JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF IRRIGATION AND DRAINAGE
MINISTRY OF AGRICULTURE
MALAYSIA

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

VOL. I

EXECUTIVE SUMMARY

AUGUST 1994

CTI ENGINEERING CO., LTD.

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DEPARTMENT OF IRRIGATION AND DRAINAGE
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LIST OF REPORTS

VOL. I	*EXECUTIVE SUMMARY*
VOL. II	*MAIN REPORT, MASTER PLAN STUDY*
VOL. III	*MAIN REPORT, FEASIBILITY STUDY*
VOL. IV	*SUPPORTING REPORT - 1*
VOL. V	*SUPPORTING REPORT - 2*
VOL. VI	*DATA BOOK*
VOL. VII	*DRAWINGS*
VOL. VIII	*PHOTOGRAPHS*

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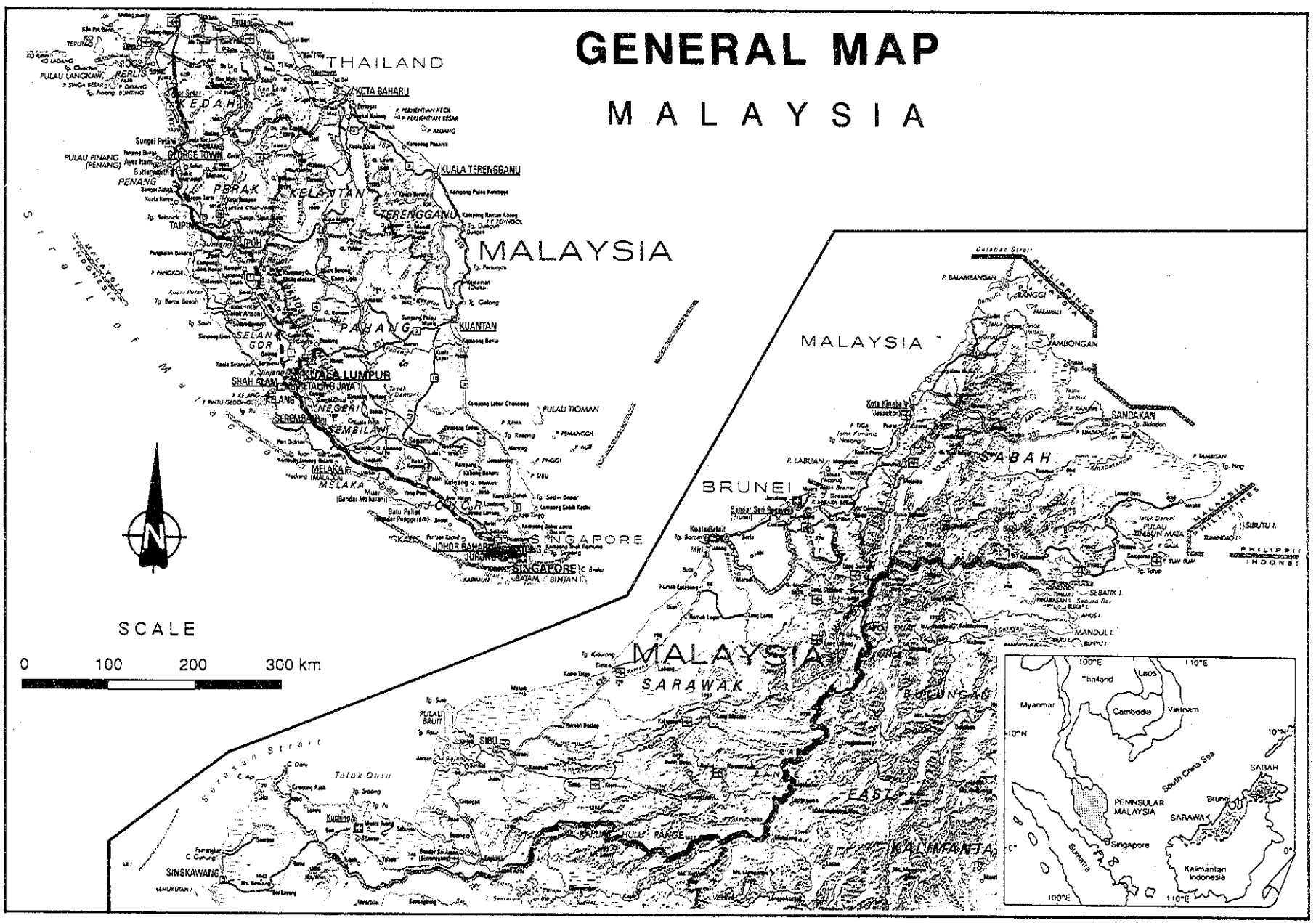
GENERAL MAP
MALAYSIA
THAILAND
MALAYSIA
SINGAPORE
BRUNEI
INDONESIA
PHILIPPINES
KOTA BAHARU
KUALA TERENGGANU
GEORGE TOWN
IPOH
KUANTAN
KUALA LUMPUR
SHAH ALAM
PETALING JAYA
JOHOR BAHARU
SINGAPORE
BATAM
BINTAN
KOTA KINABALU
SANDAKAN
TAWAU
LABUAN
SIBUTU I.
SEBATIK I.
MANDUL I.
KUCHING
SIBU
SINGKAWANG
PULAU PINANG (PENANG)
PULAU LANGKAWI
PULAU TIOMAN
KEDAH
PERLIS
PERAK
KELANTAN
TERENGGANU
PAHANG
SELANGOR
NEGERI SEMBILAN
MELAKA (MALACCA)
JOHOR
SABAH
SARAWAK
KALIMANTAN
PENINSULAR MALAYSIA
Strait of Malacca
Sulawesi Sea
Sibutu Passage
Telok Datu
Kapuas Hulu Range
SCALE
0 100 200 300 km
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Thailand
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Myanmar
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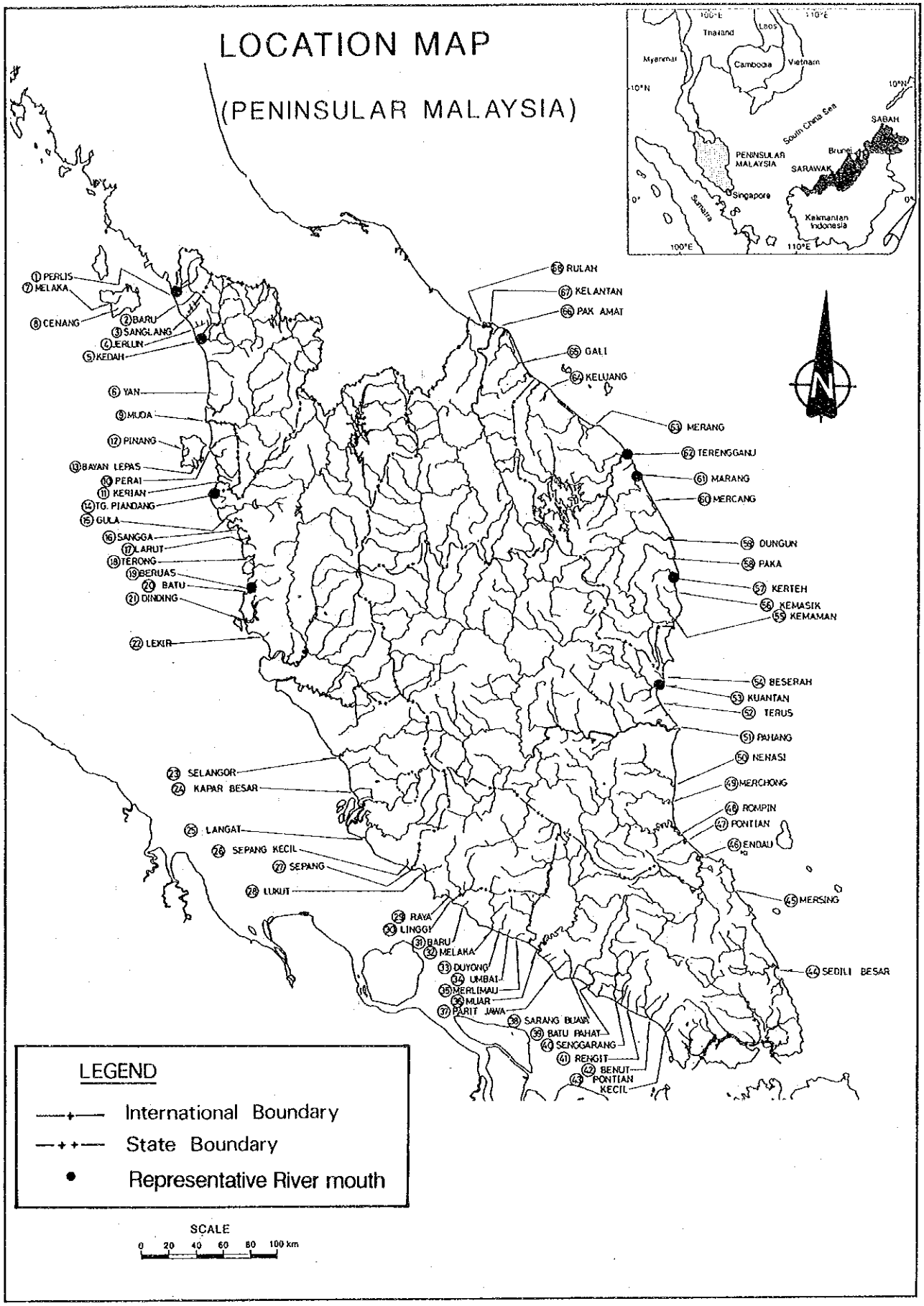
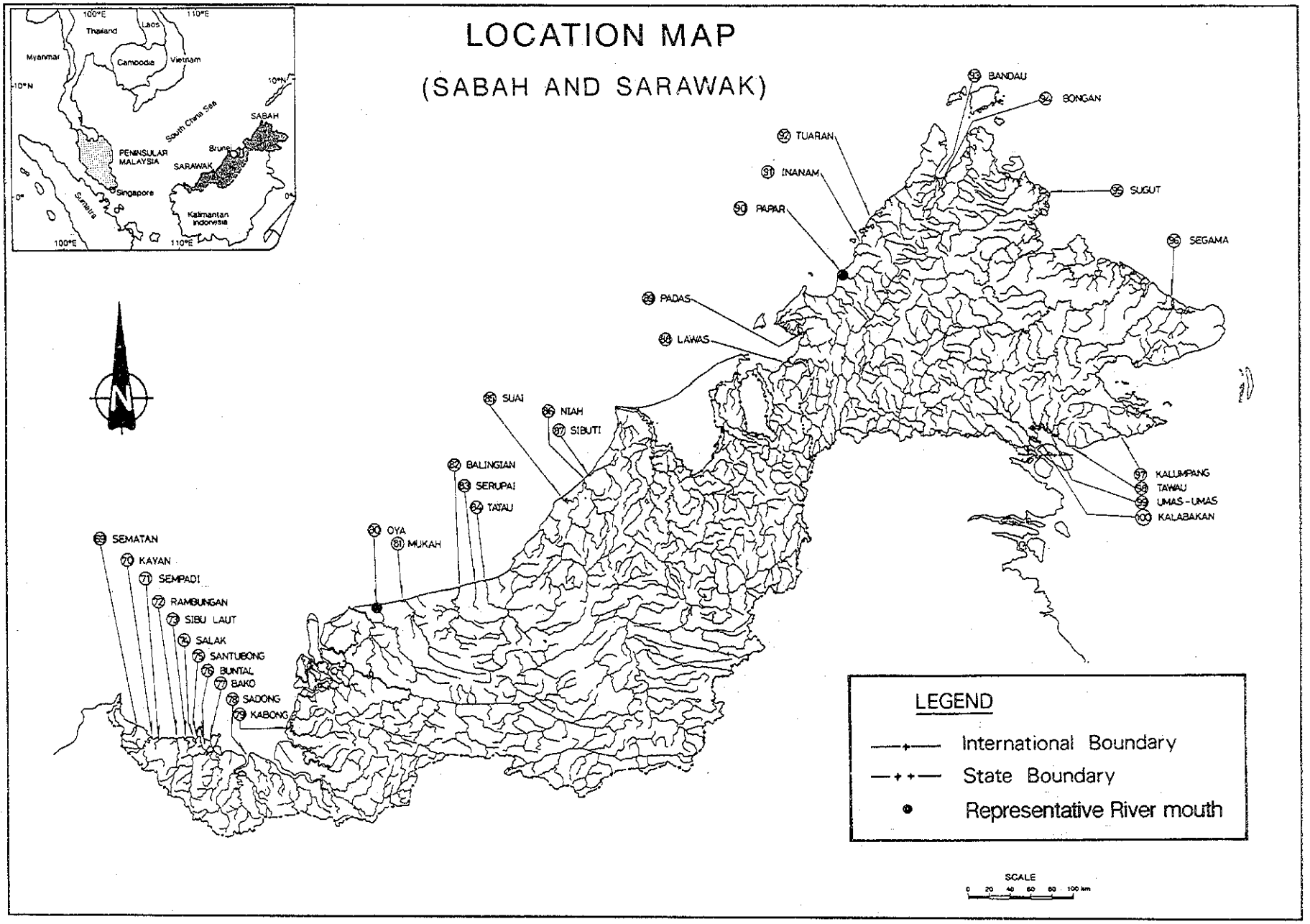

