Fig.G-6 Typical Rainfall Distribution During Three Months (1/2)

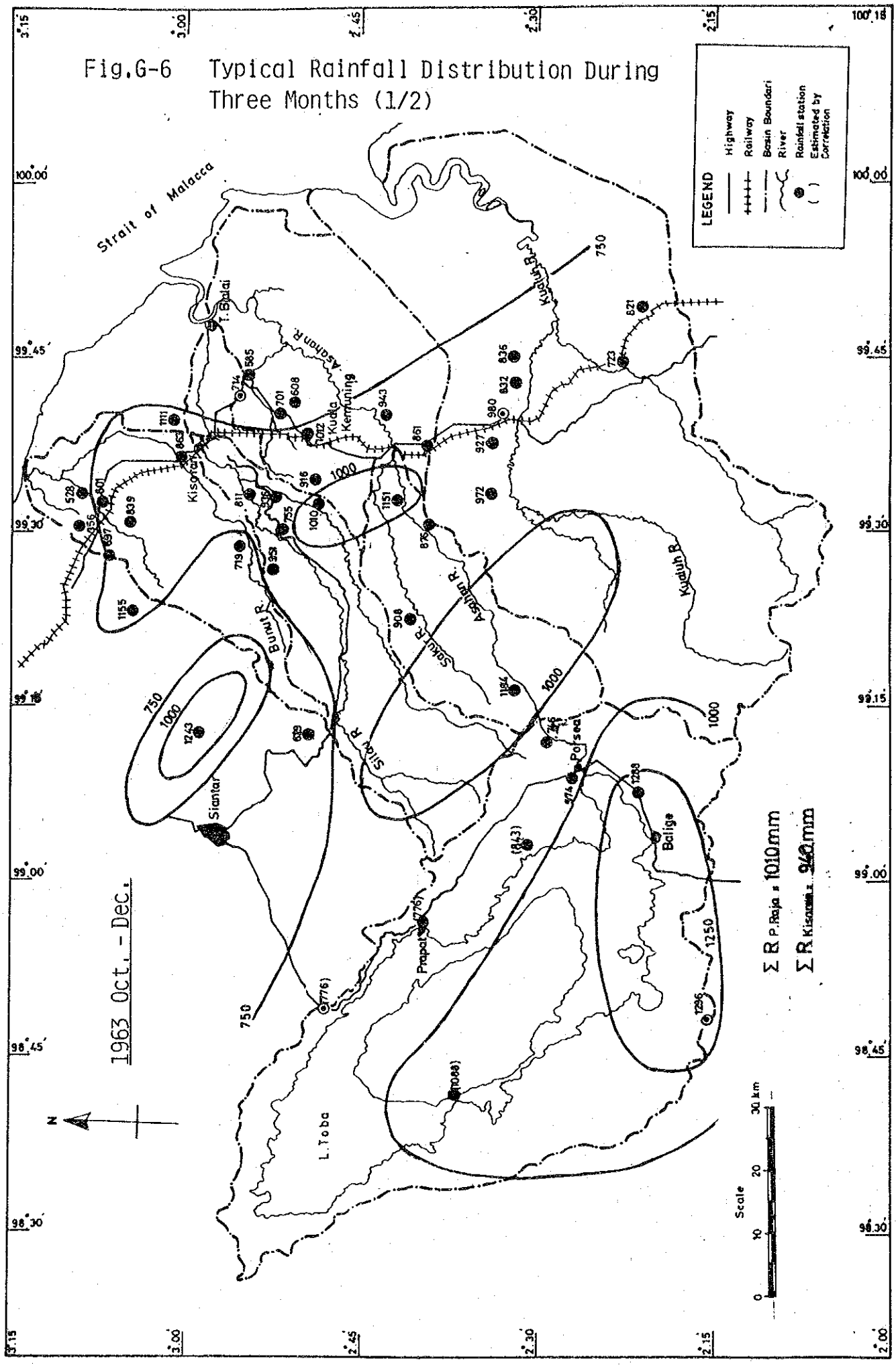


Fig.G-6 Typical Rainfall Distribution During Three Months (2/2)

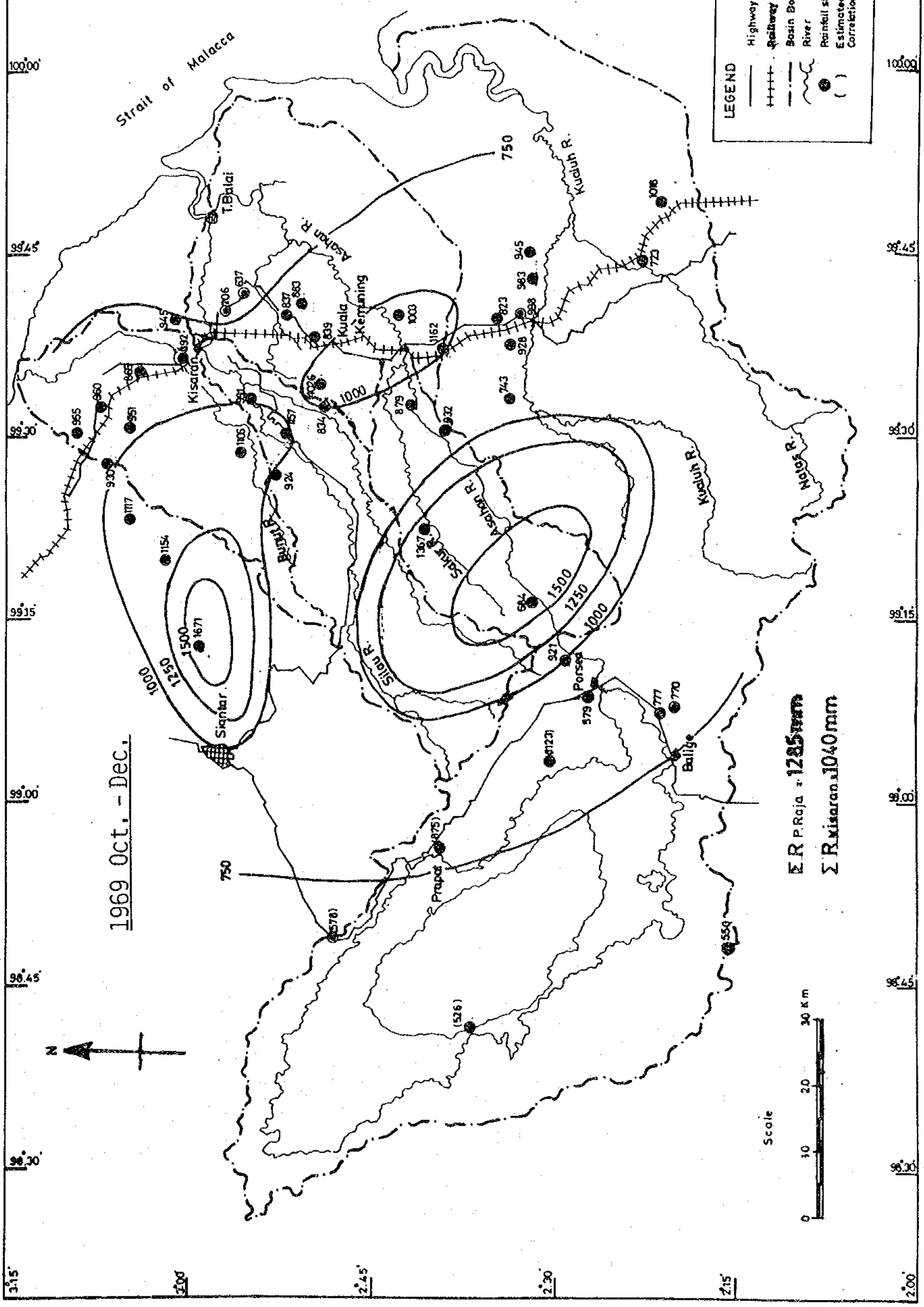


Fig.G-7 Runoff Simulation Model of Asahan and Silau Rivers for Alternative Schemes (1/3)

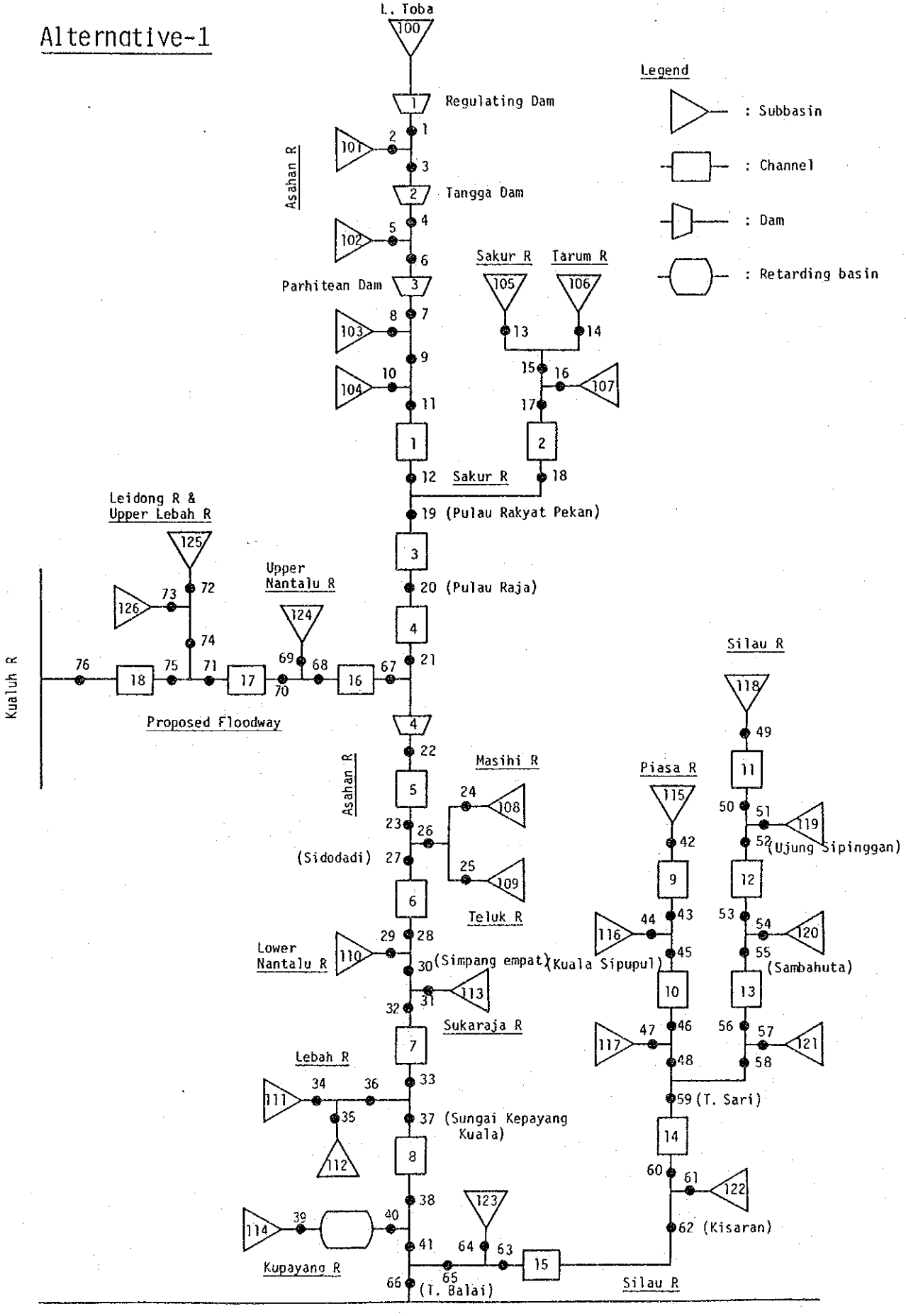


Fig.G-7 Runoff Simulation Model of Asahan and Silau Rivers for Alternative Schemes (2/3)

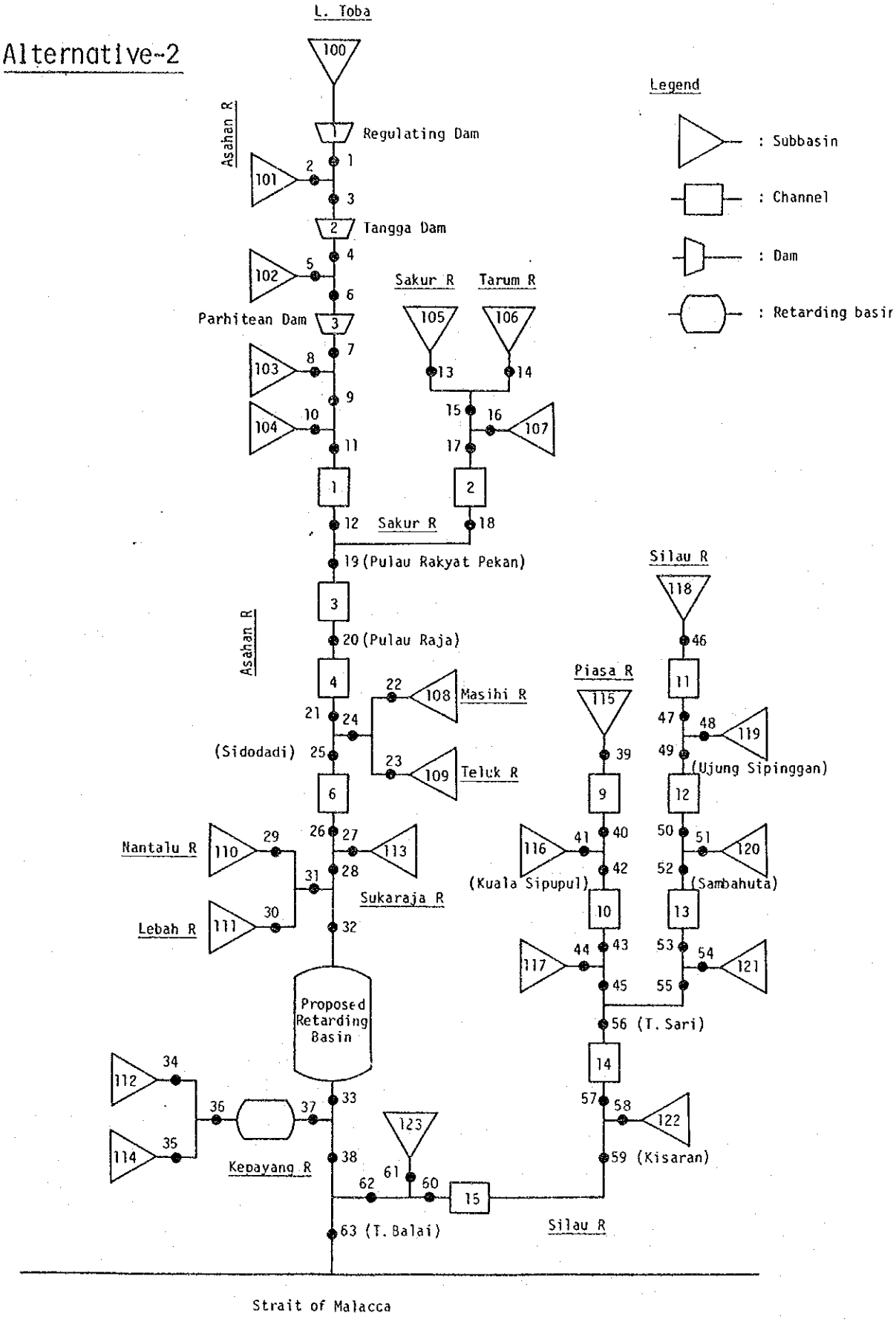


Fig.G-7 Runoff Simulation Model of Asahan and Silau Rivers for Alternative Schemes (3/3)

Alternative-3

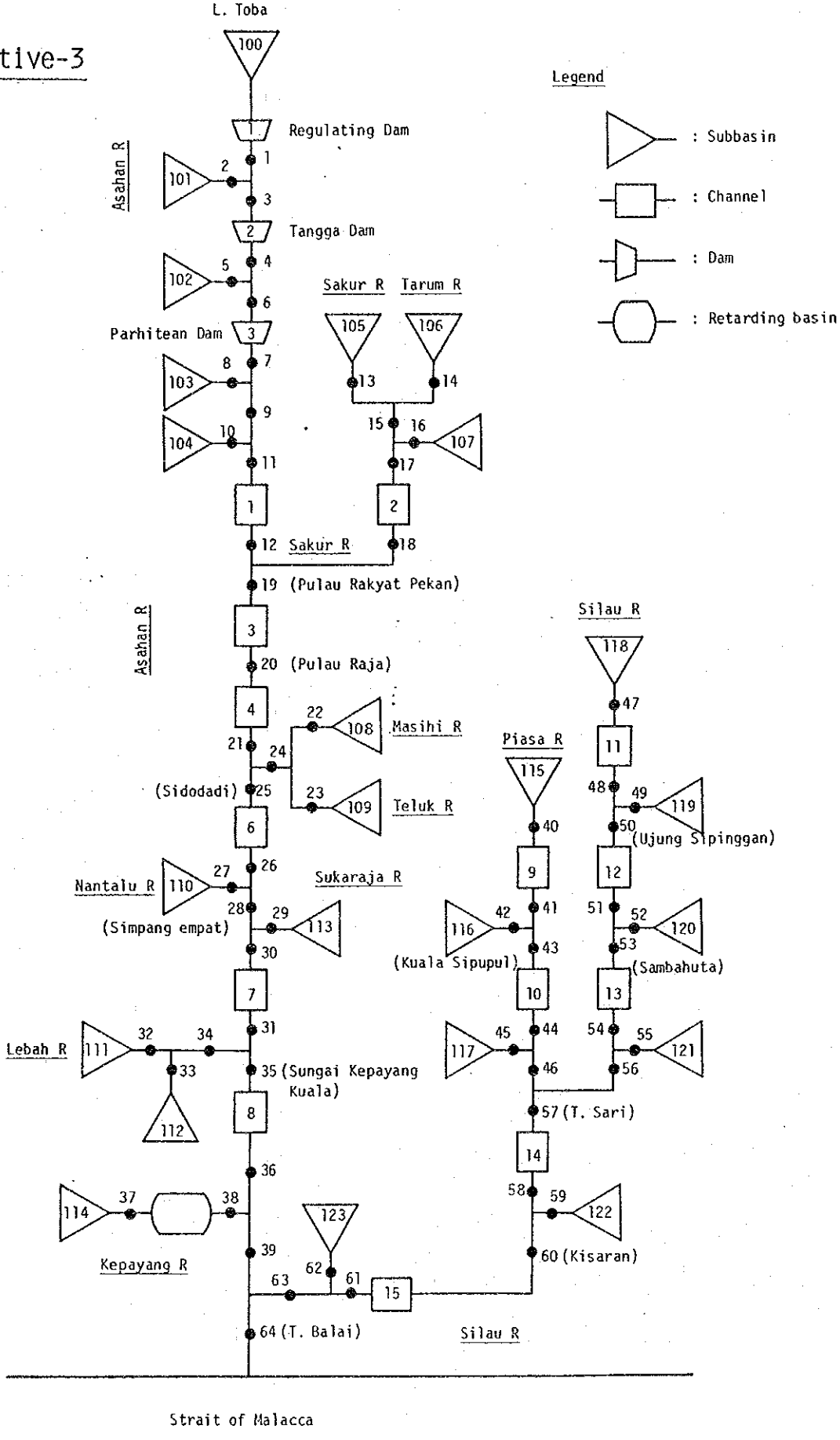


Fig.G-8 Runoff Simulation Model of Kualuh and Kiri River Basins (1/2)

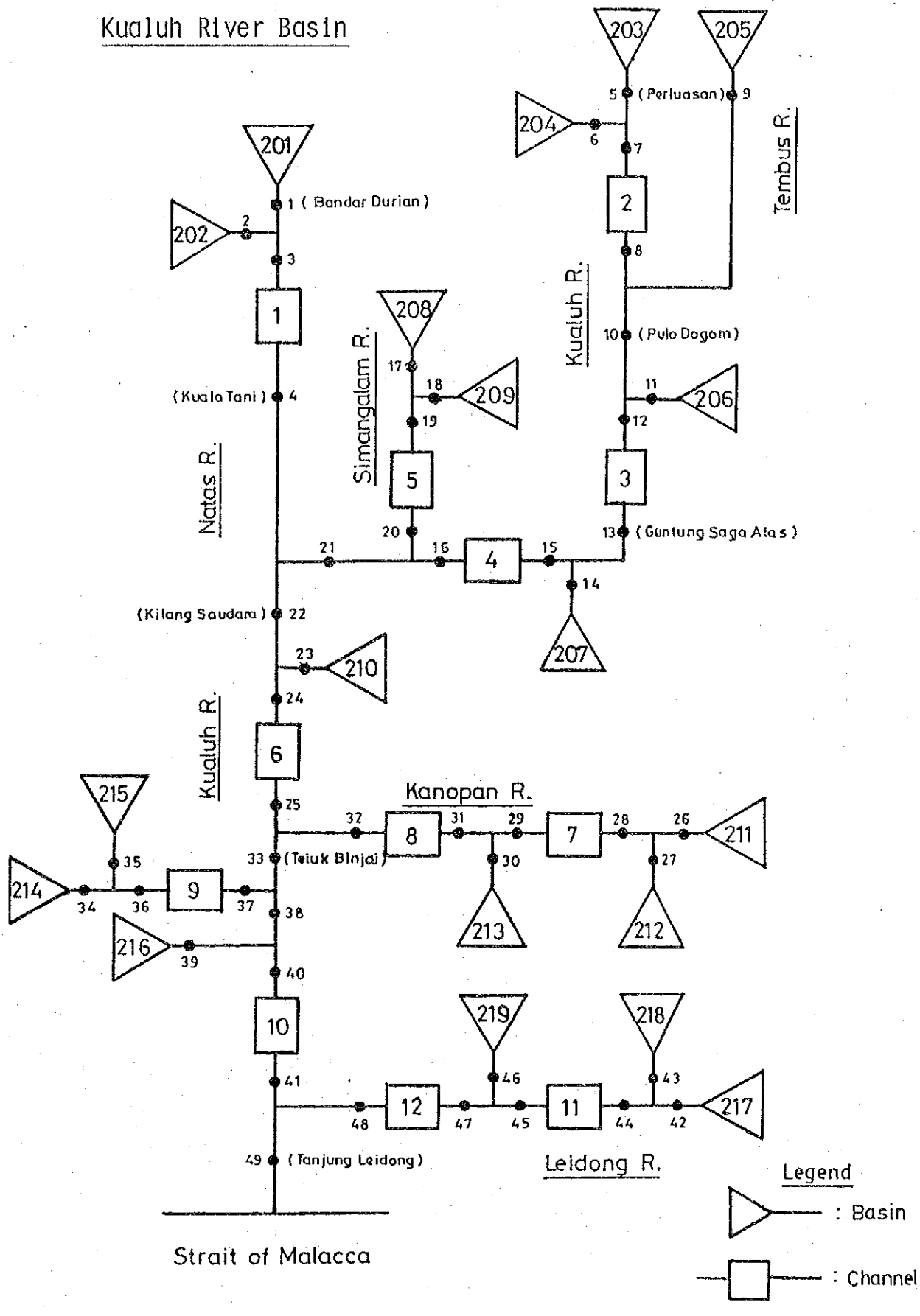


Fig.G-8 Runoff Simulation Model of Kualuh and Kiri River Basins (2/2)

Kiri River Basin

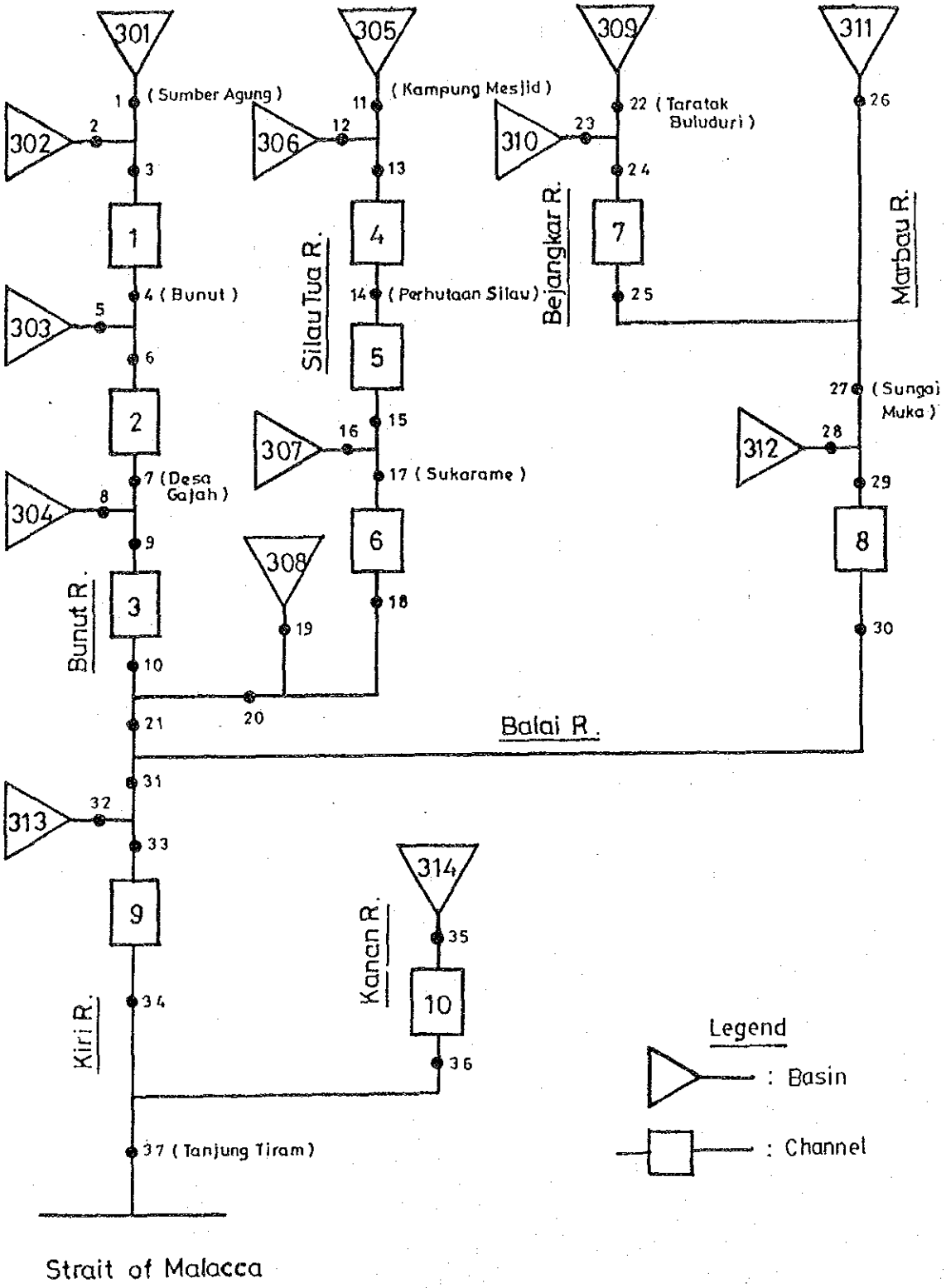
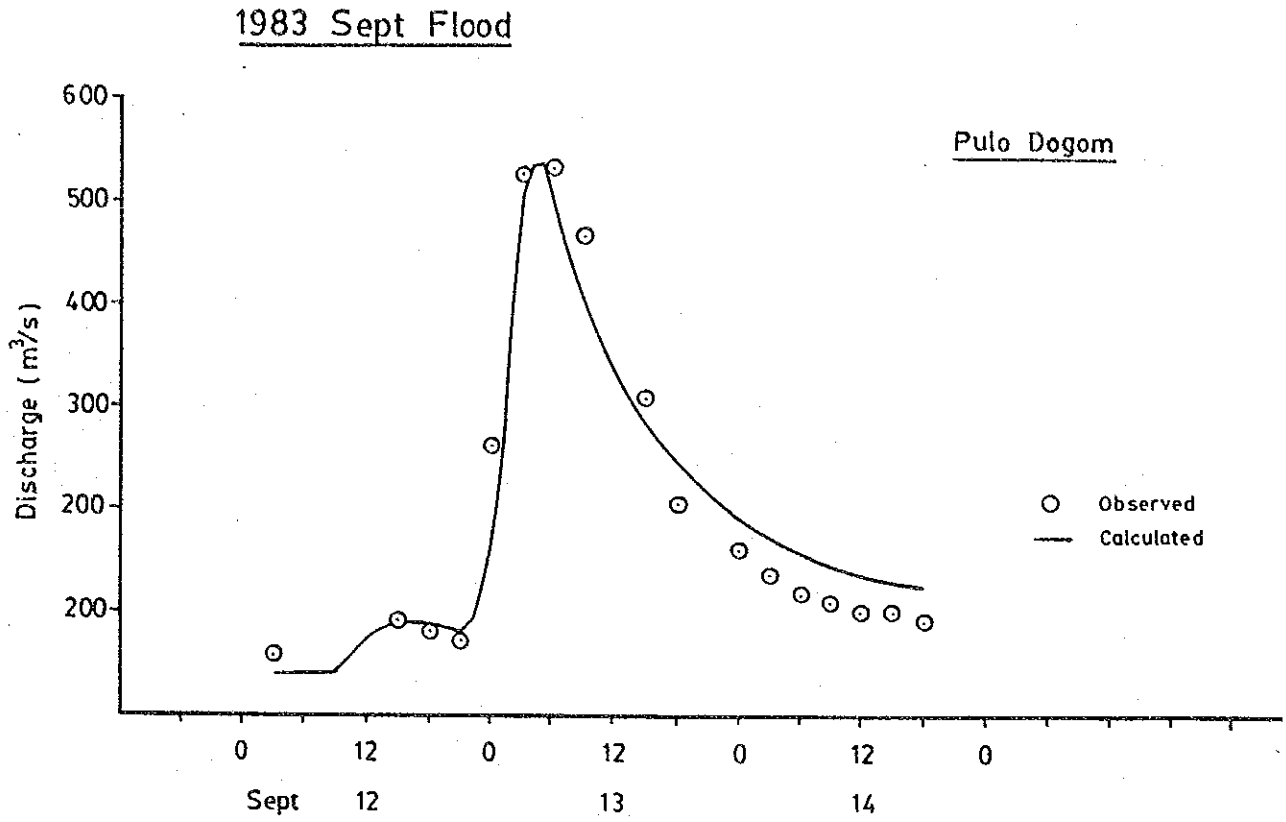
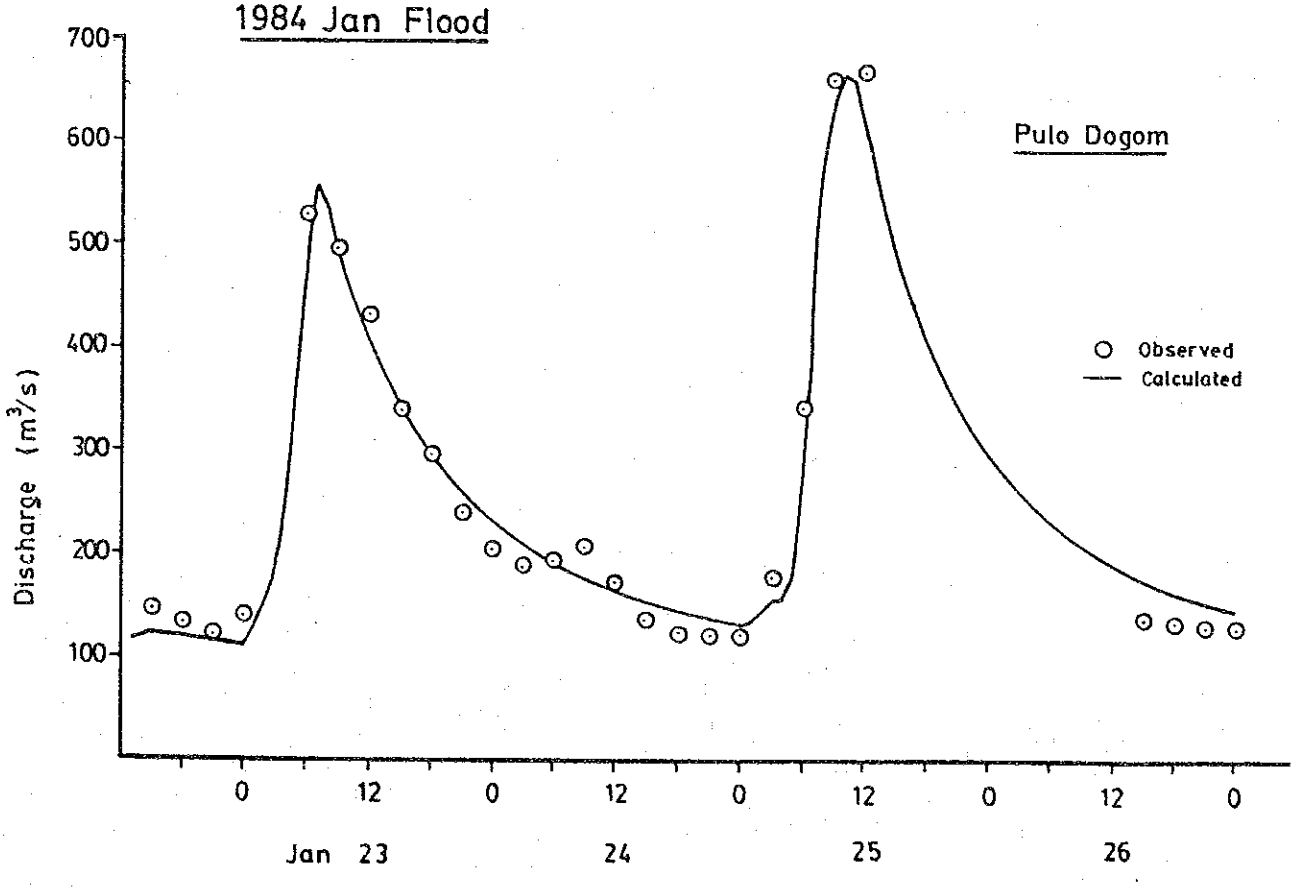


