REPORT

ON

BASIC STUDIES FOR DEVELOPMENT OF HYDRAULIC POTENTIALS OF THE NAM SAI YAI KINGDOM OF THAILAND

APPENDIX

REPORT ON RECONNAISSANCE
OF KHLONG THA DAN BASIN

JUNE 1965

OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN

(Appendix) List of Errata

Page	Line		Corrected as
6	14	must be by means of	must be done by means of
7	2	surfa	surface
8	2	and 10 km on foot travel.	and 10 km on foot travel is necessary to reach to the reservoir from there.
9	1	west side of the hill,	west side of The Dangrek mountain range,
10	24	conglomerate and conglomerate-tuff	agglomerate and agglomerate-tuff
11	5	are many anywhere	are found anywhere
12	8	and the power station for regulation of load.	and the regulating station for the load fluctuation.
12	10-11	The water reservoir capacity	the effective storage
"	22	The effective capacity of reservoir can be doubled by	The effective storage of the reservoir can be increased by
	24	discharge around No.2 power station.	discharge from No.2 pondage.
13	7	Huai Sam Rong	Huai Sam Phung
"	17	discharge of the 325 km^2 wide	discharge from the
"	21	seems to be necessary.	seems to be necessary. Future investigation depending on several data for the determination of the reservoir capacity (dam height) is necessary.
14	6-7	the water intake from	the water from

C O N T E N T S

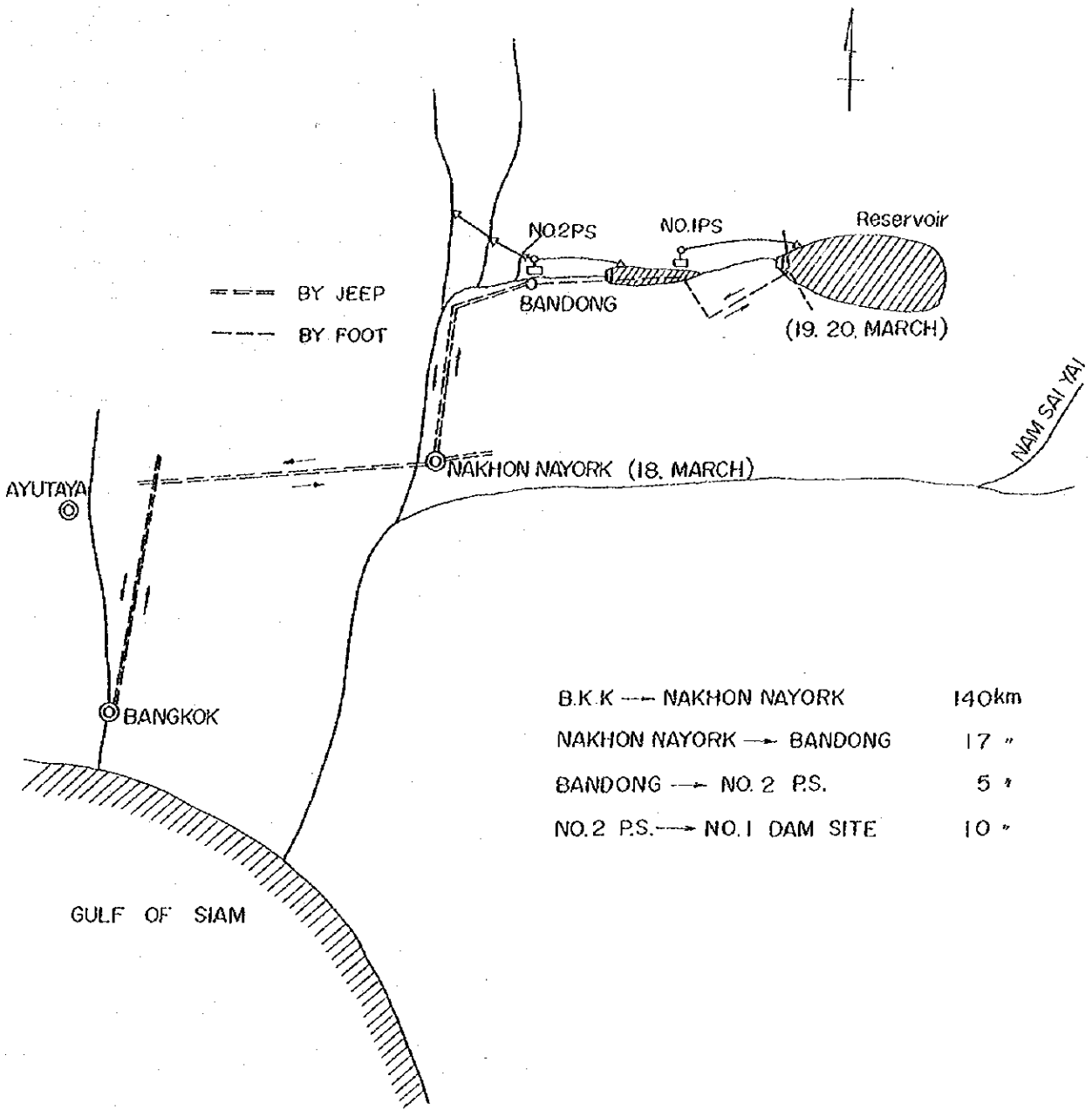
1. Preface

In February, 1965, the Japanese Government sent an investigation mission to Thailand on request by the Government of Thailand in connection with the development of hydro-electric power potentials of the Nam Sai Yai and conducted field survey of the river basin. While in Thailand, the Mission was requested by the National Energy Authority (NEA) of Thailand to conduct field investigations of the Khlong Tha Dan Basin which is adjacent basin to the Nam Sai Yai basin. In response to the request the Mission conducted an reconnaissance over the basin for 4 days from March 18, 1965 in order to study possibility of hydro-electric development of the basin. Since it was ascertained as the result of the survey that the project would be most beneficial from the technical viewpoint in constructing a reservoir as well as from economic point of view, it has been decided to attach the results of the studies on the Khlong Tha Dan river basin as a supplement to the report on the investigation of the Nam Sai Yai river basin.