LOCATION MAP
(PENINSULAR MALAYSIA)
Thailand
Laos
Myanmar
Cambodia
Vietnam
South China Sea
SABAH
Brunei
PENINSULAR MALAYSIA
SARAWAK
Singapore
Sumatra
Kalimantan Indonesia
100°E
110°E
10°N
0°
1 PERLIS
7 MELAKA
8 CENANG
2 BARU
3 SANGLANG
4 JERLUN
5 KEDAH
6 YAN
9 MUDA
17 PINANG
13 BAYAN LEPAS
14 PERAI
11 KERIAN
12 TG. PIANDANG
15 GULA
16 SANGGA
17 LARUT
18 TERONG
19 BERUAS
20 BATU
21 DINDING
22 LEKIR
23 SELANGOR
24 KAPAR BESAR
25 LANGAT
26 SEPANG KECIL
27 SEPANG
28 LUKUT
29 RAYA
30 LINGGI
31 BARU
32 MELAKA
33 DUYONG
34 UMBAI
35 MERLIMAU
36 MUAR
37 PARIT JAWA
38 SARANG BUAYA
39 BATU PAHAT
40 SENGGARANG
41 RENGIT
42 BENUT
43 PONTIAN KECIL
44 SEDILI BESAR
45 MERSING
46 ENDAU
47 PONTIAN
48 ROMPIN
49 MERCHONG
50 NENASI
51 PAHANG
52 TERUS
53 KUANTAN
54 BESERAH
55 KEMAMAN
56 KEMASIK
57 KERTEH
58 PAKA
59 DUNGUN
60 MERCANG
61 MARANG
62 TERENGGANU
63 MERANG
64 KELUANG
65 GALI
66 PAK AMAT
67 KELANTAN
68 RULAH
N
LEGEND
International Boundary
State Boundary
Representative River mouth
SCALE
0 20 40 60 80 100 km


LOCATION MAP
(SABAH AND SARAWAK)
100°E
110°E
Thailand
Laos
Myanmar
Cambodia
Vietnam
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South China Sea
SABAH
PENINSULAR MALAYSIA
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Sumatra
Kalimantan Indonesia
N
BANDAU
BONGAN
TUARAN
INANAM
SUGUT
PAPAR
SEGAMA
PADAS
LAWAS
SUAI
NIAH
SIBUTI
BALINGIAN
SERUPAI
TATAU
OYA
MUKAH
SEMATAN
KAYAN
SEMPADI
RAMBUNGAN
SIBU LAUT
SALAK
SANTUBONG
BUNTAL
BAKO
SADONG
KABONG
KALUMPANG
TAWAU
UMAS-UMAS
KALABAKAN
LEGEND
International Boundary
State Boundary
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SCALE
0 20 40 60 80 100 km

Preface

In response to a request from the Government of Malaysia, the Government of Japan decided to conduct the National River Mouths Study in Malaysia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Malaysia a study team headed by Mr. Katsuhisa Abe, CTI Engineering Co., Ltd., four times between January 1992 and June 1994.

The Team held discussions with the officials concerned of the Government of Malaysia, and conducted field surveys at the study area. After the Team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the Team.

August 1994

KIMIO FUJITA
President
Japan International Cooperation Agency

August 1994

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

S i r :

LETTER OF TRANSMITTAL

We are pleased to submit herewith the Final Report on the National River Mouths Study in Malaysia. The report contains the advices and suggestions of the authorities concerned of the Government of Japan and the Japan International Cooperation Agency (JICA), as well as the formulation of river mouth improvement projects. Also included are comments made by the Ministry of Agriculture and other agencies concerned of His Majesty's Government of Malaysia during the technical discussions on the Draft Final Report in Kuala Lumpur.

The Final Report presents the Master Plan covering the 75 river mouths in Malaysia which were selected from the 100 objective river mouths initially proposed for the study. It also presents the Feasibility Study on river mouth improvement projects for the two river mouths selected from the critical group.

In view of the urgency and necessity of socio-economic development, we recommend that His Majesty's Government of Malaysia promote the river mouth improvement projects to the next stage of implementation at the earliest opportunity.

We wish to take this opportunity to express our sincere gratitude to JICA, the Ministry of Foreign Affairs, the Ministry of Construction, and other offices concerned. We also wish to express our deep gratitude to the Department of Irrigation and Drainage of the Ministry of Agriculture and other authorities concerned of His Majesty's Government of Malaysia for the close cooperation and assistance extended to us during our investigation and study.

Very truly yours,

KATSUHISA ABE
Team Leader
The National River Mouths Study
in Malaysia

Encl.: a/s

OUTLINE OF THE PROJECT

MASTER PLAN STUDY

1.	Objective River Mouths	:	100 river mouths
2.	River Mouth Category based on Seriousness of River Mouth Problem		
	(a) Critical Category	:	35 river mouths
	(b) Significant Category	:	40 river mouths
	(c) Acceptable Category	:	25 river mouths
3.	Objective River Mouth for Master Plan (Critical and Significant Categories)	:	75 river mouths
4.	Countermeasures for River Mouth Improvement	:	Combination of Capital and Maintenance Dredging, or Capital Dredging and Structural Measures including breakwater, jetty, groin, reservoir, etc.
5.	Project Benefit	:	Flood mitigation and sea transport including increase of fish catch, savings on operation cost, savings on fishermen's opportunity cost, etc.

6. Project Cost (Initial Cost and Maintenance Cost for 30 years expressed in a manner of Net Present Value with Discount Rate of 8%)

(a)	All River Mouths (75)	:	RM 724,299,000
(b)	Critical Category Only (35)	:	RM 472,575,000
(c)	Significant Category Only (40)	:	RM 251,724,000

7. Project Benefit (Benefit for 30 years expressed in a manner of Net Present Value with Discount Rate of 8%)

(a)	All River Mouths (75)	:	RM 519,998,000
(b)	Critical Category Only (35)	:	RM 463,065,000
(c)	Significant Category Only (40)	:	RM 56,993,000

8. Economic Evaluation (Evaluated in a manner of B/C ratio)

(a)	All River Mouths (75)	:	0.72
(b)	Critical Category Only (35)	:	0.98
(c)	Significant Category Only (40)	:	0.23

9. First Phase Project

(a)	Objective River Mouths (Critical Category Only)	:	35 river mouths
(b)	Target Year	:	2005
(c)	Initial Cost	:	RM 199,962,000

(d) Maintenance Cost (per year after 2005) : RM 19,667,000

(e) Internal Rate of Return (IRR) : 11.5%

FEASIBILITY STUDY

1. Objective River Mouths (2) : Tanjung Piandang and Marang

2. Features of Tanjung Piandang River Mouth Improvement Project

(a) Design Boat Size : 10 GRT

(b) Countermeasures : Capital and Maintenance Dredging.

