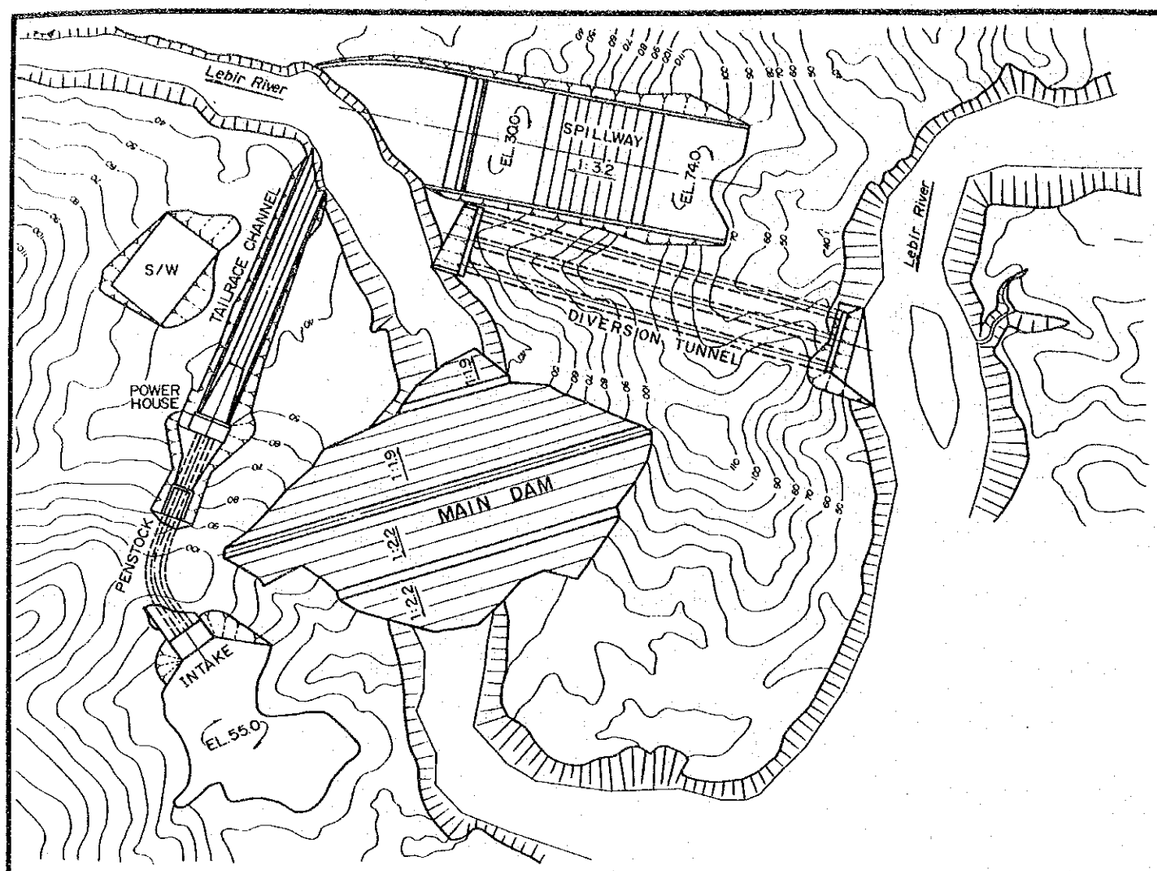
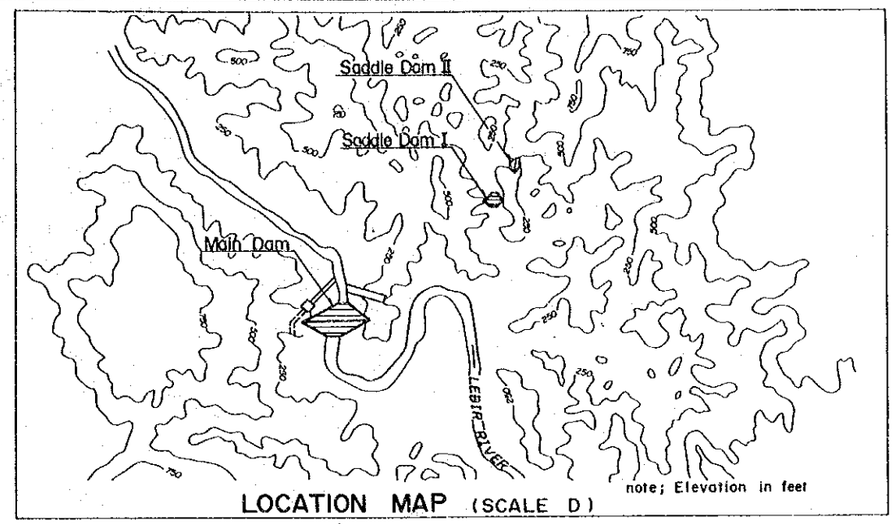
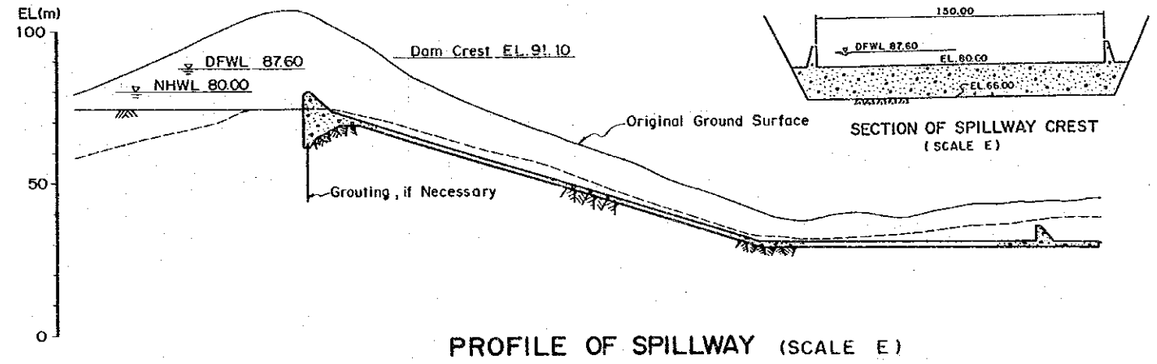


PLAN OF MAIN DAM (SCALE A)

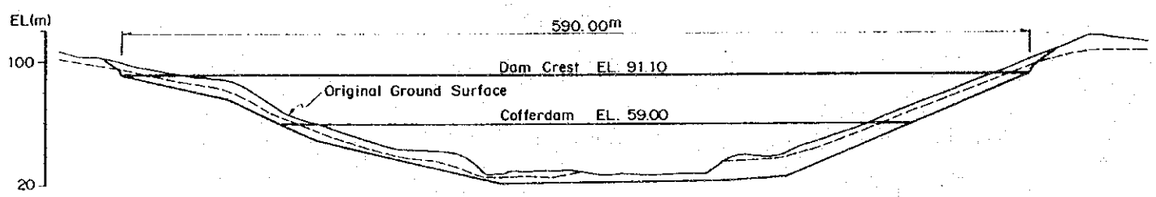


LOCATION MAP (SCALE D)

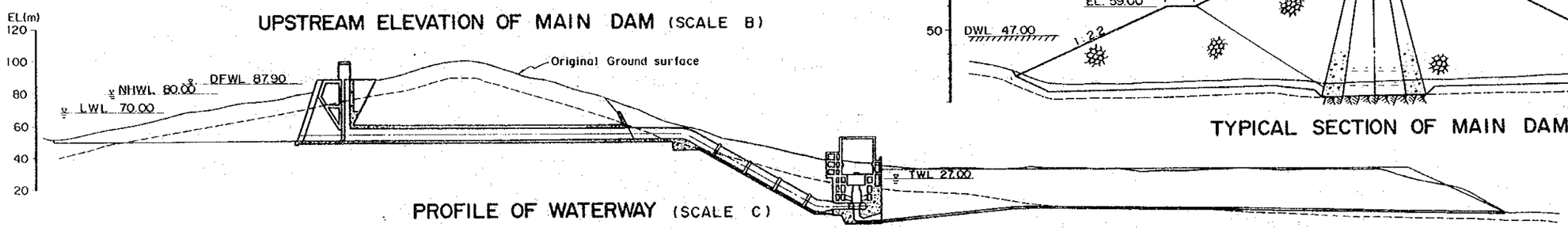


SECTION OF SPILLWAY CREST (SCALE E)

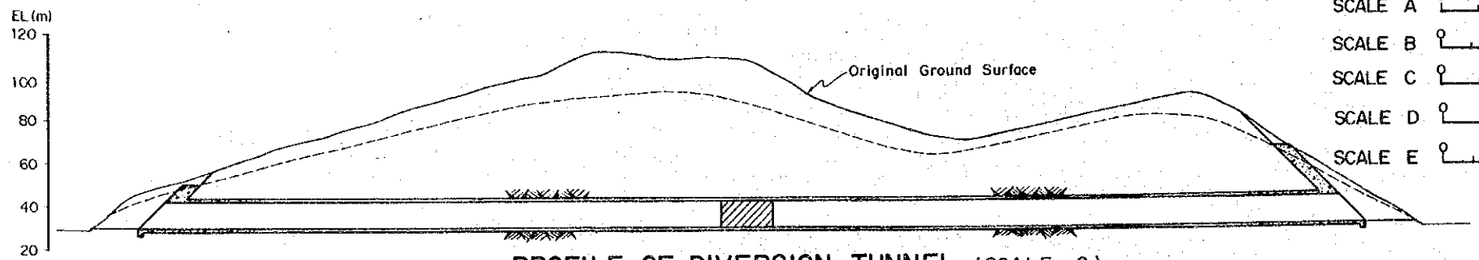
PROFILE OF SPILLWAY (SCALE E)



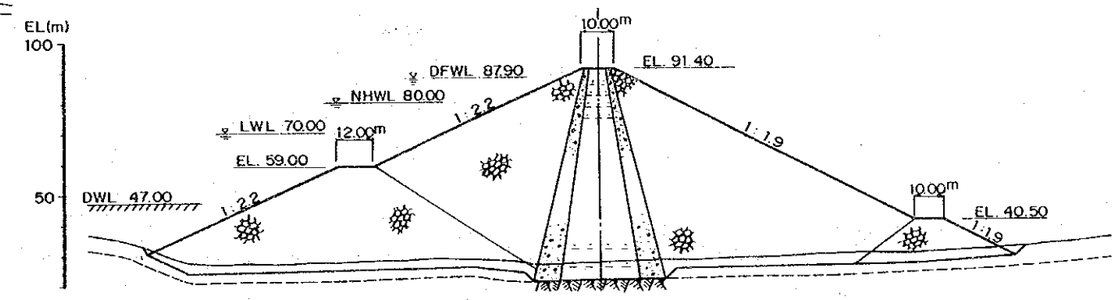
UPSTREAM ELEVATION OF MAIN DAM (SCALE B)



PROFILE OF WATERWAY (SCALE C)



PROFILE OF DIVERSION TUNNEL (SCALE C)

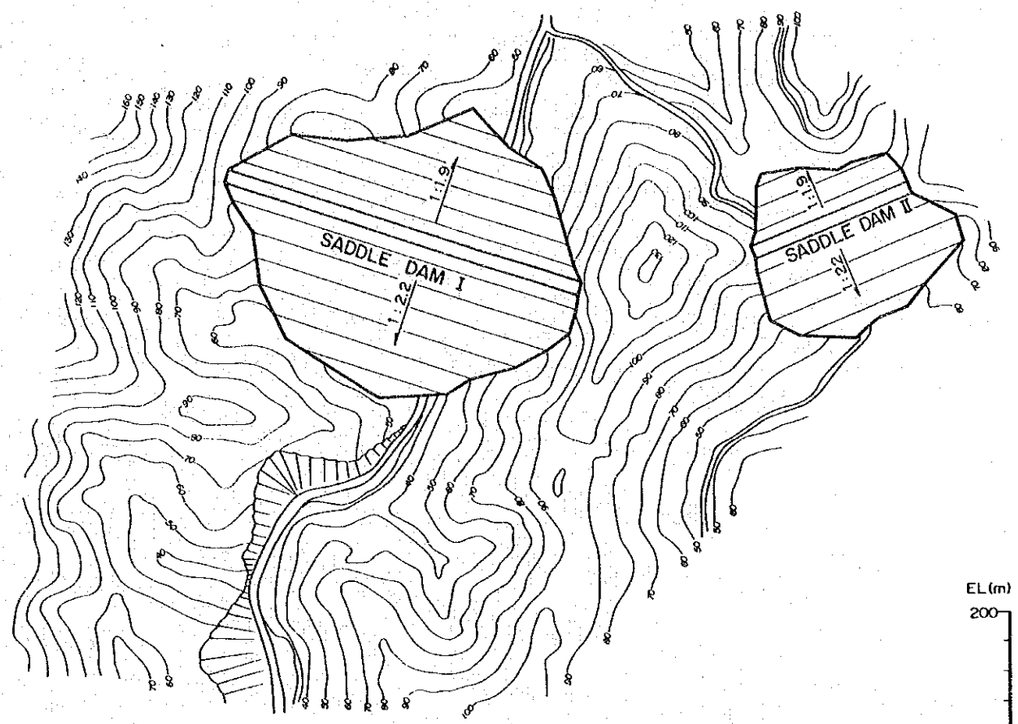


TYPICAL SECTION OF MAIN DAM (SCALE E)

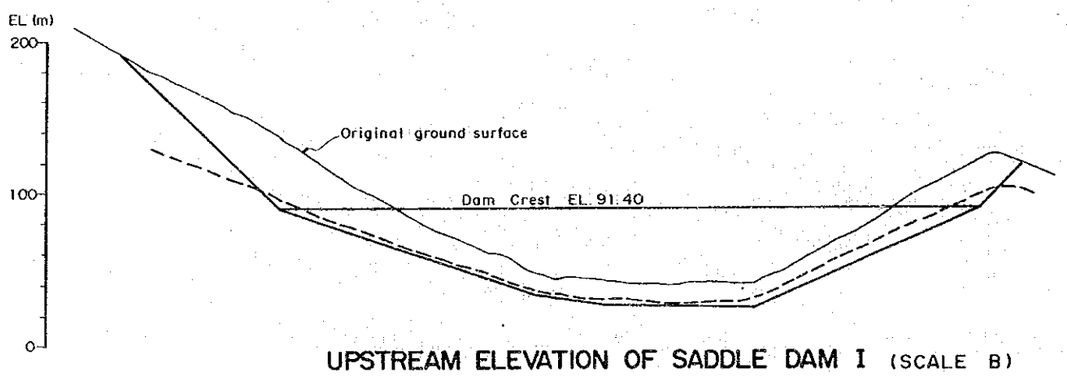
SCALE A 0 100 200 300 400(m)
SCALE B 0 100 200(m)
SCALE C 0 100(m)
SCALE D 0 1 2(km)
SCALE E 0 50 100(m)

Fig.VI.7.5
Proposed Development Plan of the Lebir Dam Sceme (1/2)

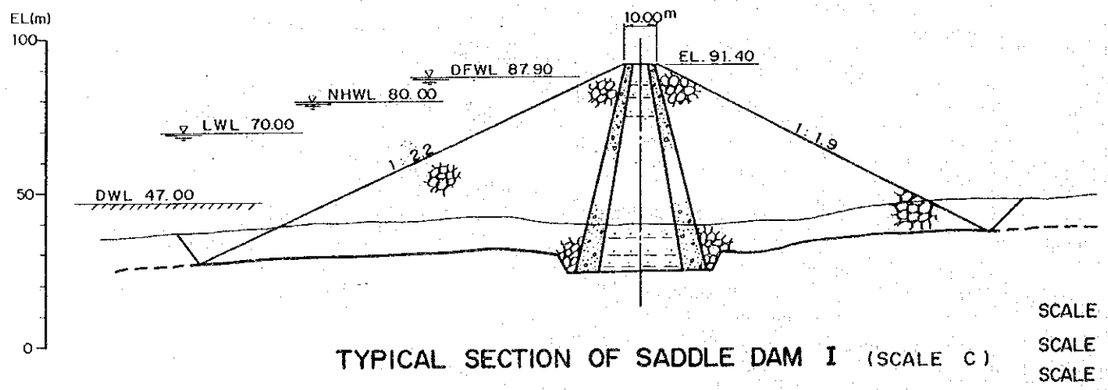
GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY



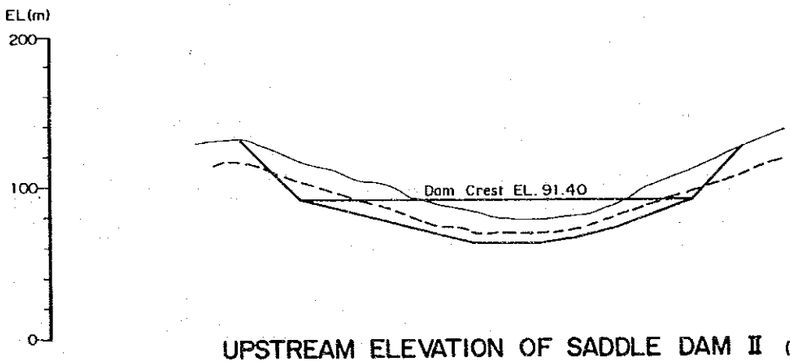
PLAN OF SADDLE DAMS (SCALE A)



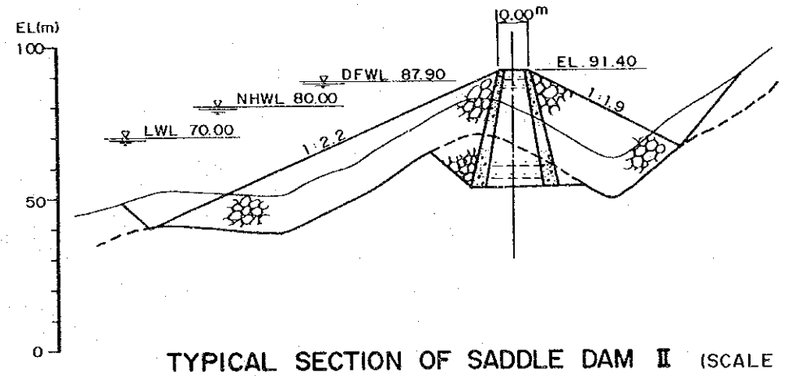
UPSTREAM ELEVATION OF SADDLE DAM I (SCALE B)



