THE WATER RESOURCES DEVELOPMENT OF THE LOWER DALAMAN RIVER
IN THE REPUBLIC OF TURKEY

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IN
THE REPUBLIC OF TURKEY

BASIN DEVELOPMENT PLAN
AND
FEASIBILITY STUDY OF
THE SANDALCIK PROJECT

MARCH 1966

OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN

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FOREWORD

The Government of Japan has, at the request of the Government of the Republic of Turkey, entrusted the execution of a preliminary survey for the water resources development of the Lower Dalaman River to the Overseas Technical Cooperation Agency. The Agency dispatched a survey mission headed by Mr. Y. Narita and consisted of six members.

The Agency, as an executive organ of the Government of Japan, has been performing such technical cooperation as the offer of consulting services to, dispatch of experts to and induction of technical trainees from developing countries.

Nothing would be more gratifying to us, if this report could be of any contribution to the promotion of the water resources development of the Lower Dalaman River as well as to the furtherance of the amity, friendship and economic relations between the Republic of Turkey and Japan.

March 1966

S. Shibusawa

SHIN-ICHI SHIBUSAWA
Director General
Overseas Technical Cooperation Agency

LETTER OF TRANSMISSION

Mr. Shinichi Shibusawa, President

Overseas Technical Cooperation Agency

Dear Sir:

As chief of the Survey and Study Mission for the Lower Dalaman River Basin Water Resources Development Program of the Republic of Turkey, the undersigned takes pleasure in submitting herewith the report of the surveys and studies carried out in fulfillment of its assignments.

The Mission, for seventy-five days from March 25, 1965, in consultation with the Government of Turkey, conducted surveys of the project area including topography, geology, conditions of rivers and streams, materials, and agricultural and electric power situations. Information and data necessary for preparations of development plans such as hydrologic data and information for estimation of construction costs were also gathered.

After return to Japan the Mission prepared this Report using the information and data collected, under the direction of the Chief Engineer of the Electric Power Development Co., Ltd. (EPD Consultants), and with the cooperation of the company's, experts in various fields such as planning of reservoirs and hydro-electric power, designing of dams and other hydraulic structures, planning of electric power supply, power transmission lines and substations, and agricultural development .

The Lower Dalaman River Basin Water Resources Development Program consists of building on the main Dalaman River three reservoirs, Sandalcik, Gurleik and Goktas and Asmacik Regulating Pond, which will have a total effective storage capacity of 900 million m^3 from a catchment area of approximately

5, 200 km^2 and annual run-off of approximately 1, 600 million m^3 in order to secure water sources for power generation and agriculture. By constructing four power stations; Sandalcik, Gurleik, Goktas and Bezkese, appurtenant to the reservoirs and the regulating pond mentioned above, it will be possible to obtain electric power of 327 thousand KW total output and 1, 454 million KWh annual energy production. This power transmitted approximately 300 km to the city of Izmir in the western part of Turkey, will help to supply the demand of the Western Area of which Izmir, where rapid progress in industrialization is being made, is the center. Further, the agriculture of this area will be promoted by construction of flood protection levees and irrigation and drainage facilities for the 14 thousand hectares of farmland in the Dalaman Plain. Execution of this Basin Program is estimated to require a construction period of approximately ten years and cost approximately 1, 500, 300, 000 Turkish Lira, but upon completion of the Program, an excess benefit of approximately 64, 326, 000 Turkish Lira annually may be anticipated.

It is considered economically and technically appropriate for this basin development program to be divided into three stages as stated in 1-5-1, (5). The Mission believes that for the purpose of expediting the agricultural development of the Dalaman Plain for which there is an urgent demand and of supplying the power demand of the Western Area it is of utmost importance to prepare final designs and to starts, as early as possible on the construction of Sandalcik Reservoir and Asmacik Regulating Pond which will serve as water sources for both agriculture and power generation, and the construction of Sandalcik Power Station and Bezkese Power Station including associated transmission lines and Substations (these are collectively called "Sandalcik Project" in this Report).

For the Sandalcik Project, it is estimated a construction period of approximately three and one-half years and a construction cost of approximately 735, 100, 000 Turkish Lira will be required. Of the entire Dalaman Development Program, this stage alone is expected to produce and annual excess benefit of approximately 35, 116, 000 Turkish Lira.

It is the ardent hope of the Mission that this Report will be useful in implementing the development program which forms a part of the economic development program of the Government of Turkey and that it may contribute to promoting friendly relations and economic interchange between Turkey and Japan.

The Mission takes this Opportunity to express its deepest gratitude to the officials of DSI and EIE and other agencies of the Government of Turkey and the officials of the Japanese Embassy in Turkey for their invaluable help and unselfish cooperation which have greatly facilitated the work of the Mission in conducting surveys in the field.

January 10, 1966

Y. Narita

Yutaka Narita, Civil Engineer
Electric Power Development Co., Ltd.

Chief of Survey and Study Mission,
Lower Dalaman River Basin Water
Resources Development Program,
Turkey

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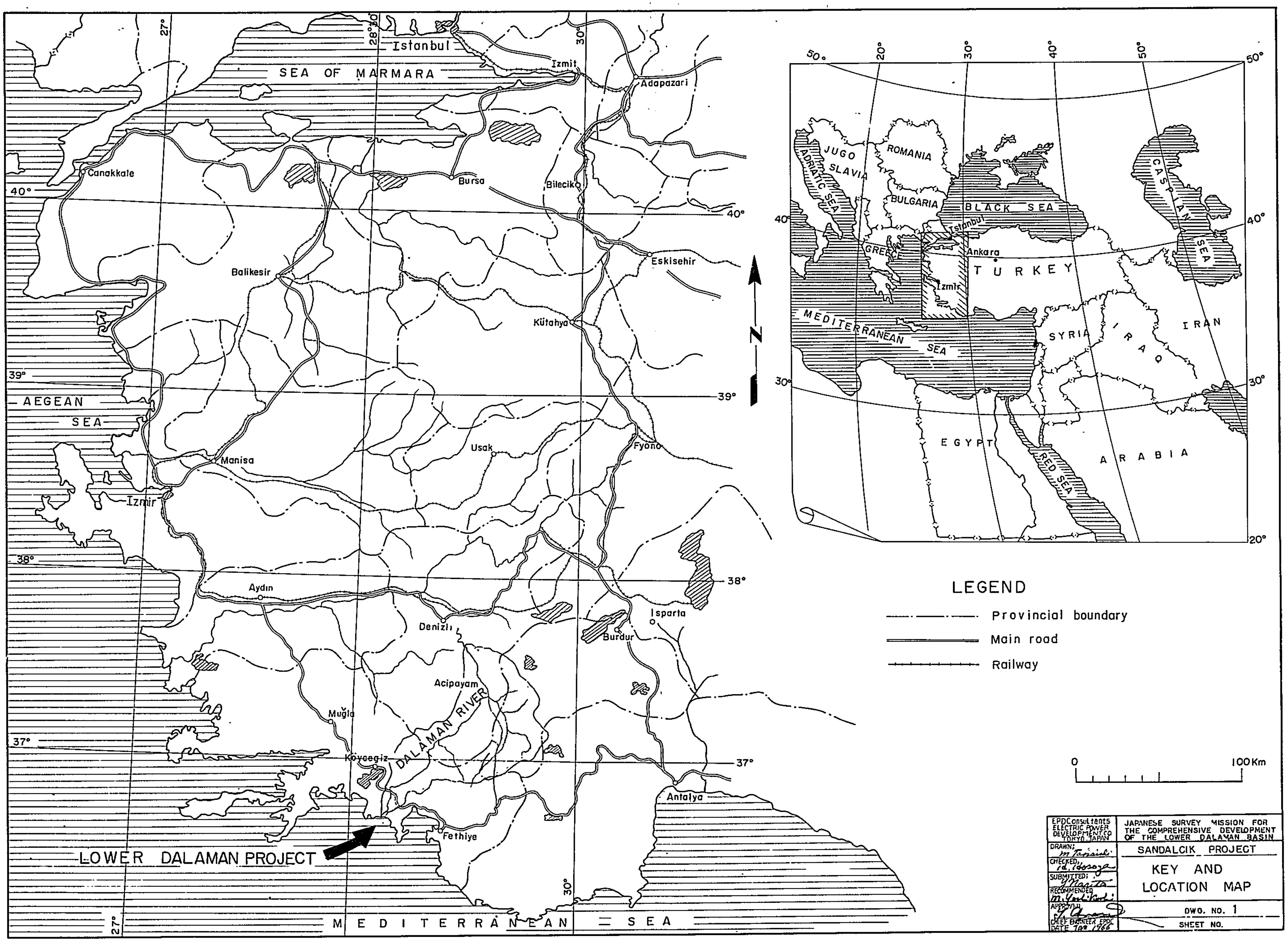
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ELECTRIC POWER DEVELOPMENT CO.
TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE
SANDALCIK PROJECT
KEY AND LOCATION MAP
DWG. NO. 1
SHEET NO.

1. SUMMARY

1-1 ANTECEDENT

At the time of the visit to Turkey by engineers of the Electric Power Development Company of Japan around the beginning of March and in July, 1964, the General Directorate of State Hydraulic Works of the Government of Turkey (hereinafter referred to as DSI) requested technical cooperation from Japan in connection with certain projects of the water resources development program which are currently being investigated in accordance with the First Five Year Plan of Turkey (1963-1967). Subsequently on October 12, 1964, the Government of Turkey formally requested the Government of Japan to despatch a survey mission in order to draw up a water resources development plan of the Dalaman River for which investigations had been continuing since 1962.

In response to this request the Government of Japan dispatched through the Overseas Technical Cooperation Agency, a six-man survey mission consisting of 5 engineers of the Electric Power Development Company and a representative of the aforesaid Agency to Turkey for a period of approximately 75 days from March 25, 1965.

The said Survey Mission conducted field surveys upon consultation with the Government of Turkey with respect to investigations and planning and returned to Japan on June 10, 1965, following which the Mission prepared in Tokyo a Report on the Lower Dalaman River Basin Development Program and the First Stage Development Program.

In addition to the members of the party, the Chief Engineer and engineers in various specialized fields of the Electric Power Development Company took part in the preparation of this Report.

1-2 PURPOSE OF THE MISSION

As stated previously, in compliance with the request made by the Government of Turkey, the Mission conducted a surveys with the purposes of studying the downstream catchment of the Dalaman River running through the southwestern part of the country, establishing a development scheme of the Lower Dalaman River Basin, establishing the order of priority of development, and making a Project Report in connection with the Sandalcik Project which ranks highest in the order of priority of development in the program for the area.

1-3 MEMBERS OF SURVEY MISSION

The members of the Survey Mission were as listed below.

	Name	Specialized Field	Company
Leader:	Yutaka Narita	Civil Engineer	Electric Power Development Comapny
Member:	Yoshio Niinomi	Coodinator	Overseas Technical Cooperation Agency
Member:	Mamoru Takaichi	Civil Engineer	Electric Power Development Company
Member:	Yozo Fukutake	Geologist	Electric Power Development Company
Member:	Tokio Jomoto	Electrical Engineer	Electric Power Development Company
Member:	Masaharu Matsui	Agricultural Engineer	Electric Power Development Company

1-4 SCOPE OF SURVEY

In order to effectively develop the water resources of the Dalaman River having a catchment area of about 5,200 km^2, this survey was conducted with the purpose of formulating a development program for the lower basin downstream of the vicinity of Mahmutlar (hereinafter referred to as the Lower Dalaman River Basin), and preparing a Project Report on the First Stage Development Program which is accorded the highest priority.

For this object, field surveys were carried out of the Lower Dalaman River Basin, and data and information on hydrology, topography, geology, materials, soils; agricultural conditions, power situation, estimates of construction cost, etc. necessary for drawing up the project were collected.

After completing these field surveys the Development Program for the Lower Dalaman River Basin was prepared in Tokyo establishing the order of development, and the First Stage Development Program which is believed to require prompt execution was also drawn up.

Out of this First Stage Development Program, technical and economic feasibilities were also studied with respect to the Sandalcik Dam and Power Station, the Asmacik Dam and Bezkese Power Station, and transmission lines and substations for which definite studies should be started. This is hereinafter referred to as the Sandalcik Project.

1-5 CONCLUSIONS AND RECOMMENDATIONS

1-5-1 CONCLUSION

This Project Report is for preparation of the Lower Dalaman River Basin Development Program and for determination of the technical and economic feasibility of the Sandalcik Project which is considered to require immediate preparations for construction.

(1) The run-off of the Dalaman River having a catchment of about 5,200 km^2 is about 1,600,000,000 m^3 annually. In order to develop this abundant water resource effectively and economically it is necessary to regulate and control the river run-off which fluctuates by season or year under present conditions and obtain a stabilized flow of water. To realize this aim, it is considered most effective to construct reservoirs in series along the Dalaman River having a combined total effective storage capacity of approximately 900,000,000 m^3.

The most economical plan for these reservoirs is to build at first the Sandalcik Reservoir, the uppermost project area with an effective storage capacity of 665,000,000 m^3 with a high water level at Elavation 705 m, next the Gürleik Reservoir with an effective storage capacity of 115,000,000 m^3 with a normal water surface level at Elevation 270 m, followed by the Goktas Reservoir with an effective storage capacity of 120,000,000 m^3 with a normal high water surface level at Elevation 145 m, and finally the most downstream Asmacik Regulating Pond with an effective storage capacity of 2,200,000 m^3 with a normal high water surface level at Elevation 71 m.

By means of the construction of these reservoirs a firm discharge of about 41 m^3/s (at the Asmacik Site) can be secured throughout the year.

(2) Appurtenant to the reservoirs and regulating pond, power stations at Sandalcik, Gürleik, Göktas and Bezkese are planned to be constructed to produce cheap and abundant power. These plants will have a combined total output of 327,000 KW and annual energy production of 1,454,000,000 KWh, fully utilizing a total head of 675 m between the normal high water surface level of 705 m at the Sandalcik Reservoir and the tailrace water level of 30 m at the Bezkese Power Station farthest downstream. Power generated and transmitted over a total distance of approximately 280 km to Izmir, will constribute to the development of the western area centering around Izmir where industrialization is now in progress.

(3) For the purpose of the agricultural development in the Dalaman plain, the following measures should be taken:

a. Construction of reservoir to secure irrigation water and establishment of the new irrigation system.

b. Construction of the new drainage system to solve the problems of surface drainage in winter and lower the ground water table below 1.2 m or more from the ground surface through the year.

c. Construction of the facilities to protect the Dalaman plain from floods.

d. Improvement of Road net in the Dalaman plain.

e. Establishment of an agricultural and animal hasbandry center to introduce and generalize new techniques.

By the achievement of this Program, agriculture in this project area can develop from the one-cotton-crop-per-year farming to progress towards intensive use of land and as a result the agricultural productivity in this project area will materially advance.

(4) In order to execute the project in this basin, a construction period of about 10 years (from 1967 to 1976) and an investment of approximately 1,500,300,000 T.L will be required.

The annual cost (C) and benefit (V) ensuing from the above investment are estimated at 102,910,000 T.L and 167,236,000 T.L respectively and therefore, an annual excess benefit (V-C) of 64,326,000 T.L can be anticipated.

(5) The order of development of the Program divided into the following 3 stages, is concluded to be most economical and technically most appropriate.

First Stage Program:

Construction of Sandalcik and Asmacik Dams

Construction of Sandalcik and Bezkese Power Stations

Construction of transmission lines and sub-station

Agricultural development of the Dalaman Plain

Second Stage Program:

Construction of Gürleik Dam and Gürleik Power Station

Construction of sub-stations

Third Stage Program:

Construction of Göktas Dam and Göktas Power Station

Of the above, early realization of the First Stage Program is highly desirable. In order to promote agricultural development of the Dalaman Plain and to comply with the power demand from the western area, necessary preparations for immediate commencement of works must be made to start partial operation of power stations on the Dalaman River by the end of 1970.

For this purpose further detailed studies should be started immediately.

The commencement dates of the works for the Second and Third Stage Programs should be decided in relation to the growth rate of power demand in the western area.

(6) Of the agricultural development plan of the Dalaman Plain included in the First Stage Program, the flood protection plan and irrigation and drainage plan require supplemental survey to support the reliability of feasibility study. In view of the fact that construction of the Sandalcik Reservoir will require quite a long period of time, and since it is inconceivable that there will be any change in the basic plan or scale or other factors of the Sandalcik Reservoir and Asmacik Regulating Pond as a result of the above supplementary survey for the agricultural development project early construction of the Sandalcik Reservoir, the Asmacik Regulating Pond which will serve as a regulating pond at the most downstream point and as an intake as well, and the two power stations of Sandalcik and Bezkese are recommended to obtain generating capacity of 161, 000 KW, which will produce 867, 600, 000 KWh of energy annually. Furthermore, by the construction of transmission lines and sub-station, the power thus generated can be sent to Izmir and even before completion of the First Stage Program great benefits can be expected as described in the paragraph below.

(7) The dam and power station included in the Sandalcik Project will require a construction period of about three and a half years (1967 through 1970). The annual cost (C) and benefit (V) from a total investment of about 735, 100, 000 T. L will be 54, 501, 000 T. L. and 89, 617, 000 T. L respectively and therefore, an annual excess benefit of 35, 116, 000 T. L can be expected. With benefit-cost ratio of 1. 64, this project can be termed to be highly economical.

Also, extremely cheap power, costing about 0. 065 T. L/KWh at the Izmir Primary Sub-station, will become available.

(8) The above values are estimates on the basis of the entire costs of common facilities for irrigation (dam) and power generation being borne by power only. However, when the First Stage Program is completed with the com-

pletion of the Dalaman Plain agricultural development project the annual cost and benefit from the total cost of about 987, 100, 000 T. L are estimated to be at 73, 060, 000 T. L and 110, 676, 000 T. L respectively and therefore, an annual excess benefit of about 37, 616, 000 T. L can be expected. Benefit-cost ratio in this case is estimated to be 1. 52.

In case the cost of common structure (dams) is allocated in proportion to the respective excess benefits, the annual cost and benefit from the total investment of about 269, 980, 000 T. L for the agricultural development project will be 19, 603, 000 T. L and 21, 059, 000 T. L respectively, and excess benefit of 1, 456, 000 T. L with a 1. 07 benefit-cost ratio can be expected.

Also, the annual cost and benefit from the total investment of about 717, 120, 000 T. L for the power development plan in this case will be 53, 457, 000 T. L and 89, 617, 000 T. L respectively and an excess benefit of about 36,160, 000 T. L with benefit-cost ratio being 1. 68 can be expected. The power cost at the Izmir Primary Sub-station will be about 0. 064 T. L/KWh, slightly lower than that before allocation of cost of common structures.

(9) The works comprising a substantial part of the Sandalcik Project and also governing its construction period are the construction of Sandalcik Arch Dam, which is approximately 145 m high and contains about 490, 000 m^3 of concrete, and Sandalcik Power Station (underground type) with a generating capacity of 150, 000 KW. In order to complete these works by the end of 1970 it would be necessary to carry out definite studies and finish a part of preparatory works between 1966 and 1967, and start the main works in 1967.

As proposed sites for the Sandalcik Dam, two locations, upper and lower sites, were considered, but because of faults on the left bank and incomplete survey of the right bank of the lower site, the upstream site is taken up in this Report for the reasons that the upstream area has less problems geologically than the downstream site and it is technically easier to plan with reliability. However, as there is the possibility of constructing a dam with greater economy at the downstream site, further thorough geological investigation for final selection of the dam site along with a definite study of the entire project will be necessary. Therefore, there is the possibility of improving the economy of the project.

1-5-2 RECOMMENDATIONS

As described in the foregoing paragraphs, the Lower Dalaman River Basin Development Program is highly economical and will make tremendous contributions towards the economic progress, not only of the western area, but also of Turkey as a whole through improvement of social and economic conditions in the project area and also through improvements in living standards of the inhabitants.

In view of the power demand of the western area, this project should be scheduled so that partial operation of the Sandalcik Power Station can be started by the end of 1970 at the latest. It is also recommended to start necessary preparatory works as promptly as possible to expedite the agricultural development of the Dalaman Plain. Of the works in the First Stage Program, there is the definite study on hydraulic structures and power generation and associated facilities which must be commenced as soon as the run-off observation, surveying and geological and material surveys, described in detail in chapter 6-4 Future Surveys, have been completed. Along with the above, the next stage of survey for the agricultural development program is recommended to be started promptly upon completion of supplemental investigations in connection with the feasibility studies of the flood protection, irrigation and drainage plans.

1-6 STATISTICAL SUMMARY

1-6-1 BASIN PLAN

Reservoir Plan:

	Sandalcik	Gurleik	Goktas	Asmacik	Total
Catchment Area (km^2)	3, 970	4, 510	4, 770	4, 780	
Annual Inflow (million m^3)	939. 9	1, 340. 6	1, 541. 7	1, 543. 6	

	Sandalcik	Gurleik	Goktas	Asmacik	Total
Normal High Water Surface Level (m)	705	270	145	71	
Reservoir Surface Area (km^2)	21.2	3.8	6.5	1.2	32.7
Total Storage Capacity (million m^3)	965	160	195	11.7	1,331.7
Effective Storage Capacity (million m^3)	665	115	120	2.2	902.2
Available Drawdown (m)	43	40	25	2	

Power Generation Plan:

	Sandalcik	Gurleik	Goktas	Bezkese	Total
Standard Intake Level (m)	698	258	133	71	
Tailrace Water Level (m)	270	145	71	30	
Standard Effective Head (m)	398	110	60	35	
Maximum Discharge (m^3/s)	44.3	107.0	129.5	36.5	
Maximum Output (MW)	150	100	66	11	327
Annual Energy Production (million KWh)	786.6	348.9	230.3	87.5	1,453.6

Transmission Line and Sub-station Plan:

Transmission Line: Sandalick P.S. to Bezkese S.S.:
39 km, 154 KV, 1-2 circuits.

Bezkese S.S. to Izumir S.S.:
240 km, 380 KV, 1 circuit.

Sub-station: at Bezkese and Izmir

Flood Protection Plan:

Dalaman River Levee:

Design Flood Discharge: 1,700 - 2,100 m^3/s

Total Length of Levees: 30 km

Tersakan New Waterway:

Design Flood Discharge:	400 m^3/s
Total Length:	8 km

Tersakan-Kargin:

Design Flood Discharge:	220 m^3/s
Total Length of Levees:	18 km

Mergenliözü-Sarisu:

Design Flood Discharge:	240 m^3/s
Total Length of Levees:	14 km

Irrigation and Drainage Plan:

Project Area:	14,000 ha
Maximum Water Requirement:	27.4 m^3/s
Unit Drainage Capacity:	plain 0.7 $m^3/s.km^2$ mountain 2.6 $m^3/s.km^2$

1-6-2 FIRST STAGE PROGRAM

The outline of the works included in the First Stage Program is as follows:

a Water Sources for Irrigation and Power Generation and Intake Facilities:

Sandalcik Dam:

Dam:

	Main Dam	Saddle Dam
Type:	concrete, arch dam	center impervious core, rock fill dam
Height:	145.00 m	40.00 m
Crest Length	384.00 m	760.00 m
Volume Content:	490,000 m^3	720,000 m^3

Spillway:

Type:	center overflow with gates
Capacity:	2,600 m^3/s.
Gate:	tainter gates, 3 sets (10.50 m x 10 m)

Asmacik Dam:

Dam:

Type:	center impervious core, gravel-fill dam
Height:	25.00 m
Crest Length:	250.00 m
Volume Content:	420,000 m^3

Spillway:

Type:	overflow type with gates
Capacity:	5,700 m^3/s
Gate:	tainter gates, 7 sets (10.50 m x 12.00 m)

b. Power Generation Facilities:

Sandalcik Power Station:

Waterway:	Pressure Tunnel	Tailrace
Type:	circular shape	Standard horseshoe shape
Length:	3,850 m	6,430 m
Inside Diameter:	4.50 m	4.60 m

Power Plant:

Type:	underground
Installed Capacity:	150,000 KW
Number of Units:	75,000 KW x 2 sets
Annual Energy Production:	786,600,000 KWh

Bezkese Power Station:

Waterway:

Type:	Pressure tunnel, standard horseshoe shape
Length:	3,040 m
Inside Diameter:	4.20 m

Power Plant:

Type:	above ground
Installed Capacity:	11,000 KW
Annual Energy Production:	81,000,000 KWh.

c. Transmission Lines and Sub-stations:

Transmission Lines:

Section:	Length	Voltage	Conductor
Sandalcik-Bezkese:	39 km	154 KV	410 mm^2
Bezkese-Izmir:	240 km	380 KV	410 mm^2 (double)

Sub-stations:

Location:	Voltage	Capacity
Bezkese:	154 KV/380 KV	200 MVA (ultimate 400 MVA) auto-transformer
Izmir:	380 KV/154 KV	"

d. Flood Protection and Irrigation and Drainage Facilities for Dalaman Plain:

Flood Protection Facilities:

Dalaman River Levee:

Total Length of Levees:	30 km
Earth Embankment:	1,500,000 m^3

Tersakan New Waterway:

Total Length:	8 km
Earth Works:	1,200,000 m^3

Tersakan-Kargin:

Total Length of Levees:	18 km
Earth Works:	545,000 m^3

Mergenliözü-Sarisu:

Total Length of Levees:	14 km
Earth Works:	355,000 m^3

Irrigation and Drainage Facilities:

Total Length of Main Canals:	80 km
Design Discharge Capacity:	15.7 - 0.2 m^3/s
Total Length of Laterals:	272 km
Design Discharge Capacity:	0.3 - 0.1 m^3/s
Pumping Stations:	3
Total Length of Main Drainage Canals:	90 km
Design Discharge Capacity:	6 - 70 m^3/s
Total Length of Branch Drainage Canals:	166 km
Design Discharge Capacity:	0.1 - 0.9 m^3/s
Drainage Pump Station:	6
Area of Readjusted Fields:	14,000 ha

Others:

Bridges:	2

e. Construction Costs:

Sandalcik Dam and Power Station	447,000,000 T.L
Asmacik Dam and Bezkese Power Station	104,000,000 T.L
Transmission Lines and Sub-stations	184,100,000 T.L
Sub-total	735,100,000 T.L
Flood Protection, Irrigation and Drainage Facilities	252,000,000 T.L
Sub-total	252,000,000 T.L
Grand Total	987,100,000 T.L

1-7 REFERENCE DATA AND SYMBOLS

1-7-1 REFERENCE DATA

The basic data and references used in planning of this Development Program were made available by DSI, EIE and the Meteorological Bureau of the Government of Turkey. Principal basic data and references used are as follows:

With respect to Geographic Map:

1) Aerial Photo Maps: 1/800,000 for entire Turkey
   1/200,000 for entire Dalaman River Basin
   1/25,000 for Lower Dalaman Riber Basin
   1/5,000 for Lower Dalaman River Basin along River

2) Topographic Map: 1/1,000 for dam site areas of Sandalcik and Asmacik Dam

With respect to Meteorology and Hydrology:

Temperature, humidity, daylight hours, precipitation, run-off, wind velocity and evaporation of the Dalaman River basin and its vicinity

With respect to Geology:

1) Dalaman havasi jeologisi ve Aşaği Dalaman projesi iteilgili mühendislik jeologisi raporu. (DSI 1965)
2) Dalaman-Sandalcik baraj yeri temel sondajlari jeoloji raporu (EIE 1965)
3) Dalaman-Göktas baraj yeri temel sondajlari jeoloji raporu (EIE 1965)
4) Dalaman-Asmacik baraj yeri temel sondajlari jeoloji raporu (EIE 1964)
5) Additional Boring Result of Sandalcik Dam Site

With respect to Electricity:

1) Seventh Annual Electric Survey 1964 (A report of EIE)
2) Statistics of Electric Power in Turkey 1961
3) Electrification Plan of Turkey (beginning of 1965)
4) First Five Year Development Plan 1963-1967
5) Memorandum II (Received from EIE)

With respect to Agriculture:

1) Aşaği Dalaman Project

   Dalaman Plain Planning Land Classification Report (DSI)

2) Aşaği Dalaman Project

   Agricultural Economy Planning Report (DSI)

3) Aşaği Dalaman Project

Dalaman Plain Drainage Report (DSI)

4) A Soil Survey of the Koyceğiz-Dalaman Area

(by Dr. L. J. Pons and Prof. Dr. C. H. Edelman)

5) Agricultural Structure and Production 1959-1961

(by State Institute of Statistics)

6) Monthly Bulletin of Statistics Dec. 1964

(by State Institute of Statistics)

7) Summary Report of Flood Damage in Dalaman Plain (DSI)

8) Ege bölgesinde yetiştirilen mahsullerin

Yetiştirme teknigi ve maliyetleri

(by Ege bölgesi sulu ziraat araştirma enstitüsü müdürlüzü)

With respect to Materials:

Test results of materials for construction of Sandalcik and Asmacik Dam

With respect to Indemnifications:

Property to be submerged and indemnification costs in connection with Sandalcik and Goktas Reservoirs

Others:

1) Economic data, Standard unit costs of construction

2) Summary Report of Lower Dalaman Projects

3) Survey Report on the areas adjacent to the Dalaman River

1-7-2 SYMBOLS

The abbreviations used in this Project Report are as follows:

m	meter(s)
km	kilometer(s)
cm	centimeter(s)
mm	millimeter(s)
m^2	square meter(s)

km^2	square kilometer(s)
cm2	square centimeter(s)
mm	square millimeter(s)
ha	hectare(s)
m^3	cubic meter(s)
g	gram(s)
kg	kilogram(s)
t	metric ton(s)
m/s	meter(s) per second
m^3/s	cubic meter(s) per second
m^3/s-day	cubic meter(s) per second-day
	(1 m^3/s day = 86, 400 m^3)
KW	kilowatt(s)
MW	megawatt(s)
MVA	mega Volt Ampere
KV	kilovolt(s)
KVA	kilovolt Ampere
KWh	kilowatt hour(s)
T.L	Turkish Lira(s)
Krs	Krush(s)
$	U.S. dollar(s)
¢	U.S. cent(s)
¥	yen(s)

1-7-3 CONVERSION RATES

1 $: 9 T.L

1 T.L : 100 Krs

1 T.L : 40 ¥

1-7-4 DEFINITION

The dependable capacity of a power station is the average of the minimum peak output of December of each year.

2. GENERAL DESCRIPTION OF PROJECT AREA

2. GENERAL DESCRIPTION OF PROJECT AREA

2-1 LOCATION

Turkey consists of what is called Asian Turkey, the Anatolian Peninsula projecting between the Black Sea and the Eastern Mediterranean from the western end of the Asian continent, and Eastern Thrace, in the southeastern part of the Balkan Peninsula, which is called European Turkey. Its total area is 767, 119 km^2, of which Asian Turkey accounts for 743, 634 km^2 and European Turkey for 23, 485 km^2.

The entire country is situated between 25°40'E and 44°48'E and between 35°49'N and 42°06'N. It borders on the Black Sea in the north, the Soviet Union in the northeast, Iran in the east, Iraq in the southeast, Syria and the eastern Mediterranean Sea in the south, the Aegean Sea in the west and Greece and Bulgaria in the northwest. The project area, which is situated in the southwestern part of Turkey, covers five prefectures; Izmir, containing the city of Izmir which is the third largest city in Turkey, Manisa, Aydin, Muğla and Denizli.

The Dalaman River flows about 220 km southeast of Izmir. Its catchment basin extends between 28°41'E and 29°47'E and between 36°42'N and 37°42'N, covering an area of about 5, 200 km^2. The total length of this river is about 190 km.

2-2 TOPOGRAPHY AND GEOLOGY

2-2-1 TOPOGRAPHY

The Anatolia region of Turkey is surrounded by sea in the north, west and south. Mountain ranges run almost parallel with the seacoasts. Between the mountain ranges and the coasts are strips of coastal plains which also stretch inland along rivers. There are a larger number of plains along the Aegean coast than along the coast of the Black Sea. Mountain ranges are low in the west and high in the east, and among them are peaks higher than 4, 000 m in elevation. Inside this mountain range lies a vast plateau which is around 1, 000 m above sea level.

The Taurus Mountains in the southwestern part of Turkey is the source of many rivers flowing southward emptying into the Mediterranean Sea. The Dalaman is the largest of these rivers, flowing over a distance of about 190 km and draining an area of about 5,200 km^2. The river has its source at Mt. Kerkeli and Mt. Kapakli and flows slightly northward from this source and is called the Horzum River in this section. It then flows into the Acipayam Plateau, is joined by the Gaudir River, turns northwestward, and flows through the Acipayam Plateau. At a point about 9 km southeast of Acipayam, it changes its course in a southwestern direction from which point it is called the Kirenis River. After this, while absorbing small tributaries, the river reaches Suçati. The river is called the Dalaman after it is joined by the Tahtaci Stream which is one of the tributaries on the left bank. The Dalaman flows rapidly through deep ravines surrounded by such mountains as Kizileagil, Cal, Sandras and Bayram down to Asmacik. Later, it meanders through the Dalaman Plain and flows into the Mediterranean Sea.

The uppermost part of the Dalaman Basin is a wooded and mountainous region 2,000 m to 2,500 m above sea level and with relatively great precipitation. The Acipayam Plateau, 900 to 1,000 m above sea level, and constituting the midstream part of the basin, however, has slight precipitation and is only partially cultivated. Most of this part is grassland or marshy ground with few trees. Along the river banks are a considerable number of terraced lands almost all of which are under cultivation. The downstream basin, which begins at Suçati, is mountainous and has relatively large precipitation. It is covered with latifoliate or conifer trees (mostly pine forests), and bare land is relatively scarce. Where the stream is rapid, rocks are exposed on the river bed. Landslides occur frequently at many places along the river, and deep deposits of sand and gravel can be seen in regions downstream of Göktas. Most parts of the Dalaman Plain, which constitutes the lowest part of the Dalaman Basin, are under cultivation. Some parts which are susceptible to floods due to poor drainage, however, are grasslands or waste land.

2-2-2 GEOLOGY

The geology of Turkey consists of Paleozoic, Mesozoic and Tertiary formations which belong to the Alpine orogenic zone. The whole of Turkey geotectonically can be divided into the following four regions:

Region	Sphere	Geology
Northern Anatolia	Pontids mountain system including the Marmara and northeastern Aegean Sea regions	Consists mainly of Paleozoic sedimentary rocks; there is also a penetration of igneous rocks; folding is marked.
Inner Anatolia	Central and western parts of Anatolia	Consists of sedimentary rocks, from Paleozoic to Tertiary formations, and thermal metamorphic rocks; Igneous activities from Cretaceous to Paleogene are particularly conspicuous.
Southern Anatolia	Mountain range and the southern region along the coast of the Mediterranean	Consists of Paleozoic, Mesozoic and Tertiary deposits.
Southeastern Anatolia	Regions along the eastern border	Deepest in the Alpine geosyncline; consists of continuous

Region	Sphere	Geology
		deposits from Paleozoic to Tertiary; new Tertiary folds are remarkable.

The project area belongs to the Inner Anatolia geotectonic zone, and the geology consists of metamorphic and sedimentary rocks of Paleozoic, sedimentary and igneous rocks of mesozoic and sedimentary rocks of the Tertiary and Quaternary periods.

Paleozoic metamorphic rocks are distributed widely in the regions lying north to northwest of the line drawn from Milas to Denizli via Yatağan. The southern edge of this region is featured by the presence of Paleozoic sedimentary rocks. Mesozoic sedimentary rocks are found in the south of the Paleozoic formation. They are distributed in the zone running from Bodorum to Tavas via Muğla and in the zone from Datça and Bozburun to Lake Bordur via Fethiye. Mesozoic igneous rocks are distributed between these two zones. The Tertiary and Quaternary formations dot the regions between the Paleozoic and Mesozoic formations. Most of them, however, are distributed widely in the inland region and along the rivers. Following is an outline of the geology in the Dalaman River Basin:

The Quaternary period consists of talus deposits, river deposits and terrace deposits. It is widely distributed in the Acipayam plains, both banks of the Hüseyin which is a tributary of the Dalaman, and in the lower part of the Dalaman River. These deposits consist of earth, sand, clay, silt and gravel, and are not consolidated. The river terrace deposits seen near Karakol village in the midstream part of Dalaman River, however, are consisderably well cemented.

Rocks of Neogene consist of marl, conglomerate, mudstone, chalk and limestones. They are widely distributed in the upstream part from the point where the Dalaman is joined by the Hüseyin tributary. Marl and limestone are yellowish gray or gray in color and are consolidated, but become somewhat softened when they absorb water. Conglomerate and mudstone are brown or red brown and are soft. Chalk is white but not pure in content. In most cases, it is chalk containing chalky marl or sand or silt and is soluble in water. Besides, there are also thin layers of sandstones and tuffite both of which are not so hard. All these neogene formations are assumed to be lucustrine sediments.

Mesozoic rocks are limestone, peridotite and schist. Limestones can be found everywhere, in the form of great mass, across the upper and middle part of the Dalaman. It can be supposed that these great mass were huge xenoliths surrounded by peridotites in the period of lively igneous activity. Peridotites are widely distributed from the upper to lower part of the Dalaman. Schist is distributed in limited areas near Sandalcik and Inbaşi.

Limestones are of two kinds; massive and bedded. Both are gray or dark gray in color and are hard, but cracks are highly developed. In many cases, the contacts with peridotites are accompanied by sheared zones. Peridotites are red brown on the surface of the ground, but are green or dark green deep beneath the ground. They are all hard. Serpentinization is marked. At many places from the middle to the upper part of the Dalaman river can be seen landslides and landcreeps of large scale. Schist is comprised of lime or marl schist and green schist. All are soft and show marked weathering on the surface of the ground.

2-3 METEOROLOGY AND HYDROLOGY

2-3-1 GENERAL OF WEATHER

Along the northern and southern seacoasts of Turkey are mountain ranges about 3,000 m high. Between these ranges lies the well-known Anatolian Plateau (average elevation, 800 m). The country is surrounded by the Black Sea in the north, the Mediterranean Sea in the south and the Aegean Sea in the west.

Accordingly, Turkey can roughly be divided into the following four zones so far as weather conditions are concerned: Black Sea Coast Zone (Northern Coastal Zone); Aegean Sea Coast Zone (Western Coastal Zone); Mediterranean Coast Zone (Southern Coastal Zone); and Central Plateau Zone (Anatolian Plateau). Seasonal periods differ slightly according to regions. In general, however, one year can be divided into four seasons; winter from December through February, spring from March through May, summer from June through August, and autumn from September through November. Following are outlines of the weather in each zone:

(1) Black Sea Coast Zone (Northern Coastal Zone)

This zone has the greatest precipitation in the country. It has precipitation throughout the year, especially heavily in winter. The mountainous regions of this zone are covered with snow as deep as 2 m. The annual precipitation ranges from 1,000 to 2,000 mm on the average, and reaches more than 3,000 mm at some places. The temperature is generally low, and in winter drops to -5° to -10°C in the coastal districts and to -15°C in the mountainous districts. Even in summer, the temperature does not rise beyond 25°C.

(2) Aegean Sea Coast Zone (Western Coastal Zone)

This zone, which is exposed to oceanic influences throughout the year, has one-half of the annual precipitation in winter alone. The annual precipitation is about 500 mm in the coastal districts and about 1,000 mm in the mountainous districts. Also the mountains higher than elevations of 1,500 m are covered with snow. The temperature goes down to about -5°C in winter and rise above 30°C in summer.

(3) Mediterranean Coast Zone (Southern Coastal Zone)

This zone is featured by so-called Mediterranean climate. It has rainy weather mainly from the end of autumn to the beginning of spring, and the annual precipitation is 500 to 1,000 mm on the average. On the southern slope of the Taurus Mountain Range, however, it reaches 1,000 to 2,000 mm. The highlands are covered with snow throughout winter. In winter and spring when this zone is on the northern side of the Cyprus low pressure zone, the strong winds known as Bora (winter) and Fohn (spring) blow through this zone, causing a reduction in humidity. This zone is mild in winter because it is sheltered by the Taurus Mountain Range which stands as a barrier to the southerly advance of cold air currents. The highest temperature in winter is 14° or 15°C and the lowest is 4° to 6°C. At some places, however, it goes down to about -5°C. There is scarcely any precipitation from spring to the beginning of fall, and it is very hot in summer. The temperature from June through September goes up above 30°C in the daytime, and sometimes exceeds 40°C:

(4) Central Plateau Zone (Anatolia Plateau Zone)

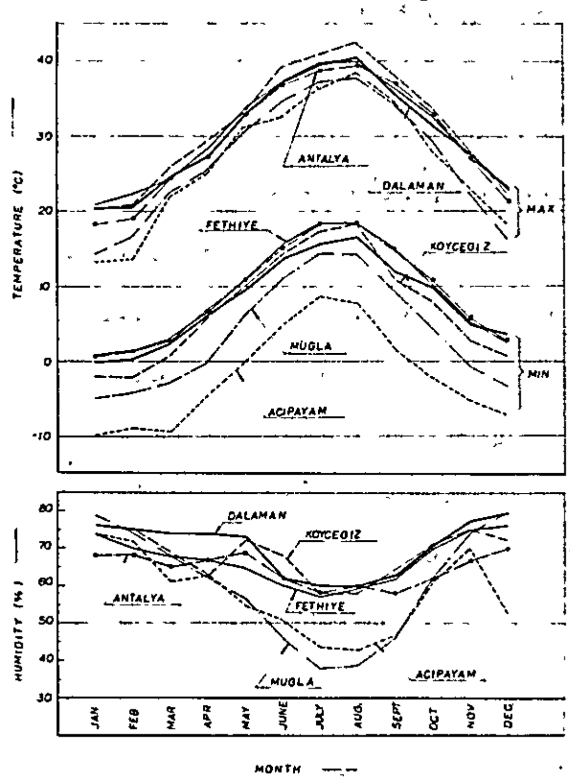
This zone has a continental climate. The precipitation is the least in the country and is almost limited to winter. The annual precipitation is less than 500 mm in general. Especially in the districts around Lake Tuz, it is less than 300 mm. Snow does not stay on the ground very long in the western part, but in the eastern part it is as deep as 1.5 m in winter. The high mountains are covered with snow all the year round. The seasonal fluctuation in temperature is very great. The temperature drops to 5°C even in the daytime and to -10°C to -15°C at night in winter, but rises to 30°C to 35°C in the daytime in summer.

2-3-2 GENERAL OF METEOROLOGY AND HYDROLOGY IN THE DALAMAN RIVER BASIN

Meteorologically, the upper Dalaman reaches belong to the Central Plateau Zone and the lower part to the Mediterranean Coast Zone. Accordingly, the annual precipitation is about 600 mm in the upper part and about 1,200 mm in the lower. Roughly, the drought season lasts from April through September and the rainy season from October through March. The highest and lowest temperatures and the average monthly humidity are shown in Fig. 2-3-1. In this chart, the temperature and humidity at Acipayam reflect those in the Central Plateau Zone and those at Dalaman, Köyceğiz and Fethiye are indicative of those in the Mediterranean Coast Zone.

As for the outflow, there is a clear difference between the upper and lower parts of the river. The mean annual specific run-off in the upper part is 0.5 $m^3/s/100\ km^2$, as against 2.5 $m^3/s/100\ km^2$ in the lower basin. The ratio between the outflow in the drought season and that in the rainy season is about 1:3.

Fig. 2-3-1 Variation of Monthly Temperature and Humidity



2-4 TRANSPORTATION AND COMMUNICATIONS

Turkey stretches across the Asian and European continents and faces the Black Sea and the Mediterranean Sea. Therefore, it has been an important center of traffic since ancient times.

Railroads connect the major cities of the country and the total length in 1960 was about 7,900 km. Trunk lines extend to Europe and Asia.

The total length of roads is about 50,000 km, and about 15% are paved with asphalt.

Marine transportation is an important factor in Turkish economic life, and there are many good harbors such as Istanbul and Izmir.

As for civil aviation, there are many international airlines which service the country, and there is a network of domestic airlines covering almost all of the important cities in the country.

In the southwestern part of the country, railroads, airways and navigation courses reach out from Izmir which is the economic center of this region. To the Dalaman Basin there is one road which leads from Izmir to Fethiye. Fethiye on the lower part of the Dalaman River is an excellent natural harbor where vessels of 10,000-ton class can be accommodated.

There is a network of telegraph and telephone services covering the major cities which is connected with international services.

2-5 POPULATION

The population of Turkey has been increasing during the past 30 years. Especially recently, the rate of increase is about 3% yearly. Population increase must be taken up as an important factor in formulating economic development plans for Turkey in the future. Following is a table of population statistics since 1927.

Table 2-5-1 Population of Turkey 1927 - 1960

	1927	1935	1940	1945	1950	1955	1960
Total Population (10^3)	13,648	16,158	17,821	18,790	20,947	24,065	27,830
Rate of annual increase (%)		.19	1.6	10.7	2.20	2.82	2.95
Male Population (%)	48.1	49.1	49.9	50.3	50.3	50.8	51.1
Rural Population (%)	82.2	80.1	79.0	78.7	78.2	74.4	71.3
Active Population (Aged 15 Above)					10,020	11,620	13,200
Population of West Region					3,022	3,440	3,938

Source: Prime Ministry of the Republic of Turkey; First Five-Year Development Plan, Section I.

As can be seen from this table, there is an exodus of population from agricultural regions to the cities. The rate of population increase in the cities is about 6% a year, as against about 2% in rural regions. Population increase in

Turkey is expected to follow the present trend, and the future population envisaged in the First Five-Year Development Plan is as follows:

Table 2-5-2 Population and Composition of Population 1960 - 1985

Population 10^3	1960	1965	1970	1975	1980	1985
High Fertility	27,830	31,996	36,697	42,558	49,947	59,162
Medium Fertility	27,830	31,936	36,401	41,579	47,744	55,016
Low Fertility	27,830	31,936	36,106	40,635	45,701	51,313
Active Population Ratio (%)						
High	53.6	53.0	53.5	53.6	52.9	52.2
Medium	53.6	53.0	54.0	54.9	55.3	55.6
Low	53.6	53.0	54.5	56.2	57.8	59.1

The figures in this table will have to be modified according to the population policy to be taken by the Turkish Government in the future. In any case, however, it must be expected that the rate of population increase in Turkey will remain considerably high.

The population of the southwestern region accounts for about 14 per cent of the total population of Turkey and was 3,928,000 in 1960. Because of its favorable geographic conditions, this region is expected to show great development in the future. Accordingly, its population, too, should greatly increase. Izmir, which is the principal city in this region, had a population of 371,000 in 1960.
It is the third largest city in Turkey following Istanbul and Ankara and is the political and economic center of the southwestern region.

2-6 INDUSTRIES AND ECONOMY

2-6-1 NATURAL RESOURCES

Turkey has few mineral resources. It produces small quantities of chrome ore, hard coal, lignite, iron, copper and salt. Besides there are very limited amounts of sulphur, mercury, lead, zinc, manganese ore, antimony and silver. Following is a table of mineral reserves and production:

Table 2-6-1 Mineral Reserves and Mineral Production 1961.

Minerals	Estimats of Reserves Weight (10^3 tons)	Production	
		Weight (10^3 tons)	Value (10^6 TL)
Hard coal	1,500,000	3,771	437.7
Lignite	847,000	2,609	90.8
Iron	85,000	840	58.8
Chrome	60,000	400	102.0
Copper	20,000	723	13.3
Lead	300	6	1.4
Bauxite	150,000	55	17.1
Manganese		40	9.7
Sulphur		31	1.5
Pyrites	8,700	116	11.0

Source: Prime Ministry of the Republic of Turkey First Five-Year Development Plan; Section VI.

The southwestern region produces iron, chrome and bauxite ores. Besides these, Turkey has forest and marine product resources.

2-6-2 ECONOMY

Turkish economic life at present is supported by agriculture. The agricultural population accounts for 70% of the total population of the country, and agricultural income account for 40% of gross national income. With modernization of a country, the weight of agriculture in economic life gradually decreases and agriculture becomes a secondary industry, but promotion and development of this industry will still be an important problem. The following table shows the sources of national income in Turkey.

Table 2-6-2 Share of Agriculture Industry and Services in National Income

		1927	1938	1948	1950	1958	1961
Agriculture	(%)	67	48	53	52	44	42
Industry	(%)	10	16	14	16	22	23
Services	(%)	23	36	33	32	34	35
National Income	(%)	100	100	100	100	100	100

	1927	1938	1948	1950	1958	1961
Per Capita Income (1938=100)	65	100	69	101	129	125
Gross National Product (10^6 TL)			10,067.0	10,384.3	36,108.8	49,213.0

Source: Prime Ministry of the Republic of Turkey, First Five-Year Plan. Section I.

Note: GNP is Current prices.

Turkey has been pursuing a 15-year development plan since 1963, with the following figures as goals:

Table 2-6-3 15-Year Targets of Planned Development

	1962	1967	1977	Remarks
Gross national Products (10^9 TL)	52.7	73.9	145.3	7% Growth Rate
Agriculture Proportion in GNP (%)	43.8	38.3	29.4	
Distribution of Active Population				
Agriculture (%)	77.4	71.1	58.1	
Industry (%)	9.8	11.9	15.6	
Services (%)	12.8	17.0	26.3	
Some Production Targets				
Transportation (ton/passenger km)	18.6	29.2	45.6	
Irrigation (10^3 hectares)	1,000	1,500	3,000	
Energy (10^6 tons of coal)	19.8	27	43	
Petroleum (10^3 tons)	3,314.8	4,780	9,955	
Cement (10^3 tons)	2,450	3,593	6,350	
Irion and Steel (10^3 tons)	560	885	1,600	
Artificial Fertilizers (10^3 tons)	325	1,263	2,843	
Cotton Fibres (10^3 tons)	128	160	250	
Wool Fibres (10^3 tons)	36	40	48	
Artificial Fibres (10^3 tons)	4	6	13	
Paper (10^3 tons)	101	140	200	

Source: Prime Ministry of the Republic of Turkey First Five-Year Plan Section II.

At present, the First Five-Year Plan (1963-1967), which is based on the said 15-year plan, is in force. This plan aims at a drastic economic development of the country, with the rate of economic growth fixed at 7% annually. The actual rate of growth, however, will decrease to 4%, if the rate of population increase remains at 3% a year hereafter. The following table shows the major target figures under the First Five-Year Plan.

Table 2-6-4 at 1961 prices

		1962	1963	1967	Growth Rate (%)
Production Torgets					
Agriculture	(10^6-TL)	34,690.0	36,470.0	43,560.0	4.7
	(%)	43.8	43.0	38.3	
Mining and quarrying	(10^6 TL)	2,341.4	2,583.9	3,577.4	8.7
	(%)	3.2	3.3	3.6	
Manufacturing	(10^6 TL)	18,203.5	20,867.1	31,462.1	11.5
	(%)	12.8	13.5	16.7	
Energy	(10^6 TL)	648.0	729.1	1,187.7	12.8
	(%)	0.8	0.9	1.1	
Transport and communication	(10^6 TL)	3,378.2	3,744.9	5,340.2	9.6
	(%)	3.9	4.1	4.6	
Total	(10^6 TL)	59,261.1	64,395.0	85,127.4	7.5
Electric Power					13
Power	(MW)	766	855	1,381	
Energy	(10^6KWh)	3,550	4,011	6,539	
Foreign Trade					
Imports (CIF)	(10^6 $)		567	704	
Exports (FOB)	(10^6 $)		348	457	

Gross national production (GNP) is to increase at a rate of more than 7% a year. Especially, manufacturing, which is related to the consumption of electric power, is to expand at a rate of 11.5%. Correspondingly, the output of energy, too, is expected to increase at a rate of 12.8%. To make such industrial development possible, foreign trade must be expanded year by year. Also the rapid economic growth requires enormous investments as shown in the following table.

Table 2-6-5 Gross Investments 1963 - 1967

(10^6 TL at 1961 prices)

	1963	1964	1965	1966	1967	Total	%
Agriculture	1,213.2	1,712.2	2,182.0	2,590.0	2,851.0	10,548.4	17.7
Mining and wuarrying	457.8	735.2	794.6	809.9	435.5	3,233.0	5.4
Manufacturing	2,166.3	2,359.9	2,276.9	1,726.4	1,559.7	10,089.2	16.9

	1963	1964	1965	1966	1967	Total	%
Energy	706.4	850.0	1,057.9	1,233.5	1,286.2	5,134.0	8.6
Transport and Communication	1,298.0	1,355.9	1,482.3	1,851.9	2,176.3	8,159.4	13.7
Services	581.0	426.1	637.0	1,030.0	1,291.8	3,965.9	6.6
Housing	2,085.0	2,229.0	2,390.0	2,594.0	2,818.0	12,116.0	20.3
Education	660.0	783.0	795.0	836.0	1,153.0	4,227.0	7.1
Health	200.5	230.1	278.2	320.2	317.9	1,346.9	2.3
Tourism	145.5	148.2	164.7	175.6	193.0	827.0	1.4
Total	9,513.7	10,829.6	12,058.6	13,167.5	14,077.4	59,646.8	100

Source: Prime Ministry of the Republic of Turkey, First Five-Year Plan, Section V.

Gross investments are equal to about 18% of GNP. Expecially, the rate of investments in such fields as housing, agriculture, manufacturing and energy is very great. The southwestern region, which faces the Mediterranean sea and has favorable climatic conditions, yields abundant farm products. The processing and export of these products are actively engaged in in this area. Especially in recent years, industries relying on the resources of this region are developing around Izmir which has a good natural harbor, making the Izmir district an important industrial center second only to the Istanbul district in the country.

3. NECESSITY OF DEVELOPMENT

3. NECESSITY OF DEVELOPMENT

3-1 ELECTRIC POWER

3-1-1 PRESENT SITUATION OF POWER FACILITIES

a. General Situation

The electric utility industry in Turkey started with the first power plant completed at Tarsus in 1902, and power supply to the public was initiated in 1913. Since then, the power industry has attained a gradual devlopment under a dual system of municipal plants and auto-producer plants, and after World War II in particular, it has shown further devlopment under a powerful national system, and is now continuing a rapid growth.

In 1953, the Develt Su Isleri (DSI) was established by law, and this organization started multipurpose devlopment of water resources whereby hydro-electric power generation became the major phace of the development projects.

In other words, hydroelectric capacity, which accounted for only 4 % of the total installed capacity in 1945, came to account for as much as 35 % as of 1964.

This fact indicates that the power development program in recent years has come to place emphasis on water power, and the said percentage is expected to increase in the near future.

As of 1964, the total installed capacity was 1,438.5 MW of which 502.8 MW (35 %) was hydroelectric power and 935.7 MW (65 %) was thermal electric power. The annual energy production was 4,434.8 million KWh, annual energy consumption 3,800 million KWh, and energy consumption per capita was about 123 KWh.

The electrification rate among the people is low, with only about 32 % of the total population being supplied with electricity. In terms of per capita of the electrified population, energy consumption is about 380 KWh.

In the future, power consumption will increase by the expansion of economic activities, decrease in the population with no electric lighting now accounting for as high as 68 % of the total population, natural increase in population, and other factors and therefore power development corresponding to this situation must be attained at a high tempo.

To meet this end, the best policy conceivable is to make use of the abundant water resources possessed by Turkey.

According to a recent survey, Turkey's economically usable water potential is said to be 90, 000 million KWh, of which only 2% has been developed to date.

a-1 Power Plants

In the early stage of development, small-scale power stations were built with engines supplying the motive force, and in 1922, power generation of 10 MW unit class using steam-turbines was started in Istanbul.

Hydroelectric-power has been developed since 1956.

Classified by types of enterprise, and also by the system of power generation, i.e., hydroelectric and thermal, the installed capacity in and after 1940 are as shown in Table 3-1-1.

a-2 Power Transmission System

Development of power transmission lines in Turkey was started in 1940 with the construction of a 33 KV, 14 km line. This was followed by the completion of the first 66 KV, 98.6 km line in 1949 and further by the completion of a 154 KV, 238 km line in 1952, and the development is still continuing.

As of 1964, power transmission lines extend to 2,783.1 km for the 154 KV lines, 1,519.4 km for the 66 KV lines, 1,274.5 km for the 33 KV lines, and 812.6 km for lines of 15 to 33 KV, and in addition, lines totalling 1,400 km are under construction. Moreover, construction of a 380 KV, 390 km transmission line of extra-high voltage is scheduled for 1965.

Table 3-1-1 Installed Capacity (1940 - 1960) Unit : Number KW

Year	Municipal Plants				Regional Plants				Auto-producer Plants				Total			
	No.	Thermal	Hydro	Total	No.	Thermal	Hydro	Total	No.	Thermal	Hydro	Total	No.	Thermal	Hydro	Total
1940	177	93,509	6,507	100,016					81	116,437	512	116,949	258	209,947	7,019	216,963
1945	190	99,852	7,240	107,092					84	136,110	2,736	138,846	274	235,962	9,976	245,938
1950	268	164,261	10,345	174,606	1	65,000		65,000	86	160,635	7,540	168,175	355	389,896	17,885	407,781
1951	281	169,151	11,989	181,140	1	65,000		65,000	86	165,062	12,040	177,102	368	399,213	24,029	423,242
1952	291	175,708	13,740	189,448	1	65,000		65,000	92	171,348	12,040	183,388	384	412,056	25,780	437,836
1953	344	217,848	17,666	235,514	1	65,000		65,000	95	187,295	11,740	199,035	440	470,143	29,406	499,549
1954	375	209,643	19,912	229,555	3	65,000	5,000	70,000	111	205,599	11,740	217,339	489	480,242	36,652	516,894
1955	381	237,049	20,578	257,627	4	108,000	5,800	113,800	147	228,466	11,740	240,206	532	573,515	38,118	611,633
1956	391	276,725	20,659	297,384	7	194,492	121,800	316,292	177	260,690	11,692	272,383	575	731,907	154,151	886,058
1957	400	283,595	21,795	305,391	9	238,944	128,360	367,304	173	255,012	11,692	266,704	582	777,551	161,847	939,399
1958	415	291,182	25,647	316,829	10	239,082	183,560	422,642	212	278,808	11,692	290,500	637	809,072	220,899	1,029,971
1959	436	295,678	26,015	321,693	12	239,082	279,560	518,642	378	308,675	12,023	320,698	826	843,435	317,598	1,161,033
1960	478	300,360	26,921	327,281	16	239,162	372,960	612,122	440	321,006	12,023	333,029	934	860,528	411,904	1,272,432
1961														878,622	445,273	1,323,895
1962														900,725	470,121	1,370,846
1963	a)													914,600	479,150	1,393,750
1964	b)													935,650	502,850	1,438,500

a) : Provisional

b) : Estimated

The present power transmission networks in Turkey can be roughly classified into the following three systems.

1. Northwestern and Western Systems covering the zone from the Northwest Area to the Western Area.

2. Regional systems located in each region for smallscale power transmission.

3. Isolated distribution systems for power supply to village units.

The Northwestern and Western Systems are of 154 KV lines, and connect power plants and load centers with power lines of about 3,000 km in total length. When transmission lines of 66 KV or lower are included, the total length reaches about 5,000 km, and these systems supply 75% of the total energy demand in Turkey.

a-3 Supply and Demand

Turkey's power supply capability as of 1964 shows a total installed capacity of 1,438.5 MW, energy production of 4,434.8 million KWh, and net energy consumption of 3,800 million KWh.

Power supply and demand in and after 1950 are as shown in Table 3-1-2.

Table 3-1-2

Year	Installed Capacity (KW)	Nonsimultaneous Peak Load (KW)	Gross Production (KWh)	Net Production (KWh)	Consumption (KWh)	Annual Increase (%)
1950	407,781	190,000	789,624	728,180	678,806	
1951	423,242	218,000	887,922	819,855	764,005	12.6
1952	437,836	268,000	1,020,248	939,674	878,527	15.0
1953	499,549	296,000	1,200,802	1,113,655	1,012,538	15.3
1954	516,894	335,000	1,402,442	1,304,269	1,191,516	17.7
1955	611,633	366,000	1,579,818	1,469,970	1,347,250	13.1
1956	886,058	399,000	1,819,156	1,691,450	1,544,839	14.7
1957	939,399	434,000	2,056,683	1,922,201	1,757,039	13.7
1958	1,029,971	501,000	2,303,442	2,163,166	1,961,540	11.1
1959	1,161,033	558,000	2,587,349	2,434,697	2,170,491	10.7
1960	1,272,432	617,000	2,815,071	2,674,641	2,395,720	10.4

Year	Installed Capacity (KW)	Nonsimultaneous Peak Load (KW)	Gross Production (KWh)	Net Production (KWh)	Consumption (KWh)	Annual Increase (%)
1961	1,323,875	694,000	3,050,000	2,868,302	2,610,000	8.9
1962	1,370,846	802,000	3,553,400	3,388,622	3,039,000	16.4
1963	1,393,750	924,000	3,960,000	3,821,100	3,420,000	12.5
1964	1,438,500	1,006,000	4,434,800	4,215,500	3,800,000	11.1

Note: Figures in and after 1962 partially include estimated values.

As is seen from Table 5-1-2, the installed capacity shows a margin of about 40 % over the peak demand, and the supply capacity therefore can be said to be sufficient.

The growth rate of power demand in the period from 1950 to 1962 is 13.3 % and its breakdown is as shown below.

Dommestic and commercial :	15.0 %
Offices :	12.2 %
Street Lighting :	13.0 %
Industry :	13.0 %
Total :	13.3 %

Also, the breakdown of power consumption by users is as shown below.

Year	1950		1960		1964	
	10^6KWh	%	10^6KWh	%	10^6KWh	%
Domestic and Commercial	108.7	16.0	460.4	19.2	612.0	16.1
Offices	21.4	3.2	68.5	2.9	160.0	4.2
Street Lighting	22.0	3.2	76.8	3.2	100.0	2.6
Industry	508.8	75.0	1,751.5	73.1	2,880.0	75.8
Traction	17.9	2.6	38.6	1.6	48.0	1.3
Total	678.8	100	2,395.7	100	3,800.0	100
Losses	49.4		278.9		420.0	
Net Production	728.2		2,674.6		4,220.0	
Consumption of Plant Auxiliaries	61.4		140.4		214.8	
Gross Production	789.6		2,815.0		4,434.8	

The EIE divides the country into the following eight areas in its regional classification in the national power supply-demand statistics of Turkey (see Drawing 36).

Area I	Northwest
Area II	North
Area III	Southwest
Area IV	South
Area V	Middle
Area VI	Northeast
Area VII	East
Area VIII	Southeast

b. Present Situation of Power Supply Capability

As of the end of 1964, power plants operating under the Northwestern System and the Western System and the existing power plants expected to be incorporated into these systems are as shown in Tables 3-1-3 and 3-1-4.

Table 3-1-3 Description of Hydroelectric Plants (as of the end of 1964)

Name of Plant	Northwestern System											Western System	
	Hirfanli	Sariyar	Yerkoperu	Sizer	Bunyan	Kayakoy	Kepez	Kovada I	Dinar	Durucasu	Hazar	Demirkopru	Kemer
River	Kizilirmak	Sakarya	Goksu	Kizilirmak	Kizilirmak	Emet	Boga	Aksu	Menderes	Yesilirmak	Hazorlake	Gediz	Akcay
Locations	110 Km Southeast of Ankara	130 Km West of Ankara	110 Km South of Konya	65 Km Northeast of Kayseri	8 Km Northeast of Kayseri	between Kunhya and Usak	10 Km West of Antalya	90 Km North of Antalya	49 Km North of Burdur	15 Km Northeast of Amasya	20 Km Southeast of Elazig	110 Km East of Izmir	60 Km Southeast of Aydin
Year of Completion	1959	1956	1959	1961	1931-1951	1960	1961	1960	1951-'54	1955	1956-'60	1960	1958
Capacity (MW)													
Name Plate	96	80	10.8	6.768	1.36	3.84	26.4	8.4	1.12	0.8	13.12	69	48
Dependable	93	75	8	6.768	1.36	3.84	26.4	8.4	1.12	0.8	13	69	18
Unit	32 x 3	40 x 2	3.6 x 3	2.256 x 3	0.32 x 2 0.72 x 1	2.8 x 3		2.8 x 3	0.48 x 2 0.16 x 1	0.4 x 2	3.28 x 4	23 x 3	16 x 3
Extension													
Capacity (MW)	32 x 1	40 x 2									12 x 1		
Date	Undecided	1966									1965		
Final Capacity (MW)	128	160	10.8	6.768	1.36	3.84	26.4	8.4	1.12	0.8	25	69	48
Annual Energy Output (million KWh)	400	400	70	38	3	12	180	41	2	5	45(80)	192	145
Type of Operation	Peak and Base	Peak and Base	Run-of-River	Run-of-River	Run-of-River	Run-of-River	Run-of River	Run-of-River	Run-of-River	Run-of-River		Peak and Base	Peak and Base

Table 3-1-4 Description of Thermal Power Plants (as of the end of 1964)

Name of Plant	Northwestern System								Western System	
	Silahtar	Catagzi	Tuncbilic	Ankara	Izmit	Eregli	Karabuk	Kirikkale	Soma	Izmir
Location	Istanbul	Zonguldak	Kutakya	Ankara	Izmit	Eregli	Karabuk	Kirikkale	Soma	Izmir
Type	steam	steam	steam	steam	steam		steam	steam	steam	steam
Fuel	coal	coal	lignite	coal	coal lignite		coal gas	lignite	lignite	lignite
Year of Completion	1924-1956	1948-1956	1956	1936-1951	1941-1951	1964	1939	1937	1957	1928-1955
Capacity (MW)										
Name Plate	127.925	120	64	22.8	11	20	20	12.25	44	40
Dependable	100	106	60	15	7	20	8	11	40	30
Unit	9.825 x 1 10 x 1 22.5 x 1 30 x 1 20 x 1 35.6 x 1	20 x 6	32 x 2	4.5 x 1 5.1 x 1 7.5 x 1 3.2 x 1 2.5 x 1	2.5 x 1 5 x 1 3.5 x 1	10 x 2	10 x 2	3 x 2 6.25 x 1	22 x 2	2.5 x 2 5 x 3 20 x 1
Extension Plan										
Capacity			60 x 1						22 x 1	
Date			1965						Undecided	
Final Capacity	127.925	120	124	22.8	11	20	20	12.25	66	40
Type of Operation	Base	Base	Base	Peak and Base					Base	Peak and Base
Ownership	Public	Public	Public	Public	Auto-producer	Auto-producer	Auto-producer	Auto-producer	Public	Public

Note, Diesel generator excluded.

3-1-2. EXISTING POWER DEVELOPMENT PLANS AND OUTLOOK

To meet the increasing power demand with the progress of the first 1963-1967 Five-Year Development Plan, power development and power system expansion and consolidation are being executed by the Turkish Government.

Power plants and power systems now under construction or under planning are as shown below.

a. Hydroelectric Power Plants

Area	Name of Plant	Dependable Capacity (MW)	Annual Energy Production (10^6KWh)	1	2
I	Seariyâr (Extension)	75		1966	1966
I	Kesikkopru	76	175	1967-68	1967-68
I	Gokcekaya	300	560	1968-69	1968-69
III	Kovada II (Ex.)	48	200	1967	1971
V	Almus	15	87	1965	1970
VIII	Hazar II (Ex.)	10	47	1966	1971
VIII	Keban	1,085	6,000	1970-76	1970-76
II	Esencay	15	75	1967	1967

Note : 1 Year for start of operation
2 Year for connection with transmission networks

Besides the abovementioned power plants, the 150 MW Kadincik Power Station (Area IV), 24.6 MW Harsit Power Station (Area VI), and 14.4 MW Cagcag Power Station (Area VIII) are the major plants now under construction. However, since these plants are expected to be used for meeting the demand in their respective areas as independent systems up to about 1977, their details have been omitted.

b. Thermal Power Plants

Area	Name of Plant	Dependable capacity MW	Year for start of operation	Year for connection with network
I	Tuncbilik(Ex.)	60	1965	1965
I	Ambarli	200	1966	1966

Besides these, the 50 MW Mersin Power Station (Area IV) is now under plan. However, since it appears this plant will not be connected with the power transmission networks until 1977, its details have been omitted.

c. Power Transmission Systems

Expansion and reinforcement of existing 154 KV, 60 KV, and 30 KV systems are being implemented. The principal work related to the Northwestern Area and the Western Area are as mentioned below.

c-1 In the Western Area, the Esencay Power Plant (Hydro-electric, 15 MW) will be completed in 1967. In this year, the extension of the present 154 KV transmission line between Izmir and the Kemer Power Plant to the Esencay Power Plant via the city of Muğla should be completed to supply power to the proposed Dalaman Paper Factory.

c-2 Also, to meet the increase in demand in the West Area, especially the increase in the load Edremit, the power line interconnection between the Western Area and Northwestern Area must be strengthened. When this project is completed, interchangeable power between the two areas will reach about 100 MW.

c-3 In the Northwestern Area, Turkey's first EHV transmission line of 380 KV will start operation in 1968 between Ankara and Istanbul by the completion of the Gokcekaya Power Plant. In addition, in 1970 when the Keban Power Plant is to start operation, one circuit of 380 KV will be completed between Ankara and Keban, and at the same time, a transmission system of 154 KV is planned to be constructed in the vicinity of Keban.

c-4 As a result, the present power network called the Northwestern System will expand its service areas to the Middle Area in 1970-1971. Thus, for convenience the power networks at this year (1970) were divided into the following three large zones.

Northwestern System: The present Northwest Area, which includes such key cities as Istanbul and Ankara, will be connected with the Southwest (III)

Area, Middle (V) Area, Samsun and vicinity of the Northeast (VI) Area, and Elazig and vicinity of the Southeast (VIII) Area. For the purpose of identification, this system is temporary named Northwestern System.

Western System: The Western System and the Northwestern System are now interconnected. Tentatively, however, it has been decided to consider the Western System and the Northwestern System separately.

Other Systems: Other areas, which are not included in the above two systems, will probably develop maintaining their respective small independent transmission systems. It is evident that the Southern (IV) Area in particular will be connected with the Keban System in the future. However, since the present power resources development plan and the future demand in the Southern Area are expected to keep balance until 1976, connection between this area and the Keban System can be considered to take place in or after 1976.

3-1-3. SUPPLY-DEMAND FORECAST

a. Basic Concept of Demand Estimates

Power demand is reflected in all social activities, such as national life and industry, and to make exact estimates is extremely difficult. Demand estimates are conducted by a combination of various methods in advanced countries. In a long-range view, power demand is said to have correlations with gross national production (GNP), population, industrial national production (INP), and so forth. However, this correlation varies in countries, and cannot be defined uniformly. Especially, in countries in the stage of development, power resources development takes precedence and sometimes stimulates demand, and locally the expansion of power distribution networks will occasionally increase demand.

In this demand estimate, a long-range average trend has been estimated from a macroscopic viewpoint by taking into account the past trend obtained from available data, the Five-Year Development Plan of the Turkish Government, demand estimates conducted by EIE, changes in power consumption per capita, and so forth.

The period for estimation was tentatively made to 1977 in the light of the 15-Year Plan now under way in Turkey.

At first, estimates were made macroscopically for the demand of entire Turkey, then demand estimates for the Northwestern System, with Keban included, at the point of completion of its expansion in the future, and also for the Western System were made.

b. Power Demand of Entire Turkey

According to the Statistics of Electric Power in Turkey, the net energy production has shown an average growth rate of about 13 % for the past ten years (1952-1962). Of this period, the first five years marked about 15 %, and the second five years about 12 %, both being considerably high growth rates.

This fact is believed to have resulted from the normal growth corresponding to economic growth during the period as well as the expansion of power transmission and distribution systems.

On the other hand, the growth rate of the GNP during this period was 5.2 % for the five-year period from 1952 to 1957 and 3.7 % for the five-year period from 1957 to 1962.

It is difficult to seek the correlation between GNP and growth of electric power from these percentages, and it is not reasonable to use the coefficients thus obtained for estimating future power demand.

However, as the power plan and the industrial production plan in Turkey progresses, the industrial structure of Turkey will come closer to that of advanced countries, and the correlation between electric power and GNP will become stronger.

As mentioned in the preceding paragraph, the growth rate in this demand estimate was made macroscopically by the following means.

The growth rate during the Second Five-Year Plan which ends in 1972 will be similar to the trend in the past. Consequently, the rate in this period was estimated at 12 % annually, and since the 1972-1977 period is expected to show a lesser growth rate, it was estimated at 9.0 % annually.

These percentages are considered to be reasonable compared with the predicted growth rate of 7 % for GNP under the 15-year development plan now under way.

Also, on the assumption that the rate of population increase is about 3 %, the net production per capita is estimated at 171 KWh for 1967, 254 KWh for 1972, and 343 KWh for 1977.

Table 3-1-5 shows the actual results and estimated values of electric power and GNP.

Table 3-1-5

	Actual			Estimates		
	1952	1957	1962	1967	1972	1977
Electric Energy Net Production (10^6 KWh)	940	1,929	3,389	6,020	10,320	15,950
(A) Growth Rate (%)		15.3	12.0	12.0	12.0	9.0
GNP (10^9 T.L)	35.6	44.0	52.7	73.9	103.5	145.3
(B) Growth Rate %)		5.2	3.7	7.0	7.0	7.0
KWh/Capita			115	179	272	365

c. Demand of Northwestern System

The demand has been classified by regions using the afore-mentioned reference materials, such as, the Seventh Annual Electric Power Survey 1964 and the Statistics of Electric Power in Turkey, and studies have been conducted of demand estimates in each region from various angles. A conclusion reached through these studies is that the present regional systems, which are not connected with the Northwestern System, will successively be incorporated in the networks of the system at the time when supply capability becomes insufficient under the development plan now being implemented.

To be more specific, it was assumed that the Isparta Regional System and Antalya System in Area III will be connected with the Northwestern System in 1971, and that the Tokat Regional System and Samsun System in Area V will be incorporated in the network by 1970, and the Elazig System in Area VIII at the time when the Keban System starts operation.

The system load factor is now about 52 %, but this will probably increase to about 55 % in the future. The estimates of demand are shown in Table 3-1-6.

d. Demand of Western System

In this study, detailed field surveys were not conducted. Therefore, the total demand in the West Area was estimated by referring to the Present and Future Energy Requirement contained in Memorandum II from EIE, and by changing the year of establishment of industrial plants on the basis of the revised industrialization plan and other information obtained in the field. The estimated values shown by EIE are a little higher than the macroscopically estimated growth rates (12 % up to 1972 and 9 % thereafter) of demand in entire Turkey mentioned above, but are considered appropriate.

The future load factor of this system is estimated to be about 52 %, which is a little lower than that of the Northwestern System. The estimated demand of this system are shown in Table 3-1-6.

e. Balance between Supply and Demand (in December)

The balance between supply (from the existing facilities, facilities under construction or planning and those expected to be established in the future under the Dalaman Project) and demand (mentioned in the preceding paragraph) until 1980 was studied, and the results are shown in Table 3-1-7. The districts, which were the objects of study were the Northwestern System and the Western System. Details of the supply capability are shown in Tables 3-1-8a, 3-1-8b and 3-1-9.

Fig. 3-1-1 ESTIMATED ELECTRIC ENERGY (KWh)

(AT SENDING END)

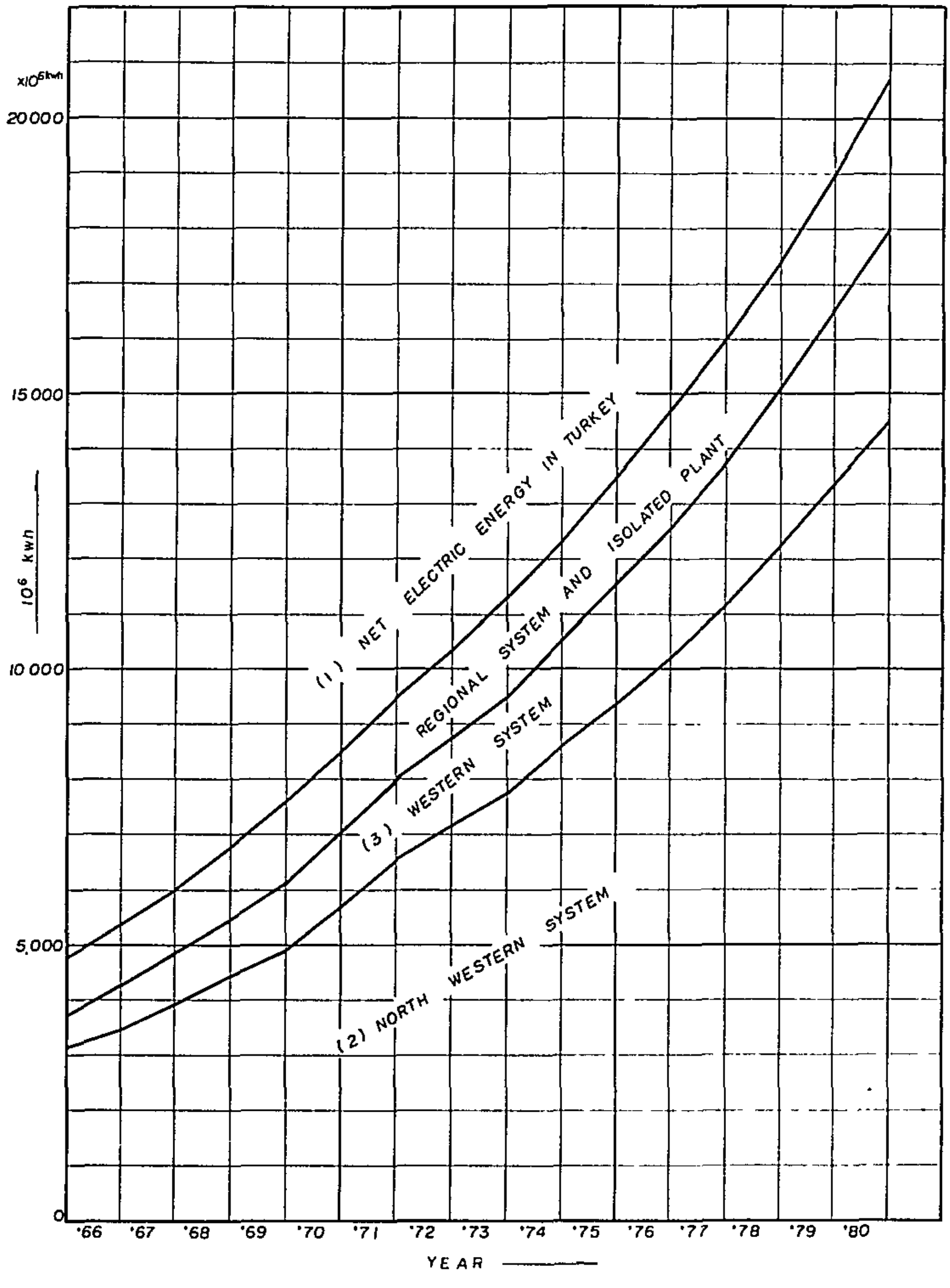


Table 3-1-6 Power Demand Forecast

		Actual					Estimated															
		'60	'61	'62	'63	'64	'65	'66	'67	'68	'69	'70	'71	'72	'73	'74	'75	'76	'77	'78	'79	'80
(1) Net energy demand in Turkey (at sending end)	million KWh	2,675	2,868	3,389	3,821	4,220	4,750	5,370	6,020	6,740	7,550	8,450	9,470	10,320	11,250	12,280	13,400	14,600	15,950	17,400	18,950	20,650
Annual growth rate	%	7.2	18.1	12.8	10.3	12.7	13.1	12.0	12.0	12.0	12.0	12.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	
Population	1,000			29,400			32,400	33,400	34,400				37,300	38,400				42,600	43,950			47,500
KWh per Capita				115			151	161	171				254	270				343	364			437
(2) North-Western System (at sending end)	million KWh						3,112	3,433	3,915	4,410	4,890	5,673	6,545	7,160	7,720	8,600	9,330	10,200	11,160	12,260	13,380	14,495
Annual growth rate	%						10.3	14.0	12.8	11.0	16.0	15.5	9.4	7.7	11.5	8.5	9.0	9.5	9.5	9.3	8.3	
Annual load factor	%						53	53	54	54	54	55	55	55	55	55	55	55	55	55	55	55
Peak power demand	1,000 KW						669	742	830	933	1,041	1,191	1,367	1,487	1,611	1,775	1,940	2,116	2,314	2,500	2,767	2,995
(3) Western System (at sending end) energy demand	million KWh						593	847	955	1,070	1,210	1,357	1,475	1,600	1,770	1,950	2,170	2,350	2,600	2,830	3,160	3,470
Annual growth sate	%						43.0	12.8	12.0	13.0	12.0	8.7	8.4	10.5	10.2	11.2	8.3	10.6	8.8	11.7	9.8	
Annual load factor	%						50	50	50	50	50	50	52	51	51	51	52	52	51	51	51	52
Peak power demand	1,000 KW						136	192	217	244	273	305	325	356	396	435	478	517	577	627	704	765
(2)+(3) = Total system energy	million KWh						3,705	4,280	4,870	5,480	6,105	7,030	8,020	8,760	9,490	10,550	11,500	12,550	13,760	15,090	16,540	17,965
$\frac{(2)+(3)}{(1)}$ x 100 = Ratio of systematization	%							79.7						85.0				86.3				87.0

e-1 1966-1969

In the period from 1966 to 1969, there will be a shortage in KWh, even with the two systems combined. This is because the operating time of the existing thermal power plants was estimated at 6,000 hrs. Therefore, the shortage can be covered easily by extending the operating hours. It will become necessary to send 66 MW in 1968 and 98 MW in 1969 from the Northwestern System to the Western System. The aforementioned plan to strengthen interconnection of power lines is to meet this necessity.

e-2 1970-1976

When the balance is examined on the assumption that the development of the power stations in the Dalaman System are completed smoothly and can supply power to the Western System in 1970-1976, it is found that there will be a surplus of energy supply capability of 225,000,000 KWh in 1971, 90,000,000 KWh in 1972 and 106,000,000 KWh in 1974. This means that thermal power generation in the Western System can be reduced correspondingly.

e-3 1977 and subsequent years

As can be seen from Table 3-1-7, there will be a shortage in both KW and KWh in 1977 in not only the Western System but in the entire system including Keban in the Northwestern System, even if the power stations of the Dalaman System are completed. It becomes necessary, therefore, to build new thermal power stations or develop new hydroelectric power resources by that year.

f. Assumed Load Factor of Dalaman System

It will be impossible to interchange power from the Northwestern System to the Western System in 1977. It will be necessary, therefore, to build new power stations in both of these systems. On the assumption that a modern thermal power station is built in the Western System, the expected load factor of the Dalaman System can be calculated as follows from the balance between supply and demand in that year:

Supply and Demand in the Western System in December, 1977:

	MW	KWh x 10^6	Operating hour
Demand at generating end	577	2,600	
Power supply capability			
Hydroelectric (Dalaman excluded)	132	412	
Thermal	70	420	6,000 hrs
New thermal Power station (Izmir)	75	525	7,000 hrs
Load factor of Dalaman System	300	1,243	4,150 hrs

Since the dependable capacity of the Dalaman System in December becomes about 10 % lower than the installed capacity, it is necessary to increase the installed capacity to about 330 MW. It is therefore proper to estimate that the load on the entire system at the time of completion of the four power stations in the system will be 1243 x million/(330, 000 x 8760) ≒ 0.43, or 43 %.

Fig. 3-1-2 ESTIMATED PEAK DEMAND (KW)
(AT SENDING END)

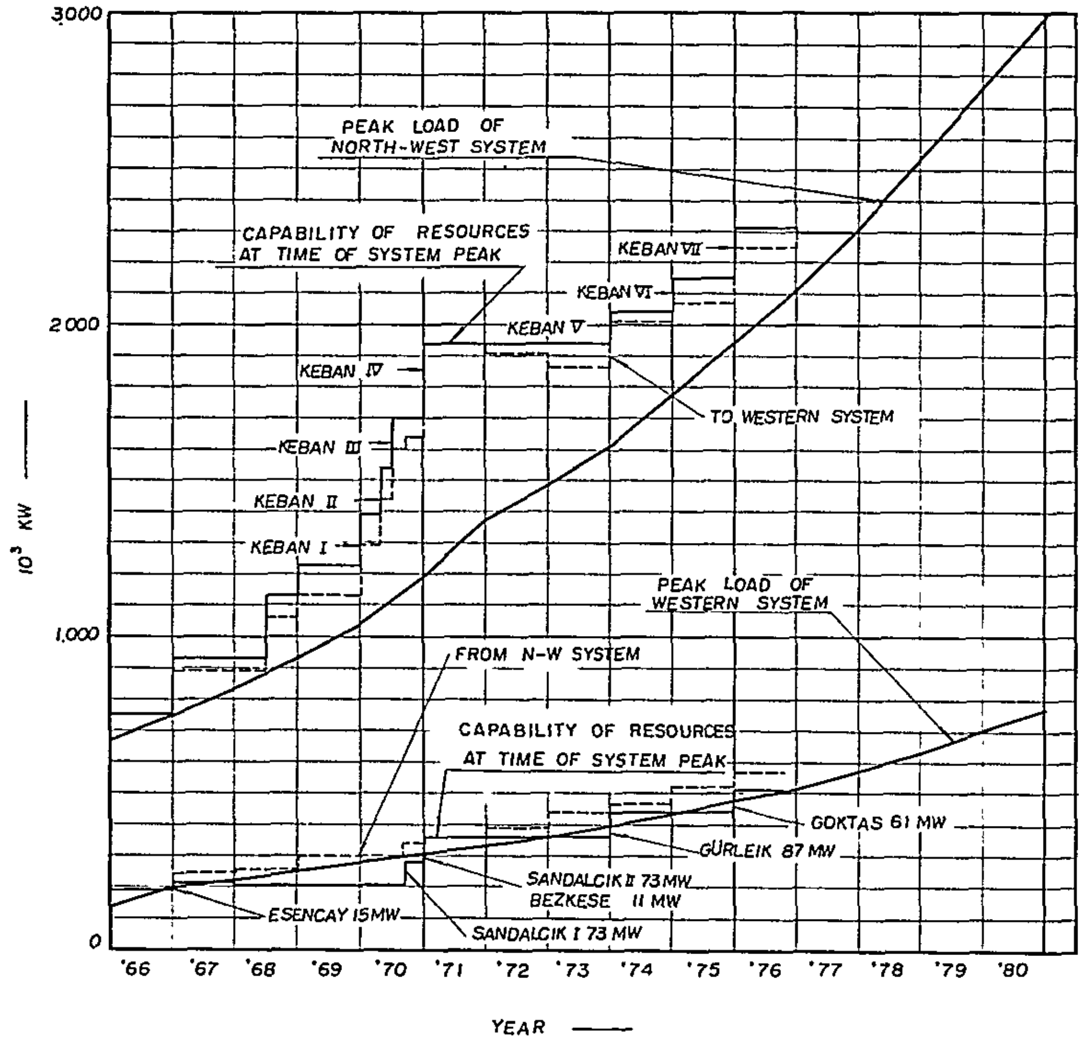


Table 3-1-7 Estimated Power and Energy Balance

		1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Remarks
North Western System																		
Peak demand at sending end	(MW)	669	742	830	933	1,041	1,191	1,363	1,487	1,611	1,775	1,940	2,116	2,314	2,540	2,767	2,995	
Dependable capacity	(MW)	572	751	927	1,127	1,227	1,699	1,937	1,937	1,937	2,047	2,152	2,307	2,300	2,300	2,300	2,300	Including under construction
Power pool	(MW)	51	△ 5	△ 36	△66	△98	△ 60	0	△33	△ 77	△33	△80	△62	-	-	-	-	△ :to Western System
Margin	(MW)	46	4	61	128	88	448	574	417	249	239	132	129	4	230	457	685	
Energy demand at sending end	(million KWh)	3,112	3,433	3,915	4,410	4,890	5,673	6,545	7,160	7,720	8,600	9,330	10,200	11,160	12,260	13,380	14,495	
Available energy	(million KWh)	3,053	3,445	4,334	4,900	5,180	7,500	9,523	9,523	9,523	10,053	10,053	10,953	10,911	10,911	10,911	10,911	
Energy pool	(million KWh)	△ 59	2	123	238	290	471	0	0	90	0	114	64	-	-	-	-	:to Western System
Surplus energy	(million KWh)	0	0	419	252	0	1,356	2,978	2,363	1,714	1,454	609	659	△ 249	△1,349	△2,469	△3,584	
Western System																		
Peak demand at sending end	(MW)	136	192	217	244	273	305	325	356	396	435	478	517	577	627	704	765	
Dependable capacity existing	(MW)	187	187	202	202	202	202	202	202	202	202	202	202	202	202	202	202	Existing value includes under construction
" " Dalaman	(MW)						73	157	157	157	244	244	305	305	305	305	305	
Power pool	(MW)	△ 51	5	36	66	98	60	0	33	77	33	80	62	-	-	-	-	from North-Western System
Margin	(MW)	0	0	21	24	27	30	34	36	40	44	48	52	△ 70	△120	△197	△258	
Energy demand at sending end	(million KWh)	593	847	955	1,070	1,210	1,357	1,475	1,600	1,770	1,950	2,170	2,350	2,600	2,830	3,160	3,470	
Available energy existing	(million KWh)	757	757	832	832	832	859	832	832	832	832	832	832	832	832	832	832	
" " Dalaman	(million KWh)						27	868	868	868	1,224	1,224	1,454	1,454	1,454	1,454	1,454	
Energy pool	(million KWh)	△ 59	0	123	238	290	471	0	0	90	0	114	64	-	-	-	-	from North-Western System
Surplus energy	(million KWh)	105	△ 90	0	0	△ 77	0	225	90	0	106	0	0	△314	△ 544	△ 874	△1,184	

Table 3-1-8a Dependable Capacity and Energy (North Western System)

Region	Name of Plant	Date of Completion	Capacity Energy	before '64	'65	'66	'67	'68	'69	'70	'71	'72	'73	'74	'75	'76	'77	Final '77	Remark
North-West (1)	Hydro																		
	Hirfanli	1960	MW Million KWh	93 400														93 400	
	Sariyar	1956	MW Million KWh	75 400		75												150 400	Extension in 1966
	Kayakoy	1960	MW Million KWh			4 12												4 12	Will be connected to system at 1966
	Kesikkopru	1967	MW Million KVh				76 90	 85										76 175	
	Gokcekaya	1968	MW Million KWh					200 280	100 280									300 560	
	Hydro Total		MW Million KWh	168 800	168 800	247 812	323 902	523 1,267	623 1,547	623 1,547	623 1,547	623 1,547	623 1,547	623 1,547	623 1,547	623 1,547	623 1,547	623 1,547	
	Thermal																		
	Silahtar	1922 - 56	MW Million NWh	100 600						△20 △120					△30 △180			50 300	
	Catalagzi	1948 - 56	MW Million KWh	106 636										△40 △240	△20 △120			46 276	
	Tuncbilik	1956	MW Million KWh	60 360	60 180	 180												120 720	
	Ankara	1936 - 53	MW Million KWh	15 90						△5 △30				△5 △30				5 30	
	Izmit	1941 - 51	MW Million KWh	7 42													△7 △42	- -	
	Eregli	1964	MW Million KWh	20 120														20 120	
	Karabuk	1939	MW Million KWh	8 48						△8 △48								- -	
	Kirikkale	1937	MW Million KWh	11 66						△11 △66								- -	
	Ambarli	1966	MW Million KWh			100 200	100 800	 200										200 1,200	
	Thermal Total		MW Million KWh	327 1,962	387 2,142	487 2,522	587 3,322	587 3,522	587 3,522	543 3,258	543 3,258	543 3,258	543 3,258	498 2,988	448 2,688	448 2,688	441 2,646	441 2,646	
	Grand Total		MW Million KWh	495 2,762	555 2,942	734 3,334	910 4,224	1,110 4,789	1,210 5,069	1,166 4,805	1,166 4,805	1,166 4,805	1,166 4,805	1,121 4,535	1,071 4,235	1,071 4,235	1,064 4,193	1,064 4,193	

Table 3-1-8b Dependable Capacity and Energy (North Western System)

Region	Name of Plant	Date of Completion	Capacity Energy	before '64	'65	'66	'67	'68	'69	'70	'71	'72	'73	'74	'75	'76	'77	Final '77	Remark
South-West (III)	Hydro																		
	Yerkopru	1959	MW	8														8	
			Million KWh	70														70	
	Kepez	1961	MW								26							26	Will be connected to system of 1971
			Million KWh								180							180	
	Kovada I	1960	MW								8							8	
			Million KWh								41							41	
	Dinar	1951	MW								1							1	
			Million KWh								2							2	
	Kovada II	1967	MW								48							48	
			Million KWh								200							200	
	Total		MW	8	8	8	8	8	8	8	91	91	91	91	91	91	91	91	
			Million KWh	70	70	70	70	70	70	70	493	493	493	493	493	493	493	493	
Middle (V)	Hydro																		
	Sizer	1961	MW	7														7	
			Million KWh	38														38	
	Bunyan	1951	MW	2														2	
			Million KWh	3														3	
	Durucasu	1951	MW							1								1	Will be connected to system at 1970
			Million KWh							5								5	
	Almus	1965	MW							15								15	Will be connected to system at 1970
			Million KWh							87								87	
	Total		MW	9	9	9	9	9	9	25	25	25	25	25	25	25	25	25	
			Million KWh	41	41	41	41	41	41	133	133	133	133	133	133	133	133	133	
East (VII)	Hydro																		
	Hazar I	1958 - 60	MW							25								25	
			Million KWh							45								45	
	Hazar II		MW							10								10	
			Million KWh							47								47	
	Keban	1970 - 76	MW							465	155			155	155	155		1,085	Estimate
			Million KWh							2,400	1,600			800	800	400		6,000	
	Total		MW							500	655	655	655	810	965	1,120	1,120	1,120	Note: Maden thermal plant will be cold reserves in 1970
			Million KWh							2,492	4,092	4,092	4,092	4,892	5,692	6,092	6,092	6,092	
North-Western System Total			MW	512	572	751	927	1,127	1,227	1,699	1,937	1,937	1,937	2,047	2,152	2,307	2,300	2,300	
			Million KWh	2,873	3,053	3,445	4,334	4,900	5,180	7,500	9,523	9,523	9,523	10,053	10,553	10,953	10,911	10,911	

Table 3-1-9 Dependable Capacity and Energy (Western System)

Region	Name of Plant	Date of Complation	Capacity Energy	before '64	'65	'66	'67	'68	'69	'70	'71	'72	'73	'74	'75	'76	'77	Final '77	Remark
West (II)	Hydro																		
	Demirkoptu	1960	MW Million KWh	69 192														69 192	
	Kemer	1958	MW Million KWh	48 145														48 145	
	Esencay	1967	MW Million KWh				15 75											15 75	by 7th Annual Electric Power Survey 1964 of EIE
	Hydro Total (1)			117 337	117 337	117 337	132 412	132 412	132 412	132 412	132 412	132 412	132 412	132 412	132 412	132 412	132 412	132 412	
	Thermal																		
	Soma	1957	MW Million KWh	40 240														40 240	
	Izmir	1928-55	MW Million KWh	30 180														30 180	
	Thermal Total (2)			70 420	70 420	70 420	70 420	70 420	70 420	70 420	70 420	70 420	70 420	70 420	70 420	70 420	70 420	70 420	
	Hydro-Thermal Total (1) + (2)			187 757	187 757	187 757	202 832	202 832	202 832	202 832	202 832	202 832	202 832	202 832	202 832	202 832	202 832	202 832	
	Dalaman Project																		
	Sandalcik	1971	MW Million KWh							73	73 787							146 787	
	Gurleik	1974	MW Million KWh											87 349				87 349	
	Goktas	1976	MW Million KWh													61 230		61 230	
	Bezkase	1971	MW Million KWh								11 81			7				11 88	
	Total (3)		MW Million KWh							73 27	157 868	157 868	157 868	244 1,224	244 1,224	305 1,454	305 1,454	305 1,454	
	Western System Total (1)+(2)+(3)		MW Million KWh							275 859	359 1,700	359 1,700	359 1,700	446 2,056	446 2,056	507 2,286	507 2,286	507 2,286	

Note; Dependable Capacity: Capacity available at the time of the systems annual peak load December)

Annual energy: Hydro power plants; average hydrological condition
Thermal power plants; Dependable Capacity x 6,000 hours

3-1-4 TIME FOR EXECUTION OF DALAMAN PROJECT

The objective of this hydroelectric power generation plan is to meet the demand in the Western System, and it is far more economical than the establishment of a modern thermal power station at Izmir. Also, it may be impossible to find hydroelectric power resources greater than the Dalaman River in the Western System.

Furthermore, the Western System can receive maximum power of only about 100 MW from the Northwestern System, even through the interconnection of the 154 KV lines. Accordingly, the power supply capacity of the Western System will begin to show a shortage from the end of 1970. It is desirable, therefore, that one of the four Dalaman power stations begin operation from December, 1970. The construction of the remaining three should be started corresponding to increase in the demand for power and all stations should be completed by the end of 1976.

In the Northwestern System, upon completion of development of Keban, the supply capacity will have a surplus after 1970. This surplus may be transmitted from Gokcekaya in the Northwestern System to Izmir by a transmission line of 380 KV. It is certain, however, that the supply capability of both the Northwestern and the Western Systems will become inadequate in 1977 even though all of Keban may have been developed. Therefore, it can be considered that it will be too early to interconnect power lines of 380 KV in 1970. The time of this interconnection should be determined after studying its merits, in relation to the decision of capacity addition by either hydroelectric power or new thermal power stations in order to meet increase of demand after 1977 in the Northwestern and the Western Systems.

3-2 AGRICULTURE

3-2-1 GENERAL DESCRIPTION

The total area of arable lands in Turkey is 23,913 thousand ha, accounting for about 30 % of the total area of the country. Of the total population of 31.8 millions in 1965, 13.2 millions are between 15 and 64 years of age. It is estimated that 10.3 millions or 77.6 % of the people in this age bracket are engaged in agriculture. The gross national product amounts to 58,068.6 million T.L of which 19,314.1 million T.L or 33.3 % is agricultural production. This estimate, however, was made for 1964 on the basis of the constant price in 1961. Of the total exports amounting to 3,696.9 million T.L in 1964, 2,803.3 million T.L or 75.8 %, were agricultural products. These agricultural exports are equal to 57.6 % of the country's imports totaling 4,878 million T.L playing a great role in acquiring foreign exchange funds for the country.

Recent developments in land uses are shown in Table 3-2-1.