The members of the Mission were as follows:

Head	Takeshi Tokuno	Civil engineer Electric Power Development Co.
	Norio Oshiki	Civil engineer Electric Power Development Co.
	Takao Toyoda	Geologist Electric Power Development Co.
	Kei Yamamoto	Civil engineer Electric Power Development Co.
	Tsutomu Kidahashi	Electrical engineer Electric Power Development Co.
	Azuma Tsunoda	Agricultural engineer Electric Power Development Co.

ROUTE OF THE KHLONG THA DAN RECONNAISSANCE



2. Conclusions and Recommendations

2-1 Introduction

The electric power development project of the Khlong Tha Dan river basin is an excellent one, which will enable 60,000 kW of power generation with large scaled reservoir. The project site is located at a short distance from the major consuming area of Bangkok and Korat requiring construction of rather short stretch of transmission line to these cities. We, therefore, consider it most proper to realize its early development after the completion of the Nam Sai Yai Project. The proposed Khlong Tha Dan No. 1 power plant is most suitable to be developed as a pumping up station from topographical viewpoint. During the rainy season when load demand is rather small, river flow from about 170 km^2 catchment area of tributaries can be collected and pumped up into the Khlong Tha Dan Reservoir from No. 2 power plant regulating pondage. The pumped up water together with the water collected from its own basin could be regulated and released from the reservoir and used economically to enhance the power generating capacity in the dry season. Furthermore, the capacity of No. 1 power plant could be raised two fold in future with additional equipment to a maximum output of 100,000 kW to carry on power generation by pumping throughout the year. Thus, generating capability at peak load hour will be enlarged and load adjustment will also be ensured in the power system.

So far no survey has ever been undertaken which is necessitated to determine the details of the power development plan for the Khlong Tha Dan basin, and no detailed data is available except 1/50,000-scale topographical map prepared by the U.S. Air Force.

The Mission has tentatively worked out a plan for the development of power resources of the Khlong Tha Dan basin on the basis of the results of the reconnaissance and the data which were made available in connection with the Nam Sai Yai Project. The outline of this plan will be given below, as well as various items of investigations which are necessitated. It is

earnestly hoped that the various investigations suggested will be completed as soon as possible and a development plan be determined for early undertaking of the project.

With the construction of the proposed reservoir, it would be possible to irrigate about 3,000 ha of arable land in the lower basin during the dry season. The irrigation plan will have to be finally studied after the scale of the reservoir is determined and detailed investigation is conducted to the purpose.

2-2 Conclusions and Recommendations as to Project Site

2-2-1 Electric Power Development

The site above the waterfall on the upper stream of the Khlong Tha Dan is topographically favourable for the creation of a reservoir. So, a huge reservoir is proposed at the site with an effective storage capacity of about 300,000,000 m^3 and high water surface elevation at 416 m. Max. discharge of 20 m^3/sec is conducted from the reservoir to No.1 power plant through a pressure tunnel of 2,100 m length. After generating, the water will be discharged to a regulating pondage which is to have high water surface at EL100m on the lower part of the river. Below the regulating pondage, the water is to be discharged to the EL 35-m point through No. 2 power plant.

The general features of the power plant will be as follows:

Power plant	Max. discharge (m^3/sec)	Rated Effective head (m)	Max. Output (kW)	Annual power producrtion (10^3 kWh)
Khlong Tha Dan No. 1	20	300	50,000	(118,000) 160,000
Khlong Tha Dan No.2	20	60	10,000	31,000
Total			60,000	(118,000) 191,000

Remark: The figure in the parenthesis indicates the power requirements for pumping up.

Moreover, maximum output of the Khlong Tha Dan No. 1 Plant can be increased in future to 100,000 kW by additional equipment. Then, it would be possible to raise the annual power generation to 320,000,000 kWh.

The electric power generated at these power plants will be transmitted, along with that obtained from the Sai Yai System, to Bangkok and Korat areas.

The total construction cost involved in this development would roughly amount to $24,000,000. Then, unit cost of power will be about $400 per kW (146,000 ¥/kW) and $0.13 per kWh (45.8 ¥/kWh). The construction cost of the second-stage work for Khlong Tha Dan No. 1 (maximum output of 50,000 kW) is estimated at $9,200,000, that is, $184 per kW (51,000 ¥/kW), a very low construction cost. The present reconnaissance has indicated that the fill type dams will be suitable for the project.

2-2-2 Agricultural development

When and after the Khlong Tha Dan Reservoir is constructed, it would be possible to irrigate more than 3,000 ha of arable land in the plain area downstream throughout the year, enabling cultivation of rice, vegetables and fruits. The mission was unable to conduct field investigations for reason of time limit. It is desired that a plan be evolved for agricultural development in the basin after conducting field investigations just as in the case of the Nam Sai Yai project.

2-3. Recommendations on Investigations to be carried out

To substantiate the basic idea proposed in this report and to study the economic aspects of the project, it is necessary to conduct the following investigations:

(1) Reservoir and pondage area

1. Topographic map

1) Reservoir, pondage area: 1/10,000 plan

2) Around the dam site: 1/2,000 plan (including auxiliary dam)

2. Geology

1) As for the No. 1 and No. 2 Dams

Investigations on the thickness of the talus weathering of the bedrock, rock characteristics, and permeability. As No. 1 Dam is to be located near the contact point of andesite and red shale, the contact point must be thoroughly investigated. The investigation must be by means of drilling. Standard positions, depth, etc., must be determined after completion of the topographical map as in the case for Sai Yai No. 1 and No. 2 Dams

2) Testing of the fill materials: examination of the quality and specific gravity of the rock materials, and testing of the grading distribution, moisture content and permeability of the soil materials. The area to be surveyed for No. 1 Dam is shown in Fig. 3-5-6.

