CHAPTER 5

ON- GOING PROJECT

Chapter 5. ON-GOING PROJECT

5.1 Watershed Management

For advancement of the watershed management of the Upper Citarum Basin, the Ministry of Forestry proposed the land use plan consisting of the following three (3) categories.

(1) Preserved forest : No development will be permitted.
(2) Buffer zone forest : The area with limited development
(3) Cultivation area : Paddy, dry field, etc.

The land use proposal is shown in Fig. 5.1.

The following erosion control measures are proposed for the areas of serious land erosion shown in Fig. 3.2.

- Terrace formation of dry fields
- Small dams for sediment storage
- Drainage channel
- Stormwater infiltration works, etc.

Some examples of the erosion control measures proposed by Ministry of Forestry are shown in Fig. 5.2.

5.2 Citarum River Improvement

The project proposed by Ministry of Public Works is comprised of the following short-term and middle-term activities. The short-term activities are on-going.

(1) Short-term activities

(a) Dredging of the Citarum River over a 5.8 km distance in the area of Dayeuh Kolot, starting from a point 4.4 km downstream of the Dayeuh Kolot bridge towards the upstream direction.

(b) Cut-off channel I : 3.1 km

(2) Middle-term activities

- Diversion of the Cisangkuy River : 3.1 km
- Cut-off channel II : 0.56 km
- Cut-off channel III : 1.26 km
- Normalization of river channel : 34.5 km
- Construction of dikes : 46 km

The total estimated cost is Rp. 45,950 million at 1986 prices.

Location of the projects is shown in Fig. 5.3.

Note: The project is subject to change after completion of this Study.

5.3 River Improvement of Tributaries

Bandung urban area sustains floods of the tributaries flowing through it. The potential flood prone area is estimated to be approximately 1,000 ha (See Fig. 5.4). To mitigate flood damages of the area, the following river improvement works are on-going with the financial assistance of ADB. Location of the projects are shown in Fig. 5.3.

Name of River	Catchment Area (km^2)	Improvement Length (km)	Remarks
(1) Cipamokolan	44.8	8.7	Under construction (ADB assistance)
(2) Cidurian	23.1	8.4	Under planning ready for construction
(3) Ciwastra	8.9	6.4	Under planning ready for construction
(4) Cicadas	24.1	9.6	Completed partially
(5) Cikapundung Kolot	22.5	5.3	Under construction (ADB assistance)
(6) Citepus	18.4	6.5	Under construction (ADB assistance)
(7) Cikapundung-Cipalasari	110.2	8.8	Under planning ready for construction
Total		53.7	

This Study Team reviewed the on-going project. The evaluation is summarized below.

(1) The design flood frequency of 20-year is adequate to meet the long-term flood control requirement of the rivers.

(2) With regard to the Cipalasari - Cikapundung, Cidurian and Cipamokolan River, the design discharge is large enough to carry flood run-offs which may occur under the future land use conditions in the year 2005. The river channel improvements may be implemented according to the existing plan.

(3) With regard to the Citepus, Cikapundung Kolot, Cicadas and Ciwastra Rivers, the design discharge is not sufficient in scale to cope with the increasing flood peaks in the future (2005 year). However, the river channel improvements may be implemented according to the existing plan to meet the urgent flood control requirement based on the following considerations;

It will be possible to increase the discharge capacity of the river channels to meet the increased flood peaks in the future by dredging within the river widths of the existing plan even after the completion of the existing plan.

(4) A comprehensive flood control approach will be required in future to cope with the following situations.

- The drainage basins may be subject to haphazard land developments in future and such developments will often bring an unexpected increase of flood peak in the tributaries.

- The on-going river improvement plan is prepared to carry the flood run-offs under the land use conditions in 2005. It can not meet the increasing floods in the far future beyond the year 2005.

Possible components of the comprehensive flood control approach are:

- Re-dredging of the river bed within the river widths
- Provision of retention ponds
- Emergency use of play ground, park and other public space for flood retention
- Preservation of forest area

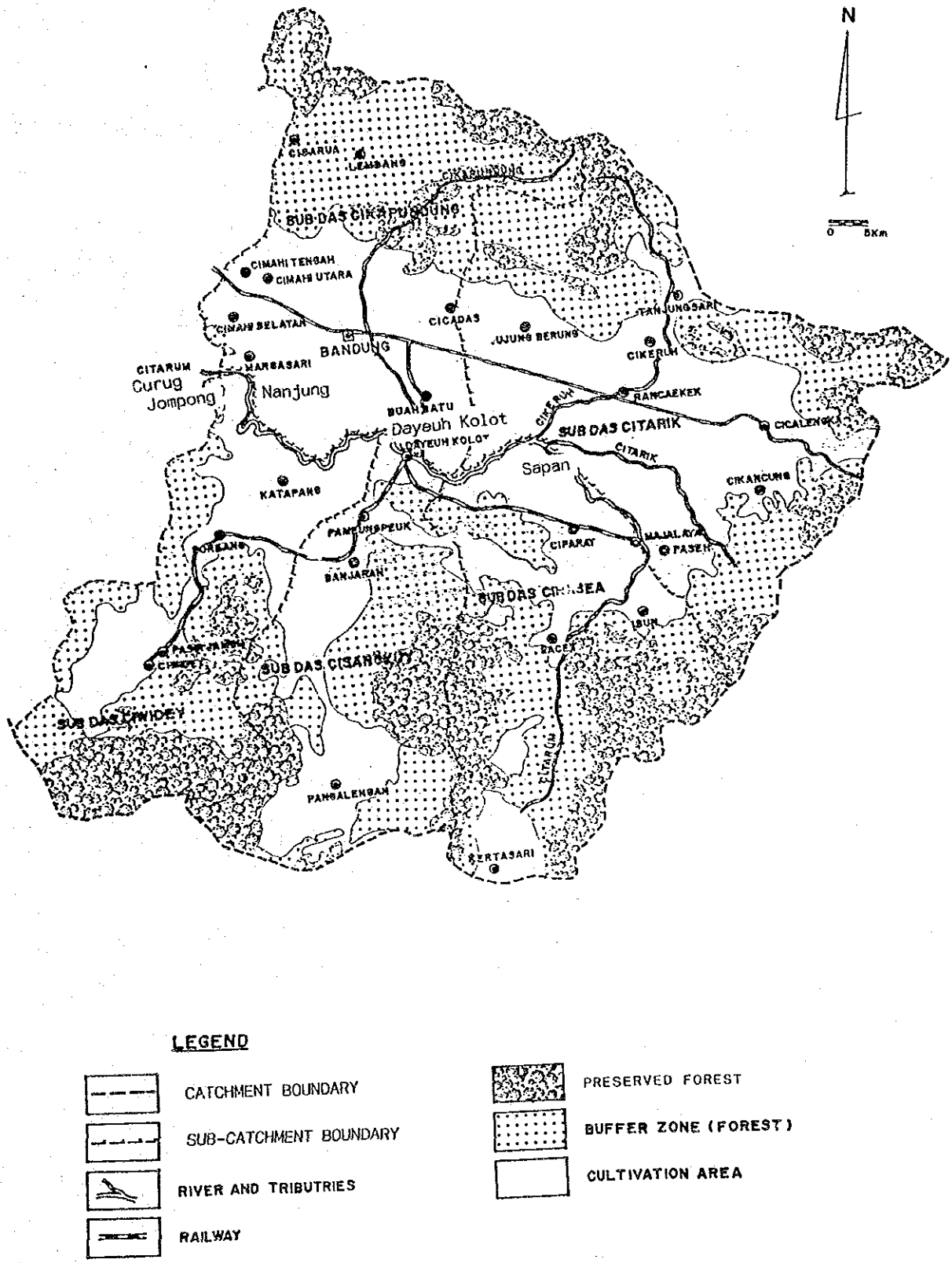

FIG. 5.1 LAND-USE PLAN FOR FOREST/CULTIVATION AREA

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

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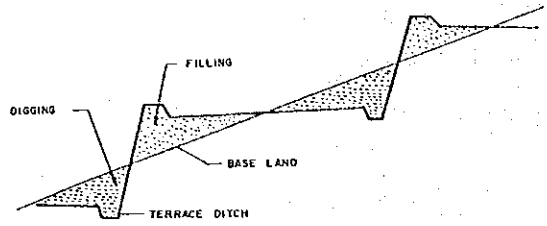
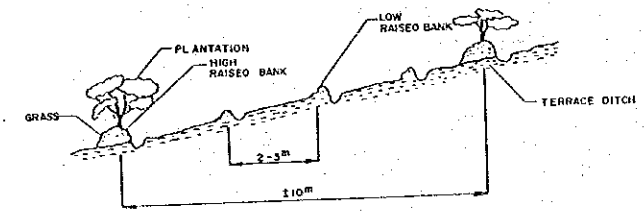
TERRACE FORMATION OF DRY FIELD

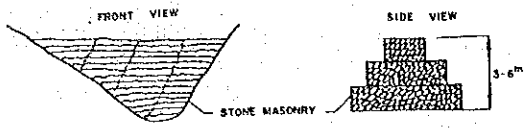


BENCH TERRACE

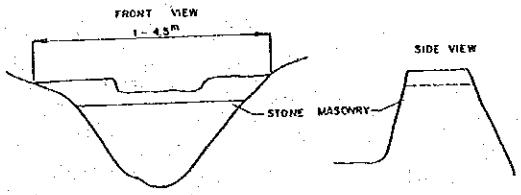


SMALL BANK TERRACE

SMALL DAMS FOR SEDIMENT STORAGE

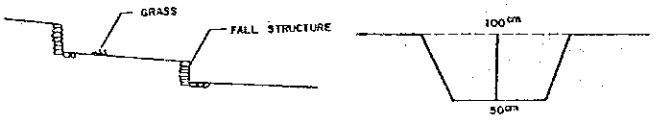


RETENTION DAM

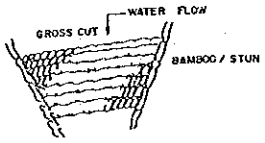


TORRENT WORKS

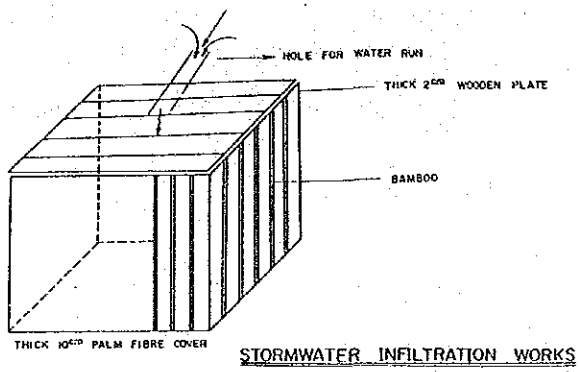
DRAINAGE CHANNEL



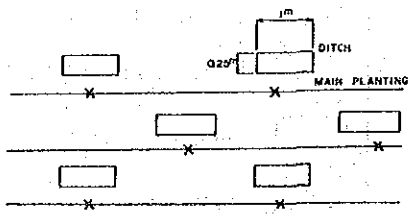
DRAINAGE CHANNEL



DROP STRUCTURE



STORMWATER INFILTRATION WORKS



SEDIMENTS TRAP

FIG. 5.2 EROSION CONTROL MEASURES BY MINISTRY OF FORESTRY

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

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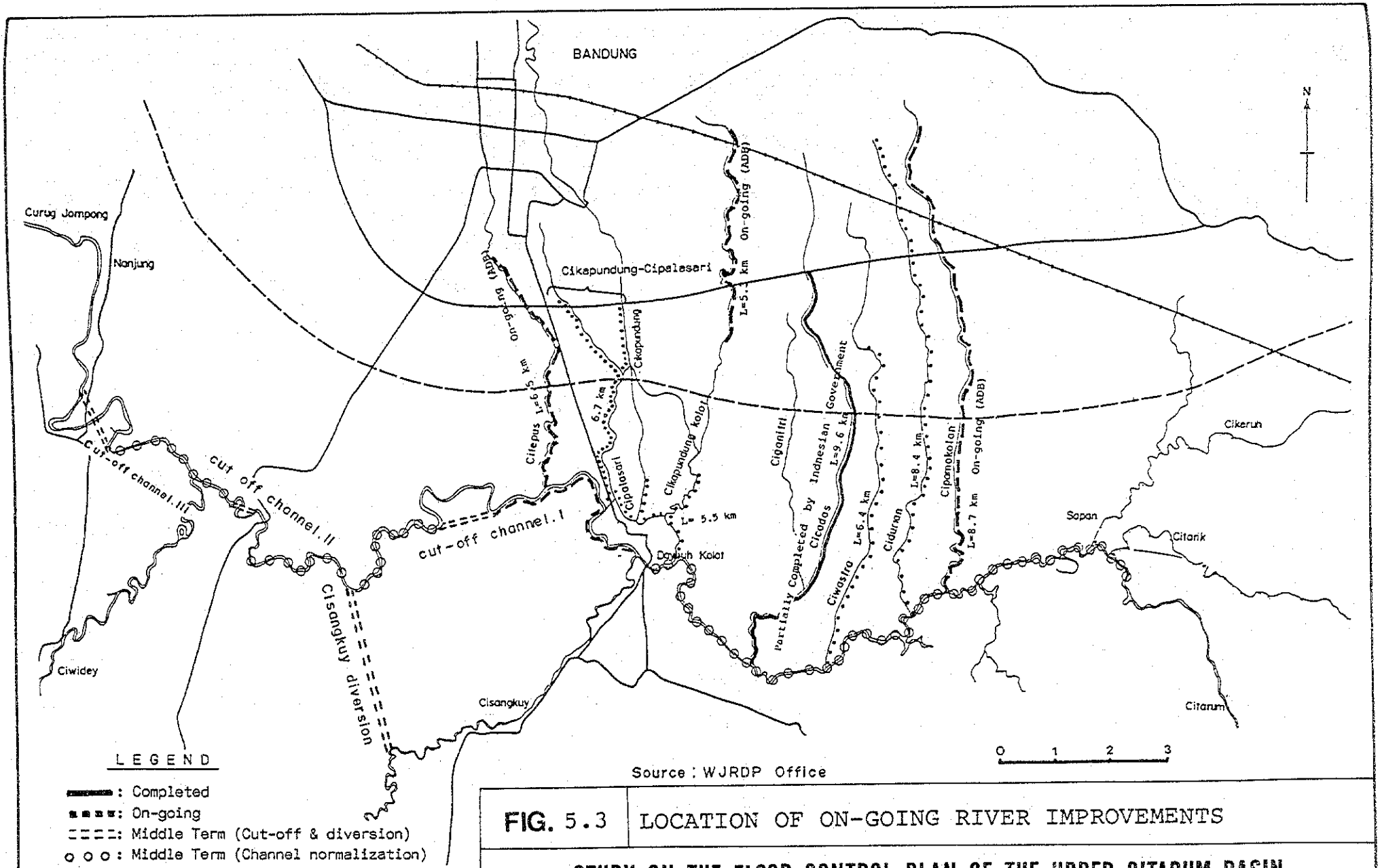