Fig.G-9 Discharge Hydrograph of Major Floods in Kualuh River





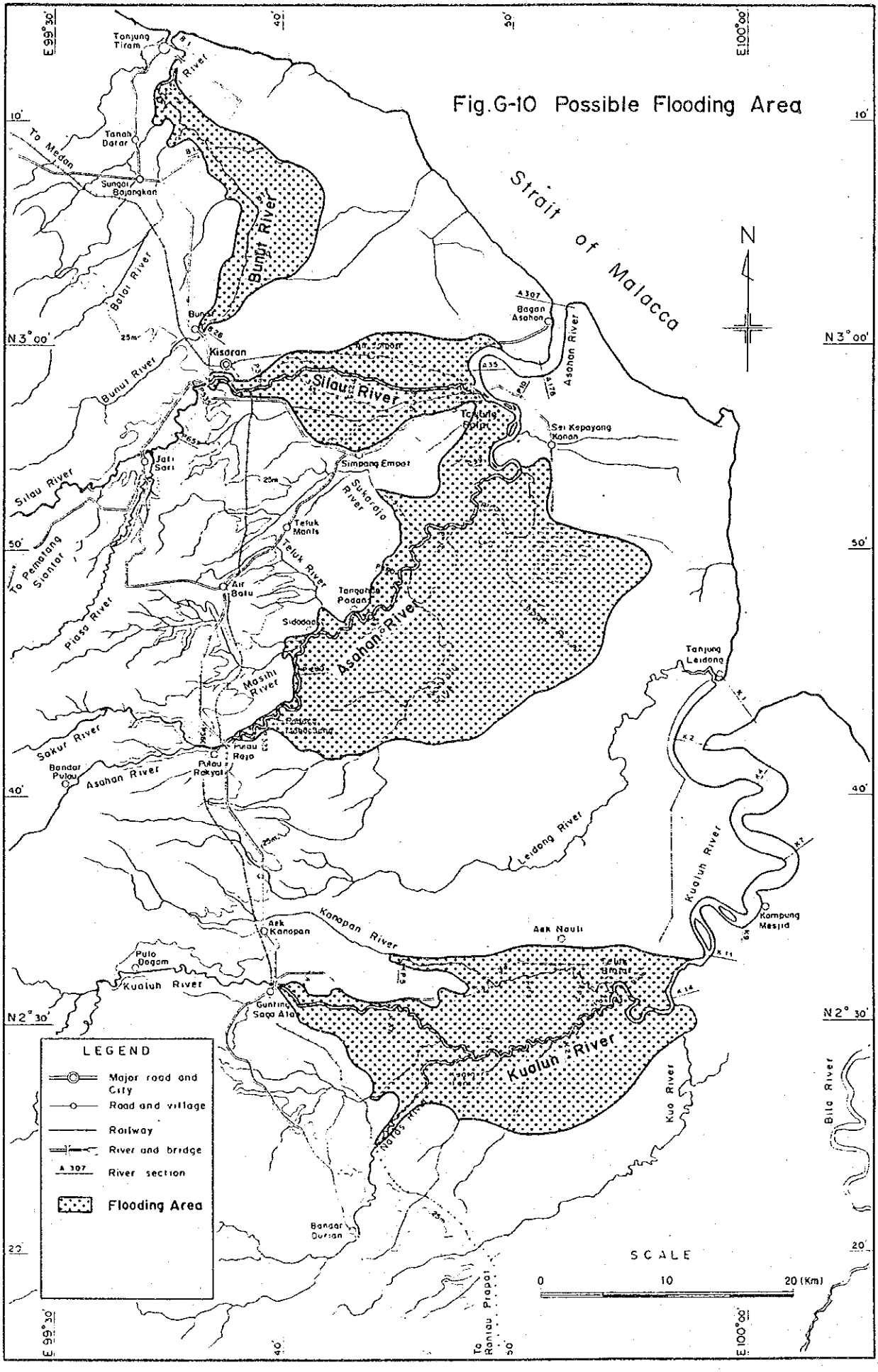


Fig.G-10 Possible Flooding Area
Strait of Malacca
N
E 99° 30'
E 100° 00'
N 3° 00'
N 2° 30'
Tanjung Tiram
To Medan
Tanah Datar
Sungai Bejangkar
Batai River
Bunut River
Bunut River
Kisaran
Bagan Asahan
Asahan River
Silau River
Silau River
Tanjung Balai
Sri Kepayang Kanan
Jati Sari
Simpang Empat
Sukarata River
To Pematang Siantar
Teluk Manis
Teluk River
Air Batu
Tanggaran Padang
Piasa River
Sidodadi
Asahan River
Masihi River
Tanjung Leidong
Sakur River
Bandar Pulau
Asahan River
Pulau Rakyat
Pulau Rejo
Leidong River
Kualuh River
Kampung Mesjid
Kanopan River
Aek Kanopan
Aek Nauli
Pulo Dogom
Kualuh River
Gunting Saga Ala
Kualuh River
Kuo River
Bila River
Bandar Durian
To Rantau Prapat
SCALE
0
10
20 (Km)
LEGEND
Major road and City
Road and village
Railway
River and bridge
A 307 River section
Flooding Area

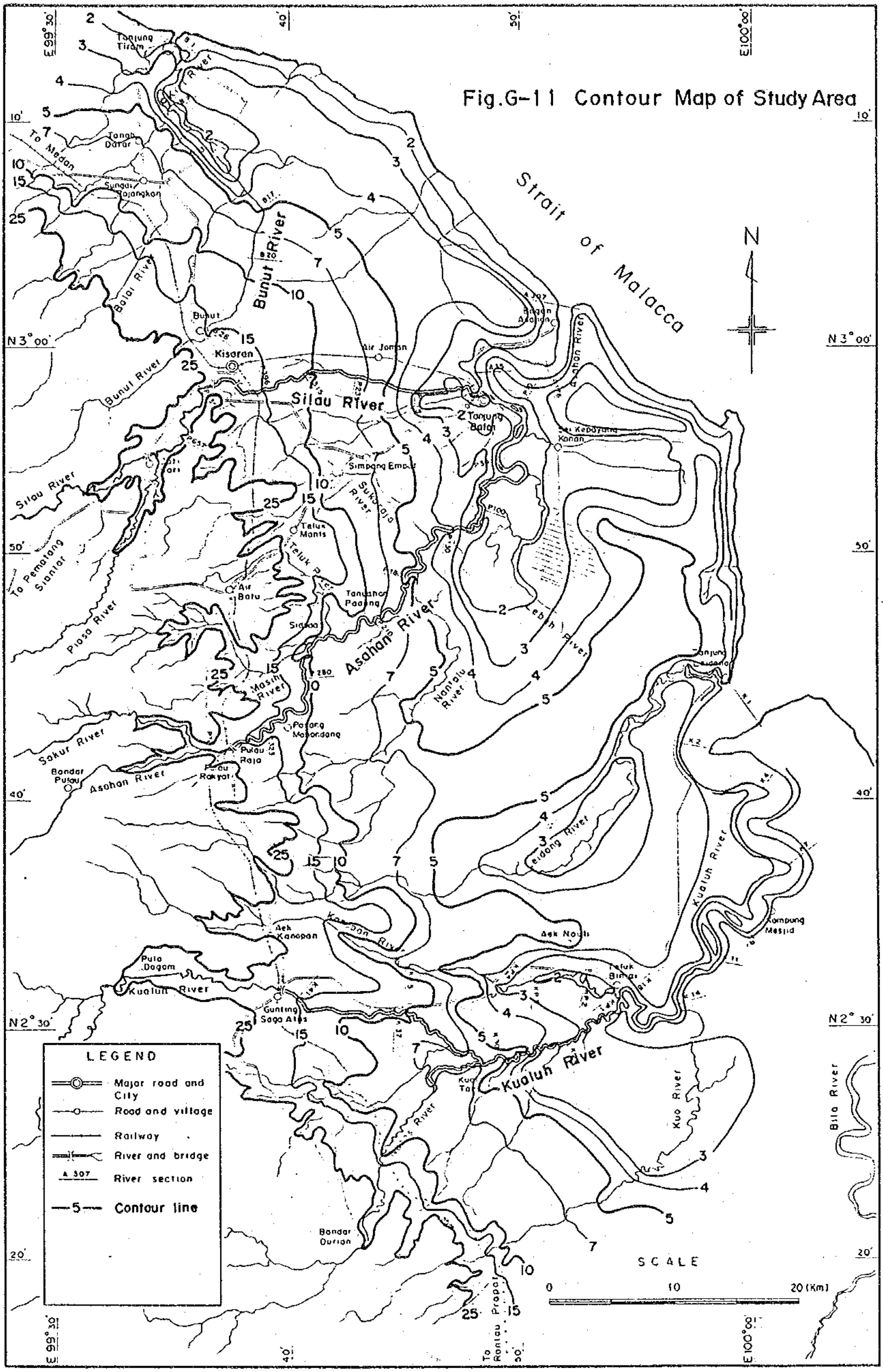


Fig.G-11 Contour Map of Study Area

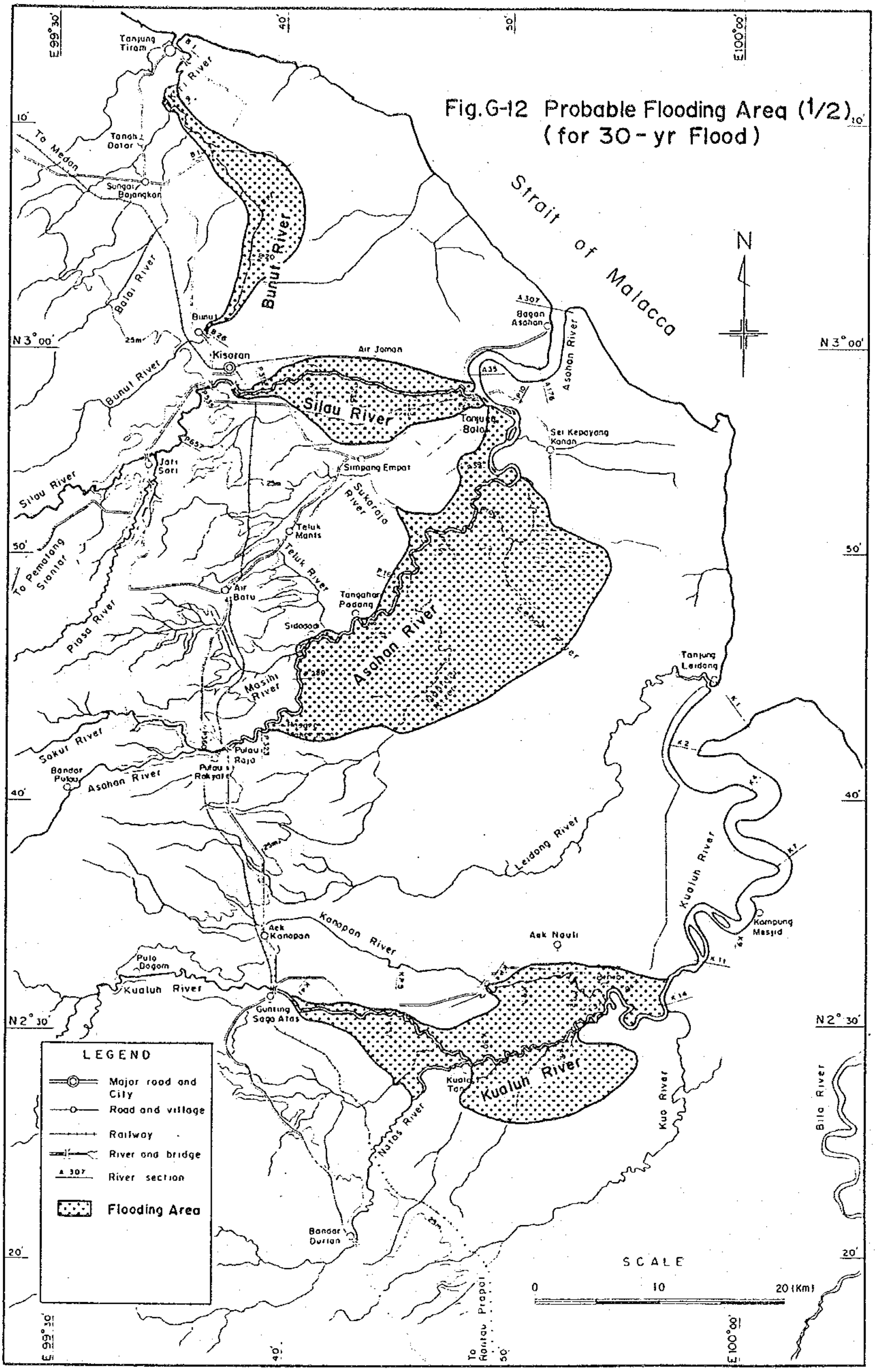


Fig.G-12 Probable Flooding Area (1/2)
(for 30-yr Flood)
Strait of Malacca
N
LEGEND
Major road and City
Road and village
Railway
River and bridge
River section
Flooding Area
SCALE
0 10 20 (Km)
Tanjung Tiram
Tanah Datar
Sungai Bajangkan
To Medan
Bunut River
Balai River
Bunut
Kisaran
Air Joman
Bagan Asahan
Asahan River
Silau River
Tanjung Balai
Sei Kepayang Kanan
Simpang Empat
Jati Sari
Sukaraja River
Teluk Manis
Teluk River
Air Batu
Tangahan Padang
Sidodadi
To Pematang Siantar
Piasa River
Masihi River
Sakur River
Pulau Raja
Bandar Pulau
Pulau Rakyat
Tanjung Leidong
Leidong River
Kualuh River
Kampung Mesjid
Aek Nauli
Aek Kanopan
Kanopan River
Pulo Dogom
Gunting Saga Atas
Natas River
Kuo River
Bila River
Bandar Durian
To Rantau Prapat
N 3° 00'
N 2° 30'
E 99° 30'
E 100° 00'

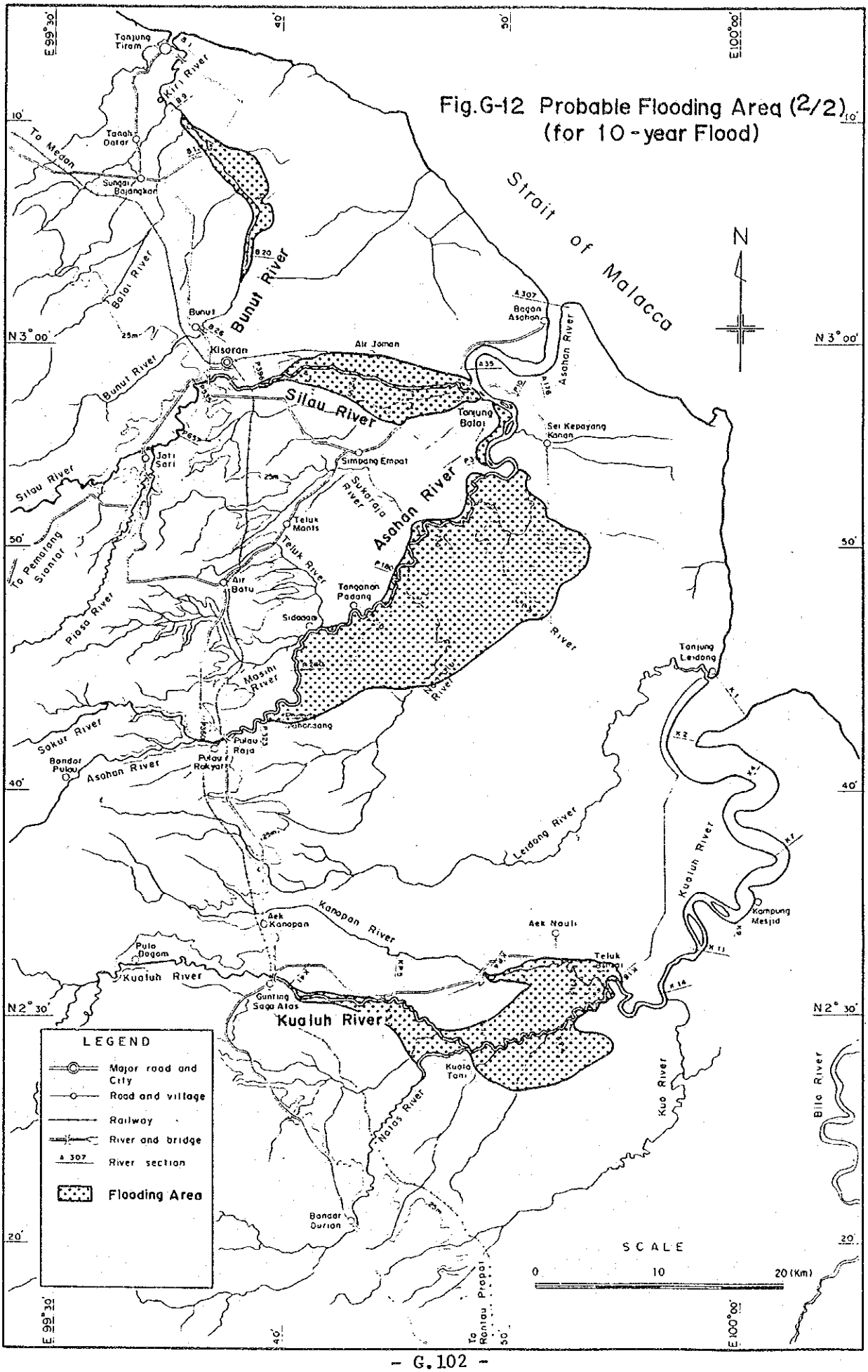


Fig.G-12 Probable Flooding Area (2/2)
(for 10-year Flood)
Strait of Malacca
N
Bunut River
Silau River
Asahan River
Kualuh River
Leidang River
Kanopan River
Sukaraja River
Teluk River
Mosiri River
Sakur River
Batai River
Kuo River
Bila River
Tanjung Tiram
Tanah Datar
Sungai Bajangkar
To Medan
Bunut
Kiseran
Air Joman
Bagan Asahan
Tanjung Balai
Sei Kepayang Kanan
Jati Sari
Simpang Empat
Teluk Manis
Air Batu
Tanganan Padang
Sidodadi
Tanjung Leidang
Pulau Raja
Pulau Rakyat
Bandar Pulau
Aek Kanopan
Aek Nauli
Pulo Dogom
Gunting Saga Atas
Kuala Tani
Kampung Mesjid
Bandar Durian
To Rantau Prapat
To Pematang Siantar
LEGEND
Major road and City
Road and village
Railway
River and bridge
River section
Flooding Area
SCALE
0
10
20 (Km)
E 99°30'
E 100°00'
N 3°00'
N 2°30'

APPENDIX H FLOOD CONTROL PLAN

APPENDIX H. FLOOD CONTROL PLAN

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1. General

On the basis of the results of field investigation and study on the present conditions of the study area, conceivable alternative schemes for long-term flood control plan are studied by a comparative study of the alternative schemes, and the final plan is formulated aiming at prevention of flood damage not only in the existing developed lands but also in adjoining lands for future development. However, the economic benefit accured from the plan at the present state of development is not so high, and a large fund is required to implement such a big project. Therefore, the time has not come yet to implement the long-term plan at present.

While, as mentioned in the APPENDIX G, the existing developed lands along the Asahan and Silau rivers suffer from habitual flood damage which can not be overlooked any longer. Realization of an urgent flood control measures is required aiming at mitigation of flood damage in the lands along the Asahan and Silau rivers. For this reason, urgent flood control plan of the Asahan and Silau rivers based on the long-term plan is studied to formulate a project to be implemented immediately in consideration of urgency as well as technical and economical effectiveness of the project under the present conditions. The urgent flood control plan aims at mitigation of the flood damage in the existing developed lands and adjoining potential lands to be developed in the near future.

2. Long-Term Flood Control Plan

2.1 Objective Area for Long-Term Plan

The long-term flood control plan aims at prevention of flood damage in the lower plain area of the Bunut, Asahan and Kualuh rivers, from viewpoint of long-range policies as rising the productivity, promoting development and bettering the living standard in the area.

The objective rivers and their stretches are as follows :

River	Stretch	length (km)
Bunut river	River-mouth of Kiri river - Highway bridge at Bunut including a part of Kiri river	36.7
Asahan river	River-mouth - Highway bridge at Pulau Raja	61.5
Silau river	Confluence to Asahan river - Road bridge at Kisaran	21.7
Kualuh river	River-mouth - Highway bridge at Gunting Saga	84.2
Kanopan river	Confluence to Kualuh river - Road bridge at Pulo Gambut	13.0
Total		217.1

2.2 Flood Control Method

In general, the following methods are considered for flood control planning.

Upper basin : flood regulation by reservoir.
Middle basin : flood retardation by retarding basin and flood prevention by channel improvement.
Lower basin : flood diversion by floodway, flood retardation by retarding basin and flood prevention by channel improvement.

For selecting the flood control method, it is necessary to consider regional characteristics of the river basin such as topography, scale of catchment area, shape of flood hydrograph, flooding conditions, construction cost, etc.

2.2.1 Flood Control Method in the Upper Basin

The river slopes upstream of the Asahan, Silau and Kualuh rivers are very steep more than 1/40. The flood runoff is therefore of the flash type with time concentration of about 7 hours. The effective measures of

flood control for such rivers are to store a flood runoff by reservoir in the upper basin. However, the rivers have very steep slopes of deep and narrow gorges. Appropriate dam site with reservoir is found only at Parhitean (8 km downstream from Tangga power station) in the upstream reaches of the Asahan river.

This dam site is taken up by PLN as hydropower project namely Asahan No.3 project. The feasibility study was made by JICA in 1982. The detailed design of the project is being carried out by PLN. According to the feasibility study report, the principal features of the project are shown in Table H-1.

The proposed intake dam for the Asahan No.3 power station will have considerably large storage capacity. It suggests a possibility of flood regulation to cut off the peak flood discharge coming from the remaining catchment area of 214 sq.km downstream from the existing regulating dam although the flood release from the regulating dam can not all be regulated because the release from Lake Toba continues as long as 30 to 90 days.

In calculation, the flood peak discharge from the area of 214 sq.km is estimated at about 410 cms and its total volume may be 30 mcm in the case of 30-year probable flood. If storage capacity of 12 mcm for flood control is secured at the NO.3 intake dam, the above peak discharge will be cut down to 100 cms. The flood control effect of this intake dam will reduce about 20% of the peak flood discharge of 1360 cms at Pulau Raja which includes the maximum flood release of 400 cms from the upstream regulating dam. So that, it is recommended to take the flood control capacity at the No.3 intake dam. It seems that the decrease of annual electric energy at the No.3 power station would be as small as less than 1% or so even in case of 12 mcm of flood control capacity during the flood season, as some part of spill-out quantity at the intake dam will reduce compensating the loss of power due to lower head during flood season.

2.2.2 Flood Control Method in the Middle Basin

In the middle basin of the said four rivers, most of the flat area along the rivers has been developed for rubber and oil palm estates. The possible areas for retarding basin are not found. In the middle reaches from Sumber Agung to Bunut of the Bunut river, from Bandar Pulau to Pulau

Raja of the Asahan river, from Samba Huta to Kisaran of the Silau river, and from Pulo Dogom to Gunting Saga of the Kualuh river, the existing river channel has adequate discharge capacity due to sufficient bank height, so that no flood control measures is necessary.

2.2.3 Flood Control Method in the Lower Basin

In the lower reaches of the rivers, the existing river channel has not adequate discharge capacity except in the stretches from Tanjung Balai to the river-mouth of the Asahan river and Teluk Binjai to the river mouth of the Kualuh river. Conceivable alternative flood control methods in those reaches are as follows :

(1) Bunut river

i) A floodway to divert the excess flood water from the Bunut river by enlarge a drainage canal over a length of 22 km from Serbangan intake to the Strait of Malacca.

ii) Channel improvement to increase the discharge capacity by means of construction of dike and excavation of channel.

(2) Asahan and Silau rivers

Asahan mainstream:

i) A floodway to divert the excess flood water from the Asahan mainstream by construction of 30 km channel from a point downstream of Pulau Raja to the estuary of the Kualuh river.

ii) Channel improvement to increase the discharge capacity by means of construction of dike and excavation of the channel.

iii) Channel improvement combined with a retarding basin to retard the flood water in the right bank area between the confluences of the Nantalu and Lebah rivers.

iv) Combination of above methods.

Silau river:

Channel improvement is the only conceivable method in the lower reaches of the Silau river owing to the topographic conditions.

(3) Kualuh river

Kualuh mainstream:

i) Channel improvement to protect the lands developed and to be developed in the future by means of diking system.

ii) Channel improvement combined with a retarding basin to retard the flood water in the right bank area between the confluences of the Natas and Kanopan rivers.

Kanopan river:

Channel improvement is the only conceivable method in the lower reaches of the Kanopan river owing to the topographic conditions.

2.2.4 Alternative Schemes

The following alternative schemes are set up for the present study.

(1) Bunut river

Alternative Scheme B-1 : Floodway.

Alternative Scheme B-2 : Channel improvement alone.

(2) Asahan and Silau rivers

Alternative Scheme A-1 :

Asahan river : Channel improvement combined with floodway.

Silau river : Channel improvement alone.

Alternative Scheme A-2 :

Asahan river : Channel improvement combined with retarding basin.

Silau river : Channel improvement alone.

Alternative Scheme A-3 :

Asahan river : Channel improvement alone.

Silau river : Channel improvement alone.

(3) Kualuh river

Alternative Scheme K-1 :

Kualuh river : Channel improvement combined with retarding basin.

Kanopan river: Channel improvement alone.

Alternative Scheme K-2 :

Kualuh river : Channel improvement alone.

Kanopan river: Channel improvememt alone.

These alternative schemes are shown in Fig.H-1.

2.3 Scale of Long-Term Plan

At present, a level of 20-year to 50-year flood is actually selected for the flood control plan for major rivers in Indonesia as shown in Table H-2.

In order to determine a scale of design flood for long-term plan, a comparative study is made selecting three design flood levels of 15 year, 30 year and 50 year for the Scheme A-2. The design flood discharges are shown in Table H-3. For comparison on economic value, the economic construction costs are estimated as shown in Table H-4. The flood control benefits are also estimated taking into account of reduction of flood damages under the future situation as of the year of 2005 for properties, farm crops, public facilities, etc. The land enhancement benefit (increase of productivity of land by implementation of the plan) and future development effects for land in the flooding area are also included in the said benefit. They are shown in Table H-5. The results of comparative study are summarized below.

Design flood (year)	Ave.annual benefit (Rp million)	Economic cost (Rp million)	B/C with discount rate of 14 %
15	10,571	56,152	1.01
30	11,662	61,404	1.03
50	12,166	69,053	0.94

The above table shows that the 30-year design flood level is most attractive because of a little high economic value of B/C compared with the others.

Taking into consideration the design flood levels of other rivers in Indonesia, result of comparison of economic value and possibility of future realistic development in the study area, the 30-year flood is proposed as design flood for the long-term flood control plan.

2.4 Comparison of Alternative Schemes

Adopting design flood of 30 year, the seven alternative schemes described in the forefoing section are studied. The schemes comprise two alternatives for the Bunut river, three alternatives for the Asahan and Silau rivers, and two alternatives for the Kualuh river. The most optimum scheme for long-term plan is selected on the basis of the comparative study. For comparison, the economic construction costs are estimated for each alternative scheme. The construction cost is composed of cost for civil works, cost for land acquisition and compensation, engineering and administration cost, and contingency. The cost required for civil works is calculated by multiplying work quantity by unit cost. They are shown in Table H-6. The benefits are estimated as the expected reduction of flood damages for private properties, farm crops, public facilities and so on, and also the expected development effect for the land which has not been utilized during the wet season. The development area and enhancement benefits expected by the long-term plan are shown in Tables H-7 and H-8 respectively. The results of comparative study on economic value are shown in Table H-9. They are summarized below.

