d) Summation

This is best shown in pictorial form and Figure 4.14 gives the components of the alternatives and a rating of the effects of the alternatives. No weighting is given to the effects as it is intended in a pre-feasibility report to define a definitive project. However alternative 3 would appear to be the best option subject to the results of a feasibility study and preliminary engineering as part of the detailed design stage.

The two alternatives proposed alternative 1 or alternative 3 both satisfy the theme of this report.

(i) As a result of the flood control works there is no shortage of flood free land.

(ii) Some development now taking place in flood prone areas have a much reduced risk of flood as a result of Flood Control Works.

One aspect of this flood control system is that no one part of the project i.e. one component of alternative 1 or alternative 3 can be developed in isolation and the other components of the alternative ignored. No flood-prone areas are flood free until the left bank dyke has been completed. Even during construction of the dykes the area is at risk until the dyke reaches the high ground near 16km.

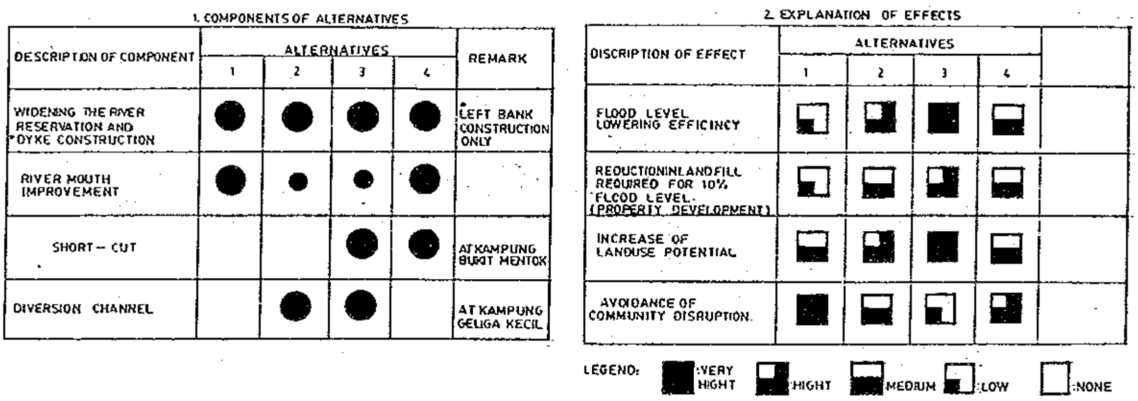


Fig. 4.14 COMPARISON OF ALTERNATIVES

CHAPTER 5 SURFACE WATER DRAINAGE

5.1 INTRODUCTION

This study has separated the two investigations of flood control and drainage as a result of an examination of the flood mechanisms.

The surface water drainage as caused by rainfall in the higher elevated town area is an independent subject. Linkage with river flood control for low laying area is only related to landfill and property development. The selection of flood control alternative 1 or 3 will control the outlet condition of the drainage system only and is discussed in Chapter 6 and was summarized in the previous chapter.

The predominant cause as discussed in Chapter 2 is inadequate drainage facilities during high intensity rainfall. It is therefore necessary to consider means of reducing the risk of flooding by various means including drainage channels (trunk and secondary); earth filling; pumping; land-use (by planning controls); flood proofing property; and by announcing flood warnings.

5.2 DESIGN BASIS

The examination made in this study was carried out in strict accordance with the DID Planning and Design Procedure No. 1 of 1975 for Urban Drainage.

The rainfall intensity is based on the 20 percent storm. Full design consideration are provided in the appendix.

It must be noted that, like the flood control, not all flooding of surface water can be stopped or prevented.

It can however be minimized and the study has been carried out on that basis.

When the river is in flood the surface water drainage is restricted at the outlets and backing-up will occur. If the rainfall exceeds design intensity and duration the trunk drains will not remove it quickly enough. If storm debris blocks a drain the drain will overflow. These events are outside the direct control of the designer, but they can be taken into consideration and the effects minimized.

5.3 TRUNK DRAINS

a) Drainage channels

The drainage channels considered here are only the trunk drains. All drains that feed into them are secondary drains or monsoon ditches constructed by the highway

Fig. 5.1 DRAINAGE SYSTEM (ALTERNATIVE – 1)

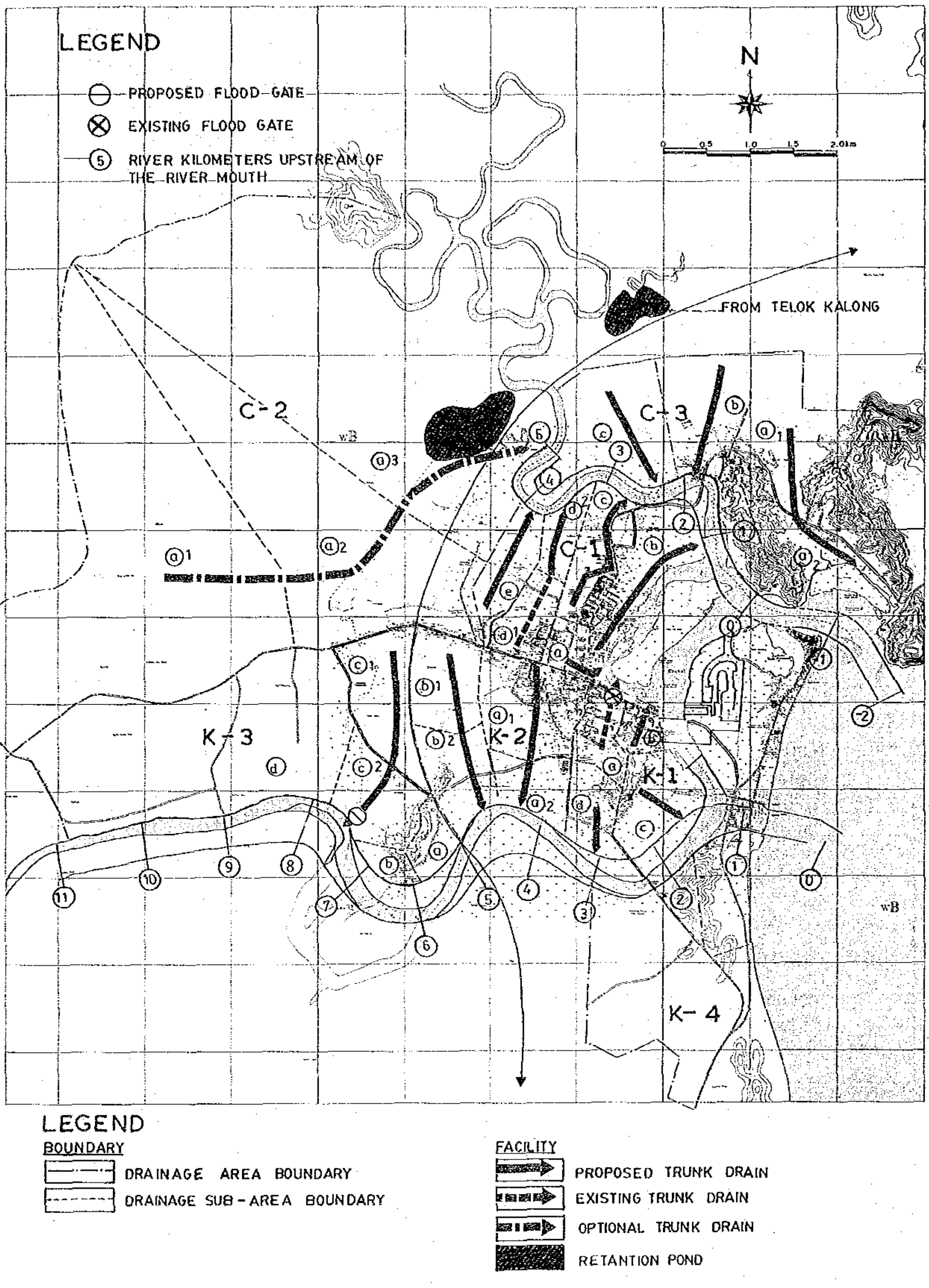


Fig. 5.2 DRAINAGE SYSTEM (ALTERNATIVE – 3)

authority for roadside drains and property drains by developers and private property owners. To complete the development of a site the property developer has to provide access for surface water drains into a trunk drain through an appropriately sized secondary drain.

In the town area, there is a defined watershed created by an existing road. This divides the area C1 and K2 which drain to the respective rivers. Use is made of existing trunk drains where these are adequately sized but these are of limited value or they are somewhat undersized. One drain in K1 draining to the north near the fish market with an existing flood gate remains unaltered. Other existing drains are considered to be secondary drains.

Because of the independence of the surface water drainage system Figure 5.1 and 5.2 represent alternatives 1 and 3 respectively. The only difference between the two is in the outlet condition as described previously.

b) Type of drains

The type of construction of the trunk drains are shown in Figure 5.4 The drain size is a function of the catchment area which is shown in Table 5.1 and the required sizes in Table 5.2.

These trunk drains should be located in their own right-of-way and because of size and water volumes the right-of-way should be protected. In the built up area there is little opportunity to use them as an environmental aide. However in the K3 and C3 area where the space considerations are not so constricting the right-of-way should be environmentally pleasant and Figure 5.3 shows an idealised requirement. Maintenance access should be provided alongside every drain where this is possible.

One drain is shown as optional under the study. This is time related to the development of the C2 area and the construction of the flood control works. Its function is to transport surface water from property development which has been land filled above the 10 percent flood level.

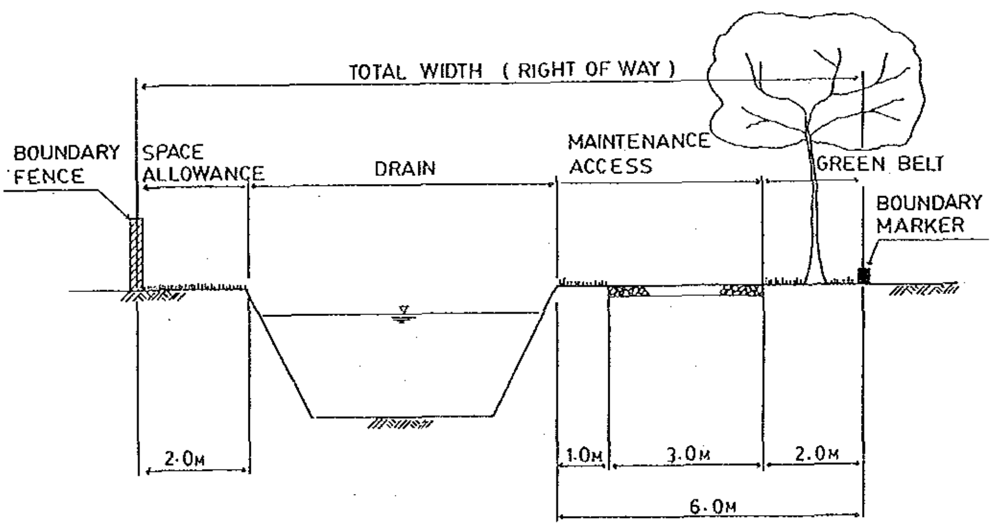


Fig. 5.3 DRAIN RESERVE

Table 5.1 URBAN DRAINAGE AREA

Unit: ha

NAME OF DRAINAGE BASIN	EXISTING AREA	ALTERNATIVE			
		1	2	3	4
K-1	259	216	236	236	216
a	55	55	55	55	55
b	22	22	31	31	22
c	114	85	96	96	85
d	68	54	54	54	54
K-2	334	334	334	334	334
a	178	178	178	178	178
b	156	156	156	156	156
K-3	941	909	909	811	761
a	38	31	31	28	28
b	147	122	122	28	48
c	218	218	218	217	153
d	538	538	538	538	532
K-4	276	276	276	276	276
K-5	319	268	303	303	268
C-1	382	371	371	371	371
a	38	38	38	38	38
b	118	112	112	112	112
c	65	64	64	64	64
d	104	101	101	101	101
e	57	56	56	56	56
C-2	2,473	2,473	2,473	2,473	2,473
C-3	587	567	567	567	567
a	302	302	302	302	302
b	115	115	115	115	115
c	170	150	150	150	150
TOTAL	5,571	5,414	5,469	5,371	5,266

Source: Study Team, 1985

Table 5.2 Size of Typical Trunk Drain (See Fig. 5.3)

NO.	CHANNEL	TYPE	LENGTH (m)	WIDTH B (m)	WIDTH b (m)	HEIGHT H (m)	HEIGHT h (m)
1	K–1–a+	A	900	5.0	–	2.0	0.3
2	K–1–b	A	400	3.0 *1 (4.0)	–	1.5 (1.6)	0.3
3	K–1–c	A	600	8.0 *1 (8.0)	–	2.0 (2.2)	0.3
4	K–1–d	A	600	5.0	–	2.0	0.3
5	K–2–a–1	A	1100	8.0	–	2.3	0.3
6	K–2–a–2	A	500	10.0	–	2.3	0.3
7	K–2–b–1	A	1000	6.0	–	2.0	0.3
8	K–2–b–2	A	900	8.0	–	2.4	0.3
9	K–3–c–1	B	1400	8.7 *2 (10.6)	6.0 (8.0)	2.4 (2.3)	0.3
10	K–3–c–2	B	800	10.5 2 (12.8)	8.0 (10.0)	2.5 (2.5)	0.3
11	C–1–a	A	600	4.0	–	1.8	0.3
12	C–1–b	A	1800	6.0	–	2.4	0.3
13	C–1–c	A	1800	4.0	–	1.8	0.3
14	C–1–d–1*	A	1100	4.0	–	2.2	0.3
15	C–1–d–2	A	800	6.0	–	2.4	0.3
16	C–1–e	A	1200	4.0	–	2.2	0.3
17	C–3–a–1	B	1000	10.7	8.0	2.4	0.3
18	C–3–a–2	B	1000	12.8	10.0	2.5	0.3
19	C–3–b	B	1200	10.6	8.0	2.3	0.3
20	C–3–c	B	1200	10.9	8.0	2.3	0.3
21	C–2–a–1	C	1200	37.4	20.0	2.6	0.3
22	C–2–a–2	C	1800	39.8	20.0	3.0	0.3
23	C–2–a–3	C	2000	47.2	25.0	3.4	0.3

Source: Study Team, 1985
Note: *1 Alternative 2, 3
*2 Alternative 3, 4
+ Existing drain re-used

Total Length : 24,900m
Proposed Drain Length : 17,900m
Used Existing Drain Length: 2,000m
Optional Drain Length : 5,000m (C–2)

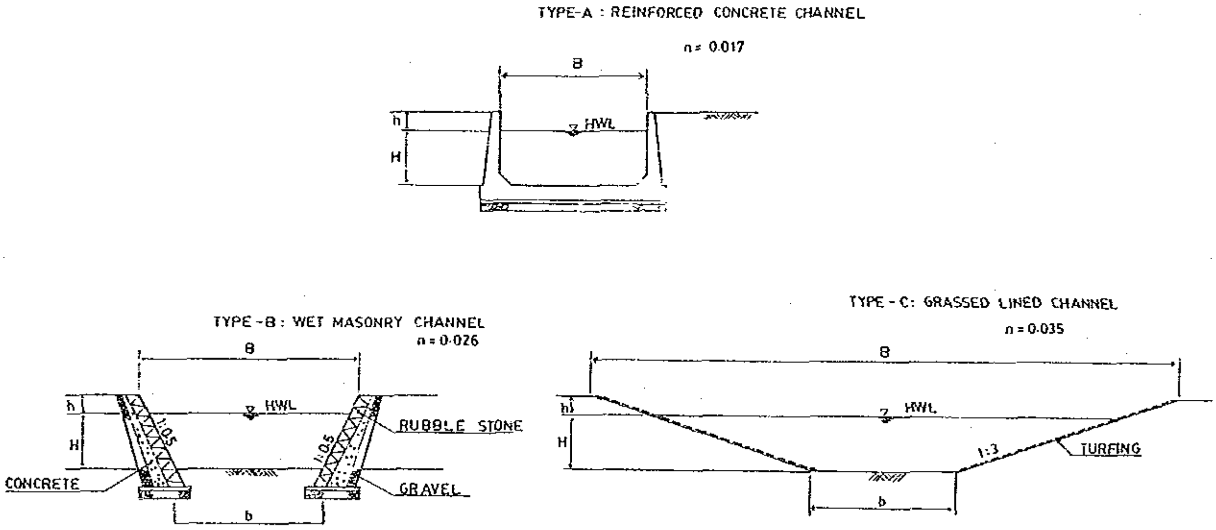


Fig. 5.4 TYPICAL CROSS SECTION OF TRUNK DRAIN

5.4 LANDFILLING

a) Flood prone land

In engineering economic the use of land-fill as an aid against flooding is well recognized. The use of the 10 percent flood level is a recognized flood condition for flood control works, and the use of an low as a filling level as possible reduces the cost of property development.

In places material recovered from dredging operations will be used to raise the river banks to this 10 percent flood level particularly in the C3 area even where this becomes higher than the existing landfill.

b) Pumping

Pumping is usually resorted to when due to local ground conditions, water had to be raised to outlet level. No pumping is considered on the main trunk lines except as discussed in Chapter 6.

Table 5.3 Proposed Ground Elevation of Drainage Area

Unit: m

NAME OF DRAINAGE AREA	ALTERNATIVE	
	1	3
K – 1	3.0	2.5
K – 2	2.5	3.0
K – 3 – a	2.5	3.5
K – 3 – b	2.5	3.5
K – 3 – c	2.5	4.0
K – 3 – d	2.5	4.0 – 4.5
K – 4	3.0	2.5
K – 5	2.5	2.5
C – 1	2.5	2.5
C – 2 – a – 1	4.0	4.0
C – 2 – a – 2	3.5	3.5
C – 2 – a – 3	2.5 – 3.0	2.5 – 3.0
C – 3	2.5	2.5

Source: Study Team, 1985

5.5 OTHER MEASURES

a) Landuse by planning controls

In the urban area planning requirements are enforced and so control of landuse can be reasonably well exercised. However in the countryside under sparse density population, this control is hard to obtain.

Landfill requirements, surface water drainage can be enforced for modern building construction through drawing approval procedures. For buildings of less permanent nature in the countryside these regulations do not apply, and infuence must then be exerted through kampung headmen.

The use of the planning controls and zoning can also influence development of property particularly in flood-prone areas. After the dyke along the Kemaman River is complete and land in K3 and C2 is flood free, and in order to promote the orderly development of surface water drainage facilities, strict application of planning controls must be enforced.

b) Flood proofing property

Heavy rainfall near the design intensity will always create a potential for flooding particularly if drainage openings become blocked by storm debris or uncleared solid waste deposited in the drains during dry spells.

Therefore drainage openings should be as large as possible to prevent blockage by debris. This is the first element of flood-proofing property. Other elements are to have the ground floors elevated over the ground using ground space for parking and storage that will not be damaged by flood.

Erosion caused by flood waters is serious and consequently any slopes on ground subject to potential stream flow should be protected to prevent scour. This can range from grassed areas, rubble or riprap and concrete walls.

When roads and accesses become flooded the usual warnings of dangerous places are not visible, thus road edges should be marked at intervals, road narrows for culverts and bridges should be clearly marked to prevent accidents.

c) Flood warings

This is outside this particular scope of the surface water drainage, but as it is usually associated with the urban drainage it is included.

