FIGURES

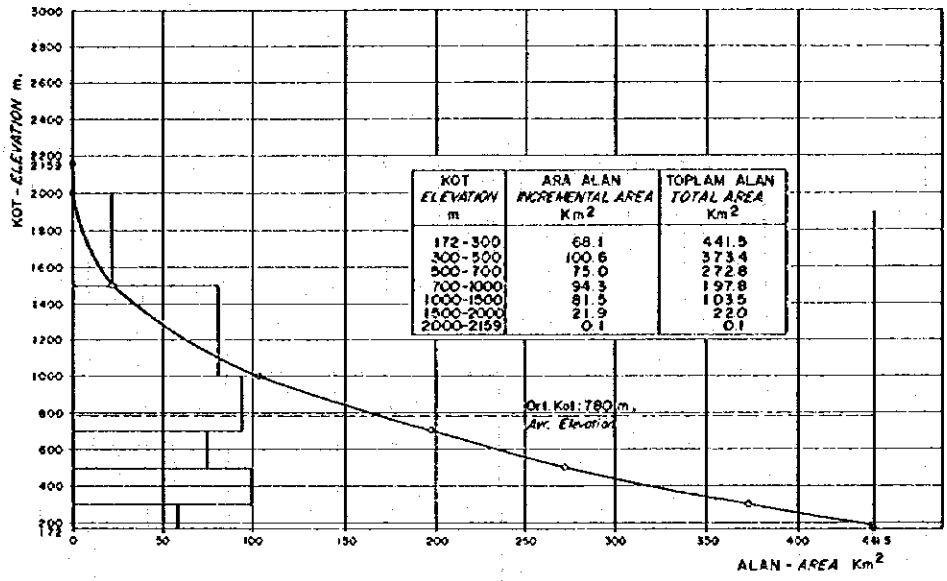


Figure-A.1 Hypsometric Curve for the Catchment Area of Beydağ Damsite

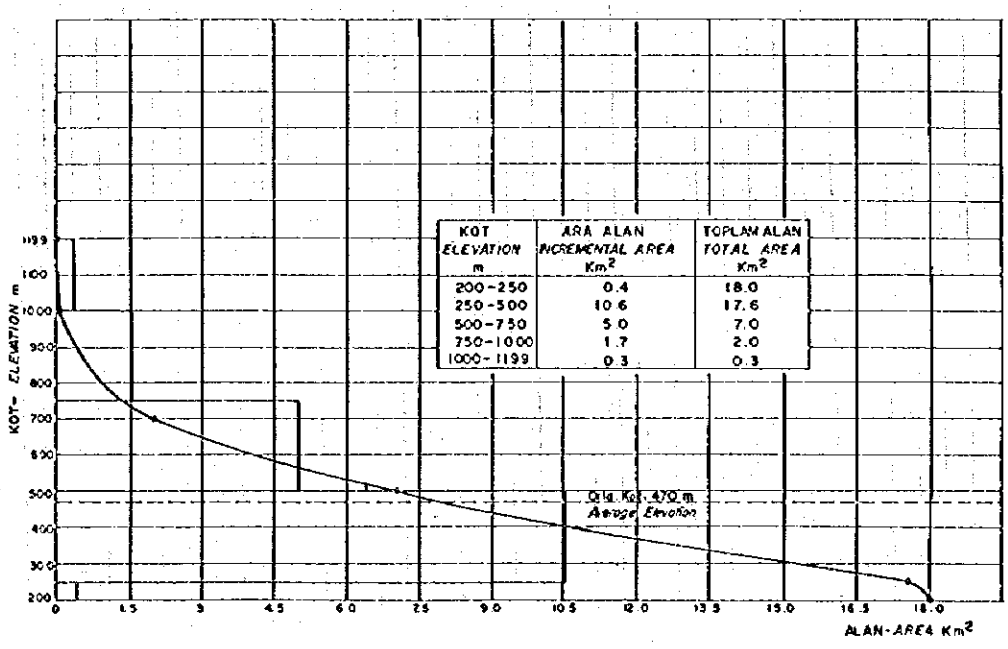


Figure-A.2 Hypsometric Curve for the Catchment Area of Bucak Damsite

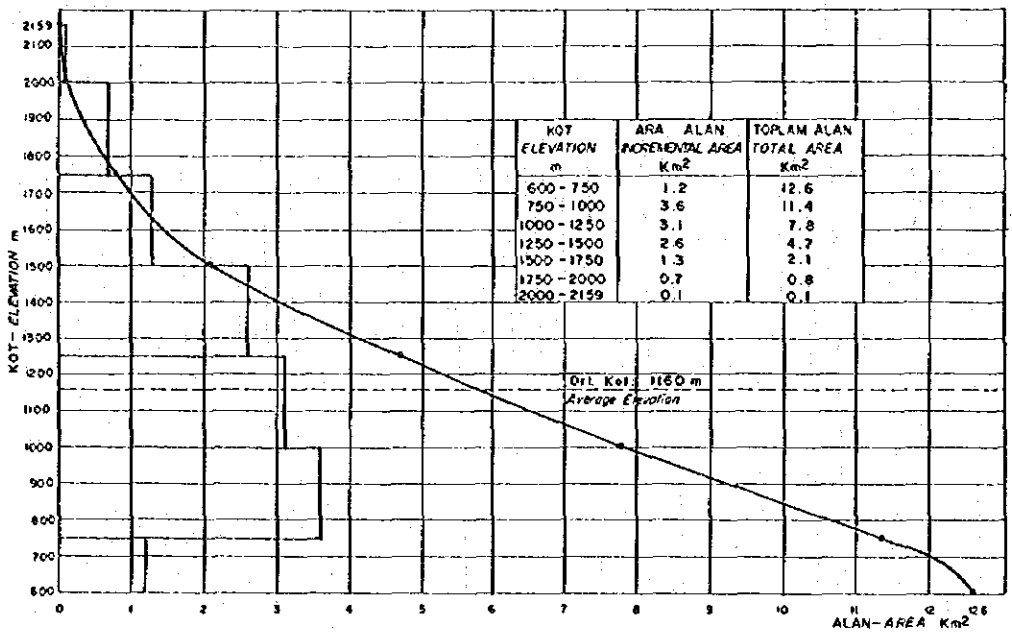


Figure-A.3 Hypsometric Curve for the Catchment Area of Birgi Damsite

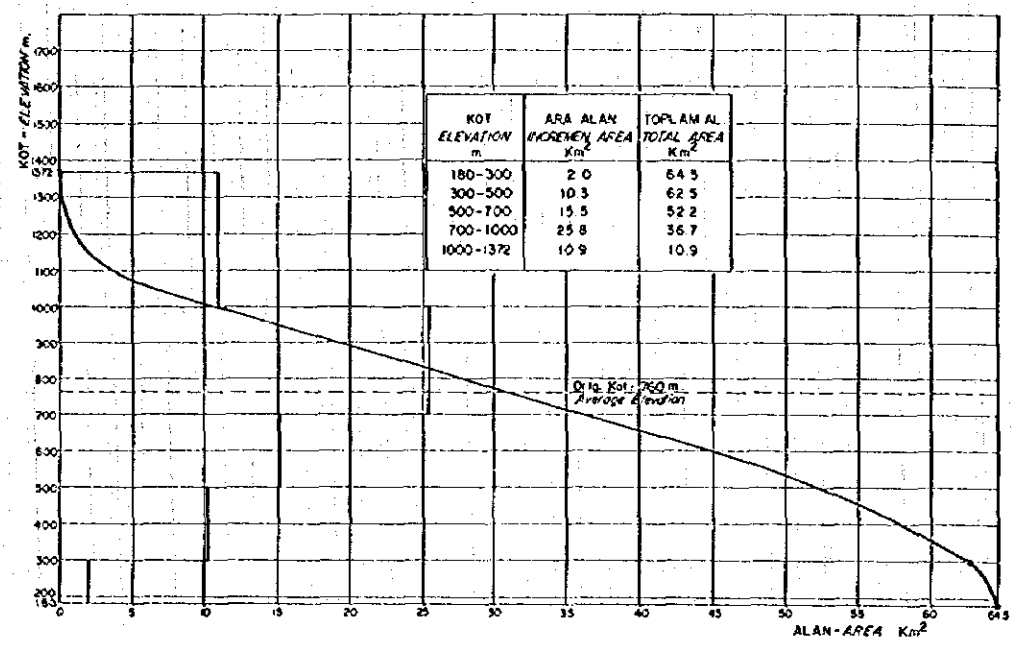


Figure-A.4 Hypsometric Curve for the Catchment Area of Ödemiş Damsite

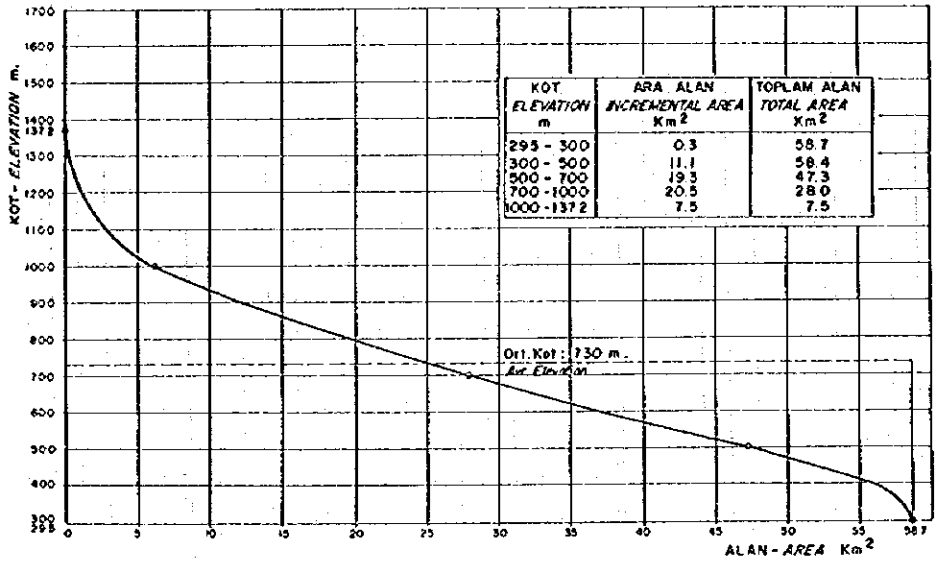


Figure-A.5 Hypsometric Curve for the Catchment Area of Aktaş Damsite

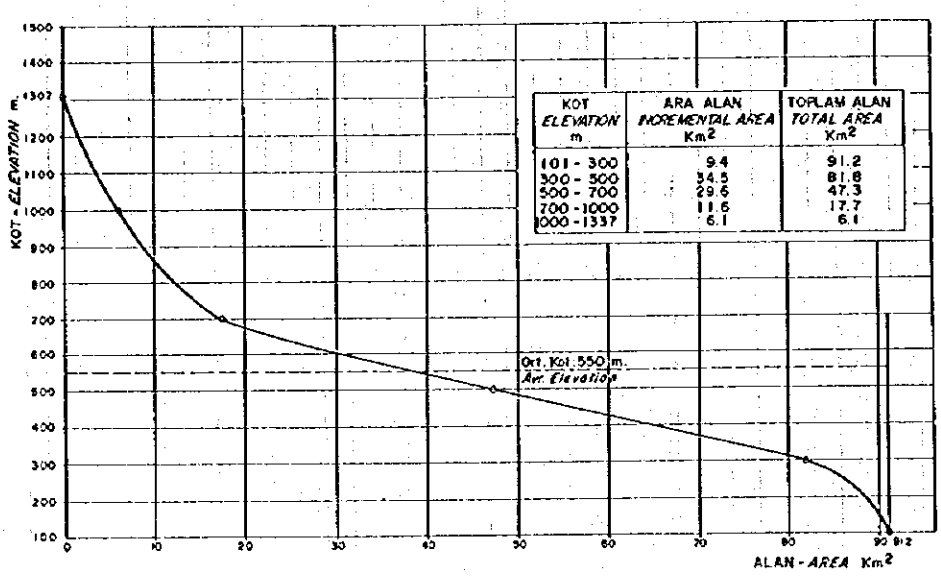


Figure-A.6 Hypsometric Curve for the Catchment Area of Burgaz Damsite

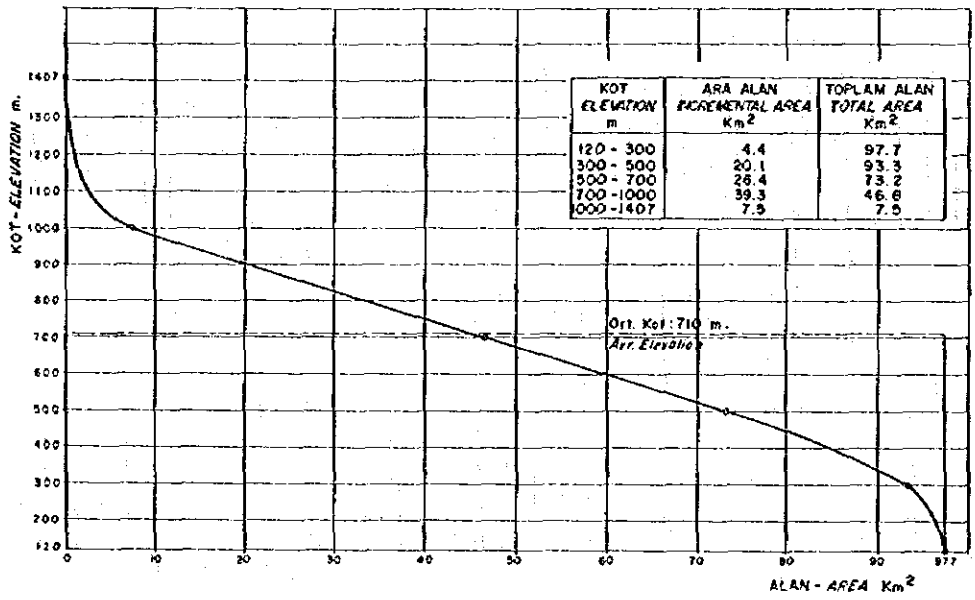


Figure-A.7 Hypsometric Curve for the Catchment Area of Ergenli Damsite

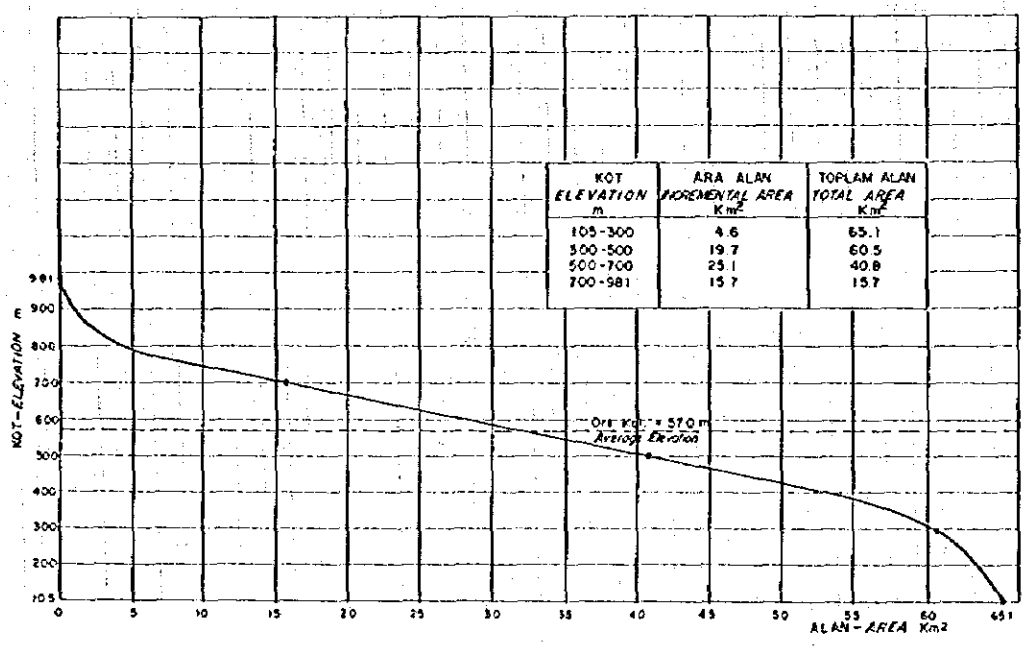


Figure-A.8 Hypsometric Curve for the Catchment Area of Uladı Damsite

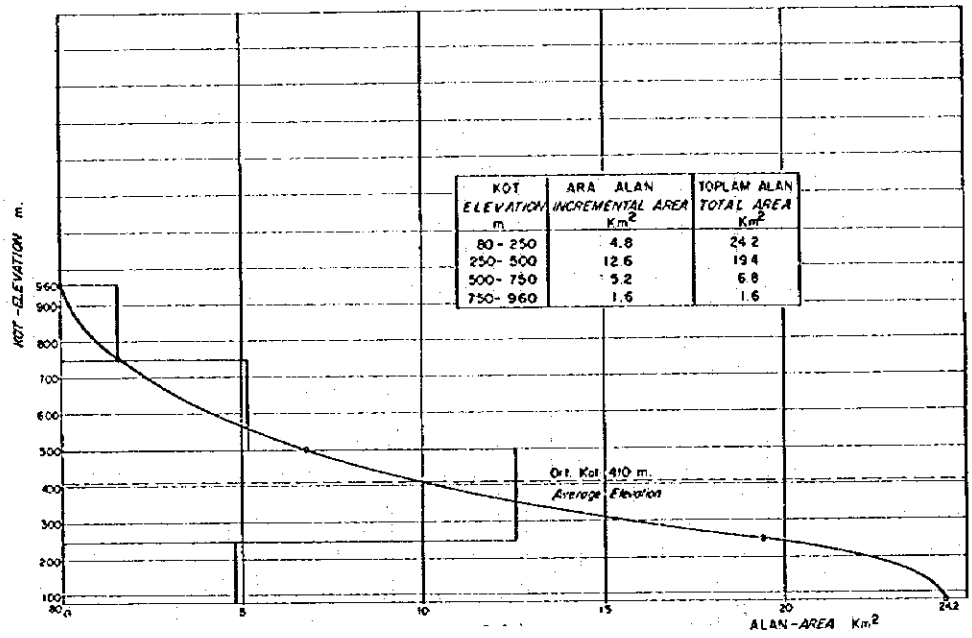


Figure-A.9 Hypsometric Curve for the Catchment Area of Akyurt Damsite

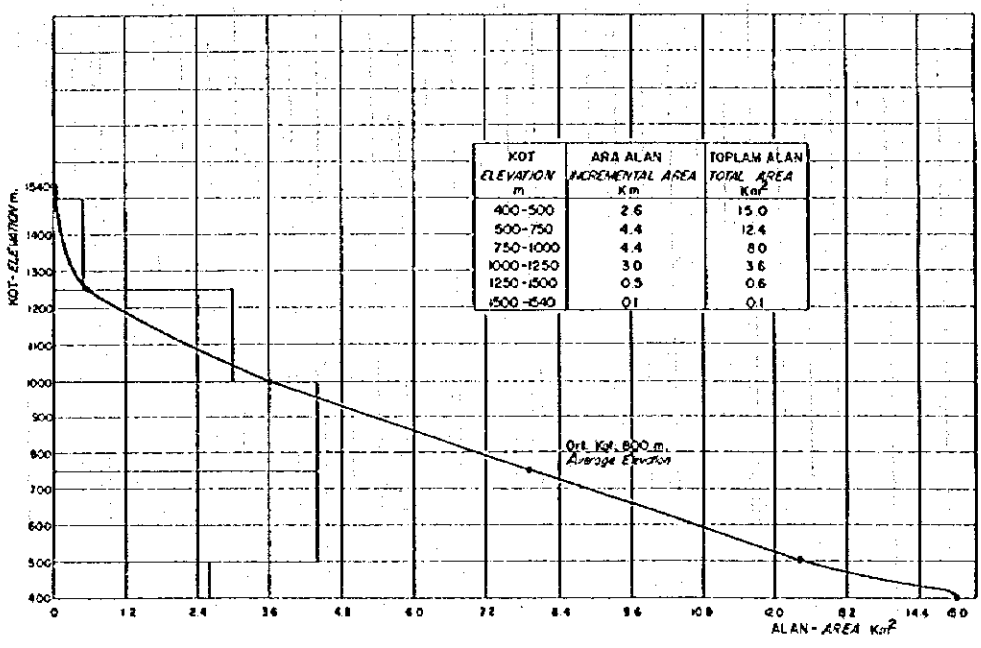


Figure-A.10 Hypsometric Curve for the Catchment Area of Yenişehir Damsite

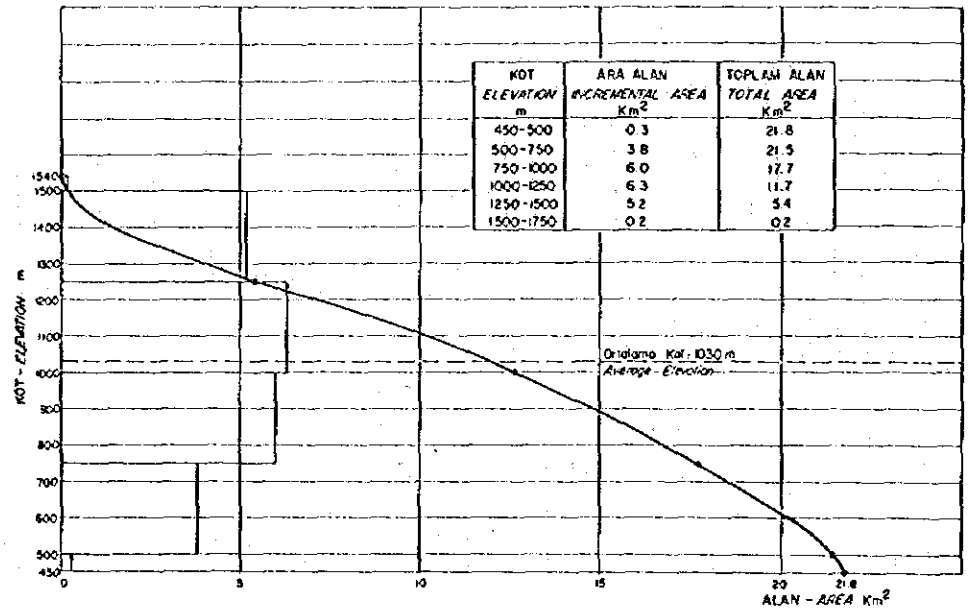


Figure-A.11 Hypsometric Curve for the Catchment Area of Eğridere Damsite

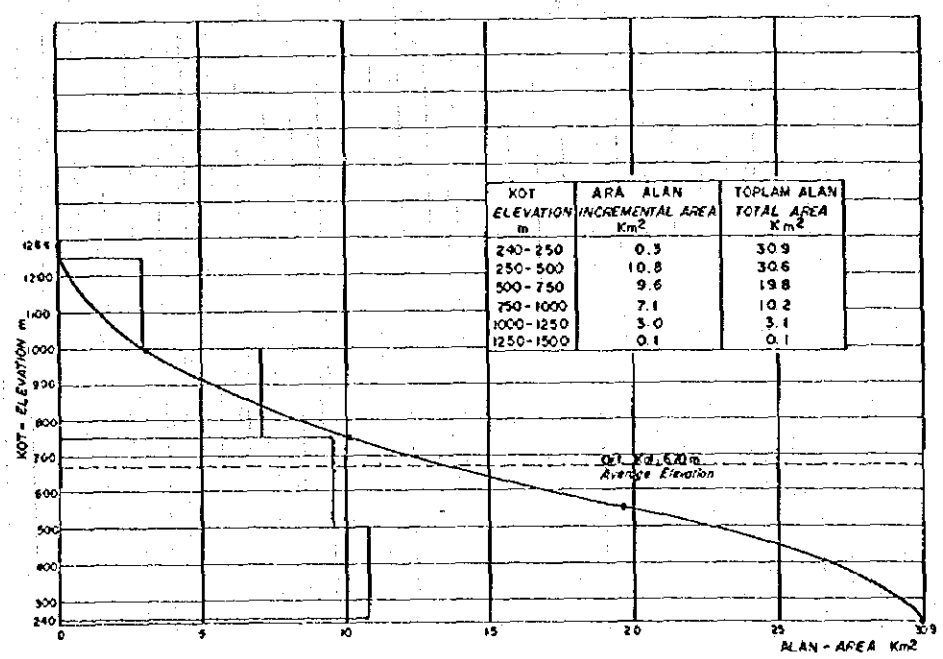


Figure-A.12 Hypsometric Curve for the Catchment Area of Sarılar Damsite

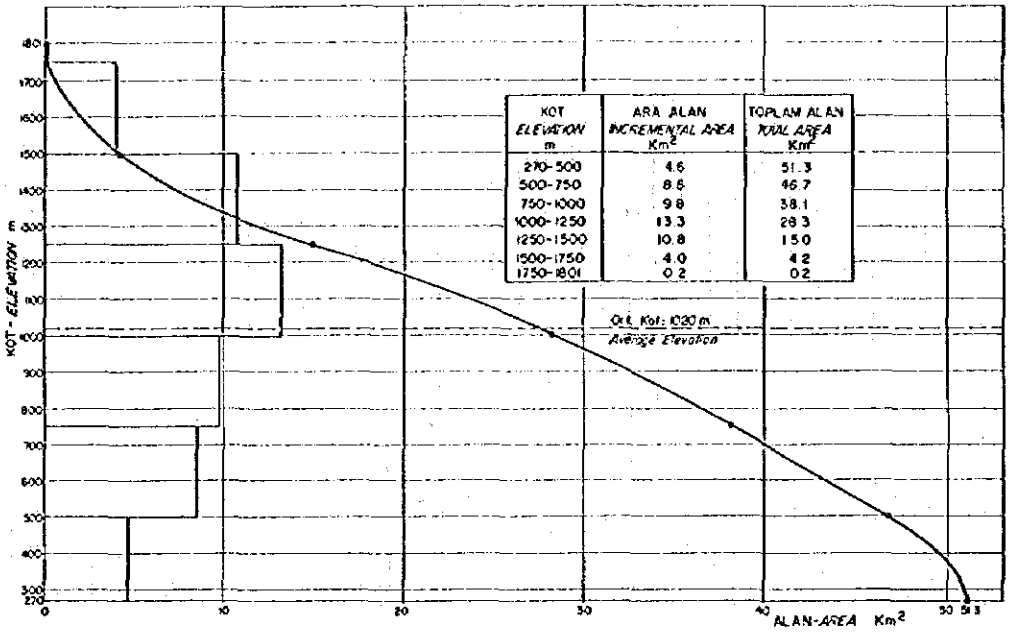


Figure-A.13 Hypsometric Curve for the Catchment Area of Pirinçci Damsite

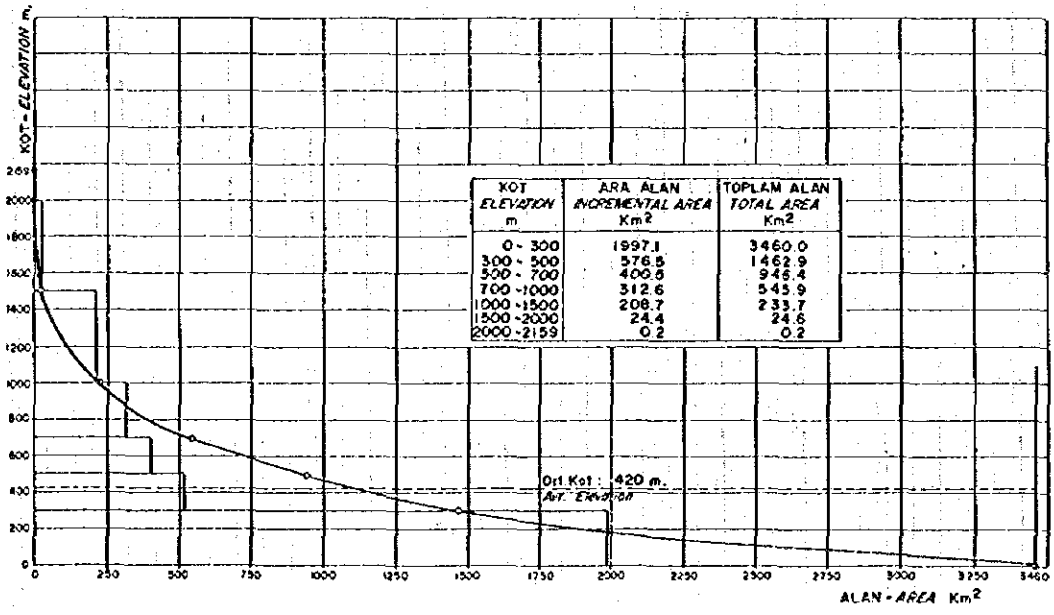


Figure-A.14 Hypsometric Curve for the Catchment Area of Küçük Menderes River

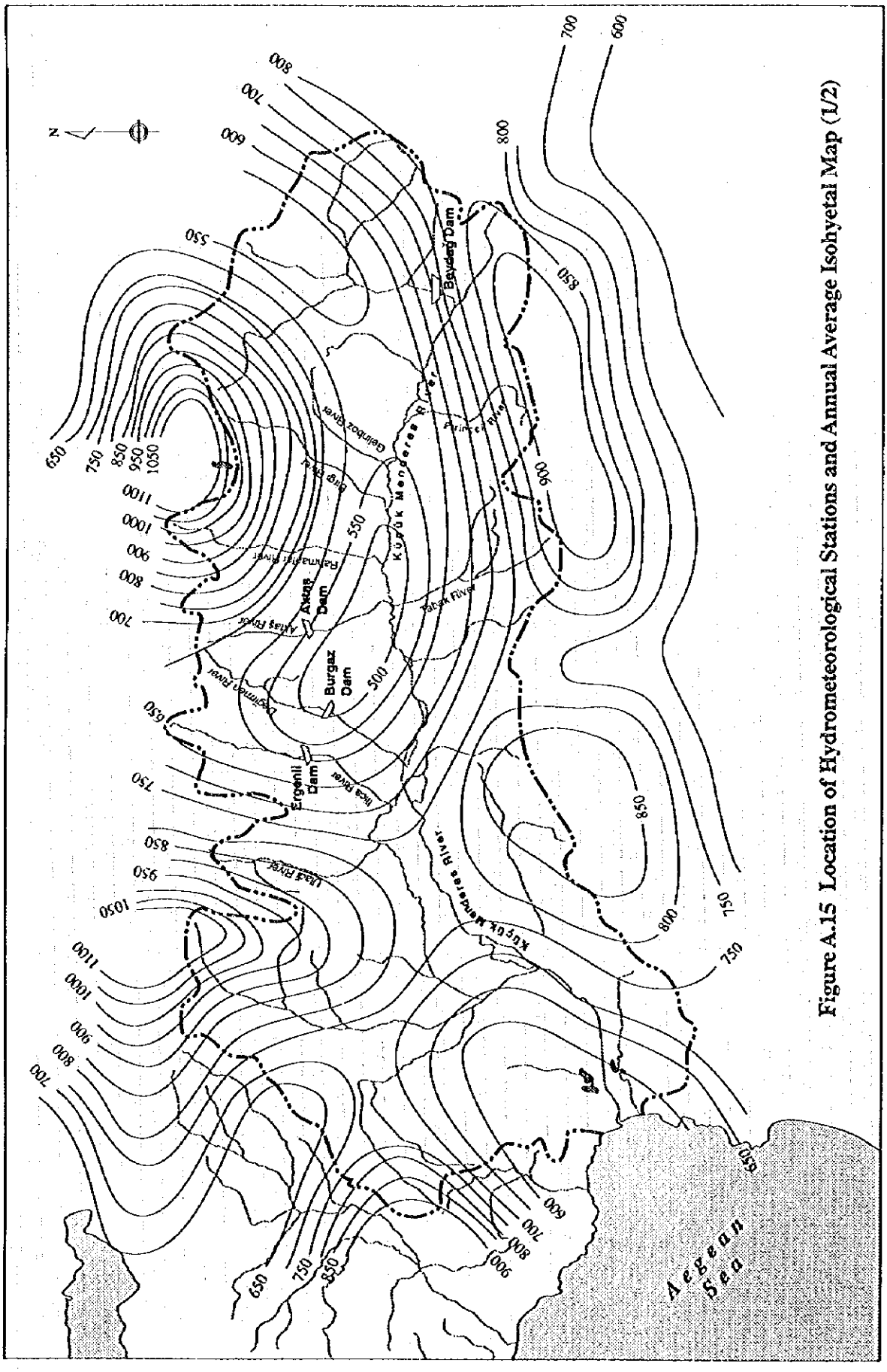
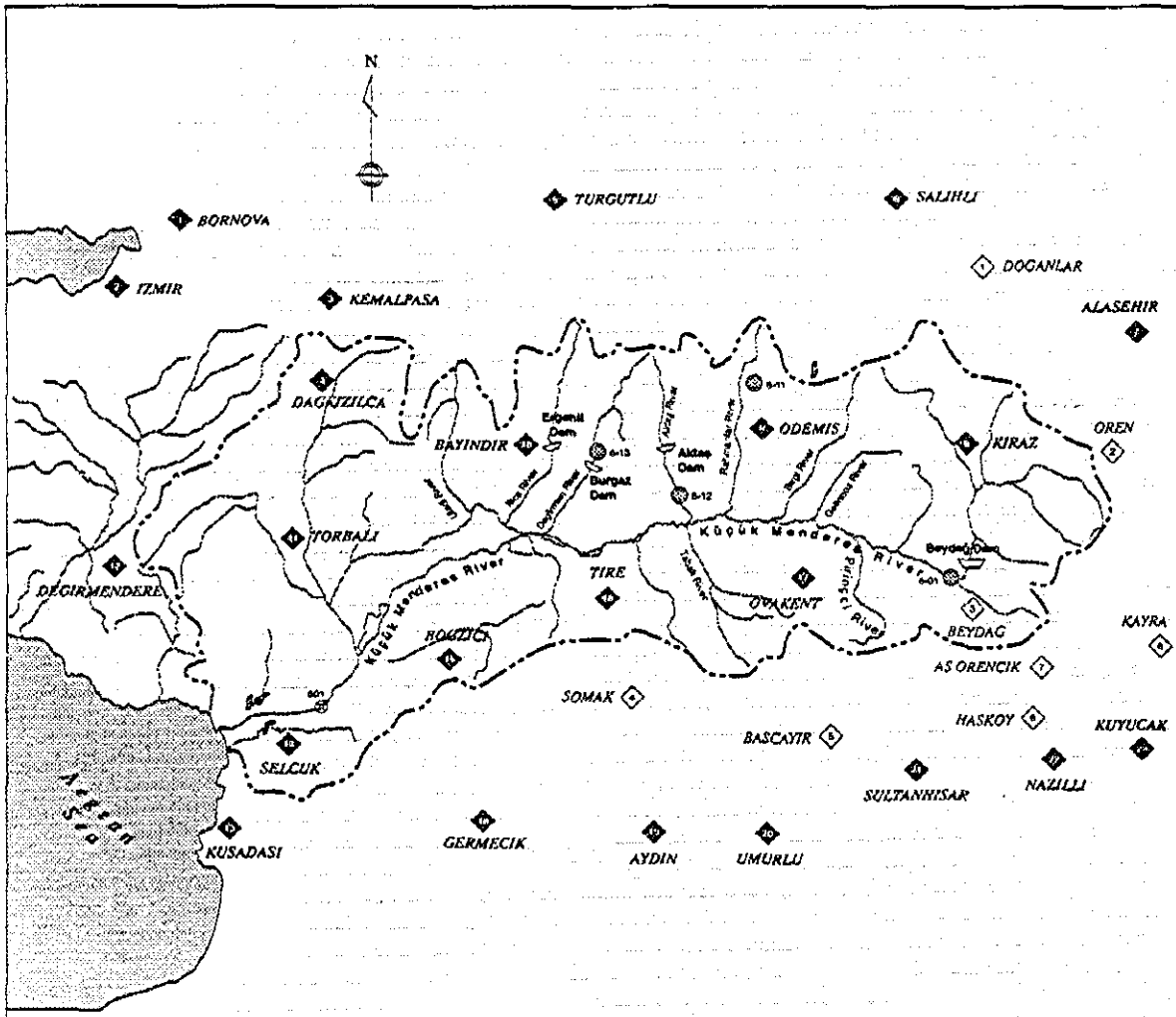