TYPICAL SECTION OF SADDLE DAM I (SCALE C)



UPSTREAM ELEVATION OF SADDLE DAM II (SCALE B)



TYPICAL SECTION OF SADDLE DAM II (SCALE B)

Fig.VI.7.5

Proposed Development Plan of the Lebir Dam Scheme (2/2)

SCALE A 0 100 200 (m)
SCALE B 0 100 200(m)
SCALE C 0 50 100 (m)

GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY

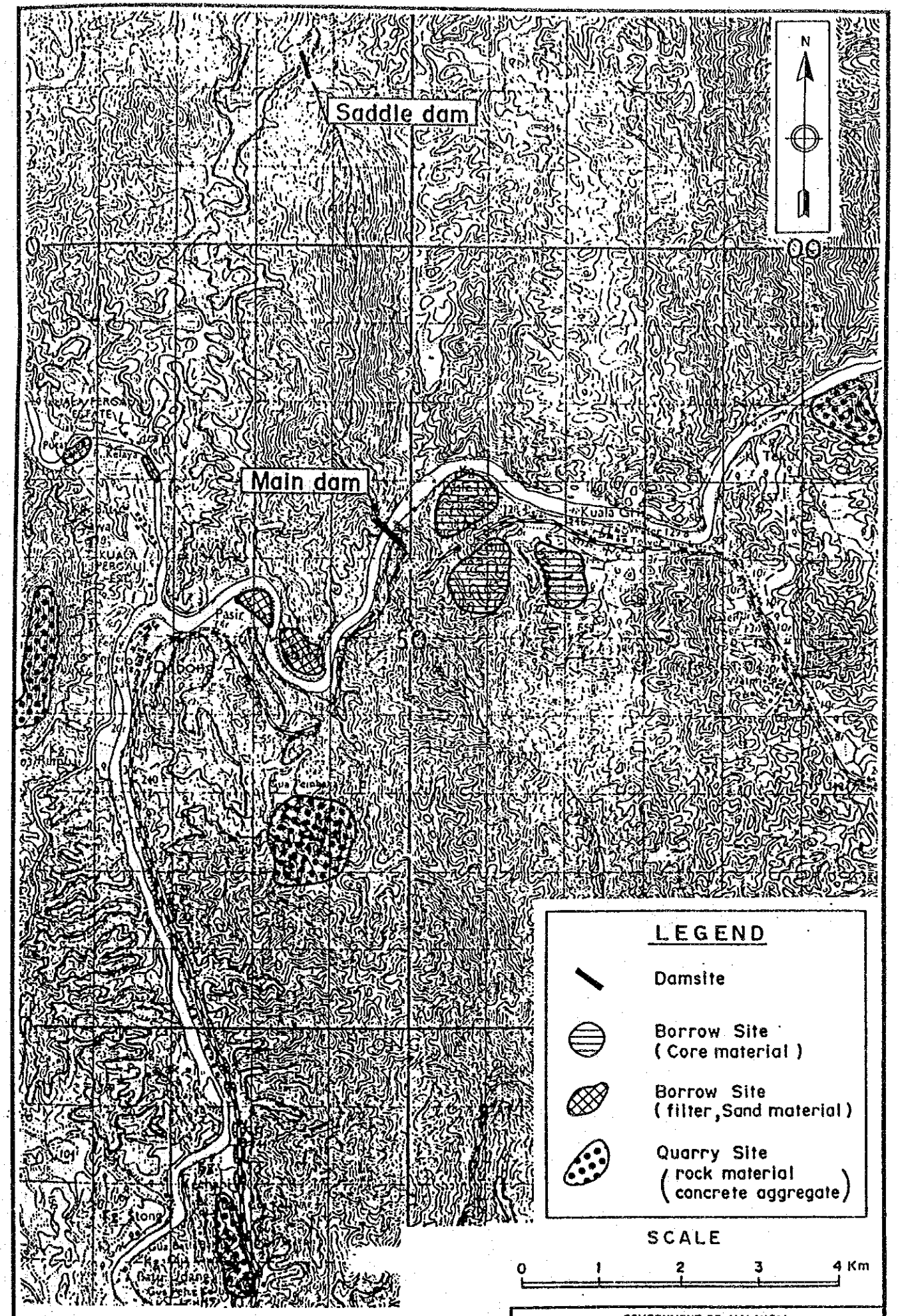


Fig.VI.7.6

Location Map of Dabong Dam

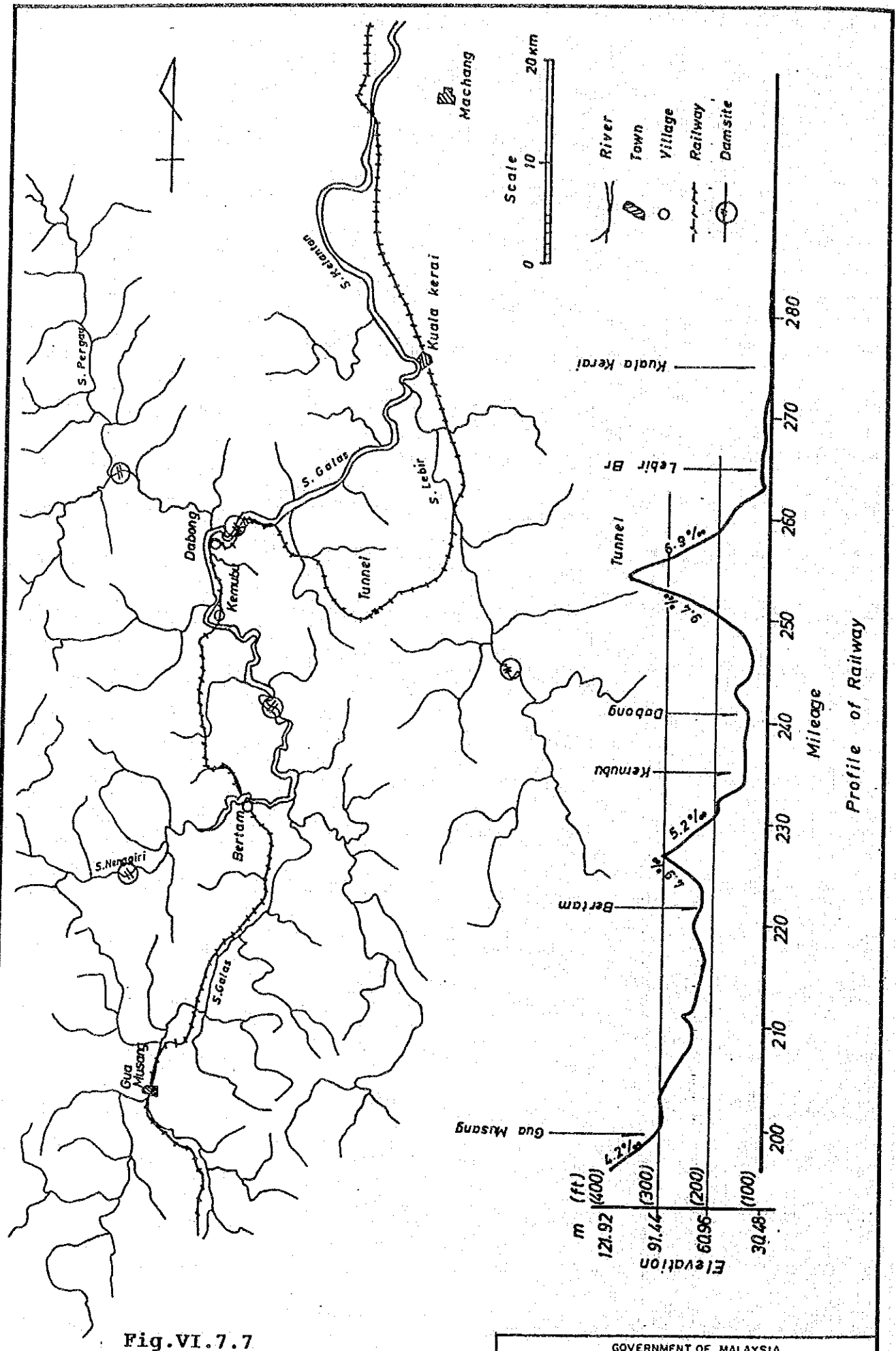
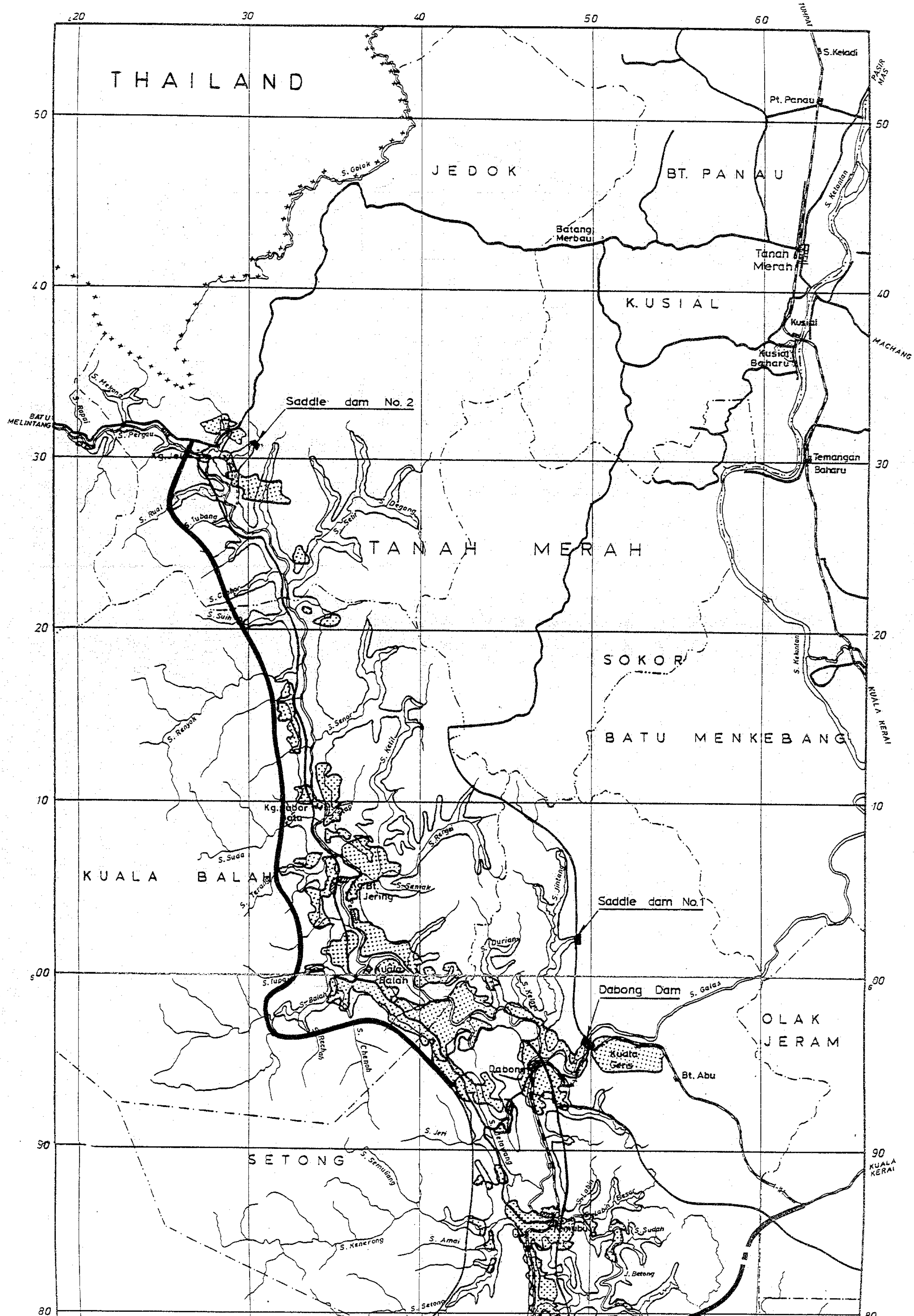
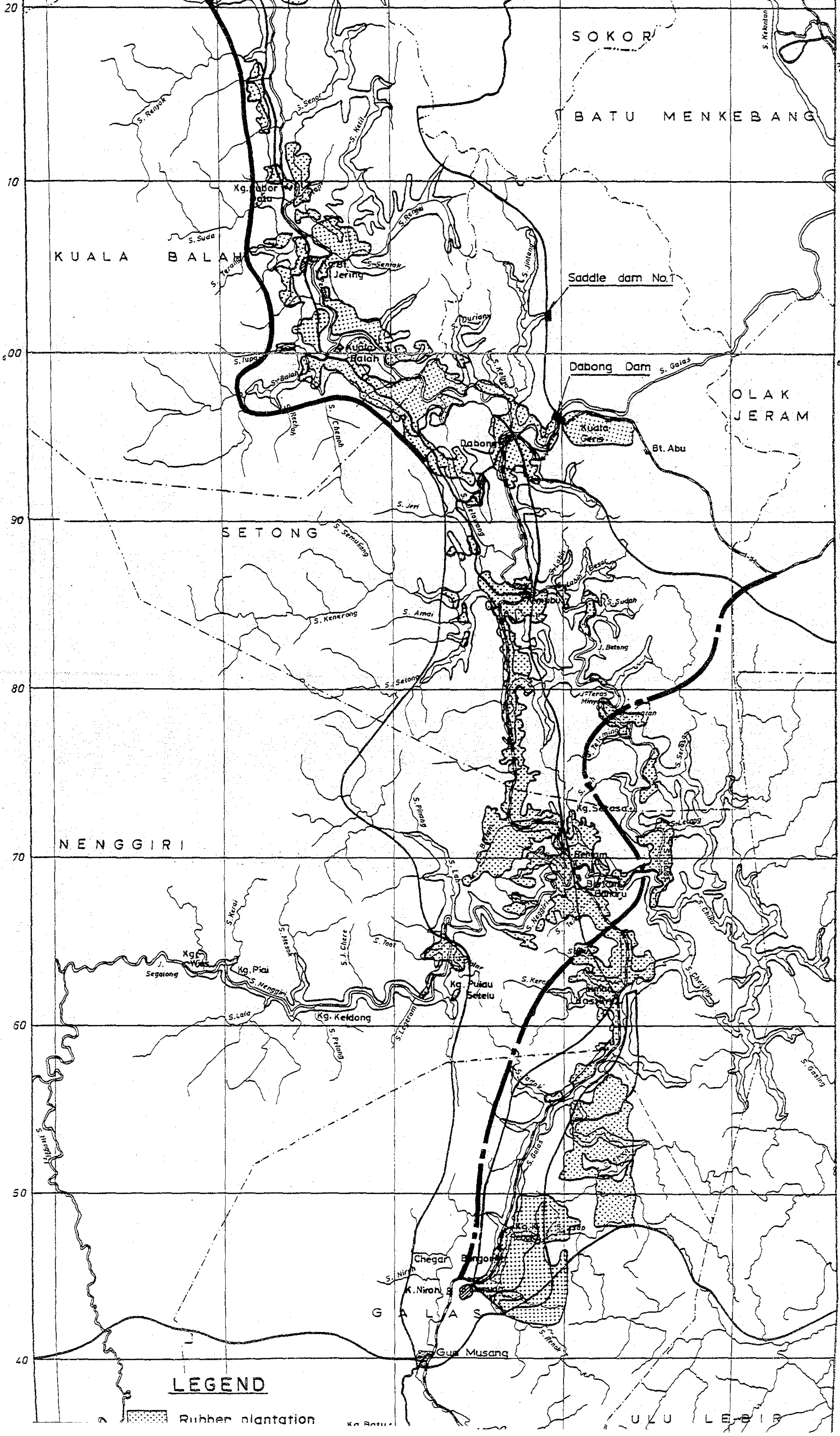


