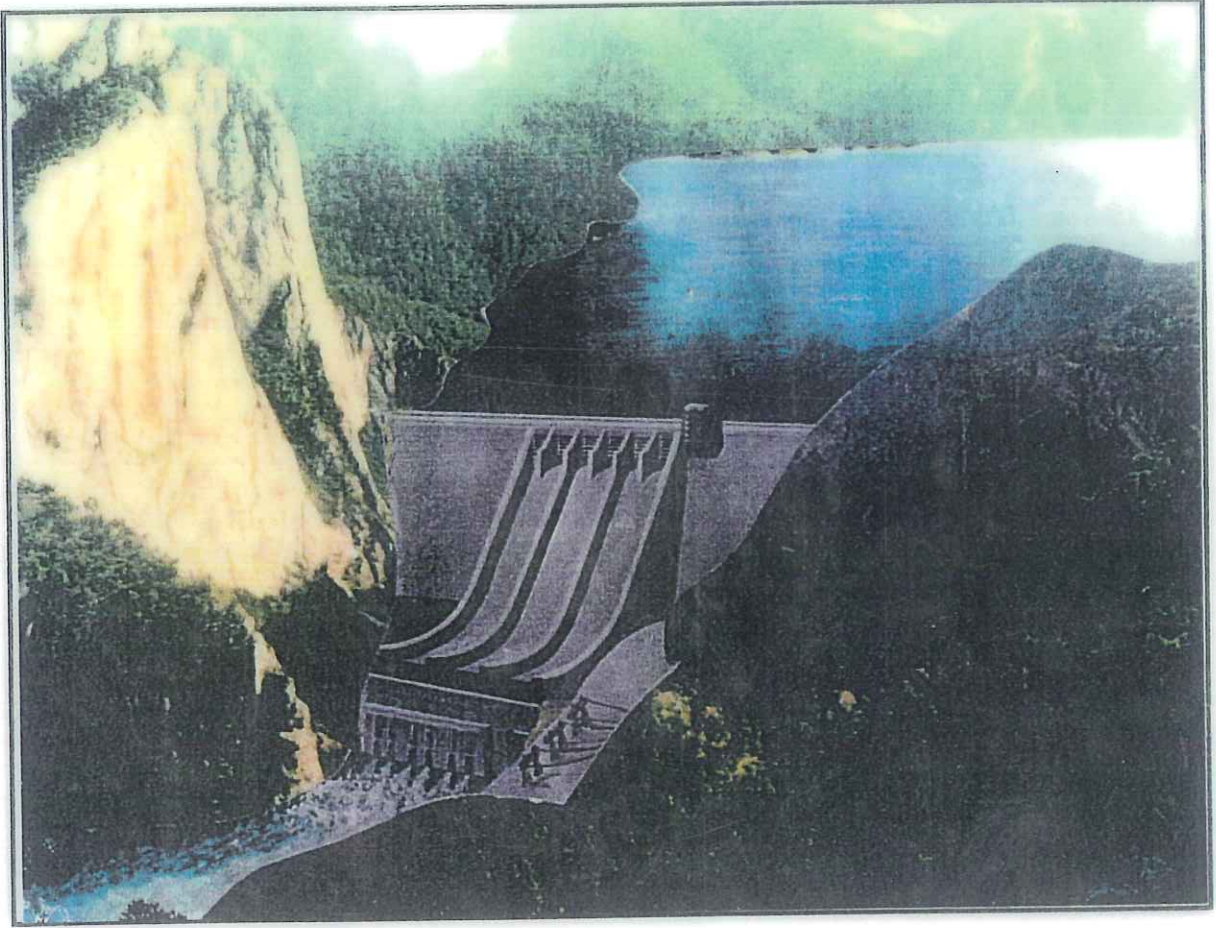


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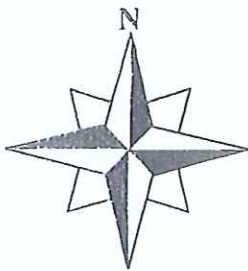
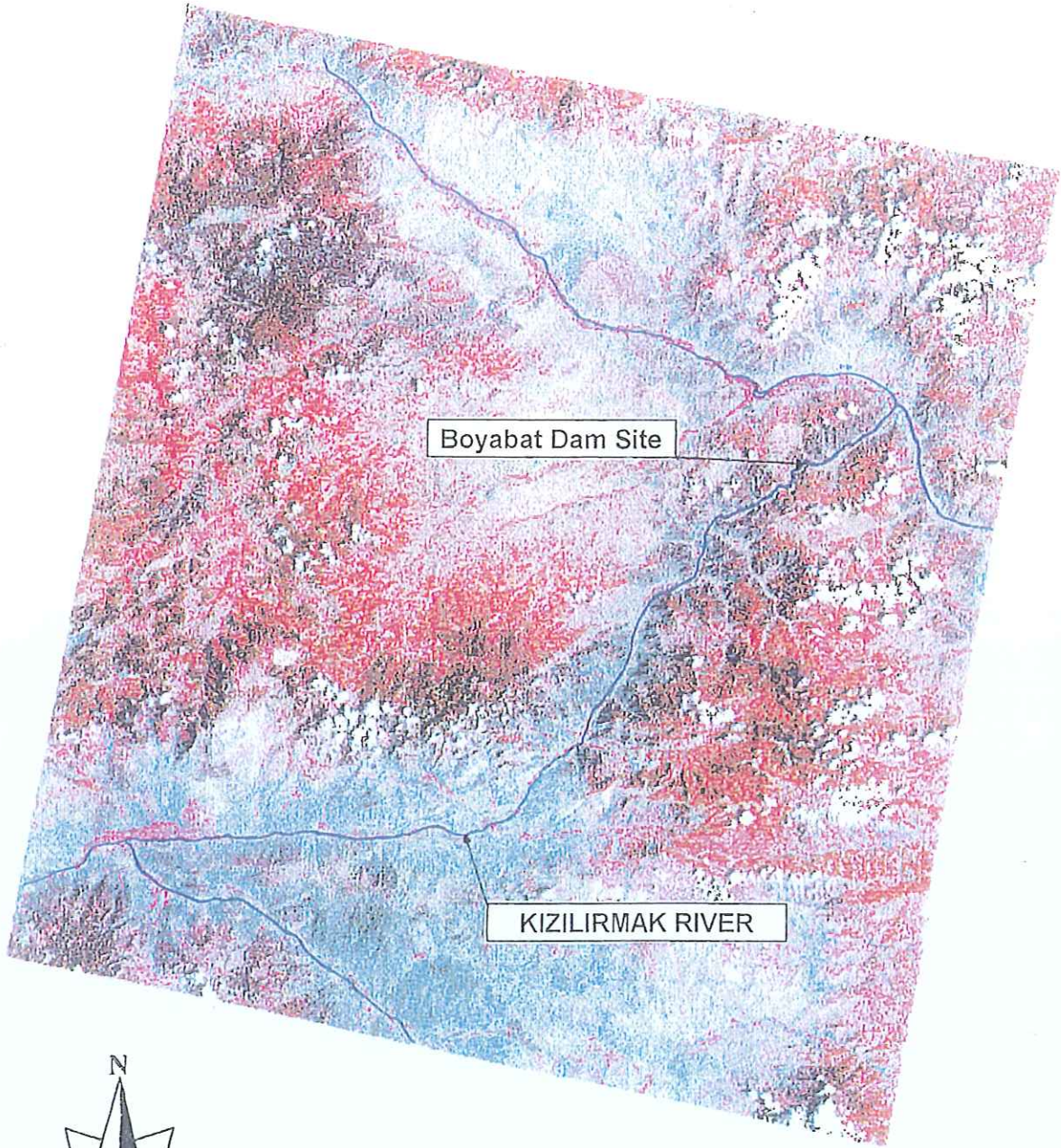


BOYABAT DAM AND HYDROELECTRIC POWER PLANT

ENVIRONMENTAL ASSESSMENT REPORT

EXECUTIVE SUMMARY

1998
ANKARA, TURKEY



BOYABAT PROJECT AREA FROM SPACE

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LIST OF ABBREVIATIONS

ASL	Above Sea Level
BERN	Convention of Bern
BOD	Biological Oxygen Demand
BOT	Built Operate Transfer Model
BTEP	Thousand Tons of Petroleum Equivalent
COD	Chemical Oxygen Demand
dB	Decibels
DMI	State Meteorological Institute
DOGUS	DOGUS Holding A.S. and DOGUS Insaat ve Ticaret A.S. Consortium
DPT	State Planning Organization
DSI	General Directorate of State Hydraulic Works
E.R.L.	European Red List
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EIE	Turkish Electricity Works Survey Administration
EIS	Environmental Impact Statement
ENCON	ENCON Environmental Consultancy Co.
EPDC	Electric Power Development Company
EXIMBANK	American Export Import Bank
FAO	United Nations Food and Agriculture Organization
GDP	Gross Domestic Product
GNP	Gross National Product
GWh	Giga Watt Hour
HARZA	HARZA Consulting Engineers And Scientists
HPP	Hydroelectric Power Plant
IFC	International Finance Corporation
JICA	Japan International Cooperation Agency
KEP	Kilogram Petroleum Equivalent

KHGM	General Directorate For Rural Affairs
kWh	Kilo Watt Hour
Leq	Noise Level Equivalent
MAFRA	Ministry Of Agriculture, Forestry And Rural Affairs
MCE	Maximum Credible Earthquake
MOH	Ministry Of Health
MTA	General Directorate of Mining Exploration And Research
MW	Mega Watt
MWL	Maximum Water Level
NGO	Non-Governmental Organization
OECD	Organization of Economic Cooperation and Development
OPIC	Overseas Private Investment Corporation
SRF	Special Resettlement Fund
SS	Suspended Solids
TDS	Total Dissolved Solids
TEAS	Turkish Electricity Authority
TKN	Total Kjeldahl Nitrogen
TOE	Tons Of Oil Equivalent
TPE	Total Petroleum Equivalent
TPP	Thermal Power Plant
USBR	United States Bureau of Reclamation

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EXECUTIVE SUMMARY

**BOYABAT DAM AND HYDROELECTRIC POWER PLANT
ENVIRONMENTAL ASSESSMENT**

EXECUTIVE SUMMARY

I. INTRODUCTION

Turkey is a rapidly developing and industrializing country, in need of reliable, inexpensive and high quality energy. In the last 5 years, energy production has increased by an average of 3.2% annually and in 1994, energy production was 32.6 million tons of oil equivalent (TOE). As of the end of 1994, total (primary) energy consumption was 64 million tons of oil equivalent (Seventh Five Year Development Plan, 1995). Turkey, with high potential of hydropower (estimated as 400 billion kWh, of which 122 billion kWh is feasible), was only producing 35.5 billion kWh by the end of 1995. Installed capacity of hydroelectric power plants reached 9,682 MW in 1995 and hydroelectric power plants had a share of 46.2% in the installed capacity. Thus, as of the end of 1995, only 29% of the economic hydraulic potential had been utilized. When an average annual energy demand increase of 8.5% is taken into account, the development of renewable resources, such as hydropower, is especially important, as it is throughout the world.

In accordance with the energy policies of the Turkish Republic, the Ministry of Energy and Natural Resources decided to build the Boyabat Dam and Hydroelectric Power Plant by the Build-Operate-Transfer (BOT) model as a unit of the Lower Kizilirmak Development Project. The Boyabat Project located 123 river kilometers from the mouth of the Kizilirmak River where it enters the Black Sea, was incorporated into the plans of State Hydraulic Works (DSI) in the late 1970's. Japan International Cooperation Agency (JICA) prepared a feasibility report for the project in 1979. To date, DSI has built the access roads (on the left side of the river) to the dam site, two diversion tunnels (on the right bank), a bridge across the river to the upstream end of the diversion tunnels, and camp facilities.

In order to select the company to develop the Boyabat Project, a tender process was initiated on June 21, 1995, in accordance with the BOT laws. Thirteen companies had applied for developing the Boyabat Project and four of them were prequalified as candidates. The previous studies carried out for the Boyabat Project were reviewed and the revised feasibility reports were prepared by these candidates. Then, the revised feasibility reports of these four competitors were evaluated, and DOGUS Holding A.S. and DOGUS Insaat ve Ticaret A.S. Consortium (DOGUS) was selected as the developer for the Boyabat Project on September 16, 1995.

Design documents, that had been prepared in January 1987, were reviewed by DOGUS, the company developing the Project, and adopted for use in implementation and construction as the developing company of the Project. The Boyabat Project consists of a concrete gravity dam (with a height of 150 m from riverbed), 510-MW semi-underground type power house and the associated switchyard site. DOGUS will take an equity stake in the concession company as a major partner which will be established to build, own and operate the Project. The name of this concession company is going to be Boyabat Electricity Production and Trade Company.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The Boyabat Dam and Hydroelectric Power Plant project was reviewed according to the World Bank Operational Directive (O.D.) 4.01. This Environmental Assessment (EA) Report has been prepared in accordance with the guidelines on environmental assessment, O.D. 4.01 Annex A (Environmental Assessment) and Annex B (a guideline for Environmental Policy for Dam and Reservoir Projects), and in agreement with the International Finance Corporation's (IFC) "Guidance for Preparation of Environmental Assessment". Consultation with, and disclosure of, information to affected groups and Non-Governmental Organizations (NGOs), as well as governmental agencies, were performed. In the preparation of this report, the Environmental Assessment Source Book, published in the World Bank's Technical Papers Series, was used for guidance throughout the environmental assessment process.

According to International Finance Corporation's (IFC) document on the World Bank Environmental Policy, April 17, 1994, the World Bank environmental policies are applicable to all projects using IFC financing. It is expected that all of the other Project Lenders will generally apply the same guidelines as the World Bank and the IFC.

This report was also submitted to the Ministry of Environment of the Republic of Turkey, in order to provide its review via Turkish authorities and got the approval of the Ministry of Environment. Actually, since this project had been started prior to the promulgation of the Environmental Impact Assessment Regulation, according to provisional Article 1, it is not subject to the preparation of an Environmental Impact Statement (EIS).

In Turkey, the Ministry of Environment is the responsible organization for the control and implementation policies adopted for protection and conservation of the environment, and for sustainable development and management of natural resources. The Turkish Environment Law No. 2872, which came into force in 1983, handles environmental issues on a very broad scope. In line with Environment Law, several regulations have been published since 1983, such as Air Pollution Control Regulation, Water Pollution Control Regulation, Solid Waste Control Regulation, Environmental Impact Assessment Regulation, Harmful Chemical Substances and Products Control Regulation, and Hazardous Waste Control Regulation.

During the preparation of this report, the regulations stated above were all adhered to. In addition, persons whose property would be expropriated for a proposed project are entitled to request the Turkish Government to resettle them under Law No. 2510 of June 21 1934 and its subsequent amendments, and these are considered in the EA Report as well. Furthermore, Boyabat Project would be realized by the Build-Operate and Transfer (BOT) model, so the laws and procedures related to this model are also considered in the preparation for EA Report.

In Turkey BOT program was first introduced in 1980's and some projects had been initialized. However, the legal basis was not sufficient, so in order to get over some legal obstacles and insufficient applications, and to strengthen the legal basis, two BOT Laws (No. 3996 and 4047) and one Decree (No. 94/5907) were put into force in 1994. Law 4047 excluded power projects from the scope of Law No. 3996, subjecting them to Law No 3096 of December 4, 1984, which allows private sector companies to conduct business in the generation, distribution and trade of electricity.

III. PROJECT PURPOSE

The social and economic development of Turkey is proceeding in parallel with industrial development. Turkey needs to exploit domestic energy sources in order to attain its development goals and activities. Hydroelectric energy, which is a renewable energy resource, is one of the country's most important domestic energy sources. The purpose of Boyabat project fits very well in this context, as it aims at the generation of reliable, inexpensive and high quality energy.

Total primary energy consumption reached 64 million tons of oil equivalent (TOE) at the end of 1994. Oil products constitute the largest item, with 40 percent share in the sector, which has approximately 49 percent dependency on imported resources. Installed capacity and production capacity of electricity power plants reached 20,857 MW and 101 billion kWh, respectively, at the end of 1994. In 1995, installed capacity reached 20,952 MW and electricity production 86,247 GWh. The reserve margin of the total energy production was 4 % in 1996, and energy shortage is expected in the near future. Therefore, it is crucial to ensure the continuity of investments to meet electricity demand continuously and safely in the next few years.

In the framework of expectations of economic growth and population increase, it is estimated that total energy demand will increase by an average of 5.3 percent annually and will reach 85.8 million TOE in 2000. Electricity demand in Turkey since 1989 and forecasted needs for 2000 and 2010 are given in Table 1.

Table 1. Electricity Demand in Turkey (Seventh Five-Year Development Plan, DPT, 1995)

	Unit	1989	1994	1995	2000	2010
Electricity Demand	Billion kWh	52.602	77.717	83.600	120-130	240-270

The Boyabat Project would provide 510 MW (approximately 4.2%) of the total installed hydropower plant capacity of 12,160 MW expected for 2000. In accordance with this estimation, Boyabat Dam and Hydroelectric Power Plant, with its large installed capacity and high annual electricity generation, will be an important facility in achieving Turkish long term energy goals.

IV. PROJECT DESCRIPTION

Construction of the Boyabat Project was started in 1987 by DSI and a left bank access road to the dam site, including a bridge to the right bank, camp facilities, diversion tunnels and access tunnels to the crest were completed. The project (Figure 1) proposed by DOGUS comprises a concrete gravity dam and appurtenant control structures (spillways, bottom outlet, and diversion tunnels), the penstock, a semi-underground power station and the associated switchyard. The dam and reservoir are located along a 60-km segment of the Kizilirmak River, with the dam in a narrow, steep-sided canyon.

IV.1. Dam and Reservoir

The dam is a concrete gravity type dam having a crest elevation of 335 m above sea level (ASL). It is 150 m high from the river bed, with river bed elevation of 185 m, and 195 m high from foundation. The spillway, which will be positioned on the dam body consists of six radial gates with center overflow and a total discharge capacity of 9,300 m³/sec. Two diversion tunnels are already built, with equal diameters of 8.5 m and a horseshoe section. Tunnel 1 has a length of 1,015 m, while the length of Tunnel 2 is 966 m. The full supply level in the reservoir is 330 m ASL, while the minimum water level is 305 m ASL during normal operation. The gross storage capacity is $3,557 \times 10^6 \text{ m}^3$ while the effective storage capacity is $1,410 \times 10^6 \text{ m}^3$. The reservoir area at maximum reservoir level (330 m) will be 65.4 km².

IV.2. Power Plant, Switchyard and the Transmission Line

The semi-underground power plant, which will be located immediately below the spillway, will be fitted with three vertical-shaft Francis-type turbines, directly connected to generators with ratings of 152 MW and 176 MW, corresponding to minimum and maximum head, respectively. The switchyard will be built on the left bank, approximately 500 m away from the dam axis, at an elevation of 570 m (Figure 2).

From the switchyard, the electricity will be transmitted to the interconnected system and to the western part of Turkey, where the electricity requirement is high. Power transmission lines to be used to transmit the electricity will be planned and built by Turkish Electricity Authority (TEAS). A transmission line, having a length of approximately 60 km, will be built between the Boyabat and Altinkaya switchyards. The capacity of this line is planned to be 380 kV. During the design phase of the transmission line, the environmental impact assessment process defined by the Environmental Impact Assessment regulation of the Turkish Republic Ministry of Environment will be followed. The environmental impact assessment report will be prepared by the Turkish Electricity Authority, after the alternative routes for the transmission line have been evaluated.

IV.3. Borrow and Disposal Areas

Various surveys undertaken at the dam site have shown that the geology will provide sufficient quantities of construction materials. The construction materials location map is presented in Figure 3. Cement required for concrete will be provided from the Corum Cement Plant, at a distance of 200 km. The disposal areas for excavated materials are 1 to 5 km from the dam axis (Figure 4) and approximately 2.2 million m³ material will be disposed to these sites.

IV.4. Secondary Structures

As a part of Boyabat Project, the dam access and crest roads have been built and are in operation. Switchyard and other roads will be built during the construction of the dam. The Boyabat Project camp facilities, including residence buildings, an administrative building, school, guest-house, restaurant, canteen, and other social facilities, have been built about eight kilometers downstream of the proposed dam axis, on the left-bank of the river, and are in operation. Additional facilities, including a camp for laborers, will be constructed on the left-bank, at the beginning of the crest access road and will be temporary structures.

Domestic wastes will be disposed at specially selected and prepared disposal sites, meeting the requirements of Turkish Regulations. Energy is supplied from the national electricity network (interconnected system) and from fuel-oil, the latter used for heating purposes.

IV.5. Construction Techniques and Labor Requirements

Under the BOT agreement, DOGUS proposed a tentative construction schedule, permitting the completion of construction in a maximum time period of 57 months. In the context of the continuing design studies, this construction period might be reduced. The key dates of the proposed schedule, considering the maximum time required for construction, are presented in Figure 5. The average personnel requirement during construction is approximately 750, while at peak construction periods approximately 1,200 personnel will be employed on the project, creating short-term employment opportunities for the local workforce.

IV.6. Project Costs

The total funding requirement of the Project up to commissioning, including payment for land acquisition, contingencies, transaction related fees and capitalized interest costs, is estimated to be \$650 million.

IV.7. Operation Characteristics and Labor Requirements

The Boyabat Power Plant will have three units, each equipped with a vertical axis Francis-type turbine. The stored and regulated water will be used for power generation of a maximum output of 510 MW and annual energy production of 1,468 GWh, with a

maximum available discharge of 471 m³/sec and an effective head of 125.5 m. Annual average inflow at the dam site is 182.0 m³/sec, with 67% of the annual inflow concentrated in the period from March to June. The starting date of water impounding and the respective schedule for taking units one, two and three into operation are discussed in Section IV.5. As can be seen from this discussion, the presented schedule is tentative and considers the maximum construction time. Thus, the starting date and period of impounding may change during the course of the design studies.

Hydraulic data for Project are presented in Figure 6. Figure 7 shows the estimated flood flow (with relative frequencies) and the monthly average runoff at the Boyabat Dam Site. In case of flood flow, the operational characteristics of the spillway can be perceived from the spillway discharge curve given in Figure 8.

During operation phase, approximately 100-120 persons are needed to run the power plant and the dam, and around 50-60 of these will be skilled workers.

V. BASELINE DATA

The studies on the baseline data are divided into three categories: physical biological, and socio-economic resources. The study areas for the categories vary, as the impacts of the project on these resources would extend over different geographic areas. For the physical environment, land resources, climate and water resources were examined separately. The boundaries for biological resources extend upstream almost to Kargi and downstream to the upper end of Altinkaya Reservoir (5 km from the Boyabat Dam axis). The main source of data for the socio-economic environment was a detailed field study conducted in 14 of the villages that will be affected by the Project.

V.1. Physical Environment

The project site is located five kilometers south east of Duragan, in northwest Turkey, on the Kizilirmak River, approximately 125 km inland from the Black Sea. The dam and reservoir are located along a 60 km segment of the Kizilirmak River. Topographically, the site is a narrow gorge with steep cliffs at both banks of the river, extremely rugged terrain peculiar to limestone, and the slope gradients are 70 to 80°.

V.1.1. Geology

The geologic setting is characterized by microcrystallized limestone and investigations concluded that this geology will provide more than adequate support as bedrock for the dam. In addition, no problems with regard to the watertightness of the reservoir are expected. There are no landslides in the vicinity of the reservoir that would create any serious problems.

The most important fault in the vicinity of site is the F-5 fault, but it would not create any problems with regard to structural stability and lies outside the stress field of the dam. The site is immediately north of the North Anatolian Fault Zone, in an area of second

degree seismic risk. The strongest earthquake recorded in that area had a magnitude of 5.9 on the Richter scale and took place in 1942. Its epicenter was 64.5 km from the site in a SSW direction.

Soils in the project area are predominantly alluvium and colluvium at the base of Kizilirmak valley and brown forest soils at higher elevations. In general, the vicinity of the project area is classified as stony. The land use map of the project area, showing various uses, given in Figure 9. The classified image of the region is given in Figure 10.

V.1.2. Climatology

The climate of the Kizilirmak River Basin is influenced by Central Anatolian and Black Sea climatic conditions. The annual precipitation is 400 mm and the annual mean temperature is 13°C at the project site. The Project is in a dry region, so a fair amount of evaporation from the reservoir may be considered to take place. Yearly evaporation from Boyabat Reservoir is expected as approximately 640 mm.

V.1.3. Hydrology and Water Quality

The Kizilirmak River is the largest river in Turkey that flows into the Black Sea. The annual run-off at the project site was estimated as $4,810 \times 10^6 \text{ m}^3$, and the specific run-off per 100 km^2 was calculated as $0.24 \text{ m}^3/\text{sec}$.

The data describing the baseline water quality conditions in the lower Kizilirmak River were obtained from published reports by DSI and the Turkish Electricity Works Survey Administration (EIE). Additional data for the Boyabat Project area were obtained from studies by Ankara University. To supplement this information, water quality parameters having importance for aquatic life were measured at the aquatic ecology sampling stations during the field studies performed in 1997. The locations of the water quality sampling stations, of DSI, EIE and Ankara University, are shown on the map given in Figure 11. The aquatic ecology sampling stations are given in Figure 12.

The existing water quality of the river was then evaluated utilizing Turkish Inland Water Quality Standards, derived from Turkish Inland Water Resources Regulations. The water quality data consist of the following parameters; temperature, pH, dissolved oxygen (DO), biological oxygen demand (BOD), turbidity, conductivity, sodium, potassium, hardness, carbonates, orto-phosphate, ammonia nitrogen, nitrate, nitrite, chlorides, sulfate, boron, total and fecal coliform, chemical oxygen demand (COD), total dissolved solids (TDS), suspended solids (SS), oil and grease, phenols and metals, such as Mn, Mg, Fe, Zn, Cu, Cr.

The Kizilirmak River water is slightly alkaline and quite hard. The annual average temperature is 13°C. Dissolved oxygen does not drop below 6.0 mg/L and the maximum value is 14.2 mg/L (indicating super saturation). The nitrogen, sulfate and

chloride levels in Kizilirmak would have no adverse effects on aquatic life. There is no significant hazard to aquatic life and human health because of the level of suspended solids.

According to the Turkish Inland Water Quality Standards, the Kizilirmak River in the project area is classified as Class III, since some of the parameters are in that class. Class III waters maybe used, following appropriate treatment, to supply water for industries, except the food and textile industries. However, the majority of the parameters satisfy the limits for Class I and II waters. In addition, groundwater in the region falls into Class II category and it is in contact with the river water to some extent at present conditions.

V.2. Biological Environment

Studies of biological resources within the project area and the potential impact area, were carried out in 1996 and 1997. Figure 12 shows the locations of the sampling stations in the Project area.

V.2.1. Flora and Vegetation

The project area is a transition zone between Iranian-Turanian and European-Siberian floristic regions. The field studies indicated 542 plant species in the area, belonging to 90 families. Their distribution according to the phytogeographic region is presented in Table 2.

Table 2. Phytogeographic Distribution of Floristic Species in the Study Area

Phytogeographic region	Number of species	Percent (%)
Iranian-Turanian	57	10.5
Mediterranean	64	11.8
European-Siberian	48	8.8
Euxine	17	3.1
Other (Wide or unknown)	356	65.7
Total	542	100.0

Among these 542 species, 28 (5.1%) are endemic to Turkey. These endemics are classified as "vulnerable," "rare," "indeterminate," "out of danger" and "not threatened," in accordance with Ekim et al. (1988). Of these endemics, 27 (96.4 %) are wide spread in Turkey and are categorized as "not threatened" (nt), in accordance with Ekim et al. (1988). Only one, the Mouse-ear, is in the R (rare) category. The elevational distribution the of Mouse-ear is between 300 to 900 m.

The land to be flooded by the reservoir consists of agricultural land (about 40%) and a rocky terrain together with degraded forest. There is no significant wetland in the proposed reservoir area or near the dam site. The total area of the wetlands in the

study area is less than 10 ha, probably because of the steep topography and local agricultural practices. There are some reforestation efforts in the vicinity of the project area, but they are located outside the impact zone of the project.

Plant communities in the study area can be grouped as, communities in the valley bed, on valley slopes, on steep rocky areas (valley shoulders), and on the hills. Rice fields cover the valley bed near the river. In addition to these, the basal flora consists of tamarisk, plane tree and willows. Reddish pine is dominant on the slopes up to an elevation of about 500 m. The floristic composition of the forests on valley shoulders and hills constitute of juniper and some broad-leaved species, such as common hornbeam, oak, elm, walnut, rowan and mulberry in addition to reddish pine.

V.2.2. Terrestrial Fauna

Mammals in the area were identified by field observation and by interviewing local people. Seventeen species were determined to be in the area, three of which, golden jackal, gray wolf, and badger, were not observed by the field team. The rest were identified by direct observation or from sign (scats, tracks, etc.). Seven of the 17 species are listed as "protected fauna species" under the Bern Convention and two are listed as "strictly protected." None are on the Red List.

A total of 86 bird species have been identified in the study area, which corresponds to 20 % of the 426 bird species identified to date in Turkey. Sixty (69 %) of the birds identified in the study area are listed as strictly protected fauna species in Appendix 2 of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) of 1997. Eighteen (21 %) species are included in the list of protected fauna species, Appendix 3 of the Bern Convention, which covers the species not included in Appendix 2 of the Bern Convention with a few exceptions. Although a high majority of the observed bird species are listed as protected species in the appendices of the Bern Convention, none of these species is included in any category of the European Red List (same as the Red List developed by the IUCN and published by the World Conservation Center in 1998).

Reptiles identified in the study area generally prefer stony areas and shrubs as habitat, and some also live in gardens, fields, and meadows close to water. Six reptile species were seen in the field, three of which are listed in Appendix 2 and the rest in Appendix 3 of the Bern Convention. The spur-thighed tortoise, which is common in the area, is the only species on the Red List, which classifies it as "threatened."

There are two amphibian species determined in the project area, namely, green toad and marsh frog. Green toad is listed in Appendix 2 of the Bern Convention and marsh frog is listed in Appendix 3. Both species are abundant in the area.

V.2.3. Aquatic Biota

V.2.3.1. Aquatic Flora Communities

The aquatic studies revealed a rich algal community. Green algae (Chlorophyta) constituted 50% of the species, but the blue-green algae (Cyanophyta) were more abundant.

Diatoms displayed a considerable diversity, with 117 diatom species identified in the river. A high diversity of diatom species in a water body indicates a fairly high water quality. Thus, the high species diversity observed in Kizilirmak and the abundance and distribution of the pollution sensitive species indicate that the Kizilirmak waters in the project area are of good quality.

V.2.3.2. Aquatic Fauna

Eight species of freshwater fish were found in the study area, the most abundant of which was the barb (196 specimens), followed by siraz (16 specimens) and wels (9). Barb were found at all sampling stations throughout the project area and accounted for about 83% of the total number of fish captured. Most fish (approximately 30% of the total catch) were captured at the sampling Station 5, about 26 km upstream of the Boyabat Dam site.

All of these fish species are common in Turkey and can be observed in most catchment areas, rivers and lakes throughout the country. Suitable habitat exists over a wide geographical area in Turkey.

Benthic macroinvertebrate species were also sampled at each station. The dominance and diversity of benthic species provide an indication of the quality of river water and the ecological health of the aquatic community. The benthic community in the study area was dominated by gammarids (small crustaceans that are relatively tolerant of poor water quality) at most stations. The Shannon-Weaver diversity index was used to obtain diversity values and these are relatively low.

In addition, water quality analyses were carried out at each sampling station on each date of sampling. According to the results, the water quality characteristics at the stations show high salinity and electrical conductivity (EC). EC values were between 1350-2150 μmhos at the surface and bottom at all stations. The levels of other parameters were all suitable for aquatic life (Train, 1979).

V.2.4. Species of International Concern

For half a century, the International Union for the Conservation of Nature and Natural Resources (IUCN) has identified species in need of protection, placing such species on the "European Red List." More recently, in 1979, the Council of Europe enacted the Convention of Bern, signed by 26 member countries of the Council (including Turkey), to protect species of international concern.

All plant species protected under the Convention of Bern are listed in Appendix 1, "Strictly Protected Flora Species." In providing broad protection, the Convention of Bern divides the faunal species of concern into three categories. Appendix 2 lists animals that are to be "strictly protected." Signatory nations agree to prohibit all forms of capture, keeping, and deliberate killing, destruction to breeding or resting areas, disturbance during breeding, rearing, or hibernation, destruction or taking of eggs, and international trade in live or dead animals or their parts (Council of Europe 1979). Appendix 2 species may or may not be threatened or endangered in the designation of the IUCN (Council of Europe 1996). The second category of Bern species is Appendix 3, "protected." These species are to be provided legislative and administrative protection to ensure that their populations are maintained. The third category of species under the Bern Convention are those not afforded specific protection. Although the individual species are not listed, the Convention protects these species, nevertheless, through the habitat protection aspects of the agreement.

The European Red List, on the other hand, is intended to draw attention to species whose populations actually are at risk or in peril. The IUCN places a species on the Red List only after a study of its populations and the reasons for its decline. Some countries pay greater attention to IUCN-listed species than to Bern-listed species, since the Red List relies on more research.

The Government of Turkey has enacted legislation, in accordance with the Convention of Bern, designating areas having special environmental protection. These areas are protected by various regulations to preserve their natural, cultural, or historical values. The Boyabat project area is not classified as such an area.

No plants found in the field surveys of the project area are listed by the IUCN or the Convention of Bern. However, one, the mouse-ear is classified as "rare" according to the "List of Rare and Endemic Plants in Turkey." It is found in the project area from 300 to 900 m elevation.

A few of the mammals observed or reported in the project area are listed in Appendix 2 (the early flying bat, and the gray wolf), or Appendix 3 (the hedgehog, pygmy shrew, weasel, badger, squirrel, and vole). Although local people have reported seeing gray wolf and badger in the project area, the presence of these species was not confirmed.

Virtually all the birds of the region are protected under Appendix 2 or Appendix 3, the exceptions being eight species that are considered to be crop pests or commensals with human habitation. No IUCN-listed birds are known breed in the project area, but some could visit it on migration or in winter.

The Mediterranean spur-thighed tortoise, the Balkan green lizard, and the tessellated water snake are listed in Appendix 2 of the Bern Convention. The tortoise is considered "vulnerable" by the IUCN, due to its heavy exploitation by the international pet trade.

Among the two amphibians identified in the area green toad is included in Appendix 2 and marsh frog in Appendix 3 of the Bern Convention. Neither of these species, is on the European Red List.

Of the eight fish species collected in the study area, three are listed in Appendix 3 by the Convention of Bern, the barb, the chub mackerel and the wels. All other species are unlisted, and no fish species found during the 1997 field studies is on the European Red List.

V.3. Socio-economic Environment

Eight villages will be directly affected by the project and another 20 will be indirectly affected according to the latest studies by DSI in the area (Figure 12). The number of people that will be affected from the project is about 12,000. The cadastral surveys for most of the villages to be expropriated were completed by DSI. For this report, a field study was conducted in 14 of the villages, selected as representative of the entire 28 and of the socio-economic characteristics in the impact region.

The populations of these 14 villages (combined population of 8,180) range from 200 to 1,200 persons. Almost half (48%) of the total population consists of persons in the under 14 and over 50 age groups. There were 1,728 households in the sample and the village average household size was between 4 and 9. All villages have experienced internal (within country) emigration. A total of 1,455 households have emigrated from these 14 villages in the recent past.

There are 655 primary school students in the villages surveyed. Since primary school education is compulsory in Turkey, every village has had at least one primary school for a long time. In all villages, all households use electricity. In only four of the villages are there medical centers/midwives. In only six villages is there running water in houses. In these villages, 75% of the houses are made from wood and the remaining 25% are concrete.

In 13 of these villages, most of the men are engaged in seasonal migratory work (in factories, construction works, etc.) outside of their villages. The total land of surveyed villages is 8,255 ha and it is privately owned by the villagers. The land distribution analysis shows that small, private land ownership seems to be the most prevailing land tenure system. The economy is mainly dependent on agriculture, with the basic crops cultivated being rice, wheat, vegetables, fruits and maize.

In some of the villages, locals have a natural apprehension about the loss of land and the amount of compensation to be paid. However, in some of them, people were optimistic about the Project, anticipating the employment that might be created during the construction period.

VI. ENVIRONMENTAL IMPACTS

VI.1. Physical Environment

VI.1.1. Geology

The site has sufficiently firm geological characteristics that subsidence due to the weight of the reservoir water will not be a problem. At the dam site there are no formations that have a potential for landslides or slope collapses. Thus, it is not expected that construction activities would create any important slope stability problems and landslides.

The dam site is located in an area having a seismic risk of the second degree. Based on the recent studies the project area may be subject to earthquakes producing a maximum ground acceleration of 0.45 g with a 10,000-year return period. This value is taken as the maximum credible earthquake (MCE) and structures would be designed according to this MCE to minimize the seismic risk.

No fault that would create a problem in the stability of the dam exists in the project site. There is no active fault system within the stress field of the dam. A catastrophic failure of the Boyabat Dam, therefore, is highly unlikely. In addition, with the dam carefully monitored, any failure would be foreseen well in advance.

On average, $30.2 \times 10^6 \text{ m}^3$ sediment will settle in Boyabat Reservoir yearly. When it is considered that the minimum reservoir volume of Boyabat Dam is $2,147 \times 10^6 \text{ m}^3$, the annual deposition of sediment will amount to only 1.4 % of the minimum reservoir volume. At the end of the economic life of the dam, which is considered as 50 years, 70 % of the minimum reservoir volume will be filled by sediment. Thus, there will not be a problem due to sedimentation.

VI.1.2. Hydrology

Large dam projects have various and extended impacts on river hydrology, affecting water quality and seasonal flow pattern. These impacts are seen both upstream and downstream of the dam, and occur during construction and operation of a project. The impacts are important from a watershed perspective, as well as the immediate project area.

VI.1.2.1. Water Quality

VI.1.2.1.1. Impacts of Project Construction

During construction of a dam, turbidity and sedimentation in the waters downstream of the site will unavoidably increase due to in-river construction activities. Additionally, excavation of the foundation, processing of aggregate, and batching of concrete all result in turbid or sediment laden wastewater. In the construction phase of Boyabat Dam, clarification and neutralization will be applied to prevent pollution.

VI.1.2.1.2. Impacts of Impoundment

When a free flowing stream is impounded, a number of physical, chemical and biological phenomena occur as a result of the change from a flowing water environment to an essentially standing or lake water environment. One of the most significant changes is in water temperature or heat distribution within the impoundment. This factor largely determines what takes place biologically, chemically and physically in the reservoir (Smalley, 1978).

Altinkaya Reservoir is located close to the Boyabat Dam site, so it can be expected that the future Boyabat Reservoir will have similar characteristics. Therefore, Altinkaya was studied for the determination of possible impacts of Boyabat Project on water quality.

VI.1.2.1.3. Altinkaya Reservoir

According to the Turkish Inland Water Standards, Altinkaya Reservoir must be considered Class III water because the values of some of its chemical constituents fall in that category. This class of water is designated to be used only for industrial purposes, although after proper treatment it can also be used for some other purposes, such as irrigation. Here it should be pointed out that the waters of Altinkaya are Class II for most parameters, exceptions being sulfate and sodium. However, the measured levels of sodium and sulfate do not have appreciable adverse effects on aquatic life. Moreover, Altinkaya waters can be utilized for the irrigation of most crops.

VI.1.2.1.4. Eutrophication

Incoming phosphorus, nitrogen, and carbon are the primary water quality parameters affecting eutrophication. The nitrogen and phosphorous values measured in Altinkaya Reservoir are very low. Phosphorus is generally the parameter controlling the level of eutrophication and the values measured in Altinkaya Reservoir, which exhibits oligotrophic conditions, are very low, being 0.02 mg PO_4/L on the average. These phosphorus levels, and the existing nitrogen levels, indicate that eutrophication is not a problem in Altinkaya, and will not likely be a problem in the Boyabat Reservoir. It is also likely that turbidity and BOD in the Boyabat Reservoir (usually) will not be high. This conclusion is supported by the secchi disk and dissolved oxygen measurements in Altinkaya Reservoir. However, the primary productivity of the Boyabat Reservoir is expected to be higher than the river, and this would enhance fish production.