Alternative scheme	Ave. annual benefit (Rp. million)	Economic const. cost (Rp. million)	B/C with discount rate of 12 %
Bunut river			
B-1.	1,839	15,555	0.77
B-2.	1,839	12,074	0.99
Asahan and Silau rivers			
A-1.	12,444	103,558	0.78
A-2.	11,662	61,404	1.24
A-3.	11,976	71,323	1.09
Kualuh river including Kanopan river			
K-1.	3,116	19,715	1.03
K-2.	3,742	25,241	0.97

The comparative study on economic value of B/C makes it clear that (1) for the Bunut river and the Asahan and Silau rivers, Scheme B-2 and Scheme A-2 indicate higher economic values than the other Schemes, and

(2) for the Kualuh river, Scheme K-1 indicates a little higher economic value than Scheme K-2.

Therefore, it is considered reasonable to select the Schemes of B-2, A-2 and K-1 for the long-term flood control plan.

2.5 Proposed Long-Term Flood Control Plan

2.5.1 Design Flood Discharge

Based on the results of flood discharge analysis described in APPENDIX G, the design flood discharges of the Bunut, Asahan mainstream, Silau, and Kualuh rivers for the long-term flood control plan are determined as shown in Fig.H-2. In determination of design flood discharge at Pulau Raja on the Asahan mainstream, flood regulation of 310 cms by Asahan No.3 Dam was considered and outflow from Regulating dam was estimated at 400 cms assuming that flood peak from the basin downstream from Regulating dam overlaps with the maximum outflow from Regulating dam.

2.5.2 Proposed Plan

The proposed long-term plan is composed of (1) channel improvement by mean of construction of dike and excavation of channel, (2) construction of drainage outlet culverts, and (3) reconstruction of irrigation free intake owing to channel improvement. The proposed alignments of dike, longitudinal profiles and cross-sections are shown in Figs.H-3 to H-5. The principal features of the proposed works are listed in Table H-10. The outline of the works of this proposed long-term plan for each river is as follows:

(1) Bunut river

The long-term plan of the Bunut river proposes the works: (1) channel improvement over a length of 33.7 km, which includes a part of the Kiri river of 7 km, in the stretch between highway bridge at Bunut and road bridge at Tanjung Tiram, (2) construction of a drainage culvert, and (3) reconstruction of a road bridge.

(2) Asahan and Silau rivers

The long-term plan of the Asahan river proposes the works: (1) chan-

nel improvement by diking system over a length of 39.7 km in the downstream reach from Pulau Raja and construction of dike for a retarding area over a length of 17.8 km on the right side bank of the Lebah river, and (2) construction of 13 drainage culverts.

The long-term plan of the Silau river proposed the works: (1) channel improvement over a length of 21.7 km in the stretch between the confluence to the Asahan mainstream and road bridge at Kisaran, (2) construction of 6 drainage culverts, and (3) reconstruction of 5 irrigation intakes.

(3) Kualuh river including Kanopan river

The long-term plan of the Kualuh river proposes the works: (1) channel improvement by diking system over a length of 33.3 km in the stretch between the confluence with the Kanopan river and highway bridge at Gunting Saga, (2) construction of 9 drainage culverts and reconstruction of an irrigation intake.

For the Kanopan river, the proposed works are (1) channel improvement by diking system over a lengh of 13.0 km in the downstream reaches from the confluence to the Kualuh mainstream to road bridge at Pulo Gambut, and (2) construction of 8 drainage culverts.

2.5.3 Construction Cost

Construction costs are composed of the costs of civil works, land acquisition and compensation, contingency and engineering and administration. Cost required for civil works is accounted by multiplying work quantity by unit cost. Engineering and administration cost is assumed to be 15 % of the sum of the civil works, land aquisition and compensation costs. Cost for contingency is assumed at 10 % of the above costs. The construction costs for the long-term plan for each river are estimated at Rp 12,550 million for the Bunut river, Rp 63,470 million for the Asahan and Silau rivers, and Rp 20,500 million for the Kualuh river. The breakdown of the costs is shown in Table H-11.

2.5.4 Economic Evaluation

(1) Economic construction cost

The economic construction cost for the long-term plan is estimated by deducting tax and contractor's profit from the Rupiah currency portion of the construction cost. The tax and contractor's profit to be deducted are assumed to be 4 % and 10 % respectively. The land acquisition and compensation costs are evaluated as a part of construction cost. The economic construction cost for the long-term flood control plan are estimated as shown in Table H-12. They are summarized below.

(Unit : Rp million)

River	Bunut R.	Asahan & Silau R.	Kualuh R.
Economic Construction Cost	12,074	61,404	19,715

(2) Benefits

Benefits are expected by recuction of flood damages to private properties, farm crops, public facilities, etc., and also expected development effect for the land which has not been utilized during the wet season. For evaluation of long-term plan, the benefits are estimated under two conditions, i.e., the present conditions in 1985 and the future development conditions in AD 2005.

Benefit under present conditions

Based on the estimated flood damages under the present conditions described in Appendix G, the expected reduction of flood damages by implementation of the proposed long-term plan is estimated as shown in Table H-13. They are summarized below.

(Unit : Rp million/yr)

River	Bunut R.	Asahan & Silau R.	Kualuh R.
Reduction of average annual Damage	1,224	5,547	1,768

In addition to the above benefits, the expected development effect for the land which has not been utilized during the wet season is estimated. Such development effects by the long-term plan may be counted as an enhancement benefit. They are estimated as shown below.

River	Bunut R.	Asahan & Silau R.	Kualuh R.
Area to be enhanced (ha)	-	6,519	4,800
Enhancement benefit (Rp million/yr)	-	751	200

Benefits under future conditions

The flood damages under the future conditions are estimated based on projected increase in population and GRDP in each sector. The expected benefits under the future development conditions by implementation of the proposed long-term plan are estimated as shown in Table H-14. They are summarized below.

(Unit : Rp million/yr)

River :	Bunut R.	Asahan & Silau R.	Kualuh R.
Reduction of damages	1,839	10,332	2,740
Enhancement benefit	-	1,330	376
Total benefits	1,839	11,662	3,116

(3) Internal rate of return

Based on the economic construction cost and benefits mentioned above, internal rate of return for long-term plan is calculated assuming the project life of 50 years. The results show that the project is expected to yield the following internal rate of return.

Conditions	Internal rate of return (%)		
	Bunut R.	Asahan & Silau R.	Kualuh R.
Present condition	8.3	8.4	8.1
Future condition	11.9	14.3	12.3

(4) Priority order

The priority of project implementation of the three plans is concluded from a standpoint of economic and social aspects of the study area. The priority order is as follows:

Priority Order	Long-term Flood Control Plan
1	Asahan and Silau Rivers
2	Kualuh and Kanopan Rivers
3	Bunut River

3. Urgent Flood Control Plan

3.1 Necessity of Urgent Flood Control Project

The lower basins of the Asahan, Silau, Bunut and Kualuh rivers have frequently suffered from flood damage. As a means of flood control in the areas, river dikes have been constructed for protecting the developed lands from flooding of the rivers. With regard to the Bunut and Kualuh rivers, the flood damage are considerably reduced at present after construction of the present dikes.

However, the lower areas of the Asahan and Silau rivers have often suffered from damage 6 times for the Asahan river and 8 times for the Silau river in the last 8 years. To make matters worse, the cultivated land is expanding even in low-lying lands surrounding the existing swamps. The social and economic damage due to floodings is increasing in these areas.

In order to prevent the area against repeated flood of the Asahan and Silau rivers, implementation of flood control project is urgently needed.

3.2 Design Flood

In order to select the level of design flood for the urgent plan, the urgent plan is examined by the design floods of 5 year, 10 year and 15 year. The design flood discharges are shown in Table H-15. For comparison on economic value, the economic construction costs are estimated as shown in Table H-16, and the benefits are also estimated as shown in Table H-17. The results of comparative study are summarized below.

Design flood (year)	Ave. annual benefit (Rp million)	Economic cost (Rp million)	B/C with discount rate of 12 %
5	3,945	33,215	0.85
10	5,124	35,369	1.03
15	5,576	44,964	0.89

The 10-year plan has a little high economic value of B/C compared with the others, so that 10-year flood is proposed as design flood for the urgent flood control plan from the standpoint of high economic value and socio-economic conditions in the area. The determined design flood discharge is shown in Fig.H-6.

3.3 Proposed Urgent Flood Control Plan

3.3.1 River Stretches for Proposed Urgent Plan

Taking into consideration the present flooding area and discharge capacity of the existing river channel, the river stretches taken for planning the urgent flood control plan are determined. The river stretches of the proposed urgent flood control plan are as follows:

River	stretches to be improved	length (km)
Asahan mainstream	Confluence of Nantalu river - Highway bridge at Pulau Raja and Lebah river	43
Silau river	Confluence to mainstream at Tanjung Balai - Railway bridge at Kisaran	19
Total		62

3.3.2 Improvement Plan of River Channel

The project proposes channel improvement over a total length of 57 km. The proposed river channel improvement plan such as alignment of dike, longitudinal profile and cross-sections is shown in Fig.H-7. The outline of the improvement plan of river channels is as follows:

(1) Asahan mainstream

The proposed improvement of river channel comprises : (i) construction of dike over a length of 19.3 km on the right bank in the stretches from Padang Mahondong intake to the confluence of the Nantalu river and (ii) construction of dike for a retarding basin over a length of 17.8 km on the right side of the Lebah river. The bulk of the works is construction of dike to protect the land from flooding.

(2) Silau river

The proposed plan of the Silau river is channel improvement over a length of 19 km by means of excavation of the low-water channel and construction of dike on both banks to secure adequate discharge capacity.

3.3.3 Proposed Urgent Flood Control Works

The following major works are proposed for the urgent flood control project in this study.

(1) Asahan mainstream

(a) Excavation/dredging of channel and embankment of dike

(b) Bank protection by means of crib and wet masonry

(c) Construction of drainage culverts

(2) Silau river

(a) Excavation/dredging of channel and embankment of dike

(b) Bank protection by means of crib

(c) Reconstruction of irrigation free intakes

(d) Construction of drainage culverts

The proposed work quantity is as follows:

Excavation/dredging works	3,650,000	m3
Embankment works	2,270,000	m3
Bank protection works	2,600	m
Reconstruction of irrigation free intakes	5	places
Construction of drainage culverts	12	places

4. Construction Plan and Cost Estimate of Urgent Flood Control Project

4.1 Basic Conditions for Construction Plan

(1) Workable day and working hour

Workable day for civil works is determined by three factors of holiday/weekday, suspension due to rainfall and also flood. Based on the records of rainfall and river discharge, workable days are estimated. Holidays consisting of Sundays and national holidays are counted in recent 5 years from 1981 to 1985.

For the estimation of workable days, the days with rainfall more than 10 mm/day are defined as suspended days due to rainfall. Estimated days are presented in Table H-19.

The suspended days due to floods are estimated based on the discharge records at Pulau Raja for the Asahan river and at Kisaran for the Silau river. Daily discharges more than 250 m3/s and 150 m3/s which correspond to the bankful discharge of low-water channel for the Asahan and Silau rivers respectively are picked up as flood.

The total workable days in a year are estimated at about 200 days (55 % of a year) as shown in Table H-19.

Daily working hour is assumed to be 8 hours for the construction

works. While, net operation hour of equipment for civil works is assumed to be 5 hours.

(2) Existing available equipment

The Water Resources Development Division of DPUP, North Sumatra owns construction equipment as listed in Table H-20 for river works. These equipment are mostly used for the maintenance works of Wampu river project and more than several years has been passed since they were purchased. So that the equipment will not be used for this project.

(3) Execution system of construction works

In general, one of the following three methods is adopted for the execution of works; full-contracting basis, force account basis, and combination of them. Considering the scale of the project and the past experiences in Indonesia, all the construction works will be executed by contractors selected through international competitive bidding.

4.2 Land Acquisition and Compensation

Land acquisition and compensation for house and crops are required prior to the execution of construction works. These are carried out by the executive agency of the project.

4.3 Construction Works

(1) Preparatory works

The project office would be provided considering the communication with authorities concerned. The temporary site offices, yard, motor pool, quarters for project personnel etc. are required to be built at several places for supervision of the works. Clearing works on the normal ground and other temporary works are included in the preparatory works.

(2) Clearing works for bush area

The clearing works for bush area of the Asahan river will be carried out on the proposed alignment of dike and access roads. The bush will be cut down using chainsaw with manpower and bulldozer.

(3) Excavation/dredging of river channel

For the Asahan river, the ground surface is stripped prior to the dredging and excavation works. After the clearing works by bulldozer, low-water channel is dredged applying the standard section. The cutoff channels are planned to moderate excessive meanderings. The dredged material is to be used for filling the depressions on high-water channel or spoiled in the low-lying area along the river course. Existing dike is to be excavated by bulldozer, backhoe and dragline. Excavated material will be used for fill-up of the embankment or reinforcement of the back-slope.

On the Silau river, dredging and excavation works are planned to be executed for the whole stretches between Tanjung Balai and Kisaran. Excavated material from bank shoulder, high-water channel and existing dike are planned to be used for embankment.

(4) Transportation and dumping of soil

Loading and transportation of excavated materials are planned to be carried out by a combination of bulldozer, backhoe and dump truck to embankment site or low-lying area.

(5) Embankment

The embankment works are planned to be carryied out by a combination of manpower (10 % to total) and equipment (90 % to total). The embankment works are carried out by a combination of bulldozer, backhoe, and vibration roller and compactor. Overembankment and settlement are considered at 20 % in total to the height of dike. Sod-facing except crown and berm will be executed by manpower to protect the embankment against erosion.

(6) Bank protection

The bank-protection works by means of crib for low-water channel are planned in the sites shown in the DRAWINGS. Wooden piles are to be driven using drop hommer with winch. Bank protection of the lower-end dike of the Asahan River at the confluence of Nantalu river is planned by wet masonry.

(7) Embankment of the Lebah river

The dike for the Lebah river is planned to be constructed along the road surrounding Sungai Lebah area. The embankment material is to be excavated from the site in front of the proposed dike. Excavated material should be spreaded for drying. The dry material is planned to be embanked step by step because the foundation of dike is not so firm.

(8) Reconstruction of intake structure

The existing intakes on the Silau river will be reconstructed as the mean water level of the channel is lowered due to the excavation works. The inlet canals are to be moved upstream.

(9) Construction of drainage culvert

Construction of drainage culvert is planned to be executed prior to the dike construction.

For the construction of structures, fine aggregate can be obtained easily in the channel of the Asahan and Silau rivers. Coarse aggregate is produced at Kp. Bandar Si Onggang on the Silau river 47 km southwestward Kisaran and Bandar Pulau in the Asahan river about 13 km upstream of Pulau Raja. As the quantity of them is limited, most of coarse aggregate will be transported from Perdagangan in the Bah Bolon river basin about 50 km northwestward far from Kisaran.

4.4 Construction Time Schedule

The proposed 6-year construction time schedule is given in Fig.H-8. This is planned based on the following assumptions.

(a) The construction period to be required is minimized as practical as possible for the efficient execution and acquiring the expected benefit soon.

(b) Detailed design will be commenced at the beginning of November in 1987 and completed by the end of January in 1989, having a total period of 15 months.

(b) Immediately after completion of the detailed design, tendering will be started, and it will be completed by October in 1990.

(c) Land acquisition and compensation will be commenced in February

1988.

(d) Civil works will be executed for about 3 years from November in 1990 to November, 1993.

The outline of the proposed sequence of execution works is described below.

(a) Dredging works of the Silau and Asahan rivers are to be commenced in February, 1991 and completed by January, 1993.

(b) Embankment works for both rivers will start in June 1991 and complete by the end of November in 1991.

(c) Construction of dike for the Lebah river is to be carried out for 34 months from February in 1991 to November, 1993. Though the work quantity is small, construction period expands for about 3 years considering the conditions of foundation.

4.5 Cost Estimate for the Project

4.5.1 Basic Conditions

The investment cost consists of construction cost for civil works, cost for land acquisition and compensation, administration cost of executive agency, cost for engineering service and contingency. It is estimated based on the end of March, 1985-price level. The followings are the basic conditions for cost estimate.

(a) The currency exchange rates are assumed at ;

US$ 1 = Rp 1,100 = Japanese ¥ 250

(b) All the construction works will be executed by contractors selected through international competitive bidding as described in the paragraph 4.1.

(c) All equipments and their spare parts required for the works are to be provided by the contractor.

(d) The construction time schedule is mentioned in the paragraph 4.4.

The cost required for civil works consists of costs for preparatory works, main civil works and miscellaneous. The cost for civil works is estimated by multiplying work quantity by unit cost. The cost for preparatory works and miscellaneous works are assumed to be 8 % and 10 %

respectively to the cost of main civil works.

Engineering cost is estimated base on the required expertise. Administration cost is assumed at 5 % of the total local-component costs for civil works, land acquisition and compensation. The physical contingency is assumed to be 10 % of the sum of the above costs.

The construction cost is further divided into foreign currency portion and local currency portion in accordance with the following classification.

(a) Foreign currency portion ;
- Depreciation cost of construction equipment including cost for spare parts and maintenance costs,
- Metal works,
- Procurement cost for special equipment such as observation and design instruments,
- Cost for technician for execution of the works, and
- Consultants' fee for engineering services.

(b) Local currency portion;
- Land acquisition and compensation,
- Labour wages,
- Local materials such as sand, gravel, timber board, etc.,
- Cost for engineering and administration expenses of the executive agency.

4.5.2 Unit Price

For estimating the unit construction cost, the unit prices of labor wages, materials and equipment expenses are surveyed about the practical unit prices which are currently applied to the similar projects in Indonesia as shown in Table H-21. The unit prices of the construction materials are divided into foreign currency portion and local currency portion. The unit prices of labor and construction materials are assumed as shown in Table H-22.

The construction equipment including their spare parts are to be provided by the contractor. The operation cost of the construction equipments required for the works is estimated based on the costs for depreciation, repair and maintenace, fuel, and costs for labor and guidance. The unit operation costs of major construction equipment are

estimated as shown in Table H-23.

The costs of land acquisition and compensation are estimated based on the data obtained from the offices concerned. The unit costs of land acquisition and house compensation are shown in Table H-24. The crops on the proposed high-water channel is to be compensated with a half value of the acquisition.

4.5.3 Unit Construction Cost

The unit construction cost is estimated by applying the unit prices of labor, construction materials and equipment expenses, and based on the construction plan mentioned in foregoing paragraph.

In estimating the unit cost, contract prices including site expenses, contractor's overhead and profit, and tax are assumed in the following conditions.

a. Site expenses	: 20 % of direct cost
b. Contractor's overhead & profit	: 15 % of the sum of direct cost and site expenses
c. Tax	: 2.5 % of total cost

The estimated unit construction costs are shown in Table H-25. Major unit costs of similar projects in Indonesia are shown in Table H-26 as reference data.

4.5.4 Cost Estimate

(1) Construction cost

The construction cost of the project is estimated at Rp 36,484 million, consisted of Rp 9,292 million of local currency portion and US$ 24,750 thousand of foreign currency portion.

The breakdown of construction cost is presented in Table H-27.

(2) Operation and maintenance cost

The operation and maintenance cost at full operation stage for the facilities after completion of the project is estimated at Rp 136 million per annum as shwon in Table H-28, and which corresponds to 0.5 % of the total cost of civil works at the March 1985-price.

5. Organization and Management for Project

5.1 Present Organization

The Asahan and Silau rivers are at present administrated and managed by DPU North Sumatra. All flood control works of the above mentioned rivers are being implemented by the Water Resources Development Division of DPU North Sumatra. Also the existing river facilities are operated and maintained by DPU.

The present organization for flood control works in lower Asahan area is shown in Fig.H-9. The organization for the Lower Asahan River Flood Control Project is not established yet because the project is being on the study stage at present.

5.2 Organization for Implementation of Project

The Ministry of Public Works will entirely be responsible for the implementation of the project, and necessary consultations will be made by the organizations concerned. For implementing the project, establishment of a project office in Kisaran will be required. The organization for the project is recommended as shown in Fig.H-10.

The Directorate General of Water Resources Development will be the executing agency for the project. The Directorate of Rivers under the control of the Directorate General of Water Resources Development will take charge of coordination with all the relevant governmental agencies and regional administrative organizations in implementing the project.

The project manager is to be appointed by the Ministry to take all the responsibility to the Ministry for the proper implementation of the project. The staffs of the project will be also appointed to support the project manager. They will support execution of detailed survey, design and planning, preparation of tender documents and specifications for civil works, equipment including materials and spare parts if neccesary and land acquisition.

Foreign consultants will have to be employed to assist the implementation of the project including the field work of the detailed design and supervision.

6. Evaluation for Urgent Flood Control Project

6.1 Economic Evaluation

(1) Economic cost

The economic construction cost for the urgent flood control project was estimated by deducting tax and contractor's profit from the local currency portion of the construction cost. This tax and contractor's profit to be deducted are assumed to be 4 % and 10 % respectively. The estimated economic construction cost is estimated at Rp 35,369 million as shown in Table H-29.

The annual economic operation and maintenance cost is assumed at Rp 132 million which is 0.5 % of the total economic cost for civil works.

(2) Benefit

Benefit are the expected reduction of flood damage for private properties, farm crops, public facilities etc., and the expected development effect for the land which has not been utilized during the wet season is also defined as enhancement benefit.

a. Flood damage reduction

Flood damage reduction is expressed as difference between with and without project as described in APPENDIX G. The reduction of the flood damage with project is estimated at Rp 4,610 million in the value of annual average.

b. Enhancement benefits

The urgent flood control project will provide an effect for land development in the area to be protected from floods, so that the area may be used as agricultural land and residential quarter in the future with the project. The expected development lands are shown in Table H-30.

Usually, enhancement of land use provided by a project such as flood control is to be taken as one of enhancement benefits. For converting the enhancement effects, into the monetary term, a rental value of land is usually used so that the effects can be counted in monetary term as a

benefit.

After completion of the Project, development effect is expected for the land which has not been cultivated during the wet season. The enhancement benefit for agriculture development is estimated assuming the land will be developed for paddy field.

As a result of estimation mentioned above, the enhancement benefits for respective return periods are estimated as shown in Table H-31. The estimated average annual enhancement benefit with project is Rp 514 million.

c. Average annual benefit

The average annual benefit from the urgent flood control project is estimated at Rp 5,124 million which is a sum of flood damage reduction and enhancement benefit mentioned above.

(3) Comparison of cost and benefit

Flow of the economic costs and benefits is shown in Table H-32. Based on this flow, cost-benefit analysis is made. The internal rate of return (IRR) is calculated at 12.4 %. The benefit-cost ratio (B/C) is calculated at 1.03 with a discount rate of 12 %.

(4) Sensitivity test

Sensitivity of IRR of the project is examined adopting increase in cost and decrease in benefit. The results of sensitivity test are summarized in Table H-33 which shows the value of IRR of the project exceeds 10 % even if the cost goes up by 20 % or the benefit comes down by 20 %. The results of comparison of cost and benefit are also shown in Fig.H-11.

6.2 Financial Aspects

(1) Required funds

The funds required for the implementation of the project were estimated on the following assumptions. The price contingency is assumed at 12 % per year for the local currency portion and 3 % per year for the

foreign currency portion taking account the rate of rise in prices for the last 5 years.

The funds needed for the project were estimated at Rp 51,420 million, which consists of Rp 18,727 million in the local currency portion and US$ 29,721 thousand (equivalent to Rp 32,693 million) in the foreign currency portion including price contingency during the construction period. These are summarized in Table H-34.

(2) Disbursement schedule

The schedule of annual disbursement of the fund mentioned above is planned as shown in Table H-35.

6.3 Project Effect and Social Impact

(1) Stabilization of people's livelihood

At present, flood damage occurs every year. Many houses and farm lands in the project area suffer extensive damage from floods. After the proposed project is completed, about 10,600 ha of land and 8,700 houses in the project area will be relieved from flooding.

The other intangible benefits such as environmental improvement for living, stabilization of people's livelihood and so on can be expected by the implementation of the project.

(2) Incremental land for agriculuture and residence

The increase of residential quarter by the project is expected from the reduction in flood damage and improved land condition. Increase of the lands for agricluture and residence are expected to be 4,695 ha and 500 ha respectively.

(3) Employment opportunity

The implementation of the project will provide employment opportunities to workers and landless farmers in and around the project area. The unskilled labor requirement for the project is estimated at 600 thousand man-days during the construction periods.

(4) Relocation of houses

There exist about 650 houses in the location of the proposed channel which will have to be relocated. About 20 ha of residential land will be required. The required land will be created by the implementation of the project.

(5) Environmental aspects

Generally, it is expected that the natural environmental conditions in the neighbouring area of such a large scale project be worsened. In the case of the lower Asahan area flood control project, the work is to improve the existing river channel only. Therefore, this project will not provide any detrimental impact on the environment.

With regard to salt water intrusion into rivers, no problem is occurred at present and some groundwater is being used by inhabitants near the river mouth. It seems that the salt water intrusion into rivers is limited to the lowest reaches owing to comparatively abundant river water during the dry season. Therefore, the implementation of the project will not produce any adverse effects of salt water intrusion.

Accordingly it seems that the present environmental situation will not change due to the implementation of the project.

Table H-1 Principal Features of Asahan No.3 Project

Description	Feature
1. Location	About 5 - 10 km downstream from Tangga Power station
2. Reservoir area	
- catchment area	3,888 sq.km
- Annual average discharge	129.3 cms
- Effective storage capacity	12 mcm
- Resevoir surface area	2.4 sq.km
- HWL (FWL)	EL. 267.0 m
- LWL	El. 262.0 m
- Design flood	1,800 cms
3. Parhitean Dam	
- Type	Center core type rock fill dam
- Dam height	130 m
- Crest length	390 m
- Embankment volume	6,800,000 cu m
4. Power Plant	
- Gross head	177.0 m
- Net head	171.0 m
- Plant discharge	208,2 cms
- Installed capacity	300,000 KW = 75,000 KW x 4 units
- Energy output	1,586 x 106 KWh/year

Source : Feasibility Report on the Asahan No.1 and No.3 Hydroelectric Power Development Project, Dec. 1982, JICA.

Table H-2 Design Discharge and its Scale of Rivers in Indonesia

No.	Name of River	Province	Catchment Area (sq.km)	Design Flood (cms)	Specific Discharge (cms/sq.km)	Return Period (year)
1.	Cimanuk	West Java	3,006	1,440	0.48	25
2.	Serang	Central Java	937	900	0.96	25
3.	Citanduy	West Java	3,680	1,900	0.52	25
4.	U l a r	North Sumatra	1,080	800	0.74	30
5.	Pemali	Central Java	1,228	1,300	1.06	25
6.	Cipanas	West Java	220	385	1.75	25
7.	S o l o	Central/East Java	3,400	1,500	0.44	10 *1
				2,000	0.59	40 *2
8.	Madiun	East Java	2,400	1,100	0.46	10 *1
				2,300	0.96	40 *2
9.	Wampu	North Sumatra	3,840	1,320	0.34	20
10.	Arakundo	A c e h	5,495	1,800	0.33	20
11.	Kring Aceh	A c e h	1,775	1,300	0.73	20
12.	Brantas	East Java	10.000	1,350	0.135	10 *1
				1,500	0.15	50 *2
13.	Bah Bolon	North Sumatra	2,776	1,220	0.44	20
14.	Walanae	South Sulawesi	3,190	2,900	0.91	20
15.	B i l a	South Sulawesi	1.368	1,900	1.39	20
16.	Jeneberang	South Sulawesi	729	3,700	5.08	50
17.	Ciujung	North Banten	1,850	1,100	0.59	10 *1
				1,600	0.86	50 *2
18.	Kuranji	West Sumatra	213	870	4.08	25 *1
				1,000	4.69	50 *2
19.	Air Dingin	West Sumatra	131	600	4.58	25 *1
				700	5.34	50 *2
20.	Marmoyo	East Java	290	230	0.79	20
21.	Surabaya	East Java	631	370	0.59	50

Note : *1 : 1st stage and/or urgent plan
*2 : 2nd stage and/or overall plan

Table H-3 Design Flood Discharges for Long-Term Plan of Asahan and Silau Rivers

(Unit : m3/s)

River/Stretch	Return Period 15-yr	30-yr	50-yr
Asahan Mainstream			
Outflow of Regulating Dam	400	400	400
After Join Baturangin River	700	810	900
Outflow of Parhitean Dam	500	500	600
Before Join Sakur River	690	800	900
Sakur River - Masihi River	950	1100	1300
Masihi River - Teluk Mesa River	950	1100	1300
Tuluk Mesa River - Retarding Basin	950	1100	1300
Retarding Basin - Kepayang River	750	750	750
Kepayang River - Silau River	750	750	750
Silau River - River mouth	1200	1400	1500
Tributaries			
Baturangin River	300	410	500
Sakur River	260	330	380
Masihi River	150	150	150
Sukaraja River	110	110	120
Kepayang River	15	15	15
Silau River			
Kisaran - Tanjung Balai	700	950	1100
Retarding Basin			
Inflow : from Mainstream	200	350	550
from Nantalu River	90	90	90
from Lebah River	45	45	50
Max. Water Level (EL.m)	3.01	3.04	3.07
Max. Water Surface Area (km2)	93	95	97
Max. Water Volume (mcm)	89	92	97

Table H-4 Economic Construction Costs for Comparison of Scale of Long-Term Plan
(Asahan and Silau Rivers : Scheme A-2)

(Unit : Rp million)

Description	Unit	Unit Economic Cost (Rp)	15-year		30-year		50-year	
			Quantity	Amount	Quantity	Amount	Quantity	Amount
1. Civil Works				42,302		46,629		52,267
1.1 Asahan River				26,277		26,774		29,607
(1) Preparatory	L.S			1,782		1,815		2,007
(2) Embankment	m3		1,550,000	3,402	1,560,000	3,421	1,700,000	3,687
- mainstream	m3	1,900	1,260,000	2,394	1,270,000	2,413	1,410,000	2,679
- Lebah river	m3	3,500	290,000	1,008	290,000	1,008	290,000	1,008
(3) Excavation	m3	3,400	1,510,000	5,134	1,550,000	5,270	1,800,000	6,120
(4) Dredging	m3	5,350	2,260,000	12,091	2,310,000	12,359	2,550,000	13,643
(5) Miscellaneous	L.S			3,868		3,909		4,150
1.2 Silau River	L.S			16,025		19,855		22,660
(1) Preparatory	L.S			1,086		1,346		1,536
(2) Embankment	m3	1,900	1,220,000	2,318	1,220,000	2,318	1,225,000	2,328
(3) Excavation	m3	3,400	2,200,000	7,480	2,840,000	9,656	3,300,000	11,220
(4) Dredging	m3	5,350	500,000	2,675	700,000	3,745	850,000	4,548
(5) Miscellaneous	L.S			2,466		2,790		3,028
2. Acquisition & Compensation	ha		399	1,068	399	1,068	399	1,068
2.1 Asahan River	ha		150	415	150	415	150	415
2.2 Silau River	ha		249	653	249	653	249	653
3. Engineering & Administration				7,677		8,125		9,440
4. Contingency				5,105		5,582		6,278
5. Total				56,152		61,404		69,053

Note : Price level in March 1985 is adopted.