Fig.VI.7.7

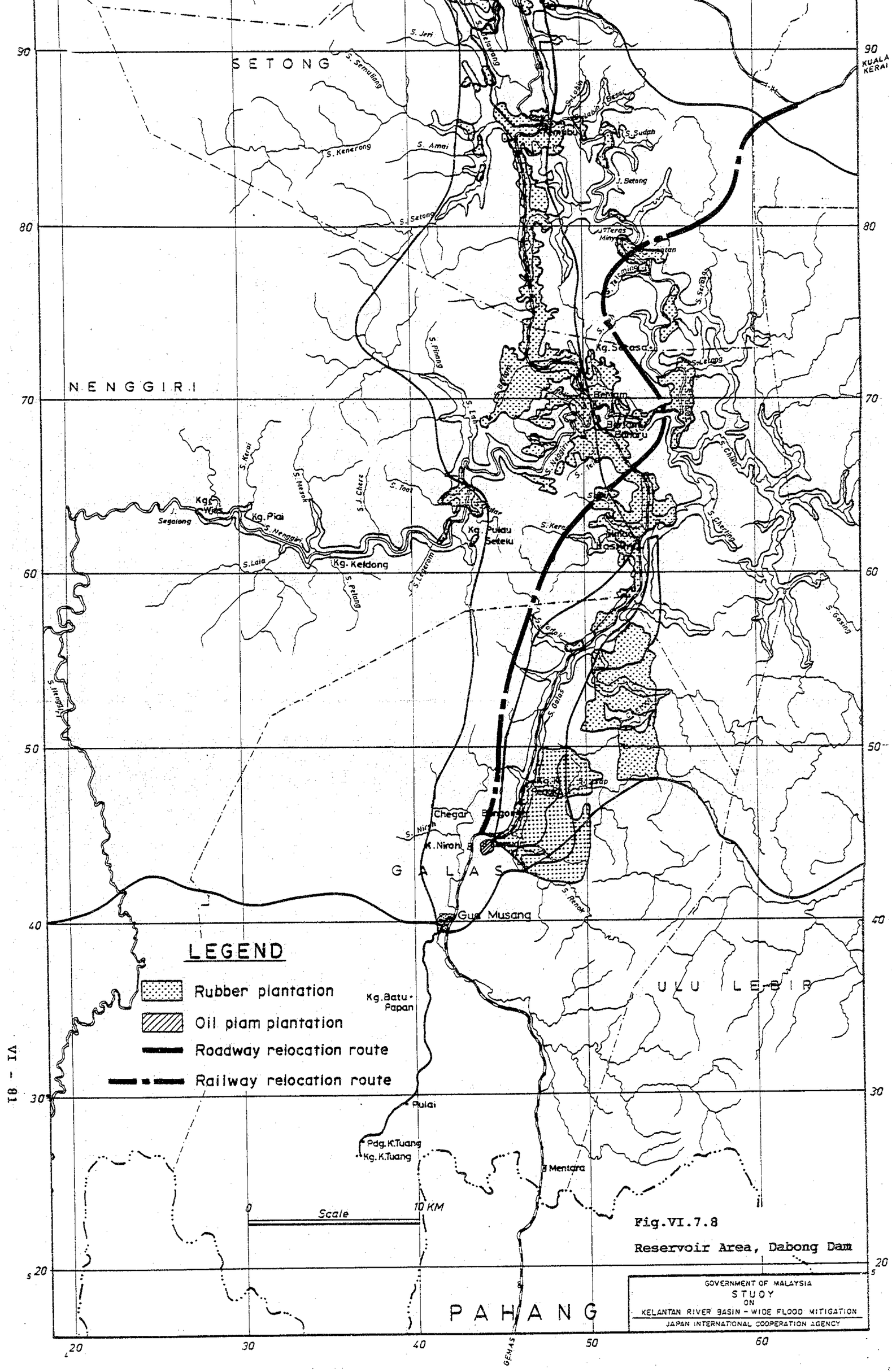
Railway, Plan and Profile

GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY


THAILAND
JEDOK
BT. PANAU
K. USIAL
TANAH MERAH
SOKOR
BATU MENKEBANG
KUALA BALAH
OLAK JERAM
SETONG
Saddle dam No. 2
Saddle dam No.1
Dabong Dam
S. Keladi
Pt. Panau
TUMPAT
PASIR MAS
Tanah Merah
Batang Merbau
Kusial
Kusial Baharu
MACHANG
Temangan Baharu
KUALA KERAI
BATU MELINTANG
S. Pergau
S. Golok
S. Rual
S. Renyok
S. Suaa
Kg. Jabor Bata
Kg. Bt. Jering
S. Senak
S. Jintang
S. Durian
Kuala Balah
S. Balah
S. Rechah
S. Chenoh
Dabong
Kuala Geris
Bt. Abu
S. Galas
S. Jeri
S. Semuliang
S. Kenerong
S. Amai
S. Setong
S. Kelantan
S. Degong
S. Sudah
J. Betong
S. Petawang



SOKOR
BATU MENKEBANG
KUALA KERAI
S. Kelantan
KUALA BALAH
Kg. Kubor
Saddle dam No.1
Dabong Dam
S. Galas
OLAK
JERAM
Kuala Geris
Bt. Abu
Kuala Balah
Bt. Jering
S. Jintang
S. Durian
S. Renyok
S. Senor
S. Keli
S. Suda
S. Tupai
S. Balah
S. Reehah
S. Chenoh
Dabong
S. Jeri
S. Kelantan
SETONG
S. Semuliang
S. Kenerong
S. Amai
S. Setong
S. Sudah
J. Betong
J. Teras Minyak
S. Telaming
S. Serbaga
Kg. Sarasa
S. Letang
Bertam
Bertam Baharu
NENGGIRI
S. Pinang
S. Lah
S. Nenggiri
S. Toot
S. J. Chere
S. Mesok
S. Kerai
Kg. Wias
J. Segalong
Kg. Piai
S. Nenggiri
S. Lala
Kg. Keldong
S. Pelang
S. Legerom
Kg. Pulau Setelu
S. Kera
S. Chiku
S. Cherting
S. Gasing
S. Galas
Chegar
Bangoi
S. Niroh
K. Niroh
GALAS
S. Renok
Gua Musang
ULU LEBIR
LEGEND
Rubber plantation
20
10
00
90
80
70
60
50
40


SETONG
NENGGIRI
GALAS
PAHANG
ULU LEBIR
KUALA KERAI
S. Jeri
S. Semulong
S. Kenerong
S. Amai
S. Setong
S. Sudah
J. Betong
S. Piring
S. Serai
S. Nenggiri
S. Kerai
S. Toot
S. Laia
S. Lagerom
S. Petaling
S. Galas
S. Renok
S. Nirah
S. Gosing
S. Cheroing
Kg. Piai
Kg. Keldong
Kg. Pulau Seteku
Kg. Batu Papan
Gua Musang
Chegar Benggor
Pulai
Pdg. K. Tuang
Kg. K. Tuang
Mentara
Scale
0
10 KM
LEGEND
Rubber plantation
Oil plam plantation
Roadway relocation route
Railway relocation route
Fig.VI.7.8
Reservoir Area, Dabong Dam
GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY

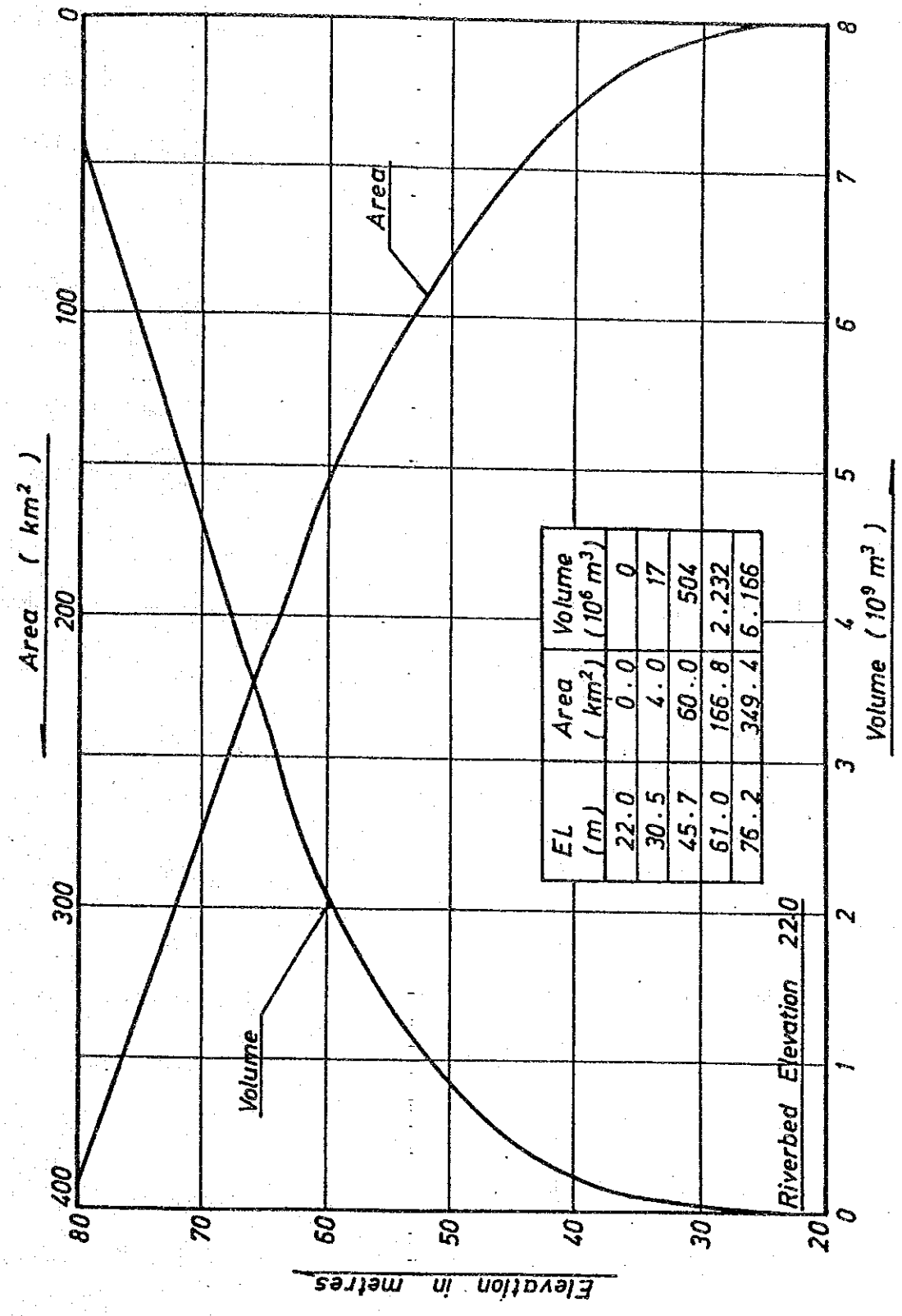
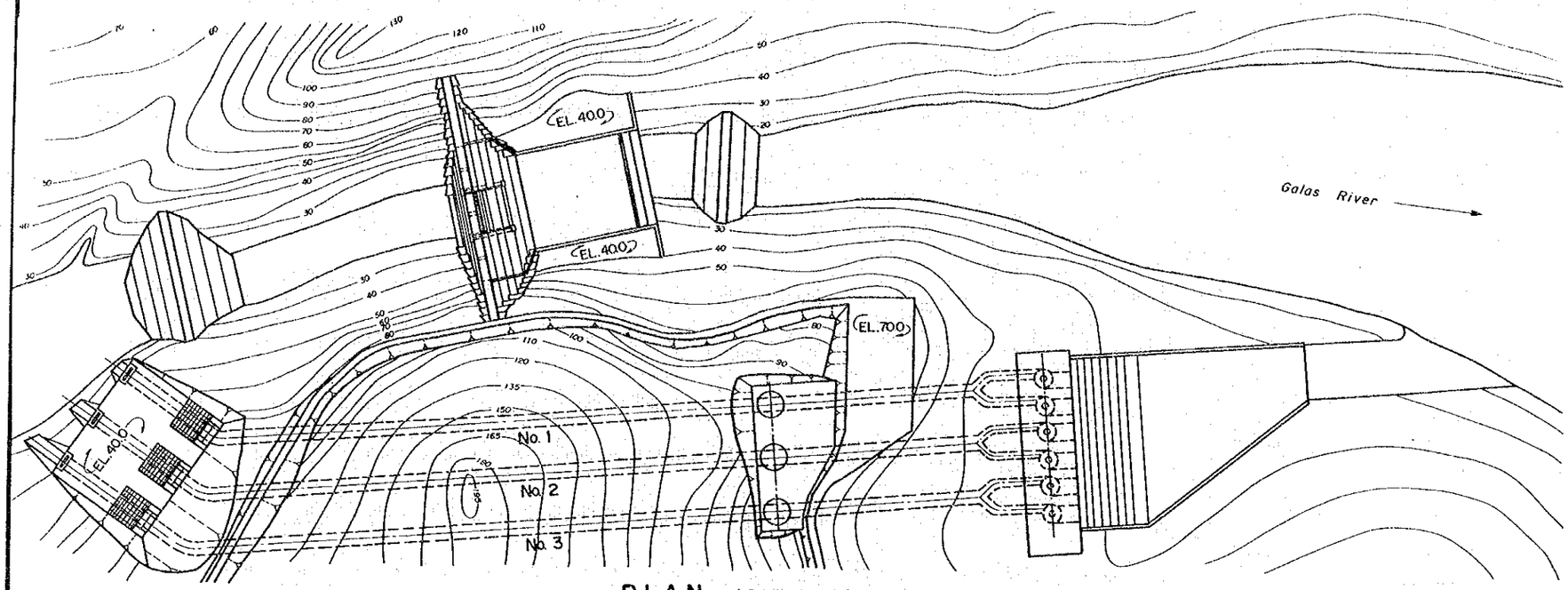


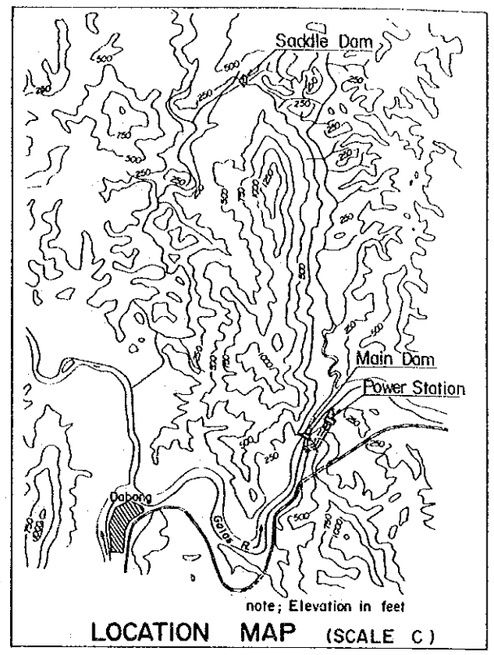
Fig.VI.7.9

Storage Capacity, Dabong Dam

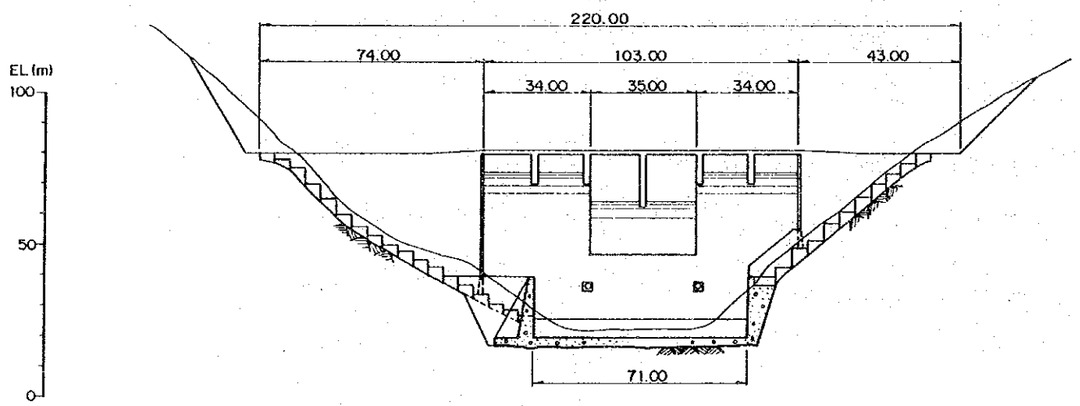
GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY



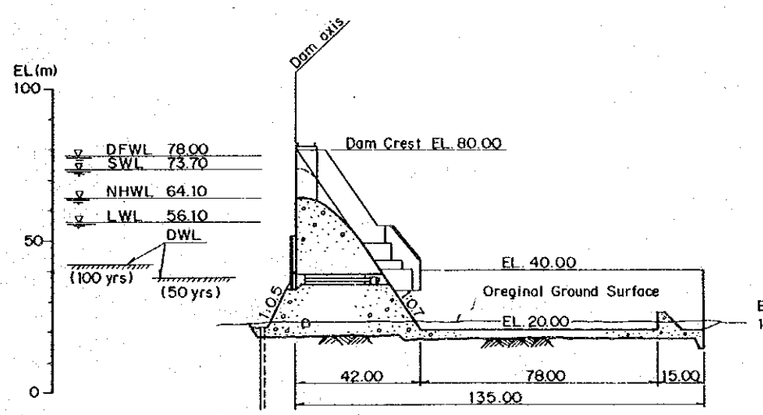
PLAN (SCALE A)



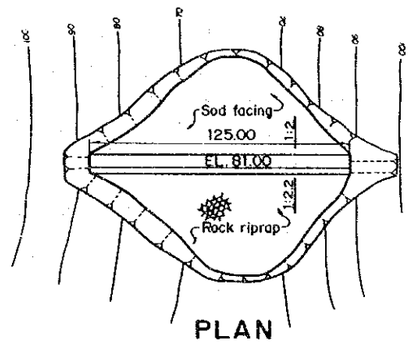
LOCATION MAP (SCALE C)



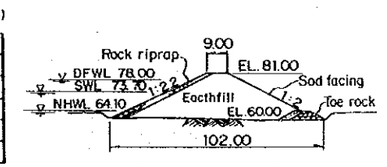
DOWNSTREAM ELEVATION OF DAM (SCALE B)



TYPICAL SECTION OF DAM (SCALE B)

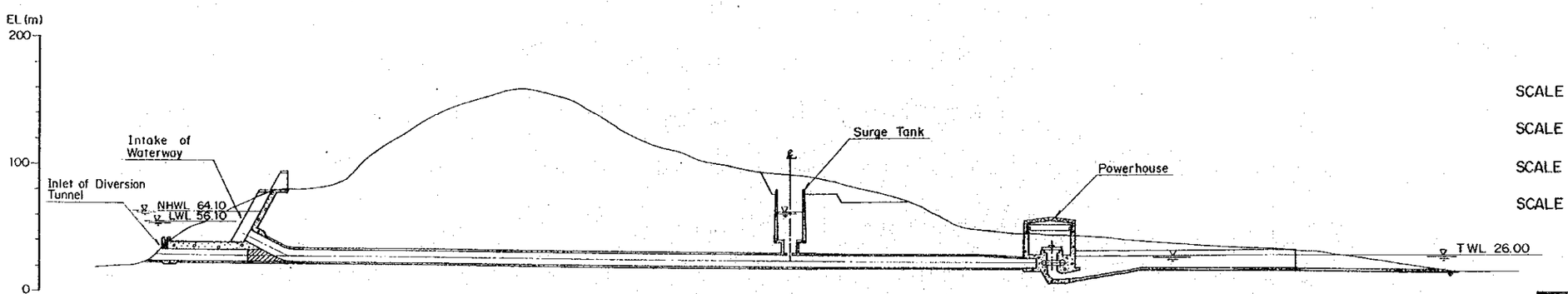


PLAN



TYPICAL SECTION

SADDLE DAM (SCALE D)