VI.1.2.1.5. Reservoir Thermal Stratification

Reservoirs result in many improvements in the water quality for most water uses. Nevertheless, the chemistry and the aquatic biota of impounded water, whether isothermal or stratified, inevitably will differ from that of the original free flowing stream. If heat is not distributed evenly throughout a reservoir, but rather, heating occurs to

limited depths, density differences occur, leading to thermal stratification (the dividing of the reservoir into horizontal layers of differing temperature and density).

Profiles in the summer season indicate that there is strong stratification in Altinkaya Reservoir. It can easily be observed that, in summer, the water temperature decreases from 20 °C (top layer) to 8 °C at 40 m depth. Since water at the Altinkaya Dam is withdrawn at about 30 m depth, there is a coldwater release that supports a trout fishery in Derbent Reservoir. As such, the Boyabat Project, which will have similar characteristics, can be expected to result in similar downstream effects.

Cold bottom water released from a stratified impoundment affects the aquatic flora and fauna downstream from the dam. If the temperature of the water below the dam is decreased, some fish species avoid that portion and migrate to other reaches. These species may be replaced by coldwater species. The temperature of the released water by the Boyabat Project will probably be similar to that of the water released from Altinkaya Dam. Thus, the water temperature will be beneficial for trout and other cold water fish species. Warmwater species presently living downstream of the Boyabat Project can be expected to continue to survive in the Gokirmak River.

VI.1.2.1.6. Reservoir Dissolved Oxygen Vertical Profiles

Stratification of a reservoir indirectly leads to changes in other water quality parameters, especially dissolved oxygen. Thermal stratification creates a density barrier; thus the deeper, waters of hypolimnion can become depleted in DO. The epilimnion (surface waters) maintains high DO levels through surface reaeration and photosynthetic activity; DO often becomes supersaturated during the day, due to photosynthesis.

The vertical profiles of DO in Altinkaya Reservoir show only slight variation with depth. DO concentration with respect to depth was almost constant in March and October, 1988. The maximum DO concentrations were observed at the water surface (as expected) and were found to be 12 mg/L in March and 7 mg/L in October. At the intake depth, the minimum DO concentration recorded was 6.1 mg/L, indicating about 70 percent saturation. The DO concentrations in June and August did not drop below 9 mg/L and 6.1 mg/L, respectively, at any depth. Therefore, it can be concluded that there is no dissolved oxygen problem at any depth in the reservoir. Similar characteristics can be expected in the future Boyabat Reservoir.

VI.1.2.2. Evaporative Loss and Effects of Downstream Releases on Water Quantity and Quality

The annual evaporation estimated for Boyabat Reservoir is 640 mm; not a significant amount compared with the reservoir volume. If Altinkaya Reservoir should fill, the Boyabat Project will be located about 3 km upstream. As a result, the downstream effects on aquatic life and water quality by the project would be limited. Thermally stratified reservoirs can have a significant effect on the quality of the water discharged. When such reservoirs have low-level intakes, low DO and low temperature waters are

released, as in Altinkaya. However, for the most part, it is anticipated that the Boyabat Project will supply better quality water to Altinkaya than it receives under existing conditions. Nonetheless, the present seasonal flow patterns in the section of the river between the Altinkaya Reservoir and the Boyabat Dam will change to reflect the generation pattern at the Boyabat Project.

VI.1.2.3. Sanitary Risk

According to the information obtained from The Ministry of Health, only malaria is seen in Turkey as a parasitic disease. The Project area is located in the Middle Black Sea Region, where, due to the climate, malaria does not occur. In addition, the Project reservoir would not be used as a drinking water source, so no increases in enteric bacterial diseases are expected as a result of the impoundment.

VI.1.2.4. Groundwater and Springs

The impoundment of water in the reservoir will probably result in some rise in the water table level near the reservoir. No significant leakage from the reservoir is expected because of the characteristics of the geological formation (limestone) in the area. The baseline data show that the groundwater and the river do not have any important water quality differences. The reservoir will not have any significant impact on the water quality of the groundwater aquifer.

VI.2. Biological Environment

Dam and hydroelectric power projects have many direct and indirect effects, as well as positive and negative effects on the biological environment. By the construction of the dam, the existing riverine and terrestrial habitats are transformed into a lentic (lake) ecosystem. This artificial water body will have a maximum capacity of about $3,557 \times 10^6 \text{ m}^3$, a length of 60 km, and an area of 6,540 ha.

Depending on local topographic conditions, the reservoir shoreline, and the annual drawdown in the reservoir, various types of habitat will be formed. The annual fluctuation in the reservoir surface elevation is expected to be less than 3 m, but this is sufficient to exert a considerable effect on the littoral ecosystem, depending on how long the surface remains at the maximum and minimum levels. The development of water dependent vegetation along the shoreline, which may occur in hollows and depressions, will be beneficial for waterbirds and some mammals. For wildlife, this water dependent vegetation will serve as a nesting place and feeding ground.

Terrestrial plants vary in their tolerance to flooding, so although many plants will be unable to survive near the reservoir edge, others, such as willows, are able to tolerate alternate periods of flooding and drying. No plant species currently exist solely below the maximum water elevation of the future reservoir, so no plant species in the area would be completely lost. The only rare plant, Mouse-ear, found in the field survey, occurs mostly above elevation 350 m. A number of other species will be substantially affected by the impoundment, but all of these are widespread.

Access roads and the diversion tunnels of the Boyabat Project are already constructed, imposing minor effects on the forests in the area. During dam construction, there can also be negative impacts on the wildlife, as existing habitat in and around the dam site would be degraded to some extent. Most medium to large mammals and birds will leave the area, due to the noise, dust, and human activity of construction.

Although the proposed reservoir will be very narrow in most places, it will be an obstruction for terrestrial animals to cross to the other side of the valley. However, since these are casual movements, the negative impact of the future reservoir on some members of fauna in this respect will not be significant. At present, there are a few footbridges permitting people, wild and domestic animals to cross the river.

VI.3. Socio-Economic Environment

Eight villages will be directly affected by the project and another 20 will be indirectly affected. The number of people that will be affected and/or displaced by the Project is approximately 12,000.

VI.3.1. Impact on Population

Young men who spend most of the year away from their villages as seasonal workers and young women will be least affected adversely by the Project. Married young men living regularly in the village, sharing the same houses with their fathers will be adversely affected from the Project, as will the elderly. Children and young people of school age will have a significant chance to benefit from the education opportunities if they settle in the towns and provincial centers.

VI.3.2. Impact on Employment

As the level of education is very low, villagers opting for urban resettlement will have difficulties finding jobs. People whose houses and/or land would not be submerged may find employment at the construction site and thus benefit from the Project.

VI.3.3. Impact on Social Interactions

The separation of villagers from each other, due to their making different resettlement choices (expropriation, urban or rural resettlement), will weaken the solidarity and dependency ties which have been beneficial in cases of poverty, sickness, and indebtedness. Families that decide to move to cities usually plan to move into the urban houses of their sons and daughters and this move may affect the receiving family in various ways.

VI.3.4. Impact on Standard of Living and Poverty

In the villages that will be affected by the Project, the subsistence economy (in which the family provides a large proportion of its own food, fuel and other necessities) protects people from extreme hardship. In selecting urban resettlement, villagers opt to sacrifice this cushion on the expectation of achieving better living conditions in the city. This depends on the head-of-household finding a job that pays enough to make up for the lost labor of children and elderly family members.

The present standard of living in the villages is maintained through the participation of all members of the families in the agricultural activities. In the case of urban resettlement, the likelihood of finding employment for these groups would be quite weak. In addition, the construction of the Project will have different impacts on the villagers, depending on whether they are rich or poor. Rich villagers do not want to leave their villages as they are the ones whose land losses would be the highest. However, it is equally plausible that they will also have the highest opportunities of setting up a new business with their compensation. On the other hand, poor villagers may benefit from the Project, providing that their needs are met. If resettled in productive areas and given sufficient land, the poor villagers will benefit from the Project.

VI.3.5. Impact on People Living in the Project Area

The villagers that will be affected by the project may either prefer compensation for expropriation or resettlement. However, there is a group who want to stay in their villages despite losing part of their land. This group will face economic difficulties, but they may obtain jobs in the construction phase of the Project. The villagers who opt for compensation for expropriation may face problems regarding the determination of real value of their property. In the case of payment of the compensation in installments, their attempt to set up businesses or to buy houses would be delayed. There are two possible types of resettlement; rural and urban resettlement. Relevant and essential capital items are provided, such as land, houses, and business premises, for resettlers.

VI.3.6. Impacts Created by the Project up to the Present

As mentioned in previous sections, Boyabat Project was incorporated into the plans of DSI in the late 1970's and a feasibility report was prepared by in 1979. Design documents were completed in 1987 and construction of the Boyabat Project was started in 1987 by DSI. To date, access roads to the dam site, including a bridge to the right bank, camp facilities, diversion tunnels, and access tunnels to the crest were completed.

When the studies on Boyabat Project were initiated in late 1970's, the locals in the project area were informed about the Project. With the start of the construction of project components in 1987, the villagers became aware that the Project would be realized in the near future. The State has not invested in the area's infrastructure since construction of the Boyabat Project had started, due to the fact that these villages are

located in the reservoir area. The villagers have not invested in real estate nor in forest. In addition, the emigration of the young from the area is strong and gaining momentum. The environmental specialists of the United States Bureau of Reclamation had reviewed five water resource development projects in Turkey in 1993, which include the Boyabat Project as well, pursuant to an agreement between the United Nations Food and Agriculture Organization (FAO) and the U.S. Bureau of Reclamation (USBR). In the context of this study, they had carried out interviews in Yaylacili Village on January 1993. The issues mentioned here and especially the decrease in population were also mentioned during their interviews and discussed by the authors in their reports dated April 1993 (Ellis, April 1993).

VII. ANALYSIS OF ALTERNATIVES

The Boyabat Dam and Hydroelectric Power Plant Project is one of the most important projects for electricity production in Turkey. Five different classes of alternatives are evaluated: the project type, location, size and mode of operation, and the "no action" alternative.

VII.1. Project Type

The economic and environmental impacts of the Project are evaluated by considering a standard-type fuel-oil fired thermal power plant (TPP) as an alternative facility. The benefit-cost ratio (B/C) for the Boyabat Project, taking into account the additional benefit at Altinkaya Power Station, was calculated as 1.197 in the Feasibility Report of JICA, 1979.

The comparison of potential environmental impacts of this alternative type of project with those of Boyabat can be made by considering some of the impacts of the two alternatives. Some of the adverse operational impacts of thermal power plants on environment are; air emissions, chemical discharges and spills, worker exposure to dust, from ash and coal, and to toxic gases leaking from boilers. Hydropower plants do not cause such effects. Generally, their major impacts are loss of land and wildlands and the displacement of people. Environmental impacts of a hydroelectric power plant are mostly initial, where those of a thermal power plant are mostly during operation. As a result, Boyabat HPP Project is more viable in terms of environmental impacts and economics than the alternative thermal power project.

VII.2. Project Location

In the 1979 feasibility report, a concrete gravity dam at the present axis or a fill dam five kilometers upstream were compared. Since the concrete dam was believed to be more economically viable, DSI commenced soil investigations at the selected site and the final explorations were completed in 1986.

Environmental impacts of the alternative site would be similar to those at the selected site. The embankment volume of the alternative rockfill dam would be about ten times that of Boyabat Dam, so much more material would be needed if that alternative were

selected. This would increase the impacts of the construction phase on the habitat and aquatic life. The proposed site for the project is economically much more feasible than the alternative site. When the potential environmental impacts of the two alternatives are considered, the proposed site is at least as viable as the alternative site.

VII.3. Project Development Scale

In contemplating the normal water level, four cases were compared: 310, 320, 330, and 340 m, taking such factors as submergence compensation costs, sedimentation, dam height and effective storage capacity into consideration.

When normal water levels of 320 m and 310 m, are compared with 330 m, the number of people affected by the Project would decrease from approximately 12,000 to 11,600 and 11,350, respectively, a decrease of 3.3 % at 320 m and 5.4 % at 310 m. A normal water level of 340 m, would result in a 4.0 % increase over 330 m in the number of affected people.

Normal water levels of 320 m and 310 m are not economically and technically viable, since the effective storage capacity decreases sharply, when compared to 330 m. At 320 m, the storage capacity is only 57 % of that at 330 m (which is $1,410 \times 10^6 \text{ m}^3$). Although the selected water level has more adverse effects on the environment than the lower alternatives, it is more beneficial when operational and economic aspects are taken into consideration together with the environmental aspects.

VII.4. Modes of Operation

Several operating modes have been analyzed in selecting the proposed mode for the Project; base load only, peaking, load following only, and a combination of these. Each alternative would exert its own environmental impacts and benefits, some of which could be mitigated.

The selected mode of operation will be a combination of baseload and load following, with one turbine in continuous operation and the others operating in response to system demand. The operation will be such that at least the estimated minimum flow of $24 \text{ m}^3/\text{sec}$ (seven day 10-year low flow) will be provided to the downstream section continuously. Although the selection of this mode was made largely on technical and economic grounds, it compares favorably with the others in adverse impacts. Moreover, the problem of fluctuating water levels in the river downstream of the dam is less extreme. The daily high flows during full operation may increase the scour of the channel, but will not pose a risk to local residents.

VII.5. No Action Alternative

If this project is not realized, the following alternatives and consequences may be expected:

- There would not be any adverse impacts that would be caused by the realization of the Boyabat Project. Wildlife habitat and agricultural land would not be lost. In addition, about 12,000 people, who currently live within the limits of the future reservoir area, would not be displaced.
- However, hydropower being one of the most feasible energy sources for Turkey, not developing this project may result in the establishment of alternative plants, such as coal-fired thermal power plants, or the utilization of gasoline, diesel and fuel-oil fueled individual gensets in the case of insufficient grid-based energy supply, which would be less economical and have much greater adverse environmental impacts.
- From a broader perspective, failure to make full use of the available low cost and peaking energy resources may ultimately limit social and economic development.

VIII. MITIGATION AND MONITORING PLANS

Although some impacts are unavoidable, the losses may be replaced (in-kind or out-of-kind); others can be avoided. Thus, all environmental impacts of the Boyabat Project can be acceptably mitigated.

The adverse impacts that will result during construction of the works and also due to the impoundment will be mitigated. The mitigation actions that will be undertaken with respect to the implementation schedule, responsible organization, and sources of funding are listed in Table 3.

For a mitigation plan to be active and successful, it should be monitored periodically for the results of the mitigation actions. A team should be created to carry out this task. The items to be monitored, again with respect to time, responsible organizations, and sources of funding are presented in Table 4.

Table 3. List of Mitigation Activities

Subject	Activity	Timing	Responsible Organization	Source Of Funding	Estimated Cost (US \$)
Structural integrity and watertightness of the reservoir	Review of already prepared design reports	Completed	Concession Company (CC)	Project Budget (PB)	No additional cost
	Grouting	During construction	CC	Project Budget	~25,000,000
	Install necessary instruments to monitor the dam safety	During construction	CC	Project Budget	400,000
Catastrophic failure	Develop a redundant communication system with Altinkaya	During construction	CC	Project Budget	40,000
	Establish an Emergency Action Plan	Before impounding	CC in coordination with State Hydraulic Works (DSI)	Project Budget	40,000
Erosion and sedimentation	Coordinate land management activities, such as reforestation and slope protection measures, with the related agency, such as Ministry of Forestry	During and after construction	Relevant Regional Forest Directorates	Budgets of Related Agencies (BRA)	125,000 (BRA)
	Restore the damaged land during and after construction	During and immediately after construction	CC	Project Budget	30,000
	Control fires from spills and accidents	During and after construction	Relevant Regional Forest Directorates & Fire Departments	Budgets of Fire Departments	20,000
Downstream water quantity	Minimum flow	During and after construction	CC	Project Budget	No additional cost
	Clarification of wastewater resulting from construction activities, equipment and vehicles, and domestic sources	During construction	CC	Project Budget	300,000
Air Quality	Take necessary precautions, such as watersprays, to prevent the adverse affects of dust on construction workers	During construction	CC	Project Budget	50,000

Table 3. (continued)

Subject	Activity	Timing	Responsible Organization	Source Of Funding	Estimated Cost (US \$)
Wildlife	Afforestation of the watershed area of Boyabat Reservoir to control erosion and to reduce siltation in the reservoir	As early as possible in the uplands	Relevant Regional Forest Directorates	Budgets of Related Agencies (BRA)	30,000
	Afforestation in compensation of the inundated forests	After completion of the dam	CC	Project Budget	120,000
	Preparation of landscaping project for recreational activities by nearby population	At the earliest convenience	DSI	Project Budget	30,000
	Implementation of landscaping project	After completion of the dam	DSI	Project Budget	250,000
	Habitat development plans	At the earliest convenience	Relevant Regional Forest Directorates & CC	Project Budget	25,000
	Implementation of habitat development plans	During and after construction	Relevant Regional Forest Directorates	Budget of Organization	30,000/year
	Precautions to minimize the probable adverse affects on the aquatic and terrestrial habitats.	During construction	CC	Project Budget	30,000
	Preparation of a fish management program for the reservoir	At the earliest convenience, prior to the foundation of the dam	DSI	Budget of Organization	20,000
	Implementation of the fish management program	Three years after the completion of the dam	DSI	Budget of Organization	60,000

Table 3. (continued)

Subject	Activity	Timing	Responsible Organization	Source Of Funding	Estimated Cost (US \$)
Resettlement	Expropriate land	Before impounding	Ministry of Energy and Natural Resources (MENR)	Project Budget	34,000,000
	Give assistance to affected people for resettlement	Before impounding	General Directorate of Rural Affairs	Budget of Organization & Government Loans	250,000
Employment	Employ and train local residents and provide necessary services	During and after construction	CC	Project Budget	No additional cost
Infrastructure	Access roads and bridge connecting two banks of the river	Completed	DSI	Budget of Organization	8,000,000
	Camp facilities	Completed	DSI	Budget of Organization	11,000,000
	Diversion tunnels	Completed	DSI	Budget of Organization	17,000,000
Socio-Economy	Provide opportunities for recreational and aesthetic uses of the reservoir	After impounding	Relevant Forest Directorates	Budgets of Related Agencies	15,000
	Protection of cultural and archeological resources that might be found	During construction	Ministry of Culture	Budget of Organization	Dependent on the resource
Institutional Development and Environmental Coordination	Improve environmental management measures	During and after construction	CC	Project Budget	110,000/year

Table 4. Monitoring Plan

Subject	Monitoring Activities To Be Undertaken For:	Monitoring Technique	Time Frame	Responsible Organization	Source Of Funding	Estimated Cost (US \$)
Seismicity	Measurement and reporting	Strong-motion accelerographs	Continuous	CC ¹ & MENR ²	Project Budget	100,000
Dam safety	Read dam monitoring instruments	Variable	Variable	CC	Project Budget	Included in operation cost
Dam safety	Reporting	-	Annually	CC	Project Budget	15,000/year
Catastrophic failure	Coordination plan	Participation meetings	Semiannually	CC	Project Budget	4,500/meeting
Catastrophic failure	Emergency Action Plan and the Communication System	Participation meetings and periodic tests	Biannually	CC & DSI (DSI is the coordinator)	Project Budget	15,000/2 years
Erosion and sedimentation	Measurement in the reservoir	Physical and chemical analyses	Annually	MENR & MAFRA ³	Budgets of Related Agencies	12,500/year
Erosion and sedimentation	Land management	Land management plan and reporting	Annually	MAFRA	Budget of Organization	10,000/year
Water quality	Measurement	Physical, chemical, biological sampling and analyses	Monthly	CC ¹ & DSI ²	Project Budget & Budget of Organization	40,000/year
Minimum flow	Maintaining downstream water uses and quality	Discharge / flow estimation	Daily	CC	Project Budget	No additional cost
Health	Control of water-borne diseases	Research and survey	When necessary	MOH ⁴	Budget of Organization	7,500/occasion
Wildlife	Control of plantation works in the watershed area of Boyabat Reservoir for erosion and reducing siltation in the reservoir	Surveys	Biannually	MAFRA	Budget of Organization	8,000/survey

Table 4. (continued)

Subject	Monitoring Activities To Be Undertaken For:	Monitoring Technique	Time Frame	Responsible Organization	Source Of Funding	Estimated Cost (US \$)
Wildlife	Preparation and implementation of landscaping project for the reservoir area	Participation meetings	Annually	MAFRA	Budget of Organization	4,500/year
	Planning and implementation of habitat development	Field research on fauna and habitat	Seasonally	Relevant Regional Forest Directorates & CC	Project Budget & Budget of Organization (BO)	5,000/year (PB) & 3,000/year (BO)
	Precautions to minimize the probable adverse affects on the aquatic and terrestrial habitats	Field research and reporting	During construction	CC	Project Budget	40,000/year
	Fishery management	Fish management program	Annually	DSI	Budget of Organization	4,000/year
Economy	Productivity of fisheries	Measurement and reporting	Annually	DSI	Budget of Organization	6,000/year
Resettlement	Determination of the condition of the resettled people	Research and reporting	Annually	MENR & General Directorate of Rural Affairs	Budgets of Related Agencies	8,000/year
Environmental coordination	Reporting	Report on compliance of monitoring plan	Annually	CC	Project Budget	10,000/year

¹ Throughout the first 15 years after construction

² Throughout the economic life after transfer

³ Ministry of Agriculture, Forestry and Rural Affairs

⁴ Ministry of Health

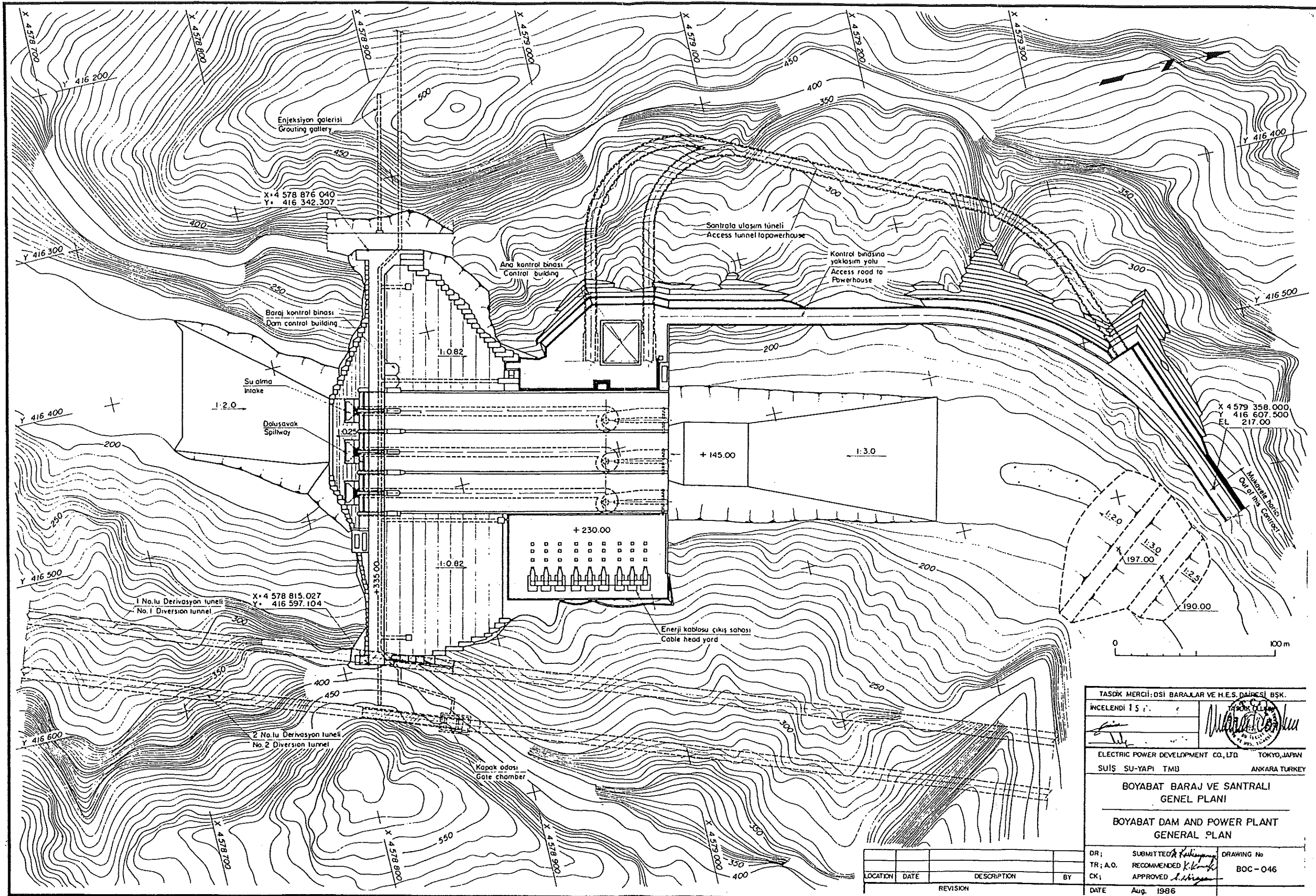
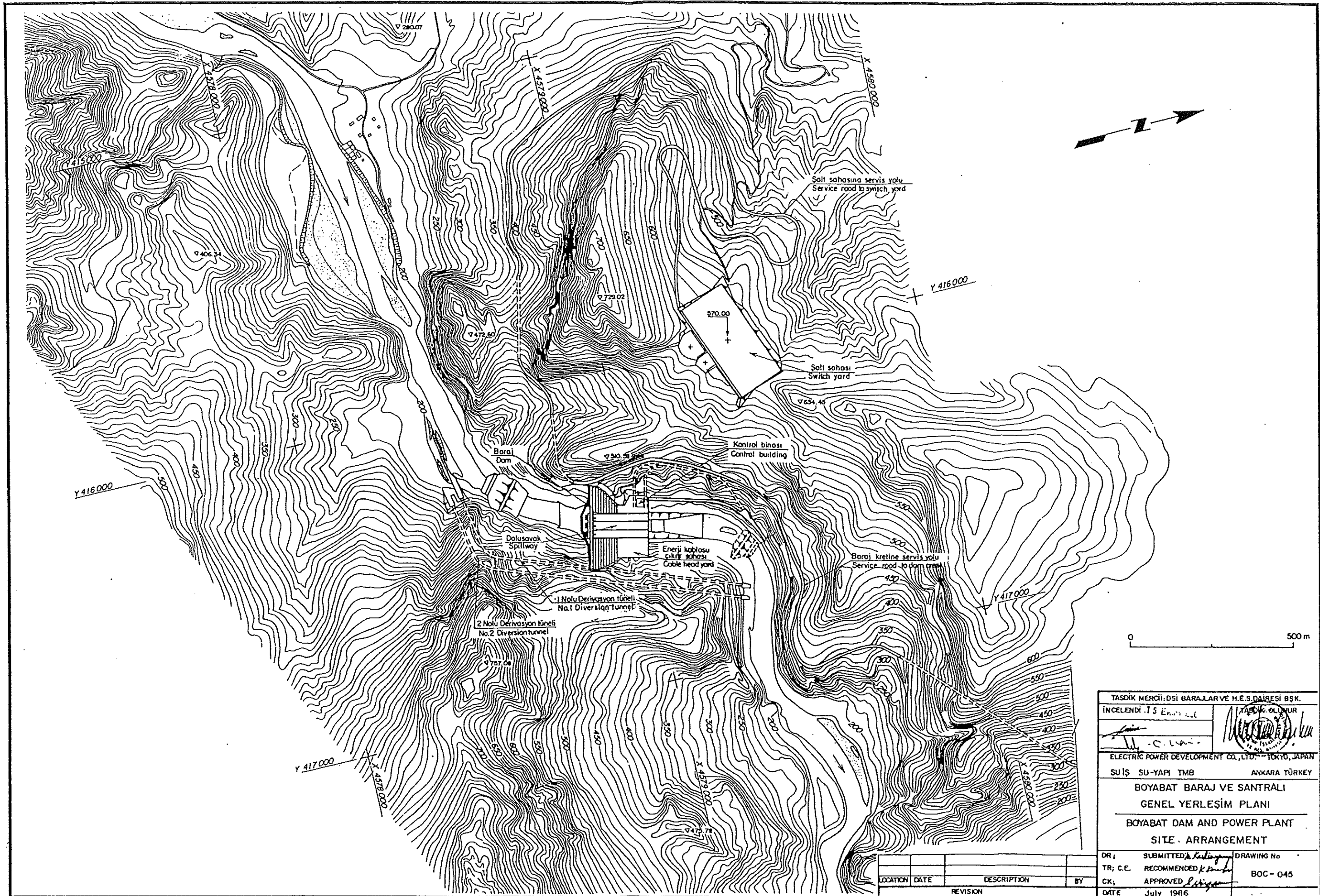


Figure 1. Boyabat Dam and Power Plant, General Plan



TASDIK MERCI: DSİ BARAJLAR VE H.E.S. DAİRESİ BŞK.	
İNCELENDİ: İ.S. ENERJİ GENEL MÜDÜRLÜĞÜ	TASDIK: ÖLÇÜMUR
ELECTRIC POWER DEVELOPMENT CO., LTD. - TOKYO, JAPAN	
SU İŞ SU-YAPIM TMB	ANKARA TÜRKİYE
BOYABAT BARAJ VE SANTRALI	
GENEL YERLEŞİM PLANI	
BOYABAT DAM AND POWER PLANT	
SITE ARRANGEMENT	
DR: SUBMITTED: <i>K. Kılıç</i>	DRAWING No
TR: C.E. RECOMMENDED: <i>K. Kılıç</i>	BOC-045
CK: APPROVED: <i>K. Kılıç</i>	
DATE: July 1986	

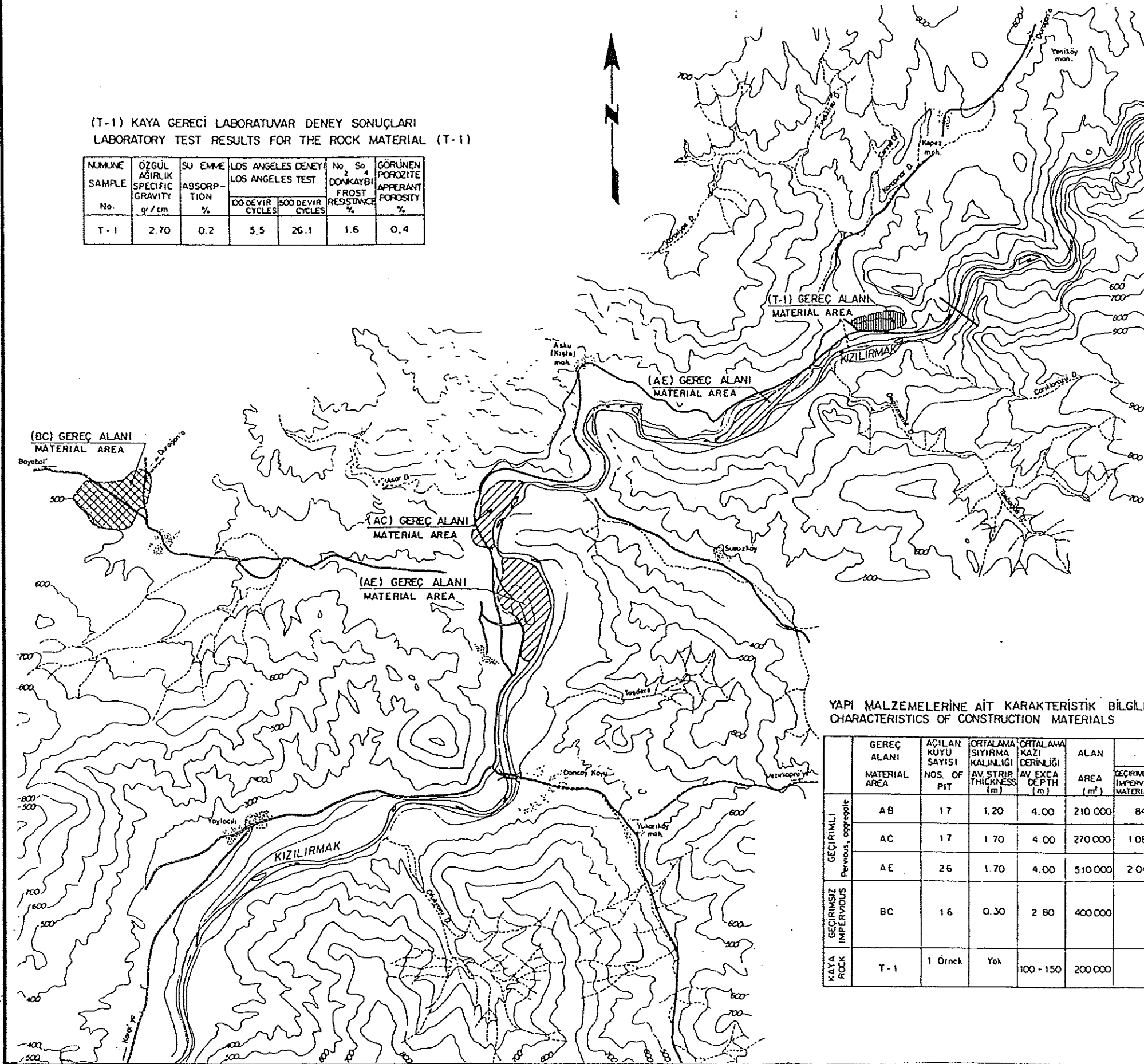
LOCATION	DATE	DESCRIPTION	BY
REVISION			

(T-1) KAYA GERECİ LABORATUVAR DENEY SONUÇLARI
LABORATORY TEST RESULTS FOR THE ROCK MATERIAL (T-1)

NUMUNE SAMPLE No.	ÖZGÜL AĞIRLIK SPECIFIC GRAVITY gr / cm	SU EMME ABSORP- TION %	LOS ANGELES DENEYİ LOS ANGELES TEST		No. 2 S ₄ DOKKAYBI FROST RESISTANCE %	GÖRÜNEN PORÖZİTE APPARENT POROSITY %
			100 DEVİR CYCLES	500 DEVİR CYCLES		
T-1	2.70	0.2	5.5	26.1	1.6	0.4

SİMGELER
LEGEND

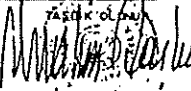
-  Geçirimli gereç ve agrega alanı
Pervious material and aggregate area
-  Geçirimsiz gereç alanı
Impervious material area
-  Kaya gereç alanı
Rock material area
-  Gereç alanı sınırı
Boundary of area



YAPI MALZEMELERİNE AİT KARAKTERİSTİK BİLGİLER
CHARACTERISTICS OF CONSTRUCTION MATERIALS

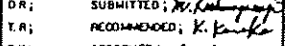
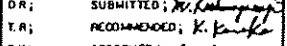
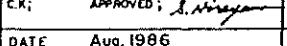
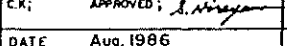
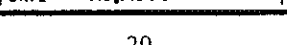
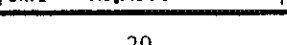
	GEREC ALANI MATERIAL AREA	AÇILAN KUYU SAYISI NOS. OF PIT	ORTALAMA SİYİRMA KALINLIĞI AV. STRIP THICKNESS (m)	ORTALAMA KAZI DERİNLİĞİ AV. EXCA DEPTH (m)	ALAN AREA (m ²)	ALINABİLECEK GEREC MİKTARI MATERIAL TO BE TAKEN (m ³)			ALANIN BARAJ EKSENİNE UZAKLIĞI DISTANCE (m)
						GEÇİRLİ GEREC IMPERVIOUS MATERIAL	GEÇİRLİSİZ GEREC PERVIOUS, AGGREGATE MATERIAL	KAYA GERECİ ROCK MATERIAL	
GEÇİRLİ Pervious, aggregate	AB	17	1.20	4.00	210 000	840 000			2 500
	AC	17	1.70	4.00	270 000	1 080 000			8 000
	AE	26	1.70	4.00	510 000	2 040 000			8 700
GEÇİRLİSİZ IMPERVIOUS	BC	16	0.30	2.80	400 000		1120 000		17 000
KAYA ROCK	T-1	1 Örnek	Yok	100 - 150	200 000			YETERİ KADAR SUFFICIENT	750

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İNCELENDİ:  TASDIK OLUNDU: 

ELECTRIC POWER DEVELOPMENT CO., LTD. TOKYO, JAPAN
SUIŞ, SU-YAPI, TMB ANKARA, TURKEY

BOYABAT BARAJ VE SANTRALİ
YAPI MALZEMELERİ
HARİTASI
BOYABAT DAM AND POWER PLANT
CONSTRUCTION MATERIALS
LOCATION MAP

DR:  SUBMITTED: 
T.R:  RECOMMENDED: 
C.K:  APPROVED: 