Source : WJRDP Office

FIG. 5.3 LOCATION OF ON-GOING RIVER IMPROVEMENTS

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

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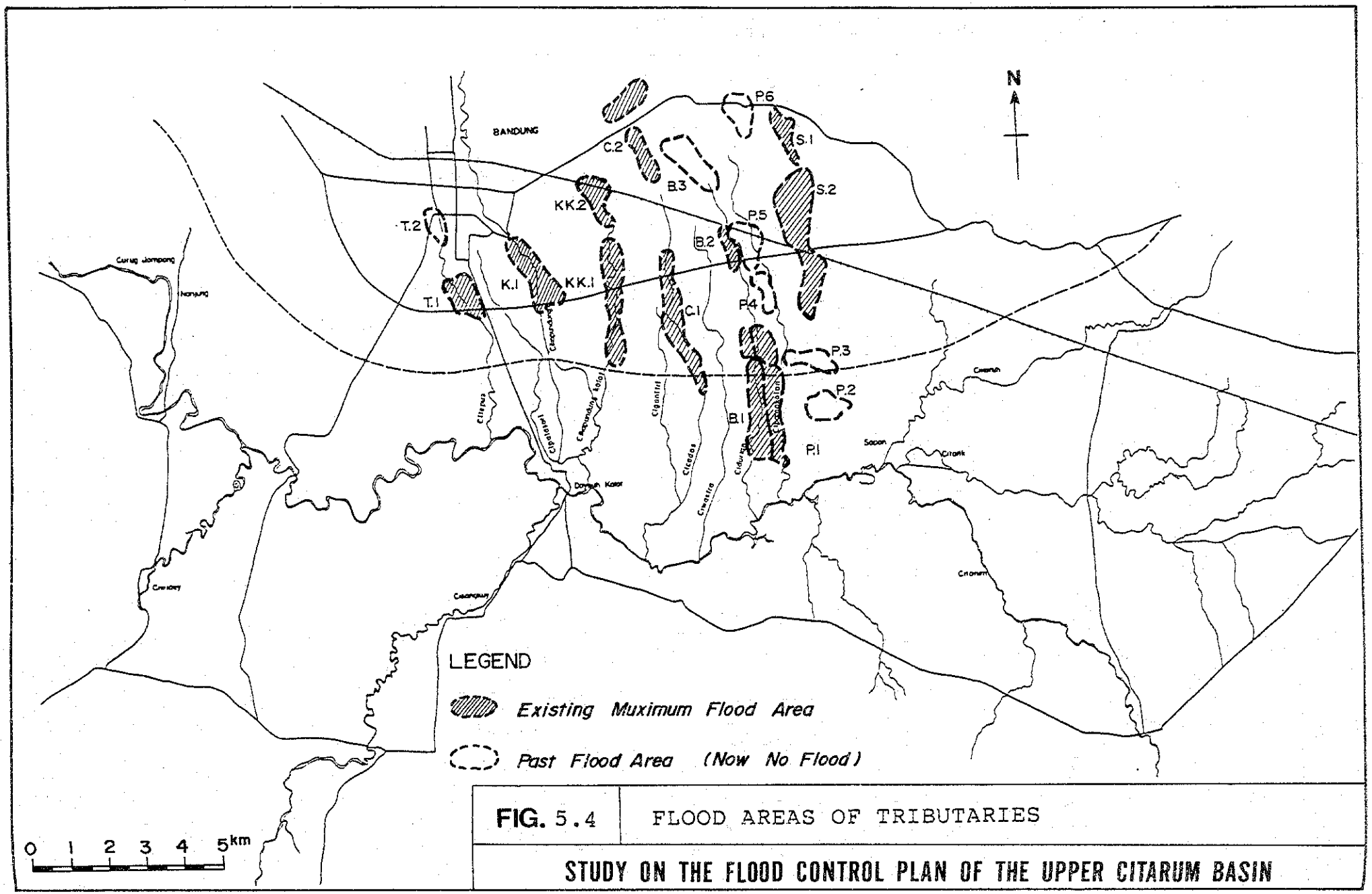


FIG. 5.4 FLOOD AREAS OF TRIBUTARIES

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

CHAPTER 6

OVERALL FLOOD CONTROL PLAN

Chapter 6. OVERALL FLOOD CONTROL PLAN

6.1 Target Flood Area and Year

Flood control measures in the Study Area will be provided to mitigate the flood problems existing in the following flood prone areas.

- Citarum River flood area
- Flood area in Bandung Urban Area

For the flood area in Bandung Urban Area, the flood control project consisting of the improvements of the related tributaries is on-going by the Government of Indonesia. This proposed on-going project is considered to meet the long-term requirement of flood control for Bandung Urban Area.

In this Study, the overall flood control plan is prepared to meet the projected socio-economic conditions in the year 2005, however, only for the Citarum flood area.

6.2 Flood Control Measures

Land developments in the watershed will increase flood peaks in the river downstream. Land developments in the flood plain will increase flood damage potential. Improvement of the flood conditions may encourage land developments in the flood plain if no proper land use control is made. These conditions would necessitate repeated flood control measures, such as river improvement works etc.

Experiences in the past show that the above-mentioned problems can not be solved only by the structural measures of river improvement. It seems to be true for the Citarum River as well in view of the following river and basin conditions.

- The low-lying area of the Citarum River Basin was originally a lake and therefore, it is much prone to flooding
- The discharge capacity of the River is small

- Large-scale enlargement of the River is difficult due to its topographical and geological conditions
- The flood plain may be subject to sprawl developments extending from Bandung area in some parts.

An integrated approach of structural and non-structural flood control measures is required to attain a satisfactory solution of the flood problems in the flood areas of the Citarum River and related tributaries. Since the non-structural flood control measures is effective only with a proper land-use regulation and guidance, both flood control and land-use plans of the Basin shall be well coordinated.
Conceivable structural and non-structural measures are as follows.

- Flood control dam
- Retarding basin
- River improvement
- Watershed management
- Flood plain management

Among the above-mentioned measures.

(1) Possible dam sites are limited to the upstream of the tributaries, and are also with a low storage volume and a small catchment area. Locations and main features of the selected major potential dams are shown in Fig. 6.1. Even these selected major dams are not effective for flood control of the Citarum Main River because their storage capacity is too small compared to the magnitude of flood. Flood control by dam is not proposed in this Study.

(2) No suitable retarding basin sites are available since the flood prone areas are all highly developed with paddy cultivation and residential uses.
Flood control by retarding basin is not proposed in this Study.

(3) Erosion control in the watersheds is essentially required to maintain the downstream river course as planned. Erosion control works of the critical areas are being carried out in accordance with the plans proposed by the Ministry of Forestry.

From the above considerations of (1) ~ (3), the flood control measures consisting of river improvements and flood plain management are only considered as the viable alternatives for the overall flood control plan of the Citarum River.

The project components constituting the overall flood conrol plan of the Upper Citarum Basin are shown in Fig. 6.2.

6.3 Alternative Study of Long-Term River Improvement Plan

6.3.1 River Improvement Method

Two (2) methods are conceivable for improvement of the Citarum River. One is dredging method including cut-off channel. Another is dyking method. The dyking method requires dyke construction not only for the main river but also for the tributaries together with pump drainage of inner water.

The construction costs of both the two (2) river improvement methods are roughly estimated as shown below. In this estimates, the design flood frequency for the river improvements is assumed to be 20 years.

(1) Dyke method (see Fig. 6.3)

1) River improvement			
- Main river	L = 16.8 km	:	Rp. 13.2 billion
- Tributaries	L = 80.7 km	:	Rp. 37.9 billion
- Other cost	L.S	:	Rp. 21.9 billion
2) Pump drainage	A = 137 km^2	:	Rp. 137.0 billion
3) Total		:	Rp. 210.0 billion

(2) Dredging method (see Fig. 6.3)

1) Main river improvement	L = 40.2 km	:	Rp. 80.3 billion
2) Tributaries improvement	L = 31.5 km	:	Rp. 13.5 billion
3) Other cost	L.S	:	Rp. 24.9 billion
4) Total		:	Rp. 118.7 billion

Dredging method is recommended for improvement of the Citarum River based on the above considerations.

6.3.2 Design Flood Frequency

The design flood frequency of long-term flood control plan in Indonesia is 20 to 50 years in general as shown in Table 6.1. In this Section, the following two (2) alternative river improvement plans are discussed.

Alternative Scheme of Design Flood Frequency

Name of River	Improvement Stretch (km)	Alternative I (20-year plan)	Alternative II (50-year plan)
Citarum (main)	40.2	20-year	50-year
Citarum (upstream)	6.0	20-year	20-year
Citarik	15.0	20-year	20-year
Cikeruh	2.0	20-year	20-year
Cisangkuy	8.5	20-year	20-year

(1) Hydraulic Design Condition

The design discharge distributions for the two (2) alternative plans are shown in Fig. 6.4. The design river bed slopes and cross sections of both alternative plans are shown in Fig. 6.5.

(2) Construction Costs

The required construction costs of the Alternative I and II are Rp. 118,996 million and Rp. 138,824 million respectively as shown in Table 6.2.

(3) Flood Damage Reduction and Economic Internal Rate of Return (EIRR)

Reduction of average annual flood damage and EIRR by the two (2) alternative plans are estimated as follows:

Item	Annual Flood Damage (Million ERp.)	Reduction (Million ERp.)	Reduction Rate (%)	EIRR (%)
Without Project	16,136	-	-	-
Alternative I	130	16,006	99.2	11.6
Alternative II	88	16,048	99.5	10.2

Note : ERp shows economic price in Rupiah

(4) Conclusion

A design flood frequency of 20-year is applied for the long-term river improvement plan based on the following facts and considerations.

1) The design flood frequency of 40 to 50-year is applied for the long-term flood control plan of the important rivers in Indonesia, in general. Those rivers are all provided with dyking system. While, a design flood of lower safety level can be applied for the flood control plan by dredging system than that by dyking system in consideration of the difference of flood damages caused by overflow floods of the rivers with dykes and without dykes.

2) The river improvement of 20-year frequency flood can drain a 50-year frequency flood with a small flood depth of 0.3 m above ground level at Dayeuh Kolot as shown in Fig. 6.6.

3) The 50-year plan increases the construction cost to a large extent than the 20-year plan. While, it produces a small additional benefit.

6.3.3 Cisangkuy Diversion

In this Section, the feasibility of the Cisangkuy Diversion is discussed.

(1) Diversion Route

The proposed diversion route is shown in Fig. 6.7.

- Inlet site : 8.5 km upstream of the Cisangkuy River
- Outlet site : 11.7 km upstream of the Citarum River
- Diversion length : Approximately 3.1 km

(2) Effect of Diversion

The diversion would make it unnecessary the improvement of the existing Cisangkuy River course and would reduce the requirement of river enlargement for the reaches between Margahayu and Dayeuh Kolot of the Citarum River.

(3) Comparison of With and Without Project Alternatives

The following two (2) alternative plans are compared.

Alternative I (Without Diversion) : Existing Cisangkuy River improvement and large scale improvement of the Citarum River

Alternative II (With Diversion) : Diversion construction and small scale improvement of the Citarum River

1) Design Discharge, River Bed Slope and Cross Section

The proposed design discharges, river bed slope and cross sections of the two (2) alternative plans are shown in Fig. 6.8.

2) Required Construction Costs

The required construction costs of the Alternative I and II are Rp. 25,100 million and Rp. 26,885 million respectively as shown in Table 6.3.

(4) Conclusion

The Cisangkuy Diversion is not recommended for the following reasons.

1) Alternative II requires a higher construction cost than Alternative I.

2) The diversion channel would split the communities and would affect the traffic and agricultural activities of the residents.

3) The diversion project can produce no beneficial effects until its completion. On the contrary, the improvement of the existing river course can yield beneficial effects in accordance with its progress.

6.3.4 Design Flood Water Level

The lowest ground elevation of the flood area is EL. 656.1 m. Dayeuh Kolot is located at an elevation of EL. 658.1 m.

The inundation area and flood prone houses existing between EL. 656.1 m and EL. 658.1 m are estimated to be approximately 1,000 ha and 2,700 houses (10% of the potential flood prone houses of 27,310). They increase at a high rate when the flood water level rises above EL. 658.1 m. On the other hand, they decrease rapidly when the flood water level lowers down to an EL. 657.6 m as shown in Fig. 6.9.