(c) Dredging Stretch

- Inner Channel : 0.9 km
- Outer Channel : 1.9 km

(d) Design Cross Section

- Bottom Width : 28 m
- Depth : LSD -2.5 m
- Slope Gradient : 1 : 5

(e) Volume of Capital Dredging

- Inner Channel : 58,900 m^3
- Outer Channel : 56,500 m^3

(f) Volume of Maintenance Dredging

- Inner Channel : 7,500 m^3
- Outer Channel : 47,900 m^3

(g) Common Jetty for Landing : 1 unit

(h) Project Cost

- Initial Cost : RM 1,909,000
- Maintenance Cost (per year) : RM 660,000

(i) Implementation Period : 1 year

(j) Project Benefit

- Year 1996* : RM 899,400
- Year 2000 : RM 869,000
- Year 2005 : RM 834,000

* The year when full benefit is expected to accure.

(k) Economic Evaluation

- Economic Internal Rate of Return (EIRR) : 17.0%

- B/C : 1.17

3. Features of Marang River Mouth Improvement Project

(a)	Design Boat Size	:	40 GRT
(b)	Countermeasures	:	Combination of Jetty, Breakwater, River Groin, Coastal Groin, Reservoir, and Capital Dredging.

(c) Jetty (North Side)

-	Length	:	490 m
-	Crown Width	:	6 m
-	Design Height	:	LSD +3.0 to 5.0 m
-	Slope Gradient	:	1 : 2; 1 : 1.5

(d) Jetty (South Side)

-	Length	:	450 m
-	Crown Width	:	6 m
-	Design Height	:	LSD +3.0 to 5.0 m
-	Slope Gradient	:	1 : 2; 1 : 1.5

(e) Breakwater

-	Length	:	200 m
-	Crown Width	:	6 m
-	Design Height	:	LSD +5.0 m
-	Slope Gradient	:	1 : 2; 1 : 1.5

(f) River Groin

- No. of Units : 4 units
- Length : 40 m
- Crown Width : 4 m
- Design Height : LSD +1.1 m
- Slope Gradient : 1 : 3

(g) Coastal Groin

- No. of Units : 2 units
- Length : 200 m
- Crown Width : 4 m
- Design Height : LSD +2.0 m
- Slope Gradient : 1 : 1.5

(h) Reservoir

- No. of Units : 1 unit
- Reservoir Area : 11.6 ha

(i) Capital Dredging

- Length (Inner Channel) : 790 m
- Length (Outer Channel) : 460 m
- Bottom Width : 45 m
- Dredging Depth : LSD -3.5 m
- Slope Gradient : 1 : 3
- Volume of Dredging
  (Inner Channel) : 79,700 m^3
  (Outer Channel) : 51,300 m^3

(j) Project Cost

- Initial Cost : RM 15,366,000
- Maintenance Cost (per year) : RM 227,000

(k) Implementation Period : 2 years

(l) Project Benefit

- Year 1997* : RM 1,434,000
- Year 2000 : RM 1,552,000
- Year 2005 : RM 1,751,000

* The year when full benefit is expected to accrue.

(m) Economic Evaluation

- Economic Internal Rate of Return (EIRR) : 11.1%

- B/C : 1.30

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

VOLUME I

EXECUTIVE SUMMARY

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND GLOSSARY

Abbreviations

DID	:	Department of Irrigation and Drainage
DOA	:	Department of Agriculture
DOE	:	Department of Environment
DOF	:	Department of Fisheries
DOS	:	Department of Statistics
DSM	:	Department of Survey and Mapping
EPU	:	Economic Planning Unit
ESCAP	:	Economic and Social Commission for Asia and the Pacific (UNDP, United Nations Development Programme)
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GRT	:	Gross Relative Tonnage
JICA	:	Japan International Cooperation Agency
JKR	:	Jabatan Kerja Raya (Public Works Department)
JPS	:	Jabatan Pengairan dan Saliran (= DID)
JPT	:	Jabatan Parit dan Taliair (= DID)
LEO	:	Littoral Environmental Observations
LKIM	:	Lembaga Kemajuan Ikan Malaysia (Malaysian Fisheries Development Authority)
MD	:	Marine Department
MMS	:	Malaysian Meteorological Service
MOA	:	Ministry of Agriculture
MOF	:	Ministry of Finance
NCES	:	National Coastal Erosion Study
NWRS	:	National Water Resources Study (by JICA)
NDP	:	National Development Policy
OPP2	:	Second Outline Perspective Plan
PA	:	Port Authority
PPC	:	Penang Port Commission
TNB	:	Tenaga Nasional Berhad (National Electricity Corporation)

Unit of Measurement

Area

ha	:	hectare
m^2	:	square meter
km^2	:	square kilometer

Weight

kg	:	kilogram
ton	:	1,000 kg

Volume

l	:	liter
ton	:	tonnage
m^3	:	cubic meter

Others

°C	:	degree centigrade
m^3/s	:	cubic meter per second

Currency

RM	:	Malaysian Ringgit
US$	:	U.S. Dollar
¥	:	Japanese Yen

Malayan Terms

Kg.	:	Kampong (village)
Kuala	:	river mouth
Pulau	:	island
Sg.	:	Sungai (river)
Telok	:	bay
Tg.	:	Tanjung (headland)

1. GENERAL

1.1 Background of the Study

Malaysia, which achieved a commendable economic growth of 6.7% per annum during the Fifth Malaysia Plan from 1986 to 1990, stepped into the Sixth Malaysia Plan for the period from 1991 to 1995 to see the Malaysian economy growing at an average rate of 7.5% per annum. Public investment in this plan is expected to increase at 3.0% per annum compared with the 0.2% in the previous plan due to the expansion of infrastructure facilities, so as to remove bottlenecks and to encourage larger private investment. To attain this objective, it is necessary to solve several problems.

Malaysia is geographically featured with a land of 329,750 km^2 in total area and a coastal line of 4,840 km in total length. Numerous rivers and creeks exist therein, and river mouths have the problem of siltation due to the heavy sediment deposition from the upper streams coupled with longshore drift. This results in the reduction of flow area for river discharge during flood time and obstruction to the smooth navigation of ships and fishing boats.

The Government of Malaysia has been making every effort to alleviate the problem by dredging and constructing breakwaters. The efforts, however, have not always succeeded and, recognizing the severity of the problem of river mouth siltation nationwide, the Government had decided to implement the National River Mouths Study (hereinafter referred to as the Study) to formulate a Master Plan of River Mouth Improvement and to conduct a Feasibility Study for the Urgent Project selected out of the Master Plan.

1.2 Objectives of the Study

The objectives of the Study are:

(1) to formulate a Master Plan for the improvement of selected river mouths for flood mitigation and navigation; and

(2) to conduct a feasibility study on the improvement of two river mouths selected for flood mitigation and navigation.

1.3 Study Area

The study area is the whole country of Malaysia. The 100 objective river mouths selected by the Government of Malaysia are shown in Table 1-1.

2. CATEGORIZATION OF RIVER MOUTH

To select the river mouths for the Master Plan Study, the 100 river mouths were categorized according to the seriousness of the existing problems into Category 1 (Critical), Category 2 (Significant), and Category 3 (Acceptable). The categorization was done based on three aspects: (1) the Physical Aspect as determined from the comparison between the minimum depth of the river mouth and draft of the registered boat at the river mouth; (2) the Economical Aspect as determined by the number of fishermen using the river mouth; and (3) the Social Aspect as determined by complaints brought by fishermen to the office concerned. As a result, 35 river mouths were categorized under Category 1, 40 river mouths under Category 2, and 25 river mouths under Category 3. Among them, the 75 river mouths belonging to Category 1 and Category 2 were selected as the objective river mouths for the Master Plan Study.

3. FORMULATION OF MASTER PLAN

3.1 Selection of Countermeasures for Representative River Mouth

(1) Grouping of Objective River Mouth and Selection of Representative River Mouth

Since it was difficult to carry out the same level of master plan study for the 75 objective river mouths, they were divided into 10 groups according to the similarity of physical characteristics such as wave, river mouth features and bed materials. A representative river mouth was then selected from each group considering the availability of data, seriousness of problems and others. The optimum countermeasures for each representative river mouth have been examined in detail.

(2) River Mouth Problem for Representative River Mouth

River mouth problems are mainly the inundation problems and navigation problems. According to the interview survey, problems on inundation are not found on many river mouths, while navigation problems of fishing boats prevail in all the river mouths. The navigation problems are caused by insufficient channel depth, shifting of river mouth location, shifting of river channel course and intrusion of rough waves. The river mouth problems for the representative river mouths are summarized in the following table.

