In addition, the Coastal Engineering Branch should commence shifting its focus of attention from engineering measures for coastal erosion to management of the coastal zone with comprehensive integrated coastal zone management. This is to ensure that any works in connection with river mouth improvement and port development will not result in increased coastal erosion and in turn other development projects in and outside the coastal zone will not adversely affect the river mouth. The Branch will therefore be in a position to provide technical advice on the actions to be taken to reduce or eliminate undesirable effects on the coastal zone that will occur due to natural or human-induced actions both upstream and within the coastal zone itself.

The role of the Dredging Committee and the Fisheries Development Committee of the Ministry of Agriculture should be maintained, since they are the most appropriate bodies to establish the policy for the dredging of river mouths as well as to finalize and approve the dredging programme.

The Marine Department shall continue with its responsibility of maintenance of river mouths and river channels leading to commercial ports. In view of the availability of private dredgers, the Marine Department may wish to contract out its dredging works as is being practiced by the Department of Irrigation and Drainage. The possibility of establishing a private national dredging company to carry out the works of both Departments should be considered.

The increased volume and the assurance of a long term contract based on a continuous dredging program, will most probably increase efficiency and reduce costs.

4.4 Financial Considerations

The present dredging programme is drawn up based on the demands and needs of the fishermen. As such, almost all river mouths with fisheries activities require improvement. However, in many cases, the more feasible and less costly option is to move the fishing activities elsewhere and allow the existing problem to remain rather than solve it.

In accordance with the National Agriculture Policy, future development of the fisheries sector will stress on deep-sea fishing, which will mainly be concentrated in the East

Coast of Malaysia. This fact is confirmed by the development plans of both LKIM and the Fisheries Department, which show the development of large LKIM fishing ports and the projection of expansion of fishing boat size to be mainly concentrated in the East Coast of Malaysia.

In view of the development plans of the Fisheries Department and LKIM, it is proposed that the status quo of existing river mouths which have not been identified for expansion of landing facilities be maintained. This means that only nominal dredging works need to be carried out to maintain or restore accessibility for existing boats of 10 GRT and below.

For river mouths where fishing facilities are to be expanded, it is important that more permanent solutions are recommended for implementation. In any case, all proposed projects should undergo feasibility studies before proceeding to detail design and implementation.

At present, the Federal Government finances all capital works on river mouths, whether it is dredging or structural works. The State Government provides no funding, and neither do the beneficiaries contribute towards the cost of the capital works.

However, siltation of river mouths is a natural and continuous phenomenon. Hence, even after dredging, further maintenance dredging on a regular basis has to be carried out to ensure that the dredged channel remains accessible throughout the year. The financing of this maintenance dredging is now in contention.

As a result of lack of funding for capital dredging, no such dredging works are carried out in the ensuing years, resulting in the dredged river mouths becoming inaccessible again within a year or two.

The existing practice of funding for capital dredging through the Malaysia Plan is adequate and should be maintained. However, the provision of funds for maintenance dredging has to be seriously considered. Some of the options available are:

(1) Federal Government to finance both capital and maintenance dredging costs.

(2) Federal Government and State Government to share the cost of maintenance dredging in the proportion to be mutually agreed.

(3) State Governments to finance maintenance dredging cost.

(4) The beneficiaries, i.e., the fishing boat owners, to contribute towards the cost of maintenance dredging.

(5) Only commercial fishing boats of 40 GRT and above are to contribute towards the cost of maintenance dredging.

In considering the above options, it should be noted that rivers are basic infrastructures provided by nature at no cost to the communities. One of the normal and natural functions of a river is to provide navigation to boats. Thus, compared to roads and highways which are developed at very high costs, rivers are available for transportation of people and goods at no capital cost. From this perspective, it is therefore reasonable that public funds are provided to maintain rivers in their natural form, especially when the deterioration to a river's navigational capacity is due to adverse impacts of development.

However, for deepening and maintenance of river mouths and channels beyond their natural or normal capacities, in order to cater for increased boat sizes, then it is logical and fair that the beneficiaries should contribute either in full or partially for the cost of the capital and maintenance works.

CHAPTER 5. RECOMMENDATIONS

(1) In this Feasibility Study, river mouth improvement plans for Tg. Piandang and Marang are formulated, and it is confirmed that the river mouth improvement projects for these 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.

(2) 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 be carried out on a regular basis to ensure the accessibility of the river channel throughout the year. For this 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.

(3) In the case of Marang River Mouth, a combination of structural measures including the jetty, the breakwater, the river and coastal groins, and the reservoir, as well as capital dredging, is selected as the optimum countermeasure. Such coastal structures may bring about adverse influences to the adjacent coastal zone. Although the magnitude of the influence has been examined through the physical model study and numerical analysis, the construction should be implemented in a phased fashion with monitoring of the influences.

(4) From the environmental impact study, it is confirmed that the projects will not give severe adverse impacts to the environment in the objective areas. However, the timing of construction works should be carefully examined to

minimize any adverse environmental impact. In this connection, it is recommended that construction works should be undertaken with monitoring of such impacts.

(5) From the flood control aspect, these two river mouths are currently free from flood damage because of the present land use conditions therearound. However, flooding problems may be brought about by future land development unless this is undertaken considering the potential flood-prone areas. In this connection, it is recommended that future land development should be carefully monitored to minimize future flood damage.

(6) To decide on the design features of the proposed breakwater and jetty at the Marang River Mouth, a physical model is constructed in the feasibility study. Since the model is, at present, still in the laboratory of the DID Ampang Branch Office, this should be utilized to examine any drastic change affecting the design features in the further study stage.

(7) In this Feasibility Study, the projects are formulated under the limited monitoring data collected such as wave, current and geomorphology. In this connection, regular monitoring programs should be provided for a better understanding of the features of the objective river mouths.

(8) The feasibility of the projects is concerned with the fishing activities which may change in the future area development, although the projects are formulated putting emphasis on the technical and economical aspects but not the future fishing industry. In this connection, it is desirable to confirm the necessity of the projects in line with the future development of the fishing industry.

TABLES

Table 1.1-1 FEATURES OF RIVER MOUTH

Coast	Serial	Name	Catchment Area (km2)	No. of Fishing Boats	No. of Fishermen	No. of Commercial Boats	Expected Minimum Water Depth (m)	B/C Ratio
	5	Kedah*	3,060	536	1,716	77	3.0	2.85
Muddy	14	Tg.Piandang	9	486	1,042	-	1.5	1.73
(West)	19	Beruas*	220	655	1,595	-	0.9	2.23
	23	Selangor	1,820	189	397	-	1.2	0.10
Sandy	1	Perlis*	600	432	2,333	20	0.6	2.40
(West)	9	Muda*	4,300	201	504	-	1.0	0.14
	32	Melaka	500	111	311	**	1.2	0.26
	45	Mersing*	250	290	435	**	0.8	0.39
Sandy	53	Kuantan*	1,710	163	570	45	2.6	1.70
(East)	61	Marang*	360	188	715	-	0.5	1.49
	62	Terengganu*	4,650	107	417	161	3.3	0.34
	67	Kelantan*	12,900	208	666	**	1.7	0.88

* : Dredging work has been conducted or scheduled.

** : Data is not available.

Table 2.1-1 SUMMARY OF NAVIGATION SURVEY RESULTS

River Mouth/ Survey Date (1993)	In-coming Boats					Out-going Boats				
	Fishing Boats			Tourist Boats	Total	Fishing Boats			Tourist Boats	Total
	Sampan	<10GRT	>=10GRT			Sampan	<10GRT	>=10GRT		
Tg. Piandang										
30 June Wed.	40	237	0	0	277	54	256	0	0	310
2 July Fri.	19	411	0	0	430	26	376	0	0	402
4 July Sun.	59	324	0	0	383	54	365	0	0	419
14 July Wed.	12	276	0	0	288	22	256	0	0	278
18 July Fri.	73	397	0	0	470	57	421	0	0	478
21 July Wed.	68	192	0	0	260	72	251	0	0	323
23 July Fri.	67	253	0	0	320	83	297	0	0	380
25 July Sun.	42	269	0	0	311	39	313	0	0	352
Marang										
16 June Wed.	42	76	25	51	194	50	53	26	68	197
18 June Fri.	11	30	13	65	119	19	18	34	72	143
20 June Sun.	11	36	34	75	156	20	36	36	73	165

Table 2.1-2 WATER QUALITY (TG. PIANDANG)

Sampling Station	Temp. (°C)	Salinity (ppt)	Cond. (uS/ca)	DO (mg/l)	pH	BOD 5 (mg/l)	COD (mg/l)	N-NH 3 (mg/l)	PO 3- 4 P (mg/l)	SS (mg/l)	Oil & Grease (mg/l)	TC (MPN/100ml)	FC (MPN/100ml)
PS *	29.6	33.5	39,625	4.8	8.00	3	-	0.029	0.003	394	N.D.	9.1x10^3	9.1x10^3
P1	29.3	31.8	38,375	4.4	7.85	4	-	0.156	0.004	1,634	N.D.	6.5x10^4	6.0x10^4
P2	29.2	25.5	36,125	1.6	7.58	8	-	0.236	0.046	15,736	N.D.	3.1x10^5	3.1x10^5
P3	29.6	11.3	16,000	0.6	7.55	6	-	1.975	0.110	9,766	2.5	7.1x10^5	7.1x10^5
P4	29.8	0.8	2,750	1.0	7.25	11	144	2.515	0.166	2,662	3.6	3.4x10^5	2.5x10^5
P5	29.9	N.D.	243	2.0	6.50	16	73	1.265	0.180	39	0.5	7.1x10^5	7.1x10^5

Note * Sampling station for coastal waters off river mouth.

N.D. Not detected.

Table 2.1-3 MEAN CONCENTRATION OF HEAVY METAL
(Tg. Piandang)

Sampling Station	Pb (ug/g)	Zn (ug/g)	Cu (ug/g)	Cd (ug/g)	Hg (ug/g)
(Total Metals)					
PS *	81	352	11	351	1.4
P1	76	361	11	296	1.6
P2	80	318	19	389	1.5
P3	80	285	133	2,434	2.0
P4	109	289	94	391	2.2
P5	169	681	721	926	4.0
Mean	116	381	165	798	2.1
(Non-residual Metals)					
PS *	31	36	4.6	81	N.D.
P1	31	39	5.7	95	N.D.
P2	32	50	14	114	N.D.
P3	35	64	19	100	N.D.
P4	54	131	50	216	N.D.
P5	161	508	336	349	N.D.
Mean	57	138	72	159	N.D.

Note * : Samples collected off river mouth.

N.D. Not detected.

Table 2.3-1 WORK ITEMS AND QUANTITIES OF TG. PIANDANG RIVER MOUTH IMPROVEMENT PROJECT

Item	Unit	Quantity	Remarks
1. Dredging Works			
1) Captial Dredging			
Outer	cu.m.	56,500	L=1900 m
Inner	cu.m.	58,900	L=900 m , mooring area
2) Maintenance Dredging			
Outer	cu.m.	47,900	assume siltation return
Inner	cu.m.	7,500	0.9m outer, 0.3m inner
2. Shiping Jetty Works			
1) Clearing and Grubbing	sq.m.	2,000	
2) Embanhment	cu.m.	300	
3) Reddish sand	cu.m.	300	t=0.15 m
4) Gravel Pavement	sq.m.	2,800	t=0.2 m
5) Wooden Works for Jetty	sq.m.	720	(40.0m*6.0m*3 jetties)
6) Jetty House	L.S.	1	
3. Bank Protection			
1) Stone Masonry	cu.m.	42	with concrete
2) Gabion Mattress	sq.m.	1,050	used gabion mattress (3.0m*1.5m*0.5m)

Table 2.3－2 COMPARISON OF DREDGING METHOD

Particular	Method 1 Cutter Suction Dredger	Method 2 Dredging Machine (Cutter Suction)	Method 3 Grab (Clamshell) Dredger	Method 4 Trailing Suction Hopper Dredger
Operation of dredger and Water depth and Waves	Approach from the offshore sea is required due to the deep draft of the dredger.	Not applicable against big waves. Employed only in inner channel.	Approach from the offshore sea is required due to the deep draft of the dredger.	The nearshore zone is too shallow for this dredger to pass during low tide.
Dumping Site of Dredged Materials	Disposal by pipeline to the spoil bank provided on the coastal area.	Disposal by pipeline to the spoil bank provided on the coastal area.	Offshore sea more than 3 km away from the river mouth.	Offshore sea far away from the river mouth. It takes a lot of time.
Impact on Fishing Boats	Pipeline Might be obstructive to the passage of fishing boats.	Pipeline Might be slightly obstructive to the passage of fishing boats.	Almost no problem.	Fishing boats will be affected in the inner channel.
Disposal of Dredged material and Environmental Impact	About 9 ha. of mangrove swamp will be converted into spoil bank. Impact study is neccessary.	About 6 ha. of mangrove swamp will be converted into spoil bank. Impact study is neccessary.	No serious problem will be expected. Investigation on fishing zone is neccessary.	No serious problem will be expected. Investigation on fishing zone is neccessary.
Economical Aspect	Most efficient method. Usually economical, but pipeline setting is costly.	Usually economical, unless dumping site is very far from dredging site.	A little higher than method 1.	Can be economical if the water depth is deep enough and volume is big.
Assesment	This can be a alternative plan for both inner and outer channel dredging. Environmental impact study on the area around spoil bank is neccessary.	Not applicable for the outer channel dredging. Suitable for the mainten－nance dredging of the inner channel.	This can be a alternative plan for both inner and outer channel dredging. Investigation for the dumping site at sea is neccessary.	Not preferable.

Table 2.3-3 DETAILED COMPARISON OF CUTTER SUCTION DREDGING AND GRAB (CLAMSHELL) DREDGING

	Particular	Cutter Suction Dredger (Method 1)	Grab (Clamshell) Dredger (Method 3)
1.	Dredging Capacity		
	– Dredger	1350 HP (Diesel) Class	Grab Dredger 320 HP,3 m3
	– Hourly Production	390 m3	115 m3
	– Daily Production	5,460 m3	1,150 m3
2.	Working and Operation Hour	18 hours (2 shifts) 14 hours Operation	11 hours 10 hours Operation
3.	Dumping Site of Dredged Material	Spoil Bank on the coastal area A = 90,000 m2 (600m x 150m)	Offshore Sea more than 3 km away from river mouth
4.	Conveyance Method of Dredged Material	Discharging by Pipeline Length = 2,000m – 700m (Average 1,500 m)	Dumping by Hauling Barge Hauling Distance = 2,000 – 4,000 m *(Average 3,000 m)*
5.	Necessary Equipment,Machines and Vessels	Discharging Pipe,Floater, Support of Pipe , Anchor Barge (1), Tug Boat (1)	Anchor Boat (1),Tug Boat (2) Hauling Barge 90m3 (3) Lighting Equipment and others
6.	Cost of Dredging V=100,000 m3		
	– Operation of Dredger	100,000 m3 x 6.2 RM/m3 = 620,000 RM	100,000 m3 x 8.5 RM/m3 = 850,000 RM
	– Pipeline Setting(1,500 m)	205,000 RM	– –
	– Spoil Bank Treatment	140,000 RM	– –
	– Others	– –	70,000 RM
		Total Cost 965,000 RM	Total Cost 920,000 RM
7.	Required Time for Dredging Works		
	– Operation Time of Dredger	0.8 Month	3.5 Month
	– Other Works	2.0 Month	0.5 Month
		Total 2.8 Month	*Total 4.0 Month*
8.	Impact on Navigation of Fishing Boats	Pipeline may be obstructive to the passage of fishing boats.	No serious problem is expected.
9.	Impact on Surrounding Environment	About 9 ha. of mangrove area will be converted into spoil bank but discharged water from spoil bank will not affect surrounding ecology.	Slight sea water contamination is expected but not serious, judging from the other cases.
10.	ASSESSMENT	Total cost is estimated to be a little higher than Grab Dredger. Not preferable for the navigation of fishing boats and preservation of mangrove.	Economically advantageous and preferable from the environmental aspect. To be recommended.

Table 2.3-4 SUMMARY OF UNIT CONSTRUCTION COST

	Work Item	Unit	Calculated Unit Cost (RM)
1.	Dredging by Grab (Clamshell) Dredger for Muddy Soil (Average Hauling Dis. 3.0 km)	cu.m.	8.50
	- for Outer Channel (Hauling dis. = 2.0 km)	cu.m.	7.60
	- for Inner Channel (Hauling dis. = 3.5 km)	cu.m.	9.50
2.	Dredging by Cutter Suction Dredger for Loose Sand (Average Hauling Dis. 600 m)	cu.m.	6.44
3.	Dredging by Breaker and Grab Dredger for Soft Rock	cu.m.	20.00
4.	Excavation for Structure	cu.m.	3.68
5.	Embankment for Bund (Using excavated material nearby Bund)	cu.m.	3.08
6.	Embankment by Using Borrow Pit Material	cu.m.	16.36
7.	Clearing and Grubbing	sq.m.	0.78
8.	Sodding	sq.m.	5.51
9.	Gravel Pavement	sq.m.	4.63
10.	Stone Masonry with Concrete	cu.m.	137.04
11.	Supply,Delivery and Placing Gabion mattress (1.5m x 1.2m x 0.5m)	sq.m.	58.81
12.	Supply,Delivery and Placing Geo-textile Mat	sq.m.	29.34
13.	Concrete without Reinforcing Bar	cu.m.	195.00
14.	Supply,Delivery and Placing Rock/Stone		
	1) Armor Stone 1 , 3 - 5 ton	cu.m.	87.94
	2) Armor Stone 2 , 1 - 3 ton	cu.m.	84.79
	3) Secondary Stone , 300 - 500 kg	cu.m.	63.48
	4) Core Stone 1 , 100 - 300 kg	cu.m.	60.10
	5) Core Stone 2 , 10 - 100 kg	cu.m.	55.31
15.	Wooden Works for Jetty	ea.	16,200
16.	Bank protection for River Mouth Reservoir	m	10.00

NOTE:

1. Unit costs are composed of direct cost and indirect cost. Direct cost includes material, labor and equipment costs, and indirect cost covers overhead contingencies, miscellaneous and profit of the contractor.
2. Unit cost of dredging does not include spoil bank treatment cost.
3. Assumed that rock materials are locally available (within 30 km).

Table 2.3-5 PROJECT COST OF TG. PIANDANG RIVER MOUTH IMPROVEMENT

Work Items	Unit	Quantit	Unit Cost (RM)	Total (RM)
I. Main Construction				1,471,000
1. Preparatory Works (10% of Main & Miscel. Works including Mobilization/Demobil.)	l.s.	1		134,000
2. Main Works				1,215,000
(1) *Navigation channel Dredging*				
1) Dredging for Muddy Soil (Outer)	cu.m.	56,500	7.60	429,000
2) Dredging for Muddy Soil (Inner)	cu.m.	58,900	9.50	560,000
3) Lighting Equipment and others	l.s.	1	70,000	70,000
(2) Jetty Works for Fishing Boat				
1) Clearing and Grubbing	sq.m.	2,000	0.78	2,000
2) Filling (Using Job Site Materials)	cu.m	300	3.08	1,000
3) Embankment(Using Borrow Pit Materials)	cu.m	300	16.36	5,000
4) Gravel Pavement 20 cm thick	sq.m.	2,800	4.63	13,000
5) Wooden Works for Jetty	ea.	3	16,200	49,000
6) Jetty House	l.s.	1	18,000	18,000
(3) Bank Protection				
1) Stone Masonry (Using concrete)	cu.m	42	137.04	6,000
2) Gabion Mattress (3.0m x 1.2m x 0.5m)	sq.m.	1,050	58.81	62,000
3. Miscellaneous Works (10% of Main Works)	l.s.	1		122,000
II. Compensation	sq.m.	0		0
III. Engineering and Administration Cost (10 % of Main construction)	l.s.	1		147,000
IV. Physical Contingencies (10 % of (I + II + III))	l.s.	1		162,000
Sub - Total				1,780,000
V. Price Escalation				129,000
TOTAL				*1,909,000*

Note:
- All costs are expressed based on the price level of late 1992 and an annual escalation rate is assumed at 2.4%.
- Assuming that engineering services will commence in 1994 and construction will terminat in 1995.

Table 2.4-1 ANNUAL CASH FLOW OF TG. PIANDANG RIVER MOUTH IMPROVEMENT PROJECT

Unit : '000 RM

No.	Year	Economic Project Cost					Fishery Benefit	Annual Cash Flow
		Construction	Eng. and Admi.	Physical Conti.	Maintenance	Total		
1	1994		88.0	8.8		96.8		-96.8
2	1995	1,294.5	59.0	135.3		1,488.8		-1,488.8
3	1996		60.0	6.0	528.0	594.0	899.4	305.4
4	1997		60.0	6.0	528.0	594.0	891.8	297.8
5	1998		60.0	6.0	528.0	594.0	884.2	290.2
6	1999		60.0	6.0	528.0	594.0	876.6	282.6
7	2000		60.0	6.0	528.0	594.0	869.0	275.0
8	2001		60.0	6.0	528.0	594.0	862.0	268.0
9	2002		60.0	6.0	528.0	594.0	855.0	261.0
10	2003		60.0	6.0	528.0	594.0	848.0	254.0
11	2004		60.0	6.0	528.0	594.0	841.0	247.0
12	2005		60.0	6.0	528.0	594.0	834.0	240.0
13	2006		60.0	6.0	528.0	594.0	834.0	240.0
14	2007		60.0	6.0	528.0	594.0	834.0	240.0
15	2008		60.0	6.0	528.0	594.0	834.0	240.0
16	2009		60.0	6.0	528.0	594.0	834.0	240.0
17	2010		60.0	6.0	528.0	594.0	834.0	240.0
18	2011		60.0	6.0	528.0	594.0	834.0	240.0
19	2012		60.0	6.0	528.0	594.0	834.0	240.0
20	2013		60.0	6.0	528.0	594.0	834.0	240.0
21	2014		60.0	6.0	528.0	594.0	834.0	240.0
22	2015		60.0	6.0	528.0	594.0	834.0	240.0
23	2016		60.0	6.0	528.0	594.0	834.0	240.0
24	2017		60.0	6.0	528.0	594.0	834.0	240.0
25	2018		60.0	6.0	528.0	594.0	834.0	240.0
26	2019		60.0	6.0	528.0	594.0	834.0	240.0
27	2020		60.0	6.0	528.0	594.0	834.0	240.0
28	2021		60.0	6.0	528.0	594.0	834.0	240.0
29	2022		60.0	6.0	528.0	594.0	834.0	240.0
30	2023		60.0	6.0	528.0	594.0	834.0	240.0
31	2024		60.0	6.0	528.0	594.0	834.0	240.0
32	2025		60.0	6.0	528.0	594.0	834.0	240.0
33	2026		60.0	6.0	528.0	594.0	834.0	240.0
34	2027		60.0	6.0	528.0	594.0	834.0	240.0
35	2028		60.0	6.0	528.0	594.0	834.0	240.0
36	2029		60.0	6.0	528.0	594.0	834.0	240.0
37	2030		60.0	6.0	528.0	594.0	834.0	240.0
38	2031		60.0	6.0	528.0	594.0	834.0	240.0
39	2032		60.0	6.0	528.0	594.0	834.0	240.0
40	2033		60.0	6.0	528.0	594.0	834.0	240.0

Internal Rate of Return (IRR) = 16.98%

B/C (annual discount rate ; 8%) = 1.173

Table 3.1-1 WATER QUALITY (MARANG)

Sampling Station	Temp. (°C)	Salinity (ppt)	Cond. (uS/ca)	DO (mg/l)	pH	BOD_5 (mg/l)	COD (mg/l)	$N\text{-}NH_3$ (mg/l)	PO_4^{3-} P (mg/l)	SS (mg/l)	Oil & Grease (mg/l)	TC (MPN/100ml)	FC (MPN/100ml)
MS *	30.2	32.8	43,400	5.9	8.20	1	-	0.015	N.D.	75	0.1	-	-
M1	30.0	25.9	42,500	5.9	8.24	1	-	0.023	N.D.	77	0.4	-	-
M2	29.9	25.0	41,150	6.0	8.24	1	-	0.019	N.D.	78	0.4	-	-
M3	30.0	23.8	39,750	6.4	8.18	1	-	0.038	0.006	76	0.6	-	-
M5	30.6	25.3	35,125	4.4	7.48	1	-	0.080	N.D.	65	0.3	-	-
M6	27.5	3.5	4,038	5.5	5.96	1	48	0.069	N.D.	30	0.8	-	-
M7	27.9	0.0	94	6.9	5.82	2	72	0.044	0.002	27	0.4	-	-

Note * Sampling station for coastal waters off river mouth.

N.D. Not detected.

Table 3.1-2 MEAN CONCENTRATION OF HEAVY METAL
(Marang)

Sampling Station	Pb (ug/g)	Zn (ug/g)	Cu (ug/g)	Cd (ug/g)	Hg (ug/g)
(Total Metals)					
MS *	41	203	2.7	77	1.1
M1	31	241	2.5	84	1.4
M2	47	206	2.5	127	3.1
M3	31	199	2.7	61	1.8
M4	60	198	6.6	99	2.7
M5	46	192	12	101	2.3
M6	37	202	2.9	63	1.2
M7	51	148	8.4	100	2.5
M8	59	233	29	107	2.8
C **	33	265	2.3	140	0.9
Mean	44	209	7.2	96	2.0
(Non-residual Metals)					
MS *	1.3	1.3	0.10	10	0.025
M1	1.4	1.9	0.09	11	N.D.
M2	2.7	3.6	0.18	10	N.D.
M3	3.2	2.2	0.32	< 10	N.D.
M4	8.1	7.8	1.1	91	Trace
M5	2.6	2.9	0.64	100	0.021
M6	7.3	12.0	0.42	38	N.D.
M7	1.5	2.9	0.60	14	0.020
M8	6.1	5.0	4.8	34	0.093
C **	1.1	2.0	0.08	< 10	N.D.
Mean	3.5	4.2	0.89	33	0.040

Note * : Samples collected off river mouth.
** : Composite sample of sand collected at the river mouth.

N.D. Not detected.

