CHAPTER I

INTRODUCTION

The Chiew Larn Multipurpose Dam Project across Khlong Saeng in Amphoe Ta Khun, Changwat Surat Thani, southern Thailand, a major Tapi-Phum Duang water resource development project of the Electricity Genearating Authority of Thailand (EGAT), when being completed will provide the flood control, irrigation water and hydro-power for the electricity generation, together with the fishery enhancement and recreation area. The dam project is composed of several main and subordinate structures (Table 1.1). The main dam is a zoned earth-and rockfilled structure. Other structures (Figure 1.1) include 2 saddle dams and 3 dikes along the right (western) prolongation of the maindam axis and a depression dam on the left (eastern) side. A 4-radial gated spillway on the right side provide a measure for the extreme flood and any emergency condition. In an early stage, a horse-shoe-shaped, concrete-lined diversion tunnel (Figure 1.2) with the upstream and downstream cofferdams will be constructed to diverse the stream water from the construction site. The tunnel will be plugged later for the water impoundment. For the hydroelectricity generation, another steel-lined power tunnel will be constructed to provide a water passage to the power house to be installed on the right down-stream river bank from the main damsite.

Table 1.1 Principal features of Chiew Larn project

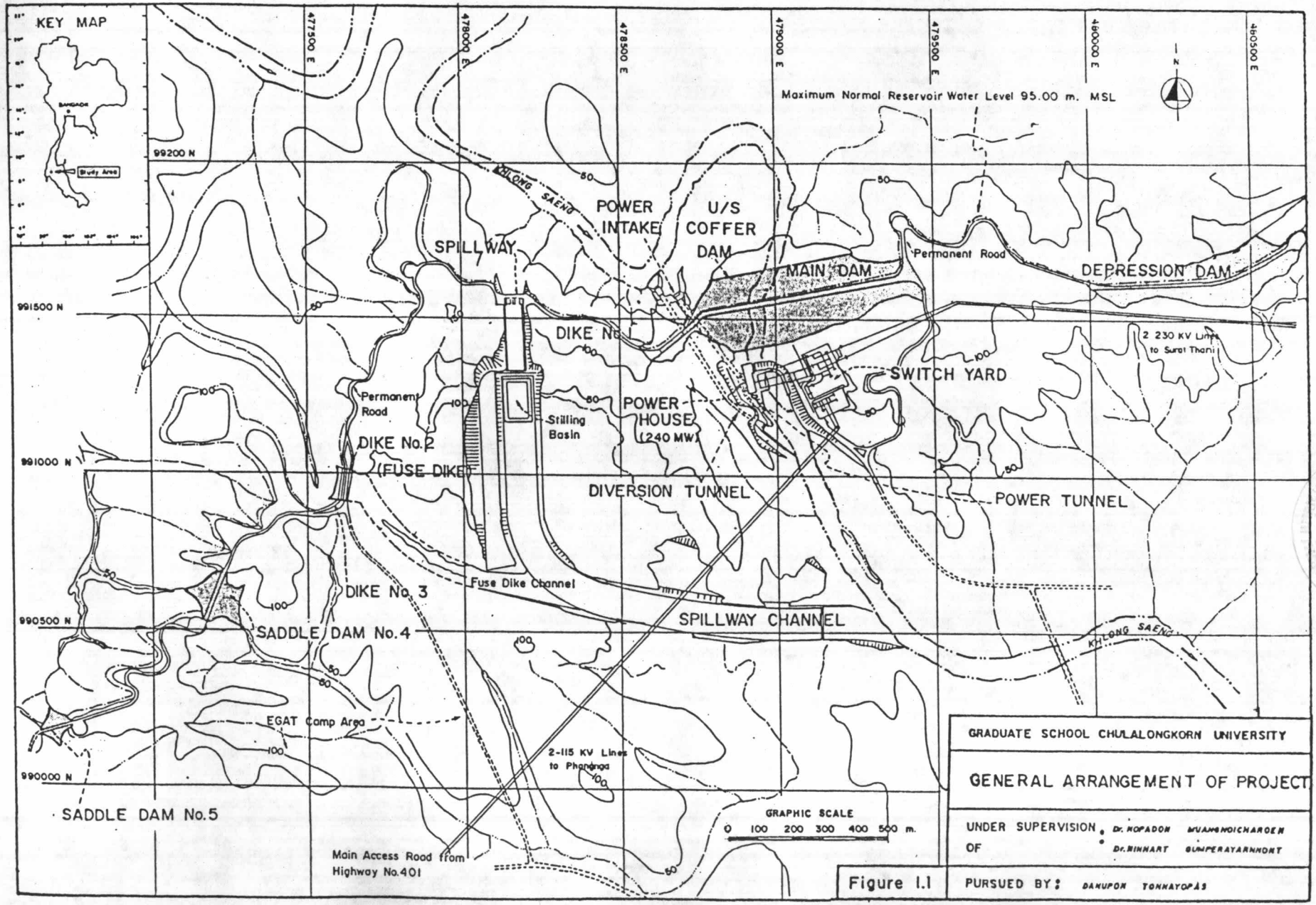
Location	: on Khlong Saeng River at Ban Chiew Larn, Tambon Khao Phang, Amphoe Ta Khun, Changwat Surat Thani or at about Lat. 8° 58'N and Long. 98° 47'E
Purpose	: Hydro-power, irrigation, flood control, fishery and recreation
Reservoir	
Drainage area	: 1,435 km^2
Average Natural Inflow	: 3,057 MCM/Year or 96.9 m^3/s
Max. Normal WS El.	: 95,00 m
Min. Normal WS El.	: 62,00 m
Storage at Max. WS El. 95.00	: 5,640 MCM
Storage at Min. WS El. 62.00	: 1,440 MCM
Active Storage	: 4,200 MCM
Reservoir Area at Max. WS El. 95.00	: 165 km^2
Average Regulated Cutflow	: 3,030 MCM/Year
Max. Exceptional WS El. :	
1,00-Year flood	: 96.80 m
PHF	: 97.70 m
PMF, all gates closed	: 98.65 m
Main and Auxiliary Dams	
Crest El.	: 100.00 m
Type	: Clay-Core Rockfill
Main Dam:	
Crest Length	: 730 m
Max. Hight on River bed	: 95 m
Total Volume (including Cofferdam)	: 6,500,000 m^3
Left Depression Dam:	
Crest Length	: 660 m
Max. Height	: 51 m
Total Volume	: 1,450,000 m^3
Saddle Dam No.4:	
Crest Length	: 160 m
Max. Height	: 26 m
Total Volume	: 125,000 m^3
Saddle Dam No.5	
Crest Length	: 180 m
Max. Height	: 25 m
Total Volume	: 200,000 m^3
River Diveration	
Recurrence Interval of Design Flood	: 100 Years
Peak Flow of Design Flood	: 2,230 m^3/s
Upstream Cofferdam:	
Crest El.	: 44.00 m
Total Volume	: 535,000 m^3