Table 3-2-1 Land Use

Land Use		Thousand Hectare				Remarks
		1962E	1963E	1964E	1965E	
1.	Area of Field	23,214	23,617	23,611	23,604	
	a) Area Sown	15,166	15,276	15,276	15,276	E:Estimated
	b) Fallow	8,048	8,341	8,335	8,328	
2.	Meadows and Pasture	28,666	28,260	28,260	28,260	
3.	Orchard and Vineyards	2,201	2,207	2,213	2,220	
4.	Forests	10,584	10,584	10,584	10,584	
5.	Wasteland	13,393	13,390	13,390	13,390	
	Total	78,058	78,058	78,058	78,058	

Source : Development Plan 1965 Annual Programme

Also the area of arable land and the area cultivated by tractors or draft animals in nation-wide figures are shown in Table 3-2-2. This table shows that the use of tractors has particularly increased in recent years.

Table 3-2-2 Area Cultivated, Number of Tractors and Draft Animals, Area Cultivated by Tractors and by Animals

Item	Year				
	1959	1960	1961	1962	1963
Area Sown	15,020	15,305	15,128	15,167	15,276
Fallow	7,920	7,922	7,948	8,048	8,637
Total	22,940	23,227	23,076	23,215	23,913

Item	Year				
	1959	1960	1961	1962	1963
Number of Draft Animals (in pair)	2,596,460	2,647,695	2,605,793	2,656,920	2,652,033
Number of Tractors	41,896	42,136	42,505	43,789	49,366
Area Cultivated by Tractors (1,000 ha)	3,142	3,160	3,188	3,284	3,702
Area Cultivated by Draft Animals (1,000 ha)	19,798	20,067	19,888	19,931	20,211
Area Cultivated by Pair of Draft Animals (ha)	7.6	7.5	7.6	7.5	7.6

Note : 1. Area Cultivated are obtained from official estimates.

2. Yearly work capacity of each tractor calculated as 75 hectares.

3. 1963 number, in the agriculture section are contemporary.

Source : State Institute of Statistics 1942 - 1963.
The Summary of Agricultural Statistics.

The areas planted with major crops, production of these crops and livestock production of the entire country, in the Aegean Sea region and in Muğla Prefecture, based on the statistics for 1962 are shown in Tables 3-2-3 and 3-2-4. According to these tables, the ratio of the area cultivated in Muğla Prefecture to that of the entire country is 0.6 % in cereals, 0.9 % in pulses 2.7 % in industrial crops, 12.9 % in citrus and 15 % in olive. It will also be noted that cultivated area is 13.1 % in millet, 11.7 % in tobacco and 10.0 % in sesame. These figures reflect the characteristics of this prefecture.

Trends in the wholesale price index of 95 major commodities and agricultural products are shown in Table 3-2-5. From this table, it can be seen that the wholesale price index for foodstuffs as a whole went down in 1964 from the level of the preceding year but that those for livestock and animal products rose by 12 % and 3 % respectively.

Table 3-2-3 Agricultural Structure and Production (1962)

	Crops	National Totals			Region II (Aegean) 1			Muğla Prefecture						
		Area Sown	Production	Yield	Area Sown	Production	Yield	Area Sown			Production			Yield
		(A) Hectares	(B) Tons	Kg. per Hec.	(C) Hectares	(D) Tons	Kg. per Hec.	(E) Hectares	$\frac{(E)}{(A)} \times 100$ (%)	$\frac{(E)}{(C)} \times 100$ (%)	(F) Tons	$\frac{(F)}{(B)} \times 100$ (%)	$\frac{(F)}{(D)} \times 100$ (%)	Kg. per Hec.
Cereals	Wheat	7,800,000	8,450,000	1,083	538,547	682,327	1,266	32,380	0.4	6.0	29,314	0.3	4.3	905
	Barley	2,800,000	3,500,000	1,250	315,015	427,216	1,356	19,040	0.7	6.0	19,208	0.5	4.5	1,009
	Rye	670,000	690,000	1,030	73,102	81,168	1,110	3,588	0.5	4.9	2,990	0.4	3.7	833
	Oats	410,000	450,000	1,098	72,797	90,446	1,242	5,617	1.4	7.7	4,795	1.1	5.3	853
	Speltz	131,000	130,000	992	12,945	15,004	1,159							
	Maize	667,000	800,000	1,199	92,496	126,706	1,369	11,320	1.7	12.2	14,195	1.8	11.2	1,253
	Millet	49,000	60,000	1,224	9,490	10,711	1,128	6,410	13.1	67.5	6,836	11.4	63.8	1,066
	Rice	81,000	165,000	2,037	1,794	4,980	2,776							
	Canary seed	37,000	23,000	622	407	250	614	(Others) 8	-	-	(Others) 8	-	-	1,000
	Mixed grains	320,000	350,000	1,094	37,260	49,442	1,326							
	Total	12,965,000	14,618,000	1,127	1,153,853	1,488,250	1,289	78,363	0.6	6.8	77,346	0.5	5.2	987
Pulses	Broad beans	40,000	53,000	1,325	29,390	38,574	1,312	2,100	5.3	7.1	1,970	3.7	5.1	938
	Peas	2,900	3,300	1,138	810	649	810							
	Chick peas	88,000	87,400	993	31,095	30,720	987	519	0.6	1.7	478	0.5	1.6	921
	Dry beans	112,800	122,800	1,089	9,694	10,828	1,116	598	0.5	6.2	515	0.4	5.8	861
	Lentils	104,600	101,000	965	6,795	5,413	796	194	0.2	2.9	114	0.1	2.1	587
	Kidney beans	2,700	2,100	778	1,750	1,550	885	130	4.8	7.4	100	4.8	6.5	770
	Cow vetch	100,000	90,000	900	11,832	7,152	604	311	0.3	2.6	15	0.02	0.2	48
	Wild vetch	122,500	114,000	931	29,543	24,989	845	1,180	1.0	4.0	979	0.9	3.9	829
	Total	573,500	573,600	1,000	120,909	119,875	991	5,032	0.9	4.2	4,171	0.7	3.5	828
Industrial Crops	Tobacco	149,346	89,793	601	88,249	51,714	586	17,439	11.7	19.8	8,641	9.6	16.7	495
	Potatoes	136,900	1,489,000	10,869	10,104	135,053	13,366	527	0.4	5.2	5,642	0.4	4.2	10,705
	Sugar beets	125,739	2,730,932	21,719	10,437	213,374	20,443							
	Hemp Fiber	13,000	9,000	692	4,100	1,929	470							
	Hemp Seed		5,900	454		3,286	801							
	Opium Gum	36,000	300	8	10,432	79	8							
	Opium Seed		19,700	556		4,718	452							
	Anise	3,500	2,200	629	3,222	2,045	634	85	2.4	2.6	40	1.8	2.0	471
	Cotton Lint	660,000	245,000	371	200,085	98,517	492	10,200	1.5	5.1	4,300	1.8	4.4	422
	Cotton Seed		409,000	620		159,966	799				7,000	1.7	4.4	686
	Flax Fiber	29,000	3,500	120	2,487	20	8							
	Flax Seed		19,000	655		1,685	678							
	Onion	48,800	430,000	8,811	7,463	45,912	6,151	710	1.5	9.5	1,000	0.2	2.2	1,408
	Garlic	8,000	27,000	3,375	1,695	4,628	2,730	188	2.4	11.1	186	0.7	4.0	989
	Sesame	71,000	41,000	577	32,105	17,345	540	7,100	10.0	22.1	4,087	10.0	23.6	575
	Others	103,760	93,100	897	14,123	14,341	1,015	590	0.6	4.2	841	0.9	5.9	1,425
	Total	1,385,045	5,614,425	1,054	384,502	754,612	1,963	36,839	2.7	9.6	31,737	0.6	4.2	862

Table 3-2-3 (Continued)

	Item / Tree	National Totals Area Sown (A) Hectares	National Totals Production (B) Tons	National Totals Yield Kg. per Hec.	Region II (Aegean) 1 Area Sown (C) Hectares	Region II (Aegean) 1 Production (D) Tons	Region II (Aegean) 1 Yield Kg. per Hec.	Muğla Prefecture Area Sown (E) Hectares	Muğla Area Sown $\frac{(E)}{(A)} \times 100$ (%)	Muğla Area Sown $\frac{(E)}{(C)} \times 100$ (%)	Muğla Production (F) Tons	Muğla Production $\frac{(F)}{(B)} \times 100$ (%)	Muğla Production $\frac{(F)}{(D)} \times 100$ (%)	Muğla Yield Kg. per Hec.
Fruits	Grapes •	773,030	3,382,270	4,375	137,987	882,183	6,393	2,413	0.3	1.7	15,927	0.5	1.8	6,600
	Melons •	219,000	2,970,000	13,561	55,903	647,637	11,585	1,685	0.8	3.0	22,487	0.8	3.5	13,345
	Citrus •	8,734	2,348,867	268	1,675	198,827	119	1,129	12.9	67.4	94,923	4.0	47.7	84
	Other fruits •	71,175	1,156,240	16	12,624	283,207	22	699	1.0	5.5	12,793	1.1	4.5	18
	Hazelnuts •	174,862	122,380	1	14	42	3	-			-			-
	Pistchios, Almonds, Walnuts •	15,712	114,430	7	1,512	17,065	11	218	1.4	14.4	2,229	1.9	13.1	10
	Olives •	59,909	290,200	5	44,883	173,721	4	8,966	15.0	20.0	2,970	1.7	1.7	-

• Area sown refers to number of trees in thousands and production refers to number in thousands.

Note: Correction has been made by the letter received from Kars government on vineyard area figures for the years 1960-61-62.

Table 3-2-4 Livestock Structure and Products

Livestock (Head) - 1962 -

Kinds of Livestock	National Totals (A)	Region II (Aegean) 1 (B)	Muğla Prefecture (C)	(C)/(A) x 100 (%)	(C)/(B) x 100 (%)
Sheep	31,614,000	3,828,242	209,546	0.7	5.5
Ordinary goats	16,420,000	2,878,727	364,685	2.2	12.7
Angora goats	5,655,000	26,956			
Cattle	12,662,000	1,285,352	133,950	1.1	10.4
Buffaloes	1,159,900	86,077	420	0.04	0.5
Camels	52,680	16,177	4,996	9.5	30.9
Horses	1,238,500	206,536	14,210	1.1	6.9
Mules	207,800	27,489	6,803	3.3	24.7
Donkeys	1,880,400	403,414	46,988	2.5	11.6
Beekives	1,522,400	379,893	86,604	5.7	22.8
Chickens	26,514	4,658	724	2.7	15.5
Livestock Products					
Milk Production					
Sheep	757,330	113,123	7,315	1.0	6.5
Ordinary goats	617,420	104,382	19,595	3.2	18.8
Angora goats	63,580	292			
Cows	2,359,570	300,722	20,899	0.9	6.9
Buffaloes	277,220	24,300	91	0.03	0.4
Wool	42,710	5,426	233	0.5	4.3
Hair	9,280	1,323	157	1.7	11.9
Mohair	8,870	34			
Honey	8,507	2,435	398	4.7	16.3
Eggs △	1,349,947	261,020	33,002	2.4	12.6

△ Number in thousands.

Table 3-2-5 1960-1964 Wholesale Price Indices of Agricultural Commodities 1958=100

Commodities Group	1960	1961	1962	1963	1964	Remarks
1. All Item Total	126	130	137	143	142	95 Articles
2. Foodstuff and Fodder	127	136	148	154	151	
Vegetables	130	146	163	168	158	
Live stock	98	92	103	116	130	
Animal Products	144	139	134	143	147	

Source : State Institute of Statistics Bulletin Dec. 1964

The estimated domestic demand for agricultural products in recent years is shown in Table 3-2-6.

Table 3-2-6 Estimates of Demand for Agricultural Commodities

Crops	Quantity Estimated (Million Ton)				Remarks
	1962	1963	1964	1965	
Wheat	7,345	7,545	7,780	8,025	Seeds and Wastage Included
Rice	112	119	126	134	Ditto
Maize	810	832	855	878	Ditto
Other Cereals	1,070	1,070	1,065	1,063	Seeds Excluded
Pulses	337	348	360	374	Seeds and Wastage Included
Vegetabls	3,305	3,605	3,800	4,000	Production
Potatoes	1,489	1,600	1,500	1,600	Ditto
Grapes	2,960	2,357	2,800	2,896	Dried Grapes Excluded
Citrus	215	289	217	285	
Apples	322	326	300	325	Seeds Excluded
Meat	430	452	481	510	
Milk	3,281	3,384	3,481	3,634	

Source : Development Plan 1965 Annual Programme

Estimates of crops and livestock production are shown in Table 3-2-7. Farmlands are exploited almost to the greatest possible extent under the present technical level. It is expected such exploitation of soil will be continued in the future. When the productivity of farmlands is taken into consideration, however, it cannot be said that the present agricultural production represents the fullest and maximum use of farmlands in the country.

Table 3-2-7 Estimates of Crops and Livestock Production

Crop	Quantity (Million Ton)			
	1962	1963	1964 E	1965 E
Wheat	8,450	9,500	8,350	8,650
Barley	3,500	4,288	3,400	3,750
Maize	800	990	1,000	1,100
Rice	165	130	130	150
Pulses	370	381	400	420
Sugar Beet	2,730	3,281	3,600	3,900
Tobacco	82	132	145	145
Cotton	245	257	270	300
Potatoes	1,489	1,600	1,500	1,600
Sunflower	60	87	120	120
Vegetables	3,305	3,605	3,800	4,000
Oranges	219	300	230	310
Lemons	74	78	65	80
Peaches	74	63	90	95
Tea (Green)	37	47	57	65
Apples	322	326	300	325
Grapes	3,382	2,693	2,300	3,250
Figs	210	208	225	225
Hazel Nuts	122	88	164	110
Olives	290	619	600	550
Meat	460 E	475 E	490	515
Milk	3,281 E	3,384 E	3,481	3,634
Wool	43	45	47	50

E : Estimated

Source : Development Plan 1965 Annual Programme

In general it can be said that the present indigenous agricultural production is commensurate with domestic demand. Consumption of those products, which are neither exported nor imported, has been changing year by year according to the output. From the long-range standpoint, however, efforts should be made to regulate production in accordance with the increase in demand. The major agricultural export items in recent years are shown in Table 3-2-8.

Table 3-2-8 Exports of Agricultural Products (At Current Prices)

Products	1962		1963		1964*		1965*	
	Q	V	Q	V	Q	V	Q	V
	1,000 t	ML. TL.	1,000 t	ML. TL.	1,000 t	ML. TL.	1,000 t	ML. TL.
Barley	-	-	58	26	60	22	35	18
Lentils	20	21	21	16	30	27	35	32
Canary Seed	10	12	11	13	10	10	10	10
Chick Peas	10	11	2	3	3	2	5	3
Oranges	4	3	11	10	15	12	13	10
Hazelnuts	44	504	41	485	43	504	45	486
Raisins	69	148	66	149	60	157	60	171
Figs	30	51	27	53	32	58	30	54
Lemons	10	12	11	12	14	16	13	13
Pistachio Nuts	5	43	3	31	3	28	5	47
Tobacco	90	865	45	600	60	756	80	900
Cotton	105	562	135	705	100	540	130	675
Cattle	123	59	115	55	150	72	120	59
Sheep	621	76	561	71	650	81	600	81
Goats	323	28	274	24	350	29	300	27
Wools	4	28	4	29	5	31	5	40
Mohair	5	69	7	114	5	72	7	117

* Programme Estimates   Q : Quantity (1,000 t)
V : Value (1,000,000 T.L.)

The estimates of investments in 1962-1965 for the expansion of agricultural production are shown in Table 3-2-9.

Table 3-2-9 Estimates of Investment in Crops and Livestock

Million TL.

Item	1962	1963	1964	1965	Remarks
Public	518	564	995	1,258	E: Estimated
Private	298 E	559	568 E	695 E	
Total	816 E	1,123 E	1,563 E	1,953 E	

3-2-2 NECESSITY FOR AGRICULTURAL DEVELOPMENT IN TURKEY

Agricultural production in Turkey is balanced with internal demand to a certain extent. Industrial production, however, is still in the stage of development, and it is necessary to import industrial machinery and equipment in order to accelerate the modernization of the country. Also, for the improvement of the cultural level of the nation, foreign commodities must be imported at the expense of the nation's foreign exchange reserves. Because of these circumstances, the balance of foreign trade has always been unfavorable since 1947. It is therefore an urgent and important problem to expand agricultural production as a means of earning foreign exchange.

The goals of gross national production and agricultural production under the 15-Year Plan are shown in Table 3-2-10.

Table 3-2-10 Estimates of GNP and Agricultural Product

Year	GNP (Billion TL)	Agricultural Product (Billion TL)	Agricultural Product (as % of) G N P	Agricultural Product per Capita (T L)	Agricultural Product per Capita of Rural Population (T L)	Agricultural Product per Capita of Active Rural Population (T L)
1962	52.7	23.1	43.8	785	1,100	2,400
1967	73.9	28.3	38.3	838	1,300	2,700
1977	145.3	42.7	29.4	941	1,900	3,800

It is expected that the present irrigated area, which amounts to one million ha, will increase to three million ha by 1977 when the plan will be completed.

(See 2-6-2, Economy)

The First Five-Year Plan was formulated and is in the stage of implementation as a means of accomplishing these long-range goals. The major objectives established by this Five-Year Plan in the agricultural field can be summarized into the following four items:

(1) Achievement of an increase in agricultural production which will sustain an average 7 percent per annum increase in national income.

(2) Improvement of the level of nutrition of the people to keep the dependency on cereals at 68 % and alter the ratio of vegetable protein and animal protein to 80.3 % and 19.7 %, respectively, with the object of securing 3,000 calories per capita by 1967.

(3) Promotion of social welfare benefits according to the goals set forth in the Five-Year Plan.

(4) Establishment of a long-term balance in land use.

The Government and people are making concerted efforts for such important purposes as reform of agricultural structure, development of intensive agriculture, establishment of measures for the acceleration of the development of agricultural cooperatives, development of farmlands by such projects as irrigation and drainage, soil conservation and fertilization, plant breeding, prevention of insect damage and the promotion of livestock and marine product industries.

As can be seen from the above, agricultural development in the Republic of Turkey is widely recognized to be one of the basic requirements indispensable for the development of the nation. The Survey Mission, too, recognizes this necessity.

3-2-3 NECESSITY OF AGRICULTURAL DEVELOPMENT IN THE DALAMAN PLAIN

The present state of agriculture in the Dalaman Plain will be described in detail in 5-5 and Appendix. Despite the fact that climatic conditions in the project area are favorable for the growing of crops, agricultural production is not stabilized because of unsuitable environmental conditions.

In the rainy season from winter to spring, the Dalaman overflows and inflicts direct damages to crops and agricultural facilities. Because of inadequate drainage system, the floodwaters remain on the ground for a long time causing the farmers to miss the optimum time for sowing or havesting. Moreover, the water remaining on the ground and that from the Dalaman or other sources cause the underground water level to rise, hindering satisfactory growth of crops. Also, the irrigation water is being obtained by natural intake from the Dalaman River.

This makes it impossible to secure sufficient supply of water for irrigation in the drought season. Furthermore, every time the river overflows, the river channel changes its course and therefore requires great expenditures of labor and money for the maintenance and control of intake facilities. Thus, securing of irrigation water is far from stabilized.

To eliminate the aforementioned factors which are hindering the development of agricultural production in the project area, the following measures should be taken.

(1) Prevention of the Dalaman River and the Thersakan Stream from overflowing into farmlands.

(2) Improvement of the drainage system in the farmlands, and maintenance of the ground waters at proper level, so that the soil will be controlled to have optimum moisture available for the growth of crops.

(3) Improvement of the irrigation system, so that the necessary supply of water can be obtained at any time for the cultivation of all kinds of crops.

(4) Land readjustment, terminal irrigation and drainage networks and agricultural roads, thereby facilitating control of water in the farmlands and improving the efficiency of agricultural production.

For the positive development of agriculture in the Dalaman Plain, not only should the basis of agricultural production be strengthened by the aforementioned measures, but also such steps as improvement of agricultural techniques, agricultural management and marketing structure should be taken in connection with the aforementioned efforts.

4. BASIC INFORMATION

4. BASIC INFORMATION

4-1 HYDROLOGY

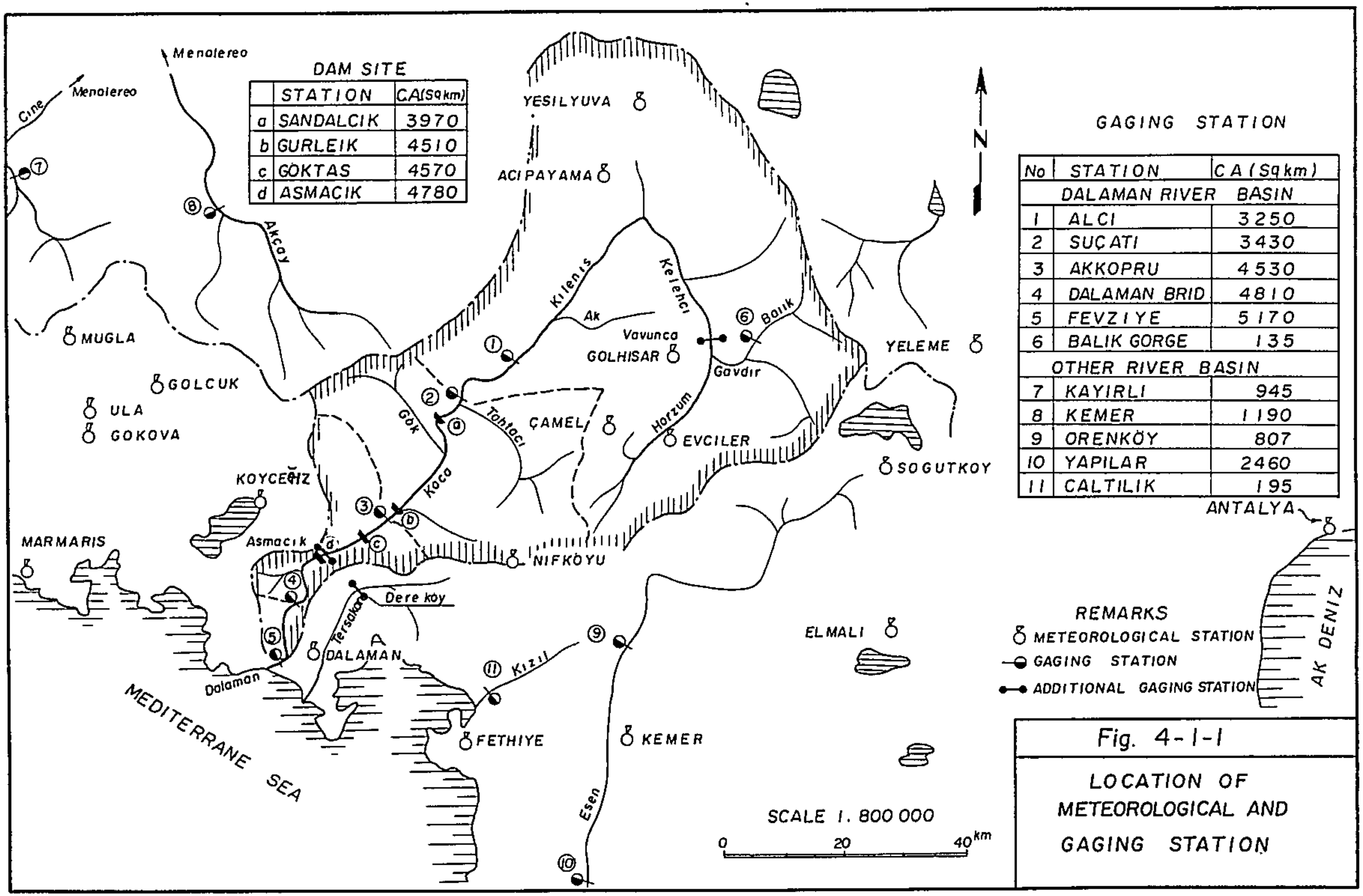
4-1-1 GENERAL DESCRIPTION

The locations of meteorological observation stations and run-off gaging stations in the Dalaman River catchment area and the surrounding district are as shown in Fig. 4-1-1. The records of precipitation and run-off are shown in Table 4-1-1 and Table 4-1-2.

Regarding precipitation observation stations, there are some, such as those at Fethiye, Mugla and Antalya, having records of 25 or more consecutive years with Antalya even having records of hourly precipitation. However, the overall distribution ratio of the stations is about 1 per every 700 km^2 which cannot be said to be adequate for the purpose of hydrological analyses.

As for run-off gaging stations, there are stations with consecutive records for many years outside of the Dalaman River drainage basin, but within the area the records are interrupted with not a single station with consecutive records for more than 10 years. Taking into consideration the inconvenience of transportation in this area it would be desirable to at least have records for the recent several years from more than 2 sites in this basin in order to prepare development plans.

A study of the run-off and flood discharge of the proposed project sites based on these records are described hereinafter.



DAM SITE

	STATION	CA(Sqkm)
a	SANDALCIK	3970
b	GURLEIK	4510
c	GOKTAS	4570
d	ASMACIK	4780

GAGING STATION

No	STATION	CA (Sqkm)
	DALAMAN RIVER BASIN	
1	ALCI	3250
2	SUÇATI	3430
3	AKKOPRU	4530
4	DALAMAN BRID	4810
5	FEVZIYE	5170
6	BALIK GORGE	135
	OTHER RIVER BASIN	
7	KAYIRLI	945
8	KEMER	1190
9	ORENKÖY	807
10	YAPILAR	2460
11	CALTILIK	195

Fig. 4-1-1

LOCATION OF METEOROLOGICAL AND GAGING STATION

TABLE. 4-1-1 PRECIPITATION RECORD (DAILY)

STATION	'40	'41	'42	'43	'44	'45	'46	'47	'48	'49	'50	'51	'52	'53	'54	'55	'56	'57	'58	'59	'60	'61	'62	'63	'64	'65
ANTALYA	FROM 1929 JAN.											(HOURLY RECORD)														
YELEME																							APR			
SOGUTKOY																						JUN				
ELMALI																										
KEMER																							OCT.			
GOLHISAR																							DEC			
ÇAMEL																						JUN				
EVCILER																										
NIFKOYU																										
FETHIYE	FROM 1939 JAN																									
YESILYUVA											AUG				NOV			MAR								
ACIPAYAMA											MAR	AUG			JUL		JUL				JAN		NOV.			
DALAMAN																	APR		AUG							
KOYCEĞIZ																										
MUGLA	FROM 1929 JAN																									
GÖLCUK																										
ULA																		AUG								
GOKOVA																										
MARMARI																										

TABLE. 4-1-2 DISCHARGE RECORD (DAILY)

STATION	RIVER	C A. (Sq. km)	'43	'44	'45	'46	'47	'48	'49	'50	'51	'52	'53	'54	'55	'56	'57	'58	'59	'60	'61	'62	'63	'64	'65
DALAMAN RIVER BASIN																									
ALCI	DALAMAN	3,430	FROM 1940 OCT.												SEP										
SUÇATI	DALAMAN	3,250																		OCT				SEPT	
AKKOPRU	"	4,530																				OCT.		SEPT	
DALMAN BRID.	"	4,810			FROM 1939 NOV																OCT			SEPT	
FEVZIYE	"	5,170			JUN							OCT						SEP.							
BALIK GORGE	BALIK	135																			OCT			SEPT	
OTHER RIVER BASINS (NEAR DALAMAN RIVER)																									
KEMER	AKÇAY	1,190																				OCT		SEPT	
KAYIRILI	CINE	945	FROM 1937 OCT																					SEPT	
ORENKÖY	ESEN	807																		OCT				SEPT	
YAPILAR	"	2,460																			OCT		SEPT		
CALTILIK	KIZIL	195																			MAR		SEPT		
AYDIN	MENDERES	19,200								APR.													SEPT		
ÇAL	"	4,200	FROM 1940 JAN																	SEPT					
SÖKE	"	23,600								OCT.													SEPT		
BESKONAK	KOPRU	2,070	FROM 1940 JAN																				SEPT		

4-1-2 STUDY OF HYDROLOGICAL DATA

a. Outline

In preparation of a development program for the Dalaman River, a study was made of the discharges at the proposed project sites based on hydrological data of Tables 4-1-1 and 4-1-2. As the hydrological records of the catchment area are inadequate as stated in 4-1-1, it was necessary to make supplements and adjustments based on information on run-off or precipitation of other catchment areas.

Of the 6 gaging stations in the catchment area, run-off data of 3 were not used in preparing plans. These are Balik Gorge, the farthest upstream, because run-off data for estimating the discharge in the downstream were available at Suçati Gaging Staion; Fevziye, the farthest downstream gaging station was not used to be on the safe side because of its poor correlation and large specific run-off compared with run-off of other gaging stations, and Dalaman Bridge, because water for irrigation is diverted on the upstream and the amount of this intake is unknown.

Alci and Suçati can be considered to be interrelated gaging stations since there are little difference in their catchment areas. These two stations fortunately have good correlation with Kayirli Gaging Station on the Cine River, and by supplementing records from Kayirli for the period from 1955 to 1960 during which observation records are not available at the former two stations, data for 21 consecutive years were prepaud.

The run-off at Akköprü Gaging Station, where the location of the station is relatively good with good correlation with Alci (or Sucati) and Kayirli Gaging Stations, was compiled for 21 consecutive years by supplementing data from Alci and from Kayirli for periods when data from Alci were not available.

The annual average specific run-off at Suçati (including the catchment area estimated from Alci, hereinafter called Suçati) is 0.47 $m^3/s/100\ km^2$.

The annual average specific run-off at Akköprü is 0.95 $m^3/s/100\ km^2$ showing a sudden increase between Suçati and Akköprü. This is understandable in view of the precipitation distribution in Fig. 4-1-4, (see "c"), where it can been seen that rainfall increases suddenly with Suçati as a boundary. From the variation curves of annual precipitation and annual average specific run-off in Fig. 4-1-6, (see "c"), it is seen that rainfall has a cycle of about 10 years and therefore it is thought that data for 21 consecutive years will be sufficient for the purpose of planning.

The discharges at the proposed project sites were obtained for 21 consecutive years from 1943 to 1964 using the equation below with Qs, Qa and Qx as run-off at Suçati, Akköprü and the particular site in question respectively and As, Aa and Ax as the catchment area of Suçati, Akköprü and the site in question respectively.

$$Qx = Qs + (Qa - Qs) \times \frac{Ax - As}{Aa - As}$$

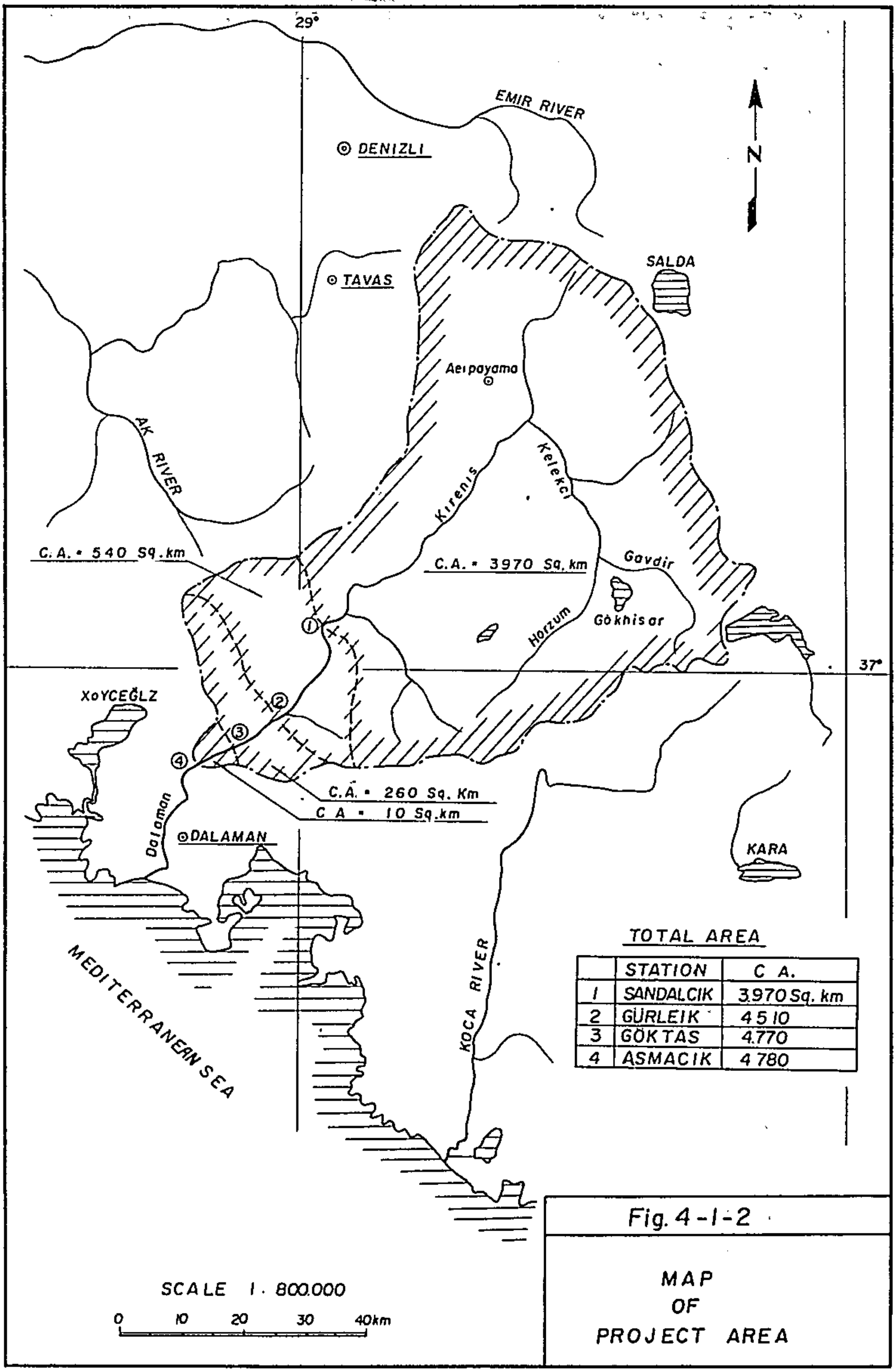
The discharges thus obtained, not considering the basin upstream from Suçati, are based on run-off at Akköprü from only a 2 year period. Long-term estimates based on such a short period cannot be said to be highly reliable, but since there is no other method of calculation at this stage, these figures were used as a basis for planning.

b. Catchment Areas

The catchment areas of the proposed project sites on the Dalaman River are shown in Fig. 4-1-2. The areas are as given below.

		Catchment Area	
Project Site	Unit	Total Area	Area Proper
Sandalcik	Km^2	3,970	.3,970
Gürleik	"	4,510	540
Göktas	"	4,770	260
Asmacik	"	4,780	10

The profile of the Dalaman River basin is shown in Fig. 4-1-3.



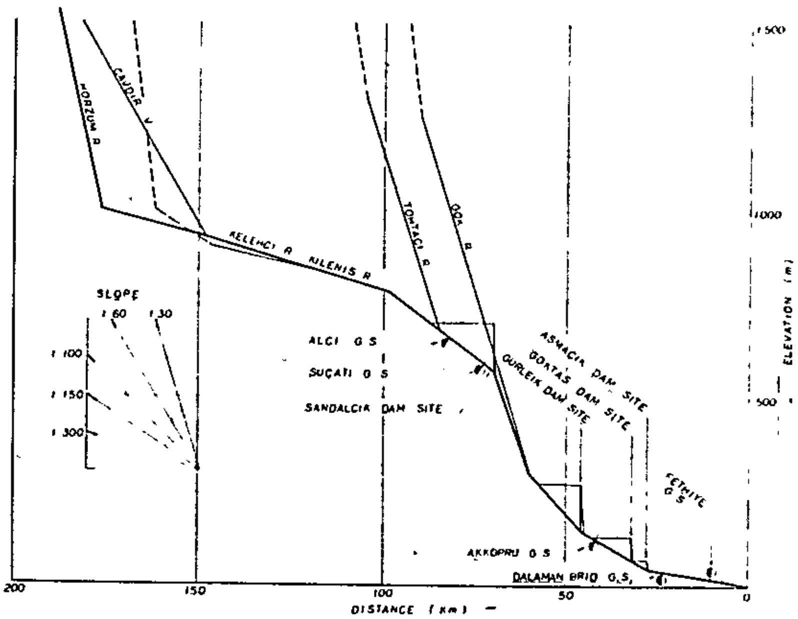
TOTAL AREA

	STATION	C A.
1	SANDALCIK	3.970 Sq. km
2	GÜRLEIK	4 510
3	GÖKTAS	4.770
4	ASMACIK	4 780

Fig. 4-1-2

MAP OF PROJECT AREA

Fig. 4-1-3 Profile of Dalaman River



c. Precipitation

According to Bati Akdeniz Havzasi Istikcaf Raporu (D.S.I. Ankara, 1962) the distribution of precipitation in the Dalaman River catchment area is as shown in Fig. 4-1-4. It will be noted that precipitation is greater in the lower basin than in the upper basin. The annual precipitation in the latter being about 600 mm while in the former it is about 1,200 mm.

The monthly variation in precipitation is given in Fig. 4-1-5. According to this trend a year can be roughly divided into two periods, the dry period from April to September, and the wet period from October to March. For the purpose, among others, of studying the relation between precipitation and run-off, the hydrologic year was considered to be from the beginning of the dry season to the end of the wet season (October to September).

The variations in annual precipitation at the various observation stations are given in Fig. 4-1-6. It is shown that in an spproximate ten-year cycle, the annual precipitation fluctuates relatively little. For example, at Fethiye, the wettest year is 140 and the driest year 65 against an index of 100 for an average year. In studying the monthly and daily precipitation in

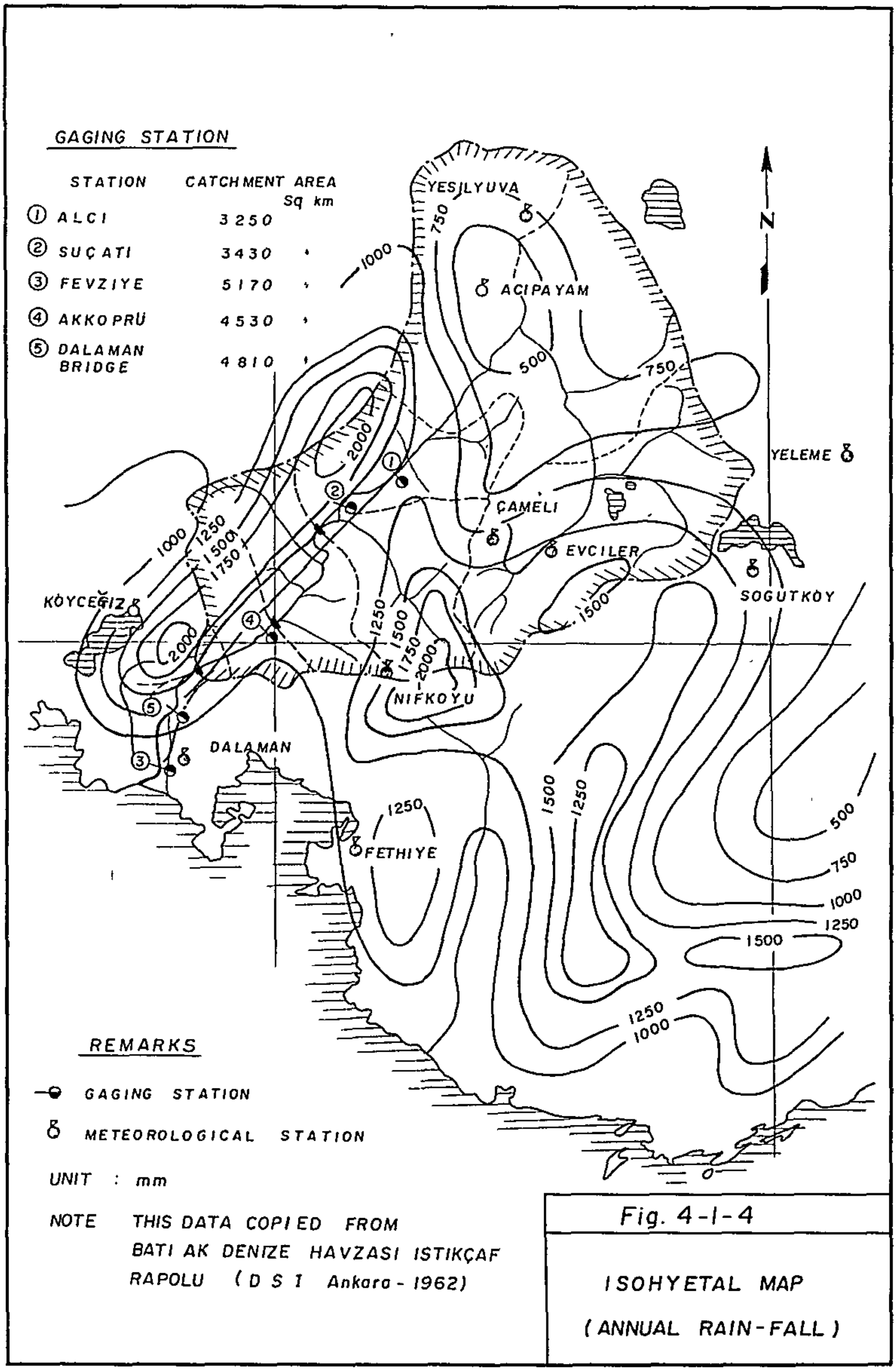


Fig. 4-1-4

ISOHYETAL MAP

(ANNUAL RAIN-FALL)

the Dalaman River, although there may be considerable differences quantitatively, there are only a few occasions when there would be rainfall at Fethiye and no rainfall at Acipayama on the same day.

Fig. 4-1-5 MONTHLY AVERAGE PRECIPITATION

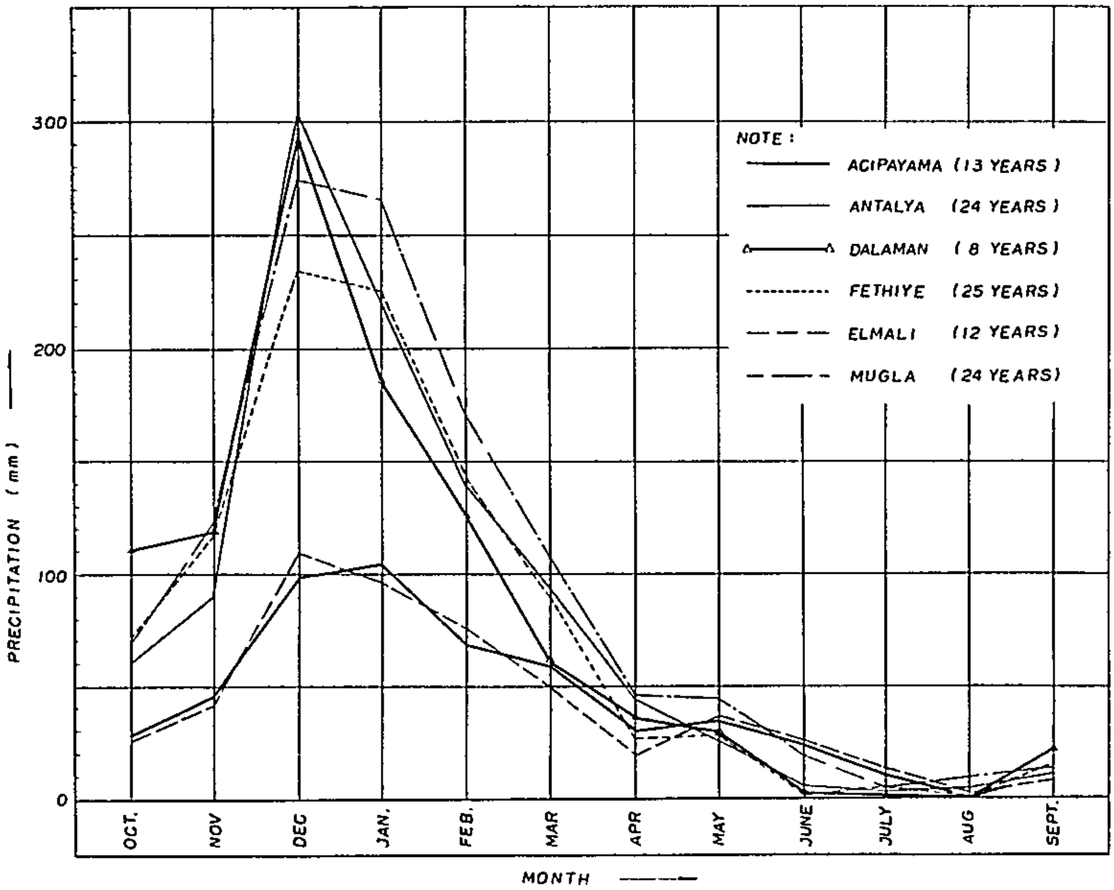
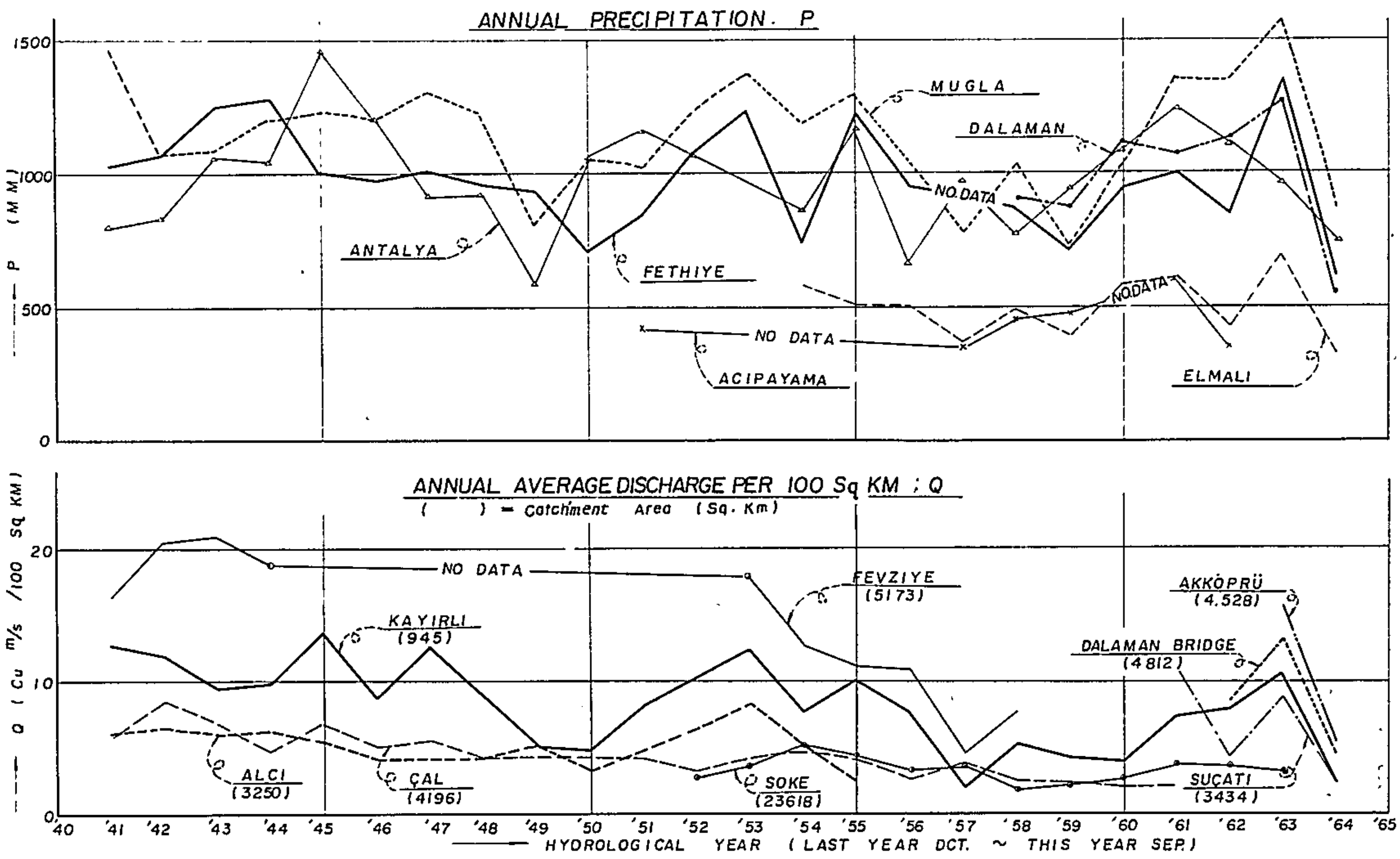


Fig 4-1-6 VARIATION OF ANNUAL PRECIPITATION AND OF ANNUAL AVERAGE DISCHARGE PER 100 Sq.KM



d. Run-off

d-1 Run-off Records

o Alci and Suçati Gaging Stations:

The two gaging stations are located on the upper stream of the Tahtaci River where there is abundant rainfall and since the difference in catchment area is only 180 km^2, they will be considered to be interrelated gaging stations. Therefore, the catchment area of Alci is converted into that of Suçati and will be considered to come under Suçati Gaging Station. The correlations between monthly run-off at Suçati and Kayirli, and between Suçati and Akköprü (the correlation between cumulative run-off from October to September for Şucati and Kayirli, and the monthly run-off for Sucati and Akköprü; details of which are described later) are comparatively good as shown in Fig. 4-1-9 and Fig. 4-1-10. Suçati is a gaging station established several years ago upon opening of a road in the area. The topography around the station is good as is the condition of the river bed. As stated above, the correlation with discharge at other gaging stations is also good. The location of the station is good and records for a comparatively long period are available so that the station is suitable for reference in preparation of development plans.

o Akköprü Gaging Station:

Although data is scarce, the correlations between monthly run-off at Akköprü and Suçati, and Akköprü and Kayirli are good as seen in Fig. 4-1-10 and Fig. 4-1-11. The condition of the river bed, topography, etc. are also relatively good. Therefore, if run-off in the past is estimated from Fig. 4-1-10 and Fig. 4-1-11, estimates for a long period can be obtained and they may be used in the planning.

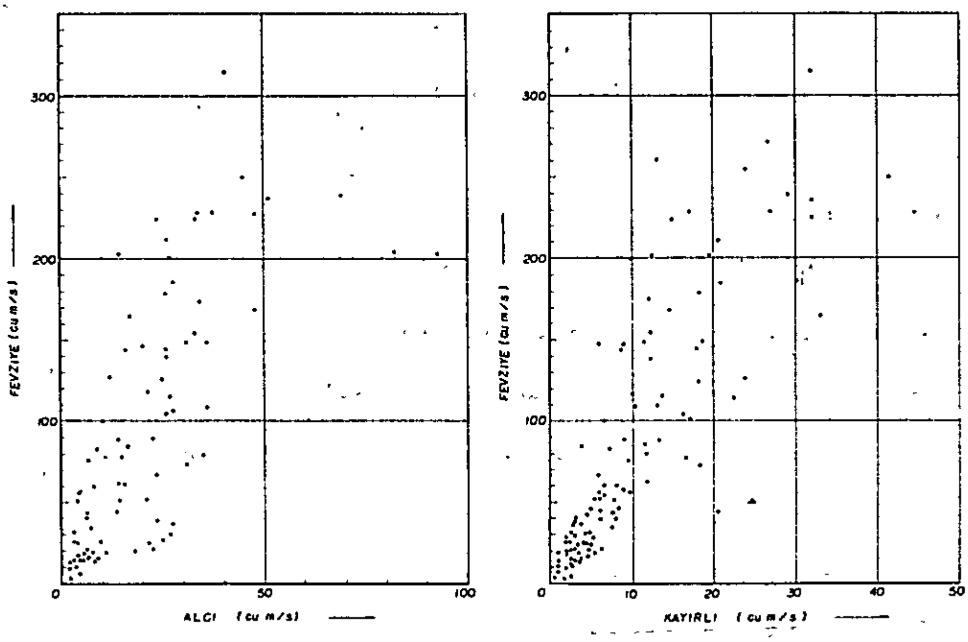
o Dalaman Bridge Gaging Station:

This gaging station has no defects but irrigation water is unfortunately being drawn on the upstream of the station and the amount of water taken is not known. Therefore unless the amount of irrigation water taken is known, the station is unsuitable for use in preparation of plans.

o Fevziye Gaging Station:

The correlation between monthly run-off at Fevziye and Alci, and Fevziye and Kayirli, as shown in Fig. 4-1-12, are extremely poor. Also, the specific run-off compared to those at Akköprü and the other stations is thought to be too great and to be on the safe side, data from this station were not included in the present plans.

Fig. 4-1-12 Correlation Between Fevziye and Alci, Kayirli (Monthly Average Dischage)



d-2 Run-off at gaging stations used in the planning as stated in d-1 above, only two gaging stations, Suçati (or Alci) and Akköprü, can be used for planning under the present circumstances. However, even these two stations have periods without records and it becomes necessary to estimate run-off for those periods by some method or other. The method of estimating discharge for those periods and calculations of discharges over the entire priod are described hereinafter.

o Suçati Gaging Station:

Up to September, 1954

Estimates were made from run-off at Alci Gaging Station based only on ratio of catchment area.

$$Qs = Qal \times \frac{3430}{3250} = 1.06\ Qal \quad \text{(4-1-1)}$$

where Qs = average monthly run-off at Suçati (m^3/s)

Qal = average monthly run-off at Alci (m^3/s)

From October, 1954 to September, 1961

The correlation between monthly run-off at Suçati and Kayirli as shown in Fig. 4-1-7 but it is not very good. However, the correlation of annual precipitation is comparatively good as seen in Fig. 4-1-8. In planning a large reservoir, some monthly fluctuation can be neglected if errors in annual run-off is small, and therefore these correlations are usable.

Fig. 4-1-7 Relation Between Kayirli and Suçati
(Monthly Average Discharge)

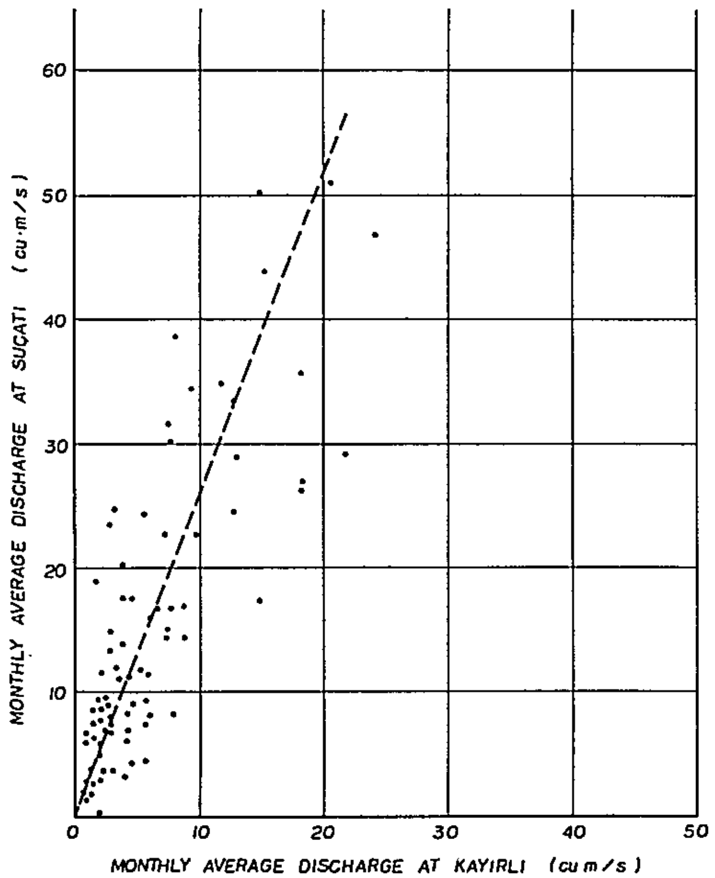


Fig. 4-1-8 Relation Between Kayirli and Suçati
(Annual Average Discharge)

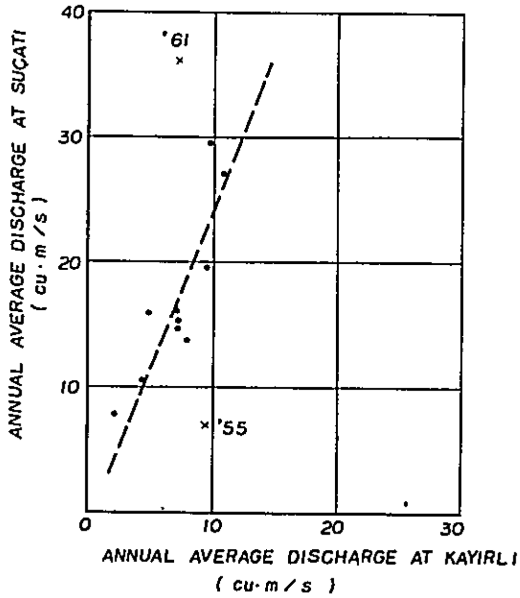
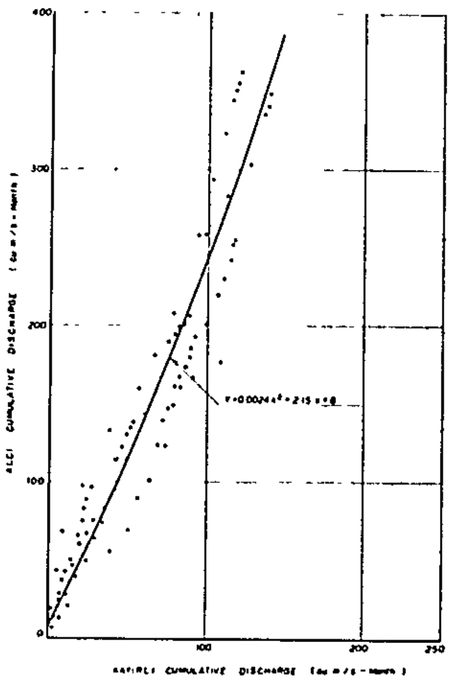


Fig. 4-1-9 Correlation Between Suçati and Kayirli
(Cumulative Discharge)



Although there may be some monthly errors, as a method of reducing these errors over the period of one year, the respective run-offs were totalled from October to September, and with Suçati on the ordinate and Kayirli on the abscissa, the run-off during the periods before and after the unrecorded periods were plotted to obtain a rather good result as shown in Fig. 4-1-9. For the hydrological years of 1954 and 1961, the run-offs actually observed at Suçati had poor correlation with Kayirli and other stations and since the data were for the first and last years of observation, the reliability of the records could not be considered to be very good so that for those years to be on the safe side the run-off at Sucati was calculated from Fig. 4-1-9 using the run-off at Kayirli Gaging Station.

$$Qs = Qal \times \frac{3430}{3250} = 1.06\ Qal \quad \ldots\ldots (4\text{-}1\text{-}2)$$

where Qs = average monthly run-off at Suçati (m^3/s)

Qal = average monthly run-off at Alci calculated from Fig. 4-1-7 using average monthly run-off at Kayirli

October, 1961 to September, 1964

Data as recorded at Suçati Gaging Station were used.

Akköprü Gaging Station:

Up to September, 1954

In taking the average monthly run-offs of Akköprü and Suçati on the ordinate and abscissa respectively, the relation between the two is found to be good as shown in Fig. 4-1-10 so that for this period Fig. 4-1-10 (Equation 4-1-3) was applied and the run-off at Akköprü was estimated from the run-off at Suçati.

$$Qa = 1.94\ Qs + 10 \quad \ldots\ldots (4\text{-}1\text{-}3)$$

where Qa = average monthly run-off at Akköprü (m^3/s)

Qs = average monthly run-off at Suçati (m^3/s)

Fig. 4-1-10 Correlation between Akköprü and Suçati
(Monthly Average Discharge)

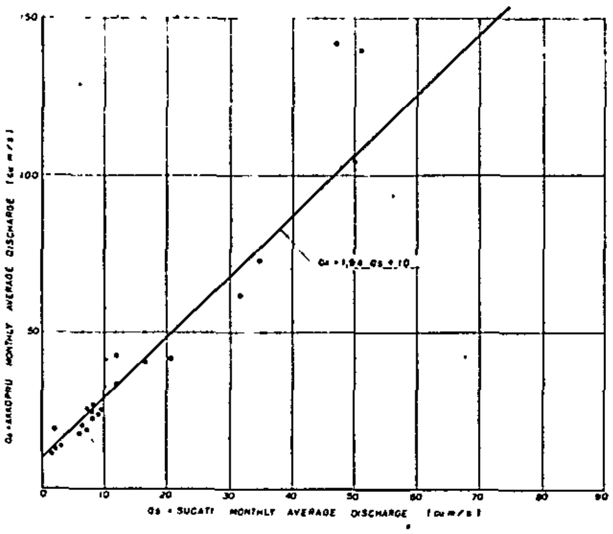
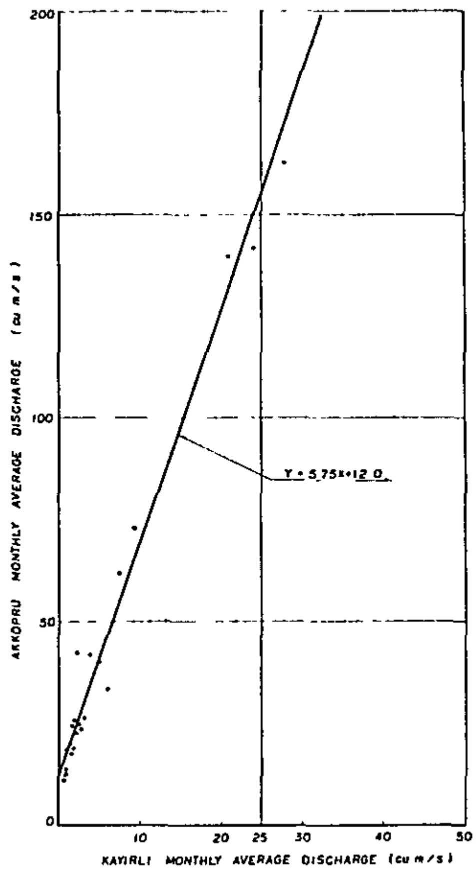


Fig. 4-1-11 Correlation between Akköprü and Kayirli
(Monthly Average Discharge)



October, 1954 to September, 1961

The correlation of average monthly run-off at Akköprü and Kayirli is also good as seen in Fig. 4-1-11 so that for this period Fig. 4-1-11 (Equation 4-1-11) was used to estimate run-off at Akköprü from run-off at Kayirli.

$$Qa = 5.75\ Qk + 12 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4\text{-}1\text{-}4)$$

where Qa = average monthly run-off at Akköprü (m^3/s)

Qk = average monthly run-off at Kayirli (m^3/s)

October, 1961 to September, 1962

Same as the period up to and including September, 1954.

October, 1962 to September, 1964

Actual recorded data at Akköprü were used.

The run-off at the two stations for the entire period (21 years from 1943 to 1964) can be calculated according to the above data and the results are shown in Table 4-1-3 and Table 4-1-4.

Upon investigation of the cycles of precipitation and run-off they are found to be approximately 10 years. It would be appropriate in consideration of the cycle to take the latest 10-year run-off in the preparation of plans. However, as previously described, the available recorded observation data for the catchment area are for two to four year periods with the remainder estimated from records of other areas. Though the recorded data at Alci are old, since the recorded period is long it was thought higher reliability could be obtained by using those records which are from the catchment area, so that approximately 2 cycles or 21 years were taken into consideration.

TABLE 4-1-3 DISCHARGE STATION SUÇATI (ALCI) CATCHMENT AREA 3430 sq. km Dalaman, Turkey

DALAMAN RIVER, IN THE BASIN OF DALAMAN ELEVATION m UNIT Cu. m/s S ° ' W ° '

YEAR	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRURY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	ANNUAL
'43 - '44	26.60	22.90	37.50	35.80	73.30	29.60	15.20	4.70	3.20	3.00	3.00	2.90	21.40
'44 - '45	6.10	6.50	16.20	50.40	28.20	32.60	36.90	14.30	4.60	7.30	7.30	6.60	18.10
'45 - '46	10.40	10.50	26.90	16.60	40.20	18.00	19.10	8.50	5.40	3.10	3.10	4.10	13.80
'46 - '47	7.80	6.00	35.10	31.30	28.10	14.80	6.80	3.20	6.00	20.20	4.80	5.30	14.10
'47 - '48	6.00	8.70	26.70	26.90	27.40	16.80	17.30	17.80	6.60	5.60	7.10	8.60	14.60
'48 - '49	11.40	11.60	17.20	14.30	13.50	77.30	32.20	10.90	8.90	3.40	3.90	4.90	17.50
'49 - '50	6.90	18.20	18.00	17.10	6.60	8.30	8.40	30.50	8.60	3.90	4.00	3.90	11.20
'50 - '51	6.10	7.00	7.70	29.10	17.70	33.00	39.10	9.40	12.00	15.10	9.00	9.30	16.20
'51 - '52	13.70	14.70	11.80	15.10	67.80	44.30	34.40	17.20	11.70	11.50	9.80	3.90	21.30
'52 - '53	12.00	35.10	27.20	87.00	97.80	24.80	14.70	4.70	24.90	7.90	5.00	7.90	29.00
'53 - '54	19.30	23.70	24.90	29.00	35.70	26.40	22.80	8.60	4.40	4.10	3.60	3.90	17.20
'54 - '55	• 14.80	• 15.30	• 40.60	• 69.10	• 63.80	• 26.90	• 22.70	• 12.70	• 7.40	• 6.90	• 4.70	• 5.30	24.20
'55 - '56	• 10.60	• 23.20	• 11.60	• 14.80	• 62.80	• 35.30	• 17.90	• 12.70	• 5.80	• 5.80	• 3.20	• 2.60	17.20
'56 - '57	• 9.50	• 5.30	• 7.40	• 8.40	• 6.90	• 7.90	• 4.70	• 4.20	• 4.70	• 2.10	• 1.10	• 2.10	5.40
'57 - '58	• 9.50	• 5.30	• 6.30	• 27.50	• 13.70	• 35.90	• 17.40	• 10.60	• 5.80	• 3.20	• 3.70	• 1.10	11.70
'58 - '59	• 10.60	• 4.20	• 11.30	• 44.80	• 12.10	• 8.40	• 5.80	• 4.20	• 6.30	• 2.10	• 1.60	• 1.10	9.40
'59 - '60	• 9.00	• 5.80	• 15.80	• 40.10	• 9.50	• 6.90	• 7.90	• 3.20	• 3.20	• 2.10	• 1.10	• 1.10	8.80
'60 - '61	• 9.00	• 3.20	• 46.40	• 41.10	• 42.70	• 19.50	• 14.20	• 10.00	• 8.40	• 4.20	• 3.20	• 2.60	17.00
'61 - 62	6.20	7.20	15.10	17.10	43.30	35.10	23.30	13.90	6.70	4.00	2.10	3.60	14.80
'62 - '63	8.00	8.20	47.10	51.20	93.00	50.40	34.90	31.60	20.40	7.70	4.10	6.40	30.20
'63 - '64	7.90	9.50	11.80	9.00	11.80	16.40	9.00	7.30	6.00	3.00	1.40	2.20	7.90
AVERAGE	10.50	12.00	22.00	32.20	37.90	27.10	19.30	11.40	8.10	6.00	4.10	4.30	16.20

(1) • : ESTEMATED BY KAYIRLI G.S.
(2) '43 - '54 : ALCI x $\frac{3.430}{3.250}$ = ALCI x 1.06
(3) '61 - '64 : SUÇATI

TABLE 4-1-4 DISCHARGE

STATION AKKÖPRÜ CATCHMENT AREA 4530 sq. km Dalaman, Turkey

DALAMAN RIVER, IN THE BASIN OF DALAMAN ELEVATION m UNIT Cu. m/s S ° ' W ° '

YEAR	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	ANNUAL.
'43 - '44	61.7	54.4	82.5	79.0	152.0	67.0	39.5	19.0	16.3	15.5	16.0	15.5	51.5
'44 - '45	21.9	22.5	41.0	108.0	64.5	73.0	81.5	37.5	19.0	24.0	23.5	23.0	45.0
'45 - '46	30.2	30.5	62.0	42.0	88.0	45.0	47.0	26.5	20.3	16.0	16.0	18.0	36.8
'46 - '47	25.2	21.5	78.0	70.7	64.5	39.0	23.0	16.5	21.5	49.0	19.0	20.3	37.4
'47 - '48	21.7	27.0	61.5	62.0	63.0	43.0	43.5	44.5	23.0	21.0	23.8	26.5	38.4
'48 - '49	32.2	32.5	43.5	37.5	36.0	160.0	72.5	31.0	27.0	17.0	17.8	19.5	43.9
'49 - '50	23.4	45.0	45.0	43.3	22.5	26.0	26.0	69.0	26.8	17.5	17.5	17.5	31.6
'50 - '51	21.8	24.0	25.2	66.5	44.5	74.0	85.5	28.0	33.5	39.5	27.5	28.0	41.5
'51 - '52	36.6	38.5	33.0	39.0	142.0	95.5	76.0	43.3	32.7	32.5	28.8	17.5	51.3
'52 - '53	33.5	78.0	62.5	179.0	200.0	58.0	38.5	19.0	58.0	25.5	19.5	25.3	66.4
'53 - '54	47.5	56.0	58.3	66.0	79.0	61.0	54.0	26.5	18.5	18.0	17.0	17.5	43.3
'54 - '55	* 29.2	* 46.5	* 116.0	* 203.0	* 149.0	* 67.0	* 57.6	* 37.4	* 27.8	* 25.2	* 21.8	* 22.6	66.9
'55 - '56	* 26.7	* 58.9	* 40.0	* 47.5	* 204.0	* 82.6	* 51.7	* 36.3	* 25.6	* 23.0	* 18.6	* 17.3	52.6
'56 - '57	* 19.1	* 23.1	* 29.1	* 29.9	* 26.4	* 32.9	* 23.9	* 23.2	* 24.2	* 18.5	* 16.0	* 16.1	23.5
'57 - '58	* 17.4	* 23.3	* 26.3	* 77.9	* 48.6	* 111.0	* 62.5	* 38.0	* 27.4	* 23.0	* 17.9	* 17.6	40.9
'58 - '59	* 20.3	* 21.0	* 36.7	* 125.0	* 46.5	* 35.7	* 29.3	* 22.6	* 30.3	* 17.5	* 16.5	* 16.0	34.7
'59 - '60	* 17.1	* 24.0	* 48.5	* 114.0	* 37.0	* 32.4	* 33.2	* 22.9	* 19.0	* 17.2	* 15.9	* 15.3	33.1
'60 - '61	* 16.2	* 19.6	* 25.9	* 20.7	* 23.5	* 57.5	* 42.2	* 33.7	* 27.1	* 21.0	* 17.8	* 17.2	35.2
'61 - '62	22.0	24.0	39.3	43.2	94.1	78.1	55.2	37.0	22.8	17.8	14.1	17.0	38.5
'62 - '63	22.8	27.2	142.2	140.0	163.0	105.0	72.8	61.8	41.9	25.4	19.0	20.4	70.1
'63 - '64	25.1	25.4	42.6	24.2	33.5	40.5	23.6	19.2	17.9	13.9	11.5	12.5	24.1
AVERAGE	27.2	34.4	54.2	77.1	84.8	65.9	49.5	33.0	26.7	22.8	18.8	19.1	43.1

(1) * : ESTEMATED BY KAYIRLI G.S. (2) '43 - '54 & '61 - '62 : 1.94 SUGATI - 10 (3) : '62 - '64 : AKKOPRU

d-3 Run-off at Proposed Project Sites

The run-off at the respective proposed sites were estimated as shown below on the basis of ratio of residual catchment area and ratio of residual run-off using the 21-year run-off at Suçati and Akköprü (Table 4-1-3 and Table 4-1-4) that were adjusted and supplemented as described in d-1 and d-2 above.

o Sandalcik

$$Qsa = Qs + (Qa - Qs) \times \frac{540}{1100}$$

$$= 0.51\ Qs + 0.49\ Qa \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4\text{-}1\text{-}5)$$

where Qsa = average monthly run-off at Sandalcik (m^3/s)

Qs = average monthly run-off at Suçati (m^3/s)

Qa = average monthly run-off at Akköprü (m^3/s)

540 = (catchment area of Sandalcik) - (catchment area of Suçati) (km^2)

1100 = (catchment area of Akköprü) - (catchment area of Suçati) (km^2)

o Gürleik:

$$Qgr = Qsa + (Qa - Qs) \times \frac{540}{1100}$$

$$= Qsa + 0.49\ (Qa - Qs) \quad \ldots\ldots\ldots\ldots \quad (4\text{-}1\text{-}6)$$

where Qgr = average monthly run-off at Gürleik (m^3/s)

Qsa = average monthly run-off at Sandalcik (m^3/s)

Qa = average monthly run-off at Akköprü (m^3/s)

540 = (catchment area of Gürleik) - (catchment area of Sandalcik), (km^2)

1100 = (catchment area of Akköprü) - (catchment area of Suçati) (km^2)

o Göktas:

$$Qgk = Qgr + (Qa - Qs) \times \frac{260}{1100}$$

$$= Qgr + 0.236\ (Qa - Qs) \quad \ldots\ldots\ldots\ldots \quad (4\text{-}1\text{-}7)$$

where Qgk = average monthly run-off at Göktas (m^3/s)

Qgr = average monthly run-off at Gürleik (m^3/s)

Qa = average monthly run-off at Akköprü (m^3/s)

Qs = average monthly run-off at Suçati (m^3/s)

260 = (catchment area of Göktas) - (catchment area of Gürleik), (km^2)

1100 = (catchment area of Akkoprù) - (catchment area of Suçati), (km^2)

Asmacik:

$$Qas = Qgk + (Qa - Qs) \times \frac{10}{1100}$$

$$= Qgk + 0.009\ (Qa - Qs) \ \ldots\ldots\ldots\ldots\ (4\text{-}1\text{-}8)$$

where Qas = average monthly run-off at Asmacik (m^3/s)

Qgk = average monthly run-off at Göktas (m^3/s)

Qa = average monthly run-off at Akkóprû (m^3/s)

Qs = average monthly run-off at Suçati (m^3/s)

10 = (catchment area of Asmacik) - (catchment area of Göktas) (km^2).

1100 = (catchment area of Akköprü) - (catchment area of Suçati) (km^2)

The results of the above are shown in Table 4-1-5, 4-1-7 and 4-1-8.

The fluctuation in monthly run-off at the respective project sites and Suçati and Akköprù Gaging Stations are shown in Fig. 4-1-13.

Fig. 4-1-13 Variation of Monthly Average Discharge

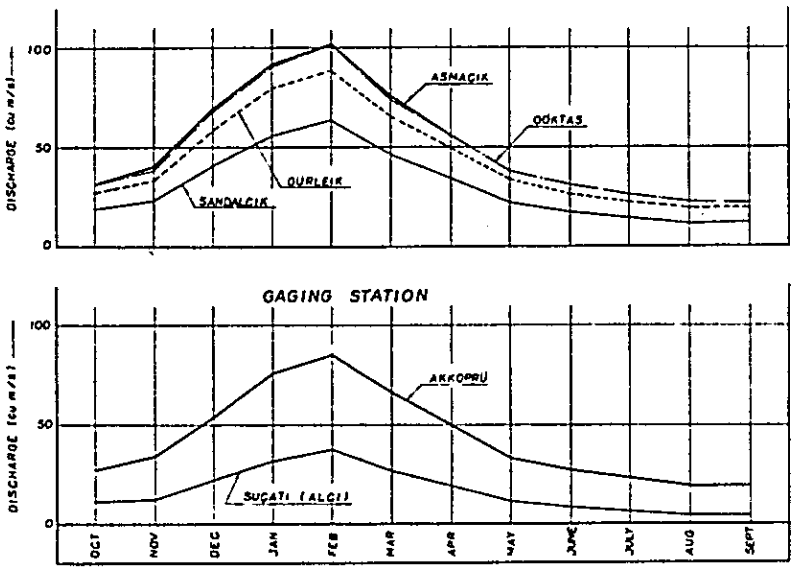


TABLE 4-1-5 DISCHARGE STATION SANDALCIK CATCHMENT AREA 3970 sq. km Dalaman, Turkey

RIVER, IN THE BASIN OF ELEVATION m UNIT Cu. m/s S ° ' W ° '

YEAR	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	ANNUAL
'43 - '44	44.0	38.5	59.7	57.1	112.0	48.1	27.2	11.7	9.7	9.2	9.4	9.1	35.9
'44 - '45	13.9	14.4	28.4	78.8	46.1	52.5	58.9	25.7	11.7	15.5	15.3	14.7	31.3
'45 - '46	20.2	20.4	44.2	29.1	63.8	31.3	32.9	17.4	12.7	9.5	9.4	10.9	24.9
'46 - '47	16.4	13.6	56.3	50.8	46.0	26.8	14.8	9.7	13.6	34.4	11.8	12.7	25.5
'47 - '48	13.7	17.7	43.9	44.2	45.0	29.7	30.3	31.0	14.8	13.2	15.3	17.4	26.3
'48 - '49	21.7	21.9	30.2	25.7	24.6	118.0	52.1	20.8	17.8	10.1	10.8	12.1	30.6
'49 - '50	15.1	31.4	31.3	30.1	14.5	17.0	17.0	49.5	17.6	10.6	10.6	10.6	21.4
'50 - '51	13.9	16.9	16.3	47.5	31.0	53.2	62.0	18.5	22.6	27.2	18.2	18.5	28.8
'51 - '52	25.0	26.4	22.3	26.9	104.0	69.5	54.9	30.1	22.0	21.8	19.2	10.6	35.6
'52 - '53	22.6	56.3	44.7	132.5	148.0	41.2	26.4	11.8	41.2	16.6	12.1	16.5	46.8
'53 - '54	33.2	39.6	41.4	46.3	57.1	43.5	38.2	17.5	11.3	10.9	10.2	10.6	29.8
'54 - '55	21.9	30.8	77.7	135.0	106.0	46.7	39.9	24.9	17.5	15.9	13.2	13.9	45.0
'55 - '56	18.6	40.8	25.6	30.9	133.0	58.7	34.6	24.3	15.5	14.4	10.8	9.9	34.0
'56 - '57	14.2	14.1	18.2	19.1	16.5	20.2	14.2	13.6	14.3	10.2	8.4	9.0	14.3
'57 - '58	13:4	14.2	16.2	52.4	31.0	73.0	39.7	24.2	16.4	13.0	10.7	9.3	26.1
'58 - '59	15.4	12.5	23.7	84.2	29.1	21.8	17.4	13.3	18.2	9.7	8.9	8.5	21.9
'59 - '60	13.0	14.7	31.9	76.7	23.1	19.5	20.4	12.9	11.1	9.5	8.4	8.1	20.8
'60 - '61	12.5	11.3	98.0	69.6	93.7	38.2	28.0	21.6	17.7	12.5	10.4	9.8	35.0
'61 - '62	14.0	15.5	27.1	30.0	68.4	56.4	39.0	25.4	14.7	10.8	8.0	10.2	26.3
'62 - '63	15.4	17.6	94.0	95.0	128.0	77.3	53.6	46.5	31.0	16.4	11.4	13.3	49.5
'63 - '64	16.4	17.3	27.0	16.4	22.5	28.3	16.2	13.2	11.9	8.4	6.4	7.3	15.9
AVERAGE	18.8	23.1	40.9	56.1	63.9	46.2	34.2	22.1	17.3	14.2	11.4	11.6	29.8

TABLE 4-1-6 DISCHARGE STATION GÜRLEIK CATCHMENT AREA 4510 sq. km Dalaman, Turkey

DALAMAN RIVER, IN THE BASIN OF DALAMAN ELEVATION m UNIT Cu. m/s S ° ' W ° '

YEAR	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	ANNUAL
'43 - '44	61.2	54.0	81.8	78.3	151.0	66.4	39.1	18.8	16.1	15.3	15.8	15.3	50.5
'44 - '45	21.6	22.3	40.5	107.0	63.9	72.4	80.8	37.1	18.8	23.7	23.3	22.8	49.5
'45 - '46	29.9	30.3	61.4	41.6	87.2	44.6	46.6	26.2	20.1	15.8	15.8	17.8	36.1
'46 - '47	24.9	21.3	77.4	70.2	63.8	38.6	22.8	16.3	21.2	48.5	18.8	20.0	36.9
'47 - '48	21.4	26.7	61.0	61.4	62.5	42.6	43.1	44.1	22.8	20.8	23.5	26.2	37.9
'48 - '49	31.9	32.1	43.1	37.1	35.7	159.0	71.9	30.7	26.7	16.8	17.6	19.3	43.6
'49 - '50	23.2	44.6	44.6	42.9	22.2	25.7	25.7	68.4	26.5	17.3	17.3	17.3	31.4
'50 - '51	21.6	25.2	24.9	65.9	44.1	73.3	84.9	30.9	33.1	39.1	27.2	27.7	41.2
'51 - '52	36.2	38.1	32.7	38.7	140.8	94.6	75.3	42.9	32.3	32.1	28.5	17.3	50.2
'52 - '53	33.1	77.4	62.0	178.0	198.0	57.5	38.1	18.8	57.4	25.2	19.2	25.0	64.9
'53 - '54	47.1	55.5	57.8	64.4	78.4	60.5	53.5	26.2	18.3	17.8	16.8	17.3	42.6
'54 - '55	29.0	46.1	114.6	200.9	147.0	66.4	57.0	37.1	27.5	24.9	21.6	22.4	65.8
'55 - '56	26.5	58.3	39.5	47.0	202.0	81.9	51.2	35.9	25.3	22.8	18.4	17.1	51.1
'56 - '57	18.9	22.8	28.8	29.6	26.1	32.4	23.6	23.0	23.8	18.2	15.8	15.9	23.2
'57 - '58	17.2	23.0	26.0	77.1	48.1	110.0	61.8	37.6	27.0	22.7	17.7	17.4	40.5
'58 - '59	20.1	20.3	36.3	123.0	46.0	35.2	29.0	22.4	30.0	17.2	16.2	15.8	34.4
'59 - '60	17.0	23.7	48.0	113.0	36.6	32.0	32.8	22.6	18.9	17.0	15.7	15.1	32.8
'60 - '61	16.1	19.4	149.0	97.9	135.0	56.9	41.7	33.3	26.8	20.8	17.6	17.0	52.3
'61 - '62	21.8	23.7	38.9	42.8	93.2	77.5	54.7	36.7	22.6	17.6	13.9	16.8	38.0
'62 - '63	22.6	26.9	136.0	139.0	162.0	104.0	72.2	61.4	41.6	25.1	18.8	20.2	68.6
'63 - '64	24.6	25.1	42.1	23.9	33.1	40.1	23.3	19.0	17.7	13.7	11.4	12.3	23.9
AVERAGE	27.0	34.1	59.4	80.0	89.4	65.3	49.0	32.7	26.4	22.5	18.6	18.8	43.4

TABLE 4-1-7 DISCHARGE STATION GÖKTAS CATCHMENT AREA 4770 sq. km Dalaman, Turkey

RIVER, IN THE BASIN OF ELEVATION m UNIT Cu. m/s S ° ' W ° '

YEAR	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	ANNUAL
'43 - '44	69.5	61.4	92.4	88.5	169.0	75.3	44.9	22.2	19.2	18.2	18.8	18.3	57.5
'44 - '45	25.4	26.1	46.4	121.0	72.5	81.9	91.3	42.6	22.2	27.6	27.2	26.7	50.8
'45 - '46	34.5	35.0	69.7	47.6	98.5	51.0	53.2	30.5	23.6	18.8	18.9	21.1	41.5
'46 - '47	29.0	24.9	87.5	79.5	72.5	44.4	26.6	19.4	24.9	55.3	22.1	23.6	42.4
'47 - '48	25.2	31.0	69.2	69.7	70.9	48.8	49.3	50.4	26.7	24.4	27.4	30.5	43.5
'48 - '49	36.8	37.1	49.3	42.6	41.0	178.0	81.4	35.4	31.0	20.0	20.9	22.8	49.8
'49 - '50	27.1	50.9	51.0	49.1	26.0	29.9	29.9	77.5	30.8	20.5	20.5	20.5	36.2
'50 - '51	25.3	29.2	29.0	74.7	50.4	83.0	95.9	32.1	38.2	44.9	31.6	32.1	47.2
'51 - '52	41.7	43.8	37.7	44.3	158.0	107.0	85.2	49.1	37.3	37.1	33.0	20.5	57.2
'52 - '53	38.2	87.5	70.4	199.0	223.0	65.3	43.8	22.1	65.3	29.4	22.7	29.2	73.7
'53 - '54	53.7	63.1	65.7	73.2	88.6	68.7	60.9	30.5	21.6	21.1	20.0	20.5	48.7
'54 - '55	32.4	53.4	132.3	233.0	167.0	75.9	65.3	42.9	32.3	29.2	25.6	26.5	75.9
'55 - '56	30.3	66.8	46.2	54.7	236.0	93.1	59.2	41.5	29.9	26.9	22.0	20.5	59.3
'56 - '57	21.2	27.0	33.9	34.7	30.7	38.4	28.1	27.4	28.4	22.1	19.3	19.2	27.5
'57 - '58	19.1	27.3	30.7	89.0	56.4	128.0	72.5	44.1	32.1	27.4	21.0	21.3	47.4
'58 - '59	22.4	24.7	42.4	142.0	54.2	41.7	34.5	26.7	35.6	20.9	19.8	19.3	40.4
'59 - '60	18.9	28.0	55.7	131.0	43.1	38.0	38.8	27.2	22.6	20.5	19.2	18.4	38.5
'60 - '61	17.8	23.2	174.0	112.0	155.0	65.9	48.4	38.9	31.3	24.7	21.0	20.4	60.6
'61 - '62	25.5	27.7	44.6	48.9	105.0	87.6	62.2	42.2	26.4	20.9	16.7	20.0	43.6
'62 - '63	26.1	31.4	156.0	160.0	178.0	117.0	81.2	68.5	46.6	29.3	22.3	23.5	77.8
'63 - '64	28.9	28.9	49.4	27.5	38.2	45.8	26.8	21.8	20.6	16.3	13.7	14.8	27.7
AVERAGE	30.9	39.4	68.2	91.4	102.0	74.5	56.2	37.8	30.8	26.4	22.1	22.4	49.9

TABLE 4-1-8 DISCHARGE STATION ASMACIK CATCHMENT AREA 4,780 sq. km Dalaman, Turkey

RIVER, IN THE BASIN OF ELEVATION m UNIT Cu. m/s S ° ' W ° '

YEAR	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	ANNUAL
'43 - '44	69.8	61.7	92.9	88.9	170.0	75.6	45.1	22.3	19.3	18.4	19.0	18.4	57.8
'44 - '45	25.5	26.2	46.6	121.0	72.8	82.2	91.7	42.8	22.3	27.8	27.4	26.9	51.1
'45 - '46	34.7	35.2	70.0	47.8	99.0	51.2	53.4	30.7	23.7	19.0	19.0	21.2	41.7
'46 - '47	29.2	25.1	87.9	79.8	72.8	44.6	26.8	19.6	25.0	55.6	22.2	23.7	42.6
'47 - '48	25.3	31.2	69.5	70.0	71.2	49.1	49.6	50.7	26.8	24.6	27.6	30.6	43.7
'48 - '49	37.0	37.3	49.5	42.8	41.2	179.0	81.8	35.6	31.1	20.2	21.0	22.9	50.1
'49 - '50	27.2	51.2	51.2	49.4	26.1	30.0	30.0	77.9	31.0	20.6	20.6	20.6	36.4
'50 - '51	25.4	29.4	29.2	75.0	50.7	83.4	96.3	32.3	38.4	45.1	31.7	32.3	47.4
'51 - '52	41.9	44.0	37.9	44.5	159.0	107.0	85.5	49.3	37.5	37.3	33.1	20.6	57.5
'52 - '53	38.4	37.9	70.7	200.0	224.0	65.6	44.0	22.2	65.6	29.5	22.8	29.3	74.0
'53 - '54	53.9	63.4	66.0	73.5	89.0	69.0	61.1	30.6	21.8	21.2	20.1	20.7	48.9
'54 - '55	32.5	53.7	133.0	234.0	168.0	76.2	65.6	43.1	32.5	29.4	25.8	26.6	76.3
'55 - '56	30.4	67.1	46.5	55.0	237.0	93.5	59.5	41.7	30.1	27.0	22.1	20.7	59.6
'56 - '57	21.3	27.2	34.1	34.9	30.8	38.6	28.3	27.6	28.6	22.3	19.4	19.3	27.7
'57 - '58	19.2	27.4	30.9	89.5	56.7	128.0	72.9	44.4	32.3	27.6	21.2	21.4	47.7
'58 - '59	22.5	24.8	42.6	143.0	54.5	41.9	34.7	26.9	35.9	21.0	19.9	19.4	40.6
'59 - '60	13.9	28.1	56.0	131.0	43.4	38.2	39.0	27.4	22.7	20.7	19.3	18.6	38.7
'60 - '61	17.9	23.4	175.0	112.0	156.0	66.2	48.6	39.1	31.4	24.9	21.2	20.6	60.9
'61 - '62	25.7	27.8	44.9	49.2	106.0	88.0	62.5	42.4	26.5	21.0	16.8	20.1	43.8
'62 - '63	26.2	31.6	157.0	160.0	179.0	118.0	81.5	68.8	46.8	29.4	22.4	23.6	78.2
'63 - '64	29.1	29.0	49.7	27.6	38.5	46.1	26.9	21.9	20.7	16.4	13.8	14.9	27.8
AVERAGE	31.1	39.7	68.6	91.9	102.0	74.8	56.4	38.0	31.0	26.6	22.2	22.5	50.1

4-1-3 FLOOD DISCHARGE (MAINSTREAM OF DALAMAN RIVER)

a. General

The proper method of calculating design flood discharge would be to make probability calculations based on flood records from a period of many years, but on study of run-off records of the Dalaman Basin it was found that flood observations had not been made so that it was decided to make estimates from precipitation data. Therefore, the values obtained here will have to be adjusted based on actual observations in the future.

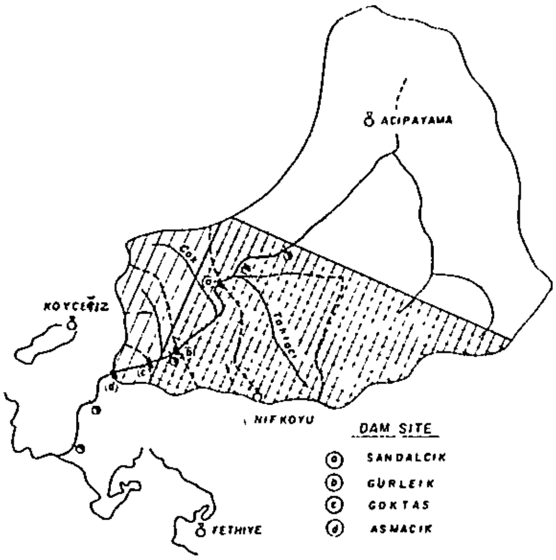
b. Estimate of Probable Daily Rainfall

Upon study of various data, three observation stations, Acipayama representing the upstream catchment area, and Köyceğiz and Nifkoyu representing the downstream catchment area were selected for rainfall data. Of the three, Köyceğiz and Nifköyu are in the same rainfall belt as Mugla and Fethiye respectively with comparatively little time lag in rainfall. Therefore, rainfall at Nifköyu was estimated for almost the whole period based on the correlation with Fethiye, while for Köyceğiz a part of the period with no record was supplemented from Mugla. At Acipayama actual records for the entire period were used for calculations.

Composite rainfall at the various sites were calculated by the Thissen method. According to these calculations the application ratio of the three observation stations are as shown in Fig. 4-1-14.

The period covered by the rainfall data used was made to coincide with the 13-year period of actual observation at Acipayama from 1950 to 1962. The main daily rainfall (the value at which composite rainfall during the same day is greatest) for each year at the three observation stations is shown in Table 4-1-9.

Fig. 4-1-14 Applied Area of Observatory Divided by Thisen Method



APPLIED AREA

(a) SANDALCIK (MAIN RIVER C A : 3430 Sq km)

- ACIPMYAMA 0 73
- NIFKOYU 0 27

(a) SANDALCIK (TRIBUTARY TAHTACI RIVER C A : 540 Sq km)

- NIPKÖYU 1 00

(b) GÜRLEIK (BELOW OF SANDALCIK GOK RIVER C A : 540 Sq km)

- NIFKÖYU 0 58
- KOYCEIZ 0 42

REVER

(c)~(d) GÖKTAS & ASMACIK (BELOW OF GURLEIK C A : 260~270 Sq km

- NIFKÖYU 0 20
- KOYCEIZ 0 80

Table 4-1-9 Main Daily Rainfall in Past 13 Years

Date	Observation Station			Remarks
	Acipayama	*Nıfkŏyu	Koyceğız	
May 7 '50	25.2	5.5	-	*: Obtained from N = 1.0F
Nov. 10 "	13.1	44.7	** 26.5	N = Daily Rainfall at Nifkŏyu
May 4 "		43.0	** 87.0	F = Daily Rainfall at Fethiye
Mar. 25 '51	51.6	47.1	-	
Oct. 7 "	0.1	132.9	** 38.6	
Jan. 18 "	-	19.1	**110.0	
Jan. 9 '52	56.0	0.1	-	**: Obtained from K = 1.5 M
Nov. 23 "	0.1	77.8	** 43.8	K = Daily Rainfall at Kŏyceğiz
Nov. 2 "	-	29.2	**135.0	M = Daily Rainfall at Mugla
Jan. 9 '53	34.0	37.2	-	
Feb. 7 "	12.0	92.4	10.7	
Nov. 3 "	-	18.5	42.2	

Date	Observation Station			Remarks
	Acipayama	•Nifkoyu	Köyceğiz	
Sep. 3 '54	56.0	0.2	-	
Dec. 8 "	28.0	78.8	40.8	
Nov. 6 "	-	29.2	88.8	
Jan. 12 '55	25.0	77.8	-	
Jan. 23 "	32.0	73.1	99.6	
Feb. 4 "	-	41.2	99.8	
Feb. 1 '56	43.5	34.4	-	
Feb. 4 "	40.0	50.1	43.5	
Dec. 27 "	-	27.6	56.5	
Dec. 1 '57	28.3	64.8	-	
" " "	"	"	30.4	
Nov. 13 "	-	24.0	48.9	
Jan. 24 '58	36.2	52.5	-	
" " "	"	"	64.1	
Oct. 19 "	-	75.5	8.0	
Nov. 10 '59	73.2	46.2	-	
Dec. 31 "	12.6	70.8	55.3	
Nov. 9 "	-	46.8	160.5	
Dec. 28 '60	43.5	61.6	-	
" " "	"	"	102.6	
" " "	-	51.9	78.9	
May 6 '61	37.8	6.5	-	
Feb. 5 "	32.5	53.0	62.4	
" " "	-	41.1	67.3	
Feb. 16 '62	43.5	123.2	-	
" " "	"	"	48.9	
" " "	-	77.8	84.6	

From the above data the composite rainfall at the respective proposed dam sites were obtained, and taking the maximum value for each year and arranging them in the order of greatest volume Table 4-1-10 was obtained.

Table 4-1-11 is obtained by calculating the maximum yearly rainfall probability at each site by the Gumbel method using the data from Table 4-1-10.

Table 4-1-10 Maximum Daily Rainfall in Year at each Proposed Dam Site

No.	Sandalcık		Gürleik	Göktas & Asmacik
	Main Stream	Tributaries	(Below Sandalcik)	(Below Gürleik)
1	100.0 mm	132.9 mm	94.6 mm	138.4 mm
2	97.1	92.4	93.3	113.8
3	70.3	78.8	84.2	107.8
4	63.9	77.8	80.7	94.8
5	62.7	77.8	78.8	94.6
6	56.9	77.8	73.6	92.3
7	56.6	75.5	62.8	78.6
8	55.0	70.8	61.5	76.9
9	54.5	64.8	58.8	62.2
10	53.8	61.6	58.1	62.0
11	46.2	53.0	57.3	53.5
12	45.8	50.1	56.9	50.9
13	35.6	44.7	47.3	37.7

Table 4-1-11 Probability Distribution of Daily Rainfall at Each Proposed Dam Site

Probability Year	Purpose of Data	Sandalcik		Gürleık (Below Sandalcik)	Göktas & Asmacik (Below Gürlcik)	Yt
		Main Stream	Tributaries			
20 YRS	Flood Protection	106 mm	137 mm	106 mm	150 mm	3.0
200 "	Spillway	147	176	140	213	5.3
1000 "	"	176	210	164	257	6.9
Gumbel Probability Equation R: Probability Daily Rainfall Yt: Auxiliary Function		R = 53 + 17.7Yt	R = 64 + 21.2Yt	R = 63 + 14.6Yt	R = 69 + 27Yt	

c. Method of Estimating Peak Flood Discharge and Flood Hydrographs

From the daily rainfall probability, using the Rational method equation, the peak flood discharge of the four areas: the mainstream and the tributaries of Sandalcik, Gürleik (below Sandalcik), Göktas and Asmacik (below Gürleik), were calculated. Next, using unit hydrographs applying the Rational method, the flood hydrographs of the four areas were estimated. These flood hydrographs were added taking into account the respective times the flood crests arrive at the locations, and the peak flood discharged of each proposed dam site were calculated.

Rational Method Equation

$$Qp = \frac{1}{3.6} \cdot f \cdot r \cdot A \quad \ldots\ldots (4\text{-}1\text{-}9)$$

where Qp = peak run-off of flood (m^3/s)

f = run-off coefficient

r = average rainfall intensity within time required for flood to reach designated point (mm/hr)

A = catchment area (km^2)

The run-off coefficient f was determined as shown in Table 2-1-12 taking into consideration vegetation, topography, area and other conditions of the drainage basins and the yearly run-off coefficients (Suçati: 15 to 25%; Suçati-Akköprü: 40 to 70%).

