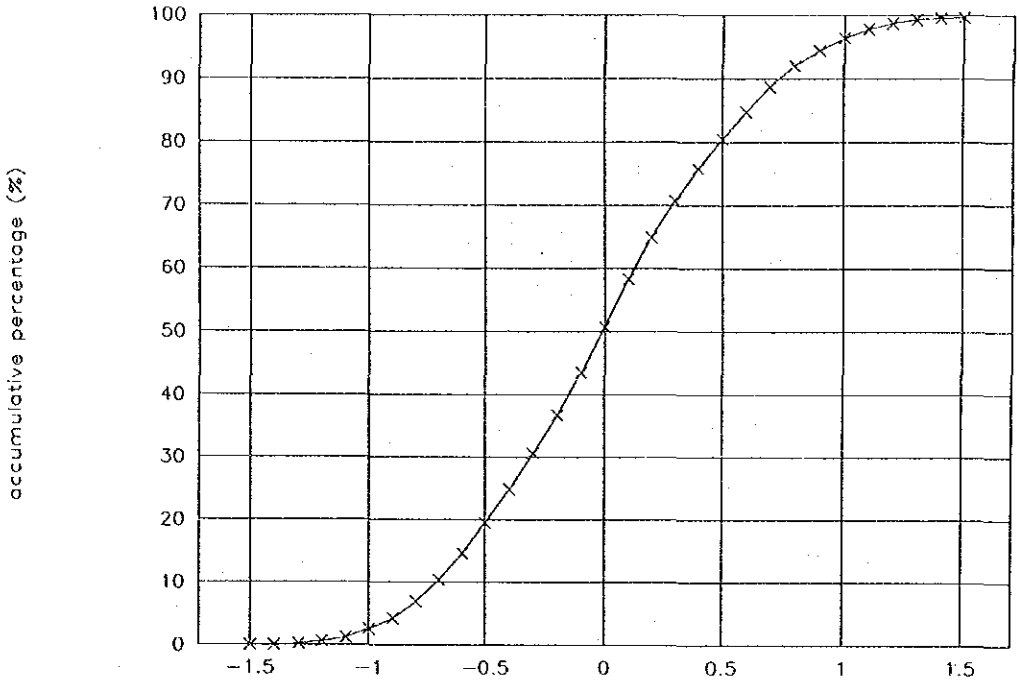
FREQUENCY DISTRIBUTION OF TIDAL LEVELS



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

Fig. 8.6-1

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

9. ENVIRONMENTAL IMPACT STUDY

THE NATIONAL RIVER MOUTHS STUDY
IN MALAYSIA

SUPPORTING REPORT NO. 9

ENVIRONMENTAL IMPACT STUDY

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXES

SUPPORTING REPORT NO. 9

ENVIRONMENTAL IMPACT STUDY

1. ENVIRONMENTAL STUDY FOR THE MASTER PLAN

1.1 General

The present environmental conditions are investigated mainly at the representative river mouths and an environmental impact matrix is prepared for the river mouth improvement projects. The environmental impact assessment for each representative river mouth is presented in Section 1.2.

Description of the River Mouth Improvement Project

The proposed countermeasures for river mouth improvement are (1) breakwater, (2) jetty, (3) training wall, (4) groin, (5) dredging and (6) reservoir. Under the Environmental Act of 1974 and Section 4 of the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987, the prescribed activities related to river mouth improvement are dredging involving an area of 50 ha or more and clearing of mangrove swamps covering an area of 50 ha or more. On this condition, the river mouth improvement project requires the implementation of an Environmental Impact Assessment Study.

Description of the Existing Environment

On the west coast of Peninsular Malaysia, mud flats are predominant and mangrove forests are the major vegetation at the banks of the river mouth. On the east coast, rivers flow into sandy beaches and mangrove trees are found only on muddy river banks. On the coast of Sabah and Sarawak, mangrove, casuarina bushes, and nipa palm form the main natural vegetation of the coastal area.

Some of the representative river mouths are situated in wetlands which are important for nature conservation. These are the Beruas River Mouth at the southern edge of the

Matang Mangrove Forest Reserve, the Papar River Mouth in the Benoni Coastal Wetlands, and the Oya River Mouth in the Third Division Swamp Forest.

Potential Impacts on Environment

The environmental impacts of the river mouth improvement project could be examined from two perspectives; namely, the short-term impacts resulting during the period of construction works and the long-term impacts occurring for longer periods at the operation of the project. The following are the possible activities during the construction and operation phases of the project.

(1) Preliminary Investigation

- (a) Engineering investigation (site and geophysical survey)
- (b) Hydrological survey
- (c) Oceanographic survey

(2) Construction

- (a) Breakwaters and jetties
- (b) Training walls
- (c) Groins
- (d) River works
- (e) Coastal works
- (f) Dredging
- (g) Excavation
- (h) Drainage alteration
- (i) Reclamation

(3) Operation and Maintenance

- (a) Dredging
- (b) Transportation

(4) Consequent Projects

- (a) Fishery development
- (b) Recreation

The possible impacts on the environment resulting from the activities are as follows:

(1) Preliminary Investigation

The preliminary investigation carried out prior to the construction stage will not contribute any significant impact on the environment.

(2) Breakwater and Jetty

To maintain the navigation channel at the river mouth, breakwaters or jetties are constructed. These will modify river flow, drainage pattern, and water quality because of the variation of tidal exchange and flood flow. Sometimes, saltwater intrusion into the upper reaches of the river affects the existing use of water. These changes are also expected to affect aquatic and marine life and their aquatic and estuary habitats and communities.

The construction of jetties at the mouth also sometimes causes shoreline erosion and accretion nearby the river mouth because of the modification of the littoral sediment transport and sediment supply from the river.

During the construction stage, noise and air pollution by construction machinery causes certain problems although the area and duration is limited. With the construction of breakwaters or jetties, nursery and breeding areas may be destroyed or affected by siltation.

From the aesthetic point of view, the breakwater will improve the landscape at the river mouth.

(3) Training Walls and River Structures

For maintaining the navigation course, training walls are constructed along the river. These will modify the tidal pattern and river flow. In a limited extent, the drainage pattern, water quality, and flow variation will be also changed and may bring modification to the estuarine habitats and communities.

The construction of training wall may destroy the buffer zone along the river.

(4) Groins

Groins are used to regulate the flow pattern at the river mouth. They will bring modification to the drainage pattern, flow variation, and estuarine habitats and communities in a limited extent.

The construction of groins may bring the change of bottom interface because of the scouring and accretion around them.

(5) Coastal Works

Coastal works will cause variations to the coastlines together with the modification of marine habitats and communities because of the change of waves and currents. They may also destroy the buffer zone along the coast.

(6) Dredging

To maintain the navigation channel at the river mouth, sometimes the channel is dredged. Dredging will modify flow variation, drainage pattern and water quality due to the change of tidal flow and wave conditions. Sometimes, saltwater intrusion into the upper reaches of the river may impose some impacts to the existing use of water. These changes will also affect aquatic and marine life and their aquatic and estuary habitats and communities.

The dredging works at the mouth will cause beach erosion and accretion in the adjacent coastline because of the modification of littoral sediment transport and sediment supply from the river.

During the dredging operation, nursery and breeding areas will be destroyed directly or affected by the siltation. Dredging and dumping of the dredged materials will also affect marine life and their estuarine and marine habitats and communities. The dredging may destroy the buffer zone along the river mouth.

(7) Excavation

To increase the tidal exchange at the river mouth, the land is excavated to create a lagoon. This may modify the flow variation and drainage pattern. The

excavation will cause changes in landform, land use, and landscape. It will also modify the buffer zone and terrestrial vegetation.

(8) Drainage Alteration

Relative to the river and coastal works, the drainage system sometimes has to be changed. The drainage alteration may modify flood plains and swamps. It will also change land use and flow pattern which could bring influences on the terrestrial vegetation.

(9) Reclamation

For the use of dredged material, reclamation will be conducted. Reclamation may cause changes on landforms, land use and drainage pattern. Sometimes, estuarine habitats and communities are effected by the reclamation.

(10) Access Road and Base Camp

During the construction stage, access roads and a base camp will be set up. They will change landforms and land use although the area and duration are limited.

The proposed river mouth improvement project will provide a safer and deeper navigation channel and improved access to the landing jetty. Hence, substantial economic benefits and improvements are expected for fishing communities.

Environmental Impact Matrix

For a clear presentation of the impacts of activities on the environment, an environmental matrix is prepared as shown in Table 9.1-1.

1.2 Environmental Impact Assessment for Representative River Mouth

1.2.1 Perlis River Mouth

The proposed countermeasures for the improvement of the Perlis River Mouth are capital and maintenance dredging. The possible environmental impacts of these countermeasures are given in Table 9.1-2.

Dredging of the navigation channel at the river mouth will modify the river flow, drainage pattern, and water quality due to the change of tidal flow and wave conditions. The change will also affect aquatic and marine life and may destroy their estuary habitats and communities. The environmental impacts could be as follows:

(1) Beach erosion in the adjacent coastline due to the modification of the littoral sediment transport and sediment supply from the river, and destruction of the buffer zone along the river mouth.

(2) Destruction of nursery and breeding areas by siltation during the dredging period.

(3) Impact to aquatic and marine life and their estuarine and marine habitats and communities.

To alleviate such impacts, it is necessary to consider the following:

(1) Provision of dumping yard for dredged materials at areas where erosion and destruction of the buffer zone are expected.

(2) Appropriate planning of the dredging schedule and selection of the dredging method to minimize the impact.

(3) Selection of site for the dumping yard to minimize the impact to aquatic and marine life and their estuarine and marine habitats and communities.

Reclamation of the shore for a port development project is ongoing at the left bank of the Perlis River Mouth and dredging has been conducted. Compared with the project scale of the reclamation, the scale of the proposed capital and maintenance dredging is

not so large to cause any significant impact to aquatic and marine life, and no severe environmental impact by dredging has been reported. However, the right bank where a remarkable retreat of the coastline has been observed seems to be susceptible to any change of physical conditions, so that careful consideration is required for project execution.

The proposed river mouth improvement project will provide a safer and deeper navigation channel and improved access to the landing jetty. Hence, substantial economic benefits and improvements are expected for the fishing community.

1.2.2 Kedah River Mouth

The proposed countermeasures for the improvement of Kedah River Mouth are capital and maintenance dredging. The possible environmental impacts of these countermeasures are given in Table 9.1-3.

Dredging of the navigation channel at the river mouth will modify the river flow, drainage pattern, and water quality due to the change of tidal flow and wave conditions. The change will also affect aquatic and marine life and may destroy their estuary habitats and communities. The environmental impacts could be as follows:

(1) Beach erosion in the adjacent coastline due to the modification of the littoral sediment transport and sediment supply from the river, and destruction of the buffer zone along the river mouth.

(2) Destruction of nursery and breeding areas by siltation during the dredging period.

(3) Impact to aquatic and marine life and their estuarine and marine habitats and communities.

To alleviate such impacts, it is necessary to consider the following:

(1) Provision of dumping yard for dredged materials at areas where erosion and destruction of the buffer zone are expected.

(2) Appropriate planning of the dredging schedule and selection of the dredging method to minimize the impact.

(3) Selection of site for the dumping yard to minimize the impact to aquatic and marine life and their estuarine and marine habitats and communities.

Dredging has started at the Kedah River Mouth and no severe environmental impact has been reported. However, the coastline adjacent to the river mouth is retreating most probably due to the demise of mangrove and the coastal geomorphology is fragile for any change in the environment. Hence, careful consideration is required for project execution.

The proposed river mouth improvement project will provide a safer and deeper navigation channel and improved access to the landing jetty. Hence, substantial economic benefits and improvements are expected for the fishing community.

1.2.3 Tanjung Piandang River Mouth

The proposed countermeasures for the improvement of Tanjung Piandang River Mouth are capital and maintenance dredging. The possible environmental impacts of these countermeasures are given in Table 9.1-4.

Dredging of the navigation channel at the river mouth will modify the river flow, drainage pattern, and water quality due to the change of tidal flow and wave conditions. The change will also affect aquatic and marine life and may destroy their estuary habitats and communities. The environmental impacts could be as follows:

(1) Beach erosion in the adjacent coastline due to the modification of the littoral sediment transport and sediment supply from the river, and destruction of the buffer zone along the river mouth.

(2) Destruction of nursery and breeding areas by siltation during the dredging period.

(3) Impact to aquatic and marine life and their estuarine and marine habitats and communities.

To alleviate such impacts, it is necessary to consider the following:

(1) Provision of dumping yard for dredged materials at areas where erosion and destruction of the buffer zone are expected.

(2) Appropriate planning of the dredging schedule and selection of the dredging method to minimize the impact.

(3) Selection of site for the dumping yard to minimize the impact to aquatic and marine life and their estuarine and marine habitats and communities.

Compared with Perlis and Kedah river mouths, the volume of dredging in Tanjung Piandang River Mouth is not so large to cause any severe environmental impact. However, the swampy area covered by mangrove adjacent to the river mouth is susceptible to any change in the environment, so that careful consideration is required for project execution.

The proposed river mouth improvement project will provide a safer and deeper navigation channel and improved access to the landing jetty. Hence, substantial economic benefits and improvements are expected for the fishing community.

1.2.4 Beruas River Mouth

The proposed countermeasures for the improvement of Beruas River Mouth are capital and maintenance dredging. The possible environmental impacts of these countermeasures are given in Table 9.1-5.

Dredging of the navigation channel at the river mouth will modify the river flow, drainage pattern, and water quality due to the change of tidal flow and wave conditions. The change will also affect aquatic and marine life and may destroy their estuary habitats and communities. The environmental impacts could be as follows:

(1) Beach erosion in the adjacent coastline due to the modification of the littoral sediment transport and sediment supply from the river, and destruction of the buffer zone along the river mouth.

(2) Destruction of nursery and breeding areas by siltation during the dredging period.

(3) Impact to aquatic and marine life and their estuarine and marine habitats and communities.

To alleviate such impacts, it is necessary to consider the following:

(1) Provision of dumping yard for dredged materials at areas where erosion and destruction of the buffer zone are expected.

(2) Appropriate planning of the dredging schedule and selection of the dredging method to minimize the impact.

(3) Selection of site for the dumping yard to minimize the impact to aquatic and marine life and their estuarine and marine habitats and communities.

Dredging at the Beruas River Mouth was once conducted in 1988-90 and no severe environmental impact has been reported. However, the northern shoreline has retreated by 50 m in a period of 15 years from 1966 to 1981 and this may be enhanced by the dredging work. Hence, careful consideration is required for project execution.

The proposed river mouth improvement project will provide a safer and deeper navigation channel and improved access to the landing jetty. Hence, substantial economic benefits and improvements are expected for the fishing community.

1.2.5 Kuantan River Mouth

The proposed countermeasures for the improvement of Kuantan River Mouth are capital and maintenance dredging. The possible environmental impacts of these countermeasures are given in Table 9.1-6.

Dredging of the navigation channel at the river mouth will modify the river flow, drainage pattern, and water quality due to the change of tidal flow and wave conditions. The change will also affect aquatic and marine life and may destroy their estuary habitats and communities. The environmental impacts could be as follows:

(1) Beach erosion in the adjacent coastline due to the modification of the littoral sediment transport and sediment supply from the river, and destruction of the buffer zone along the river mouth.

(2) Destruction of nursery and breeding areas by siltation during the dredging period.

(3) Impact to aquatic and marine life and their estuarine and marine habitats and communities.

To alleviate such impacts, it is necessary to consider the following:

(1) Provision of dumping yard for dredged materials at areas where erosion and destruction of the buffer zone are expected.

(2) Appropriate planning of the dredging schedule and selection of the dredging method to minimize the impact.

(3) Selection of site for the dumping yard to minimize the impact to aquatic and marine life and their estuarine and marine habitats and communities.

Dredging at the Kuantan River Mouth is scheduled to start in 1993 and the environmental impact by dredging may then be studied. Periodical observation has to be conducted for reference in further project execution.

The proposed river mouth improvement project will provide a safer and deeper navigation channel and improved access to the landing jetty. Hence, substantial economic benefits and improvements are expected for the fishing community.

1.2.6 Kerteh River Mouth

The proposed countermeasures for the improvement of Kerteh River Mouth are jetty, capital dredging and reservoir. The possible environmental impacts of these countermeasures are given in Table 9.1-7.

The improvement works and dredging of the navigation channel at the river mouth will modify the river flow, drainage pattern, and water quality due to the change of tidal

flow and wave conditions. The change will also affect aquatic and marine life and may destroy their estuary habitats and communities. The environmental impacts could be as follows:

(1) Beach erosion in the adjacent coastline due to the modification of the littoral sediment transport and sediment supply from the river, and destruction of the buffer zone along the river mouth.

(2) Destruction of nursery and breeding areas by siltation during the dredging period.

(3) Impact to aquatic and marine life and their estuarine and marine habitats and communities.

To alleviate such impacts, it is necessary to consider the following:

(1) Provision of dumping yard for dredged materials at areas where erosion and destruction of the buffer zone are expected.

(2) Provision of countermeasures to prevent coastal erosion.

(3) Appropriate planning of the construction schedule and selection of the construction method to minimize the impact.

(4) Selection of site for the dumping yard to minimize the impact to aquatic and marine life and their estuarine and marine habitats and communities.

A jetty has been provided at the Kerteh River Mouth and dredging was conducted in 1992, although it is not as large as the one proposed in this study. No adverse environmental impact has been reported, but since this seems to be a prototype model test in situ the environmental impact should be observed and made as reference in further project execution.

The proposed river mouth improvement project will provide a safer and deeper navigation channel and improved access to the landing jetty. Hence, substantial economic benefits and improvements are expected for the fishing community.

1.2.7 Marang River Mouth

The proposed countermeasures for the improvement of Marang River Mouth are jetty, capital dredging, breakwater, groin and reservoir. The possible environmental impacts of these countermeasures are given in Table 9.1-8.

The improvement works and dredging of the navigation channel at the river mouth will modify the river flow, drainage pattern, and water quality due to the change of tidal flow and wave conditions. The change will also affect aquatic and marine life and may destroy their estuary habitats and communities. The environmental impacts could be as follows:

(1) Beach erosion in the adjacent coastline due to the modification of the littoral sediment transport and sediment supply from the river, and destruction of the buffer zone along the river mouth.

(2) Destruction of nursery and breeding areas by siltation during the dredging period.

(3) Impact to aquatic and marine life and their estuarine and marine habitats and communities.

To alleviate such impacts, it is necessary to consider the following:

(1) Provision of dumping yard for dredged materials at areas where erosion and destruction of the buffer zone are expected.

(2) Provision of countermeasures to prevent coastal erosion.

(3) Appropriate planning of the construction schedule and selection of the construction method to minimize the impact.

(4) Selection of site for the dumping yard to minimize the impact to aquatic and marine life and their estuarine and marine habitats and communities.

Dredging at the Marang River Mouth was once conducted in 1980 for a volume of 231,000 m^3 which is twice the proposed capital dredging volume. No adverse

influence has been reported; however, the proposed structures and capital dredging may bring about inequilibrium to the drifting materials at the neighboring coastline so that careful consideration is required for project execution.

The proposed river mouth improvement project will provide a safer and deeper navigation channel and improved access to the landing jetty. Hence, substantial economic benefits and improvements are expected for the fishing community. From the aesthetic point of view, the jetty and reservoir will improve the landscape at the river mouth.

1.2.8 Terengganu River Mouth

The proposed countermeasures for the improvement of Terengganu River Mouth are jetty, capital dredging, breakwater, groin and reservoir. The possible environmental impacts of these countermeasures are given in Table 9.1-9.

The improvement works and dredging of the navigation channel at the river mouth will modify the river flow, drainage pattern, and water quality due to the change of tidal flow and wave conditions. The change will also affect aquatic and marine life and may destroy their estuary habitats and communities. The environmental impacts could be as follows:

(1) Beach erosion in the adjacent coastline due to the modification of the littoral sediment transport and sediment supply from the river, and destruction of the buffer zone along the river mouth.