Figure A.15 Location of Hydrometeorological Stations and Annual Average Isohyetal Map (1/2)



«Observed Items at DMI Precipitation Stations in Operations»

Station No.	Balance Pluviograph	Syphon Pluviograph	Evaporation	Temperature	Termohy-grograph	Bimetalic Actinograph	Annual Average Precipitation
1		○	○	○	○		606,3 mm
2		○	○	○	○		683,1 mm
3		○		○			1079,2 mm
4				○			634,2 mm
5				○			612,3 mm
6		○	○	○	○		463,3 mm
7				○			476,1 mm
8							551,3 mm
9		○		○	○		637,3 mm
10				○			683,9 mm
11				○			662,2 mm
12				○			940,1 mm
13		○	○	○	○	○	654,7 mm
14		○	○	○	○		684,0 mm
15							843,3 mm
16	○		○	○	○		770,5 mm
17				○			620,5 mm
18				○			719,4 mm
19		○	○	○	○		657,4 mm
20				○			686,4 mm
21	○		○	○	○		616,1 mm
22			○	○	○		589,3 mm
23							557,0 mm

«Observed Items at DMI Precipitation Stations out of Operations»

Station No.	Balance Pluviograph	Syphon Pluviograph	Evaporation	Temperature	Termohy-grograph	Bimetalic Actinograph	Annual Average Precipitation
1							616,7 mm
2							703,1 mm
3							806,3 mm
4	○						740,0 mm
5	○						814,0 mm
6		○					732,9 mm
7							724,1 mm
8							741,6 mm

«Legend»

DMI Precipitation (Pluviometer) Stations in Operations
DMI Precipitation Stations out of Operations
DSI Hydrometric Stations in Operation
EIE Hydrometric Stations with Limnigeraph in Operation
River
Dam
Swamp

Figure 3.15 Location of Hydrometeorological Stations and Annual Average Isohyetal Map (2/2)

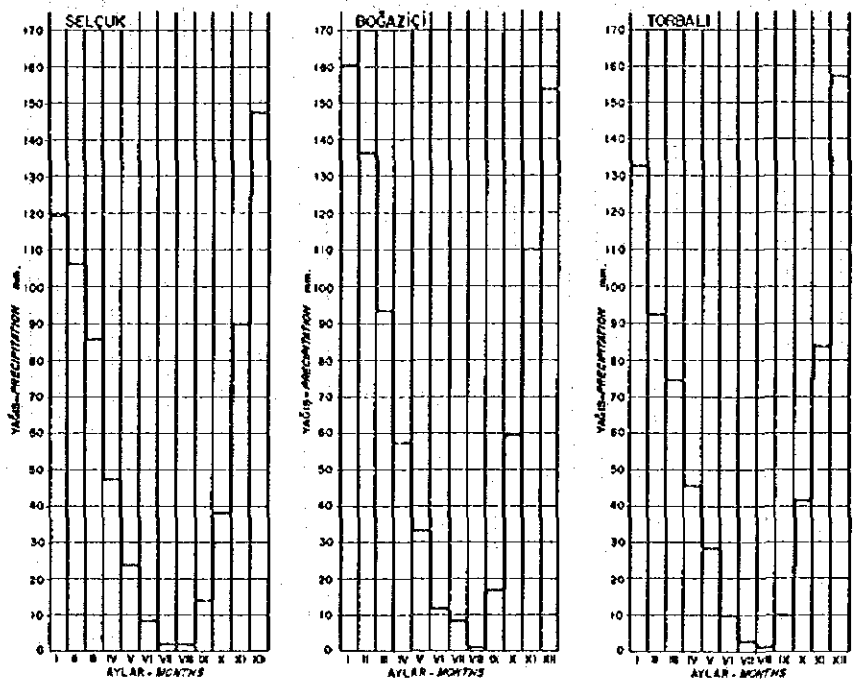


Figure-A.16 Mean Monthly Precipitation Distribution (Selçuk, Boğaziçi, Torbalı)

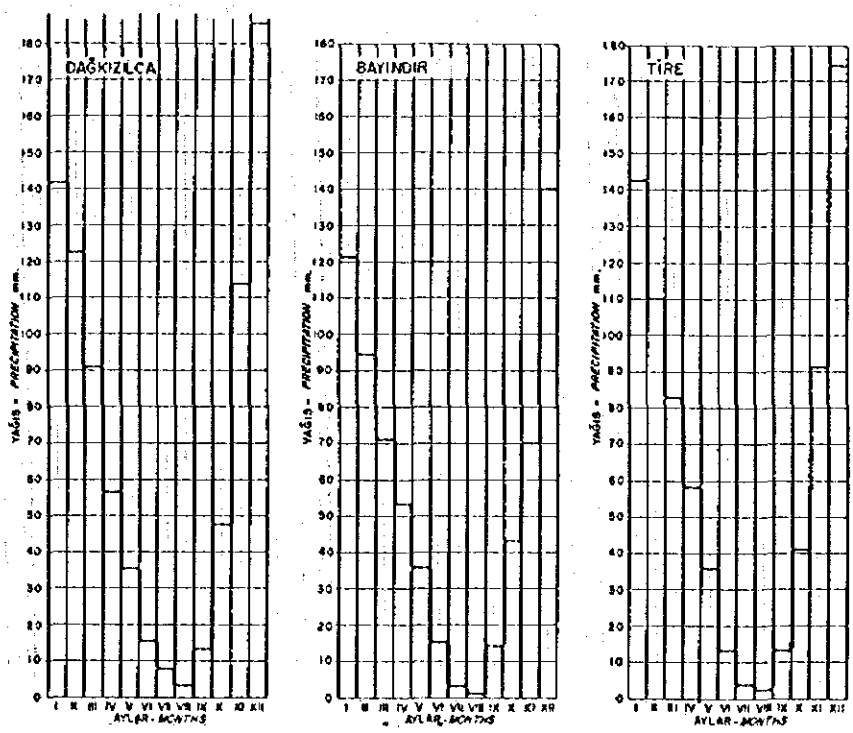


Figure-A.17 Mean Monthly Precipitation Distribution (Dağkızılca, Bayındır, Tire)

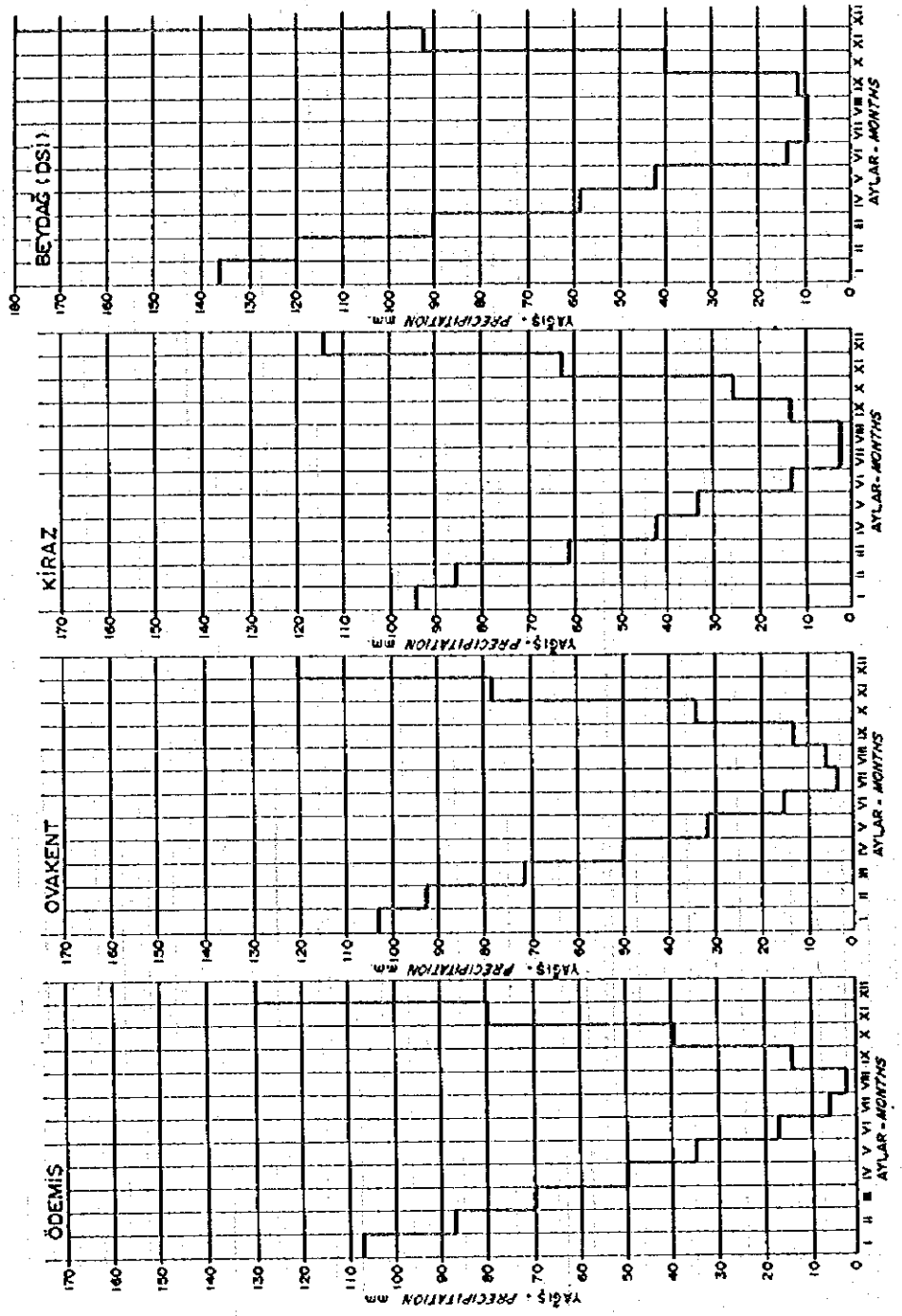


Figure-A.18 Mean Monthly Precipitation Distribution (Ödemiş, Ovakent, Kiraz, Beydağ)

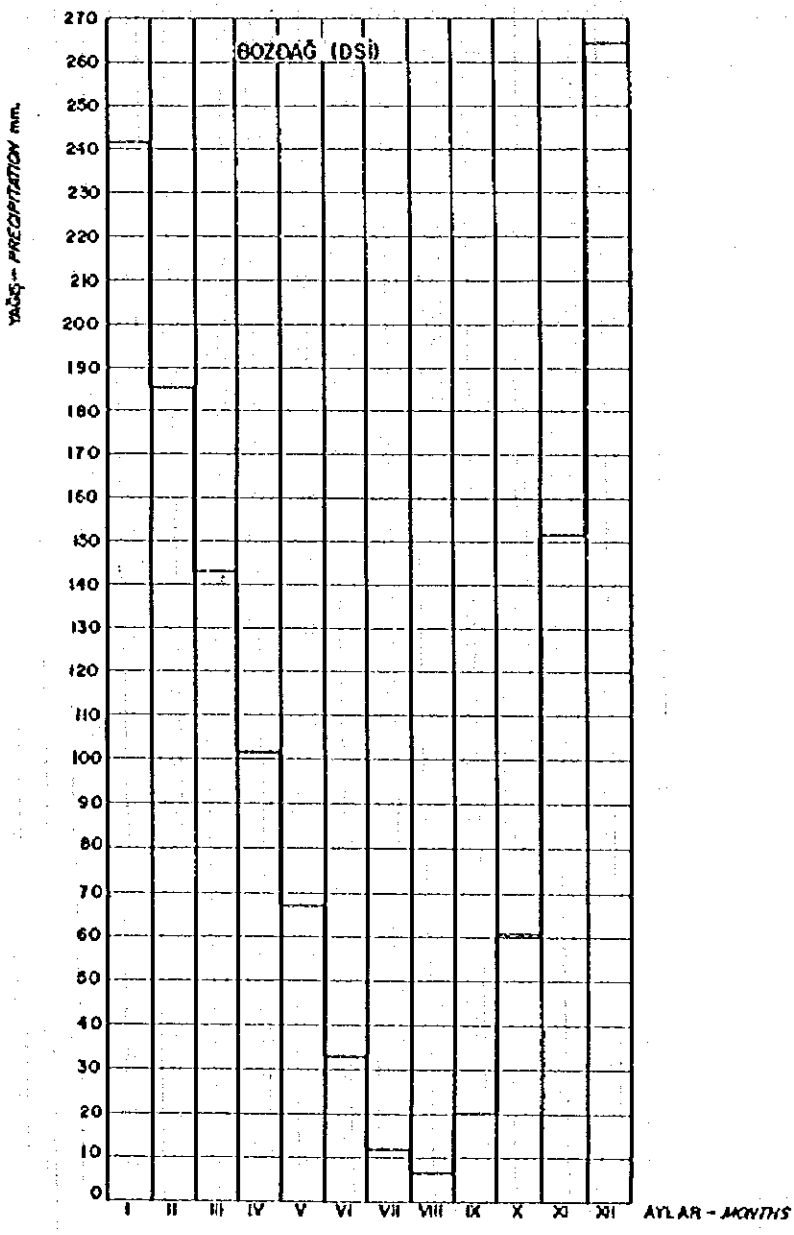


Figure-A.19 Mean Monthly Precipitation Distribution (Bozdağ)

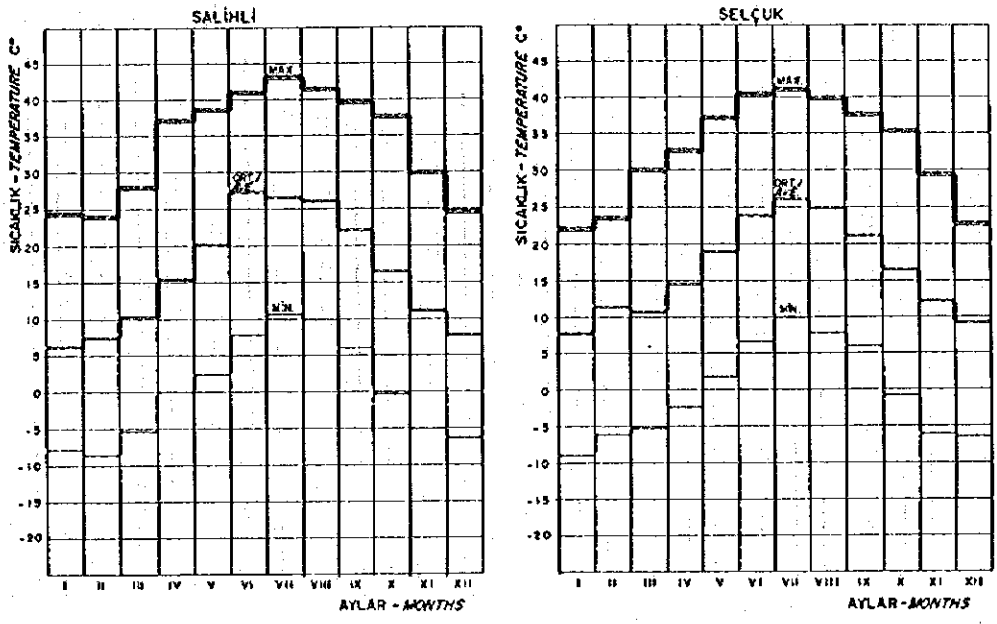


Figure-A.20 Monthly Temperature Distribution (Salihli, Selçuk)

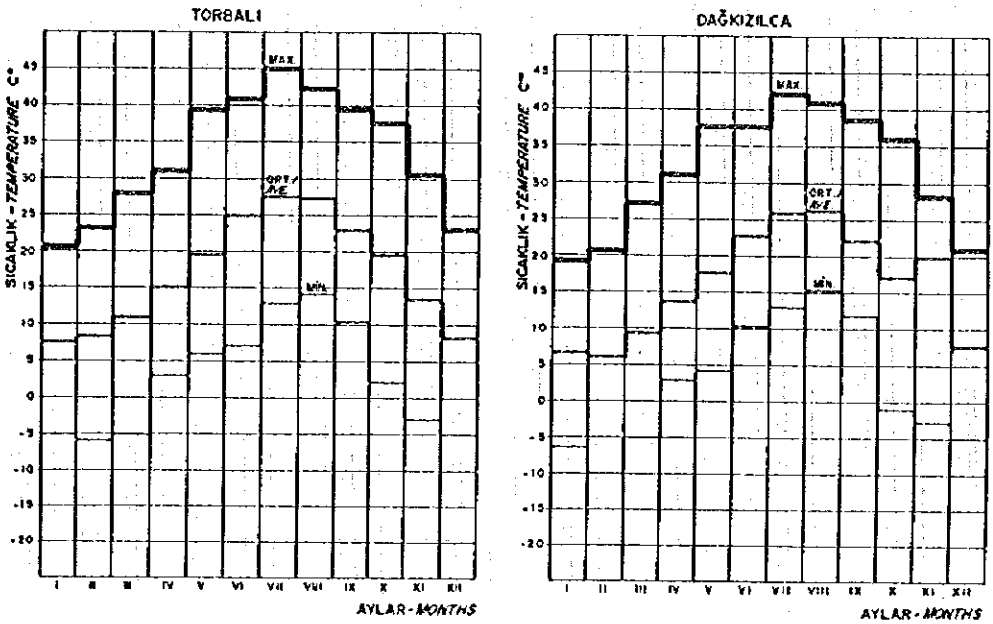


Figure-A.21 Monthly Temperature Distribution (Torbalı, Dağkızılca)

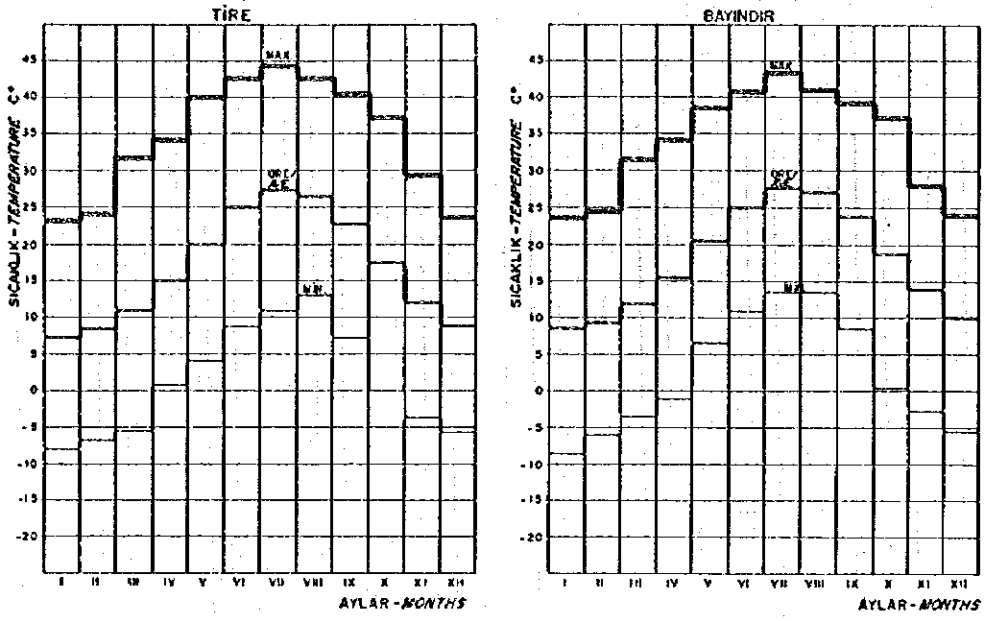


Figure-A 22 Monthly Temperature Distribution (Tire, Bayındır)

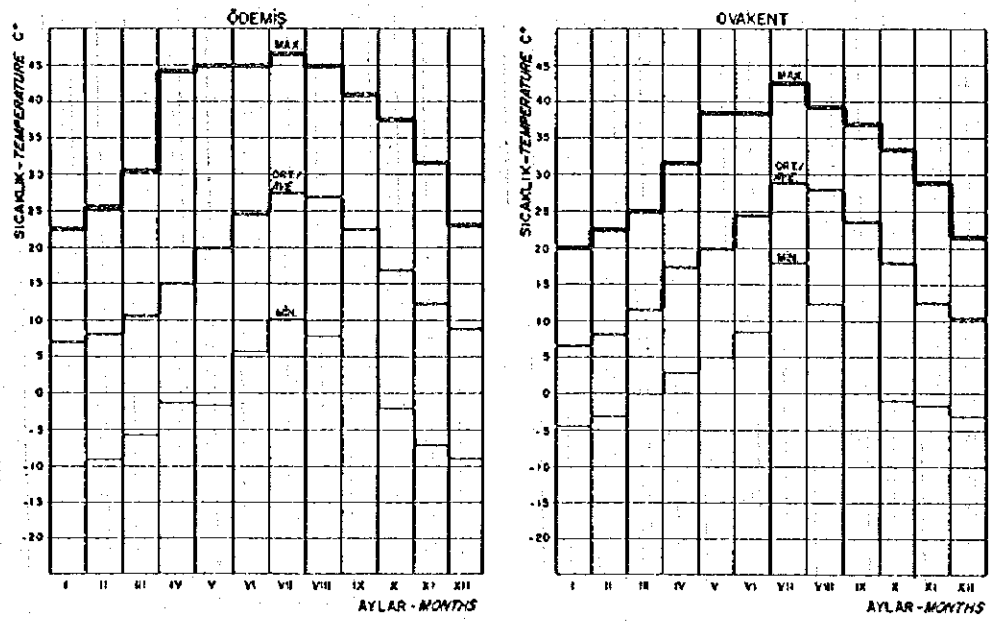


Figure-A 23 Monthly Temperature Distribution (Ödemiş, Ovakent)

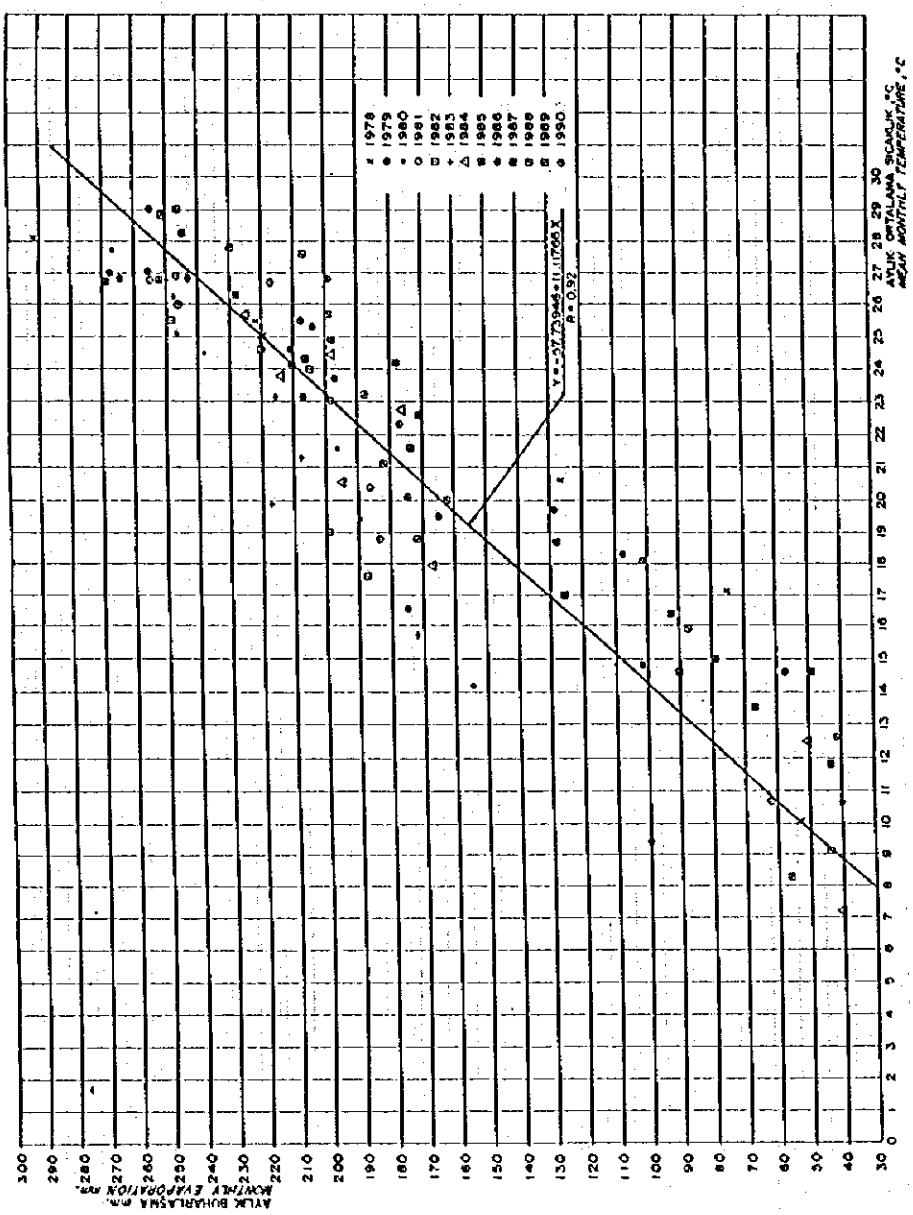


Figure-A.24 **Correlation Between Temperature and Evaporation of Tire Meteorological Station**

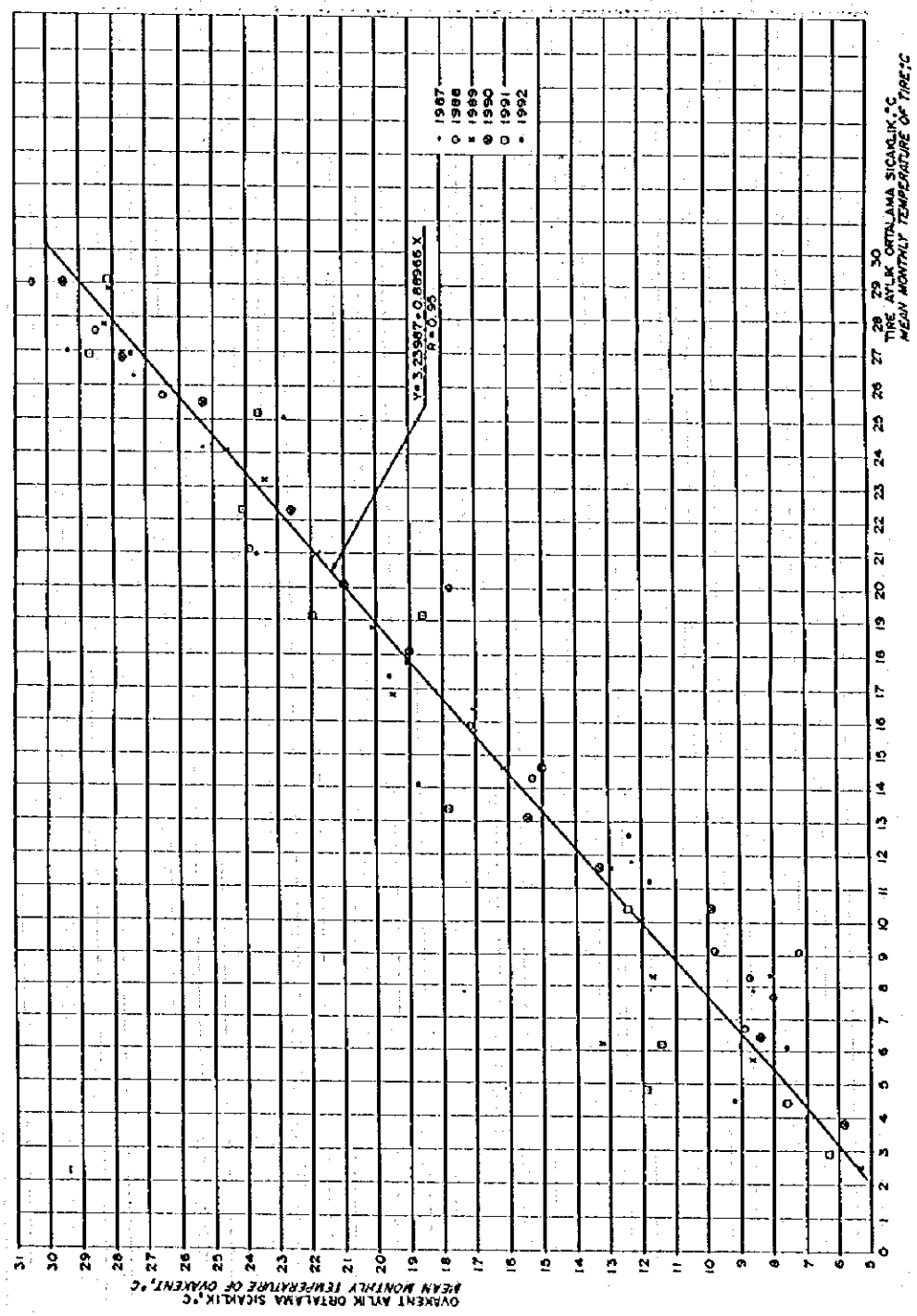


Figure-A.25 Mean Monthly Temperature Correlation of Tire and Ovakent Meteorological Stations