Table 4-1-12 Run-Off Coefficient

Catchment Area	Run-Off Coefficient	
	Large-Scale Floods	Small-Scale Floods
Sandalcik (Main Stream)	25 %	20 %
" (Tributaries)	60	40
Sandalcik-Gürleik	60	40
Gürleik-Göktas & Asmacik	60	40

The "r" is determined by the time required for flood dischanges to arrive from the farthest point upstream and the pattern of hourly rainfall distribution. The time was calculated by the Rziha equation and the Kraven equation based on the river gradient profile.

c-1 Rziha Equation (mountain area, see Fig. 4-1-15)

$$\left.\begin{aligned} W_1 &= 72\left(\frac{H_1}{L_1}\right)^{0.6} \\ T_1 &= \frac{L_1}{W_1} \end{aligned}\right\} \quad \ldots\ldots (4\text{-}1\text{-}10)$$

where W_1 : flood propagation speed (km/hr)

H_1 : head (km)

L_1 : distance (km)

T_1 : time required for arrival (hr)

c-2 Kraven Equation (plain area, see Fig. 4-1-15)

$$\left.\begin{array}{llll} H_2/L_2 & : \text{not less than } 1/100 & 1/100\text{-}1/200 & \text{not more than } 1/200 \\ W_2(\text{km/hr}) & : 12.6 & 10.8 & 7.6 \\ T_2 = L_2/W_2 & & & \end{array}\right\} \quad \cdots\cdots \quad (4\text{-}1\text{-}11)$$

where W_2 : flood propagation speed (km/hr)

H_2 : head (km)

L_2 : distance (km)

T_2 : time required for arrival (hr)

It was assumed the propagation speed within the reservoir would be 1/2 the speed of the flood wave.

$$\left.\begin{array}{l} W_3 = \sqrt{\dfrac{gh}{2}} \\ T_3 = L_3/W_3 \end{array}\right\} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (4\text{-}1\text{-}12)$$

where W_3 : propagation speed within reservoir (m/s)

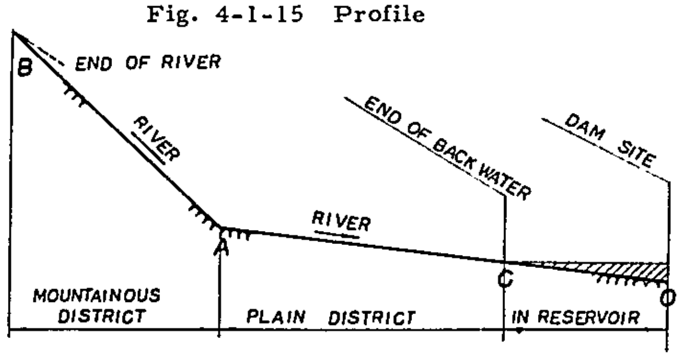
h : average depth of reservoir (m)

g : acceleration speed of gravity: 9.8 m/s

L_3 : distance within reservoir (m)

T_3 : time required for arrival (hr)

Fig. 4-1-15 Profile



The distances (L), propagation speeds (W), and times required for arrival (T) are shown in Table 4-1-13. The L, W and T between the various proposed dam sites are shown in Table 4-1-14.

Table 4-1-13 Horizontal Length (L), Propagation Speed (W), Time of Arrival (T) to Each Dam Site

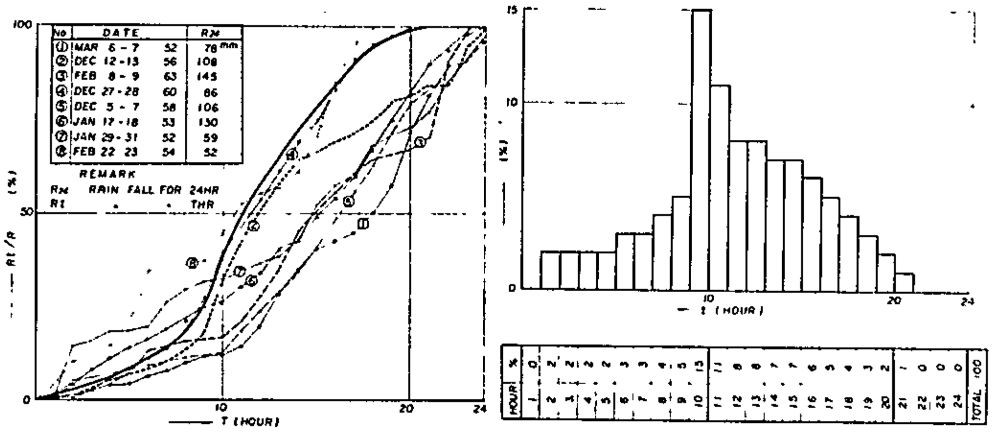
Site	Mountain Area (see Fig. 4-1-15)				Plain Area (see Fig. 4-1-15)				Reservoir				Total of Times of Arrival
	L_1	H_1/L_1	W_1	T_1	L_2	H_2/L_2	W_2	T_2	L_3	h	W_3	T_3	$T=T_1+T_2+T_3$
Sandalcik (Main Stream)	km 14	1/24	km/hr 10.5	hr 1.3	km 90	1/300	km/hr 7.6	hr 11.8	km 17	m 50	m/s 11.2	hr 0.4	1.3+11.8+ 0.4 ≒14hr
Sandalcik (Tributaries)	16	1/27	9.5	1.7					17	50	11.2	0.4	1.7+0.4 ≒ 2 hr
Gürlcik (Below Sandalcik)	28	1/29	9.5	2.6					10	60	11.0	0.3	2.6+0.3 ≒ 3 hr
Göktas & Asmacik (Below Gürlcik)	17	1/14	13.2	1.3					13	25	7.8	0.5	1.3+0.5 ≒ 2 hr

Table 4-1-14 Horizontal Length (L), Propagation Speed (W) Time of Arrival (T) between Proposed Dam Sites

Section	Upstream Dam to End of Backwater (by Kraven Equation)				Reservoir				Total of Times of Arrival $T=T_2+T_3$
	L_2	H_2/L_2	W_2	T_2	L_3	h	W_3	T_3	
Sandalcik-Gürlcik	km 14	1/21	km/hr 12.6	hr 1.1	km 10	m 60	m/s 11.0	hr 0.3	1.1+0.3 = 1.4 hr
Gürlcik-Göktas & Asmacik					13	25	7.8	0.5	0.5 hr

The pattern of hourly rainfall distribution was estimated from the hourly rainfall data at Antalya. A comparison of cumulative hourly rainfall and daily rainfall is shown in Fig. 4-1-16. The critical extent of rainfall (maximum t-hour rainfall is the maximum) was considered and a distribution (pattern of rainfall shown in the diagram) as shown by the heavy line in the diagram was assumed.

Fig. 4-1-16 Distribution of Hourly Rain-Fall at Antalya



o Unit hydrograph applying the Rational equation

The Rational equation gives the maximum flood discharge by expressing the flood wave form of the site in question in a triangle with the flood increasing linearly from 0 within the time required for arrival (tr) reaching its maximum at t=tr and after that decreasing linearly until it becomes 0 at t=2tr. Assuming that this is an unit hydrograph, the flood wave form for rainfall, other than the maximum rainfall within the time required for arrival of the flood, can also be estimated as shown in the shaded portions (///) of Fig. 4-1-17. By placing these one on top of another, an approximate of entire flood wave form can be obtained.

The unit hydrographs for the mainstream and tributaries of the Dalaman River at Sandalcik, Gürleik (below Sandalcik), Góktas and Asmacik (below Gürleik) obtained by applying the theory of Rational equation are shown in Fig. 4-1-18. The flood hydrographs obtained in this manner may differ from the actual pattern, but there are no other methods and since the peak flood discharges can be considered to be comparatively reliable this method was used.

Fig. 4-1-17 Hydrograph

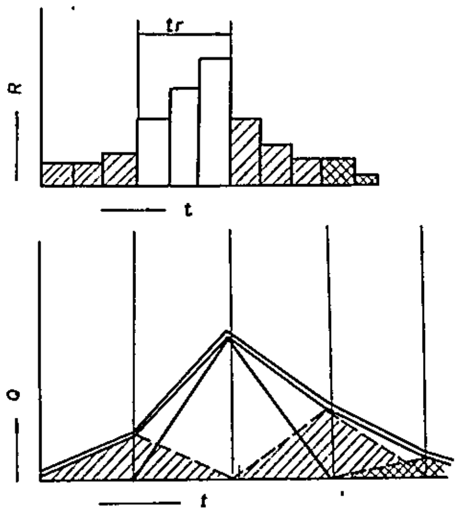
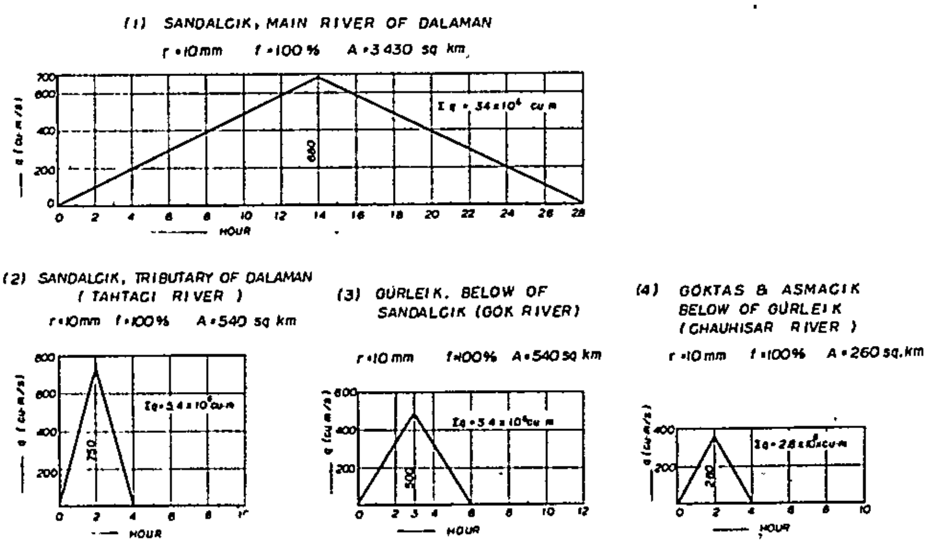


Fig. 4-1-18 Unit-Hydrograph at each Stage



d. Design Flood Discharge of Proposed Dam Sites

o Design Flood Discharge at Sandalcik

The flood discharge at Sandalcik obtained by the method described above is as shown in Fig. 4-1-19. According to this the maximum natural flood discharge is 3,200 m^3/s.

At Sandalcik Reservoir a surcharge of 2 m (V = 43 million m^3) will be provided to control peak flood discharges. Operation of gates as described below will be carried out with two purposes in mind. One will be to reduce peak flood discharges in connection with design of spillway capacity of the respective proposed dams. The other will be to reduce peak flood discharges and thereby prevent overlapping of peaks with downstream flood discharges as a means of flood protection of the lower stream of the Dalaman River. In this case it was assumed floods would occur at normal high water surface level (El. 705 m) and design of spillway capacity was planned based on 200-year flood probability while flood protection plans were based on 20-year flood probability.

d-1 Until flood flow releases through the spillway reach 700 m^3/s, inflow will be released untpuched in order to maintain water in the reservoir at normal high water surface level (El. 705 m).

d-2 After spillway discharge reaches 700 m^3/s, discharge will be maintained constant at 700 m^3/s until the reservoir water level reaches El. 706.6 m.

d-3 When the water level of the reservoir reaches El. 706.6 m, the discharge will be maintained constant at 1,600 m^3/s until the reservoir water surface reaches the maximum level (El. 707 m).

d-4 When the water level reaches approximately to the maximum (El. 707 m), all gates will be opened full and discharge left to nature.

Calculation of control of peak flow after full-opening of gates is based on the Cheng diagram method of analysis while for the spillway capacity curve, Fig. 4-1-21 was used. In Fig. 4-1-21, for the benefit of actual gate operation, the relation betweeen gate opening and water storage level when discharge is maintained constant at 700 m^3/s and 1,600 m^3/s are also shown.

When control of peak flow is carried out according to the above criteria to determine the spillway capacity, Fig. 4-1-20 is obtained. According to this, the design flood discharge for the spillway capacity at Sandalcik will be 2,600 m^3/s.

Fig. 4-1-19 Design Flood Discharge Curve at Sandalcik

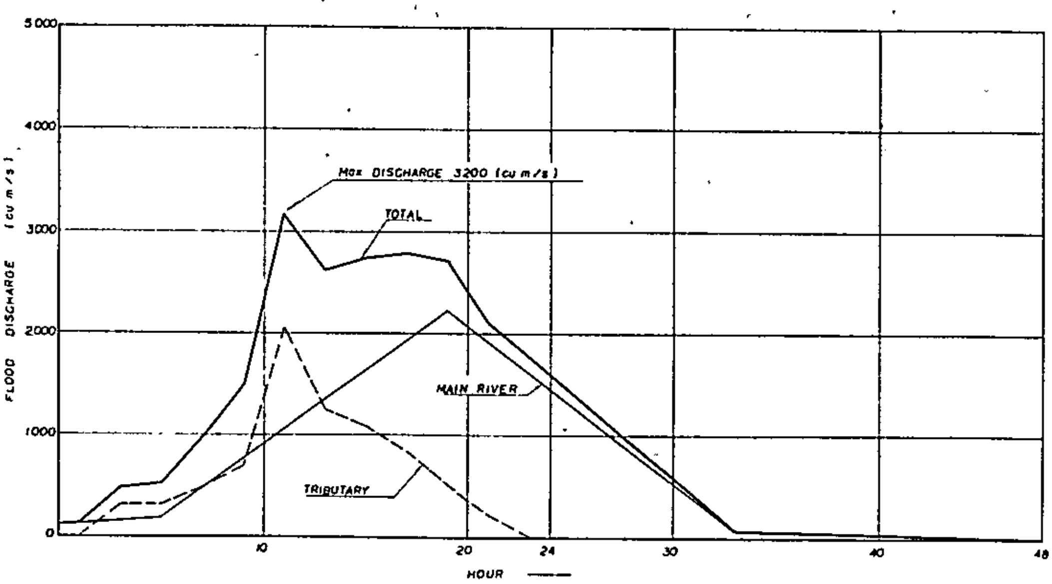


Fig. 4-1-20 Flood Discharge Curve and Flood Control at Sandalcik (For Design Flood of Spillway)

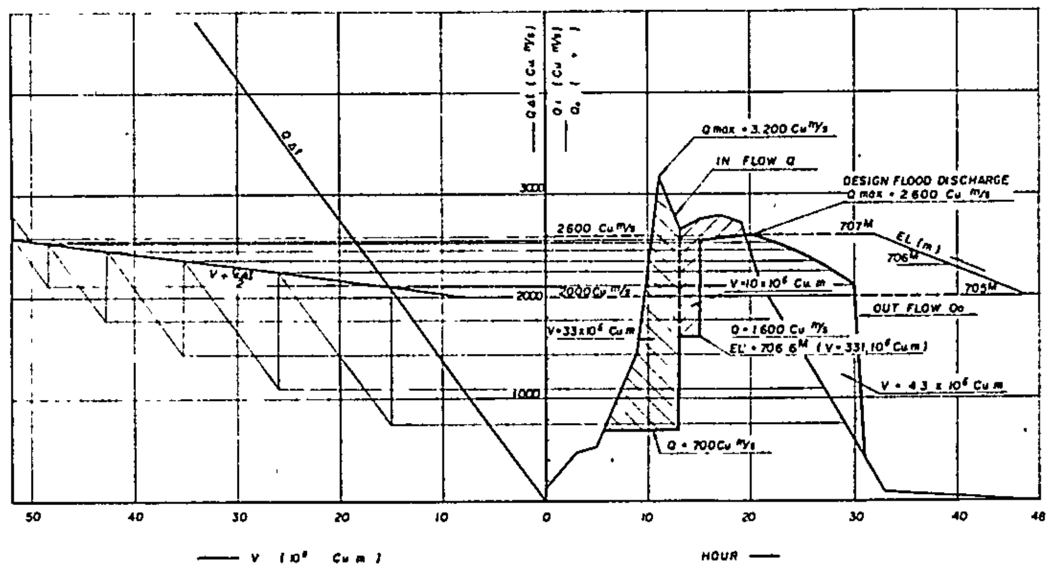
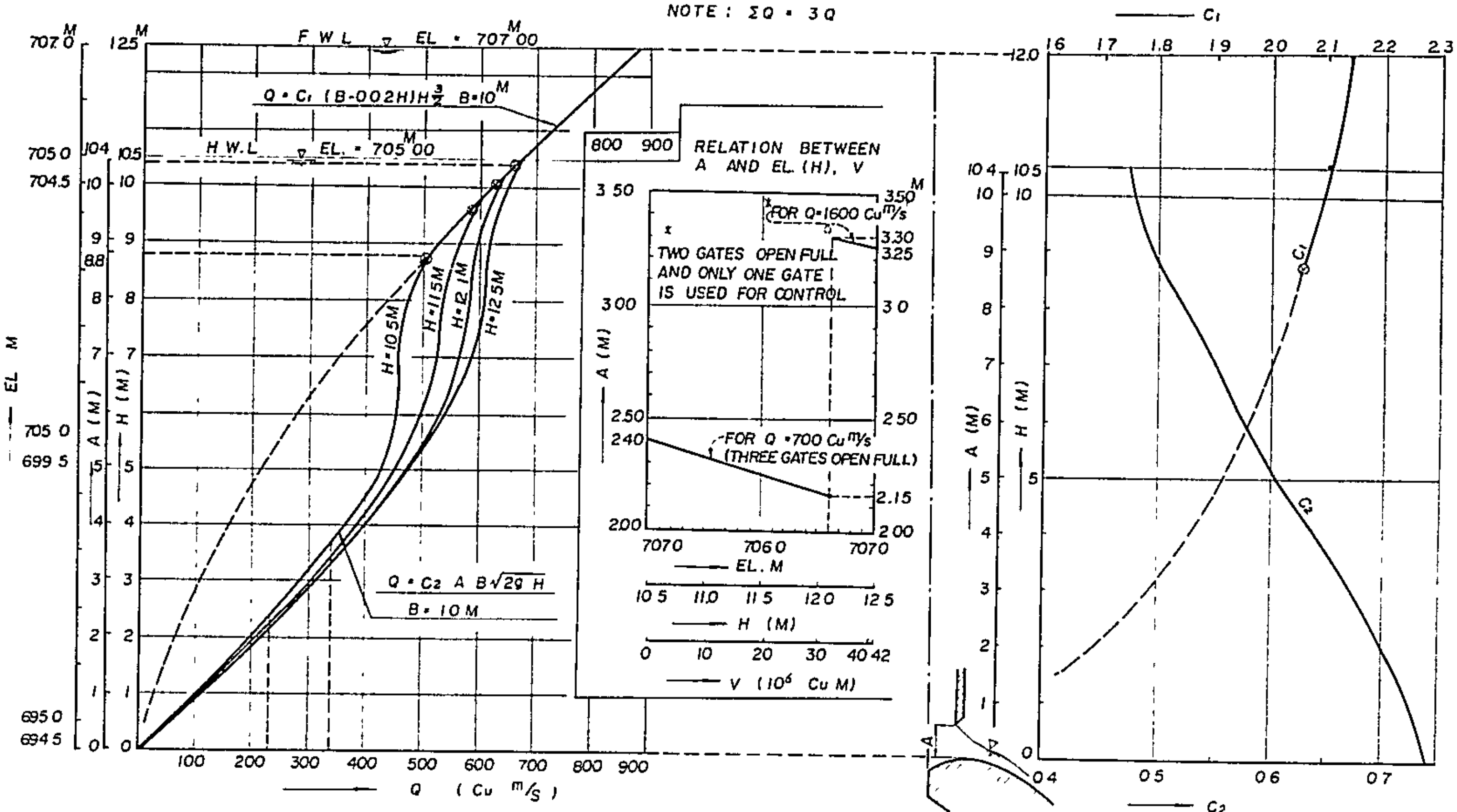


Fig. 4-1-21 SPILL-WAY CAPACITY CURVE AT SANDALCIK
(FOR ONE GATE)



LEGEND { Q = SPILL WAY CAPACITY FOR ONE GATE V = STORAGE CAPACITY OVER EL 705 M
H = WATER LEVEL A = OPENING OF GATE B = WIDTH OF OUT FLOW

o Design Flood Discharge At Gürleik

The design flood discharge for the spillway capacity at Gürleik is 3,400 m^3/s obtained from the flood flow between Sandalcik and Gürleik to which the flood discharge from Sandalcik is added taking into consideration the time required for arrival.

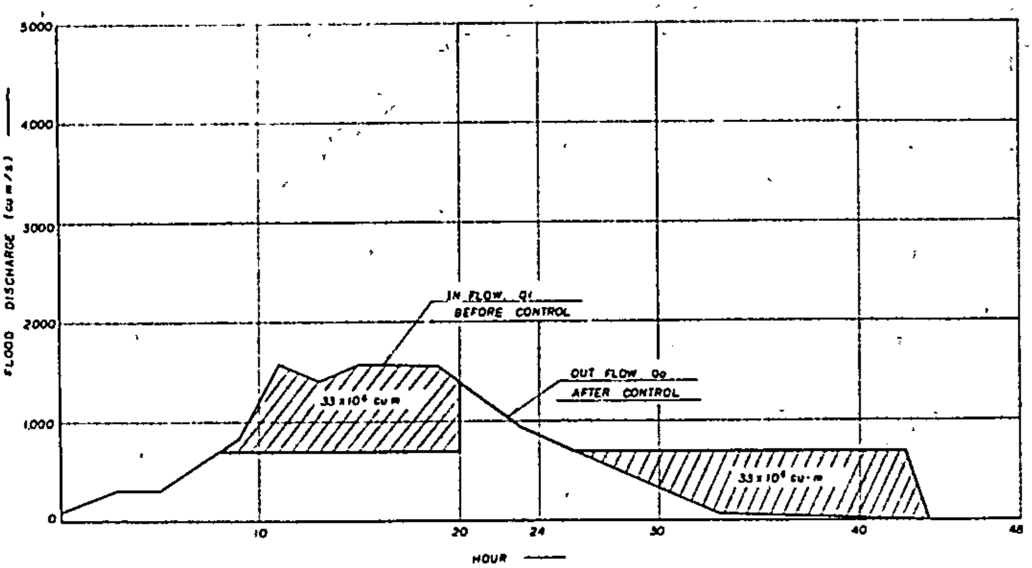
o Design Flood Discharge at Göktas

The design flood discharge for the spillway capacity at Göktas is 3,600 m^3/s obtained from the flood flow between Gürleik and Göktas to which the flood discharge from Gürleik is added taking into consideration the time required for arrival.

o Design Flood Discharge at Asmacik

As the proposed dam at Asmacik is a rock-fill structure, large-scale floods which can not be regulated at Sandalcik were taken into consideration for design of spillway capacity. In other words, a 1,000-year probability flood was considered and from calculations based on the same method as the other sites, the design flood discharge for the spillway capacity at Asmacik will be 5,700 m^3/s.

Fig. 4-1-22 Flood Discharge Curve and Flood Control at Sandalcik (For Flood Defense of Lower Dalaman Basin)



o Flood Flow for Flood Protection Plans of the Lower Dalaman Basin

When control of peak flood discharges is carried out at Sandalcik for downstream flood protection based on the beforementioned operation criteria, Fig. 4-1-22 is obtained. Adding to the floodwaters between Sandalcik to Gürleik, Gürleik to Göktas (=Asmacik), the design flood discharge at Asmacik for the downstream flood protection plans is 1,700 m^3/s.

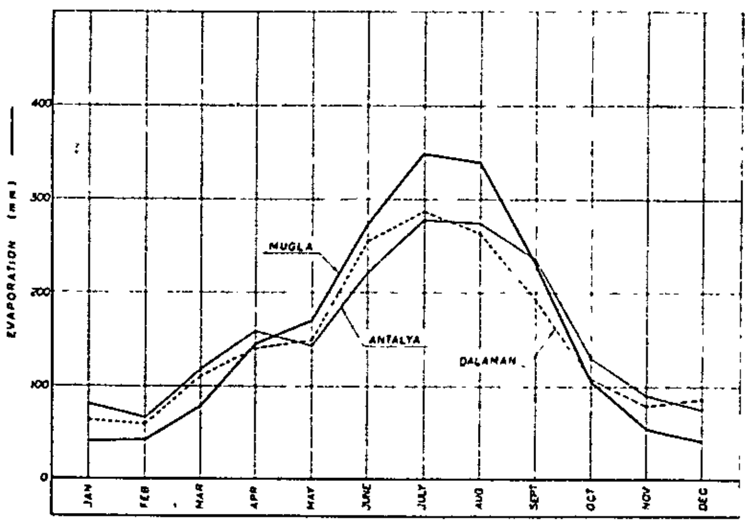
4-1-4 EVAPORATION

Evaporation loss measured in the vicinity of the Dalaman River is as shown in the following table and in Fig. 4-1-24.

Table 4-1-15 Evaporation Loss Around Dalaman River Area

Observation Station	Evaporation (mm)			Remarks
	Oct. - Mar.	Apr. - Sept.	Total for Year	
Antalya (Class a Pan)	558	1312	1870	Average of Most Recent 3 Years
Mugla (Class a Pan)	357	1512	1869	Ditto
Dalaman (Class a Pan)	508	1292	1800	Ditto
Dalaman (Open Pool)	(389) 346	(1051) 976	(1440) 1322	(Average of Most Recent 3 Years) Average of Most Recent 9 Years

Fig. 4-1-23 Variation of Monthly Evaporation



According to the above table, the yearly evaporation loss measured by evaporation meters is 1,800 to 1,900 mm which is roughly constant regardless of location. The evaporation loss measured by open pool at Dalaman is 1,400 mm. In general, the ratio between evaporation measured with an evaporation meter and the evaporation from a natural lake surface is 60 to 80%. Compared to this, the ratio of evaporation from the open pool to the evaporation shown in the above table is 78%. Therefore, it may be said the evaporation from the open pool at Dalaman represents the evaporation loss from natural lake surfaces. From the above, it is determined that the evaporation loss from lake surfaces in the Dalaman valley will be 1,400 mm annually.

4-1-5 SEDIMENTATION

Regarding sediment carrying characteristics of the Dalaman River, there is only data of 2 days of investigations. There are no data at all for estimation of sedimentation, such as, erosion conditions within the drainage basin. Therefore, the sedimentation within reservoirs must be estimated from examples of rivers with similar drainage basin conditions. In the past, in Japan and other countries, determinations made in this manner have not been uncommon and so long as the conditions of the drainage basins are similar good results can be obtained.

Fortunately, in the case of the Dalaman River, there is the Kemer Dam in the adjacent drainage basin (Ak River) where the catchment area, precipitation, flood discharge, etc. are similar, and the figures obtained at Kemer Dam will be used as recorded for Sandalcik Reservoir. On this basis, the sediment which will be carried into the Sandalcik Reservoir in 1 year will be approximately 400 m^3/km^2.

4-2 GEOLOGY

4-2-1 GENERAL

Geological surveys have been carried for the entire Dalaman River Basin by geologists of DSI and a 1/25,000 geological map has been prepared. Furthermore, at the Sandalcik, Göktas and Asmacik sites, geological surveys and borings have been conducted by DSI and 1/5,000, 1/10,000 and 1/1,000 geological maps have been prepared.

The number of borings is as shown below.

Site	No. of Bore Holes	Total Length (m)
Sandalcik, main dam	12	1,305.03
" , " "	1 (Adit)	200.00
" , saddle dam	5	407.54
Göktas Dam (upstream site)	4	610.99
Asmacik Dam	3	169.30

The Mission carried out studies of all boring cores with the exception of three, SK-1 to SK-3 at the Sandalcik Main Dam site, and geological surveys of the proposed sites. Based upon the results of the investigations it recommended that 7 borings be made at the site of Sandalcik Main Dam. Of these seven, data on four borings, SKB-1 to SKB-4, were received by the Mission late in October, 1965.

4-2-2 TOPOGRAPHY AND GEOLOGY OF PROPOSED SITES

a. Sandalcik

o Topography

The poposed site of the Sandalcik Main Dam located approximately 1.5 km to 2.0 km downstream of the confluence of the mainstream of the Dalaman River and Hüseyin (Tahtaci) River, a tributary. This part of the river is a gorge with the river bed elevation between approximately 550 m and 580 m and the width of the valley at the river bed between approximately 5 m and 30 m. Within the reservoir area the topography is a V-shaped valley along the

Dalaman River, while along the Hüseyin the width of the valley at the river bed is broad with development of river terraces in many places.

There are two prospective sites for the main dam, the upstream and downstream sites. The topography of the upstream site shows a river bed width of approximately 15 m with steep cliffs of 70° to 80° rising on both banks from the river bed up to around El. 660 m from where the slope becomes gentle, 20° to 25°. The downstream site is approximately 500 m downstream of the upstream site. The valley width at the river bed is about 3 m to 5 m with both banks forming steep cliffs of 70° to 80°, but a saddle is found on the left bank at approximately El. 720 m.

At Sandalcik, a saddle dam is planned in addition to the main dam. The location is approximately 1.5 km south of the river confluence and the vicinity is a hilly area with numerous gullies.

o Geology

The bedrock at the proposed alternative dam sites and the reservoir area is composed of Mesozoic limestone, schist, peridotite and Neogene marl and conglomerate.

The limestone is distributed at the proposed dam sites and at a location 6 to 7 km upstream of the mainstream from the dam sites. Schist is found in the limestone and in small areas around the limestone. Peridotite is widely distributed on the right bank side of the Dalaman River upstream of the dam sites. Lake deposits composed of marl and conglomerate are widely distributed on the left bank of the Dalaman River upstream of the dam sites and along the Hüseyin River.

Of these rocks, limestone has close connection with leakage and especially the limestone found at the proposed dam sites and at the location 6 to 7 km upstream are liable to show leakage. The limestone at the dam sites will be described in detail in Chapter 6. However, the limestone at the upstream location has not been surveyed due to lack of topographical maps and it will be necessary to make surveys in the future. Furthermore, there is at around El. 700 m at Kizilyer near the fork of the Dalaman and Hüseyin Rivers a distribution of Neogene limestone which also should be an object of future investigation.

- Main Dam Sites

The foundation rock at the main dam sites is composed of limestone, schist and peridotite. At the upstream dam site the distribution is found to be bedded limestone in the river bed, massive limestone and schist on the left bank and massive limestone, schist and peridotite on the right bank. At the downstream dam site, except where interspersed in part by schist on the left bank, the entire area consists of massive limestone.

Talus desposits are distributed on both banks of the upstream dam site from El. 670 m and above. The thickness is an average of 2 to 3 m and includes blocks of limestone and peridotite. There are no deposits of sand and gravel in the river bed, the bedrock being exposed.

Faults are found mostly between the upstream and downstream sites and at the left bank of the downstream site. Especially, at the saddle on the left bank of the downstream site, there are large-scale faults roughly parallel to the river.

- Saddle Dam Site

The geology of the saddle dam site is formed of Neogene lake deposits mainly composed of marl and conglomerate partly interspersed with chalk and mudstone. The thickness of the formation is more than 100 m and for the sake of convenience, this formation which is confirmed by borings is classified as shown below.

Division	Characteristics
Upper formation	Located at the top, chiefly marl
Middle formation	Located below the upper formation, consists of conglomerate, mudstone,

Division	Characteristics
	chalk and marl
Lower formation	Lowermost stratum found in boring investigations consisting of conglomerate

The upper formation is distributed over the entire dam site. The thickness of the formation is irregular being 3 m in thin places and 60 to 70 m in thick places. Strike and dip of the bedding is N 30° - 60°E, 15° - 25°NW near the dam axis and N80° - 90°E, 20°NW along the Hüseyin River. The rock character is silty to sandy and muddy being chalky in parts. To a depth of 5 to 10 m from the surface, weathering has occurred and the rock is platy and fractures easily but the interior is massive. In dry condition the rock is generally hard, but when it absorbs moisture it becomes soft and especially, the chalky material is very soluble.

The middle formation is exposed high on the right bank, but near the dam site it is covered with marl and is seldom found exposed. The thickness of the formation is usually 10 to 50 m with the general strike and dip N50° - 80°E, 15° - 20°SE. The rock character is on the whole uncemented and soft. Chalk especially is highly soluble, conglomerate crumbles easily and the roundness of gravel is poor.

The lower formation is exposed in the vicinity of the junction of the Dalaman River and the Hüseyin River and downstream of the junction, but is not exposed at the dam site. The thickness is thought to be of considerable extent. The rock character is uncemented and is light brown to yellowish brown in color containing gravel of serpentinite and peridotite. The size of the gravel is normally from 3 to 10 cm, but some particles are as large as 30 cm.

o Geology of Proposed Intake, Waterway, Underground Power Plant and Tailrace Sites

The geology of the area where waterway structures will be located chiefly consists of peridotite with a partial distribution of limestone.

Peridotite is distributed at the proposed intake site, most of the length of the pressure tunnel and the entire length of the tailrace, while limestone is found in parts of the pressure tunnel section and at the penstocks and underground power plant sites. However, the limestone is in the form of large xenoliths in the peridotite and the size and shape are not known. Therefore, it will be necessary to investigate whether or not the penstocks from El. 635 m to El. 268 and the whole of the underground power plant will be located in limestone.

The rock color and condition of cracks of the peridotite is similar to that found at the proposed dam sites. However, since serpentinization has developed markedly it is anticipated that alteration of rock character will be pronounced in the section through which the tunnel will pass. Especially, the tailrace section shows characteristics which are even more serious.

b. Gürleik

o Topography

The site of the proposed Gürleik Dam is at the junction of the Cehennem Valley and the Dalaman River, approximately 4.5 km upstream of the village of Karakol on the middle stream section of the Dalaman River.

The dam site and reservoir area form a typical V-shape valley in general, but in the peridotite distribution which is upstream from a point approximately 4 km above the dam site there are many places where there are traces of landslides or landcreeps.

The river bed at the proposed dam site is at an elevation of approximately 150 m and is approximately 40 m wide. The slopes of both right and left banks are approximately 50°.

o Geology

The bedrock of the dam site and reservoir area consists of Mesozoic limestone and peridotite. The limestone is distributed along the entire

Cehennem Valley area and to about 4 km upstream of the dam site. Above this point the rock is peridotite. The limestone in this area is most widly distributed in the entire Dalaman River Basin and it is extensive and a stable mass, but there is fear of leakage. In the peridotite, serpentinization is very conspicuous. The foundation rock of the dam site and the power plant site is limestone and except for a deposit of fallen rock on part of the left bank, there are hardly any talus deposits or river deposits. Limestone at the proposed dam site is of massive limestone and bedded limestone. The massive limestone is located below approximately 240 m above sea level and the bedded limestone is located above the elevation. The color of the rock is white to greyish colour and it is very hard. Weathering of the rock is not particularly advanced, but there are many cracks, especially in the left bank. There are no large faults at the dam site, except for three minor faults between approximately 250 m and 350 m upstream of the dam site on the left bank. The strikes and dips of these faults are N30°E 70°NW, N-S 40°W, N40°E 65°SE, and all are accompanied by sheared zones.

c. Göktas

o Topography

The proposed Göktas Dam sites are approximately 6.5 km downstream of the Gürleik dam site. The reservoir area is a relatively wide V-shape or U-shape valley with river terraces in many places.

There are two prospective sites for the dam, one being the upstream site immediately above the confluence of the Arapacik Valley and the Dalaman River and the other, the downstream site, in a gorge approximately 3.5 km downstream of the former.

Four borings have already been made by DSI at the upstream side. The elevation of the river bed is approximately 80 m, the width of the river bed is approximately 45 m and the slopes of the right and left banks are 45° to 55°.

The downstream site river bed is at approximately El. 68 m.

Its width is approximately 10 to 20 m and the right and left bank canyon walls are on a slops of 80° to 85°.

o Geology

The bedrock of the dam sites and the reservoir area is composed of Mesozoic limestone and peridotite. The limestone is distributed at the gorges where the upstream and downstream dam sites are located and along the entire left bank from a point 1 km above the upstream site down to the downstream site. The peridotite is distributed along the right bank from the upstream site to the downstream site and around a point 1 km above the upstream site.

For both upstream and downstream sites the contact between the limestone and the peridotite is in the form of a fault. However, since the hydraulic gradient from the reservoir along the faults are 0.04 to 0.07 per 100 m of elevation for both sites, there should be little concern of leakage through these faults.

The limestone is a large-scale mass widely distributed on the left bank with many dissolved holes and there is great danger of leakage. Together with the Gürleik reservoir area a detailed geological survey will be necessary.

o Upstream Dam site

The bedrock of this dam site is limestone. The river deposit is thick at this site reaching about 40 m. The deposit consists of gravel, sand and silt, with large sized gravel of 20 cm to 30 cm in diameter although mostly the gravel is smaller than 10 cm.

According to the EIE survey report the coefficients of permeability of this river deposit are roughly as given below.

	Coefficient of Permeability (cm/s)	
Depth in Borehole (m)	Maximum	Minimum
1.5 - 10.5	1.92×10^{-3}	7.88×10^{-3}
10.5 - 13.5	3.44×10^{-2}	3.84×10^{-2}
13.5 - 27.5	1.02×10^{-2}	9.75×10^{-2}

The limestone is bedded limestone with strike and dip N15° - 50°W, 15° - 30°NE. The limestone is gray to dark gray in color and is an alternation of sandy and slaty limestone 5 to 10 cm thick. Weathering of the foundation rock at this site is advanced with craks penetrating deeply and the foundation rock as a whole is loose.

According to boring results the loosening and weathering of the foundation rock extends more than 100 m and if the dam site is to be selected in this location, it would be advisable to move the dam axis approximately 700 m upstream from the point where boring investigations are presently being conducted.

o Downstream Dam Site

Boring investigations have not been conducted of the downstream dam site, but it is thought the depth and characteristics of the river deposit are little different from those of the upstream site.

The foundation rock on both right and left banks is massive limestone with numerous cracks and slickensides, but the rock is tight. The fact that there are considerable slickensides indicates there has been tectonic movement and thorough investigation is necessary.

In comparing this site with the upstream site, there is little difference in elevation of the river bed and the weathering of the foundation rock is thinner while open cracks are fewer so that the geology at this site is more favorable. Therefore, in this Report, the downstream site has been tentatively used in planning of the Göktas Dam Project.

The proposed power plant site is located on the right bank approximately 200 to 250 m downstream of the dam site. This point is near the boundary between limestone and peridotite and since this boundary is a fault, detailed surveys will be necessary to decide on the final location of the power plant.

d. Asmacik

o Topography

The Asmacik Dam site is approximately 4 km downstream of the proposed Göktas downstream site. This site is at a narrow but extremely meandering part of the river, with the river bed approximately 100 m wide at an elevation of about 50 m. The right bank is a mountain slope of approximately 35° to 40° while the left bank is formed by hills of approximately 110 m elevation with slopes of 30° to 35°. Narrow saddles are found in these hills.

Upstream in the reservoir area, the river valley widens and there are many river terraces formed on the left bank.

o Geology

The bed rock at the dam site and in the regulating basin is composed of Mesozoic limestone, dunite and what is thought to be Quaternary conglomerate.

The limestone is distributed near the end of the backwater, and most of it is covered with conglomerate. The conglomerate is distributed below elevation 100 m in the area between the vicinity of the end of the backwater to a point about 1 km downstream. This conglomerate is well cemented. Dunite covers almost all of the regulating basin area.

The foundation rock at the dam site is dunite. The river deposit is approximately 50 to 60 m thick and is composed of gravel, sand and silt. The size of the gravel is generally under 20 cm in diameter.

The left bank saddle area has a fault with a sheared zone approximately 3 m in width which runs across the saddle. The strike and dip of this fault is N80°E, 60°NW. Details are given in Chapter 6-1-3.

Waterway and Power Plant Sites

The geology of proposed sites for intake, waterway and power plant consists entirely of dunite. The rock has discolored to yellowish brown at the surface, but in deep parts the color is black-green. Both surface and interior are hard, but serpentinization is seen although it is not as extreme as at the Sandalcik tailrace area.

4-2-3 EARTHQUAKES

Earthquakes in Turkey in the past have occured in the three regions of the Aegean Sea coast in the west, the vicinity of Bolu City in the north and the vicinity of Erzincan in the east which is famous for the Erzincan Earthquake of 1939. In the Anatolian Plateau running east-west in the center of Turkey and along the Mediterranean Sea coastal area on the south there have been no earthquakes of a magnitude to affect structures. The project area is on the boundary of the Aegean Sea region and the Mediterranean Sea region which has no earthquakes. The Dalaman Gorge which runs north-south between Fethiye and Koyecegiz belongs to the southern undersea earthquake zone extending from the coastline to Rodhas Island.

Presently there are seismographs installed at 4 places; Istanbul, Cine, Kastamonn and Roman. Records of earthquakes in the project areas detected at these observation stations are not clearly known, but according to results of surveys of earthquakes for entire Turkey conducted by Dr. Shunichiro Omote of Istanbul Engineering University Seismological Research Institute (presently, Professor, University of Tokyo) and Muzaffer Ipek, Civil Engineer, earthquakes actually felt during the 100 years from 1859 to 1958, listed by intensity have been as follows:

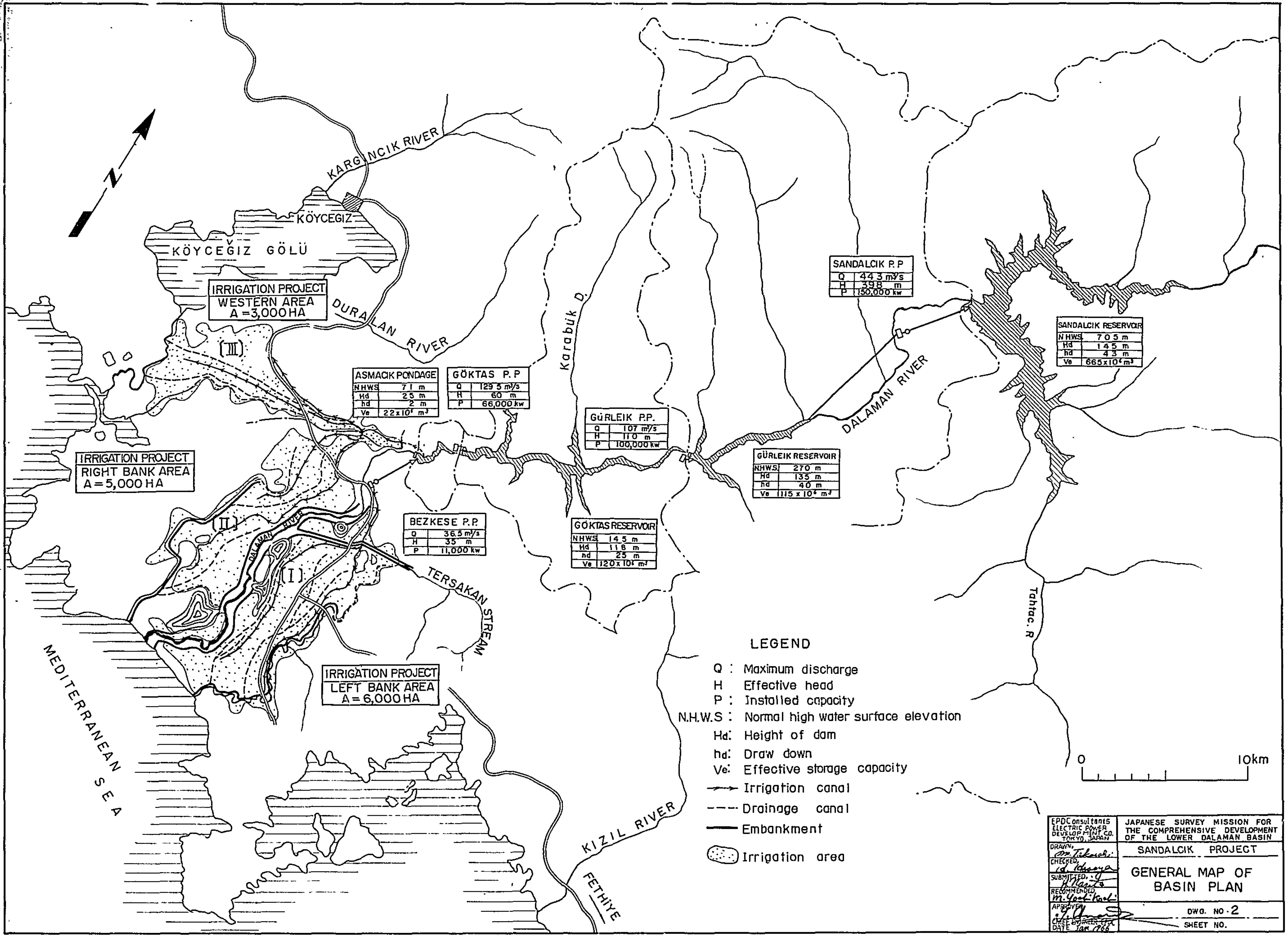
Earthquakes by Intensity

Greater than V	10 times; west and south of Dalaman
	8 times; in the Dalaman Gorge
Greater than VII	3 times; east of Dalaman
	2 times; west of Dalaman
Greater than IX	2 times; around Denizli
	1 time; a great distance to the west

Judging from the above, although further detailed study will be necessary, it is thought adequate to consider earthquake intensities of IX on the Mercalli intensity scale in designing of dams in the project areas.

There have been earthquakes recorded in Japan which have been greater in intensity than IX on the Mercalli scale, but for arch dams and rock-fill dams the technological intensity of $\alpha=0.24$ is adopted and for the Dalaman River it is thought sufficient to consider intensities of about the same degree as Japanese standards.

5. LOWER DALAMAN RIVER BASIN DEVELOPMENT PLAN


N
KARGINCIK RIVER
KÖYCEGIZ
KÖYCEĞIZ GÖLÜ
IRRIGATION PROJECT
WESTERN AREA
A = 3,000 HA
DURALAN RIVER
(III)
ASMACIK PONDAGE
NHWS 71 m
Hd 25 m
hd 2 m
Ve 22x10⁶ m³
GÖKTAS P.P
Q 129.5 m³/s
H 60 m
P 66,000 kw
Karabük D.
GÜRLEIK P.P.
Q 107 m³/s
H 110 m
P 100,000 kw
SANDALCIK P.P
Q 44.3 m³/s
H 398 m
P 150,000 kw
SANDALCIK RESERVOIR
N.HWS. 705 m
Hd 145 m
hd 43 m
Ve 665x10⁶ m³
DALAMAN RIVER
GÜRLEIK RESERVOIR
NHWS 270 m
Hd 135 m
hd 40 m
Ve 115 x 10⁶ m³
IRRIGATION PROJECT
RIGHT BANK AREA
A = 5,000 HA
(II)
DALAMAN RIVER
(I)
BEZKESE P.P.
Q 36.5 m³/s
H 35 m
P 11,000 kw
GÖKTAS RESERVOIR
N.HWS. 145 m
Hd 118 m
hd 25 m
Ve 120x10⁶ m³
TERSAKAN STREAM
Tahtac. R
MEDITERRANEAN SEA
IRRIGATION PROJECT
LEFT BANK AREA
A = 6,000 HA
LEGEND
Q : Maximum discharge
H Effective head
P : Installed capacity
N.H.W.S : Normal high water surface elevation
Hd: Height of dam
hd: Draw down
Ve: Effective storage capacity
Irrigation canal
Drainage canal
Embankment
Irrigation area
0
10km
KIZIL RIVER
FETHIYE
EPDC Consultants
ELECTRIC POWER DEVELOPMENT CO.
TOKYO, JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER
DATE Jan. 1966
SANDALCIK PROJECT
GENERAL MAP OF
BASIN PLAN
DWG. NO. 2
SHEET NO.

5. LOWER DALAMAN RIVER BASIN DEVELOPMENT PLAN

5-1 BASIC CONCEPTION

5-1-1 INTRODUCTION

The Dalaman River with a catchment area of about 5,200 km^2 is blessed with abundant water resources having an annual run-off of approximately 1,600,000,000 m^3. However, its water resources remain completely undeveloped except for some water being utilized for irrigation in the lower Dalaman Plain area.

Agricultural pattern of the Dalaman Plain is the growing of one-crop-per-year. The cultivated land is inundated at times of flood and damages are inflicted to crops affecting yield and quality.

The ratio of annual run-off of the Dalaman River between wet and dry years is pronounced, being approximately 3:1. In order to effectively utilize the run-off of the river which fluctuates so greatly, it will be necessary to provide reservoirs which can regulate the run-off over a number of years. From this viewpoint, the plan for the development of the Dalaman Basin is to build three reservoirs and a regulating pond on the main stream of the Dalaman River to regulate the run-off and make available a firm supply of water throughout the year. Considerable benefit can be gained by utilizing this water for irrigation and power generation.

At present, the main source of agricultural water of the Dalaman Plain is the Dalaman River, but this river is extremely dry in summer and the run-off fluctuates greatly by the year, and as this area sees little or no rain during the summer, agricultural production is very unstable. Therefore, in order to promote agriculture in the Dalaman Plain it will be necessary to secure an assured source of water supply by the construction of the beforementioned reservoirs and regulating pondage and to provide irrigation and drainage systems as well as to take measures to lower ground water levels and for flood protection.

The area of land in the Dalaman Plain which can be irrigated is approximately

14,000 ha. The water required for irrigation can be secured by reservoirs having a combined effective storage capacity of approximately 120,000,000 m^3. As for flood control measures for the Dalaman Plain, it will not be very economical to attempt complete regulation of flood discharges with reservoirs and it is more advisable to build levees along the banks of the river in the plain area to discharge the great part of the run-off through the river channel.

Together with the reservoirs and regulating pond, 4 power stations will be built and the electric power generated will be transmitted to Izmir by a transmission line approximately 280 km in length to supply demands for power of the southwestern areas where Izmir is the center.

As described above, the Lower Dalaman River Basin Development Program consisting of flood Protection, irrigation and drainage works of the Dalaman Plain and electric power development, has been prepared with the purpose of effective utilization of the Dalaman River Water resources. Since the total storage capacity of the three reservoirs exceeds far over the required water quantity for irrigation in the Dalaman Plain, which is 120,000,000 m^3, the determination of the reservoir capacities was made based on the power generation program.

5-1-2 BASIC CONDITIONS

The scale of reservoirs was examined based upon the following conditions.

a. The economically justifiable scale of reservoirs was considered on the basis of maximum excess benefit (V-C) that is the difference between total benefit derived from development programs proportionate to the scale of each reservoir (V) and the total annual cost (C).

b. As the standard for benefit from power generation a standard thermal power plant was assumed. Based on this standard thermal power plant, expense per KW and KWh was calculated and these were considered the standard unit values of effective output and effective electric energy.

c. Power output and electric production energy were calculated on a monthly basis based on run-off data of the 21 years from October, 1943 to September, 1964. The average of the December peak output securable for the 21 years was considered the firm power output (dependable capacity).

The abovementioned run-off data were based on actual records of Sucati (in early years, Alci) Gauging Station and Akkopru Gauging Station and converted values from Kayirli Gauging Station.

d. The installed output of each power station was based on the assumption that overall load factor of the hydroelectric power plants on the Dalaman River would be approximately 43% with some allowance added.

e. The topographical maps used for preparation of the plan were as listed below.

1/200,000	topographical map:	entire drainage basin
1/25,000	topographical map:	Lower Dalaman River basin
1/5,000	topographical map:	Lower Dalaman River basin
1/1,000	topographical map:	Sandalcik and Asmacik Dam sites

All surveying for the above maps was conducted by DSI.

f. Interest rates on construction costs were set at 5% for power generation facilities to be built by DSI and 7% for power transmission lines and substations to be built by Etibank.

Taxes were considered for only the work to be performed by Etibank, no considerations being made for work to be executed by DSI.

g. Construction costs were estimated referring to standard unit costs used by the DSI and costs in Japan and other countries.

5-1-3 SELECTION OF RESERVOIR SITES

The following 4 locations were selected and surveyed as sites for reservoirs in consideration of the topographical and geological conditions of the Lower

Dalaman River, run-off at each site and method of development of the river:

a. Sandalcik Reservoir Site

A point approximately 1. 1 km downstream of the junction of the Tahtaci (Hüseyin) Stream, a left-bank tributary, and the main Dalaman River.

b. Gürleik Reservoir Site

A point immediately below the junction of a right bank tributary, Cehennen Stream and the main river.

c. Göktas Reservoir Site

A point approximately 2. 5 km downstream of the junction of a right-bank tributary, the Bayali Stream, and the main river.

d. Asmacik Regulating Pond Site

A point approximately 4 km upstream from the Dalaman Bridge.

A upper Sandalcik reservoir site was also considered at a point approximately 2 km upstream of the junction of a tributary, the Kirkgecon Stream,. and the main river. In a comparison study of the case in which 2 reservoirs would be built, one at this site and the other at the Sandalcik site, and the case in which one large-scale reservoir would be built at Sandalcik only, it was found that the latter would be more economical and so the idea of a reservoir at the upstream site was abandoned.

5-2 RESERVOIRS

5-2-1 RUN-OFF AT EACH PROPOSED SITE

The monthly run-off of each proposed site calculated in 4-1-2 are as shown in Table 4-1-5 through 4-1-8. The wet and dry years and the run-off characteristics of the 21 years from October, 1943 to September, 1964 are tabulized below.

Table 5-2-1 Run-Off Characteristics of Each Projected Site

Site		(1) Annual Run-Off 10^6 m^3	(2) Max. Monthly Run-Off 10^6 m3	(3) Min. Monthly Run-Off 10^6 m^3	Remark	
					(2)/(3)	Dry/Wet
	Wet Year	1,562	309	31	10.00	
Sandalcik	Dry Year	452	54	23	2.40	3.50
(3,970 km^2)	21Year Ave.	940	155	30	5.20	
	(above in m^3/s)	(29.80)	(63.90)	(11.60)		
	Wet Year	2,165	392	50	7.80	
Gürleik	Dry Year	733	87	41	2.10	3.00
(4,510 km^2)	21-Year Ave.	1,367	216	49	4.40	
	(above in m^3/s)	(43.40)	(89.40)	(18.80)		
	Wet Year	2,455	432	60	7.20	
Gõktas	Dry Year	868	103	50	2.10	2.80
(4,770 km^2)	21-Year Ave.	1,573	246	58	4.20	
	(above in m^3/s)	(49.90)	(101.6)	(22.40)		
	Wet Year	2,466	433	60	7.20	
Asmacık	Dry Year	874	103	50	2.10	2.80
(4,780 km^2)	21-Year Ave.	1,581	247	58	4.20	
	(above in m^3/s)	(50.10)	(102.10)	(22.50)		

The 21-year average annual run-off at the Gõktas site is approximately 18,200 m^3/s-day (1,570,000,000 m^3). Approximately 56% of this run-off comes in the four-month period from December to March while the run-off during the four-month dry period of June to September is only about 17% of the annual run-off. The ratio between wet years and dry years is 3:1 and there is considerable fluctuation according to the year. For a river having such great fluctuation in run-off, it is necessary to build reservoirs and provide seasonal regulation of run-off to firm up the dry season run-off in order to effectively utilize its water. Furthermore, for even greater utilization of water, it is desirable to build a large-scale reservoir to provide run-off regulation over a period of years if construction of the reservoir is economically feasible.

Next, monthly mass curves of the Sandalcık, Gürleik and Göktas sites were prepared based on monthly run-off over the 21 years from October, 1943 to September, 1964. As seen from these mass curves, the one cycle of May, 1956 to April, 1963 which includes a consecutive number of dry years beginning with the dryest year, 1957, is the critical period in deciding the project. Therefore, the scale of the plan is based on this series of consecutive dry years.

5-2-2 DETERMINATION OF RESERVOIR CAPACITY

As stated in 5-1-3, there are 3 locations, Sandalcik, Gurleik and Goktas which are considered as sites for reservoirs. In order to determine the effective storage of water necessary for the most effective development of the Dalaman River, studies were made of 5 alternatives for the total effective storage capacity of the 3 reservoirs: 500,000,000 m^3, 700,000,000 m^3, 900,000,000 m^3, 1,100,000,000 m^3 and 1,500,000,000 m^3. The effective capacity of the respective reservoirs for each alternative was based on the following considerations:

Sandalcık is located at the most upstream point and also has a very high storage efficiency so that the capacity was made larger than the other 2 sites. Dead water was considered to be 300,000,000 m^3 and the low water level of the reservoir for each of the alternative was assumed to be the same.

Gürleik and Göktas will have dam-type power plants and as fluctuation in available drawdown will have great effect on head, the available drawdown was considered at 1/3 or less of maximum head in order to minimize the effect.

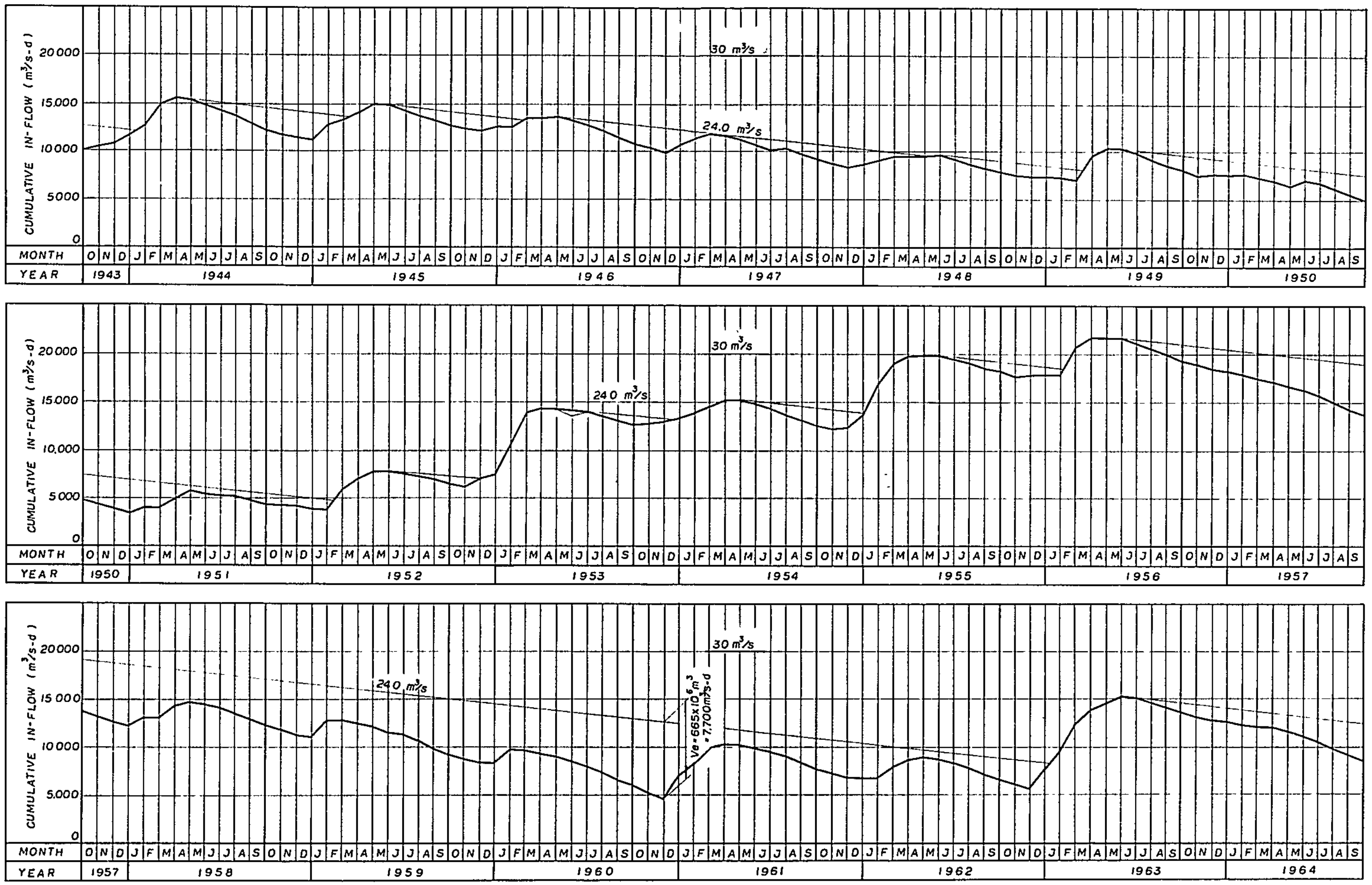


Fig. 5-2-1

MASS CURVE

AT SANDALCIK SITE

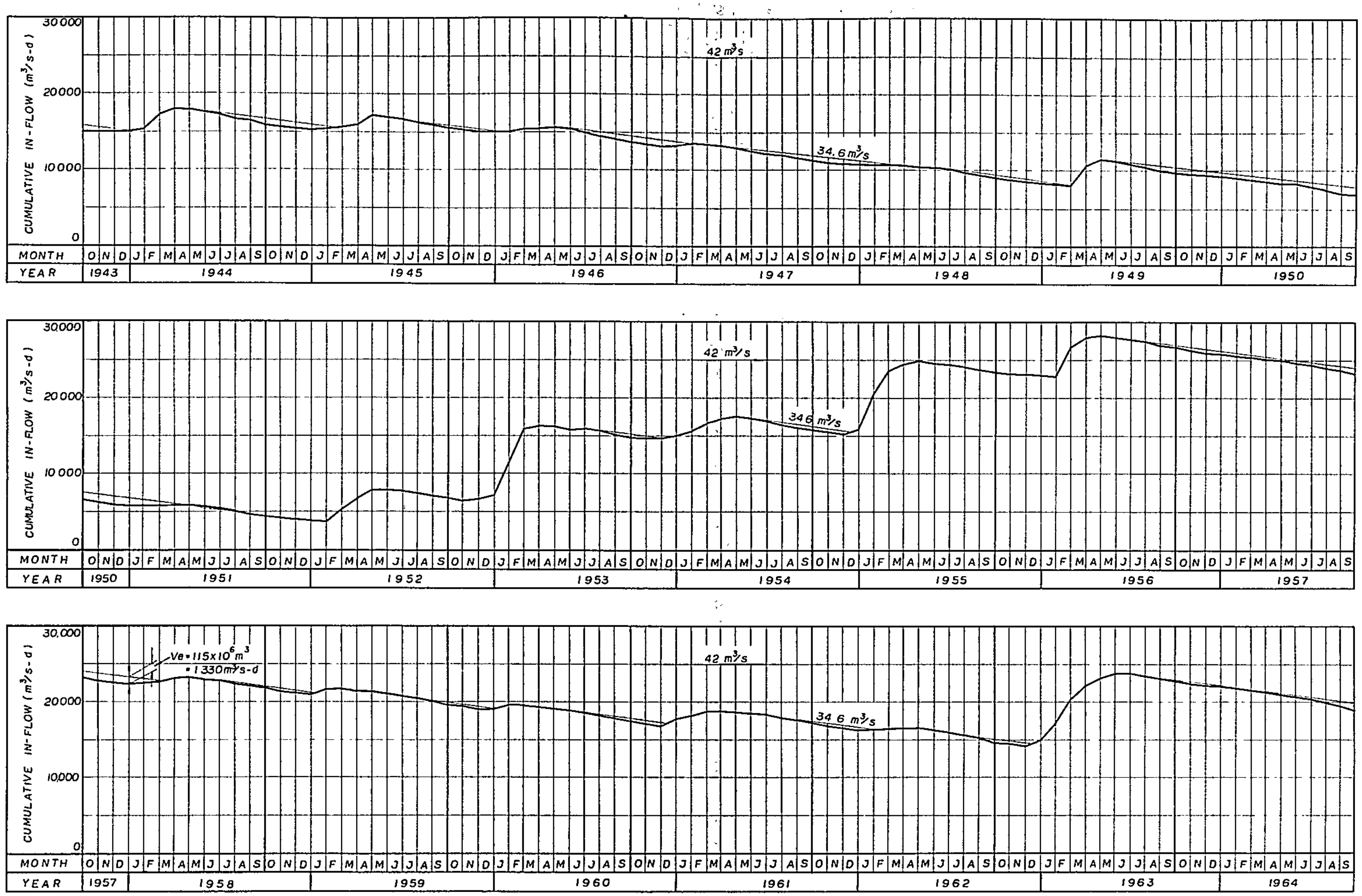


Fig. 5-2-2

MASS CURVE

AT GÜRLEIK SITE

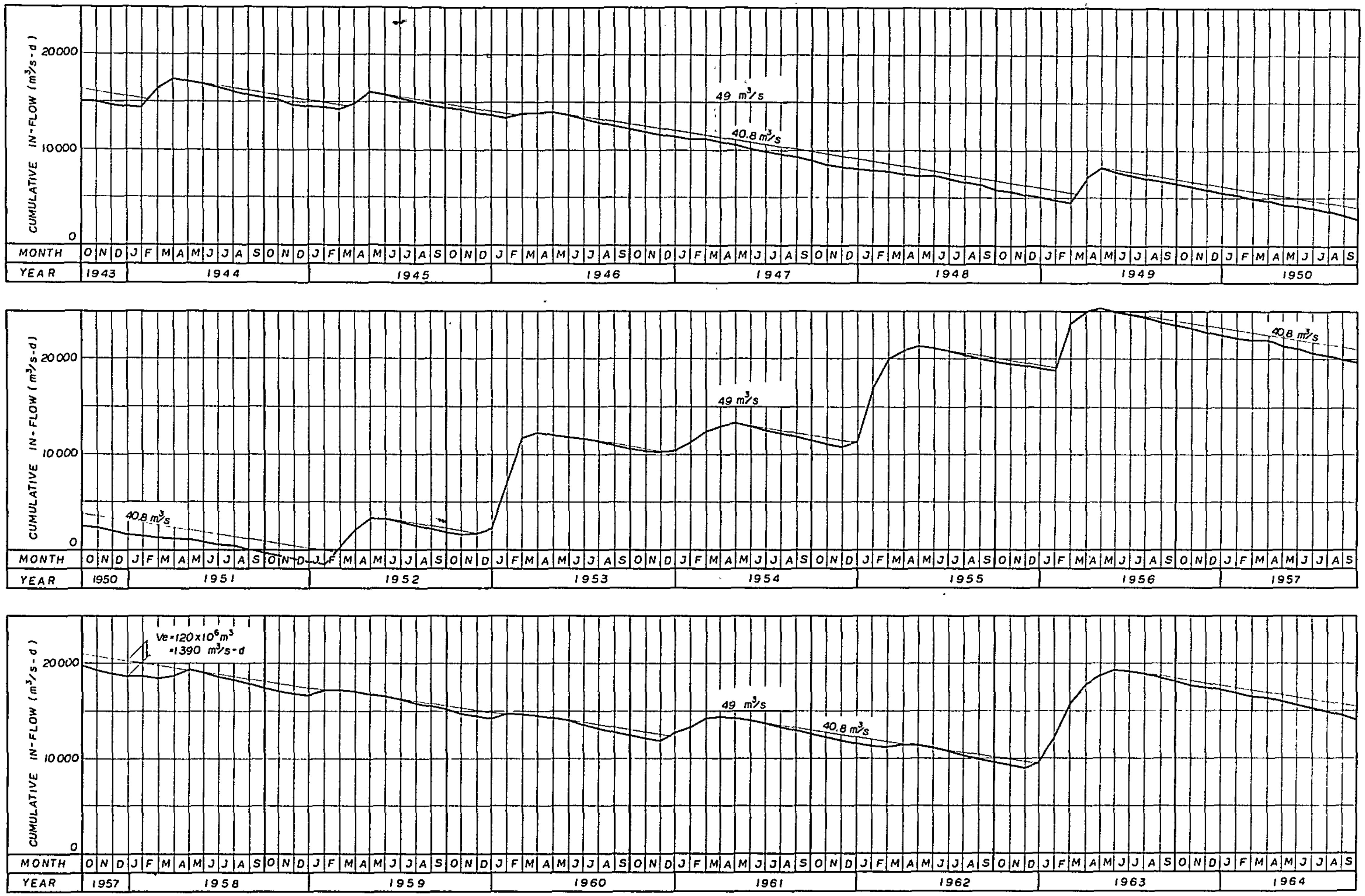


Fig. 5-2-3

MASS CURVE

AT GÖKTAS SITE

Table 5-2-2 Effective Capacities of Reservoirs for Various Alternatives

Total Storage Capacity (m^3)	Item	Unit	Sandalcik	Gürleik	Göktas
500 x 10^6	Normal Water Surface Level	m	690	250	127
	Effective Capacity	10^6m^3	370	60	70
700 x 10^6	Normal Water Surface Level	m	698	262	135
	Effective Capacity	10^6m^3	520	85	95
900 x 10^6	Normal Water Surface Level	m	705	270	145
	Effective Capacity	10^6m^3	665	115	120
1,100 x 10^6	Normal Water Surface Level	m	712	280	150
	Effective Capacity	10^6m^3	820	135	145
1,500 x 10^6	Normal Water Surface Level	m	723	308	150
	Effective Capacity	10^6m^3	1,110	245	145

The result of brief studies of the above are given in Fig. 5-2-8 and it is shown the total effective capacity at which excess benefit will be the maximum is 900,000,000 m^3. The relation between effective capacity of reservoir and utilization factor of run-off at Göktas is shown in Fig. 5-2-9. As can be seen from this graph the utilization factor of run-off when effective capacity is 900,000,000 m^3 will be approximately 95% and in order to increase the utilization factor any more, the effective capacity will have to be increased drastically. Therefore, it can be said that approximately 95% will be most economical.

5-2-3 EFFECTIVE CAPACITY OF VARIOUS RESERVOIRS

The catchment areas for the respective proposed sites are as tabulized below.

Table 5-2-3 Catchment Area of Projected Sites

Projected Area	Catchment Area Proper km^2	Total Catchment Area km^2
Sandalcik	3,970	3,970
Gürleik	540	4,510
Göktas	260	4,770

Projected Area	Catchment Area Proper km^2	Total Catchment Area km^2
Asmacik	10	4,780

As stated previously, reservoirs are proposed at Sandalcik, Gürleik and Göktas, and the respective capacities were computed from 1/5,000 scale topographical maps. The capacity curves of these reservoirs are shown in Fig. 5-2-4 through Fig. 5-2-7.

The normal high water surface levels and effective capacities of the respective reservoirs under the various alternative plans are as shown in Table 5-2-4.

The storage capacity required for regulation of the Dalaman River run-off, as described in 5-2-2, is 900,000,000 m^3 total effective capacity at the 3 reservoirs of Sandalcik, Gürleik and Göktas. The 4 alternative plans tabulized below were studied in determining the effective capacities of the respective reservoirs to obtain a total effective capacity of 900,000,000 m^3.

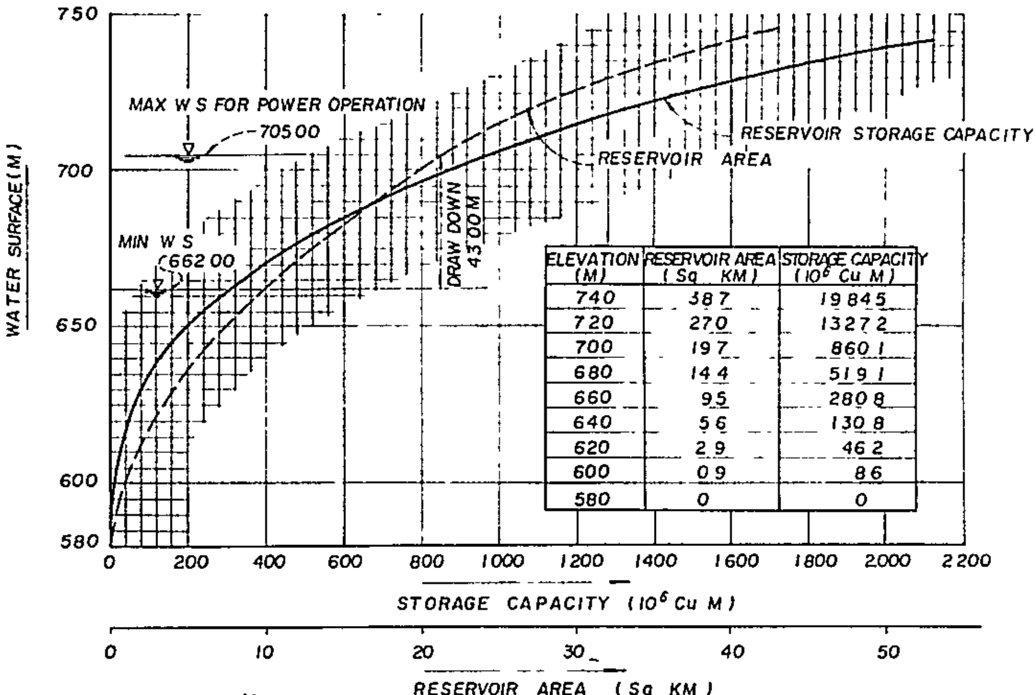
Table 5-2-4 Normal Water Surface Level and Effective Capacity of Reservoirs Under Various Plans

Reservoir		Proposed Plan			
		No. 1	No. 2	No. 3	No. 4
Sandalcik Reservoir	Normal Water Surface Level m	695	700	705	710
	Effective Capacity 10^6m^3	460	560	665	770
Gürleik Reservoir	Normal Water Surface Level m	325	305	270	255
	Effective Capacity 10^6m^3	320	220	115	60
Göktas Reservoir	Normal Water Surface Level m	145	145	145	130
	Effective Capacity 10^6m^3	120	120	120	70

The effective capacities of the reservoirs under the various alternative plans were calculated by the same methods as in 5-2-2.

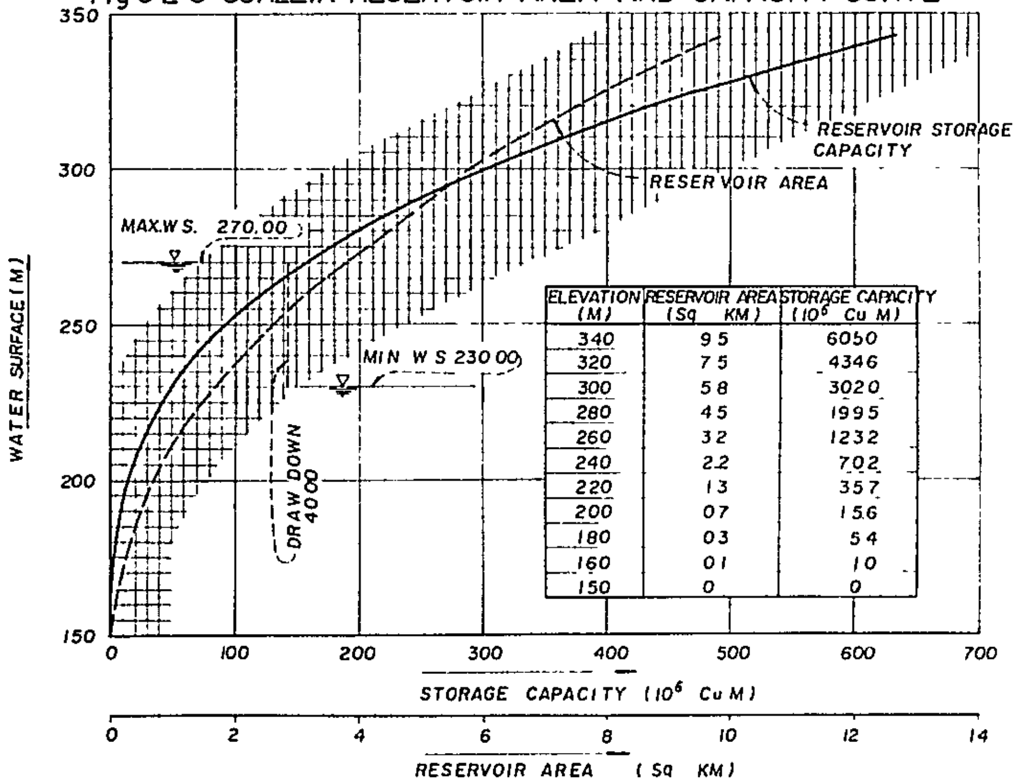
The results of studies of these various alternative plans, as described in detail in 5-3, Hydroelectric Power Generation Program, show that Plan No. 3 in which the normal high water surface level of Sandalcik Reservoir is at El. 705 m, is the most advantageous (See Fig. 5-2-10). The pertinent data of the respective reservoirs in this case are as shown below.

Fig.5-2-4 SANDALCIK RESERVOIR AREA AND CAPACITY CURVE



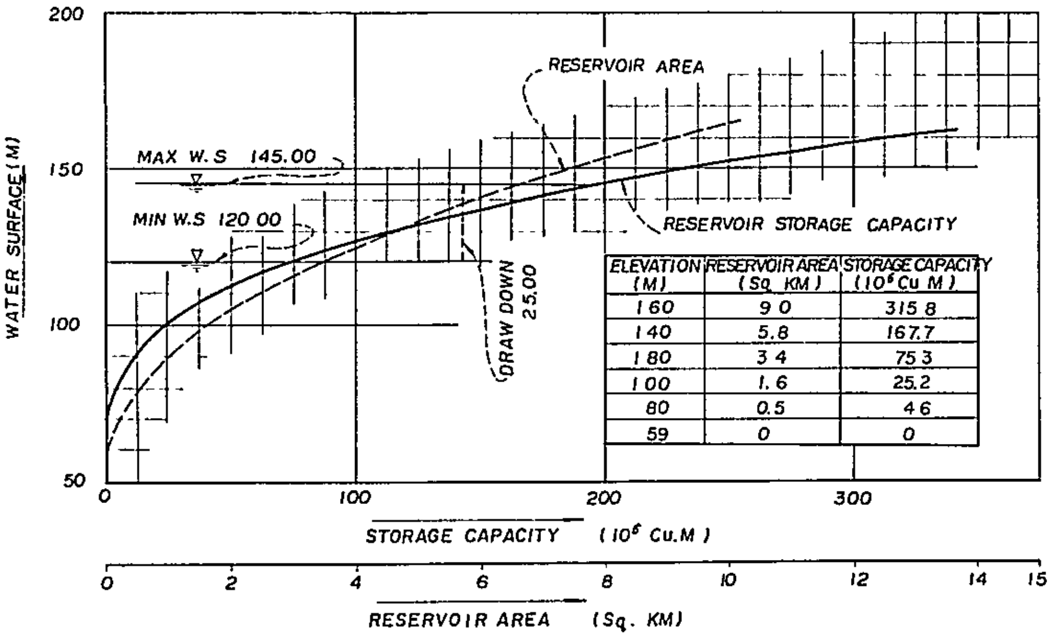
ELEVATION (M)	RESERVOIR AREA (Sq KM)	STORAGE CAPACITY (10^6 Cu M)
740	38 7	1984 5
720	27 0	1327 2
700	19 7	860 1
680	14 4	519 1
660	9 5	280 8
640	5 6	130 8
620	2 9	46 2
600	0 9	8 6
580	0	0

Fig 5-2-5 GÜRLEIK RESERVOIR AREA AND CAPACITY CURVE



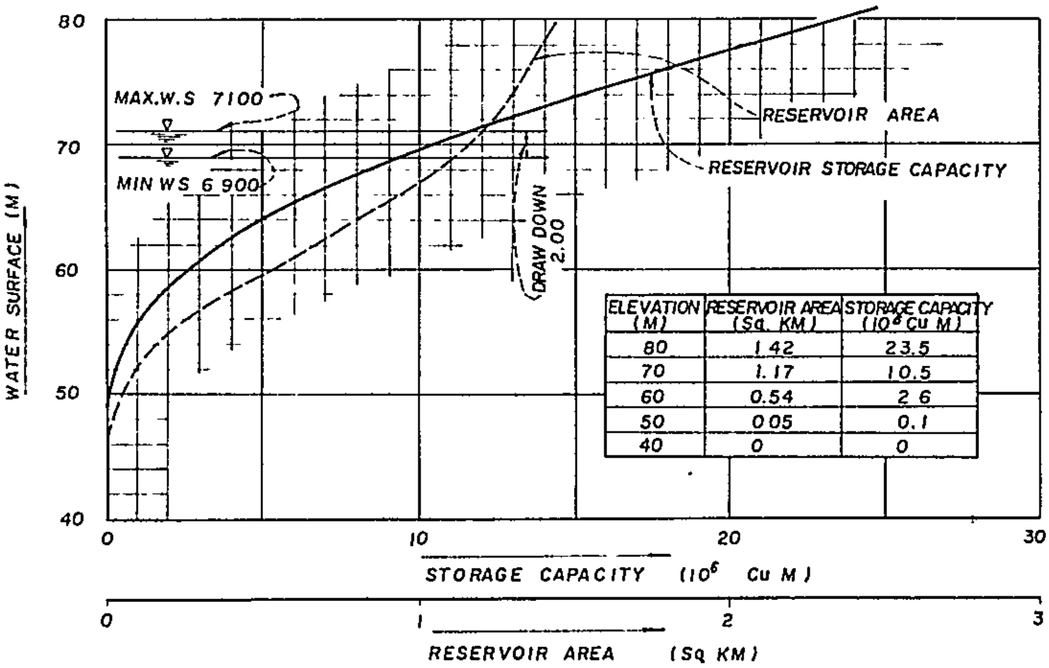
ELEVATION (M)	RESERVOIR AREA (Sq KM)	STORAGE CAPACITY (10^6 Cu M)
340	9 5	605 0
320	7 5	434 6
300	5 8	302 0
280	4 5	199 5
260	3 2	123 2
240	2 2	70 2
220	1 3	35 7
200	0 7	15 6
180	0 3	5 4
160	0 1	1 0
150	0	0

Fig 5-2-6 GÖKTAS RESERVOIR AREA AND CAPACITY CURVE



ELEVATION (M)	RESERVOIR AREA (Sq. KM)	STORAGE CAPACITY (10^6 Cu M)
1 60	9 0	315 8
1 40	5.8	167.7
1 80	3 4	75 3
1 00	1. 6	25.2
80	0.5	4 6
59	0	0

Fig. 5-2-7 ASMACIK POND AREA AND CAPACITY CURVE



ELEVATION (M)	RESERVOIR AREA (Sq. KM)	STORAGE CAPACITY (10^6 Cu M)
80	1.42	23.5
70	1. 17	10.5
60	0.54	2 6
50	0 05	0. 1
40	0	0

Fig. 5-2-8
COMPARISON OF RESERVOIR CAPACITY

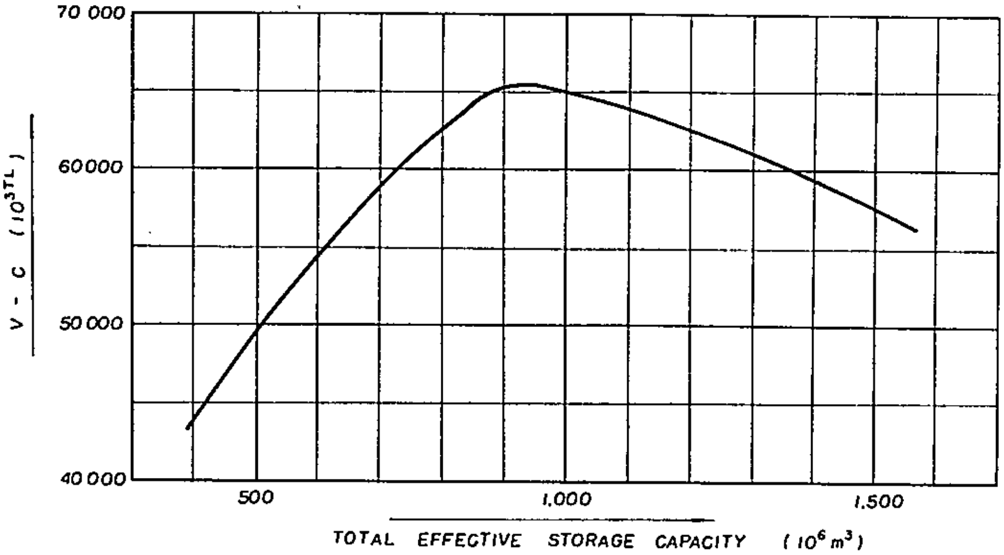


Fig. 5-2-9
UTILIZATION FACTOR OF RUN-OFF
AT GÖKTAŞ SITE

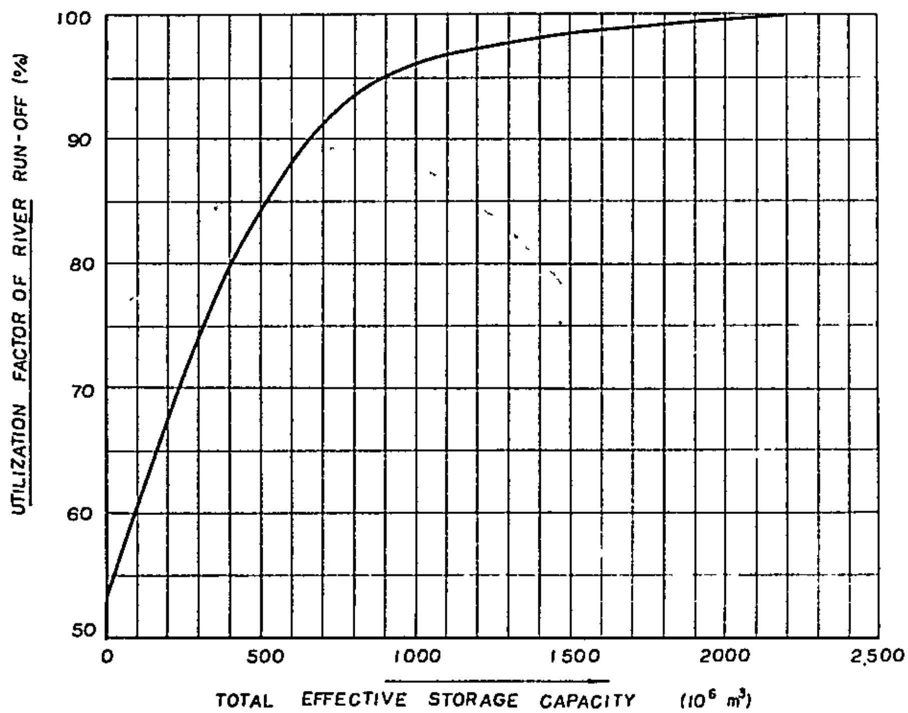
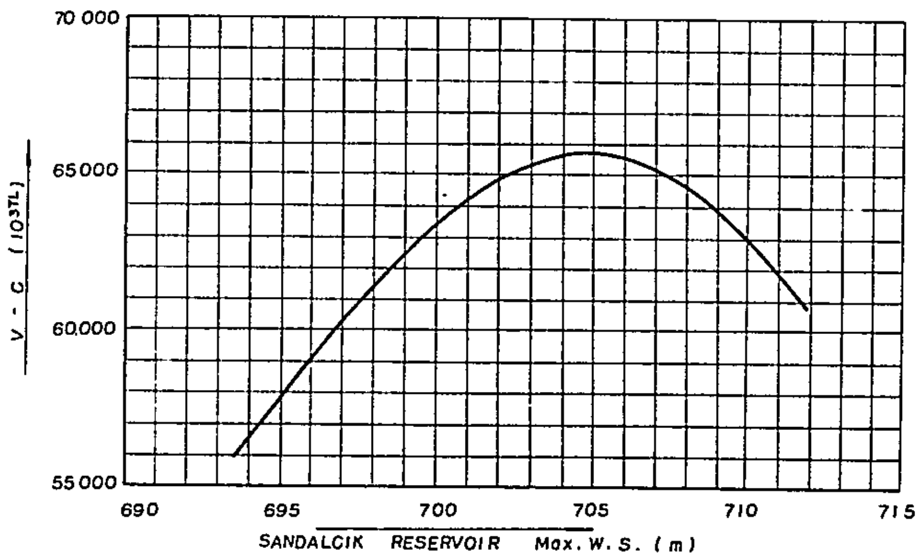


Table 5-2-5 Pertinent Data of Reservoirs

Item	Unit	Sandalcik Reservoir	Gurleik Reservoir	Goktas Reservoir	Asmacik Regulating Pond
Catchment Area	km^2	3,970	4,510	4,770	4,780
Annual Inflow	10^6m^3	940	1,367	1,573	1,581
Normal High Water Surface Level	m	705	270	145	71
Reservoir Surface Area	km^2	21.2	3.8	6.5	1.2
Total Storage Capacity	10^6m^3	965	160	195	11.7
Effective Capacity	10^6m^3	665	115	120	2.2
Available Drawdown	m	45	40	25	2

Fig. 5-2-10

COMPARISON OF EACH RESERVOIR CAPACITY



5-2-4 AVAILABLE DISCHARGE OF RESERVOIRS

The total effective capacity of 900, 000, 000 m^3 of the 3 reservoirs correspond to about 60% of the 21-year average annual run-off of approximately 1, 600, 000, 000 m^3 of the Dalaman River at the lowermost Göktas Reservoir site. This effective capacity is a capacity which is adequate for regulating the greatly fluctuating run-off of the Dalaman River over a number of years.

The available discharge of the respective reservoirs when this storage capacity is effectively used is as described below:

- Sandalcik Reservoir

  The effective capacity of 665, 000, 000 m^3 of Sandalcik Reservoir corresponds to about 70% of the annual run-off of approximately 940, 000, 000 m^3 at this site. With this reservoir, it will be possible to carry out seasonal regulation of run-off, and also yearly regulation by storage of run-off of wet years for release in dry years.

  The firm available discharge of this reservoir will then be 24. 00 m^3/s.

- Gürleik Reservoir

  The effective capacity of 115, 000, 000 m^3 of Gúrleik Reservoir corresponds to about 27% of the annual run-off of about 430, 000, 000 m^3 of the catchment area remaining below the Sandalcik site.

  Combined with the regulated run-off from the upstream dam, the firm available discharge of this reservoir will be 34. 60 m^3/s.

- Göktas Reservoir

  The effective capacity of 120, 000, 000 m^3 of Göktas Reservoir corresponds to about 60% of annual run-off of about 210, 000, 000 m^3 of the catchment area remaining below the Gürleik site.

  With this reservoir, it will be possible to carry out seasonal regulation of run-off and also yearly regulation by storage of run-off of wet years for release in dry years.

  Combined with the regulated run-off from the upstream dams, the firm available discharge of this reservoir will be 40.80 m^3/s.

o Asmacik Regulating Pond

The effective storage capacity of the Asmacik regulating pond is 2, 200, 000 cubic meters.

With this storage capacity the pond can store, and regulate the released discharge of the upstream power plants during peak generation to secure a firm discharge of 27.37 m^3/s for irrigation use as well as peak supply of 36.5 m^3/s for generation at the power plant.

Based on the studies as mentioned above, average inflow, discharge, evaporation and overflow will be as shown in the following table over the period of 21 years.

Table 5-2-6 Annual Inflow Discharge, Evaporation and Overflow

	Sandalcik	Gürlcik	Göktas	Asmacik
Annual Inflow 10^6m^3	940	1,340	1,540	1,540
Discharge 10^6m^3	820	1,272	1,460	1,270
Evaporation 10^6m^3	26	5	8	2
Overflow 10^6m^3	94	64	71	269

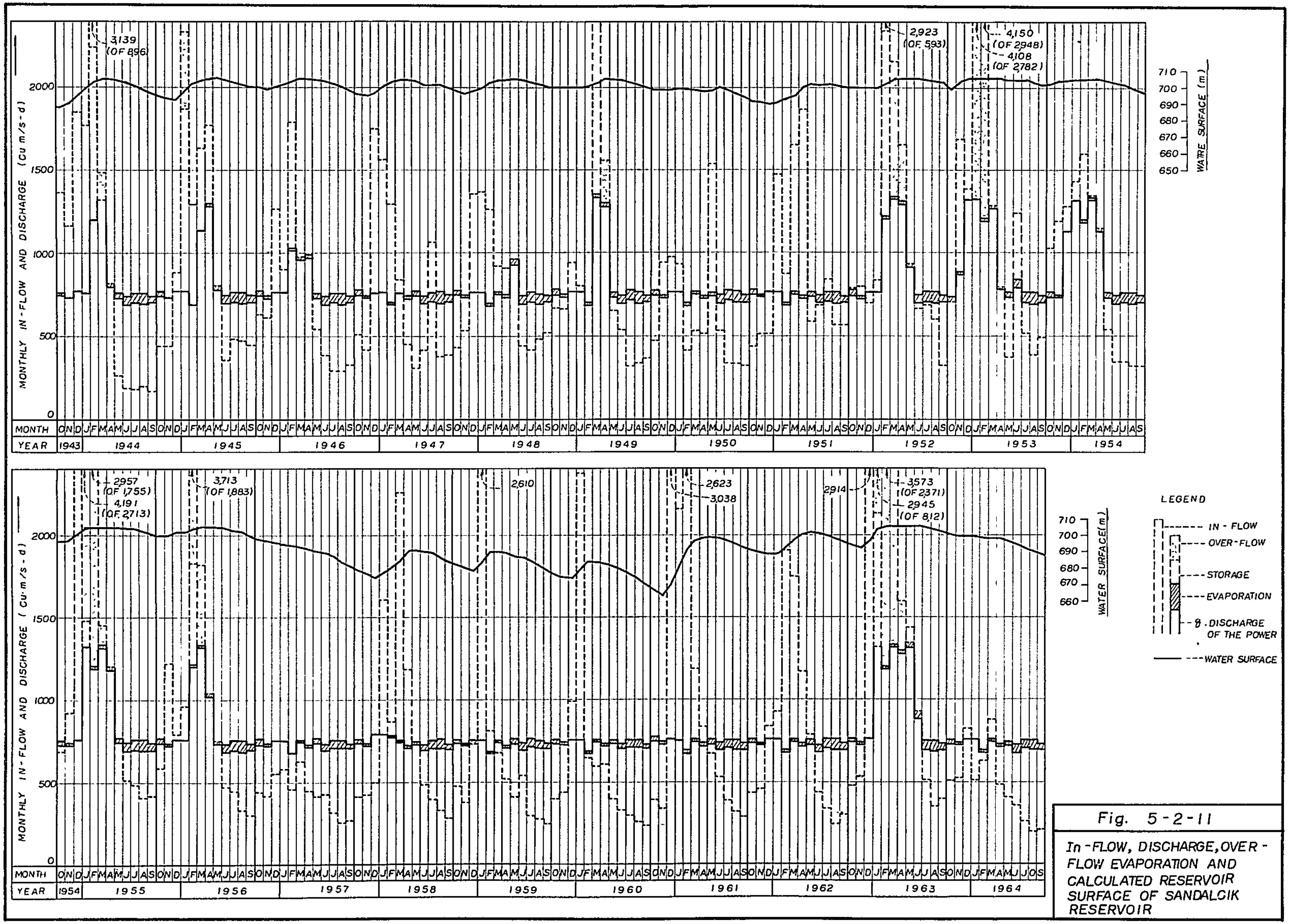


Fig. 5-2-11

In-FLOW, DISCHARGE, OVER-FLOW EVAPORATION AND CALCULATED RESERVOIR SURFACE OF SANDALCIK RESERVOIR

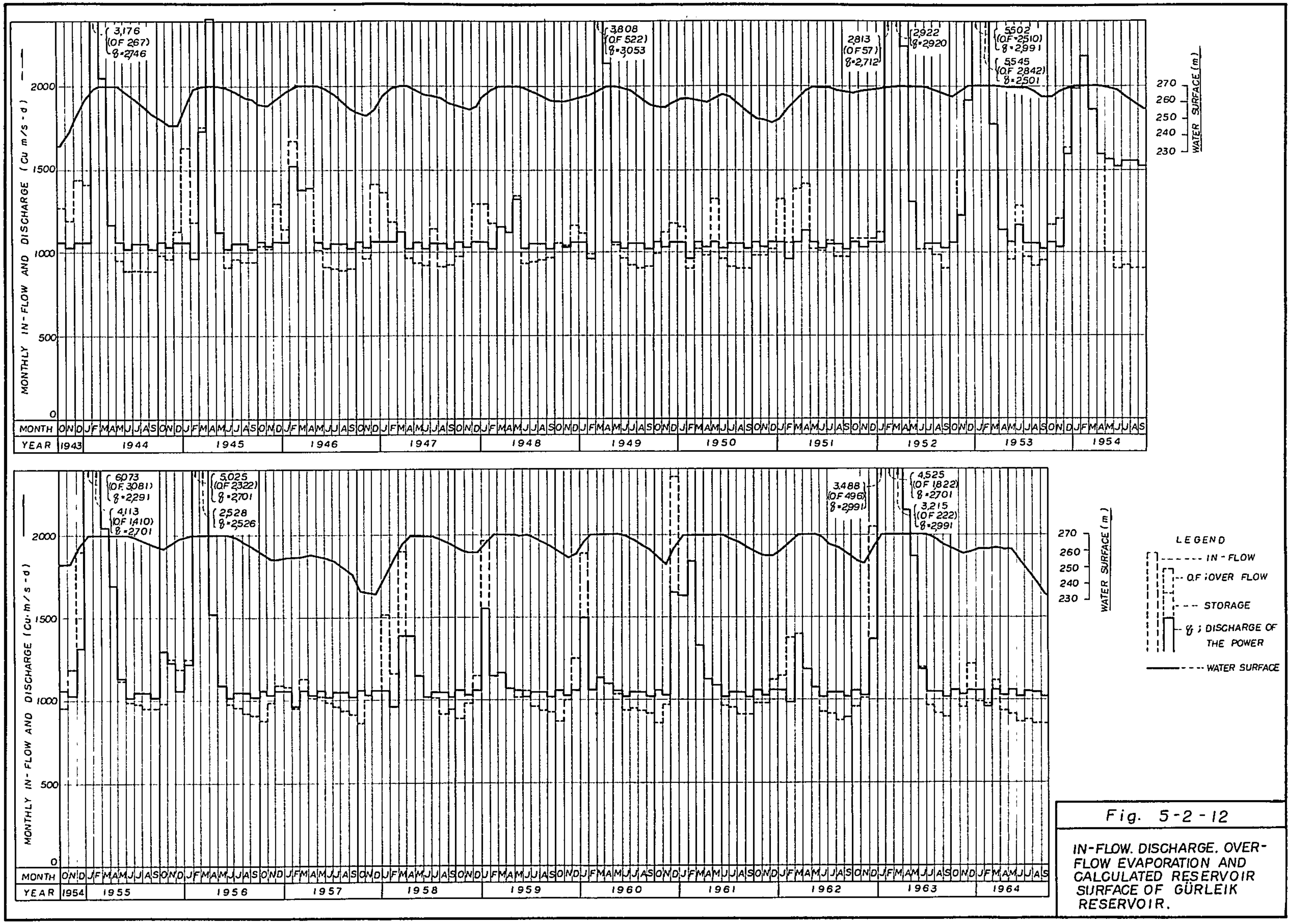


Fig. 5-2-12

IN-FLOW. DISCHARGE. OVER-FLOW EVAPORATION AND CALCULATED RESERVOIR SURFACE OF GÜRLEIK RESERVOIR.