(2) Destruction of nursery and breeding areas by siltation during the dredging period.

(3) Impact to aquatic and marine life and their estuarine and marine habitats and communities.

To alleviate such impacts, it is necessary to consider the following:

(1) Provision of dumping yard for dredged materials at areas where erosion and destruction of the buffer zone are expected.

(2) Provision of countermeasures to prevent coastal erosion.

(3) Appropriate planning of the construction schedule and selection of the construction method to minimize the impact.

(4) Selection of site for the dumping yard to minimize the impact to aquatic and marine life and their estuarine and marine habitats and communities.

Periodical dredging of the inner channel has been conducted at the Terengganu River Mouth since 1987 and erosion of the shore at the left side of the mouth has been reported. Although the cause and impact is not yet clear, careful consideration is required for project execution.

The proposed river mouth improvement project will provide a safer and deeper navigation channel and improved access to the landing jetty. Hence, substantial economic benefits and improvements are expected for the fishing community. From the aesthetic point of view, the breakwater will improve the landscape at the river mouth.

1.2.9 Oya River Mouth

The proposed countermeasures for the improvement of Oya River Mouth are training wall, capital and maintenance dredging. The possible environmental impacts of these countermeasures are given in Table 9.1-10.

The improvement works and dredging of the navigation channel at the river mouth will modify the river flow, drainage pattern, and water quality due to the change of tidal flow and wave conditions. The change will also affect aquatic and marine life and may destroy their estuary habitats and communities. The environmental impacts could be as follows:

(1) Beach erosion in the adjacent coastline due to the modification of the littoral sediment transport and sediment supply from the river, and destruction of the buffer zone along the river mouth.

(2) Destruction of nursery and breeding areas by siltation during the dredging period.

(3) Impact to aquatic and marine life and their estuarine and marine habitats and communities.

To alleviate such impacts, it is necessary to consider the following:

(1) Provision of dumping yard for dredged materials at areas where erosion and destruction of the buffer zone are expected.

(2) Appropriate planning of the construction schedule and selection of the construction method to minimize the impact.

(3) Selection of site for the dumping yard to minimize the impact to aquatic and marine life and their estuarine and marine habitats and communities.

The dredging volume at the Oya River Mouth is not so large compared with the other river mouths, and the environmental impact may not be severe. However, the area around the river mouth is full of activities which are susceptible to any change in the environment. Therefore, careful consideration is required for project execution.

The proposed river mouth improvement project will provide a safer and deeper navigation channel and improved access to the landing jetty. Hence, substantial economic benefits and improvements are expected for the fishing community. From the aesthetic point of view, the training wall will improve the landscape at the river mouth.

1.2.10 Papar River Mouth

The proposed countermeasures for the improvement of Oya River Mouth are jetties, groins, reservoir, capital and maintenance dredging. The possible environmental impacts of these countermeasures are given in Table 9.1-11.

The improvement works and dredging of the navigation channel at the river mouth will modify the river flow, drainage pattern, and water quality due to the change of tidal flow and wave conditions. The change will also affect aquatic and marine life and may

destroy their estuary habitats and communities. The environmental impacts could be as follows:

(1) Beach erosion in the adjacent coastline due to the modification of the littoral sediment transport and sediment supply from the river, and destruction of the buffer zone along the river mouth.

(2) Destruction of nursery and breeding areas by siltation during the dredging period.

(3) Impact to aquatic and marine life and their estuarine and marine habitats and communities.

To alleviate such impacts, it is necessary to consider the following:

(1) Provision of dumping yard for dredged materials at areas where erosion and destruction of the buffer zone are expected.

(2) Provision of countermeasures to prevent coastal erosion.

(3) Appropriate planning of the construction schedule and selection of the construction method to minimize the impact.

(4) Selection of site for the dumping yard to minimize the impact to aquatic and marine life and their estuarine and marine habitats and communities.

The proposed river mouth improvement project will provide a safer and deeper navigation channel and improved access to the landing jetty. Hence, substantial economic benefits and improvements are expected for the fishing community. From the aesthetic point of view, the jetties and groins will improve the landscape at the river mouth.

1.3 Environmental Impact Assessment for the Master Plan

The environmental impact is assessed based on the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987. The main activities related to river mouth improvement are dredging at the river mouth for navigation and

construction of structures, while the proposed countermeasure for the improvement of most river mouths is mainly the combination of capital and maintenance dredging. Only a few river mouths have the construction of jetty, breakwater, groin, etc., included.

According to the Order, the prescribed activities are related to sand dredging involving an area of 50 ha or more. On the other hand, the construction of structures for river mouth improvement is not included in the prescribed activities, although some considerations are necessary.

In this connection, EIA of the proposed countermeasures will not be necessary, because almost all of the dredging areas are under 50 ha. However, careful examination is required for project execution with the following environmental impacts taken into consideration:

(1) Beach erosion in the adjacent coastline due to the modification of the littoral sediment transport and sediment supply from the river, and destruction of the buffer zone along the river mouth.

(2) Destruction of nursery and breeding areas by siltation during the dredging period.

(3) Impact to aquatic and marine life and their estuarine and marine habitats and communities.

To alleviate such impacts, it is necessary to consider the following:

(1) Provision of dumping yard for dredged materials at areas where erosion and destruction of the buffer zone are expected.

(2) Appropriate planning of the construction schedule and selection of the construction method to minimize the impact.

(3) Selection of site for the dumping yard to minimize the impact to aquatic and marine life and their estuarine and marine habitats and communities.

Details of the environmental impact are as discussed in the preceding Section 1.1 and 1.2.

2. ENVIRONMENTAL STUDY FOR THE FEASIBILITY STUDY

2.1 Tanjung Piandang River Mouth

2.1.1 Description of Existing Environment

Chemical Environment

(1) Water Quality

The water quality of Tanjung Piandang River was assessed by determining selected physico-chemical and microbiological water quality parameters of the river water. Sampling stations were identified at and in the vicinity of the river mouths as well as upstream of the river. Their approximate locations are shown in Fig. 9.2-1 and described in Table 9.2-1. Water samples were collected at or close to the middle of the river and at approximately 0.5 m below surface during ebb tides. The sampling was conducted on 02 and 16 August 1993.

The following water quality parameters were determined: pH, temperature, conductivity, dissolved oxygen (DO), salinity, BOD, suspended solids (SS), ammoniacal nitrogen (ammonia-N), orthophosphate (PO^{3-}_4-P), total coliform (TC) and faecal coliform (FC). In addition, chemical oxygen demand (COD) determinations were carried out on those water samples with salinity less than 5 ppt. The analysis procedure follows APHA (1989).

The mean results are shown in Table 9.2-2. The data show that the river is grossly polluted with organic wastes, most probably sewage, in view of the relatively high ammoniacal nitrogen and FC concentrations detected. The water quality is very poor upstream but gradually improves towards the river mouth due to the dilution effect of the sea.

The river water carries extremely high SS content especially near the river mouth. Most of these solids probably originate from the muddy coast and are carried into the river by tidal action. Over the years, large quantity of silt have been deposited on the river mouth making the river very shallow. As a result of the shallow bottom along the navigable stretch of the river, the busy fishing boat traffic constantly churn up large amount of silt; thus, causing the murkiness of the river water.

(2) Heavy Metals in Sediment

Heavy metal pollution in Tanjung Piandang River was assessed by analyzing the surface sediments which act as traps for various types of pollutants including heavy metals. Sampling stations for the sediments were identical to those for the water samples. Their locations are shown in Fig. 9.2-1 and described in Table 9.2-1. The top 5 cm surface sediment samples were collected using a PVC corer on 02 and 16 August, 1993. The samples were kept in polyethylene bags and frozen upon reaching the laboratory.

Total metal analysis was conducted by digesting the sediment in a Milestone Model MLS-1200 Mega-microwave digester. The analysis of total non-residual (TNR) metals follows the leaching technique described in Chester and Voutsinou (1981). The concentrations of zinc (Zn), copper (Cu), lead (Pb) and cadmium (Cd) were determined using a GBC Model 903 atomic absorption spectrophotometer (flame or graphite furnace) while mercury (Hg) was determined by the cold vapour technique.

The mean total and non-residual metal concentrations are shown in Table 9.2-3. The data show that in general there is a reduction in the non-residual and total metal concentrations towards the river mouth. The decrease is most drastic from the non-tidal to the tidal stretches. In contrasts, the decrease is very gradual within the tidal stretch probably due to the flushing action of the tides. This indicates that the sources of metal pollution are land-based.

The results of the heavy metal concentrations in sediment of Tanjung Piandang River were compared with those of other rivers as shown in Table 9.2-4. Since it is the non-residual metal concentrations which truly reflect the metal pollution level, only the TNR metal concentrations are used for comparison. It is evident that Tanjung Piandang River can be considered as polluted with Pb, Cu and Zn in view of the high TNR metal concentrations comparable to those found in a polluted river. The most significant source of Zn pollution is the sewage discharged from the Tanjung Piandang Town. Copper pollution is probably caused by the usage of anti-fouling marine paints for boats and the residual effect of pig waste though it should be mentioned that pig farming has been discontinued in the area. The source of Pb pollution probably comes from urban runoff since leaded petrol is still in use.

Biological Environment

(1) Mangrove Vegetation

The coastal vegetation in the Tanjung Piandang area is made up of mangroves. This is part of the almost continuous stretch of mangroves which is characteristic of much of the West Coast of Peninsular Malaysia. An examination of the aerial photographs of the coastline and information from the Jabatan Parit dan Saliran (1986), shows that the coastline in Tanjung Piandang is in a state of dynamic flux; some parts were eroding while others were accreting (see JICA 1992). Parts of these changes in the mangrove vegetation appear to be the result of human actions.

The mangroves of Tanjung Piandang had partially been reclaimed for agriculture. A series of bunds has been constructed on the landward part of the mangrove. As a result of the bunds, the hydrological regime had been changed and the areas behind the bunds were no longer subjected to regular sea water inundation. The mangrove plants would therefore not be able to survive. The former mangrove areas were used for padi cultivation.

The present mangrove vegetation can be regarded as remnant mangrove of a much more extensive mangrove forest. A survey of the mangroves at the north

end and south of the Tanjung Piandang estuary shows that it includes *Rhizophora spp.* (or bakau), *Sonneretia spp.* (berembang, perepat and gedabu), *Cereiops* (tengar) and *Kandelia* (berus-berus). It is likely that these species were originally present as these are found north of the Tanjung Piandang area, such as in the Byram Mangrove Forest in Penang or the Matang Mangrove Forest in Perak, which is south of Tanjung Piandang. These areas had been relatively less disturbed.

A number of species usually found in the mangrove ecotone (i.e., the zone between mangrove forests and dry land forest) were found in Tanjung Piandang. These include *Pulchea indica* (belutan), *Exoecaria.* There were very few species of mangrove trees. The dominant species of mangrove tree are from genus *Avecennia* and the three species present are all known locally as "api-api". The three species are *Avicennia alba*, *Avicennia intermedia* and *Avicennia affinalis*. These mangrove species are characteristic of the seaward side of the mangrove species and there are regarded as pioneer species. They are usually the species that colonize the mudflats along the west coast of Peninsular Malaysia. Another mangrove species is *Brugueria parviflora*, but they are few in number compared with the *Avicennia*. The other species of mangrove are conspicuous by their absence. These *Agallocha* (buta-buta), *Derris uliginosa* (setui), *Acanthus ilicifolius* (juruju) puteh) and *Acostichum aureum* (plia lasa). There are found at the mangrove fringing the bunds.

Despite the paucity of mangrove species, the mangrove does provide various habitats for the animals found in mangroves. Crabs are still regularly collected from the mangroves. However the wood of the *Avicennia* species have limited uses, as they do not have the properties of the *Rhizophora spp.* (bakau), which is used for construction, in piling, scaffolding and general construction as well as for fuel. The api-api had been used by the villagers at Tanjung Piandang for fuel and for charcoal, but they reported that *Avicennia spp.* is vastly inferior to *Rhizophora spp.* for such purposes.

(2) Mangrove Fauna

The macrofauna community at Tanjung Piandang is typical of the *Avicennia* mangrove community of northern Malaysia. However, there are considerable differences between the macrofauna of the dead mangrove stands compared to the live stands (Table 9.2-5).

(a) Distribution of Animal Communities

The differences between the macroinvertebrate community found in the dead and live mangrove areas reflect the differences in the environment of these two areas. These differences are discussed below.

There appear to be no slope succession at the mangroves of Tanjung Piandang. This may result as a result of the bund/road construction adjacent to the mangrove stands. A typical cross section of the coastal area at Tanjung Piandang is given in Fig. 9.2-2.

Differences in the distribution of macrofauna is governed by the immediate characteristic of the habitat rather than slope related characteristics such as tidal inundation and exposure. This made for patchy distribution of the macrofauna with no apparent trends. Rather, the major differences that exist can be attributed to the presence or absence of the *Avicennia* stands and within the dead stands, the distance of a location from the tidal creeks.

Uca, Sesarmid and Scylla crabs dominate the mangroves here. The numbers of these are higher in the dead mangrove areas. Scylla was absent within the live mangrove stands. These mud crabs were active during the rising tide as found by the significantly greater numbers of crabs caught during this period. Their activity were however restricted to the mangrove creeks.

Littorina scabra was found on the stems of Acivcennia plants within the living stands. Their distribution were patchy but was spread throughout the whole of the living mangrove stands. The numbers of

Littorina within the dead mangroves were very low. At low tide these periwinkles are attached to the lower trunks of the trees. The rising tide caused the animals to climb up the trunks to avoid submersion.

(b) Species Composition

The mangrove macrofauna was dominated by the crustacean families *Xanthidae, Ocypodidae* and *Grapsidae.* The gastropod molluscs were represented by the *Neritidae, Littorinidae, Muriciidae* and *Ellobiidae.* These are typical of the mangroves of the Indo-West Pacific region (Berry, 1963, 1972, Macnae and Kalk, 1962, Day 1974 and Sasekumar 1974).

Marine and Estuarine Communities

The estuarine and marine communities studied involved those species of economic importance to the area. These were the Penaeid shrimps harvested at or near the Tanjung Piandang estuary.

(1) Sampling of Benthic Crustaceans and Mollusc

Tremmel nets were used in the study. Each net were 25 m long and 1.5 m wide. A net consisted of three layers of monofilament laid together of mesh sizes 3.0, 1.5, 1.0 inches (Fig. 9.2-3).

End floats and weights were adjusted to the nets so as to allow them to trawl near the bottom. The nets were then allowed to drift perpendicular to the current for an approximated distance of 0.5 km in a preselected area. On deployment the nets were followed by a small 25 HP boat.

A total of four nets were employed altogether. These were set during the flooding tide.

The nets were taken back to Tanjung Piandang where the catch was sorted. These were then preserved in 15% formalin to be analyzed in the laboratory.

(2) Sampling of Nearshore Crustaceans

Collapsible crab traps known locally as 'bubu' were employed to capture the crabs that inhabit the nearshore subtidal zone. These traps (Fig. 9.2-4) of dimensions 1.5 m long by 0.3 m wide by 0.3 m high were baited with trash fish and left for a period of not more than four hours in the water. Their position in the water were marked with floats. Upon collection the contents of the trap were transported to the laboratory for analysis.

The area sampled for both occasions is given in Fig. 9.2-5. The area was chosen based on:

(a) familiar fishing ground for the local fishermen; and

(b) the proximity to the Tanjung Piandang estuary.

(3) Results

(a) Benthic Crustaceans and Molluscs

The dominant organisms obtained from the tremmel nets were penaeid prawns. Penaeus merguensis were caught in all nets and formed bulk of the catch. A total of 7 kg. of M. merguensis were harvested from the four nets. Other species caught were P. indicus, P. monodon and P. merguensis.

One specie of crab was found in two of the nets. These are the common portunid crabs Portunis pelagicus. The total catch of P. pelagicus was 1.7 kg.

(b) Nearshore Crustaceans

Of the ten crab traps, most contained the mangrove crab. Two traps contained one specie of hermit crab. Two other traps contained a catfish and a mudskipper. The dominant Scylla serrata observed within the mangrove area was not seen in the intertidal area. However Uca species were observed on the mudflats at low tide but were not sampled

in the traps. Some ghost crabs of the species were also observed near the waters edge but were not sampled.

Animal Communities

The animal communities in the marine/estuarine environment can be classified according to their habitat vis. the pelagic community and the benthic community. The pelagic community consisted mainly of fishes and will be considered in another section. The benthic community consisted the sedentary benthos and the transients. The latter represent benthic organisms that are on the move on the bottom.

The dominant sedentary benthos observed at Tanjung Piandang consisted of the molluscs *Murex spp.* and *Anadara granosa* - the blood cockle. *Murex spp.* due to its morphology were easily sampled in the nets but Anadara shells were seen littering the beach adjacent to Tanjung Piandang.

The dominant transients seen here were the shrimps. Fishermen here talked of good prawn fishing days where landings are high. These were related to the tides. Twenty to twenty-two days in a month were spent at sea. However, the better landings were obtained at the approach of spring tides. These can be associated with the movement of the shrimps in water. According to the fishermen, the penaeid shrimps follow a definite migratory route in the area. This was observed to be close to the 1 to 3 m bathymetric contour off the coast of Tanjung Piandang.

(1) Distribution and Abundances

Small engine boats (less than 40 HP outboard motors) kept to fishing areas less than 5 km from the coast. The profitable catch here are the penaeid shrimps. The distribution of penaeid shrimps and their abundance is closely associated with mangroves and estuaries.

(2) Species Composition

Of the benthic animal communities found at Tanjung Piandang mangroves the crustaceans and molluscs were the dominant groups. The common groups of crustaceans and molluscs are listed in Table 9.2-6 and 9.2-7.

Fishes

(1) Species Composition

Fish population of the Tanjung Piandang River estuary was studied at various sites; namely, the river mouth, shore areas and open sea, to determine the species composition of the area. The northern and southern shores and the open sea areas facing the river mouth up to a distance of 3 km were sampled. The river mouth, that is, areas near the banks were also sampled for fish.

Samplings were done by using nets, primarily gill nets, trammel nets, benthic nets, and cast nets (Gulland, 1980; Hamley, 1980; Craig, 1980). To reduce net-size selectivity, gangs of nets with different mesh sizes were used (Hamley, 1980). Monofilament gill nets of 3.2, 5.7, 7.6 and 9.2 cm and trammel net of 9.2 by 4.1 by 9.2 cm stretched mesh were used. Each gang of net is 30 m long and 3 m deep; whereas, the cast net have a 2.3-m radius.

To obtain uniform effort and to reduce bias, the fishing gears were operated by the same individuals during sampling and periods of sampling were standardized. Sites to be sampled were selected using stratified random sampling design. Samplings of the upper, middle and bottom layers of the water column were carried out in order to catch pelagic as well as demersal species. Since the river is a busy fishing port, sampling designs were modified and adjusted according to the boat traffic as well as the local and traditional fishing customs and activities.

The species composition for Tanjung Piandang River is shown in Table 9.2-8. A total of 21 families and 29 species were collected during the study. Most of the species collected are common estuarine species such as the families *Ariidae* (ikan duri/catfish), *Cyanoglossidae* (ikan lidah/tounge sole), *Engraulidae* (ikan bilis/anchovies) and *Sciaenidae* (ikan gelama/jewfish). Families such as *Ariidae* are commonly found in estuarine areas due to their ability to tolerate fluctuating salinity and suspended sediment in the water. However, these hardy species are not preferred commercially and are seldom exploited by fishermen.

Engraulid species are also observed at Tanjung Piandang River. These species are commonly available along Malaysian coastal areas and are usually exploited by artisanal as well as commercial fishermen. These shoreline species usually travel in large schools and hence are easily caught.

Sciaenid species were also obtained during the study. These fish are caught by fishermen for use as salted fish. These species also congregate primarily inshore and are usually available in estuaries and areas with extensive mangroves.