Table 3.3-1 WORK ITEMS AND QUANTITIES OF MARANG RIVER MOUTH IMPROVEMENT PROJECT

Item		Unit	Quantity	Remarks
1. Dredging Works				
1) 20 GRT	Sand	cu.m.	42,000	Boat clearlance 0.6 m
	Rock	cu.m.	9,800	
2) 30 GRT	Sand	cu.m.	75,500	Boat clearlance 0.8 m
	Rock	cu.m.	15,900	
3) 40 GRT	Sand	cu.m.	109,000	Boat clearlance 1.0 m
	Rock	cu.m.	22,000	
2. Structure Works				
1) Breakwater				L= 200 m
	Armor Stone 1	cu.m.	15,700	3-5 t
	Secondary stone	cu.m.	11,200	300-500 kg
	Core Stone 1	cu.m.	11,300	100-300 kg
	Geo-Textile Mat	sq.m.	2,200	440 m * 5 m
2) Jetty				
North Jetty				L= 490 m
	Armor Stone 2	cu.m.	19,600	1-3 t
	Core Stone 2	cu.m.	18,800	10-100 kg
	Geo-Textile Mat	sq.m.	2,450	490 m * 5 m
South Jetty				L= 450 m
	Armor Stone 2	cu.m.	12,600	1-3 t
	Core Stone 2	cu.m.	10,900	10-100 kg
	Geo-Textile Mat	sq.m.	2,250	450 m * 5 m
3) River Groin				L= 40 m * 2
	Armor Stone 2	cu.m.	1,840	1-3 t
	Core Stone	cu.m.	720	10-100 kg
4) Coastal Groin				L= 200 m * 2
	Armor Stone 2	cu.m.	9,900	1-3 t
	Core Stone 2	cu.m.	7,800	10-100 kg
5) Reservoir		m	4,100	Excavation & Bank Works

Table 3.3-2 PROJECT COST OF MARANG RIVER MOUTH IMPROVEMENT

Work Items	Unit	Quantity	Unit Cost (RM)	Total (RM)
I. Main Construction				11,722,000
1. Preparatory Works (10% of Main & Misce. works including Mobilization and Demobilization of Dredger & Vessels)	l.s.	1	1,066,000	1,066,000
2. Main Works				10,149,000
(1) Breakwater				
1) Armor Stone 1 , 3 - 5 ton (Supply,Delivery and Placing Rock)	cu.m.	15,700	87.94	1,381,000
2) Secondary stone , 300 - 500 kg (Supply,Delivery and Placing Rock)	cu.m.	11,200	63.48	711,000
3) Core Stone 1 , 100 - 300 kg (Supply,Delivery and Placing Rock)	cu.m.	11,300	60.10	679,000
4) Supply, Delivery and Placing Geotextile Mat	sq.m.	2,200	29.34	65,000
(2) North Jetty				
1) Armor Stone 2 , 1 - 3 ton (Supply,Delivery and Placing Rock)	cu.m.	19,600	84.79	1,662,000
2) Core Stone 2 , 10 - 100 kg (Supply,Delivery and Placing Rock)	cu.m.	18,800	55.31	1,040,000
3) Supply, Delivery and Placing Geotextile Mat	sq.m.	2,450	29.34	72,000
(3) South Jetty				
1) Armor Stone 2 , 1 - 3 ton (Supply,Delivery and Placing Rock)	cu.m.	12,600	84.79	1,068,000
2) Core Stone 2 , 10 - 100 kg (Supply,Delivery and Placing Rock)	cu.m.	10,900	55.31	603,000
3) Supply ,Delivery and Placing Geotextile Mat	sq.m.	2,250	29.34	66,000
(4) Coastal Groin				
1) Armor Stone 2 , 1 - 3 ton	cu.m.	9,900	84.79	839,000
2) Core Stone , 10 - 100 kg	cu.m	7,800	55.31	431,000
(5) River Groin				
1) Armor Stone 2 , 1 - 3 ton	cu.m.	1,840	84.79	156,000
2) Core Stone , 10 - 100 kg	cu.m.	720	55.31	40,000
(6) Navigation channel Work				
1) Dredging for Loose Sand	cu.m.	109,000	6.44	702,000
2) Dredging for Soft Rock	cu.m.	22,000	20.00	440,000
3) Pipe Line Setting	l.s.	1	133,000	133,000
4) Spoil Bank Treatment	l.s.	1	20,000	20,000
(7) Reservoir	m	4,100	10.00	41,000
3. Miscellaneous Works (5% of Main Works)	l.s.	1		507,000
II. Compensation	sq.m.	0	-	0
III. Engineering and Administration Cost (10 % of Main Construction)	l.s.	1	1,172,000	1,172,000
IV. Contingencies (10 % of I + II + III)	l.s.	1	1,289,000	1,289,000
Sub-Total				14,183,000
V. Price Escalation				1,183,000
TOTAL				15,366,000

Table 3.3-3 ANNUAL DISBURSEMENT SCHEDULE OF MARANG RIVER MOUTH IMPROVEMENT PROJECT

Unit : RM

Description	Amount	First Year (1994)	Second Year (1995)	Third Year (1996)
I. Main Construction	11,722,000	-	6,753,000	4,969,000
1. Preparatory Works	1,066,000	-	614,000	452,000
2. Breakwater				
Armor Stone 1	1,381,000	-	1,381,000	-
Armor Stone 2	0	-	0	-
Secondary Stone	711,000	-	711,000	-
Core Stone 1	679,000	-	679,000	-
Geotextile	65,000	-	65,000	-
3. North Jetty				
Armor Stone 2	1,662,000	-	1,662,000	-
Core Stone 2	1,040,000	-	1,040,000	-
Geotextile	72,000	-	72,000	-
4. South Jetty				
Armor Stone 2	1,068,000	-	-	1,068,000
Core Stone 2	603,000	-	-	603,000
Geotextile	66,000	-	-	66,000
5. Coastal Groin				
Armor Stone 2	839,000	-	-	839,000
Core Stone 2	431,000	-	-	431,000
6. River Groin				
Armor Stone 2	156,000	-	156,000	-
Core Stone 2	40,000	-	40,000	-
7. Navigation Channel Work				
Dredging (Sand)	702,000	-	-	702,000
Dredging (Soft Rock)	440,000	-	-	440,000
Pipe Line Setting	133,000	-	-	133,000
Spoil Bank Treatment	20,000	-	-	20,000
8. Reservoir	41,000		41,000	
9. Miscellaneous Works	507,000	-	292,000	215,000
II. Compensation	-	-	-	-
III. Engineering and Administration Cost	1,172,000	469,000	387,000	316,000
IV. Physical Contingencies	1,289,000	47,000	714,000	529,000
Sub-Total	14,183,000	516,000	7,854,000	5,814,000
V. Price Contingencies	1,183,000	25,000	579,000	579,000
TOTAL	15,366,000	541,000	8,433,000	6,393,000

Note:

(1) All costs are expressed at on the price level of late 1992 and an annual escalation rate is assumed at 2.4%.

(2) Annually recurrent O & M cost after the year 1997 is estimated to be RM 227,000 including administration cost of RM 21,000.

Table 3.4-1 ECONOMIC COST OF MARANG RIVER MOUTH IMPROVEMENT PROJECT

Unit : RM

Description	Amount	Firat Year	Second Year	Third Year
I. Main Construction	10,315,360	-	5,942,640	4,372,720
1. Preparatory Works	938,080	-	540,320	397,760
2. Breakwater	2,495,680	-	2,495,680	0
3. North Jetty	2,441,120	-	2,441,120	0
4. South Jetty	1,528,560	-	0	1,528,560
5. Coastal Groin	1,117,600	-	0	1,117,600
6. River Groin	172,480		172,480	0
7. Navigation Channel Work	1,139,600	-	0	1,139,600
8. Reservoir	36,080	-	36,080	0
9. Miscellaneous Works	446,160	-	256,960	189,200
II. Compensation	-	-	0	0
III. Engineering and Administration Cost	1,172,000	469,000	387,000	316,000
IV. Physical Contingency	1,148,736	46,900	632,964	468,872
TOTAL	12,636,096	515,900	6,962,604	5,157,592

Table 3.4-2 ANNUAL CASH FLOW OF MARANG RIVER MOUTH IMPROVEMENT PROJECT

Unit : '000 Ringgit

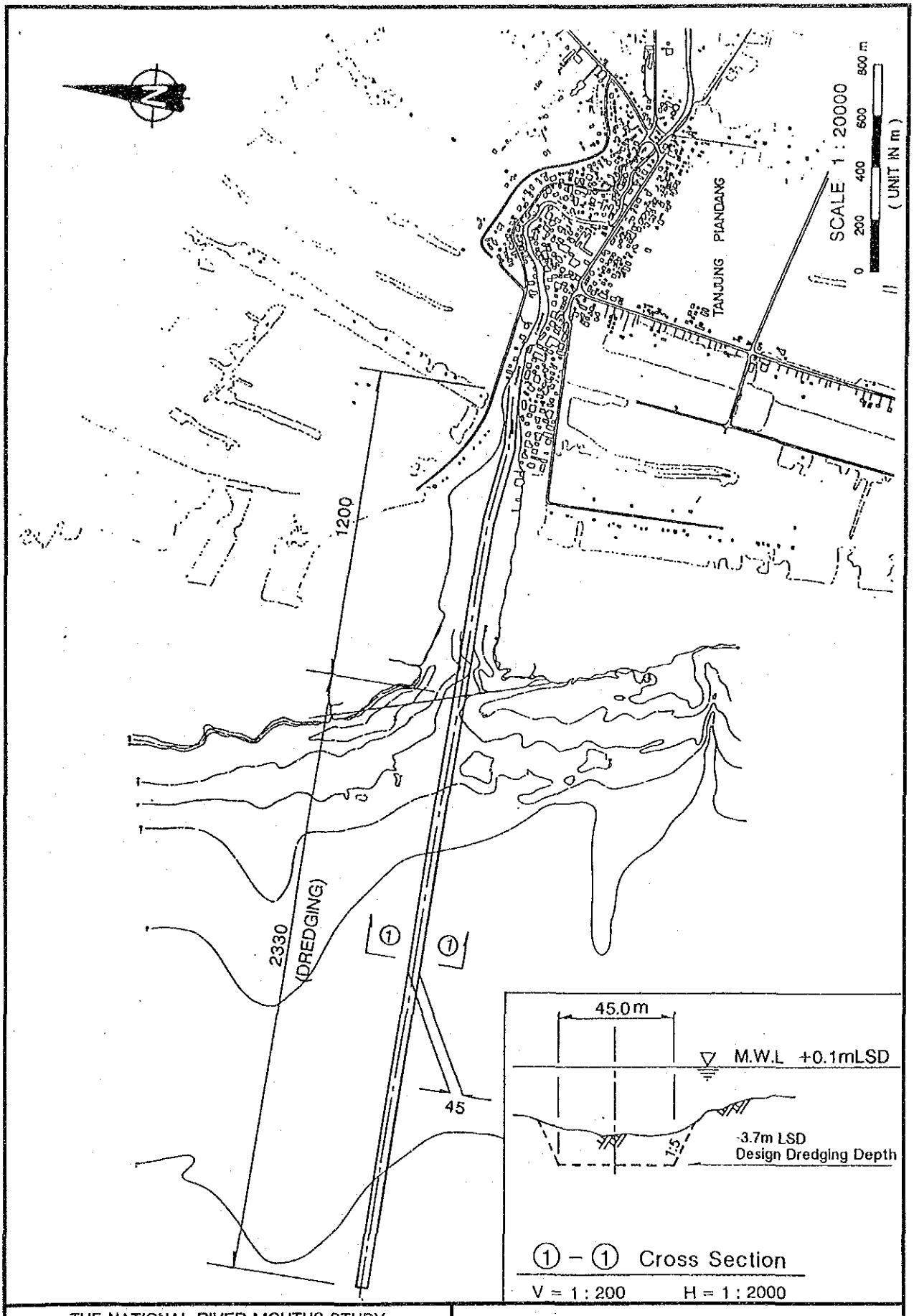
No.	Year	Economic Project Cost					Benefit			Annual Cash Flow
		Construc-tion	Eng. & Admi.	Physical Conti.	Mainte-nance	Total	Fishery	Sea Trans.	Total	
1	1994		469.0	46.9		515.9				-515.9
2	1995	5,942.6	387.0	633.0		6,962.6				-6,962.6
3	1996	4,372.7	316.0	468.9		5,157.6	745.8	183.3	929.1	-4,228.5
4	1997		21.0	2.1	181.3	204.4	1,152.6	281.0	1,433.6	1,229.2
5	1998		21.0	2.1	181.3	204.4	1,186.4	286.0	1,472.4	1,268.0
6	1999		21.0	2.1	181.3	204.4	1,220.2	292.0	1,512.2	1,307.8
7	2000		21.0	2.1	181.3	204.4	1,254.0	298.0	1,552.0	1,347.6
8	2001		21.0	2.1	181.3	204.4	1,287.6	304.0	1,591.6	1,387.2
9	2002		21.0	2.1	181.3	204.4	1,321.2	310.0	1,631.2	1,426.8
10	2003		21.0	2.1	181.3	204.4	1,354.8	316.0	1,670.8	1,466.4
11	2004		21.0	2.1	181.3	204.4	1,388.4	322.0	1,710.4	1,506.0
12	2005		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
13	2006		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
14	2007		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
15	2008		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
16	2009		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
17	2010		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
18	2011		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
19	2012		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
20	2013		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
21	2014		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
22	2015		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
23	2016		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
24	2017		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
25	2018		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
26	2019		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
27	2020		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
28	2021		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
29	2022		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
30	2023		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
31	2024		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
32	2025		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
33	2026		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
34	2027		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
35	2028		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
36	2029		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
37	2030		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
38	2031		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
39	2032		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6
40	2033		21.0	2.1	181.3	204.4	1,422.0	329.0	1,751.0	1,546.6

Internal Rate of Return (IRR) = 11.12%

B/C (annual discount rate ; 8%) = 1.302

Note : It is assumed that 2/3 (66.6%) of the benefit in 1996 may accrue due to progress of dredging works.

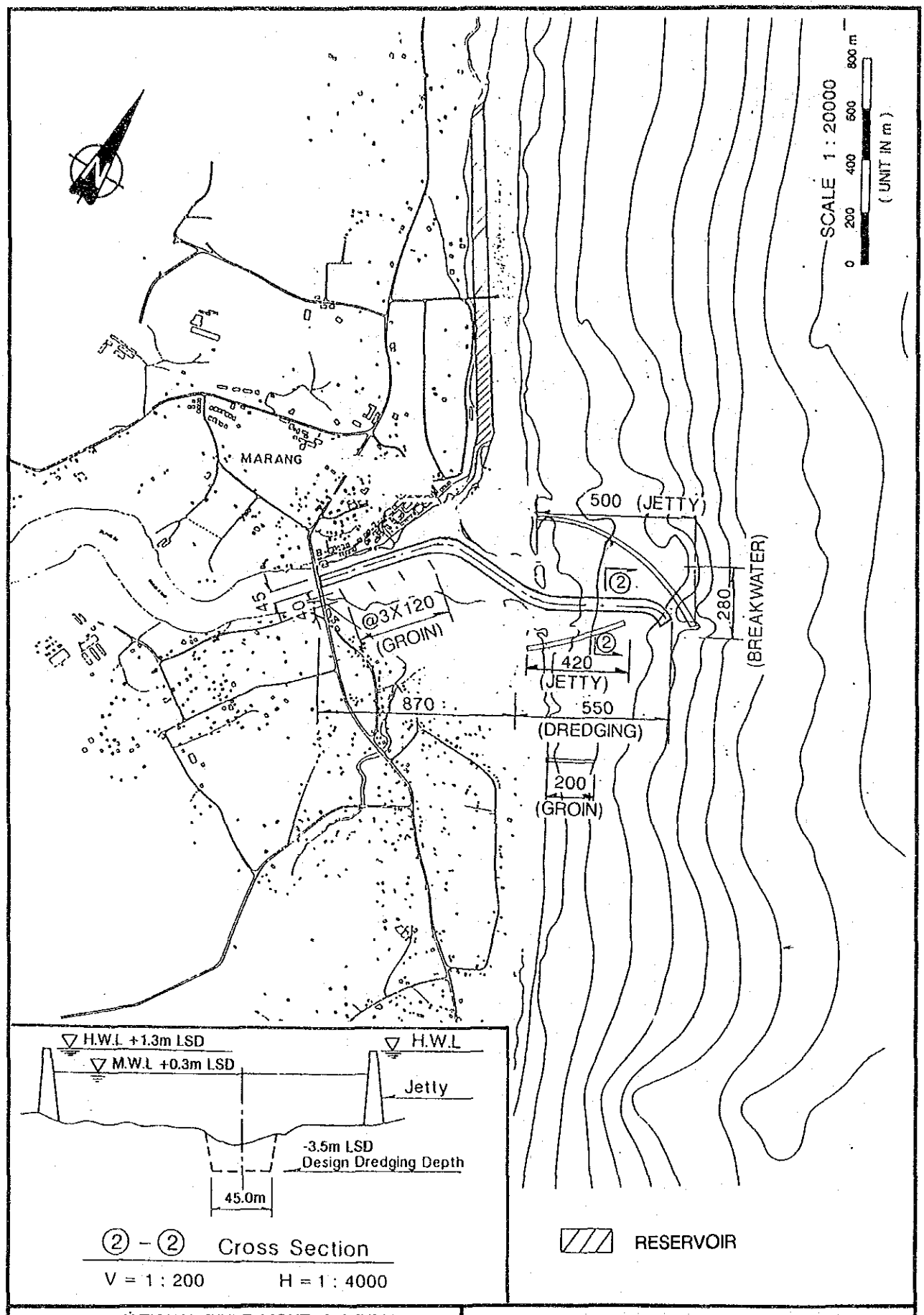
FIGURES



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

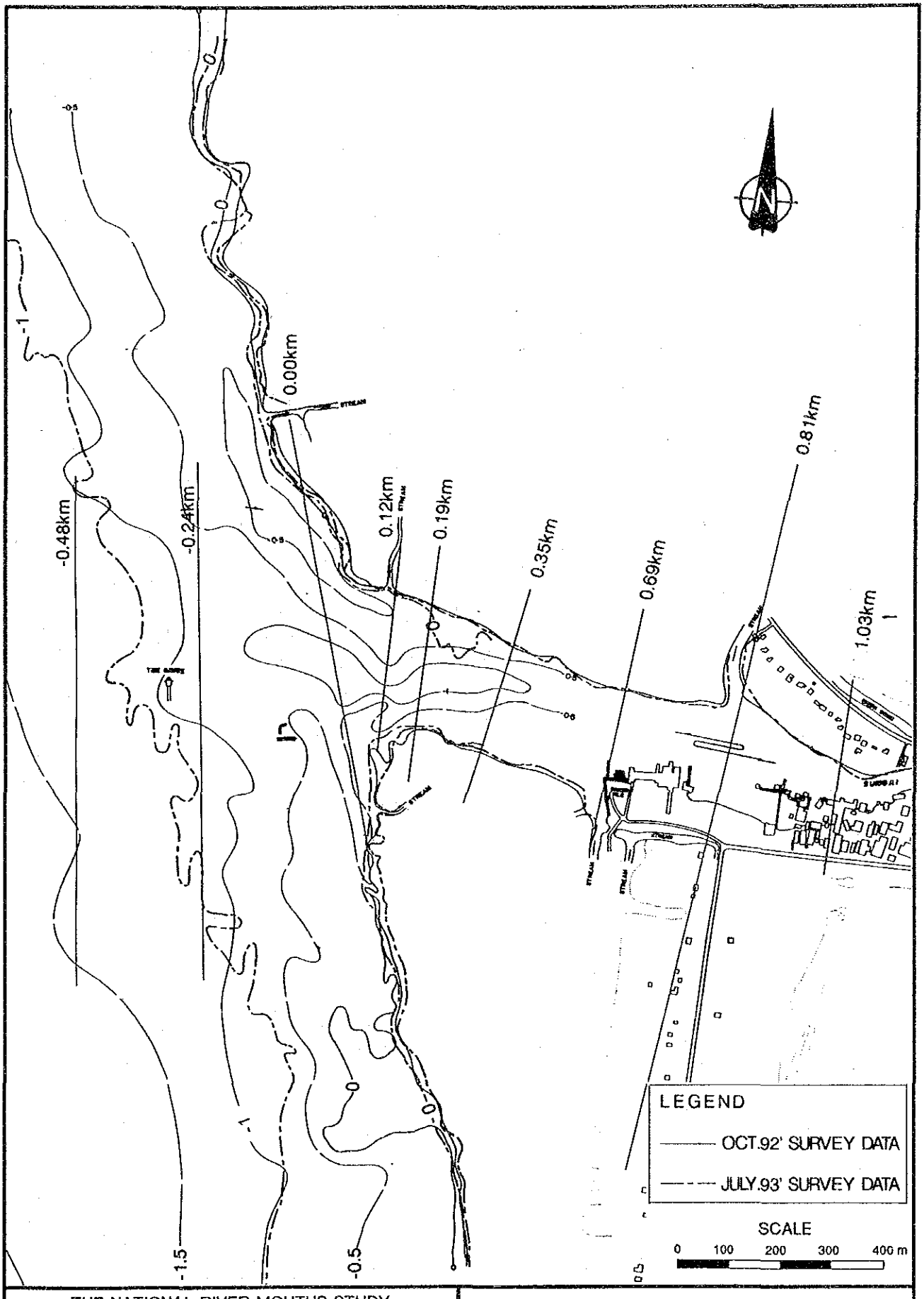
OPTIMUM COUNTERMEASURES PROPOSED IN MASTER PLAN (TG. PIANDANG RIVER MOUTH) Fig.1.2-1



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

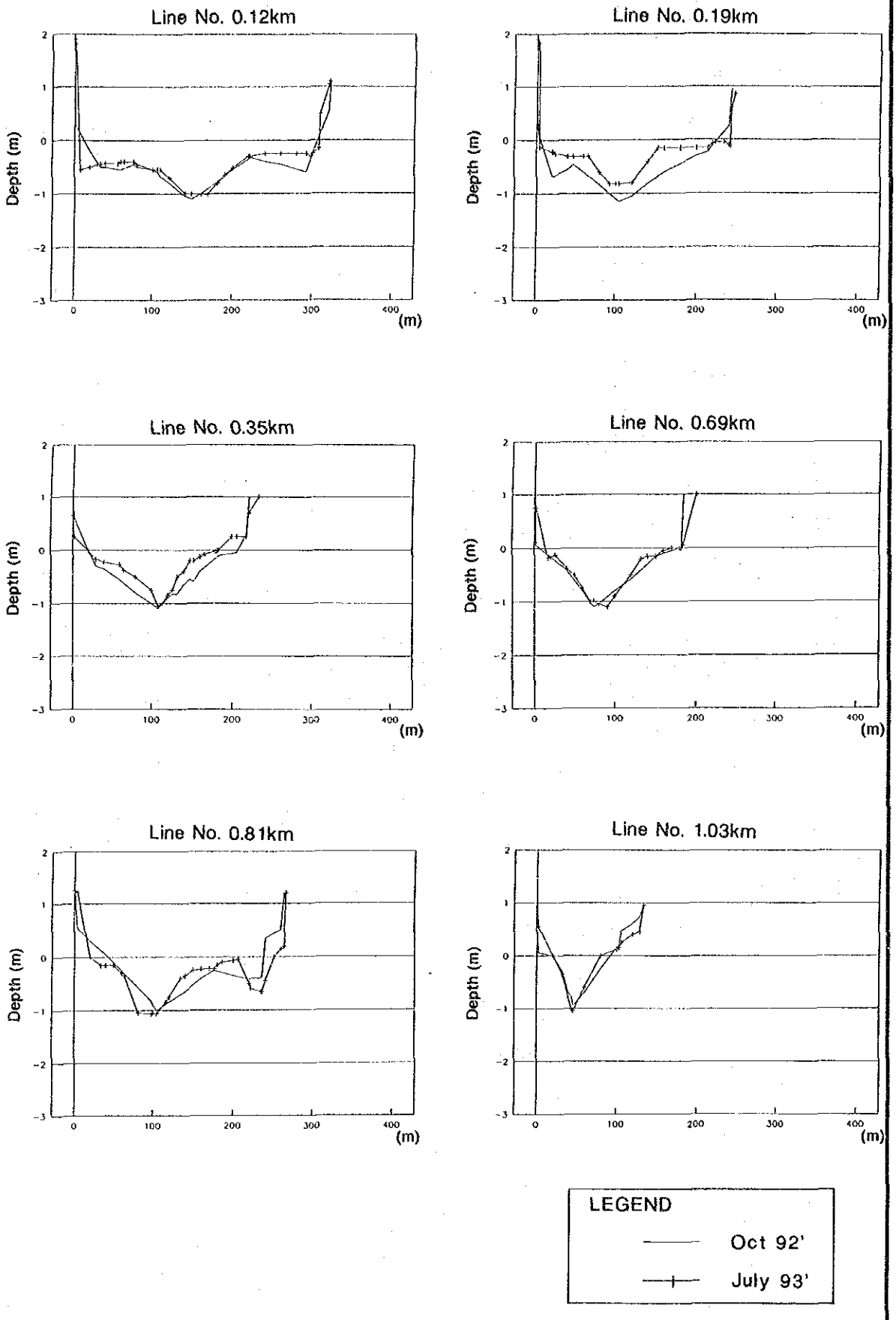
OPTIMUM COUNTERMEASURES PROPOSED IN MASTER PLAN (MARANG RIVER MOUTH) Fig.1.2-2



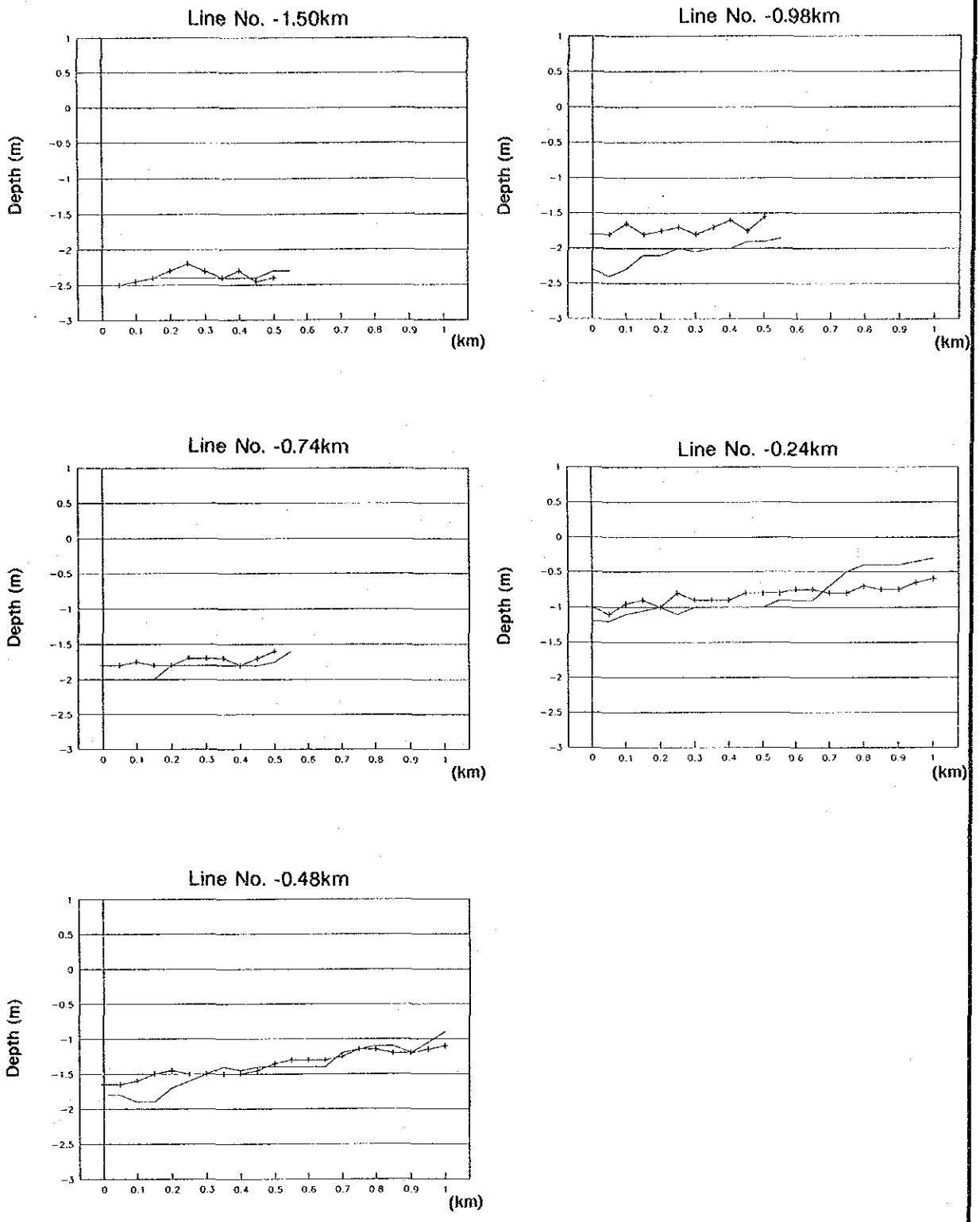
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