From the above facts, the design flood water level of the Citarum River at Dayeuh Kolot is decided to be at an elevation between EL. 658.1 m and EL. 657.6 m.

Lowering of the design flood water level increases the required river dredging cost although it will reduce flood damages. The following two (2) alternatives are compared to obtain the optimum design flood water level.

Item	Alt. I	Alt. II	Difference
Design Flood Frequency	1/20	1/20	-
Design Flood Water Level (EL. m)	658.1	657.6	0.5
Required Construction Cost (Million Rp.)	118,996	138,824	19,826
Annual Flood Damage Reduction (Million ERp.)	16,006	16,048	42

Alternative I is recommended.

The design flood water level of the Citarum River at Dayeuh Kolot is proposed to be EL. 658.1 m, allowing approximately 1,000 ha of inundation and 2,700 houses unrelieved from floods in the low-lying parts of the flood plain.

6.4 Proposed Long-Term River Improvement Plan (Structural Measure)

6.4.1 Planning Policy and Design Criteria

The long-term river improvement is planned and designed in accordance with the following policy and criteria.

(1) Target year is set for the year 2005. Plans are to be prepared to meet the population and land use condition projected in the year 2005.

(2) The plans are to be prepared to mitigate flood damage in the existing potential flood prone area.

(3) As for design flood and rainfall pattern, respectively, a 20-year frequency flood and the March 1986 Storm are adopted.

(4) Allowable inundation area considered is approximately 1000 ha.

(5) Target flood water levels determined at Dayeuh Kolot, Sapan and Rancakemit are respectively of EL. 658.1 m, EL. 660.1 m and 661.6 m, considering the ground elevation in the flood prone area and extent of allowable inundation area.

(6) The proposed river channel will be improved by dredging and no major dykes will be provided.

(7) Manning's coefficient of roughness adopted are 0.030 and 0.035, respectively for low-water and high-water channels, based on the channel conditions.

(8) A standard bank slope for the river channel will be adopted as follows:

Citarum River	:	1:1.5 - 1:2
Cisangkuy River	:	1:1.5
Other Rivers	:	1:2

6.4.2 Improvement Reaches and Design Discharge

The Citarum River will be improved along the reaches from Curug Jompong to the uppermost site of the flood prone area to attain a full scale flood control.

The improvement of the tributaries, the Citarum (upstream), Citarik, Cikeruh and Cisangkuy Rivers, will also be included in the Citarum River Improvement Project as a package, since flooding in those tributaries are caused by backwater of the Citarum River.

The existing river length to be improved are as follows:

Citarum River (main)	: Curug Jompong to Sapan	:	40.2 km
Citarum River (upstream)	: Upstream of Sapan	:	6.0 km
Citarik River		:	15.0 km
Cikeruh River		:	2.0 km
Cisangkuy River		:	8.5 km
	Total	:	71.7 km

The design discharge hydrograph at Dayeuh Kolot and design peak discharge distribution are shown in Fig. 6.10.

6.4.3 Proposed River Alignment, Profile and Cross Section

(1) Proposed River Alignment

Cut-off channels are proposed for the river stretches with a large meandering of the Citarum River (main) to shorten the river course and to steepen the river gradient. Meanders where a cut-off rate of more than 50% is expected are selected for the cut-off channels. Eight (8) cut-off channels are proposed for the reaches between Curug Jompong and Sapan of the Citarum River.

The river length between Curug Jompong and Sapan will be reduced from 40.2 km to 31.2 km by the proposed cut-off channels.

Three (3) small cut-off channels are proposed for the large meanders of each Citarik and Cisangkuy River. No cut-off channels are proposed for the other tributaries.

Location of the proposed cut-off channels and their cut-off rates are shown in Fig. 6.11.

The river improvement lengths of the Citarum, Citarik, Cikeruh and Cisangkuy Rivers are as follows (see Fig. 6.12).

Citarum River

Main Stream	:	31.2 km	(Curug Jompong - Sapan)
Upstream	:	6.0 km	(Sapan - uppermost site of the flood area)
Citarik River	:	14.8 km	(Sapan - uppermost site of the flood area)
Cikeruh River	:	2.0 km	(Sapan - uppermost site of the flood area)
Cisangkuy River	:	7.4 km	(Dayeuh Kolot - uppermost site of the flood area)

(2) Proposed River Profile

The design flood water slope is determined to be 1/5,500 (0.00018) for the Citarum River (main stream), 1/3,600 (0.00028) for the Citarum River (upstream), 1/4,500 (0.00022) and 1/1,100 (0.00091) for the Citarik River, 1/4,500 (0.00022) for the Cikeruh River and 1/2,800 (0.00036) for the Cisangkuy River, tracing the slopes of their river banks and the target flood water levels as mentioned in the Section 6.4.1.

The design river bed slope is determined to be in parallel to the design flood water level to maintain a uniform flow condition.

The proposed river profiles of the Citarum, Citarik, Cikeruh and Cisangkuy Rivers are shown in Fig. 6.13 ~ 6.16.

(3) Proposed River Cross Section

The design river cross sections for the Citarum (main) are proposed based on the following considerations.

1) Double section will be applied in principle to maintain stability of the river course and bed.

2) River width will be set less than 100 m to minimize the required land acquisition and resettlements.

3) Lowering of the river bed is limited because soft rocks and stiff soils are underlying the existing river bed throughout the downstream stretches of Dayeuh Kolot.

4) Ratio of the proposed river width to depth will be set within 8 to 12, based on the facts that the existing river width to depth ratio falls within the range of 8 to 12 in the stable stretches of river bed.

5) Frequent floods will be discharged by low-water channel of the proposed double cross section. The discharge capacity of the low-water channel will be almost equivalent to that of the existing channel. Target section area is approximately 100 m^2 at Sapan and 170 m^2 at the confluence of the Ciwidey River.

6) For the downstream reaches of the confluence of the Ciwidey River, cross section of single type will be applied. Application of double type is not economical because there are hilly lands of soft rock or stiff soil close to both river banks.

The design considerations for the tributaries are as follows:

1) Double section will be also applied in principle. However, for the Cisangkuy and the uppermost reaches of the Citarik River, a single section is adopted. This is because their river-bed slopes are steep enough to counter the sedimentation problem.

2) River width will be set to minimize the required land acquisition and resettlement.

3) For the middle and uppermost reaches of the Citarik River, river cross sections including small dikes for the irrigation works will be considered.

The proposed cross sections of the Citarum River (main) and its tributaries are illustrated in Fig. 6.17.

6.4.4 Construction Works

Major improvement works of the proposed long-term river improvement plan are river dredging including cut-off channels and the construction of related river structures such as, bank protection, bridge, irrigation weir and ground sill. The proposed construction works are summarized below.

- River dredging	:	$9{,}409 \times 10^3$ m^3
- Bank clearing and grubbing	:	1.0 km
- Dike	:	12.90 km
- Bank Protection	:	6.1 km
- Bridge	:	16 places
- Ground sill	:	1 place
- Irrigation weir	:	2 places
- Maintenance/Connection Road	:	97.3 km
- Land acquisition	:	165.7 ha
- Resettlement	:	254 houses

Location of the proposed major structures is shown in Fig. 6.18.

6.5 Flood Plain Management (Non-structural Measure)

Flood plain management is planned to supplement the flood control by structural measures. The possible measures are :

- Land-use regulation including relief to house damage by non-structural measures
- Flood forecasting and warning system

6.5.1 Flood Risk Map

Flood risk map, an essential information for flood plain management, is prepared for the study area under the following two (2) flooding conditions :

(1) Affected by a 20-year flood after completion of the proposed long-term plan

(2) Affected by a 50-year flood after completion of the proposed long-term plan

The corresponding flood risk maps are shown in Fig. 6.19.

6.5.2 Target Area of Flood Plain Management

Flood plain management will be performed for the flood risk area of a 50-year flood (1,260 ha).

6.5.3 Land-use Regulation

A proper land-use regulation is recommended to be instituted by the Government to prevent sprawl housing and other development activities in the flood prone area, there-by curbing the increase in flood damage.
The conceivable land-use regulation includes;

- Restriction of housing development in critical areas
- Guidance for flood-proof housing development

The following non-structural measures will be required to relieve the existing houses in the critical areas

- Land filling of house yard
- Raising of house floor
- Construction of flood walls surrounding house

6.5.4 Flood Forecasting and Warning System

The existing flood forecasting and warning system, established mainly for the purpose of the operation of the Sagling Dam, will be improved to facilitate the evacuation of residents living in the critical flood prone areas, as well.

6.6 Project Cost of Long-Term Plan

The project cost of long-term plan including both the structural and non-structural measures amounts to Rp. 120,596 million at 1987 price as given below.

Project Cost of Long-Term Plan

Item	Cost (Million Rp.)
A. Direct Cost	85,778
(1) Civil Work	(84,513)
(2) Flood Warning System	(1,265)
B. Indirect Cost	23,855
(1) Land Acquisition/Compensation	(9,555)
(2) Administration/Engineering	(14,300)
C. Physical Contingency	10,963
Total	120,596

Breakdown in the project cost of long-term plan is shown in Table 6.4.

6.7 Economic Evaluation

6.7.1 Economic Cost

Economic construction cost for the long-term plans is estimated considering deduction of any transfer payment such as tax and duty from local currency portion of the construction cost. The economic construction cost for the long-term plan is estimated at Rp. 117,591 million as shown in Table 6.5.

The construction period is assumed to be ten years and in each year the same amount of construction cost will be incurred untill the completion of the project. Thus, annual construction cost for the long-term plan amounts to Rp. 11,759 million. The operation and maintenance costs of the project is assumed to be 0.5% of the cost of civil works, hence it is estimated at Rp. 427 million, as shown in Table 6.7.

6.7.2 Economic Benefit

The amount of flood damages estimated for various frequency floods without project and with the proposed long-term project are shown in Table 6.6. The expected flood damage reduction by the project for various frequency floods are also shown in the same table.

The average annual flood damage is estimated to be:

- Rp. 16,136 million for without project
- Rp. 130 million for with project

Benefit, expected flood damage reduction, of the long-term project is estimated to be Rp. 16,006 million per annum under the present socio-economic conditions.

The partial benefits up to completion of construction works are assumed to accrue from the fourth year after the start of the construction and to increase linearly up to the matured benefit in the eleventh year, i.e., the year of the completion of the works. The flow of these benefit is shown in Table 6.7.

6.7.3 Economic Internal Rate of Return (EIRR)

Based on the economic cost and benefit mentioned before, internal rate of return for the proposed long-term plan is calculated under the condition that the project life is assumed at 50 years after completion of the construction works.

Estimated EIRR, B/C and net present value (NPV) in the case discounted at the rate of 10% per annum under the present socio-economic conditions are 11.6%, 1.18 and Rp. 13,092 million respectively as shown in Table 6.7.

Table 6.1 DESIGN DISCHARGE OF RIVERS IN INDONESIA

No.	Name of River	Province	Catchment Area (km2)	Design Flood (m3/s)	Return Period (Year)
1	Sungai Cimanuk	West Java	3,006	1,440	25
2	Kali Serang	Central Java	937	900	25
3	Sungai Citanduy	West Java	3,680	1,900	25
4	Sungai Ular	North Sumatra	1,080	800	30
5	Kali Pemali	Central Java	1,228	1,300	25
6	Sungai Cipanas	West Java	220	385	25
7	Bengawan Solo	Central/East Java	3,320	2,000	40
8	Kalo Madiun	East Java	2,400	2,300	40
9	Sungai Wanpu	North Sumatra	3,840	1,320	20
10	Sungai Arakundo	Aceh	5,495	2,100	50
11	Krung Aceh	Aceh	1,775	1,960	50
12	Kali Brantas	East Java	10,000	1,500	50
13	Sungai Bah Bolon	North Sumatra	2,776	1,200	20
14	Sungai Walanae	South Sulawesi	3,190	2,900	20
15	Sungai Bila	South Sulawesi	1,368	1,900	20
16	Sungai Jeneberang	South Sulawesi	729	3,700	50

Table 6.2 COST COMPARISON OF DESIGN FLOOD ALTERNATIVES

Name of River	Cost (Million Rp.) (1987 price) Alternative I	Altenative II
I. Civil Works		
(a) Citarum River (Main)	73,234	87,349
(b) Citarum River (Up-stream)	1,615	1,615
(c) Citarik River	5,721	5,721
(d) Cikeruh River	932	932
(e) Cisangkuy River	3,011	3,011
Sub-total	84,513	98,628
II. Land Acquisition / Compensation		
(a) Citarum River (Main)	7,100	8,660
(b) Citarum River (Up-stream)	335	335
(c) Citarik River	1,305	1,305
(d) Cikeruh River	200	200
(e) Cisangkuy River	615	615
Sub-total	9,555	11,115
III. Others		
(a) Administration / Engineering Cost	14,110	16,461
(b) Contingency	10,818	12,620
Sub-total	24,928	29,081
IV. Grand Total	118,996	138,824

Table 6.3 COST COMPARISON OF CISANGKUY DIVERSION ALTERNATIVES

(1987 Price)