Other important commercial species sampled included *Pampus argenteus* (bawal putih/pompret), *Liza subviridis* (belanak anding/mullet), *Valamugil cunnesius* (kedera/mullet), and *Lates calcarifer* (siakap/sea bass). Two relatively uncommon species with little commercial value, however, were sampled. These are *Harpadon nehereus* (Family *Harpadontidae*/bombay duck) and *Traypauchen vagina* (Family *Traypauchenidae*).

(2) Abundance and Biomass

In terms of abundance, a large number of mullets (*Valamugil cunnesius* and *Liza subviridis*) locally known as "kedera" and "belanak" were obtained from the mangrove areas (Table 9.2-9). These are common shoreline species usually coming into the beach during high tides to feed. However in terms of value, these fish are not usually preferred by fishermen in Tanjung Piandang River who usually go for shrimps instead. In terms of biomass, the family *Ariidae* (38.9%) dominated the catch due to their ability to stay in poor quality water (Table 9.2-9). These fish are solitary in nature and do not congregate and travel in schools like the mullets. Furthermore, they are primarily bottom dwelling species with ability to tolerate adverse water quality conditions such as heavy suspended sediments and muddy waters such as what was observed to occur at Tanjung Piandang River.

Furthermore, the riverine communities at the mouth of the river discharge most of their domestic wastes in the river and these wastes are probably utilized by

the ariids which is widely known for their catholic feeding habits. As such, these species are shunned by the fishermen due to their poor marketability.

In terms of juveniles and young-of-the-year (YOY), none was observed in significant numbers in the river mouth and the open seas. However, these groups were observed in the nearshore areas, especially the mangroves fringing the shoreline of Tanjung Piandang. Juvenile mullets for example, were observed and caught feeding in the mangrove areas to the north and south of the river mouth. Previous studies such as by Khoo (1989) showed that the mangroves fringing the river systems provide important habitats for fish as well as juveniles. Some species such as *Ambassis, Arius spp.* and *Liza subviridis* spend their whole life cycles in the fringing mangroves. Species such as *Epinephelus spp.* and *Lutjanus spp.* also spend part of their life cycles in the mangroves.

(3) Species Distribution

Most fish were caught in the open sea in front of the river mouth to a distance of about 3 km from the shore and very little were obtained close to the banks of the estuary. The high abundance at seashore was due to the capture of one large school of mullets and thus did not reflect the true species distribution. Excluding the mullets from the shore section, the total number and biomass caught in the open sea section were higher than that of the estuary. Also the number of species caught in this section was larger than the other sections. A total of 25 species were caught in the open sea as compared to 8 and 4 in the estuary and shore, respectively.

(4) Catch

The catches according to gears indicate that the most efficient gear is the trammel net. This gear is very widely used by the artisanal fishermen in the area. However, the gear is used primarily to catch shrimps. Small mesh gill nets (3.2 cm mesh) caught the highest number of fish; whereas, the other larger meshes including the bottom net were negligible possibly indicating low numbers of large size fish in the area due to heavy fishing activities. In general,

local artisanal fishermen in the area generally fish for shrimps rather than fish due to the higher market value. The known fishing grounds utilized by local fishermen are shown in Fig. 9.2-6.

Birds

The study area, Tanjung Piandang Estuary, was divided into three habitants for the study. The survey was conducted over a period of 4 days during low and high tide conditions. The habitats were divided into:

(a) Coastal Intertidal Mudflats/Open Sea;

(b) Mangrove Belt; and

(c) Scrubland, Settlement Area and Rice Cultivation Area.

The data collected was based on primary survey of the site area and the adjacent coastal/estuary area during the site survey and on primary data collected before the start of the project in the preceding years. Data from secondary sources was also used in this report. The equipment used to identify birds were 9 x 30 binoculars, 30 x 50 telescope and magnetic tape recorder to record bird calls and bird songs.

The whole coastal mangrove/intertidal mudflats from the Juru Estuary in Penang State till the Larut Estuary for the northern part of Peninsular Malaysia are important feeding and wintering grounds for northern winter migrants, as well as a major stopover feeding and resting grounds for migrants on transit to the southern region and on their way back north for the summer.

(1) Coastal Intertidal Mudflats/Open Sea

There are no extensive mudflats during low tide. Extensive mudflats may not have formed as the fishing boats entering and leaving the estuary at high speed, created strong waves in their wakes that would not allow mud banks to be formed. At ebb tide some narrow coastal mudflats are exposed along the mangrove coast. This exposed area and very shallow areas during low tide conditions are the feeding grounds of shore birds, waders, egrets, herons and birds of prey. Terns, gulls and birds of prey also feed over the sea just off the

coast. As the site survey was conducted during the non-migratory season, no migrants were sighted but data of previous surveys done during the migratory season show that migrants do feed along this coastline.

White-bellied Sea Eagle was more often seen over the sea at the estuary and seldom hunting over the river. The Brahminy Kite, being a scavenger often fed on the trash fish floating along the coast. Waders, egrets, herons and other waterfowl feed along the coastal intertidal mudflats during low tide. The Lesser Adjutant also sometimes feeds along this coast. The Milky Stork, an endangered species, on some occasions come to this area to feed. The main concentration of the Lesser Adjutant and the Milky Stork is in the Matang Forest Reserve, and Tanjung Piandang borders this important mangrove reserve. As stated before, since the mud flats along this coast of Tanjung Piandang estuary is not extensive, the number of birds and the diversity of species feeding in this section of the coastline is relatively small when compared to the adjacent estuaries of Kuala Kurau, Kuala Gula and Kuala Selinsing. On the whole this coastal intertidal mudflats and mudbanks support a large number of waterfowl and wintering northern migrant waders and waterfowl. Common resident birds like the Little Heron, the White-collared Kingfisher and the Stork-billed Kingfisher do often feed along the mangrove coastline and the intertidal mud flats, although not in large numbers.

(2) Mangrove Belt

The mangrove belt at the estuary and coastline is not very extensive and in some areas especially sections to the south of the estuary are degenerated where the mangrove belt extends less then 60 meters inland. The mangrove habitant supports most of the resident mangrove bird species and a few migrant species. Large mammals like the Long-tailed Macaque - *Macaca fascicularis*, and Sliver Leaf Monkey *Presbytis cristatus* were spotted of which the macaques are the larger population. Monitor lizards and snakes were also seen in and the fringe of the mangroves. The Otter *Lutra spp.* which is known to be present in the mangroves was not sighted.

Brahminy Kite was the most abundant bird of prey. Most of them were feeding from the river mouth till about 500 meters upstream. They feed on trash fish discarded by the fishermen which accounts for the large number of them being present in this particular section. On one occasion over 20 of the kites were recorded either scavenging for trash fish or perched in the mangrove trees along the riverbank. Three of the kites were sub-adults but a survey of the mangroves and cultivated areas did not indicate any nesting areas or any nesting trees. Another 10 Brahminy Kites were recorded soaring, either over the sea, over the mangroves and the cultivated areas. Out of the 30 kites recorded at this particular time, 66% were scavenging along the river. Although the Brahminy Kite is common, the concentration of the birds here was relatively high when compared to the adjacent estuaries. The large quantities of trash fish discarded into the river seemed to be the main reason for this high concentration. Based on this easily available food source, it can be reasonably assumed that migrant terns like the Black-naped Tern, White-winged Tern, Lesser and Greater Crested Terns will also be foraging along the river during the migratory season, though the crested terns are often sea foraging birds.

The White-bellied Sea Eagle was recorded over the mangrove belt and over the sea. The Crested Serpent Eagle was recorded perched on the mangrove trees and in the scrubland and cultivated area. Four birds were sighted and they were mostly in the scrubland and cultivated areas and occasionally in the mangroves. The Crested Serpent Eagle is known to nest in mangroves but no nests were found in the estuary mangroves. The Black-crowned Night Heron which are nocturnal feeders, feed on freshwater fish in the ricefields and have been sometimes seen along the mangrove fringe in the adjacent estuaries of Kuala Kurau and Kuala Gula. These night herons have a large heronry in the Kuala Kurau Estuary. Little Herons were common in the mangroves especially along the fringes of the mangroves.

There is an overlap of bird species inhabiting the rice cultivation areas, settlement areas into the mangrove fringe areas. Birds like the White-throated

Kingfisher, Common Myna, Yellow-bellied Prinia, Magpie Robin, Yellow-vented Bulbul and Common Tailorbird were inhabiting the mangrove fringes, especially the mangrove fringe adjacent to the overgrown bunds. The Stork-billed Kingfisher inhabits the mangroves and the cultivated areas. Flyeater, Mangrove Whistler, Ashy Tailorbird and Mangrove Blue flycatcher are exclusive mangrove habitant birds. The Common Iora was fairly abundant in the mangroves, but it also inhabits the cultivated areas. The Large-billed Crow was recorded in the coastal mangroves and the riverine mangroves. Another 2 crows spotted at a distance flying over the mangroves looked like the House Crow but could not be positively identified. The House Crow, an introduced species from Sri Lanka, is common in Selangor and Penang and is seldom seen along this part of the coastline. The mangrove belt not only provides feeding grounds for resident birds but also breeding sites as well. They are also wintering grounds for migrant birds like the Artic Warbler, Forest Wagtail and Black-caped Kingfisher.

(3) Scrubland, Settlement Area and Rice Cultivation Area

This whole environment has human settlement, animal husbandry, small plots of coconut palms and proportionally greater rice cultivation area. Except for the main town along the waterfront, the rest is typical rice growing rural habitant. Other than domestic animals like dogs, cats, cattle, goats, sheep and poultry, here again there is an overlap and intermingling of bird species from the mangrove area and some intertidal mudflat bird species.

The most abundant species in the settlement and cultivated areas was the Common Myna, and Eurasian Tree Sparrow was most abundant in the settlement areas. The Spotted Dove, Yellow-vented Bulbul, Philippine Glossy Starling, House Swift and Pacific Swallow were also found in large numbers in this habitant. Other fairly common birds here were Black-naped Oriole, Magpie Robin, Brown-throated Sunbird and Olive-backed Sunbird. The Jungle Myna was only seen in the village rubbish dump and the adjacent open scrubland. Birds of prey which are far ranging and were found in the mangroves and also recorded here, were Brahminy Kite, Crested Serpent Eagle

which were foraging and roosting. The Black-shouldered Kite, an open country bird were very active over the ricefields due to the abundance of rodents which is their staple food. Coastal and offshore birds that forage in the ricefields during the ploughing season, when the plough turn up insects, fish and other small animals are mostly Little Tern, Black-winged Tern, Little Egret and Cattle Egret. Pink-necked Pigeon were mostly in the vegetated areas around the dwellings. The ricefields have different birds inhabiting and foraging at the different stages of the rice growth. During the ploughing and early stages of planting, waders, herons, egrets, bitterns and terns feed in the flooded ricefields. When the rice is in its third quarter of the growing cycle, when the fields are less wet, the waders and terns do not use the ricefields any more except for the bitterns and the Little Heron. Other species move into the ricefields during this period. These species are mostly passerines, warblers, babblers, munias, drongos and some birds of prey. When harvesting takes place there is an overlap of bird species of the early rice planting season. Birds of prey often hunt over the ricefields during the harvesting and post harvesting season. Mynas, drongos and some waders like the Common Sandpiper, Wood Sandpiper and Little Heron forage in the fields that are being harvested and the fields that have already been harvested when the fields are still slightly damp and soggy. This is also the season when owls are attracted to the ricefields in greater numbers; otherwise, the number of owls in this habitat is comparatively small.

Socio-Economic Environment

(1) General

Located at the Tanjung Piandang estuary is the fishing village of Tanjung Piandang which has a population of 13,485 being predominantly of Chinese "Teochew" origin. This is unlike Kuala Kurau, another fishing village about 10 km away, which is predominantly Chinese "Hokkien." Tanjung Piandang is the sixth largest village in the Kerian district in Perak (see Table 9.2-10).

The primary income for the inhabitants of Tanjung Piandang is related to the harvesting, sorting and distribution of fish and prawns from coastal waters and partly from fish cultured in floating cages in the sea off Bagan Tiang.

The population of Tanjung Piandang has a slightly higher female-male ratio: females (52%) compared with males (48%). Table 9.2-11 shows the population and living quarters distribution of Tanjung Piandang and other mukims in Kerian District.

The table also shows that except for Parit Buntar all the other mukims, including Tanjung Piandang, are recently experiencing a declining population. During the period between 1957 and 1970 Tanjung Piandang town had the highest annual growth rate (7.4%), but during 1970 to 1980 it had the lowest annual growth rate (-2.8, Table 9.2-12). This may be due to over-fishing in the Strait of Malacca in the 1970's which precipitated an out-migration trend.

(2) Capture Fisheries

The capture fisheries are dependent on 180 "Apollo" mini-trawlers, 255 gill-netters of various types, 13 trap-netters and 5 purse seiners. At Tanjung Piandang, there are a total number of 453 registered fishing boats, but since "brother" boats are needed for operating the "Apollo" trawls and the purse seiners, it is estimated that the boat number at Tanjung Piandang estuary is about 638 (Table 9.2-13).

The use of "Apollo" trawl nets is prohibited in other parts of Malaysia except for the Kerian District, Perak, due to the destructive consequences in using such fishing gear.

The catch composition of the various fishing gears used in Tanjung Piandang are shown in Table 9.2-14 to 9.2-17.

Depending on the nature of the fishing gear and the size of the boats, the fishing grounds of the Tanjung Piandang fishermen are located in different areas, all of which are at least 5.0 km away from the Tanjung Piandang estuary, except for the occasional subsistence harvest of mullets using cast-nets. The

mini-trawlers located at Tanjung Piandang operate in coastal waters north of Tanjung Piandang up to Penang waters at least 5.0 km away from the coasts; mini-trawlers from Kuala Kurau operate in waters up to Tanjung Piandang, so that there is no competition for similar fishing areas for both these groups of mini-trawlers. This informal arrangement is based on mutual verbal agreement to minimize conflicts. For the other fishing gears, there is no restriction as to where fishing is permissible so long as the conditions of the fishing license are fulfilled. Apparently, the quality of prawns caught by Tanjung Piandang mini-trawlers are of better eating quality than those landed by Kuala Kurau mini-trawlers for reasons that are yet to be fully understood.

(3) Fish Marketing

There are 30 private fish dealers at Tanjung Piandang, the largest fish dealer being Kang Meng Khoon Sdn. Bhd. and the largest prawn dealer being Nam Huat Sdn. Bhd. There is no LKIM fish landing complex at Tanjung Piandang. It is estimated that about 70% of the total prawn landings and 80% of the total finned-fish landings for the Kerian District originate from Tanjung Piandang. The District Fisheries Department collate data of monthly fish landings based on sub-sampling of catch of different fishing gears used at selected fishing villages such that the actual quantity and value of fish and prawns landed at particular village is not known. Nevertheless, it is clear that Tanjung Piandang is of vital importance for the landing, sorting and sale of finned fish and prawns in the Krian district. Tanjung Piandang is not involved in the marketing of cockles and mangrove crabs (see Table 9.2-18).

(4) Mariculture

Eight residents of Tanjung Piandang are owner-operators of floating fish farms in coastal waters, each having multiple units of floating cages of 3.2 m x 3.2 m x 2.7 m dimension. The largest operator is Mr. Eng Hai Seng who has floating cages over an area of 4,232 square meters (Table 9.2-19). None of these farms are located within a 3 km vicinity of the Tanjung Piandang estuary. All of them

are located in coastal waters off Bagan Tiang where apparently better water quality is available.

The main species cultured are the barramundi, *Lates calcarifer*, the groupers, *Epinephalus spp.* and snappers *(Lutianidae)*. For 1992 and early 1993, many of these fish farms suffered financial losses due to fish diseases.

The annual production per cage varies from 70 to 100 kg. Prices of fish fluctuate from RM 8-10/kg for barramundi and RM 12-20/kg for groupers. All fish from this culture area are brought back to Tanjung Piandang for sale. None of the cultured fish are sold alive, but are rather packed fresh on ice for distribution.

There is no culture activity for cockle, oyster or crabs at Tanjung Piandang estuary as the water conditions here are often too rough and muddy.

Near the seaward end of the estuary at Tanjung Piandang, there is a recent enterprise in the breeding and sale of breeder tiger prawns, *Penaeus monodon*. Operated by Weng Chean Huat Tiger Prawns Co., the hatchery has a potential to produce 3 million PL20 prawn fry per cycle. Water is obtained from the estuary on the flood tide during hours of minimal boat traffic and allowed to settle for 48 hours before being used. Breeder prawns are landed here by fishermen where they are kept alive either for larvae production or for sale to other prawn hatcheries. The production system is now fully operational.

(5) Value of the Fisheries

There are no data available on the value of fish landed in Tanjung Piandang. However, an estimate of the value of fish landed in Tanjung Piandang can be made, based on the proportional number of boats there compared with that of the state of Perak.

The total fisheries value for the state of Perak is RM 362.32 million for 1990 (Annual Fisheries Statistics, 1990). Using this figure, it is estimated that the value of fisheries landed in Tanjung Piandang is RM 36.14 million (Table 9.2-20).

(6) Future Development

According to the Draft Structure Plan for Larut and Matang, Selama and Krian 1990-2010, Tanjung Piandang will be further developed as a service center for the fisheries industry.

2.1.2 Potential Significant Impacts

General

The project activities are divided into three stages; namely, (a) construction and development, (b) operation and maintenance, and (c) consequent activities in the case of Tanjung Piandang. However, only project activities in construction and development as well as consequent activities were considered for Marang. The environmental components follow the categories given in the DOE Handbook.

A beneficial impact is depicted by a hollow circle; whereas, an adverse impact is represented by a solid circle. In both cases, three circle sizes have been chosen with the largest one representing the most significant impact, the smallest representing the least significant impact and the medium-sized representing intermediate significant impact. The impact matrix thus provides a graphical summary of the types and significance of impacts arising from the project. However, it should be noted that the matrix does not describe the magnitude of the impacts.

A matrix has been prepared for Tanjung Piandang, as shown in Fig. 9.2-7.

Potential Significant Impacts

Project activities which would give rise to major environmental impacts include capital dredging, spoil disposal and consequent activities.

(1) Capital Dredging

(a) Physico-Chemical Impacts

The major adverse impacts associated with dredging are increased turbidity and possible release of trapped nutrients, organic matters and

toxic substances from the sediments into the water phase. Increase in turbidity will result in reduced light penetration and reduced photosynthesis. Increase in organic matters will result in depletion of dissolved oxygen along the river stretch downstream of the dredging activities. These impacts may not be important in the case of Tanjung Piandang River because the river already carries a very high SS load. The main concern is the possible release of some heavy metals from the sediments into the water phase during dredging. Studies by Windom (1972) and May (1974) had shown that heavy metals do not appear to be increased in the vicinity of actual dredging.

(b) Biological Impacts

Increased Turbidity

The increased turbidity from dredging will affect the gills of fish by the smothering action of fine sediment. However, fish can avoid the high sediment load of the water by moving away. On the other hand, macrobenthic organisms such as mollusc which stay at the sea bed would be affected since their ability to move is limited. The impact of the increased turbidity is temporary as sediment would eventually settle and part of it carried away by currents.

Loss of Habitat for Benthic Organisms

The removal of mud by dredging means that the habitat on which various benthic organisms live would be lost. However, there are not many organisms of economic importance in the affected area as no cockle culture takes place in the proposed dredging zone.

Remobilization of Heavy Metals in Sediment

Possible remobilization of heavy metals and other toxic substances would affect the growth and survival of some of the macrobenthic organisms. Some of the heavy metals such as copper are known to be toxic to the macrobenthic organisms and would inhibit their growth.

The availability of heavy metals means that some of those in the seawater will be absorbed by plankton and the levels of heavy metal may increase through the food chain. The metals may be concentrated at the different trophic levels.