Flood warnings should be issued to the inhabitants in the lower laying areas, particularly to those who live near the trunk drain outlets; who live outside the flood-free areas; and those who live upstream of the Kemaman River in the flood-prone areas outside the study area.

The critical factors are tides and rainfall, and local meteoroloical office could be useful in providing the necessary service with support from Cukai town officers responsible for the operation of the drainage outlets.

This subject should be studied in greater detail when the matters discussed in the next chapter are clarified.

5.6 CONCLUSION

(i) The examination of flood mechanism showed clearly that the present trunk drains in the town have been overtaken by development and cannot carry the surface water run-off.

(ii) The surface water drainage system of the higher town area is indepenedent of flood control and can be undertaken independently.

(iii) Outlet conditions must be coordinated with flood control.

(iv) Land use and property development must be controlled to ensure adequate future surface water run-off.

(v) With flood control works making flood-free land available for development this new land must be co-ordinated into the surface water drainage requirements.

CHAPTER 6 FLOOD CONTROL AND SURFACE WATER INTERFACE

6.1 INTRODUCTION

This subject was introduced in the two previous chapters and is discussed in this. The subject matter is important as both Flood Control and Surface Water Drainage are independent subjects and it is on the banks of the river that the two meet.

Works related to matters of quality of life must not be linked in time to other works unless directly related, and consequently the surface drainage work in the Cukai urban area must be carried out idependently of any flood control work.

Drainage work always commences at the outlet, and this is related to the flood control works. This would appear to be a contradiction but in fact need not be so.

There are three methods considered in the study. Open discharge; gate controlled discharge; and pump discharge.

In order to plan the design requirements, Figure 6.1 is used. There are three conditions under consideration, "without project" i.e. no flood control works are implemented; alternative 1; and alternative 3. The study selected the three methods of discharge and examined them against the three flood control conditions.

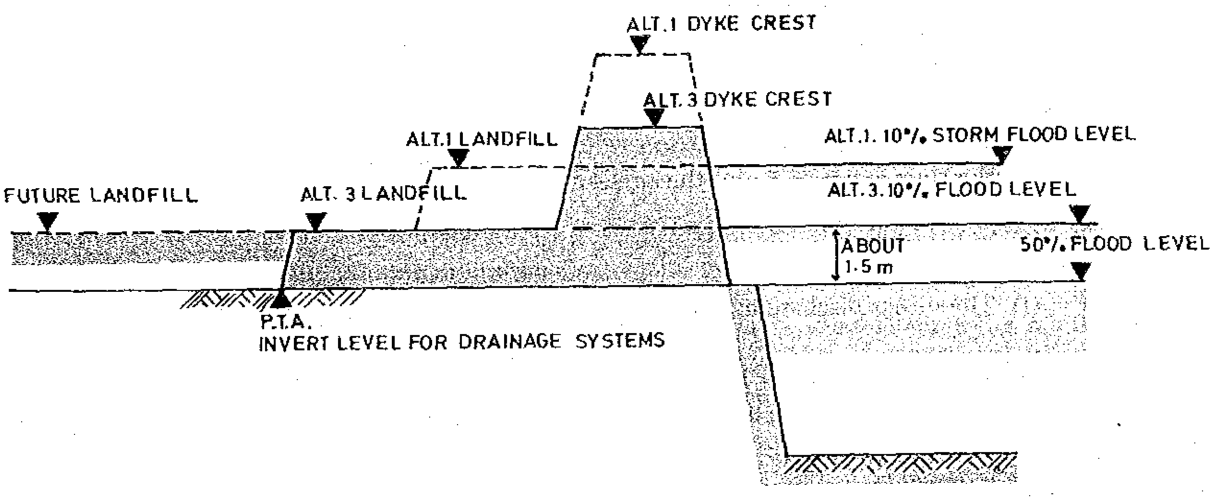


Fig. 6.1 SCHEMATIC ARRANGEMENT OF LEVELS

The first basic point of the drainage design is that all development of land must be to the level of the 10 percent storm under alternative 3 conditions. This is approximately 1 to 1.5 metres above river bank level.

Therefore Pt. A is the theoretical invert level for all trunk drains under any of the three flood control conditions. As this is at existing ground level the trunk drain must be constructed in land-fill to meet this design requirements.

6.2 OPEN DISCHARGE

This condition exists at present on the unimproved river where the drains are below existing ground level. These drains are affected by every flood.

When the ground level is raised to the 10 percent flood level of alternative 3, the new trunk drain invert can now drain into the river at about the existing ground level. This means that the 50 percent flood level i.e., the frequent flood will not cause flooding but will back-up the drain and invert is still submerged under a 10 percent storm. The drain will be determined by its discharge and 10 percent river flood level. Water levels in excess of the 10 percent flood level will cause flooding.

This open discharge method is examined for each condition.

a) "Without project" – no flood control

(i) The existing drain outlets are inadequate and the drains should be diverted into a new trunk drains, thus the outlets will become redundant.

(ii) The trunk drains shown in the previous chapter should be constructed such that the design water level is at 10 percent flood level for alternative 3.

(iii) This means that the drains must be constructed on or in land-fill providing the required gradient and levels.

(iv) This height will permit storm water to flow out of the town area, even though the river is flooded, and the adjacent river banks are inundated.

b) Alternative 1

(i) The drains discharging into the Cukai River will be open discharge.

(ii) The existing drains leading into the channel South of Pulau Pak Mud will be reconstructed and enlarged. The outlet will be raised as discussed.

c) Alternative 3

(i) In addition to the drains listed for alternative 1 all drains, except the one furthest upstream, will be open discharge.

6.3 GATE CONTROLLED DISCHARGE

This system uses a gate to close the outlet of the drain when the river flood water is above the drain capacity level. It prevents the river from flooding the flood-free land by backing up the drain.

This will cause local flooding around the drain from the surface water run-off accumulating behind the closed gate. When this accumulated water level exceeds the river level the gate can be opened and the drain water will flow into the river.

a) "Without project"

(i) The existing drain outlet will be retained with the gate, but the drain will be reduced in length. The drain will be not to be reconstructed.

(ii) No new gates will be established.

b) Alternative 1

(i) Existing flood gate and drain will be retained.

(ii) Drains in K1 area draining into Kemaman River will require flood gates.

c) Alternative 3

(i) Existing flood gate and drain will be retained.

(ii) Drain furthermost upstream of the Kemaman River will require a flood gate.

6.4 PUMP DISCHARGE

This is a complicated subject as it is not practical to install sufficient pumps of sufficient capacity to pump out the water as it arrives at the pumping station. Therefore a balancing arrangement is necessary between storage of water waiting to be pumped, and installed pumping capacity.

It is usual to determine a storage capacity requirement in hours or in days and then determine the pumping requirements.

In the study a 24hr detention was selected and a suitable pumping requirement selected. From this data and using a submerged pump principle a storage area of between 4 and 6 hectares per 100 hectares of catchment area is required.

This very large size, due to depth limitations there is a severe handicap to this method. Only by raising drain invert level can this area be decreased and hence the drain would be above recommended land-fill level. It is an impractical situation.

a) "Without project"

(i) No requirement

b) Alternative 1

(i) Required for drains in K2 and K3

c) Alternative 3

(i) No requirement

6.5 SUMMARY

Using the landfill principle for flood-prone areas the Urban Stormwater Drainage works can be executed independently of the flood control works. This is significant as it permits the Cukai town drainage project to be carried on its own merits and priorities without having to have its programme typing in with that of the flood control programme.

The pumped discharge requirements for water storage are a severe handicap to the alternative 1 project. The use of a storage facility with permanent standing water in a town area is a potential health hazard and not to be recommended.

The question of the interface for alternative 1 is an engineering detail and problem that must be resolved by further investigation in the feasibility stage.

Alternative 3 avoids the problem.

CHAPTER 7 NEW TOWN CENTRE DEVELOPMENT

7.1 INTRODUCTION

The theme developed earlier for this study was that in Cukai area:

(i) There is a shortage of flood-free land.

(ii) Development is taking place in flood-prone area.

In the Chapter 4 discussion of alternatives 2 and 3 mention was made of using the material obtained from the diversion channel through Kampung Geliga Kechil to fill the Kemaman River channel and to use this new ground for the construction of a new town centre.

This chapter discusses this arrangement and established certain basic concepts.

The new diversion channel displaces many of the inhabitants of the kampung. These people must be rehoused before the channel excavation begins. There are moorings for about 100 fishing vessels which must have new moorings. This constitutes the preliminary phase. The construction phase is the landfill reclamation and the third phase is the infrastructure phase.

7.2 PRELIMINARY PHASE

a) Rehousing

It is necessary that the spiritual value of the kampung should remain intact and those houses not affected by the works should remain part of the same community.

There is State land of a low lying flood-prone type beside the river to the immediate northwest of the kampung. To relocate those displaced by the works to this place would retain the homogenuity of the kampung.

b) Landfill

The land must be reclaimed to a suitable flood free level, and then housing built. The landfill cannot come from the new diversion channel unless temporary housing is immediately available. It is proposed that landfill is obtained by dredging the swamp area to the south of Pulau Sekaping. (If this is done in an orderly manner the site becomes available for future development).

c) Commencement of diversion channel

When the inhabitants are rehoused temporarily the first cut through for the diversion channel can be made. This should be on the south side of the channel and should be used to landfill to the north of the relocated kampung. This material cannot be used for the reclaming the river channel until there is through water between the river and the sea. When the breach is made the construction phase can commence.

7.3 CONSTRUCTION PHASE

The axis of the new town centre will be Jalan Abdul Rahman and will be four blocks wide to include Jalan Masjid extended across the river and also Jalan Che Ting.

The reclamation will also extended up river about 150 metres to give a potential industrial site. The total reclaimed area will be 16 hectares with 9 hectares for the commercial centre and 7 hectares for the industrial site.

a) Reclamation

The sand dredged will be pumped by floating pipeline into the general area and then allowed to settle out, generally the slope of the fill under water is very gentle and unless beaches are wanted the fill has to be retained by bunds. It is probably that the north face will be a beach and the south face will be walled for the fishing boats. The finished level of the reclamation must be about flood level of the 2 percent flood. However due to tidal effect this is not nearly as high as up river and one metre freeboard will be added.

The new diversion cut must be able to take the increased water flow from the river as the river is blocked by reclamation. This will require considerable planning by the dredging contractor.

It is normal to bulldoze the rising sand level into 3 or 4 metre high mounds to assist in consolidating the sand. Sand usually settles very quickly under load and using the reclamation material is a very convenient way of getting the major settlement of the new ground completed before constructing the buildings.

b) Access

When the landfill comes out of the water it will be used by the public whilst work is still in progress. This is dangerous as the contractor will be using heavy earthmoving plant and there may well be many soft areas. It will be also used to get to and from the kampungs on the shore.

Unauthorized people must be discouraged from using the area by notices and by action of the authorities but access by the shore kampungs must be considered, for as soon as the cut is breached at the end of the preliminary phase the shore area is isolated until the reclamation comes out of the water.

The contractor will be required to work to a coordinated programme considering these facts.

c) Small craft harbour

The kampungs boats are currently moored where the diversion cut will be made.

When the kampung people are relocated the moorings must be as convenient as at present.

Thus the new moorings will be adjacent to the kampung inside the existing river alignment to the north of the diversion cut. To permit the river to sweep round from the northerly direction to an easterly direction the outside of the bend across the existing river bed must be protected against erosion. This bank will also be a separating bank between the new river and the old river portion. A special entrance shall be made to the small carft harbour away from the river bend.

Primarily intended for the kampung fishing craft, if the sides of the harbour are retained by walls small craft can use the area commercially.

7.4 INFRASTRUCTURE PHASE

When the dreding contractor has finished the reclamation to the required levels, grades and profiles, access to the area must be ensured, and the site prepared for development.

Land value, which are discussed in another place, depends upon the availability of the infrastructure.

Infrastructure is termed for public supplied facilities which include roads, footpaths, surface water drains, street lighting, sewers, electric power, water supply, telephones and landscaping.

The work for installing these must commence immediately after the dredging contractor has handed over the site, as the realization of land values can only occur when investors see the infrastructure being installed.

With installation of the infrastructure comes the realization of the land use planning and the reclassification of the land discussed in Chapter 4.

7.5 PROPERTY DEVELOPMENT

a) Concepts

Figure 7.1 shows a simplified layout of the new town area after development has taken place.

(i) The basic concept is that the administrative area, the existing business area and the new town centre must be contiguous. This maintains the historical and traditional centres of Cukai to remain cenral to the town. The ncessary new facilities to support Telok Kalong industrial estate are provided in the town without displacing the existing centres.

(ii) The small craft harbour should be a subsidiary employment centre not only for the Kampung Geliga Kechil, but also for the town.

The proximity to the new and old business centres with good access to both provides excellent opportunities for service industries directly supporting Telok

Kalong and so these can be integrated into the town community.

(iii) The previously isolated shoreline Kampungs should be brought into the town community.

This can be done by extending the principal new town axis road Jalan Abdul Rahman to the main shore road and permitting the establishment of small commercial properties along this axis.

(iv) Development of land adjacent to the new town area for recreational and residential purposes in close proximity to the new town.

The relocation of Kampung Geliga Kechil is the first phase of this, and the landscaping and filling of the area to the south of Pulau Sekeping brings many hectares of land close to the town centre into an attractive community centre. These concepts are simplified in Figure 7.2.

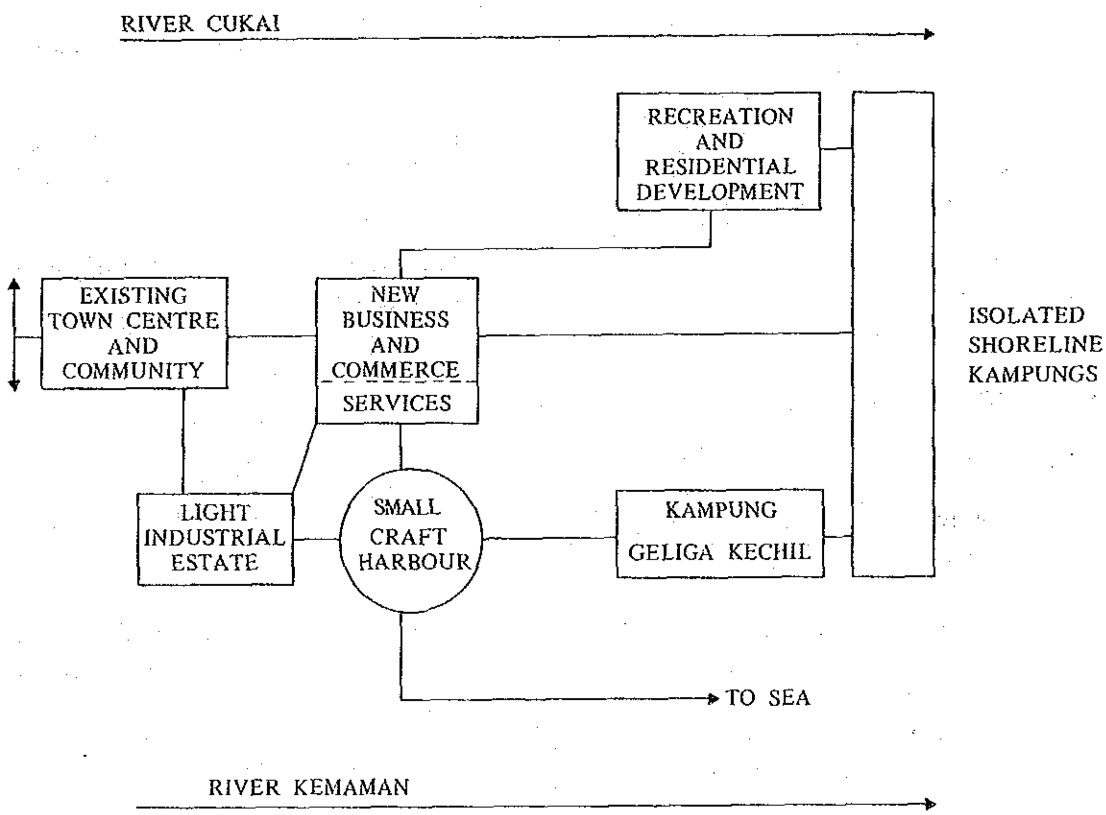


Fig. 7.1 NEW TOWN – CENTER CONCEPT

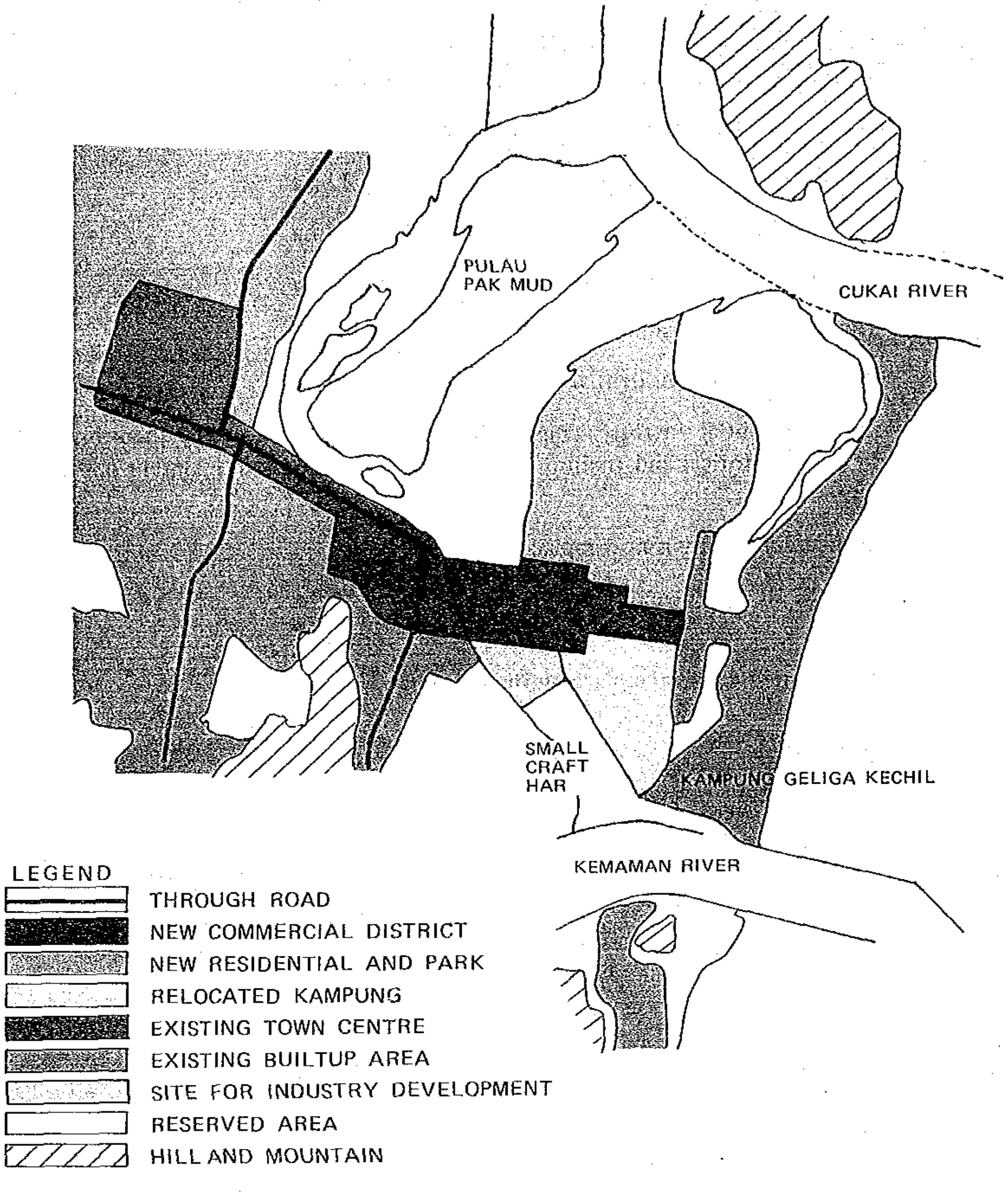


Fig. 7.2 CONCEPTUAL PLANNING

b) Achievements

Land use classification Figure 2.2 shows the classification at present.