Name of River Mouth	Inundation Problem	Navigation Problem			
		Insufficient Depth Mouth	Shifting River Mouth	Shifting River Course	Intrusion of Rough Wave
Perlis	-	Yes	-	-	-
Kedah	-	Yes	-	-	-
Tg. Piandang	-	Yes	-	-	-
Beruas	-	Yes	-	-	-
Kuantan	-	Yes	-	-	-
Kerteh	-	Yes	Yes	-	-
Marang	-	Yes	Yes	Yes	Yes
Terengganu	Yes	Yes	-	Yes	Yes
Oya	-	Yes	Yes	-	-
Papar	-	Yes	Yes	Yes	-

(3) Countermeasures for Representative River Mouth

The optimum countermeasures to cope with the river mouth problems were selected through the comparison study among the alternative cases, as follows:

Name of River Mouth	Dredging (Capital, Mainte-nance)	Jetty	Break-water	River Groin	Coastal Groin	Train-ing Dike	Reser-voir
Perlis	Yes	-	-	-	-	-	-
Kedah	Yes	-	-	-	-	-	-
Tg. Piandang	Yes	-	-	-	-	-	-
Beruas	Yes	-	-	-	-	-	-
Kuantan	Yes	-	-	-	-	-	-
Kerteh	Yes*	Yes	-	-	Yes	-	Yes
Marang	Yes*	Yes	Yes	Yes	Yes	-	Yes
Terengganu	Yes	-	Yes	Yes	-	-	-
Oya	Yes	-	-	-	-	Yes	Yes
Papar	Yes*	Yes	-	Yes	Yes	-	Yes

* Capital Dredging only

(4) Cost of Countermeasures for Representative River Mouth

The cost of countermeasures for the representative river mouth were calculated, multiplying the unit cost by the work volume required for river mouth improvement.

The total cost, including initial and maintenance costs, was estimated in a manner of net present value (NPV), assuming that project life is 30 years and discount rate is 8%. (Refer to Table 3-1.)

(5) Benefit

Benefits on river mouth improvement basically include the flood control benefit and the navigation condition improvement benefits for fishing and commercial boats. Among the navigational benefits, those for the fishing boats were estimated considering the following aspects: savings on boat running cost, savings on fishermen's' opportunity cost, savings on fish refrigeration cost, and preservation of fish quality.

3.2 Countermeasures and Cost and Benefit for Other River Mouths

The countermeasures for the representative river mouth were applied to the other river mouths in the group. The cost and benefit for the other river mouths were modified from those of the representative river mouth considering the river mouth scale, number of fishing boats, etc.

3.3 Economic Evaluation of Master Plan

The economic viability of the Master Plan was evaluated in a manner of cost and benefit ratio (B/C). As identified in the B/C ratio of 0.72, the economic viability of the Master Plan is not so high. However, the economic viability for the critical group shows a relatively high economic return with the B/C ratio of 0.98, while that of the significant group is only 0.22 (refer to Table 3-1). Hence, the Master

Plan puts emphasis on the critical group of 35 river mouths, while project execution for the significant group of 40 river mouths considers the future development of the area surrounding the river mouth.

3.4 The First Phase Project

To facilitate the realization of the Master Plan, a First Phase Project in the critical group with the target year 2005 was examined considering the implementation schedule in accordance with the prioritization as shown in Table 3-2. As a result, the First Phase Project gives the EIRR of 11.5% which shows viability for realization.

4. FEASIBILITY STUDY

4.1. Selection of the Objective River Mouth

The objective river mouths for the Feasibility Study were selected from among those of the Master Plan Study under the following considerations:

(1) Two river mouths are selected from the group under Category 1 (Critical Condition).

(2) One of the objective river mouths selected is from a muddy coast and the other is from a sandy coast.

Among the river mouths under Category 1, the following are given high priority by each State:

Coast	State	River Mouth with High Priority
West Coast	Perlis	Perlis*
	Kedah	Kedah*
	P. Pinang	Muda
	Perak	Tg. Piandang*, Beruas*
	Selangor	Selangor*
	N.Sembilan	---
	Melaka	Melaka
East Coast	Kelantan	Kelantan
	Terengganu	Marang, Terengganu
	Pahang	Kuantan
	Johor	Mersing
	Sabah	---
	Sarawak	---

* River mouth located in a muddy coast.

The comparative study has led to the selection of the Tanjung Piandang and Marang river mouths, which are from a muddy coast and a sandy coast, respectively, for the following reasons:

(1) In the physical aspect, a river mouth with a small basin has less flow discharge to maintain the mouth open.

(2) In the economic aspect, the B/C ratio is high enough and worth conducting the feasibility study.

(3) In the social aspect, complaints of fishermen are very serious.

4.2. Improvement of Tanjung Piandang River Mouth

Optimum Countermeasures

(1) River Mouth Problem

In Tg. Piandang River Mouth the water depth which is only about 1.0 m below LSD (Land and Survey Datum) becomes some 10 cm at low tide both in the inner channel and the approach channel, while the draft of boat is about 1.5 m, so that fishing boats as well as fishing activities are forced to depend on the tide. (Refer to Fig. 4-1.)

River mouth shifting and wave intrusion are not serious problems at the Tg. Piandang River Mouth.

(2) Selection of Countermeasures

As the optimum countermeasure, dredging in combination with capital and maintenance dredging which has an economical advantage and is also reliable in the technical aspect is selected in the Master Plan Study.

Further Basic Study and Analysis

The following study and analysis were conducted to determine the design features and benefit for the river mouth improvement plan.

(1) Siltation Rate in the Navigation Channel

In the Master Plan, the siltation rate is presumed from the previous dredging records and hydrographic survey results. In this Feasibility Study, the siltation rate is examined by numerical analysis using the monitoring data on siltation for test pits as the data for verification. The siltation rate of 0.9 m/year in the outer channel and 0.3 m/year in the inner channel are obtained.

(2) Wave Intrusion into the River Mouth

In general, countermeasures are provided to keep the river mouth open, so that sea waves tend to intrude into the river mouth sometimes resulting in damage to facilities and ships moored around the river mouth. To confirm the magnitude of wave intrusion, wave refraction analysis was made and the results show that the wave height in the inner channel is less than 30 cm, which is within the limit in the guidelines used in Japan to plan fishing port facilities. Thus, the selected countermeasures are considered acceptable.

(3) Influence of Countermeasures to Adjacent Coastline

Countermeasures for river mouth improvement sometimes bring about adverse influence to the adjacent coastline in a manner of coastal erosion resulting in damage to assets and facilities. The influence of countermeasures were examined by numerical analysis. The results show that dredging does not bring about severe erosion to the adjacent coastline, while the coastline of the northern side of the river mouth is currently retreating.

Design Features for Project Formulation

In the Master Plan Study, the design boat size of 40 GRT is given as the design criteria. In this Feasibility Study, the design boat size was examined considering the present and the expected future distribution of boat size. Although the future distribution of boat size is difficult to project because of unknown factors involved such as fishing resources, market and government policy, DOF presumes the following future distribution:

Period	Distribution of Boat Size (No.)		
	10 GRT>	10-40 GRT	40 GRT<
Present	481	5	0
1995	476	0	0
2000	456	0	0
2005	438	0	0

According to the table above, it is expected that only boats with the size of less than 10 GRT will engage in fishing at the Tg. Piandang River Mouth even in 2005. There is no plan to accommodate fishing boats from the other river mouths nearby. Therefore, the design boat size of 10 GRT is applied to the design features of dredging in this Feasibility Study.

The dredging stretch seaward, which is decided by the distance from the river mouth to the point where the sea bed height corresponds to the design water depth, is 1.9 km from the river mouth.

The dredging stretch of the inner channel is from the river mouth to the point of 0.9 km where the design dredging width corresponds to the river width, although fishing boats cannot access to their private jetties located in the further upper reaches of the design dredging stretch.

To assure the landing of catch for such boats even at low tide, it is proposed to provide common jetties in the dredging stretch. (Refer to Fig. 4-2.)

Selection of Dredging Method

In accordance with the DID's guidelines, the dumping site of dredging material is proposed at a site located 3.0 km away from the river mouth.

Among several dredging methods applicable to the proposed navigation channel, the grab dredger, which has an economical advantage in consideration of dredging site and dumping site, is selected as the suitable dredging method.

Implementation Schedule

The implementation schedule is shown in Fig. 4-3. The project contains a few work items and the work quantities are rather small. Therefore, the project should be implemented altogether in the same year soon after the detail design work and fund preparation. All works, namely capital dredging, jetty and bank protection works, can be completed in the first year after commencement. In addition, maintenance dredging should be annually implemented.

Project Cost

The main work is channel dredging in combination with capital and maintenance dredging. As minor works, construction of common jetty and bank protection works are proposed. The project cost is summarized as below.

(a)	Main and Minor Works			
	Capital Dredging	:	RM	1,059,000
	Jetty Work	:	RM	88,000
	Bank Protection Works	:	RM	68,000
(b)	Miscellaneous Works	:	RM	122,000
(c)	Mobilization and Demobilization of Dredger and Barges	:	RM	134,000
(d)	Compensation Cost	:	RM	0
(e)	Engineering and Administration Cost	:	RM	147,000
(f)	Physical Contingencies	:	RM	162,000
(g)	Price Escalation	:	RM	129,000
	Total	:	RM	1,909,000
(h)	Annual Maintenance Dredging	:	RM	660,000

Project Benefit and Economic Evaluation

(1) Project Benefit

The benefit on fishing boats may include:

(a) increase in fish catch;

(b) savings on operation cost;

(c) savings on fishermen's opportunity cost;

(d) savings on fish refrigeration cost; and

(e) preservation of fish quality.

Among the benefits above, that on small fishing boats is expected to be only the increase in fish catch, judging from their fishing activities.

The presently estimated number of fishing boats and fishermen which will receive the benefit from the project is 480 and 720, respectively, and this may change in the future. The annual project benefit is calculated at RM 899,400 in 1996 when the benefit is expected to accrue, RM 869,000 in 2000 and RM 834,000 in and after 2005 in accordance with the change in number of boats in the future.

(2) Economic Evaluation

The economic viability is evaluated by internal rate of return (EIRR) and cost-benefit ratio (B/C), and the EIRR of 17.0% and B/C of 1.173 are figured out.