Table 1.1 (Cont.)

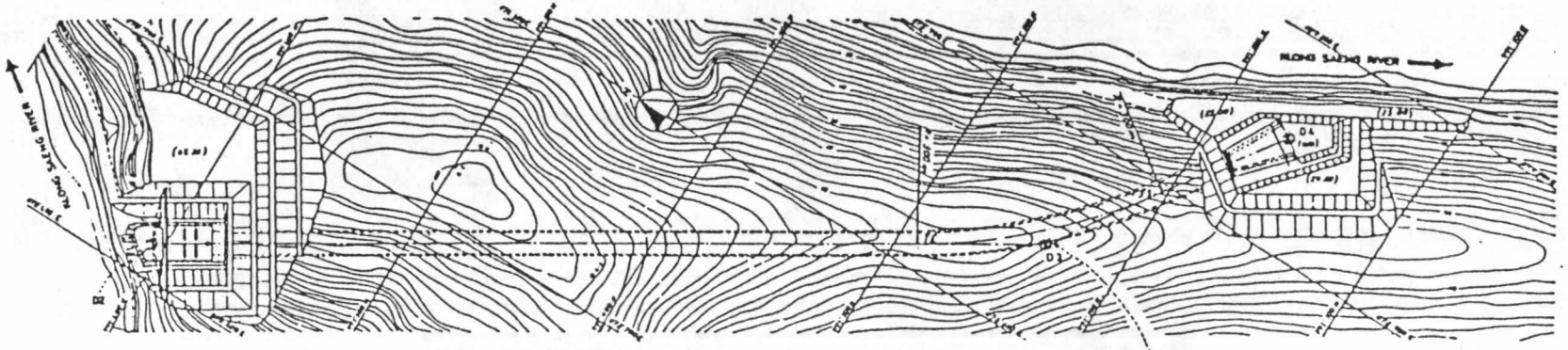
Max. WS El. for design flood	: 43.35 m
Diversion Tunnel, Concrete Lined:	
Diameter	: 10.00 m
Length	: 500 m
Routed Design Flow at WS El. 43.35	: 1,275 m^3/s
Downstream Cofferdam:	
Crest El.	: 19.00 m
Total Volume	: 15,000 m^3
Gated Spillway	
Design Flood	: PMF
PMF Peak Flow	: 5,300 m^3/s
1,000-Year Flood Peak	3,900 m^3/s
Radial Cates (Four):	
Width	: 10.00 m
Height	: 8.00 m
Gate Sill El.	: 87.50 m
Gate Top El.	: 95.50 m
Discharge Capacity:	
At WS El. 95.00	: 1,650 m^3/s
At WS El. 96.80	: 2,250 m^3/s
At WS El. 97.70	: 2,700 m^3/s
Fuse Dikes (Dike No.2 and Dike No.3)	
Sill El.	: 91.50 m
Crest El.	
No. 2	: 97.00 m
No. 3	: 97.50 m
Crest length	
No. 2	: 70.00 m
No. 3	: 50.00 m
Total Discharge Capacity:	
At WS El. 97.70	: 1,700 m^3/s
At WS El. 98.65	: 4,300 m^3/s
Irrigation Outlet	
Location	: Through Diversion Tunnel Plug
Pressure Conduit	
Diameter	: 1.40 m
Length	: 30.00 m
Main Value, Howell-Bunger Type:	
Diameter	: 1.40 m
Safety Valve, Ring Follower Gate Type	
Diameter	: 1.40 m
Discharge Capacity at Res. WS El. 62.00	: 10.00 m^3/s