Item	Quantity			Price (Rp.)	Total Cost (Million Rp.)	
	Unit	Alternative I	Alternative II		Alternative I	Alternative II
I. Citarum River						
A. Main Civil Work						
(a) Dredging						
-Common Soil	x10^3m3	846	705	3,516	2,974.5	2,478.8
-Stiff Soil	x10^3m3	665	554	6,849	4,554.6	3,794.3
-Soft Rock	x10^3m3	553	460	16,720	9,246.2	7,691.2
Sub Total					16,775.3	13,964.3
(b) Road Bridge	m2	672	632		815.6	767.0
	place	(1)	(1)	1,213,658		
(c) Maintenance & Connection Road	m	16,600	16,600	18,874	313.3	313.3
(d) Miscellaneous	L.s.				1,790.4	1,504.5
Sub-total					19,694.6	16,549.1
B. Land Acquisition/ Compensation						
(a) Land Acquisition	x10^3m2	281	253	5,000	1,405.0	1,265.0
(b) House Resettlement	nos	137	124	5,000,000	685.0	620.0
Sub-total					2,090.0	1,885.0
C. Total					21,784.6	18,434.1
II. Cisangkuy River						
A. Main Civil Work						
(a) Dredging	x10^3m3	473	-	3,516	1,663.1	-
(b) Road Bridge	m2	1,024	-	5,660,000	724.5	-
	(place)	(4)		773,488	792.1	
(C) Miscellaneous	L.s.		-		245.5	-
Sub-total					2,700.7	
B. Land Acquisition/ Compensation						
(a) Land Acquisition	x10^3m2	94	-	5,000	470.0	-
(b) House Resettlement	nos	29	-	5,000,000	145.0	-
Sub-total					615.0	-
C. Total					3,315.7	

(Continued)

Item	Quantity			Price (Rp.)	Total Cost (Million Rp.)	
	Unit	Alternative I	Alternative II		Alternative I	Alternative II
III. Cisangkuy Diversion						
A. Main Civil Work						
(a) Dredging	x10^3m3	-	663	7,170	-	4,753.7
(b) Road Bridge	m2	-	1,424	773,488	-	1,101.4
	(place)	-	(5)			
(c) Water Conveyance	m2	-	365	906,000	-	330.7
	(place)	-	(2)			
(d) Ground Sill	m	-	45	19,000,000	-	855.0
	(place)		(3)			
(e) Sluice	place	-	1	20,000,000	-	20.0
(f) Maintenance & Connection Road	m	-	6,200	18,874	-	117.0
(g) Miscellaneous	L.s.	-			-	717.8
Sub-total						7,895.6
B. Land Acquisition/ Compensation						
(a) Land Acquisition	x10^3m2	-	111	5,000	-	555.0
(b) House Resettlement	nos	-	-	5,000,000	-	-
Sub-total						555.0
C. Total						8,450.6
IV. Grand Total					25,100.3	26,884.7

Table 6.4 BREAKDOWN IN PROJECT COST OF LONG-TERM PLAN

(1987 price)

Item	Local Currency L/C (Rp 10^6)	Foreign Currency F/C (us$ 10^3)	Equivalent Total (Rp 10^6)
A. Structual Measures			
I Civil Work			
(1) Citarum River (Main)	11,754.5	37,148.0	73,234.3
(2) Citarum River (Up-Stream)	315.0	785.5	1,615.1
(3) Citarik River	1,192.5	2,735.9	5,720.6
(4) Cikeruh River	179.1	455.3	932.4
(5) Cisangkuy River	511.5	1,510.1	3,010.6
Sub-Total	13,952.6	42,634.8	84,513.0
II Land Acquisition / Compensation			
(1) Citarim River (Main)	7,100.0	-	7,100.0
(2) Citarum River (Up-Stream)	335.0	-	335.0
(3) Citarik River	1,305.0	-	1,305.0
(4) Cikeruh River	200.0	-	200.0
(5) Cisangkuy River	615.0	-	615.0
Sub-Total	9,555.0	-	9,555.0
III Total	23,507.6	42,634.8	94,068.0
IV Administration/Engineering (III) * 15%	3,526.1	6,395.2	14,110.2
V Contingency (III + IV) * 10%	2,703.4	4,903.0	10,817.8
VI Structual Total	29,737.1	53,933.0	118,996.0
B. Non Structual Measures (Flood Warning System)			
I Equipment Installation and Accessaries	252.4	612.0	1,265.2
II Administration/Engineering (III) * 15%	37.9	91.8	189.8
III Contingency (III + IV) * 10%	29.0	70.4	145.5
IV Non Structual Total	319.3	774.2	1,600.5
C. Grand Total	30,056.4	54,707.2	120,596.5

Note: Excharge rate US$ 1.00 = Rp.1655 = ¥135

Table 6.5 ECONOMIC COST FOR PROPOSED OVERALL FLOOD CONTROL PLAN

(1987 price)

Item	Loacal Currency			Foreign Currency		Economic Cost
	Construction Cost (Million Rp.)	Tax (Million Rp.)	Economic Cost (Million Rp.)	Construction Cost (10^3 US$)	Equivalant (Million Rp.)	(Million Rp.)
Structural Measure	29,737.1	2,973.7	26,763.4	53,933.0	89,259.1	116,022.5
Non-structural Measure	319.3	31.9	287.4	774.2	1,281.3	1,568.7
Total	30,056.4	3,005.6	27,050.8	54,707.2	90,540.4	117,591.2

Note:1.Rate of Tax is assumed 10% of construction cost of local currency.
2.US$ 1 = Rp.1,655

Table 6.6 ESTIMATED FLOOD DAMAGE WITH AND WITHOUT PROJECT AT ECONOMIC PRICE

ESTIMATED FLOOD DAMAGE AND AVERAGE ANNUAL DAMAGE POTENTIAL
UNDER WITHOUT-PROJECT CONDITION

(Unit: Million Rupiahs) (1987 Price)

Asset Item	Recurrence Iterval						
	1986 Flood	2-Years	5-Years	10-Years	20-Years	50-Years	100-Years
Houses	5,946.8	7,401.0	11,821.2	16,545.0	19,910.1	23,111.1	25,010.7
Industry	1,510.6	1,717.7	2,068.0	2,274.4	2,422.6	2,595.1	2,704.8
Paddy	4,258.6	4,408.5	4,633.0	4,695.9	4,717.0	4,741.8	4,751.7
Fishpond	18.2	18.2	18.2	18.2	18.2	18.2	18.2
Infrastructure	1,491.5	1,823.7	2,777.8	3,763.9	4,466.5	6,141.2	5,543.1
Indirect Damage	661.3	768.5	1,065.9	1,364.9	1,576.7	1,780.4	1,901.4
Total	13,887.0	16,137.6	22,384.2	28,662.2	33,111.2	37,387.8	39,929.9
Average Annual Damage							16,135.5

ESTIMATED FLOOD DAMAGE AFTER COMPLETION OF HTE LONG-TERM PLAN

(Unit: Million Rupiahs) (1987 Price)

Asset Item	Recurrence Iterval						
	1986 Flood	2-Years	5-Years	10-Years	20-Years	50-Years	100-Years
Houses	10.7	17.2	70.0	135.9	265.1	454.3	818.3
Industry	5.1	8.6	27.9	52.9	100.4	176.7	274.3
Paddy	9.0	13.5	36.0	61.5	134.5	309.6	620.6
Fishpond	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Infrastructure	3.2	5.2	19.6	37.8	73.1	126.2	218.5
Indirect Damage	1.4	2.2	7.7	14.4	28.7	53.3	96.6
Total	29.4	46.7	161.2	302.5	601.8	1,120.1	2,028.3
Average Annual Damage							129.8

ESTIMATED FLOOD REDUCTION BENEFIT BY ASSET ITEM OF LONG TERM PLAN

(Unit: Million Rupiahs) (1987 Price)

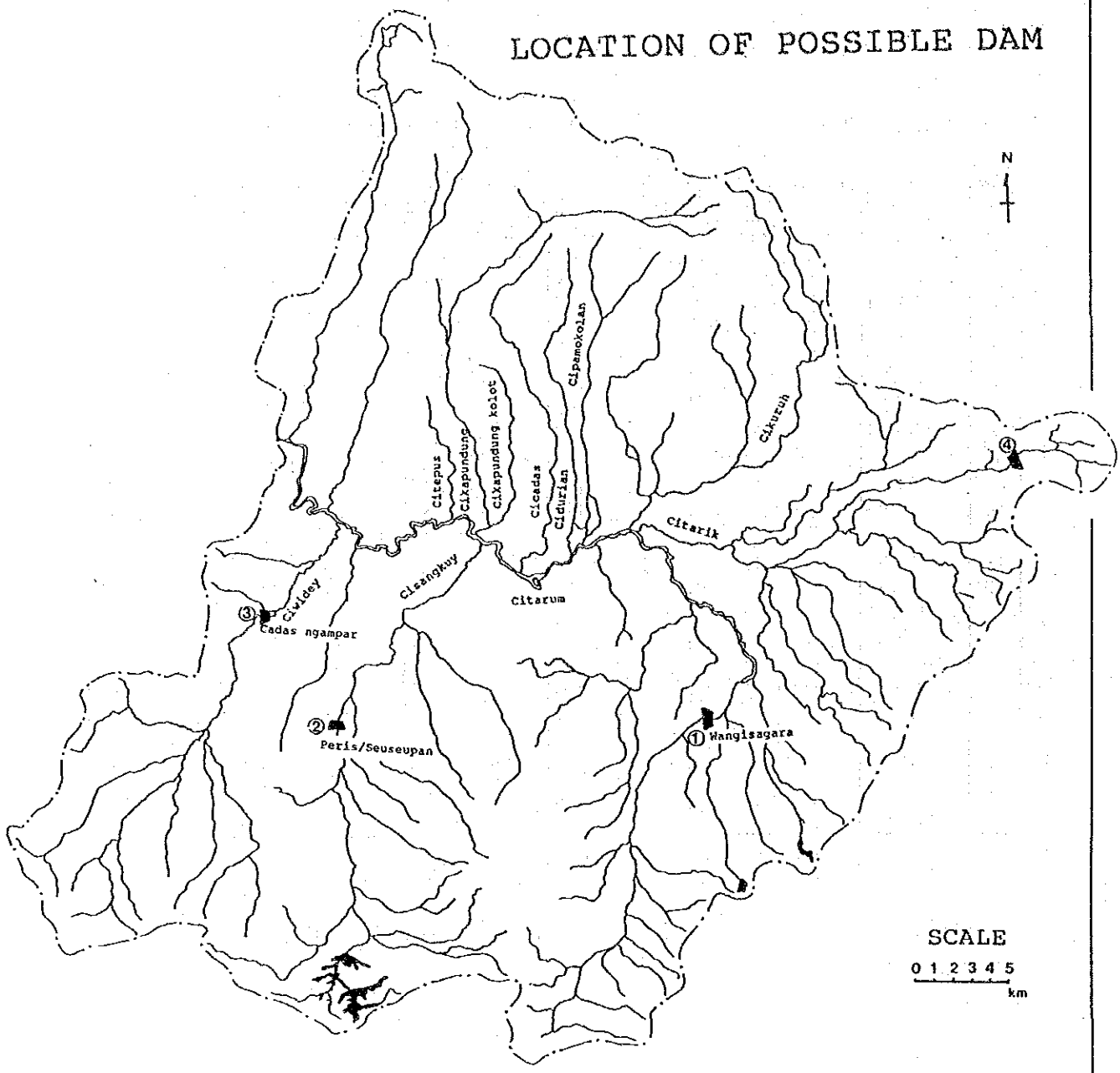
Asset Item	Recurrence Iterval						
	1986 Flood	2-Years	5-Years	10-Years	20-Years	50-Years	100-Years
Houses	5,936.1	7,383.8	11,751.2	16,409.1	19,645.0	22,656.8	24,192.4
Industry	1,505.5	1,709.1	2,040.1	2,221.5	2,322.2	2,418.4	2,430.5
Paddy	4,249.6	4,395.0	4,597.0	4,634.4	4,582.5	4,432.2	4,131.1
Fishpond	18.2	18.2	18.2	18.2	18.2	18.2	18.2
Infrastructure	1,488.3	1,818.6	2,758.3	3,726.1	4,393.4	4,015.0	5,324.6
Indirect Damage	659.9	766.2	1,058.2	1,350.5	1,548.1	1,727.0	1,804.8
Total	13,857.6	16,090.9	22,223.0	28,359.8	32,509.4	36,267.7	37,901.6
Average Annual Damage							16,005.8

Table 6.7 ANNUAL FLOW OF ECONOMIC COST AND BENEFIT OF LONG-TERM PLAN

(Unit : Million Rupiahs) (1987 price)

No.	Year	Economic Cost			Economic Benefit	Difference
		Construction	O/M Cost	Total		
1	1990	11,759	0	11,759	0	-11,759
2	1991	11,759	0	11,759	0	-11,759
3	1992	11,759	0	11,759	0	-11,759
4	1993	11,759	53	11,812	2,001	-9,811
5	1994	11,759	107	11,866	4,001	-7,865
6	1995	11,759	160	11,919	6,002	-5,917
7	1996	11,759	214	11,973	8,003	-3,970
8	1997	11,759	267	12,026	10,004	-2,022
9	1998	11,759	320	12,079	12,004	-75
10	1999	11,759	374	12,133	14,005	1,872
11	2000	0	427	427	16,006	15,579
12	2001	0	427	427	16,006	15,579
13	2002	0	427	427	16,006	15,579
14	2003	0	427	427	16,006	15,579
15	2004	0	427	427	16,006	15,579
-	-	"	"	"	"	"
-	-	"	"	"	"	"
-	-	"	"	"	"	"
-	-	"	"	"	"	"
59	2048	0	427	427	16,006	15,579
60	2049	0	427	427	16,006	15,579

