5.2.2 Extent of Water Source Reserve Area

The proposed water source reserve area shall cover the catchment area of the existing Muda Dam, the proposed Beris Dam, and the Jeniang Barrage. The present major forest reserve area located in the upper reaches is also added to the water reserve area. Hence, the water source reserve area comes to about 2,529 km^2 or 60.1% of the entire Muda river basin. The water source reserve area is further divided into the present forest reserve area of 2,211 km^2 and agricultural area of 318 km^2 corresponding to about 52.5% and 7.6% of the basin total, respectively.

5.2.3 Required Activities for Water Source Reserve Area

The water source reserve area overlaps with the forest reserve area and the agricultural land. The State Authority appointed the Department of Forest as a legal controller for the forest reserve area and the Department of Land and Mining for the agricultural land. The overlapping area is rather extensive, and it is deemed difficult to transfer such present jurisdiction to the proposed river management body.

Due to the situation, it is proposed that the river management body will not directly control the reserve area. Instead, the body will monitor the logging and/or agricultural activities and will provide the technical reference related to the river conditions to the present legal controllers and/or the State Authority.

The water resource reserve area proposed above is further divided into the following six (6) sub-zones, to clarify more definitive monitoring and management objectives for each sub-zone (refer to Table 6.2.1 and Fig. 6.2.1).

(1) Zone 1

Zone 1 is proposed to cover the present forest reserve area of 240 km^2 surrounding the existing Muda Dam and the proposed Beris Dam. The zone is to be used as a buffer between the dam reserve area and its adjacent land. The area for Muda Dam is called "the catchment area" of 155 km^2 by the Department of Forest, where excessive logging activities are controlled to avoid aggravation of the dam environment. As for the area of Beris Dam, the whole present forest reserve area of 85 km^2 in the dam catchment area is included in Zone 1.

A research on the effect of logging activities on the basin runoff conditions was started in 1994 in the present forest reserve area of about 830 ha located in the upper reaches of Ketil River. The research is jointly undertaken by the Department of Forest, the Forest Research Institute, DID and the University of Pertanian Malaysia. Zone 1 will directly influence the morphology of the dam reservoir, and legal arrangement is proposed to be obtained to freeze all logging activities in Zone 1 for the time being until the effects of logging activities to the dam reservoir are clarified through the ongoing joint research.

(2) Zone 2

Zone 2 is proposed to cover the present forest reserve area of 829 km^2 located in the catchment area of Muda Dam. The river management body will monitor the logging activities as well as the basin runoff discharge and sediment yield, and

provide the technical reference about ongoing logging activities to the Department of Forest when the conditions of basin runoff and sediment yield are judged to be seriously affected by the logging activities.

(3) Zone 3

Zone 3 is proposed to cover the agricultural land located in the catchment area of the proposed Beris Dam and the Reman Dam. The size of Zone 2 is 63 km^2 which is divided into 31 km^2 for Beris Dam and 32 km^2 for Reman Dam. The river management body will monitor all of the agricultural activities and alienation or temporary occupation of the land. At the same time, the body will monitor the basin runoff discharge, pollution load and sediment load to the dam reservoir. Based on the monitoring results, the river management body will provide the technical reference pertaining to the land activities to the Department of Land and Mining Office when the river environment are judged to be seriously affected by them.

(4) Zone 4

Zone 4 is proposed to cover the present forest reserve area of 1,142 km^2 located in non-catchment area of the existing and proposed dams. The river management body will monitor the logging activities and relate them with the natural river conditions (river hydrology, biography, morphology and water quality). Based on the monitoring results, the river management body will provide the technical reference as in Zone 2.

(5) Zone 5

Zone 5 is proposed to cover the agricultural land of 89 km^2 located in the catchment area of the proposed Jeniang Barrage but out of the dam catchment area in the upper reaches.

Muda Dam is located about 40 km upstream of Jeniang barrage, impounding all basin runoff discharge and conveying it to Pedu Dam. As the results, the river maintenance flow could be released solely by the proposed Beris Dam, and no river maintenance flow is guaranteed for the river stretch between the Muda dam site and the confluence with Beris River.

Due to this, the river water quality could be possibly aggravated, should excessive basin development be induced along the river stretch. To prevent such aggravation, monitoring and management of basin development in this zone is indispensable.

The river management body will take the same basin monitoring objectives as those for Zone 4 and relate them with the natural river conditions (river hydrology, biography, morphology and water quality). Based on the monitoring results, the river management body will provide the necessary technical reference to the Department of Land and Mining.

5.3 River Reserve Area

5.3.1 Purpose of River Reserve Area

The various land development activities such as urban, industrial and agricultural development is now expanding to the riverside area. In parallel with such land development, land acquisition for the river improvement works tends to be difficult. At the same time, the flood damage potential is going to increase, and the river morphology as well as the river environment are seriously affected by the land development activities. In due consideration of these conditions, the major purposes for the river reserve area are placed on the following items.

(a) To facilitate river improvement works;

(b) To preserve the natural flood retarding effects and protect the river from the undesirable activities; and

(d) To minimize the damage caused by flood inundation and channel erosion and/or meandering.

5.3.2 Extent of River Reserve Area

The river reserve area is limited to the possible flood inundation area extending in the lower and middle reaches of the river basin. Details of the extent have been determined through the study on the flood mitigation plan in SECTOR II. Moreover, the detailed zoning plan within the limits of the river reserve area is proposed as a part of the river environmental management plan, as described in SECTOR IV.

5.3.3 Required Activities for River Reserve Area

The river reserve area is significant in particular for control of the present excessive sand mining activities on Muda River, and it is deemed necessary that the river management body will take jurisdiction over the reserve area. From these viewpoints, Section 62 of the Malaysian National Land Code should be applied to the river reserve area. That is, the gazette of river reserve area is proposed to be reserved for public purpose, and the river management body is appointed as a controller for the reserve area.

6. PROPOSED RIVER BASIN MANAGEMENT AND MONITORING SYSTEM

6.1 Overall River Basin Management and Monitoring System

In the proposed system, the river management body will integrate the various monitoring items related both to the river conditions and the land development activities in the water source reserve area and the river reserve area (refer to Table V.6.1.1). Based on the integrated monitoring data, the river management body will execute the short-term actions for flood mitigation works, water allocation, and

river environmental improvement works. The body will also formulate the long-term basin development and management plans. The proposed monitoring items are enumerated as below; thus, the proposed river management works are carried out on the basis of the monitoring results as shown in Table V.6.1.1 and Fig. V.6.1.2.

(1) Monitoring on Hydrological Data

The data include basin rainfall, river water level/discharge, sediment load, water quality and inflow/outflow of the dams and barrages. The data are presently gauged by DID in the states of Kedah and Pulau Pinang, PWA and MADA. The existing gauging network will be built-up as described in the following Section 6.2. In the proposed system, the present competent agency on the actual gauging works will remain as it is, but the gauged data will be integrated by the river management body.

(2) Monitoring on Water Abstraction Volume from Muda River

The water abstraction volume at each intake point is monitored independently by competent government authorities such as DID, PWA and PWD. In the proposed system, the water abstraction volume at each intake is calibrated and the monitored data will be integrated by the river management body so as to execute the appropriate water allocation for each water user. The calibration will be entrusted to the present competent government agencies based on the specification as well as budget of the river management body.

(2) Monitoring on Land Development/Activities and Construction of Infrastructure

The local government or other competent government authorities will notify to the river management body about the structural plan for urban and industrial development and/or the alienation or temporally occupation of the land. The river management body will also directly monitor the excessive agricultural activities in the dam catchment area.

(3) Monitoring on Sand Mining and River Morphology

River channel erosion extensively occurs due to the present excessive sand mining operations. In this connection, the sand mining activities as well as the related river morphology are being monitored by DID in the states of Kedah and Pulau Pinang. In the proposed system, the monitoring data will be transferred to the river management body.

(4) Monitoring on Other Items

The flood damage conditions are surveyed by DID after every major flood inundation occurs and submitted to DID HQ. Survey on fauna/flora and navigation in Muda river system are also monitored by the Department of Wildlife and Natural Park and the Department of Fisheries, respectively. In the proposed system, these survey results will be integrated by the river management body.

6.2 Proposed Hydrological Gauging Network

The overall monitoring measures will be classified into the following five (5) groups according to the aforesaid proposed monitoring items (refer to Table V.6.1.1):

(a) Hydrological gauging to monitor rainfall, basin runoff discharge and sediment load;

(b) Sampling and laboratory tests to monitor water quality;

(c) Field survey (river channel survey) to monitor the river morphology;

(d) On-site inspection to monitor the sand mining operations, construction of river structures, fauna/flora and flood damage; and

(e) Notification from the competent government authorities to know the water abstraction volume from the river and the detailed applications for sand mining operations, the land development, construction of river structures and navigation.

Among the above monitoring measures, major facilities are required for the hydrological gauging under items (a) and (b). In this connection, the integrated hydrological gauging networks for items (a) and (b) are newly proposed as described in the following subsections.

6.2.1 Reference Point

The present monitoring network is not consistently arranged for the sake of integrated river monitoring and management. For instance, the water level gauging stations are independently monitored by the State DID of Kedah and P. Pinang at almost the same locations but on the opposite banks along the state boundary located downstream from Ldg. Victoria. Due to the present conditions, integrated reference points are proposed to consistently monitor the river hydrology and water quality. The location of the reference points are selected considering the locations of the existing gauging stations, the confluence of the major tributaries and the major river structures (refer to Table V.6.2.1 and Figs. V.6.2.1 and V.6.2.2), as below:

Proposed Reference Points in Muda River System

Principal Reference Point (Class 1)			Sub-Reference Point (Class 2)		
Name	River	Catchment Area (km^2)	Name	River	Catchment Area (km^2)
(1) Muda Dam	Muda	984	(1) Telui Timor	Muda	2,377
(2) Jeniang	Muda	1,740	(2) Reman Dam	Reman	32
(3) Jam. Syed Omar	Muda	3,330	(3) Batu Rima	Chepir	233
(4) Ldg. Victoria	Muda	4,010	(4) Muda Barrage	Muda	4,201
(5) Beris Dam	Beris	116	(5) Merbau Pulas	Sedim	219
(6) Kuala Pegang	Ketil	704			

As listed above, the proposed reference points are classified into the principal and sub-reference points. The principal reference points (Class 1) are placed along the main stream of Muda River and/or downstream of the major tributaries. The data monitored at the principal reference points are used as the principal information for all river management works including the flood mitigation, water resources management and sediment control. Accordingly, the monitoring works need to be constantly made throughout a year including the flood and low river flow regime. The objectives monitored at the principal reference points will include the water level, the runoff discharge (dam inflow/outflow discharge in case of Muda and Beris dams), water quality, sediment load and fluctuation of the river channel cross-section. Furthermore, priority on-line system is given to the data transmittal on the runoff discharge monitored at the principal reference point.

The sub-reference points (Class 2) are placed to supplement the information for water allocation and/or flood mitigation works. Among the sub-reference points, those at Muda Dam, Beris Dam and Reman Dam will be used to monitor the dam inflow discharge and the flood discharge spilled over the dam. As for the reference point at Telui Timor, the monitoring works are carried out during the period of low flow regime for the sake of water allocation. The principal objectives monitored at these sub-reference points will be the runoff discharge.

In addition to the above reference points (Class 1 and Class 2), those for Class 3 are proposed for the purpose of flood forecasting. The reference points for Class 3 are placed at four (4) sites of the existing gauging stations controlled by DID (refer to Table V.6.2.1).

6.2.2 Rainfall Gauging Network

There exist 15 rainfall gauging stations in Muda river basin. These gauging stations are, however, unevenly distributed in the lower reaches of the basin. Out of the existing gauging stations, only two (2) stations are located in the proposed water source reserve area as shown in Fig. V.6.2.2.

This uneven distribution is attributed to the difficult accessibility to the mountainous side in the upper reaches. Nevertheless, the proposed water source reserve area is regarded as the hydrological blind area at present, and it is difficult to evaluate the basin runoff discharge under the present rainfall gauging network. In this context, 10 rainfall gauging stations are newly proposed to monitor the rainfall conditions principally for the water source reserve area (refer to Table V.6.2.2 and Fig. V.6.2.2). All proposed rainfall gauging stations are accessible via the existing road or the waterway.

Muda river basin will have 25 rainfall gauging stations in total for the whole catchment area of 4,210 km^2 when all gauging stations are installed. Thus, the average coverage per gauging station could reach about 170 km^2 which is not enough but available to evaluate the basin average rainfall.

6.2.3 River Water Quality and Hydrological Gauging Network

Gauging stations are proposed for each reference point as described below.

(1) Class 1 Gauging Station

The stations are placed at the principal reference points to monitor all hydrological items of water level, discharge and sediment load both for flood and low flow terms, and also to periodically monitor the water quality.

(2) Class 2 Gauging Station

The stations are placed at the sub-reference point to monitor the above items for Class 1 other than the sediment load. Out of the stations, however, the station at Kuala Pegang is now used as a flood forecasting station, therefore, the flood water level is also monitored at the station.

(3) Class 3 Gauging Station

These are placed at the present water level gauging stations to monitor the flood river flow for the purpose of flood forecasting and warning systems.

The total number of proposed gauging stations is 15 which are divided into 6 for Class 1 station, 5 for Class 2 station, and 4 for Class 3 station. All stations for Class 1 are converted from the existing gauging stations, therefore, their hydrological data so far recorded could be incorporated into the further monitoring works (refer to Table V.6.2.1). On the other hand, the Class 2 gauging stations are newly proposed, except the station at Muda Barrage, to supplement the present hydrological gauging network.

7. ACTION PLAN ON PROPOSED RIVER BASIN MANAGEMENT AND MONITORING SYSTEM

The various structural plans are proposed for the sake of comprehensive management on the Muda river basin for flood mitigation, water resources development, and river environmental improvement. The implementation of each structural plan is scheduled with the entire target completion year of 2010 (refer to SECTOR VIII). To facilitate the successful implementation of the structural plans and the integrated operation for the structures, the watershed management and monitoring plans are further scheduled to be completed in the succeeding years in due consideration of items (1) to (3) below.

Target Completion Year for Proposed Watershed Management and Monitoring Work

Work Item	Target Completion Year
(1) Institutional Setup for River Management Body	1998
(2) Zoning (River Reserve Area and Water Source Reserve Area)	2000
(3) Monitoring System for : Hydrological Data	2000
: Water Abstraction Volume	2005
: Others	2007

(1) Institutional Setup for River Management Body

It is desirable to establish the river management body as early as possible so as to take over all proposed river management works including the ongoing preparatory works for the construction of Beris Dam. However, a certain period for coordination among the related government agencies and budgetary arrangement will be required to finally setup the proposed river management body.

Following the construction of Beris Dam, the development of lakeshore resort around the Beris dam reservoir is scheduled to start in 1998. In this connection, the target year to setup the river management body is assumed in the starting year of lakeshore development.

(2) Zoning on Water Source Reserve Area and River Reserved Area

Among the proposed structural plans, the earliest completion is for Beris Dam in the year 2000. Before the completion, delineation of the water resources reserve area is required to ensure the jurisdiction of the river management body over the dam catchment area. Moreover, land acquisition for the river channel improvement is proposed to start in 2001. Prior to the start of land acquisition, it is indispensable to delineate the river reserve area covering the necessary land for the river improvement works. In due consideration of these conditions, zoning of the watershed for basin monitoring and management is scheduled to be completed in the year 2000.

(3) Monitoring System

Buildup of the monitoring system is to be completed in accordance with the following schedule:

(a) Monitoring Network on Hydrological Data and Water Abstraction Volume at Intake Points

The Jenlang Diversion Works and Naok Dam are to be completed in 2005, and since then, an integrated basin-wide water allocation will become a critical issue. From this viewpoint, setting up of the monitoring system by the year 2005 is required.

(b) Monitoring on Others

River channel improvement works are proposed for five (5) river stretches. Among them, the major construction works are to be carried out, for a period from 2007 to 2010, along the downstream stretch of 40 km. In this connection, setting up of the monitoring system on the following items is required before commencement of the major construction works in 2007: (i) sand mining activities and river morphology; (ii) river biology (fauna and flora); (iii) land development; (iv) flood damage condition, and (v) river scenery.

8. NECESSITY OF NATIONWIDE RIVER INFORMATION SYSTEM

Muda River poses various problems associated with flood, the ever-increasing water demand, the siltation of the river mouth and the mining of riverbed materials. The water quality of Muda River will also pose a potential problem by the future intensive urban and industrial development.

To minimize these problems and to realize a well-balanced basin development, this Study proposes, in addition to the various structural measures, the following non-structural measures: (1) institutional setup for the river management body; (2) zoning to delineate the boundary of jurisdiction for river management; and (3) establishment of integrated river monitoring system.

In Malaysia, the comprehensive river basin management plan is the first attempt in case of Muda River, and has never been implemented for other rivers. Accordingly, the results of this Study should be used as a model case and applied as a guide and reference for other rivers in the country. In the country, there are more than 1,500 rivers experiencing habitual flood inundation and the recurrent shortage of water supply. The deterioration of river conditions could be attributed specially to the lack of the aforesaid non structural river management measures. In this connection, the first step for the comprehensive river basin management must be given to such non-structural measures including institutional setup of a nationwide river management body, zoning for jurisdiction of river management, and establishment of a river monitoring system on a nationwide scale.

Among the above three (3) items of non-structural measures, essentially required is the nationwide river monitoring system for the purpose of planning and design, development and regular management for the rivers so that prompt action can be taken whenever necessary. The river information to be monitored by the system will be voluminous and dynamic in nature, requiring frequent updating and systematic storage. A computerized information system is therefore essential to improve in efficiency and effectiveness in the management of rivers.

The Government of Malaysia is keen to establish the nationwide river information system through the technical cooperation program of Japan. This nationwide river information will be useful for the aforesaid comprehensive river basin management, and therefore, its early implementation is strongly recommended.

TABLES

SECTOR V

WATERSHED MANAGEMENT AND MONITORING PLAN

TABLE V.3.1.1 PRESENT LAND USE IN MUDA RIVER BASIN AND KEDAH STATE

Item	Muda River Basin		Kedah State	
	(km2)	(%)	(km2)	(%)
1. Agricultural land	1,771	42.06	4,756	51.22
(1) Mixed Horticulture	163	3.88	426	4.59
(2) Rubber	1,393	33.09	2,504	26.96
(3) Oil Palm	76	1.80	219	2.36
(4) Paddy	131	3.11	1,448	15.60
(5) Others	8	0.18	158	1.70
2. Non-Agricultural Land	2,439	57.94	4,530	48.78
(1) Urban and Associated Area	2	0.05	122	1.31
(2) Forest	2,361	56.09	3,944	42.47
(a) Forest	2,251	53.46	3,483	37.51
(b) Scrub Forest	109	2.59	334	3.60
(c) Scrub Grass	2	0.04	127	1.37
(3) Newly Cleared Land	62	1.48	129	1.39
(4) Lake & Swamp	14	0.33	162	1.75
(5) Others	Nil	0.00	172	0.00
Grand Total	4,210	100.00	9,285	100.00

Source : Land use map from Ministry of Agriculture
Development Statistics of Kedah Darul Aman

TABLE V.3.3.1 POPULATION IN AND OUT OF MUDA RIVER BASIN

Classification of Area	Area		Population						Population Density			Average Annual Population Growth	
	(km^2)	(% to State Total)	('000 Person)			(% to State Total)			(Person/km^2)			(%/year)	
			1991	2000	2010	1991	2000	2010	1991	2000	2010	1991-2000	2000-2010
1. State of Kedah	9,446	100.0	1,305	1,577	2,033	100.0	100.0	100.0	138	167	215	2.17	2.57
3.1 Out of Muda River Basin	5,296	56.1	947	1,128	1,426	72.6	71.5	70.2	178.8	213.0	269.3	2.00	2.37
3.2 In Muda River Basin	4,150	43.9	358	449	607	27.4	28.5	29.8	86.2	108.1	146.2	2.60	3.06
(1) Uppera Reaches of Muda River Basin	978	10.4	11	15	21	0.8	0.9	1.0	11.3	15.2	21.4	3.43	3.46
(2) Middle Reaches of Muda River Basin	1,103	11.7	69	81	99	5.3	5.1	4.9	62.6	73.6	90.2	1.85	2.05
(3) Lower Reaches of Muda River Basin	297	3.1	131	191	302	10.1	12.1	14.9	442.9	643.4	1,018.2	4.32	4.70
(4) Upper Reaches of Kechil River Basin	554	5.9	12	12	13	0.9	0.8	0.6	21.4	22.4	23.5	0.52	0.51
(5) Lower Reaches of Kechil River Basin	684	7.2	90	100	113	6.9	6.3	5.6	131.7	146.0	165.2	1.17	1.24
(6) Sedim River Basin	533	5.6	44	50	58	3.4	3.1	2.9	83.2	92.9	109.1	1.25	1.61
2. State of Perlis	795	100.0	184	228	301	100.0	100.0	100.0	231.4	286.8	378.6	2.46	2.82
3. State of P. Pinang	1,031	100.0	1,065	1,276	1,659	100.0	100.0	100.0	1,033.0	1,237.6	1,609.1	2.07	2.68

TABLE V.3.3.2 POPULATION DENSITY IN MUDA RIVER BASIN

Classification of Area			Area (km^2)	Population			Population Density (Person/km^2)			Average Annual Population Growth (%/year)	
No.	District	Munkim		1991	2000	2010	1991	2000	2010	1991-2000	2000-2010
I.	Uppera Reaches of Muda River Basin		978.48	11,079	14,918	20,965	11.3	15.2	21.4	3.43	3.46
1	Sik	Sok	859.16	8,026	10,385	13,818	9.3	12.1	16.1	2.96	2.90
2	Pendang	Padang Peliang	119.32	3,053	4,533	7,148	32.0	47.5	74.9	4.58	4.66
II.	Middle Reaches of Muda River Basin		1,103.18	69,043	81,184	99,456	62.6	73.6	90.2	1.85	2.05
3	Sik	Sik	654.80	35,019	45,250	61,196	53.5	69.1	93.5	2.95	3.06
4	Sik	Jeneri	139.00	11,608	11,882	12,117	83.5	85.5	87.2	0.26	0.20
5	Padang Terap	Tekai	142.92	6,994	8,163	9,649	128.8	150.3	177.7	1.77	1.69
6	Kuala Muda	Gurun	39.85	6,386	7,157	8,136	801.2	898.0	1,020.9	1.30	1.29
7	Kuala Muda	Telui Kiri	126.61	9,036	8,731	8,358	71.4	69.0	66.0	-0.39	-0.44
III.	Lower Reaches of Muda River Basin		296.53	131,342	190,777	301,915	442.9	643.4	1,018.2	4.32	4.70
8	Kuala Muda	Kota	6.22	2,974	3,292	3,701	478.1	529.3	595.0	1.16	1.18
9	Kuala Muda	Kuala	6.92	2,603	2,803	3,036	376.2	405.1	438.8	0.84	0.80
10	Kuala Muda	Kekula	21.66	8,632	11,245	15,211	398.5	519.1	702.3	3.04	3.07
11	Kuala Muda	Pinang Tunggal	36.17	3,240	3,086	2,737	89.6	85.3	75.7	-1.16	-1.19
12	Kuala Muda	Rantau Panjang	10.21	2,684	2,776	2,882	262.9	271.9	282.2	0.38	0.38
13	Kuala Muda	Sidam Kiri	68.19	6,914	6,607	6,256	101.4	96.9	91.7	-0.51	-0.54
14	Kuala Muda	Sungai Pasir	36.63	44,628	79,545	151,703	1,218.3	2,171.6	4,141.5	6.76	6.67
15	Kuala Muda	Sungai Petani	110.53	59,667	81,422	116,388	899.7	1,227.7	1,755.0	3.58	3.64
IV.	Upper Reaches of Kechil River Basin		554.39	11,842	12,400	13,052	21.4	22.4	23.5	0.52	0.51
16	Baling	Sioog	554.39	11842	12,400	13,052	21.4	22.4	23.5	0.52	0.51
V.	Lower Reaches of Kechil River Basin		684.14	90,095	99,867	112,996	131.7	146.0	165.2	1.17	1.24
17	Baling	Bongor	41.36	5584	6,313	7,290	135.0	152.6	176.2	1.40	1.45
18	Baling	Baling	46.93	8,166	8,179	8,202	174.0	174.3	174.8	0.02	0.03
19	Baling	Pulai	153.30	19972	23,042	27,307	130.3	150.3	178.1	1.63	1.71
20	Baling	Kupang	191.30	23442	25,275	27,598	122.5	132.1	144.3	0.86	0.88
21	Baling	Telui Kanan	124.37	14647	16,937	19,987	117.8	136.2	160.7	1.66	1.67
22	Baling	Tawar	126.88	18284	20,121	22,612	144.1	158.6	178.2	1.09	1.17
VI.	Sedim River Basin		533.28	44,394	49,556	58,162	83.2	92.9	109.1	1.25	1.61
23	Baling	Bakai	279.80	12,552	12,708	12,912	44.9	45.4	46.1	0.14	0.16
24	Kulim	Bagan Sena	61.33	5,352	5,560	5,827	87.3	90.7	95.0	0.43	0.47
25	Kulim	Karangan	80.10	6,949	10,101	15,678	86.8	126.1	195.7	4.33	4.49
26	Kulim	Padang Meha	58.66	7,587	7,422	7,232	129.3	126.5	123.3	-0.25	-0.26
27	Kulim	Sidam Kanan	38.82	9,594	11,513	14,203	247.1	296.6	365.9	2.09	2.12
28	Kulim	Pandang China	14.57	2,360	2,252	2,312	539.7	515.1	528.7	-0.53	-0.59
Muda Basin Total			4,150.00	357,794	448,701	606,546	86.2	108.1	146.2	2.60	3.06

