THE KINGDOM OF THAILAND

FEASIBILITY REPORT
ON
LOWER QUAE YAI REGULATING DAM PROJECT

OCTOBER 1976

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

The Government of Japan, in response to the request of the Government of the Kingdom of Thailand, entrusted the Japan International Cooperation Agency with the study of the Lower Quae Yai Regulating Dam Project.

The Japan International Cooperation Agency organized Engineering Mission composed of six members and headed by Mr. Shinichi Nojiri of the Electric Power Development Co., Ltd, and carried out field investigations for forty-five days from November 12 through December 26, 1975.

The results of the analyses and studies of the Project on the basis of the field investigations as well as collected data are described in the Report.

Nothing would be more gratifying to our Agency than if the Report could be of any help for promoting water resource development in Thailand, for economic co-operation, as well as promoting closer relationship between Thailand and Japan.

In closing, I would like to take this opportunity to express my sincere gratitude to the officials of the Government of Thailand, Japanese Embassy in Bangkok, the Ministry of Foreign Affairs and the Ministry of the International Trade and Industry for the wholehearted cooperation and assistance extended to us.

October 1976

Shinsaku Hogen
Director General
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Mr. Shinsaku Hogen, Director General
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir:

Submitted herewith is the Feasibility Report on the Lower Quae Yai Regulating Dam Project in the Kingdom of Thailand.

The Engineering Mission organized for the study of the Project visited Thailand for fourty-five days from November 12 through December 26, 1975 and carried out field investigation with the cooperation of the Electricity Generating Authority of Thailand.

During the stay in Thailand, the Mission collected available data and information for forty-five days from November 12 through December 26, 1975 and carried out the proposed sites and, after return to Japan, prepared the report on the feasibility study of the Regulating Dam Project as well as preliminary study of the pumped-storage scheme using the said regulating reservoir as a lower pondage on the basis of the results of the field investigation and data collected.

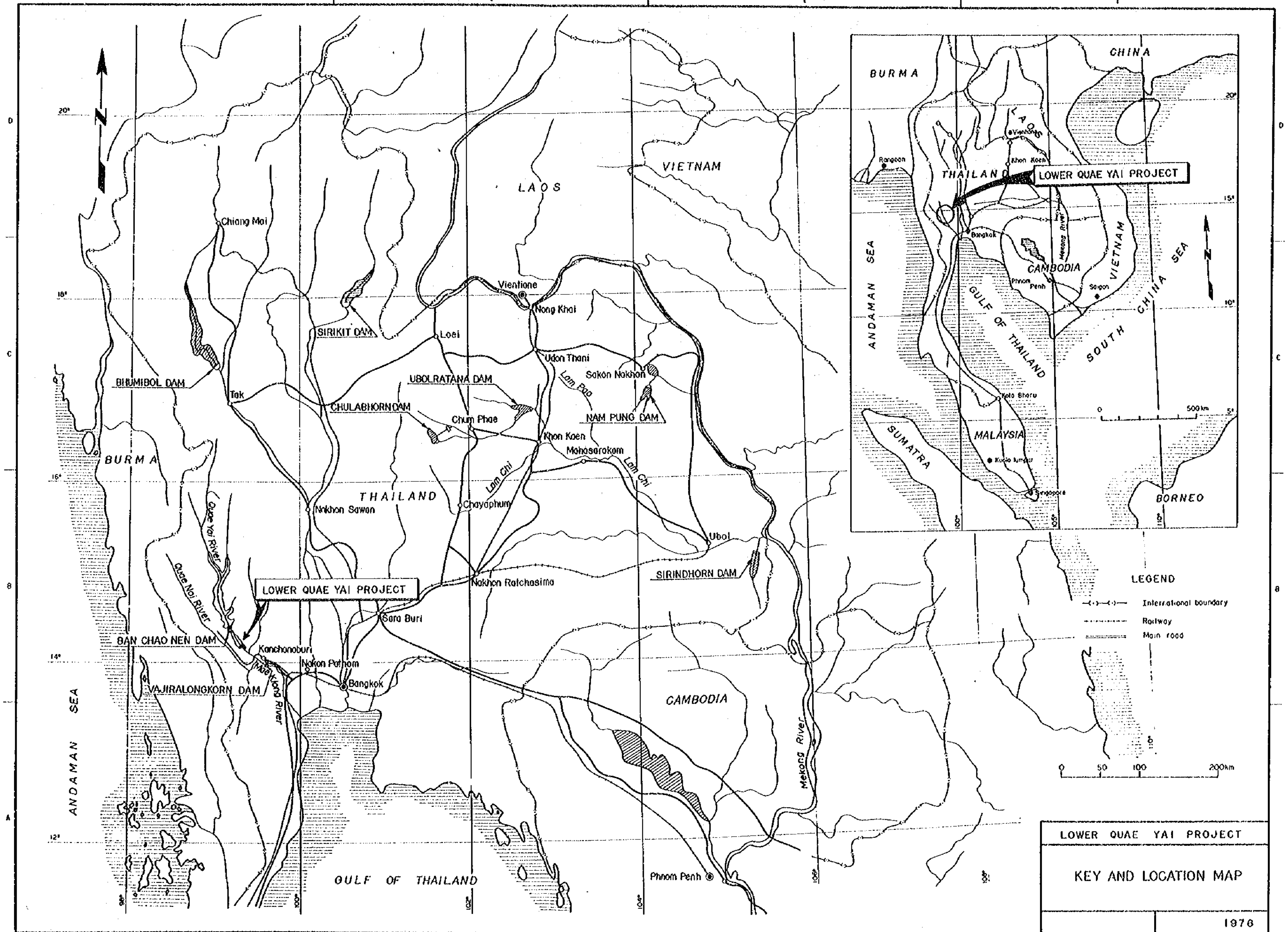
It is our wish that the Report will contribute to the further progress of the development of water resources of Thailand.

On the occasion of submitting the Report, I sincerely express my profound gratitude to all persons concerned for their generous assistance and cooperation in performing the studies.

Your respectfully,

S. Nojiri

Shinichi Nojiri, Chief
Lower Quae Yai Regulating Dam Project
Engineering Mission


LOWER QUAE YAI PROJECT
KEY AND LOCATION MAP
1978
LEGEND
International boundary
Railway
Main road
BURMA
LAOS
VIETNAM
THAILAND
CAMBODIA
ANDAMAN SEA
GULF OF THAILAND
Chiang Mai
Vientiane
Nong Khai
Loei
Udon Thani
Sakon Nakhon
Tak
Chum Phae
Khon Kaen
Mahasarakam
Nakhon Sawan
Chayaphum
Ubol
Nakhon Ratchasima
Sara Buri
Kanchanaburi
Nakon Pathom
Bangkok
Phnom Penh
SIRIKIT DAM
BHUMIBOL DAM
UBOLRATANA DAM
CHULABHORN DAM
NAM PUNG DAM
SIRINDHORN DAM
LOWER QUAE YAI PROJECT
BAN CHAO NEN DAM
VAJIRALONGKORN DAM
Quae Yai River
Quae Noi River
Mae Klong River
Lam Pao
Lam Chi
Mekong River
CHINA
MALAYSIA
SUMATRA
BORNEO
SOUTH CHINA SEA
Rangoon
Singapore
Kuala lumpur
Kota Bharu
Saigon

GENERAL DESCRIPTION OF PROJECT

1.	Construction purpose	1) Providing lower pondage for pumping-up operation of 2nd stage Ban Chao Nen project, 2) reregulating power discharge of Ban Chao Nen project, 3) developing hydro-electric potential in downstream basin and 4) providing lower pondage for future pumped-storage project.
2.	Location	Ban Tha Thung Na site on the Quae Yai river approximately 150 km north-west of Bangkok
3.	Catchment area	11,428 km^2
4.	Annual inflow	4,410 x 10^6 m^3
5.	Design flood	3,000 m^3/sec
6.	Reservoir	
	High water level	59.70 m
	Low water level	55.50 m
	Total storage capacity	56.3 x 10^6 m^3
	Effective storage capacity	27.7 x 10^6 m^3
	Available drawdown	4.20 m
7.	Dam	
	Type	Concrete gravity with spillway section and rockfill with center impervious core
	Crest elevation	63.00 m
	Height	30 m
	Crest length	860 m
	Volume	350,000 m^3 (concrete : 50,000 m^3 and rockfill : 300,000 m^3)
	Slope	Upstream surface: Vertical (concrete); 1 : 2.5 (rockfill) Downstream surface: 1 : 0.8 (concrete); 1 : 2.0 (rockfill)
	Spillway gates	6 radial gates, 12.50 m x 7.00 m

8. Intake

Type	Reinforced concrete structure
Screen	5 sets, 6.80 m x 17.23 m
Control gates	4 roller gates with hoisting devices, 7.30 m x 13.50 m

9. Powerhouse — Reinforced concrete structure

10. Power generating facilities

Installed capacity	37,000kW
Turbine	
Type	Vertical shaft, Kaplan turbine
Number of units	2
Rated head	15.10 m
Power discharge	145 m^3/sec
Rated output	19,000 kW
Revolution per minute	125 rpm
Generator	
Type	Three phase, AC, synchronous generator
Number of units	2
Capacity	20,600kVA at rated power factor 0.9 lag
Frequency	50 Hz
Transformer	
Type	Three phase, oil immersed, forced air cooled transformer
Number of units	2
Capacity	20,600 kVA
Voltage	115/11 kV

11. Transmission line

Location	From Ban Tha Thung Na power plant to 115 kV transmission line between Kanchanaburi and Ban Chao Nen power plant
Length	Approximately 2.5km
Voltage	115 kV
Number of circuits	1cct, π connection

12. Telecommunication equipment

Type	Power line carrier system

13. Construction cost

Total cost	847,400,000 Baht
Foreign currency	486,600,000 Baht
Domestic currency	360,800,000 Baht

14. Annual energy production 155,000,000 kWH

15. Benefit cost ratio (B/C) 1.32

16. Construction schedule

Proposed commencement date	December 1977
Proposed operation date	October 1980
Construction period	35 months

CONTENTS

CHAPTER 1 INTRODUCTION

1.1 History

With the rapid expansion of the national economy in Thailand in recent years, both industrial and domestic demands for electric power have been increasing year by year. This trend is remarkable particularly in the metropolitan area. This growth trend which is a relatively high rate is forecasted to continue into the future.

Under the circumstances, the Electricity Generating Authority of Thailand (hereinafter called EGAT) which owns most of the generating capacity of the country is constructing both thermal and hydroelectric power plants, and is also planning and conducting field studies for future development projects. Since the oil crisis which occured at the end of 1973, the utilization program of lignite, an indigenous energy resource, has been reviewed, the plan for construction of nuclear power plants has been expedited and at the same time the importance of hydropower development has been recognized.

The development plan of the Quae Yai River with the largest hydroelectric potential in Thailand following the Mekong, an international river, has been studied before the oil crisis developed. After tedious geologic investigations it was concluded that the reservoir and dam foundation are watertight, and the first stage construction of the Ban Chao Nen Project started in 1974 immediately after the conclusion was made. It is stated in the Feasibility Report of the Ban Chao Nen Project, which was prepared in March 1968, that construction of hydroelectric projects on the upstream of the Quae Yai River and regulating dam on the downstream should be promoted in succession to the construction of the Ban Chao Nen project. In the Reconnaissance Report of the Upper Quae Yai basin prepared in November 1973, a suggestion was made to construct a pumped-storage power plant with this regulating dam as a lower pondage.

In response to this suggestion, EGAT invited an expert from Japan who in cooperation with EGAT engineers started basic field investigations to promote the various projects on the upstream and downstream of the Ban Chao Nen site. In 1975, EGAT requested through DTEC (Department of Technical and Economic Cooperation) the Japanese Government to dispatch an engineering team to study the feasibility of the regulating dam porject on the downstream of the Quae Yai River.

In response to this request, the Japanese Government dispatched the Engineering Mission to carry out the feasibility study of this project from November 12 to December 26, 1975.

1.2 Purpose of investigation

This investigation concerns with the feasibility study of the Regulating Dam Project which includes a dam and power plant located downstream of the Ban Chao Nen power plant on the Quae Yai River and preliminary studies were also made with regard to the Ban Tha Thong Mon pumped-storage Project which will use this regulating reservoir as a lower pondage.

The Lower Quae Yai Regulating Dam Project plays an important role of providing the lower pondage necessary for pumping-up operation of the Ban Chao Nen power plant, reregulating the large fluctuation of power discharge of the same power plant, developing the hydraulic potential in the downstream basin and providing also the lower pondage for the future pumped-storage power plant as described below. Pumping-up operation of the Ban Chao Nen power plant is realized by construction of this regulating dam. For the effective operation of the power system, the Ban Chao Nen power plant will be forced to operate during peak load hours which will cause repeated sharp daily fluctuation of power discharge (798 m^3/sec at maximum to 0) of the said power plant, however, this sharp fluctuation of the water surface in the downstream basin will be essentially controlled on account of reregulation operation of this reservoir assuring efficient operation of the Ban Chao Nen power plant to meet with power demand. The Ban Tha Thung Na power plant to be constructed adjacent to the dam is to utilize the hydraulic potential in the lower Quae Yai basin to the maximum in view of topographic conditions and, in spite of its relatively small generating capacity, considerable amount of annual energy production will be available due to effective regulation of annual inflow at the upstream Ban Chao Nen reservoir. This reservoir will also provide sufficient storage capacity required for the lower pondage of the future Ban Tha Thong Mon Pumped-storage Project.

As stated above, the Lower Quae Yai Regulating Dam Project plays an important role in the hydro-electric power development schedule of the Quae Yai River on account of direct benefit by power generation as well as effective contribution to the Ban Chao Nen project and is regarded as one of the most important future development projects of EGAT.

The feasibility study of the Lower Quae Yai Regulating Dam Project has been made to meet with the construction purposes mentioned above. The optimum features of the dam and power plant to cope with the design criteria and operation schedule inclusive of pumping-up operation of the Ban Chao Nen power plant were decided and the basic designs of the main structures were then prepared. For the Ban Tha Thong Mon Project, the required reservoir capacity and scale of development are based on the presently available information on the possible power source for pumping-up operation, and preliminary layout were made on the basis of the assumed and available data.

1.3 Members of Mission

The members of the Mission who conducted field investigations, collection of data and studies are as follows.

Chief	Shinichi Nojiri,	Electric Power Development Co., Ltd. Senior Civil Engineer
Members	Hidetoshi Abe,	Electric Power Development Co., Ltd. Civil Engineer-Planning
〃	Isao Otsuka,	Electric Power Development Co., Ltd. Electrical Engineer

Masahiro Shibata,	Electric Power Development Co., Ltd. Geologist
Minaichi Takeoka,	Electric Power Development Co., Ltd. Civil Engineer-Design
Hiroyoshi Inoue,	Japan International Cooperation Agency Coordinator

CHAPTER 2 CONCLUSION AND RECOMMENDATION

2.1 Conclusion

Described in the following paragraphs are the conclusions with respect to the Lower Quae Yai Regulating Dam Project as the result of field investigations, and studies and preliminary designs based on the field works.

2.1.1. Importance of early development of Project

The Lower Quae Yai Regulating Dam Project plays an important role in assuring effective operation of the upstream Ban Chao Nen power plant corresponding to power demand and, accordingly, time schedule requires the completion of construction of the structures related to operation of this reservoir by the time of operation of Units No. 1 and No. 2 of the Ban Chao Nen power plant in September and December 1979.

Commencement of filling the Ban Chao Nen reservoir is scheduled in June 1977 and, if the construction works of this project are carried out during the period of filling the said reservoir, the project construction cost will be remarkably reduced because there is no need of full-scale diversion facilities for care of river.

Under these circumstances, it is essential to start the early development of the Lower Quae Yai Regulating Dam Project and once this timing is missed, it will result not only in impairing the economic advantage of this project but also hindering the generating operation of the upstream Ban Chao Nen project. Therefore, the construction works of the main civil structures must be commenced at around the end of 1977 at the latest taking into account the required time for further field investigations and definite studies, and the preparation works such as construction facilities, etc. at the site must be started a few months ahead of that time.

2.1.2. Ban Tha Thung Na reservoir and power generating facilities

Among three proposed dam sites, Ban Tha Ta On, Ban Wang Kula and Ban Tha Thung Na shown in Fig 2-1, the first priority was given to the Ban Tha Thung Na dam site located at the lowest reach in consideration of the most effective development of hydro-electric potential in the area downstream of the Ban Chao Nen power plant, topography and geology of the site and required reservoir capacity. The general features of the project is described below.

(a) At the Ban Tha Thung Na dam site approximately 28 km downstream of the Ban Chao Nen power plant, there is no unusual technical problems to construct the proposed dam, powerhouse and other structures from a geological point of view.
There will be also no apprehension about watertightness of the surrounding foundation taking into consideration general topography in the reservoir area, geological distribution and structures and information of ground water level.

(b) A concrete dam with spillway structure is to be constructed at the river bed section adjoined on the right wing by a rockfill dam. The generating facilities such as intake, powerhouse and tailrace are to be constructed on the left bank adjoining the concrete dam. General description of the reservoir and power plant are as follows.

Reservoir:

High water level	EL 59.70 m
Low water level	EL 55.50 m
Effective storage capacity	27,700,000 m^3

Dam:

Height	30 m	
Crest length	860 m	
Volume	350,000 m^3	
	(Concrete	50,000 m^3)
	(Rockfill	300,000 m^3)

Development scheme:

Maximum discharge	290 m^3/sec
Rated head	15.10 m
Maximum output	37,000 kW
Annual energy production	155 x 10^6 kWH

(c) Electric power produced at this plant will be stepped-up to 115 kV at a switchyard erected near the power plant and 2.5 km long line will tie into the 115 kV transmission line which is recently constructed between the Ban Chao Nen power plant and Kanchanaburi substation.

(d) Construction schedule of this project was prepared in consideration of advantages that in case the main part of the civil works are constructed during the period of filling the Ban Chao Nen reservoir, the construction cost will be economized as full-scale diversion facilities will not be required, and that the efficient operation of the Ban Chao Nen power plant can be assured as the reservoir will be ready for reregulating operation prior to the start of generating operation of the Ban Chao Nen power plant. In the proposed construction schedule, it is scheduled to start the construction of the main civil works at around the end of 1977 and complete most part of the said works prior to the start of operation of Unit No. 1 of the Ban Chao Nen power plant in September 1979, and to have the reservoir ready for reregulating operation. The target date of start of operation of this power plant is October 1980 in consideration of period required for manufacturing and installation of main electric equipment such as turbines and generators etc., and a total construction period of thirty-five months will be required.

(e) The costs for construction of the Ban Tha Thung Na Project is estimated as follow:

Total construction cost	847,400,000 Baht
Domestic currency portion	360,800,000 Baht
Foreign currency portion	486,600,000 Baht

(f) For the purpose of evaluating the economic justification of the Project, an alternative thermal power plant of 300 MW constructed in Bangkok which is equivalent to the largest size unit of the existing thermal power plant of EGAT was assumed. Annual benefit (B) of a hydro-electric power plant calculated on the basis of annual cost of the alternative thermal power plant and annual cost (C) of this power plant based on the required construction cost are 104,250,000 Baht and 78,890,000 Baht, respectively and the benefit-cost ratio B/C comes to 1.32 which justifies the economic construction of the Ban Tha Thung Na Project.

2.1.3. Ban Tha Thong Mon Pumped-storage Project

Among three proposed pumped-storage projects (D_A, D_B and D_C) located on the right bank of the Ban Tha Thung Na reservoir, the Ban Tha Thong Mon Project (D_B plan) which is justified to be most economic and has no effect on the Erawan Fall resort is selected. This project has a siting advantage compared with the upstream Huai Klong Ngu pumped-storage power plant proposed as a part of electric power development scheme of the Quae Yai River on account of the short distance from power plants around Bangkok which will supply the electric power for pumping-up operation.

However, development of this project is considered to be after 1990 in view of the studies on reserve capacity as well as possible time of receiving power for pumping-up operation on the basis of load forecast and corresponding power development schedule prepared by EGAT. The scale of development must also be justified when a more firm forecast of power demand and supply after 1990 is made. Following are the general features of the Project at the present stage of studies.

Upper pondage:

High water level	EL 585 m
Low water level	EL 560 m
Effective storage capacity	3×10^6 m^3

Lower pondage: Ban Tha Thung Na reservoir

Power development scheme:

Maximum discharge	124 m^3/sec
Rated head	494.4 m
Maximum output	500,000 kW

Since the Ban Tha Thung Na regulating reservoir is used as a lower pondage of this project, the additional reservoir capacity required for pumping-up operation of this project must be taken into consideration in the study of reservoir capacity of the Ban Tha Thung Na regulating reservoir to assure the possibility of developing this project in the future.

2.2 Recommendation

In order to promote the development of the Ban Tha Thung Na Project, it is recommended to actively proceed with the following field investigations and preparation activities.

(a) Early development of Project

In order to assure the effective operation of the Ban Chao Nen power plant being constructed in the upstream and the economical development of this project, the pressing development of the Ban Tha Thung Na Project is required.

(b) Geological investigation

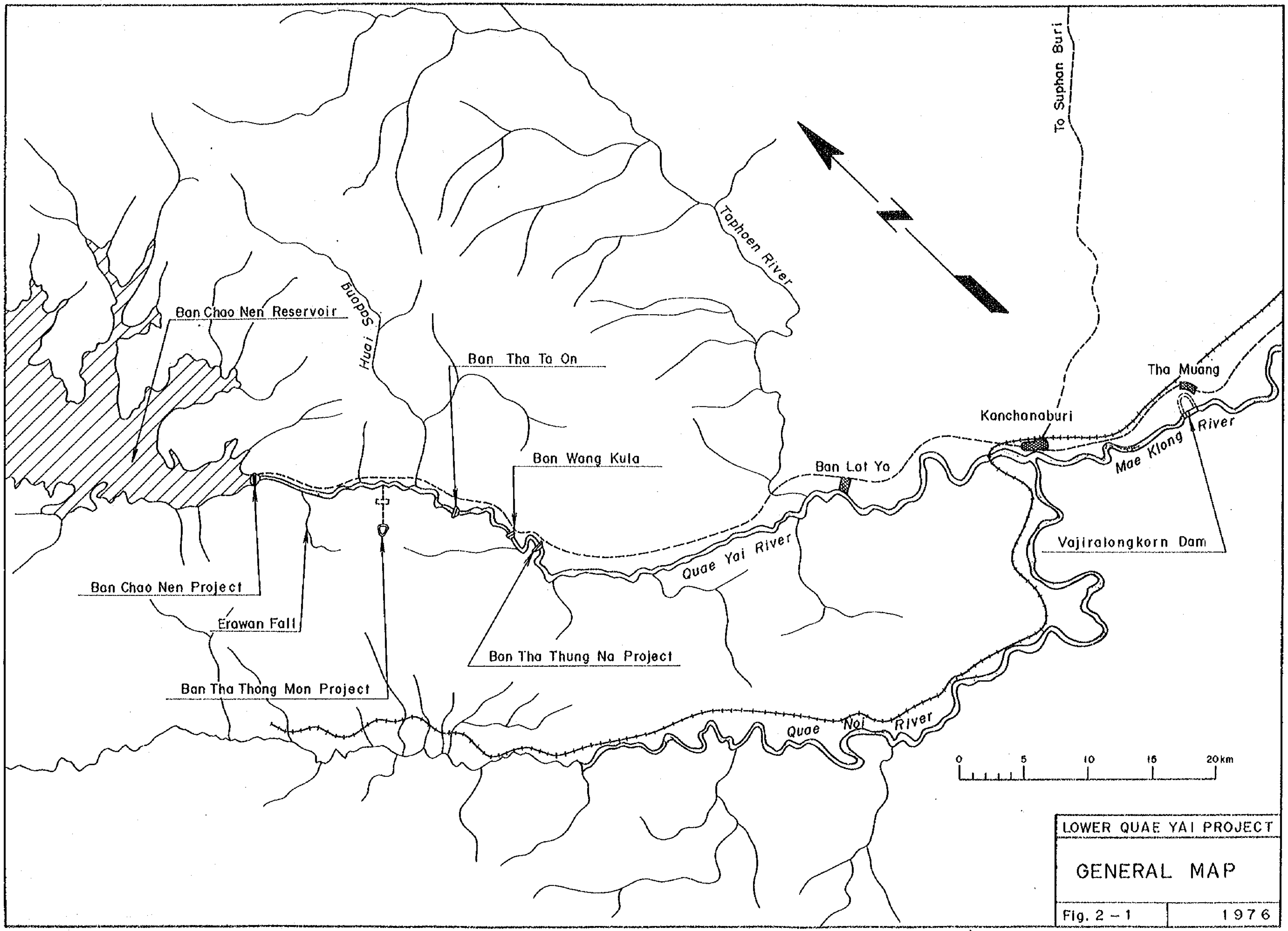
In order to enhance the accuracy of the geological maps prepared during the recent field investigations, it is desirable to investigate further the geology around the site on the basis of newly prepared 1:2,000 scale topographic maps. The geology of the foundation rocks at the dam site was essentially confirmed by the said investigations, however, the type of rock strata of the Paleozoic era which forms the foundation of the structures changes at the river bed portion showing possible existence of fault and, therefore, inclined test drilling from both river banks toward the river center is required. A few additional test drilling is also required in the left abutment and test grouting should be executed depending on the results of the test drilling.

(c) Field investigation of construction materials

According to the late investigations, it is confirmed that construction materials suitable for concrete aggregates and embankment materials are distributed around the dam site and it is required to ascertain the available quantities and qualities of these materials.

(d) Definite studies

All the preparations prior to the construction activities such as the definite design of the dam and power plant, financing, acquisition of land and counter-measures for environmental impact etc. must be made in such a manner as to meet with the construction schedule.


To Suphan Buri
Taphoen River
Huai Sadong
Ban Chao Nen Reservoir
Ban Tha To On
Ban Wang Kula
Ban Lot Ya
Kanchanaburi
Tha Muang
Mae Klong River
Vajiralongkorn Dam
Quae Yai River
Ban Chao Nen Project
Erawan Fall
Ban Tha Thung Na Project
Ban Tha Thong Mon Project
Quae Noi River
0 5 10 15 20km
LOWER QUAE YAI PROJECT
GENERAL MAP
Fig. 2 – 1
1976

CHAPTER 3 LOAD FORECAST

3.1 Present situation of electric power demand and supply

3.1.1. General

The electric power industry of Thailand is being undertaken by the Electricity Generating Authority of Thailand (EGAT) which is mainly in charge of power generation, the Metropolitan Electricity Authority (MEA) mainly in charge of power distribution in the metropolitan area and the Provincial Electricity Authority in the whole country except for the metropolitan area. The most port of electric power produced by EGAT is supplied to MEA and PEA while minor electric power to some industrial enterprises directly.

Total installed generating capacity of EGAT as of March 1976, composed of seven hydro-electric, five thermal, seven gas-turbine and four diesel power plants, is 2,437,350 kW as listed in Table 3-1. Main power plants among them are two large thermal power plants: North Bangkok and South Bangkok near Bangkok city, and two large hydro-electric power plants: Bhumibol and Sirikit, and the maximum power generation of these four power plants amounts to 2,032,500 kW which accounts for more than 83 percent of EGAT's total capacity.

The power system of EGAT is divided into four regions, namely, Region 1 covering the Bangkok metropolitan area, Region 2 covering the north-eastern area, Region 3 covering the southern area and Region 4 covering the northern area of Thailand. Among these regions, three are interconnected except for Region 3 which forms an isolated power system with the key station being Krabi thermal power plant. However, complete power system interconnection of the country connecting Region 1 and 3 is scheduled by the end of 1978. The transmission line system of EGAT is composed of 230 kV trunk line: ring line connecting thermal power plants around Bangkok with substations and main line connecting this ring line with power plants in Region 4, 115 kV transmission line connecting above-mentioned trunk line with power plants in Region 2 and isolated 115 kV transmission line in Region 3. Total length of 230 and 115 kV transmission lines as of September 1975 are approximately 2,200 km and 4,100 km respectively as shown in Fig.3-2.

3.1.2. Present status of power demand and supply

Owing to active industrialization policy of the government of Thailand and modernization of public and private facilities in the Bangkok area, past electric power demand in Thailand recorded remarkable growth rate of 20 to 40 percent up to 1969. Thereafter, the high growth rate until that time gradually decreased reflecting the decrease of Viet Nam special procurement, etc. and, especially after the oil crisis in 1973, the growth rate of power demand recorded an abrupt decline as shown in Table 3-2, Fig. 3-3 and Fig. 3-4. The growth rate of 1974 was approximately 5 percent which was extremely low compared with the past records and this might have resulted from switching-off of neon signs, shortening of screening time of cinemas and curtailing of street lights, etc. forced by governmental restrictions to save energy consumption in December 1973. On account of gradual relaxation of the said restrictions by the end of 1974, the growth rate of 1975 was improved to approximately 12 percent and the maximum power demand in September 1975 was 1,407 MW.

On the other hand, in order to cope with above-mentioned remarkable growth of power demand, Bhumibol hydro-electric power plant (420 MW) was completed in 1964 followed by completion of North Bangkok thermal power plant (237.5 MW) in 1968, South Bangkok thermal power plant (#1 to #4, 1,000 MW) and Sirikit hydro-electric power plant (375 MW) by November 1975, and thus power supply source has been reinforced especially in recent years. Power supply capacity as of September 1975 is approximately 1,972 MW maintaining a reserve capacity of 565 MW or in other words approximately 40 percent compared with the maximum power demand aforementioned.

In parallel with the reinforcement of power supply sources, transmission line system has also been expanded rapidly from around 1968 as shown in Fig. 3-2 in order to transmit to the metropolitan area the power produced at power plants in Regions 2 and 4 and to consolidate the power line system within the metropolitan area.

3.2 Forecast of electric power demand and supply balance

3.2.1. Forecast of future power demand

In September 1976, EGAT forecasted and summarized future power demand by each industry and by MEA, PEA and other enterprises to which EGAT supplies electricity directly. Growth rate of power demand by MEA and PEA, etc. in the next 15 years (first 8 years, 1976 to 1983 and latter 7 years, 1984 to 1990) is forecasted as follows:

(a) In the MEA area, growth rate of approximately 7 to 9 percent and 6 percent for the first and latter periods, respectively.

(b) In the PEA area, growth rate of approximately 11 to 17 percent and 8 to 11 percent for the first and latter periods, respectively. These growth rates are considered comparatively high, however, such values were induced from the ground that diffusion of lighting in the PEA area shows very low rate of approximately 20 percent at present and growth rate of about 10 percent of power demand for lighting is deemed to be continuously maintained throughout the next 15 years regardless of economical conditions of the country.

(c) Growth rate of power demand directly supplied by EGAT to other enterprises is estimated at approximately 2.5 percent through the first and latter periods.

The integrated growth rates of power demand on EGAT are forecasted to be approximately 9 to 13 percent and 6 to 7 percent for the first and latter periods, respectively and these values are lower than those of the last few years. In contrast with actual records of maximum power and annual energy demands of approximately 1,400 MW and 8,200 x 10^6 kWH in 1975, forecasted demands in concrete figures are 3,600 MW and 21,400 x 10^6 kWH in 1985 and 5,000 MW and 29,500 x 10^6 kWH in 1990, in other words, increment of 2,200 MW and 13,200 x 10^6 kWH after 10 years and

3,600 MW and 21,300 x 10^6 kWH after 15 years.

The above-mentioned is the forecast of the future electric power demand prepared by EGAT. On the other hand, the macrographical studies on the progressive trend of future power demand is made as follows.

The trend of electric power demand of various countries in the world is shown in Fig. 3-5 in which electricity consumption per capita in 1973 and growth rate of the same between 10 years through 1964 to 1973 are plotted on the abscissa and the ordinate, respectively. And correlation between gross domestic product (GDP) and electricity consumption per capita both in 1973 is shown in Fig. 3-6. According to Fig. 3-5, Thailand is a possible country to make great stride in electricity consumption in the future and comes within the category of growing stage. The tendency of this remarkable growth is also observed in Fig. 3-6 and it is considered, as shown in the same figure, that the growth hereafter will draw closer to average value with rate of a little smaller than that traced since 1970. As described in the above, EGAT estimated growth rates of 9 to 13 percent for the first period and 6 to 7 percent for the latter period in forecasting power demand in the next 15 years and this forecast is considered appropriate.

In this report, the EGAT forecast of the future power demand is applied.

3.2.2. Electric power development schedule

In order to cope with increasing power demand mentioned above, it is required to newly develop power sources of approximately 2,200 MW and 3,600 MW by 1985 and 1990, respectively. The value for 1990 corresponds to 1.5 times the capacity of existing power facilities (2,400 MW) and requires hereafter capacity addition of approximately 240MW every year. Electric power projects being constructed by EGAT are the following four.

(a) South Bangkok oil fired thermal power plant (Units No. 5)

South Bangkok thermal power plant is being expanded following the completion of Unit No. 4 in November 1975. Units No. 5 (300 MW) is scheduled to be completed in October 1978, and the ultimate installed capacity of the project will be 1,360MW.

(b) New Mae Moh lignite fired thermal power plant

In addition to two lignite fired thermal power plants (Mae Moh 6.25 MW and Krabi 60 MW), New Mae Moh thermal power plant located in the northern part of Thailand is being constructed for the exclusive use of national resources. Units No. 1 and No. 2 (75 MW each) are scheduled to be completed in May 1977 and May 1978, respectively.

(c) Ban Chao Nen hydro-electric power plant (1st stage)

Ban Chao Nen multi-purpose project located at about 190 km north-west of Bangkok is being constructed for irrigation, flood control and power generation purposes by constructing a rockfill dam of 135 m high across the Quae Yai River. The maximum installed capacity of the first stage Ban Chao Nen project is to be 360 MW (120 MW x 3 units) generating annual energy of 1,160 x 10^6 kWH, and Units No. 1, No. 2 and No. 3 are scheduled to be completed in September 1979, December 1979 and May 1980, respectively. Furthermore, the second stage Ban Chao Nen project, pumped-storage of 360 MW (180 MW x 2 units), is being promoted with a completion target in October 1986.

(d) Pattani hydro-electric power project

Pattani project located in southern Thailand near the border line of Thailand and neighboring Malaysia is in preparation, and its maximum installed capacity and annual energy production are 40 MW (20 MW x 2 units) and 200 x 10^6 kWH, respectively. This project is scheduled to be completed in October 1981.

Besides, there are major proposed projects such as extension of Bhumibol hydro-electric power plant (Unit No. 7, 100 MW), Quae Noi hydro-electric project (290 MW), Lang Suan hydro-electric project (80 MW), new thermal project (300 MW x 2, 600 MW x 1, 1,200 MW in total) and nuclear power plant (600 MW). According to the present development schedule mentioned above, new power generation facilities of 4,167 MW in total, consisting of 1,917 MW, 1,950 MW and 600 MW of hydro-electric, thermal and nuclear projects respectively, are scheduled to be completed within the next 15 years by the end of 1990 as shown in Table 3-4 and Fig. 3-7.

3.2.3. Power demand and supply balance in the future

Following are the studies on kW and kWH balance in the future based on the above-mentioned power demand forecast and development schedule. On study of kW balance, maximum installed capacity for nuclear, thermal and gas-turbine power plants and mean value of maximum installed capacity and available capacity at the time of the lowest reservoir surface for hydro-electric power plant are taken as dependable capacities.

Dependable capacity, maximum power demand, normal reserve capacity and reserve capacity at forced outage of the biggest unit in service in the respective years are shown in Table 3-5 and Fig. 3-8. As observed in these figures, some amount of reserve capacity is still maintained even in case of forced outage. The trend is that the reserve capacity will decrease from 1981 and take an upward rise again from 1986 by nuclear power plants going into service.

However, compared with the available reserve capacity of 560 MW in 1975, it decreases to 385 MW (reserve capacity ratio 13%), which is deemed to be critical because in 1982 the total installed capacity will be more than two times of that in 1975. After 1986 there will be no problem with power supply, maintaining sufficient reserve capacity of more than 20% on the condition that the nuclear power plants are put in service as scheduled.

On the other hand, annual energy production, energy demand and reserve energy for average and dry years are shown in Table 3-6 and Fig. 3-9. They generally trace the tendency similar to the case of kW balance and remarkable difference between the two is that energy production is almost equal to energy demand for certain period and this will possibly create a critical situation of supplying energy from 1981 through 1983 than that of supplying power.

The above-mentioned studies on power demand and supply balance are carried out on the condition that the proposed projects of EGAT shall be incorporated in the power system on time, and, therefore, it is indispensable that the projects are completed and put in service as scheduled, especially for those projects to complete after 1981 when the power supply situation is forecasted to aggravate. It may be considered very difficult to timely develop those projects which involve various problems.

It is also important to keep in mind that there is a potential of rapid growth of electric power demand in Thailand, that is, present latent demands may possibly invite sharp growth rate of the same magnitude that were observed in the past, when the economic recession of late years picks up. In view of this situation it is feared that EGAT may face a critical situation to supply power demand resulting from the delay of implementing electric power development programs, especially of nuclear power plants, therefore, the present electric power development program may require revision, and it may be advisable to proceed with the early development of water resources and, at the same time, to study further utilization program of lignite and natural gas in the future.

Table 3-1 Installed Capacity (Nov. 1975)

Name	No. of unit	Capacity (MW)
(Hydro)		
Bhumibol	6	420
Sirikit	3	375
Ubolratana	3	25
Sirindhorn	2	24
Chulabhorn	2	40
Nam Pung	2	6
Kang Krachan	1	19
Sub-total	19	909
(Thermal)		
North Bangkok	3	237.50
South Bangkok	4	1,000
Surat Thani	1	30
Mae Moh	1	6.25
Krabi	3	60
Sub-total	11	1,333.75
(Gas turbine)		
North Bangkok	2	30
South Bangkok	4	60
Bang Kapi	1	15
Bangkok Noi	1	15
Nakhon Ratchasima	1	15
Udon Thani	1	15
Hat Yai	1	15
Sub-total	11	165
(Diesel)		
Mae Moh	9	9
Chiangmai	8	8
Phuket	4	10.60
Nakhon Si Thammarat	2	2
Sub-total	23	29.60
Total	64	2,437.35

Table 3-2 Actual Generation Record and Load Forecast

Fiscal year	Peak generation		Energy production		Annual load factor
	MW	Growth (%)	kWH X 10^6	Growth (%)	
(Actual record)					
1963	133	17.8	605	18.2	51.9
1964	178	33.8	780	28.9	50.0
1965	235	32.0	1,097	40.6	53.4
1966	319	35.7	1,529	39.4	54.8
1967	399	25.1	2,034	33.0	58.2
1968	520	30.3	2,612	28.4	57.3
1969	638	22.7	3,368	28.9	60.3
1970	748	17.2	4,095	21.6	62.5
1971	873	16.7	4,793	17.0	62.7
1972	1,029	17.9	5,711	19.2	63.4
1973	1,199	16.5	6,873	20.3	65.4
1974	1,256	4.8	7,259	5.6	66.0
1975	1,407	12.0	8,212	13.1	66.6
(Forecast)					
1976	1,590	13.0	9,205	12.1	66.1
1977	1,775	11.6	10,257	11.4	66.0
1978	1,965	10.7	11,468	11.8	66.6
1979	2,159	9.9	12,658	10.4	66.9
1980	2,372	9.9	13,913	9.9	67.0
1981	2,616	10.3	15,401	10.7	67.2
1982	2,852	9.0	16,794	9.0	67.2
1983	3,100	8.7	18,272	8.8	67.3
1984	3,357	8.3	19,802	8.4	67.3
1985	3,606	7.4	21,262	7.4	67.3
1986	3,863	7.1	22,767	6.5	67.3
1987	4,127	6.8	24,316	6.8	67.3
1988	4,407	6.8	25,957	6.7	67.2
1989	4,704	6.7	27,691	6.7	67.2
1990	5,019	6.7	29,530	6.7	67.2

(Prepared by EGAT)

Table 3-3 Gross Domestic Product of Thailand (1969-1975)

	1969	1970	1971	1972	1973	1974	1975
GDP	112,550	120,730	127,730	131,620	143,130	153,355	163,205
Growth rate against previous year	7.3	7.3	5.8	3.0	8.7	7.1	6.4

(National Income of Thailand, JETRO)

Table 3-4　　Development Schedule

Calender year	Month		Hydro	Thermal	Nuclear	Total
1977	May	New Mae Moh #1		75		125
	Dec.	Nam Ngum Surplus	50			
1978	May	New Mae Moh #2		75		375
	Oct.	South Bangkok #5		300		
1979	Sep.	Ban Chao Nen #1	120			240
	Dec.	Ban Chao Nen #2	120			
1980	May	Ban Chao Nen #3	120			157
	Oct.	Ban Tha Thung Na	37			
1981	Oct.	Pattani #1, 2	40			40
1982	Jul.	Bhumibol #7	100			400
	Oct.	New Thermal #1		300		
1983	Sep.	Lang Suan	80			380
	Oct.	New Thermal #2		300		
1984	Oct.	Quae Noi #1, 2	290			290
1985	Oct.	Nuclear #1			600	600
1986	Oct.	Ban Chao Nen #4, 5	360			360
1987	Oct.	New Thermal #3		600		600
1989	Oct.	Upper Quae Yai	600			600
		Total	1,917	1,650	600	4,167

(Prepared by EGAT)

Table 3 - 5 KW Balance

(MW)

Fiscal Year	Peak Demand (A)	Installed Capacity (Existing)				Installed Capacity (Future Development)				Total Installed Capacity					Total Dependable Capacity (B)	Reserve Capacity (B - A)	Rate of Reserve Capacity (B-A/A)%	Largest Thermal or Nuclear Unit	Reserve Capacity less Largest Unit
		Hydro	Thermal	Gas and Diesel	Total	Hydro	Thermal	Nuclear	Total	Hydro	Thermal	Nuclear	Gas and Diesel	Total					
1975	1,407	909	1,034	195	2,138	0	0	0	0	909	1,034	0	195	2,138	1,972	565	40	300	265
1976	1,590	909	1,034	195	2,138	0	300	0	300	909	1,334	0	195	2,438	2,272	682	43	300	382
1977	1,775	909	1,034	195	2,138	0	75	0	75	909	1,409	0	195	2,513	2,347	572	32	300	272
1978	1,965	909	1,034	195	2,138	50	75	0	125	959	1,484	0	195	2,638	2,472	507	26	300	207
1979	2,159	909	1,034	195	2,138	120	300	0	420	1,079	1,784	0	195	3,058	2,880	721	33	300	421
1980	2,372	909	1,034	195	2,138	240	0	0	240	1,319	1,784	0	195	3,298	3,097	725	31	300	425
1981	2,616	909	1,034	195	2,138	37	0	0	37	1,356	1,784	0	195	3,335	3,116	500	19	300	200
1982	2,852	909	1,034	195	2,138	140	0	0	140	1,496	1,784	0	195	3,475	3,237	385	13	300	85
1983	3,100	909	1,034	195	2,138	80	300	0	380	1,576	2,084	0	195	3,855	3,609	509	16	300	209
1984	3,357	909	1,034	195	2,138	0	300	0	300	1,576	2,384	0	195	4,155	3,909	552	16	300	252
1985	3,606	909	1,034	195	2,138	290	0	0	290	1,866	2,384	0	195	4,445	4,149	543	15	300	243
1986	3,863	909	1,034	195	2,138	0	0	600	600	1,866	2,384	600	195	5,045	4,749	886	23	600	286
1987	4,127	909	1,034	195	2,138	360	0	0	360	2,226	2,384	600	195	5,405	5,069	942	23	600	342
1988	4,407	909	1,034	195	2,138	0	600	0	600	2,226	2,984	600	195	6,005	5,669	1,262	29	600	662
1989	4,704	909	1,034	195	2,138	0	0	0	0	2,226	2,984	600	195	6,005	5,669	965	21	600	365
1990	5,019	909	1,034	195	2,138	600	0	0	600	2,826	2,984	600	195	6,605	6,209	1,190	24	600	590

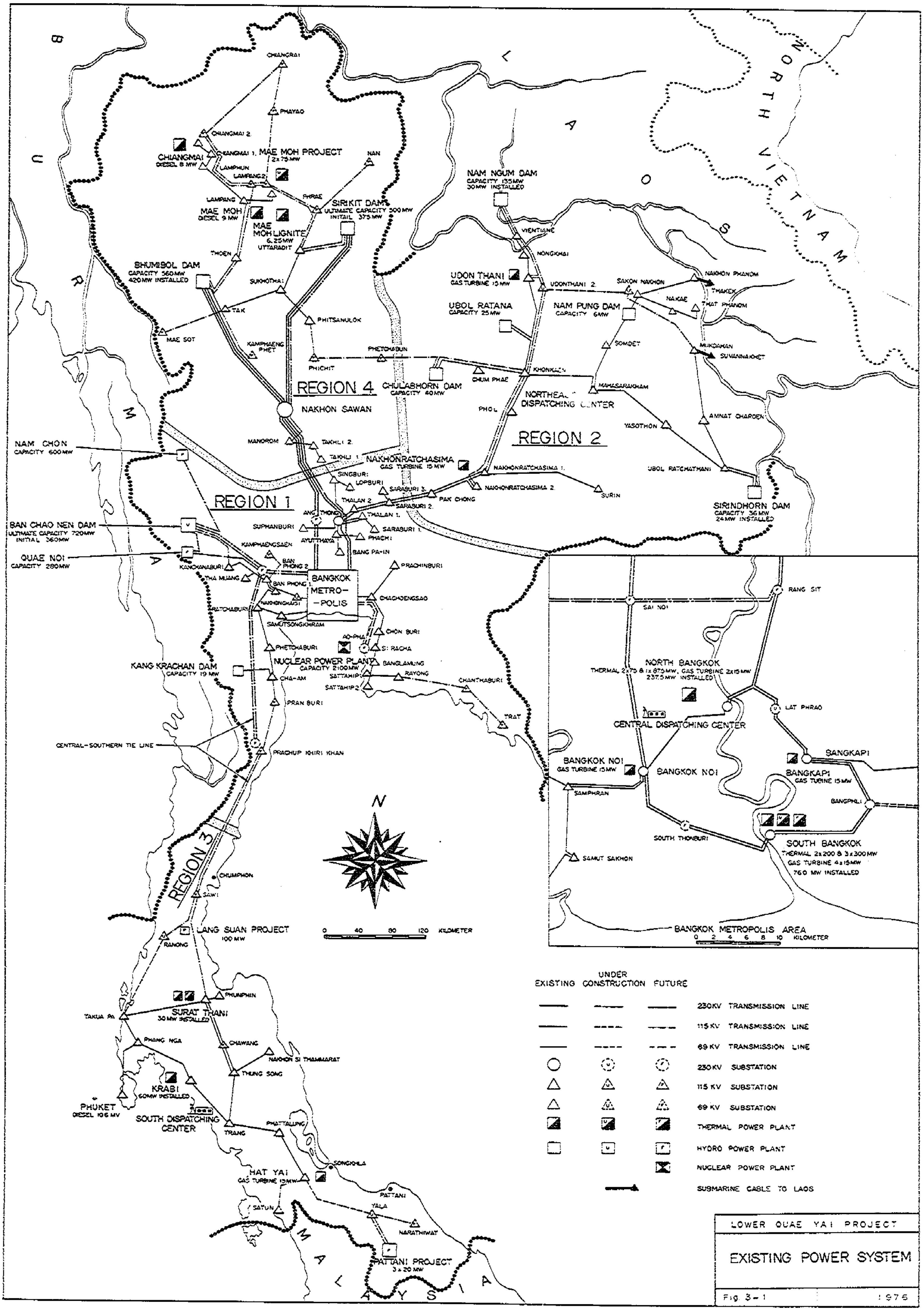
(Prepared by EGAT)

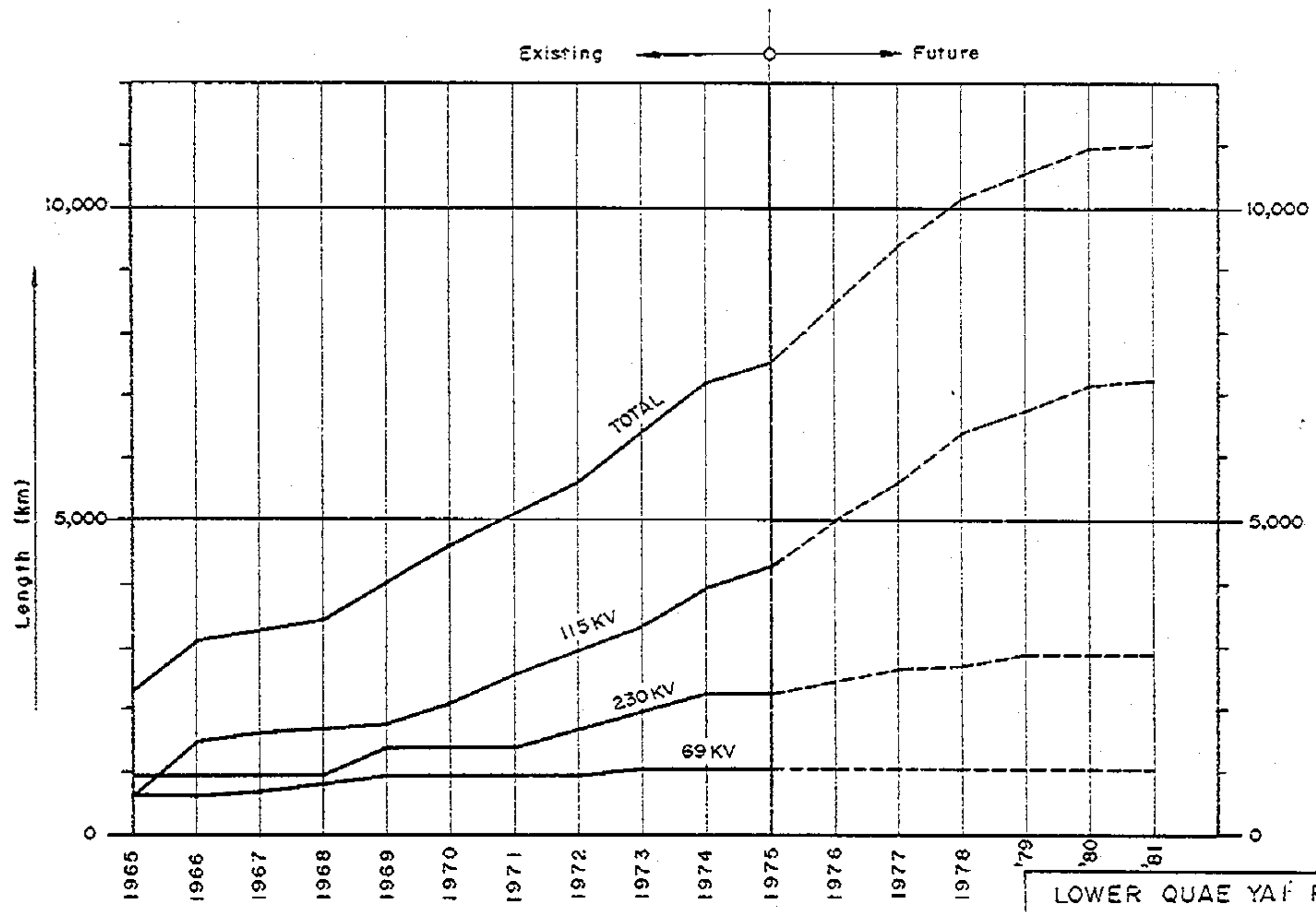
Table 3 - 6 KWH Balance

(Million kWH)

Fiscal Year	Annual Energy Demand (A)	Annual Load Factor (%)	Firm Annual Energy					Average Annual Energy		Reserve Energy for Firm Energy (B - A)	Reserve Energy for Average Energy (C - A)
			Hydro	Thermal	Nuclear	Gas and Diesel	Total (B)	Hydro	Total (C)		
1975	8,211	66.6	1,729	7,969	0	170	9,868	2,853	10,990	1,657	2,779
1976	9,205	66.1	1,729	10,187	0	170	12,086	2,853	13,210	2,881	4,005
1977	10,257	66.0	1,729	10,630	0	170	12,529	2,853	13,654	2,272	3,397
1978	11,468	66.6	2,062	11,222	0	170	13,454	3,186	14,578	1,986	3,110
1979	12,658	66.9	2,199	13,932	0	170	16,301	3,350	17,452	3,643	4,794
1980	13,913	67.0	2,969	13,932	0	170	17,071	4,413	18,515	3,158	4,602
1981	15,401	67.2	3,119	13,932	0	170	17,221	4,563	18,665	1,820	3,264
1982	16,794	67.2	3,239	13,932	0	170	17,341	4,755	18,857	547	2,063
1983	18,272	67.3	3,259	16,297	0	170	19,726	4,780	21,247	1,454	2,975
1984	19,802	67.3	3,480	18,662	0	170	22,312	5,055	23,888	2,510	4,086
1985	21,262	67.3	3,840	18,662	0	170	22,672	5,735	24,568	1,410	3,306
1986	22,767	67.3	3,840	18,662	4,310	170	26,982	5,735	28,877	4,215	6,110
1987	24,316	67.3	3,840	18,662	4,310	170	26,982	5,735	28,877	2,666	4,561
1988	25,957	67.2	3,840	23,392	4,310	170	31,712	5,735	33,608	5,755	7,651
1989	27,691	67.2	3,840	23,392	4,310	170	31,712	5,735	33,608	4,021	5,917
1990	29,530	67.2	4,840	23,392	4,310	170	32,712	6,915	34,788	3,182	5,258

(Prepared by EGAT)

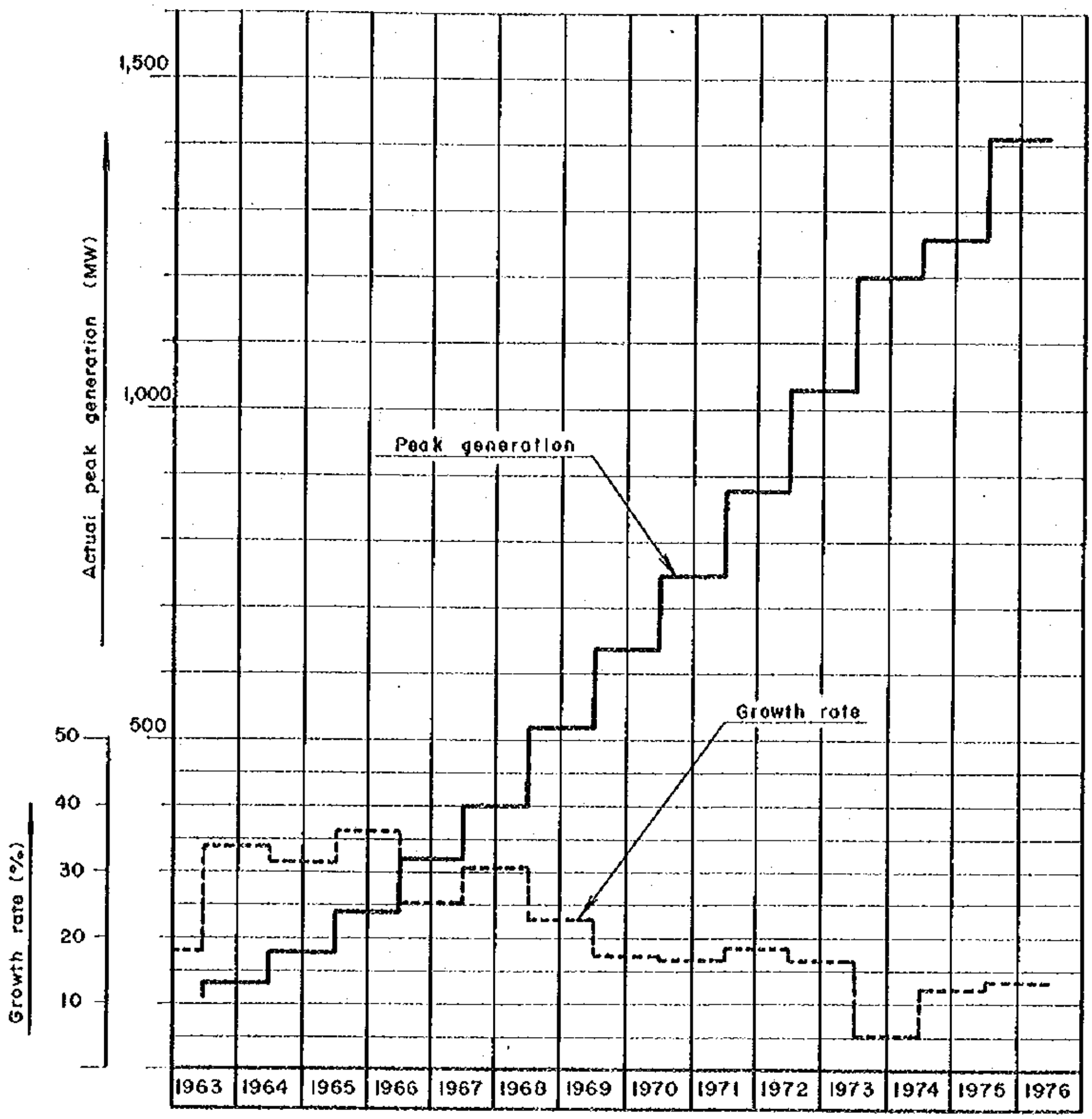

NORTH VIETNAM
LAOS
BURMA
MALAYSIA
REGION 1
REGION 2
REGION 3
REGION 4
CHIANGRAI
PHAYAO
CHIANGMAI 2
CHIANGMAI 1
MAE MOH PROJECT
2x75 MW
NAN
CHIANGMAI
DIESEL 8 MW
LAMPHUN
LAMPANG 2
PHRAE
LAMPANG
MAE MOH
DIESEL 9 MW
MAE MOH LIGNITE
6.25 MW
SIRIKIT DAM
ULTIMATE CAPACITY 500 MW
INITIAL 375 MW
UTTARADIT
THOEN
BHUMIBOL DAM
CAPACITY 560 MW
420 MW INSTALLED
SUKHOTHAI
TAK
PHITSANULOK
MAE SOT
KAMPHAENG PHET
PHICHIT
PHETCHABUN
CHULABHORN DAM
CAPACITY 40 MW
CHUM PHAE
KHONKAEN
NAKHON SAWAN
NAM NGUM DAM
CAPACITY 135 MW
30 MW INSTALLED
VIENTIANE
NONGKHAI
UDON THANI
GAS TURBINE 15 MW
UDONTHANI 2
UBOL RATANA
CAPACITY 25 MW
NAM PUNG DAM
CAPACITY 6 MW
SAKON NAKHON
NAKHON PHANOM
THAKEK
NAKAE
THAT PHANOM
SOMDET
MUKDAHAN
SUVANNAKHET
MAHASARAKHAM
NORTHEAST DISPATCHING CENTER
PHOL
YASOTHON
AMNAT CHAROEN
UBOL RATCHATHANI
SIRINDHORN DAM
CAPACITY 36 MW
24 MW INSTALLED
NAKHONRATCHASIMA 1
NAKHONRATCHASIMA 2
SURIN
NAKHONRATCHASIMA
GAS TURBINE 15 MW
MANOROM
TAKHLI 2
TAKHLI 1
SINGBURI
LOPBURI
SARABURI 3
SARABURI 2
SARABURI 1
PAK CHONG
THALAN 2
THALAN 1
ANG THONG
SUPHANBURI
AYUTTHAYA
PHACHI
BANG PA-IN
NAM CHON
CAPACITY 600 MW
BAN CHAO NEN DAM
ULTIMATE CAPACITY 720 MW
INITIAL 360 MW
QUAE NOI
CAPACITY 280 MW
KAMPHAENGSAEN
KANCHANABURI
BAN PHONG 2
BAN PHONG 1
THA MUANG
NAKHONCHAISI
BANGKOK METRO-POLIS
PRACHINBURI
CHACHOENGSAO
RATCHABURI
SAMUTSONGKHRAM
CHON BURI
AO-PHAI
SI RACHA
PHETCHABURI
NUCLEAR POWER PLANT
CAPACITY 2100 MW
BANGLAMUNG
SATTAHIP 1
SATTAHIP 2
RAYONG
CHANTHABURI
TRAT
KANG KRACHAN DAM
CAPACITY 19 MW
CHA-AM
PRAN BURI
CENTRAL-SOUTHERN TIE LINE
PRACHUP KHIRI KHAN
N
0 40 80 120 KILOMETER
CHUMPHON
SAWI
LANG SUAN PROJECT
100 MW
RANONG
PHUNPHIN
TAKUA PA
SURAT THANI
30 MW INSTALLED
PHANG NGA
CHAWANG
NAKHON SI THAMMARAT
THUNG SONG
KRABI
60 MW INSTALLED
PHUKET
DIESEL 10.6 MW
SOUTH DISPATCHING CENTER
TRANG
PHATTALUNG
SONGKHLA
HAT YAI
GAS TURBINE 15 MW
PATTANI
SATUN
YALA
NARATHIWAT
PATTANI PROJECT
3 x 20 MW
RANG SIT
SAI NOI
NORTH BANGKOK
THERMAL 2x75 & 1x87.5 MW, GAS TURBINE 2x15 MW
237.5 MW INSTALLED
LAT PHRAO
CENTRAL DISPATCHING CENTER
SANGKAPI
BANGKAPI
GAS TURBINE 15 MW
BANGKOK NO1
GAS TURBINE 15 MW
BANGKOK NO1
SAMPHRAN
BANGPHLI
SOUTH THONBURI
SOUTH BANGKOK
THERMAL 2x200 & 3x300 MW
GAS TURBINE 4x15 MW
760 MW INSTALLED
SAMUT SAKHON
BANGKOK METROPOLIS AREA
0 2 4 6 8 10 KILOMETER
EXISTING
UNDER CONSTRUCTION
FUTURE
230KV TRANSMISSION LINE
115KV TRANSMISSION LINE
69KV TRANSMISSION LINE
230KV SUBSTATION
115KV SUBSTATION
69KV SUBSTATION
THERMAL POWER PLANT
HYDRO POWER PLANT
NUCLEAR POWER PLANT
SUBMARINE CABLE TO LAOS
LOWER QUAE YAI PROJECT
EXISTING POWER SYSTEM
Fig 3-1
1976