Figure 4.13 shows this for alternative 3. Comparison of the two alternatives shows that a large rise in land classification occurs from alternative 3.

A total of 62 hectares is added to Cukai town area, comprising:

Road and public facilities	: 11 ha
Parks and public recreation	: 14 ha
Commercial and business property	: 15 ha
Higher standard residential area	: 12 ha
Medium standard residential area	: 10 ha

This is a substantial increase which will enhance the value of the town but still maintain the historical and traditional centres of town and still maintain one close community.

The theme of the study is now replace

(i) There is NO shortage of flood free land.

(ii) Dvelopment CAN take place on flood-free land.

CHAPTER 8 IMPLEMENTATION PROGRAMME

8.1 INTRODUCTION

This chapter is divided into 4 sections. Using approximate quantities and rates for doing the work outline construction costs are obtained. At a prefeasibility stage any accuracy better than ±25 percent on this size of project should not be expected.

The costs for all four alternatives are derived using common costs based on 1984 prices obtaining in Malaysia. Consultants fees for design and supervision is assumed 5% of Flood Control Cost and Trunk Drain Cost.

The Expenditure Schedule Tables to show expenditures in 5 year periods from 1985 to 2000.

Tables given are self explanatory and no additional explanations are necessary.

Realization of land sales to cover the project costs or financing charges are not allowed in this chapter and are covered in the next chapter.

8.2 CONSTRUCTION COST

a) Table 8.1 Construction cost summary

b) Construction costs

(i) Table 8.2 Flood Control Costs

(ii) Table 8.3 Urban Drainage Costs

Table 8.1 Construction Cost Summary

Unit: M\$$10^6$

ITEM	ALTERNATIVE			
	1	2	3	4
Flood Control	74.16	91.93	92.22	87.95
Urban Drainage	107.00	101.23	88.27	89.70
Total	181.16	193.16	180.49	177.65

Source: Study Team, 1985

Table 8.2 Flood Control Costs

Unit: M$ 10^6

	ITEM	ALTERNATIVE 1	2	3	4
KEMAMAN RIVER	River mouth improvement	11.52	16.64	16.64	11.52
	Diversion channel	-	12.88	12.88	-
	Separation levee	-	3.00	3.00	-
	Dredging and dyke/fill-up	32.20	21.75	21.50	45.45
	(1) Downstream of div. chan.	(17.20)	-	-	(17.20)
	(2) Upstream of diversion channel	(11.25) (3.75)	(11.25) (6.75) (3.75)	(11.25) (3.75)	(11.25) (6.75) (3.75)
	(3) Short-cut	-	-	(6.50)	(6.50)
	Revetment	2.34 3.51	3.51	3.51	2.34 3.51
	Kampung relocation	Approx. 5.0	3.70	4.48	Approx. 5.0 0.78
	Land acquisition	1.86	1.86	1.62	1.62
	Sub Total	56.43	63.34	63.63	70.22
CUKAI RIVER	River mouth improvement	-	8.96	8.96	-
	Dredging and dyke/fill-up	2.80	3.90	3.90	2.80
	Revetment	1.90	2.70	2.70	1.90
	Bush clearing (with trees)	0.03	0.03	0.03	0.03
	Sub Total	4.73	15.59	15.59	4.73
	Total	61.16	78.93	79.22	74.95
OTHERS	Bridge reconstruction	8.00	8.00	8.00	8.00
	Barrage	Approx. 5.0	Approx. 5.0	Approx. 5.0	Approx. 5.0
	Total	74.16	91.93	92.22	87.95

Source: Study Team, 1985

Table 8.3 Urban Drainage Costs

Unit: M$$10^6$

ITEM	ALTERNATIVE 1	2	3	4
Trunk Drain including Gates and Bridges	34.72	34.36	34.45	36.31
Secondary Drain (1)	35.58	36.72	37.82	35.58
Land Filling (2)	-	30.15	16.00	17.81
*Pumping Station	36.70	-	-	-
Total	107.00	101.23	88.27	89.70

Source: Study Team, 1985

Note : *Maintenance Cost M$16.53 X 10^6 every 20 years
M$ 0.14 X 10^6 every year

(1) and (2) will be constructed by the developer.

8.3 IMPLEMENTATION PROGRAMME

The preparation of the bar chart on a time scale is the end product of a rationalization process. The various factors that have to be taken into consideration have been discussed in the various chapters, and certain basic factors predominate.

a) Factors to be considered

(i) Work will proceed from downstream to up stream

(ii) Kampung relocation imposes time constraints

(iii) Geliga Bridge has to be reconstructed

(iv) The volume of material that can be dredged in one year.

(v) Direct government involvement because of social impacts

(vi) Effect of monsoon on the works

(vii) Barrage construction at early date before saline intrusion.

b) Simplified PERT chart

It is necessary to put these controlling factors into an activity of PERT diagram. This report is based on a prefeasibility study and therefore a simplified version is used to ensure that a logical continuity of activity is maintained. It has no other function. The chart is prepared for the flood control works only as this is a complicated procedure. The urban stormwater drainage works have priorities which are not known at this stage.

Only two PERT charts are prepared Figure 8.1 for alternative 1 and 4 and Figure 8.2 for alternative 2 and 3.

c) Bar charts

(i) The Bar charts are formed by converting the activity sequence of the PERT shorter distance of the "short cut" through Kampung Bukit Mentok is compensated by the larger amount of dredging.

On the Bar chart the urban drainage is added, however, this is shown as a continuous on going project. Figure 8.3 is given for alternative 1 and Figure 8.4 for alternative 3.

(ii) Comparison of the two charts is relatively easy as the duration of both alternatives is the same – 9 years plus the final stages of the urban stormwater drainage.

The controlling factor is the Kemaman River dredging, and the distance saved on the new diversion cut is compensated by the increase in dredging.

Compression of activity duration is possible by increasing plant and installed horse power, however acceptance of project shut down during monsoon weather has been made. If continuous working can be performed – except in flood – then 5 seasons can be saved.

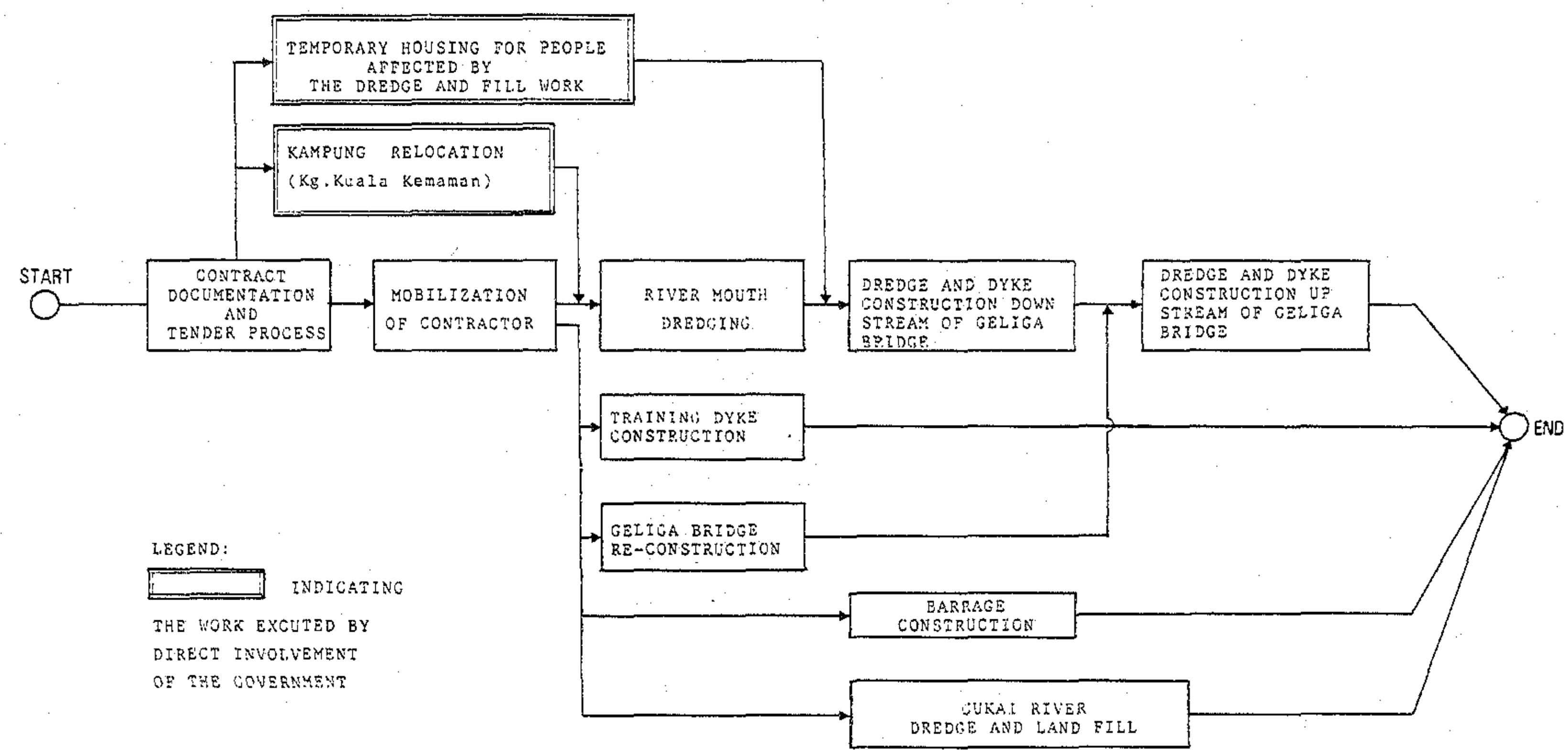


Fig. 8.1 RIVER IMPROVEMENT IMPLEMENTATION SCHEDULE (SIMPLIFIED PERT CHART)
ALTERNATIVE – 1 AS SHOWN
– 2 KDD KAMPUNG RELOCATION (Kg. Bukit Mentok)

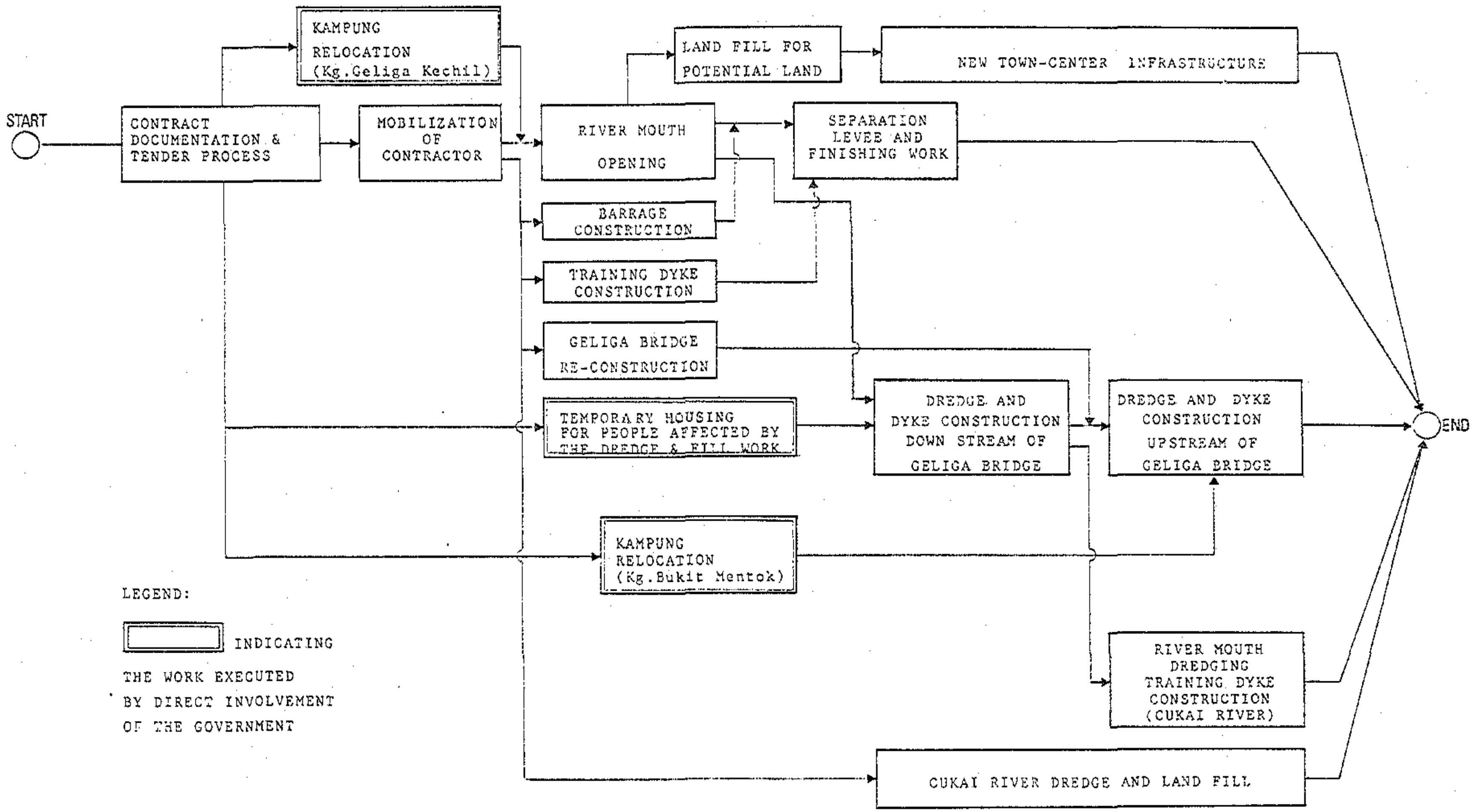
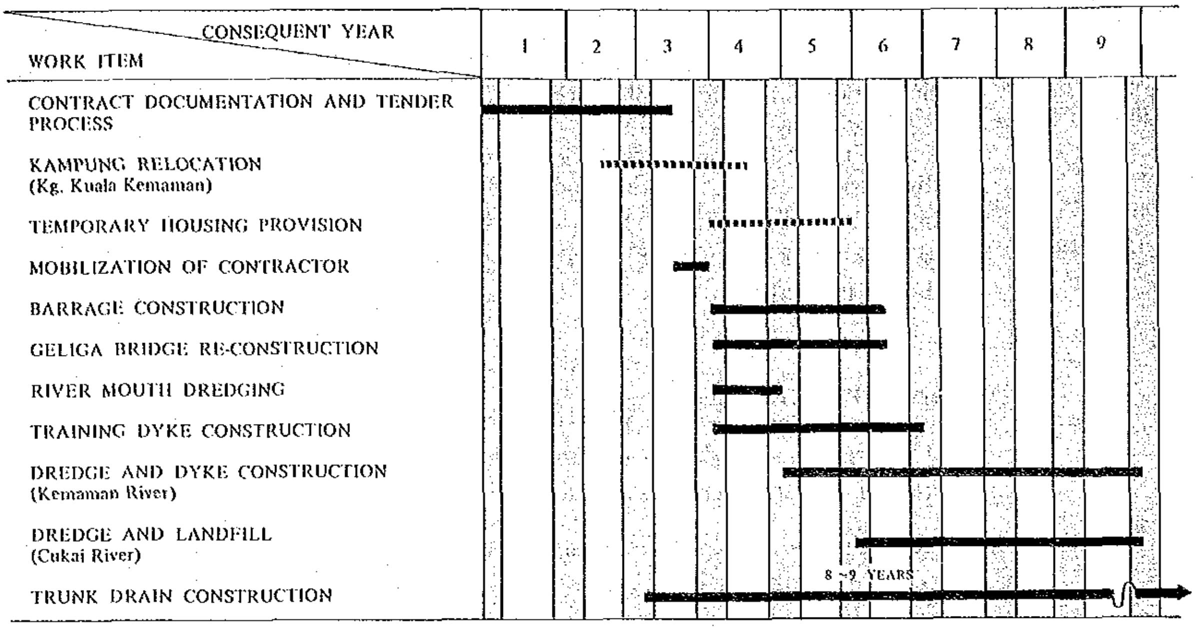
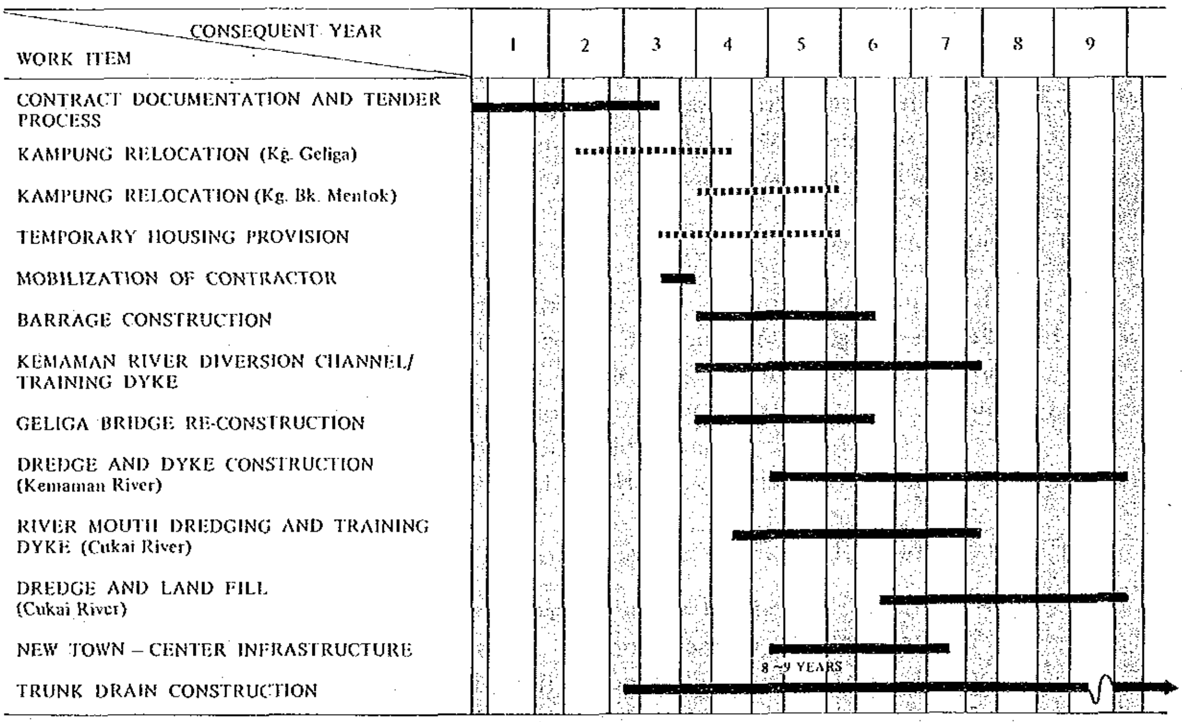


Fig. 8.2 RIVER IMPROVEMENT IMPLEMENTATION SCHEDULE (SIMPLIFIED PERT CHART)
ALTERNATIVE – 3 AS SHOWN
– 2 DEDUCT KAMPUNG RELOCATION (Kg. Bukit Mantok)



Note: ▮▮▮▮▮▮▮▮ Indicating the work executed by direct involvement of the Government
☐ Indicating "Monsoon season" period

Fig. 8.3 FLOOD CONTROL AND DRAINAGE PROJECT IMPLEMENTATION SCHEDULE ALTERNATIVE – 1



Note: ▮▮▮▮▮▮▮▮ Indicating the work executed by direct involvement of the Government
☐ Indicating "Monsoon season" period.