TABLE V.3.4.1 PRESENT INDUSTRIAL ESTATES
(AS OF 1993)

State	Developed by	District	Industrial Estate	Area in Operation (ha)	Area Developed (ha)	Occupancy Rate (%)
Kedah	KSDC	Kota Setar	Mergong II	35.20	41.40	85.0
			Mergong Barrage	31.14	40.60	76.7
		Kuala Muda	Tikam Batu	32.81	36.00	91.1
			Bakar Arang	174.80	225.80	77.4
			Sungai Petani	221.75	251.72	88.1
		Kulim	Kulim	145.98	174.00	83.9
		KSDC AREA TOTAL		641.68	769.52	83.4
	KEDA	Kubang Pasu	Binjal	0.90	3.49	25.8
		Padang Terap	Naka	0.64	5.66	11.3
		Baling	Baling	1.29	6.87	18.8
		Sic	Sik	10.91	12.45	87.6
			Jeniang	2.32	6.66	34.8
		Pendang	Sg. Tiang	0.84	0.84	100.0
		Langkawai	Langkawi	3.94	3.94	100.0
		KEDA AREA TOTAL		20.84	39.91	52.2
	State Total			662.52	809.43	81.9
Penang	PDC	S.P.U.	Mak Mandin	55.61		
			Seberang Jaya	22.19	756.69	
		S.P.T.	Perai	340.54		
			Perai F.I.Z.	154.90		
			Bukit Tengah	77.65		
		Penang Island	Bayan Lepas	57.74	230.13	
			Bayan Lepas F.I.Z.	172.39		
	State Total			881.02	986.82	89.3
Grand Total				1,543.54	1796.25	85.9

Note : KSDC = Kedah State Economic Development Corporation
KEDA = Kedah Regional Economic Authority
PDC = Penang Development Corporation
S.P.U. = Seberang Perai Utara (Seberang Perai North)
S.P.T. = Seberang Perai Tengah (Seberang Perai Central)
F.I.Z. = Free Industrial Zones

Source : Development Statistics of Kedah Darul Aman by Kedah SEPU, February, 1994.
Penang Statistic by Penang Development Corporation, February, 1994.

TABLE V.3.4.2 INDUSTRIAL AREA DEVELOPMENT
PROJECTED BY STATE GOVERNMENT
(YEAR OF 1993 AND 2000)

State	Developed by	District	Industrial Area (Industrial Estate)	Area Develped 1993 (ha)	Area Develped 2000 (ha)
Kedah	KSDC	Kubang Pasu	Bukit Kayu Hitam		179
		Kota Setar	Mergong II	41	66
			Mergong Barrage	41	41
			Pokok Sena		176
		Kuala Muda	Sungai Petani	252	252
			Bakar Arang	226	226
			Bakar Arang Light		7
			Kempas Park		3
			Tikam Batu	36	36
		Baling	Kuala Ketil		738
		Kulim	Kulim	174	174
			Kulim Hi-Tech Park		255
		KSDC AREA TOTAL		770	2,154
	KEDA	Kubang Pasu	Binjal	3	9
		Pg Terap	Naka	6	15
		Baling	Baling	7	18
		Sic	Sik	12	33
			Jeniang	7	18
		Pendang	Sg. Tiang	1	2
		Langkawai	Langkawi	4	11
		Kubang Pasu	IKS KEDA Park		10
		Pendang	IKS KEDA Park		10
		Kulim	IKS KEDA Park		14
		KEDA AREA TOTAL		40	140
	Private	Kubang Pasu	Darulaman		87
		Kota Setar	Sri Tandop		81
		Kuala Muda	BKT. Selambau		163
			Sungai Petani Park		202
			Selarogan (MIEL)		5
		Kulim	Taman Makmur Light		0
		PRIVATE AREA TOTAL			538
	KEDAH STATE TOTAL			809	2,832
Penang	PDC	SPU/SPT	Butterworth	757	1,472
		SPT	Kepala Batas		202
		SPU	Tasek Gelugor		77
		SPT	Bukit Mertajam		206
		SPU	Permatang Tinggi		64
		SPS	Jawi (Valdor)		435
		SPS	Nibong Tebal		152
		MPPP P. Pinang	Bayan Lepas	230	262
	PENANG STATE TOTAL			987	2,869
GRAND TOTAL				1,744	5,701

Source: Kedah Development Action Plan (1991-2000)
Report from KSDC (written in Japanese)
Draft Structural Plan by Seberang Perai Municipal Council (1985-2000)
Penang Island Structure Plan

TABLE V.4.1.1 PRESENT MONITORING SYSTEM OF MUDA RIVER AND MUDA IRRIGATION AREA

Monitoring Purpose	Agency in Charge	Monitoring Item/Point		Monitoring Location
		Item	Point	
1. Monitoring for Muda River in Kedah State				
1-1 Flood Forecasting & Warning	DID	Water Level	10	Gauging Station
		Rainfall	3	- ditto -
1-2 Allocation for Irrigation Water	DID	Water Level	28	Intake Point
1-3 Allocation for Domestic & Industrial Water	PWD	Water Level	17	Intake Point
		Water Quality	17	- ditto -
1-4 River Water Quality Control	DOE	Water Quality	17	Sampling P int
1-5 River Channel Stability	DID	River Bed Elevation	3	Gauging Station
1-6 Hydrological Data Base	DID	Water Level	10	Gauging Station
		Water Level & Discharge	3	- ditto -
		Rainfall	16	- ditto -
2. Monitoring for MADA Irrigation System				
2-1 Control of Low Flow Regime of the River	MADA	Water Level	8	Gauging Station
		Gate Control of Pdg. Terap Barrage	1	Barrage
		Gate Control of Muda/Pedu/Ahning Dam	3	Dam Reservoir
		Water Quality of Muda/Pedu Dam Reservoir	2	- ditto -
2-2 Allocation for Irrigation Water	MADA	Rainfall	70	Irrigation Area
		Gate Control of Irrigation Facility	9	- ditto -
3. Monitoring for Muda River in P. Pinang State				
3-1 Flood Forecasting & Warning	DID	Water Level	2	Gauging Station
3-2 Intake of Irrigation Water	DID	Water Level	2	Intake Point
3-3 Intake of Domestic & Industrial Water	PWA	Water Level	1	Intake Point
		Gate Control of Muda Barrage	1	Barrage
3-4 River Channel Stability	DID	River Bed Elevation	2	Gauging Station
		Sand Mining	9	Mining Point
3-5 Hydrological Data Base	DID	Water Level & Discharge	2	Gauging Station

TABLE V.5.1.1 EXTENT AND PURPOSE OF PROPOSED WATERSHED ZONING

Classified Zone		Extent	Size (km^2)	Size (%)	Purpose
Water Source Reserve Area	Zone 1	Present forest reserve area surrounding dam reservoir *1	240 *2	5.7	• Preserve the water quality, beatification/ morphology of the dam reservoir • Restrain the basin sediment yield, and polluted runoff discharge to dam reservoir. • Preserve the basin waster storage capacity.
	Zone 2	Present forest reserve area in dam catchment area other than Zone 1.	849 *3	20.1	
	Zone 3	Present cultivation area in the proposed dam catchment area	63 *4	1.5	
	Zone 4	Present forest reserve area in non-dam catchment area	1,142	27.1	• Preserve the water quality, beatification/ morphology of the river. • Restrain the polluted runoff discharge to the natural river flow. • Preserve the basin water storage capacity.
	Zone 5	Present cultivation area to critically effect river water quality and basin runoff condition	255	6.1	
	Sub-total (Present Forest Reserve Area:) (Present Cultivation Area :)		2,529 (2,211) (318)	60.0 (52.5) (7.5)	
River Reserve and Controlled Area	Zone 6	Probable flood inundation area (100-year return period) and shore belt of dam reservoirs	57	1.4	Facilitate river improvement, preserve flood retarding effect; protect river from undesirable activities, and minimize damages caused by flood and channel erosion/ meandering
Potential Land Development Area	Zone 7	Area other than those belonged to above classifications.	1,624	38.6	Use as the potential urban, industrial and agricultural development land.
Grand Total			4,210	100.0	

Note *1 Exclude the shore belt where the detailed zoning plan will be formulated as a part of river reserve area (Zone 6).

*2 Composed of 155 km^2 for Muda dam and 85 km^2 for the proposed Beris dam.

*3: Applied solely to the catchment area of Muda dam.

*4: Composed of 31 km^2 for the proposed Beris dam and 32 km^2 for the proposed Reman dam.

TABLE V.5.1.2 MONITORING ITEMS AND REQUIRED ACTIVITIES FOR PROPOSED WATERSHED ZONING

Classified Zone		Required Activities	Monitoring Items	
			River Basin and Corridor	River and Dam Reservoir
Water Source Reserve Area	Zone 1	• Freeze any logging activities	• Logging activities	• Dam inflow and out flow discharge • Dam inflow and outflow sediment volume
	Zone 2	• Provide technical reference on the logging activities, if necessary.	• Logging activities	• Water quality of dam reservoir • Fauna and flora in dam reservoir
	Zone 3	• Provide technical reference on the agricultural activities, if necessary.	• Agricultural activities • Alienation or temporary occupation of the land	• Basin run-off discharge • Basin run-off sediment load • River water quality • Fauna and flora
	Zone 4	• Provide technical reference on the logging activities, if necessary.	• Logging activities	
	Zone 5	• Provide technical reference on the agricultural activities, if necessary.	• Agricultural activities • Alienation or temporary occupation of the land	
River Reserve and Controlled Area	Zone 6	• Control the excessive land development activities • Control the illegal sand mining and other water works.	• Agro-tourism/resort development • Agricultural activities • Conversion of land • Land development • Flood damage potential	• River flow discharge • Scenery of river channel • Morphology of river channel • Water quality of river flow • Sand mining activities • Fauna and flora

TABLE V.6.1.1 PROPOSED MONITORING ITEMS AND PURPOSE

Monitoring Item	Monitoring Measure	Monitoring Purpose											
		Flood Management				Water Resources Management				River Environment Management			
		(1) Flood Forecasting & Warning (2) Control of Flood Flow Discharge (3) Retention of Flood Runoff from Catchment Area (4) Reduction of Flood Damage Potential				(1) Increment of Low Water Runoff from Catchment Area (2) Control of Low Flow Regime of the River (3) Water Allocation 1 (for Irrigation) (4) Water Allocation 2 (for Domestic & Industrial)				(1) Agro-tourism/Resort Development (2) Nature Preserve (3) Improvement of River Scenery (4) Navigation			
		(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
1. Monitoring of River													
1.1 River Hydrology 1 (Water Level & Discharge)	Gauging	●*	○*	○		○	●*	●*	●*		○		
1.2 River Hydrology 2 (Suspended Sediment & River Bed Material)	Sampling & Laboratory Test												○
1.3 River Hydrology 3 (Water Quality & Pollutant Source)	Sampling & Laboratory Test							○	○	○	○		
1.4 River Hydrology 4 (Inflow & Outflow of Dam & Barrage)	Gauging		○*				●*	●*	●*				
1.5 River Morphology (Erosion/Sedimentation/Meandering)	Channel Survey & On-site Inspection				○					○	○	○	○
1.6 Water Abstraction Volume at Intake Point	Gauging							●*	●*				
1.7 Sand Mining (Location/Mining Volume/Mining Measure)	Notification & On-site Inspection				○					○		○	○
1.8 Construction of River Structure (Bridge, Water Pipe, River Bank, etc.)	Notification & On-site Inspection									○	○	○	
1.9 Fauna and Flora	On-site Inspection									○	○	○	
1.10 Damages caused by Actual Flood	On-site Inspection				○								
1.11 Navigation	Notification & On-site Inspection												○
2. Monitoring of Watershed and River Corridor													
2.1 Watershed Hydrology (Rainfall and Evaporation)	Gauging	●*	○*	○		○	●*	●*					
2.2 Land Use of Watershed and River Corridor (Vegetation/Land Development)	Survey on Aero-photograph			○	○	○		○	○	○	○	○	
2.3 Infrastructure (Road Network, Water Supply Network, etc.)	Notification & On-site Inspection							○	○	○		○	

Note : ● = Existing ○ = Proposed * = Real Time Monitoring

TABLE V.6.2.1 PROPOSED REFERENCE POINT AND RIVER HYDROLOGICAL MONITORING STATION

Name of Reference Point and Monitoring Station	Class*	River	Catchment Area (km^2)	Present Competent Agency			Location
				Water Level	Discharge	Water Quality	
1. Muda Dam	Class 1	Muda	984	MADA	MADA	MADA	Existing Muda dam site
2. Jeniang	Class 1	Muda	1,740	DID Kedah	DID Kedah	DOE Kedah	Existing water level gauging station (to be transferred to the proposed Jeniang Barrage.
3. Jam. Syed Omar	Class 1	Muda	3,330	DID Kedah	DID Kedah	DOE Kedah	Existing water level gauging station
4. Ldg. Victoria	Class 1	Muda	4,010	DID P. Pinang	DID P. Pinang		Existing water level gauging station
5. Beris Dam Reservoir	Class 2	Beris	116				Proposed Beris dam site
6. Kuala Pegang	Class 2	Ketil	704	DID Kedah	DID Kedah	DOE Kedah	Existing water level gauging station
7. Telui Timor	Class 2	Muda	2,377			PWD Kedah	Existing intake point for D & I water
8. Reman Dam Reservoir	Class 2	Reman	32				Proposed Reman dam site
9. Batu Lima	Class 3	Chepir	233				Existing intake point for D & I water (Controlled by PWD)
10. Muda Barrage	Class 1	Muda	4,201	PWD P. Pinang	PWD P. Pinang	PWD Kedah	Existing Muda Barrage
11. Merbau Pulas	Class 3	Sedim	219				Previous water level gauging station (gauging period : 1961 - 1972)
12. Pdang Cikak	Class 3	Muda	1,550	DID Kedah			Existing monitoring station for flood forecasting.
13. Sik	Class 3	Chepir	153	DID Kedah		PWD Kedah	Existing monitoring station for flood forecasting.
14. Kg. Baru	Class 3	Ketil	148	DID Kedah			Existing monitoring station for flood forecasting.
15. Pulai	Class 3	Ketil	389	DID Kedah		DOE Kedah	Existing monitoring station for flood forecasting.

TABLE V.6.2.2 PROPOSED RAINFALL MONITORING STATION

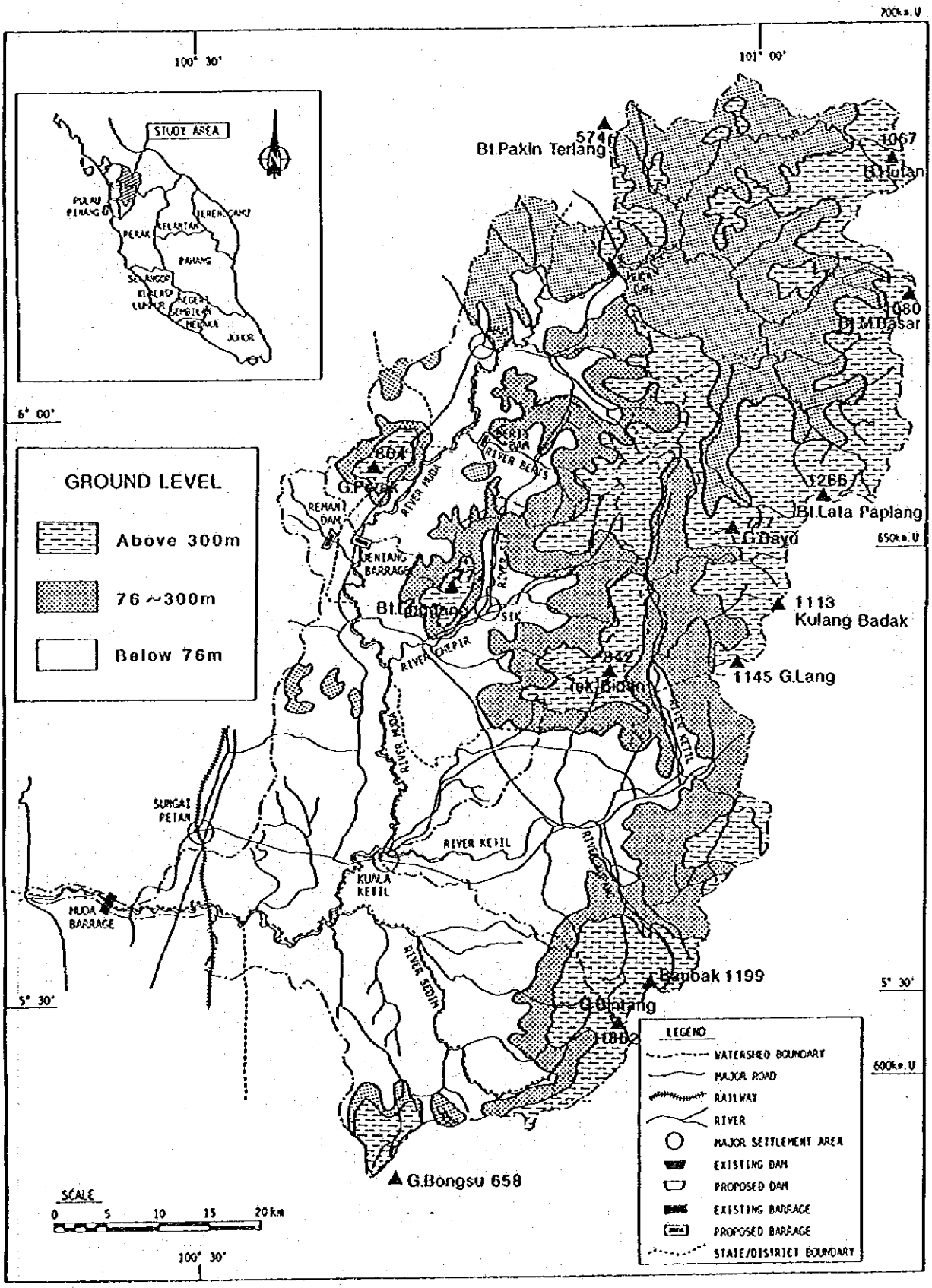
Monitoring Station			Location		
	Name	Ref.* Number	Basin Boundary	Latitude	Longitude
Newly Proposed					
1.	Muda Dam Reservoir (A)		Muda Dam Catchment	6° 09'	100° 51'
2.	Muda Dam Reservoir (B)		Muda Dam Catchment	6° 12'	100° 56'
3.	Muda Dam Reservoir (C)		Muda Dam Catchment	6° 07'	100° 57'
4.	Kg. Siprit		Upper Reaches of Muda River	6° 02'	100° 42'
5.	Kg. Lambang Bata		Upper Reaches of Muda River	5° 53'	100° 36'
6.	Beris Dam Reservoir		Beris Dam Catchment	5° 57'	100° 48'
7.	Air Terjun		Beris Dam Catchment	5° 54'	100° 50'
8.	Kg. Lubok Besar		Upper Reaches of Chepir River	5° 46'	100° 46'
9.	Kg. Legong		Upper Reaches of Ketil River	5° 49'	100° 56'
10.	Kg. Charok Perdiat		Upper Reaches of Ketil River	5° 33'	100° 55'
Existing					
1.	Komplek Rumah Muda	6108001	Muda Dam Catchment		
2.	Kg. Gajah Putch	5806065	Middle Reaches of Muda River		
3.	Jeniang Klinik	5806066	Middle Reaches of Muda River		
4.	Sik	5807067	Upper Reaches of Chepir River		
5.	Ladang Lubok Segintah	5606077	Lower Reaches of Muda River		
6.	Ladang Bukit karangan	5506082	Lower Reaches of Muda River		
7.	Ladang Henrietta	5505084	Lower Reaches of Muda River		
8.	Lahar Ikan Matu, Kepala Batas	5504035	Lower Reaches of Muda River		
9.	Batu 61 Jln. Baling	5806001	Upper Reaches of Ketil River		
10.	Kg. Terbak	5708071	Upper Reaches of Ketil River		
11.	Hospital Baling	5609072	Middle Reaches of Ketil River		
12.	Pulai	5608074	Middle Reaches of Ketil River		
13.	Batu 27 Jln. Baling	5507076	Lower Reaches of Ketil River		
14.	Ladang Dubin	5407080	Upper Reaches of Sedim River		
15.	Kelang Baharu, Kulim	5406083	Upper Reaches of Sedim River		