LOWER QUAE YAI PROJECT

TOTAL LENGTH OF TRANSMISSION LINES

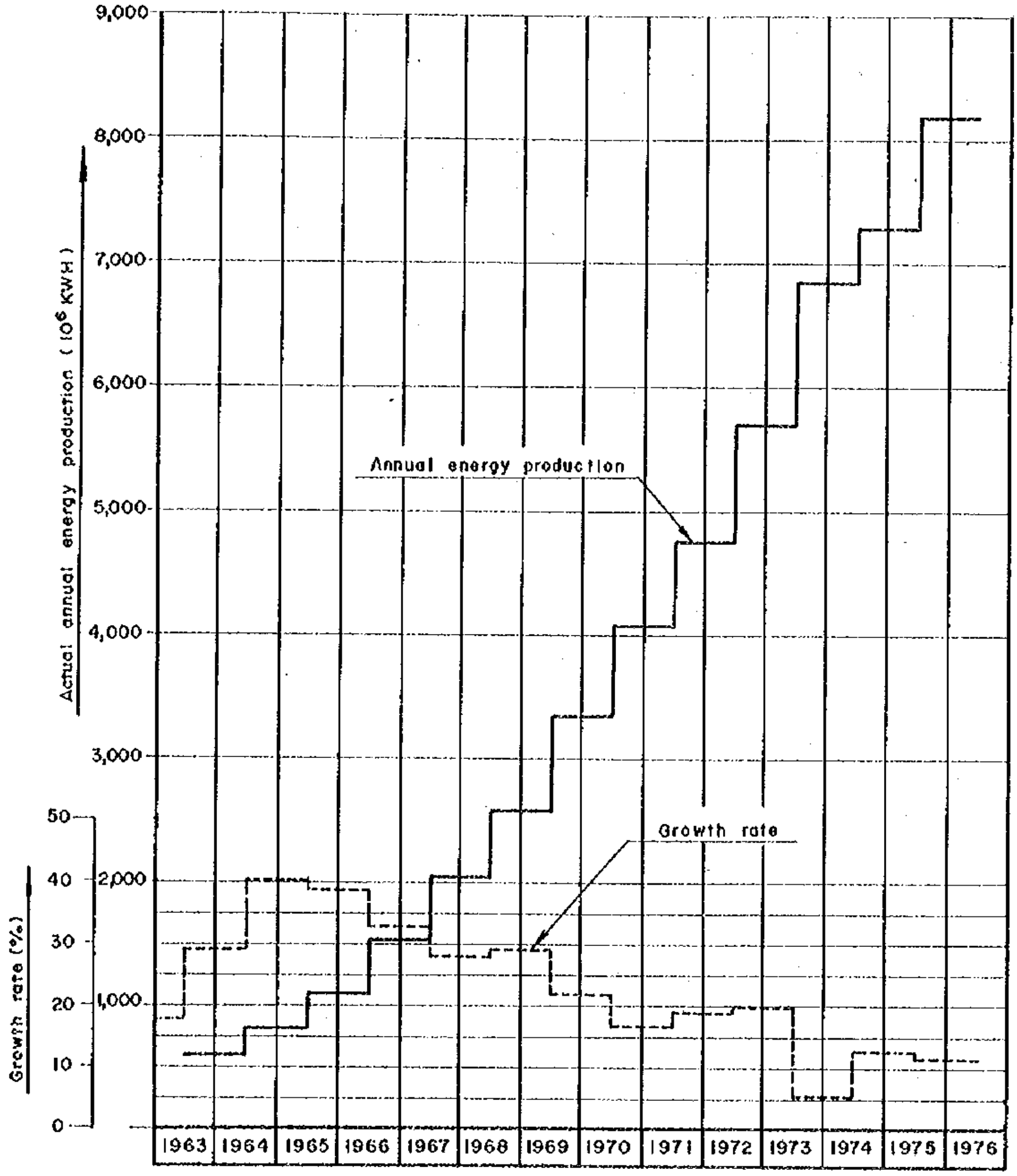
Fig. 3-2 1976



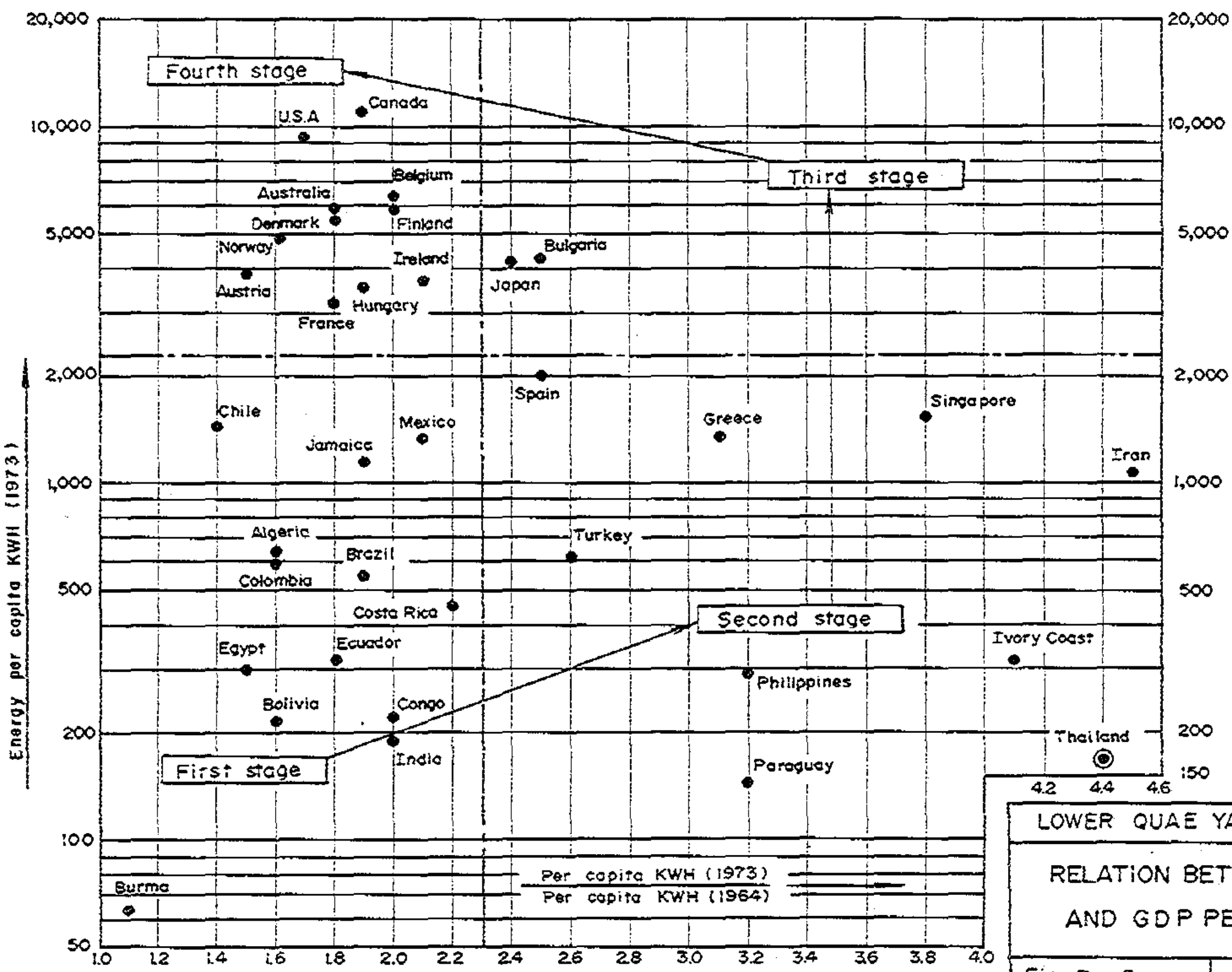
LOWER QUAE YAI PROJECT

ACTUAL PEAK GENERATION AND GROWTH RATE

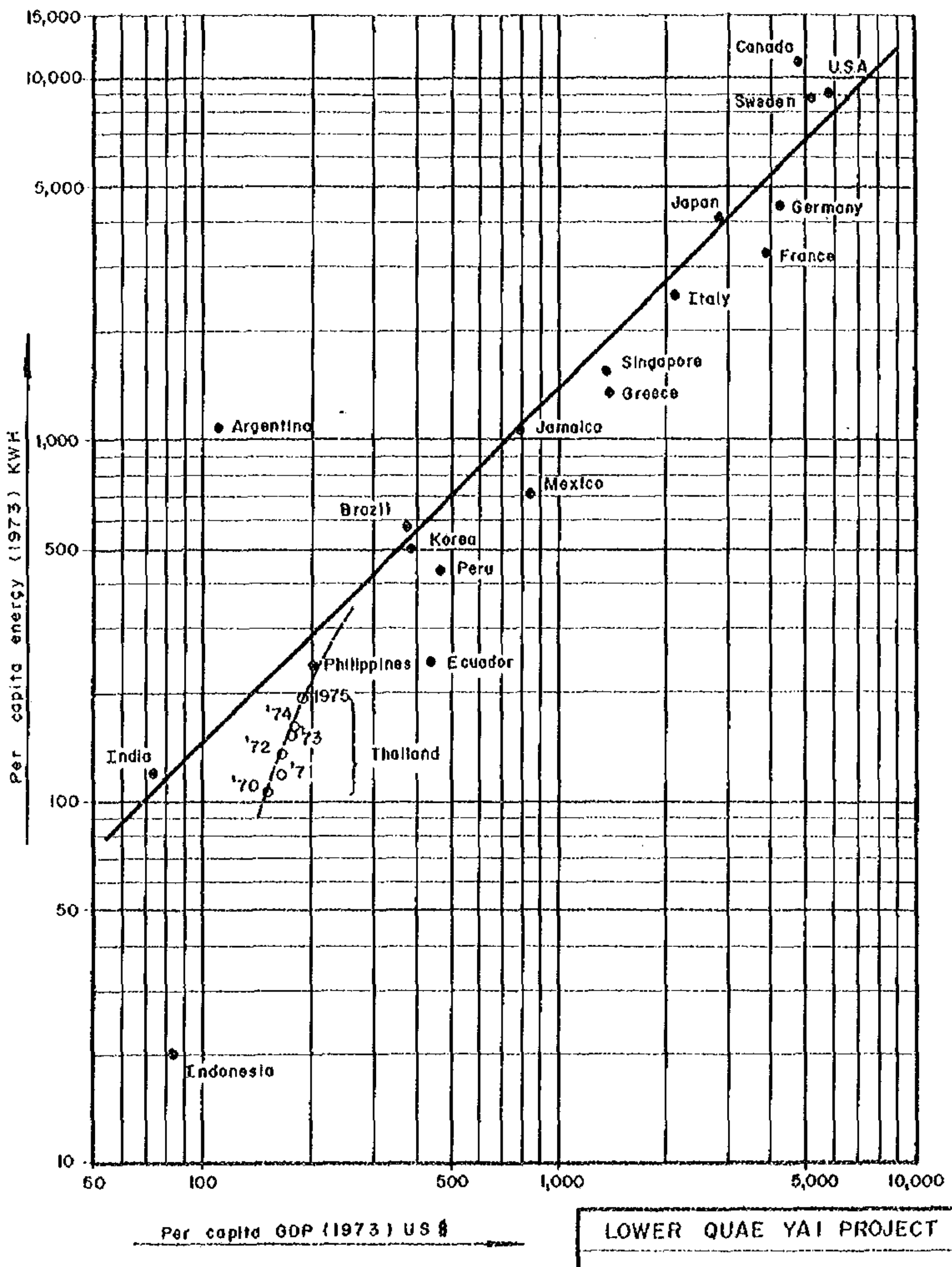
Fig. 3 - 3 | 1976



LOWER QUAE YAI PROJECT	
ANNUAL ENERGY PRODUCTION AND GROWTH RATE	
Fig. 3 – 4	1976



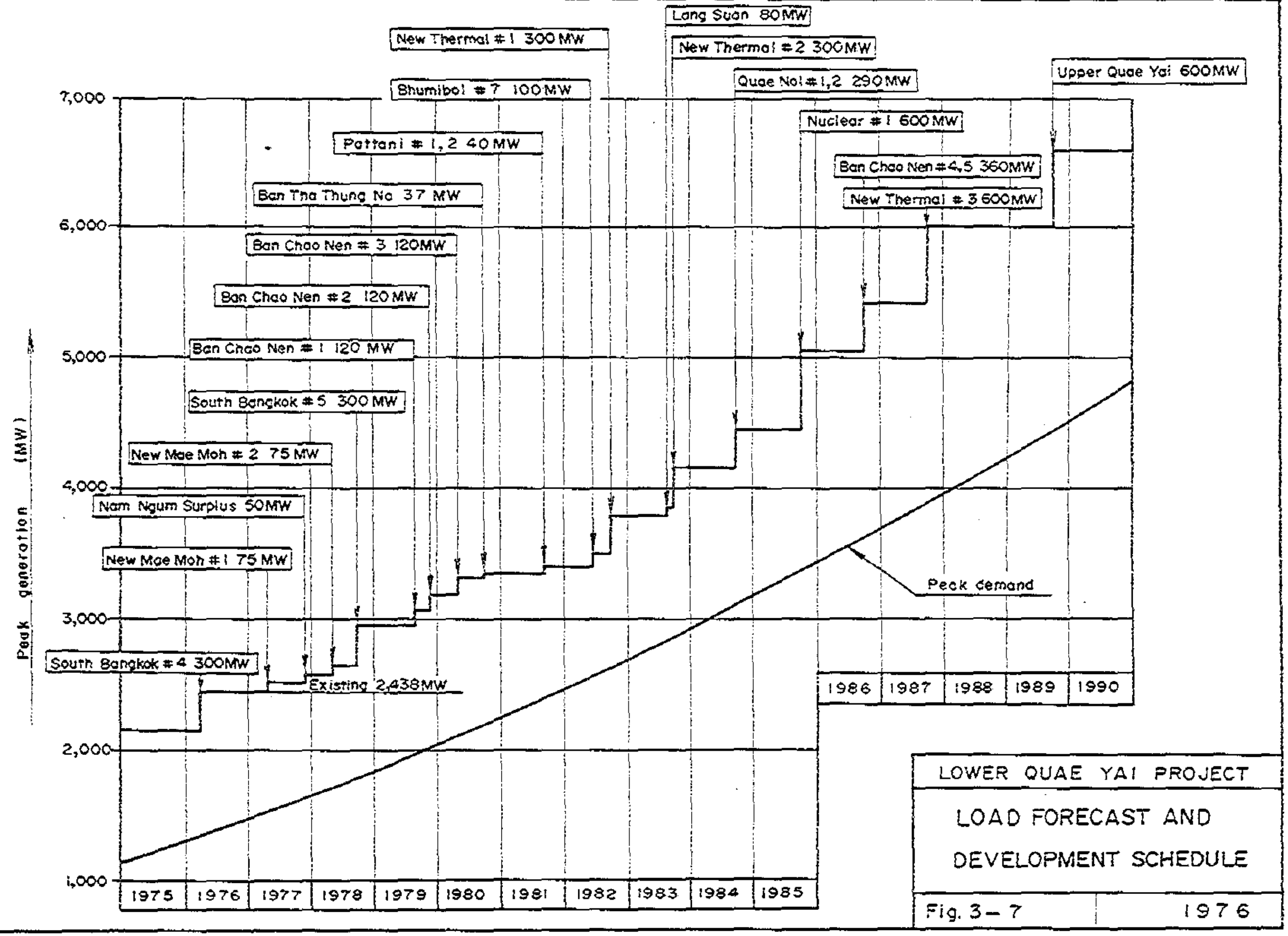
LOWER QUAE YAI PROJECT	
RELATION BETW. ENERGY AND GDP PER CAPITA	
Fig. 3—5	1976



LOWER QUAE YAI PROJECT

RELATION BETW. ENERGY AND GDP PER CAPITA

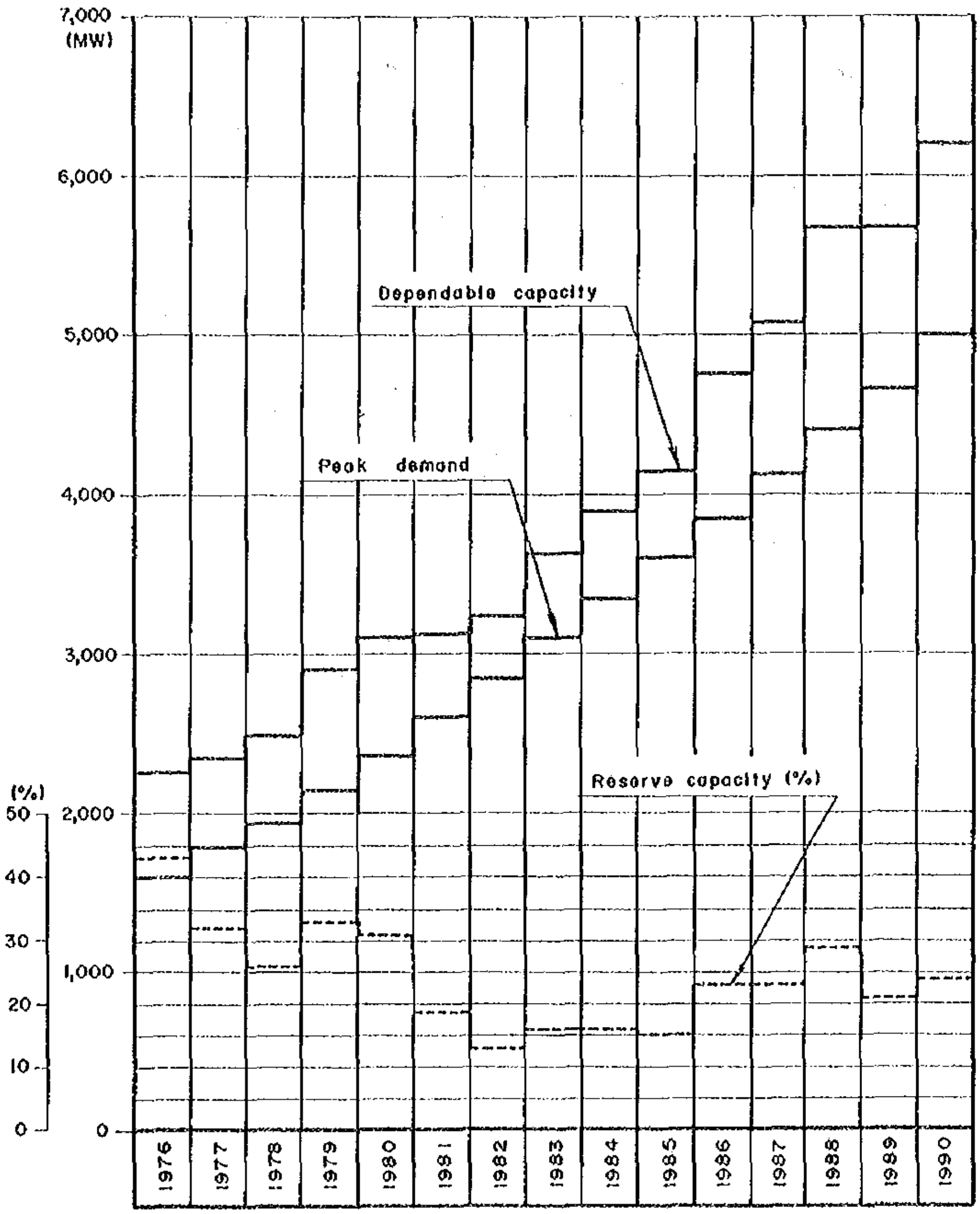
Fig. 3-6	1976



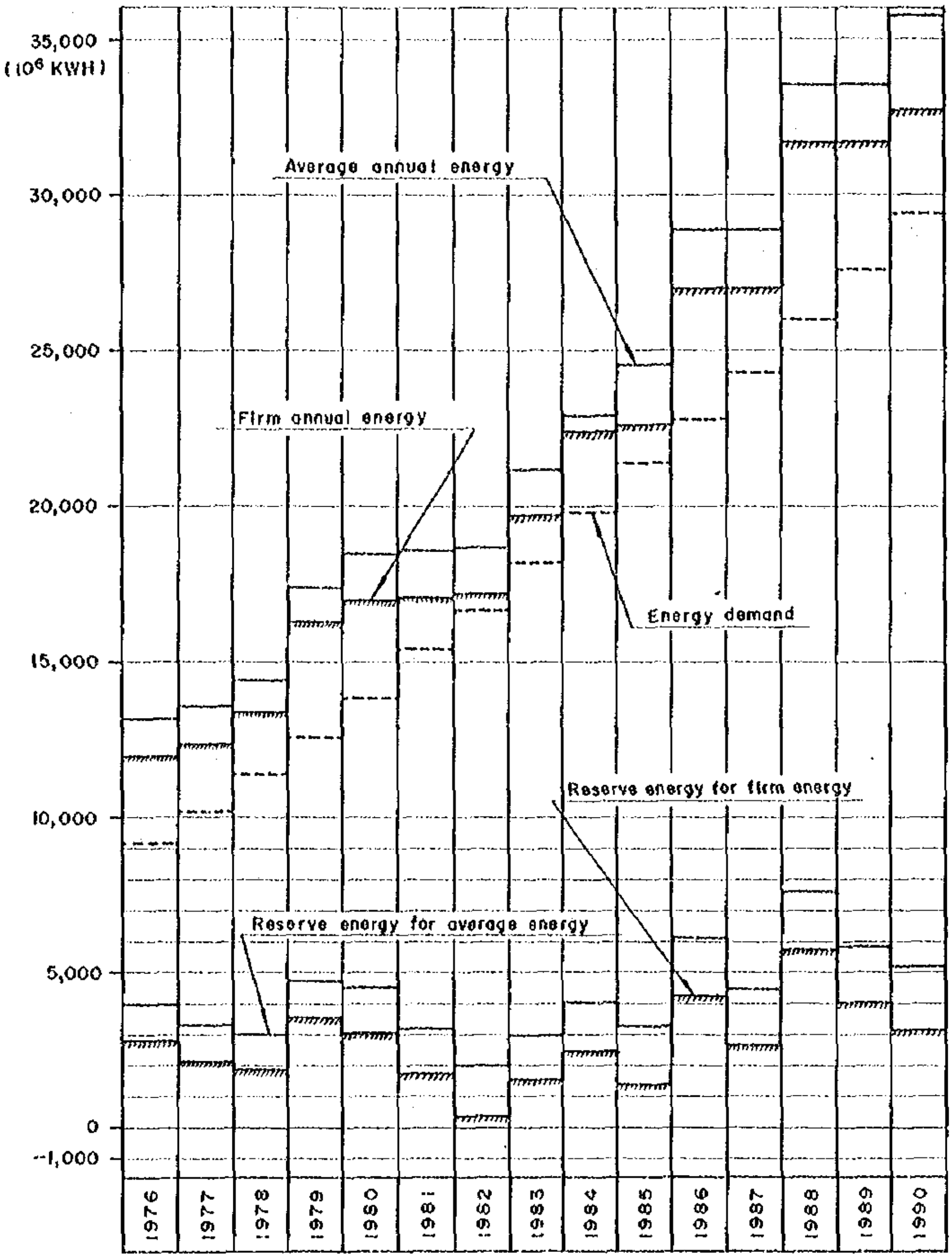
LOWER QUAE YAI PROJECT

LOAD FORECAST AND DEVELOPMENT SCHEDULE

Fig. 3-7 1976



LOWER QUAE YAI PROJECT	
DEPENDABLE CAPACITY, PEAK DEMAND & RESERVE CAPACITY	
Fig. 3-8	1976



LOWER QUAE YAI PROJECT	
ANNUAL ENERGY AND RESERVE ENERGY.	
Fig. 3-9	1976

CHAPTER 4 GEOLOGY

4.1 General

Prior to the recent study, reconnaissance was carried out at two sites, Ban Tha Ta On and Ban Wang Kula, proposed for the Lower Quae Yai Regulating Dam in the Feasibility Report of the Quae Yai No. 1 Hydroelectric Project, 1968.

Investigations at these sites were originally included in this study, however, as it was considered that the Ban Tha Thung Na dam site located further downstream will be most favorable as a result of comprehensive studies on the development plan described in the succeeding chapters, subsequent geological investigations have been concentrated on this site.

This chapter deals with the results of the recent geological investigations, especially with geological features and conditions in the Ban Tha Thung Na dam site. This chapter also provides the results of preliminary studies at a site proposed for the Ban Tha Thong Mon Pumped-storage Project which is one of the subjects of this study.

4.2 Regional geology

4.2.1 Topography

The Quae Yai River flows generally in a south-easterly direction with local meandering of the river in the project area. A watershed between the Quae Yai River and the Quae Noi River flowing parallel about 15 to 20km away from the right bank of the Quae Yai River forms a mountain range extending toward NW-SE with an elevation of 800 to 900m. On a slope facing the Quae Yai River, there exists many flat plateaus at an elevation higher than 500m, but as a whole, it forms a steep slope facing the river.

On the other hand, the area 2 to 3km away from the left bank of the river is dotted with peaks of 500 to 600m high, and the hillside of the bank generally forms a steep slope bordering on the Quae Yai River.

Between the Ban Chao Nen and the Ban Tha Thung Na dam sites, fluvial terraces with elevations of 50 to 60m are formed in various places on both banks of the Quae Yai River. In the area between Ban Chao Nen dam and a site 10km toward the downstream, terraces are narrow and the width of a valley is only 100 to 150m at an altitude of 100m, but at sites further downstream, terraces are larger and the valley width ranges from 1.5 to 2.5km at the same elevation. At sites further down the river from Ban Tha Thung Na, mountains on both banks of the river become gradually lower with gentle slopes and the valley width becomes wider as a whole.

Between Ban Chao Nen and Ban Tha Thung Na, the average gradient of the stream is 1 : 1,700 to 1 : 1,800.

4.2.2 Geology

Fig.4-1 shows the general geology of the Lower Quae Yai Project area and its neighboring areas. From the scope of structual geology, this area forms a part of the Burmese-Malayan geosynclinal belt, where strata formed in the Paleozoic era are distributed, oriented toward NW-SE corresponding to the topographic feature.

The geologic feature of the Lower Quae Yai Project area is as a whole, similar to that of Ban Chao Nen area in the upper stream. With regard to the classification of the strata in the Lower Quae Yai Project area, this report is based on Quae Yai No. 1 Project, Geological Investigations of Reservoir Area, February 1972 by EPDC.

The strata can be classified as given in Table 4-1.

(a) Metamorphic rocks

Metamorphic rocks with continuous distribution of more than 70km long exist along the mountain range of NE-SE trend forming the watershed between the Quae Yai and Quae Noi Rivers and its south-eastern end crosses the Quae Yai River at the downstream of the Ban Tha Thung Na dam site. Metamorphic rocks are classified as low grade metamorphic rocks consisting mainly of metasedimentary rocks and high grade metamorphic rocks mostly composed of gneiss and crystalline schist, corresponding to the metamorphosing grade.

(b) Formation A

Formation A is mostly distributed extending over the Ban Chao Nen dam site to the downstream basin and in this project area, there exists narrow distribution on the left bank along the Quae Yai River. Formation A is mainly composed of quartzite, calcareous sandstone, slate and limestone locally interbedded with shale and impure limestone.

(c) Formation B

Formation B is distributed on the right bank and in the river bed of the Quae Yai River, and on the left bank beyond the above-mentioned Formation A. Formation B is mainly composed of shale, limestone, calcareous shale, calcareous sandstone and local alternation of them.

(d) Rat Buri limestone

The Rat Buri limestone is widely distributed on relatively higher land of the right bank of the river in the project area and probably overlies the above-mentioned formations in uncomformity. This formation is mostly composed of massive pure limestone and forms karst topography at various spots in this area.

According to the Geological Map of Thailand, 1969, Department of Mineral Resources of Thailand, it is assumed that metamorphic rocks, and formations A and B belong to Tanaosi Group most likely formed in the Silurian, Devonian and Carboniferous periods and that Rat Buri limestone was formed in the periods of the Carboniferous to Permian. Except Rat Buri limestone, each stratum distinctly showed the folded structure and the axis of the folds generally oriented toward NW-SE.

Of faults either actual or assumed, those that indicate NW-SE strike corresponding to the general strike of strata in the project area and NE-SW strike which crosses the NW-SE strike are prevalent. Deposits formed in the Cenozoic era include diluvium and alluvium, with the former being river terrace deposits along the banks of the Quae Yai River and the latter being talus deposits, residual soil for the most part in the mountainous area and deposits on river bed. These Cenozoic deposits directly cover the Paleozoic formations.

4.3 Geology of Ban Tha Thung Na dam site (cf. Fig.4-1, 4-2, 4-3, 4-5)

4.3.1 Field investigation

Topographical survey and geological explorations of Ban Tha Thung Na dam site were commenced by EGAT in the latter half of 1975. During the field investigation the Mission requested additional test pits and core drillings and the following investigation works were completed by the end of April, 1976.

26 test pits, 78.0 m in total length

16 core drill holes, 483.85 m in total length

The features of the test pits and drill holes are listed in Tables 4-2 and 4-3, and the locations are shown on Fig. 4-2.

Detailed geological logs of test pits and drill holes are also shown on Fig. 4-5 and Appendix (c, sheet 1 to 33), respectively.

The field geological mapping in the dam site and its vicinity was carried out, in co-operation with EGAT and Mission, using aero-topographical maps (1 : 5, 000 scale) and topographical maps (1 : 50, 000 scale). The results of the said studies are shown on Fig. 4-2 and 4-3. In preparing these figures reference was made to the topographical maps of 1 : 2, 000 scale which was prepared by EGAT at the end of April, 1976.

4.3.2 Topography

The Quae Yai River menders forming a oxbow at the Ban Tha Thung Na dam site. It flows locally to the south at the dam axis, to east at the upstream and to the west at the downstream, respectively. The gradient of river at the site is approximately 1 : 2, 000.

The valley of the damsite bounds on steep mountain on the left bank and to a gently sloped mountain range beyond a flat terrace of several hundreds meters wide on the right bank. The width of the valley is about 800 m at the proposed high water level of the reservoir.

The river water level is about 40 m above sea level and the width of the river channel is about 70 m in the dry season.

Fig. 4-3 shows the topographical profile of the dam axis.

4.3.3 Geology

(a) Bedrock

(1) Rock type and distribution

In the Ban Tha Thung Na dam site and its neighboring areas, most of strata are diluvial and alluvial deposits except for continued outcrops of bedrock on the steep slope of mountains on the left bank of the river. On the right bank, there are only local outcrops along the river and the gentle slope of mountains.

Bedrock in this area are for the most part assumed to have been formed during the Paleozoic era and, judging from scattered outcrops, test pits and cores of drill holes, the types and the distribution of the rocks can be classified as follows:

Namely at the dam site, as illustrated in Figs. 4-2 and 4-3, limestone is distributed over higher parts of the mountain of the left bank, calcareous shale on the outskirts of the left mountains and limestone and calcareous shale along the river. On the right bank of the river, shale is found over flat terrace and skirts of mountains and metasendimentary rocks in the mountainous area. As a whole, these strata show zonal distribution crossing the dam axis.

Details are given below with regard to the types of rocks distributed in this region.

(Limestone)
Other than on the steep slopes of mountains on the left bank, limestone is exposed only in several locations over the area adjacent to the dam axis and on each side of the river bed, as verified by core drill holes, BL-1, BL-2, BR-1 and BR-6 drilled in the area adjacent to the river bed and the neighborhood.

Limestone distributed in this area is grey and/or greyish black. It is generally fine grained though contains in part sandy or argillaceous matters and is compact and hard. For the most part, it presents banded structure and its bedding is visible.

BC-1 drilled into the river bed shows the presence of whitish, massive, compact and hard limestone, but the range of distribution is considered relatively small.

(Calcareous shale)
Calcareous shale is not only exposed on the excavated slope on highway running along the river on the left bank but also found by drill holes BL-2 and BR-2. The calcareous shale is compact and hard, and it features distinct bedding that tends to exfoliate and is brittle as compared to limestone. Also, very thin veins of calcite have generally been developed.

(Shale)
Shale crops out at the areas of the mountain foot of the right bank on the proposed dam axis and at places on the river bed of the right bank about 800m upstream from the dam axis.

The presence of shale has been confirmed by test pits, PR-3, 5, 7, 10, 13, 15, 21, 22 and 25 and core drill holes, BR-3, 4, 5, 7, 9 and 10 drilled at the right bank. This shale is black and non-calcareous. It is in part subjected to metamorphism and composed of slaty facies. Most of the rocks are fine grained, mixed locally with sandy facies. The shale is generally compact and solid, but more exfoliative and fragile than calcareous shale, especially in the weathered portions. Flat area on the right bank shows dominant distribution of black shale, mingled in part with slightly calcareous and noncalcareous sandstone as found in drill hole BR-9.

The alternation of calcareous shale and limestone was found in drill holes, BL-3, 4 and 5 and BC-1 adjacent to the river bed, but no outcrops of these rocks were found. It was observed that beds with thickness of 20-30cm prevailed, but in some limited cases, the thickness reached 1 meter. The alternation of the strata is unidentified with regard to its overall distribution, but it is assumed with relative certainty that the strata show a dominant distribution along the main stream of the Quae Yai River.

(Metasedimentary rocks)
It is also considered that metasedimentary rocks are extensively distributed from the dam abutment on the right bank to the inside of mountains, but these rocks are not distributed in the area of the dam foundation. The recent geological investigation discovered a large number of outcrops of sandstone showing schistosed structure in this region, including minor outcrops of calcareous sandstone with schistosed structure and black schist. Though the degree of metamorphism locally varies, the metasedimentary rocks are generally exfoliative.

(2) Geological structure

The formations of bedrock, though having undergone local changes in width, appeared in conformity as a whole.

The formations, though locally forming somewhat steep folding structure, show the types of gentle and symmetrical folding structure having axis oriented toward NNW-SSE.

Judging from the outcrops, the strike and dip of strata, except on the dam abutment of the right bank, indicate N 10^o - 30^o W in strike crossing the dam axis as a whole. As regards the dip of the formation, it inclines to vertical in places from the proximity of the river bed to the flat area, while it varies 35^o to 75^o NE on the left bank.

Various types of rocks show clear bedding on their outcrops, but the presence of the structures is more evident in shale and calcareous shale, with each type of rocks showing local joints which cross the strike of bedding plane.

Though no major faults have been discovered by the recent field geological investigations, several minor faults have been detected in drill holes, BR-3, 4 and 5. It is unidentified as yet whether the faults are continuous.

Data or other information showing the boundary between black noncalcareous shale and metasedimentary rocks are presently not collected, but it may be inductively assumed that there is the presence of faults judging from the presence of local irregularity in strike and dip of strata. Also, judging from the presence of reconsolidated sheared zone in some of the cores of drill holes, it is assumed that some faults and sheared zones locally exist.

(3) Weathering

The outcrops of limestone are solid and relatively fresh and have weathered joints or bedding planes. Weathering is limited to these structures.

Weathering occurs to the outcrops of calcareous shale, only to a depth of less than 1 meter where rocks have been discolored or embrittled. The weathered portion of rock is not so thick.

Though alternation of calcereous shale and limestone are not distributed in the river bed, judging from the cores of borings, weathering tends to extend along the calcareous shale. Nevertheless, bedrocks as a whole have not been subjected to serious weathering.

Shale is subjected to weathering more than any other rocks in the foundation of the proposed dam. Partially exposed shale has been discolored and extremely softened due to weathering. According to observation of test pits and core borings, the shale has been badly weathered from the surface to a depth of 5 to 10m, and become more brittle and fragile.

Schistosed sandstone which is most widely exposed than other sedimentary rocks, is light brown or reddish brown color due to weathering. But, as a whole the outcrops of this sandstone is little, and therefore, information about weathering is insufficient, however it appears that this sandstone is subjected to little deterioration in its characters.

(4) Solubility of calcareous rocks

Small solution cavities and narrow and shallow open fissures were locally observed in the outcrops of limestone. These are not continuous and form cylindrical shape, with diameters ranging from 20 to 30cm. Bottoms were visible for most of the cavities and fissures, with a part of them being clogged with fine grained materials or secondary lime deposits. The deepest one is estimated about several meters. It often occurs that open fissures spread along bedding planes or joints, with width of 2 to 3cm and depth of less than several meters.

The outcrops of calcareous shale exhibit the phenomenon of solution cavities, though in a smaller scale compared to those of limestone. Of exploratory holes drilled near the river bed or on the left bank, there were portions in BR-1, BR-6, BR-8, BL-1 and BL-5 penetrating calcareous shale over a fair depth where core was not recovered. The drillers attribute this to the presence of solution cavities.

Especially, core recovery is quite poor over a section of 15 m long, as in the case of BR-1, which may be due to the drill extending into a vertical solution cavity.

Also, judging from the results of boring of calcareous rocks, it is assumed that most of individual cavities are formed on a small scale and distributed at a depth of 10 m from rock surface, even though the coreless portions may have been solution cavities.

(b) Quaternary deposits

(1) Diluvium

The diluvium near the dam site has for the most part been formed by river terrace deposits. One shows long, slender distribution along the left bank and the other a wide distribution over flat river terrace on the right bank.

A part of the outcrops of the diluvium forms a cliff of higher than 10 m along the southern border of the terrace of right bank. Other areas are, as a whole, covered with alluvium and have been penetrated by test pit and core boring in the neighborhood of the dam site. The elevation of the surface of this deposit is up to 60m and down to a minimum of 45 m, directly covering bedrock.

These deposits are mainly composed of clay, silt, sand and other fine grained materials and, generally gravels exist in lower layers. The deposits locally contain small concretions of secondary lime.

Sorting is locally observed in these particles of different diameter, but generally stratification cannot be identified.

Soil of the deposits is in part relatively compact, but is generally loose.

The diluvium will be more than 15m in maximum thickness, with its thickness being 2 to 12m above the dam axis.

(2) Alluvium

The alluvium is for the most part formed by talus deposits on the slopes and skirts of mountain, flood plain and river bed deposits, and topsoil. Moreover, there are deposits of secondary lime in local, limited area. These deposits are found on diluvium or directly on bedrock.

Talus deposits have a long and slender distribution along the skirts of hills on the left bank and, as verified by drill hole BL-2, it is 4m thick in certain parts, but generally not more than 1m thick. Otherwise, the talus deposits have little distribution, if any, over foot of hills on the right bank.

River deposits are composed of silt, sand and gravel, and are extremely loose as a whole, with thickness varying at locations to a large degree, up to a maximum of about 15m.

Topsoil is thinner than 50cm as a whole and some layers of secondary lime had a thickness of 1.8m as observed in drill hole BL-5, but their distributions are limited.

(c) Water table

There is a spring beside a road on the left bank. This is located on a foot of a hill about 80m upstream of the dam axis, and its elevation is about 64m. The discharge of the spring was recorded to be about 4 to 5 l/min in the dry season of 1975.

In the neighboring area, no other spring or water flow in hill stream was found during this season.

In the drill holes, water table was measured before and after each permeability test. Table 4-4 shows the water tables in the bore holes during the final stage of permeability test and indicates that underground water is flowing toward the river as a whole with gentle slopes.

Upon recording the geology of a test pit (November 1975) on the right bank, standing water was observed on the bottom of pits PR-7, 10 and 15, but the relationship between the standing water and the water table cannot be identified yet.

(b) Permeability

Bedrock permeability test was conducted in all bore holes, except BL-4. Figures 4-3 and Appendix (C) show relative results.

Permeability tests were accompanied with boring by means of the single packer injection process. The calculation of the coefficient of permeability (K) was based on the United States Bureau of Reclamation formula:

$$K = \frac{Q}{2\pi LH} \cdot \log_e \frac{L}{r} \quad , \quad L \geqq 10r$$

Where:

K = Coefficient of permeability
Q = constant rate of flow into the hole
L = length of the portion of the hole tested
H = differential head of water
r = radius of hole tested
loge = natural logarithm

Table 4-5 shows the coefficients of permeability by depth of each drill hole. The results of the permeability tests are as follows:

(1) Permeability in limestone formation varies much with the location. For example, in the case of BR-1, the coefficient of permeability was so great and it did not allow the packer adhesion, whereas in the case of BR-6, some portions did not allow the leakage of water. The coefficient of permeability ranges from 2.2×10^{-3} cm/sec. to 3.7×10^{-6} cm/sec.

(2) The coefficient of permeability for calcareous shale ranges from 7.5 x 10^{-4} cm/sec. to 3.6 x 10^{-6} cm/sec. Generally, permeability is relatively low.

(3) The coefficient of permeability for the alternation of calcareous shale and limestone ranges from 1.7 x 10^{-3} cm/sec. to 7.8 x 10^{-6} cm/sec. The range of fluctuation is wide.

(4) The coefficient of permeability for shale ranges from 9.3 x 10^{-4} cm/sec. to 1.3 x 10^{-5} cm/sec. A part of BR-7 and BR-10 is impermeable. Generally, permeability is relatively low.

4.3.4 Engineering geology

(a) Dam axis

Four possible dam axes were considered for the Lower Quae Yai Project, identified as Sections I, III, IV and V in Fig. 4-2, from topographic conditions and distribution of outcrops of bedrock. Therefore, various investigations were made into these alternative dam axes.

As a result of geological investigations, including the confirmation of the location of the bedrock for the dam foundation, it was found that deposit on the bedrock is the thinnest on Section IV on the left bank and near river bed, and on Section IV and a little upstream on the right bank. Consequently, A-A section was selected as the dam axis as indicated in Fig. 4-2.

(b) Foundation of civil works

(1) Foundation of concrete dam

River deposits, with a thickness of 5 to 12 m, are distributed within the foundation of the concrete dam.

The foundation is composed of limestone, calcareous shale and alternation of limestone and calcareous shale. Weathering of the surfaces of the bedrock have not progressed. It appeared that the surfaces of the bedrock might be fairly rugged due to the presence of solution cavities.

As a foundation of the structures, the bedrock shall require some treatment including excavation or dental work to prepare a smooth surface, in addition to removal of river deposits. Also, consolidation grouting will be needed depending on the features of the solution cavities.

Judging from the results of the permeability tests, curtain grouting will be required. Though further studies will be required on the depth of the grouting, it may be tentatively concluded that grout curtains extending to a depth of about 25 m from the surface of bedrock will be required for the structure foundation.

(2) Foundation of rockfill dam

Diluvium and alluvium, which cover the bedrock of black shale, have a thickness ranging from 2 to 10 m and become thinner toward the right abutment.

The black shale is fragile and embrittled from the surface to several meters deep due to the strong effect of weathering.

In order to prepare the foundation on which to build the relatively higher portion of the fill dam adjoining the concrete dam, the overburden and especially badly weathered portion of shale need to be excavated.

On the right flat area, it will be sufficient to excavate weathered surface of shale in relation to the height of the dam.

Though curtain grout may be required at portions where the dam height is great, it is assumed that no curtain grouting is necessary on the flat area of the right bank, judging from the dam height, the permeability of foundation, water table, etc., and it will be sufficient to execute blanket grouting which will also serve the purpose of consolidation grouting.

(3) Foundation of intake, powerhouse and tailrace

Overburden with an approximate thickness of 10 to 15 m are distributed at sites proposed for the construction of these structures.

Bedrock is composed of limestone, calcareous shale, shale and alternation of these rocks, but the surface of these rocks is not subjected to excessive weathering as seen in drill hole BL-1 and relatively solid portions are mixed, as found in BL-4 and 5, with portions where core recovery rate is low from the surface to a depth of 5 to 7 m due to existence of weathered rock and/or solution cavities. Weathered bedrock should be excavated to prepare the foundation for the intake structure.

Bedrock at the power plant site is designed to be excaveted to elevation 26 m and no specific defects have been found with regard to the geology of this area.

The curtain grout for the dam foundation will be required to be extended over the entire length of the intake structure.

According to the data of drill hole BL-2 (elevation of water table: 54.14 m), the water table at the left bank is higher than the elevation (about 40 m) of the water surface of the main stream during the dry season, but it is lower than the normal high water level (elevation: 59.70 m) of the regulating reservoir. Moreover, considering that the bedrock of the left bank is calcareous rocks, the curtain grout will most probably have to be extended into the left bank.

4.4 Geology of Ban Wang Kula dam site

4.4.1 Field investigation

Regarding the Ban Wang Kula dam site, preliminary geological reconnaissance was conducted in 1967 (Feasibility Report, Quae Yai No. 1 Hydroelectric Project, 1968).

During the period between 1967 and middle of 1975, topographic map on a scale of 1:2,000 was prepared for the proposed dam site, but no geological investigation was conducted.

Recently, the Mission, with the cooperation of EGAT, carried out field geological mapping of the dam site using the 1:2,000 scale topographic map in order to compare the geology of this project with that of the Ban Tha Thung Na site and to analyse the geological structures in the reservoir area.

4.4.2 Geological condition

The Ban Wang Kula dam site is situated about 3.5km upstream of the Ban Tha Thung Na dam site. This dam site faces a steep mountain on the left bank and, on the right bank, there is a river terrace about 400m wide which adjoins a ridge.

The entire configuration of the valley is similar to that of the Ban Tha Thung Na site, but it is slightly narrower than the latter, with a width of about 500m at the high water level of the regulating reservoir.

The present geological mapping will enable one to get approximate features of geological structure as follows.

a) Stratigraphically, bedrocks in this site belong to the same geological unit which mainly consists of calcareous rocks distributed in mountains on the left bank of Ban Tha Thung Na dam site.

b) Outcrops of bedrocks found at the site can be classified as follows:

Left Bank : Calcareous sandstone and sandstone
River bed and flat terrace on right bank : Calcareous sandstone
Ridge on right bank : Limestone, calcareous shale and shale

c) One fault with sheared zone of about 30m wide crops out on the slope of the highway just downstream of the proposed dam axis on the left bank, with a strike parallel to the dam axis and vertical dip.
By this fault, the geology is divided into different units and the stratification of the strata is disturbed in the vicinity of the fault.
The fault is consealed with overburden and it might extend to the right bank crossing the river.

d) Calcareous rocks are locally exposed on the flat terrace on the right bank. Though relatively small and shallow, there are a few solution cavities of diameters ranging from 1 to 1.5m on the surface.

e) Close observation of 1 : 2,000 scale topographical maps will enable one to detect the presence of topographical depressions, though on a small scale, in the flat plains around the dam site. This is suggestive of the existence of solution phenomenon in calcareous rocks immediately below the ground surface.

As a result of geological field reconnaissance performed this time, it may reasonably be concluded that the Ban Wang Kula site is not better than the Ban Tha Thung Na site in view of geological conditions.

4.5 Geology of reservoir area

4.5.1 Field investigation

Geological investigations of the lower Quae Yai reservoir area have not been executed so far. However, geological investigations around the Ban Chao Nen project was carried out from 1970 to 1973 which included most part of this regulating reservoir area in order to analyse the overall geological structures and the results were compiled in the following reports.

Report on the Reservoir Photogeological survey,
Quae Yai No. 1 Project, 1971 by KASC.

Evaluation of Photogeological Survey of
Quae Yai No. 1 Project, 1971 by EPDC.

Quae Yai No. 1 Project, Geological Map of Reservoir, 1973 by EPDC.

The recent investigations of the reservoir area were carried out mostly along the river banks and the existing road on the left bank with 1 : 5,000 aerial map and 1 : 50,000 map, and geological maps covering the area between the Ban Chao Nen project and a site approximately 5km downstream of the Ban Tha Thung Na Project.

4.5.2 Topography

High water level of the Ban Tha Thung Na reservoir is 59.70m above mean sea water level and the length of the reservoir is approximately 28km. The upstream end of the reservoir reaches to the Ban Chao Nen power plant. Width of the reservoir immediately upstream of the dam is approximately 1.5km, more than 300m up to a point approximately 5km upstream and in the flood plain in the upper stream. Therefore, the reservoir as a whole forms a relatively narrow lake. High water level of the reservoir mostly reaches to the terrace surfaces along both banks of the Quae Yai River and the reservoir water reaches to the steep slopes of the mountains at only a few places. There are many terrace scarps of a few meters to over ten meters high on both banks.

4.5.3 Foundation rock and overburden

(a) Foundation rock

There are outcrops of the foundation rock on the river banks in the reservoir area. The locations of outcrops confirmed by the recent geological investigations generally coincide with the points along the river in Fig. 4-1 showing strikes and dips of strata.

Foundation rock is composed of sandstone, shale, limestone, calcareous shale and calcareous sandstone. The outcrops confirmed are of alternation of sandstone and shale in the area upstream of Huai Sadong which joins the Quae Yai River midway of the reservoir and black non-calcareous shale in the downstream area. Though there exist disturbance of strikes and dips of strata locally, strikes of the foundation rock of N 10° - 40°W which generally conform to the direction of river course in the reservoir area are predominant. Dips in the upper basin are mostly 60° - 75° SE, in the intermediate basin between Huai Sadong and the Ban Wang Kula site irregular and in the lower basin are vertical.
As mentioned above, the foundation rock at the most part of the reservoir area is judged to be Formation B and Formation A near the Ban Chao Nen project in consideration of types and geological structures of the foundation rock.

(b) Overburden

Most part of the regulating reservoir area is covered with diluvium and alluvium. This overburden consists of materials of various sizes and its thickness is more than 10m around the river bed and gradually tapers toward the mountain skirt.

4.5.4 Watertightness

In the study of possible leakage through the reservoir foundation composed of calcareous rocks, there are two essential subjects to be examined: analysis of geological structures and undulation of water tables in and around the reservoir area.

Following are the geological conditions concerning the water-tightness of the reservoir foundation revealed from the recent investigations.

(a) The foundation rock in and around the regulating reservoir is composed of limestone and non-calcareous rocks which are distributed alternately as a whole. Especially, metasedimentary rocks distributed on the right bank of the dam site extend toward the upstream mostly parallel with the reservoir making negative justification of possible leakage through the foundation on the right bank of the reservoir.

(b) No wide distribution of pure limestone which creates big solution cavities and sinkholes has observed in the reservoir area.

(c) The foundation rock throughout the reservoir area sustains the folding structures of various grade and extension of each geological unit and its thickness are both varied.

(d) During the recent investigations, there were running water in some small streams around the reservoir area in spite of the dry season as shown in Fig.4-1.

(e) On the left bank of the Ban Tha Thung Na dam site, calcareous rocks are mainly distributed with partial intercalation of non-calcareous rocks. There is a spring at elevation higher than the river surface and water tables measured in drill holes are also higher than the river surface in this area.

The maximum depth of the reservoir created by the dam is only 30m and there will be small possibility of noteworthy leakage from the reservoir taking the above-mentioned geological conditions into consideration. Furthermore, fine grained materials which may function as a blanket layer under this small water pressure are included in the overburden covering most part of the regulating reservoir area providing a favourable condition for watertightness.

4.5.5 Stability of slopes

The normal high water level of the regulating reservoir borders on diluvium and alluvium as a whole. Locally, these unconsolidated deposits form cliffs with a height of several meters.

It is probable that in such places, some cliffs are subjected to erosion and local slope failure may occur due to fluctuation of water level of the regulating reservoir.

Though detailed investigations have not been initiated against such phenomena, according to our investigations, a large number of cliffs exist below the normal high water level of the regulating reservoir and we assumed that large scale slope sliding will seldom occur even in some of the cliffs above the high water level.

In this area, there have been found no place which will cause landslide or large scale slope sliding.

4.6 Geology at Ban Tha Thong Mon Project

4.6.1 Field investigations

Initial steps of the field investigation of this project was reconnaissance study conducted by the Mission. Aerial inspection with helicopter was carried out over the proposed area, preliminary to the geological reconnaissance with 1:5,000 and 1:50,000 scale maps in the area where the upper pondage, power plant and outlet of tailrace tunnel are planned. The project area is also included within the region of the photogeological interpretation performed as a part of geological investigations of the Ban Chao Nen reservoir area.

4.6.2 Topography

This project is located on the right bank of the Quae Yai River, approximately 9km downstream of the Ban Chao Nen dam or approximately 19km upstream of the Ban Tha Thung Na dam site.

There extends wide table land at an elevation of around 600m on the upper portion of the right bank of the Quae Yai River, forming a steep slope between the said table land and the Quae Yai River, though comparatively gentle slopes are found at elevation 400m to 500m. Therefore, this area provides desirable topographical conditions for the pumped-storage scheme.

The area for the upper pondage is covered with dense vegetation of bamboos, shrubs and arbores, and the ground surface is generally flat with less undulations showing that this area is corrosion plateau, one of the Karst phenomena usually observed in this region.

The mountain in which the headrace tunnel, powerhouse and tailrace tunnel are planned have some hillstreams on the slope faced to the upstream as viewed from the Quae Yai River and forms a curved and relatively steep slope toward the downstream of the river. There are narrow terraces along the main stream.

4.6.3 Geology

Generally, there are few outcrops observed on the mountain in the project area. Only a few outcrops of grey to pale grey and rather massive pure limestone were found at the proposed site of the upper pondage. Also, sandstone and alternation of shale and sandstone outcrops were observed at some places of a small stream located upstream of the tunnel route.

Following are the geological conditions of the project site assumed on the basis of the results of photogeologic interpretation, etc. carried out so far at the Ban Chao Nen project.

(a) Foundation rock is of the Paleozoic era.
Rat Buri limestone is distributed at the upper pondage site, and so called Formation B composed of shale, limestone, sandstone, calcareous shale, calcareous sandstone and alternation of these rocks at the proposed outlet structure site. Rat Buri limestone probably covers the Formation B in unconformity.

(b) The entire surface of the proposed upper pondage site is covered with overburden and no outcrop is observed, however the foothill around this area is dotted with outcrops of limestone. Thickness of the overburden is not clarified at present. As this area is assumed to be a part of flat corrosion plateau, the overburden will be mainly composed of residual soil, secondary lime deposits and some topsoil.

(c) It is assumed that Rat Buri limestone is distributed at the upper section and Formation B at the lower section of the tunnel route.
However, the location and features of the boundary of these strata (unconformity plane) have not been confirmed yet.
In Fig. 4-4, the location of unconformity plane is tentatively drawn by making reference to the existing data (Quae Yai No. 1 Project, Geological Investigation of Reservoir Area, Feb. 1973 by EPDC).

Table 4-1 Generalized Geologic Sequence of Lower Quae Yai Project Area

Era	Stratigraphic unit		Rock	Distribution	Characteristic
Cenozoic	Quaternary system		Terrace, flood plain, river bed, talus deposits and topsoil.	Widespread	Mainly fine materials, unconsolidated
	Unconformity				
Paleozoic	Rat Buri limestone		Massive pure limestone	Forms cliff and tableland; Quae Noi basin to right bank of Quae Yai River.	Remarkable KARSTIC phenomena gently folded
	Unconformity				
	Tanaosi group (So-called Kanchanaburi series)	Formation B	Shale, limestone, sand-stone, calcareous shale and sandstone, and alternation of these strata.	Both banks of Quae Yai River.	Folded
		Formation A	Quartzite, calcareous sandstone and slate; locally with impure limestone and shale, beds.	Damsite to east-ern mountain area.	Rock is very hard, but folded.
	?				
	Metamorphic rocks		Metasedimentary rocks.	Divide between Quae Yai and Quae Noi River.	Severely folded.
			Schist and gneiss.		

Table 4-2 List of Test Pits at Ban Tha Thung Na Dam Site

Pit No.	Top Elevation (m)	Depth (m)	Location	Remarks
PL- 1	47.33	4.7	Section III, left bank	
PR- 1	51.73	4.0	Section III, right bank	
PR- 2	49.50	7.0	100m upstream of Section I, right bank	
PR- 3	58.78	0.9	Section III, right bank	Weathered shale (bedrock) at 0.8 m to bottom
PR- 4	55.31	4.8	100m upstream of Section I, right bank	
PR- 5	58.37	1.0	Section III, right bank	Weathered shale (bedrock) at 0.2 m to bottom
PR- 6	48.62	5.3	100 m upstream of Section I, right bank	
PR- 7	59.98	1.5	Section III, right bank	Weathered shale (bedrock) at 0.2 m to bottom
PR- 8	48.08	5.0	100 m upstream of Section I, right bank	
PR- 9	55.85	1.9	Section I, right bank	
PR-10	52.64	4.7	Section I, right bank	Weathered shale (bedrock) at 4.5 m to bottom
PR-11	54.26	2.8	Section I, right bank	
PR-12	56.16	3.0	Section III, right bank	
PR-13	55.10	3.0	Section IV, right bank	Weathered shale (bedrock) at 1.3 m to bottom
PR-14	59.11	2.1	Section IV, right bank	
PR-15	58.52	1.6	Section IV, right bank	Weathered shale (bedrock) at 1.4 m to bottom
PR-16	55.87	2.0	Section V, right bank	
PR-17	55.13	3.2	Section V, right bank	
PR-18	52.88	3.0	120 m downstream of Section V, right bank	
PR-19	52.47	3.0	130 m downstream of Section V, right bank	
PR-20	58.55	3.0	Section I, right bank	
PR-21	56.26	2.5	Section IV, right bank	Weathered shale (bedrock) at 2.3 m to bottom
PR-22	56.42	0.5	Section IV, right bank	Weathered shale (bedrock) at 0.2 m to bottom
PR-23	56.49	3.0	Section V, right bank	
PR-24	55.55	3.0	Section V, right bank	
PR-25	56.33	1.5	Section V, right bank	Weathered shale (bedrock) at 0.8 m to bottom
	Total	78.0		

Table 4-3 List of Drill Holes at Ban Tha Thung Na Damsite

Hole No.	Location	Top Elevation (m)	Direction of Hole	Length of Hole (m)	Thickness of Over-burden(m)	El. of Bedrock surface(m)	Length of Casing Pipe (m)	Core Re-covery (%)	Diameter of Hole (mm)	Rock Type of Bedrock	Commenced / Completed
BR-1	Right bank	45.48	Vertical	40.00	13.7	31.78	29.28	52.1	114 - 49.7	LS	Oct. 24 1975 Dec. 3 1975
BR-2	"	43.93	"	26.20	11.20	32.91	11.30	100.0	91.3 - 76.2	CSH	Jan. 23 1976 Feb. 13 1976
BR-3	"	54.34	"	24.20	4.7	49.64	8.30	63.4	"	SH, SS CSH	Jan. 26 1976 Feb. 10 1976
BR-4	"	59.91	"	22.00	6.7	53.21	11.30	96.7	"	SH, Sandy SH	Feb. 12 1976 Feb. 21 1976
BR-5	"	63.02	"	21.25	0	63.02	6.05	64.5	"	SH	Feb. 23 1976 Feb. 29 1976
BR-6	"	42.96	"	35.00	0.5	42.46	4.05	98.7	"	LS	Jan. 23 1976 Feb. 2 1976
BR-7	"	55.73	"	45.00	7.5	48.23	12.50	70.5	"	SH	Dec. 23 1976 Jan. 13 1976
BR-8	"	55.96	" "	21.00	6.0	49.96	7.50	98.9	"	LS	Feb. 11 1976 Feb. 16 1976
BR-9	"	55.00	"	29.50	4.0	51.00	7.50	92.4	"	SH, SS	Feb. 10 1976 Feb. 28 1976
BR-10	"	59.73	"	25.00	8.0	51.73	7.50	94.1	"	SH	Mar. 3 1976 Mar. 11 1976
BC-1	River bed	39.40	"	20.50	5.5	33.90	5.40	100.0	114 - 76.2	LS SH/CSS	Feb. 20 1976 Feb. 27 1976
BL-1	Left bank	44.47	"	16.20	1.2	43.27	2.90	96.3	91.3 - 76.2	LS	Jan. 10 1976 Jan. 18 1976
BL-2	"	65.08	"	65.00	3.85	61.23	1.85	97.8	"	LS, CSH	Jan. 10 1976 Feb. 5 1976
BL-3	"	55.70	"	33.00	17.4	38.3	18.00	99.0	"	CSH, LS CSH/LS	Mar. 29 1976 Apr. 1 1976
BL-4	"	55.59	"	30.00	11.8	43.79	17.00	63.2	"	LS, SH	Mar. 18 1976 Mar. 22 1976
BL-5	"	48.38	"	30.00	10.2	38.18	15.00	81.1	"	CSH/LS	Mar. 23 1976 Mar. 27 1976
			Total : 483.85								

Abbreviation of rock type

LS : Limestone
SH : Shale
SS : Sandstone
CSH : Calcareous shale
CSS : Calcareous sandstone
CSH/LS : Alternation of CSH and LS

Table 4-4 Water Table in Drill Hole

Hole No.	Top Elevation(m)	Drilled Depth(m)	Depth to Water Table (m)	El. of Water Table (m)	Date	Remarks
BR- 1	45.48	40.0	No record	—	—	
BR- 2	44.11	26.2	3.6	40.51	Feb.-13-1976	
BR- 3	54.34	24.2	10.0	44.34	Feb.-10-1976	
BR- 4	59.91	22.0	17.0	42.91	Feb.-21-1976	
BR- 5	63.02	21.25	10.7	52.32	Feb.-29-1976	
BR- 6	42.96	35.0	2.66	40.30	Feb.-2-1976	
BR- 7	55.73	45.0	12.68	43.05	Jan.-13-1976	
BR- 8	55.96	21.0	14.3	41.66	Feb.-16-1976	
BR- 9	55.00	29.5	11.71	43.29	Feb.-28-1976	
BR-10	59.73	25.0	17.0	42.73	Mar.-11-1976	
BC- 1	39.40	20.5	(+0.8)	(*40.20)	Feb.-27-1976	*El. of river water surface
BL- 1	44.47	16.2	2.6	41.87	Jan.-19-1976	
BL- 2	65.08	65.0	10.95	54.13	Jan.-6-1976	
BL- 3	55.70	33.0	16.0	39.7	Apr.-1-1976	
BL- 4	55.59	30.0	No record	--	—	
BL- 5	48.38	30.0	8.5	39.88	Mar.-27-1976	

Table 4-5 Coefficient of Permeability of Bedrock

Hole No.	Tested Depth (m)	Coefficient of Permeability (cm/sec)	Rock Type	Remarks
BR- 1	30.3 - 35.3	7.9×10^{-4}	LS	
BR- 2	12.0 - 16.0	1.6×10^{-5}	Calc. SH	
	16.0 - 21.0	2.7×10^{-5}	"	
	21.0 - 26.2	4.1×10^{-5}	"	
BR- 3	12.5 - 15.0	4.2×10^{-5}	Mainly SH	
	20.0 - 24.2	2.2×10^{-5}	SH and Calc. SH	
BR- 4	13.0 - 19.0	6.1×10^{-5}	Mainly SH	
	16.0 - 19.0	5.3×10^{-5}	Mainly Sandy SH	
	19.0 - 22.0	2.1×10^{-4}	Sandy SH	
BR- 5	9.0 - 12.0	1.3×10^{-5}	SH	Including sheared zone
	14.0 - 17.0	1.3×10^{-4}	"	Including fault zone
	17.0 - 21.25	2.3×10^{-5}	"	
BR- 6	5.3 - 10.3	5.2×10^{-6}	LS	
	9.65 - 14.65	No leakage	"	P. max. 3.3 kg/cm^2
	14.95 - 19.95	"	"	P. max. 4.3 kg/cm^2
	19.6 - 24.6	3.1×10^{-5}	"	
	24.35 - 29.35	No leakage	"	P. max. 5.3 kg/cm^2
	29.0 - 35.0	"	"	P. max. 5.3 kg/cm^2
BR- 7	14.85 - 22.85	9.5×10^{-6}	SH	
	22.1 - 27.1	2.3×10^{-5}	"	
	27.0 - 32.0	1.2×10^{-6}	"	
	32.0 - 37.0	No leakage	"	P. max. 6.2 kg/cm^2
	35.0 - 40.0	"	"	P. max. 6.2 kg/cm^2
	40.0 - 45.0	"	"	P. max. 6.3 kg/cm^2
BR- 8	7.0 - 11.0	3.7×10^{-6}	Mainly LS	
	11.0 - 16.0	6.3×10^{-4}	"	
	16.0 - 21.0	9.5×10^{-6}	"	
BR- 9	15.25 - 18.25	6.7×10^{-4}	SS	
	17.85 - 22.85	Failed in test	Mainly SS	
	26.5 - 29.5	1.7×10^{-4}	Mainly SH	

Hole No.	Tested Depth (m)	Coefficient of Permeability (cm/sec)	Rock Type	Remarks
BR-10	9.5 - 14.5	5.6×10^{-4}	SH	
	14.65 - 19.65	No leakage	"	P. max. 5.7 kg/cm^2
	21.5 - 25.0	9.3×10^{-4}	"	
BC- 1	6.0 - 10.0	2.9×10^{-3}	LS	
	10.0 - 15.0	4.9×10^{-4}	SH/Calc. SS	
	15.0 - 20.5	2.2×10^{-5}	"	
BL- 1	5.0 - 8.0	1.5×10^{-3}	LS	
	8.0 - 13.0	1.1×10^{-3}	"	
	12.2 - 16.2	1.3×10^{-3}	"	
	14.2 - 16.2	2.2×10^{-3}	"	
BL- 2	4.0 - 9.0	6.7×10^{-4}	LS	
	9.0 - 14.0	4.7×10^{-5}	"	
	14.0 - 19.4	6.5×10^{-6}	LS and Calc. SH	
	19.0 - 24.0	1.0×10^{-5}	Calc. SH	
	24.0 - 29.0	1.1×10^{-4}	"	
	29.0 - 34.0	1.6×10^{-4}	"	
	33.3 - 39.0	8.5×10^{-5}	"	
	36.0 - 44.4	6.4×10^{-5}	"	
	44.4 - 49.0	5.2×10^{-6}	"	
	49.0 - 54.0	7.5×10^{-4}	"	
	54.0 - 59.0	2.1×10^{-4}	"	
	59.0 - 62.0	3.3×10^{-5}	"	
	62.0 - 65.0	3.6×10^{-6}	"	
BL- 3	17.85 - 22.85	5.3×10^{-4}	LS and Calc. SH	
	23.0 - 28.0	1.3×10^{-5}	LS/Calc. SH	
	28.0 - 33.0	7.8×10^{-6}	"	
BL- 5	17.0 - 20.0	3.4×10^{-4}	LS/Calc. SH	
	20.0 - 25.0	4.0×10^{-4}	"	
	25.0 - 30.0	1.7×10^{-3}	"	

Abbreviation of rock type

LS : Limestone

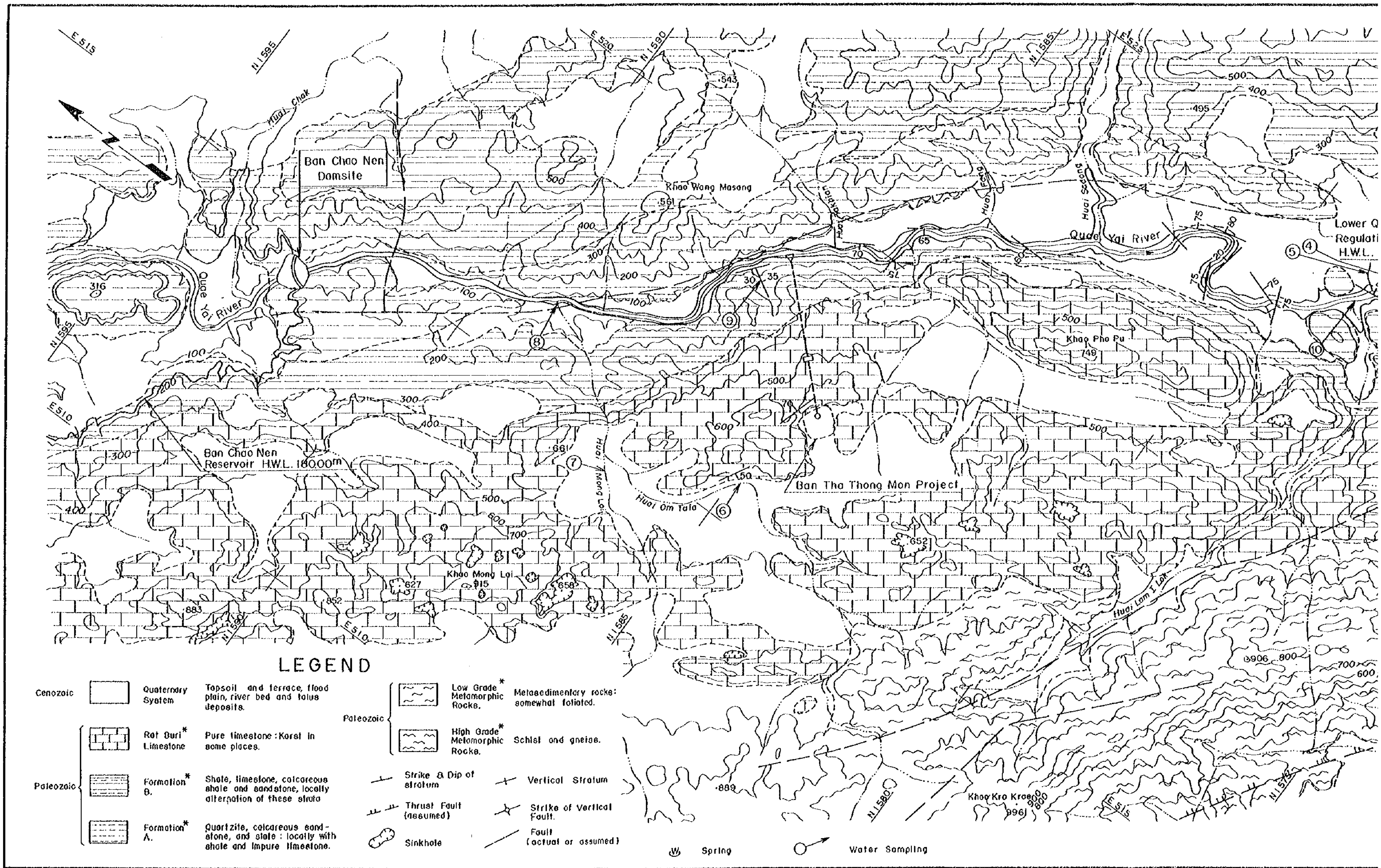
SH : Shale

SS : Sandstone

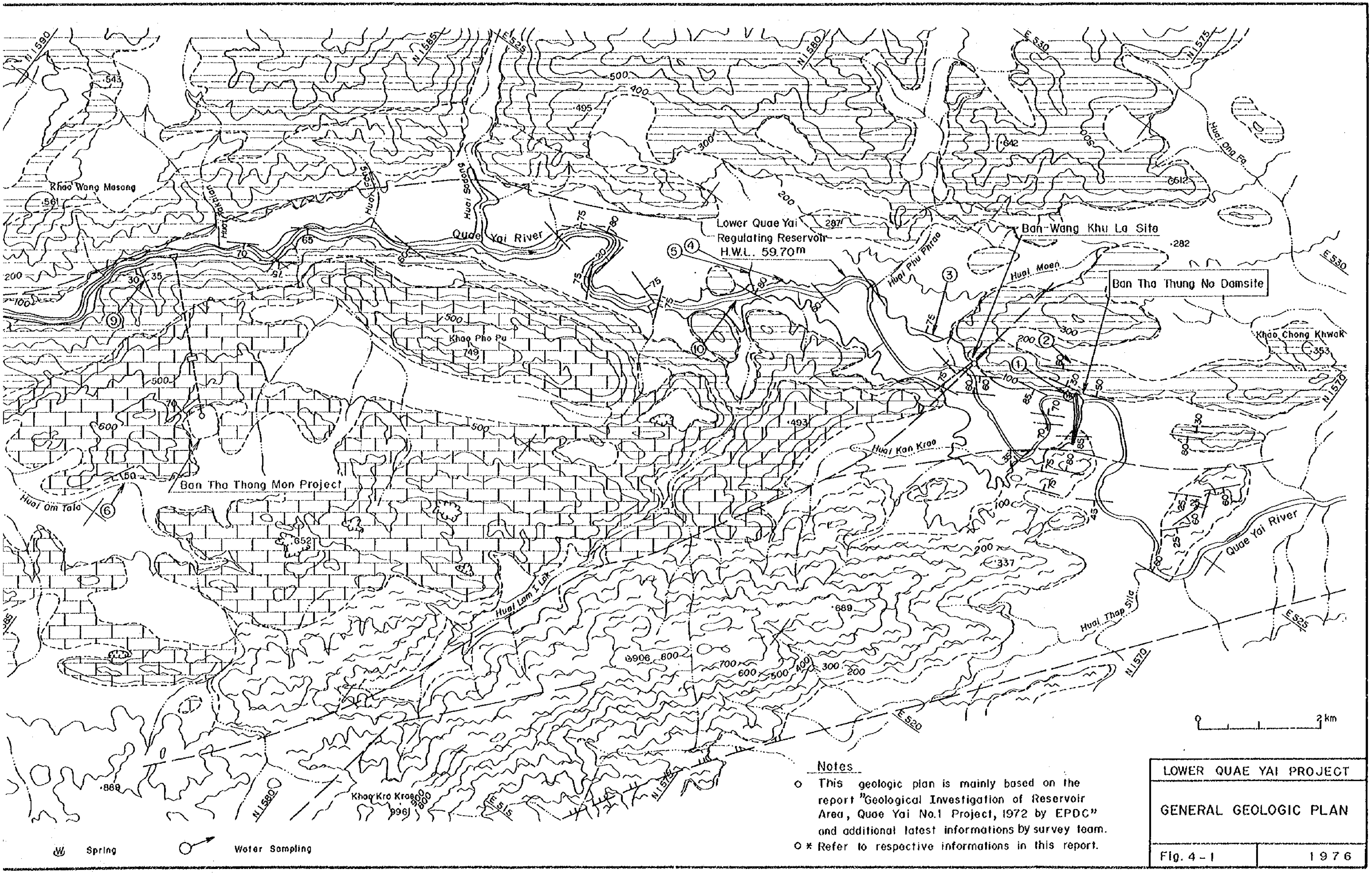
Calc. : Calcareous

SH/LS : Alternation of shale and limestone

P. max. Maximum pressure



Ban Chao Nen Damsite
Khao Wang Masang
Quae Yai River
Lower Q
Regulati
H.W.L.
Khao Pho Pu
Ban Chao Nen Reservoir H.W.L. 180.00m
Ban Tha Thong Mon Project
Huai Chak
Huai Om Tala
Huai Lam I Lak
Khao Mong Lai
Khao Kra Kraeng
LEGEND
Cenozoic
Quaternary System
Topsoil and terrace, flood plain, river bed and talus deposits.
Paleozoic
Rat Buri* Limestone
Pure limestone: Karst in some places.
Formation* B.
Shale, limestone, calcareous shale and sandstone, locally alternation of these strata
Formation* A.
Quartzite, calcareous sandstone, and slate: locally with shale and impure limestone.
Paleozoic
Low Grade* Metamorphic Rocks.
Metasedimentary rocks: somewhat foliated.
High Grade* Metamorphic Rocks.
Schist and gneiss.
Strike & Dip of stratum
Vertical Stratum
Thrust Fault (assumed)
Strike of Vertical Fault.
Sinkhole
Fault (actual or assumed)
Spring
Water Sampling

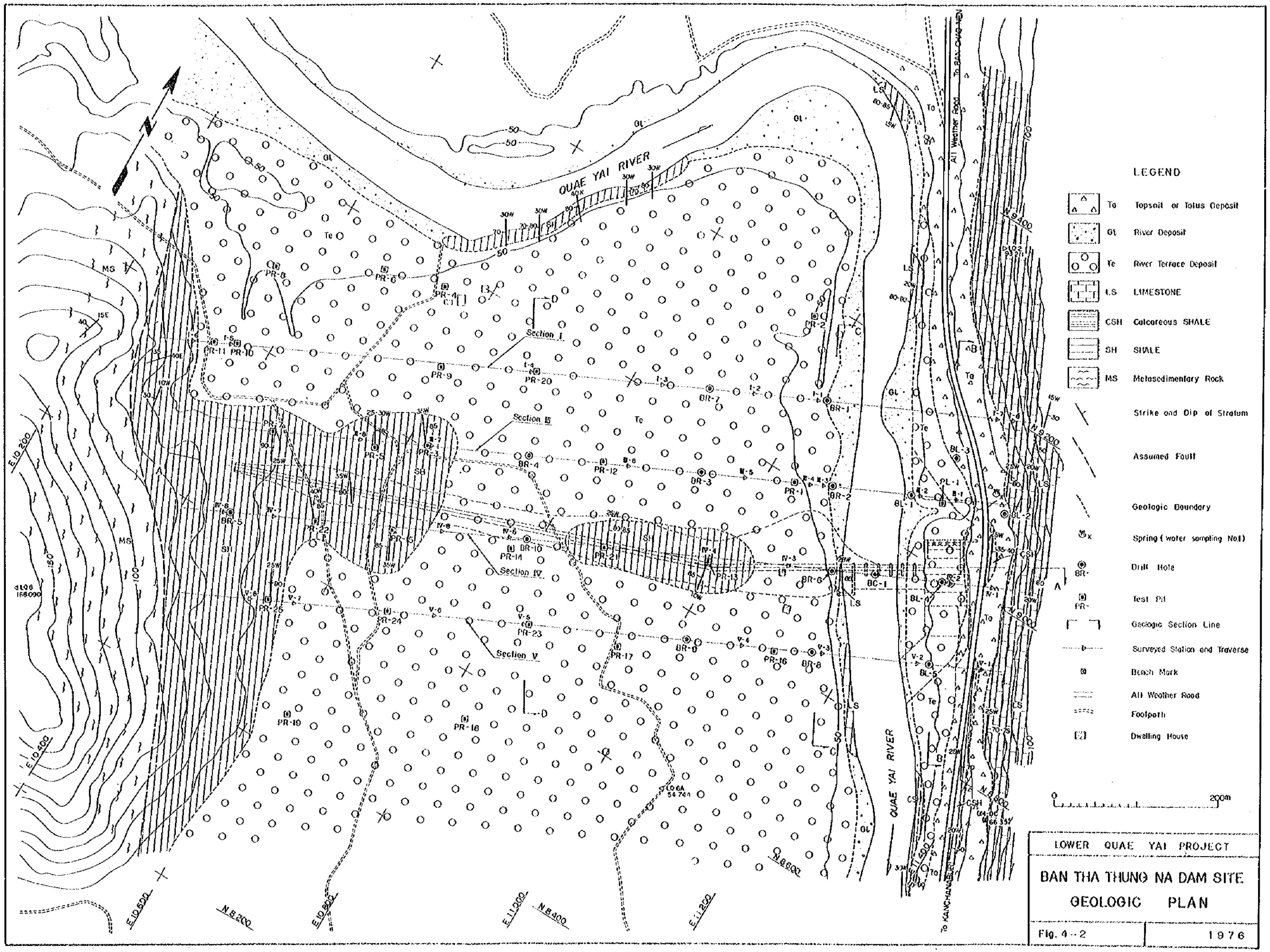


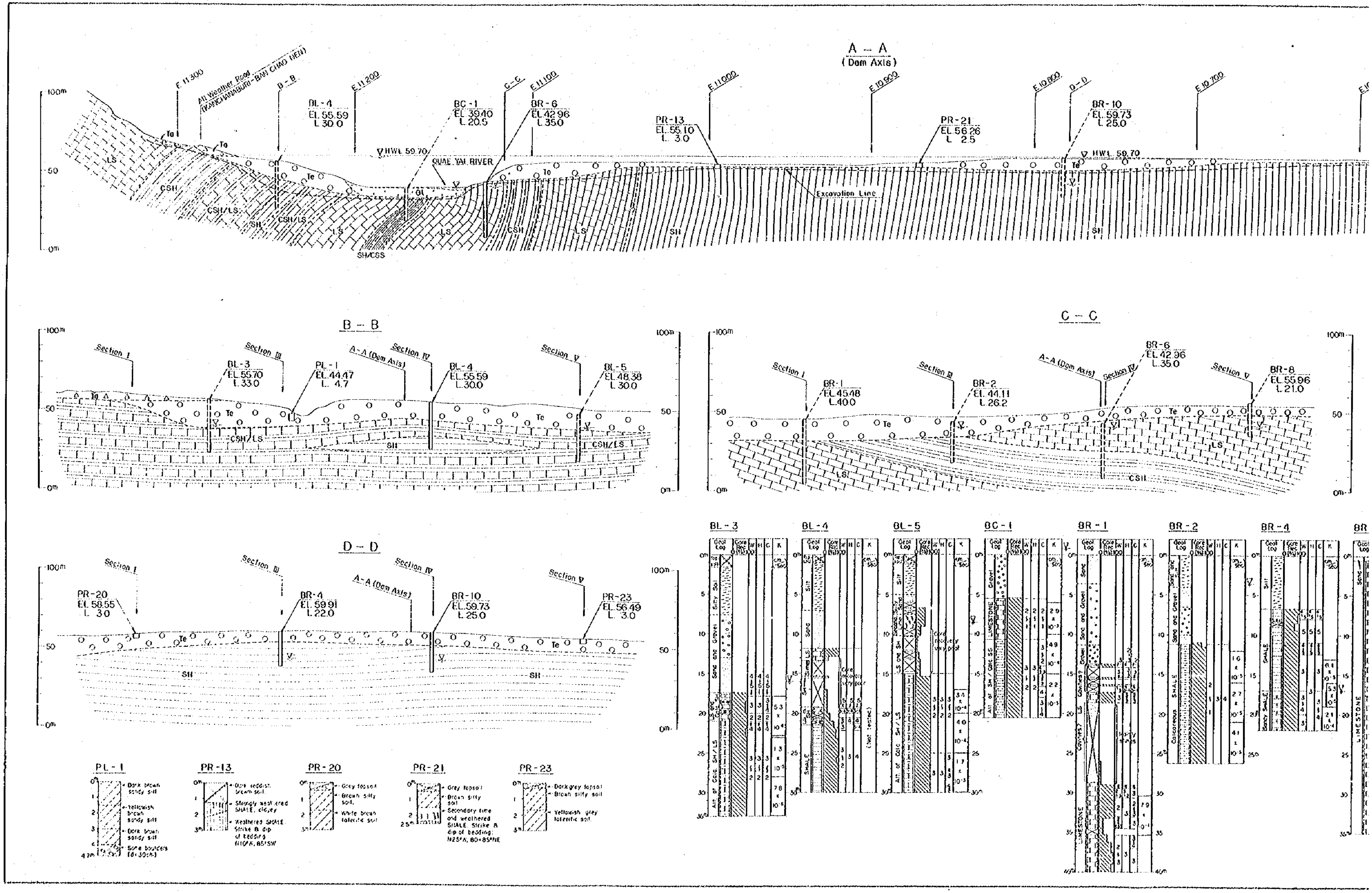
Notes

○ This geologic plan is mainly based on the report "Geological Investigation of Reservoir Area, Quoe Yai No.1 Project, 1972 by EPDC" and additional latest informations by survey team.