However, the levels of heavy metals may be low and, if dispersed over a larger area, may be diluted to below critical levels. A scientific study is required to evaluate such an impact.

(c) Socio-Economic Impacts

The dredging activities is not likely to disrupt the movement of boats in and out of the river mouth, as the dredging can be scheduled to avoid such disruptions. From an economic point of view, there is very little actual fishing activities in the proposed alignment of the dredging. Hence, there would be negligible economic impact. There is also no cockle culture activities in the proposed alignment. The cockle culture activities takes place north of the estuary at Pulau Burung and at the south of the estuary, at Kuala Kurau.

(2) Dredged Spoil Disposal

The JICA Team proposes two possible options for the disposal of dredged material (spoil); namely, disposal in spoil bank on coastal area and disposal at sea. The disposal sites have been tentatively identified and shown in Fig. 9.2-8.

(a) Physico-Chemical Impacts

If the dredged spoil is disposed of in the spoil bank, the anticipated physico-chemical impacts would be that some heavy metals may be remobilized and leached into the ground.

On the other hand, if the 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 waterphase. The U.S. Environmental Protection Agency (EPA) has listed the limits of the

various pollution parameters in sediments for determining the acceptability of disposal to fresh and saline waters. The sediment will be considered unacceptable for open water disposal if one or more of the limits expressed in Table 9.2-21 have been exceeded. It should be mentioned that these criteria have been the subject of much controversy. The findings of several studies have indicated no clear-cut relationship between the proposed criteria and observed water quality changes. In the light of this uncertainty, the EPA criteria can be used only as a rough guide.

Comparison of the mean TNR concentrations of Hg, Pb and Zn in the surface sediments at the river mouth (PS, P1, P2 and P3) where dredging is going to be carried out with the EPA criteria indicates that the heavy metal concentrations are lower than the specified limits except the zinc level at P3. However, the exceedance of the limit may not be of much significance in this case because the metal level at depth is usually much lower than that at surface especially for polluted sediment.

(b) Biological Impacts

If the dredged spoil is disposed of on land, the construction of the spoil bank would mean the loss of mangroves. The mangrove at the proposed spoil bank site are, however, generally poor with many areas of bare mud flats.

If the spoil is disposed of at sea, the impacts on biota will be similar to those already described under capital dredging. There will be adverse impact on benthic communities at the spoil disposal site but there is no easy way to predict whether the impact will be long term or whether recolonization will be rapid. Impacts on organisms with relatively high mobility such as fishes will not be long term since water quality changes such as increased turbidity appear to be transient.

(c) Socio-Economic Impacts

There are very little negative socio-economic impacts. The establishment of spoil bank may have some positive benefits as it would provide employment for some of the residents during the construction phase. The excavated mud can be used for the construction of bunds to protect the agricultural areas.

(3) Consequent Activities

The main beneficiaries of the river improvement works are the fishermen. It was observed that they have adapted to the shallow river channels by traversing the estuary only during high tides. If the channel were to be deepened it is likely that the fishermen would be able to reap certain benefits, e.g., zero waiting time for bringing in their fisheries and they can go fishing without having to wait for high tide. If the channel were to be permanently deepened, then more potential benefits could be anticipated, e.g., the development of deep-sea fishing industry at Tanjung Piandang.

However, the true impact of the river improvement works upon the fishing industry could not be estimated, except by way of the logical extension indicated above. As the size of the fishing industry is estimated to be RM 36 million, even a 5% improvement would imply an annual RM 1.8 million benefit to the industry.

2.1.3 Mitigation and Abatement Measures

Various adverse environmental impacts could be significantly reduced by the application of mitigation measures consisting of design practices, planning control and legal requirements. Summary of the impacts and mitigation measures are given in Table 9.2-22.

Mitigation of Dredging Impacts

The capital dredging should be scheduled to avoid the southwest monsoon season which lasts from April to July. The monsoon season always generates big waves which will aggravate the turbidity and water quality problems if there are dredging activities.

In a similar manner, the daily dredging activities should be scheduled so as to minimize the disruption to the movement of fishing boats.

Mitigation of Spoil Disposal Impacts

If 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 following DID's guidelines pertaining to the disposal of dredged material at sea should be complied with.

(1) Disposal site is to be located at least 3 km away from the river mouth;

(2) Water depth at disposal site is to be more than 10 m; and

(3) The site is to be located in the downside of littoral drift.

If the dredged spoil is to be disposed of in spoil bank on land, the base of the site should be lined with low permeability material to contain the leachate which is to be treated if found necessary.

2.1.4 Environmental Monitoring Programme

Under the monitoring programme, environmental quality data are collected to detect possible changes to the environment due to the project. Since this kind of exercise demands heavy commitment of financial and human resources, the parameters chosen should be limited to those of utmost importance.

Physico-Chemical Parameters

If the dredged spoil is to be disposed of at sea, the levels of selected heavy metals in the water near the disposal site should be monitored before and after dumping.

If the disposal is to be conducted on land, the composition of the leachate collected should be determined.

Biological Parameters

The levels of primary productivity in the vicinity of the disposal site at sea should be monitored before and after dumping of spoil.

To gauge the impact on economic activity, the shrimp catch in the vicinity of dredging and spoil disposal site at sea should be monitored, since this is economically the most important catch of the inshore artisan fishermen.

2.2 Marang River Mouth

2.2.1 Description of Existing Environment

Chemical Environment

(1) Water Quality

The water quality of Marang River was assessed following the same procedure as described in the preceding section for Tg. Piandang. However the TC and FC determinations were not conducted due to logistics problem. The location and description of the sampling stations are given in Fig. 9.2-9, 9.2-10 and Table 9.2-23, respectively. The samplings were carried out on 25 July and 25 August, 1993. The mean results are presented in Table 9.2-24. The data indicate that Marang River is relatively clean because of the large amount of dilution provided by the seawater. The salinity data show very clearly that the bulk of the water at the river mouth and even as far upstream as station M5 is seawater. Since the bacteria data are not available in this study, the water quality data from the Department of Environment (DOE) monitoring programme are used. The DOE water quality monitoring stations are shown in Fig. 9.2-11 and the data are presented in Table 9.2-25 and 9.2-26. The microbial data indicate significant bacterial pollution most probably due to

sewage for the stretch of the river downstream of Kampung Batangan to the river mouth.

(2) Heavy Metals in Sediment

The methodology of sampling and methods of analysis follow those described for Tg. Piandang. Sampling stations for the sediments were identical to those for the water samples. Their locations are shown in Fig. 9.2-9 and 9.2-10 and described in Table 9.2-23. Samplings for sediments and water were conducted on the same day.

The mean results are shown in Table 9.2-27. In general, there is no discernible trend in the distribution patterns of both the total and TNR metal concentrations along the course of the river. The TNR metal concentration values are at least one order of magnitude lower than those observed in the Tanjung Piandang River. Comparison of the TNR values with those rivers (Table 9.2-4) indicate clearly that Marang River is not polluted by Pb, Cu, Zn and Cd because their TNR concentrations are lower than those of an unpolluted river.

Biological Environment

(1) Coastal Vegetation

While Tanjung Piandang consists of mud flats and mangroves, the coastal vegetation of Kuala Marang is sandy and the beach regularly subjected to wave action. As a result, there is very little vegetation on the beach itself. Above the high tide mark, there are a number of different species which are common along the whole of the sandy coast of the east coast of Peninsular Malaysia. Since the land immediately above the high tide mark is inhabited, with a number of villagers, most of the natural vegetation had been cleared, and coconut trees planted instead. However, remnants of the beach vegetation can be found. The tree, *Casuarina equiuietifolia* (ru) which is characteristic of many stretches of the coastline is represented in Kuala Marang by young trees and seedlings. These appear to have been distributed naturally by the waves from other parts

of the east coast. Besides these, there were common beach species such as *Scaveola Frutisons, Hibicus tiliaceous* and *Pandanus odoratissimus*. Besides these trees and shrubs, there are the creepers such as *Iponea Pes-capre Capavalia maritima* and *Iachaemuam muticum*. Some small herbaecous were also found, such as *Fimbristylis cymosa, Indigofera Hisita, Vigna Marina* and the grass *Spinifax littoreus*. The beach is too exposed to the waves for any mangrove to established. However, the mangrove species *Avicennia* (api-api) was found inside the southern part of the estuary. The vegetation on the riverbanks had been cleared sometime ago, and the plants found in the riverbanks are those associated with villagers. Many of the plants are regarded as weed species, such as *Malastoma Malabatrichum, Urena Lobata* and *Eupatorium Odoratum*.

(2) Coastal Fauna

(a) Mangrove and Estuarine Communities

Distribution of Animal Communities

Most of the molluscs found within the riparian zones of the Marang estuary were either on the sediment surface or attached to the vegetation along this zone. The dominant mollusc on the surface is Telescopium telescopium. Specimens found ranged from 3 to 12 cm long. These were always found within the intertidal areas of the mangroves where the sediment is kept wet by the tidal flux. *Saccostrea cucullata* (Born) was found attached to the Avicennia roots in large numbers. These were especially high on the nipa stems that fringe the Marang River in the seaside area. There are also a large number of the *Balanus amphitrite* Darwin on the Avicennia roots. Some of these barnacles were being predated on by *Murex capucinus* (Lamark). Similar traps like those used in Tanjung Piandang were used to capture the mangrove crabs, *Scylla serrata*, in Marang. These crabs were always found in the subtidal zones. Active foraging appeared to occur during the rising tide where a large proportion of the samples were

taken. Size class analysis of these crabs showed that the crabs trapped from the south bank of the river were significantly larger than those from the north bank. The north bank is more accessible to the public. It lies within a short distance to the road. The bank is being used by sports fishermen for their aesthetic activities. Some crab traps were also employed on this bank. In contrast the south bank was accessible only by boat and is less disturbed. This explains the greater number of catches and size classes observed in the south bank.

Species Composition

The species composition of the dominant molluscs found within the Marang estuary is given in Table 9.2-28. The molluscs composed of one representative from the Bivalvia group and 9 species from the Gastropoda.

Six dominant species of crustaceans were found within the riparian zones of Marang River (Table 9.2-29). Most of these are Brachyurans. The most important commercially is the mangrove crab *Scylla serrata.* Male to female ratio of this crab is 1:1. The females appear to be the larger specimens but this was not significant in the samples taken.

(b) Marine Communities

Features of Marine Communities

The coastal areas of Marang experience true marine waters with salinity reaching that of the open seas at 35 ppt. This is reflected by the presence of nearshore submerged coral reefs just off the Marang estuary.

Data Collection and Sampling

Collection of mollusc and crustaceans was done at low tide. Representative areas of the sandy beaches within the intertidal zones were sampled using a rake of mesh size 3 mm. The samples collected

were then preserved in formalin to be identified in the laboratory. In accessible areas transect observations were carried out. Samples were then collected by hand.

Invertebrate Communities

The distribution of molluscs on the beaches of Marang was patchy. Most of this were found in the intertidal zones. The expanse of this zone at Marang especially near the estuary is large.

Many of these were found on the surface of the sediment. No attempt was made to identify the dead molluscs as these might have been washed ashore from other areas. *Donax spp.* were abundant. This small shellfish is between 1 to 5 cm in length but due to its abundance it is sometimes collected by the locals as food.

Species Composition

Of the molluscs, five species of bivalves and eight species of gastropods were dominant on the beaches of Marang.

Six species of crustaceans were sampled. Five of this species are highly prized as commercial shellfish. The list of dominant molluscs and crustaceans found at Marang are given in Table 9.2-30 and Table 9.2-31.

(c) Fishes

Species Composition

The same fishing gears and methodologies used to sample fish in Tanjung Piandang River were also used for Marang River. The areas sampled are the open sea, the shores and the banks of the river mouth.

Gears used were gill nets, trammel nets, benthic nets, and cast nets (Gulland, 1980; Hamley, 1980; Craig, 1980). Monofilament gill nets of 3.2, 5.7, 7.6 and 9.2 cm and trammel net of 9.2 by 4.1 by 9.2 cm

stretched mesh were used. Each gang of net is 30 m long and 3 m deep; whereas, the cast net have a 2.3-m radius. Sites to be sampled were selected using stratified random sampling design. Samplings of the upper, middle and bottom layers of the water column were carried out in order to catch pelagic as well as demersal species. Since Marang River is a busy fishing port, acting as both storm shelter and landing port for fish catches, sampling designs were modified and adjusted according to the boat traffic as well as the local and traditional fishing customs and activities.

A total of 25 families and 38 species were sampled from Marang River. Some common riverine families such as *Ariidae* (ikan duri/catfish) and *Plotosidae* (ikan sembilang/catfish) were sampled. Other common open sea families such as *Carangidae* (ikan pelata/jack), *Belonidae* (ikan todak/gar), *Gerreidae* (ikan kapas/mojarra) and *Leiognathidae* (ikan kekek/ponyfish) were also obtained.

The waters around the Marang river estuary and the surrounding seas are clear without any visible suspended matters. As such, more open sea species and species preferring clean clear water are present. A school of silversides (Family *Atherinidae*) was observed among the pilings of the Lembaga Kemajuan Ikan Malaysia (LKIM) jetty. A large population of archer fish (*Toxotes jaculatrix*) were also observed in the estuary. Species such as the siganids (spinefoots) (*Siganus javus* and *S. cannaliculatus*) and the theraponids (tiger basses) (*Therapon jarbua* and *Eu therapon theraps*) were also sampled.

Important commercial species were also sampled during the study. These include species such as Decapterus russelli, Gerres filamentosus, Leiognathus spp., Lutjanus spp., Liza subviridis, Epinephelus tauvina, Sillago sihama, and Sphyraena jello. However species common in Tanjung Piandang River such as the engraulids and the sciaenids are rare in Marang River; whereas, those that are common in Marang River such as the leiognathids, lutjanids and siganids are uncommon in

Tanjung Piandang River. In general, species caught in the Marang river areas also included both the riverine, shore and the open sea types. Species such as the arrids and plotosids (catfishes) and archer fish are usually found in the river mouth and close to the shores; whereas, species such as the carangids (jacks) and the belonids (gars) are pelagic species and species such as the siganids (spinefoots) can be observed in the coral areas. Thus, the species composition in Marang River is more diverse.

Abundance and Biomass

Again, as in Tanjung Piandang River, schooling fish such as *Alanetta forskali* and *Leiognathus splendens,* were in abundance. However, for *A. forskali,* the biomass is insignificant (0.5%) and this species is also not preferred commercially. Sampled were four commercial species of leiognathids with *Leiognathus splendens* and *L. brevirostris* being most abundant. However, in terms of biomass these small-size species were also insignificant. Other species abundant numerically but not in terms of biomass included *Ambassis dayi.*

Large size species such as *Tylosurus crocodilus, Arias sagor, Sphyraena jello,* and *Thysanophrys indicus* were not abundant numerically but contributed to the biomass of the population. However, there was no one group that dominated the biomass as observed with the ariids in Tanjung Piandang River.

In terms of the presence of the young-of-the-year (YOY) or juveniles, no observation or sampling was made during the sampling activities. However, this did not indicate that these important groups of fish were not present. Since sampling was done only during this limited period rather than extending over a period of time, there was a possibility that the YOY and the juveniles were missed. However, estuaries are known as important nurseries for fish. This is especially true for rivers such as Marang which lacks significant mangrove stands to function as nursery

areas. From the survey with the local fishermen, YOY and juvenile fish regularly enter the estuary for feeding especially during the monsoon period.

Species Distribution

The jetty has the highest number of fish due to the presence of schools of *Alanetta forskali*. This is followed by the north bank of the estuary which is deeper than the south bank which has extensive sand banks and is thus much shallower. In contrast to Tanjung Piandang River, more fish and fish species were found in the estuary compared to sea. Species distribution in the sea off Marang River is probably influenced by transients. Transient species that travel in large schools such as the mackerels (*Rastrelliger spp.*) will come and go depending on food availability and breeding cycles. These species are not territorial in nature. This probably explains the poor species composition off the Marang river estuary.

On the other hand there were also open water species present in the estuary itself. Species such as *Leiognathus spp.*, *Selar spp.*, and *Caranx spp.* are common in the open sea. However, their presence in the estuary is probably due to better food availability as compared to the open sea. Other species present in the estuaries are more territorial in nature and these included *Plotosius spp.*, *Arius spp.*, and *Siganus spp.*

Catch

The most efficient gear at Marang River were gill nets (3.2 cm mesh) and trammel nets. In Marang River, most artisanal fishermen used gill nets instead of trammel nets. These nets are used to catch mullet (known locally as belanak anding) probably of the species *Liza subviridis*. Fishermen also used long-lines and traps to catch species such as *Nemipterus spp.* and *Epinephelus spp.* from areas adjacent to coral reefs.

Catches from the open sea were a little higher and both the gill and trammel nets were efficient at catching fish. However, the high catch from the open sea was essentially due to few large individuals of *Tylosurus spp.* entangled by 3.2 cm gill net and thus did not reflect the true situation whereby the estuary also produced as large a catch as the sea and with greater number of species.

(d) Birds

The study area, Marang River Estuary, was divided into three habitants for the study. The survey was conducted over a period of 3 days during low and high tide conditions.

The habitants were divided into:

- Coastal Intertidal Mudflats and Sandbanks/River Mouth;
- Riverine Belt; and
- Scrubland/Forested Area, Settlement Area and Cultivation Area.

The data collected was based on primary on-site survey of the study area and data from published secondary sources. The equipment used to identify birds were 9 x 30 binoculars, 30 x 50 telescope and magnetic tape recorder to record bird calls and bird songs for identification.

The East Coast of Peninsular Malaysia is an important flyway for migrant waders but the more vital feeding and wintering areas are in the extreme northern part of the East Coast (which extends into the eastern coast of South Thailand) and Southeastern Johore. Of these two areas (excluding the Thai coast) the Johore section is the more important feeding and wintering grounds for northern winter migrants, as well as a major stopover feeding and resting grounds for migrants on transit to the southern region and on their way back north for the summer. The Marang Estuary and the adjacent estuaries being sandy offer less nutrients than muddy estuaries and coastlines and as a result, only a

small number of waders use the Marang Estuary as feeding/wintering grounds along the migration flyway.

Coastal Intertidal Mudflats and Sandbanks/River Mouth

As the on-site survey was conducted during the very early stage of the southerly migratory season, very few migrants were sighted, but published data of surveys done during the migratory season show that a small number of migrants do feed in the Marang coastal area.

There are no mudflats but there are a few sandbanks which are exposed during low tide on the seaward side of the coast. The sandbanks are often washed by strong waves and the substrata is coarse sand which are deficient in nutrients. Only a single Little Tern was seen resting on the sandbank of the outer river mouth.

The coastal shoreline substrata is coarse sand. Very few bird species inhabit this area except for a few Common Myna, Eurasian Tree-sparrow, Spotted Dove, Richard's Pipit, Magpie Robin and Peaceful Dove. Swifts and swallows were also seen hawking for insects. The bird density of this shoreline is estimated to be 1 to 2 per 10 kilometer of coast (J.R. Howes et al, 1986).

The enlarged inner river mouth is fringed by a small mangrove patch on the right side of the shore. The substrata was sandy mud. The dominant mangrove vegetation was *Rhizaphora dpiculata* in this thinly vegetated mangrove. The most abundant birds in this small mangrove area were the Collared Kingfisher, Common Myna and Brown-throated Sunbird. Other birds inhabiting this mangrove were Ashy Tailorbird, Black-naped Oriole, Magpie Robin, Common Sandpiper and Olive-backed Sunbird. A few Spotted Dove and Peaceful Dove were on the fringe of the mangrove and the adjacent settled area. The left shore has a shallow lagoon with sandy mud substrata and only the Common Sandpiper and the Common Myna were recorded.