Note:*: Reference Number given by DID

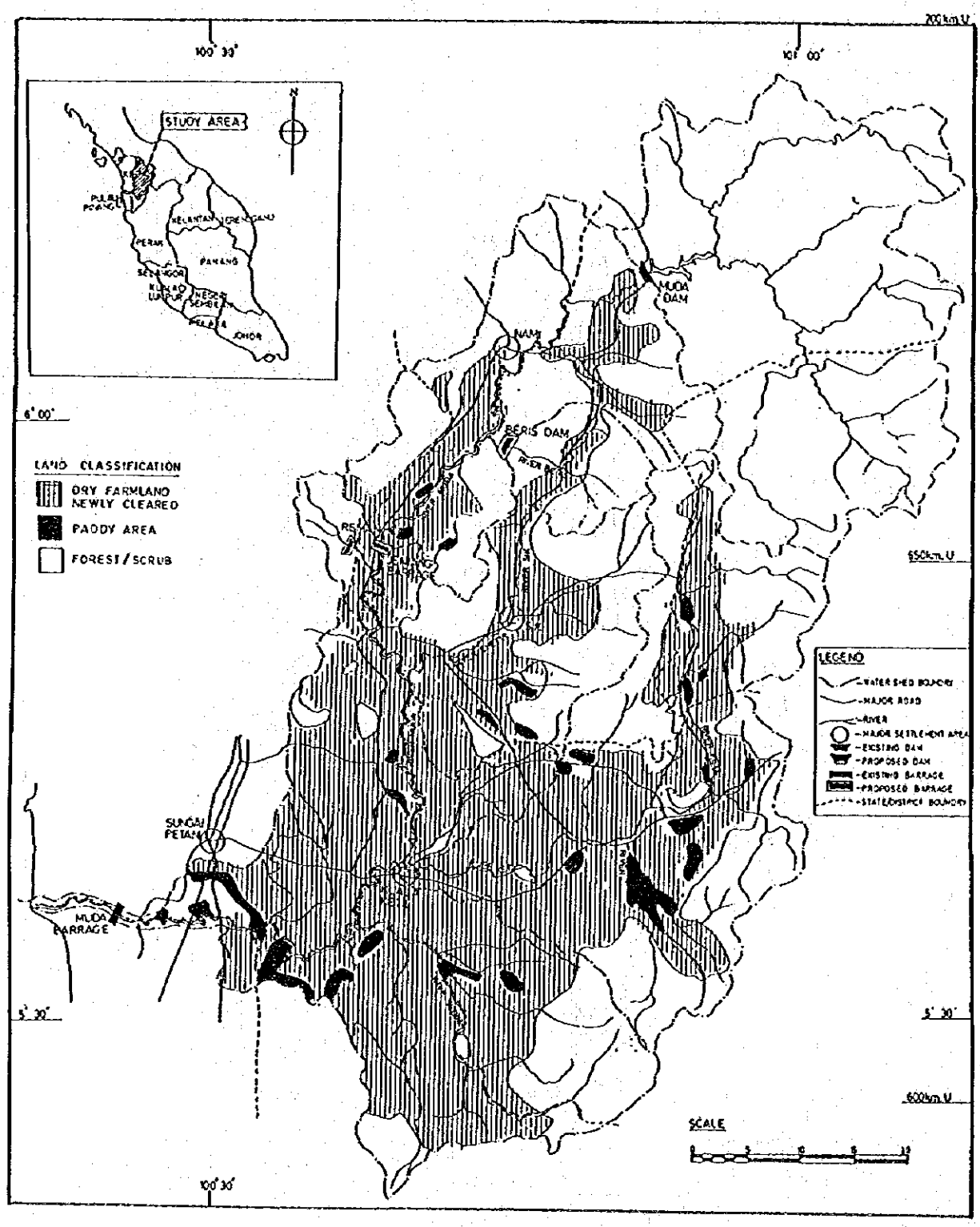
FIGURES

SECTOR V

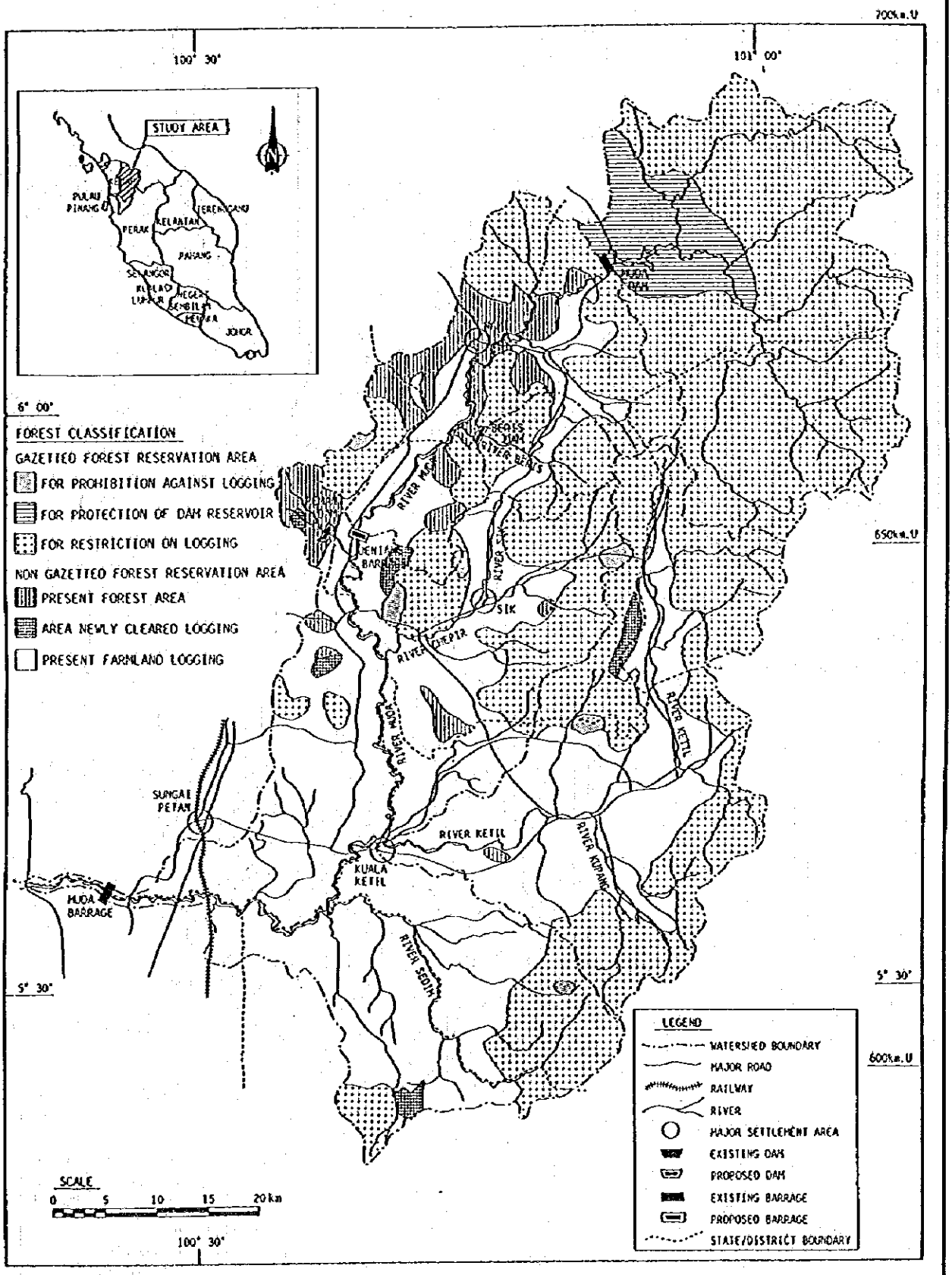
WATERSHED MANAGEMENT AND MONITORING PLAN



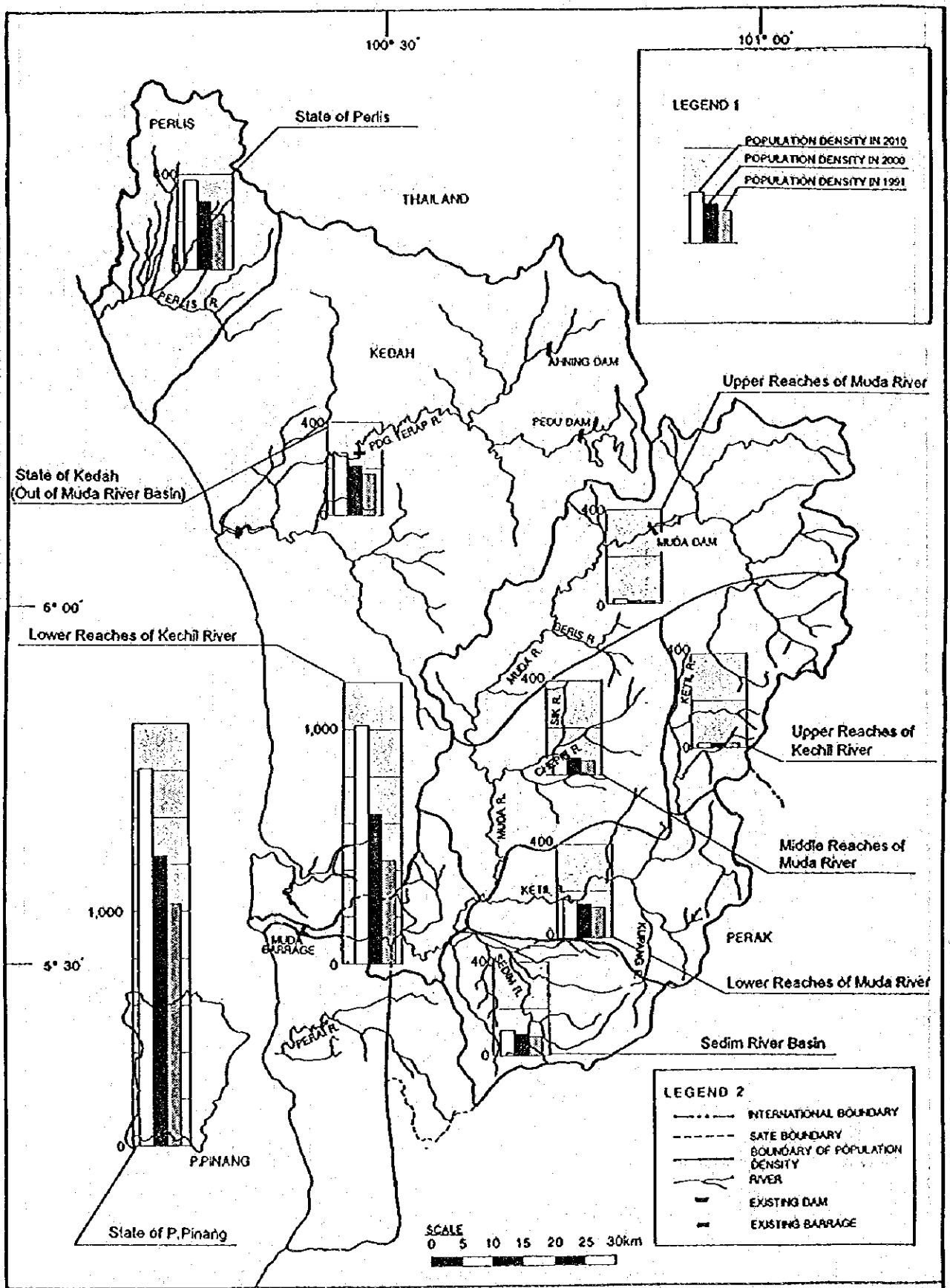
COMPREHENSIVE MANAGEMENT PLAN OF MUDA RIVER BASIN	FIG. V.2.1.1 TOPOGRAPHY OF MUDA RIVER BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY	



COMPREHENSIVE MANAGEMENT PLAN OF MUDA RIVER BASIN	FIG. V. 3. 1. 1
JAPAN INTERNATIONAL COOPERATION AGENCY	PRESENT LAND USE IN MUDA RIVER BASIN



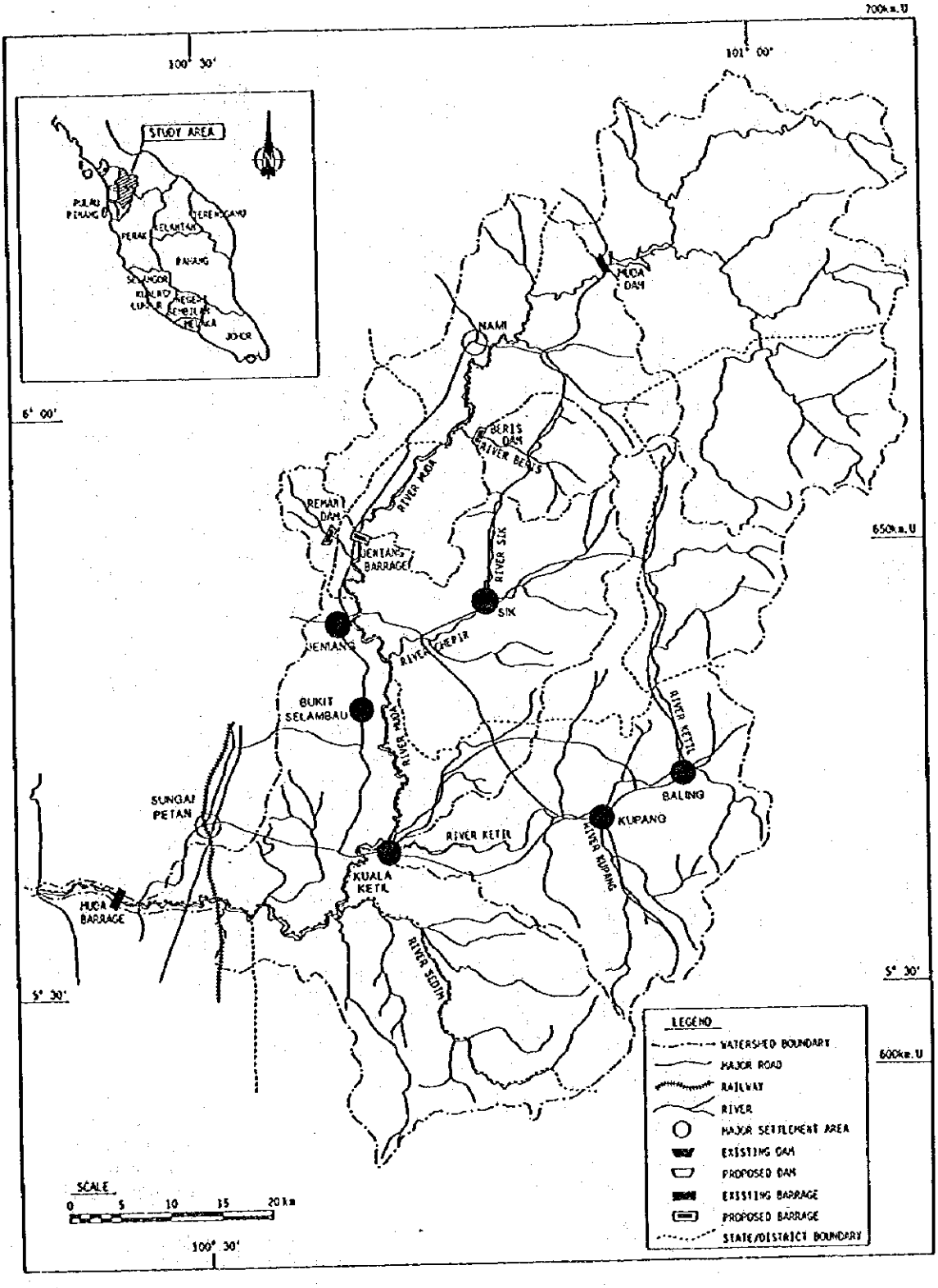
COMPREHENSIVE MANAGEMENT PLAN OF MUDA RIVER BASIN	FIG. V. 3. 2. 1
JAPAN INTERNATIONAL COOPERATION AGENCY	PRESENT FOREST AREA IN MUDA RIVER BASIN



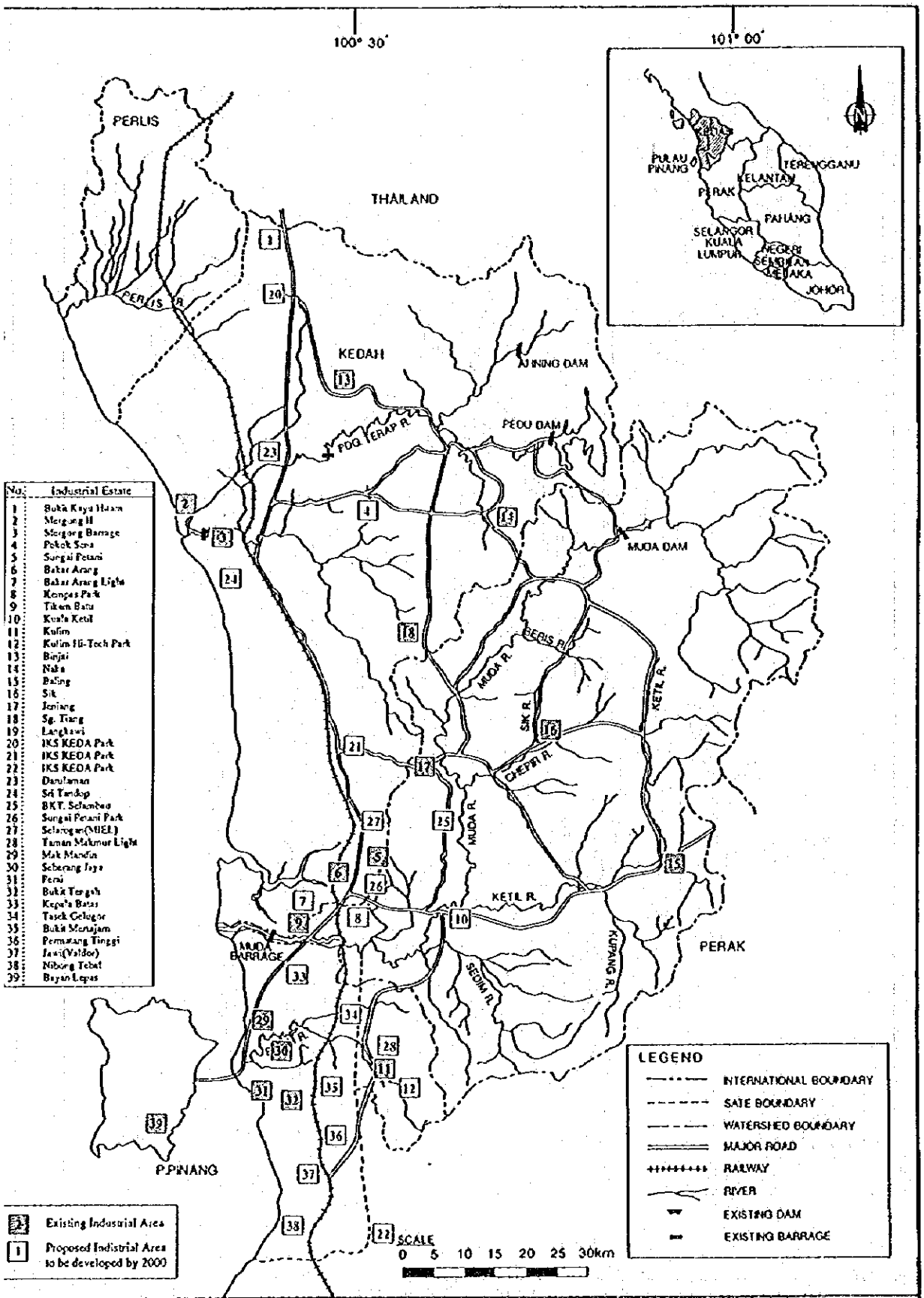
COMPREHENSIVE MANAGEMENT PLAN OF MUDA RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

FIG.V.3.3.1
POPULATION DENSITY IN AND AROUND MUDA RIVER BASIN



COMPREHENSIVE MANAGEMENT PLAN OF MUDA RIVER BASIN	FIG. V. 3. 3. 2
JAPAN INTERNATIONAL COOPERATION AGENCY	PROJECTED URBAN CENTERS IN MUDA RIVER BASIN

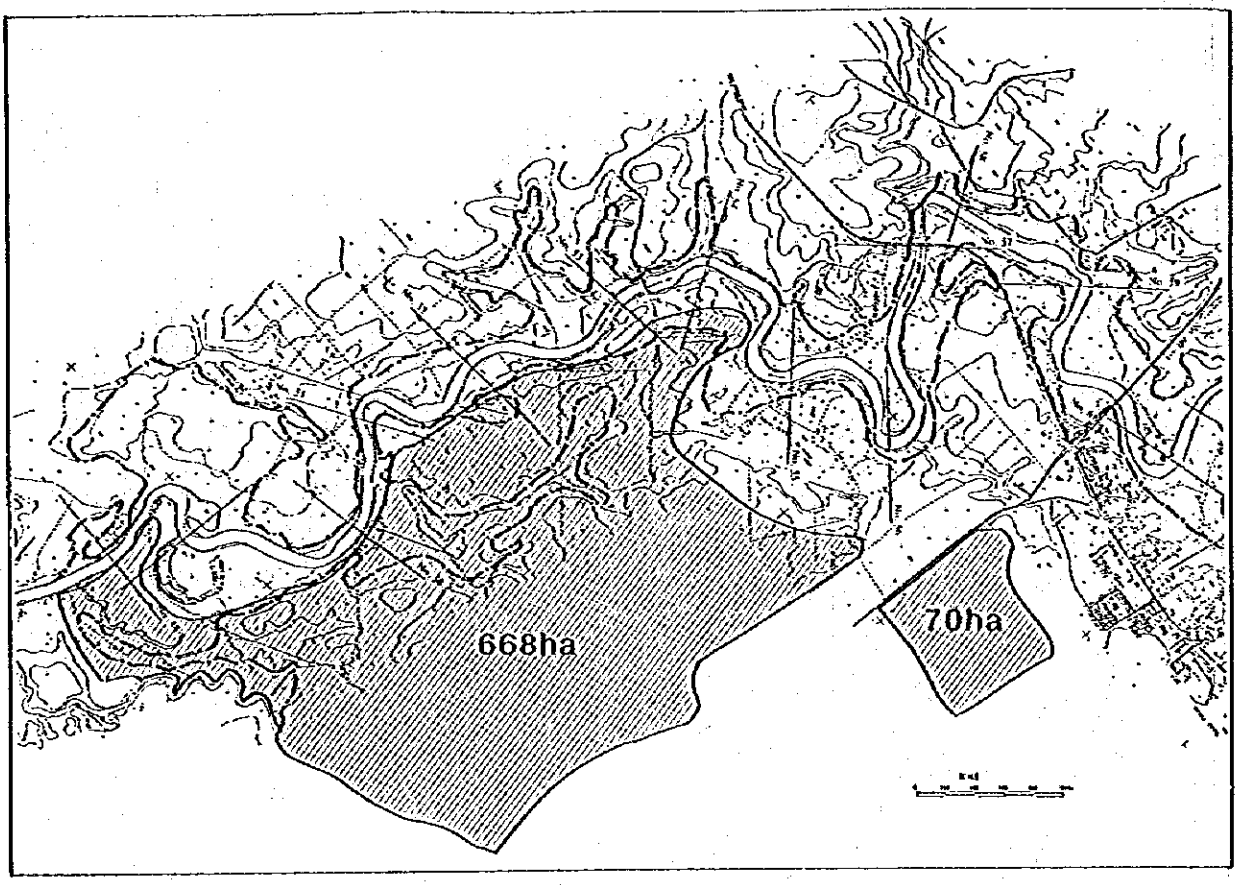


OMPREHENSIVE MANAGEMENT PLAN OF IUDA RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

FIG. V. 3. 4. 1

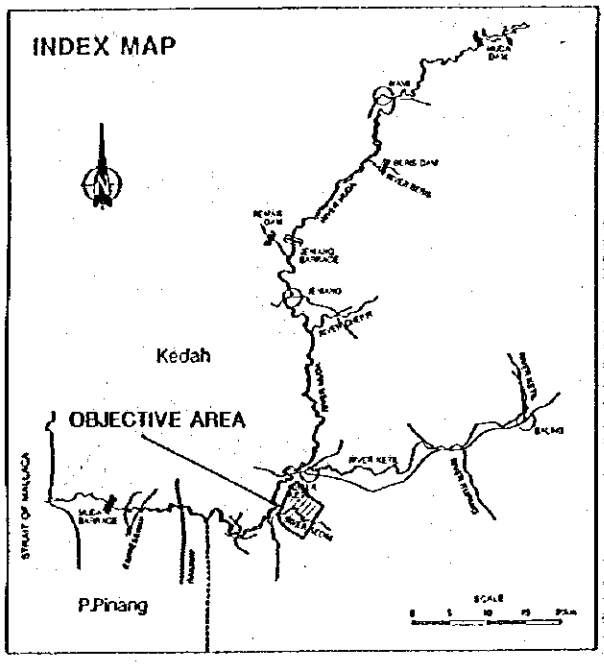
PRESENT AND PROJECTED INDUSTRIAL AREA IN 2000