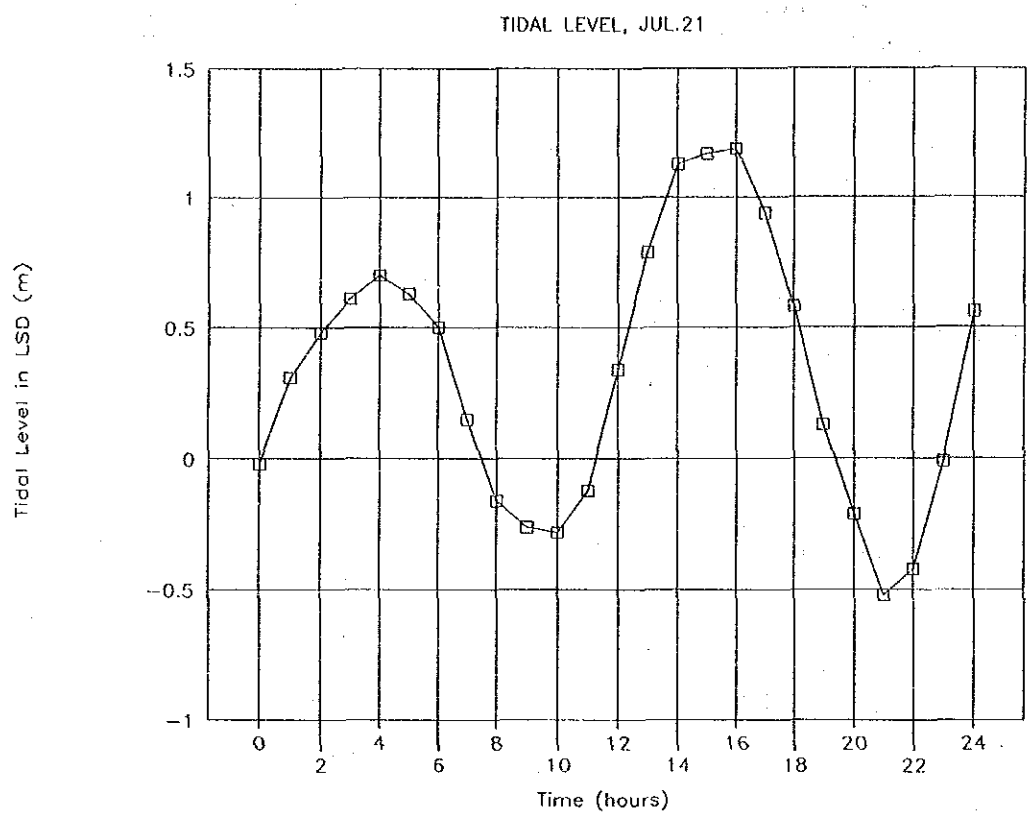
COMPARISON OF BATHYMETRIC SURVEY AT TG. PIANDANG RIVER MOUTH Fig. 2.1-1

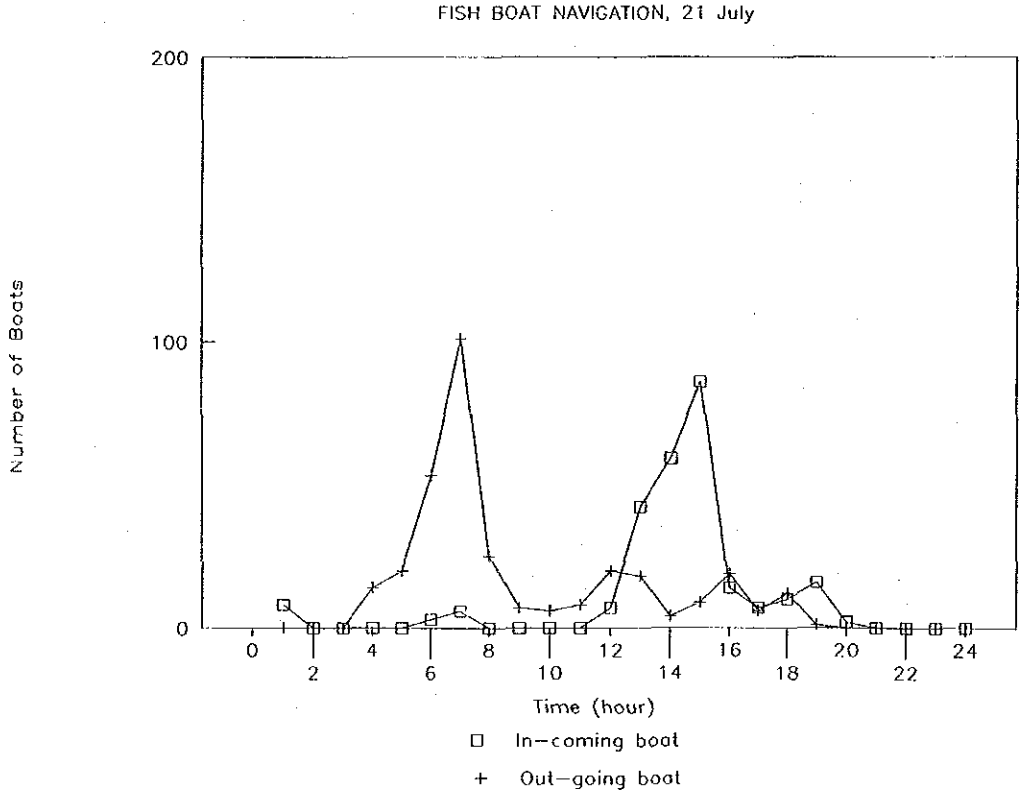


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	COMPARISON OF CROSS SECTION SURVEY AT TG. PIANDANG RIVER MOUTH (INNER CHANNEL)
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 2.1-2



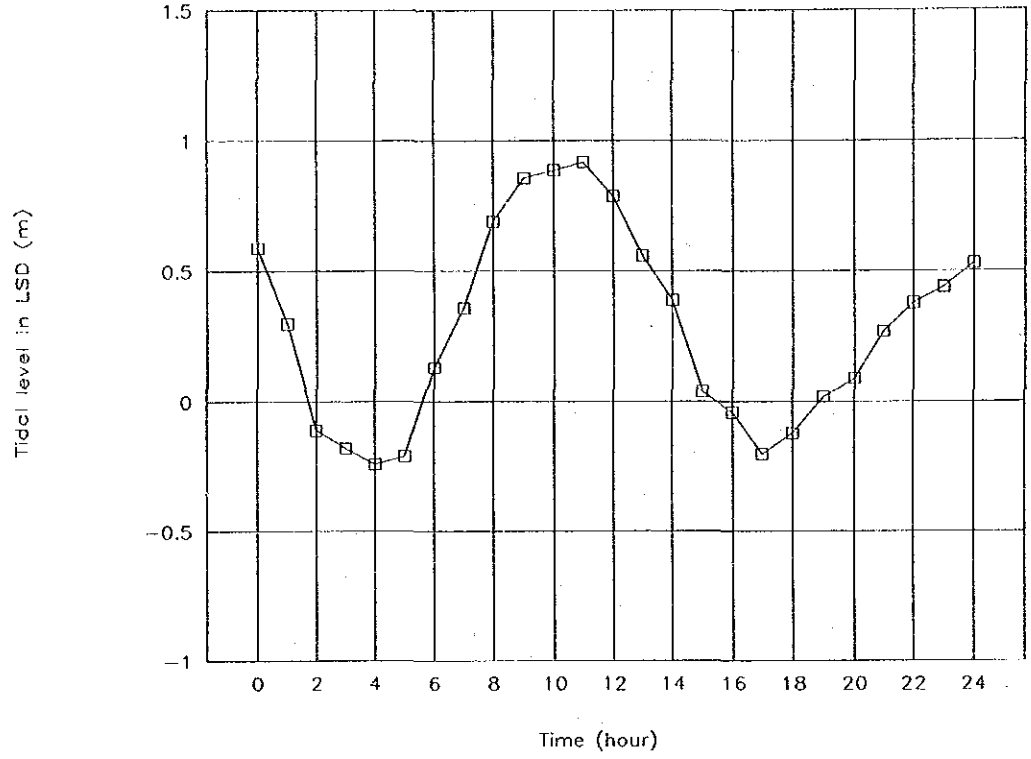
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	COMPARISON OF CROSS SECTION SURVEY AT TG. PIANDANG RIVER MOUTH (SEA-SIDE)
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 2.1-3



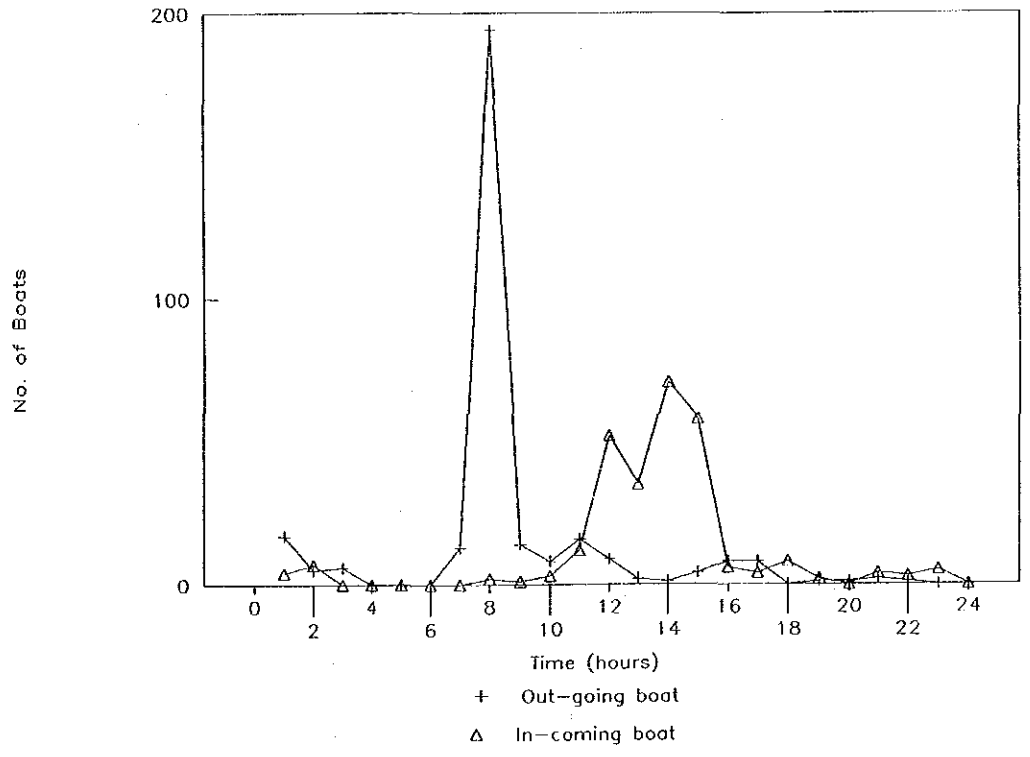


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	TIDAL LEVEL AND BOAT NAVIGATION AT TG. PIANDANG ON JULY 21, 1993
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 2.1-4

TIDAL LEVEL, JUN.30

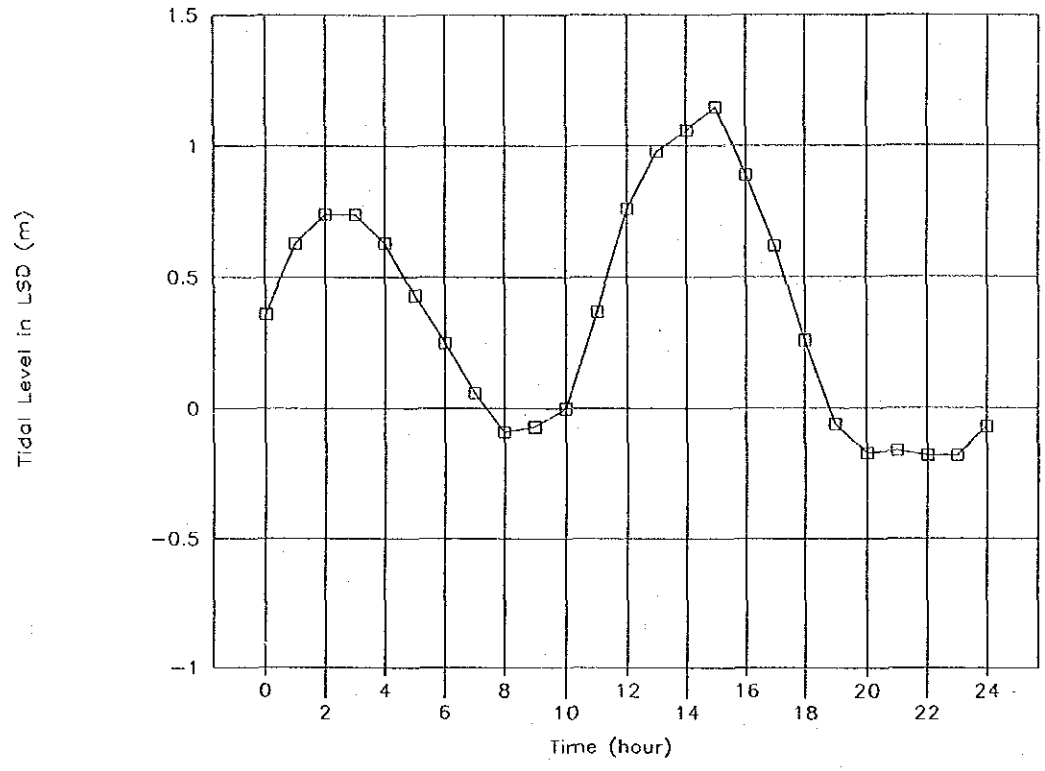


FISH BOAT NAVIGATION, JUN.30

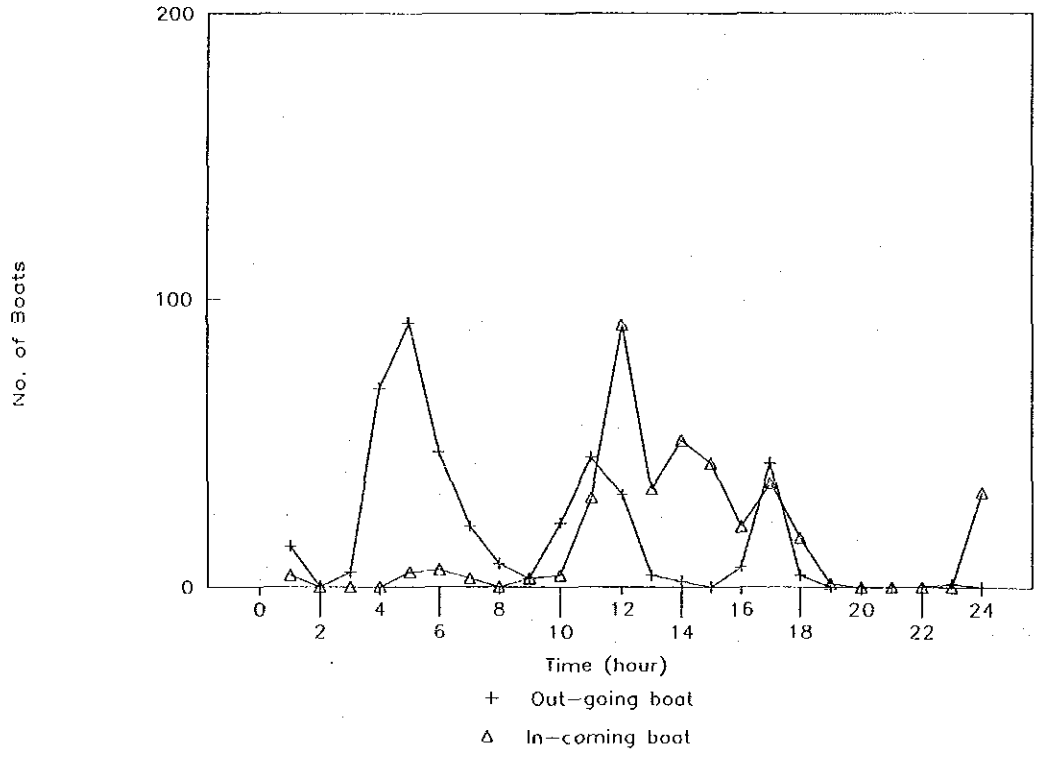


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	TIDAL LEVEL AND BOAT NAVIGATION AT TG. PIANDANG ON JUNE 30, 1993 Fig. 2.1-5
JAPAN INTERNATIONAL COOPERATION AGENCY	

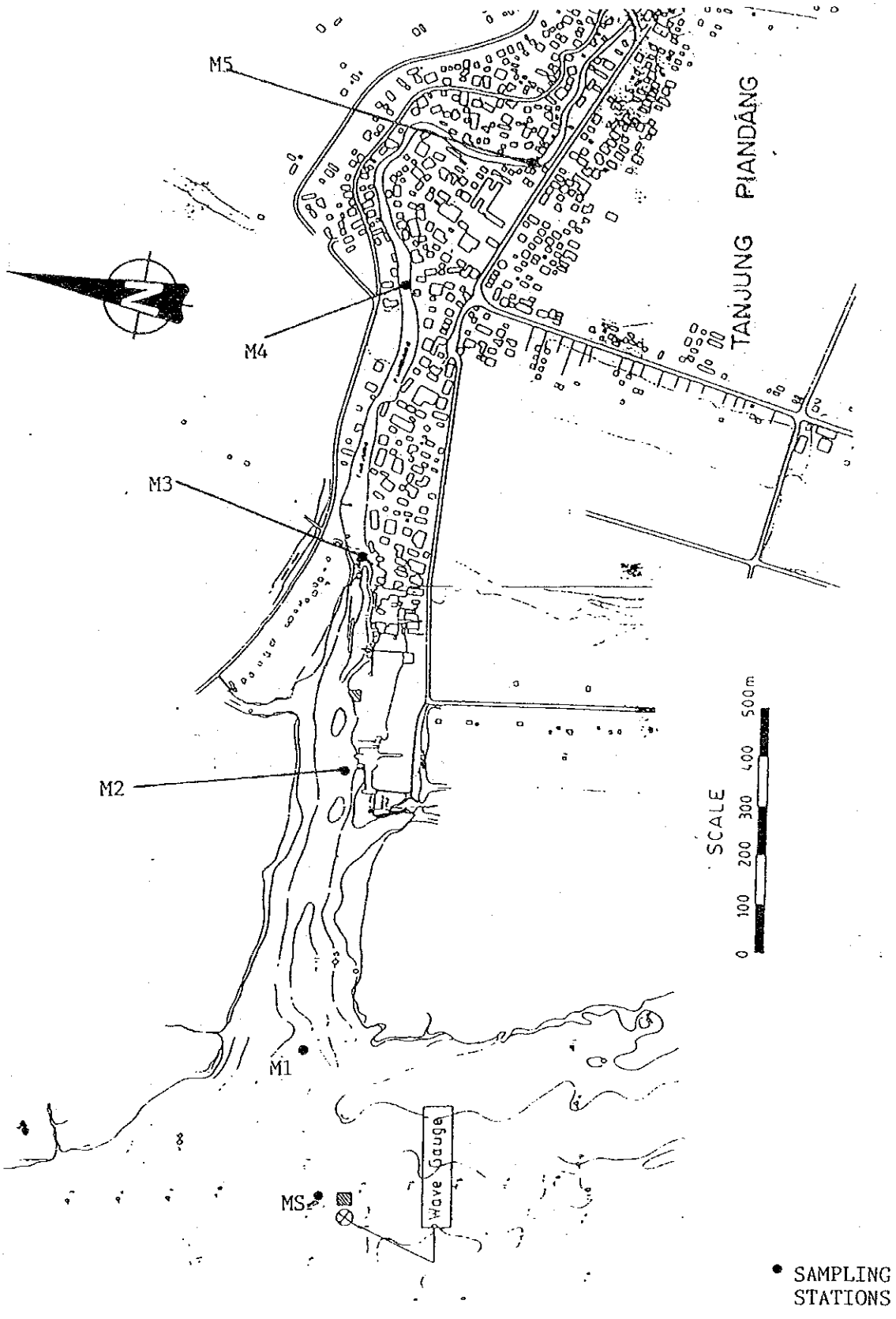
TIDAL LEVEL, JUL.4



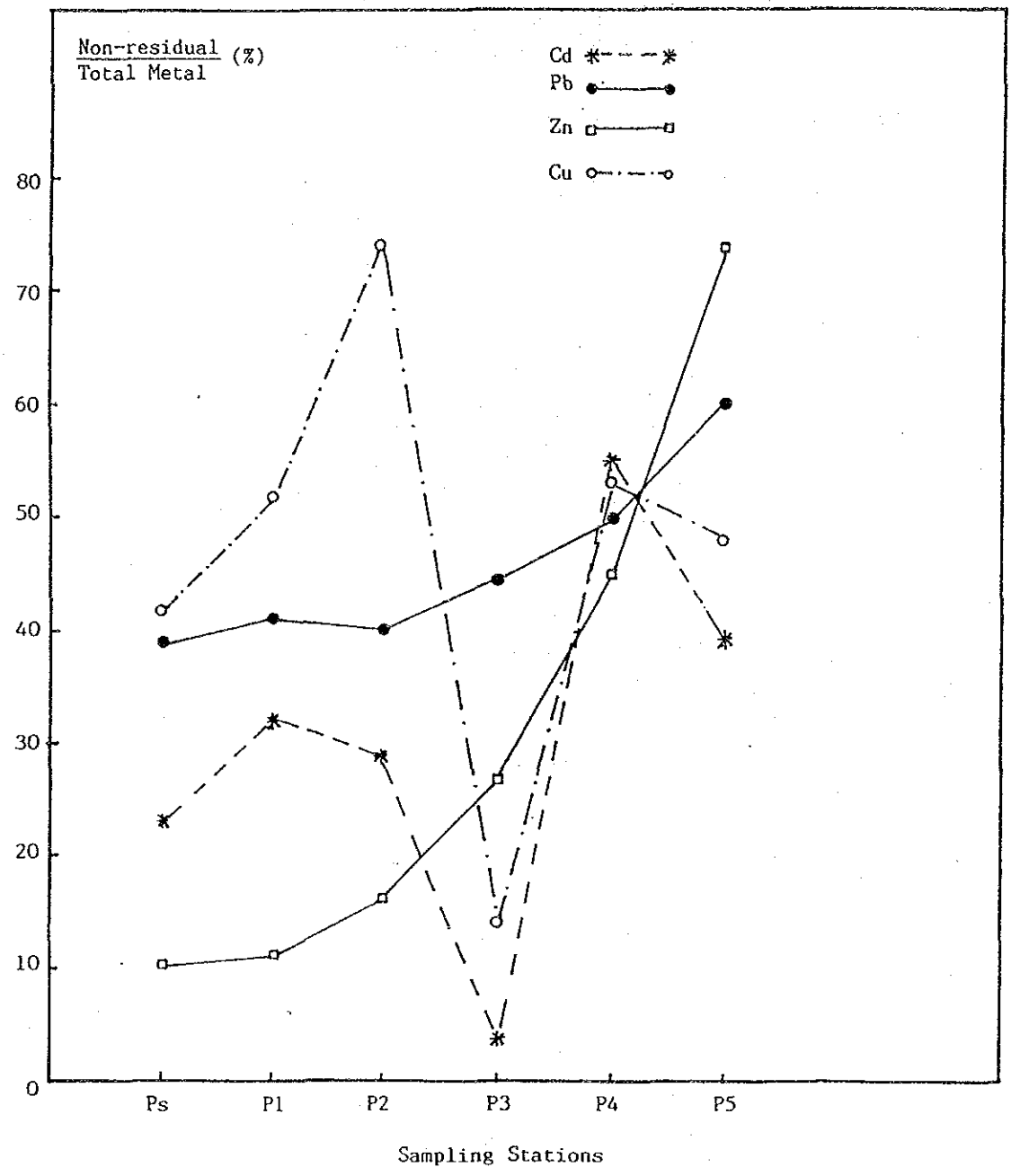
FISH BOAT NAVIGATION, JUL.4



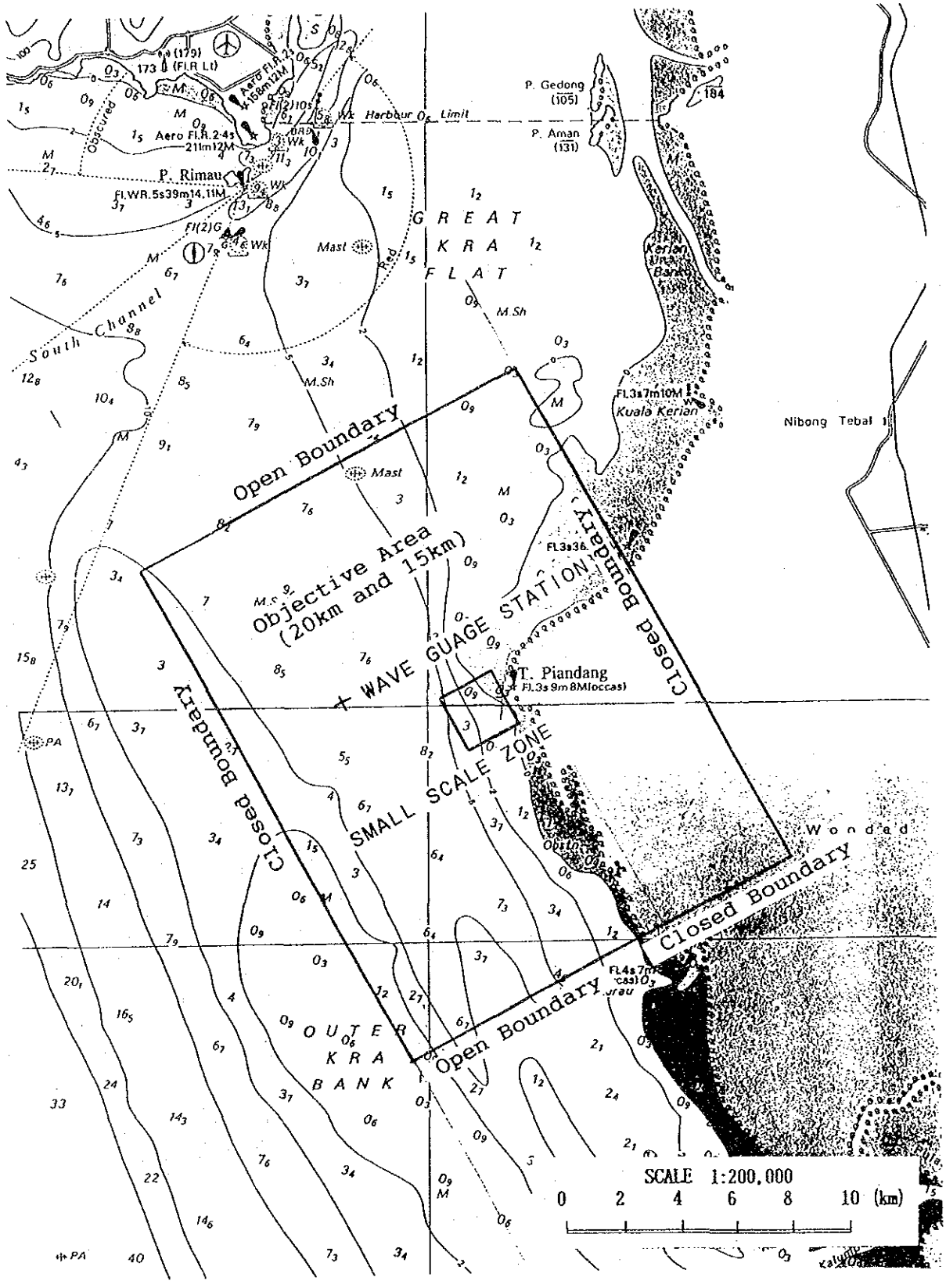
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	TIDAL LEVEL AND BOAT NAVIGATION AT TG. PIANDANG ON JULY 4, 1993
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 2.1-6