(2) Waterway and power plant

1. Topographical map

Preparation of a map on 1/2,000 scale showing the areas around the intake, and the surge tank - penstock - generating plant,

2. Geology

Geological survey by means of drilling and shafts at the sites of the

surge tank, penstock and power plant, in order to investigate the thickness of the surface talus, characteristics of the bedrock, etc.

(3) Aggregate

Investigate approximate amount and quality of the natural aggregate available at the reservoir site and the area downstream therefrom to Nakhon Nayrok.

(4) River Profile

River profile measuring shall be conducted of the river stretch covering project area.

(5) Access road

Select the route and carry on actual measuring of the access road so as to determine the quantity of work necessitated.

(6) Stream flow and rainfall

Set up observation posts at three places at least within the project area for recording of stream flow and rainfall.

3. Basic Idea of the Development

3-1 Location of the Project Area

The basin of the Khlong Tha Dan lies about 120 km to the northeast of Bangkok. The river runs through the City of Nakhon Noyork and flows into the Mae Nam Bang Pakong, then southward into the Siam Bay at a point near Chon Buri about 100 km to the east of Bangkok.

The basin is adjacent to the Nam Sai Yai basin to the west, and is separated by a watershed from the Nam Mune basin of the Korat Plateau to

the north. No. 2 power plant site can be reached from Nakhon Nayork City by one hour car driving and 10 km on foot travel. The project site is extremely easy of access.

3-2 Hydrology

The catchment area has no such records of observation of stream-flow and rainfall as enables us to estimate the run-off of the basin. Therefore, we decided to estimate the outflow of the catchment of Khlong Tha Dan on the basis of the records of several rain-gauge stations located in the peripheral zone and the data of discharge of the neighbouring catchment, the Nam Sai Yai.

Inferring from the data available at the rain-gauge stations found in the areas surrounding the two river basins, Khlong Tha Dan and Sai Yai, the rainfall in the two catchment areas is deemed almost equal in annual total. It was considered safe to apply the values of the Nam Sai Yai area directly to the Khlong Tha Dan catchment area.

3-3 Topography and Geology

3-3-1 Topography

This area is situated near the south-western end of Korat Plateau, to the immediate west of the Sai Yai Project area. As seen in the topographical map, the project area extends from the hill running northwest to southeast at an altitude of 400 meters to 1,000 meters, westward down to the flat land. At the transition from the hilly side to the plain, the slope makes 100 meters to 300 meters high cliffs here and there. The hilly zone has topographically horst structure, a fact leading us to infer that this terrain was made up through a sort of crustal movement.

Collecting water on the west side of the hill, the Khlong Tha Dan river flows roughly westward. The upper stream has many curves and flows slowly because the land is flat. But the middle and lower streams are more rapid and straight because of the geological and geographical structures.

3-3-2 Geology

Belonging to the Korat series, like the Sai Yai Project area, the bedrock of the Korat plateau is mainly constituted of sandstone, conglomerate and red shale (siltstone), and the strata are in gentle wave-fold.

On the west border of Korat Plateau, andesites are widely distributed. These rocks are said to belong to Tertiary, but how they were occured is not known.

Fig. 3-5-5 which is the general geological map (1/50,000) of the project area shows the geological distribution and geological structure as interpreted from aerial photographs.

(1) Bedrocks

The formations of this project area are said, on account of their rock facies, to belong to Phra Wihan Stage or Phukadung Stage i.e. to the middle or lower part of Korat series. The formation are generally horizontal, but they are somewhat dipped gently southward in the northern part of area, and a little southeastward in the eastern part of area. In the western area, namely, in the considerably wide area upstream of No. 1 dam, red shale, as often observed in the lower Korat formation, is distributed.

The thickness of single layer of formation, ranges from several meters. Layers of hard, soft, coarse and fine grained rocks

lie alternated. The cohesion between the layers is not so compact, with a thin shale layer in some instances.

Andesite is distributed immediately downstream of No. 1 dam, but its detail of distribution is not so clear.

No mentionable fault was found in the area. But, so far as the judgement by the interpretation of aerial photographs is concerned, weak lines, as indicated in Fig. 3-5-5 "General geological map", are recognizable. Whether the weak line indicates a fault or joint or crack is not clear.

Sandstone The sandstone belongs to the same formation as the sandstone distributed in the Sai Yai project area, but it does not seem to be distributed in the area of this project.

Red shale Red shale is distributed along the upperstream of the No. 1 dam site.

Generally the thickness of single layer is several centimeters. The formation is almost horizontal, and it is fractured in part. Reddish brown and compact, and the rock itself seems to be impermeable. But the cohesion between layers is not so compact, being soft and loose. The rock is comparatively compact while it is new, but it is easy to weather and erode, being liable to transforming into clay.

Andesite group

Andesite is predominant, but judging from boulders porous and slightly soft conglomerate and conglomerate-tuff may partially distributed. Andesite is massive and hard, but joints and cracks considerably developed and partially flowstructures

are also many. At the sites of No. 1 and No. 2 dams, joints with strike of NE-SW and vertical of dips are predominant. For the bedrock, andesite is relatively favourable.

(2) Alluvial deposit

Alluvial deposits are many anywhere in the river basin in the project area. Along theupperstream of the dam site for No. 1 dam, the sand layer is predominant, and down the dam site, andesite pebbles and gravels are deposited.

3-4 Power Demand

Electric power demand in Thailand is increasing so remarkably that the development of new electric power source is strongly urged.

As regards the power demand, a detailed statement is made in the report on investigation of the Nam Sai Yai Electric Power Development Project. So, it is omitted here.

In view of the probability of the Nam Sai Yai Project being commenced in or about 1970, it is considered appropriate to start with the development of Khlong Tha Dan immediately following the completion of Sai Yai Project.

3-5 Hydroelectric Power Development

3-5-1 Introduction

Bangkok, the capital of Thailand, and its vicinity must receive hydroelectric power over a very long transmission, except for the supply from the Mae Nam Mae Khlong (Kaeng Rieng, etc.) Mae Nam Bang Pakong (Nam Sai Yai, etc.). Therefore, on account of economy of power generation, these power sources must preferably be

which an output of 60,000 kW will be realized in the first stage, and 50,000 kW in the second stage, totalling 110,000 kW.