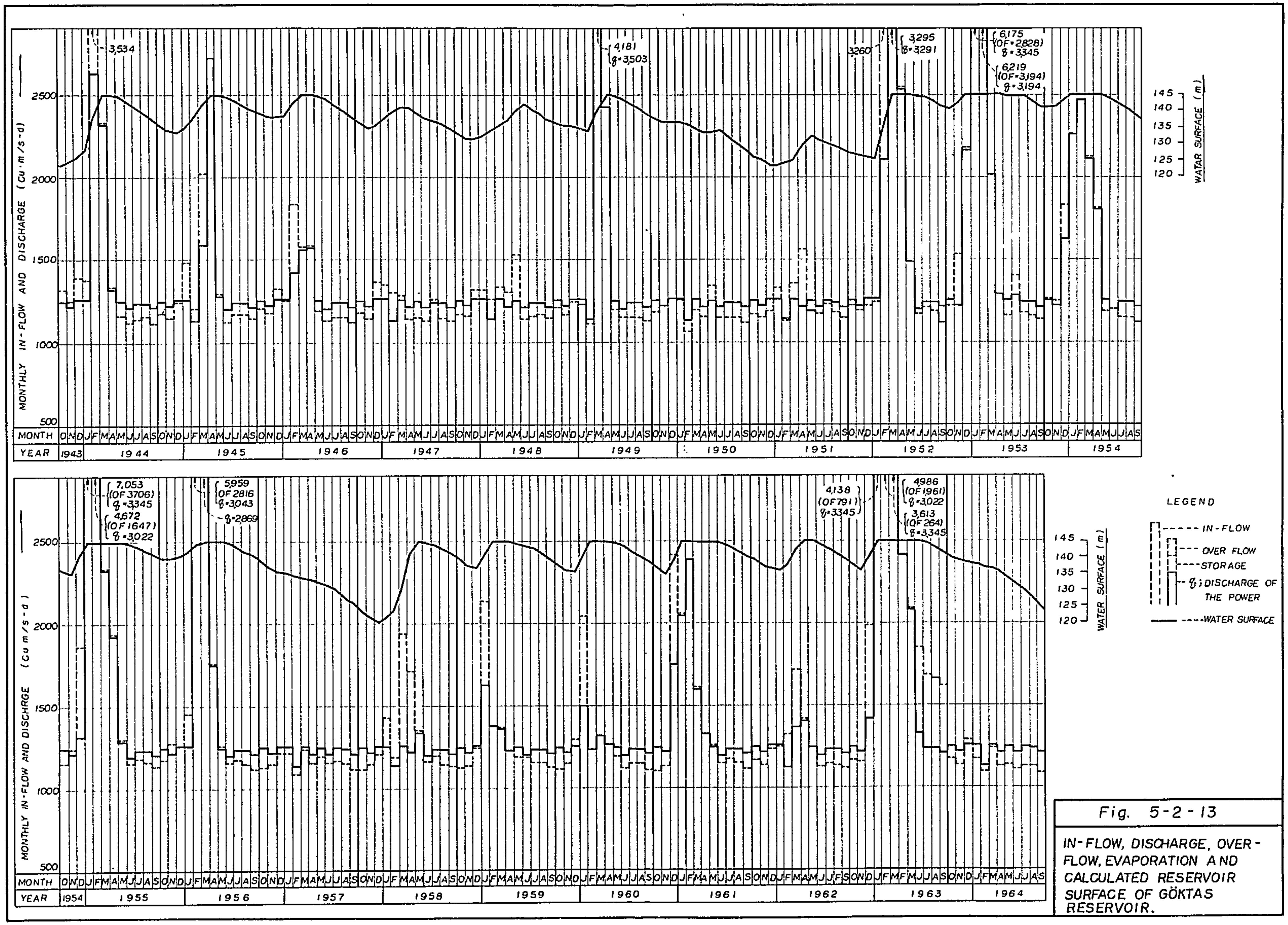


Fig. 5-2-13

IN-FLOW, DISCHARGE, OVER-FLOW, EVAPORATION AND CALCULATED RESERVOIR SURFACE OF GÖKTAS RESERVOIR.

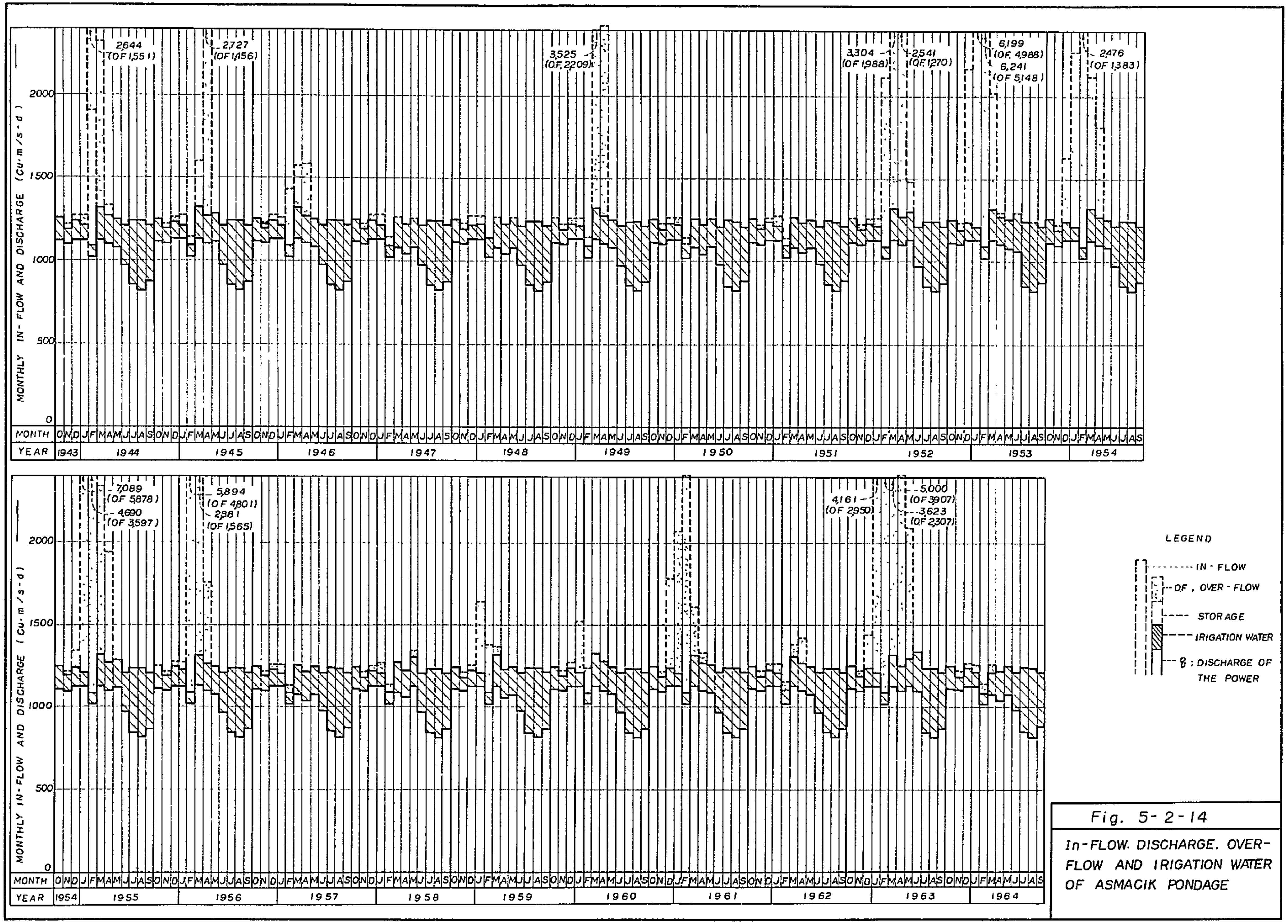


Fig. 5-2-14

In-FLOW. DISCHARGE. OVER-FLOW AND IRIGATION WATER OF ASMACIK PONDAGE

5-3 HYDROELECTRIC POWER GENERATION PLAN

5-3-1 ENERGY PRODUCTION STUDIES

a. Introduction

The following matters were taken into consideration in the study of methods and scale of the hydroelectric power generation plan for the Lower Dalaman River.

Methods and scale of power generation were selected to correspond to the estimated demand for electric power in the western regions of Turkey.

The "Summary of Lower Dalaman Project - July, 1963, Ankara," prepared by DSI, points out the possibility of 5 power stations which could be built by the methods listed below as comprising the hydroelectric power generation plan of the Lower Dalaman River:

Proposed Site	Power Station	Method of Generation
Sandalcik	Sandalcik	Dam-type
Narli	Narli	Waterway-type
Gürleik	Gürleik	Dam-type
Göktas	Göktas	Dam-type
Asmacik	Bezkese	Waterway-type

As a result of the field surveys of the Lower Dalaman River conducted by the Survey Mission, it was found there would be numerous problems topographically and especially geologically in selecting a waterway route and power plant site if a power station of the waterway-type were to be built at Narli after construction of a dam-type power station at Sandalcik. Therefore, upon studying these problems, it was decided to build Sandalcik Power Station as a dam-and-waterway type (underground power plant) instead of building plants separately at Sandalcik and Narli, as it would be more desirable to develop the head down to the Narli site in one step.

The power generation scheme of the Lower Dalaman River thus will consist of one power station each at Sandalcik, Gürleik, Göktas and Asmacik. The type of power generation of these 4 power stations will be as follows:

Proposed Site	Power Station	Method of Generation
Sandalcik	Sandalcik	Dam-and-waterway type
Gürleik	Gürleik	Dam-type
Göktas	Göktas	Dam-type
Asmacik	Bezkese	Dam-and-waterway type

The available discharge of each proposed site as already described, were determined based on studies of mass curves prepared using 21-year monthly run-off data, and of the continuous drought years of May, 1956 to April, 1963. The calculation of electric energy used in study of the scale of power stations were based on monthly figures of the run-off during the abovementioned 7 years.

The 15.64 cubic meters per second maximum discharge to be taken in at Asmacik for irrigation of the right bank of the Dalaman Plain will not pass through Bezkese Power Station to be built on the left bank.

b. Energy Production under Various Alternative Plans

The discharge of Sandalcik, Gürleik and Göktas Power Sations under the various power generation schemes corresponding to the reservoir capacities described in 5-2-3 were computed from the mass curves described in 5-2-1, while the discharge of Bezkese Power Station was calculated as the run-off remaining after drawing 15.64 cuibc meters per second for right bank irrigation from the discharge of the upstream Goktas Power Station.

The energy production figures for the various alternative plans calculated from the aforementioned 7-year period are as shown in Table 5-3-1.

Table 5-3-1 Energy Production of Various Alternative Plans

Item	Unit	Power Station				Total
		Sandalcık	Gürleık	Göktas	Bezkese	
Normal Water Suface Level	m	695	325	145	71	
Standard Intake Level	m	682	301	133	71	
Plan Tail Race Level	m	325	145	71	30	
Standard Effective Head	m	341	153	60	35	
No. 1 Firm Discharge	m^3/s	22.6	36.0	42.0	26.4	
Firm Power Output	KW	65,500	46,800	21,400	7,800	141,500
Firm Energy Output	16^6KWh	573.8	410.0	187.5	68.3	1,239.6
Normal Water Surface Level	m	700	305	145	71	
Standard Intake Level	m	687	287	133	71	
Plan Tail Race Level	m	305	145	71	30	
Standard Effective Head	m	363	137	60	35	
No. 2 Firm Discharge	m^3/s	23.3	36.0	42.2	26.6	
Firm Power Output	KW	72,000	42,000	21,500	7,900	143,400
Firm Energy Output	10^6KWh	630.7	367.9	188.3	69.2	1,256.1
Normal Water Sureace Level	m	705	270	145	71	
Standard Intake Level	m	689	258	133	71	
Plan Tail Race Level	m	270	145	71	30	
Standard Effective Head	m	398	110	60	35	
No. 3 Firm Discharge	m^3/s	24.0	34.6	40.8	25.2	
Firm Power Output	KW	81,000	32,300	20,800	7,500	141,600
Firm Energy Output	106 KWh	709.6	282.9	182.2	65.7	1,240.4
Normal Water Surface Level	m	710	255	130	71	
Standard Intake Level	m	691	245	123	71	
Plan Tail Race Level	m	255	130	71	30	
Standard Effective Head	m	414	110	52	35	
No. 4 Firm Discharge	m^3/s	24.8	34.5	40	24.4	
Firm Power Output	KW	87,000	32,000	17,000	7,200	143,200
Firm Energy Output	10^6 KWh	762.1	280.3	148.9	63.1	1,254.4

c. Installed and Firm output of Various Alternative Plans

o Installed Power Capacity of Various Power Stations

As stated in 3-1, it is estimated that overall load factor of the various hydroelectric power stations will be about 43% in 1977, the year scheduled for completion of development of the Dalaman River.

Therefore, in studying the installed capacity of the various power plants, the overall load factor of the 4 power stations was taken to be approximately 43% and the load factor of each plant determined in consideration of the generating method, etc. of each plant.

The load factor of Sandalcik Power Station was assumed to be about 54% in view of the fact this station would be a dam-and-waterway type with a comparatively long tunnel.

The load factors of Gürleik and Göktas Power Stations were set low at 30 to 35% in consideration of these stations being dam-type plants and in order to provide daily peak generation of 6 hours or longer.

As part of the discharge of Bezkese Power Station would be utilized for irrigation, the load factor there was set at 65 to 70%.

Based on the above load factors and taking some allowance into consideration, the installed capacity of the various power stations will be as shown in Table 5-3-2.

Table 5-3-2 Installed Capacity

	Sandalcık	Gurleik	Goktas	Bezkese	Total
Plan No. 1	118,000	128,000	68,000	12,000	326,000
Plan No. 2	132,000	120,000	68,000	12,000	332,000
Plan No. 3	150,000	100,000	66,000	11,000	327,000
Plan No. 4	162,000	98,000	60,000	10,000	330,000

o Firm Output of Various Power Stations

The peak output of a power station which can be secured in the month of maximum power demand (KW), is taken as the Firm output of that power station. As described in 3-1 the maximum power demand (KW) in Turkey is in December. Therefore, in this plan the average of the minimum output in December of each year was calculated and taken as the dependable capacity.

The dependable capacity of each power station is as shown in Table 5-3-3.

Table 5-3-3 Firm Output

	Sandalcik KW	Gurlcik KW	Goktas KW	Bezkese KW	Total KW
Plan No. 1	114,500	118,000	62,700	12,000	307,200
Plan No. 2	128,000	108,500	63,000	12,000	311,500
Plan No. 3	146,000	86,800	61,000	11,000	304,800
Plan No. 4	157,000	83,000	51,500	10,000	301,500

d. Estimated Construction Costs

It would be satisfactory if the 4 power sations were to be completed in approximately 10 years in consideration of the forecasted demand and supply of power in the western area.

A preliminary estimate of the construction costs of the respective projects for various alternative plans are tabulized below.

Table 5-3-4 Estimates of Construction Costs of Dams and Power Stations

Unit million T. L.

Plan	Item	Sandalcik	Gürlcik	Göktas	Bezkese	Total
Plan No. 1	Dam	161	385	98	51	695
	Power Generation Facilities	215	128	110	59	512
	Total	376	513	208	110	1,207
Plan No. 2	Dam	189	277	98	51	615
	Power Generation Facilities	222	120	110	59	511
	Total	411	397	208	110	1,126
Plan No. 3	Dam	206	163	98	51	518
	Power Generation Facilities	241	106	107	53	507
	Total	447	269	205	104	1,025

	Item	Sandalcık	Gürleik	Göktas	Bezkese	Total
Plan No. 4	Dam	233	128	81	51	493
	Power Generation Facilities	259	164	97	49	569
	Total	492	292	178	100	1,062

As described in 5-3-6, transmission lines and substations will be constructed and will consist of 1 to 2 circuits of 154 KV between Sandalcik and Bezkese Substations and 1 circuit of 380 KV between Bezkese and Izmir substations.

Substations will be built at 2 places, Bezkese and Izmir (Bornova) and the capacity will be 200 MVA for both.

The construction costs for transmission lines and Substations facilities were estimated to be the same for all alternative plans, and preliminary estimates are given in Table 5-3-5.

Table 5-3-5 Estimates of Construction Cost of Transmission Lines and Substation

Item	1,000 T.L
Transmission Lines	112,500
Substations	110,800
Total	223,300

e. Determination of Installed Capacity

The construction costs per KW and KWh at the generating end are shown in Table 5-3-6.

Table 5-3-6 Construction Cost per KW and KWh for Various Alternative Plans

	Item	Sandalcik	Gürleik	Göktas	Bezkese	Total
Plan No. 1	Maximum Output, KW	120,000	135,000	63,000	11,500	329,500
	Electric Energy Production, 10^6KWh	635.6	459.3	214.0	71.8	1,380.7

	Item		Sandalcik	Gürleik	Göktas	Bezkese	Total
Plan No.1	Generating end	Construction cost, 10^6T.L	376	513	208	110	1,207
		T.L/KW	3,186	4,008	3,059	9,166	3,702
		T.L/KWh	0.59	1.12	0.97	1.53	0.87
Plan No.2	Maximum Output, KW		130,000	123,000	63,000	11,600	327,600
	Electric Energy Production, 10^6KWh		680.4	412.6	217.4	72.7	1,383.1
	Generating end	Construction cost, 10^6T.L	411	397	208	110	1,126
		T.L/KW	3,114	3,304	3,059	9,166	3,390
		T.L/KWh	0.60	0.96	0.96	1.51	0.81
Plan No.3	Maximum Output, KW		150,000	100,000	66,000	11,000	327,000
	Electric Energy Production, 10^6KWh		750.6	325.4	211.5	69.2	1,356.7
	Generating end	Construction cost, 10^6T.L	447	269	205	104	1,025
		T.L/KW	2,980	2,690	3,106	9,455	3,135
		T.L/KWh	0.59	0.83	0.97	1.50	0.76
Plan No.4	Maximum Output, KW		162,000	105,000	60,000	9,600	336,600
	Electric Energy Production, 10^6KWh		790.5	339.0	176.5	65.5	1,371.5
	Generating end	Construction cost, 10^6T.L	492	292	178	100	1,062
		T.L/KW	3,037	2,974	2,967	10,000	3,222
		T.L/KWh	0.62	0.86	1.01	1.53	0.77

The electric energy shown above is the available output calculated for the May, 1956 to April, 1963 period based on the reservoir operation described in 5-2-4.

The excess benefit calculated for each plan is shown in Table 5-3-7.

Table 5-3-7 Excess Benefit

Unit 1,000 T.L

		Total
Plan No.1	Annual Costs	100,977
	Annual Benefit	158,657
	Excess Benefit	57,680

		Total
Plan No. 2	Annual Costs	96,498
	Annual Benefit	159,840
	Excess Benefit	63,342
Plan No. 3	Annual Costs	90,588
	Annual Benefit	156,370
	Excess Benefit	65,782
Plan No. 4	Annual Costs	93,205
	Annual Benefit	156,411
	Excess Benefit	63,206

From the above it is evident that Plan No. 3 is the most economical and the scale of development was determined based on this plan.

5-3-2 ENERGY PRODUCTION OF VARIOUS POWER STATIONS BASED ON PLAN 3

As described in the foregoing, Plan No. 3 was adopted and electric energy of the various power stations was calculated for the 21-year period from October, 1943 to September, 1964. The available energy output of the various power stations are as shown in Fig. 5-3-1 through Fig. 5-3-5. The amounts of inflow, storage, evaporation, discharge and overflow, and water levels of the various reservoirs are as shown in Fig. 5-2-11 through Fig. 5-2-14.

According to the above the annual available energy production of the entire Dalaman River System is 1, 454, 000, 000 KWh.

Table 5-3-8 Sandalcik Power Station - Morthly Energy Production (21 Years) (10^6KWh)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	ANNUAL
'43 - '44	59.8	59.3	62.2	61.2	100.7	111.5	67.6	61.7	58.1	58.8	58.4	57.8	817.1
'44 - '45	60.6	59.7	62.0	62.4	56.9	95.4	107.9	64.9	58.2	59.0	58.0	58.1	803.1
'45 - '46	61.2	60.5	63.1	63.2	85.6	81.0	81.9	61.7	58.2	58.9	57.8	57.9	791.0
'46 - '47	60.8	59.9	62.5	63.0	56.9	63.2	60.8	61.4	58.0	58.9	58.0	58.1	721.5
'47 - '48	61.0	60.1	62.7	63.0	56.9	63.1	61.7	78.6	58.3	59.0	58.0	58.1	740.5
'48 - '49	61.3	60.6	63.1	63.0	56.6	111.4	107.9	61.7	58.2	59.8	58.0	58.1	819.7
'49 - '50	61.0	60.4	62.9	62.9	56.4	62.3	59.9	60.9	57.8	58.6	57.6	57.5	718.2
'50 - '51	60.3	59.4	61.5	61.5	55.7	62.0	60.3	61.4	58.0	58.9	58.0	56.7	713.7
'51 - '52	61.3	60.6	63.1	63.0	100.7	111.5	107.9	76.3	58.4	59.1	58.2	58.3	878.4
'52 - '53	61.2	73.2	111.5	111.5	100.7	106.8	65.6	61.6	66.9	59.1	58.1	58.3	934.5
'53 - '54	61.5	61.1	94.6	111.5	100.7	111.5	95.4	61.7	57.8	58.9	57.9	57.9	930.5
'54 - '55	60.7	60.2	63.2	111.5	100.7	111.5	99.7	62.8	58.3	59.0	58.0	58.2	903.8
'55 - '56	61.2	60.6	63.3	63.3	100.7	111.5	86.2	61.7	58.3	59.0	57.9	58.2	841.9
'56 - '57	61.0	60.1	62.5	62.2	55.8	61.6	59.2	59.9	56.8	57.7	56.8	56.2	709.8
'57 - '58	59.7	57.5	59.3	59.6	54.0	60.4	58.9	60.1	57.0	57.8	57.0	56.5	697.8
'58 - '59	59.2	57.9	60.0	60.6	55.3	61.2	58.9	59.6	56.6	57.5	56.6	56.0	699.4
'59 - '60	58.4	57.0	59.2	59.8	54.5	60.3	58.0	59.0	55.9	56.9	56.0	55.1	690.1
'60 - '61	57.1	55.6	58.6	60.4	55.5	62.2	60.0	60.9	57.9	58.4	57.5	57.3	701.1
'61 - '62	60.1	59.1	61.3	61.4	55.6	62.3	60.3	61.4	58.0	58.8	57.7	57.7	713.7
'62 - '63	60.6	59.6	62.6	111.5	100.7	111.5	107.9	111.5	74.7	59.1	58.1	58.3	976.1
'63 - '64	61.3	60.6	62.9	62.8	56.4	62.3	60.0	60.6	57.4	58.2	57.1	56.9	716.5
Average	60.4	60.1	65.8	71.4	72.3	83.1	75.5	65.2	59.0	58.6	57.7	57.5	786.6

Table 5-3-9 Gurleik Power Station - Monthly Energy Production (21 Years) (10^6KWh)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	ANNUAL
'43 - '44	18.7	19.8	22.5	24.6	67.2	50.9	28.7	26.1	24.5	24.5	23.5	21.9	352.9
'44 - '45	22.0	20.7	21.4	23.6	23.3	42.8	59.9	27.8	24.9	25.3	24.6	23.5	339.8
'45 - '46	23.9	23.1	24.6	25.4	37.3	34.0	34.3	26.2	24.8	25.0	24.0	22.5	325.1
'46 - '47	22.6	21.6	23.3	25.1	26.2	27.7	25.4	25.6	24.2	24.9	24.6	23.3	294.5
'47 - '48	23.6	22.5	23.8	25.1	25.1	28.5	27.7	33.2	25.2	25.4	24.8	23.6	308.5
'48 - '49	24.3	23.5	24.6	25.0	22.7	74.4	53.2	26.2	25.2	25.4	24.7	23.1	372.3
'49 - '50	23.5	22.8	24.2	24.8	22.3	24.5	23.4	24.8	24.3	24.7	23.6	22.2	285.1
'50 - '51	22.1	22.0	21.6	22.3	21.3	24.7	30.2	26.2	25.2	25.9	25.6	24.7	291.8
'51 - '52	25.4	24.9	25.8	26.1	67.2	72.7	55.8	32.2	25.3	25.9	25.6	24.3	431.2
'52 - '53	25.0	29.6	47.7	74.4	67.2	44.0	28.0	26.1	28.6	25.9	25.4	24.0	445.9
'53 - '54	25.0	24.9	39.4	49.6	54.3	46.3	39.5	26.2	24.8	24.9	24.0	22.5	401.4
'54 - '55	22.5	22.0	31.2	74.4	67.2	50.9	42.1	27.7	25.3	25.8	25.3	24.1	438.5
'55 - '56	24.6	24.3	25.9	30.2	67.2	62.9	37.7	27.0	25.3	25.7	25.0	23.8	399.6
'56 - '57	23.8	22.4	23.1	23.4	21.1	23.4	22.9	23.4	22.4	22.7	21.9	20.5	271.0
'57 - '58	19.0	18.2	18.7	20.8	20.9	33.0	34.5	28.6	25.4	26.1	25.5	24.2	294.9
'58 - '59	24.5	23.2	24.0	37.1	28.6	29.0	26.6	26.2	25.3	25.8	25.2	23.8	319.3
'59 - '60	23.9	22.6	23.9	36.0	26.3	28.4	27.3	26.3	25.2	25.4	24.7	23.5	313.5
'60 - '61	23.4	21.9	38.4	40.6	45.7	33.0	28.2	27.1	25.3	25.6	25.0	23.7	357.9
'61 - '62	23.9	22.9	24.2	24.2	23.7	34.9	29.6	26.8	25.2	24.9	30.5	22.9	313.7
'62 - '63	23.1	22.0	31.9	74.4	67.2	74.4	53.4	46.5	29.7	25.9	25.3	23.9	497.7
'63 - '64	24.4	23.2	24.2	24.5	22.0	24.6	23.7	24.3	22.1	21.6	19.5	17.8	271.9
Average	23.3	22.8	26.9	34.8	39.2	41.2	34.9	27.8	25.2	25.1	24.7	23.0	348.9

Table 5-3-10 Goktas Power Station - Monthly Energy Production (21 Years) (10^6KWh)

YEAR	Oct.	Nov.	Dec.	Jan	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	ANNUAL
'43 - '44	12.9	12.8	13.6	14.2	34.8	34.0	19.4	18.1	17.1	17.2	16.7	15.9	226.7
'44 - '45	16.0	15.1	15.5	15.9	14.9	22.4	39.9	18.7	17.6	17.7	17.3	16.5	227.5
'45 - '46	16.9	16.1	16.7	16.6	20.0	23.0	23.1	18.2	17.3	17.3	16.9	16.0	218.1
'46 - '47	16.2	15.4	16.0	16.4	15.4	17.4	16.9	16.8	15.9	16.2	15.9	15.1	193.6
'47 - '48	15.3	14.5	15.0	15.3	14.1	16.0	15.9	17.1	16.8	17.0	16.7	15.9	189.6
'48 - '49	16.1	15.5	15.9	15.7	14.1	47.9	35.5	18.2	17.3	17.5	17.2	16.2	247.1
'49 - '50	16.5	15.7	16.3	16.3	14.6	15.7	15.0	15.4	15.0	15.1	14.5	13.6	183.7
'50 - '51	13.5	12.9	13.0	13.0	11.8	13.3	14.0	15.1	14.3	14.5	14.2	13.6	163.2
'51 - '52	13.8	13.3	13.6	13.5	26.8	48.3	37.2	21.7	17.6	18.0	17.7	16.9	258.4
'52 - '53	17.2	17.2	31.8	49.1	44.4	29.5	46.5	18.2	18.7	18.1	17.7	16.9	325.3
'53 - '54	17.3	17.0	23.3	33.2	36.2	31.0	26.5	18.2	17.2	17.3	16.9	16.0	270.1
'54 - '55	16.2	15.6	18.4	49.1	44.4	34.3	28.4	18.9	17.6	17.3	17.5	16.9	294.6
'55 - '56	17.1	16.6	17.3	17.7	44.4	42.1	25.7	18.3	17.6	17.8	17.4	16.7	268.7
'56 - '57	16.9	15.9	16.2	16.0	14.2	15.6	15.0	15.2	14.4	13.2	14.2	13.2	180.0
'57 - '58	13.0	12.2	12.2	12.6	11.8	14.9	17.1	19.7	17.6	18.0	17.5	16.9	183.5
'58 - '59	17.0	16.0	16.4	22.6	20.2	20.0	18.1	18.2	17.4	17.7	17.3	16.5	217.4
'59 - '60	16.6	15.6	16.2	20.8	18.1	19.4	18.6	18.2	17.3	17.5	17.1	16.2	211.6
'60 - '61	16.3	15.4	24.0	30.2	35.1	23.5	19.5	18.4	17.6	17.8	17.4	16.6	251.8
'61 - '62	16.9	16.0	16.4	16.3	15.0	19.5	20.7	18.3	17.4	17.7	17.2	16.4	207.8
'62 - '63	16.5	15.7	19.6	49.1	44.4	49.1	35.4	30.5	19.5	[illegible]	17.7	17.6	333.2
'63 - '64	17.1	16.4	16.8	16.6	14.8	16.3	15.5	15.4	14.4	14.3	13.7	12.7	184.0
Average	16.0	[illegible]	17.4	22.4	24.3	26.3	24.0	18.4	16.9	16.9	16.6	15.8	230.3

Table 5-3-11 Bezkese Power Station - Monthly Energy Production (21 Years) (10^6KWh)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	ANNUAL
'43 - '44	8.0	7.8	8.1	8.1	7.3	8.1	7.8	7.7	7.0	6.1	5.8	6.2	88.0
'44 - '45	7.9	7.8	8.1	8.1	7.3	8.1	7.8	7.9	6.9	6.1	5.8	6.2	88.0
'45 - '46	7.9	7.8	8.1	8.1	7.3	8.1	7.8	7.7	6.9	6.1	5.8	6.2	87.8
'46 - '47	7.9	7.8	8.1	8.1	7.3	7.7	7.4	7.7	7.0	6.1	5.8	6.2	87.1
'47 - '48	7.9	7.8	8.1	8.1	7.3	7.7	7.5	7.7	7.0	6.1	5.8	6.2	87.2
'48 - '49	7.9	7.8	8.1	8.1	7.3	8.1	7.8	7.7	7.0	6.1	5.8	6.2	87.9
'49 - '50	7.9	7.8	8.1	8.1	7.3	7.7	7.4	7.8	7.0	6.1	5.9	6.3	87.4
'50 - '51	7.9	7.8	8.1	8.1	7.3	7.7	7.5	7.7	7.0	6.1	5.9	6.3	87.4
'51 - '52	7.9	7.8	8.1	8.1	7.3	8.1	7.8	8.1	7.0	6.1	5.8	6.2	88.3
'52 - '53	7.9	7.8	8.1	8.1	7.3	8.1	7.8	7.7	7.5	6.1	5.8	6.2	88.4
'53 - '54	7.9	7.8	8.1	8.1	7.3	8.1	7.8	7.7	6.9	6.1	5.8	6.2	87.8
'54 - '55	7.9	7.8	8.1	8.1	7.3	8.1	7.8	8.0	7.0	6.1	5.8	6.2	88.2
'55 - '56	7.9	7.8	8.1	8.1	7.3	8.1	7.8	7.7	7.0	6.1	5.8	6.2	87.9
'56 - '57	7.9	7.8	8.1	8.1	7.3	7.7	7.4	7.7	7.0	6.1	5.9	6.3	87.3
'57 - '58	7.9	7.8	8.1	8.1	7.3	7.8	7.5	8.1	7.0	6.1	5.8	6.2	87.7
'58 - '59	7.9	7.8	8.1	8.1	7.3	8.1	7.6	7.7	7.0	6.1	5.8	6.2	87.7
'59 - '60	7.9	7.8	8.1	8.1	7.3	8.1	7.8	7.7	7.0	6.1	5.8	6.2	87.9
'60 - '61	7.9	7.8	8.1	8.1	7.3	8.1	7.8	7.8	7.0	6.1	5.8	6.2	88.0
'61 - '62	7.9	7.8	8.1	8.1	7.3	8.1	7.8	7.7	6.9	6.1	5.8	6.2	87.8
'62 - '63	7.9	7.8	8.1	8.1	7.3	8.1	7.8	8.1	7.8	6.1	5.8	6.2	89.1
'63 - '64	7.9	7.8	8.1	8.1	7.3	7.7	7.4	7.7	7.0	6.1	5.9	6.3	87.3
Average	7.9	7.8	8.1	8.1	7.3	8.0	7.7	7.8	7.0	6.1	5.8	6.2	87.6

Table 5-3-12 4-Power Station - Monthly Energy Production (21 Years) (10^6KWh)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	ANNUAL
'43 - '44	99.1	99.7	106.4	108.1	210.0	204.5	123.5	113.6	106.7	106.6	104.4	101.8	1,484.7
'44 - '45	106.5	104.3	107.0	110.0	102.4	168.7	215.5	119.3	107.6	108.1	105.7	104.3	1,458.4
'45 - '46	109.9	107.5	112.5	113.3	150.2	146.1	147.1	113.8	107.2	107.3	104.5	102.6	1,422.0
'46 - '47	107.5	104.7	109.9	112.6	105.8	116.0	110.5	111.5	105.1	106.1	104.3	102.7	1,296.7
'47 - '48	107.8	101.9	109.6	111.5	103.4	115.3	112.8	136.6	107.3	107.5	105.3	103.8	1,325.8
'48 - '49	109.6	107.4	111.7	111.8	100.7	241.8	204.4	113.8	107.7	108.8	105.7	103.6	1,527.0
'49 - '50	108.9	106.7	111.5	112.1	100.6	110.2	105.7	108.9	104.1	104.5	101.6	99.6	1,274.4
'50 - '51	109.8	102.1	104.2	101.9	96.1	107.7	112.0	110.4	104.5	105.4	103.7	101.3	1,256.1
'51 - '52	108.4	106.6	110.6	110.7	202.0	240.6	208.7	138.3	108.3	109.1	107.3	105.7	1,656.3
'52 - '53	111.3	127.5	199.1	243.1	219.6	188.1	147.9	113.6	121.7	109.2	107.0	105.4	1,794.1
'53 - '54	111.7	110.8	165.4	202.4	198.5	196.9	169.2	113.8	106.7	107.2	104.6	102.6	1,689.8
'54 - '55	107.3	105.6	120.9	243.1	219.6	204.8	178.0	117.4	108.2	108.2	106.6	105.4	1,725.1
'55 - '56	110.8	109.3	114.6	119.3	219.6	224.6	157.4	114.7	108.2	108.6	106.1	104.9	1,598.1
'56 - '57	104.6	106.2	109.9	109.7	98.4	108.3	104.5	106.2	100.6	99.7	98.8	96.2	1,248.1
'57 - '58	99.6	95.7	98.3	101.1	94.0	116.1	118.0	116.5	107.0	108.0	105.8	103.8	1,263.9
'58 - '59	108.6	101.9	108.5	128.4	111.4	118.3	111.2	111.7	106.3	107.1	104.9	102.5	1,323.8
'59 - '60	106.8	103.0	107.4	124.7	106.2	116.2	111.7	111.2	105.4	105.9	103.6	101.0	1,303.1
'60 - '61	104.7	100.7	129.1	129.3	143.6	126.8	115.5	114.2	107.5	107.9	105.7	103.8	1,398.8
'61 - '62	108.8	105.8	110.0	110.0	101.6	124.8	118.4	114.2	107.5	107.5	111.2	103.2	1,323.0
'62 - '63	108.1	105.1	122.2	243.1	219.6	243.1	201.5	196.6	131.7	109.2	106.9	106.0	1,896.1
'63 - '64	110.7	108.0	112.0	112.0	100.5	110.9	106.6	108.0	100.9	100.2	96.2	93.7	1,259.7
Average	107.6	106.0	118.2	136.7	143.1	158.6	142.1	119.2	108.1	106.7	104.8	102.5	1,453.6

Table 5-3-13 4-Power Stations-Average Monthly Energy Production

(106 KWh)

	Sandalcik P.S.		Gurlcik P.S.		Göktas P.S.		Bezkese P.S.		Total
	Average	Firm	Average	Firm	Average	Firm	Average	Firm	Average
Oct.	60.4	60.4	23.3	23.3	16.0	16.0	7.9	7.9	107.6
Nov.	60.1	60.1	22.8	22.5	15.3	15.3	7.8	7.8	106.0
Dec.	65.8	62.1	26.9	23.9	17.4	16.0	8.1	8.1	118.2
Jan.	71.4	62.3	34.8	24.9	22.4	16.4	8.1	8.1	136.7
Feb.	72.3	56.4	39.2	23.4	24.3	15.2	7.3	7.3	143.1
Mar.	83.1	62.5	41.2	25.9	26.3	17.4	8.0	8.0	158.6
Apr.	75.5	60.3	34.9	25.3	24.0	17.1	7.7	7.7	142.1
May	65.2	61.1	27.8	25.9	18.4	17.5	7.8	7.8	119.2
June	59.0	58.2	25.2	24.9	16.9	16.8	7.0	7.0	108.1
July	58.6	58.6	25.1	25.1	16.9	16.9	6.1	6.1	106.7
Aug.	57.7	57.7	24.7	24.5	16.6	16.6	5.8	5.8	104.8
Sept.	57.5	57.5	23.0	23.0	15.8	15.8	6.2	6.2	102.5
Total	786.6	717.2	348.9	292.6	230.3	197.0	87.8	87.8	1,453.6

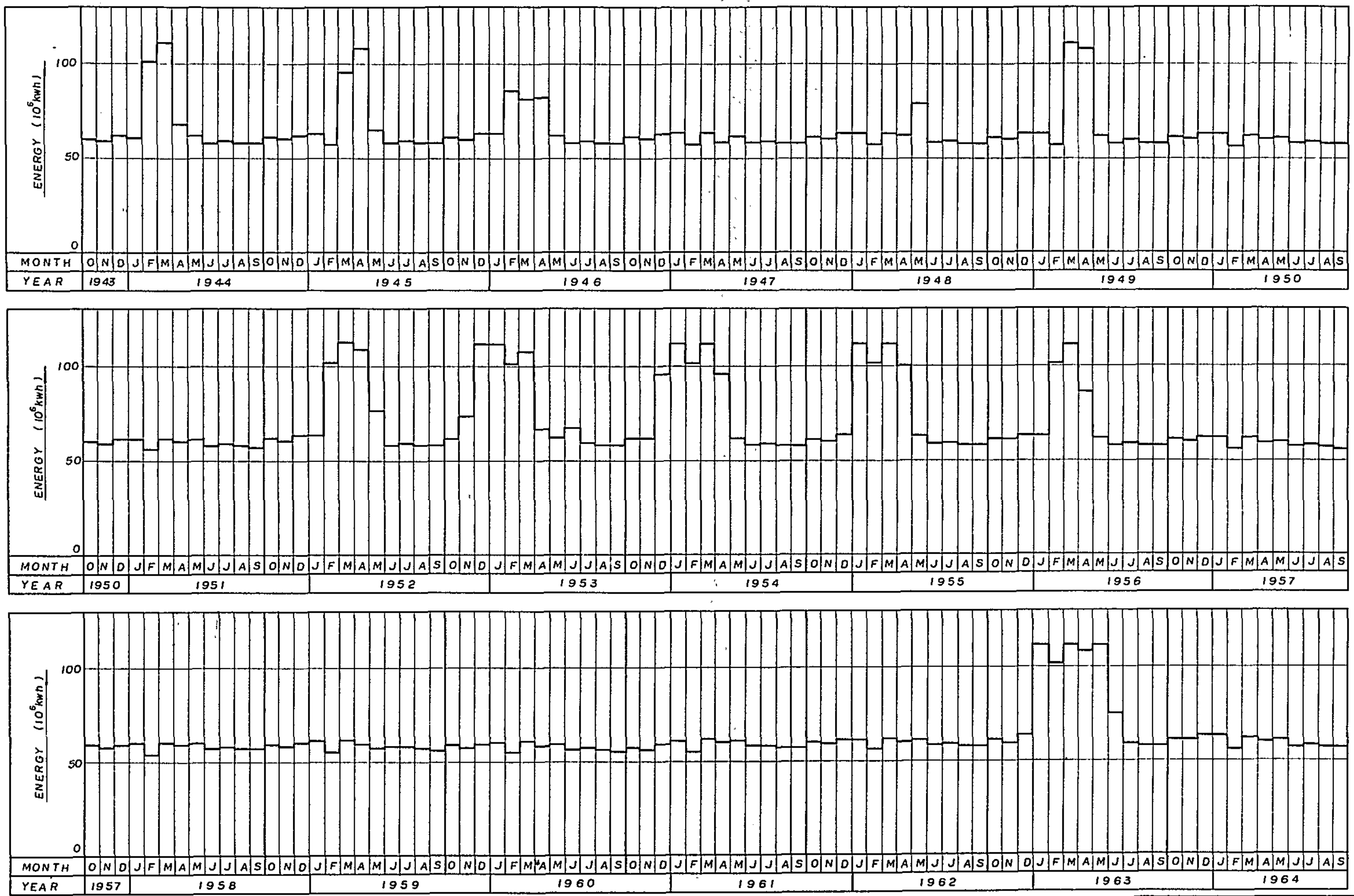


Fig. 5-3-1

MONTHLY ENERGY PRODUCTION OF SANDALCIK POWER STATION

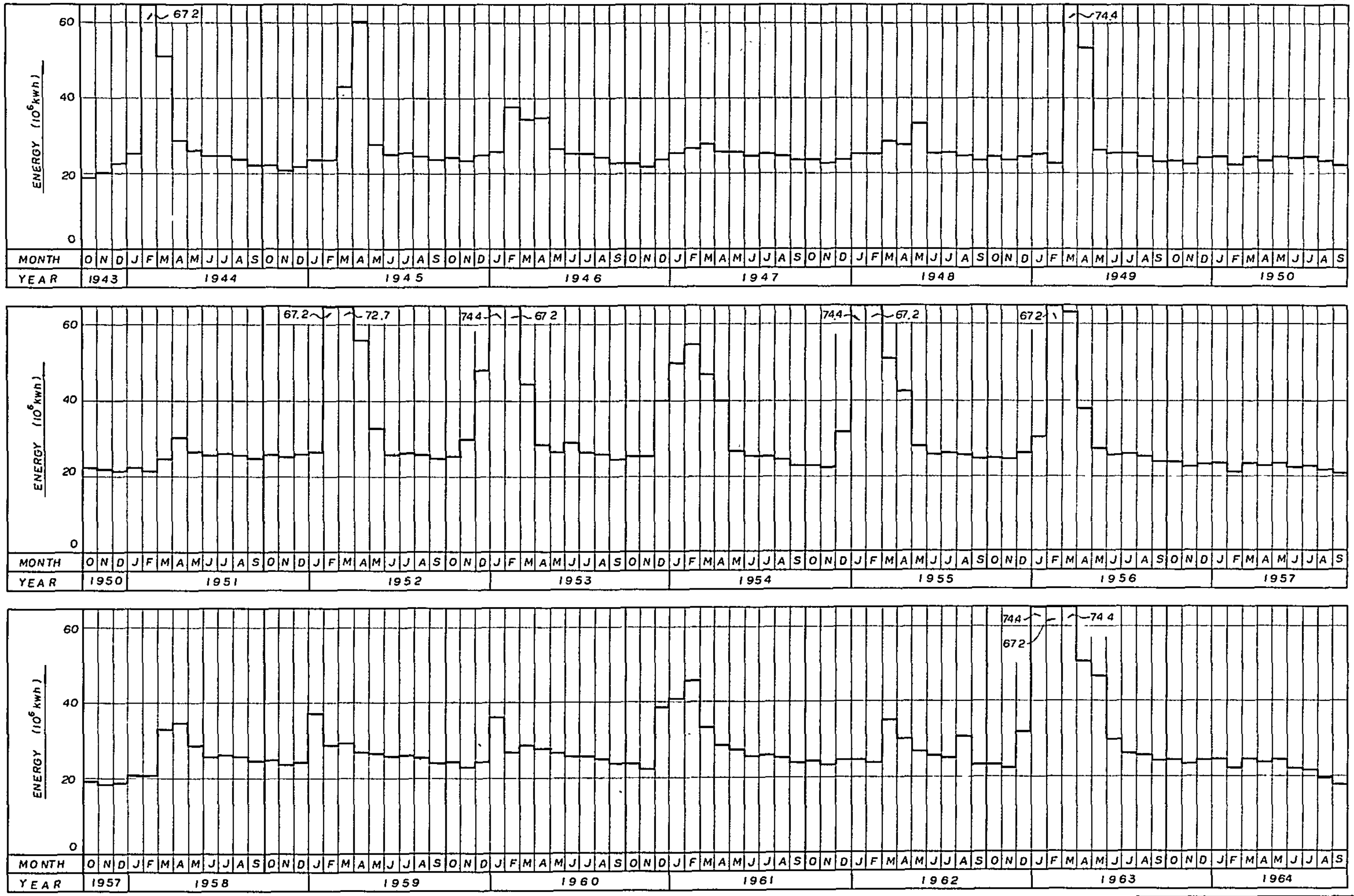


Fig. 5-3-2

MONTHLY ENERGY PRODUCTION OF GÜRLEIK POWER STATION

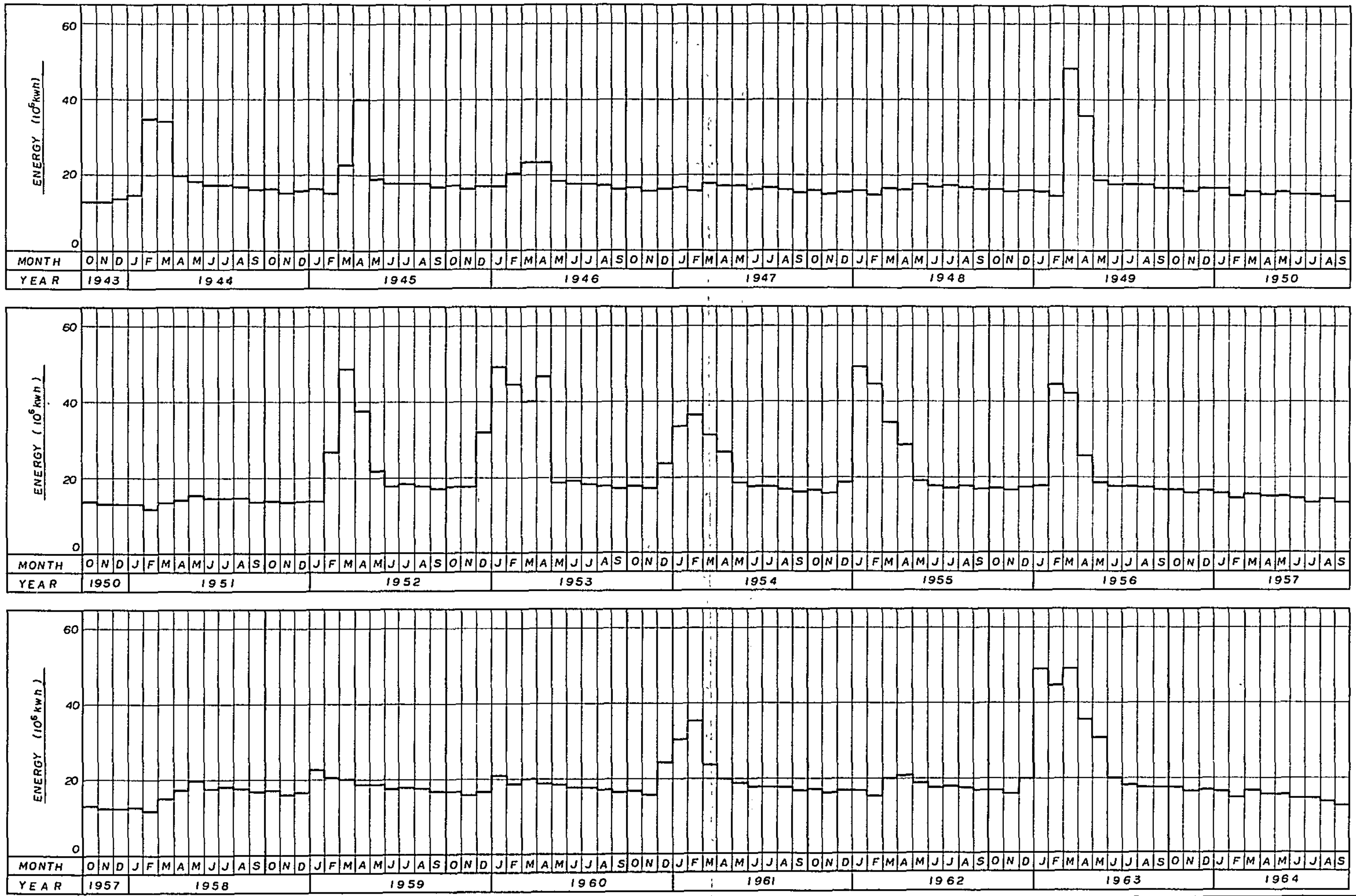


Fig. 5-3-3

MONTHLY ENERGY PRODUCTION OF GÖKTAS POWER STATION

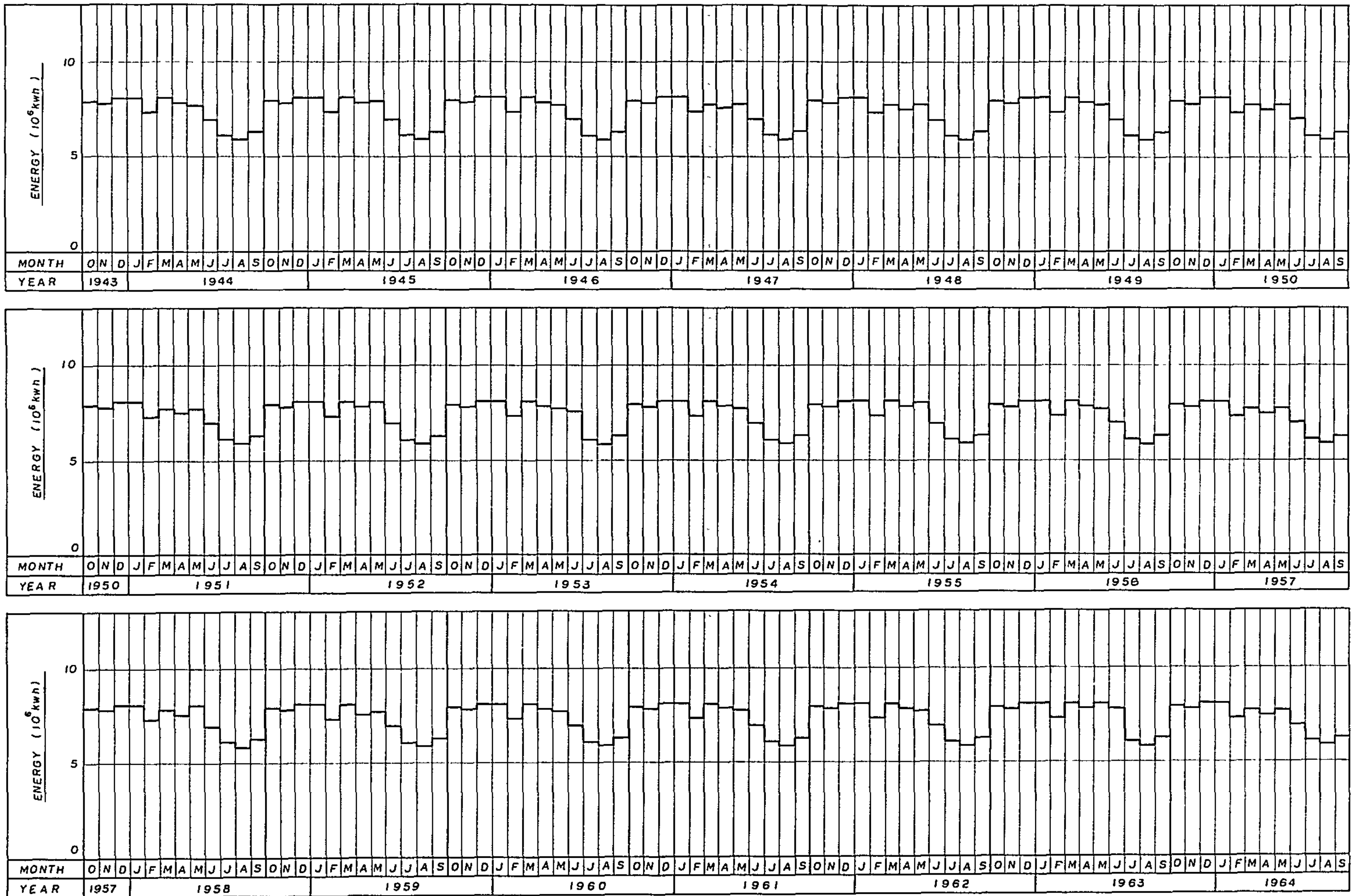


Fig. 5-3-4

MONTHLY ENERGY PRODUCTION OF BEZKESE POWER STATION

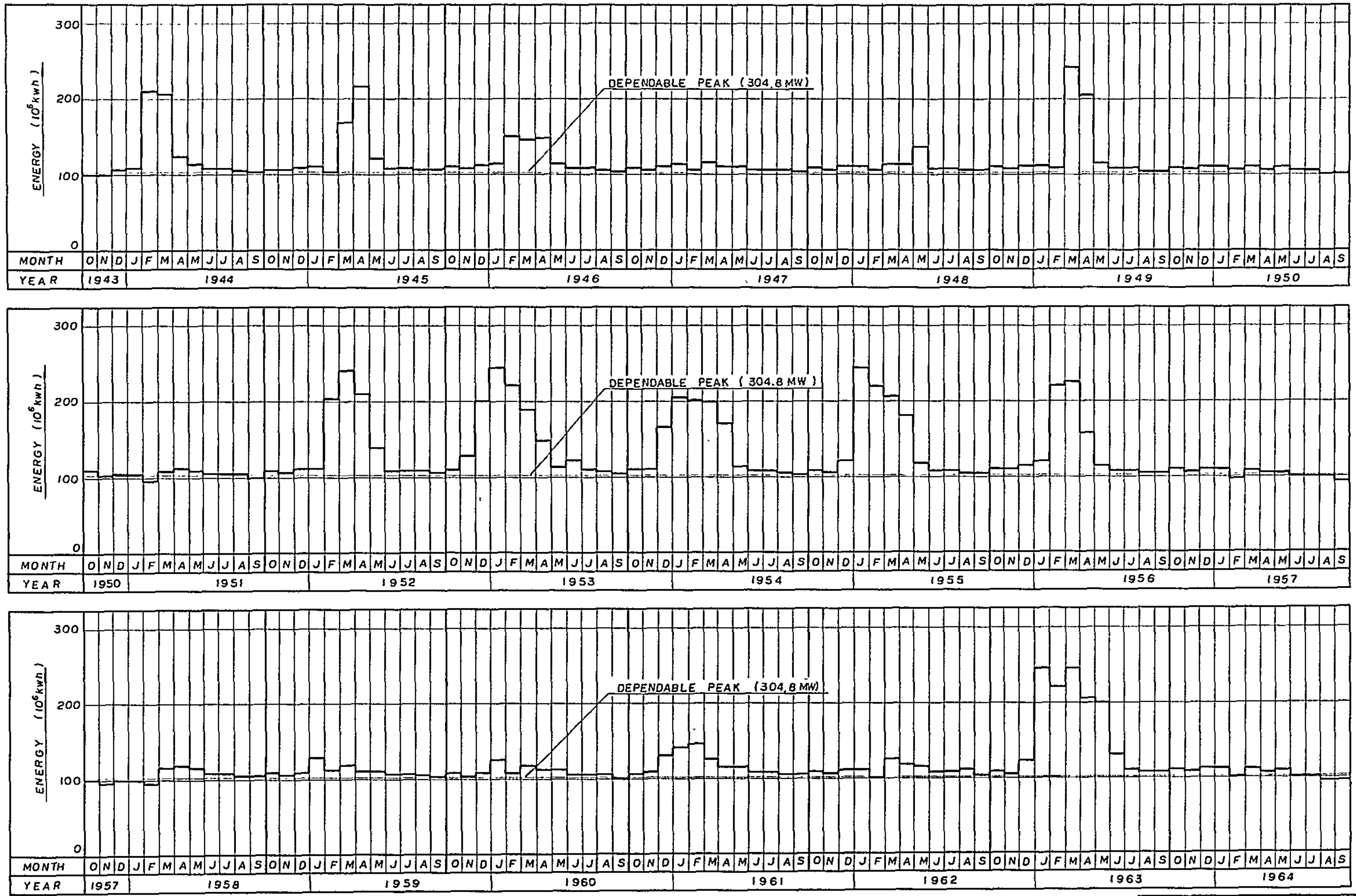


Fig. 5-3-5

MONTHLY ENERGY PRODUCTION OF 4 POWER STATIONS

5-3-3 DESCRIPTION OF RECOMMENDED PLAN

a. General

As previously described, the most advantageous hydroelectric development plan for the Lower Dalaman River Basin is to build 3 reservoirs and 1 regulation pond to regulate the run-off of the approximately 5, 000 km^2 catchment area, utilize the total head of 675 m from the high water level of 705 m of the uppermost reservoir down to the tailrace elevation of 30 m of the lowermost power plant, constant 4 power stations of Sandalcik, Gürleik, Göktas and Bezkese to obtain a total output of 327, 000 KW to generate 1, 454, 000, 000 KWh of energy annually KWh. The estimated total construction cost at the generating end is approximately 1, 025, 000, 000 T. L and the construction cost per KW and KWh 3, 135 T. L/KW and 0. 71 T. L/KWh respectively.

b. Description of Power Stations

The outlines of the 4 power stations are as shown in Table 5-3-14. The outline of the plan for each power station is described below.

- Sandalcik Power Station

A concrete arch-type dam 145 m in height and 384 m in crest length will be constructed at the uppermost point of the Lower Dalaman River Basin in order to create a reservoir with a normal water surface level of 705 m, available drawdown of 43 m and effective storage capacity of 665, 000, 000 m^3. A rock-fill dam 40 m high and 760 m in crest length will be built at the saddle at a location approximately 1. 5 km from the main dam in order to prevent overflow of water from the reservoir.

By means of this reservoir the run-off of the catchment area proper of 3, 970 square kilometers will be stored and regulated over the years to be utilized for power generation.

An intake will be provided on the left bank immediately upstream of the dam to draw a maximum discharge 44. 30 cubicmeters per second. This water will be conducted to the Sandalcik Power Station (underground type) approximately 4 km downstream through a pressure tunnel 4. 50 m in diameter and 3, 850 m in length, and utilizing a standard effective head of 398 m to generate a maximum output of 150, 000 KW (75, 000 KW x 2 units). The annual load factor of this power station is 54% and peak generation will be possible approximately 13 hours per day on the average throughout the year.

- Gurleik Power Station

Approximately 25 km downstream from the Sandalcik Dam site, a concrete arch dam 135 m high with a crest length of 310 m will be constructed to create a reservoir with normal water surface level at an elevation of 270 m, availabel drawdown of 40 m and an effective storage capacity of 115, 000, 000 m^3. By means of this reservoir, the run-off of the catchment area proper of 540 km^2 of the reservoir and the discharge from the upstream Sandalcik Power Station will be regulated and utilized for power generation.

An intake will be provided at the left bank immediately above the dam and a maximum discharge of 107. 0 cubic meters per second will be drawn and conducted to a power plant on the left bank immediately downstream of the dam and utilizing a standard effective head of 110 m it will generate a maximum output of 100, 000 KW (50, 000 KW x 2 units). The annual energy production will be 349, 000, 000 KWh. The annual load factor of this power station will be 32. 3% and it will be possible for peak generation of 7. 7 hours per day on the average throughout the year.

- Göktas Power Station

Approximately 19 km downstream of the Gürleik Dam site, a concrete arch gravity dam 118 m high with a crest length of 90 m will be constructed to create a reservoir with a normal water surface level of 145 m, available drawdown of 25 m and effective storage capacity of 120, 000, 000 m^3. By means of this reservoir the run-off of the catchment area proper of 260 km^2 of the reservoir and the discharge from the upstream Gürleik Power Station will be regulated and utilized for power generation.

An intake will be provided at the right bank immediately upstream of the dam and a maximum discharge 129.5 cubic meters per second will be drawn and conducted to the power plant on the right bank immediately downstream of the dam and utilizing a standard effective head of 60 m it will generate a maximum output of 66,000 KW (33,000 KW x 2 units). The annual energy production will be 230,000,000 KWh. The annual load factor of this power station will be 31.5% and peak generation of 7.5 hours per day will be possible throughout the year.

o Bezkese Power Station

Approximately 4 km downstream of the Göktas Dam site, a regulating pond with a normal water surface level of 71 m, availabel drawdown of 2.0 m and effective storage capacity of 2,200,000 m^3 will regulate the run-off of the catchment area proper of the regulating pond and the discharge of the upstream Göktas Power Station. From the regulated run-off, a maximum discharge 15.64 cubic meters per second will be drawn through an intake provided on the right bank for irrigation of 8,000 ha of the plain on the right bank. Another intake will be provided on the left bank immediately above the dam to draw a maximum discharge 36.50 m^3/s, which will be conducted by a tunnel with an inner diameter of 4.20 m and a length of 3,040 m, to Bezkese Power Station to be constructed at Bezkese. The standard effective head will be 30 m and a maximum output of 11,000 KW will be generated. The annual energy production will be 88,000,000 KWh. The load factor of the power station will be 68% and it will be possible to obtain peak generation of an average of 16.5 hours per day throughout the year.

After generation of power a maximum discharge 11.73 m^3/s will be utilized for irrigation of 6,000 ha in the left bank plain and the remainder will be discharged into the Dalaman River.

Table 5-3-14 Outline of Power Generation Plan

Item		Power Station				
		Sandalcik	Gürleik	Göktas	Bezkese	Total
Method of Power Generation		Dam-Waterway Type	Dam Type	Dam Type	Dam-Waterway Type	
Catchment Area						
Upstream	km^2	-	3,970	4,510	4,770	
Catchment Area Proper or Residual Area	km^2	3,970	540	260	[illegible]	
Total	km^2	3,970	4,510	4,770	4,780	
Reservoir or Regulating Pond						
Annual Inflow						
Upstream	10^6m^3 (m^3/s)	-	913.4 (29.0)	1,336.0 (42.4)	1,533.7 (48.6)	
Catchment Area Proper or Residual	10^6m^3 (m^3/s)	939.9 (29.8)	427.2 (13.5)	205.7 (6.5)	7.9 (0.3)	
Total	10^6m^3 (m^3/s)	939.9 (29.8)	1,340.6 (42.5)	1,541.7 (48.9)	1,543.6 (48.9)	
Regulating Factor		70.8	8.5	7.8	-	
Reservoir						
Name		Sandalcık	Gürleik	Göktas	Asmacık	
Normal High Water Surface Level	m	705	270	145	71	
Reservoir Surface Area	km^2	21.2	3.8	6.5	1.2	
Total Storage Capacity	10^6m^3	965	160	195	11.7	
Effective Storage Capacity	10^6m^3	665	115	120	2.2	900
Available Drawdown	m	43	40	25	2	
Dam						
Type		Concrete Arch	Concrete Arch	Arch Gravity	Rock-Fill	
Height x Crest Length	m	145 x 384	135 x 310	118 x 90	25 x 250	
Volume	m^3	490,000	450,000	280,000	420,000	
Waterway						
Headrace, Diameter X Length	m	4.5 x 3,850	-	-	4.2 x 3,040	
Tailrace, Diameter x Length	m	4.6 x 6,430	-	-	Open 20x84	
Power Generation						
Standard Intake Level	m	698	258	133	71	
Tailrace Water Level	m	270	145	71	30	
Standard Effective Head	m	398	110	60	35	

Item		Power Station				
		Sandalcik	Gürleik	Göktas	Bezkese	Total
Method of Power Generation		Dam-Waterway Type	Dam Type	Dam Type	Dam-Waterway Type	
Powerhouse Discharge						
Maximum	m^3/s	44.3	107.0	129.5	36.5	
Annual Average	m^3/s	26.0	40.3	46.3	33.7	
Firm	m^3/s	24	34.6	40.8	-	
Output						
Maximum	MW	150	100	66	11	327
Annual Average	MW	89.7	39.9	26.3	10.0	
Dependable Capacity	MW	146	86.8	61	11	304.8
Electric Energy Production	10^6KWh	786.6	348.9	230.3	87.8	1,453.6
Total Construction						
Cost	10^6T.L	447	269	205	104	1,025
Per KW	T.L	2,980	2,690	3,106	9,455	3,135
Per KW	T.L	0.57	0.77	0.89	1.19	0.71
* V-C	10^3T.L	42,922	17,721	10,609	445	71,697
* V/C		2.08	1.72	1.58	1.06	1.79

Note: * (1) Annual cost (C) is for case of construction cost of common facilities (dams) borne by power only.

(2) Transmission and substation costs of various power stations are allocated in proportion to respective transmission capacities.

(3) Excess benefit (V-C) and V/C are based on the assumption that the respective power stations are completed simultaneously.

5-4 POWER TRANSMISSION LINES AND SUBSTATIONS

5-4-1 SYSTEM FORMATION

The power stations of this plan will be at the 4 places, Sandalcik 150 MW, Gürleik 100 MW, Göktas 66 MW and Bezkese 11 MW, for a total capacity of 327 MW. This electric power is to be transmitted to Izmir, the center of demand, through interconnection with the Western System.

The following methods of transmission can be considered:

No. 1 Direct step-up to 380 KV at each power station and transmit to Izmir by 1 circuit.

No. 2 Direct step-up to 275 KV at each power station and transmit to Izmir by 2 circuits.

No. 3 Connect power stations with 154 KV lines and provide step-up sub-station at Bezkese and transmit from here to Izmir by 1 circuit, 380 KV.

The three alternatives were studied from technical, economic and system operational viewpoints as follows:

In comparison of alternatives No. 1 and No. 3, it is found that in alternative No. 1 the unit capacity of each power station is small so that the cost of equipment of outdoor switchyards will be proportionately greater and the construction cost of a transmission line between Sandalcik and Bezkese will also be high. The extra construction cost will be higher than the construction cost of the step-up sub-station at Bezkese so it is evident that alternative No. 3 is superior. Alternative No. 3 is superior also in operation of the system and transmission losses do not differ greatly.

In comparing alternative No. 2 and alternative No. 3, it is found that in alternative No. 2 the three phase reclosing can be adopted for protection of transmission lines and the service level is also higher than alternative No. 3.

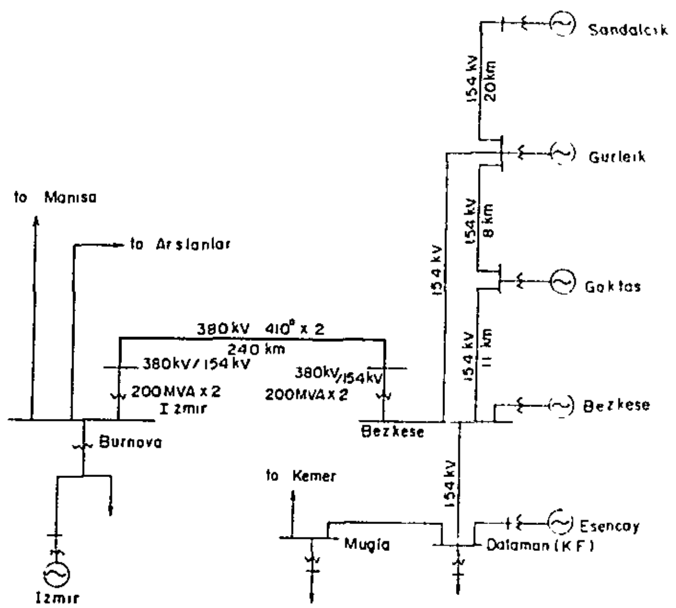
But alternative No. 2 costs more than alternative No. 3 by approximately

29, 000, 000 T. L in transmission line costs and approximately 18, 000, 000 T. L in equipment costs of power stations or a total of 47, 000, 000 T. L. However, the approximately 55, 400, 000 T. L cost of construction of Bezkese Sub-station will not be required so that in a simple comparison, alternative No. 2 will be approximately 8, 400, 000 T. L cheaper. On the other hand, the construction cost of Bezkese Sub-station includes import duty of 14, 600, 000 T. L so that if this were deducted Bezkese would become cheaper by 6, 200, 000 T. L. In either case the difference is insignificant compared to the total cost of construction of transmission lines and substations.

Alternative No. 2 will have 20% more power and energy losses compared to alternative No. 3, so that the latter is superior in this respect. Also, the latter is superior in transmission capacity. Again, if Bezkese Sub-station and the Poposed Dalaman Paper Factory were connected with a 154 KV line, it will be convenient in operation of the system and also match with the standardization of voltages in Turkey.

Therefore, the system will be formed as shown in Fig. 5-4-1 taking into consideration the points described below.

Fig 5-4-1 SYSTEM DIAGRAM



5-4-2 TRANSMISSION LINES

a. 380 KV Transmission Lines

As described above, a 154 KV/380 KV step-up sub-station will be provided at Bezkese and one-circuit of 380 KV transmission line 240 km in length will be constructed.

For conductors 410 mm^2 ACSR, double-conductor will be adopted in consideration of corona noise, power losses and operation costs. However, since the power line carrier equipment will be used on this line, it will be desirable to carry out working designs with thorough consideration given to harmony between corona noise and performance of communication equipment.

b. 154 KV Transmission Lines

For selection of the type of conductor to be used for lines connecting the various power stations and the line extending to Bezkese Substation, power losses and annual costs for the 3 sizes, 240 mm^2, 330 mm^2 and 410 mm^2 were compared. The conductor size most suited for each respective section differs, but as it was judged advantageous to standardize materials, it was decided to use 410 mm^2 ACSR, single-conductor, same as the conductor of the 380 KV transmission line.

c. Study of Operational Voltages and Power Current Flow

Assuming the load factors of substations in the Western Area based on data of EIE, the power flow and voltage situation in 1976, when the development of Dalaman Projects will have been completed, will be as shown in Fig. 5-4-2 as a result of analysis with an alternating current network analyzer. The power factors of the loads were taken to be 90%.

c-1 The voltage at the various places on the power flow diagram are for cases of tapping of transformers at rating and it is thought the required voltage can be maintained by switching taps of transformers.

c-2 However, in the Bornova and Balikesir regions it will be necessary to install phase advancers such as static condensers. The capacity should be determined upon study of the sizes of loads, power factors, and the structure of the system at peak and off-peak times.

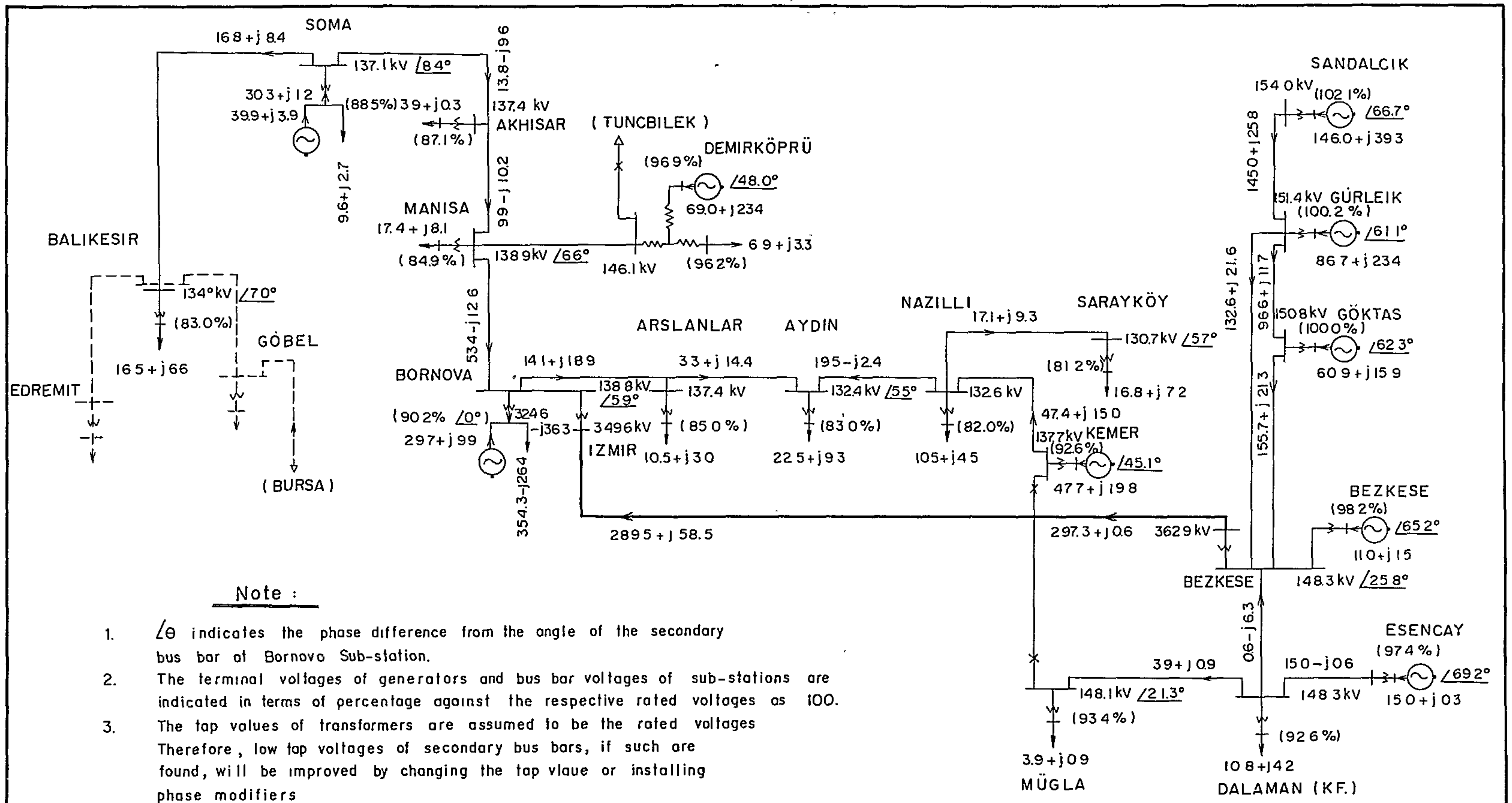
c-3 Upon trial computations with the analyzer, it is found that the difference of phase angle between the Gobel Edremit and Dalaman Systems is too great and it will be difficult to carry out parallel operation. Therefore, the loads of the two substations will be supplied from the Northwestern System and be separated at the bus of Balikesir Substation so that only the load of Balikesir will be supplied by the Dalaman System.

c-4 The interconnection of Pasalar-Bursa-Balikesir will have to be strengthened by the time the load of Edremit Steelworks (40 MW, scheduled for completion in 1966) is added to the system. In other words, for strengthening of the interconnection of the Northwestern and Western Systems the construction of the 154 KV transmission line between Tuncbilke and Demirköpru now being planned should be canceled and existing routes from the North-west to the West should be strengthened.

c-5 The present transmission and distribution networks should be improved since there will be locations to which stabilized transmission and distribution will be difficult with the increase in power demand.

d. Steady-state Stability

Upon study by the Wagner Method of the extra-high voltage power transmission by the 1 circuit, 380 KV line, using the AC network analizer, the steady-state of power transmission is found to be stable.



Note :

1. /θ indicates the phase difference from the angle of the secondary bus bar of Bornova Sub-station.
2. The terminal voltages of generators and bus bar voltages of sub-stations are indicated in terms of percentage against the respective rated voltages as 100.
3. The tap values of transformers are assumed to be the rated voltages Therefore, low tap voltages of secondary bus bars, if such are found, will be improved by changing the tap vlaue or installing phase modifiers
4. If Edremit Sub-station and Gobel Sub-station are operated in parallel, with Dalaman System, it will be necessary to cut off the system at the bus bar of Balikesir Sub-station since the voltage regulation of Edremit and Gobei Sub-station will become difficult, and further, the pnase difference of Sandalcik Power Plant will become large.

Fig 5 – 4 – 2

POWER FLOW AT PEAK TIME IN DECEMBER 1976(MW)

e. Transient Stability

A study of transient stability due to high-speed single phase reclosure (length of disorder time, 5 cycles) at time of single phase earthing at the sending end of a 380 KV system (in case of 1 circuit), reveals it to be unstable at length of no-voltage period 30 cycles, critical point is at 24 cycles and stable at 10 cycles. However, if secondary arc current is considered, the length of the no-voltage period is required to be 0.4 seconds (20 cycles) or longer, thus the high-speed single phase reclosing is difficult.

In the case of 275 KV, 1 circuit, it is unstable at no-voltage time of 18 cycles. However, if transmission is by 275 KV, 2 circuits, it is stable at no-voltage time of 24 cycles not only for single phase earthing but also for two phase earthing at the sending end if high-speed, 3 phase reclosure is adopted.

However, due to the reasons described later, a 380 KV, 1 circuit line will be adopted and single phase reclosure will not be employed.

f. Charging of 380 KV Transmission Line

The voltage rise at the receiving end due to the Ferranti effect of the 380 KV, 1 circuit line is 104.9% if only the transmission line were taken into consideration, and if no-load charging of the transmission line were carried out to make the voltage 100% at the receiving end (380 KV), the charging capacity would be 125 MVA. However, since the capacities of generators of this system are small, it will be impossible to charge the line by only one power station. In order that charging can be accomplished from either sending or receiving end, a 100 MVA shunt reactor will be provided. Therefore, this will be divided and located at both sending and receiving ends with a 50 MVA shunt reactor at each end. These shunt reactors can also be used in voltage regulation at times of light load.

g. Protection Methods

Since single phase reclosure is found to be useless as a result of study of transient stability in the case of 380 KV, 1 circuit, and it cannot be helped if the entire system is out of service at times of disorder in the transmission line. If reliability of supply is highly demanded, it will be necessary to adopt a high-speed, 3 phase reclosure system with extra-high voltage lines being 2 circuits of 275 KV, with the power station side 154 KV system being 2 circuits for their entire lengths. However, the Keban System now being planned in Turkey is 380 KV for which reclosure systems are not adopted. If the same degree of reliability is to be considered, it is thought 380 KV, 1 circuit will be appropriate. For improvement in the service level of the system, shortening of repair time should be accomplished by adopting the line fault-locator and VHF described separately under plans for communications facilities. From the above considerations, it is unnecessary to provide circuit breakers for the 380 KV system. Breakers will be provided at the 154 KV side of interconnecting transformers and for protection of power station transformers, and also at the transmission line side of 154 KV connecting power stations.

5-4-3 SUB-STATIONS

As described in 5-4-1, 380 KV sub-stations will be provided at Bezkese and Izmir. The interconnecting transformers to be installed at these two places will be auto-transformers as existing 154 KV systems are direct grounding systems of neutral point. One 200 MVA unit will be installed at the time of start of operation at Sandalcik and Bezkese and an additional 200 MVA unit at the time of operation of the next power station (scheduled to be Gürleik).

The interconnecting transformer at Izmir will be provided with ± 5% load ratio tap changer (LRC). Transformers at both sending and receiving ends will be made so that shunt reactors with tertiary winding capacities of 50 MVA can be inserted.

5-4-4 COMMUNICATIONS FACILITIES

Communications facilities are absolutely indispensable in operation of power stations, substations and transmission lines. The service level of operation of a power system will depend on the performance of these facilities. It is therefore considered appropriate that the communications facilities described below be provided.

a. Conditions for Circuit Formation

As Bezkese Substation and Bezkese Power Plant are adjacent to each other, they will use common communications facilities and it will be assumed a local operation center will be provided at Bezkese Substation for maintenance and operation of power stations, substations and transmission lines.

Commands to the Dalaman System will be issued from Izmir Substation to Bezkese Substation and the Bezkese Substation will issue operation orders to the various power stations.

b. Outline of Communications Facilities

b-1 Communications Facilities for Load Dispatching and Maintenance

For Formation of a communications circuit, power station and substations will be provided with apparatus for telephone communication consisting of power line carrier and automatic exchange boards. At Bezkese and Izmir Substations, VHF mobile radio stations will be provided for communication when patrolling transmission lines and VHF fixed relay stations will be provided at appropriate locations along the transmission lines.

The various communications circuits will be made up as follows:

Load Dispatching Communication Circuits:

This will be made up of exclusive use telephone circuits.

Power Station and Substation Maintenance Communications Circuits:

This will be made up of automatic exchange telephone circuits.

Line Maintenance Communication Circuits:

A press-to-talk system making possible communication between the local operation center, Bezkese Substation, with mobile VHF radio stations along the transmission lines through fixed VHF relay stations connected with power line carrier circuits.

b-2 Other Communications Circuits

A line fault-locator will be provided at Bezkese Substation for rapid repair of disorders in the 380 KV transmission line. Telemeter equipment will be installed at Bezkese and Izmir Substations to record power production and two other factors of each power station.

c. Items for Survey and Study

Before starting actual designs the following should be surveyed and studied:

c-1 Allocation of radio Frequency

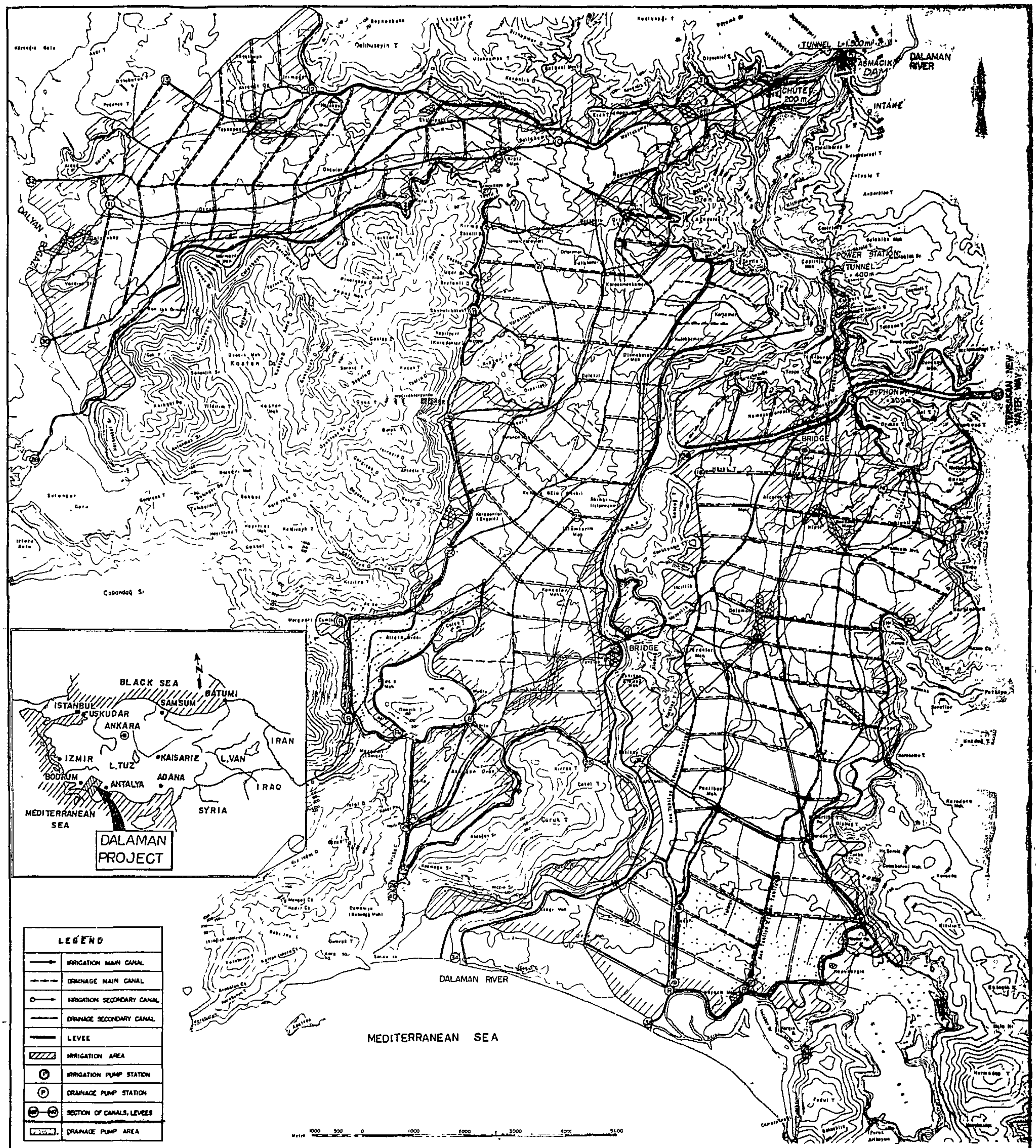
It will be necessary to receive allocation of radio frequencies for power line carrier telephone and VHF radio equipment in accordance with provisions of Turkish laws.

c-2 Selection of Station Locations

In selection of station locations for fixed VHF radio stations, it will be necessary for field surveys and transmission tests to be carried out by specialists.

c-3 Others

Thorough consideration of the effect of corona noise of the 380 KV transmission line on power line carrier telephones will be necessary in carrying out working design of communications equipment.



LEFT BANK AREA
IRRIGATION AREA 6 000 HA

	CANAL NAMES	SECTION	LENGTH (KM)	CAPACITY (M³/S)
IRRIGATION MAIN CANAL	I-L-1	①-②	3,5	11,8
	I-L-2	②-③	12,7	7,1-0,3
	I-L-3	②-④	13,7	3,8-0,3
SECONDARY IRRIGATION CANAL			121,0	0,3-0,1
DRAINAGE MAIN CANAL	D-L-1	[illegible]	5,6	6,8
	D-L-2	[illegible]	6,0	4,3
	D-L-3	[illegible]	4,4	15,1
	D-L-4	[illegible]	6,0	11,5
SECONDARY DRAINAGE CANAL			64,0	0,9-0,1

RIGHT BANK AREA
IRRIGATION AREA 5.600 HA

	CANAL NAMES	SECTION	LENGTH (KM)	CAPACITY (M³/S)
IRRIGATION MAIN CANAL	I-R-1	[illegible]	8,3	15,7-10,0
	I-R-2	[illegible]	16,4	6,0-0,3
	I-R-3	[illegible]	6,4	3,3-0,3
SECONDARY IRRIGATION CANAL			94,0	0,3-0,1
DRAINAGE MAIN CANAL	D-R-1	[illegible]	9,4	19,0
	D-R-2	[illegible]	10,0	11,4
	D-R-3	[illegible]	8,0	12,1
	D-R-4	[illegible]	5,0	10,7
SECONDARY DRAINAGE CANAL			61,0	0,9-0,1

WESTERN AREA
IRRIGATION AREA 3 000 HA

	CANAL NAMES	SECTION	LENGTH (KM)	CAPACITY (M³/S)
IRRIGATION MAIN CANAL	I-W-1	[illegible]	1,6	5,8
	I-W-2	[illegible]	10,5	3,0-0,3
	I-W-3	[illegible]	6,7	3,0-0,3
SECONDARY IRRIGATION CANAL			57,0	0,3-0,1
DRAINAGE MAIN CANAL	D-W-1	[illegible]	15,0	54,7
	D-W-2	[illegible]	7,0	8,6
	D-W-3	[illegible]	12,0	63,3
SECONDARY DRAINAGE CANAL			41,0	0,9-0,1

FLOOD CONTROL

NAMES	SECTION	LENGTH (KM)	HEIGHT (M)	QUANTITY: BANKING	QUANTITY: CUTTING
DALAMAN RIVER	[illegible]	30,0	3,7	4800	—
TERSAKAN NEW WATER WAY	[illegible]	8,0	2,5	[illegible]	[illegible]
TERSAKAN-[illegible] STREAM	[illegible]	19,0	3,0	348	[illegible]
[illegible] STREAM	[illegible]	[illegible]	[illegible]	[illegible]	170

FIG. 5-5-1

GENERAL PLAN OF AGRICULTURAL DEVELOPMENT IN DALAMAN PROJECT AREA

5-5 OUTLINE OF AGRICULTURAL DEVELOPMENT PROJECT

The items mentioned in this chapter are based on results of study of the agricultural Development Project attached to Appendix. For details of the project, Appendix should be referred to.

5-5-1 INTRODUCTION OF PROJECT AREA

The Dalaman Plain is alluvial land formed by the Dalaman River over a long period of years. In the northwest part the plain is adjacent to the Dalyan Plain, spreads out to the south of Lake Köyceğiz and is surrounded by the northern mountain range, eastern mountain range and western mountain range, all between 100 m and 600 m above sea level, and the Mediterranean Sea. The plain is located at north latitude 36°42' to 36°52' and east longitude 28°37' and 28°52'. The elevation is in most parts 0 to 22 m.

The project area is roughly 18,400 ha out of which approximately 14,600 ha is used for agriculture. The major crops of the area are cotton, maize and citrus.

The Dalaman River meanders through approximately the middle of the Dalaman Plain to empty into the Mediterranean Sea and is the largest river in the area.

At the foot of the eastern mountains, there is the Tersakan-Kargin Stream which collects the waters of the eastern mountains and flows into the Mediterranean sea. This stream is also a main drainage waterway of the left bank side of the plain.

At the foot of the western mountains, there is the Mergenliözü-Sarisu Stream which collects the waters of the western mountains and flows into the Mediterranean sea. This stream is also a main drainage waterway of the right bank area of the Dalaman.

The Dalyan Plain to the northwest is drained by the Dalyan-Bogazi Stream which flows from Lake Köycegiz to the Mediterranean Sea.

The climate of this area is a mild Mediterranean climate. Annual mean temperature is 18.2°C and the annual mean precipitation is 986.4 mm. Rainfall is concentrated in the winter and spring and there is little or no rain in summer.

Snowfall and frost are not seen of the plain and it is considered that crops can be grown 365 days of a year.

The water of the Dalaman River is utilized for irrigation of the plain area, but becomes scarce in summer and also fluctuates according to the year. The irrigation system is not organized so that from the point of view of irrigation it cannot be said that the agriculture is stable.

The run off of the Dalaman River and the Tersakan Stream increase during the rainy season from winter to spring, and overflow their river beds to enter the farmland. The floodwaters remain on low and flat parts of the plain for long periods to cause delays in sowing of crops in the spring. Because of this the harvesting of crops coincides with the beginning of the rainy season and there are crops which suffer in yield and quality. One of the crops that suffers is cotton which is the first of the major crops of this area.

In the plain area, the drainage system in general is incomplete and the ground water level is very high throughout the year, being mostly 0 to 1.0 m from the ground surface. This also is a hindering factor in introduction of crops to this area.

Furthermore, in this area, there are approximately 1,900 ha of land with salinity problems, but some part of the land may be easily improved.

The soil of the Dalaman Plain is mostly alluvial soil and the soil character is clayey. The permeability of the soil tested with disturbed samples is in general good to medium. The land of the Dalaman Plain classified according to DSI standards are as listed below.

1.	Arable land (Class I)	211 ha
2.	Arable land (Class II)	2,988 ha
3.	Arable land (Class III)	1,988 ha
4.	Temporarily non-arable land (Class V)	8,877 ha
5.	Non-arable land (Class VI)	4,315 ha
	Total	18,390 ha

The total number of agricultural units in the plain is 1,553. Besides these there is the Dalaman State Farm (approximately 4,300 ha). The total population of the plain is estimated to have been approximately 17,000 in 1965.

5-5-2 OBJECT OF DEVELOPMENT PROJECT

The object of development and improvement of the area is based on a change from the present one-crop-per-year agriculture to year round cropping as a rule. Also, in the relatively higher locations where the ground water level is lower and the land is suited to citrus growing, the agriculture is to be changed over to this high-yield crop, while for the purpose of introducing dairy farming into farm management, feed production will be carried out throughout the year. The introduction of two-crop farming and dairy farming into the area will absorb the idle labor force in the winter to increase farm income while use of barn manure will help to stabilize crop production. Especially, introduction of rotation cropping in fields where yearly consecutive planting of the one crop of cotton had been the custom will prevent emaciation of the soil fertility as well as disease and insect damage caused by consecutive planting, thus increasing productivity.

In order to accomplish this, the following program should be pursued.

(1) Levees of suitable height should be constructed on both banks of the Dalaman River to prevent flood run-off of winter and spring from entering the fields.

(2) Floodwaters of the Tersakan Stream Should be drained into the Dalaman River by excavating a large drainage waterway from the vicinity of Dereköy to the Dalaman. The water of the mountain area can then be discharged quickly into the Dalaman River. Although the catchment area will thus be reduced to half, there will still be the fear that rainwater of the eastern mountains will enter the Tersakan-Kargin Stream and overflow into the plain so that levees should be built along the stream in low areas for prevention of floods. In order to prevent rainwater of the western mountains from overflowing into the plain area, levees should be built along the stream in low

areas.

(3) By construction of reservoirs (common facilities with power generation) at points upstream of the Dalaman River from Asmacik Tepe and of a new irrigation system within the area, optimum planting times will be secured and it will become possible for suitable quantities of water to be supplied at suitable times during the growth period of crops. For positive intake of water, all existing intakes should be abandoned and a new left bank intake constructed at the tailrace of the Bezkese Power Station from which the discharge will be conducted to the left bank irrigation system to be newly constructed. For the right bank area, water will be drawn directly from Asmacik Regulating Reservoir. In other words an intake structure is to be constructed in the Asmacik Regulating Reservoir, and by excavating a tunnel through the right bank area, connection will be made with the right bank irrigation system to be newly built.

In this manner the present natural intake method of irrigation will be abandoned and controlled irrigation water will be distributed. For farmland of higher elevation, pumped irrigation will be carried out. The irrigated area upon completion of the project will be 6,000 ha in the Dalaman left bank area, 5,000 ha in the Dalaman right bank area and 3,000 ha in the western area totalling 14,000 ha.

(4) The drainage systems in the area is to be improved. Drainage canals all be given capacities sufficient to drain the rainwater of winter and spring, and main and branch drainage canals are to be constructed in order to lower ground water level of the farmland to more than 1.2 m below the surface throughout the year. Where natural drainage will be impossible because of elevation, pump drainage is to be performed.

(5) Vehicular bridges are to be constructed at Fevzie on the Dalaman River and over the Tersakan New Waterway along with agricultural roads in the area to accompany the construction of the irrigation and drainage systems to make possible maintenance and control of the waterways, smoothness of

farm management activities and convenience of transportation of farm produce. Also, various information will be obtained more rapidly and communication and exchange between communities will be expedited to contribute to advancement of social conditions in the area. The inhabitants will also be able to cope speedily with emergencies and disasters which may arise by making use of the road network.

(6) An agricultural and animal husbandry center should be established in the area for dessemination of information regarding agriculture and livestock farming and to introduce and promote new techniques. For this purpose it will be desirable to expand the organization of the Dalaman State Farm.

5-5-3 DESCRIPTION OF MAJOR SCHEMES

a. Flood Protection Scheme

a-1 Dalaman River Levees

The design flood discharge of the Dalaman River at Asmacik upon completion of the Dalaman Project will be 1,700 m^3/s. Downstream, below the outlet of the proposed new waterway connecting with the Tersakan Stream the design flood discharge will become 2,100 m^3/s by the diversion of 400 m^3/s of water from the Tersakan Stream. In order to discharge this run off without overflowing into the plain area, 16 km of levees on the left bank, 14 km on the right bank or a total of 30 km is to be built along the banks of the Dalaman River. The volume of earth embankment is estimated to be about 1,500,000 m^3 and is estimated to cost 30,000,000 T.L.

a-2 Tersakan New Waterway

The design flood discharge of the Tersakan Stream near Dereköy will be 400 m^3/s. If the run-off from the catchment area of Tersakan Stream is discharged through its natural bed an enormous improvement work will become necessary of the Tersakan-Kargin Stream in the downstream plain area. Therefore, in this project, a waterway approximately 8 km long is to be excavated, to divert 400 m^3/s of water into the Dalaman River. Earthwork, including excavation and embankment, will be about 1,200,000 m^3 and the cost is estimated at 9,600,000 T.L.

a-3. Tersakan-Kargin Stream

The Tersakan-Kargin Stream will serve to drain the downstream area below Dereköy. The design flood discharge will be 220 m^3/s near the mouth of the stream and to prevent this water from overflowing into the low plain areas, levees are to be built on the right bank of the Tersakan-Kargin Stream for approximately 18 km from the mouth of the stream. It is estimated that earthwork will amount to 545,000 m^3 and the cost will be 5,700,000 T.L.

a-4. Mergenliözü-Sarisu Stream

The Mergenliözü-Sarisu Stream will serve as the main drainage waterway for the rainwaters of the western mountains and the farmland on the right bank side of the Dalaman River. The design flood discharge will be 240 M^3/s and to prevent this water from overflowing into the farmlands, levees are to be built on the left bank for 14 km upstream from the mouth of the stream. The amount of earthwork is estimated to be 355,000 m^3 and the cost 3,900,000 T.L.

b. Irrigation Scheme

b-1 Water Source

With the natural run-off of the Dalaman River in the present condition, it will be impossible to irrigate the 14,000 ha planned in the downstream area at suitable times with suitable amounts of water. As a result of study it is found that agricultural water will be short in the 4 months of July, August, September and October and to supplement this shortage, storage of 120,000,000 m^3 will be necessary. Construction of a reservoir is necessary for this purpose and in this project the Sandalcik Reservoir will be a common facility with the power development project.

b-2 Agricultural Water Rights after Completion of Project

As a result of study, it is proposed that water rights for agriculture to be established upon completion of the project should be as shown in Table 5-5-1.

Table 5-5-1 Proposed Water Right for Agriculture

(Unit Million m^3)

	Toral Area	Detail		
Month	14,000 ha	Left Bank Area 6,000 ha	Right Bank Area 5,000 ha	Western Area 3,000 ha
I	11.3	4.5	4.3	2.5
II	10.1	4.0	3.8	2.3
III	26.2	10.4	10.1	5.7
IV	25.5	10.2	9.8	5.5
V	26.3	11.4	9.4	5.5
VI	36.3	16.0	12.5	7.8
VII	60.0	26.0	21.1	12.9
VIII	63.7	27.3	22.5	13.9
IX	50.8	21.8	17.9	11.1
X	22.6	9.9	7.8	4.9
XI	14.4	6.3	5.4	2.7
XII	15.0	5.8	6.2	3.0
Total	362.2	153.6	130.8	77.8

b-3. Irrigation Facilities

From the standpoint of topography and of the present irrigation system, the farmland of the Dalaman Plain should be divided into the Dalaman left bank area, the Dalaman right bank area and the western area (the Dalyan Plain chiefly irrigated at present with water from the Dalaman).

After completion of the Program the acreage of these areas will be 6,000 ha for the left bank area, 5,000 ha for the right bank area and 3,000 ha for the western area.

In the left bank area, part of the farmland near Dereköy is presently being irrigated by the Tersakan Stream, but this district also has unstable dry season run-off so that 150 ha, the area which can reasonably be irrigated with the dry season run-off, will use the Tersakan Stream as the main source of water with water to be supplemented from the Dalaman when necessary.