Table 1.1 (cont.)

Power Intake	
Wheel Gates (two):	
Width	: 4.20 m
Height	: 10.00 m
Sill El.	: 44.00 m
Trashracks Gross Area	: 500 m^2
Power Tunnel (Penstook)	
Steel Lined:	
Diameter	: 11.20 m
Length	: 280 m
Design Flow	: 364.5 m^3/s
Powerhouse	
Tailwater Level:	
Max./Min.	: 15.00/11.00 m
Gross Head:	
Max./Min.	: 83.10/46.20 m
Net Head:	
Max./Min.	: 83.10/46.20 m
Design Flow	: 364.5 m^3/s
Installed Capacity	: 240 (3 x 80) MW
Quaranteed Capacity at Min. Head	: 117 MW
Annual Generating:	
Primary	: 484 GWh
Average	: 554 GWh
Average Plant Factor	: 0.25
Turbines	: Three Francis Vertical Axis
Rated Capmoity	: 80 MW
Design Head	: 73.00 m_3
Design Flow	: 121.5 m^3/s
Specific Speed	: 233.3 rpm
Synchronous Speed	: 176.0 rpm
Runaway Speed	: 331.0 rpm
Normal Max. Speed Rise	: 45 percent
Runner Diameter	: 3.65 m
Generator (three)	
Rated Capacity	: 88.9 NVA
Power Factor	: 0.9
Synchronous Speed (50 Hz)	: 176.0 rpm
Fly-wheel Effect	: 7,350 tm^2
Rated Voltage	: 13.8 KV
Main Transformers (three phase)	
Rated Capacity	: 90 MVA
Output Voltage	: 230 KV


KEY MAP
BANGKOK
Study Area
477500 E
478000 E
478500 E
479000 E
479500 E
480000 E
480500 E
Maximum Normal Reservoir Water Level 95.00 m. MSL
N
99200 N
KHLONG SAENG
POWER INTAKE
U/S COFFER DAM
SPILLWAY
MAIN DAM
Permanent Road
DEPRESSION DAM
991500 N
DIKE No.1
2 230 KV Lines to Surat Thani
SWITCH YARD
Permanent Road
POWER HOUSE (240 MW)
Stilling Basin
DIKE No.2 (FUSE DIKE)
991000 N
DIVERSION TUNNEL
POWER TUNNEL
Fuse Dike Channel
DIKE No.3
990500 N
SADDLE DAM No.4
SPILLWAY CHANNEL
KHLONG SAENG
EGAT Camp Area
2-115 KV Lines to Phanom
990000 N
SADDLE DAM No.5
GRAPHIC SCALE
0 100 200 300 400 500 m.
Main Access Road from Highway No.401
GRADUATE SCHOOL CHULALONGKORN UNIVERSITY
GENERAL ARRANGEMENT OF PROJECT
UNDER SUPERVISION OF
Dr. NOPADON MUANGNOICHAROEN
Dr. RINNART SUMPERAYARNNONT
Figure 1.1
PURSUED BY: DANUPON TONNAYOPAS