DATE Aug. 1986

DRAWING No.
BOC - 038

Figure 3. Construction Materials Location Map

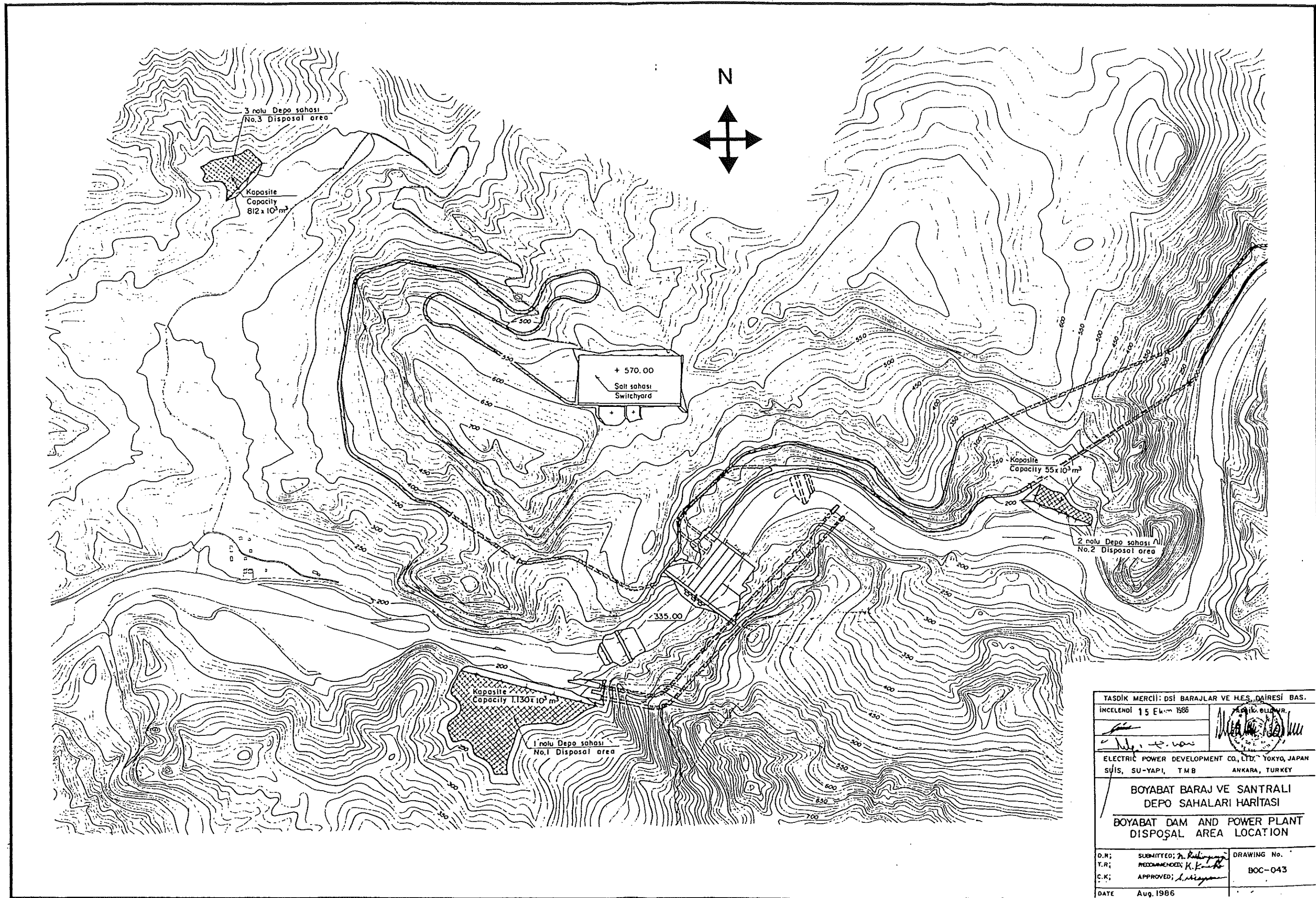


Figure 4. Disposal Areas Location Map

BOYABAT DAM AND HEPP CONSTRUCTION WORK SCHEDULE

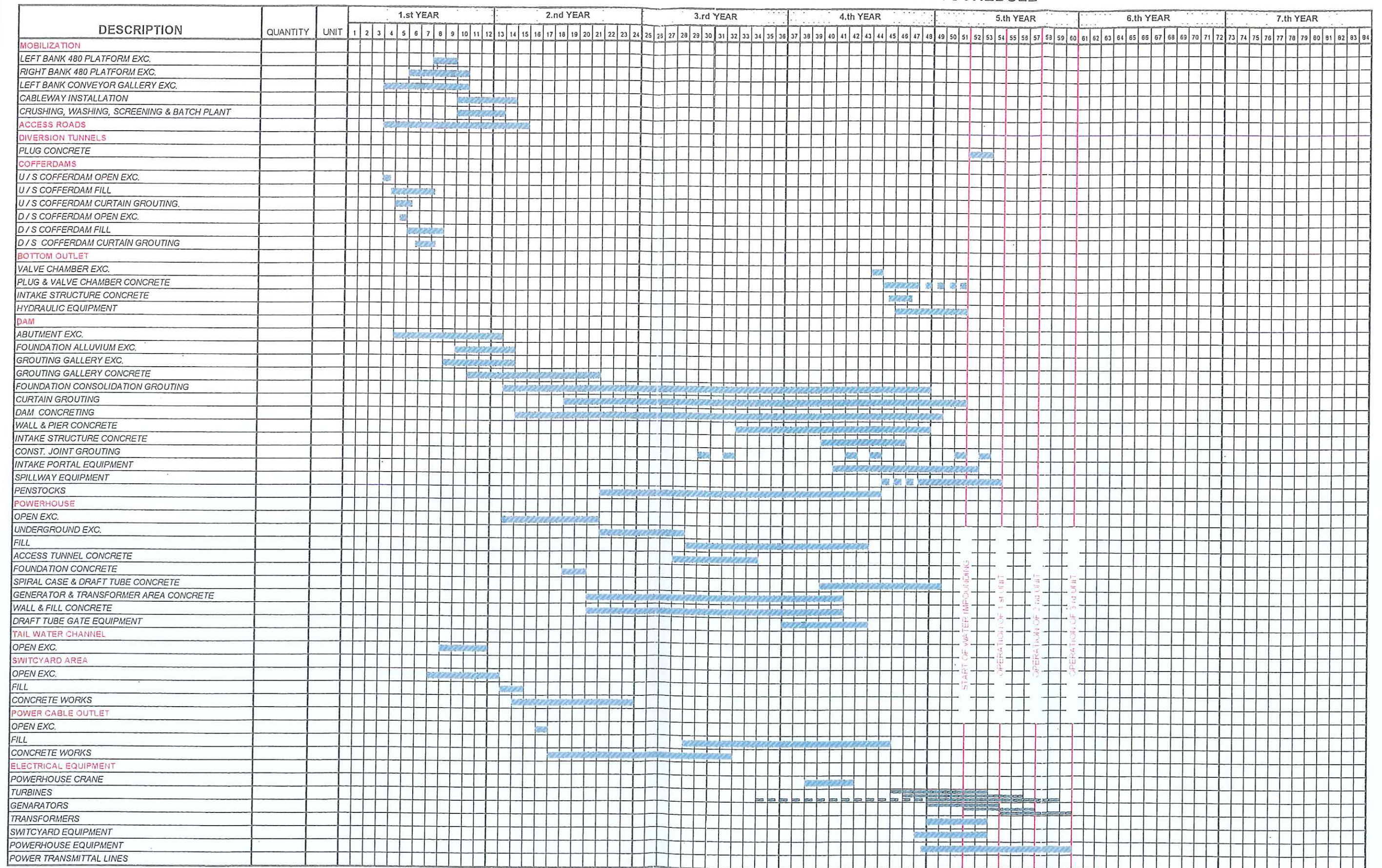
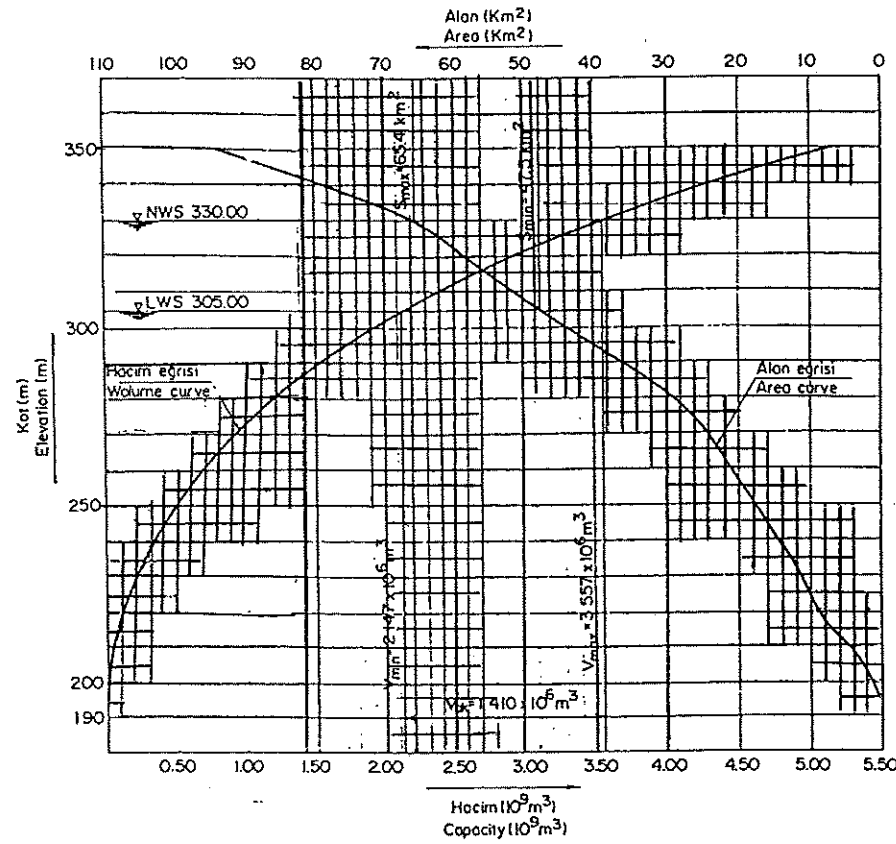
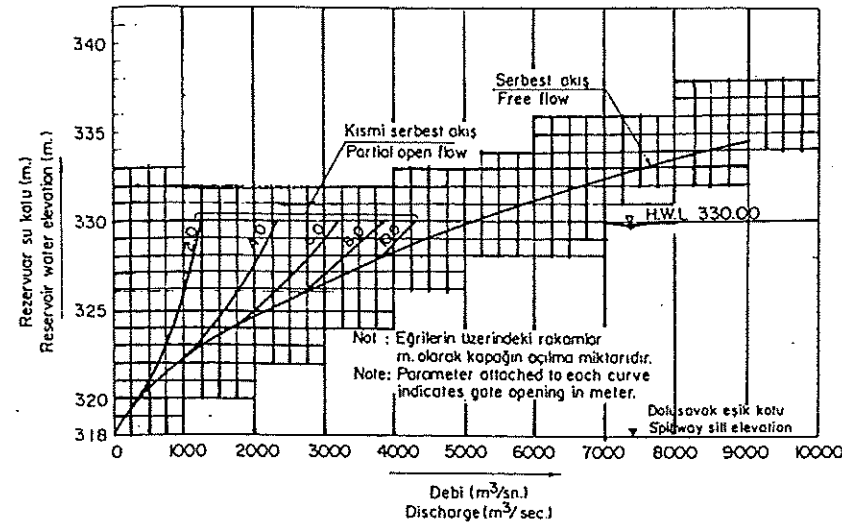


Figure 5. Boyabat Dam, Work Plan

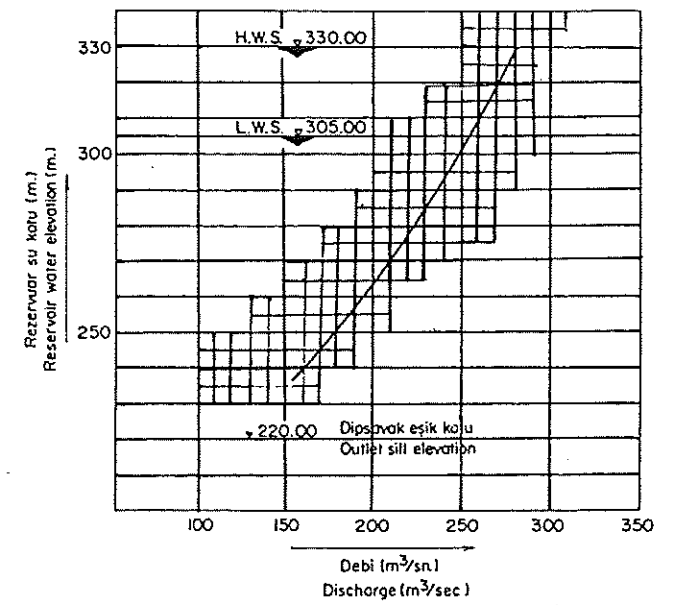
HACIM-ALAN EĞRİLERİ AREA-CAPACITY CURVES



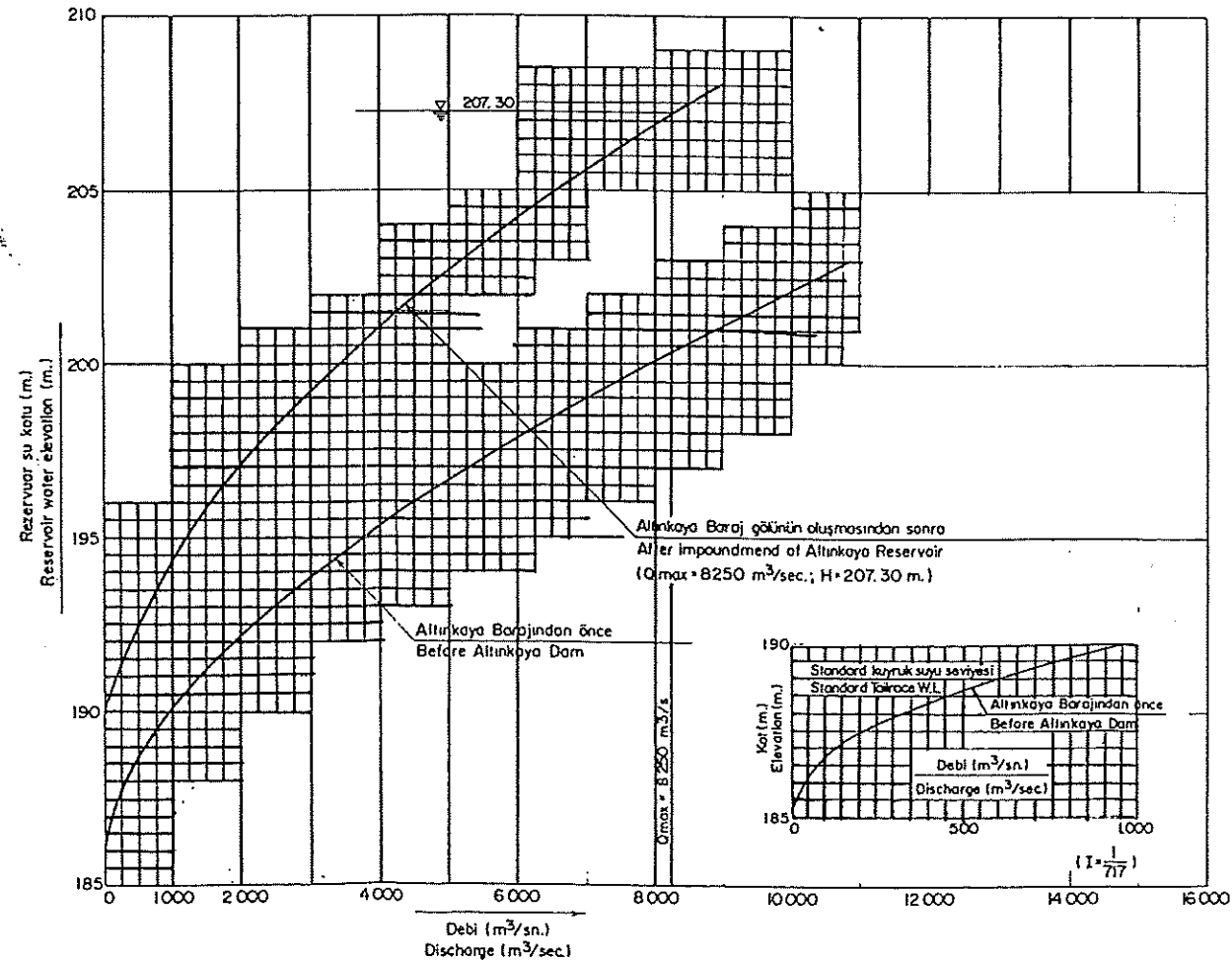
DOLUSAVAK DEŞARJ EĞRİSİ SPILLWAY RATING CURVE



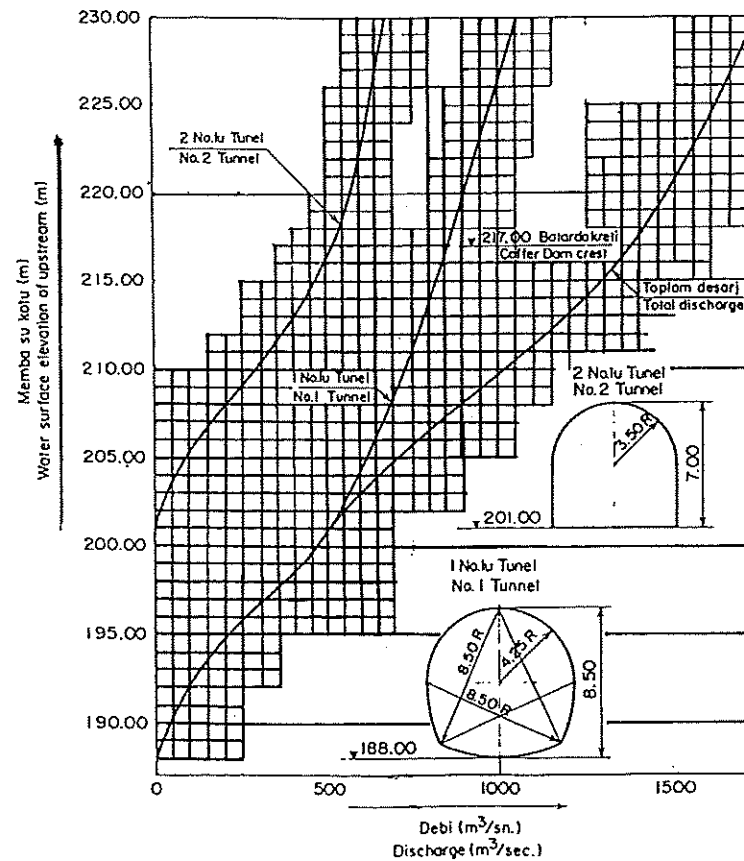
DİPSAVAK DEŞARJ EĞRİSİ OUTLET RATING CURVE



BOYABAT BARAJ YERİ ANAHTAR EĞRİSİ RATING CURVE AT BOYABAT DAM SITE



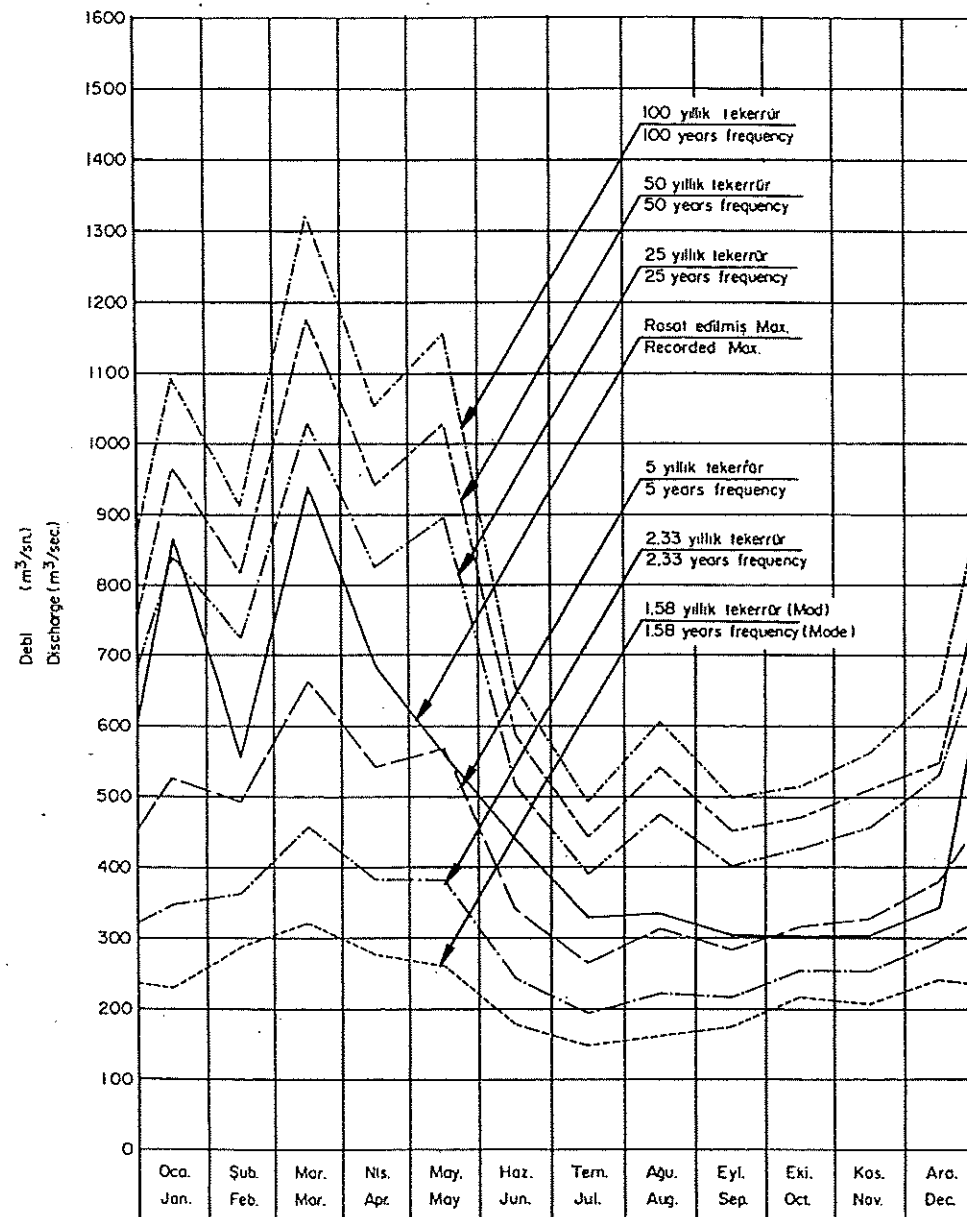
DERİVASYON TUNELİ DEŞARJ EĞRİSİ DISCHARGE CURVE OF DIVERSION TUNNEL



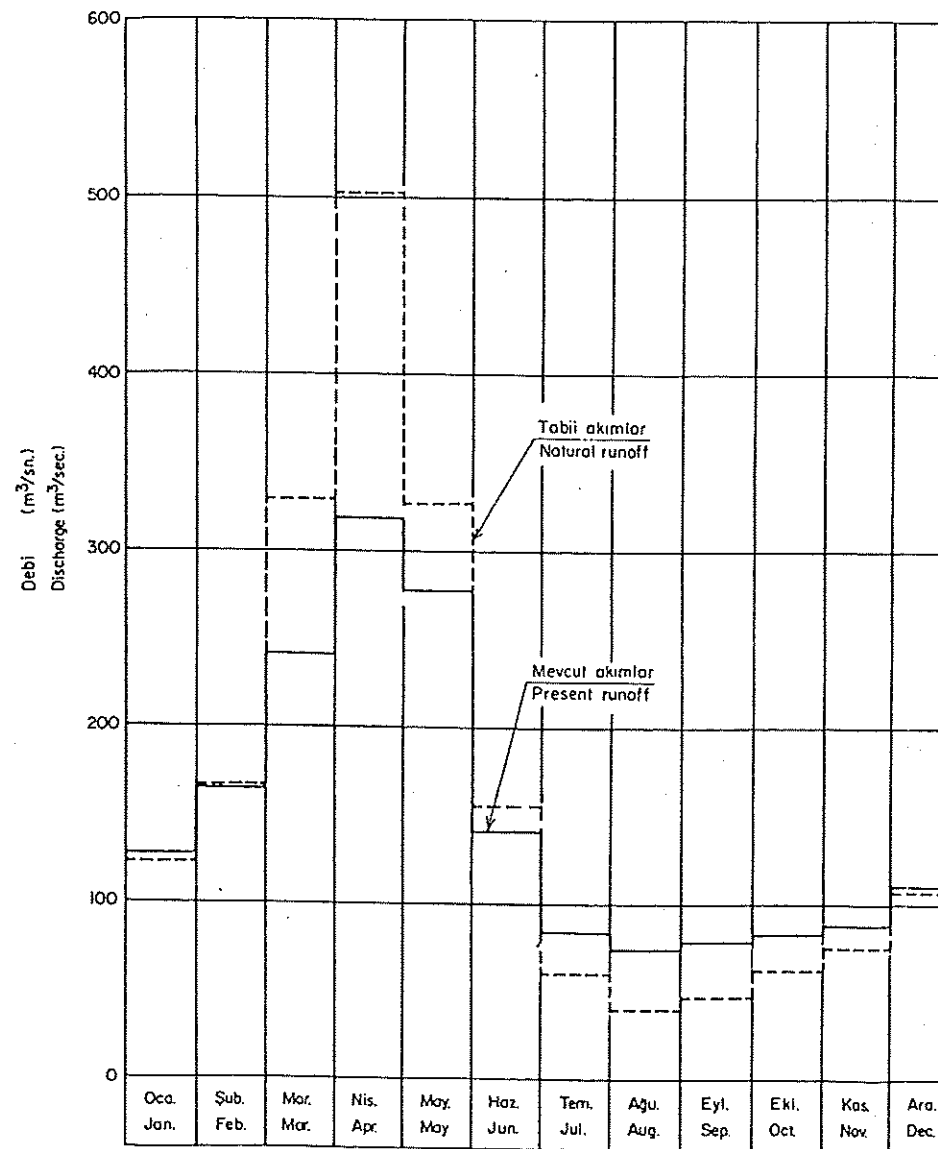
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İNCELENDİ 1:		TASOK ÜNİVERSİTESİ	
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SUIS SU-YAPİ TMB		ANKARA, TURKEY	
BOYABAT BARAJ VE SANTRALİ HİDROLİK BİLGİLER			
BOYABAT DAM AND POWER PLANT HYDRAULIC DATA			
DR: Ş.C.	SUBMITTED	DATE	DRAWING No
TR: A.O.	RECOMMENDED	DATE	BOC-008
CK: Y.K.	APPROVED	DATE	
REVISION			

Figure 6. Hydraulic Data for Boyabat Project

TAŞKIN SARFIYATLARI
FLOOD FLOW



AYLIK ORTALAMA AKIM
MONTHLY AVERAGE RUNOFF



- Notlar: 1) Tekerrür hesaplarında Gumbel metodu kullanılmıştır.
- 2) Boyabat barajı max. aylık debilerin tekrürü Aşar köprüsü (1536) A.R. istasyonu değerlerinin Boyabat baraj yerine taşınmasıyla bulunmuştur.
- 3) Boyabat baraj yerindeki aylık tabii ortalama akımların bulunmasında, İnöz (1533), Yahşihan (1503), Gülşehir (1532) ve Kuyuluş (1524) akım rasat istasyonlarından yararlanılmıştır. 1939-1984 arasındaki akım değerlerinden istifade edilmiştir.
- 4) Boyabat baraj yerindeki aylık mevcut ortalama akımların bulunmasında Hıranlı baraj işletmesi dikkate alınmıştır.

- Note: 1) Probability calculation is made employing Gumbel's Method.
- 2) Frequency of max. monthly peak discharges for Boyabat dam axis are calculated on to basis of observed records at (1536) Aşar köprüsü.
- 3) Monthly natural average runoff at Boyabat dam axis is calculated based on the observed records at İnöz (1533), Yahşihan (1503), Gülşehir (1532) and Kuyuluş (1524) gaging stations. Runoff data between 1939 to 1984 have been evaluated.
- 4) Monthly present average runoff at Boyabat dam axis is evaluated based on the Hıranlı dam operation.

TASDİK MERCİİ : DSI BARAJLAR VE H.E.S. DAİRESİ BSK.			
İNCELENDİ	TASDİK BULUNDU		
ELECTRIC POWER DEVELOPMENT CO., LTD. TOKYO, JAPAN			
SUIŞ SU-YAPI TMB ANKARA TÜRKİYE			
BOYABAT BARAJ VE SANTRALI			
HİDROLOJİK BİLGİLER (3-3)			
BOYABAT DAM AND POWER PLANT			
HYDROLOGIC DATA (3-3)			
DR: M.C.	SUBMITTED	DRAWING No	
TR: A.O.	RECOMMENDED	BOC-007	
CK: Y.K.	APPROVED		
DATE	May 1986		

Figure 7. Hydrologic Data for Boyabat Project

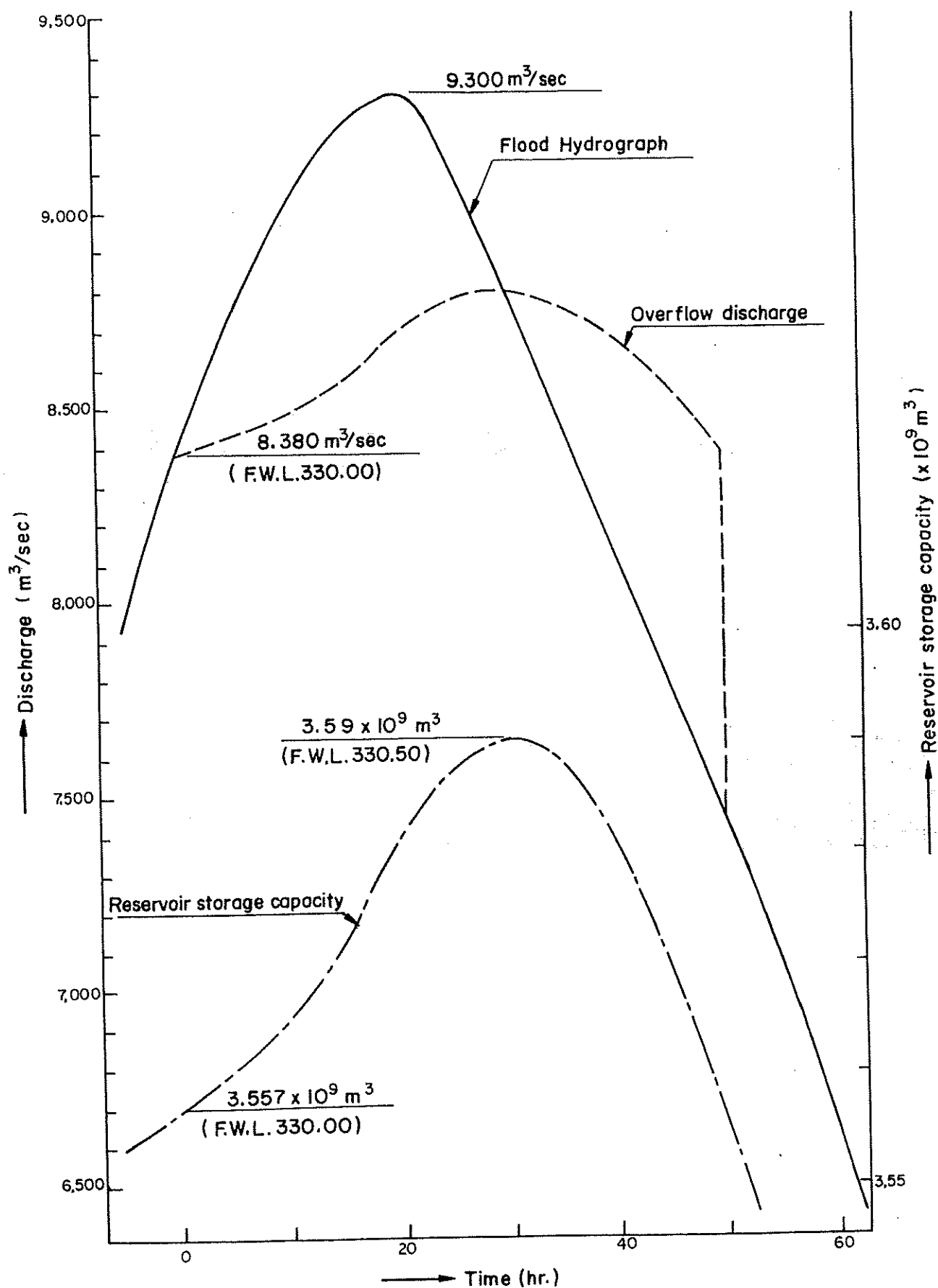
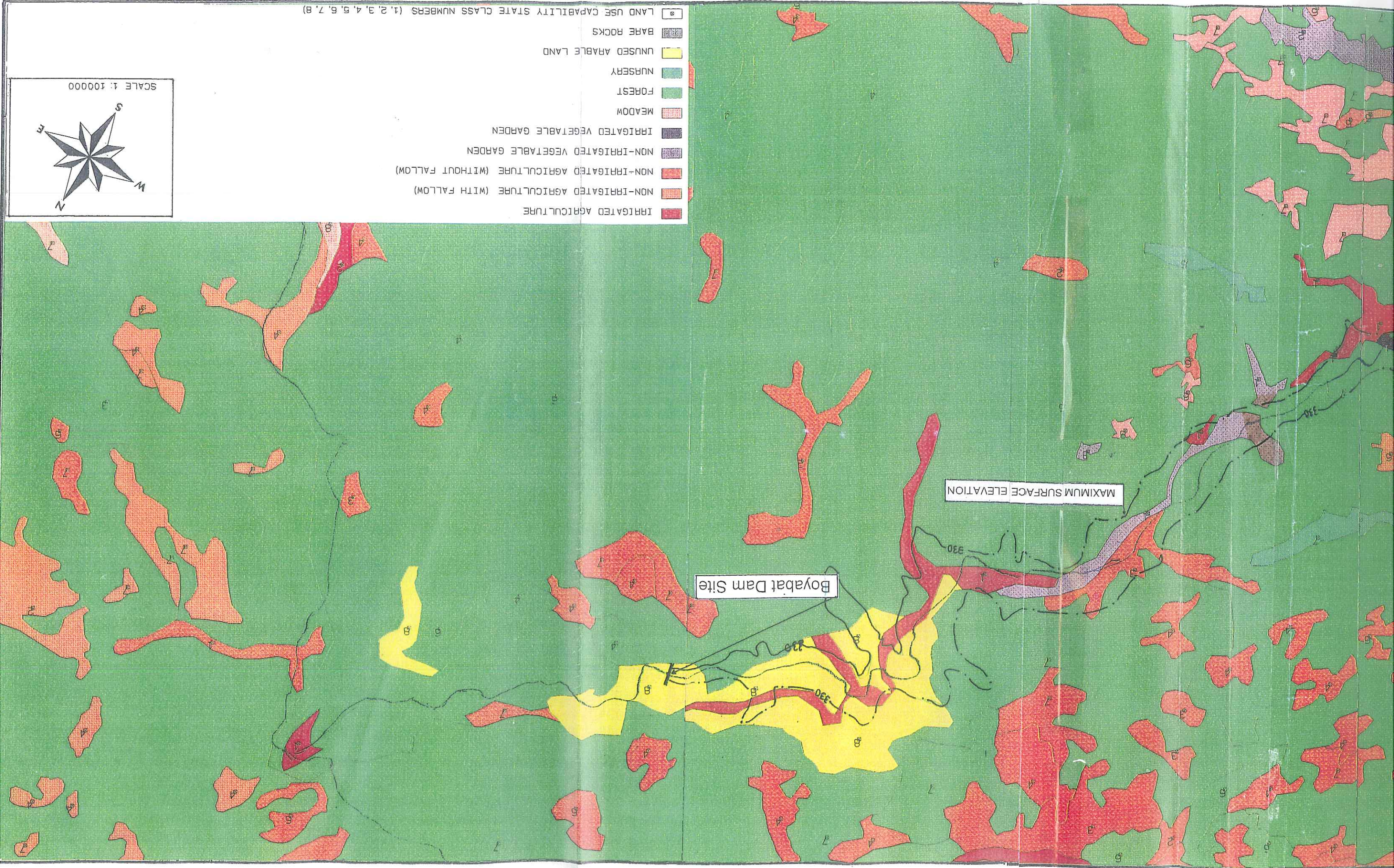
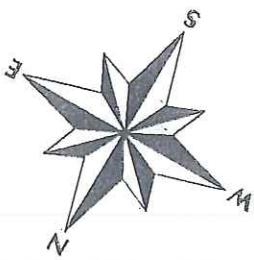


Figure 8. Spilway Discharge Curve

LAND USE CAPABILITY STATE CLASS NUMBERS (1, 2, 3, 4, 5, 6, 7, 8)

- IRRIGATED AGRICULTURE
- NON-IRRIGATED AGRICULTURE (WITH FALLOW)
- NON-IRRIGATED AGRICULTURE (WITHOUT FALLOW)
- NON-IRRIGATED VEGETABLE GARDEN
- IRRIGATED VEGETABLE GARDEN
- MEADOW
- FOREST
- NURSERY
- UNUSED ARABLE LAND
- BARE ROCKS

SCALE 1:100000



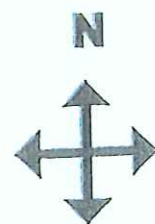
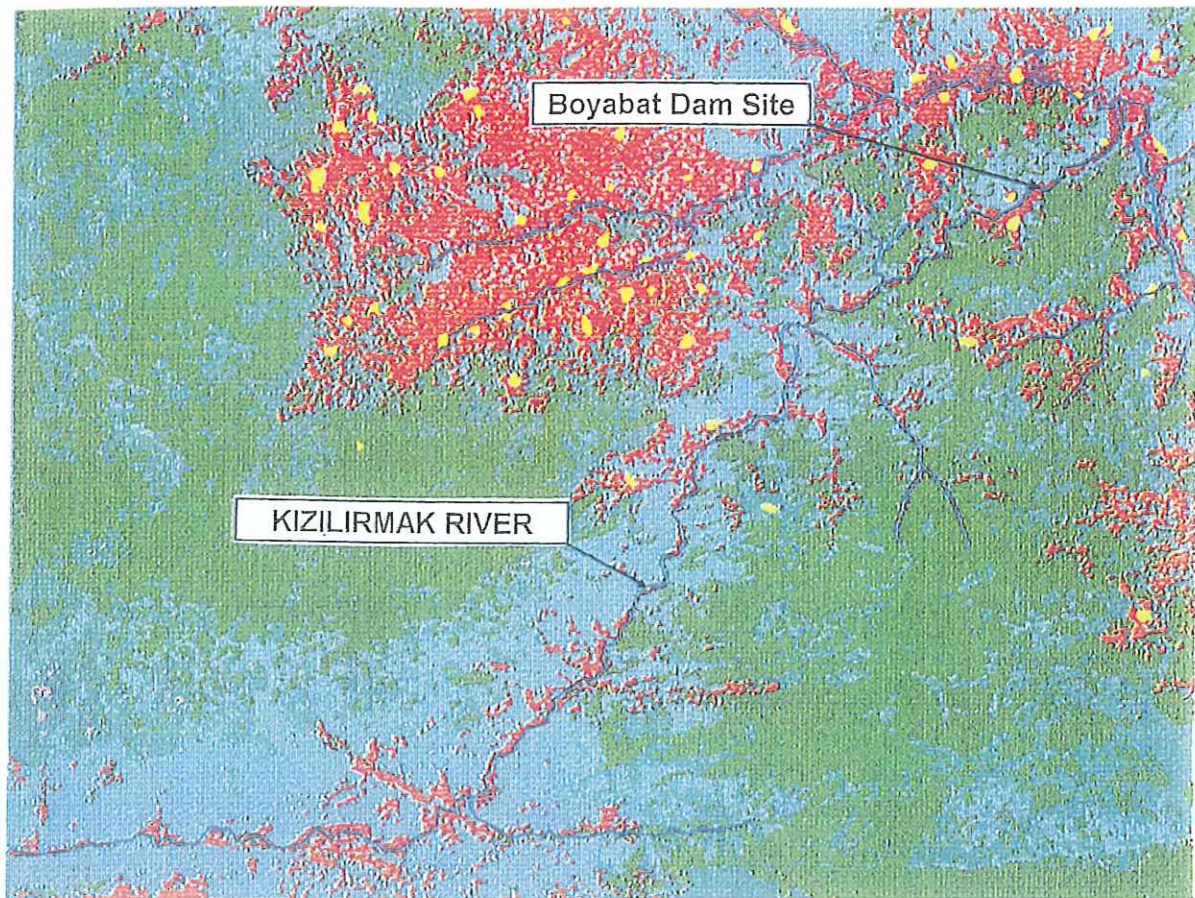
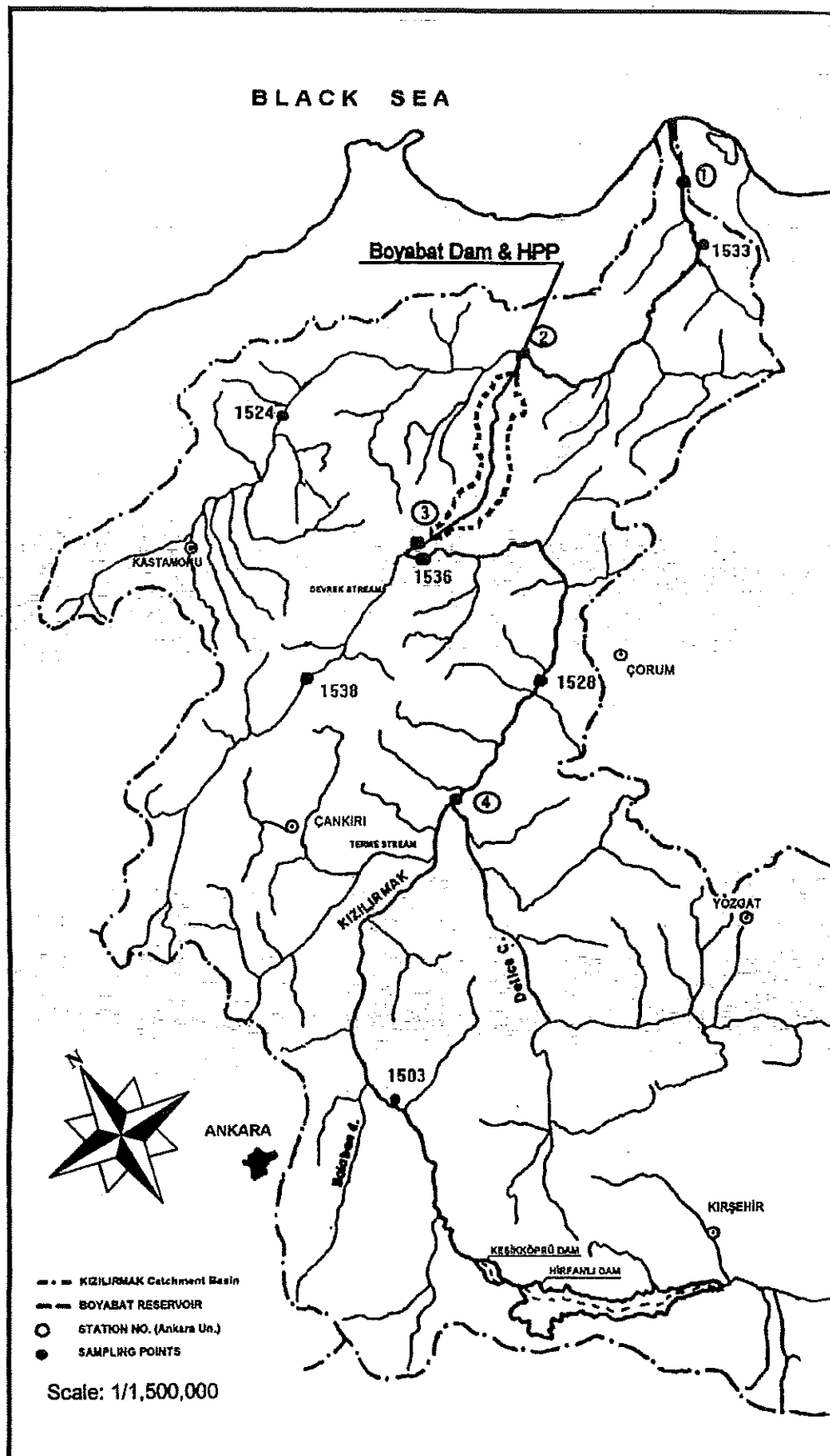