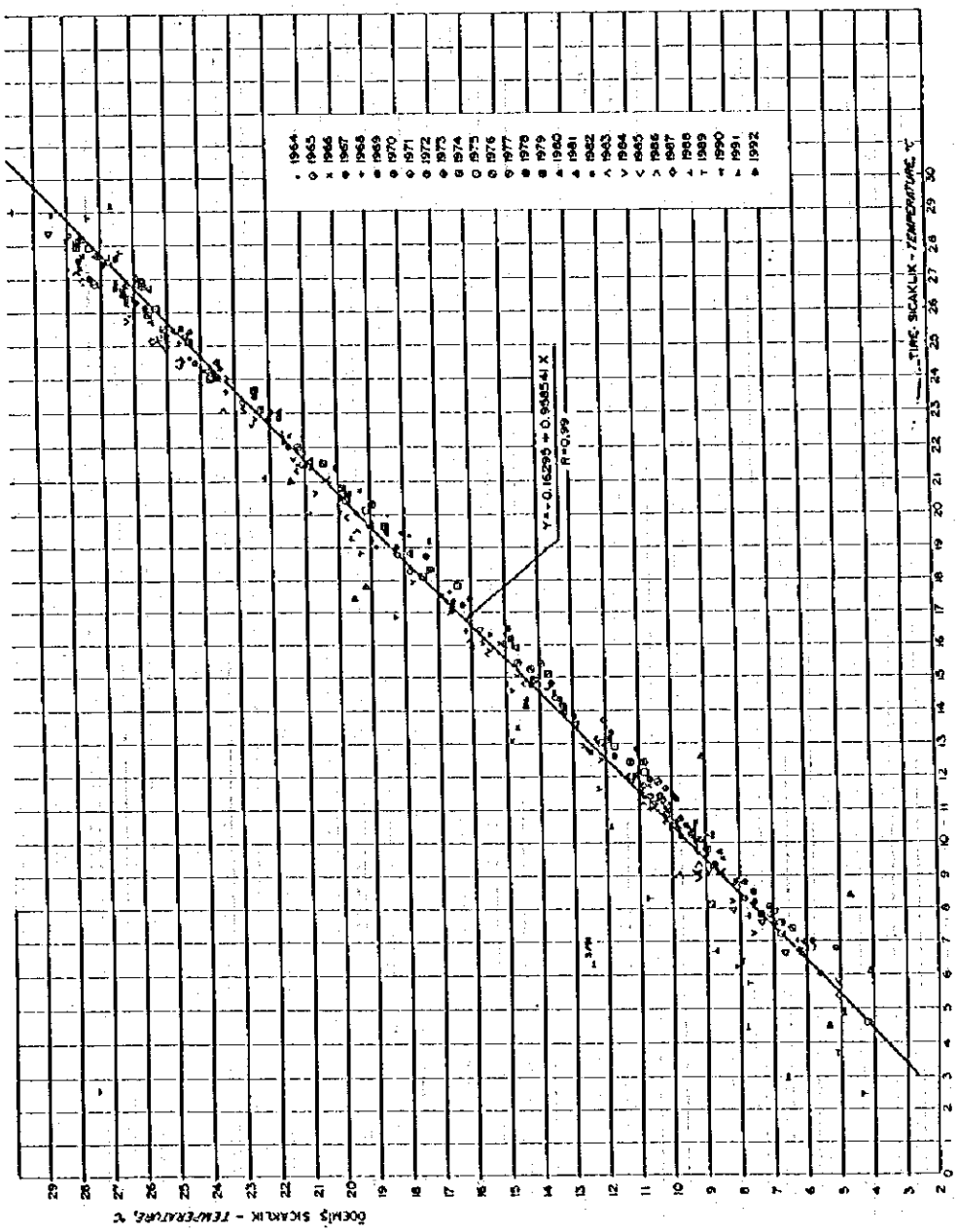


Figure-A.26 Mean Monthly Temperature Correlation Between Tire and Ödemiş Meteorological Stations

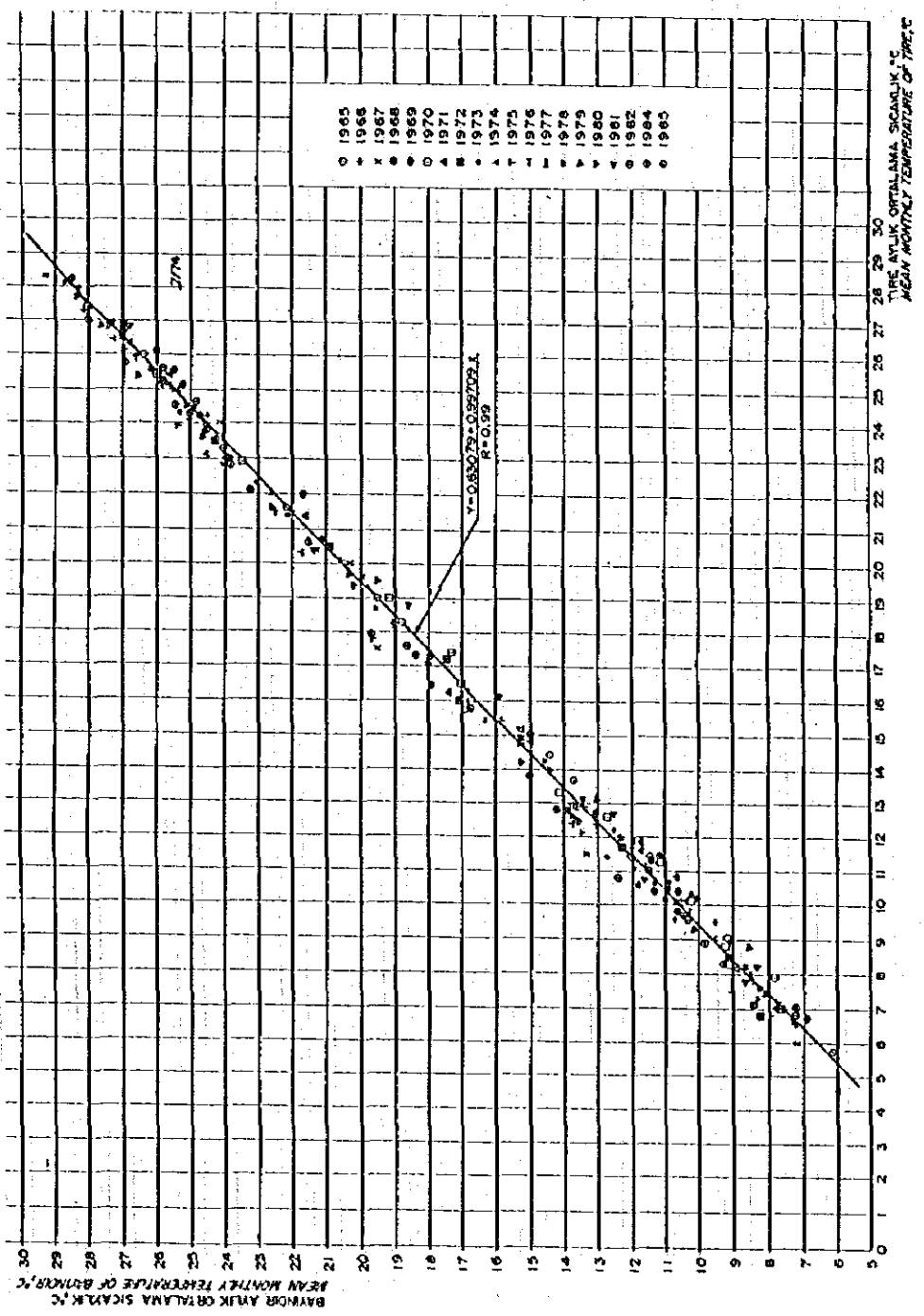


Figure-A.27 Mean Monthly Temperature Correlation Between Tire and Bayındır Meteorological Stations

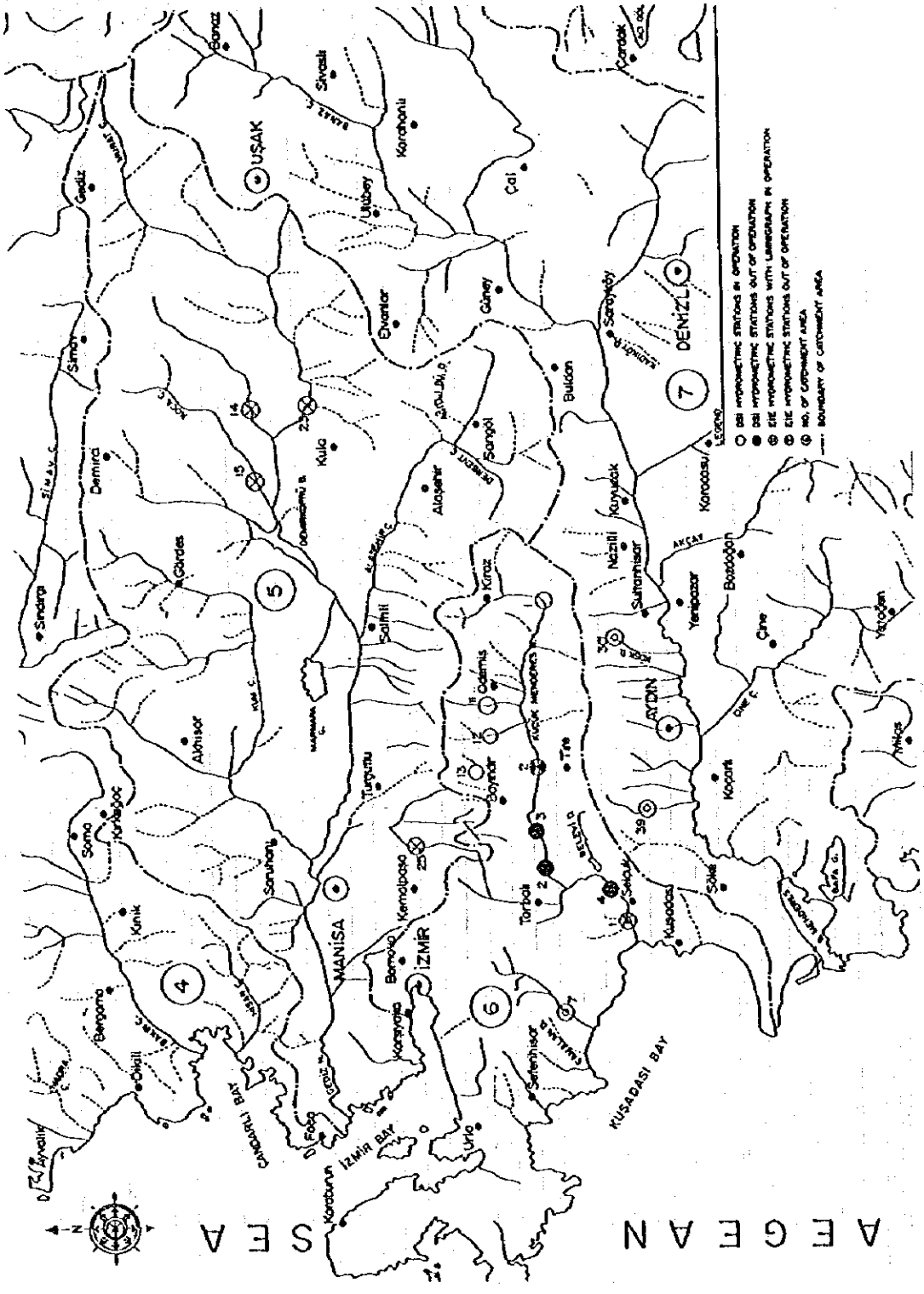


Figure-A.28 **Hydrometric Network Within and Nearby the Catchment Area of Küçük Menderes of Which Data Have Been Used**

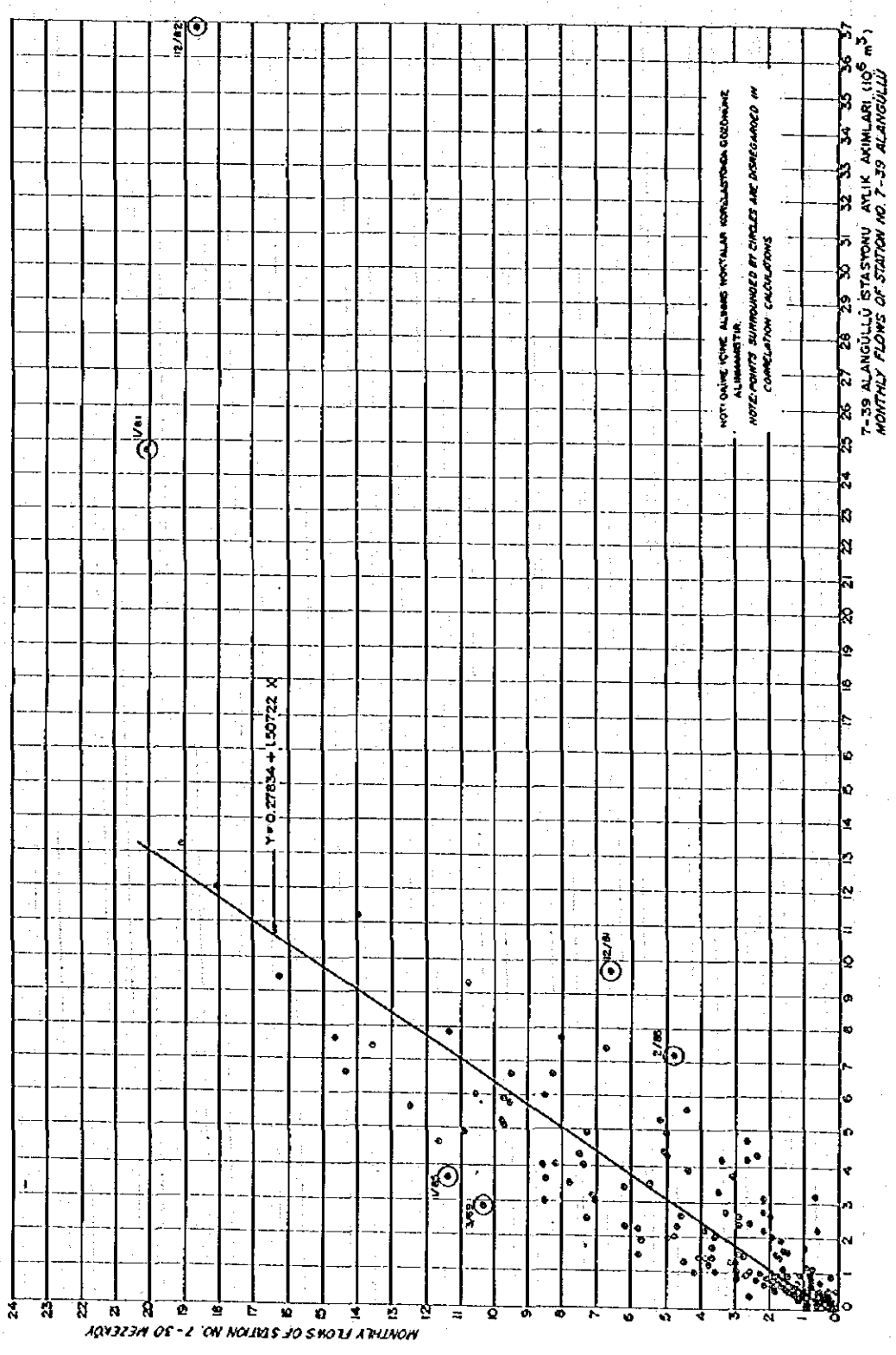


Figure-A.29 Correlation Between the Monthly Flows of Stations 7-30 Mezeköy and 7-39 Alangüllü

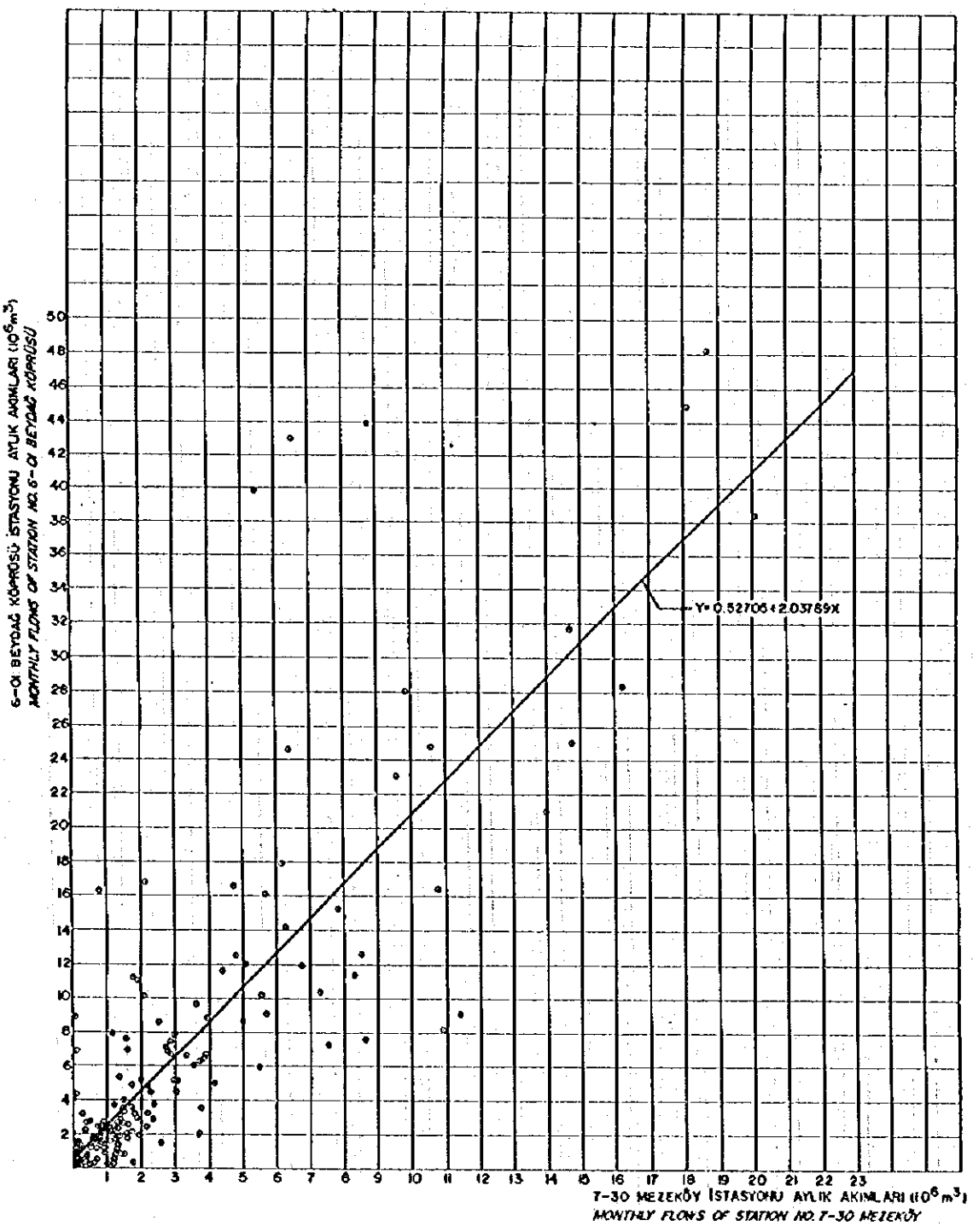


Figure-A.30 Correlation Between the Monthly Flows of Stations 6-01 Beydağ Köprüsü and 7-30 Mezeköy

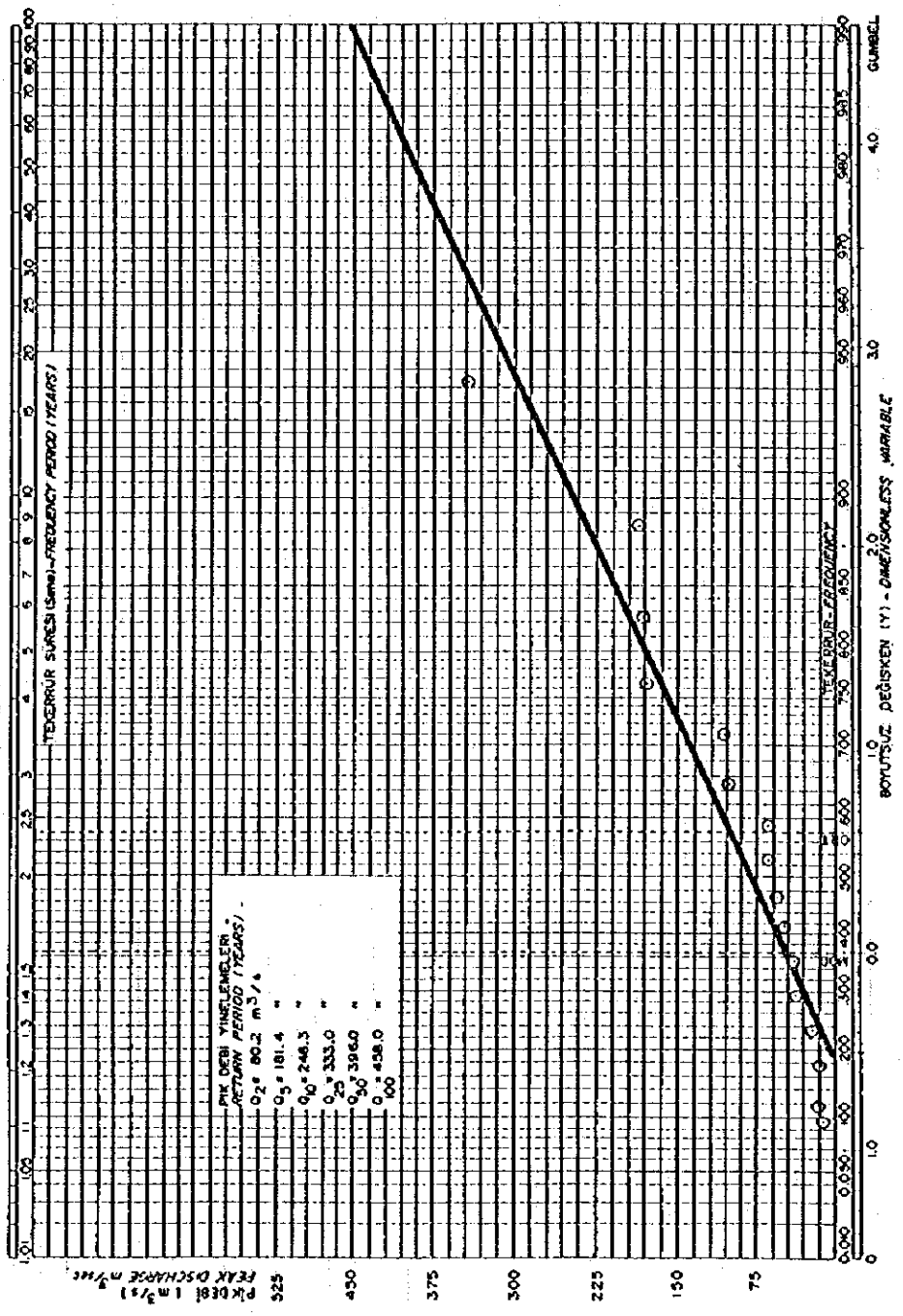


Figure-A.31 **Frequency Analysis of the Peak Discharge Series of 6-01 Beydağ Station and Beydağ Damsite**