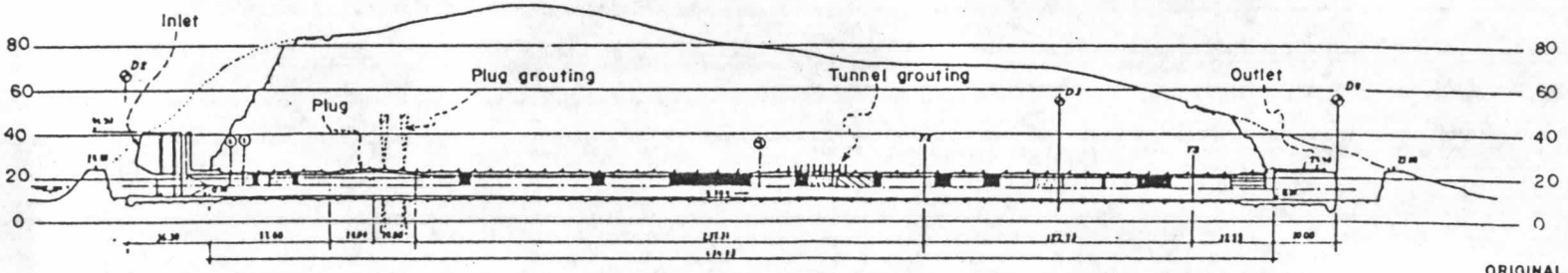
PLAN



① EXTENSOMETER SECTION 1 (5 SET) AT STATION 0.56
① EXTENSOMETER SECTION 2 (3 SET) AT STATION 0.47

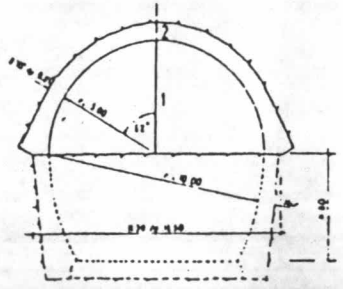
Δ = 11° 46'
R = 300 m
T = 62.19 m
D = 117.33 m

LONGITUDINAL PROFILE

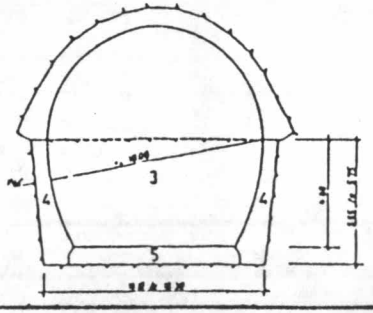


CONSTRUCTION METHOD (INDICATIVE ONLY)

TOP HEADING



BENCHING



1 Excavation
2 Concrete lining
3 Excavation
4 Wall lining
5 Floor lining

LEGEND

- TYPE 1 UNSUPPORT
- TYPE 2 WIRE MESH AND REINFORCE SHOTCRETE
- TYPE 3 STEEL RIB
- TYPE 4 ROCK BOLTS
- TYPE 5 ROCK BOLTS AND WIRE MESH

ORIGINAL GRAPHIC SCALE

0 20 40 60 80 100 m

GRADUATE SCHOOL CHULALONGKORN UNIVERSITY

PLAN AND PROFILE OF DIVERSION TUNNEL

UNDER SUPERVISION OF : Dr. ROPADOL MUANGNOICHAROEN
Dr. BENNART SUWANTARATHORN

Figure 1.2

PURSUED BY : DANUPON TONNAYOPAS

As a standard procedure in an engineering construction, the location and design of the structures as well as the construction techniques to be employed can be adapted from the initial plan, especially during the early stage of the project, just to suit the natural conditions, e.g. the rock types and their homogeneity, strength and elastic constants of rock specimens, geologic structures, ground-water condition, natural state of stress in the rock mass occurred at depth, etc. Thus, a geotechnical study for the lithology and engineering properties is essential. The study is to be performed as soon as the ground preparation take place, and continues until the excavation is completed. The present research is to assess the rock mass behavior using the engineering classification systems. The study result is then applied to determine the stability of the tunnel, slopes, and foundation. Once the stability is determined, a suggestion for the proper protection or ground improvement could be given.