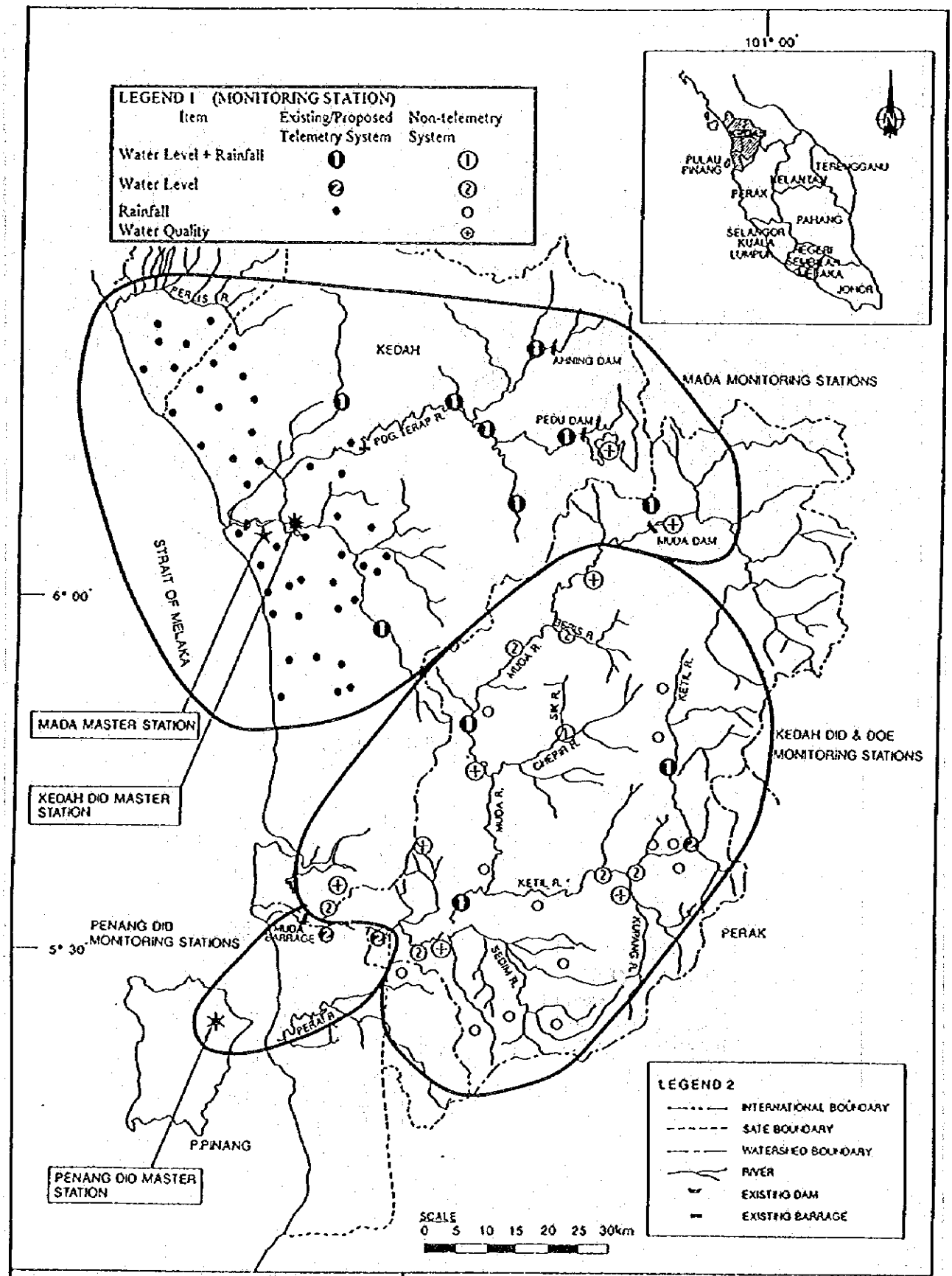
LEGEND

INDUSTRIAL DEVELOPMENT AREA

BOUNDARY OF RIVER RESERVED AREA (Approximate Extent of Flood Inundation for 100-year Return Period)



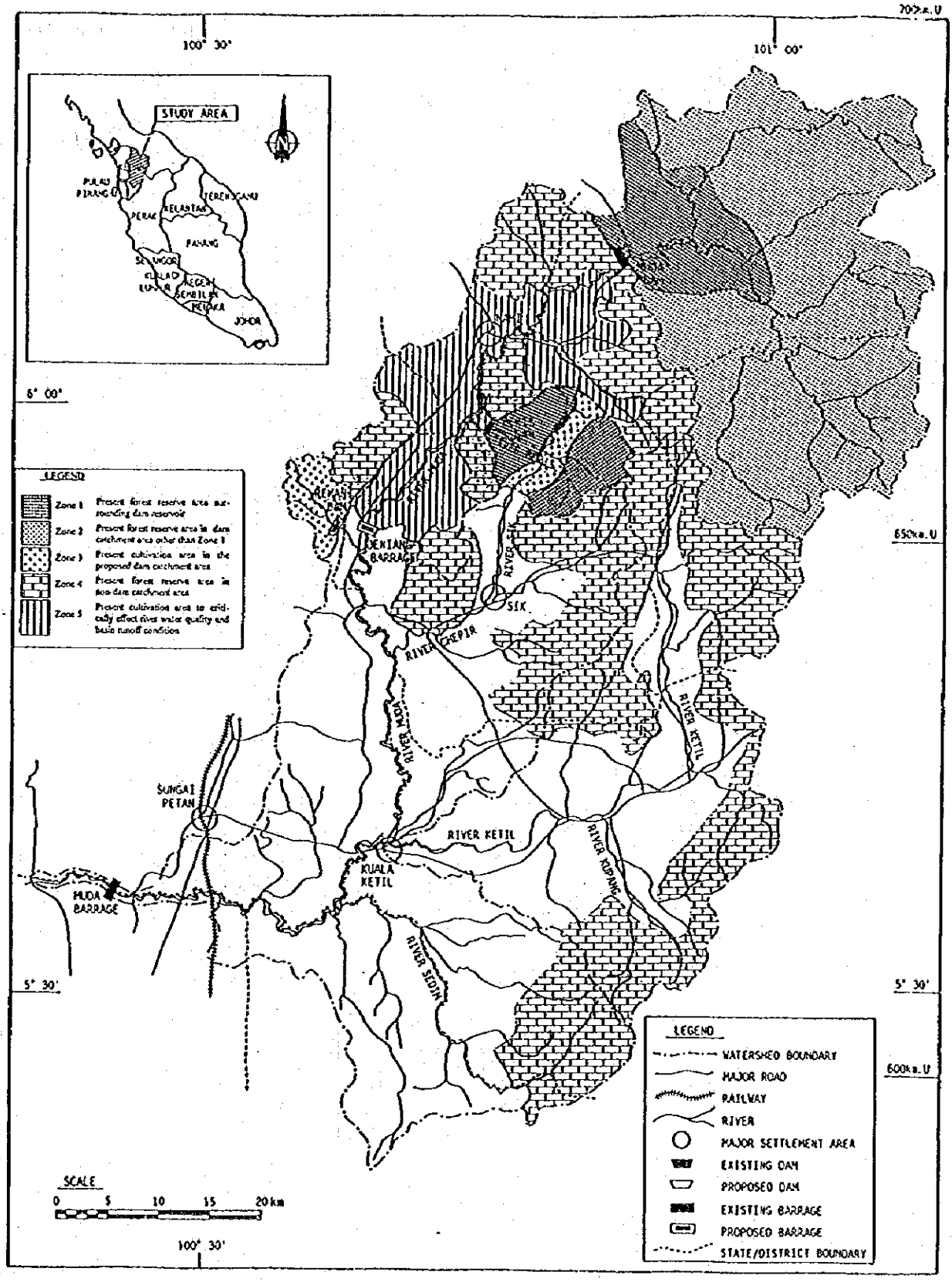
COMPREHENSIVE MANAGEMENT PLAN OF MUDA RIVER BASIN	FIG.V.3.4.2 INDUSTRIAL DEVELOPMENT AREA IN KUALA KETIL
JAPAN INTERNATIONAL COOPERATION AGENCY	



COMPREHENSIVE MANAGEMENT PLAN OF MUDA RIVER BASIN

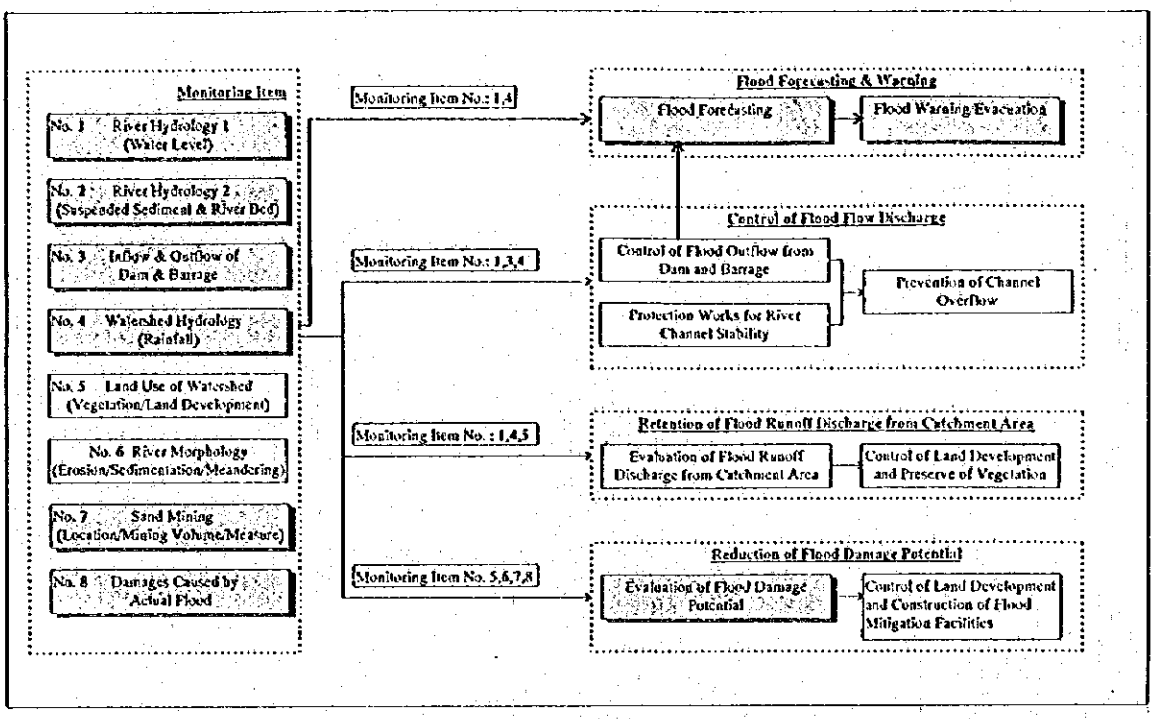
JAPAN INTERNATIONAL COOPERATION AGENCY

FIG.V.4.1.1
PRESENT MONITORING SYSTEM OF MUDA RIVER AND MUDA IRRIGATION AREA

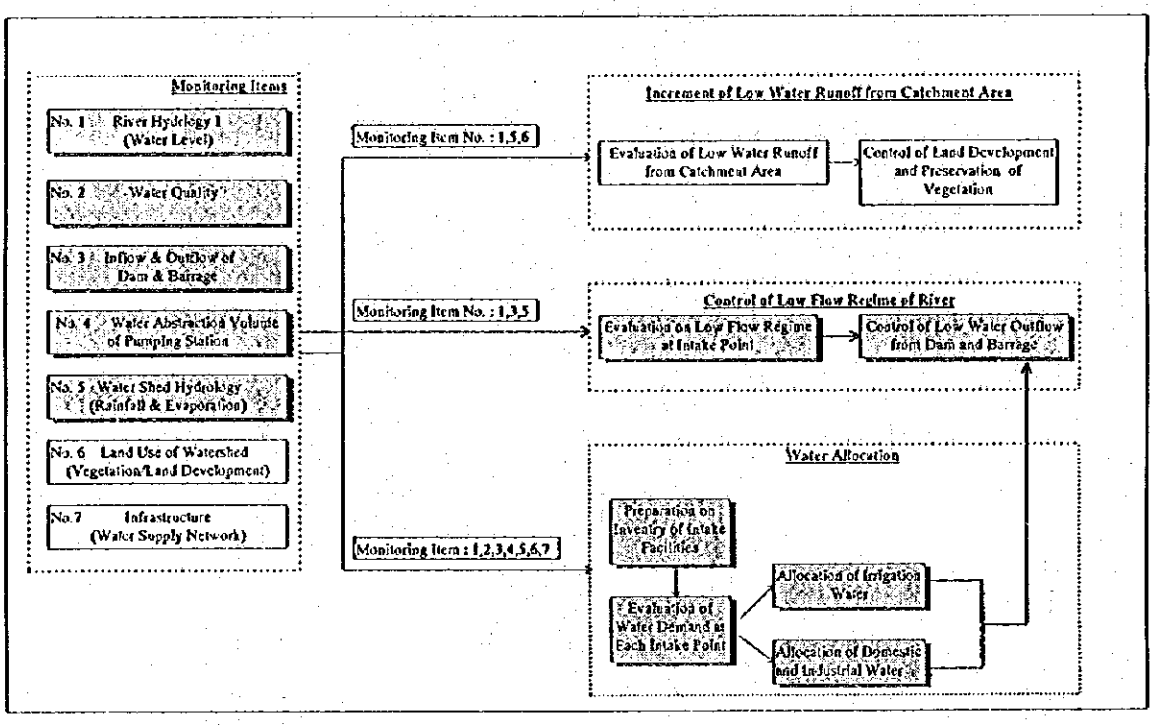


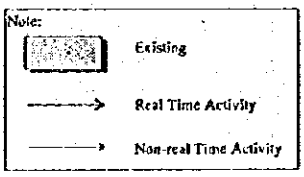
COMPREHENSIVE MANAGEMENT PLAN OF MUDA RIVER BASIN JAPAN INTERNATIONAL COOPERATION AGENCY	FIG. V. 5. 1. 1 PROPOSED ZONING PLAN FOR WATER SOURCE RESERVE AREA

Flood Management



Water Resources Development Management



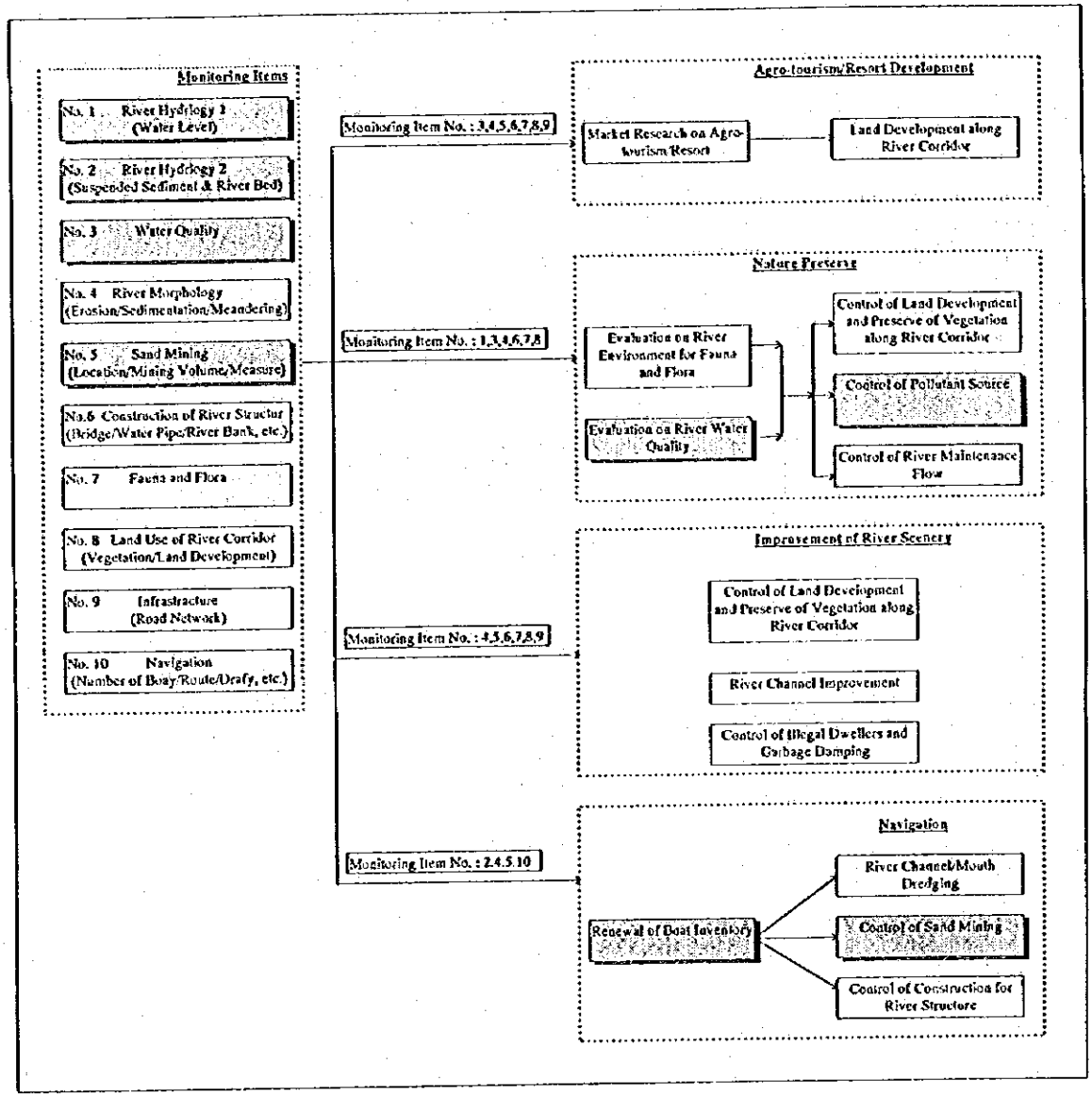


COMPREHENSIVE MANAGEMENT PLAN OF MUDA RIVER BASIN

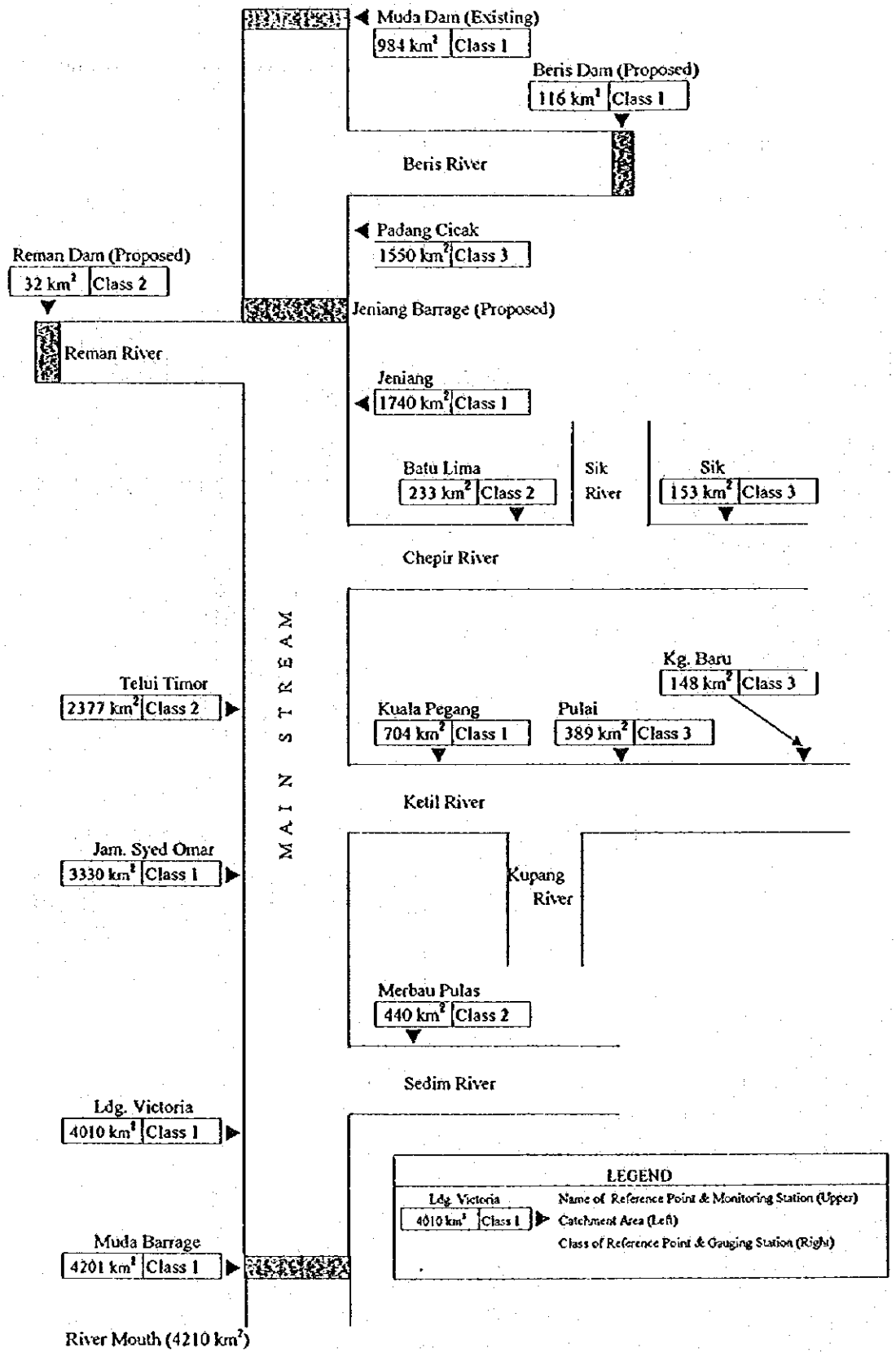
JAPAN INTERNATIONAL COOPERATION AGENCY

FIG. V. 6. 1. 1
DIAGRAM OF PROPOSED MONITORING SYSTEM (1/2)

River Environmental Management



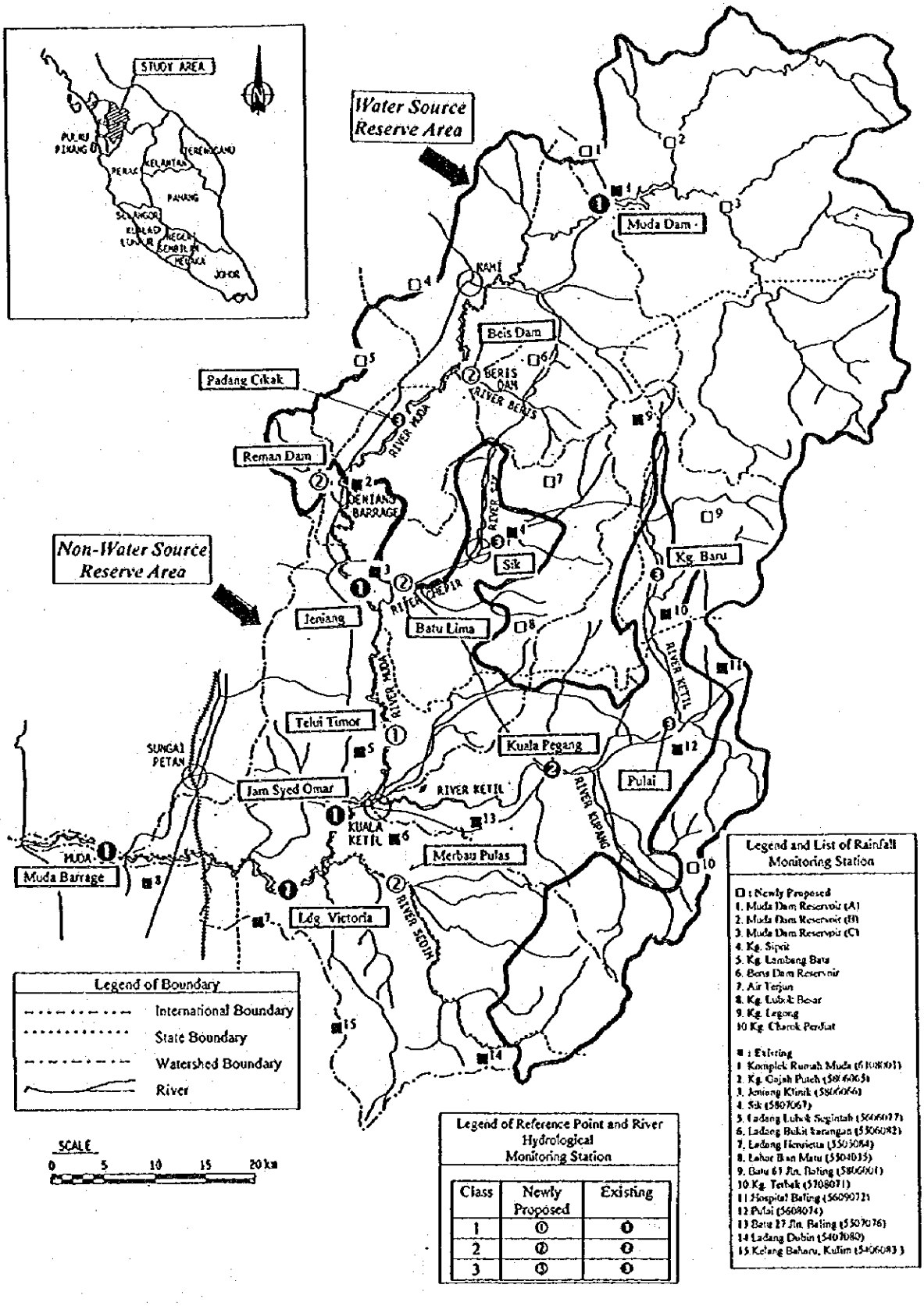
COMPREHENSIVE MANAGEMENT PLAN OF MUDA RIVER BASIN	FIG.V.6.1.1 DIAGRAM OF PROPOSED MONITORING SYSTEM(2/2)
JAPAN INTERNATIONAL COOPERATION AGENCY	



COMPREHENSIVE MANAGEMENT PLAN OF MUDA RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

FIG. V. 6. 2. 1
CONCEPTUAL DIAGRAM OF PROPOSED REFERENCE POINTS AND RIVER HYDROLOGICAL GAUGING STATIONS



COMPREHENSIVE MANAGEMENT PLAN OF MUDA RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

FIG. V. 6. 2. 2

LOCATION OF PROPOSED REFERENCE POINTS AND HYDROLOGICAL MONITORING STATIONS

SECTOR VI

CONSTRUCTION PLAN AND COST ESTIMATE

SECTOR VI
CONSTRUCTION PLAN AND COST ESTIMATE

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LIST OF FIGURES

1. CONSTRUCTION PLAN

1.1 Inventory of Present River Structures

The inventories of relevant river structures such as dams, barrages and pump stations are given in Tables VI.1.1.1 to VI.1.1.5, as described below.