The sandbanks in the inner river mouth which were exposed during high tide, had a few migrants either foraging or roosting. The substrata ranged from sandy mud to coarse sand. The Common Sandpiper was fairly common at the sandbanks and the shores of the river mouth. The Mongolian Plover and Greater Sandplover were fairly common. Two Little Terns were roosting on one of the sandbanks on a few occasions. The Terek Sandpiper was common on the sandbanks and the shoreline especially near the mangrove patch.. A Common Redshank was seen only once alighting on a sandbank before taking to flight in its southerly migration flight. A few Curlew Sandpipers and Rufous-necked Stints were foraging in the sandbanks.

The Pacific Swallow, the Barn Swallow, a migrant, the Fork-tailed Swift, another migrant, and the House Swift were common over the inner river mouth and the shoreline of the mangrove patch. The House Swifts had a large nesting colony under the main bridge over the Marang River. Over 300 House Swifts were seen over the bridge and over 150 nests were counted.

The Brahminy Kite, which is fairly common along the East Coast of Peninsular Malaysia, was the only bird of prey recorded at the mouth of the river. It was seen only on one occasion just over the bridge.

Secondary sources indicate that the Little Heron, Bartailed Godwit, Blackcapped Kingfisher, Common Iora, Common Kingfisher, Lesser Golden Plover, Little Ringed Plover, and Ruddy Turnstone also inhabit this area.

Blacknaped Tern and Whitewinged Tern which have been recorded over the offshore islands of the East Coast can occasionally occur along the Marang coastline. The migrant bird of prey, the Osprey, has been recorded along the coast.

Riverine Belt

The riverine mangrove vegetation is a narrow belt of degenerated mangrove trees and nipa palm (*Nypa spp.*) and did not support the diversity nor density of avifauna as those of riverine mangroves of the West Coast of Peninsular Malaysia. In many places, human encroachment was right up to the river banks. Here, too, the riverbank substrata was mainly sandy mud. Monitor lizards were abundant, Long-tailed Macaque-Macaca fascicularis, Plantain Squirrel - *Callosciurus notatus* and Grey-bellied Squirrel - *Calloscirus caniceps* were some of the large mammals observed.

The dominant bird species in this habitant were non-mangrove dependent birds. The Common Myna, Olive-backed Sunbird, Brown-throated Sunbird, Strip-throated Bulbul (usually not found in mangroves but due to the small area of mangrove these birds had overlapped into the riverine mangrove from the adjacent habitant of scrubland and overgrown secondary growth), Collared Kingfisher, Pied Fantail, Yellow-vented Bulbul, Magpie Robin, Large-billed Crow and Dollarbird were fairly common.

Three White-bellied Sea Eagles were recorded in the upper parts of the estuary. These birds of prey are fairly common along the coast and waterways of the East Coast. The Stork-billed Kingfisher was often seen along the mangrove riverine area. A few White-throated Kingfisher were seen in the mangroves but they were mainly in the fringe area of the mangrove and the adjacent cultivated/scrubland. A flock of five Linated Barbets were feeding on a small fig tree in some degraded mangroves adjacent to some cleared scrubland.

Mangrove Blue Flycatcher, an exclusive mangrove bird was recorded in the upper reaches of the estuary. Other bird species in the riverine vegetation include Artic Warbler, Asian Palm-Swift, Pied Triller, Black-capped Kingfisher, Crested Serpent-Eagle, Common

Goldenback, Green-billed Malkhoa, Spotted dove and White-bellied Swiftlet.

Scrubland/Secondary Forest, Settlement and Cultivation Area

The settled area, scrubland, secondary forest and cultivated areas bordering the river mouth and riverine vegetation had a greater number of birds and a greater diversity of bird species. There was an overlap of bird species of the riverine habitant into this habitant.

Birds in the human settlement and scrubland areas were Common Iora, Eurasian Tree-sparrow, Brown-throated Sunbird, Common Myna, Pacific Swallow, and House Swift, which were abundant, especially, around the buildings and houses. Yellow-bellied Prinia, Scarlet-backed Flowerpecker, Magpie Robin, Yellow-vented Bulbul and Common Tailorbird, House Swift, Forktailed Swift, Pied Fantail, Black-naped Oriole, Olive-backed Sunbird, Dark-necked Tailorbird and Spotted Dove were common. The Large-billed Crow, Dollarbird, Hill Myna, Philippine Glossy Starling, Red-tailed Tailorbird, Green-billed Malkoha and White-throated Kingfisher were also recorded. The Linated Barbet, a species restricted mainly to the northern states, was fairly common in this habitant. It was even recorded in a tree, beside the busy fish landing jetty.

Birds that occur in the open areas, rice and tobacco fields, coconut plantations and the forested areas adjacent to the Marang District were Barn Owl, Barn Swallow, Pacific Swallow, Forktail Swift, White-bellied Swiftlet, Barred Buttonquail, Bay Owl, Baya Weaver, Hill Myna, Blue-throated Bee-eater, Baya Weaver, Brown Shrike, Cinnamon Bittern, Common Koel, Dollarbird, Common Goldenback, White-throated Kingfisher, Long-tailed Parakeet, Great Reed Warbler, White-breasted Waterhen, Wood Sandpiper, Yellow Wagtail, Yellow-bellied Prinia Red Jungle Fowl and Zitting Cisticola. The Black

Hornbill has been recorded in the secondary forests and can sometimes be seen in wooded and cultivated areas.

The Red-wattled Lapwing which were fairly common in the northern East Coast states is now very fairly seen in recent times. The White-shouldered Kite, a very common open country bird of the West Coast is very rarely seen in the East Coast but has been recorded in Terengganu.

Socio-Economic Environment

(1) General

The Marang estuary provides refuge from the northeast monsoon for several villages located up to 10 km upstream from the sea coast. Marang town and Kampung Seberang Marang, located only about 500 m from the sea, have a population of 4,738, while the others have less than a population of 500 (see Table 9.2-32). Many of the inhabitants are of the low income group earning less than RM 350 per mensem, many of which are dependent on the marine fisheries. In the Marang district, there are a total of 1,057 fishermen, all of which are of Malay origin. At the Marang estuary, there are 966 Malay fishermen.

With the development of the deep harbour at Chedering for deep-sea trawlers, only fishing boats of less than 40 tons are located in the Marang estuary which has limited access for boats due to its shallow entrance. As such, the marine fisheries at Marang are restricted to the exploitation of the coastal fisheries by small fishing boats, most of which land their catch at the LKIM Fish Complex located in the Marang estuary.

The Marang estuary is unpolluted and has a good diversity of fish species, some of which are coral reef fishes, which move into the estuary with the incoming tide. However, the potential of mariculture in the estuary has yet to be fully exploited although some pioneering projects have been initiated.

Other than the marine fisheries, another major economic activity in Marang is tourism. In 1992, an estimated 35,000 tourists visited Marang in March to October and this number is expected to increase as improved facilities in both Marang and the neighbouring coral island of Pulau Kapas to attract tourists are being planned or being constructed. The service industry for tourism has therefore been identified as a primary economic activity in Marang, provided the natural environment that attracts the tourists is conserved.

(2) Capture Fisheries

Despite its shallow entrance, the Marang estuary is an important base for coastal fishermen. Of the total of 244 fishing boats in the Marang district in 1992, 186 boats (76%), all of which have inboard engines, are located in the Marang estuary. The sizes of these boats and their respective fishing gears employed are shown in Table 9.2-33 and 9.2-34, respectively. There are another 22 passenger boats in Marang town which transport tourists to Pulau Kapas or conduct tours up the Marang River.

For most part of the year, the small fishing boats from the Marang estuary exploit mainly the coastal pelagic fisheries. This is reflected by the fish species landed at the LKIM fish complex at Marang where in 1992, a total of 520.69 tons valued at about RM 965,000 was traded. Table 9.2-35 shows the monthly fish landings at the LKIM fish complex. Fluctuation in monthly fish landings is very evident, possibly due to weather conditions, with the maximum in September (94.48 tons) and the minimum in November (11.55 tons), the latter during the onset of the Northeast monsoon. This is despite the fact that in Terengganu during the Northeast monsoon period (November-February), trawling is permitted in shallow coastal waters within 8 km from the coast. The capture fisheries is based primarily on finned fish, mainly of pelagic origin, and squid or cuttlefish. Table 9.2-36 shows the main fish species landed at the Marang LKIM fish complex. It should be noted that for 1992, only 450 kg of tiger prawns *(Penaeus monodon)*, 30 kg of rainbow prawns *(Parapeneopsis sculptilis)*, were landed in Marang between January and March. In November and December, two other prawn species; namely, the banana prawn, *Penaeus*

merguiensis (340 kg), and the pink prawn, *Metapenaeus ensis* (3,330 kg) have also been landed. No prawns were observed being landed at the LKIM fish complex at Marang in August and September, 1993. In contrast, the squids, *Loligo duvaucelli, Loligo edulis* and *Sepioteuthetis lessoniana,* form an important component of the coastal fisheries in Marang with a total of 22.29 tons being caught in 1992 valued at RM 74,950 (Table 9.2-37).

Most of the boats at Marang exploit the fishing grounds south of Pulau Kapas, the smaller boats fishing within 20 km of Pulau Kapas. Purse-seiners may fish as far as 50 km away from the coast depending on pelagic fish movements in the area. The waters in the vicinity of Pulau Kapas is a very important fishing ground for squid, which are caught using gill nets or by jigging using artificial lures.

Fishing boats above 8 m in size are unable to leave the Marang estuary during Low Water, Spring Tide for about 6 days per month. During such time, these boats are parked outside the estuary to facilitate movement to the fishing grounds at appropriate time of the day. The deepening of the entrance of the Marang estuary will evidently overcome this problem of the many coastal fishermen residing in the villages along the Marang estuary.

(3) Mariculture

During Spring tide, seawater moves upstream for about 10 km from the entrance of the Marang estuary. With available clean sea water, it is surprising that mariculture has not been extensively practiced in the Marang estuary. According to the District Office, Marang, the current socio-economic status and the limited technical competence of the residents would require substantial capital assistance and inputs of technical expertise before the aquatic resources in the estuary can be utilized for mariculture. With available road access to many parts of the Marang estuary, it is evident that the mariculture potential of the Marang estuary has yet to be fully realized in the absence of a comprehensive feasibility study for mariculture development. At present, there is no Master Plan for mariculture development in the Marang estuary.

Mariculture is a relatively new activity in the Marang estuary. The Fisheries Department is assessing the suitability of selected sites for oyster culture and work is currently in progress in Kerak River.

A pioneering attempt in the commercial culture of fish in floating cages in brackish-water in the Marang estuary has been initiated by Mr. Nordin B. Jusoh with the construction of 14 floating cages at a cost of about RM 10,000 at Pengkalan Kuin, Kg Setol Patah. Some 9,000 juvenile barramundi (ikan siakap), *Lates calcarifer*, presented by the Fisheries Department, were released into these cages on 23 May 1993. About 45 kg of trash fish (RM 20) were provided daily as feed. The fish grew well till mid-September, 1993, when following a period of continuous rainfall, the water salinity fell from 25 ppt to 3 ppt and substantial fish mortality was experienced. Till 20 September 1993, about 500 fishes have died. Due to a breach of security, about 330 specimens of 300 gm fish were stolen on the night of 14 September 1993. The project is still in operation with action taken to improve the security of the project and the health of the cultured fish. Further research inputs pertaining to site-specific problems are needed to improve the management techniques currently being practiced. Attempts to collect fish fry in the Marang estuary for the culture project have indicated that fish fry of commercial species, including carangids, snappers, groupers and siganids, are abundant in the river estuary during the month of April. Within the estuary, several species of snappers and groupers can be caught by gill-nets or by angling throughout the year, although October is the best time. The possibility that the Marang estuary and other estuaries of the Ibai River and Merchang River may be important nursery grounds of commercial fish species warrants a more detailed study as these sheltered waters may be more productive in comparison with the open waters of the South China Sea. It is likely that many pelagic species spawn in open waters and that the fish larvae were transported into the estuary by water currents possibly during February-March. As such, the timing for improving the entrance of the Marang estuary should take into consideration this observation. It is expected that with the deepening of the entrance of the

Marang estuary, water movement in the estuary will improve such that better water conditions for mariculture would result.

The farming of penaeid prawns in ponds is also very recent in the Marang estuary. At Kampung Gong Nangka, four ponds, each measuring 0.4 ha, have been constructed in 1990 by Mr. Haji Alwi B. Ismail, the headman of the village. The initial culture cycles in 1991 gave poor yields, but in 1992, each pond produced 2.0 tons of tiger prawns, *Penaeus monodon.* The wholesale selling price was RM 14,000 per ton. Success in prawn farming is dependent on many factors, including the quality of the prawn fry, the water quality, the type of feed provided and management techniques practiced. Marketing of cultured prawns is not problematic as the hotels and restaurants around Kuala Terengganu has inadequate supply of fresh prawns.

For the development of tiger prawn farming in the Marang estuary, the supply of prawn fry will not be problematic as there are two commercial hatcheries in Terengganu; namely, the Overseas Hatchery at Batu 34, Jalan Dungun, Kampung Jambu Bongkok, Marang and the Panjang Hatchery at Sura, Dungun. Developed at a cost of RM 350,000, the Overseas Hatchery began operations in March, 1993, with a production capacity of 5 million PL20 per cycle. The Panjang Hatchery began operations in 1992 and from January to July, 1993, has produced 750 million prawn naupli, although its production of PL20 prawn fry during the same period is not known.

(4) Tourism in Marang

(a) General

Tourism is an important economic activity in Marang. In 1992, an estimated 35,000 tourists visited Marang especially during the months of April to September.

Tourists come to enjoy the scenic beauty of Marang which has a variety of natural habitats with its interesting fauna and flora: the beach, the estuary, the nipa swamp, the rivers and the coral reefs. These unspoiled

habitats complemented with the friendly nature of the local villagers living in unique kampung houses are attractive features that must be conserved if tourism is to be further developed, as proposed in the Structure Plan Study Report for the Marang District 1990-2010. As yet, the tourism resources in the district have yet to be fully exploited. It is envisaged that the number of tourists to the district will increase by 2 to 4% annually such that accommodation and supporting service facilities have to be further developed. Currently, foreign tourists constitute 76% of the total number of tourists staying for at least a night in the district.

(b) Accommodation

There are 12 resorts that are presently in operation providing a total of 91 rooms and 127 chalets in September, 1993. As shown in Table 9.2-38, the most recent is the Marang Resort and Safari at Pulau Kerengga which is partially completed, but is currently operating 30 chalets. Located in a nipa swamp next to the beach, it provides an undisturbed natural surroundings which is very attractive for foreign tourists. The market at Marang has been converted into a 30-room hotel by the Marang District Council but the hotel is yet to be in operation. Resort facilities on Kapas Island will be further improved if the proposed Gemia Beach Resort of 51 rooms (chalet style) and the proposed Aseania Resort of 81 rooms (chalet style) are approved for development.

(c) Service Facilities

A total of 22 passenger boats are based in the Marang estuary for transporting tourists to Kapas Island located about 5 km away from the estuary. The return trip per tourist is RM 15 and each boat can accommodate 10 passengers. These boats also conduct a half-day river safari from Marang up to Kampung Batangan for RM 15 per person as and when there is a request. With increased tourist arrivals, the jetty at

Marang needs to be improved to facilitate the embarkation and disembarkation of tourists more safely. The deepening of the entrance of the Marang estuary will also enable these boats to ferry tourists to Kapas Island whenever required. Presently, these boats are unable to leave the estuary at Low Water, Spring Tide. There are also 3 tour agencies that conduct excursion trips for night watching of turtles that come up to the beach near Rantau Abang to lay eggs from June till September annually. Small owner-operator food stalls are located in Marang or along the main road to Dungun to cater to the needs of tourists, but organized food centers have yet to be developed in Marang town. Such facilities are expected to be incorporated in the overall beautification plan for Marang town.

(5) Recommendation

Improvement of the Marang estuary will enhance the socio-economic status of the local inhabitants provided the natural habitants are conserved to promote eco-tourism and its potential mariculture development. An integrated long-term master plan, which should include a comprehensive feasibility study on aquaculture development of the Marang river basin, will optimize the utilization of the available natural resources.

2.2.2 Potential Significant Impacts

General

Project activities which would give rise to major environmental impacts include the following:

(1) Countermeasures for the improvement of Marang River Mouth such as construction of breakwater, jetty, coastal and river groins and capital dredging;

(2) Dredged spoil disposal; and

(3) Consequent activities.

A matrix has been prepared for Marang, as shown in Fig. 9.2-12.

Potential Significant Impacts

(1) Countermeasures

(a) Physico-Chemical Impacts

As the dredged material is sand which would settle rapidly after dredging and is not polluted, the impact on the water quality would be very minimal.

(b) Biological Impacts

The impact of dredging on marine life would be low. However, the construction of breakwater, jetty and groins may affect the movement of fish to the estuary for feeding and breeding.

(c) Socio-Economic Impacts

There is likely to have impact on the riverine fisheries during the construction stage. However, no impact on the coastal fisheries is anticipated. There may be some disruption to the fishing boats traversing the estuary because of the construction of the breakwater. However, this disruption would be only for the duration of the construction.

(2) Dredged Spoil Disposal

It is proposed that the dredged sand would be deposited on the southern bank of the river mouth to replenish the sand that may be eroded away and not replenished because of the construction of breakwater and jetty. No significant impact is anticipated in the disposal of spoils.

(3) Consequent Activities

The impact of the river improvement works would benefit both the fishing and tourist industries. The latter is developing very rapidly for Marang.

The overall impact on the fishing industry is that it will mainly allow the fishermen to go and come into the estuary as and when they please, without waiting for the tide.

The tourist industry will also benefit from a deepened channel as they can be certain about their travel plans. The tourist industry at Pulau Kapas, and the surrounding region, which use the estuary are likely to benefit greatly. Tourists who value their time (as they can determine more precisely the period of enjoyment) will probably come in greater numbers to this area. The tourism industry can be expected to grow in Marang.

In terms of value, it is estimated that the economic benefits arising from the tourism industry will outweigh that of the fishing industry.

For the fishing industry, if deep-sea fishing could be developed here (as in Chedering and Kuala Terengganu), then there would be tremendous benefits. The fishing industry is valued at RM 0.92 million annually.

Additionally, the potential of developing riverine mariculture is there. The river works would undoubtedly improve additional stretches of the river for this purpose because of anticipated better flow regime.

In terms of the tourism industry, if we assume that only one quarter of the 25,000 tourists were to visit the outer islands, and spend an average of RM 50, then the size of the tourism industry is probably worth about RM 0.3 million annually. This is not an unreasonable estimate as the boat fare alone cost RM 15 one way. This could be considered as a low estimate.

Hence, the value of the economic activity here is estimated at more than RM 2.0 million annually.

At this stage, the total economic benefits for the Kuala Marang river improvement works could not be estimated.

2.2.3 Mitigation and Abatement Measures

Mitigation of Dredging and Construction Impacts

The capital dredging should be scheduled to avoid the northeast monsoon season for the same reason as explained in Section 2.1.3, Mitigation of Dredging Impacts for Tg. Piandang. The construction of countermeasures should be scheduled after the known breeding period of a number of economically important species of fish. The known breeding period is immediately after the northeast monsoon. Construction should therefore begin from March to avoid interference with the normal breeding period.

The daily dredging and construction activities should be scheduled to minimize disruption to the movement of fishing and tourist boats. If too much disruption is anticipated, then an arrangement with Chedering should be made. Alternatively, a channel should be maintained such that boats could move freely during the construction period. This would also benefit the tourist industry.

Mitigation of Spoil Disposal Impacts

Since significant environmental impact arising from the dredged spoil disposal is not anticipated, mitigation measures are not necessary.

2.2.4 Environmental Monitoring Programme

Physico-Chemical Parameters

The turbidity of the estuarine water during dredging and construction of the countermeasures should be monitored. In addition, it is important to monitor the changes in coastal geomorphology because of possible erosion in the southern bank of the estuary.

Biological Parameters

The levels of primary productivity in the vicinity of construction areas should be monitored as primary productivity is the basis of the productivity of all fisheries. This can be easily measured.