Figure 10. Classified Image of the Region



ENCON

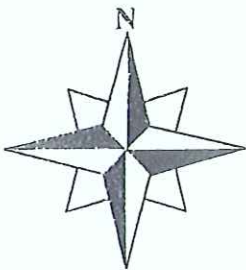
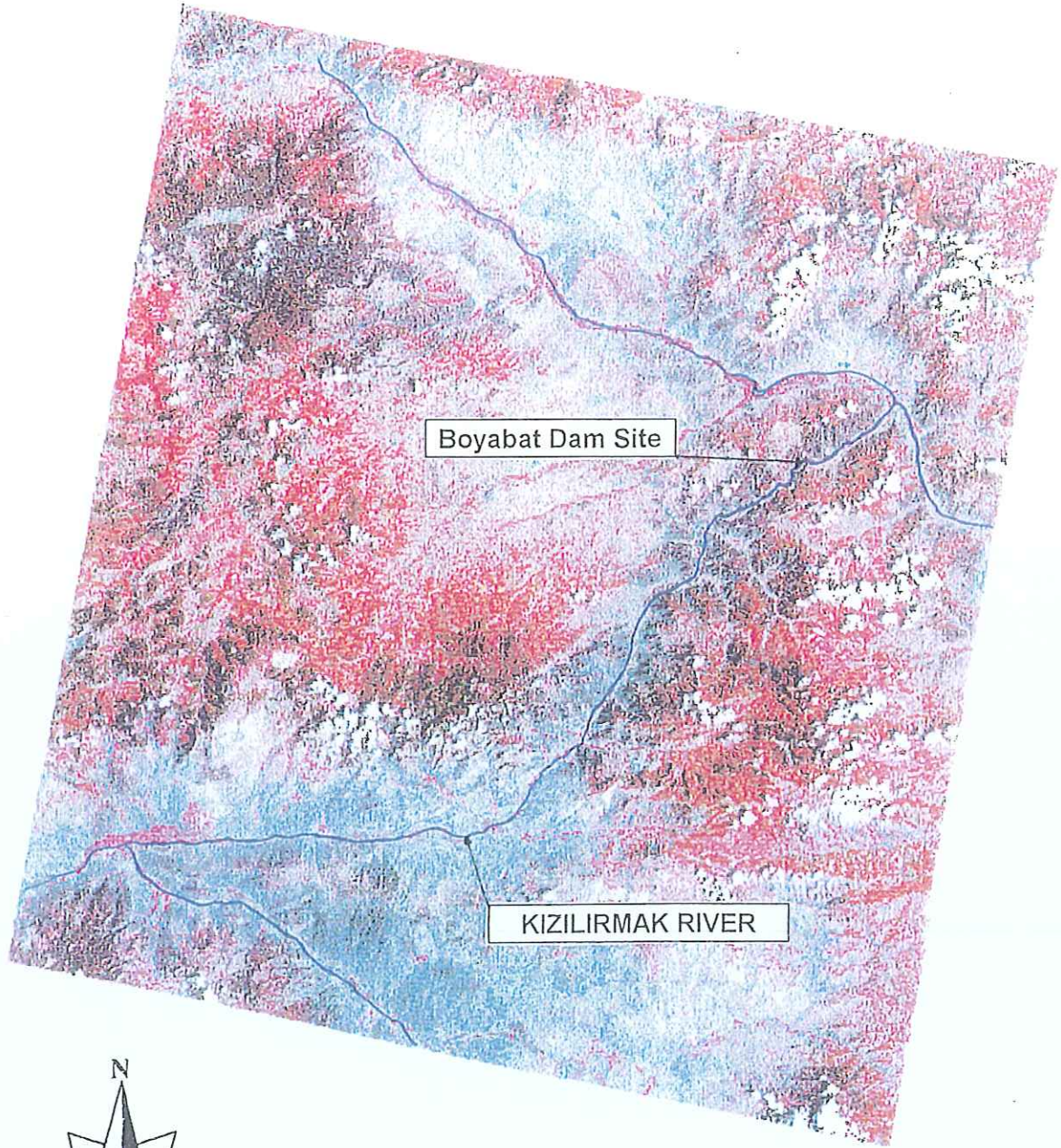
DOGUS GROUP



BOYABAT DAM AND HYDROELECTRIC POWER PLANT

ENVIRONMENTAL ASSESSMENT REPORT

1998
ANKARA, TURKEY



BOYABAT PROJECT AREA FROM SPACE

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LIST OF ABBREVIATIONS

ASL	Above Sea Level
BERN	Convention of Bern
BOD	Biological Oxygen Demand
BOT	Built Operate Transfer Model
BTEP	Thousand Tons of Petroleum Equivalent
COD	Chemical Oxygen Demand
dB	Decibels
DMI	State Meteorological Institute
DOGUS	DOGUS Holding A.S. and DOGUS Insaat ve Ticaret A.S. Consortium
DPT	State Planning Organization
DSI	General Directorate of State Hydraulic Works
E.R.L.	European Red List
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EIE	Turkish Electricity Works Survey Administration
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
ENCON	ENCON Cevre Danismanlik Ltd. Sti.
EPDC	Electric Power Development Company
EXIMBANK	American Export Import Bank
FAO	United Nations Food and Agriculture Organization
GDP	Gross Domestic Product
GNP	Gross National Product
GWh	Giga Watt Hour
HARZA	HARZA Consulting Engineers And Scientists
HPP	Hydroelectric Power Plant
IFC	International Finance Corporation
JICA	Japan International Cooperation Agency

KEP	Kilogram Petroleum Equivalent
KHGM	General Directorate For Rural Affairs
kWh	Kilo Watt Hour
Leq	Noise Level Equivalent
MAFRA	Ministry Of Agriculture, Forestry And Rural Affairs
MCE	Maximum Credible Earthquake
MOH	Ministry Of Health
MTA	General Directorate of Mining Exploration And Research
MW	Mega Watt
MWL	Maximum Water Level
NGO	Non-Governmental Organization
OECD	Organization of Economic Cooperation and Development
OPIC	Overseas Private Investment Corporation
SRF	Special Resettlement Fund
SS	Suspended Solids
TDS	Total Dissolved Solids
TEAS	Turkish Electricity Authority
TKN	Total Kjeldahl Nitrogen
TOE	Tons Of Oil Equivalent
TPE	Total Petroleum Equivalent
TPP	Thermal Power Plant
USBR	United States Bureau of Reclamation

I. INTRODUCTION

I. INTRODUCTION

Energy policies of the countries throughout the world changed significantly in the 1970's, due to the oil crisis. Various estimates of fossil fuel resources indicate that they would be exhausted in about a century. These estimates increase the importance of other, especially renewable, energy resources. One of the most important and usable of these resources is hydropower.

Turkey, as a rapidly developing and industrializing country, is in need of reliable, inexpensive, and high quality energy. In the last five years, energy production has increased by an average of 3.2% annually and in 1994, energy production was 32.6 million tons of oil equivalent (TOE). As of the end of 1994, total (primary) energy consumption was 64 million tons of oil equivalent (Seventh Five Year Development Plan, 1995). In the energy sector, oil products, which are approximately 49% dependent on imported resources, have a 40% share.

Installed capacity of electricity power plants reached 20,857 MW and the production capacity of these plants was 101 billion kWh at the end of 1994. In 1995, installed capacity reached to 20,952 MW and 86.25 billion kWh of electricity production was realized. Electricity demand was met with this quantity of production as of 1995, but this demand is increasing rapidly and investments should continue to meet electricity demand. While the reserve margin of the total energy production was four percent in 1996, an energy shortage is expected in the near future.

Turkish social and economic policies (including energy policy) are generally expressed in Five Year Development Plans prepared by the State Planning Organization (DPT). Seventh Five Year Development Plan aims to establish a stable and sustainable development trend through implementation of structural harmonization and macroeconomics, social, and cultural policies. Reducing unemployment and establishing regional balances for investment and development are also among the main targets. The State Planning Organization estimates that during the Seventh Plan period, Gross Domestic Product (GDP) will increase by 5-6.6% annually and Gross National Product (GNP) will grow by about 5.5-7.1% on an annual average.

Current energy policy emphasizes the importance of meeting the energy demand of the increasing population and a continuously developing economy insofar as possible, by using domestic energy resources. Turkey, with high potential for hydropower (estimated as 400 billion kWh, of which 122 billion kWh is feasible), was only producing 35.5 billion kWh by the end of 1995. Installed capacity of hydroelectric power plants reached 9,682 MW in 1995 and hydroelectric power plants had a share of 46.2% in the installed capacity. Thus, as the end of 1995, only 29% of the economic hydroelectric potential had been utilized.

The lignite reserves of Turkey are 8.5 billion tons, while thermal power plants consume about 35 million tons of lignite per year. However, since the lignite produced in Turkey is low quality, with respect to calorific value and sulphur content,

generally, thermal power plants operating with lignite require the importation of good quality lignite. Obviously, when an average annual energy demand increase of 8.5% is taken into account, the development of renewable resources, such as hydropower, is especially important, as it is throughout the world.

One of the objectives of this plan is to increase the share of the private sector in investments and operational activities in the energy sector, in order to meet the electricity demand. In this plan, special importance is given to privatization and the Build-Operate-Transfer (BOT) model for the realization of energy investments.

1.1. Project Identification and Background

In accordance with the energy policies of Turkish Republic, the Ministry of Energy and Natural Resources decided to build the Boyabat Dam and Hydroelectric Power Plant by the BOT model as a unit of the Lower Kizilirmak Development Project. The project was incorporated into the plans of State Hydraulic Works (DSI) in the late 1970's. Japan International Cooperation Agency (JICA) prepared a feasibility report and the proposed project was determined to be economically and technically the most feasible option. Later, in January 1987 design documents were prepared by the Japan Electric Power Development Company (EPDC), Su-Is Project Engineering Company, Su-Yapi Engineering and Consultancy, and Terzibasoglu Consultancy and Engineering Companies. To date, DSI has built the access roads to the dam site, the bridge across to the right bank of the river, diversion tunnels, access tunnels to the crest, and the camp facilities.

In order to select the company to develop the Boyabat Project, a tender process was initiated on June 21, 1995, in accordance with the BOT laws. Thirteen companies had applied for developing the Boyabat Project and four of them were prequalified as candidates. The previous studies carried out for the Boyabat Project were reviewed and the revised feasibility reports were prepared by these candidates. Then, the revised feasibility reports of these four competitors were evaluated, and DOGUS Holding A.S. and DOGUS Insaat ve Ticaret A.S. Consortium (DOGUS) was selected as the developer for the Boyabat Project on September 16, 1995.

DOGUS is the developer of the Boyabat Project and will take an equity stake in the concession company as a major partner which will be established to build, own and operate the Project. The name of this concession company is going to be Boyabat Electricity Production and Trade Company. Boyabat Electricity Production and Trade Company, the Concession Company (CC), in which DOGUS is a major partner, proposes to construct the Boyabat Dam and Hydroelectric Power Plant Project in agreement with the design documents prepared for DSI, consisting of a concrete gravity dam (with a height of 150 m from riverbed), 510-MW semi-underground type power house, and the associated switchyard site. Design documents, that had been prepared in January 1987, were reviewed by DOGUS and adopted for use in implementation and construction. The electricity produced will be distributed to the western part of Turkey, where most of the industries are located, by power

transmission lines that will be planned and built by the Turkish Electricity Authority (TEAS). The capacity of these lines is considered to be 380 kV.

The Boyabat Project is located on the downstream part of Kizilirmak River, the largest river of the Republic of Turkey, which rises in the Northeastern Anatolian Plateau, flows through the Central Anatolia and into the Black Sea through the Central Black Sea Region. CC is considering borrowing funds for construction from a variety of Turkish and international sources, including, but not limited to: International Finance Corporation (IFC), the Overseas Private Investment Corporation (OPIC), the Export-Import Bank of Japan (JEXIM), the Export Credit Agencies of various other nations (ECA's), commercial banks (either with or without political and country risk insurance from various private and public sector insurers and/or MIGA or the World Bank) and the capital markets (collectively the "Project Lenders").

The project site topographically is a narrow gorge with steep cliffs on both banks. It is the third project on lower Kizilirmak River, located upstream of Altinkaya Dam and Hydroelectric Power Plant (500 MW). Altinkaya Dam is located upstream of Derbent Dam and Hydroelectric Power Plant. There are also other projects on the Kizilirmak, located well upstream of the Boyabat Project. Three of these projects have been already completed and are in operation. The Boyabat Project site is located five km southeast of Duragan Town, in the northwest of Turkey, on the Kizilirmak River, approximately 125 km inland from the Black Sea. Kargi is the town located at the upstream end of the future reservoir. The project area lies in the Middle Black Sea Region within the provinces of Samsun, Sinop and Corum.

1.2. Regulatory Background

Although this project has received an environmental clearance from the government of Turkey, this Environmental Assessment (EA) was prepared to fulfill the requirements of the Project Lenders. The report was prepared in accordance with the World Bank Operational Directive 4.01 Annex A (Environmental Assessment) and Annex B (Environmental Policy for Dam and Reservoir Projects), and in agreement with the IFC's "Guidance for Preparation of Environmental Assessment".

An interdisciplinary team of experts took part in the preparation of the EA report. Both private consultants and experts from Middle East Technical University and Hacettepe University participated in the preparation of the EA report (see Annex 1). The overall coordination and preparation of the EA was carried out by the environmental consulting firm ENCON Cevre Danismanlik Ltd. Sti., Turkey, with the assistance of HARZA Engineering Company International.

Various documents were consulted during the preparation of the EA, including policy and legal reports, laws and regulations, technical and economical feasibility reports, publications on land use, natural resources, geology, socio-economic features of the project area, maps, various data on water quality, hydrology, and climatology obtained from different agencies (governmental, non-governmental, etc.). In

3
In addition, field studies were carried out in 1996 and 1997 to collect baseline data on the physical, biological and socio-economic environments. Basic information to identify and evaluate the impacts of the project were obtained during these studies.

Also, a series of meetings were held to facilitate interagency coordination and to learn the concerns of the related governmental and non-governmental agencies, affected groups and the public. Surveys and public meetings were carried on in the region that is going to be affected by the project, to gain an understanding of the views of the people living in the area (local people). A summary of the agencies and individuals contacted, the issues raised and responses are provided in Annex 6.

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The Boyabat Dam and Hydroelectric Power Plant project was reviewed according to the World Bank Operational Directive (O.D.) 4.01. This Environmental Assessment (EA) Report has been prepared in reference to Operational Directive on Environmental Assessment, O.D. 4.01, Annex A (Environmental Assessment) and Annex B (a guideline for Environmental Policy for Dam and Reservoir Projects). Consultation with and disclosure of information to affected groups and Non-Governmental Organizations (NGO) were performed. In the preparation of this report, the Environmental Assessment Source Book, published in the World Bank's Technical Papers Series, was used for guidance throughout the environmental assessment process.

According to International Finance Corporation's (IFC) document on the World Bank Environmental Policy, April 17, 1994, the World Bank environmental policies are applicable to all projects using IFC financing. It is expected that all of the other Project Lenders will generally apply the same guidelines as the World Bank and the IFC.

Turkish version of this report was also prepared according to the Turkish Environmental Impact Assessment (EIA) Regulation and submitted to the Ministry of Environment of the Republic of Turkey, to obtain its review via Turkish authorities and, received the approval of the Ministry of Environment. Actually, since this project had been started prior to the promulgation of the Environmental Impact Assessment Regulation, according to provisional Article One, it is not subject to the preparation of an Environmental Impact Assessment Report (Environmental Impact Statement). The procedural framework is described in the following sections.

II.1. Laws and Regulations Related to The Environment

The Ministry of Environment is the responsible organization for the control and implementation policies adopted for protection and conservation of the environment and for sustainable development and management of natural resources. The Ministry of Environment was first established as an Undersecretariat in 1987 and was promoted to the rank of Ministry of Environment in August 1991, according to the Establishment Law No. 443. The central office of the Ministry of Environment is located in Ankara, complemented by 34 Regional Environmental Directorates. There are three General Directorates and one Independent Department within the Ministry of Environment. These units are;

1. General Directorate of Environmental Impact Assessment (EIA) and Planning,
2. General Directorate of Environmental Conservation,
3. General Directorate of the Prevention and Control of Environmental Pollution,
4. Department of Foreign Relations.

The Turkish Environment Law No. 2872, which came into force in 1983, handles environmental issues on a very broad scope. According to the basic principles that

govern the application of the Environment Law, and as stated in the Constitution, citizens as well as the state bear responsibility for the protection of environment. Complementary to the Environment Law and its Regulations, other laws govern the protection and conservation of the environment, the prevention and control of pollution, and the implementation of measures for the prevention of pollution. Some of these laws are:

- Water Products Law and Regulations (1971, 1973)
- Tourism Intensive Law (1982)
- National Parks Law (1983)
- Conservation of Cultural and Natural Assets Law (1983)
- Specially Protected Areas Law (1969)
- The Coast Law (1990)

In line with the Environment Law, several regulations have been published since 1983. These are:

1. Air Pollution Control Regulation, that was put into force on 2nd of November 1986.
2. Noise Control Regulation, that was put into force on 11th of December 1986.
3. Water Pollution Control Regulation that was put into force on 4th of September 1988.
4. Solid Waste Control Regulation, that was put into force on 14th of March 1991.
5. Environmental Impact Assessment Regulation, that was put into force on 7th of February 1993.
6. Medical Waste Control Regulation, that was put into force in 1993.
7. Harmful Chemical Substances and Products Control Regulation, that was put into force on 11th of July 1993.
8. Hazardous Waste Control Regulation, that was put into force on 27th of August 1995.

During the preparation of this report, the Settlement Law No. 2510 and Built-Operate and Transfer (BOT) Laws No. 3996, 3096 and 4047 were also taken into account.

II.2. Environmental Impact Assessment Procedure in Turkey

In the Environment Law, the 10th article stated the details of Environmental Impact Assessment procedure, and within this legal framework EIA Regulation was put into force after its publication in the Official Gazette No. 21489 on February 7, 1993.

Although industrial development started about 50-60 years ago in Turkey, it is only recently that Environmental Impact Statements are being prepared in the classical sense. Environmental Assessment and Impact Assessment for infrastructural activities are of special concern, since the impacts from this group of activities may be more detrimental for the environment than other types of activities.

When an activity is planned, the proponent is responsible for preparing an Environmental Impact Statement (EIS) along with many other permits required to realize the project, but not all facilities are subject to the preparation of an EIS.

Depending on the type of the facility, its capacity, or the location of the activity, an EIS or initial EIA is required. The format of the initial EIA is given in Annex I of the EIA Regulation.

The initial EIA consists of filling out a questionnaire and control list which are given in Annex IV of the EIA Regulation. If the planned activity is within the Annex III of the EIA Regulation (Activities that require an Initial EIA), a Local Environmental Committee decides whether an EIS would be required or not, after evaluating the initial EIA.

The guidelines given in Annex V of the EIA Regulation, consisting of the issues to be included in an EIS, are generally valid for all facilities. However, some of the titles given in this Annex are not relevant for all types of activities. Thus, the General Directorate of EIA and Planning of the Ministry of Environment (referred to as EIA Administration in this text) prepares special formats (list of titles to be included in the EIS) for different types of facilities. During the preparation of the list by adding or omitting some titles, a sort of a scoping has been made according to the site selection and environmental impacts of a specific facility listed in Annex I.

After the preparation of the EIS for a single activity or for an industrial area, the EIA Administration goes over the report to evaluate it with respect to format first and the evaluation period starts. If the format is found to be appropriate, this means that the report is ready for public hearings. After public comment is obtained about the project, according to Article 15, it is ready for evaluation by the Evaluation Committee with respect to the fulfillment of other requirements. In this case, the public participation meeting is organized during the evaluation period of the Committee.

The Evaluation Committee is formed by;

- representatives of organizations related to the activity,
- proponent (Owner of the facility),
- representative of the team that prepared the EIS,
- the representatives from the Ministry of Environment who prepared a report on the public hearing.

The Evaluation Committee evaluates an EIS with respect to the following considerations; according to Article 18 of the Regulation:

- Is it appropriate with respect to the format supplied by the Ministry?
- Are the investigations and calculations provided in the statement detailed enough and based on realistic data?
- Are the Appendices sufficient? (Tables, maps etc.)
- Are the environmental impacts predicted realistic and complete?
- Are the alternatives with respect to site and technology studied and explained clearly?

After the Statement is evaluated, the Evaluation Committee may need additional information or data, before making the final decision. In this case, the Committee

may ask other organizations (mostly governmental) to do investigations at the site or to supply more information, or the Committee may call experts from universities, institutions, or organizations of professionals for their contribution to check the validity of information given in the statement. They can also perform a local survey, themselves, if they find it necessary. The committee members review the statement according to their scope of responsibilities and activities.

- The Ministry of Energy and Natural Resources is responsible for the production and control of sustainable consumption of natural resources and energy, as well as for investigations of river discharges. The General Directorate of State Hydraulic Works (DSI) is an affiliate of the Ministry of Energy and Natural Resources. DSI is responsible for; the development of hydraulic resources for irrigation and hydropower, the prevention of adverse affects on the quality and quantity of surface and ground waters and the fisheries in the reservoirs. The MENR (DSI) has also legal responsibility for expropriation under long standing Turkish laws and procedures.
- Within the Ministry of Forestry, the General Directorate of Protection and Control and the General Directorate of Forestry conduct projects related to water pollution control; identification, protection and management of wildlife, National Parks, Natural Reserves and Nature Parks.
- The Ministry of Culture is responsible for the preservation of cultural and antique resources.
- The Ministry of Agriculture and Rural Affairs, the General Directorate of Protection and Control, General Directorate of Forestry and General Directorate of Rural Affairs conduct projects related to environmental management; sewage systems and irrigation networks in rural areas. The Ministry of Agriculture and Rural Affairs is responsible from the fisheries in the lakes, rivers and seas as well. General Directorate of Rural Affairs is also responsible for the resettlement of the persons specified under the Resettlement Law.
- The Environmental Health Service of the Ministry of Health is responsible for health networks and, in particular, for the monitoring of air quality.
- The State Planning Organization, which is an affiliate of the Prime Ministry, is the main body responsible for the preparation of Five Year Development Plans and for annual implementation programs in all sectors of activity. Recently, this organization carried out the installation, accounting and survey for the development of environmental statistics. Its role might actually evolve towards a consultative-type function attached to the central government (Prime Minister's office).
- The Ministry of Tourism is responsible for the determination of touristic areas and financing the environmentally sound projects within these areas.

- The Bank of Provinces is an affiliate of the Ministry of Public Works and Settlement, and is responsible for drinking water supply, sewerage and domestic water and wastewater treatment issues.

II.3. Resettlement Law and Process

II.3.1. Resettlement Law

Persons whose property would be expropriated for the proposed project are entitled to request the Turkish Government to resettle them under Law No. 2510 of June 21 1934, and its subsequent amendments. The Resettlement Law lists four categories of people entitled to resettlement: farmers without land, or with limited land; victims of landslides, floods, or other natural disasters; persons living in overgrown bushlands, swampy areas, or hazardous areas and restricted military zones; and "those who have to be relocated because of agricultural, administrative, political, social, economic or military reasons". People whose lands are expropriated for power projects fall into the last group. Two types of resettlement are possible under the law;

- rural (preferred by farmers),
- urban (preferred by merchants, artisans and professional people).

Relevant and essential capital items are provided, such as land, house, business premises, and operating capital on credit. Farmers receive;

- sufficient land,
- animals for farming,
- equipment and tools,
- seed,
- barns,
- storage areas and other facilities.

In addition, the Turkish Government transports the people being resettled, along with their goods and animals.

Settlers are obliged to liquidate within one year the movable and immovable property that they own in the place they have left, such as unflooded land, or other property. Immovable property provided to the settlers by the Turkish Government cannot be sold, pledged or otherwise liened in any manner for a period of ten years. The only exception to this rule is the use of such property as collateral to receive credits from the Turkish Agricultural Bank.

Settlers under Government sponsorship are exempt from building and land taxes for one year after the new properties are registered in their names. The Resettlement Law also states that for persons to be resettled, the concerned agencies will deposit their expropriation compensation into the Special Resettlement Fund (SRF). In practice, displaced property owners are actually paid their money, and must deposit it themselves into the Special Resettlement Fund.

The costs of resettlement are set against the amount paid into the SRF and if the amount paid into the SRF is greater than the resettlement cost, the difference is paid back to the settler. On the other hand, if the amount paid into the SRF is less than the resettlement cost, the Government provides long term loans to the settlers that are repayable over twenty years at two percent interest, after an initial five year grace period. In order to estimate target incomes for farmers and non-farm settlers, the equivalent of 7,500 kg of wheat per year for a family of five persons, by the end of five years, is used as a standard. By the end of ten years the target reaches the equivalent income of 13,500 kg wheat per annum. In cases where the family exceeds five members, this figure is increased by 10% for each additional family member. The size of the land area allocated to farmers, broken down into arable, pasture and tree crops plots, is determined by the class of land available, the climate and the presence of irrigation.

II.3.2. Resettlement Process

After cadastral surveys have been completed by the agency (The General Directorate of State Hydraulic Works) for a village, and the commission has decided on the land value of each property, the agency returns to the village and pays each owner in turn for his or her property. If the owner considers the amount to be too small, he/she can reject it, and the agency deposits the designated amount in a special bank account. This, then exonerates the agency from further action, and the property can be considered as expropriated. The aggrieved owner may then take the matter to the court for settlement. In the event of a higher amount being awarded to the claimant, the difference between the awarded amount and the amount deposited by the agency is payable by the Central Government.

Following the DSI disbursement team, officers from the General Directorate for Rural Affairs (KHGM) interview those who have accepted the expropriation amount, to ascertain whether or not they would like to be resettled. The KHGM staff explain what benefits are provided under their resettlement program, and if the person makes a positive choice, he is required to deposit the cash compensation received in a special account. Later, resettled people have to pay back the difference between the actual cost and the amount deposited. After KHGM has ascertained a particular household's intention to be resettled the staff carries out a simple socio-economic survey of the household, its property and income earning activities. Only after KHGM staff have an idea of how many households in total for a particular project want to be resettled, can land be released or acquired for resettlement purposes by the Cabinet. Therefore, KHGM staff are not in a position, when asking people if they wish to be resettled, to inform them of the location to which they will go.

People not opting for formal resettlement by the KHGM are free to go wherever they like, and do whatever they want, whether this means rebuilding their villages on land already owned or purchased, moving to stay with relatives in cities, purchasing an apartment, or constructing a house. It should, be noted that, over and above the

involvement of KHGM, Provincial Governors in affected areas often play a key role in assisting those engaging in self-resettlement, under village improvement programs.

It is important to note that because of the sequence of steps in the resettlement process it is not possible to prepare a detailed plan based on people's final resettlement decisions until after the cadastral surveys of land and inventories of property are complete, and values put on such property. To reach this stage may take years in some cases, extending into the construction period. It should also be noted that in BOT projects similar to Boyabat, the Concession Company plays no role in the expropriation and resettlement process, other than to pay for the estimated expropriation cost.

II.4. Build-Operate and Transfer Law and Process

Build-Operate-Transfer (BOT) is a contemporary program for some special projects which need high technology and substantial amount of financial resources. With this model, a private sector organization that makes the investments that would otherwise be handled by the government sells the goods and/or services to the public administration and the public itself, for a certain period of time, according to a contract signed. At the end of this period, the facilities are transferred to the related public administration.

This program permits infrastructure projects such as, bridges, tunnels, dams, irrigation facilities, water supply and sewerage, water treatment plants, communication, highways, railways, upground and underground parking spaces, civil airports and harbors, and similar investments to be constructed and operated by domestic or foreign capital.

II.4.1. Build-Operate and Transfer Law

In Turkey, BOT program was first introduced in 1980's and some projects had been initialized. However, the legal basis was not sufficient, so in order to get over some legal obstacles and unsatisfactory applications, and to strengthen the legal basis, two BOT Laws (No. 3996 and 4047) and one Decree (No. 94/5907) were put into effect in 1994. Law 4047 excluded power projects from the scope of Law No. 3996, subjecting them to Law No 3096 of December 4, 1984 which allows private sector companies to conduct business in the generation, distribution and trade of electricity.

The major points of this legislation could be summarized as follows:

- The public administration responsible for the realization of the project should apply to the High Planning Board through the related and competent Ministry.
- The High Planning Board authorizes the public administration to execute the project under BOT program and, at the end, approves the final contract.

- The administration should prepare specifications and announce the project in Turkey and abroad, maintaining full competition.
- The following bidding methods should be applied: Sealed letter, invited bidders sealed letter and bargaining.
- The duration of the contract, including the investment and operation period, shall not exceed 49 years.
- The method for determining the price of goods or services to be produced shall be the cost plus profit method or the ceiling price method.
- A company should be formed in order to implement the investment. The equity capital to be brought by the company shall not be less than 20% of the amount of proposed total fixed investment.
- Treasury guarantee is given to the company for the cost of goods and services to be purchased by the public administration.
- Exemption from certain levies and stamp duty to the company and administration is provided.
- The company is eligible for investment incentive certificate to receive certain incentives.

II.4.2. Implementation of the BOT Program In Turkey

The major projects planned to be financed by the BOT program take part mainly in energy, transport and urban infrastructure sectors. In this context, according to 1995 data, there are 34 major projects which have a total cost of approximately, US\$ 20 billion.

So far, three hydroelectric power projects are in operation and two hydroelectric power projects are under construction by the BOT model. The Turkish Government is giving a high priority to the realization of these BOT projects. For this purpose, a coordination committee was established in 1994 in order to overcome any obstacles in these projects. The committee is chaired by one of the state ministers and includes the highest officials from the related public agencies.

ENCON

DOGUS GROUP

III. PROJECT PURPOSE

**BOYABAT DAM AND HYDROELECTRIC POWER PLANT
ENVIRONMENTAL ASSESSMENT**

III. PROJECT PURPOSE

Social and economic development of Turkey is going in parallel to the industrial development. For social, economic, and industrial development, energy is a crucial necessity.

Turkey needs to exploit domestic energy sources in order to attain its development goals and activities. Hydroelectric energy is one of the country's most important domestic energy sources, since Turkey has an important potential with rich surface water resources. In addition, it should be noted that hydroelectric energy is a renewable energy resource, which is a very significant issue in the long run. Extensive scientific research on the world's energy resources has shown that fossil sources are rapidly being depleted.

The purpose of Boyabat project fits very well in this context, as it aims at the generation of reliable, inexpensive, and high quality energy. The location of the Boyabat Project is also close to the industrial production and energy consumption centers of Turkey, providing additional benefits such as lower transmission costs and reduced transmission losses. The following sections discuss the energy needs of Turkey associated with the development goals of the country.

III.1. Social and Economic Policy

Five Year Development Plans, prepared by the State Planning Organization (DPT), generally dictate Turkish social and economic goals and policies. These include policies on the sectors and issues affecting social and economic development, such as energy and industrialization policies. The principal goal of the Seventh Five Year Development Plan (1995-2000) is establishing a stable and sustainable development environment by implementing macroeconomic, social, cultural and structural harmonization policies. To achieve these objectives, DPT has estimated that growth of Gross Domestic Product (GDP) should be annually around five percent for this period.

III.2. Present Situation and Objectives in Energy Sector

III.2.1. Present Situation

Primary energy and electricity consumption have increased since the 1950's in Turkey. In this period, primary energy consumption has increased by an average of 5.2 percent and electricity consumption by 11 percent, annually. Primary energy and electricity consumption remain below the levels of more developed countries.

Primary energy production increased by an average of 3.2 percent annually and reached to 32.6 million tons of oil equivalent (TOE) between 1990 and 1995 (6th Plan Period). The most significant developments in production were observed in hydraulic energy and oil production.

In the 1980's, lignite investments were given emphasis. Production capacity reached to 80 million ton/year, as of 1994. However, owing to the fact that electricity demand was not realized as envisaged and hydroelectric power plants were given priority, the expected increase in power plants based on lignite was not realized. Therefore, demand and capacity utilization rates in lignite production remained at low levels.

Total primary energy consumption reached 64 million TOE at the end of 1994. Oil products constitute the largest item, with a 40 percent share in the sector, which has approximately 49 percent dependency on imported resources. The share of power plants and industry in consumption increased while the share of residences decreased with time. Shares of these two sectors within total consumption are presently at the level of 30 percent.

Installed capacity and production capacity of electric power plants reached 20,857 MW and 101 billion kWh, respectively at the end of 1994. Based on 1991 figures, percent shares of energy resources in installed and production capacities are presented in Figure III.1. As of 1994, electricity demand, which amounted to 78 billion kWh, was met continuously with a high reserve margin. In 1995 installed capacity reached to 20,952 MW and electricity production was 86.25 billion kWh. The reserve margin of the total energy production was four percent in 1996, and energy shortages are expected in the near future. Therefore, it is crucial to ensure the continuity of investments to meet electricity demand continuously and safely in the coming years.

Investments in the sector with regard to meeting the requirements of a growing population and a developing economy were inadequate in the last planning periods. Investments realized after 1990, although the demand was doubled, were reduced to the level of half of the investments realized in the period of 1977-1987. Contribution expected from privatization efforts and the private sector could not be realized. In the meantime, public investments were reduced. The difficulties in existing legislation and its implementation negatively affected the continuity of investments as planned. For this reason, the possibility of electricity shortages has become likely in the near future. As a result, since governmental resources are limited, the necessary investments should be realized by the private sector.

III.2.2. Objectives

In the framework of the expectations of economic growth and population increase aimed at in the Plan period, it is estimated that total energy demand will increase by an average of 5.3 percent annually and will reach 85.8 million TOE in 2000. Studies of long term electricity demand based on alternative growth scenarios indicate that demand will reach 120-130 billion kWh in 2000 and 240-270 billion kWh in 2010. Electricity demand in Turkey since 1989 and forecasted needs for 2000 and 2010 are given in Table III.1. Energy investments will be given priority to meet the increasing demand on time. In the Plan period, new large capacity power plant projects will be started. Also, distribution and network investments in line with the objectives to reduce losses and improve networks will continue.

Table III.1. Electricity Demand in Turkey (Seventh Five-Year Development Plan, DPT, 1995)

	Unit	1989	1994	1995	2000	2010
Electricity Demand	Billion kWh	52.602	77.717	83.600	120-130	240-270

Electricity demand is expected to reach 122 billion kWh by the end of the Plan period with an average annual increase of eight percent. In order to meet this demand with a 13.0 percent reserve, it is estimated that installed capacity of power plants should increase to 27,930 MW by an addition of 6,650 MW and production capacity to 138 billion kWh. With these developments, total energy consumption per capita will reach 1,285 kg oil equivalent and electricity consumption per capita to 1,825 kWh in 2000. Developments of primary energy and the production and consumption of electricity are given in Table III.2.

Table III.2. Developments of Primary Energy and the Production and Consumption of Electricity (Seventh Five-Year Development Plan, DPT, 1995)

		1989	1994	1995	2000	Annual Average Increase (%)	
	Unit	Realization	Realization	Realization	Estimate	VI. Plan Period	VII. Plan Period
Primary Energy							
Production	BTEP	27,827	32,553	33,955	40,885	3.2	3.8
Consumption	BTEP	52,149	63,982	66,200	85,800	4.2	5.3
Consumption Per Capita	KEP	948	1,057	1,074	1,284	2.2	3.6
Electricity Installed Capacity	MW	15,806	20,587	21,277	27,930	5.7	5.6
Thermal	MW	9,209	10,993	11,413	15,770	3.6	6.7
Hydroelectric	MW	6,597	9,864	9,864	12,160	8.4	4.3
Production	GWh	52,043	78,256	84,100	122,000	8.5	7.7
Thermal	GWh	34,103	47,681	51,400	83,000	6.9	10.1
Hydroelectric	GWh	17,940	30,575	32,700	39,000	11.3	3.6
Import (Export)	GWh	559	(539)	(500)	-	-	-
Consumption	GWh	52,602	77,717	83,600	122,000	8.1	7.9
Consumption Per Capita	kWh	956	1,284	1,356	1,825	6.1	6.1

BTEP: Thousand tons of petroleum equivalent

KEP : kg petroleum equivalent

GWh : Million kilowatt-hour

A review of the estimated hydraulic energy for 2000 indicates the importance of the Boyabat Dam and Hydroelectric Power Plant Project. This project would provide 510 MW (approximately 4.2%) of the total installed hydro capacity of 12,160 MW expected for 2000. In accordance with this estimate, Boyabat Dam and Hydroelectric Power Plant, with its large installed capacity and high annual electricity generation, would be an important facility for achieving Turkish long term energy goals.