EIRR : 11.6%
B/C : 1.18
NPV : Rp 13,092 million



MAIN FEATURES OF POSSIBLE DAMS

	Name of Dam	River	Catchment Area (km2)	Gross Storage Volume (10^3 m3)	Effective Storage Volume (10^3 m3)	Dam Height (m)
1	Wangi Sagara	Citarum	97.5	730	592	18.5
2	Seuseupan / Peris	Cisangkuy	157.2	440	270	19.0
3	Cadas Ngampar	Ciwidey	183.1	630	513	22.0
4	-------	Citarik	13.66	1500		50.0

Source: Bina Program (1986; Raya Consult),
West Java Province Public Work Service (1985, PT Seconria Java)

FIG. 6.1 LOCATION AND MAIN FEATURES OF POSSIBLE DAM

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

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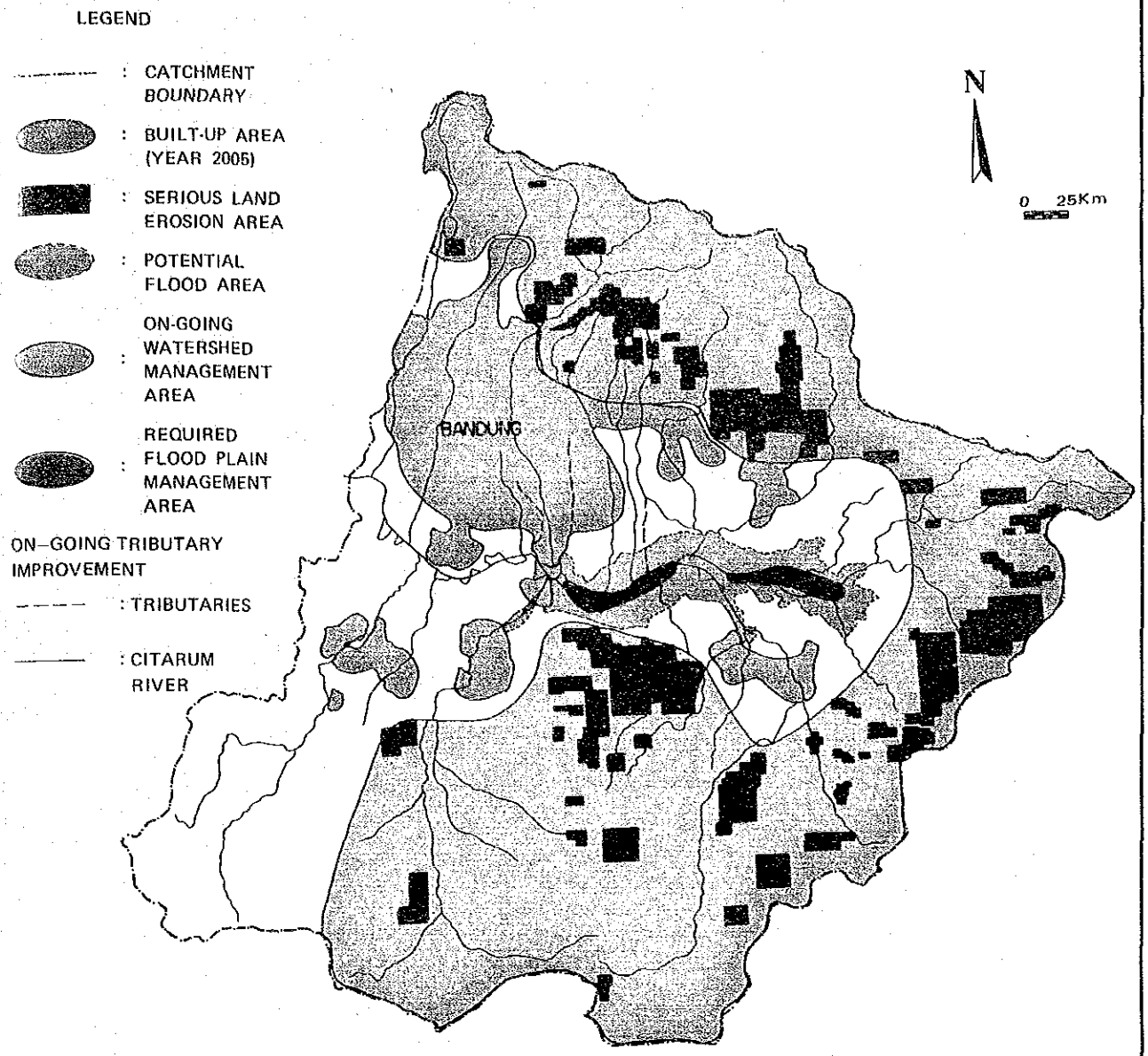

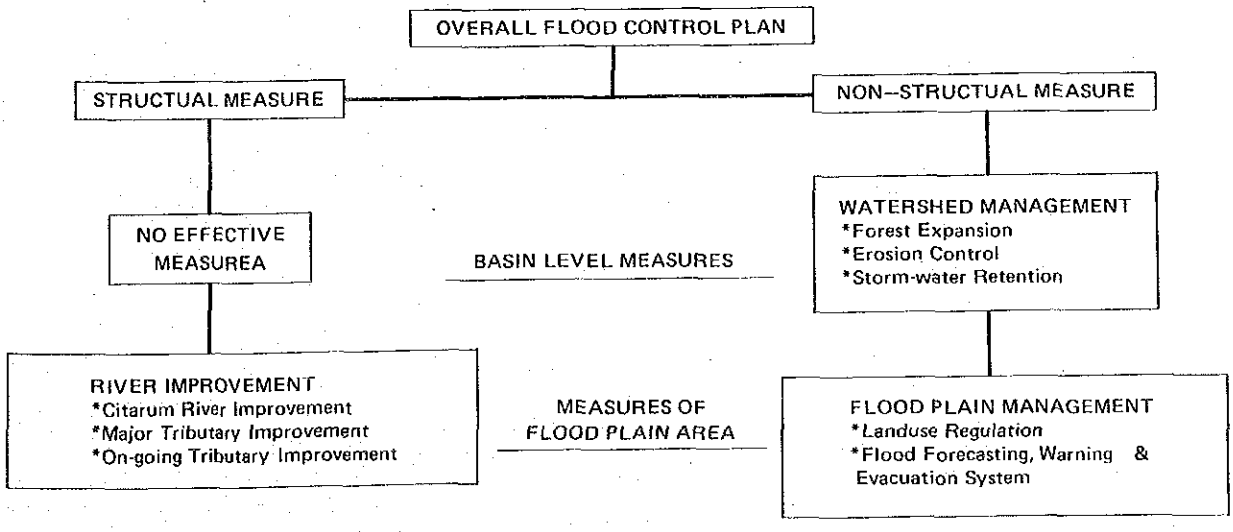

Fig. 6.2 **COMPONENT OF PROPOSED OVERALL FLOOD CONTROL PLAN**

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

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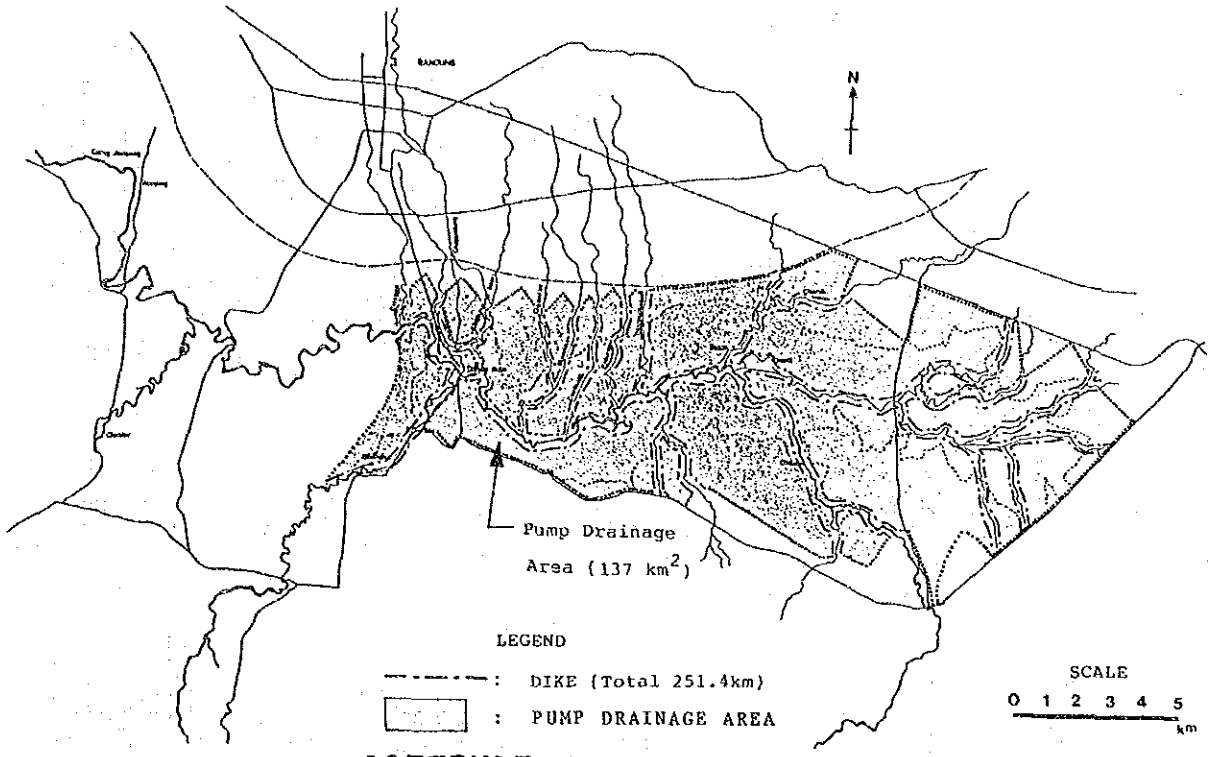
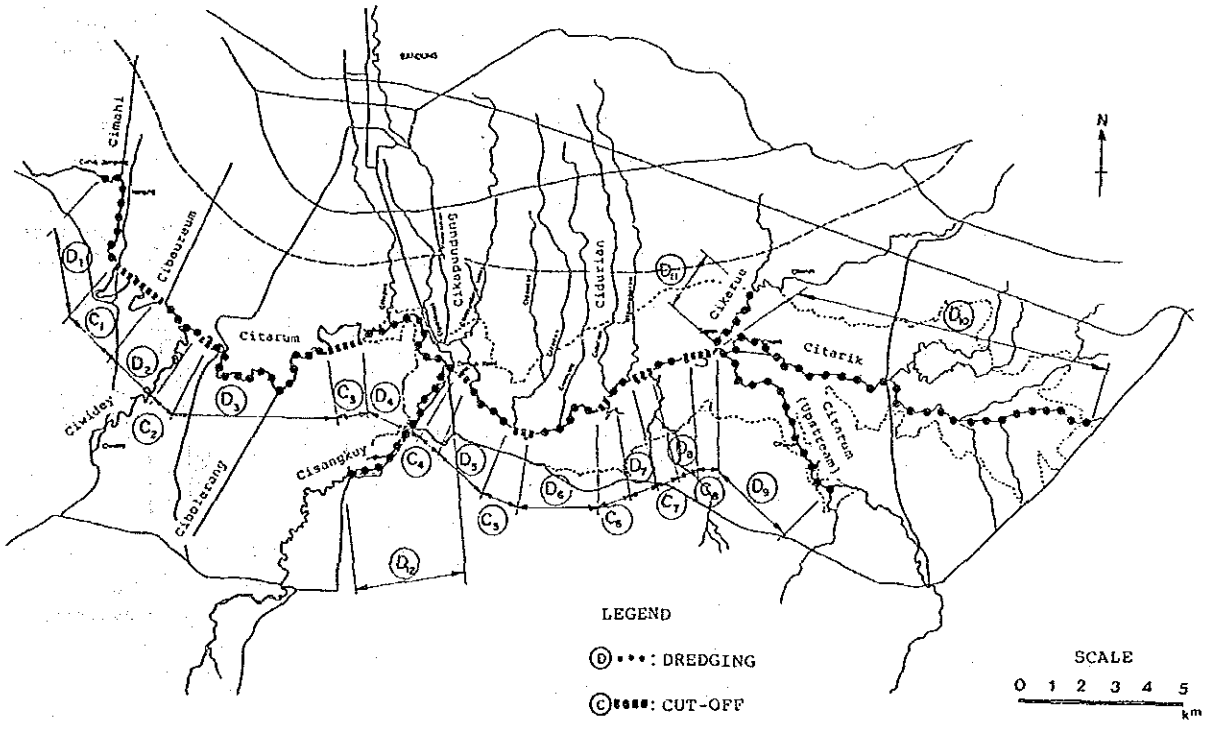