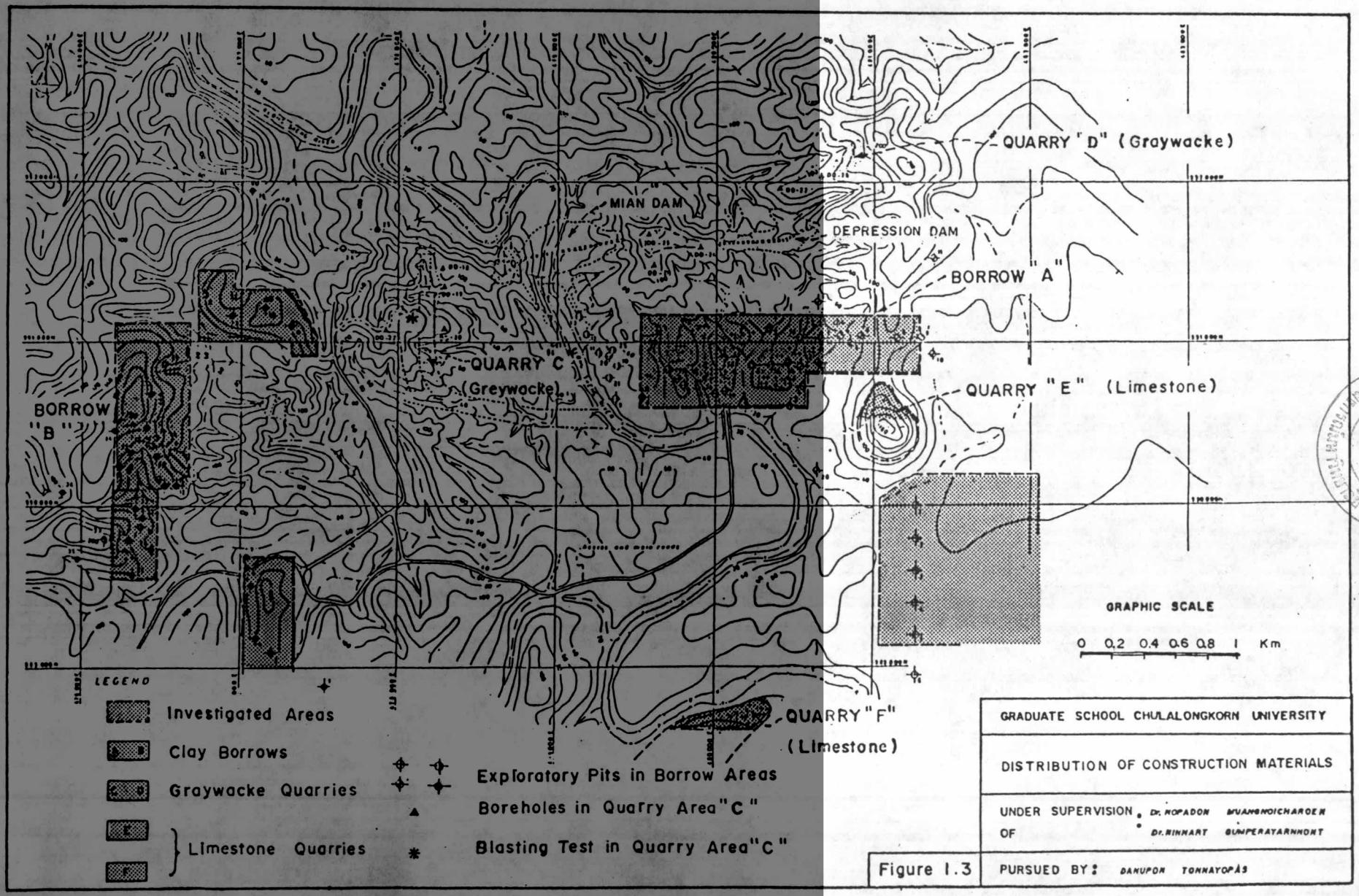
A part of the study was also devoted to the substitute construction materials in an attempt to find a sufficient supply of the suitable materials for the entire project. In the Chiew Larn Dam construction project, 3 types of construction materials are needed. They are the fine materials for the impervious clay-core of the dams, materials for the rock fill, and the concrete aggregates. The quality of the materials as well as the amount of reserves must be known for a smooth construction planning. Here, the fine materials are available as the deep tan-red, medium plastic sandy clay from the burrows over the left and right banks

of Khlong Saeng, downstream from the damsite (Figure 1.3). The rock-fill materials are the pebbly graywacke available from 2 quarries, one further on the left side of the main dam axis in the reservoir area and the other on the right side of the river, further downstream from the spillway. Besides, there is yet a small limestone hill further downstream from the project site. The hill is considered as the second source of the rock-fill materials. Unfortunately it locates too close to a community, while the reserve is rather small, and the solution cavities are extensive. These make the hill unlikely to be open-quarried except in an extreme necessity.

The resource for the concrete aggregates, however, is of a big problem. The gravels and sands from the river bed and terraces are perfectly usable, but the reserves have never been sufficient. In Thailand, the crushed limestone is used regularly in the construction works. Here in the project area the only near-by resource available is the limestone hill mentioned above. The other possible resource is perhaps the crushed pebbly graywackes to be quarried at the project site.

1.1 Purpose and Scope of Study

The present study was designed to determine the stability of the diversion tunnel. The study was also to establish a general investigation program and index properties for a similar construction project to be performed in the same area with the presumed-similar geologic condition. Furthermore, the stability of the



GRADUATE SCHOOL CHULALONGKORN UNIVERSITY	
DISTRIBUTION OF CONSTRUCTION MATERIALS	
UNDER SUPERVISION OF	Dr. NOPADON MUANGNOICHAROEN Dr. RINHART SUNPERATARNHONT
Figure 1.3	PURSUED BY: DANUPON TONNAYOPAS

portal slopes was analysed while the crushed pebbly graywackes were determined as an alternative resouroe of the concrete aggregates. The sequences of the study program were as follow.

1. To identify the characteristics of the geologic condition along the diversion tunnel and its portal slopes by mean of geotechnical logging and mapping at a scale 1:100.

2. To determine the physical, mechanical and lithological properties of the rocks found on the surfaces and at depth in the construction area, so the relationship between these properties be found and the index properties be established.

3. To assess the intact rock materials quantitative by using geological and intact- rock classifications.

4. To determine some basic physical and mechanical properties of the coarsely crushed pebbly graywackes as the concrete aggregates.

5. To assess the rock mass quality at the diversion tunnel and slope cuts of its portal by means of the engineering rock-mass classification systems.