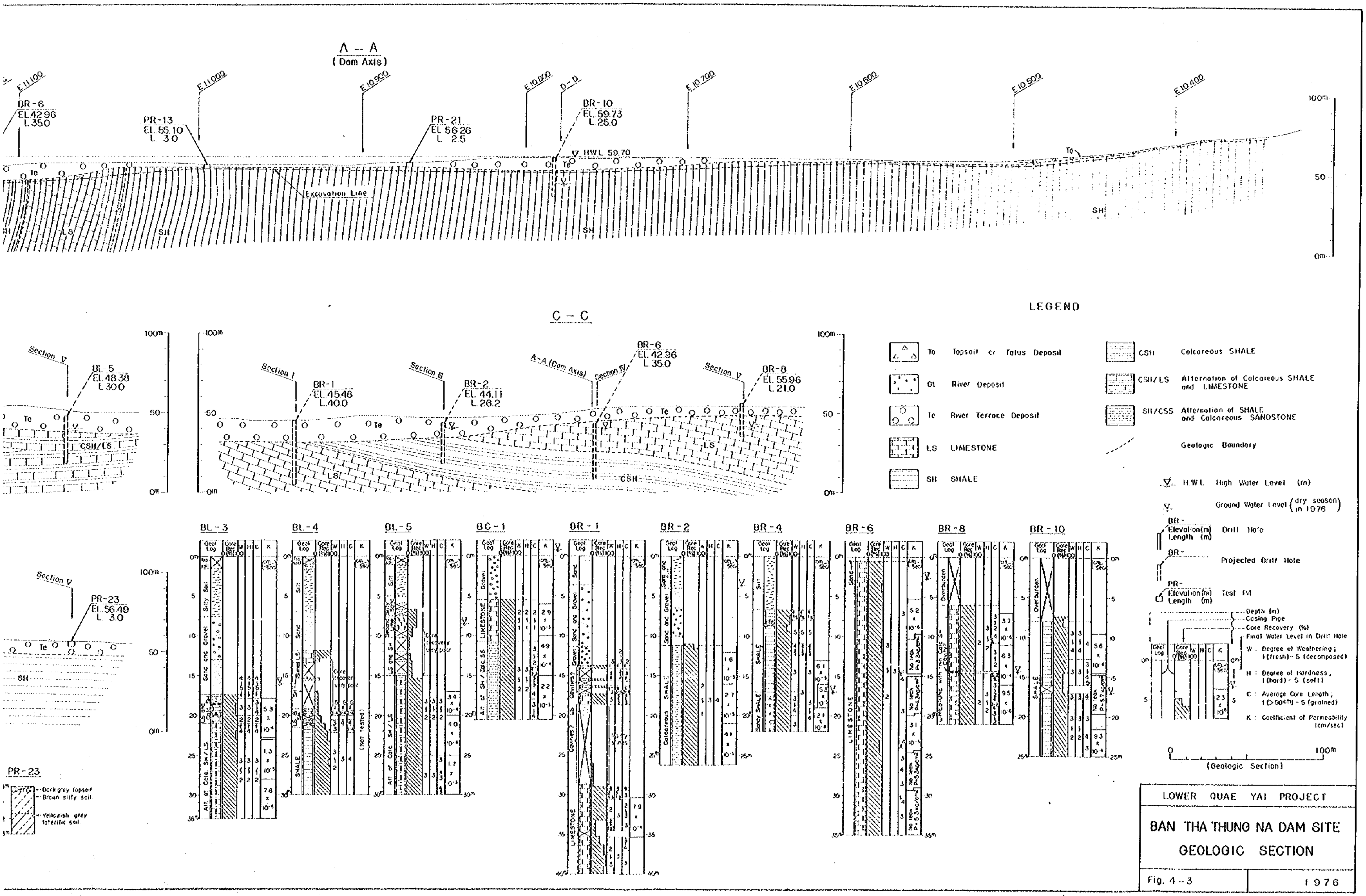
○ * Refer to respective informations in this report.

LOWER QUAE YAI PROJECT	
GENERAL GEOLOGIC PLAN	
Fig. 4-1	1976


LEGEND
To Topsoil or Talus Deposit
Gl River Deposit
Te River Terrace Deposit
LS LIMESTONE
CSH Calcareous SHALE
SH SHALE
MS Metasedimentary Rock
Strike and Dip of Stratum
Assumed Fault
Geologic Boundary
Spring (water sampling No.)
Drill Hole
Test Pit
Geologic Section Line
Surveyed Station and Traverse
Bench Mark
All Weather Road
Footpath
Dwelling House
QUAE YAI RIVER
Section I
Section II
Section IV
Section V
LOWER QUAE YAI PROJECT
BAN THA THUNG NA DAM SITE
GEOLOGIC PLAN
Fig. 4-2
1976



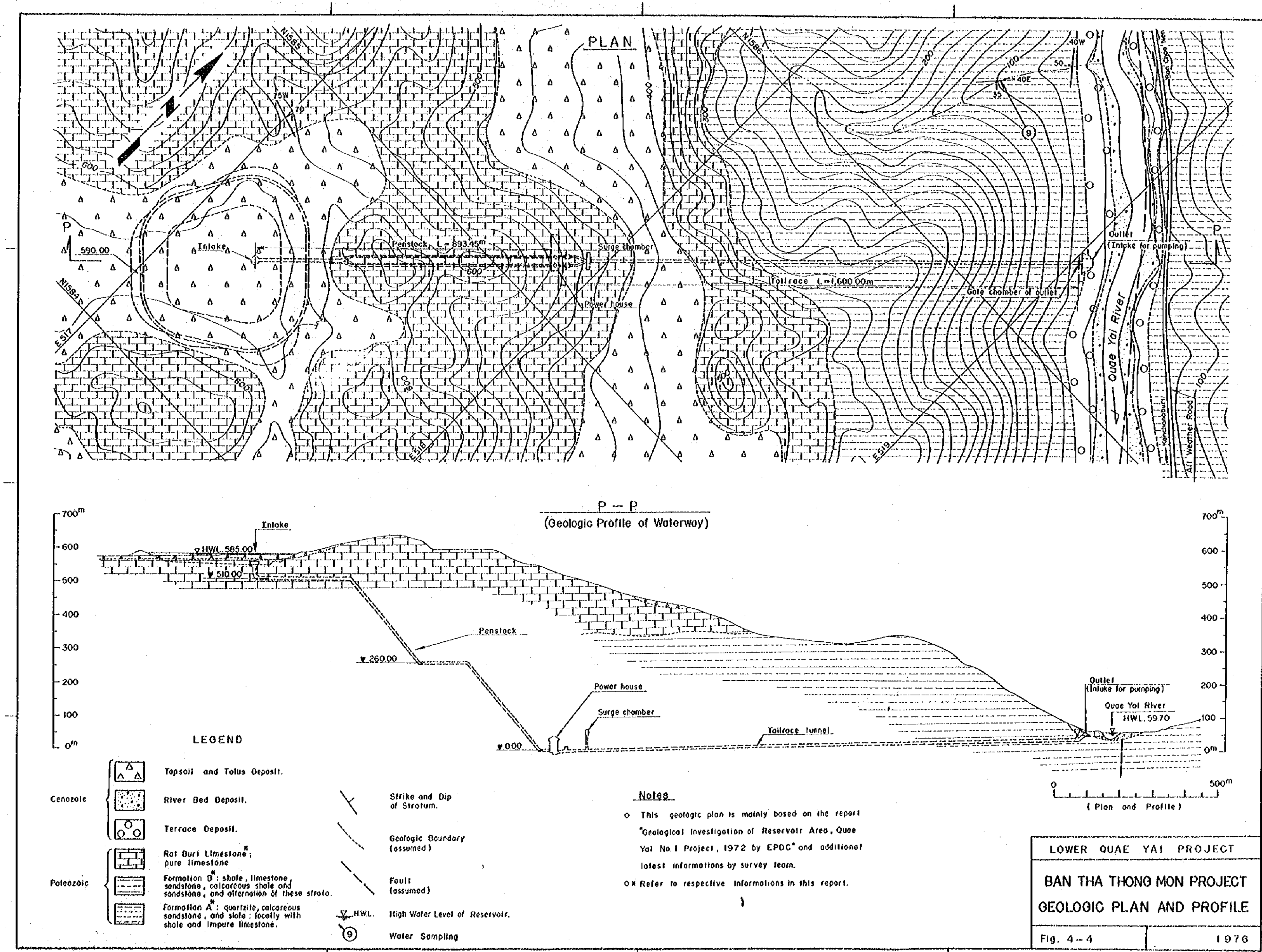
A – A
(Dam Axis)
E 11,300
All Weather Road (KANCHANABURI - BAN CHAO NEN)
B – B
E 11,200
BL - 4
EL 55.59
L 30.0
BC - 1
EL 39.40
L 20.5
C – C
E 11,100
BR - 6
EL 42.96
L 35.0
E 11,000
PR - 13
EL 55.10
L 3.0
E 10,900
PR - 21
EL 56.26
L 2.5
E 10,800
D – D
BR - 10
EL 59.73
L 25.0
E 10,700
HWL 59.70
QUAE YAI RIVER
Excavation Line
LS
CSH
CSH/LS
SH
SH/CSS
Te
Ta
Ql
B – B
Section I
Section III
A-A (Dam Axis)
Section IV
Section V
BL - 3
EL 55.70
L 33.0
PL - 1
EL 44.47
L 4.7
BL - 5
EL 48.38
L 30.0
C – C
BR - 1
EL 45.48
L 40.0
BR - 2
EL 44.11
L 26.2
BR - 8
EL 55.96
L 21.0
D – D
PR - 20
EL 58.55
L 3.0
BR - 4
EL 59.91
L 22.0
PR - 23
EL 56.49
L 3.0
PL - 1
Dark brown sandy silt
Yellowish brown sandy silt
Dark brown sandy silt
Some boulders (6÷30cm)
PR - 13
Dark reddish brown soil
Strongly weathered SHALE, clayey
Weathered SHALE. Strike & dip of bedding: N10°W, 85°SW
PR - 20
Grey topsoil
Brown silty soil
White brown lateritic soil
PR - 21
Grey topsoil
Brown silty soil
Secondary lime and weathered SHALE. Strike & dip of bedding: N25°W, 80÷85°NE
PR - 23
Dark grey topsoil
Brown silty soil
Yellowish grey lateritic soil
BL - 3
BL - 4
BL - 5
BC - 1
BR - 1
BR - 2
BR - 4
BR
Geol Log
Core Rec
W
H
C
K
Silty Soil
Sand and Gravel
Alt. of Calc. SH / LS
Silt
Sand
SHALE
(Not tested)
Core recovery very poor
LIMESTONE
Alt. of SH / Calc. SS
Sand and Gravel
Cavities?
Calcareous SHALE
Sandy SHALE

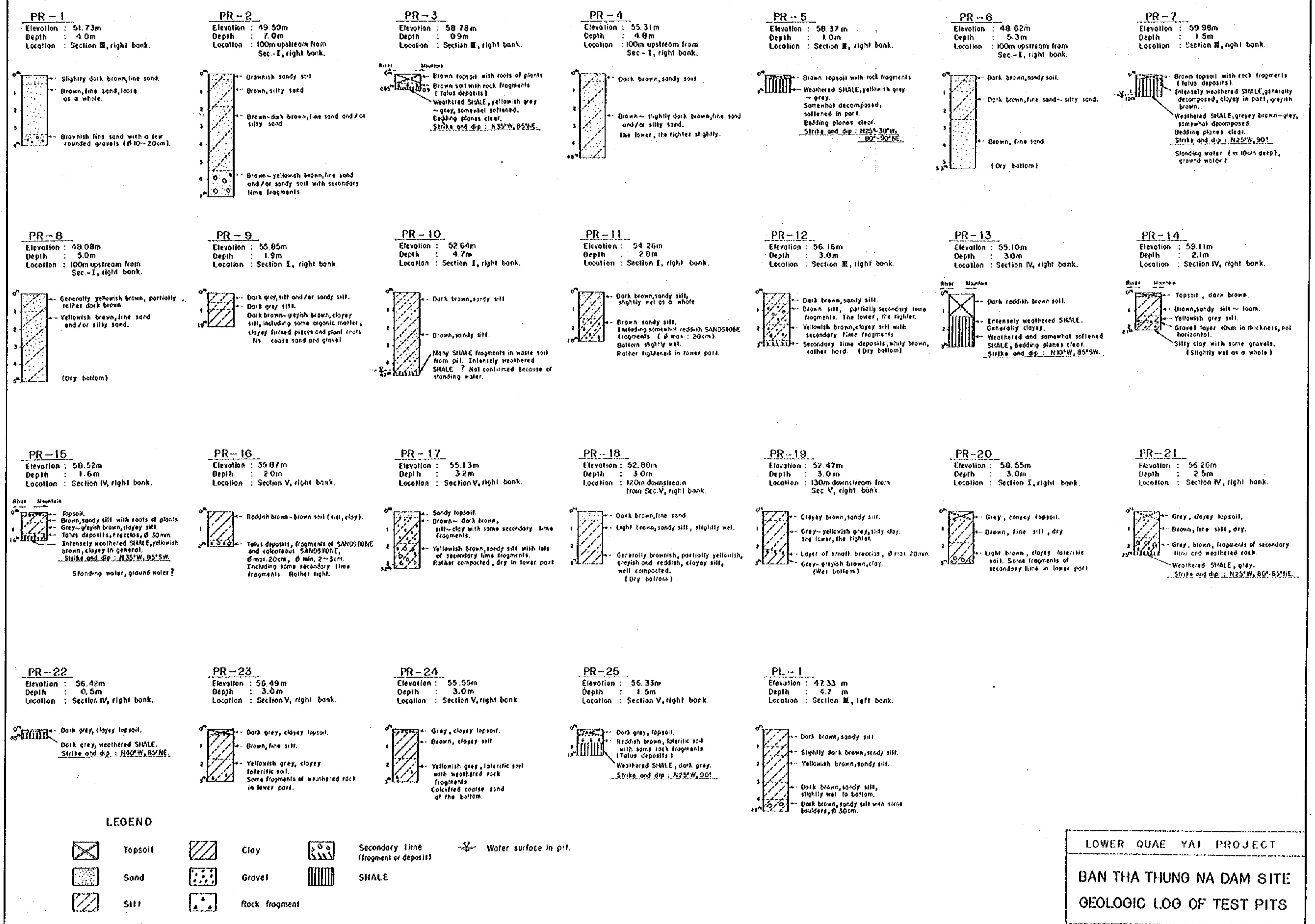


LOWER QUAE YAI PROJECT

BAN THA THUNG NA DAM SITE GEOLOGIC SECTION

Fig. 4-3 1976


PLAN
Intake
Penstock L=893.45m
Surge chamber
Power house
Tailrace L=1,600.00m
Gate chamber of outlet
Outlet
(Intake for pumping)
Quae Yai River
All Weather Road
590.00
P – P
(Geologic Profile of Waterway)
Intake
HWL 585.00
510.00
Penstock
260.00
Power house
Surge chamber
Tailrace tunnel
0.00
Outlet
(Intake for pumping)
Quae Yai River
HWL 59.70
700m
600
500
400
300
200
100
0m
0
500m
(Plan and Profile)
LEGEND
Cenozoic
Topsoil and Talus Deposit.
River Bed Deposit.
Terrace Deposit.
Paleozoic
Rat Buri Limestone*; pure limestone
Formation B*: shale, limestone, sandstone, calcareous shale and sandstone, and alternation of these strata.
Formation A*: quartzite, calcareous sandstone, and slate: locally with shale and impure limestone.
Strike and Dip of Stratum.
Geologic Boundary (assumed)
Fault (assumed)
HWL. High Water Level of Reservoir.
Water Sampling
Notes
o This geologic plan is mainly based on the report "Geological Investigation of Reservoir Area, Quae Yai No.1 Project, 1972 by EPDC" and additional latest informations by survey team.
o * Refer to respective informations in this report.
LOWER QUAE YAI PROJECT
BAN THA THONG MON PROJECT
GEOLOGIC PLAN AND PROFILE
Fig. 4-4
1976



LOWER QUAE YAI PROJECT

BAN THA THUNG NA DAM SITE
GEOLOGIC LOG OF TEST PITS

Fig. 4-5 | 1976

CHAPTER 5 HYDROLOGY

5.1 General

The Quae Yai River which is one of the biggest rivers in Thailand with a total length of about 380km and catchment area of 14,800km^2 originates in the mountainous area on the border of north-western Thailand and Burma, flows down southward and is called the Mae Klong River after it merges with the Quae Noi River in the vicinity of Kanchanaburi and finally empties into the Gulf of Thailand at about 100km west of Bangkok. Most part of the drainage basin is mountainous area covered with thick forest and the upper part of the river forms a deep gorge with steep gradient. However, in the lower basin near the Ban Tha Thung Na dam site, the river becomes wide with gentle gradient and on the terraces along the river there are corn, sugar cane and fruit plantations, bamboo groves, settlements and schools. An asphalt paved road is constructed on the left bank of the river from the Ban Chao Nen project site to Ban Lat Ya which leads to Bangkok through Kanchanaburi. People living along the banks of the river use the water for all purposes and cross the river by small boats. There are also sight-seeing boats cruising between Kanchanaburi and the Erawan Fall located approximately 25km upstream of the Ban Tha Thung Na dam site. The Ban Tha Thung Na site with a catchment area of 11,428km^2 is at mid point, 60km, between Kanchanaburi and the Ban Chao Nen project which is under construction.

5.2 Meteorology and hydrology

Annual average temperature in this tropical area is approximately 28°C and annual rainfall in the upper and lower basins are about 1,600mm and 1,000mm, respectively. Annual inflow and average discharge at the Ban Tha Thung Na site are approximately 4,400 x 10^{6}m^3 and 140m^3/sec respectively. Normally, river discharge gradually increases from May reaching its maximum in August through October, and thereafter decreases recording the minimum value in March or April. Monthly average temperature, rainfall and river discharge records are as shown in Figs. 5-1, 5-2 and Table 5-3 (2). Total runoff within three months of August to October and six months of June to November accounts for 60 percent and 85 percent of the annual runoff dividing a year clearly into dry and wet seasons. Rating curve measured at the site is as shown in Fig. 5-3.

5.3 Runoff at Ban Tha Thung Na site

After completion of the Ban Chao Nen project, inflow at the Ban Tha Thung Na dam site is calculated as a total sum of power discharge of the Ban Chao Nen power plant and runoff from residual basin between the Ban Chao Nen and Ban Tha Thung Na projects.

5.3.1 Monthly average power discharge of Ban Chao Nen power plant

The Ban Chao Nen reservoir (HWL 180.00m, LWL 159.00m RWL 178.50m) is to be so operated as to seasonally regulate annual inflow in consideration of irrigation, navigation and other requirements during dry season in the downstream area and, accordingly, power discharge of the Ban Chao Nen power plant is inevitably controlled by the said operation plan. Four cases of Ban Chao Nen reservoir operation plans were previously studied as shown in Table 5-1 and mean value deducted therefrom for each month is taken as the monthly average power discharge of the Ban Chao Nen power plant as shown in Tables 5-1 and 5-3 (4).

5.3.2 Runoff from residual basin

Runoff from residual basin is calculated by the following formula and on the basis of runoff records at the Ban Chao Nen site shown in Fig. 5-2.

$$Q_X = Q_B \cdot \frac{A_X}{A_B} \cdot \alpha \quad , \quad Q_{XR} = Q_X - Q_B$$

where,

- Q_X : Runoff at site having catchment area of A_X (m^3/sec)
- Q_B : Runoff at Ban Chao Nen site (m^3/sec)
- A_X : Catchment area at site X (km^2)
- A_B : Catchment area at Ban Chao Nen site (10,880 km^2)
- α : Coefficient shown in Fig. 5-4 (quoted from Basic Study of Quae Yai No. 1 Hydroelectric Project, 1968). This coefficient was estimated by setting up a cardinal point on records of Kang Rieng gaging station and adopted in this calculation without modification because of the short distance between Ban Chao Nen project and the said gaging station.
- Q_{XR} : Runoff from residual basin at site X (m^3/sec)

Figures shown in Table 5-3 (3) are the calculated runoff at the Ban Tha Thung Na dam site from residual basin.

5.3.3 Evaporation

Following monthly net evaporation losses estimated in the Feasibility Report, Quae Yai No. 1 Hydroelectric Project are quoted.

Month	Evaporation (mm)	Month	Evaporation (mm)
Jan.	-103.9	July	-18.0
Feb.	-97.2	Aug.	-14.6
Mar.	-107.4	Sept.	-49.1
Apr.	-91.4	Oct.	-50.4
May	-6.2	Nov.	-23.3
June	-29.0	Dec.	-81.9

Evaporation losses calculated at the time of mean water level (57.60m) of the Ban Tha Thung Na regulating reservoir are as shown in Table 5-3 (6).

5.3.4 Runoff at the site

River runoff at the Ban Tha Thung Na dam site, that is, available power discharge of the Ban Tha Thung Na power plant is as shown in Table 5-3 (7).

5.4 Flood discharge at Ban Tha Thung Na dam site

Flood discharge at the Ban Tha Thung Na dam site is calculated as a total of spilled water regulated by the Ban Chao Nen reservoir and natural flood discharge from residual basin. The design flood of 2,580 m^3/sec at the Ban Chao Nen dam site estimated on the basis of flood hydrograph with maximum discharge of 7,100 m^3/sec is planned to be released through spillway structure (2,420 m^3/sec) and outlet works (160 m^3/sec) as shown in Fig. 5-5. The maximum spill at the Ban Chao Nen dam on the basis of the flood hydrograph computed from rainfall records on October 1963 occurs eight days after maximum daily rainfall as observed in Fig. 5-5 and, on the contrary, peak flood from residual basin is considered to occur within a short time after maximum hourly rainfall and there is big time lag between these two. Taking these circumstances into consideration, the maximum flood discharge at this site was studied on the basis of the above-mentioned rainfall records for the next two cases, that is, at the time of peak flood from residual basin and maximum spill at the Ban Chao Nen dam.

5.4.1 Time of concentration and maximum flood discharge

Time of concentration (tp) is estimated by the Linsley Kohler and Paulher formula,

$$tp = Ct \left(\frac{L \cdot Lc}{\sqrt{s}} \right) 0.38 = 10 \text{ (Hr)}$$

where,

tp : Time of concentration (Hr)

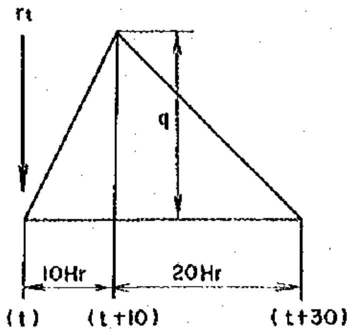
Ct : Coefficient corresponding to natural conditions in drainage basin, 0.35

L : Length of main stream in the basin, 31.4 miles

Lc : Distance between project site and center of drainage basin, 13 miles

s : Mean gradient of main stream (1 : 300)

It is estimated that flood discharge caused by hourly rainfall r_t observed at certain time t will reach its maximum value at approximately 10 hours after the said rainfall.



Assuming that flood hydrograph for unit rainfall is triangular shape with 10 hours increasing period and 20 hours decreasing period as shown in the figure, the maximum flood discharge q at time t + 10 is as calculated below.

$$q = \frac{2A \times r_t}{30 \times 3,600} \times 10^3 = 10.1\, r_t \ (m^3/sec)$$

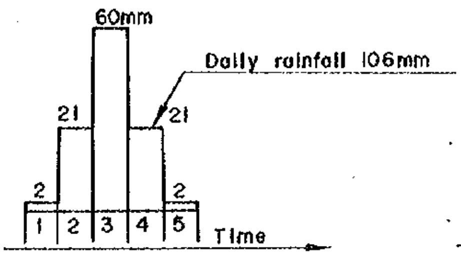
where,

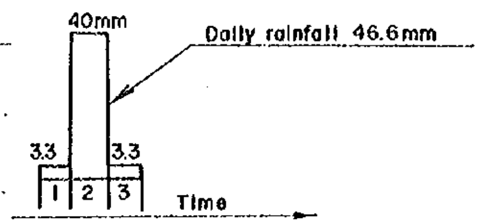
A : Residual catchment area ($548 km^2$)

r_t : Effective hourly rainfall at time t (mm)

5.4.2 Correlation between daily and hourly rainfall

Maximum flood discharge at the Ban Chao Nen dam site is estimated on the basis of daily rainfall records as shown in Fig. 5-5, however, hourly rainfall records shall be applied for the case of comparatively small catchment basin. Correlation between maximum daily and hourly rainfall obtained from the observation records from May 1973 through October 1975 is as shown in Fig. 5-6. Effective daily rainfall on the day of maximum precipitation and around the day of maximum flood release in Fig. 5-5 are 106 mm and 46.6 mm, respectively. Applying the correlation shown in Fig. 5-6, maximum hourly rainfall for these two cases are estimated to be 60 mm and 40 mm with triangular hourly distribution shown below.





5.4.3 Estimation of maximum flood discharge

The design flood discharge at the Ban Tha Thung Na dam site is estimated as follows on the basis of the above-mentioned conditions.

Case	Unit	Discharge from residual basin	Base flow	Spill at BCN	Total
Max. rainfall	(m^3/sec)	1,033	35	1,410	2,478
Max. spill	(m^3/sec)	466	35	2,290	2,791

The above-mentioned calculations are based on the rainfall records in October 1963 which is applied for design of the Ban Chao Nen dam as they form a flood hydrograph deriving therefrom the maximum flood discharge at the Ban Chao Nen dam. It is estimated that the maximum daily rainfall in the residual basin of this project will be 92.5mm taking an average of rainfall records at Kang Rieng and Sri Sawat in October, 1952. The maximum flood discharge at the Ban Chao Nen dam induced from the flood hydrograph based on this rainfall record is smaller than that above-mentioned, however, it figures the maximum flood discharge from the residual basin. The results of calculations are shown below.

	Unit	Discharge from residual basin	Base flow	Spill at BCN	Total
Max. rainfall	(m^3/sec)	1,190	9	1,380	2,579
Max. spill	(m^3/sec)	300	9	2,210	2,519

Besides, the following alternative calculations are made for reference.

(a) Estimation by proportional allotment of catchment area

Catchment area at Ban Chao Nen site	:	10,880km^2
Max. flood discharge at Ban Chao Nen site	:	7,100m^3/sec
Catchment area at Ban Tha Thung Na site	:	548km^2
Max. flood discharge from residual basin	=	$7,100 \times \frac{548}{10,880}$
	=	360m^3/sec
Max. flood discharge at Ban Tha Thung Na site	=	2,580 + 360
	=	2,940m^3/sec

(b) Estimation by envelope curve

According to Fig. 5-7 quoted from "Relationship between Max. Peak Flow and Drainage Area" in "Hydrology and Water Studies, August 1968" compiled by the Royal Irrigation Department (RID) of Thailand, maximum flood discharge for residual catchment area of 548km^2 is estimated to be approximately 430m^3/sec and, accordingly, maximum flood discharge at the Ban Tha Thung Na dam site will be approximately 3,010m^3/sec.

Taking these estimations into consideration, the design flood discharge at the Ban Tha Thung Na dam site is decided to be 3,000 m^3/sec, and 2,710 m^3/sec and 290 m^3/sec shall be released through spillway structure and power plant, respectively.

5.5 Sedimentation in regulating reservoir

It is considered that all of suspended sediments and bed loads in the area upstream of the Ban Chao Nen dam which creates an extremely big reservoir will be caught and deposited in the said reservoir. Therefore, it is considered appropriate to study the sedimentation problem by suspended sedimants and bed load from residual basin only for the Ban Tha Thung Na reservoir. Suspended sediment discharge measured by EGAT at the Ban Chao Nen site is as shown in Appendix (D) and it is observed that the amount of suspended sediment contained in river flow varies remarkably in proportion with river discharge and increases rapidly for bigger discharge. According to Table 5-4 induced from Appendix (D), it seems that more than 80 percent of annual suspended sediment will be carried down when the river flow is more than $500 m^3/sec$.

Fig. 5-8 drawn on the basis of field investigation in 1972 and 1973 shows the correlation between river flow of more than $500 m^3/sec$ and corresponding amount of suspended sediment discharge, and annual suspended sediment for each year is estimated to be as shown in Table 5-5 applying unit content of suspended sediment per various river flow in Fig. 5-8 and daily runoff records separately prepared. For the case of river flow of less than $500 m^3/sec$, the unit content of suspended sediment assumed from Table 5-4 is 0.169×10^{-3} tons per unit river discharge. Then it can be estimated that the total amount of suspended sediment trasported into the reservoir will be approximately $146,000 m^3/year$ or 190,000 tons/year at bulk specific gravity of $1.3t/m^3$. Beside the above, there is bed load which is estimated to be probably 10 percent of the above-mentioned suspended sediment or equivalent to $15,000 m^3/year$.

Some part of suspended sediment will deposit in the reservoir and the remaining will flow down over the spillway crest, and its percentage varies corresponding to the ratio of reservoir storage capacity and annual inflow as shown in Fig. 5-9 which is a method devised by G.M. Brune. At the Ban Tha Thung Na reservoir, approximately 62 percent of total suspended sediment equivalent to $100,000 m^3/year$ will deposit in the reservoir and the remaining 38 percent will flow down.

The gross sedimentation in the Ban Tha Thung Na reservoir in 100 years is estimated to be approximately $10.0 \times 10^6 m^3$ or 20 percent of the reservoir storage capacity.

Table 5-1 Power Discharge of Ban Chao Nen Project

Unit in MCM, ( ) in m^3/sec

	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Case 1	666.8 (257.3)	305.7 (114.1)	268.0 (103.4)	218.9 (81.7)	234.0 (87.4)	255.4 (98.5)	355.9 (132.9)	313.4 (120.9)	229.4 (85.6)	283.2 (105.7)	502.7 (207.8)	775.3 (289.5)	4,408.7
Case 2	666.8 (257.3)	305.0 (113.9)	270.4 (104.3)	220.5 (82.3)	207.7 (77.5)	213.6 (82.4)	356.3 (133.0)	310.6 (119.8)	225.8 (85.6)	281.7 (105.2)	502.7 (207.8)	775.3 (289.5)	4,336.4
Case 3	666.8 (257.3)	304.9 (113.8)	263.0 (101.5)	214.6 (80.1)	197.6 (73.8)	191.7 (74.0)	275.0 (102.7)	308.9 (119.2)	216.9 (81.0)	281.7 (105.2)	502.7 (207.8)	775.3 (289.5)	4,199.1
Case 4	666.8 (257.3)	305.0 (113.9)	260.5 (100.5)	210.6 (78.6)	201.4 (75.2)	225.0 (86.8)	326.9 (122.1)	313.7 (121.0)	230.5 (86.1)	281.3 (105.0)	502.7 (207.8)	775.3 (289.5)	4,299.7
Average	666.8 (257.3)	305.2 (113.9)	265.5 (102.4)	216.2 (80.7)	210.2 (78.5)	221.4 (85.4)	328.5 (122.7)	311.7 (120.2)	225.7 (84.3)	282.0 (105.3)	502.7 (207.8)	775.3 (289.5)	4,311.2 (137.3)

Note: Case 1 : Qin 1952, Case 2 : Qin 1957,

Case 3 : Qin 1963, Case 4 : Qin 1968,

Ex. Qin 1952 indicates 20 year hydrological cycle starting 1952

Table 5-2 Runoff Record at Ban Chao Nen Project

Year	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
1952	69.9	77.7	160.7	350.9	752.6	510.6	1,328.5	523.6	198.2	133.9	118.5	107.1	4,332.2
1953	90.7	144.6	269.6	739.2	2,370.4	1,257.1	1,007.1	795.4	364.3	230.3	152.4	128.6	7,549.7
1954	101.1	185.7	279.4	385.7	605.3	889.1	924.1	292.9	182.1	101.8	75.0	64.3	4,086.5
1955	75.2	88.4	139.9	278.6	310.7	819.1	565.1	355.1	160.7	104.5	67.6	56.3	3,021.2
1956	77.8	216.9	199.6	329.4	637.5	904.6	835.7	305.7	187.5	139.3	82.3	66.9	3,983.2
1957	59.6	42.9	165.9	318.7	883.9	1,060.1	1,333.8	308.5	163.4	112.5	72.6	58.9	4,580.8
1958	59.6	77.7	171.1	573.2	533.0	1,156.0	728.5	266.9	149.9	101.8	65.3	56.3	3,939.3
1959	54.4	83.0	145.2	227.7	575.9	844.9	1,459.7	287.7	155.4	101.8	67.7	50.9	4,054.3
1960	46.7	72.3	80.4	101.8	583.9	451.0	827.6	230.7	187.5	96.4	65.3	53.6	2,797.2
1961	44.1	128.6	254.0	942.8	1,968.6	1,959.6	1,071.4	425.1	222.3	152.7	99.2	85.7	7,354.1
1962	75.2	96.4	176.3	439.3	886.6	1,620.0	956.2	287.7	163.4	107.1	65.3	58.9	4,932.4
1963	41.5	34.8	98.5	530.3	798.2	1,223.4	1,826.7	544.3	233.0	144.6	91.9	72.3	5,639.5
1964	72.6	174.1	165.9	334.8	591.9	787.9	1,457.1	445.8	241.1	147.3	101.6	112.5	4,632.6
1965	82.9	131.2	463.9	666.9	816.9	585.2	720.5	277.3	155.4	115.2	87.1	69.6	4,172.1
1966	64.8	112.5	204.8	423.2	634.8	1,049.8	583.9	246.2	166.1	115.2	75.0	61.6	3,737.9
1967	85.3	107.0	105.0	238.0	857.0	816.0	786.0	258.0	156.0	15.0	93.3	87.3	3,603.9
1968	93.3	140.0	119.0	259.0	845.0	613.0	440.0	168.0	118.0	104.0	84.2	85.7	3,069.2
1969	40.0	71.6	108.0	361.0	1,090.0	1,050.0	702.0	358.0	158.0	113.0	75.2	58.6	4,185.4
1970	53.3	80.5	128.0	364.0	658.0	753.0	765.0	399.0	250.0	125.0	72.8	62.3	3,710.9
1971	75.5	102.0	274.0	696.0	640.0	655.0	476.0	267.0	140.0	101.0	70.4	58.8	3,555.7
Average	68.2	108.4	185.5	428.0	852.0	950.3	939.7	352.1	187.6	118.1	84.1	72.8	4,346.9
	(26.3)	(40.5)	(71.6)	(159.8)	(318.1)	(366.6)	(350.8)	(135.8)	(70.0)	(44.1)	(34.8)	(27.2)	(137.8)

Note: Unit in MCM, ( ) in m^3/sec

Table 5-3 Discharge at Ban Tha Thung Na Project

(Unit: m^3/sec)

Month	Inflow at BCN (1)	Inflow at BTTN (2)	Residual discharge betw. BCN & BTTN (3)	Power discharge of BCN (4)	Total inflow at BTTN (5)	Evaporation (6)	Power discharge of BTTN (7)
Apr.	26. 3	26. 8	0. 5	257.3	257. 8	-0. 2	257. 6
May	40. 5	41. 3	0. 8	113. 9	114. 7	0	114. 7
June	71. 6	73. 0	1. 4	102. 4	103. 8	-0. 1	103. 7
July	159. 8	162. 8	3..0	80. 7	83. 7	0	83. 7
Aug.	318. 1	324. 1	6. 0	78. 5	84. 5	0	84. 5
Sept.	366. 6	373. 6	7. 0	85. 4	92. 4	+0. 1	92. 5
Oct.	350. 8	357. 5	6. 7	122. 7	129. 3	+0. 1	129. 4
Nov.	135. 8	138. 5	2. 6	120. 2	122. 8	-0. 1	122. 7
Dec.	70. 0	71. 3	1. 3	84. 3	85. 7	-0. 2	85. 5
Jan.	44. 1	44. 9	0. 8	105. 3	106. 1	-0. 2	105. 9
Feb.	34. 8	35. 5	0. 7	207. 8	208. 5	-0. 2	208. 3
Mar.	27. 2	27. 7	0. 5	289. 5	290. 0	-0. 2	289. 8
Average	137. 1	139. 7	2. 6	137. 3	139. 9		139. 9

Note: BCN : Ban Chao Nen Project

BTTN : Ban Tha Thung Na Project

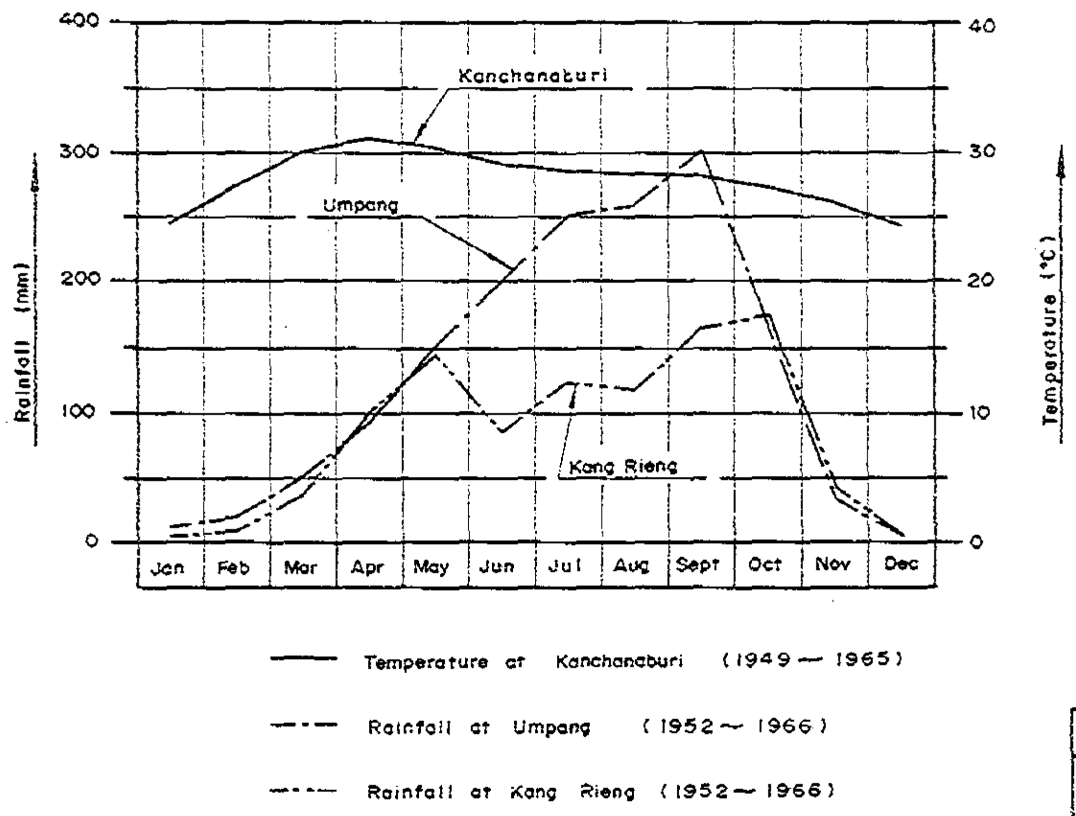
Table 5-4 Suspended Sediment at Ban Chao Nen Site

	Q< 500			500<Q<750			750<Q<1000			Q> 1000			Total	
	Runoff (10^6m^3)	Sediment (10^3t)	Sediment (%)	Runoff (10^6m^3)	Sediment (10^3t)	Sediment (%)	Runoff (10^6m^3)	Sediment (10^3t)	Sediment (%)	Runoff (10^6m^3)	Sediment (10^3t)	Sediment (%)	Runoff (10^6m^3)	Sediment (10^3t)
1972	3,681	697	13.4	1,284	806	15.5	700	757	14.6	509	2,934	56.5	6,174	5,194
1973	3,223	472	20.8	1,454	1,269	55.8	226	533	23.4	-	-	-	4,903	2,274

Table 5-5 Annual Suspended Sediment Assumed

	Runoff ($10^6 m^3$)			Sediment ($10^3 t$)			Sediment at BTTN ($10^3 t$)	Remarks
	Q<500	Q>500	Total	Q<500	Q>500	Total		
1952	3,247	1,085	4,332	549	2,686	3,235	162	Sediment per
1953	4,548	3,002	7,550	769	17,021	17,790	890	unit runoff of
1954	3,466	621	4,087	586	454	1,040	52	less than 500
1955	2,923	98	3,021	494	57	551	28	m^3/sec: 0.169
1956	3,775	208	3,983	638	144	782	39	x 10^{-3} t/m^3
1957	3,105	1,476	4,581	525	2,202	2,727	136	
1958	3,488	451	3,939	589	403	992	50	
1959	2,721	1,333	4,054	460	2,855	3,315	166	
1960	2,580	217	2,797	436	178	614	31	
1961	3,676	3,678	7,354	621	8,918	9,539	477	
1962	3,139	1,793	4,932	530	8,144	8,674	434	
1963	3,474	2,166	5,640	587	9,749	10,336	517	
1964	3,128	1,505	4,633	529	2,404	2,933	147	
1965	3,944	228	4,172	667	200	867	43	
1966	3,318	420	3,738	561	311	872	44	
1967	3,317	287	3,604	561	156	717	36	
1968	2,970	99	3,069	502	60	562	28	
1969	2,936	1,249	4,185	496	1,326	1,822	91	
1972	3,681	2,493	6,174	622	5,869	(5,194) 6,491	326	
1973	3,223	1,680	4,903	545	1,393	(2,274) 1,938	97	
Average	3,333	1,204	4,537	563	3,227	3,790	190	

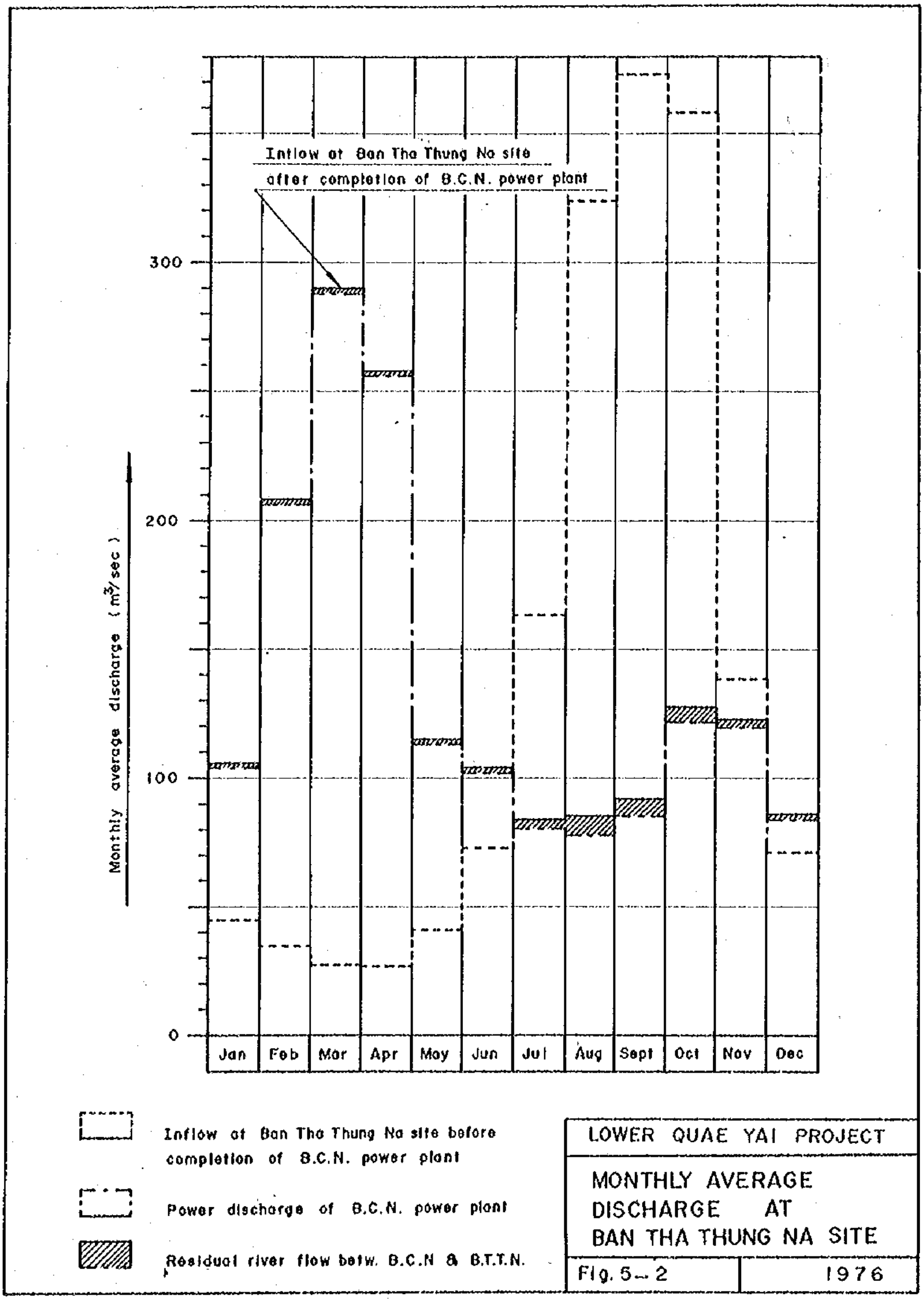
Note: ( ) sediment in Table 5-4
BTTN : Ban Tha Thung Na Project



LOWER QUAE YAI PROJECT

MONTHLY AVERAGE
TEMPERATURE & RAINFALL

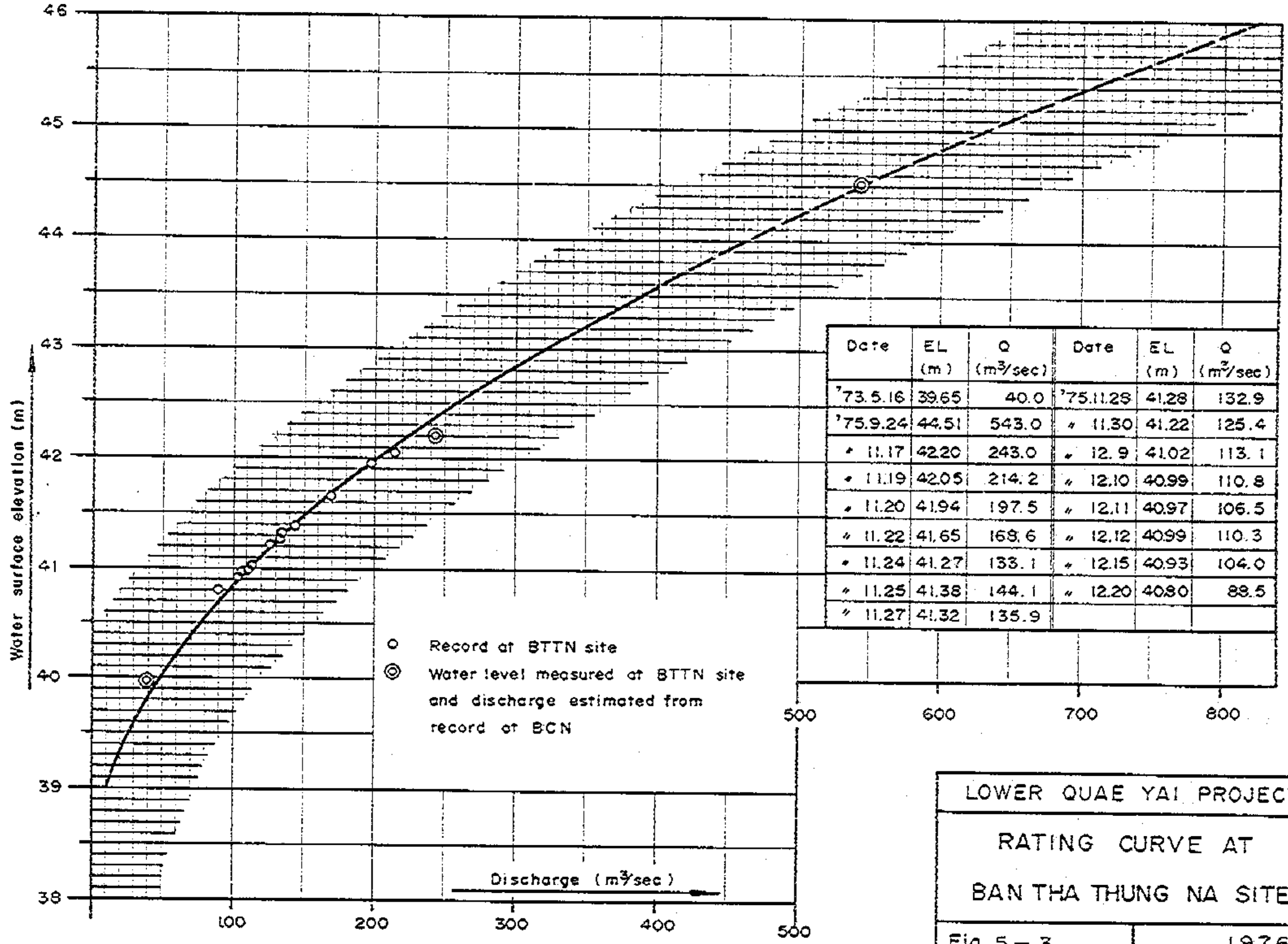
Fig. 5-1 | 1976



LOWER QUAE YAI PROJECT

MONTHLY AVERAGE DISCHARGE AT BAN THA THUNG NA SITE

Fig. 5-2	1976

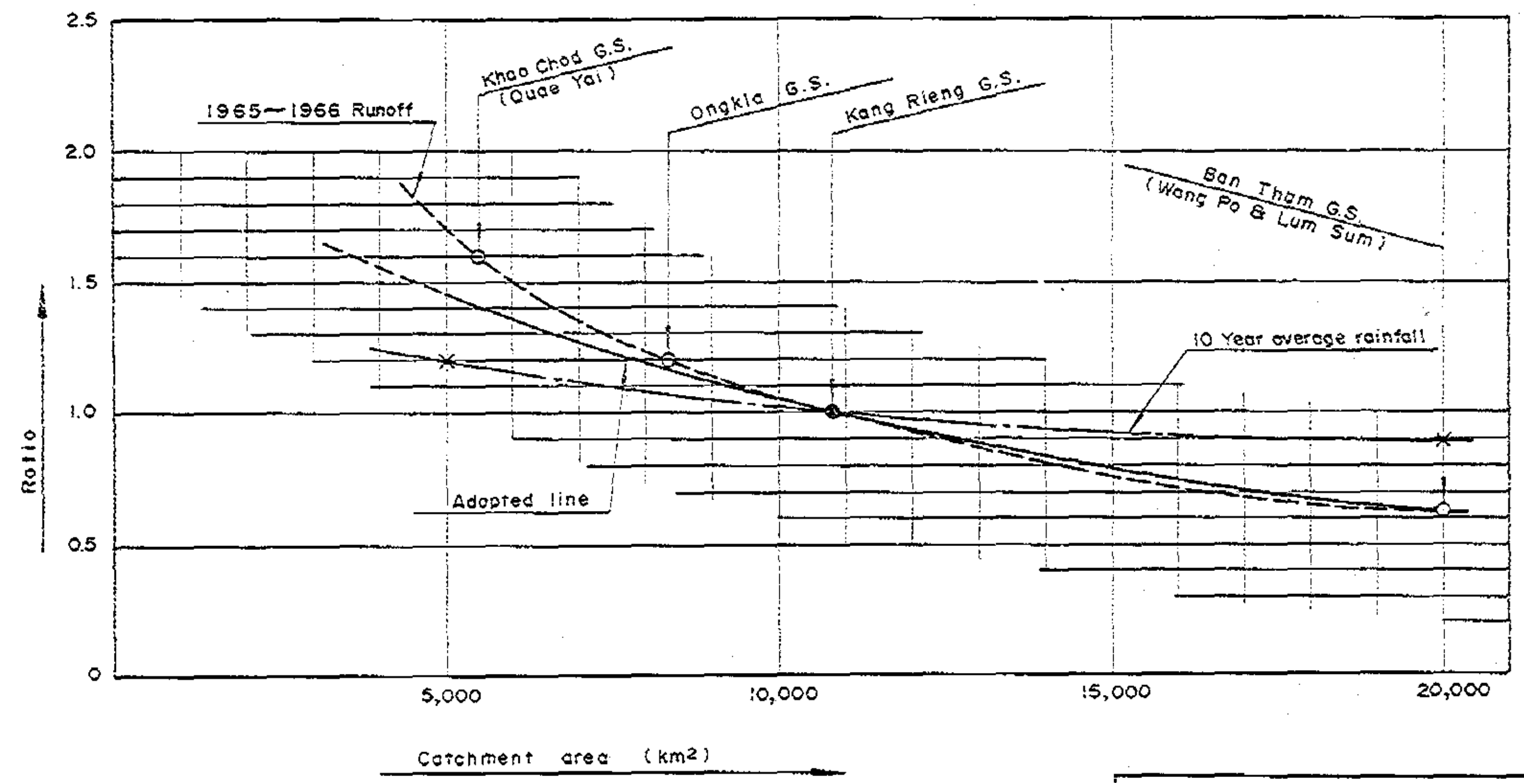


Date	EL (m)	Q (m³/sec)	Date	EL (m)	Q (m³/sec)
'73.5.16	39.65	40.0	'75.11.28	41.28	132.9
'75.9.24	44.51	543.0	〃 11.30	41.22	125.4
〃 11.17	42.20	243.0	〃 12.9	41.02	113.1
〃 11.19	42.05	214.2	〃 12.10	40.99	110.8
〃 11.20	41.94	197.5	〃 12.11	40.97	106.5
〃 11.22	41.65	168.6	〃 12.12	40.99	110.3
〃 11.24	41.27	133.1	〃 12.15	40.93	104.0
〃 11.25	41.38	144.1	〃 12.20	40.80	88.5
〃 11.27	41.32	135.9			

LOWER QUAE YAI PROJECT

RATING CURVE AT BAN THA THUNG NA SITE

Fig. 5 – 3 1976

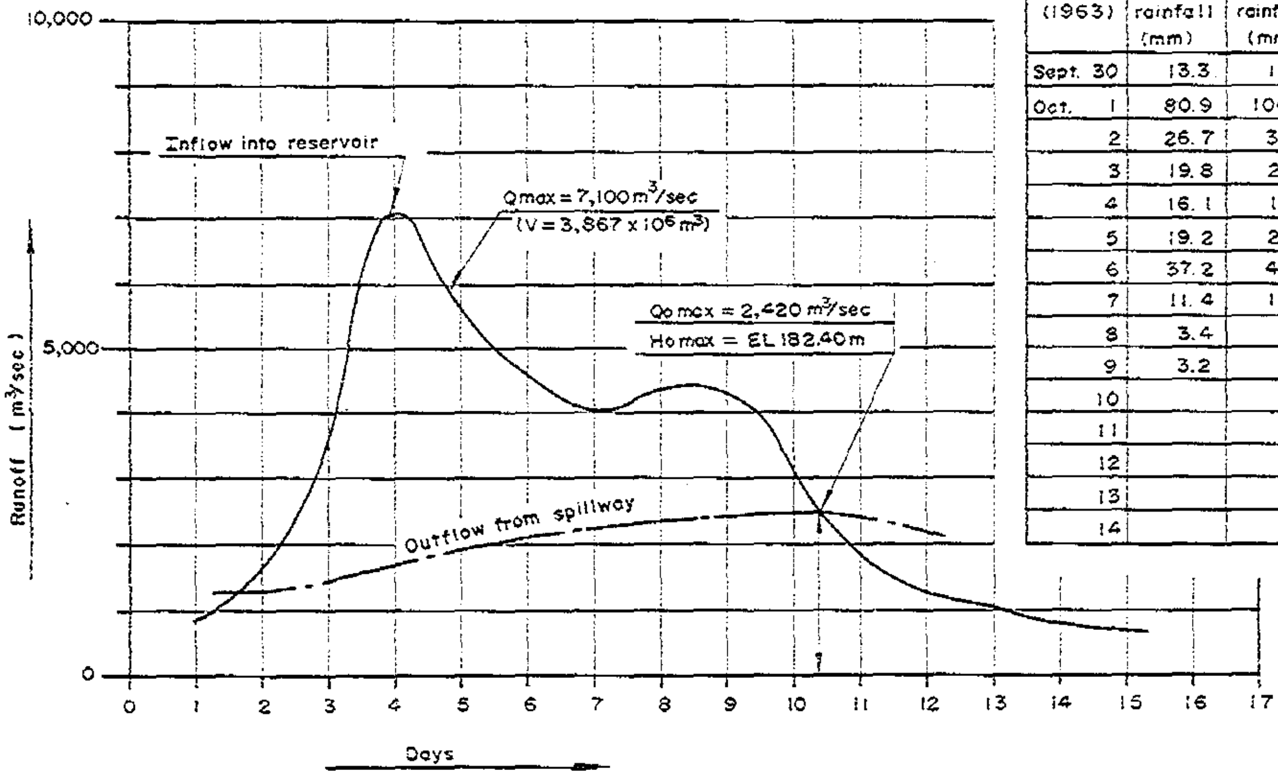


cf. Feasibility Report, Quae Yai No.1, March 1968

LOWER QUAE YAI PROJECT

RATIO OF ANNUAL RAINFALL AND SPECIFIC RUNOFF OF EACH SITE TO KANG RIENG G.S.

Fig. 5-4 1976



Date (1963)	Historical rainfall (mm)	Effective rainfall (mm)	Discharge (m^3/sec)
Sept. 30	13.3	14.1	788
Oct. 1	80.9	106.0	1,626
2	26.7	32.3	3,595
3	19.8	22.9	7,104
4	16.1	17.9	5,684
5	19.2	22.1	4,541
6	37.2	46.6	4,029
7	11.4	11.5	4,350
8	3.4	0.6	4,372
9	3.2		2,984
10			1,853
11			1,289
12			1,071
13			766
14			704

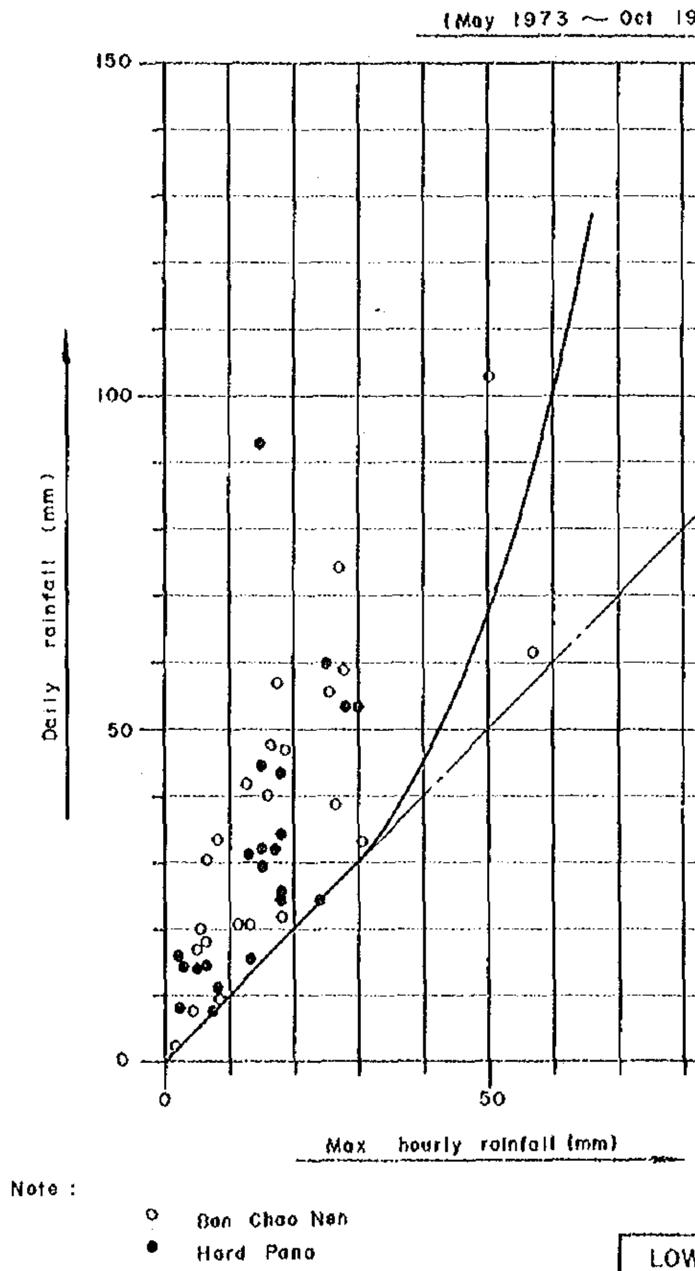
Note.