ALTERNATIVE I : DIKE METHOD



ALTERNATIVE II : DREDGING METHOD

FIG. 6.3 ALTERNATIVE SCHEMES OF RIVER IMPROVEMENTS

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

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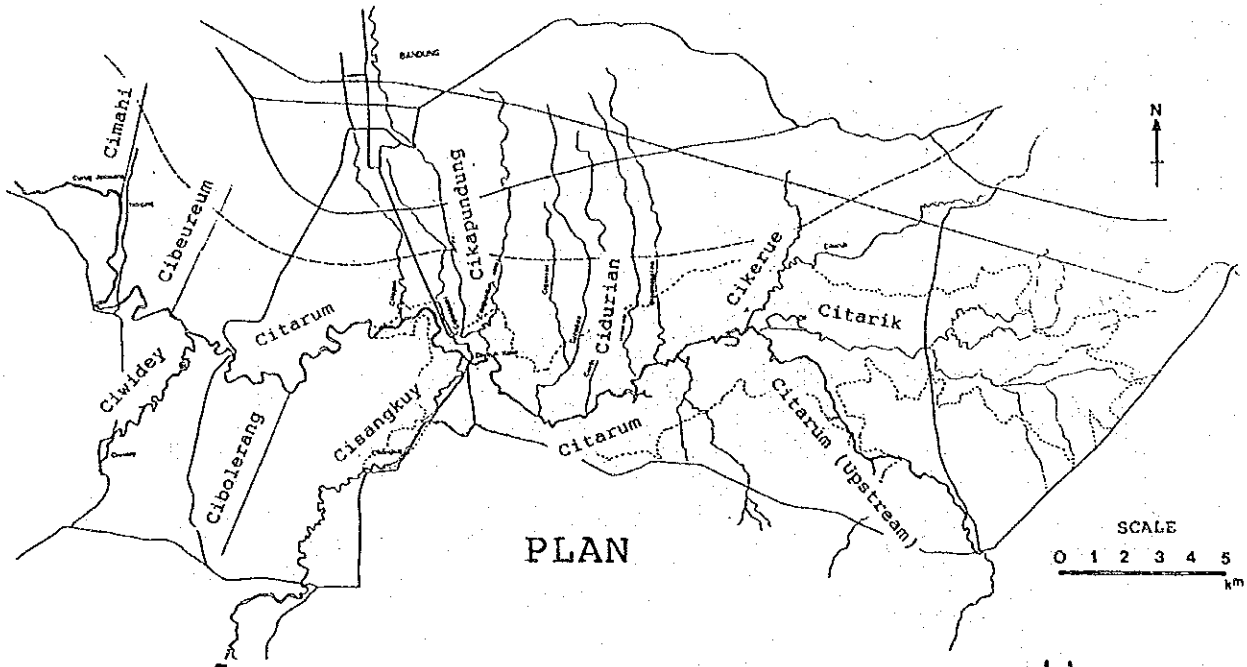
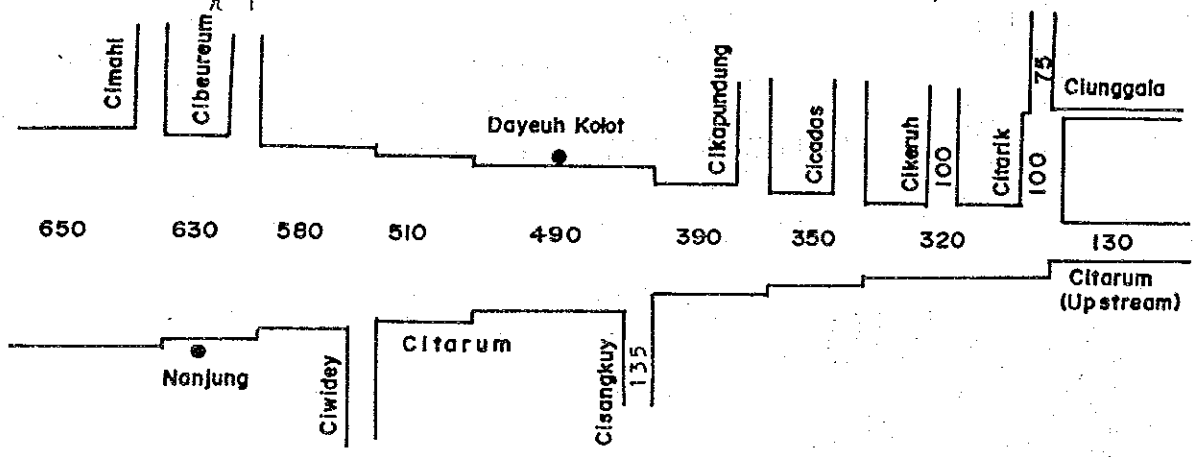
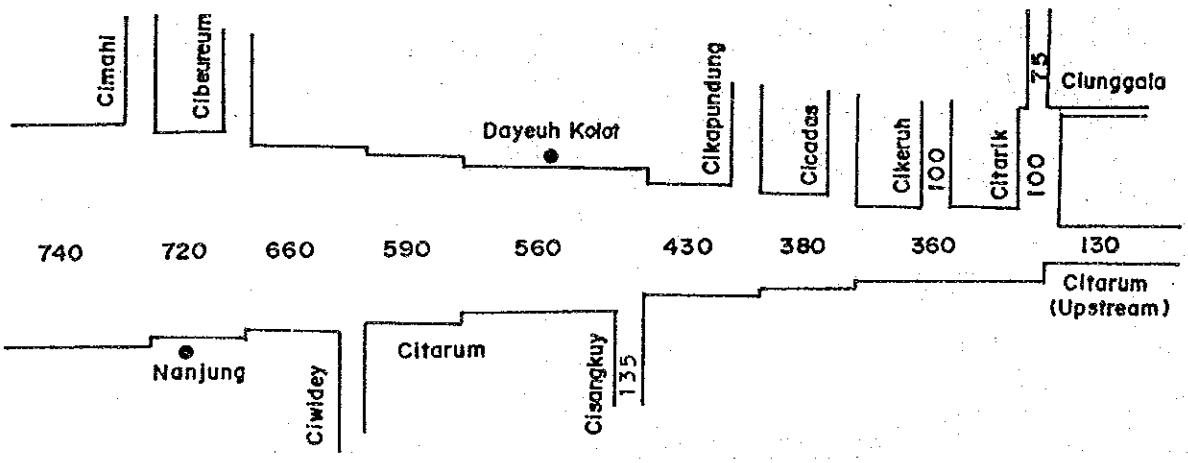




ALTERNATIVE I (Citarum River : 20-Year Frequency Flood Discharge
Tributaries : 20-Year Frequency Flood Discharge)



ALTERNATIVE II (Citarum River : 50-Year Frequency Flood Discharge
Tributaries : 20-Year Frequency Flood Discharge)

FIG. 6.4 DESIGN DISCHARGE DISTRIBUTION ALTERNATIVES

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

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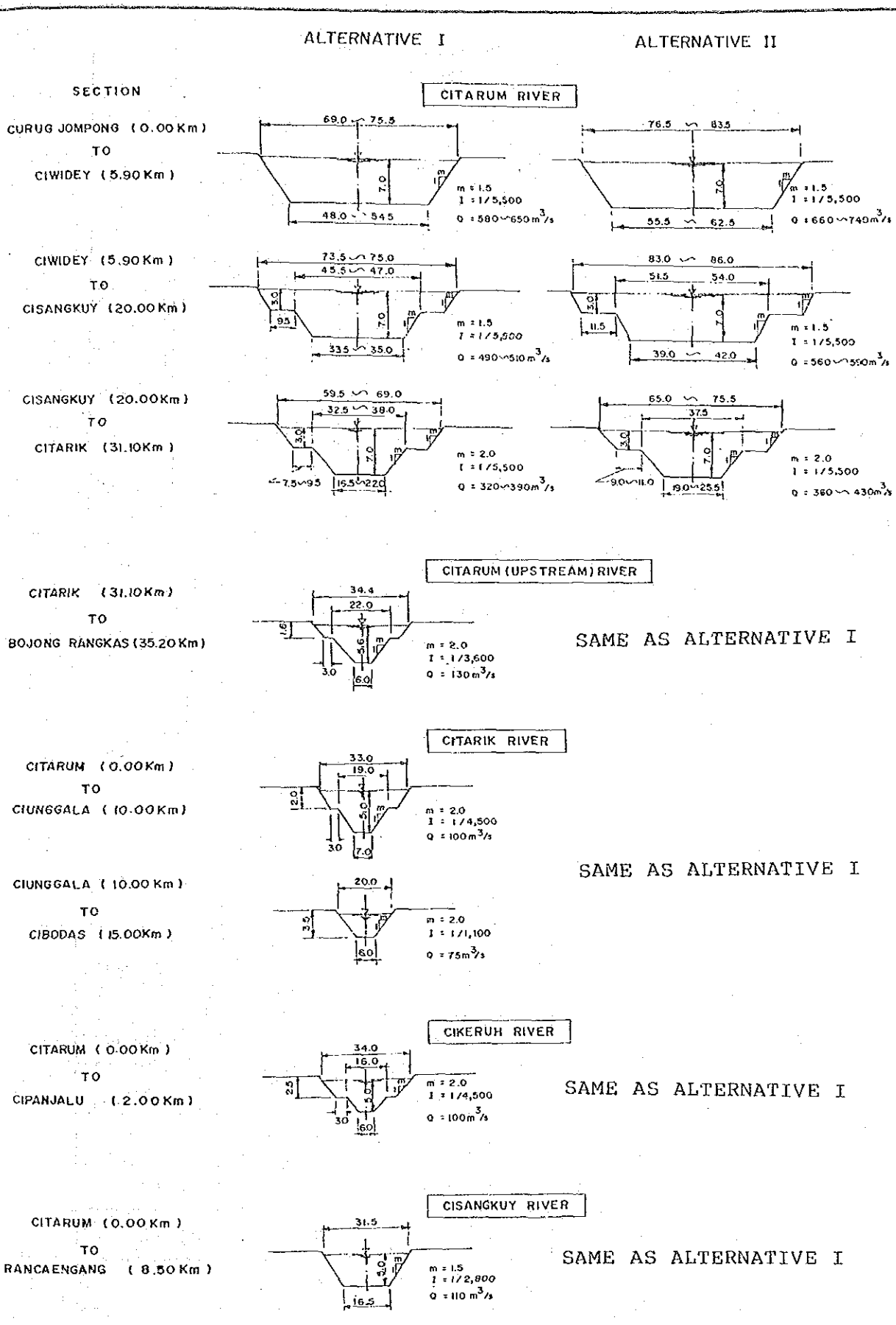

FIG. 6.5 DESIGN RIVER CROSS SECTION ALTERNATIVES

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

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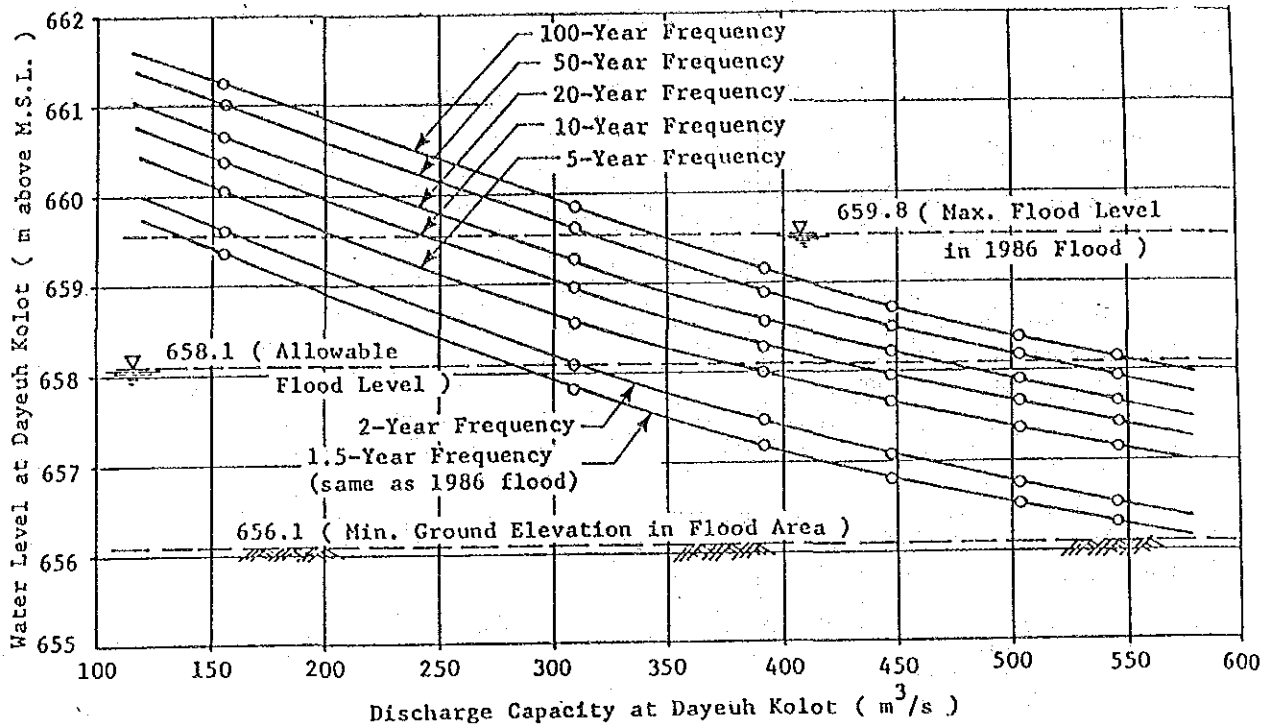
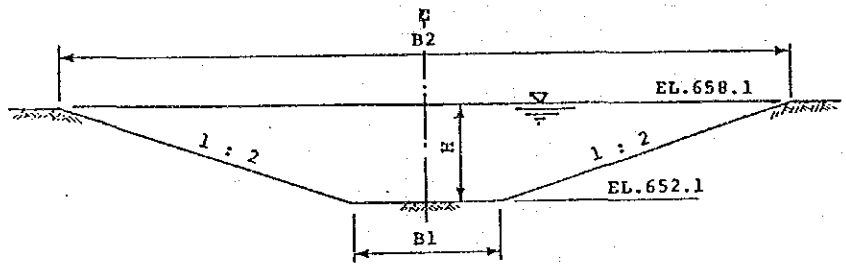