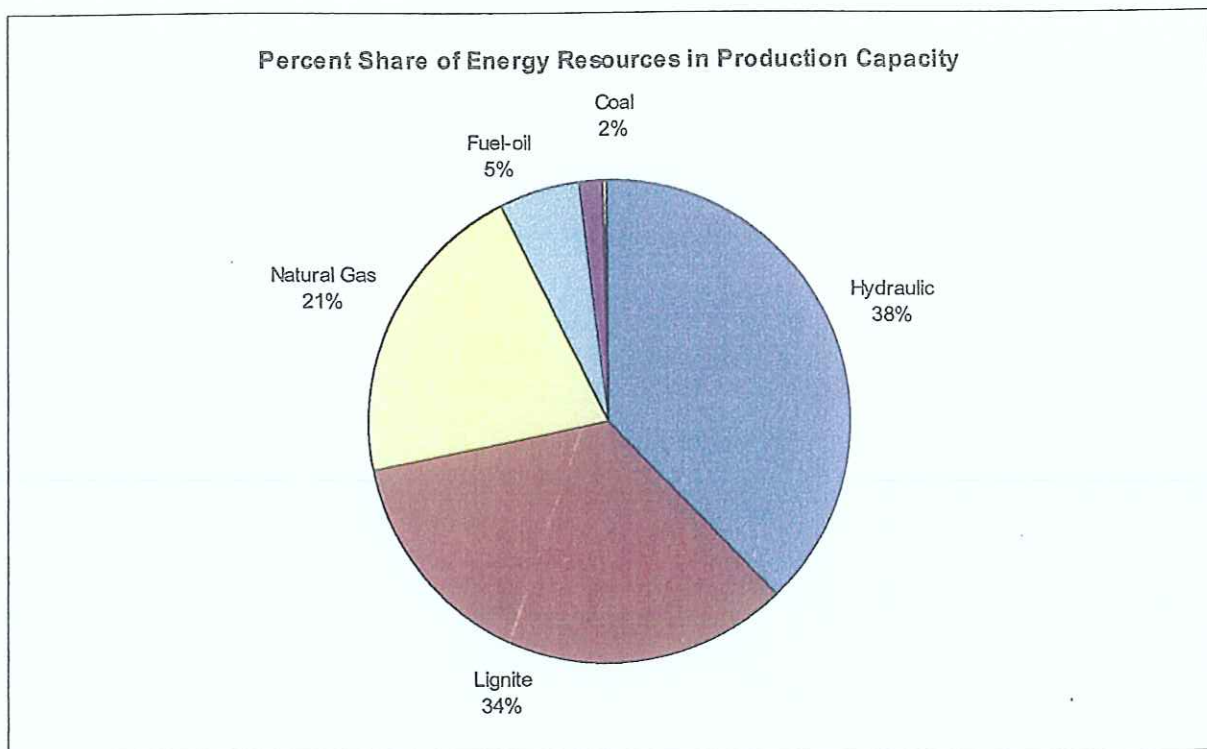
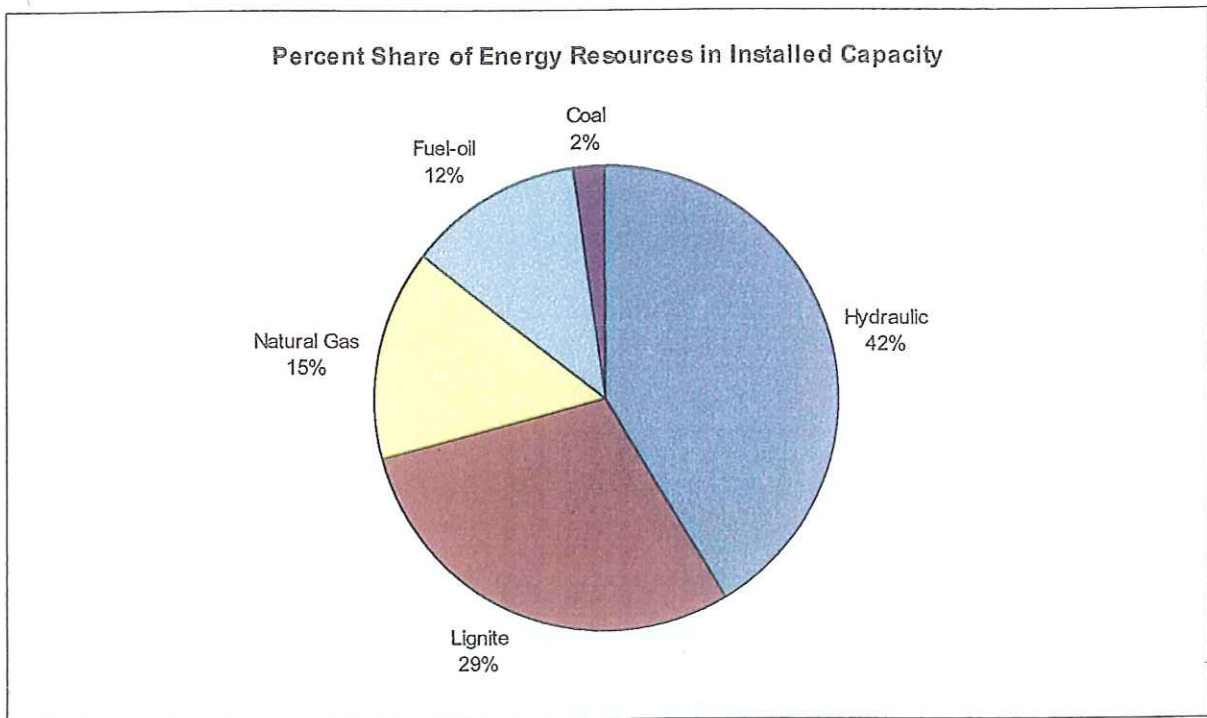


Figure III.1. Percent Shares of Energy Resources in Installed and Production Capacities

IV. PROJECT DESCRIPTION

IV. PROJECT DESCRIPTION

Construction of the Boyabat Project was started in 1987 by DSI and access road to the dam site, including a bridge to the right bank, camp facilities, diversion tunnels, and access tunnels to the crest were completed. With the inclusion of the Project in the Turkish government's BOT program, DSI halted development of the Project and DOGUS applied to construct and operate the proposed dam and hydroelectric power plant.

The project (see Figure IV.1) comprises a concrete gravity dam and appurtenant control structures (spillways, bottom outlet, and diversion tunnels), penstocks, a semi-underground power station, and the associated switchyard. The following discussion provides a description of the project location, structure, construction techniques, and operational characteristics.

IV.1. Project Location

The Boyabat Project site is located five kilometers southeast of Duragan Town, in the northwest of Turkey, on the Kizilirmak River, approximately 125 km inland from the Black Sea. Kargi is a town located at the upstream end of the future reservoir. Thus, the project area lies in the Middle Black Sea Region within the provinces of Samsun, Sinop and Corum, located between latitudes 41°05' - 41°25' north and longitudes 34°20' - 35°10' east.

The project area is bounded by Altinkaya Reservoir on the north, Gokirmak Basin on the west, Devres Creek on the south and Kunduz and Cal Mountains on the east. The dam and the future reservoir are located along a 60 km segment of the Kizilirmak River, with the dam in a narrow, steep-sided canyon.

The Kizilirmak River flows down through the Central Anatolian Plateau changing its course from west to southwest, and at a point about 20 km north of the city of Nevsehir changes its course again in a northwest direction and flows into Hirfanli Reservoir. Upon generation of maximum output of 96 MW at Hirfanli Power Station with maximum available discharge of 196.5 m³/sec and effective head of 60 m, the river flows into two other reservoirs, namely, Kesikkopru and Kapulukaya. After these two reservoirs, the river changes its course north to northeast and then enters a gorge in the mountainous area running parallel to the Black Sea coast.

The project is located near where the river enters the gorge. This site is also near the end of the backwater of Altinkaya Reservoir. After passing beyond Altinkaya Dam, the valley widens and the river gently flows through the broad Bafra Plain to discharge into the Black Sea.

The mean elevation of the river basin of this Project is 1,100 m. Consequently, the river basin is mostly in the form of steppe with little vegetation, and the average inflow at the project site is 152 m³/sec (0.24 m³/sec/100 km²).

IV.2. Description of Structural Components

IV.2.1. Dam and Reservoir

The dam, presented in Figure IV.2, is a concrete gravity type dam. It is 150 m high with river bed elevation of 185 m and a crest elevation of 335 m above sea level (ASL). The height of the crest, from foundation, is 195 m. The crest is 262 m in length and 10 m in width. The volume of concrete required for the dam body is 2,300,000 m³ and the total concrete requirement is 2,765,000 m³. The excavation required for the dam is 2,605,000 m³.

The Kizilirmak River in the vicinity of the projected dam axis has a channel on a roughly straight line in the SSW-NNE direction for a stretch of approximately one kilometer, while upstream and downstream of this section, the direction of flow is E-W. The projected dam axis is located roughly in the middle of the section in the SSW-NNE direction, which forms a limestone-distributed gorge of width 80 to 100 m. Schist is predominantly distributed in the surroundings of the E-W direction channels in upstream and downstream directions and the valleys are wide.

The full supply level (maximum water level) in the reservoir is 330 m ASL, while the minimum water level is 305 m ASL during normal operation. The gross storage capacity is $3,557 \times 10^6$ m³ and the effective storage capacity is $1,410 \times 10^6$ m³. The reservoir is approximately 60 km in length. Its area at full supply level (at 330 m) is 65.4 km².

IV.2.2. Spillways and Bottom Outlets

The maximum flood peak discharge of the Kizilirmak River at the dam site is 9,300 m³/s (JICA, 1979). The relatively small capacity of the reservoir, with respect to the flood inflow, precludes the possibility of significantly reducing the peak discharge through temporary storage. Therefore, this discharge must be passed through the spillway. The spillway, which will be located on the dam body, consists of six radial gates with center overflow and with a total discharge capacity of 9,300 m³. Each gate has a width of 10.00 m and a height of 13.00 m.

The bottom outlets are incorporated in diversion Tunnel 2. They are designed for a flow of 280 m³/s under full head and minimum flow of 250 m³/s. These outlets will be used to control the initial filling of the reservoir. The bottom outlet is equipped with two high pressure slide gates (1.70 × 2.10 m) and two rapid flow gates.

IV.2.3. Diversion Tunnels and Cofferdams

Two diversion tunnels are already built, with equal diameters of eight and a half meters and a horseshoe section. Plan, profile and sections are shown in Figure IV.3. Tunnel 1 has a length of 1,015 m, and Tunnel 2 966 m. The capacity of the diversion tunnels is 1,400 m³/s at an elevation of 215 m (the 10-year return flood of 1,355 m³/s is adopted as the design flood of the diversion tunnels). The diversion tunnel entrances and exits are shown in Photographs IV.1 and IV.2, respectively.

The upstream cofferdam has been designed as a rockfill dam with a clay core at a crest elevation of 217 m. The volume of fill is 300,000 m³. The downstream cofferdam is also a rockfill dam with a clay core at a crest elevation of 197 m and the volume of fill is 150,000 m³.

IV.2.4. Penstock and Power Plant

The penstock and power plant are presented in Figure IV.4 and Figure IV.5. The semi-underground power plant is 108.00 m long, 25.10 m wide and 47.00 m high in its central section. It will be fitted with three vertical Francis-type turbine generators with ratings of 152 MW and 176 MW, corresponding to minimum and maximum head, respectively. The power plant will be located immediately below the spillway and will consist of a machine hall and a transformer hall.

IV.2.5. Switchyard and Transmission Line

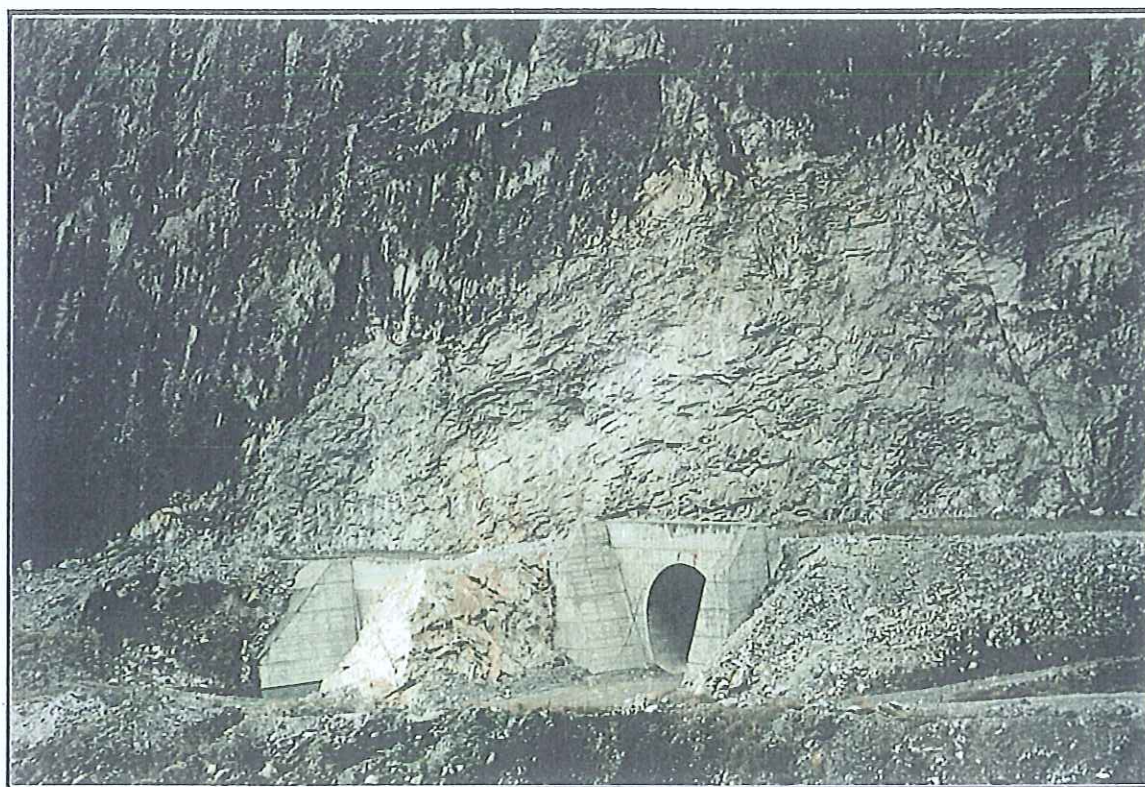
The switchyard will be built on the left bank of the Kizilirmak, approximately 500-600 m from the projected dam axis at an elevation of 570 m. The switchyard connection of each unit will be done from the Power Cable Headyard, which will be located on the right bank and next to the power plant, at an elevation of 230 m. The length of connecting line for each unit is approximately 700 m. The location of the proposed switchyard is shown in Figure IV.6.

From the switchyard, the electricity will be given to the interconnected system and will be transmitted to the western part of Turkey where electricity requirement is high. Power transmission lines to be used to transmit the electricity will be planned and built by Turkish Electricity Authority. A transmission line, having a length of approximately 60 km, will be built between the Boyabat and Altinkaya switchyards. The capacity of this line is planned to be 380 kV. During the design phase of the transmission line, the environmental impact assessment process summarized in Chapter II, Section II.2. "Environmental Impact Assessment (EIA) Procedure in Turkey" will be followed. The environmental impact assessment report will be prepared by the Turkish Electricity Authority, after the alternative routes have been evaluated. In that EIA; project description, site selection, economic and social dimensions of the project, baseline data, impacts of the project on the environment in construction, operation, and post operation phases and the mitigation measures, analysis of alternatives and the selected alternative with reasons, and the monitoring plan will be described.

The transmission line EIA report will be evaluated by the Ministry of Environment and the related agencies, as described in Section II.2. As a result of this evaluation, necessary mitigation measures to minimize the impacts on physical, biological and sociological environments will be concluded and committed. A Monitoring Plan will be completed after taking the opinions of the evaluation committee into account, with the Ministry of Environment responsible for monitoring. As a result of this evaluation period, if there are no problems related to the project route and the report is found sufficient, the report will be approved by the Ministry of Environment and the project will get clearance from the Ministry.



Photograph IV.1. The Diversion Tunnel Entrance



Photograph IV.2. The Diversion Tunnel Exit

IV.2.6. Borrow and Disposal Areas

Boyabat Dam is a concrete gravity type dam and the required embankment volume is $2.3 \times 10^6 \text{ m}^3$. Also, 300,000 m^3 and 150,000 m^3 clay-core rock embankments are required for upstream and downstream cofferdams, respectively.

Various surveys undertaken at the dam site have shown that the local geology will provide sufficient quantities of construction materials. For instance, material for concrete aggregate can be collected from the river bed, and crushed and treated as required. Impervious material required for cofferdam construction will be extracted from the Fakili area, approximately eight kilometers upstream of the dam location. It is believed that there is over five million cubic meters of such suitable material at this location. Rock fill material required for the construction of cofferdams will also be supplied from excavated material. A construction materials location map is provided in Figure IV.7.

Cement required for concrete will be provided from Corum Cement Plant, which is at a distance of 200 km. Furthermore, the amount of water that will be used in construction phase will be around 750,000 m^3 .

The disposal areas for excavated materials are one to five kilometers from the dam axis and approximately 2.2 million m^3 material will be disposed of at these sites. The locations of disposal sites are indicated in Figure IV.8.

IV.2.7. Camp Facilities and Off-site Investments

IV.2.7.1. Access Roads and Tunnels

As a part of Boyabat Project, Boyabat Dam access and crest roads have been built and are in operation. The access road to the dam site is shown in Photograph IV.3. There is a stabilized gravel road running for about 60 km along the river with a width of around five meters. This road is being used as an access road now. After impoundment, only the part running downstream of the dam axis would be used as an access road. The main road connecting the town of Havza and the city of Kastamonu does not follow the Kizilirmak River, but passes through Duragan. In addition, there are village roads in the higher elevations at both banks of the river. The access road connecting the main road and camp facilities is an asphalt road and is about two kilometers long and five meters wide. Switchyard access and other roads will be built during the construction of the dam. In Figure IV.9 the general layout of the construction facilities is given.

The access to the switchyard is to be provided by a road (partially a tunnel) that will be constructed at the left bank. The access road to the control building of the power plant and access tunnel to the powerhouse will be constructed at the left bank of the river. The power house will be accessed by a tunnel branching into two. Delivery of mechanical and electrical equipment to the power plant will be done by utilizing an access road constructed on the left bank of the Kizilirmak River.



Photograph IV.3. Access Road to the Dam Site

IV.2.7.2. Camp Facilities

As a part of the Boyabat Project, camp facilities have been built about eight kilometers downstream of the proposed dam axis, on the left bank of the river, and are in operation. These facilities include residence buildings, an administrative building, school, guest-house, restaurant, canteen and other social facilities (see Photographs IV.4 and IV.5). Additional facilities and labor camps will be constructed on the left bank, at the beginning of the crest access road, and will be temporary structures. About 700 workers will be employed during construction and these facilities will meet their housing and social needs.

Domestic wastes will be disposed to specially selected and prepared disposal sites, meeting the requirements of Turkish Regulations. These sites will be continuously monitored and controlled. Transportation between the site and the nearby settlements will be carried out by bus services. Telephone is the basic means of communication and the phone lines provided by the Turkish Telephone Authority is being used. Energy is supplied from the national electricity network (interconnected system) and with local backup generators using fuel-oil. Fuel-oil is used for heating purposes.

IV.3. Construction Techniques and Operation Characteristics

IV.3.1. Construction Techniques and Schedule

In the 1986 Construction Program of DSI, the construction of access roads, camp facilities and diversion tunnels for Boyabat Dam was commenced. Accordingly, the access road to the dam site and the crest, including a bridge to the right bank, camp facilities, and construction of diversion tunnels have already been completed.

Under the BOT agreement, DOGUS proposed a tentative construction schedule, permitting the completion of construction in a maximum time period of 57 months. In the context of the continuing design studies, this construction time might be reduced. According to this tentative schedule, water impoundment is planned to be started at the end of the 48th month of construction. The first, second and third units will be taken into operation after 51, 54 and 57 months from the start of construction, respectively. However, in the course of the design studies, these dates may change and the impounding may start earlier. In addition depending on the starting date of impounding, it may last longer than 3 months. The key dates of the proposed schedule, considering the maximum time required for construction, are presented in Figure IV.10.

IV.3.1.1. River Diversion

Diversion of the river is the first step of dam construction. The diversion tunnels were previously completed due to inclusion of Boyabat Project in the 1986 Construction Program of DSI.



Photograph IV.4. Site Facilities and Kizilirmak



Photograph IV.5. Administrative Building

The upstream cofferdam excavation will last for approximately one month and the excavation of the downstream cofferdam will start after the excavation for the upstream one is finished. The construction of the upstream and the downstream cofferdams will be completed in approximately two and a half and four months, respectively.

IV.3.1.2. Excavation and Foundation Treatment

Left bank conveyor gallery excavation will start at the beginning of construction and last for six months. In the second month of that excavation, right bank platform and cavern excavations will have to be started. Excavated materials, depending on their quality, will be either used as aggregates for concrete or will be transported to disposal sites.

Construction of the access roads will start at the same time with the left bank conveyor gallery excavation and last for 12 months. During this period, the access roads and tunnels to the switchyard and the power house will be constructed as well.

Consolidation grouting will be performed in advance of dam concrete casting. Curtain grouting will be performed during dam body construction from galleries that are provided inside the dam body and from curtain grouting galleries that are provided at both banks. The foundation treatment of the dam is presented in Figures IV.11 and IV.12.

Seepage of water through and around grout curtains may be observed. To avoid the building up of excess hydrostatic pressures at the base of the structure, a network of drain holes will be drilled downstream following the completion of the high-pressure grout curtain.

IV.3.1.3. Dam Construction

Dam body concrete operation will take around 35 months, while spillway piers and wall concrete will be built in 16 months, starting at the half stage of body construction. Water intake structure concrete construction is scheduled to last for seven months. Installation of spillway equipments will start at month 42 and will continue for nine months. Concrete aggregate will be produced from excavated material, sand and gravel borrow areas and quarry operation.

IV.3.1.4. Electrical Equipment

The tentative installation schedule, according to a maximum construction period of 57 months, will be as follows:

- Turbines: begin 31 months after the construction starts and lasts for 25 months.

- Powerhouse Crane: begin 36 months after the construction starts and lasts for four months.
- Generators: begin 46 months after the construction starts and lasts for 12 months.
- Transformers: begin 46 months from the beginning of construction and the duration is planned to be five months.
- Switchyard Equipment: starts 45 months after the beginning of construction and ends at 51st month.
- Powerhouse Equipment: starts 45 months after the construction begins and lasts through 57th month.

As stated previously, in the context of the continuing design studies, this construction period might be reduced and the dates mentioned above are based on the maximum time required for construction.

IV.3.2. Construction Labor Requirements and Project Filling Time

The average personnel requirement during construction is approximately 750, while at peak construction periods approximately 1200 personnel will be employed on the project. This would create short-term employment opportunities for the local workforce. It is currently envisaged that work creation/training schemes will be introduced to provide longer term employment opportunities, including greater leisure-related activities.

The number of skilled and semi-skilled workers will be around 520 and the number of unskilled workers about 80 in the construction phase. In addition, there will be approximately 150 workers for supporting services.

Water impounding will start after 48 months from the beginning of construction according to the proposed tentative schedule, and the first unit is planned to be taken into operation in July. Impounding might be started earlier depending on the developments during the design studies and the required time for impounding might change accordingly. During this period, while water is being impounded, the bottom outlet will be used to provide the minimum flow downstream of the dam.

IV.3.3. Project Costs

The total funding requirement of the Project up to commissioning, including payment for land acquisition, contingencies, transaction related fees and capitalized interest costs is estimated to be \$650 million.

It is estimated that the total funding requirements will be met from a combination of equity subscribed, in the form of ordinary share capital and shareholder subordinated

loans, for about 20% of the total funding requirements, plus mezzanine debt and senior debt facilities, for the remaining 80%, to be raised on a limited recourse basis.

It is DOGUS's current intention to take an equity stake in the Project Company of at least 30%, and the selected Co-Lead Investor will be expected to at least match this level of ownership.

Debt facilities are expected to include ECA buyer credit facilities in respect to imported goods and services, other forms of credit-enhanced loans from the Project Lenders.

IV.3.4. Operation Characteristics and Labor Requirements

The Boyabat Power Plant will have three units, each one equipped with a vertical axis Francis type turbine. According to the Boyabat Project Report the stored and regulated water will be used for power generation of a maximum output of 510-MW and annual energy production of 1,468 GWh with maximum available discharge of 471.0 m³/sec and effective head of 125.5 m. The water utilized for power generation will flow into Altinkaya Reservoir and will again be used for power generation of a maximum output of 700 MW at Altinkaya Power Station.

Annual average inflow at the dam site is 182.0 m³/sec with 67% of the annual inflow concentrated in the four months period from March to June. Snowmelt starts in March and it is followed by the wet season lasting from April to June. The inflow is decreased to 30% of the average inflow in the dry season of August, September and October. Thus, a matter of great importance in the hydroelectric development scheme is to store and regulate the inflow of large seasonal variation in the reservoir aiming to average out the available discharge.

Hydraulic data for Boyabat Project are presented in Figure IV.13. This figure includes the rating curve at Boyabat Dam Site, spillway and bottom outlet rating curves, discharge curve of the diversion tunnel and the area-capacity curve of the Boyabat Reservoir. Figure IV.14 shows the estimated flood flow (with relative frequencies) and the monthly average runoff at the Boyabat Dam Site. In case of flood flow, the operational characteristics of the spillway can be perceived from the spillway discharge curve given in Figure IV.15.

The Boyabat Project will be operated in a combination of base load and load following modes. One turbine would be operated continuously, providing a constant output of 105-176 MW (depending on the available head) to the TEAS grid. The other two turbines will be operated in response to the electricity load of TEAS, which responds to daily consumer demand in its service region.

Following its first filling, the reservoir will be maintained at the highest surface elevation possible, consistent with the generating requirements described above. A Reservoir Operation rule curve will be developed in accordance with seasonal changes of flow and hydrologic forecasts.

During the operation phase, approximately 100-120 persons are needed to run the power plant and the dam. Around 50-60 of these will be skilled workers (engineers, mechanics, hydromechanics, electricians, electronics specialists) and administrative staff, and the remaining will be unskilled workers and secondary staff (guards, cooks, gardeners, etc.) who will be, preferably, hired locally.

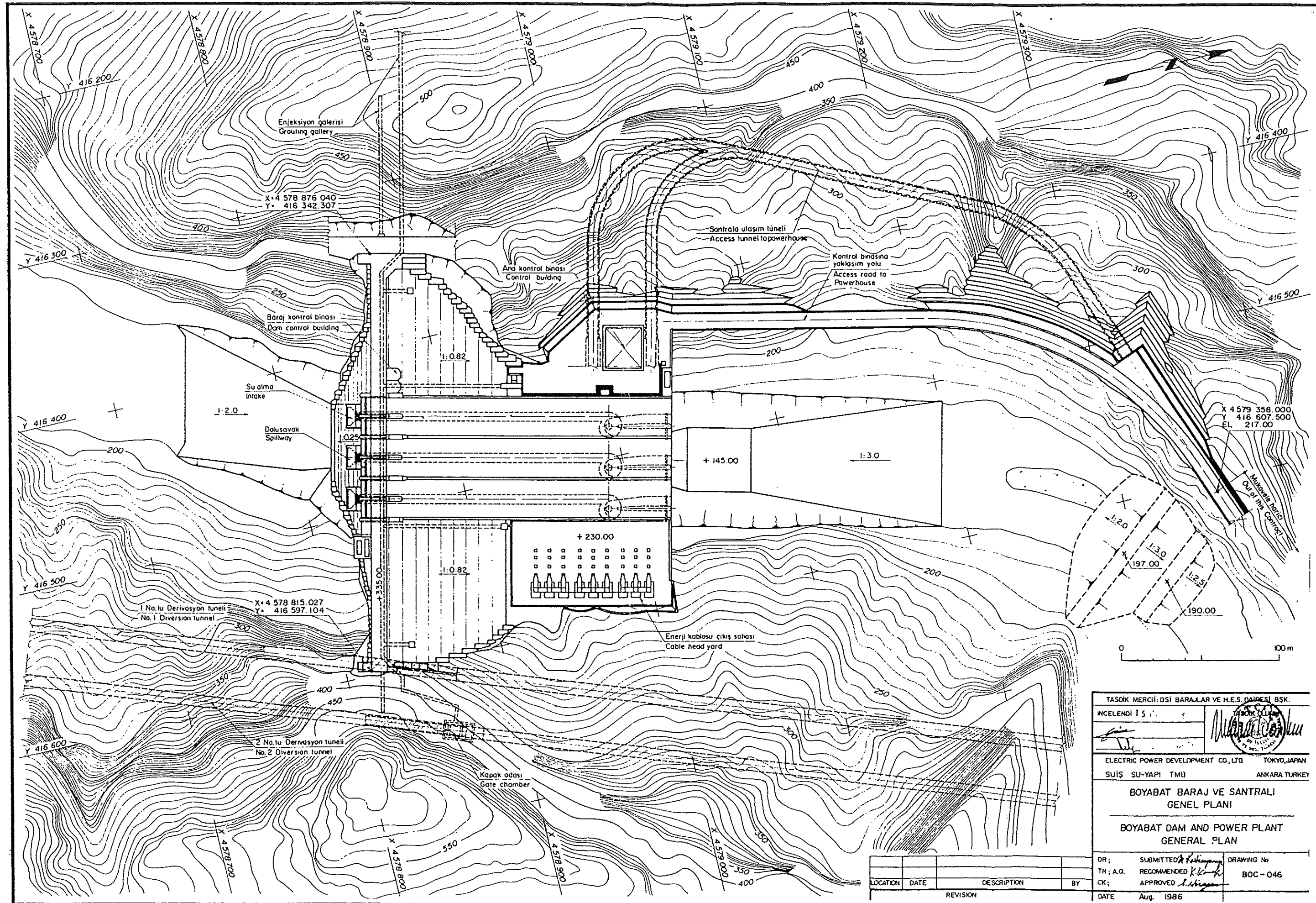


Figure IV.1. Boyabat Dam and Power Plant, General Plan

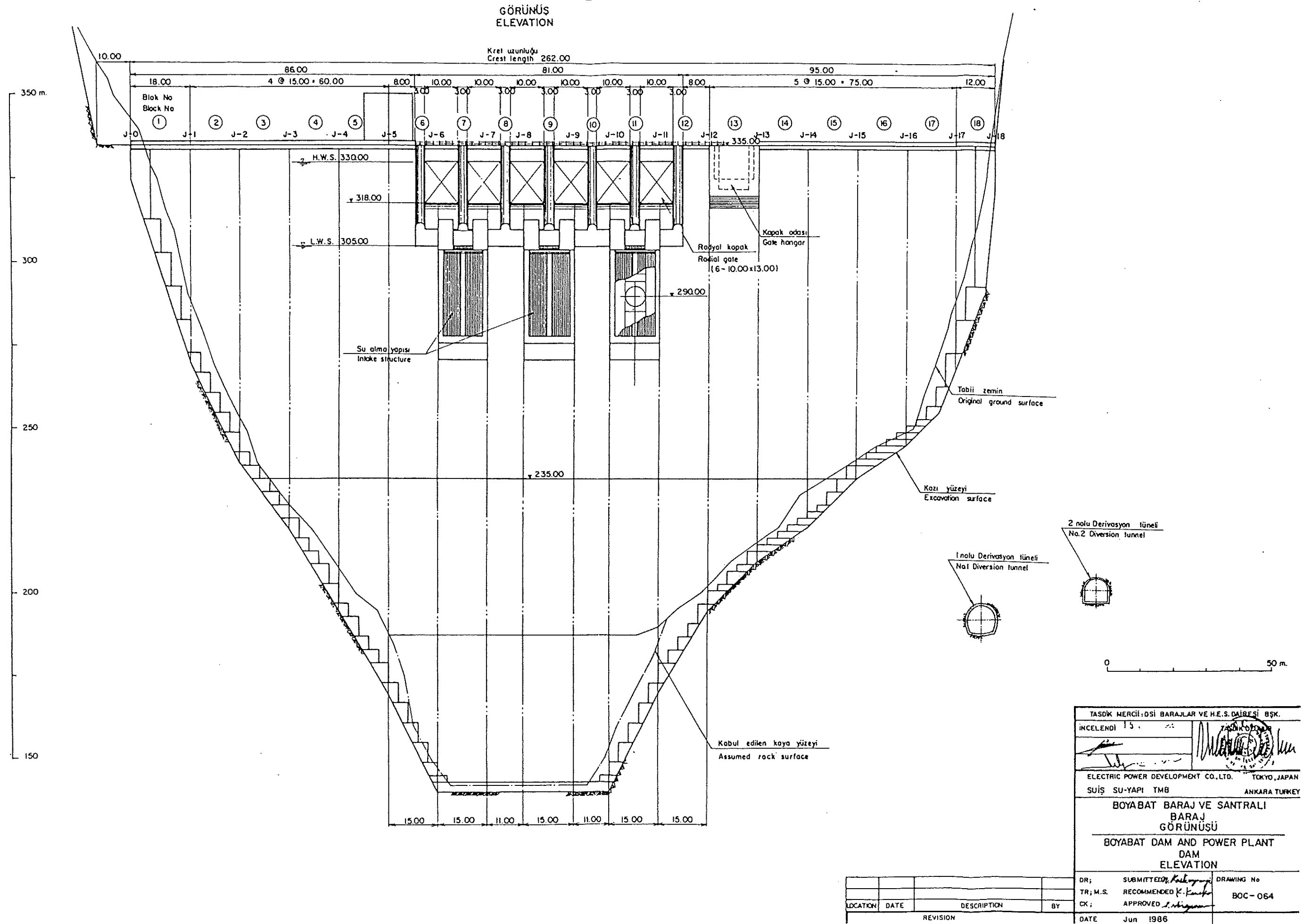
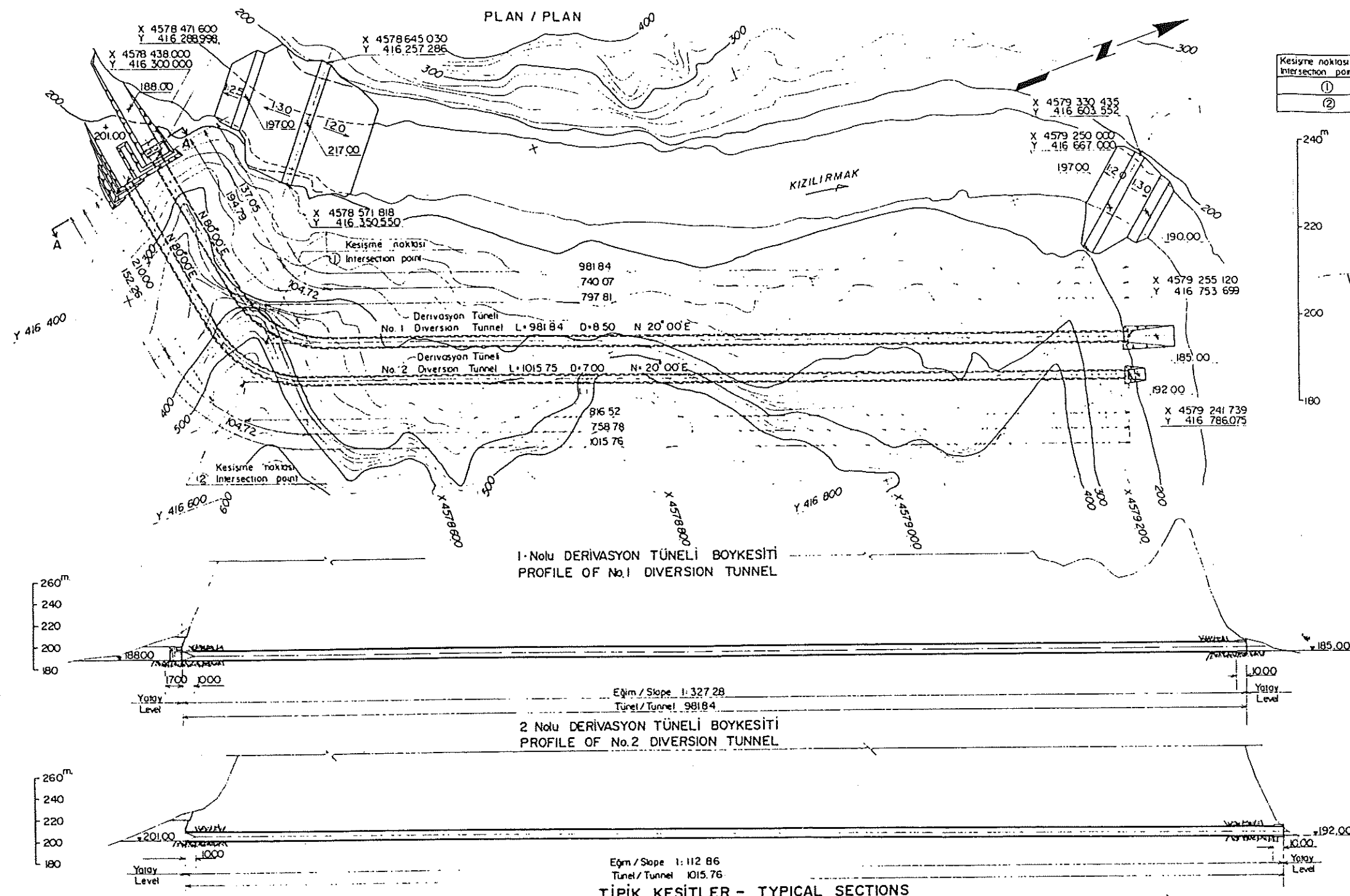
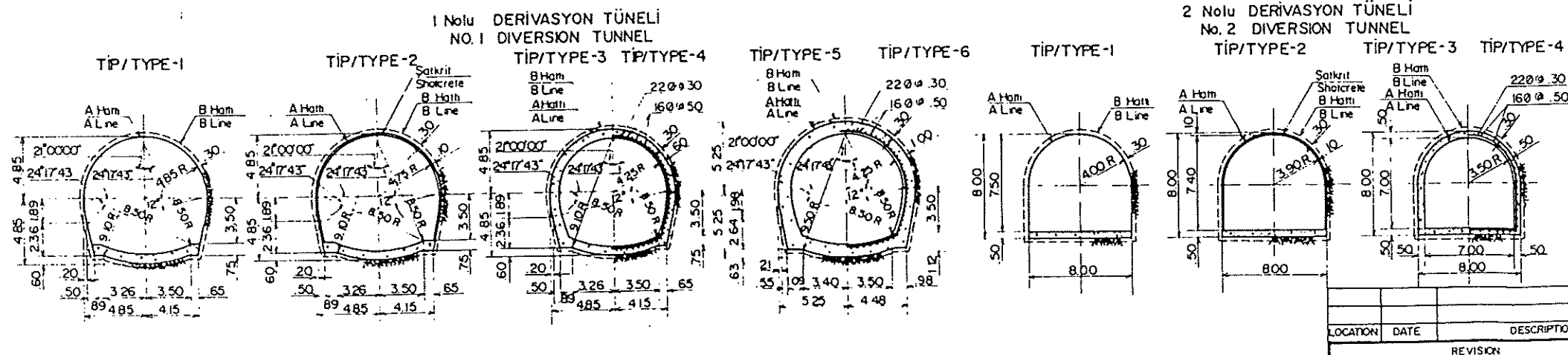
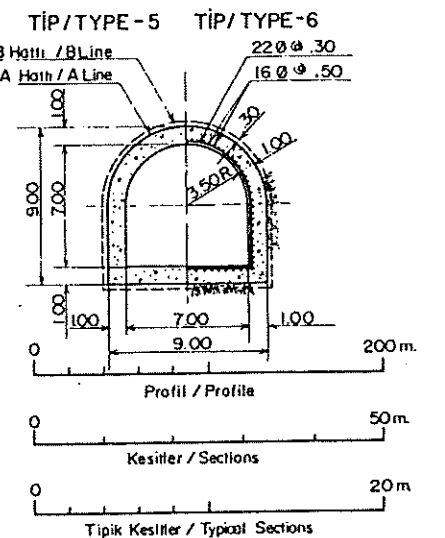
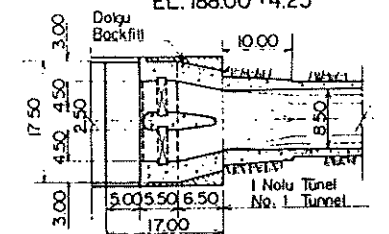
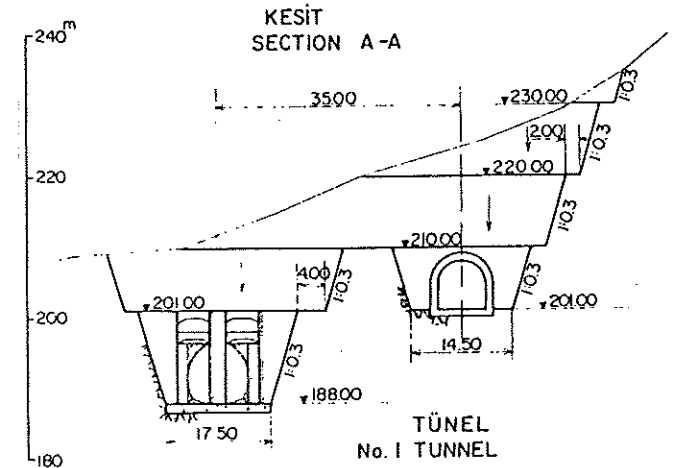