PROFILE OF WATERWAY/DIVERSION TUNNEL No. 1 (SCALE A)

SCALE A 0 100 200 (m)

SCALE B 0 50 100 (m)

SCALE C 0 5 10 (km)

SCALE D 0 100 (m)

Fig.VI.7.10 Proposed Development Plan of the Dabong Dam Scheme

GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY

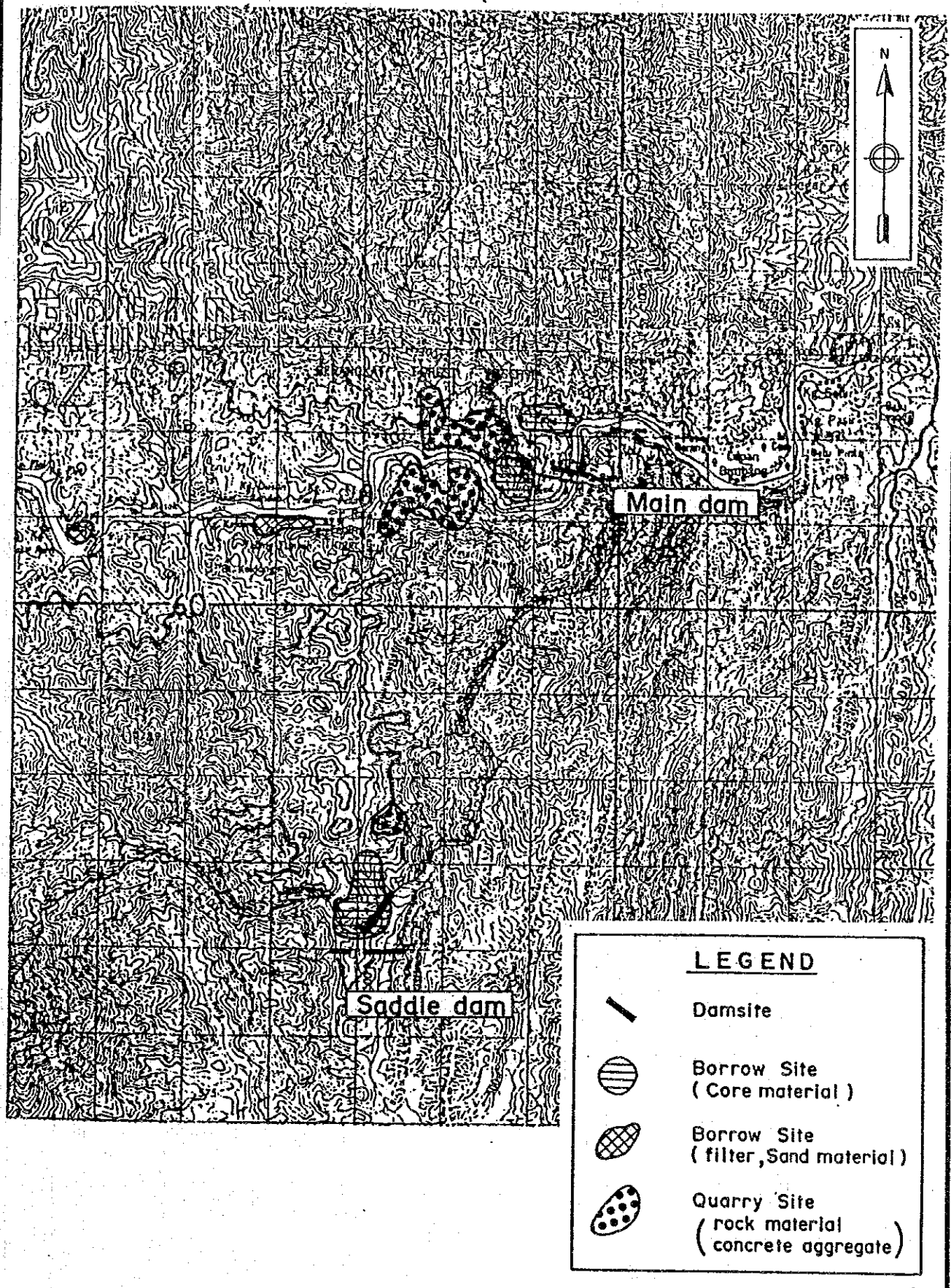


Fig.VI.7.11

Location Map of Nenggiri Dam

GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY

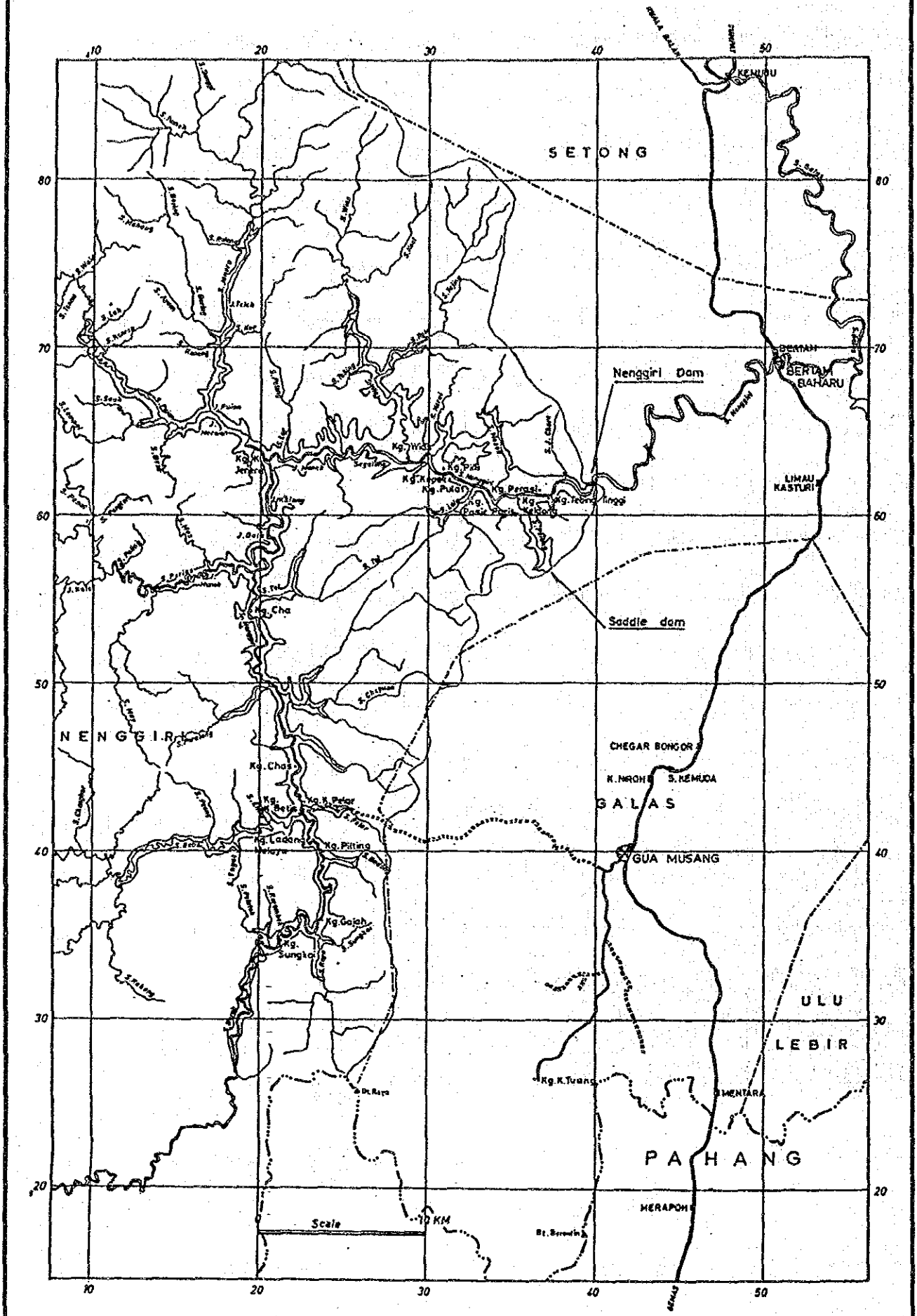
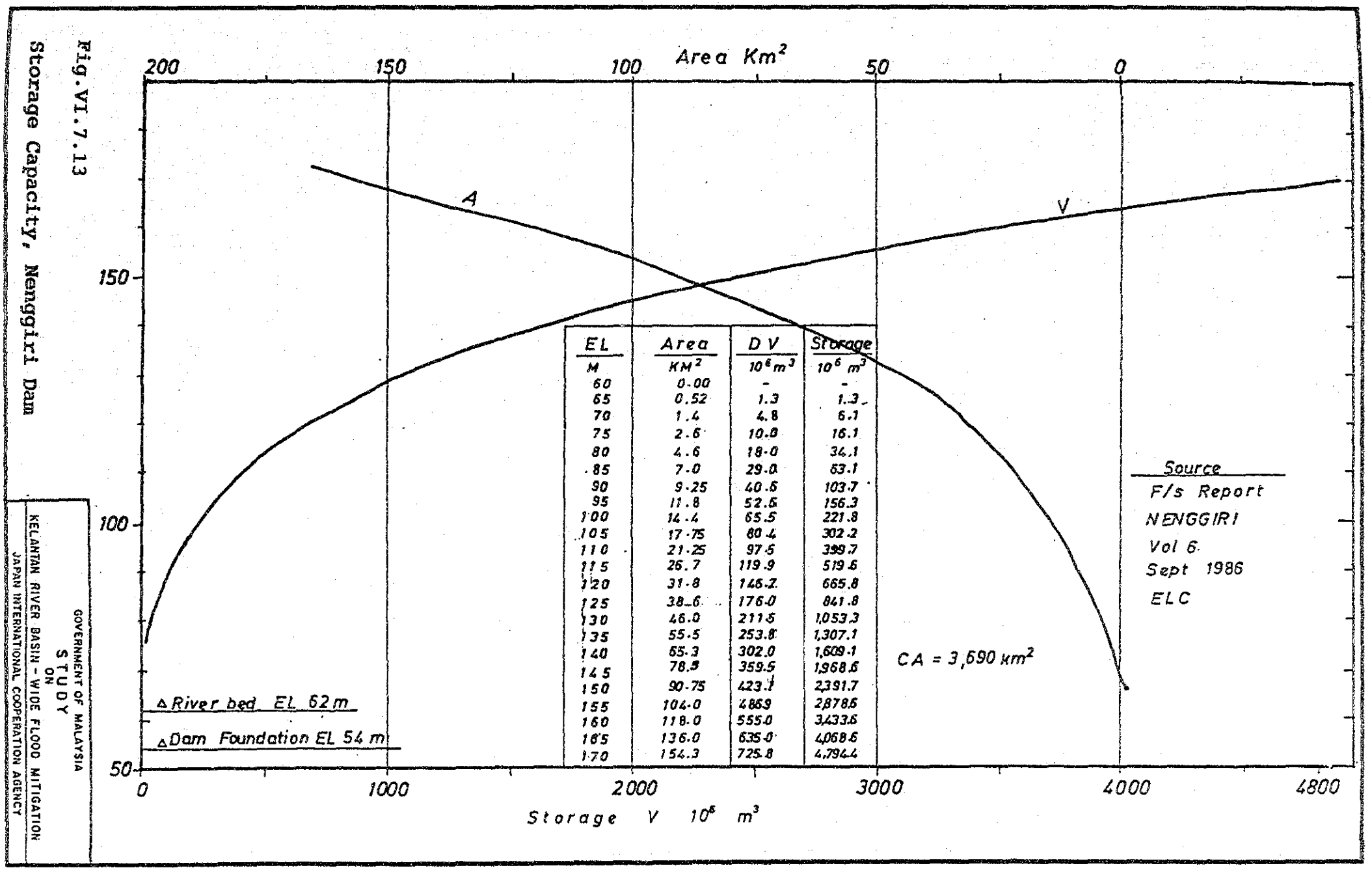


Fig.VI.7.12

Reservoir Area, Nenggiri Dam

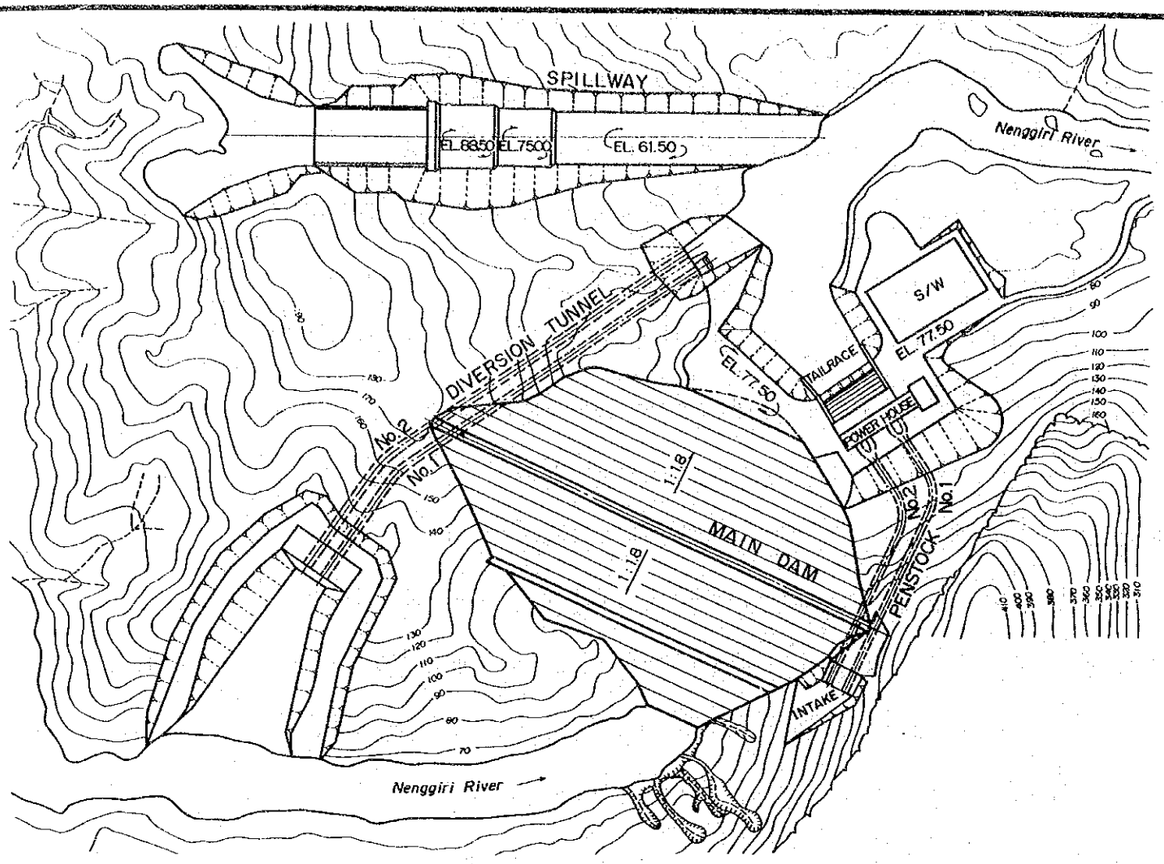
GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY



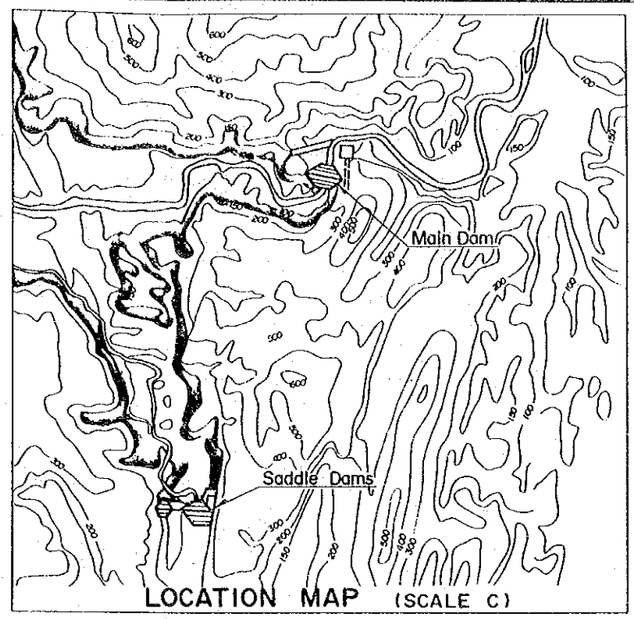
EL M	Area KM²	DV 10⁶m³	Storage 10⁶ m³
60	0.00	-	-
65	0.52	1.3	1.3
70	1.4	4.8	6.1
75	2.6	10.8	16.1
80	4.6	18.0	34.1
85	7.0	29.0	63.1
90	9.25	40.6	103.7
95	11.8	52.5	156.3
100	14.4	65.5	221.8
105	17.75	80.4	302.2
110	21.25	97.5	399.7
115	26.7	119.9	519.6
120	31.8	146.2	665.8
125	38.6	176.0	841.8
130	46.0	211.5	1,053.3
135	55.5	253.8	1,307.1
140	65.3	302.0	1,609.1
145	78.9	359.5	1,968.6
150	90.75	423.1	2,391.7
155	104.0	486.9	2,878.6
160	118.0	555.0	3,433.6
165	136.0	635.0	4,068.6
170	154.3	725.8	4,794.4