Table H-5 Flood Control Benefits for Comparison of Scale of Long-Term Plan (Asahan and Silau Rivers : Scheme A-2)

Description	Design Scale (return period) 15-year	30-year	50-year
Benefits (Rp million)			
Damage reduction	9,333	10,322	10,796
Enhancement benefit	1,238	1,330	1,369
Total	10,571	11,662	12,166
Annual benefit (with discount rate of 14 %)	34,351	37,897	39,534
Cost (Rp million)			
Investment cost	56,152	61,404	69,053
Annual Cost (with discount rate of 14 %)	33,728	36,877	41,933
B / C (with discount rate of 14 %)	1.01	1.03	0.94
I R R	14.2	14.3	13.4

Note : (1) Benefits are estimated under future conditions.

(2) Price level in March 1985 is adopted.

Table H-6 Economic Construction Cost for Alternative Scheme of Long-Term Flood Control Plan (1/5)

Description	Unit	Unit Economic Cost (Rp)	Quantity	Amount (Rp million)
Bunut River : Scheme B-1				
1. Civil Works				11,870
(1) Preparatory	L.S			805
(2) Embankment	cu m	1,900	740,000	1,406
(3) Excavation	cu m	3,400	1,440,000	4,896
(4) Bank protection	m	238,500	800	191
(5) Bridge (b=4m)	m	1,800,000	280	508
(6) Diversion weir & gate	m	50,000,000	60	3,000
(7) Miscellaneous	L.S			1,064
2. Acquisition & Compensation				216
(1) Land	ha		102	213
(2) House	nos.		9	3
3. Engineering & Administration				2,055
4. Contingency				1,414
5. Total				15,555
Bunut River : Scheme B-2				
1. Civil Works				9,072
(1) Preparatory	L.S			615
(2) Embankment	cu m	1,900	1,200,000	2,280
(3) Excavation	cu m	3,400	1,450,000	4,930
(4) Bank protection	m	238,500	1,000	239
(5) Drainage culvert	nos.	56,610,000	1	57
(6) Bridge (b=4m)	m	1,800,000	100	180
(7) Miscellaneous	L.S			771
2. Acquisition & Compensation				308
(1) Land	ha		153	305
(2) House	nos.		12	3
3. Engineering & Administration				1,596
4. Contingency				1,098
5. Total				12,074

Table H-6 Economic Construction Cost for Alternative Scheme of Long-Term Flood Control Plan (2/5)

Description	Unit	Unit Economic Cost (Rp)	Quantity	Amount (Rp million)
Asahan and Silau Rivers : Scheme A-1				
1. Civil Works				78,723
1.1 Asahan River				18,805
(1) Preparatory	L.S			1,228
(2) Clearing for bush	sq m	960	667,000	640
(3) Embankment	cu m	1,900	1,040,000	1,976
(4) Excavation	cu m	3,400	1,010,000	3,434
(5) Dredging	cu m	5,350	1,610,000	8,614
(6) Bank protection	m	238,500	1,300	310
(7) Drainage culvert	nos.		7	377
(8) Miscellaneous	L.S			1,538
1.2 Silau River				19,855
(1) Preparatory	L.S			1,346
(2) Embankment	cu m	1,900	1,220,000	2,318
(3) Excavation	cu m	3,400	2,840,000	9,656
(4) Dredging	cu m	5,350	700,000	3,745
(5) Bank protection	m	238,500	2,000	477
(6) Intake structure	nos.		5	321
(7) Drainage culvert	nos.		6	302
(8) Miscellaneous	L.S			1,690
1.3 Floodway				40,750
(1) Preparatory	L.S			2,763
(2) Clearing for bush	sq m	960	3,730,000	3,581
(3) Embankment	cu m	1,900	2,990,000	5,681
(4) Excavation	cu m	3,400	7,090,000	24,106
(5) Drainage culvert	nos.		6	264
(6) Bridge (b=4m)	m	1,800,000	230	414
(7) Diversion weir	m	7,500,000	65	488
(8) Miscellaneous	L.S			3,453
2. Acquisition & Compensation				1,718
2.1 Asahan River				341
(1) Land	ha		126	202
(2) House	nos.		508	139
2.2 Silau River				653
(1) Land	ha		249	496
(2) House	nos.		336	157
2.3 Floodway				724
(1) Land	ha		302	593
(2) House	nos.		260	131
3. Engineering & Administration				13,703
4. Contingency				9,414
5. Total				103,558

Table H-6 Economic Construction Cost for Alternative Scheme of Long-Term Flood Control Plan (3/5)

Description	Unit	Unit Economic Cost (Rp)	Quantity	Amount (Rp million)
Asahan and Silau Rivers : Scheme A-2				
1. Civil Works				46,629
1.1 Asahan River				26,774
(1) Preparatory	L.S			1,815
(2) Clearing for bush	sq m	960	827,000	795
(3) Embankment	cu m		1,560,000	3,421
- mainstream	cu m	1,900	1,270,000	2,413
- Lebah river	cu m	3,500	290,000	1,008
(4) Excavation	cu m	3,400	1,550,000	5,270
(5) Dredging	cu m	5,350	2,310,000	12,359
(6) Bank protection	m	238,500	1,000	239
(7) Drainage culvert	nos.		13	604
(8) Miscellaneous	L.S			2,272
1.2 Silau River (same as Scheme A-1)				19,855
2. Acqusition & Compensation				1,068
2.1 Asahan river				415
(1) Land	ha		150	276
(2) House	nos		508	139
2.2 Silau river (same as Scheme A-1)				653
3. Engineering & Administration				8,125
4. Contingency				5,582
5. Total				61,404
Asahan and Silau Rivers : Scheme A-3				
1. Civil Works				54,301
1.1 Asahan River				34,445
(1) Preparatory	L.S			2,335
(2) Clearing for bush	m2	960	902,000	866
(3) Embankment	m3	1,900	2,240,000	4,256
(4) Excavation	m3	3,400	2,260,000	7,684
(5) Dredging	m3	5,350	2,310,000	12,359
(6) Bank protection	m	238,500	1,600	382
(7) Drainage culvert	nos.		12	641
(8) Drainage sluice	nos.	3,000,000,000	1	3,000
(9) Miscellaneous	L.S			2,922
1.2 Silau River (same as Scheme A-1)				19,855

(continued)

Table H-6 Economic Construction Cost for Alternative Scheme of Long-Term Flood Control Plan (4/5)

Description	Unit	Unit Economic Cost (Rp)	Quantity	Amount (Rp million)
Asahan and Silau Rivers : Scheme A-3 (continued)				
2. Acqusition & Compensation				1,101
2.1 Asahan River				448
(1) Land	ha		203	332
(2) House	nos.		428	116
2.2 Silau River (same as Scheme A-1)				653
3. Engineering & Administration				9,437
4. Contingency				6,484
5. Total				71,323
Kualuh and Kanopan Rivers : Scheme K-1				
1. Civil Works				14,477
1.1 Kualuh River				9,797
(1) Preparatory	L.S			496
(2) Clearing for bush	m2	960	230,000	221
(3) Embankment	m3	1,900	1,485,000	2,822
(4) Excavation	m3	3,400	1,500,000	5,100
(5) Bank protection	m	238,500	500	119
(6) Intake structure	nos.	56,610,000	1	57
(7) Drainage culvert	nos.		9	359
(7) Miscellaneous	L.S			623
1.2 kanopan River				4,680
(1) Preparatory	L.S			250
(2) Clearing for bush	m2	960	50,000	48
(3) Embankment	m3	1,900	700,000	1,330
(4) Excavation	m3	3,400	700,000	2,380
(5) Drainage culvert	nos.		8	359
(7) Miscellaneous	L.S			313
2. Acqusition & Compensation				842
2.1 Kualuh River				754
(1) Land	ha		433	722
(2) House	nos.		95	32
2.2 Kanopan River				88
(1) Land	ha		42	83
(2) House	nos.		16	5
3. Engineering & Administration				2,604
4. Contingency				1,792
5. Total				19,715

Table H-6 Economic Construction Cost for Alternative Scheme of Long-Term Flood Control Plan (5/5)

Description	Unit	Unit Economic Cost (Rp)	Quantity	Amount (Rp million)
Kualuh and Kanopan Rivers : Scheme K-2				
1. Civil Works				18,770
1.1 Kualuh River				14,090
(1) Preparatory	L.S			786
(2) Clearing for bush	m2	960	530,000	509
(3) Embankment	m3		1,885,000	4,222
- normal ground	m3	1,900	1,485,000	2,822
- soft ground	m3	3,500	400,000	1,400
(4) Excavation	m3	3,400	2,000,000	6,800
(5) Bank protection	m	238,500	1,000	239
(6) Intake structure	nos.	56,610,000	1	57
(7) Drainage culvert	nos.		12	491
(8) Miscellaneous	L.S			983
1.2 Kanopan River (same as Scheme K-1)				4,680
2. Acqusition & Compensation (same as Scheme K-1)				842
3. Engineering & Administration				3,334
4. Contingency				2,295
5. Total				25,241

Table H-7 Development Area Expected by Long-Term Flood Control Plan

River / Zone	Area (ha)	Development for	Schemes concerned
Bunut River	-	-	-
Asahan & Silau Rivers			
(1) AS-14 (Rawa Mahondang area)	3,000	Agricultural land	A-1, A-2, A-3
(2) AK- 9 (Sei Lebah area)	1,695	- do -	A-1, A-2, A-3
(3) AS-15 (Sampan Kotak area)	824	- do -	A-1, A-2, A-3
(4) Sungai Celincing area	400	- do -	A-1, A-2, A-3
(5) Natural retarding area	1,500	- do -	A-3
(6) Sei Kepayangkiri Kuala area	1,000	- do -	A-1
(7) Teluk Ketapang area	400	Residential area	A-1, A-2, A-3
(8) Tanjung Balai-1 area	100	- do -	A-1, A-2, A-3
(9) Tanjung Medan area	100	- do -	A-1, A-2, A-3
Kualuh & Kanopan Rivers			
(1) LBT-8 (Aek Naetek area)	700	Agricultural land	K-1, K-2
(2) Kanopan area	700	- do -	K-1, K-2
(3) Tanjung Pasir area	400	- do -	K-1, K-2
(4) Aek Pamengke area	3,000	- do -	K-2

Table H-8 Enhancement Benefit by Long-Term Flood Control Plan (1/2)

(Unit : Rp million)

River/ Scheme	Return Period (year)	Agriculture development	Housing development	Damage reduction of the Leidong river	Total
Bunut River		-	-	-	-
Asahan & Silau Rivers					
A-1	2	248.0	10.5	21.2	279.7
	5	995.0	52.7	115.6	1,163.3
	10	1,258.5	72.5	264.3	1,595.3
	15	1,351.5	81.9	395.6	1,829.0
	30	1,444.5	94.8	573.0	2,112.3
	50	1,481.7	101.8	613.5	2,197.0
	100	1,509.6	107.6	646.0	2,263.2
	Max	1,549.9	117.0	679.5	2,346.4
A-2	2	212.1	10.5	-	222.6
	5	851.2	52.7	-	903.9
	10	1,076.6	72.5	-	1,149.1
	15	1,156.2	81.9	-	1,238.1
	30	1,235.7	94.8	-	1,330.5
	50	1,267.6	101.8	-	1,369.4
	100	1,291.4	107.6	-	1,399.0
	Max	1,325.9	117.0	-	1,442.9
A-3	2	265.9	10.5	-	276.4
	5	1,066.9	52.7	-	1,119.6
	10	1,349.5	72.5	-	1,422.0
	15	1,449.2	81.9	-	1,531.1
	30	1,548.9	94.8	-	1,643.7
	50	1,588.8	101.8	-	1,690.6
	100	1,618.7	107.6	-	1,726.3
	Max	1,661.9	117.0	-	1,778.9

Note : (1) Agriculture development
A-1 : Rp 320,000/ha x (6,919 ha x 0.7) = Rp 1,549.9 million
A-2 : Rp 320,000/ha x (5,919 ha x 0.7) = Rp 1,325.9 million
A-3 : Rp 320,000/ha x (7,419 ha x 0.7) = Rp 1,661.9 million

(2) Housing development :
Rp 260,000/ha x (600 ha x 0.75) = Rp 117.0 million

Table H-8 Enhancement Benefit by Long-Term Flood Control Plan (2/2)

(Unit : Rp million)

River/ Scheme	Return Period (year)	Agriculture development	Housing development	Total
Kualuh & Kanopan Rivers				
K-1	2	64.5	-	64.5
	5	258.9	-	258.9
	10	327.4	-	327.4
	15	351.6	-	351.6
	30	375.8	-	375.8
	50	385.5	-	385.5
	100	392.7	-	392.7
	Max	403.2	-	403.2
K-2	2	172.0	-	172.0
	5	690.3	-	690.3
	10	873.1	-	873.1
	15	937.6	-	937.6
	30	1,002.1	-	1,002.1
	50	1,027.9	-	1,027.9
	100	1,047.2	-	1,047.2
	Max	1,075.2	-	1,075.2

Note : Agriculture development ;
K-1 : Rp 320,000/ha x (1,800 ha x 0.7) = Rp 403.2 million
K-2 : Rp 320,000/ha x (4,800 ha x 0.7) = Rp 1,075.2 million

Table H-9 Economic Value of Alternative Scheme for Long-Term Flood Control Plan

River/ Scheme	Benefit (Rp million)				Cost (Rp million)		B/C with discount rate of 12%	IRR (%)
	Damages	Enhancement	Total	Annual	Investiment	Annual		
Bunut River								
B - 1	1,839	-	1,839	7,737	15,555	10,059	0.77	9.5
B - 2	1,839	-	1,839	7,737	12,074	7,805	0.99	11.9
Asahan and Silau Rivers								
A - 1	10,332	2,112	12,444	52,356	103,558	66,965	0.78	9.7
A - 2	10,332	1,330	11,662	49,067	61,404	39,692	1.24	14.3
A - 3	10,332	1,644	11,976	50,385	71,323	46,121	1.09	12.9
Kualuh and Kanopan Rivers								
K - 1	2,740	376	3,116	13,110	19,715	12,737	1.03	12.3
K - 2	2,740	1,002	3,742	15,744	25,241	16,312	0.97	11.7

Note : Price level in March 1985 is adopted.

Table H-10 Principal Features of Proposed Long-Term Flood Control Works

Description	Unit	Bunut	Asahan/ Silau	Kualuh/ Kanopan
1. Stretch	km	33.7	84.2	46.3
2. Civil Works				
2.1 Embankment				
- length	km	67.4	99.7	80.3
- volume	cu m	1.20million	2.78million	2.22million
2.2 Excavation/dredging				
- length	km	26.7	60.5	-
- volume	cu m	1.45million	7.40million	2.20million
2.3 Bank protection				
(1) wet masonries				
- length	m	-	60	60
- volume	cu m	-	50	50
(2) crib	m	1,000	3,000	500
2.4 Reconstruction of structures				
(1) intake	place	-	5	1
(2) bridge	place	1	-	-
2.5 Construction of drainage culvert	place	1	19	17
3. Land acquisition/ Compensation				
3.1 Land	ha	153	375	475
3.2 House	nos.	12	844	111

Table H-11 Construction Cost of Long-term Flood Control Plan (Bunut River)(1/5)

Description	Unit	Quantity	Local Currency		Foreign Currency			Equivalent Total (Rp million)
			Unit Cost(Rp)	Amount (Rp million)	Unit Cost($)	Amount ($ thousand)	Amount (Eq.Rp million)	
1. Civil Works				2,278.5		6,491.6	7,140.8	9,419.3
(1) Preparatory	L.S			154.5		440.1	484.1	638.6
(2) Clearing for bush	sq m	2,000	250	0.5	0.68	1.4	1.5	2.0
(3) Embankment	cu m	1,200,000	560	672.0	1.31	1,572.0	1,729.2	2,401.2
(4) Excavation	cu m	1,450,000	680	986.0	2.56	3,712.0	4,083.2	5,069.2
(5) Bank protection	m	1,000	83,400	83.4	151.45	151.4	166.6	250.0
(6) Drainage culvert	nos.	1	24,000,000	24.0	32,700.00	32.7	36.0	60.0
(7) Bridge (b = 4 m)	m	100	1,650,000	165.0	318.00	31.8	35.0	200.0
(8) Sub-total (2)-(7)				1,930.9		5,501.4	6,051.5	7,982.4
(9) Miscellaneous	L.S			193.1		550.1	605.2	798.3
2. Acquisition & Compensation				307.9		-	-	307.9
(1) Land acquisition	sq m	514,000		153.1				153.1
(2) Land compensation	sq m	1,015,000		151.5				151.5
(3) House compensation	nos.	12		3.3				3.3
3. Sum (1.+ 2.)				2,586.4		6,491.6	7,140.8	9,727.2
4. Engineering & Administration				543.1		1,038.7	1,142.5	1,685.6
5. Sum (3.+ 4.)				3,129.5		7,530.3	8,283.3	11,412.8
6. Contingency (10 % of 5.)				313.0		753.0	828.3	1,141.3
7. Grand Total				3,442.5		8,283.3	9,111.6	12,554.1

Note : (1) Price level in March 1985 is adopted.
(2) Exchange rate : US$ 1 = Rp 1,100 = Japanese ¥ 250.

Table H-11 Construction Cost of Long-term Flood Control Plan (Asahan and Silau Rivers)(2/5)

Description	Unit	Quantity	Local Currency		Foreign Currency			Equivalent
			Unit Cost(Rp)	Amount (Rp million)	Unit Cost($)	Amount ($ thousand)	Amount (Eq.Rp million)	Total (Rp million)
1. Civil Works				10,353.5		34,390.5	37,829.6	48,183.1
1.1 Asahan River				5,890.5		19,792.0	21,771.2	27,661.7
(1) Preparatory:(8) x 8%				399.4		1,341.8	1,476.0	1,875.4
(2) Clearing for bush	sq m	827,000	250	206.8	0.68	562.4	618.6	825.4
(3) Embankment	cu m	1,560,000		963.5		2,385.8	2,624.4	3,587.9
- mainstream	cu m	1,270,000	560	711.2	1.31	1,663.7	1,830.1	2,541.3
- Lebah river	cu m	290,000	870	252.3	2.49	722.1	794.3	1,046.6
(4) Excavation	cu m	1,550,000	680	1,054.0	2.56	3,968.0	4,364.8	5,418.8
(5) Dredging	cu m	2,310,000	1,050	2,425.5	4.05	9,355.5	10,291.0	12,716.5
(6) Bank protection				86.1		152.4	167.7	253.8
- wet masonry	cu m	50	54,700	2.7	17.43	0.9	1.0	3.7
- crib	m	1,000	83,400	83.4	151.45	151.5	166.7	250.1
(7) Drainage culvert	nos.	13		256.0		348.8	383.7	639.7
- 1.5 x 1.5	nos.	9	16,000,000	144.0	21,800.00	196.2	215.8	359.8
- 2.0 x 2.5	nos.	3	24,000,000	72.0	32,700.00	98.1	107.9	179.9
- 2.0 x 2.5 x 2	nos.	1	40,000,000	40.0	54,500.00	54.5	60.0	100.0
(8) Sub-total:(2)-(7)				4,991.9		16,772.9	18,450.2	23,442.1
(9) Miscellaneous : (8) x 10%				499.2		1,677.3	1,845.0	2,344.2
1.2 Silau River				4,463.0		14,598.5	16,058.4	20,521.4
(1) Preparatory:(9) x 8%				302.6		989.7	1,088.7	1,391.2
(2) Clearing for bush	sq m	8,000	250	2.0	0.68	5.4	5.9	7.9
(3) Embankment	cu m	1,220,000	560	683.2	1.31	1,598.2	1758.0	2,441.2
(4) Excavation	cu m	2,840,000	680	1,931.2	2.56	7,270.4	7,997.5	9,928.7
(5) Dredging	cu m	700,000	1,050	735.0	4.05	2,835.0	3,118.5	3,853.5
(6) Bank protection	m	2,000	83,400	166.8	151.45	302.9	333.2	500.0

(continued)

Note : (1) Price level in March 1985 is adopted.
(2) Exchange rate : US$ 1 = Rp 1,100 = Japanese ¥ 250.

Table H-11 Construction Cost of Long-term Flood Control Plan (Asahan and Silau Rivers)(3/5)

Description	Unit	Quantity	Local Currency		Foreign Currency			Equivalent Total (Rp million)
			Unit Cost(Rp)	Amount (Rp million)	Unit Cost($)	Amount ($ thousand)	Amount (Eq.Rp million)	
(continued)								
(7) Intake structure	nos.	5		136.0		185.3	204.0	340.0
- 2.0 x 2.5	nos.	4	24,000,000	96.0	32,700.00	130.8	144.0	240.0
- 2.0 x 2.5 x 2	nos.	1	40,000,000	40.0	54,500.00	54.5	60.0	100.0
(8) Drainage culvert	nos.	6		128.0		174.4	192.0	320.0
- 1.5 x 2.0	nos.	4	16,000,000	64.0	21,800.00	87.2	96.0	160.0
- 2.0 x 2.5	nos.	1	24,000,000	24.0	32,700.00	32.7	36.0	60.0
- 2.0 x 2.5 x 2	nos.	1	40,000,000	40.0	54,500.00	54.5	60.0	100.0
(9) Sub-total : (2)-(8)				3,782.2		12,371.6	13,608.9	17,391.3
(10)Miscellaneous : (9) x 10%				378.2		1,237.2	1,360.8	1,738.9
2. Acquisition & Compensation				1,068.0		-	-	1,068.0
2.1 Asahan River				415.0		-	-	514.0
(1) Land acquisition	sq m	382,000		114.0				114.0
(2) Land compensation	sq m	1,120,000		162.0				162.0
(3) House compensation	nos.	508		139.0				139.0
2.2 Silau River				653.0		-	-	653.0
(1) Land acquisition	sq m	842,000		251.0				251.0
(2) Land compensation	sq m	1,650,000		245.0				245.0
(3) House compensation	nos.	336		157.0				157.0
3. Sum (1.+ 2.)				11,421.5		34,390.5	37,829.6	49,251.1
4. Administration & Engineering				2,398.5		5,502.5	6,052.7	8,451.2
5. Sum (3.+ 4.)				13,820.0		39,893.0	43,882.3	57,702.3
6. Contingency (10% of 5.)				1,382.0		3,989.3	4,388.2	5,770.2
7. Grand total				15,202.0		43,882.3	48,270.5	63,472.5

Table H-11 Construction Cost of Long-term Flood Control Plan (Kualuh River)(4/5)

Description	Unit	Quantity	Local Currency		Foreign Currency			Equivalent Total (Rp million)
			Unit Cost(Rp)	Amount (Rp million)	Unit Cost($)	Amount ($ thousand)	Amount (Eq.Rp million)	
1. Civil Works				3,577.0		10,416.3	11,453.9	15,030.9
1.1 Kualuh River				2,403.3		7,062.8	7,767.1	10,170.4
(1) Preparatory	L.S			121.7		357.6	393.4	515.1
(2) Clearing for bush	sq m	230,000	250	57.5	0.68	156.4	172.0	229.5
(3) Embankment	cu m	1,485,000	560	831.6	1.31	1,945.4	2,139.9	2,971.5
(4) Excavation	cu m	1,500,000	680	1,020.0	2.56	3,840.0	4,224.0	5,244.0
(5) Bank protection				44.4		76.6	84.3	128.7
- wetmasonry	cu m	50	54,700	2.7	17.43	0.9	1.0	3.7
- krib	m	500	83,400	41.7	151.45	75.7	83.3	125.0
(6) Intake structure	nos.	1	24,000,000	24.0	32,000.00	32.7	36.0	60.0
(7) Drainage culvert	nos.	9		152.0		207.1	225.8	377.8
- 1.5 x 1.5	nos	8	16,000,000	128.0	21,800.00	174.4	191.8	319.8
- 2.0 x 2.5	nos.	1	24,000,000	24.0	32,700.00	32.7	36.0	60.0
(8) Sub-total (2)-(7)				2,129.5		6,258.2	6,882.0	6,882.0
(9) Miscellaneous	L.S			152.1		447.0	491.7	643.8
1.2 Kanopan River				1,173.7		3,353.5	3,686.8	4,860.5
(1) Preparatory	L.S			62.7		179.1	197.0	259.7
(2) Clearing for bush	sq m	50,000	250	12.5	0.68	34.0	37.4	49.9
(3) Embankment	cu m	700,000	560	392.0	1.31	917.0	1,008.7	1,400.7
(4) Excavation	cu m	700,000	680	476.0	2.56	1,792.0	1,971.2	2,447.2
(5) Drainage Culvert	nos.	9		152.0		207.1	225.8	377.8
- 1.5 x 1.5	nos	8	16,000,000	128.0	21,800.00	174.4	191.8	319.8
- 2.0 x 2.5	nos.	1	24,000,000	24.0	32,700.00	32.7	36.0	60.0
(6) Sub-total (2)-(5)				1,032.5		2,950.1	3,243.1	4,275.6
(7) Miscellaneous	L.S			78.5		224.3	246.7	325.2

(continued)

Note : (1) Price level in March 1985 is adopted.
(2) Exchange rate : US$ 1 = Rp 1,100 = Japanese ¥ 250.

Table H-11 Construction Cost of Long-term Flood Control Plan (Kualuh River)(5/5)

Description	Unit	Quantity	Local Currency		Foreign Currency			Equivalent Total (Rp million)
			Unit Cost(Rp)	Amount (Rp million)	Unit Cost($)	Amount ($ thousand)	Amount (Eq.Rp million)	
(continued)								
2. Acuisition & Compensation				845.5		-	-	845.5
2.1 Kualuh River				755.9		-	-	755.9
(1) Land acquisition	sq m	535,000		158.7				158.7
(2) Land compensation	sq m	3,790,000		564.0				564.0
(3) House compensation	nos.	95		33.2				33.2
2.2 Kanopan River				89.6		-	-	89.6
(1) Land aquisition	sq m	152,500		44.8				44.8
(2) Land compensation	sq m	264,000		38.9				38.9
(3) House compensation	nos.	16		5.9				5.9
3. Sum (1.+ 2.)				4,422.5		10,416.3	11,453.9	15,876.4
4. Administration & Engineering				928.7		1,666.6	1,833.3	2,762.0
5. Sum (3.+ 4.)				5,351.2		12,082.9	13,287.2	18,638.4
6. Contingency (10 % of 5.)				535.1		1,208.3	1,329.1	1,864.2
7. Grand total				5,886.3		13,291.2	14,616.3	20,502.6

Note : (1) Price level in March 1985 is adopted.

(2) Exchange rate : US$ 1 = Rp 1,100 = Japanese ¥ 250.

Table H-12 Economic Construction Cost of Proposed Long-Term Plan

(Unit : Rp million)

Description	Long-Term Plan		
	Bunut	Asahan/Silau	Kualuh
1. Civil Works	9,072	46,629	14,477
(1) Preparatory	615	3,161	746
(2) Clearing for bush	2	802	269
(3) Embankment	2,280	5,739	4,152
(4) Excavation	4,930	14,926	7,480
(5) Dredging	-	16,104	-
(6) Bank protection	239	719	122
- wet masonry	-	3	3
- crib	239	716	119
(7) Reconstruction of	180	321	57
- intake structure	-	321	57
- bridge	180	-	-
(8) Construction of drainage culvert	57	906	718
(9) Miscellaneous	769	3,951	933
2. Acquisition & Compensation	309	1,068	842
(1) Land acquisition	154	365	202
(2) Land compensation	152	407	603
(3) House compensation	3	296	37
3. Sum (1.+ 2.)	9,381	47,697	15,319
4. Engineering & Compensation	1,595	8,125	2,604
5. Contingency (10 % of 3.+ 4.)	1,098	5,582	1,792
6. Grand Total	12,074	61,404	19,715

Note : (1) Price level in March 1985 is adopted.

(2) Exchange rate : US$ 1 = Rp 1,100 = Japanese ¥ 250.

Table H-13 Benefits under Present Condition

Description	Long-Term Plan		
	Bunut	Asahan	Kualuh
Benefits (Rp million)			
Damage reduction	1,224	5,547	1,768
Enhancement benefit	-	751	200
Total	1,224	6,298	1,968
Annual benefit (with discount rate of 8 %)	9,736	48,557	15,172
Cost (Rp million)			
Investment cost	12,074	61,404	19,715
Annual Cost (with discount rate of 8 %)	9,149	46,538	14,926
B / C (with discount rate of 8 %)	1.03	1.04	1.02
I R R	8.3	8.4	8.1

Note : Price level in March 1985 is adopted.

Table H-14 Benefits under Future Condition

Description	Long-Term Plan		
	Bunut	Asahan	Kualuh
Benefits (Rp million)			
Damage reduction	1,839	10,322	2,740
Enhancement benefit	-	1,330	376
Total	1,839	11,662	3,116
Annual benefit (with discount rate of 12 %)	7,737	49,067	13,110
Cost (Rp million)			
Investment cost	12,074	61,404	19,715
Annual Cost (with discount rate of 12 %)	7,805	39,692	12,737
B / C (with discount rate of 12 %)	0.99	1.24	1.03
I R R	11.9	14.3	12.3

Note : Price level in March 1985 is adopted.

Table H-15 Design Flood Discharges for Urgent Plan of Asahan and Silau Rivers

(Unit : m3/s)

River/Stretch	Return Period 5-yr	10-yr	15-yr
Asahan Mainstream			
Outflow of Regulating Dam	400	400	400
After Join Baturangin River	570	650	700
Before Join Sakur River	680	810	890
Sakur River - Masihi River	850	1100	1200
Masihi River - Teluk Mesa River	850	1100	1200
Tuluk Mesa River - Retarding Basin	850	1100	1200
Retarding Basin - Kepayang River	750	750	750
Kepayang River - Silau River	750	750	750
Silau River - River mouth	1200	1200	1200
Tributaries			
Baturangin River	170	250	300
Sakur River	160	220	260
Masihi River	150	150	150
Sukaraja River	110	110	110
Kepayang River	15	15	15
Silau River			
Kisaran - Tanjung Balai	500	600	700
Retarding Basin			
Inflow : from Mainstream	150	350	450
from Nantalu River	90	90	90
from Lebah River	45	45	45
Max. Water Level (EL.m)	2.93	3.00	3.02
Max. Water Surface Area (km2)	90	92	94
Max. Water Volume (mcm)	83	88	90

Table H-16 Economic Construction Cost for Comparison of Scale of Urgent Flood Control Plan of Asahan and Silau Rivers

(Unit : Rp millon)

Description	Unit	Unit Economic Cost (Rp)	5-year		10-year		15-year	
			Quantity	Amount	Quantity	Amount	Quantity	Amount
1. Civil Works				24,670		26,334		33,746
1.1 Asahan River				15,287		16,284		17,721
(1) Preparatory	L.S			1,037		1,104		1,201
(2) Embankment	m3		1,040,000	2,433	1,060,000	2,471	1,130,000	2,640
- mainstream	m3	1,900	750,000	1,425	770,000	1,463	840,000	1,596
- Lebah river	m3	3,500	290,000	1,008	290,000	1,008	290,000	1,008
(3) Excavation	m3	3,400	1,200,000	4,080	1,280,000	43520	1,410,000	4,794
(4) Dredging	m3	5,350	1,050,000	5,618	1,150,000	6,153	1,270,000	6,795
(5) Miscellaneous	L.S			2,119		2,204		2,327
1.2 Silau River	L.S			9,381		10,050		16,025
(1) Preparatory	L.S			636		681		1,086
(2) Embankment	m3	1,900	1,210,000	2,299	1,210,000	2,299	1,220,000	2,318
(3) Excavation	m3	3,400	1,100,000	3,740	1,220,000	4,148	2,200,000	7,480
(4) Dredging	m3	5,350	150,000	803	180,000	963	500,000	2,675
(5) Miscellaneous	L.S			1,903		1,959		2,466
2. Acquisition & Compensation	ha		386	983	386	983	386	983
2.1 Asahan River	ha		137	353	137	353	137	353
2.2 Silau River	ha		249	630	249	630	249	630
3. Engineering & Administration				4,542		4,836		6,147
4. Contingency				3,020		3,215		4,088
5. Total				33,215		35,369		44,964

Note : Price level in March 1985 is adopted.