RELATION BETWEEN FLOOD WATER LEVEL AND DISCHARGE CAPACITY AT DAYEUH KOLOT



Hydraulic Cross Section at Dayeuh Kolot

Improvement Plan	B1 (m)	B2 (m)	H (m)	Expected Discharge Cap. (m^3/s)	Corresponding Frequency
Case 1	Existing Cross Section			160	Frequent
Case 2	30.5	54.5	6.0	310	2-Year
Case 3	40.0	64.0	6.0	390	5-Year
Case 4	47.0	71.0	6.0	450	10-Year
Case 5	53.0	77.0	6.0	505	20-Year
Case 6	56.5	80.5	6.0	540	50-Year

FIG. 6.6 HYDRAULIC EFFECTS OF RIVER IMPROVEMENTS

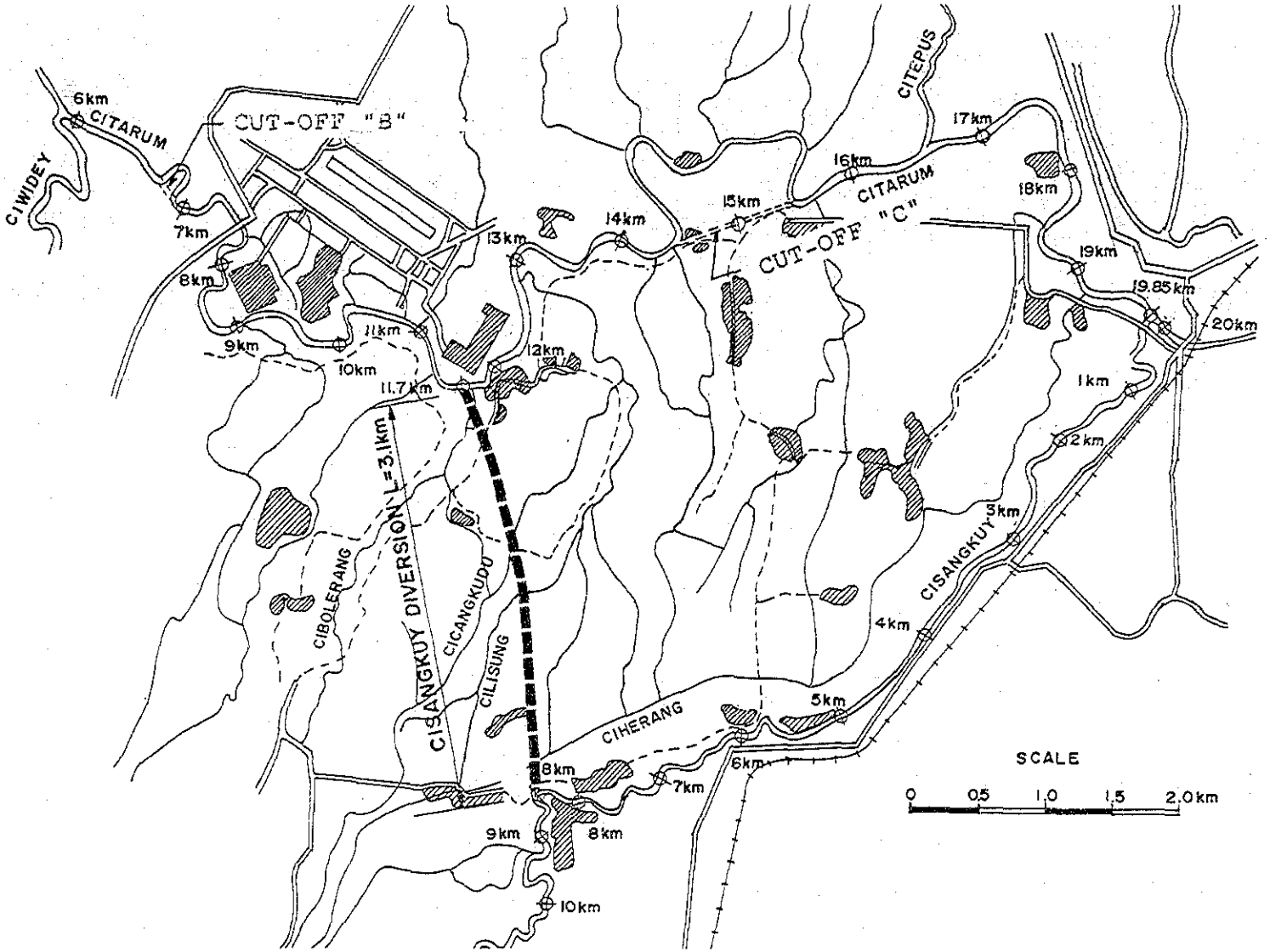


FIG. 6.7 LOCATION OF PROPOSED CISANGKUY DIVERSION

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

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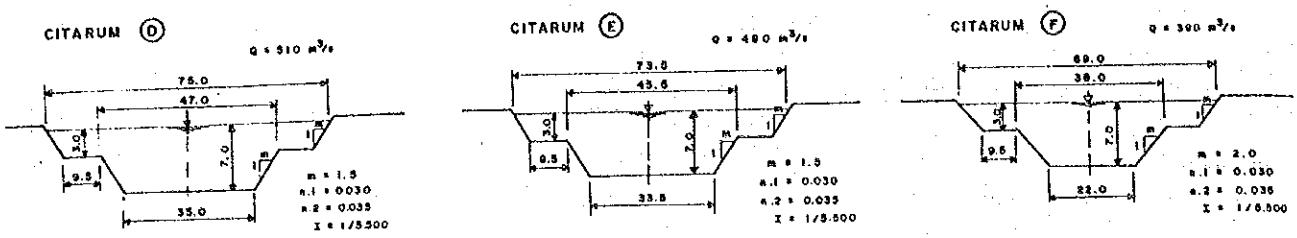
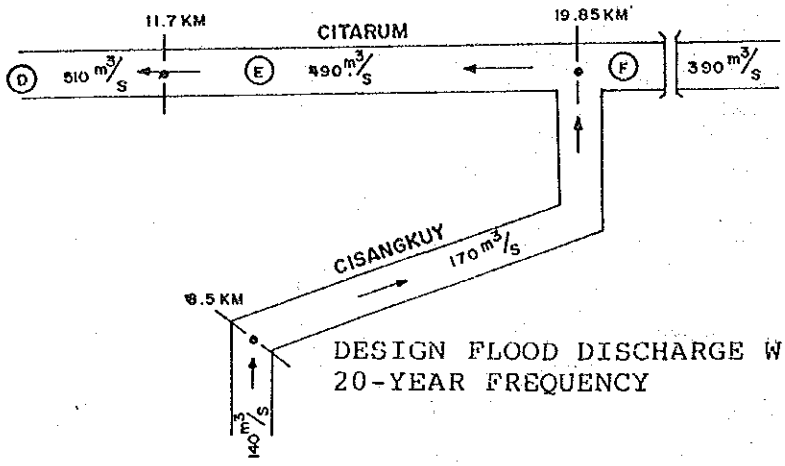
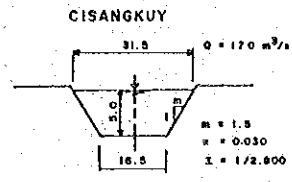


DESIGN CROSS SECTION OF CITARUM RIVER

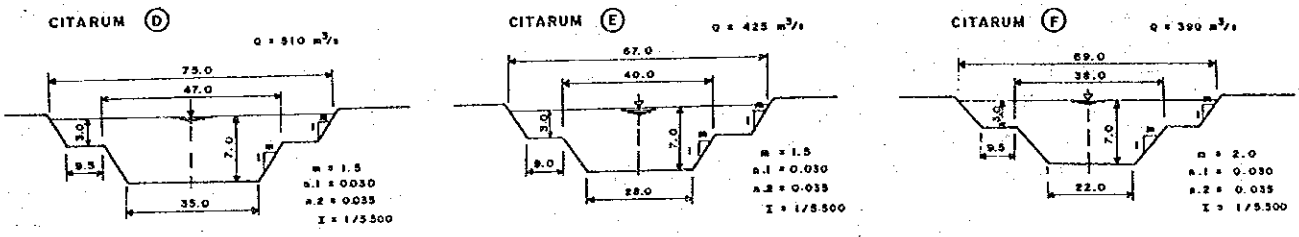


DESIGN FLOOD DISCHARGE WITH 20-YEAR FREQUENCY

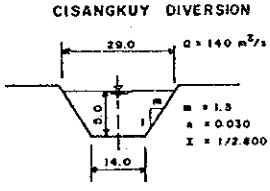


DESIGN CROSS SECTION OF CISANGKUY RIVER

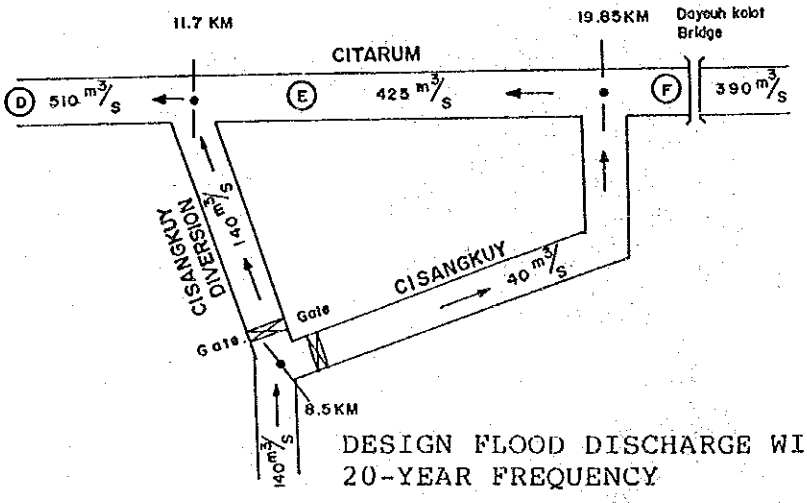
ALTERNATIVE I (WITHOUT CISANGKUY DIVERSION)



DESIGN CROSS SECTION OF CITARUM RIVER



DESIGN CROSS SECTION OF CISANGKUY DIVERSION)



DESIGN FLOOD DISCHARGE WITH 20-YEAR FREQUENCY

ALTERNATIVE II (WITH CISANGKUY DIVERSION)

FIG. 6.8 DESIGN DISCHARGE/RIVER CROSS SECTION OF CISANGKUY DIVERSION ALTERNATIVE

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

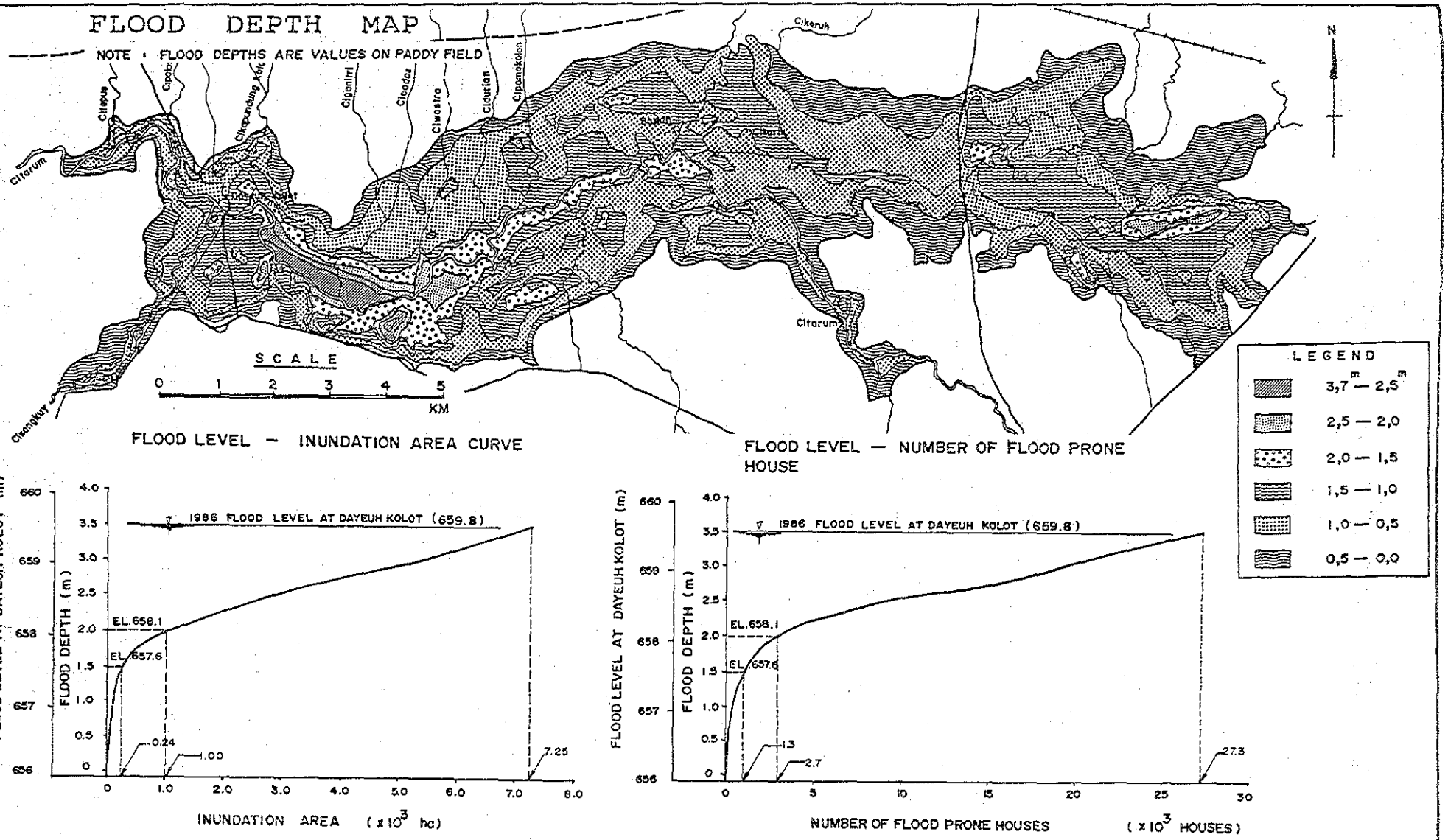
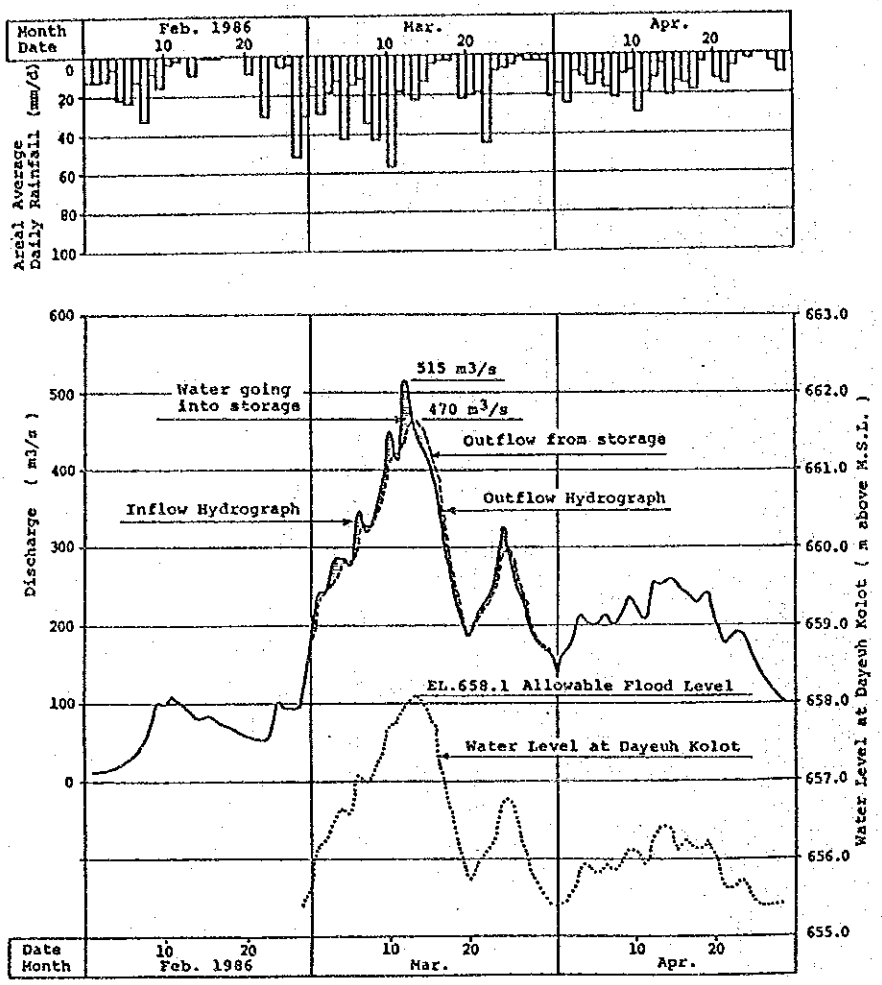