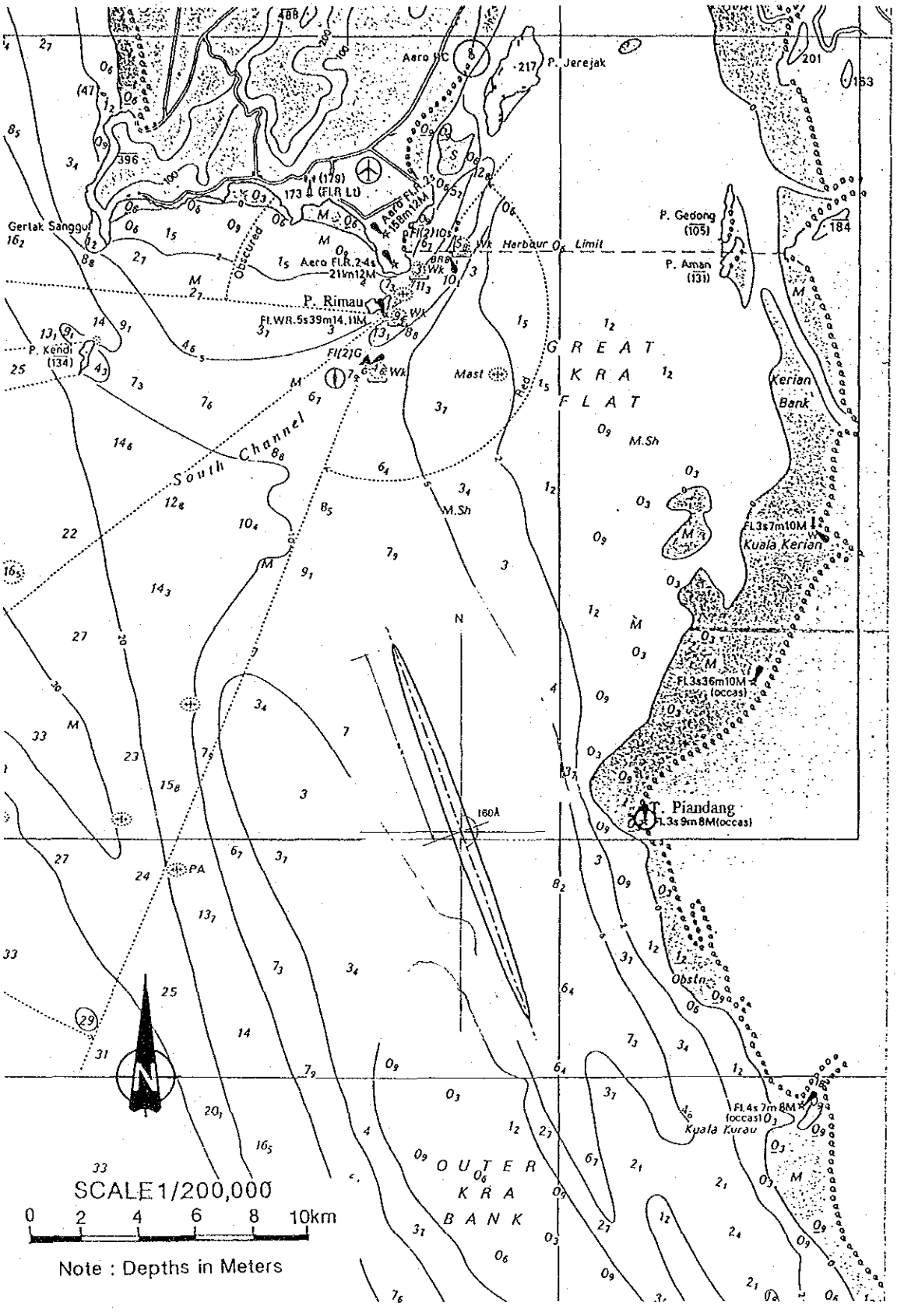
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	LOCATION OF SAMPLING POINTS (TG. PIANDANG)
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 2.1-7



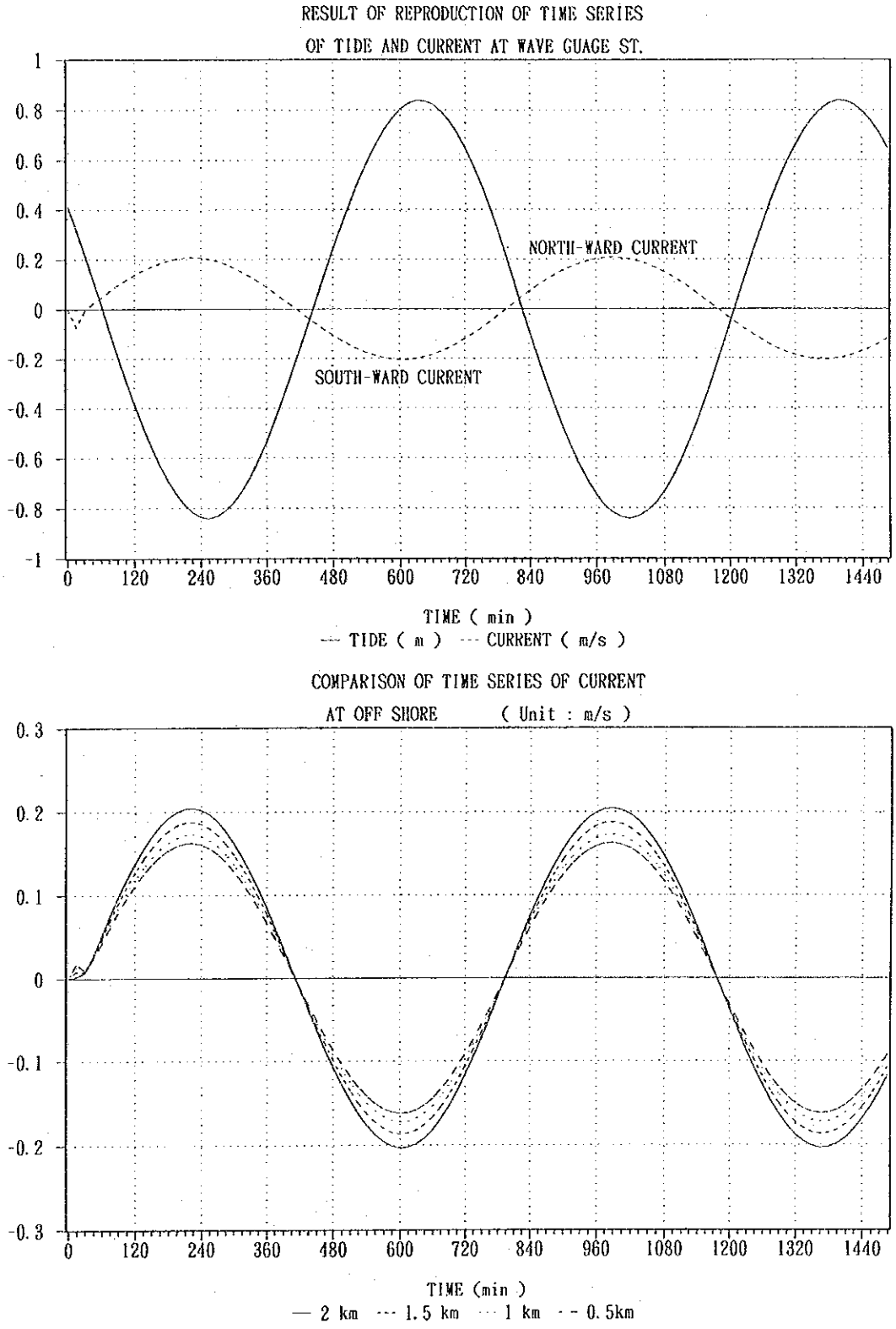
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA JAPAN INTERNATIONAL COOPERATION AGENCY	PERCENTAGE OF NON-RESIDUAL METALS IN SEDIMENT (TG. PIANDANG) Fig. 2.1-8



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	CALCULATION AREA FOR SILTATION RATE
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 2.2-1

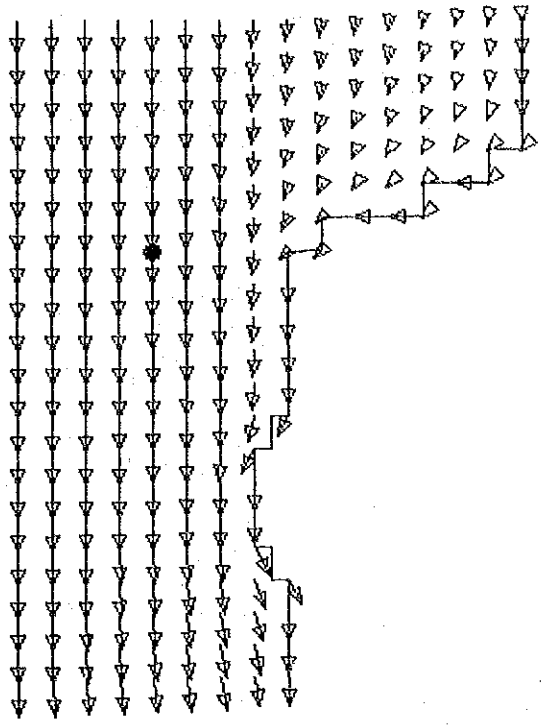


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	TIDAL CURRENT ELLIPSE AT WAVE GAUGE STATION
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 2.2-2

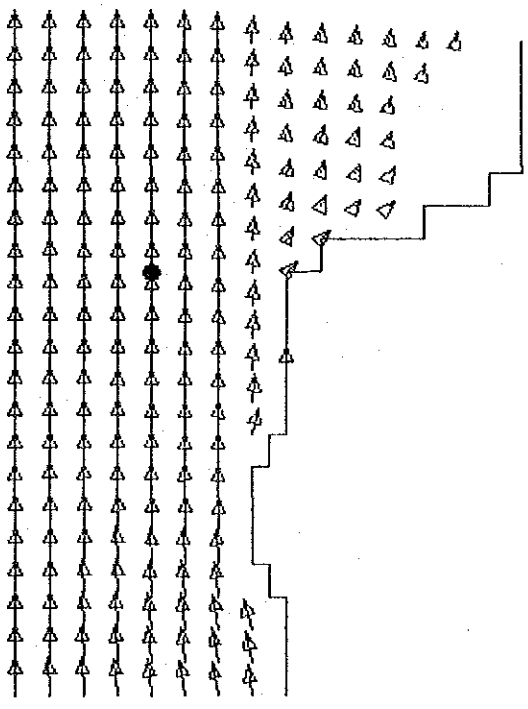


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	CALCULATION RESULT FOR LARGE SCALE AREA
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 2.2-3

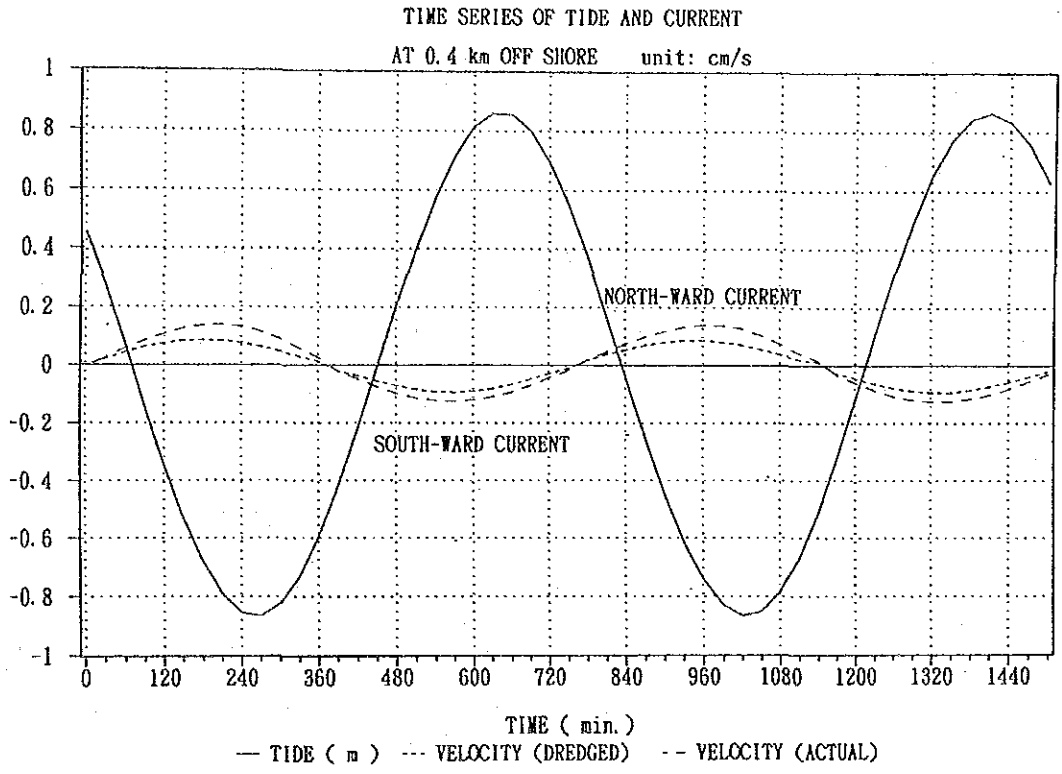
V= 0.198 [m/s]
A= 0.4643 [m]

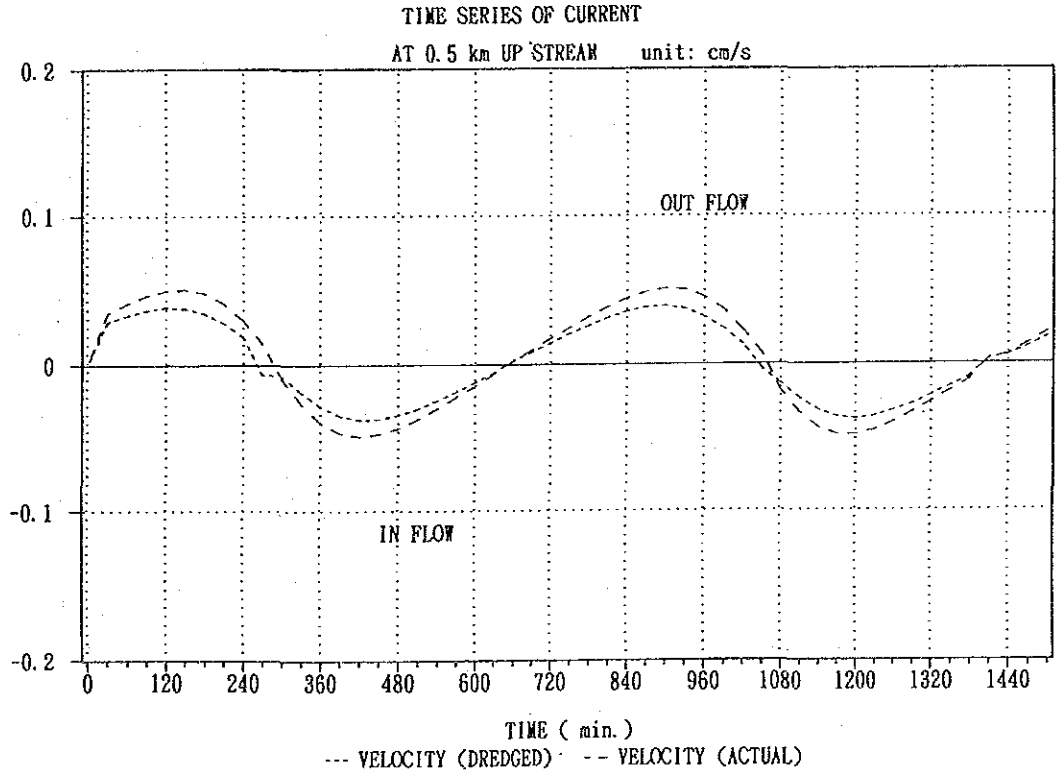


V= 0.200 [m/s]
A= 0.5445 [m]

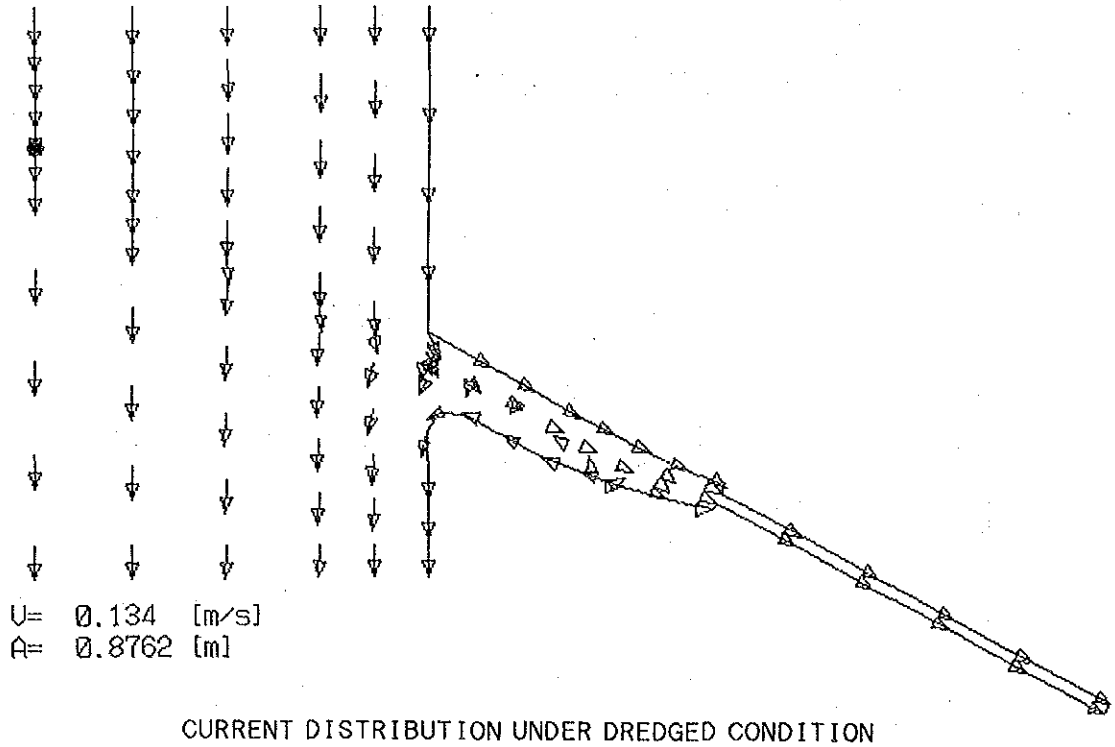


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	CURRENT DISTRIBUTION FOR LARGE SCALE AREA
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 2.2-4

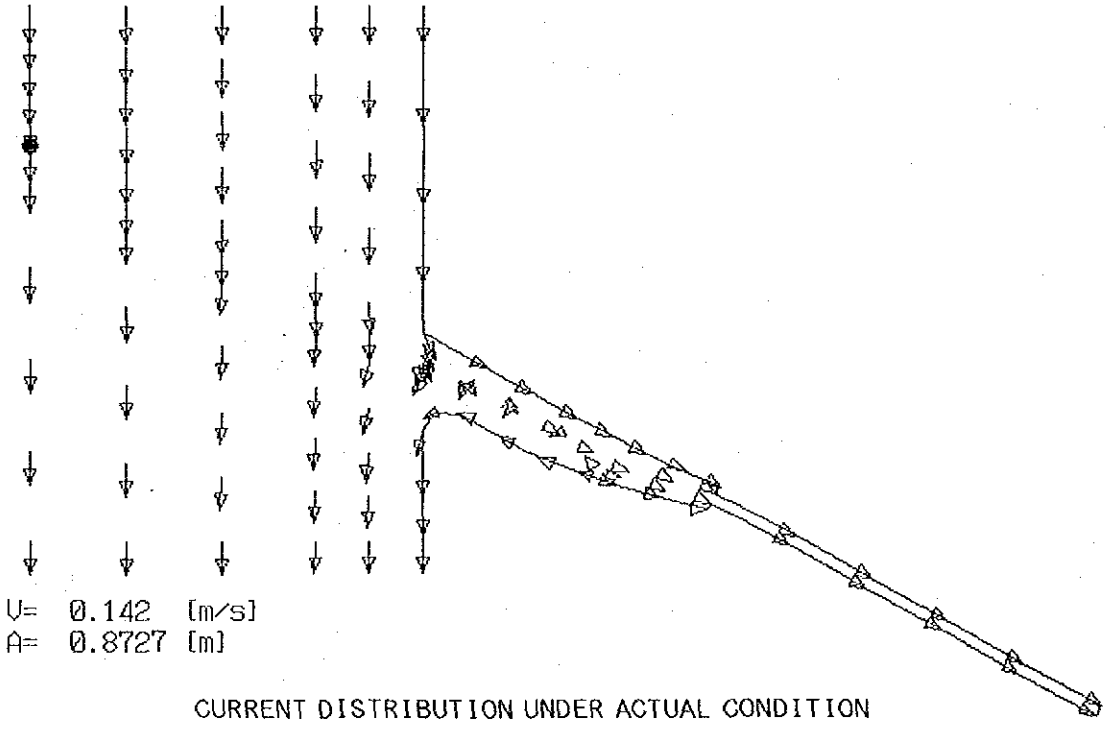




THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	CALCULATION RESULT FOR SMALL SCALE AREA
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 2.2-5

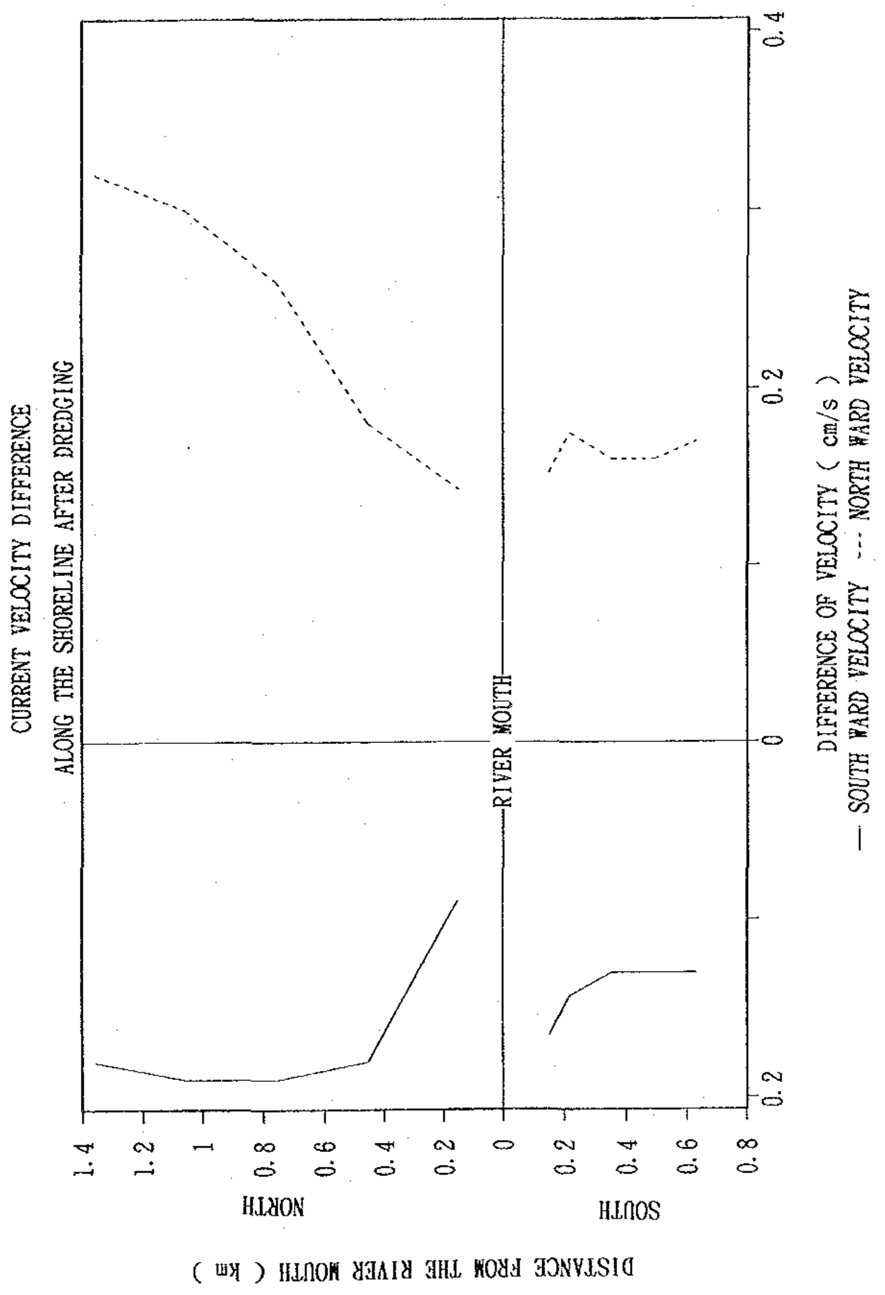


CURRENT DISTRIBUTION UNDER DREDGED CONDITION

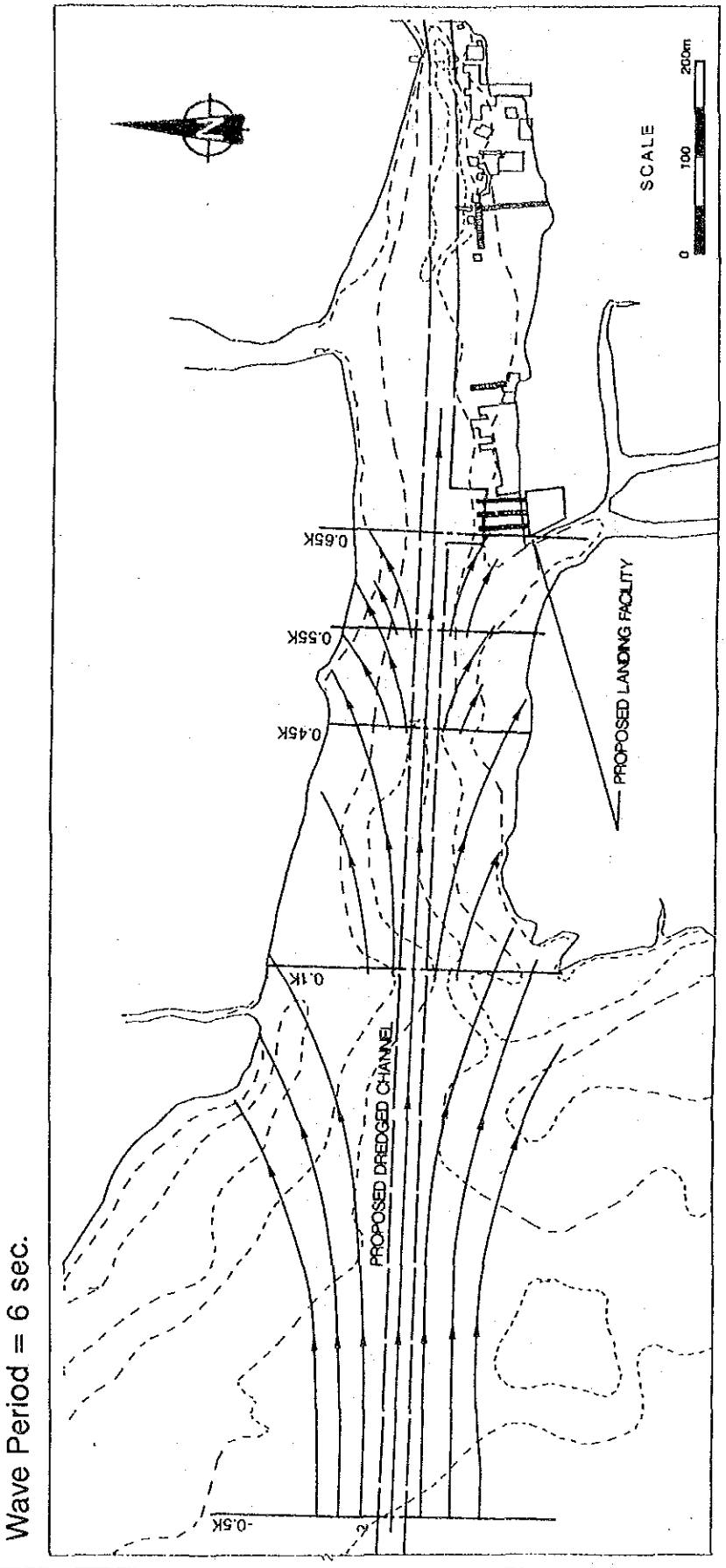


CURRENT DISTRIBUTION UNDER ACTUAL CONDITION

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	CURRENT DISTRIBUTION FOR SMALL SCALE AREA
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 2.2-6