Preliminary Environmental Impact Assessment

(1) Major Environmental Impacts and the Consequences

The major environmental impacts arise from the project activities including capital dredging, spoil disposal and related activities, and the consequences are given as follows:

(a) Dredging will increase turbidity and possible release of trapped nutrients, organic matters and toxic substances from the sediment into the water phase. These impacts may not be significant because the river already carries a very high SS load.

(b) When the dredged spoil is disposed of at sea, the adverse impacts will be increased turbidity and possible release of trapped nutrients, organic matters and toxic substances into the water phase. The exceedance of the limit may not be of much significance in the case of Tg. Piandang because the metal level at depth is usually much lower than that at the surface, especially for polluted sediment.

(2) Mitigation of Dredging Impacts

The capital dredging should be scheduled to avoid the southwest monsoon season which generates big waves aggravating the turbidity and water quality problems if dredging activities are undertaken. In a similar manner, the daily dredging activities should be scheduled so as to minimize disruption to movement of fishing boats.

When the disposal of spoil is at sea, it is important to ensure that the disposal site is not in the near vicinity of known fishing grounds and aquaculture areas. In addition, the DID's guidelines pertaining to the disposal of dredged material at sea should be complied with.

4.3 Improvement of Marang River Mouth

Optimum Countermeasures

(1) River Mouth Problem

In the Marang River Mouth the water depth which is only about 1.5 m below LSD (Land and Survey Datum) becomes a few 10 cm at low tide in the navigation channel, while the draft of boat is about 2.5 m, so that fishing boats as well as tourist boats are forced to depend on the tide (refer to Fig. 4-4). The river mouth and the river channel shift in location and course and thus, unstable. Wave intrusion into the river mouth is expected to be severe when the river mouth is kept open.

(2) Selection of Countermeasures

As the optimum countermeasure, the combination of capital dredging, jetty, breakwater, river and coastal groins and reservoir is selected in the Master Plan Study.

Further Basic Study and Analysis

The following study and analysis were conducted to determine the design features and benefit for the river mouth improvement plan formulation.

(1) Siltation Rate in the Navigation Channel

In the Master Plan, it is assumed that siltation can be prevented by the construction of jetty to maintain the navigation channel without maintenance dredging. In this Feasibility Study, the siltation rate was examined through the hydraulic model experiment and it was confirmed that maintenance dredging in the navigation channel could be minimized.

(2) Wave Intrusion into the River Mouth

As in the case of Tg. Piandang River Mouth, the magnitude of wave intrusion by the river mouth improvement of Marang was also examined through the hydraulic model experiment. The results show that the wave height in the inner channel is less than 30 cm, which is within the limit in the guidelines used in Japan to plan fishing port facilities. Thus, the countermeasures are considered acceptable.

(3) Influence of Countermeasures to Adjacent Coastline

Countermeasures for river mouth improvement sometimes bring about adverse influence to the adjacent coastline in a manner of coastal erosion resulting in damage to assets and facilities. The influence of countermeasures was examined by numerical analysis. The results show that the countermeasures may bring about coastal erosion of 35 m in 30 years. However, the rate of retreat does not seem to be severe, although the shoreline is relatively stable around the Marang River Mouth in these years.

Design Features for Project Formulation

(1) Design Boat Size

In the Master Plan Study, the design boat size of 40 GRT is given as the design criteria. The same design boat size is adopted in this Feasibility Study considering those at the present condition and future prospect, as follows.

Period	Distribution of Boat Size (No.)		
	10 GRT>	10 - 40 GRT	40 GRT<
Present	140	48	0
1995	130	40	0
2000	110	30	10
2005	90	20	20

(2) Design Water Depth and Dredging Stretch

The design depth for the navigation channel is decided on the basis of the draft of design boat and allowance. In this connection, a clearance of 1.0 m is applied for the 40 GRT boat size, while the design draft is 1.7 m. The design water depth is 3.5 m below LSD, considering that MLLW is -0.8 m LSD.

The dredging stretch seaward, which is decided by the distance from the river mouth to the point where the sea bed height corresponds to the design water depth, is 460 m from the river mouth.

The dredging stretch of the inner channel is from the river mouth to the center of the port of 790 m where landing facilities are located.

(3) Structures

The design features of the structures examined through the hydraulic model experiment are as follows (refer to Fig. 4-5):

Jetty

- North Jetty : 490 m
- South Jetty : 450 m

Breakwater	:	200 m
River Groin	:	40 m x 4
Coastal Groin	:	200 m x 2
Reservoir	:	11.6 ha

Implementation Schedule

The project consists of the construction of north and south jetties, breakwater, river and coastal groins, reservoir and dredging of the navigation channel.

The proposed implementation period is two years, including mobilization and preparatory works (refer to Fig. 4-6). This was decided considering previous practices on similar projects.

Project Cost

The project cost is summarized as follows:

(a)	Preparatory Works	:	RM	1,066,000
(b)	Main Works			
	Breakwater	:	RM	2,836,000
	North Jetty	:	RM	2,774,000
	South Jetty	:	RM	1,737,000
	River Groin	:	RM	196,000
	Coastal Groin	:	RM	1,270,000
	Navigation Channel Dredging	:	RM	1,295,000
	Reservoir	:	RM	41,000
(c)	Miscellaneous Works	:	RM	507,000
(d)	Compensation Cost	:	RM	0
(e)	Engineering and Administration Cost	:	RM	1,172,000
(f)	Physical Contingencies	:	RM	1,289,000
(g)	Price Escalation	:	RM	1,183,000
	Total Estimated Construction Cost	:	RM	15,366,000
(h)	Annually Recurrent O&M Cost	:	RM	227,000

Project Benefit and Economic Evaluation

(1) Project Benefit

The presently estimated number of fishing boats, fishermen and tourist boats which will receive the benefit from the project is about 170, 350 and 20, respectively, which may change in the future. The annual project benefit is calculated as below.

Year	Fishery	Sea Transport	Total (RM)
1997*	1,153,000	281,000	1,434,000
2000	1,254,000	298,000	1,552,000
2005	1,422,000	329,000	1,751,000

* The year when full benefit is expected to accrue, although partial benefit is expected in 1996.

(2) Economic Evaluation

The economic viability is evaluated by internal rate of return (EIRR) and cost-benefit ratio (B/C), and the EIRR of 11.1% and B/C of 1.302 are figured out.

Preliminary Environmental Impact Assessment

(1) Major Environmental Impacts

Major environmental impacts could arise from project activities including capital dredging and construction of structures. No significant impact is anticipated in the disposal of dredged material.

(2) Mitigation of Dredging Impacts

The construction of structures scheduled after the known breeding period of a number of economically important species of fish should begin from March to avoid interference with the normal breeding period.

The capital dredging should be scheduled to avoid the northeast monsoon season which generates big waves aggravating the turbidity and water quality problems if dredging activities are undertaken. The daily dredging and construction activities should be scheduled so as to minimize the disruption to the movement of fishing and tourist boats.

5. RECOMMENDATIONS

(1) The Master Plan for the river mouth improvement project is formulated to cover 75 river mouths. Although the economic viability of the Master Plan is not high, this kind of infrastructure project is essential to improve the living conditions of people in the vicinity of the river mouth. In this connection, it is recommended that the Master Plan be considered as a part of the Malaysian National Development Plan.

(2) To facilitate the realization of the Master Plan, a First Phase Project having 2005 as the target year is also formulated putting emphasis on the improvement of the 35 river mouths in critical condition identified in the Study. The First Phase Project should be considered for further study, since its economic viability of EIRR 11.5% with the total cost of about RM 300 million is high enough to promote it to the further study stage. In consideration of the future development of the fishing industry, however, the prioritization of components of the First Phase Project should be carefully made.

(3) In the Feasibility Study, river mouth improvement plans for Tg. Piandang and Marang are formulated, and it is confirmed that the river mouth improvement projects for the two river mouths are both technically feasible

and economically viable with the Economic Internal Rate of Return (EIRR) of 17.0% and 11.1%, respectively. Therefore, it is strongly recommended that the projects be promoted to the next stage of implementation at the earliest possible opportunity.

(4) In the case of Tg. Piandang River Mouth, dredging in combination with capital and maintenance dredging is selected as the optimum countermeasure. Under past experiences, only capital dredging is undertaken and maintenance dredging is never executed due to financial restrictions, so that the river mouth easily returns to its original condition before dredging. In this connection, it is recommended that maintenance dredging should be carried out regularly to ensure the accessibility of the river channel throughout the year and, for the purpose, the provision of funds for maintenance dredging should be considered from among the options for financial sources including the Federal and State governments and beneficiaries.

(5) In the case of Marang River Mouth, structures including the jetty, the breakwater, the river and coastal groins, and the reservoir, as well as capital dredging, are selected as the optimum countermeasures. Such coastal structures may bring about adverse influences to the adjacent coastal zone. Therefore, the construction should be carefully implemented by monitoring the influences.