Fig. 8.4 FLOOD CONTROL AND DRAINAGE PROJECT IMPLEMENTATION SCHEDULE ALTERNATIVE – 3

The barrage construction is assuming a complex structure with navigation locks. If detailed design produces a simpler structure and hence a shorter construction period is possible. This is not a critical timing factor except that early start is required.

Geliga Bridge is a constraint and completion is critical. The existing bridge cannot be removed until the new one is in use as river improvements cannot go upstream of the existing bridge without putting the safety of the bridge and the public at large at risk.

8.4 CONTRACT PACKAGING

It is not conceived practical to put the whole works out as one contract package unless the financial arrangements are included as a Turnkey Contract with design.

A project of this nature would require financial assistance by a funding agency and in this case multiple packaging has some desirable features and increases the opportunities for Malaysian contractors to complete as prime contractors.

a) Consulting engineers

Consultants would be required to carry out a feasibility study and evaluation to confirm the project and then to carry out detailed design and contract documentation. Supervision of construction would be performed by the same consultant.

b) Kampung re-location. Contract A

This is seen as a Malaysian contract awarded and supervised by the State Government. The object is to get the temporary housing ready for kampung dwellers before dredging commences to relocate fishing moorings, and then to construct the new kampung houses. This is a key project for overall timing.

c) Flood control works. Contract B

This is the major work project and would be for dredging and reclamation works including bridge reconstruction, barrage construction, training dykes and urban stormwater drain outlets. This would also include small craft harbour works if required. An examination was made for multi contracts and phased construction. This was found to be impracticable as it is necessary for all the works to be carried out at one time to maintain integrity of the project.

d) Urban stormwater drainage works. Contract C

This contract is considered as one contract for simplicity, but it may be considered for one large prime contractor or as a series of individual contracts. Suitable for award to major Malaysian contractors this will result in considerable disruption to the town and strict contractor discipline to timing and procedures will be required. Close supervision is indicated.

e) New town centre infrastructure. Contract D

This is suitable for a Malaysian contractor well experienced in urban construction. This contract requires considerable planning abilities to achieve the necessary overall development. Employment of Cukai sub-contractors should be possible.

The scale of these works and the labour force necessary to achieve this will bring considerable monetary benefits to the citizens of Cukai and the surrounding communities.

CHAPTER 9 PROJECT EVALUATION

9.1 INTRODUCTION

The technical aspects of flood control works and drainage works have been discussed in the previous chapters. Practical method of migitating floods have been examined and alternative proposals prepared. Each alternative has a different effect upon the area under examination.

It is therefore necessary to carry out an economic evaluation of each alternative to determine the project with the best investment efficiency (EIRR), the best in terms of benefits and costs and then to allow for variations in cost assumptions by use of sensitivity analysis of the most economic alternative.

The detailed procedures and assumptions are given in Appendix E which supplements the presentation in this chapter.

9.2 ECONOMIC EVALUATION

a) Result of evaluation

Alternative 3 is the recommended solution. This project has superior economic advantages over the other alternatives by virtue of:

Firstly, it has the best investment efficiency.

Secondly, it has the greatest mitigation effect upon flood in the Cukai area.

Thirdly, it provides the greatest social benefits in regional development.

The results are summarized in Tables 9.1 and 9.2. These indicators show the superiority of Alternative 3, followed by Alternative 2.

Superiority of alternative 3 is demonstrated by its efficiency. The costs is the lowest by 9 million Malaysian dollars and the benefits from the alternative exceeds that of the next alternative by 28 million Malaysian dollars. In sum, alternative 3 is the least cost alternative with the largest flood mitigation effect amongst all the alternatives.

Another superiority is its effect to create a new flood free are of 887 hectares and to make the present swamp area adjacent to the existing urban area available for future development.

b) Assumptions

The assumptions used in the evaluation are:

Table 9.1 General Effect of the Project

	Incremental Flood Free Area (ha)	Created for Potential Development (ha)	Population in the Flood Prone Area at the year 2000 (persons)	Incremental Income/Sales [1/] (10^6 M$)	Employment Opportunity [2/] (100 person/ day)
Alternative 1	877	–	26,800	11	1,580
Alternative 2	837	62		11	1,692
Alternative 3	887	62		11	1,600
Alternative 4	877	–		11	1,570

Notes: 1/ Incremental Income/Sales is atributable to the additional working days resulting from the project and included in the total flood mitigation benefits in Table 9.2.

2/ This is derived by the function below:
Employment opportunity = Total labour cost / 27 (M$/day)

Table 9.2 Investment Efficiency

	Total Economic Cost (10^6 M$)	Total Benefits (10^6 M$)	EIRR (%)	B/C (discount rate = 8%)
Alternative 1	166	428	6.0	0.76
Alternative 2	162	477++	6.5	0.81
Alternative 3	153	505	7.2	0.90
Alternative 4	163	436	6.2	0.78

(i) The benefit flow period is 30 years after 1994, while the cost flow period begins at 1986.

(ii) The reduction in flood damage increases linearly between 1994 and 2010. Beyond the year 2010, it is constant.

(iii) Economic discount rate is set at 8%.
(Source; National Parameters for Project Evalaution, EPU, 1979)

c) Project cost

Costs in 1985 prices are shown in Chapter 8. For the economic evaluation, the nominal cost is processed into the economic cost by using the following process;

(i) Total cost is distributed in accordance with implementation schedule.

(ii) Cost for each year is divided into labour cost and construction/maintenance cost.

(iii) Labour and construction/maintenance costs are converted into economic prices by using conversion factors (Source; National Parameters for Project Evaluation, EPU, 1979)

The results are tabulated in Appendix E.

d) Project benefit

The economic benefit obtained from flood control and drainage projects is the difference in flood damage potentials between the cases of "with the project" and "without the project," considered for each alternative.

For the purpose of estimating project benefits, certain basic conditions are established. With the identification of benefits, each item of benefit is then established.

(i) Basic conditions:

These are;

- Land use
- Population
- Number of houses/commercial buildings

(ii) Benefit estimate:

Project benefits comprises three items with various sub-items. The three items are:

- General property damage potential
- Public property damage potential
- Income/sales loss potential

Gross total of damage potential in the year, 1985, 2000, and 2010 calculated by flood frequency, is weighted by frequency of flood and its aggregation makes the flood damage potential of each year.

Results are tabulated in Appendix E for each alternative.

e) Other factors

Area-wide effects of the project are classified into two groups:

(i) Effect upon further regional development:

- to guarantee continuous activities in industrial and commercial sectors, and to activate production activities,

- to increase flood free area and improve land use from an urban structure aspect by improving drainage, which creates amentities and improves the town's image,

- to raise the competitive power of Terengganu for the establishment of new factories in region, and consequently to enhance the support of industrialization.

(ii) Effect of improved amenties:

- to contribute by convenience in daily life and in stabilization of the resident's livelihood,

- to improve public health,

- to improve the image of the town.

This project is a pre-requisite for economic development of the region, as it is necessary to create an urban core to anchor the development of industry and commerce.

9.3 FINANCIAL CONSIDERATIONS

Pecuniary return is expected form this project, which accrues from increase in land values. It is large enough to pay back a large portion of the project cost.

a) Increase in value of residential land:

Increase is realized in two ways: –

Firstly, pecuniary return accrues fromthe increases in price for the filled-in residential land in the present flood prone areas.

Secondly, pecuniary return accurues from increase in value of the present swamp-land for the proposed new town centre.

Table 9.3 Increase in Value of Residential Land

	Incremental Flood Free Land (ha)	Incremental Value of Land (M$/m²)	Incremental Land Value (10^6 M$)
Alternative 1	877	13	114
Alternative 2	837	13	109
Alternative 3	887	13	115
Alternative 4	877	13	114

The market for residential land property is assumed to be kept equilibrium in the future because:—

(i) Land for building is planned to expand according to the demand increase.

(ii) Massive influx of industrial workers are expected.

b) Distribution of financial cost and benefit

Table 9.4 summarizes the distribution of pecuniary return showing the financial burden sharing between the public and private sectors.

Table 9.4 Financial Cost and Benefit Distribution

(Unit: $x10^6$ M$)

	Cost			Benefit		
	Total	Governments	Private	Total	Governments	Private
Alternative 1	199	117	82	114	–	114
Alternative 2	211	141	70	198	89	109
Alternative 3	198	134	64	204	89	115
Alternative 4	195	107	88	114	–	114

Cost of the private sector includes the cost for secondary drains and land filling, and the public sector is expected to stand the rest of the project cost.

Government's benefit accrues from the land sales for a proposed new town centre, while the private can derive benefit from saling the filled-up land.

9.4 SENSITIVITY ANALYSIS

Sensitivity analysis is carried out to determine the effect of variations caused by influential factors on the evaluation and to take into account the case whereby growth is severely restricted.

For this purpose, the EIRR of the best alternative, Alternative 3, is examined using the assumption of various cost and benefit levels, and of two evaluation periods (30 years and 50 years).

Results are shown in Table 9.5. The EIRR ranges from 4.8 to 8.5. In a case that the benefit is assumed to be smaller than the estimated figures, the EIRR shows the most elastic movement. The lowest figure 4.8, however, suggests the rationale of this kind of project.

Table 9.5 Results of Sensitivity Analysis
(Alternative 3, Evaluation Period : 30 years)

(%)

	Cost					Benefit				
	-20	-10	+10	+20	+30	-30	-20	-10	+10	+20
EIRR	8.9	8.0	6.6	6.0	5.5	4.8	5.7	6.5	7.9	8.5

The EIRR at the assmption of 50 years evaluation period appears higher than the EIRR in the previous case by 1% as shwon in Table E.15.

9.5 OTHER CONSIDERATIONS

In terms of land development costs, Alternative 3 will realize the least cost for further development by improving flood conditions in Class 4 areas such as block C-2, K-3 and K-4. When the planned railway is constructed, the Cukai station is planned to be in block K-3. These land development with proper drainage will be able to provide suitable building and development sites at the least cost amongst the alternatives.

CHAPTER 10 RESULTS OF THE STUDY

10.1 CONCLUSIONS

The theme developed in Chapter 2 has been examined in each chapter,

(i) There is a shortage of flood free land

(ii) Development is taking place on flood-prone land.

As a result of this study the theme has been revised,

(i) There is NO shortage of flood free land

(ii) Development CAN take place on flood free land.

a) Existing situation

(i) Development is now taking place on flood prone land due to insufficient flood free land

(ii) Existing town area above river flood level incurs flooding due to inadequate surface water dainage

(iii) Recent development do not consider flood control or drainage measures

Summary : The necessity for flood control works and urban surface water drainage has become the most important factor for development in the Cukai region.

b) Alternative proposals

Two basic schemes were prepared, alternative 1 and 2 and one variation of each 4 and 3 respectively. One urban surface water drainage scheme was prepared with different outlet conditions for each flood control alternatives.

Each alternative was examined from the aspects of flood control, drainage and land-use. Each was examined with the same constant factors. It was determined that each alternative must be considered as a whole package and cannot be broken down into stage packaging.

Summary: This is presented in Table 10.1 which shows costs, and the relative advantages and dis-advantages of each alternative. As these consideration factors have not been weighted, no numerical basis has been used to recommend one alternative over another.

The clear advantage of alternative 3 must make this the logical scheme to the examined in more detail.

Table 10.1 Comparison of Alternatives

ITEM / ALTERNATIVE			WITHOUT PROJECT	ALT. 1	ALT. 2	ALT. 3	ALT. 4
Flood Level of Kemaman River at 14KM (MSL, M)	10% Flood (10-Year Flood)		5.3	5.0	4.3	3.8	4.5
	2% Flood (50-Year Flood)		6.9	6.3	5.5	5.0	5.8
Total Construction Cost (10^6 M$)	(Flood Control, Drainage, Land Filling, Bridge Reconstruction, Kg. Relocation etc.)		–	(181)	(193)	(180)	(178)
Advantages	Potential Flood Damage (Year 2000 Conditions, 10^6 M$)	10% Flood	(37.8)	(8.6)	(5.1)	(5.1)	(7.6)
		2% Flood	(70.3)	(32.7)	(27.5)	(27.5)	(33.2)
	Possibility of New Town Centre	Potential Land Area (HA)	–	–	62	62	–
		Land Value Increase (10^6 M$)	–	–	(89)	(89)	–
	Expected Land Value Change	Flood Free Area (HA) <Area Increased>	–	1364 <877>	1324 <837>	1374 <887>	1364 <877>
		Land Value Increase (10^6 M$) Min.	–	(114)	(109)	(115)	(114)
	Possibility of Urban Sructure		△	△	○	◎	△
	Possibility of New Small Craft Harbour		–	–	○	○	–
	Support for Industrial Development		×	○	○	○	○
	Image of Cukai Town		×	○	◎	◎	○
	Effects on Socio-Economic Activity		×	○	○	○	○
	Stabilization of Living People		×	○	○	○	○
Dis-Advantages	River Navigation (Because of Barrage)		–	△	△	△	△
	Difficulty in Kampong Relocation		–	△	○	△	×
	Possibility of Refects on Sand Dlift of Neighboring Coast		–	△	△	△	△
EIRR (Flood Damage Saving Only)			–	6.0	6.5	7.2	6.2
Overall Evaluation			×	△	○	◎	△

Source: Study Team

LEGEND ◎ Very Good ○ Good △ Fair × Poor

10.2 RECOMMENDATIONS

a) Selection of alternative

(i) Based on the conclusions of the study, alternative 3 is recommended for the flood control works project together with the urban stormwater drainage scheme and outlet works compatible with alternative 3.

(ii) The reasons for selection are:

- Minimizes flood damage
- Lowers flood levels of the river:

Diversion and dredging	1.1 meters
Shortcut and dredging	0.4 metres

- Reduces land filling by developers of approximately 15×10^6 cu. metres.
- Pumping stations are avoided
- Increases land use potential areas 62 (ha) incremental land value (M$89 $\times 10^6$)

Without project	(M$5 $\times 10^6$)
With project	(M$94 $\times 10^6$)

- Enhances urban structure with new town centre
- Potential for improving fishing industry
- Promotes image formation
- Supports industrial development.

b) Proviso

Should kampung relocation become difficult alternative 1 is the second recommendation. However this still involves the relocation of Kampung Kuala Kemaman and has less flood control effects.

c) Upstream of study area

This study was restricted to the downstream area of both rivers, and flood control works are designed for stable upstream conditions.

(i) Development of upstream floodfree areas must consider the effect of increase of sediment inflow and flood discharge.

(ii) Trunk drain discharges from Telok Kalong area should be into the nearest to month of Cukai River or otherwise must be held in retention ponds.

d) Integrity of alternatives

No component part of the flood control works shll be taken out of the alternative to be performed alone or a differing sequence. Each alternative is designed as linked unit, to remove a link destroys the integrity of the design and prevents and achievement of the objectives.

10.3 FURTHER STUDIES

This has been a pre-feasibility study to examine options in a broad sense and to establish a basis for further investigation by feasibility study into detail design.

In order to achieve this, additional research and examination is necessary to confirm requirements and to understand certain phenomena.

a) Hydrological analysis

(i) To determine design flood discharge distribution and to determine basis for a flood warning system for kampungs in the upstream areas.

(ii) Research shall be made into topography, rainfall, discharges, river profiles.

b) River improvement planning

(i) To determine river characteristics

Reserch and examination of river profile, river bed material, downstream area topography, river flood levels, tides, land-use, and social conditions.

(ii) To determine effects of river mouth improvements to diversion channel and Cukai River.

Research into data for the topography in the estuary, winds, waves, coastal currents, sea bed materials and river flow.

(iii) To determine alignment, height, structural type, profile and littoral drift on shore-line and training banks.

Research and experiment using hydraulic model.

c) Effects of river improvements on salinity intrusion at Sungai Pinang Intake

(i) Measurement of saline wedge under existing river conditions for high tide and low flow conditions

(ii) Analysis of saline wedge under improved river condition

(iii) Propose solution such as barrage, submarged wall etc.

d) Trunk drain study

(i) Detailed examination and planning for trunk drains including retention ponds from detailed topographic maps.

e) Flood warning system

(i) Establish data link from the hydrological study of rainfall and hydrograph
(ii) Establish data for flood level prediction
(iii) Research for a telecommunication system
(iv) Establish stages of warning
(v) Examine use of weather forecast broadcasts
(vi) Proposals on organization

APPENDIX A

LANDUSE

CONTENTS

A.1. FUTURE LANDUSE

Future landuse corresponding to the flood control alternatives, are shown on following pages. Area of each landuse category is shown in Table A.1.

Table A.1 Urban Landuse (Year 2000)

(unit: ha)

Landuse	Present	Future (2000)			
		ALT 1	ALT 2	ALT 3	ALT 4
Commercial & Business	40	40	67	67	40
Industry	63	58	69	69	58
Residential	1039	1825	1819	1869	1825
Reserved	–	75	75	255	75
Park and Recreational (include Hill & Mountain)	230	410	475	295	410

Source: Study Team

Note : These area is not including the other landuse categories, such as swamp area, agricultural area, etc. in the Urban Area.