Two species of shrimps *(Penaeus merguiensis* and *Acetes spp.)* are locally important in the vicinity of the estuary and should be monitored.

TABLES

Table 9.1-1 ENVIRONMENTAL IMPACT MATRIX

ENVIRONMENTAL COMPONENTS		PROJECT ACTIVITIES /	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Land	Landforms								D	D		D	D	D	D		U			
	Flood Plains/Swamps					D	D	D	D	D		D	D				U			
	Land use						E			U	U	D	D	D		D			U	U
	Buffer zone						D		D	U	D	D	U	U						
Surface water	Shoreline					D			D		D						D			
	Bottom interface						D	D	U	D	D						D			
	Flow variation					D	D	D	D	D	U	D	D	D			D			
	Water quality					D	D	U	D	U	U	U	U	U			U		U	U
	Drainage pattern					D	D	D	D	D	U	D	D	D	U		U			
	Flooding					E	E	U	E	E	U	U	U	U			U			
	Existing use					U			U	U		U	U							
Ground water	Existing use					U			U	U		U	U							
Atmosphere	Air quality																			
Noise	Intencity															U		U		U
	Duration															U		U		U
Species	Terrestrial vegitation											D	U	U	U					
	Terrestrial wildlife											U	U	U	U					
	Other terrestrial fauna											U	U	U	U					
	Aquatic/marine flora					D	U	U	D	D	U		U				D			
	Fish					D	U	U	D	D	U		U				D			
	Other aquatic/marine fauna					D	U	U	D	D	U		U				D			
Habitats	Terrestrial habitats											U	U	U	U					
	Terrestrial communities											U	U	U	U					
	Aquatic estuarine habitat					D	D	D	D	D	U	U	U	D			U			
	Marine habitat					U			D		D									
	Aquatic estuarine communities					D	D	D	D	D	U	U	U	D			U			
	Marine communities					U			D		D									
Health	Physical safety																	U		
Socio/economic	Employment					E	E	E	U	E	E	E					U		E	E
	Amenities																			U
Aesthetic	Landscape					D	U	D		D	D	U	U	U						

D: Adverse Impact, U: Uncertain, E: Enhance

Project Activities

1: Engineering Investigation
2: Hydrological Survey
3: Oceanographical Survey
4: Breakwaters and Jetties
5: Training Walls
6: Groins
7: Dredging
8: River Works
9: Coastal Works (e.g. rock revetment)
10: Excavation
11: Drainage Alternation (diversion of outlet)
12: Reclamation
13: Access Road
14: Base Camp
15: Maintenance Dredging
16: Transportation
17: Fishery Development
18: Recreation

Table 9.1-2 ENVIRONMENTAL IMPACT MATRIX FOR PERLIS RIVER MOUTH

Environmental Components		Project Activities							
		1	2	3	4	5	6	7	8
Land	Landform				D		D		
	Flood plains/Swamps				U		U		
	Land use							U	
	Buffer zone				U		U		
Surface water	Shoreline				D		D		
	Bottom interface				D		D		
	Flow variation				U		U		
	Water quality				D		D	U	
	Drainage pattern				U		U		
	Flooding				E		E		
Species	Aquatic/marine flora				D		D		
	Fish				D		D	U	
	Other aquatic/marine fauna				D		D		
Habitats	Aquatic estuarine habitat				D		D	U	
	Marine habitat				D		D		
	Aquatic estuarine communities				D		D	U	
	Marine communities				D		D		
Social/Economic	Employment				U		U	E	

D: Adverse Impact, U: Uncertain, E: Enhance

Project Activities

1: Breakwaters and Jetties
2: Training Walls
3: Groins
4: Dredging
5: Reservoir
6: Maintainance Dredging
7: Fishery Development
8: Recreation

Table 9.1-3 ENVIRONMENTAL IMPACT MATRIX FOR KEDAH RIVER MOUTH

Environmental Components		Project Activities							
		1	2	3	4	5	6	7	8
Land	Landform				D		D		
	Flood plains/Swamps				U		U		
	Land use							U	
	Buffer zone				U		U		
Surface water	Shoreline				D		D		
	Bottom interface				D		D		
	Flow variation				U		U		
	Water quality				D		D	U	
	Drainage pattern				U		U		
	Flooding				E		E		
Species	Aquatic/marine flora				D		D		
	Fish				D		D	U	
	Other aquatic/marine fauna				D		D		
Habitats	Aquatic estuarine habitat				D		D	U	
	Marine habitat				D		D		
	Aquatic estuarine communities				D		D	U	
	Marine communities				D		D		
Social/Economic	Employment				U		U	E	

D: Adverse Impact, U: Uncertain, E: Enhance

Project Activities

1: Breakwaters and Jetties
2: Training Walls
3: Groins
4: Dredging
5: Reservoir
6: Maintainance Dredging
7: Fishery Development
8: Recreation

Table 9.1-4 ENVIRONMENTAL IMPACT MATRIX FOR TG. PIANDANG RIVER MOUTH

Environmental Components		Project Activities							
		1	2	3	4	5	6	7	8
Land	Landform				D		D		
	Flood plains/Swamps				U		U		
	Land use							U	
	Buffer zone				U		U		
Surface water	Shoreline				D		D		
	Bottom interface				D		D		
	Flow variation				U		U		
	Water quality				D		D	U	
	Drainage pattern				U		U		
	Flooding				U		U		
Species	Aquatic/marine flora				D		D		
	Fish				D		D	U	
	Other aquatic/marine fauna				D		D		
Habitats	Aquatic estuarine habitat				D		D	U	
	Marine habitat				D		D		
	Aquatic estuarine communities				D		D	U	
	Marine communities				D		D		
Social/Economic	Employment				U		U	E	

D: Adverse Impact, U: Uncertain, E: Enhance

Project Activities

1: Breakwaters and Jetties
2: Training Walls
3: Groins
4: Dredging
5: Reservoir
6: Maintainance Dredging
7: Fishery Development
8: Recreation

Table 9.1-5 ENVIRONMENTAL IMPACT MATRIX FOR BERUAS RIVER MOUTH

Environmental Components		Project Activities							
		1	2	3	4	5	6	7	8
Land	Landform				D		D		
	Flood plains/Swamps				U		U		
	Land use							U	
	Buffer zone				U		U		
Surface water	Shoreline				D		D		
	Bottom interface				D		D		
	Flow variation				U		U		
	Water quality				D		D	U	
	Drainage pattern				U		U		
	Flooding				E		E		
Species	Aquatic/marine flora				D		D		
	Fish				D		D	U	
	Other aquatic/marine fauna				D		D		
Habitats	Aquatic estuarine habitat				D		D	U	
	Marine habitat				D		D		
	Aquatic estuarine communities				D		D	U	
	Marine communities				D		D		
Social/Economic	Employment				U		U	E	

D: Adverse Impact, U: Uncertain, E: Enhance

Project Activities

1: Breakwaters and Jetties
2: Training Walls
3: Groins
4: Dredging
5: Reservoir
6: Maintainance Dredging
7: Fishery Development
8: Recreation

Table 9.1-6 ENVIRONMENTAL IMPACT MATRIX FOR KUANTAN RIVER MOUTH

Environmental Components		Project Activities							
		1	2	3	4	5	6	7	8
Land	Landform				D		D		
	Flood plains/Swamps				U		U		
	Land use							U	
	Buffer zone				U		U		
Surface water	Shoreline				D		D		
	Bottom interface				D		D		
	Flow variation				U		U		
	Water quality				D		D	U	
	Drainage pattern				U		U		
	Flooding				U		U		
Species	Aquatic/marine flora				D		D		
	Fish				D		D	U	
	Other aquatic/marine fauna				D		D		
Habitats	Aquatic estuarine habitat				D		D	U	
	Marine habitat				D		D		
	Aquatic estuarine communities				D		D	U	
	Marine communities				D		D		
Social/Economic	Employment				U		U	E	

D: Adverse Impact, U: Uncertain, E: Enhance

Project Activities

1: Breakwaters and Jetties
2: Training Walls
3: Groins
4: Dredging
5: Reservoir
6: Maintainance Dredging
7: Fishery Development
8: Recreation

Table 9.1-7 ENVIRONMENTAL IMPACT MATRIX FOR KERTEH RIVER MOUTH

Environmental Components		Project Activities							
		1	2	3	4	5	6	7	8
Land	Landform	U			D	D			
	Flood plains/Swamps				U				
	Land use					U		U	
	Buffer zone	U			U	U			
Surface water	Shoreline	D			D	U			
	Bottom interface	U			D	U			
	Flow variation	D			U	U			
	Water quality	U			D	U		U	
	Drainage pattern	U			U	U			
	Flooding	E			U	U			
Species	Aquatic/marine flora	U			D	U			
	Fish	U			D	U		U	
	Other aquatic/marine fauna	U			D	U			
Habitats	Aquatic estuarine habitat				D	D		U	
	Marine habitat				D	U			
	Aquatic estuarine communities				D	D		U	
	Marine communities				D	U			
Aesthetic Landscape		U				U			
Social/Economic	Employment				U			E	

D: Adverse Impact, U: Uncertain, E: Enhance

Project Activities

1: Breakwaters and Jetties
2: Training Walls
3: Groins
4: Dredging
5: Reservoir
6: Maintainance Dredging
7: Fishery Development
8: Recreation

Table 9.1-8 ENVIRONMENTAL IMPACT MATRIX FOR MARANG RIVER MOUTH

Environmental Components		Project Activities							
		1	2	3	4	5	6	7	8
Land	Landform	U			D	D			
	Flood plains/Swamps		U	U	U				
	Land use					U		U	U
	Buffer zone	U	U	U	U	U			U
Surface water	Shoreline	D			D	U			
	Bottom interface	U	U	U	D	U			
	Flow variation	D	D	D	U	U			
	Water quality	U	U	U	D	U		U	U
	Drainage pattern	U	U	U	U	U			
	Flooding	E	E	U	U	U			
Species	Aquatic/marine flora	U	U	U	D	U			
	Fish	U	U	U	D	U		U	U
	Other aquatic/marine fauna	U	U	U	D	U			
Habitats	Aquatic estuarine habitat	U	D	D	D	D		U	
	Marine habitat		U		D	U			
	Aquatic estuarine communities		U	U	D	D		U	
	Marine communities	U	U		D	U			
Aesthetic Landscape		U	U	U		U			U
Social/Economic	Employment				U			E	E

D: Adverse Impact, U: Uncertain, E: Enhance

Project Activities

1: Breakwaters and Jetties
2: Training Walls
3: Groins
4: Dredging
5: Reservoir
6: Maintainance Dredging
7: Fishery Development
8: Recreation

Table 9.1-9 ENVIRONMENTAL IMPACT MATRIX FOR TERENGGANU RIVER MOUTH

Environmental Components		Project Activities							
		1	2	3	4	5	6	7	8
Land	Landform	U			D		D		
	Flood plains/Swamps			U	U		U		
	Land use							U	U
	Buffer zone	U		U	U		U		U
Surface water	Shoreline	D			D		D		
	Bottom interface	U		U	D		D		
	Flow variation	D		D	U		U		
	Water quality	U		U	D		D	U	U
	Drainage pattern	U		U	U		U		
	Flooding	E		U	U		U		
Species	Aquatic/marine flora	U		U	D		D		
	Fish	U		U	D		D	U	U
	Other aquatic/marine fauna	U		U	D		D		
Habitats	Aquatic estuarine habitat	U		D	D		D	U	
	Marine habitat				D		D		
	Aquatic estuarine communities			U	D		D	U	
	Marine communities	U			D		D		
Aesthetic Landscape		U	U	U		U			U
Social/Economic Employment					U		U	E	E

D: Adverse Impact, U: Uncertain, E: Enhance

Project Activities

1: Breakwaters and Jetties
2: Training Walls
3: Groins
4: Dredging
5: Reservoir
6: Maintainance Dredging
7: Fishery Development
8: Recreation

Table 9.1-10 ENVIRONMENTAL IMPACT MATRIX FOR OYA RIVER MOUTH

Environmental Components		Project Activities							
		1	2	3	4	5	6	7	8
Land	Landform				D		D		
	Flood plains/Swamps		U		U		U		
	Land use							U	
	Buffer zone		U		U		U		
Surface water	Shoreline				D		D		
	Bottom interface		U		D		D		
	Flow variation		D		U		U		
	Water quality		U		D		D	U	
	Drainage pattern		U		U		U		
	Flooding		U		U		U		
Species	Aquatic/marine flora		U		D		D		
	Fish		U		D		D	U	
	Other aquatic/marine fauna		U		D		D		
Habitats	Aquatic estuarine habitat		D		D		D	U	
	Marine habitat				D		D		
	Aquatic estuarine communities		U		D		D	U	
	Marine communities				D		D		
Aesthetic Landscape			U						
Social/Economic Employment					U		U	E	

D: Adverse Impact, U: Uncertain, E: Enhance

Project Activities

1: Breakwaters and Jetties
2: Training Walls
3: Groins
4: Dredging
5: Reservoir
6: Maintainance Dredging
7: Fishery Development
8: Recreation

Table 9.1-11 ENVIRONMENTAL IMPACT MATRIX FOR PAPAR RIVER MOUTH

Environmental Components		Project Activities							
		1	2	3	4	5	6	7	8
Land	Landform	U			D	D			
	Flood plains/Swamps			U	U				
	Land use					U		U	
	Buffer zone	U		U	U	U			
Surface water	Shoreline	D			D	U			
	Bottom interface	U		U	D	U			
	Flow variation	D		D	U	U			
	Water quality	U		U	D	U		U	
	Drainage pattern	U		U	U	U			
	Flooding	E		U	U	U			
Species	Aquatic/marine flora	U		U	D	U			
	Fish	U		U	D	U		U	
	Other aquatic/marine fauna	U		U	D	U			
Habitats	Aquatic estuarine habitat	U		D	D	D		U	
	Marine habitat				D	U			
	Aquatic estuarine communities			U	D	D		U	
	Marine communities	U			D	U			
Aesthetic Landscape		U		U		U			
Social/Economic Employment					U			E	

D: Adverse Impact, U: Uncertain, E: Enhance

Project Activities

1: Breakwaters and Jetties
2: Training Walls
3: Groins
4: Dredging
5: Reservoir
6: Maintainance Dredging
7: Fishery Development
8: Recreation

Table 9.2-1 Description of Sampling Stations (Tg.Piandang)

Station Code	Type of Sample	Location
Ps	Water and Sediment	About 1/2 km off the river mouth near the lighthouse
P1	Water and Sediment	River mouth
P2	Water and Sediment	First fish landing site and jetty
P3	Water and Sediment	About 400 m upstream of P2
P4	Water and Sediment	About 1 km upstream of P3
P5	Water and Sediment	Near the pedestrian overhead bridge

Table 9.2-2 MEAN VALUE OF WATER QUALITY PARAMETERS FOR TG. PIANDANG RIVER

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 4- 3- 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 9.2-3 MEAN CONCENTRATION OF HEAVY METALS IN SURFACE SEDIMENTS OF TG. PIANDANG RIVER

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 9.2-4 COMPARISON OF MEAN HEAVY METAL CONCENTRATIONS (ug/g) IN SEDIMENTS OF VARIOUS RIVERS

River	Pb		Cu		Zn		Cd		Remark	Reference
	T*1	TNR*2	T	TNR	T	TNR	T	TNR		
Tg.Piandang	116	57	165	72	381	138	0.798	0.159		
Marang	44	3.5	7.2	0.89	209	4.2	0.096	0.033		
Pisuerga (Spain)	18.77	11.96	66.53	45.16	245	219	1.05	0.91		
Shatt (Al-Arab)	16.1	12.2	34	11.9	62.80	6	0.204	0.150		
Juru	34	25	44	24	145	100	-	-		

Note *1 : Total metal
*2 : Total non-residual metal

Table 9.2-5 Comparison of Environmental Features of Line and Dead Stands Mangrove

Parameters	Live Stands	Dead Stands
Seawater inflow	Not restricted but requires a tidal height of about 1.2 m before flooded.	Initially interrupted by the embank ment. Lader due to the collapse of the embankment seawater intrusion occured.
Salinity	Seawater salinity of about 27 - 30 ppt.	Salinity range greater due to freshwater inflow during the wet season and high evaporation during the dry season.
Exposure	The soil surface was not exposed to the heat and light due to the heavy plant canopy	The soil was exposed to the intense heat and sunlight due to the reduction of the plant canopy.
Drainage	There is generally a good drainage within these stands.	Poor drainage leaving waterlogged areas within the stands.
Organic content in soils	The amount of organic matter in the soils is relatively low	The organic matter content in the soil is high due to the rotting vegetation

Table 9.2-6 List of dominant crustaceans at Tg. Piandang

FAMILY	SPECIES
Ocypodidae	
	Uca annulipes
	Uca forcipata
Grapsidae	
	Sesarma versicolor
Portunidae	
	Scylla serrata
Carcinidae	
	Carcinus maenas
Penaeidae	
	Penaeus merguiensis
	Penaeus indicus
	Penaeus monodon
Alpheidae	
	Alpheopsis sp.