Figure IV.2. Boyabat Dam and Power Plant, Dam Elevation



KESİŞME NOKTALARI KOORDİNATLARI
COORDINATES OF INTERSECTION POINTS

Kesim noktası Intersection point	X	Y	Acı	R	T	L
①	4578 505.424	416 480.832	60° 00' 00"	100.00	57.74	104.72
②	4578 474.466	416 506.810	60° 00' 00"	100.00	57.74	104.72



TASDIK MERCİİ-ÖSİ BARAJLAR VE H.E.S. Dairesi BSK

İNCELENDİ

ELECTRIC POWER DEVELOPMENT CO. LTD. TOKYO, JAPAN

SUİS SU-YAPI TMB ANKARA, TURKEY

BOYABAT BARAJ VE SANTRALİ
DERIVASYON TUNELLERİ
PLAN, PROFİL VE KESİTLERİ
BOYABAT DAM AND POWER PLANT
DIVERSION TUNNELS
PLAN, PROFILE AND SECTIONS

OR; SUBMITTED
TR; A.E. RECOMMENDED
CK; APPROVED

DRAWING No.
BOC-049

DATE July 1986

Figure IV.3. Diversion Tunnels, Plan, Profile and Sections

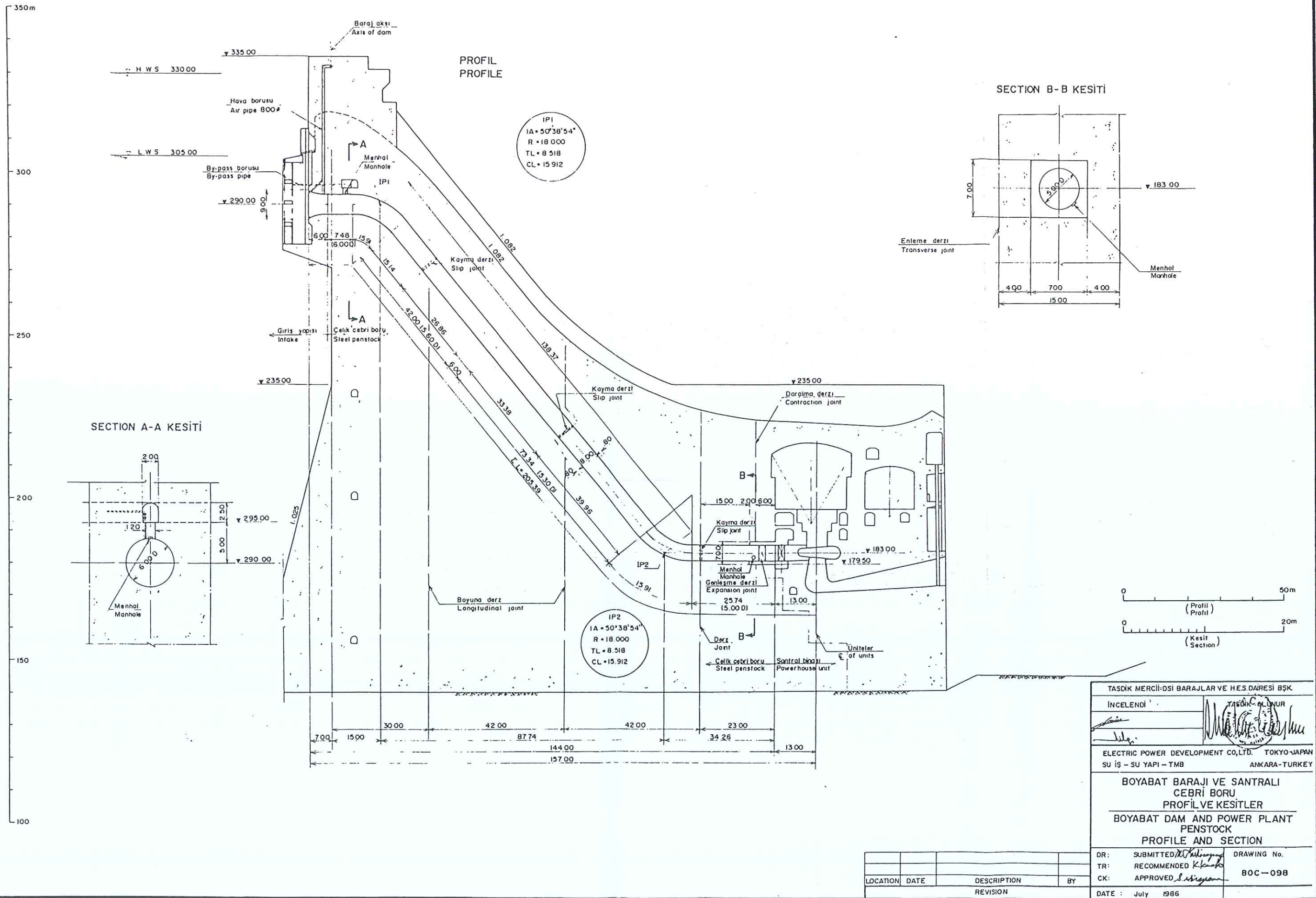


Figure IV.4. Penstock and Power Plant Profile and Sections

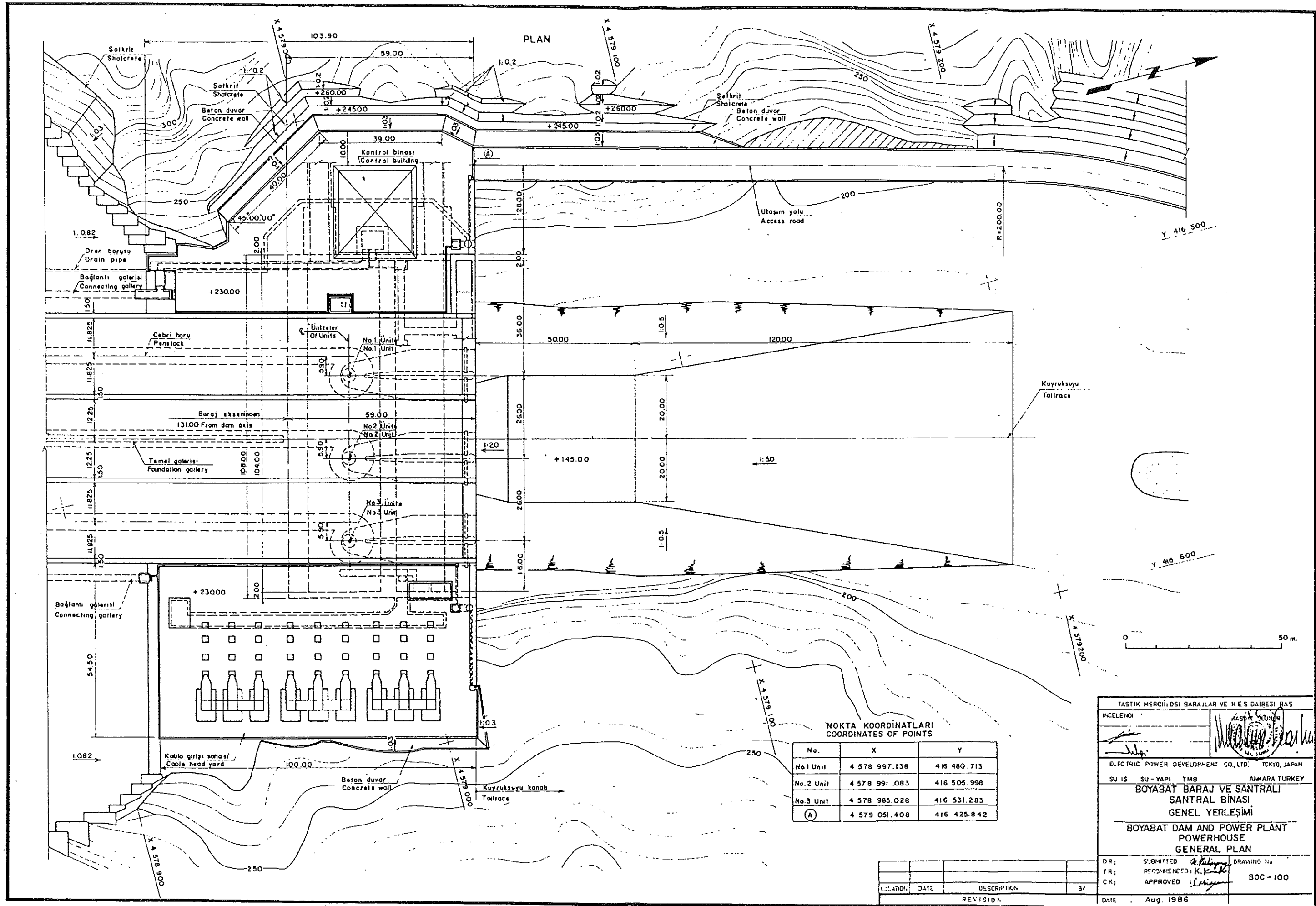


Figure IV.5. Power House General Plan

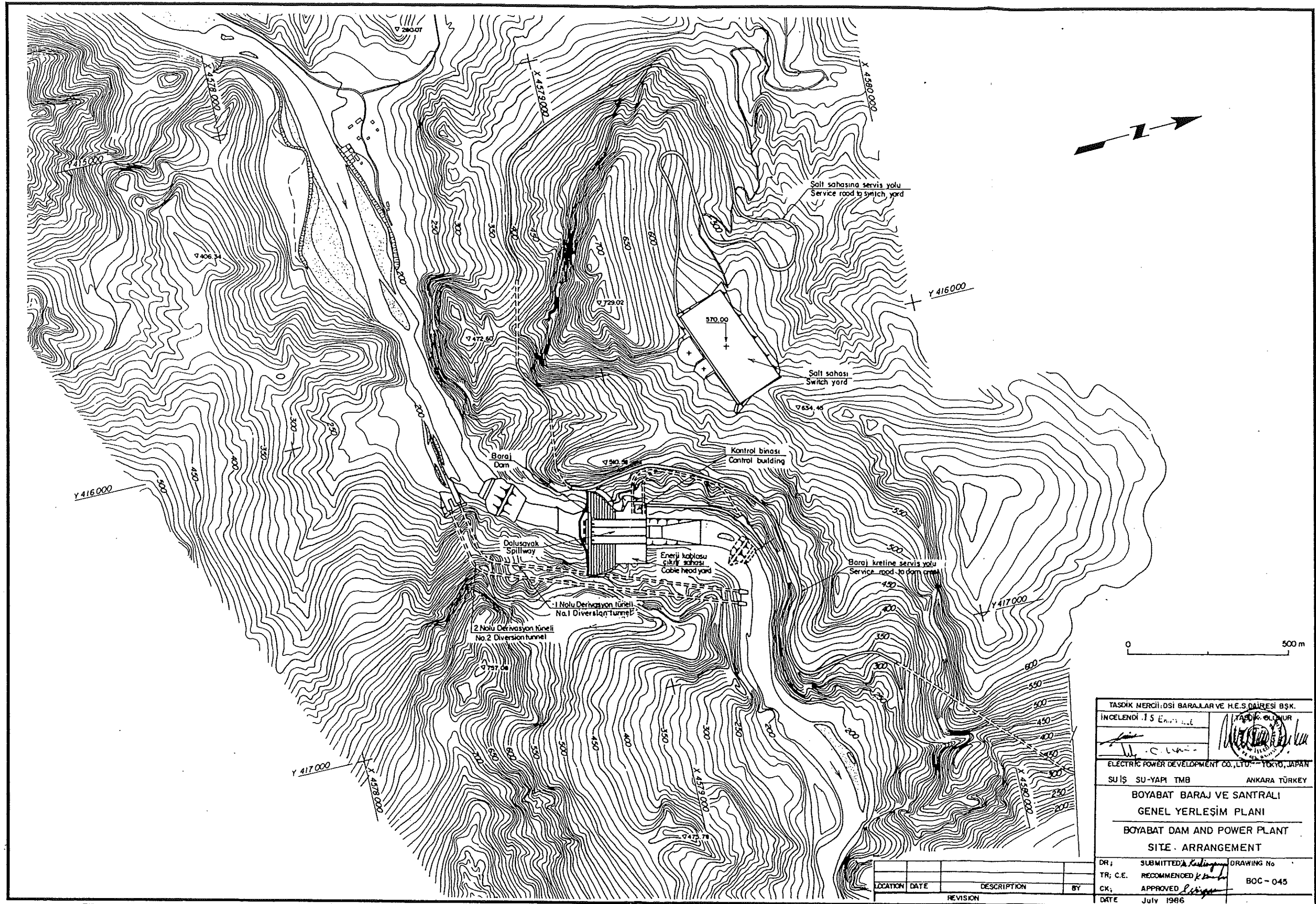


Figure IV.6. General Layout

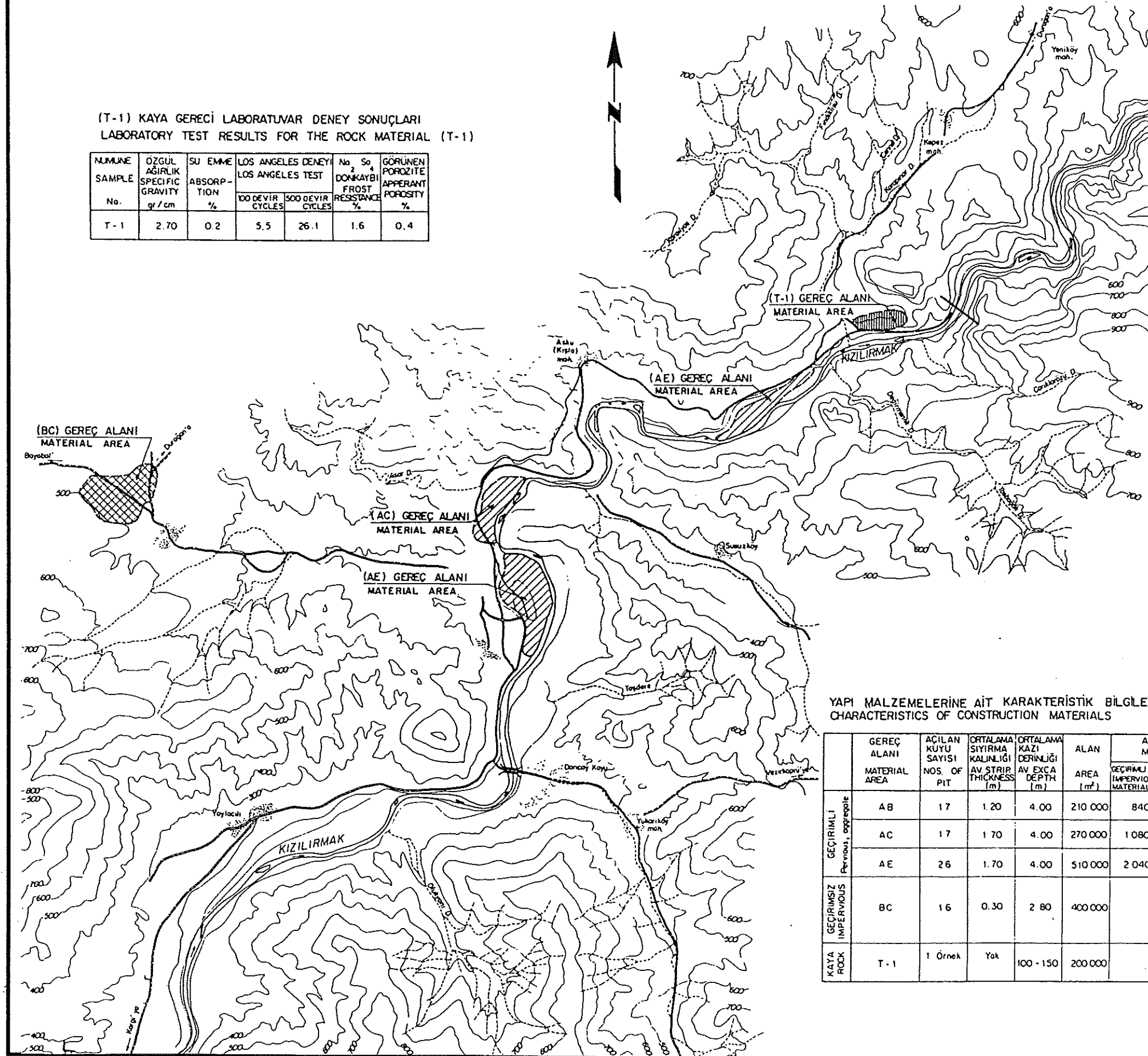
TASDIK MERÇİİ: DSİ BARAJLAR VE H.E.S. DAİRESİ BŞK.			
İNCELENDİ: İS		TASDIK OLUNUR	
 İS		 İS	
ELECTRIC POWER DEVELOPMENT CO., LTD. - TOKYO, JAPAN			
SU İŞ SU-YAPI TMB		ANKARA TÜRKİY	
BOYABAT BARAJ VE SANTRALİ			
GENEL YERLEŞİM PLANI			
BOYABAT DAM AND POWER PLANT			
SITE - ARRANGEMENT			
DR:	SUBMITTED: 	DRAWING No	
TR: C.E.	RECOMMENDED: 	BOC - 045	
CK:	APPROVED: 		
DATE	July 1986		

(T-1) KAYA GERECİ LABORATUVAR DENEY SONUÇLARI
LABORATORY TEST RESULTS FOR THE ROCK MATERIAL (T-1)

NUMUNE SAMPLE No.	ÖZGÜL AĞIRLIK SPECIFIC GRAVITY gr / cm	SU EMME ABSORP- TION %	LOS ANGELES DENEYİ LOS ANGELES TEST		No. 2 DOKKAYBI FROST RESISTANCE %	GÖRÜNEN PORÖZİTE APPEARANT POROSITY %
			100 DEVİR CYCLES	500 DEVİR CYCLES		
T-1	2.70	0.2	5.5	26.1	1.6	0.4

SİMGELER
LEGEND

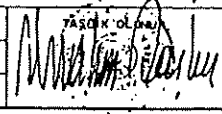
-  Geçirimli gerek ve agrega alanı
Pervious material and aggregate area
-  Geçirimsiz gerek alanı
Impervious material area
-  Kaya gerek alanı
Rock material area
-  Gerek alanı sınırı
Boundary of area



YAPI MALZEMELERİNE AİT KARAKTERİSTİK BİLGİLER
CHARACTERISTICS OF CONSTRUCTION MATERIALS

	GEREC ALANI MATERIAL AREA	AÇILAN KUYU SAYISI NOS. OF PIT	ORTALAMA SIYIRMA KALINLIĞI AV STRIP THICKNESS (m)	ORTALAMA KAZI DERİNLİĞİ AV EXCA DEPTH (m)	ALAN AREA (m ²)	ALINABİLECEK GEREC MİKTARI MATERIAL TO BE TAKEN (m ³)			ALANINBARAJ EKSENİNE UZAKLIĞI DISTANCE (m)
						GEÇİRLİ GEREC IMPERVIOUS MATERIAL	GEÇİRLİSİZ GEREC PERVIOUS AGGREGATE MATERIAL	KAYA GERECİ ROCK MATERIAL	
GEÇİRLİ Pervious aggregate	AB	17	1.20	4.00	210 000	840 000			2 500
	AC	17	1.70	4.00	270 000	1 080 000			8 000
	AE	26	1.70	4.00	510 000	2 040 000			8 700
GEÇİRLİSİZ IMPERVIOUS	BC	16	0.30	2.80	400 000		1 120 000		17 000
KAYA ROCK	T-1	1 Örnek	Yok	100 - 150	200 000			YETERİ KADAR SUFFICIENT	750

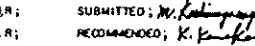
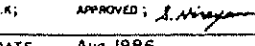
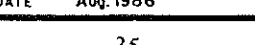
TASDİK MERCI: OSİ BARAJLAR VE H.E.S. DAİRESİ BAŞ.

İNCELENDİ:  TASDİK OLUNDU: 

ELECTRIC POWER DEVELOPMENT CO., LTD. TOKYO, JAPAN
SUIŞ, SU-YAPI, TMB ANKARA, TURKEY

BOYABAT BARAJ VE SANTRALI
YAPI MALZEMELERİ
HARİTASI

BOYABAT DAM AND POWER PLANT
CONSTRUCTION MATERIALS
LOCATION MAP

D.R.; SUBMITTED: 
T.R.; RECOMMENDED: 
C.K.; APPROVED: 

DATE Aug. 1986 DRAWING No. BOC - 038

Figure IV.7. Construction Materials Location Map

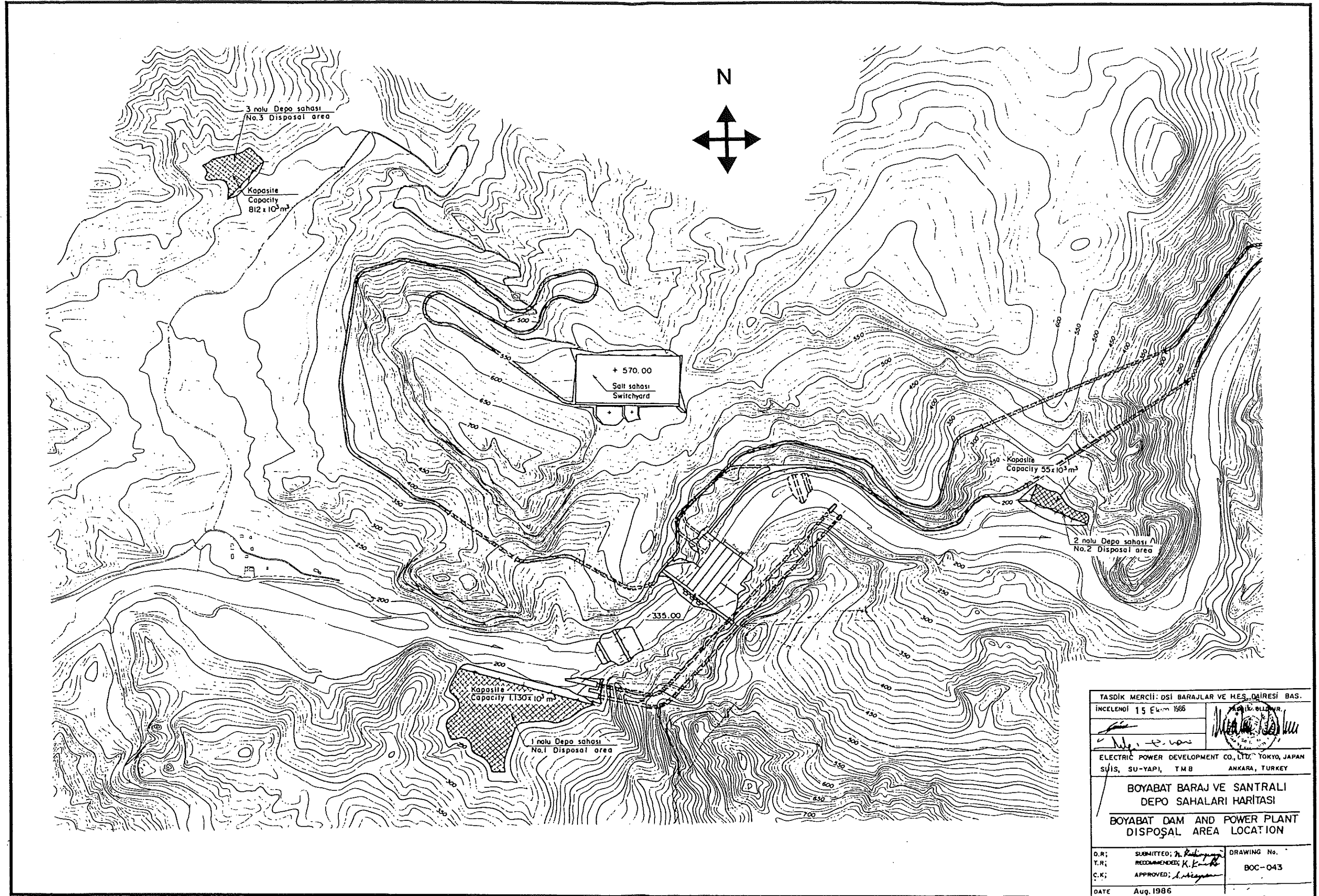


Figure IV.8. Disposal Areas Location Map

BOYABAT DAM AND HEPP CONSTRUCTION WORK SCHEDULE

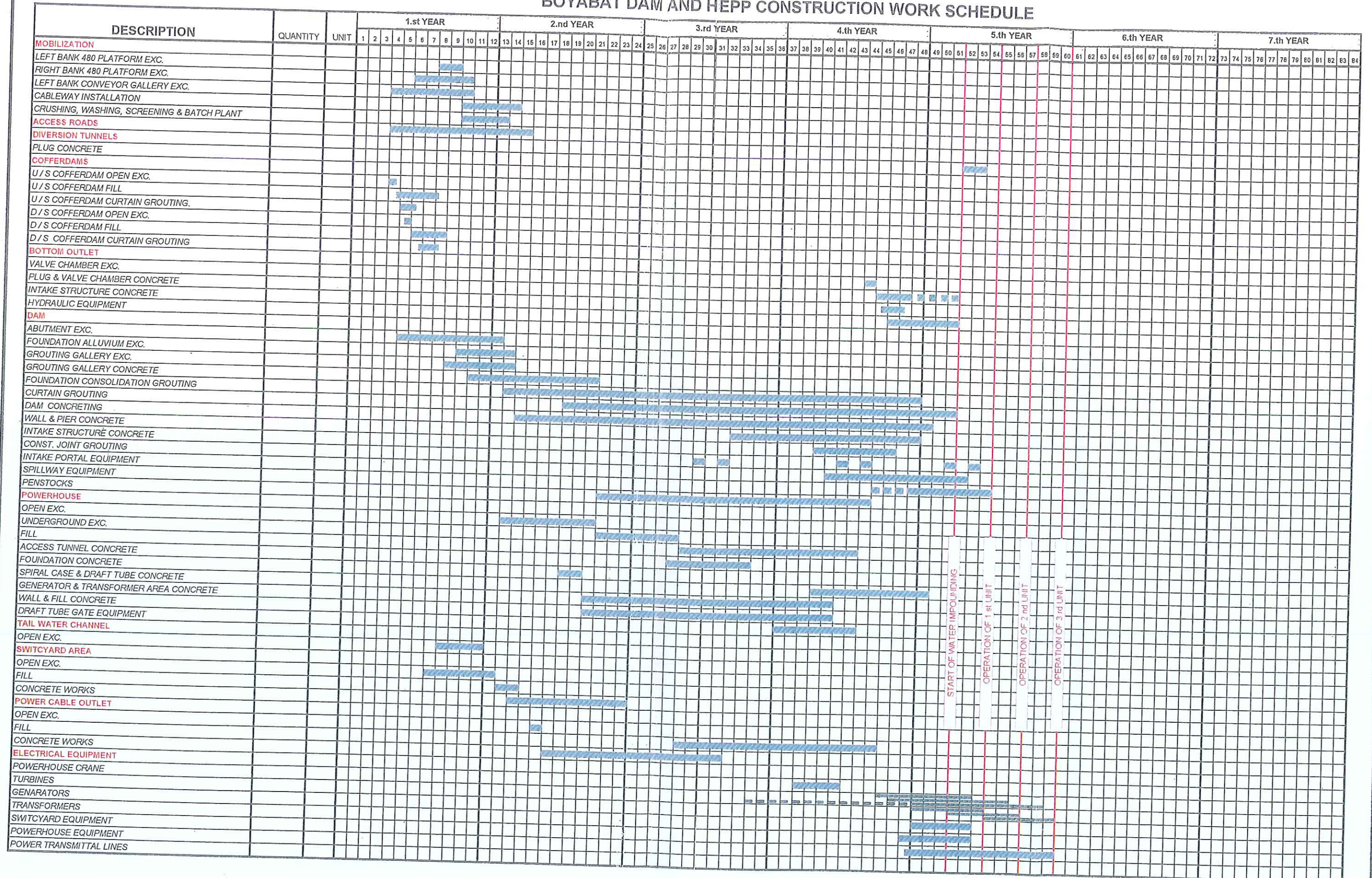


Figure IV.10. Boyabat Dam, Work Plan

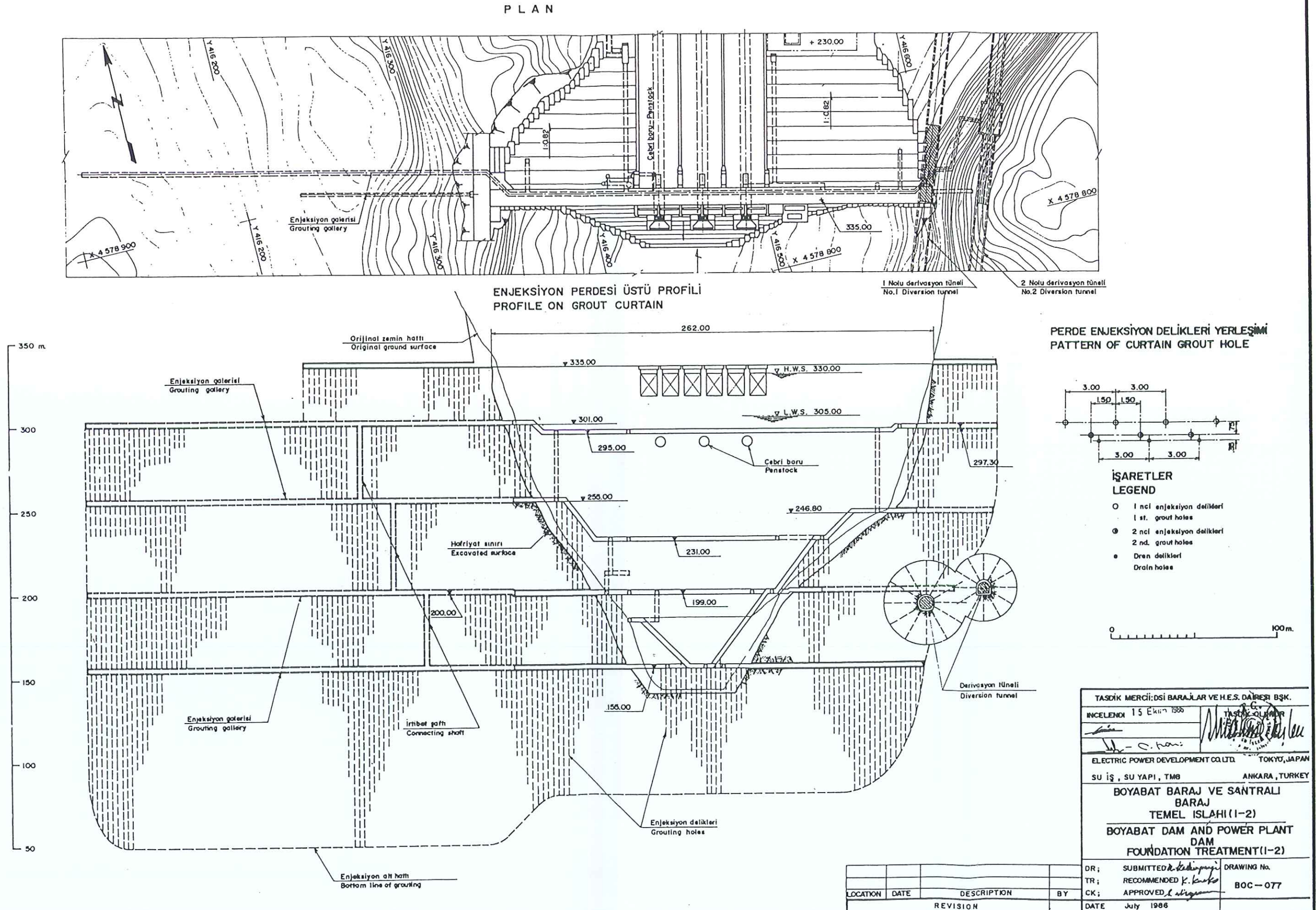
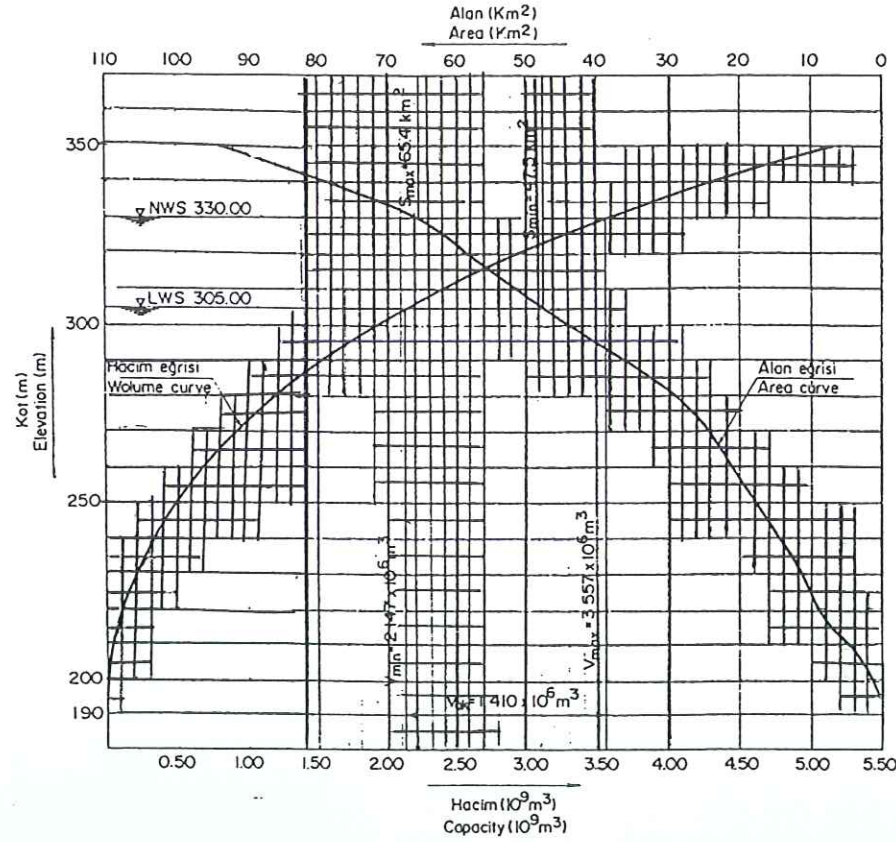
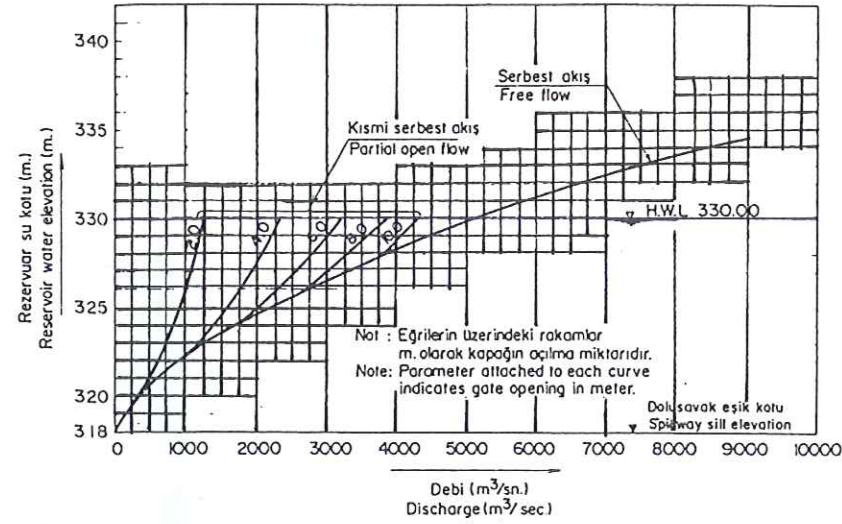


Figure IV.11. Foundation Treatment of the Dam (1)

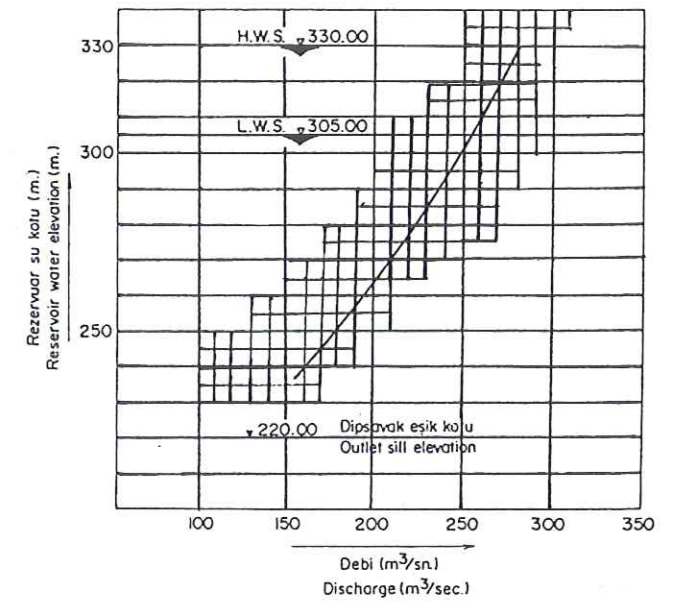
HACIM-ALAN EĞRİLERİ AREA-CAPACITY CURVES