6. To analyse the stability of the tunnel, portal slopes, and main dam foundation using the gathered knowledge.

The flow charts of the present research are enclosed as Figures 3.2 to 3.10.

1.2 Location and Accessibility

The project area is located in Ban Chiew Larn, Tambon Khao Phang, Amphoe Ban Ta Khun, Changwat Surat Thani in southern Thailand at the latitude 8 ° 58 ' N and longitude 98 ° 47 ' E. It is covered in the 1:50,000 scale topographic map sheet 4726 I series L7017, Amphoe Phanom.

The area is reached via Highway 401 which joins Phunphin to Ta Kua Pa (Figure 1.4). At Km 67 + 700, there is a side road leading northward to the site which is 14 Km away. The highway and access road are asphaltic-pavement.

1.3 Climate

The Khlong Saeng basin is in the tropical rainy climate with the maximum precipitation in October, average 20.9 rainy day per month and 346.8 mm, and the minimum, average 2.7 rainy day and 13.2 mm, in February. The mean annual rainfall is 1,755.3 mm and the mean annual evaporation is 750.1 mm.

The peninsular is also characterised by a small seasonal variation of the temperature and relative humidity. The mean annual temperature is 26 ° C in December to 29 ° C in April with the mean maximum temperature of 29 ° C in August to 35 ° C in April and the minimum temperature of 20 ° C in February to 24 ° C in May. The regional humidity is fairly high and relatively constant all year