Table H-17 Economic Value of Alternative Scheme for Urgent Flood Control Plan of Asahan and Silau Rivers

Description	Design Scale (return period) 5-year	10-year	15-year
Benefits (Rp million)			
Damage reduction	3,542	4,610	5,020
Enhancement benefit	403	514	556
Total	3,945	5,124	5,576
Annual benefit (with discount rate of 12 %)	18,197	23,636	25,720
Cost (Rp million)			
Investment cost	33,215	35,369	44,964
Annual Cost (with discount rate of 12 %)	21,472	22,854	25,720
B / C (with discount rate of 12 %)	0.85	1.03	0.89
I R R	10.3	12.4	10.7

Note : (1) Benefits are estimated under present conditions.

(2) Price level in March 1985 is adopted.

Table H-18 Percentage of Suspended Days due to Rainfalls

Month	Total days	10 - 15 mm/day		16 - 30 mm/day		more than 31 mm/day		Suspended Days	
		Rainfall days	Suspended days	Rainfall days	Suspended days	Rainfall days	Suspended days	Total	(%)
Jan.	31	0.5	0.25	1.4	1.40	1.5	3.00	4.65	15.0
Feb.	28	0.3	0.15	1.0	1.00	0.9	1.80	2.95	10.5
Mar.	31	1.6	0.80	1.5	1.50	1.1	2.20	4.50	14.5
Apr.	30	1.7	0.85	1.2	1.20	1.0	2.00	4.05	13.5
May	31	1.9	2.85	1.8	3.60	2.1	6.30	12.75	41.1
Jun.	30	0.3	0.15	1.3	1.30	0.8	1.60	3.05	10.2
Jul.	31	1.1	0.55	3.8	3.80	2.2	4.40	8.75	28.2
Aug.	31	1.1	1.65	2.2	4.40	2.0	6.00	12.05	38.9
Sep.	30	2.1	3.15	2.0	4.00	2.7	8.10	15.25	50.8
Oct.	31	2.1	3.15	3.2	6.40	2.6	7.80	17.35	56.0
Nov.	30	2.3	3.45	1.5	3.00	2.5	7.50	13.95	46.5
Dec.	31	1.7	2.55	2.2	4.40	1.8	5.40	12.35	39.8
Total	365	16.7	19.55	23.1	36.00	21.2	56.10	111.65	30.6

Note : (1) Rainfall days are estimated by the recent records at Kisaran, Sungai dadap and Pulau Raja-1.

(2) Suspended days are estimated under the following assumption.

Daily rainfall (mm/day)	less than 9	10 - 15	16 - 30	more than 31
Jan.- Apr. & Jun.- Jul.	0.0	0.5	1.0	2.0
May and Aug.- Dec.	0.0	1.5	2.0	3.0

Table H-19 Workable Days

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Total days (T)	31	28	31	30	31	30	31	31	30	31	30	31	365
Holidays (H)	5.4	4.0	4.6	5.4	6.2	5.0	5.2	5.8	5.2	5.2	4.4	5.8	62.4
Asahan River													
Suspended due to													
Rainfall (R, %)	15.0	10.5	14.5	13.5	41.1	10.2	28.2	38.9	50.8	56.0	46.5	39.8	30.6
Flood (F, %)	5.5	14.6	7.4	17.0	27.7	4.7	0.0	0.3	1.0	1.6	2.7	2.6	7.0
Workable days (D)	20.6	18.3	20.9	17.7	10.6	21.4	18.5	15.4	12.1	11.2	13.3	14.8	194.8
Silau River													
Suspended due to													
Rainfall (R, %)	15.0	10.5	14.5	13.5	41.1	10.2	28.2	38.9	50.8	56.0	46.5	39.8	30.6
Flood (F, %)	2.6	1.1	0.3	1.3	2.6	0.0	0.0	0.0	1.3	2.6	4.0	5.8	1.8
Workable days (D)	21.2	21.2	22.5	21.0	14.2	22.5	18.5	15.4	12.0	11.1	13.1	14.3	207.0

Note : $D = (T - H) \times (1 - R) \times (1 - F)$

Table H-20 Available Existing Construction Equipment owned by Water Resources Development Division of DPUP, North Sumatra

(as of June '85)

Equipment	Capacity	Nos.	Year of Perchase	Age
Bulldozer	180 HP	2	1974	11
	140 HP	2	1974	11
Crawler Excavator	69 HP	5	1973	12
Backhoe	71 PS	1	1974	11
Vibration Roller	8.5 PS	1	1980	5
	7 ton	2	1979	6
Stamper	4 HP	6	1980	5
Dump Truck	6 ton	2	1974	11
Dredger	970 HP	1	1974	11
	480 HP	1	(unknown)	
	240 HP	1	1962	23
Tugboat	63 HP	1	1962	23
	43 HP	1	(unknown)	

Source : Water Resources Development Division of DPUP, North Sumatra

Table H-21 Unit Prices of Labor Wages and Construction Materials adopted for Similar Project

(Unit : Rp)

Description	Unit	DPUP,North Sumatra *1	Ular River Project *2	Padang Area Project *3	West Jakarta Project *4
I. Labor	day(8hr)				
Foreman		2,900	3,400	3,500	3,300
Skilled labor		3,400	2,600	3,000	2,750
Common labor		2,400	1,750	2,000	2,200
Operator		4,000	-	4,400	4,400
Assistant operator		2,900-3,500	-	3,800	-
Driver		3,500-4,000	-	2,800	3,300
Assistant driver		2,900	-	-	-
Mechanic		3,850	-	3,800	-
Assistant mechanic		2,900	-	3,300	-
Carpenter		3,400	3,000	3,000	2,750
Mason/Brick layer		3,400	3,000	3,000	2,750
Steal bar bender		3,400	3,000	3,000	2,400
Concrete worker		3,400	-	2,500	2,400
II. Fuel and Materials					
Gasoline	liter	350	-	320	320
Diesel oil	liter	165	-	150	-
Portland cement	40kg	3,600	2,900	3,000	3,100
Cobble stone	cu.m	4,500	7,500	4,000-6,000	10,000
Crushed stone	cu.m	7,500-11,000	-	7,000	5,491
Gravel	cu.m	7,000	6,500	4,000-5,000	10,000
Sand	cu.m	1,750-2,000	4,000	4,000-4,500	7,590
Steel plate	kg	450-850	-	560	560
Wooden plate for form	cu.m	55,000-135,000	74,100	70,000	70,000
Bamboo net	sq.m	1,000	-	850	180
Reinforcement bar	kg	500-550	310	600	600
Bolt and nut	kg	700-900	-	900	900

Source :

*1 PUD-Kab. Asahan (as of 1984/1985)

*2 Overall Ular River Improvement and Irrigation Project (as of June 1983, average cost of FC-1 and FC-3)

*3 Study Report on Padang Area Flood Control Project; Dec. 1983, JICA (as of June 1983)

*4 Evaluation on west Jakarta Flood Control Project (as of April 1983)

Table H-22 Unit Prices of Labor and Construction Materials for Cost Estimation (1/2)

(Unit : Rp)

Item	Unit	Local Currency	Foreign Currency	Total	Ratio of F.C (%)
I. Labor	day(8hr)				
Foreman		2,900	-	2,900	0
Skilled labor		3,400	-	3,400	0
Common labor		2,400	-	2,400	0
Operator		4,000	-	4,000	0
Assistant operator		3,500	-	3,500	0
Driver		3,500	-	3,400	0
Assistant driver		2,900	-	2,900	0
Mechanic		3,850	-	3,850	0
Assistant mechanic		2,900	-	2,900	0
Carpenter		3,400	-	3,400	0
Mason/Brick layer		3,400	-	3,400	0
Steal bar bender		3,400	-	3,400	0
Concrete worker		3,400	-	3,400	0
II. Fuel and Materials					
Gasoline	liter	175	175	350	50
Diesel oil	liter	82	83	165	50
Lubricant	liter	775	775	1,550	50
Hydraulic oil	liter	675	675	1,350	50
Grease	kg	1,375	1,375	2,750	50
Gear oil	liter	1,375	1,375	2,750	50
Transmission oil	liter	1,150	1,150	2,300	50
Light oil	liter	60	60	120	50
Sand for concrete	cu.m	940	1,060	2,000	53
Sand for others	cu.m	822	928	1,750	53
Gravel for concrete	cu.m	2,800	4,200	7,000	60
Unscreened gravel	cu.m	2,800	4,200	7,000	60
Stone for masonry	cu.m	2,800	4,200	7,000	60
Cobble stone	cu.m	1,800	2,700	4,500	60
Portland cement	kg	31	59	90	65
Rainforcement bar	kg	110	440	550	80
Steel plate	kg	-	600	600	100
Shape steel	kg	-	550	550	100
Steel sheet pile	kg	-	700	700	100
H-section steel	kg	-	600	600	100
Bolt and nut	kg	-	900	900	100
Wire rope 18mm	kg	-	2,050	2,050	100

Note : 1. Price level at the end of March 1985 is adopted.

2. Ratio of foreign currency portion in unit price is estimated based on the data prepared by the West Jakarta Flood Control Project, April 1983.

3. Exchange rate : US$1 = Rp 1,100 = Japanese ¥ 250.

Table H-22 Unit Prices of Labor and Construction Materials for Cost Estimation (2/2)

(Unit : Rp)

Item	Unit	Local Currency	Foreign Currency	Total	Ratio of F.C (%)
Zine wire 0.4mm	kg	-	800	800	100
Nail	kg	-	700	700	100
Wooden palate for form	cu.m	70,500	4,500	75,000	6
Wooden beam	cu.m	47,000	3,000	50,000	6
Wooden pile ϕ15 x 5m	nos.	5,546	354	5,900	6
Wooded pile ϕ15 x 3m	nos.	3,384	216	3,600	6
Paint	kg	1,250	1,250	2,500	50
Bamboo net	sq.m	1,000	-	1,000	0
Turf	sq.m	144	16	160	10

Note : 1. Price level at the end of March 1985 is adopted.

2. Ratio of foreign currency portion in unit price is estimated based on the data prepared by the West Jakarta Flood Control Project, April 1983.

3. Exchange rate : US$ 1 = Rp 1,100 = Japanese ¥ 250.

Table H-23 Estimated Operation Cost of Equipment per Day

Equipment	Capacity	Local Currency Portion(Rp)			Foreign Currency Portion(US$)				Equivalent Total (Rp)
		Fuel	Labor	Total	Owing & Repair	Fuel	Guidance	Total	
Bulldozer, swamp	15 ton	13,500	6,400	19,900	121.00	12.24	6.80	140.04	173,944
	12 ton	9,900	6,400	16,300	96.65	8.98	6.80	112.43	139,973
	7 ton	5,900	6,400	12,300	51.25	5.37	6.80	63.42	82,062
Backhoe, swamp	0.7 m3	11,750	6,400	18,150	139.30	10.68	6.80	156.78	190,608
	0.5 m3	7,680	6,400	14,080	95.45	6.98	6.80	109.23	134,233
	0.3 m3	6,800	6,400	13,200	76.50	6.20	6.80	89.50	111,650
Dragline, ordinary	0.6 m3	9,230	6,400	15,630	154.65	8.40	6.80	169.85	202,465
Dump truck	6 ton	15,000	3,500	18,500	27.85	13.62	-	41.47	64,117
	2 ton	8,500	3,500	12,000	15.55	7.71	-	23.26	37,586
Tire roller	12 ton	8,160	6,400	14,560	80.35	7.42	-	87.77	111,107
Vibration roller	2 ton	1,470	4,000	5,470	38.85	1.34	-	40.19	49,679
	1 ton	650	4,000	4,650	17.95	0.59	-	18.54	25,044
Vibration compactor	50 kg	1,140	2,400	3,540	4.25	1.00	-	5.25	9,315
Rummer	60 kg	1,100	2,400	3,500	3.75	1.00	-	4.75	8,725
Tumper	60 kg	1,100	2,400	3,500	4.30	1.00	-	5.30	9,330
Portable concrete mixer	0.3 m3	1,660	2,400	4,060	20.00	1.51	-	21.51	27,721
Concrete vibrator	ϕ30 mm	650	2,400	3,050	2.60	0.58	-	3.18	6,548
Diesel pile driver	1.3 ton	81,100	3,850	84,950	81.10	8.40	6.80	96.30	190,880
	2.5 ton	131,400	3,850	135,250	131.40	9.79	6.80	147.99	298,039
Crawler crane	30 ton	9,250	6,400	15,650	126.30	8.40	6.80	141.50	171.300
	40 ton	9,250	6,400	15,650	164.45	8.40	6.80	179.65	213,265
Hydraulic truck crane	20 ton	20,260	6,400	26,660	111.60	18.42	6.80	136.82	177,162
	10 ton	20,260	6,400	26,660	64.05	18.42	6.80	89.27	124,857
	2 ton	10,610	6,400	17,010	5.30	9.64	6.80	22.14	41,364
Ordinary truck	4.5 ton	14,420	3,400	17,820	18.95	13.18	-	32.13	53,163
	1 ton	7,200	3,400	10,600	7.20	6.59	-	13.79	25,769

Note : (1) Price level at the end of March 1985 is adopted.

(2) Exchange rate : US$ 1 = Rp 1,100 = Japanese ¥ 250.

Table H-24 Unit Cost for Land Acquisition and House Compensation

I. Land Acquisition

Item	Compensation Cost (Rp/m2)
Residential area	250
Paddy field	300
Land for upland crops	200
Swamp / bush	0

II. House Compensation

Class	Average House Area (m2) *1	Unit Price (Rp/m2) *2	Compensation Cost (Rp/house)
I	80	15,000	1,200,000
II	60	10,000	600,000
III	30	7,000	210,000

Note : *1 our estimation based on the information of the Statistics office of Kab. Asahan.

*2 House depreciation rate of 50 % is considered.

Table H-25 Estimated Unit Construction Cost

Work Item	Unit	Local Currency (Rp)	Foreign Currency (US$)	Equivalent Total (Rp)	Remarks
Clearing (1)	sq m	20	0.04	65	
Clearing (2)	sq m	250	0.68	1,000	for bush area
Excavation	cu m	680	2.56	3,500	
Dredging	cu m	1,050	4.05	5,500	
Embankment (1)	cu m	560	1.31	2,000	
Embankment (2)	cu m	870	2.49	3,600	for Lebah river
Wet masonry	cu m	54,700	17.43	73,870	
Crib	m	83,400	151.45	250,000	
Culvert (1)	nos.	16×10^6	21,800	40×10^6	b x h=1.5m x1.5m
Culvert (2)	nos.	24×10^6	32,700	60×10^6	.b x h=2.0m x2.5m
Culvert (3)	nos.	40×10^6	54,500	100×10^6	b x h=2.0m x2.5m x2
Concrete work	cu m	49,600	5.76	55,900	
Form work	sq m	8,200	4.87	13,560	
Bar work	ton	66,000	717.00	854,700	
Excavation	cu m	230	0.98	1,310	for structure
Back fill	cu m	280	1.22	1,620	- do -

Note : (1) Price level in March 1985 is adopted.

(2) Exchange rate : US$ 1 = Rp 1,100 = Japanese ¥ 250.

Table H-26 Major Unit Construction Cost in Similar Projects

(Unit: Rp 1,000)

Work item	Unit	DPUP,North Sumatra *1	Ular River Project *2	Padang F/C Project *3	Karian Dam Project *4	W.Jakarta Project *5
Clearing for land except bush	m2	0.065 - 0.070	0.064	-	-	-
Excavation	m3	2 - 2.5	1.87 - 2.6	1.95 - 2.02	2.8 - 3.0	1.8 -2.05
Dredging	m3	-	5.03	4.24	4.58	4.28
Embankment	m3	3 - 4.5	1.94 - 2.58	1.49 - 1.89	0.88 - 4.35	2.05
Wet masonry	m3	60 - 76	65.78	49.5	26.1	70.31
Culvert						
(1.5 x 1.5 x 1)	nos.	-	-	37,200	41,000	-
(2.0 x 2.5 x 1)	nos.	-	-	56,400	88,000	-
(2.0 x 2.5 x 2)	nos.	-	-	80,300	-	-

Note ;

*1 : DPUP, North Sumatra (as of 1984/85)

*2 : Overall Ular River Improvement and Irrigation Prtoject (as of June 1984)

*3 : Study Report on Padang Area Flood Control Project, Dec. 1983, JICA (as of June 1983)

*4 : Draft Final Report on Feasibility Study of Karian Multipurpose Dam Construction Project, March 1985, JICA (as of 1984)

*5 : Evaluation Report on West Jakarta Flood Control Project (as of April 1983)

Table H-27 Breakdown of Construction Cost for Proposed Urgent Project (1/2)

Description	Unit	Quantity	Local Currency		Foreign Currency			Equivalent Total (Rp million)
			Unit Cost(Rp)	Amount (Rp million)	Unit Cost($)	Amount ($ thousand)	Amount (Eq.Rp million)	
1. Civil Works				6,084.8		19,248.8	21,173.7	27,258.5
1.1 Asahan River				3,572.6		12,044.6	13,249.1	16,821.7
(1) Preparatory :(8) x 8%				242.2		816.6	898.3	1,140.5
(2) Clearing for bush	sq m	470,000	250	117.5	0.68	319.6	351.5	469.0
(3) Embankment	cu m	1,060,000		683.5		1,730.8	1,903.9	2,587.4
- mainstream	cu m	770,000	560	431.2	1.31	1,008.7	1,109.6	1,540.8
- Lebah River	cu m	290,000	870	252.3	2.49	722.1	794.3	1,046.6
(4) Excavation	cu m	1,280,000	680	870.4	2.56	3,276.8	3,604.5	4,474.9
(5) Dredging	cu m	1,150,000	1,050	1,207.5	4.05	4,657.5	5,123.2	6,330.7
(6) Bank protection				52.7		91.8	101.0	153.7
- wet masonry	cu m	50	54,700	2.7	17.43	0.9	1.0	3.7
- crib	m	600	83,400	50.0	151.45	90.9	100.0	150.0
(7) Drainage culvert	nos.	6	16,000,000	96.0	21,800.00	130.8	143.9	239.9
(8) Sub-total:(2)-(7)				3,027.6		10,207.3	11,228.0	14,255.6
(9) Miscellaneous:(8) x 10%				302.8		1,020.7	1,122.8	1,425.6
1.2 Silau River				2,512.2		7,204.2	7,924.6	10,436.8
(1) Preparatory:(8) x 8%				170.3		488.4	537.3	707.6
(2) Clearing for bush	sq m	8,000	250	2.0	0.68	5.4	5.9	7.9
(3) Embankment	cu m	1,210,000	560	677.6	1.31	1,585.1	1,743.6	2,421.2
(4) Excavation	cu m	1,220,000	680	829.6	2.56	3,123.2	3,435.5	4,265.1
(5) Dredging	cu m	180,000	1,050	189.0	4.05	729.0	801.9	990.9
(6) Bank protection	m	2,000	83,400	166.8	151.45	302.9	333.2	500.0
(7) Intake structure	nos.	5		136.0		185.3	203.8	339.8
- 2.0 x 2.5	nos.	4	24,000,000	96.0	32,700.00	130.8	143.9	239.9
- 2.0 x 2.5 x 2	nos.	1	40,000,000	40.0	54,500.00	54.5	59.9	99.9

(continued)

Note : (1) Price level in March 1985 is adopted.
(2) Exchange rate : US$ 1 = Rp 1,100 = Japanese ¥ 250.

Table H-27 Breakdown of Construction Cost for Proposed Urgent Project (2/2)

Description	Unit	Quantity	Local Currency		Foreign Currency			Equivalent Total (Rp million)
			Unit Cost(Rp)	Amount (Rp million)	Unit Cost($)	Amount ($ thousand)	Amount (Eq.Rp million)	
(continued)								
(8) Drainage culvert	nos.	6		128.0		174.4	191.8	319.8
- 1.5 x 1.5	nos.	4	16,000,000	64.0	21,800.00	87.2	95.9	159.9
- 2.0 x 2.5	nos.	1	24,000,000	24.0	32,700.00	32.7	36.0	60.0
- 2.0 x 2.5 x 2	nos.	1	40,000,000	40.0	54,000.00	54.5	59.9	99.9
(9) Sub-total (2)-(8)				2,129.0		6,105.3	6,715.7	8,844.7
(10)Miscellaneous:(9) x 10%				212.9		610.5	671.6	884.5
2. Acquisition & Compensation				983.2		-	-	983.2
2.1 Asahan River				353.1		-	-	353.1
(1) Land acquisition	sq m	366,000		109.3				109.3
(2) Land compensation	sq m	1,000,000		147.0				147.0
(3) House compensation	nos.	370		96.8				96.8
2.2 Silau River				630.1		-	-	630.1
(1) Land acquisition	sq m	838,000		249.3				249.3
(2) Land compensation	sq m	1,650,000		245.0				245.0
(3) House compensation	nos.	293		135.8				135.8
3. Sum (1.+ 2.)				7,068.0		19,248.8	21,173.7	27,258.5
4. Administration (5 % of Local component of 3.)				353.4		-	-	353.4
5. Engineering				1,026.0		3,224.0	3,546.4	4,572.4
6. Sum (3.+ 4.+ 5.)				8,447.4		22,472.8	24,720.1	33,167.5
7. Contingency (10 % of 6.)				844.7		2,247.3	2,472.0	3,316.7
8. Grand Total (6.+ 7.)				9,292.1		24,720.1	27,192.1	36,484.2

Table H-28 Estimated Annual Operation and Maintenance Cost

Work Item	Annual O/M Cost (Rp million)
1. Dredging works (15,000 m3/year) 14,500 m3/year x Rp 5,500/m3 = Rp 79,750,000	80
2. Dike and bank protection - dike : 75,100 m x Rp 30/m = Rp 2,250,000 - bank protection : 2,700 m x Rp 1,000/m = Rp 2,700,000	5
3. Clearring works	3
4. Machinary	10
5. Office running cost including staffs	15
6. Sub-total	113
7. Miscellaneous (20 % of 6.)	23
Total	136

Table H-29 Breakdown of Economic Construction Cost for Proposed Urgent Project (1/2)

Description	Unit	Quantity	Local Currency		Foreign Currency			Equivalent Total (Rp million)
			Unit Cost(Rp)	Amount (Rp million)	Unit Cost($)	Amount ($ thousand)	Amount (Eq.Rp million)	
1. Civil Works				5,160.1		19,248.8	21,173.7	26,333.8
1.1 Asahan River				3,034.5		12,044.6	13,249.1	16,283.6
(1) Preparatory :(8) x 8%				205.7		816.6	898.3	1,104.0
(2) Clearing for bush	sq m	470,000	213	100.1	0.68	319.6	351.5	451.6
(3) Embankment	cu m	1,060,000		566.6		1,730.8	1,903.9	2,470.5
- mainstream	cu m	770,000	459	353.4	1.31	1,008.7	1,109.6	1,463.0
- Lebah River	cu m	290,000	735	213.2	2.49	722.1	794.3	1,007.5
(4) Excavation	cu m	1,280,000	584	747.5	2.56	3,276.8	3,604.5	4,352.0
(5) Dredging	cu m	1,150,000	895	1,029.3	4.05	4,657.5	5,123.2	6,152.5
(6) Bank protection				45.5		91.8	101.0	146.5
- wet masonry	cu m	50	47,027	2.4	17.43	0.9	1.0	3.4
- crib	m	600	71,905	43.1	151.45	90.9	100.0	143.1
(7) Drainage culvert	nos.	6	13,760,000	82.6	21,800.00	130.8	143.9	226.5
(8) Sub-total:(2)-(7)				2,571.6		10,207.3	11,228.0	13,799.6
(9) Miscellaneous:(8) x 10%				257.2		1,020.7	1,122.8	1,380.0
1.2 Silau River				2,125.6		7,204.2	7,924.6	10,050.2
(1) Preparatory:(8) x 8%				144.1		488.4	537.3	681.4
(2) Clearing for bush	sq m	8,000	213	1.7	0.68	5.4	5.9	7.6
(3) Embankment	cu m	1,210,000	459	555.4	1.31	1,585.1	1,743.6	2,299.0
(4) Excavation	cu m	1,220,000	584	712.5	2.56	3,123.2	3,435.5	4,148.0
(5) Dredging	cu m	180,000	895	161.0	4.05	729.0	801.9	962.9
(6) Bank protection	m	2,000	71,905	143.8	151.45	302.9	333.2	477.0
(7) Intake structure	nos.	5		117.0		185.3	203.8	320.8
- 2.0 x 2.5	nos.	4	20,640,000	82.6	32,700.00	130.8	143.9	226.5
- 2.0 x 2.5 x 2	nos.	1	34,400,000	34.4	54,500.00	54.5	59.9	94.3

(continued)

Note : (1) Price level in March 1985 is adopted.
(2) Exchange rate : US$ 1 = Rp 1,100 = Japanese ¥ 250.

Table H-29 Breakdown of Economic Construction Cost for Proposed Urgent Project (2/2)

Description	Unit	Quantity	Local Currency		Foreign Currency			Equivalent Total (Rp million)
			Unit Cost(Rp)	Amount (Rp million)	Unit Cost($)	Amount ($ thousand)	Amount (Eq.Rp million)	
(continued)								
(8) Drainage culvert	nos.	6		110.0		174.4	191.8	301.8
- 1.5 x 1.5	nos.	4	13,760,000	55.0	21,800.00	87.2	95.9	150.9
- 2.0 x 2.5	nos.	1	20,640,000	20.6	32,700.00	32.7	36.0	56.6
- 2.0 x 2.5 x 2	nos.	1	34,400,000	34.4	54,000.00	54.5	59.9	94.3
(9) Sub-total (2)-(8)				1,801.4		6,105.3	6,715.7	8,517.1
(10)Miscellaneous:(9) x 10%				180.1		610.5	671.6	851.7
2. Acquisition & Compensation				983.2		-	-	983.2
2.1 Asahan River				353.1		-	-	353.1
(1) Land acquisition	sq m	366,000		109.3				109.3
(2) Land compensation	sq m	1,000,000		147.0				147.0
(3) House compensation	nos.	370		96.8				96.8
2.2 Silau River				630.1		-	-	630.1
(1) Land acquisition	sq m	838,000		249.3				249.3
(2) Land compensation	sq m	1,650,000		245.0				245.0
(3) House compensation	nos.	293		135.8				135.8
3. Sum (1.+ 2.)				6,143.3		19,248.8	21,173.7	27,317.0
4. Administration (5 % of Local component of 3.)				307.2		-	-	307.2
5. Engineering				983.0		3,224.0	3,546.4	4,529.4
6. Sum (3.+ 4.+ 5.)				7,433.5		22,472.8	24,720.1	32,153.6
7. Contingency (10 % of 6.)				743.4		2,247.3	2,472.0	3,215.4
8. Grand Total (6.+ 7.)				8,176.9		24,720.1	27,192.1	35,369.0

Table H-30 Expected Development Area by Urgent Flood Control Project of Asahan and Silau Rivers

Development	Zone	Area (ha)
for Agricultural land		
	(1) AS-14 (Rawa Mahandang area)	3,000
	(2) AK-8 (Sei Lebah area)	1,695
	sub-total	4,695
for Residential quarter		
	(1) Teluk Ketapang area	400
	(2) Tanjung Balai-1 area	100
	sub-total	500
Total		5,195

Table H-31 Enhancement Benefit by Urgent Flood Control Project of Asahan and Silau Rivers

(Unit : Rp million)

Return Period (year)	Agriculture development	Housing development	Total
2	89.4	8.8	98.2
5	358.7	43.9	402.6
10	453.7	60.5	514.2
15	487.2	68.3	555.5
30	520.7	79.0	599.7
50	534.1	84.8	618.9
100	544.2	89.7	633.9
Max.	558.7	97.5	656.2

Note : Agriculture development ; (Y - Cp - Ci) x A = Rp 558,700,000
Y : unit yield (= Rp 193,000/ton x 2.5 ton/ha)
Cp : production cost (= Rp 240,000/ha)
Ci : annual investment cost (= Rp 72,500/ha)
A : area to be developed (= 4,695 ha x 0.7)

Housing development ; (Pa - Pb) x N x R x A = Rp 97,500,000
Pa : land value after project is implemented (= Rp 1,500 sqm)
Pb : land value before project is implemented (= Rp 250 sqm)
N : rate of rental value of land (= 1/12)
R : increase ratio of rental value (= 0.25)
A : area to be developed (= 500 ha x 0.75)

Table H-32 Economic Cost and Benefit Flow for Urgent Flood Control Project

(Unit: Rp million)

Year in Order	Fiscal Year	Economic Cost			Benefit
		Construction cost	O & M cost	Total	
1	1987/88	906	-	906	-
2	1988/89	1,724	-	1,724	-
3	1989/90	325	-	325	-
4	1990/91	3,008	-	3,008	-
5	1991/92	13,855	-	13,855	-
6	1992/93	12,429	-	12,429	-
7	1993/94	3,073	132	3,205	4,099
8	1994/95	-	132	132	5,124
9	1995/96	-	132	132	5,124
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
57	2043/44	-	132	132	5,124

Table H-33 Sensitivity of IRR for Urgent Flood Control Project

Assumption	IRR (%)
1. Base estimate	12.4
2. Cost : +10 %	11.4
3. Cost : +20 %	10.5
4. Benefit : -10 %	11.2
5. Benefit : -20 %	10.0
6. Cost : +10 % & Benefit : -10 %	10.3
7. Cost : +10 % & Benefit : -20 %	9.2
8. Cost : +20 % & Benefit : -10 %	9.5
9. Cost : +20 % & Benefit : -20 %	8.4