As a result of study, it was determined that the maximum irrigation water for the left bank irrigation system will be 11.47 m^3/s, and for the right bank system 15.65 m^3/s out of which 6.00 m^3/s will be for the western area. The irrigation water for the left bank area will be secured by conducting water after discharge from Bezkese Power Station through a tunnel to the irrigation system to be newly built in the left bank area. Irrigation water for the right bank area and the western area will be drawn directly from Asmacik Regulating Reservoir. An intake structure is to be constructed in the Asmacik Regulating Reservoir and a tunnel will be excavated through the right bank to conduct the water to the irrigation system to be newly built.

A head of approximately 10 m will be obtained at the outlet of the tunnel after intake from Asmacik Regulating Reservoir and in the present study it was decided to provide chute works. This is because there are presently two watermills on the right bank irrigation system which are being utilized by the farmers both in wet and dry seasons and since it has not been investigated or decided whether the farmers will desire water or electricity for motive power conversion of this energy into electric power was not considered in the present plan. Therefore, this matter should be determined through confirmation of the wills of the farmers.

For effective distribution of water and prevention of seepage both main lateral and distributary canals will be lined.

Where farmland is located at higher elevations and it will be impossible to accomplish irrigation by gravity flow, pumping from the nearest waterways should be planned to eliminate water shortages. These districts are as listed below.

(1)	Akçagöl District	49 ha
(2)	Mergenli Camis District	34 ha
(3)	Güvez Dere District	54 ha

Total	137 ha

The total length of main canals will be 79 km and lateral canals 272 km. The construction cost including appurtenant structures is estimated at 62,601,000 T.L.

c. Drainage Scheme

The main drainage routes of the Dalaman Plain will be the same as at present with natural drainage to be carried out in principle. It is also planned to lower the ground water to 1.2 m or more below the surface of the ground. The main drainage routes are the three streams listed below.

(1) Tersakan-Kargin Stream

(2) Mergenliözü-Sarisu Stream

(3) Dalyan Bogazi Stream

In six districts where it is impossible to carry out natural drainage due to low elevations, pumped drainage is to be performed.

The present waterways as a rule are to be improved in case of main drainage canals, but where this is inadequate, new drainage canals are to be constructed.

The unit drainage discharge is determined as follows:

(1) Surface water	Field	$q_1 = 0.7\ m^3/s.km^2$
	Hill	$q_2 = 2.6\ m^3/s.km^2$
(2) Ground Water		$q_3 = 3.6$ mm/day

Drainage canals will all be plain cut and the system is planned for effective drainage to be carried out in concert with the planned irrigation system. For this purpose, lateral drainage canals are to be constructed parallel to lateral irrigation canals.

The length of main drainage canals will be 88 km and lateral drainage canals 166 km. There will be six pumping stations. The total cost is estimated to be 32,611,000 T.L.

d. Readjustment of Farmland

In view of expansion in the scale of farm management and introduction of large-sized farm equipment in the future; size of farm blocks agricultural roads and terminal irrigation canals and drainage canals, are to be readjusted. In order to lower ground water levels 1.2 m or more below the surface, the bottoms of drainage waterways will as a rule be 2.0 m below the ground surface and where necessary, tile drains will be buried. Land which there are topographical restrictions for utilization as farmland are to be improved by cutting down of trees and shrubs, uprooting, claring of gravel and stones, land leveling, etc. The total cost is estimated at 45,500,000 T.L.

e. Others

Two bridges are to be included in the project: one at the crossing of the Tersakan New Waterway and National Highway No. 6 and the other on the Dalaman River taking advantage of the levees to be constructed along the river.

Dalaman River, Fevziye	length	250 m
Tersakan New Waterway, Bezkese	length	.150 m

The construction cost is estimated to be 6,000,000 T.L. As the costs of establishing an agricultural and animal husbandry center and of land acquisition for facilities 250,000 T.L and 3,922,000 T.L respectively were estimated.

Furthermore, it is estimated that a supplemental survey period of two years and a construction period of three years will be required for realization of the Project and including the cost of these, the investment for the Project is estimated to be 252,000,000 T.L.

5-5-4 ANNUAL BENEFIT FROM EXECUTION OF PROJECT

a. Agriculture

The calculation of benefits of the agricultural phase of this project was based on comparison of income, in consideration of the soil characteristics and the crop suitabilities of this area, which was estimated from yield of crops assumed to be introduced upon execution of the project and before execution of the project. It was estimated that 5 years will be required for crops to begin to produce the planned yields. The annual benefits were calculated assuming that yield would increase linearly after completion of the Project and reach the planned level in 5 years.

In the case of citrus, there are 500 ha planted with citrus fruit trees which are 10 years old. If the agricultural program is executed an additional 2, 360 ha may be newly planted, and annual benefits which may be created by this additional area were estimated.

As a result of study, the annual increment of benefit which may be derived from execution of the Project is as shown in Table 5-5-2. This was calculated on the basis of an economic analysis period of 50 years and interest rate of 5% per annum.

b. Animal Husbandry and Dairy Farming

With the execution of the Project it will become possible to carry out planned production of forage crops. Also, by introduction of dairy farming in farm management, the economy of the agriculture unit will be greatly improved and the nutrition level of the farmers will be raised to help in improvement of the health of the farmers. In this way, the Project will produce considerable benefits in the animal husbandry and dairy farming, but as basic information sufficient to accurately calculate these benefits could not be collected they were not estimated. As a substitute, forage crops were included in agricultural production and benefits were estimated based on farmyard delivery prices. Therefore, reliable calculation of benefits from animal husbandry and dairy farming will have to be made from the results of future investigations. However, an evaluation of the effect to this phase can be made from nutrient content of feed which will be increased by 828 tons in digestible crude protein, 4, 984 tons in starch value and 7, 401 tons in total digestible nutrients.

Table 5-5-2 Annual Increase Benefit of Agricultural Products in Dalaman Plain

Item	Without Project			After Completion of Project			Annual Increase Benefit
	Crops	Citrus	Total	Crops	Citrus	Total	
1. Annual Value of Production (T.L)	23,193,510	8,474,400	31,667,910	* 47,383,518	33,645,924	81,029,442	49,361,532
2. Annual Production Cost (T.L)	15,075,782	4,283,550	19,359,332	* 27,881,797	19,780,254	47,662,051	28,302,719
3. Annual Net Agricultural Income (T.L)	8,117,729	4,190,850	12,308,579	* 19,501,720	13,865,670	33,367,390	21,058,811
4. Annual Net National Agricultural Income (T.L)	17,395,133	6,250,050	23,645,183	* 29,321,437	22,126,950	51,448,387	27,803,204
5. Annual Gross National Agricultural Income (T.L)	19,714,484	6,344,100	26,058,584	* 33,619,903	22,664,916	56,284,819	30,226,235
Cf. 1. Estimated Area of Production (ha)	14,062	450	14,512	13,675	2,574	16,249	1,737
Cf. 2. Annual Yield (Kg)	18,527,500	14,125,500	32,653,000	84,878,900	56,074,500	140,953,400	108,300,400
Cf. 3. Annual Irrigation Water Price in the production Cost	-	-	-	1,263,686	463,320	1,727,006	1,727,066

* These figures are gained by development period calculation.

c. Others

Flood control levees for the Dalaman Plain have been planned based on studies to prevent overflow of flood discharges of 1,700 m^3/s in the upstream areas and 2,100 m^3/s in the downstream areas. On one hand the highest run-off recorded at Fevzie on the Dalaman River is 522.5 m^3/s, but since flood discharges in this case are thought to have overflowed at Çayli in the upstream area and below Yerbelen Tepe and spread to the west, this record cannot be determined as reflecting the total run-off accurately. Therefore, at this stage, based on actual run-off records, it is not possible to ascertain the cycle at which the design flood discharge of 2,100 m^3/s will occur. Also, it is not clear what the total damages were in case of great floods of the past and it is not possible to estimate the effect of the levees in terms of the monetary amounts of damage prevented. Therefore, this will not be evaluated at this time, but presumably, the construction of the levees will surely protect real assets such as farmland, farm houses, roads, livestock, etc., as well as movable property and reduce the damages experienced in the past to a great degree. Furthermore, land values will rise and there will be possibilities for introduction of agricultural products processing plants. With the execution of the Project, the productivity of farmland will be increased so that the value of the land itself will rise. In land other than agricultural use, conditions will be created to convert land for processing plants for agricultural and animal husbandry products. These cannot be estimated in monetary values at this time, but are without doubt benefits which will be derived from execution of the Project.

5-5-5 ANNUAL COST OF EXECUTION OF PROJECT (EXCLUSIVE AGRICULTURAL FACILITIES)

As previously described, the initial investment of this Project is estimated as shown in Table 5-5-3 below.

Table 5-5-3 Initial Investment

	Item	1,000 T.L
1.	Flood Protection	49,200
2.	Irrigation	62,601
3.	Drainage	32,611
4.	Land Readjustment	45,500
5.	Bridges	6,000
6.	Land Acquisition	3,922

7.	Establishment of Agricultural and Animal Husbandry Center	250
8.	Administrative Costs	
	Including Investigations and Engineering	12,000
9.	Contingencies	25,694
10.	Interest during Construction	14,222
	Total	252,000

Annual expenses were estimated based on a useful life of 15 years for pumping facilities and 50 years for other facilities.

annual costs are as shown in Table 5-5-4.

Table 5-5-4 Annual Cost

Item	Annual Cost Thousand TL	Remarks
a. Maintenance and Operation	3,584	
1) Flood Protection Structure, Irrigation System Drainage System	2,939	
2) Agricultural and Animal Husbandry Service Center	645	
b. Amortization of Investment Cost	13,805	
At 50 Yrs. 5% Interest		
c. Replacement of Pumping Equipment	120	
At 15 Yrs. 5% Interest		
d. Reserve for Unexpected Agricultural Damage due to Natural Calamity	1,050	About 5% of Annual Increase in Net Agricultural Income
Total	18,559	

5-5-6 ECONOMIC JUSTIFICATION OF THE PROJECT

As already described up to the preceding section, the annual increased benefit (initial benefit) of the agricultural phase of the Program was estimated as shown in Table 5-5-2 and the annual increased cost of facilities exclusively for this phase of the Program is shown in Table 5-5-4. The comparison of benefit and cost not including the allocated costs of common facilities are as shown in Table 5-5-6.

Table 5-5-6 Comparison between Benefit and Cost

Annual Increase Benefit TL (1)	Annual Increase Cost TL (2)	Annual Excess Benefit TL (3) = (1) - (2)	Benefit - Cost Ratio (4) = (1)/(2)	Remarks
21,058,811	18,559,000	2,499,811	1.13	* Capitalized
384,449,654 *	338,813,104 *	45,636,550 *	-	n = 50 years i = 0.05 Factor = 18.256

The values of the above table will be used as the basic values for cost allocation of the common facilities. As a result of cost allocation carried out in a separate section, the amount to be borne by this phase of the Program was determined to be 1,044,000 T.L per year. The comparison of benefit and cost as adjusted by these figures are as shown in Table 5-5-7.

Table 5-5-7 Comparison between benefit and Cost
(Included Allocation Cost)

Annual Increase Benefit TL (1)	Annual Increase Cost TL (2)	Annual Excess Benefit TL (3) = (1) - (2)	Benefit - Cost Ratio (4) = (1)/(2)	Remarks
21,058,811	19,603,000	1,455,811	1.07	* Capitalized
384,449,654 *	357,872,368 *	26,577,286 *	-	n = 50 years i = 0.05 Factor = 18.256

Next, as is the method used in Turkey, the comparison between benefit and cost, using net national income as the benefit derived is as shown in Table 5-5-8.

Table 5-5-8 Comparison between Net National Benefit and Cost
(Included Allocation Cost)

Annual Increase National Benefit TL (1)	Annual Increase Cost TL (2)	Annual Excess National Benefit (3) = (1) - (2) TL	Ratio (4) = $\frac{(1)}{(2)}$	Remarks
27,803,204	19,603,000	8,200,204	1.42	* Capitalized
507,575,292 *	357,872,368 *	149,702,924 *	-	n = 50 Years i= 0.05 Factor=18.256

Using gross national income as the benefit, the comparison between benefit and cost is as shown in Table 5-5-9.

Table 5-5-9 Comparison between Gross National Beneft and Cost (Included Allocation Cost)

Annual Increase National Benefit (1) TL	Annual Increase Cost (2) TL	Annual Excess National Benefit (3) = (1) - (2) TL	Ratio (4) = $\frac{(1)}{(2)}$	Remarks
30,226,235	19,603,000	10,623,235	1.54	* Capitalized n = 50 years i = 0.05 Factor=18.256
551,810,146 *	357,872,368 *	193,937,778 *	-	

As seen from these tables the investment for this phase of the Program is justified economically even from the point of only initial benefit and the Project will contribute greatly to the national economy.

5-5-7 CONCLUSION

As a result of study on economic justification, and technical feasibility of the Project based on available data, this Project is found to be promising and it would be worth continuing with its surveys.

Therefore, it would be desirable to conduct some supplementary surveys for exclusive facilities (see Conclusions and Recommendations, and Future Surveys) and proceed towards completion of the Project. It is also important to establish at the earliest date an agricultural and animal husbandry center where farmers may freely exchange information in order to promote advancement of agriculture and livestock farming. At the same time political and economic considerations should be given to strengthening of the structures of agricultural cooperatives and mutual associations for stabilization of farm management.

5-6 ECONOMIC STUDY

5-6-1 ORDER OF DEVELOPMENT

As previously described, the development program of the basin consists of construction of 3 reservoirs, 1 regulating pond and 4 power stations for generation of a total 327,000 KW of electric power, construction of levees for flood protection of the Dalaman Plain and irrigation and drainage of 14,000 ha of land.

The order of development as described in 3. "Necessity of Development" will be governed by the necessity for meeting the demand for power in the Western Area and the necessity for agricultural development of the Dalaman Plain now undergoing exploitation.

The following 6 orders of development are conceivable.

	Plan I	Plan II	Plan III	Plan IV	Plan V	Plan VI
Sandalcik Dam and Power Station	1	1	2	3	3	2
Gürleik Dam and Power Station	2	3	1	1	2	3
Göktas Dam and Power Station	3	2	3	2	1	1
Asmacik Dam and Bezkese Power Station	1	1	1	1	1	1
Flood Protection, Irrigation and Drainage of Dalaman Plain	1	1	1	1	1	1

Note: 1 indicates First Stage, 2 Second Stage and 3 Third Stage

In consideration of the order of development, the flood protection, irrigation and drainage of the Dalaman Plain and the Asmacik intake dam were all planned for the First Stage Program in view of the necessity of early development of agriculture. Also, from the standpoint of overall economy, since the Asmacik intake dam and the left bank irrigation tunnel are common facilities with power generation, Bezkese Power Station should be constructed at the same time as the above facilities and therefore this power station is included in the First Stage Program.

The difference in order of construction of the 3 upstream power stations will have no effect on the irrigation plans of the Lower Dalaman Plain. Bezkese Power Station would be affected, but this will have little influence on the economic properties of the various combinations of the order of development of the 3 upstream power stations. Therefore, the order for these power stations can be considered with regard only to these stations. The economics of Sandalcik, Gürleik and Göktas Power Stations in Plan I are as follows:

		Sandalcik	Gürleik	Göktas
Construction cost per KW,	T.L	2,980	2,690	3,106
Construction cost per KWh,	T.L	0.57	0.77	0.89
Benefit-cost ratio	V/C	2.08	1.72	1.58

As shown above, Sandalcik Power Station is the most economical followed by Gürleik and Göktas. Furthermore, the Gürleik site will receive downstream benefit from Sandalcik, and Göktas from Sandalcik and Gürleik, so that unit construction costs will be higher if the respective upstream sites are not developed. Therefore, if development is to be carried out from the most economical site in determining the order of development, Sandalcik should be developed first, followed by Gürleik and Göktas. Also, surveys of dam sites at Sandalcik and Asmacik are much more advanced than the other sites, while access to the two sites is also much easier.

From the above it would be most economical to select Plan I for the order of development dividing the basin development program into 3 stages. This is also appropriate from the standpoint of construction technology.

In further consideration of the First Stage Program mentioned above, in regard to agricultural development of the Dalaman Plain, it is technically impossible to design flood protection, irrigation and drainage facilities based on the surveys carried out to date and proceed with a definite study immediately.

Therefore, further surveys will have to be continued, but since the construction period for flood protection, irrigation and drainage facilities will be 3 years, while the construction period for Sandalcik Reservoir, the water source, will be approximately 5 years including definite study, and since it is not conceivable that small changes in flood protection facilities and irrigation and drainage facilities deviating from the overall basin program, which may be decided as a result of future detailed study, will not affect the design of Sandalcik Reservoir and appurtenant power generation facilities, the definite study of reservoir works and power generation, transmission line and substation out of the First Stage Program of which feasibilities can be substantiated in Chapter 6, is desirable to be started at once in order to prepare for commencement of construction.

5-6-2 CONSTRUCTION COSTS

a. Dams

Estimated construction costs of Sandalcik, Gürleik, Göktas and Asmacik Dams broken down according to major items are as follows:

Unit : 10^3 T.L

Item	Sandalcik	Gürleik	Göktas	Asmacik	Total
Land Acquisition and Compensation	11,900	650	1,100	200	13,850
Diversion Tunnels Coffer Dam and Others	5,370	905	960	3,090	10,325
Dam	131,630	110,700	68,880	34,500	345,710
Contingency and Others	44,300	41,445	21,360	11,070	118,175
Sub-total	193,200	153,700	92,300	48,860	488,060
Interest during Construction	12,900	9,300	5,700	1,960	29,860
Total	206,100	163,000	98,000	50,820	517,920

b. Power Generating Facilities

Construction costs of Sandalcik, Gurleik, Goktas and Bezkese power generating facilities broken down into major items are as follows:

Unit: 10^3 T.L.

Item	Sandalcik	Gürleik	Göktas	Asmacik	Total
Waterways	111,320	14,700	20,696	23,950	170,666
Power Plant	16,290	13,900	13,900	2,410	46,500
Electrical Machinery and Equipment	46,110	44,340	37,940	13,255	141,645
Contingency and Others	51,080	27,360	28,634	11,525	118,599
Sub-total	224,800	100,300	101,170	51,140	477,410
Interest during Construction	16,100	5,700	5,830	2,040	29,670
Total	240,900	106,000	107,000	53,180	507,080

c. Power Transmission lines and Substations Facilities

Construction costs of transmission lines of Sandalcik, Gürieik, Göktas and Bezkese Power Stations and of Bezkese and Izmir Substations in the First Stage Program and the cost of addition of substations after completion of Gürleik and Göktas Power Stations broken down by major items are as follows:

Unit : 10^3 T.L

Item	First-Stage	Addition	Total
Transmission Line	112,500		112,500
Bezkese Substation	35,800	19,600	55,400
Izmir Substation	35,800	19,600	55,400
Total	184,100	39,200	223,300

d. Flood Protection, Irrigation and Drainage Facilities

Construction costs of the flood protection, irrigation and drainage facilities of the Dalaman Plain are as shown below.

Unit : 10^3 T.L

Item	Cost
Flood Protection Facilities	49,200
Irrigation Facilities	62,601
Drainage Facilities	32,611
Land Readjustment	45,500
Others	47,866
Sub-total	237,778
Interest during Construction	14,222
Total	252,000

e. Summary

Unit : 10^3 T.L

Item	Cost
Dams and Power Generation	1,025,000
Transmission Lines and Substation	223,300
Sub-total	1,248,300
Flood Protection, Irrigation and Drainage Facilities Etc.	252,000
Sub-total	252,000
Total	1,500,300

5-6-3 ANNUAL COST

Item	(A)	(B)	Remarks
Dam	10^3 T.L	10^3 T.L	(A): In case of 4 power stations developed simultaneously
Sandalcik	11,974	11,974	
Gürleik	9,470	8,180	
Göktas	5,694	4,461	(B): Converted to time of completion of First Stage Program
Bezkese	2,952	2,952	
Sub-total	30,090	27,567	

Item	(A)	(B)	Remarks
Power Generation	10^3 T. L	10^3 T. L	
Sandalcik	17,641	17,641	
Gürleik	8,366	7,227	
Göktas	8,176	6,406	
Bezkese	3,972	3,972	
Sub-total	38,155	35,246	
Transmission Lines and Substation			
First Stage	17,962	17,962	
Future Extension	4,381	3,576	
Sub-total	22,343	21,538	
Total	90,588	84,351	
Flood Protection Irrigation and Drainage Etc.		18,559	
Sub-total		18,559	
Grand Total		102,910	

5-6-4 BENEFITS

Item	(A)	(B)	Remarks
	10^3T.L	10^3T.L	(A) : In case of 4 power stations completed simultaneously
Electric Power			
Sandalcik	82,783	82,783	
Gürleik	42,391	34,604	(B) : Converted to time of completion of First Stage Program
Göktas	28,992	20,671	
Bezkese	8,119	8,119	
Sub-total	162,285	146,177	
Agriculture		21,059	
Sub-total		21,059	
Total		167,236	

5-6-5 OVERALL EVALUATION

The annual cost (C) and the benefit (V) upon completion of this Program are estimated at 102, 910, 000 T. L and 167, 236, 000 T. L respectively and the excess benefit (V-C) and Benefit-cost ratio as calculated below are 64, 326, 000 T. L and 1. 62 respectively.

	10^3 T.L
Annual Cost (C)	
Dam	27,567
Power Generation	35,246
Transmission Lines and Substations	21,538
Agriculture	18,559
Total	102,910
Benefit (V)	
Electric Power	146,177
Agriculture	21,059
Total	167,236
Evaluation	
Excess Benefit (V-C)	64,326
Benefit-cost Ratio (V/C)	(1.62)

6. FEASIBILITY STUDY OF THE SANDALCIK PROJECT (FIRST STAGE DEVELOPMENT PROJECT)

6. FEASIBILITY STUDY OF THE SANDALCIK PROJECT (FIRST STAGE DEVELOPMENT PROJECT)

6-1 GENERAL DESCRIPTION

6-1-1 SCOPE OF THE FIRST STAGE PROJECT

The order of development of the downstream reaches of the Dalaman River basin and the nature of the First Stage Project are as already described. The works listed below are those which are to be promptly carried out among the various works of the First Stage Project which hereinafter called the Sandalcik Project.

(1) Construction of the Sandalcik Dam as a source of irrigation water for the Dalaman Plain and for the purpose of power generation.

(2) Construction of Sandalcik Power Station

(3) Construction of Asmacik Dam for irrigation, power generation and re-regulation of discharge from the upstream dam.

(4) Construction of Bezkese Power Station

(5) Construction of transmission line from Sandalcik through Bezkese to Izmir.

(6) Construction of Bezkese and Izmir Sub-stations.

The results of evaluation of technical and economical feasibility of the abovementioned Sandalcik Project are explained hereinafter.

6-1-2 POWER OUTPUT OF THE FIRST STAGE PROJECT

The power output during the period from the operation of the Sandalcik and Bezkese Power Stations up to the completion of the Gürleik and Goktas Power Stations in the First Stage Project is as follows:

Item	Sandalcik Power Station	Bezkese Power Station	Total
Maximum Output (KW) :	150,000	11,000	161,000
Firm Output (KW) :	146,000	11,000	157,000

Table 6-1-1 Bezkese Power Station (1st stage) - Monthly Energy Production (21 Years) (10^6 KWh)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	ANNUAL
'43 - '44	8.1	7.8	8.1	8.1	7.3	8.1	7.8	6.3	5.3	4.2	4.0	4.6	79.7
'44 - '45	6.8	7.0	8.1	8.1	7.3	8.1	7.8	8.0	5.5	4.9	4.6	5.2	81.4
'45 - '46	7.4	7.7	8.1	8.1	7.3	8.1	7.8	6.9	5.6	4.3	4.0	4.8	80.1
'46 - '47	7.0	7.0	8.1	8.1	7.3	8.0	6.5	6.2	5.7	6.9	4.2	4.9	79.9
'47 - '48	6.8	7.4	8.1	8.1	7.3	8.1	7.8	8.1	5.8	4.7	4.6	5.4	82.2
'48 - '49	7.6	7.8	8.1	8.1	7.3	8.1	7.8	7.3	6.1	4.5	4.2	4.9	81.8
'49 - '50	6.9	7.8	8.1	8.1	6.7	6.9	6.7	8.1	6.1	4.4	4.1	4.7	78.6
'50 - '51	6.8	7.2	7.5	8.1	7.3	8.1	7.8	7.0	6.7	6.2	4.9	5.5	83.1
'51 - '52	7.9	7.8	8.1	8.1	7.3	8.1	7.8	8.1	6.6	5.6	5.0	4.7	85.1
'52 - '53	7.7	7.8	8.1	8.1	7.3	8.1	7.8	6.3	7.8	5.0	4.3	5.3	83.6
'53 - '54	8.1	7.8	8.1	8.1	7.3	8.1	7.8	6.9	5.5	4.5	4.1	4.7	81.0
'54 - '55	6.5	7.8	8.1	8.1	7.3	8.1	7.8	8.1	6.5	5.2	4.7	5.3	83.5
'55 - '56	6.8	7.8	8.1	8.1	7.3	8.1	7.8	7.8	6.4	5.0	4.4	4.9	82.5
'56 - '57	5.8	7.3	8.1	8.1	7.2	8.1	6.9	7.1	6.4	4.9	4.4	4.8	79.1
'57 - '58	5.5	7.4	7.9	8.1	7.3	8.1	7.8	8.1	6.7	5.5	4.3	5.2	81.9
'58 - '59	5.8	7.2	8.1	8.1	7.3	8.1	7.6	7.0	7.1	4.8	4.5	5.0	80.6
'59 - '60	5.6	7.4	8.1	8.1	7.3	8.1	7.8	7.3	5.9	4.8	4.5	4.9	79.8
'60 - '61	5.5	7.1	8.1	8.1	7.3	8.1	7.8	7.9	6.2	5.0	4.3	4.9	80.3
'61 - '62	6.8	7.2	8.1	8.1	7.3	8.1	7.8	7.8	5.8	4.5	3.9	4.7	80.1
'62 - '63	6.6	7.5	8.1	8.1	7.3	8.1	7.8	8.1	7.8	5.1	4.3	4.8	83.6
'63 - '64	7.0	7.0	8.1	7.3	7.3	8.0	6.2	5.9	5.2	4.0	3.6	4.2	73.8
Average	6.8	7.5	8.1	8.1	7.3	8.0	7.6	7.3	6.2	4.9	4.3	4.9	81.0

Table 6-1-2 2-Power Station (1st stage) - Monthly Energy Production (21 Years) (10^6 KWh)

YEAR	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	ANNUAL
'43 - '44	67.9	67.1	70.3	69.3	108.0	119.6	75.4	68.0	63.4	63.0	62.4	62.4	896.8
'44 - '45	67.4	66.7	70.1	70.5	64.2	103.5	115.7	72.9	63.7	63.9	62.6	63.3	884.5
'45 - '46	68.6	68.2	71.2	71.3	92.9	89.1	89.7	68.6	63.8	63.2	61.8	62.7	871.1
'46 - '47	67.8	66.9	70.6	71.1	64.2	71.2	67.3	67.6	63.7	65.8	62.2	63.0	801.4
'47 - '48	67.8	67.5	70.8	71.1	64.2	71.2	69.5	86.7	64.1	63.7	62.6	63.5	822.7
'48 - '49	68.9	68.4	71.2	71.1	63.9	119.5	115.7	69.0	64.3	64.3	62.2	63.0	901.5
'49 - '50	67.9	68.2	71.0	71.0	63.1	69.2	66.6	69.0	63.9	63.0	61.7	62.2	796.8
'50 - '51	67.1	66.6	69.0	69.6	63.0	70.1	68.1	68.4	64.7	65.1	62.9	62.2	796.8
'51 - '52	68.2	68.4	71.2	71.1	108.0	119.6	115.7	84.4	65.0	64.7	63.2	63.0	963.5
'52 - '53	68.9	81.0	119.6	119.6	108.0	114.9	73.4	67.9	74.7	64.1	62.4	63.6	1,018.1
'53 - '54	69.6	68.9	102.7	119.6	108.0	119.6	103.2	68.6	63.3	63.4	62.0	62.6	1,011.5
'54 - '55	67.2	68.0	71.3	119.6	108.0	119.6	102.5	70.9	64.8	64.2	62.7	63.5	987.3
'55 - '56	68.0	68.4	71.4	71.4	108.0	109.6	94.0	69.5	64.7	64.0	62.3	63.1	924.4
'56 - '57	66.8	67.4	70.6	70.3	63.0	69.7	66.1	67.0	63.2	62.6	61.2	61.0	788.9
'57 - '58	65.2	64.9	67.2	67.7	61.3	68.5	66.7	68.2	63.7	63.3	61.3	61.7	779.7
'58 - '59	65.0	65.1	68.1	68.7	62.6	69.3	66.5	66.6	63.7	62.3	61.1	61.0	780.0
'59 - '60	64.0	64.4	67.3	67.9	61.8	68.4	65.8	66.3	61.8	61.7	60.5	60.0	769.9
'60 - '61	62.6	62.7	66.7	68.5	62.8	70.3	67.8	68.8	63.8	63.4	61.8	62.2	781.4
'61 - '62	66.9	66.3	69.4	69.5	62.9	70.4	68.1	69.2	63.8	63.3	61.6	62.4	793.8
'62 - '63	67.2	67.1	70.7	119.6	108.0	119.6	115.7	119.6	82.5	64.2	62.4	63.1	1,059.7
'63 - '64	68.3	67.6	71.0	70.1	63.7	70.3	66.2	66.5	62.6	62.2	60.7	61.1	790.3
Average	67.2	67.6	73.9	79.5	79.6	91.1	83.1	72.5	65.2	63.5	62.0	62.4	867.6

The annual energy production of the Sandalcik Power Station at the stage of completion of the above first two stations 786, 600, 000 KWh as already described.

Until completion of the Gürleik and Göktas Reservoirs, the discharge of the river downstream of the Sandalcik Power Station will not be regulated. Therefore, the annual energy production of the Bezkese Power Station is somewhat smaller, compared to that at the stage of completion of the other three stations on the upper stream. The monthly energy production of the Bezkese Power Station under this condition calculated on the basis of the past 21 years run-off between October, 1943 and September, 1964 is as shown in Tables 6-1-1 through 6-1-3.

The annual energy production of the Sandalcik and Bezkese Power Stations, in the case only these two are in operation, is 867, 600, 000 KWh. The construction costs of these two power stations at the generating end is 551, 000, 000 T.L and the unit construction costs in terms of KW and KWh are 3, 422 T.L/KW and 0. 635 T.L/ KWh respectively.

Table 6-1-3 2-Power Stations (1st stage)
Average Monthly Energy Production

(10^6 KWh)

Month	Sandalcik P.S.	Bezkese P.S.	Total
Oct.	60.4	6.8	67.2
Nov.	60.1	7.5	67.6
Dec.	65.8	8.1	73.9
Jan.	71.4	8.1	79.5
Feb.	72.3	7.3	79.6
Mar.	83.1	8.0	91.1
Apr.	75.5	7.6	83.1
May	65.2	7.3	72.5
June	59.0	6.2	65.2
July	58.6	4.9	63.5
Aug.	57.7	4.3	62.0
Sept.	57.5	4.9	62.4
Total	786.6	81.0	867.6

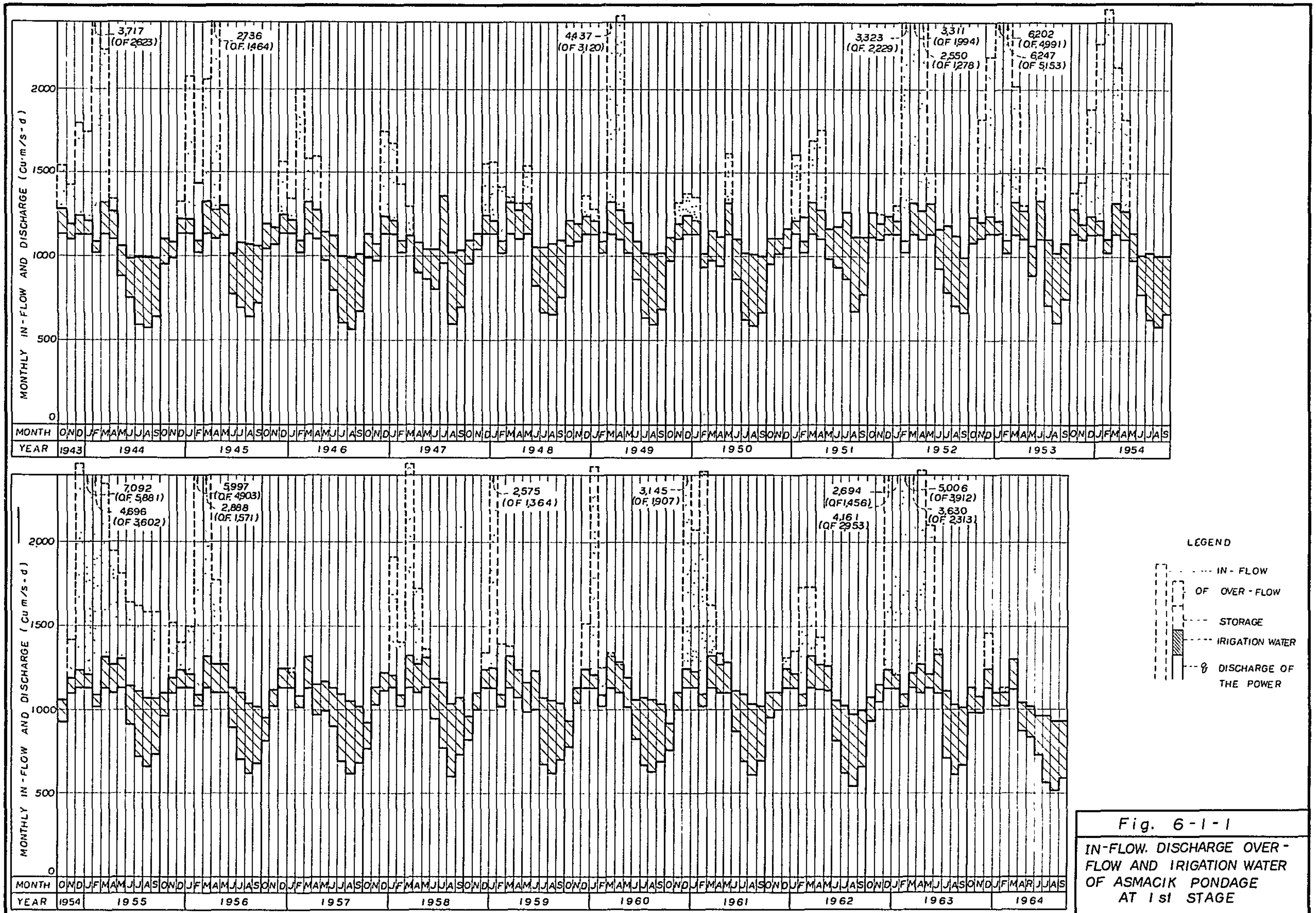


Fig. 6-1-1

IN-FLOW. DISCHARGE OVER-FLOW AND IRIGATION WATER OF ASMACIK PONDAGE AT 1st STAGE

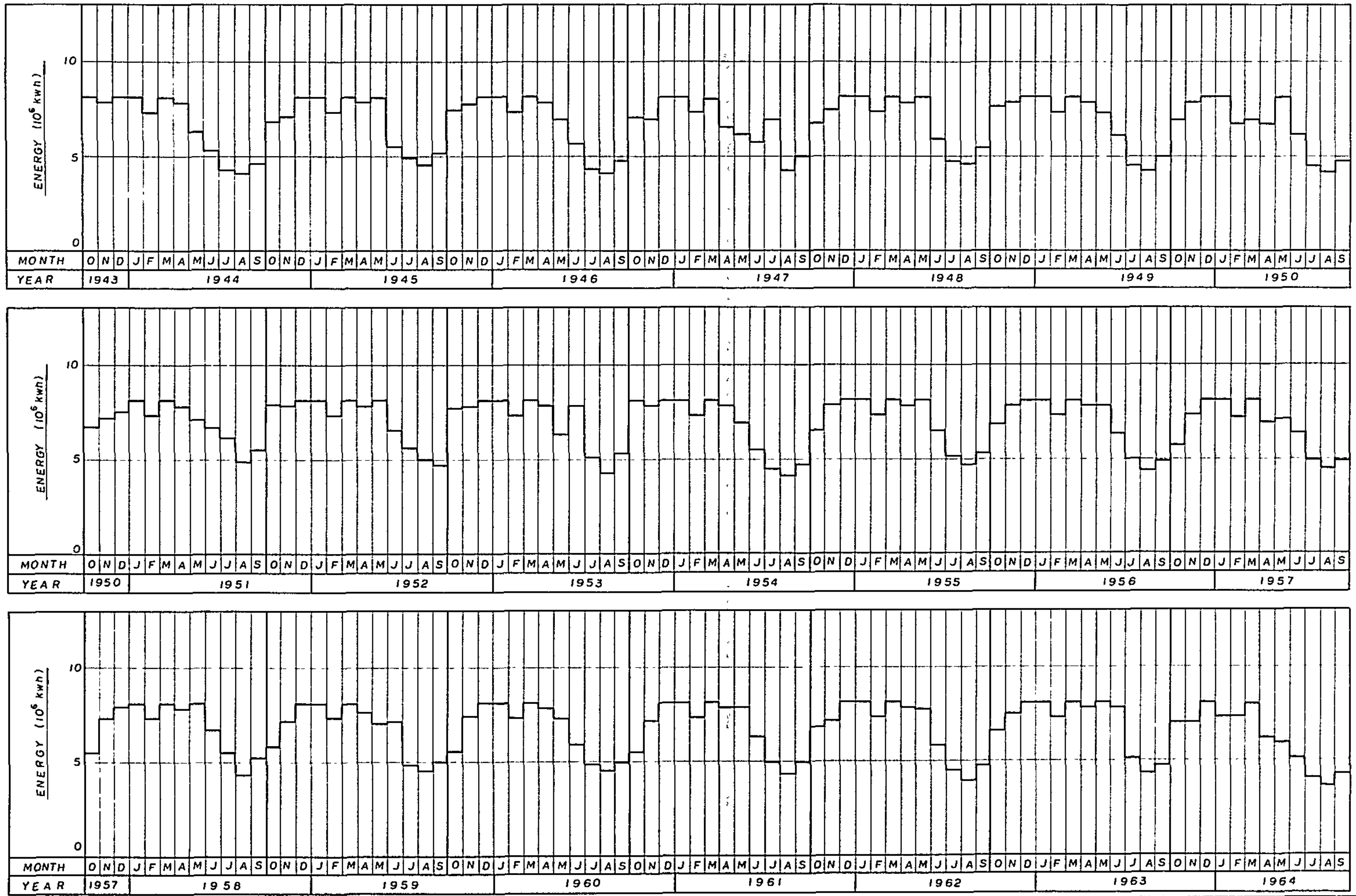


Fig. 6-1-2

MONTHLY ENERGY PRODUCTION OF BEZKESE POWER STATION AT 1st STAGE

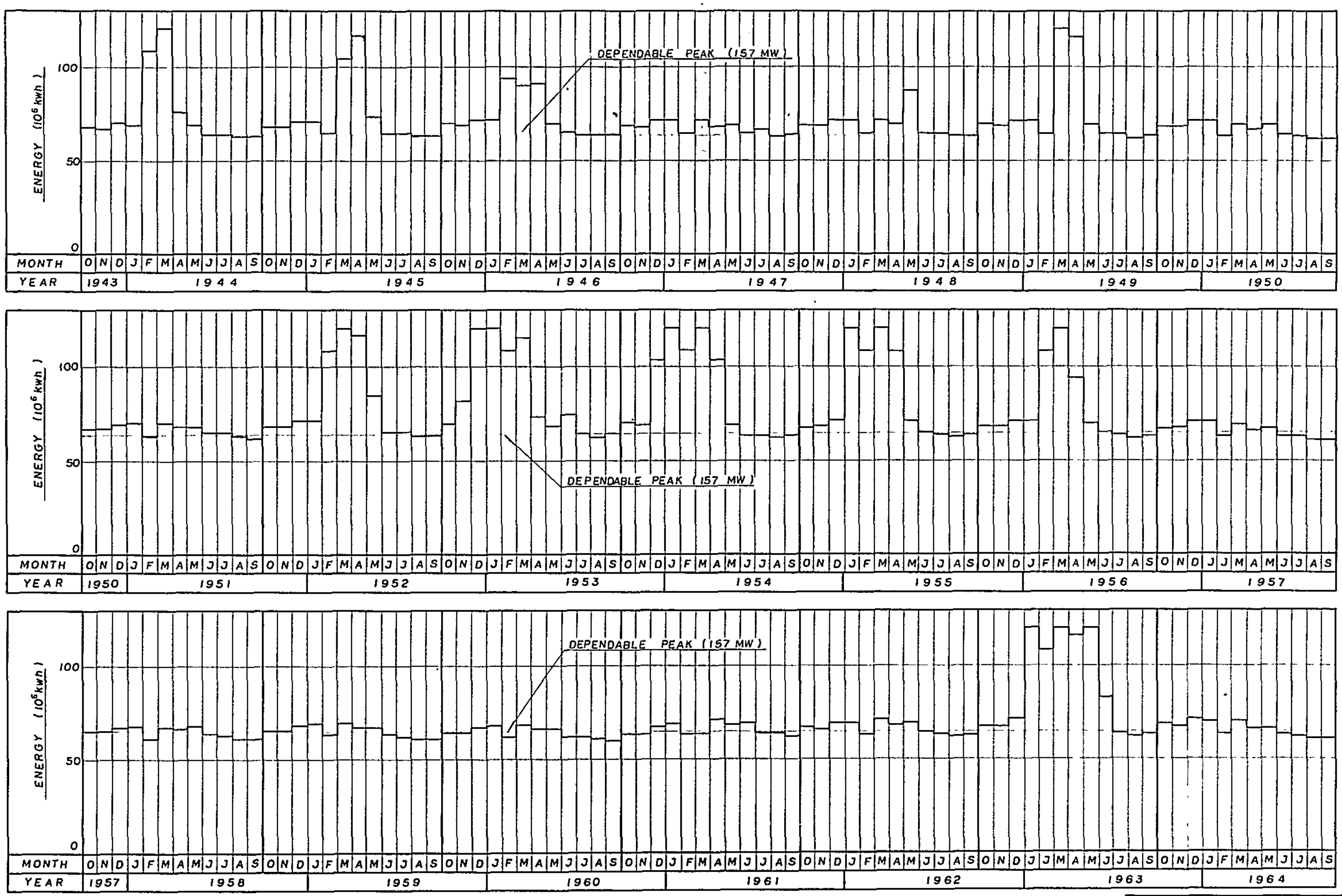


Fig. 6-1-3

MONTHLY ENERGY PRODUCTION OF SANDALCIK & BEZKESE POWER STATION AT 1st STAGE

6-1-3 PERTINENT DATA

a. Sandalcik Reservoir and Dam

Reservoir:

Catchment Area:	km^2	3,970.00
Normal High Water Surface Level :	m	705.00
Reservoir Surface Area :	km^2	21.20
Total Storage Volume :	$10^6 m^3$	965.00
Effective Storage Volume :	$10^6 m^3$	665.00
Available Drawdown :	$10^6 m^3$	43.00

Dam:

		(Main Dam)	(Saddle Dam)
Type:		Concrete arch	Rock-fill with center impervious core
Crest Elevation:	m	710.00	710.00
Width of Dam Crest:	m	6.00	8.00
Length along Dam Crest:	m	384.00	760.00
Height:	m	145.00	40.00
Freeboard:	m	3.00	3.00
Gradient of Upstream Slope:	m	-	1 : 2.5
Gradient of Downstream Slope:	m	-	1 : 2.0
Volume Content:	m^3	490,000	720,000

Spillway:

Design Flood Discharge:	m^3/s	2,600
Design Flood Water Surface Level:	m	707.00
Elevation of Overflow Crest:	m	674.50
Effective Overflow Width:	m	30.00

Gate:

Type: Radial

Dimensions	10.50 m x 10 m x 3 units	

b. Sandalcik Power Station

Intake:

Type:	Submerged intake with gate controlled from vertical shaft	

Submerged Tower:

Top Elevation:	m	664.50
Floor Elevation:	m	652.00
Maximum Capacity:	m^3/s	44.30
Screen:		3.40^m x 12.00^m x 8 units

Vertical Shaft:

Cross Section:		2.50^m x 4.50^m
Height:	m	31.00
Gate:		4.50^m x 4.50^m x 1 unit (caterpillar gate)

Pressure Tunnel:

Type:		Circular type
Cross Section:		inside diameter: 4.50^m
Length:	m	3,850

Surge Tank:

Type:		water chamber type
Cross Section:		circular, inside diameter: 4.50^m--6.00^m--13.00^m

Penstock:

Type:		inclined shaft, steel lined steel pipe
Cross Section:		inside diameter: 3.20^m --2.70^m--1.80^m
Distance:	m	630.00
Line:		1 (branched into 2 lines at lower portion)

Power Station:

Type:		underground
Generator Capacity:		85,000 KVA
Number of Unit:		2
Turbine Capacity:		78,000 KW
Number of Unit:		2
Dimension of Powerhouse		width: 16.00^m, length: 67.00^m height: 33.00^m (inside measurements including transformer room)

Tailrace Surge Tank:

Type:		water chamber
Dimensions:		8.00^m x 15.00^m

Tailrace:

Type:		standard horseshoe shape
Cross Section:		inside diameter: 4.60 ^{m}
Length:	m	6,430

c. Asmacik Regulating Pond and Dam

Regulating Pond:

Catchment Area:	km^2	4,770.00
Normal High Water Surface Level:	m	71.00
Surface Area:	km^2	1.20
Total Storage Volume:	10^6m^3	11.70
Effective Storage Volume:	10^6m^3	2.20
Available Drawdown:	m	2.00

Dam:

Type:		fill type
Crest Elevation:	m	74.00
Width of Dam Crest:	m	8.00
Length along Dam Crest:	m	251.00

Height:	m	30.00
Freeboard:	m	3.00
Gradient of Upstream Slope:		1 : 2.8
Gradient of Downstream Slope:		1 : 2.3
Volume Content:	m^3	420,000

Spillway:

Overflow Type:		
Design Flood Discharge:	m^3/s	5,700.00
Design Flood Water Level:	m	71.00
Elevation of Overflow Crest:	m	60.50
Total Length:	m	102.00
Effective Width of Overflow Gate:	m	12.00 x 7 = 84
Type:		Radial
Dimensions:		10.50^m x 12.00^m x 7 units

d. Bezkese Power Station:

Intake:

Type:		inclined
Crest Elevation:	m	73.00
Floor Elevation	m	57.50
Maximum Capacity:	m^3/s	36.50
Gate:		4.20^m x 4.20^m

Pressure Tunnel:

Type:		standard horseshoe shape
Cross Section:		inside diameter: 4.20^m
Length:	m	3,043

Surge Tank:

Type:		simple surge tank
Cross Section:		Circular, inside diameter: 21.00^m

Pensfock:

Type:		exposed steel pipe supported by ring girder.
Cross Section:		Inside Diamater: 3.40^m - 2.80^m
Length:	m	61.00
Line:		1

Power Station:

Type:		above ground
Generater Capacity:		12,000 KVA
Number of Unit:		1
Turbine Capacity:		11,000 KW
Number of Unit:		1
Dimension of Powerhouse:		width: 23.00^m, length: 20.00^m height: 28.50^m

Tailrace:

Type:		open canal type
Discharge Capacity:	m^3/s	36.50

e. Transmission Line and Substation

Transmission Line:

Section	Distance	Voltage	Conducter
Sandalcik-Bezkese	39 km	154 KV	240 sq. mm
Bezkese-Izmir	240 km	380 KV	410 sq. mm double conductor

Substation:

Location	Voltage	Capacity
Bezkese	154 KV/380 KV	200 MVA auto-transformer
Izumir	380 KV/154 KV	200 MVA auto-transformer

6-1-4 SURVEY

a. Topographic Survey:

The topographical maps used in planning of the First Stage Development Project are those prepared by the Turkish Government Bureau of Maps and

DSI and also those made by DSI in the latest survey (March, 1965 through June, 1965) by actual field survey, of which the principal ones are as follows:

Area			
Entire Turkey	Aerial Photographic Map	1/800, 000 250 m Contour	prepared by Bureau of Maps, Turkish Government
Entire Catchment Area of Dalaman River	Aerial Photographic Map	1/200, 000 50 m Contour	prepared by Bureau of Maps, Turkish Government
Area of Lower Dalaman River	Aerial Photographic Map	1/25, 000 10 m Contour	prepared by Bureau of Maps, Turkish Government
Area of Lower Dalaman River	Aerial Photographic Map	1/5, 000 2 m Contour	prepared by Bureau of Maps, Turkish Government
Vicinity of Sandalcik Dam Site	Surveying Map	1/1, 000 2 m Contour	prepared by DSI
Supplement of the above	Surveying Map	1/1, 000 2 m Contour	Prepared by DSI in the latest survey
Vicinity of Asmacik Dam Site	Surveying Map	1/1, 000 2 m Contour	by DSI

b. Geology

b-1 Geological Survey:

Geological survey of the Sandalcik Dam site was commenced by DSI as early as 1962, and the following two alternative sites, upstream and downstream sites, and the site for saddle dam were investigated by DSI in April, 1965.

Dam Site	Location
Upper Site	about 70 m downstream of Kapiz Bridge
Lower Site	about 670 m downstream of Kapiz Bridge
Saddle Dam	about 1. 5 km south of confluence of Dalaman River and Huseyin River

The survey works carried out by DSI are shown in Table 6-1-4.

Test borings at 3 locations, SK-1 to SK-3, for the upstream site were conducted in 1962. However, the period and detailed data of this investigation are not available. Later, in the period January, 1964 through September, 1964, test borings at 3 locations, SK-4 to SK-6, for the upstream site and at 5 locations, SK-101 to SK-105 at the site of the saddle dam were carried out, followed by a survey for the downstream site.

As of May, 1965, 2 borings, SK-201 and SK-202, and 1 adit were completed, and boring of SK-203 was started for the downstream site.

During the course of our field investigations it was recommended that the axis of upstream dam site be moved about 70 m downstream from the present location and that 7 borings, SK-B1 to SK-B7, be carried out. Results of 4 borings, SK-B1, SK-B2, SK-B3 and SK-B4 were received in November, 1965.

Dam Site	Location
Upper Site	about 140^{m} downstream of Kapiz Bridge
Lower Site	about 670^{m} downstream of Kapiz Bridge
Saddle Dam	about 1.5^{km} south of confluence of Dalaman River and Huseyin River

Table 6-1-4

Site	Boring No.	Coordinate		Elevation (m)	Length (m)	Period
		X	Y			
Main Dam upper site	SK-1	418,773	4,107,284	730.83	114	
Ditto	SK-2	418,770	4,107,055	594.63	100.2	
Ditto	SK-3	418,677	4,106,980	675.68	121	
Ditto	SK-4	418,495	4,106,940	704.53	120	Jan. 20, '64 - Mar. 22, '64
Ditto	SK-5	418,695	4,107,075	642.55	100	Jan. 23, '64 - Mar. 16, '64
Ditto	SK-6	418,643	4,107,007	673.68	100	Mar. 23, '64 - Apr. 22, '64
Ditto	SK-B1	418,580	4,107,170	680	115.2	Aug. 6, '64 - Aug. 28, '64
Ditto	SK-B2	418,580	4,107,010	665	115	Jul. 25, '65 - Aug. 28, '65
Ditto	SK-B3	418,520	4,107,170	670	115.2	Sep. 4, '65
Ditto	SK-B4	418,580	4,106,915	720	65	Sept. 9, '65
Lower Site	SK-201	418,125	4,106,910	712.53	134.43	Feb. '65 - Apr. '65
Ditto	SK-202	418,105	4,106,995	719.85	105	Feb. '65 - May '65

Lower Site	Adit NoI	418,125	4,107,035	691	200	
Saddle Dam site	SK-101	419,580	4,106,120	700*	80.2	July 13, '64 - Aug. 20, '64
Ditto	SK-102	419,630	4,105,740	700*	83	May 30, '64 - June 18, '64
Ditto	SK-103	419,720	4,105,650	668*	74	June 2, '64 - June 26, '64
Ditto	SK-104	419,780	4,105,420	705*	70	June 24, '64 - July 6, '64
Ditto	SK-105	420,000	4,105,240	730*	100.34	July 2, '64 - July 17, '64

Note : * means both coordinate and elevation are not from field levelling survey
Elevations are from readings of altitude meter.

The surveys for the site of the Asmacik Dam were conducted during the period between September 2, 1963 to November 23, 1963, and 3 borings as shown in Table 6-1-5 below were carried out in addition to preparation of a geological map to a scale of 1/1000.

Table 6-1-5

Site	Boring No.	Co-ordinate		Elevation (m)	Length (m)	Period
		X	Y			
River bed (Right bank)	SK-1	1,558	1,500	49.60	63.63	Oct. 5, '63 - Nov. 14, '63
River bed (Left bank)	SK-2	1,480	1,410	50.68	68.87	Oct. 8, '63 - Nov. 23, '63
Left bank	SK-3	1,500	1,110	58.11	36.80	Sep. 12, '63 - Sep. 9, '63

b-2 Sandalcik Dam and Power Station:

Upstream Site:

General

The geology at the upper dam site as described in 4-2-2 consists of limestone, calcareous schist and peridotite and the mountain-side is partially covered with a talus deposit. In addition, on the right side bank about 200^m downstream of this site a landslide about 150^m wide may be observed between elevation of about 615^m up to 690^m.

Foundation Rock

Limestone comprising the greater portion of the foundation rock is massive limestone, but bedded limestone lenses are distributed below elevations of about 590^{m} to 600^{m} on both banks. Bedding of bedded limestone runs almost parallel with the river and dips to the north. Further, according to the result of the SK-B2 boring, the bed rock near the boundary between massive limestone and bedded limestone has many cracks, but no fault is observed.

Both massive limestone and bedded limestone at this site are white or gray in color, and hard and compact, but have markedly developed irregular cracks. The cracked surfaces of limestone are generally discolored brown, while some cracks hold clay or are open. The width of such openings is usually less than 0.5^{cm}. However, where there are dissolved portions along the surface, the width ranges from 1^{cm} to 3^{cm}. Further, according to the results of SK-5 and SK-6, open cracks about 26^{cm} wide were observed at depths of about 57^{m} and about 11.20^{m}. These cracks are fairly large for open cracks at this site. The pressure test of SK-5 conducted at depths between 56^{m} and 58^{m} recorded 736 liter/2^{m} of leakage for the initial 10 minutes and 436 liter/2^{m}/$10^{min.}$ for the succeeding 30 minutes, under 8 kg/cm^{2}.

Calcareous schist exists interspersed between limestone at elevations of about 640^{m} up to 670^{m} on the right bank and at elevations of about 680^{m} up to 700^{m} on the left bank. As most of the outcrops are extremely weathered and are flaky and muddy, the details of strike and dip and character of rock are unknown. However, it can be assumed from the boring results that this schist dips with a gradient of 15° to 20° either to north or south.

At depths between 5^{m} and 15^{m} from the ground surface there is calcareous schist mostly flaky, and it can be assumed that cracks are closely developed to a considerable depth.

Peridotite covers limestone from elevations of about 690^{m} up to 700^{m} or above on the right bank. The boundary between peridotite and limestone lies on a moderate slope of 15° to 20°, and some peridotite at the contact appears like cemented breccia. This rock is brown on the ground surface and dark green deep underground. Irregular cracks are developed in the peridotite, 5^{cm} to 10^{cm} apart, and on the whole marked serpentinization may be observed.

Faults:

Faults existing between the upstream and downstream dam sites have been confirmed and are identified as Fl through F9 as shown in Drawing No. 5. A general description of those existing near the upstream dam site are given below.

F7 Fault:

This fault exists on the left bank at about 170^{m} to 200^{m} downstream of the dam site. This fault is exposed only on a cliffs, which is inaccessible. The foothill is covered with talus deposits and it was impossible to investigate the fault. However, from remote observations the fault dips towards the downstream with a sheared zone 1^{m} to 1.5^{m} in width, and it can be assumed that this probably connects with F9 Fault on the right bank.

F8 Fault:

This exists on the opposite side of F7, and an outcrop is observable at around elevations of 640^{m} to 690^{m}, but below this, this fault cannot be seen due to a landslide. Above around El. 690^{m} this fault connects with F9 Fault. The strike and dip of this fault are N45°E, 70° NW and the sheared zone is about 5^{m} wide.

F9 Fault:

This also exists on the opposite side of F7 and connects with F8 Fault to make a V-shape near El. 690^{m}. Outcrops cannot be seen below El. 620^{m} as the fault is covered with talus deposit. However, this presumably connects with F7 Fault. The strike and dip of this fault is N20°E 80° NW and the width of the sheared zone is about 2^{m}. The bed rock with a width of about 10^{m} to 30^{m}, lying between this fault and F8 Fault, is considerably sheared. Outcrops are not clearly distinguishable at above El. 690 ^{m} where these two faults join together.

Since all of these faults F7, F8 and F9 exist 50^{m} to 200^{m} away from the dam site, none has any direct effect upon the dam.

Downstream Site:

General:

The geology at the dam site consists of limestone and calcareous schist. A talus deposit is distributed both on the upstream and downstream site of the saddle on the left bank, and its thickness is 1 ^{m} to 3 ^{m}. There is no gravel deposit on the river bed, and bed rock is exposed.

Foundation Rock:

A substantial portion of the foundation rock is massive limestone. According to the survey results obtained at the adit excavated at about El. 691^{m} on the left side bank, limestone at this site is gray, dark gray or reddish brown in color, and extremely hard and dense. Calcite veins are well developed in general. Judging from the conditions of the outcrops, although surveys have not yet been conducted, the right side bank can be assumed to be of the same limestone as the left bank.

Cracks in the limestone here are relatively fewer than at the upstream dam site in general, and those observable in the adit are mostly tight, but some are open. Most of the open cracks have been dissolved at the cracked surfaces, and the crack openings are normally less than 2^{cm} but lens-shaped solution holes with maximum width of 8^{cm} are observable on the left wall about 20^{m} from the entrance of the adit. According to the results of the SK-201 boring drilled through the sheared zone, numerous cracks are found due to the effects of fault movement down to a depth of 90^{m}, but from the results of the SK-202 boring which is distant from fault, limestone is generally dense except for some partial cracks. No wide open cracks as observed at borings SK-5 and SK-6 can be observed at this site.

Calcareous schist is observable in the area of 95^{m} to 120^{m} from the adit entrance. This schist is not exposed as it is covered with talus deposit, but it can be assumed it is distributed at the saddle. Schist in the adit is gray, fresh and dense, but hard and soft portion appear alternately because of shear effects in general.

Faults:

The principal faults confirmed at this dam site are Fl through F6 Fault, all existing on the left bank, and a general description of these faults are given below.

Fl Fault:

This fault was found at the area up to 18^m from the adit entrance. The strike and dip is N-S, 40°E, and the fault breccia is about 15^{cm} wide, but it is well compacted.

F2 Fault:

This fault exists at a distance of about 86^m from the adit entrance and its strike and dip is EW 50°S, but it is not accompanied by any breccia or sheared zones.

F3, F4 and F5 Fault:

F3, F4 and F5 Faults exist at distances of 94^m, 114^m and 160^m from the adit entrance respectively and the strikes and dips of these are N 40°E 50°-70°SE, N60°E 80°SE and N 40°E 60°SE respectively. The sheared zone is 66^m wide from the F3 to F5 Faults, and 17^m from F3 to F4 Faults there are alternations of hard schist and fault clay. The distance of 48^m from F4 to F5 Faults is almost completely sheared zone, and scattered blocks of limestone are in soft wet clay.

These faults are the largest in scale among those found at both the upstream and downstream dam sites, but they may have faded away, as no outcrops can be found at upstream cliffsides although judging from their strikes and dips it would appear they would be exposed. However, as it is an obvious fact that these faults exist in the reservoir area, and there is danger of leakage through the sheared zones.

F6 Fault:

This fault is located at a distance of 188^m from the adit entrance, but the width of the sheared zone is not measurable as the adit is blocked by fault clay which have collapsed from the ceiling of the adit. The strike and dip is N60°E 80°SE. Though this fault does not directly have any effect upon the foundation of the dam, danger of leakage from the reservoir is highly probable.

Apart from the above faults existing around the upstream and downstream dam sites, it is conceivable that there is a fault connecting with limestone at the entrance of the valley. The magnitude and the strike and dip of this fault are as yet unknown, but this is assumed to be a sizable fault, in view of the fact that calcarious schist and serpentinite adjoining limestone are found crushed and limestone blocks are scattered in the sheared zone.

Permeability of Foundation Rock and Ground Water Surface:

Permeability of the foundation rock of the upstream and downstream dam sites was examined from data of pressure tests conducted at a total of 9 borings, SK-4 through SK-6, SK-201 to SK-202 and SK-B1 through SK-B4.

In the presure tests, pressure of 2, 4, 6, 8 and 10 kg/cm^2 were applied every 10 minutes at every 2^m of depth and the leakage at each section was measured. Permeability was examined by the Lugeon's values (l/min. /m/ 10 kg/cm^2) of every 2^m of depth. Examinations of permeability for the section near the ground surface where packer was not perfect and for the sections where leakage was extremely large were not made.

In calculation of the Lugeon's values the following points were taken into consideration.

i) As the pressure applied to each section of test was measured at the top of bore holes, a value equivalent to the head between the hole top and the measured section was added to the measured pressure.

ii) For the sections where test results were obtainable of test pressure less than $10 kg/cm^2$ Lugeon's value was assumed as follows:

For the section where three kinds of measured results were obtainable leakage at 10 kg/cm^2 was assumed from a graph which was drawn based on the results to express pressure-leakage relationship. For other sections for which test results were available only for one or two kinds of pressure Lugeon's value was assumed to have a magnitude ten times the probable leakage at unit pressure (kg/cm^2) which was calculated from the measured leakage under the largest pressure applied.

Result of Examination:

1) The breakdown of Lugeon's values obtained from 397 sections in total measured at the upstream and downstream dam sites is as follows:

Lugeon's Value	Permeability	Ratio (%)
Over 50	very high leakage	16
20-50	high leakage	36
5-20	moderate leakage	19
0-5	low leakage	29

These values separated into the upstream and downstream dam sites are as follows:

2) Breakdown of Lugeon's Values of 302 Test Sections at Upstream Dam Site:

Lugeon's Value	Ratio (%)
over 50	19
20 - 50	39
5 - 20	20
0 - 5	22

3) Breakdown of Lugeon's Values of 95 Test Sections at Downstream Dam Site:

Lugeon's Value	Ratio (%)
over 50	11
20 - 50	25
5 - 20	14
0 - 5	50

4) The Lugeon's values for every 10^m of depth obtained from the above data are as plotted in Fig. 6-1-4.

As a conclusion of the foregoing analysis the foundation rock at the upstream and downstream dam sites are in general of high permeability, the condition being as per Fig. 6-1-4, and there seems to be no remarkable correlation between depths and Lugeon's values.

Generally speaking, the foundation rock of the upstream site has greater permeability than that of the downstream site.

Ground Water Surface:

SK-5 and SK-6 are inclined borings, and of the other 7 vertical borings only the ground water surface of SK-4 has been determined. The ground water surface of SK-4 is recorded at the depth of 119.20^m (at El. 585.80^m). This location is very close to the elevation of the river-surface, and therefore, a survey to explore the relation between the ground water surface confirmed in SK-4 and the water surface of the river is necessary. It will also be necessary to re-check ground water surfaces of other boring holes wherever possible.

Conclusion:

Judging from the abovementioned data and information, the geology of the Sandalcik Dam can be summarized as follows:

1) The foundation rock of the upstream dam site consists of massive limestone, bedded limestone, calcareous schist and peridotite, and the downstream site of massive limestone. The downstream site is superior from the standpoint of uniformity of foundation rock.

2) None of the faults has anything directly to do with the foundation of dams,

but there are 3 fairly large faults, between F3 and F6 at the saddle of the left bank on the downstream site. However, the extent of these faults in both upstream and downstream directions have not been extensively surveyed and confirmed. The treatment of these faults should be considered after further detailed investigations of the extent and scale have been completed, but judging only from the results of the present adit and the SK-201 boring, construction of concrete water-stops and thorough grouting thereafter would appear to be adequate as the treatment.

3) Irregular cracks are developed in the foundation rock at both upstream and downstream sites, but with adequate grouting the foundation rock is judged to have enough bearing capacity for an arch dam.

4) Permeability of the foundation rock at both sites is relatively high, but construction of a curtain wall is judged to be possible through sufficient grouting.

5) Judging from the topography, the downstream dam site is superior as a site for an arch dam in comparison with the upstream site. However, due to the fact that investigation of the fault at the saddle on the left bank is inadequate and the foundation on the right bank is not yet completed it appears to be premature to make any decision on selection of the dam sites from the geological point of view. Future investigations should be made for both upstream and downstream dam sites, and the final decision should be made only after these investigations have been completed.

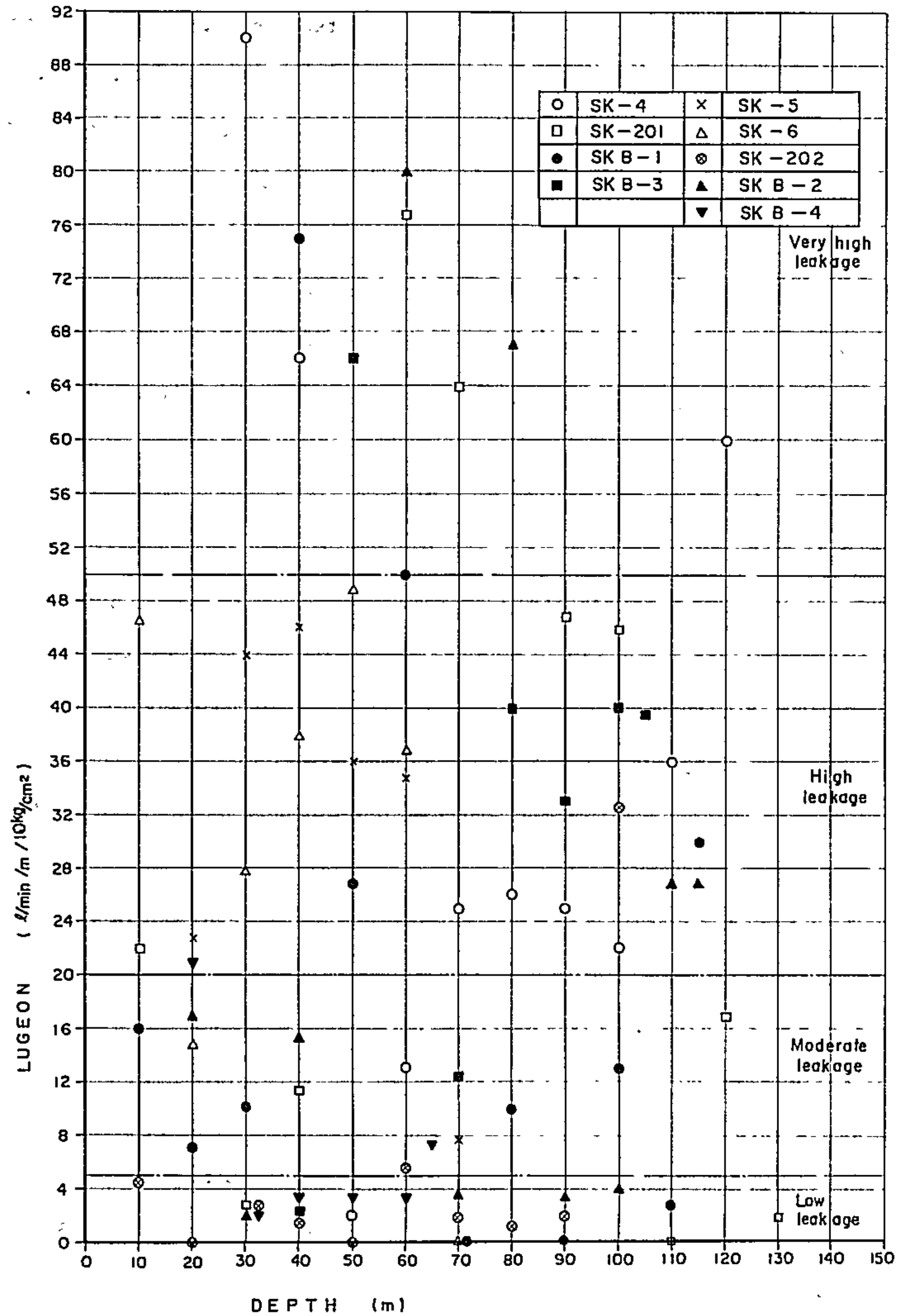
<u>Geology of the Sandalcik Waterway and Intake Structures Sites</u>

Intake:

The intake will be located on the left bank at about 300^m upstream from the upper dam site. The foundation rock consists of peridotite, but there is an outcrop of limestone at an elevation of about 660^m. Peridotite 5^m to 10^m from the ground surface is weathered and has numerous cracks, but in deeper sections fresh and dense rock is expected. Limestone is in the form of

Fig 6-1-4

DEPTH — LUGEON VALUE



xenoliths and the exact sizes are as yet unknown. Future survey of sizes and boundary conditions between peridotite is essential.

Headrace Tunnel:

The headrace tunnel will pass underneath the mountain range stretching from the left bank of the dam site in direction S30°W. The total length will be approximately 3,900^{m}. The tunnel will be a pressure type, with cross section of 4.5^{m}, excavated between El. 640^{m} and 635^{m} and the maximum thickness of overburden above the tunnel section is 250^{m}.

The geology of the tunnel section is comprised of peridotite and limestone. Peridotite lies at sections about 3.3^{km} from the intake and about 400^{m} from the surge tank. In between these two sections of peridotite there is a huge xenolith of limestone.

Serpentinization of peridotite is presumably at a well advanced stage. Although our investigation was very brief, change of rock character of peridotite and serpentinite in the area appears to be marked, and in addition, since excavation of a long tunnel through a serpentinite zone usually is accompanied by a great deal of technical difficulties, an extensive additional survey is therefore indispensable. Further, it is advisable that concreting should be done as soon as possible after excavation even through the peridotite in this area.

Limestone is gray or dark gray in color and very hard. As the limestone is massive, its distribution has not been confirmed. Therefore, the scale and the condition of the boundary with peridotite should be subject to future investigation.

Surge Tank:

The surge tank site lies almost on the boundary between peridotite and limestone. The boundary conditions between the two rocks are not known in detail, but the bedrock underneath the tank is assumed to be peridotite.

Penstock and Power Plant:

The length of the penstock is about 632^m extending from an elevation of about 635^m to 269^m, and the power plant located at an elevation of about 268^m is to be an underground type with dimensions of about 35^m in height, about 42^m in length and about 16^m in width.

According to our survey, the bedrock around these structures is assumed to be limestone. However, in view of the fact that limestone in this district frequently formed huge xenoliths, investigation by boring is necessary to confirm whether limestone extends to the site of the power plant located about 130^m below the present river bed.

Exposed limestone is gray or dark gray and very hard, but development of joints is marked. The strike and dip of main joints are N-S 80°-90°W, N60°E 60°-80°SE. The joints are open about 10^{cm} at elevations of about 550^m.

Geological surveys at the sites of the headrace tunnel, penstock and power plant have not been thoroughly carried out. Therefore, further detailed geological survey including seismic prospecting, borings and adits is necessary for determination of the distribution of faults in the section where the tunnel will be excavated, relationship between peridotite and limestone, and the magnitude and rock character of limestone formations at the sites of penstock and power plant.

Tailrace:

The tailrace with cross section of 4.6^m is $6,430^m$ long and its outlet elevation is 266^m. The geology of the tailrace section near the power plant consists of limestone, but across the Dalaman River peridotite stretches down to the point where the tailrace bay is located. Serpentinization and weathering of peridotite here are marked and landslides and landcreeps are observed here and there along the Dalaman River.

At the point where the tailrace crosses the Dalaman River there exists a fault which forms a boundary between limestone and serpentinite. The strike and dip and width of the sheared zone of this fault have not yet been confirmed, but it is assumed to be a fairly sizable fault judging from the extension of fault assumable from the topography. Further investigation of this fault is essential.

b-3 Saddle Dam Site:

General:

The geology of the dam site consists of marl, conglomerate, mudstone and chalk as stated in 4-2-2 and are divided into upper, middle and lower formations. A surface deposit is distributed thinly on a part of the right bank only, and on most of the ground surface there is exposed flaky weathered marl.

Foundation Rock:

The foundation rock of the dam is mostly marl of the upper formation, and conglomerate belonging to the middle formation is assumed to be exposed around the SK-102 boring depending upon the depth of foundation excavations.

Marl of the upper formation is weathered and weak to as far as 5 m to 10 m from the ground surface, but it is hard and compact in deeper sections. However, as will be described, the permeability is the largest among the rocks at this site. Irregular cracks are developed in marl, but they are all thin cracks and are not open.

Conglomerate of the middle formation is not cemented, but it is well compacted.

Fault:

No fault has been confirmed except for some slickenside found in the SK-103 boring. Topographically, however, there are some places which may be assumed to be fault gullies.

Permeability and Ground Water:

Pressure tests at the site of the saddle dam were conducted for 5 borings, SK-101. through SK-105. The same testing procedures as for the main dam were followed. Further, rocks at this site are not cemented except for marl, and in view of the thick distribution of conglomerate, chalk and mudstone relatively similar to gravel or mud, the permeability of bed rock was expressed in coefficient of permeability in addition to which Lugeon's values have been provided. The results of examination are as follows:

1) Permeability of Each Formation:

Formation	Lugeon's Value (1/min. /m/10kg/cm^2)	Coefficient of Permeability(cm/s)
Marl (Upper Formation)	58 --- 0	1.1×10^{-3} - 9.6×10^{-5}
Conglomerate (Middle Formation)	22 --- 0.9	3×10^{-4} - 1×10^{-5}
Chalk (Middle Formation)	64 --- 0	7.4×10^{-4} - 6×10^{-5}
Mudstone (Middle Formation)	35 --- 1.4	4.3×10^{-4} - 1×10^{-5}
Conglomerate (Lower Formation)	36 --- 0.7	6.2×10^{-4} - 3.5×10^{-6}

Judging from the above results, permeability of the bed rock of this site can be termed as being low permeability or very low permeability, although there are found some partially high Lugeon's values.

2) According to the examination of results obtained from 72 points taken in the sections of test where $10^{kg/cm^2}$ of pressure at the top of borehole was applied in the pressure test, there is a limit pressure beyond which leakage sharply increases. The relation between this limit pressure(Pl) and the depth is as follows:

Depth (m)	Pressure Pl (kg/cm^2)
0 - 35	4 - 10
35 - 65	8 - 14
65 and up	11 - 15

In reviewing the relation between this pressure and geology, leakage sharply increases at pressures of 4 to 10 kg/cm^2 in marl, and 8 to 14 kg/cm^2 in conglomerate and mudstone, This implies that small cracks are probably opened by these pressures.

3) Apart from permeability, physical and chemical properties and dis-

tribution of chalk which lies in between the middle formation should be examined accurately as it is seems to easily dissolve in water.

The ground water is as follows:

Boring No.	Depth of Ground Water in Borehole (m)	Elevation of Ground Water (m)
SK-101	52.0	648.0
SK-102	39.6	660.4
SK-103	31.0	639.0
SK-104	47.85	657.15
SK-105	35.0	695.0

The ground water surface made by plotting the water level in boreholes is almost consistent with the topography of the ground surface.

Conclusion:

Judging from the solid state of the geology at the site of saddle dam and physical and chemical properties of rocks, it is deemed unsuitable as a foundation for a concrete dam, but it is considered to be adequate as a site for a rock-fill dam. However, as there is fear of leakage, further elaborate investigation will be necessary. Especially, concern is entertained as to the effect of grouting the uncemented conglomerate, mudstone and chalk, and grouting tests for confirmation of the effect are necessary. Further, it is of significance to check the discharge of the swamp running downstream of the dam site for a long period of time in order to estimate the leakage after storage of water.

b-4 Asmacik Dam and Bezkese Power Station:

Dam Site:

The foundation of the dam consists entirely of dunite. While there is little talus deposit, river deposits are as thick as 52.69^{m} to 59^{m} according to the boring results. Almost all of the deposit consists of silt, sand and gravel, but consolidated conglomerate was observed in a part of SK-1. The size of gravel is usually smaller than 5 to 10^{cm}, but the largest particles are about 20^{cm}.

Permeability of deposit was tested using the boreholes and the results are as follows:

Boring No.	Depth (m)	Coefficient of Permeability(cm/s) (min)	(max)
SK-1	1.50 - 9.00	1.86×10^{-1}	1.89×10^{-1}
	9.00 - 15.00	1.92×10^{-3}	1.13×10^{-3}
	15.00 - 21.00	2.23×10^{-3}	7.41×10^{-4}
	*21.00 - 31.50	14	3
	31.50 - 45.00	2.38×10^{-1}	1.83×10^{-1}
	45.00 - 63.63	4	1
SK-2	1.50 - 7.50	2.09×10^{-3}	7.24×10^{-4}
	7.50 - 18.00	9.21×10^{-2}	8.83×10^{-2}
	18.00 - 45.00	9.45×10^{-2}	9.16×10^{-2}
	45.00 - 58.50	9.24×10^{-2}	7.47×10^{-4}

Note : * indicate Lugeon's Value

Foundation Rock:

The dunite 3^{m} from the ground surface, is weathered and is brown or tinged with green, but in deeper sections it is blackish green and hard. Little serpentinization was observed in a microscopic analysis.

There are many cracks and joints, and cracks are developed irregularly. The joints are mostly in the direction of NS 80° E or W, N40°E 15°-20°SE, and N50°W 30°SW. There are two faults in the saddle of the left bank. F1 fault crossing the narrowest part of the saddle is accompanied by a sheared zone of about 3^{m} and its strike and dip are in the direction of N80°E 60°NE. F2 Fault almost parallel with the saddle has a sheared zone of about 20cm and its strike and dip are N20°W 50°NE. These two faults were confirmed in the SK-3 boring, and their permeabilities are about 13 by Lugeon's value.

Pressure tests were carried out at three borings to examine the permeability of bed rock. The results of which were 1 to 8 in the Lugeon's value for rocks of river bed and 2.5 to 6.5 in the section near the fault on the left bank so that permeability is not remarked.

Bezkese Power Station and Headrace Tunnel:

The geology of the section between the intake and the power station consists entirely of dunite as described in 4-2-2. Dunite outcrops near the power station showed considerable serpentinization under microscopic examination. It is considered this condition exists throughout the tunnel section and the entire power station area.

As detailed surveys have not been conducted, the location of faults and their size, etc. are unknown, but they are assumed to be large in number, judging from the topography of the vicinity.

c. Material Survey

The survey for construction materials of the Sandalcik and Asmacik Dams has been conducted in the past by DSI and tests were made of materials from test pits 21 and 12 in the Sandalcik and Asmacik districts.

In our survey 46 pits in the Sandalcik district and 29 in the Asmacik district were additionally tested.

The results of survey are summarized as follows:

1) Distribution of Materials:

Sandalcik District:

Area A:

Location: about 3.5^{km} to northwest along the main road from the saddle dam site. Road conditions to this area from the dam site are good.

Materials taken: non-permeable materials

Number of Test Pets: 13

Estimated available quantity: 700, 000m^3

Area B:

Location: river bed at both banks about 2.5^{km} upstream along the Huseyin River from the junction of the Dalaman and Huseyin Rivers. About 1.5^{km} from the dam site along the main road, but there is no bridge over the Huseyin River.

Materials taken: semi-permeable and permeable materials

Number of Test Pits: 41

Estimated available quantity: semi-permeable materials 500,000 m^3

permeable materials 1.500,000 m^3

Area C:

Location: river terrace along the right bank of the Huseyin River, about 3 to 3.5^{km} north of the dam site. The road from the dam site to the Huseyin River is good, but a means of crossing the river is necessary.

Materials taken: semi-permeable and permeable materials

Number of Test Pits: 8

Estimated available quantity: semi-permeable materials 500,000 m^3

permeable materials 3,000,000 m^3

Area D:

Location: river terrace along the right bank of the Huseyin River, near the junction with the Dalaman River and about 1.0^{km} downstream of Area C.

Materials taken: non-permeable materials

Number of Test Pits: 5

Estimated available quantity: 100,000 m^3

Excavated material of the main dam are to be used as rock materials but in case of shortage of quantity the filter zone where natural river deposit sand and gravel are to be used will be enlarged to make up the shortage of rocks. Aggregates for concrete are sufficiently available from natural deposits of the Huseyin River.

Area	Non-permeable	Semi-permeable	Permeable	Aggregates
Area A	700,000			Natural deposit
Area B		500,000 m^3	1,500,000 m^3	of Huseyin River
Area C		500,000	3,000,000	
Area D	100,000			
Total	800,000	1,000,000	4,500,000	7,000,000

According to the proposed plan the required amount of each type of material for the saddle dam is as follows and is available in sufficient quantity in the area.

Core Material: 110,000 m^3

Filter Material: 62,000 m^3

Rock Material: 540,000 m^3

Asmacik District:

Area A:

Location: terrace stretched on the right bank about 600 m downstream of the dam site and the area along the Dalaman River

Materials taken: The previous DSI survey reported non-permeable material to be available, but in the recent survey it is reported that the material is gravel aggregate instead of non-permeable material.

Number of Test Pits: 25

Estimated available quantity:

previous survey --- non-permeable material 7,000,000m^3

recent survey --- gravel aggregate 5,000,000m^3

Area B:

Location: inner area of the terrace of right bank of Area A

Materials taken: semi-permeable material and aggregate

Number of Test Pist: 16

Estimated available quantity:	semi-permeable material--previous survey:	500,000 m^3
	recent survey:	1,000,000 m^3
aggregate	previous survey:	6,000,000 m^3
	recent survey:	5,000,000 m^3

It will be noted that the results of the previous and recent surveys in both areas differ and above all the recent survey reports no distribution of non-permeable material in the two areas, whereas in the previous survey the test results of Pit Nos. 203, 204 and 207 were reported as non-permeable. Further detailed examination will be necessary for non-permeable material.

Area	Non-permeable	Semi-permeable	Gravel Aggregate
Area A	*7,000,000 m^3		5,000,000 m^3
Area B		1,000,000 m^3	500,000 m^3
Total	7,000,000 m^3	1,000,000 m^3	5,500,000 m^3

Note: * previous survey, other values from the recent survey

The required amount of each material for the Asmacik Dam is as follows:

Core Material:	78,000 m^3
Filter Material:	26,000 m^3
Gravel:	314,000 m^3

2) Property of Materials:

Sandalcik District:

Soil tests of the Sandalcik district were conducted of 3 pits in Area A and 1 pit in Area B with respect to i) specific gravity, ii) compaction, iii) Atterberg's limit, iv) permeability test and v) triaxial compression test. The results of these tests are shown in Drawing-13 and the materials can be generally judged to be usable as core material, as the specific gravity is 2.7 t/m^3, M. D. D. (maximum dry density) 1.4 to 1.7 t/m^3, O. M. C. (optinum moisture content) 17 to 30%, coefficient of permeability 2.4 x 10^{-6} to 6.55 x 10^{-8} cm/s and the results of triaxial compression test ϕ = 29 to 35°, C = 0.8 to 1.3 kg/cm^2. Excavated rock of the main dam are to be used as rock materials. Specific gravity and water absorption of limestone here were 2.7 to 3 g/cm^3 and 0.2% respectively.

Aggregate for concrete is to be taken from natural deposits of the Dalaman and Huseyin Rivers and the test results are as shown in Drawing - 13

Asmacik District

Soil test of the Asmacik district were conducted of 4 pits in area A and 11 Pits in Area B with respect to i) Specific gravity, ii) Çompaction, iii) Atterberg's limit, iv) Permealility test and v) Triaxial compression test. The results of these tests are shown in Drawing-17 and materials can be generally judged, as the specific gravity to 2.7 t/m^3, maximum dry density 1.6 - 1.7 t/m^3, optimum moisture content 18-20 %, Coefficient of permeability 2.4 x 10^{-6} - 1.6 x 10^{-8} cm/s and results of triaxial compression test ϕ = 23 - 25°, C = 0.7 to 1.0 kg/cm^2.

The type of main dam is a gravel fill type, using material of gravel of river deposit instead of rock material.

The result of these tests are as shown in Drawing - 17.

6-2. PRELIMINARY DESIGN

6-2-1. SANDALCIK DAM AND POWER STATION

a. Dams

a-1 Selection of Main Dam Site:

Two locations, the upper about 140 m and the lower 670 m below the Kapiz Bridge were selected as alternative sites for the Main Sandalcik Dam. Topographical, geological and material surveys of these sites have been conducted by DSI since 1962 as described in 6-1-3.

Topographically, the width of the valley at the upstream site is about 350 m at the dam crest against a dam eight of about 145 m and the ratio is about 1: 2.4.

The valley of the downstream site is very narrow being about 110 m at the dam crest against a dam height of 150 m and the ratio is about 1 : 0.75.

On the other hand, geologically speaking, the upstream site consists mainly of massive limestone belonging to the Mesozoic Cretaceous period, and development of irregular cracks can be seen, but it is hard bed rock.
No significant fault is found around the dam site.

The geology of the downstream site is massive limestone of good quality having less cracks compared to the upstream site. However, there is a saddle section at about 80 m from the abutment of the dam on the left bank where a large fault exists. The direction and size of which is unknown since no boring has been performed there.

In the comparison between the upstream and downstream sites the latter is obviously better topographically than the former as described above, but has the disadvantage of the geological conditions being unconfirmed. As a conclusion of our survey, the upstream site having no major defect geologically, was tentatively selected as the site of the main dam in planning of the Project, but the final decision in selection of the dam site should be made after further detailed investigation is carried out of the downstream site.

In consideration of foregoing, this report will be devoted to a development plan of the upstream site. However, the result of studies of the downstream site will be mentioned as a guide for future survey.

a-2 Main Dam:

Type: The dam site is about 40 m wide at the river bed, and about 350 m wide at the dam crest at an elevation of 710 m. Both banks form steep narrow cliffs from the river bed up to about El. 640 m above which they flatten out into comparatively gentle slopes. The bed rock, as already described, consists of massive limestone which although having irregular cracks is relatively good rock in general permitting any type of dam to be built upon it.

According to the results of material tests, in case a concrete dam is built, sufficient quantity of aggregates for the dam can be easily obtained from river deposits 1 to 4 km upstream of the Kapiz Bridge.

In the event a rock-fill dam is adopted, filter materials and earth materials can be easily obtained from the right bank 1 to 2 km upstream of Kapiz Bridge, but rock material which is limestone must be quarried from a site on the left bank about 5 km upstream of the proposed dam site.

In consideration of the abovementioned topography, and results of geological and material surveys and flood discharge, either a concrete arch dam or a rock-fill dam can be built at this site. As a result of comparative studies between these two types, the former was evidently more economical and so a concrete arch dam was adopted for this site.

Shape of Dam:

The shape of the dam will be of double curvature so as to distribute stresses over the whole structure in view of the topographical conditions of the valley. The horizontal arch will be of three center, variable thickness and the ratio between thickness of crown and abutments will be about 1 : 1.3.

By increasing the thickness of abutments it would serve to reduce stresses transmitted to the foundation rock and increase the stability of the abutments.

The radius of the upstream face at the dam crest will be about 200 m and the thickness 6 m. The freeboard from high water level of the reservoir is 3 m in consideration of wave height due to wind and earthquake. The cross-section of the crown slightly overhangs in the downstream direction and the base is to be 22 m in thickness. A gallery is to be constructed at the foundation of the dam and high pressure grouting will be executed from it to construct a water blanket. This can be used as an inspection gallery after completion of the works.

Spillway:

As already mentioned, the design flood discharge of the spillway is 2, 600 m^3/s. The overflow will be free-falling from the dam crest and three sets of radial gates, 10. 50 x 10. 00 m, will be installed. Since the width of the river bed at this site is narrow, free fall of water over a great width from the dam crest could damage the foundation rock of the dam, and therefore, the effective overflow width will be 30 m as already described and a relatively deep nappe will be made to fall freely. Also, a sub-dam 20 m high will be constructed at a location 105 m downstream of the main dam to raise the downstream water level in order to provide an adequate stilling basin. The bed rock at the bottom of the basin will be protected with a concrete mat of about 2 m thick. Prior to final design the depth of the basin should be studied by hydraulic model experiments.

Outlet:

An outlet with inside diameter of 2. 75 m will be constructed in the body of the dam to order to lower the water level of the reservoir during periods of repair or inspection of intake.

Diversion Tunnel and Coffer Dam:

The design discharge of the temporary diversion waterway during construction works is 440 m^3/s. This structure will be a tunnel in the left bank in consideration of topography and geology at the location. In order to increase the discharge, the tunnel will be concrete-lined throughout with an inside diameter of 6 m, total length of 440 m, and a gradient of 1:50. The upstream primary coffer dam will be an earth-fill structure and the secondary coffer dam a concrete arch structure 15 m high with the crest elevation at 585 m. The downstream coffer dam will be the permanent sub-dam.

a-3 Saddle Dam:

The saddle dam is to be built on the saddle located on the left bank about 1.5 km from the main dam. The topography of the site is a valley 760 m wide at the dam crest and the height of dam will be 40 m, so that the saddle is very long. Geologically, the foundation of the dam consists of marl, chalk, conglomerate and mudstone.

As the type of dam for this site a center impervious core type rock-fill structure was considered in view of minimizing the load to be sustained by the foundation and to prevent irregular settlement. Earth and filter materials are readily available at a site 3 km upstream from Kapiz Bridge, and rock materials will be excavated rocks from both abutments of the main dam site.

The upstream slope are to be 1: 2.5, 1: 0.5 and 1: 0.4 for rock, filter and core respectively, and the downstream slope 1: 2.0 1: 0.5 and 1: 0.4 for rock, filter and core respectively.

The width of the dam crest will be 8 m and a freeboard of 3 m above normal water level will be provided in consideration of waves due to wind and earthquake.

The weathered surface material of the core foundation zone will be excavated to less weathered strata and curtain grouting will be carefully performed prior to embankment of earth.

a-4 Alternative Main Dam Site:

As an alternative site for the main dam a location about 530 m downstream from the proposed main dam site is considered.

The topographical and geological conditions of this site are as already described. The layout of the dam which can be assumed from the present stage of investigations is explained hereinafter. Topographically, as already described, the valley is V-shaped and very narrow, and geologically, the bedrock of the dam foundation, except for the fault in the saddle of the left bank, consists of good solid limestone with little cracks.

A slender concrete arch dam can be considered for this site, assuming that the mass rock with little cracks in between the left bank fault and abutments can safely support the arch thrust. However, in case an arch type is found unsuitable after further investigation, a concrete gravity type dam should be considered.

As to the treatment of the fault in the left bank saddle the portion with especially poor geology above the fault is to be excavated from the ground surface and replaced with concrete and a concrete gravity type dam built upon it. Between the excavated surface and the fault, a gallery will be provided through which grouting is to be executed to stabilize the foundation and to prevent seepage of water.

The spillway is to be of a chute type with an inlet built in the concrete gravity dam built for treatment of faults in the left bank saddle. Water released through the chute will have a hydraulic head of about 40 m from the reservoir normal high water level. A flip bucket will be constructed at the bottom of the chute to dissipate energy before releasing the water into the natural bed of the Dalaman River. In case of the downstream site is selected as the site for the main dam, the saddle dam will be a gravel-fill structure.

Based on assumptions from our survey, a layout is shown in Drawing-25 as a reference for future surveys in case a concrete arch dam is decided to be built.

b. Waterways

b-1 Intake:

The intake is to be constructed about 300 m upstream from the main dam on the left bank.

The intake will be a submerged structure in view of the relatively great available depth of 43 m of the reservoir and also moderate slope in the topography. A gate shaft will be built about 280 m behind the intake.

The intake is designed for natural intake of maximum 44.30 m^3/s and for a velocity of less than 1 m at the screen. The top section of the tower will be exposed when the reservoir surface drops to low water level.

To shut-off of water during inspections of the pressure tunnel and at times of accidents, a high pressure gate will be installed in the shaft. The gate will be a caterpillar-type gate and the hoisting equipment will be placed on a slab above normal high water surface level (El, 707 m) and will be of such structure as to enable quick lowering of the gate in time of emergency.

b-2 Pressure Tunnel:

The pressure tunnel will be on a straight line, 3,850 m in length, from the intake to the surge tank and is designed for maximum discharge of 44.30 m^3/s. The shape will be circular with an inside diameter of 4.50 m and lined with concrete throughout the length with steel reinforcement wherever necessary. For the safety of the tunnel, grouting is to be performed along and around the tunnel through the entire length to fill openings between the concrete lining and bed rock and cracks in the rock.

Further elaborate investigation will be necessary with respect to the geology along the proposed route of the tunnel, although it appears it will be sufficiently stable because the entire length of the tunnel is 150 m or more underground from ground surface.

b-3 Surge Tanks:

An upper surge tank and a lower surge tank respectively, will be provided at the end of the pressure tunnel and at the entrance of the tailrace.

Upper Surge Tank:

The upper surge tank is to be an improved water chamber type in consideration of the locations of the pressure tunnel and power plant and the overburden. Determination of dimensions of the tank is based on the following specifications:

The maximum discharge will be 44.30 m^3/s and calculation of surging was based upon the consideration of up-surging at shut down of total load and down-surging at sudden load increase of 50 to 100%.

From the above consideration the lower, upper and uppermost water chambers will be circular having inside diameters of 4.50 m, 6.00 m and 13.00 m respectively. The surge chamber will be of open type.

Lower Surge Tank:

The lower surge tank is to be a water chamber type and will be constructed at the entrance of the tailrace. In determination of dimensions, the water level of the tailrace bay was assumed to be at an elevation of 275.00 m, and the same conditions as for the upper surge tank were considered in calculation of surging. As the result of the above examination the water chamber will be 8.00 m wide, 15.00 m long and 16.00 m high.

Further examination will be necessary to determine the size of the surge tank, depending upon determinations of flood water levels around the tailrace bay and geological survey of the vicinity of the proposed site of the surge tank.

b-4 Penstock:

A steel penstock is to be installed in an inclined shaft and the opening between the excavated surface and the penstock is to be filled with concrete. The total length of the penstock including horizontal section is 630 m and the inclined section will be on a gradient of 40°. At the bottom, the penstock will branch out into two pipes to serve two turbines. The capacity is designed on the basis of maximum turbine discharges of 44.30 m^3/s, and inside diameter is 3.2 m at the upper section tapering down to 1.8 m at the bifurcation point.

As the internal pressure at the bifurcation point will be great, a spherical branch will be adopted. Valves will be installed at the upper and lower sections of the penstock for inspection, etc. of the penstock and turbines.

In the final design, a suitable structure to transmit a part of the hydraulic pressure to the bed rock should be considered for steel pipe installed inside a tunnel and also for exposed type, banded steel pipe or special steel pipe should be studied in consideration of the properties and stress conditions of the bed rock and methods of construction.

b-5 Tailrace:

The tailrace tunnel will be on a straight line extending from the turbine exit to the tailrace bay. The length will be about 6, 500 m. The design discharge was based upon the maximum turbine discharges of 44. 30 m^3/s. The tunnel will be horseshoe shape, and lined with concrete throughout the entire length with steel reinforcement wherever necessary. This tunnel will be gravity flow under normal conditions but will serve as a pressure tunnel at times of great floods. For the purpose of inspection and maintenance of turbines and of the tailrace tunnel, one gate each will be installed near the entrance of the tailrace tunnel--the downstream end of the draft tube--and at the tailrace bay. Near the entrance of the tailrace, there will be one gate for each turbine to be installed adjacent to the surge chamber. The gates will be sluice gates 5. 0 m by 4. 0 m and winches will be mounted on top. The height at which the winches will be mounted was determined in view of maximum rise in water level obtained from analysis of surging. As the gates at the tailrace bay will be used very infrequently they will be flash-board type gates.

c. Underground Power Plant

As already described in 5-3-1, the Sandalcik Power Station will be an underground plant with a pressure tunnel and a tailrace tunnel due to the topographical and geological conditions. The maximum power output of this station will be 150,000 KW and two generators 75,000 KW each will be installed as a result of studies of operating conditions and economy. The outline of this underground plant is as shown in Drawing-26. Underground stations of this size have been constructed at many places in foreign countries as well as in Japan, and there will be no technical problems in the construction in view of the fact that bed rock consists of solid hard limestone. Since an underground plant must be built in space excavated out of bed rock, the layout of machinery and equipment was planned to be as compact as possible.

As a result of careful examination and consideration of the depth of the power plant from the ground surface, the length of access tunnel and cable tunnel, meteorological conditions and experiences in operation of Japanese underground stations, the layout of machinery and equipment was planned so that the main transformer and control board will be installed underground. Power generated will be transmitted to the switchyard on the surface through OF cable, and the office, emergency power source, workshop, storage rooms, etc. will be built above ground concentrated around the entrance of the access tunnel.

The arch section and walls will be concreted and adequate grouting will be performed to fill cracks in the surrounding rock to stabilize the foundation of the power station.

In regard to the walls, the cases that can be considered are no concrete lining depending upon the rock condition, gunniting with thin layer of mortar construction of thick curved concrete, wall to increase resistance against external pressure or construction of double walls if the quantity of water seepage in the rock is great. However, which one of these methods is to be employed will be a matter for study after further investigations.

On the other hand, as this power plant is located fairly deep in the ground, access by automobiles through a tunnel requires an uneconomical distance of about 1.5 km, assuming a gradient of 10 %, and the use of an elevator through a pit is also not practical, judging from its depth. Therefore, in this preliminary design an inclined shaft with a gradient of 1: 3.8 is planned taking into account the assumed maximum weight and measurement of equipment to be delivered, connection with existing road, and its serviceability for other purposes during the construction works. Incline equipment will be installed in this shaft. With an incline of this degree of gradient, take-out of excavated materials by belt conveyor is not only possible but will also be efficient during the excavation of the underground power plant. In case of an underground power station attention must be paid to the ventilation of the interior. Though it is possible to ventilate with equipment of sufficient capacity through only the accese tunnel, it was decided to have the air duct of the tailrace surge tank serve also as the ventilation shaft for the power station in this design. Ventilation of the power station can be carried out without difficulties through this air duct and in addition it can also effectively serve as an adit for the excavation of the arch section and concrete delivery route as well during construction.

d. Electrical Equipment

The principal electrical equipment of the Sandalcik Power Station will be as follows:

Turbine:

Number of Units:	2
Type:	vertical Francis type
Standard Effective Head:	398 m
Standard Power Output:	78 MW
Revolution:	500 r.p.m.