3-5-2 Determination of Size of Reservoir

The inflow which is needed in estimating the scale of the reservoir was induced from the discharge of the Nam Sai Yai.

Also, the inflow through tunnels of 7,200 m length to the intake of No. 2 plant from tributaries such as Huai Sam Rong and others was calculated by assuming the maximum capacity of the channel at 10 m^3/sec.

The above calculation envisages that the No. 2 plant, during the rainy season, will generate power with the inflow from the tributaries, and the No. 1 plant will daily generate power by pumping up and further, during the dry season, the water discharged from the reservoir will enable both No. 1 and No. 2 plants to operate.

As regards the scale of the reservoir, it is required to store at least the annual discharge of the 325 km^2 wide catchment area, something like 250 million m^3. And, considering the need for supplement in the most dry year, a total capacity of 350 million m^3, i.e. effective storage of about 300 million m^3, seems to be necessary.

3-5-3 Outline of Electric Power Generation Plan

Khlong Tha Dan No. 1 power plant (50,000 kW) is to be constructed as the station attached to the Khlong Tha Dan reservoir. Another, the No. 2 plant (10,000 kW), is to be built at the location about 8 km downstream from the No. 1 plant. The surge tank of No. 2 plant will have the water intake from about the 156 km^2 wide catchment including such branch streams as Huai Nang Rong, Huai Som Phung. The water is used by the No. 2 power station at the peak time, while, off the peak-load hour, it is pumped to the reservoir of Khlong Tha Dan through the regulating pondage of the No. 2 plant. This regulating pondage is to be made use of as the regulating pondage for No. 2 plant, and moreover, it will serve as the lower reservoir of the No. 1 plant (pumping-up generating station).

It must be added that, as the demand will increase in future and the surplus power in rainy season and midnight will also increase, a pumping-up power plant of a maximum output of 50,000 kW will be additionally constructed at the site of the No. 1 plant by way of a second stage work.

Particulars of the power generating scheme are given in the following table.

Khlong Tha Dan Project (First stage)

Item \ Name of Station	Khlong Tha Dan No. 1	Khlong Tha Dan No. 2	Total
Catchment area			
Direct (km^2)	152.7		
Indirect (")	(Pumping-up)172.6		
Total (")	325.3	325.3	
Reservoir			
Name	Khlong Tha Dan No.1	Khlong Tha Dan No.2	
High Water Surface (m)	416.	100	
Surface Area (km^2)	27.2	0.7	
Effective Storage ($10^6 m^3$)	300.	2.	
Draw Down (m)	18.5	3	
Dam			
Type	Rock fill	Rock fill	
Height x Length (m)	56. x280	50. x220	
Volume of Dam (m^3)	950.000	650.000	
Head Race			
Main Tunnel (m)	2,100 (ϕ=3.5)	1,550 (ϕ=3.5)	
Sub Tunnel (m)	7,210 (ϕ=2~	-	
Tail Race (m)	- 2.6)	300 (ϕ=3.5)	
Power Project			
Nor. Intake Level (m)	410	100	
Tail Water Surface (m)	100	35	
Rated Effective Head (m)	300	60	
Max Discharge (m^3/sec.)	20	20	
Installed Capacity (kW)	50,000	10,000	60,000
Annual Energy Production (10^6kWh)	160	31	191
(Pumping-up Energy)	(118)		(118)
Costraction Cost (10^3\$)	17,220	7,060	24,280
(10^6¥)	(6,200)	(2,540)	(8,740)
\$/kWh	344	706	405
(¥/kW)	(124,000)	(254,000)	(146,000)
\$/kWh	0.108	0.228	0.127
(¥/kWh)	(38.8)	(81.9)	(45.8)

Note: 1. The construction cost does not include the expenses for transmission line and the expenses for construction of access road to the dam site.

2. The No. 1 power plant will have additional installation of pumping-up generating equipment for 50,000 kW in the second stage work. This will make the total output of No. 1 plant 100,000 kW.

3-5-4 Power Transmission Plan

The electric power to be produced by the present project can easily be led to the Sai Yai power transmission network near Prachin Buri if only about 20 km long transmission line for 115 kv is constructed. This means that the power will be soon transmitted to Bankok and Korat also. Some details of the transmission system are already stated in the report on the Sai Yai Project, so no more reference is made here.

3-6 Figures and Photographs

Figure 3-5-1 Location Map

Figure 3-5-2 General Plan

Figure 3-5-3 Profile of the Project

Figure 3-5-4 Surface Area and Storage Capacity of Khlong Tha Dan Reservoir

Figure 3-5-5 Geological Map of Project Area

Figure 3-5-6 Proposed Area of No. 1 Dam Materials

Table of catchment area		
Khlong Tha Dan	(NO.1 Dam + NO.2 Dam)	152.7 km²
"		16.4 "
Huai Som Phung		70.0 "
Huai Nong Rong		74.3 "
Other		11.9 "
Total		325.3 "

ΣC.A. = 325.3km²

No.1 P.S. 50,000KW

No.2 P.S. 10,000KW

NAKHON NAYOK

PRACHIN BURI

Prachantakam

Pak Phli

Maenam Nakhon Nayok

BANGKOK

Bangkok

Khlong Tha Dan Proj. Sc.