Table 9.2-7 List of dominant molluscs at Tg. Piandang

FAMILY	SPECIES
Potamidae	
	Telescopium telescopium
	Cerithidae obtusa
	Cerithidae singulata
Nerithidae	
	Nerita artioulata
	Nerita undata
Littorinidae	
	Littorina ventricosa
	Littorina melanostoma
	Littorina scabra
Olividae	
	Oliva sp.
Acmaeidae	
	Collisella striata
Ellobinae	
	Elloboium aurisjudae
Melongidae	
	Pogilina cochlidium

Table 9.2-8 Checklist of fish species at Sg. Tg. Piandang Estuary

Species	Tg. Piandang	Local name
Ambassidae		
Ambassis daiy Bleeker	x	seriding
Ariidae		
Arius caelutus Valenciennes		duri
A. sagor (Hamilton-Buchanan)	x	duri sagur
A. venosus (Valenciennes)	x	duri ngong
Osteogoneisus militaris (L.)	x	tegak misai
Carangidae		
Selar mate (Cuvier)	x	selar gelek
Selar malam Bleeker	x	selar papan
Clupeidae		
Ilisha elongata (Bennet)	x	tamban keling
Cynoglossidae		
Cynoglossus brachycephalus	x	lidah
C. bilineatus	x	lidah
Engraulidae		
Setipinna taty (Valenciennes)	x	kasai janggut
Thryssa hamiltonii (Gray)	x	bakok daun
T. kammalensis (Bleekker)	x	jemedi
Coilia sp.	x	kasai bulu ayam
Stolephorus sp.	x	bilis
Harpadontidae		
Harpadon nehereus (Hamilton-Buchanan)	x	lumi-lumi
Latidae		
Lates calcarifer (Bloch)	x	siakap
Leiognathidae		
Secutor insidiator (Bloch)	x	kekek jalur
Megalopidae		
Megalops cyprinoides (Broussart)	x	bulan
Mugilidae		
Liza subviridis (Valenciennes)	x	belanak anding
Valamugil cunnesius (Valenciennes)	x	kedera
Mullidae		
Upeneus sulphureus Cuvier	x	biji nangka
Orectolobidae		
Chiloscyllium indicum (Gmelin)	x	yu bodoh
Plotosidae		
Plotosus anguillaris (Bloch)	x	sembilang
Scatophagidae		
Scatophagus argus (L.)	x	ketang
Sciaenidae		
Bahaba taipingensis (Herre)	x	gelama pisang
Johnius coitor (Hamilton-Buchanan)	x	gelama papan
Otolithus ruber (Schneider)	x	tengkerong
Soleidae		
B.commersoni (Swainson)	x	lidah
Stromateidae		
Pampus argenteus (Euphrasen)	x	bawal putih
Theraponidae		
Therapon jarbua (Forskal)	x	kerong-kerong
Trichiuridae		
Trichiurus haumela (Forskal)	x	timah
Trypauchenidae		
Trypauchen vagina (Bloch & Schneider)	x	belachak arus

x - indicates presence

Table 9.2-9 Mean percentage of catch of various fish species from Sg. Tg. Piandang estuary

Species	Numbers (%)	Mean weight (%)	Mean weight (g)	Weight Min.	Weight Max.
Arridas (catfish)					
Arius sagor (E,S)	2.3	12.9	176.7	8.3	720
A. venosus	0.8	9.4	129.8	19.1	215
Osteogoneisus militaris	0.4	16.6	228.5	215	342
Ambassidae					
Ambassis dayi (E,S)	1	0.3	3.8	3.3	
Soleidae (sole)					
Brachirus commersoni	0.8	1	14.2	8.3	27.6
Sciaenidae (jewfish)					
Bahaba taipingensis	0.6	0.5	6.4	4	8.7
Johnius coitor (E,S)	13.1	1.2	16.4	5	46.8
Otolithus ruber	0.4	3.9	53.4		
Orectolobidae (catshark)					
Chiloscyllim indicum	0.2	10.8	149		
Cyanoglossidae (tounge sole)					
Cyanoglossus lingua	1	1.4	18.9	7.6	56.9
Engraulidae (anchovy/anchovetta/herring)					
Coilia sp.	3.1	0.3	4.2	0.9	10.5
Setipinna taty (E,S)	5.6	0.7	10.1	2.4	130
Thryssa hamiltoni	2.5	0.4	5	2.6	6.8
T.kammalensis (E,S)	5.4	0.6	8.1	4.6	26.1
Stolephorus spp.	0.2	0.3	3.7		
Ilisha elongata	4.2	1.5	20.6	4.8	20.1
Harpadontidae (bombay duck)					
Harpadon neheus (E)	0.2	0.3	4.4		
Latidae (seabass)					
Lates calcarifer (H)	0.2	9.1	125		
Stomateidae (pomfret)					
Pampus argenteus	1	1.7	22.9	12.2	41.8
Leiognathidae (ponyfish)					
Secutor insidiator	0.4	0.2	2.9	1.4	4.3
Carangidae (jack/mackerel)					
Selar mate	0.2	1.1	15.4		
Scatophagidae					
Scatophagus arrgus (E,S)	1.2	3.7	50.9	39.2	69.1
Mugilidae (mullet)					
Liza subviridis (E)	49.3	2	27	10.3	64.1
Valamugil cunnesius (H,S)					
Megalopidae (tarpon)					
Megalops cyprinoides (H)	0.2	8.7	120		
Trichiuridae (ribbonfish)					
Trichiurus haumela	0.4	2.4	33.5	15.3	51.6
Theraponidae (tiger bass)					
Therapon jarbus (H,S)	0.6	1.3	17.3	10.6	21.7
Trypauchenidae					
Trypauchen vagina	0.2	5	68.3		
Mullidae (goatfish)					
Upeneus sulphureus	0.8	0.4	5.3	4	6.5

E,S,H - indicate species found in estuary, sea and/or shore whereas those without letters are caught from sea.

Table 9.2-10 Population distribution in Kerian District, Perak, 1992

Location	Size
1. Bagan Serai	33,035
2. Kuala Kurau	28,749 (19.4)
3. Parit Buntar	28,319
4. Gunung Seamanggol	14,475
5. Bagan Tiang	13,730
6. Tanjung Piandang	13,485 (9.1)
7. Alor Pongsu	8,864
8. Selinsing	7,921

Source : Police Department, Kerian District.

Table 9.2-11 Living Quarters, Households and Population by mukim in Kerian District, 1980 & 1991

Kerian District	1980			1991		
	Living quarters	House hold	Population	Living quarters	House hold	Population
Bagan Seral	7192	6841	36097	7915	6988	33035
Bagan Tiang	2703	2652	14803	2868	2655	13730
Beriah	2168	2012	9924	2196	1915	8864
Gunong Semanggol	3553	3256	16585	3602	2975	14472
Kuala Kurau	5781	5745	33260	6414	5735	28749
Parit Buntar	3952	3931	20452	7057	5916	28319
Selinsing	1700	1611	8259	1944	1688	7921
Tanjong Piandang	2771	2723	16216	2768	2627	13485
Wayfarers		1	169			
Total	29820	28772	155765	34764	30499	148575

Source : 1991 Census

Table 9.2-12 Growth of Towns

Town	1957	1970	1980	Annual Growth Rate (%) 1957-70	1070-80
Taiping	48199	54216			
Aulong	5499	8841			
Pokok Assam	8005	10658			
Kampung Pinang	2956	7089			
Taiping Municipality	64659	80804	149254	2.3	5.3
Bagan Serai	5390	8439	9402	4.6	1.1
Kuala Kurau	5283	8063	8599	4.3	0.7
Tanjung Piandang	3231	6572	4945	7.4	-2.8
Parit Buntar	4022	5776	6793	3.7	1.6
Simpang	3113	4035	-	2.6	-
Port Weld	2260	3281	-	3.8	-
Selama	3355	2640	2835	-	0.7
Matang	1779	2176	2124	2.0	-
Terong	1461	1843	1713	2.4	-0.7
Batu Kurau	1257	1510	1473	1.9	-0.3
Bagan Baharu	930	1260	1146	3.1	-0.9
Temerloh	-	917	1209	-	2.8
Total Urban	95810	126399	189493	2.2	4.1

Sources : 1957,1970 and 1980 Census

Table 9.2-13 Registered fishing boats at Tg. Piandang, 1993

Type	Numbers
1. Apollo" mini-trawlers (1-7 ton)	180
2. Purse seiners (10-24 ton)	5
3. Gill-netters (multiple use)	60
4. Gill-netters (trammel; 3-layered nets)	160
5. Gill-netters (Spanish mackerel)	14
6. Gill-netters (prawns)	19
7. Gill-netters (mullets)	2
8. Trap-netters (set nets)	13
Total	453

Note that each mini-trawler has another "brother" boat to operate the "Apollo" trawl net and that each purse-seiner also has another smaller "brother" boat. With another 185 unregistered" boats, the actual number of boats at Tanjung Piandang is 638.

Sourse : Fisheries Department, Krian District.

Table 9.2-14 Species composition of daily catch from five "Apollo" mini-trawlers at Tg. Piandang on 23rd September 1993

	Catch(kg)				
Boat	1	2	3	4	5
Species					
Crabs					
Crarybdis cruciata			2.0	1.5	
Prawns					
Metapenaeus brevicornis		3.5			
Metapenaeus lysianassa	87.0	120.0	150.0	130.0	75.0
Parapeneopsis hungerfordi	30.0		30.0	18.0	
Metapenaeus ensis	16.0	3.0	40.5	27.0	10.0
Parapeneopsis sculptilis	2.0	2.0			1.0
Penaeus merguiensis	2.5	0.5	0.5	1.0	1.5
Squid/Cuttlefish		1.5	3.0		2.0
Sepia esculeata					
Trash fish	15.0				

Table 9.2-15 Species composition of daily catch of two gill-netters (pomfret) at Tg. Piandang on 8th August 1993

	Catch (kg)	
Boat	1	2
Fish species		
Pampus chinensis	8.5	2.8
Pampus argenteus	1.0	
Arius caelatus	3.0	
Polynemus spp.	2.7	7.9
Plotosus canius	1.4	
Mixed species	3.4	

Source : Fisheries Department, Kerian District

Table 9.2-16 Species composition of daily catch of five gill-netters (spanish mackerel) at Tg. Piandang on 25th August 1993

	Catch(kg)				
Boat	1	2	3	4	5
Fish species					
Scomberomorus commersoni	147.0	46.0	74.0	40.0	35.0
Scomberomorus guttatus	1.0				
Aurius caelatus	19.0	11.0			
Pampus argenteus	1.0		1.0		
Parastomateus niger			1.0	2.0	
Polynemuws spp.	3.0				1.0
Sphyraena spp.	15.0	5.0	7.5	22.0	3.0
Chirocentrus dorab	2.0		3.0	1.0	3.0
Sharks		4.5			3.5

Table 9.2-17 Species composition of daily catch of five gill-netters (tremmel, 3-layered nets) at Tg. Piandang on 25th August 1993

	Catch(kg)				
Boat	1	2	3	4	5
Species					
Prawns					
Penaeus merguiensis	25.0	19.0	14.0	23.0	10.0
Metapenaeus ensis	2.5	2.0	4.0	19.0	1.0
Parapeneopsis sculptilis				1.0	1.5
Squid/Cuttlefish					
Sepia spp.	2.0				
Fish					
Plotosus canius	2.0				
Jewfish (Sciaenidae)			3.0		0.5
Arius spp.					1.5
Trash fish					9.0

Source : Fisheris Department, Kerian District.

Table 9.2-18 Estimated percentage of total district landings of some marine products at different fishing villages in Kerian District, Perak

	Prawn	Fish	Cockle	Crab (mangrove)
Location				
Tanjung Piandung	70	80	-	-
Kuala Kurau	30	20	15	10
Bagan Tiang	-	-	15	-
Kuala Gula	-	-	70	30
Selinsing	-	-	-	60

Source : Fisheries Department, Kerian District.

Table 9.2-19 List of fish farmers in Tg. Piandang and their respective areas of floating cage fish cultures in waters off Bagan Tiang

Name of operator	Culture area (sq. metre)
Kau Kin Seng	874
Khor Lye Hock	2,852
Lim Kwee Huat	3,964
Eng Hai Seng	4,232
Oh Yong Teik	3,404
Kuah Choo Huat	874
Tan Siew Boy	2,159
Teoh Toh Beng	3,595

Source : Fisheries Department, Kerian District.

Table 9.2-20 Estimated value of fish landings in different towns in Kerian District

	Fisheries Value (RM) Million
Kerian District	90.58
Tanjung Piandang	36.14
Kuala Kurau	34.6
Kuala Gula	12.59
Bagan Tiang	4.71
Selinsing	2.45
Kalumpang	0.09

Table 9.2-21 U.S. EPA Criteria for Acceptability of Dredged Spoil for Open Water Disposal

Parameters	Concentration % (dry wt. basis)
Volatile solids	6.0
Chemical oxygen demand	5.0
Total Kjeldahl nitrogen	0.10
Oil and grease	0.15
Mercury	0.001 (10 ppm)
Lead	0.005 (50 ppm)
Zinc	0.005 (50 ppm)

Table 9.2-22 Summary of Potential Impacts and Mitigation Measures

Activity	Environmental Components	Potential Impacts	Mitigation Measures	Location and of Impact
TANJUNG PIANDANG				
Construction Stage				
Capital dredging	(a) Physico-chemical	(i) Increased turbidity (ii) Increase in organic matter resulting in depleting of dissolved oxygen (iii) Possible remobilization of heavy metals	(i) Proper scheduling of dredging activities -the high waves during the south west monsoon from April to July	(i) short term (ii) Localized along the dredged channel
	(b) Biological	(i) Smothering of macrobenthic organisms due to increased sediment load (ii) Loss of habitat for benthic organisms (iii) Growth and survival of some macro-benthic organisms may be affected by remobilized heavy metals	(i) As above	(i) Short term (ii) Localized along the dredged channel
	(c) Socio-economic	(i) Minor disruption of fishing boat traffic	(i) Proper scheduling of dredging activities to avoid disruption of fishing boat traffic	(i) Short term

Table 9.2-23 Description of Sampling Stations (Marang)

Station Code	Type of Sample	Location
Ms	Water and Sediment	About 1/2 km off the river mouth
M1	Water and Sediment	River mouth
M2	Water and Sediment	Off the mouth of lagoon
M3	Water and Sediment	Marang Bridge
M4	Water and Sediment	About 800 m upstream of M3
M5	Water and Sediment	Bridge across Kerak River along Jalan Marng-Wakaf Tapai
M6	Water and Sediment	Bridge near Kg. Pengkalan Berangan
M7	Water and Sediment	Bridge near Kg. Temala Tanjung
M8	Sediment	Along the road to Kg. Bukit Perpat

Table 9.2-24 MEAN VALUE OF WATER QUALITY PARAMETERS FOR MARANG RIVER

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- (mg/l)	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 9.2-25 MEAN VALUES OF WATER QUALITY PARAMETER MONITORED AT STATION KUALA SG. MARANG

Parameters	Unit	Year			
		1989	1990	1991	1992
Color	Hazen	8	13	26	16
Turvidity	NTU	34	7	51	5
Ammonical Nitrogen	mg/l	0.24	0.16	0.20	0.37
Nitrate Nitrogen	mg/l	0.59	0.46	0.86	0.42
Total Nitrogen	mg/l	4.43	5.62	3.50	1.99
Phosphate	mg/l	trace	0.02	0.47	0.02
Suspended Solids	mg/l	486	547	452	372
Oil and Grease	mg/l	1.76	1.35	1.82	4.64
Temperature	C. degree	28.20	27.50	26.20	26.00
Dissolved Oxygen	mg/l	5.17	4.58	5.43	6.70
Salinity	ppt	17.90	13.60	24.80	28.60
ph		7.62	7.25	7.78	7.86
Conductivity	us/cm	31,729	22,666	39,616	43,900
E. Coli	MPN/100ml	-	-	-	7,300
Coliform	MPN/100ml	-	-	-	13,000

N.D. Not detected.

Table 9.2-26 MEAN VALUE OF WATER QUALITY PARAMETERS AT WQMS OF MARANG RIVER (1992 DATA)

Parameters	Unit	WQMS			
		513610	5131604	5130608	5130609
Color	Hazen	43	45	139	156
Ammonical Nitrogen	mg/l	0.26	0.27	0.15	0.21
DO	mg/l	6.15	5.96	7.25	5.85
BOD5	mg/l	2.5	0.8	0.8	0.7
COD	mg/l	820.00	827.00	50.00	46.00
Suspended Solids	mg/l	242	211	64	38
Oil and Grease	mg/l	2.85	-	-	-
Temperature	C. degree	27.25	27.25	26.75	25.50
Salinity	ppt	17.90	15.80	0.00	0.00
ph		6.93	6.80	6.50	6.81
Conductivity	us/cm	25,225	22,275	59	29
E. Coli	MPN/100ml	12,000	-	-	-
Coliform	MPN/100ml	15,000	-	-	-

N.D. Not detected.

Table 9.2-27 MEAN CONCENTRATION OF HEAVY METALS IN SURFACE SEDIMENTS OF MARANG RIVER

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 9.2-28 Dominant molluscs found within riparian zones of Sungai Marang

MOLLUSCA	
	BIVALVIA
	Enigmonia aenigmatica
	GASTROPODA
	Nerita artioulata
	Littorina carinifeca Merke
	L. scabra Linne
	Cerithidea cingulata Gmelin
	C. quadrata Sowerby
	Telescopium telescopium Linne
	T. mauritsi Butot
	Cassidula aurisfelis Brug.
	C.musteline Deshayes

Table 9.2-29 Dominant crustaceans found within riparian zones of Sungai Marang

CRUSTACEA	
	Brachyura
	Scylla serrata Forskal
	Uca annulipes
	U.forcipata
	chiromanthes (S) onychophorum
	Balanus amphiprite
	ANOMURA
	Thalassina anomala Herbst.

Table 9.2-30 Dominant molluscs found in coastal areas of Marang.

MOLLUSCA
BIVALVIA
Donax fada
Donax dysono
Malleus irregularis
Solen sp.
Polinices sp.
GASTROPODA
Brachytoma vexillum
Crepidula walshi
Mactra mera
Natica maculosa
Polinices pyriformis
Strombis vitatus
Thai tissoti
Turritella sp.

Table 9.2-31 Dominant crustaceans found in coastal areas of Marang.

CRUSTACEA
Portunis pelagicus
Macropthalmus malaccensis
Penaeus monodon
Penaeus indicus
Penaeus merguiensis
Panulirus versicolor

Table 9.2-32 Ppopulation of different villages in Marang esturay, Terengganu

Location	Population
1. Marang/Kampung Seberang Marang	4,738
2. Kampung Pengkalan Star Kiri	+
3. Kampung Tengah	+
4. Kampung Batangan	866
5. Kampung Pengkalan Kuin	129
6. Kampung Gong Nangka	215
Total	5,948

Source : District office, Marang.

Table 9.2-33 Size of fishing boats in Marang estuary, 1992

Size(m)	Marang district	Marang estuary
Up to 7.99	20	12
8.00 - 11.99	147	114
12.00 - 14.99	60	55
15.00 - 19.99	10	5
Above 20.00	7	-
Total	244	186

Source : Fisheries Department, Marang District.

Table 9.2-34 Fishing gears employed by boats in Marang estuary

Fishing gear		
Hook and line	100	79
Gill-net	85	69
Purse-seine	30	15
Trap	3	2
Seine	1	-
Lift net	4	4
Set net	3	3
Trawl net	2	1
Support boats	16	13
Total	244	186

Note that purse-seiners and lift-netters require support boats during fishing maneuvers.

Table 9.2-35 Monthly fish landings at LKIM fish complex, Marang, 1992

Month	Weight (ton)	Value (RM)
January	34.66	101,453.20
February	28.57	84,296.90
March	43.40	122,703.90
April	46.48	92,417.80
May	62.87	97,236.75
June	27.18	49,606.30
July	31.06	49,265.35
August	87.61	129,530.64
September	94.48	135,779.00
October	24.00	33,932.45
November	11.55	16,379.75
December	28.84	52,326.00
Total	520.70	964,928.04

Source : LKIM, Marang.

Table 9.2-36 Species of fish landed at LKIM fish complex, Marang

Common name(Malay)	Species
Kembong	Rastrelliger kanagurta
Pelaling	Rastrelliger brachysoma
Lolong	Selar boops
Selar kuning	Selaroides leptolepis
Selar	Selar mate
Aya hitam	Thunnus tonggol
Aya kurik	Euthynnus affinis
Cupak	Caranx sexfasciatus
Betong	Selar malam
Cincaru	Megalaspis cordyla
Suji	Decapterus russelli
Tenggiri batang	Makaira indica
Tenggiri papan	Scomberomorus commersoni
Gerung belang	Scomberomorus guttatus
Kapur	Caranx speciosus
Ebek	Alepes kalla
Demudok	Alectis indicus
Tamban sisik	Carangoides fluvuguttatus
Kekek	Sardinella fimbriata
Alu-alu	Leiognathus spp.
Dengkis	Sphyraena jello
Della	Siganus spp.
Pisang-pisang	Caesio spp.
Parang	Elagatis bipinnulatus
Layur	Chirocentrus dorab
Remong	Trichiurus spp.
Kekunyit	Lutjanus lineolatus
	Lutjanus spp.