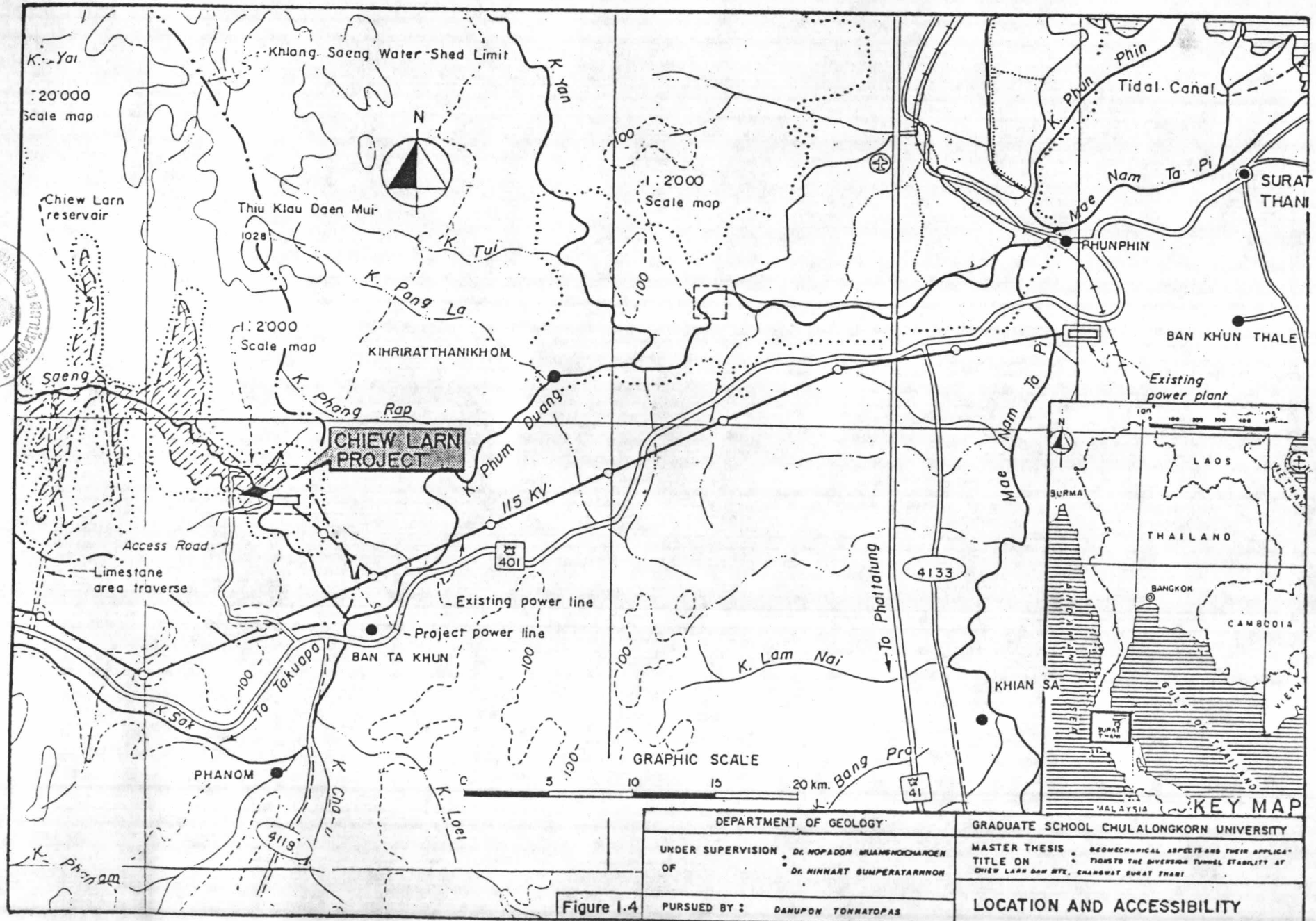

K. Yai
1:20,000
Scale map
Khlong Saeng Water Shed Limit
K. Yan
N
Chiew Larn
reservoir
Thiu Klau Daen Mui
1028
K. Tui
K. Pang La
1:2000
Scale map
KIHRIRATTHANIKHOM
K. Saeng
K. Phong Rap
CHIEW LARN
PROJECT
K. Phum Duang
115 KV.
Access Road
Limestone
area traverse
401
Existing power line
Project power line
BAN TA KHUN
To Takuapa
K. Sak
PHANOM
K. Chan
K. Loei
4119
K. Phanom
100
GRAPHIC SCALE
0 5 10 15 20 km.
1:2000
Scale map
K. Phun Phin
Tidal Canal
Nam Ta Pi
Mae
SURAT
THANI
PHUNPHIN
BAN KHUN THALE
Existing
power plant
Mae Nam Ta Pi
4133
To Phattalung
K. Lam Nai
KHIAN SA
Bang Pra
41
KEY MAP
LAOS
BURMA
THAILAND
BANGKOK
CAMBODIA
GULF OF THAILAND
MALAYSIA
DEPARTMENT OF GEOLOGY
GRADUATE SCHOOL CHULALONGKORN UNIVERSITY
UNDER SUPERVISION OF : Dr. HOPADON BUAMSNOCHAROEN
Dr. HINNART SUMPERATARNNON
MASTER THESIS TITLE ON : GEOMECHANICAL ASPECTS AND THEIR APPLICATIONS TO THE DIVERSION TUNNEL STABILITY AT CHIEW LARN DAM SITE, CHANGWAT SURAT THANI
PURSUED BY : DANUPON TONNATOPAS
LOCATION AND ACCESSIBILITY

Figure 1.4

round with the range of 52.0 to 97.0 percent. The meteorological and hydrological features of Changwat Surat Thani is depicted in Figure 1.5.

1.4 Physiography

1.4.1 Topography

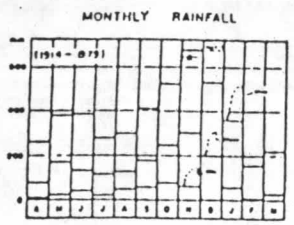
The whole region of Khlong Saeng basin, where the study area is located, consists of mostly cliff mountains, complex hills and mountain ranges of diverse relief. Almost all mountain ranges orient approximately in the north-south and northeast-southeast tending. The attitude varies from the highest elevation of Khao To Tao, 638 m above the mean sea level to the minimum elevation in the flood plain of Khlong Saeng with the average elevation of about 300 m above the mean sea level.

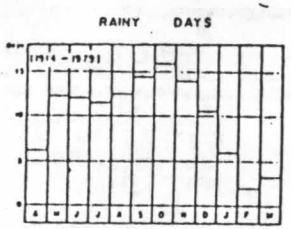
1.4.2 Drainage Pattern

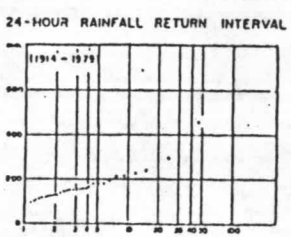
The drainage pattern within the study area is, nevertheless, more complicated. The streams of both permanent and intermitten types are apparent in various sizes. Within the immediately surrounding area of the project site there are a few important permanent streams, namely, Khlong Mui, Khlong Na Nga, Khlong Takhian and Khlong Khon Thuan. All streams flow generally southward to join Khlong Saeng.

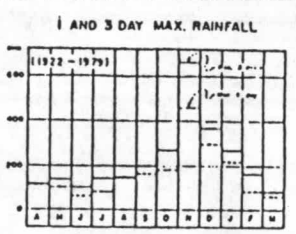
1.4.3 Vegetation

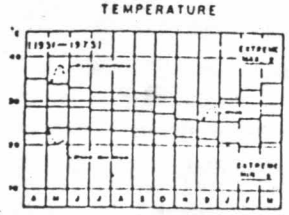
The whole study area is covered with a dense tropical rain forest. However, portions of the flood plain of Khlong Saeng