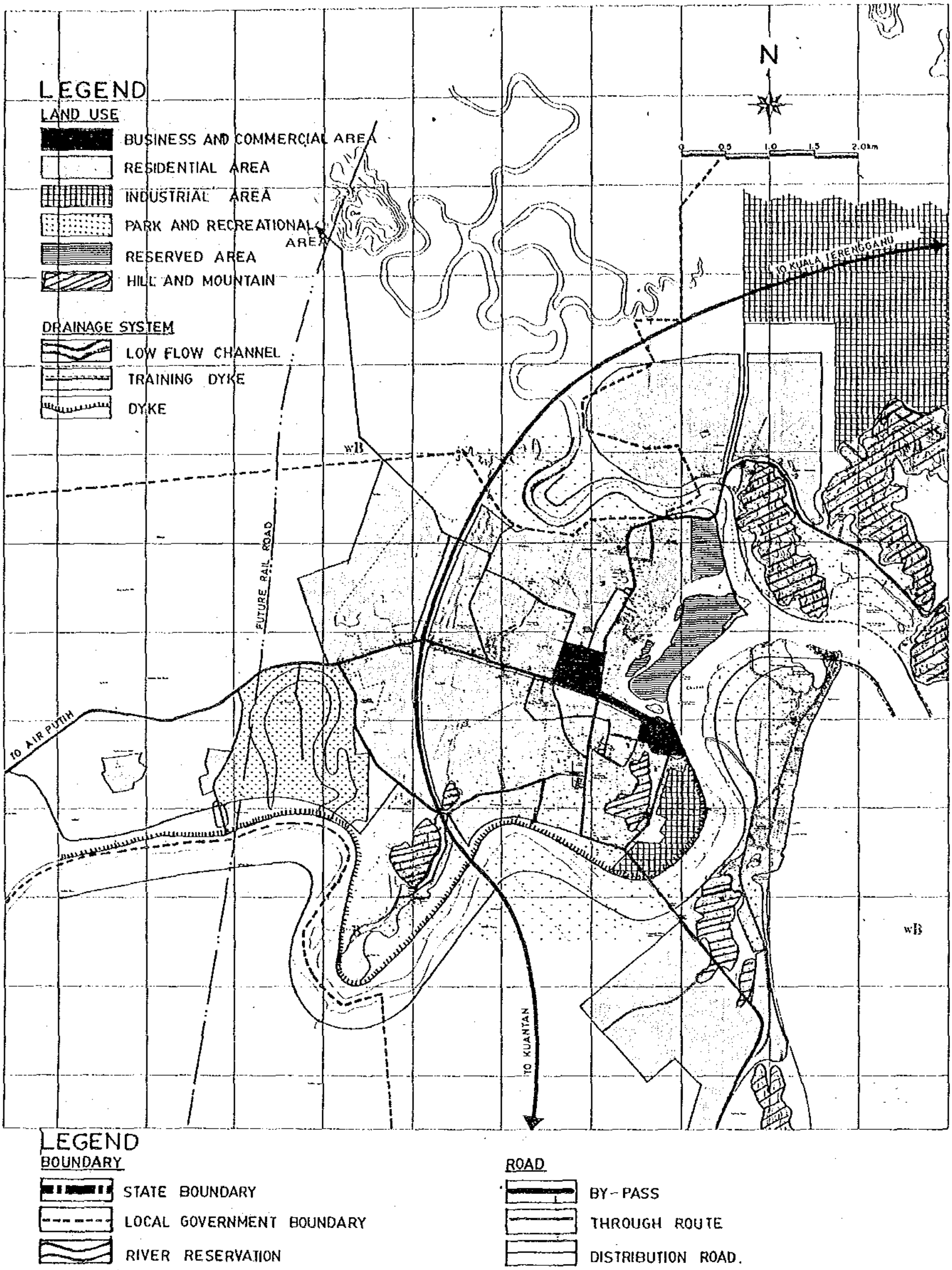


FIG. A. 1. FUTURE LANDUSE (ALTERNATIVE .1)

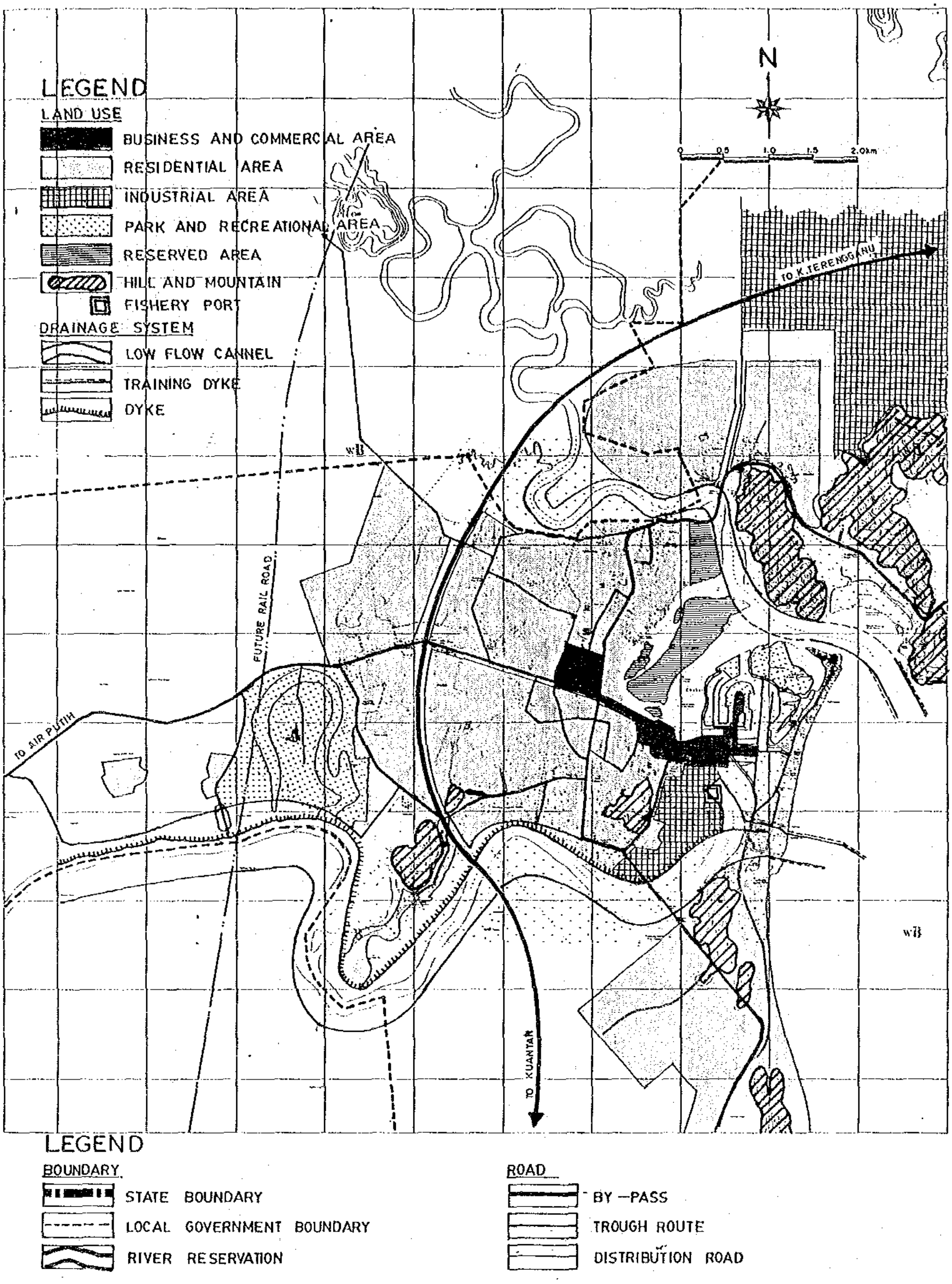
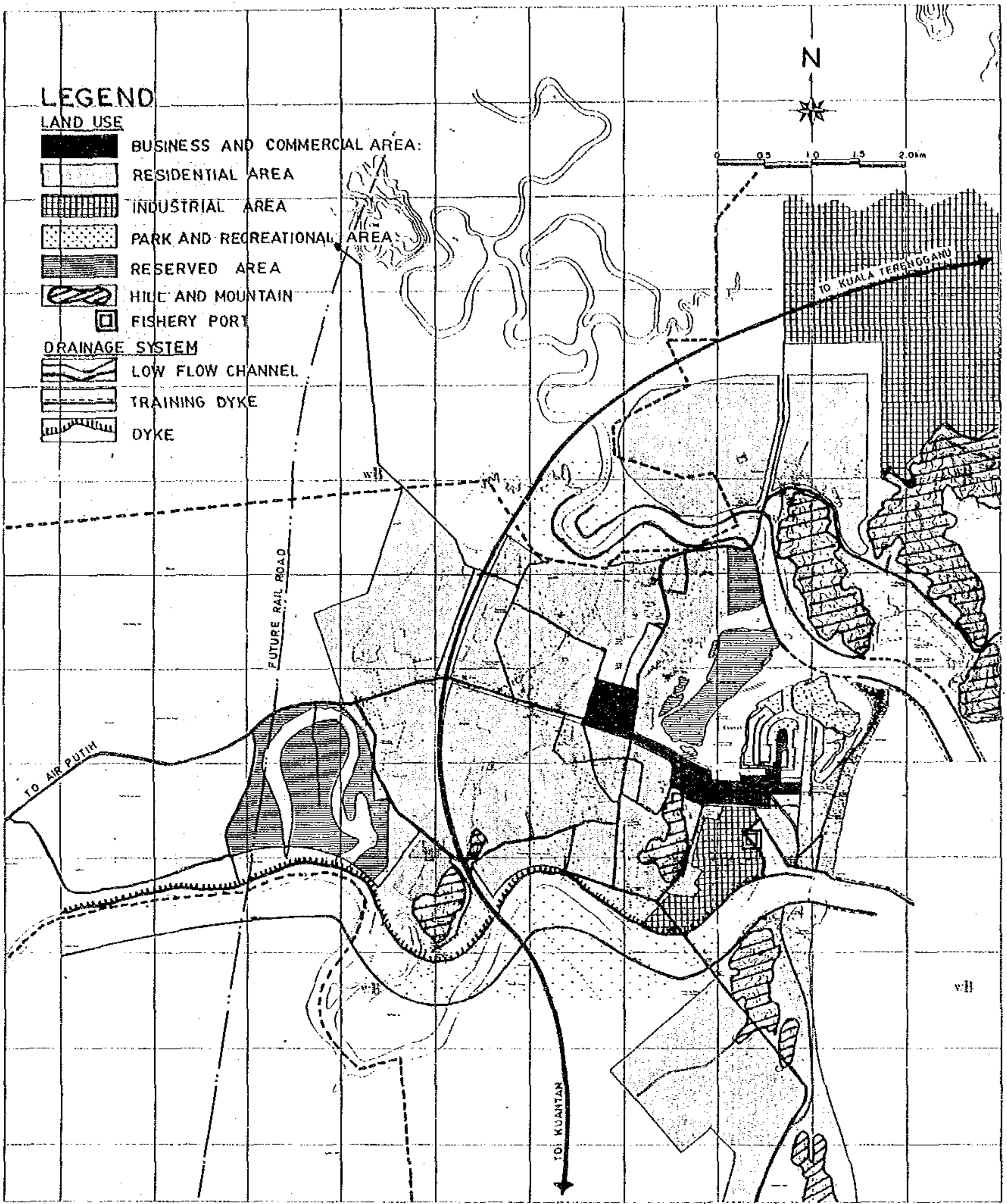


FIG: A.2. FUTURE LANDUSE (ALTERNATIVE 2)



LEGEND

BOUNDARY

- STATE BOUNDARY
- LOCAL GOVERNMENT BOUNDARY
- RIVER RESERVATION

ROAD

- BY-PASS
- THROUGH ROAD
- DISTRIBUTION ROAD

FIG. A. 3. FUTURE LANDUSE (ALTERNATIVE .3)

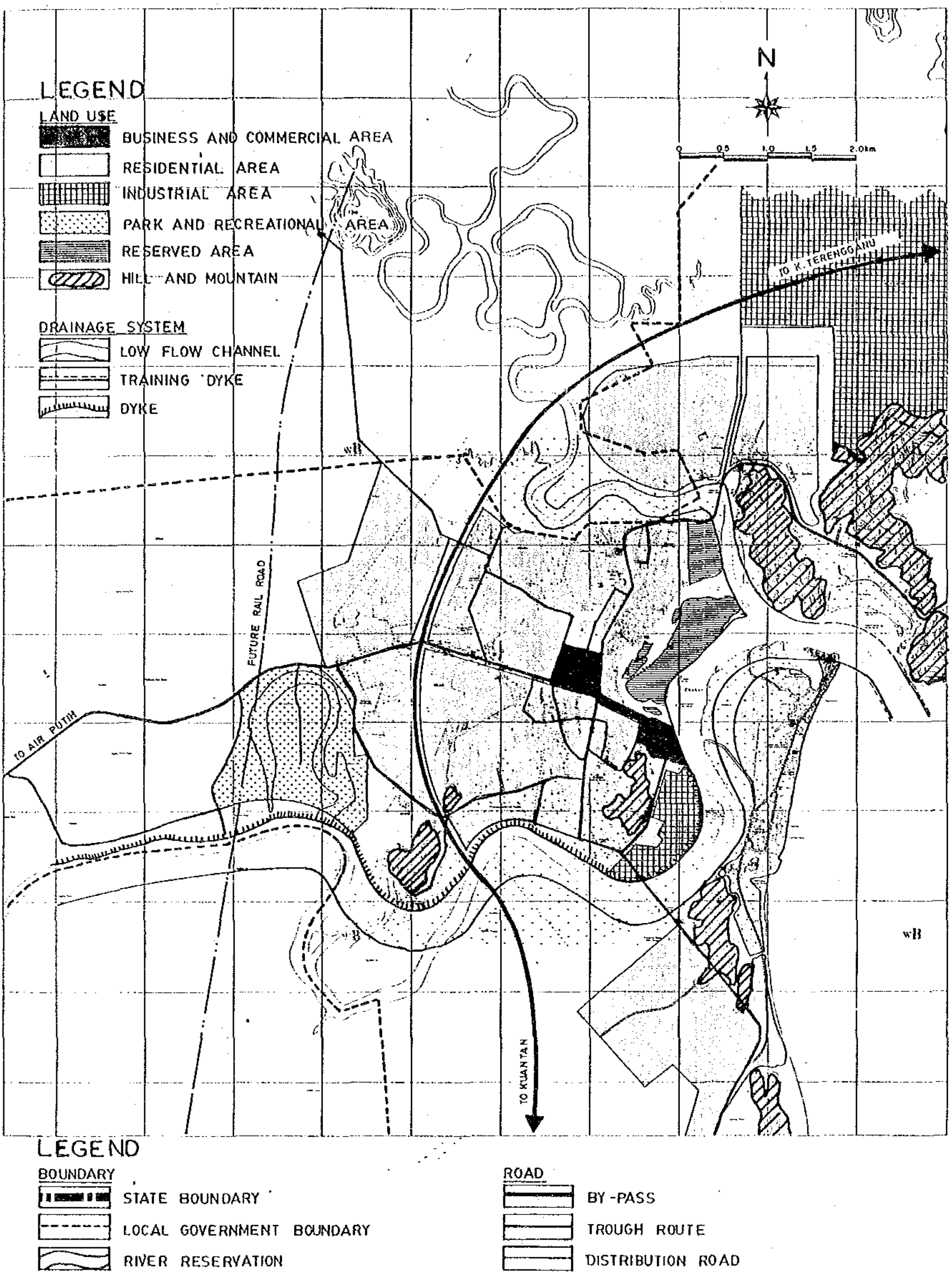


FIG. A.4 FUTURE LANDUSE (ALTERNATIVE 4)

A.2 DEVELOPMENT POTENTIAL

1. Development Potential Increase by the Projects

TABLE A.2 LAND CLASSIFICATION CHANGE BY THE PROJECT

ALTERNATIVE -1 Unit: ha

LAND CLASSIFICATION		AREA 1985	AREA 2000	AREA CHANGE
CLASS	1	390	703	+ 313
CLASS	2	97	661	+ 564
CLASS	3	610	270	- 340
CLASS	4	4474	3780	- 694

ALTERNATIVE - 2 Unit: ha

LAND CLASSIFICATION		AREA 1985	AREA 2000	AREA CHANGE
CLASS	1	390	838	+ 448 1/
CLASS	2	97	548	+ 451
CLASS	3	610	270	- 340
CLASS	4	4474	3813	- 661

ALTERNATIVE -3 Unit: ha

LAND CLASSIFICATION		AREA 1985	AREA 2000	AREA CHANGE
CLASS	1	390	838	+ 448 1/
CLASS	2	97	598	+ 501
CLASS	3	610	270	- 340
CLASS	4	4474	3665	- 809

Source: Study Team

Note : CLASSIFICATION to be used are shown on chapter 2.

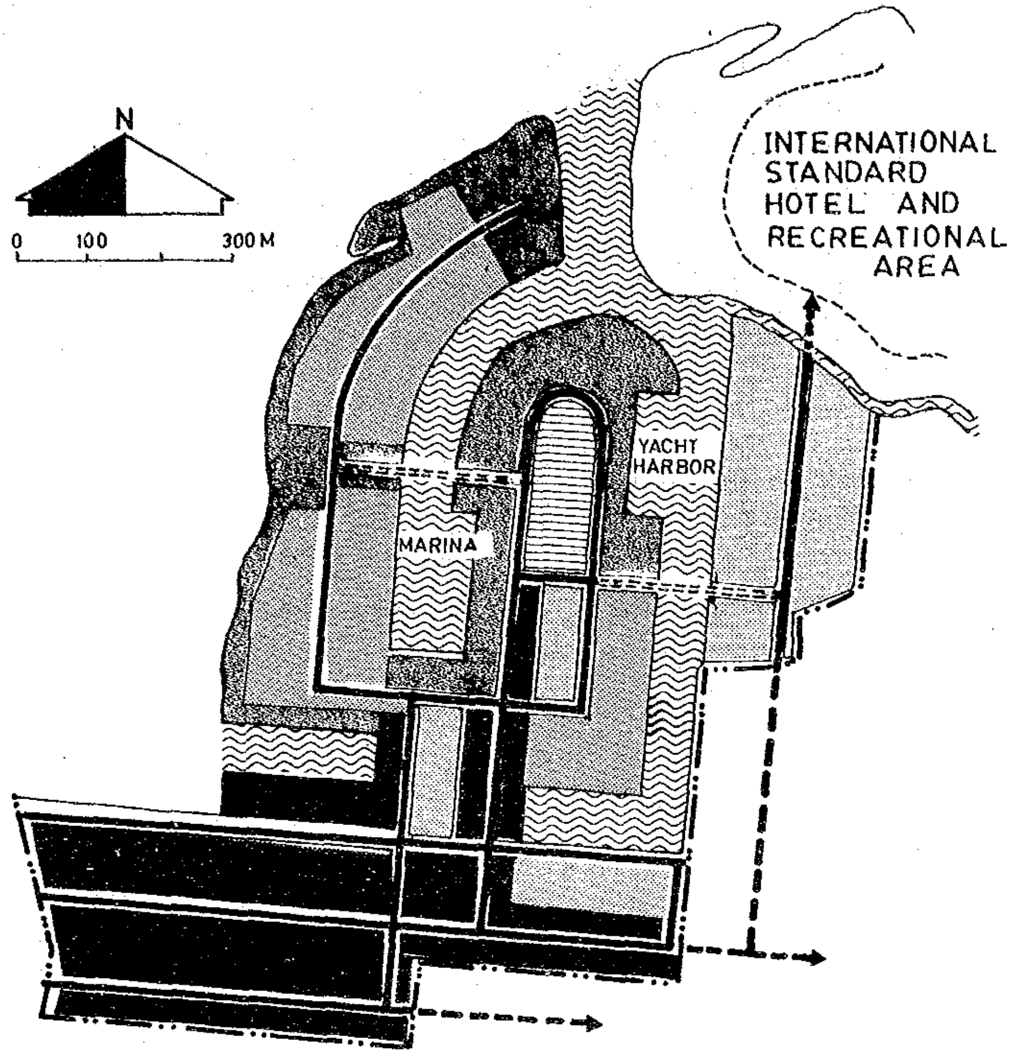
1/ Including 62 ha. of New Town Centre area

2. Reserved Land/Park

Reserved land at west of future by-pass. In case of ALTERNATIVE – 3, 180 ha. of land which has development potential can be reserved. One to one and a half metre (1 – 1.5m) of land fill turn the land into flood free land same as the other residential area. This area can be developed as residential area, recreational area or other purposes. In case of railroad comes to this region, the Cukai station is planned at the west edge of this reserved area. Railroad related development will be able to carried out in this area.