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	MAXIMUM VELOCITY DIFFERENCE ALONG THE SHORELINE
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 2.2-7

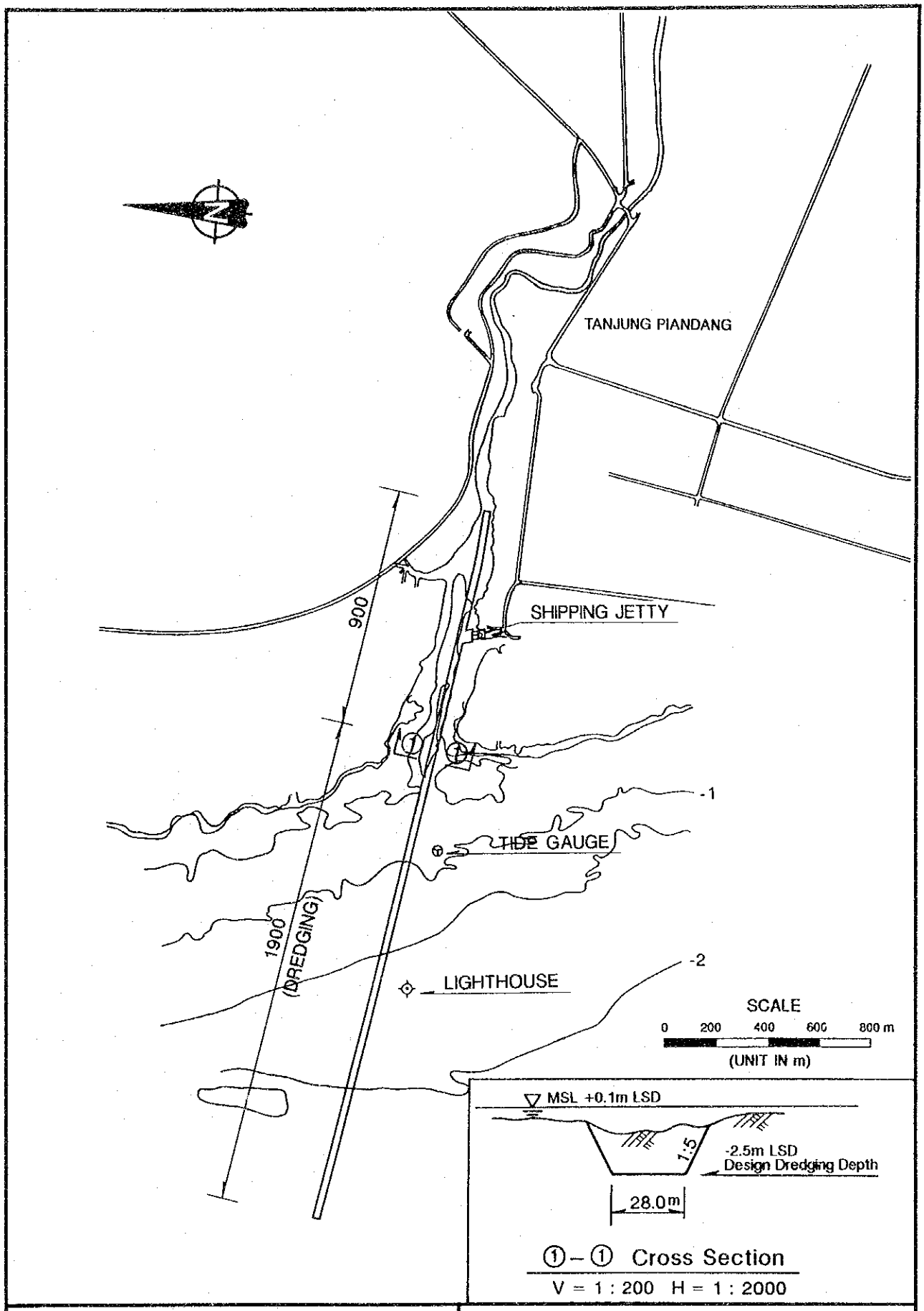


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

WAVE REFRACTION DIAGRAM

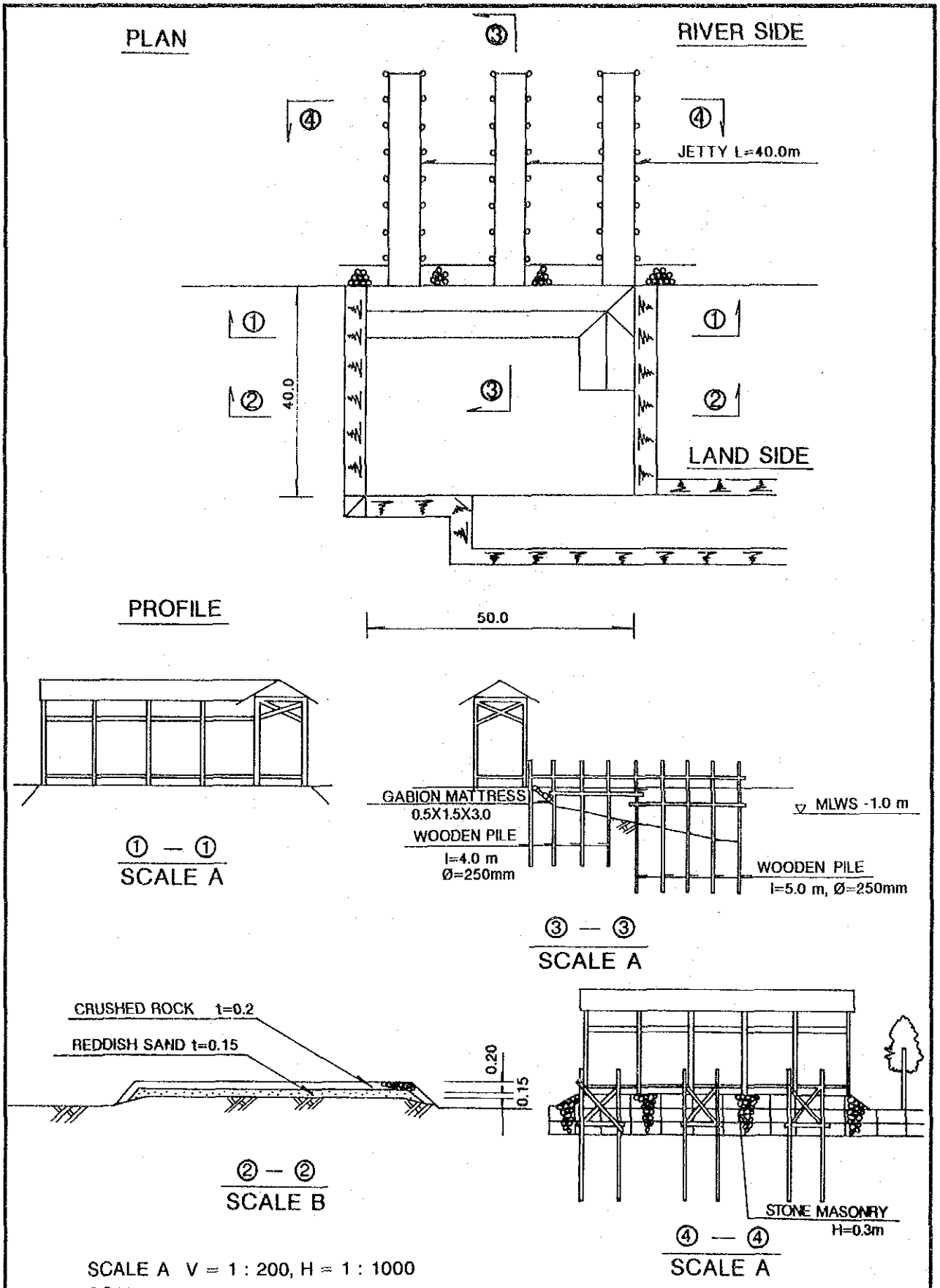
Fig. 2.2-8



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

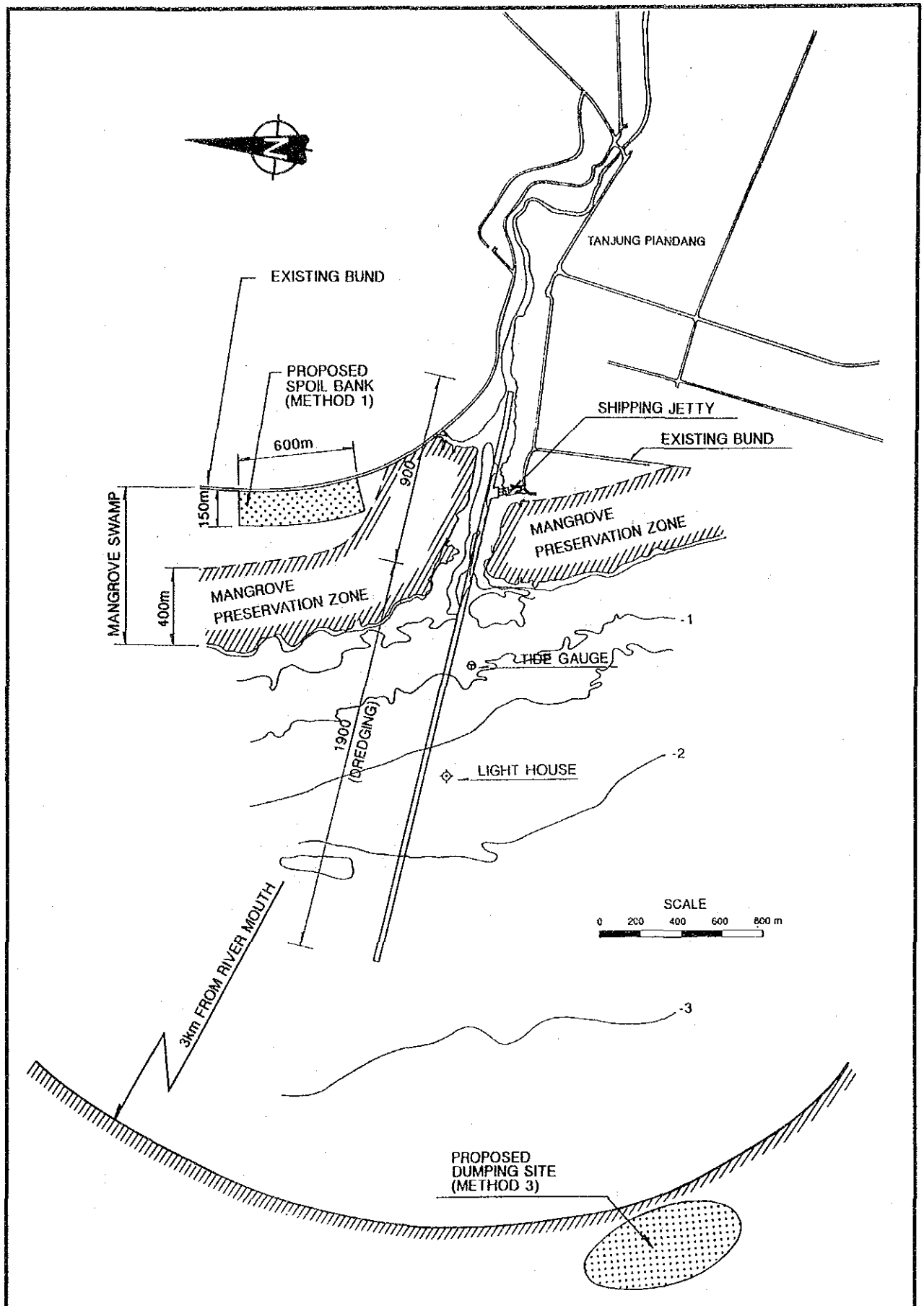
JAPAN INTERNATIONAL COOPERATION AGENCY

GENERAL LAYOUT OF OPTIMUM COUNTERMEASURES AT TG. PIANDANG RIVER MOUTH Fig. 2.3-1



SCALE A V = 1 : 200, H = 1 : 1000
SCALE B V = 1 : 100, H = 1 : 1000

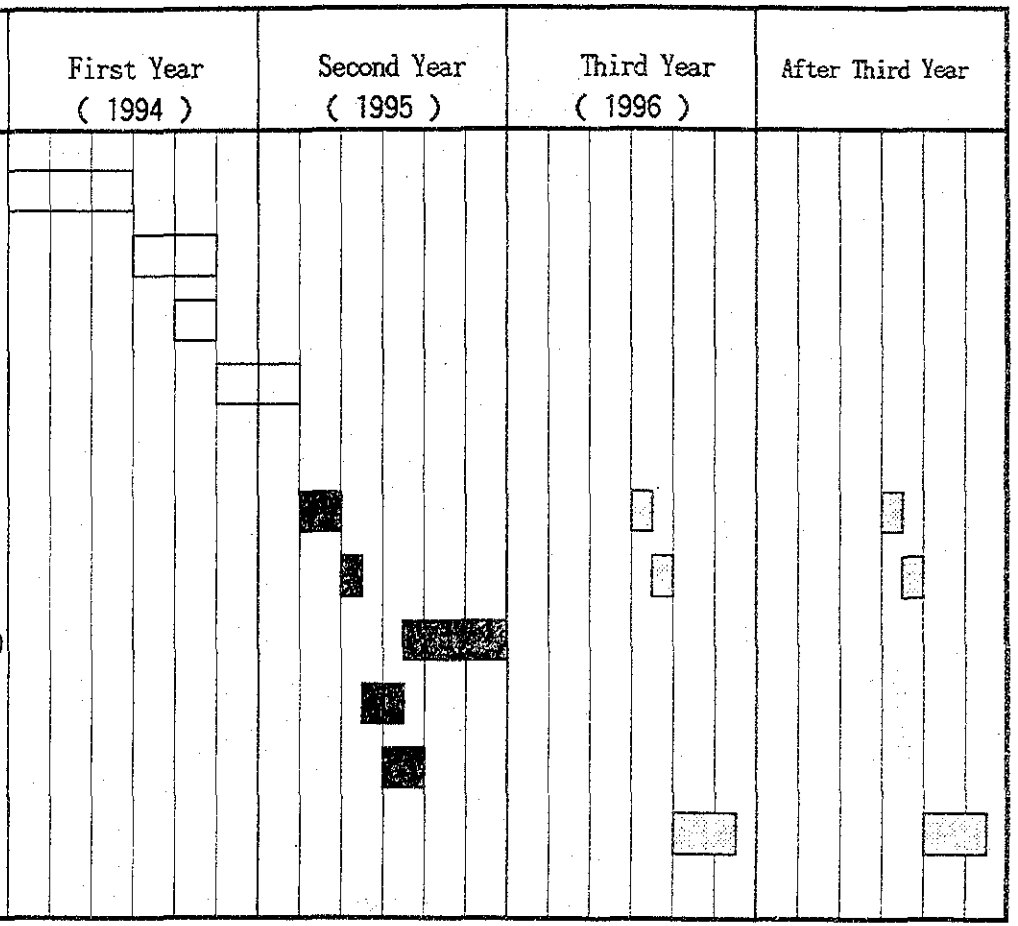
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	GENERAL LAYOUT OF FISHING JETTY
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 2.3-2



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA JAPAN INTERNATIONAL COOPERATION AGENCY	PROPOSED DUMPING SITE OF DREDGED MATERIAL Fig. 2.3-3

Fig. 2.3-4 IMPLEMENTATION SCHEDULE FOR TG.PIANDANG RIVER MOUTH IMPROVEMENT PROJECT

Description	Unit	Quantity
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

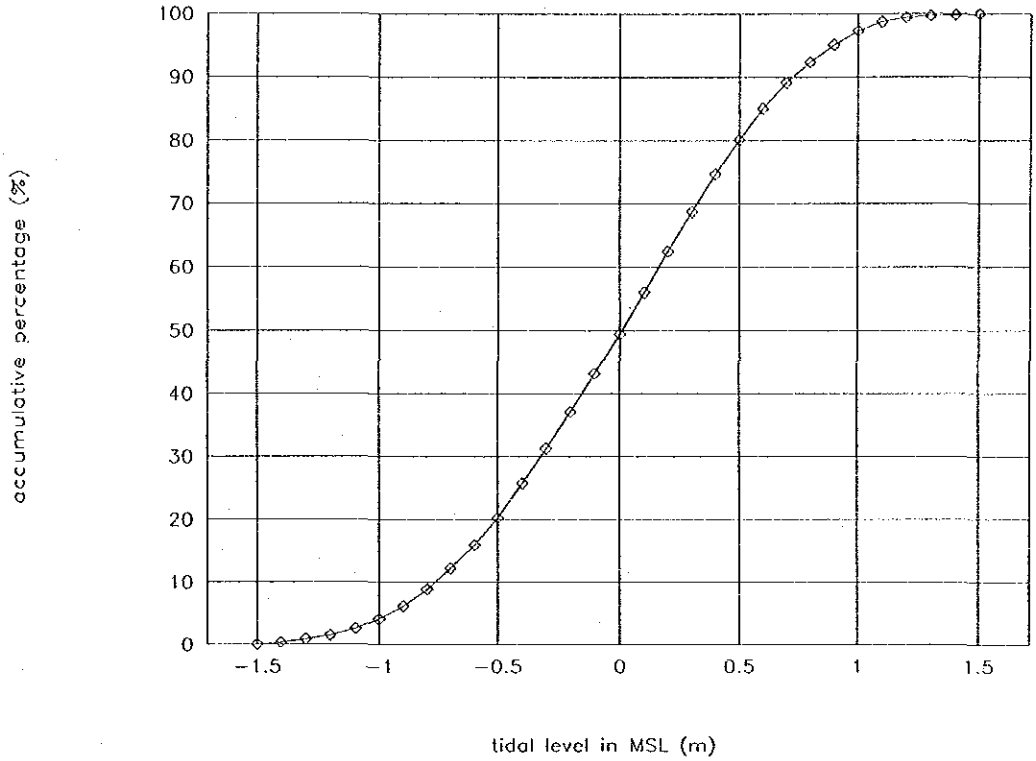


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

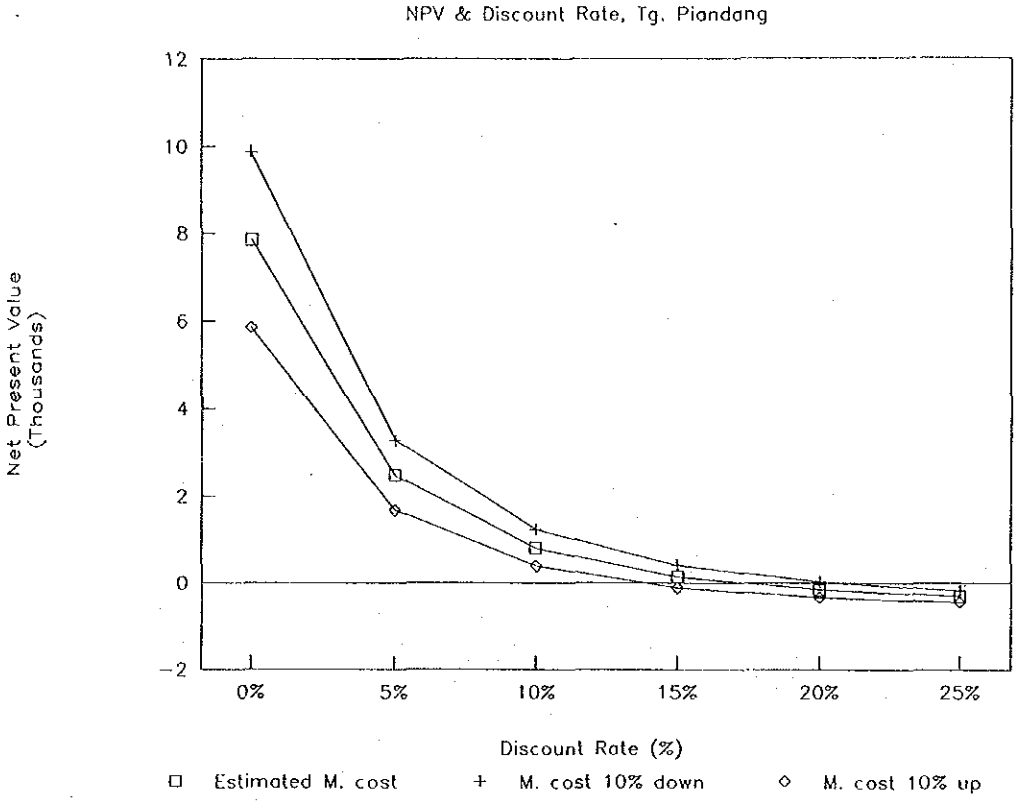
IMPLEMENTATION SCHEDULE OF TG. PIANDANG RIVER MOUTH IMPROVEMENT PROJECT Fig. 2.3-4

FREQUENCY DISTRIBUTION OF TIDAL LEVELS



MSL (m)	Distribution (%)	Accumulation (%)
-1.5	0.00	0.00
-1.4	0.30	0.30
-1.3	0.50	0.80
-1.2	0.60	1.40
-1.1	1.10	2.50
-1.0	1.50	4.00
-0.9	2.10	6.10
-0.8	2.70	8.80
-0.7	3.40	12.20
-0.6	3.70	15.90
-0.5	4.30	20.20
-0.4	5.50	25.70
-0.3	5.60	31.30
-0.2	5.80	37.10
-0.1	6.10	43.20
0.0	6.20	49.40
0.1	6.60	56.00
0.2	6.40	62.40
0.3	6.30	68.70
0.4	6.00	74.70
0.5	5.40	80.10
0.6	5.00	85.10
0.7	4.00	89.10
0.8	3.20	92.30
0.9	2.80	95.10
1.0	2.20	97.30
1.1	1.40	98.70
1.2	0.70	99.40
1.3	0.30	99.70
1.4	0.10	99.80
1.5	0.20	100.00

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	FREQUENCY DISTRIBUTION OF HOURLY TIDAL LEVELS AT KEDAH PIER STATION IN 1990 Fig. 2.4-1
JAPAN INTERNATIONAL COOPERATION AGENCY	



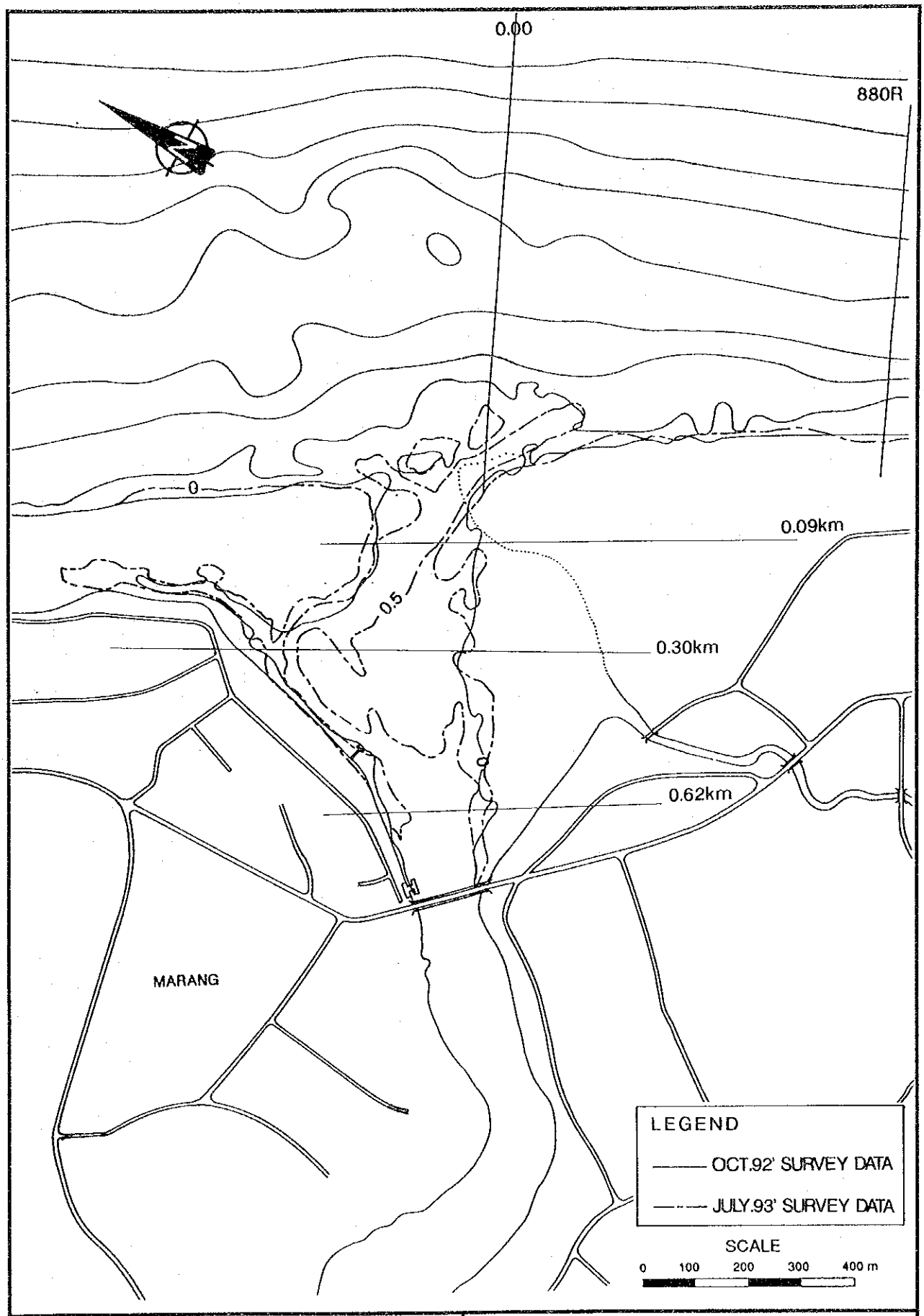
IRR is a value (i) which can satisfy the following formula:

$$\sum_{n=1}^{N} \frac{B_n - C_n}{(1+i)^n} = 0$$

where;

B_n : Benefit in the n-th year
C_n : Cost in the n-th year
i : Annual discount rate (%)
N : Number of years (project life)

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA JAPAN INTERNATIONAL COOPERATION AGENCY	SENSITIVITY OF ECONOMIC VIABILITY BY CHANGES OF MAINTENANCE COST Fig. 2.4-2