Retention water level	178.50m
Max. reservoir water level	182.40m
Outflow from spillway	2,420 m^3/sec
Outflow from outlet	160 m^3/sec

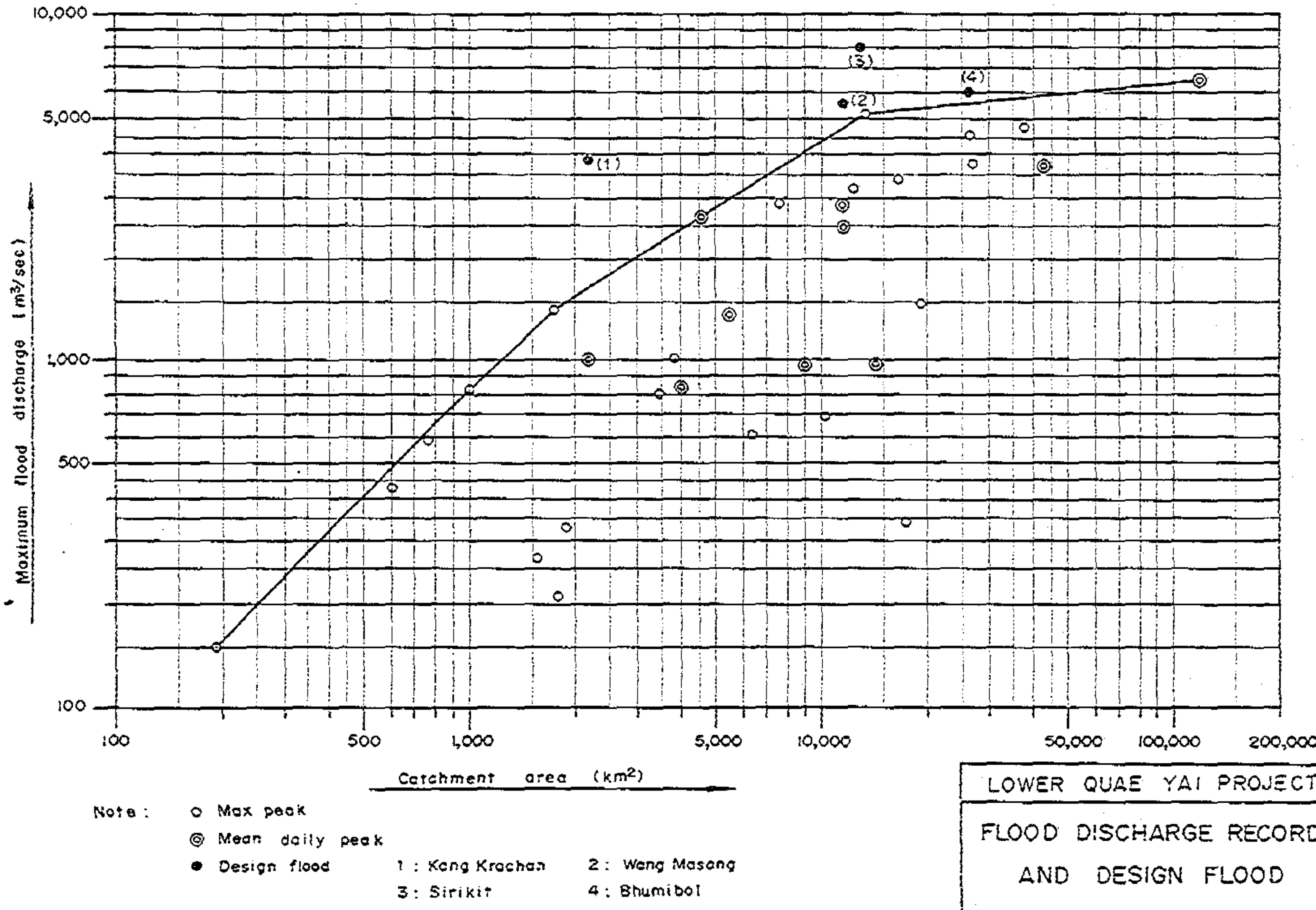
LOWER QUAE YAI PROJECT

FLOOD HYDROGRAPH OF BAN CHAO NEN PROJECT

Fig. 5-5 1976

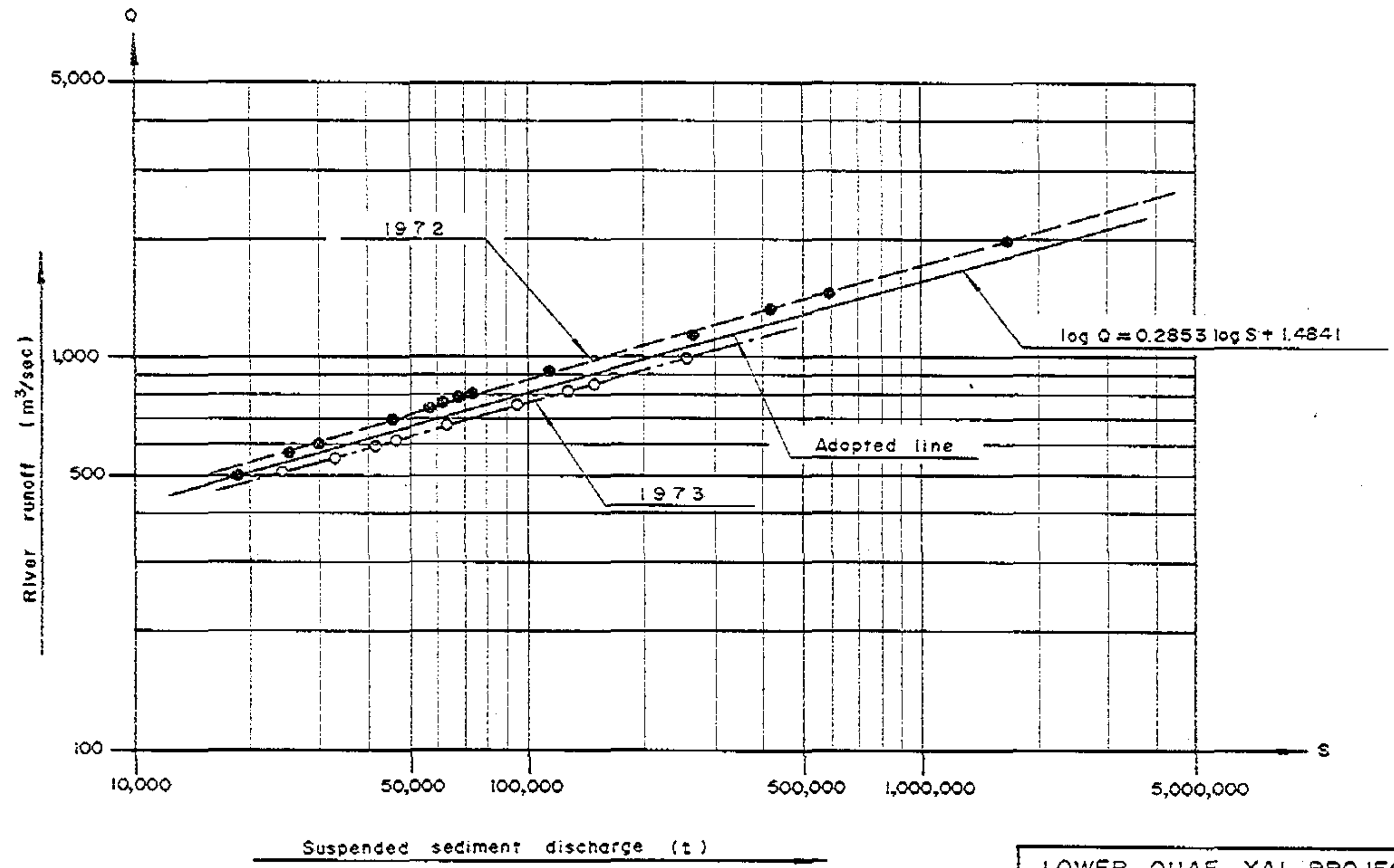


LOWER QUAE YAI PROJECT	
DAILY AND HOURLY RAINFALL	
Fig. 5 – 6	1976

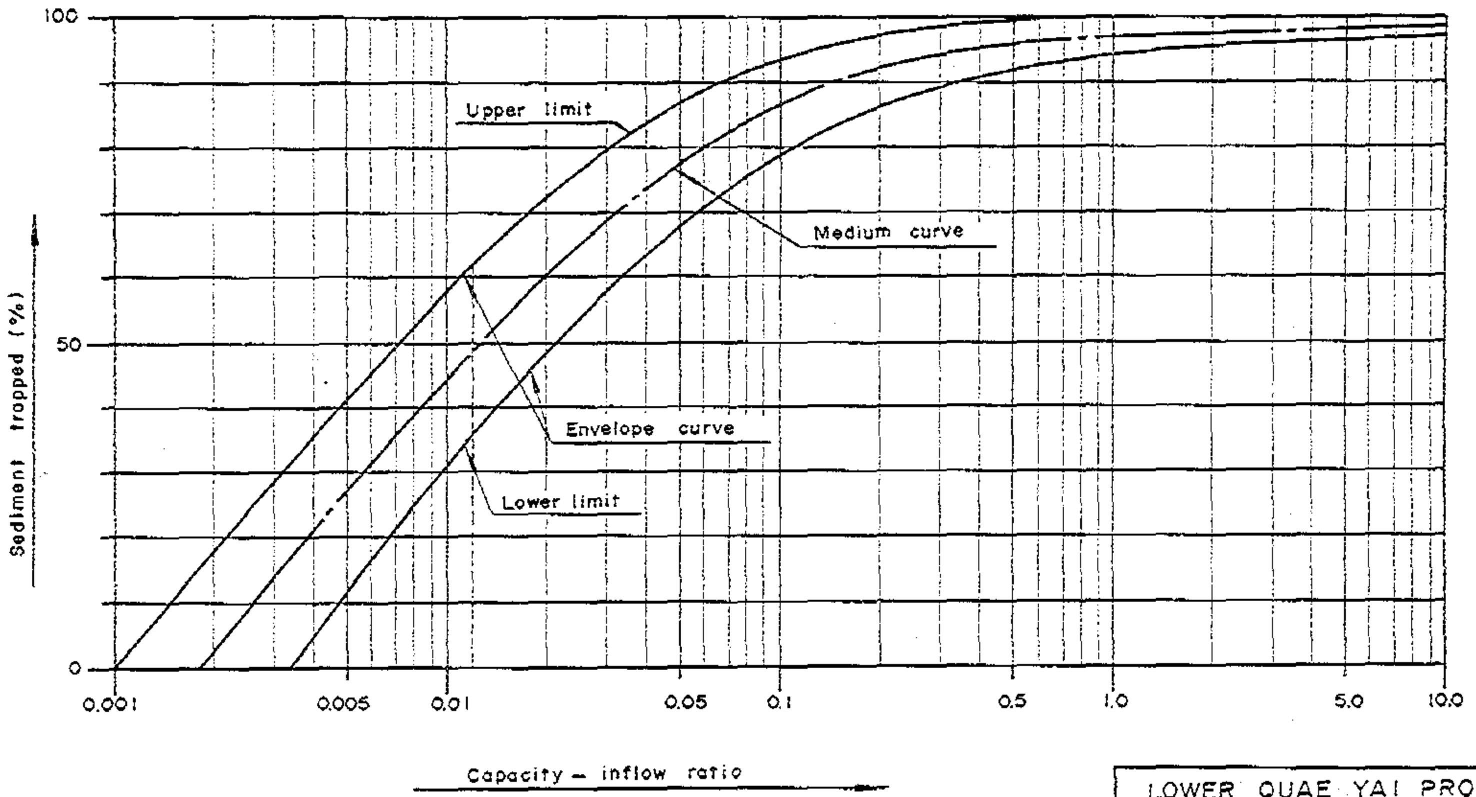


(From RID Report, Aug. 1968)

LOWER QUAE YAI PROJECT	
FLOOD DISCHARGE RECORD AND DESIGN FLOOD	
Fig. 5 – 7	1976



LOWER QUAE YAI PROJECT	
SUSPENDED SEDIMENT DISCHARGE IN RUNOFF	
Fig. 5-8	1976



$$\frac{\text{Reservoir capacity}}{\text{Annual inflow (BTTN)}} = \frac{56,400,000}{4,412,000,000} = 0.013$$

(From Handbook of Applied Hydrology)

LOWER QUAE YAI PROJECT	
SEDIMENTATION	
Fig. 5–9	1976

CHAPTER 6 BASIC PLAN OF LOWER QUAE YAI HYDRO-ELECTRIC PROJECT

6.1 General consideration

In the basic development scheme of the Quae Yai River, this is the lowest hydro-electric development project in the area downstream of the Ban Chao Nen power plant due to topographic conditions and, therefore, the development plan of this project must be to make the most efficient use of hydraulic potentials within the limit of economic justification. However, it should also be noted, in consideration of extremely large capacity of the Ban Chao Nen reservoir, that the said plan shall be inevitably governed by design conditions and operation plan of the Ban Chao Nen reservoir. Namely, the required reservoir capacity varies corresponding to peak duration of the first and second stage Ban Chao Nen power plant (360MW each, 720MW in total) and the allowable fluctuation of reservoir water level, as described later, is subject to design conditions of the Ban Chao Nen project. Main features of this project, such as the installed capacity and number of units, etc. have also close connection with seasonal fluctuation of power discharge of the Ban Chao Nen power plant.

At the first stage of the studies of the lower Quae Yai development scheme, the Ban Tha Ta On and Ban Wang Kula dam sites located at 19.5km and 24.5km downstream of the Ban Chao Nen dam site respectively were proposed only to complement the operation plan including pumping-up operation of the Ban Chao Nen power plant. Thereafter, the Ban Tha Thong Mon Project near the steep cliff located at the right bank in the regulating reservoir area in place of the Huai Klong Ngu pumped-storage hydro-electric project in the upper Quae Yai basin was proposed.

In view of this new situation the Ban Tha Thung Na dam site 3.5km further downstream was newly proposed to cope with the additionally required reservoir capacity and to utilize the undeveloped available head to the maximum. The relative location of those three dam sites and the Ban Chao Nen dam site, and profile of the Quae Yai River in this area are shown in Figs. 6-1 and 6-2, and reservoir capacity curves at the respective dam sites are shown in Figs. 6-3, 6-4 and 6-5.

6.2 Required reservoir capacity

6.2.1 Basic conditions

For study of required reservoir capacity which is one of the foundamental factors in deciding the dam site, the following items must be taken into consideration.

(a) For the efficient operation of the EGAT power system, the first and second stages of the Ban Chao Nen power plant will be required to operate mainly for peak generation and, accordingly, the Lower Quae Yai Project shall be so operated as to re-regulate the power discharge of the Ban Chao Nen power plant in order to meet the requirements for irrigation, domestic water uses and navigation in the downstream basin.

(b) Sufficient amount of reservoir capacity necessary for pumping-up operation of the second stage Ban Chao Nen power plant shall be secured.

(c) Taking into account the huge effective storage capacity of 4,740 x $10^6 m^3$ of the Ban Chao Nen reservoir capable of carry-over regulation of the annual inflow, the Ban Chao Nen power plant will be possibly required, in addition to normal scheduled operation, to perform emergency operation in case of forced outage of other hydroelectric or thermal power plants or transmission lines, etc. Therefore, it is necessary to provide some allowance of reservoir capacity to accommodate discharge by such emergency operation.

(d) It is also required to secure sufficient storage capacity for the Ban Tha Thong Mon Pumped-storage Project.

6.2.2 Reservoir capacity in relation to Ban Chao Nen power plant

Following are the analytical studies of operation pattern of the Ban Chao Nen project in the overall operation schedule of EGAT power generation facilities and of the approach to measuring the capacity of re-regulating reservoir required for operation of the said power plant.

(a) The composite ratios by source of generation of EGAT power system are shown in Table 6-1 and Fig. 6-6. Forty percent is hydro power and sixty percent is thermal power. It is considered that there will be little difference of composite ratios even though the EGAT long term development schedule described in Chapter 3 be realized.

(b) Daily load represented by daily load duration curve is partially shared at present by the South and North Bangkok thermal power plants for base loads, by the Bhumibol and Sirikit hydro-electric power plants for intermediate loads and by the other hydro-electric, gas turbine and diesel power plants for peak loads as shown in Table 6-2.
At around 1987, it is forecasted that nuclear power plants and some of thermal power plants will supply base loads, the other thermal power plants the intermediate loads, the existing hydro-electric power plants for comparatively long duration peak loads (approximately 10 to 12 hours duration) and future hydro-electric power plants including the first and second stage Ban Chao Nen project for comparatively short duration peak loads. This was induced from the fact that the existing EGAT hydro-electric power plants can be operated for comparatively long equivalent peak duration of 8 to 10 hours, as shown in Table 6-3, on account of abundant inflow.
It is forecasted that the same status of load allotment will be continued until the large scale nuclear power plants will be developed after 1990.
As mentioned above, the Ban Chao Nen power plant will be operated to cover the comparatively short duration peak load in the daily load curve and its equivalent peak duration is expected to be around 6 hours.

(c) The Ban Chao Nen reservoir operation is scheduled as shown in the aforenamed Fig. 5-2 taking into consideration annual inflow and irrigation requirements in the downstream basin and, except for February, March and April when large amount of water is required for irrigation purpose, the amount of water available for power generation of the first and second stage Ban Chao Nen power plant during the other nine months is very small corresponding to an equivalent peak duration of 3 to 4 hours.
Therefore, the pumping-up operation to supplement two hour generating operation of the first and second stage Ban Chao Nen power plant will be employed during this period. And the second stage Ban Chao Nen power plant shall be operated for about 5 hours during midnight off-peak hours to pump-up water required for the abovementioned two hour generating operation.

(d) It is difficult to directly define the supplementary reservoir capacity required for emergency operation of the Ban Chao Nen power plant as stated in the preceding paragraph 6.2.1 (c). However, it is assumed that the peak duration to be specially influenced by outage of thermal power plant or transmission line is about 8 hours in total: 2 hour peak duration in the morning, 3 hours in the afternoon and 3 hours in the evening lighting up time and, consequently, it is necessary to take into account the allowance equivalent to 2 hours in addition to normal equivalent peak duration.

6.2.3 Reservoir capacity required for Ban Tha Thong Mon Project

As stated in Clause 11.3 of Chapter 11, the expected time of developing this pumped-storage project will be after 1990 when the major part of total generating capacity is nuclear power plants. It is assumed that the peak load in the load duration curve at this stage will be mostly shared by existing and future hydro-electric power projects and this pumped-storage type project will serve for partial or reserve operation with specially short peak duration of about 4 hours in the peak load. Therefore, reservoir capacity required for operation of the Ban Tha Thong Mon Project will be equivalent to the volume of water to be discharged for power generation for about six hours including an allowance of two hours.

6.2.4 Estimation of required reservoir capacity

In addition to the above consideration, required reservoir capacity also varies depending upon the operation pattern of the Lower Quae Yai Project, that is, if this plant is operated to supply peak loads the required reservoir capacity is less. However, taking into account imposed restriction on abrupt fluctuation of river surface in the downstream basin, estimation is made for the case of complete re-regulation which gives the biggest reservoir capacity.

(a) Reservoir capacity for operation of the first and second stage Ban Chao Nen project.
In case supplementary peak operation time of the first and second stage Ban Chao Nen power plant by pumped-storage is taken to be two hours in consideration of power source available for pumping-up operation, the correlation between available peak duration and consequently required reservoir capacity at certain daily average discharge available from the Ban Chao Nen reservoir is as shown

in Fig. 6-7 and in this case the maximum required reservoir capacity is estimated at approximately 20 x $10^6 m^3$. It is, however, deemed sufficient to take into account peak duration of eight hours which was stated earlier on the basis of the assumed load allocation for the first and second stage Ban Chao Nen power plant and for this purpose the required reservoir capacity is approximately 17.3 x $10^6 m^3$ as shown in the same figure.

(b) Required reservoir capacity for Ban Tha Thong Mon Project.
As described in Chapter 11 clause 11.4 the maximum power discharge of this project is assumed to be 124 m^3/sec and reservoir capacity required for generating operation of this power plant for about six hours is 2.7 x $10^6 m^3$.

Therefore, the required reservoir capacity including this requirement is estimated at 20 x $10^6 m^3$.

6.3 Allowable limit of fluctuation of reservoir surface and effective reservoir capacity

Following are the conditions in deciding high and low water levels of this reservoir in relation to the design criteria of the Ban Chao Nen power plant.

6.3.1 High water level

The most advantageous arrangement for the total generating capacity of both the upstream and downstream power plants is to coincide the tailwater level of the Ban Chao Nen power plant and the high water level of this reservoir as described below.

(a) To determine the high water level of the reservoir higher than the tailwater level of the Ban Chao Nen power plant results in a rise of construction cost of the downstream project with no increase of gross head.

(b) To determine the high water level lower than the tailwater level of the Ban Chao Nen power plant causes undeveloped potential remaining between the two and results in loss of gross head.

Consequently, the high water level of this regulating reservoir was fixed at elevation 59.70 m which corresponds to the tailwater level of the Ban Chao Nen power plant at maximum power discharge of 798 m^3/sec which is after completion of the second stage Ban Chao Nen power plant.

6.3.2 Low water level

As the regulating reservoir is planned to be a lower pondage for pumping-up operation of the second stage Ban Chao Nen power plant (360 MW), the low water level of the reservoir is also restricted by the design criteria of the said power plant. Namely, the low water level must be kept so as to maintain the minimum draft head (Hs) which must be secured during pumping-up operation. Though general mechanical dimensions of the second stage Ban Chao Nen power plant are not finally studied yet in detail, it is estimated that the Hs will not be more than 12 m according to our latest preliminary study. On the other hand, the elevation of the center of the reversible pump-turbine for pumping-up water is already fixed to be EL. 43.50m and low water level of the reservoir is thus decided to be EL. 55.50m taking those conditions into consideration.

6.3.3 Effective storage capacity

Effective storage capacities at the respective dam sites with high and low water levels of 59.70m and 55.50m both induced from the above-mentioned studies are as follows:

Dam site	Effective storage capacity (m^3)
Ban Tha Ta On	10,200,000
Ban Wang Kula	17,800,000
Ban Tha Thung Na	27,700,000

These capacities, however, are calculated on the basis of 1 : 5,000 aerial maps and 1 : 50,000 topographic maps and shall be adjusted on completion of detailed survey.

6.4 Selection of dam site

The following are the comparative studies of the effective storage capacity at the three proposed sites with required reservoir capacity above-mentioned.

(a) The effective storage capacity at the Ban Tha Ta On site is not satisfactory even for operation of the Ban Chao Nen power plant including pumping-up operation and excludes the requirement for the Ban Tha Thong Mon Pumped-storage Project.

(b) The effective storage capacity at the Ban Wang Kula site seems to barely satisfy the requirement for operation of the Ban Chao Nen power plant, but it is considered still insufficient if sedimentation which will gradually decrease the storage capacity is taken into account. This site also will not create the required storage capacity for the proposed Ban Tha Thong Mon Pumped-storage Project.

(c) The Ban Tha Thung Na site will provide sufficient reservoir capacity required for operation of both the Ban Chao Nen and Ban Tha Thong Mon power plants, even if consideration is given to sedimentation in the reservoir. Should the Ban Chao Nen power plant be forced to serve an additional and extraordinary operation in consideration of large reserve capacity of the Ban Chao Nen reservoir, the surplus capacity of this regulating reservoir complies easily with such particular condition.

Furthermore, as described in Chapter 4, the geological condition at the Ban Tha Thung Na site will adequately sustain the structures planned to be constructed at the site and the geology is better than that at the upstream sites. Taking all these factors into consideration, the Ban Tha Thung Na site was selected as the dam site and accordingly, investigations and studies have been concentrated on this site.

6.5 Development scheme of Ban Tha Thung Na power plant

6.5.1 Present condition of dam site

The Ban Tha Thung Na dam site is located midway between Kanchanaburi and Ban Chao Nen dam site and an asphalt road between the same passes by the dam site. A terrace formed by relatively hard rock at the right bank and a steep rock ridge on the left bank causes the river to make a big bend at this site. There are outcrops on both banks and the overburden is relatively thin. Normally the river water surface is about 80 m wide but at the time of the largest recorded flood (Q = 2,500 m^3/sec), the river was about 140 m wide recording about 12 m rise of water surface. The terrace on the right bank is covered with thin forest and there are farm houses with tenants farming small plots of land.

6.5.2 Dam

Taking into account the result of geological studies and topographical conditions as described in Chapter 4, the dam axis was selected where the bedrock is shallow and require less excavation. A concrete spillway structure is to be constructed in the river bed flanked on the right wing with a central core rockfill dam in consideration of the following conditions.

(a) As described later in Chapter 7 "Construction Schedule", the flood discharge at the dam site is possibly expected to be under 90 m^3/sec by coinciding the construction period of this project with the period of filling the upstream Ban Chao Nen reservoir and consequently, the river flow can be diverted by coffering half of the river without constructing a full-scale diversion system for care of the river. In this case, the dam should be of concrete construction, otherwise diverting the river flow can be by no means carried out at the second stage coffering of the river.

(b) In view of economy, a rockfill dam is recommendable on the right wing of the spillway structure as the bedrock is deeply weathered but the permeability is low.

(c) The most optimum design for a rockfill dam is to construct the spillway in an area separate from the dam, but at this site due to topographical conditions, the dam with spillway structure in the river bed will have to be constructed.

Judging from the results of test borings, two rows of curtain grouting extending to a maximum depth of 25 m and blanket grouting of less than 10 m in depth should be sufficient to improve the relatively good calcareous sandstone foundation existing from the river bed to the left bank of the Quae Yai River. It is considered that no unusual construction method should be required. Taking into consideration the limited working time dictated by filling period of the Ban Chao Nen reservoir, an inspection gallery should be constructed to permit additional curtain grouting from the gallery, provided that, in case an inspection gallery is recognized as unnecessary from the result of the foundation treatment from the rock surface, the gallery can be discarded. The spillway will have six radial gates which can release 2,710 m^3/sec of the total design flood discharge and the remaining amount of 290 m^3/sec can be discharged through the turbines. The rockfill dam is of the central impervious core type with upstream and downstream slopes of 1 : 2.5 and 1 : 2.0, respectively and the crest width of the dam will be 8.0m which is the minimum width achievable taking into account working conditions.

6.5.3 Power intake, powerhouse and tailrace

The various facilities for power generation such as power intake, powerhouse and tailrace will be constructed adjacent to the left side of the dam. The reasons for constructing the powerhouse on the left bank are as follows.

(a) Heavy equipment such as turbines, generators, etc can be easily hauled in and the design load on the bridge over the spillway structure can be set to a minimum value.

(b) The extent of excavation is larger on the right bank judging from the bottom elevation of the draft tube.

The power intake will be 40.00m wide and 38.50m high, and will have five trashracks and four control gates.

The number of units and maximum output must be determined before starting on the design of the powerhouse taking the following conditions into consideration.

(a) Operation of the Ban Chao Nen reservoir is governed by the basic conditions to secure the irrigation requirement (290m^3/sec at maximum) and the minimum discharge of 50m^3/sec for navigation and other uses. The same conditions are naturally applied to this project and daily average discharge in a year is subject to sharp fluctuation of about 6 times as described above.

(b) It is considered that this power plant will be required to carry peak loads in accordance with the daily load curve. Fluctuation of power discharge by time will show the same value judging from the discharge at the economical maximum output to be mentioned later.

(c) Due to the relatively small effective head available, the turbine will be of the Kaplan type. Mechanically, the minimum discharge at which the turbine can be operated is about 20 percent of the discharge at the maximum output, and only one unit of Kaplan turbine may not cope with the big fluctuation of discharge mentioned above.

Taking these reasons into consideration, the number of units was decided as two, and economic comparison was made to determine the maximum installed capacity. The maximum output at each maximum discharge and annual energy production are shown in Table 6-4. After comparative studies described later in Chapter 9, the maximum installed capacity was decided to be 37,000kW at a maximum discharge of 290m^3/sec and a rated head of 15.10m. The powerhouse building at EL.44.50m (generator floor) and EL.55.00m (erection bay) are 17.50m x 38.50m and 17.50m x 50m, respectively which are the minimum dimensions to accommodate two units and ancillary equipment. Four draft gates will be installed at the end of the draft tubes.

The tailrace channel will be 35.00m long and 41.50m wide at the terminal.

6.5.4 Switchyard

The switchyard will be located in an area 40m x 50m adjacent to the power plant. Switching equipment besides two sets of main transformers will be installed there and connected with the power plant by cables installed in cable duct.

6.5.5 Transmission line

One circuit of 115kV transmission line for sending power to the Ban Chao Nen project during construction and in the future for transmitting power to Kanchanaburi is recently constructed and will pass by about 2.5km away from this site.
A transmission line from the switchyard will be constructed to tie into the above-mentioned transmission line by π connection.

6.5.6 Other facilities

Besides the above facilities, telephone system for communication between Ban Tha Thung Na power plant and Ban Chao Nen power plant as well as Kanchanaburi substation will be installed. Power line carrier relaying system for protection of the 115kV transmission line will also be installed.

6.5.7 Principal features of the project

The principal features, preliminary designs and single line diagram for the Ban Tha Thung Na Project are shown in the front table and Figures 6-8, 6-9, 6-10, 6-11, 6-12 and 6-13.

6.6 Construction materials

Further detail investigations of the construction materials in the field are required and the results of preliminary field investigations in the vicinity of the Ban Tha Thung Na Project are as follows.

(a) Impervious core material

Clay and fine silt in diluvium and talus deposit which are distributed at the terrace around dam site and gentle piedmont, and heavily weathered portion of rock foundation mainly composed of shale will be the possible sources for impervious core material.

(b) Filter material

River deposits and weathered rocks existing in this area will be the possible sources for filter material.
As far as superficially obserbed, river deposits seems to mostly contain fine-grained materials with limited amount of coarse materials. It will be required to investigate sandbars in the river bed. Among weathered rocks, relatively coarse-grained portions of talus deposits and weathered portions of rock foundations will be considered as the sources for filter material.

(c) Rock material

Among limestone and metamorphic sedimentary rock around the site, schistosed sandstone forming the hills with gentle slopes is the most suitable material for rockfill embankment.

(d) Aggregate for concrete

Gravel and sand included in the river deposit or quarry run materials will be used. According to the latest field investigation by EGAT, river deposits include little amount of impure matters and seems to be suitable for fine aggregate both in quantity and quality. It is required to investigate sandbars in the river bed for obtaining coarse aggregate. Limestone and schistosed sandstone will be available for manufactured coarse aggregate, however, it is noted that schistosed sandstone has a exfoliative characteristic.

Table 6-1 Composition of Power Facility

	Hydro		Thermal		Diesel & Gas		Nuclear		Total
Fiscal year	Installed capacity (MW)	Rate (%)	Installed capacity (MW)	Rate (%)	Installed capacity (MW)	Rate (%)	Installed capacity (MW)	Rate (%)	Installed capacity (MW)
1975	909	43	1, 034	48	195	9	0	0	2, 138
1976	909	37	1, 334	55	195	8	0	0	2, 438
1977	909	36	1, 409	56	195	8	0	0	2, 513
1978	959	36	1, 484	56	195	8	0	0	2, 638
1979	1, 079	35	1, 784	58	195	7	0	0	3, 058
1980	1, 319	40	1, 784	54	195	6	0	0	3, 298
1981	1, 356	41	1, 784	53	195	6	0	0	3, 335
1982	1, 496	43	1, 784	51	195	6	0	0	3, 475
1983	1, 576	41	2, 084	54	195	5	0	0	3, 855
1984	1, 576	38	2, 384	57	195	5	0	0	4, 155
1985	1, 866	42	2, 384	54	195	4	0	0	4, 445
1986	1, 866	37	2, 384	47	195	4	600	12	5, 045
1987	2, 226	41	2, 384	44	195	4	600	11	5, 405
1988	2, 226	37	2, 984	49	195	4	600	10	6, 005
1989	2, 226	37	2, 984	49	195	4	600	10	6, 005
1990	2, 826	43	2, 984	45	195	3	600	9	6, 605

Table 6-2 Thermal, Gas Trubine and Diesel Power Plant Annual Utilization Factor

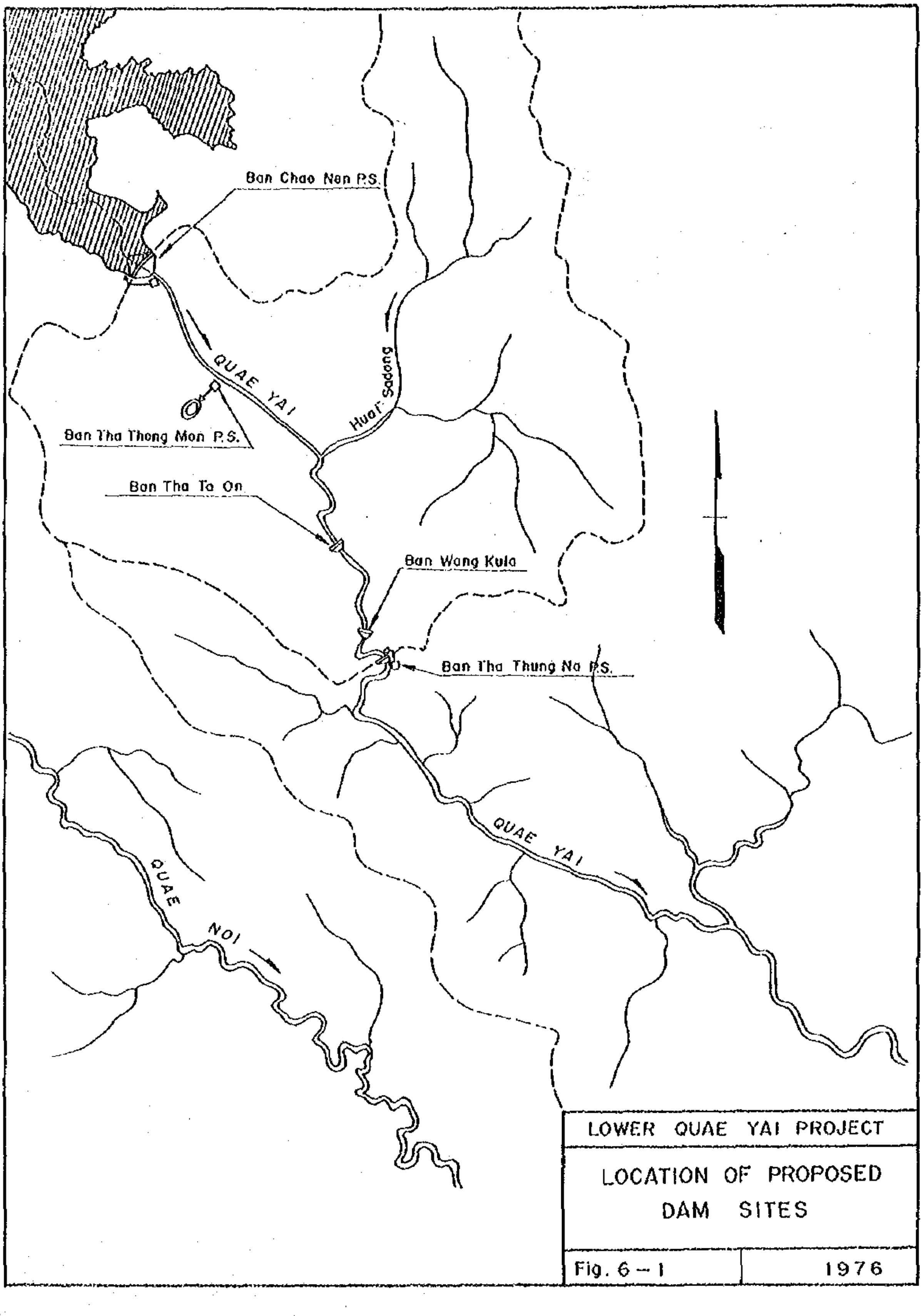
Name	Unit	Installed Capacity (MW)	Average Annual Energy (10^6kWH)	Annual Utilization Factor (%)
(Thermal)				
North Bangkok	3	237.5	1,900	91
South Bangkok	4	1,000	7,420	85
Surat Thani	1	30	210	80
Mae Moh	1	6.25	50	91
Krabi	3	60	300	57
(Gas Turbine)				
North Bangkok	2	30	26	10
South Bangkok	4	60	53	10
Bang Kapi	1	15	13	10
Bangkok Noi	1	15	13	10
Nakhon Ratchasima	1	15	13	10
Udon Thani	1	15	13	10
Hat Yai	1	15	13	10
(Diesel)				
Mae Moh	9	9	8	10
Chiangmai	8	8	7	10
Phuket	4	10.6	9	10
Nakhon Si Thammarat	2	2	2	10

Table 6-3 Equalized Peaking Load (Existing Hydro-Power Station)

Name	Annual Energy (10^6 kWh)	Daily Energy (MWh)	Equalized Peaking Load (hour)
Bhumibol (420MW)	1,550	4,250	10.1
Sirikit (375MW)	965	2,640	7.0
Ubolratana (25MW)	65	178	7.1
Sirindhorn (24MW)	73	200	8.3
Chulabhorn (40MW)	115	315	7.9
Nam Pung (6MW)	15	41	6.8
Kang Krachan (19MW)	70	191	10.1
Total	2,853	7,815	8.6

Table 6-4 Maximum Discharge vs Installed Capacity and Annual Energy

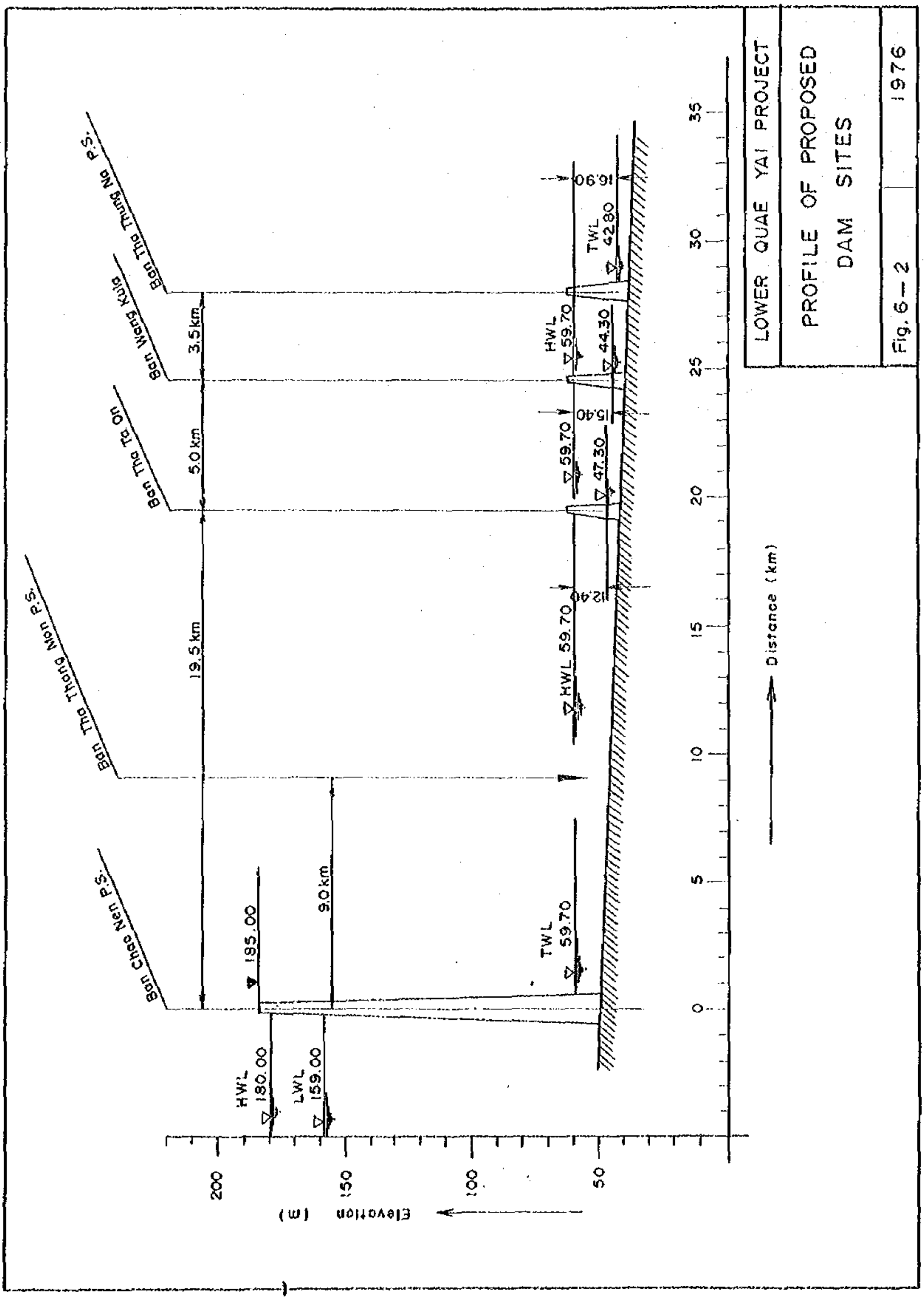
Maximum Discharge (m^3/sec)	Installed Capacity (KW)	Annual Energy (10^3 kWh)	Spilled Energy (10^3 kWh)
200 (100 x 2)	26,800	146,900	14,600
220 (110 x 2)	29,200	149,800	10,100
240 (120 x 2)	31,400	152,200	6,400
260 (130 x 2)	33,600	154,700	2,800
280 (140 x 2)	35,800	154,900	900
290 (145 x 2)	37,000	155,000	0
300 (150 x 2)	38,000	154,100	0
320 (160 x 2)	39,700	152,500	0

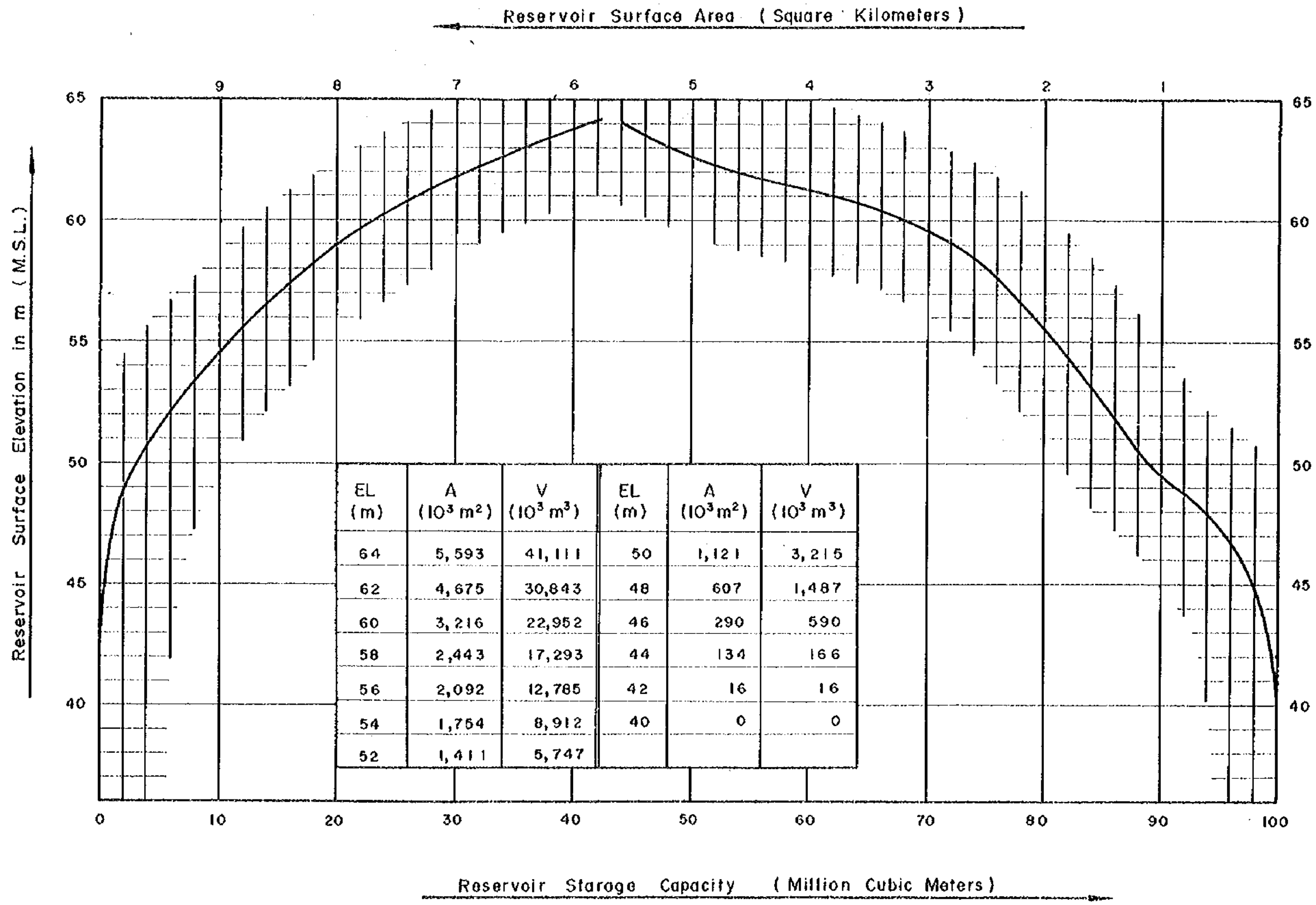


LOWER QUAE YAI PROJECT

LOCATION OF PROPOSED DAM SITES

Fig. 6 – 1 1976


LOWER QUAE YAI PROJECT
PROFILE OF PROPOSED DAM SITES
Fig. 6-2
1976
Ban Chao Nen P.S.
Ban Tha Thung Na P.S.
Ban Wang Kula
Ban Tha Ta On
19.5 km
5.0 km
3.5 km
9.0 km
HWL 180.00
LWL 159.00
185.00
TWL 59.70
HWL 59.70
12.40
59.70
47.30
15.40
44.30
TWL 42.80
16.90
Distance (km)
Elevation (m)
0
5
10
15
20
25
30
35
50
100
150
200

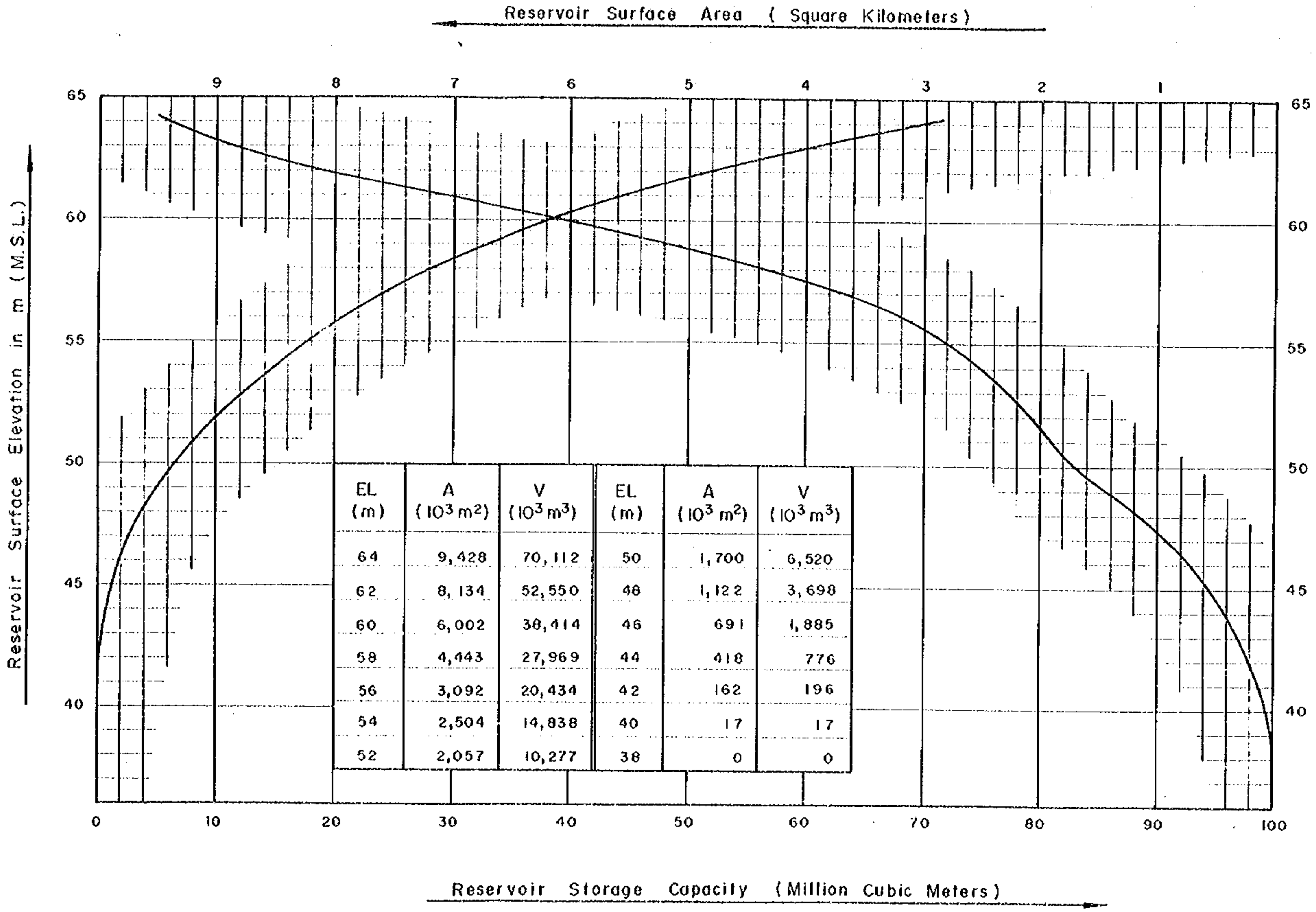


EL (m)	A ($10^3 m^2$)	V ($10^3 m^3$)	EL (m)	A ($10^3 m^2$)	V ($10^3 m^3$)
64	5,593	41,111	50	1,121	3,215
62	4,675	30,843	48	607	1,487
60	3,216	22,952	46	290	590
58	2,443	17,293	44	134	166
56	2,092	12,785	42	16	16
54	1,754	8,912	40	0	0
52	1,411	5,747			

LOWER QUAE YAI PROJECT

RESERVOIR STORAGE CAPACITY AND AREA CURVE (Ban Tho Ta On)

Fig. 6 ~ 3 | 1976

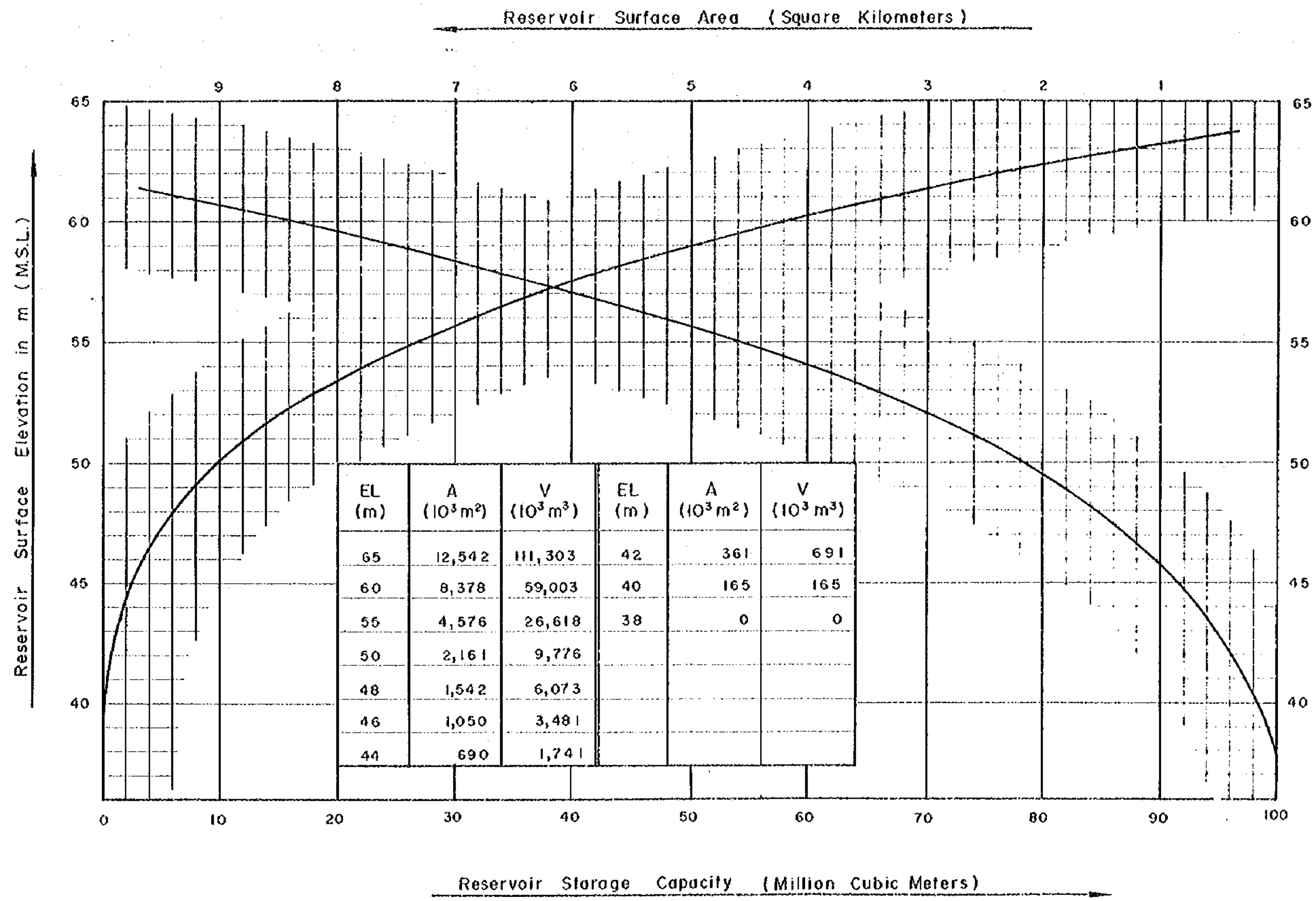


EL (m)	A ($10^3 m^2$)	V ($10^3 m^3$)	EL (m)	A ($10^3 m^2$)	V ($10^3 m^3$)
64	9,428	70,112	50	1,700	6,520
62	8,134	52,550	48	1,122	3,698
60	6,002	38,414	46	691	1,885
58	4,443	27,969	44	418	776
56	3,092	20,434	42	162	196
54	2,504	14,838	40	17	17
52	2,057	10,277	38	0	0

LOWER QUAE YAI PROJECT

RESERVOIR STORAGE CAPACITY AND AREA CURVE
(Ban Wang Kula)

Fig. 6 ～ 4 | 1976

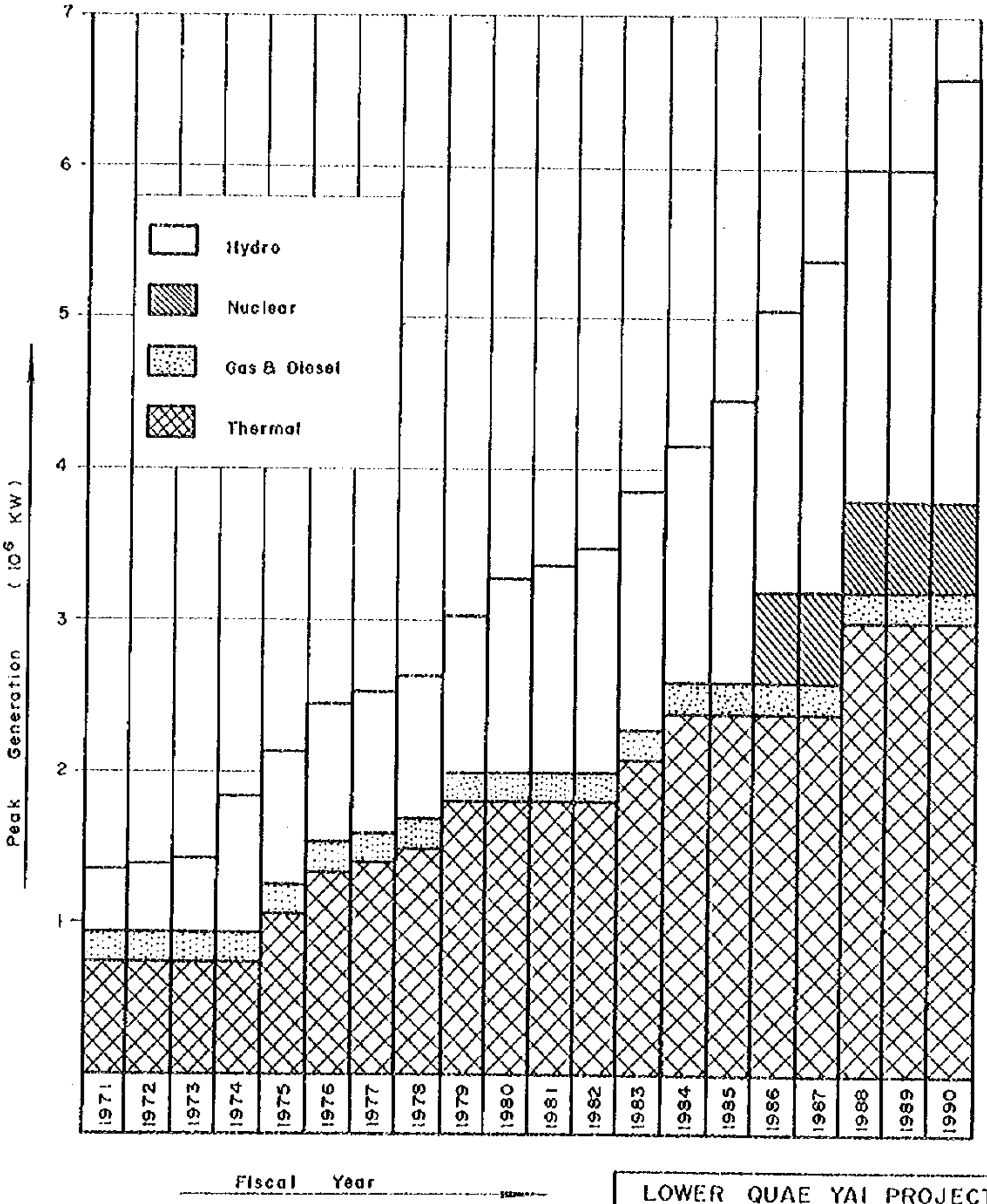


EL (m)	A ($10^3 m^2$)	V ($10^3 m^3$)	EL (m)	A ($10^3 m^2$)	V ($10^3 m^3$)
65	12,542	111,303	42	361	691
60	8,378	59,003	40	165	165
55	4,576	26,618	38	0	0
50	2,161	9,776			
48	1,542	6,073			
46	1,050	3,481			
44	690	1,741			

LOWER QUAE YAI PROJECT

RESERVOIR STORAGE CAPACITY AND AREA CURVE (Ban Tha Thung Na)

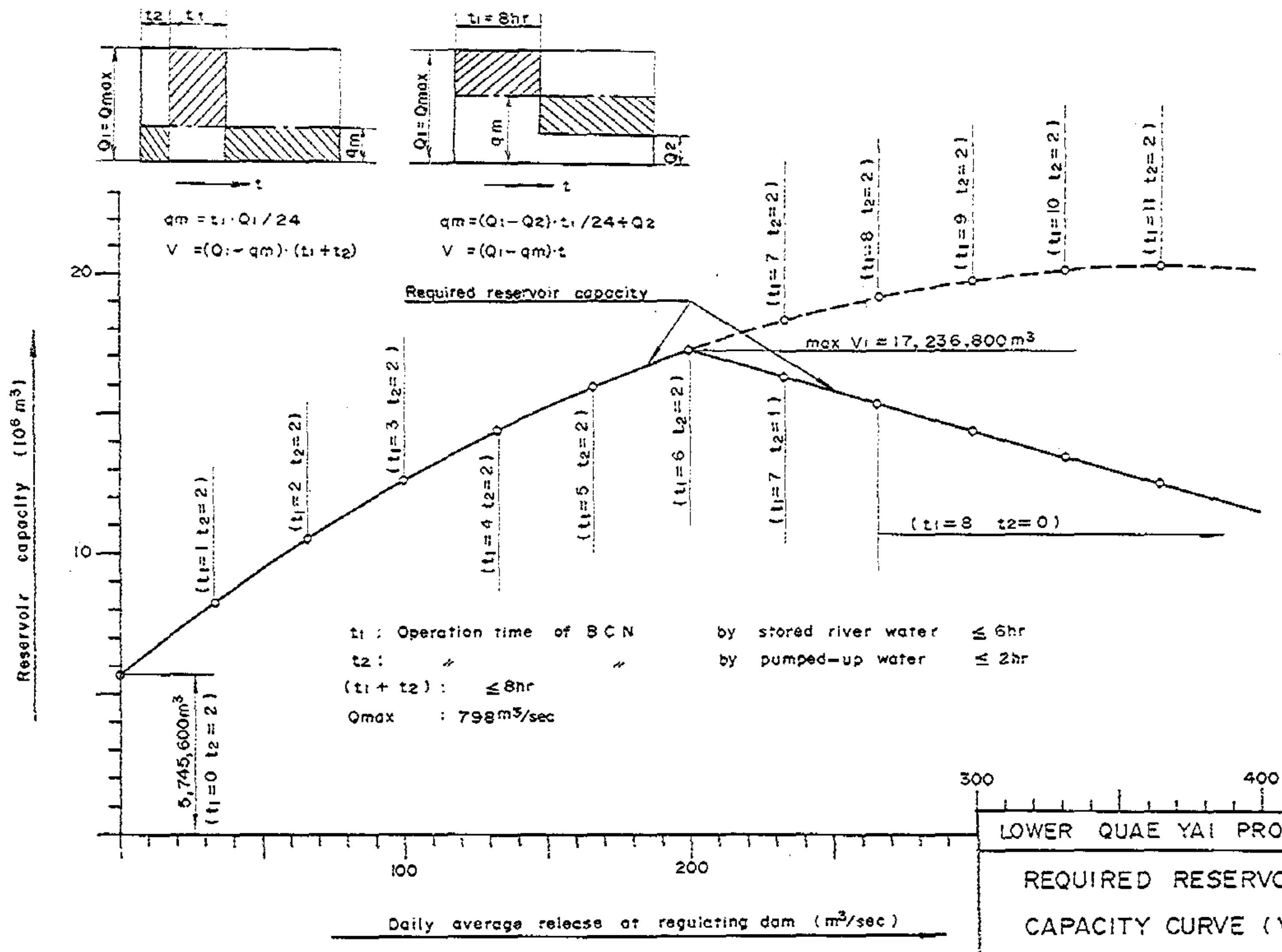
Fig. 6 ~ 5 | 1976



LOWER QUAE YAI PROJECT

COMPOSITION OF POWER FACILITY

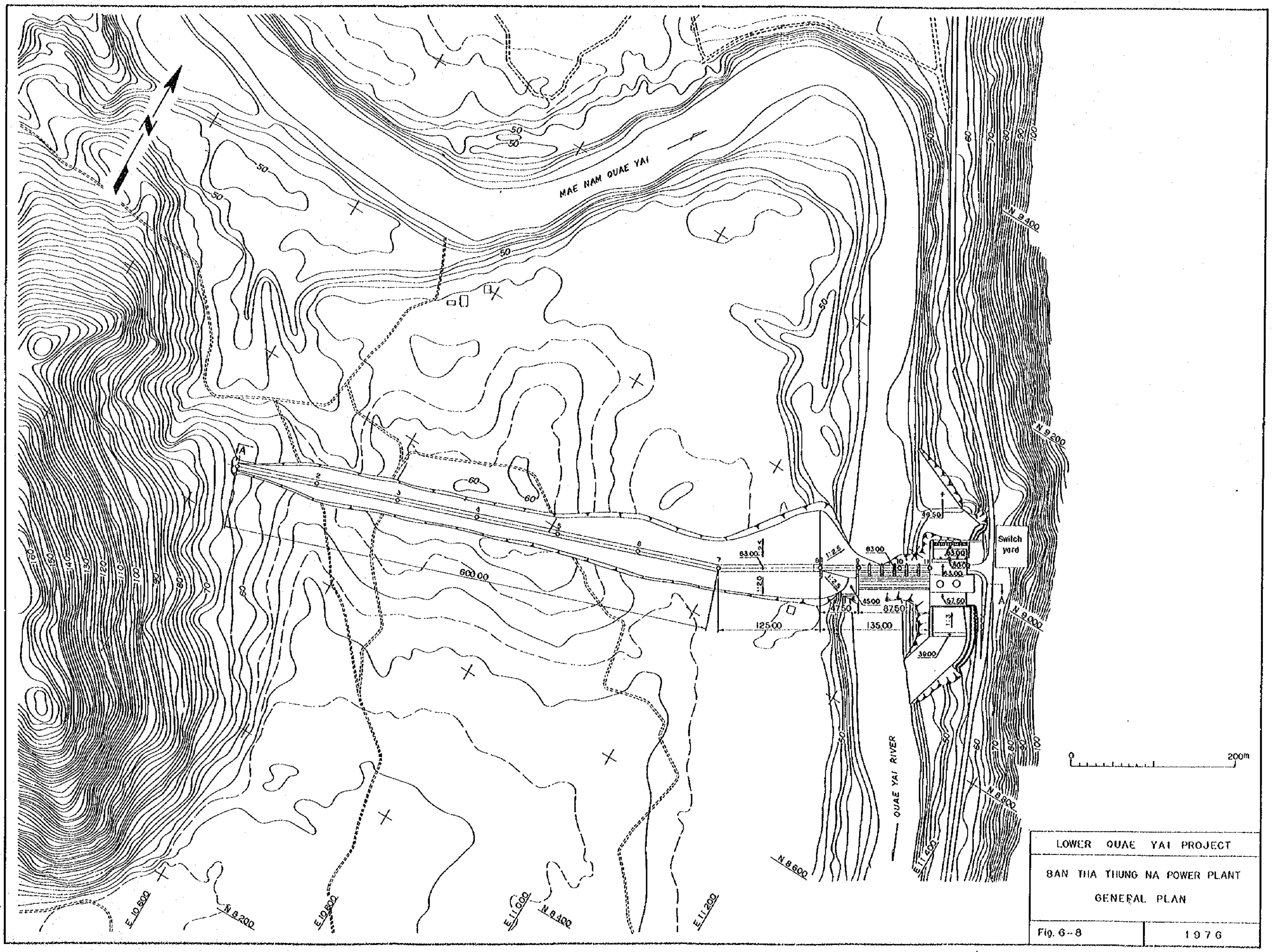
Fig. 6 -- 6 | 1976



LOWER QUAE YAI PROJECT

REQUIRED RESERVOIR CAPACITY CURVE (V_t)

Fig. 6−7 1976

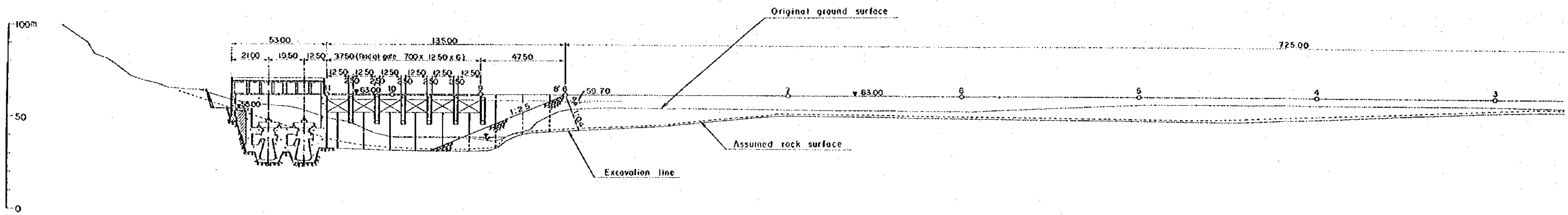


LOWER QUAE YAI PROJECT

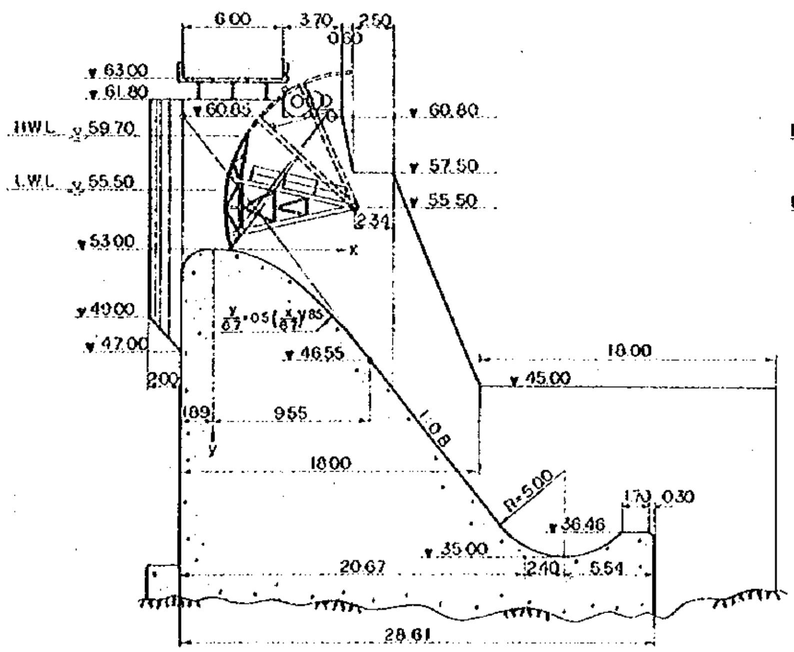
BAN THA THUNG NA POWER PLANT

GENERAL PLAN

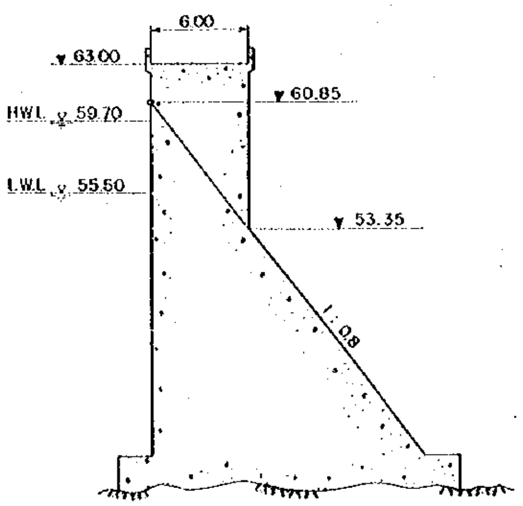
Fig. 6-8 | 1976



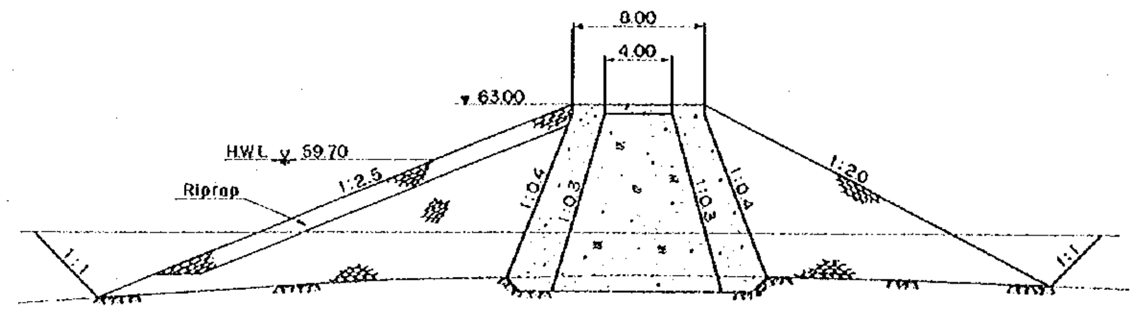
TYPICAL CROSS SECTION (OVERFLOW SECTION)



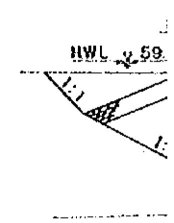
TYPICAL CROSS SECTION (NONOVERFLOW SECTION)

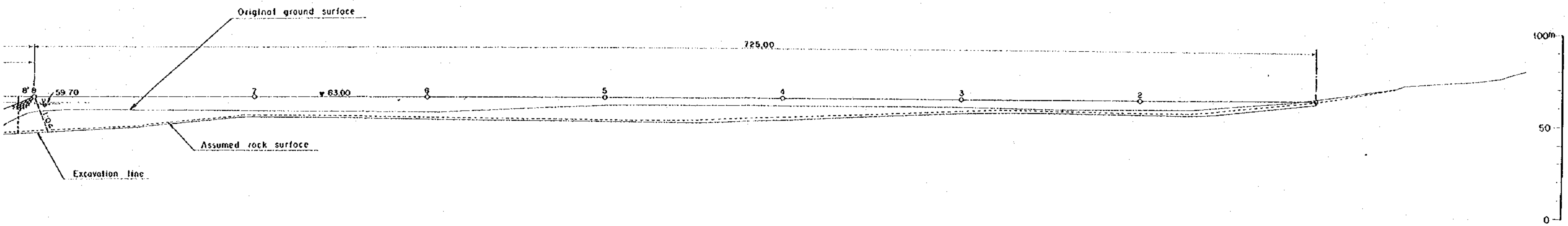


TYPICAL CROSS SECTION (ROCKFILL SECTION TYPE I)