In case of other alternatives this area can be developed in the future same way as alternative 3. However, required hight of land fill will be 0.5 – 1 metre higher than alternative – 3.

In all case, this area is better to be either reserved land or park area where no permanent facilities will be constructed.



LEGEND:

▇	COMMERCIAL DISTRICT	15ha
▤	PUBLIC FACILITIES AREA	2ha
▒	HIGH STANDARD RESIDENTIAL	12ha
░	MEDIUM STANDARD RESIDENTIAL	10ha
▓	PARK AND RECREATIONAL	14ha
≈	WATER SURFACE	20ha
═	ROAD (AND OTHER PUBLIC SPACE)	9ha
┅	FOOT PATH	

FIG. A.5. AN EXAMPLE OF NEW TOWN CENTRE DEVELOPMENT PLAN

A.3 KAMPUNG RELOCATION PROGRAMME

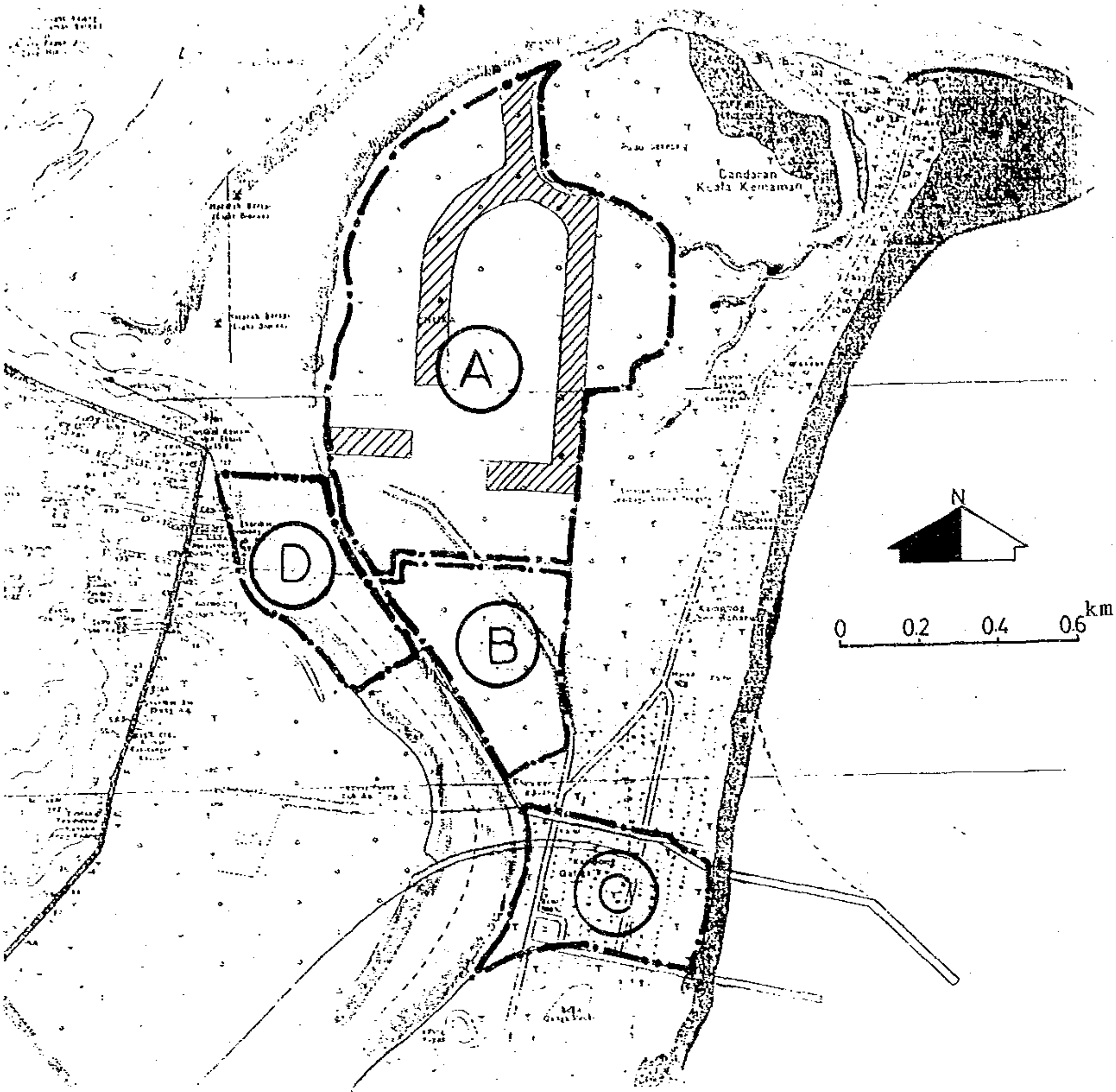


FIG. A.6 KAMPUNG RELOCATION PROGRAM (Kg. Geliga Kechil)

NOTE:
1. Number of houses to be relocated: 250
2. Number of people to be relocated: 1400
3. Area (Approx. ha.) (A) 75 ha/ (B) 16 ha/ (C) 16 ha/(D) 14 ha
4. Relocation Schedule;
   i) dredge the canal (Approx. 14 ha) in area (A) and fill area (B)
   ii) relocate the people living area (C) to area (B)
   iii) dredge the new river reservation area (C) and fill to area (D) and area (A).

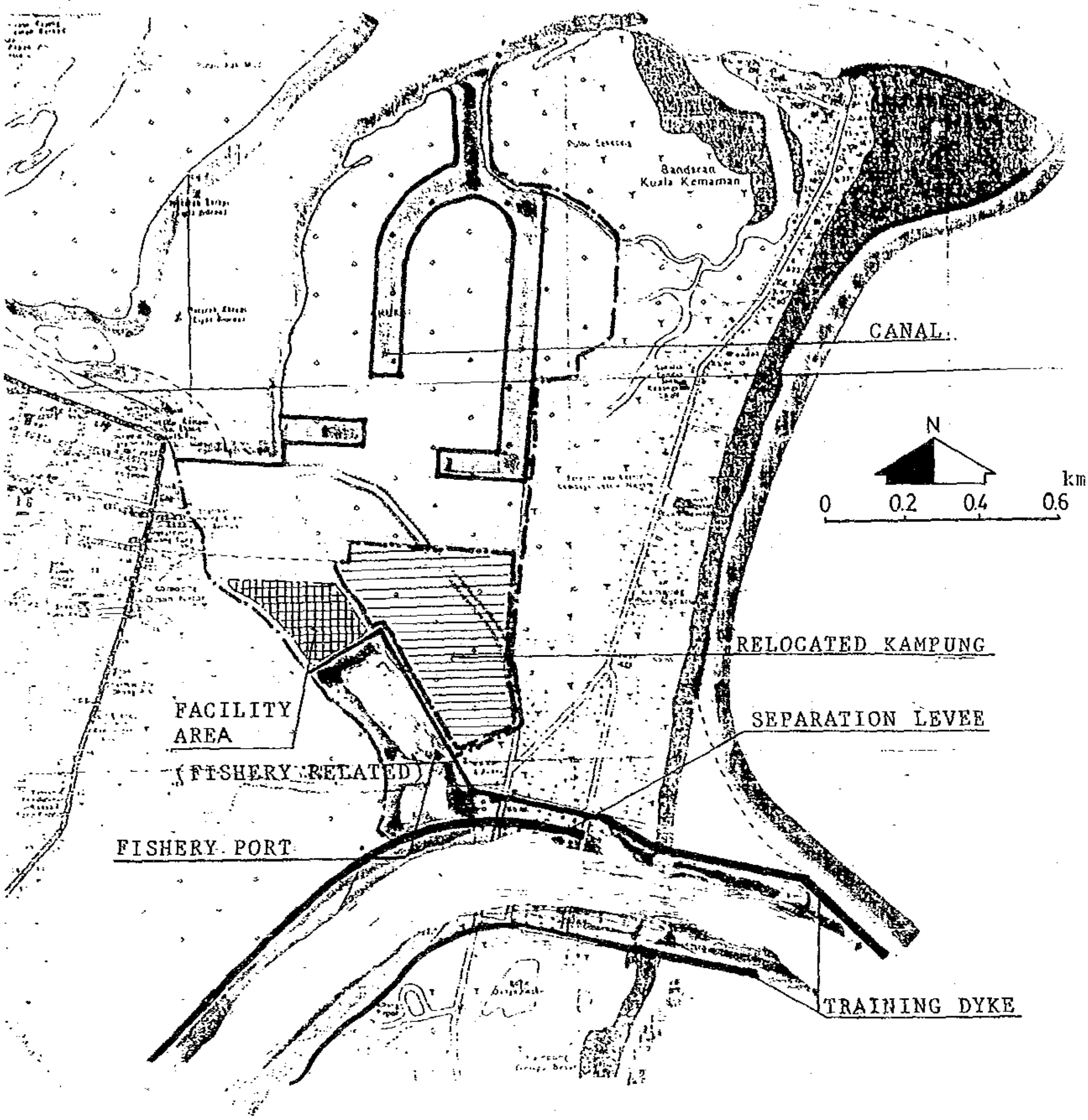


FIG. A.7 FUTURE LOCATION OF RIVER FACILITIES AND RELOCATED KAMPUNG, AND FISHERY FACILITIES. (Kg. Geliga Kechil)

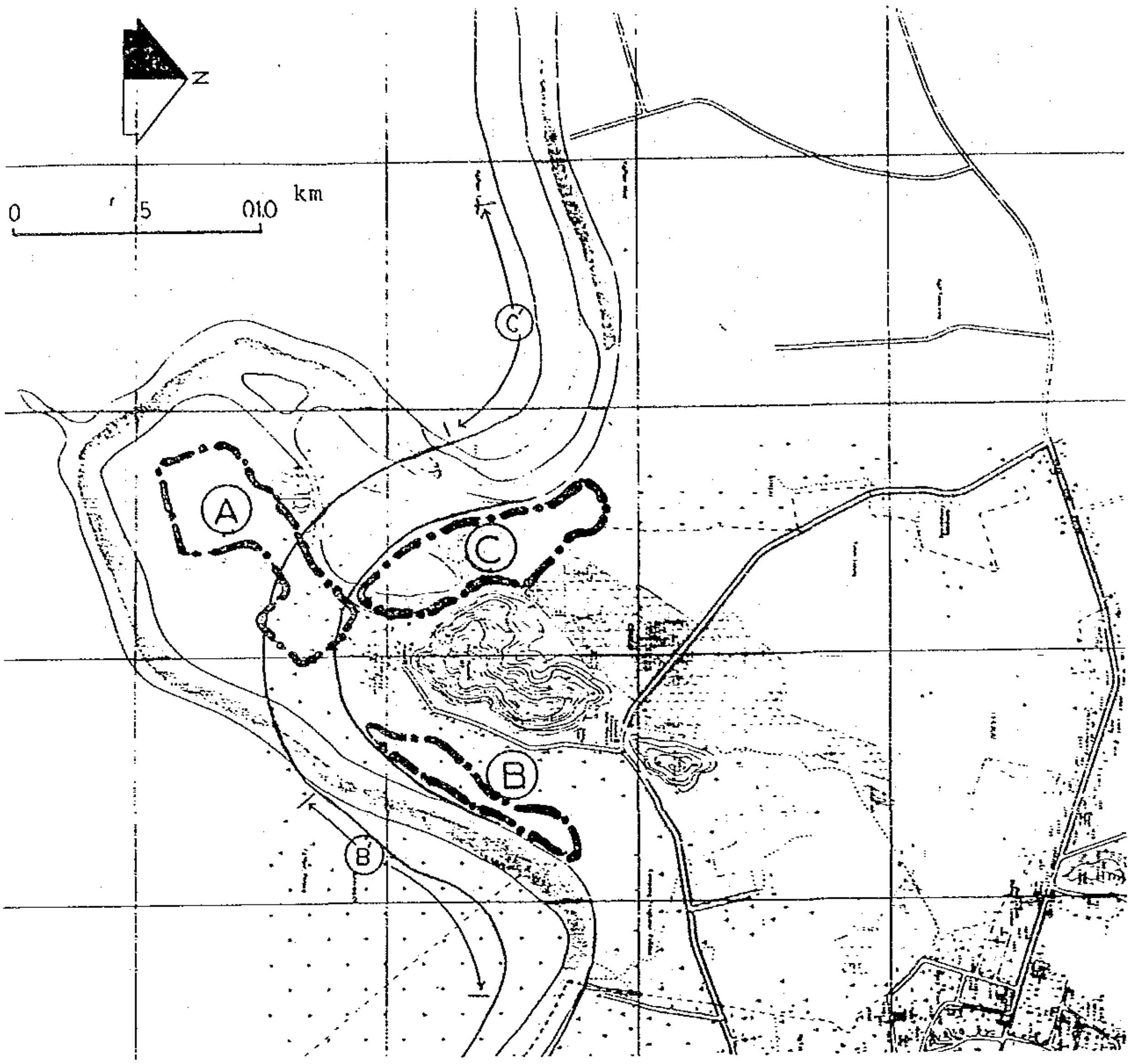


FIG A.8 KAMPUNG RELOCATION PROGRAMME (Kg. Bukit Mentok)

NOTE: 1. Number of houses to be relocated: 65
2. Number of people to be relocated: 420
3. Area (Approx) (A) 30 ha/ (B) 10 ha/ (C) 20 ha
4. Relocation Schedule
   i) dredge the river section (B') and fill area (B)
   ii) dredge the river section (C') and fill area (C)
   iii) relocate the people living in area (A) to area (B) and (C).
   iv) dredge the new river reservation area and construct the dyke.

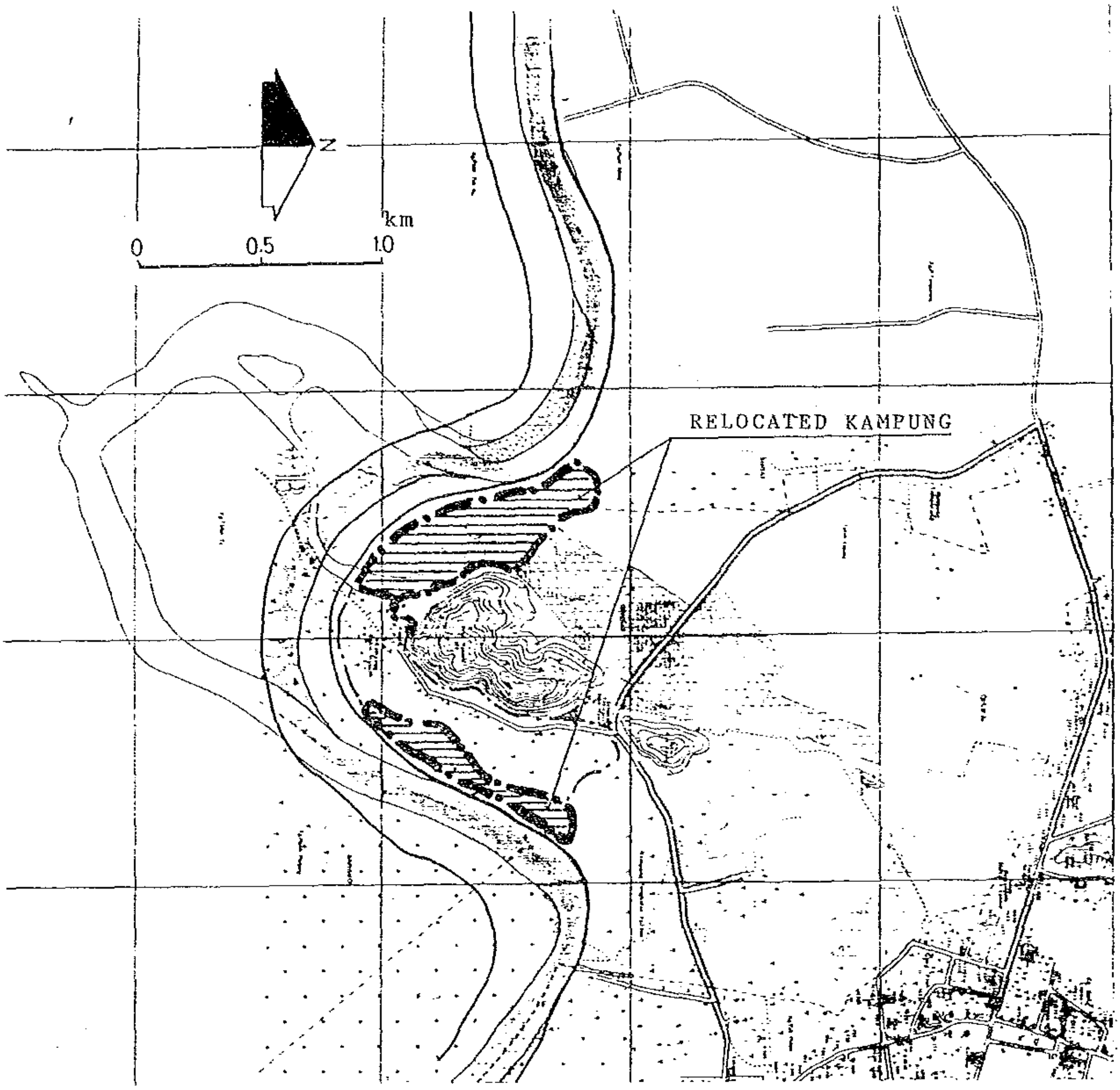


FIG.A.9 FUTURE LOCATION OF RIVER RESERVATION
AND RELOCATED KAMPUNG (Kg. Bukit Mentok)

APPENDIX B

FLOOD CONTROL

B.1 EXISTING CONDITION

1. Tide

TABLE B.1 TIDAL LEVELS AT STANDARD PORTS

Standard Port	Lowest Astronomical Tide	Mean Lower Low Water	Mean Higher Low Water	Mean Sea Level	Mean Lower High Water	Mean Higher High Water	Highest Astronomical Tide	Authority for (*a*)			Years of Tidal Observations (*b*)
								Observations	Constants	Predictions	
	m.	m.	m.	m.	m.	m.	m.				
Horsburgh Lt. Ho.	−0·3	+0·6	+1·3	+1·5	+2·1	+2·2	+2·8	I.T.S.	I.T.S.	T.I.	1979 (1)
Tanjong Gelang	+0·1	+1·0	+1·7	+1·9	+2·0	+2·8	+3·7	H.A.	T.I.	T.I.	1977 (1)
Trengganu	−0·4	+0·4	+1·0	+1·0	+1·0	+1·7	+2·7	H.	T.I.	T.I.	1937 (1)
Sandakan	−0·1	+0·4	+0·8	+1·1	+1·2	+1·9	+2·7	H.A.	T.I.	T.I.	1925 – 6 (1)
Labuan (Victoria Hr.)	+0·3	+0·8	+1·4	+1·5	+1·6	+2·2	+2·7	H.A.	N.	T.I.	1896 (1)
Muara Harbour	0·0	+0·6	+1·4	+1·3	+1·4	+2·0	+2·7	H.A.	T.I.	H.A.	1976 (1)
Kuala Baram	−0·2	+0·3	Δ	+0·9	Δ	+1·5	+2·0	H.A.	T.I.	S.M.D	1964 – 5 (1)
Miri	0·0	+0·5	Δ	+1·1	Δ	+1·6	+2·1	H.A.	T.I.	S.M.D	1978 (1)
Kuala Mukah	−0·1	+0·8	+1·7	+1·6	+1·9	+2·1	+2·6	S.M.D	T.I.	S.M.D	1976 – 7 (1)
Sibu	+0·5	+1·4	+2·0	+2·4	+2·9	+3·3	+3·9	S.M.D	T.I.	S.M.D	1975 (1)
Pulau Lakei	+0·2	+1·2	+2·1	+3·1	+4·4	+4·8	+5·6	H.A.	T.I.	S.M.D	1955 (1)
Kuching	+0·2	+1·2	+2·2	+3·1	+4·4	+4·7	+5·8	S.M.D	T.I.	S.M.D	1975 (1)

The above levels are referred to *CHART DATUM*, which is the same as the zero of the tidal predictions in all cases.