TABLES

Table 3-1 LIST OF OBJECTIVE RIVER MOUTHS AND CATEGORIZATION FOR THE STUDY

River Mouth Serial	River Mouth Name	State	Catchment Area (km2)	Category *1
1	Perlis	Perlis	600	1
2	Baru	"	80	1
3	Sanglang	Kedah	80	1
4	Jerlun	"	40	1
5	Kedah	"	4,040	1
6	Yan	"	10	1
7	Melaka	"	40	3
8	Cenang	"	10	1
9	Muda	P. Pinang	4,300	1
10	Perai	"	450	3
11	Kerian	"	1,420	1
12	Pinang	"	20	1
13	Bayan Lepas	"	7	2
14	Tg. Piandang	Perak	9	1
15	Gula	"	30	1
16	Sangga	"	170	2
17	Larut	"	170	2
18	Terong	"	60	2
19	Beruas	"	240	1
20	Batu	"	70	2
21	Dinding	"	370	3
22	Lekir	"	5	2
23	Selangor	Selangor	1,820	1
24	Kapar Besar	"	110	2
25	Langat	"	1,815	2
26	Sepang Kecil	"	50	2
27	Sepang	"	90	2
28	Lukut	N. Sembilan	120	3
29	Raya	"	10	3
30	Linggi	"	1,270	1
31	Baru	Melaka	25	2
32	Melaka	"	500	1
33	Duyong	"	40	2
34	Umbai	"	20	2
35	Merlimau	"	30	2
36	Muar	Johor	6,160	2
37	Parit Jawa	"	80	2
38	Sarang Buaya	"	170	2
39	Batu Pahat	"	2,230	2
40	Senggarang	"	70	2
41	Rengit	"	100	2
42	Benut	"	440	2
43	Pontian Kecil	"	40	1
44	Sedili Besar	"	1,445	1
45	Mersing	"	250	1
46	Endau	"	4,740	1
47	Pontian	Pahang	240	3
48	Rompin	"	3,980	1
49	Merchong	"	500	3
50	Nenasi	"	860	1
51	Pahang	Pahang	29,140	1
52	Terus	"	40	2
53	Kuantan	"	1,710	1
54	Beserah	"	20	3
55	Kemaman	Terengganu	1,775	1
56	Kemasik	"	40	2
57	Kerteh	"	240	2
58	Paka	"	850	1
59	Dungun	"	1,875	1
60	Mercang	"	150	2
61	Marang	"	460	1
62	Terengganu	"	4,650	1
63	Merang	"	210	2
64	Keluang	"	80	3
65	Gali	Kelantan	10	3
66	Pak Amat	"	20	2
67	Kelantan	"	12,900	1
68	Rulah	"	20	3
69	Sematan	Sarawak	210	2
70	Kayan	"	1,020	2
71	Sempadi	"	90	3
72	Rambungan	"	120	3
73	Sibu Laut	"	120	3
74	Salak	"	80	3
75	Santubong	"	60	3
76	Buntal	"	40	2
77	Bako	"	40	2
78	Sadong	"	3,100	1
79	Kabong	"	1,500	3
80	Oya	"	1,820	1
81	Mukah	"	2,150	1
82	Balingian	"	2,520	2
83	Serupai	"	200	3
84	Tatau	"	4,780	2
85	Suai	"	1,400	3
86	Niah	"	1,270	3
87	Sibuti	"	830	2
88	Lawas	"	930	2
89	Padas	Sabah	8,600	1
90	Papar	"	770	2
91	Inanam	"	10	3
92	Tuaran	"	970	2
93	Bandau	"	290	3
94	Bongan	"	470	3
95	Sugut	"	2,900	2
96	Segama	"	4,300	3
97	Kalumpang	"	970	3
98	Tawau	"	130	1
99	Umas-Umas	"	370	2
100	Kalabakan	"	1,340	2

Note: *1 1:Critical, 2:Significant, 3:Acceptable

Table 3-2 COST-BENEFIT RATIOS OF THE MASTER PLAN OBJECTIVE RIVER MOUTHS

Group	No.	Serial No.	Name			Design Boat Size (GRT)	Net Present Value (NPV) Project Benefit ('000RM)	Net Present Value (NPV) Economic Cost ('000RM)	B/C
A	1	45	Mersing		#	150	19,477	49,762	0.391
A	2	48	Rompin		#	70	1,895	20,307	0.093
A	3	61	Marang	*	#	40	22,802	15,254	1.495
A	4	81	Mukah		#	70	18,324	41,231	0.444
A	5	82	Balingian			40	835	45,320	0.018
A	6	84	Tatau			40	3,842	20,238	0.190
B	7	44	Sedili Besar		#	150	132	7,598	0.017
B	8	46	Endau		#	200	22,219	11,898	1.867
B	9	50	Nenasi		#	70	1,457	5,959	0.245
B	10	52	Terus			40	795	6,641	0.120
B	11	53	Kuantan	*	#	200	35,244	20,682	1.704
B	12	55	Kemaman		#	100	1,126	1,185	0.951
B	13	58	Paka		#	40	199	1,676	0.119
B	14	59	Dungun		#	100	1,166	4,949	0.236
B	15	60	Mercang			40	1,603	1,793	0.894
B	16	92	Tuaran			40	2,226	2,302	0.967
C	17	56	Kemasik			40	3,061	9,918	0.309
C	18	57	Kerteh	*		40	3,021	7,897	0.383
C	19	87	Sibuti			40	13	4,639	0.003
D	20	1	Perlis	*	#	150	104,446	43,468	2.403
D	21	25	Langat			40	0	156	0.000
D	22	99	Umas-umas			40	0	29	0.000
E	23	2	Baru		#	40	6,784	9,335	0.727
E	24	3	Sanglang		#	40	1,868	2,826	0.661
E	25	4	Jerlun		#	40	305	2,114	0.144
E	26	6	Yan		#	40	5,287	13,502	0.392
E	27	8	Cenang		#	40	2,239	13,129	0.171
E	28	12	Pinang		#	40	12,799	11,398	1.123
E	29	13	Bayan Lepas			40	6,426	12,417	0.517
E	30	14	Tg. Piandang	*	#	40	12,773	9,450	1.352
E	31	20	Batu			40	808	17,745	0.046
E	32	22	Lekir			40	1,457	13,399	0.109
E	33	24	Kapar Besar			40	4,306	8,663	0.497
E	34	26	Sepan Kecil			40	0	42	0.000
E	35	27	Sepang			40	0	0	0.000
E	36	30	Linggi		#	40	1,881	2,163	0.870
E	37	31	Baru			40	2,067	2,357	0.877
E	38	32	Melaka		#	40	225	868	0.259
E	39	33	Duyong			40	384	2,395	0.160
E	40	34	Umbai			40	662	2,396	0.276
E	41	35	Merlimau			40	888	1,610	0.552
E	42	37	Parit Jawa			40	3,220	3,610	0.892
E	43	40	Senggarang			40	411	3,201	0.128
E	44	41	Rengit			40	2,875	6,748	0.426
E	45	42	Benut			40	1,272	11,741	0.108
E	46	43	Pontian Kecil		#	40	8,360	5,871	1.424
E	47	98	Tawau		#	40	4,929	3,514	1.402
F	48	69	Sematan			40	53	1,472	0.036
F	49	70	Kayan			40	13	828	0.016
F	50	80	Oya	*	#	40	3,538	4,518	0.783
G	51	11	Kerian		#	40	411	3,285	0.125
G	52	15	Gula		#	70	2,014	25,142	0.080
G	53	16	Sangga			40	0	6,468	0.000
G	54	17	Larut			40	556	11,931	0.047
G	55	18	Terong			40	0	134	0.000
G	56	19	Beruas	*	#	100	36,635	16,422	2.231
G	57	23	Selangor		#	40	782	7,608	0.103
G	58	36	Muar			40	0	942	0.000
G	59	39	Batu Pahat			40	265	1,355	0.196
G	60	76	Buntal			40	4,160	12,096	0.344
G	61	77	Bako			40	649	8,080	0.080
G	62	78	Sadong		#	40	278	8,337	0.033
G	63	89	Padas		#	40	556	1,868	0.298
G	64	100	Kalabakan			40	0	145	0.000
H	65	51	Pahang		#	70	1,448	11,989	0.121
H	66	62	Terengganu	*	#	150	13,775	41,067	0.335
H	67	67	Kelantan		#	100	5,270	5,983	0.881
H	68	95	Sugut			40	0	358	0.000
I	69	38	Sarang Buaya			40	13	2,599	0.005
I	70	63	Merang			40	2,743	4,267	0.643
I	71	66	Pak Amat			40	2,955	7,162	0.413
I	72	90	Papar	*		40	3,206	3,293	0.974
J	73	5	Kedah	*	#	150	111,084	38,917	2.854
J	74	9	Muda		#	40	1,338	9,299	0.144
J	75	88	Lawas			40	2,146	5,338	0.402
			All the river mouths -->				519,998	724,299	0.718
			Critical category -->				463,065	472,575	0.980
			Significant category -->				56,933	251,723	0.226