(1) Dam

Muda Dam is the only existing dam in the Muda river basin. The water stored in the reservoir of Muda Dam is diverted through Saiong Tunnel to the adjacent Pedu Dam which is located upstream of Padang Terap River. Ahning Dam which is located on the upper right tributary of Padang Terap River was completed in 1988.

In addition to these existing dams, the previous studies proposed several relevant dams, as shown in Table VI.1.1.1. Among these dams, Beris, Naok of Jeniang Transfer System, and Reman will be the major water supply facilities related to the Muda river basin and their structural features are discussed in Section 1.6.

(2) Barrage

Muda Barrage, the only existing major barrage in the Muda river basin, is situated at around 5 km downstream of the Merdeka Bridge or 10 km from the Muda river mouth. The structural features of the barrage are as shown in Table VI.1.1.2. The barrage is operated and maintained by PWA. In addition, there are several existing and proposed barrages in and around Muda river basin, and their structural features are as shown in Table VI.1.1.2.

(3) Pump Station

(a) Irrigation Pump Station

Major pump stations along the mainstream of Muda River are listed in Table VI.1.1.3. Gravity irrigation and small-scale pump irrigation systems are also located along the tributaries of Muda River (refer to Table VI.1.1.4).

(b) Domestic and Industrial Water Supply Pump Stations

Principal features of domestic and industrial water supply pump stations are given in Table VI.1.1.5.

1.2 Basic Conditions for Plan Formulation

1.2.1 Design Standard

All construction plans of proposed structures are to be prepared in accordance with the following Malaysian standards. Internationally applied standards will also be made as reference.

(a) Urban Drainage Design Standards and Procedures for Peninsular Malaysia, 1975, DID.

(b) Design Manual for Water Conveyance Systems, DID.

(c) Guidelines on Processing of Applications and Determining Conditions for Bridges and Culverts, River Engineering Division, DID.

(d) Guidelines on Processing of Applications for Gas Pipeline Crossing at Rivers, Drains and Canals, 1993, River Engineering Division, DID.

1.2.2 Construction Material

The price of basic construction materials such as cement, reinforcement bars, bitumen, diesel oil, and gasoline is controlled by the Government. The unit prices of these materials including some other major ones are shown in Table VI 1.2.1. Labor wages are also shown in Table VI.1.2.2. The availability of construction materials in and around Muda river basin is described, as below.

(1) Sand

The middle and lower reaches of Muda River is the major source of sand in and around the river basin. The sand mining is being carried out by private firms and fluctuates to a certain extent in accordance with the demand of construction works.

The quality of sand from Muda River is generally good and utilized as fine aggregate for concrete. There are also the following sand quarries in the vicinity of the river basin, however, they are classified as second class and often used for plastering because of mixture with very fine materials.

Location	District	Source
Karangan	Kulim	-
Terap	Kulim	-
Terap	Kuala Muda	Mine tailing

(2) Coarse Aggregate

Gravel is available in Pendang, Sik, Baling and Kulim districts which are located in the middle reaches of Muda River. The size and amount of deposits

vary depending on the location of the mining area. The types of deposit are mainly granite and limestone.

In addition to these quarry sites, Syarikat Bina & Kuari Kedah Sendivian Co., Ltd. has a granodiorite quarry at the foot of Mt. Perak in Pendang District which is located at around 16 km north of the Jeniang Transfer Project site. Crusher run, aggregate for concrete and asphalt are available here.

(3) Cement

The following cement factories are located around the Muda river basin:

Factory	Location	Brand
Cima	Chuping, Pelis	Lion
Kedah*	Langkawi, Kedah	Tiger
Perak-Anjung	Bt. Berapit, Perak	Camel
Tasik Cement	Ipoh, Perak	Crocodile

* Cement produced is mainly for export.

Perak-Anjung Cement was recently established and the other cement manufacturers are also upgrading their production facilities to cater to the increasing demand in the construction sector. Supply of cement has been satisfactory for the past few years.

(4) Steel Material

The manufacturing and supply of steel material is made only by Malayawata Company which is located at Prai industrial area in the State of Penang. Steel products imported from Korea, Japan or some other countries are generally used in construction works.

(5) Timber

Plywood is the typical material of formwork. There are many manufacturers and suppliers, and shortage of the material has never been reported.

1.2.3 Accessibility

Accessibility to the site is described, as follows.

(1) Port of Disembarkation

Three major ports are available for handling international and domestic cargoes. Port Klang near Kuala Lumpur and Butterworth Wharf in Prai are equipped with container handling facilities. Penang Port on Penang Island is also used for unloading bulk cargo; however, container handling facilities are not available.

(2) Road

Penang Island and the mainland are linked by Penang Bridge, the length of which is about 13.5 km. A two-lane north-south national highway is available from Port Klang, Butterworth to Sungai Petani, Gurun and Alor Setar.

(3) Railway

The national railway has a cargo service and connects Port Klang, Butterworth, Sungai Petani and Alor Setar.

1.2.4 Workable Day

The number of holidays and weather conditions especially daily rainfall data are used as the basic data to estimate possible workable days for the construction works.

(1) Public Holiday

Most of the public holidays in Malaysia are based on religious belief or custom. In public offices in Kedah State, Thursday is a half-working day and Friday is non-working day instead of Saturday and Sunday. Thus, Friday, national holidays and religious event days are considered as non-workable days.

(2) Daily Rainfall Records

The daily rainfall records from "Jeniang Klinik" near the proposed Jeniang Barrage were collected and the records from 1979 to 1988 were analyzed.

(3) Possible Workable Day

(a) Concrete Works

Daily rainfall of more than 5 mm is accounted for a non-workable day and the number of possible workable days amounts to 295 annually.

(b) Earthwork

Earthwork is very sensitive to rainfall. Daily rainfall of more than 5 mm is accounted for a non-workable day and suspended days are counted in accordance with the following criteria:

Daily Rainfall (mm)	Suspended Days
5 < R <1 0	0
10 < R < 15	0
15 < R <3 0	1
30 < R	3

The number of workable days is calculated at 212 annually.

(c) Daily Working Hours and Work Shift

All construction works will be implemented under a single shift of 9-hour labor including 2-hour overtime per day.

(4) Construction Method

Standard construction methods will be adopted in combination with the equipment available in Malaysia and other foreign countries.

1.3 Structures on the River Channel Improvement Section

The information on existing structures of the river channel improvement section, such as bridges, pump stations, dikes, and barrages were collected as the basic data for the construction plan. The relevant drawings, information and major findings through the field investigation were summarized, as follows:

(1) Pump Station

There exist 13 pump stations along the proposed river channel improvement section stretching downstream of Muda River. One pump station is also located at the pondage area of the proposed Jeniang Barrage.

Item	Pump Station	Cross Section	Location (Bank)	Flood Water Level (m)	Type of Information
1	Kota II	No. 12+850	Right	3.81	Drg.,W.L.
2	Pekula	No. 14+500	Right	3.98	N.A.
3	Bumbung Lima	No. 15+200	Left	4.39	W.L.
4	Lahar Tiang	No. 23+200	Left	-	W.L.
5	Pinang Tunggal	No. 24+750	Right	5.49	N.A.
6	Sungai Petani	No. 25+350	Right	-	Drg.
7	Pinang Tunggal	No. 25+600	Right	-	Drg., W.L.
8	Kelim	No. 26+150	Right	-	Drg., W.L.
9	Pinang Tunggal	No. 27+050	Left	7.01	W.L.
10	Terat Batu	No. 31+750	Left	-	N.A.
11	Pantai Perai	No. 32+150	Right	6.40	Drg.
12	Sidam Kiri	No. 39+450	Right	-	Drg., W.L.
13	Sidam Kanan	No. 40+000	Left	-	Drg.
14	Jeneri	No. 109+1,700	Right	-	Drg., W.L.

Note: Drg. = Drawing; W.L. = Operational water level; N.A. = Not available; Flood water level = Flood in 1988

These pump stations are categorized as follows:

(a) Pump Stations in Pulau Pinang

Three pump stations in Pulau Pinang, Bumbung Lima, Lahar Tiang and Pinang Tunggal, are located on the outer bank of the meandered section of Muda River. Around 500 m of channel connects to each pump station, where the dikes are also aligned in parallel with the connecting channel to

prevent the station from flooding. Previous floods had never reached the floor level of the three stations and no damage has been reported.

(b) Pump Stations in Kedah

The pump stations in Kedah are classified in three types in accordance with their ground conditions and structures.

(i) Vertical Type

Pumps and suction pipes are aligned vertically at the edge of the river banks, where the ground level is rather steep and high from the water level. The pump stations of Sidam Kanan and Sidam Kiri belong to this type

(ii) Inclined Type

Pumps are installed on the riverbanks apart from the waterway and the suction pipes are laid on the banks accordingly. The slope of such riverbanks is generally mild. The pump stations of Terat Batu, Pantai Perai, Pinang Tunggal (PWD, Kedah) and Sungai Petani (PWD, Kedah) belong to this type.

(iii) Forebay Type

A forebay is placed in front of a pump house where the elevation of the riverbank is not so high from the river water level. The pump stations of Pinang Tunggal (DID, Kedah), Pekula and Kota II belong to this type.

Terat Batu is the only one pump station where the flood water reached above the floor of the pump house (around 0.5 m in depth) in 1988, however, there was no damage to the facilities. As for Pekula Station, the flood water rose up almost to the floor level of the pump house at that time.

(c) Kulim Pump Sation

The station located on the right bank of Muda River near Pinang Tunggal Railway Bridge is now under construction. The concrete structure of pump house and intake chamber is already completed; whereas; the up- and downstream guidewalls composed of sheet piles, tie rods and stay blocks are at their final stage of construction. The intake chamber occupies the original river course to a certain extent, where the width of the river is rather narrow. The cross-sectional area of the river has been reduced and this will hinder the river channel flow and cause higher flood water level.

(d) Jeneri Pump Station

The station located on the right bank of Muda River near Kg. Gajah Puteh (near the proposed Jeniang Barrage) has a concrete intake chamber and will not cause a disturbance to the river flow judging from its location.

(2) Bridges

(a) Piers

Along the river channel improvement section, there exist 14 bridges and the data and information obtained are given in Table VI.1.3.1

Two water main pipe bridges located at Pantai Perai have concrete pile piers with the span of 12 m. Such type of piers is liable to cause turbulence flow; hence, severe scouring around piers would occur during floods. In addition, flushed logs and rubbish may be clogged at the piers and then decrease the cross-sectional area of river. This may be one of the reasons why the flood water in 1988 reached above the floor level at Terat Batu Pump Station located around 100 m upstream of the bridges. Monitoring of the bridges during big floods is recommended to ensure safety.

(b) Footing

The footing of piers is designed to be below the riverbed in consideration of lowering of the riverbed due to scouring and/or channel improvement works. All the footings of Sidam Kiri Bridge and those of the Expressway Bridge are undermined although they have supporting piles underneath. With reference to the design drawings of the Expressway Bridge and the bridge at Kg. Titi Panjang, the footings in the river course are placed above the riverbed instead of placing them in the riverbed. In view of the safety and durability of bridges, designing the footing below the riverbed is recommended even if supporting piles are provided.

(3) Other Structures

(a) Sluiceway

There are some tributaries, drainage and creeks flowing into Muda River and sluiceways have to be provided at the confluences with the river improvement stretches.

(b) River Bund and Dikes

The river bund and dikes are well developed on the left bank of Muda River, especially in Pulau Pinang; however, it is feared that such dikes aligned on only one side of the river may cause inundation to the other side.

The drawings of the quarry stone dikes at the river mouth of Muda River were provided by the Public Works Department of Pinang State. Also, the PWA provided the drawings of Muda Barrage.

(c) Transmission Lines

Two national grid transmission lines cross Muda River near the Merdeka Bridge. The transmission towers on the left bank are rather close to the river (around 50 m away),while those on the right bank are around 120 m away from the river.

1.4 Implementation Schedule

The implementation schedule is proposed, as shown in Fig. VI.1.4.1.

Detailed design and tender document for Beris Dam are already completed. Survey for compensation is in the final stage.

The construction of Beris Dam is to be implemented in the 7th Five-Year Malaysia Plan.

Detailed design, tender document and compensation survey for Jeniang Transfer System (including Naok Dam) and Reman Dam are also to be implemented in the 7th Malaysia Plan.

River improvement work for the tributaries of Muda River is to be implemented earlier than that of Muda River in view of the following reasons:

(a) The flood prone areas along the tributaries are rather densely populated and receive more frequent damage than the main stream, so that the benefit is generated immediately after the completion of work.

(b) Construction cost for the tributary-improvement is rather small and this would ease the early implementation in parallel with the Jeniang Transfer System (including Naok Dam).

(c) The improvement at Baling and Sik stretch can be executed independently from the improvement works for the mainstream.

(d) As for the improvement at Kuala Ketil, the mainstream stretch, downstream of the confluence, should be commenced earlier than the tributary, Ketil River, because the flood discharge capacity is dependent on the mainstream.

(e) The improvement work on the downstream stretch of Muda River is to be executed from downstream (River Mouth) to upstream.

(f) The construction of New Muda Barrage and its adjacent improvement sections should be started prior to the improvement of Muda River in consideration of its function and construction period.

(g) Environmental improvement works may be divided into two stages. The first stage is the reservoir environmental improvement related to Beris and/or Muda reservoirs. The second stage is the river environmental improvement related to the river improvement projects on Muda River and its tributaries.

1.5 Major Structures to be Constructed/Renovated

To meet the flood control plan, the existing river crossing structures are to be reconstructed or renovated and such major structures planned are explained as follows.

(1) Muda Barrage

A new barrage equipped with shell type roller gates is planned, and the total width is 185 meters. The river section is 175 m (7 spans × 25 m for each span) and the rest of the 10 m span is utilized for lock structure for navigation and fishway. The new barrage site is located on the right bank, immediately upstream of the existing barrage, where the old river course was formed. Temporary coffer is not necessary here and the dry works for foundation can be easily attained. The plan is shown in Fig. VI.1.5.1.

(2) Bridges

(a) Merdeka Bridge

With reference to the drawing of Merdeka Bridge, the foundation of piers on the existing riverbanks (outside the river course) was not designed as that of the piers in the water. These riverbanks are to be excavated for the low-water course based on the river channel planning and underneath the footing of piers is also excavated.

Three main spans are to be left and the rest of the approach sections are planned to be reconstructed. Some cracks are found on the concrete beams on the approach section.

(b) Expressway Bridge

As mentioned above, the footings of piers were originally designed above the riverbed. The riverbed protection with concrete blocks underneath the bridge and the reinforcement underneath the footings are planned for renovation.

(c) Railway Bridge

The bridge at Pinang Tunggal is located at one of the narrowest sections of Muda River and the existing abutments and piers are placed on the riverbanks. The river channel at this section is to be widened almost twice as that of the existing width and three piers on the left bank will be enclosed in the low water course. Reconstruction of new bridge is planned

around 15 m downstream of the existing bridge. The relocation plan is shown in Fig. VI.1.5.2.

(d) Water Pipe Bridges

With reference to the drawings of the two water pipe bridges at Pantai Perai, the concrete piles are not driven deep enough into the riverbed. The existing riverbed is to be excavated to reach the planned riverbed elevation, therefore, a new bridge bearing two water pipes together with pedestrian/motor cycle load is required. The span of piers would preferably be more than 20 m.

(e) Sidam Kiri Bridge

The riverbed is undermined seriously, however, the riverbed protection with concrete blocks and the reinforcement underneath the footings are taken into consideration.

(f) Sisik Lantai Bridge

A new bridge (3 m wide and 130 m long) is to be provided on the shortcut section of Muda River at Kuala Ketil stretch to connect Kg. Sisik Lantai.

(3) Sluiceways

Mainly, on the downstream stretch of Muda River, sluiceways are planned at the confluence with the tributaries and drainage outlets. Roller gates are equipped with the sluice structures at the confluence with the tributaries and slide gates are provided for the sluices of drainage outlets. Such sluices are categorized, as shown in Fig. VI. 1.5.3.

(4) Transmission Tower

The footings of two transmission towers near the Pekula Pump Station are to be enclosed with the low water course; therefore, an island protected with sheet piles is envisaged.

1.6 Structural Features of Major Water Supply Facilities

Beris Dam, Naok Dam of Jeniang Transfer System and Reman Dam are selected as the major water supply facilities, as described before. The main features of these facilities are explained, as follows.

(1) Beris Dam

The following main features were extracted from the "Beris Dam Detailed Design Report." Layout plan, typical cross section and face-slab plan are shown in Figs. VI.1.6.1 and VI.1.6.2.

(a) Reservoir

Catchment Area	116 km^2
Average Annual Inflow	112.5 MCM
Probable Maximum Flood (PMF) Inflow Peak	
Short Duration Storm	3,513 m^3/s
Long Duration Storm	2,015 m^3/s
Maximum Pool Level	El. 86.40 m
Normal Pool Level	El. 84.00 m
Lowest Pool Level	El. 68.00 m
Surface Area	
At Normal Pool	13.7 km^2
At Maximum Pool	16.1 km^2
Reservoir Capacity	
Gross	112.4 MCM
Effective (bet. El. 68.0 m and 84.0 m)	114.0 MCM

(b) Main Dam

Type	Concrete face rockfill dam
Maximum Height	40.0 m
Top of Parapet Wall	El 89.0 m
Crest Level of Roadway	El. 88.0 m
Crest Length	155 m
Crest Width	6 m
Upstream Slope	1V : 1.5H
Downstream Slope	1V : 1.5H
Embankment Volume	158,000 m^3

(c) Spillway

Type	Overflow ogee with side channel, chute and bucket
Crest Level	El 84.0 m
Crest Length	30 m
Design Discharge	266 m^3/s
Chute Length	89 m
Energy Dissipator	Flip bucket with invert at El. 53.0 m and lip at El. 54.0 m

(d) Conduits

Type	Steel penstock
No. and Size	2 units, 1.5 m dia.
Length	180.6 m left side; 183.7 m right side
Design Discharge	15 m^3/s per conduit

(e) Valves

Type	Fixed cone
No. and Size	2 units, 1.22 m dia.
Gate Valve	0.3 m dia.
Regulation Valve	0.3 m dia.

(f) Saddle Dam

Type	Earth core rockfill
Maximum Height	27 m
Crest Level	El. 89.0 m
Crest Length	200 m
Crest Width	6 m
Upstream Slope	1V : 2.0H
Downstream Slope	1V : 1.8H
Embankment Volume	120,000 m^3

(2) Jeniang Transfer System

The following main features were extracted from the Feasibility Study for Proposed Jeniang Diversion, Naok Reservoir and Transfer Canal. The plan view and typical cross sections of the Jeniang Diversion Barrage are shown in Fig. VI.1.6.3 and Fig. VI. 1.6.4, respectively. The typical sections of diversion canal are also shown in Fig. VI.1.6.5.

(a) Jeniang Barrage

Design Peak Flood	720 m^3/s (200-year return period)
Maximum Upstream Water Level	El. 34.13 m
Normal Design Level	El. 34.00 m
Normal Operating Level	El. 32.00 m
Crest Width (11 m x 3)	El. 33.00 m
Crest Level	El. 27.50 m
Upstream Bed Level	El. 27.00 m
Apron Level	El. 25.50 m
Downstream Water Level	El. 33.70 m
Stilling Basin	
Length (downstream of the sill)	29 m
Slab Elevation	El. 25.50 m
Intake	
Sill Elevation	El. 29.00 m
Channel	Two channels of 2.75 m(W) × 39 m(L)

(b) Transfer and Conveyance Canals

Transfer canal starts from the intake at Jeniang Barrage and ends at Naok Dam. The conveyance canal is from Naok dam to the southern canal of MADA Irrigation System. The outline of both canals is as follows:

Description	Transfer Canal	Conveyance Canal
Length (km)	8	22
Max. Capacity (m^3/s)	40	40
Normal Upstream Water Level (m)	32	--
Bed Width (m)	12	10
Depth (m)	3.7	3
Side Slope (cut)	1 : 1.5	1 : 1.5
Side Slope (Compacted Fill)	1 : 2	1 : 2
Berm Width (m)	3	3
Freeboard (m)	1	1
Road Width (m)	3.5	3.5
Bed Gradient	1 : 12,000	3 : 10,000
Discharge (m^3/s)	40	40
Max. Velocity (m/s)	0.62	0.96
Manning's Coefficient (n)	0.028	0.028

(3) Naok Dam

The following main features were extracted from the Feasibility Study for Proposed Jeniang Diversion, Naok Reservoir and Transfer Canal, 1984. The site plan and typical cross sections of Naok Dam are shown in Fig. VI.1.6.6 and VI.1.6.7.

(a) Reservoir

Catchment Area	15 km^2
Top Water Level	El. 30.00 m
Min. Drawoff Level	El. 20.00 m
Surface Area	5.7 km^2
Reservoir Capacity	
Effective	27.4 MCM

(b) Dam

Type	Earthfill dam
Max. Height	18 m
Crest Elevation	El. 32 m
Crest Length	2,750 m
Crest Width	7 m
Upstream Slope	1V : 4H
Downstream Slope	1V : 3.5H
Embankment Volume	2,200 x $10^3 m^3$

(4) Reman Dam

The following main features were extracted from the Final Report of the Feasibility Study on Reman Reservoir Project, 1984. The layout plan, typical cross sections and profile of waterway of Reman Dam are shown in Figs. VI.1.6.8 to VI.1.6.10.