Fig. VI.7.13 Storage Capacity, Nenggiri Dam

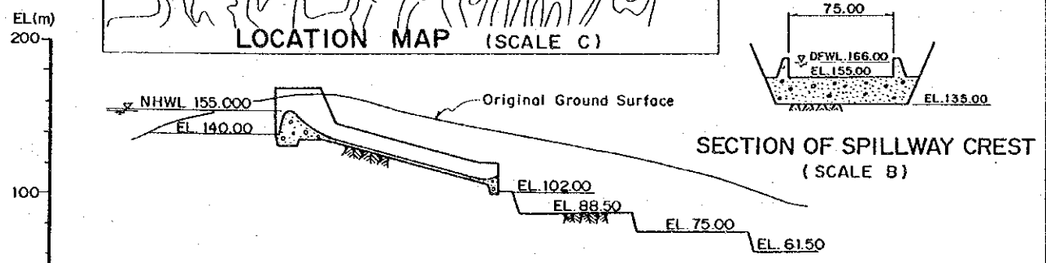
GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN (SCALE A)

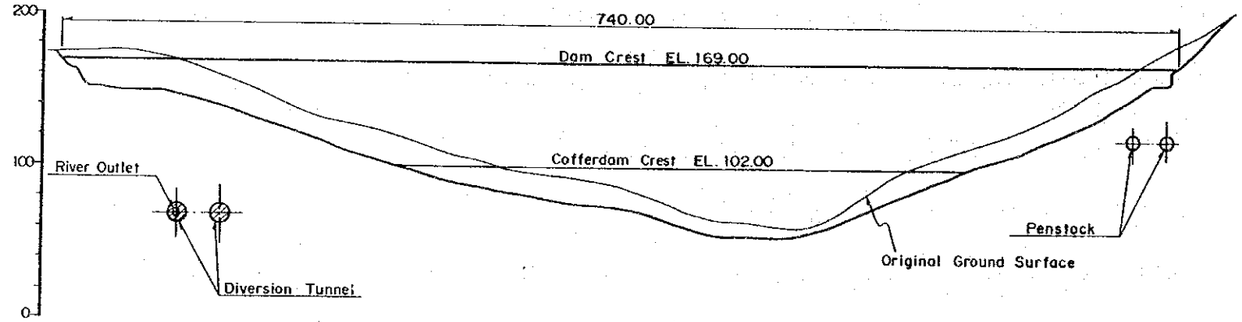


LOCATION MAP (SCALE C)

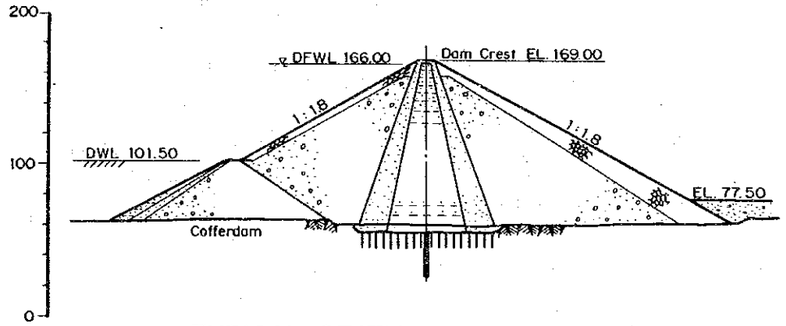


PROFILE OF SPILLWAY (SCALE B)

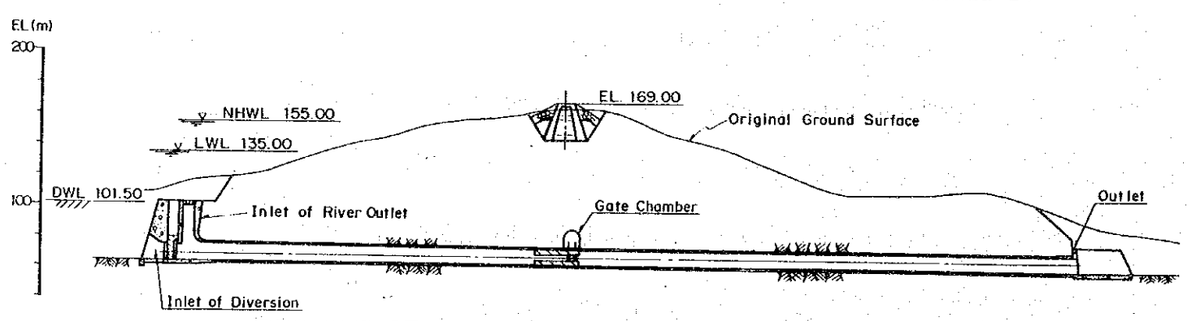
SECTION OF SPILLWAY CREST (SCALE B)



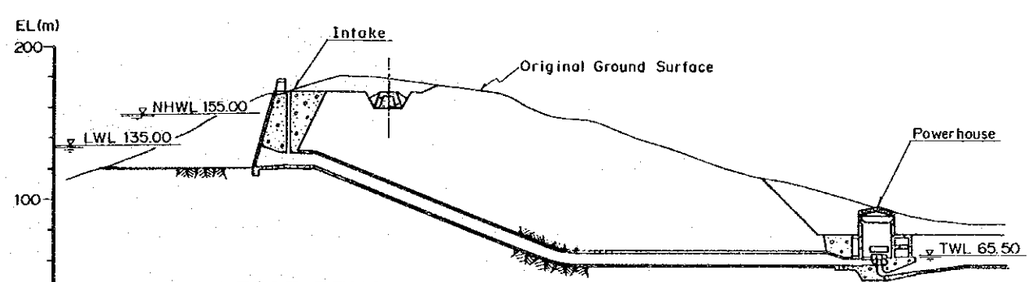
UPSTREAM ELEVATION OF MAIN DAM (SCALE B)



TYPICAL SECTION OF MAIN DAM (SCALE B)



PROFILE OF DIVERSION TUNNEL No.1/ RIVER OUTLET (SCALE B)

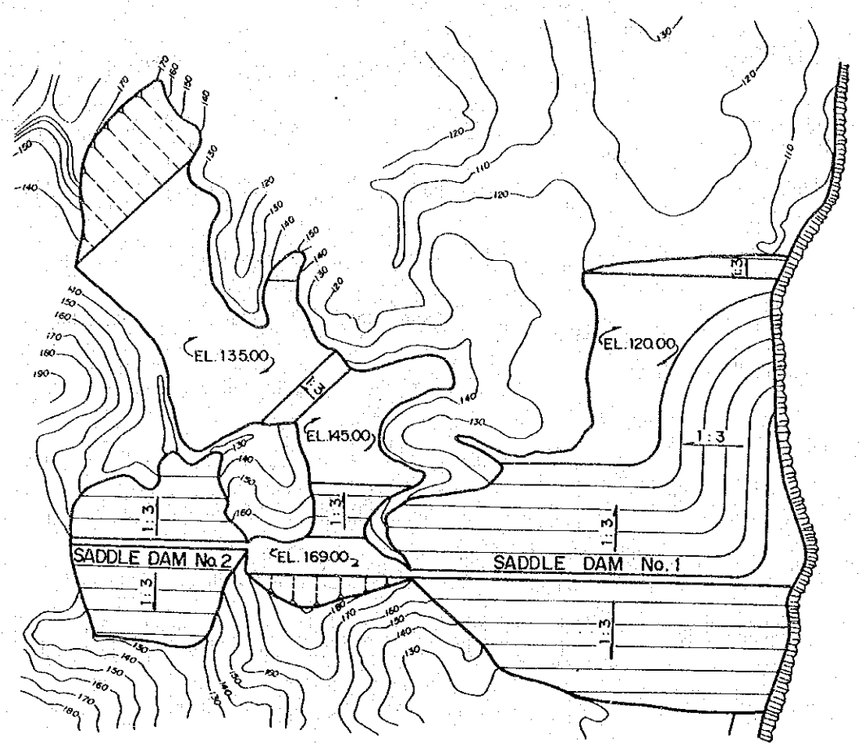


PROFILE OF PENSTOCK No.1 (SCALE B)

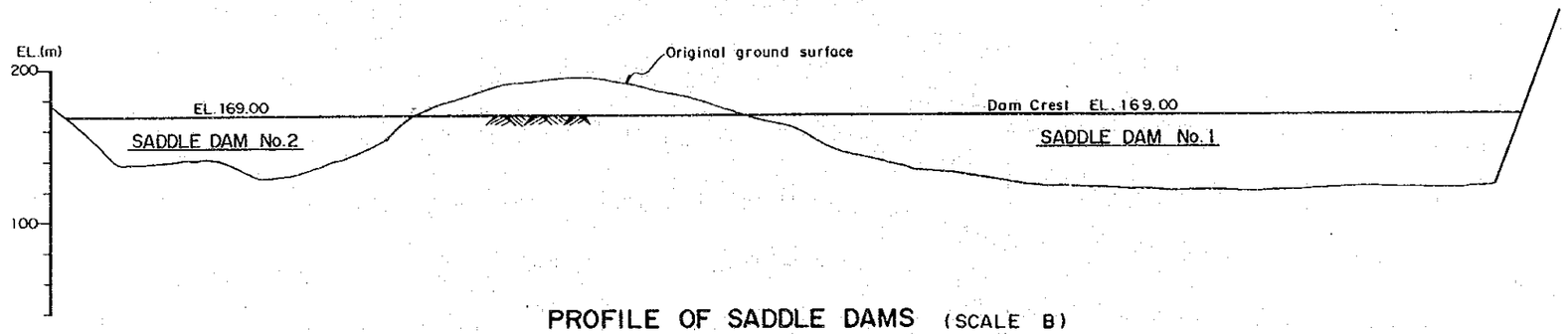
SCALE A 0 100 200 300 400 (m)
SCALE B 0 100 200 (m)
SCALE C 0 1 2 3 4 5 (km)

GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY

Fig.VI.7.14
Proposed Development Plan of the Nenggiri Dam Scheme (1/2)



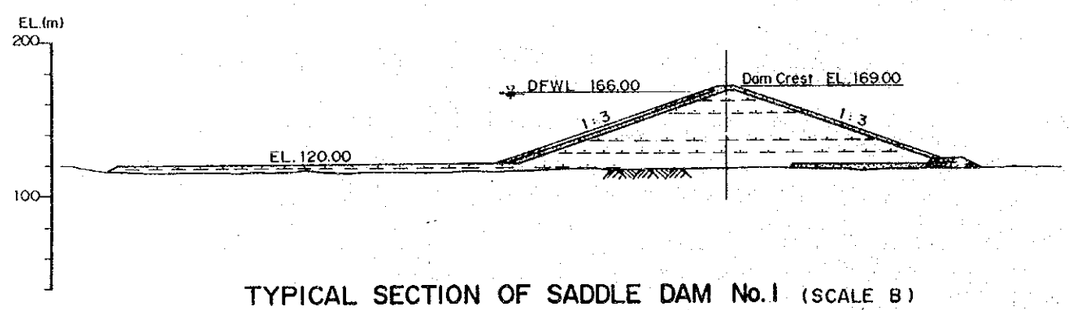
PLAN OF SADDLE DAMS (SCALE A)



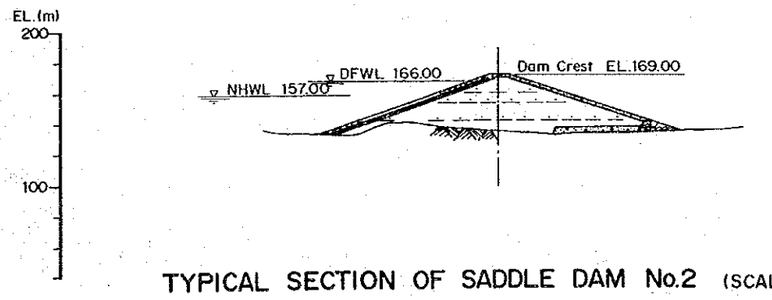
PROFILE OF SADDLE DAMS (SCALE B)

SCALE A 0 100 200 300 400 (m)

SCALE B 0 100 200 (m)



TYPICAL SECTION OF SADDLE DAM No.1 (SCALE B)



TYPICAL SECTION OF SADDLE DAM No.2 (SCALE B)

Fig.VI.7.14

Proposed Development Plan of the Nenggiri Dam Scheme (2/2)

GOVERNMENT OF MALAYSIA
STUDY
ON
KELANTAN RIVER BASIN - WIDE FLOOD MITIGATION
JAPAN INTERNATIONAL COOPERATION AGENCY

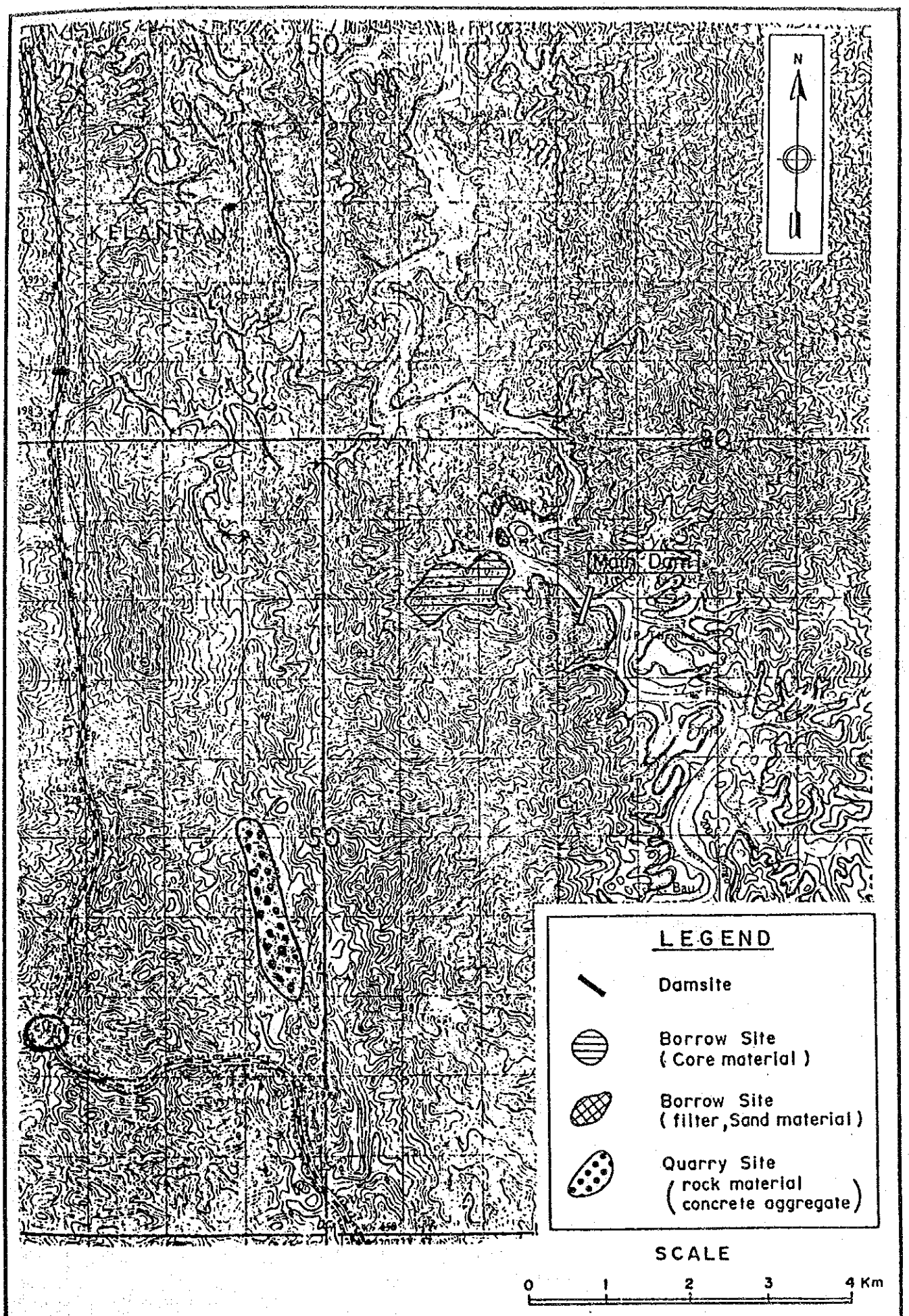


Fig.VI.7.15

Location Map of Kemubu Dam

GOVERNMENT OF MALAYSIA
STUDY
ON
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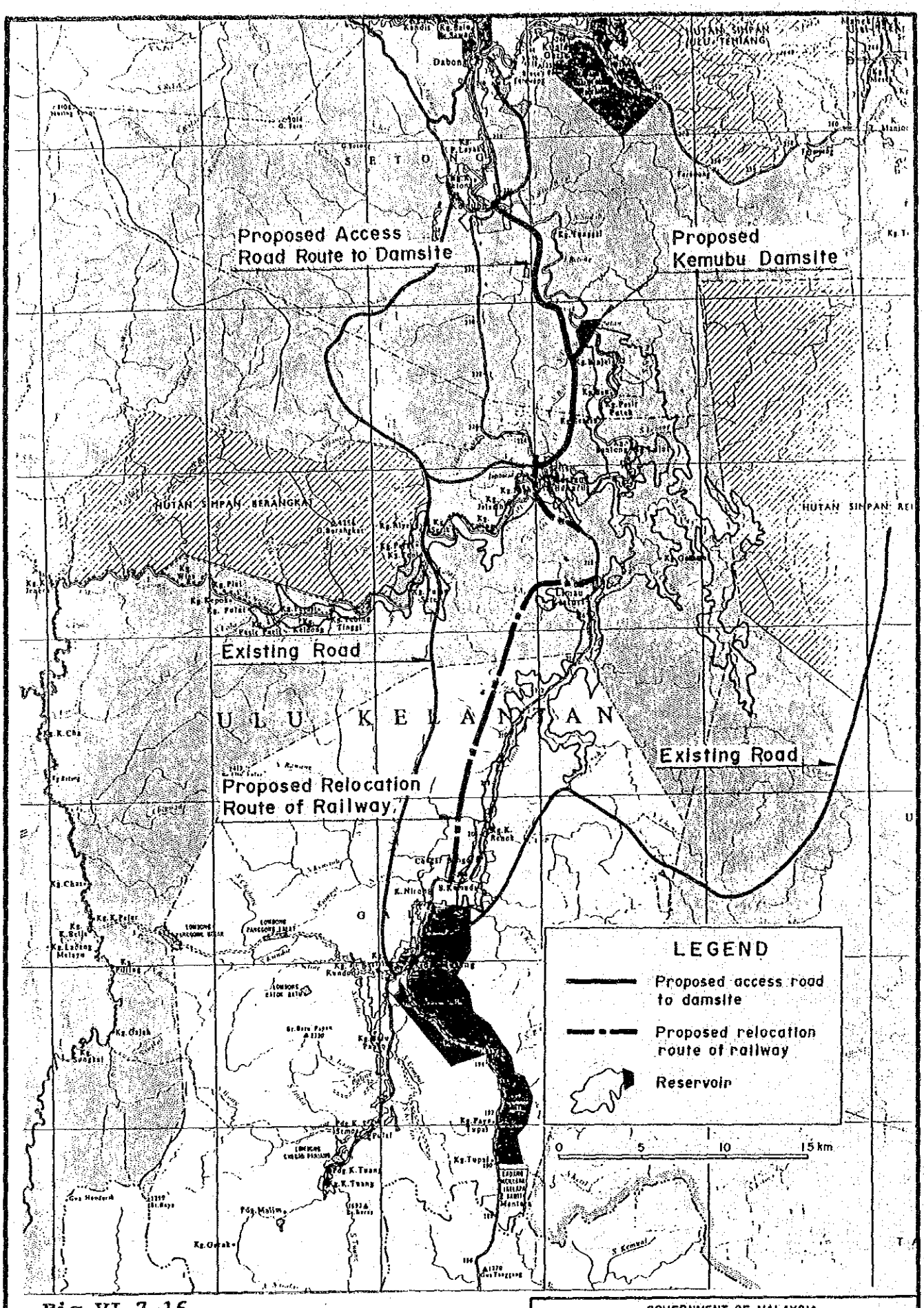