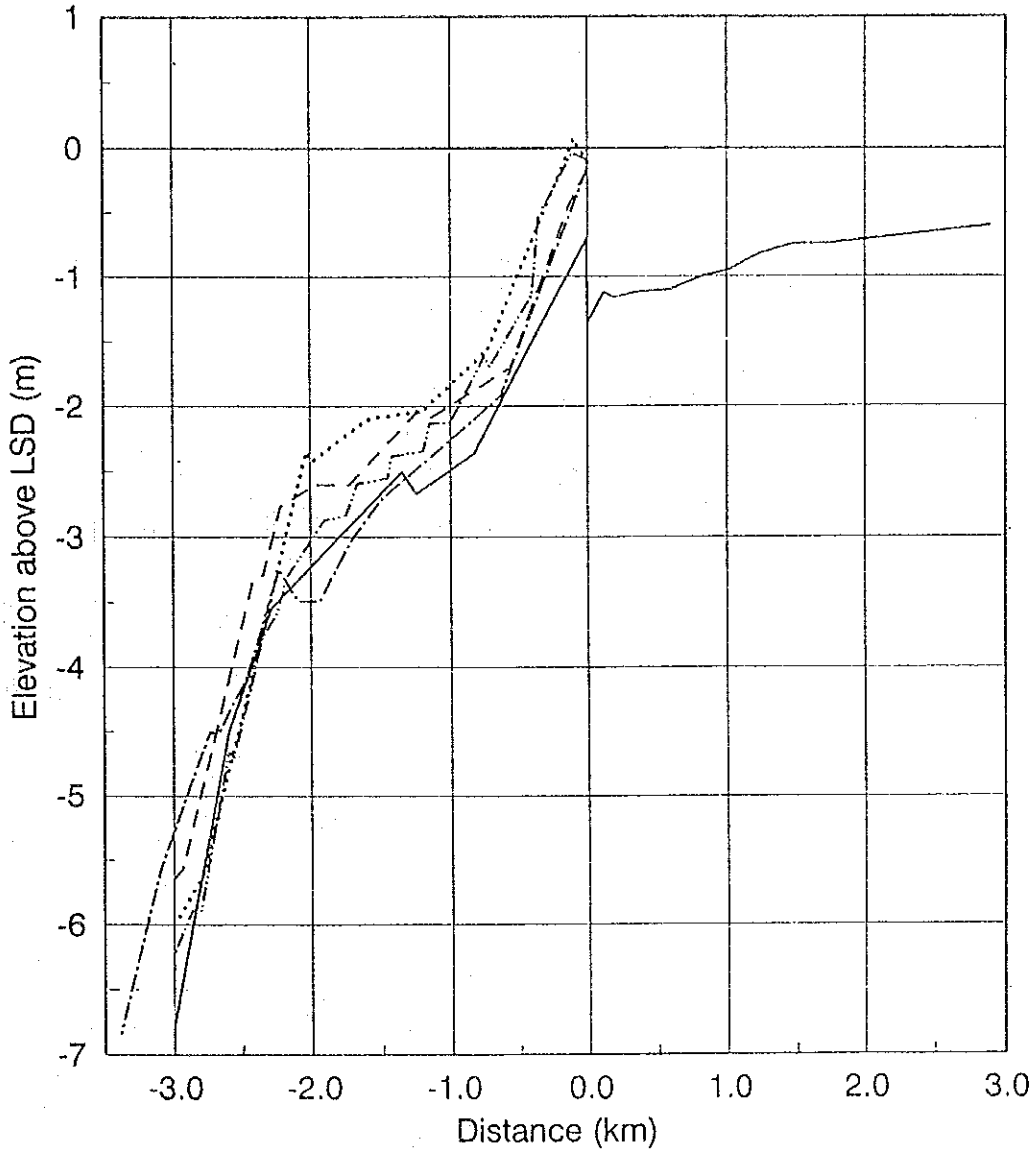
Note
* : Representative river mouth
# : River mouths in critical category

Table 3-3 PRIORITIZATION OF RIVER MOUTHS FOR FIRST PHASE PROJECT

(Unit: '000 RM)

Priority/ Expected Construction Period	Serial	Name	State	Initial Cost	O&M Cost (Per Year)	Agency Concerned
	1	Perlis	Perlis	10,134	2,526	MOT
	5	Kedah	Kedah	8,437	2,327	MOT
First Priority	14	Tg. Piandang	Perak	2,668	508	MOA
	19	Beruas	Perak	4,465	897	MOA
(The First Half	30	Linggi	Melaka	345	140	MOA
of the 7th	46	Endau	Johor	1,726	785	MOA
Malaysia Plan)	53	Kuantan	Pahang	3,706	1,302	MOA
	59	Dungun	Terengganu	534	343	MOT
	61	Marang	Terengganu	12,639	73	MOA
	67	Kelantan	Kelantan	4,810	28	MOT
				49,464	8,929	
	9	Muda	P.Pinang	1,044	641	MOA
Second Priority	23	Selangor	Selangor	920	519	MOA
	32	Melaka	Melaka	118	58	MOA
(The Latter Half	43	Pontian Kecil	Johor	795	393	MOA
of the 7th	44	Sedili Besar	Johor	841	525	MOA
Malaysia Plan)	51	Pahang	Pahang	10,024	59	MOA
	55	Kemaman	Terengganu	94	85	MOA
	81	Mukah	Sarawak	35,080	204	MOA
	98	Tawau	Sabah	560	228	MOA
				49,476	2,712	
	2	Baru	Perlis	1,396	613	MOA
Third Priority	3	Sanglang	Kedah	382	189	MOA
	8	Cenang	Kedah	2,092	850	MOA
(The First Half	12	Pinang	P.Pinang	1,817	738	MOA
of the 8th	45	Mersing	Johor	42,322	241	MOT
Malaysia Plan)	50	Nenasi	Pahang	474	428	MOA
	80	Oya	Sarawak	2,107	168	MOA
	89	Padas	Sabah	226	127	MOA
				50,816	3,354	
	4	Jerlun	Kedah	286	141	MOA
Forth Priority	6	Yan	Kedah	2,086	880	MOA
	11	Kerian	P.Pinang	397	224	MOA
(The Latter Half	15	Gula	Perak	3,241	1,696	MOA
of the 8th	48	Rompin	Pahang	16,614	98	MOA
Malaysia Plan)	58	Paka	Terengganu	122	122	MOA
	62	Terengganu	Terengganu	26,452	943	MOT
	78	Sadong	Sarawak	1,008	568	MOA
				50,206	4,672	

FIGURES

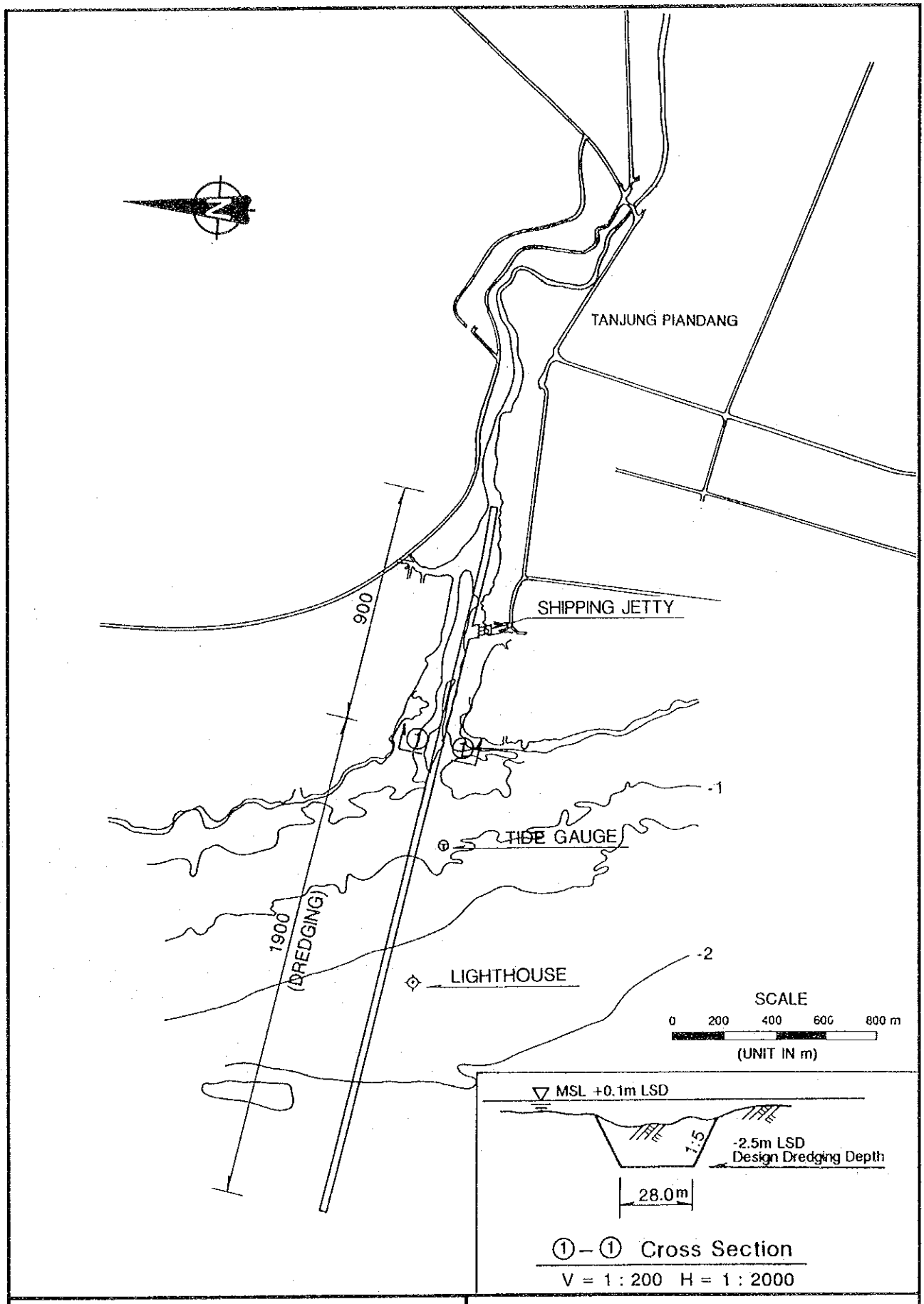


No. 0	No. 1000R	No. 1000L	No. 1500R	No. 1500L
October, '92	October, '92	October, '92	October, '92	October, '92

LEGEND

——— : Bed Height Along the Navigation channel

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	INNER AND OUTER CHANNEL PROFILE OF TG. PIANDANG RIVER MOUTH
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig.4-1