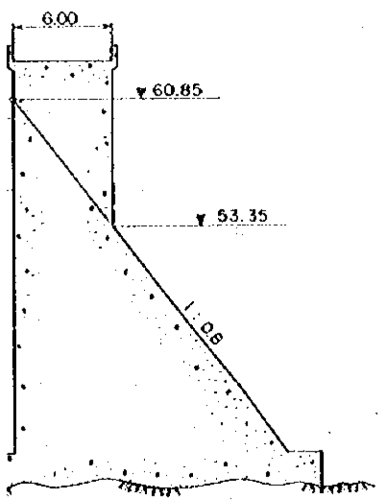


TYPICAL

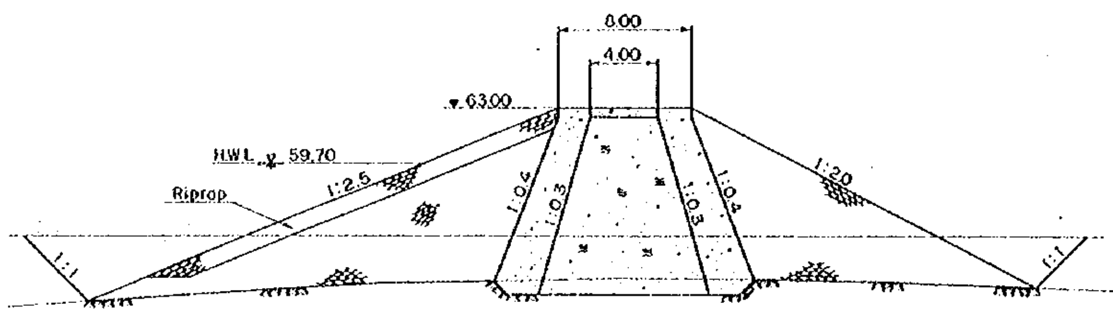




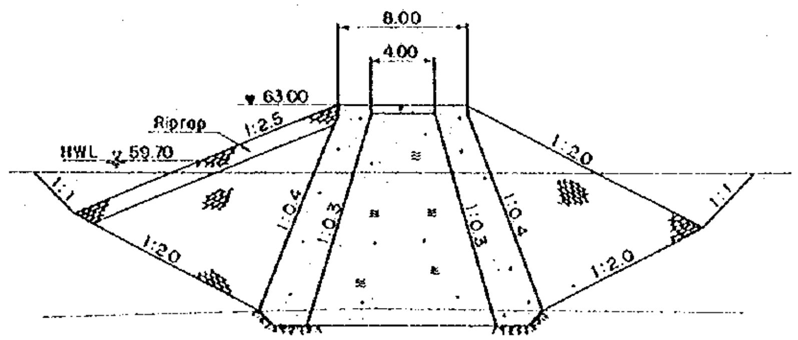
CROSS SECTION (NONOVERFLOW SECTION)

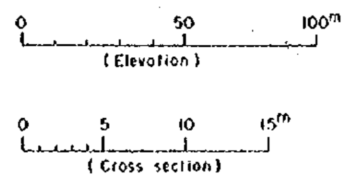


TYPICAL CROSS SECTION (ROCKFILL SECTION TYPE I)

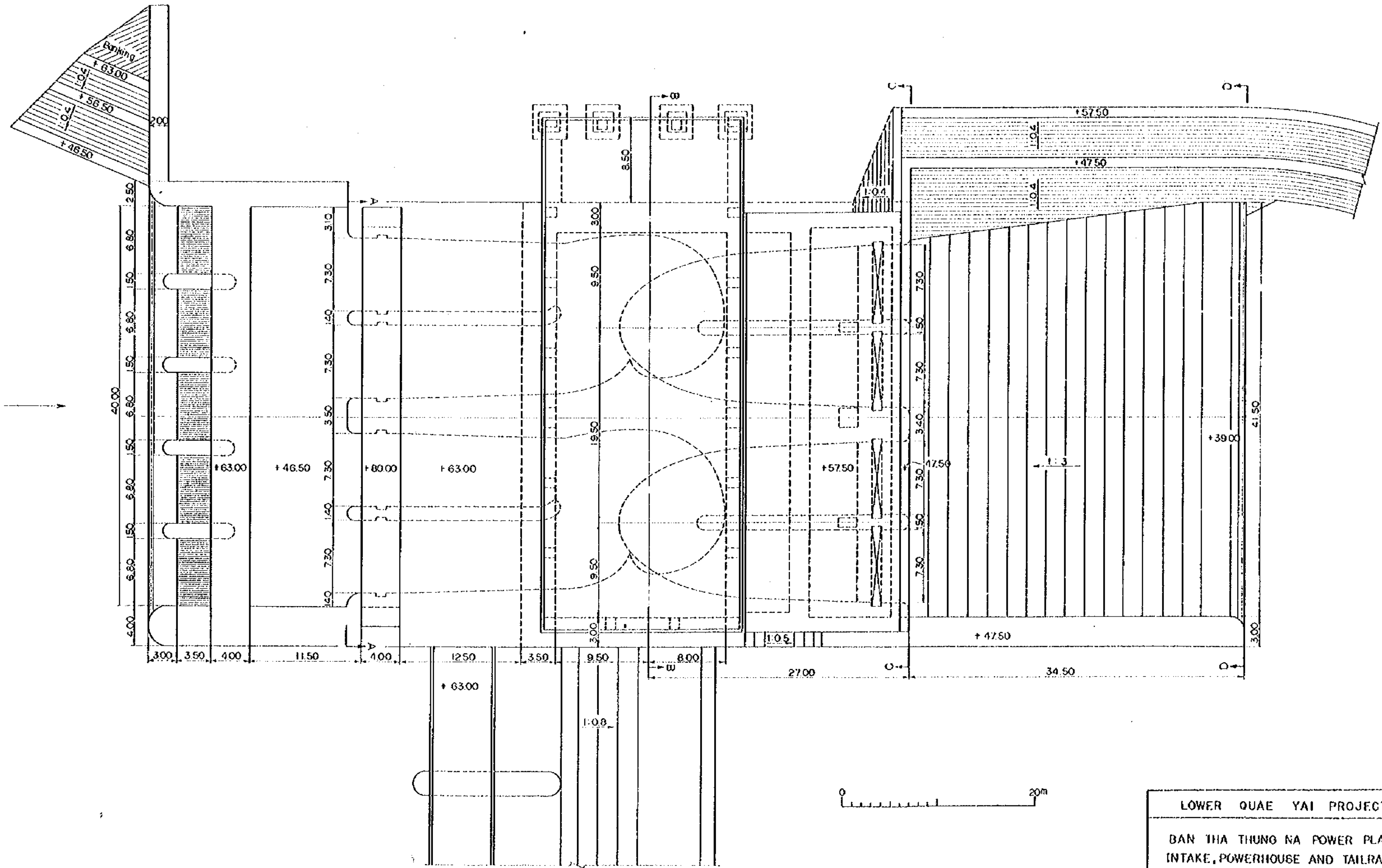


TYPICAL CROSS SECTION (ROCKFILL SECTION TYPE II)
(St. No.4 ~ No.5)

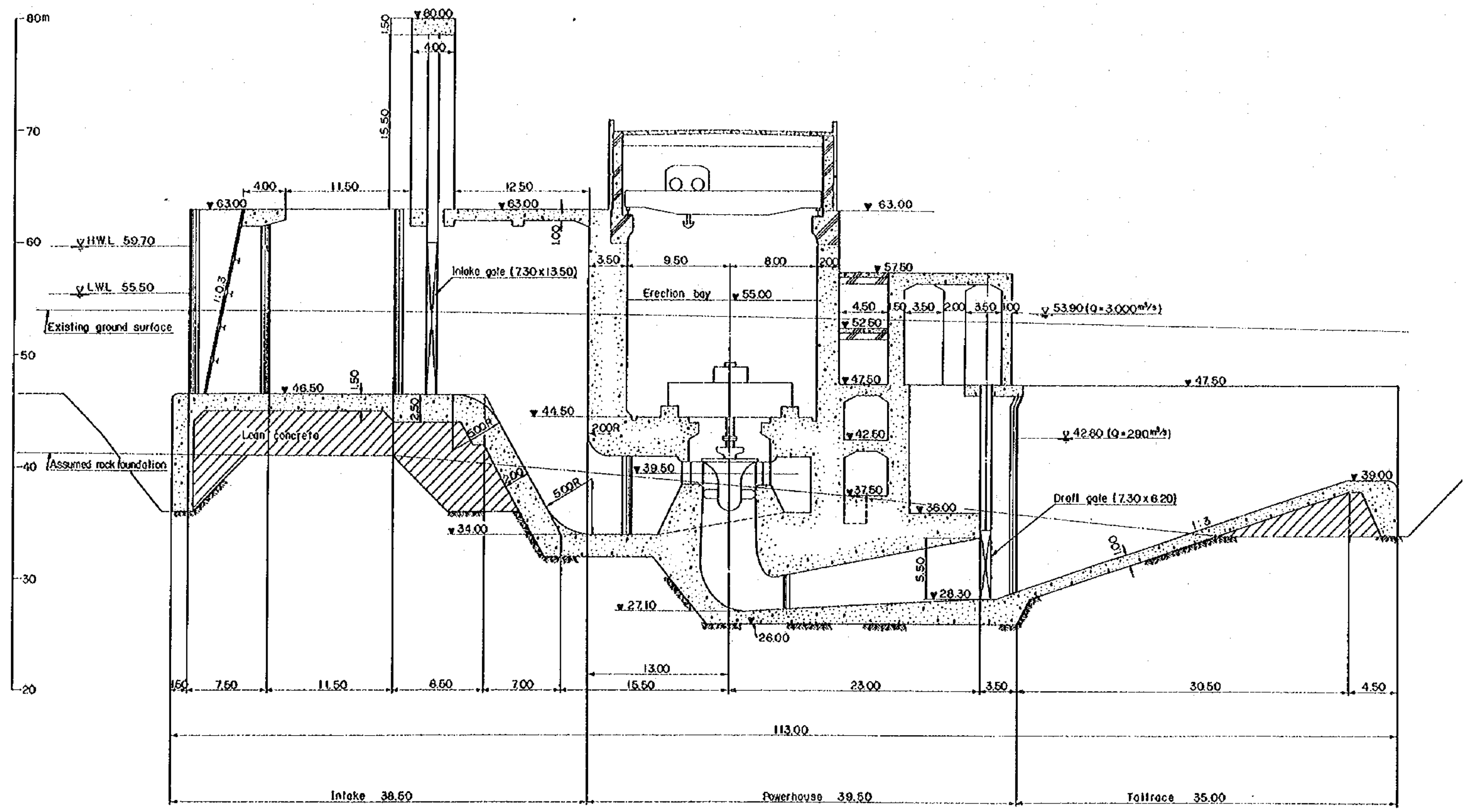




LOWER QUAE YAI PROJECT	
BAN THA THUNG NA DAM ELEVATION AND TYPICAL CROSS SECTION	
Fig. 6-9	1976



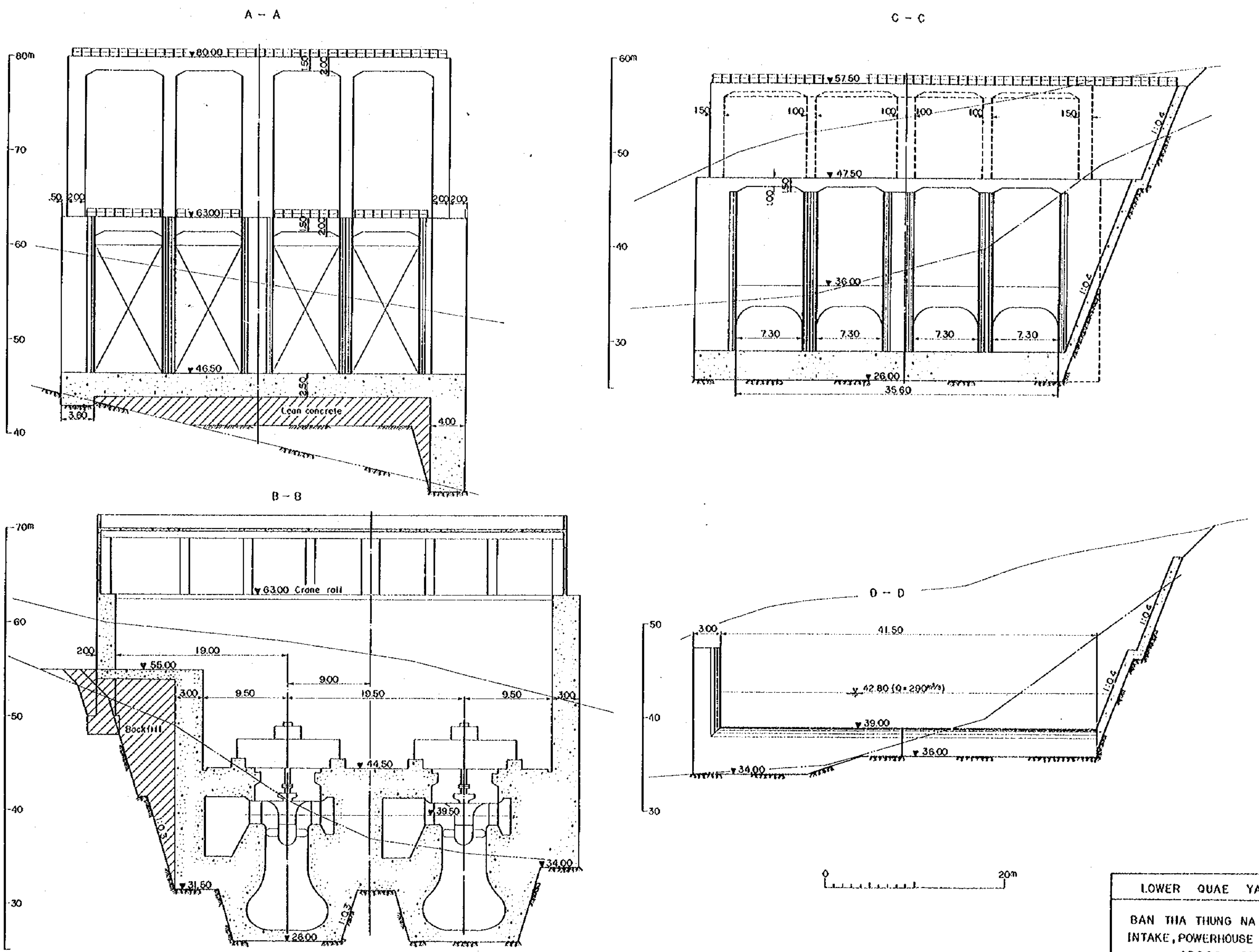
LOWER QUAE YAI PROJECT	
BAN THA THUNG NA POWER PLANT INTAKE, POWERHOUSE AND TAILRACE PLAN	
Fig. 6-10	1976



LOWER QUAE YAI PROJECT

BAN THA THUNG NA POWER PLANT
INTAKE, POWERHOUSE AND TAILRACE
PROFILE

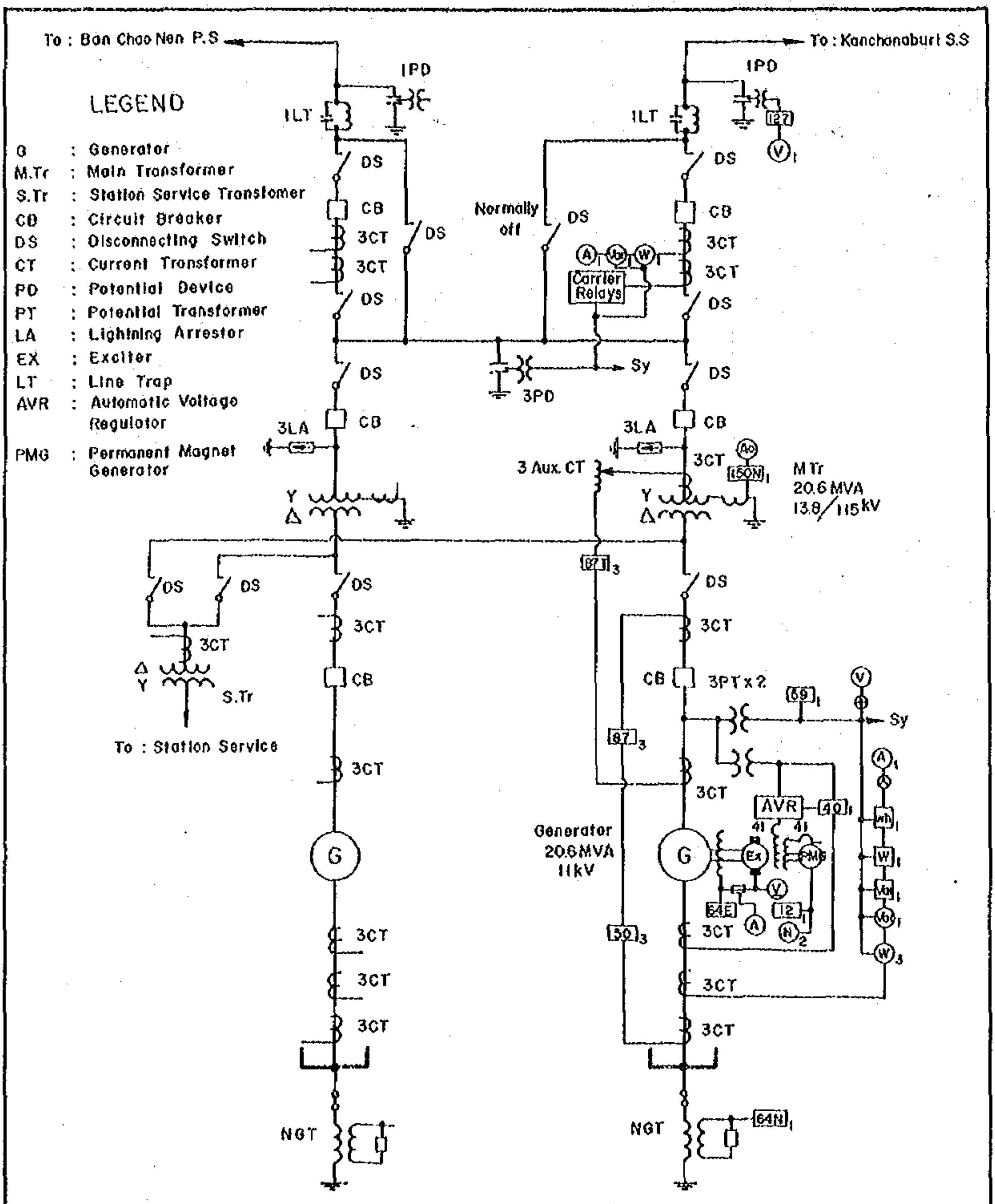
Fig. 6-11 | 1976



LOWER QUAE YAI PROJECT

BAN THA THUNG NA POWER PLANT
INTAKE, POWERHOUSE AND TAILRACE
CROSS SECTION

Fig. 6-12 | 1976



LOWER QUAE YAI PROJECT

BAN THA THUNG NA POWER PLANT

SINGLE LINE DIAGRAM

Fig. 6-13 1976

CHAPTER 7 CONSTRUCTION SCHEDULE

7.1 Basic consideration

For the construction of the Ban Tha Thung Na Project, it is essential to take into account the construction schedule of the Ban Chao Nen project which is under construction on the upstream. The main part of the civil works must be completed during the period between commencement of filling the Ban Chao Nen reservoir and start of operation of the Ban Chao Nen power plant for the most economical development of this project and consequently, the construction schedule will be relatively tight.

(a) The commencement dates of filling reservoir and start of operation of the Ban Chao Nen project are as follows.

Filling reservoir	:	July, 1977
Start of operation	:	Sept. 1979 (Unit No.1, Q_{max} = 133 m^3/sec)
	:	Dec. 1979 (Unit No.2, Q_{max} = 133 m^3/sec)
	:	May, 1980 (Unit No.3, Q_{max} = 133 m^3/sec)

According to the above-mentioned schedule, it is expected that the power discharge for test operation of the Ban Chao Nen power plant will begin after July 1979 about two months ahead of the start of partial operation of the power plant and it should be noted that the water surface of the regulating reservoir will gradually rise, and sometimes reach higher than the spillway crest elevation.

(b) It is required to complete the construction of all structures which directly face the running water resulting from the rise of the reservoir water surface and/or release over the spillway crest. The installation works of the intake and draft gates must also be finished by that time to enable the installation of the electrical equipment inside the powerhouse building.

7.2 Construction schedule

Fig.7-1 shows the construction schedule prepared on the basis of these basic considerations. The construction period from the commencement of the civil works to the start of operation is estimated to be 35 months and it will be required to award the contract of the civil works at the latest by October 1977.

Since the period required for manufacturing and installation of the hydraulic equipment is 30 months, the contract therefor must be awarded at the latest by October, 1977 in order to complete the installation works of the intake and draft gates by June, 1979 as stated in preceding paragraph.

The period required for manufacturing and installation of the electrical equipment is also estimated to be 30 months and the contract therefor must be awarded by March, 1978 in consideration of the construction schedule of the civil works.

The preparation works at the site to be performed in advance of the civil works must start at around July, 1977. The target date of starting operation is October 1, 1980.

The latter half of 1977, which is the first year, will be mainly devoted for preparation works such as temporary camp facilities and power distribution lines etc. by EGAT. After award of the contract, coffering about the areas for construction of left wing of the dam, intake, powerhouse and tailrace structures followed by the partial switching of the Quae Yai River shall be carried out by the end of this year.

In 1978, the second year, excavation, grouting for foundation treatment and concrete placing in the above-mentioned areas will be carried out. Switching the riverflow into the bypass conduits provided in the concrete dam will be performed in November followed by excavation, grouting for foundation treatment and placing concrete in the right half section of the river bed. At the terrace on the right bank where the rockfill section is to be constructed, excavation and grouting for foundation treatment will be carried out during the latter half of this year. The construction of transmission line will also be carried out this year to receive the power for construction purpose before completion of the power plant.

In 1979, the third year, embankment of the rockfill section will be commenced. The installation works of the intake and draft gates shall be commenced by the end of March. In the latter half of the year, the overhead travelling crane will be installed followed by installation of the electrical equipment. The spillway gate frames must be installed in place before the water surface rises to overflow crest.

The year 1980, the fourth year, the work will be mainly architectural works and installation of the electrical equipment. The construction of the switchyard will also be carried out this year. Upon completion of the installation works of the spillway gates, plug concrete will be placed following closure of the bypass conduits in April.

For the smooth execution of the works in accordance with above-mentioned construction schedule, the preparation works including acquisition of land must be started in time. Especially, the detail design, preparation of the tender documents and further field investigations to be probably required therefor must be urgently undertaken.

Works	Quantity	Schedule notes (1976: 9–12; 1977–1980: 1–12)	Remarks
(I) Definite study			Includes preparation of tender documents
Civil works			
Hydraulic equipment			
Electric equipment			
Transmission line			
(II) Preparation works			
Comp facility			
Highway relocation	ℓ = 2.6km	(Surfacing)	Embankment 150,000m³
Resettlement works			
(III) Civil works			
Construction facilities		(Common)	
Clearing			
Dam (Excavation)	325,600m³	(Rock)	
(Concrete)	49,560m³	(Plug)	Dam concrete 48,600m³
(Embankment)	314,000m³		
(Grouting)	54,000 S		Drilling 10,500m
Intake (Excavation)	70,000m³		
(Concrete)	20,600m³		
Powerhouse (Excavation)	59,000m³		
(Concrete)	24,900m³		Superstructure concrete excluded
(Superstructure)			
Tailrace (Excavation)	94,000m³		
(Concrete)	6,350m³		
Switchyard (Excavation)	10,000m³		
(Concrete)	960m³		
(IV) Hydraulic equipment			
Spillway gate	6		
Road bridge	6		
Closure gate	1		
Intake gate	4		
Draft gate	4		
(V) Electrical equipment			
Turbine & generator			
Crane			
Other equipment			
(VI) Transmission line			

Note: ——— Construction and installation works

- - - - Manufacturing, ocean freight and inland transportation

LOWER QUAE YAI PROJECT

CONSTRUCTION SCHEDULE

Fig. 7-1 | 1976

CHAPTER 8 COST ESTIMATION

8.1 Basic assumptions

The construction costs are estimated taking into account the natural and local conditions of the site, present technical standard as well as the following basic assumptions.

(a) Scope of cost estimation

The estimation includes the costs of the Ban Tha Thung Na dam and power plant, transmission line to be interconnected with the 115 kV transmission line which is constructed between the Ban Chao Nen power plant and the Kanchanaburi substation and telecommunication facilities. It also includes the costs to be required for land acquisition in the reservoir and working areas, indemnification and resettlement, and relocation of existing road which will submerge in the reservoir.

(b) Quantities of civil works

Quantities of the civil works are calculated on the basis of the preliminary drawings prepared in accordance with 1/2000 scale maps newly surveyed at the site and the results of field investigations by test pits and core drillings.

(c) The hydraulic equipment including spillway, intake and draft gates, etc. and electrical equipment including turbines, generators and main transformers, etc, are all assumed to be manufactured and imported from abroad. The costs for equipment are estimated on the basis of FOB prices plus ocean freight, insurance premium, landing charges and custom duties, and the costs for transportation in Thailand and installation at the site.

(d) The costs of preparation works include acquisition of land in the reservoir and working areas, indemnification and resettlement, relocation of the highway and temporary camp facilities.

(e) Interest during construction

Interest during construction is estimated on the basis of annual fund requirements shown in Table 8-2 and the rate of interest is 7.5 percent on both foreign and domestic currency portions.

(f) Engineering fee

The engineering fee includes the costs for detail design, preparation of the tender documents and supervision service of the construction works.

(g) Contingency

Reasonable amount of contingency by each item of work is estimated and summarized.

(h) Classification of foreign and domestic currency funds

The construction costs are estimated by dividing them into foreign and domestic currency portions. The domestic currency portion includes the wages of local workers, living expenses for foreign workers and engineers, the costs of materials procured in Thailand, custom duties levied on imported materials and equipment and transportation cost in Thailand. All other consts are included in the foreign currency portion.

8.2 Estimated construction cost

The total cost required for construction of the Ban Tha Thung Na power plant is estimated at 847,400,000 Baht. Of this amount, foreign and domestic currency portions are 486,600,000 Baht and 360,800,000 Baht, respectively as listed in Table 8-1.

Table 8-2 shows the annual fund requirements estimated on the basis of following terms of payment.

(a) Civil works

An advance payment equivalent to 10 percent of the contract price will be made upon conclusion of a contract and this advance payment will be recovered in an amount equivalent to 10 percent of each monthly statement until the cumulative of payment covers the said advance payment.

(b) Hydraulic equipment

Payment for the hydraulic equipment will be made at the rate of 10 percent of the CIF price upon conclusion of the contract, 60 percent at shipment, 20 percent upon completion of the installation works and 10 percent after the issue of the final acceptance certificate. For the installation works, payment will be made at the rate of 20 percent at the start of installation, 40 percent upon completion of the installation works and 40 percent after the issue of the final acceptance certificate.

(c) Electrical equipment

Payment for the electrical equipment will be made at the rate of 90 percent of the CIF price at shipment and 10 percent after the issue of the final acceptance certificate. For the installation works, payment will be made at the rate of 20 percent at the start of installation, 40 percent upon completion of the installation works and 40 percent after the issue of the final acceptance certificate.

Table 8 - 1 Construction Cost

(Unit : 1, 000 Baht)

Works	Estimated construction cost		
	FC portion	DC portion	Total
(A) Generating facilities	373, 357	285, 211	658, 568
(a) Preparation works	910	41, 190	42, 100
(b) Civil works	116, 355	169, 102	285, 457
(c) Hydraulic equipment	44, 092	21, 369	65, 461
(d) Electrical equipment	212, 000	53, 550	265, 550
(B) Engineering fee	33, 000	-	33, 000
(C) Interest during construction	47, 800	39, 800	87, 600
(D) Contingency	32, 443	35, 789	68, 232
Total	486, 600	360, 800	847, 400

Table 8 - 2 Annual Expenditure Schedule

(Unit : 1, 000 Baht)

Works	1977		1978		1979		1980	
	FC	DC	FC	DC	FC	DC	FC	DC
Preparation works	-	11,000	670	24,150	240	6,040	-	-
Civil works	11,636	16,910	39,380	64,242	46,898	65,989	18,441	21,961
Hydraulic equipment	2,015	-	14,485	-	19,208	15,167	8,384	6,202
Electrical equipment	-	-	1,400	1,200	185,800	38,330	24,800	14,020
Sub - total	13,651	27,910	55,935	89,592	252,146	125,526	51,625	42,183
Engineering fee	15,500	-	6,600	-	6,600	-	4, 300	-
Interest during construction	1,750	1,230	4,960	6,360	17,970	15,410	23,120	16,800
Contingency	2,049	4,790	7,365	14,408	18,254	11,974	4,775	4,617
Total	32,950	33,930	74,860	110,360	294,970	152,910	83,820	63,600

CHAPTER 9 ECONOMIC JUSTIFICATION

9.1 Selection of alternative thermal power plant

The economic justification of the Ban Tha Thung Na Project is evaluated on the basis of a 300 MW oil fired thermal power plant around Bangkok equivalent to the maximum unit capacity of the existing high efficiency thermal power plant of EGAT. The annual cost of the alternative thermal power plant is broken down into fixed and variable costs which are estimated at 957 Baht/kW and 0.41 Baht/kWH, respectively. The construction cost, general features and annual costs of the alternative thermal power plant are as shown in Table 9-1.

9.2 Annual cost factor and benefit of hydro-electric power plant

The annual cost factor of a hydro-electric power plant is estimated, as shown in Table 9-2, at 9.31 percent on the basis of annual interest rate of 7.5 percent and, 50 and 25 serviceable years for civil constructions and generating facilities, respectively. The construction cost of the transmission line is deemed extremely small having no effect on calculation of the annual cost factor and therefore, it is neglected.

The annual benefit of a hydro-electric power plant is calculated on the basis of the benefit per kW and per kWH. The benefit per kW is to be the product of the annual fixed cost per kW of the alternative thermal power plant multiplied by a kW adjustment factor. The thermal power plant has a larger outage factor than the hydro-electric power plant due to accidents and also scheduled maintenance. Therefore, if a thermal power plant is newly constructed, it will need to have additional supply capability corresponding to this outage factor. The necessity of having additional equipment, which is considered to be extra advantage of the hydro-electric power plant over the thermal power plant, is the kW adjustment factor which is taken to be 15 percent in this report. The benefit per kWH is the annual variable cost per kWH of the alternative thermal power plant. Consequently, the benefit per kW and per kWH of a hydro-electric power plant are calculated to be 1,100 Baht/kW and 0.41 Baht/kWH respectively.

9.3 Economical justification of Ban Tha Thung Na Project

Table 9-3 shows the results of economic studies of the Ban Tha Thung Na Project based on the above-mentioned values. As the river discharge in the upstream basin is annually regulated by the Ban Chao Nen reservoir, it is capable of producing a large amount of annual energy with comparatively small generating facilities giving large kWH benefit to the Project. The excess annual benefit and benefit-cost ratio of the Project are 25,360,000 Baht and 1.32, respectively and the project is justified to be feasible.

In Table 9-3, calculations corresponding to 8 cases classified by various power discharges are also shown in order to determine the optimum scale of the power plant. It is concluded that the power plant using the whole of the power discharge of the Ban Chao Nen power plant, that is, the power plant with a maximum discharge of 290 m^3/sec and maximum installed capacity of 37,000 kW is most economical.

Since annual interest rate of 7.5 percent is adopted in the calculation, there will be no substantial effect on the comparative studies mentioned above even some modification of the rate is taken into consideration.

Table 9-1 Alternative Thermal Power Plant

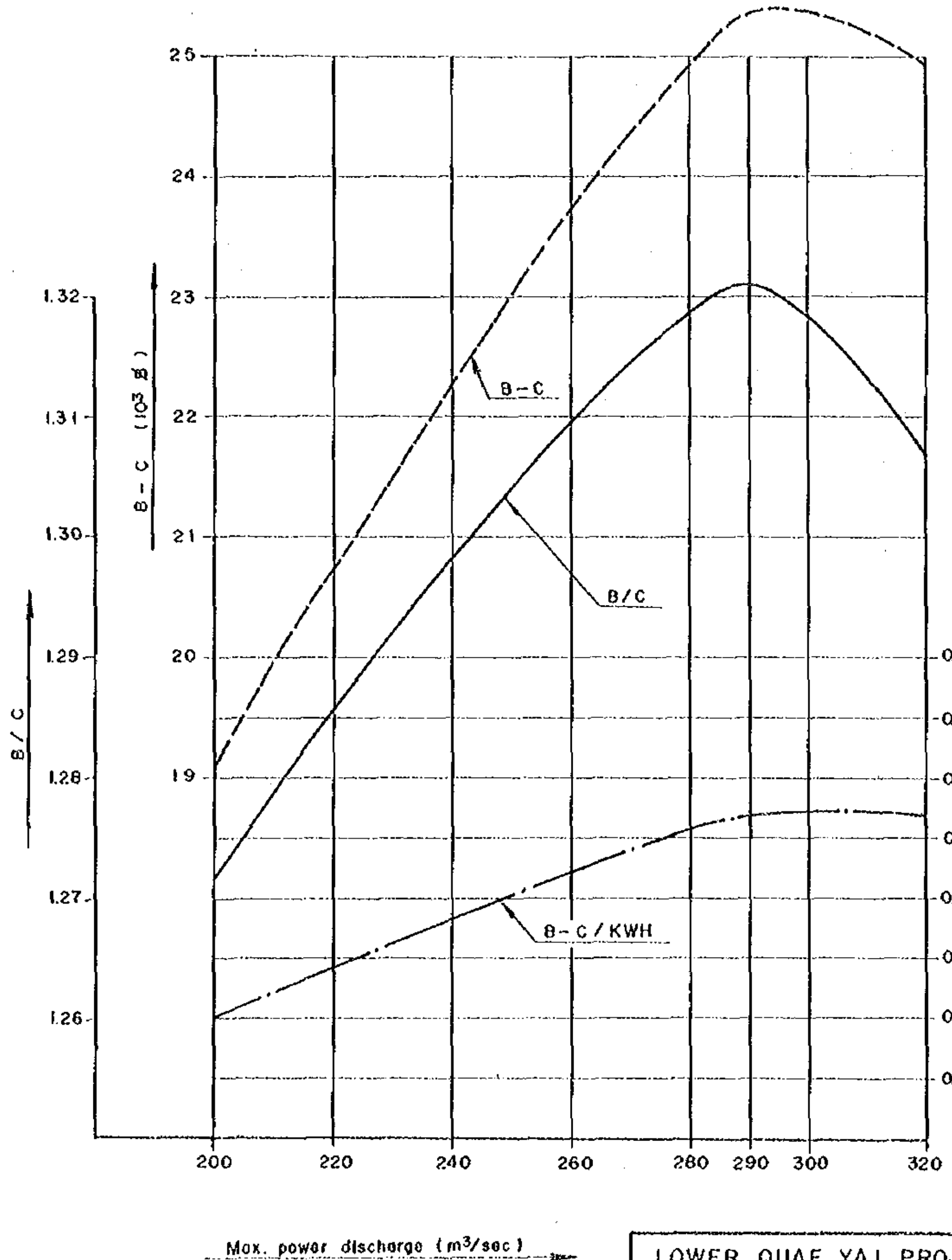
Plant capacity	300,000 kW
Plant factor	70 %
Annual energy production	1,839.6 million kWH
Station service use	5 %
Thermal efficiency at sending end	36 %
Construction cost	2,400 million ฿
Serviceable life	25 years
Annual interest rate	7.5 %
Annual cost	
Fixed cost	
Amortization	215,280,000 ฿
Operation and maintenance	48,000,000 ฿
Annual salaries	5,760,000 ฿
Administration cost	3,840,000 ฿
Sub-total	272,880,000 ฿ (957 ฿/kW)
Variable cost	
Fuel cost	717,400,000 ฿
Sub-total	717,400,000 ฿ (0.41 ฿/kWH)
Total	990,280,000 ฿

Table 9-2 Annual Cost

Item	Generating plant
Serviceable year	50 years (Civil constructions)
	25 years (Generating facilities)
Annual interest rate	7.5 %
Annual cost	
(1) Amortization	8.01 %
(2) Operation and maintenance	1.0 %
(3) Administration	0.3 %
Total	9.31 %

Table 9-3 Economical Comparison of Development Scale

Max. discharge (m^3/sec)	200	220	240	260	280	290	300	320
Effective power (kW)	26,800	29,200	31,400	33,600	35,800	37,000	38,000	39,700
Annual effective energy (10^3kWH)	146,900	149,800	152,200	154,700	154,900	155,000	154,100	152,500
kW benefit (10^3 ฿)	29,480	32,120	34,540	36,960	39,380	40,700	41,800	43,670
kWH benefit (10^3 ฿)	60,230	61,420	62,400	63,430	63,510	63,550	63,180	62,530
Total benefit (B) (10^3 ฿)	89,710	93,540	96,940	100,390	102,890	104,250	104,980	106,200
Construction cost (10^3 ฿)	758,000	778,100	802,050	823,430	838,780	847,400	855,600	872,500
Annual cost (C) (10^3 ฿)	70,570	72,440	74,670	76,660	78,090	78,890	79,660	81,230
B/C	1.271	1.291	1.298	1.310	1.318	1.321	1.318	1.307
B - C (10^3 ฿)	19,140	21,100	22,270	23,730	24,800	25,360	25,320	24,970
(B - C)/kWH (฿/kWH)	0.130	0.141	0.146	0.153	0.160	0.164	0.164	0.164



LOWER QUAE YAI PROJECT

ECONOMICAL COMPARISON OF DEVELOPMENT SCALE

Fig. 9 - 1	1976

CHAPTER 10 INFLUENCES DUE TO FILLING RESERVOIR AND FLUCTUATION OF RIVER SURFACE

In and around the reservoir and working areas there will be no noteworthy environmental impact caused by construction of the Ban Tha Thung Na power plant. However, the following matters must be taken into consideration and scrupulous research and settlement therefor should be urgently made.

(1) Influences due to filling reservoir

Some of farm houses and small existing farm lands scattered along the banks of the Quae Yai River between the Ban Chao Nen and Ban Tha Thung Na power plants will be inundated due to filling the reservoir. On a terrace on the right bank just upstream of the Ban Tha Thung Na dam, there is also a wide plantation of sugar cane which will be inundated. There are ferryboats crossing the river near the Erawan Fall, however, practical trouble with ferrying resulting from fluctuating power discharge by peak operation of the Ban Chao Nen power plant will not be happen due to regulation effect of this reservoir.

Asphalt paved highway running along the Quae Yai River will be partially inundated as shown in Fig. 10-1. In relocating sections of this road lower than EL 62.00m, allowance for wave height above high water level must be taken into account, and it is required to reconstruct three sections of 2.6km in the downstream of Huai Sadong. The total length which require relocation is equivalent to approximately 6 percent of the existing highway between Ban Chao Nen and Ban La Ya. According to topographic conditions, it seems advantageous to heighten the existing road instead of detouring the existing road. In this case, it is desirable to embank highly permeable materials in consideration of fluctuation of the reservoir water surface and, therefore, direct transportation and embankment of excavated materials from rock foundation for the dam and other structures will be recommendable for economical road construction. The amounts of excavated materials and requirement for embankment will balance and, there is sufficient time before the final finishing works.

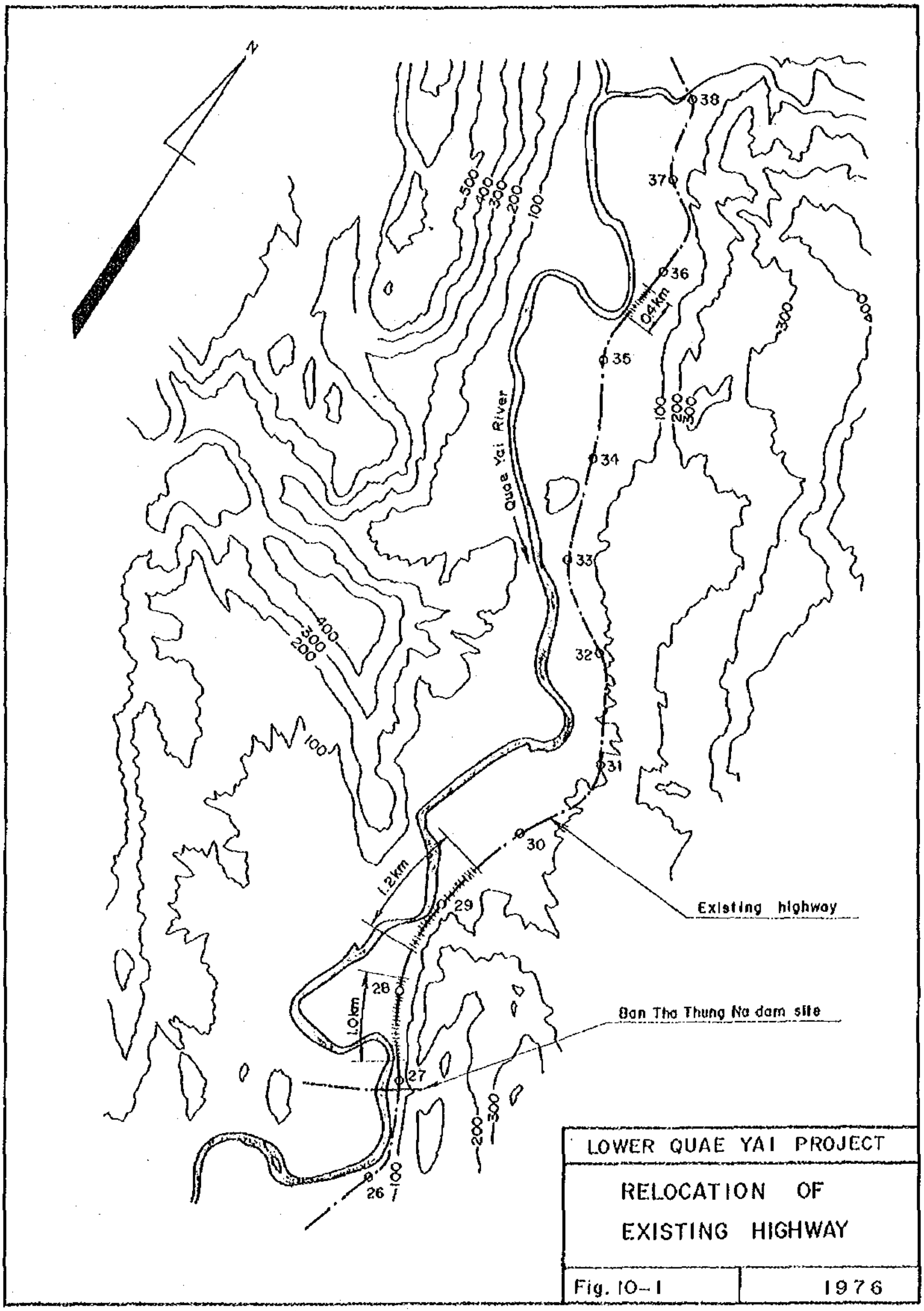
Beside the above, there are two schools to be inundated in the area upstream of the dam and the details of the objects to be inundated must be clarified by further field investigations.

(2) Influence due to fluctuation of river surface

The Ban Chao Nen power plant is required to operate for peak generation and, consequently, the river surface in the downstream basin will be subject to sharp fluctuation resulting from repeated power discharge of 798 m^3/sec to nil. However, both the maximum amplitude and hourly movement in the area upstream of this regulating dam will be greatly mitigated by operation of the Ban Tha Thung Na regulating reservoir and no water flow condition will also not occur. For the area downstream of the Ban Tha Thung Na dam, it must be studied taking into consideration the operation pattern of this power plant. Fluctuation of the river surface in the downstream basin varies depending on power discharge and peaking time of this power plant, and the results of mathematical analysis of fluctuation of the river surface at some downstream places for various peaking times t of 4, 8 and 12 hours are shown in Fig. 10-2 on the conditions that the maximum power discharge Qmax is 300 m^3/sec and minimum required discharge Qmin is 50 m^3/sec. The rise of the river surface at just downstream of dam will reach to 2.70 m for a short time, however, hourly fluctuation of river surface will show gradual decrement at Ban Vang Chan, Ban Nong Bua and the Vajiralongkorn headworks which are approximately 19.1 km, 39.7 km and 69.3 km respectively on the downstream. Especially at the Vajiralongkorn headworks, the said fluctuation becomes very small having no effect on the function of the same.

In the downstream basin of the dam, there are many houses existing along the banks of the Quae Yai River and the daily life of inhabitants seems to have close connection with the river and due consideration for prevention of accident by sharp fluctuation of the river surface must be made, especially in the area within 10 km downstream from the dam where the river surface shows comparatively quick rise.

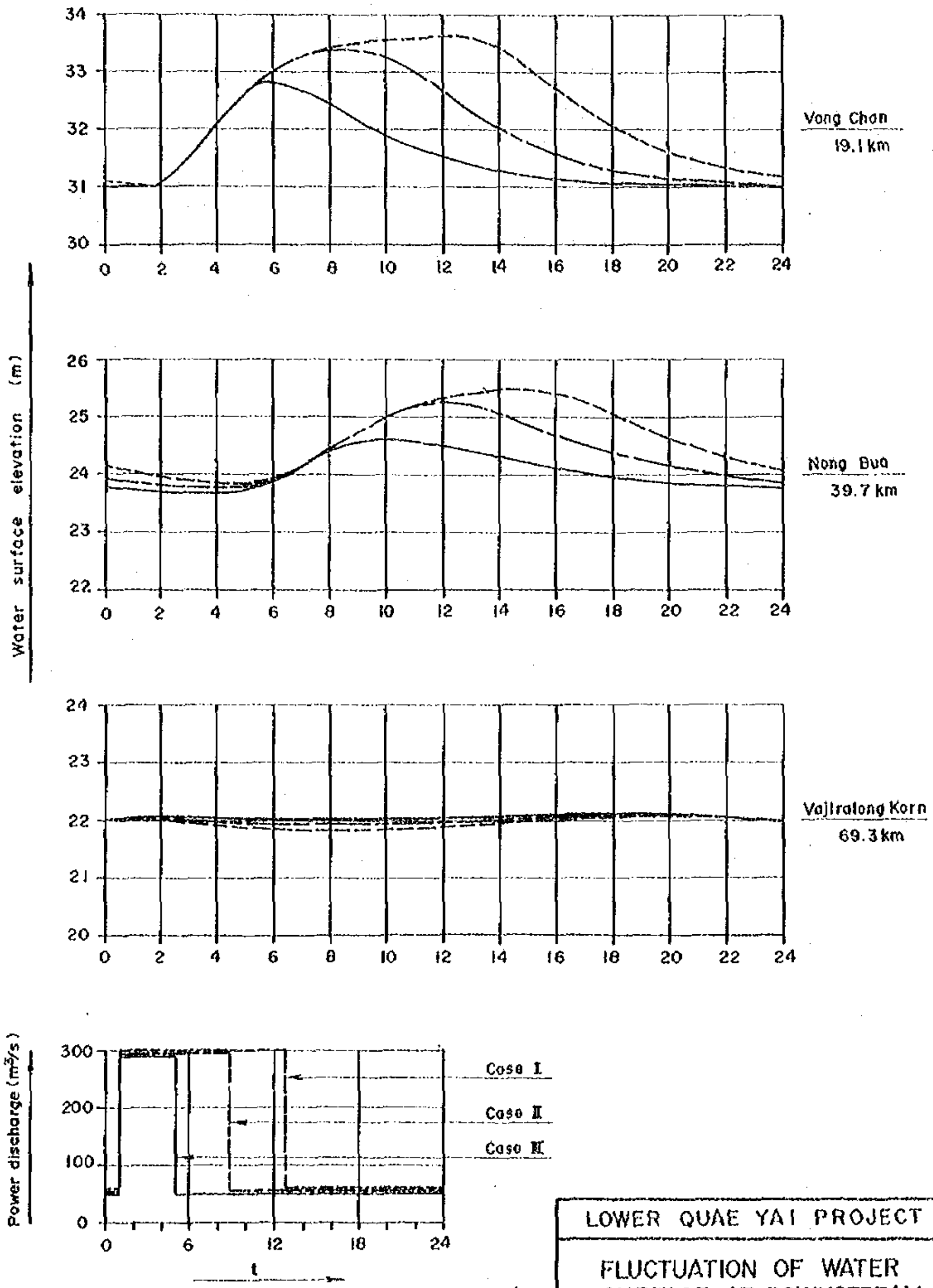
Traffic by boats cruising by the dam site at present must be closed but the said fluctuation of the river surface will have little influence on the boat traffic in the downstream basin.



LOWER QUAE YAI PROJECT

RELOCATION OF EXISTING HIGHWAY

Fig. 10-1 1976



LOWER QUAE YAI PROJECT

FLUCTUATION OF WATER SURFACE AT DOWNSTREAM AREA

Fig. 10-2 | 1976

CHAPTER 11. BAN THA THONG MON PUMPED-STORAGE SCHEME

11.1 Location of project

As a part of the power development scheme in the lower Quae Yai basin, the Ban Tha Thong Mon Pumped-storage Scheme has been planned by utilizing the Ban Tha Thung Na reservoir for lower Pondage. This project was proposed in the Reconnaissance Report, Upper Quae Yai Hydro-electric Project, Appendix B, November 1973 and preliminary studies were made in that Report.

The pumped-storage project is located, as shown in Fig. 11-1, approximately 9km downstream of the Ban Chao Nen power plant taking advantage of the steep configuration close to the right bank of the Ban Tha Thung Na reservoir. There exists table land favorable for construction of upper pondage at an elevation of about 600m providing the topography desirable for pumped-storage scheme. This project has also a siting advantage of short distance from the thermal power plants around Bangkok or future nuclear power plants which will supply the power for pumping-up operation.

In the Reconnaissance Report mentioned-above, three sites D_A, D_B and D_C were proposed taking into consideration topographic conditions for constructing the upper pondage, and economic comparisons were made. It is considered that the said comparisons are still applicable at this stage. However, D_A plan which will cause serious damage on the Erawan Fall was dropped from consideration and D_B plan was selected as the most feasible site taking also the results of economic comparison into consideration.

It seems that there is little justification to proceed with urgent development of this project in the future power development program of EGAT. Following are the preliminary studies on timing and scale of development of this project.

11.2 Future daily load duration curve and energy for pumping-up operation

It is estimated that the present daily load duration curve of the EGAT system will make little change in the future. The annual load factor of the EGAT power system in 1990 is estimated to be about 67 percent which is almost the same as present one of about 66 percent. Accordingly, future load duration curve is drawn on the basis of actual value in 1975.

The following four time targets were picked up for study: 1980, 1985, 1986 when nuclear power plant will be completed providing substantial amount of power source for pumping-up operation and 1990. Actual load allocation to each type of power source by year will be a little different from that of Fig. 11-2 in which nuclear and thermal power plants are to be operated in such a manner as to supply base portion of load duration curve up to their maximum capacities in order to find out the maximum available power source for pumping-up operation, and available power sources thus estimated are 500 MW, 430 MW, 940 MW and 930 MW at the respective times shown in the same figure.

11.3 Timing and scale of development

Following are the results of studies on timing of development of the Ban Tha Thong Mon Pumped-storage Hydro-electric Project.

Namely, available power source is estimated at approximately 940 MW in 1987 when pumping-up operation of the second stage Ban Chao Nen power plant will be put in service. The required power for pumping-up operation of the said plant will be approximately 400 MW and there remains a margin of approximately 550 MW for pumping-up operation of the other project. The situation will remain unchanged until 1990.

However, as described previously in sub-clause 3.2.3 on power demand and supply balance, nuclear power plants are planned to be completed by 1987 at which time there will be a high rate of reserve capacity of approximately 20 percent, and it is considered not appropriate to construct new pumped-storage power plant at that stage. Furthermore, running cost for pumping-up operation will be rather high around 1987 as it is considered that the required power will be sent from oil fired thermal power plants being operated at present.

Under these circumstances, the timing of development of this pumped-storage project will be after 1990 when nuclear power plants are sufficiently developed and there are sufficient amount of energy available for pumping-up operation. It is forecasted that the total installed capacity after 1990 will be between 5,500 MW and 6,000 MW, and the appropriate development scale of this project will be about 500 MW which is equivalent to approximately 10 percent of the total generating capacity in view of its function of peak supplementation and emergency.

11.4 Ban Tha Thong Mon pumped-storage power plant

Owing to scanty information of topography as well as geology in the project area, the design of the power generating facilities is consequently of preliminary stage.

The general layout of the power generating facilities based on the above-mentioned development scale is as described below.

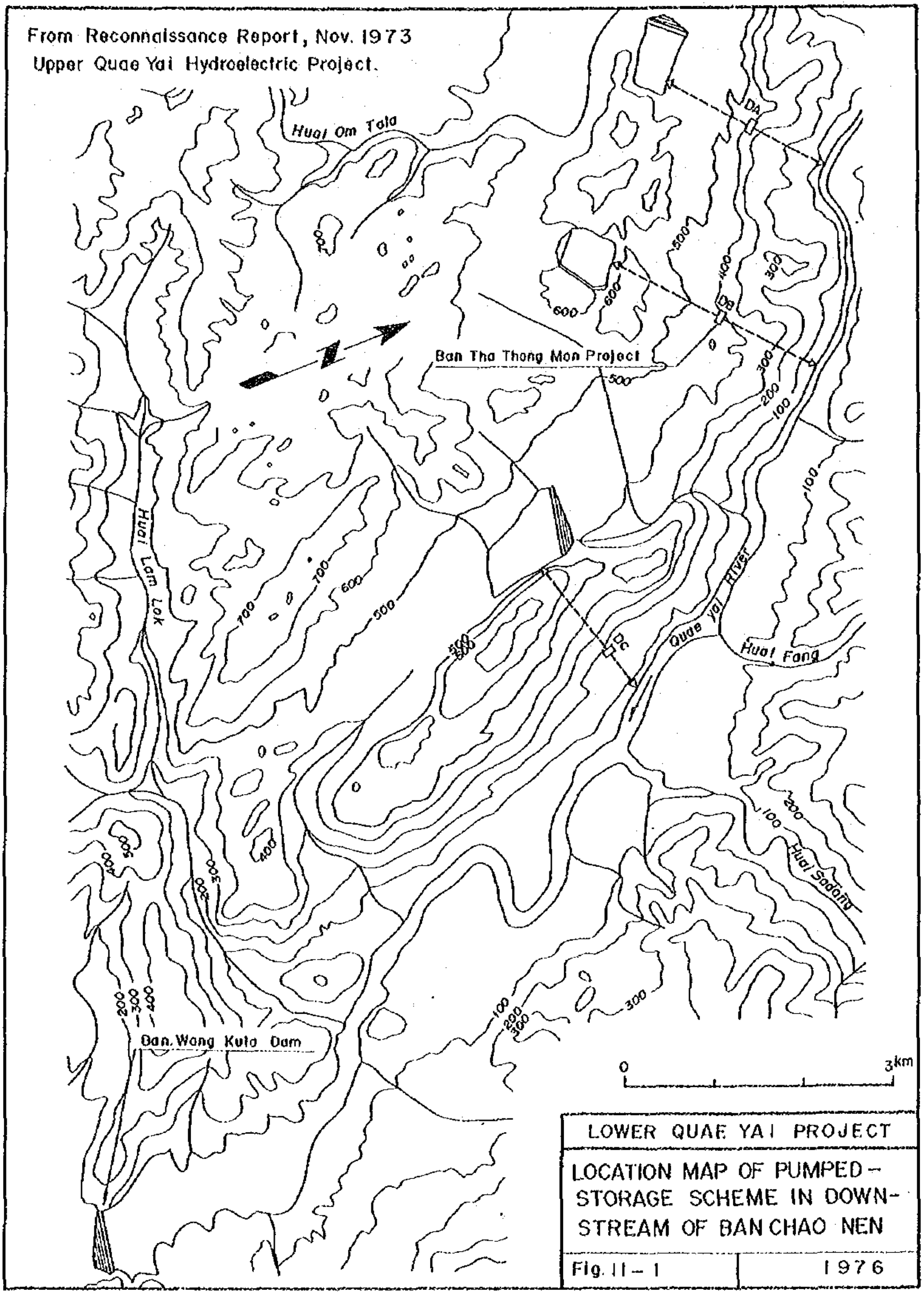
The upper pondage is to be constructed on a table land at elevation of about 600 m. All the inner surfaces made by embankment and excavation works must be protected with impervious asphalt surfacing. High water level, low water level, available drawdown and effective storage capacity of the upper pondage are 585 m, 560 m, 25 m and $3 \times 10^6 m^3$, respectively.

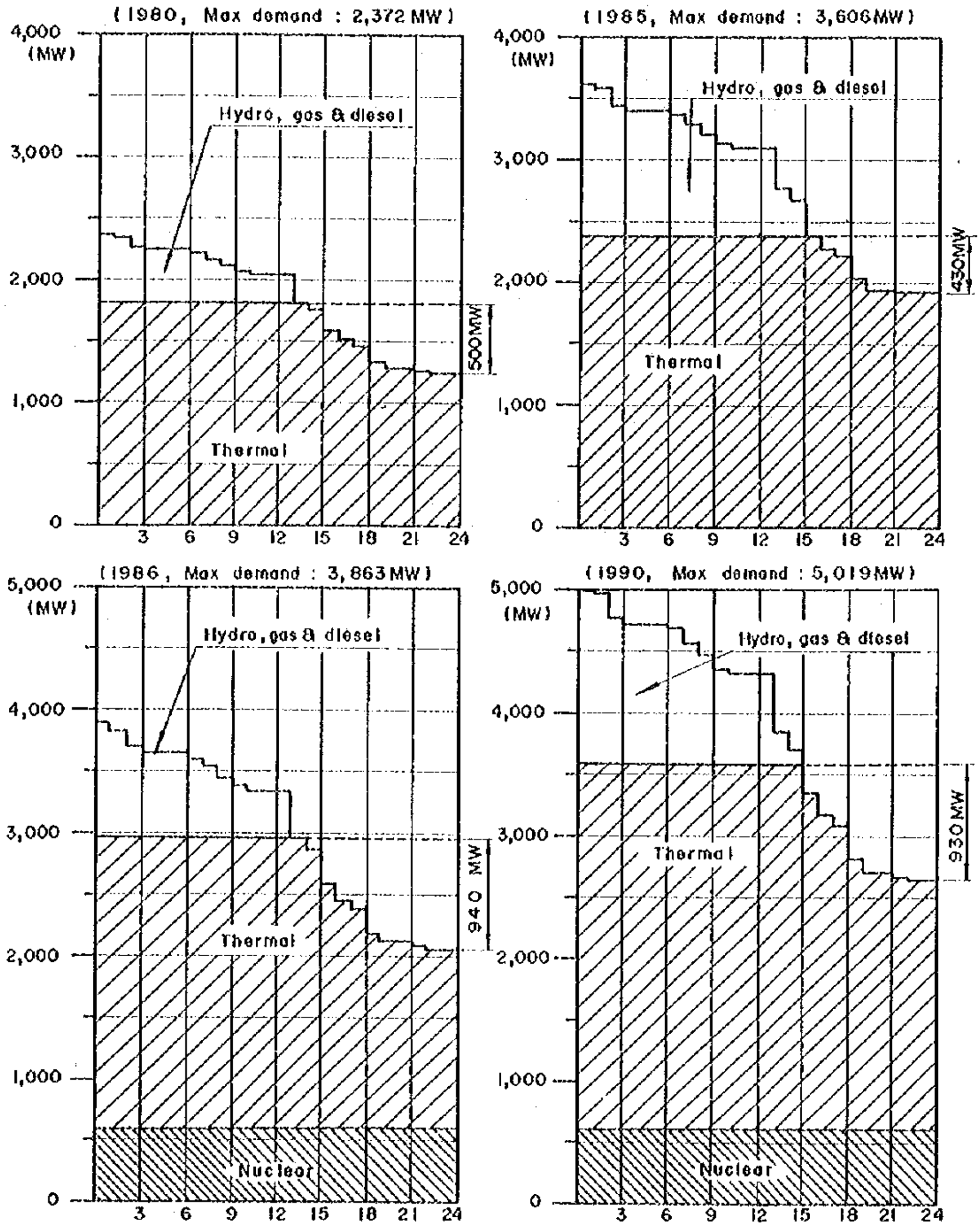
The intake structure is located at the bottom of the upper pondage. Lengths of the headrace tunnel and penstock are 56.56 m and 1131.26 m respectively and the penstock pipe branches midway into two lines. In the underground powerhouse of 22.00 m wide, 106.00 m long and 48.00 m high, two units of vertical shaft reversible Francis turbines, generators and other ancillary equipment will be installed.

The tailrace tunnel is 1644.50 m long and its reservoir side outlet functions as an inlet structure during pumping-up operation.

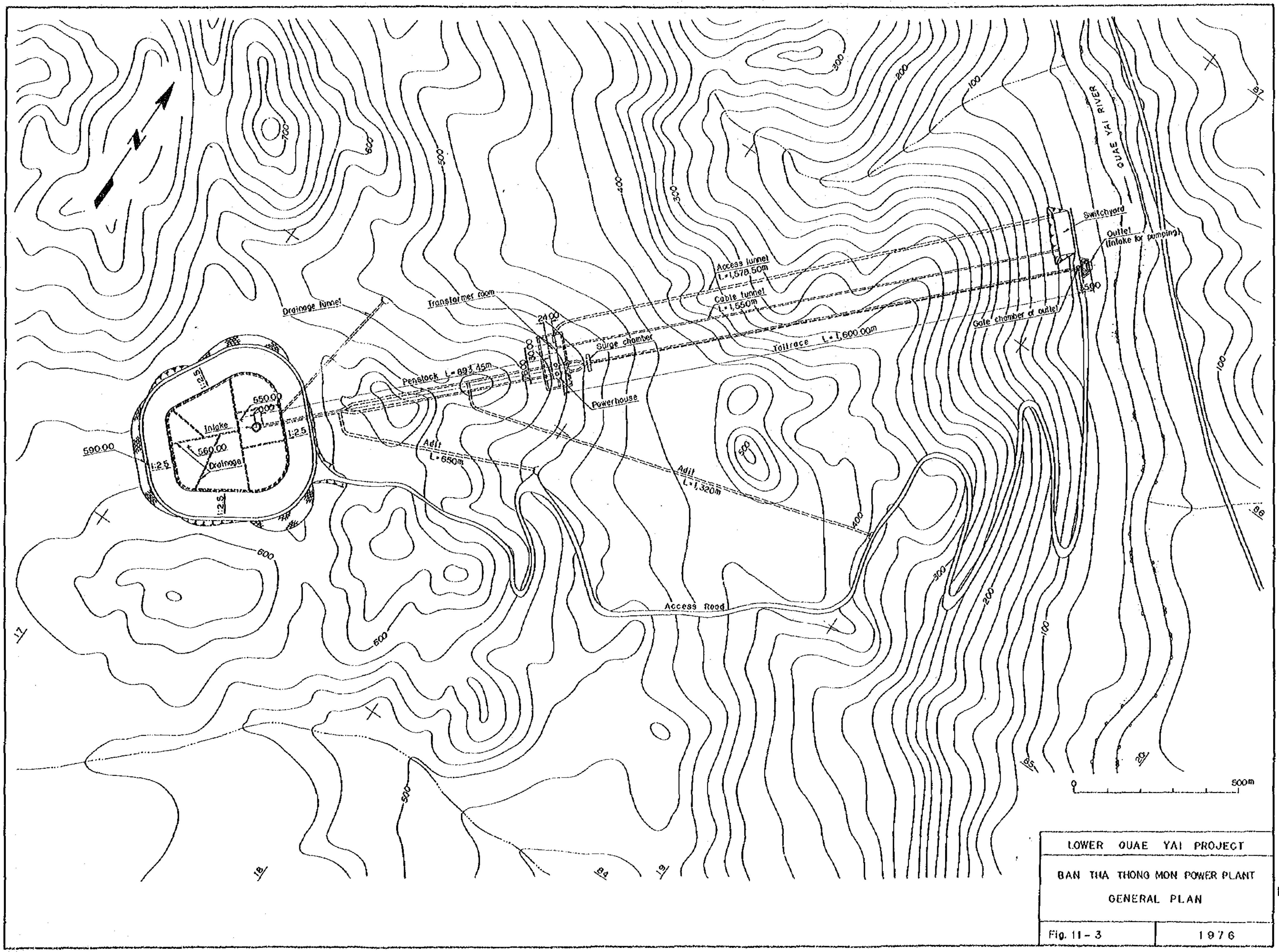
General arrangement and dimensions of principal features are shown in Fig. 11-3 and Fig. 11-4, and power development plan is shown below.

Maximum discharge	124 m^3/sec (62 m^3/sec x 2)
Gross head	518.40 m
Rated head	494.40 m
Maximum output	500,000 kW
Number of units	2


From Reconnaissance Report, Nov. 1973
Upper Quae Yai Hydroelectric Project.
Huai Om Tala
DA
DB
DC
Ban Tha Thong Mon Project
Huai Lam Lok
Quae Yai River
Huai Fang
Ban Wang Kula Dam
0
3km
LOWER QUAE YAI PROJECT
LOCATION MAP OF PUMPED-STORAGE SCHEME IN DOWN-STREAM OF BAN CHAO NEN
Fig. II - 1
1976



LOWER QUAE YAI PROJECT	
DAILY LOAD DURATION CURVE	
Fig. II-2	1976



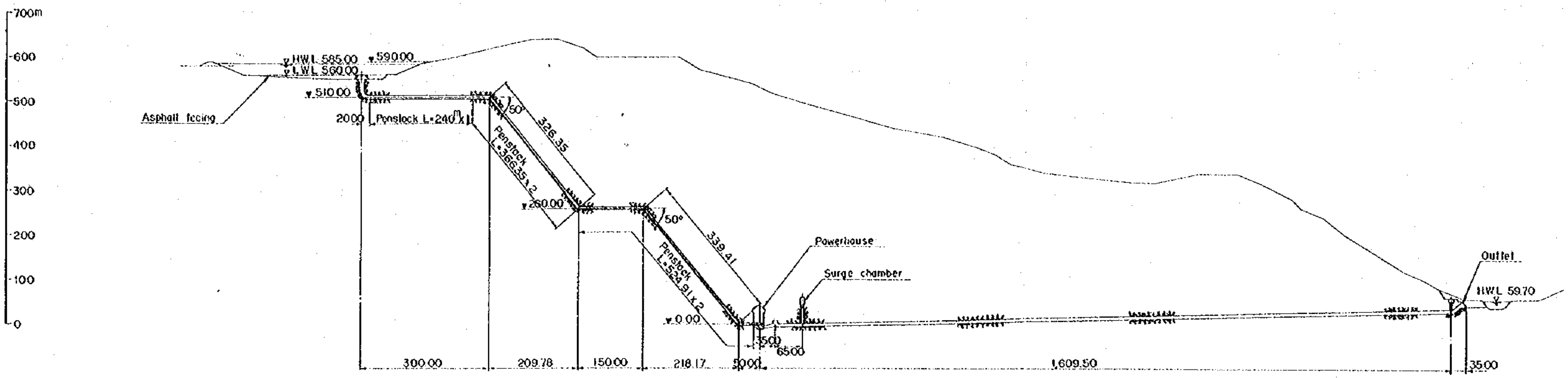
LOWER QUAE YAI PROJECT

BAN THA THONG MON POWER PLANT

GENERAL PLAN

Fig. 11-3 1976

PROFILE OF WATERWAY



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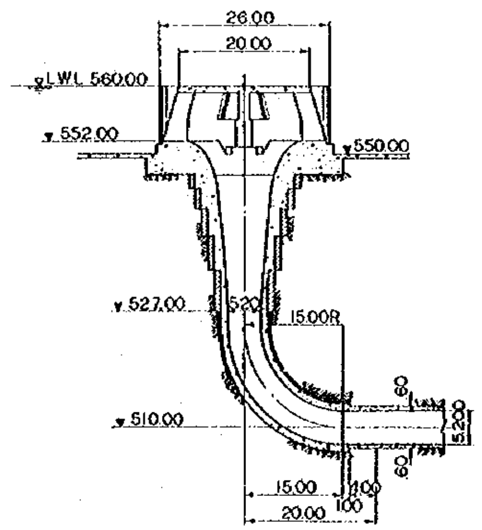

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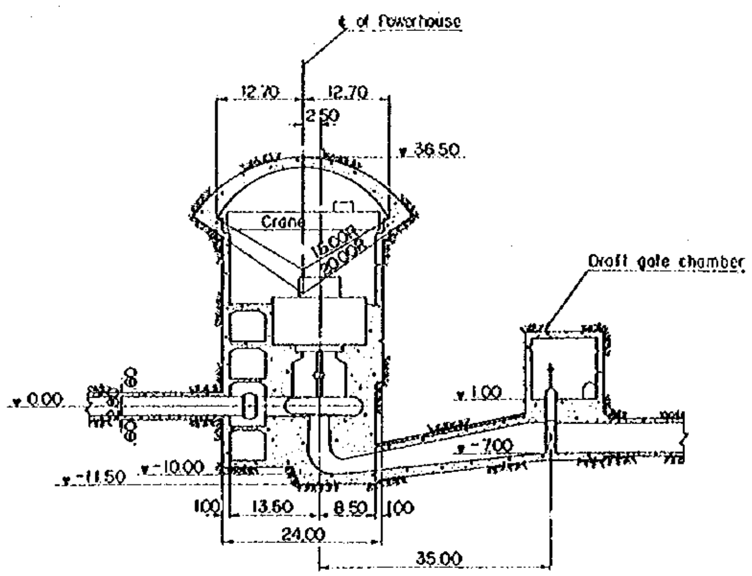

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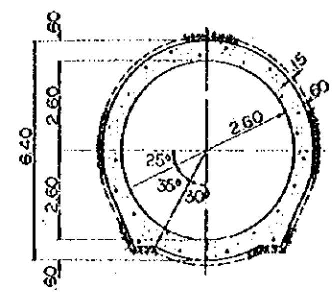

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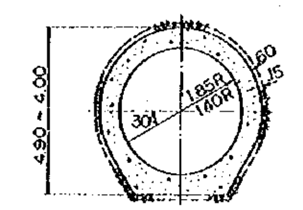

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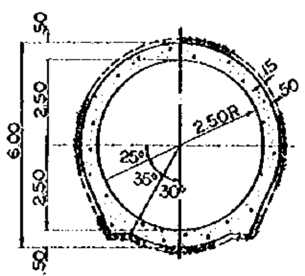
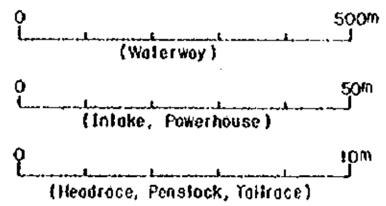




LOWER QUAE YAI PROJECT	
BAN THA THONG MON POWER PLANT PROFILE	
Fig. II-4	1976

APPENDIX

APPENDIX

(A) Topographic map

Scale	Sheet	Remarks
1 : 250,000	2	Sheet No. ND47-7, NE47-11
1 : 50,000	2	Sheet No. 4837III, 4837IV
1 : 5,000	6	Covering Ban Chao Nen, Ban Tha Thung Na area No. 1 - No. 6
1 : 5,000	7	Plan and longitudinal section of Quae Yai River between Ban Chao Nen and Ban Tha Thung Na sites No. 8QY-SV-001, Sheet No. 1 - No. 7
(1 : 100 (1 : 1,000	6	Cross section of Quae Yai River between Ban Chao Nen and Ban Tha Thung Na sites T-001 - T-0074
1 : 2,000	3	Ban Tha Thung Na dam site No. 1 - No. 3

(B) Bibliography

1. Geologic Reconnaissance of the Mineral Deposits of Thailand, 1953 by Brown, G.F. et al.

2. Geological Map of Thailand (1 : 1,000,000), 1969 by Department of Mineral Resources, Thailand.

3. Evaluation of Photographical Survey of Quae Yai No. 1 Project, 1971 by Electric Power Development Co., Ltd.

4. The Greater Me Klong Multi-purpose Project, Thailand, Second Stage Development for Irrigation, Flood Control and Hydro Power, August, 1968 by Royal Irrigation Department.