Phnom Penh

Saigon

Kota Bharu

Singapore

BURMA

CHINA

THAILAND

CAMBODIA

MALAYA

SUMATRA

BORNEO

ANDAMAN SEA

GULF OF SIAM

SOUTH CHINA SEA

KEY MAP

0 5 10 15 20km

LEGEND

- Road
- Railway Track
- Town
- Capital City of Province
- Pumping up area

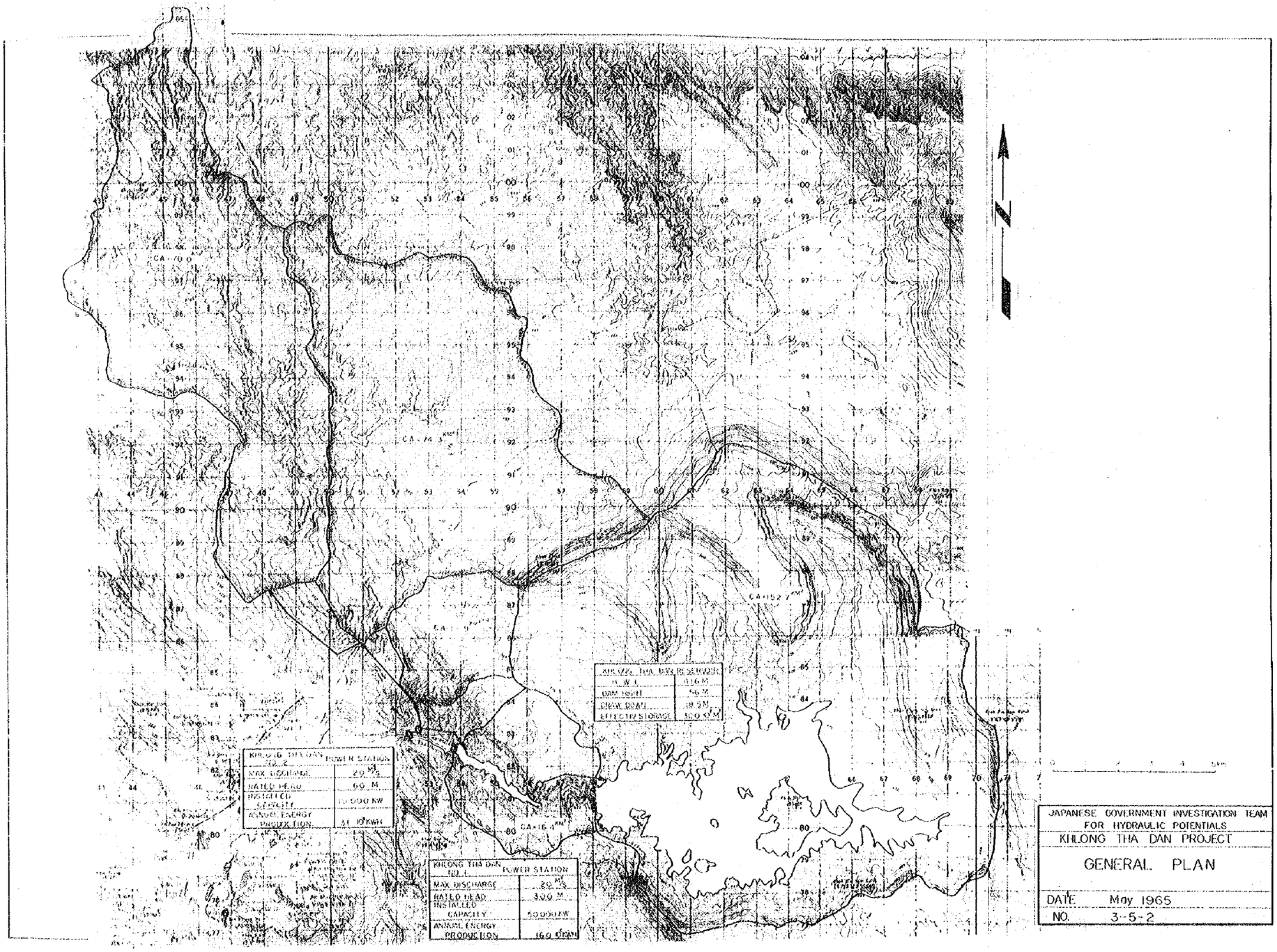
JAPANESE GOVERNMENT INVESTIGATION TEAM FOR HYDRAULIC POTENTIALS

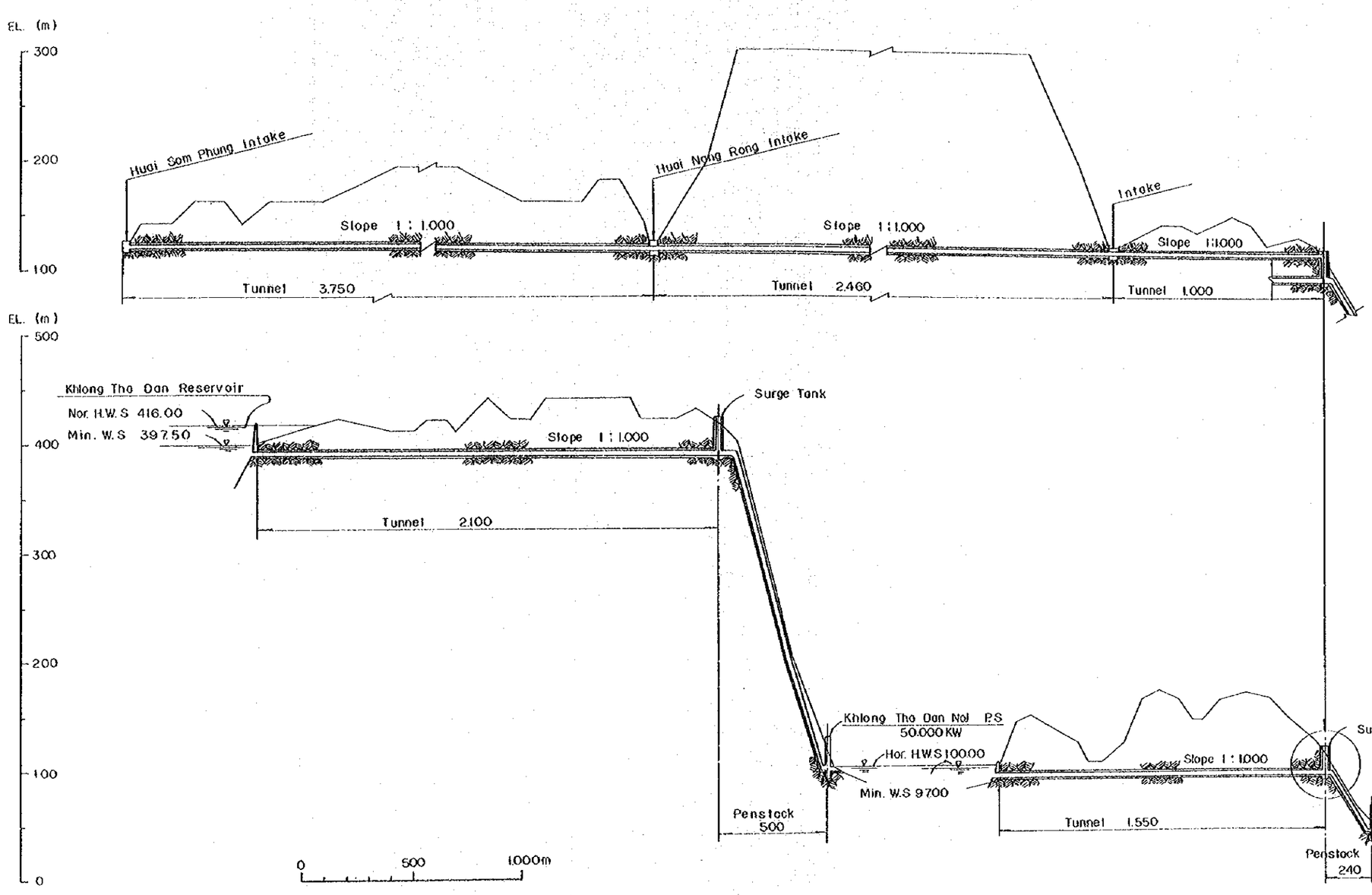
KHLONG THA DAN PROJECT

LOCATION MAP

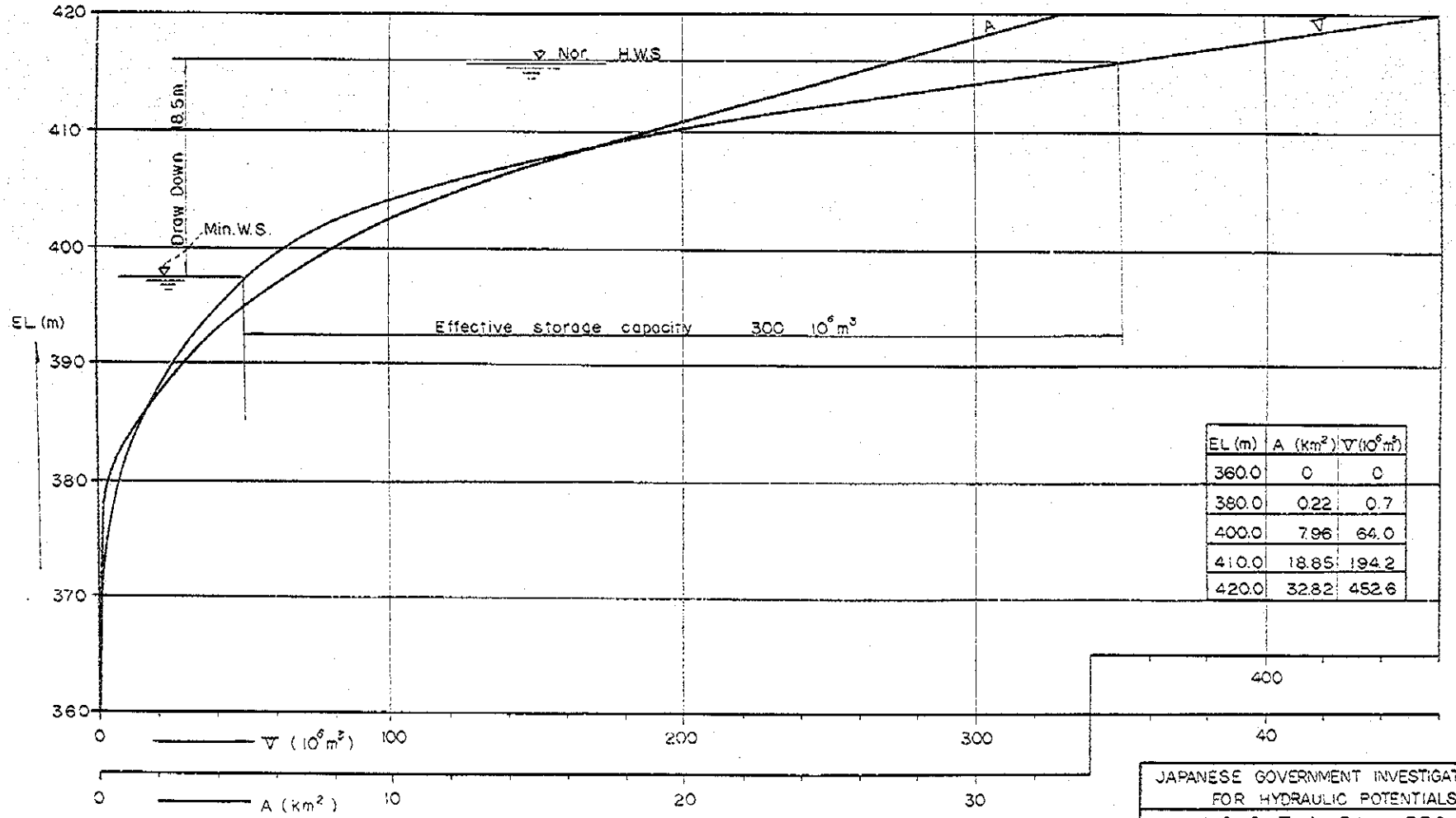
DATE May 1965

NO. 3-5 1


N
KHLONG THA DAN NO. 2 POWER STATION
MAX. DISCHARGE 20 m³/s
RATED HEAD 60 M.
INSTALLED CAPACITY 10,000 KW
ANNUAL ENERGY PRODUCTION 31 10⁶KWH
KHLONG THA DAN RESERVOIR
N.W.L. 110 M.
DAM HEIGHT 56 M.
CREST LENGTH 1,820 M.
EFFECTIVE STORAGE 100 10⁶M³
KHLONG THA DAN NO. 1 POWER STATION
MAX. DISCHARGE 20 m³/s
RATED HEAD 300 M.
INSTALLED CAPACITY 50,000 KW
ANNUAL ENERGY PRODUCTION 160 GWH
JAPANESE GOVERNMENT INVESTIGATION TEAM FOR HYDRAULIC POTENTIALS
KHLONG THA DAN PROJECT
GENERAL PLAN
DATE May 1965
NO. 3-5-2