Fig.VI.7.16

Proposed Route of Railway around the Pass between Kemubu and Bertam

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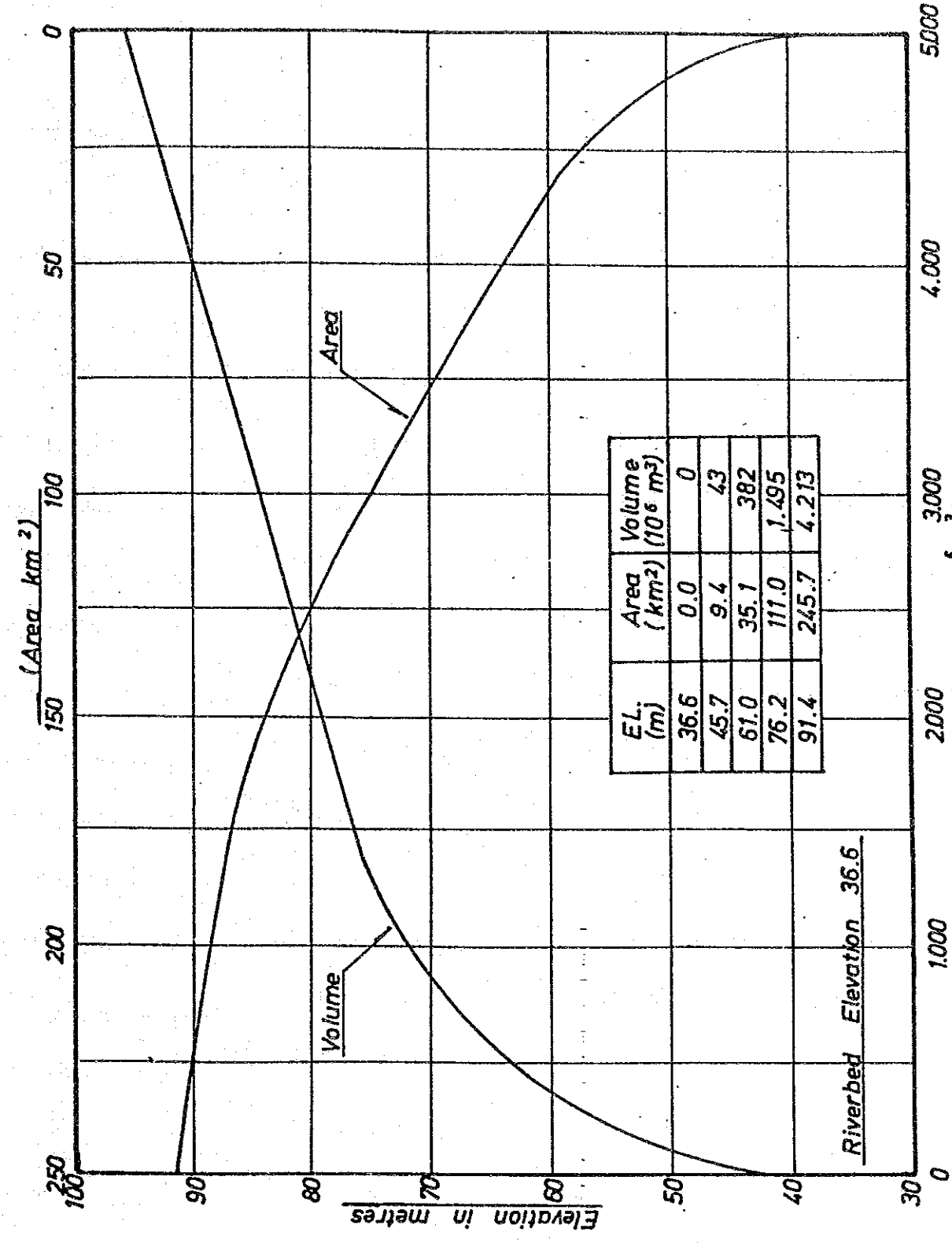

Fig.VI.7.17

Storage Capacity, Kemubu Dam

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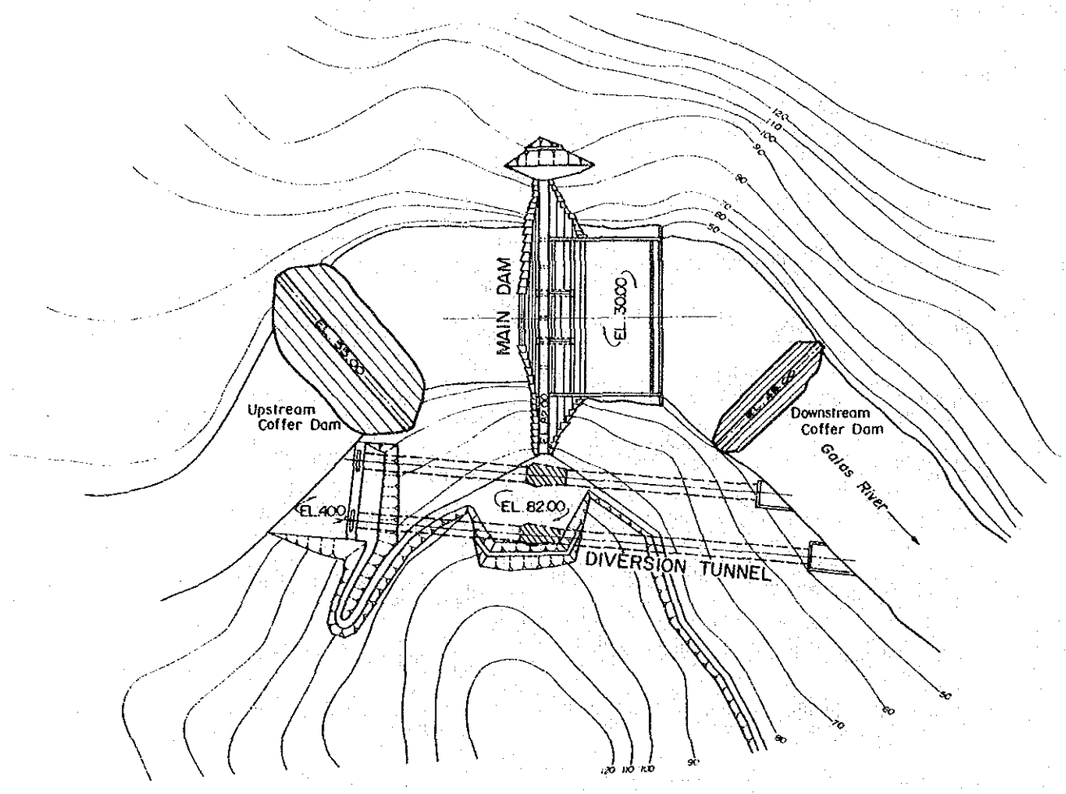
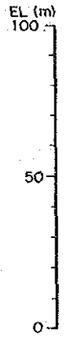
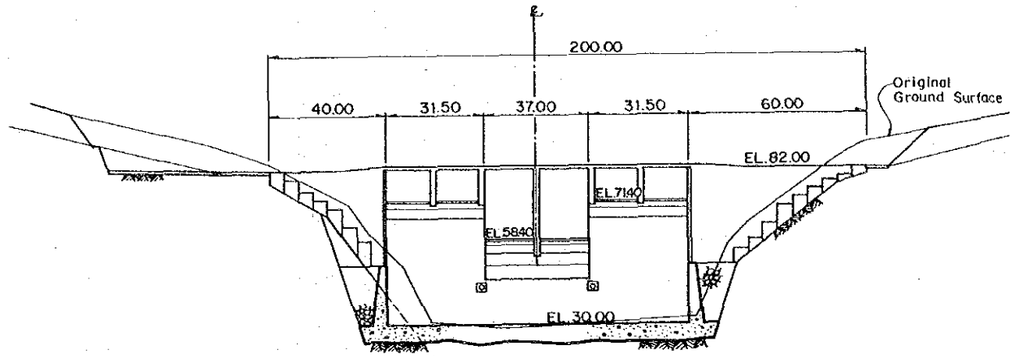
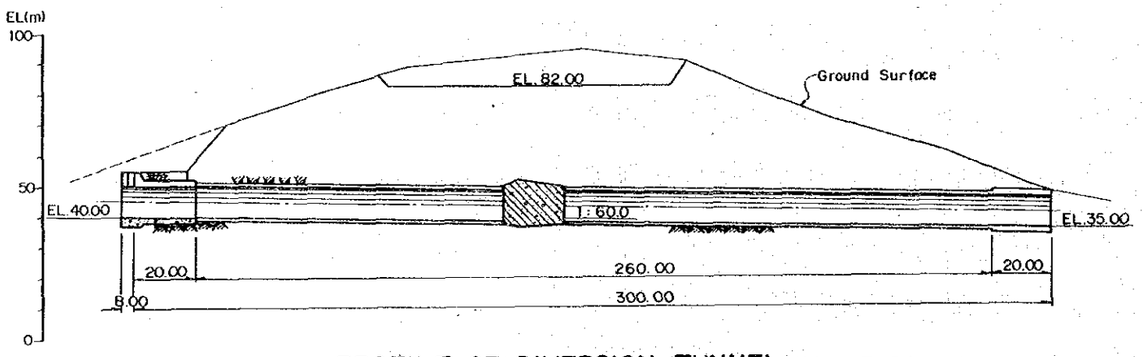


PLAN (SCALE A)

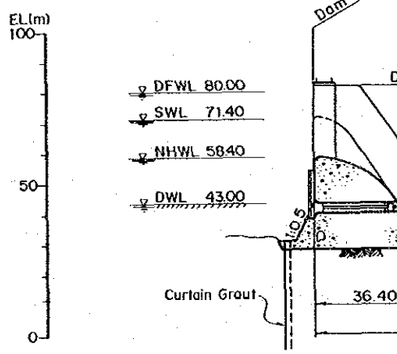




DOWNSTREAM ELEVATION OF DAM (SCALE B)



PROFILE OF DIVERSION TUNNEL (SCALE B)



TYPICAL SECTION OF DAM (SCALE B)

SCALE A 0 100 200 (m)

SCALE B 0 50 100 (m)

Fig.VI.7.18

Proposed development Plan of the Kemubu Dam Scheme

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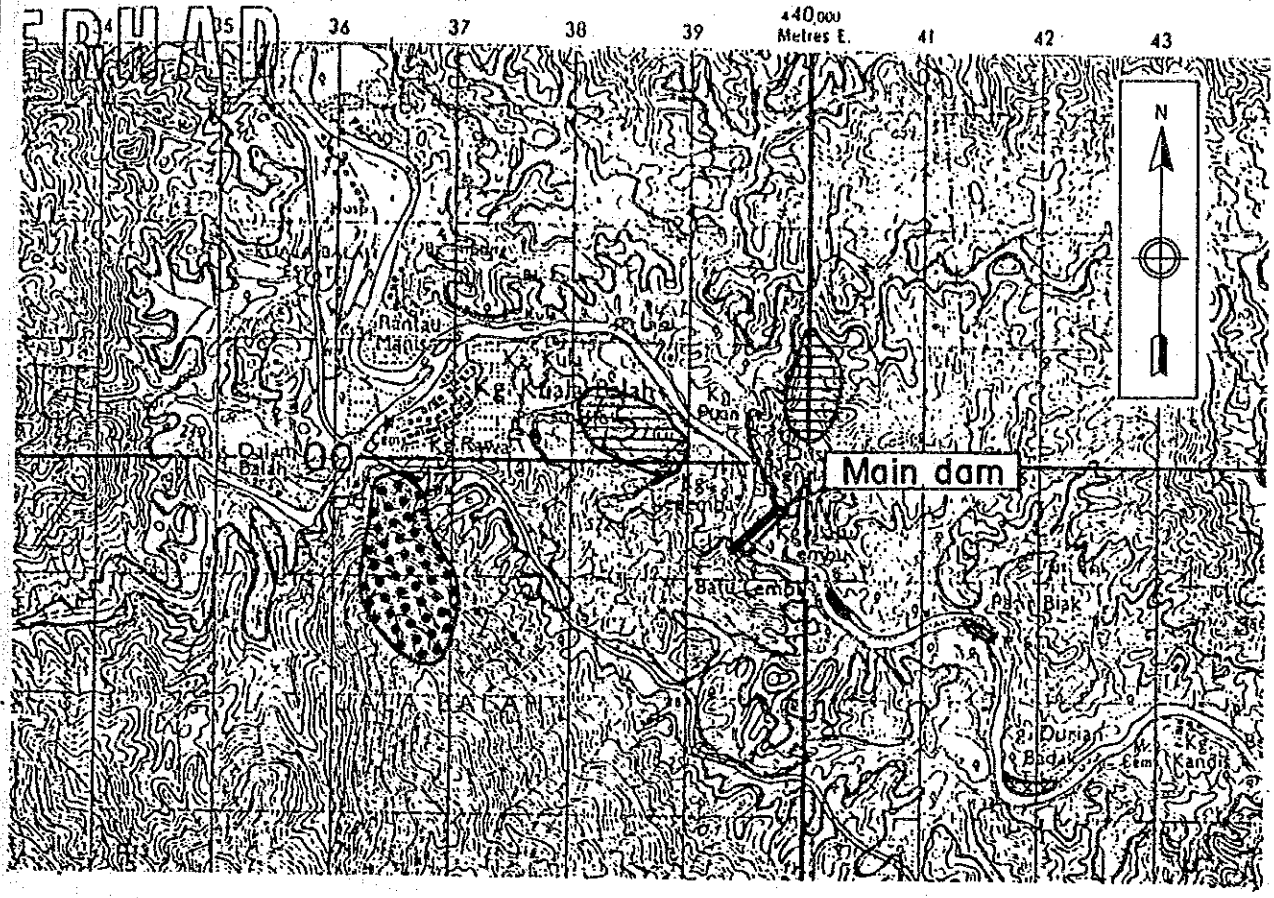

LEGEND

- Damsite
- Borrow Site (Core material)
- Borrow Site (filter, Sand material)
- Quarry Site (rock material (concrete aggregate))

SCALE

0 1 2 3 4 Km

Fig.VI.7.19

Location Map of Lower Pergau Dam

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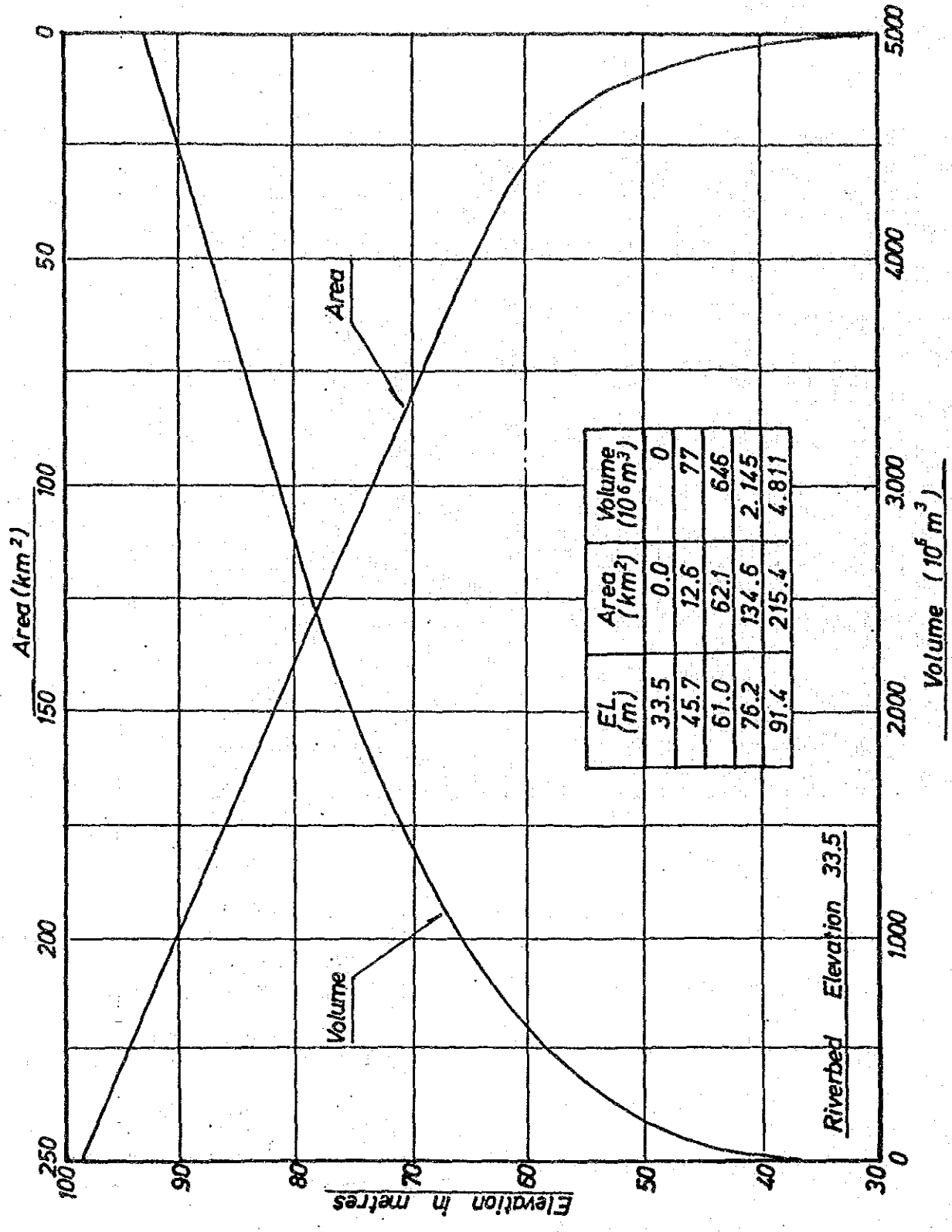

Fig.VI.7.20

Storage Capacity, Lower Pergau Dam

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APPENDIX-1

Methodology of Filling for Missing Data in the Record of Natural Flow Discharge at Proposed Damsite

(1) Lebir Dam

Missing data were filled through the following equation on the basis of (1) the monthly discharge observed at Kg.Tualang located near to the damsite and (2) the monthly and five-day average discharges observed at Guillemard Bridge.

$$Ql.m = A \cdot Qg.m + B$$

$$Ql.d = Qg.d \cdot Ql.m / Qg.m$$

where, Ql.m : Monthly discharge at the Lebir damsite.