5. Feasibility Report, Quae Yai No. 1 Hydroelectric Project, March 1968 by Electric Power Development Co., Ltd.

6. Reconnaissance Report, Upper Quae Yai Hydro-electric Porject, November 1973 by Overseas Technical Cooperation Agency, Government of Japan.

7. Handbook of Applied Hydrology by Ven Te Chow

(C) Log of Core Boring

Location	Sheet	Remarks
Ban Tha Thung Na	33	Sheet No. 1 - No. 33

(D) Suspended Sediment Discharge Record

Location	Sheet	Remarks
Ban Chao Nen	2	1972 - 1973

(E) Hourly Reinfall Record

Location	Sheet	Remarks
Ban Chao Nen	29	May 1973 - Oct. 1975 (May 1974 missing)
Hard Pana	28	May 1973 - Oct. 1975 (June and Sept. 1974 missing)

(F) Water Level and Discharge Record

Location	Sheet	Remarks
Ban Chao Nen	4	Apr. 1972 - Mar. 1974
Khao Salob	2	Apr. 1974 - Mar. 1975
Ban Wang Chan	6	Apr. 1972 - Mar. 1975
Ban Nong Bua	6	Apr. 1972 - Mar. 1975

LOG OF CORE BORING

Sheet No. 1

River: Quae Yai — Site: Ban Tha Thung Na — Boring No. BR-1 (sheet 1 of 2)

Location	Right Bank, Damsite	Depth of hole	40.0 m	Commenced	Oct. 24 1975
Elevation	45.48 m	Depth of overburden	13.7 m	Completed	Dec. 8 1975
Angle from horizontal	90°	Total length of core	11.30 m	Boring machine	Acker No.2
Bearing of angle hole	—	Core recovery	62.1 %	Drilled by	Tanit (EGAT)
				Logged by	

Column headings: Date | Depth (m) | Geology | Symbol of geology | Core recovery (%) | Cementation, Casing | Kind of bit, Diameter of hole | Description: Colour of rock, Degree of weathering, Degree of hardness, Degree of fissure, crack (1↔5), Remarks | Drill, Pressure (kg/cm²), Time (min.) | Water Pressure Test: Loss Water (l/min.), Pressure (kg/cm²), Drill, Supply water, Leakage water (l/min.) | Depth (m)

Date	Depth (m)	Geology	Casing / Bit	Colour of rock	Weathering	Hardness	Fissure, crack	Remarks
	0–3.6	Sand	Ø 4" C.P.; Ø 114 mm					Mostly yellowish brown – light brown, fine grained sand, a few pebbles and gravels (Ø 2mm ~ 10mm).
	3.6–11.3	Sand and Gravel	NX. C.P.; NX. Casing Shoe Bit Ø 91.3 mm					3.6 Mostly white – light brown, medium grained sand, some gravels (Ø 5 ~ 20mm)
	11.3–13.7	Gravel						Rounded gravels with a few medium grained sand. Gravel size Ø 10mm ~ 50mm
Nov. 28	13.7–14.1	LIMESTONE	AX. C.P.; NXM Ø 63mm	grey	3	2~(3)	2	13.7 Many calcite veins. Somewhat brittle in part.
	14.1–15.4				No	core		Cavity?
	15.4–15.6			grey	3	3~2	3	Slightly disturbed, rather brittle.
	15.6–16.15				No	core		Cavity?
	16.15–16.6			grey	3	3~(4)	3~4	Somewhat cracky.
	16.6–17.3				No	core		Cavity?
Nov. 29	17.3–18.6			dark grey	3	3 ~ 2	2 ~ 3	Muddy LIMESTONE, many CALCITE veins, slightly brittle in general.
	18.6–20				No	core		Cavity?

0.-13.7 River deposits.

No record of G.W.L.

13.7 – 18.6 As a whole grey LS, with many CALCITE veins, slightly brittle, bedding not clear.

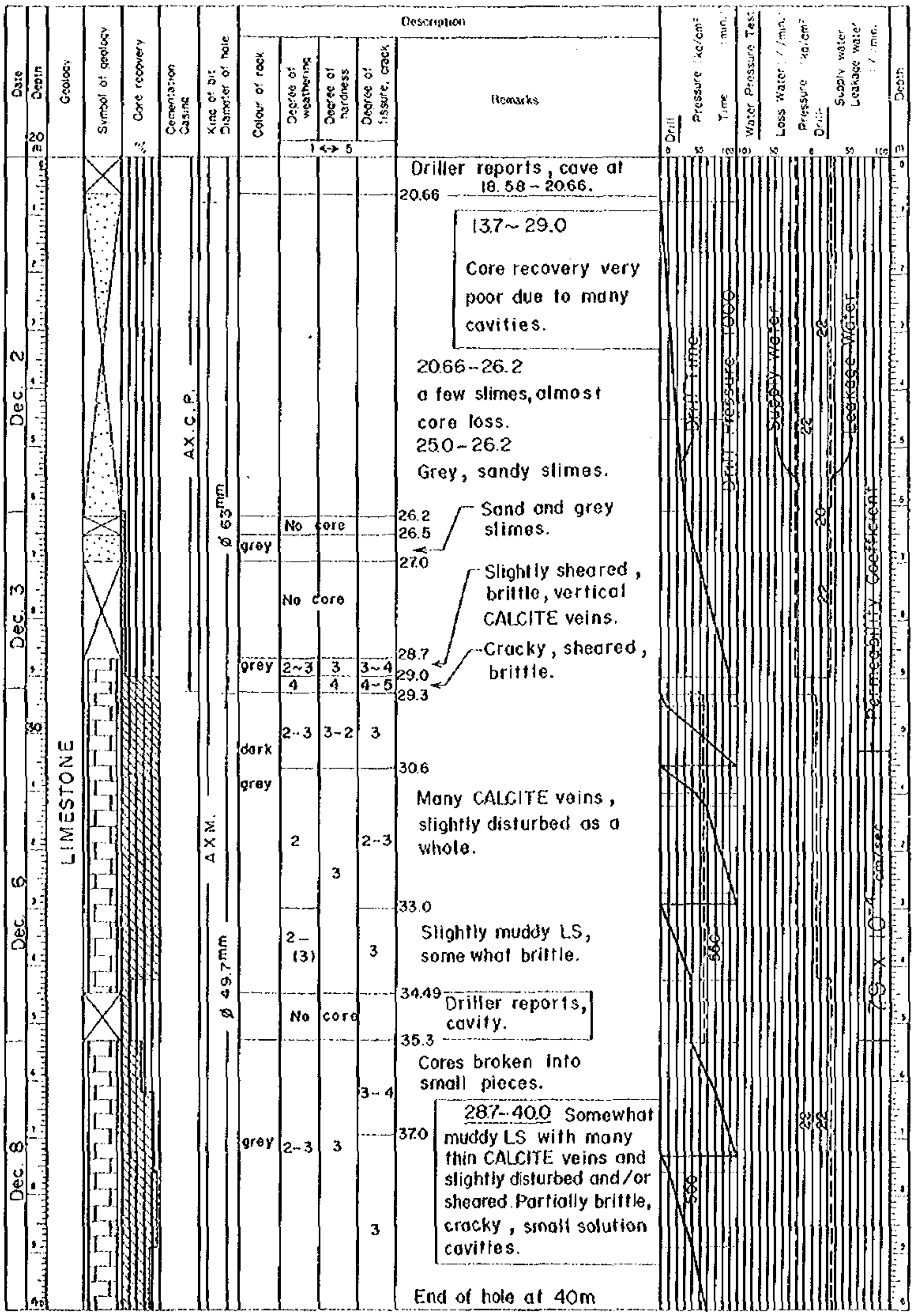
Drill Time; Drill Pressure 1000; Supply Water; Leakage Water

LOG OF CORE BORING

Sheet No. 2

River: Quae Yai | Site: Ban Tha Thung Na | Boring No. BR-1 (sheet 2 of 2)

Location	Right Bank, Damsite	Depth of hole	40.0 m	Commenced	Oct. 24 1975
Elevation	45.48 m	Depth of overburden	13.7 m	Completed	Dec. 8 1975
Angle from horizontal	90°	Total length of core	11.30 m	Boring machine	Acker No.2
Bearing of angle hole	—	Core recovery	52.1 %	Drilled by	Tanit (EGAT)
				Logged by	



LOG OF CORE BORING

Sheet No. 3

River Quae Yai — Site Ban The Thung Na — Boring No. BR-2 (sheet 1 of 2)

Location	Right Bank, Damsite	Depth of hole	26.2 m	Commenced	Jan. 23 1976
Elevation	44.11 m	Depth of overburden	11.2 m	Completed	Feb. 13 1976
Angle from horizontal	90°	Total length of core	15.00 m	Boring machine	UNEX Junior A.1
Bearing of angle hole	—	Core recovery	100 %	Drilled by	Yosamuth; S. (UNEX.)
				Logged by	

Date	Depth (m)	Geology	Casing	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks
Jan. 23	0 – 4.0	Sand and Silt	NX. C.P.	NX. Casing Shoe Bit, ø 91.3 mm					Topsoil and fine grained sand and/or silt. Final G.W.L. EL. 40.51 ▽3.6
Jan. 24	4.0 – 6.5	Sand							Coarse grained sand.
Jan. 25, Jan. 27, Jan. 28, Jan. 29	6.5 – 10.0	Gravel							Gravel.
Feb. 8, Feb. 9	10.0 – 11.2	Sand							Coarse grained sand.
Feb. 10, Feb. 11, Feb. 12	11.2 – 20	Calcareous SHALE		NMLC ø 76.2 mm	grey	2-1	3	4	Grey calcareous SHALE, fresh, but GRAPHITE films remarkable. Cores exfoliate easily.

Degree scale: 1 ↔ 5

Water pressure test columns: Drill, Pressure (kg/cm²), Time (min.), Water Pressure Test, Loss Water (ℓ/min.), Pressure (kg/cm²), Drill, Supply water, Leakage water (ℓ/min.)

Chart labels: Drill Time; Supply Water; Leakage Water; Permeability Coefficient; 1.6 × 10⁻⁵ cm/sec; 2.7 × 10⁻⁵ cm/sec

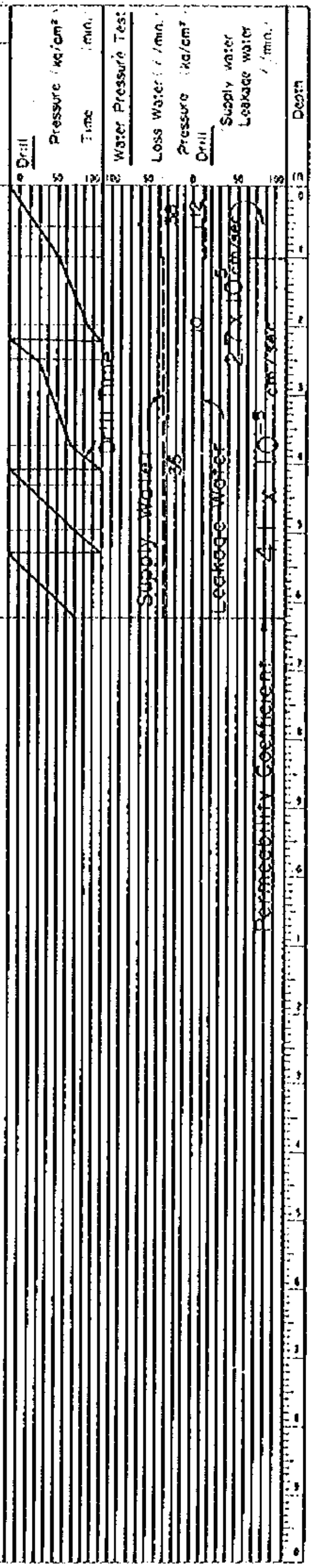
LOG OF CORE BORING

Sheet No. 4

River: Quae Yai — Site: Ban Tha Thung Na — Boring No. BR-2 (sheet 2 of 2)

Location	Right Bank, Damsite	Depth of hole	26.2 m	Commenced	Jan. 23, 1976
Elevation	44.11 m	Depth of overburden	11.2 m	Completed	Feb. 13, 1976
Angle from horizontal	90°	Total length of core	15.00 m	Boring machine	UNEX. Junior A. I
Bearing of angle hole	—	Core recovery	100 %	Drilled by	Yosomuth; S. (UNEX.)
				Logged by	

Date	Depth (m)	Geology	Symbol of geology	Core recovery (%)	Cementation Casing	Kind of bit Diameter of hole	Colour of rock	Degree of weathering (1↔6)	Degree of hardness (1↔6)	Degree of fissure, crack (1↔6)	Description: Remarks
Feb. 12 / Feb. 13	20–26.2	Calcareous SHALE				ø 76.2mm	grey	2–1	3	4	Grey calcareous SHALE, fresh, but GRAPHITE films remarkable. Cores exfoliate easily.
	26.2										End of hole at 26.2m



LOG OF CORE BORING

Sheet No. 5

River: Quae Yai | Site: Ban Tha Thung Na | Boring No. BR-3 (sheet 1 of 2)

Location	Right Bank, Damsite	Depth of hole	24.20 m	Commenced	Jan. 26 1976
Elevation	54.34 m	Depth of overburden	4.7 m	Completed	Feb. 10 1976
Angle from horizontal	90°	Total length of core	12.36 m	Boring machine	UNEX Junior A.3
Bearing of angle hole	—	Core recovery	63.4 %	Drilled by	Yasumuth; S. (UNEX)
				Logged by	—

Columns: Date | Depth (m) | Geology | Symbol of geology | Core recovery (%) | Cementation Casing | Kind of bit Diameter of hole | Description: Colour of rock, Degree of weathering, Degree of hardness, Degree of fissure, crack (1 <-> 5), Remarks | Drill: Pressure (kg/cm²), Time (min.) | Water Pressure Test: Loss Water (l/min.), Pressure (kg/cm²), Supply water, Leakage water (l/min.) | Depth

Depth (m)	Colour of rock	Weathering	Hardness	Fissure, crack	Remarks
0 – 4.7					Topsoil
4.7 – 7.0	grey	5	5	5	Strongly weathered SHALE, clayey as a whole.
7.0 – 8.0	black ~ brown	5~(4)	5~(4)	5	Black SHALE, flaky cores, weathered along cracks, brown.
8.0 – 8.65		No	core		Flaky cores.
8.65 – 9.2	grey	5~(4)	5~(4)	5	Gravelly cores, mostly 5cm long, all cracks weathered and brown.
9.2 – 10.35		4-5	3	4-5	
10.35 – 11.0		No	core		Core loss.
11.0 – 11.6	yel. grey	5	5	5	Black SH, flaky to gravelly cores, sheared zone?
11.6 – 12.5					
12.5 – 12.9					Slimes
12.9 – 13.0	grey	No	core		Core loss. (12.9–13.0 SHALE, flaky cores only.)
13.0 – 13.4		5 / No	5 / core	5	
13.4 – 14.3	black	5	5	5	Flaky cores only, sheared zone?
14.3 – 14.65	grey	No	core		
14.65 – 14.8					Grey, hard SANDSTONE, gravelly cores, Weathered along cracks.
14.8 – 15.05	black	3	3	4~5	Black SH.
15.05 – 15.3		No	core		
15.3 – 15.8	black	3	3	4~5	Black SH, somewhat sheared, gravelly cores.
15.8 – 16.65		No	core		
16.65 – 16.7		6	6	6	Fault breccias?
16.7 – 17.1		3	3	3	Black SH
17.1 – 18.0		5-4	5-4	5-4	Sheared zone, very weak, like coal.
18.0 – 21.2	black	3	3	3-4	18.0–21.2 Black SH, 3–10cm cores, very exfoliative along laminae, not weathered along cracks.

Dates: Jan. 26 (0 – ~7.0 m); Jan. 27 (~7.0 m); Jan. 30; Jan. 31; Feb. 2 (~12.7 m); Feb. 3; Feb. 4; Feb. 5; Feb. 6 (20 m).

Geology: Topsoil (0 – 4.7 m); SHALE (4.7 – ~12.5 m); SANDSTONE (~12.5 – 15 m); SHALE (15 – 20 m).

Cementation / Casing: NX. C.P. to 7.6m; Cementation (Feb. 1) to 12.5m; Cementation, 20m – 8m (Feb. 7).

Kind of bit / Diameter: Chopping Bit, ø 91.3 mm; NMLC, ø 76.2 mm.

Groundwater: ▽ 10.0 — Final G.W.L. EL. 44.34

Water Pressure Test: Drill Time; Supply Water; Leakage Water; Permeability Coefficient 2×10⁻⁵ cm/sec (approx.); 30; 35; 50; 0.

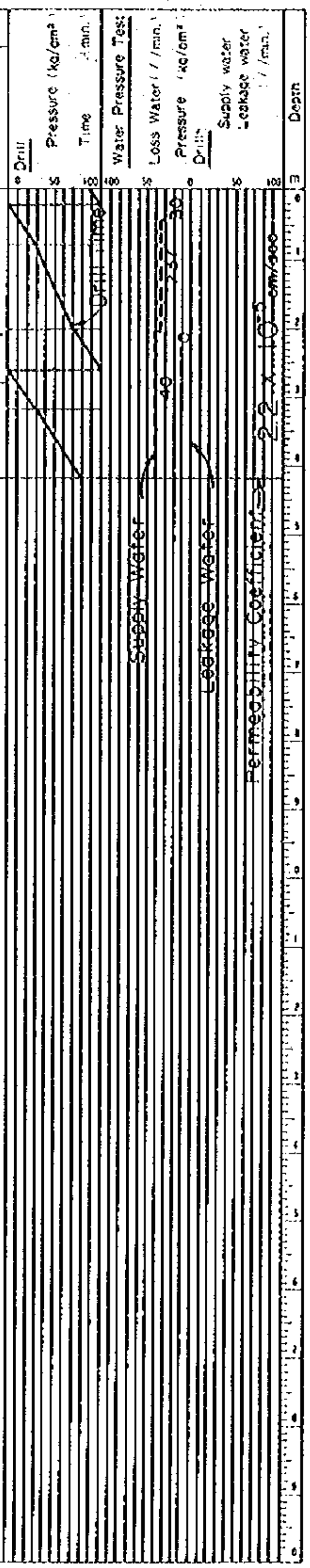
LOG OF CORE BORING

Sheet No. 6

River Quae Yai Site Ban Tha Thung Na Boring No. BR-3 (sheet 2 of 2)

Location	Right Bank, Damsite	Depth of hole	24.20 m	Commenced	Jan. 26 1976
Elevation	54.34 m	Depth of overburden	4.7 m	Completed	Feb. 10 1976
Angle from horizontal	90°	Total length of core	12.36 m	Boring machine	UNEX Junior A.3
Bearing of angle hole	—	Core recovery	63.4 %	Drilled by	Yasamuth, S. (UNEX)
				Logged by	

Date	Depth (m)	Geology	Symbol of geology	Core recovery %	Cementation Casing	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks
Feb. 9	20 – 21.2	SHALE				NMLC ø 76.2 mm			3	3-4	21.2
Feb. 9 / Feb. 10	21.2 – 22.8	SHALE				NMLC ø 76.2 mm	black	3	4-5	4-5	Flaky to gravelly cores, exfoliative, not weathered. 22.8
Feb. 10	22.8 – 24.2	Calc. SH				NMLC ø 76.2 mm			3	4-5	Black calcareous SH. not weathered, but sheared as a whole.
											End of hole at 24.2m



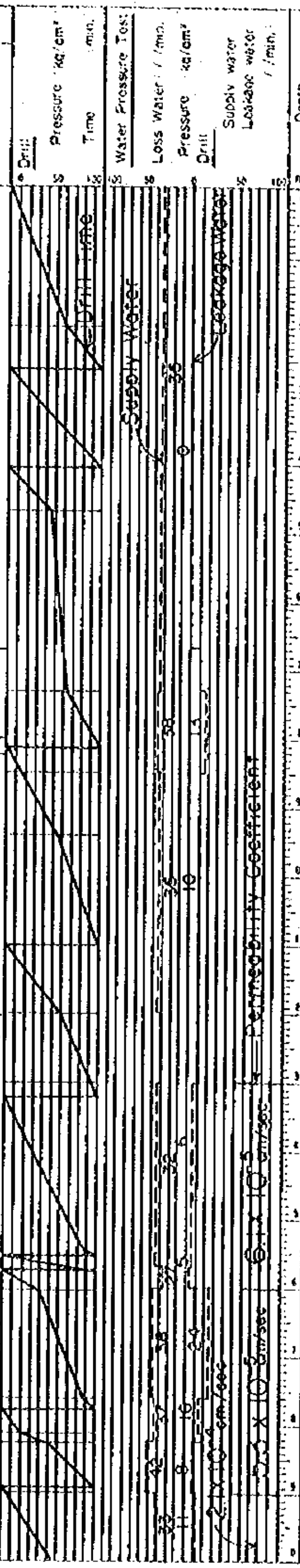
LOG OF CORE BORING

Sheet No. 7

River: Quae Yai | Site: Ban Tha Thung Na | Boring No. BR-4 (sheet 1 of 2)

Location	Right Bank, Damsite	Depth of hole	22.0 m	Commenced	Feb. 12 – 1976
Elevation	59.91 m	Depth of overburden	6.70 m	Completed	Feb. 21 – 1976
Angle from horizontal	90°	Total length of core	14.50 m	Boring machine	UNEX Junior A.3
Bearing of angle hole	—	Core recovery	96.7 %	Drilled by	Yosamuth, S. (UNEX)
				Logged by	

Date	Depth (m)	Geology	Kind of bit / Diameter of hole	Casing	Colour of rock	Degree of weathering (1↔5)	Degree of hardness	Degree of fissure, crack	Remarks
Feb. 12, Feb. 13	0–6.7	Silt	Fishtail Bit, ø 91.3mm	NX. C.P.					Overburden (silt) yellowish soil.
Feb. 14	6.7–8.00	SHALE			black ~ brown	4–5	4–5	4–5	Cracky, brittle, weathered along cracks.
	8.00–8.22				dark brown	5	5	5	Fault breccias, soft.
	8.22–8.40								Flaky cores.
	8.40–8.80					No	core		
	8.80–11.0					5	5	5	Cracks weathered to brn. Most cores flaky or sheared breccias. As a whole sheared zone.
Feb. 15	11.0–12.0		NMLC., ø 76.2mm			4–5	4–5	4–5	Bedding very clear looks like SCHIST, 3~30cm cores, cracks weathered brown.
	12.0–12.4					5	5	5	Flaky cores, sheared zone.
Feb. 16, Feb. 17	12.4–17.00				black	3	3	3	Black SH with CALCITE veins, somewhat sandy generally 10–30cm cores. at 15.00~15.20 and 15.60~15.70 cracks brown and somewhat sheared and reconsolidated. Final G.W.L. EL. 42.91, ▽ 17.0
Feb. 18, Feb. 20, Feb. 21	17.00–20	Sandy SHALE				3–4		3–4	Sandy SH. 3~5cm cores, cracks brown but hard cores. 18.25~18.70 Reconsolidated sheared zone, hard.



LOG OF CORE BORING

Sheet No. 8

River Quae Yai Site Ban Tha Thung Na Boring No. BR-4 (sheet 2 of 2)

Location Right Bank, Damsite	Depth of hole 22.0 m	Commenced Feb.-12-1976	Drilled by Yasamuth; S. UNEX
Elevation 69.91 m	Depth of overburden 6.70 m	Completed Feb.-21-1976	
Angle from horizontal 90°	Total length of core 14.5 m	Boring machine UNEX Junior A.3	Logged by
Bearing of angle hole —	Core recovery 96.7 %		

Date	Depth (m)	Geology	Symbol of geology	Core recovery (%)	Cementation Casing	Kind of bit Diameter of hole	Colour of rock	Degree of weathering (1↔5)	Degree of hardness (1↔5)	Degree of fissure, crack (1↔5)	Remarks	Drill: Pressure (kg/cm²), Time (min.)	Water Pressure Test: Loss Water (l/min.), Pressure (kg/cm²), Drill, Supply water, Leakage water (l/min.)	Depth
Feb. 21		Sandy SHALE				NMLC. — ø76.2mm	black	3	3	3-4	Sandy SH, cracks generally fresh, recemented sheared zone (hard) at 20.8~21.1.	Drill Time	Supply Water, Leakage Water, Permeability Coefficient	
											End of hole at 22.0m			

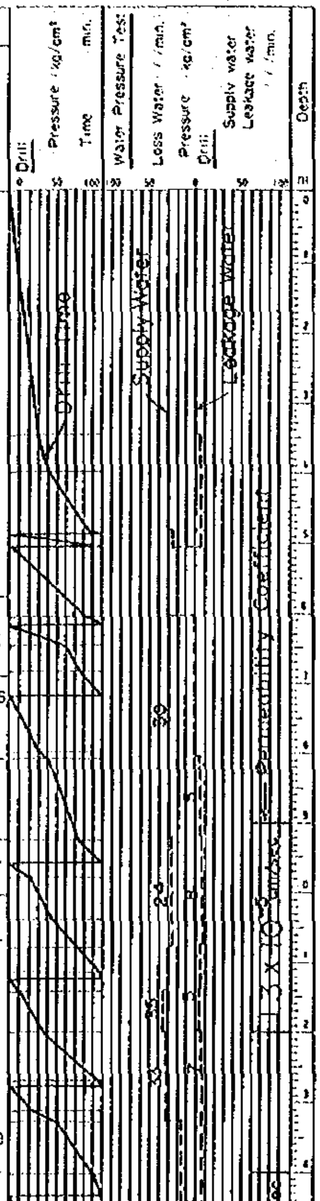
LOG OF CORE BORING

Sheet No. 9

River Quae Yai — Site Ban Tha Thung Na — Boring No. BR–5 (sheet 1 of 2)

Location: Right Bank, Damsite	Depth of hole: 21.25 m	Commenced: Feb. 23 1976	Drilled by: Yarsomuth; S. (UNEX)
Elevation: 63.02 m	Depth of overburden: 0 m	Completed: Feb. 29 1976	
Angle from horizontal: 90°	Total length of core: 13.7 m	Boring machine: Unex Junior A–2	Logged by:
Bearing of angle hole: —	Core recovery: 64.5 %		

Date	Depth (m)	Geology	Casing	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks
Feb. 23 / Feb. 24	0 – 5.75	SHALE	NX. C.P.	Casing Shoe Bit Ø 91.3mm	brwn ~ grey	5	5	5	0.– 5.75 Completely weathered SHALE, mostly slimes or flaky cores.
	5.75 – 6.00	SHALE				4	3	4	5.75 – 6.25 Fault breccias and gravelly cores, black SH.
	6.00 – 6.25					No	core		
Feb. 26	6.25 – 8.1	SHALE			black ~ brwn	5	3	5	Black SH, mostly gravelly cores, weatherd brown cracks.
	8.1 – 9.33					4			Black SH, mostly 5–10cm cores, cracks wheathered and brown.
	9.33 – 9.6					No	core		
	9.6 – 10.2				black	5–4	5–4	5–4	Black SH, sheared zone. 10.35–10.40
	10.2 – 11.07				black ~ grey	5	5	5	Final G.W.L. EL.52.32 ∇10.7
	11.07 – 11.4					4–5	4–5	4–5	11.07 Fault breccias. 10.5 – 10.8
Feb. 27	11.4 – 11.8					No	core		
	11.8 – 15.0			NLMC Ø 76.2mm	black	5	5	5	11.8 Black SH, sheared zone somewhat brecciated. 10.8–11.07 Like black SCHIST. 11.07–11.4 Gravelly cores with some breccias. Black SH, flaky to 5cm cores. Mostly flaky cores.
Feb. 28	15.0 – 15.4	Fault clay			grey	5	5	5	Grey, fault clay.
	15.4 – 16.4	SHALE			brown / black	3 / 3–4	3 / 3–4	5	Gravelly cores, partially flakey, cracks brown.
	16.4 – 16.8	QTZ			white				QUARTZ vein.
	16.8 – 17.0					3–2	3–2	4	Somewhat siliceous, cracks brown.
Feb. 29	17.0 – 18.6	SHALE			black	4–3	4–3	5	Flaky to gravelly cores, cracks brown.
	18.6 – 19.56					4	3	4	3–10cm cores, cracks brown, reconsolidated sheared zone.
	19.56 – 20					No	core		



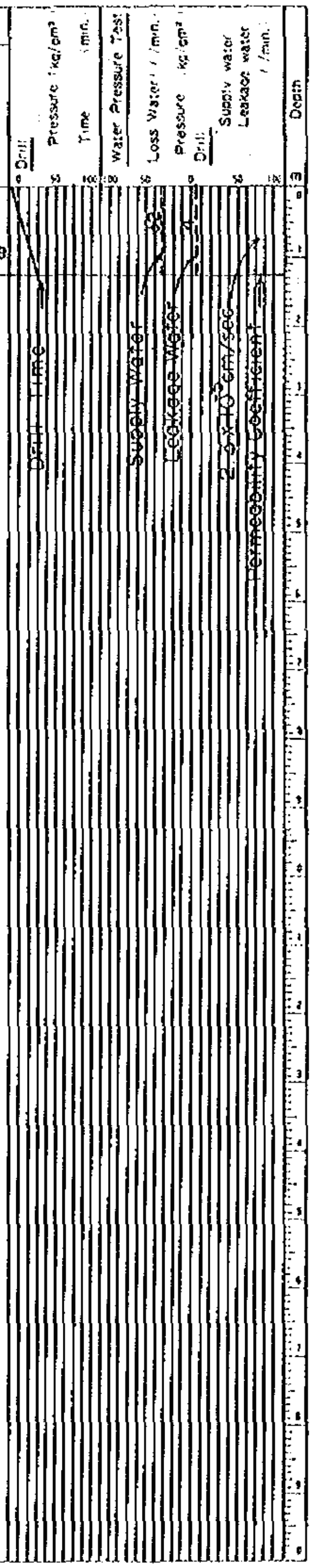
LOG OF CORE BORING

Sheet No. 10

River: Quae Yai — Site: Ban Tha Thung Na — Boring No. BR-5 (sheet 2 of 2)

Location	Right Bank, Damsite	Depth of hole	21.25 m	Commenced	Feb. 23 1976	Drilled by Yarsamuth; S. (UNEX)
Elevation	63.02 m	Depth of overburden	0 m	Completed	Feb. 29 1976	
Angle from horizontal	90°	Total length of core	13.7 m	Boring machine	Unex Junior A-2	Logged by
Bearing of angle hole	—	Core recovery	64.5 %			

Date	Depth (m)	Geology	Symbol of geology	Core recovery %	Cementation Casing	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering (1↔5)	Degree of hardness (1↔5)	Degree of fissure, crack (1↔5)	Remarks
Feb. 29	20.25 – 21.25	SH				NLMC / ⌀76.2 mm	brsh grey	3	3	3-4	20.25 No core; SHALE, 5-10 cm cores as a whole, reconsolidated shd. zone
											End of hole at 21.25 m



LOG OF CORE BORING

Sheet No. 11

River: Quae Yai — Site: Ban Tha Thung Na — Boring No. BR-6 (sheet 1 of 2)

Location	Right Bank, Damsite.	Depth of hole	35.0 m	Commenced	Jan. 23 1976
Elevation	42.96 m	Depth of overburden	0.5 m	Completed	Feb. 2 1976
Angle from horizontal	90°	Total length of core	34.1 m	Boring machine	Acker No.2
Bearing of angle hole	–	Core recovery	98.7 %	Drilled by	Tonli (EGAT)
				Logged by	

Columns: Date | Depth (m) | Geology | Symbol of geology | Core recovery (%) | Cementation Casing | Kind of bit Diameter of hole | Description: Colour of rock, Degree of weathering, Degree of hardness, Degree of fissure, crack (1 ↔ 5), Remarks | Drill: Pressure (kg/cm²), Time (min.) | Water Pressure Test: Loss Water (l/min.), Pressure (kg/cm²), Drill, Supply water, Leakage water (l/min.) | Depth

Date: Jan. 23 (0–4.5 m); Jan. 24 (4.5–7 m); Jan. 26 (10–12 m); Jan. 27 (15–18 m); Jan. 28 (18–20 m)

Geology: Sand (0–0.5 m); LIMESTONE (0.5–20 m)

Casing: NX. C.P. (to 4.5 m). Bit: ø 91.3 mm; Diamond Core Bit, ø NXM.

Colour of rock: grey. Degree of weathering: 3–2. Degree of hardness: 3. Degree of fissure, crack: 3; 4 (14.3–14.5); 3.

Remarks:

0–0.5 River deposits, silty sand.

Driller reports, cavity at 4.21 – 4.31, and drilling water completely loss at 4.21.

▽ 2.66

Final G.W.L. EL. 40.30

4.21–4.31

0.5 – 35.0

Grey LIMESTONE, many CALCITE veins, generally fresh. Cores 5 ~ 30 cm long.

Though cracks not brown nor weathered, all cracks coated by black GRAPHITE.

14.3–14.5 ← Cracky part.

Water pressure test: Drill Time; Supply Water; Leakage Water; Permeability coefficient; Drill Pressure 500; 22; 22; 34; 0; 46; 0; K = 5.2 × 10⁻⁵ cm/sec; No leak under max. P = 5.5 kg/cm²; K = 1 × 10⁻⁵ cm/sec; No leak under max. P = 4.3 kg/cm²

LOG OF CORE BORING

Sheet No. 12

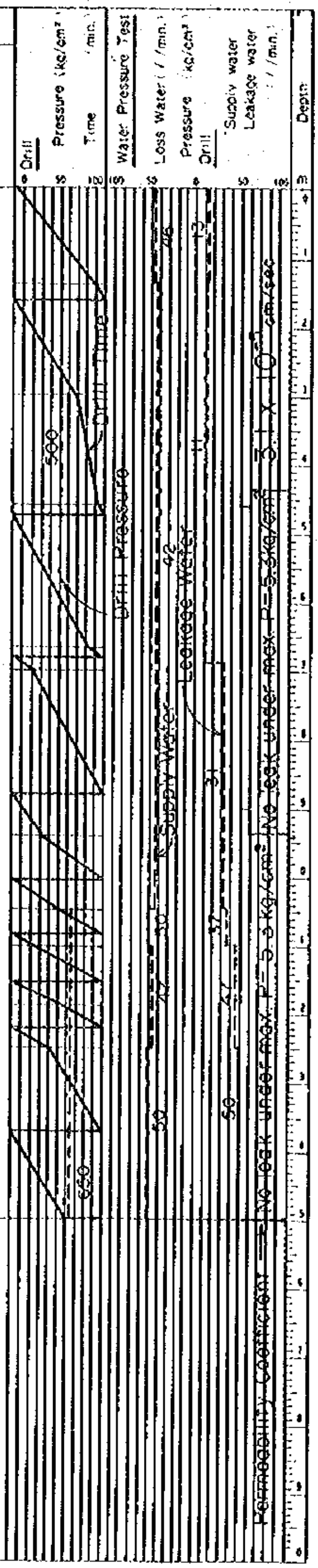
River Quae Yai   Site Ban Tha Thung Na   Boring No. BR-6   (sheet 2 of 2)

Location	Right Bank, Damsite	Depth of hole	35.0 m	Commenced	Jan. 23 1976
Elevation	42.96 m	Depth of overburden	0.5 m	Completed	Feb. 2 1976
Angle from horizontal	90°	Total length of core	34.1 m	Boring machine	Acker No. 2
Bearing of angle hole	—	Core recovery	98.7 %		

Drilled by Tonli (EGAT)

Logged by

Date	Depth (m)	Geology	Symbol of geology	Core recovery (%)	Cementation · Casing	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering (1↔5)	Degree of hardness (1↔5)	Degree of fissure, crack (1↔5)	Remarks
Jan. 28	20	LIMESTONE				Diamond Bit N X M.	grey	3–2	3	3	0.5 – 35.0 Grey LIMESTONE, many CALCITE veins, generally fresh. Cores 5 ~ 30cm long.
											23.3 Cracky at 23.3.
Jan. 29										4	23.9 – 24.0 Cracky part.
										3	
										4	26.6 – 27.0 Cracky part.
Jan. 30										3	
	30									4	29.8 – 30.0 Cracky part.
Jan. 31										3	
Feb. 2	35										End of hole at 35.0 m



LOG OF CORE BORING

Sheet No. 13

River: Quae Yai — Site: Ban Tha Thung Na — Boring No. BR-7 (sheet 1 of 3)

Location	Right Bank, Damsite.	Depth of hole	45.00 m	Commenced	Dec. 23 1975
Elevation	55.73 m	Depth of overburden	7.50 m	Completed	Jan. 13 1976
Angle from horizontal	90°	Total length of core	26.4 m	Boring machine	Acker No.2
Bearing of angle hole	—	Core recovery	70.5 %		

Drilled by: Tonli (EGAT)
Logged by:

Date	Depth (m)	Geology	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks
Dec. 23	0 – 7.5	Overburden					Topsoil and fine grained materials (river deposits) with some fragments of secondary lime.
Dec. 26	7.5 – 8.53	SHALE	white	5	5	5	Fault breccias, white color, soft.
Dec. 26 – Dec. 29	8.53 – 12.0	SHALE	brown	5-4	5-4	5-4	Weathered SHALE, recovered only slimes and some pieces of SH.
Dec. 30	12.0 – 14.0	SHALE	brown ~ black	4-5	4-5	4-5	Black SHALE, flaky cores, 1-3 cm long, all cracks weathered, brown.
Jan. 2	14.0 – 14.5	SHALE		3	3	3	Cores 10~20 cm long, cores hard but cracks brn. weathered.
Jan. 2 – Jan. 3	14.5 – 17.20	SHALE	black	4-5	4-5	4-5	Flaky to pieces (5 cm) cores, cracks weathered and brn. cores exfoliate easily along laminae.
Jan. 5	17.20 – 20	SHALE		3	3		Same condition with above, but no brn. cracks.

Casing: NX. C.P. (0 – 12.0 m)
Kind of bit / Diameter of hole: Auger drilling (0 – 7.5 m); Diamond Core Bit ø NX M. (7.5 – 20 m)

Final G.W.L. EL. 43.05 — ▽12.68

12.0-7.5 Driller reports, soft drilling.

Drill time; Supply Water; Leakage Water; Drill Pressure 0; Permeability Coefficient 9.5 × 10⁻⁵ cm/sec ~ 4.9 × 10⁻⁵ cm/sec

LOG OF CORE BORING

Sheet No. 14

River Quao Yai Site Ban Tha Thung Na Boring No. BR-7 (sheet 2 of 3)

Location	Right Bank, Damsite	Depth of hole	45.0 m	Commenced	Dec. 23 1975
Elevation	55.73 m	Depth of overburden	7.50 m	Completed	Jan. 13 1976
Angle from horizontal	90°	Total length of core	26.42 m	Boring machine	Acker No.2
Bearing of angle hole	—	Core recovery	70.5 %	Drilled by	Tonit (EGAT)
				Logged by	

Geology: SHALE (20 m – 40 m)

Kind of bit / Diameter of hole: Diamond Bit, Ø NXM.

Degree scale: 1 ↔ 5

Date	Depth (m)	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks
Jan. 5	20 – 25.60	black	3-2	3-2	4, 3-2, 4, 3-2, 4	Black SHALE rather massive and hard. Commonly cores 20~30cm long, partially cracky.
Jan. 6						
Jan. 7	25.60 – 26.40					Slimes
Jan. 8	26.40 – 32.0	black	2	3	4-5	Black SH. Cores 2~10cm and flaky but no brn. cracks, cores exfoliate easily along laminae.
Jan. 9	32.0 – 32.75					Slimes
	32.75 – 33.9	black	2	3	4	As same as at 26.4~32.0 no brn. cracks.
	33.9 – 34.15					Slimes
Jan. 10	34.15 – 34.87	black	2	3	3-4	5~15cm cores.
	34.87 – 34.92					slimes
	34.92 – 36.0	black	3	3	3	10~25cm cores, somewhat sheared in general.
	36.0 – 36.7					Slimes
	36.7 – 37.0	black	3	3	4	Sheared but recemented.
	37.0 – 39.0					Slimes
Jan. 12	39.0 – 40	black	4-5	4-5	4-5	GRAPHITE rich, sheared as a whole.

LOG OF CORE BORING

Sheet No. 15

River Quae Yai Site Ban Tha Thung Na Boring No. BR-7 (sheet 3 of 3)

Location	Right Bank, Damsite.	Depth of hole	45.00 m	Commenced	Dec. 23 1975
Elevation	55.73m	Depth of overburden	7.50 m	Completed	Jan. 13 1976
Angle from horizontal	90°	Total length of core	26.4 m	Boring machine	Acker No. 2
Bearing of angle hole	--	Core recovery	70.5 %	Drilled by	Tanit (EGAT)
				Logged by	

Date	Depth (m)	Geology	Symbol of geology	Core recovery %	Cementation Casing	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks
Jan. 12	40–41.0	SHALE				Diamond Bit ø NXM					Slimes
	41.0–42.0						black	3	3	4~5	Black SH, with GRAPHITE flaky cores (2~5cm)
Jan. 13	42.0–44.4										Slimes
	44.4–45.0						black	3	3	4	Black SHALE, with GRAPHITE materials, slightly sheared as a whole.

End of hole at 45.0m

Drill Pres. 7.0
Supply Water
Leakage Water
Drill time
22
10
Permeability Coefficient: No leak under max. P=6.5kg/cm²

LOG OF CORE BORING

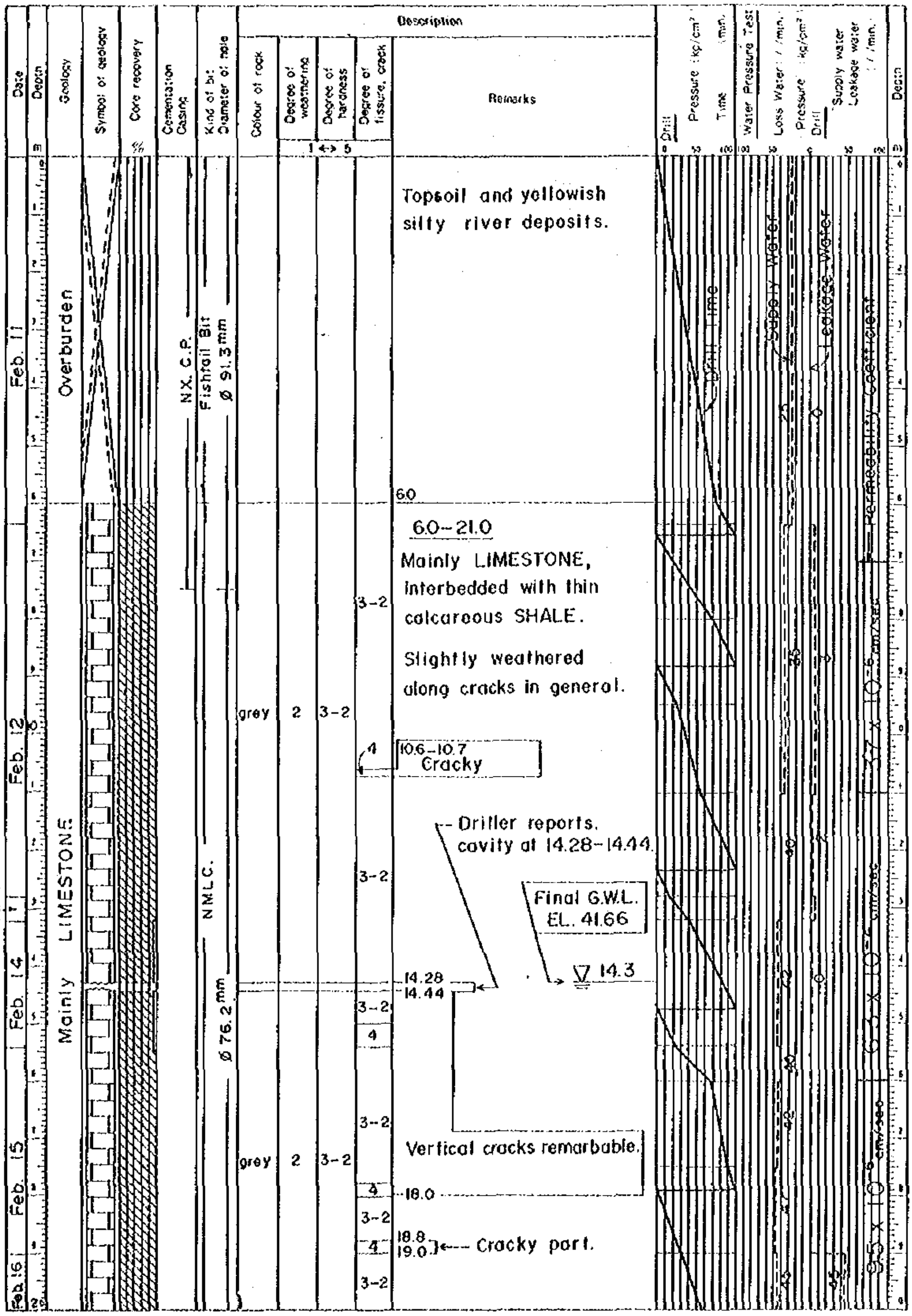
Sheet No. 16

River Quae Yai Site Ban Tha Thung Na Boring No. BR-8 (sheet 1 of 2)

Location	Right Bank, Damsite	Depth of hole	21.00 m	Commenced	Feb. 11 1976
Elevation	55.96 m	Depth of overburden	6.00 m	Completed	Feb. 16 1976
Angle from horizontal	90°	Total length of core	14.8 m	Boring machine	UNEX Junior A.2
Bearing of angle hole	—	Core recovery	98.9 %		

Drilled by Yasamuth, S. (UNEX)

Logged by



LOG OF CORE BORING

Sheet No. 17

River Quae Yai Site Ban Tha Thung Na Boring No. BR-8 (sheet 2 of 2)

Location Right Bank, Damsite	Depth of hole 21.00 m	Commenced Feb. 11 1976	Drilled by Yosomuth; S. (UNEX)
Elevation 55.96m	Depth of overburden 6.00 m	Completed Feb. 16 1976	
Angle from horizontal 90°	Total length of core 14.8 m	Boring machine UNEX Junior A. 2	Logged by
Bearing of angle hole —	Core recovery 98.9 %		

Date	Depth (m)	Geology	Symbol of geology	Core recovery (%)	Cementation Casing	Kind of bit Diameter of hole	Colour of rock	Degree of weathering (1↔5)	Degree of hardness (1↔5)	Degree of fissure, crack (1↔5)	Remarks
Feb. 16	20	LS				NMLC Ø76.2mm	grey	2	3-2	3-2	Mainly LIMESTONE.
	21										End of hole at 21.00m

Water Pressure Test columns: Drill Pressure (kg/cm²), Time (min.), Loss Water (l/min.), Pressure (kg/cm²), Drill, Supply water, Leakage water (l/min.), Depth (m)

Annotations: Drill Time; Supply Water; Leakage Water; 9.5 x 10⁻⁶ cm/sec; Permeability Coefficient; 46; 45

LOG OF CORE BORING

Sheet No. 18

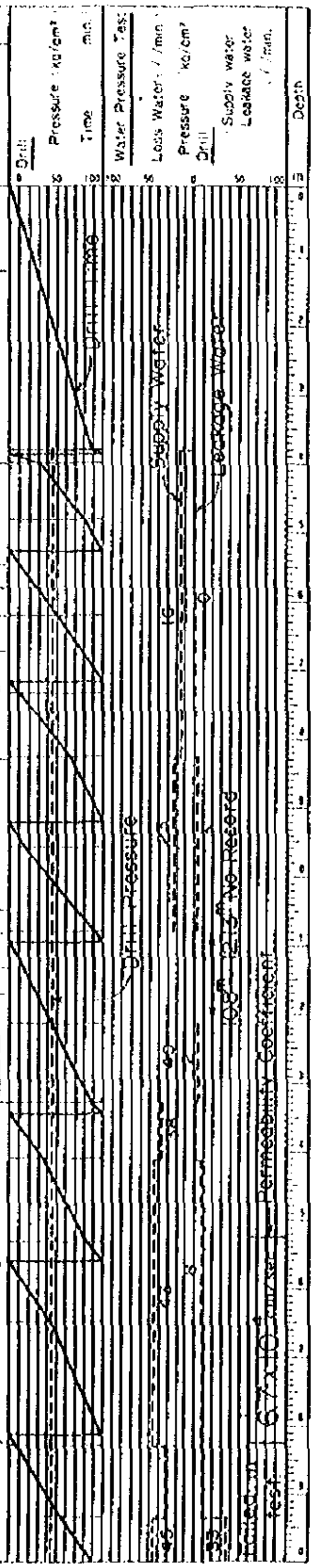
River: Quae Yai — Site: Ban Tha Thung Na — Boring No. BR-9 (sheet 1 of 2.)

Location	Right Bank, Damsite.	Depth of hole	29.5 m	Commenced	Feb. 10 1976
Elevation	55.00 m	Depth of overburden	4.00 m	Completed	Feb. 28 1976
Angle from horizontal	90°	Total length of core	23.6 m	Boring machine	Auger No.11
Bearing of angle hole	—	Core recovery	92.4 %		

Drilled by: Annop & Tanit (EGAT)
Logged by: —

Date	Depth (m)	Geology	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks
Feb. 10	0–1.2	Topsoil	Auger Drilling; NX.C.P.					Laterite.
Feb. 10	1.2–4.0	Silt	Auger Drilling; NX.C.P.					Silt, grey like ash.
Feb. 11	4.0–6.0	Slightly calc. SANDSTONE	ø 91.3 mm	light grey	3	3	3~4	Very slightly calcareous SANDSTONE, cracks weathered and brown.
Feb. 11	6.0–6.2							Slimes, probably SHALE.
Feb. 11	6.2–7.35	SHALE		black	4	4	4~5	Black SHALE, brittle.
Feb. 13	7.35–7.55	SHALE						Slimes. (SH)
Feb. 13	7.55–8.28	SHALE		black	3	3	4	Black SH, cracks brown with seams 5–10cm cores, and gravelly cores.
	8.28–8.74	SHALE			Slimes			Slimes
Feb. 19	8.74–10.65	SHALE	Diamond Bit ø NXM.	black	3~4	3~4	4~5	8.74–13.28 Black SHALE, commonly cracky, weathered along cracks and somewhat brittle.
	10.65–11.00	SHALE					3~4	
	11.00–11.50	SHALE			4	3	4	Final G.W.L. EL. 43.29 ▽ 11.71
	11.50–12.00	SHALE			3		3	
	12.00–12.07	SHALE			4~5	4~5	4~5	Slimes.
	12.3–12.6	SHALE			3		3	5–10cm cores, with CAL. veins
	12.6–13.28	SHALE			3~4		4~5	Somewhat sheared, sandy in part.
Feb. 20	13.28–14.0	SANDSTONE	Diamond Bit ø NXM.			3	4	Somewhat sheared, 3–10cm cores.
Feb. 20	14.0–15.31	SANDSTONE					3~4	Cracks coated by secondary lime, 3–15cm cores.
Feb. 20–21	15.31–20	SANDSTONE		grey	3	3~2	3	Some cracks slightly weathered, brown, most of cracks coated by thin secondary lime films. Partially thin CALCITE veins.

27.4–13.28 SANDSTONE grey, slightly weathered, Somewhat cracky as a whole.



LOG OF CORE BORING

Sheet No. 19

River Quae Yai   Site Ban Tha Thung Na   Boring No. BR-9 (sheet 2 of 2)

Location Right Bank, Damsite.	Depth of hole 29.5 m	Commenced Feb. 10 1976	Drilled by Annop & Tonti (EGAT)
Elevation 55.00 m	Depth of overburden 4.00 m	Completed Feb. 28 1976	
Angle from horizontal 90°	Total length of core 23.6 m	Boring machine Auger No. II	Logged by
Bearing of angle hole —	Core recovery 92.4 %		

Date	Depth (m)	Geology	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks
Feb. 21	20.0–21.75	SAND-STONE	grey	3	3–2	3	20.0 - 27.0 SANDSTONE partially inter-bedded with black SHALE.
Feb. 23	21.75–22.0		No core				21.75
	22.0–22.6	SH	black				22.0–22.6 Black SHALE, fresh, brittle, not weathered.
Feb. 26	22.6–27.0	SANDSTONE	grey	3	3–2	3	Cracks coated by secondary lime films in part. 27.0 ~ 27.4 somewhat sheared.
Feb. 27	27.0–27.4	SHALE					27.4 - 29.5 Black SH, partially sandy.
	27.4–27.7		black	3	3	5	Cracks fresh, but sheared as a whole, cracks coated by GRAPHITE.
	27.7–28.0		No core				
	28.0–28.6		black	3	3	4	← Looks like black SCHIST.
Feb. 28	28.6–29.0		grey	5	5	5	← Flaky, sheared as a whole
	29.0–29.5		~ black	3	3	3~4	Somewhat sandy, exfoliative.

Kind of bit / Diameter of hole: Diamond Bit ϕ NXM

End of hole at 29.5m.

Note: Rocks slightly metamorphosed in lower section of this hole.

Water pressure test: Drill Time; Drill Press. 45, 45; Supply Water; Leakage Water; 36, 36, 48, 49, 58, 58, 52, 52, 56, 53; Failed in test; Permeability coefficient = 1.7 × 10^{-4} cm/sec

LOG OF CORE BORING

Sheet No. 20

River Quae Yai Site Ban Tha Thung Na Boring No. BR-10 (sheet 1 of 2)

Location	Right Bank, Damsite.	Depth of hole	25.00 m	Commenced	Mar. - 3 - 1976
Elevation	59.73 m	Depth of overburden	8.0 m	Completed	Mar. - 11 - 1976
Angle from horizontal	90°	Total length of core	16.0 m	Boring machine	Acker No. 2
Bearing of angle hole	---	Core recovery	94.1 %	Drilled by	Annop & Tonit (EGAT)
				Logged by	

Date	Depth (m)	Geology	Core recovery (%)	Cementation / Casing	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Description / Remarks
Mar. 3	0 – 8.0	Over burden		NX. C.P.	Auger Drilling ø 91.3 mm					0 – 8.0 Topsoil and silty river deposits.
Mar. 5	8.0 – 12.7	SHALE			Diamond Bit ø NXM	light brown	3-4	3-4	4	8.0 Light brown, rather massive SHALE, cracks brown, weathered, gravelly to 10cm cores.
Mar. 6	12.7 – 15.6					black	3	3	3-4	12.7 Black SHALE, mostly 5-10cm cores, cracks weathered and brown.
	15.6 – 16.0								5	15.6 Gravelly cores, very cracky.
	16.0 – 17.0						No	core		16.0 Core loss. 17.0
Mar. 10	17.0 – 17.7						3	3	4	Gravelly to 10cm cores.
	17.7 – 20					black	3-2	3-2	3	17.7 Cracks slightly weathered. Black SH, mostly 10–30cm cores, cracks fresh.

Final G.W.L. EL 42.73 ▽ 17.0

Water Pressure Test: Drill time; Drill Pres. 450; Supply water; Leakage water; Permeability coefficient 5.6 × 10⁻⁴ cm/sec; No leak under max. P = 5.7 kg/cm²

LOG OF CORE BORING

Sheet No. 21

River Quae Yai — Site Ban Thò Thung Na — Boring No. BR-10 (sheet 2 of 2)

Location Right Bank, Damsite.	Depth of hole 25.00 m	Commenced Mar. - 3 - 1976	Drilled by Annop & Tonit (EGAT)
Elevation 69.73 m	Depth of overburden 8.0 m	Completed Mar. - 11 - 1976	
Angle from horizontal 90°	Total length of core 16.0 m	Boring machine Acker No. 2	Logged by
Bearing of angle hole --	Core recovery 94.1 %		

Date	Depth (20 m)	Geology	Symbol of geology	Core recovery %	Cementation Casing	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering (1 ↔ 5)	Degree of hardness	Degree of fissure, crack	Remarks
Mar. 10 – Mar. 11	20–25	SHALE				Diamond Bit, Ø NXM.	black	3 - 2	3 - 2	3	Black SHALE, mostly 10-30cm cores, cracks fresh. Generally good cores.
	22.2–22.7									4	22.2 – 22.7 Cracky
										3	
	25.0										End of hole at 25.0m

Drill: Pressure (kg/cm²) 0–50–100, Time (min.) — Drill Pres. 450, Drill Time

Water Pressure Test: Loss Water (l/min.) 100–50–0, Pressure (kg/cm²), Drill; Supply water, Leakage water (l/min.) 0–50–100 — Supply Water 40, 53; Leakage Water 53; Permeability Coefficient 9.3 x 10⁻² cm/sec

LOG OF CORE BORING

Sheet No. 22

River Quae Yai   Site Ban Tha Thung Na   Boring No. BC-1 (sheet 1 of 1)

Location River Bed, Damsite.	Depth of hole 20.50 m	Commenced Feb. 20 1976	Drilled by Yosamuth S. (UNEX)
Elevation 39.40m	Depth of overburden 5.50 m	Completed Feb. 27 1976	
Angle from horizontal 90°	Total length of core 15.00 m	Boring machine UNEX. Junior A.1	Logged by
Bearing of angle hole —	Core recovery 100 %		

Date	Depth (m)	Geology	Core recovery (%)	Cementation / Casing	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks
Feb. 20 – Feb. 22	0–5.5	Gravel		ø 4" C.P.; NX. C.P.	Casing Shoe Bit & Chopping Bit ø 114mm					0–5.5m River deposits, gravel. River water level EL.40.2 (Water level in drill hole) ▽10.8m
Feb. 23 – Feb. 24	5.5–10.65	LIMESTONE	100		ø 91.3mm	white	2–1	2–1	2–1	5.5 Massive, hard LIMESTONE. Not weathered.
Feb. 25 – Feb. 26	10.65–16.6	Alternation of SHALE and Calcareous SANDSTONE	100		NMLC. ø 76.2mm	black ~ grey	3–2	3–2	3–2; 4–3; 3–2	10.65 Alt. of black SHALE and calcareous SANDSTONE. Thickness of each layer 5-20cm, boundary gradually change each other. Good cores as a whole. Mostly black SHALE with calc. SANDSTONE, cracky but not weathered along cracks.
Feb. 26	16.6–18.0					black			4	16.6; 16.9–17.5 Reconsolidated sheared zone.
Feb. 26 – Feb. 27	18.0–20.5					black ~ grey			3–4	18.0 Black SH/calc. SS, boundary for each layer gradually changed, no brown cracks. End of hole at 20.5m.

Water pressure test columns: Drill Time; Supply Water; Leakage Water; Permeability Coefficient.
Pressure (kg/cm²) / Time (min.); Loss Water (l/min.); Pressure (kg/cm²); Drill; Supply water, Leakage water (l/min.)

Values shown: 30, 33, 30, 36, 35, 38, 30, 30, 30, 30;
Permeability: 2.9 × 10⁻⁵ cm/sec (5.5–10.65 m); 2.0 × 10⁻⁵ cm/sec (10.65–16 m); 2.2 × 10⁻⁵ cm/sec (16–20.5 m)

LOG OF CORE BORING

Sheet No. 23

River Quae Yai — Site Ban Tha Thung Na — Boring No. BL – I (sheet 1 of 1)

Location	Left Bank, Damsite	Depth of hole	16.20 m	Commenced	Jan. 10 1976
Elevation	44.47 m	Depth of overburden	1.20 m	Completed	Jan. 18 1976
Angle from horizontal	90°	Total length of core	14.45 m	Boring machine	UNEX Junior A. I
Bearing of angle hole	—	Core recovery	96.3 %	Drilled by	Yosamuth; S. (UNEX)
				Logged by	

Date	Depth (m)	Geology	Cementation / Casing	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Description / Remarks
Jan. 10	0 – 1.2	Sand		SX.C.S.B.	(white)				River deposits, silty sand. Driller reports white sand at 0 – 1.2.
Jan. 11 / Jan. 15	1.2 –	LIMESTONE	NX. C.P. 3.0m	NX. ∅ 91.3mm	grey	3	3	3	Some cracks brown.
	1.65 – 2.0								No core. Driller reports, cave.
					grey	3	3	3	Somewhat shaly. ▽2.6 Some cracks brown.
	2.8 – 3.0		2.90m						No core. Driller reports, cave.
Jan. 16 / Jan. 18	3.0 – 16.2	LIMESTONE	Cementation (Jan. 17) 8.0m	NMLC. ∅ 76.2mm	grey	3 – 2	3 – 2	3 – 2	Generally, grey, fresh and hard LIMESTONE interbedded with thin calcareous SHALE. Many CALCITE veins and small solution cavities in part. Many small cavities at 13.25 – 13.3 and 13.6 – 13.7.
	16.20								End of hole at 16.20m

Final G.W.L. EL. 41.87

Drill — Pressure (kg/cm²) — Time (min.) — Water Pressure Test — Loss Water (l/min.) — Pressure (kg/cm²) — Drill — Supply water — Leakage water (l/min.) — Depth

Supply Water — Leakage Water — Permeability Coefficient — Drill time

LOG OF CORE BORING

Sheet No. 24

River Quae Yai — Site Ban Tha Thung Na — Boring No. BL-2 (sheet 1 of 4)

Location	Left Bank, Damsite	Depth of hole	65.0 m	Commenced	Jan. 10 1976
Elevation	65.08 m	Depth of overburden	3.85 m	Completed	Feb. 5 1976
Angle from horizontal	90°	Total length of core	59.6 m	Boring machine	UNEX Junior A2
Bearing of angle hole	—	Core recovery	97.8 %	Drilled by	Yasomuth S. (UNEX)
				Logged by	

Date	Depth (m)	Geology	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks
Jan. 10	0–0.6	Top soil					Black soil. 0.6
Jan. 11	0.6–3.85	Overburden?					Driller reports, drilling in boulders, cave at 2.39m. Probably talus.
	3.85	LIMESTONE				3-2	3.85 Rather pure LIMESTONE,
						4	weathered along cracks, slightly brown.
							Partially sheared but reconsolidated.
			grey } white	3-2	3-2	3-2	5.0-5.1 Slikenside.
	10.9						10.9 Final G.W.L. EL. 54.13 (10.95)
						4	Reconsolidated shear zone, gravelly cores. 11.8
Jan. 13	13.7–14.5					3-2	13.7-14.5 Reconsolidated shear zone, many open cracks.
						4	Cracks coated by CALCITE crystals or soil.
						3-2	
						4	Reconsolidated shear zone.
						3-2	Contact between L.S, and black calc. SHALE.
	17.0	Calc. SHALE				4	17.0
			black	3	3-4	3-4	17.0 - 30.0 Black calcareous SHALE.
	18.02–18.34						18.02 - 18.34 No core.
Jan. 14	20		black	3	3-4	3-4	Many CALCITE veins and sheared breccias.

Symbol of geology: Top soil ⊠; Overburden △; LIMESTONE brick pattern; Calc. SHALE horizontal lines, ⊠ at 18.02–18.34 (no core).

Core recovery: 0–20 m (hatched).

Cementation / Casing: 1.85m NX.C.P.; 3.85m Cementation (Jan. 11); Cement head at 15m.; Cementation at 29m. (Jan. 15)

Kind of bit / Diameter of hole: BX Casing Shoe Bit ø91.3mm; NX.; N.M.L.C. ø 76.2mm

Water pressure test: Drill time; Supply Water; Leakage Water; Permeability Coefficient: 6.7 × 10⁻⁶ cm/sec; 4.7 × 10⁻⁵ cm/sec; 1.0 × 10⁻⁶ cm/sec; 6.5 × 10⁻⁵ cm/sec

LOG OF CORE BORING

Sheet No. 25

River Quae Yai Site Ban Tha Thung Na Boring No. BL-2 (sheet 2 of 4)

Location	Left Bank, Damsite	Depth of hole	65.0 m	Commenced	Jan. 10 1976
Elevation	65.08 m	Depth of overburden	3.85 m	Completed	Feb. 5 1976
Angle from horizontal	90°	Total length of core	59.8 m	Boring machine	UNEX Junior A.2
Bearing of angle hole	—	Core recovery	97.8 %	Drilled by	Yasamuth, S. (UNEX)
				Logged by	

Date	Depth (m)	Geology	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks
Jan. 14	20	Calcareous SHALE	black	3	3-4	3-4	18.02 - 18.34 No core.
							17.0 - 30.0 Black calcareous SHALE, many CALCITE veins and sheared breccias. Partially 10cm - 20cm cores. No brown cracks.
					3-4	3-4	
Jan. 15			black	3			30.0
Jan. 16							30.0 - 45.0 Black calcareous SHALE, sheared as a whole. Generally gravelly cores to 10cm, fine CALCITE veins remarkable.
					3	3-4	34.0
Jan. 19							Slightly brecciated by faulting (less fault breccias than upper zone 17m - 30m). No brown cracks.
Jan. 1	41						

Core recovery: 1 ↔ 5

Cementation (Jan. 15) 29.0m; 29.45m

Cementation (Jan. 17) 33.0m

Cementation (Jan. 19) 39.0m; 39.0m

Kind of bit / Diameter of hole: N M L C., ø 76.2 mm

Water Pressure Test: Drill time; Supply water; Leakage water; Permeability Coefficient 1.0 × 10⁻³ cm/sec; 1.0 × 10⁻⁴ cm/sec; 1.0 × 10⁻⁴ cm/sec; 5.5 × 10⁻⁵ cm/sec; 6.4 × 10⁻⁵ cm/sec

LOG OF CORE BORING

Sheet No. 26

River Quae Yai Site Ban Tha Thung Na Boring No. BL-2 (sheet 3 of 4)

Location	Left Bank, Damsite	Depth of hole	65.0 m	Commenced	Jan. 10 1976
Elevation	65.08 m	Depth of overburden	3.85 m	Completed	Feb. 6 1976
Angle from horizontal	90°	Total length of core	59.8 m	Boring machine	UNEX Junior A.2
Bearing of angle hole	—	Core recovery	97.8 %	Drilled by	Yasomuth, S. (UNEX)
				Logged by	

Date	Depth (m)	Geology	Cementation / Casing	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Description / Remarks
Jan. 21	40	Calcareous SHALE	Cementation (Jan. 22) — 31.46m; 44.0m	NLMC Ø 76.2mm		3	3	4-3	
Jan. 22	45				black				45.0
Jan. 28	50					3	3	3-4	45.0-60.0 Black calcareous SHALE, cores mostly 5cm-10cm, partially gravelly, but fresh, no sheared breccias, CALCITE veins remarkable.
Jan. 30									53.0-53.25 No core.
Jan. 31					black	3	3	3-4	
Feb. 1 / Feb. 4	60								

Water Pressure Test: Drill time; Pressure (kg/cm²): 40, 35, 38, 36, 22, 20.6; Supply water, Leakage water (l/min): 40, 35, 37, 20, 5; Permeability Coefficient: 6.4 × 10⁻⁵ cm/sec, 5.2 × 10⁻⁵ cm/sec, 7.5 × 10⁻⁵ cm/sec, 2.1 × 10⁻⁵ cm/sec, 3.3 × 10⁻⁵ cm/sec

LOG OF CORE BORING

Sheet No. 27

River: Quae Yai — Site: Ban Tha Thung Na — Boring No. BL-2 (sheet 4 of 4)

Location	Left Bank, Damsite	Depth of hole	65.0 m	Commenced	Jan. 10 1976
Elevation	65.08 m	Depth of overburden	3.05 m	Completed	Feb. 5 1976
Angle from horizontal	90°	Total length of core	59.8 m	Boring machine	UNEX Junior A.3
Bearing of angle hole	–	Core recovery	97.8 %	Drilled by	Yosamuth; S. (UNEX)
				Logged by	

Date	Depth (m)	Geology	Symbol of geology	Core recovery (%)	Cementation Casing	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks	Drill: Pressure (kg/cm²) / Time (min.)	Water Pressure Test: Loss Water (l/min.) / Pressure (kg/cm²) / Supply water, Leakage water (l/min.)	Depth
Feb. 4 / Feb. 5	60–65	Calcareous SHALE				N.L.M.C. Ø 76.2 mm	black	3-2	3-2	3-2	60.0 – 65.0 Black calcareous SHALE, mostly 10cm cores, good.	Drill time	Supply Water 32, Leakage Water 24, Pressure 12; Permeability Coefficient 3.6 × 10⁻⁵ cm/sec	
	65.0										End of hole at 65.0m			

LOG OF CORE BORING

Sheet No. 28

River: Quae Yai — Site: Ban Tha Thung Na — Boring No. BL-3 (sheet 1 of 2)

Location	Left Bank, Damsite	Depth of hole	33.00 m	Commenced	Mar. - 29 - 1976
Elevation	55.70 m	Depth of overburden	17.40 m	Completed	Apr. - 1 - 1976
Angle from horizontal	90°	Total length of core	14.45 m	Boring machine	Acker No. 2
Bearing of angle hole	--	Core recovery	99.0 %	Drilled by	Anoop & Tanit (EGAT)
				Logged by	

Column headings: Date | Depth (m) | Geology | Symbol of geology | Core recovery (%) | Cementation Casing | Kind of bit, Diameter of hole | Description: Colour of rock, Degree of weathering, Degree of hardness, Degree of fissure, crack (1 ↔ 5), Remarks | Drill: Pressure (kg/cm²), Time (min.) | Water Pressure Test: Loss Water (l/min.), Pressure (kg/cm²), Drill, Supply water, Leakage water (l/min.) | Depth

Date: Mar. 29 (0–17 m); Mar. 30 (17–20 m)

Geology: Topsoil (0–1.5 m); River Deposits (1.5–17.4 m); Calc. SH (17.4–18.5 m); LS (18.66–19.65 m); C.SH (from 19.65 m)

Casing: NX. C.P. — Kind of bit: Auger & Casing Shoe Bit, ø 91.3 mm; NWM, ø 76.2 mm

Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack
brn. grey	4-6	4-5	4-5
grey black	3	3	3-4
grey	3	3	3
black	4	4	3

Remarks:

Topsoil, black

1.0 – 1.5 } Grey soil.