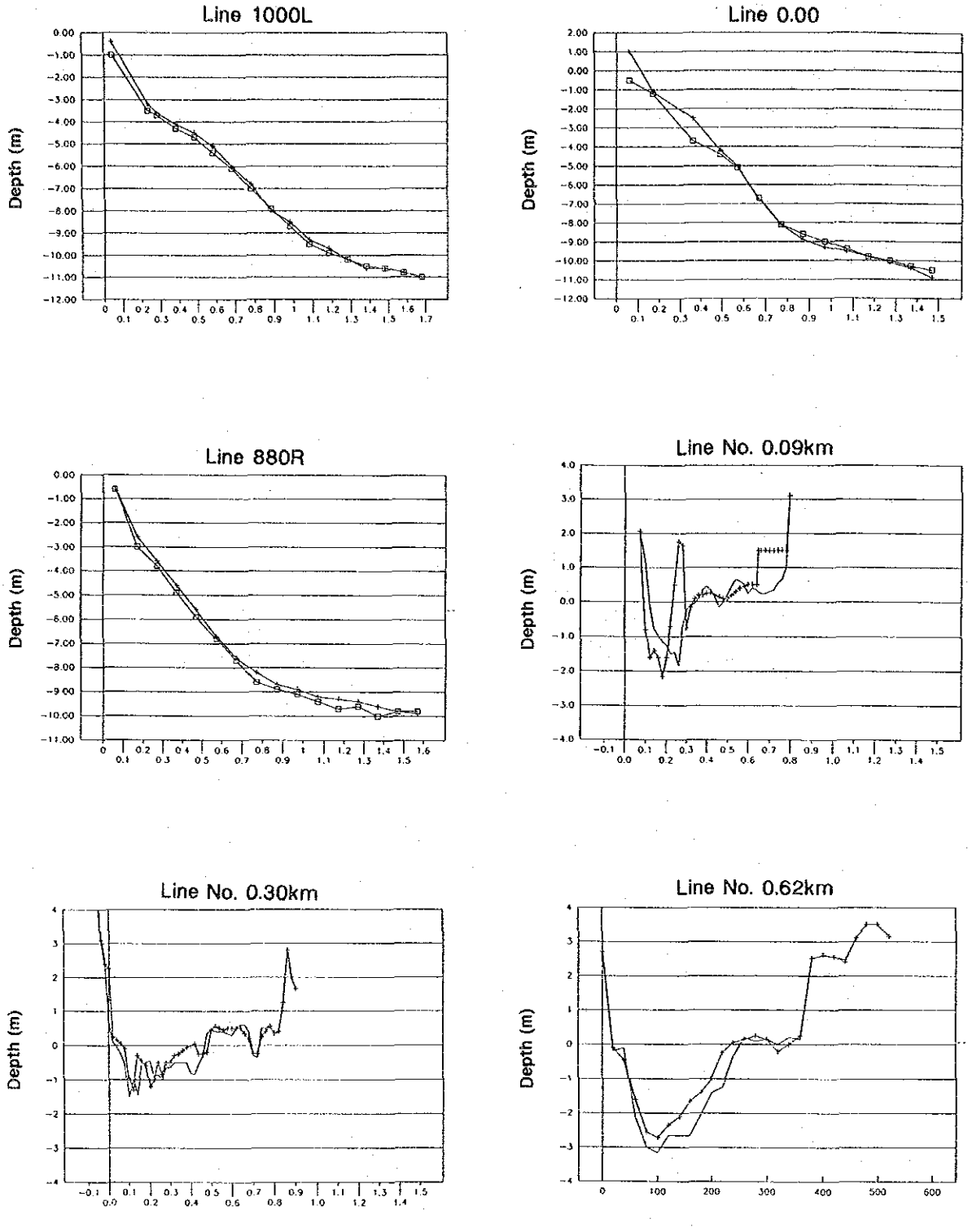


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

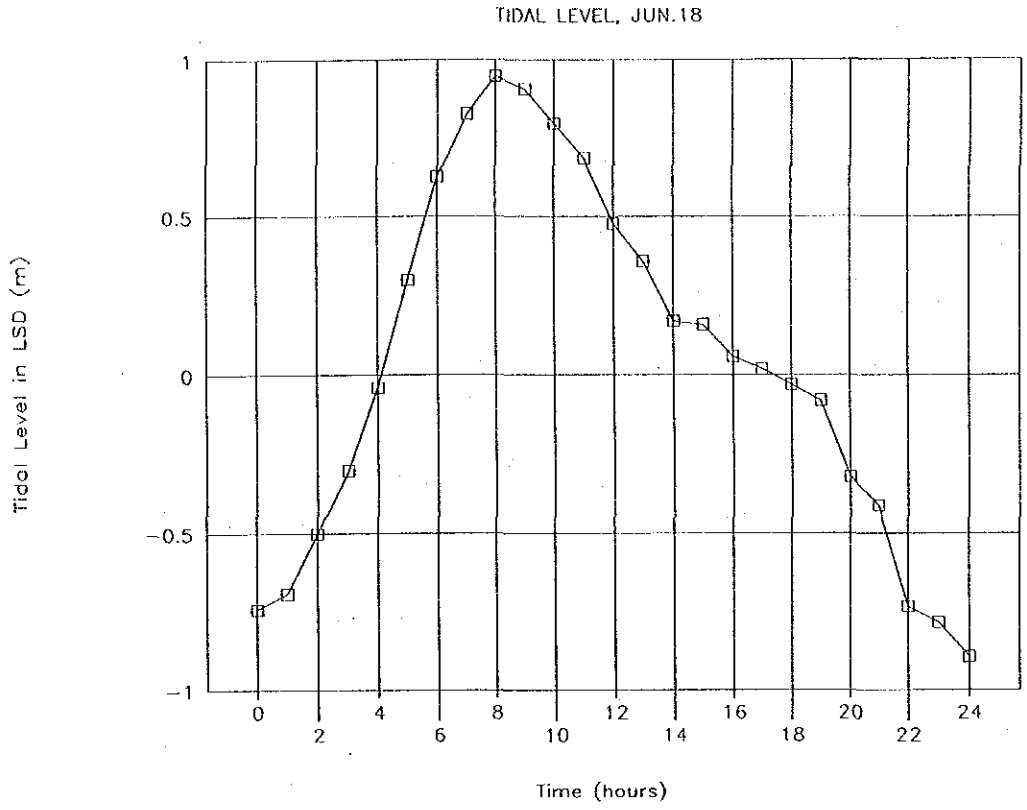
JAPAN INTERNATIONAL COOPERATION AGENCY

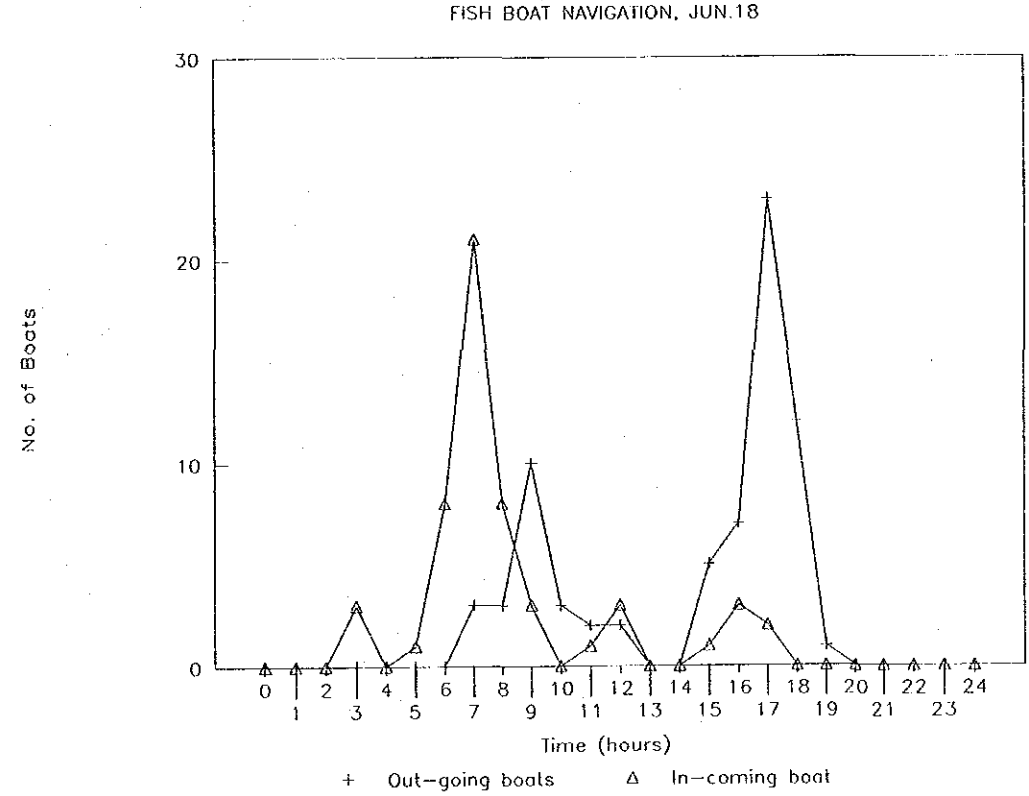
COMPARISON OF BATHYMETRIC SURVEY AT MARANG RIVER MOUTH

Fig. 3.1-1

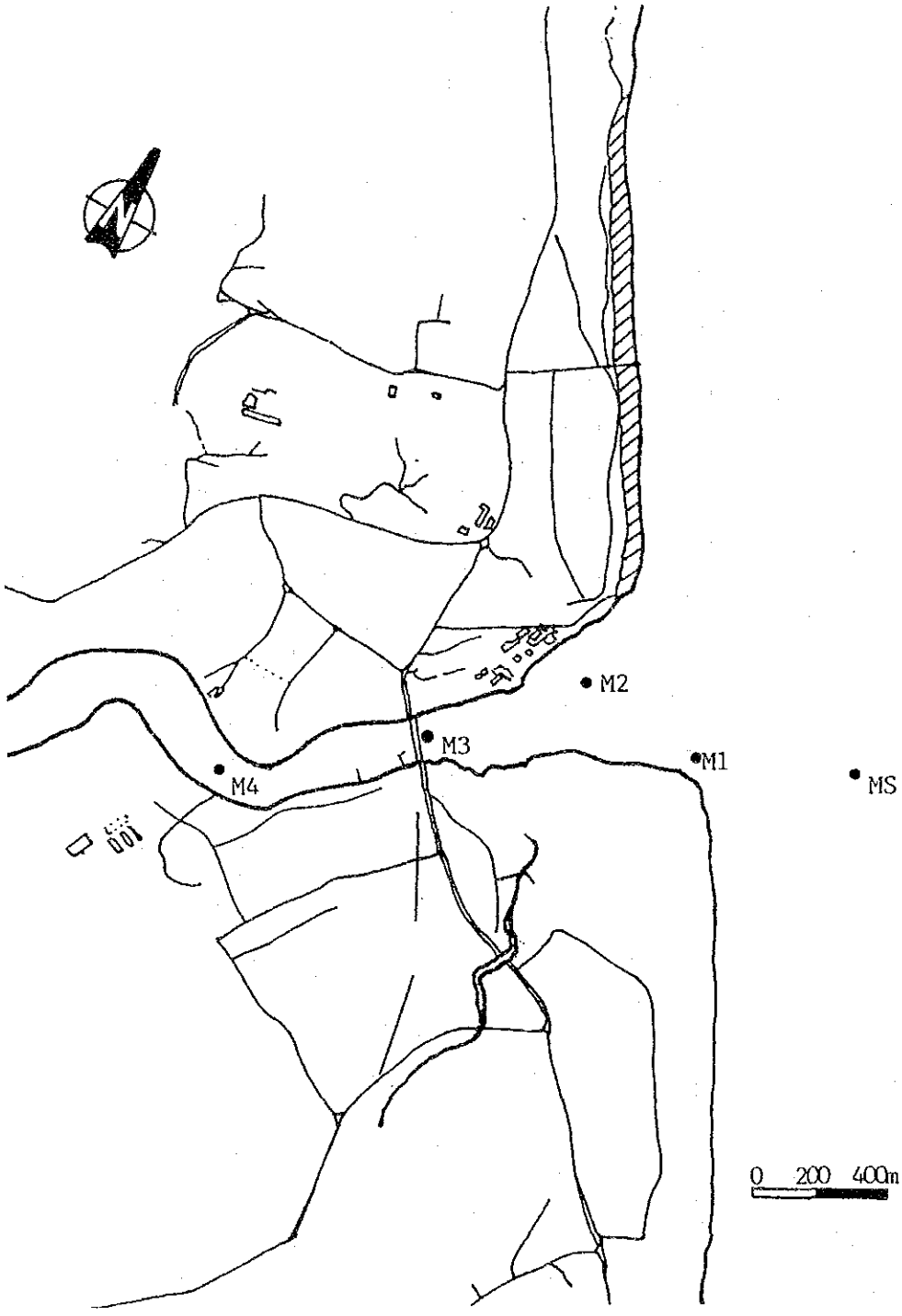


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA JAPAN INTERNATIONAL COOPERATION AGENCY	COMPARISON OF CROSS SECTION SURVEY AT MARANG RIVER MOUTH Fig. 3.1-2

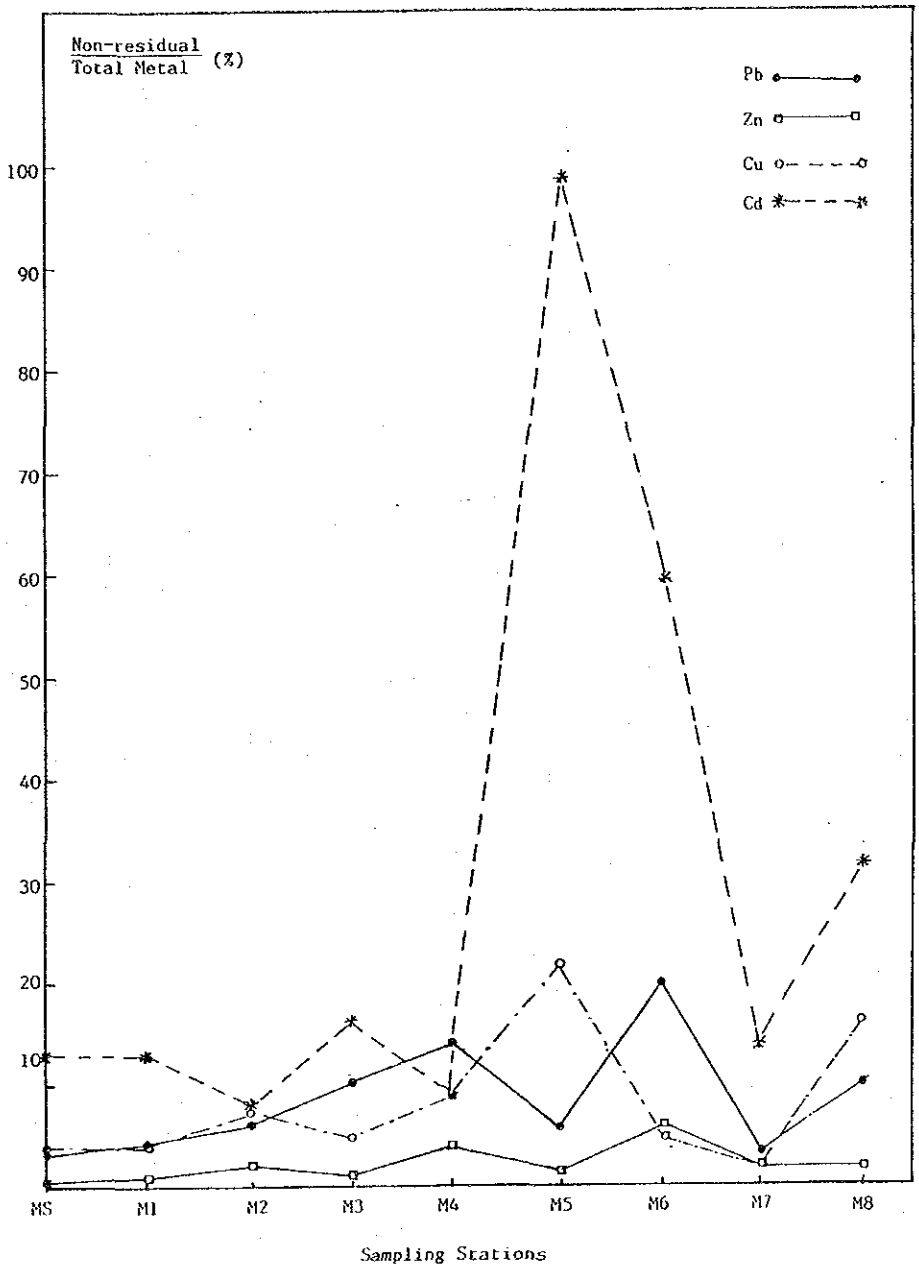




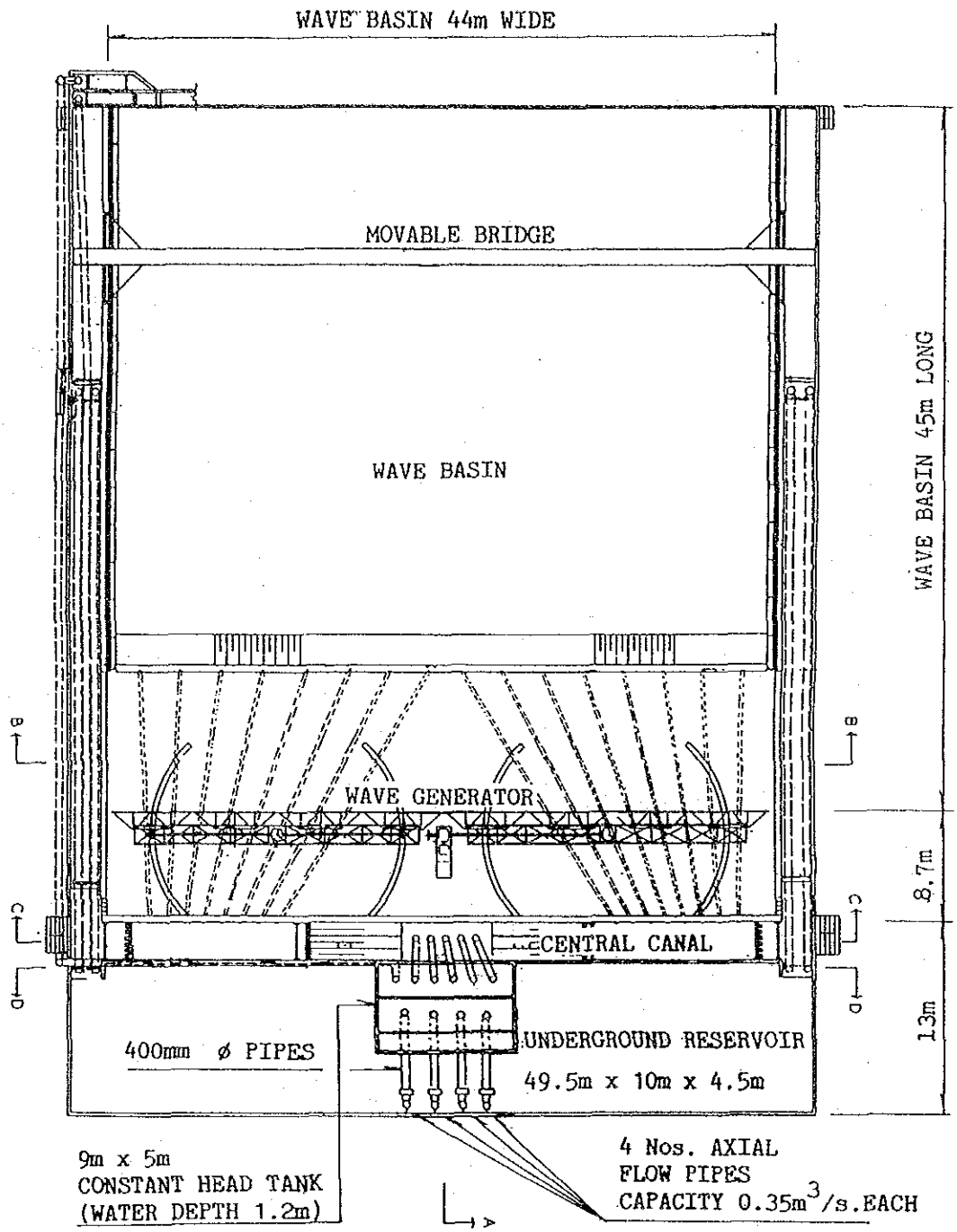
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA JAPAN INTERNATIONAL COOPERATION AGENCY	TIDAL LEVEL AND BOAT NAVIGATION AT MARANG RIVER MOUTH ON JUNE 18, 1993 Fig. 3.1-3



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	LOCATION OF SAMPLING POINTS (MARANG)
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.1-4



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	PERCENTAGE OF NON-RESIDUAL METALS IN SEDIMENT (MARANG) Fig. 3.1-5
JAPAN INTERNATIONAL COOPERATION AGENCY	



WAVE GENERATOR DETAILS

Wave Board - 2 x 22m

Wave Direction - $\pm$ 30°

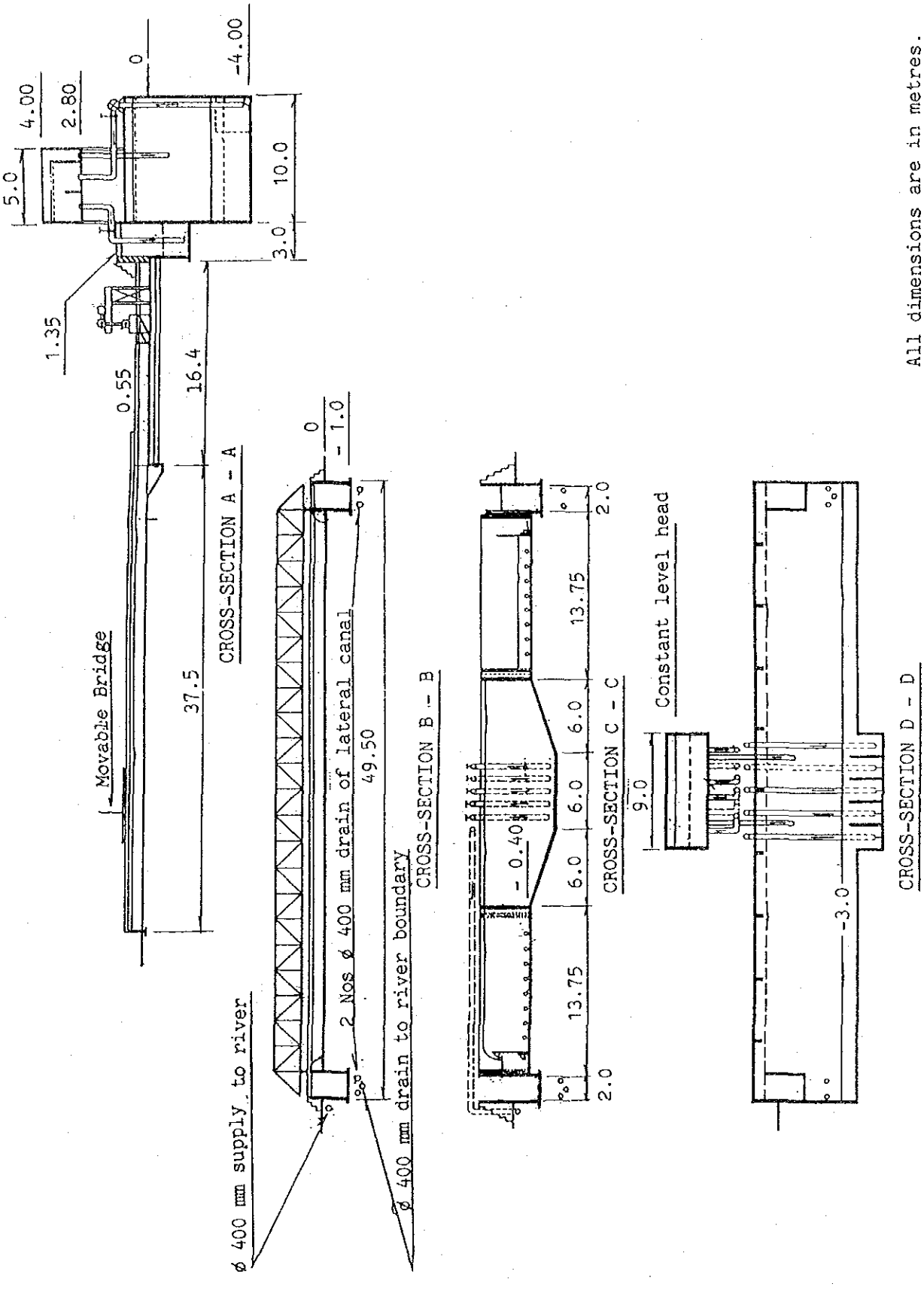
Wave Type - Translatory/Regular

Wave Period - 0.5s to 3.0s

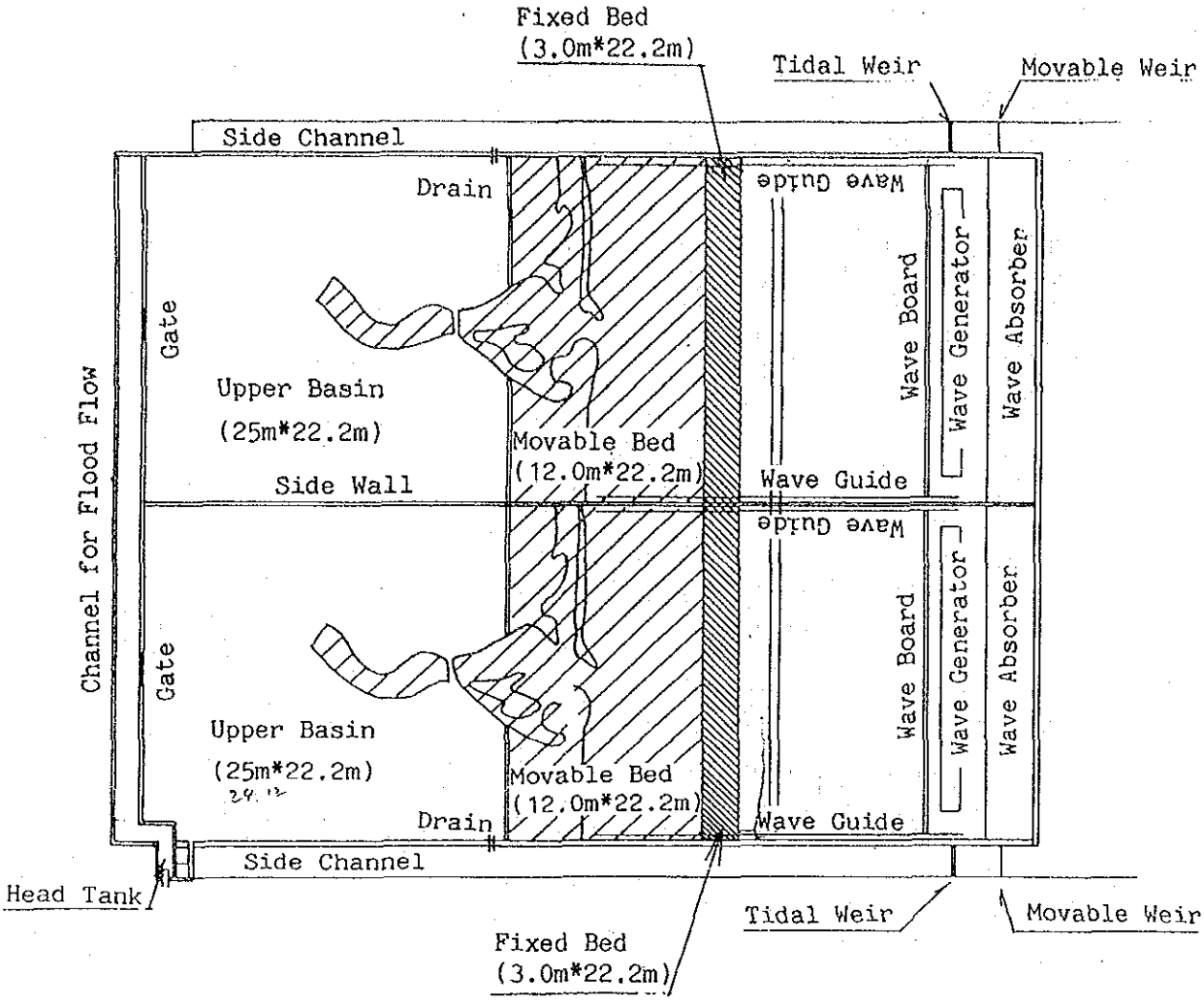
Wave Height - Maximum 0.15m

Water Depth - Maximum 0.4m

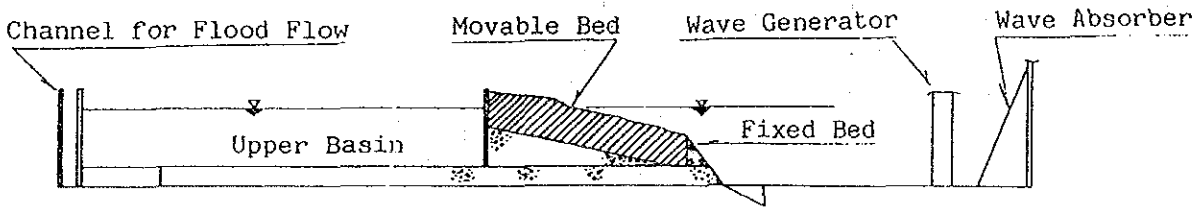
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	PLAN OF WAVE BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.2-1