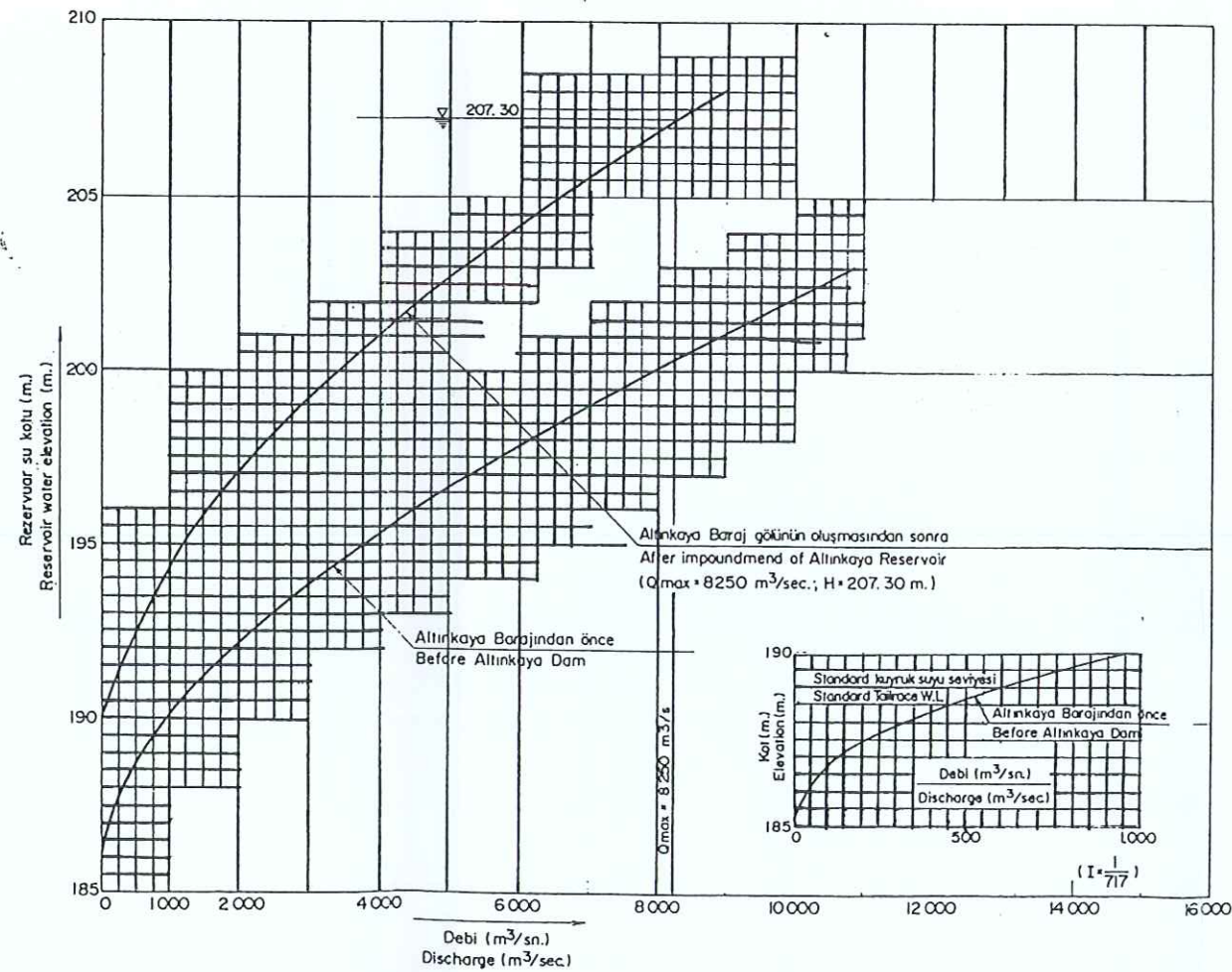
DOLUSAVAK DEŞARJ EĞRİSİ SPILLWAY RATING CURVE



DİPSAVAK DEŞARJ EĞRİSİ OUTLET RATING CURVE



BOYABAT BARAJ YERİ ANAHTAR EĞRİSİ RATING CURVE AT BOYABAT DAM SITE



DERİVASYON TUNELİ DEŞARJ EĞRİSİ DISCHARGE CURVE OF DIVERSION TUNNEL

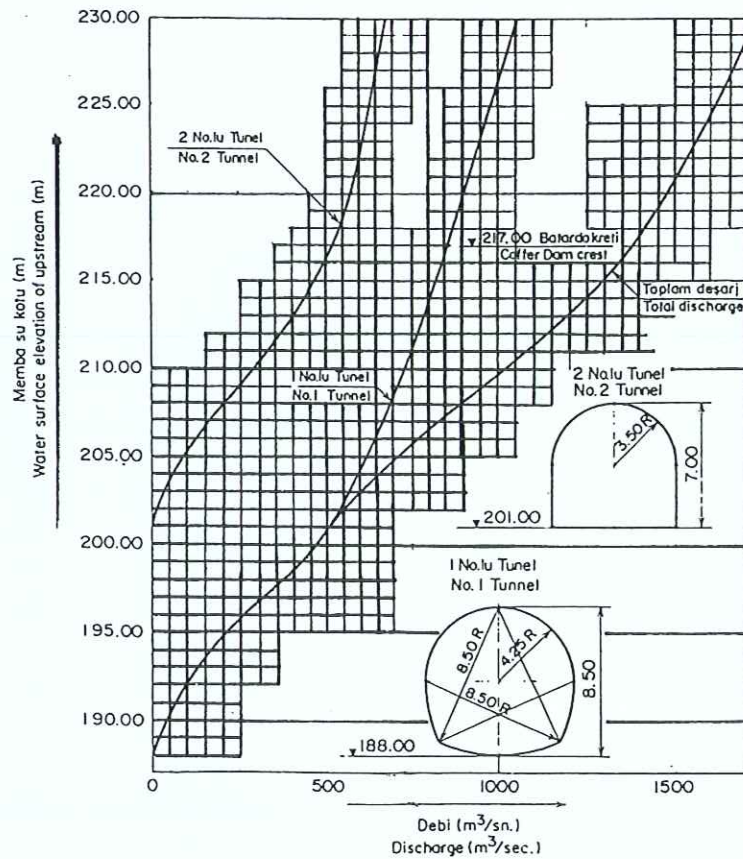
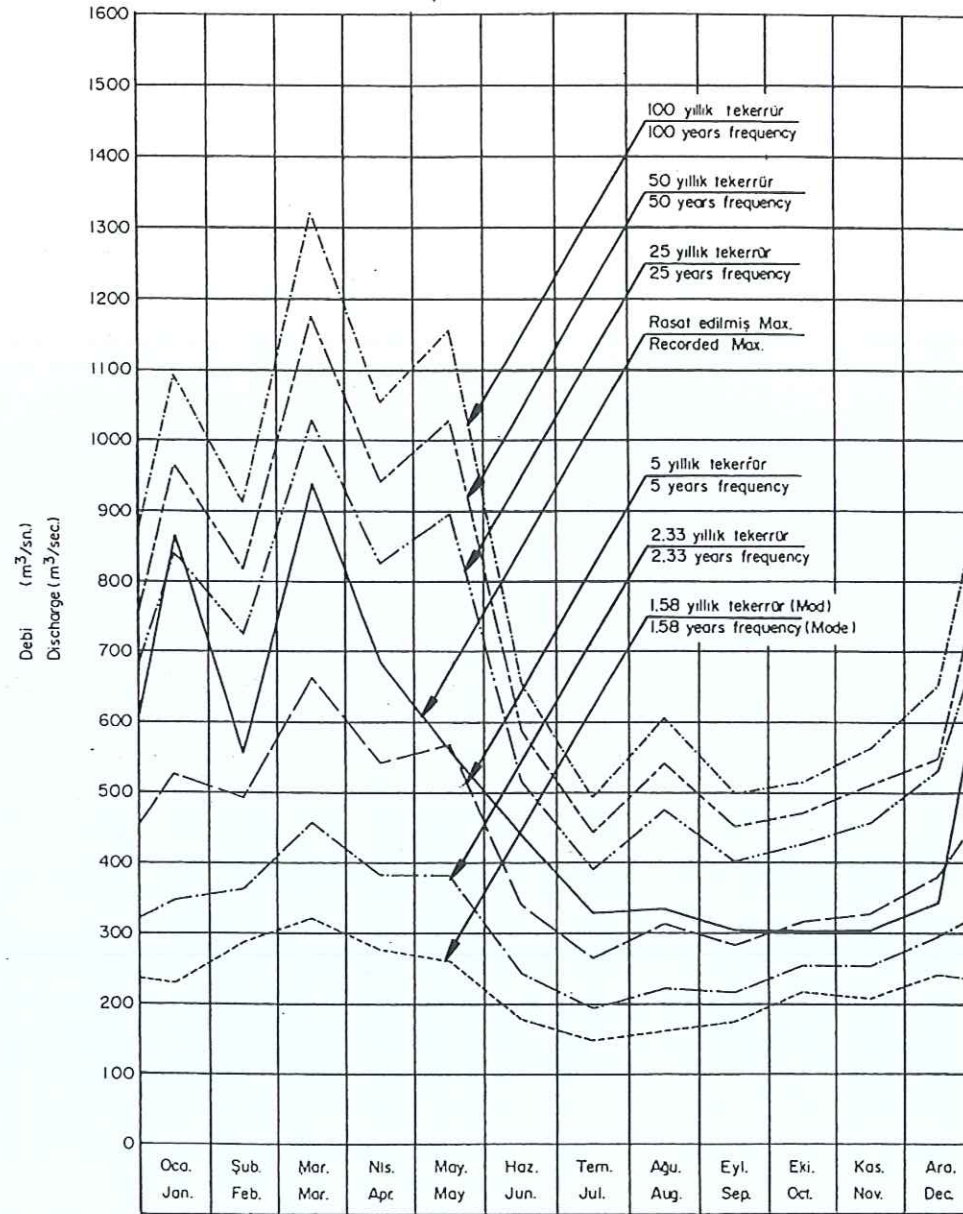


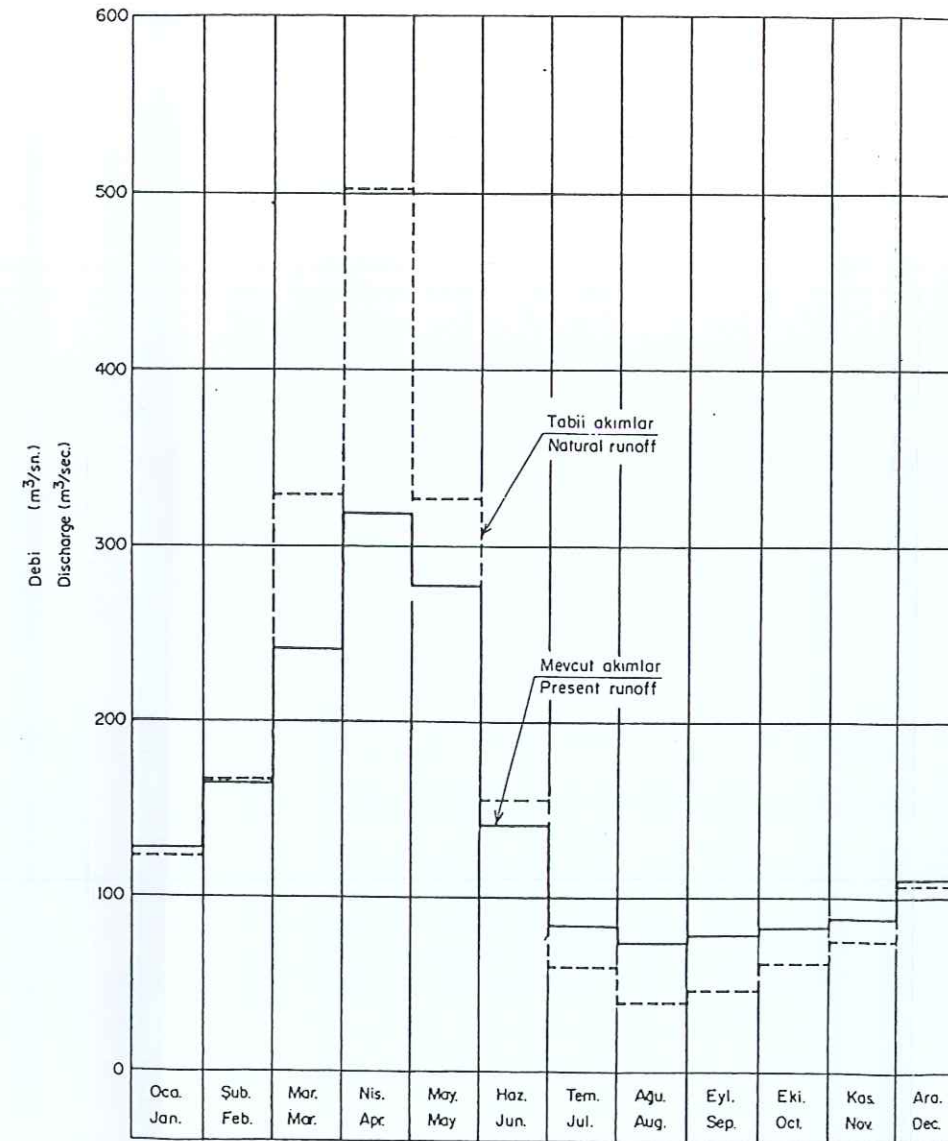
Figure IV.13. Hydraulic Data for Boyabat Project

TASCK MERCİİ: DSİ BARAJLAR VE H.E.S. DAİRESİ BŞK.			
İNCELENDİ 1:		TASCK ÜST BÖLGE MÜDÜRÜ	
ELECTRIC POWER DEVELOPMENT CO., LTD.		TOKYO, JAPAN	
SUIS SU-YAPI TMB		ANKARA, TURKEY	
BOYABAT BARAJ VE SANTRALİ HİDROLİK BİLGİLER			
BOYABAT DAM AND POWER PLANT HYDRAULIC DATA			
DR; Ş.C.	SUBMITTED	DRAWING No	BOC-008
TR; A.O.	RECOMMENDED		
CK; Y.K.	APPROVED		
DATE	May 1986		

TAŞKIN SARFIYATLARI
FLOOD FLOW



AYLIK ORTALAMA AKIM
MONTHLY AVERAGE RUNOFF



- Notlar : 1) Tekerrür hesaplarında Gumbel metodu kullanılmıştır.
- 2) Boyabat barajı max. aylık debilerin tekrürü Aşar köprüsü (1536) A.R. istasyonu değerlerinin Boyabat barajı yerine taşınmasıyla bulunmuştur.
- 3) Boyabat barajı yerindeki aylık tabii ortalama akımların bulunmasında, İnözü (1533), Yahşihan (1503), Gülşehir (1532) ve Kuyuluş (1524) akım rasat istasyonlarından yararlanılmıştır. 1939-1984 arasındaki akım değerlerinden istifade edilmiştir.
- 4) Boyabat barajı yerindeki aylık mevcut ortalama akımların bulunmasında Hirfanlı baraj işletmesi dikkate alınmıştır.

- Note : 1) Probability calculation is made employing Gumbel's Method.
- 2) Frequency of max. monthly peak discharges for Boyabat dam axis are calculated on to basis of observed records at (1536) Aşar köprüsü.
- 3) Monthly natural average runoff at Boyabat dam axis is calculated based on the observed records at İnözü (1533), Yahşihan (1503), Gülşehir (1532) and Kuyuluş (1524) gaging stations. Runoff data between 1939 to 1984 have been evaluated
- 4) Monthly present average runoff at Boyabat dam axis is evaluated based on the Hirfanlı dam operation.

TASDIK MERCİİ : DSİ BARAJLAR VE H.E.S. DAİRESİ BSK.			
İNCELENDİ		TASDIK OLUNDU	
ELECTRIC POWER DEVELOPMENT CO., LTD.		TOKYO, JAPAN	
SUIŞ SU-YAPI TMB		ANKARA TÜRKİYE	
BOYABAT BARAJ VE SANTRALİ HİDROLOJİK BİLGİLER (3-3)			
BOYABAT DAM AND POWER PLANT HYDROLOGIC DATA (3-3)			
DR; M.Ç.	SUBMITTED	DRAWING No	
TR; A.O.	RECOMMENDED	BOC-007	
CK; Y.K.	APPROVED		
DATE	May 1986		

Figure IV.14. Hydrologic Data for Boyabat Project

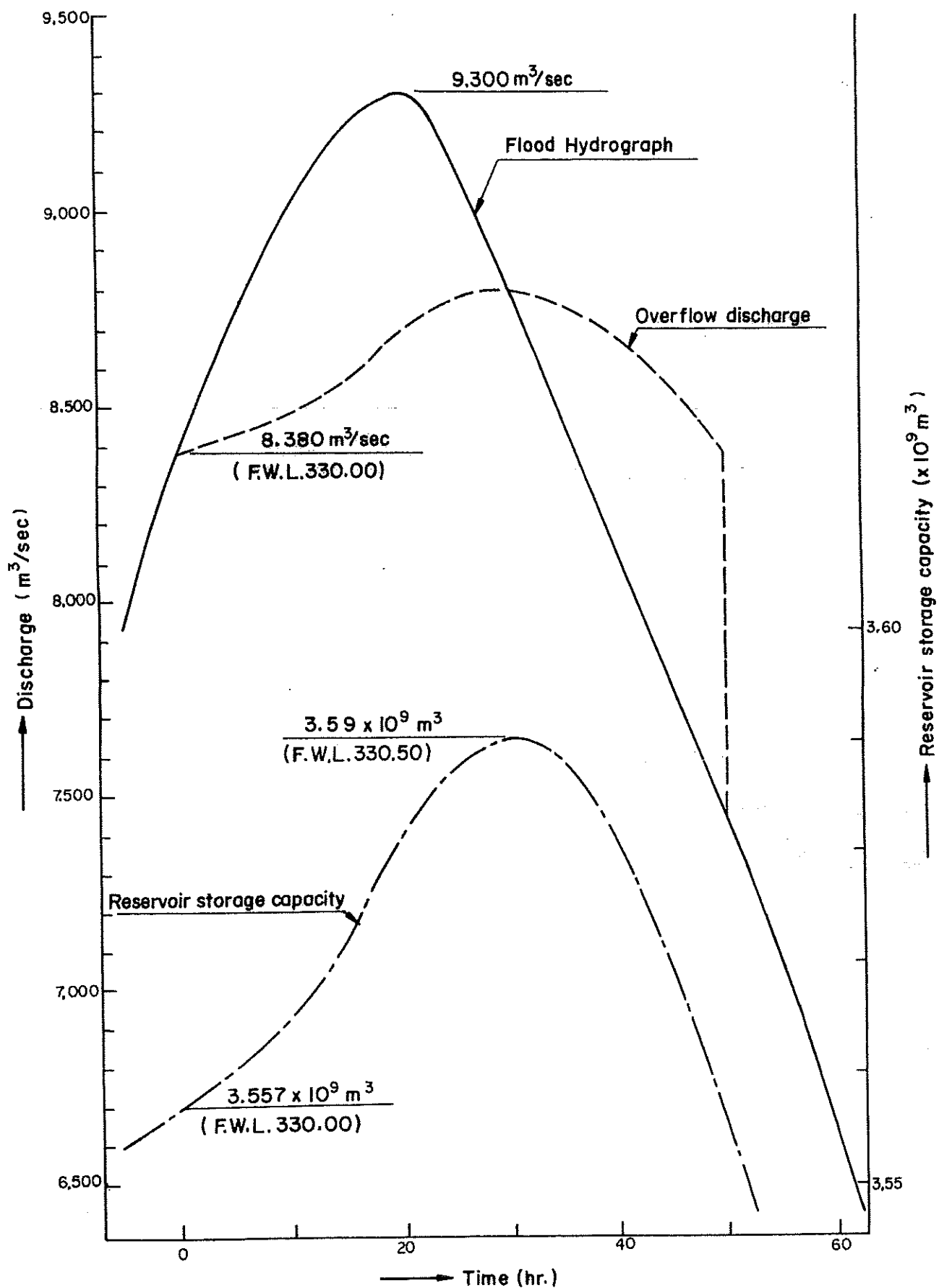


Figure IV.15. Spilway Discharge Curve

V. BASELINE DATA

V. BASELINE DATA

The studies on the baseline data are divided into three categories. These are the studies on physical environment, biological environment and socio-economic environment. Each of the study categories is discussed in a different section.

Study Area

The limits of the study area for each category vary, because the impacts of the project on these environments extend over different geographic areas. In the determination of study area for the physical environment, land resources, climate and water resources were examined separately. In the determination of study intensities for the physical, biological and socio-economic environments, the following resources were given primary importance;

- the resources in the reservoir area,
- the resources close to the dam site,
- the resources primarily affecting the project,
- the resources being primarily affected by the project.

For land resources, principal information, which was considered in the design of the project, was obtained for the Boyabat Dam site and the future reservoir area. For soils and erosion and land use patterns, the area surrounding the future reservoir was also studied.

Data from Boyabat and Osmançik meteorological gauging stations were considered for the examination of climatological conditions. These data were used in the design of the Boyabat Dam and Hydroelectric Power Plant Project.

For water resources, the data obtained from State Hydraulic Works (DSI), Electricity Works Survey Administration (EİE) and Ankara University were used. To supplement this information, water quality parameters having importance for aquatic life were measured at the aquatic ecology sampling stations during the field studies performed in 1997.

The locations of the DSI, EİE and Ankara University sampling sites are shown in Figure V.1. Sampling stations 1503, 1533, 1536, 1538 and 1528 located on Kizilirmak are operated by DSI and EİE. Data from stations 1, 2, 3 and 4 were obtained from a project carried out by Ankara University. In addition, the aquatic ecology sampling stations, where significant water quality parameters were measured in 1997, are presented in Figure V.2.

The boundaries for biological resources extended upstream almost to Kargı, and downstream to the end of Altinkaya Reservoir (5 km from the Boyabat Dam axis). The biological environment was examined between these two points, covering a 70 km reach of the Kizilirmak River, including the 60-km-long reservoir area.

The main source of data for the socio-economic environment was a detailed field study conducted in 14 of the villages that will be affected by the Boyabat Project. Five villages from Kargi, five from Osmancik, two from Vezirkopru and two from Boyabat districts were selected to represent the villages that will be affected from the project.

V.1. Physical Environment

In this section, baseline physical conditions, under which the Boyabat Project would be realized, are discussed. The discussion is divided into subsections on physiography, geology, climatology and hydrology.

V.1.1. Topography

Boyabat Dam and Hydroelectric Power Plant Project site is located five kilometers southeast of Duragan, in the northwest of Turkey, on the Kizilirmak River. Kizilirmak is the largest river of the country having a length of 1,355 km. The project site is approximately 125 km inland from the Black Sea and 270 km northwest of Ankara, at the boundary between the Central Anatolia and the Black Sea Coastal Region. Boyabat Reservoir is located within the provinces of Samsun, Sinop and Corum, between 41°05' - 41°25' north latitudes, and 34°20' - 35°10' east longitudes. Kizilirmak Plain is surrounded by Ilgaz Mountains (1,500-1,600 m) in the northwest and Kunduz (1,791 m) and Cal (1,732 m) Mountains in the southeast. Altinkaya Reservoir is located to the north, the Gokirmak Basin to the west, Devrez Creek to the south and Kunduz and the Cal Mountains to the east of the project site.

The reservoir will have a length of 60 km. Boyabat Dam site topographically is a narrow gorge with steep cliffs on both banks of the river, extremely rugged terrain peculiar to limestone, and slope gradients of 70 to 80°. Two and three dimensional elevation maps of the project area obtained by processing LANDSAT 5-MSS image are given in Figure V.3 and V.4. The surface elevation at the dam site riverbed is 185 m and elevation sharply increases on both banks of the riverbed. The mountaintop on the left bank is at an elevation of 510 m while that on the right bank is at 577 m. The gorge width is 110 m at an elevation of 200 m, 185 m at an elevation of 250 m and 250 m at an elevation of 330 m. The ratio between height and the valley width is approximately 1/1.4 at 330 m elevation. The Boyabat Project is located at the end of the backwater of Altinkaya Reservoir, which is located upstream of Derbent Dam and Hydroelectric Power Plant.

V.1.2. Geology

The geology at the proposed dam location generally comprises microcrystallized limestone. Various geologic surveys had been undertaken at the dam site since the end of 1960's, when it was initially identified as a potential dam site (JICA, 1979; EPDC, 1987; DOGUS, 1995). To carry out these surveys, various drill holes were placed at the dam site. Their locations are shown in Figure V.5. Numerous investigations have concluded that this geology will provide more than adequate

support as bedrock for the dam. In addition, no problems with regard to the watertightness of the reservoir are expected. The geological map of the region is given in Figure V.6. In Figure V.7 geological plan of the project area is presented.

V.1.2.1. General Geology

V.1.2.1.1. Lithology and Stratigraphy

In the surrounding area of the Kizilirmak, from Kalecik to the mouth of the river, a metamorphic series of the Paleozoic Era, limestone, an ophiolitic series, flysch and a volcanic series of the Mesozoic Era, and flysch of the Cenozoic Tertiary Period are mainly distributed. These basal rocks are covered with Quarternary deposits.

V.1.2.1.2. Structure

Sedimentation, diagenesis, regional metamorphism, and intrusion of igneous rocks (ophiolitic series) are seen in the region, which is complex both in terms of lithofacies and geological structures.

In general, the major geological structures have an orientation of roughly east-west, and fold axes and faults are mostly in that direction. Symmetrical folds, asymmetrical folds, and overturned folds are present, but recumbent folds do not exist. Faults are formed in large numbers in areas where the metamorphic series and ophiolitic series are distributed.

V.1.2.1.3. Seismicity

Turkey is situated on the Alpine Earthquake Belt and a fair number of earthquakes have occurred. The country can be divided into three predominant earthquake zones:

- North Anatolian Zone (along the Black Sea),
- South Eastern Zone (the area surrounding Antakya),
- Western Zone (the area surrounded by the Aegean Sea and the Marmara Sea).

The study area is located immediately north of the North Anatolian Fault. A tectonic map, showing the fault zones in Turkey, is given in Figure V.8.

Data on earthquakes that took place in the area between 40°00' to 42°00' north latitudes and 33°50' to 35°50' east longitudes, between years 1900 and 1995 were obtained from the Ministry of Reconstruction and Settlement. When these records are inspected, it is seen that only a few (Table V.1) occurred within a radius of 50 km from the dam site. The approximate coordinates of the dam site are 41.35° N and 35.00° E.

The project site is located in an area of second degree seismic risk. Earthquakes with magnitudes around 5.5 to 5.9 are accepted as moderate-sized earthquakes. In the selected area around the site no seriously damaging earthquakes were recorded.

However, as can be seen from the recorded seismic events in the last century, the maximum detected magnitude was 5.9 at a distance of 64.5 km from the site in a south-southwest (SSW) direction, on December 11, 1942. The closest event to the dam site in this range was detected on September 30, 1944, and had a magnitude of 5.5. The number of earthquakes that have a magnitude greater than four, recorded within a 50-km radius from the dam site in the last century is nine. The last earthquake observed was in 1988, having a magnitude of four.

Table V.1. Records of Seismic Activities within a Radius of 50 km from the Dam Site (Ministry of Reconstruction and Settlement, 1995)

No	Date (dd/mm/yy)	Latitude (°N)	Longitude (°E)	Depth (km)	Intensity (Richter scale)	Distance and Direction from the Dam Site (km-direction)
1	21/11/1942	40.82	34.44	80	5.5	68 - SSW
2	02/12/1942	41.04	34.88	20	5.4	34 - SSW
3	11/12/1942	40.76	34.83	40	5.9	64.5 - SSW
4	30/09/1944	41.11	34.87	10	5.5	26.3 - SSW
5	04/09/1950	41.28	34.25	10	4.9	63 - SSW
6	21/09/1957	40.75	34.02	40	5.1	95 - SSW
7	01/08/1973	40.91	34.60	19	4.0	56 - SSW
8	06/12/1978	40.50	34.97	17	4.6	90 - SSW
9	31/05/1988	40.66	34.78	10	4.0	77.3 - SSW

Seismicity in this region is generally shallow (depth < 50 km). It can be said that the events all are concentrated to the south-southwest of the Boyabat Dam site when the coordinates where they occurred are examined. This area is under the influence of the North Anatolian Fault Zone.

The earthquakes that have occurred within a radius of 50 km from the dam site are indicated in Figure V.9 on the Seismic Map, according to the information obtained from the Ministry of Public Works and Settlement and the "Earthquake Catalogue of Turkey and Surroundings" prepared by Istanbul Technical University.

V.1.2.2. Geology at the Dam Site and in the Reservoir Area

V.1.2.2.1. Lithology and Stratigraphy

The basal rocks in the vicinity of Boyabat Dam site consist of limestone and schist, with the greater part made up of limestone. These basal rocks are covered by small-scale slope wash, while at the riverbed, a sand-gravel layer (alluvium layer) is deposited to a thickness of approximately 45 m.

Slope wash is distributed on the left bank side at the gully and at the portion of change in topography (comprising a gully topography) on the right bank upstream of the dam axis. The slope wash on the left bank is clayey sand intermixed with breccia

of schist (weathered and friable) and limestone (relatively fresh and hard), while that on the right bank is mostly breccia of limestone and there is practically no content of fine particles. The thickness of these slope wash deposits is around five meters.

Schist is distributed at the back of the dam abutment, from the ground surface to a depth of 300 to 500 m underground. Although not observable at the ground surface, there is calcareous schist underground on the left bank side. Furthermore, underground on the right bank side, upstream of the dam axis, there is metaconglomerate. The schist is weak against mechanical shocks, such as from drilling, and the cores are mostly in poorer condition than the original. From this fact, it is also estimated that the schist distributed at this dam site is slightly crushed as a whole. As an exception, the metaconglomerate is comparatively massive and hard.

The limestone is fresh and hard on the whole, with spacings between cracks, having 50 to 200 cm sizes, and the condition is good as the foundation for a structure. Limestone is good strength-wise, but there are some cavities and small caves existing in the project area due to dissolution by water. Those cavities and small caves are formed along faults and seams, but are discontinuous and individual caves are present in the form of lenses.

The stratigraphic sequence of reservoir area is presented in Table V.2. These rocks are distributed most widely throughout the reservoir area.

Table V.2. Stratigraphic Sequence of Reservoir Area

Era			
Period	Series	Symbol	Lithology
Epoch			
Cenozoic			
Quaternary	Alluvium	Al	
	Fan deposit	Fd	
	Slope wash	Sl	
	Travertine	ktv	
	Terrace dt	kt	
Tertiary			
Pliocene	Karaboya fm	Tkb	sandstone, conglomerate
Eocene-Oligocene	Akbelen fm	Ta	flysch
Eocene	Kuzkoy fm	Tkz	volcanic flysch
	Sariyar fm	Ts	conglomerate
	Boztepe	Tb	flysch
Paleocene-Eocene	Karimca fm	Tk	sandstone, limestone
Mesozoic			
Cretaceous	Ophiolitic	Mo	serpentine, diabase
Paleozoic	Metamorphic	Pk	schist (Kepez Schist)
Paleozoic	Metamorphic	Pb	limestone (Delikbek Limestone)

There are various tributaries and gullies joining the Kizilirmak in the reservoir area, but few are perennial creeks with water flowing throughout the year. The majority consist of ephemeral creeks with water only in the wet season.

Gullies in the entire reservoir area are developed in a dendritic pattern reflecting the geological state of wide distribution of schist. There are very few gullies where limestone is distributed, with only small scale ones formed along some faults and shear zones. Alluvial fans are developed at the mouths of gullies.

V.1.2.2.2. Structure

On looking at the geologic plan and cross-sections of the dam site, provided in Figure V.10 and V.11, the greater part is made up of limestone. However, considered from a widened viewpoint, limestone is intercalated by schist in the form of lenses and blocks. The distance from the middle of the river to where schist is distributed at both sides is around 300 m within the dam site, and 300 m to 500 m deep underground. The boundary between limestone and schist is a fault (F-5) with a brittle section of more than 20 m including weathered portions, but it lies outside the stress field of the dam. Prominent faults developed in the vicinity of the dam site are F-1 to F-7, but they do not cause problems with regard to structural stability and the existence of the proposed reservoir is not considered likely to significantly effect the seismic behavior of the faults. A list of the faults at Boyabat Dam site is provided in Table V.3 and these faults are shown in Figures V.10 and V.11.

Table V.3. List of Faults at Boyabat Dam Site (JICA, 1979)

	Strike and Dip	Sheared Zone	Note
F1	N 15-52° W, 30-48° SW	cl + sh : 10-100 cm	Dipping in upstream direction and strike roughly orthogonal to river
F2	N 45° W, 55° SW	cl + sh : 20-30 cm	Dipping in upstream direction and strike roughly orthogonal to river
F3	N 5-12° W, 40-42° NE	cl + sh : 10 cm	Dipping in right bank direction intersecting river diagonally at a gentle angle
F4	NS, 40° W	cl + sh : 30 cm	Roughly parallel to river, dipping in left bank direction
F5	N 20° E, 78° NW	cl + sh : 100 cm	Roughly parallel to river, at boundary of limestone and schist
F6	N 27° E, 40° SE	cl + sh : 20 cm	Parallel to river, dipping in right bank direction
F7	N 8° W, 52° NE		

Note: cl: clay, sh: sheared zone

V.1.2.2.3. Watertightness

Many of the sections, from the present ground surface down to depths of around a hundred meters, are generally permeable. The limestone along the F-5 fault is also permeable. Various reasons may be considered for the high permeability. Cavities

formed in the limestone can be cited as one of them. Other than the above and with some local exceptions the water tightness is good.

Limestone is also distributed in the reservoir area and the form of this distribution is that of Kepez Schist intercalated in blocks and lenses of limestone. There is little limestone that would be submerged below the maximum water level (330 m). The places where submergence will occur are described in order from upstream to downstream. There are several places downstream of the vicinity of Kargi, but these are rock bodies of diameters between 100 and 200 m. There are distributions of limestone at two locations in the vicinity of Maksutlu, one at the mouth of Tekkesin Creek, immediately downstream of Asikbuku, and several places at Asagi Zeytin. Among the above, there is no limestone body which reaches up to the watershed with another river except at the surrounding area of the Boyabat Dam Site, and all have orientations continuing in the upstream-downstream direction of the river.

V.1.2.2.4. Slope Stability

With regard to the landslides and slope collapses distributed in the west reservoir area, and to landslides and slope collapses which may occur during water impoundment, the following may be said:

- Landslides and slope collapses occurring at places where damage will be inflicted on densely populated areas, main roads and structures related to the dam should be carefully considered. Large-scale landslides which would suddenly raise the reservoir water level should also be taken into account.
- Landslides, slope collapses, or small-scale collapses other than the above do not require much attention.

Landslides in the Kuzkoy Formation distributed to five kilometers southwest of Kamil are observed, but are one to two kilometers distance from the reservoir surface and do not directly affect the reservoir. Since there are no dwellings either, they will not create any problem. The landslide which occurred on the left bank southwest of Hacıbay is approximately three kilometers distant from the reservoir surface and there would be no important problem. There are also small-scale collapses of slopes downstream of Kamil, but they would not cause any problem.

V.1.2.2.5. Mineral Resources

The General Directorate of Mining Exploration and Research (MTA) is the agency that is responsible for the exploration and control of the mineral, thermal and geothermal resources in the country. A written application was made to obtain information on these resources in the project area. The General Directorate of Mining Exploration and Research stated that according to their studies and surveys, carried out in 1993, no mineral, thermal, or geothermal resources had been located in the project area.

V.1.2.2.6. Soils, Erosion and Land Use

Boyabat Reservoir will inundate a 60 km segment of the Kizilirmak. Boyabat Dam site, topographically, is a narrow gorge with steep cliffs on both banks of the river, extremely rugged terrain peculiar to limestone, with the slope gradients of 70 to 80 degrees.

Soils in the project area are dominantly alluvium and co-alluvium soils at the base of the Kizilirmak valley and brown forest soils at higher elevations. The thickness of the soils varies between 20 to 50 cm. In this area, approximately 65% of soils are subject to intense erosion and the erosion effect is less intense on the remaining 35%. In general, the vicinity of the project area is classified as stony.

Erosion is also highly related to land use in the area. The area to be flooded is approximately 65 km² and the amount of farmland in this area is as follows:

First class irrigated land	:	1,962.1 ha
Second class irrigated land	:	1,047.5 ha
First class non-irrigated land	:	816.5 ha
Second class non-irrigated land	:	508.2 ha
Third class non-irrigated land	:	598.5 ha
Total	:	4,932.8 ha

The land use map of the project area, showing different uses, is given in Figure V.12. The classified image of the region is given in Figure V.13.

Most of the irrigated land is used for rice production and rice is the most important commercial product for the people living in the area. Wheat, barley and sunflower are the other important crops produced in this area. Rice production varies between 45 and 60 kg/ha and wheat production, from 12 to 15 kg/ha. Additionally, fruits and vegetables produced in the area have commercial value.

There are no industries in the vicinity of the project area and there are no large settlements, such as towns, that would be directly affected from the project. The forests that can be reached by the villagers have been damaged to obtain land for agriculture. There are reforestation efforts, by the Ministry of Forestry, on the high slopes surrounding the future reservoir area.

V.1.3. Climatology

Turkey is surrounded by four seas: Aegean, Mediterranean, Black Sea and Marmara Sea, and the coastlines amount to 8,272 km. In spite of this fact, climate varies greatly depending on the region because of the high mean elevation of the land at 1,132 m and the influence of the mountainous areas running parallel to the coast lines.

Because of the varied geographical conditions, Turkey shows great diversity in climate. The country is usually subdivided into seven regions. Black Sea, Marmara, Aegean and Mediterranean regions are coastal ones and Central Anatolia, East Anatolia and Southeast Anatolia are mountainous regions that are subject to harsh climatic conditions. Weather is much drier and colder when compared with the other regions.

The climate of the Kizilirmak River Basin is influenced by Central Anatolian and Black Sea climatic conditions. The Boyabat Project area is located at the boundary between the Central Anatolia and the Black Sea Regions. The catchment area of Kizilirmak at the dam site is about 65,000 km², with a greater part consisting of steppes with annual precipitation of 400 mm and mean temperature of about 11°C.

The annual run-off at the project site is $4,810 \times 10^6$ m³ and the specific run-off per 100 km² is estimated to be very small, 0.24 m³/sec. The annual precipitation is 400 mm, the mean temperature is 13°C and the number of days of precipitation is about 120 days annually. The isohyetal map of mean annual precipitation of Kizilirmak basin is given in Figure V.14.

The annual precipitation in the Anatolian Plateau, the inland part of Turkey is less than 500 mm. The basin of the Boyabat Project is mostly in this region with the exception of a small section. Areas with relatively large precipitation are only found in the most upstream part of the Kizilirmak River.

The precipitation shows the same pattern everywhere in the basin with more precipitation in the period from December to May. Two thirds of the annual precipitation occurs during this half-year period. The month of May has the most precipitation with about 50 to 60 mm. July and August have the least precipitation with only a few millimeters.

As mentioned above, the annual mean temperature at the Boyabat Project area is about 13°C; July to August being hottest, with a maximum temperature of 40°C, and January being coldest, with a minimum temperature of -16°C.

The Boyabat Project Basin is in a dry region, therefore, a fair amount of evaporation from the reservoir may be considered to take place. Yearly evaporation from Boyabat Reservoir was determined as approximately 640 mm.

V.1.4. Hydrology

V.1.4.1. Outline of Kizilirmak River Basin

Kizilirmak River is the largest river in Turkey which flows into the Black Sea. The source of the Kizilirmak River is on Mountain Kizil, 140 km east of the city of Sivas, which is located in East Anatolian Region. The river is 1,355 km in length and has a catchment area of 77,000 km² corresponding to one tenth of the national territory.

Kizilirmak River flows down through the Central Anatolian Plateau, changing its course from west to southwest, and at a point of 20 km north of the city of Nevsehir changes its course again in northwest direction and flows into Hirfanli Reservoir. Upon generation of maximum output of 96 MW at Hirfanli Power Station with maximum available discharge of $196.5 \text{ m}^3/\text{sec}$ and effective head of 60 m, the river flows down farther changing its course north to northeast after Kesikkopru Dam located downstream of Hirfanli Dam and enters a gorge in the mountainous area running parallel to the Black Sea Coast. The Boyabat Project site is located where the river leaves the gorge. The end of the backwater of Altinkaya Reservoir is located downstream of the Boyabat Project site. The reservoir formed by Derbent Dam is located immediately downstream of Altinkaya Dam. After passing through the Derbent Reservoir the river gently flows through the Bafra plain to discharge into the Black Sea. In Figure V.15 and Figure V.16 the location of proposed Boyabat Dam in the Kizilirmak Basin and the layout of the Boyabat Reservoir are given respectively.

V.1.4.2. Estimation of Run-off at Project Site

There are numerous stream flow gauging stations in the Kizilirmak River Basin including tributaries. The locations of these stations are shown in Figure V.17. The stream flow at the site of Boyabat Dam was calculated using the stream flow data of eight of these stations. The period of record in these stations ranged from 15 years to 50 years.

For example, at Yamula (no: 1501) gauging station there are stream flow records between 1939 and 1990. The stream flow records obtained from Salur (no: 1528) and Avsar (no: 1536) gauging stations were obtained between 1966 and 1994. At Gulsehir (no: 1532) gauging station record period is 15 years and there are records between the years 1960 and 1975. The stream flow data consists of the records between the years, 1939 and 1986 at Yahsihan (no: 1503), 1960 and 1990 at Inozu (no: 1533), 1955 and 1990 at Kuylus (no: 1524), on Gokirmak River, and 1971 and 1993 at Celtikcibasi (no: 1538), on Devres River, stations. Average flowrates of Kizilirmak River at Salur and Avsar Bridges, and Celtikcibasi Station are presented in Figures V.18, V.19 and V.20 respectively.