Generator:

Number of Units:	2

Type:	standard vertical type
Output:	85 MVA
Voltage:	13.2 KV
Power factor	0.9 (lag)
Frequency:	50 c/s

Main Transformer:

Number of Units:	2
Type:	out-door, 3 phase, forced oil cooled
Capacity:	85 MVA
Voltage:	13/154 KV

Number of Units:

With the growth in power systems in Turkey unit capacities are becoming larger and among the power stations now under construction there are some with unit capacities of 100 MW. Generally, about 10% of the system capacity would be considered to be the maximum unit capacity. Therefore, two units of 75 MW are planned in this design.

Type of Turbine:

This power plant is a high head and large capacity station and the conditions are just near the borderline for choosing between a Francis type or Pelton type turbine. However, in view of recent trend to use Francis type up to considerably high heads and the anticipation of future improvements in this direction, the selection of this type is judged to be accompanied by no technical difficulty.

Economically, the rotation speed of the Francis type is about 1.7 times that of the Pelton type (500 r.p.m. : 300 r.p.m.), the weight is lighter, the price cheaper, and greater effective head can be obtained. Also, it occupies much less space upon installation.

Location of Main Transformer:

The Sandalcik Power Station is an underground type and the main transformers can be placed either above surface or underground. However, as a result of economic analysis including construction cost, power loss, etc., the transformers are planned to be placed underground.

Delivery Facilities for Machinery and Equipment:

The delivery of machinery and equipment into the power station will be by the incline, and an overhead travelling crane of 30 ton capacity will be installed as a hoisting device.

Control System:

The operation system of turbines will be a one-man control system, and a high pressure synchronous system will be employed from the view point of economy, and synchronous breakers will be used omitting transmission line protective breakers.

Emergency Power Source:

The Sandalcik Power Station will be the first plant to be built in the system and it is very probable that power supply may not be obtained from the system during stoppages in operation. Therefore, a 200 KVA diesel generator is planned to be installed as a station service power source.

6-2-2. ASMACIK DAM AND BEZKESE POWER STATION

a. Dam:

The sand and gravel deposit in the river bed of this site is very deep, ranging from 52 to 59 m at the deepest point. The right bank of the dam site has a slope of about 35° and the river bed is about 180 m wide and is covered with sand and gravel. The left bank forms a low ridge with a saddle. It is almost impossible to excavate this deep sand and gravel deposit, and therefore, the type of dam to be constructed here is planned to be of gravel-fill type with grouted cut-off, utilizing this great deposit of sand and gravel.

According to the result of geological survey, the sand and gravel deposit on the river bed of the dam mainly consists of sand and gravel between 5 to 10 cm in size so it will be possible to construct a dependable cut-off wall by grouting.

The results of survey indicate that a large volume of excellent sand and gravel, located immediately downstream of the dam site, can be used as material for the dam body and the excavated rocks from the proppsed site for the spillway on the saddle of the left bank can also be used in the dam. The height and crest length of the dam are 30 m and 251 m respectively. The upstream slopes of the rock zone will be 1 : 1.28, the core 1 : 0.3 and the downstream slopes of rock zone will be 1 : 2.3 and the core 1 : 03. The width of dam crest is 8 m and a freeboard of 3 m above normal high water level is planned in consideration of waves due to wind and earthquake.

The spillway is to be built on the left bank saddle, taking advantage of the topography around the dam site. As a result of geological survey, two sheared zones, one running parallel with the saddle and the other crossing the narrowest section of the saddle, have been confirmed. However, these zones can be treated by grouting or partially replaced with concrete without incurring large expenditures.

The design spillway discharge is 5,700 m^3/s.

The spillway is an over flow type with one radial gate 10.50 m by 12.00 m mounted on a concrete over flow dam.

Embanking the Asmacik Dam can be commenced at the end of the rainy season and be finished before the following rainy season. Therefore, the design discharge of the temporary diversion waterway during the construction period will be 600 m^3/s.

From topographical considerations, the diversion waterway will be a tunnel with inside diameter of 7.20 m excavated through the left bank. Other than this method, there are ways of diverting the river flow, namely, an open waterway in the saddle or by construction of the over flow section first and building the upstream coffer dam 5 to 6 m higher. The former entails much more excavation and concrete work and is not economical for this site. The latter increases the cost of grouting in sand and gravel deposit for prevention of seepage as the height of the upstream coffer dam will be raised about 1.5 times. The latter method involves many unknown factors from presently available results of geological survey and appears to be uneconomical. It is necessary to make further studies by conducting more detailed geological surveys.

The upstream coffer dam could be constructed as a part of the main dam, but it has not been planned so in this preliminary design because of complication of works at the main dam such as treatment to prevent leakage from the upstream coffer dam, grouting of sand and gravel deposit at the main dam and embankment works, etc.

b. Waterway:

b-1 Intake:

Due to the topographical and geological conditions the intake is planned to be built on the left bank about 700 m upstream of the spillway. The intake will be a sloping structure judging from the topography of this site and is designed for natural intake of 36.50 m^3/s which is the powerhouse maximum discharge. A sluice gate 4.20 m by 4.20 m and two screens 4.0 m by 9.0 m will be installed at the intake. The Asmacik Regulating Pond is relatively small and as it is located farthest downstream of the entire Dalaman River Project, it is thought there will be a great amount of debris so that a trash net and trash removal equipment are to be installed.

b-2 Headrace Tunnel:

The headrace tunnel will be constructed on the shortest route due to the relationship between intake and power station sites, and it is planned to go through the deepest section of the mountain in view of topographical and geological conditions. The length will be about 3,050 m.

Capacity is designed on the basis of maximum powerhouse discharge of 36.50 m^3/s. In selection of the type of tunnel both non-pressure and pressure type were given consideration. However, when the combination of head tank and surge tank constructed at the end of the tunnel in each case is compared with the other, the pressure type is found to be economical and has therefore been selected. The shape is a standard horseshoe type and the cross section will have an inside diameter of 4.2 m. As the external pressure against the tunnel is relatively small, grouting of mortar into the arch section only will be adequate for sections of good geology and for geologically poorer sections, grouting of surrounding areas is also planned together with steel reinforcement wherever necessary.

The headrace tunnel is relatively long and is located where it is difficult to provide access adits. This may cause delays in the work schedule in case excavation becomes difficult due to poor conditions in the rock, and so an extensive examination will be necessary after further geological surveys including boring.

b-3 Surge Tank:

As the Bezkese Power Station will have a pressure tunnel about 3,050 m long, a surge tank will be necessary. It is planned to be constructed at the end of the tunnel and has been decided to be a simple surge tank after analysing water level variations due to sudden change in load of the power station and other hydraulic phenomena.

Along with future surveys of topography and geology, further consideration of the surge tank and head tank together with the type of tunnel will be necessary.

b-4 Penstock:

The penstock will connect the tank and power plant in a straight line 61 m long and is designed on the basis of maximum powerhouse discharge of 36.50 m^3/s and inside diameter of 3.40 to 2.89 m.

It is of a ring-girder type installed on a maximum gradient of 45°, and will be fixed with anchor blocks in between which piers for support of the penstock pipe will be installed.

b-5 Tailrace:

The tailrace will be an open waterway and the discharge level is designed to be at an elevation of 30.0 m in consideration of the maximum powerhouse discharge of 36.50 m^3/s. An intake for irrigation with a capacity of 11.73 m^3/s to draw water after it has been used for power generation will be constructed in the tailrace.

c. Power Plan:

Based on discharge water level, topographical conditions and geological surveys, the power plant is to be a semi-underground type with its foundation on bed rock. The control room, office, etc. are to be built above ground. An existing highway is to be used as the access road to the power station, and unloading and assembly of equipment will be handled by a gantry crane installed on the power plant building.

The transformer will be installed in a compound adjacent to the power plant, and the power will be stepped-up to 154 KV and transmitted to the Bezkese Sub-station located at about 700 m upstream.

d. Electrical Equipment:

The principal electrical equipment of the Bezkese Power Station will be as follows:

Turbine:

Number of Units:	1
Type:	vertical Kaplan
Standard Effective Head:	35 m
Rated Output:	11 MW
Revolutions:	300 r.p.m.

Generator:

Number of Units:	1
Type:	standard vertical type

Output:	12 MVA
Voltage:	6.6 KV
Power Factor:	0.9 (lag)
Frequency:	50 c/s

Main Transformer:

Number of Units:	1
Type:	outdoor, 3 phase, oil immersed self-cooling
Capacity:	12 MVA
Voltage:	66/154 KV

Crane:

Crane for Assembly:	Gantry crane, 40 tons capacity
Emergency Power Source:	1 diesel generator, 100 KVA

A Kaplan type turbine is to be used at the Bezkese Power Plant due to low head. Synchronizing will be by a low pressure synchronizing system, and operation will be by a one-man control system.

6-2-3. TRANSMISSION LINE AND SUB-STATION EQUIPMENT

a. Transmission Line:

A description of design of the 380 KV and 154 KV transmission lines is as follows:

Description of Equipment

	Bezkese SS-Izmir SS	Sandalcik PP-Gurleik PP	Gurleik PP-Bezkese SS
Distance	240 km	20 km	19 km
Voltage	380 KV	154 KV	154 KV
Circuits	1	1	2
Conductor	410 mm^2 ACSR x 2 (Al 26/4.5mm St 7/3.5mm)	410 mm^2 ACSR (Al 26/4.5mm St 7/3.5mm)	410 mm^2 ACSR (Al 26/4.5 mm St 7/3.5mm)
Overhead Ground Wire			

Type	90 mm^2 GSC (7/3.5 mm)	90 mm^2 GSC (7/3.5 mm)	90 mm^2 GSC (7/3.5 mm)
Number of Wires	2	1	1
Insulator			
Type	250 mm Suspension Insulator 35,000 lb Ball & Socket	250 mm Suspension Insulator 25,000 lb Ball & Socket	250 mm Suspension Insulator 25,000 lb Ball & Socket
Number	21	8	8
Shielding Angle	less than 20°	less than 30°	less than 30°
Minimum Clearance from Ground	9.5 m	7 m	7 m

Note:

Counter-Poise: Installed at places with grounding resistance of 10 or more

Armer rod and damper to be attached to conductors

380 KV Transmission Line:

This 380 KV transmission line covers a distance of 240 km between the Bezkese Sub-station built adjacent to the Bezkese Power Station and the Izmir Sub-station.

The line will be single circuit with double conductors (410 mm^2 ACSR) spaced 40 cm apart and two lines of 90 mm^2 GSC overhead ground wires will be strung.

The topography en route is flat or hilly in general, including some mountaineous area, but maximum elevation is about 800 m.

Towers are self-supporting and conductors will be arranged horizontally. The standard span is to be 350 m and 95% of the towers were assumed to be suspension towers and 5% tension towers.

Guyed towers may be partially used, depending upon the result of further detailed topographical and geological survey.

The design conditions were determined on the basis of meteorological observation data of the past 10 to 30 years issued by the Ministry of Agriculture, State Meteorological Service (1962-1963).

The worst condition of wind velocity of 30 m/s and temperature of -15 °C is taken into consideration, and the height of standard steel towers was decided on the basis of maximum temperature of 45 °C. No consideration was made for icing. Insulation should be considered for lightning and switching surge. However, attempting to obtain perfect prevention of flushover will end in uneconomical design. Therefore, overhead ground wires are for lightning, making the shielding angle less than 20°, to avoid direct strikes on conductors as much as possible, and counter-poise will be installed on towers to reduce ground resistance. Number of insulator discs and clearance were decided on the basis of switching surge.

The extent of the switching surge was so designed as not to cause flush-over at 2.5 times of the maximum system voltage in view of the fact this system will be a directly grounded. The required number of insulator discs for a 250 mm suspension insulator (ball & socket, 35,000 lb) is 21 and all insulators will have horns. The minimum insulation distance is to be 2.05 m. Though the Izmir Sub-station side is close to the seashore and salt damage is conceivable, no particular protection of line in this regard was considered in the stage of final design salt pollution on insulator will be necessary to re-examine the Izmir district, referring to the operation data of the existing 154 KV transmission line.

In designing the conductor and overhead ground wires, tensile strength is to be determined by E. D. S. (Every Days Stress). The E. D. S. condition at 15 °C temperature under no wind was taken to be less than 13% for galvanized steel stranded wire and less than 24% for ACSR.

Apart from the above, corona loss and corona noise are matters of special concern. In case of a 400KV phase voltage, the average potential gradation against earth is about 16 KV/cm and the noise level will be about 60 db at a distance of 10 m directly underneath the conductor in rainy condition.

Since this value is by no means small, attention must be paid in selection of a transmission line route to keep it as far as possible from inhabited areas, and special care must be taken where radio wave level is low.

Corona loss varies drastically depending upon the precipitation difference between localties, as its ratio between rainy and clear weather is as high as 30 to 40. Corona loss of a 380 KV system at voltage of 400KV will be approximately 16.5 KW/km/ϕ in rainy weather and 0.4 KW/km/ϕ in clear weather.

The number of days of rainfall along this route is estimated to be about 40 days per year equivalent.

The ratio of total loss including corona loss and power loss of this system as a whole is as follows:

Loss Ratio of Dalaman System

	Ratio of Electric Energy Loss (%)	Ratio of Power Loss (%)	Remarks
First Stage	3.8	10.9	upon completion of Sandalcik and Bezkese Power Station
Second Stage	3.6	8.4	after completion of Gürleik Power Station
Third Stage	3.5	7.8	upon completion of Göktas Power Station

Note: Power Loss-Ratio is the loss factor at full operation under rainy condition.

Countermeasures against electromagnetic induction disturbances of communication lines caused by single phase earthing of the transmission line must be considered after detailed investigation of the communication system along the route. It will be necessary to use overhead ground wires with high conductivity in order to reduce induced voltage on the communication line.

154 KV Transmission Line:

The 154 KV transmission line consists of an one circuit line 20 km long between the Sandalcik Power Station and Gürleik Power Station and a two circuit line 19 km long from the Gürleik Power Station through Göktas Power

Station to Bezkese Power Station. This route, compared with the 380 KV transmission line, passes through steep mountain zones, but relatively better topography is available on the left bank of the Dalaman River.

Steel towers will be self-supported with standard spans of 300 m. Due to the steepness of topographical conditions, they are estimated to be 90% suspension steel towers and 10% tension towers. The weights of towers are estimated to be 15 tons/km (2 CCT) and 11.5 tons/km (1 CCT). The total number of towers is estimated to be 54 for the 2 circuit section and 57 for the 1 circuit section.

The conductor is 410 mm^2 ACSR single conductor and overhead ground wire is 90 mm^2 GSC single line. This transmission line have used direct grounded system and connecting into the 380 KV line at the auto-transformer at Bezkese Sub-station. The insulation design is the same as that for the 380 KV line. Insulators will be 250 mm suspended insulators (ball & socket, 25,000 lb) and will have 8 discs to a string of insulator.

b. Sub-station:

Sub-stations inter-connecting the 154 KV and 380 KV lines are to be built at Bezkese and Izmir.

The location of Bezkese Sub-station is to be adjacent to the Bezkese Power Station and the Izmir Substation built adjacent to the existing Bornova Sub-station.

The outline of each station is as follows:

Description of Equipment

	Bezkese Sub-station	Izmir Sub-station
Main Transformer	auto-transformer	auto-transformer
Voltage	380 KV/154 KV/15.4 KV	380 KV ± 5%/154 KV/15.4 KV
Capacity	200/200/60 MVA	200/ 200/200/60 MVA
Connection	⅄ ⅄ △	⅄ ⅄ △

Number of Units	First Stage 1	First Stage 1
	Second Stage 1	Second Stage 1
	Total 2	Total 2
Phase Modifying Equipment		
Shunt Reactor		
Voltage & Capacity	154 KV 25 MVA	154 KV 25 MVA
Number of Units	First Stage 2	First Stage 2
	Second Stage -	Second Stage -
	Total 2	Total 2
Outgoing Circuits		
154 KV	4 circuits	2 circuits
380 KV	1 circuit	1 circuit

Main Transformers:

One unit each of main transformer will be installed upon completion of both Sandalcik and Bezkese Power Station, and a shunt reactor is to be inserted in the tertiary winding.

Another unit is to be added upon completion of the Gürleik Power Station. A on-load tap-changer for voltage regulation (±5%) is to be attached to the Izmir side main transformer.

Phase Modifying Equipment:

Shunt reactors will be installed at both sub-stations to compensate the charging capacity of transmission lines. Capacity and number of shunt reactors are 25 MVA x 2. These reactors can also serve as voltage regulators under light load. In addition, at load centers such as Bornova and Balikesir, phase modifying equipment such as static condenser may be necessary under heavy load condition. The final decision of such installation is to be made after detailed examination of power flow conditions prevailing at that time.

No. of Outgoing Circuits of Substations:

The 154 KV incoming and outgoing facilities of Bezkese Sub-station are the 4 circuits to Gürieik, Göktas, Bezkese and the proposed paper factory at Dalaman and an outgoing installation for one 380 KV circuit to Izmir.

The outgoing facilities for 154 KV lines at Izmir Sub-station are 2 circuits for Bornova and an incoming installation for 380 KV one circuit from Bezkese.

c. Communication Facilities:

Communication Circuit for Load Dispatching:

One channel is to be allotted for load dispatching communication between the power stations and substations.

Communication Circuit for Maintenance:

An automatic telephone exchange handling 20 circuits for each power station (except for the exchange at Bezkese Power Station which will be used in common with Bezkese Sub-station) and 40 circuit exchange at the Izmir and Bezkese Sub-station are to be installed for inter-office communication and communication between the power plants and substation is to be maintained by power line carrier system (over 2 CH).

Communication Circuit for Maintenance of Transmission Line:

Two VHF radio stations each for 380 KV and 154 KV transmission lines are to be established at suitable places along the routes to provide communication between a mobile station at a random location along the route and the VHF fixed station. However, as to the VHF of the 154 KV transmission line, in the first-stage of this project, dependability of communication may be low due to the topographical condition, as power stations en route will not yet be completed. In such a case temporary radio stations is to be considered. Solar batteries are considered as a power source for the radio stations.

Fault Locator

A fault locator is to be installed at the Bezkese Sub-station for locating of fault in the 380 KV transmission line for prompt repair of accidents.

Remote Control Device:

Remote control devices are to be installed in the control room of power stations to observe water level of dams and other items.

Also, a remote control device is to be installed at the load dispatching center of the Bezkese and Izmir Sub-stations for telemetering of about three elements at each power station, such as, output, etc.

The outside band of telephone circuits will be used for telemeter channel.

6-2-4 CONSTRUCTION SCHEDULE AND CONSTRUCTION PLAN

a. Construction Schedule:

a-1 Sandalcik Dam and Power Station:

As already described, the construction schedule of this power development project calls for commencement of partial operation at the end of 1970, and therefore, assuming start of the construction work in October, 1967, a schedule as shown in Fig. 6-2-1 is obtained in consideration of the scale of the work, river run-off, method of construction and volume of work.

The total period of construction is 51 months from the start of works to commencement of power generation, including preparatory works such as construction of access roads and others. About 31 months after starting of principal works, partial storage of the reservoir will be begun and 8 months thereafter partial generation of power will be commenced.

The major works that will govern the entire work schedule of this project are the construction of arch dam, power station and tailrace tunnel. The volume of excavation is about equal to the volume of concrete work in construction of the arch dam and the work will depend greatly upon the timing of diversion of the river and the methods of excavation.

As the hauling of excavated rocks of the power plant will coincide with the construction of the penstock and tailrace surge chamber, it is necessary to secure the work schedule of the access tunnel and ventilation shaft. Since the tailrace tunnel is 6,430 m long and the geology is not favorable, it is important to secure the schedule by careful planning to select locations of access adits on the way and for methods of hauling excavated rocks.

a-2 Asmacik Dam and Bezkese Power Station:

The Bezkese Power Station is required to be finished by the time of completion of the Sandalcik Power Station on the upstream and the facilities for irrigation of the Dalaman Plain. Consequently, its completion schedule is set for the same time as that of the Sandalcik Power Station as shown in Fig. 6-2-2.

It is considered that the construction period up to beginning of power generation will require 32 months including preparatory works, of which the principal works will require 26 months after the start of construction.

b. Construction Plan:

b-1 General:

i) Transportation Route to the Dam and Power Station Site:

The existing road of about 100 km to the Sandalcik Dam site which branches from the highway connecting Fethiye and Mugla requires repair or improvement of bridges and narrow or sharply curved points en route, while a road branching from it to the power station and the road from the Dalaman Bridge to the Asmacik Dam site on the right bank are to be newly constructed for transport of construction materials and electrical machinery and equipment.

The nearest harbor facilities available for this project is Port Fethiye which can accommodate ships of 10,000 ton class and can serve as an unloading point for imported or domestic construction materials.

ii) Procurement of Materials:

A majority of laborers for construction is available in Turkey. The type of cement to be used will be Portland cement to be transported from Izmir to Fethiye by sea and thereafter by trucks. Most of steel bar and other steel materials are available in Turkey and are to be transported likewise. Domestic explosives are also available.

Principal machinery and equipment such as penstocks, turbines and generators, transformers, and transmission line conductor, etc. are to be imported. Machinery for construction works will be partially imported, but the remainder will be transferred here from other projects in Turkey.

iii) Power Supply for Construction Works:

On the assumption that a 154 KV transmission line from Mugla to Dalaman will be completed by the time of commencement of this project, power for construction works will be available by construction of a transmission line of 60 KV extending over 50 km or so from Dalaman to Sandalcik receiving end sub-stations are to be constructed at Bezkese and Sandalcik.

b-2 Sandalcik Dam and Power Station:

i) Preparatory Works:

From the existing permanent road already described, access roads will be built to a point upstream of the dam site, aggregate pits, surge tank, tailrace, etc. Main distribution lines from the Sandalcik Sub-station for construction works to the dam site, aggregate plant, power station, tailrace, etc. are also to be built. These preparatory works are required to be finished for the most part before the commencement of principal works.

ii) Construction of Dam:

o Diversion of River:

As aforementioned, in order to start partial storage of the reservoir in May, 1970, the temporary diversion tunnel is required to be completed by February, 1968.

o Treatment of Dam Foundation:

The total volume of excavation for the dam foundation is estimated to be about 480, 000 m^3. The excavation will be started first from about an elevation of 670 m downward to widen the river bed. Excavation downward from the crest level of the dam will then follow until the foundation of the arch dam will hit hard solid bed rock. Excavated rocks will be loaded on trucks at the river bed and transported and temporarily dumped at the spoil bank upstream of the dam. A part of this will be used as rock for the saddle dam.

Prior to concreting of the dam, consolidation grouting of the foundation rock is to be performed in order to secure conditions of elasticity satisfactory as a foundation of an arch dam. In addition, high pressure curtain grouting will be carried out from the gallery in order to prevent seepage of water from the foundation rock.

- Concreting of Dam:

Aggregates for dam concrete will be taken from the natural deposit of sand and gravel above the dam site and transported to the aggregate plant established upstream of the dam. The aggregate plant as shown in the Drawing of Construction Plan will be located at an elevation of about 600 m on the left bank. A substantial portion of concreting of the main dam is to be finished by the commencement of partial storage of water in the reservoir, and aggregates necessary for concreting of the remaining portion of the main dam and for waterways and the power station, total concrete volume about 100, 000 m^3, will be screened and temporarily stored downstream of the saddle dam.

Cement is to be transported by cement trucks from Fethiye via the construction road to a silo near the dam site and stocked there. A batching plant for weighing and mixing of concrete material, with a maximum capacity of 120 m^3/hr or equivalent, and a cooling plant to cool the concrete are to be established at about elevation of 700 m.

For delivery of concrete a cable crane with a capacity of 18 tons, one end fixed and one end movable, is to be used.

The capacity for placing concrete of these facilities will be 45,000 m^3 maximum per month and 1,800 m^3 maximum per day.

Between each lift pipes will be embedded for initial pipe-cooling in treatment of heat of hydration hardening and secondary pipe-cooling for final stability of the dam. Before storage of water is commenced, grouting of horizontal joints will be performed. Through this, leakage of the dam will be prevented and the arch action of the dam secured for maximum safety of the dam.

- Closing of Diversion Tunnel:

Water storage will be started in May, 1970 by closing the inlet gate of the diversion tunnel. Promptly after beginning storage, the tunnel will be plugged and pipe cooling and grouting will be carried out to obtain tight contact with the bed rock and to prevent leakage.

iii) Construction of Power Station and Waterway:

- Intake:

Excavation of the vertical shaft of the intake is to begin from the road bed level at elevation 710 m and excavation of intake portal and tunnel will be started from the intake. After completion of all excavation concreting of tunnel section, intake portal and deck for gate hoisting winch will follow.

- Pressure Tunnel:

The pressure tunnel will be excavated by the full face method from the intake portal, the access adit to be provided midway and the work shaft branching to the valve chamber of penstock. After completion of excavation concrete lining will be performed followed by high pressure grouting for bonding of contact of concrete lining and bed rock and to fill cracks in the bed rock.

- Penstock:

The penstock will be installed inside an inclined shaft with a total length of about 630 m. Work shafts will consist of one shaft branching from the work pit for the power station which will be described later and another shaft reaching an elevation of about 520 m which is midway down the penstock. Excavation of the penstock tunnel will be performed by excavating a pilot tunnel from the bottom of each work shaft upward and widening will start from top to bottom. Excavated rocks are to be dropped down the pilot tunnel to be taken outside by a belt conveyor. The penstock pipe is to be brought in through a work shaft at about El. 440 m and the access tunnel to the valve chamber and will be installed from bottom to top. Concrete will be placed to fill the opening around the pipe immediately after installation of the penstock, followed by high pressure grouting.

o Surge Tank:

Two work pits, one from the ground surface and the other branched from the access tunnel to the valve chamber, are to be provided for the excavation of the surge tank, and following the completion of these access, widening will be started from top to bottom. Excavated rocks will be dropped into and taken out from the above mentioned work pits by belt conveyors. Simultaneous to widening of the cross section from the top, dead lining of concrete will be placed followed by the normal lining.

o Power Station:

The work of the power station will start with excavation of an access tunnel and ventilation shaft followed by excavation of the arch section of the power station and tailrace surge chamber and then concreting. After completion of concreting, a work pit on a suitable gradient reaching down to the bottom of the draft tube is to be built from the powerhouse access tunnel. From here a shaft will be dug upwards after which excavation will start from the top of the power station. Excavated rocks will be taken out from the powerhouse access tunnel by a belt conveyor. Upon completion of the excavation work, draft tubes, turbines, generators and other electrical equipment will be brought in through the powerhouse access tunnel and installation work will begin corresponding with progress of civil and architectural.

o Tailrace:

The tailrace will have a total length of 6, 500 m and in consideration of the work schedule, two inclined will be provided along its route, dividing the whole section into about 1, 800 m each, and full face excavation will be carried out. Depending upon the geological condition, the arch section may be excavated first arch access tunnel may be dug and concrete lined before excavating the full cross section of the tunnel. Concrete lining is to be performed after excavation is completed.

b-3 Asmacik Dam and Bezkese Power Station

i) Construction of Dam

o Diversion of River:

It will be necessary to complete the diversion waterway if the diversion of the river flow is to be performed in June, 1969.

o Spillway Dam:

The spillway dam will not be affected by the river water so that this work will be carried out along with the diversion waterway. This work is to be completed by the time the flow of the river is by-passed through the diversion work.

Aggregate for dam concrete will be collected from natural sand and gravel deposits near the dam.

o Construction of Gravel-fill Dam:

There is a sand and gravel deposit extending to a maximum depth of 60 m at the foundation of the dam and therefore a impervious blanket will be constructed by grouting. After completion of the grouting, core and filter material will be collected from suitable places near the dam

Fig. 6-2-1 SANDALCIK DAM AND HYDROELECTRIC CONSTRUCTION SCHDULE

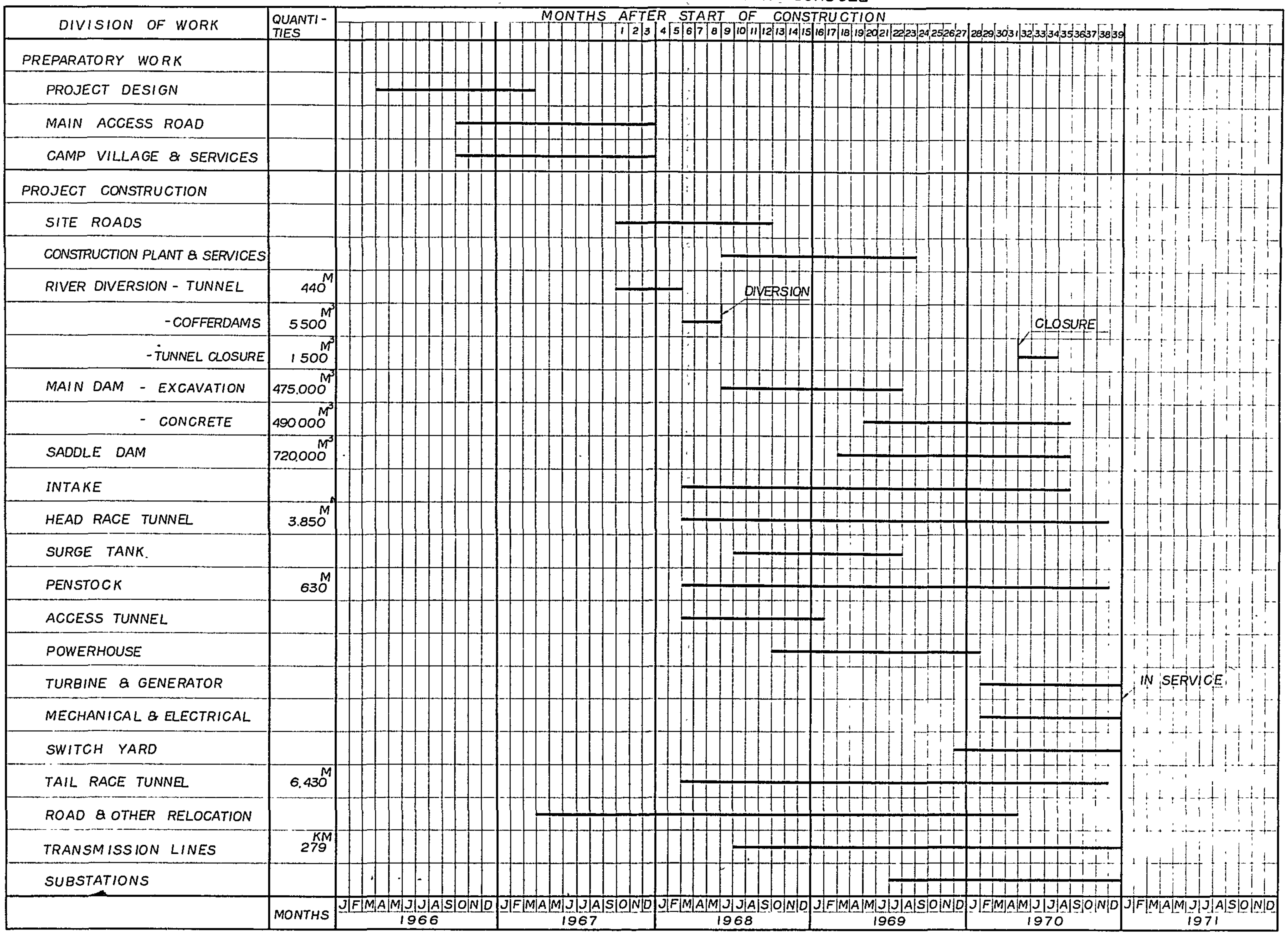
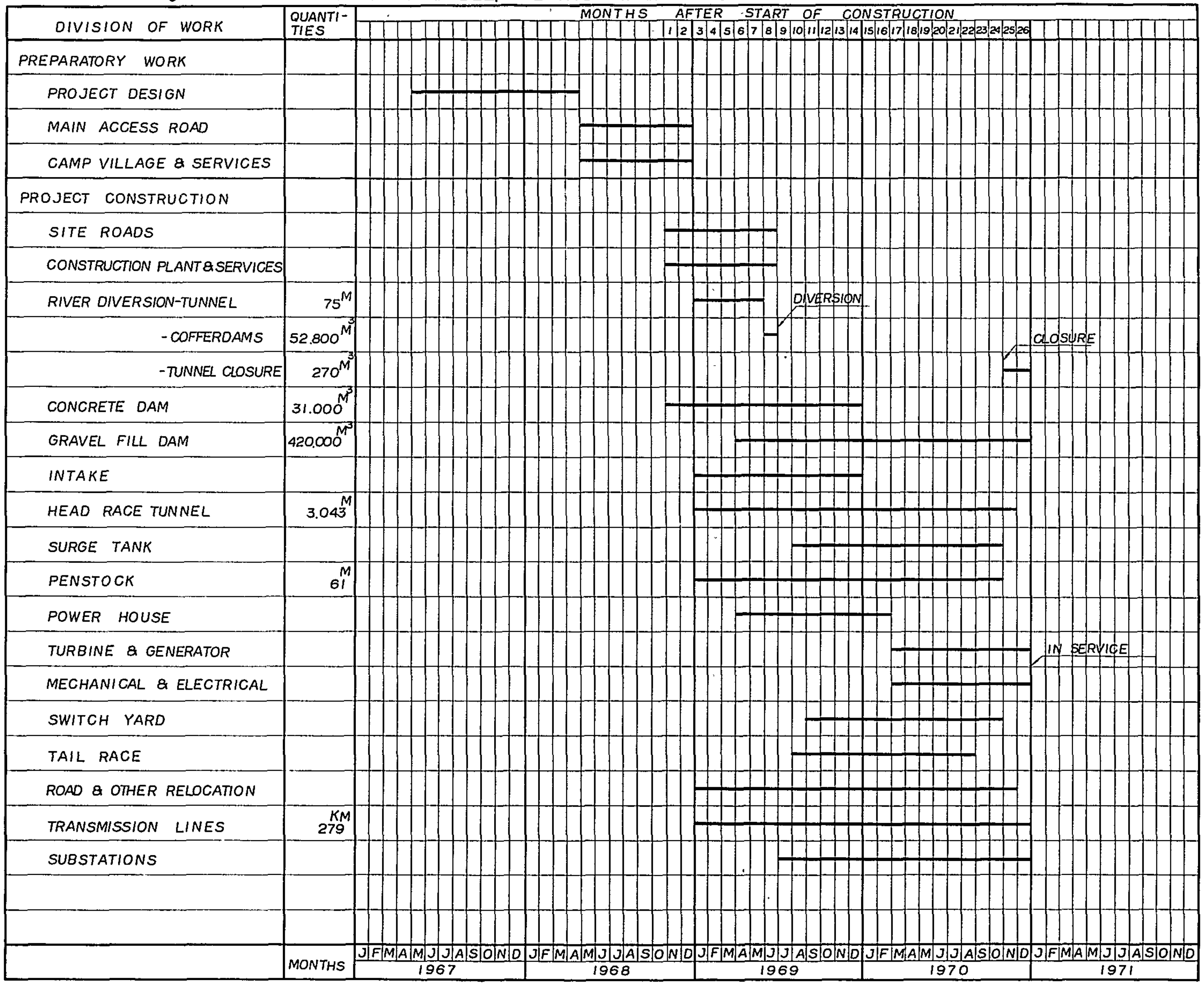


Fig 6-2-2 ASMACIK DAM AND BEZKESE HYDROELECTRIC CONSTRUCTION SCHEDULE



and, filled and compacted thoroughly. Sand and gravel deposit above and below the dam site will be hauled and embanked.

- Closing of Diversion Tunnel:

Storage of water will be started by lowering the gate of the diversion tunnel, taking into account the storage conditions at upstream Sandalcik. Immediately after beginning storage, the tunnel will be plugged with concrete, cooled and grouted in order to assure thorough bonding of concrete and bed rock and to reduce danger of seepage of water.

6-3 ECONOMIC EVALUATION

6-3-1 CONSTRUCTION COSTS

a. Outline

The total costs of dams and electric power installations of this Project are estimated to be 735,100,000 T.L and the breakdown of these costs is as shown in Table 6-3-1. The construction costs were calculated taking into consideration natural conditions, scale of construction work and the technical level conceivable at this time and including necessary contingencies. The commodity prices used in the calculations were prices as of June, 1965.

Construction costs are divided into domestic currency requirements and foreign currency requirements. Domestic currency requirements include wages of domestic labor, living expenses of construction supervisors and technicians and construction materials such as steel, lumber and oil and lubricants procurable in the country as well as construction machinery other than heavy plants and machinery. All other items were listed as requiring expenditure of foreign currency.

The construction cost were estimated on the basis of awarding the works to a contractor who will perform the work under a contract with the owner of the project which is DSI, and the costs of the consulting engineer who will design the project and who will supervised the construction. Certain assumptions were made regarding the relationships between the three parties and the scope of responsibility of each in the calculations of costs of the project.

o Dam and Power Generating Facilities

The construction cost of civil engineering works was calculated by the Total Quantity Method. In this method, the equipment required and the total number of hours of operation of the equipment is first obtained based on the construction schedule and the quantity of the work. Using this as a basis the depreciation costs of the construction equipment, operating cost, labor costs, material costs and other expenses which comprise direct construction costs were calculated. Further, expenses of all construction roads, buildings used in construction, construction equipment and labor necessary for smooth operation of the beforementioned construction equipment and facilities as well as indirect expenses of the contractor were added to the construction costs.

Importation, transportation and installation costs were included in calculation of costs for spillway gates, intake gates, penstock, etc.

Manufacture, transportation and installation of turbines, generator and appurtenant facilities were included in the costs of electrical machinery and equipment.

Indemnification costs, based on survey data of DSI, include the cost of relocating roads to be submerged, and indeminification of land and buildings to be submerged in the reservoir under the present design high water level.

Cost of roads, power transmission and distribution lines, buildings, furnitures and fixtures, vehicles, etc. necessary for accomplishing the construction works were listed collectively under "Construction Facilities".

Costs of detailed survey and design, engineering and supervisory work and other administrative and general expenses were lumped together under "Administrative Cost". (However, expenses to be incurred by DSI were not included.)

Contingencies included are 15% for civil engineering and steel bridge work, 5% for electrical machinery and equipment and 10% for others.

Interest during construction, as the result of a survey, were calculated based on 5% per annum for both domestic and foreign currency. Import duty on power station and switchyard equipment were not taken into consideration.

o Transmission Lines and Substations

The transmission lines between Sandalcik and Gürleik, Gürleik and Bezkese, Bezkese and Izmir and the costs of machinery and equipment, communication facilities, steel towers, conductors, insulator and other materials, transportation and installation were included under "Transmission Lines" and "Substations." Temporary facilities, administrative costs and land purchase costs necessary for the construction work of the above were also calculated. contingency of 5% against the total cost were taken into consideration.

For interest during construction, a rate of 7% per annum was considered for both domestic and foreign currency while for imported machinery and equipment, necessary amounts of duty were included.

b. Dams and Electric Power Facilities

o General

Table 6-3-1 Construction Costs of Sandalcik Project (First Stage Development Program)

(1 U.S.$ = 9 T.L)

Item	Cost in U.S. Dollar	Equivalent in T.L
	$1,000	T.L 1,000
Dam		
Sandalcik	22,900	206,100
Asmacik	5,647	50,820
Sub-total	28,547	256,920
Power Generation Facilities		
Sandalcik	26,767	240,900
Bezkese	5,909	53,180
Sub-total	32,676	294,080
Transmission Lines and Substations		
Transmission Lines	12,500	112,500
Bezkese Sub-station	3,977	35,800
Bornova Sub-station	3,977	35,800
Sub-total	20,454	184,100
Total	81,677	735,100

o Sandalcik and Bezhese Power Station

Table 6-3-2 Summary of Sandalcik Power Station Construction Costs

(1 U.S.$ = 9 T.L)

No.	Item	Foreign Currency $ 1,000	Domestic Currency T.L 1,000	Total	
				$1,000	T.L 1,000
1.	Land Acquistion		11,900	1,322	11,900
2.	Diversion Waterway & Care of River	263	3,000	596	5,370
3.	Dam	3,252	102,360	14,626	131,630
-1	Concrete Dam	2,949	94,050	13,399	120,590
-2	Saddle Dam	303	8,310	1,227	11,040
4.	Waterway	3,952	75,750	12,369	111,320
-1	Intake	288	2,350	549	4,940
-2	Headrace	763	24,130	3,445	31,000
-3	Surge Tank	121	2,630	413	3,720
-4	Penstock	1,148	9,180	2,168	19,510
-5	Tailrace	1,632	37,460	5,794	52,150
5.	Power Station	410	12,600	1,810	16,290
-1	Power Plant	186	6,370	894	8,050
-2	Access Tunnel	189	5,290	777	6,990
-3	Ventilation Shaft	35	940	139	1,250
6.	Turbine & Generator	2,472	3,440	2,854	25,690
-1	Turbine	1,037	1,580	1,212	10,910
-2	Generator	1,435	1,860	1,422	14,780
7.	Auxiliary Electrical Equipment	1,019	1,200	1,152	10,370
8.	Miscellaneous Apparatus	667	1,200	800	7,200
9.	Outdoor Switchyard	189	1,150	317	2,850
10.	Construction Facilities	520	26,570	3,472	31,250
11.	Administrative Cost	614	13,100	2,070	18,630
12.	Contingencies	1,197	34,730	5,056	45,500
13.	Total	14,555	287,000	46,444	418,000
14.	Interest During Construction			3,222	29,000
-1	Foreign Currency	1,000		1,000	9,000
-2	Domestic Currency		20,000	2,222	20,000
15.	Grand Total	15,555	307,000	49,666	447,000

Table 6-3-3 Summary of Bezkese Power Station Construction Costs

(1U.S.$ = 9 T.L)

No.	Item	Foreign Currency $ 1,000	Domestic Currency T.L 1,000	Total $1,000	Total T.L 1,000
1.	Land and Indemnity		200	22	200
2.	Diversion Waterway & Care of River	108	2,120	343	3,090
3.	Dam	1,317	22,650	3,833	34,500
-1	Concrete Dam	900	10,420	2,058	18,520
-2	Gravel-Fill Dam	417	12,230	1,775	15,980
4.	Waterway	783	16,900	2,661	23,950
-1	Intake	52	1,120	177	1,590
-2	Headrace	552	12,060	1,892	17,030
-3	Surge Tank	56	1,400	211	1,900
-4	Penstock	53	560	115	1,040
-5	Tailrace	70	1,760	266	2,390
5.	Power Station	53	1,930	268	2,410
6.	Turbine & Generator	585	885	683	6,145
-1	Turbine	281	520	339	3,050
-2	Generator	304	365	344	3,095
7.	Auxiliary Electrical Equipment	241	220	265	2,390
8.	Miscellaneous Apparatus	200	870	297	2,670
9.	Outdoor Switchyard	163	580	228	2,050
10.	Construction Facilities	134	6,870	898	8,080
11.	Administrative Cost	157	2,600	446	4,010
12.	Contingencies	259	8,175	1,167	10,505
13.	Total	4,000	64,000	11,111	100,000
14.	Interest During Construction	160		444	4,000
-1	Foreign Currency	160		160	1,440
-2	Domestic Currency		2,560	284	2,560
15.	Grand Total	4,160	66,560	11,555	104,000

o Transmission Lines and Substations

Table 6-3-4 Summary of Transmission Line Construction Costs

(1 U.S.$ = 9 T.L)

No.	Item	Foreign Currency $ 1,000	Domestic Currency T.L 1,000	Total	
				$ 1,000	T.L 1,000
1.	Transmission Line	2,655	44,912	7,646	68,814
	380 KV				
-1	Bezkese - Izmir	2,187	40,311	6,667	60,000
	154 KV				
-2	Sandalcık-Gürleık	94	1,474	258	2,320
-3	Gürleik-Bezkese	166	1,852	371	3,344
-4	Communication Facilities for Maintenance & Repair	208	1,275	350	3,150
2.	Facilities for Construction		3,897	433	3,897
3.	Administrative Cost	117	5,935	776	6,986
4.	Land Purchase		382	43	382
5.	Contingencies	309	1,270	451	4,055
6.	Sub-Total	3,081	56,396	9,349	84,134
7.	Interest During Construction	260	5,167	844	7,505
8.	Total	3,341	61,563	10,182	91,639
9.	Import Duties		20,861	2,318	20,861
10.	Grand Total	3,341	82,424	12,500	112,500

Table 6-3-5 Summary of Bezkese Sub-station Construction Costs

(1 U.S.$ = 9 T.L)

No.	Item	Foreign Currency $ 1,000	Domestic Currency T.L 1,000	Total	
				$ 1,000	T.L 1,000
1.	Land Purchase		375	42	375
2.	Buildings		1,320	142	1,320
3.	Machinery & Equipment Foundations		650	72	650
4.	Machinery & Apparatus	1,877	2,643	2,171	19,538
-1	Main Transformer	1,028	625	1,097	9,875
-2	Shunt Reactor	69	125	83	750
-3	Distribution Board and Switchgear	556	500	611	5,500
-4	Outdoor Steel Structure		750	83	750

No.	Item	Foreign Currency $ 1,000	Domestic Currency T.L 1,000	Total	
				$ 1,000	T.L 1,000
-5	Various Machinery	97	50	103	925
-6	Communication Facilites	114	275	145	1,300
-7	Miscellaneous Apparatus	13	318	49	438
5.	Administrative Cost	34	1,683	221	1,988
6.	Contingencies	96	286	127	1,146
7.	Sub-Total	2,007	6,957	2,780	25,017
8.	Interest During Construction	134	403	178	1,608
-1	Foreign Currency	134			1,205
-2	Domestic Currency		403		403
9.	Total	2,141	7,360	2,958	26,625
10.	Tax		9,175	1,019	9,175
11.	Grand Total	2,141	16,535	3,977	35,800

Table 6-3-6 Summary of Bornova Sub-Station Construction Costs

(1 U.S.$ = 9 T.L)

No.	Item	Foreign Currency $ 1,000	Domestic Currency T.L 1,000	Total	
				$1,000	T.L 1,000
1.	Land Purchase		750	83	750
2.	Buildings		1,320	147	1,320
3.	Machinery & Equipment Foundations		650	72	650
4.	Machinery & Apparatus	1,849	2,643	2,143	19,288
-1	Main Transformer	1,167	625	1,236	11,125
-2	Shunt Reactor	69	125	83	750
-3	Distribution Board and Switchgear	389	500	444	4,000
-4	Outdoor Steel Structure		750	83	750
-5	Miscellaneous Equipment	97	50	104	925
-6	Communication Facilities	114	275	144	1,300
-7	Miscellaneous Apparatus	13	318	49	438
5.	Administrative Cost	34	1,663	219	1,968
6.	Contingencies	94	290	135	1,214
7.	Sub-Total	1,977	7,316	2,799	25,190
8.	Interest During Construction	132	429	174	1,572
-1	Foreign Currency	132			
-2	Domestic Currency		429		
9.	Total	2,109	7,745	2,973	26,762

No.	Item	Foreign Currency $ 1,000	Domestic Currency T.L 1,000	Total	
				$ 1,000	T.L 1,000
10.	Tax		9,038	1,004	9,038
11.	Grand Total	2,109	16,783	3,977	35,800

6-3-2 ANNUAL COSTS

The rate of interest for construction expenditures such as dams and power stations to be carried out by DSI were calculated at 5% per annum and that of works such as transmission lines and substations to be carried out by Etibank were calculated at 7% per annum. The annual costs of dams and other facilities exclusively for electric power in the First Stage Program are described below.

a. Dam

a-1 Basis of Calculation

Annual costs were calculated based on economic life of 50 years with amortization based on sinking fund method.

Interest and depreciation: 5.48% of construction costs

Maintenance and repair: 0.3% of construction costs

Others: 0.03% of construction costs

a-2 Annual Cost (Unit: 1,000 T.L)

o Sandalcik Dam

Interest and depreciation	11,294
Maintenance and repair	618
Other Costs	62
Sub-total	11,974

o Asmacik Dam

Interest and depreciation	2,785
Maintenance and repair	152
Other costs	15
Sub-total	2,952
Total	14,926

b. Electric Power Facilities

b-1 Basis of Calculation

Using the same methods as above, the economic life of the transmission lines and sub-stations were taken to be 50 years and 25 years respectively and amortization were based on the sinking fund method.

o Power Generating Facilities

Interest and depreciation: 5.48% of construction costs

Salaries and miscellaneous wages:

$$400,000 \times \left(\frac{\text{Installation Capacity in KW}}{10,000\ \text{KW}}\right)^{\frac{1}{2}} \text{T.L}$$

Maintenance and repair: 1.00% of construction costs

Others: 0.20% of construction costs

o Transmission Lines

Interest and depreciation: 7.25% of construction costs

Maintenance and repair: 1.00% of construction costs

Taxes: 0.60% of construction costs

o Sub-stations

Interest and depreciation: 8.58% of construction costs

Maintenance and repair: 2.00% of construction costs

Taxes: 0.60% of construction costs

b-2 Annual Costs (Unit: 1000 T.L)

o Sandalcik Power Generating Facilities

Interest and depreciation	13,201
Salaries and miscellaneous wages	1,549
Maintenance and repair	2,409
Other costs	482
Sub-total	17,641

o Bezkese Power Generating Facilites

Interest and depreciation	2,914
Salaries and miscellaneous wages	420

Maintenance and repair	532	
Other expenses	106	
Sub-total	3, 972	
Total	21, 613	
o Transmission Lines		
Interest and depreciation	8, 156	
Maintenance and repair	1, 125	
Taxes	675	
Sub-total	9, 956	
o Sub-stations		
Interest and depreciation	6, 144	
Maintenance and repair	1, 432	
Taxes	430	
Sub-total	8, 006	
Grand Total	17, 962	39, 575

c. Summary of Cost (Unit 1000 T. L)

Dams	14, 926
Electric Power Facilities	39, 575
Total	54, 501

6-3-3 BENEFITS

a. Electric Power

a-1 Basis of Calculation

The 75 MW x 2 units standard steam power generating plant at Izmir was used as the basis of calculation of benefits of the electric power phase of the project. Based on the standard steam power plant, KW and KWh costs were calculated and these were considered as the standard unit values of effective output and effective electric energy. The specifications and unit values used in calculation of the standard unit values are as given below.

Basic Steam Power (Heavy Oil Burning Steam Power)

o Specifications

Output	75 MW x 2
Plant Utilization Rate	70 %
KW Adjustment Rate	16 %
Thermal Efficiency at Generating End	34 %, steam pressure 109 kg/cm^2, temperature 540° C
Heat Value of Fuel	10, 000 kcal/kg
Construction Cost	232, 030, 000 T. L (1, 547 T. L/KW)
Unit Price of Fuel	230 T. L/kl

o Annual Cost

Interest Rate	7%
Fixed Costs	
Interest and Depreciation	19, 168, 000 T. L
Operation and Maintenance	6, 126, 000 T. L
Insurance and Taxes	5, 841, 000 T. L
Total	31, 135, 000 T. L
Unit Value per KW	263 T. L
Variable Costs	
Operation and Maintenance	1, 455, 000 T. L
Fuel	52, 973, 000 T. L
Total	54, 428, 000 T. L
Unit Value per KWh	6. 32 Krs

a-2 Benefits

	Sandalcik Power Station	Bezkese Power Station	Total
KW Benefit (V_1)			
Firm Output, KW	146, 000	11, 000	157, 000
Loss Factor, %	11. 00	9. 40	

	Sandalcik Power Station	Bezkese Power Station	Total
Effective Power, KW	130, 000	10, 000	140, 000
Unit Value, T. L.	263. 00	263. 00	
V_1, 10^3T. L	34, 190	2, 630	36, 820
KWh Benefit (V_2)			
Annual Energy Output 10^3KWh	786, 600	81, 000	867, 600
Loss factor, %	3. 80	2. 80	
Effective Energy, 10^3KWh	756, 700	78, 700	835, 400
Unit Value, Krs	6. 32	6. 32	
V_2, 10^3T. L	47, 823	4, 974	52, 797
$V = V_1 + V_2$, 10^3T. L	82, 013	7, 604	89, 617

6-3-4 GENERAL EVALUATION

The excess benefit (V-C) upon completion of this Project is 35, 116, 000 T. L as calculated below and the V/C is 1. 64. The cost per KWh at the primary sub-station at Izmir, the center of demand in the western region is 0. 065 T. L/KWh.

Annual Cost (C)	54, 501, 000 T. L
Benefit (V)	89, 617, 000 T. L
Excess Benefit (V-C)	35, 116, 000 T. L
Benefit-cost Ratio (V/C)	1. 64
Annual Energy Output 10^3KWh	867, 600
Effective Energy 10^3KWh	835, 400
Cost per KWh T. L	0. 065

The above figures are based on the total cost of the dams allocated to the electric power phase of the development, but as the dams will also become water supply sources for the agricultural development program the overall benefit and annual costs including agricultural development should be calculated. The results of calculations are shown below and the excess benefit (V-C) is 37, 616, 000 T. L and the benefit-cost ratio is 1.52.

Annual Cost (C)		
Common Structures	10^3T.L	14,926
Electric Power	10^3T.L	39,575
Agriculture	10^3T.L	18,559
Sub-total	10^3T.L	73,060
Benefit (V)		
Electric Power	10^3T.L	89,617
Agriculture	10^3T.L	21,059
Sub-total		110,676
Excess Benefit (V–C)	10^3T.L	37,616
Benefit-cost Ratio (V/C)		1.52

The annual cost and benefit of agriculture above are the values obtained from the basin development program described in 5-5 and Appendix.

6-3-5 COST ALLOCATION

a. Cost Allocation

The cost of common structures (dams) allocated between agriculture and electric power by the method described below results in a ratio of 7:93.

The method of allocation is to subtract the cost of the respective exclusive facilities for electric power and agriculture from the respective benefits to obtain the surplus benefits and allocate the cost of common structures between electric power and agriculture according to the ratio of the surplus benefits.

The costs of construction and annual expenses for electric power and agriculture after allocation of the cost of common structures by this method are shown in Table 6-3-7.

Construction Costs

	T.L 1,000
Common Structures (Dams and Reservoirs)	256,920
Electric Power	
Power Generation Facilities	294,080
Transmission Lines and Substations	184,100
Sub-total	478,180
Agriculture	252,000
Total	987,100

Annual Cost

	Annual Cost T.L 1,000	Capitalized Cost T.L 1,000
Common Structures	14,926	272,489
Electric Power		
Power Generating Facilities	21,613	394,567
Transmission Lines and Substations	17,962	247,894
Sub-total	39,575	642,461
Agriculture	18,559	338,813
Total	73,060	1,253,763

Benefits

	Benefit T.L 1,000	Capitalized Benefit T.L 1,000
Electric Power	89,617	1,236,804
Agriculture	21,059	384,450
Total	110,676	1,621,254

Table 6-3-7 Cost Allocation

No.	Item			Electric Power	Agriculture	Total
1	Total Construction Cost	10^3T.L				987,100
2	Exclusive Facilities Construction Costs	10^3T.L		478,180	252,000	730,180
3	Common Structures Construction Costs	10^3T.L	1-2			256,920
4	Benefit (Capitalized)	10^3T.L		1,236,804	384,450	1,621,254
5	Exclusive Facilities Cost (Capitalized)	10^3T.L		642,461	338,813	981,274
6	Surplus Benefit (Capitalized)	10^3T.L	4-5	594,343	45,637	639,980
7	Allocation Ratio	%		93	7	100
8	Allocated Common Structure Construction Cost	10^3T.L		238,940	17,980	256,920
9	Construction Cost After Allocation	10^3T.L	2+8	717,120	269,980	987,100
10	Annual Cost After Allocation	10^3T.L	a+b	53,457	19,603	73,060
	a. Exclusive Facilities	10^3T.L		39,575	18,559	58,134
	b. Common Structures	10^3T.L		13,882	1,044	14,926

b. Annual Cost and Benefit of Electric Power after Allocation

The excess benefit (V-C) that may be realized upon completion of Sandalcik and Bezkese Power Stations of the First Stage Program is 36,160,000 T.L and the benefit-cost ratio is 1.68 as calculated below. Expense per KWh at the primary sub-station at Izmir, the center of demand in the western district, is 0.064 T.L/KWh, also as shown below.

Annual Cost (C)	10^3T.L	53,457
Benefit (V)	10^3T.L	89,617
Excess Benefit	10^3T.L	36,160
Benefit-Cost Ratio		1.68
Annual Energy Output	10^3KWh	867,600
Effective Electric Energy	10^3KWh	835,400
Cost per KWh	T.L	0.064

7. FUTURE INVESTIGATIONS FOR THE FIRST STAGE DEVELOPMENT PROGRAM

7. FUTURE INVESTIGATIONS FOR THE FIRST STAGE DEVELOPMENT PROGRAM

The present survey has been for the purpose of studying the drainage basin development plans of the downstream section of the Dalaman River and as a part of the above, to prepere a Project Report of the First Stage Development Program. Run-off observation, surveying and geological studies have been limited to the scope required for preliminary design work. In order to complement feasibility study made for agricultural phase or to give further detailed information and data for a definite study of this development program, the following investigations should be carried out.

7-1 RUN-OFF GAUGING AND METEOROLOGICAL OBSERVATION

The run-off data used for preparation of the plan were from records of Suçati and Akköpru Gauging Stations and it is necessary to carry out the following run-off and meteorological observations regarding flood discharges, etc.

At Suçati Gauging Station, an automatic water level recorder should be newly installed for continued run-off observation along with Akköpru Gauging Station. Run-off observations during floods should be specially conducted.

New run-off gauging stations equipped with automatic water level recorders should be provided near Kavunca on the main stream and near Geris on a tributary, the Tahtaci Stream, both upstream on the Dalaman River from the Sandalcık project site. Run-off observations during floods should be specially conducted.

At Asmacik, at the lowest point of this project, a gauging station equipped with an automatic water level recorder should be newly provided. Run-off observations during floods should be specially conducted.

Near Dereköy on the Tersakan Stream, a gauging station equipped with an automatic water level recorder should be newly provided. Run-off observation during floods should be especially conducted.

Rainfall observation stations at Acipayama, Çamel, Nifkoyu, Dalaman, Köyceğiz and Fethiye should all be provided with automatic rainfall recorders and rainfall observation should be conducted continuously.

At Dalaman State Farm and Karaagac Village, automatic rainfall recorders should be installed for observation of rainfall.

At Sandalcik, a meteorological observation station equipped with automatic rainfall recorders should be newly provided for observation of rainfall, temperature, etc.

7-2 SURVEYING

a. Sandalcik Dam and Power Station

Triangulation of the area covering dam sites, intakes, headrace, power plant and tailrace sites should be conducted in order to indicate all structures by coordinates.

Detailed topographical maps of 1/500 scale with 2 m contour lines should be prepared for dam sites including the saddle dam site.

Detailed topographical maps of 1/500 scale with 2 m contour lines should be prepared for the vicinities of the intake, surge tank and power plant sites.

Profiles of waterways including intake, headrace, power plant and tailrace should be prepared.

b. Asmacik Dam and Bezkese Power Station

Triangulation of the area covering dam site, intake, headrace, power plant, tailrace and Bezkese Sub-station should be conducted in order to indicate all structures by coordinates.

Detailed topographical maps of 1/500 scale with 2 m contour lines should be prepared of the dam site including the spillway.

Detailed topographical maps of 1/500 scale with 2 m contour lines should be prepared of the vicinities of the intake, surge tank, penstock, power plant and tailrace.

Profiles of waterways including intake, headrace, power plant and tailrace should be prepared.

c. Transmission Lines and Sub-stations

Topographical maps of 1/5, 000 scale with 5 m contour lines covering a zone 600 m wide along the transmission line route should be prepared.

Profiles (height 1/400 and distance 1/2, 000 scale) of the transmission line route should be prepared.

Detailed topographical maps of 1/100 scale with 1 m contour lines should be prepared of steel tower locations.

Topographical maps of 1/500 scale with 1 m contour lines should be prepared of the vicinities of Bezkese and Izmir Sub-stations.

d. Dalaman Plain Area and Tersakan-Kargin Stream

Topographic survey and levelling survey should be carried out on the approximately 25 km from the mouth of the Dalaman River upstream to Asmacik Tepe. Maps of 1/3, 000 scale should be prepared including the area up to 200 m on the outside of both left and right banks of the proposed levee should be surveyed. Contour lines should be at 1 m intervals as a rule with auxiliary contour lines at 0. 5 m wherever possible. River profile drawings and cross-sectional drawings should be prepared with the distance between surveying points to be 100 m.

Topographic survey and levelling survey of the approximately 25 km from the mouth of the Tersakan Stream upstream through Dereköy to Karaagac Village should be carried out. The nature of the survey work should be the same as that described for the Dalaman River. However, the width of the survey zone should be from a line approximately 200 m outside of the proposed right bank levee line to an elevation about the same height as the proposed levee on the left bank mountain side.

Topographic survey and levelling survey of the Tersakan New Waterway between Dereköy and Çaybşi should be carried out according to the procedure described for the Dalaman River. Especially, since there is a great difference between the existing 1/5, 000 and 1/25, 000 topographical maps for the Dereköy, Akçagolüzü, Oyuklutepe, Bezkesedüzü, and Taşilburun vicinities, a dependable topographical map should be made. For this Project, Dereköy to Çaybşi has been proposed as the route of the New Waterway, but depending on the result of topographical survey, there is a possibility that Dereköy to Taşliburun will be more economical and this should be kept in mind when conducting the survey work.

Topographic survey and levelling surveys of the proposed new irrigation and drainage canal routes and levees should be carried out.

7-3. GEOLOGICAL SURVEY

a. Sandalcik Main Dam Sites

Geological surveys should be carried out of the upper and lower sites of the Sandalcik Main Dam. The purpose of the investigation is detailed survey of foundation rock of the dam for the upper site and study of the unsurveyed right bank, and detailed survey of magnitude and length of faults in the left bank of the lower site.

Upper Dam Site (See Dwg. -5)

Table 7-3-1 Adit

Adit No.	Elevation (m)	Co-ordinate		Length (m)	Note
		X	Y		
UT- 1	575	418,535	4,107,110	80	N40°E
UT- 2.	660	418,653	4,107,142	50	25 - 50m N30°W
UT- 3	670	418,603	4,107,153	50	N
UT- 4	690	418,581	4,107,189	60	N
UT- 5	700	418,545	4,107,212	80	40 - 80m N35°W
UT- 6	580	418,612	4,107,058	50	S
UT- 7	660	418,600	4,107,020	50	S
UT- 8	675	418,565	4,107,000	50	S
UT- 9	690	418,612	4,106,963	40	S
UT-10	700	418,515	4,106,968	50	S15°E
Total				560	

Bearing tests should be performed and modulus of elasticity of foundation rock obtained for all adits.

Table 7-3-2 Boring

Adit No.	Elevation (m)	Co-ordinate		Length (m)	Note
		X	Y		
SK-B5	710	418,618	4,107,249	55	Vertical
SK-B6	685	418,618	4,107,197	85	Vertical
SK-B7	655	418,618	4,107,120	100	Vertical
SK-B8	680	418,618	4,106,987	100	Vertical
SK-B9	695	418,584	4,106,956	100	Vertical
SK-10	575	418,468	4,107,100	100	Direction S Dip 65° } Cross the river bed.
SK-11	585	418,533	4,107,060	100	Direction N Dip 60° } Cross the river bed.
Total				640	

Lower Dam Site (See Dwg. -5)

Table 7-3-3 Adit

Adit No.	Elevation (m)	Co-ordinate		Length (m)	Note
		X	Y		
LT-2	630	418,158	4,107,092	310	0 - 135m S20°W 135 - 270m S30°E 135m to branch S85°W (40m)
LT-3	620	418,100	4,107,112	30	N60°W N35°W
LT-4	670	418,014	4,107,045	30	Co-ordinate is not exact S35°E
LT-5	670	418,058	4,107,020	30	Co-ordinate is not exact
Total				400	

Bearing tests should be performed and modulus of elasticity of foundation rock obtained from all adits.

Table 7-3-4 Trench

Trench No.	Elevation (m)	Length (m)	Note
1	650	180	Location is shown on the map
2	680	240	Location is shown on the map
3	700	130	Location is shown on the map
Total		550	

Table 7-3-5 Boring

Boring No.	Elevation (m)	Co-ordinate		Length (m)	Note
		X	Y		
SK-B 204	715	418,030	4,107,125	100	Vertical
SK-B 205	720	417,997	4,107,105	100	Vertical
SK-B 206	715	418,084	4,107,003	150	Direction N15°E Dip 80°
SK-B 207	715	418,057	4,106,993	100	Vertical
Total				450	

b. Saddle Dam Site (See Dwg-10)

b-1 Geological survey based on a 1/1, 000 topographical map should be carried out for the entire dam site area.

b-2 Run-off of the gully at a point downstream of the dam site should be measured periodically once a month.

b-3 Boring should be carried out as per the table below.

Table 7-3-6 Boring

Boring No.	Co-ordinate		Length (m)	Note
	X	Y		
SK-106	419,380	4,105,875	80	Vertical
SK-107	419,380	4,105,740	80	Vertical
SK-108	419,525	4,105,875	80	Vertical

Boring No.	Co-ordinate		Length (m)	Note
	X	Y		
SK-109	419,514	4,105,720	80	Vertical
SK-110	419,504	4,105,590	80	Vertical
SK-111	419,640	4,105,570	80	Vertical
SK-112	419,640	4,105,430	80	Vertical
SK-113	419,790	4,105,570	80	Vertical
Total			640	

c. Waterway Structures

Intake Site (See Dwg. -12)

1) Geological survey based on 1/500 and 1/1,000 topographical maps should be carried out and depth of surface soil and talus deposits investigated by trenches.

2) Boring should be conducted near the center of the intake.

Pressure Tunnel

1) Geological survey based on a 1/5,000 topographical map should be carried out over the entire length of the tunnel.

2) Should any large-scale fault crossing the waterway be encountered as a result of the above survey, the fault should be confirmed by boring.

3) Wherever topographically feasible, seismic prospecting should be carried out above the tunnel and at locations perpendicularly crossing the tunnel.

4) Several borings should be performed from the ground surface to the tunnel base to investigate the rock character of peridotite and serpentinite. The boring locations should be decided based on topography and geology.

Surge Tank (See Dwg. -12)

1) Geological survey should be carried out based on 1/1,000 or 1/5,000 topographical maps. The contact between peridotite and limestone existing near the tank, especially, should be thoroughly investigated.

2) Boring should be conducted at the tank center down to the foundation.

Penstock Route and Power Plant (See Dwg. -12)

1) Geological survey over a wide area should be carried out based on 1/1, 000 and 1/5, 000 topographical maps. Especially, as it is assumed there will be landcreeps and faults near the penstock construction adits, and inclined access tunnel to the power plant, thorough investigation will be necessary.

2) Investigations by boring and adits will be necessary for the above sites. It would be desirable to locate these borings and adits at the proposed sites of construction adits and the inclined access tunnel.

Tailrace

1) Geological survey should be carried out over the entire length of the tailrace based on a 1/5, 000 topographical map.

2) As the Dalaman River where it is crossed by the tailrace may be a fault valley, 2 cross borings to investigate the river bed at this point will be absolutely necessary.

3) Wherever topographically feasible, seismic prospecting should be carried out above the tailrace and at locations perpendicularly crossing the tunnel.

4) Several borings should be performed from the ground surface to the tunnel base to investigate the rock character of peridotite and serpentinite. The boring locations should be decided based on topography and geology.

d. Asmacik Dam, Bezkese Pressure Tunnel and Power Plant Sites (See Dwg. -14, 16)

1) Borings should be carried out in the river bed and on both banks, at the same time conducting permeability tests in the river bed and pressure tests on the river banks.

2) Geological survey should be carried out over the entire length of the

pressure tunnel based on a 1/5,000 topographical map and should any large-scale fault crossing the tunnel be encountered, the fault should be confirmed by boring.

3) Wherever topographically feasible, seismic prospecting should be carried out.

4) Several borings should be performed from the ground surface to the tunnel base to investigate the rock character of dunite and serpentinite. The boring locations should be decided based on topography and geology.

5) For the vicinities of the surge tank and the power plant geological survey should be carried out based on a 1/1,000 topographical map and borings conducted at the center of the various structures down to the foundation.

Table 7-3-7 Boring at Dam Site

Boring No.	Elevation (m)	Co-ordinate		Length (m)	Note
		X	Y		
SK-4		1,443	1,366	50	Vertical, river bed
SK-5		1,443	1,456	70	Vertical, river bed
SK-6		1,443	1,530	40	Vertical, river bed
SK-7		1,482	1,490	70	Vertical, river bed
SK-8		1,523	1,368	40	Vertical, river bed
SK-9		1,523	1,450	70	Vertical, river bed
SK-10		1,523	1,530	50	Vertical, river bed
SK-11		1,563	1,410	70	Vertical, river bed
SK-12	80	1,480	1,580	40	Vertical, right bank
SK-13	80	1,482	1,330	40	Vertical, left bank
Total				540	

e. Dalaman Plain Area

Boring investigations should be carried out over the proposed tunnel routes of the irrigation canal system and pumping stations.

7-4 MATERIAL SURVEY

a. Sandalcık Dam and Power Station

The material found at the proposed aggregate pit sites along the Tahtacı Stream above the dam site should be tested for suitability as aggregate for concrete and concrete tests should be conducted.

The soil material found at the proposed borrow pit sites should be subjected to further testing in the laboratory and compaction tests carried out in the field.

b. Asmacik Dam and Power Station

Field compaction tests should be carried out on soil material from proposed borrow pit sites.

The area of the proposed borrow pit sites should be expanded and laboratory tests similar to those made in the present survey should be conducted. Field compaction tests should also be carried out.

c. Flood Protection Levees

Surveys should be made of borrow pit sites of levee embankment material and soil surveys should be made.

7-5 OTHERS

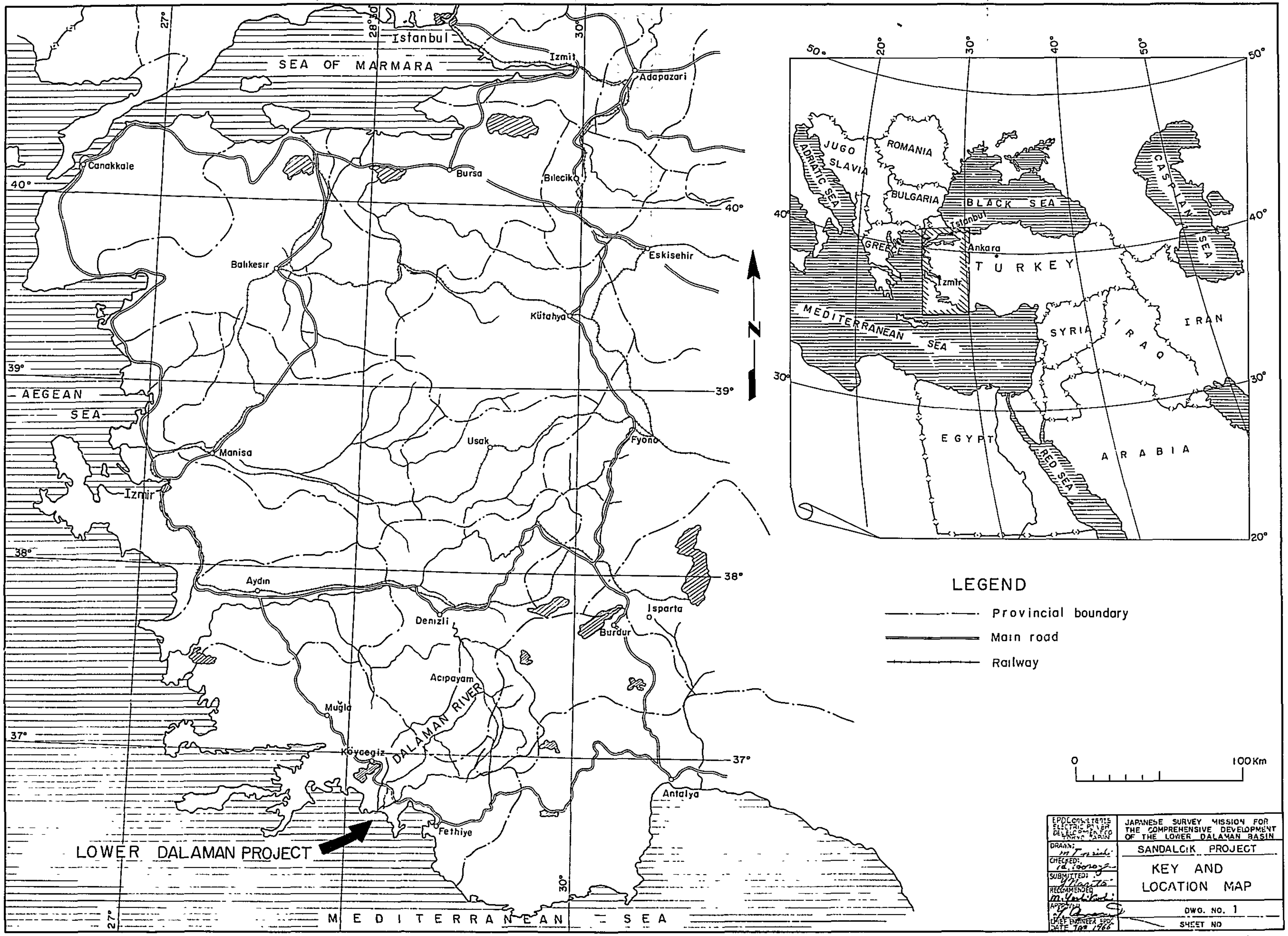
Engineering experiments necessary for establishment of branch irrigation methods should be carried out.

Field survey and gathering of planning data regarding the proposed flood control reservoir at Karaagac should be carried out.

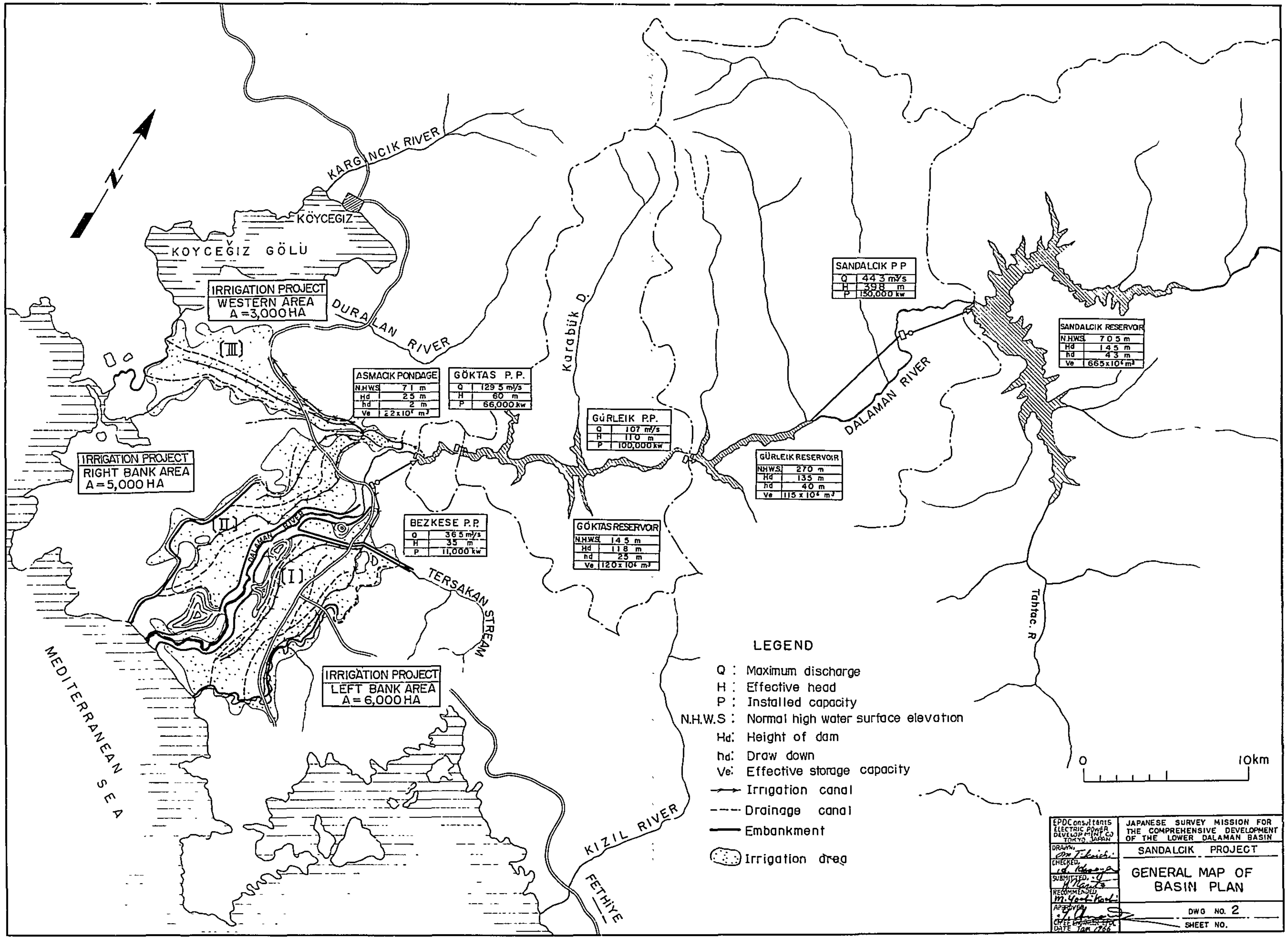
Investigation of the Dalaman River in the plain area by river engineer should be carried out.

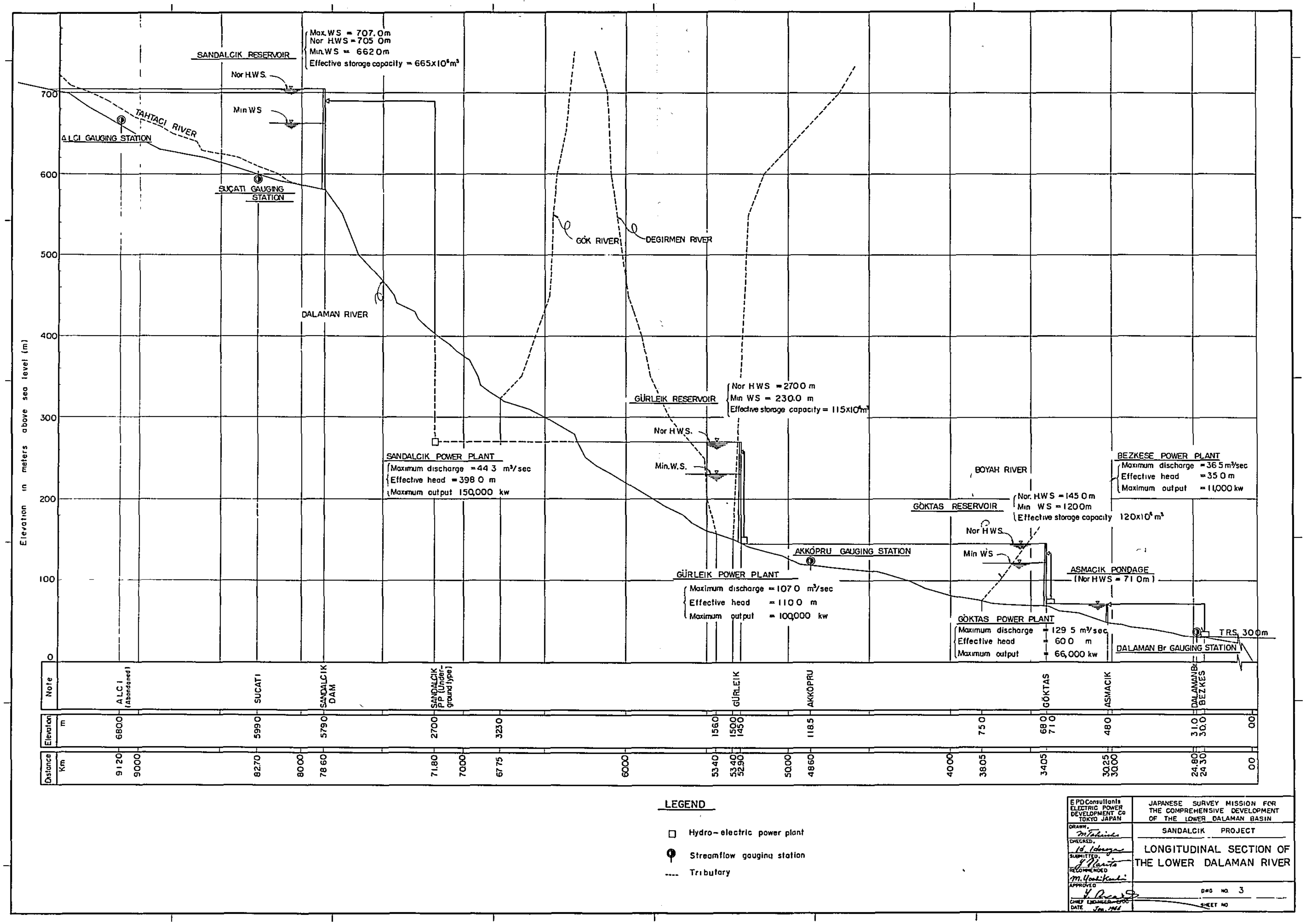
DRAWINGS OF SANDALCIK PROJECT

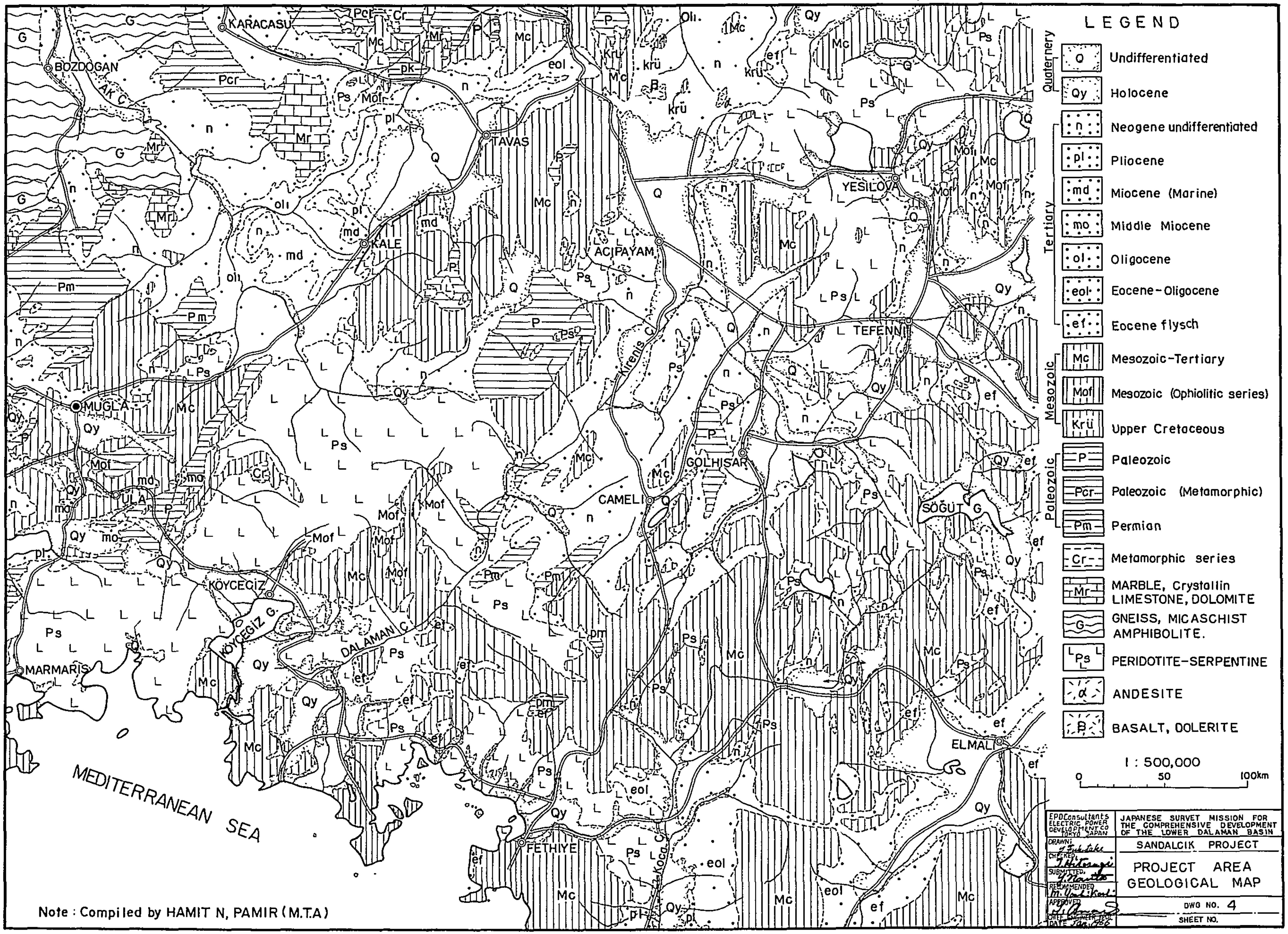
LIST OF DRAWINGS

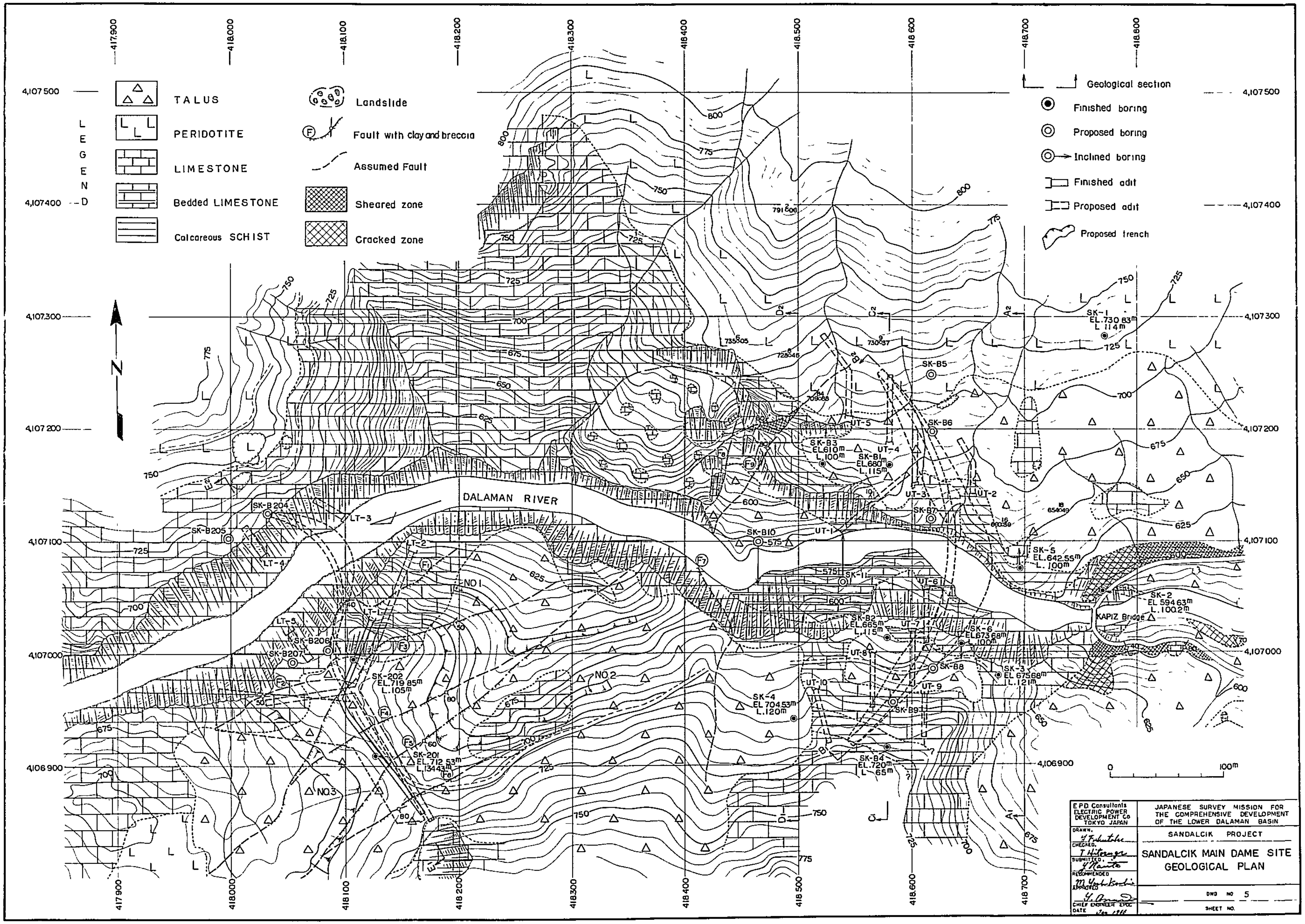


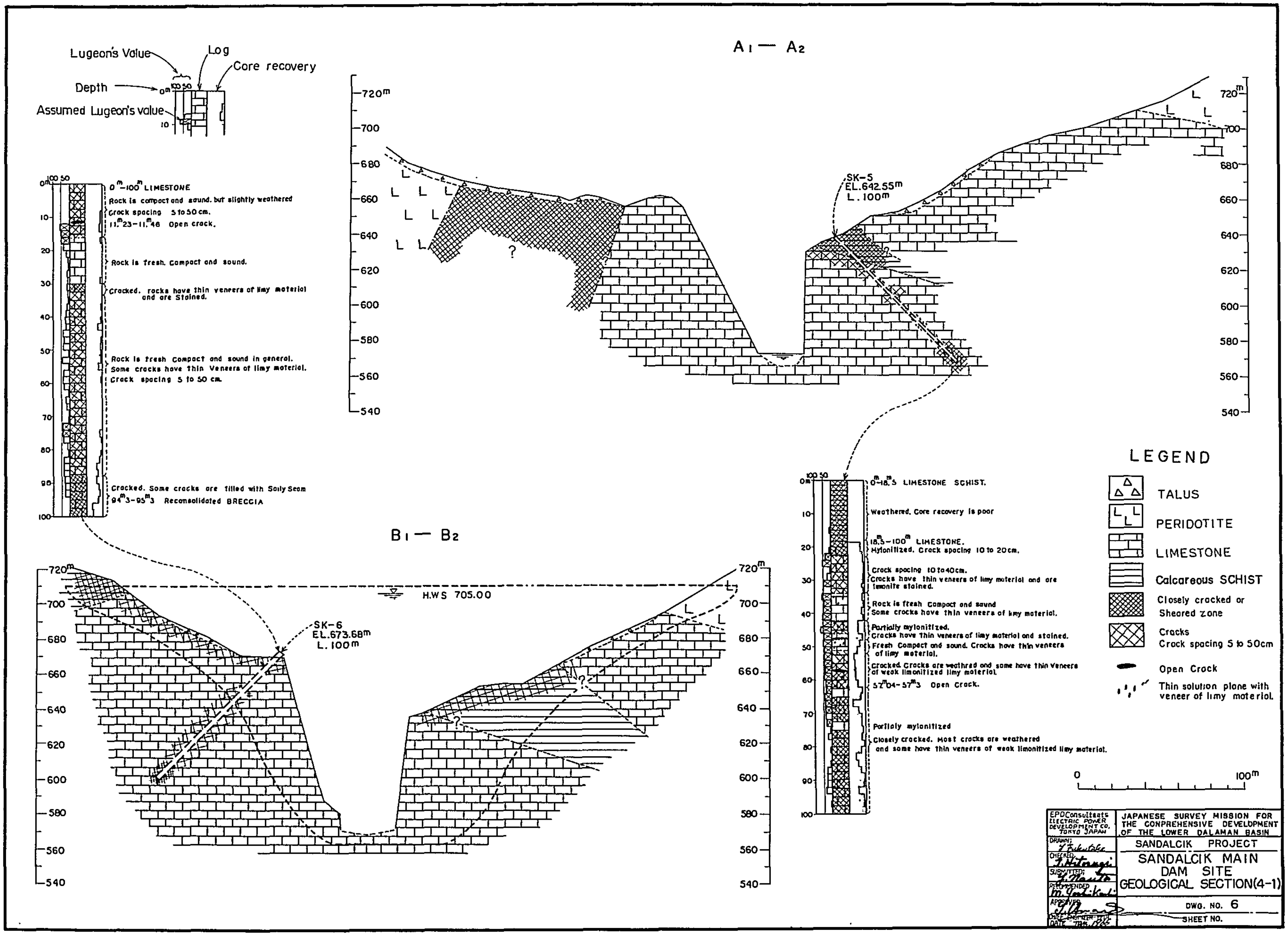
Istanbul
SEA OF MARMARA
Izmit
Adapazari
Canakkale
Bursa
Bilecik
Balıkesir
Eskisehir
Kütahya
AEGEAN
SEA
Manisa
Usak
Fyon
Izmir
Aydın
Denizli
Isparta
Burdur
Acıpayam
Mugla
DALAMAN RIVER
Köycegiz
Antalya
Fethiye
LOWER DALAMAN PROJECT
MEDITERRANEAN SEA
N
JUGO SLAVIA
ROMANIA
ADRIATIC SEA
BULGARIA
BLACK SEA
CASPIAN SEA
GREECE
Istanbul
Ankara
TURKEY
Izmir
MEDITERRANEAN SEA
SYRIA
IRAQ
IRAN
EGYPT
RED SEA
ARABIA
LEGEND
Provincial boundary
Main road
Railway
0
100Km
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
KEY AND LOCATION MAP
DWG. NO. 1
SHEET NO
DRAWN:
CHECKED:
SUBMITTED:
RECOMMENDED:
APPROVED:


KARGINCIK RIVER
KÖYCEGIZ
KOYCEĞIZ GÖLÜ
IRRIGATION PROJECT
WESTERN AREA
A =3,000 HA
DURALAN RIVER
(III)
ASMACIK PONDAGE
N.H.W.S 71 m
Hd 25 m
hd 2 m
Ve 22x10⁶ m³
GÖKTAS P.P.
Q 129.5 m³/s
H 60 m
P 66,000 kw
Karabük D.
GÜRLEIK P.P.
Q 107 m³/s
H 110 m
P 100,000 kw
SANDALCIK P P
Q 44.3 m³/s
H 398 m
P 150,000 kw
SANDALCIK RESERVOIR
N.H.W.S. 705 m
Hd 145 m
hd 43 m
Ve 665x10⁶ m³
DALAMAN RIVER
GÜRLEIK RESERVOIR
N.H.W.S. 270 m
Hd 135 m
hd 40 m
Ve 115 x 10⁶ m³
IRRIGATION PROJECT
RIGHT BANK AREA
A = 5,000 HA
(II)
(I)
BEZKESE P.P.
Q 36.5 m³/s
H 35 m
P 11,000 kw
GÖKTAS RESERVOIR
N.H.W.S. 145 m
Hd 118 m
hd 25 m
Ve 120 x 10⁶ m³
TERSAKAN STREAM
Tahtac. R
MEDITERRANEAN SEA
IRRIGATION PROJECT
LEFT BANK AREA
A = 6,000 HA
KIZIL RIVER
FETHIYE
LEGEND
Q : Maximum discharge
H : Effective head
P : Installed capacity
N.H.W.S : Normal high water surface elevation
Hd: Height of dam
hd: Draw down
Ve: Effective storage capacity
Irrigation canal
Drainage canal
Embankment
Irrigation area
0 10km
EPDC consultants ELECTRIC POWER DEVELOPMENT CO TOKYO, JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE Jan 1966
SANDALCIK PROJECT
GENERAL MAP OF BASIN PLAN
DWG NO. 2
SHEET NO.


SANDALCIK RESERVOIR
Max. WS = 707.0m
Nor H.WS = 705 0m
Min. WS = 662.0m
Effective storage capacity = 665x10⁶m³
Nor H.W.S.
Min WS
TAHTACI RIVER
ALCI GAUGING STATION
SUÇATI GAUGING STATION
DALAMAN RIVER
GÖK RIVER
DEGIRMEN RIVER
GÜRLEIK RESERVOIR
Nor HWS = 270.0 m
Min WS = 230.0 m
Effective storage capacity = 115x10⁶m³
Nor H.W.S.
Min. W.S.
SANDALCIK POWER PLANT
Maximum discharge = 44.3 m³/sec
Effective head = 398.0 m
Maximum output 150,000 kw
BOYALI RIVER
GÖKTAS RESERVOIR
Nor. HWS = 145.0m
Min WS = 120.0m
Effective storage capacity 120x10⁶m³
Nor HWS
Min WS
BEZKESE POWER PLANT
Maximum discharge = 36.5 m³/sec
Effective head = 35.0 m
Maximum output = 11,000 kw
AKKÖPRU GAUGING STATION
GÜRLEIK POWER PLANT
Maximum discharge = 107.0 m³/sec
Effective head = 110.0 m
Maximum output = 100,000 kw
ASMACIK PONDAGE
(Nor HWS = 71.0m)
GÖKTAS POWER PLANT
Maximum discharge = 129.5 m³/sec
Effective head = 60.0 m
Maximum output = 66,000 kw
TRS. 30.0m
DALAMAN Br GAUGING STATION
Elevation in meters above sea level (m)
700
600
500
400
300
200
100
0
Note
ALCI (Abandoned)
SUCATI
SANDALCIK DAM
SANDALCIK PP (Underground type)
GÜRLEIK
AKKÖPRU
GÖKTAS
ASMACIK
DALAMAN Br
BEZKES
Elevation m
680.0
599.0
579.0
270.0
323.0
156.0
150.0
145.0
118.5
75.0
68.0
71.0
48.0
31.0
30.0
0.0
Distance Km
91.20
90.00
82.70
80.00
78.60
71.80
70.00
67.75
60.00
53.40
53.40
52.90
50.00
48.60
40.00
38.05
34.05
30.25
30.00
24.80
24.30
0.0
LEGEND
Hydro-electric power plant
Streamflow gauging station
Tributary
EPDC Consultants
ELECTRIC POWER DEVELOPMENT CO
TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
LONGITUDINAL SECTION OF THE LOWER DALAMAN RIVER
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE
DWG NO. 3
SHEET NO


LEGEND
Quaternery
Q Undifferentiated
Qy Holocene
Tertiary
n Neogene undifferentiated
pl Pliocene
md Miocene (Marine)
mo Middle Miocene
ol Oligocene
eol Eocene-Oligocene
ef Eocene flysch
Mesozoic
Mc Mesozoic-Tertiary
Mof Mesozoic (Ophiolitic series)
Krü Upper Cretaceous
Paleozoic
P Paleozoic
Pcr Paleozoic (Metamorphic)
Pm Permian
Cr Metamorphic series
Mr MARBLE, Crystallin LIMESTONE, DOLOMITE
G GNEISS, MICASCHIST AMPHIBOLITE.
Ps PERIDOTITE-SERPENTINE
α ANDESITE
B BASALT, DOLERITE
1 : 500,000
0 50 100km
KARACASU
BOZDOGAN
AK C.
TAVAS
YESILOVA
KALE
ACIPAYAM
TEFENNI
MUGLA
Kırenis C.
GOLHISAR
ULA
CAMELI
SOGUT G.
KÖYCEGIZ
KÖYCEGIZ G.
DALAMAN C.
MARMARIS
ELMALI
FETHIYE
Koca C.
MEDITERRANEAN SEA
Note : Compiled by HAMIT N, PAMIR (M.T.A)
EPDC Consultants ELECTRIC POWER DEVELOPMENT CO. TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
PROJECT AREA GEOLOGICAL MAP
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER
DATE
DWG NO. 4
SHEET NO.