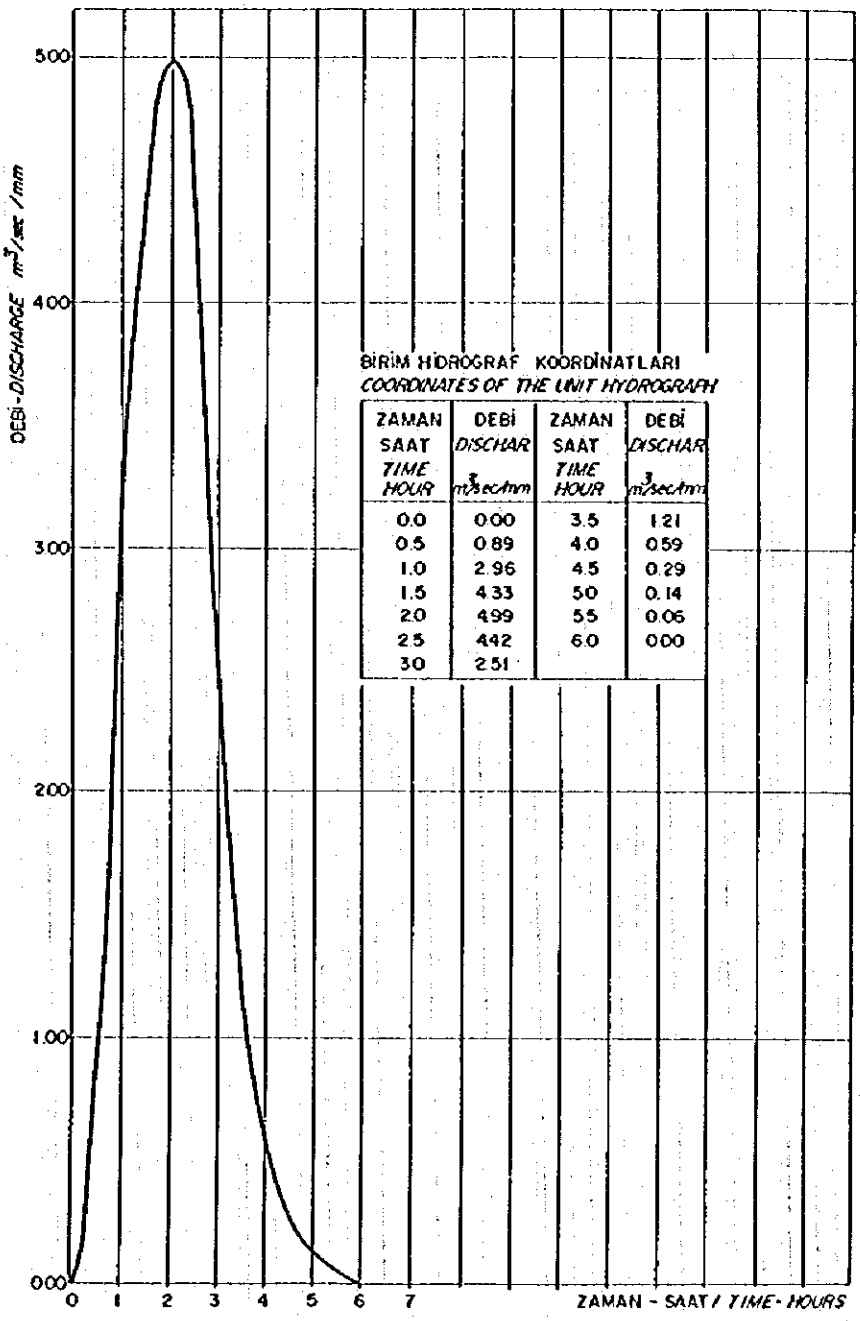


Figure-A.32 2 hours-1 mm Unit Hydrograph for Uladı Damsite

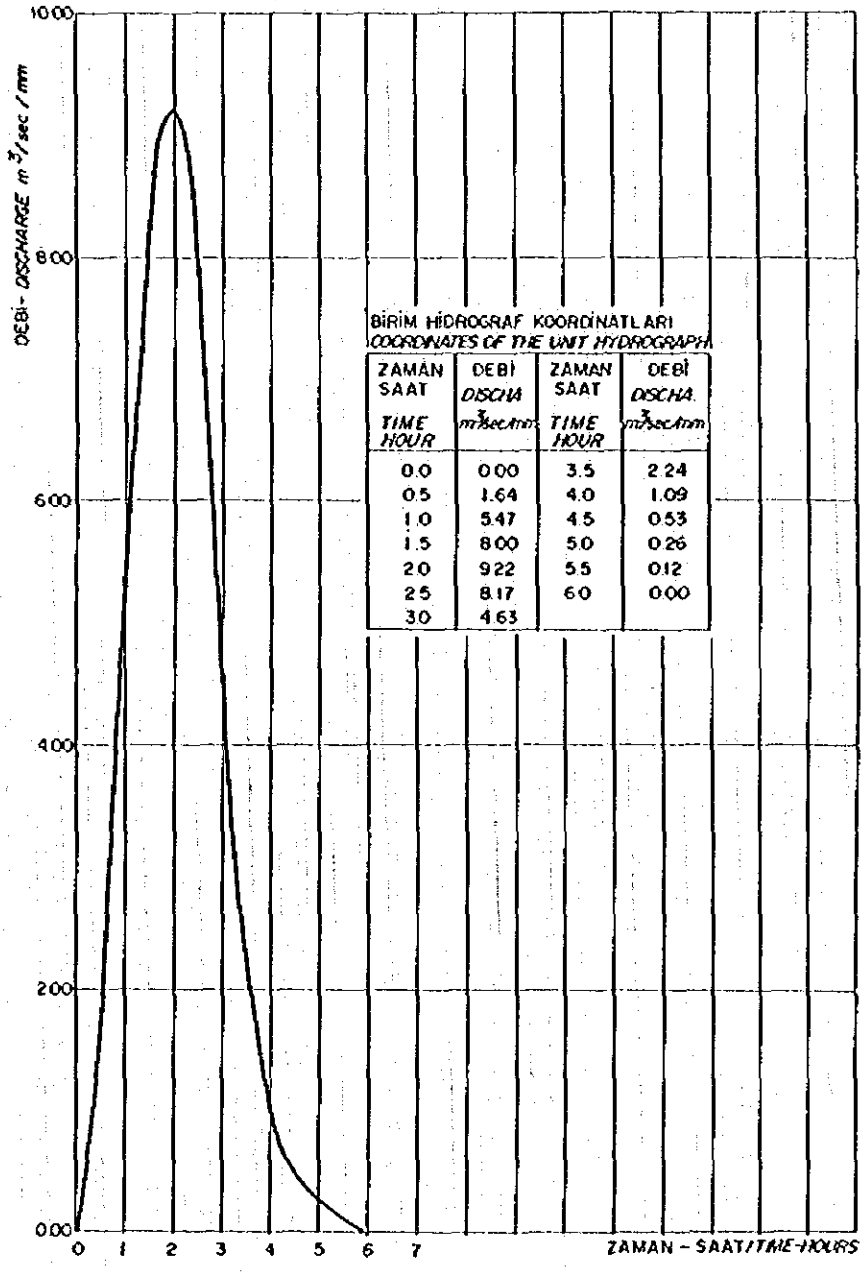


Figure-A.33 2 hours-1 mm Unit Hydrograph for Ergenli Damsite

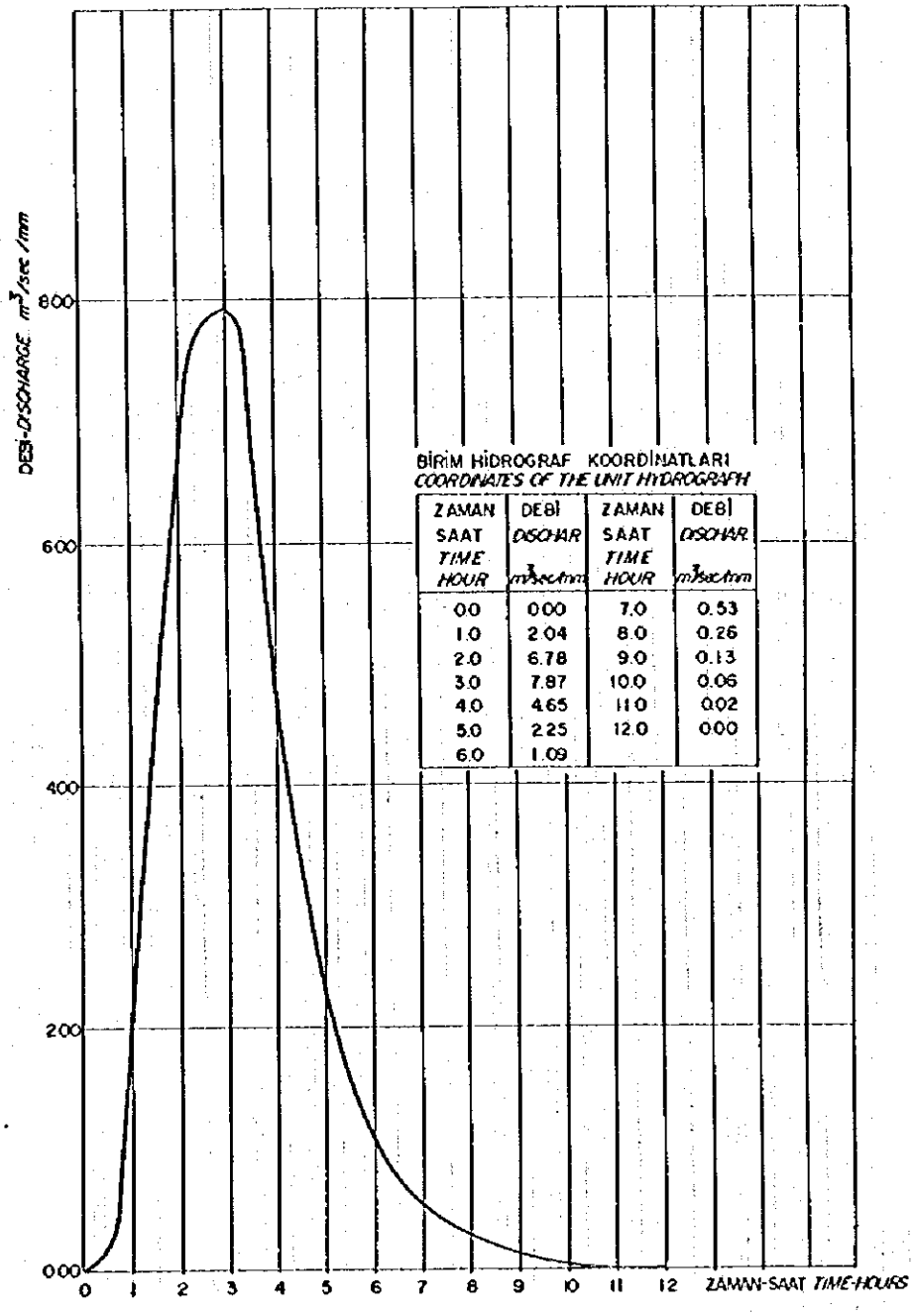
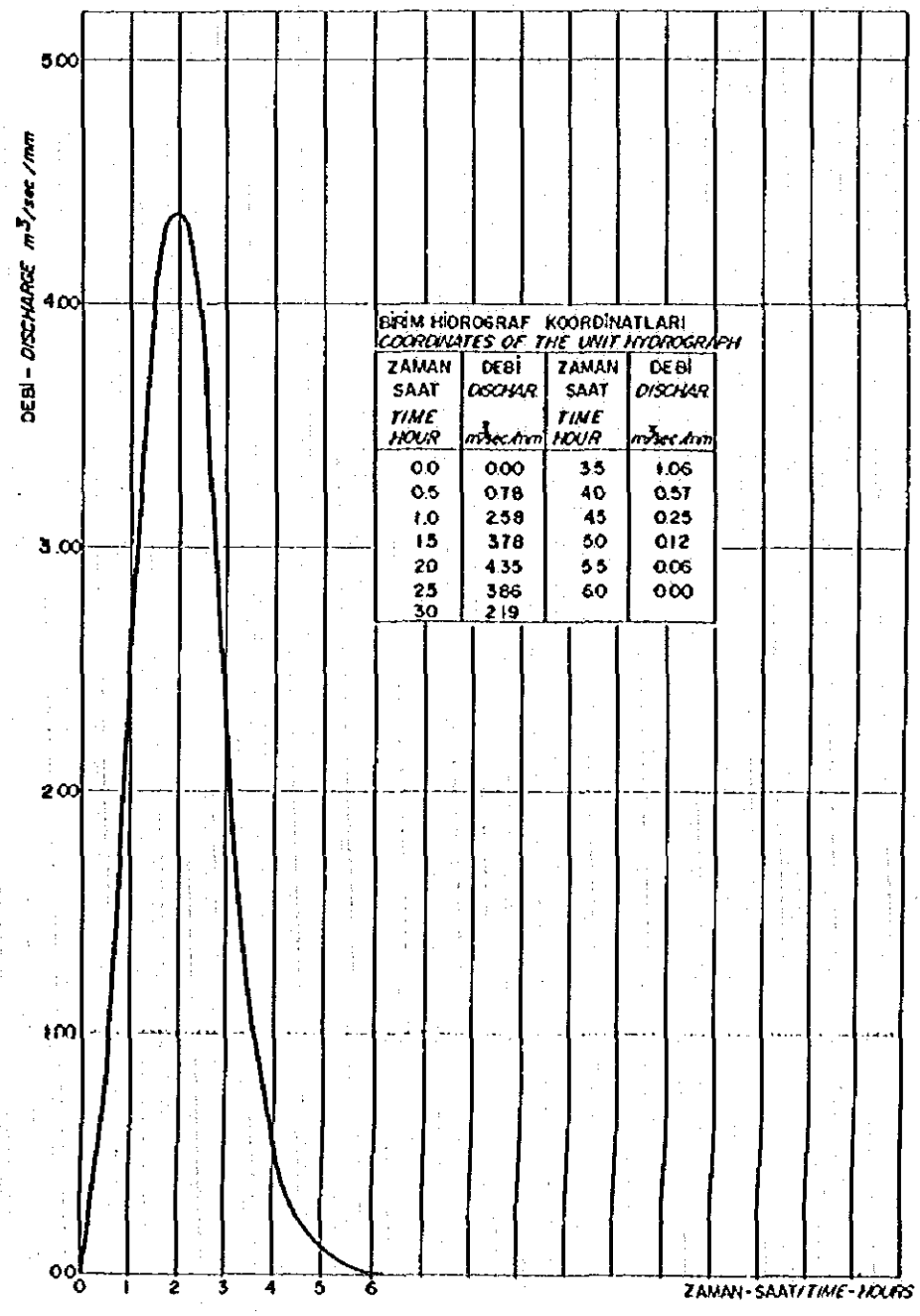


Figure-A.34 2 hours-1 mm Unit Hydrograph for Burgaz Damsite



ZAMAN SAAT TIME HOUR	DEBİ DISCHAR. m³/sec.Atm	ZAMAN SAAT TIME HOUR	DEBİ DISCHAR. m³/sec.Atm
0.0	0.00	3.5	1.06
0.5	0.78	4.0	0.57
1.0	2.58	4.5	0.25
1.5	3.78	5.0	0.12
2.0	4.35	5.5	0.06
2.5	3.86	6.0	0.00
3.0	2.19		

Figure-A.35 2 hours-1 mm Unit Hydrograph for Aktaş Damsite

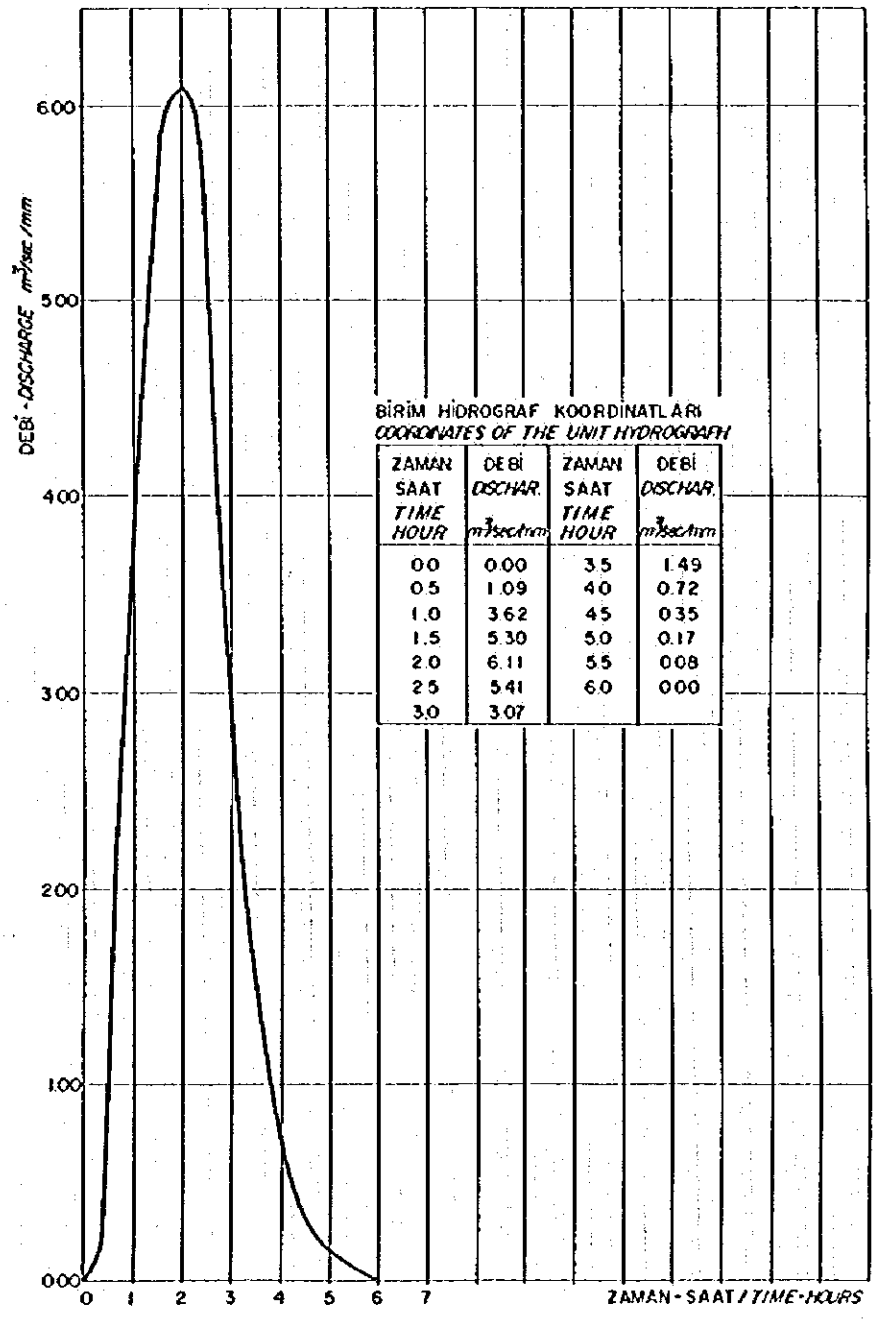


Figure-A.36 2 hours-1 mm Unit Hydrograph for Ödemiş Damsite

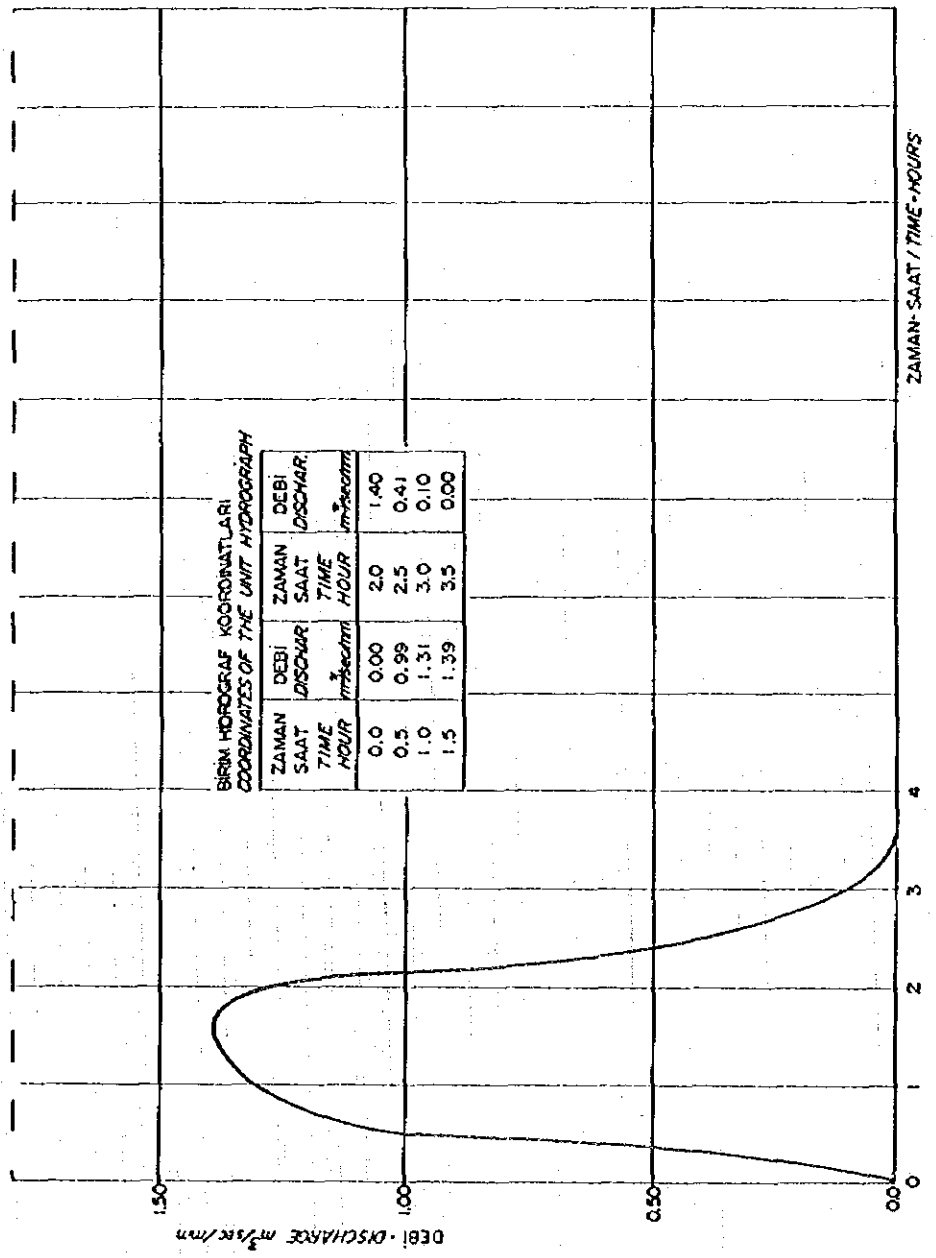


Figure-A.37 2 hours-1 mm Unit Hydrograph for Birgi Damsite

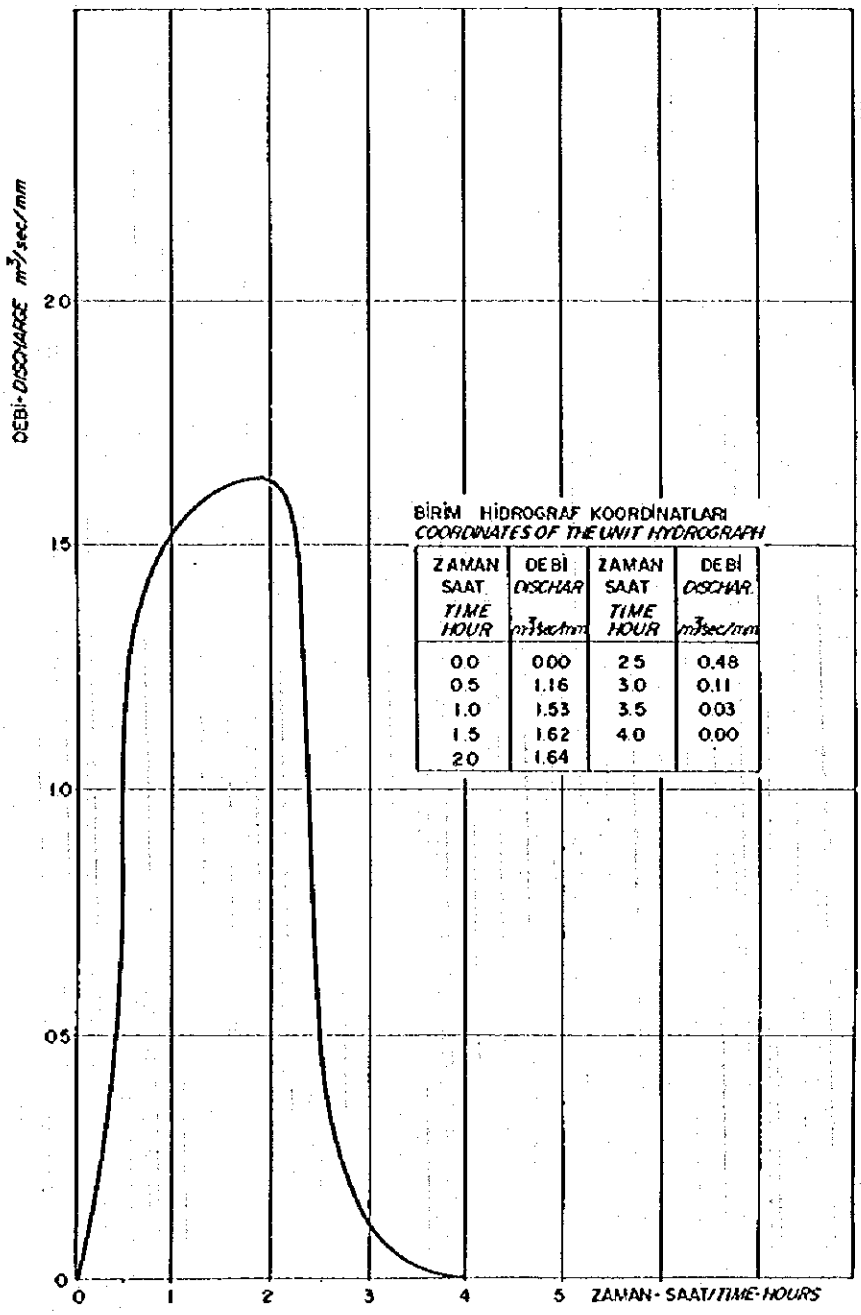


Figure-A.38 2 hours-1 mm Unit Hydrograph for Bucak Damsite

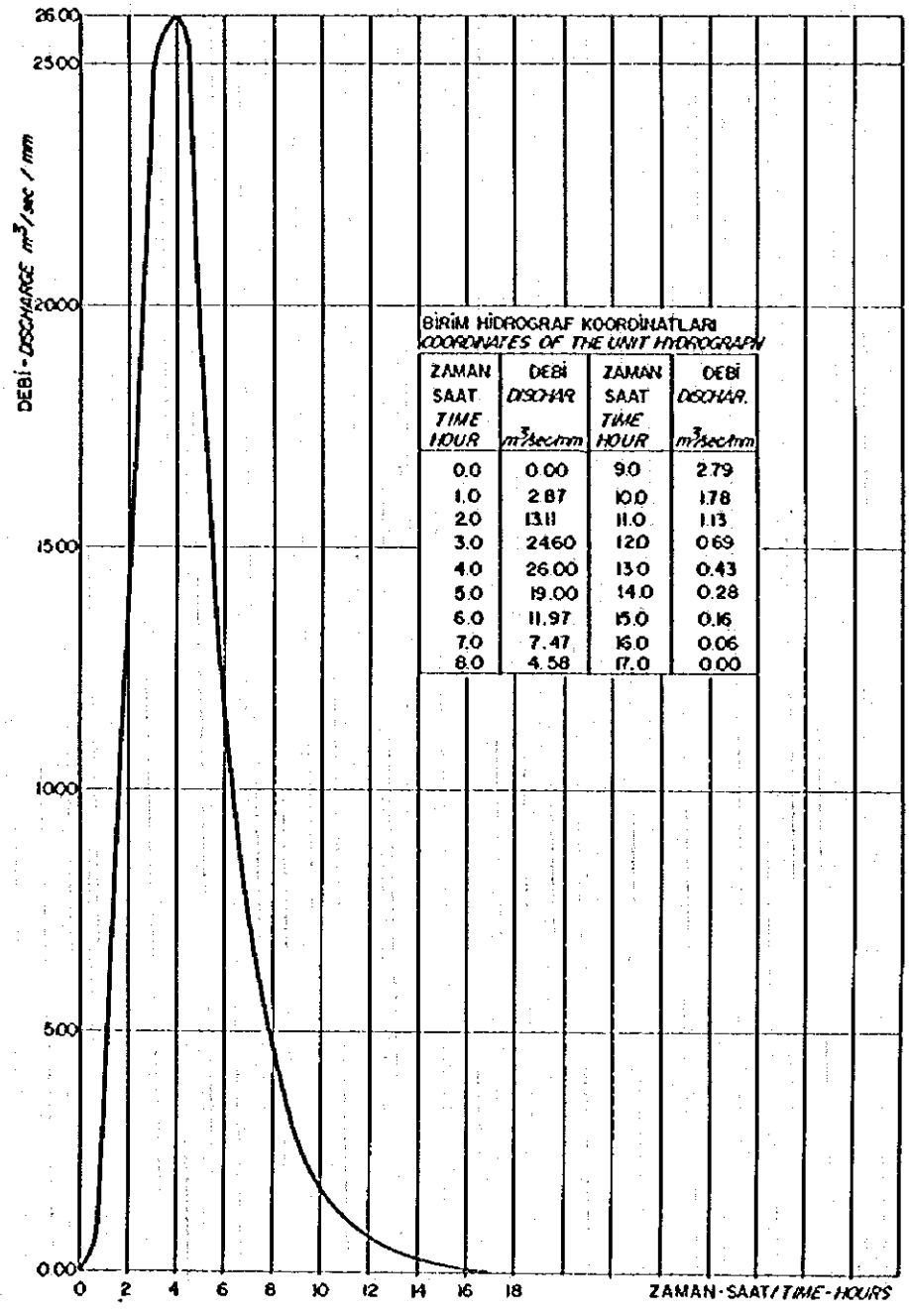


Figure-A.39 2 hours-1 mm Unit Hydrograph for Beydağ Damsite

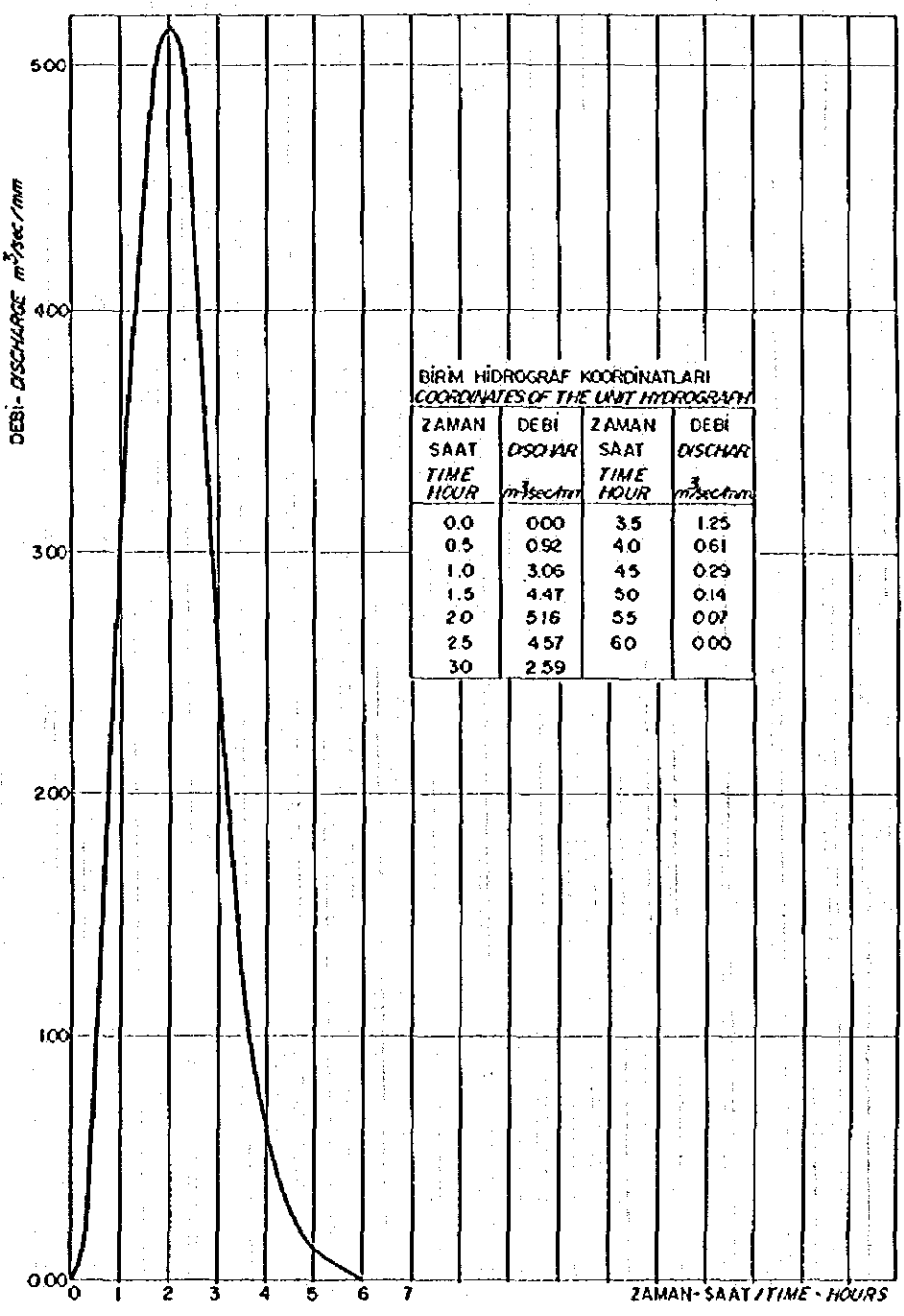
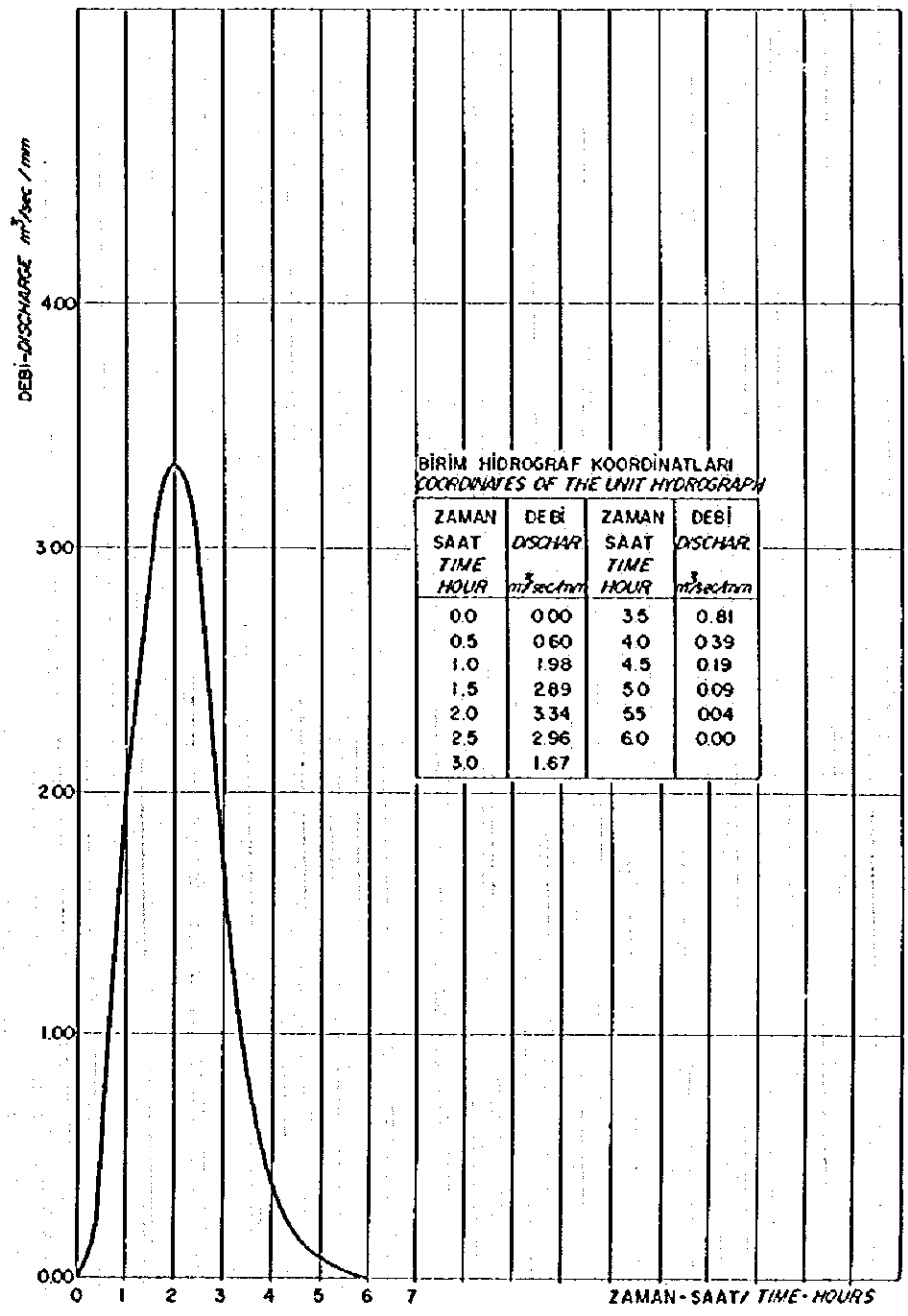
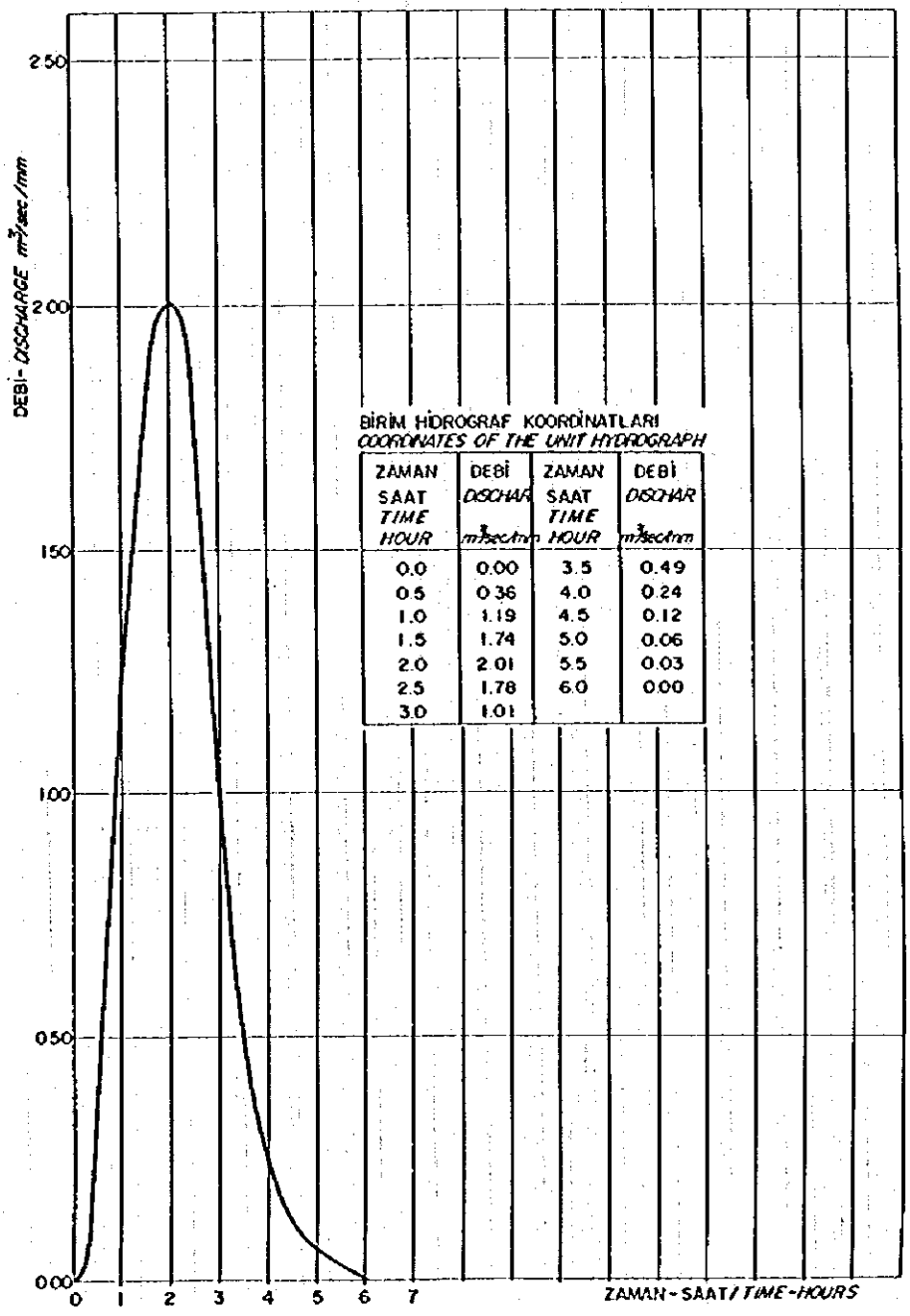