The average flow at Yamula gauging station (catchment area, $15,362 \text{ km}^2$) which was $0.43 \text{ m}^3/\text{sec}/100 \text{ km}^2$ rapidly decreased to $0.38 \text{ m}^3/\text{sec}/100 \text{ km}^2$ at Gulsehir gauging station (catchment area, $20,368 \text{ km}^2$) and $0.29 \text{ m}^3/\text{sec}/100 \text{ km}^2$ at Yahsihan gauging station (catchment area, $30,023 \text{ km}^2$) as the river flows through the dry Central Anatolian Plateau. For a catchment area of $50,000 \text{ km}^2$, it becomes $0.22 \text{ m}^3/\text{sec}/100 \text{ km}^2$ at the vicinity of the confluence with the tributary Delice River, Salur gauging station, roughly one half of the figure for Yamula gauging station. At Inozu Gauging Station, which has a catchment area of $74,992 \text{ km}^2$, the average flow becomes $0.24 \text{ m}^3/\text{sec}/100 \text{ km}^2$ with the confluence of the tributaries, Devres and Gokirmak Rivers. The annual flow at the project site was estimated as $4,810 \times 10^6 \text{ m}^3$.

In November 1957, Hirfanli Dam and Kesikkopru Dam were constructed upstream on the Kizilirmak River, so the regulating effects of these reservoirs must be considered, but as Kesikkopru Reservoir is located immediately downstream of Hirfanli, only regulation by Hirfanli was taken into consideration during the estimation of flowrates.

Drainage area at the dam site is $64,700 \text{ km}^2$. Since the above flows were quoted from the 1979 JICA report, average flow at the dam site was updated to the period 1966-94 to be $150 \text{ m}^3/\text{sec}$. That equals the sum of average flows at the Avsar gage ($136.5 \text{ m}^3/\text{sec}$, $60,560 \text{ km}^2$, 1966-94) and Celtikcibasi gage ($8.2 \text{ m}^3/\text{sec}$, $1,960 \text{ km}^2$, 1971-94) times the drainage areas ratio, $64,700 \text{ km}^2/62,520 \text{ km}^2$.

The seven day 10-year low flow at the dam site was estimated from frequency analysis of concurrent daily data at those two gages to be about $24 \text{ m}^3/\text{sec}$. The Avsar gage flows incorporate regulation by the upstream Hirfanli and Kesikkopru reservoirs ($26,500 \text{ km}^2$), which were built before the gage started. The daily gage records are presented in Annex 3.

For the method of calculating stream flow, since the catchment area of the Kizilirmak River is large and the run-off durations of the various basins differ, it was judged better to adopt the method of calculating by correlations of annual run-offs, especially correlations of cumulative run-offs, rather than the method of calculating by catchment area ratios.

Boyabat Reservoir will have a surface area of 65.4 km^2 at a maximum water elevation and the maximum storage volume is $3,557 \times 10^6 \text{ m}^3$. The retention time of the water will be approximately 270 days. The retention time was calculated by the dividing the reservoir volume by average discharge. The reservoir will have a long and narrow characteristic having a length of 60 km. The maximum water level will be 330 m and the minimum water level will be 305 m.

V.1.4.3. Water Quality

The data describing the baseline water quality conditions in the lower Kizilirmak River were obtained from published reports by the General Directorate of State Hydraulic Works (DSI) and the Turkish Electricity Works Survey Administration (EIE). Additional data for the Boyabat Project area were obtained from studies by Ankara University. To supplement this information, water quality parameters having importance for aquatic life were measured at the aquatic ecology sampling stations during the field studies performed in 1997.

The existing water quality of the river was then evaluated utilizing Turkish Inland Water Quality Standards, derived from Turkish Inland Water Resources Regulations. These Water Quality Standards, given in Table V.4; are based on water use classifications. Class I water uses include drinking water supply after disinfection, all recreational activities, propagation of trout, irrigation and all other uses. Class II waters can be used for supply of drinking water following appropriate treatment, recreational purposes, propagation of fish other than trout, irrigation and industrial

uses. Class III waters maybe used, following appropriate treatment, to supply water for industries, except foodstuff and textile industries. Class IV waters are inferior quality when compared with Class I, II, and III waters and can not be used for any purposes without appropriate treatment. The Kizilirmak River in the project area is classified as Class III because some of the parameters are in this class. However, the majority of the parameters satisfy the limits for Class I and II waters.

V.1.4.3.1. River Water Quality Studies Performed by DSI and EIE

Water quality of Kizilirmak River has been monitored by (EIE) and (DSI) in different parts of the river. The water quality monitoring is carried out by EIE for management of water resources; for their proper use, control and development. EIE has been operating and collecting data since 1935, for its own projects and for other departments that need these data. Discharge of rivers has been determined since 1935 and sediment transportation observations started in 1962. In 1970, water quality observations were added to the monitoring program.

There are numerous water quality sampling stations located throughout the Kizilirmak River, operated by EIE. Inozu water quality sampling station (No. 1533) is the closest of these stations to the Boyabat Project area and is located 60 km downstream (2.5 km downstream of Altinkaya Dam Axis) of the Boyabat Dam Axis. The next closest water quality sampling station to Boyabat Project area is Yahsihan (No. 1503), which is located 180 km upstream of the Boyabat Reservoir Area. This station is located approximately 30 km downstream of Kapulukaya Dam. Figure V.1 shows the locations of these sampling stations.

The data obtained from EIE on water quality for the Kizilirmak River at these two sampling points are presented in Tables A4.1 and A4.2 in Annex 4. DSI also carries out water quality measurements at these two sampling stations. Water quality data, collected by DSI, are tabulated in Tables A4.3 and A4.4 in Annex 4. In addition, in Table A4.5 water quality data obtained from Yahsihan and Inozu Stations are compared.

The average Kizilirmak River water **temperature** at the Yahsihan sampling station (No. 1503) over the period of record is approximately 13°C. The water temperature in winter and in fall periods, averages four degrees Celsius and 13°C, respectively. In the summer season temperature ranges between 18°C and 20 °C. The maximum temperature measured at this station was 24°C and the minimum was one degree Celsius. The average river water temperature at the Inozu sampling station (No. 1533) was also 13°C. In fall, the average temperature is 13°C, while in winter it falls to six degrees Celsius.

The water temperature reaches 11°C and 21° in spring and summer, respectively. Although the overall average temperature is almost the same, the river water temperature at Yahsihan is cooler than Inozu station in summer and spring.

Table V.4. Water Quality Standards According to Turkish Inland Water Resources Regulation

Parameters	Units	Water Quality Classes			
		I	II	III	IV
A) Physical, inorganic chemical param.					
1- Temperature	°C	25	25	30	>30
2- pH		6.5-8.5	6.5-8.5	6.0-9.0	6.0-9.0
3- Dissolved oxygen	(mg/L)	8	6	3	<3
4- Oxygen saturation	%	90	70	40	<40
5- Cl ⁻	(mg/L)	25	200	400	>400
6- SO ₄	(mg/L)	200	200	400	>400
7- NH ₄ -N	(mg/L)	0.2	1.0	2.0	>2.0
8- NO ₂ -N	(mg/L)	0.002	0.010	0.050	>0.050
9- NO ₃ -N	(mg/L)	5	10	20	>20
10- PO ₄ -P	(mg/L)	0.02	0.16	0.65	>0.65
11- Total dissolved solids	(mg/L)	500	1500	5000	>5000
12- Color	Pt-Co unit	5	50	300	>300
13- Na	(mg/L)	125	125	250	>250
B) Organic parameters					
1- COD	(mg/L)	25	50	70	>70
2- BOD	(mg/L)	4	8	20	>20
3- Organic carbon	(mg/L)	5	8	12	>12
4- Total K-N	(mg/L)	0.5	1.5	5.0	>5.0
5- Emulsified oil and grease	(mg/L)	0.02	0.30	0.50	>0.50
6- Methylene blue active substances	(mg/L)	0.05	0.20	1.00	>1.5
7- Phenolic substances	(mg/L)	0.002	0.010	0.100	>0.100
8- Mineral oils and derivatives	(mg/L)	0.02	0.10	0.50	>0.50
9- Total pesticide	(mg/L)	0.001	0.010	0.100	>0.100
C) Inorganic pollution parameters					
1- Hg	µg/L	0.1	0.5	2.0	>2.0
2- Cd	µg/L	3	5	10	>10
3- Pb	µg/L	10	20	50	>50
4- As	µg/L	20	50	100	>100
5- Cu	µg/L	20	50	200	>200
6- Cr (total)	µg/L	20	50	200	>200
7- Cr ⁺⁶	µg/L	-	20	50	>50
8- Co	µg/L	10	20	200	>200
9- Ni	µg/L	20	50	200	>200
10- Zn	µg/L	200	500	2000	>2000
11- CN	µg/L	10	50	100	>100
12- F	µg/L	1000	1500	2000	>2000
13- Cl ₂	µg/L	10	10	50	>50
14- S	µg/L	2	2	10	>10
15- Fe	µg/L	300	1000	5000	>5000
16- Mn	µg/L	100	500	3000	>3000
17- B	µg/L	1000	1000	1000	>1000
18- Se	µg/L	10	10	20	>20
19- Ba	µg/L	1000	2000	2000	>2000
20 - Al	mg/L	0.3	0.3	1.0	1.0
21-Radioactivity	Ci/L				
α activity		1	10	10	>10
β activity		10	100	100	>100
D) Bacteriological parameters					
1- Fecal coliforms	MPN/100 ml	10	200	2000	>2000
2- Total coliforms	MPN/100 ml	100	20000	100000	>100000

The pH values of the water at both Yahsihan and Inozu stations (No. 1503 and 1533, respectively) range between 7.2 and 8.3, indicating that the water has slightly alkaline characteristics. The pH remains consistently alkaline throughout the year. Considering the pH, this water can be used as potable water and for irrigation. In addition, the water is favorable for the development of aquatic life. In general, pH does not cause direct lethal effects to fish within a range of pH 5.0 to 9.5. From the standpoint of productivity, a pH in the range of about 6.5 to 8.2 is best for most of the fresh water fish.

Because acid waters are generally corrosive, pH plays a critical role in corrosion control. Corrosion takes place below pH 6.5 and is generally uniform. In the range between pH 6.5 and 8.0, the corrosion is more likely to be pitting and pH adjustment alone is often insufficient to control corrosion in waters that are low in carbonate or bicarbonate alkalinity.

Electrical Conductivity (EC) provides a good indication of the mineral salt content in water. The specific electrical conductivity values obtained at the upstream, Yahsihan (No. 1503), station are between 1,200 and 1,800 $\mu\text{mhos/cm}$, with an average of 1,411 $\mu\text{mhos/cm}$ (at 25°C). The same values for the downstream Inozu (No. 1533) station are more disparate, being between 450 and 2400 $\mu\text{mhos/cm}$, with an average of 1,483 $\mu\text{mhos/cm}$. Specific electrical conductivity values are given in Tables A4.1 and A4.2 in Annex 4. The significant fall in electrical conductivity during spring months might be due to high amounts of rainfall. According to the EC ranges observed upstream and downstream of the Boyabat Project site, the river water is suitable for irrigation, although irrigation is not a proposed major use of the Boyabat Reservoir. From the standpoint of fish and other aquatic life, a diverse fauna can be found in waters with a specific conductance less than 2000 $\mu\text{mhos/cm}$ at 25 °C.

Sodium is a major constituent of water. Since sodium salts are extremely soluble in water, any sodium leached from soil or discharged to rivers remains in solution. The observed average concentrations of sodium at the upstream (No. 1503) and downstream (No. 1533) stations are 144.4 and 158.9 mg/L, respectively. This elevated level of sodium does not have adverse effects on aquatic life or on irrigation, with a few exceptions of sensitive crops.

Potassium is one of the most active metals and reacts vigorously with oxygen and water. Thus, it is commonly observed in water samples in the ionized or molecular form. Higher concentrations are observed at the upstream station (No. 1503) while the average potassium concentrations at the upstream and downstream (No. 1533) stations are 4.68 and 1.95 mg/L, respectively. These values are compatible with different uses of water.

Magnesium-Calcium Hardness, which is measured as a combination of Calcium and Magnesium ion concentrations in water was determined to be 420 mg/L as CaCO_3 , at the upstream station (No. 1503), while it is 400 mg/L as CaCO_3 at downstream station (No. 1533). The river water is quite hard. However, if toxic

metals exist in the water, they would be expected to be less toxic when the hardness of the water is high (McKee, 1978). The measurements of DSI and EIE show similar results.

The concentration of **carbonates** (CO_3^{2-}) in natural waters is a function, not only of the substances added thereto, but also of the temperature, pH, cations and other dissolved salts. The same statement is true of **bicarbonates** (HCO_3^-). The concentrations of carbonates at upstream (No. 1503) and downstream (No. 1533) stations are quite low, with values of 3.6 and 3.1 mg/L, while the same values for bicarbonates are 161.8 and 195 mg/L, respectively. Although excessive bicarbonates add to the salinity and total solids content of the water, bicarbonates in water are seldom considered as detrimental.

Chlorides are another quality parameter of significance. Chlorides in natural water result from the leaching of chloride-containing rocks and soils with which the water comes into contact. The average values for upstream (No. 1503) and downstream (No. 1533) stations are 170.8 and 194.9 mg/L, respectively. The significance of chlorides in water is from an economic point of view for industrial purposes, but these values would have no adverse effect on human health and aquatic life.

Sulfate occurs in almost all natural waters as a result of leaching from gypsum and other common minerals. The average values for downstream (No. 1533) and (No. 1503) upstream stations are 349.4 and 296.6 mg/L, respectively. The presence of sulfates in water also does not have negative effects on human health or the aquatic life, but may be undesirable for some special industrial purposes.

Boron occurs as sodium borate or calcium borate in mineral deposits and natural waters. The average concentrations observed at the upstream (No. 1503) and (No. 1533) downstream stations are 0.32 and 0.34 mg/L. Boron is an essential element in the nutrition of higher plants and these values would have no adverse effect on human health or aquatic life.

Levels of **dissolved oxygen** (DO) at the respective stations are shown in Tables A4.3 and A4.4 in Annex 4. The average DO at Yahsihan (No. 1503) is 8.2 mg/L, and reaches 10.7 at the Inozu sampling point (No. 1533). According to the data obtained for 1994 and 1995, DO values did not drop below six milligrams per liter. The observed maximum value, 14.2 mg/L, occurred in January 1994 at the Inozu Station (No. 1533).

Biochemical Oxygen Demand values are quite low throughout the river. The average BOD value at the Yahsihan station (No. 1503) in 1994 was 1.8 mg/L, and the maximum, 2.4 mg/L. In 1995, the average and maximum values were 2.8 mg/L. At Inozu, there was only one measurement for BOD in 1994 (1.0 mg/L); in 1995, the average BOD at that station was 1.4 mg/L, with a maximum value of 2.4 mg/L.

The measurements of **turbidity** indicate that it reaches 12 NTU at the Yahsihan sampling station (No. 1503). This level implies good quality for aquatic life and various uses of water. No measurements of turbidity were made at the Inozu station.

Ammonia nitrogen concentrations at these two stations varied between 0.06 and 0.3 mg/L. The average level was 0.09 mg/L and 0.2 mg/L at the Yahsihan (No. 1503) and Inozu (No. 1533) stations, respectively. The average **nitrate nitrogen** concentration of Yahsihan and Inozu sampling points were 0.43 mg/L and 1.68 mg/L, respectively. The **nitrite nitrogen** levels were 0.014 and 0.038 mg/L for these two stations, respectively. The values observed at Inozu station are relatively higher possibly due to increased run-off and human sources.

The measurements of DSI showed that **ortho-phosphate** levels are quite low, having average values for both stations between 0.05 mg/L and 0.11 mg/L. Because phosphate is the limiting nutrient, this low level indicates a modest level of biological productivity in the river.

V.1.4.3.2. River Water Quality Study Performed by Ankara University in the Boyabat Project Area

An investigation on river water quality was accomplished by Ankara University, Department of Chemistry in 1992 on the Kizilirmak River at four locations (Figure V.1). The investigation was carried out between May 1992 and October 1992. The reason for inclusion of this investigation in water quality study is the fact that in this investigation, some additional parameters which were not measured at Yahsihan and Inozu Stations were present. In addition, Stations 2 and 3 are more local to the project site when compared to Yahsihan sampling station and are not influenced by Altinkaya Dam when compared to Inozu station. At each station, five samples were drawn during this six months period. The samples were taken on May 25-26, June 29-30, August 27-28, September 29-30 and October 26-27.

Station 1 was located at the upstream of the city of Bafra, close to the point where the Kizilirmak River reaches the Black Sea. Station 2 was situated on the Gokirmak, where it joins the Kizilirmak River. Station 3 was located downstream of Kargi (upstream part of Boyabat Reservoir, 60 km upstream of Boyabat Dam Axis), and Station 4 was located at the point where Delice Creek joins to Kizilirmak River. Annex 4 (Tables A4.6, A4.7, A4.8, A4.9) displays the water quality data for these four stations.

Temperature: Since the measurements were made between the spring and fall seasons (May, June, July, September and October) the temperature range was between 14 and 19°C at these four stations.

pH: The measurement of pH ranged between 7.0 and 8.7, and all pH values at Station 2 were above 8.0. The water is highly alkaline for freshwater, and it is slightly higher than the optimum conditions for fresh water productivity.

Sodium: Except at Station 2, where the concentrations were quite low (between 1.6 and 6.6 mg/L), Na concentrations in the Kizilirmak were between 120 and 210 mg/L. These sodium concentrations are suitable for aquatic life and do not have appreciable effects on irrigation.

Magnesium: As one of the most common elements in the crust of earth, magnesium salts are very soluble and commonly found in waters. At Station 2, the range was between 17 and 36.5 mg/L, relatively higher than the other stations that had a level of 6.0 mg/L. The values indicate no harmful effect for human health and aquatic life.

Chlorides: The quantity of chlorides at Station 2 was very low (2.1-7.4 mg/L) while they were relatively higher (350.4-389.4 mg/L) at Station 4. They do not pose any problems with respect to aquatic life and human health at this level.

Sulfates: The levels of sulfates at Stations 1 and 2 were relatively lower than those at Stations 3 and 4. The total range was between 33.6 and 130.9 mg/L. They do not pose any problems with respect to aquatic life and human health at this level.

Boron: The quantity of Boron was less than 0.1 mg/L in all samples. These values are suitable for aquatic life and would have no adverse effect on human health.

Dissolved Oxygen: Dissolved oxygen is required for the respiration of aerobic microorganisms as well as all other aerobic life forms. However, oxygen is only slightly soluble in water. Because the rate of biochemical reactions that use oxygen increases with increasing temperature, dissolved oxygen levels tend to be critical in the summer months. The problem is compounded in summer months because stream flows are usually lower, thus the total quantity of oxygen available is also lower. The observed supersaturation values of 9-19 mg/L may be due to the collection of samples from points of water falls. Still these values imply that water is rich in dissolved oxygen. This may suggest for a potential total gas supersaturation in the river water.

Biochemical Oxygen Demand: The most widely used parameter of organic pollution applied to surface water is the five-day BOD (BOD_5). This determination involves the measurement of the dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter. BOD_5 ranges between 4.0 and 12.0 mg/L among the four stations, indicating there is no significant organic pollution.

Ammonia Nitrogen: The values measured at Station 1 (average; 2.27 mg/L) are slightly higher than the other three stations. At Station 4, the concentration ranges between 0.2 mg/L and 1.0 mg/L. In the other two stations it is less than 0.2 mg/L.

Nitrate: Nitrate is one of the major ions in natural waters. Nitrate (in drinking water) has two adverse health effects; induction of methemoglobinemia, especially in infants and the potential formation of carcinogenic nitrosamines. The values measured at the four stations that range between 0.01 and 1.45 are quite low and would have no adverse effects on human health or aquatic life.

Total Kjeldahl Nitrogen (TKN): Kjeldahl Nitrogen is the total of organic and ammonia nitrogen. This is an important parameter for fresh water ecology since nitrogen is essential to the growth of algae and known as nutrient or biostimulant. At Station 1, the TKN concentration is relatively higher than the other three stations (average; 2.7 mg/L), while at all of the other stations values below one milligram per liter were observed.

Total Ortho-Phosphates (T-PO₄-P): Phosphorus is also essential to the growth of algae and other living organisms. Because of noxious algal blooms that occur in surface waters, there is much interest in controlling the amount of phosphorus compounds that enter the surface waters in wastewater discharges and natural run-off. At Station 4, the concentrations measured (average 0.21 mg/L) are higher than the other three stations (range 0.02-0.079 mg/L).

Total Coliform: The direct search for the presence of a specific pathogen in water is uneconomical and slow for routine control purposes. Instead, water is examined for an indication of fecal contamination and when such an indication is found, it is assumed that the water poses a potential health problem. The coliform group of organisms, referred to as total coliform, is commonly used as an indicator of water microbial quality. The numbers of total coliforms in 100 ml, range between 2,000 and 12,000 among the four stations. This indicates that there might be anthropogenic sources that discharge into the Kizilirmak River, or soil, vegetable and other non-fecal origin sources might be the reason for these values.

Fecal Coliforms: Fecal coliforms provide stronger evidence of the possible presence of fecal pathogens than do total coliforms. Although the test does determine coliforms of fecal origin, it does not distinguish between human and animal contamination. Except at Station 4, where the number of fecal coliforms range between 14 and 32, in the other three stations the fecal coliform numbers in 100 ml, range between 690 and 1,300, indicating probable fecal origin of contamination from the settlements in the vicinity or agricultural activities.

Chemical Oxygen Demand: The COD test is used to measure the content of organic matter of both wastewater and natural waters. The COD of a water is, in general, higher than the BOD because more compounds can be chemically oxidized than can be biologically oxidized. COD ranged between 48 and 61 mg/L among the four stations and had an average of 47 mg/L. This values imply that there is no serious pollution problem with respect to COD.

TDS (Total Dissolved Solids): In natural waters, the dissolved solids consist mainly of carbonates, bicarbonates, chlorides, sulfates, phosphates, calcium, magnesium, sodium and potassium with traces of iron, manganese and other substances. The observed values determined Stations 1 and 2 were quite high (365-900 mg/L), possibly due to natural contribution, while those determined in Stations 3 and 4 were relatively low (87-153 mg/L).

Suspended Solids (SS): In natural waters, suspended solids consist normally of erosion silt, organic detritus and plankton. However, human activities like discharge of liquid wastes from communities and industries or increased erosion from deforested and cultivated areas, can also alter the suspended solids in surface waters. While the suspended solids were between 4.0 and 13.4 mg/L at Stations 1, 3, and 4, relatively high values (peak 63 mg/L) were observed at Station 2. These values of suspended solids do not indicate a hazard towards aquatic life and human health.

Cadmium: Cadmium enters the environment from a variety of industrial applications, including mining and smelting operations, electroplating, and pigment and plasticizer production. The USEPA has classified cadmium as a probable human carcinogen (group B1). At all four stations, the observed concentration was less than 0.5 µg/L, indicating no harmful effects for aquatic life.

Lead: Health effects of lead are generally correlated with blood test levels. Infants and young children absorb ingested lead more readily than do older children and young adults. At all four stations, the observed concentration was less than 15 µg/L. Lead concentrations of 100 µg/L have been deleterious to fish life, especially in soft waters, and the dissolved lead content of Class III surface waters is restricted to 50 µg/L by Turkish Inland Water Standards. The level of Pb in Kizilirmak is at the level of Class II water and the river is suitable for aquatic life.

Copper: Low levels (generally below 20 µg/L) can derive from rock weathering. Copper is a nutritional requirement and copper doses in excess of nutritional requirements are excreted. However, at high doses, copper can cause acute effects such as damage to the liver and renal systems and anemia. At Stations 1 and 3 the observed concentrations were less than 10 µg/L. The Cu concentration is about 12 µg/L at the other sampling stations. These Cu concentrations are considered to be suitable for all forms of aquatic life.

Total Chromium: Chromium occurs in drinking water in its +3 and +6 valance states with +3 being more common. Primary sources in water are old mining operations, and fossil fuel combustion. Chromium III is nutritionally essential, non-toxic and poorly absorbed. Chromium VI is toxic, producing liver and kidney damage, internal hemorrhage and respiratory disorders. Chromium VI has not been shown to cause cancer in humans through ingestion exposure. At all four stations, the observed concentrations were less than 10 µg/L. These values are much below the permissible limit for fish life. The highest chromium concentration value is 1.0 mg/L for fish and 0.05 mg/L for other aquatic life. The river water is suitable for fish and other aquatic life.

Zinc: At all four stations, the observed concentration was less than 100 µg/L, which allows use of water for various purposes. Class I waters may have a zinc concentration up to 200 µg/L according to Turkish Inland Water Standards. Generally, fish can tolerate Zinc concentrations between 0.3 and 0.7 mg/L. Additionally, the water hardness has an antagonistic effect toward zinc toxicity and Kizilirmak waters are quite hard.

Nickel: Although incidence of respiratory tract cancers have been more commonly observed among nickel refinery workers than the whole population, nickel has not been shown to be carcinogenic via oral exposure. At all four stations, the observed concentration of nickel was less than 50 µg/L, which allows use of water for several purposes. Nickel in river water should be less than 20 µg/L to classify this water as Class I according to Turkish Inland Water Standards. European Community drinking water standards have an upper limit of 50 µg/L for nickel. It was estimated that (Water Quality Criteria, 1978) fish can tolerate nickel concentrations up to 800 µg/L.

Iron: Natural waters may be polluted by iron-bearing industrial wastes and by the leaching of soluble iron salts from soil and rocks. At all four stations, the observed concentrations were less than 100 µg/L, which allows use of water for various purposes. For Class I waters maximum iron concentration in water must be less than 300 µg/L. Waters with iron concentrations up to 700 µg/L can support good fish fauna.

Manganese: Manganese is not found pure in nature, but its ores are very common and are widely distributed. At all four stations, the observed concentrations were less than 100 µg/L, which allows use of water for all purposes. Manganese concentration up to one milligram per liter is not deleterious for fish and aquatic life.

Sulfur: Elemental sulfur occurs in a free state in nature and it may also result in water from the oxidation of sulfides. At all four stations, the observed concentration was less than one microgram per liter, indicating good quality for the fish and aquatic life.

V.1.4.3.3. River Water Quality Studies Performed in the Project Area in 1997

During the 1997 field studies (May - September), pH, temperature, dissolved oxygen (DO), electrical conductivity (EC), salinity, and secchi depth were measured at each of the stations. The characteristics of the river bottom and the shore were also recorded. The locations of the sampling stations are presented in Figure V.2 and the results of the measurements, including the sampling dates, are given in Annex 4 (Table A4.10).

A YSI SCT-meter Model 33 equipped with a YSI-3300 model SCT probe was used to measure the temperature (in °C), electrical conductivity (in µmhos/cm) and salinity (in ‰) of water at the selected stations. A YSI DO-meter Model 5514 equipped with a Model 5521 DO probe was used to measure the dissolved oxygen (in ppm) at these stations. Depth and secchi depth, both in cm, were measured using a sounding-lead and a secchi disc, respectively. The pH was measured using a Type 400 Chemitrx pH-meter. The current and wave conditions were observed on-site and the bottom conditions were determined using a bottom skimmer (dip net).

pH: The pH values did not differ significantly from station to station. The pH was generally around 6.5 in May and 6.0 in June, while the values were slightly alkaline (about pH eight) from July to September. These pH values indicate water that is suitable for any use.

Temperature: Water temperatures were between 19 °C and 26 °C at all stations during May-September. Because the maximum water depth at the deepest station was only about 300 cm, there was no temperature variation with depth. The average temperature increased from 23 °C in May to about 25 °C in July, then decreased to 20 °C in September.

Dissolved Oxygen (DO): The dissolved oxygen values varied from 6.2 to 10.9 mg/L, the average concentrations being eight milligrams per liter in spring and summer, and nine milligrams per liter fall. Significant variation in DO with depth was not observed at any of the stations. DO values are suitable for aquatic life.

Electrical Conductivity (EC): Electrical conductivity is normally high in the Kizilirmak due to the minerals dissolving from the regional soils. The EC values did not change appreciably from station to station on a given sampling date, and were between 1,400 and 2,150 µmhos/cm (at 25 °C) at all stations during the 1997 studies. The average EC was 1,500 µmhos/cm (at 25 °C) and increased to 2,050 µmhos/cm (at 25 °C) in summer due to evaporation. These EC values are slightly high for most water uses, but river water with these values can be used for irrigation without treatment.

Salinity: Salinity values were from 0.8 to 1.8 ‰ (parts per thousand) and did not differ greatly with season or by station. The average salinity was 1.0 ‰ at all stations. Water having such salinity values can be used only for irrigation purposes.

Secchi depth: The secchi depths measured at the sampling stations were generally less than 20 cm. The average secchi depths were 15 cm in May and in September, but were only about five centimeters in summer. The relatively high turbidity, as well as the reddish brown color of Kizilirmak, is caused by soils eroding from the steep slopes in the valley.

V.1.4.3.4. Groundwater/Springs

Groundwater use in the project area is basically non-commercial. Generally, the wells opened by villagers are used for individual needs. There are also some small springs in the area, but they do not provide sufficient quantities of water to meet the domestic water requirements.

Groundwater is being used to meet the drinking and domestic water needs of the already existing camp facilities. Additionally, it can be used to meet the water requirements for construction.

Other than the wells used by the villagers, some wells are also opened by State Hydraulic Works (DSI) for various purposes. There is almost no information in hand about the level of groundwater quality in the village wells. On the other hand, there is valuable information on groundwater table levels, groundwater potential and quality, collected by DSI in the wells that they explored.

There are six wells explored by DSI in the close vicinity of the dam site and camp facilities. In fact, four of these wells are very close to the camp facilities and explored to supply the domestic water needs of the facilities. One of the other wells is at Korucuk Village, which is about seven kilometers from the dam site in northwest direction. The sixth well is located at around Gorlen, and is about 20 km from the dam site to the west. Information on the level of groundwater table and quality can be representative for both the dam site and reservoir area. The location of the wells and their characteristics are given in Table V.5 below.

Only considering the yields measured in these wells, it can be said that groundwater can be used as the water supply source of the camp facilities and can be used for construction purposes as well. When static head values are examined, it can be supposed that there might be recharge and discharge between the river and the aquifer.

From the geological studies, it was also estimated that cavities exist in large numbers in the zone of ground surface line to depths of around 100 m. The limestone along the F-5 fault, which is roughly parallel to river and forms the boundary between limestone and schist (Figure V.10 and Figure V.11), is permeable as well. There might be water movement (in a way leakage) between these cavities and along the F-5 fault, so some recharge and discharge can take place, between groundwater and the river, as a result of this movement.

Table V.5. Location and Characteristics of The Wells of DSI

No	Location	Elevation (m)	Depth (m)	Static Head (m)	Dynamic Head (m)	Yield (Q) (L/sec)
1	Gorlen		15	0.40	0.67	13.00
2	Korucuk	270	25	6.87	13.30	25.00
3	Site Facility	190	58	16.75	21.37	60.00
4	Site Facility	190	30	5.95	7.75	35.00
5	Site Facility	188.5	42	15.20	32.20	2.00
6	Site Facility	188.5	43.5	7.76	8.73	30.00

The quality of water source is also very important in selecting this source for domestic water supply. Groundwater is relatively constant in quality from season to season. However, groundwater supplies may be variable in quality from one well location to other. Changes in hydrogeological conditions can produce different water quality over a short distance. Groundwater quality is usually superior to that of surface water with respect to bacteriological content, turbidity, and total organic concentrations. On the other hand, basic groundwater quality problems are typically associated with the mineral content; high hardness, iron and manganese when groundwater is considered as a domestic water supply source. Currently, the quality of groundwater with respect to trace concentrations of organic chemicals, such as pesticides, is of great concern as well. Groundwater supplies are frequently used with minimal treatment.

Groundwater quality had been analyzed in some of the wells of DSI mentioned above. In these analyses some of the physical and chemical parameters were considered. The well numbers and the parameters measured in these wells are provided in Table V.6 including the results of the measurements.

According to the tabulated results, hardness is high. As organic matter (as carbon) is very low it can be supposed that there is no problem about the organic parameters. When these results are compared with the Turkish Inland Water Classes Standards, presented in Table V.4, the value of Na^+ , Cl^- , SO_4^{-2} are slightly greater from the limits of Class I waters. Class I waters can be used for any purpose, including drinking water purposes, by only disinfection and aeration, recreation, and fish farming purposes. It can be concluded that this groundwater falls into Class II category. With regard to Turkish standards Class II waters can be used as drinking water supplies after appropriate treatment. In addition, they can be used for recreation, fisheries (other than trout), but can be used for irrigation depending on values of individual parameters. For instance, when Cl^- is considered the values found may create some problems if this supply is used for irrigation purposes. For general irrigation purposes SO_4^{-2} concentration seems to be lower than the upper permissible limits.

Table V.6. Results of Groundwater Quality Analyses

Parameter	Well No.			
	2	3	4	6
pH	7.2	7.8	8	7.6
EC $\times$ E6 ($\mu\text{mhos/cm}$)	655	1804	1300	1470
Cations (meq/L)	7.89	18.44	15.70	17.34
Na^+ (meq/L)	1.04	7.39	7.40	7.30
K^+ (meq/L)	0.05	0.10	0.05	0.09
Ca^{+2} (meq/L)	4.05	6.70	5.20	5.60
Mg^{+2} (meq/L)	2.75	4.25	3.05	4.35
Anions (meq/L)	7.89	18.44	15.7	17.34
CO_3^{-2} (meq/L)	0.00	0.00	0.00	0.00
HCO_3^- (meq/L)	6.25	5.30	4.50	5.50
Cl^- (meq/L)	0.52	6.40	5.45	5.80
SO_4^{-2} (meq/L)	1.12	6.74	5.75	6.04
Hardness FS°	34	55	41	50
Organic matter (mg/L) as carbon	-	0.30	1.60	0.70
Nitrite (mg/L)	-	-	0.00	0.00
Nitrate (mg/L)	-	-	0.00	0.00
Ammonia (mg/L)	-	-	0.00	0.00

In conclusion, the springs within the project area are not noteworthy in quantity. Regarding groundwater, when the data obtained from the wells of DSI are accepted to be representative for the vicinity of the project area, it can be said that groundwater in the area is in contact with the river water to some extent at present conditions. The studies of DSI indicate that groundwater is flowing towards the river at present conditions. The quality of groundwater indicates the fact that there should be some appropriate treatment before using this water source for drinking water supply. In addition, while using the groundwater for other purposes, such as irrigation, attention should be given to some of the parameters that has higher values than the standards for Class 2 waters.

V.1.4.4. Existing Water Use in the Project Area

Mainly groundwater and fountains are used to supply drinking water and for domestic purposes in the villages. Also, in orchards far from the river, groundwater is used with irrigation purposes. It is known that, at present conditions, groundwater in the area is in contact with the river water to some extent.

In this area river water is mainly used for irrigation. The rice fields in the valley bed are the main crops depending on the river water. Occasionally, water pumps are used in order to transmit the river water to the fields in relatively higher elevations. Since there is no industry or a similar facility in the area, other than irrigation river water has not much domestic use.

Kizilirmak waters have biological uses in addition to the domestic uses mentioned above. The river is used by the fauna species and the livestock living in the area. The uses of the river water by wildlife, and its significance are discussed in the "Biological Environment" section (Section V.2).

V.2. Biological Environment

Boyabat Dam site is located 14 km upstream from the junction of the Kizilirmak and Gokirmak Rivers, southwest of Duragan which is a town in the Kizilirmak basin of Central Black Sea region. Boyabat Reservoir will have a length of 60 km and will cover an area of 65 km². Studies of the biological environment, the project area, and the potential impact area, were carried out in 1996 and 1997.

The studies on biological environments cover terrestrial and aquatic resources and include flora and fauna species, as well as habitat descriptions. The objectives of these studies were identification of the flora and vegetation types, terrestrial fauna (mammals, birds, reptiles, amphibians) and aquatic species within the study area and the determination of the potential impacts on biological resources.

To achieve these objectives the information on the biological environment was collected by the means of following:

- The pertinent literature.
- Communication with the inhabitants in the study area during the field studies.
- Field studies carried out in the Project Area between April and September of 1997.

During these studies, site-specific data on flora and fauna were collected for the project study area. The data were evaluated throughout these studies and particular attention was given to the species of international concern and their habitats. Types of ecological information obtained in these studies included; species habitat requirements, feeding and breeding characteristics, movements of aquatic and terrestrial fauna (seasonal or local), and species distribution.

For the flora and terrestrial fauna studies the same grid system was used, so as to provide a description of habitat types within the project area where the terrestrial species were identified. During the field studies, habitats that could be utilized by the species of concern were also given special attention.

The baseline information for flora and vegetation communities in the study area is presented in Section V.2.1 and for terrestrial fauna in Section V.2.2. The information on aquatic biological resources is given in Section V.2.3. In the light of this baseline information and the proposed features of the project, potential impacts of the project on the biological resources were assessed and mitigation measures were evaluated, where appropriate, and presented in the following chapters.

V.2.1. Flora and Vegetation Communities

The steep topography of the Kizilirmak valley at the dam site affects the formation and distribution of the vegetation. In addition, the natural forests and woodland observed in the project area were generally destroyed by the settlers for fuel and timber, and overgrazing in the environs of settlements. However, in the study area, it is still possible to see typical samples of natural forest free from anthropogenic effects.

The study area is in the Middle Black Sea Region and located in the Iranian-Turanian and European-Siberian phytogeographic areas, forming a transitional zone. The study area is in the A5 grid according to the grid mapping system of "Flora of Turkey and East Aegean Islands" (Davis, 1965-1988).

V.2.1.1. Materials and Methods

The geographical coverage of the study area was based on preliminary field observations and an aerial view of the area obtained from a video recorded by a helicopter overflight. The field studies cover an area from the village of Erduasi downstream to the village of Karaboya upstream. Thus, an area approximately 70 km long was studied, including the 60-km long reservoir area and five kilometers upstream and downstream of the reservoir area.

In the vicinity of the dam axis, the river bed elevation of the Kizilirmak is about 185 m, and elevation reaches 330 m a few kilometers upstream of Egzen (Demiroren) village. The upstream limit of the reservoir reaches a river kilometer of approximately 183. The floristic survey was limited to an elevation of 500 m, since the maximum water level in the reservoir will be 330 m.

The area sampled covered approximately 40% of the impact area. However, the sampling sites (transects) were distributed such that they would be representative of the whole area. For vegetation studies, fixed sampling sites were determined by the "minimal area" method, while for the floristic studies, observations were carried out along the river and samples of plant species were collected throughout the study area. The sampling sites are shown on the map showing the future Boyabat Reservoir, in Figure V.2.

During the field studies conducted in 1997, numerous samples were collected in the study area during spring, summer and fall. Two field visits were conducted each month from April to September. Each field sampling visit lasted for two to four days for about 12 hours a day. One senior and one junior botanist took part in most of the field studies. On each day of sampling a distance of about 150 km was traveled in the study area from Erduasi village to Karaboya village.

During sampling, habitat characteristics, plant communities observed and their elevation were recorded. The average heights of the common tree and shrub species were also recorded. The samples collected from the field were pressed and dried for further identification and then identified in the laboratory according to "Flora of Turkey and the East Aegean Islands" (Davis, 1965 through 1988). The flora inventory of the study area was organized according to the taxonomic order in the reference document, indicating the phytogeographic region, elevation range and endemism for the species. Further, the species were classified according to the "List of Rare and Endemic Plants in Turkey" (Ekim, *et al*) as follows:

E	Endangered
V	Vulnerable
R	Rare
I	Indeterminate
K	Insufficiently Known
nt	Not threatened

The following abbreviations were used for the phytogeographic regions:

Euro-Sib	European-Siberian
Ir.-Tur.	Iranian-Turanian
Medit.	Mediterranean
E. Medit.	Eastern Mediterranean
Euxin.	Euxine
Hyr.Euxin.	Hyrcano-Euxine