LEGEND
TALUS
PERIDOTITE
LIMESTONE
Bedded LIMESTONE
Calcareous SCHIST
Landslide
Fault with clay and breccia
Assumed Fault
Sheared zone
Cracked zone
Geological section
Finished boring
Proposed boring
Inclined boring
Finished adit
Proposed adit
Proposed trench
DALAMAN RIVER
KAPIZ Bridge
SK-1 EL.730.83m L.114m
SK-2 EL.594.63m L.100.2m
SK-3 EL.675.68m L.121m
SK-4 EL.704.53m L.120m
SK-5 EL.642.55m L.100m
SK-6 EL.673.68m L.100m
SK-201 EL.712.53m L.134.43m
SK-202 EL.719.85m L.105m
SK-B1 EL.680m L.115m
SK-B2 EL.665m L.115m
SK-B3 EL.610m L.100m
SK-B4 EL.720m L.65m
0 100m
EPD Consultants ELECTRIC POWER DEVELOPMENT Co. TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
SANDALCIK MAIN DAME SITE GEOLOGICAL PLAN
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE
DWG NO. 5
SHEET NO.


A1 — A2
B1 — B2
Lugeon's Value
Log
Core recovery
Depth
Assumed Lugeon's value
SK-5
EL.642.55m
L.100m
SK-6
EL.673.68m
L.100m
H.W.S 705.00
0m–100m LIMESTONE
Rock is compact and sound. but slightly weathered
Crack spacing 5 to 50 cm.
11.m23–11.m46 Open crack.
Rock is fresh. Compact and sound.
Cracked. rocks have thin veneers of limy material and are Stained.
Rock is fresh Compact and sound in general.
Some cracks have thin Veneers of limy material.
Crack spacing 5 to 50 cm.
Cracked. Some cracks are filled with Soily Seam
94m3–95m3 Reconsolidated BRECCIA
0m–18.m5 LIMESTONE SCHIST.
Weathered. Core recovery is poor
18.m5–100m LIMESTONE.
Mylonitized. Crack spacing 10 to 20cm.
Crack spacing 10 to 40cm.
Cracks have thin veneers of limy material and are limonite stained.
Rock is fresh Compact and sound
Some cracks have thin veneers of limy material.
Partially mylonitized.
Cracks have thin veneers of limy material and stained.
Fresh Compact and sound. Cracks have thin veneers of limy material.
Cracked. Cracks are weathred and some have thin Veneers of weak limonitized limy material.
57m04–57m3 Open Crack.
Partialy mylonitized
Closely cracked. Most cracks are weathered and some have thin veneers of weak limonitized limy material.
LEGEND
TALUS
PERIDOTITE
LIMESTONE
Calcareous SCHIST
Closely cracked or Sheared zone
Cracks
Crack spacing 5 to 50cm
Open Crack
Thin solution plane with veneer of limy material.
0
100m
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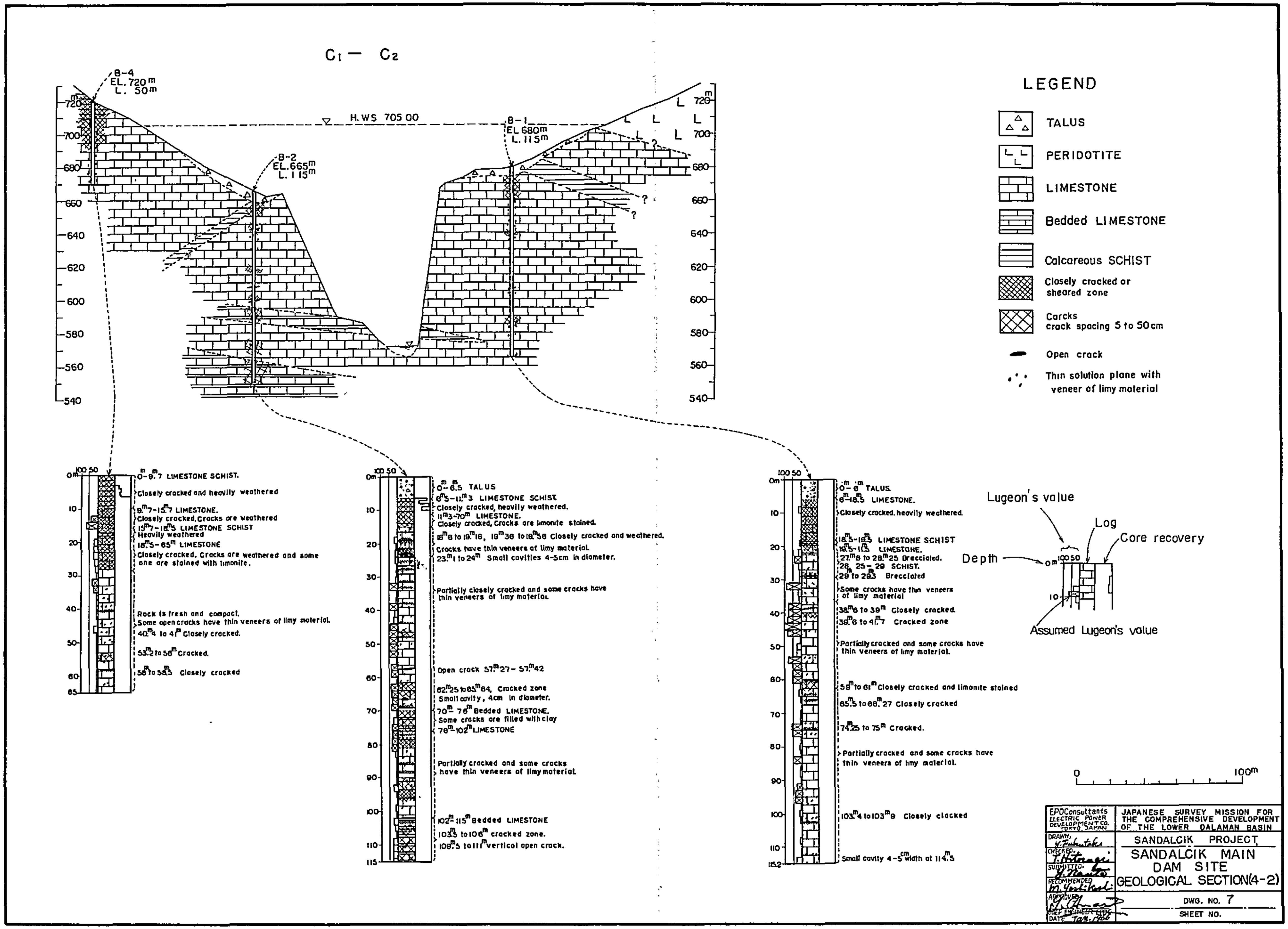
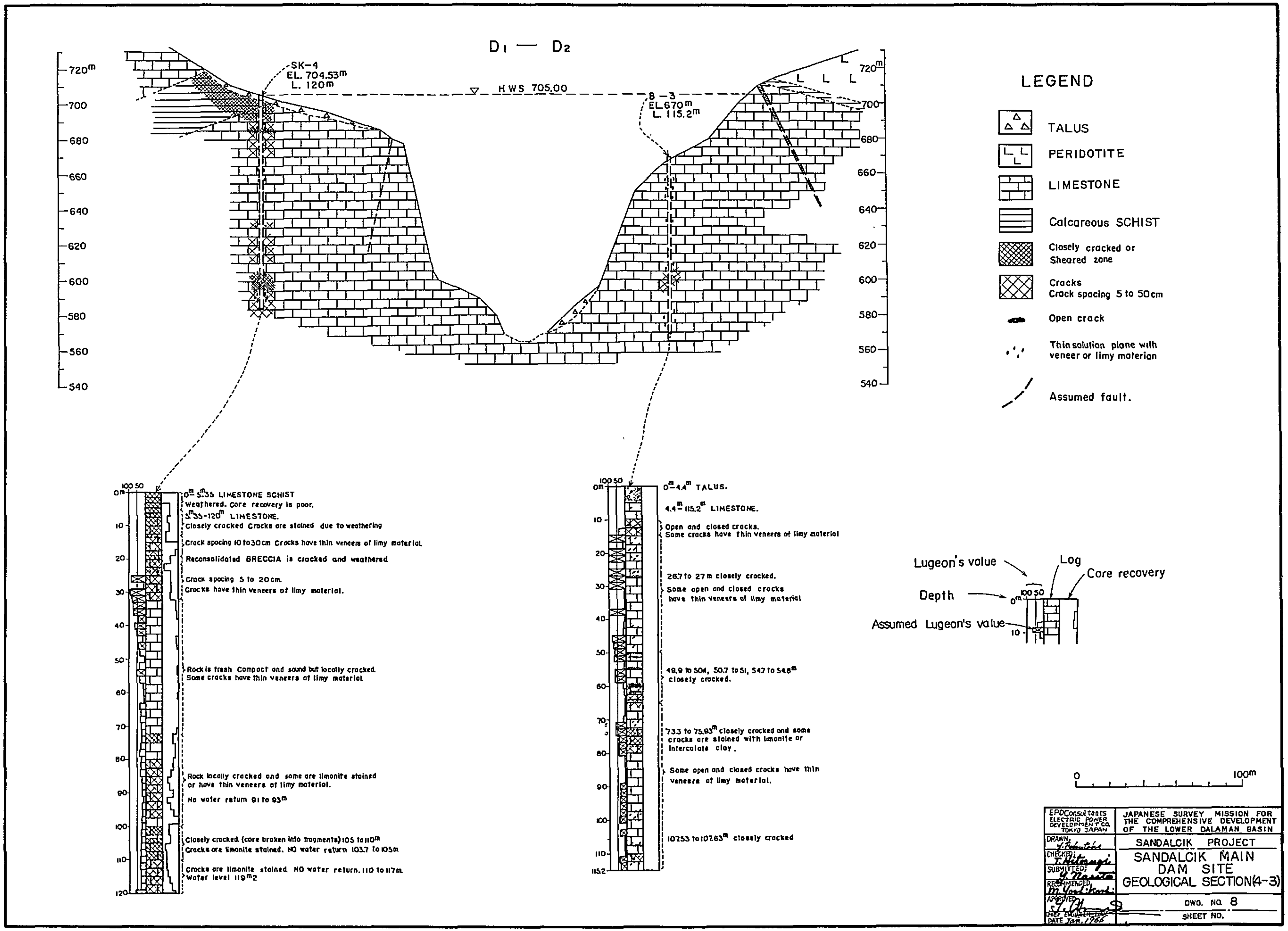
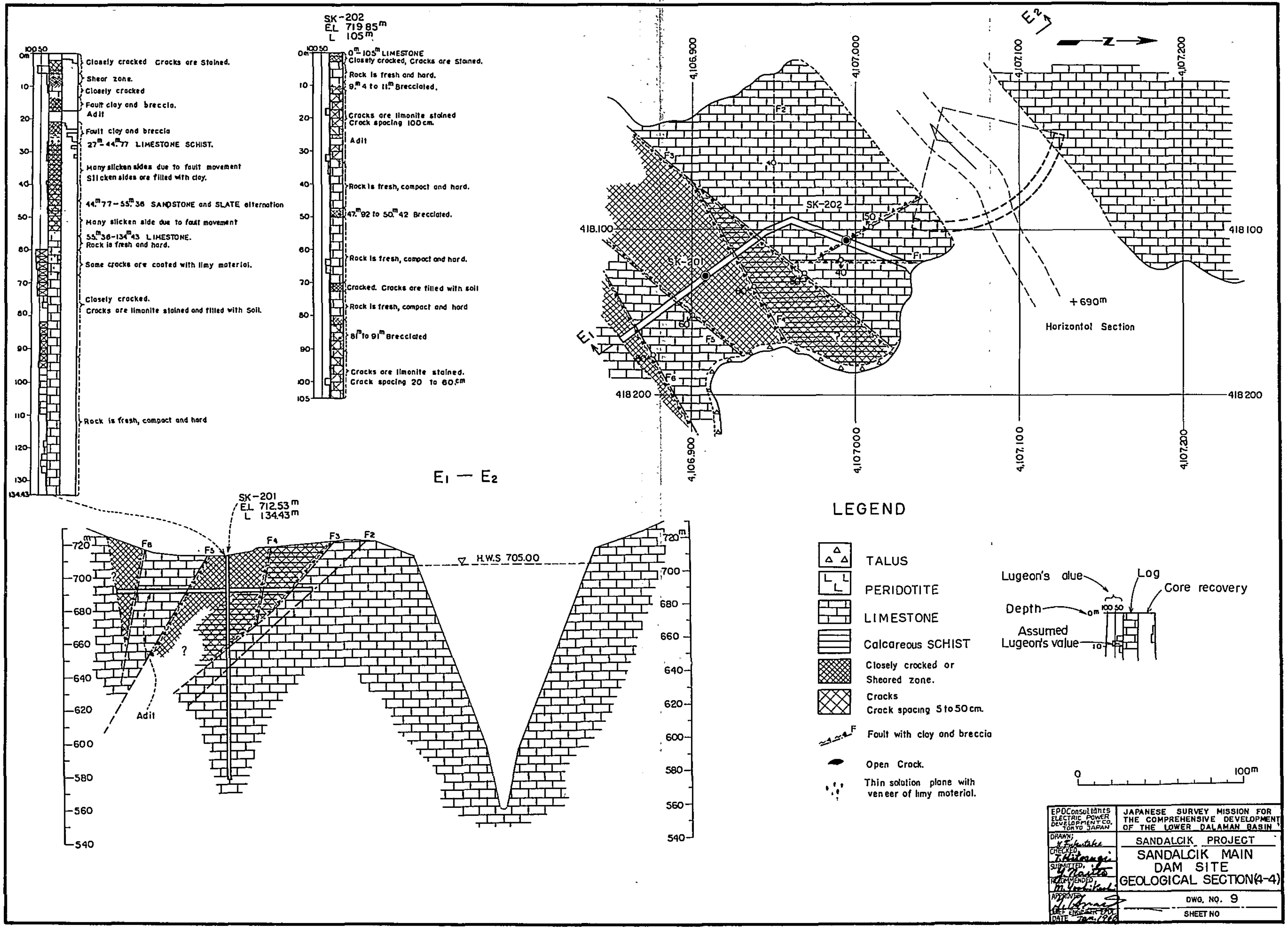
JAPANESE SURVEY MISSION FOR THE CONPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
SANDALCIK MAIN DAM SITE GEOLOGICAL SECTION(4-1)
DRAWN;
CHECKED;
SUBMITTED;
RECOMMENDED;
APPROVED;
DATE
DWG. NO. 6
SHEET NO.

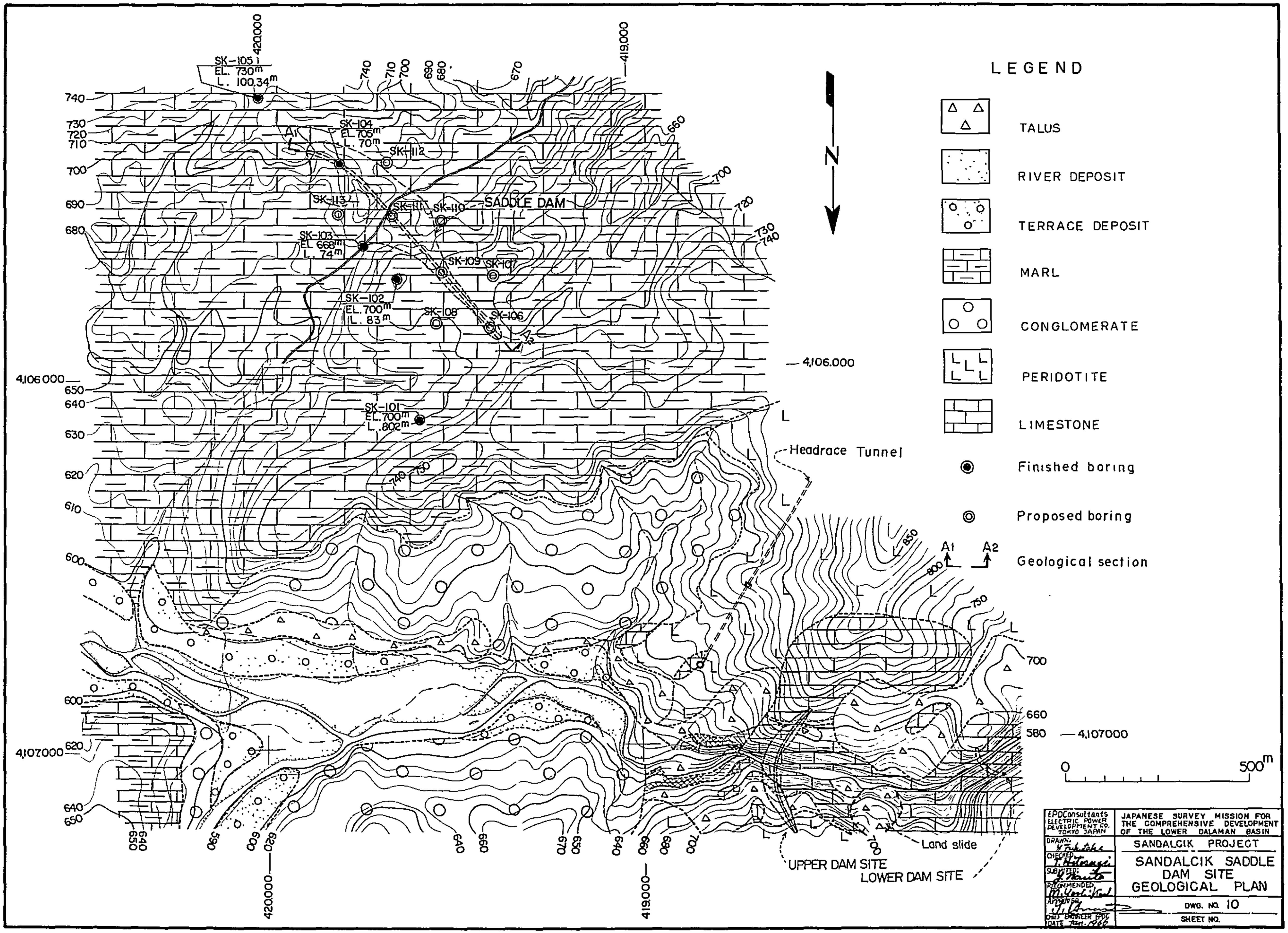


C1 — C2
B-4
EL. 720m
L. 50m
B-2
EL.665m
L. 115m
B-1
EL 680m
L. 115m
H.WS 705.00
LEGEND
TALUS
PERIDOTITE
LIMESTONE
Bedded LIMESTONE
Calcareous SCHIST
Closely cracked or sheared zone
Carcks crack spacing 5 to 50cm
Open crack
Thin solution plane with veneer of limy material
0-9.7 LIMESTONE SCHIST.
Closely cracked and heavily weathered
9.7-15.7 LIMESTONE.
Closely cracked. Cracks are weathered
15.7-18.5 LIMESTONE SCHIST
Heavily weathered
18.5-65 LIMESTONE
Closely cracked. Cracks are weathered and some one are stained with limonite.
Rock is fresh and compact.
Some open cracks have thin veneers of limy material.
40.4 to 41 Closely cracked.
53.2 to 56 Cracked.
58 to 58.5 Closely cracked
0-6.5 TALUS
6.5-11.3 LIMESTONE SCHIST
Closely cracked, heavily weathered.
11.3-70 LIMESTONE.
Closely cracked, Cracks are limonite stained.
18.8 to 19.16, 19.36 to 19.58 Closely cracked and weathered.
Cracks have thin veneers of limy material.
23.1 to 24 Small cavities 4-5cm in diameter.
Partially closely cracked and some cracks have thin veneers of limy material.
Open crack 57.27 - 57.42
62.25 to 65.84, Cracked zone
Small cavity, 4cm in diameter.
70 - 76 Bedded LIMESTONE.
Some cracks are filled with clay
76-102 LIMESTONE
Partially cracked and some cracks have thin veneers of limy material.
102-115 Bedded LIMESTONE
103.5 to 106 cracked zone.
108.5 to 111 vertical open crack.
0-6 TALUS.
6-18.5 LIMESTONE.
Closely cracked, heavily weathered.
18.5-18.5 LIMESTONE SCHIST
18.5-115 LIMESTONE.
27.8 to 28.25 Brecciated.
28.25-29 SCHIST.
29 to 29.3 Brecciated
Some cracks have thin veneers of limy material
38.8 to 39 Closely cracked.
38.8 to 41.7 Cracked zone
Partially cracked and some cracks have thin veneers of limy material.
59 to 61 Closely cracked and limonite stained
65.5 to 68.27 Closely cracked
74.25 to 75 Cracked.
Partially cracked and some cracks have thin veneers of limy material.
103.4 to 103.9 Closely clacked
Small cavity 4-5cm width at 114.5
Lugeon's value
Log
Core recovery
Depth
Assumed Lugeon's value
0
100m
EPOConsultants
ELECTRIC POWER DEVELOPMENT CO.
TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN,
CHECKED,
SUBMITTED,
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE
SANDALCIK PROJECT
SANDALCIK MAIN DAM SITE
GEOLOGICAL SECTION(4-2)
DWG. NO. 7
SHEET NO.

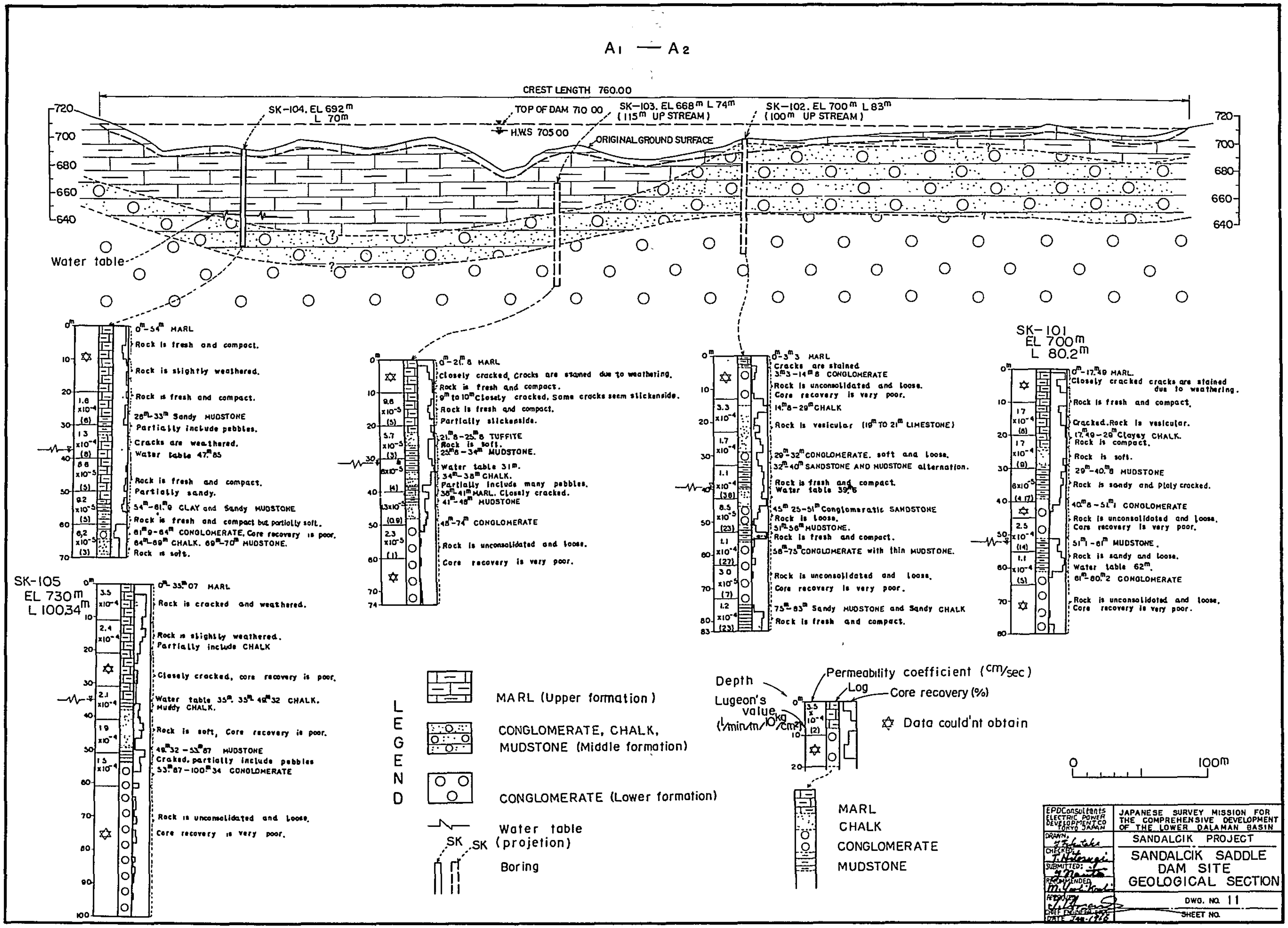


D1 — D2
SK-4
EL. 704.53m
L. 120m
H W S 705.00
B-3
EL.670m
L. 115.2m
LEGEND
TALUS
PERIDOTITE
LIMESTONE
Calcareous SCHIST
Closely cracked or Sheared zone
Cracks
Crack spacing 5 to 50cm
Open crack
Thin solution plane with veneer or limy materion
Assumed fault.
0m–5.35m LIMESTONE SCHIST
Weathered. Core recovery is poor.
5m35–120m LIMESTONE.
Closely cracked Cracks are stained due to weathering
Crack spacing 10 to 30cm Cracks have thin veneers of limy material.
Reconsolidated BRECCIA is cracked and weathered
Crack spacing 5 to 20cm.
Cracks have thin veneers of limy material.
Rock is fresh Compact and sound but locally cracked.
Some cracks have thin veneers of limy material
Rock locally cracked and some are limonite stained
or have thin veneers of limy material.
No water return 91 to 93m
Closely cracked. (core broken into fragments) 105 to 110m
Cracks are limonite stained. NO water return 103.7 to 105m
Cracks are limonite stained. NO water return. 110 to 117m.
Water level 119m2
0m–4.4m TALUS.
4.4m–115.2m LIMESTONE.
Open and closed cracks.
Some cracks have thin veneers of limy material
26.7 to 27m closely cracked.
Some open and closed cracks
have thin veneers of limy material
49.9 to 50.4, 50.7 to 51, 54.7 to 54.8m
closely cracked.
73.3 to 75.93m closely cracked and some
cracks are stained with limonite or
intercalate clay.
Some open and closed cracks have thin
veneers of limy material.
10253 to 107.83m closely cracked
Lugeon's value
Log
Core recovery
Depth
Assumed Lugeon's value
0
100m
EPDConsultants
ELECTRIC POWER DEVELOPMENT CO.
TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER
DATE Jan. 1966
SANDALCIK PROJECT
SANDALCIK MAIN DAM SITE
GEOLOGICAL SECTION(4-3)
DWG. NO. 8
SHEET NO.

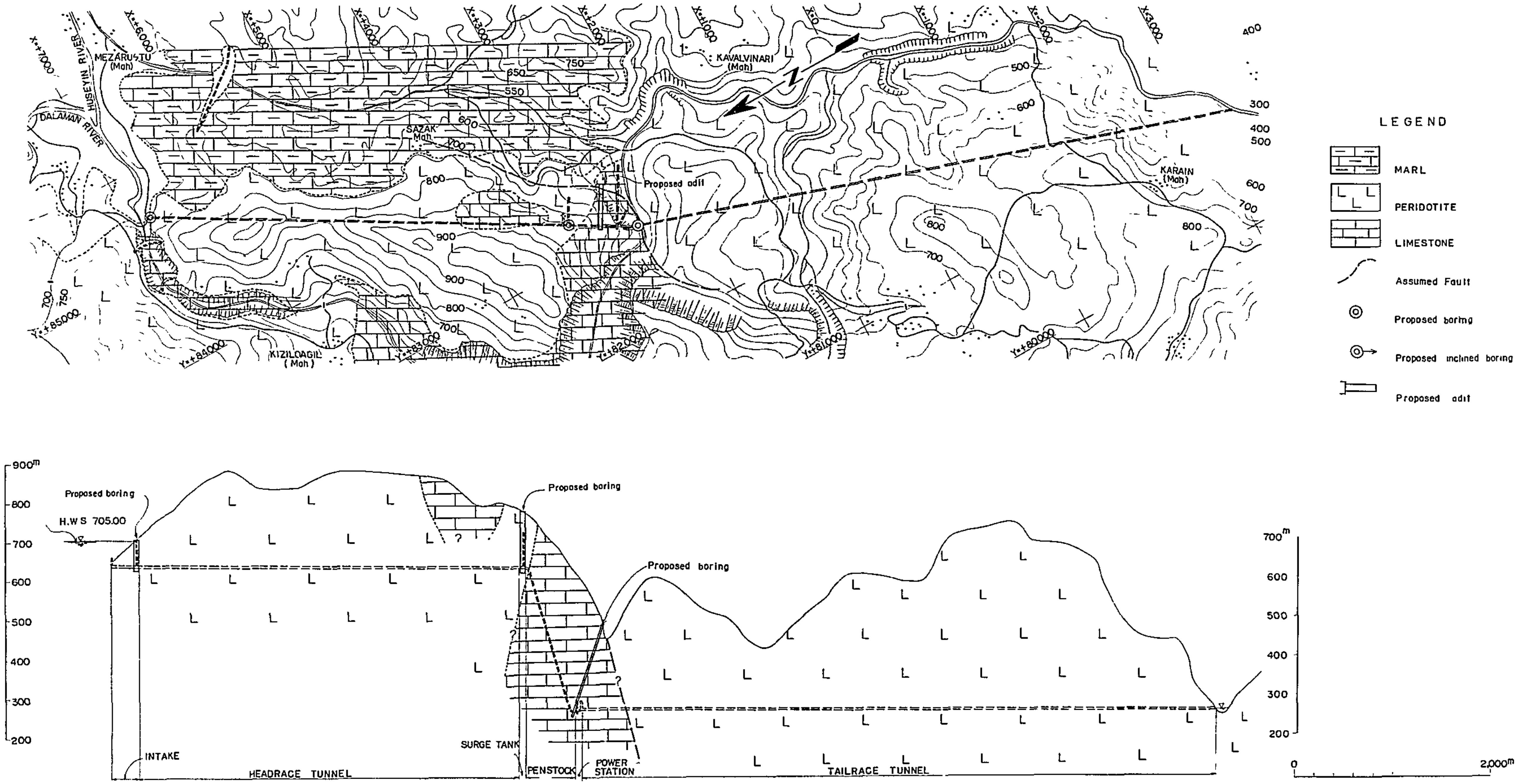

SK-202
EL 719.85m
L 105m
0m–105m LIMESTONE
Closely cracked, Cracks are Stained.
Rock is fresh and hard.
9.4m to 11m Brecciated.
Cracks are limonite stained
Crack spacing 100 cm.
Adit
Rock is fresh, compact and hard.
47.92m to 50.42m Brecciated.
Rock is fresh, compact and hard.
Cracked. Cracks are filled with soil
Rock is fresh, compact and hard
81m to 91m Brecciated
Cracks are limonite stained.
Crack spacing 20 to 60 cm
Closely cracked Cracks are Stained.
Shear zone.
Closely cracked
Fault clay and breccia.
Adit
Fault clay and breccia
27m–44.77m LIMESTONE SCHIST.
Many slicken sides due to fault movement
Slicken sides are filled with clay.
44.77m–55.36m SANDSTONE and SLATE alternation
Many slicken side due to fault movement
55.36m–134.43m LIMESTONE.
Rock is fresh and hard.
Some cracks are coated with limy material.
Closely cracked.
Cracks are limonite stained and filled with Soil.
Rock is fresh, compact and hard
E1 — E2
SK-201
EL 712.53m
L 134.43m
F6
F5
F4
F3
F2
H.W.S 705.00
Adit
SK-202
SK-201
4,106,900
4,107,000
4,107,100
4,107,200
418,100
418,200
+690m
Horizontal Section
LEGEND
TALUS
PERIDOTITE
LIMESTONE
Calcareous SCHIST
Closely cracked or Sheared zone.
Cracks
Crack spacing 5 to 50 cm.
Fault with clay and breccia
Open Crack.
Thin solution plane with veneer of limy material.
Lugeon's value
Log
Core recovery
Depth
Assumed Lugeon's value
0
100m
EPDC Consultants
ELECTRIC POWER DEVELOPMENT CO.
TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE
SANDALCIK PROJECT
SANDALCIK MAIN DAM SITE
GEOLOGICAL SECTION (4-4)
DWG. NO. 9
SHEET NO



LEGEND
TALUS
RIVER DEPOSIT
TERRACE DEPOSIT
MARL
CONGLOMERATE
PERIDOTITE
LIMESTONE
Finished boring
Proposed boring
Geological section
A1 A2
N
0 500m
SK-105 EL. 730m L. 100.34m
SK-104 EL. 705m L. 70m
SK-103 EL. 668m L. 74m
SK-102 EL. 700m L. 83m
SK-101 EL. 700m L. 802m
SK-106
SK-107
SK-108
SK-109
SK-110
SK-111
SK-112
SK-113
SADDLE DAM
Headrace Tunnel
Land slide
UPPER DAM SITE
LOWER DAM SITE
420000
419000
4,106 000
4,107000
EPDConsultants ELECTRIC POWER DEVELOPMENT CO. TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
SANDALCIK SADDLE DAM SITE GEOLOGICAL PLAN
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE
DWG. NO. 10
SHEET NO.



A1 — A2
CREST LENGTH 760.00
TOP OF DAM 710.00
H.W.S 705.00
ORIGINAL GROUND SURFACE
SK-104. EL 692m L 70m
SK-103. EL 668m L 74m (115m UP STREAM)
SK-102. EL 700m L 83m (100m UP STREAM)
Water table
SK-101 EL 700m L 80.2m
SK-105 EL 730m L 100.34m
LEGEND
MARL (Upper formation)
CONGLOMERATE, CHALK, MUDSTONE (Middle formation)
CONGLOMERATE (Lower formation)
Water table
SK SK (projetion)
Boring
Depth
Permeability coefficient (cm/sec)
Log
Core recovery (%)
Lugeon's value (l/min/m/10kg/cm²)
Data could'nt obtain
MARL
CHALK
CONGLOMERATE
MUDSTONE
0 100m
EPDConsultants ELECTRIC POWER DEVELOPMENT CO TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
SANDALCIK SADDLE DAM SITE GEOLOGICAL SECTION
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER
DATE
DWG. NO. 11
SHEET NO.



EPDC Consultants
ELECTRIC POWER DEVELOPMENT Co
TOKYO JAPAN

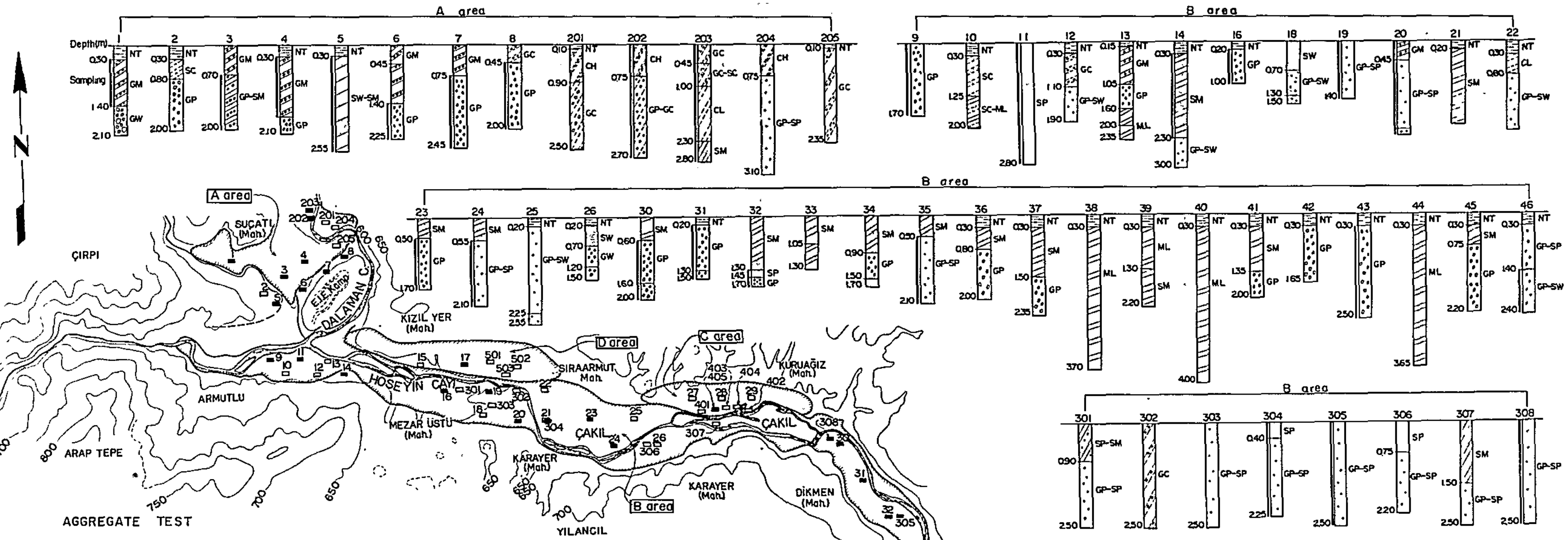
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN

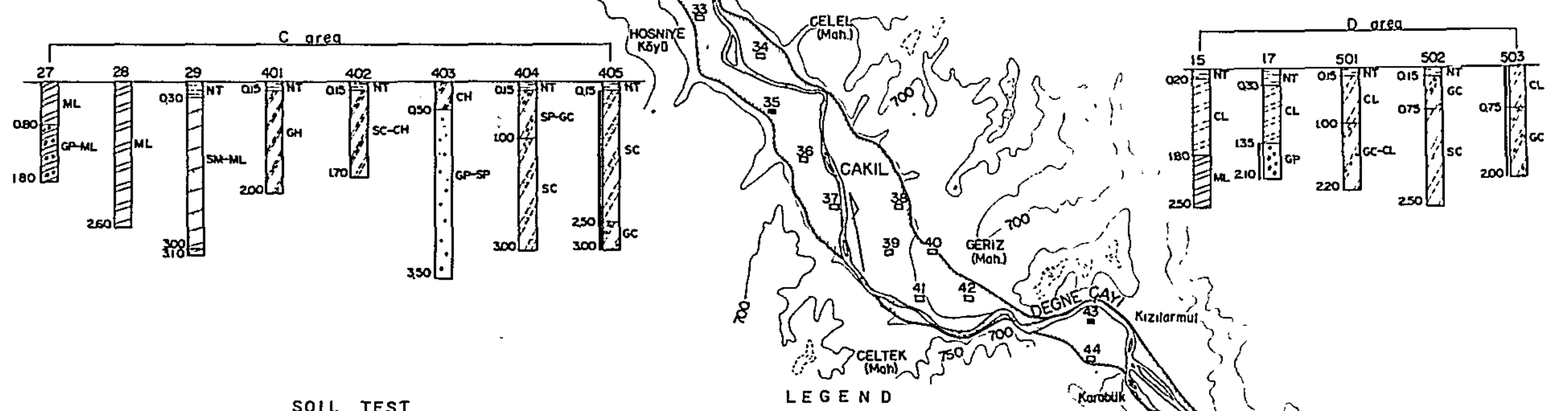
SANDALCIK PROJECT

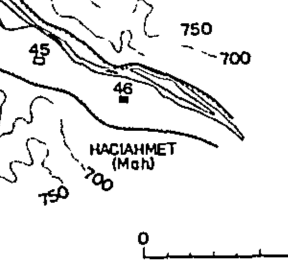
SANDALCIK WATER WAY
GEOLOGICAL PLAN AND SECTION

DRAWN: Y. Fukutake
CHECKED: T. Hitsuzi
SUBMITTED: Y. Naito
RECOMMENDED: M. Yoshikoshi
APPROVED: Y. Ama
CHIEF ENGINEER EPDC
DATE

DWG NO. 12
SHEET NO.







AGGREGATE TEST

Laboratory NO	Test pit NO	Unit weight kg/m³		Specific gravity t/m³ %		NO. 200 Passing sieve %		Kil topakları miktarı %		Freezing loss %		Abrasion %	
		Sand	Gravel	Sand	Gravel	Sand	Gravel	Sand	Gravel	Sand	Gravel	100 Revolution	500 Revolution
165/1	17	1514	—	255 50	258 30	159	07	114	28	93	167	—	—
165/2	11	1692	—	247 61	—	173	—	—	—	—	—	—	—
165/3	46	1871	—	259 37	263 20	6.1	04	15	04	72	67	57	109
165/4	30	1875	1700	256 40	262 18	07	04	1.5	06	115	32	52	218
165/5	3	1692	—	230 78	256 57	129	07	99	27	95	341	68	286
165/6	8	1800	1728	242 95	258 47	166	35	125	47	182	245	—	—
165/7	32	1728	—	235 32	261 23	32	05	14	04	73	69	—	—
165/8	31	1692	1764	247 40	246 52	89	16	22	05	102	179	—	—
165/9	23	1764	1800	248 60	265 16	103	11	58	13	99	77	27	204
165/10	35	1603	1639	253 24	265 17	102	1.5	49	21	152	68	41	209
165/11	6	1567	1800	242 74	263 38	45	01	04	01	99	135	66	266
165/12	43	1657	1692	243 40	265 11	79	08	64	08	122	92	—	—
165/13	24	1692	1800	253 24	265 12	66	08	27	09	90	48	—	—
165/14	16	1692	1835	244 56	269 28	130	11	51	1.4	124	38	25	207
165/15	19	1728	1817	252 34	265 13	108	08	27	21	57	22	44	206
165/16	9	1763	1607	255 30	265 15	62	06	27	12	127	36	48	152
165/17	20	1514	1711	237 60	267 24	116	12	151	34	228	93	46	234
165/18	7	1693	—	238 44	254 55	61	29	55	34	81	21.0	—	—

SOIL TEST

Test pit No	Depth m	Specific gravity t/m³	Compaction		Atterberg limits				Natural water content W %	Porosity %	Permeability cm/sec	Triaxial shearing		Classification and group symbol
			MDD t/m³	OMC %	LL %	PL %	PI	RL				kg/cm²	φ°	
1		2.70	158	244	550	312	238			Very small	655×10^{-8}	130	29°	GM
4	2.10	2.72	140	308	590	342	248			—	—	—	—	GM
5	2.55	2.55	174	176	363	295	68			Very small	240×10^{-8}	080	35°	SW-SM
14	3.00	2.59	159	210	428	282	146			—	—	—	—	SM

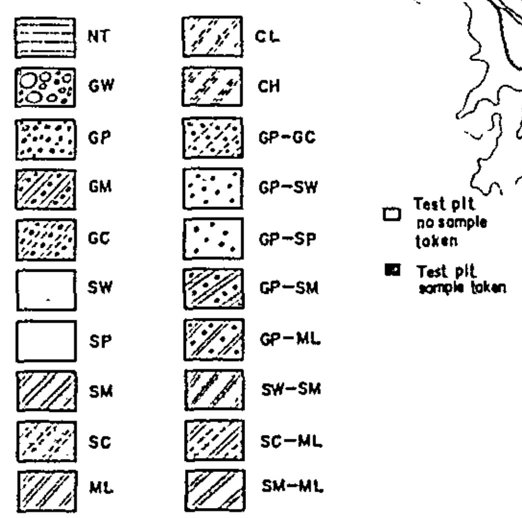
ROCK TEST

Laboratory NO	Test pit NO	Specific gravity t/m³	Absorption %	Abrasion %		Pressure strength kg/cm²	Pressure strength after freezing kg/cm²	Freezing loss %	Visible Porosity %
				100 Revolution	500 Revolution				
253	47	270	0.2	60	275	—	—		
253	48	268	03	51	239	510	405		

SIEVE ANALYSIS

Test pit NO	Depth m	762mm	381mm	191mm	952mm	#4 476mm	#10 238mm	#20 084mm	#40 042mm	#60 025mm	#100 0149mm	#120 0094mm
1			7400	6488	5823	4843	3858	2902	2189	1744	1499	1371
4	2.10		9303	7265	6091	5195	4482	3882	3426	3062	2692	2508
5	2.55		9380	8588	7883	6113	5305	3975	2855	1869	1193	996
14	3.00		—	9002	8547	7618	6528	5597	4854	4214	3520	3021

LEGEND



EPDC Consultants
ELECTRIC POWER DEVELOPMENT Co
TOKYO JAPAN

JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN

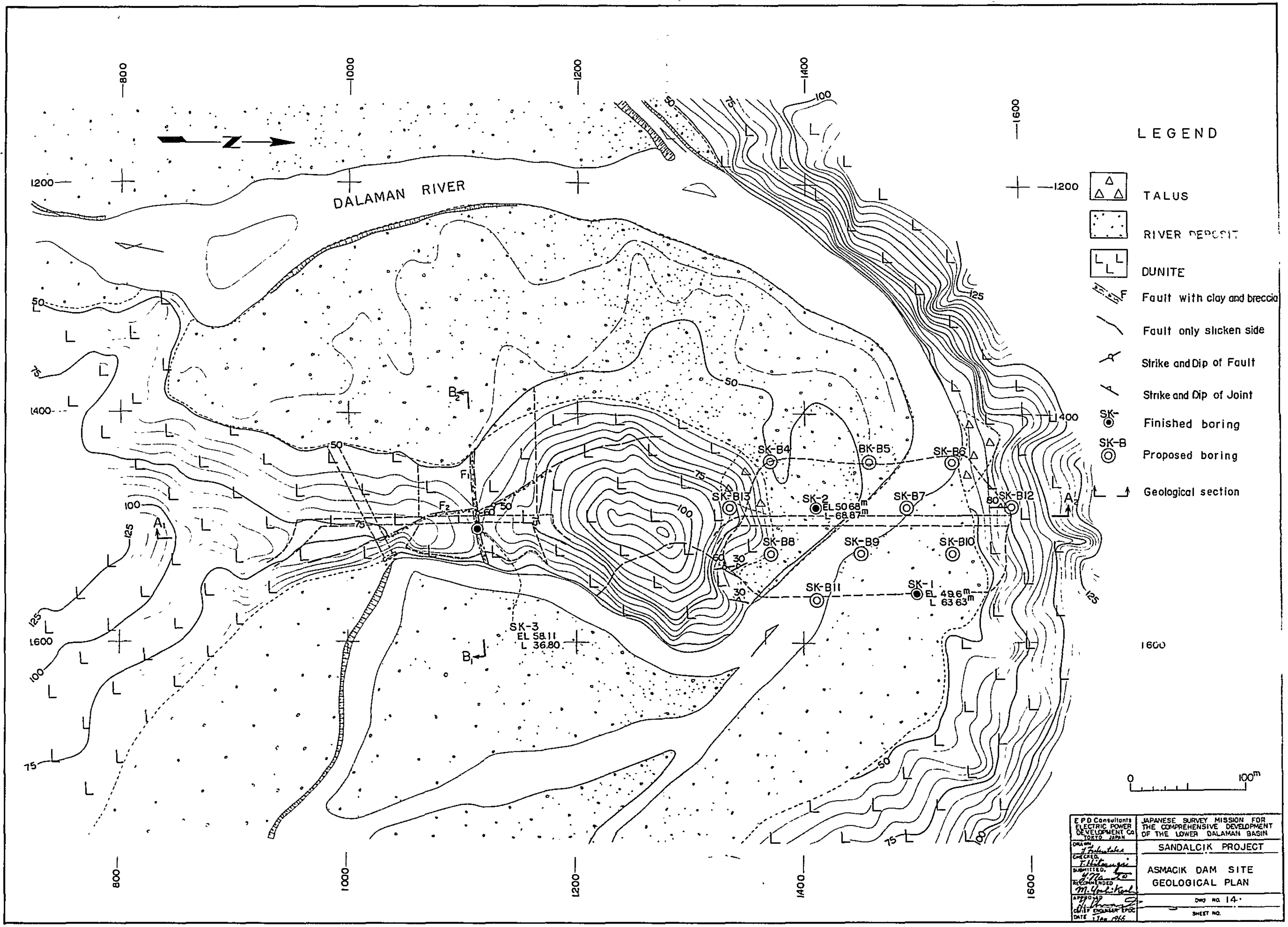
DRAWN: [signature]
CHECKED: [signature]
SUBMITTED: [signature]
RECOMMENDED: [signature]
APPROVED: [signature]
CHIEF ENGINEER EPDC
DATE

SANDALCIK PROJECT

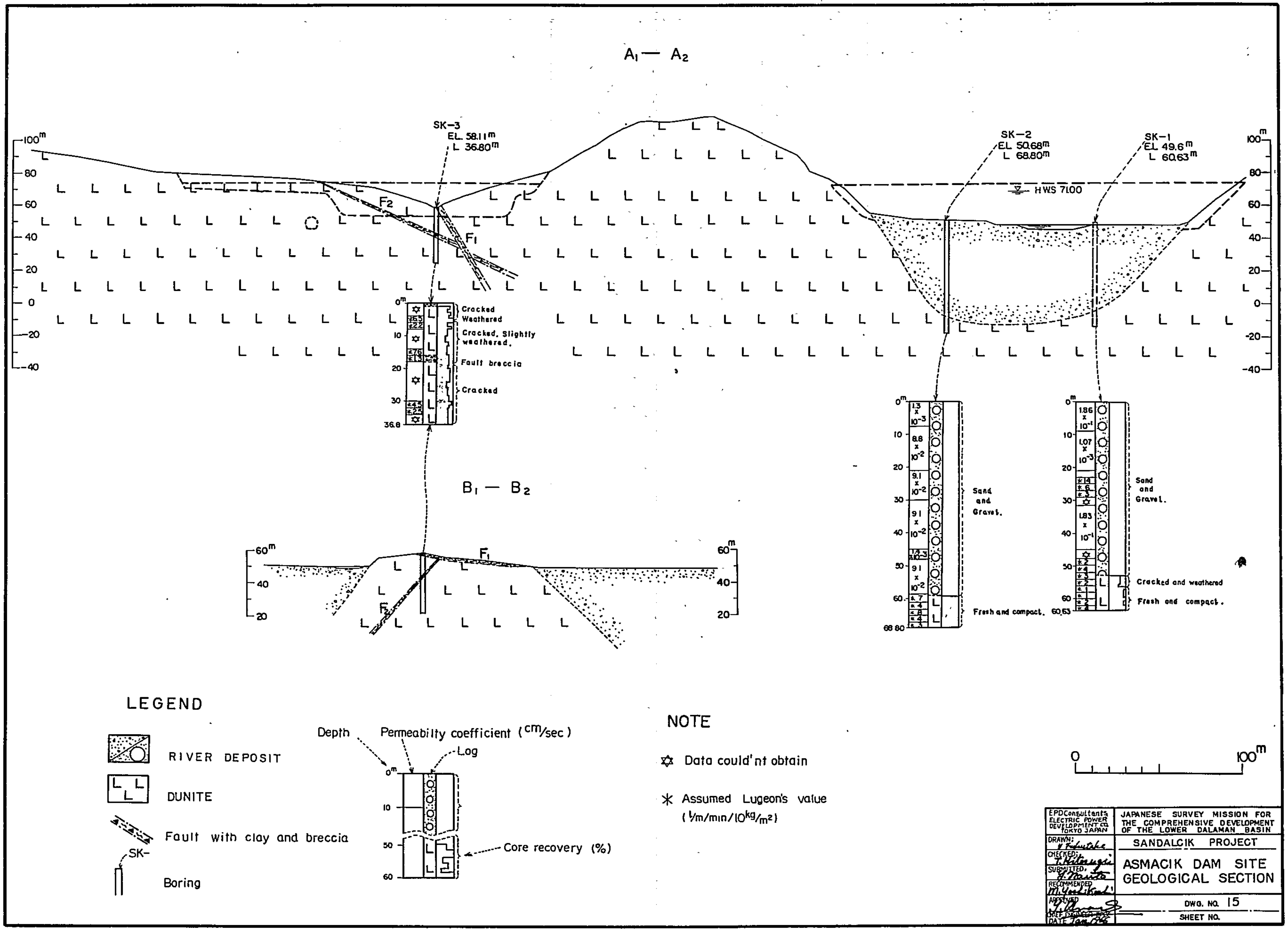
SANDALCIK DAM CONSTRUCTION MATERIAL INVESTIGATION

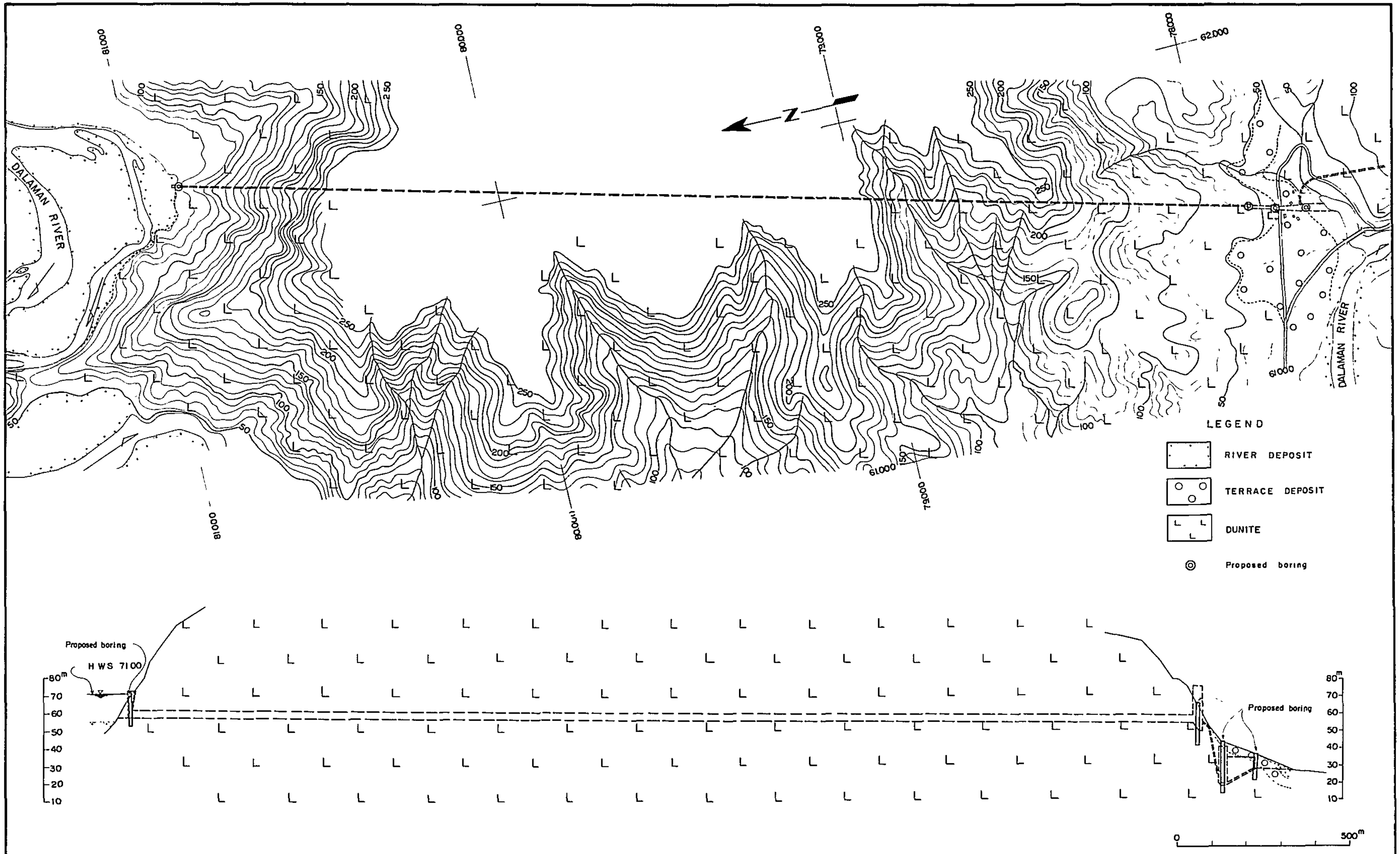
DWG NO 13

SHEET NO



DALAMAN RIVER
LEGEND
TALUS
RIVER DEPOSIT
DUNITE
Fault with clay and breccia
Fault only slicken side
Strike and Dip of Fault
Strike and Dip of Joint
Finished boring
Proposed boring
Geological section
SK-B4
BK-B5
SK-B6
SK-B7
SK-B8
SK-B9
SK-B10
SK-B11
SK-B12
SK-B13
SK-2 EL 50.68m L 68.87m
SK-1 EL 49.6m L 63.63m
SK-3 EL 58.11 L 36.80
0 100m
E P D Consultants ELECTRIC POWER DEVELOPMENT Co. TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
ASMACIK DAM SITE
GEOLOGICAL PLAN
DWG NO. 14
SHEET NO.
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE


A1 — A2
SK-3
EL. 58.11m
L 36.80m
SK-2
EL 50.68m
L 68.80m
SK-1
EL 49.6m
L 60.63m
HWS 71.00
F2
F1
Cracked
Weathered
Cracked, Slightly weathered.
Fault breccia
Cracked
Sand and Gravel.
Fresh and compact.
Cracked and weathered
Fresh and compact.
B1 — B2
LEGEND
RIVER DEPOSIT
DUNITE
Fault with clay and breccia
SK-
Boring
Depth
Permeabilty coefficient (cm/sec)
Log
Core recovery (%)
NOTE
Data could'nt obtain
Assumed Lugeon's value
(l/m/min/10kg/m2)
0
100m
EPDConsultants
ELECTRIC POWER DEVELOPMENT CO.
TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER
DATE
SANDALCIK PROJECT
ASMACIK DAM SITE
GEOLOGICAL SECTION
DWG. NO. 15
SHEET NO.



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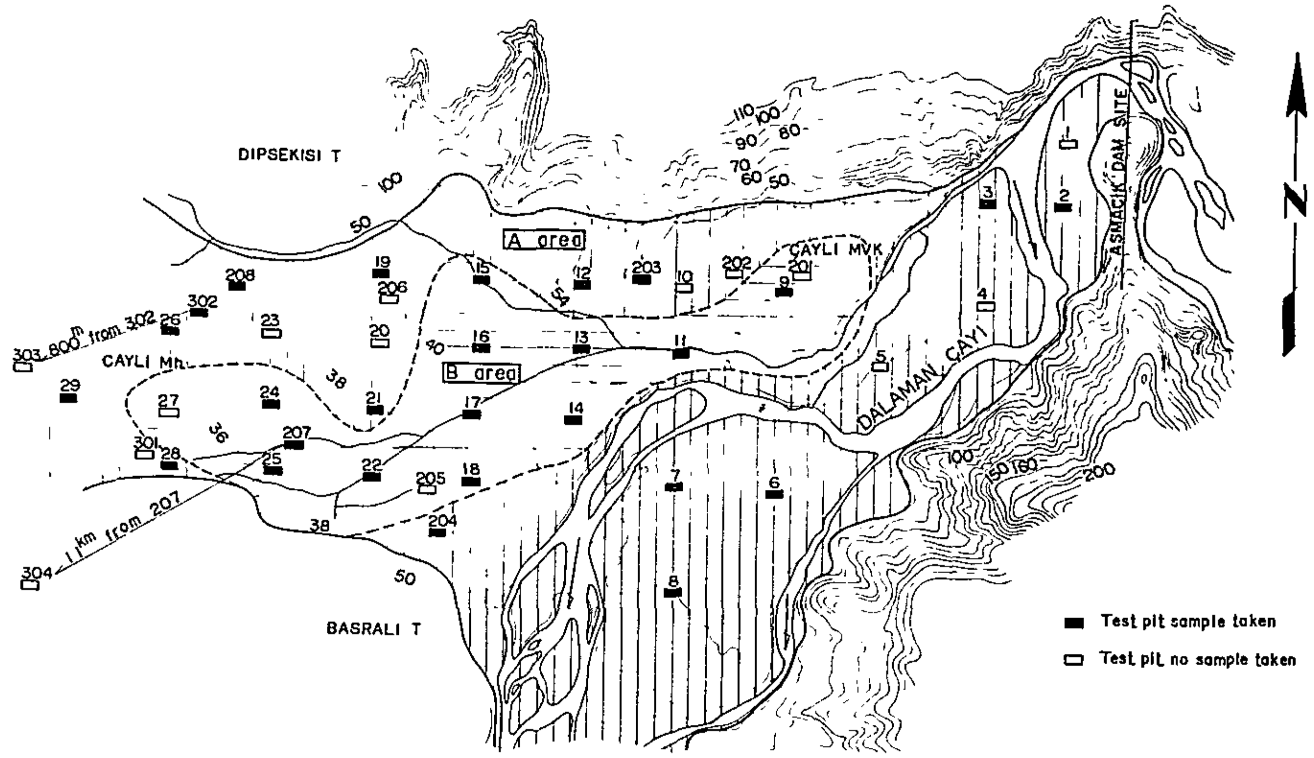
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN

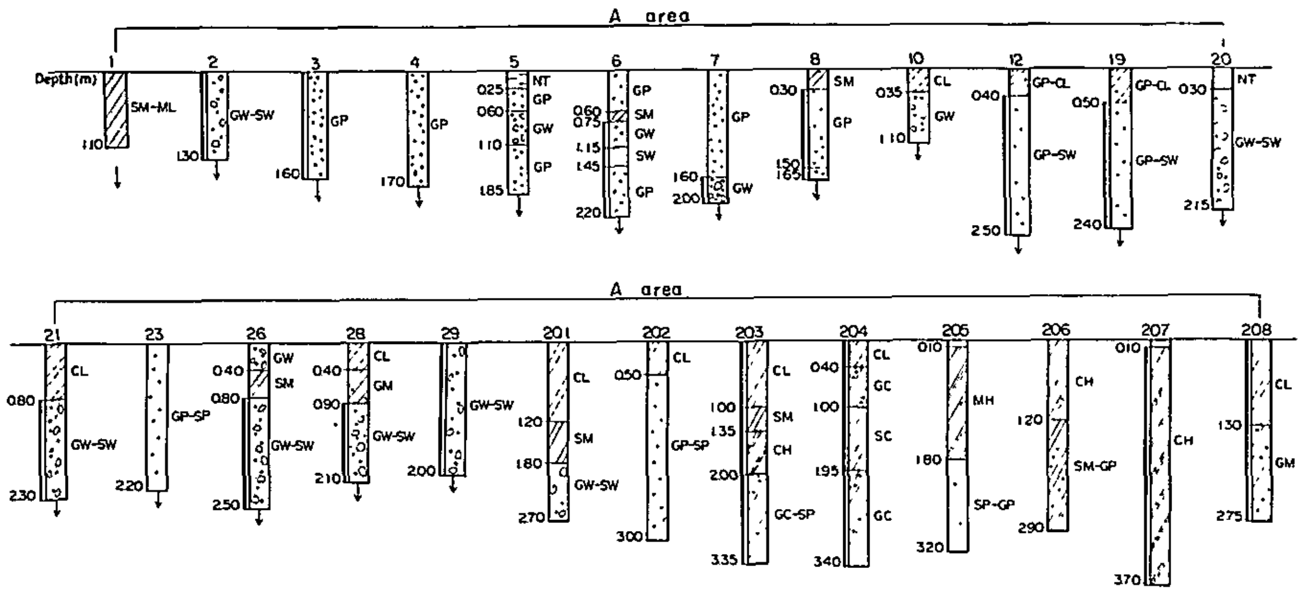
SANDALCIK PROJECT

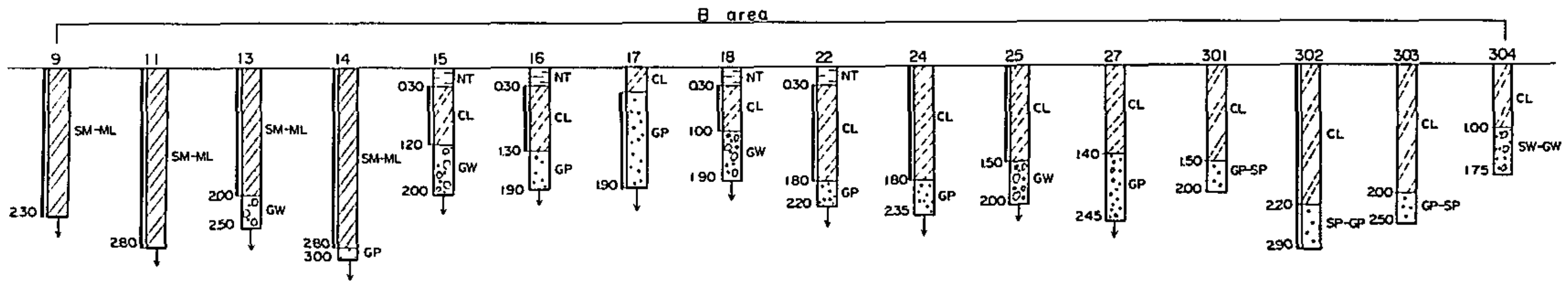
ASMACIK WATER WAY
GEOLOGICAL PLAN AND SECTION

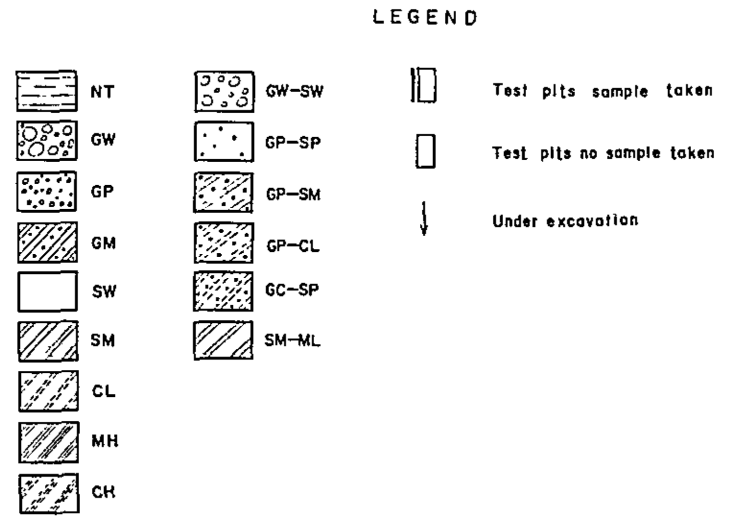
DRAWN.
CHECKED.
SUBMITTED.
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE

DWG NO. 16
SHEET NO.









AGGREGATE TEST

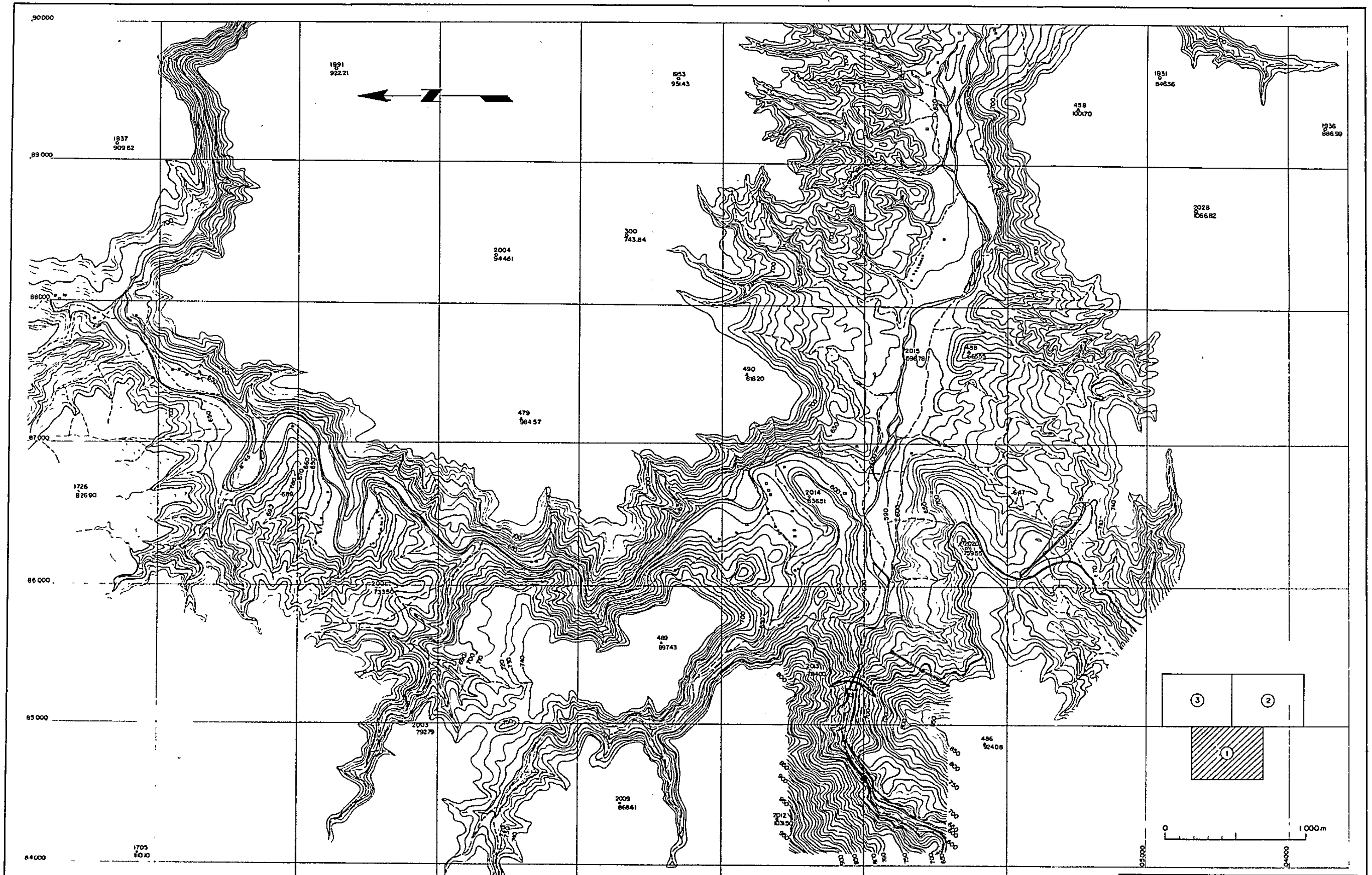
Laboratory No	Test pit No	Unit weight kg/m³ Sand	Unit weight kg/m³ Gravel	Specific gravity t/m³ % Sand	Specific gravity t/m³ % Gravel	No 200 passing sieve test % Sand	No 200 passing sieve test % Gravel	Kil topaklari miktari % Sand	Kil topaklari miktari % Gravel	Freezing loss % Sand	Freezing loss % Gravel	Abrasion % 100 Revolution	Abrasion % 500 Revolution
185/1	19	1692	1582	254 28	253 13	50	05	23	07	67	112	23	227
185/2	6	1622	–	262 20	270 09	43	34	12	05	67	55	41	222
185/3	28	1692	–	257 25	270 16	32	04	33	07	81	134	–	–
185/4	17	1622	–	259 31	269 14	45	07	19	09	68	165	–	–
185/5	12	1695	–	268 31	271 14	75	04	26	06	83	152	–	–
185/6	8	1695	–	258 30	269 09	66	05	16	06	61	15	–	–
185/7	7	1625	–	263 20	272 13	45	02	15	06	52	45	–	–
185/8	21	1585	–	258 48	255 07	43	05	23	10	65	144	–	–
185/9	2	1692	–	262 25	274 07	43	04	23	08	54	134	–	–
185/10	29	1692	–	252 30	269 15	50	06	16	07	73	115	–	–
185/11	26	1515	–	256 27	273 11	55	06	12	08	79	155	46	234
185/12	3	1692	–	264 24	274 07	88	03	27	05	69	43	127	297

SOIL TEST

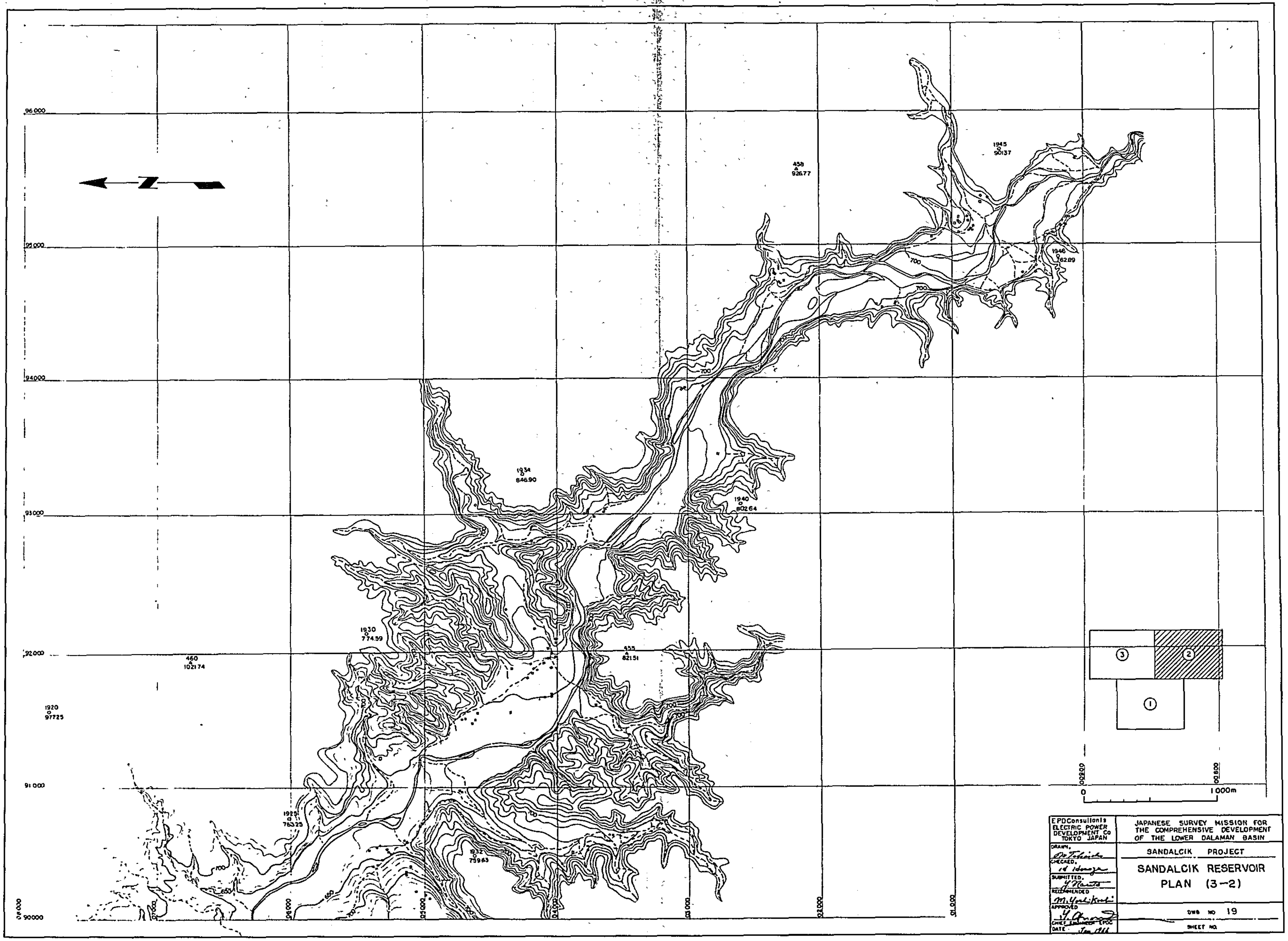
Testpit No	Depth	Specific gravity t/m³	Compaction M.D.D t/m³	Compaction O.M.C %	Atterberg limits L.L %	Atterberg limits P.L %	Atterberg limits P.I	Atterberg limits R.L	Natural water content %	Porosity %	Permeability cm/sec	Triaxial shearing kg/cm²	Triaxial shearing φ°	Classification and group symbol
9	23	273	174	180	–	–	–				240×10^{-8}	090	32°	ML
11	–	275	169	192	342	188	154				–	–	–	CL
13	–	275	166	212	399	216	183				–	–	–	CL
14	30	278	173	190	300	122	118				120×10^{-7}	095	22°–30'	CL
15	20	276	165	218	394	202	192				–	–	–	CL
16	19	275	172	188	346	190	156				–	–	–	CL
18	18	275	166	206	388	212	176				320×10^{-8}	135	26°–30'	CL
22	–	277	160	231	454	214	240				–	–	–	CL
24		270	161	220	416	217	199				160×10^{-8}	140	25°–30'	CL
25	–	268	160	212	458	227	231				–	–	–	CL
203	–	272	160	–	487	241	246				160×10^{-7}	12	28°	CL
204	–	273	162	–	512	242	270				92×10^{-7}	07	23°	GC-SC
207	–	273	156	–	510	250	260				64×10^{-8}	14	19°	CH
208	–	270	183	–	–	–	–				–	–	–	GM
302	–	269	158	–	448	241	207				–	–	–	CL

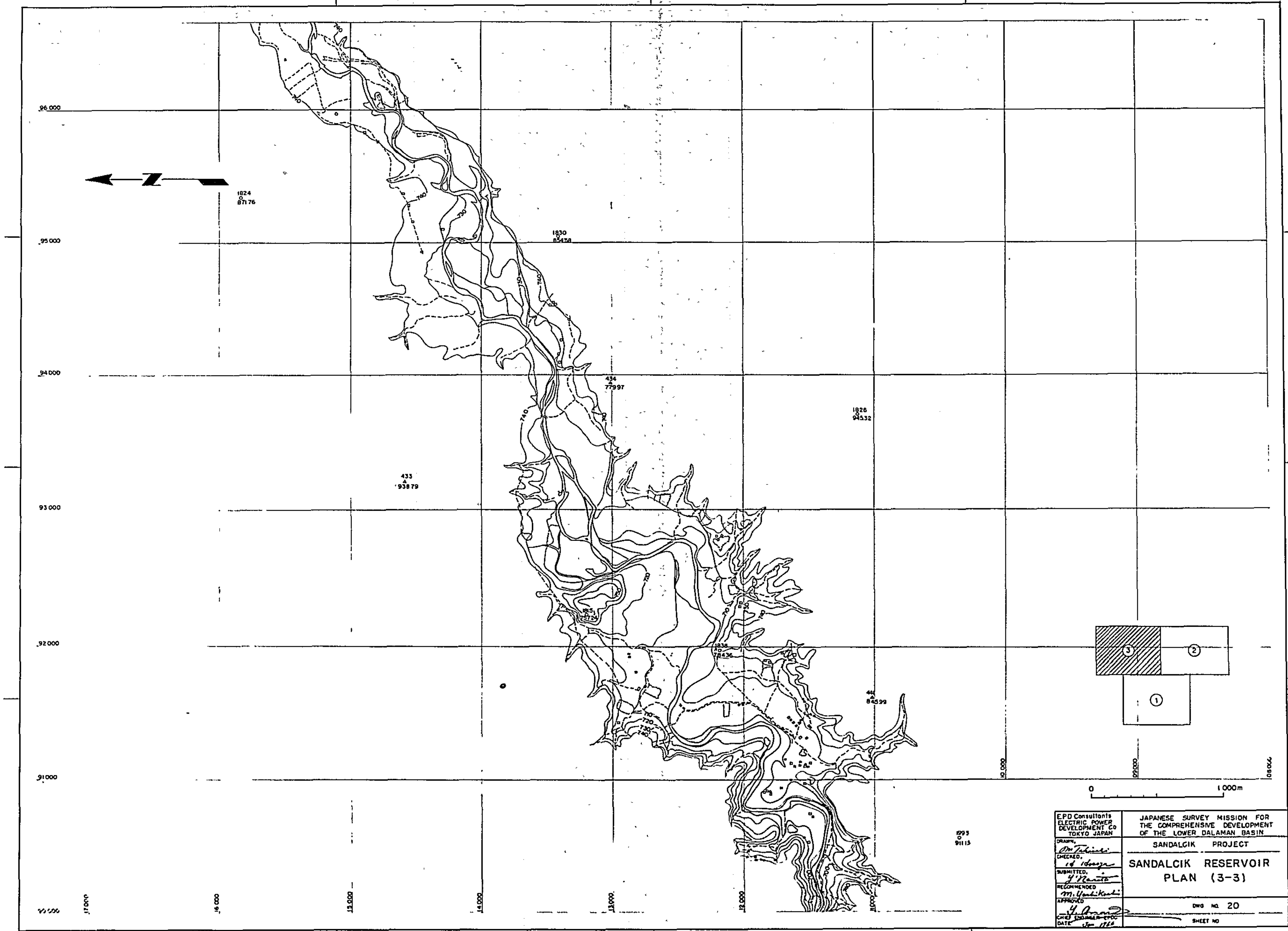
0 — 1000m

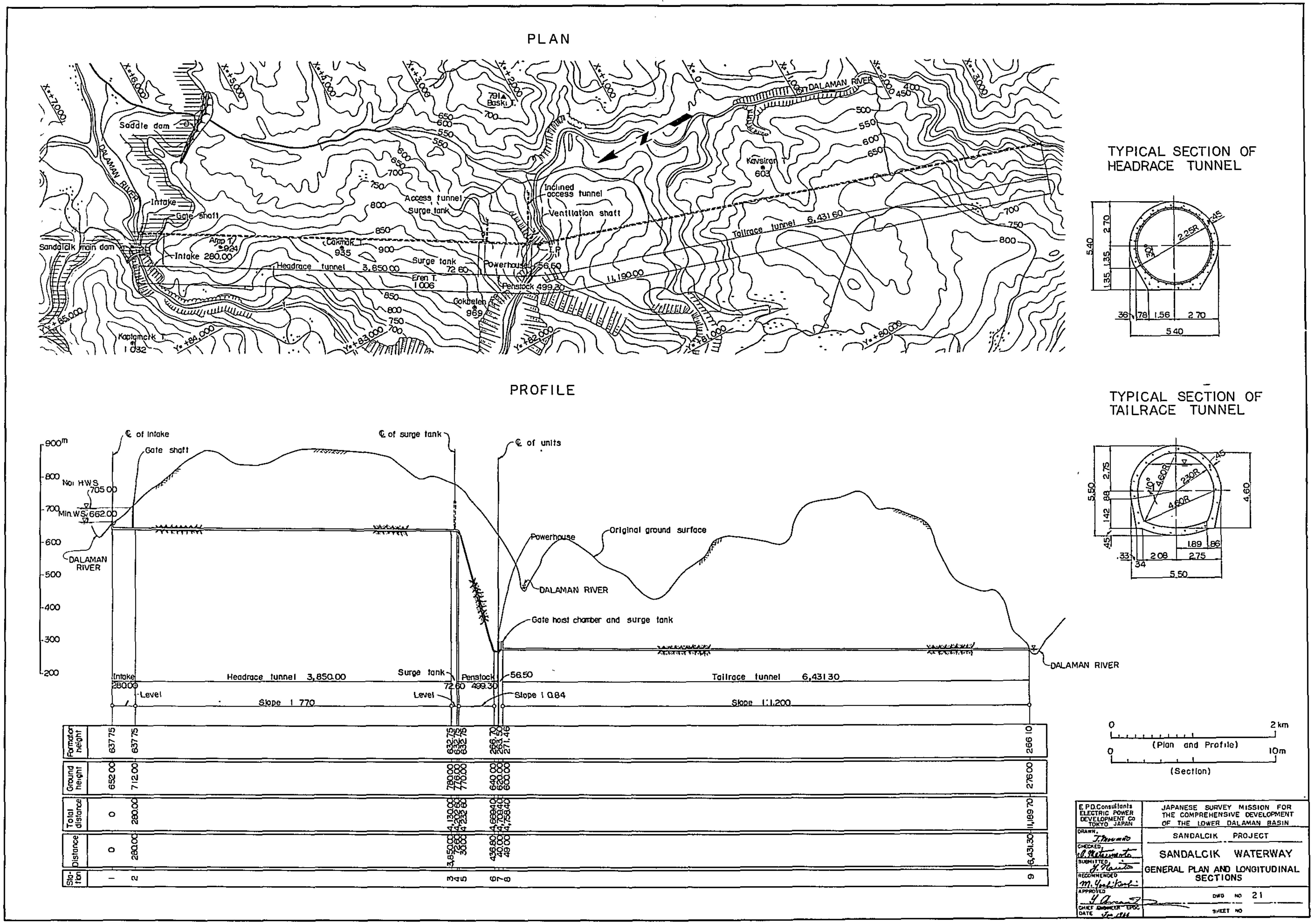
E PD Consultants ELECTRIC POWER DEVELOPMENT Co TOKYO JAPAN	JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN. Y. Fukutake	SANDALCIK PROJECT
CHECKED. T. Hitonaga	ASMACIK DAM CONSTRUCTION MATERIAL INVENSTIGATION
SUBMITTED. Y. Nanto	
SUBMITTED. M. Yoshikoshi	
APPROVED Y. [illegible] CHIEF ENGINEER EPDC	DWG NO 17
DATE Jan 1966	SHEET NO.

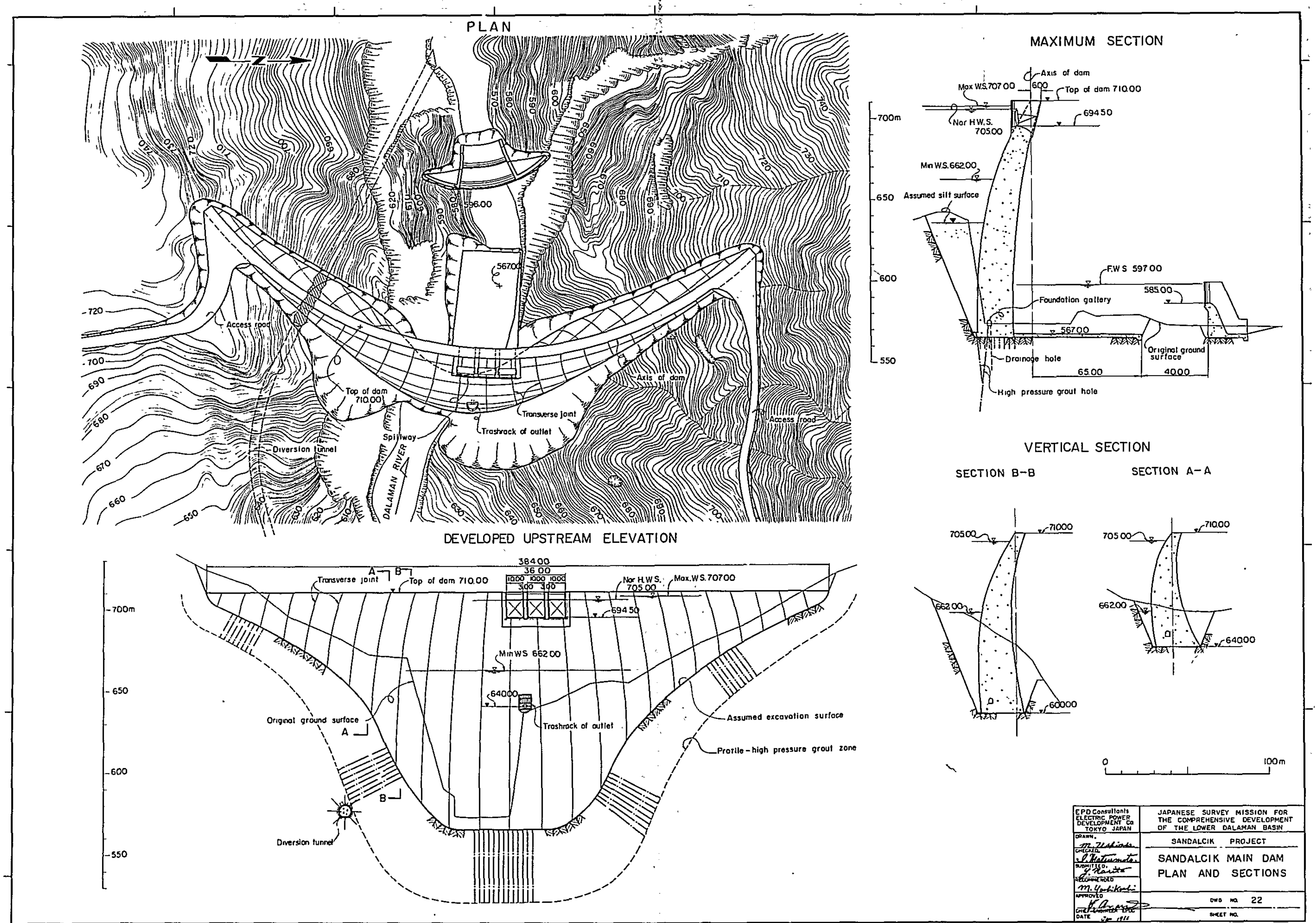


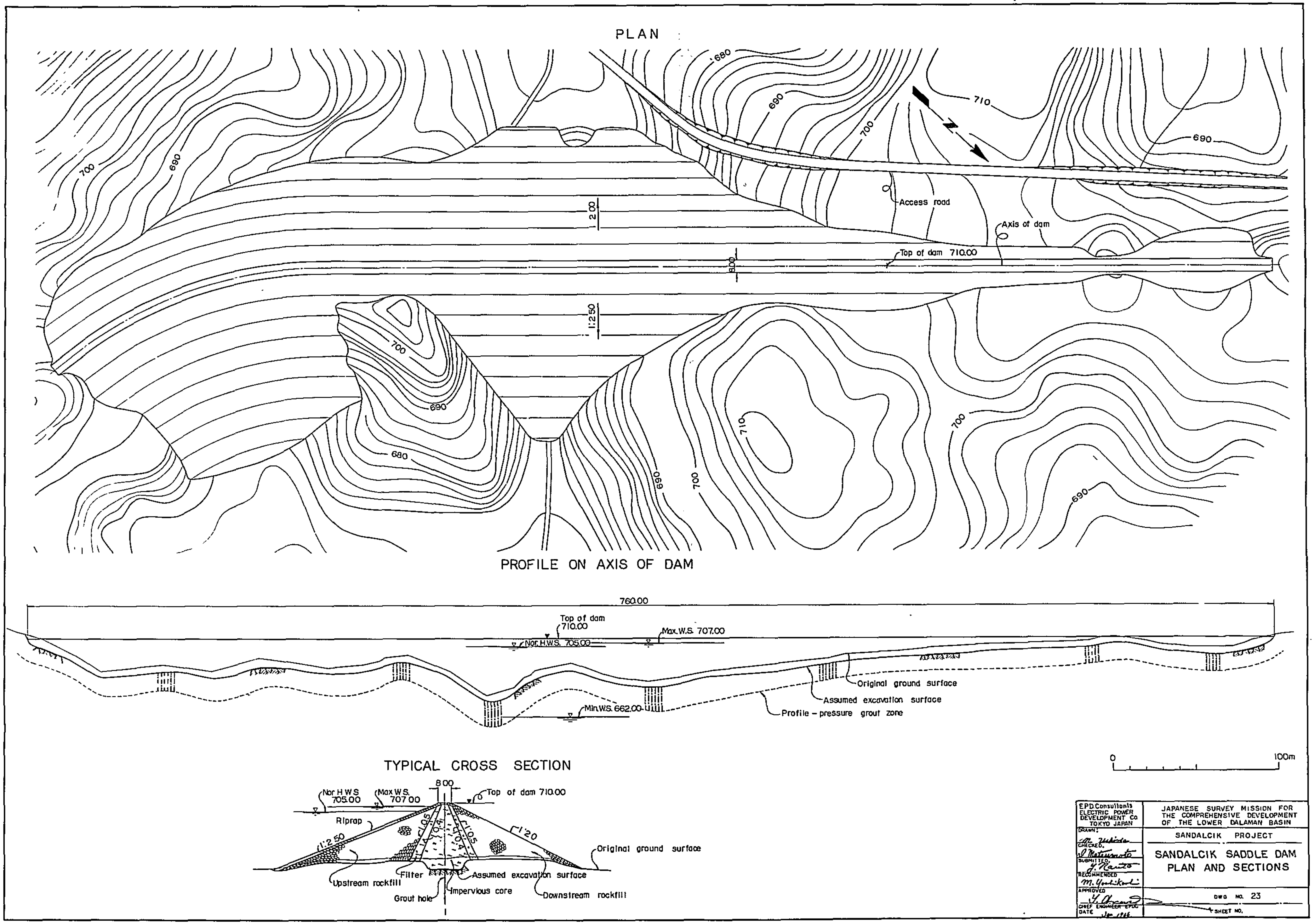
EPD Consultants ELECTRIC POWER DEVELOPMENT Co TOKYO JAPAN	JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN CHECKED SUBMITTED RECOMMENDED APPROVED CHIEF ENGINEER EPDC DATE	SANDALCIK PROJECT SANDALCIK RESERVOIR PLAN (3-1)
	DWG NO. 18 SHEET NO.

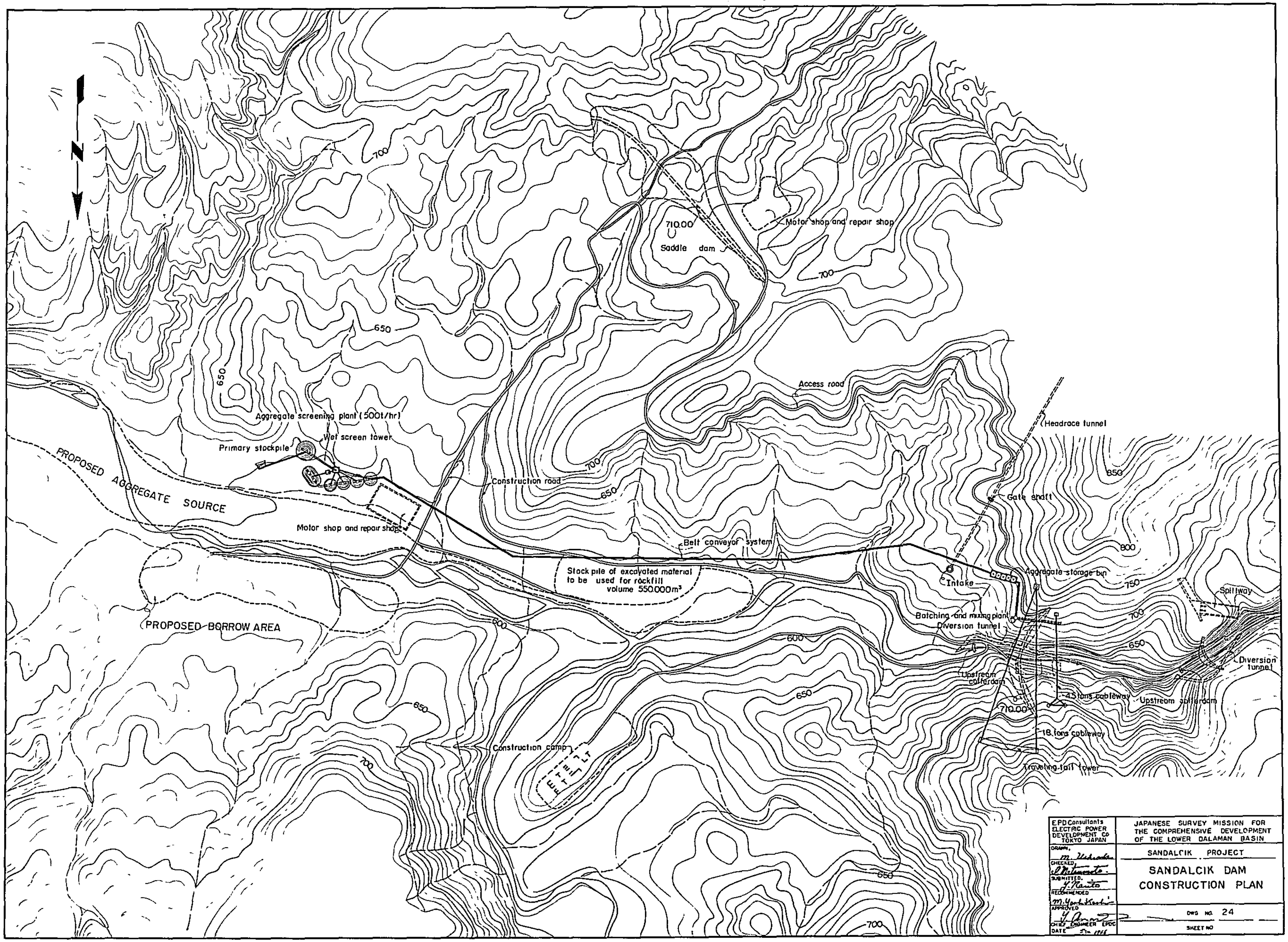

N
96000
95000
94000
93000
92000
91000
90000
1945
90137
458
926.77
1946
862.89
700
1934
846.90
1940
802.64
1930
774.59
460
1021.74
455
821.51
1920
977.25
1925
763.25
1932
759.63
0
1000m
EPDConsultants
ELECTRIC POWER
DEVELOPMENT Co
TOKYO JAPAN
JAPANESE SURVEY MISSION FOR
THE COMPREHENSIVE DEVELOPMENT
OF THE LOWER DALAMAN BASIN
DRAWN,
CHECKED,
SUBMITTED,
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE
SANDALCIK PROJECT
SANDALCIK RESERVOIR
PLAN (3-2)
DWG NO 19
SHEET NO.