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	CROSS SECTION OF WAVE BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.2-2

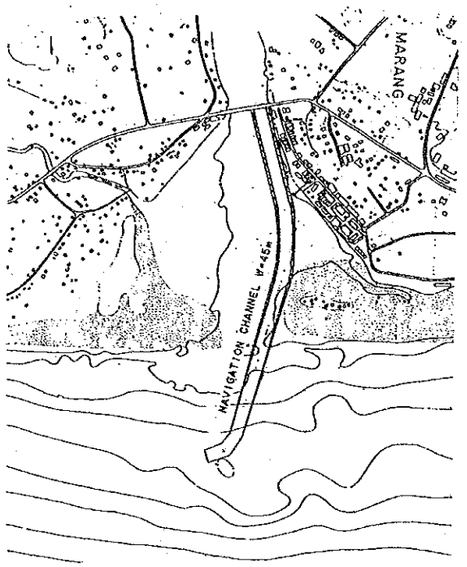


PLAN

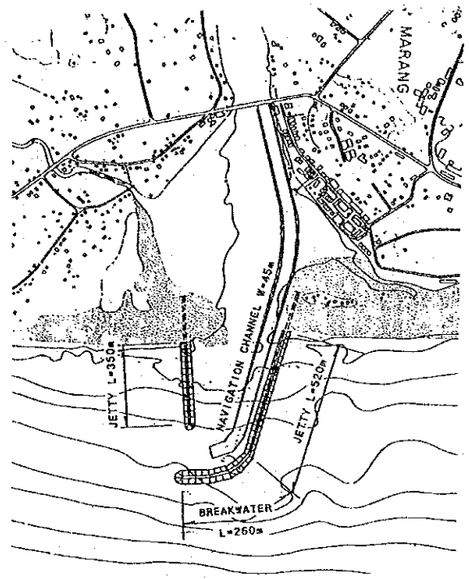


LONGITUDINAL SECTION

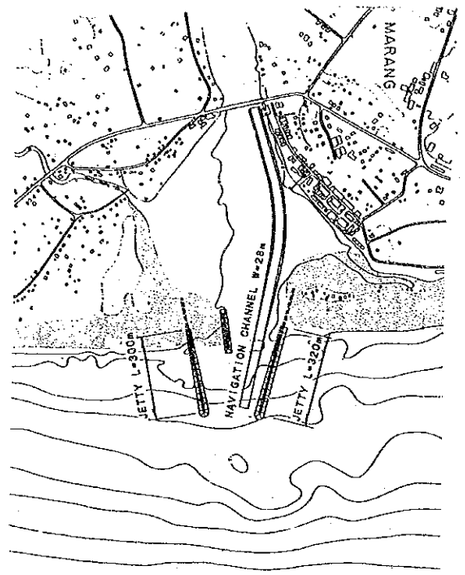
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA JAPAN INTERNATIONAL COOPERATION AGENCY	ARRANGEMENT OF MODEL Fig. 3.2-3



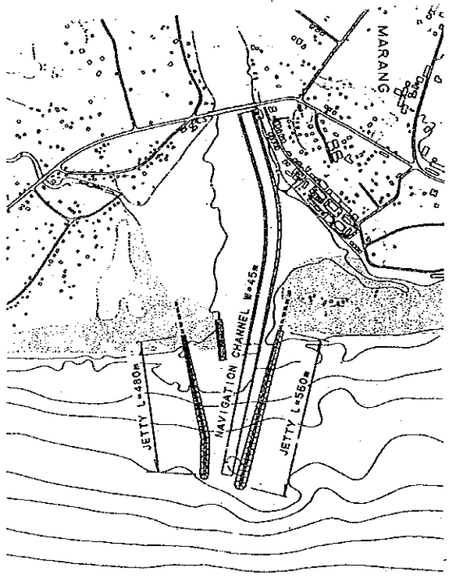
CASE-1 : DREDGED ONLY
NAVIGATION CHANNEL (HEIGHT -3.5 m)



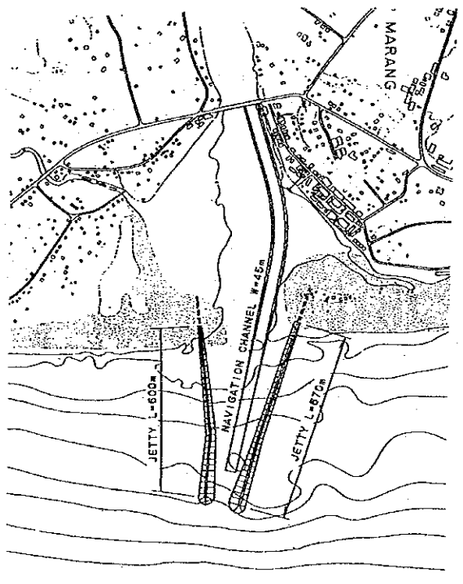
CASE-2 : JETTY AND BREAKWATER
NAVIGATION CHANNEL (HEIGHT -3.5 m)
CASE-3 : SAME ALIGNMENT OF CASE-2
CASE OF LOWERED THE HEIGHT OF BREAKWATER AND JETTY



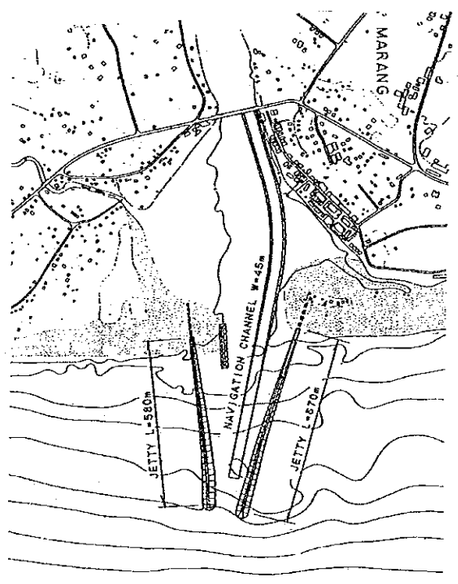
CASE-4 : JETTY
NAVIGATION CHANNEL (HEIGHT -2.6 m)



CASE-5 : JETTY
NAVIGATION CHANNEL (HEIGHT -3.5 m)

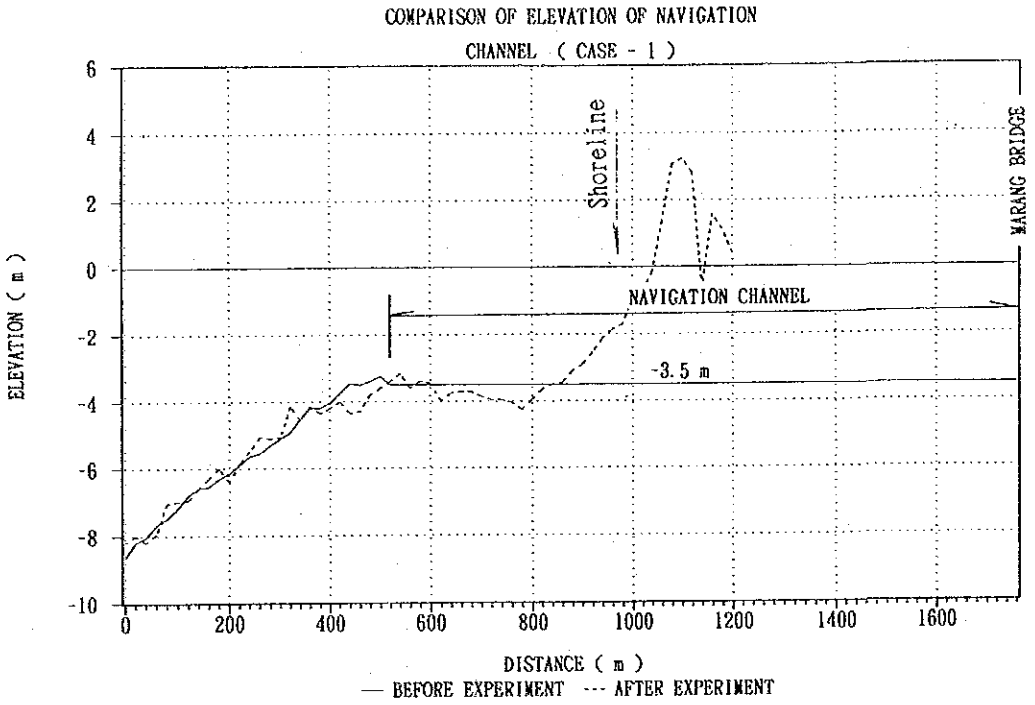


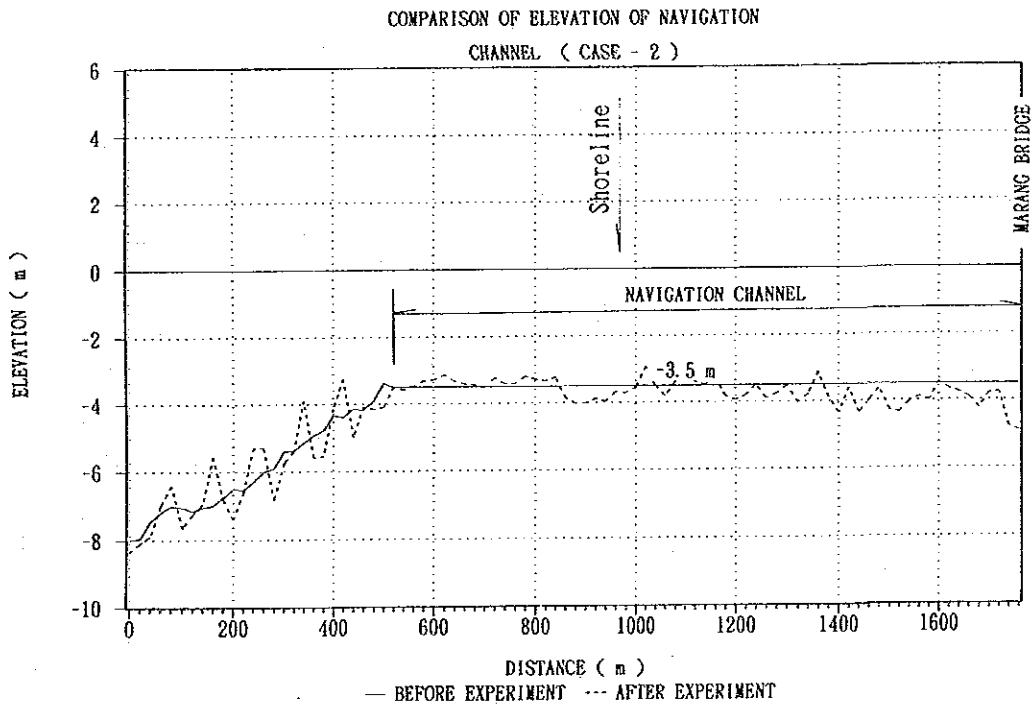
CASE-6 : JETTY
NAVIGATION CHANNEL (HEIGHT -3.5 m)



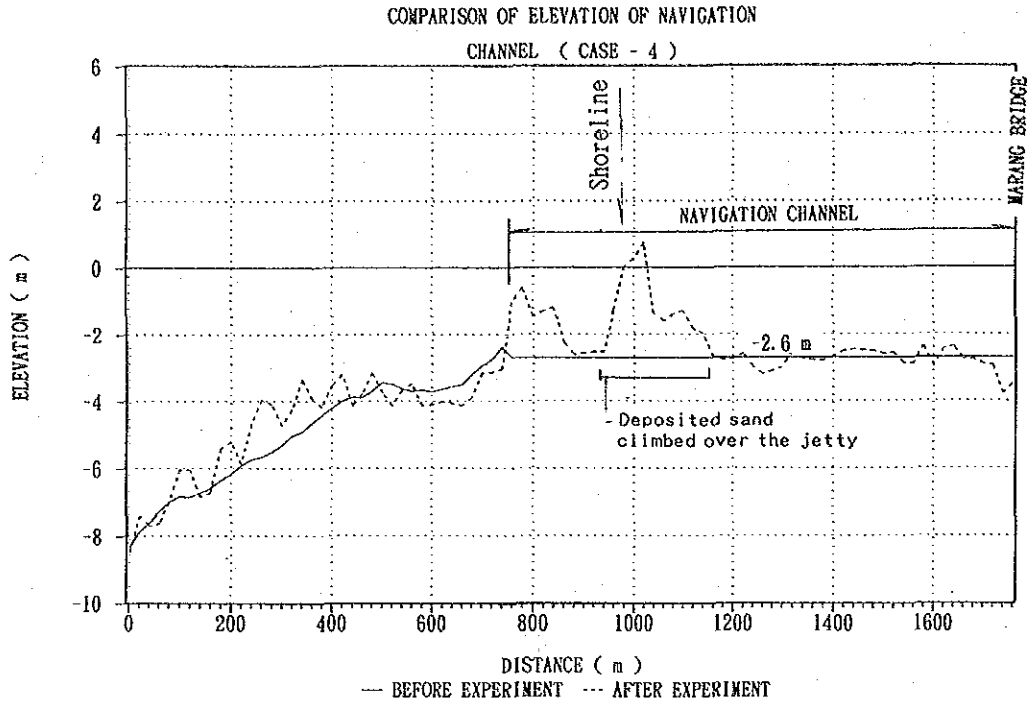
CASE-7 : JETTY
NAVIGATION CHANNEL (HEIGHT -3.5 m)

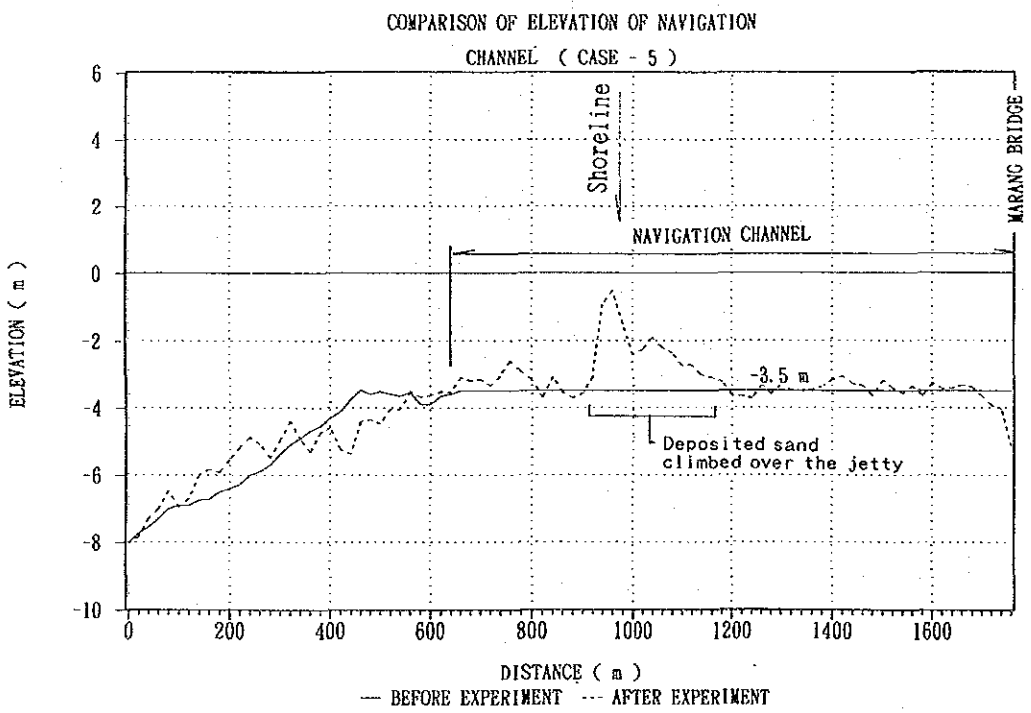
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	PLAN OF EXPERIMENTAL CASES
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.2-4



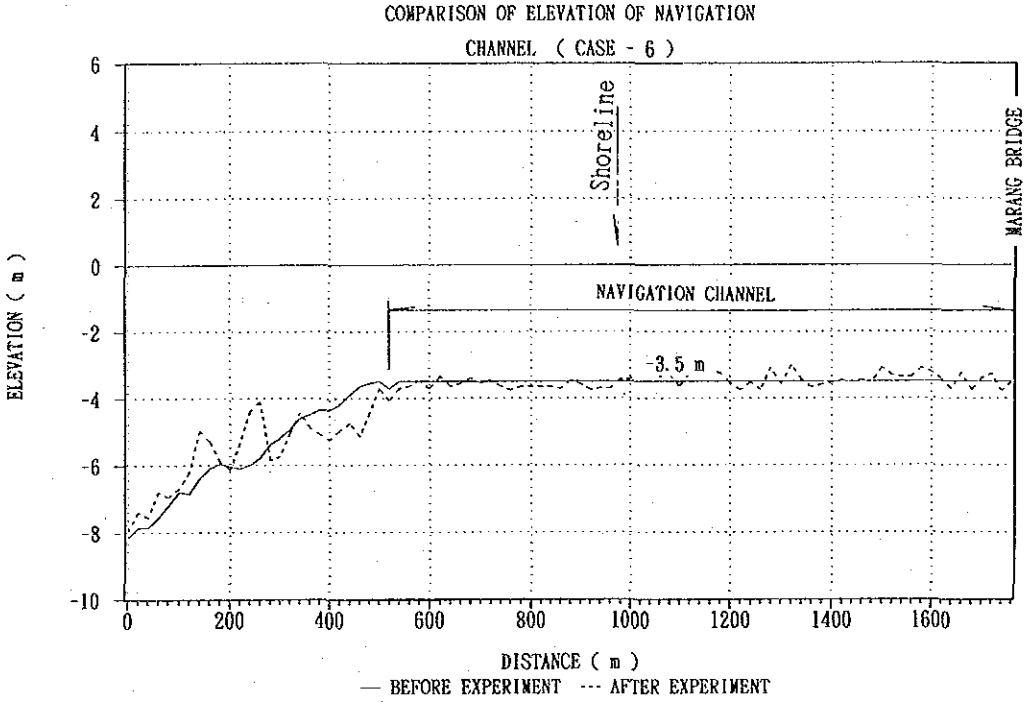


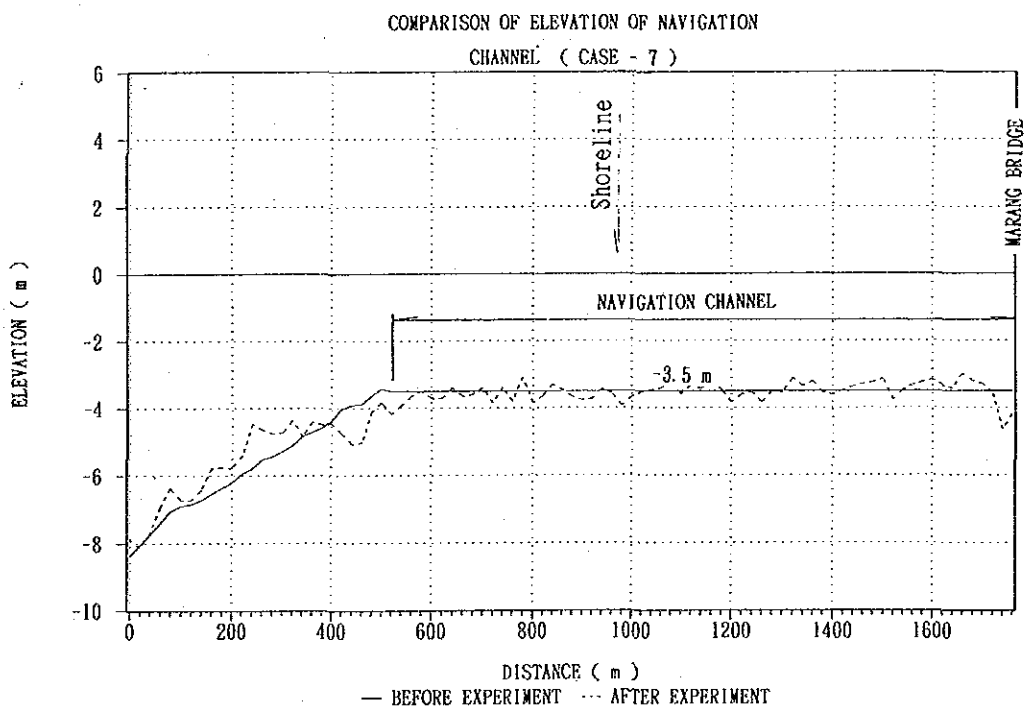
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	ELEVATION CHANGE ALONG THE NAVIGATION CHANNEL
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.2-5 (1/3)



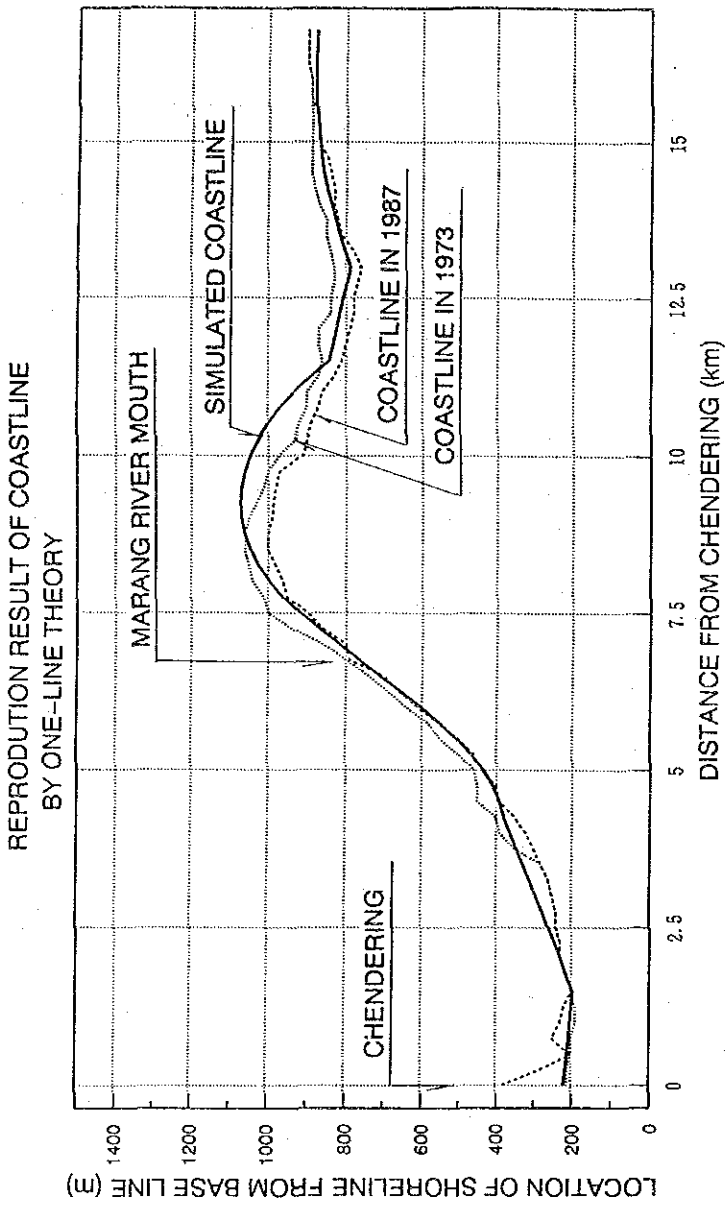


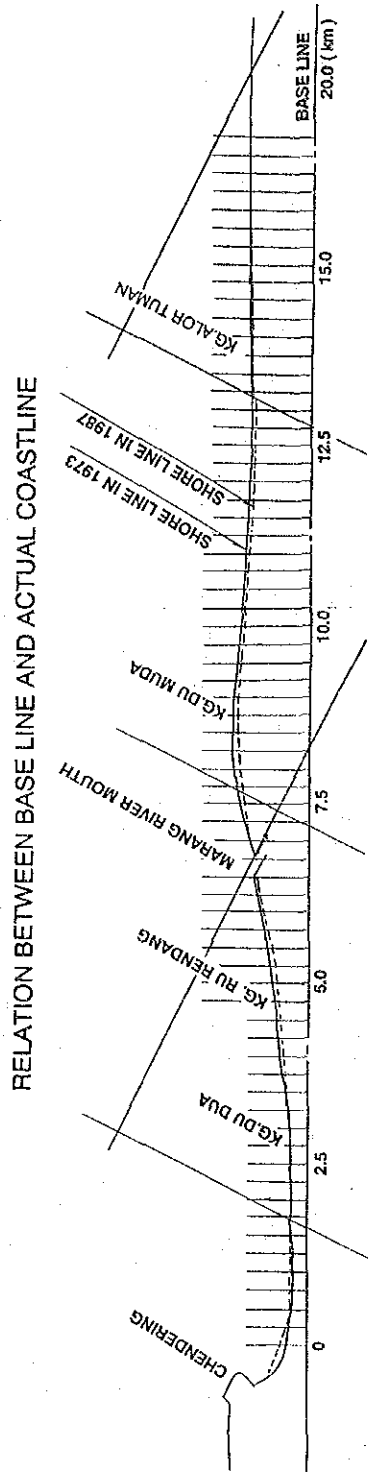
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA JAPAN INTERNATIONAL COOPERATION AGENCY	ELEVATION CHANGE ALONG THE NAVIGATION CHANNEL Fig. 3.2-5 (2/3)