A, B : Regression coefficients for the relationship of monthly discharges at the Lebir damsite and Guillemard Bridge. (Note: The correlation of monthly discharges is as shown in Fig. VI.A.1.)

Qg.m : Monthly discharge at Guillemard Bridge.

Ql.d : Five-day average discharge at the Lebir damsite.

Qg.d : Five-day average discharge at Guillemard Bridge.

(2) Dabong Dam

There is a water level/discharge gauging station at Kg.Dabong which is located near to the proposed damsite, but its discharge data were not applied due to unreliability (refer to Table VI.5.3). Instead, synthesized data estimated by the following equation were applied;

$$Qd.m = (Qg.m - Ql.m) \cdot Ad / (Ag - Al)$$

$$Qd.d = Qg.d \cdot Qd.m / Qg.m$$

where; Qd.m : Monthly discharge at the Dabong damsite.

Qg.m : Monthly discharge at Guillemard Bridge.

Ql.m : Monthly discharge at the Lebir damsite.

Ad : Catchment area at the Dabong damsite.

Ag : Catchment area at Guillemard Bridge.

Al : Catchment area at the Lebir damsite.

(3) Nenggiri Dam

Missing data were filled through the following equation on the basis of (1) the monthly discharge observed at Chegau Atas located near to the damsite and (2) the monthly and five-day average discharges observed at Guillemard Bridge.

$$Qn.m = A \cdot Qg.m + B$$

$$Qn.d = Qg.d \cdot Qn.m / Qg.m$$

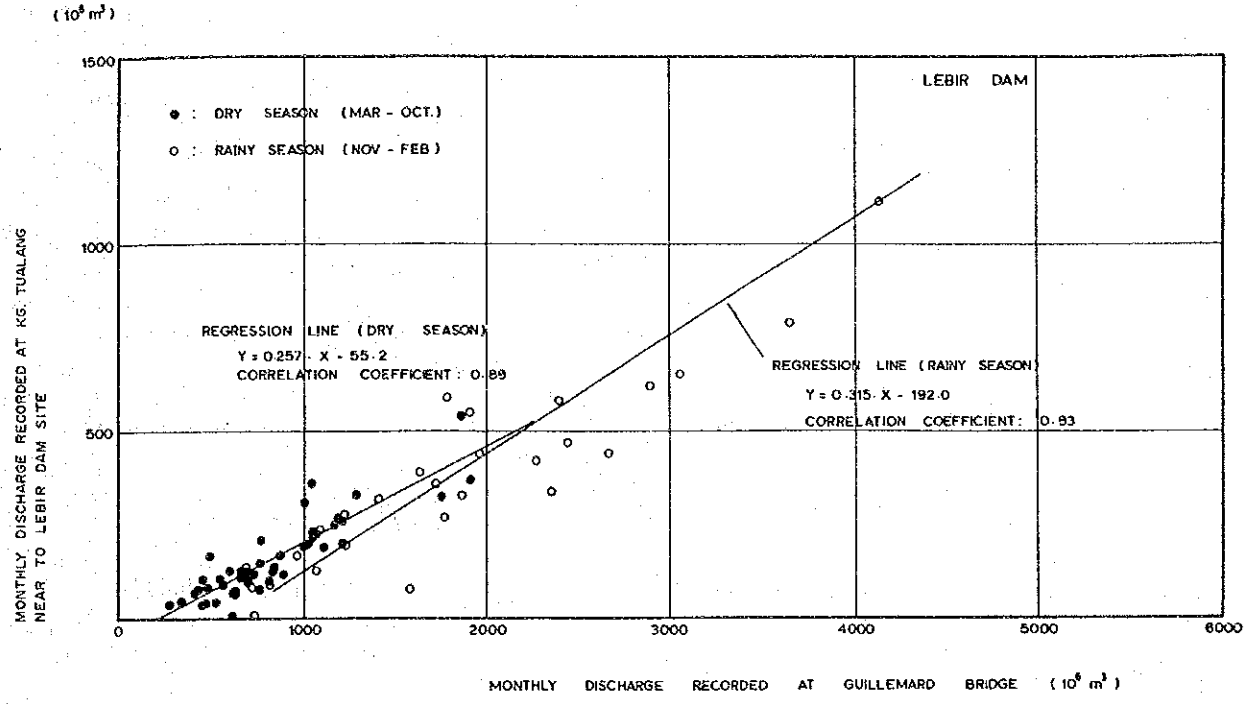
where, Qn.m : Monthly discharge at the Nenggiri damsite.

A, B : Regression coefficients for the relationship of monthly discharges at the Nenggiri damsite and Guillemard Bridge. (Note: The correlation of monthly discharges is as shown in Fig. VI.A.1)

Qg.m : Monthly discharge at Guillemard Bridge.

Qn.d : Five-day average discharge at the Nenggiri damsite.

Qg.d : Five-day average discharge at Guillemard Bridge.



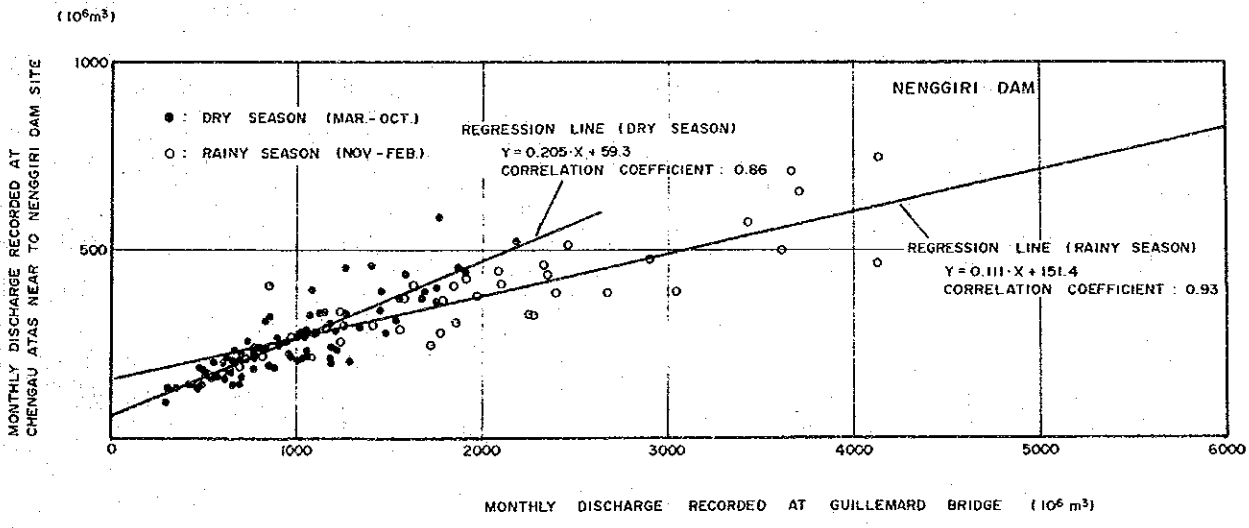


Fig.VI.A.1

Correlation of Monthly Discharges at Guillemard Bridge and Proposed Damsite

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APPENDIX-2

Screening of Five Promising Schemes

1. Introduction

The Kelantan River basin draining a catchment area of 13,100 km^2 is characterized as the river basin with high potential for water resources development due to ample rainfall replenished by the northeast monsoon. Availing this ample rainfall, agricultural practice focussing on staple foods is well developed in the vast plain extended in the downstream reaches. In fact, this lowland area is designated as one of eight granary areas in Malaysia.

Seasonal flow change of the Kelantan River is great, even with ample flow. Large flow decrease in dry seasons hampers the efficient development of agriculture in the downstream reaches. Torrential downpour of rainfall in wet seasons, on the other hand, causes habitual flooding in the downstream reaches, which is another shackle for the development of the Kelantan River basin.

The identification of damsites to create a large impounding reservoir is tried to aim at not only utilizing the ample Kelantan River water efficiently for water resources development, but also mitigating flooding habitually repeated as an annual event. The creation of head by dam will also generate a huge amount of hydropower.

2. Potential Damsites

Possible damsites were tried to identify using available topographic maps for the purpose of water resources development and flood mitigation in the downstream reaches of the Kelantan River. A total of 15 sites was identified as shown in Table VI.B.1 and Fig.VI.B.1. Fig.VI.B.2 depicts the relationship between the location and elevation for the identified schemes.

Four sites, Schemes 8 to 11, identified in the Nenggiri River basin are located in the reaches forming a V-shaped valley after the last main tributary merges to the Nenggiri River. Steep river gradient further upstream of the Nenggiri River prevents from making the reservoirs to be worthy for evaluation.

Schemes 1 and 2 and 4 to 7 are identified in the reaches between the confluences of the Galas River with the Nenggiri and Lebir rivers. The Galas River branches into small tributaries upstream of the confluence with the Nenggiri River, resulting in no possible damsites.

Only one site, Scheme 3, is identified in the Pergau River due to the wide valley as endorsed by the agricultural practice well developed in the valley bottom. The Lebir River shows four possible damsites in the middle to lower reaches; Scheme 12 to 15. Wide river valleys and branching into small tributaries in the upper reaches form no possible damsites.

3. Selection of Promising Dam Schemes

The selection of promising dam schemes in this scheme identification study is based on the reservoir efficiency defined as the ratio of active storage to dam volume. Since the dam volume and active storage can be read as the terms to represent production costs and resulting benefits respectively, the scheme with a higher value of reservoir efficiency shows the more attractiveness for development.

A rockfill type is first of all assumed as the dam type, and then dam volume for full development is calculated; that is, volume corresponding to topographic maximum elevation. A space of 6 m between dam crest and high water level is secured as the flood space in estimating active storage. Furthermore, sediment volume for 50 years is deducted for active storage.

Table VI.B.2 summarizes the calculation results of reservoir efficiency for the 15 identified schemes. Two schemes, Scheme 1 and 2, located on the Galas River between the confluences of the Pergau and Lebir rivers are quite promising for development with the high reservoir efficiency values of 2,060 and 9,078, respectively. Both schemes, the sites of which are so close, are conceived as the site alternative of a project, so that Scheme 2 with the higher value of reservoir efficiency is retained for the study of water resources development and flood mitigation in the downstream reaches of the Kelantan River, named the Dabong scheme.

Only one damsite, Scheme 3, is identified in the Pergau River. Showing less attractiveness in reservoir efficiency, the Scheme 3 called the Lower Pergau is retained for the study of water resources development and flood mitigation in the downstream reaches of the Kelantan River.

Of four schemes identified in the Galas River between the confluences of the Nenggiri and Pergau rivers, Scheme 7 shows the highest attractiveness for development with the reservoir efficiency value of 2,275. Since four schemes are located in the short distance of some 15 km to each other, those four are conceived as site alternatives of a project. Therefore, Scheme 7 is retained for further study as the scheme with highest development potential in these river reaches.

Scheme 9 shows the relatively high reservoir efficiency among four schemes identified in the Nenggiri River. Since the dam of Scheme 9 can create high head for power generation, actual scheme attractiveness is greater than that shown in the reservoir efficiency. In fact, the feasibility study of Scheme 9 called the Nenggiri Project has been carried out by focussing on hydropower generation, and verified the viability of the project. Therefore, Scheme 9 is retained for the study of water resources development and flood mitigation in the downstream reaches of the Kelantan River.

Scheme 13 out of four schemes identified in the Lebir River shows the highest attractiveness. Indeed, the viability of Scheme 13 called the Lebir Project has been assessed by focussing on hydropower generation by JICA. Therefore, Scheme 13 is retained for the study of water resources development and flood mitigation in the downstream reaches of the Kelantan River. It is concluded that five schemes, Schemes 2 (Dabong), 3 (Lower Pergau), 7 (Kemubu), 9 (Nenggiri) and 13 (Lebir), out of 15 schemes are retained for further study as the dam schemes aiming at water resources development and flood mitigation in the downstream reaches of the Kelantan River. It is finally noted that hydropower development is possible to add to the development objectives of Dabong, Nenggiri and Lebir schemes, because of possibility to create high head.

Table VI.B.1 Location of Dam Schemes Identified in the Kelantan River

Damsite	River system	Distance from Kuala Krai (km)	Riverbed elevation (m)	Catchment area (km^2)
Site 1	Galas	10.0	16.3	7,700
Site 2 (Dabong)	Galas	40.7	22.0	7,480
Site 3 (Lower Pergau)	Pergau	50.7	33.5	1,280
Site 4	Galas	58.7	31.5	5,800
Site 5	Galas	69.4	34.9	5,680
Site 6	Galas	70.9	35.4	5,640
Site 7 (Kemubu)	Galas	74.6	36.6	5,630
Site 8	Nenggiri	98.3	49.0	3,870
Site 9 (Nenggiri)	Nenggiri	120.3	60.0	3,690
Site 10	Nenggiri	131.6	66.5	3,580
Site 11	Nenggiri	142.3	72.7	3,350
Site 12	Lebir	34.4	28.8	2,485
Site 13 (Lebir)	Lebir	37.1	30.0	2,480
Site 14	Lebir	47.1	34.3	2,300
Site 15	Lebir	56.4	38.3	2,100

Note: The riverbed elevation at Kuala Krai is 14.4m.