JAPANESE GOVERNMENT INVESTIGATION TEAM FOR HYDRAULIC POTENTIALS	
KHLONG THA DAN PROJECT	
PROFILE OF THE PROJECT	
DATE	May 1965
NO.	3-5-3



EL (m)	A (km^2)	▽ ($10^6 m^3$)
360.0	0	0
380.0	0.22	0.7
400.0	7.96	64.0
410.0	18.85	194.2
420.0	32.82	452.6

Note. Prepared using U. S. Army Map Service map (S = 1/50,000)

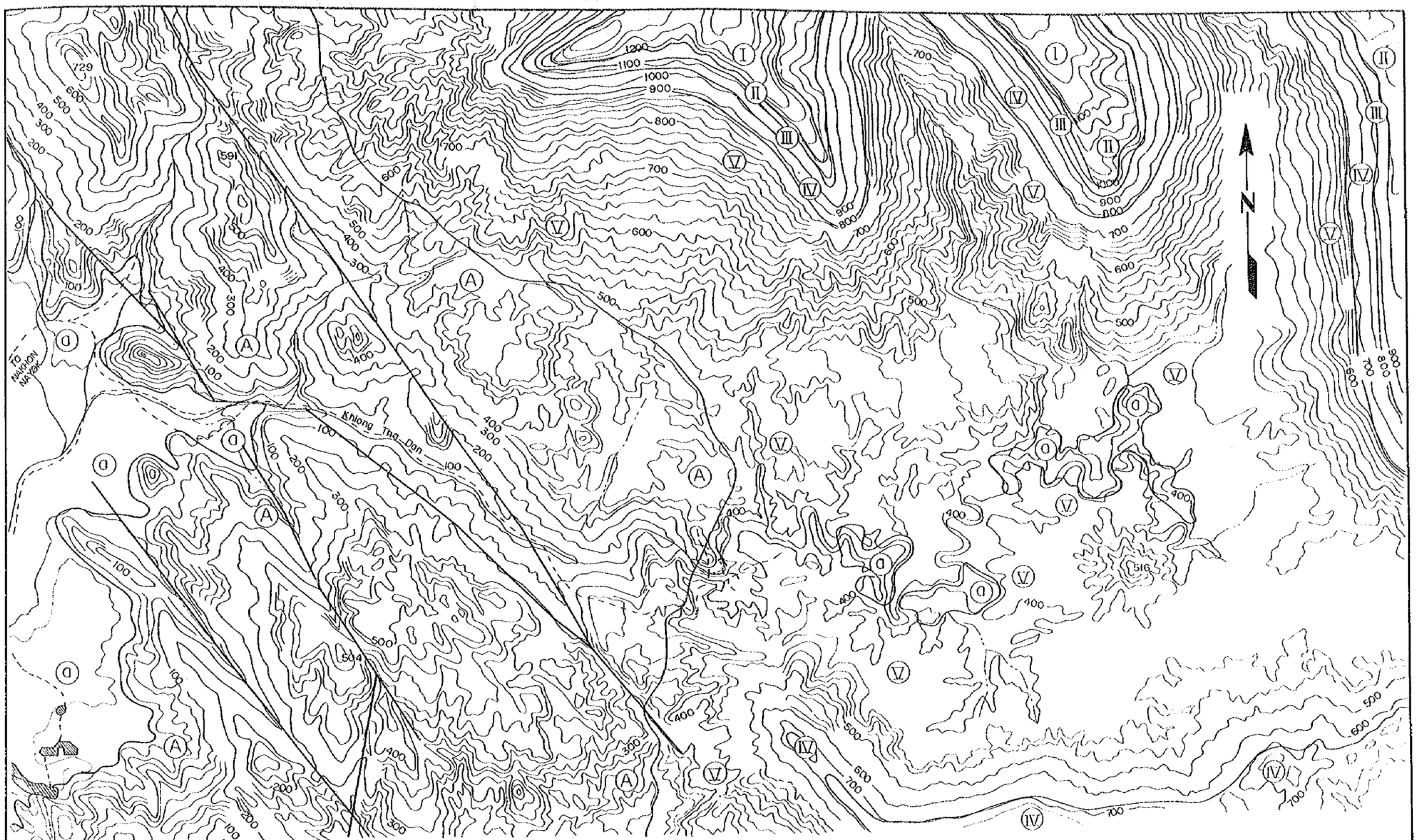
JAPANESE GOVERNMENT INVESTIGATION TEAM FOR HYDRAULIC POTENTIALS

KHLONG THA DAN PROJECT

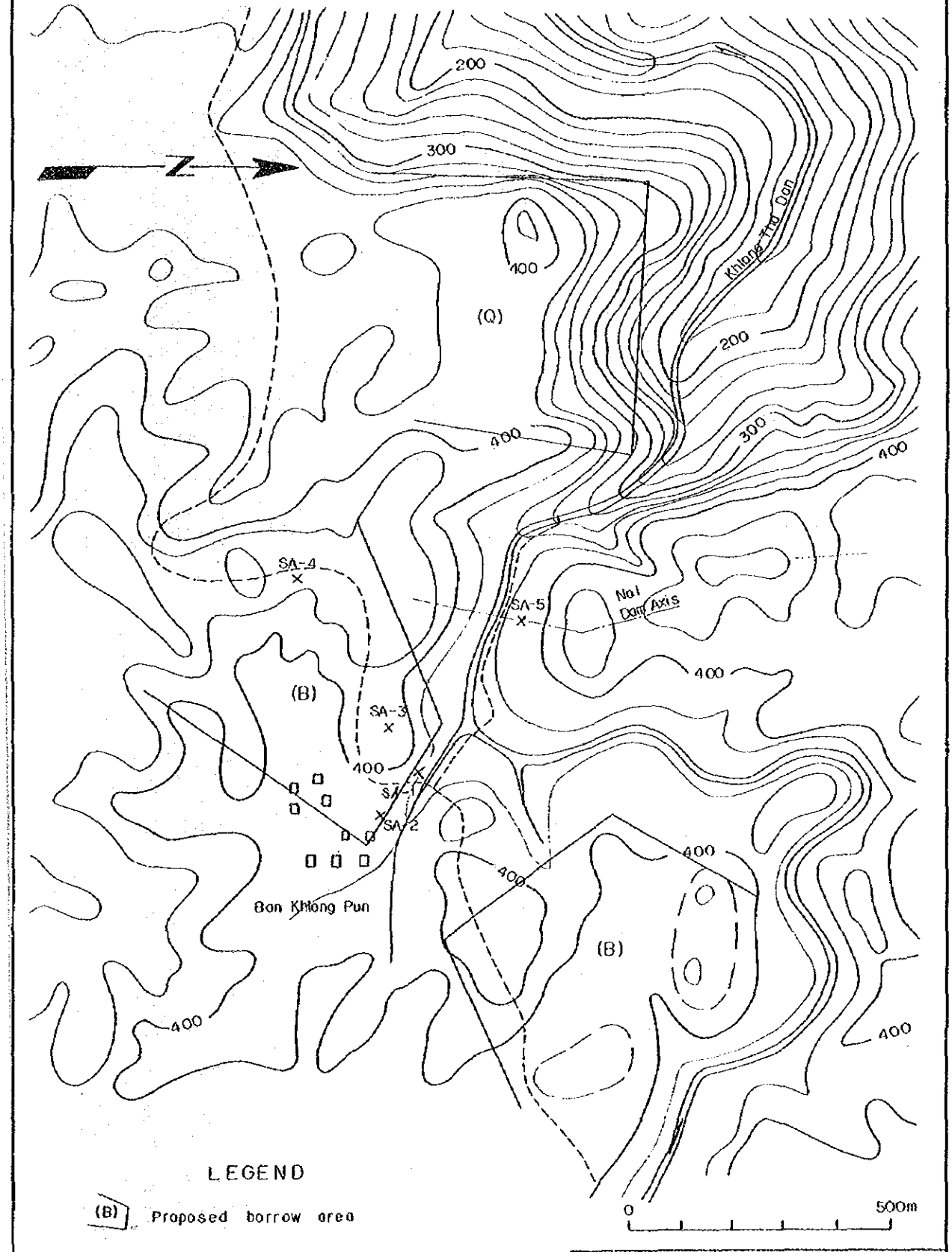
SURFACE AREA AND STORAGE CAPACITY OF KHLONG THA DAN RESERVOIR

DATE May 1965

NO. 3-5-4