Figure-A.40 2 hours-1 mm Unit Hydrograph for Pirinçel Damsite



ZAMAN SAAT TIME HOUR	DEBİ DISCHAR. m³/sec/mm	ZAMAN SAAT TIME HOUR	DEBİ DISCHAR. m³/sec/mm
0.0	0.00	3.5	0.81
0.5	0.60	4.0	0.39
1.0	1.98	4.5	0.19
1.5	2.89	5.0	0.09
2.0	3.34	5.5	0.04
2.5	2.96	6.0	0.00
3.0	1.67		

Figure-A.41 2 hours-1 mm Unit Hydrograph for Sarılar Damsite



ZAMAN SAAT TIME HOUR	DEBİ DISCHAR m³/sec/mm	ZAMAN SAAT TIME HOUR	DEBİ DISCHAR m³/sec/mm
0.0	0.00	3.5	0.49
0.5	0.36	4.0	0.24
1.0	1.19	4.5	0.12
1.5	1.74	5.0	0.06
2.0	2.01	5.5	0.03
2.5	1.78	6.0	0.00
3.0	1.01		

Figure-A.42 2 hours-1 mm Unit Hydrograph for Yenişehir Damsite

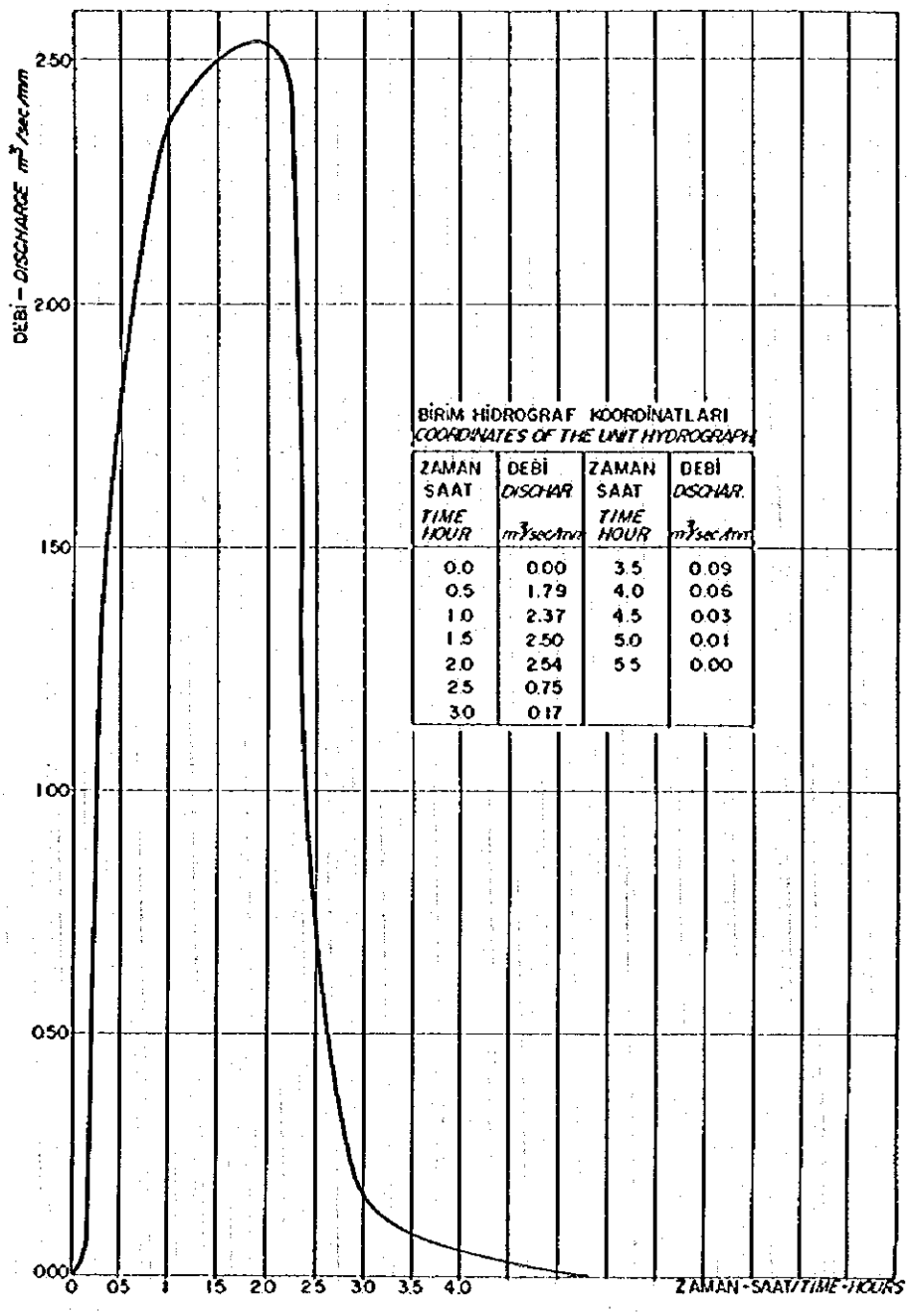
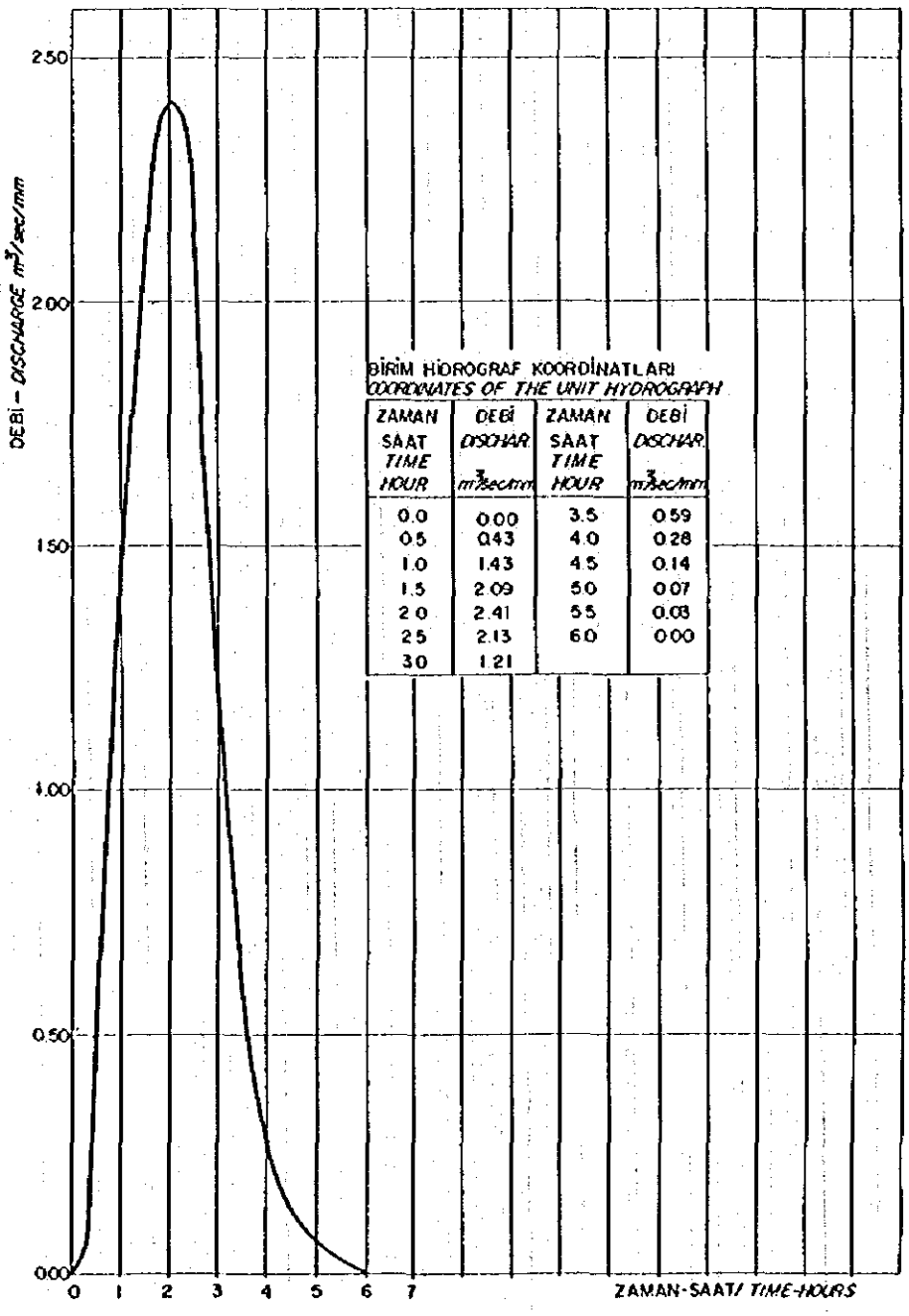


Figure-A.43 2 hours-1 mm Unit Hydrograph for Eğridere Damsite



ZAMAN SAAT TIME HOUR	DEBİ DISCHAR. m³/sec/mm	ZAMAN SAAT TIME HOUR	DEBİ DISCHAR. m³/sec/mm
0.0	0.00	3.5	0.59
0.5	0.43	4.0	0.28
1.0	1.43	4.5	0.14
1.5	2.09	5.0	0.07
2.0	2.41	5.5	0.03
2.5	2.13	6.0	0.00
3.0	1.21		

Figure-A.44 2 hours-1 mm Unit Hydrograph for Akyurt Damsite

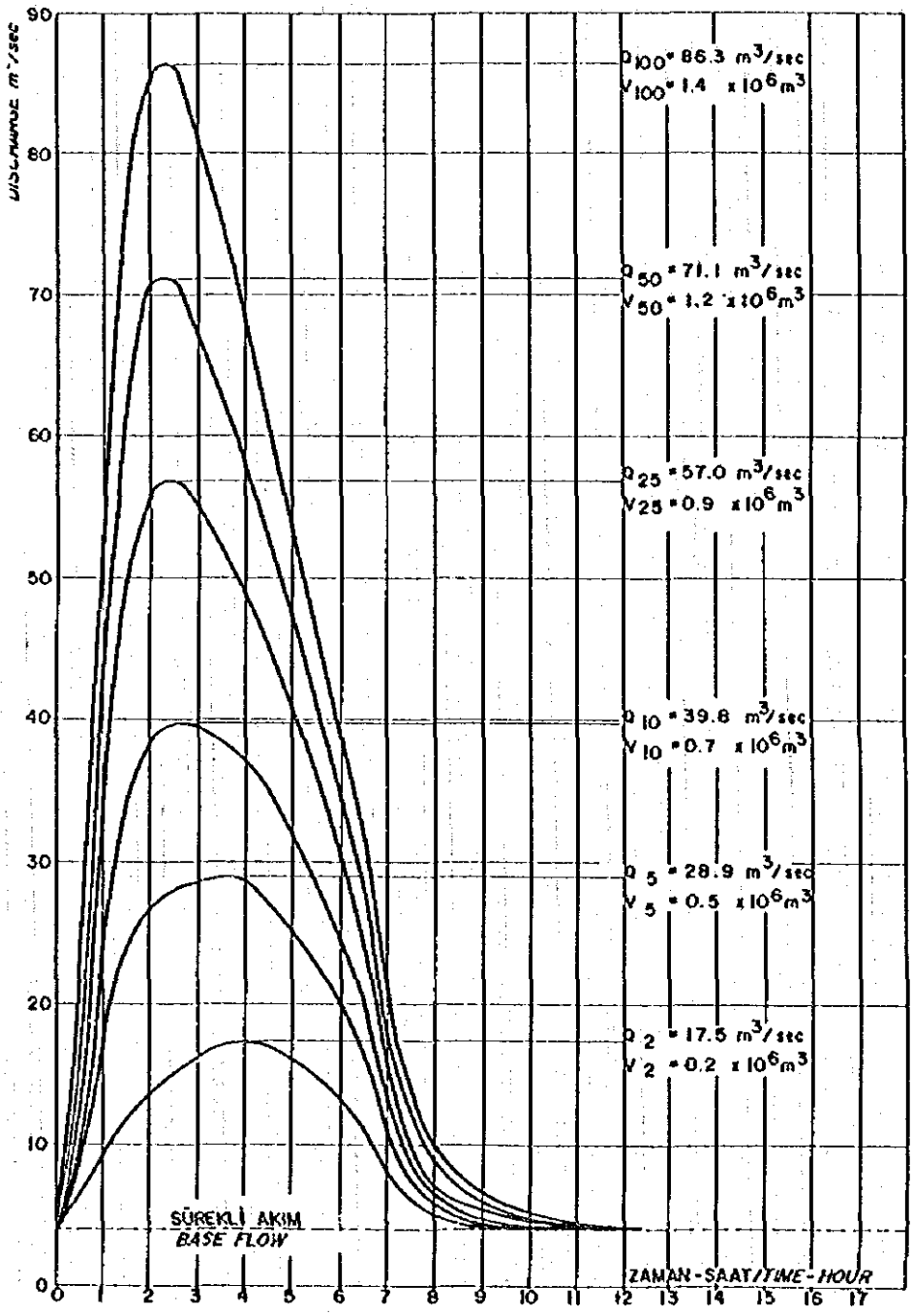


Figure-A.45 Flood Hydrographs of Various Recurrence Intervals for Uladı Damsite

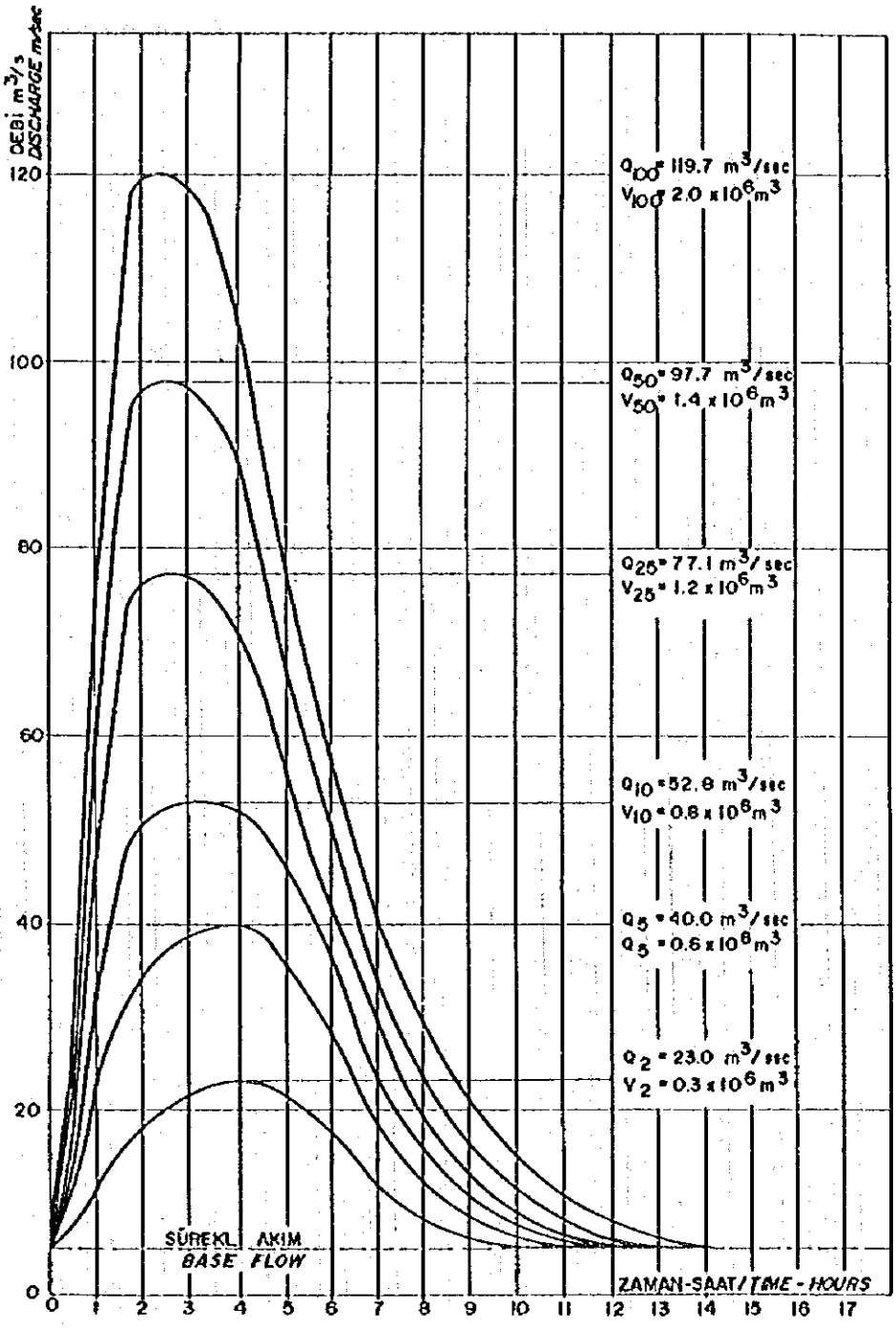


Figure-A.46 Flood Hydrographs of Various Recurrence Intervals for Ergenli Damsite