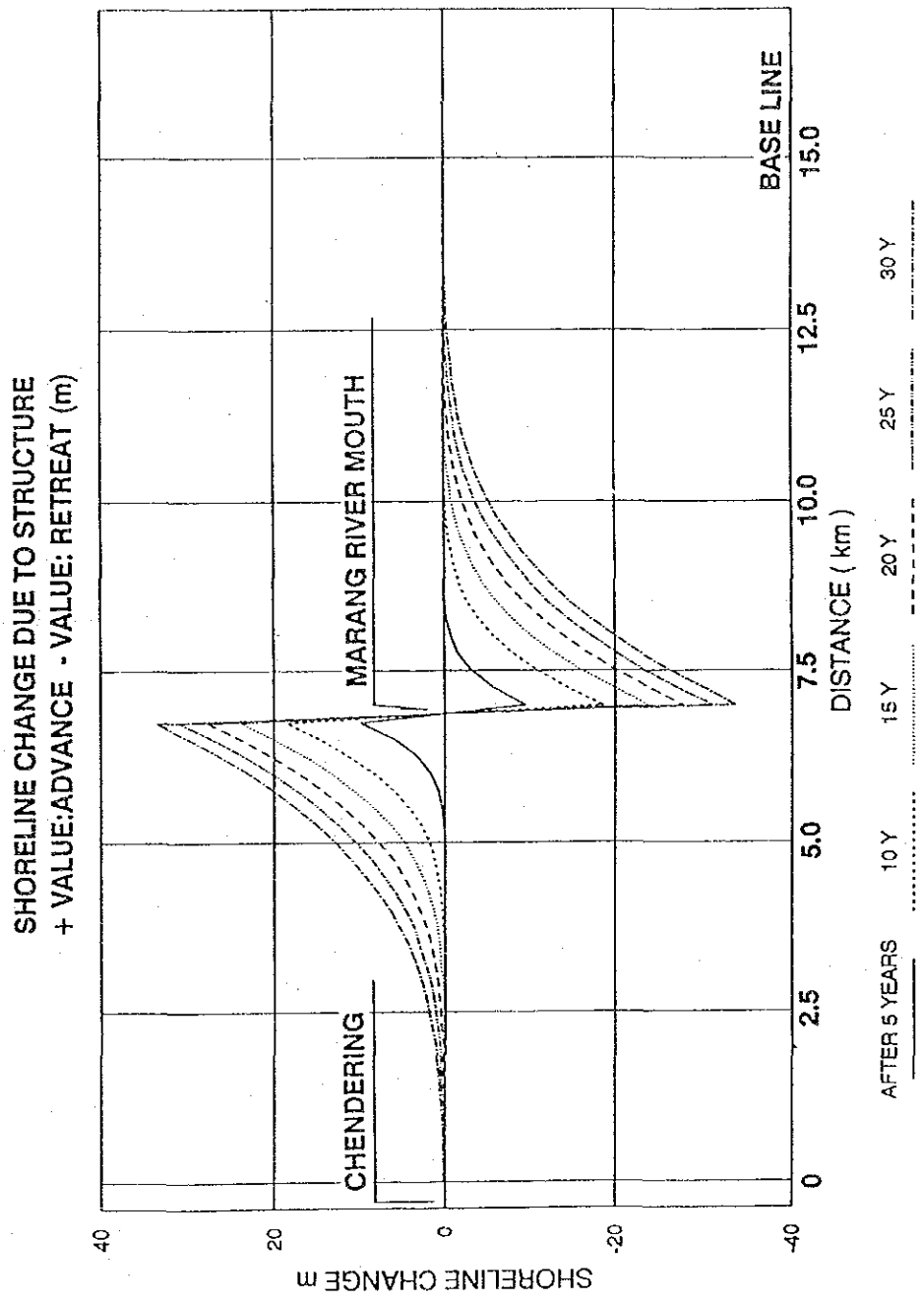


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	ELEVATION CHANGE ALONG THE NAVIGATION CHANNEL
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.2-5 (3/3)

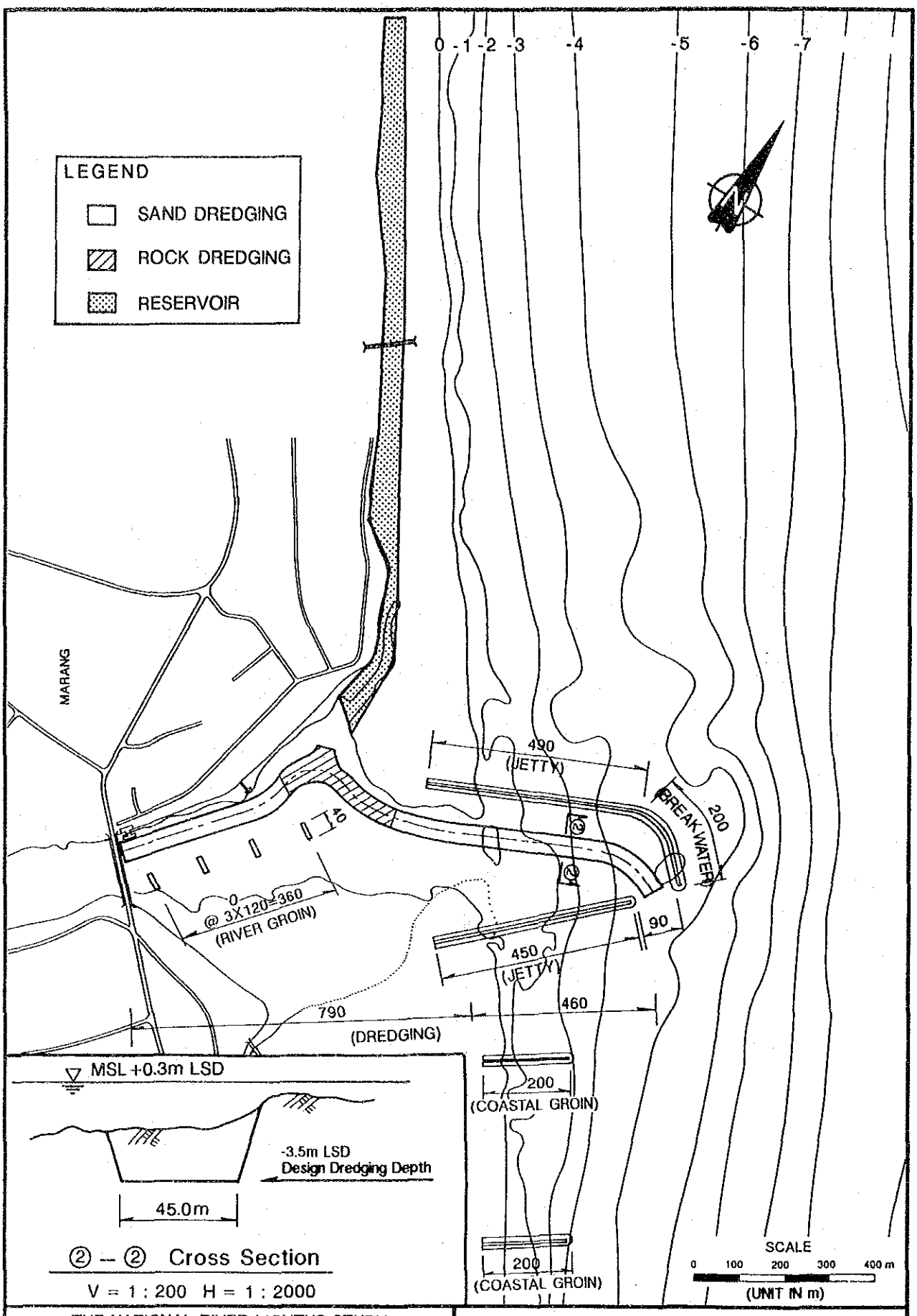




THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	REPRODUCTION RESULT OF COASTLINE
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.2-6



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	CALCULATION RESULT OF COASTLINE CHANGE
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.2-7



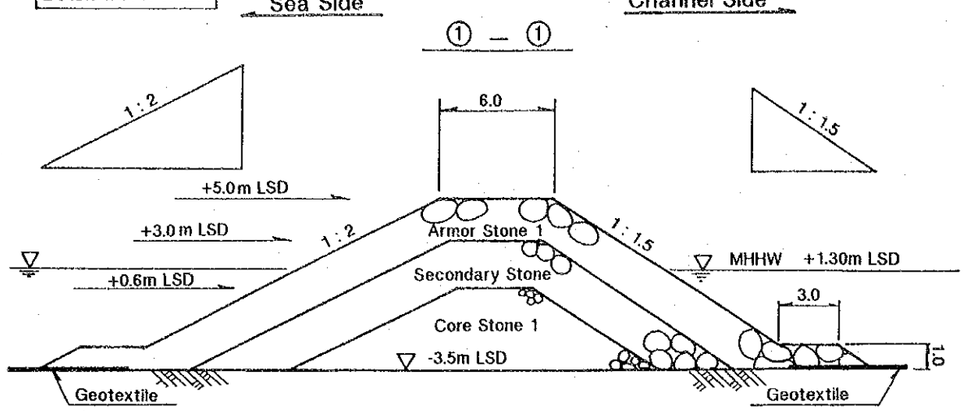
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

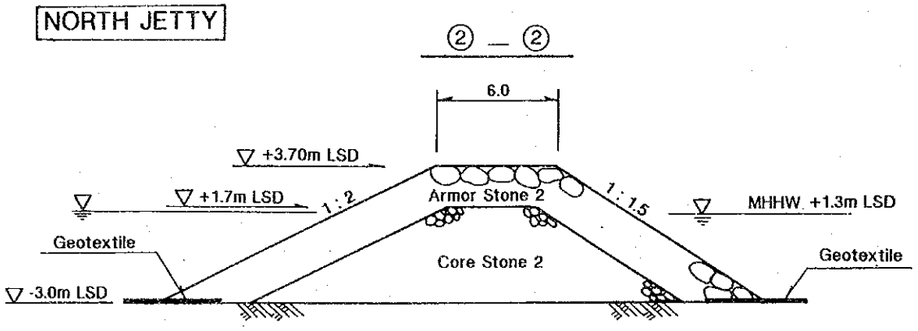
GENERAL LAYOUT OF OPTIMUM COUNTERMEASURES AT MARANG RIVER MOUTH Fig. 3.3-1

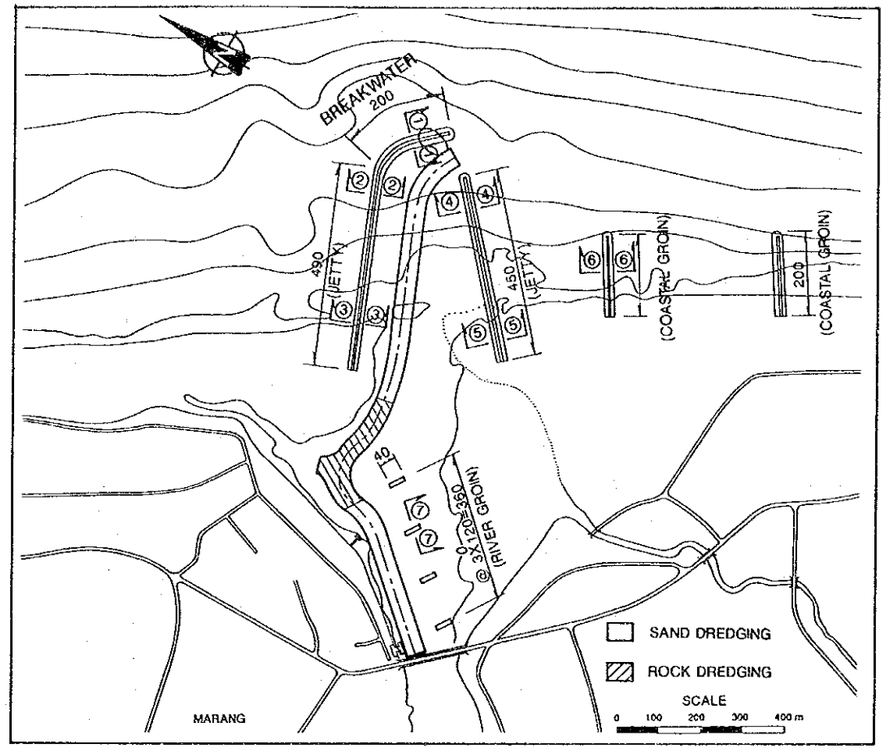
UNIT : m

BREAKWATER

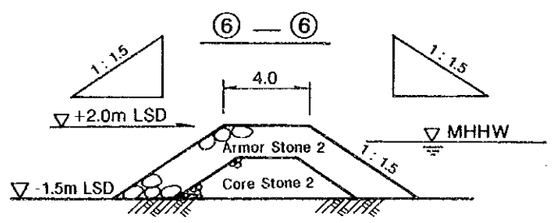


NORTH JETTY

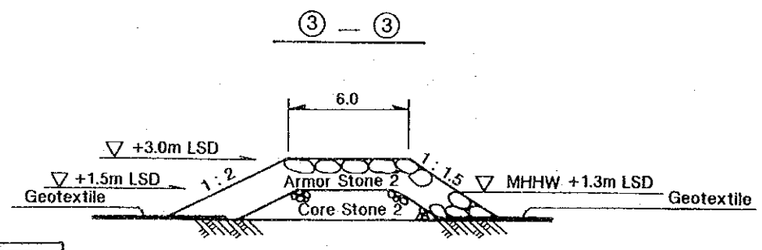


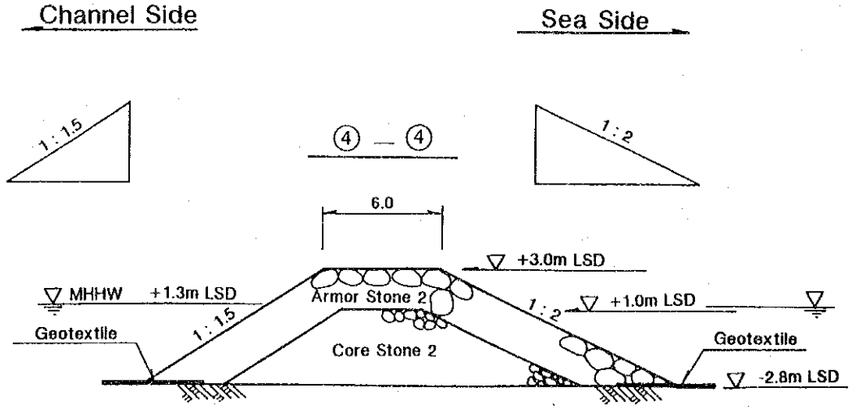


COASTAL GROIN

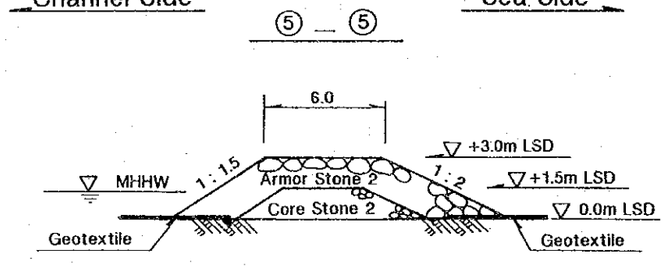


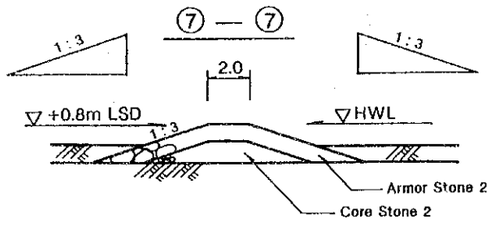
SOUTH JETTY





RIVER GROIN





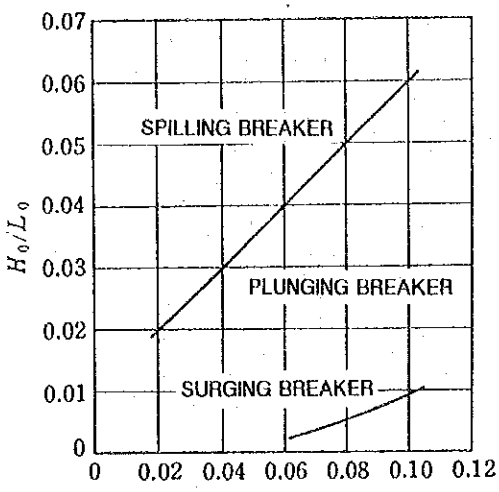
LEGEND

Armor Stone 1	:	3~5t
Armor Stone 2	:	1~3t
Secondary Stone	:	300~500kg
Core Stone 1	:	100~300kg
Core Stone 2	:	10~100kg

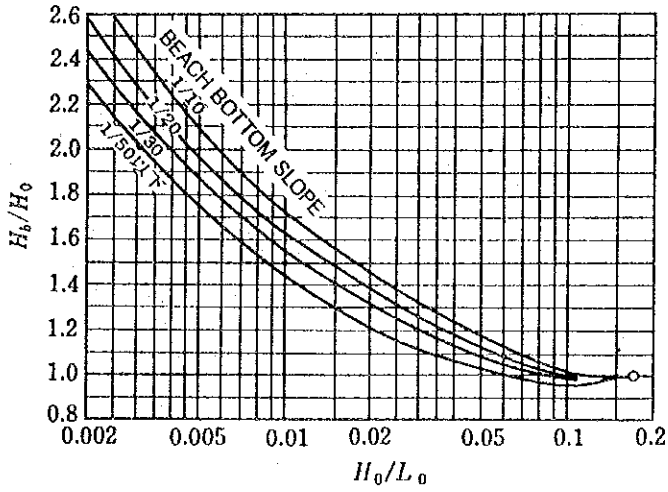
SCALE
0 5 10m

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

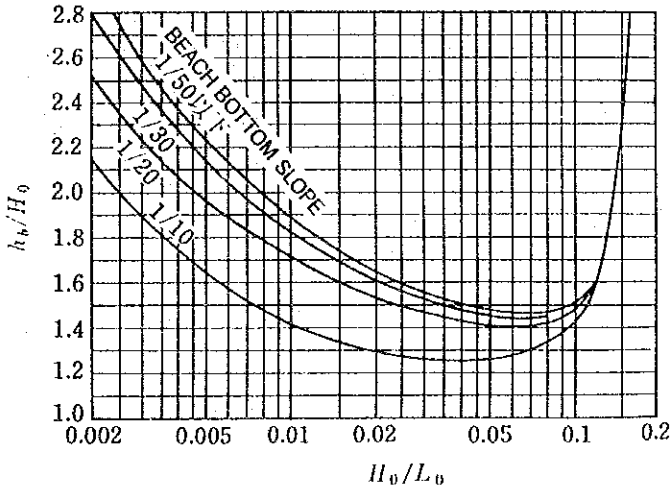
PROPOSED CROSS SECTION OF BREAKWATER, JETTY AND GROIN AT MARANG RIVER MOUTH
Fig. 3.3-2



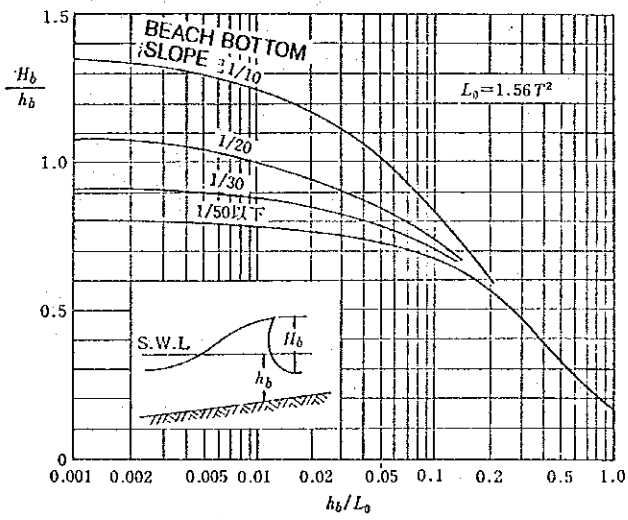
TYPE OF BREAKERS



DEPTH OF BREAKING

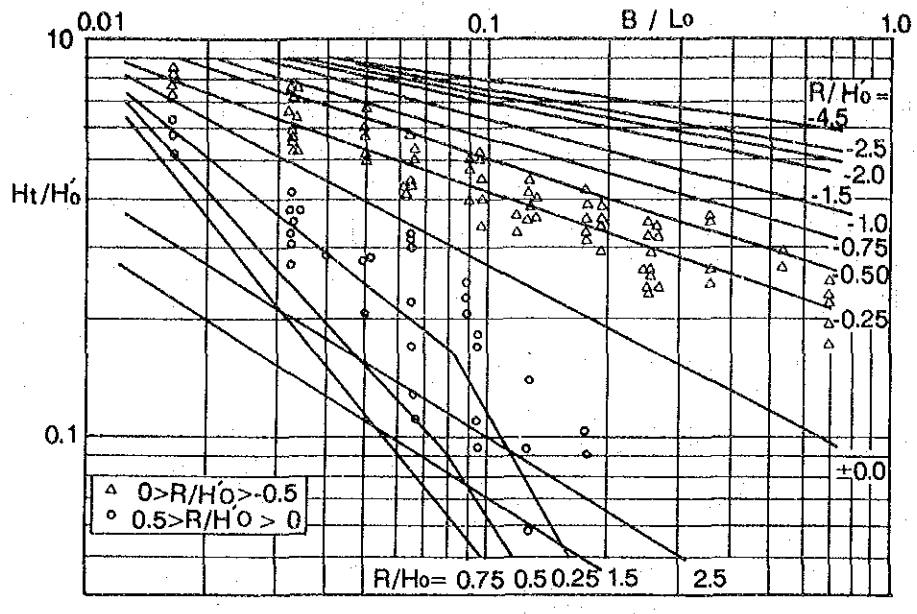


WAVE HEIGHT OF BREAKERS

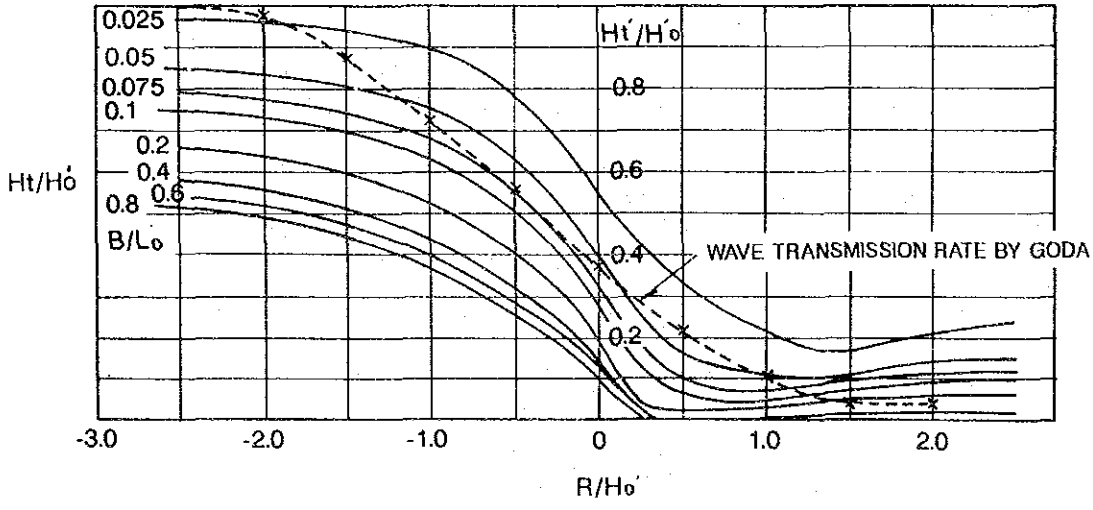


BREAKING LIMIT

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	ESTIMATION CHART OF WAVE HEIGHT OF BREAKERS
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.3-3



REDUCTION EFFECT OF WAVE HEIGHT BY BREAKWATER HEIGHT
(RELATION BETWEEN Ht/H'o AND B/Lo)



REDUCTION EFFECT OF WAVE HEIGHT BY BREAKWATER HEIGHT
(RELATION BETWEEN Ht/Ho AND R/Ho)

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	CALCULATION DIAGRAM OF WAVE TRANSMISSON COEFFICIENT
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 3.3-4

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							

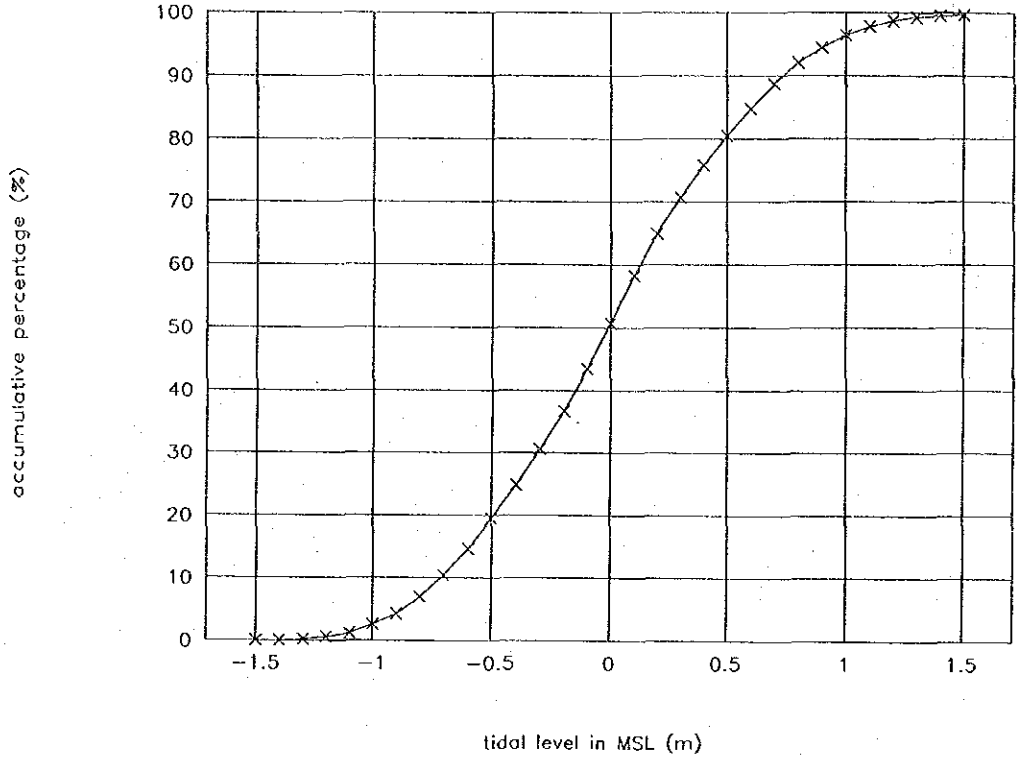
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

IMPLEMENTATON SCHEDULE OF MARANG RIVER MOUTH IMPROVEMENT PROJECT

Fig. 3.3-5

FREQUENCY DISTRIBUTION OF TIDAL LEVELS



MSL (m)	Distribution (%)	Accumulation (%)
-1.4	0.0	0.0
-1.3	0.2	0.2
-1.2	0.4	0.6
-1.1	0.6	1.2
-1.0	1.3	2.5
-0.9	1.7	4.2
-0.8	2.7	6.9
-0.7	3.5	10.4
-0.6	4.2	14.6
-0.5	4.9	19.5
-0.4	5.3	24.8
-0.3	5.8	30.6
-0.2	6.1	36.7
-0.1	6.8	43.5
0.0	7.2	50.7
0.1	7.6	58.3
0.2	6.6	64.9
0.3	5.8	70.7
0.4	5.1	75.8
0.5	4.7	80.5
0.6	4.3	84.8
0.7	3.9	88.7
0.8	3.3	92.0
0.9	2.5	94.5
1.0	1.9	96.4
1.1	1.4	97.8
1.2	0.9	98.7
1.3	0.6	99.3
1.4	0.2	99.5
1.5	0.1	99.6
1.6	0.4	100.0

THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	FREQUENCY DISTRIBUTION OF HOURLY TIDAL LEVELS AT CENDERING STATION Fig. 3.4-1
JAPAN INTERNATIONAL COOPERATION AGENCY