(*a*) Abbreviations.

- I.T.S. International Tidal Survey
- H. Hydrographer of the Navy.
- H.A. Local Harbour Authority.
- N. Netherlands Government.
- Rb. Messrs. Edward Roberts & Son.
- T.I. Institute of Oceanographic Sciences.
- S.M.D. **Sarawak Marine Department.**

(*b*) The years between which the observations were obtained are given, with the number of complete year's observations in brackets.

All predictions are calculated by the harmonic method.

Δ Tide is usually diurnal.

TANJONG GELANG – 1.62 m. below Land Survey Datum.

Source: Tide Table, 1984

2. Water Level of the Past Floods

TABLE B.2.1 SUNGAI KEMAMAN

M.S.L.
(in Meter)

YEAR	STATION	WATER LEVEL	DATE	TIME
1967	Kuala Tayor	28.96	6. 1.67	12.00 NOON
	Paya Dadong	12.85	5. 1.67	6.00 A.M.
1968	Paya Dadong	11.97	14.12.68	12.00 NOON
1969	Paya Dadong	13.15	2.12.69	7.00 P.M.
1970	Kuala Tayor	29.90	31.12.70	8.00 P.M.
	Paya Dadong	13.98	27.12.70	4.00 P.M.
1971	Paya Dadong	14.43	4. 1.71	3.00 A.M.
	Rantau Panjang	10.88	11.12.71	2.00 P.M.
	Air Puteh	14.63	10.12.71	9.00 P.M.
	Sungai Pinang	7.44	11.12.71	5.00 P.M.
	Pengkalan Binjai	5.03	12.12.71	11.00 A.M.
	Pengkalan Pandan	2.56	12.12.71	12.00 NOON
	Pasir Gajah	8.41	11.12.71	7.00 A.M.
1972	Air Puteh	16.31	17.12.72	1.00 P.M.
	Paya Dadong	14.63	17.12.72	3.00 P.M.
	Rantau Panjang	11.52	16.12.72	4.00 P.M.
	Pengkalan Binjai	5.91	18.12.72	5.00 P.M.
	Pengkalan Pandan	3.60	18.12.72	10.00 P.M.
	Cukai	2.38	19.12.72	9.00 P.M.
	Sungai Pinang	8.54	19.12.72	1.00 A.M.
	Pengkalan Binjai	5.91	18.12.72	5.00 P.M.

TABLE B.2.2 SUNGAI KEMAMAN

YEAR	STATION	WATER LEVEL	DATE	TIME
1973	Air Puteh	15.91	8.12.73	2.00 P.M.
	Paya Dadong	13.01	16.12.73	11.00 A.M.
	Rantau Panjang	10.94	17.12.73	11.00 A.M.
	Pasir Gajah	8.78	11.12.73	6.00 P.M.
	Sungai Pinang	7.44	11.12.73	10.00 A.M.
	Pengkalan Binjai	4.97	11.12.73	10.00 A.M.
	Pengkalan Pandan	2.93	11.12.73	12.00 P.M.
	Cukai	2.35	11.12.73	11.00 P.M.
1974/ 1975	No Record			
1975/ 1976	Air Puteh	15.36	28.11.75	3.00 A.M.
	Paya Dadong	13.72	28.11.75	9.00 A.M.
	Rantau Panjang	11.86	28.11.75	11.00 A.M.
	Pasir Gajah	8.81	29.11.75	6.00 A.M.
	Sungai Pinang	7.25	29.11.75	12.00 NOON
	Pengkalan Binjai	4.72	29.11.75	12.00 NOON
1976/ 1977	No. Record			
1977/ 1978	No Flood For This Year			
1978/ 1979	Air Puteh	14.5	7.12.78	1.00 A.M.
	Sungai Pinang	4.17	8.12.78	8.00 A.M.
1979/ 1980	Air Puteh	14.66	27.11.79	4.00 A.M.
	Sungai Pinang	6.40	28.11.79	8.00 P.M.
	Pengkalan Pandan	2.01	29.11.79	5.00 A.M.
	Rantau Panjang Hilir	10.88	27.11.79	9.00 A.M.

TABLE B.2.3 SUNGAI KEMAMAN

YEAR	STATION	WATER LEVEL	DATE	TIME
1980/	Air Puteh	12.58	16.12.81	6.00 P.M.
1981	Sungai Pinang	3.61	17.12.81	8.00 A.M.
	Paya Dadong	10.97	16.12.81	6.00 P.M.
	Pengkalan Pandan	1.35	9.11.81	6.00 A.M.
	Paya Paman	3.19	17.12.81	6.00 A.M.
1980	Air Puteh	15.24		
	Paya Dadong	11.34		
	Sungai Pinang	5.13	21.12.80	2.00 A.M.
1982/	Air Puteh	16.82	14.12.82	12.00 P.M.
1983	Rantau Panjang Hilir	11.95	15.12.82	10.10 A.M.
	Sungai Pinang	6.60	16.12.82	8.00 P.M.
	Jambatan Geliga	2.00	18.12.82	12.00 P.M.

Source: SDID

TABLE B.3 RIVER BED OF THE KEMAMAN

DISTANCE	TIME	TIDE(T)	WATER LEVEL H = T - 1.62	WATER DEPTH(m)	BOTTOM HIGHT(m)
0.0km	15:30	1.8	0.2	9.5	- 9.3
1.0	"	"	"	5.5	- 5.3
2.0	"	"	"	5.5	- 5.3
3.0	"	"	"	2.4	- 2.2
4.0	9:30	1.2	- 0.4	5.0	- 5.4
4.5	"	"	"	5.0	- 5.4
5.0	"	"	"	3.0	- 3.4
5.7	"	"	"	9.0	- 9.4
6.0	10:00	"	"	3.0	- 3.4
7.0	"	"	"	3.5	- 3.9
8.0	"	"	"	3.5	- 3.9
9.0	10:30	1.1	- 0.5	3.5	- 4.0
10.0	"	"	"	3.7	- 4.2
11.0	"	"	"	1.4	- 1.9
12.0	11.00	1.0	- 0.6	1.0	- 1.6
13.0	"	"	"	1.1	- 1.7
14.0	"	"	"	3.8	- 4.4
15.0	11.30	"	"	1.7	- 2.3
16.0	"	"	"	3.5	- 4.1
17.0	"	"	"	8.0	- 8.6

Source: 1. Study Team, 1985
2. Tide Tables 1985, Port Authority Terengganu, Marine Department

TABLE B.4 RIVER BED OF THE CUKAI

DISTANCE	TIME	TIDE (T)	WATER LEVEL H=T - 1.62	WATER DEPTH(m)	BOTTOM HIGHT(m)
0.0 km	16:00	1.9	0.3	7.0	- 6.7
1.0	"	"	"	4.5	- 4.2
2.0	"	"	"	5.0	- 4.7
3.0	"	"	"	10.0	- 9.7
4.0	"	"	"	6.8	- 6.5
5.0	"	"	"	7.0	- 6.7

Source: 1. Study Team, 1985

2. Tide Tables 1985, Port Authority Terengganu, Marine Department.

Note : 1. Tanjong Gelang tide datum is 1.62 m below Land Survey Datum.

2. Water level is based on Mean Sea Level.

B.2 ESTIMATION OF FLOOD DISCHARGE

Design flood discharges by-frequency are roughly estimated, using the results of past studies (Fig. B.1 and Table B.5).

1. Assumption

- Upstream of this study area are the same conditions as existing river and catchment.
- Increase of river flood discharge due to river improvement is taken into account.
- Curve III of Fig. B.1 is used to take catchment area effect on discharge into account.
- Table B.5 is used to obtain the discharges by frequency for catchment area of 622 KM^2.

TABLE B.5 DESIGN FLOOD DISCHARGE BY FREQUENCY

UNIT: M^3/S

FREQUENCY (YEAR)	Q_o	KEMAMAN RIVER				CUKAI RIVER
		Q_{k10}	Q_{k1}	Q_{k20}	Q_{k2}	Q_c
	A = 622KM^2	A = 1780 KM^2	A = 1780 KM^2	A = 2183 KM^2	A =2183 KM^2	A = 381 KM^2
2	538	1180	1370	1345		
5	793	1740	1930	1983	2100	485
10	991	2170	2350	2478	2700	607
20	1189	2600	2790	2973	3153	728
50	1444	3160	3350	3610	3800	884
100	1699	3720	3910	4248	4500	1040

$$Q_{k10} = Q_o \times \frac{Q_{1780} \text{ of Curve III}}{Q_{622} \text{ of Curve III}}$$

$Q_{k1} = Q_{k10}$ + Flooded Water

$$Q_{k20} = Q_o \times \frac{Q_{2183} \text{ of Curve III}}{Q_{622} \text{ of Curve III}}$$

$Q_{k2} = Q_{k20}$ + Flooded Water

$$Q_c = Q_o \times \frac{381}{622}$$

Note: 1) Q_o = Estimated by " the South Coastal Terengganu Water Resources" P 10.9

2) Q_{k10}= Upstream of Cukai River junction (existing river)

3) Q_{k1} = Upstream of Cukai River junction (after river improvement)

4) Q_{k20}= From river mouth to Cukai River junction (existing river)

5) Q_{k2} = From river mouth to Cukai River junction (after river improvement)

6) Q_{k1}, Q_{k2} and Q_c are used as the design flood discharges

7) Q_{k1}, Q_{k2} , Q_c and Q_{k10} are used for economic evaluation as flood levels of the river by frequency for each alternative.

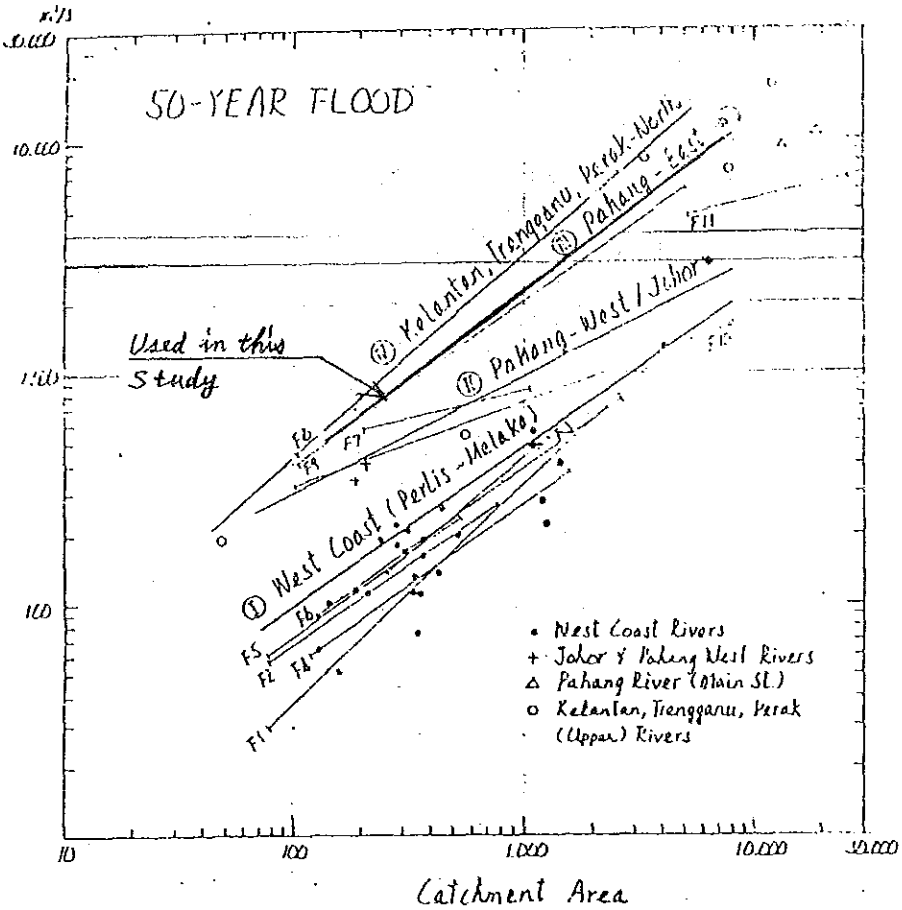


FIG.B.1 RELATIONSHIP BETWEEN FLOOD DISCHARGE AND CATCHMENT AREA

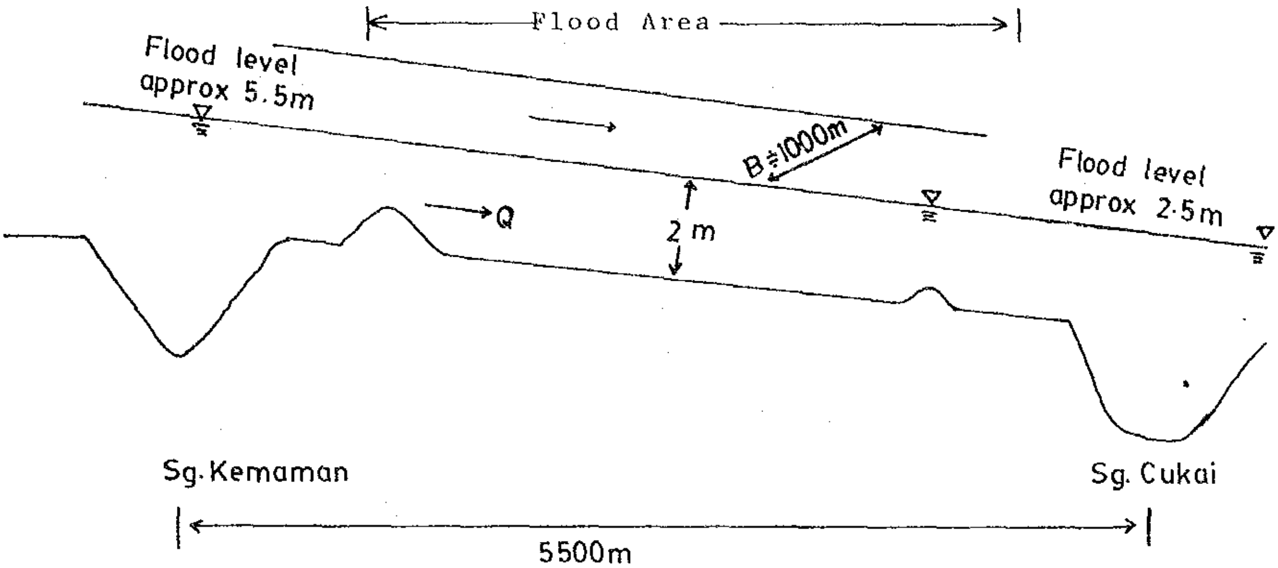
Source: National Water Resources Study Malaysia

TABLE B.6 ESTIMATED DISCHARGE (Kemaman River at Kg. Rantau Panjang Hilir) A = 622 Km^2

Frequency (Year)	Discharge (M^3/S)
2	538
5	793
10	991
20	1189
50	1444
100	1699

Source: South Coastal Terengganu Water Resources, 1981

Estimation of flood discharge from the Kemaman River to the Cukai River.
(1972 flood)



$I = \frac{5.5 - 2.5}{5500} = \frac{1}{1833}$, $n \fallingdotseq 2$

$Q = \frac{1}{n} R^{2/3} I^{1/2} A$ $\qquad A \fallingdotseq 2.0 \times 1000 = 2000 \; m^2$

$= 0.018 \; m/s \times 2000 \; m^2$ $\qquad R = 2.0 \; m$

$= \underline{37 \; m3/s}$ (n=2)

74 " (n=1)

Estimation of flood discharge in the flood prone area along the Kemaman River (1972 flood)

$B = 700\ m,\ n \doteqdot 2$

$I = \dfrac{5.92 - 3.60}{5000} = \dfrac{2.32}{5000} = \dfrac{1}{2155}$

$R = d \doteqdot 2.5m,\quad A = 2.5^{m} \times 700^{m} = 1750m^2$

$Q = \dfrac{1}{n} R^{2/3} I^{1/2} A$

$= 0.020\ m/s \times 1750 = \underline{35\ m^3/S}\quad (n = 2)$

$= 70\ m^3/S\quad (n = 1)$

Right Bank Side Area

$B = 1500m,\ n \doteqdot 2\ ,\ d = 3m = R$

$I = \dfrac{4.0 - 2.6}{2500} = \dfrac{1}{1800}\qquad A = 4500\ m^2$

$Q = \dfrac{1}{n} R^{2/3} I^{1/2} A$

$= 0.025\ m/s \times 4500\ m^2 = \underline{110\ m^3/S}$

B.3 STUDY OF RIVER IMPROVEMENT

1. Basic Conditions and Ideas

a) Coefficient of roughness (n);

Low flow channel	$n_1 = 0.035$
Major bed	$n_2 = 0.08$

b) Design flood discharge;

River dyke (Kemaman); 50-Year frequency (2%)

c) Method of improvement

- Widening and dyke on left bank side for the Kemaman River is considered.
- For the Cukai river, it has about 800 m^2 of bank-full flow area at 4.5 KM point. Assuming flow velosity is 0.8 m/S, discharge capacity becomes 640 m^3/S which is nearly equals to 10-year frequency flood. Dreging of narrow portion only is proposed.
- Double section type is proposed considering river bed stability

d) Alignment of the river

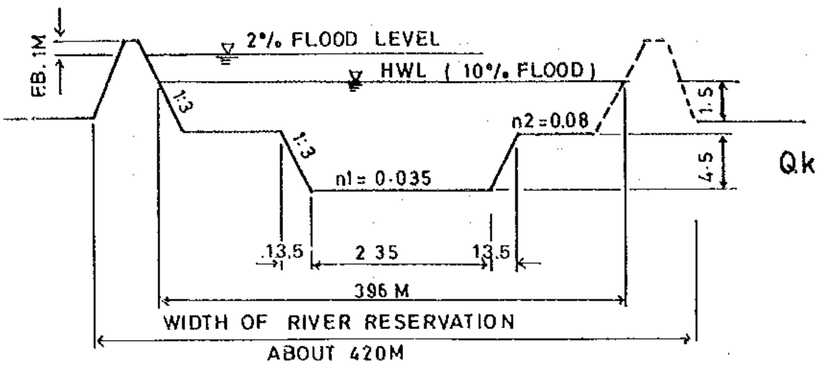
- Existing alignment is adopted as much as possible.
- Moderately meandering alignment is adopted to fix it by partial revetment as much as possible.

e) Longitudinal profile

- Existing river bed will not be dredge but widened in the case of Kemaman River, considering sediment transported from the upstream.
- Proposed slope of flood water surface is same as that of 1972 flood to keep similar velosity .
- Proposed height of major bed is around existing ground to minimize earth work volume.