Table VI.B.2 Reservoir Efficiency of Identified Scheme

Scheme	Topo.max elevation (El;m) (1)	Dam volume (mcm) (2)	Storage volume (mcm) (3)	Sediment volume (mcm) (4)	Active storage (mcm) (5)	Reservoir efficiency (5)/(2)	Remarks
1	76.2	2.7	5,720	158	5,562	2,060	Dabong group
2	80.0	0.6	5,600	153	5,447	9,078	Dabong group
3	50.0	0.2	66	26	40	200	Lower Pergau
4	76.2	1.4	1,000	119	881	629	Kemubu group
5	76.2	0.6	1,110	116	994	1,657	Kemubu group
6	76.2	0.5	1,070	115	955	1,910	Kemubu group
7	82.0	0.6	1,480	115	1,365	2,275	Kemubu group
8	137.2	8.6	3,060	79	2,981	347	Nenggiri group
9	169.0	10.0	3,815	76	3,739	374	Nenggiri group
10	137.2	4.2	559	73	486	116	Nenggiri group
11	182.9	9.3	1,050	69	981	105	Nenggiri group
12	91.4	6.5	3,330	51	3,279	504	Lebir group
13	91.4	5.4	3,230	51	3,179	589	Lebir group
14	90.0	6.8	2,260	47	2,213	325	Lebir group
15	90.0	2.9	1,630	43	1,587	547	Lebir group

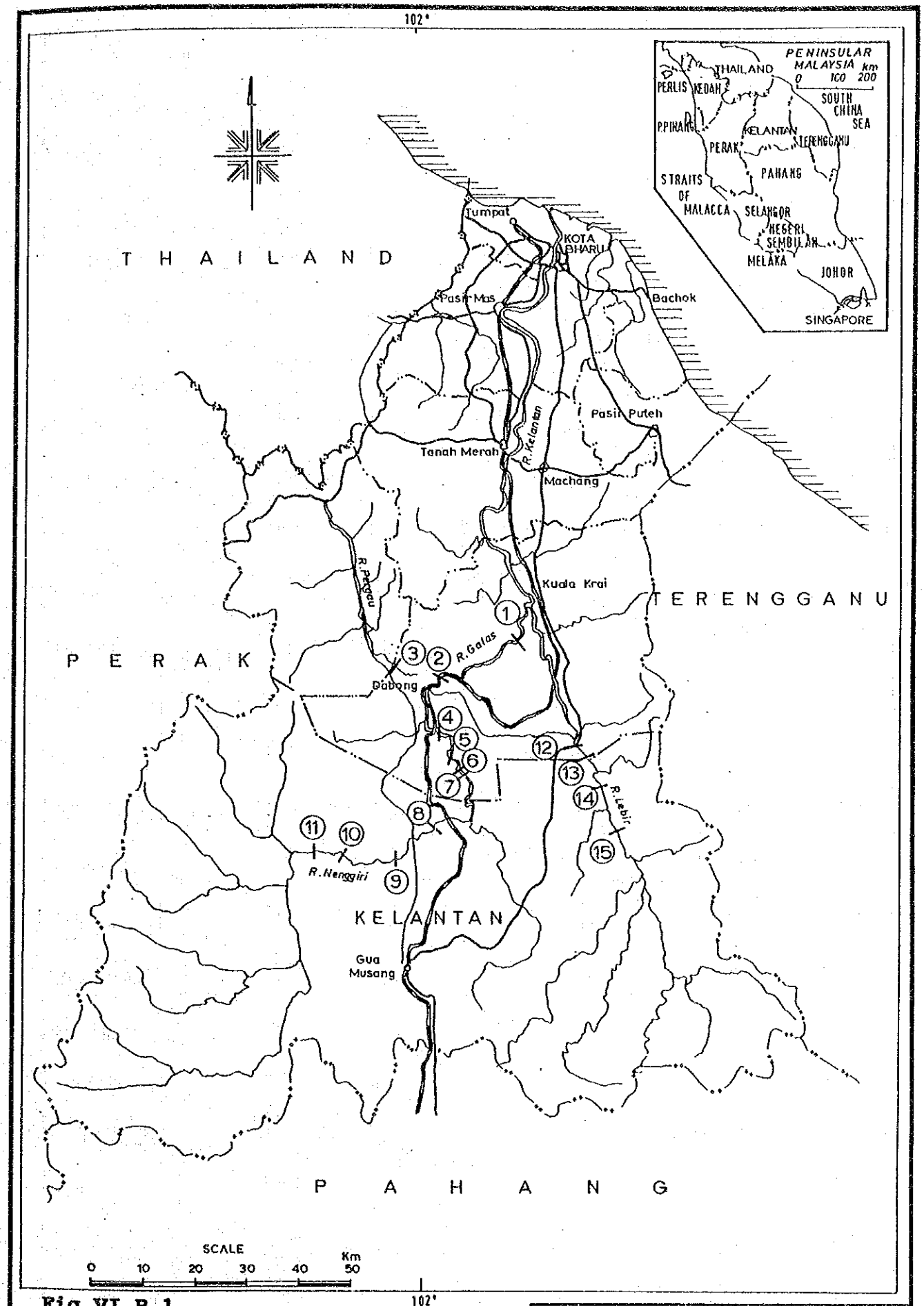

Fig.VI.B.1

Potential Damsites in the Kelantan River Basin

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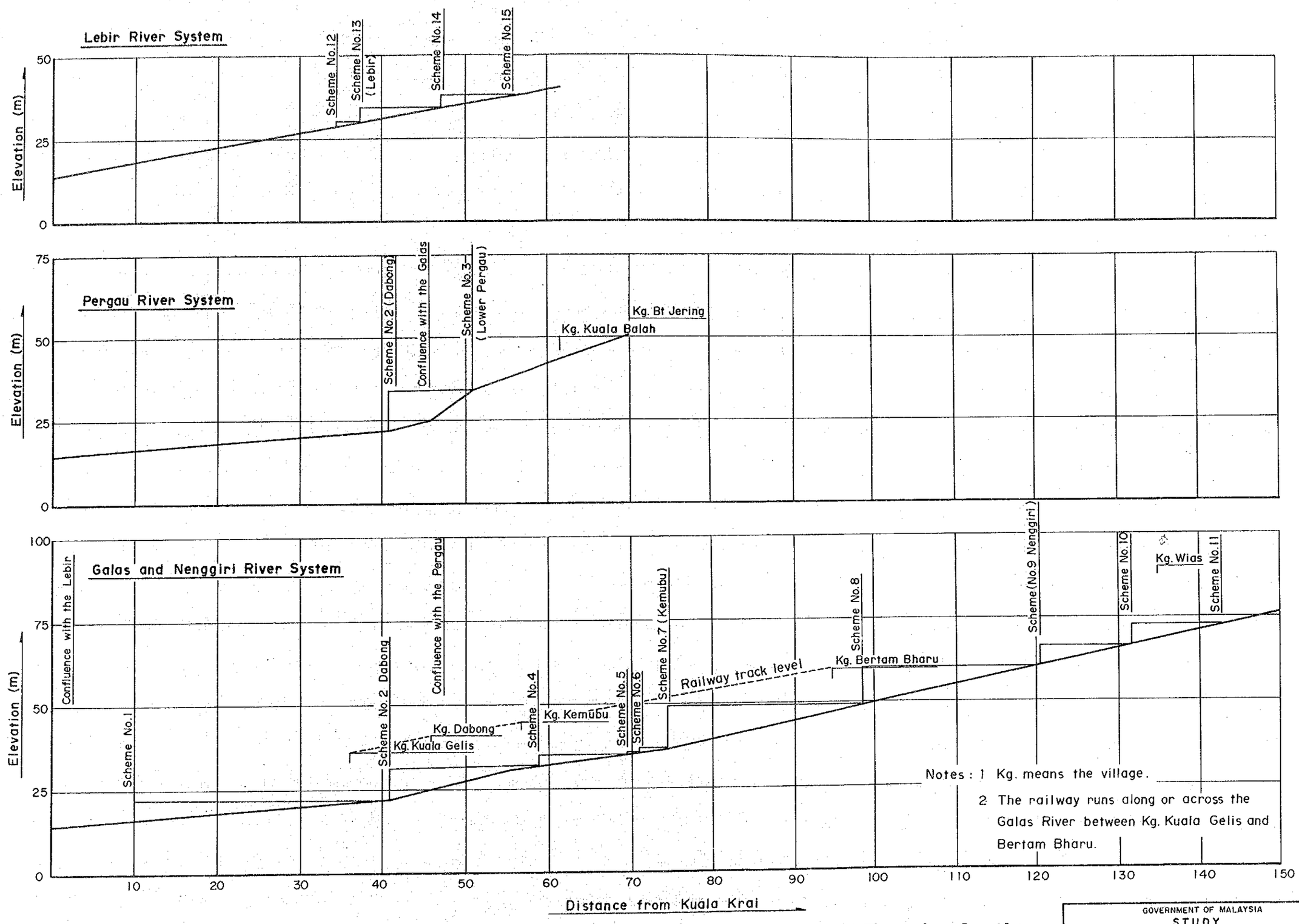

Fig.VI.B.2 Relationship between Location and Elevation for the Schemes Identified in the Kelantan River System

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ANNEX VII

ENVIRONMENTAL IMPACT STUDY

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VII. ENVIRONMENTAL IMPACT STUDY

1. INTRODUCTION

The land in the study area, i.e. the Kelantan River basin is topographically classified into two; hilly and flat land in the northern part and mountainous land in the southern part. The northern part is well developed as agricultural lands. The southern part is reserved as forest lands. Various kinds of wildlives and aborigines in Malaysia called Orang Asli inhabit and migrate in the forest land. In fact, the southmost area is enacted as Taman Negara (National Park) for protecting wildlives. On the other hand, logging activities in this forest land are progressed in a considerably high pace as a major source of foreign exchange earning.

Flood mitigation in the downstream reaches of the Kelantan River is contemplated by regulating flood flow by the reservoirs created by dam in the upstream reaches and river improvement in the downstream river stretch. The dam schemes conceived to be promising for flood mitigation are the Dabong, Kemubu, Nenggiri, Lower Pergau and Lebir as shown in Fig.VII.1.1, out of which one or two dam schemes will finally be selected as the structural measures for the flood mitigation in the downstream reaches of the Kelantan River.

The proposed five dam schemes are located in the southern hilly and mountainous areas covered with forests, and will have a considerably large reservoir area, resulting in property losses due to submergence and environmental changes. Considering these points, the objectives of the environmental impact survey are focussed on the following:

- to analyse the present environmental status of the Kelantan River basin, and
- to point out environmental problems in relation to basin-wide flood mitigation plan, especially the creation of reservoirs by dam schemes.

The following three environmental impact assessment reports are available in this study area;

(1) Nenggiri Dam Project Feasibility Study
Environmental Impact Assessment (September 1986)

(2) Pergau Hydroelectric Project, Volume 6
Environment and Socio-economic Study (June 1987)

(3) Environmental Impact Statement for the Lebir Dam Project in Malaysia (February 1988).

The environmental impact survey in this study is in

principle based on the review of the above three reports, however, new data will also be collected for the study, if necessary. In this Report, the present environmental status in the Kelantan River basin is presented.

Since the creation of reservoirs by dam is conceived to have considerable impacts to the surrounding environment, following items will mainly be surveyed in the Kelantan River basin focussing on the impact due to the creation of reservoir:

- River Environment (water quality, and fish and fisheries)
- Flora
- Fauna
- Ethnicity
- Public Health.

2. PRESENT ENVIRONMENTAL STATUS OF THE SURVEY AREA

2.1 General

The objective of this section is to understand the present environmental status of the survey area in relation to river environment, flora, fauna, ethnicity and public health which are anticipated to be influenced by the creation of large scale reservoirs.

2.2 River Environment

2.2.1 General

The Kelantan River drains a total area of more than 13,000 km^2 and comprises virtually the whole of the State of Kelantan located in the north-eastern part of Peninsular Malaysia. The basin area is bounded by the State of Perak and Thailand on the west, by the State of Pahang on the south and by the State of Terengganu on the east.

Main tributaries of the Kelantan River are the Galas and Lebir rivers. The Galas River is further divided into the Nenggiri and Pergau rivers.

Organic pollution in the rivers is caused by domestic and industrial sewage in the urban areas and effluent from rubber factories, palm oil mills and animal husbandries in the rural areas. Fig.VII.2.1 shows the organic pollution sources in the Kelantan River, which are mainly located downstream of Kuala Krai. A part of waste water from Kota Bharu, which is the largest pollution source in the basin, drains to the Kelantan River some 10 km upstream from the estuary, resulting in no direct relation with this environmental impact study.

2.2.2 Water quality of the Kelantan River system

Chemical quality of surface water in the Kelantan River was recently surveyed by DID at five monitoring stations as shown in Fig.VII.2.2. The results of analyses are shown in Tables VII.2.1 to VII.2.3. On the other hand, some environmental impact assessment of dam projects in the Kelantan River reports the results of water quality survey as shown in Tables VII.2.4 and VII.2.5.

(i) pH

The Kelantan River system is in general neutral with pH values ranging from 6.3 to 7.6 (refer to Tables VII.2.1 to VII.2.3). A little lower value representing slightly acidic water is observed at the Lebir River. Fig.VII.2.3 depicts the variation of pH values observed at Guillemard Bridge.

(ii) Suspended solid (SS)

Suspended solid in water samples shows high concentration with the range of 5.0 to 244.0 mg/l in surface water as given in Fig.VII.2.4. High concentration of suspended solids detected in the Kelantan River is considered to be associated with heavy rainfall prior to sampling. At the monitoring stations located upstream, SS level is relatively low. However, river water presents a reddish brown colour which indicates characteristics of laterite.

(iii) Dissolved oxygen (DO)

Dissolved oxygen measured in the Kelantan River indicates an amount of more than 7.0 mg/l except the measurement on September 15, 1987, the level of which accounts for high saturation as given in Fig.VII.2.5.

(iv) Biochemical oxygen demand (BOD)

BOD concentration in the Kelantan River is low except for the measurement on July 28, 1987 as shown in Fig.VII.2.6. This means that there are no high pollution sources along the Kelantan River.

(v) Total phosphorus (T-P)

The level of phosphorus indicates the values of 0.08 to 0.60 mg/l in the Kelantan River. This high level of phosphorus is likely to be associated with heavy rainfall prior to sampling; that is, heavy rainfall flushes out sediments deposited in the riverbed. On the contrary, the level of phosphorus in the upper reaches of the Kelantan River indicates the low values of N.D - 0.23 mg/l at the Lebir River and 0.01 - 0.07 mg/l at the Nenggiri River (refer to Tables VII.2.4 and VII.2.5).

(vi) Other parameters related with water quality

Although the Kelantan River is a tidal river, the average of the chloride level is 2.8 mg/l at Guillemard Bridge. Therefore, there is no influence of tide in the middle stream of the Kelantan River. Further discussions on salt water intrusion are discussed in Annex VI.

The level of all metal ions is low in all the water samples obtained from the Kelantan River system.

2.2.3 Fish and fisheries

(1) Fish fauna

The number of species of fishes that inhabit in rivers, stream and swamps in Peninsular Malaysia is probably less than two hundred. This is far less, of course, than sea fishes, but the fresh-water ones are not without economic importance.

The Kelantan River system is well known as an abundant area of freshwater fishes. Table VII.2.6 shows the fish species in the Kelantan River system. Besides, there are some rare and endangered fish species in the Kelantan River system as given in Tables VII.2.7 and VII.2.8.

(2) Fisheries

The existing fisheries in the Kelantan River system consist mainly of artisanal fisheries in a small scale. The majority of participants within riverine fisheries is part-time fishermen who catch fish mainly for their own consumption. There is only a small group of fishermen who actively participate in the fisheries in full time.

The majority of part-time fishermen within the Kelantan River system fishes using artisanal gears such as hand lines, cast nets, small gill nets and traps.

The most common species are Lompan Jawa, Lee Koh, Tongsang Makan Rumput, Tongsang Kepala Besar which constitute about 60% of the total freshwater fish production in 1985 as shown in Table VII.2.9. Recently, the production of Jelawat and Udang Galah is increasing.

2.2.4 Assessment of existing river environment

(1) Water quality

The water quality of the Kelantan River system in its upstream and middle stretches is not highly contaminated except for the total phosphorus. The level of total phosphorus indicates the high value in middle reach of the Kelantan River. While, the level of Suspended Solid indicates the high value. This high level is considered to be caused by crumbly laterite of river banks.

The water quality in the downstream stretch of the Kelantan River has been deteriorated by industrial and domestic sewage, especially by sewage from Kota Bharu.

(2) Fish and fisheries

There are 55 species observed in the Kelantan River system. However, it is impossible to assess the number of species of fish fauna in the Kelantan River system from these data. It is reported that there are some rare and endangered fish species in the Kelantan River system.

2.3 Flora

2.3.1 General

The flora of Malaysia (Peninsular Malaysia and Singapore, 132,100 km^2) is exceedingly rich, and is conservatively estimated to comprise 7,900 species and 1,500 genera of seed plants. While, the British Isles (311,000 km^2) in the north temperate zone have an area 2.3 times larger than Malaysia, but the kind of species is not so much as being 1,430 species (18%) and 628 genera (42%) native.

Sumatra, Malaysia and Borneo, lying on the Sunda shelf in the centre of the western part of the Indo-Malaysia tropical forest, have close floral similarities, but there are also marked diversities among species in the different regions of the tropical forest.

2.3.2 Forest

The natural vegetation in the Kelantan River basin mostly consists of tropical rain forest which has the most complex and abundant species. This forest mainly consists of lowland Dipterocarps.

The type of vegetation in the Kelantan River basin will be classified into the five categories, i.e. (i) lowland Dipterocarp forests, (ii) hill Dipterocarp forests, (iii) riverine vegetation, (iv) secondary vegetation which is defined as planted forest and (v) mixed vegetation which is the combined type of the riverine and secondary forests. Although there are no data showing their distribution, it is presumed that lowland and hill Dipterocarp forests are located in the upper reach of the Kelantan River basin, and riverine vegetation is located along the Kelantan River system. Almost all secondary vegetation and mixed vegetation are located in the middle and lower reaches of the Kelantan River basin.

According to the foregoing three EIS reports, there are no data about precious or rare species in the Kelantan River basin. Three EIS reports described as follows;

Lebir dam project;

There was a total of 452 samples in Plot 1 comprising 122 plant species from 79 Genera and 35 Families. In Plot 2 only 311 specimens were recorded and was made up of 95 Species, 65 Genera and 27 Families. When the two plots were combined, 185 species were recorded consisting of 102 Genera and 40 Families. Those species common to the both plots were very few. This represents a typical distribution of the plant species in tropical zones.

Nenggir dam project;

There are various endemical species of plants and ferns in the examined area. Hibiscus floccolusus, a 25 m high tree, is a regional species which could be an attractive ornamental tree. Another regional species is Ficus semicordata which bears fruits at ground level.
Among rare ferns are to be quoted the epiphyte Davallia corniculata, two terrestrial species (Amphineuron terminans and Mesophlebion trichopodum) and two new species for the region, Lygodium auriculatum and Osmunda bachelli.

Pergau dam project;

The plant lists indicate a flora typical of Peninsular Malaysia with some influence of Siamese elements.

While, in respect of the nature conservation, forest reserve areas are designated in the south-east and south-west of the State of Kelantan as shown in Fig. VII.2.7.

2.4 Fauna

2.4.1 General

Animals of south-east Asia are divided into two groups corresponding to the Sunda and Sahul shelf areas by the Weber's line. Animals in Malaysia belong to the Sunda group.

The Sunda group is an extensively placental mammal fauna and of clear continental Asiatic origin. It includes primates, tigers, elephants, monkeys and ungulates. Majority of them is strictly arboreal and is living in the dense forest for habitat and food.

2.4.2 Present status of fauna

(1) Mammals

It is stated in the previous EIS reports that the mammalian fauna in the State of Kelantan is rich. Mammals recorded in the upper reaches of the Kelantan River system are shown in Table VII.2.10. Among those mammals, eight species are endangered. They are Stump-tailed macaque, Indian elephant, Red dog, Leopard panther, Malaysian tiger, Banteng, Malaysian tapir and Sumatran rhinoceros.

In Peninsular Malaysia, there are two most popular macaques observed. They are Long-tailed and Pig-tailed macaques. However, it becomes very difficult and rare to observe them at hinterland areas.

(2) Avifauna