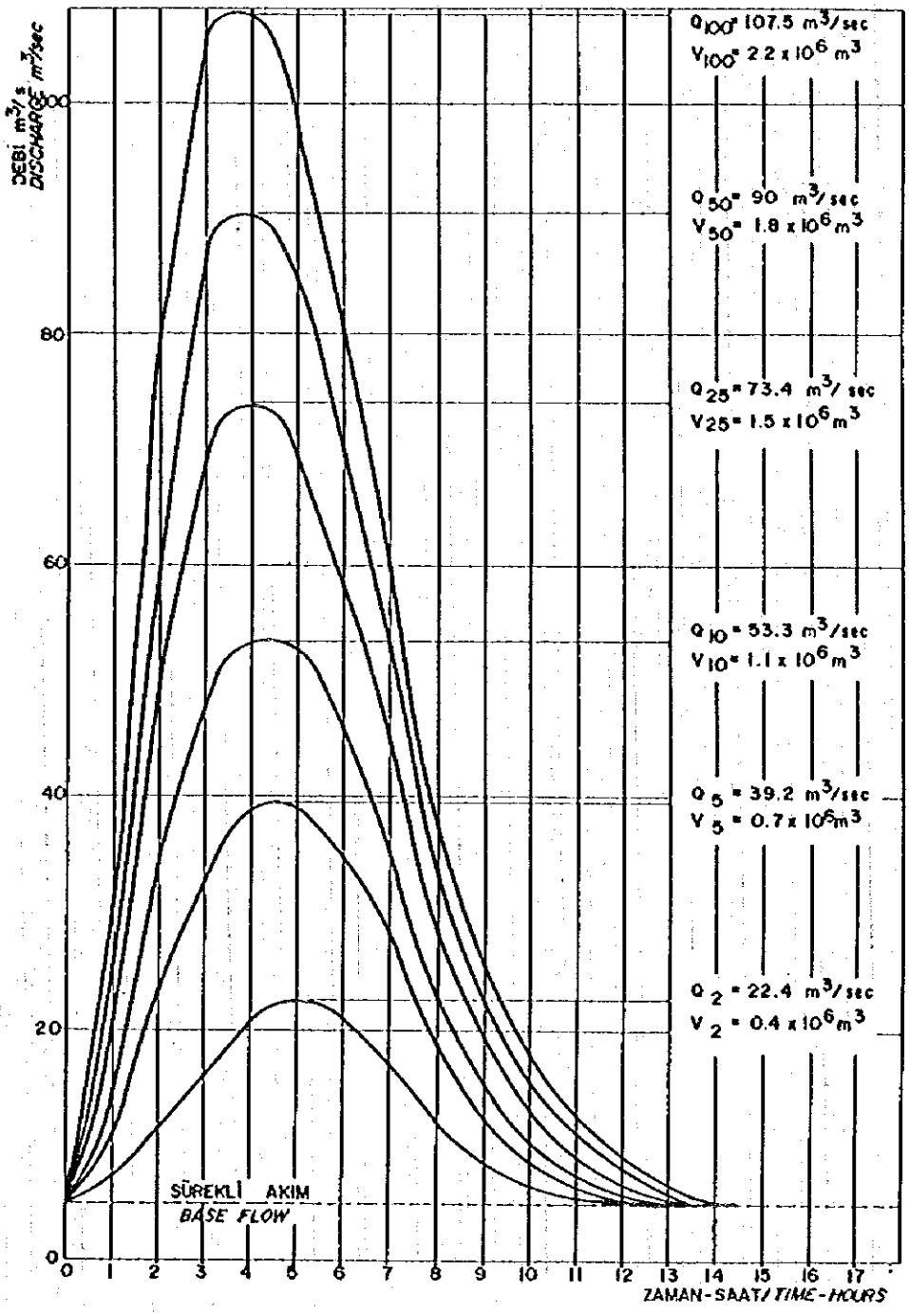


Figure-A.47 Flood Hydrographs of Various Recurrence Intervals for Burgaz Damsite

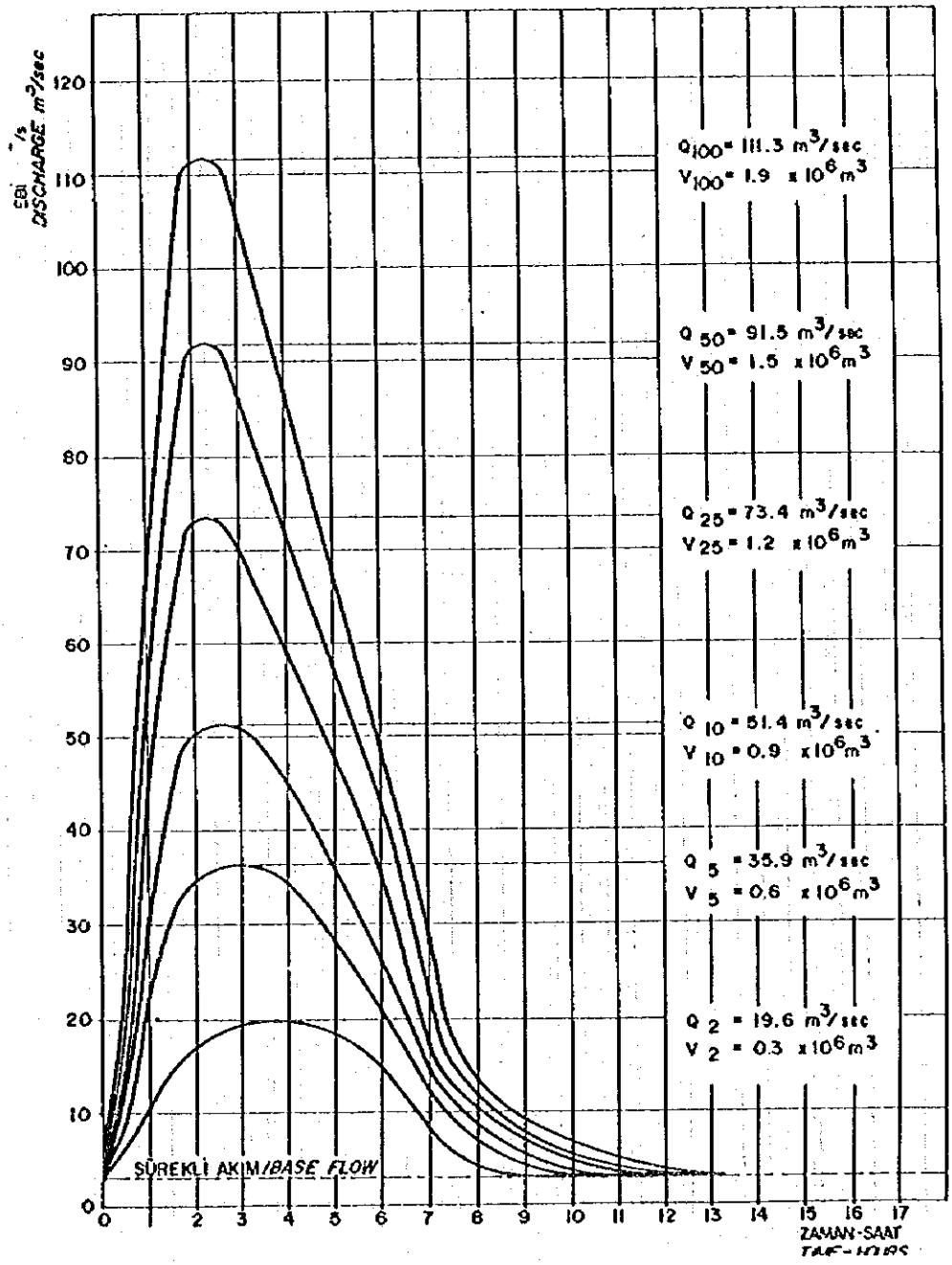


Figure-A.48 Flood Hydrographs of Various Recurrence Intervals for Aktaş Damsite

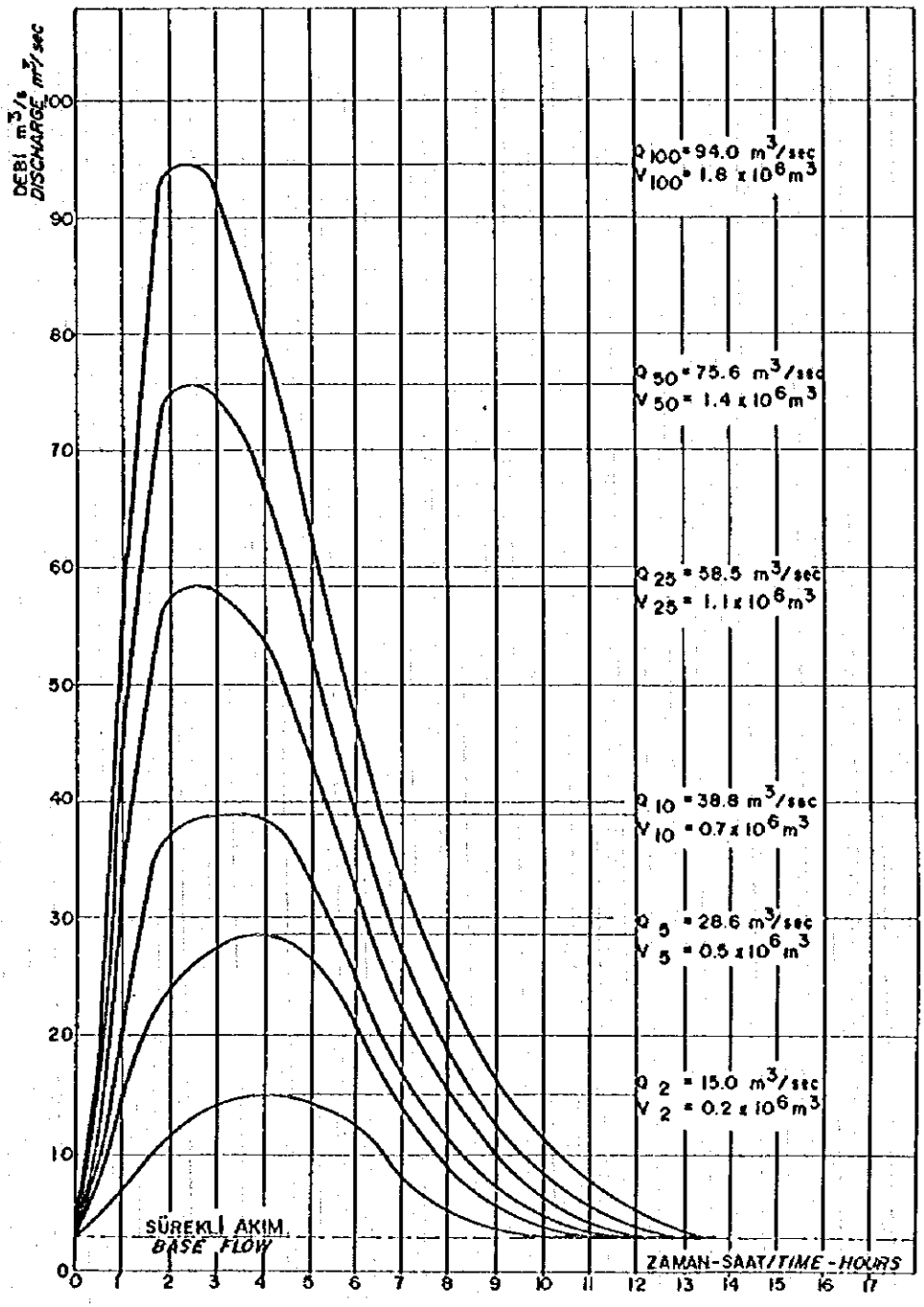


Figure-A.49 Flood Hydrographs of Various Recurrence Intervals for Ödemiş Damsite

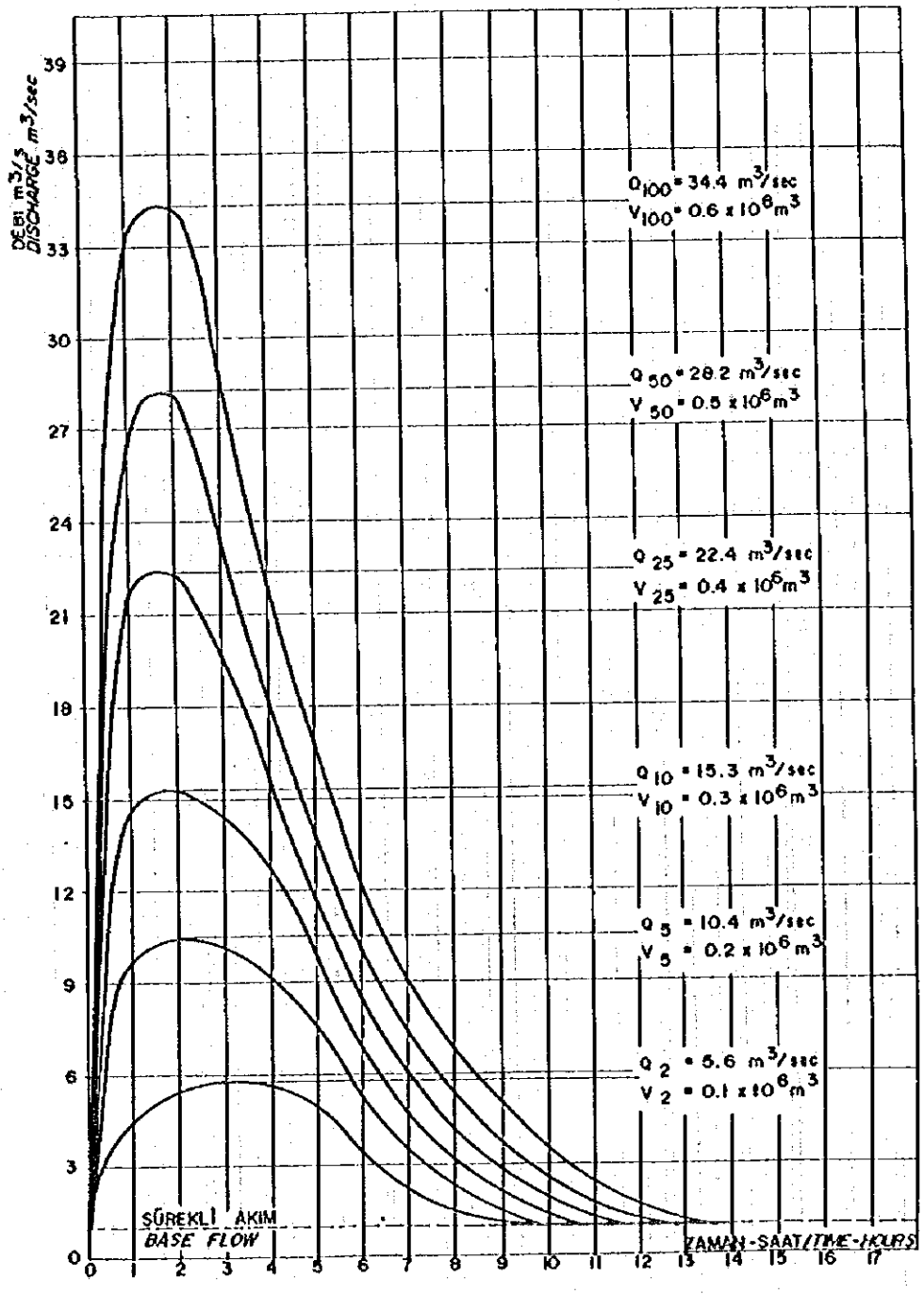


Figure-A.50 Flood Hydrographs of Various Recurrence Intervals for Birgi Damsite

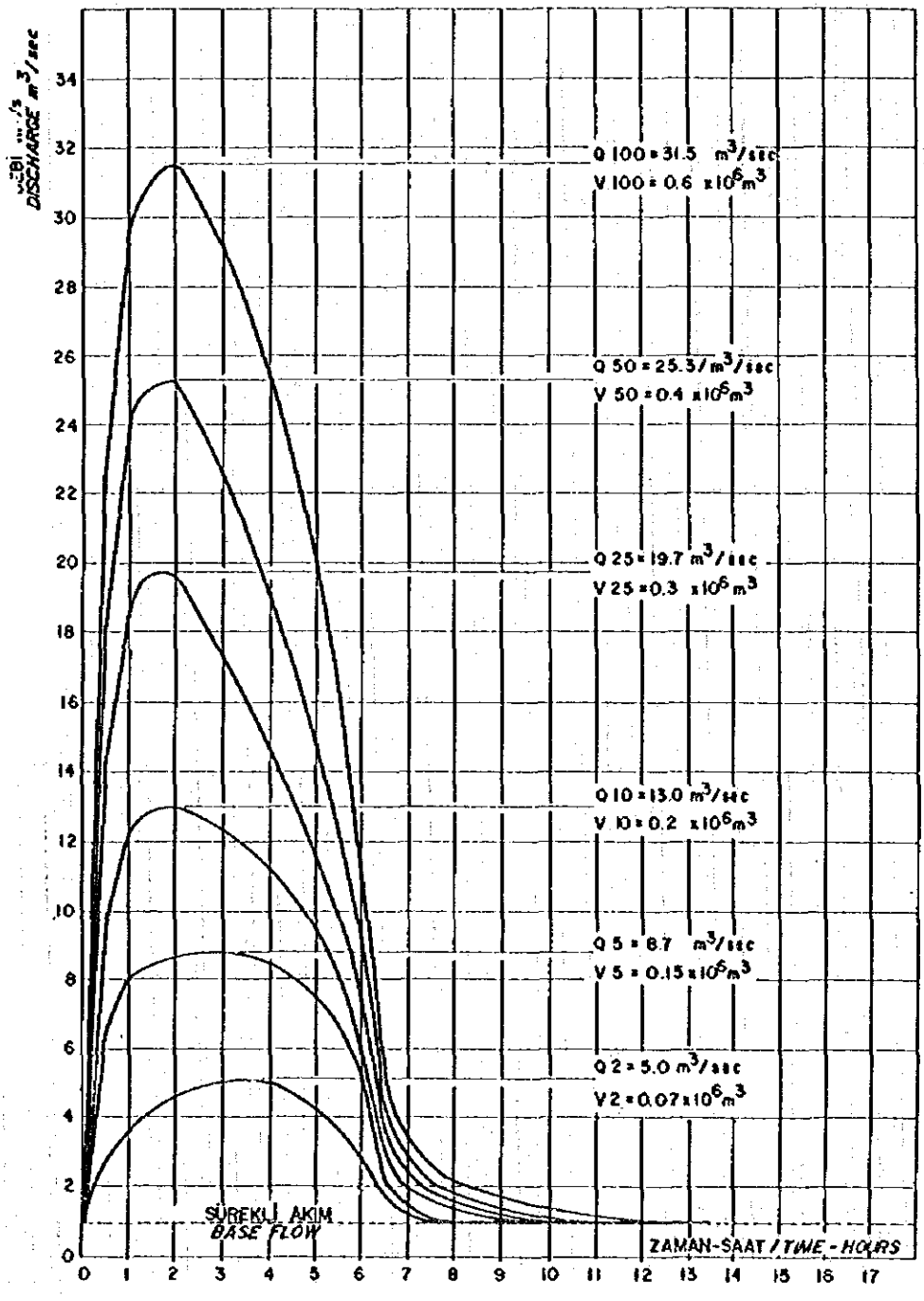


Figure-A.51 Flood Hydrographs of Various Recurrence Intervals for Bucak Damsite

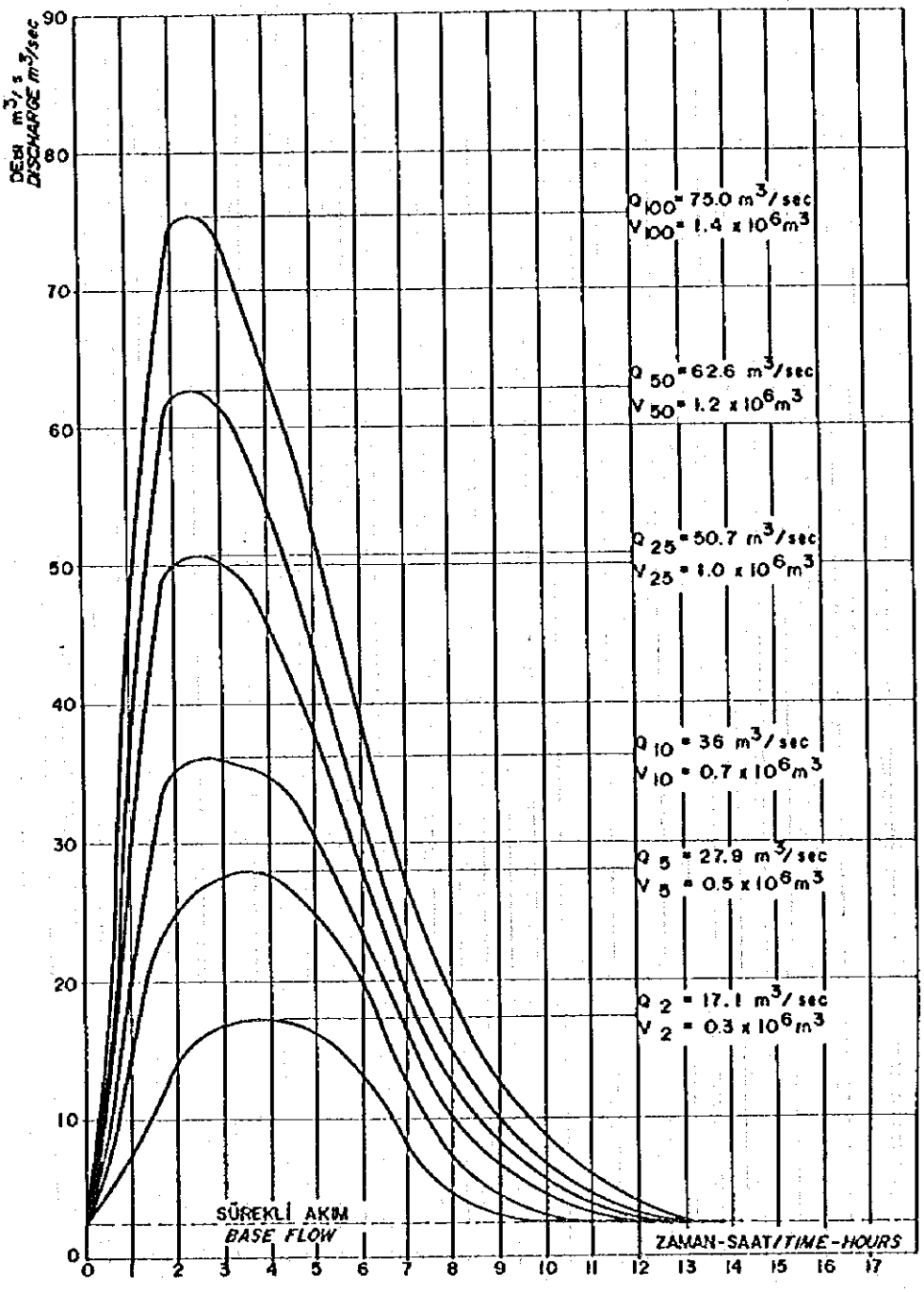


Figure-A.52 Flood Hydrographs of Various Recurrence Intervals for Pirinçci Damsite

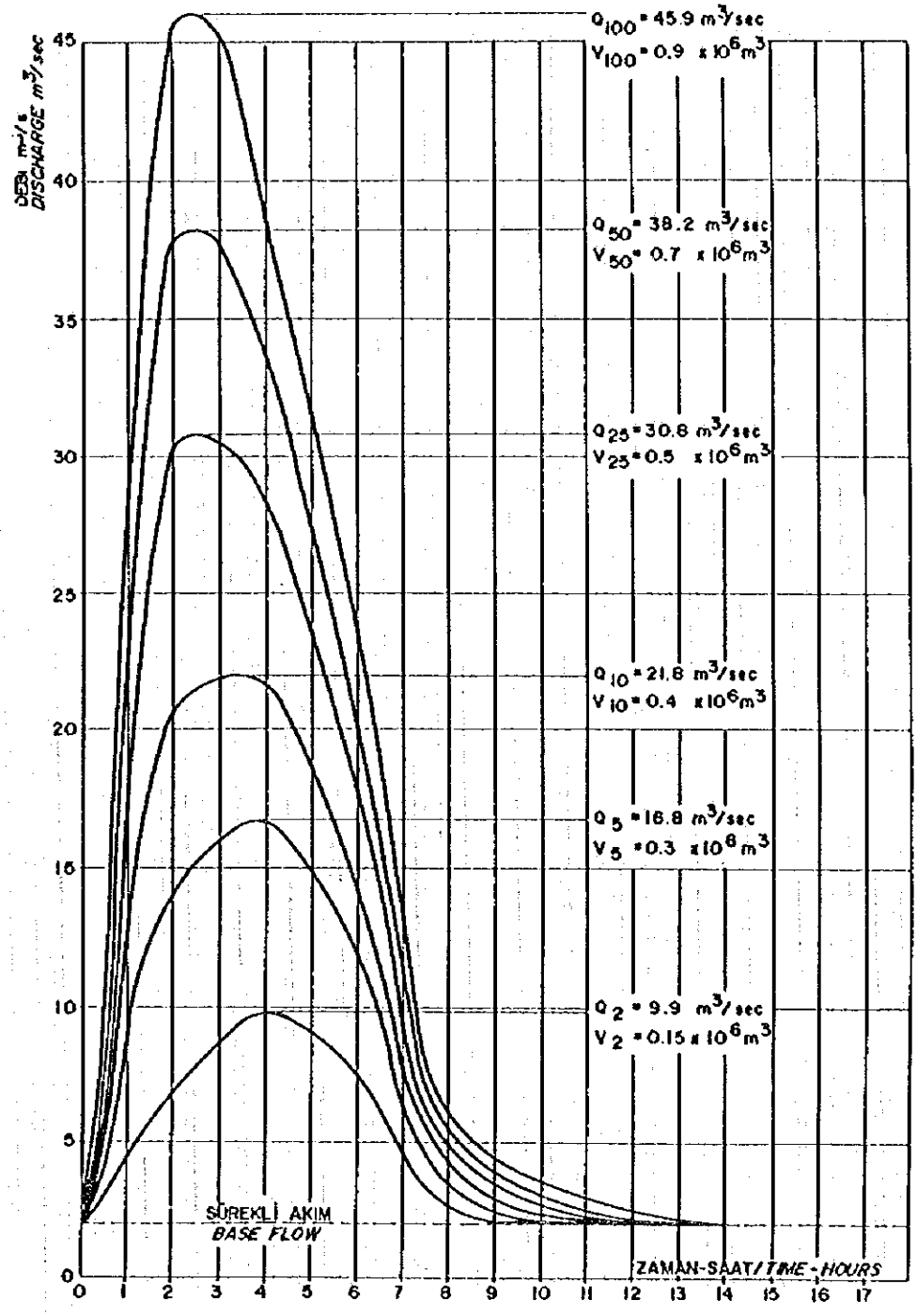


Figure-A.53 Flood Hydrographs of Various Recurrence Intervals for Sarılar Damsite

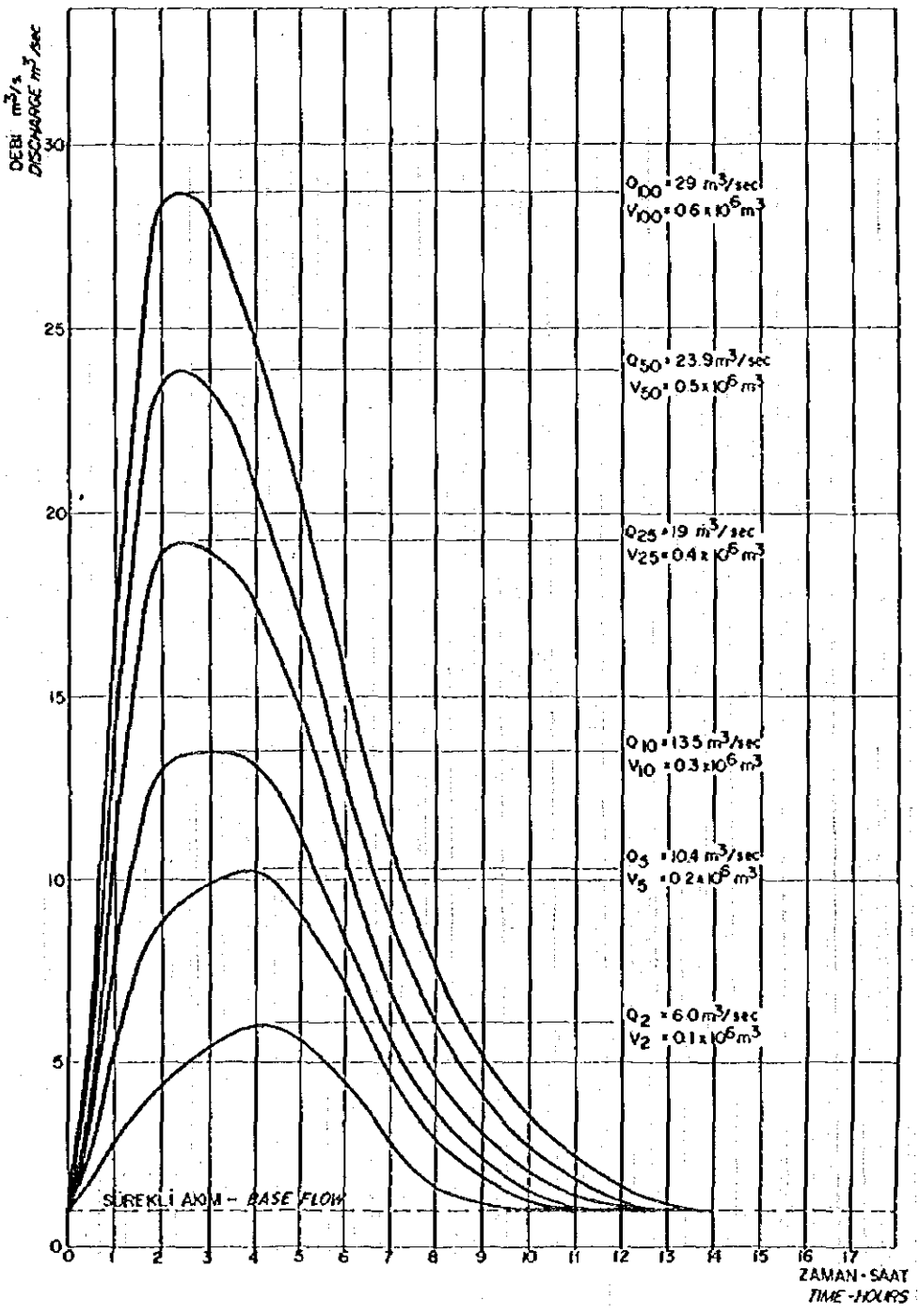


Figure-A.54 Flood Hydrographs of Various Recurrence Intervals for Yenişehir Damsite

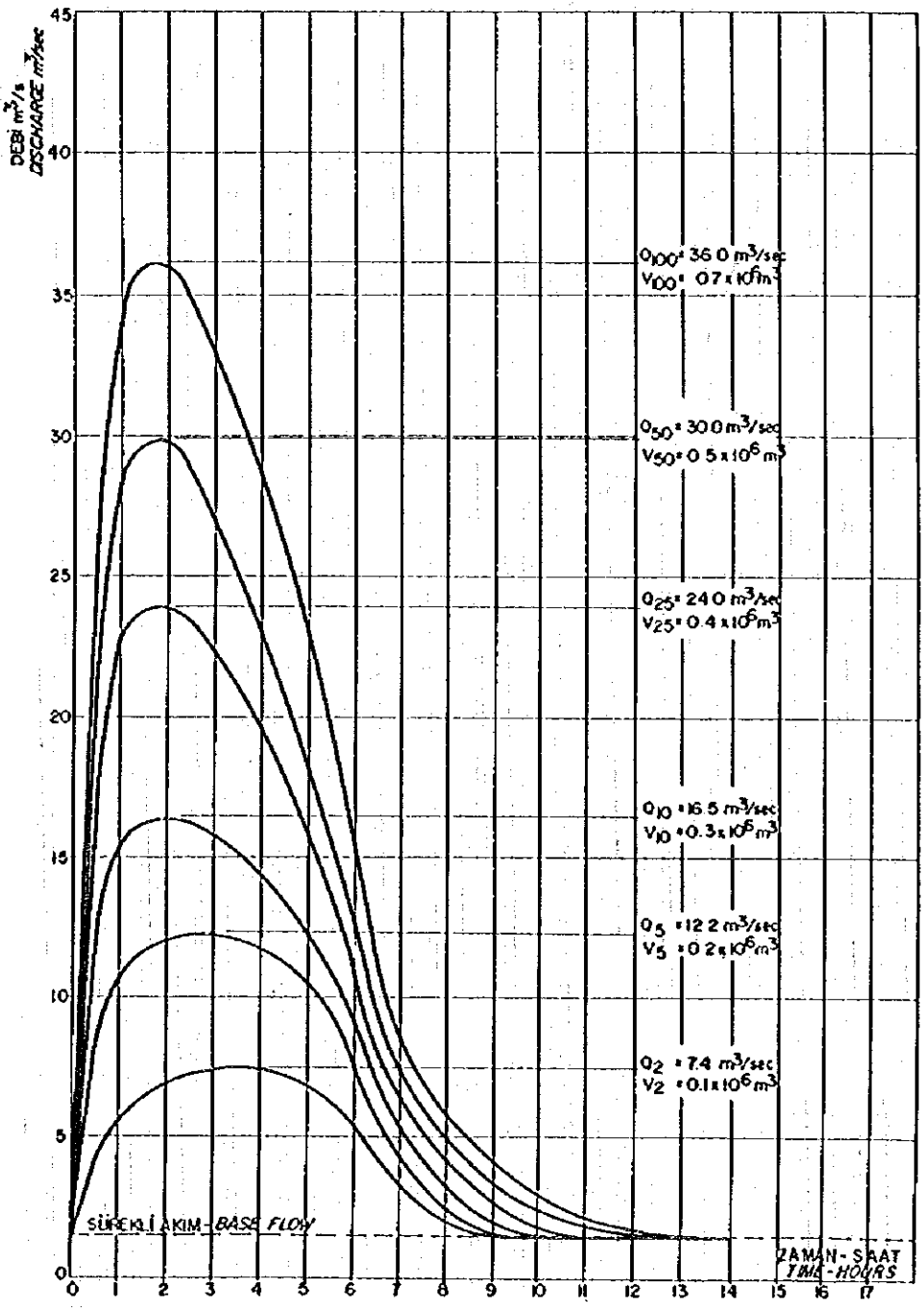


Figure-A.55 Flood Hydrographs of Various Recurrence Intervals for Eğridere Damsite

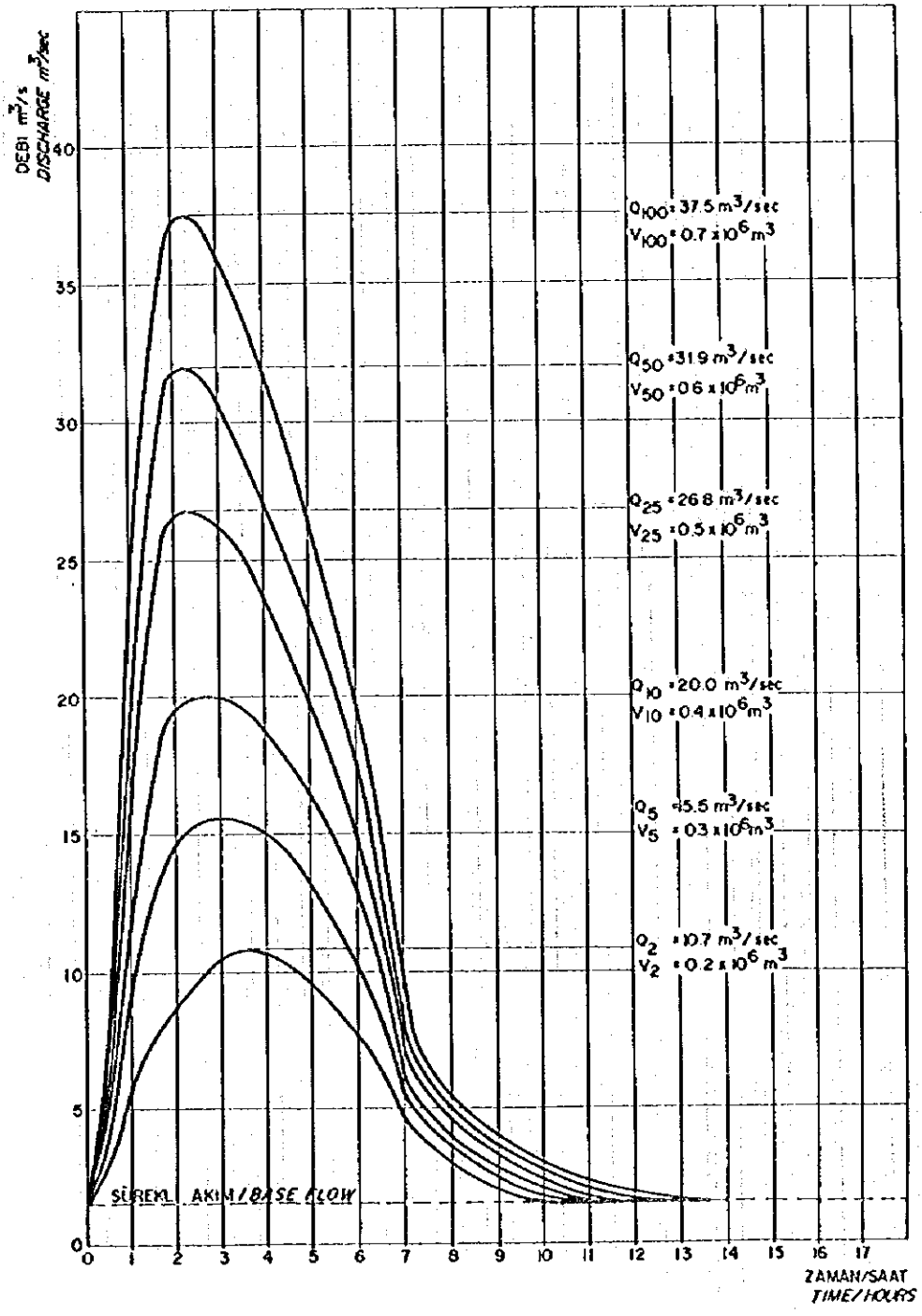


Figure-A.56 Flood Hydrographs of Various Recurrence Intervals for Akyurt Damsite

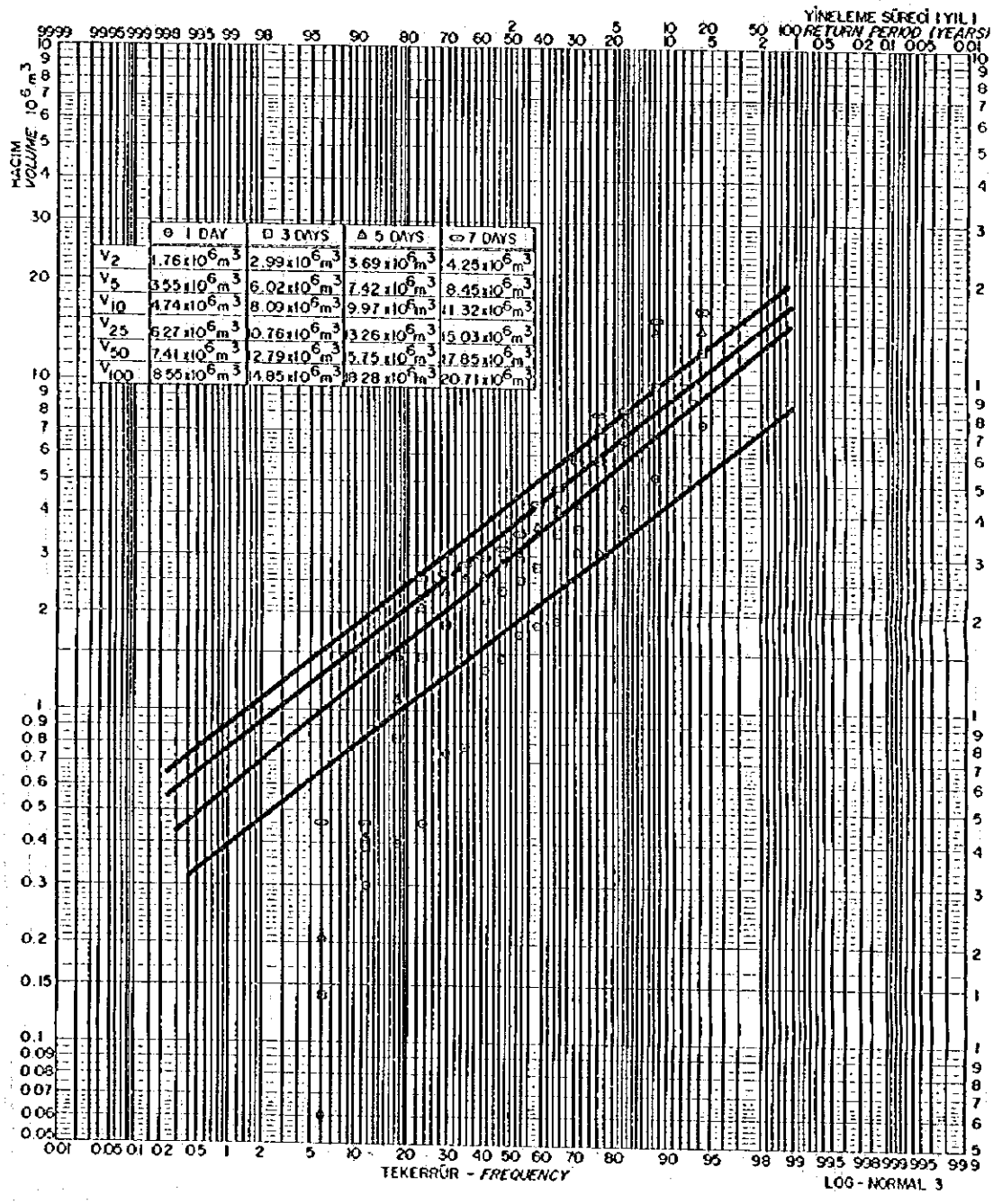


Figure-A.57 **Frequency Analysis of Annual Maximum Flow Volume Series of Beydağ Bridge Runoff Gauging Station No: 6-01 and Beydağ Damsite**