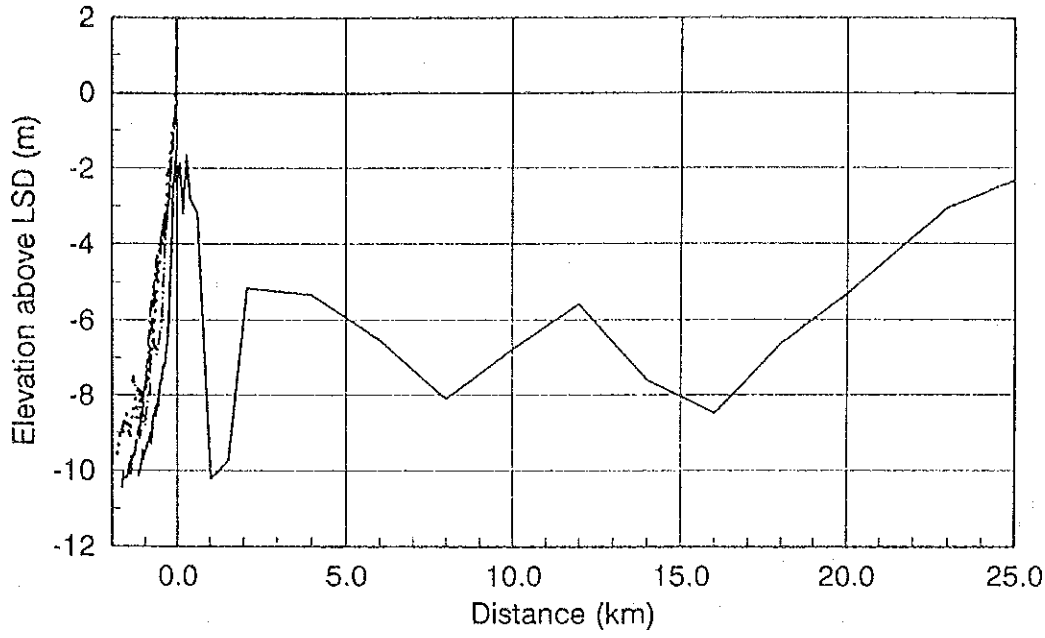


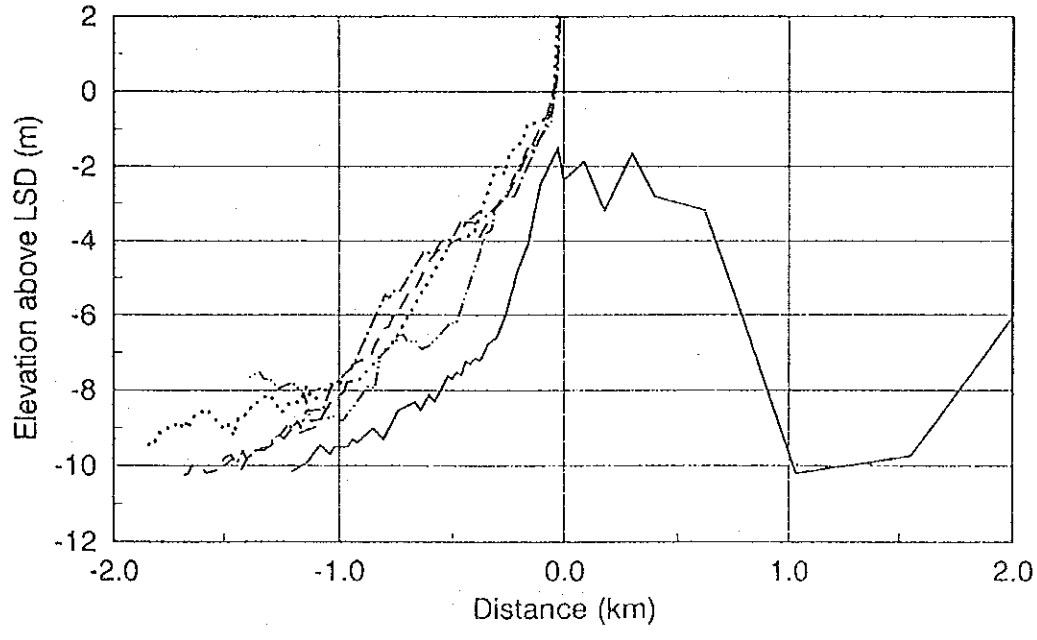
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	GENERAL LAYOUT OF OPTIMUM COUNTERMEASURES AT TG. PIANDANG RIVER MOUTH Fig. 4-2
JAPAN INTERNATIONAL COOPERATION AGENCY	

IMPLEMENTATION SCHEDULE FOR TG.PIANDANG RIVER MOUTH IMPROVEMENT PROJECT

Description	Unit	Quantity	First Year (1994)	Second Year (1995)	Third Year (1996)	After Third Year
Survey and Study		-				
Detailed Design		-				
Financing		-				
P/Q and Tendering		-				
Construction						
Mobilization	L.S.	1				
Preparatory Work	L.S.	1				
Capital Dredging	m3	115,400				
Bank Protection	L.S.	1				
Jetty Works	L.S.	1				
Maintenance Dredging	m3	55,400				

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	IMPLEMENTATION SCHEDULE OF TG. PIANDANG RIVER MOUTH IMPROVEMENT PROJECT Fig. 4-3
JAPAN INTERNATIONAL COOPERATION AGENCY	



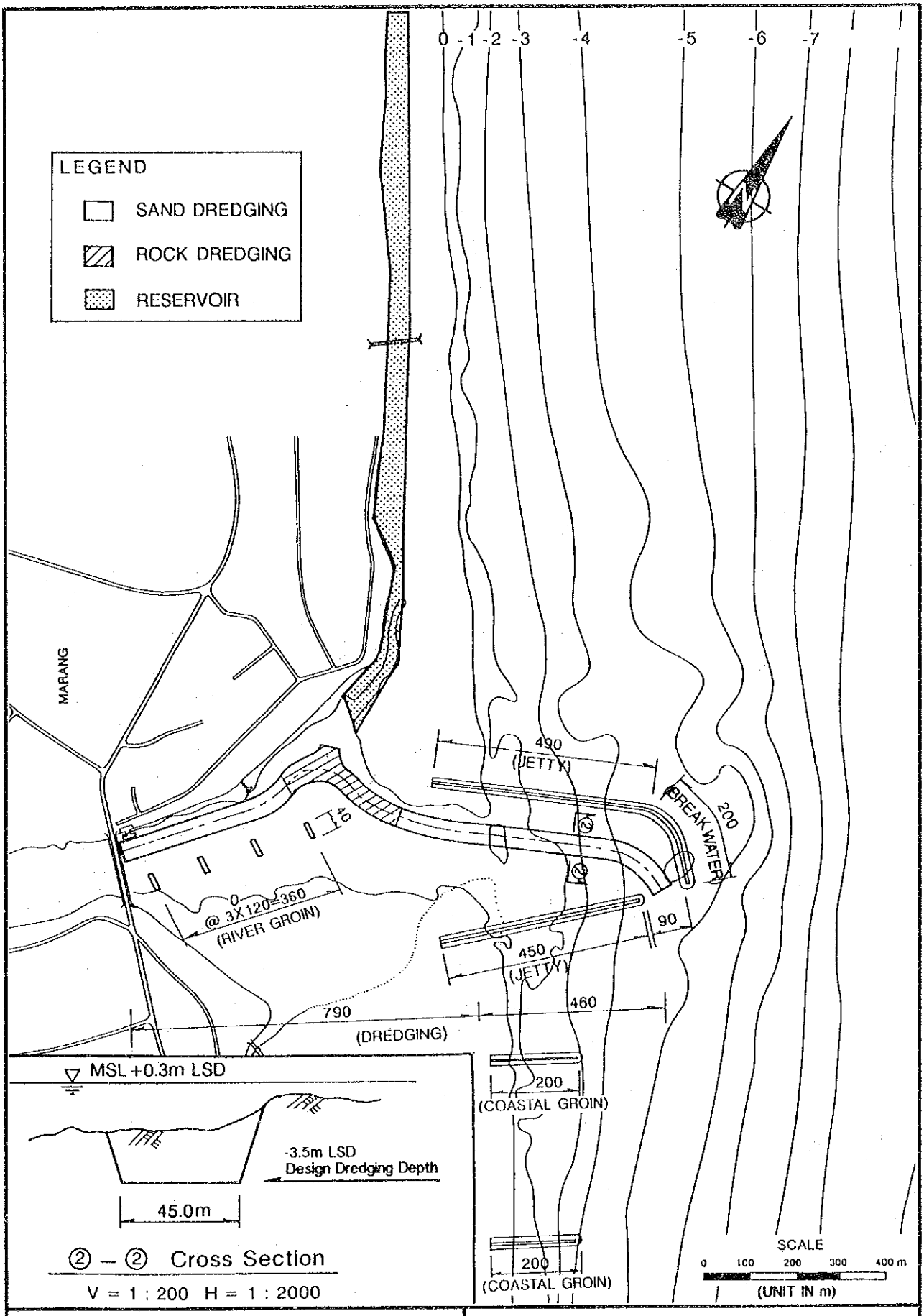


No. 0	No. 1000R	No. 1000L	No. 2000R	No. 2000L
October, '92	October, '92	October, '92	October, '92	October, '92

LEGEND

——— : Bed Height Along the Navigation channel

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	INNER AND OUTER CHANNEL PROFILE OF MARANG RIVER MOUTH Fig. 4-4
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

GENERAL LAYOUT OF OPTIMUM COUNTERMEASURES AT MARANG RIVER MOUTH Fig. 4-5

IMPLEMENTATION SCHEDULE FOR MARANG RIVER MOUTH IMPROVEMENT PROJECT

Description	Unit	Quantity	First Year (1994)	Second Year (1995)	Third Year (1996)	Fourth Year (1997)	After Fourth Year (1998)
Survey and Study		-					
Detailed Design		-					
Financing		-					
P/Q and Tendering		-					
Construction							
Mobilization	L.S.	1					
Preparatory Work	L.S.	1					
North Jetty	m3	38,400					
South Jetty	m3	23,500					
Breakwater	m3	38,200					
Coastal Groin	m3	17,700					
River Groin	m3	2,560					
Reservoir	m	4,100					
Dredging (Sand)	m3	109,000					
Dredging (Soft rock)	m3	22,000					
Operation and Maintenance Works							

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

IMPLEMENTATION SCHEDULE OF MARANG RIVER MOUTH IMPROVEMENT PROJECT Fig. 4-6