Table H-34 Required Fund for Proposed Project

Description	L.C. (Rp million)	Required Loan (F.C.) (US$ thousand)	Equivalent Total (Rp million)
1. Civil Works	6,084.8	19,248.8	27,258.5
1.1 Asahan River	3,572.6	12,044.6	16,821.7
1) Preparatory	242.2	816.6	1,140.4
2) Clearing	117.5	319.6	469.1
3) Embankment	683.5	1,730.8	2,587.4
4) Excavation	870.4	3,276.8	4,474.9
5) Dredging	1,207.5	4,657.5	6,330.7
6) Bank protection	52.7	91.8	153.7
7) Drainage culvert	96.0	130.8	239.9
8) Others	302.8	1,020.7	1,425.6
1.2 Silau River	2,512.2	7,204.2	10,436.8
1) Preparatory	170.3	488.4	707.6
2) Clearing	2.0	5.4	7.9
3) Embankment	677.6	1,585.1	2,421.2
4) Excavation	829.6	3,123.2	4,265.1
5) Dredging	189.0	729.0	990.9
6) Bank protection	166.8	302.9	500.0
7) Intake structure	136.0	185.3	339.8
8) Drainage culvert	128.0	174.4	319.8
9) Others	212.9	610.5	884.5
2. Land Acquisition	983.2	-	983.2
3. Administration	353.4	-	353.4
4. Engineering	1,026.0	3,224.0	4,572.4
5. Total (1.to 4.)	8,447.4	22,472.8	33,167.5
6. Physical Contingency	844.7	2,247.3	3,316.7
7. Total (5.+ 6.)	9,292.1	24,720.1	36,484.2
8. Price Contingency	9,434.7	5,000.9	14,935.7
9.Grand Total	18,726.8	29,721.0	51,419.9

Remarks: 1. Base year used in estimating cost: 1985
2. Price escalation: L.C. = 12 % per annum
F.C. = 3 % per annum
3. Exchange rate: US$ 1 = Rp 1,100

Table H-35 Disbursement Schedule of Required Fund (1/2)

(Unit: L.C.= Rp million, F.C.= US$ thousand)

Description	1987/88		1988/89		1989/90		1990/91	
	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.
1. Civil Works								
(1) Asahan River	-	-	-	-	-	-	274.5	989.2
(2) Silau River	-	-	-	-	-	-	109.4	375.0
2. Land Acquisition	-	-	49.2	-	295.0	-	295.0	-
3. Administration	35.4	-	53.0	-	53.0	-	53.0	-
4. Engineering	179.6	564.2	333.4	1,047.8	-	-	128.3	403.0
5. Total (1 - 4)	215.0	564.2	435.6	1,047.8	348.0	-	860.2	1,767.2
6. Physical Contingency	21.5	56.4	43.5	104.8	34.8	-	86.0	176.7
7. Total (5 + 6)	236.5	620.6	479.1	1,152.6	382.8	-	946.2	1,943.9
8. Price Contingency	60.2	37.8	194.0	106.8	219.5	-	721.3	309.7
9. Grand Total	296.7	658.4	673.1	1,259.4	602.3	-	1,667.5	2,253.6

(continued)

Note: 1. Base year used in estimating cost: April 1985

2. Physical contingency: Local currency 10 %
Foreign currency 10 %

3. Price escalation: Local currency 12 % per annum
Foreign currency 3 % per annum

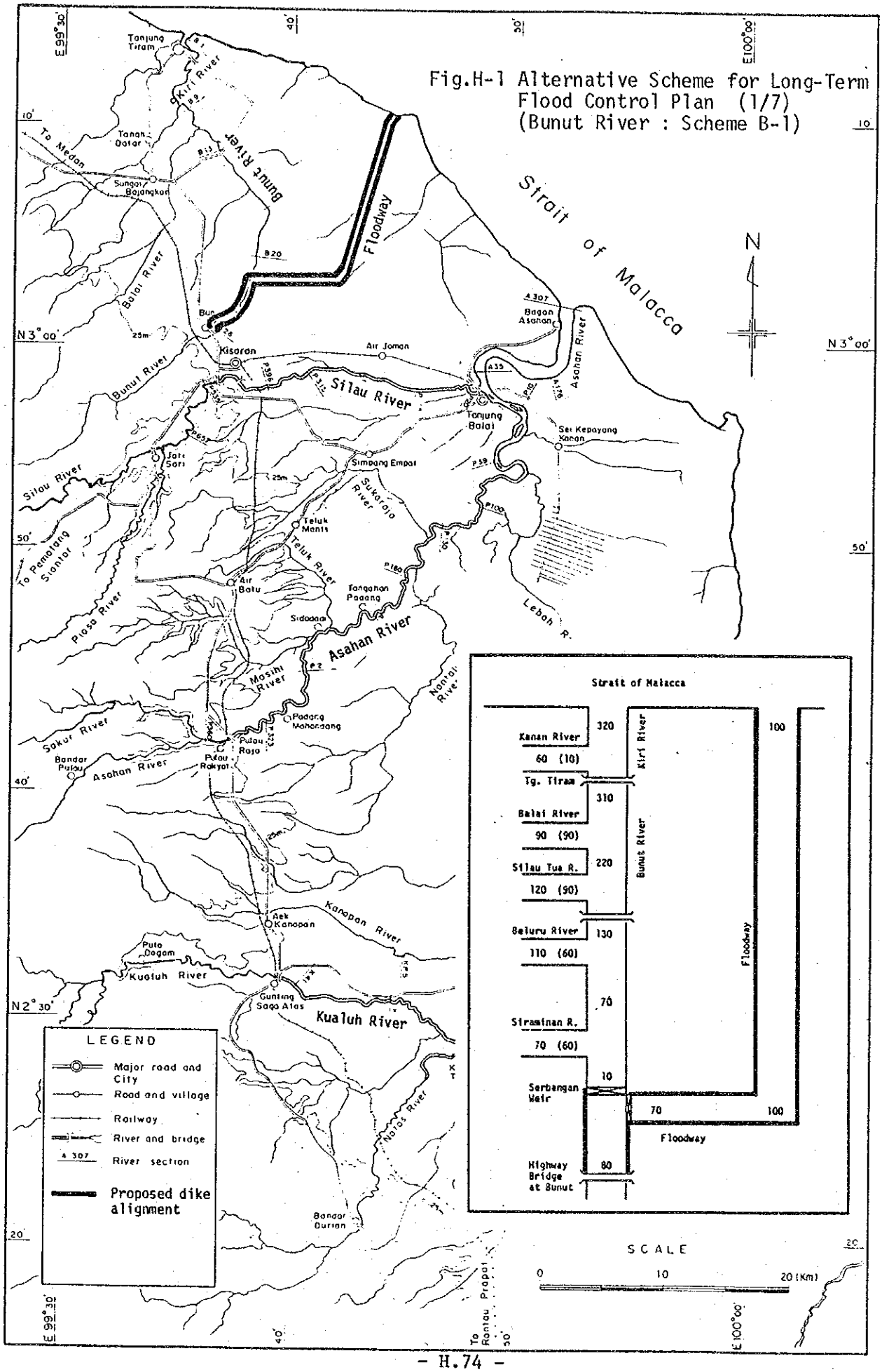
Table H-35 Disbursement Schedule of Required Fund (2/2)

(Unit: L.C.= Rp million, F.C.= US$ thousand)

Description	1991/92		1992/93		1993/94		Total	
	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.
(continued)								
1. Civil Works	2,609.8	8,697.9	2,437.1	7,700.9	654.0	1,485.8	6,084.8	19,243.8
(1) Asahan River	1,585.3	5,516.7	1,435.5	4,847.9	277.3	690.8	3,572.6	12,044.6
(2) Silau River	1,024.5	3,181.2	1,001.6	2,853.0	376.7	795.0	2,512.2	7,204.2
2. Land Acquisition	196.6	-	147.4	-	-	-	983.2	-
3. Administration	53.0	-	53.0	-	53.0	-	353.4	-
4. Engineering	128.3	403.6	128.2	403.0	128.2	403.0	1,026.0	3,224.0
5. Total (1 - 4)	2,987.7	9,100.9	2,765.7	8,103.9	835.2	1,888.8	8,447.4	22,472.8
6. Physical Contingency	298.8	910.1	276.6	810.4	83.5	188.9	844.7	2,247.3
7. Total (5 + 6)	3,286.5	10,011.0	3,042.3	8,914.3	918.7	2,077.7	9,292.1	24,720.1
8. Price Contingency	3,200.4	1,943.1	3,683.3	2,049.4	1,356.0	554.1	9,434.7	5,000.9
9. Grand Total	6,486.9	11,954.1	6,725.6	10,963.7	2,274.7	2,631.8	18,726.8	29,721.0

Note: 1. Base year used in estimating cost: April 1985
2. Physical contingency: Local currency 10 %
Foreign currency 10 %
3. Price escalation: Local currency 12 % per annum
Foreign currency 3 % per annum

Fig.H-1 Alternative Scheme for Long-Term Flood Control Plan (1/7)
(Bunut River : Scheme B-1)



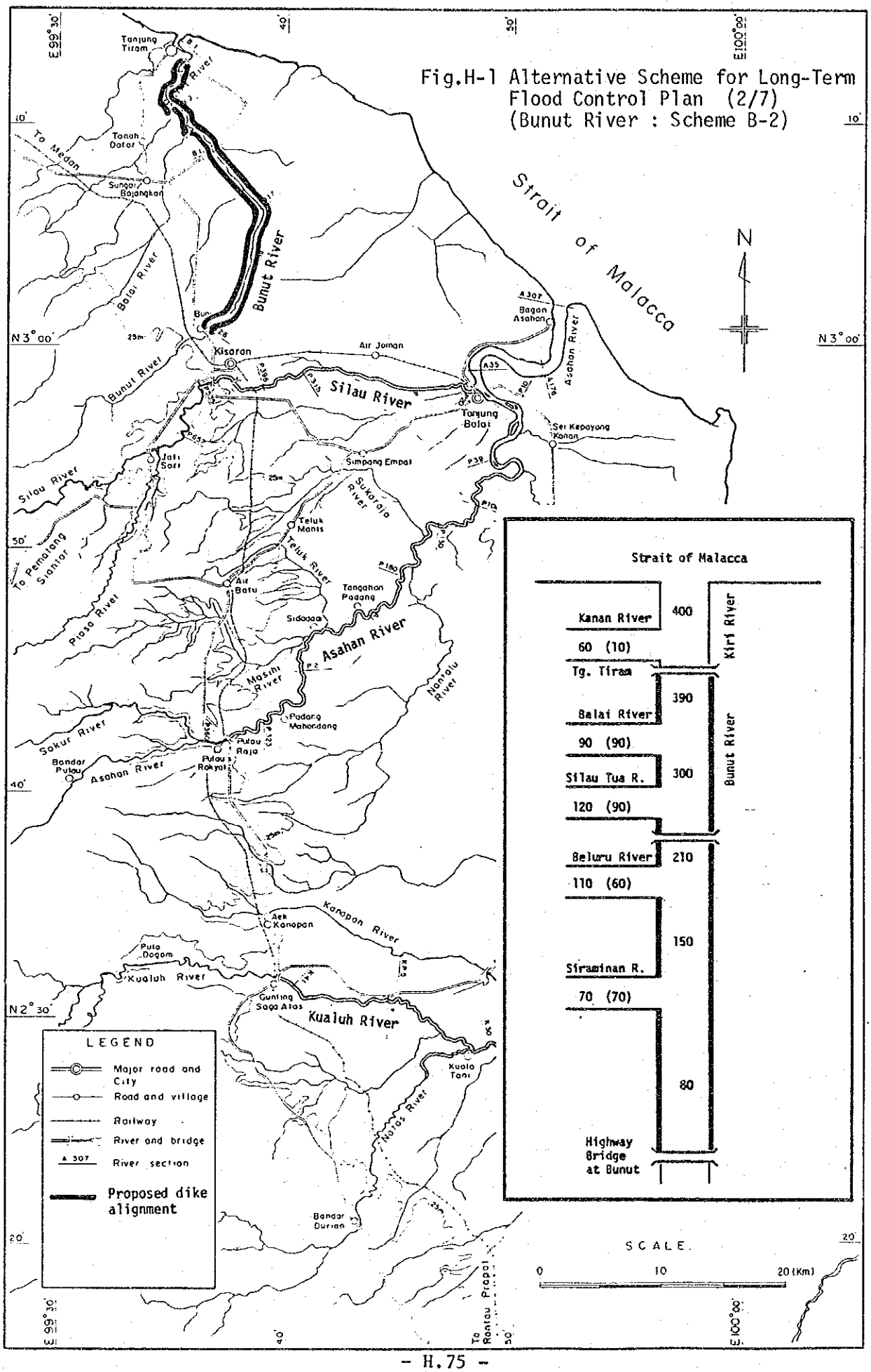


Fig.H-1 Alternative Scheme for Long-Term Flood Control Plan (2/7) (Bunut River : Scheme B-2)
Strait of Malacca
N
Bunut River
Silau River
Asahan River
Kisaran
Air Joman
Tanjung Balai
Bagan Asahan
Sei Kepayang Kanan
Simpang Empat
Jati Sari
Teluk Manis
Teluk River
Sukarata River
Air Batu
Tangahan Padang
Sidodadi
Masihi River
Padang Mahondang
Pulau Raja
Pulau Rakyat
Bandar Pulau
Sakur River
Piasa River
Nanralu River
Kanopan River
Aek Kanopan
Pulo Dogom
Kualuh River
Gunting Saga Atas
Kuala Tanc
Notas River
Bandar Durian
To Pematang Siantar
To Medan
To Rantau Prapat
Tanjung Tiram
Tanah Datar
Sungai Bajangkan
Balai River
Kirri River
Kanan River
Tg. Tiram
Balai River
Silau Tua R.
Beluru River
Siraminan R.
Highway Bridge at Bunut
400
60 (10)
390
90 (90)
300
120 (90)
210
110 (60)
150
70 (70)
80
LEGEND
Major road and City
Road and village
Railway
River and bridge
A 307 River section
Proposed dike alignment
SCALE
0 10 20 (Km)
N3°00'
N2°30'
E99°30'
E100°00'

Fig.H-1 Alternative Scheme for Long-Term Flood Control Plan (3/7)
(Asahan and Silau Rivers : Scheme A-1)

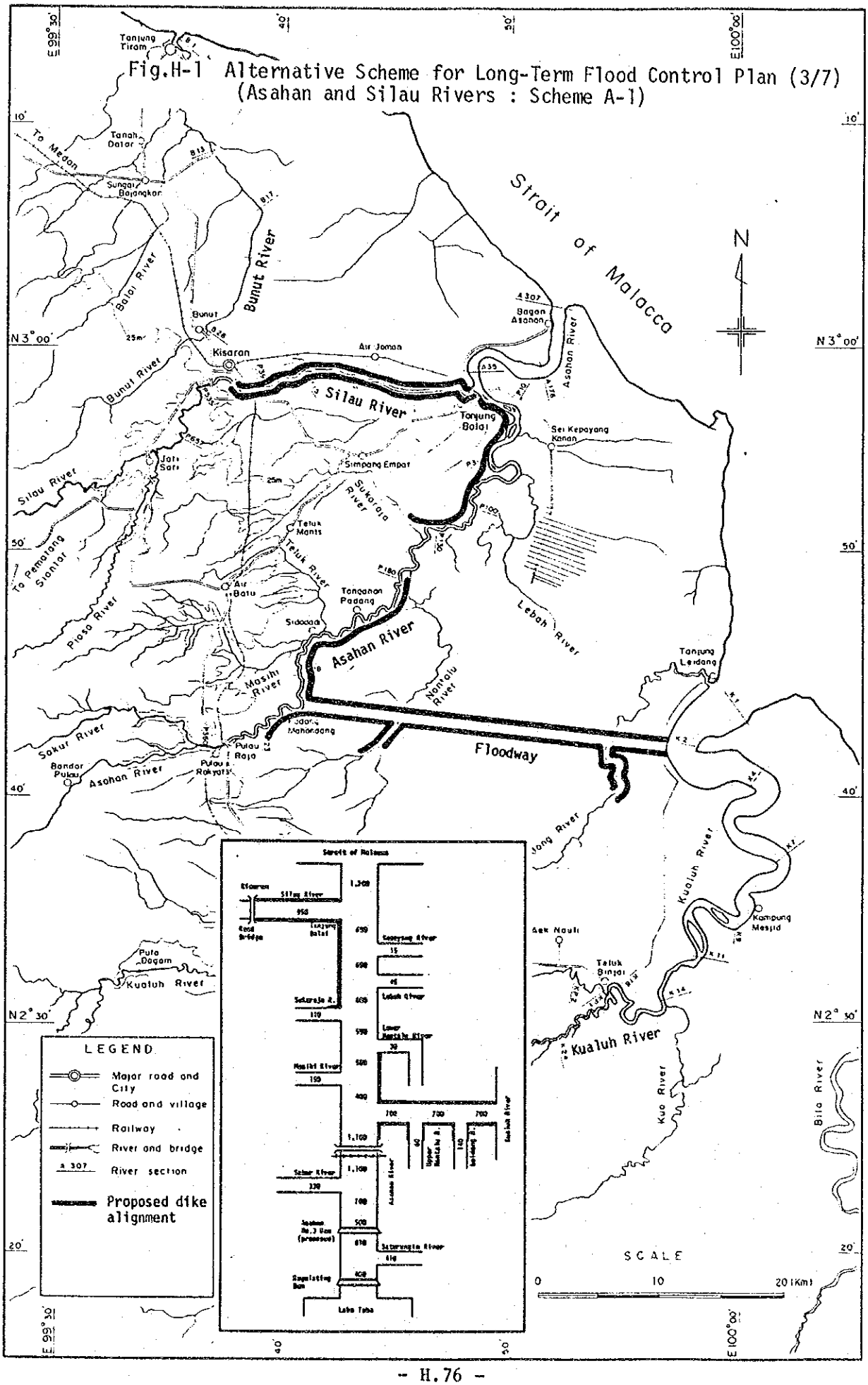


Fig.H-1 Alternative Scheme for Long-Term Flood Control Plan (4/7)
(Asahan and Silau Rivers : Scheme A-2)

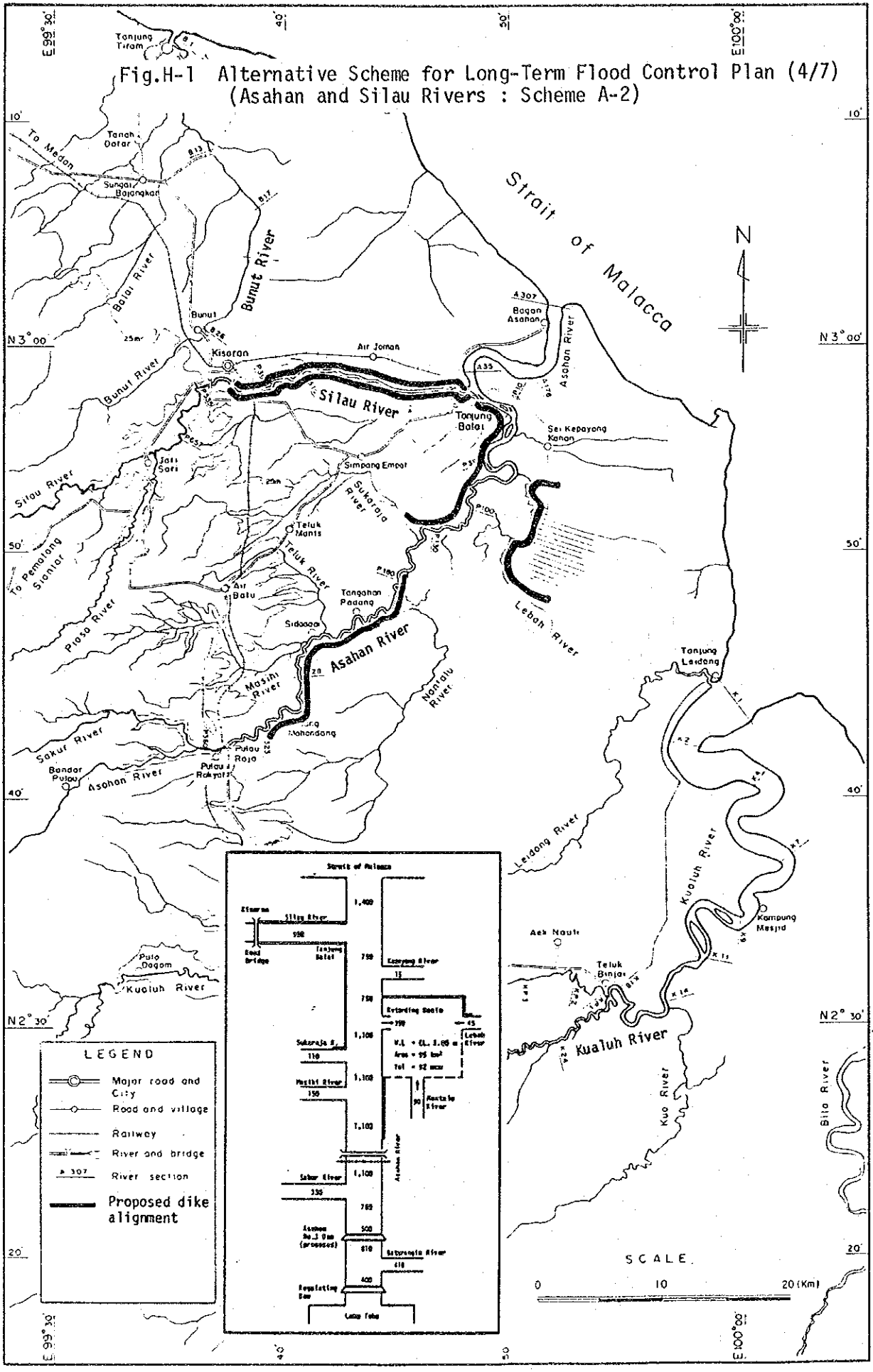


Fig.H-1 Alternative Scheme for Long-Term Flood Control Plan (5/7)
(Asahan and Silau Rivers : Scheme A-3)

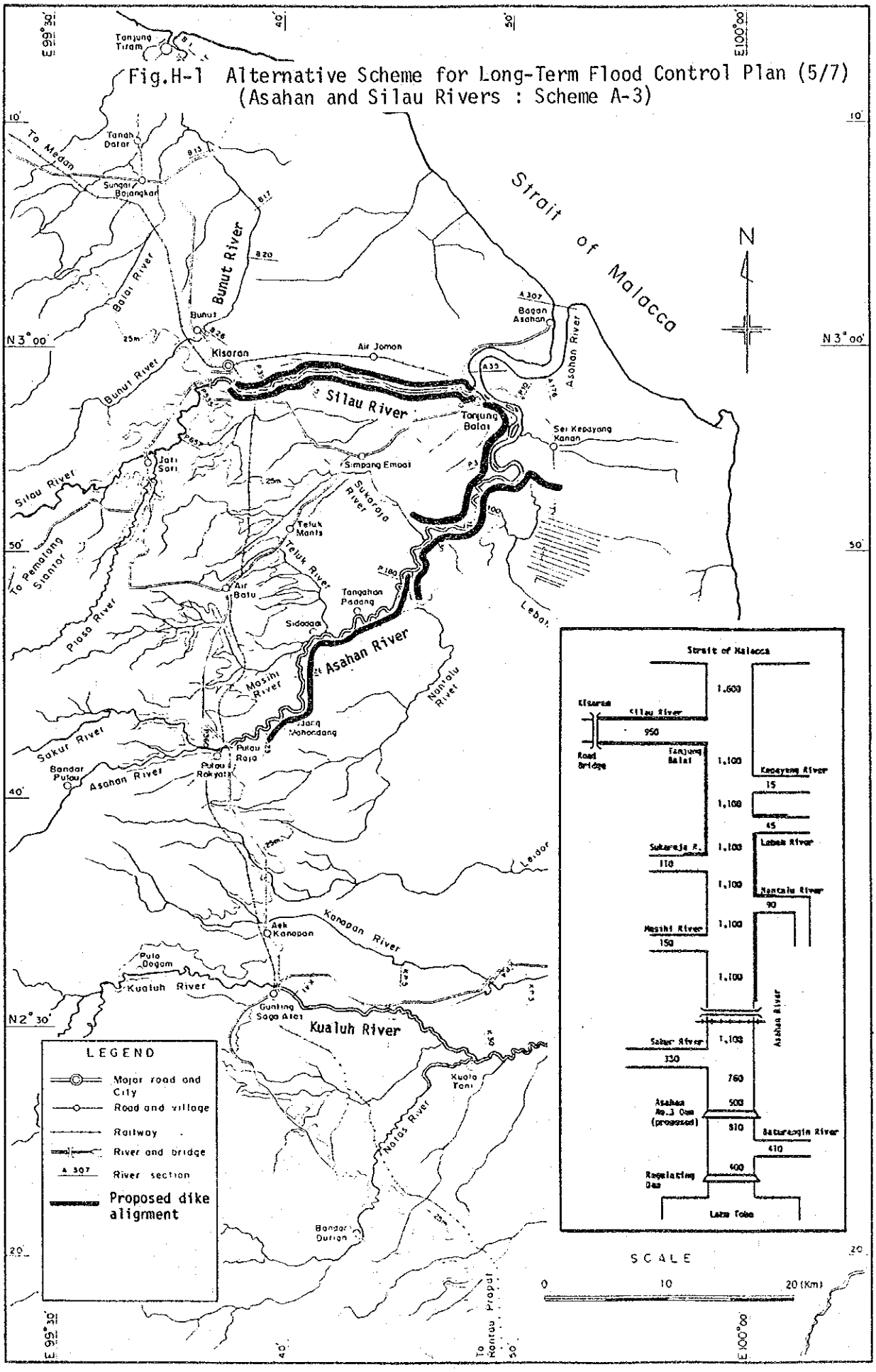
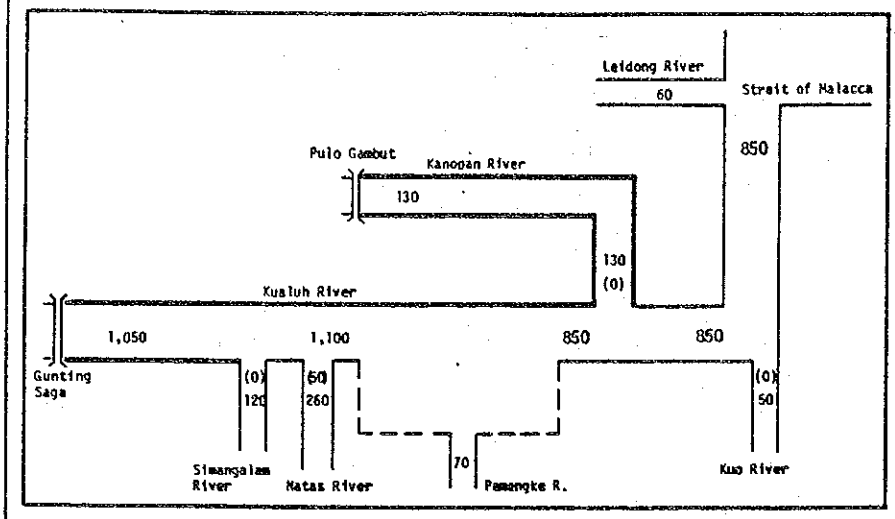


Fig.H-1 Alternative Scheme for Long-Term Flood Control Plan (6/7)
(Kualuh and Kanopan Rivers : Scheme K-1)



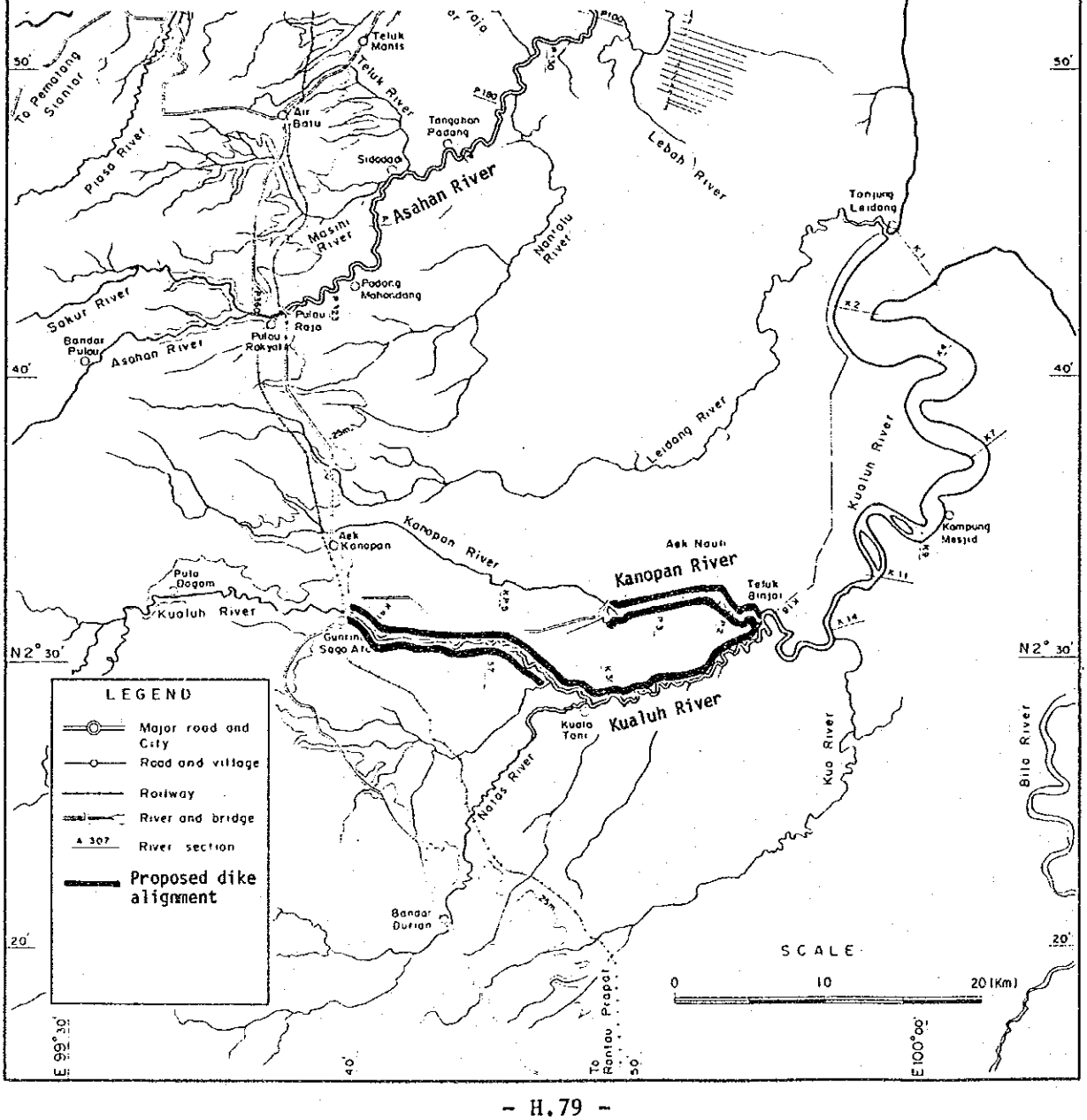


Fig.H-1 Alternative Scheme for Long-Term Flood Control Plan (7/7)
(Kualuh and Kanopan Rivers : Scheme K-2)