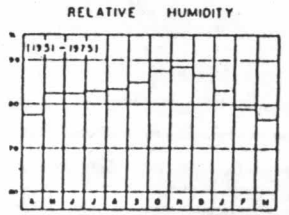


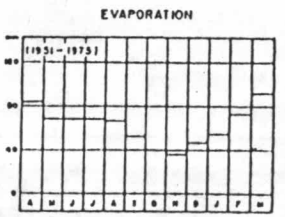


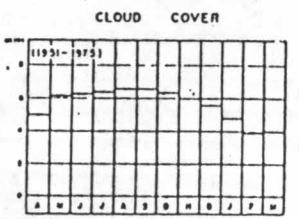


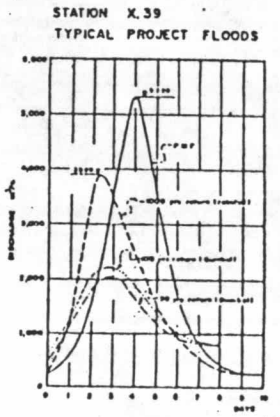


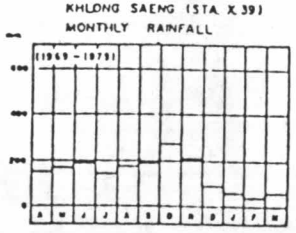


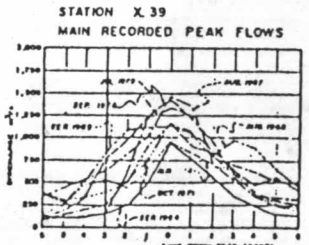


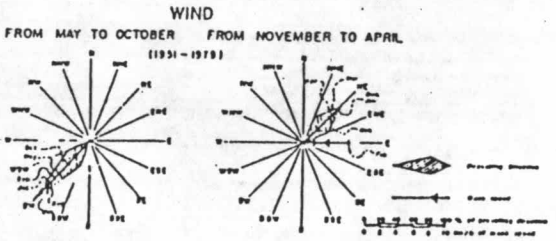


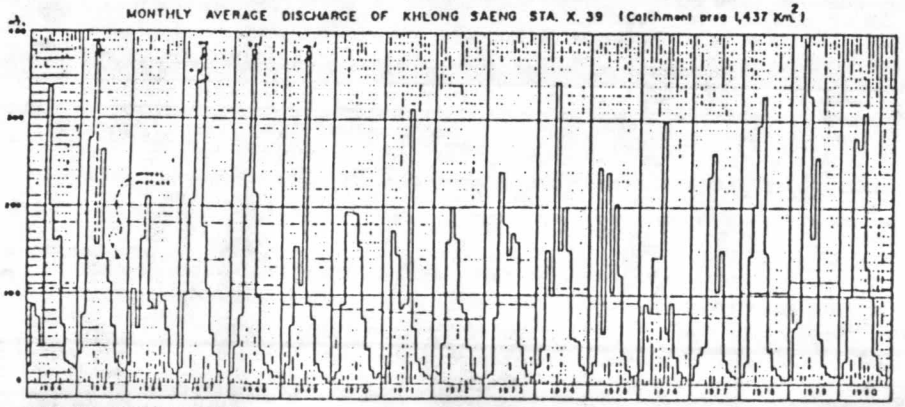


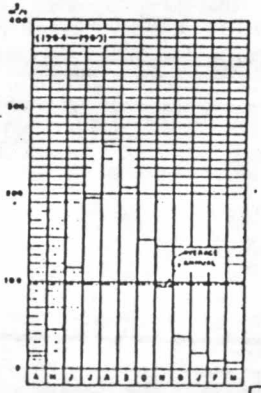












NOTES

NOTES

For location of meteorological stations

Surat Thani — No.11 Code 61031

Khlong Saeng

(Hydro. Sta. x 39) — No. 20 Code 61181

GRADUATE SCHOOL CHULALONGKORN UNIVERSITY

METEOROLOGICAL AND HYDROLOGICAL FEATURES OF SURAT THANI

UNDER SUPERVISION OF : Dr. ROPADOR MUANGNOICHAROEN
Dr. RIWBART SUTTERAYARTHORN

PURSUED BY : DAMRONG THANTOPAS

Figure 1.5

are being cultivated, mostly for the para-rubber plantations, paddy fields and various types of fruit orchards.

1.5 Previous Geological Investigations

As a very first stages of the Chiew Larn project, the preliminary investigations have been undertaken in 1971 to 1972 by the Royal Irrigation Department (RID) and the Electroconsult Co., Italy (ELC). The study was followed by the borehole drilling of 37 holes with a total hole depth of 1,997 m in 1972 to 1973.

Additionally, EGAT drilled 15 more boreholes with the trail trenches, exploratory adits, test borrow pits, blasting sites for quarry, and hydrological measurement records since 1978 to 1981 to confirm the feasibility of the project and to search for a possibility to increase the dam height from the previous design at 84 m MSL to 99.5 m MSL elevation.

Subsequently in 1981, Mantajit and his staff survey investigated the regional and structureal geology in the project area using the air-photo interpretation and the field reconnaissance. Another investigation was performed with respect to the environmental impact including the review and analysis of the known geological conditions and the determination of the probable effect on geology and mineral deposit.