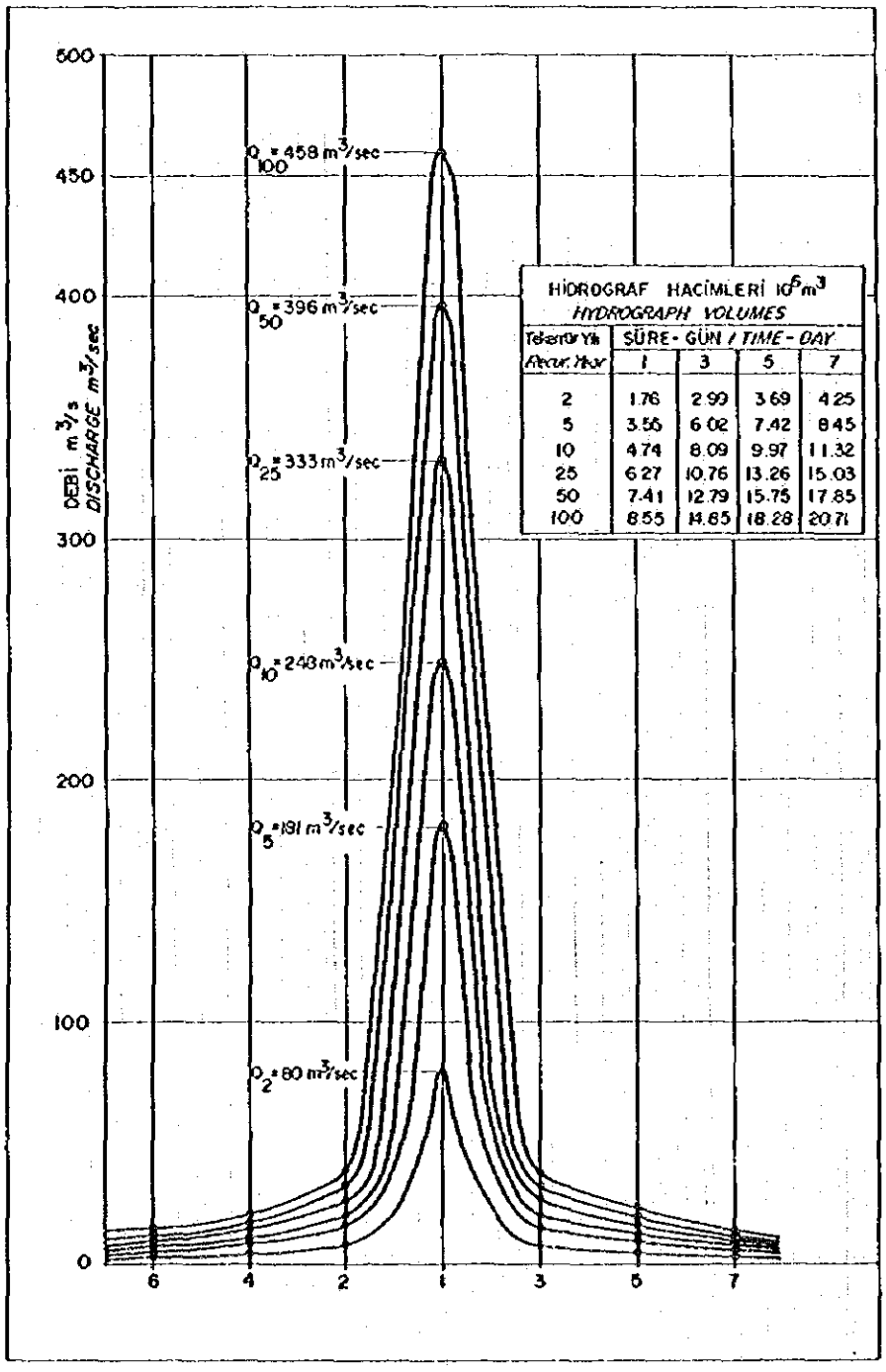


Figure-A.58 Flood Hydrographs of Various Recurrence Intervals for Beydağ Damsite

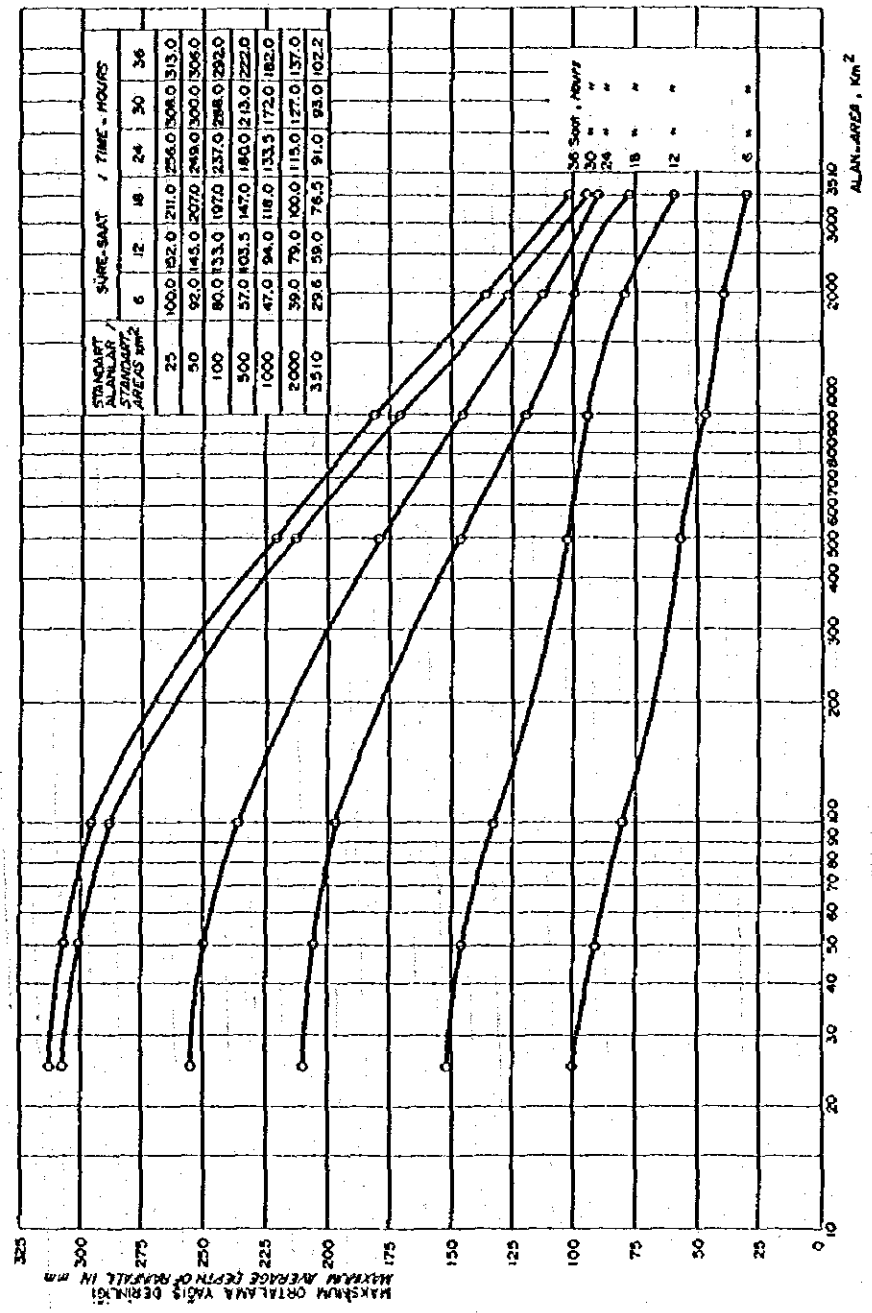


Figure-A.59 Maximum Rainfall Depth-Area-Duration Curves for Küçük Menderes Basin

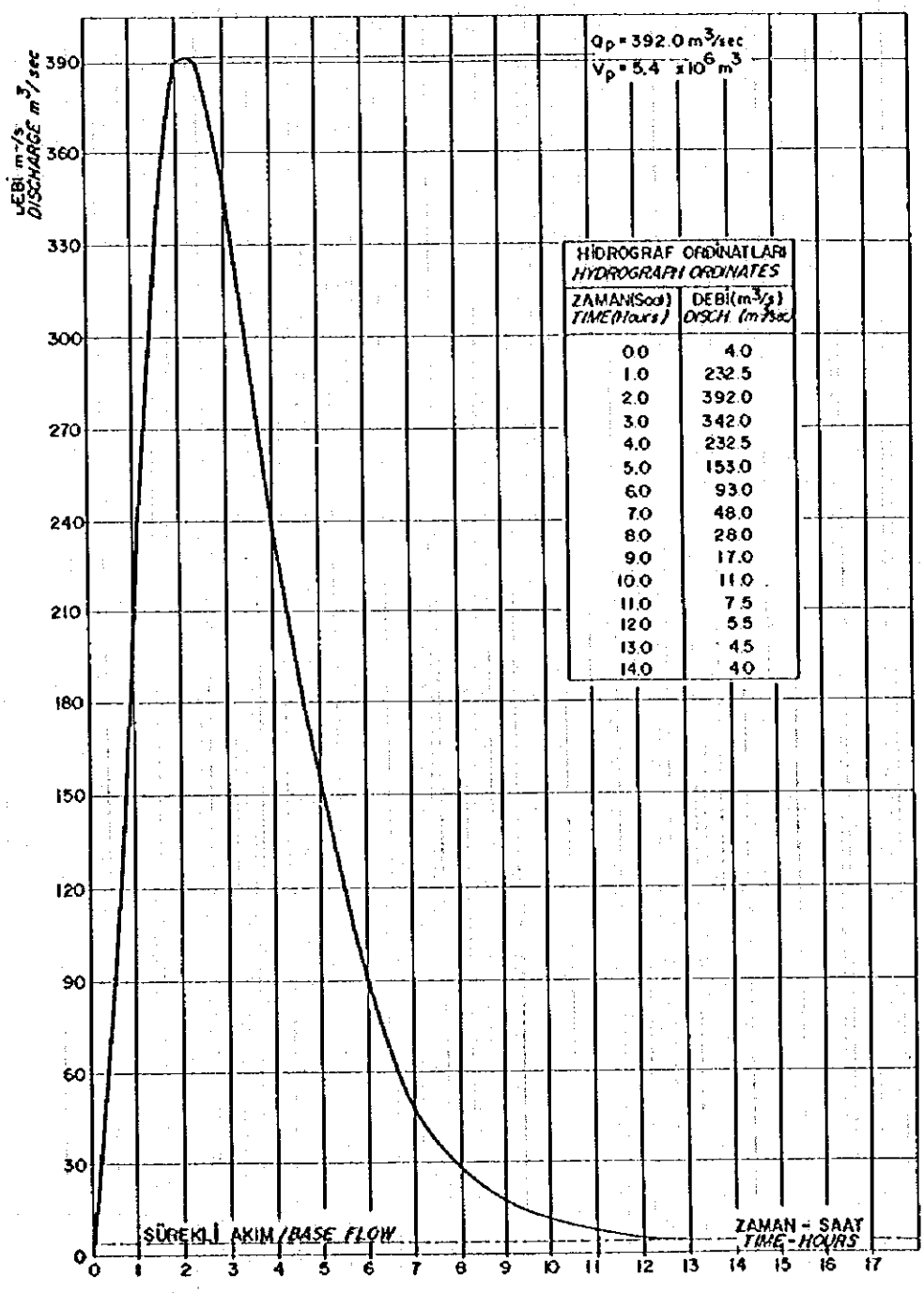


Figure-A.60 Probable Maximum Flood Hydrograph for Uladı Damsite

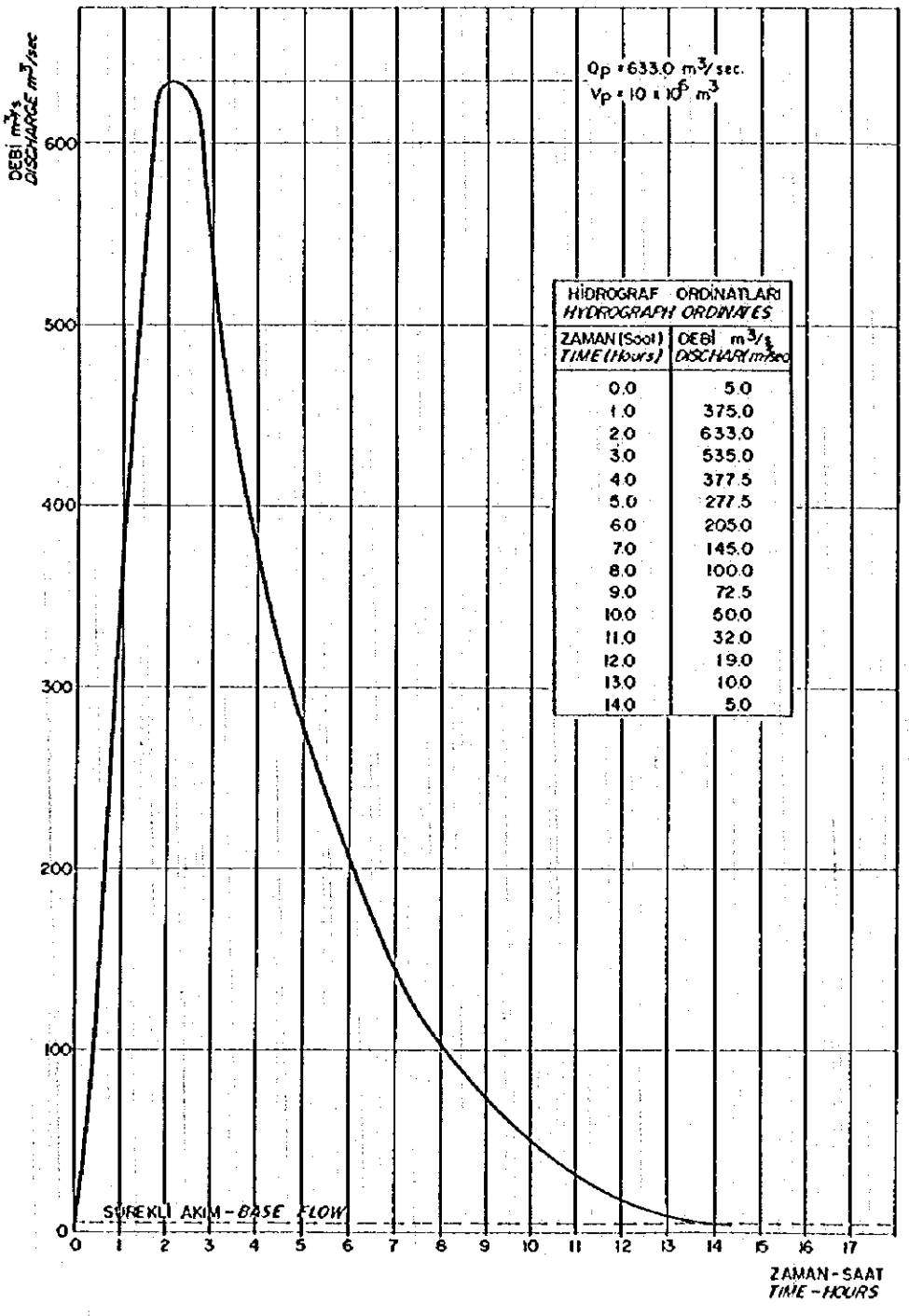


Figure-A.61 Probable Maximum Flood Hydrograph for Ergenli Damsite

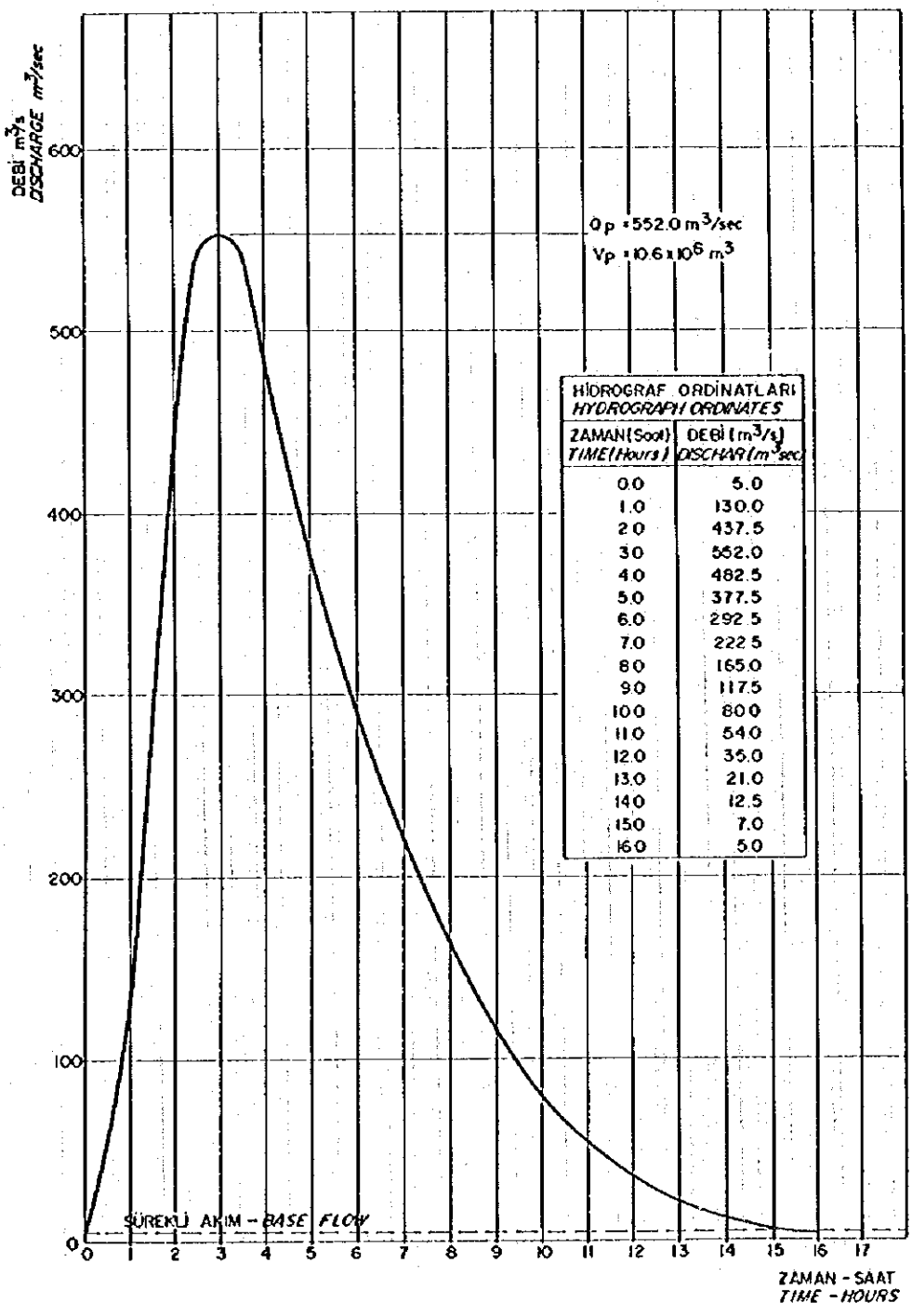


Figure-A.62 Probable Maximum Flood Hydrograph for Burgaz Damsite

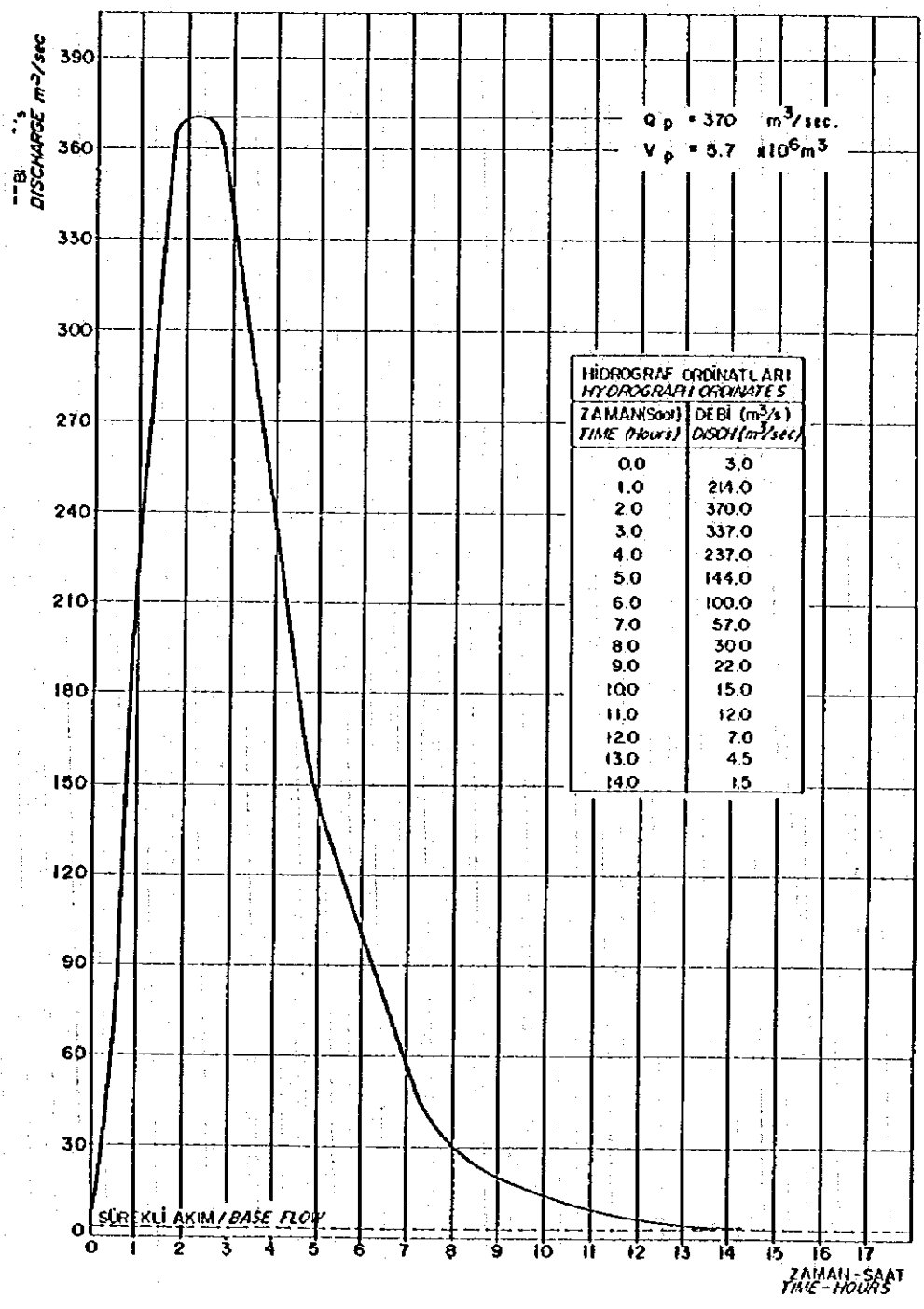


Figure-A.63 Probable Maximum Flood Hydrograph for Aktaş Damsite

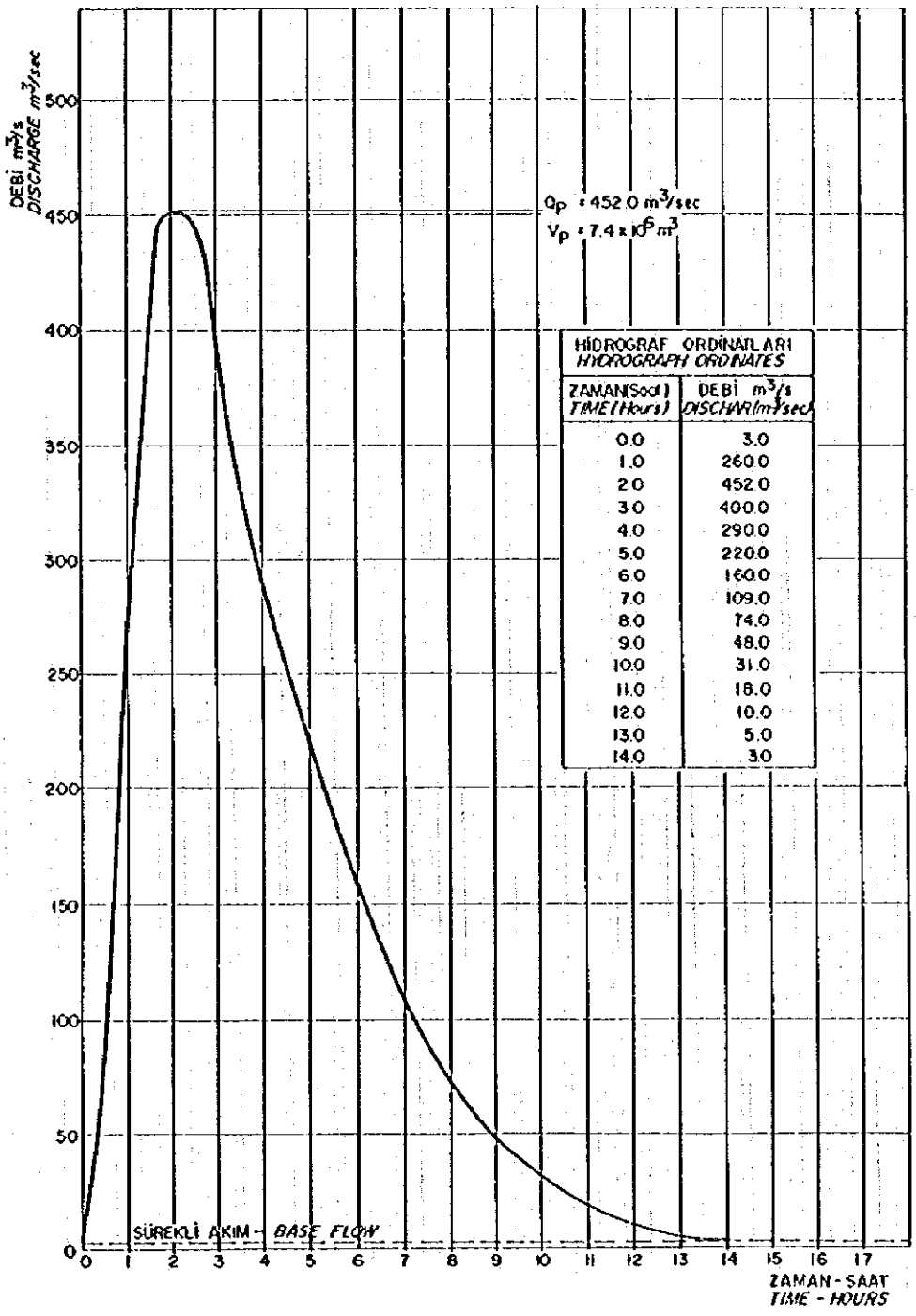


Figure-A.64 Probable Maximum Flood Hydrograph for Ödemiş Damsite

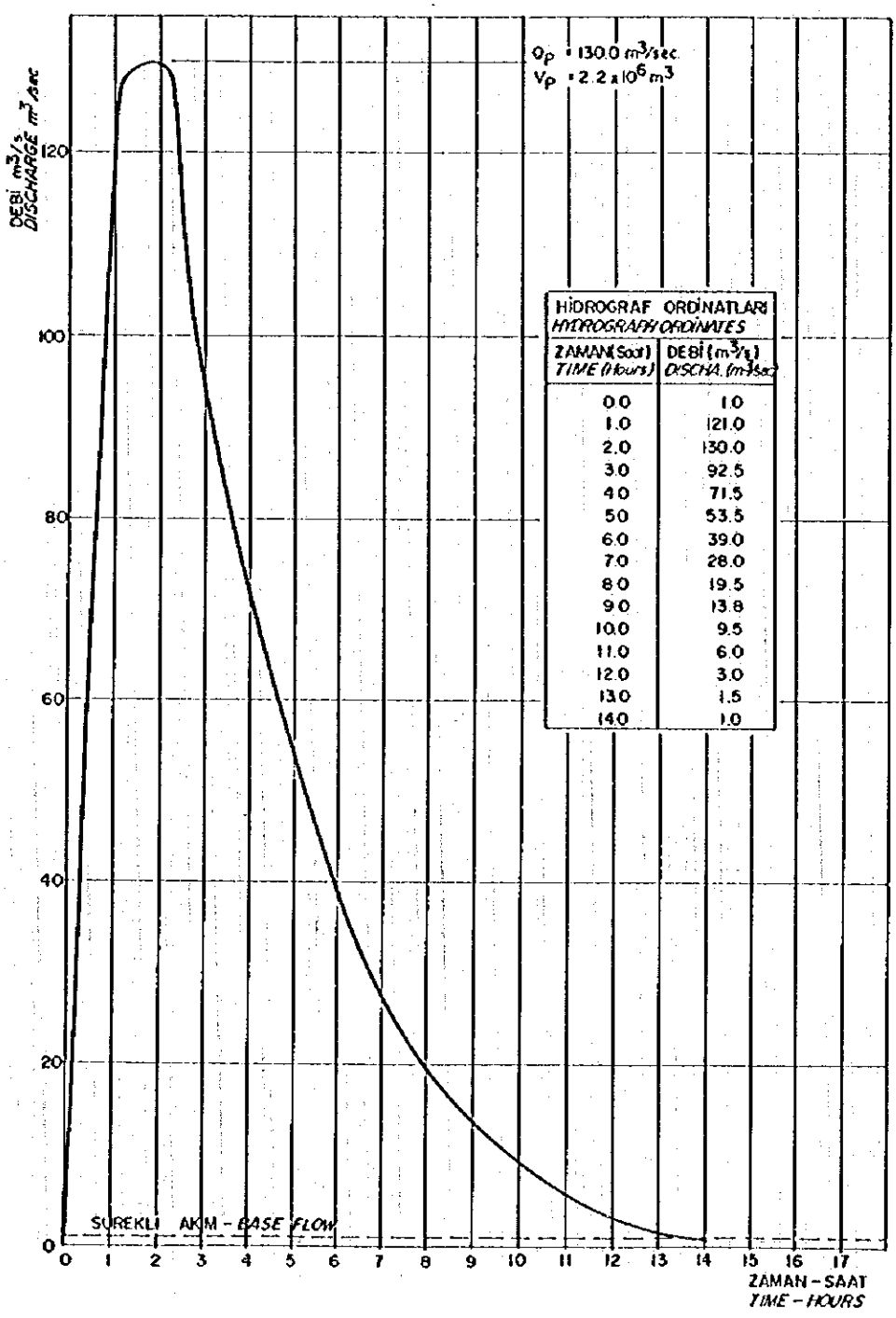


Figure-A.65 Probable Maximum Flood Hydrograph for Birgi Damsite

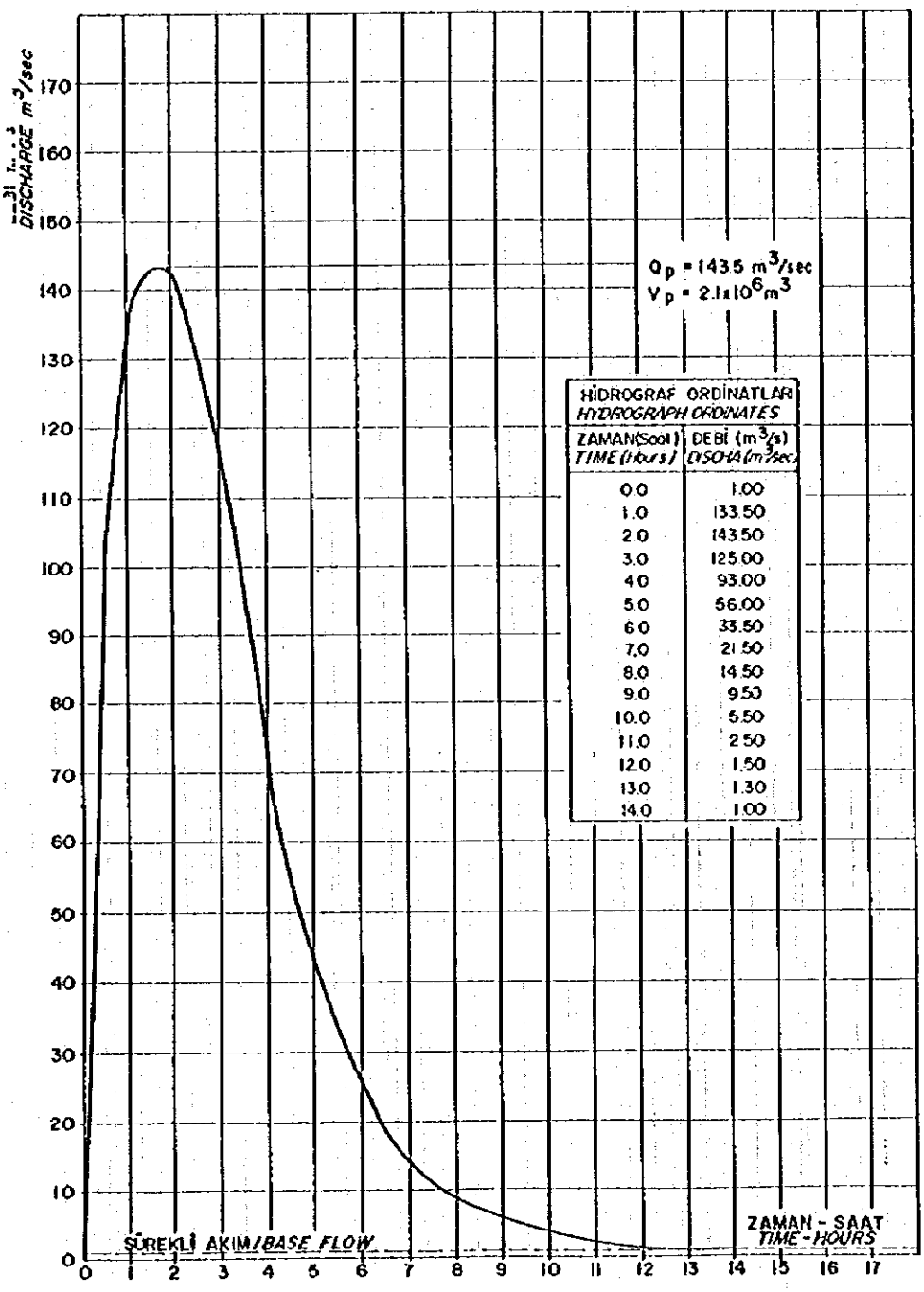


Figure-A.66 Probable Maximum Flood Hydrograph for Bucak Damsite

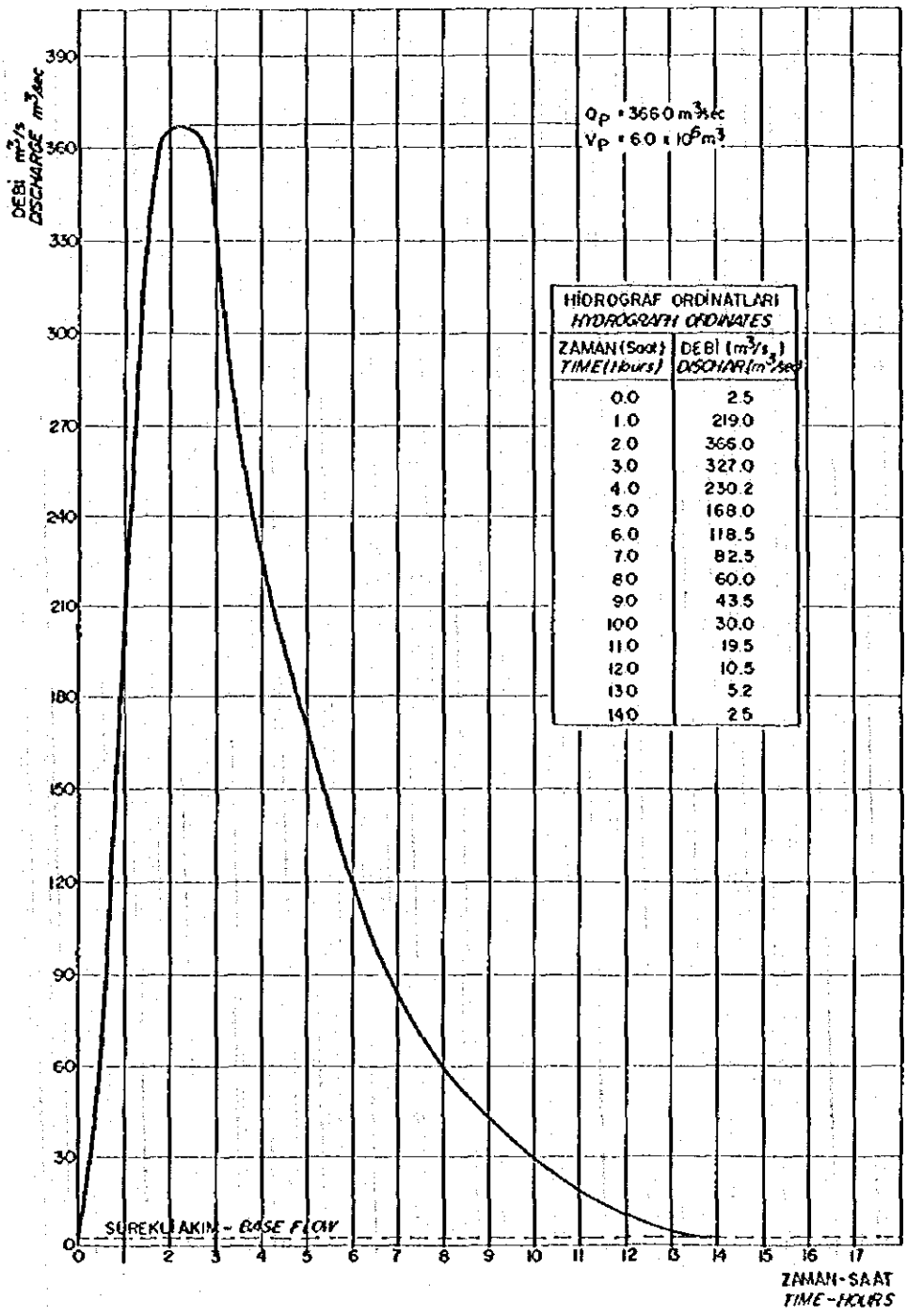


Figure-A.67 Probable Maximum Flood Hydrograph for Pirinçel Damsite

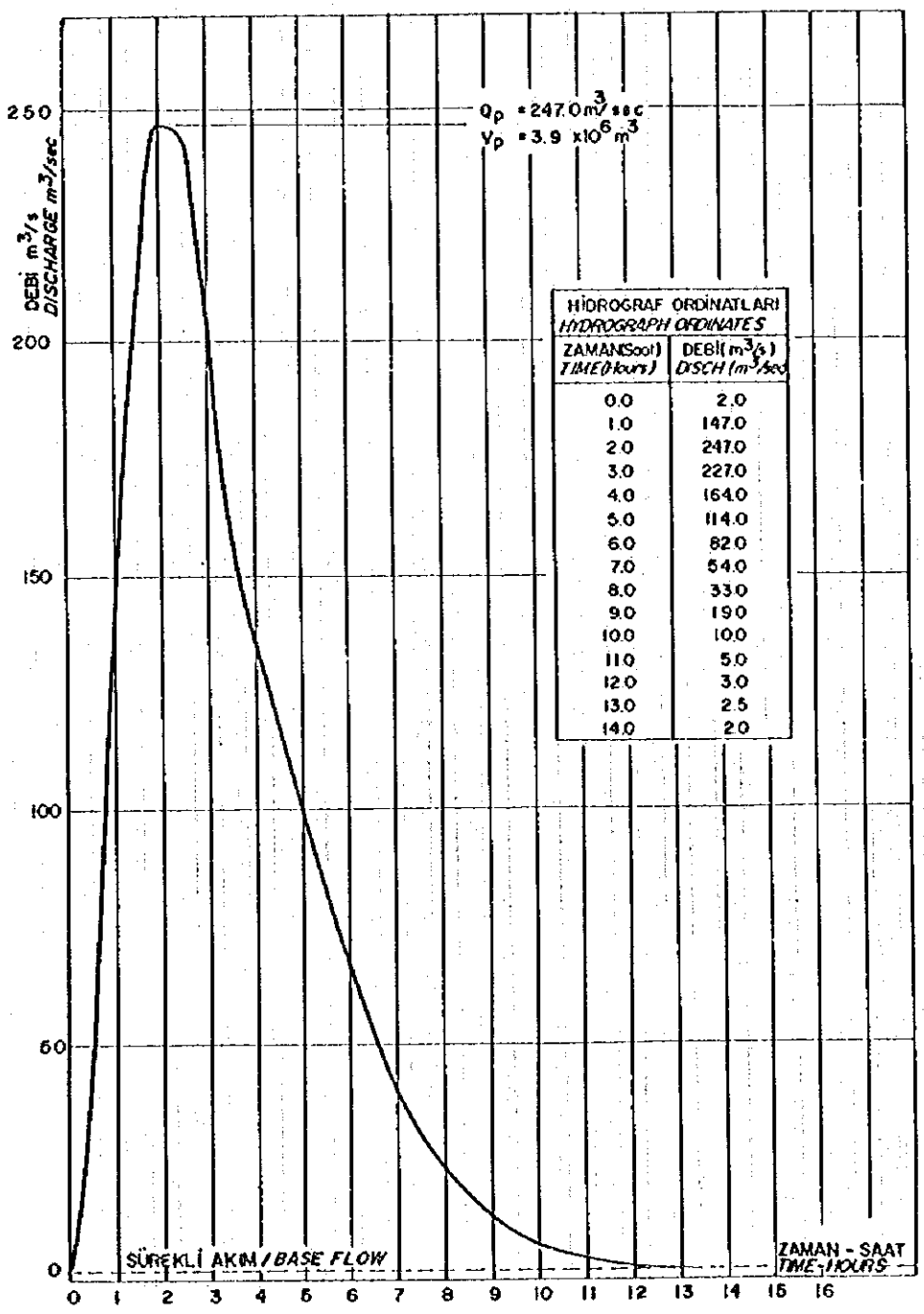


Figure-A.68 Probable Maximum Flood Hydrograph for Sarılar Damsite

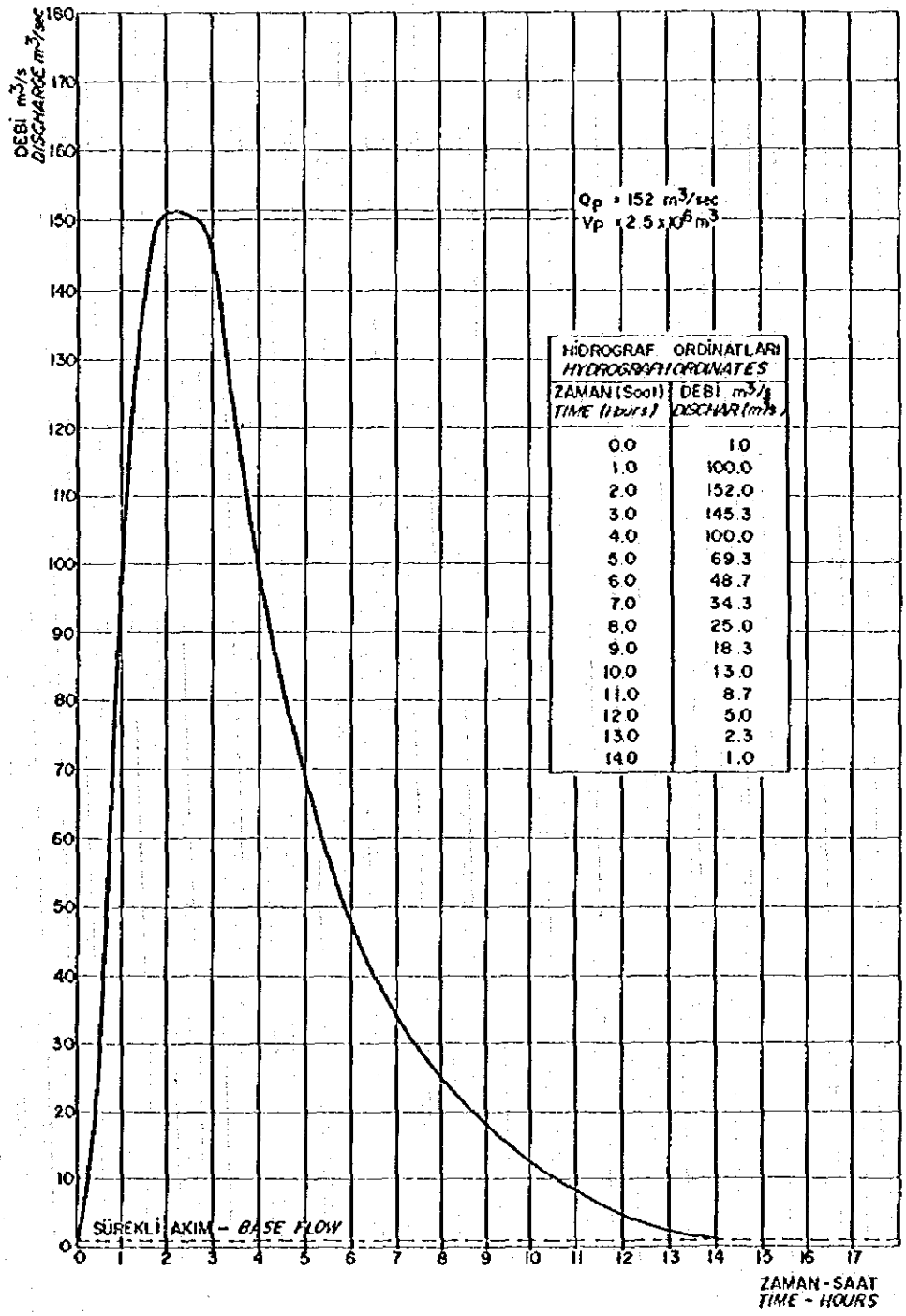


Figure-A.69 Probable Maximum Flood Hydrograph for Yenişehir Damsite

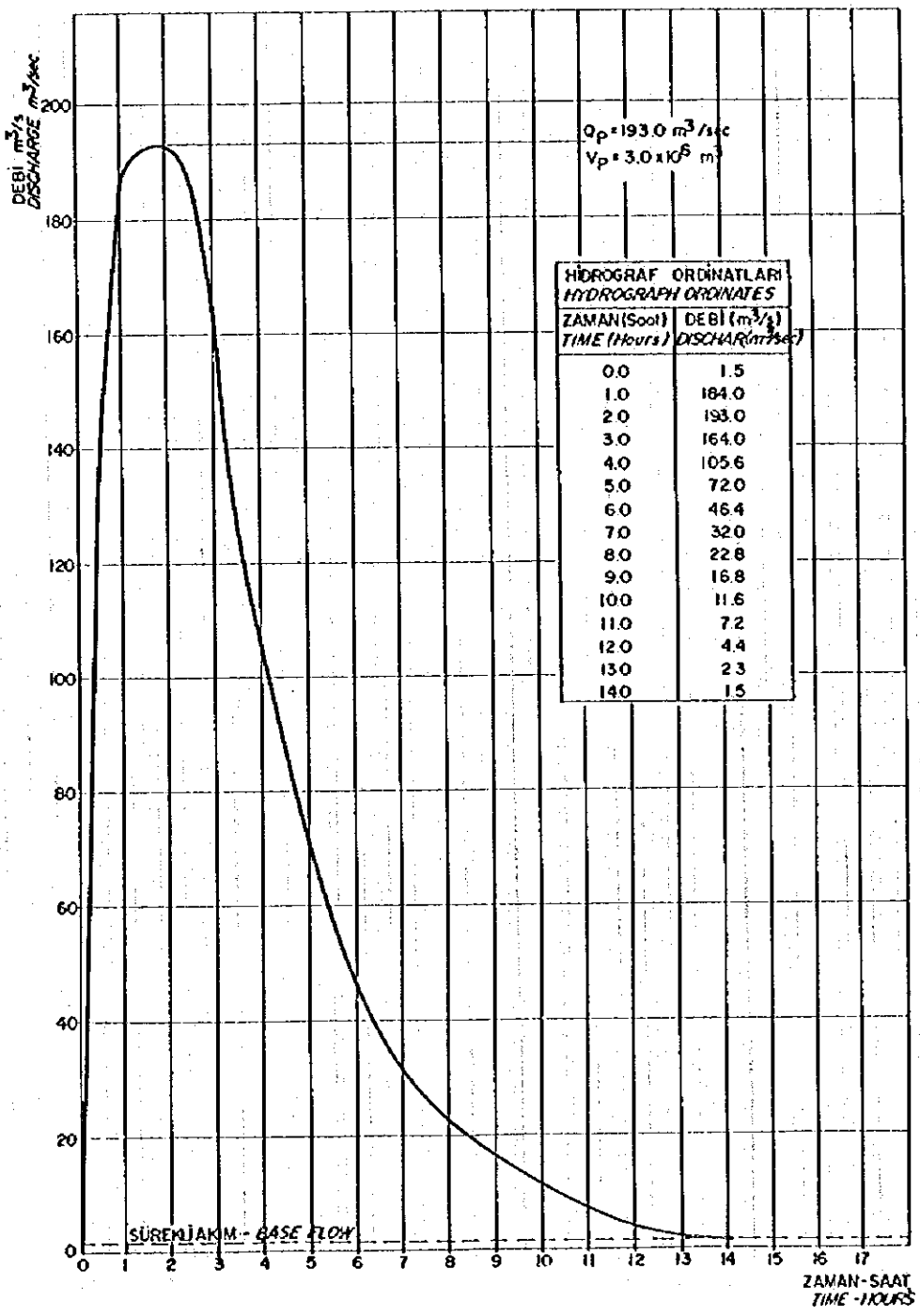


Figure-A.70 Probable Maximum Flood Hydrograph for Eğridere Damsite

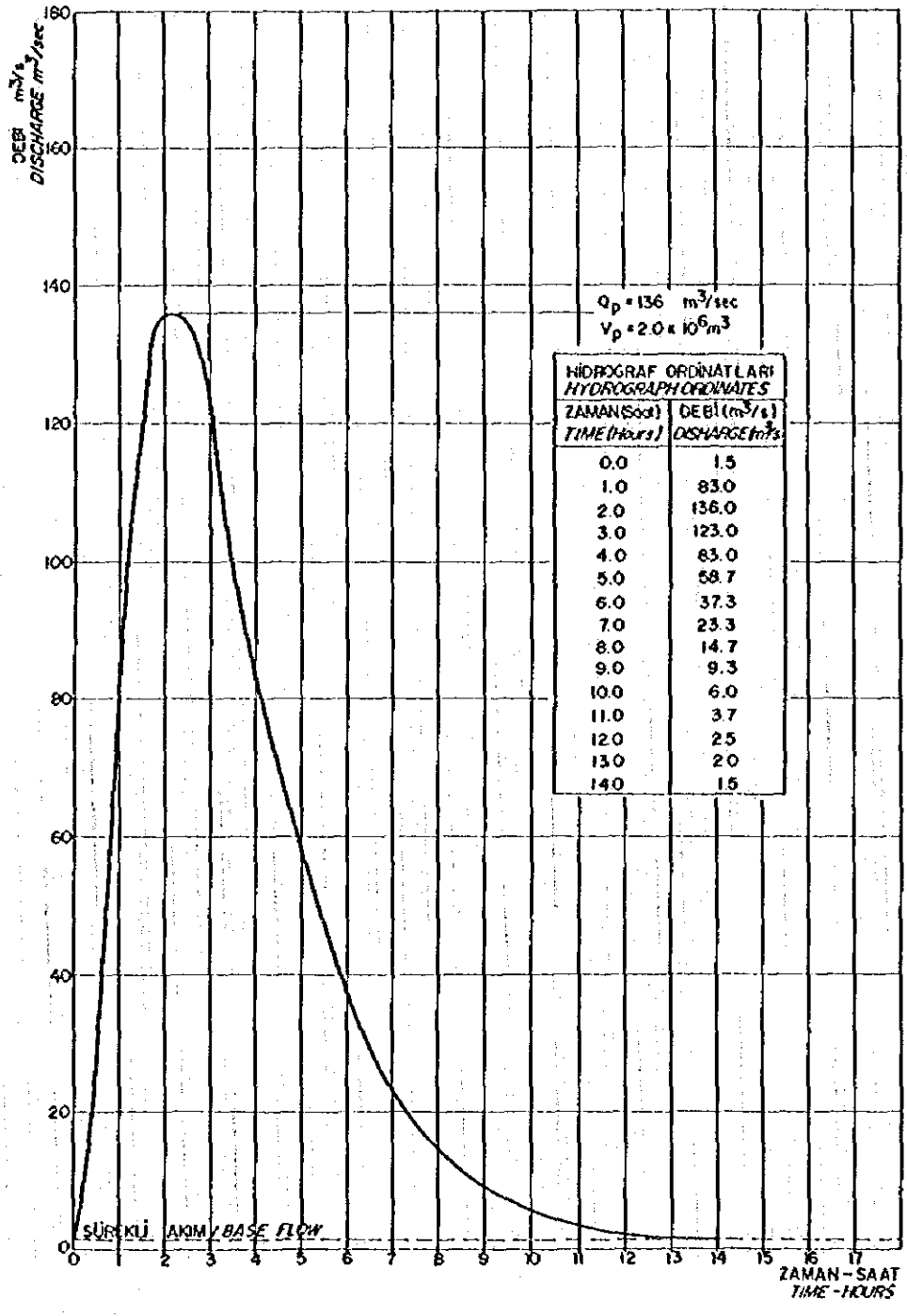


Figure-A.71 Probable Maximum Flood Hydrograph for Akyurt Damsite

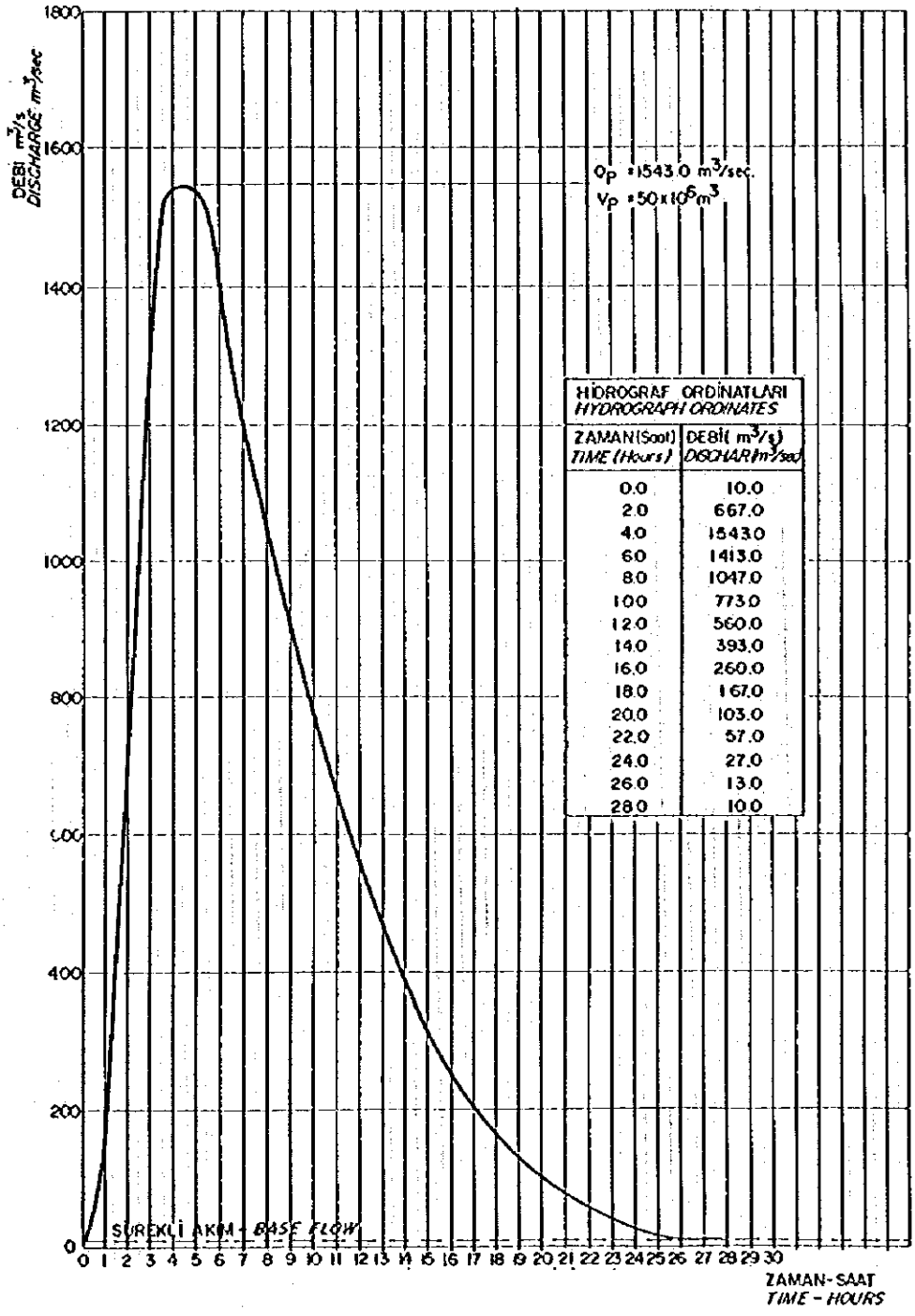


Figure-A.72 Probable Maximum Flood Hydrograph for Beydağ Damsite

ANNEX B

GEOLOGY

ANNEX B

GEOLOGY

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ANNEX B

GEOLOGY

1. General Geology around the Küçük Menderes River Basin

The basement rocks of Küçük Menderes river basin are composed mainly of highly metamorphosed rock complex called Menderes Massif, which was formed mostly by the Alpidic Tectogenesis. While Cenozoic Volcanics distribute widely from the north of Gediz river, and Mesozoic Group and ultramafic rocks exist in the southwards of the Büyük Menderes river.

2. Geology of the Küçük Menderes River Basin

2.1 General Geology

The general geology of the Küçük Menderes river basin is shown in Figure B.1. The basement rocks of the river basin are composed mainly of metamorphosed rocks called Menderes Massif which is largely divided into three according to their metamorphic phases, i.e., the core, the mantle and the outer part.

The core part of the massif, which is mainly composed of highly metamorphosed rocks such as gneiss and leptite, lies around Kiraz located at the east end of the river basin. The gneiss of the core part is characterized by Augen Structure, where alkali feldspar is large lenticular-shaped. The leptite is mainly composed of fine granules of irregular-shaped feldspars and biotites, partly quartzes and/or amphiboles etc.. This rocks often change into biotite schist.

The mantle part of the massif surrounds the core part, mainly forming the mountainous area around Ödemiş. The main composition of this part is mica schist.

The outer part of the massif is subdivided into the lower part and the upper part. The massif in the lower part consists mostly of phyllite, mica-quartz schist and mica schist, and that in the upper part is mainly of marble. The rocks of this part are situated near the coast of Aegean Sea with Mesozoic Limestone and neogene sedimentary rocks. The neogene sedimentary rocks consist of siltstone, conglomerate and limestone. The siltstone is usually very soft, while the conglomerate and limestone are porous.

The plain along the Küçük Menderes river consists of alluvium and fan deposits. The former consists of very thick fills (maximum thickness over than 340m), and the latter distributes widely around the mouth of the streams from mountains, of which foot portions are composed of the outwash detrital material derived from the rock basement of mountains.

2.2 Geology around the Identified Dam Sites

The geological maps and profiles around dam sites identified in the Phase-I Study are shown in Figure B.2.

As to the Beydağ Dam and the Aktaş Dam, the feasibility studies have been done by DSİ, abd their geological maps have been made rather in detail in the feasibility steudies. Figure B.2 and Figure B.3 are prepared based on these results.

The basement along the Beydağ Dam axis is composed of the core part of Menderes Massif and very thick alluvium. In case of the Aktaş Dam, the basement rock is of hard biotiteschist (the mantle part of Menderes Massif) and unconsolidated sediment.

Figure B.4 through Figure B.10 show the geological maps around dam sites and geological profiles along dam axes of the Burgaz, the Ergenli and other dam sites studied. The geology of these dam sites is mostly composed of micaschist and/or phyllite (partly quartzschist, calcschist) except the Bucak and Akyurt dam sites: the former is of augengneiss and fan deposit, and the latter is of marble and micaschist.

3. Geology of Beydağ - Ödemiş Area

3.1 Geology of the Area

The basement rocks of Beydağ - Ödemiş Area are composed of the core part of the Menderes Massif which consists of gneiss, leptite, micaschist, granite and amphibole.

In the plain area, alluvial deposits, of whic maximum thickness is more than 200m, fill the graben of Menderes Massif. Their composition is usually sand to silt bearing a lot of mica-fragment. The alluvial fan deposits composed of a large number of cobbles and boulders distribute widely along the foot of mountains.

3.2 Geology along the Proposed Main Canal