N
1824
87176
1830
85458
434
77997
1826
94532
433
93879
1836
78436
1993
91113
96 000
95 000
94 000
93 000
92 000
91 000
17 000
16 000
15 000
14 000
13 000
12 000
11 000
10 000
09 000
08 000
740
730
720
710
0
1 000m
③
②
①
EPD Consultants
ELECTRIC POWER
DEVELOPMENT Co
TOKYO JAPAN
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE
JAPANESE SURVEY MISSION FOR
THE COMPREHENSIVE DEVELOPMENT
OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
SANDALCIK RESERVOIR
PLAN (3-3)
DWG NO. 20
SHEET NO

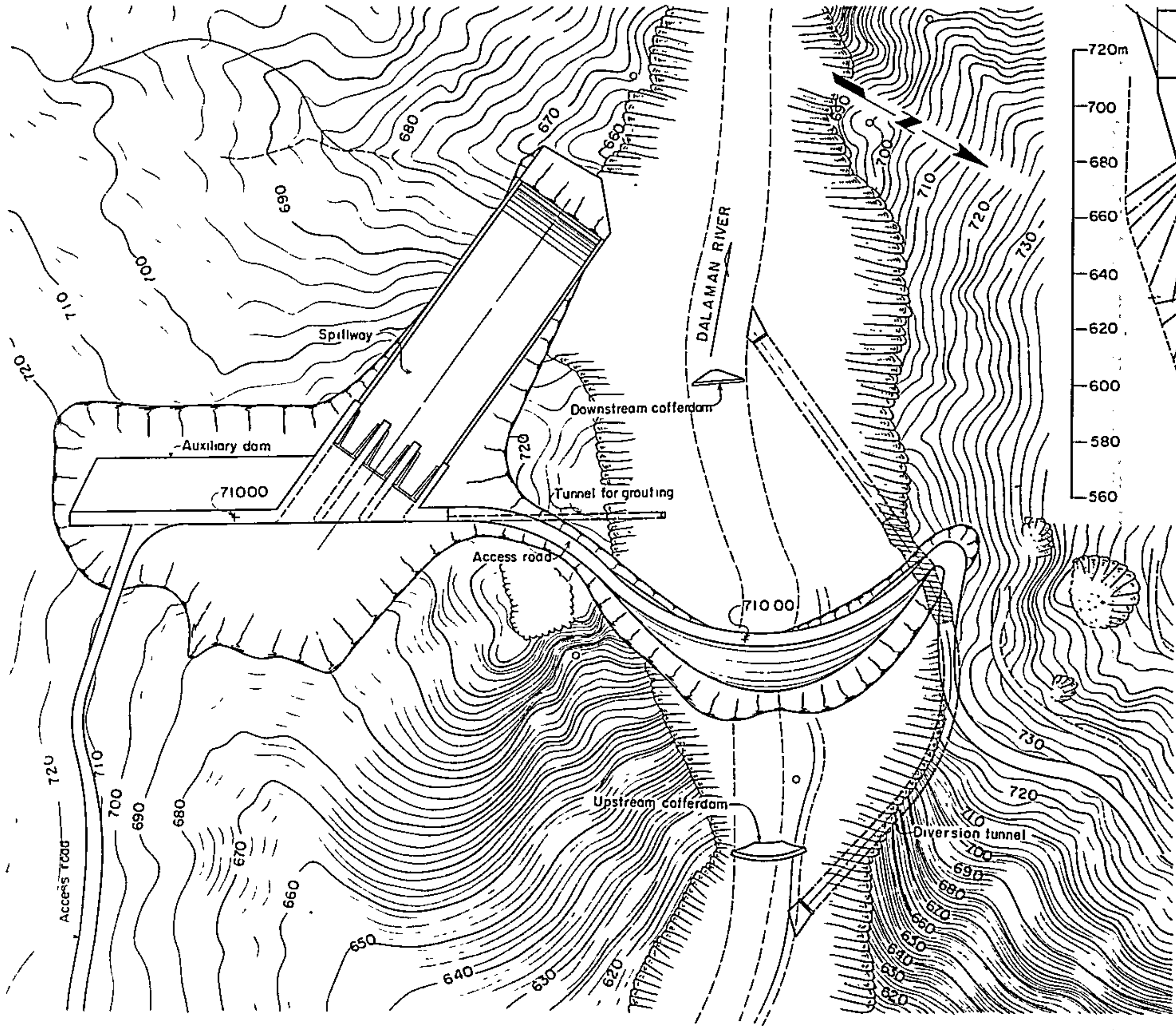

PLAN
PROFILE
TYPICAL SECTION OF HEADRACE TUNNEL
TYPICAL SECTION OF TAILRACE TUNNEL
Saddle dam
DALAMAN RIVER
Intake
Gate shaft
Sandalcik main dam
Intake 280.00
Headrace tunnel 3,850.00
Surge tank 72.60
Access tunnel
Surge tank
Inclined access tunnel
Ventilation shaft
Powerhouse 56.60
Penstock 499.30
Tailrace tunnel 6,431.60
11,190.00
Baski T.
Kavsiran T.
Cakmak T.
Eren T.
Gokbelen T.
Kaplancik T.
℄ of intake
℄ of surge tank
℄ of units
Nor. H.W.S. 705.00
Min. W.S. 662.00
Original ground surface
Gate hoist chamber and surge tank
Slope 1:770
Slope 1:0.84
Slope 1:1,200
Level
Formation height
Ground height
Total distance
Distance
Station
(Plan and Profile)
(Section)
E.P.D. Consultants ELECTRIC POWER DEVELOPMENT Co TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
SANDALCIK WATERWAY
GENERAL PLAN AND LONGITUDINAL SECTIONS
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE
DWG NO 21
SHEET NO


PLAN
Access road
Top of dam 710.00
Spillway
Diversion tunnel
DALAMAN RIVER
Transverse joint
Trashrack of outlet
Axis of dam
596.00
567.00
MAXIMUM SECTION
Axis of dam
Max W.S.707.00
Top of dam 710.00
Nor H.W.S. 705.00
694.50
Min W.S.662.00
Assumed silt surface
F.W.S 597.00
585.00
Foundation gallery
567.00
Original ground surface
Drainage hole
High pressure grout hole
65.00
40.00
VERTICAL SECTION
SECTION B-B
SECTION A-A
DEVELOPED UPSTREAM ELEVATION
384.00
36.00
Transverse joint
Top of dam 710.00
Nor H.W.S. 705.00
Max.W.S.707.00
694.50
Min WS 662.00
640.00
Original ground surface
Trashrack of outlet
Assumed excavation surface
Profile-high pressure grout zone
Diversion tunnel
100m
EPD Consultants ELECTRIC POWER DEVELOPMENT Co. TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
SANDALCIK MAIN DAM PLAN AND SECTIONS
DWG NO. 22
SHEET NO.

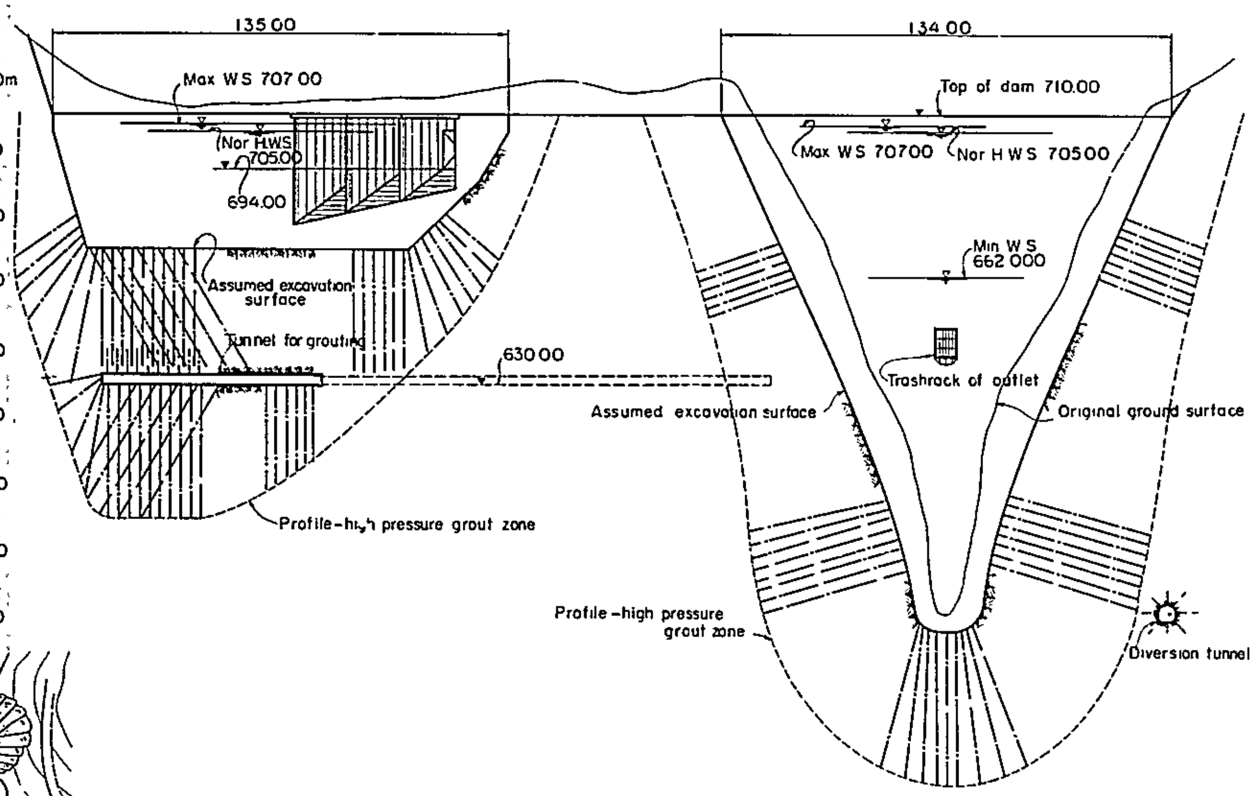

PLAN
680
690
700
710
Access road
Axis of dam
Top of dam 710.00
1:2.00
8.00
1:2.50
PROFILE ON AXIS OF DAM
760.00
Top of dam
710.00
Max.W.S. 707.00
Nor.H.W.S. 705.00
Original ground surface
Assumed excavation surface
Profile - pressure grout zone
Min.W.S. 662.00
TYPICAL CROSS SECTION
8.00
Nor.H.W.S.
705.00
Max.W.S.
707.00
Top of dam 710.00
Riprap
1:2.50
1:2.0
Original ground surface
Upstream rockfill
Filter
Assumed excavation surface
Impervious core
Grout hole
Downstream rockfill
0
100m
E.P.D. Consultants
ELECTRIC POWER DEVELOPMENT CO.
TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN:
CHECKED.
SUBMITTED.
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE
SANDALCIK PROJECT
SANDALCIK SADDLE DAM
PLAN AND SECTIONS
DWG NO. 23
SHEET NO.


N
700
710.00
Saddle dam
Motor shop and repair shop
700
650
650
Access road
Headrace tunnel
Aggregate screening plant (500t/hr)
Wet screen tower
Primary stockpile
PROPOSED AGGREGATE SOURCE
Construction road
700
650
850
Gate shaft
Motor shop and repair shop
Belt conveyor system
800
Stock pile of excavated material
to be used for rockfill
volume 550,000m³
Intake
Aggregate storage bin
750
Spillway
Batching and mixing plant
Diversion tunnel
700
PROPOSED BORROW AREA
600
600
650
Diversion tunnel
Upstream cofferdam
45 tons cableway
Upstream cofferdam
710.00
650
650
18 tons cableway
Construction camp
Traveling tail tower
700
650
700
EPD Consultants
ELECTRIC POWER
DEVELOPMENT CO
TOKYO JAPAN
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE
JAPANESE SURVEY MISSION FOR
THE COMPREHENSIVE DEVELOPMENT
OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
SANDALCIK DAM
CONSTRUCTION PLAN
DWG NO. 24
SHEET NO

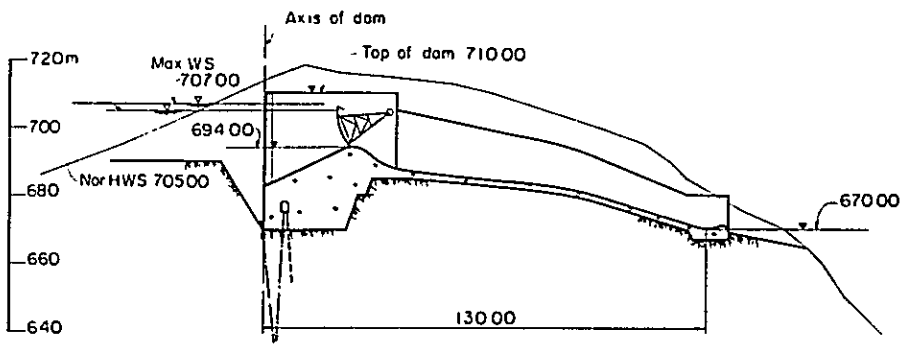
PLAN



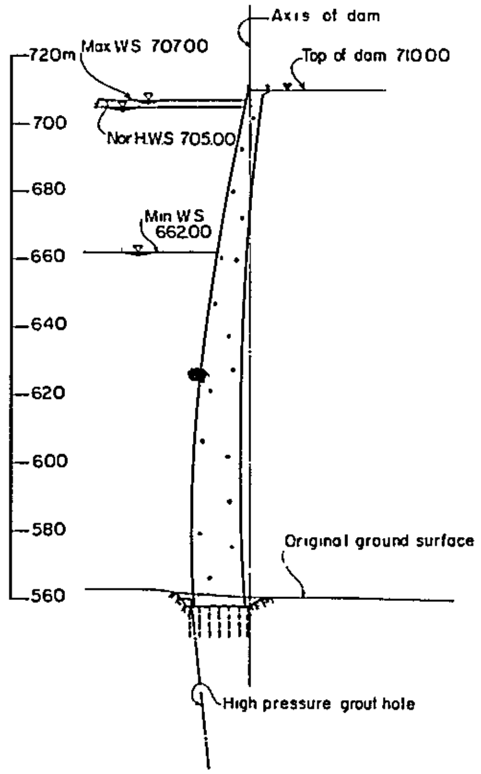
DEVELOPED UPSTREAM ELEVATION OF DAM



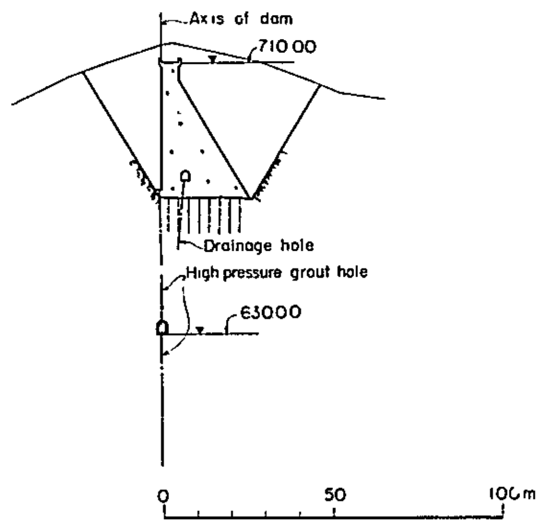
PROFILE OF SPILLWAY



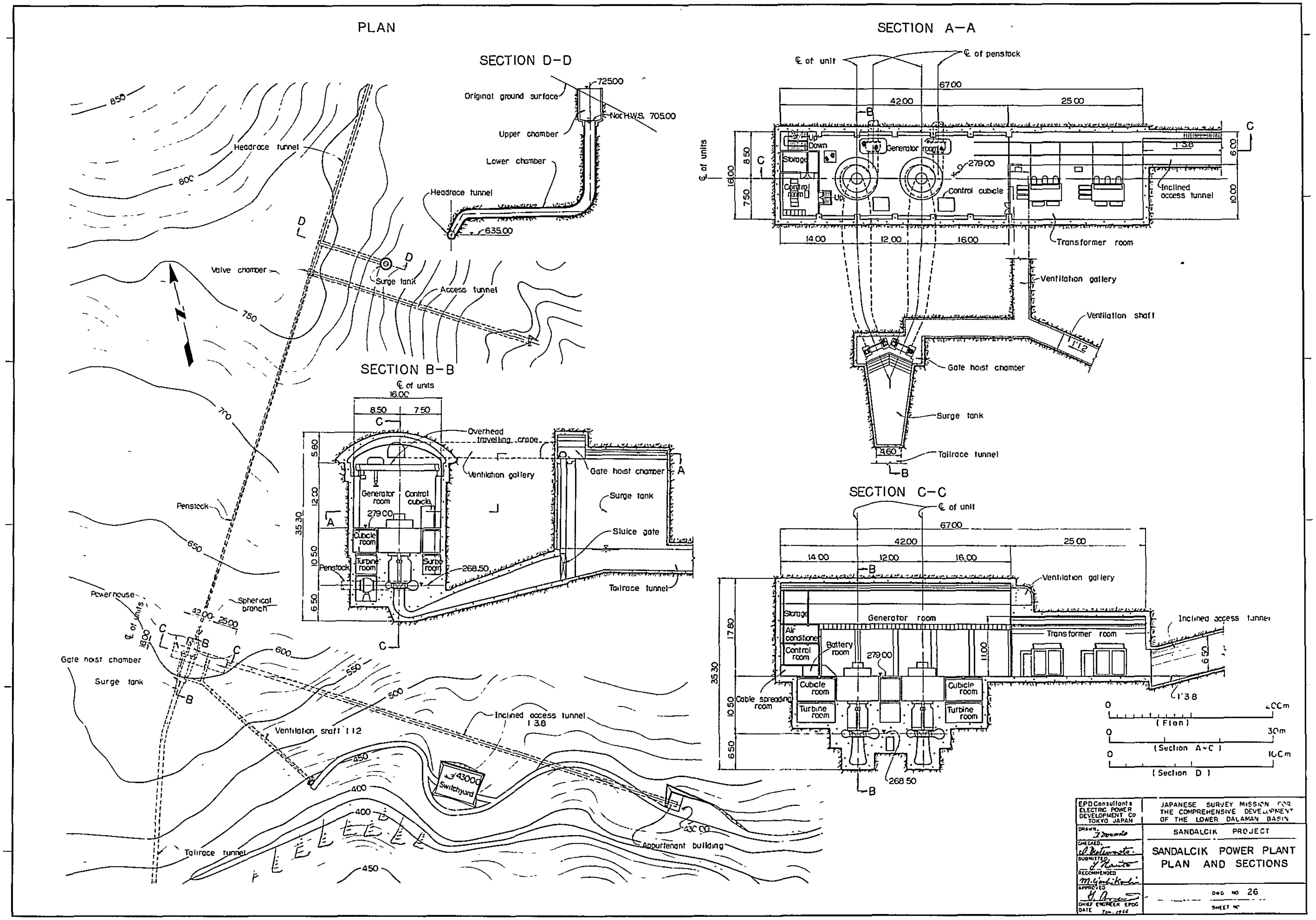
MAXIMUM SECTION OF MAIN DAM

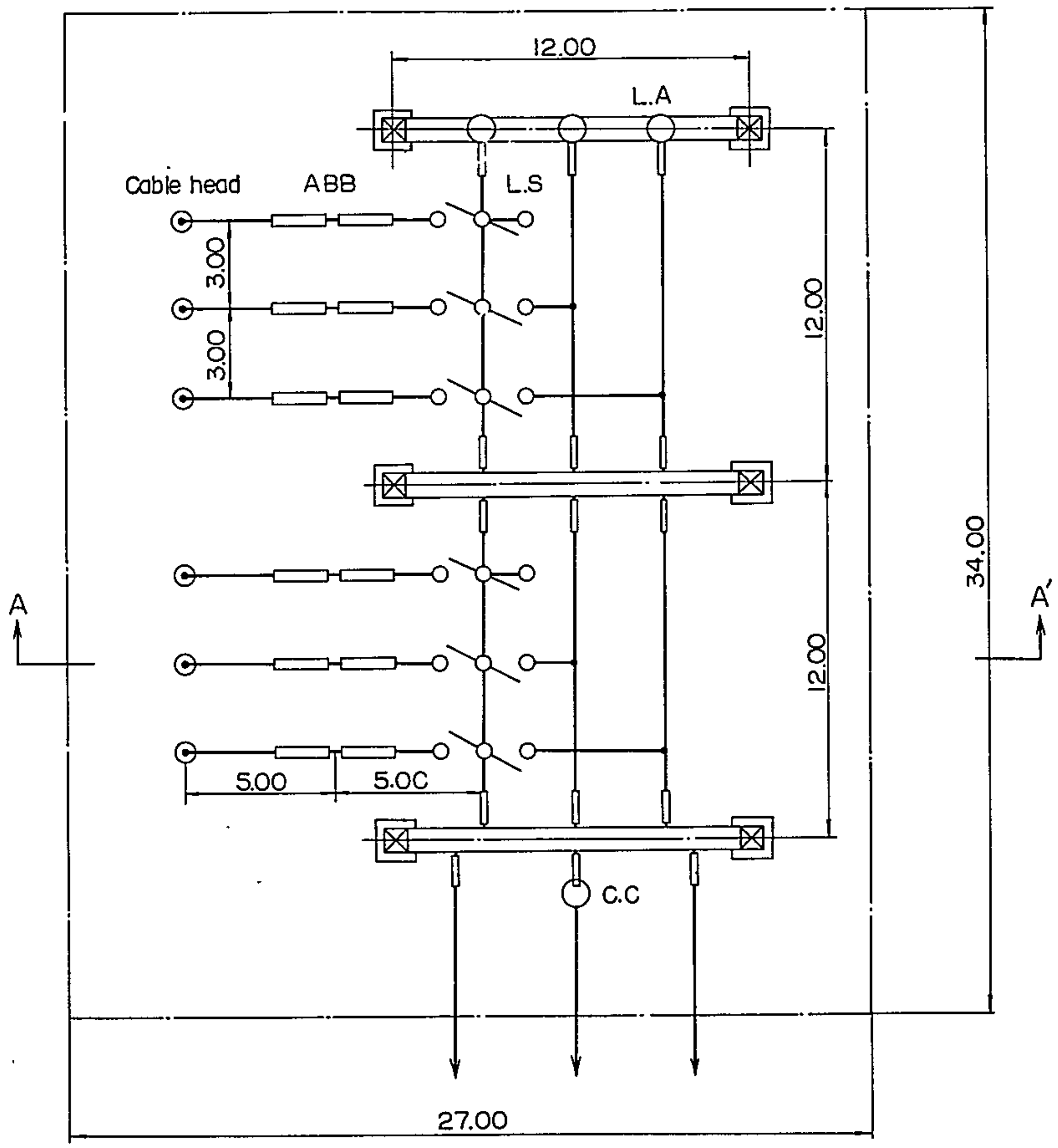


TYPICAL SECTION OF AUXILIARY DAM

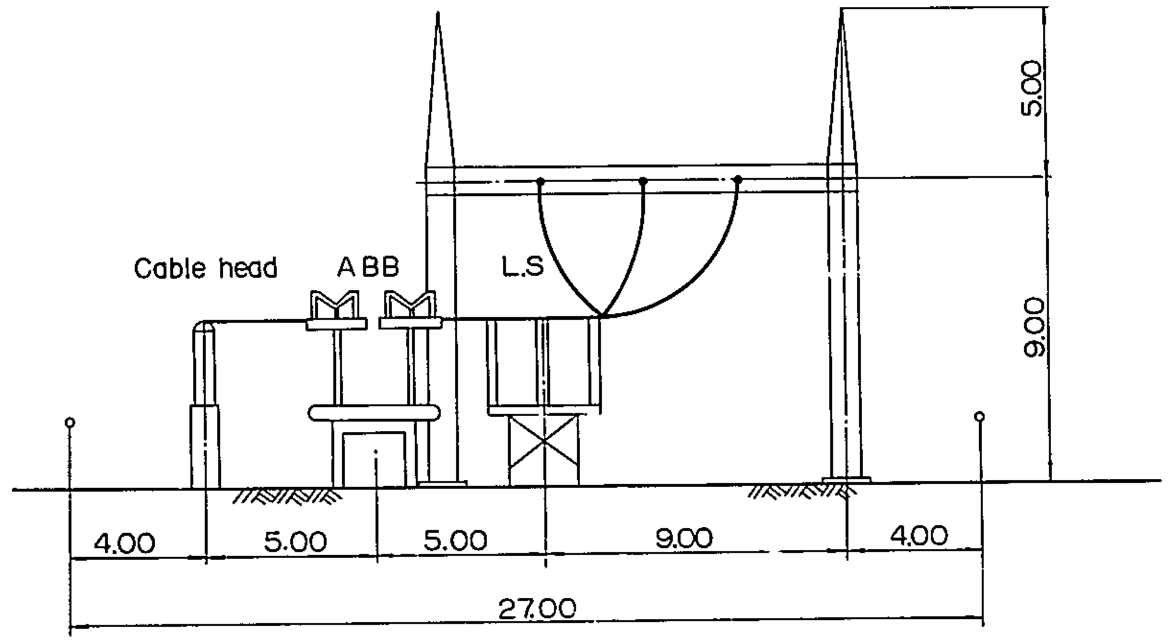


EPD Consultants ELECTRIC POWER DEVELOPMENT Co TOKYO JAPAN	JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN	SANDALCIK PROJECT
CHECKED	SANDALCIK MAIN DAM PLAN AND SECTIONS (ALTERNATIVE)
SUBMITTED	
RECOMMENDED	
APPROVED	DWG NO 25
CHIEF ENGINEER EPDC	
DATE	SHEET NO


PLAN
SECTION D–D
SECTION A–A
SECTION B–B
SECTION C–C
Original ground surface
725.00
Nor.H.W.S. 705.00
Upper chamber
Lower chamber
Headrace tunnel
635.00
Valve chamber
Surge tank
Access tunnel
Penstock
Powerhouse
Spherical branch
Gate hoist chamber
Ventilation shaft 1:12
Inclined access tunnel 1:3.8
Switchyard
Appurtenant building
Tailrace tunnel
℄ of unit
℄ of penstock
℄ of units
Generator room
Control cubicle
Control room
Storage
Up
Down
Transformer room
Inclined access tunnel
Ventilation gallery
Ventilation shaft
Gate hoist chamber
Surge tank
Tailrace tunnel
Overhead travelling crane
Cubicle room
Turbine room
Sluice gate
Air conditioner
Battery room
Cable spreading room
279.00
268.50
67.00
42.00
25.00
14.00
12.00
16.00
(Plan)
(Section A~C)
(Section D)
EPD Consultants
ELECTRIC POWER DEVELOPMENT CO
TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
SANDALCIK POWER PLANT
PLAN AND SECTIONS
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE
DWG NO 26
SHEET NO



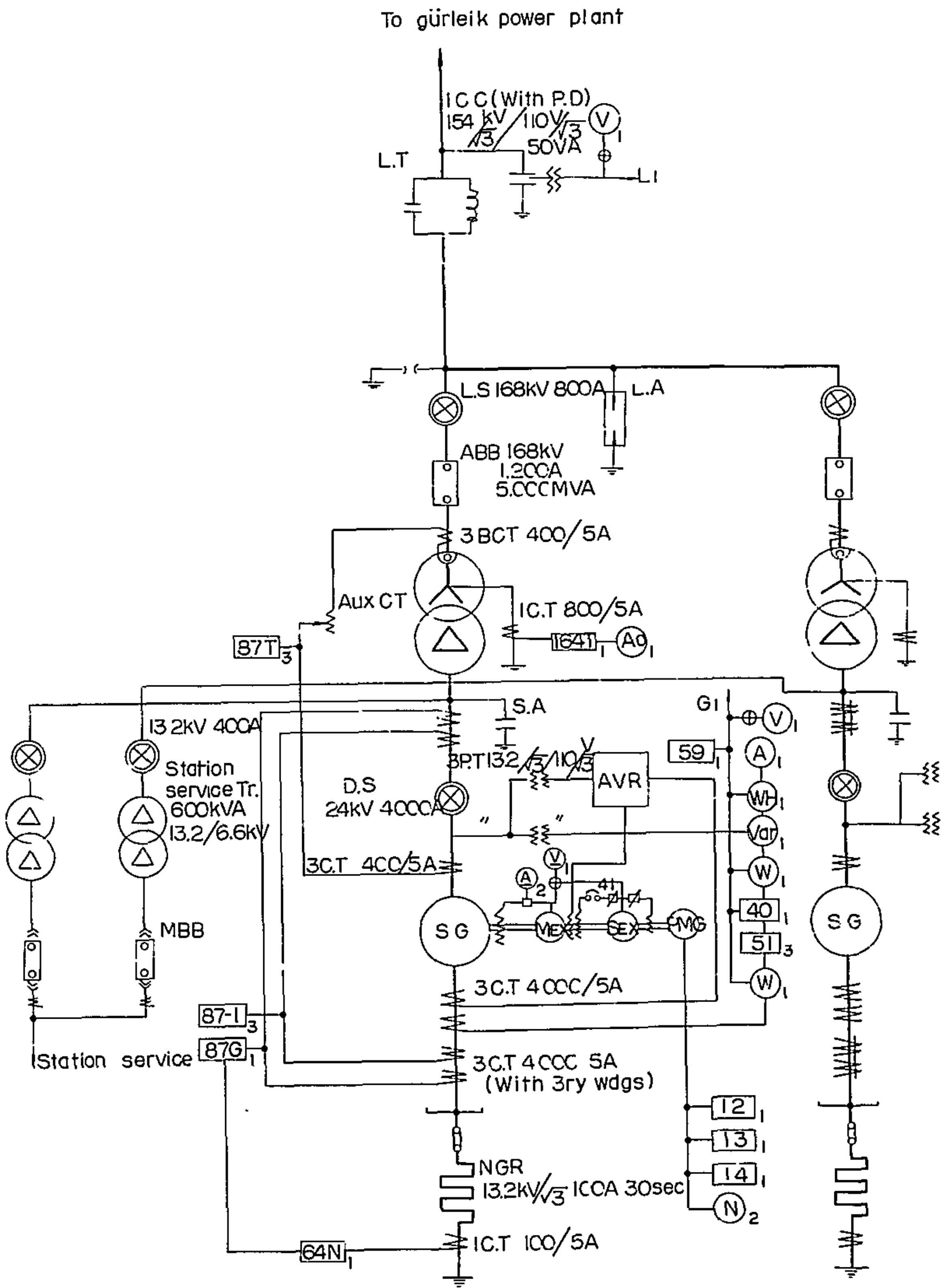
A—A′ SECTION



LEGEND

ABB : Air blast circuit breaker
L.S : Line switch
L.A : Lightning arrester
C.C : Coupling condenser

EPDC consultants ELECTRIC POWER DEVELOPMENT CO. TOKYO JAPAN	JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN	SANDALCIK PROJECT
CHECKED	SANDALCIK POWER PLANT SWITCH YARD
SUBMITTED	
RECOMMENDED	
APPROVED	DWG. NO. 27
CHIEF ENGINEER EPDC DATE	SHEET NO.



LEGEND

S G	:	Synchroncus generator
M. Tr	:	Main transformer
A B B	:	Air blast circuit bresker
M B B	:	Magne blast circuit bresker
C. C	:	Coupling condenser
L. S	:	Line switch
D. S	:	Disconnecting switch
C. T	:	Current transformer
P. D	:	Potential device
P. T	:	Potential transformer
L. A	:	Lightning arrester
L. T	:	Line trap
B C T	:	Bushing current transformer
Aux.CT	:	Auxiliary current transformer
N G R	:	Neutral grounding resistor
M E X	:	Main exciter
S E X	:	Sub exciter
P M G	:	Permanent magnet generator
V	:	Volt meter
A	:	Am meter
W	:	Watt-meter
Var	:	Var-meter
W H	:	Watt-hour meter
Ao	:	Ground Ammeter
V	:	Direct current volt meter
A	:	Direct current am meter
N	:	Speed indicator
12	:	Over speed relay
13	:	Rated speed relay
14	:	Under speed relay
40	:	Field relay
51	:	Over current relay
59	:	Over voltage relay
64N	:	Over current ground relay
87-1	:	Generator differential relay
87G	:	Generator differential ground relay
87T	:	Transformer differential relay
164T	:	Line overcurrent ground relay

EPDC Consultants Electric Power Development Co Tokyo Japan

JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN

DRAWN: | SANDALCIK PROJECT

CHECKED: | SANDALCIK POWER PLANT ONE LINE DIAGRAM

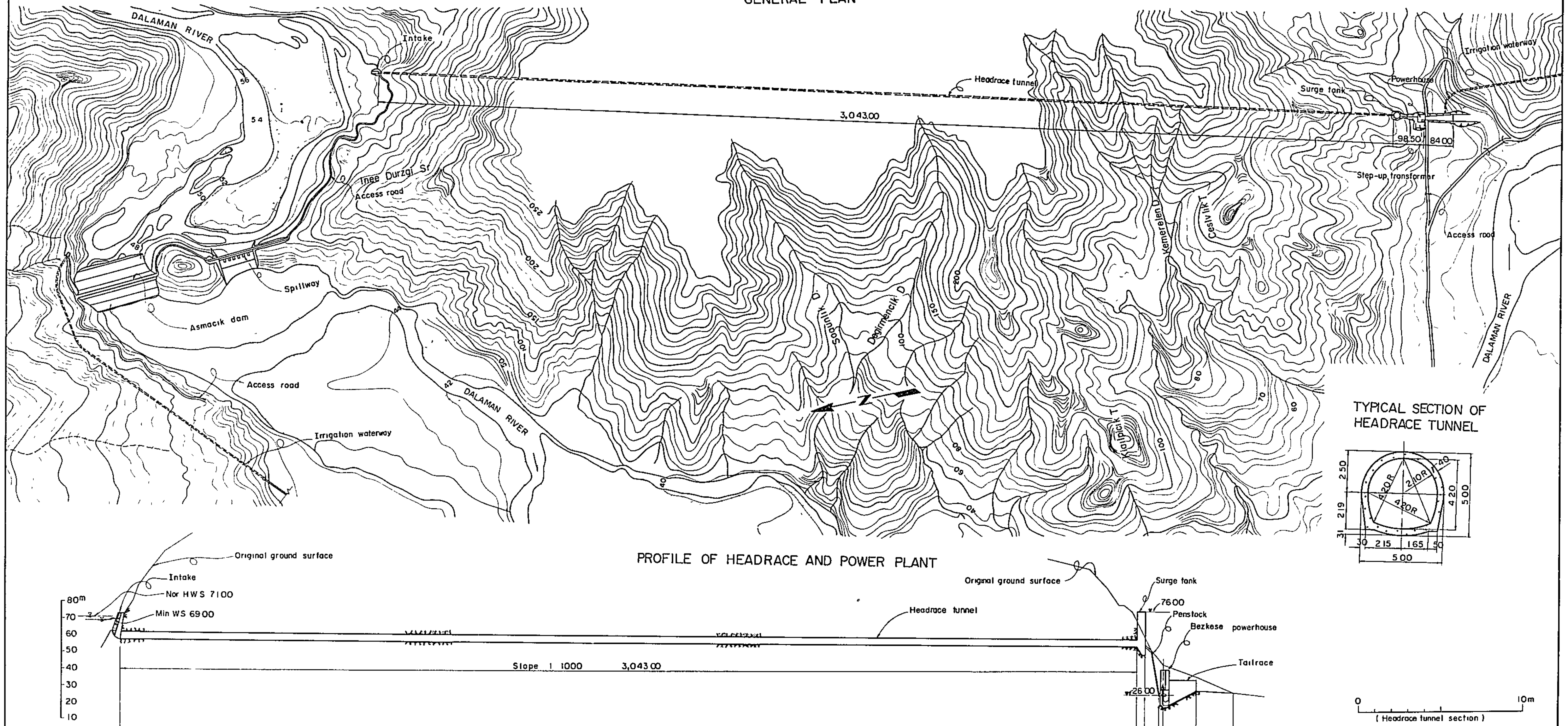
SUBMITTED:

RECOMMENDED:

APPROVED: | DWG NO 28

DATE: Jan 1966 | SHEET NO.

GENERAL PLAN



Formation height	57 50	57 00	56 50	56 00	55 50	55 00	54 46 55 00	26 00	28 50	27 30
Ground height	70 00	300 00	350 00	320 00	200 00	220 00	73 00 63 00	45 00 44 00	42 00	27 30
Total distance	0	500 00	1000 00	1500 00	2000 00	2500 00	3,043 3,068 0	3,112 0 3,123 0	3,220 5	3,340 5
Distance	0	500 00	500 00	500 00	500 00	500 00	543 00 25 00	44 00 11 00	97 50	120 00

E.P.D Consultants
ELECTRIC POWER DEVELOPMENT Co
TOKYO JAPAN

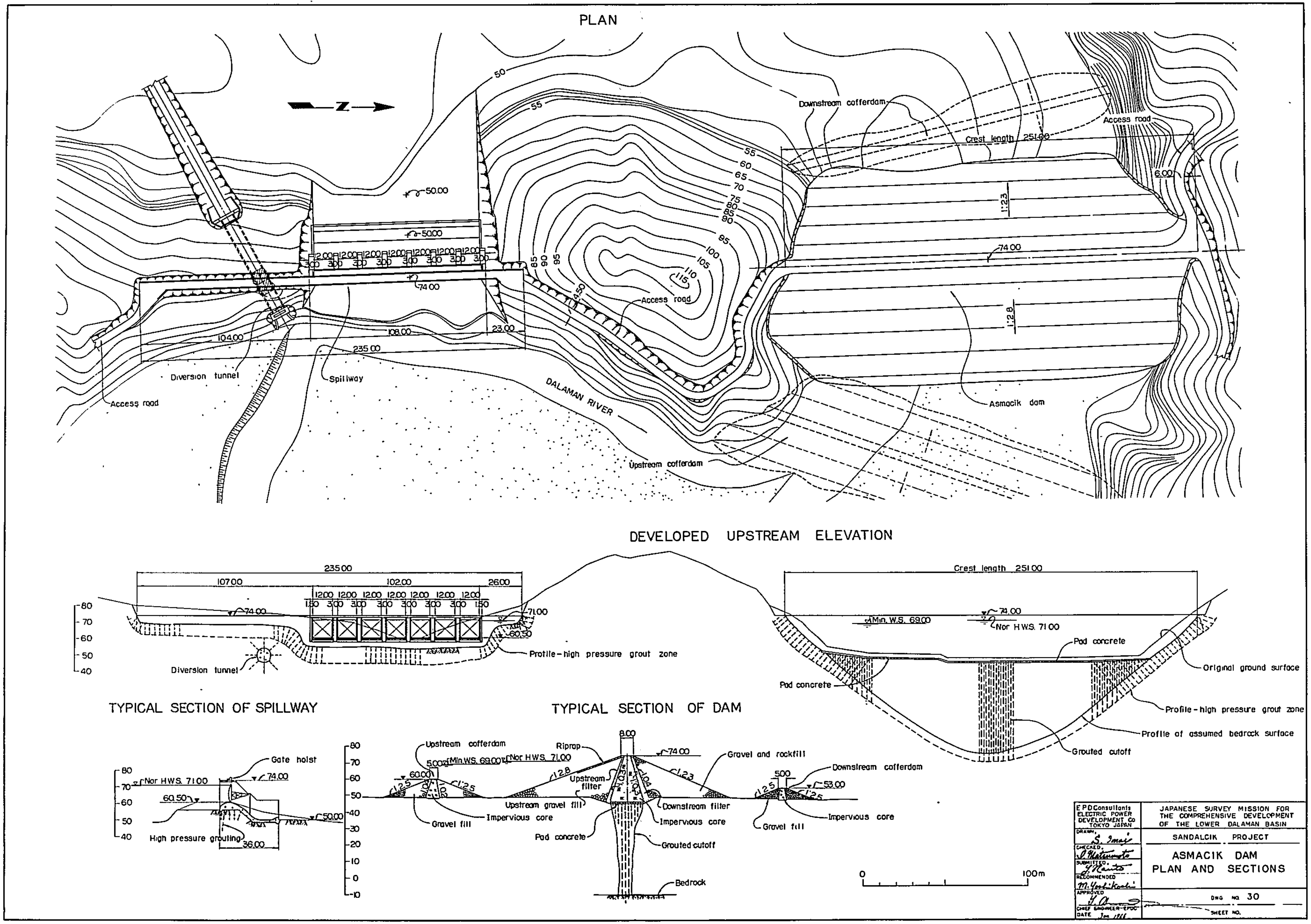
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN

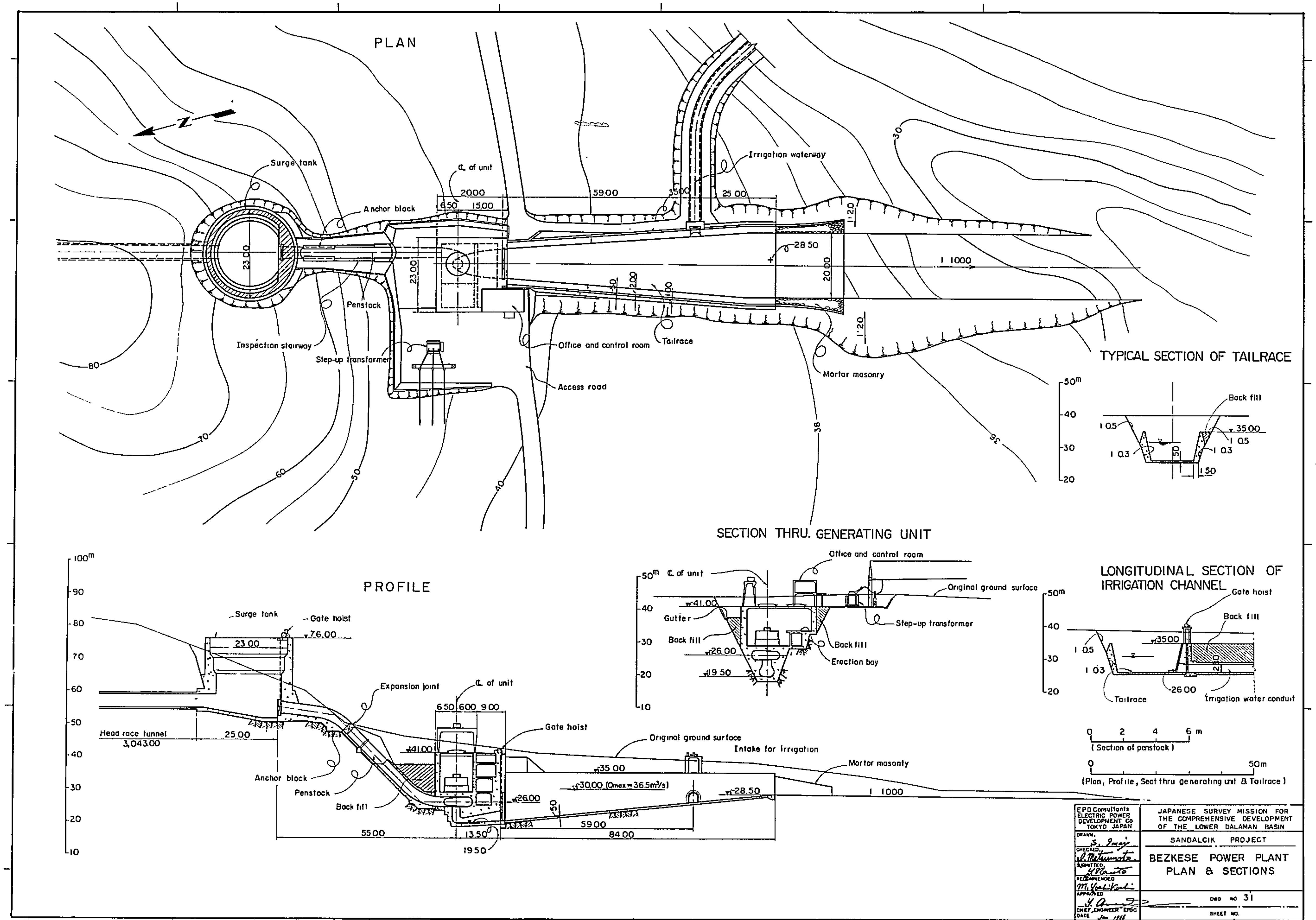
SANDALCIK PROJECT

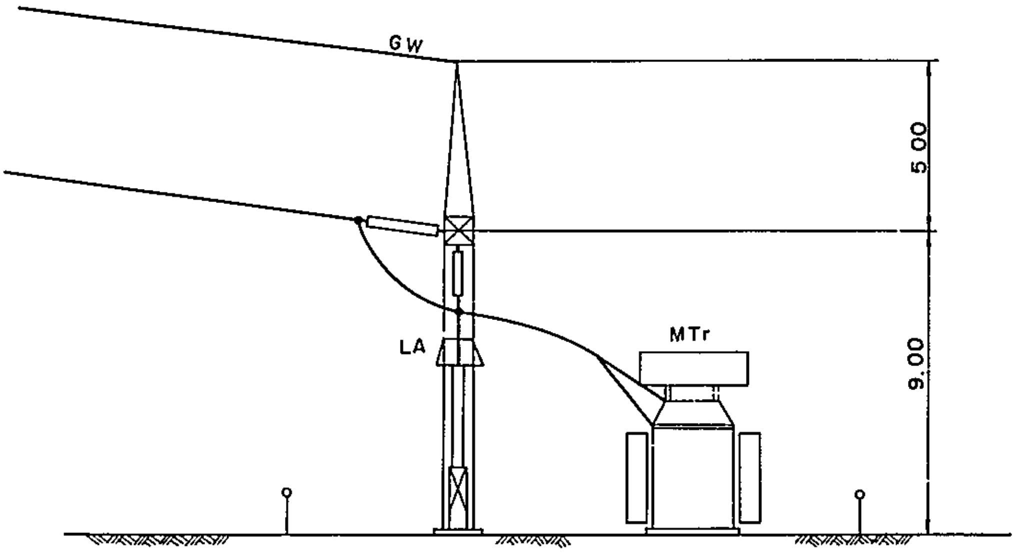
BEZKESE WATERWAY GENERAL PLAN AND LONGITUDINAL SECTION

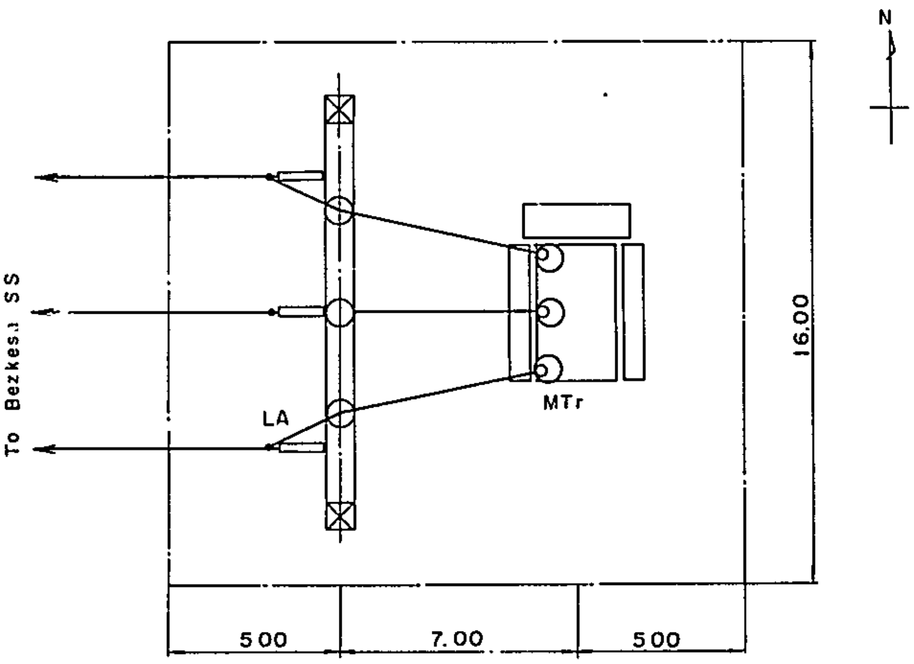
DRAWN,
CHECKED,
SUBMITTED,
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE

DWG NO 29
SHEET NO.


PLAN
Downstream cofferdam
Access road
Crest length 251.00
6.00
1:2.3
74.00
1:2.8
50.00
12.00
3.00
104.00
108.00
23.00
235.00
Diversion tunnel
Spillway
Access road
DALAMAN RIVER
Upstream cofferdam
Asmacik dam
DEVELOPED UPSTREAM ELEVATION
235.00
107.00
102.00
26.00
1.50
71.00
60.50
Diversion tunnel
Profile-high pressure grout zone
Crest length 251.00
Min. W.S. 69.00
Nor HWS. 71.00
Pad concrete
Original ground surface
Profile-high pressure grout zone
Profile of assumed bedrock surface
Grouted cutoff
TYPICAL SECTION OF SPILLWAY
Gate hoist
Nor HWS. 71.00
High pressure grouting
36.00
TYPICAL SECTION OF DAM
Upstream cofferdam
Riprap
8.00
Gravel and rockfill
Downstream cofferdam
Min.W.S. 69.00
Upstream filter
Upstream gravel fill
Downstream filter
Gravel fill
Impervious core
Pad concrete
Grouted cutoff
Bedrock
53.00
0
100m
EPDC Consultants
ELECTRIC POWER DEVELOPMENT Co
TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
ASMACIK DAM
PLAN AND SECTIONS
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER-EPDC
DATE
DWG NO. 30
SHEET NO.


PLAN
Surge tank
Anchor block
℄ of unit
20.00
6.50
15.00
59.00
35.00
25.00
Irrigation waterway
23.00
28.50
20.00
1:20
1:1000
Penstock
Inspection stairway
Step-up transformer
Office and control room
Tailrace
Access road
Mortar masonry
80
70
60
50
40
38
36
30
TYPICAL SECTION OF TAILRACE
Back fill
35.00
1:0.5
1:0.3
1.50
SECTION THRU. GENERATING UNIT
Office and control room
℄ of unit
Original ground surface
41.00
Gutter
Back fill
Step-up transformer
26.00
Erection bay
19.50
LONGITUDINAL SECTION OF IRRIGATION CHANNEL
Gate hoist
Tailrace
Irrigation water conduit
PROFILE
Surge tank
Gate hoist
76.00
Expansion joint
℄ of unit
6.50 6.00 9.00
Gate hoist
Original ground surface
Intake for irrigation
Head race tunnel
3,043.00
25.00
Anchor block
Penstock
Back fill
Mortar masonry
35.00
30.00 (Qmax = 36.5m³/s)
28.50
1:1000
55.00
13.50
19.50
59.00
84.00
0 2 4 6 m
(Section of penstock)
0 50m
(Plan, Profile, Sect thru generating unit & Tailrace)
EPDC Consultants
ELECTRIC POWER DEVELOPMENT Co
TOKYO JAPAN
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
BEZKESE POWER PLANT
PLAN & SECTIONS
DWG NO 31
SHEET NO.

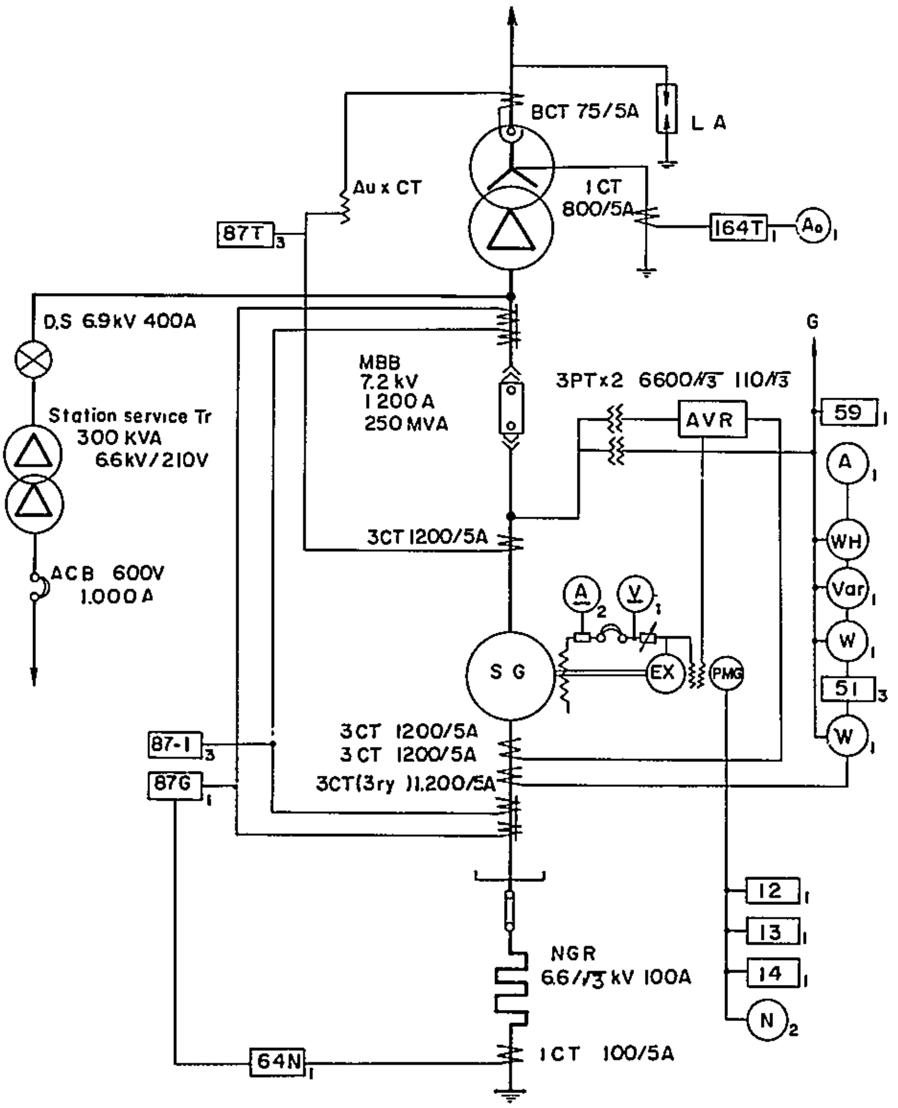




LEGEND.

MTr : Main Transformer
LA : Lightning Arrester

EPDC Consultants ELECTRIC POWER DEVELOPMENT CO. TOKYO JAPAN	JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN	SANDALCIK PROJECT
CHECKED	BEZKESE POWER PLANT .. SWITCH YARD
SUBMITTED	
RECOMMENDED M. Yoshikuni	
APPROVED	DWG. NO. 32
CHIEF ENGINEER EPDC DATE	SHEET NO.



EPDConsultants
ELECTRIC POWER DEVELOPMENT CO.
TOKYO JAPAN

JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN

DRAWN: T. Kidokoro

SANDALCIK PROJECT

CHECKED:

SUBMITTED:

RECOMMENDED: M. Yoshikoshi

APPROVED:

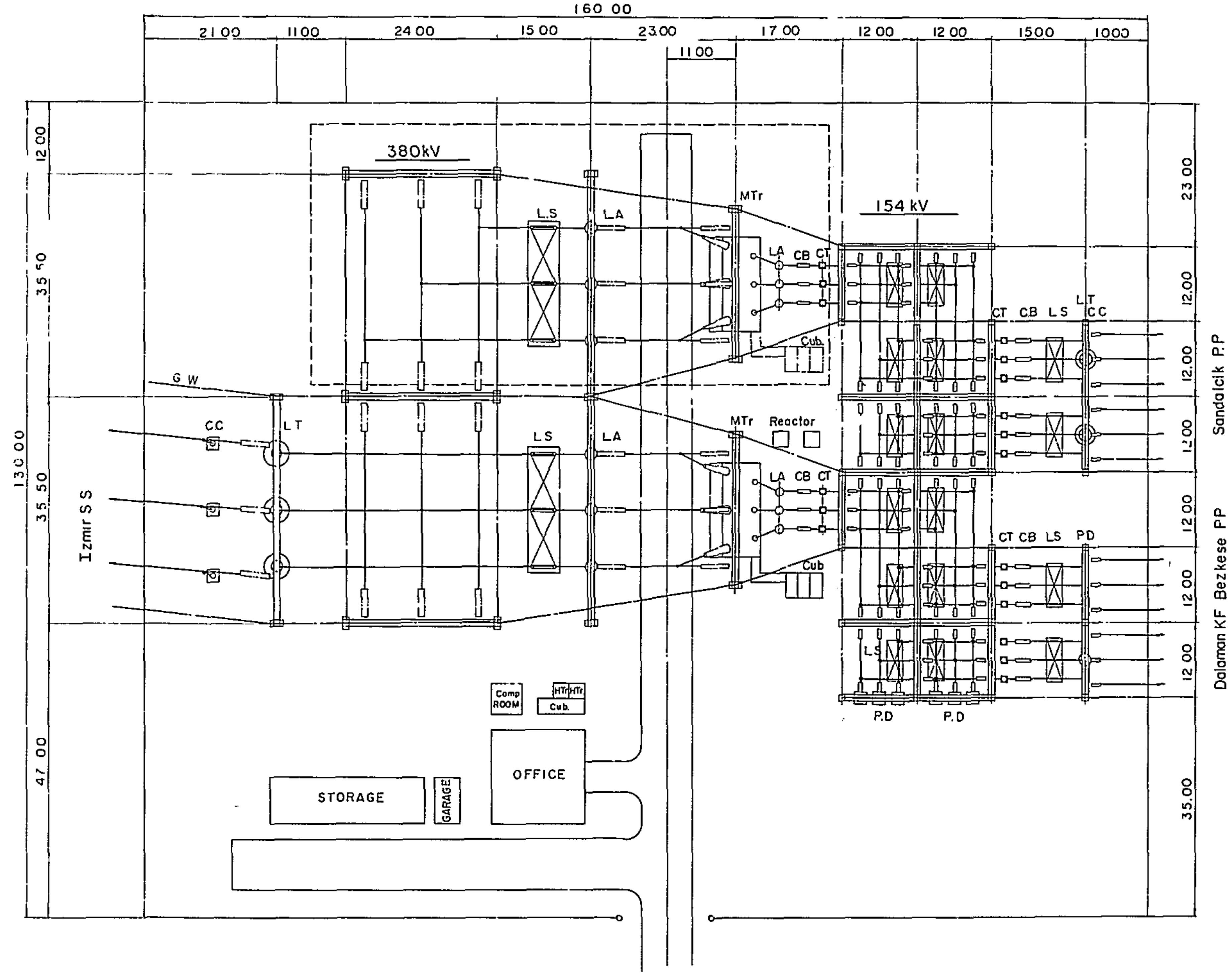
CHIEF ENGINEER EPDC

DATE Jan. 1966

BEZKESE POWER PLANT
ONE LINE DIAGRAM

DWG. NO. 33

SHEET NO.



LEGEND

CC	Coupling condenser (with PD)
LS	Line switch
PD :	Potential device
CT :	Current transformer
CB :	Circuit breaker
LA .	Lightning arrester
LT	Line trap
MTr	Main transformer

Note Dotted line section to be installed in future

E.P.D. Consultants ELECTRIC POWER DEVELOPMENT Co. TOKYO JAPAN

JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN

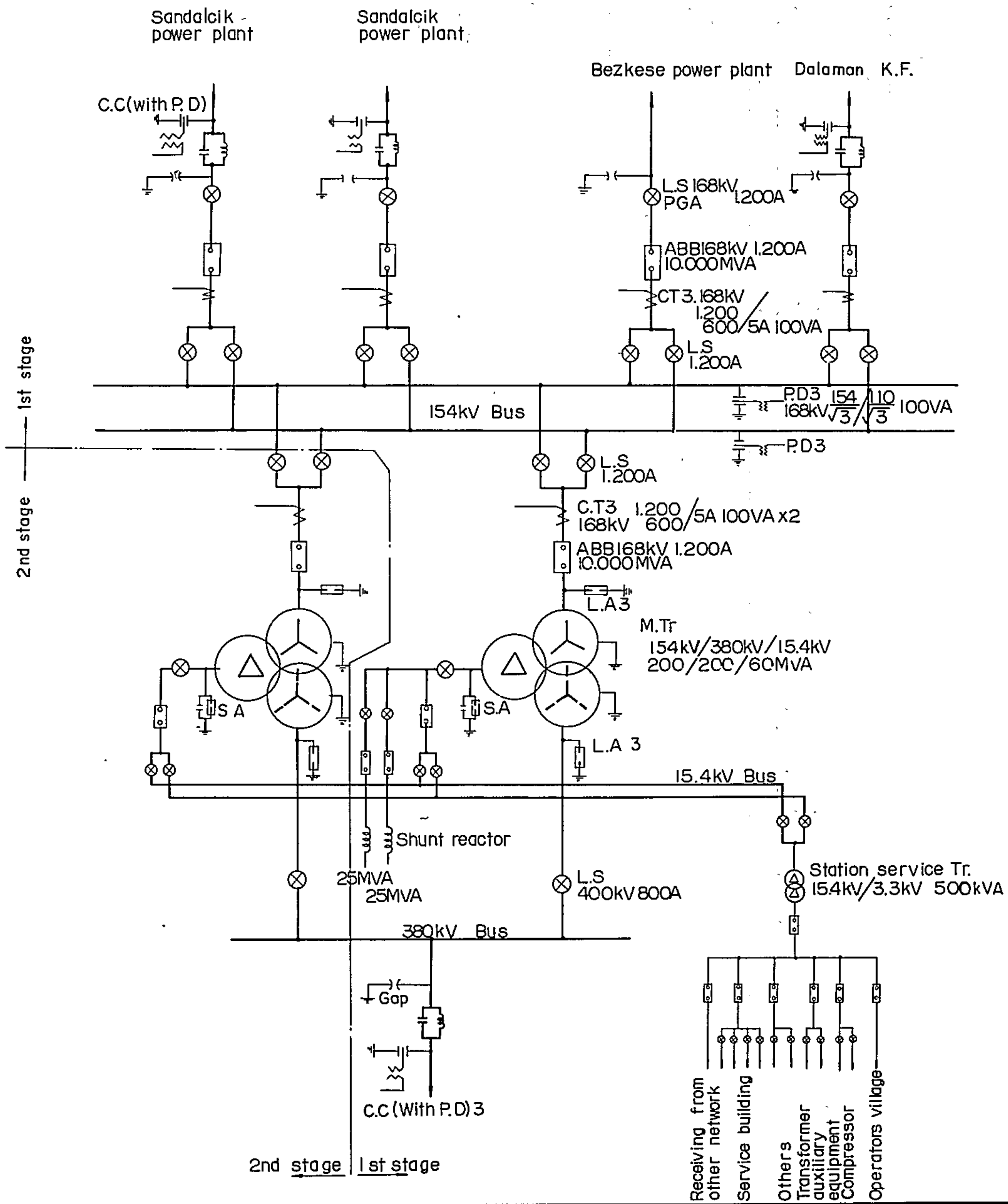
SANDALCIK PROJECT

BEZKESE SUBSTATION
GENERAL PLAN

DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE

DWG NO 34

SHEET NO.



LEGEND

M Tr	:	Main transformer
ABB	:	Air circuit breaker
L.S	:	Line switch
C.T	:	Current transformer
P.D	:	Potential device
C.C	:	Coupling condenser
L.A	:	Lightning arrester
S.A	:	Surge absorber

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ELECTRIC POWER DEVELOPMENT CO.
TOKYO JAPAN

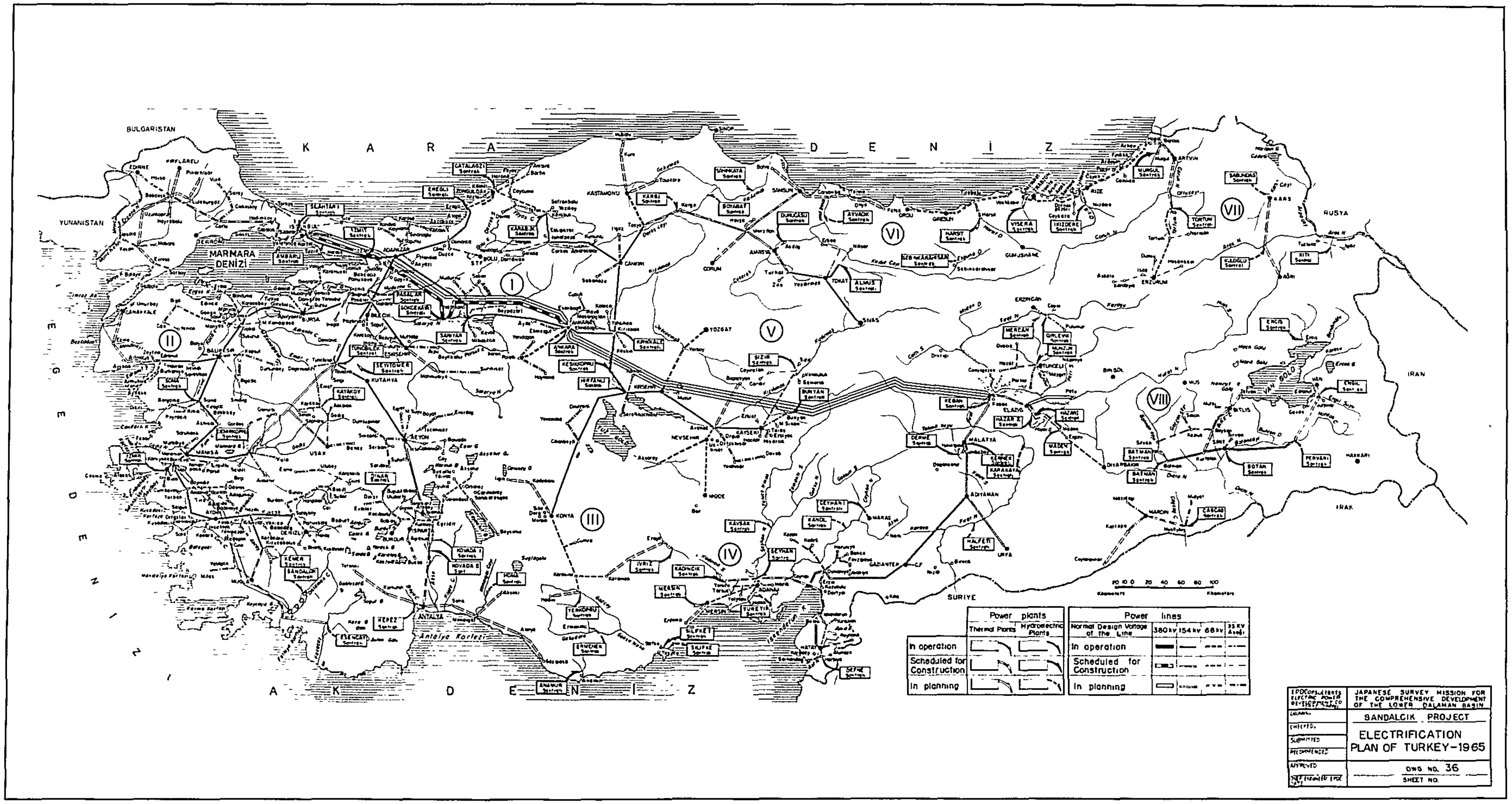
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN

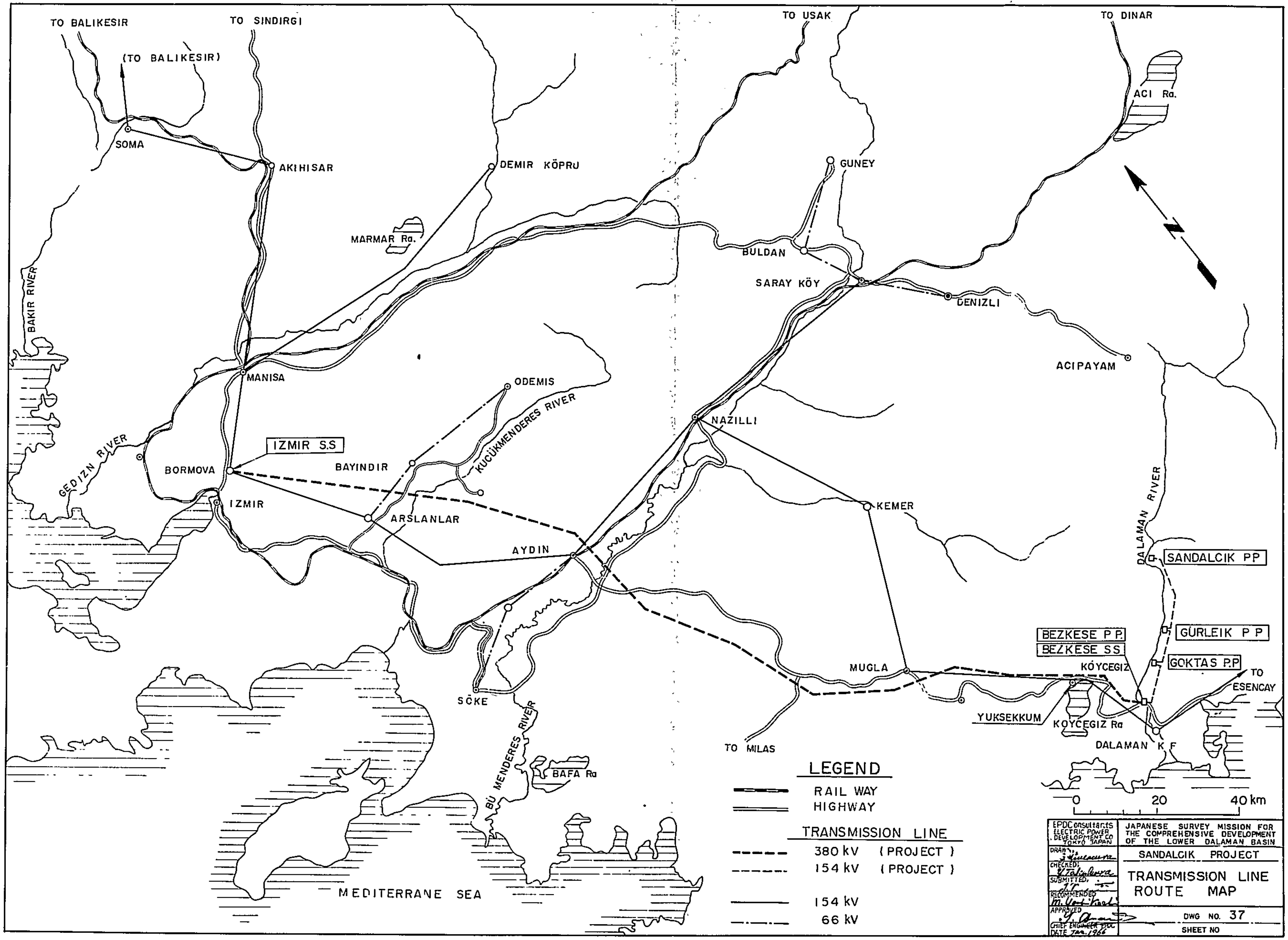
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER
DATE Jan. 1966

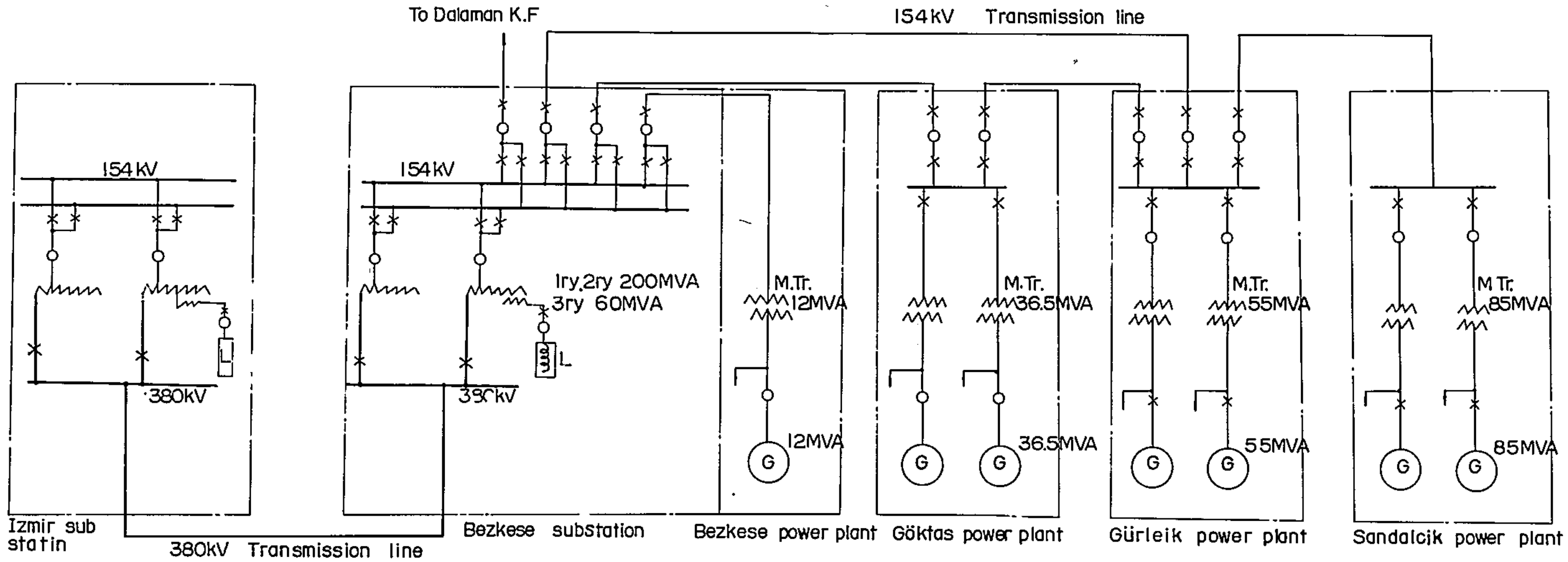
SANDALCIK PROJECT

BEZKESE SUBSTATION
ONE LINE DIAGRAM

DWG NO. 35
SHEET NO.


BULGARISTAN
YUNANISTAN
KARA DENİZ
MARMARA DENİZİ
EGE DENİZİ
AKDENİZ
RUSYA
IRAN
IRAK
SURIYE
KONYA
ANKARA
I
II
III
IV
V
VI
VII
VIII
Antalya Korfezi
Kilometers
Power plants
Thermal Plants
Hydroelectric Plants
In operation
Scheduled for Construction
In planning
Power lines
Normal Design Voltage of the Line
380 kv
154 kv
66 kv
35 KV
In operation
Scheduled for Construction
In planning
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
SANDALCIK PROJECT
ELECTRIFICATION PLAN OF TURKEY-1965
DWG NO. 36
SHEET NO.

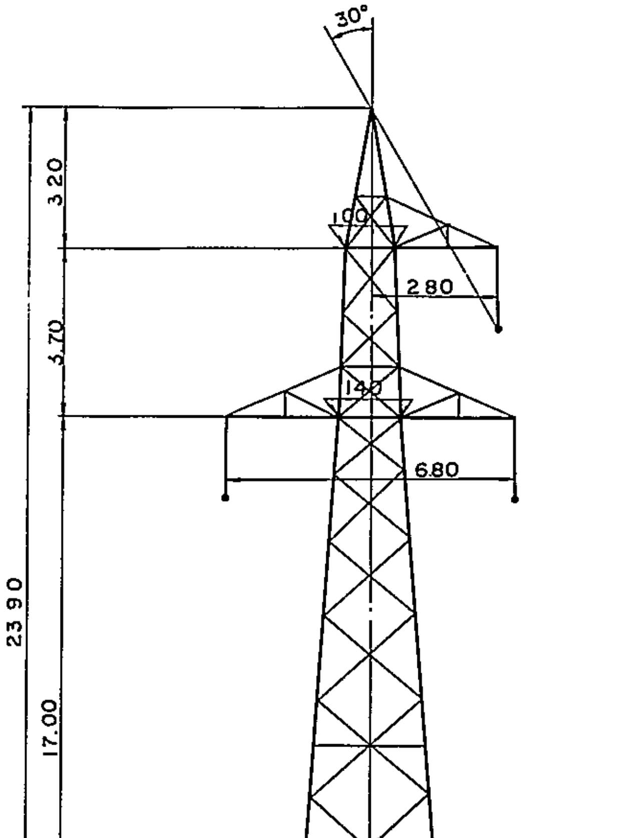

TO BALIKESIR
TO SINDIRGI
(TO BALIKESIR)
TO USAK
TO DINAR
ACI Ra.
SOMA
AKIHISAR
DEMIR KÖPRU
GUNEY
MARMAR Ra.
BULDAN
SARAY KÖY
DENIZLI
BAKIR RIVER
MANISA
ODEMIS
ACIPAYAM
KUCÜKMENDERES RIVER
NAZILLI
GEDIZN RIVER
IZMIR S.S
BORMOVA
BAYINDIR
IZMIR
ARSLANLAR
KEMER
DALAMAN RIVER
AYDIN
SANDALCIK PP
BEZKESE P.P.
GÜRLEIK P P
BEZKESE SS
KÓYCEGIZ
GOKTAS P.P
MUGLA
TO ESENCAY
SÖKE
YUKSEKKUM
KOYCEGIZ Ra
BÜ MENDERES RIVER
DALAMAN
K F
TO MILAS
BAFA Ra
LEGEND
RAIL WAY
HIGHWAY
TRANSMISSION LINE
380 kV (PROJECT)
154 kV (PROJECT)
154 kV
66 kV
0
20
40 km
MEDITERRANE SEA
EPDConsultants ELECTRIC POWER DEVELOPMENT CO TOKYO JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
CHIEF ENGINEER EPDC
DATE Jan. 1966
SANDALCIK PROJECT
TRANSMISSION LINE ROUTE MAP
DWG NO. 37
SHEET NO



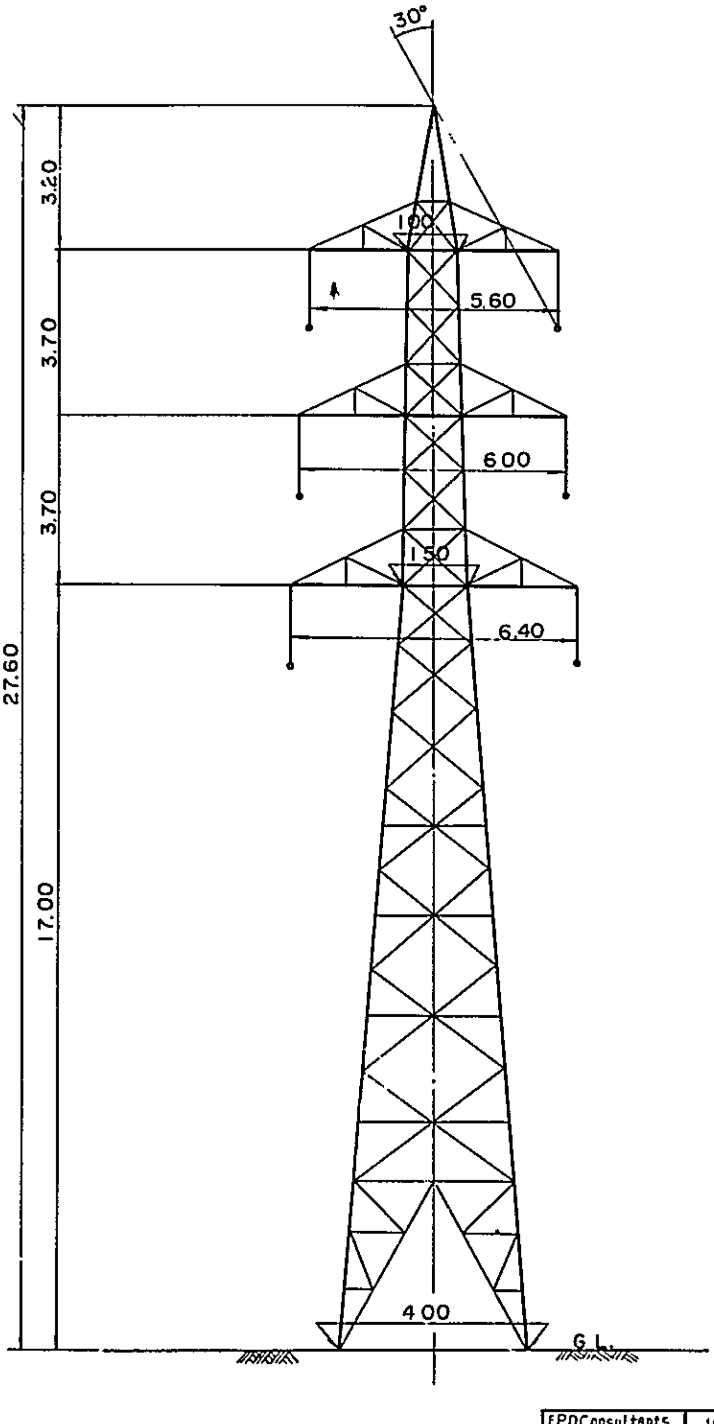
LEGEND

G : Generator
M.Tr. : Main transformer
O : Circuit breaker
x : Line switch or disconnecting switch
L : Shunt leactor

EPDC onsultants ELECTRIC POWER DEVELOPMENT CO. TOKYO, JAPAN	JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN	SANDALCIK PROJECT
CHECKED	TRANSMISSION SYSTEM DIAGRAM
SUBMITTED	
RECOMMENDED	
APPROVED	DWG. NO. 38
CHIEF ENGINEER EPDC DATE	SHEET NO.



EPDConsultants ELECTRIC POWER DEVELOPMENT CO. TOKYO JAPAN	JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN: S.Hinata...	SANDALCIK PROJECT
CHECKED: Y.Takakura	TRANSMISSION LINE-154KV, 1CCT.
SUBMITTED:	TANGENT TOWER
RECOMMENDED: M. Yoshitomi	
APPROVED:	DWG. NO 39
CHIEF ENGINEER EPDC DATE Jan 1966	SHEET NO.



EPDC Consultants
ELECTRIC POWER DEVELOPMENT CO
TOKYO JAPAN

JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN

SANDALCIK PROJECT

TRANSMISSIOM LINE-154kV, 2CCT,

TANGENT TOWER

DRAWN:

CHECKED:

SUBMITTED:

RECOMMENDED:

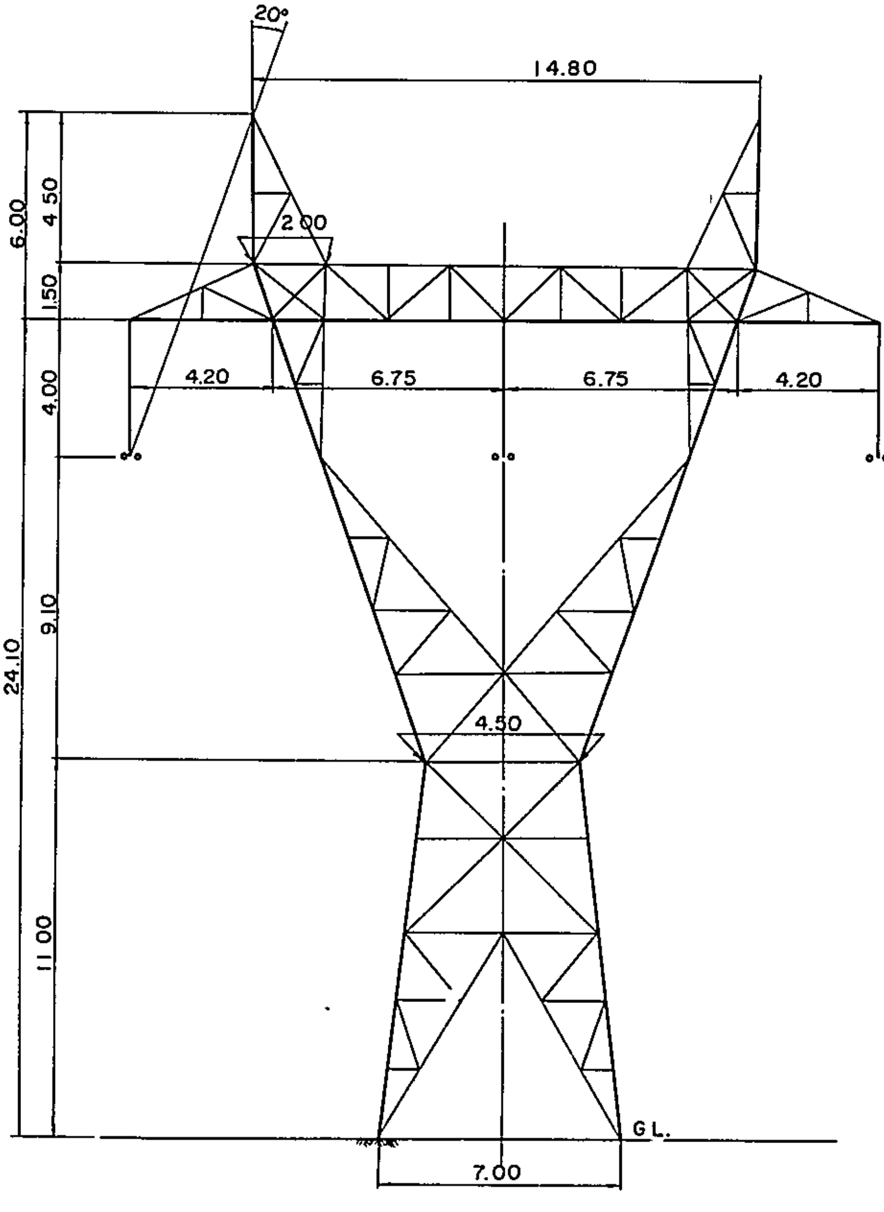
APPROVED:

CHIEF ENGINEER EPDC

DATE JAN 1966

DWG. NO 40

SHEET NO.



EPDConsultants
ELECTRIC POWER DEVELOPMENT CO. TOKYO JAPAN

JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN

DRAWN:

CHECKED:

SUBMITTED:

RECOMMENDED:

APPROVED:

CHIEF:

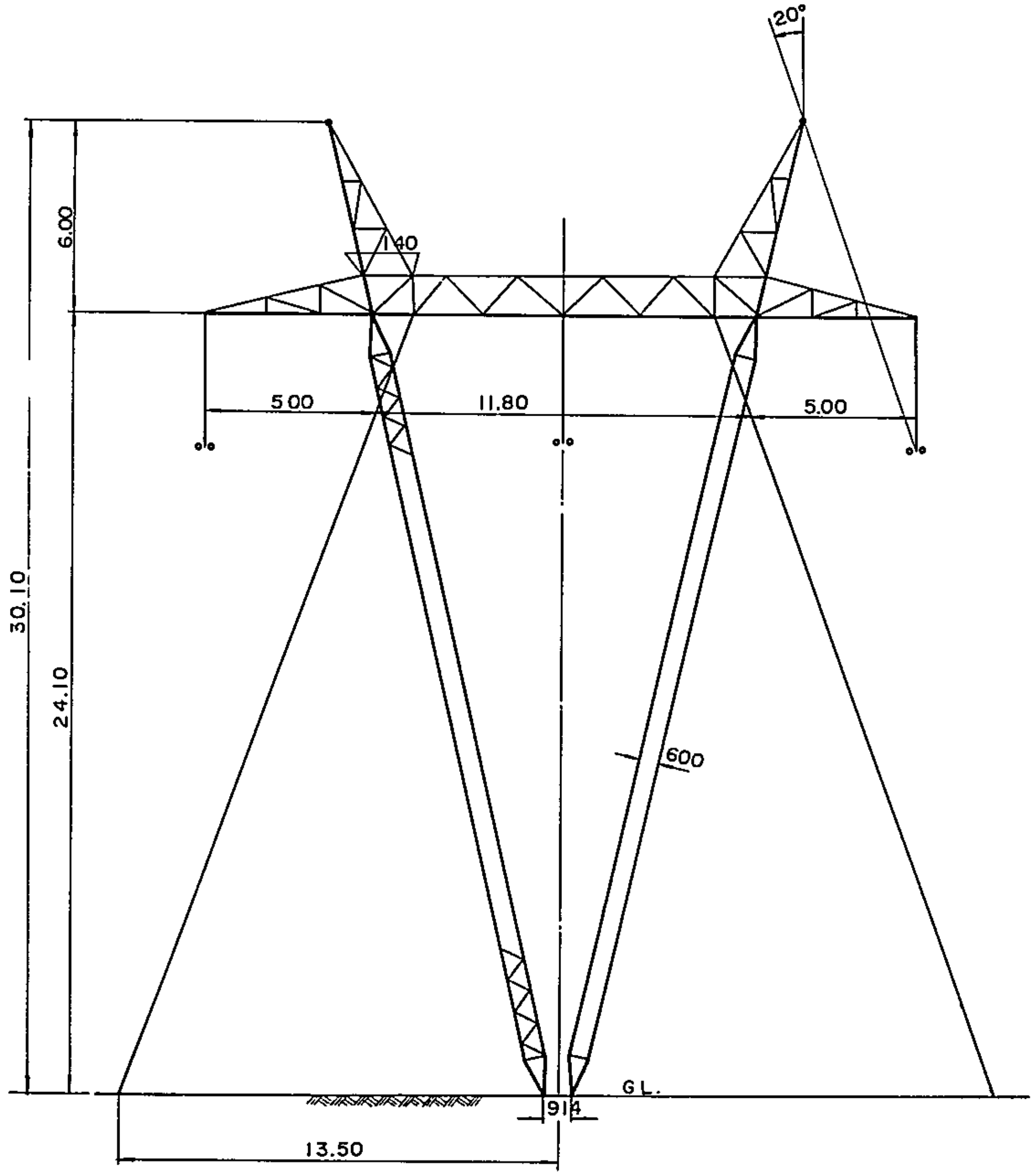
DATE: Jan. 1966

SANDALCIK PROJECT

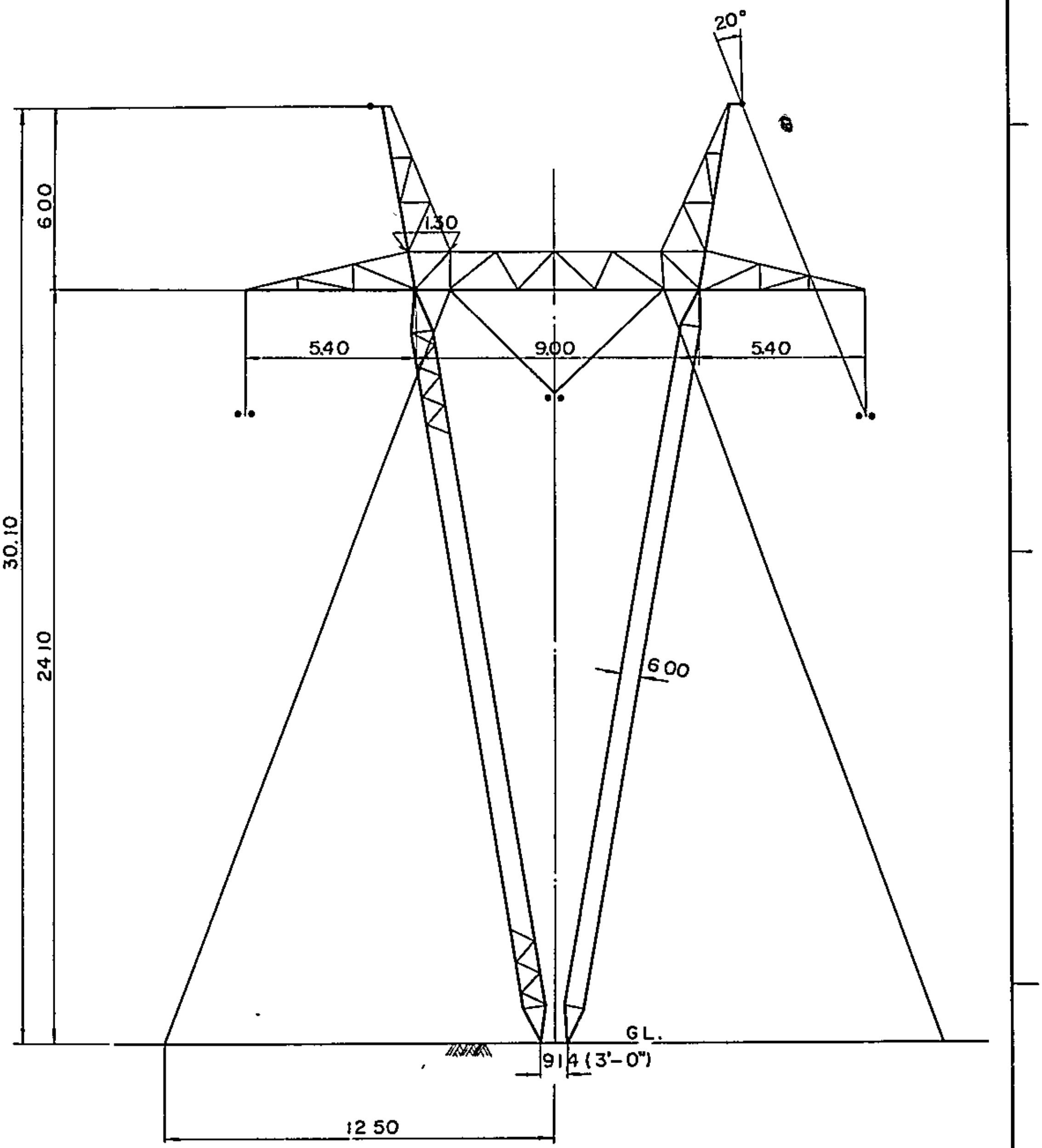
TRANSMISSION LINE-380KV, SELF STANDING, TANGENT TOWER

DWG NO. 41

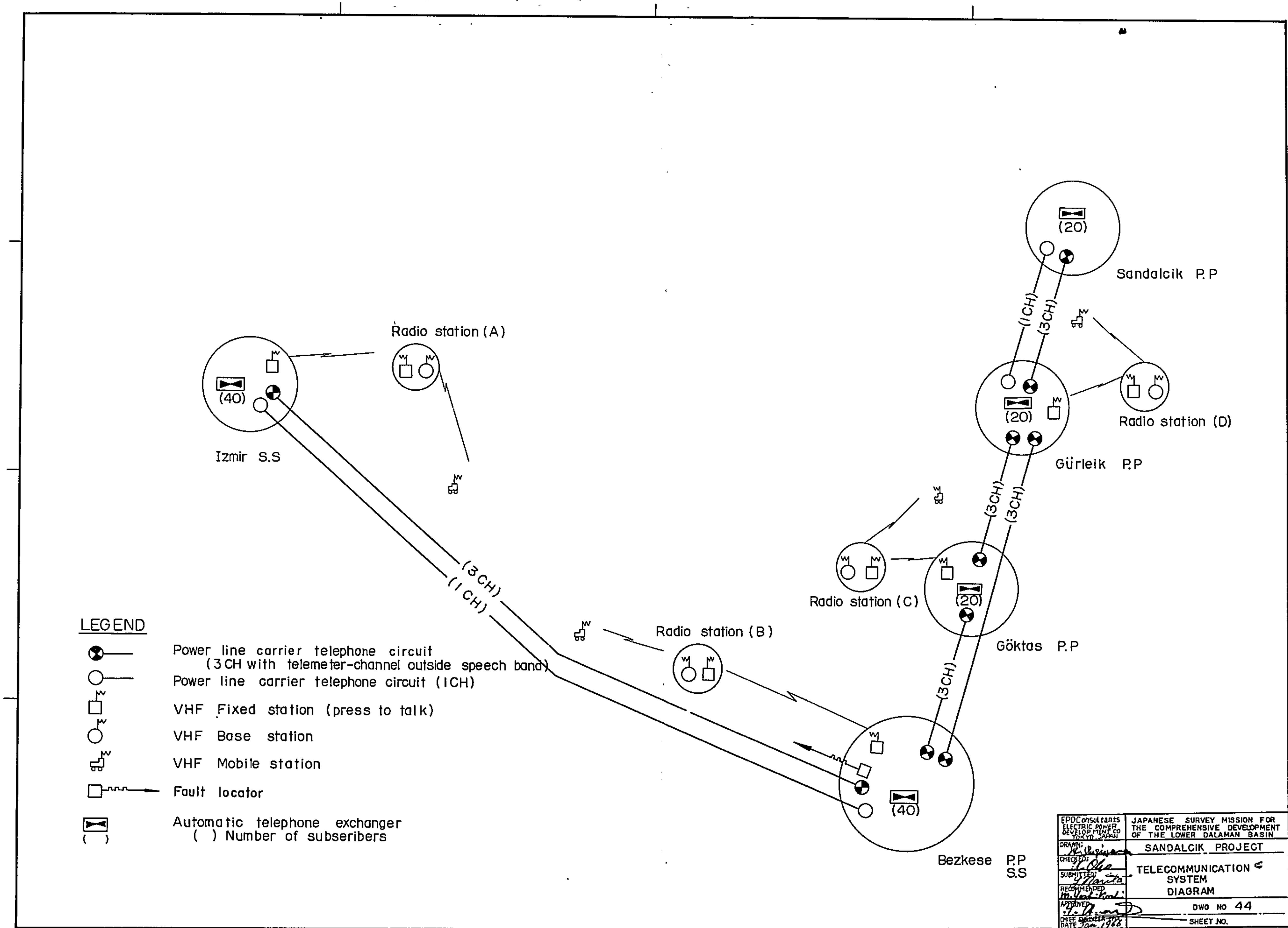
SHEET NO



EPDC onsultants ELECTRIC POWER DEVELOPMENT CO. TOKYO, JAPAN	JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN:	SANDALCIK PROJECT
CHECKED:	TRANSMISSION LINE-380kV GUYED TANGENT TOWER
SUBMITTED:	
RECOMMENDED:	
APPROVED:	DWG. NO. 42
CHIEF ENGINEER EPDC DATE Jan. 1986	SHEET NO.



EPDC Consultants ELECTRIC POWER DEVELOPMENT CO. TOKYO JAPAN	JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN:	SANDALCIK PROJECT
CHECKED:	TRANSMISSION LINE – 380 kV.
SUBMITTED:	GUYED, TANGENT TOWER (V-STRING)
RECOMMENDED:	
APPROVED:	DWG. NO 43
CHIEF ENGINEER EPDC DATE Jan. 1966	SHEET NO.


(20)
Sandalcik P.P
(1CH)
(3CH)
Radio station (A)
(40)
Izmir S.S
(20)
Radio station (D)
Gürleik P.P
(3CH)
(3CH)
(3 CH)
(1 CH)
Radio station (C)
(20)
Göktas P.P
Radio station (B)
(3CH)
(40)
Bezkese P.P
S.S
LEGEND
Power line carrier telephone circuit
(3 CH with telemeter-channel outside speech band)
Power line carrier telephone circuit (1CH)
VHF Fixed station (press to talk)
VHF Base station
VHF Mobile station
Fault locator
Automatic telephone exchanger
( ) Number of subseribers
EPDConsultants
ELECTRIC POWER DEVELOPMENT CO
TOKYO, JAPAN
JAPANESE SURVEY MISSION FOR THE COMPREHENSIVE DEVELOPMENT OF THE LOWER DALAMAN BASIN
DRAWN:
CHECKED:
SUBMITTED:
RECOMMENDED
APPROVED
CHIEF ENGINEER
DATE Jan. 1966
SANDALCIK PROJECT
TELECOMMUNICATION SYSTEM DIAGRAM
DWG NO 44
SHEET NO.