(a) Reservoir

Catchment Area	32.2 km^2
Probable Maximum Flood (PMF) Inflow Peak	1,800 m^3/s
Max. Pool Level	El. 58.3 m
High Water Level	El. 57.0 m
Low Water Level	El. 36.5 m
Surface Area	17.6 km^2
Reservoir Capacity	
Gross	283 MCM
Effective	240 MCM

(b) Main Dam

Type	Zoned rolled-fill
Max. Height	40 m
Crest Elevation	El. 60.0 m
Crest Length	170 m
Crest Width	10 m
Upstream Slope	1V : 2.4H
Downstream Slope	1V : 2.3H
Embankment Volume	286,000 m^3

(c) Saddle Dams

Type	Homogeneous earthfill
Number	8
Height	
No. 1	11.0 m
No. 2	14.5 m
No. 3	12.0 m
No. 5	10.0 m
No. 8B	7.5 m
No. 8C	3.5 m
No. 9A	6.0 m
No. 9B	80.0m
Crest Elevation	El. 60.0 m
Total Crest Length (8 dams)	1,282 m
Crest Width	8 m
Upstream Slope	1V : 3.0H
Downstream Slope	1V : 2.7H
Total Embankment Volume (8 dams including blanket)	273,000m^3

(d) Emergency Spillway

Type	Fuse-plugged overflow
Crest Elevation (Overflow Weir)	El. 57.0 m
Width	30 m
Capacity	70 m^3/s

(e) Tunnel

Type	Concrete-lined
Section	Circular
Inside Diameter	3.5 m
Length	270 m

(f) Pipeline

Type	Steel
Section	Circular
Inside Diameter	2.8 m to 3.5 m
Length	100 m

(g) Pump Station

T.W.L.	El. 30.3 m to 30.8 m
Type of Pump	Induction motor-driven mixed flow
No. of Pump Units	4 (including 1 standby unit)
Capacity	3 units × 5 m^3/s
Operating Head of Pump	5.8 m to 30.2 m
Power for Motors	3 units × 2,250 kW

(h) Release Valve

Type	Hollow jet valve
No. of Valves	2
Diameter	2.8 m
Capacity	2 units × 20 m^3/s

(i) Conveyance Canal

Type	Reinforced concrete for upstream portion and earth for downstream portion
Section	Rectangular for upstream portion and Trapezoidal for downstream portion

2. PROJECT COST ESTIMATE

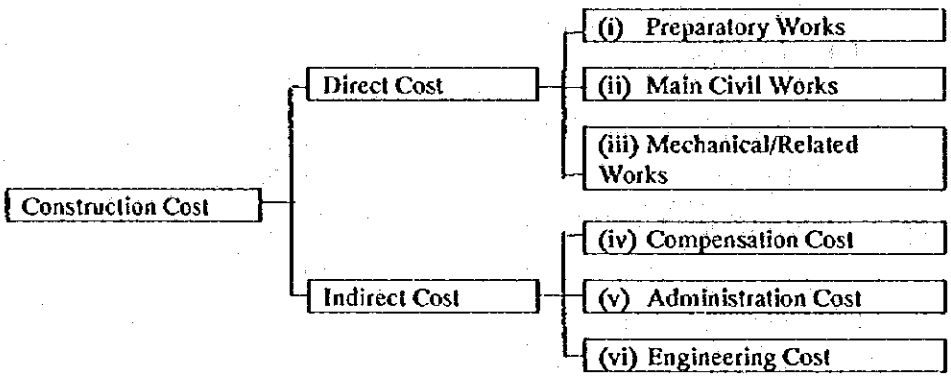
2.1 Basic Conditions

The project cost is estimated on the basis of the design, construction plan and schedule, and the following assumptions and conditions.

(a) All unit costs are expressed based on the price level at the end of 1994.

(b) The exchange rate of currency is US$1.00 = RM 2.51

(c) The project cost is composed of construction cost and contingency. The construction cost is divided into direct cost and indirect cost, as follows:



(d) The calculation of costs is carried out as follows:

Preparatory Works = 10% of (ii) Main Civil Works and (iii) Mechanical/Related Works

Main Civil Works = Work Quantities x Unit Prices

Mechanical Works = Estimated in accordance with the work quantities

Compensation Cost = Area of land and/or number of houses x Unit compensation cost

Administration Cost = 5% of Items (i) to (iv)

Engineering Cost = 10% of Items (i) to (iii)

(e) Contingencies consist of physical contingencies and price escalation.

Physical Contingencies = 10% of Items (i) to (vi)

Price escalation rate of foreign currency portion and that of local portion is 3% and 3.5%, respectively.

2.2 Other Conditions for Cost Estimate

(1) Flood Control Facility

The cost of flood control facility and relevant structures are generally estimated based on the basic conditions explained in the preceding paragraph. The unit construction cost applied for the flood control facilities is shown in Table VI.2.2.1.

(2) Water Supply Facilities

To clarify the economic viability of the whole river system of Muda River, the project costs for the proposed water supply facilities are estimated for the sake of economic analysis. The proposed facilities include Beris Dam, Jeniang Transfer Canal and Naok Dam, and Reman Dam. The project cost for the facilities were previously estimated and the review work on the previous estimation was made on the following items.

(a) Beris Dam

The project cost was estimated in the price level of 1994, but details are confidential and not collected. Therefore, the review has been made based on some detail design technical reports and other collected materials.

(b) Jeniang Transfer System including Naok Dam

The price level of the previous estimation is as of 1983. The quantity by construction work item is very limited especially for Naok Dam; therefore, the rate of price escalation is applied for the estimation.

(c) Reman Dam

The price level is as of 1983. The quantity by construction work item is available, therefore, the unit construction cost shown in Table VI.2.2.2 was applied.

(3) Compensation Cost

The following unit costs for land acquisition and compensation for house evacuation ere estimated, referring to the actual price in and around the Muda river basin.

Item	Unit	Unit Price (RM)
Land Acquisition		
Paddy Land (Irrigated)	ha.	50,000
Paddy Land (Non-irrigated)	ha.	21,000
Estate	ha.	25,000
Orchard	ha.	30,000
Residential (Suburbs)	ha.	25,000
Residential (Urban)	ha.	70,000
House Evacuation		
Suburbs	no.	25,000
Urban	no.	70,000

(4) Operation and Maintenance Cost

The annual operation and maintenance costs include the salaries of project administrative and operational staff, the material and labor costs for operation, repair and maintenance of O&M equipment, and replacement and running costs for the project facilities. The annual O&M costs were estimated to be 0.5% of the total direct construction cost.

2.3 Project Cost Estimate and Annual Disbursement

The project costs estimated are shown in Tables VI.2.3.1 to VI.2.3.11 and summarized below. Annual disbursement on each project has been estimated based on the implementation schedule and shown in Tables VI.2.3.12 to VI.2.3.19.

Unit: RM 1,000

Name of Project	F.C.	L.C.	Total
Beris Dam	75,505	100,056	175,561
Jeniang Transfer System	56,576	109,509	166,086
Reman Dam	49,750	78,806	128,556
Muda Downstream Improvement	171,143	152,443	323,586
Kuala Ketil Stretch Improvement	6,994	11,270	18,264
Baling Stretch Improvement	3,031	6,779	9,810
Sik Stretch Improvement	2,212	5,138	7,350
River Environment Improvement	10,977	31,224	42,201

TABLES

SECTOR VI

CONSTRUCTION PLAN AND COST ESTIMATE

TABLE VI.1.1.1 PRINCIPAL FEATURE OF DAMS ON MUDA RIVER AND ADJACENT BASIN

Feature / Name of Dam	River system	Year of completion	Purpose***	Reservoir				Dam					Operation	Remarks
				C.A (km2)	S.A (km2)	NHWL (m)	Ve**** (10 m3)	Type	Crest elevation (m)	Crest length (m)	Dam Height (m)	Dam volume (1,000 m3)		
<Existing>														
Muda	Muda	1968	I	984.0	26.0	100.6	160.0	Concrete buttress	106.0	250	37	30	MADA	
Pedu	Kedah	1969	I	171.0	65.0	97.5	1,049	Rock fill	101.0	220	61	580	MADA	
Ayer Hitam	Ayer Hitam	1962	W	6.1	0.2		2.5	Earth	234.2	210	51.8	2.6	PWA	
Ahning	Kedah	1988	W,I,P	120.0	9.0	113.0	200.0	Concrete facing	-	-	-	750	MADA	
Timah-Tasoh	Perlis		F,I	150.0	12.2	27.4	37.0	Earth	-	4,300	10	-	DID	
Mengkuang	Mengkuang	1985	W	3.9	1.7	43.3	23.0	Earth	-	792	31	24	PWA	
<Final Design>														
Naok	Muda		I	15.0	5.7	30.0	27.4	Earth	33.0	2,750	18	2,200		F/S completed in 1985
Beris	Muda		I	116.0	13.7	84.0	114.0	Concrete facing	88.0	155	40	158		Completed 1994 F/S 1985
<C/D>*														
Arau	Perlis	-	F	58.0	5.5	23.6	25.0	Earth	-	900	-	-	-	
<F/S>**														
Reman	Muda		I	32.2	17.6	57.0	240.0	Rock fill	60.0	170	40	286		Completed 1984
<Planned>*****														
Tawar Muda	Muda		I	129.0	9.1	77.0	54.0	Rock fill		337	34	281		Planned by PWD
Durian	Kedah		I	74.0	4.6	74.0	41.0	Rock fill		697	39	1,056		
Sari	Kedah		I	61.0	3.3	85.0	32.0	Concrete		150	41	50		
Badak-Temin	Kedah		I	112.0	9.4	45.0	58.0	Rock fill		1,013	29	67		
Merbok	Merboc/ Muda		I,W	-	13.0	9.5	110	Earth	-	-	-	-		
Ma	Muda		I	40.0	4.0	75.0	35	Rock fill		500	30	700		
Rui	Rui/Muda		I,P	278/305	9.1/10.7	241/238	205/230	Rock fill		436/283	73	2,387/1,634		
Khlong Thelpha	Kedah		I	173.0	16.0	125.0	78	Rock fill		600	50	800		

*<F/S>: Feasibility Study, **<C/D>: Conceptual design, ***I: Irrigation, W: Water Supply (Domestic/Industrial), P: Hydro Power, F: Flood Mitigation,
****Ve: Active Storage, *****Source: F/S of Jeniang Diversion, Naok Reservoir & Transfer Canal

TABLE VI.1.1.2 PRINCIPAL FEATURE OF BARRAGES ON MUDA RIVER AND ADJACENT BASIN

Item / Name of Facility	River system	Year of completion	Purpose***	Principal Features					O/M	Remarks
				C.A (km2)	Gate Type	No(s). of Gate	Length (m)	NHWL (m)		
<Existing>				***						
Muda	Muda	1972	W,I,T	4,201	Radial	6	82.3	2.4	PWA	Gate Width = 12.2m
Pelubang	Kedah	1969	I	1,247	Overshot leaf gate	5		7.7	MADA	Gate Width = 5.4m
Kedah	Kedah	1970	I,T		Roller	7			MADA	Gate Width = 16.2m
Perai	Perai		D,I,F		Roller				PWA	(Double stage)
<Planned>										
Jeniang	Muda	F/S (1984)	I,W	1,651	Roller	3	39.0	32.0		Including Muda dam catchment

* W: Water Supply, I: Irrigation, T: Tidal Control, F: Flood Control

TABLE VI.1.1.3 PRINCIPAL FEATURE OF MAJOR IRRIGATION PUMP STATIONS

Feature / Name of scheme or pump station	Year of completion	Engine				Pump				** Irrigation area (ha)	Remarks
		* Energy	Nos. of Unit	Manufacturer	H.P	Type	Discharge dia. (cm)	Capacity (cm3/sec)	Total head (m)		
<Existing>											
-Kedah State-											
Padang Cicak	1984	D	2	Andoria	67	Axial	30.5	0.14	10.6	51	
Pantai Cicak	1985	D	2	Isuzu	18	Centrifugal	30.5	0.08	5.6	40	
Lubok Kiab	1986	D	2	Kubota	10	Centrifugal	20.3	0.07	4.3	53	
Kg. Kemumbong	1986	D	3	Kubota	11	Centrifugal	20.3	0.07	4.3	55	
Sidam Kanan	1987	E	3	BBC	60.3	Axial	45.7	0.23	4.9	500	
Sidam Kiri	1987	E	3	BBC	27.6	Axial	40.6	0.34	4.7	219	
Terat Batu	1987	E	2	ABS	12	Centrifugal	45.7	0.08	6.8	28	
Pantai Prai	1981	D	3	Andoria	80	Axial	48.3	0.51	6.1	259	
Pinang Tunggal	1986	E	3	BBC	-	Axial	40.6	0.34	4.3	279	
Pekula	1986	E	3	ABS	-	Vertical	71.1	1.27	3.8	1,557	
Kota II	1986	E	4	BBC	90	Axial	91.4	1.73	4.6	2,149	
-Penang State-											
Pinang Tunggal	1964	E	2	Lancashire	350	Axial	127.0	3.82	4.5	898	
	1980	E	1	ASEA	375	Axial	142.2	3.82	4.9	173	
Bumbung Lima	1967	E	1	AEI	495	Axial	127.0	5.66	3.8	6,945	
	1957	E	3	Metrol Vickers	160	Axial	96.5	2.83	3.9	-	

*D: Diesel, E: Electricity

** There are some discrepancy in the figure depending on the source

TABLE VI.1.1.4 PRINCIPAL FEATURE OF MINOR IRRIGATION FACILITIES ON MUDA RIVER BASIN

Feature / Name of scheme or pump station	Name of Tributary	Year of completion	Engine				Pump				** Irrigation area (ha)	Remarks
			* Energy	Nos. of Unit	Manufacturer	H.P	Type	Discharge dia. (cm)	Capacity (cm3/sec)	Total head (m)		
<Existing>												
-Kedah Central-												
1. Kg. Parit	Jeneri		G						0.40		192	
2. Tanjung Sik	Chepir		G						0.25		91	
3. Tanjung Besar	Chepir	1979	D	3	Andoria	35	Axial	55.9	0.23	11.0	172	
4. Teloi	Chepir	1984	D	3	Kubota	16	Axial	25.4	0.08	11.6	71	
5. Tanjung Pari	Ketil	1982	G						0.28		98	
6. Kg. Luar A	Ketil	1986	D	3	Yanmar	19	Centrifugal	20.3	0.08	17.7	170	
Kg. Luar B	Ketil	1986	D	3	Yanmar	19	Centrifugal	20.3	0.06	13.3		
Kg. Luar C	Ketil	1986	D	3	Yanmar	15	Centrifugal	20.3	0.06	11.1		
7. Spg. Empat	Ketil		G						0.11		28	
8. Pulai	Ketil	1986	D	3	Daihatsu	18.5	Axial	30.5	0.08	9.5	239	
9. Sungai Tiak	Ketil	1982	G						0.08		109	
10. Kg. Iboi	Ketil		G						0.37		156	
11. Kg. Landak	Ketil	1980	D	2	S 320 ER	18	Centrifugal	30.5	0.14	12.0	40	
12. Sungai Limau	Ketil	1988	E	3	ABS		Axial		0.08		85	
13. Kg. Tawar	Ketil		G						0.20		40	
14. Kg. Badang	Sedim		G						0.20		50	
15. Kg. Mempelam	Sedim	1980	G						0.20		67	
16. Ulu Sedim/Si Pute	Sedim		G						0.34		114	
17. Ulu Bakal	Sedim		G						0.23		75	
- Kedah South -												
18. Merbau Pulas	Sedim										95	
19. Pdg. Meha/Pagar Museh	Karangan										150	
20. Titi Karangan	Karangan										225	

*G: Gravity irrigation, D: Diesel, E: Electricity

SOURCE: STATE DID (Kedah Central Office)

TABLE VI.1.1.5 PRINCIPAL FEATURE OF DOMESTIC/INDUSTRIAL WATER SUPPLY PUMP STATIONS

Feature / Name of scheme or pump station	Year of completion	Engine				Pump				Intake volume (mgd)	Remarks
		Energy	Nos. of Unit	Manufacturer	Kw/ H.P.	Type	Discharge dia. (cm)	Capacity (m3/sec)	Total head (m)		
<Existing>											
-Kedah State-											
Nami, Sik	1990	Electricity	2	KSB Pump Ltd.	20 Kw	Submersible	20	2.77	22.0	0.88	
Lubuk Merbau, Pendang	1968	Electricity	2	Kirloskar	10 Kw	Centrifugal	15	0.02	24.4	0.30	
Jeneri, Sik	1992	Electricity	4	KSB Pump Ltd.	28 Kw	Submersible	20	3.06	31.0	1.90	
Jeniang, Sik	1990	Electricity	4	KSB Pump Ltd.	64 Kw	Submersible	40	5.53	29.0	3.20	
Batu Lima, Sik	1992	Electricity	4	KSB Pump Ltd.	30 Kw	Submersible	40	3.58	24.0	2.20	Chepir River
Teloi, Baling	1988	Electricity	2	Tsurumi		Submersible	25	0.05	48.0	0.47	
Sungai Limau, Baling	1991	Electricity	4	KSB Pump Ltd.	63 Kw	Submersible	40	6.30	30.0	4.00	Kuala ketil
Kuala Ketil, Baling	1991	Electricity	2	KSB Pump Ltd.	58.5 Kw	Submersible	20	10.76	24.0	3.30	Kuala ketil
Bikan, Kulim	1991	Electricity	2	KSB Pump Ltd.	28 Kw	Submersible	20	4.16	22.0	1.30	Sedim River
Kulim, Stage 2	-	-	-	-	-	-	-	-	-	35.00	in progress
Pinang Tunggal	1970	Electricity	6	Tsurumi	22 Kw	Centrifugal	25	0.10	14.6	6.00	
Sungai Petani, Stage 1	1991	Electricity	5	Kirlostar	84.45 Kw	Centrifugal	40	0.36	20.1	15.00	
- Penang State -											
Lahar Tiang	1972	Electricity	3	James Warren	60 H.P.	Axial flow	60	2.00	6.0	12.00	
(Sungai Muda)	1972	Electricity	2	James Warren	26 H.P.	Axial flow	26	2.00	6.0	6.00	
	1981	Electricity	1	Ca Ca	90 H.P.	Inclined axial flow	90	1.50	6.0	30.00	Lahar Tiang total intake
	1987	Diesel	3	Isuzu E 120	110 H.P.	Weir axial flow	90	1.50	6.0	30.00	130 mgd

1 mgd = 4.55 x 10 m3/day

TABLE VI.1.2.1 UNIT PRICE OF BASIC CONSTRUCTION MATERIALS

No.	Material	Unit	F.C. (MR)	L.C. (MR)	Unit Price (MR)	
1	Diesel oil *	lit	0.33	0.33	0.66	
2	Lubricant *	lit	3.75	3.75	7.50	
3	Gasoline *					
	-Unlended	lit	0.55	0.55	1.10	
	-Super	lit	0.57	0.56	1.13	
4	Grease	kg	3.00	3.00	6.00	
5	Dynamite	kg	7.00	7.00	14.00	
6	Cement*	50k/bag	4.50	4.50	9.00	
7	Retarder	kg	2.16	0.54	2.70	
8	Reinforcement bar*					
	-Round/6mm, 10mm dia.	t	950.00	239.00	1,189.00	average
	-Round/12mm dia.	t	920.00	232.00	1,152.00	1,142.00
	-Round/ 10mm or more	t	870.00	215.00	1,085.00	
	-Deformed/10mm dia.	t	980.00	249.00	1,229.00	average
	-Deformed/12mm dia.	t	950.00	239.00	1,189.00	1,180.00
	-Deformed/16mm or more	t	900.00	224.00	1,124.00	
9	River sand (for concrete)	m3	0.00	24.00	24.00	
10	Crusher run	m3	0.00	24.00	24.00	
11	Crushed aggregate					
	-Granite 13mm	m3	0.00	29.00	29.00	average
	-Granite 19mm	m3	0.00	30.00	30.00	30.00
	-Limestone 13mm	m3	0.00	26.00	26.00	
	-Limestone 19mm	m3	0.00	29.00	29.00	
12	Linestone 23cm	m3	0.00	24.00	24.00	
13	Plywood					
	-1.2m x 2.4m x 6mm	pc	0.00	20.00	20.00	
	-0.9m x 2.1m x 6mm	pc	0.00	16.50	16.50	
	-0.9m x 1.8m x 6mm	pc	0.00	13.50	13.50	
	-1.2m x 2.4m x 12mm	pc	0.00	52.00	52.00	
	-0.9m x 1.8m x 12mm	pc	0.00	35.00	35.00	
14	Sheetpile					
	-51.0kg/m	m2	144.00	36.00	180.00	
15	Shaped steel	t	1,760.00	440.00	2,200.00	
16	Steel pipe pile/600mm dia.	t	2,000.00	500.00	2,500.00	
17	Wooden pile (Mangrove)	no.	0.00	5.00	5.00	
	Minimum 90mm dia. l=4.2~4.8m					
18	Hume R.C. Pipe					
	dia. 0.45m	m	41.00	41.00	82.00	
	dia. 0.60m	m	49.50	49.50	99.00	
	dia. 0.90m	m	57.50	57.50	115.00	
	dia. 1.20m	m	147.50	147.50	295.00	
	dia. 1.50m	m	197.00	197.00	394.00	
19	Bitumen*					
	-80/100 penetration	t	183.00	182.50	365.50	
	-Cutback	t	182.00	182.00	364.00	
20	Farbric reinforcement (wire mesh)					
	A6	m2	3.40	0.90	4.30	
	AB	m2	5.60	1.40	7.00	
	DA4	m2	3.40	0.90	4.30	

As of March 1994

Note: *Government controlled price items

TABLE VI.1.2.2 LABOUR WAGES

Unit:MR/day

No.	Category	Wage
1	Foreman	50
2	Operator	45
3	Assistant operator	30
4	Driver	35
5	Mechanic	40
6	Electrician	40
7	Welder	35
8	Concrete worker	30
9	Bar bender	35
10	Mason	40
11	Carpentor	35
12	Painter	30
13	Power operator	45
14	Plumber	35
15	Driller	40
16	Boring worker	40
17	Grout worker	40
18	Fitter	35
19	Skilled laborer	35
20	Semi-skilled laborer	30
21	Common laborer	25
22	Dredge master	95
23	Dredge master's assistant	60
24	Crewman	45
25	Drain layer	35

Note: Inclusive of site allowances

TABLE VI.1.3.1 BRIDGES ON THE RIVER IMPROVEMENT STRETCHES

No.	Name of Bridges or Location	Purpose	River	Cross Section	Length (m)	Beam Soffit Elevation (m)	Span (m)	Water Level (m)		Drawings
								H.W.L.	L.W.L.	
1	Merdeka Br.	Road	Muda	No.14	269*		14,17,39,57,*			A
2	Expressway Br.	Road	Muda	No.17	272	5.74	16.7, 17.2, 34.1	4.78	1.98	A
3	P.Tunggal Br.	Railway	Muda	No.26	228*	7.3	20, 40, 88 *			A
4	P. Perai Br.	Water Main	Muda	No.31+650	164*	9.00	10, 12			A
5	P. Perai Br.	Water Main & Pedestrian	Muda	No.31+660	164*	9.00	10, 12 *			N.A.
6	Sidam Kiri Br.	Road	Muda	No.41	121*		15, 19, 28 *			N.A.
7	Kp.Lubok Segintah	Road	Muda	No.60	128	14.80	32 *			N.A.
8	Kp.Batu	Road	Ketil	No.1						N.A.
9	Pekan Sik	Road	Chepir	CH9000+50						N.A.
10	Pekan Sik	Road	Chepir	No.0						N.A.
11	Baling	Pedestrian	Ketil	No.29+1900	42					N.A.
12	Baling	Light Vehicle	Ketil	No.29+2050	50					N.A.
13	Baling	Water Main	Ketil	No.29+1900	40					N.A.
14	Baling	Road	Ketil	No.23	43					N.A.