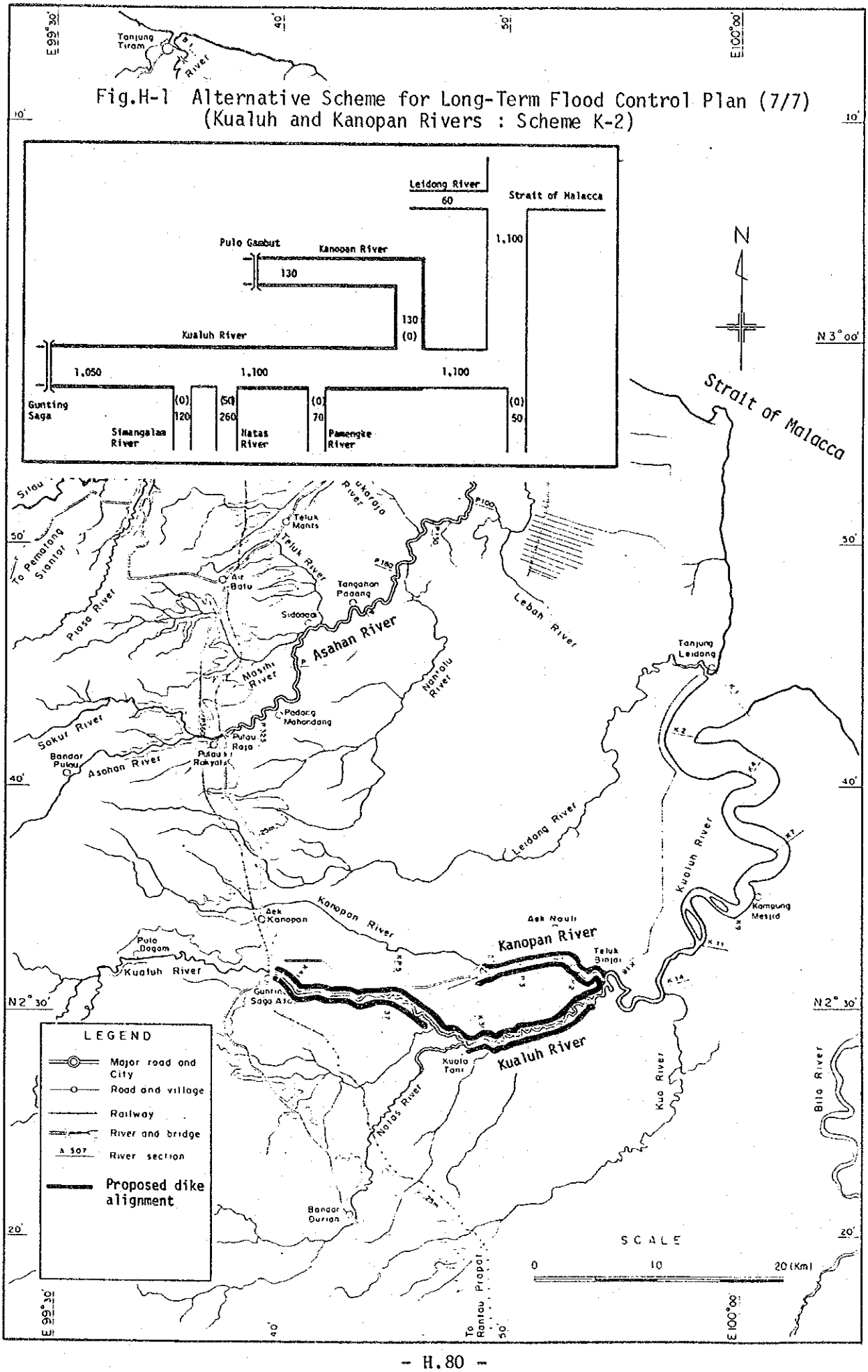


Fig.H-2 Design Flood Discharge for Proposed Long-Term Plan (1/3)

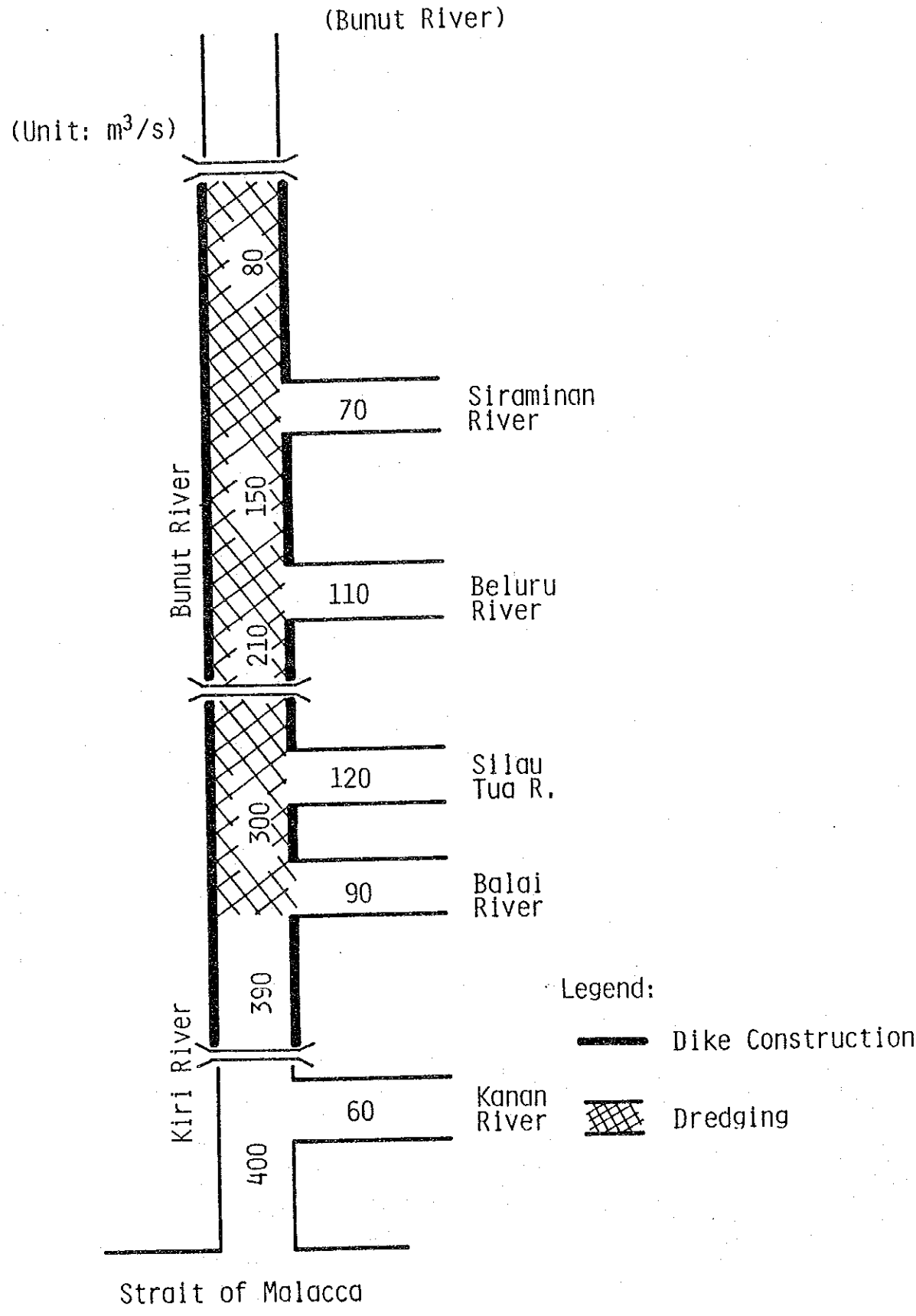


Fig.H-2 Design Flood Discharge for Proposed Long-Term Plan (2/3)

(Unit: m^3/s)

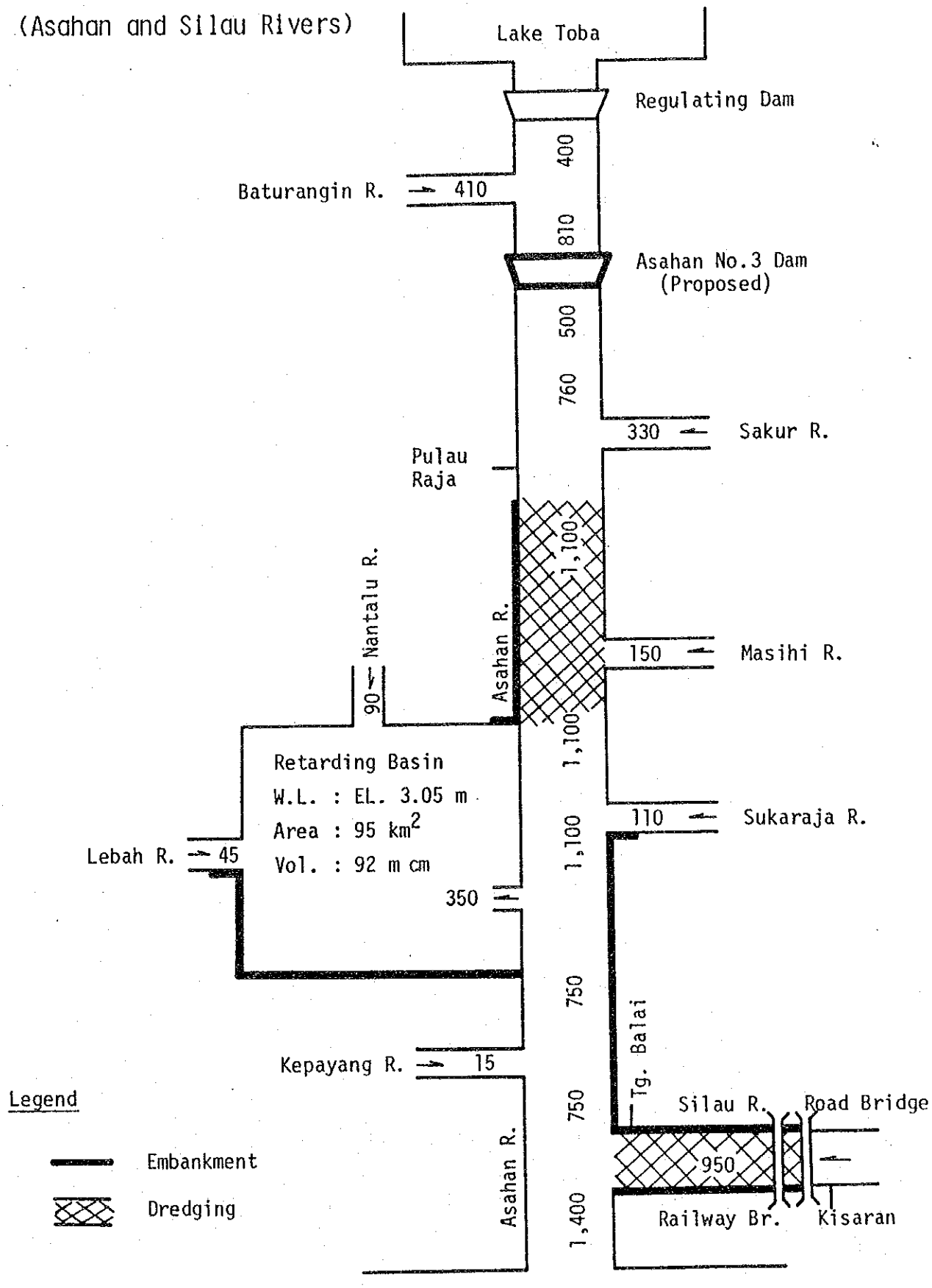


Fig.H-2 Design Flood Discharge for Proposed Long-Term Plan (3/3)

(Kualuh River)

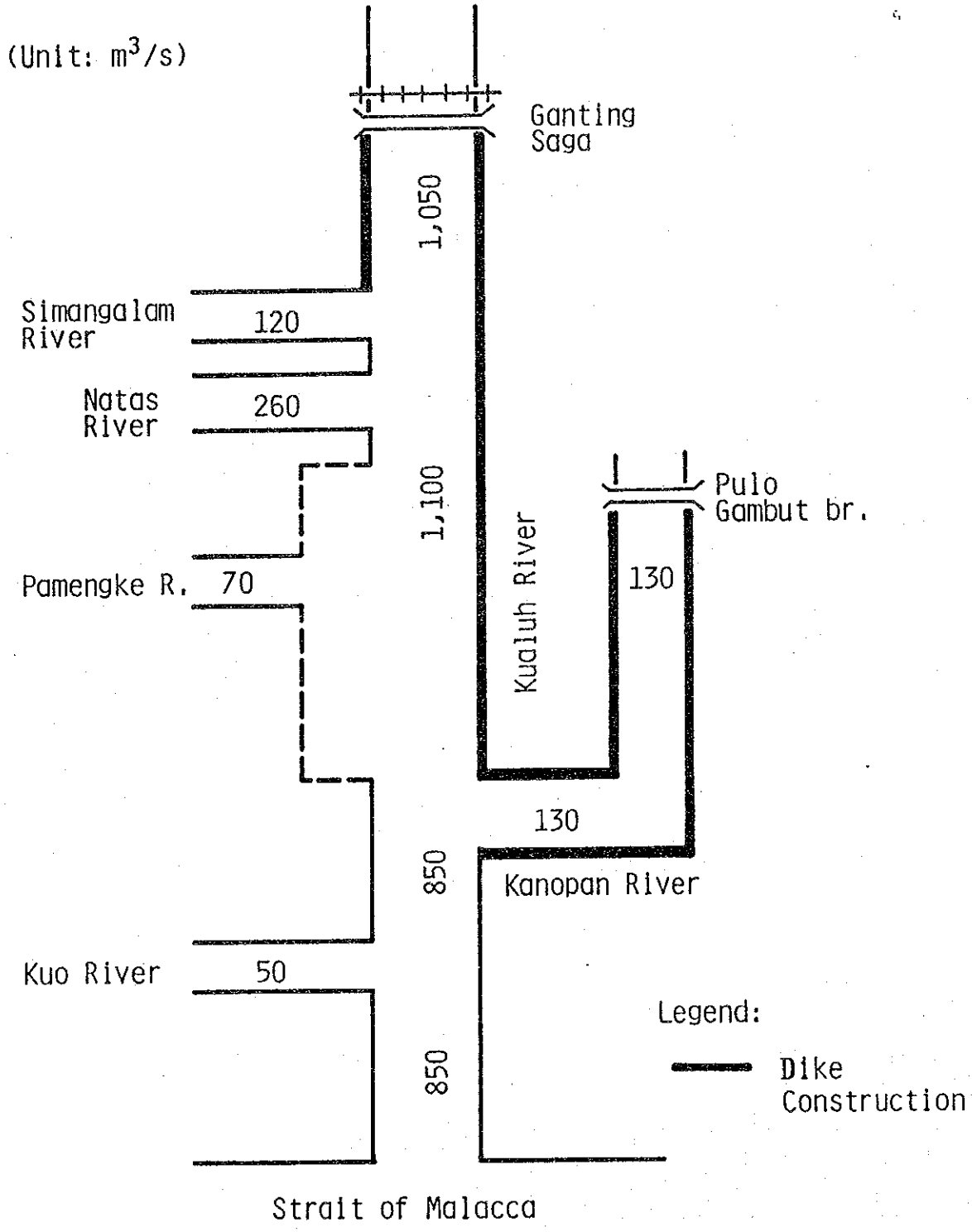


Fig.H-3 Proposed Long-Term Plan of Bunut River (1/3)

(Dike Alignment)

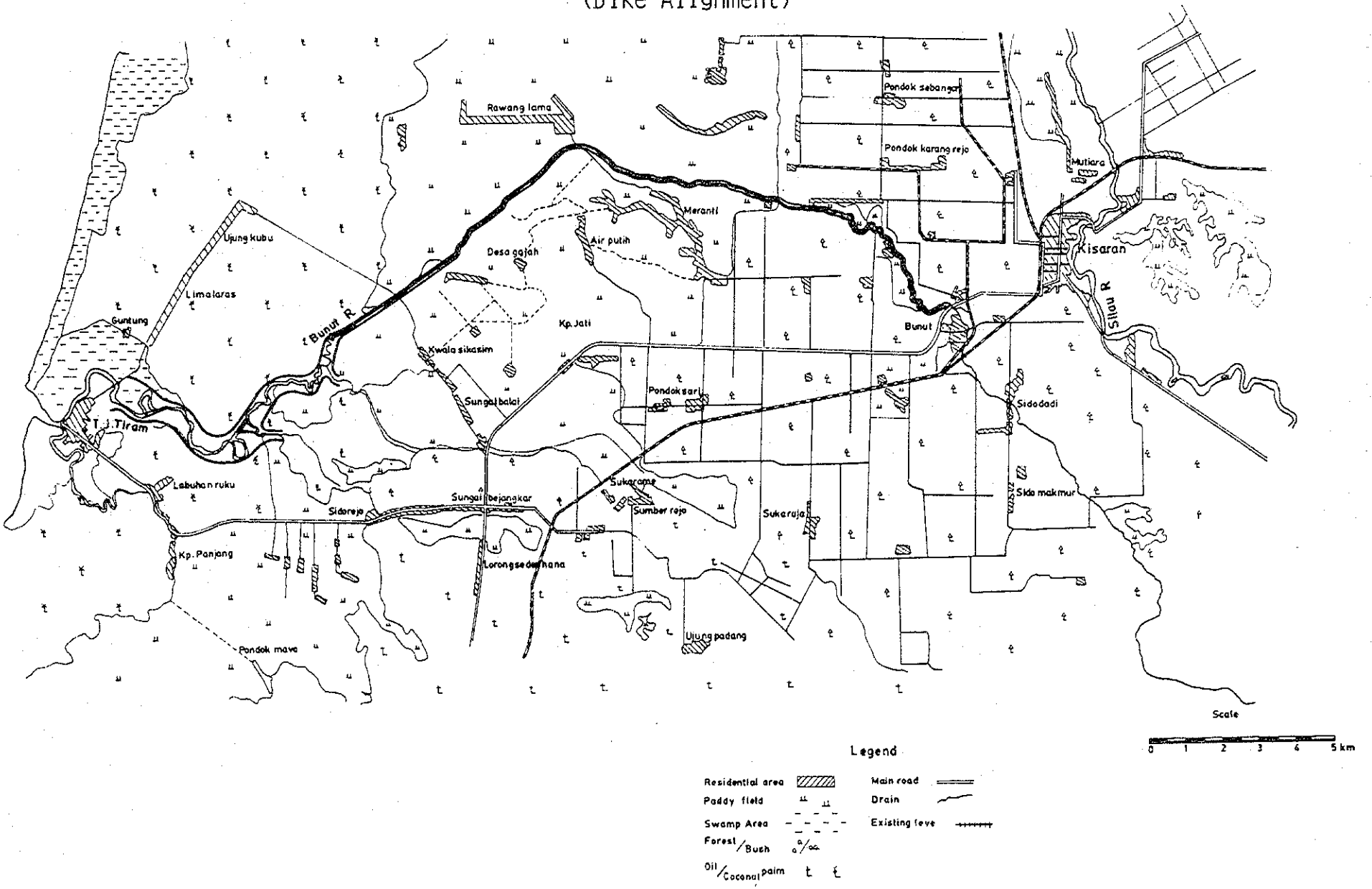


Fig.H-3 Proposed Long-Term Plan of Bunut River (2/3)
(Longitudinal Profile)

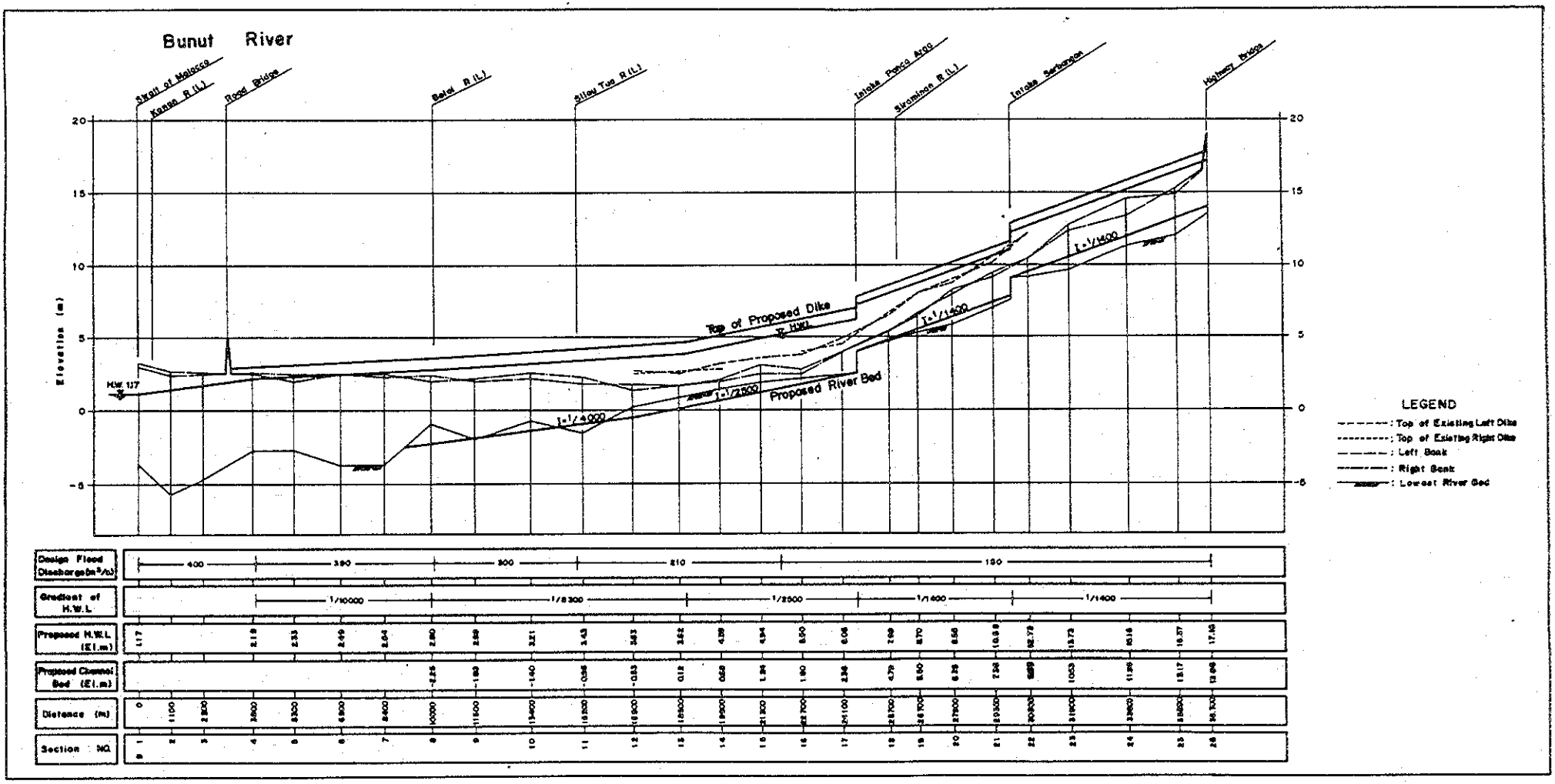
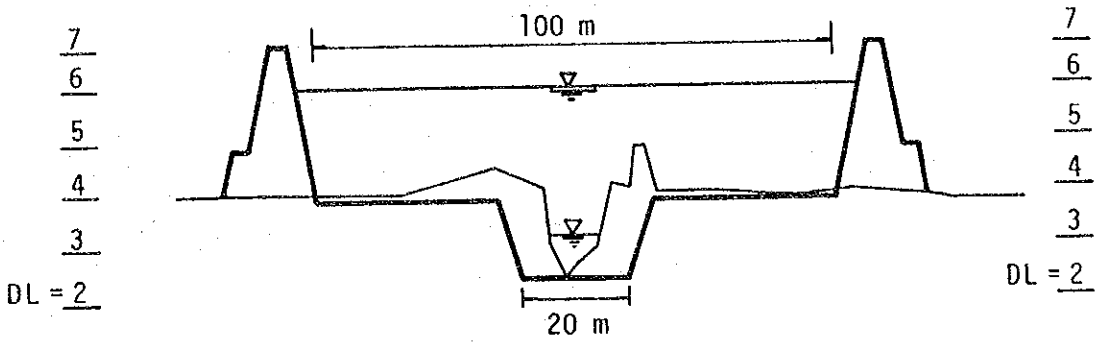


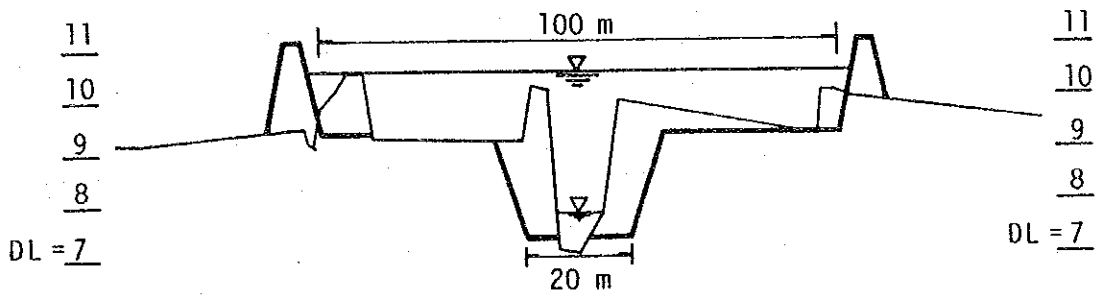
Fig.H-3 Proposed Long-Term Plan of Bunut River (3/3)

(Cross-section)

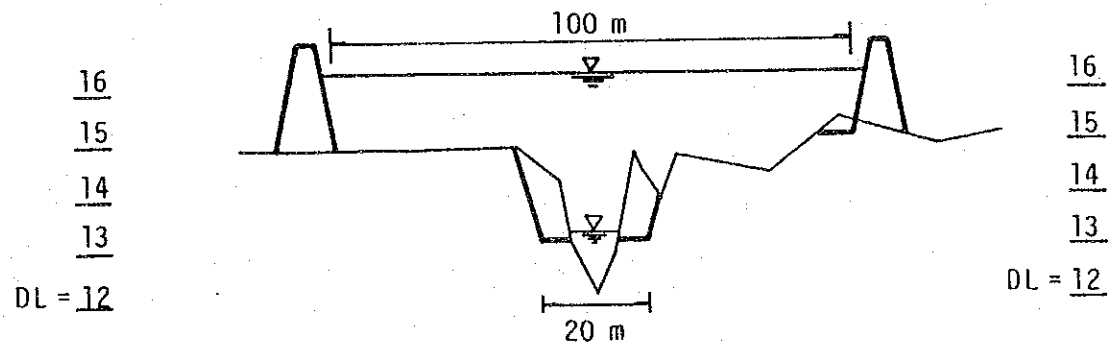
B.17



B.21



B.25



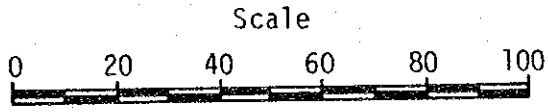


Fig.H-4 Proposed Long-Term Plan of Asahan and Silau Rivers (1/6)

(Dike Alignment)

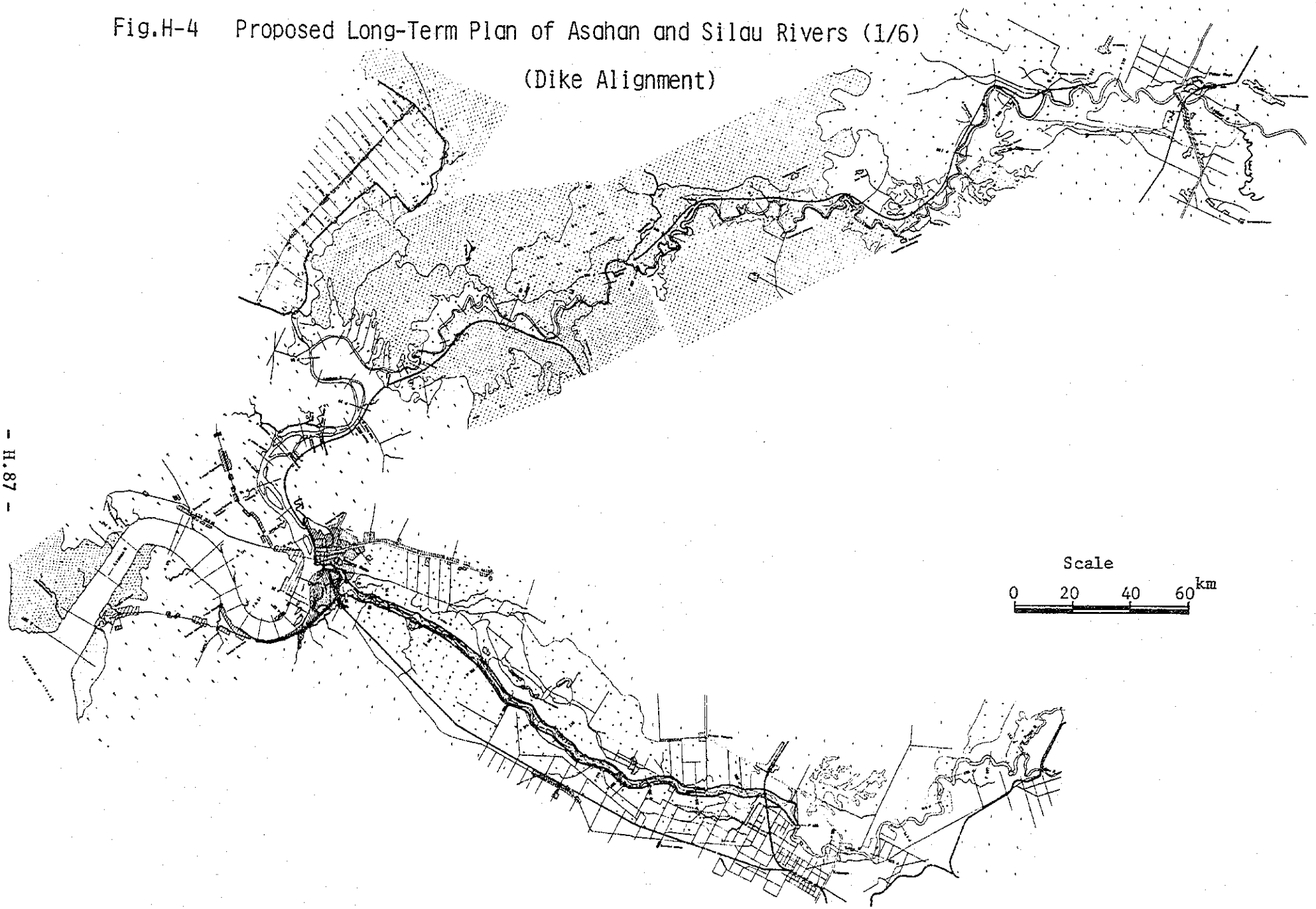
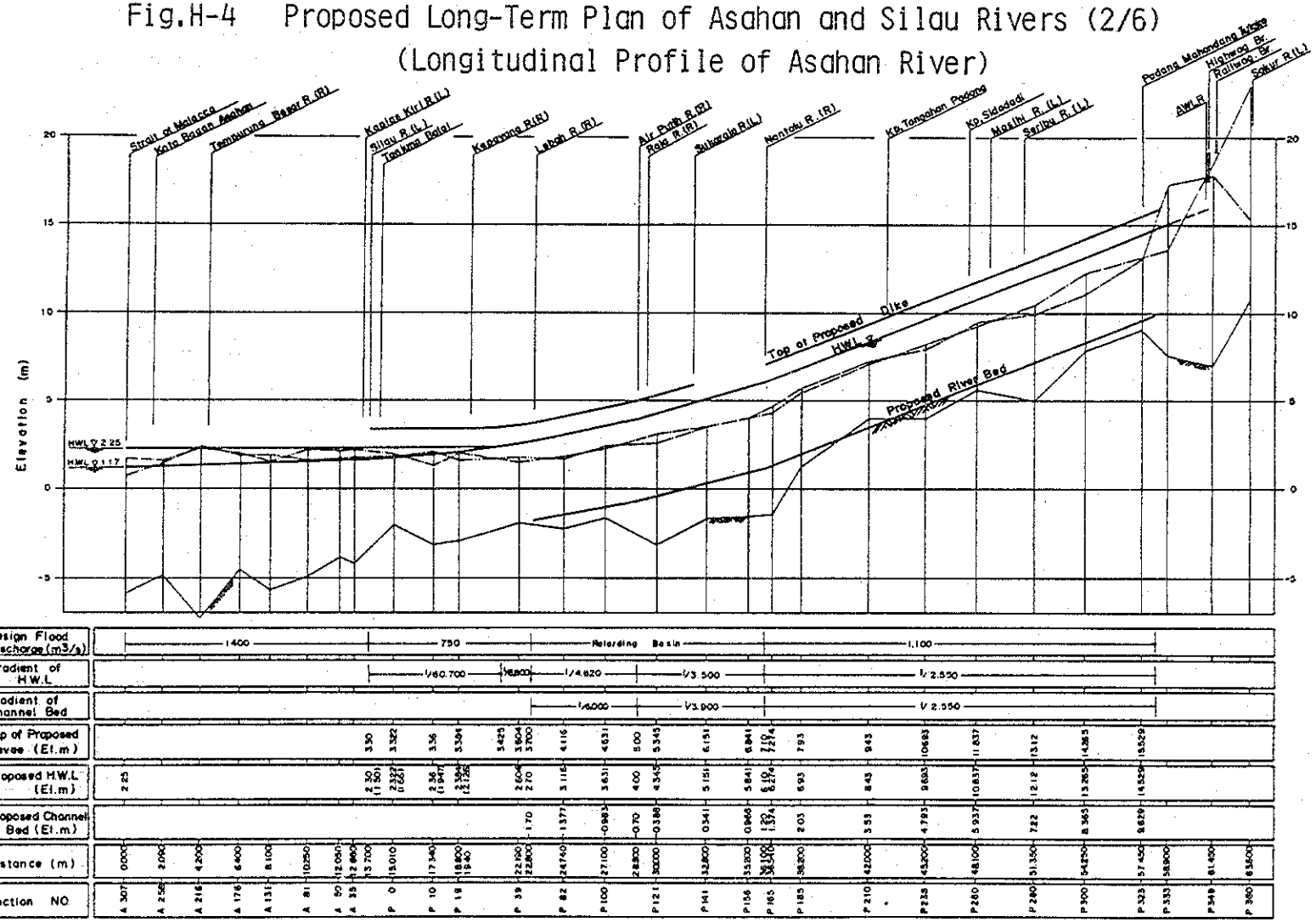