1.5 – 6.0
Grey soil ~ laterite. (?)

Probably terrace deposits.

6.0 – No core – 7.63

Boulders of grey LS, top and bottom of cores coated by secondary lime. (7.63 – 8.69)

9.2 – 9.65 No core.

7.36 – 13.0
Several cores of boulders, 25–35cm long.

9.65 – 13.0: Boulders, weathered LS.

Probable rock surface.

13.0 – 17.4: No core. Driller reports quickly down. Fine grained deposits ?

17.4 – 17.8
Calcareous SH, softened due to weathering.

G.W.L. EL. 39.7 (16.0)

17.8 – 18.5
Calc. SH, very clear horizontal laminae, like coins. 3-10cm cores. No brown cracks.

18.5 – 18.66 No core.

Hard, rather fresh, sandy in part. No brown cracks. (18.66 – 19.65)

19.65 – 20.0 Black calcareous SH.

Graph labels: Drill time; Drill Pressure 450; Supply Water 50 / 45; Leakage Water 50 / 45; Permeability Coefficient; 5 × 10⁻⁶ cm/s

LOG OF CORE BORING

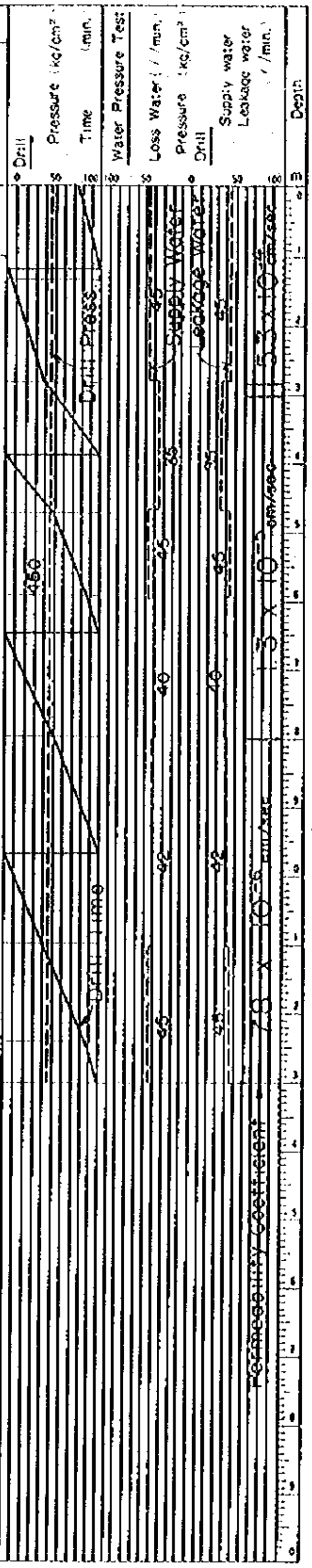
Sheet No. 29

River: Quae Yai — Site: Ban Tha Thung Na — Boring No. BL-3 (sheet 2 of 2)

Location	Left Bank, Damsite	Depth of hole	33.00 m	Commenced	Mar. 29 1976
Elevation	55.70 m	Depth of overburden	17.40 m	Completed	Apr. 1 1976
Angle from horizontal	90°	Total length of core	14.45 m	Boring machine	Acker No. 2
Bearing of angle hole	—	Core recovery	99.0 %	Drilled by	Annop & Tanit (EGAT)
				Logged by	

Date	Depth (m)	Geology	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks
Mar. 30	20.0	LS	N W M. ⌀ 76.2mm	grey	2	2	2	20.0 Hard and fresh LS.
	21.0 – 21.2	Alternation of Calcareous SHALE / LIMESTONE		grey	4	4	4	21.0 – 21.2 ← Black calcareous SHALE.
				black	3-2	3-2	3-2	
Mar. 31	22.81 – 22.86							22.81 – 22.86 No core.
				grey				21.2 – 33.0 Alternation of black calcareous SH and grey LS. Thickness of each bed 20-30cm. No brown cracks. Generally 5-20cm cores.
Apr. 1	30			black	3-2	3-2	3-2	
	33.0							End of hole at 33.0m

Degree scale: 1 ↔ 5



LOG OF CORE BORING

Sheet No. 30

River Quae Yai   Site Dan Tha Thung Na   Boring No. BL-4   (sheet 1 of 2)

Location	Left Bank, Damsite.	Depth of hole	30.00 m	Commenced	Mar. 18 1976
Elevation	55.59 m	Depth of overburden	11.8 m	Completed	Mar. 22 1976
Angle from horizontal	90°	Total length of core	11.5 m	Boring machine	Acker No. 2
Bearing of angle hole	—	Core recovery	63.2 %	Drilled by	Annop & Tanit (EGAT)
				Logged by	

Column headings: Date | Depth (m) | Geology | Symbol of geology | Core recovery (%) | Cementation Casing | Kind of bit Diameter of hole | Description: Colour of rock, Degree of weathering, Degree of hardness, Degree of fissure, crack (1 <-> 5), Remarks | Drill: Pressure (kg/cm²), Time (min.) | Water Pressure Test: Loss Water (l/min.), Pressure (kg/cm²), Drill, Supply water, Leakage water (l/min.) | Depth (m)

Date	Depth (m)	Geology	Colour of rock	Weathering	Hardness	Fissure	Remarks
Mar. 18	0 – 1.0	Topsoil					Brown topsoil.
	1.0 – 5.0	Fine Silt					Light yellow fine silt.
	5.0 – 7.0	Silt					Light yellow silt. No record of G.W.L.
	7.0 – 11.8	Sand					Light yellow sand. 1.0 – 11.8 River deposits.
Mar. 19	11.8 – 13.3	LS	white				White LS. Weathered. Boulder ?
	13.3 – 15.3						Slimes.
	15.3 – 15.56	SH	reddish brown	5	5	5	Reddish brown SH, flaky cores.
	15.56 – 19.2						No core.
	19.2 – 19.4	SH	reddish brown	5	5	5	Reddish SH, flaky.
	19.4 – 19.8	LS	grey	3-4	3-4	3-4	LS with small solution cavities. some what sheared.
	19.8 – 20.0	SH	black	3	3	3	Black SHALE.

Casing: NX. C.P. (to 11.8 m)

Kind of bit: (Auger Drilling) Ø 91.3 mm (0 – 11.8 m); UX M. Ø 76.2 mm (below 11.8 m)

Chart annotations: Drill time; Drill Pressure; 450; Supply Water; Leakage Water; 52; 51

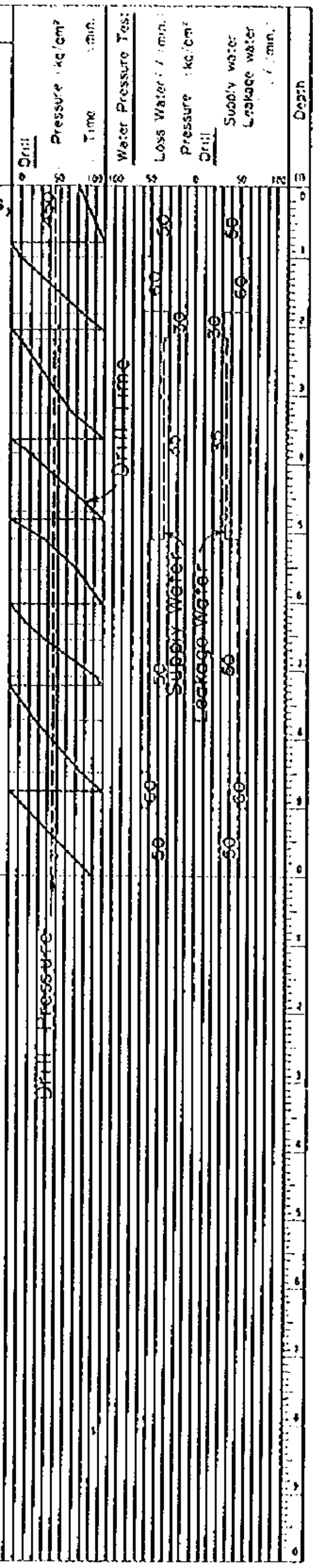
LOG OF CORE BORING

Sheet No. 31

River Quae Yai | Site Ban Tha Thung Na | Boring No. BL-4 (sheet 2 of 2)

Location	Left Bank, Damsite	Depth of hole	30.00 m	Commenced	Mar. 18 1976
Elevation	55.59 m	Depth of overburden	11.8 m	Completed	Mar. 22 1976
Angle from horizontal	90°	Total length of core	11.5 m	Boring machine	Acker No. 2
Bearing of angle hole	–	Core recovery	63.2 %	Drilled by	Annop & Tonit (EGAT)
				Logged by	

Date	Depth (m)	Geology	Colour of rock	Degree of weathering (1↔5)	Degree of hardness	Degree of fissure, crack	Kind of bit, Diameter of hole	Remarks
Mar. 19	20–21	SH	black	No / 3	core / 4	4		20.5 – Black SH, flaky cores, exfoliative.
	21.0–21.4	LS	grey / black	No / 3	core	4 / 3		21.0, 21.3, 21.4 – LS, gravelly, sheared breccias ? 22.1 – Black SH, gravelly to 20cm cores, cracks fresh, no brown.
Mar. 20, Mar. 21, Mar. 22	22.3–30	Black SHALE	black	3-2	3	4	NXM, ø 76.2 mm	22.3 – 30.0 Black SHALE, not weathered along cracks, commonly core length less than 10cm, very exfoliative.
	30							End of hole at 30.0m



LOG OF CORE BORING

Sheet No. 32

River Quae Yai   Site Ban Tha Thung Na   Boring No. BL-5 (sheet 1 of 2)

Location: Left Bank, Damsite	Depth of hole: 30.00 m	Commenced: Mar. 23 1976	Drilled by: Anoop & Tonit (EGAT)
Elevation: 48.38 m	Depth of overburden: 10.2 m	Completed: Mar. 27 1976	
Angle from horizontal: 90°	Total length of core: 16.05 m	Boring machine: Acker No. 2	Logged by:
Bearing of angle hole: —	Core recovery: 81.1 %		

Columns: Date | Depth (m) | Geology | Symbol of geology | Core recovery (%) | Cementation, Casing | Kind of bit, Diameter of hole | Description: Colour of rock | Degree of weathering | Degree of hardness | Degree of fissure, crack (1 ↔ 5) | Remarks | Drill: Pressure (kg/cm²), Time (min.) | Water Pressure Test: Loss Water (l/min.), Pressure (kg/cm²), Drill, Supply water, Leakage water (l/min.) | Depth (m)

Date: Mar. 23 (0–9.26 m); Mar. 24 (9.26–15.0 m); Mar. 25 (15.0–20.0 m)

Geology: Topsoil (0–1.0); Silt (1.0–5.0); Sand (5.0–6.0); Silty (6.0–7.56); Secondary Lime (7.56–9.26); LS; LS; LS; LS / SH; Alt. of Calc. SH / LS (15.0–20.0)

Casing: NX. C.P.; C S B.

Bit: Drilling with Casing Bit and Auger; ø 91.3 mm; ø 76.2 mm

Remarks:

- Grey, fine grained soil.
- 1.0
- 1.0–5.0 Reddish yellow silt.
- 8.96–13.18 Driller reports quickly drilling.
- 5.0 Grey silty sand.
- 6.0
- 6.7 Core loss
- 7.0
- 7.56 Core loss
- Final G.W.L. EL. 39.88 ▽ 8.50
- Secondary lime.
- 9.26 No core
- 10.2 — LS, fresh. (grey)
- 10.25 — LS, gravelly to 10 cm cores.
- Cave? No core
- 12.0 — LS, clear solution cracks. (grey)
- 12.21
- Cave? No core
- 13.0 — LS, solution cracks, but not brown. (grey)
- 13.18
- Cave? No core
- 14.69
- 15.0 — 14.92 Black SH, non-calc. not brown. (grey / black)
- 9.26–15.0 Uncertain due to poor core recovery. Sound bedrock at 15 m.
- 15.0–20.0 Alternation of grey LS and calcareous SH. No brown cracks, mostly cores 5–25 cm long. (grey; weathering 3–2; hardness 3–2; fissure 3–2)
- Solution cracks at 15.7–16.0 and 19.7–20.0.
- 20.0

LOG OF CORE BORING

Sheet No. 33

River Quae Yai — Site Ban Tha Thung Na — Boring No. BL-5 (sheet 2 of 2)

Location	Left Bank, Damsite	Depth of hole	30.00 m	Commenced	Mar. 23 1976
Elevation	48.38 m	Depth of overburden	10.2 m	Completed	Mar. 27 1976
Angle from horizontal	90°	Total length of core	16.05 m	Boring machine	Acker No.2
Bearing of angle hole	—	Core recovery	81.1 %	Drilled by	Annop & Tonit (EGAT)
				Logged by	

Date	Depth (m)	Geology	Kind of bit / Diameter of hole	Colour of rock	Degree of weathering	Degree of hardness	Degree of fissure, crack	Remarks
Mar. 26	20.0 – 25.0	Alternation of Calcareous SH / LS	NXM ø 76.2mm	grey ~ black	3-2	3-2	3-2	20.0 Alternation of grey - black, fresh, hard, calcareous SH and LS alternation. No brown cracks, mostly cores 5~10cm long.
	25.0 – 30.0				3	3	3, 4, 3, 4, 3	25.0 Alternation of grey-black, calc. SH and LS. Vertical bedding planes. Somewhat cracky in part, but no brown cracks. Cracky at 27.2 – 27.4 and 29.2 - 29.3.
	30.0							End of hole at 30.0m

Water Pressure Test: Drill Pressure, Drill Time, Supply Water, Leakage Water; 4.0 × 10⁻⁵ cm/sec; 1.7 × 10⁻³ cm/sec; values 40, 50, 45, 50, 55, 60, 40.

SUSPENDED SEDIMENT DISCHARGE

STATION BAN CHAO NEN | UNIT TON | YEAR 1972

DAYS	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.
1	66.3	62.6	68.2	378.0	72,600.0	8,270.0	61,100.0	2,110.0	2,180.0	333.0	161.0	102.0
2	64.5	56.8	66.3	368.0	48,300.0	6,770.0	44,500.0	1,890.0	1,730.0	323.0	158.0	102.0
3	64.5	54.2	75.6	328.0	24,800.0	6,100.0	27,900.0	1,670.0	1,440.0	313.0	155.0	102.0
4	77.5	50.4	95.5	308.0	16,600.0	4,860.0	28,200.0	1,510.0	1,270.0	303.0	152.0	101.0
5	60.8	49.1	93.2	378.0	12,500.0	3,940.0	29,500.0	1,370.0	1,130.0	294.0	149.0	97.8
6	60.8	47.9	136.0	485.0	8,510.0	3,490.0	62,300.0	1,310.0	1,000.0	285.0	146.0	97.8
7	75.6	49.1	223.0	445.0	7,070.0	5,120.0	93,700.0	1,250.0	912.0	280.0	146.0	97.8
8	66.3	46.6	186.0	629.0	6,210.0	66,600.0	38,200.0	1,410.0	869.0	275.0	143.0	95.5
9	62.6	45.4	257.0	507.0	4,620.0	414,000.0	22,700.0	1,690.0	849.0	266.0	143.0	101.0
10	58.1	41.1	563.0	439.0	3,760.0	263,000.0	16,500.0	1,750.0	912.0	257.0	141.0	102.0
11	58.1	41.6	313.0	439.0	3,070.0	47,100.0	14,300.0	1,870.0	899.0	257.0	138.0	104.0
12	64.5	40.4	323.0	1,130.0	2,930.0	21,300.0	10,700.0	1,440.0	859.0	247.0	136.0	104.0
13	114.0	39.2	266.0	16,200.0	2,850.0	18,300.0	8,750.0	1,290.0	799.0	239.0	134.0	97.8
14	83.1	38.1	211.0	61,100.0	3,280.0	13,600.0	8,190.0	1,160.0	718.0	231.0	132.0	93.2
15	106.0	38.1	182.0	29,200.0	3,670.0	9,450.0	8,930.0	1,060.0	683.0	227.0	129.0	88.9
16	125.0	36.9	161.0	16,300.0	3,430.0	7,690.0	11,500.0	1,030.0	665.0	223.0	127.0	93.2
17	88.9	38.1	146.0	12,000.0	4,370.0	7,070.0	12,700.0	1,050.0	603.0	215.0	127.0	95.5
18	81.2	45.4	134.0	10,800.0	11,000.0	5,810.0	9,280.0	976.0	563.0	215.0	125.0	90.9
19	95.5	68.2	141.0	9,280.0	14,700.0	35,200.0	11,600.0	1,070.0	531.0	206.0	125.0	112.0
20	77.5	114.0	231.0	5,400.0	23,400.0	1,670,000.0	10,100.0	989.0	507.0	203.0	123.0	143.0
21	68.2	146.0	266.0	3,700.0	18,200.0	587,000.0	8,270.0	925.0	479.0	199.0	120.0	167.0
22	60.8	120.0	223.0	3,160.0	13,600.0	113,000.0	6,770.0	1,060.0	459.0	193.0	117.0	138.0
23	56.8	112.0	203.0	2,650.0	10,500.0	46,200.0	5,670.0	1,340.0	439.0	186.0	112.0	136.0
24	55.5	102.0	170.0	2,360.0	7,690.0	28,700.0	5,030.0	1,400.0	419.0	182.0	110.0	141.0
25	55.5	97.8	152.0	5,400.0	6,590.0	22,200.0	4,130.0	4,250.0	405.0	179.0	109.0	149.0
26	62.6	101.0	146.0	24,600.0	5,850.0	25,600.0	3,610.0	19,600.0	393.0	176.0	106.0	136.0
27	54.2	95.5	131.0	18,100.0	6,650.0	48,700.0	3,190.0	7,830.0	383.0	173.0	106.0	125.0
28	55.1	79.3	149.0	34,800.0	5,950.0	68,400.0	3,030.0	4,700.0	373.0	170.0	104.0	125.0
29	93.2	71.9	143.0	56,400.0	5,950.0	96,800.0	2,950.0	3,880.0	358.0	167.0		112.0
30	59.4	68.2	219.0	45,400.0	6,950.0	61,100.0	2,770.0	2,930.0	348.0	164.0		109.0
31		61.5		50,500.0	7,690.0		2,410.0		343.0	161.0		101.0
TOTAL	2,175.1	2,064.4	5,676.8	403,184.0	373,290.0	3,715,370.0	578,480.0	75,810.0	23,528.0	7,142.0	3,674.0	3,463.4

ANNUAL SUSPENDED SEDIMENT DISCHARGE = 5,193,857 TON

SUSPENDED SEDIMENT DISCHARGE

STA STATION BAN CHAO NEN | UNIT TON | YEAR 1973

DAYS	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.
1	117.0	80.0	215.0	433.0	1,650.0	54,300.0	42,000.0	1,060.0	406.0	202.0	135.0	110.0
2	112.0	80.0	225.0	391.0	1,570.0	31,300.0	51,200.0	963.0	391.0	200.0	133.0	110.0
3	106.0	103.0	218.0	440.0	1,570.0	22,300.0	34,600.0	882.0	376.0	197.0	131.0	110.0
4	105.0	131.0	209.0	433.0	1,390.0	17,700.0	27,600.0	824.0	369.0	194.0	127.0	108.0
5	103.0	125.0	228.0	373.0	1,260.0	13,700.0	51,800.0	790.0	363.0	191.0	125.0	108.0
6	101.0	148.0	205.0	373.0	1,190.0	9,780.0	60,700.0	757.0	359.0	189.0	123.0	110.0
7	105.0	129.0	194.0	420.0	1,120.0	7,140.0	46,300.0	723.0	350.0	186.0	123.0	114.0
8	105.0	123.0	244.0	565.0	2,020.0	5,720.0	39,500.0	689.0	345.0	183.0	123.0	112.0
9	106.0	114.0	273.0	591.0	2,490.0	5,050.0	22,300.0	656.0	335.0	183.0	123.0	114.0
10	105.0	121.0	363.0	824.0	2,070.0	4,810.0	24,400.0	639.0	321.0	181.0	123.0	110.0
11	99.0	123.0	326.0	2,880.0	1,620.0	4,930.0	34,300.0	715.0	317.0	178.0	127.0	112.0
12	97.5	114.0	292.0	15,800.0	1,390.0	4,220.0	18,500.0	631.0	313.0	178.0	125.0	108.0
13	94.5	131.0	241.0	4,390.0	1,230.0	3,630.0	12,200.0	639.0	303.0	175.0	125.0	105.0
14	93.0	133.0	225.0	2,730.0	1,470.0	4,570.0	8,590.0	715.0	299.0	172.0	125.0	105.0
15	91.5	133.0	238.0	2,120.0	1,520.0	4,310.0	6,640.0	799.0	292.0	169.0	123.0	106.0
16	90.1	135.0	313.0	1,970.0	1,650.0	3,980.0	5,360.0	904.0	281.0	166.0	123.0	110.0
17	88.6	129.0	689.0	2,140.0	1,470.0	3,670.0	4,870.0	916.0	273.0	163.0	123.0	110.0
18	88.6	133.0	11,800.0	3,210.0	1,420.0	3,940.0	4,140.0	723.0	269.0	163.0	123.0	112.0
19	94.5	133.0	41,000.0	2,730.0	1,970.0	6,090.0	4,180.0	673.0	262.0	161.0	131.0	110.0
20	97.5	129.0	53,000.0	2,930.0	3,400.0	9,180.0	3,630.0	681.0	258.0	158.0	131.0	105.0
21	93.0	123.0	17,200.0	3,590.0	5,050.0	40,000.0	2,930.0	782.0	254.0	156.0	135.0	110.0
22	94.5	117.0	5,970.0	3,670.0	3,900.0	32,900.0	2,610.0	851.0	251.0	150.0	150.0	110.0
23	93.0	116.0	2,660.0	3,590.0	4,660.0	23,300.0	2,270.0	715.0	247.0	148.0	131.0	103.0
24	88.6	127.0	1,490.0	2,860.0	7,570.0	53,000.0	1,970.0	624.0	238.0	146.0	125.0	101.0
25	85.7	146.0	1,070.0	2,340.0	30,000.0	257,000.0	1,770.0	578.0	231.0	144.0	119.0	110.0
26	82.9	163.0	939.0	2,270.0	46,300.0	94,800.0	1,600.0	545.0	228.0	144.0	116.0	110.0
27	82.9	238.0	815.0	2,140.0	53,600.0	47,500.0	1,440.0	505.0	218.0	142.0	114.0	108.0
28	82.9	181.0	689.0	2,660.0	46,900.0	32,100.0	1,410.0	479.0	218.0	140.0	112.0	105.0
29	81.4	200.0	515.0	2,340.0	57,000.0	63,000.0	1,380.0	446.0	215.0	138.0		99.0
30	80.0	175.0	465.0	1,900.0	149,000.0	59,200.0	1,300.0	427.0	209.0	138.0		99.0
31		172.0		1,850.0	127,000.0		1,190.0		205.0	135.0		99.0
TOTAL	2,864.7	4,205.0	142,331.0	74,953.0	564,470.0	923,120.0	519,680.0	21,331.0	8,996.0	5,170.0	3,524.0	3,343.0

ANNUAL SUSPENDED SEDIMENT DISCHARGE = 2,273,987 TON

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH MAY YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																	1.1	26.2	4.0	5.0	1.2	0.8	0.3		38.6
3								0.2						5.0	0.8			8.5				0.2			14.7
4													3.8	0.8	0.2										4.8
5																									
6																									
7																									
8																									
9																									
10																					0.2				0.2
11							0.2																		0.2
12																1.5									1.5
13													0.6												0.6
14														0.8	17.6		0.2								18.6
15																0.8	0.2	25.8	0.4	0.6	1.0	0.2			29.0
16	0.2					0.2																			0.4
17																									
18																									
19															1.2										1.2
20																						0.2			0.2
21																									
22																					0.2	0.2		0.2	0.6
23																									
24																		2.2	0.6						2.8
25																		9.1	1.1	1.0	2.0	0.2			13.4
26																0.2	0.2								0.4
27						0.2																			0.2
28																									
29																									
30																									
31																				10.2	1.2	7.8	1.4	0.2	20.8

TOTAL 148.2

MAX. 26.2

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH JUNE YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3															24.2	0.2			0.4	0.8	0.6				26.2
4									0.2												0.4	0.4			1.0
5									0.6																0.6
6															3.2						1.4	0.2			4.8
7														9.8	3.2	0.6									13.6
8					0.2									0.2											0.4
9																0.2									0.2
10																				0.6	0.6	0.6			1.8
11															2.2										2.2
12					0.2																				0.2
13																									
14																			0.2						0.2
15						0.2			1.8	0.4	1.2	0.2	0.8		0.2									0.4	5.2
16	0.4	0.4	0.4					0.2	0.2				0.2							0.8	1.2	2.6	11.0	8.6	26.0
17	1.0	0.2			0.2	0.8	2.8	3.4	4.0	1.4	4.1	8.4	17.6	3.4	0.2				0.2					8.2	56.2
18	1.4	0.2		0.2	3.0	0.2							0.2	0.2											5.4
19						0.2					0.2				0.4		1.0	0.2							2.0
20										0.2															0.2
21																									
22																									
23																									
24															7.6	2.2									9.8
25																									
26									0.2																0.2
27									0.2																0.2
28																									
29																	1.4	9.0							10.4
30																26.0	1.6								27.6
31																									

TOTAL 194.4

MAX. 26.0

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH JULY YEAR 1973

DAY \ TIME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3															5.8										5.8
4																									
5																		0.2	0.2						0.4
6				2.8	0.6												0.6	0.2					0.4		4.6
7		0.2	0.2	0.2		1.4	0.2	1.8	1.6																5.6
8																									
9						0.2		0.2																	0.4
10						1.6	0.8	0.4				0.2													3.0
11			0.8	0.6	0.2																				1.6
12													0.2						0.4			0.2			0.8
13				3.8	2.2	3.0	0.6			0.2	0.2														10.0
14									0.2																0.2
15									3.8																3.8
16														1.8	1.2										3.0
17						0.8	2.6	1.2	0.4	0.2	0.2		0.2												5.6
18								0.4	0.6	0.6	0.2														1.8
19				0.4	0.2									5.2	0.2		3.4	0.2							9.6
20																	1.8	0.2							2.0
21							0.2																		0.2
22																									
23																									
24																									
25																									
26																			1.4	0.2					1.6
27																									
28																									
29																			0.4	0.4	0.2				1.0
30									0.2											0.2	0.4	0.2			1.0
31					0.2												11.4	9.0							20.6

TOTAL 82.6

MAX. 11.4

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH AUGUST YEAR 1973

DAY \ TIME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																	20.8	12.8	1.0						34.6
2		26.0	3.1	0.2		0.2													0.2	1.7	27.2				58.6
3									0.2								8.6	1.5							10.3
4																									
5																					0.2				0.2
6		0.2																	0.4	0.2					0.8
7						0.2																			0.2
8		0.2																	0.4	1.0					1.6
9																					2.2			0.4	2.6
10	0.2														0.2										0.4
11																			0.2						0.2
12														3.7											3.7
13														1.0											1.0
14																								0.2	0.2
15																									
16																									
17																									
18																									
19			0.2																						0.2
20					0.2											0.2	0.2								0.6
21	0.2						6.0	1.6		0.2														0.2	8.2
22								0.2									0.8		0.2	0.4	0.2		0.2		2.0
23		0.2	0.8	0.2	0.2		0.2																		1.6
24															5.2	1.2	1.8	1.2	0.4	1.2					11.0
25				0.2																		0.2			0.4
26														0.2	0.6										0.8
27																									
28					0.4	0.4																			0.8
29																									
30									0.2					8.5	1.5					0.8	0.8	0.4		0.2	12.4
31				0.6	0.2			0.2										2.5							3.5

TOTAL 155.9

MAX. 27.2

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH SEPTEMBER YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1												4.4	1.2												5.6
2																		0.6	0.4				0.2		1.2
3																	0.2								0.2
4																0.2	0.6	0.4							1.2
5						0.2																			0.2
6																									
7																	0.2		0.4	0.2	0.2				1.0
8				0.2															1.2	0.2		0.2			1.8
9															3.9	0.2									4.1
10																									
11									0.2																0.2
12																0.4			0.2	0.2			2.0	0.2	3.0
13																									
14							0.2						2.9	3.0			1.1								7.2
15							0.2																		0.2
16																							0.8	0.8	1.6
17	0.4													0.8		0.4		0.8	2.0				0.4	0.8	5.6
18	4.4	0.4	0.2																0.2	1.4	6.0	1.4	0.2	0.4	14.6
19	0.2	0.2	0.2												2.7			0.4			0.2	0.2			4.1
20																			0.4		5.4	0.2		0.8	6.8
21																									
22		0.6				0.2	8.0				0.2														9.0
23															1.9	1.9									3.8
24				2.0	4.0	1.4	0.2	0.2																	7.8
25																									
26															0.2	0.2						0.2	0.6	0.6	1.8
27	1.0	0.2	0.2												4.5	6.2	3.2	2.0	0.2				0.2		17.7
28	0.2			0.2														3.6	4.8	5.8	1.2	0.2	0.2		16.2
29							0.4	1.0	0.4								1.2	0.8	0.6						4.4
30	0.2														0.2										0.4
31																									

TOTAL 119.7
MAX. 8.0

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH OCTOBER YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																		8.0	6.0						14.0
2	0.2																								0.2
3													2.1							0.2	1.4	3.4	4.4	5.2	16.7
4	5.2	0.8										3.3	0.8	5.2	0.8					1.0	3.2	1.0	9.2	16.6	47.1
5	11.6	0.6		3.1	0.2		2.2	6.8	0.8											5.5	3.4	3.6	1.6	0.2	39.6
6				0.2																0.4		1.2	0.2	4.7	6.7
7					4.2			1.2																	5.4
8																					1.2	0.8			2.2
9	0.2																6.4	5.0	10.4	1.4	2.6	0.8	0.2	2.0	29.0
10	0.8	0.5	0.2	0.4																					1.9
11					0.2											2.4									2.6
12																									
13																									
14																									
15																									
16	0.8	0.8					0.2																		1.8
17	0.6	0.2			0.2																				1.0
18			0.2																						0.2
19						0.2																			0.2
20																									
21							0.2																		0.2
22																									
23																									
24						0.2																			0.2
25																									
26																									
27							0.2	0.2																	0.4
28																									
29																									
30					0.2																				0.2
31																									

TOTAL 169.6
MAX. 16.6

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH NOVEMBER YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3						0.2																			0.2
4																									
5																									
6																									
7																									
8																									
9																									
10																1.2									1.2
11		4.9				0.2																			5.1
12																			0.2	0.2					0.4
13			0.4	0.2	0.2	0.2	0.2		0.2						0.2	0.6		0.2		0.2	0.2				2.8
14	1.4	0.4		0.2											0.2							0.6			2.8
15																									
16				0.2																					0.2
17						0.2																			0.2
18		0.2																						0.4	0.6
19	0.2	1.8	0.4	2.0	3.2	0.4	0.2					0.6	0.6				0.2		0.6	1.4	2.2	0.4	0.2	0.2	14.6
20		0.2			0.4	0.2			0.2																1.0
21							0.2																		0.2
22																									
23																									
24																									
25					0.2																				0.2
26						0.2																			0.2
27						0.2																			0.2
28						0.2																			0.2
29						0.2																			0.2
30																									
31																									

TOTAL 30.3
MAX. 4.9

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH DECEMBER YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1			0.2																						0.2
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14						0.2																			0.2
15																									
16								0.2																	0.2
17																									
18						0.2																			0.2
19								0.2																	0.2
20																									
21								0.2																	0.2
22																									
23																									
24																									
25																									
26																									
27							0.2																		0.2
28																									
29																									
30																									
31																									

TOTAL 1.4
MAX. 0.2

HOURLY RAINFALL

STATION BAN CHAO NEN   UNIT mm   MONTH JANUARY   YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 0.0
MAX.

HOURLY RAINFALL

STATION BAN CHAO NEN   UNIT mm   MONTH FEBRUARY   YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																				13.0	7.4				20.4
19					0.2																				0.2
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 20.6
MAX. 13.0

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH MARCH YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																	3.7								3.7
8															15.3	0.4									15.7
9					0.2																				0.2
10																			4.0						4.0
11																									
12																									
13																									
14																	4.6	0.6							5.2
15								0.2																	0.2
16																									
17																									
18																			6.1	3.5					9.6
19																	1.0								1.0
20																									
21	18.2	0.2																	0.6		2.8				21.8
22																									
23																		1.2		10.4	11.0				22.6
24																									
25																									
26																									
27																									
28																									
29																			0.2						0.2
30																		1.6	13.4	3.2	0.4	1.8	0.4	0.4	21.2
31								0.2										3.6	0.2						4.0

TOTAL 109.4
MAX. 18.2

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH APRIL YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2															5.3					3.2	1.2	7.0	2.6	0.2	19.5
3		4.4	0.3	0.4	0.2																				5.3
4																									
5																									
6																									
7																									
8																									
9											0.6														0.6
10																		20.0	2.0	0.4					22.4
11			0.2																	0.6	1.4	1.0			3.2
12															0.2	1.4			0.2	0.4					2.2
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 53.2
MAX. 20.0

HOURLY RAINFALL

STATION: BAN CHAO NEN UNIT: mm MONTH: JUNE YEAR: 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1													0.4												0.4
2							0.2	0.4	0.2																0.8
3										0.2				0.6		5.6		0.2							6.6
4										0.4						0.7	0.2		1.2	0.2					2.7
5		0.2						0.2	1.4	0.8															2.6
6							0.2															0.2			0.4
7						0.2		0.2							0.2										0.6
8					0.2	0.4	0.4																		1.0
9													2.4	0.2											2.6
10													0.8	0.6	2.8	1.4									5.6
11						0.4	0.2													0.2					0.8
12			0.2	0.2		0.2																0.2			0.8
13																									
14																				0.2		0.2			0.4
15			0.2		1.4	1.7				0.4	0.4	0.8	0.2												5.1
16																									
17																									
18																0.2									0.2
19														6.8	6.2	0.2						0.2			13.4
20																									
21															16.2	0.4									16.6
22										0.8	0.8														1.6
23													1.6			5.8		0.2			0.2	0.2	0.4		8.4
24		0.2																							0.2
25																0.4									0.4
26																						0.2			0.2
27																						0.2	0.2		0.4
28																									
29																									
30																3.6	4.6	6.6	4.4	1.4	0.4				21.0
31																									

TOTAL 73.9

MAX. 16.2

HOURLY RAINFALL

STATION: BAN CHAO NEN UNIT: mm MONTH: JULY YEAR: 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5						0.2																			0.2
6							0.2	0.4						0.6	0.8	0.6									2.6
7						0.2		0.2		0.2												0.2			0.8
8		0.2						0.2	0.2																0.6
9																				0.2		0.2			0.4
10			0.2																						0.2
11																									
12																									
13																									
14																									
15					0.2																				0.2
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																6.0	25.2	0.6	12.0	3.0	5.8	1.8	0.6	1.2	56.2
25	0.6						0.2										4.0	1.0	1.0	0.2	0.2				3.6
26																					0.2	0.4		0.2	0.8
27																					1.2	1.2	0.2	0.2	2.8
28																									
29			0.2															0.2							0.4
30			1.6	5.4	3.2	2.6	1.6	0.8	0.2								1.8	0.4	1.4	0.8				0.2	20.0
31														0.2			0.6	0.4							1.2

TOTAL 90.0

MAX. 25.2

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH AUGUST YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																						0.1			0.1
2				0.4																					0.4
3																							1.2	25.0	26.2
4	3.0	2.1	0.6	0.2																					5.9
5																0.2		1.0	0.4						1.6
6									0.2			0.2	2.8		0.2										3.4
7		0.2									2.2	0.4													2.8
8						0.2																			0.2
9																									
10																									
11																									
12													0.6	1.4	1.2			0.2	5.2	2.8	0.6		5.6	1.2	18.8
13		1.8	0.4	0.2	1.4	0.2							0.4	0.2											4.6
14												9.8				0.2	0.6								10.6
15			0.2	3.0		0.2		0.2	0.2	0.4				0.2			0.8	0.4	0.2	0.2	0.4				6.4
16				0.6	1.0	0.4	0.8	0.2		0.2											0.4	0.4	0.2	0.6	4.8
17	0.1	4.2	1.8	6.4	0.8		0.4		3.8	0.8	0.6	0.6	5.7	0.2	2.8	0.2	0.2	0.2	0.6	0.2	0.2		0.2	0.2	30.2
18	6.0	1.8	2.6	0.6	0.6	0.2	0.2		0.2	0.6	0.2	1.0	0.8	2.8	0.6							0.2		0.2	18.6
19			0.2	0.2	0.6	0.4																			1.4
20																									
21																									
22																									
23													0.2	0.2	1.0										1.4
24																0.2		0.8							1.0
25																									
26								0.2								4.8	1.0	0.6			0.2				6.8
27	0.2	0.6	1.0	0.6	0.6	0.8	1.0	0.8	0.2										0.2	0.2					6.2
28							0.2																		0.2
29		0.2											0.8												1.0
30																									
31														0.8											0.8

TOTAL 153.4

MAX. 25.0

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH SEPTEMBER YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																	0.1								0.1
2																2.3	1.2		0.4	0.4					4.3
3							0.2									0.2		0.2							0.6
4																									
5														0.5						0.2					0.7
6								0.2																	0.2
7														5.6	2.5	0.2	0.4	1.2	0.4	0.4	0.2			0.4	11.3
8	0.4	0.4			0.2											0.6			8.0	1.0	0.6	0.2			11.4
9					0.4																				0.4
10																0.2		0.2							0.4
11														14.2	0.2										14.4
12				0.2									0.9												1.1
13																			0.2	0.8	0.8		0.2	0.2	2.2
14																					1.2	1.0	0.4		2.6
15	0.2													0.4					0.2						0.8
16			0.2					0.2	0.6	0.2	0.2					0.6	7.2	1.2							10.4
17													0.6												0.6
18																				6.2	19.4	3.0	1.8	3.0	33.4
19	1.8	0.2	0.2													1.8	0.2					0.4	2.3		6.9
20																2.6	0.2				0.2	1.0	0.4	0.2	4.6
21	0.2												0.4												0.6
22				0.2	0.2		0.7					0.8		1.4	0.8										4.1
23																							3.5	0.2	3.7
24		6.9	7.3	1.9			0.8							0.6	0.2	1.4	0.4	2.3		9.2		1.0	1.2	0.2	33.4
25			3.6	4.6	0.6	0.2	1.2	3.1	3.0	1.2	1.0	1.9	0.4	0.2	2.4	12.6	2.2	1.4	0.2	0.8			0.6	0.6	41.8
26	0.6					0.4												4.2	2.6	0.6					8.4
27																									
28																									
29																									
30																							1.9	1.7	3.6
31	1.3	0.2	0.2																						1.7

TOTAL 201.7

MAX. 19.4

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH OCTOBER YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																	0.1								0.1
4																			0.2						0.2
5									0.2																0.2
6				0.2				0.2							0.6									1.0	2.0
7	1.0	0.6		2.9	0.2	0.4		0.2							7.9							0.2			13.4
8						0.2								4.2	0.4		0.2				0.2				5.2
9	0.4	0.2							6.6	2.8	1.0	0.2	0.6			0.6	15.4	0.2		0.2	0.2	0.2	2.0	2.9	31.7
10	2.5	5.8	3.2	0.6		0.2	0.2	0.8	1.0		0.4	4.4	28.0	18.9	0.2						0.2	2.0	1.6	0.6	70.6
11		0.2																21.6	50.0	12.6	4.8	7.6	3.1	3.0	102.9
12	1.8	0.6			0.2																				2.6
13																16.6	21.2	0.2	1.0	5.0	4.3	1.0			49.3
14															1.2							11.0	15.5	0.2	27.9
15											0.3	3.6	2.6	1.8									2.6	1.2	12.1
16	2.4	2.6	11.1	4.4	2.2	0.4										1.7									24.8
17														0.6		0.2									0.8
18																									
19														10.0											10.0
20												8.5	1.6	0.4											10.5
21																							1.2	1.5	2.7
22	2.0	0.2	0.2		4.4	0.2												1.4	0.6						9.0
23		2.0	3.0					0.2																	5.2
24																									
25																									
26																									
27																									
28																				13.0	1.6		21.4	5.6	41.6
29	1.2																						7.7	0.4	9.3
30																									
31									0.2														4.0	2.2	6.4

TOTAL 438.5
MAX. 50.0

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH NOVEMBER YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1															0.4	12.2									12.6
2																									
3																									
4																									
5									0.2								1.4	0.2		1.1	0.6	0.2			3.7
6					0.2																				0.2
7																									
8																									
9									0.2																0.2
10																						17.8	1.2	3.2	22.2
11	1.5	0.2												0.2										9.4	11.3
12	2.4	2.8	0.4		7.2	2.3									8.0	5.2	3.0	2.2		0.2					33.7
13					0.2																				0.2
14																									
15																									
16																						0.2		0.2	0.4
17	1.0		0.8	0.2	0.4	0.8	0.4	0.2	0.4	0.4															4.6
18																									
19																									
20								0.2																	0.2
21																									
22																									
23																									
24			0.2																						0.2
25																									
26																									
27																									
28								0.2																	0.2
29																									
30																									
31																									

TOTAL 89.7
MAX. 17.8

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH DECEMBER YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 0.0

MAX.

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH JANUARY YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5					0.2												0.2								0.4
6																									
7																									
8																									
9																1.0							0.2		1.2
10							1.2		0.2									0.2	0.4						2.0
11						0.2										0.6		1.2							2.0
12																									
13			1.4	1.2																					2.6
14		0.2	0.6	0.8	0.4	0.2		0.2																	2.6
15																									
16							0.2																		0.2
17																									
18																									
19																									
20																2.6									2.6
21																									
22								0.2																	0.2
23																									
24																									
25																									
26								0.2																	0.2
27																									
28																									
29																									
30						0.2																			0.2
31																									

TOTAL 14.2
MAX. 2.6

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH FEBRUARY YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3			1.2																						1.2
4																			0.2						0.2
5								0.2																	0.2
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 1.6
MAX. 1.2

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH MARCH YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																		19.4		0.8		0.2			20.4
2																									
3																									
4																									
5																									
6																									
7																									
8																4.8									4.8
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																					40.2	1.8	2.4		44.4
18																									
19																									
20																				0.2	3.8	0.2			4.2
21																									
22									0.2																0.2
23																									
24															55.6	5.8									61.4
25							0.2																		0.2
26																									
27																									
28																									
29																									
30																									
31																						10.0	43.0	2.6	55.6

TOTAL 191.2
MAX. 55.6

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH APRIL YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1	2.8	1.4																2.2	2.2	0.2					8.8
2																									
3																									
4																									
5																								0.8	0.8
6	0.2													8.6	0.2				0.2						9.2
7						0.2																			0.2
8																				0.6	0.2				0.8
9	0.2																								0.2
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									
21																		0.4	0.4	0.2					1.0
22																									
23																			0.4	0.2					0.6
24	0.2																								0.2
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 21.8
MAX. 8.6

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH MAY YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																	0.2	0.2	0.4		0.4	0.2			1.4
2																									
3													2.2	20.6	2.0										24.8
4						0.2	0.2			0.2	0.6	4.2		1.2			0.2								6.8
5		1.4	0.4							0.4				7.0	0.2	2.8	18.6	13.0	2.2	0.8					46.8
6														6.6	5.4	0.2									12.2
7																									
8			0.4																	0.4	1.0	0.2			2.0
9																									
10																									
11																									
12															0.8			1.8	0.8	0.4	0.2				4.0
13																									
14																									
15																									
16																									
17																									
18																	4.6	0.2							4.8
19																0.2									0.2
20																1.8	0.2	1.0	1.0	0.4					4.4
21															0.2	0.2									0.4
22															0.7	9.8				0.2	0.4	0.2	0.2		11.5
23														19.0	3.6	0.2				0.4					23.2
24																					0.4			0.2	0.6
25																									
26			0.2																						0.2
27		0.2																							0.2
28																									
29																									
30																									
31																6.8									6.8

TOTAL 150.3
MAX. 20.6

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH JUNE YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1				1.4	0.2										1.6	0.6	0.2								4.0
2						0.2																			0.2
3	0.2	0.2	1.2					0.2							0.6		0.4	0.2							3.0
4																1.6	0.2					0.2	0.2		2.2
5	1.0	0.2		0.4	0.2				0.2		1.0														3.0
6																									
7							0.8								0.4										1.2
8			0.2		1.2	4.8	1.4	1.4							0.2					0.6	0.2	0.2			10.2
9			0.2														0.6								0.8
10													0.8						1.4	0.2					2.4
11																									
12																									0.4
13																									
14																									
15										0.2															0.2
16													0.2												0.2
17													0.6	1.2											1.8
18			0.6								17.0														17.6
19																									
20																		0.8	0.2	0.2	0.2	0.6	0.2	1.2	3.4
21	0.2					0.2												9.6	4.6	2.8	4.2	2.4			24.0
22	0.8	0.6	0.2														3.8	1.6	0.2	0.2	0.4	0.4	0.2		8.4
23																									
24																									
25																									
26																									
27			0.6	0.6	0.2	0.2																			1.6
28																									
29																0.6									0.6
30																									
31																									

TOTAL 85.2
MAX. 17.0

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH JULY YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1				0.2	0.2																				0.4
2																5.6									5.6
3								0.2						0.4											0.6
4													1.0				0.6								1.6
5																									
6																									
7																									
8												0.2	6.8	1.8											8.8
9																									
10																									
11		0.2					0.4	1.4	0.6											0.4	1.8	1.0	0.4	0.8	7.0
12																									
13																									
14																									
15																									
16															5.2	2.4	0.8	0.6	0.4	0.2		0.2		0.2	10.0
17	0.2									0.2												0.2			0.6
18							0.2																		0.2
19																									
20	24.6	4.0	0.2		0.2																2.0	2.2	0.4		33.6
21			0.2															0.6	0.2	1.6	0.8	0.2			3.6
22		0.2																			0.6	0.6	0.2		1.6
23														0.4				0.2	0.6		0.2	0.2	0.2	0.2	2.0
24																									
25																							9.4	0.2	9.6
26					0.2									0.2											0.4
27																0.8	1.2	0.2	1.4	4.4	1.8		0.4	0.2	10.4
28	0.2														4.0	5.0		1.6	2.4	3.4	0.2				16.8
29																									
30												0.2													0.2
31																									

TOTAL 113.0

MAX. 24.6

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH AUGUST YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1															0.4										0.4
2																	1.8	1.2							3.0
3											0.2														0.2
4								0.2																	0.2
5						2.0	0.8	1.0	0.4	0.2															4.4
6											0.2														0.2
7														2.2	2.8										5.0
8																7.0									7.0
9																									
10																									
11					0.6	0.2	0.2									0.2		0.2		0.2	1.0	0.6	0.2		3.4
12								0.2	0.4									1.4	1.6			0.2			3.8
13											4.0	4.6													8.6
14									0.2			0.2	0.6	0.2											1.2
15															0.8	20.2	4.0	0.8			0.2		0.2	0.2	26.4
16																									
17												0.2	0.4		0.8	0.2									1.6
18																									
19																									
20																									
21																									
22																									
23															1.8	0.2									2.0
24							0.2																		0.2
25														2.0		4.2	0.6		0.2						7.0
26																			0.2				0.2		0.4
27		0.2	0.4								0.6		4.2	0.4				0.2			0.2	0.2	0.2	1.0	7.6
28	0.2	0.4	1.2	2.2	0.2	0.2		0.2	0.2																4.8
29														0.4		0.2			0.6	0.8	0.6	1.0	1.0	0.4	5.0
30	0.2	0.4		0.4	0.2															0.2	0.6	0.4	0.2	0.2	2.8
31		0.2													0.2						0.4			0.8	1.6

TOTAL 96.8

MAX. 20.2

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH SEPTEMBER YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1	0.4																								0.4
2																					1.0	0.6			1.6
3																					0.2				0.2
4								3.4	4.6	1.2	1.2					1.6	5.6	0.6	2.6	1.6	1.0	0.2		1.0	24.6
5	1.4	3.6	3.8	0.6						3.8	1.0				1.4		1.8	1.2	1.2	0.2					20.2
6	0.2										4.8	0.2											0.2	0.8	6.2
7		0.2					0.2																		0.4
8																									
9																									
10																									
11																									
12																	3.0	7.8	2.8	1.0	0.2	0.2		0.2	15.2
13	0.4	0.4	3.2	0.2																					4.2
14																				0.2					0.2
15																	0.4								0.4
16																	4.8								4.8
17			0.2									0.8				0.6	1.2	1.4	0.6						5.0
18																									
19													0.4												0.4
20																									
21																									
22																1.6	6.2	0.8	0.2		0.2	0.2	0.4	0.6	10.2
23	0.4	0.2													11.2				7.6	5.0	6.6	2.4	0.8	0.8	35.0
24	0.6	0.4																	1.6						2.6
25																					3.2				3.2
26								1.0																	1.0
27																	0.8								0.8
28													0.2												0.2
29																	8.4						8.6	1.4	18.4
30	1.6	0.8	0.2	0.2											6.6			4.0	1.4		27.0	25.6	6.6		74.0
31																									

TOTAL 229.2
MAX. 27.0

HOURLY RAINFALL

STATION BAN CHAO NEN UNIT mm MONTH OCTOBER YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1	0.2																								0.2
2																				30.4	2.0	0.2			32.6
3			0.2		0.2												1.0	0.8			0.6	0.2			3.0
4																									
5													0.6		0.6										1.2
6																13.8	0.2	0.6	1.2						15.8
7																									
8																									
9																				0.6	0.8				1.4
10							0.2											25.4	1.8	0.4	1.2	2.6	0.6		32.2
11		0.2																							0.2
12						0.2	0.4	0.2														2.0	0.6	0.2	3.6
13																	0.2		0.2		1.6				2.0
14		0.4	0.8																				1.0	0.8	3.0
15	1.6					0.6	3.4	2.8																	8.4
16	0.2																								0.2
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 103.8
MAX. 25.4

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH MAY YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																	9.5								9.5
2																			15.0	11.0	4.5	1.0	0.5		32.0
3															2.0	0.5			1.0						3.5
4																									
5																0.3									0.3
6																									
7				0.4																					0.4
8																									
9																									
10																									
11														4.0	14.0										18.0
12																									
13																									
14														0.5		3.5	1.0	1.0							6.0
15																		0.7			0.5				0.7
16																									
17																									
18															4.0										4.0
19																									
20																					0.7				0.7
21															2.0	0.1									2.1
22														6.0											6.0
23															0.4										0.4
24													0.4								3.0	2.0			5.4
25																	1.5			0.5	1.5				3.5
26																									
27																									
28																	7.0	2.0	6.0	1.0		0.5			10.5
29																		4.0							4.0
30																		0.5		0.3					0.8
31																	1.0	10.0				4.0	0.3		15.3

TOTAL 129.1

MAX. 15.0

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH JUNE YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1											1.0										1.0	5.5			7.5
2																									
3																				0.5	0.5				1.0
4																	0.5		0.5						1.0
5															0.5	2.0	0.2								2.7
6																		0.3							0.3
7	1.0														1.0	1.0		1.0							4.0
8														0.5	0.5	7.0	1.0								9.0
9	0.6													1.0											1.6
10																									
11																									
12																									
13																5.0	2.6								7.6
14																	0.5								0.5
15			0.5	1.0			1.0			1.0	0.5														4.0
16			0.5	2.0		0.5	0.5	1.0	1.0										1.0	1.0				2.0	9.5
17	2.0	1.0				3.0	10.0		14.0	15.0	15.0	12.0	5.0	2.0						2.0			2.0	10.0	93.0
18	2.0	2.0		2.0	4.0	5.0	1.0	1.0					1.0		1.0		1.0	1.0							21.0
19									1.0	3.0		1.0						6.5	1.0						12.5
20																									
21																									
22																									
23																									
24																	1.2								1.2
25																									
26																									
27																									
28																			2.0						2.0
29															3.0	4.8									7.8
30																		0.5							0.5
31																									

TOTAL 186.7

MAX. 15.0

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH JULY YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																	3.0								3.0
5																									
6				1.0	1.0	2.0							5.0						1.0	3.0					13.0
7						1.0	0.3																		1.3
8																									
9															1.0										1.0
10					1.0				0.2																1.2
11																									
12											4.0														4.0
13				1.0			0.5																		1.5
14							0.4																		0.4
15																									
16																								0.3	0.3
17						0.7	2.0	2.0	2.0	2.0		0.3													9.0
18									0.4																0.4
19												0.8					0.2								1.0
20													0.9												0.9
21																									
22																									
23																									
24																									
25																									
26																			24.0						24.0
27																									
28																		1.8							1.8
29																		2.0	1.0	0.4					3.4
30															2.0	1.0					1.0	2.0	2.0	1.0	9.0
31																									

TOTAL 75.2
MAX. 24.0

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH AUGUST YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1														0.4				1.1				0.3			1.8
2																1.0	0.3								1.3
3														0.3					6.0						6.3
4																									
5																									
6																				1.0	2.0	0.5	0.5		4.0
7																					1.0	2.0	3.0	5.0	11.0
8	1.0																								1.0
9													1.0	0.8											1.8
10																									
11																									
12																									
13																									
14						0.5											1.0		1.0						2.5
15																									
16																									
17																			1.0		0.3				1.3
18																						1.5	0.5		2.0
19																									
20																									
21					1.0	2.0	0.6													1.0	1.0				5.6
22								0.2														1.0			1.2
23																									
24			0.6						0.5					1.0	1.5		0.5	1.0	1.0	1.0					7.1
25							0.8															1.0			1.8
26							0.2																	0.3	0.5
27																									
28	0.5			0.8	0.3				0.2																1.8
29		2.0	0.4													8.0								0.6	11.0
30																1.5									1.5
31	5.0	2.0																							7.0

TOTAL 70.5
MAX. 8.0

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH SEPTEMBER YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1										1.4															1.4
2																3.0								0.5	3.5
3																									
4									0.5						0.5										1.0
5																									
6																									
7														2.0											2.0
8																				2.0	1.0	1.0	0.2		4.2
9																3.0	1.2								4.2
10																									
11															5.0	4.0	3.8								12.8
12																		0.2	3.0				2.0	9.8	15.0
13				0.2										2.0											2.2
14																7.0	1.0								8.0
15																			16.0	2.0	0.8				18.8
16																0.5									0.5
17													0.5				5.5	29.0		1.0	1.0				37.0
18				1.0			1.0		3.0	1.5		0.5	1.5					0.5	2.0	5.0	2.5				18.5
19		0.5	0.1	0.1					0.8	1.0	1.0		1.0		2.5		0.5	1.0	3.0	3.0	0.5				12.0
20																	0.5	1.0	3.0	4.0	3.0				11.5
21				1.0	1.0	4.0	1.5									2.5									10.0
22																									
23												3.8					0.5	13.0	7.0						24.3
24								1.0	0.5																1.5
25																									
26															11.5		0.8	0.2		1.0				0.5	14.0
27																									
28												0.5						1.0	9.0	14.0	1.0	18.0			43.5
29												0.5				0.5	0.5				0.5	0.5	0.5	0.5	3.5
30													11.5				0.5								12.0
31																									

TOTAL 261.4

MAX. 29.0

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH OCTOBER YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																1.8	7.0								8.8
2															0.3										0.3
3											0.7	1.5										0.5	1.0	12.0	15.7
4	3.0														3.0					1.0		18.0	6.0	3.0	34.0
5					1.0	4.0	7.0	0.5													7.5	5.0	3.0	0.2	28.2
6								0.3																	0.3
7																									
8																			5.0	15.0	3.0	2.0		0.8	25.8
9																3.0	3.0	2.0	2.0	1.5			0.5	0.5	12.5
10	0.5	1.0	2.5			0.5	1.0	1.0																	6.5
11																									
12		6.0	6.5																						12.5
13											0.3														0.3
14																							0.4		0.4
15																									
16																									
17		0.3			0.2							1.0													1.5
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27							0.8		0.2				1.0		0.5										2.5
28		0.5	2.0	0.3																					2.8
29																									
30																									
31																									

TOTAL 152.1

MAX. 18.0

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH NOVEMBER YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10													6.4												6.4
11																									
12		0.8		1.2	1.0	2.0								0.8	3.2		0.5		1.5	1.0	0.5	0.5	0.4	0.6	14.0
13	1.0			0.2	1.0	0.5		0.7	0.3										1.0	1.2			0.5		6.4
14	0.5																								0.5
15																									
16																									
17																									
18																									
19		0.8		0.5			1.2	1.0		0.5		0.3	1.0	1.0		1.0	2.4	0.6	0.5						10.8
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 38.1
MAX. 6.4

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH DECEMBER YEAR 1973

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5						0.4		0.6																	1.0
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 1.0
MAX. 0.6

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH JANUARY YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 0.0
MAX.

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH FEBRUARY YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																					2.0	0.5	1.0		3.5
19																									
20																		18.0	7.0						25.0
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 28.5
MAX. 18.0

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH MARCH YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8							1.0	2.0																	3.0
9																			1.0	0.7					1.7
10																	7.0	5.0							12.0
11																									
12																									
13																									
14																	0.5								0.5
15																	2.0		0.5						2.5
16																									
17																									
18																									
19																									
20																					10.0	1.0			11.0
21																			0.9						0.9
22																									
23																		0.5							0.5
24																									
25																									
26																									
27																									
28																					1.0	0.7			1.7
29									0.2					2.0				4.0	6.0	2.0					14.2
30																			8.2						8.2
31																									

TOTAL 56.2
MAX. 8.2

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH APRIL YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																				4.0	3.0	13.0	5.0	6.0	31.0
3	0.5																								0.5
4																									
5																0.5									0.5
6																									
7																									
8																									
9															1.0	0.5	0.2								1.7
10																1.3	9.8								11.1
11																						0.2			0.2
12																2.0	0.8								2.8
13																	0.3								0.3
14																3.0									3.0
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																						0.5			0.5
27																				0.5	3.0	1.0		1.0	5.5
28	1.0	2.0	1.0	2.0																		0.2			6.2
29			0.2			0.1							1.5	4.5			1.5	0.8							8.6
30																									
31																									

TOTAL 71.9
MAX. 13.0

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH MAY YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																1.8									1.8
2															0.1										0.1
3															3.1		1.0		1.0						5.1
4													0.3												0.3
5																									
6																									
7																									
8																									
9																									
10																	2.0					1.0		1.0	4.0
11	1.0	1.0																				1.0			3.0
12																		7.8							7.8
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 22.1
MAX. 7.8

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH JULY YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5			0.2																					1.0	1.2
6				0.4		0.5							0.1												1.0
7														1.7						0.3					2.0
8								0.4																	0.4
9																									
10																									
11																									
12																									
13																									
14																									
15																0.1									0.1
16																									
17																									
18																									
19																									
20						1.2									1.0										2.2
21																									
22																									
23																								1.0	1.0
24																		17.0		7.8		6.0		1.2	32.0
25								0.3		0.5									1.2		2.8				4.8
26																				1.0		0.8		0.2	2.0
27																								3.0	3.0
28													5.8									17.2		2.2	25.2
29		0.2		0.1		0.2		0.1		0.1						0.1		0.7		3.3		2.1		17.9	24.8
30		1.0		3.0				1.0										2.0		1.0		9.5		0.5	18.0
31		0.8																							0.8

TOTAL 118.5
MAX. 17.9

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH AUGUST YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12															0.3			0.2		0.5				1.8	2.8
13					4.1							1.2		0.7											6.0
14																			0.3						0.3
15																		0.9							0.9
16								1.5										0.5		0.5		0.5	0.5	1.0	4.5
17	2.0	2.0	2.5	2.5			0.9	1.0			1.3	2.4			0.6							0.2			15.4
18			0.7	1.0		1.0				0.6	1.0	2.4	2.7			0.7									10.1
19																									
20																	2.2								2.2
21																									
22																0.9									0.9
23																									
24															0.5			0.5							1.0
25																		3.0							3.0
26																2.0				0.5		0.5			3.0
27		0.5		0.5	1.0																				2.0
28																1.9									1.9
29																									
30																									
31																									

TOTAL 54.0
MAX. 4.1

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH OCTOBER YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																		1.0							1.0
18																									
19																									
20														1.5											1.5
21																				0.1					0.1
22																			0.8						0.8
23		0.6		1.0																					1.6
24																	5.0								5.0
25																									
26																0.2									0.2
27																									
28																	2.2								2.2
29		0.3																							0.3
30	0.7																				0.5				1.2
31	7.4																								7.4

TOTAL 21.3
MAX. 7.4

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH NOVEMBER YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5												1.0					8.0	4.0	3.0	1.5				0.1	17.6
6																									
7																									
8																									
9																									
10																	10.5						14.5	4.5	29.5
11	3.8	0.9													2.0										4.7
12												2.1		3.9											6.0
13			0.8																						0.8
14																									
15																									
16																					0.2				0.2
17	0.7	1.9	0.6	0.4	0.7	1.3		0.6	0.6	0.6	1.3														8.7
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 67.5
MAX. 14.5

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH DECEMBER YEAR 1974

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 0.0
MAX.