2. Cross Section

1) Kemaman River (Alt.3 and 4)

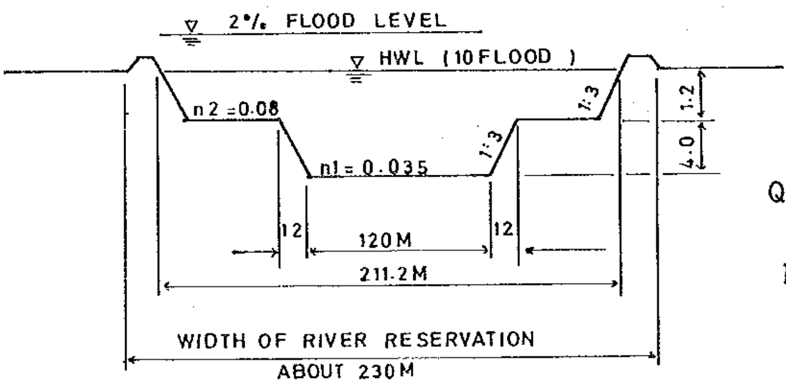


Qk1 = 2400 M³/S (10%)
3400 M³/S (2 %)

I = 1/3500

2) Cukai River (Alt. 1, 2, 3 and 4)

After resedimentation of river mouth, there is a possibility that the depth of Cukai River becomes shallower than existing depth. Therefore, it is necessary to have a river reservation area under such condition.

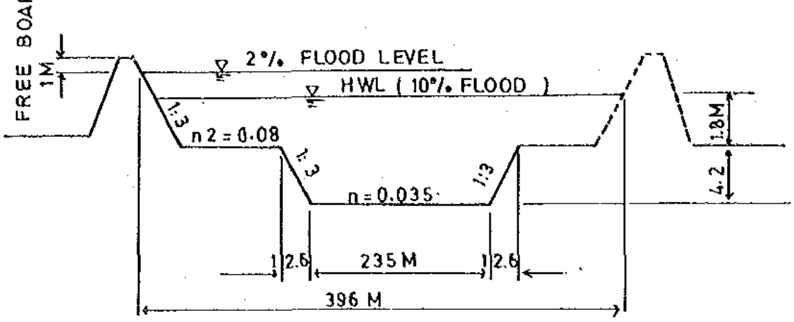


QC = 610 M³/S (10%)
890 M³/S (2 %)

I = 1/8800

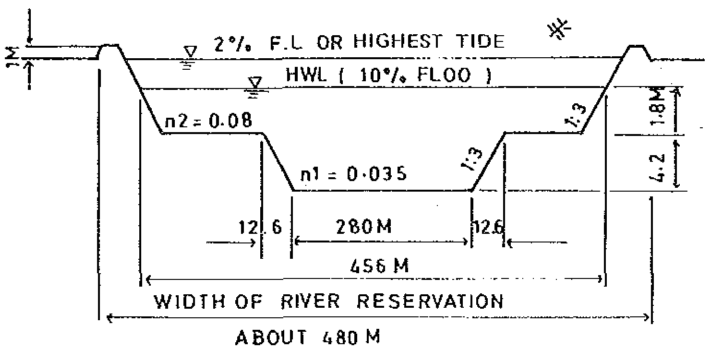
3) Kemaman River (Alt. 1 and 4)

5 ~ 16KM



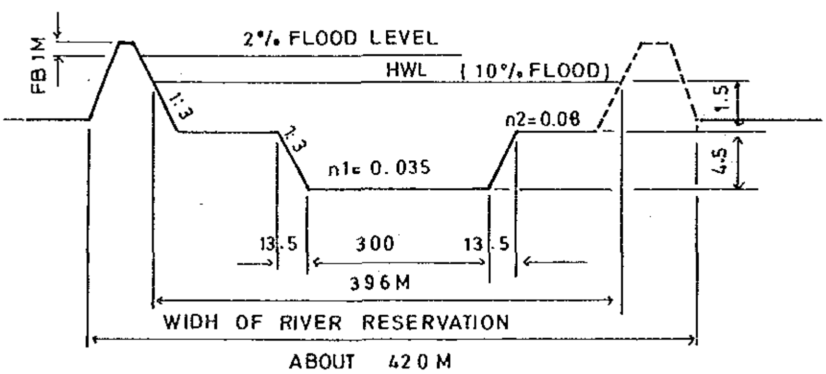
Qk1 = 2400 M^3/S (10%)
3400 M^3/S (2 %)
I = 1/3 500

CUKAI RIVER JUNCTION ~ 5KM



Qk1 = 2 400 M^3/S (10%)
3400 M^3/S (2 %)
I = 1/5000
※About 3meters above MSL (Terengganu Coastal Region Study)

RIVER MOUTH ~ CUKAI RIVER JUNCTION



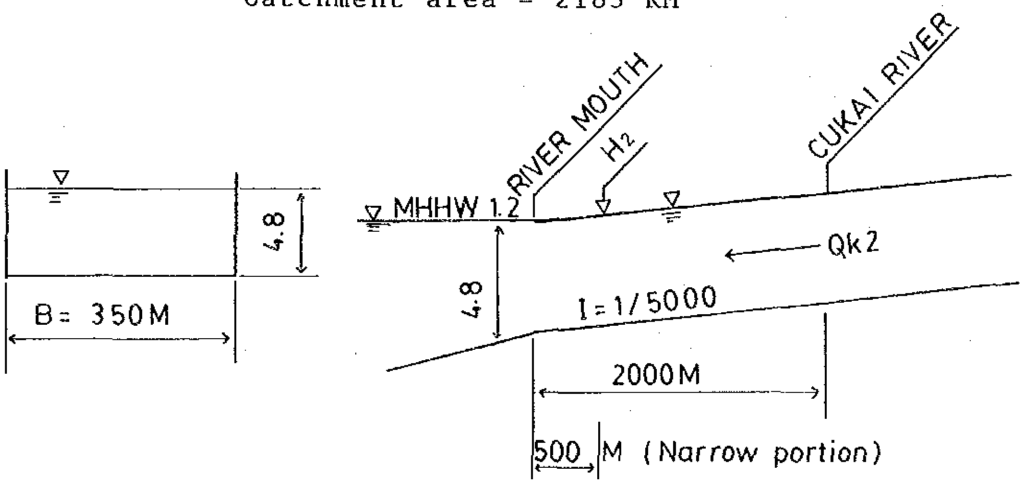
Qk1 = 2700 M^3/S (10%)
3800 M^3/S (2%)
I = 1/5000

4) River Mouth (Alt. 1 and 4)

Frequency (Year)	Estimated Discharge (M^3/S)	Design Flood Discharge Q (M /S)
2	1345 + 0	1400
5	1983 + 100	2100
10	2478 + 180	2700
20	2973 + 180	3200
50	3610 + 180	3800
100	4248 + 180	4500

Increase due to the river improvement

Catchment area = 2183 KM^2

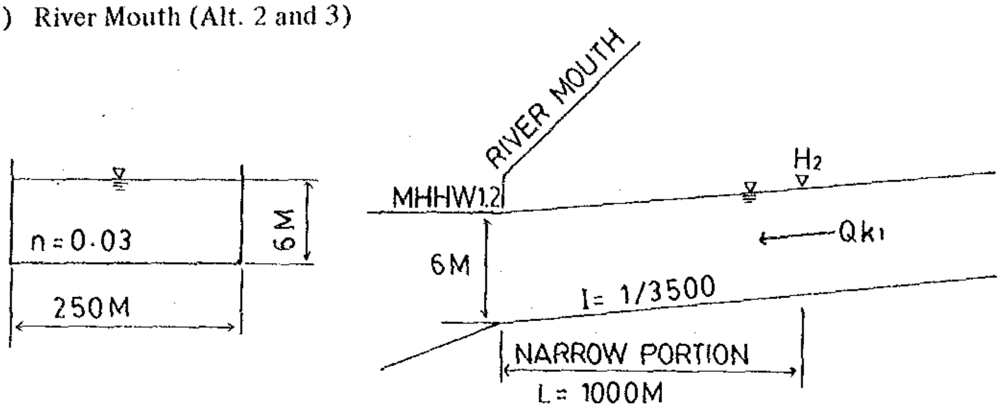


H_2 = 1.55 M (ΔH = 0.35M)
when Q_{k2} = 3800 M^3/S, B = 350 M

H_2 = 1.66 M (ΔH = 0.46M)
when Q_{k2} = 3800 M^3/S, B = 300M

For 10% flood, H_2 = 1.38M

5) River Mouth (Alt. 2 and 3)



Q_{k1} = 2400 M. 3/S(10%)

3400 M 3/S(2 %)

H_2 = 1.6 M when Q_{k1} = 3400 m^3/S, B = 250 M

H_2 = 1.4 M when Q_{k1} = 2400 m^3/S, B = 250 M

6) Effect of Telok Kalong reclamation

Decreased storage volume of flood water = (1200 ha x 10^6 x 1 m (depth)
(area)

= 12 x 10^6 m^3

About 12 x $10^6 m^3$ of flood water will be concentrated into the Cukai River during its flood.

TABLE B.7 3. FLOOD LEVEL OF THE RIVER BY FREQUENCY

UNIT: METERS ABOVE MSL

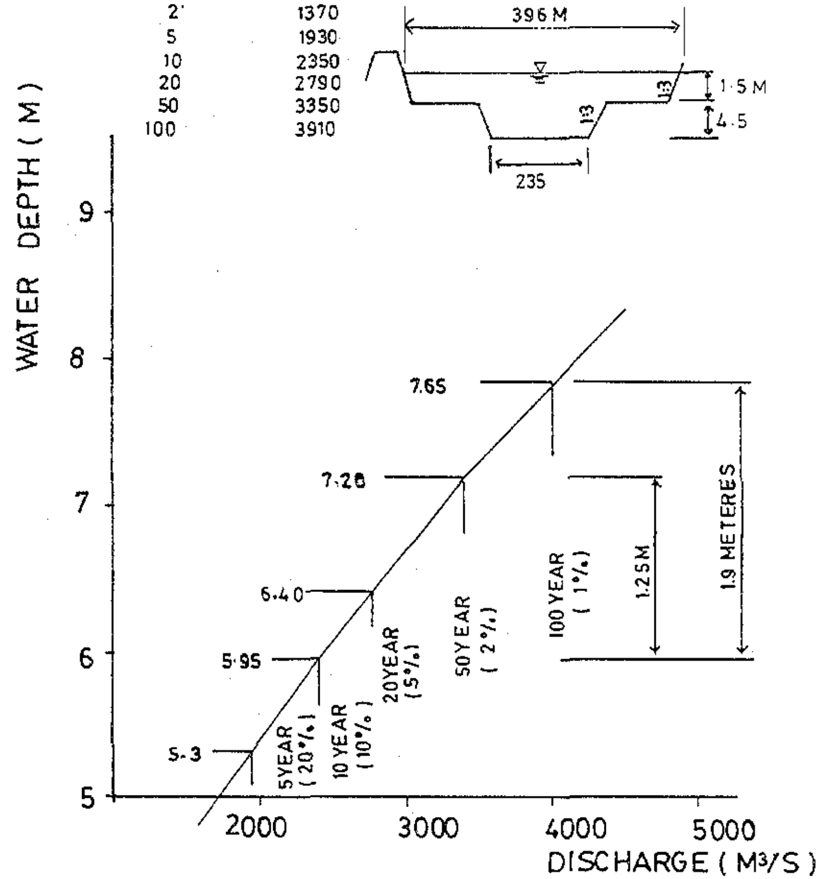
CASE		FREQUENCY	5-YEAR (20%)	10-YEAR (10%)	20-YEAR (5%)	50-YEAR (2%)	100-YEAR (1%)
KEMAMAN RIVER	AT 8 KM	WITHOUT PROJECT	2.7	3.6	4.3	5.2	5.9
		ALTERNATIVE 1 and 4	2.6	3.2	3.6	4.5	4.9
		ALTERNATIVE 2 and 3	1.9	2.5	3.0	3.3	4.2
	AT 14 KM	WITHOUT PROJECT	4.5	5.3	6.0	6.9	7.6
		ALTERNATIVE 1	4.4	5.0	5.5	6.3	6.7
		ALTERNATIVE 2	3.6	4.3	4.7	5.5	5.9
		ALTERNATIVE 3	3.1	3.8	4.2	5.0	5.4
		ALTERNATIVE 4	3.9	4.5	5.0	5.8	6.2
CUKAI RIVER	AT 4KM	WITHOUT PROJECT	1.8	2.3	2.7	3.2	3.6
		ALTERNATIVE 1 and 4	1.7	2.2	2.6	3.1	3.5
		ALTERNATIVE 2 and 3	1.5	2.0	2.4	2.9	3.3

Source: Study Team

Note : 8KM and 14KM points are distances from the river mouth along existing alignment of the river channel.

KEMAMAN RIVER

FLOOD FREQUENCY. (YEAR)	DISCHARGE (M3/S)
2	1370
5	1930
10	2350
20	2790
50	3350
100	3910



CUKAI RIVER

FLOOD FREQUENCY. (YEAR)	DISCHARGE (M3/S)
2	330
5	490
10	610
20	720
50	890
100	1040

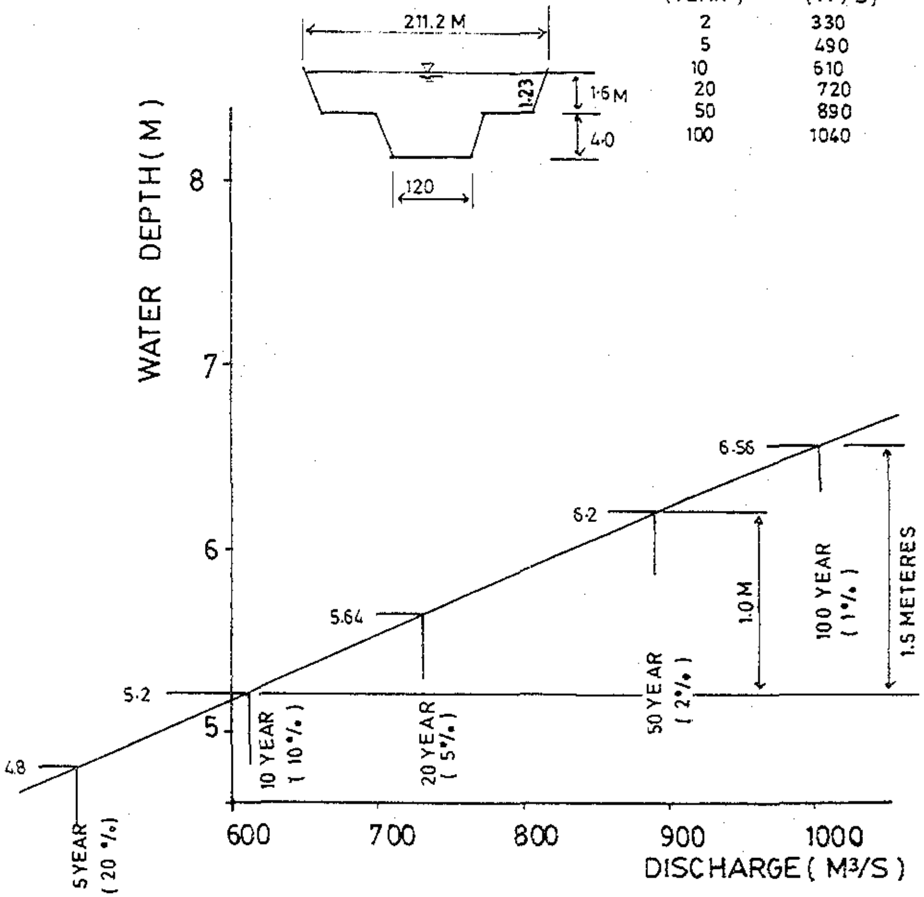
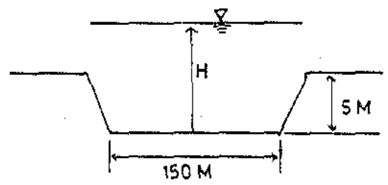


FIG: B.2 RIVER WATER DEPTH BY FREQUENCY. (IMPROVED RIVER)

KEMAMAN RIVER

FLOOD FREQUENCY (YEAR)	DISCARGE (M^3/S)
2	1180
5	1740
10	2170
20	2600
50	3160
100	3720

I= 1/3500
n= 0.035



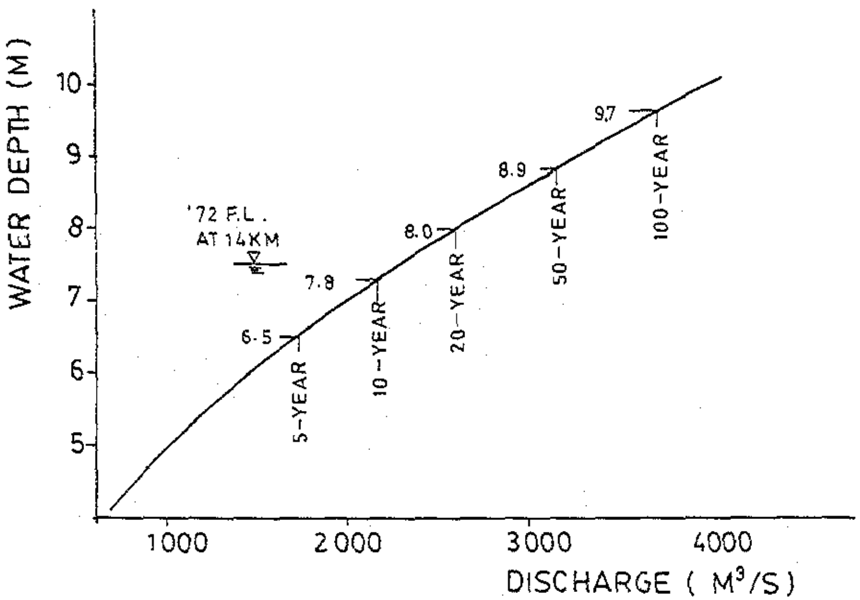


FIG. B.3 RIVER WATER DEPTH BY FREQUENCY (EXISTING RIVER)

4. Possibility of Flood Control of Upstream Area

If necessity of development occures in the upstream area, it is required to provide some flood control facilities.

Dam in the upstream of the main stream and the Cherul River may be possible, depending on topography and geology.

Possibility of retarding basins in the swamp areas is considered near the junction of the Cherul River.