Note: This map is mostly drawen up by Photo geological interpretation.



LEGEND

(B) Proposed borrow area

(Q) Proposed quarry area

× Locality of sampling for core material

Reconnaissance course

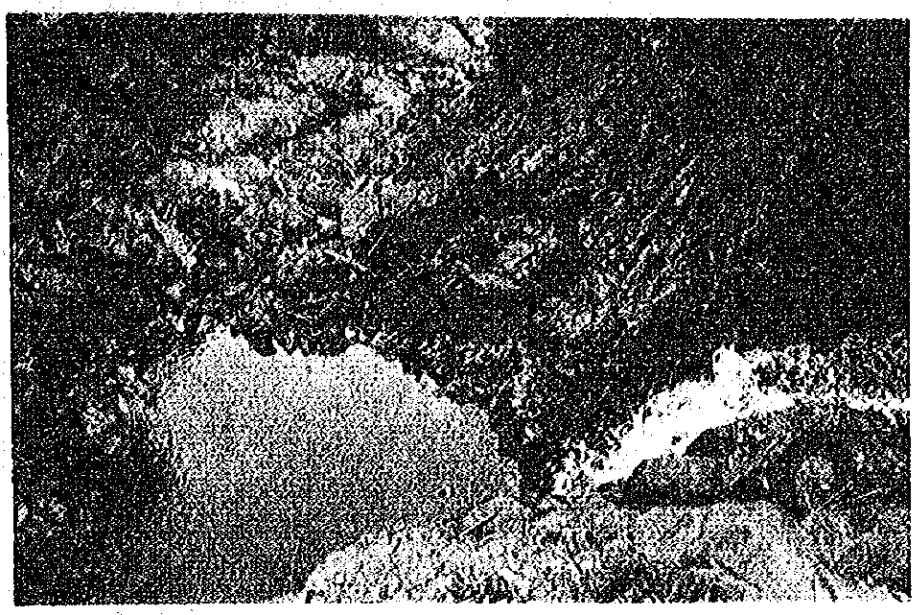
JAPANESE GOVERNMENT INVESTIGATION TEAM FOR HYDRAULIC POTENTIALS
KHLONG THA DAM PROJECT
PROPOSED AREA OF No. I DAM MATERIALS
DATE May-1965
NO. 3-5-6

Photo—1

Downstream view of Khlong Tha Dan №1 Dam site(right bank)

Photo—2

Downstream view of Khlong Tha Dan №1 Dam site(lift bank)



Photo—3

Waterfall downstream of Khlong Tha Dan No.1 Dam site (viewed into downstream)