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH JANUARY YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																			0.7	1.3	2.0				4.0
5	0.7																								0.7
6															0.3										0.3
7			0.2																						0.2
8																									
9																									
10							0.7									1.4									2.1
11					1.3						0.9														2.2
12																									
13				0.6	0.6	1.5	1.5	1.8			2.1														8.1
14																									
15																									
16																									
17																									
18																					6.0				6.0
19																									
20																	1.8								1.8
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 25.4
MAX. 6.0

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH FEBRUARY YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																									
21																									
22																									
23																									
24																									
25																									
26																									
27																									
28																				5.0	5.0	3.6	0.5		14.1
29																									
30																									
31																									

TOTAL 14.1
MAX. 5.0

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH MARCH YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																						0.6			0.6
2																									
3																									
4																									
5																									
6																									
7																									
8																			1.0				1.0		2.0
9																	33.0	14.3							47.3
10																									
11																		6.9							6.9
12																									
13																									
14																									
15																									
16																									
17																29.7				6.0	11.0	1.5	1.5	3.0	52.7
18	7.0																								7.0
19																									
20																0.4									0.4
21																19.0	7.5								26.5
22																									
23																									
24																	5.6								5.6
25																									
26																									
27																									
28																								0.2	0.2
29																									
30																									
31																				24.8	7.0	3.0	4.0	2.0	40.8

TOTAL 190.0
MAX. 33.0

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH APRIL YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																					4.1				4.1
9																									
10																									
11																									
12																									
13																									
14																									
15																									
16																									
17																									
18																									
19																									
20																	1.7	13.5							15.2
21																									
22																			1.8						1.8
23														1.1	0.9										2.0
24																									
25																									
26																									
27																									
28																									
29																									
30																									
31																									

TOTAL 23.1
MAX. 13.5

HOURLY RAINFALL

STATION HARD PANA   UNIT mm   MONTH MAY   YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																25.5	2.5	4.0	1.2						33.2
2																									
3														2.3	14.6	1.8									18.7
4										1.2						5.0	1.0				0.5			0.5	8.2
5	0.7		1.3	2.0											4.0		10.6	1.8	12.5	2.0					31.9
6												5.5	1.8		14.5										21.8
7															1.7		1.5								3.2
8																	1.5		7.5	5.0					14.0
9								2.1																	2.1
10																									
11																									
12														7.6	4.8				1.6						14.0
13													3.9	1.0		1.1	1.0								7.0
14																									
15																									
16																									
17																									
18														1.5				2.5							4.0
19																			0.6						0.6
20																		20.2	28.5	3.5	1.0		0.5		53.7
21																	0.5								0.5
22																0.5									0.5
23															8.8										8.8
24																4.0	0.2								4.2
25																						2.0	1.0	0.7	3.7
26	1.3																	0.5	0.1						1.9
27																									
28																									
29																			0.2			1.7	0.5		2.4
30																									
31											0.6														0.6

TOTAL 215.0
MAX. 28.5

HOURLY RAINFALL

STATION HARD PANA   UNIT mm   MONTH JUNE   YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1														0.8			2.0								10.0
2					1.5				0.2	0.3												1.0			3.0
3		1.5	1.5						0.7		2.3														6.0
4												1.0					1.0							0.6	2.6
5			0.8				1.5		0.2																2.5
6																									
7																								1.5	1.5
8			0.1														2.3				0.3				2.7
9																2.3		3.0							5.3
10														0.7											0.7
11																0.1									0.1
12																									
13															2.0	0.8									2.8
14																									
15																									
16																									
17																2.0									2.0
18		0.5	0.5		1.0												3.0	2.0	2.0	1.0	2.0	2.3			14.3
19																									0.7
20					0.3												0.7						2.0	0.6	3.6
21		0.4												0.8	3.2	4.8				1.5	2.0	0.3	1.0	1.0	15.0
22																						(18.0)	1.2	5.4	24.6
23																									
24																									
25																									
26							0.2																		0.2
27																									
28														1.9											1.9
29															3.0	0.8	0.7								4.5
30													0.5												0.5
31																									

TOTAL 101.5
MAX. 18.0

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH JULY YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2											0.5														0.5
3																									
4																									
5																	0.4								0.4
6																									
7																									
8																									
9																									
10															0.5										0.5
11															0.5		2.0	2.0	5.0	4.0	15.0	5.0	1.0	1.0	35.5
12				0.5																					0.5
13																									
14						0.6				0.4	0.5														1.5
15																									
16										0.8	0.2	1.0	0.8		0.2	0.5	0.5						0.5		4.5
17		0.1	0.2	0.3		0.5														2.5	3.0		1.0		7.6
18					0.2									0.8											1.0
19																			5.5						5.5
20																									
21				0.5	0.5																	2.0	1.0		4.0
22																				1.4	35.1	0.5	0.7		37.7
23																						0.3			0.3
24																									
25																									
26															1.0								1.9		2.9
27																									
28	2.1	1.4														9.6				2.3	2.5	3.5	0.9	0.1	22.4
29																					3.2	3.8			7.0
30																									
31																									

TOTAL 131.8
MAX. 35.1

HOURLY RAINFALL

STATION HARD PANA UNIT mm MONTH AUGUST YEAR 1975

TIME / DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																									
2														1.5											1.5
3																									
4											1.0														1.0
5			0.1																						0.1
6																									
7													2.0	2.0	1.5										5.5
8																									
9																	0.1								0.1
10														0.5				0.8							1.3
11						1.5		0.5		0.5	0.5						0.3				1.7				5.0
12							1.0	0.7																	1.7
13																									
14							0.9																		0.9
15								1.3						1.5	3.8										6.6
16																									
17																									
18																			0.1						0.1
19																2.6	0.4	0.6							3.6
20																									
21																		4.5							4.5
22																									
23																									
24																	0.3								0.3
25																	4.6								4.6
26																		1.2							1.2
27			0.5											0.8	1.4				0.7	0.9	0.1		0.1		4.5
28		0.8	3.0	1.5			0.4						0.2												5.9
29														5.0	4.0						1.0	1.0	1.0	1.0	13.0
30	0.2	0.3	1.1														3.6					0.5	1.0	0.9	7.6
31														0.8											0.8

TOTAL 69.8
MAX. 5.0

HOURLY RAINFALL

STATION HARD PANA　　UNIT mm　　MONTH SEPTEMBER　　YEAR 1975

DATE \ HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1																								0.2	0.2
2	1.0																								1.0
3																									
4														2.0		11.2	1.5	1.5							16.2
5			0.5	0.2			0.5					1.0	3.8	1.0	4.8										11.8
6							0.2			1.6							3.4	1.0					0.5		6.7
7		0.5															3.2	0.2	0.8						4.7
8																									
9																									
10																									
11																					0.5				0.5
12																			0.3			0.2			0.5
13																		0.5							0.5
14																		1.0	2.2						3.2
15																	0.6			0.2					0.8
16																		0.5	0.6	2.0	1.8				4.9
17																1.3	4.8								6.1
18																					1.4				1.4
19																									
20																	2.3		2.3						4.6
21																	2.4				0.8				3.2
22															0.6				0.4			1.4	2.9	0.1	5.4
23	0.8	0.2																			14.0	11.0	25.0	9.0	60.0
24	2.0	1.0																	1.8	0.9					5.7
25																		1.9							1.9
26															0.5										0.5
27																									
28																									
29															0.5										0.5
30	4.0									1.9	0.2								3.9				1.5		11.5
31	0.5																								0.5

TOTAL 152.3
MAX. 25.0

HOURLY RAINFALL

STATION HARD PANA　　UNIT mm　　MONTH OCTOBER　　YEAR 1975

DATE \ HOUR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
1										5.0															5.0
2														5.0	0.5										5.5
3				1.5	0.5										0.5		10.0	10.0	0.2	14.8	6.8	0.6			44.9
4																									
5															2.4						0.2				2.6
6															0.8			10.0		2.0	1.2				14.0
7																		0.8							0.8
8																				24.2	12.3				36.5
9														0.4											0.4
10														0.8	0.7				10.5	3.0			1.5		16.5
11													3.5		0.2										3.7
12																			0.5	0.2	0.8				1.5
13															2.1				0.9	0.5	3.5	2.0			9.0
14																									
15	3.0	0.2	2.8	1.9		2.1	1.0																		11.0
16																									
17					0.3																				0.3
18																									
19																									
20				14.2	3.0	2.0	1.8							4.1	2.0										27.1
21																									
22																									
23																									
24																									
25																									
26								1.0			0.2														1.2
27																2.5									2.5
28	12.0																			2.0	0.9				14.9
29							1.0												0.9						1.9
30	0.8	2.2	8.0	4.0	8.1	5.0	8.0	2.0	1.0													1.2			40.3
31				3.8	0.7																				4.5

TOTAL 244.1
MAX. 24.2

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G. S BAN CHAO NEN C. A. 10,880 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M). Q(C.M.S) FOR THE WATER YEAR OF 1972

DATE	APR.		MAY		JUN.		JUL.		AUG.		SEP.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	0.83	22.8	0.81	21.6	0.84	23.1	1.77	83.9	6.86	805	4.64	372
2	0.82	22.2	0.77	19.2	0.83	22.8	1.75	82.5	6.45	740	4.41	340
3	0.82	22.2	0.75	18.0	0.88	25.8	1.67	76.9	5.78	566	4.29	325
4	0.89	26.4	0.72	16.2	0.98	31.8	1.63	74.1	5.35	484	4.02	292
5	0.80	21.0	0.71	15.6	0.97	31.2	1.77	83.9	5.01	431	3.79	265
6	0.80	21.0	0.70	15.0	1.17	43.2	1.94	95.8	4.67	376	3.64	248
7	0.88	25.8	0.71	15.6	1.44	60.8	1.88	91.6	4.46	347	4.08	300
8	0.83	22.8	0.69	14.5	1.34	53.8	2.12	110	4.31	327	6.77	784
9	0.81	21.6	0.68	14.0	1.52	66.4	1.97	97.9	3.96	285	8.72	1,310
10	0.78	19.8	0.67	13.5	2.04	103	1.87	90.9	3.73	258	8.15	1,140
11	0.78	19.8	0.65	12.5	1.64	74.8	1.87	90.9	3.50	234	6.42	704
12	0.82	22.2	0.64	12.0	1.66	76.2	2.58	147	3.45	229	5.63	537
13	1.07	37.2	0.63	11.5	1.54	67.8	5.32	479	3.42	226	5.47	506
14	0.92	28.2	0.62	11.0	1.41	58.7	6.68	763	3.57	244	5.13	446
15	1.03	34.8	0.62	11.0	1.33	53.1	5.95	600	3.70	255	4.78	392
16	1.12	40.2	0.61	10.5	1.26	48.6	5.33	480	3.62	246	4.56	360
17	0.95	30.0	0.62	11.0	1.21	45.6	5.00	425	3.90	278	4.46	347
18	0.91	27.6	0.68	14.0	1.16	42.6	4.91	412	4.92	413	4.23	318
19	0.98	31.8	0.84	23.4	1.19	44.4	4.76	389	5.21	460	6.12	636
20	0.89	26.4	1.07	37.2	1.46	62.2	4.14	307	5.72	554	10.94	1,950
21	0.84	23.4	1.21	45.6	1.54	67.8	3.71	256	5.46	504	9.24	1,460
22	0.80	21.0	1.10	39.0	1.44	60.8	3.53	237	5.13	446	7.31	919
23	0.77	19.2	1.06	36.6	1.39	57.3	3.34	218	4.88	407	6.40	699
24	0.76	18.6	1.01	33.6	1.29	50.4	3.23	207	4.56	360	5.93	596
25	0.76	18.6	0.99	32.4	1.23	46.8	4.14	307	4.38	336	5.67	544
26	0.83	21.6	1.00	33.0	1.21	45.6	5.77	564	4.24	319	5.81	572
27	0.75	18.0	0.98	31.8	1.16	42.6	5.45	502	4.39	338	6.46	713
28	0.78	19.8	0.90	27.0	1.22	46.2	5.78	566	4.26	321	6.80	791
29	0.97	31.2	0.86	24.6	1.20	45.0	6.60	745	4.26	321	7.17	882
30	0.79	20.4	0.84	23.4	1.43	60.1	6.38	694	4.44	344	6.68	763
31			0.82	22.2			6.50	722	4.56*	360		
SUM		735.6		666.5		1,558.8		9,998.4		11,781		19,541
MEAN		24.5		21.5		52.0		323		380		651
MAX		40.2		45.6		103		763		805		1,950
MIN		18.0		10.5		22.8		74.1		226		248

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G. S BAN CHAO NEN C. A. 10,880 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M). Q(C.M.S) FOR THE WATER YEAR OF 1972

DATE	OCT.		NOV.		DEC.		JAN.		FEB.		MAR.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	6.68	763	3.13	197	3.16	200	1.68	77.6	1.26	48.6	1.01	33.6
2	6.36	690	3.03	188	2.95	180	1.66	76.2	1.25	48.0	1.01	33.6
3	5.90	590	2.92	178	2.80	167	1.64	74.8	1.24	47.4	1.01	33.6
4	5.91	592	2.84	171	2.68	156	1.62	73.4	1.23	46.8	1.00	33.0
5	5.96	603	2.75	162	2.58	147	1.60	72.0	1.22	46.2	0.99	32.4
6	6.70	768	2.71	159	2.49	139	1.58	70.6	1.21	45.6	0.99	32.4
7	7.13	872	2.67	155	2.42	134	1.57	69.9	1.21	45.6	0.99	32.4
8	6.20	654	2.78	165	2.38	130	1.56	69.2	1.20	45.0	0.98	31.8
9	5.69	548	2.93	179	2.36	129	1.54	67.8	1.20	45.0	1.00	33.0
10	5.31	482	2.95	181	2.42	134	1.52	66.4	1.19	44.4	1.01	33.6
11	5.18	455	3.02	187	2.41	133	1.52	66.4	1.18	43.8	1.02	34.2
12	4.90	410	2.80	167	2.37	130	1.50	65.0	1.17	43.2	1.02	34.2
13	4.70	380	2.70	158	2.31	125	1.48	63.6	1.16	42.6	0.99	32.4
14	4.63	370	2.60	149	2.22	118	1.46	62.2	1.15	42.0	0.97	31.2
15	4.72	383	2.53	143	2.18	114	1.45	61.5	1.14	41.4	0.95	30.0
16	4.96	419	2.51	141	2.16	113	1.44	60.8	1.13	40.8	0.97	31.2
17	5.06	435	2.52	142	2.09	107	1.42	59.4	1.13	40.8	0.98	31.8
18	4.76	389	2.47	138	2.04	103	1.42	59.4	1.12	40.2	0.96	30.6
19	4.97	420	2.51	141	2.00	100	1.40	58.0	1.12	40.2	1.06	36.6
20	4.85	402	2.48	138	1.97	97.9	1.39	57.3	1.11	39.6	1.20	45.0
21	4.64	372	2.43	134	1.93	95.1	1.38	56.6	1.10	39.0	1.28	49.8
22	4.41	340	2.53	143	1.90	93.0	1.36	55.2	1.08	37.8	1.18	43.8
23	4.20	314	2.73	161	1.87	90.9	1.34	53.8	1.06	36.6	1.17	43.2
24	4.06	297	2.77	164	1.84	88.8	1.33	53.1	1.05	36.0	1.19	44.4
25	3.84	274	3.87	274	1.82	87.4	1.32	52.4	1.04	35.4	1.22	46.2
26	3.68	253	5.55	522	1.80	86.0	1.31	51.7	1.04	34.8	1.17	43.2
27	3.54	238	4.58	363	1.78	84.6	1.30	51.0	1.03	34.8	1.12	40.2
28	3.49	233	3.98	288	1.76	83.2	1.29	50.4	1.02	34.2	1.12	40.2
29	3.46	230	3.77	263	1.73	81.1	1.28	49.8			1.06	36.6
30	3.39	223	3.45	229	1.71	79.7	1.27	49.2			1.04	35.4
31	3.25	209			1.70	79.0	1.26	48.6			1.02	34.2
SUM		13,605		5,783		3,605.7		1,903.3		1,165.8		1,123.8
MEAN		439		193		116		61.4		41.6		36.3
MAX		872		522		200		77.6		48.6		49.8
MIN		209		134		79.0		48.6		34.2		30.0

TOTAL = 6,170 MILLION M^3 MAX = 1,950

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G. S BAN CHAO NEN. C. A. 10,880 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1973

DATE	APR.		MAY		JUN.		JUL.		AUG.		SEP.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	0.99	32.4	0.76	18.6	1.39	57.3	1.90	93.0	3.05	190	6.33	639
2	0.96	30.6	0.76	18.6	1.42	59.4	1.84	88.8	3.00	185	5.69	548
3	0.93	28.8	0.91	27.6	1.40	58.0	1.91	93.7	3.00	185	5.42	497
4	0.92	28.2	1.06	36.6	1.37	55.9	1.90	9.30	2.89	175	5.23	461
5	0.91	27.6	1.03	34.8	1.43	60.1	1.80	86.0	2.81	168	5.02	428
6	0.90	27.0	1.14	44.4	1.36	55.2	1.80	86.0	2.74	162	4.73	384
7	0.92	28.2	1.05	36.0	1.32	52.4	1.88	91.6	2.69	157	4.45	346
8	0.92	28.2	1.02	34.2	1.48	63.6	2.10	108	3.22	206	4.22	316
9	0.93	28.8	0.97	31.2	1.56	69.2	2.14	111	3.41	225	4.11	303
10	0.92	28.2	1.01	33.6	1.77	83.9	2.43	134	3.24	205	4.07	298
11	0.89	26.4	1.02	34.2	1.69	78.3	3.57	241	3.03	188	4.09	301
12	0.88	25.8	0.97	31.2	1.61	72.7	5.14	448	2.89	175	3.94	283
13	0.86	24.6	1.06	36.6	1.47	62.9	3.98	268	2.77	164	3.79	265
14	0.85	24.0	1.07	37.2	1.42	59.4	3.51	235	2.94	180	4.02	292
15	0.84	23.4	1.07	37.2	1.33	60.1	3.26	210	2.97	182	3.96	285
16	0.83	22.8	1.08	37.8	1.66	76.2	3.20	204	3.05	190	3.88	276
17	0.82	22.2	1.05	36.0	2.27	122	3.27	211	2.94	180	3.80	266
18	0.82	22.2	1.07	37.2	4.89	408	3.68	253	2.91	177	3.87	274
19	0.86	24.6	1.07	37.2	5.90	590	3.51	235	3.20	204	4.26	424
20	0.88	25.8	1.05	36.0	6.11	634	3.59	243	3.73	258	4.67	376
21	0.85	24.0	1.02	34.2	5.21	460	3.78	261	4.14	303	5.88	586
22	0.86	24.6	0.99	32.4	4.26	321	3.80	266	3.86	273	5.73	556
23	0.85	24.0	0.98	31.8	3.48	232	3.78	264	4.01	295	5.46	504
24	0.82	22.2	1.04	35.4	2.95	180	3.56	240	4.50	352	6.11	634
25	0.80	21.0	1.13	40.8	2.65	154	3.35	219	5.66	542	7.50	971
26	0.78	19.8	1.21	45.6	2.54	144	3.32	216	6.00	611	6.60	745
27	0.78	19.8	1.46	62.2	2.42	134	3.27	211	6.12	636	6.02	615
28	0.78	19.8	1.27	49.2	2.27	122	3.48	232	6.01	613	5.71	552
29	0.77	19.2	1.31	53.8	2.07	106	3.35	219	6.17	647	6.25	665
30	0.76	18.6	1.25	48.0	1.95	96.5	3.17	201	7.00	840	6.20	654
31			1.24	47.4			3.15	199	6.85	800		
SUM		742.8		1,154.0		4,728.1		6,084.1		9,674		13,646
MEAN		24.8		37.2		158		196		312		455
MAX		32.4		62.2		634		448		840		971
MIN		18.6		18.6		52.4		86.0		157		265

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G. S BAN CHAO NEN. C. A. 10,880 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1973

DATE	OCT.		NOV.		DEC.		JAN.		FEB.		MAR.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	5.92	594	2.64	153	1.86	90.2	1.35	54.5	1.08	37.8	0.95	30.0
2	6.08	628	2.56	145	1.84	88.8	1.31	53.8	1.07	37.2	0.95	30.0
3	5.77	564	2.49	139	1.81	86.7	1.31	53.1	1.06	36.6	0.95	30.0
4	5.60	531	2.43	134	1.79	85.3	1.32	52.4	1.04	35.4	0.94	29.4
5	6.09	630	2.39	131	1.77	83.9	1.31	51.7	1.03	34.8	0.94	29.4
6	6.22	658	2.35	128	1.76	83.2	1.30	51.0	1.02	34.2	0.95	30.0
7	6.00	614	2.31	125	1.74	81.8	1.29	50.4	1.02	34.2	0.97	31.2
8	5.87	584	2.27	122	1.73	81.1	1.28	49.6	1.02	34.2	0.96	30.6
9	5.42	497	2.23	118	1.71	79.7	1.28	49.8	1.02	34.2	0.97	31.2
10	5.50	512	2.21	117	1.68	77.6	1.27	49.2	1.02	34.2	0.95	30.0
11	5.69	548	2.30	124	1.67	76.9	1.26	48.6	1.04	35.4	0.96	39.6
12	5.27	470	2.20	116	1.66	76.2	1.26	48.6	1.03	34.8	0.94	29.4
13	4.92	413	2.21	117	1.64	74.8	1.25	48.0	1.03	34.8	0.92	28.2
14	4.61	367	2.30	124	1.63	74.1	1.24	47.4	1.03	34.8	0.92	28.2
15	4.37	335	2.40	132	1.61	72.7	1.23	46.8	1.02	34.2	0.93	28.8
16	4.16	309	2.51	141	1.58	70.6	1.22	46.2	1.02	34.2	0.95	30.0
17	4.08	300	2.52	142	1.56	69.2	1.21	45.6	1.02	34.2	0.95	30.0
18	3.92	280	2.31	125	1.55	68.5	1.21	45.6	1.02	34.2	0.96	30.6
19	3.93	282	2.25	120	1.53	67.1	1.20	45.0	1.06	36.6	0.95	30.0
20	3.79	265	2.26	121	1.52	66.4	1.19	44.4	1.06	36.6	0.92	28.2
21	3.59	243	2.38	130	1.51	65.7	1.16	43.8	1.08	37.8	0.95	30.0
22	3.46	230	2.46	137	1.50	65.0	1.15	42.0	1.15	42.0	0.95	30.0
23	3.32	216	2.30	124	1.49	64.3	1.14	41.4	1.06	36.6	0.91	27.6
24	3.20	204	2.19	115	1.46	62.2	1.13	40.8	1.03	34.8	0.90	27.0
25	3.12	196	2.12	110	1.44	60.8	1.12	40.2	1.00	33.0	0.95	30.0
26	3.02	187	2.07	106	1.43	60.1	1.12	40.2	0.96	31.8	0.95	30.0
27	2.92	178	2.01	101	1.40	58.0	1.11	39.6	0.97	31.2	0.94	39.4
28	2.90	176	1.97	97.9	1.40	55.9	1.10	39.0	0.96	30.6	0.92	28.2
29	2.88	174	1.92	94.4	1.39	57.3	1.07	38.4			0.89	26.4
30	2.82	169	1.89	92.3	1.37	55.9	1.09	38.4			0.89	26.4
31	2.74	162			1.36	55.2	1.08	37.8			0.89	26.4
SUM		11,513		3,651.6		2,217.3		1,423.5		980.4		907.2
MEAN		371		122		71.5		45.9		35.0		29.3
MAX		658		153		90.2		54.5		42.0		31.2
MIN		162		92.3		55.2		37.8		30.6		26.4

TOTAL = 4,991 MILLION M^3 MAX = 971

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G.S KHAO SLOB (B.C.N) C.A. 10,880 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1974

DATE	APR.		MAY		JUN.		JUL.		AUG.		SEP.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	0.63	32.8	1.07	67.6	1.41	95.9	1.30	86.0	2.88	247	3.36	304
2	0.63	32.8	1.25	82.0	1.33	88.7	1.32	87.8	2.74	231	3.46	347
3	0.62	32.0	1.50	104	1.41	95.9	1.25	82.0	2.46	201	3.65	342
4	0.85	50.0	0.98	60.4	1.32	87.8	1.23	80.4	2.30	183	3.70	349
5	0.71	38.8	0.84	49.2	1.63	116	1.19	77.2	2.40	162	3.56	330
6	0.70	38.0	0.76	42.8	1.97	149	1.22	79.6	2.00	152	3.39	305
7	0.67	35.8	0.70	38.0	1.71	123	1.36	91.4	2.07	159	3.21	285
8	0.60	30.5	0.65	34.2	1.68	120	1.54	108	2.33	186	3.16	279
9	0.58	29.1	0.63	32.8	1.65	118	1.83	135	2.47	202	3.39	303
10	0.57	28.4	0.60	30.5	1.74	126	1.79	131	2.23	175	3.38	306
11	0.60	30.5	0.76	42.8	2.77	235	1.94	146	2.19	171	3.29	293
12	0.68	36.5	0.67	35.8	2.22	174	1.83	135	2.12	164	3.29	295
13	0.68	36.5	0.64	33.5	1.92	144	1.74	126	2.40	194	3.22	286
14	0.66	35.0	0.64	33.5	1.77	129	1.89	141	3.06	267	3.31	301
15	0.65	34.2	0.64	33.5	1.72	124	1.78	130	5.56	662	3.20	284
16	0.75	42.0	0.69	37.2	1.72	124	1.66	118	4.97	544	3.01	265
17	0.64	33.5	0.70	38.0	1.70	122	1.60	113	5.55	660	2.85	244
18	0.60	30.5	0.73	40.4	1.62	115	1.50	104	6.59	974	2.81	239
19	0.56	27.7	0.78	44.4	1.59	112	1.49	103	7.97	1,250	2.94	253
20	0.56	27.7	0.82	47.6	1.51	105	1.53	107	7.96	1,250	2.95	254
21	0.87	51.6	0.93	56.4	1.42	96.8	1.49	103	6.50	860	2.96	256
22	0.54	26.3	1.17	75.6	1.47	101	1.85	137	5.65	682	3.09	271
23	0.53	25.6	1.09	69.2	1.47	101	1.97	149	4.96	545	3.23	288
24	0.52	24.9	1.12	71.6	1.48	102	1.91	143	4.64	487	3.57	331
25	0.52	24.9	1.24	81.2	1.46	100	1.92	144	4.20	420	4.12	408
26	0.56	27.7	1.29	85.2	1.51	105	1.92	144	4.05	398	5.33	613
27	0.61	31.2	1.31	86.9	1.57	110	1.84	136	4.07	401	7.20	1,050
28	0.62	32.0	1.24	81.2	1.53	107	2.20	172	3.94	383	5.74	702
29	0.76	42.8	1.29	85.2	1.45	99.5	2.29	182	3.77	359	4.66	491
30	0.90	54.0	1.51	105	1.37	92.3	2.49	204	3.67	345	4.05	398
31			1.45	99.5			2.67	224	3.54	323		
SUM		1,023.3		1,825.2		3,518.9		3,919.4		13,257		10,652
MEAN		34.1		58.9		117		126		428		355
MAX		54.0		105		235		224		1,250		1,050
MIN		24.9		30.5		87.8		77.2		152		239

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G.S KHAO SLOB (BCN) C.A. 10,880 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1974

DATE	OCT.		NOV.		DEC.		JAN.		FEB.		MAR.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	3.72	352	3.49	321	1.86	138	1.22	79.6	1.02	63.6	0.89	53.2
2	3.48	349	3.69	348	1.82	134	1.21	78.8	1.01	61.8	0.87	51.6
3	3.44	314	3.77	359	1.78	130	1.20	78.0	1.01	62.8	0.95	58.0
4	3.25	290	3.37	305	1.76	128	1.19	77.2	1.01	62.8	0.94	57.2
5	3.17	280	3.10	272	1.73	125	1.17	75.6	1.01	62.8	0.87	51.6
6	3.15	278	2.99	259	1.71	123	1.16	74.8	0.99	61.2	0.85	50.0
7	3.18	282	3.15	278	1.68	120	1.16	74.8	0.98	60.4	0.82	47.6
8	2.99	259	3.22	286	1.66	118	1.17	75.6	0.96	58.8	0.80	46.0
9	3.10	272	3.07	268	1.67	119	1.19	77.2	0.95	58.0	0.80	46.0
10	3.42	312	2.86	245	1.64	117	1.18	76.4	0.93	56.4	0.81	46.8
11	5.20	587	3.06	267	1.59	112	1.18	76.4	0.91	54.8	0.80	46.0
12	7.24	1,060	3.14	277	1.55	108	1.19	77.2	0.90	54.0	0.78	44.4
13	9.87	1,850	3.18	282	1.52	106	1.21	78.8	0.89	53.2	0.78	44.4
14	6.21	1,320	3.04	265	1.49	103	1.22	79.6	0.88	52.4	0.76	42.8
15	6.60	904	2.87	246	1.47	101	1.25	82.0	0.87	51.6	0.75	42.0
16	6.58	899	2.70	227	1.46	100	1.27	83.6	0.87	51.6	0.74	41.2
17	6.17	801	2.59	215	1.44	98.6	1.21	78.8	0.86	50.8	0.73	40.4
18	5.60	671	2.55	210	1.43	97.7	1.18	76.4	0.86	50.8	0.87	51.6
19	5.13	574	2.81	239	1.41	95.9	1.36	91.4	0.85	50.0	0.84	49.2
20	5.14	576	2.81	239	1.38	93.2	1.33	88.7	0.85	50.0	0.80	46.0
21	4.82	517	2.56	212	1.37	92.3	1.67	119	0.84	49.2	0.82	47.6
22	4.66	491	2.41	195	1.35	90.5	1.44	98.6	0.83	48.4	0.78	44.4
23	4.34	441	2.32	185	1.34	89.6	1.29	85.2	0.83	48.4	0.76	42.6
24	4.18	417	2.23	175	1.31	86.9	1.20	78.0	0.82	47.6	0.77	43.6
25	3.86	374	2.17	169	1.30	86.0	1.16	74.8	0.82	47.6	0.74	41.2
26	3.65	342	2.10	162	1.28	84.4	1.12	71.6	0.81	46.8	0.73	40.4
27	3.46	317	2.04	156	1.27	83.6	1.04	65.2	0.81	46.8	0.73	40.4
28	3.36	304	2.00	152	1.27	83.6	1.08	68.4	0.82	47.6	0.72	39.6
29	3.43	313	1.95	147	1.26	82.8	1.06	66.8			0.72	39.6
30	3.44	314	1.90	142	1.25	82.0	1.04	65.2			0.72	39.6
31	3.63	339			1.24	81.2	1.03	64.4			0.72	39.6
SUM		16,366		7,103		3,210.3		2,436.1		1,511.2		1,414.8
MEAN		528		237		104		78.6		54.0		45.6
MAX		1,850		359		138		119		63.6		58.0
MIN		259		142		81.2		64.4		46.8		39.6

TOTAL = 5,720 MILLION M^3 MAX = 1,850

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G.S BAN WANG CHAN C.A. 11,353 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1972

	APR.		MAY		JUN.		JUL.		AUG.		SEP.	
DATE	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	0.91	19.5	0.92	20.0	0.99	23.5	1.62	67.6	6.08	653	4.44	382
2	1.02	25.2	0.91	19.5	0.92	20.0	1.86	87.4	5.78	596	4.19	348
3	1.00	24.0	0.87	17.5	0.91	19.5	1.78	80.4	5.51	548	4.08	333
4	0.98	23.0	0.85	16.5	0.94	21.0	1.78	80.4	5.38	526	3.92	313
5	0.94	21.0	0.81	14.5	1.07	28.2	1.72	75.6	5.24	502	3.69	284
6	0.93	20.5	0.80	14.0	1.09	29.4	1.89	90.1	5.07	476	3.53	265
7	0.92	20.0	0.78	13.2	1.30	43.0	1.94	94.6	4.91	452	3.68	284
8	0.96	22.0	0.77	12.8	1.45	54.0	1.93	93.7	4.80	435	5.40	529
9	0.97	22.5	0.75	12.0	1.57	59.6	2.12	111	4.53	394	7.95	1,060
10	1.05	27.0	0.73	11.2	1.76	80.4	1.95	95.5	4.27	358	8.70	1,250
11	0.94	21.0	0.72	10.8	1.87	88.3	1.91	91.9	3.74	290	6.79	795
12	0.91	19.5	0.71	10.4	1.56	62.8	2.05	104	3.56	268	5.54	553
13	1.13	31.8	0.70	10.0	1.49	57.2	2.99	200	3.40	249	5.20	496
14	1.23	38.1	0.70	10.0	1.40	50.0	5.42	532	3.37	245	4.96	459
15	1.11	30.6	0.70	10.0	1.38	48.6	5.50	546	3.46	250	4.57	400
16	1.30	43.0	0.70	10.0	1.33	45.1	5.07	476	3.44	254	4.29	361
17	1.25	39.5	0.88	18.0	1.30	43.0	4.66	434	3.37	245	4.22	352
18	1.12	31.2	0.99	23.5	1.29	42.3	4.54	396	3.97	319	4.03	327
19	1.01	26.4	1.08	28.8	1.31	43.7	4.51	392	4.48	387	4.52	393
20	1.01	26.4	1.21	36.7	1.42	51.6	4.28	359	4.45	383	8.36	1,170
21	1.00	24.0	1.25	39.5	1.59	65.2	3.66	280	4.41	377	10.86	1,880
22	0.95	21.5	1.30	43.0	1.57	63.6	3.38	247	4.37	372	7.52	961
23	0.90	19.0	1.22	37.4	1.53	60.4	3.22	227	4.29	361	6.48	731
24	0.88	18.0	1.20	36.0	1.48	56.4	3.01	206	4.21	350	5.77	594
25	0.86	17.0	1.17	34.2	1.39	49.3	3.35	243	4.13	340	5.47	541
26	0.86	17.0	1.14	32.4	1.33	45.1	4.39	375	4.04	328	5.44	536
27	0.91	19.5	1.15	33.0	1.28	41.6	4.82	438	4.03	327	5.88	615
28	0.89	18.5	1.13	31.8	1.26	40.2	4.81	436	4.07	332	6.57	749
29	0.91	19.5	1.06	27.6	1.33	45.1	5.59	561	3.98	320	6.86	810
30	0.96	22.0	1.03	25.8	1.35	46.5	5.79	598	4.03	333	6.68	772
31			1.00	24.0			5.61	565	4.22	352		
SUM		726.2		654.1		1,424.6		8563.2		11,626		18,542
MEAN		24.3		22.1		47.5		276		375		618
MAX		43.0		43.0		88.3		598		653		1,880
MIN		17.0		10.0		19.5		67.6		245		265

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G.S BAN WANG CHAN C.A. 11,353 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1972

	OCT.		NOV.		DEC.		JAN.		FEB.		MAR	
DATE	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	6.28	694	3.11	214	3.21	226	1.81	82.9	1.39	49.3	1.13	31.8
2	6.31	697	3.03	205	2.93	193	1.79	81.2	1.38	48.6	1.13	31.8
3	5.78	596	2.97	198	2.69	169	1.78	80.4	1.37	47.9	1.12	31.2
4	5.74	589	2.88	188	2.86	186	1.76	78.8	1.36	47.2	1.12	31.2
5	5.57	558	2.83	182	2.75	174	1.74	77.2	1.35	46.5	1.12	31.2
6	5.96	634	2.78	177	2.66	161	1.72	75.6	1.34	45.8	1.11	30.6
7	7.11	866	2.73	171	2.56	153	1.71	74.8	1.33	45.1	1.11	30.6
8	6.22	680	2.69	167	2.46	143	1.69	73.2	1.32	44.4	1.11	30.6
9	5.60	563	2.94	194	2.42	139	1.67	71.6	1.31	43.7	1.14	32.4
10	5.24	502	2.96	197	2.43	140	1.65	70.0	1.31	43.7	1.14	32.4
11	4.92	453	2.91	191	2.40	137	1.65	70.0	1.30	43.0	1.14	32.4
12	4.83	440	2.87	187	2.35	132	1.63	68.4	1.29	42.3	1.13	31.8
13	4.57	400	2.75	174	2.32	129	1.62	67.6	1.28	41.6	1.11	30.6
14	4.44	382	2.66	164	2.30	127	1.60	66.0	1.27	40.9	1.09	29.4
15	4.49	389	2.59	156	2.24	122	1.59	65.2	1.27	40.9	1.08	28.8
16	4.69	418	2.51	151	2.19	117	1.58	64.4	1.26	40.2	1.08	28.8
17	4.97	460	2.54	151	2.16	114	1.56	62.8	1.25	39.5	1.14	32.4
18	4.63	410	2.56	153	2.13	112	1.55	62.0	1.24	38.8	1.09	29.4
19	4.60	405	2.49	146	2.10	109	1.53	60.4	1.23	38.1	1.13	31.8
20	4.60	405	2.57	154	2.07	106	1.52	59.6	1.22	37.4	1.25	39.5
21	4.56	399	2.49	146	2.04	104	1.51	58.8	1.21	36.7	1.36	47.2
22	4.34	368	2.45	142	2.01	101	1.50	58.0	1.20	36.0	1.38	48.6
23	4.10	336	2.69	167	1.97	97.3	1.48	56.4	1.19	35.4	1.34	45.8
24	3.91	315	2.86	186	1.95	95.5	1.46	54.8	1.18	34.8	1.39	49.3
25	3.77	293	3.06	208	1.92	92.8	1.45	54.0	1.17	34.2	1.38	48.6
26	3.62	275	5.35	520	1.91	91.9	1.44	53.2	1.16	33.6	1.35	46.5
27	3.48	259	4.79	434	1.90	91.0	1.43	52.4	1.15	33.0	1.29	42.3
28	3.42	251	4.10	336	1.88	89.2	1.42	51.6	1.14	32.4	1.27	40.9
29	3.37	245	3.69	284	1.85	86.5	1.41	50.8			1.23	38.1
30	3.34	242	3.31	238	1.84	85.6	1.40	50.0			1.20	36.0
31	3.23	229			1.82	83.8	1.40	50.0			1.18	34.8
SUM		13,750		6,181		3,930.6		2,002.1		1,141.0		1,106.8
MEAN		444		206		127		64.6		40.8		35.7
MAX		866		520		226		82.9		49.3		49.3
MIN		229		142		83.8		50.0		32.4		28.8

TOTAL = 6,018 MILLION M³ MAX. = 1,880

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G. S BAN WANG CHAN C. A. 11,353 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1973

DATE	APR.		MAY		JUN.		JUL.		AUG.		SEP.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	1.16	33.6	0.87	17.5	1.45	54.0	1.97	99.1	2.97	198	6.16	668
2	1.13	31.8	0.88	18.0	1.51	58.8	1.94	94.6	2.98	199	5.59	561
3	1.10	30.0	1.32	44.4	1.52	59.6	1.92	92.8	2.92	192	5.22	499
4	1.09	29.4	1.06	27.6	1.54	61.2	1.94	91.6	2.89	189	6.07	654
5	1.07	28.2	1.14	32.4	1.49	57.2	1.90	91.0	2.79	178	4.80	435
6	1.06	27.6	1.23	38.1	1.51	58.8	1.85	86.5	2.75	174	4.56	399
7	1.07	28.2	1.23	38.1	1.44	53.2	1.86	87.4	2.66	164	4.29	361
8	1.09	29.4	1.15	33.0	1.51	58.8	2.01	101	2.58	188	4.03	327
9	1.07	28.2	1.11	30.6	1.54	61.2	2.15	114	3.26	232	3.88	307
10	1.11	30.6	1.11	30.6	1.72	75.6	2.24	122	3.16	220	3.82	300
11	1.06	27.6	1.12	31.2	1.85	86.5	2.68	166	3.11	214	3.86	305
12	1.04	25.8	1.11	30.6	1.69	73.2	4.68	417	2.88	188	3.74	290
13	1.01	24.6	1.14	32.4	1.65	70.0	4.12	339	2.76	175	3.59	272
14	1.00	24.0	1.17	34.2	1.55	62.0	3.52	263	2.81	180	3.70	285
15	0.99	23.5	1.16	34.8	1.54	61.2	3.25	231	2.84	183	3.74	290
16	0.95	23.0	1.18	34.8	1.55	62.0	3.11	214	2.92	192	3.66	280
17	0.97	22.5	1.17	34.2	2.01	101	3.07	209	2.90	190	3.59	272
18	0.96	22.0	1.16	33.6	2.76	175	3.40	249	2.82	181	3.62	275
19	0.98	23.0	1.17	34.2	5.49	544	3.39	248	2.98	199	3.86	305
20	1.08	28.8	1.16	33.6	5.50	600	3.38	247	3.26	232	4.20	349
21	1.02	25.2	1.14	32.4	5.46	539	3.52	263	3.82	300	4.93	454
22	1.00	24.0	1.12	31.2	4.46	384	3.60	273	3.72	287	5.79	598
23	0.98	23.0	1.11	30.6	3.68	283	3.58	271	3.76	295	5.32	515
24	0.96	22.0	1.13	31.8	3.13	217	3.49	260	3.89	309	5.68	577
25	0.94	21.0	1.22	37.4	2.78	177	3.25	231	4.92	453	7.23	894
26	0.92	20.0	1.23	38.1	2.61	158	3.22	227	5.76	592	6.85	808
27	0.90	19.0	1.40	50.0	2.54	151	3.18	223	5.87	613	5.93	625
28	0.88	18.0	1.42	51.6	2.37	134	3.19	224	5.93	625	5.54	553
29	0.87	17.5	1.45	54.0	2.22	120	3.29	236	5.88	615	5.60	563
30	0.87	17.5	1.39	49.3	2.09	108	3.09	212	6.42	719	6.18	672
31			1.33	45.1			3.09	212	6.91	821		
SUM		749.0		1,095.4		4,704.3		6,198.0		9,497		13,690
MEAN		25.0		35.3		157		200		306		456
MAX		33.6		54.0		600		417		821		894
MIN		17.5		17.5		53.2		86.5		164		272

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G. S BAN WANG CHAN C. A. 11,353 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1973

DATE	OCT.		NOV.		DEC.		JAN.		FEB.		MAR.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	5.68	577	2.58	155	1.90	91.0	1.59	65.2	1.38	48.6	1.18	34.8
2	5.74	589	2.51	148	1.86	89.2	1.58	64.4	1.37	47.9	1.18	34.8
3	5.70	581	2.44	141	1.86	87.4	1.58	64.4	1.36	47.2	1.17	34.2
4	5.38	526	2.39	136	1.85	86.5	1.57	63.6	1.34	45.8	1.17	34.2
5	5.82	604	2.35	132	1.83	84.7	1.57	63.6	1.33	45.1	1.18	34.8
6	6.05	648	2.31	128	1.81	82.9	1.56	62.8	1.32	44.4	1.18	34.8
7	5.79	598	2.28	125	1.80	82.0	1.55	62.0	1.31	43.7	1.19	35.4
8	5.73	587	2.25	122	1.78	80.4	1.54	61.2	1.30	43.0	1.20	36.0
9	5.24	502	2.22	120	1.77	79.6	1.54	61.2	1.30	43.0	1.19	35.4
10	5.10	480	2.19	117	1.77	79.6	1.53	60.4	1.29	42.3	1.21	36.7
11	5.50	546	2.20	118	1.76	78.8	1.53	60.4	1.29	42.3	1.19	35.4
12	5.16	490	2.21	119	1.76	78.8	1.52	59.6	1.28	41.6	1.19	35.4
13	4.76	429	2.15	114	1.76	78.8	1.52	59.6	1.28	41.6	1.16	33.6
14	4.42	379	2.26	123	1.74	77.2	1.51	58.8	1.27	40.9	1.16	33.6
15	4.14	341	2.33	130	1.74	77.2	1.51	58.8	1.27	40.9	1.15	33.0
16	3.96	318	2.40	137	1.72	75.6	1.50	58.0	1.26	40.2	1.17	34.2
17	3.84	302	2.46	143	1.72	75.6	1.49	57.2	1.26	40.2	1.17	34.2
18	3.73	289	2.32	129	1.70	74.0	1.48	56.4	1.25	39.5	1.20	36.0
19	3.66	280	2.22	120	1.68	72.4	1.47	55.6	1.29	42.3	1.20	36.0
20	3.60	273	2.26	123	1.66	70.8	1.46	54.8	1.27	40.9	1.18	34.8
21	3.42	251	2.28	125	1.66	70.8	1.46	54.8	1.27	40.9	1.15	33.0
22	3.29	236	2.39	136	1.66	70.8	1.45	54.0	1.27	40.9	1.24	38.8
23	3.17	221	2.30	127	1.65	70.0	1.45	54.0	1.28	41.6	1.16	33.6
24	3.07	209	2.20	118	1.64	69.2	1.44	53.2	1.26	40.2	1.15	33.0
25	3.00	201	2.14	113	1.63	68.4	1.43	52.4	1.24	38.8	1.15	33.0
26	2.91	191	2.08	107	1.63	68.4	1.42	51.6	1.22	37.4	1.20	36.0
27	2.83	182	2.02	102	1.62	67.6	1.41	50.8	1.20	36.0	1.18	34.8
28	2.77	176	1.93	99.1	1.61	66.8	1.41	50.8	1.19	35.4	1.16	33.6
29	2.75	174	1.95	95.5	1.60	66.0	1.40	50.0			1.14	32.4
30	2.73	171	1.92	92.8	1.60	66.0	1.39	49.3			1.12	31.2
31	2.66	164			1.60	66.0	1.38	48.6			1.16	33.6
SUM		11,515		3,695.4		2,352.5		1,777.5		1,172.6		1,070.3
MEAN		371		123		75.9		57.3		41.9		34.5
MAX		648		155		91.0		65.2		48.6		38.8
MIN		164		92.8		65.0		48.6		35.4		31.2

TOTAL = 4,970 MILLION M3 MAX = 894

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G.S BAN WANG CHAN   C.A. 11,353 SQKM   QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG   UNIT H(M), Q(C.M.S)   FOR THE WATER YEAR OF 1974

DATE	APR.		MAY		JUN.		JUL.		AUG.		SEP.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	1.21	36.7	1.62	67.6	1.94	94.6	1.81	82.9	3.41	250	3.86	305
2	1.22	37.4	1.58	64.4	1.90	91.0	1.82	83.8	3.42	251	3.89	309
3	1.25	39.5	2.16	114	1.91	91.9	1.79	81.2	3.12	215	4.03	327
4	1.22	37.4	1.75	78.0	1.84	85.6	1.75	78.0	2.93	193	4.20	349
5	1.26	40.2	1.52	59.6	1.94	94.6	1.71	74.8	2.73	171	4.10	336
6	1.30	43.0	1.42	51.6	2.42	139	1.70	74.0	2.60	157	3.92	313
7	1.29	42.3	1.33	45.1	2.32	129	1.78	80.4	2.56	153	3.76	292
8	1.23	38.1	1.21	36.7	2.22	120	1.95	95.5	2.79	178	3.66	280
9	1.18	34.8	1.24	38.8	2.18	116	2.25	122	2.99	200	3.86	305
10	1.15	33.0	1.21	36.7	2.16	114	2.32	129	2.84	183	3.88	307
11	1.16	33.6	1.21	36.7	2.85	184	2.33	130	2.76	175	3.88	307
12	1.20	36.0	1.42	51.6	3.05	207	2.41	138	2.65	162	3.73	289
13	1.30	43.0	1.27	40.9	2.56	153	2.26	123	2.76	175	3.73	289
14	1.25	39.5	1.23	38.1	2.33	130	2.36	133	3.18	224	3.79	296
15	1.26	40.2	1.23	38.1	2.24	122	2.31	130	5.72	555	3.78	295
16	1.33	45.1	1.25	39.5	2.23	121	2.19	117	5.56	644	3.52	263
17	1.28	41.6	1.27	40.9	2.23	121	2.14	113	5.86	611	3.40	249
18	1.21	36.7	1.32	44.4	2.18	116	2.06	105	7.25	898	3.31	238
19	1.16	33.6	1.38	48.6	2.16	114	1.97	97.3	8.30	1,150	3.46	256
20	1.14	32.4	1.44	53.2	2.04	104	2.05	104	8.99	1,340	3.45	255
21	1.27	40.9	1.54	61.2	1.99	99.1	1.99	99.1	7.59	977	3.56	265
22	1.18	34.8	1.75	78.0	1.99	99.1	2.07	106	6.60	755	3.51	266
23	1.10	30.0	1.69	73.2	2.00	100	2.53	150	5.78	596	3.80	297
24	1.08	28.8	1.76	78.8	1.98	98.2	2.42	139	5.36	522	4.07	332
25	1.06	27.6	1.79	81.2	2.00	100	2.46	143	4.93	454	4.55	398
26	1.07	28.2	1.92	92.8	1.99	99.1	2.42	139	4.63	410	5.90	619
27	1.18	34.8	1.95	95.5	2.06	105	2.40	137	4.58	402	7.63	985
28	1.19	35.4	1.90	91.0	2.08	107	2.55	152	4.56	399	6.94	828
29	1.21	36.7	1.88	89.2	2.00	100	2.80	179	4.34	365	5.59	561
30	1.45	54.0	1.99	99.1	1.92	92.8	2.91	191	4.24	354	4.82	438
31			2.01	101			3.10	213	4.19	336		
SUM		1,115.3		1,965.5		3,448.0		3,740.0		13,454		10,852
MEAN		37.2		63.4		115		121		434		362
MAX		54.0		114		207		213		1,340		985
MIN		27.6		36.7		85.6		74.0		153		238

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G.S BAN WANG CHAN   C.A. 11,353 SQKM   QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG   UNIT H(M), Q(C.M.S)   FOR THE WATER YEAR OF 1974

DATE	OCT.		NOV.		DEC.		JAN.		FEB.		MAR.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	4.43	360	4.12	339	2.41	138	1.72	75.6	1.52	59.6	1.29	42.3
2	4.11	337	4.10	336	2.35	135	1.70	74.0	1.51	58.8	1.36	47.2
3	4.10	336	4.40	376	2.34	131	1.69	73.2	1.50	58.0	1.39	49.3
4	3.91	311	4.07	332	2.30	127	1.68	72.4	1.56	62.8	1.46	54.8
5	3.78	295	3.85	304	2.27	124	1.68	72.4	1.53	60.4	1.38	48.6
6	3.78	295	3.67	281	2.24	122	1.69	73.2	1.50	58.0	1.34	45.8
7	3.80	297	3.70	285	2.21	119	1.68	72.4	1.47	55.6	1.31	43.7
8	3.60	273	3.75	291	2.19	117	1.67	71.6	1.46	54.8	1.29	42.3
9	3.55	267	3.68	283	2.18	116	1.67	71.6	1.44	53.2	1.28	41.6
10	3.72	287	3.71	286	2.16	114	1.68	72.4	1.43	52.4	1.28	41.6
11	5.09	478	3.74	290	2.12	111	1.69	73.2	1.41	50.8	1.29	42.3
12	7.15	876	3.73	289	2.07	108	1.68	72.4	1.40	50.0	1.26	40.2
13	10.78	1,850	3.89	309	2.05	104	1.70	74.0	1.39	49.3	1.25	39.5
14	10.49	1,770	3.67	281	2.03	103	1.72	75.6	1.38	48.6	1.24	38.8
15	8.03	1,090	3.55	267	2.01	101	1.76	78.8	1.37	47.9	1.22	37.4
16	7.59	977	3.34	242	1.99	99.1	1.79	81.2	1.36	47.2	1.21	36.7
17	7.12	869	3.20	225	1.97	97.3	1.75	78.0	1.35	46.5	1.20	36.0
18	6.18	677	3.17	221	1.95	95.5	1.69	73.2	1.35	46.5	1.31	47.7
19	6.09	655	3.23	229	1.94	94.6	1.65	70.0	1.34	45.8	1.38	48.6
20	5.92	623	3.50	261	1.92	92.8	1.70	74.0	1.34	45.8	1.29	42.3
21	5.63	568	3.20	225	1.90	91.0	1.95	95.5	1.33	45.1	1.33	45.1
22	5.37	524	3.03	205	1.88	89.2	2.05	104	1.32	44.4	1.27	40.9
23	5.11	482	2.91	191	1.85	86.5	1.84	85.6	1.31	43.7	1.26	40.2
24	4.86	444	2.82	181	1.83	84.7	1.73	76.4	1.30	43.0	1.23	38.1
25	4.61	406	2.74	172	1.82	83.8	1.67	71.6	1.30	43.0	1.21	36.7
26	4.33	366	2.67	165	1.80	82.0	1.63	68.4	1.29	42.3	1.20	36.0
27	4.12	339	2.61	158	1.79	81.2	1.60	66.0	1.29	42.3	1.18	34.8
28	3.98	320	2.55	152	1.77	79.6	1.58	64.4	1.28	41.6	1.17	34.2
29	4.09	335	2.50	147	1.76	78.8	1.56	62.8			1.17	34.2
30	4.09	335	2.45	142	1.75	78.0	1.55	62.0			1.16	33.6
31	4.22	352			1.74	77.2	1.53	60.4			1.17	34.2
SUM		17,409		7,465		3,161.3		2,296.3		1,397.4		1,270.7
MEAN		562		249		102		74.1		49.9		41.0
MAX		1,850		376		138		104		62.8		54.8
MIN		267		142		77.2		60.4		41.6		33.6

TOTAL = 5,840 MILLION M^3 MAX. = 1,850

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G.S BAN NONG BUA C.A. 14,037 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1972

DATE	APR.		MAY		JUN.		JUL.		AUG.		SEP.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	1.00	21.0	1.02	22.0	1.10	26.0	1.70	66.0	6.01	701	4.29	389
2	1.04	23.0	1.00	21.0	1.08	25.0	1.94	87.6	6.03	705	4.13	364
3	1.05	23.5	0.98	20.2	1.06	24.0	1.86	80.4	5.51	602	4.03	348
4	1.04	23.0	0.95	19.0	1.11	26.5	1.86	80.4	5.00	507	3.90	329
5	1.05	23.5	0.94	18.6	1.18	30.0	1.80	75.0	4.75	464	3.70	300
6	1.00	21.0	0.92	17.8	1.21	31.6	1.97	90.3	4.44	413	3.55	279
7	1.03	21.5	0.91	17.4	1.42	44.4	2.04	97.0	4.15	367	3.73	304
8	1.06	24.0	0.91	17.4	1.56	54.8	2.01	94.0	3.99	342	4.97	502
9	1.06	24.0	0.90	17.0	1.62	59.6	2.20	113	3.87	324	6.83	887
10	1.04	23.0	0.89	16.7	1.56	50.4	2.03	96.0	3.59	265	7.72	1,110
11	1.01	21.5	0.87	16.4	2.01	91.0	1.98	91.2	3.41	259	6.42	787
12	0.99	20.6	0.86	15.8	1.81	75.9	2.13	106	3.30	244	5.33	568
13	1.15	28.5	0.86	15.8	1.83	77.7	3.07	213	3.30	244	4.99	505
14	1.24	33.4	0.85	15.5	1.70	66.0	5.50	600	3.28	241	4.83	478
15	1.13	27.5	0.84	15.2	1.60	58.0	5.58	615	3.47	268	4.55	431
16	1.33	38.8	0.84	15.2	1.51	50.8	5.15	534	3.45	265	4.32	394
17	1.31	37.6	0.84	15.2	1.45	46.5	4.74	463	3.42	261	4.21	377
18	1.16	29.0	0.84	15.2	1.39	42.4	4.62	442	3.85	322	4.06	353
19	1.14	28.0	0.89	16.7	1.35	40.0	4.59	437	4.40	407	4.22	378
20	1.16	29.0	1.08	25.0	1.52	51.6	4.32	394	4.97	502	6.77	867
21	1.18	25.0	1.25	34.0	1.73	65.7	3.78	311	5.06	518	9.45	1,640
22	1.04	23.0	1.37	41.2	1.67	63.6	3.41	259	4.80	473	7.07	942
23	1.01	21.5	1.30	37.0	1.62	59.6	3.27	240	4.57	434	6.12	724
24	0.97	19.8	1.27	35.2	1.58	56.4	3.14	222	4.36	401	5.51	602
25	0.96	19.4	1.23	32.8	1.49	49.3	3.16	225	4.09	358	5.28	558
26	0.96	19.4	1.18	30.0	1.42	44.4	4.53	428	3.98	344	5.33	568
27	1.03	22.5	1.19	30.5	1.38	41.8	4.96	500	3.93	334	5.61	627
28	0.97	19.8	1.17	29.5	1.35	40.0	4.86	483	4.00	344	6.24	749
29	1.00	21.0	1.11	26.5	1.42	44.4	5.66	630	3.92	332	6.40	783
30	1.04	23.0	1.08	25.0	1.45	46.5	5.86	670	3.98	341	6.43	790
31			1.01	23.0			5.68	634	4.10	359		
SUM		735.8		697.5		1,519.9		9,376.9		11,958		17,928
MEAN		24.5		22.5		50.7		302		386		598
MAX		38.8		41.2		94.0		670		705		1,640
MIN		19.4		15.2		24.0		66.0		244		279

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G.S BAN NONG BUA C.A. 14,037 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1972

DATE	OCT.		NOV.		DEC.		JAN.		FEB.		MAR.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	6.05	710	3.12	220	3.51	278	1.94	87.6	1.53	52.4	1.29	36.4
2	6.09	718	3.03	208	3.32	247	1.92	85.8	1.52	51.6	1.28	35.8
3	5.63	625	2.96	199	3.13	221	1.90	84.0	1.51	50.8	1.27	35.2
4	5.51	602	2.90	192	3.00	204	1.88	82.2	1.50	50.0	1.26	34.6
5	5.34	570	2.84	185	2.86	187	1.86	80.4	1.50	50.0	1.26	34.6
6	5.60	619	2.79	179	2.76	175	1.84	78.6	1.50	50.0	1.25	34.0
7	6.42	787	2.75	174	2.68	166	1.83	77.7	1.49	48.6	1.24	33.4
8	5.93	684	2.71	169	2.71	169	1.82	76.8	1.47	47.9	1.24	33.4
9	5.40	581	3.12	220	2.65	162	1.80	75.0	1.46	47.2	1.25	34.0
10	5.11	527	2.94	197	2.64	161	1.79	74.1	1.46	47.2	1.26	34.6
11	4.90	490	2.91	193	2.63	160	1.78	73.2	1.45	46.5	1.28	35.8
12	4.78	470	2.93	196	2.63	160	1.77	72.3	1.44	45.8	1.28	35.8
13	4.59	437	2.77	176	2.59	156	1.75	70.5	1.44	45.8	1.27	35.2
14	4.39	405	2.70	168	2.55	152	1.73	68.7	1.43	45.1	1.24	33.4
15	4.50	423	2.65	162	2.50	146	1.72	67.8	1.42	44.4	1.22	32.2
16	4.60	439	2.59	156	2.47	143	1.71	66.9	1.42	44.4	1.22	32.2
17	4.80	473	2.59	156	2.40	135	1.70	66.0	1.41	43.7	1.27	35.2
18	4.60	439	2.61	161	2.34	128	1.69	65.2	1.40	43.0	1.22	32.2
19	4.53	428	2.55	152	2.29	123	1.68	64.4	1.40	43.0	1.24	33.4
20	4.61	441	2.63	160	2.24	117	1.66	62.8	1.39	42.4	1.31	39.4
21	4.56	433	2.53	149	2.21	114	1.65	62.0	1.38	41.8	1.45	46.5
22	4.34	397	2.52	148	2.18	111	1.64	61.2	1.37	41.2	1.48	48.6
23	4.21	377	2.68	166	2.15	108	1.62	59.6	1.36	40.6	1.42	44.4
24	4.01	346	2.95	198	2.12	105	1.61	58.8	1.34	39.4	1.41	43.7
25	3.86	323	3.17	226	2.08	101	1.60	58.0	1.33	38.8	1.43	45.1
26	3.69	299	4.86	483	2.06	99.0	1.59	57.2	1.32	38.2	1.46	47.2
27	3.51	273	4.73	461	2.04	97.0	1.58	56.4	1.31	37.6	1.39	42.4
28	3.41	259	4.06	353	2.02	95.0	1.56	54.8	1.30	37.0	1.37	41.2
29	3.35	251	3.79	313	2.00	93.0	1.55	54.0			1.36	40.6
30	3.33	248	3.74	306	1.99	92.1	1.55	54.0			1.33	37.6
31	3.22	233			1.97	90.3	1.54	53.2			1.28	35.8
SUM		14,307		6,426		4,495.4		2,109.2		1,254.4		1,163.9
MEAN		462		214		145		68.0		44.8		37.5
MAX		787		483		278		87.6		52.4		48.6
MIN		233		148		90.3		53.2		37.0		32.2

TOTAL = 6,220 MILLION M^3 MAX = 1,640

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G.S BAN NONG BUA C.A. 14,037 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1973

DATE	APR.		MAY		JUN.		JUL.		AUG.		SEP.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	1.27	35.2	1.02	22.0	1.66	62.8	2.10	103	2.97	200	5.78	654
2	1.25	34.0	1.00	21.0	1.64	61.2	2.05	98.0	2.97	200	5.25	552
3	1.22	32.2	1.60	58.0	1.64	61.2	2.02	95.0	2.91	193	5.00	507
4	1.20	31.0	1.23	32.8	1.69	65.2	2.05	98.0	2.91	193	4.89	488
5	1.19	30.5	1.29	36.1	1.60	58.0	2.03	96.0	2.81	181	4.67	451
6	1.18	30.0	1.33	38.8	1.64	61.2	1.96	89.4	2.77	176	4.46	417
7	1.18	30.0	1.37	41.2	1.58	56.4	1.96	89.4	2.70	168	4.22	378
8	1.17	29.5	1.28	35.8	1.57	55.6	2.11	104	2.75	174	4.00	344
9	1.17	29.5	1.26	34.6	1.66	62.8	2.20	113	3.16	225	3.79	313
10	1.19	30.5	1.22	32.2	1.77	72.3	2.24	117	3.13	221	3.77	310
11	1.17	29.5	1.26	34.6	2.04	97.0	2.57	154	3.02	207	3.76	308
12	1.15	28.5	1.26	31.6	1.82	76.8	4.37	402	2.88	190	3.70	300
13	1.13	27.5	1.25	34.0	1.75	70.5	4.11	361	2.75	174	3.58	283
14	1.12	27.0	1.30	37.0	1.66	62.8	3.48	269	2.77	176	3.61	287
15	1.11	26.5	1.31	37.6	1.64	61.2	3.22	233	2.83	184	3.70	300
16	1.10	26.0	1.30	37.0	1.65	62.0	3.07	213	2.89	191	3.64	292
17	1.09	25.5	1.32	38.2	1.97	90.3	3.02	207	2.91	193	3.55	279
18	1.08	25.0	1.30	37.0	2.71	169	3.26	238	2.82	182	3.68	297
19	1.12	27.0	1.31	37.6	4.93	495	3.33	248	2.91	193	3.83	318
20	1.17	29.5	1.31	37.6	5.30	562	3.28	241	3.14	222	4.05	352
21	1.13	27.5	1.30	37.0	5.20	543	3.40	258	3.62	289	4.52	426
22	1.12	27.0	1.26	34.6	4.40	407	3.49	271	3.67	296	5.58	615
23	1.12	27.0	1.26	34.6	3.65	293	3.46	266	3.60	286	5.13	530
24	1.11	26.5	1.26	34.6	3.15	224	3.44	264	3.65	293	5.28	558
25	1.08	25.0	1.32	38.2	2.82	182	3.23	234	4.45	415	6.40	783
26	1.06	24.0	1.37	41.2	2.64	161	3.18	227	5.31	564	6.37	777
27	1.06	24.0	1.46	47.2	2.57	154	3.15	224	5.42	585	5.61	621
28	1.04	23.0	1.58	56.4	2.44	139	3.10	217	5.51	602	5.32	566
29	1.02	22.0	1.53	52.4	2.32	126	3.25	237	5.44	589	5.27	556
30	1.02	22.0	1.55	54.0	2.19	112	3.10	217	5.74	616	5.84	666
31			1.49	49.3			3.07	213	6.29	760		
SUM		832.4		1,197.5		4,704.3		6,196.8		9,168		13,528
MEAN		27.7		38.6		157		200		296		451
MAX		35.2		58.0		562		402		760		783
MIN		22.0		21.0		55.6		89.4		168		279

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G.S BAN NONG BUA C.A. 14,037 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1973

DATE	OCT.		NOV.		DEC.		JAN.		FEB.		MAR.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	5.44	589	2.71	169	2.02	95.0	1.53	52.4	1.28	35.8	1.12	27.0
2	5.40	584	2.62	159	2.00	93.0	1.52	51.6	1.27	35.2	1.11	26.5
3	5.46	592	2.57	154	1.99	92.1	1.51	50.8	1.26	34.6	1.11	26.5
4	5.25	552	2.52	148	1.96	89.4	1.50	50.0	1.25	34.0	1.10	26.0
5	5.54	608	2.47	143	1.94	87.6	1.48	48.6	1.24	33.4	1.10	26.0
6	5.71	640	2.45	140	1.92	85.8	1.47	47.9	1.23	32.8	1.11	26.5
7	5.57	613	2.40	135	1.90	84.0	1.46	47.2	1.22	32.2	1.11	26.5
8	5.52	604	2.37	132	1.88	82.2	1.46	47.2	1.21	31.6	1.13	27.5
9	5.16	536	2.34	128	1.85	79.5	1.46	47.2	1.20	31.0	1.11	26.5
10	5.10	525	2.31	125	1.83	77.7	1.45	46.5	1.20	31.0	1.12	27.0
11	5.39	579	2.30	124	1.81	75.9	1.44	45.8	1.19	30.5	1.12	27.0
12	5.21	545	2.34	128	1.80	75.0	1.44	45.8	1.19	30.5	1.11	26.5
13	4.92	493	2.27	121	1.79	74.1	1.43	45.1	1.18	30.0	1.10	26.0
14	4.65	448	2.36	134	1.78	73.2	1.42	44.4	1.18	30.0	1.07	24.5
15	4.43	412	2.40	135	1.76	71.4	1.41	43.7	1.17	29.5	1.07	24.5
16	4.22	378	2.47	143	1.74	69.6	1.40	43.0	1.17	29.5	1.07	24.5
17	4.06	353	2.53	149	1.72	67.8	1.38	41.8	1.16	29.0	1.09	25.5
18	3.85	322	2.44	139	1.70	66.0	1.37	41.2	1.16	29.0	1.10	26.0
19	3.74	306	2.37	132	1.68	64.4	1.37	41.2	1.20	31.0	1.13	27.5
20	3.68	297	2.40	135	1.66	62.8	1.37	41.2	1.18	30.0	1.16	29.0
21	3.52	275	2.38	131	1.64	61.2	1.36	40.6	1.18	30.0	1.10	26.0
22	3.38	255	2.46	142	1.64	61.2	1.36	40.6	1.18	30.0	1.10	26.0
23	3.28	244	2.44	139	1.63	60.4	1.36	40.6	1.20	31.0	1.12	27.0
24	3.17	226	2.33	127	1.62	59.6	1.34	39.4	1.18	30.0	1.08	25.0
25	3.10	217	2.26	120	1.61	58.8	1.33	38.8	1.16	29.0	1.07	24.5
26	3.02	207	2.22	115	1.59	57.2	1.32	38.2	1.15	28.5	1.12	27.0
27	2.95	198	2.17	110	1.58	56.4	1.32	38.2	1.13	27.5	1.12	27.0
28	2.89	191	2.12	105	1.56	54.8	1.32	38.2	1.12	27.0	1.11	26.5
29	2.89	191	2.09	102	1.55	54.0	1.31	37.6			1.10	26.0
30	2.84	185	2.05	98	1.54	53.2	1.31	37.6			1.07	24.5
31	2.78	178			1.54	53.2	1.30	37.0			1.09	25.5
SUM		12,337		3,959.0		2,196.5		1,349.4		863.6		812.0
MEAN		398		132		70.9		43.5		30.8		26.2
MAX		640		169		95.0		52.4		35.8		29.0
MIN		178		98.0		53.2		37.0		27.0		24.5

TOTAL = 4,940 MILLION M^3 MAX = 783

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G.S BAN NONG BUA C.A. 14,037 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1974

DATE	APR.		MAY		JUN.		JUL.		AUG.		SEP.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	1.17	29.5	1.46	47.2	2.00	93.0	1.93	86.7	3.30	244	3.86	323
2	1.15	28.5	1.61	58.8	1.96	69.4	1.84	78.6	3.38	255	3.83	315
3	1.27	35.2	2.10	103	1.96	89.4	1.85	79.5	3.15	224	3.93	334
4	1.17	29.5	1.73	68.7	1.94	87.6	1.82	76.8	2.98	202	4.18	372
5	1.28	35.8	1.47	47.9	1.96	89.4	1.78	73.2	2.80	180	4.12	362
6	1.24	33.4	1.36	40.6	2.33	127	1.75	70.5	2.65	162	3.97	332
7	1.20	31.0	1.28	35.8	2.43	138	1.82	76.8	2.59	156	3.76	308
8	1.18	30.0	1.21	31.6	2.28	122	2.00	93.0	2.75	174	3.66	294
9	1.13	27.5	1.17	29.5	2.25	118	2.23	116	2.95	198	3.80	314
10	1.10	26.0	1.16	29.0	2.24	117	2.38	133	2.90	192	3.84	320
11	1.09	25.5	1.14	28.0	2.62	159	2.36	131	2.79	179	3.80	314
12	1.16	29.0	1.39	42.4	3.12	220	2.47	143	2.71	169	3.76	308
13	1.19	30.5	1.20	21.0	2.66	164	2.35	130	2.75	174	3.75	307
14	1.18	30.0	1.18	30.0	2.43	138	2.37	132	3.07	213	3.78	311
15	1.20	31.0	1.18	30.0	2.31	125	2.42	137	4.69	454	3.79	313
16	1.23	32.8	1.17	29.5	2.31	125	2.31	125	5.52	601	3.58	283
17	1.23	32.8	1.22	32.2	2.28	122	2.23	116	5.32	566	3.47	265
18	1.16	29.0	1.24	33.4	2.27	121	2.15	108	6.50	805	3.39	255
19	1.14	28.0	1.31	37.6	2.20	113	2.05	98.0	7.36	1,020	3.58	283
20	1.10	26.0	1.39	42.4	2.16	109	2.10	103	8.12	1,230	3.54	278
21	1.08	25.0	1.48	48.6	2.05	98.0	2.07	100	7.27	992	3.64	292
22	1.27	35.2	1.67	63.6	2.02	95.8	2.07	100	6.51	807	3.56	260
23	1.08	25.0	1.62	59.6	2.03	93.0	2.54	150	5.83	664	3.85	322
24	1.01	23.0	1.68	64.4	2.05	98.0	2.49	145	5.40	581	4.08	356
25	1.02	22.0	1.69	65.2	2.06	98.0	2.51	147	4.96	500	4.50	423
26	1.02	22.0	1.25	34.0	2.02	95.0	2.28	122	4.61	441	5.29	560
27	1.09	25.5	1.88	82.2	2.10	103	2.48	144	4.53	428	7.10	949
28	1.13	27.5	1.83	77.7	2.16	109	2.55	152	4.53	428	6.72	855
29	1.14	28.0	1.80	75.0	2.09	102	2.79	179	4.35	399	5.57	613
30	1.28	35.8	1.97	90.3	2.01	94.0	2.88	190	4.24	381	4.94	497
31			2.08	101			3.06	212	4.13	364		
SUM		870.0		1,590.2		3,456.8		3,748.1		13,386		11,344
MEAN		29.0		51.3		115		121		432		378
MAX		35.8		103		220		212		1,230		949
MIN		22.0		26.0		87.6		70.5		156		255

WATER LEVEL (H) AND DISCHARGE (Q)

NAME OF G.S BAN NONG BUA C.A. 14,037 SQKM QUAE YAI THAILAND

QUAE YAI RIVER IN THE BASIN OF ME KLONG UNIT H(M), Q(C.M.S) FOR THE WATER YEAR OF 1974

DATE	OCT.		NOV.		DEC.		JAN.		FEB.		MAR.	
	H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1	4.97	502	4.33	396	2.65	162	1.91	84.9	1.69	65.2	1.47	47.9
2	4.71	458	4.25	383	2.61	158	1.90	84.0	1.68	64.4	1.51	50.8
3	4.52	426	4.52	426	2.57	151	1.89	83.1	1.67	63.6	1.53	52.4
4	4.27	386	4.29	389	2.53	149	1.86	80.4	1.70	66.0	1.60	58.0
5	4.09	358	4.00	344	2.49	145	1.85	79.5	1.68	64.4	1.54	53.2
6	3.88	326	3.84	320	2.47	143	1.84	78.6	1.66	62.8	1.51	50.8
7	3.96	338	3.87	324	2.43	138	1.83	77.7	1.65	62.0	1.48	48.6
8	3.78	311	3.90	329	2.41	136	1.82	76.8	1.62	59.6	1.46	47.2
9	3.69	299	3.85	322	2.40	135	1.82	76.8	1.61	58.8	1.45	46.5
10	4.06	353	3.70	300	2.38	133	1.84	78.6	1.60	58.0	1.45	46.5
11	5.01	509	3.75	307	2.35	130	1.85	79.5	1.59	57.2	1.45	46.5
12	6.81	876	3.82	317	2.31	125	1.86	80.4	1.59	57.2	1.44	45.8
13	9.01	1,500	4.02	347	2.29	123	1.87	81.3	1.58	56.4	1.43	45.1
14	9.91	1,800	3.80	314	2.26	120	1.87	81.3	1.56	54.8	1.42	44.4
15	8.42	1,320	3.75	307	2.22	115	1.88	82.2	1.56	54.8	1.41	43.7
16	7.77	1,120	3.60	286	2.21	114	1.90	84.0	1.55	54.0	1.40	43.0
17	7.39	1,030	3.51	273	2.20	113	1.92	85.8	1.54	53.2	1.39	42.4
18	7.08	944	3.49	271	2.17	110	1.85	79.5	1.53	52.4	1.44	45.8
19	7.00	924	3.44	264	2.15	108	1.83	77.7	1.52	51.6	1.54	53.2
20	6.61	829	3.69	299	2.13	106	1.84	78.6	1.52	51.6	1.45	46.5
21	6.23	747	3.47	268	2.11	104	2.01	97.0	1.52	51.6	1.42	44.4
22	5.78	654	3.29	243	2.08	101	2.25	118	1.51	50.8	1.45	46.5
23	5.52	604	3.19	229	2.07	100	2.02	95.0	1.50	50.0	1.44	45.8
24	5.23	549	3.09	216	2.06	99.0	1.92	85.8	1.49	49.3	1.40	43.0
25	4.95	498	3.03	208	2.03	96.0	1.86	80.4	1.49	49.3	1.40	43.0
26	4.71	458	2.94	197	2.01	94.0	1.82	76.8	1.48	48.6	1.39	42.4
27	4.48	420	2.85	186	2.00	93.0	1.78	73.2	1.48	48.6	1.38	41.8
28	4.32	394	2.79	179	1.98	91.2	1.76	71.4	1.47	47.9	1.37	41.2
29	4.40	407	2.73	172	1.97	90.3	1.74	69.6			1.37	41.2
30	4.36	401	2.70	168	1.94	87.6	1.72	67.8			1.36	40.6
31	4.31	393			1.92	85.8	1.70	66.0			1.36	40.6
SUM		20,134		8,584		3,658.9		2,511.7		1,564.1		1,428.8
MEAN		649		286		118		81.0		55.9		46.1
MAX		1,800		426		162		118		66.0		58.0
MIN		299		168		85.8		66.0		47.9		40.6

TOTAL = 6,240 MILLION M3 MAX. = 1,800

THE KINGDOM OF THAILAND FEASIBILITY REPORT ON LOWER QUAE YAI REGULATING DAM PRO