Fig.H-4 Proposed Long-Term Plan of Asahan and Silau Rivers (2/6)

(Longitudinal Profile of Asahan River)



LEGEND

- : Top of Existing Left Dike
- : Top of Existing Right Dike
- : Left Bank
- : Right Bank
- : Lowest River Bed
- : Proposed Dike

Fig.H-4 Proposed Long-Term Plan of Asahan and Silau Rivers (3/6)

(Cross-sections of Asahan River)

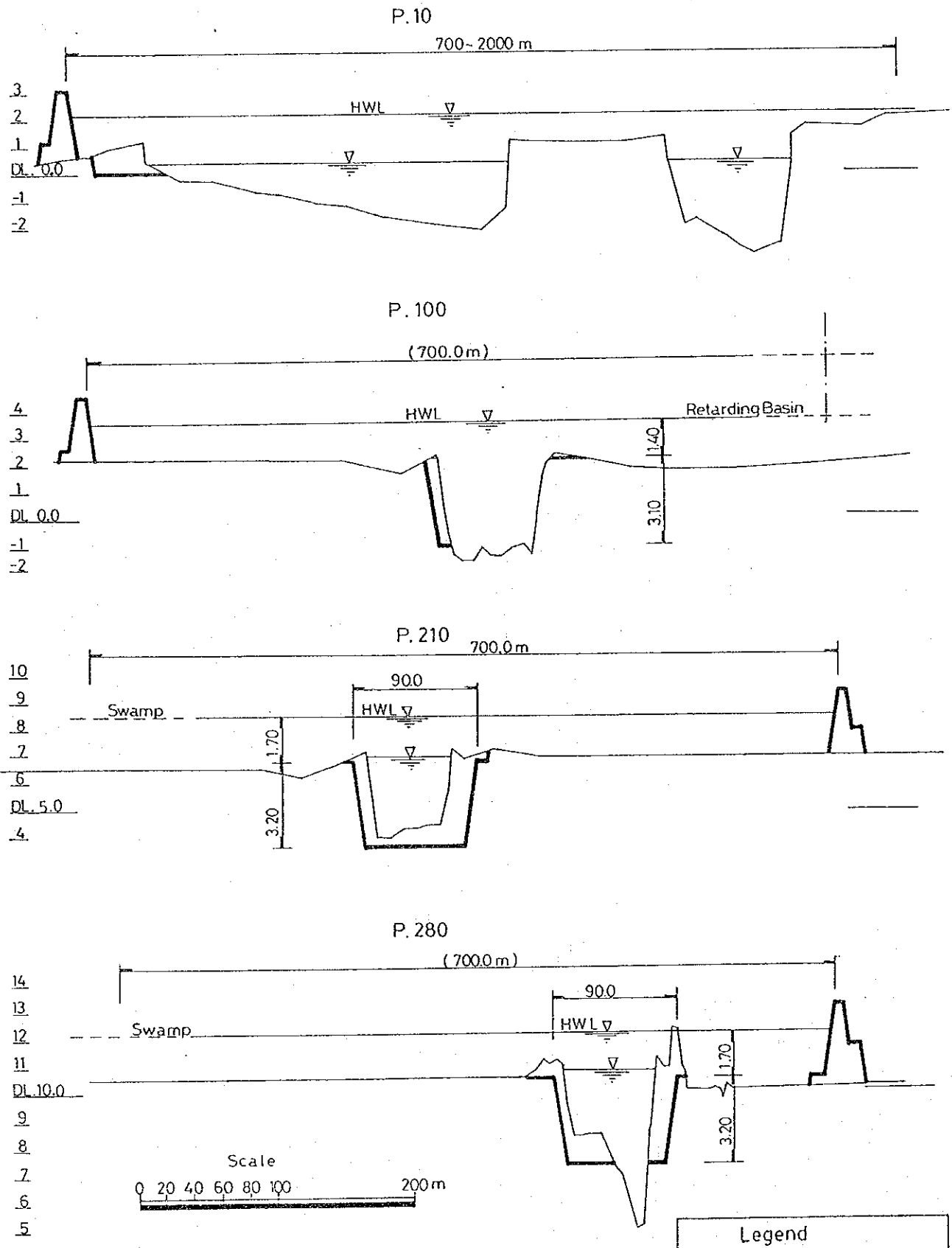
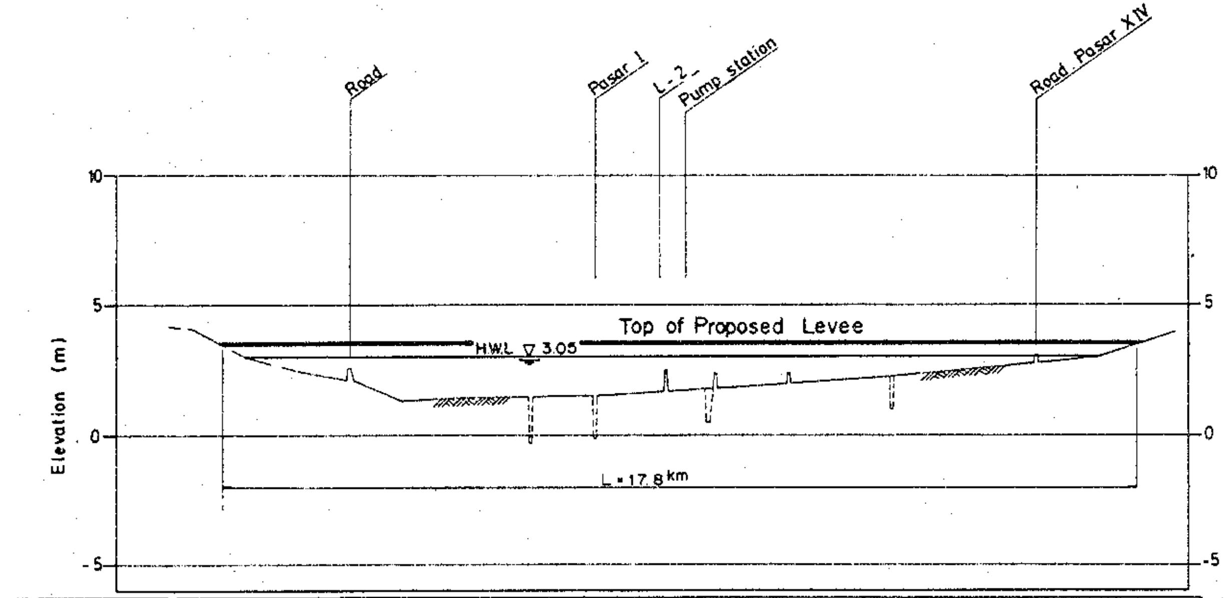


Fig.H-4 Proposed Long-Term Plan of Asahan and Silau Rivers (4/6)

(Longitudinal Profile and Cross-sections of Lebah River)



Section No	-3	-2	-1	C 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Top of Proposed Levee (EL.m)				3.50	3.50	3.50			3.50					3.50			3.50			
Proposed H.W.L (EL.m)				3.05	3.05	3.05			3.05					3.05			3.05			
Ground Hight (EL.m)	4.0	3.0	2.5	2.1	1.3	1.4			1.5					2.2			2.8			
Distance (Km)	-3.00	-2.00	-1.00	0	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00

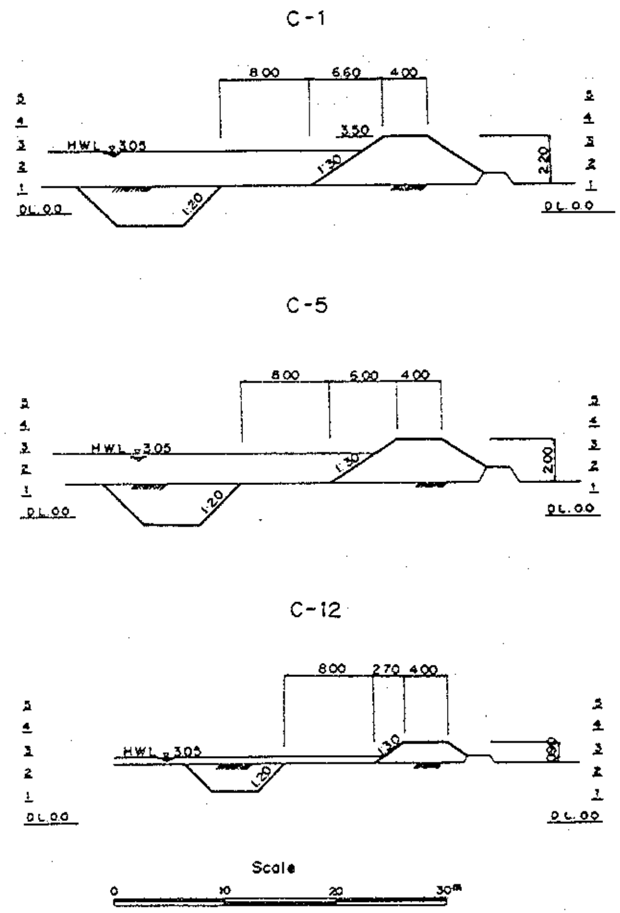
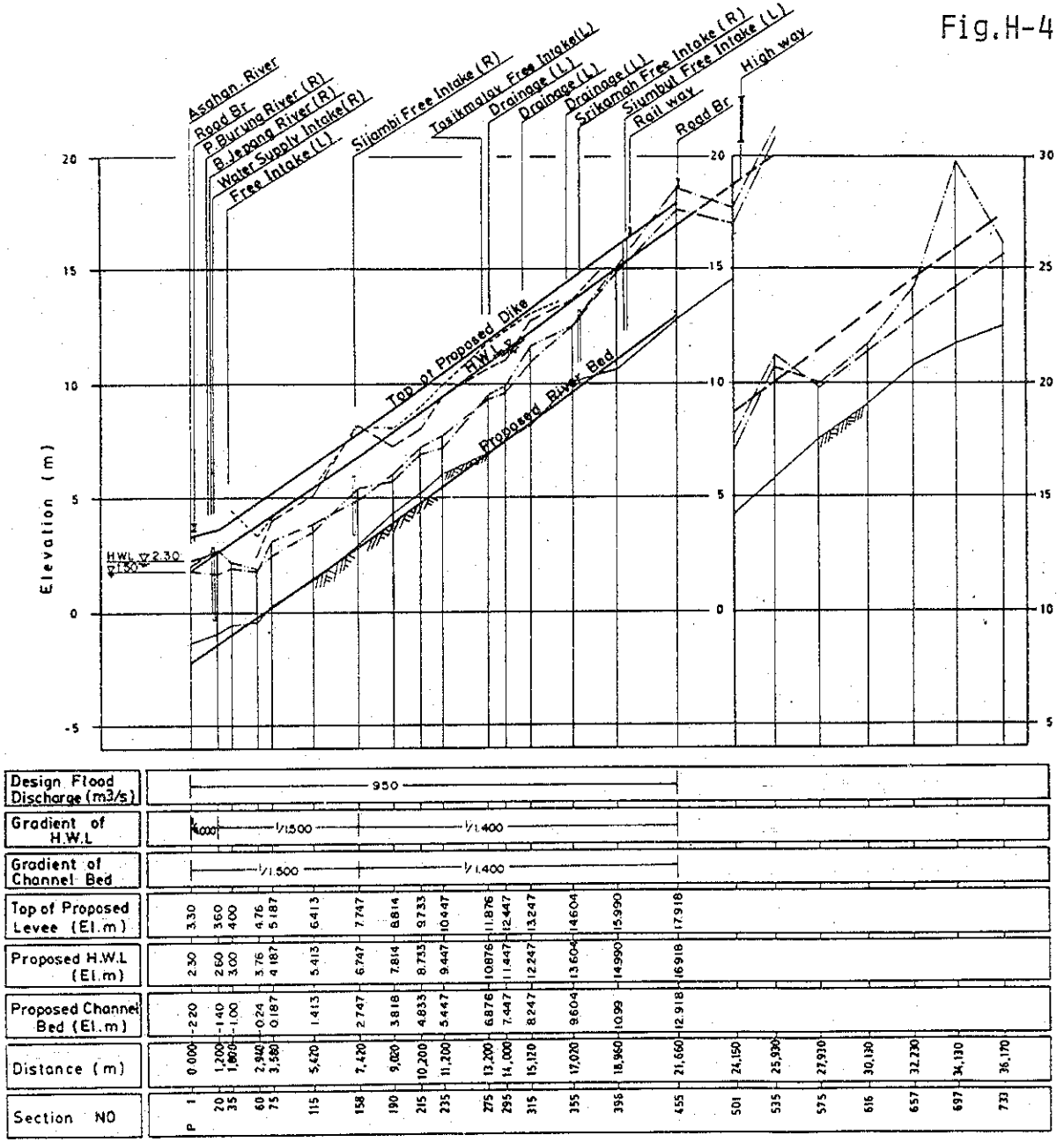


Fig.H-4 Proposed Long-Term Plan of Asahan AND Silau Rivers (5/6)

(Longitudinal Profile of Silau River)



LEGEND

- : Top of Existing Left Dike
- : Top of Existing Right Dike
- : Left Bank
- : Right Bank
- : Lowest River Bed
- : Proposed Dike

Fig.H-4 Proposed Long-Term Plan of Asahan and Silau Rivers (6/6)

(Cross-sections of Silau River)

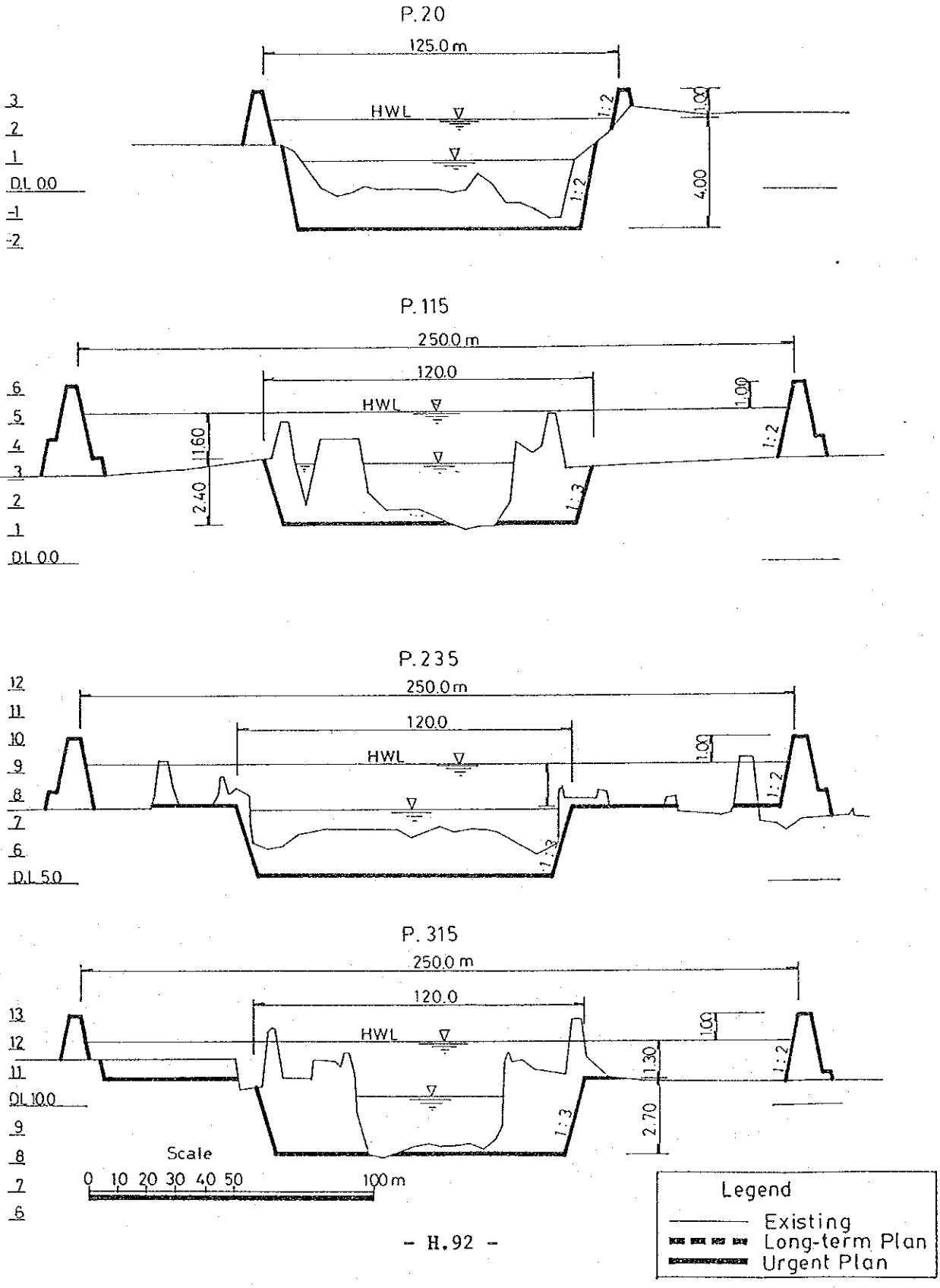


Fig.H-5 Proposed Long-Term Plan of Kualuh River (1/3)

(Dike Alignment)

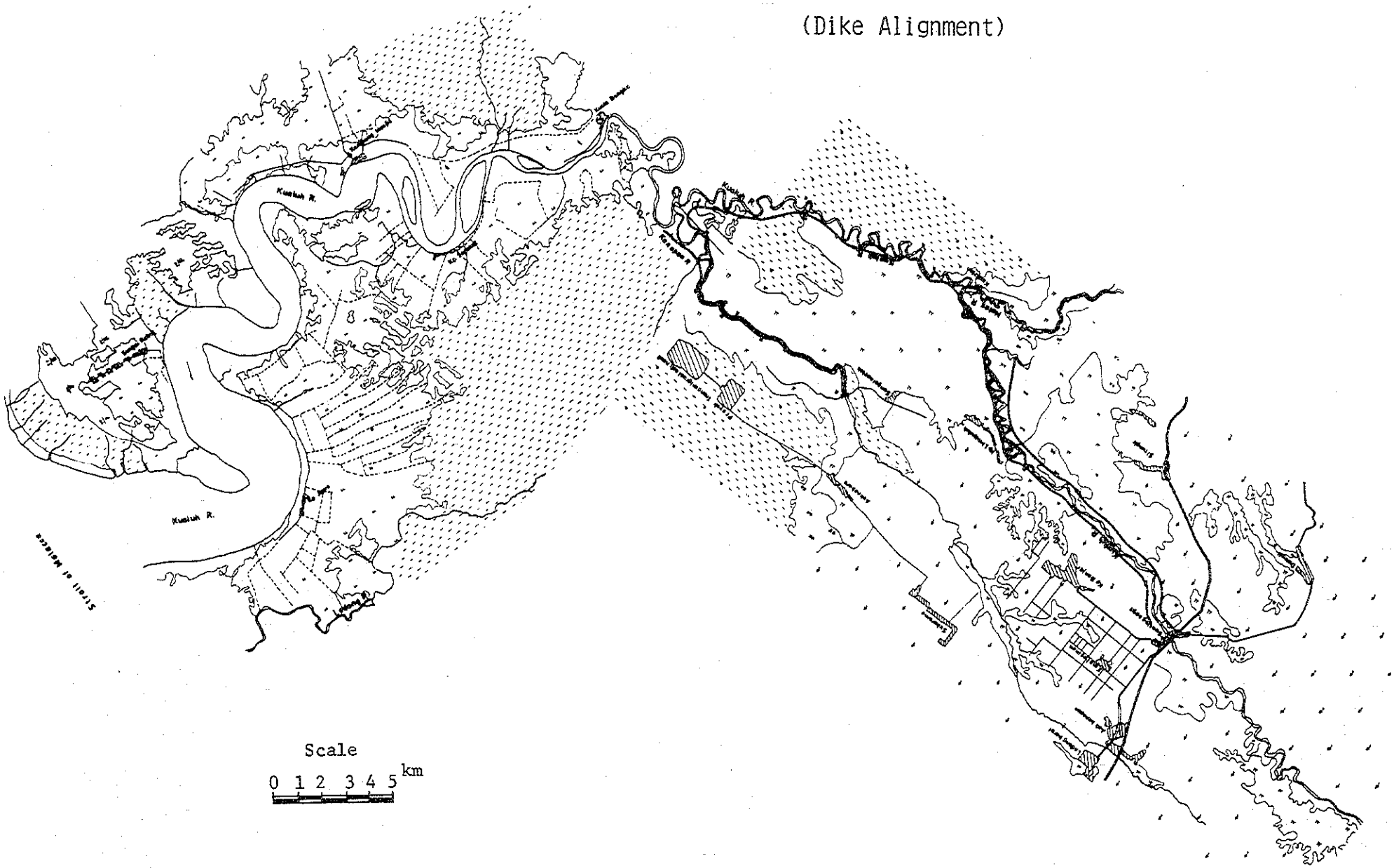


Fig.H-5 Proposed Long-Term Plan of Kualuh River (2/3)
(Longitudinal Profile)

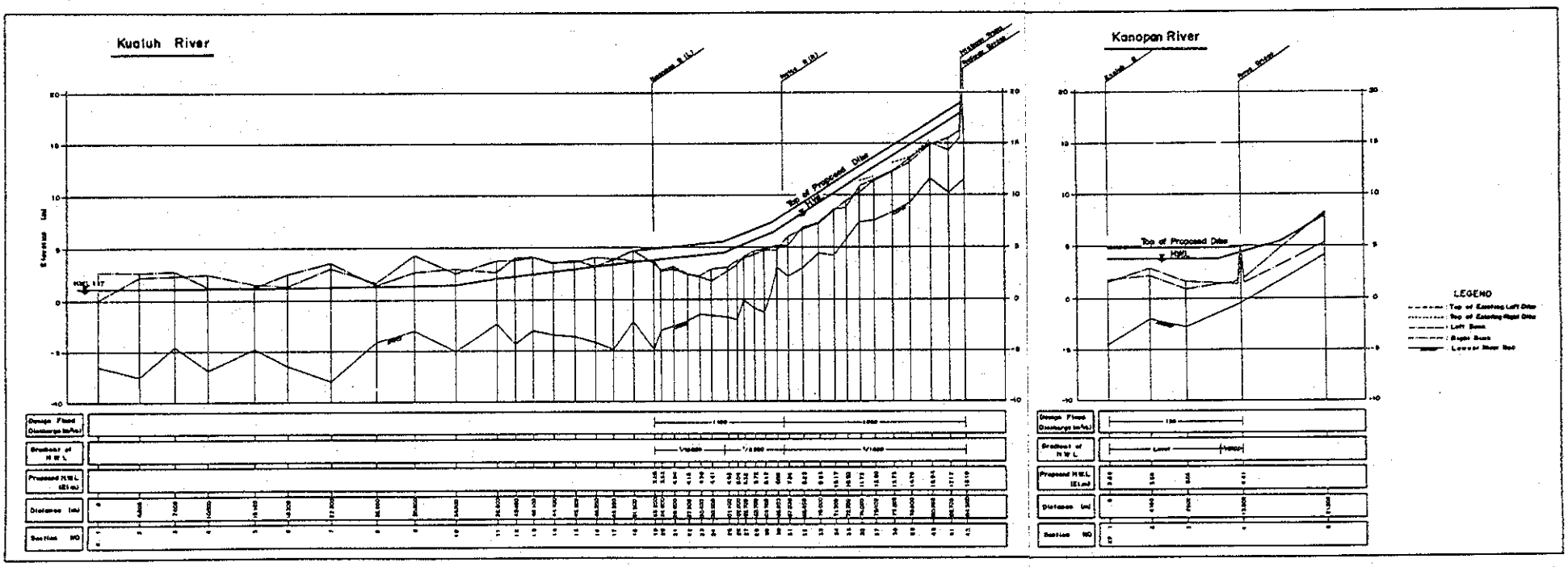
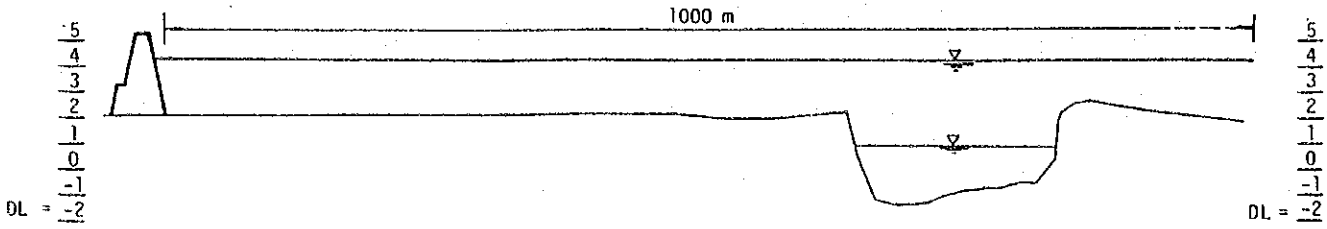


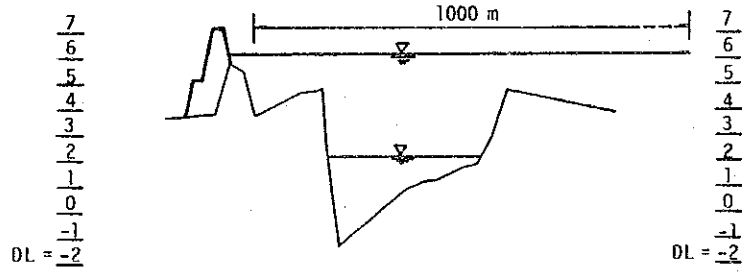
Fig.H-5 Proposed Long-Term Plan of Kualuh River (3/3)

(Cross-section)

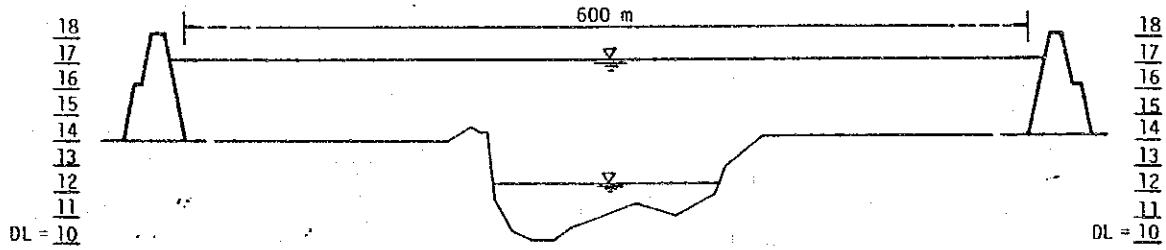
K.23



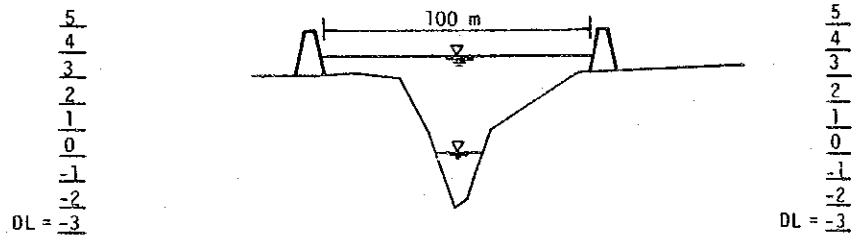
K.29



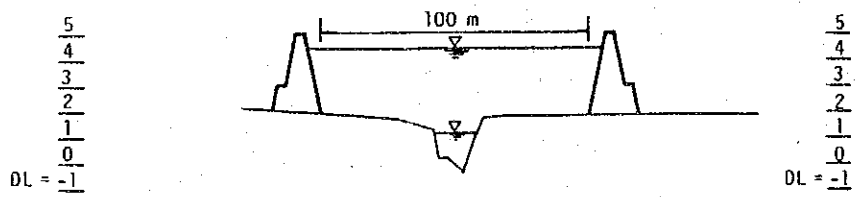
K.41



Kp.2



Kp.4



Scale

0 20 40 60 80 100

Fig.H-6 Design Flood Discharges for Proposed Urgent Plan

(Unit: m^3/s)