Table 9.2-37 Monthly landings of squid at LKIM fish complex, 1992

Species	Catch (kg) Loligo	Sepioteuthetis
Month		
January	70	-
February	320	-
March	1,510	-
April	6,710	-
May	4,800	-
June	300	-
July	1,200	-
August	1,700	780
September	1,240	2,250
October	210	1,200
November	-	-
December	-	-
Total	18,060	4,230

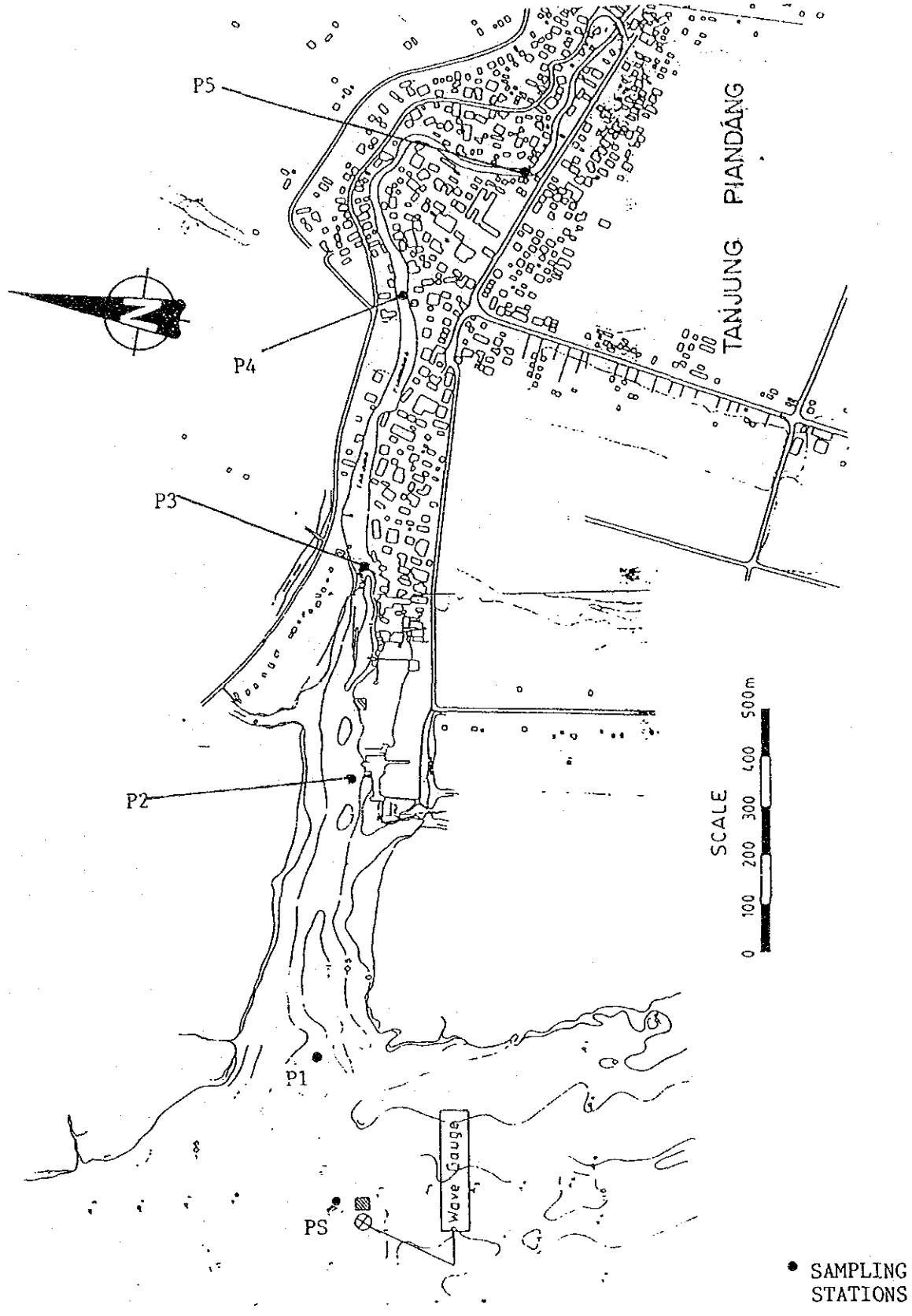
Source : LKIM, Marang.

Table 9.2-38 Available accomodation in Marang

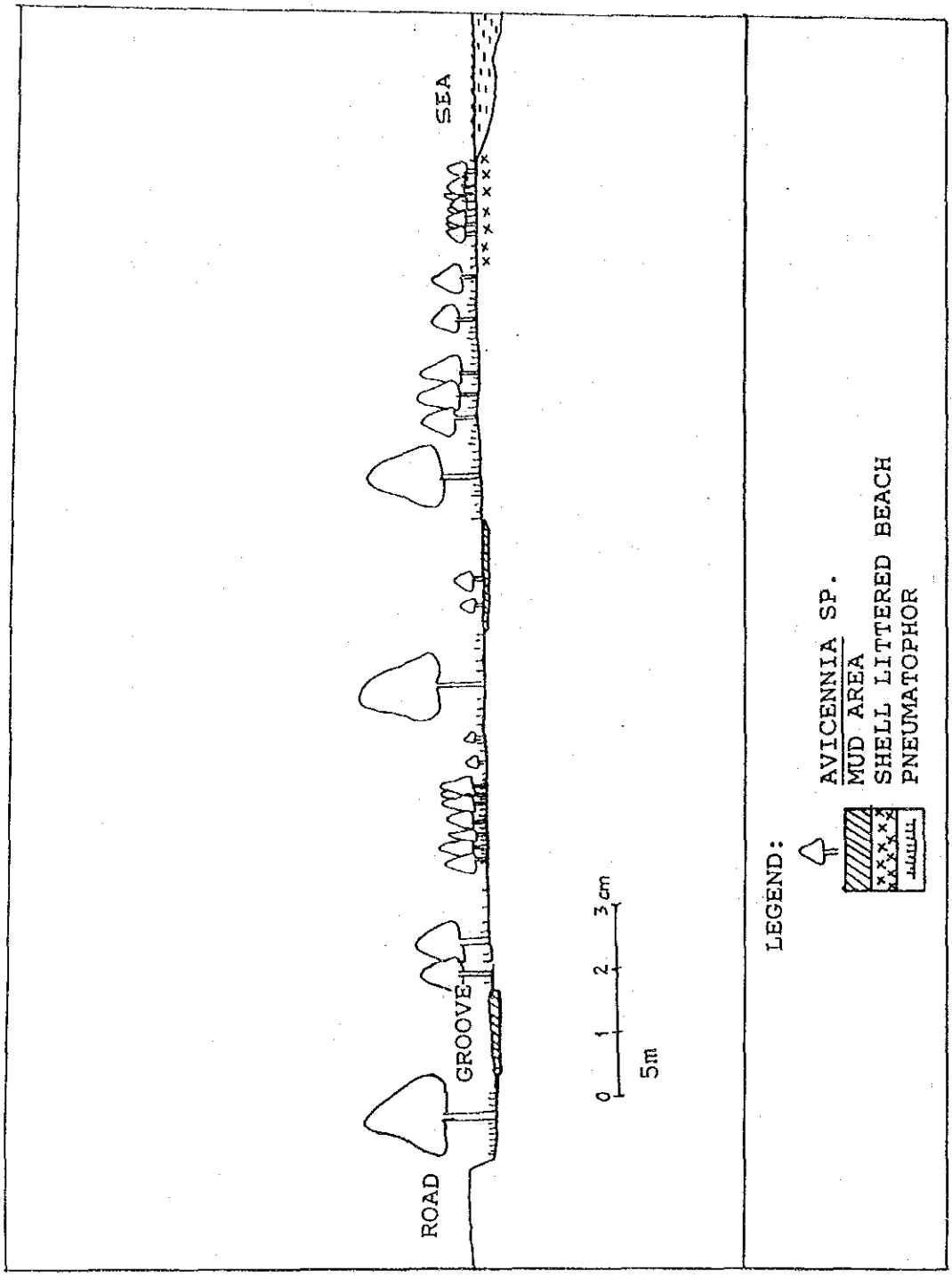
Accomodation	Room	Chalets
1. Marang Resort and Safaris Pulau Kerengga		100*
2. Lisa Inn, Pulau Kerengga	20	
3. Semarak Rest House Pantai Kelulut	20	
4. Ru Muda Beach Resort Seberang Marang		12
5. Angulia Beach Resort Seberang Marang	7	25
6. Kamal Guest House, Marang	9	3
7. Mere Nostrum Beach Resort Seberang Marang	19	7
8. Island View Resort, Marang		8
9. Marang Guesthouse & Restaurant	16	
10.Market Hotel, Marang	30**	
11.Zaki Beach Chalet Kapas Island		12
12.Pulau Kapas Resort Kapas Island		10
13.Primula Beach Resort Kapas Island		20

Source : District Office, Marang. * Partially completed and in operation (30chalets), fully completed in 1994;
** Completed but yet to be operated as at September, 1993.

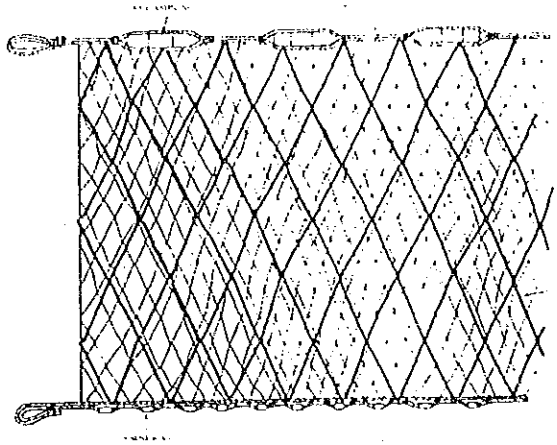
FIGURES

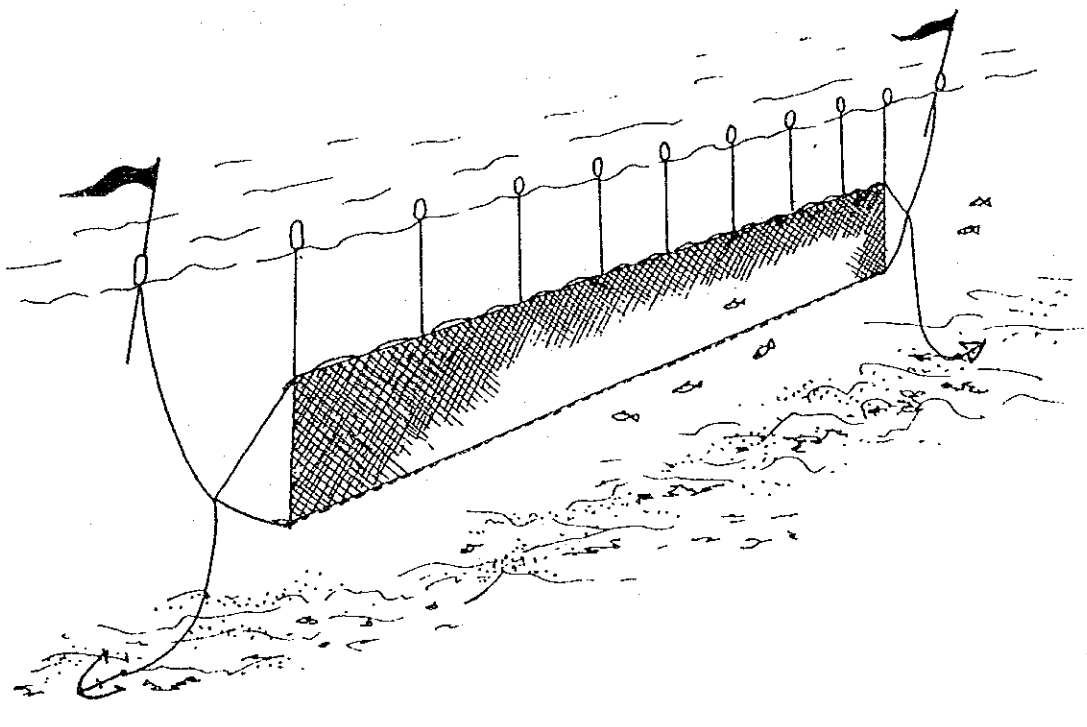


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	SAMPLING STATIONS FOR TG. PIANDANG RIVER
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 9.2-1

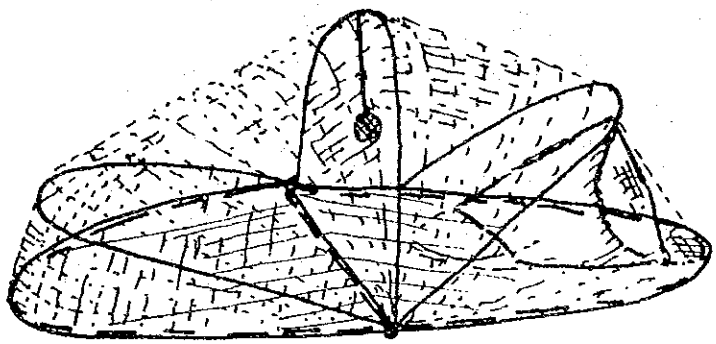


THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	TYPICAL CROSS SECTIONS OF COASTAL AREA AT TG. PIANDANG
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 9.2-2

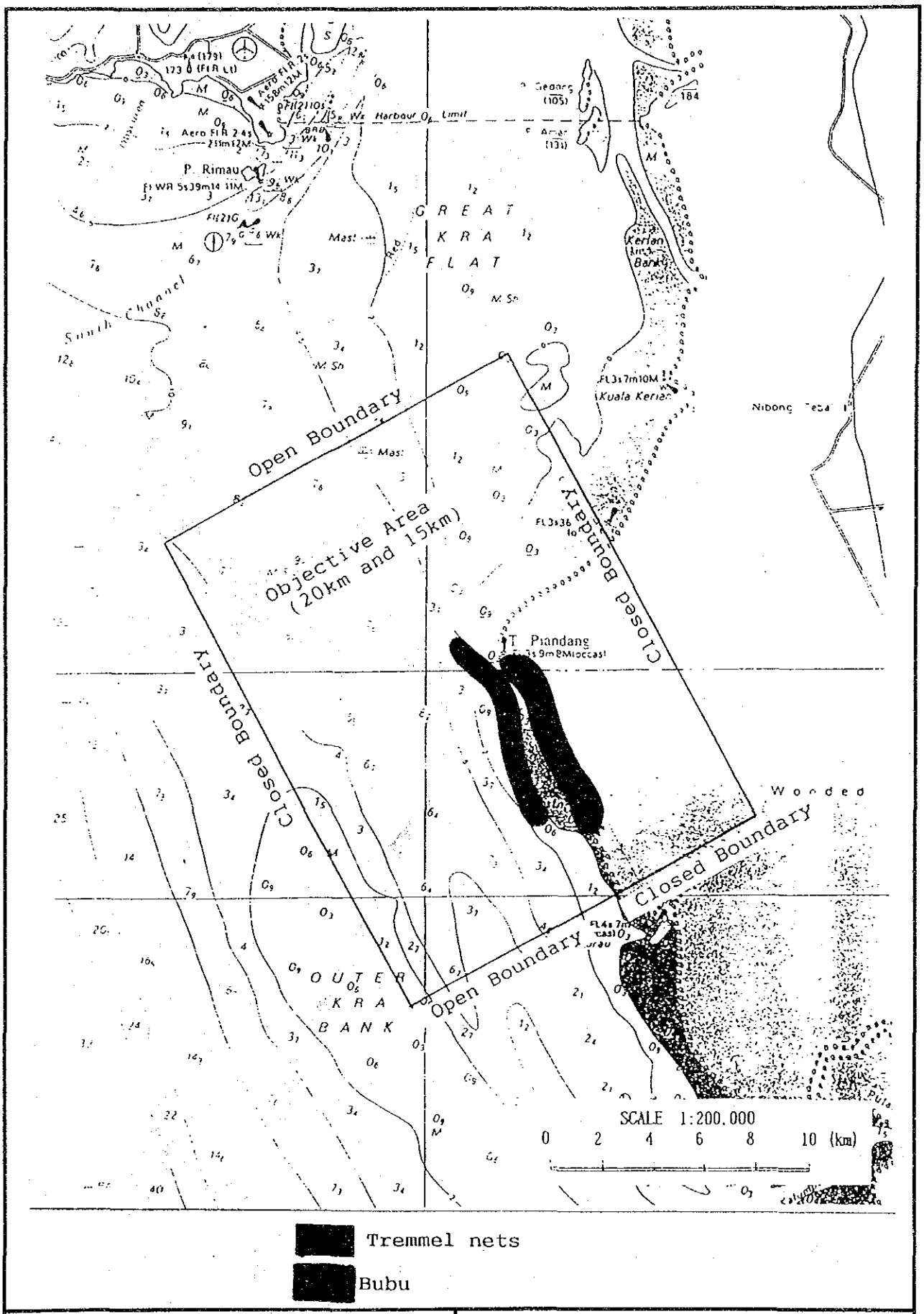




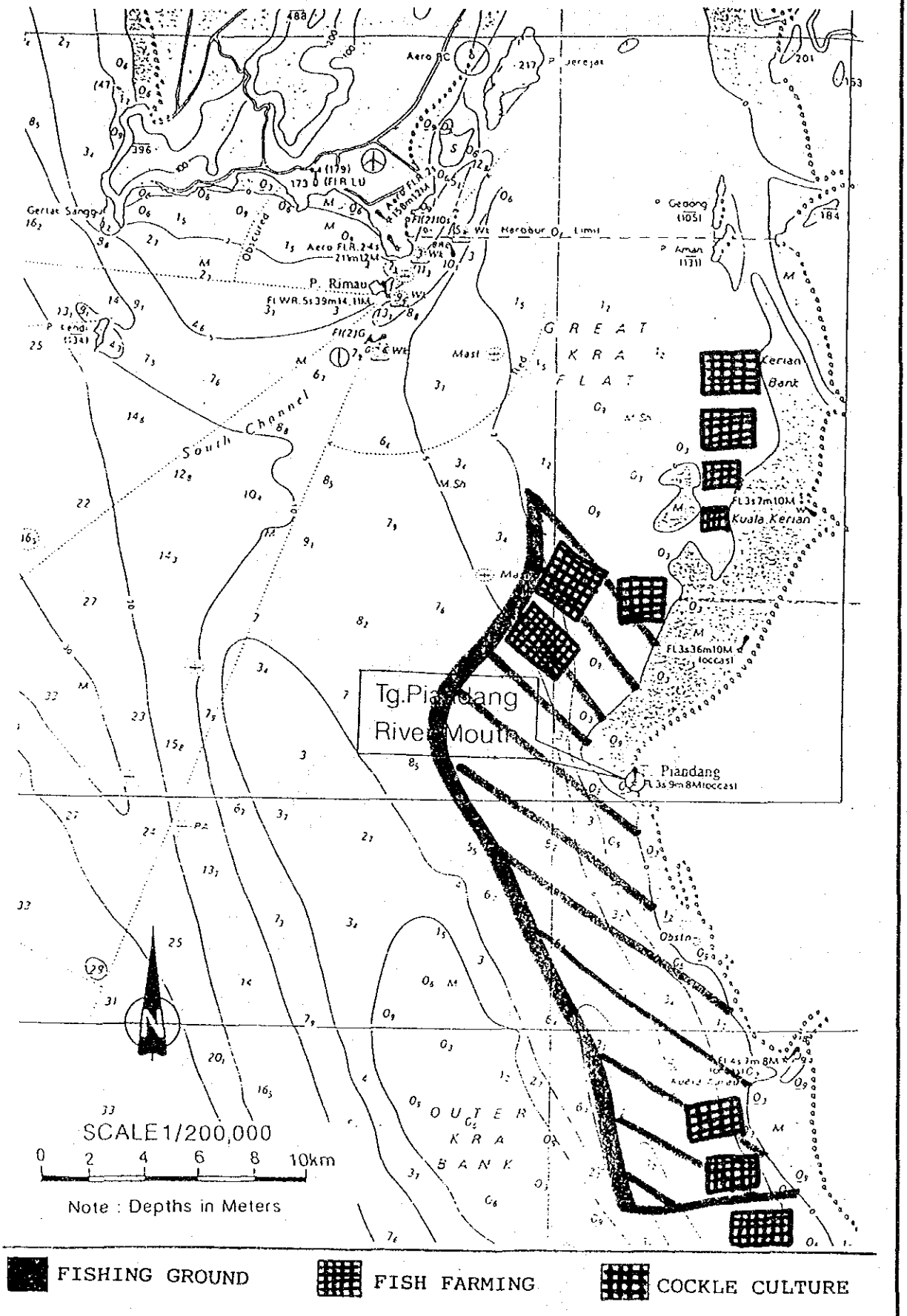
THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	TREMMEL NETS
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 9.2-3



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	COLLAPSIBLE CRAB TRAPS (BUBU)
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 9.2-4



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	INVERTEBRATE SAMPLING STATIONS AT TG. PIANDANG
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 9.2-5



THE NATIONAL RIVER MOUTHS STUDY IN MALAYSIA	MAJOR FISHING ACTIVITY SITES AT TG. PIANDANG
JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 9.2-6