Note: No.1 to No.6 = Muda River Downstream Stretch, No.7 =Muda River Kuala Ketil Stretch
No.8 =Kuala Ketil Town Stretch, No.9 , 10 = Sik Town Stretch , No.11 to 14 =Baling Town Stretch
* =The figures are estimated from the topo survey result , A = Available , N.A. = Not Available

TABLE VI.2.2.1 UNIT COST FOR RIVER IMPROVEMENT AND RELEVANT FACILITIES

Description	Unit	Unit Cost (MR)		
		F.C.	L.C.	Total
Clearing	ha	0.0	3,000.0	3,000.0
Excavation				
- Common	cu m	2.0	3.0	5.0
- Weathered Rock	cu m	4.0	6.0	10.0
River Dredging	cu m	2.2	3.3	5.5
- Sandy Soil	cu m	2.0	3.0	5.0
- Muddy Soil	cu m	2.4	3.6	6.0
Offshore Dredging	cu m	2.6	3.9	6.5
- Sandy Soil	cu m	2.4	3.6	6.0
- Muddy Soil	cu m	2.8	4.2	7.0
Embankment	cu m	3.2	4.8	8.0
Sod Facing	sq m	0.0	3.0	3.0
Rock Placing				
- Gradation 2.0 - 5.0 t	cu m	38.0	57.0	95.0
- Gradation 1.0 - 3.0 t	cu m	38.0	57.0	95.0
- Gradation 0.2 - 0.5 t	cu m	24.0	36.0	60.0
- Gradation 0.1 - 0.3 t	cu m	24.0	36.0	60.0
- Gradation 0.01 - 0.1 t	cu m	24.0	36.0	60.0
Levee Road Pavement	sq m	14.0	6.0	20.0
Revetment				
- Steel Sheet Pile (Type II, L=10 m)	no.	700.0	300.0	1,000.0
- R.C. Pile (Dia.=400 mm, L=30 m)	no.	700.0	300.0	1,000.0
- Wooden Pile (Dia.=100 mm, L=4 m)	no.	4.5	2.5	7.0
- Dry Masonry (t=50 cm)	sq m	35.0	15.0	50.0
- Wet Masonry (t=50 cm)	sq m	42.0	18.0	60.0
- Gabion	cu m	30.0	120.0	150.0
Geotextile Sheet	sq m	21.0	9.0	30.0
Sand-filled Tubes (Dia.=1,800 mm)	m	1,540.0	660.0	2,200.0
Bridge				
- Demolition	sq m	1.0	9.0	10.0
- Construction	sq m	1,120.0	480.0	1,600.0
- Concrete, plain	cu m	23.0	207.0	230.0
- Concrete, reinforced	cu m	25.0	225.0	250.0
Land Scaping				
- Turfing	sq m	0.0	2.8	2.8
- Recreation Facilites	sq m	1.6	2.4	4.0
- Tree Planting	no.	0.0	50.0	50.0
- Shrubs Planting	no.	0.0	5.0	5.0
Reinforcement	t	1,440.0	360.0	1,800.0
Primary Access Raod	km	80,000.0	320,000.0	400,000.0
Secondary Access Road	km	40,500.0	162,000.0	202,500.0

TABLE VI.2.2.2 UNIT COST FOR DAM AND RELEVANT FACILITIES

Description	Unit	Unit Cost (MR)		
		F.C.	L.C.	Total
Excavation				
- Common	cu m	4.2	1.8	6.0
- Weathered Rock	cu m	8.4	3.6	12.0
- Rock	cu m	14.0	6.0	20.0
- Tunnel & Shaft	cu m	98.0	42.0	140.0
- Underground	cu m	63.0	27.0	90.0
Concrete				
- Open	cu m	23.0	207.0	230.0
- Dam	cu m	18.0	162.0	180.0
- Tunnel	cu m	33.0	297.0	330.0
- Shaft, tower	cu m	40.0	360.0	400.0
- Spillway (Structure)	cu m	28.0	252.0	280.0
- Plug	cu m	30.0	270.0	300.0
Embankment				
- Impervious earth material	cu m	4.0	6.0	10.0
- Filter	cu m	14.0	21.0	35.0
- Soft Rock	cu m	16.0	24.0	40.0
- Rock	cu m	20.0	30.0	50.0
- Transition	cu m	8.0	12.0	20.0
- Riprap	cu m	24.0	36.0	60.0
- Backfill	cu m	4.0	8.0	12.0
Grouting				
- Curtain, consolidation	m	60.0	240.0	300.0
- Blanket	m	50.0	200.0	250.0
- Backfill	cu m	300.0	1,200.0	1,500.0
Metal Work	t			
- Gate	t	18,000.0	2,000.0	20,000.0
- Trash Rack	t	10,800.0	1,200.0	12,000.0
- Steel Pipe		7,300.0	700.0	8,000.0
Reinforcement	t	1,440.0	360.0	1,800.0

TABLE VI.2.3.1 PROJECT COST OF BERIS DAM

Work Item	Quantity	Unit	Unit Cost		Amount		
			F.C. (R.)	L.C. (R.)	F.C. (Thous. R.)	L.C. (Thous. R.)	Total (Thous. R.)
I. Direct Cost					62,401	41,600	104,001
1. Preparatory Works (10% of Items 2 & 3)					5,673	3,782	9,455
2. Road & Bridges					16,364	10,909	27,273
3. Main Works (Civil & Mechanical)					40,364	26,909	67,273
II. Indirect Cost					6,240	49,360	55,600
1. Compensation Cost					0	40,000	40,000
a. House Evacuation					0	15,000	15,000
b. Land Acquisition					0	25,000	25,000
2. Administration Cost (5% of Item I. allotted to L.C. only)					0	5,200	5,200
3. Engineering Cost (10% of Item I)					6,240	4,160	10,400
III. Physical Contingency (10% of Item I & II)					6,864	9,096	15,960
IV. Total Cost					75,505	100,056	175,561

Notes: *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding
*3 Price contingency is not included

TABLE VI.2.3.2 PROJECT COST OF JENIANG TRANSFER SYSTEM (JENIANG BARRAGE)

Work Item	Quantity	Unit	Unit Cost		Amount		
			F.C. (R.)	L.C. (R.)	F.C. (Thous. R.)	L.C. (Thous. R.)	Total (Thous. R.)
I. Direct Cost					8,710	13,388	22,097
1. Preparatory Works (10% of Items 2 & 3)					792	1,217	2,009
2. Main Civil Works					2,255	11,542	13,797
(1) Main Structure					1,642	9,614	11,256
a. Earthworks					656	984	1,640
b. Concrete Works					908	8,172	9,080
c. Miscellaneous (5% of a & b)					78	458	536
(2) Intake Structure					445	1,676	2,121
a. Earthworks					296	444	740
b. Concrete Works					128	1,152	1,280
c. Miscellaneous (5% of a & b)					21	80	101
(3) Protective Dikes					168	252	420
a. Embankment					160	240	400
b. Miscellaneous (5% of a)					8	12	20
3. Electro-Mechanical Works					5,662	629	6,292
a. Main Gates					2,844	316	3,160
b. Intake gates					527	59	585
c. Miscellaneous (20% of a & b)					674	75	749
d. Delivery & Erection (40% of a to c)					1618	180	1,798
II. Indirect Cost					871	3,160	4,031
1. Compensation Cost						682	682
a. House Evacuation	17	nos.				425	425
b. Land Acquisition	9	ha				257	257
2. Administration Cost (5% of Items I & II.1 , allotted to L.C. only)						1,139	1,139
3. Engineering Cost (10% of Item I)					871	1,339	2,210
III. Physical Contingency (10% of Item I & II)					958	1,655	2,613
IV. Total Cost					10,539	18,202	28,741

Notes:*1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding
*3 Price contingency is not included

TABLE VI.2.3.3 PROJECT COST OF JENIANG TRANSFER SYSTEM (TRANSFER CANAL)

Work Item	Quantity	Unit	Unit Cost F.C. (R.)	Unit Cost L.C. (R.)	Amount F.C. (Thous. R.)	Amount L.C. (Thous. R.)	Amount Total (Thous. R.)
I. Direct Cost					4,323	7,245	11,568
1. Preparatory Works (10% of Item 2)					393	659	1,052
2. Main Civil Works					3,930	6,586	10,516
(1) Acess Road & Bridges					1,369	587	1,956
a. Levee Road Pavement	8	km			112	48	160
b. Bridges	10	nos.			1,257	539	1,796
(2) Transfer Canal					2,365	5,706	8,071
a. Site Clearance	34	ha			0	102	102
b. Excavation, Common	680,000	cu m			1,360	2,040	3,400
c. Embankment	228,500	cu m			731	1,097	1,828
d. Canal Structure					274	2,467	2,741
- Sg. Reman Syphon	1	no.			81	729	810
- Outfall to Naok	2	nos.			47	426	473
- Cross Drainage Structures	8	nos.			65	583	648
- Overflow Wasteways	2	nos.			81	729	810
(3) Canalization					189	284	473
a. Sg. Reman	1	l.s.			189	284	473
(4) Desnagging					6	10	16
a. Sg. Kalai	1.2	km			6	10	16
II. Indirect Cost					432	2,254	2,686
1. Compensation Cost					0	906	906
a. House Evacuation	0	no.			0	0	0
b. Land Acquistion	34	ha			0	906	906
2. Administration Cost (5% of Items I & II.1 , allotted to L.C. only)					0	624	624
3. Engineering Cost (10% of Item I)					432	724	1,157
III. Physical Contingency (10% of Item I & II)					476	950	1,425
IV. Total Cost					5,231	10,449	15,679

Notes: *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding
*3 Price contingency is not included

TABLE VI.2.3.4 PROJECT COST OF JENIANG TRANSFER SYSTEM (NAOK DAM)

Work Item	Quantity	Unit	Unit Cost F.C. (R.)	Unit Cost L.C. (R.)	Amount F.C. (Thous. R.)	Amount L.C. (Thous. R.)	Amount Total (Thous. R.)
I. Direct Cost					24,917	46,549	71,466
1. Preparatory Works (10% of Item 2)					2,265	4,232	6,497
2. Main Civil Works					22,652	42,317	64,969
(1) Acess Road & Bridges	66.7	km			934	400	1,334
(2) Diversion Culvert & Scour Outlet					338	3,038	3,375
(3) Embankment					19,018	27,742	46,760
a. Core	396,000	cu m			1,584	1,590	3,174
b. Transition	1,606,000	cu m			12,848	19,272	32,120
c. Filter	198,000	cu m			2,772	4,158	6,930
d. Riprap	22,700	cu m			1,814	2,722	4,536
(4) Outlet Works					810	7,290	8,100
(5) Drilling & Grouting					945	3,780	4,725
(6) Laboratory, Instrumentation					608	68	675
II. Indirect Cost					2,492	8,510	11,001
1. Compensation Cost					0	268	268
a. House Evacuation	5	no.			0	125	125
b. Land Acquisition	6.5	ha			0	143	143
2. Administration Cost (5% of Items I & II.1 , allotted to L.C. only)					0	3,587	3,587
3. Engineering Cost (10% of Item I)					2,492	4,655	7,147
III. Physical Contingency (10% of Item I & II)					2,741	5,506	8,247
IV. Total Cost					30,150	60,564	90,714

Notes: *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding
*3 Price contingency is not included

TABLE VI.2.3.5 PROJECT COST OF JENIANG TRANSFER SYSTEM (CONVEYANCE CANAL)

Work Item	Quantity	Unit	Unit Cost F.C. (R.)	Unit Cost L.C. (R.)	Amount F.C. (Thous. R.)	Amount L.C. (Thous. R.)	Amount Total (Thous. R.)
I. Direct Cost					8,808	13,206	22,014
1. Preparatory Works (10% of Item 2)					801	1,201	2,001
2. Main Civil Works					8,007	12,006	20,013
(1) Acess Road & Bridges					2,831	1,213	4,044
a. Levee Road Pavement	24	km			336	144	480
b. Bridges	26	nos.			2,495	1,069	3,564
(2) Irrigation Canal					5,177	10,793	15,969
a. Site Clearance	98	ha			0	294	294
b. Excavation, Common	1,030,000	cu m			2,060	3,090	5,150
c. Embankment	860,000	cu m			2,752	4,128	6,880
d. Canal Structure					365	3,281	3,645
- Sg. Titi Teras Syphon	1	no.			81	729	810
- Rectangular Inclined Drops	6	nos.			81	729	810
- Cross Drainage Structures	21	nos.			162	1,458	1,620
- Overflow Wasteways	1	nos.			41	365	405
II. Indirect Cost					881	5,241	6,121
1. Compensation Cost					0	2,685	2,685
a. House Evacuation	0	no.			0	0	0
b. Land Acquisition	98	ha			0	2,685	2,685
2. Administration Cost (5% of Items I & II.1 , allotted to L.C. only)					0	1,235	1,235
3. Engineering Cost (10% of Item I)					881	1,321	2,201
III. Physical Contingency (10% of Item I & II)					969	1,845	2,814
IV. Total Cost					10,658	20,292	30,949

Notes: *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding
*3 Price contingency is not included

TABLE VI.2.3.6 PROJECT COST OF REMAN DAM

Work Item	Quantity	Unit	Unit Cost		Amount		
			F.C. (R.)	L.C. (R.)	F.C. (Thous. R.)	L.C. (Thous. R.)	Total (Thous. R.)
I. Direct Cost					41,116	28,279	69,395
1. Preparatory Works (10% of Items 2 & 3)					3,738	2,571	6,309
2. Main Civil Works					15,432	23,283	38,715
(1) Acess Road					320	1,280	1,600
(2) Civil Works					15,112	22,003	37,115
3. Electro-Mechanical Works					21,946	2,425	24,371
II. Indirect Cost					4,112	43,363	47,474
1. Compensation Cost					0	35,300	35,300
a. House Evacuation	200	nos.			0	5,000	5,000
b. Land Acquisition	35	ha			0	30,300	30,300
2. Administration Cost (5% of Items I & II.1 , allotted to L.C. only)					0	5,235	5,235
3. Engineering Cost (10% of Item I)					4,112	2,828	6,939
III. Physical Contingency (10% of Item I & II)					4,523	7,164	11,687
IV. Total Cost					49,750	78,806	128,556

Notes: *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding
*3 Price contingency is not included

TABLE VI.2.3.7 PROJECT COST OF MUDA DOWNSTREAM STRETCH IMPROVEMENT PROJECT

Work Item	Quantity	Unit	Unit Cost F.C. (R.)	Unit Cost L.C. (R.)	Amount F.C. (Thous. R.)	Amount L.C. (Thous. R.)	Amount Total (Thous. R.)
I. Direct Cost					141,410	98,464	239,904
1. Preparatory Works (10% of Items 2)					12,858	8,951	21,809
2. Main Civil Works					128,582	89,512	218,095
(1) Earthwork					26,015	42,772	68,788
a. Clearing	358.5	ha	0	3,000	0	1,076	1,076
b. Offshore Dredging	120,000	cu m	3	4	312	468	780
c. River Excavation	10,136,000	cu m	2	3	22,299	33,449	55,748
d. Embankment	1,063,800	cu m	3	5	3,404	5,106	8,510
e. Sod Facing	891,200	sq m	0	3	0	2,674	2,674
(2) Levee Road Pavement	239,200	sq m	14	6	3,349	1,435	4,784
(3) Revetment	83,000	sq m	85	155	7,055	12,865	19,920
(4) Sluice					20,438	4,695	25,133
Type A	4	no.	105,000	65,000	420	260	680
Type B	5	no.	136,000	70,000	680	350	1,030
Type C	5	no.	152,000	80,000	760	400	1,160
Type D	5	no.	534,000	147,000	2,670	735	3,405
Type E	2	no.	390,000	120,000	780	240	1,020
Type F	2	no.	1,030,000	240,000	2,060	480	2,540
Type G	2	no.	2,095,000	369,000	4,190	738	4,928
Type H	2	no.	2,346,000	434,000	4,692	868	5,560
Type I	1	no.	4,186,000	624,000	4,186	624	4,810
(5) Bridge					12,545	9,535	22,080
a. Merdika Bridge/Renovation	1	ls.	0	0	1,680	965	2,645
b. Expressway Bridge/Renovation	1	ls.	0	0	445	3,730	4,175
c. New Railway Bridge	1	ls.	0	0	7,030	3,010	10,040
d. Water Pipe Bridge/Relocation	1	ls.	0	0	3,240	540	3,780
e. Sidam Bridge/Renovation	1	ls.	0	0	150	1,290	1,440
(6) Relocation of Pump House	3	nos.	20,000	80,000	60	240	300
(7) Reconstruction of Muda Barrage	1	ls.	0	0	58,700	17,200	75,900
(8) Reinforcement of Transmission Tower	1	ls	0	0	420	770	1,190
II. Indirect Cost					14,141	40,121	54,265
1. Compensation Cost					0	17,409	17,409
a. House Evacuation	149	nos.	0	25,000	0	3,725	3,725
b. Land Acquisition							
- Grass Land	11.6	ha	0	18,000	0	209	209
- Orchard	124.8	ha	0	30,000	0	3,744	3,744
- Swamp	18.8	ha	0	8,000	0	150	150
- Paddy	128.0	ha	0	50,000	0	6,400	6,400
- Oil Palm	15.2	ha	0	25,000	0	380	380
- Rubber	40.8	ha	0	25,000	0	1,020	1,020
- Scrub/Bush	80.6	ha	0	15,000	0	1,209	1,209
- Cultivated Land	3.0	ha	0	21,000	0	63	63
- Pond	42.4	ha	0	12,000	0	509	509
2. Administration Cost (5% of Items I & II.1, allotted to L.C. only)					0	12,866	12,866
3. Engineering Cost (10% of Item I)					14,141	9,846	23,990
III. Physical Contingency (10% of Item I & II)					15,558	13,858	29,417
IV. Total Cost					171,143	152,443	323,586

Notes: *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding
*3 Price Contingency is not included

TABLE VI.2.3.8 PROJECT COST OF KUALA KETIL STRETCH

Work Item	Quantity	Unit	Unit Cost F.C. (R.)	Unit Cost L.C. (R.)	Amount F.C. (Thous. R.)	Amount L.C. (Thous. R.)	Amount Total (Thous. R.)
I. Direct Cost					5,781	8,177	13,958
1. Preparatory Works (10% of Items 2)					526	743	1,269
2. Main Civil Works					5,255	7,434	12,689
(1) Earthwork					1,141	1,800	2,941
a. Clearing	4.3	ha	0.0	3,000	0	13	13
b. Offshore Dredging	0	cu m	2.6	3.9	0	0	0
c. River Excavation					1,070	1,604	2,674
- Cutoff Channel	394,000	cu m	2.0	3.0	788	1,182	1,970
- River Dredging	128,000	cu m	2.2	3.3	282	422	704
d. Embankment	22,400	cu m	3.2	4.8	72	108	179
e. Sod Facing	25,000	sq m	0.0	3.0	0	75	75
(2) Levee Road Pavement	8,400	sq m	14.0	6.0	118	50	168
(3) Revetment	23,100	sq m	85	155	1,964	3,581	5,544
(4) Sluice					253	184	437
a. Type C (W=1m, H=1m, L=16m)	2	nos.	99,000	65,000	198	130	328
b. Type D (D=0.60m, L=17m)	1	nos.	55,000	54,000	55	54	109
(5) Road Bridge (W=3 m, L=130 m)	390	sq m	1,120	480	437	187	624
(6) Drop Structure					467	393	860
a. Upstream	1	no.	150,000	135,000	150	135	285
b. Downstream	1	no.	317,000	258,000	317	258	575
(7) Miscellaneous (20%)	1	l.s.	0	0	876	1,239	2,115
II. Indirect Cost					578	2,068	2,646
1. Compensation Cost					0	526	526
a. House Evacuation	9	nos.	0	25,000	0	225	225
b. Land Acquistion					0	301	301
- Grass Land	0.8	ha	0	18,000	0	14	14
- Orchard	7.5	ha	0	30,000	0	225	225
- Scrub/Bush	1.7	ha	0	15,000	0	26	26
- Cultivated Land	1.3	ha	0	21,000	0	27	27
- Clear Land	0.5	ha	0	18,000	0	9	9
2. Administration Cost (5% of Items I & II.1 , allotted to L.C. only)					0	724	724
3. Engineering Cost (10% of Item I)					578	818	1,396
III. Physical Contingency (10% of Item I & II)					636	1,025	1,660
IV. Total Cost					6,994	11,270	18,264

Notes: *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding
*3 Price contingency is not included

TABLE VI.2.3.9 PROJECT COST OF BALING STRETCH

Work Item	Quantity	Unit	Unit Cost F.C. (R.)	Unit Cost L.C. (R.)	Amount F.C. (Thous. R.)	Amount L.C. (Thous. R.)	Amount Total (Thous. R.)
I. Direct Cost					2,505	3,313	5,819
1. Preparatory Works (10% of Items 2)					228	301	529
2. Main Civil Works					2,278	3,012	5,290
(1) Earthwork					123	259	383
a. Clearing	1.4	ha	0.0	34,000	0	48	48
b. Offshore Dredging	0	cu m	2.6	3.9	0	0	0
c. River Excavation	37,500	cu m	2.2	3.3	83	124	206
d. Embankment	12,800	cu m	3.2	4.8	41	61	102
e. Sod Facing	8,900	sq m	0.0	3.0	0	27	27
(2) Levee Road Pavement	4,500	sq m	14.0	6.0	63	27	90
(3) Revetment	12,100	sq m	85	155	1,029	1,876	2,904
(4) Sluice/Type B (D=0.6m, L=16m)	2	nos.	52,000	50,000	104	100	204
(5) Bridge					579	248	827
a. Road Bridge							
- (W=6.6 m, L=55 m)	363	sq m	1,120	480	407	174	581
- (W=2.5 m, L=55 m)	138	sq m	1,120	480	154	66	220
b. Pedestrian Bridge							
- (W=1.5 m, L=55 m)	83	sq m	224	96	18	8	26
(6) Miscellaneous (20%)	1	ls.	0	0	380	502	882
II. Indirect Cost					251	2,849	3,100
1. Compensation Cost					0	2,121	2,121
a. House Evacuation							
- Urban	28	nos.	0	70,000	0	1,960	1,960
b. Land Acquisition							
- Residential (urban)	2.3	ha	0	70,000	0	161	161
2. Administration Cost (5% of Items I & II.1 , allotted to L.C. only)					0	397	397
3. Engineering Cost (10% of Item I)					251	331	582
III. Physical Contingency (10% of Item I & II)					276	616	892
IV. Total Cost					3,031	6,779	9,810

Notes: *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding
*3 Price contingency is not included

TABLE VI.2.3.10 PROJECT COST OF SIK STRETCH

Work Item	Quantity	Unit	Unit Cost		Amount		
			F.C. (R.)	L.C. (R.)	F.C. (Thous. R.)	L.C. (Thous. R.)	Total (Thous. R.)
I. Direct Cost					1,828	3,120	4,948
1. Preparatory Works (10% of Items 2)					166	284	450
2. Main Civil Works					1,662	2,836	4,498
(1) Earthwork					60	132	192
a. Clearing	1.5	ha	0.0	13,600	0	20	20
b. Offshore Dredging	0	cu m	2.6	3.9	0	0	0
c. River Excavation	6,200	cu m	2.2	3.3	14	20	34
d. Embankment	14,400	cu m	3.2	4.8	46	69	115
e. Sod Facing	7,500	sq m	0.0	3.0	0	23	23
(2) Levee Road Pavement	4,800	sq m	14.0	6.0	67	29	96
(3) Revetment	13,600	sq m	85	155	1,156	2,108	3,264
(4) Sluice/Type A (D=0.6m, L=14m)	2	nos.	51,000	47,000	102	94	196
(5) Miscellaneous (20%)	1	l.s.	0	0	277	473	750
II. Indirect Cost					183	1,552	1,734
1. Compensation Cost					0	945	945
a. House Evacuation							
- Urban	12	nos.	0	70,000	0	840	840
b. Land Acquisition							
- Residential (urban)	1.5	ha	0	70,000	0	105	105
2. Administration Cost (5% of Items I & II.1 , allotted to L.C. only)					0	295	295
3. Engineering Cost (10% of Item I)					183	312	495
III. Physical Contingency (10% of Item I & II)					201	467	668
IV. Total Cost					2,212	5,138	7,350

Notes: *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding
*3 Price contingency is not included

TABLE VI.2.3.11 PROJECT COST OF RIVER ENVIRONMENT IMPROVEMENT WORK

Work Item	Quantity	Unit	Unit Cost F.C. (R.)	Unit Cost L.C. (R.)	Amount F.C. (Thous. R.)	Amount L.C. (Thous. R.)	Amount Total (Thous. R.)
I. Direct Cost					9,072	22,446	31,518
1. Preparatory Works (10% of Items 2 &3)					825	2,041	2,865
2. Environment Improvement					2,671	17,418	20,089
(1) Type A					131	1,181	1,312
a. A - 1 (2ha)	2	no.	17,000	153,000	34	306	340
b. A - 1 (3ha)	1	no.	18,000	162,000	18	162	180
c. A - 2 (12ha)	1	no.	37,200	334,800	37	335	372
d. A - 2 (20ha)	1	no.	42,000	378,000	42	378	420
(2) Type B					76	686	762
a. B - 1 (1ha)	1	no.	1,000	9,000	1	9	10
b. B - 2 (2ha)	2	no.	16,600	149,400	33	299	332
c. B - 3 (20ha)	1	no.	42,000	378,000	42	378	420
(3) Type C					107	965	1,072
a. C - 1 (15ha)	1	no.	24,000	216,000	24	216	240
b. C - 2 (20ha)	1	no.	38,000	342,000	38	342	380
c. C - 2 (38ha)	1	no.	45,200	406,800	45	407	452
(4) Type D					2,356	14,587	16,943
a. D - 1 (1ha)	12	no.	1,900	17,100	23	205	228
b. D - 2 (2ha)	6	no.	18,000	162,000	108	972	1,080
c. D - 3 (18ha)	1	no.	49,800	448,200	50	448	498
d. D - 4 (56ha)	1	no.	102,000	918,000	102	918	1,020
e. D - 4 (68ha)	1	no.	111,000	999,000	111	999	1,110
f. D - 5 (2ha/Muda dam)	1	no.	556,800	2,227,200	557	2,227	2,784
g. D - 5 (5ha/Beris dam)	1	no.	767,000	3,068,000	767	3,068	3,835
h. D - 6 (222ha/Beris res.)	1	no.	638,800	5,749,200	639	5,749	6,388
3. Additional Civil Works (Muda Barrage & Express way Bridge)					5,577	2,987	8,564
(1) Earthwork					369	755	1,124
a. Clearing	64.5	ha	0.0	3,000.0	0	194	194
b. Offshore Dredging	0	cu m	2.6	3.9	0	0	0
c. River Excavation	160,000	cu m	2.2	3.3	352	528	880
d. Embankment	5,200	cu m	3.2	4.8	17	25	42
e. Sod Facing	2,800	sq m	0.0	3.0	0	8	8
(2) Levee Road Pavement	800	sq m	14.0	6.0	11	5	16
(3) Revetment	0	sq m	85.0	155.0	0	0	0
(4) New Muda Barrage Bridge					5,197	2,227	7,424
a. Road Bridge	4,400	m^3	1,120	480	4,928	2,112	7,040
b. Pedestrian Bridge	1,200	m^3	224	96	269	115	384
II. Indirect Cost					907	5,940	6,847
1. Compensation Cost					0	2,018	2,018
a. House Evacuation	40	no.	0	25,000	0	1,000	1,000
b. Land Acquisition					0	1,018	1,018
- Grass Land	0	ha	0	18,000	0	0	0
- Orchard	15.2	ha	0	30,000	0	456	456
- Swamp	0	ha	0	8,000	0	0	0
- Paddy	4.2	ha	0	50,000	0	210	210
- Oil Palm	0	ha	0	25,000	0	0	0
- Rubber	0	ha	0	25,000	0	0	0
- Scrub/Bush	14.2	ha	0	15,000	0	213	213
- Cultivated Land	0	ha	0	21,000	0	0	0
- Pond	11.6	ha	0	12,000	0	139	139
2. Administration Cost (5% of Items I & II.1 , allotted to L.C. only)					0	1,677	1,677
3.Engineering Cost (10% of Item I)					907	2,245	3,152
III. Physical Confingency (10% of Items I & II)					998	2,839	3,836
IV. Total Cost					10,977	31,224	42,201

Notes: *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding
*3 Price contingency is not included

TABLE VI.2.3.12 ANNUAL DISBURSEMENT SCHEDULE OF BERIS DAM
(1996 - 2000)

Unit : Thousand K.