(1) Along the Right Main Canal

The basement of few kilometer section from Beydağ Dam is composed of alternation of marble and micaschist as shown in Figure B.11. Marble is usually hard and massive, sometimes a lot of cracks develop. Micaschist is partly weathered, but fresh part is hard. The base of canal in this section is composed of relatively hard rock, so that rock excavation may be needed.

After the above section, for about 20 to 25 km, the basement along the elevation of 180 m is composed of soil for about one-third of the section, and the rest is composed of rock which is mainly of leptite, while the basement along the elevation of 150m is composed of soil for almost full length. Leptite is the relatively hard, medium grained and of well-schistose rock. Soil in this section is generally micaceous and reddish brown. Gravel and sand distribute mainly along the stream lines, and silty soil gradually develops as apart from the stream.

For about 10 km or more after the above section, the basement is composed of gneiss particularly in the mountain sides. The first 7 to 8 km along the elevation 150m runs along the border between hard rock and sediment, and after that fan deposits are predominant. Gneiss is generally hard and forms relatively steep slope. Soil in the upstream side is composed of fan consisting of gravelly silty sand bearing cobbles, boulders, gravels and micaceous silt, and silty soil in the downstream side.

(2) Along the Left Main Canal

The basement along a few kilometer in the uppermost stream consists of fan deposits composed of cobbles and boulders bearing sandy silt. Permeability of the soil along this section seems relatively high.

For about 20 km after the above section, micaschist and gneiss are predominant along the elevation of 180m, while along the elevation of 150m is mostly composed of soil. Micaschist is generally well-weathered and soft, while gneiss is hard and forms a steep slope. Soil in the upper stream side is composed of fan deposit consisting of sand and gravels, and reddish brown silty soil originated from weathered rocks in the downstream side. Permeability of sand and gravel is usually high, while that of silty soil is low.

As for the reaches of 15 km of further downstream section from the above section, its central part is occupied by a hill composed of micaschist and quartz-micaschist. The other part

is composed of fan deposit and/or alluvium or residual soil. The fan deposit is generally of gravel bearing silty sand, and the other is of light brown sandy silt and reddish brown fine soil derived from weathered micaschist and mica-quartz schist. Micaschist and mica-quartz schist are well-weathered and remarkably softened.

After the above-mentioned sections, the geology is composed of mica-quartz schist and gneiss in the mountain side. As for the plain side, gravel bearing silty sand of fan deposit is mainly found in the upstream side and light brown sandy silt in the downstream side.

Generally, above mentioned soil is well-consolidated and relatively dense, so that depression may not occur. The groundwater table along the canal route seems deep below the ground surface and may not affect to the stability of the facilities.

The permeability of soil seems to be relatively high, because they are sandy, and then the leakage may likely happen. If the excavated pond will reserve water statically, however, mica fragment may form a thin surface layer on the bottom of pond and the leakage through the bottom may be checked to some extent.

3.3 Embankment Material and Aggregate

For the Beydağ Dam and Aktaş Dam, the geotechnical properties such as location, volume, and their physical and mechanical properties of embankment material and concrete aggregate are mentioned in the feasibility studies made by DSİ. These results are summarized in Figure B.12 and B.13.

In case of Ergenli and Burgaz Dam, the geotechnical study has not been carried in depth so that embankment material especially impermeable material will need to be further investigated.

In Turkey, the following values are considered as the standard for the dam embankment material and concrete aggregate.

(a) Impermeable Material

- Specific Gravity	Min. 2.5
- Liquid Limit (LL)	40 ~ 50%
Plasticity Index (PI)	14 ~ 20%
Max. Dry Density	Min. 1.6 ton/m^3
Opt. Moisture Content	15 ~ 20% (Min. 10%)
Cohesion Strength	0.5 ~ 0.75 kg/m^2
Internal Friction Angle	26°C ~ 30°C

(b) Permeable Material

- Specific Gravity	Min. 2.6
- Weight % Retaining 200# Sieve	Max. 3 ~ 5%
- Water Absorption Ratio	Max. 1%
- Weight Loss by Los Angels Abrasion	Max. 40 ~ 50%
- Soundness to Sodium Sulfate	Sand, Max. 8 ~ 10%
- Gravel, Max. 10 ~ 12%	

(c) Rock Material

- Specific Gravity	Min. 2.6
- Water Absorption Ratio	Max. 1.8%
- Weight Loss by Los Angels	

- Abrasion Max. 40%
- Soundness to Sodium Sulfate Max. 10%

As material for canal embankment, enough quantity of impermeable material is difficult to be found out in the Study Area. Besides, the ground seems not to have good water tightness because of their composition being micaceous silt and sand. Fundamentally, excavated material will be used for canal embankment, however, they may need the lining because of the of above-mentioned reason.

As concrete aggregates, crushed material of marble to be collected from the quarry site located at the right bank side of Beydağ Dam site should be suitable matrials showing the following technical data, and also their quantity should be sufficient for the construction of the dam and the canal structures.

- Water Absorption Ratio 0.32 ~ 0.54%
- Weight Loss by Los Angels Abrasion Test 35 ~ 36% (500 cycle)