Description	Amount			1,996		1,997		1,998		1,999		2,000	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
I. Construction Base Cost	62,401	41,600	104,001	0	0	11,346	7,564	19,855	13,236	17,018	11,345	14,182	9,455
1. Preparatory Works (10% of Item I.2)	5,673	3,782	9,455	0	0	2,837	1,891	2,837	1,891	0	0	0	0
2. Main Works	56,728	37,818	94,546	0	0	8,509	5,673	17,018	11,345	17,018	11,345	14,182	9,455
Sub-Total	62,401	41,600	104,001	0	0	11,346	7,564	19,855	13,236	17,018	11,345	14,182	9,455
II. Compensation Cost	0	40,000	40,000	0	40,000	0	0	0	0	0	0	0	0
1. House Evacuation	0	15,000	15,000	0	15,000	0	0	0	0	0	0	0	0
2. Land Acquisition	0	25,000	25,000	0	25,000	0	0	0	0	0	0	0	0
III. Administration Cost	0	5,200	5,200	0	1,300	0	1,040	0	1,040	0	1,040	0	780
1. Administration (5% of Item I & II,alloted to L.C. only)	0	5,200	5,200	0	1,300	0	1,040	0	1,040	0	1,040	0	780
IV. Engineering Cost	6,240	4,160	10,400	0	0	936	624	1,872	1,248	1,872	1,248	1,560	1,040
1. Detailed Design (Completed in 1994)	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Construction Supervision	6,240	4,160	10,400	0	0	936	624	1,872	1,248	1,872	1,248	1,560	1,040
V. Physical Contingency (10% of Items I to IV)	6,864	9,096	15,960	0	4,130	1,228	923	2,173	1,552	1,889	1,363	1,574	1,127
VI.Sub-Total (Items I to V)	75,505	100,056	175,561	0	45,430	13,510	10,150	23,900	17,077	20,779	14,997	17,316	12,402
VII. Price Contingency of Item VI (3%F.C. & 3.5%L.C.)	10,922	12,516	23,439	0	3,236	1,253	1,104	3,000	2,519	3,310	2,815	3,360	2,843
VIII. Grand Total	86,427	112,572	199,000	0	48,666	14,763	11,254	26,899	19,596	24,089	17,811	20,676	15,245

Notes : *1 Price Level in December 1994

*2 Figures may not add up to totals due to rounding

TABLE VI.2.3.13 ANNUAL DISBURSEMENT SCHEDULE OF JENIANG TRANSFER SYSTEM
(1998 - 2005)

Unit: Thousand R

Description	Amount			1998		1999		2000		2001		2002		2003		2004		2005	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
I. Construction Base Cost	46,757	80,389	127,146	0	0	0	0	0	0	0	0	4,964	7,691	13,884	24,040	16,150	28,272	11,759	20,386
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1. Preparatory Works	4,251	7,309	11,560	0	0	0	0	0	0	0	0	1,986	3,077	2,265	4,232	0	0	0	0
2. Main Civil Works	42,506	73,080	115,586	0	0	0	0	0	0	0	0	2,978	4,614	11,619	19,808	16,150	28,272	11,759	20,386
Sub-Total	46,757	80,389	127,146	0	0	0	0	0	0	0	0	4,964	7,691	13,884	24,040	16,150	28,272	11,759	20,386
II. Compensation Cost	0	4,541	4,541	0	0	0	0	0	2,137	0	2,324	0	80	0	0	0	0	0	0
1. House Evacuation	0	550	550	0	0	0	0	0	213	0	300	0	37	0	0	0	0	0	0
2. Land Acquisition	0	3,991	3,991	0	0	0	0	0	1,924	0	2,024	0	43	0	0	0	0	0	0
III. Administration Cost	0	6,585	6,585	0	659	0	659	0	782	0	1,317	0	1,194	0	659	0	659	0	659
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1. Administration (5% of Item I & II, alloted to L.c. only)	0	6,585	6,585	0	659	0	659	0	782	0	1,317	0	1,194	0	659	0	659	0	659
IV. Engineering Cost	4,676	8,039	12,715	842	1,447	1,665	2,818	299	559	0	0	131	203	511	872	711	1,244	517	897
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1. Detailed Design (60% of Item IV)	2,806	4,823	7,629	842	1,447	1,665	2,818	299	559	0	0	0	0	0	0	0	0	0	0
2. Construction Supervision (40% of Item IV)	1,870	3,216	5,086	0	0	0	0	0	0	0	0	131	203	511	872	711	1,244	517	897
V. Physical Contingency (10% of Items I to IV)	5,143	9,955	15,099	84	211	166	348	30	348	0	364	510	917	1,440	2,557	1,686	3,017	1,228	2,194
VI. Sub-Total (Item I to V)	56,576	109,509	166,086	926	2,316	1,831	3,824	329	3,825	0	4,005	5,605	10,085	15,835	28,127	18,546	33,191	13,504	24,135
VII. Price Contingency (3%F.C. & 3.5%L.C.)	18,360	41,159	59,519	116	342	292	718	64	877	0	1,091	1,495	3,195	4,826	10,207	6,378	13,628	5,189	11,102
VIII. Grand Total	74,936	150,669	225,605	1,042	2,658	2,123	4,542	393	4,702	0	5,096	7,100	13,280	20,661	38,335	24,925	46,820	18,693	35,237

Notes : *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding

TABLE VI.2.3.14 ANNUAL DISBURSEMENT SCHEDULE OF REMAN DAM
(2000 - 2007)

Unit: Thousand R

Description	Amount			2000		2001		2002		2003		2004		2005		2006		2007	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
I. Construction Base Cost	41,116	28,279	69,395	0	0	0	0	0	0	0	0	5,607	3,856	16,820	11,569	11,213	7,712	7,476	5,142
1. Preparatory Works (10% of Item I.2)	3,738	2,571	6,309	0	0	0	0	0	0	0	0	1,869	1,286	1,869	1,286	0	0	0	0
2. Main Works	37,378	25,708	63,086	0	0	0	0	0	0	0	0	3,738	2,571	14,951	10,283	11,213	7,712	7,476	5,142
Sub-Total	41,116	28,279	69,395	0	0	0	0	0	0	0	0	5,607	3,856	16,820	11,569	11,213	7,712	7,476	5,142
II. Compensation Cost	0	35,300	35,300	0	0	0	0	0	10,590	0	24,710	0	0	0	0	0	0	0	0
1.House Evacuation	0	5,000	5,000	0	0	0	0	0	1,500	0	3,500	0	0	0	0	0	0	0	0
2. Land Acquisition	0	30,300	30,300	0	0	0	0	0	9,090	0	21,210	0	0	0	0	0	0	0	0
III. Administration Cost	0	5,235	5,235	0	524	0	524	0	1,047	0	1,047	0	524	0	524	0	524	0	524
1. Administration (5 % of Item I & II, alloted to L.C.only)	0	5,235	5,235	0	524	0	524	0	1,047	0	1,047	0	524	0	524	0	524	0	524
IV. Engineering Cost	4,112	2,828	6,940	1,234	848	1,234	848	0	0	0	0	164	113	658	452	493	339	329	226
1. Detailed Design (60 % of Item IV)	2,467	1,697	4,164	1,234	848	1,234	848	0	0	0	0	0	0	0	0	0	0	0	0
2. Construction Supervision (40 % of Item IV)	1,645	1,131	2,776	0	0	0	0	0	0	0	0	164	113	658	452	493	339	329	226
V. Physical Contingency (10% of Items I to IV)	4,523	7,164	11,687	123	137	123	137	0	1,164	0	2,576	577	449	1,748	1,254	1,171	858	780	589
VI. Sub-Total (Item I to V)	49,751	78,806	128,557	1,357	1,509	1,357	1,509	0	12,801	0	28,333	6,348	4,942	19,226	13,799	12,878	9,433	8,585	6,480
VII. Price Contingency (3%F.C. & 3.5%L.C.)	19,651	31,946	51,597	263	346	312	411	0	4,055	0	10,282	2,183	2,029	7,387	6,347	5,483	4,821	4,022	3,655
VIII. Grand Total	69,402	110,752	180,154	1,620	1,855	1,669	1,920	0	16,856	0	38,615	8,532	6,971	26,613	20,146	18,360	14,254	12,607	10,135

Notes : *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding

TABLE VI.2.3.15 ANNUAL DISBURSEMENT SCHEDULE OF MUDA DWONSTREAM STRETCH
(2003 - 2010)

Unit: Thousand R.

Description	Amount			2003		2004		2005		2006		2007		2008		2009		2010	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
I. Construction Base Cost	141,440	98,463	239,903	0	0	0	0	0	0	16,716	11,637	47,575	33,119	38,575	26,854	25,716	17,902	12,858	8,951
1. Preparatory Works (10% of Item I.2)	12,858	8,951	21,809	0	0	0	0	0	0	3,857	2,685	9,001	6,266	0	0	0	0	0	0
2. Main Civil Works	128,582	89,512	218,094	0	0	0	0	0	0	12,858	8,951	38,575	26,854	38,575	26,854	25,716	17,902	12,858	8,951
Sub-Total	141,440	98,463	239,903	0	0	0	0	0	0	16,716	11,637	47,575	33,119	38,575	26,854	25,716	17,902	12,858	8,951
II. Compensation Cost	0	17,409	17,409	0	0	0	0	0	8,705	0	8,705	0	0	0	0	0	0	0	0
1. House Evacuation	0	3,725	3,725	0	0	0	0	0	1,863	0	1,863	0	0	0	0	0	0	0	0
2. Land Acquisition	0	13,684	13,684	0	0	0	0	0	6,842	0	6,842	0	0	0	0	0	0	0	0
III. Administration Cost	0	12,181	12,181	0	1,218	0	1,218	0	1,827	0	1,827	0	1,827	0	1,827	0	1,218	0	1,218
1. Administration (5% of Item I & II, allotted to L.C. only)	0	12,181	12,181	0	1,218	0	1,218	0	1,827	0	1,827	0	1,827	0	1,827	0	1,218	0	1,218
IV. Engineering Cost	14,144	9,846	23,990	4,243	2,954	4,243	2,954	0	0	849	591	1,414	985	1,414	985	1,414	985	566	394
1. Detailed Design (60% of Item IV)	8,486	5,908	14,394	4,243	2,954	4,243	2,954	0	0	0	0	0	0	0	0	0	0	0	0
2. Construction Supervision (40% of Item IV)	5,658	3,938	9,596	0	0	0	0	0	0	849	591	1,414	985	1,414	985	1,414	985	566	394
V. Physical Contingency (10% of Items I to IV)	15,558	13,790	29,348	424	417	424	417	0	1,053	1,756	2,276	4,899	3,593	3,999	2,967	2,713	2,011	1,342	1,056
VI. Sub-Total (Items I to V)	171,142	151,689	322,832	4,668	4,589	4,668	4,589	0	11,585	19,321	25,035	53,889	39,524	43,988	32,632	29,844	22,116	14,766	11,619
VII. Price Contingency (3%F.C. & 3.5%L.C.)	84,631	87,616	172,248	1,423	1,665	1,605	1,884	0	5,329	8,226	12,795	25,249	22,290	22,548	20,189	16,652	14,936	8,929	8,529
VIII. Grand Total	255,774	239,306	495,079	6,090	6,255	6,273	6,473	0	16,914	27,547	37,829	79,137	61,814	66,536	52,821	46,496	37,051	23,696	20,148

Notes : *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding

TABLE VI.2.3.16 ANNUAL DISBURSEMENT SCHEDULE OF KUALA KETIL STRETCH
(2001 - 2004)

Unit: Thousand R.

Description	Amount			2001		2002		2003		2004	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
I. Construction Base Cost	5,781	8,177	13,958	0	0	0	0	2,103	2,973	3,679	5,204
1. Preparatory Works (10% of Item I.2)	526	743	1,269	0	0	0	0	526	743	0	0
2. Main Civil Works	5,255	7,434	12,689	0	0	0	0	1,577	2,230	3,679	5,204
Sub-Total	5,781	8,177	13,958	0	0	0	0	2,103	2,973	3,679	5,204
II. Compensation Cost	0	526	526	0	0	0	526	0	0	0	0
1. House Evacuation	0	225	225	0	0	0	225	0	0	0	0
2. Land Acquisition	0	301	301	0	0	0	301	0	0	0	0
III. Administration Cost	0	724	724	0	109	0	253	0	217	0	145
1. Administration (5% of Item I & II, allotted to L.C. only)	0	724	724	0	109	0	253	0	217	0	145
IV. Engineering Cost	578	818	1,396	347	491	0	0	69	98	162	229
1. Detailed Design (60% of Item IV)	347	491	838	347	491	0	0	0	0	0	0
2. Construction Supervision (40% of Item IV)	231	327	558	0	0	0	0	69	98	162	229
V. Physical Contingency (10% of Items I to IV)	636	1,025	1,660	35	60	0	78	217	329	384	558
VI. Sub-Total (Items I to V)	6,995	11,270	18,264	381	659	0	857	2,389	3,617	4,224	6,135
VII. Price Contingency (3% F.C. & 3.5% L.C.)	2,269	4,283	6,552	88	180	0	272	728	1,313	1,453	2,519
VIII. Grand Total	9,264	15,553	24,816	469	839	0	1,129	3,117	4,930	5,677	8,655

Notes : *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding

TABLE VI.2.3.17 ANNUAL DISBURSEMENT SCHEDULE OF BALING STRETCH
(2001 - 2003)

Unit: Thousand R.

Description	Amount			2001		2002		2003	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
I. Construction Base Cost	2,506	3,313	5,819	0	0	0	0	2,506	3,313
1. Preparatory Works (10% of Item I.2)	228	301	529	0	0	0	0	228	301
2. Main Civil Works	2,278	3,012	5,290	0	0	0	0	2,278	3,012
Sub-Total	2,506	3,313	5,819	0	0	0	0	2,506	3,313
II. Compensation Cost	0	2,121	2,121	0	0	0	2,121	0	0
1. House Evacuation	0	1,960	1,960	0	0	0	1,960	0	0
2. Land Acquisition	0	161	161	0	0	0	161	0	0
III. Administration Cost	0	397	397	0	79	0	199	0	119
1. Administration (5% of Item I & II, allotted to L.C. only)	0	397	397	0	79	0	199	0	119
IV. Engineering Cost	251	331	582	151	199	0	0	100	132
1. Detailed Design (60% of Item IV)	151	199	349	151	199	0	0	0	0
2. Construction Supervision (40% of Item IV)	100	132	233	0	0	0	0	100	132
V. Physical Contingency (10% of Items I to IV)	276	616	892	15	28	0	232	261	356
VI. Sub-Total (Item I to Item V)	3,033	6,778	9,811	166	306	0	2,551	2,867	3,921
VII. Price Contingency (3%F.C. & 3.5%L.C.)	912	2,314	3,226	38	83	0	808	874	1,423
X. Grand Total	3,945	9,093	13,037	204	389	0	3,360	3,741	5,344

Notes : *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding

TABLE VI.2.3.18 ANNUAL DISBURSEMENT SCHEDULE OF SIK STRETCH
(2001 - 2003)

Unit: Thousand R.

Description	Amount			2001		2002		2003	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
I. Construction Base Cost	1,828	3,120	4,948	0	0	914	1,560	914	1,560
1. Preparatory Works (10% of Item I.2)	166	284	450	0	0	83	142	83	142
2. Main Civil Works	1,662	2,836	4,498	0	0	831	1,418	831	1,418
Sub-Total	1,828	3,120	4,948	0	0	914	1,560	914	1,560
II. Compensation Cost	0	945	945	0	945	0	0	0	0
1. House Evacuation	0	840	840	0	840	0	0	0	0
2. Land Acquisition	0	105	105	0	105	0	0	0	0
III. Administration Cost	0	295	295	0	59	0	148	0	89
1. Administration (5% of Item I & II, allotted to L.C. only)	0	295	295	0	59	0	148	0	89
IV. Engineering Cost	183	312	495	110	187	37	62	37	62
1. Detailed Design (60% of Item IV)	110	187	297	110	187	0	0	0	0
2. Construction Supervision (40% of Item IV)	73	125	198	0	0	37	62	37	62
V. Physical Contingency (10% of Items I to IV)	201	467	668	11	119	95	177	95	171
VI. Sub-Total (Item I to Item V)	2,212	5,139	7,351	121	1,310	1,046	1,947	1,046	1,882
VII. Price Contingency (3%F.C. & 3.5%L.C.)	625	1,657	2,282	28	357	279	617	319	683
VIII. Grand Total	2,838	6,796	9,633	149	1,667	1,325	2,564	1,364	2,565

Notes : *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding

TABLE VI.2.3.19 (1/2) ANNUAL DISBURSEMENT SCHEDULE OF RIVER ENVIRONMENT IMPROVEMENT WORK
(1996 - 2010)

Unit: Thousand R.

Description	Amount			1996		1997		1998		1999		2000		2001		2002	
	F.C.	L.C.	Total	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
I. Construction Base Cost	9,073	22,446	31,519	0	0	0	0	1,072	2,653	825	2,041	825	2,041	0	0	577	1,428
1. Preparatory Works (10% of Item I.2)	825	2,041	2,866	0	0	0	0	248	612	0	0	0	0	0	0	165	408
2. Main Civil Works	8,248	20,405	28,653	0	0	0	0	825	2,041	825	2,041	825	2,041	0	0	412	1,020
Sub-Total	9,073	22,446	31,519	0	0	0	0	1,072	2,653	825	2,041	825	2,041	0	0	577	1,428
II. Compensation Cost	0	2,018	2,018	0	0	0	0	0	0	0	0	0	0	0	1,413	0	605
1. House Evacuation	0	1,000	1,000	0	0	0	0	0	0	0	0	0	0	0	700	0	300
2. Land Acquisition	0	1,018	1,018	0	0	0	0	0	0	0	0	0	0	0	713	0	305
III. Administration Cost	0	1,677	1,677	0	84	0	84	0	168	0	168	0	84	0	168	0	84
1. Administration (5% of Item I & II, allotted to L.C. only)	0	1,677	1,677	0	84	0	84	0	168	0	168	0	84	0	168	0	84
IV. Engineering Cost	907	2,245	3,152	82	202	109	269	36	90	36	90	36	90	218	539	154	382
1. Detailed Design (60% of Item IV)	544	1,347	1,891	82	202	109	269	0	0	0	0	0	0	218	539	136	337
2. Construction Supervision (40% of Item IV)	363	898	1,261	0	0	0	0	36	90	36	90	36	90	0	0	18	45
V. Physical Contingency (10% of Items I to IV)	998	2,839	3,837	8	29	11	35	111	291	86	230	86	221	22	212	73	250
VI. Sub-Total (Items I to V)	10,978	31,225	42,203	90	314	120	389	1,219	3,201	947	2,528	947	2,436	239	2,331	805	2,749
VII. Price Contingency (3% F.C. & 3.5% L.C.)	3,690	12,253	15,943	5	22	11	42	153	472	151	474	184	558	55	635	215	871
VIII. Grand Total	14,668	43,478	58,146	95	337	131	431	1,372	3,674	1,098	3,002	1,131	2,994	294	2,966	1,019	3,620

Notes : *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding

TABLE VI.2.3.19 (2/2) ANNUAL DISBURSEMENT SCHEDULE OF RIVER ENVIRONMENT IMPROVEMENT WORK
(1996 - 2010)

Unit: Thousand R.

Description	2003		2004		2005		2006		2007		2008		2009		2010	
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.
I. Construction Base Cost	1,031	2,551	1,031	2,551	0	0	825	2,041	825	2,041	825	2,041	825	2,041	412	1,020
1. Preparatory Works (10% of Item I.2)	206	510	206	510	0	0	0	0	0	0	0	0	0	0	0	0
2. Main Civil Works	825	2,041	825	2,041	0	0	825	2,041	825	2,041	825	2,041	825	2,041	412	1,020
Sub-Total	1,031	2,551	1,031	2,551	0	0	825	2,041	825	2,041	825	2,041	825	2,041	412	1,020
II. Compensation Cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1. House Evacuation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Land Acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
III. Administration Cost	0	84	0	84	0	84	0	168	0	168	0	84	0	84	0	84
1. Administration (5% of Item I & II, allotted to L.C. only)	0	84	0	84	0	84	0	168	0	168	0	84	0	84	0	84
IV. Engineering Cost	18	45	18	45	18	45	36	90	36	90	36	90	36	90	36	90
1. Detailed Design (60% of Item IV)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Construction Supervision (40% of Item IV)	18	45	18	45	18	45	36	90	36	90	36	90	36	90	36	90
V. Physical Contingency (10% of Items I to IV)	105	268	105	268	2	13	86	230	86	230	86	221	86	221	45	119
VI. Sub-Total (Items I to V)	1,154	2,947	1,154	2,947	20	142	947	2,528	947	2,528	947	2,436	947	2,436	494	1,313
VII. Price Contingency (3% F.C. & 3.5% L.C.)	352	1,070	397	1,210	8	65	403	1,292	444	1,426	486	1,507	529	1,645	298	964
VIII. Grand Total	1,506	4,017	1,551	4,158	28	207	1,350	3,820	1,391	3,953	1,433	3,942	1,476	4,080	792	2,277

Notes : *1 Price Level in December 1994
*2 Figures may not add up to totals due to rounding