FIG. 6.9 FLOOD LEVEL - INUNDATION AREA AND FLOOD PRONE HOUSE CURVES

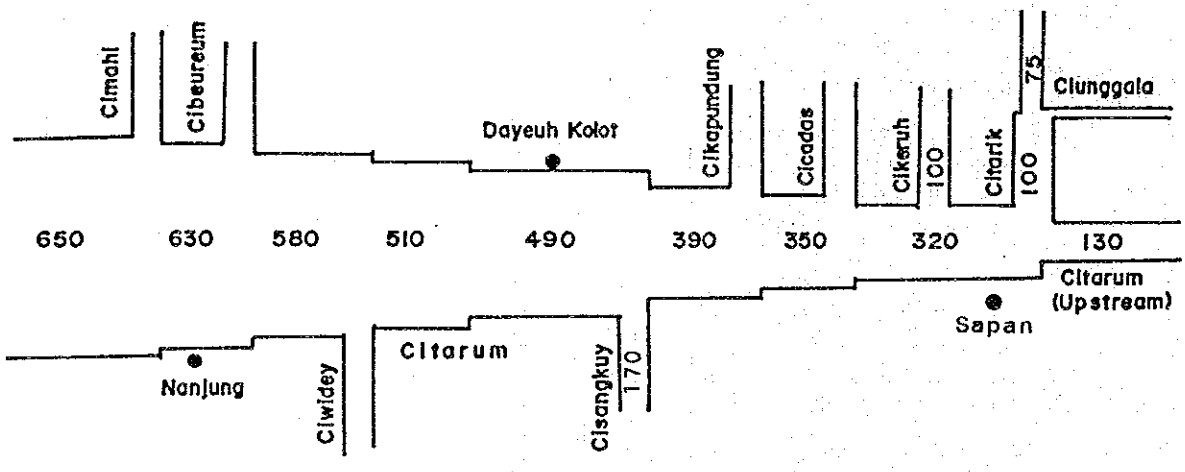
STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



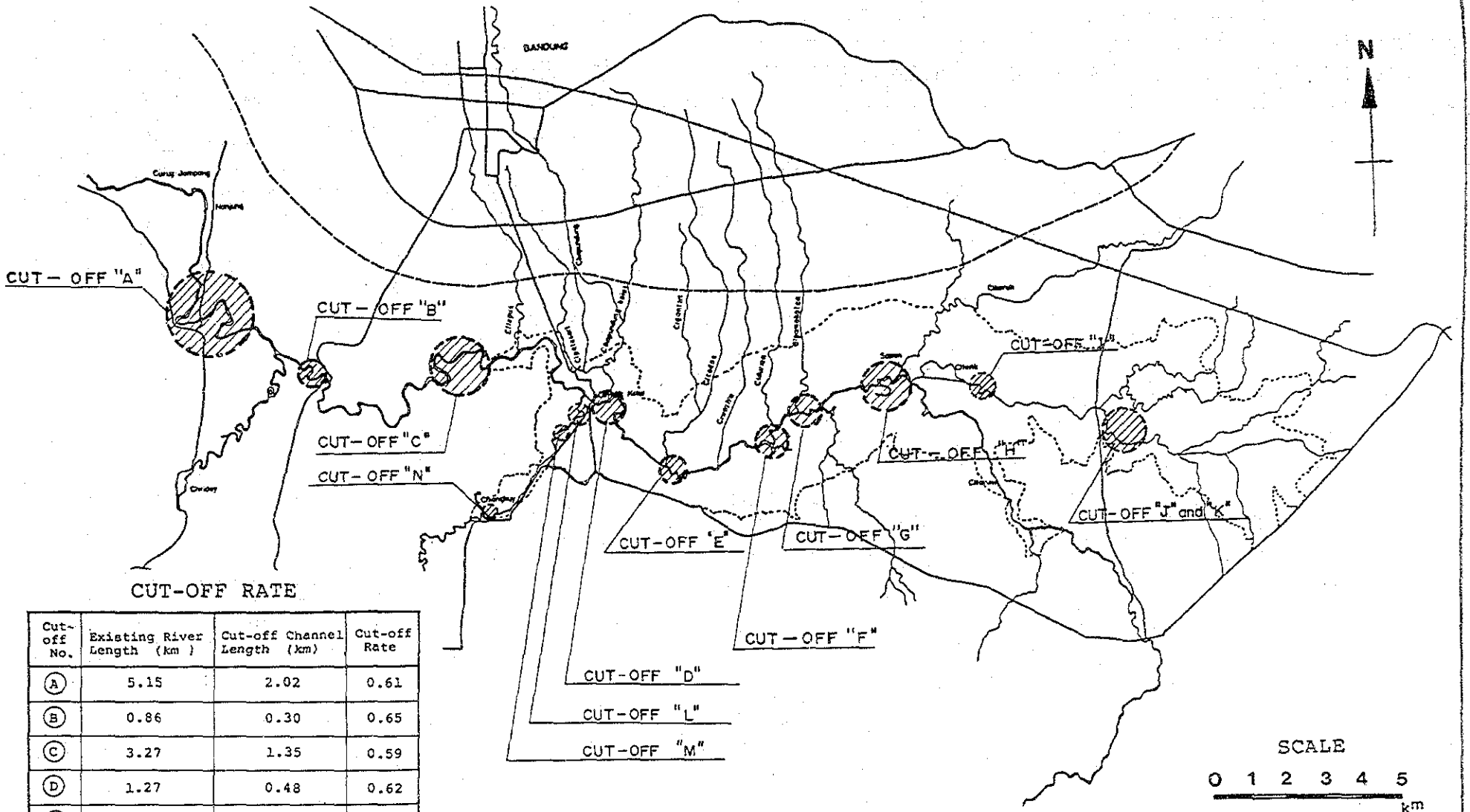
20-Year Frequency

DESIGN DISCHAREGE HYDROGRAPH AT DAYEUH KOLOT



DESIGN PEAK DISCHARGE DISTRIBUTION

FIG. 6.10 DESIGN DISCHARGE HYDROGRAPH AT DAYEUH KOLOT AND PEAK DISCHARGE DISTRIBUTION OF PROPOSED LONG-TERM PLAN



CUT-OFF RATE

Cut-off No.	Existing River Length (km)	Cut-off Channel Length (km)	Cut-off Rate
(A)	5.15	2.02	0.61
(B)	0.86	0.30	0.65
(C)	3.27	1.35	0.59
(D)	1.27	0.48	0.62
(E)	1.05	0.54	0.49
(F)	0.99	0.48	0.52
(G)	0.95	0.50	0.47
(H)	2.45	1.31	0.47

FIG. 6.11 PROPOSED CUT-OFF CHANNELS OF LONG-TERM PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

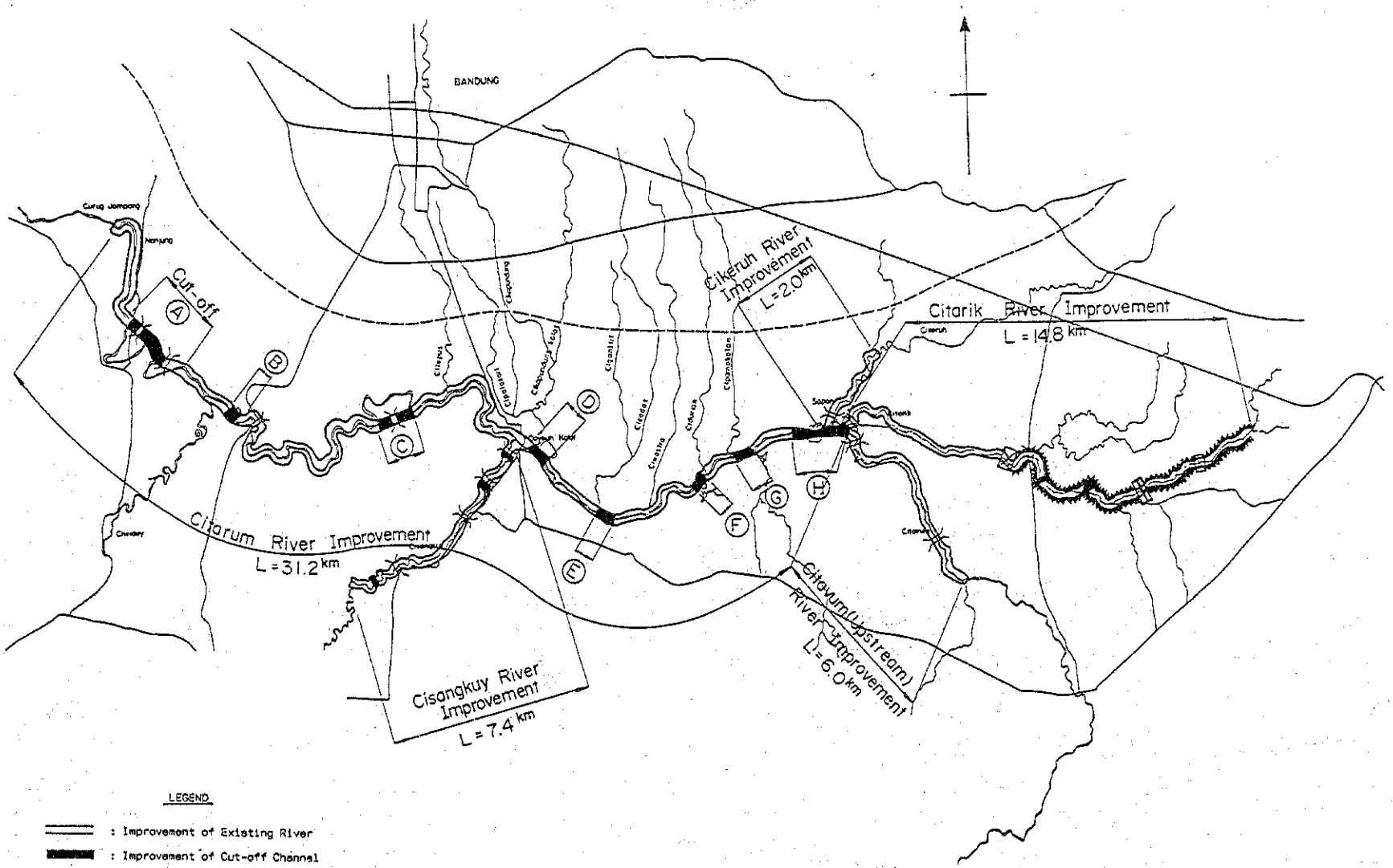


FIG. 6.12 PROPOSED IMPROVEMENT REACHES FOR LONG-TERM PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

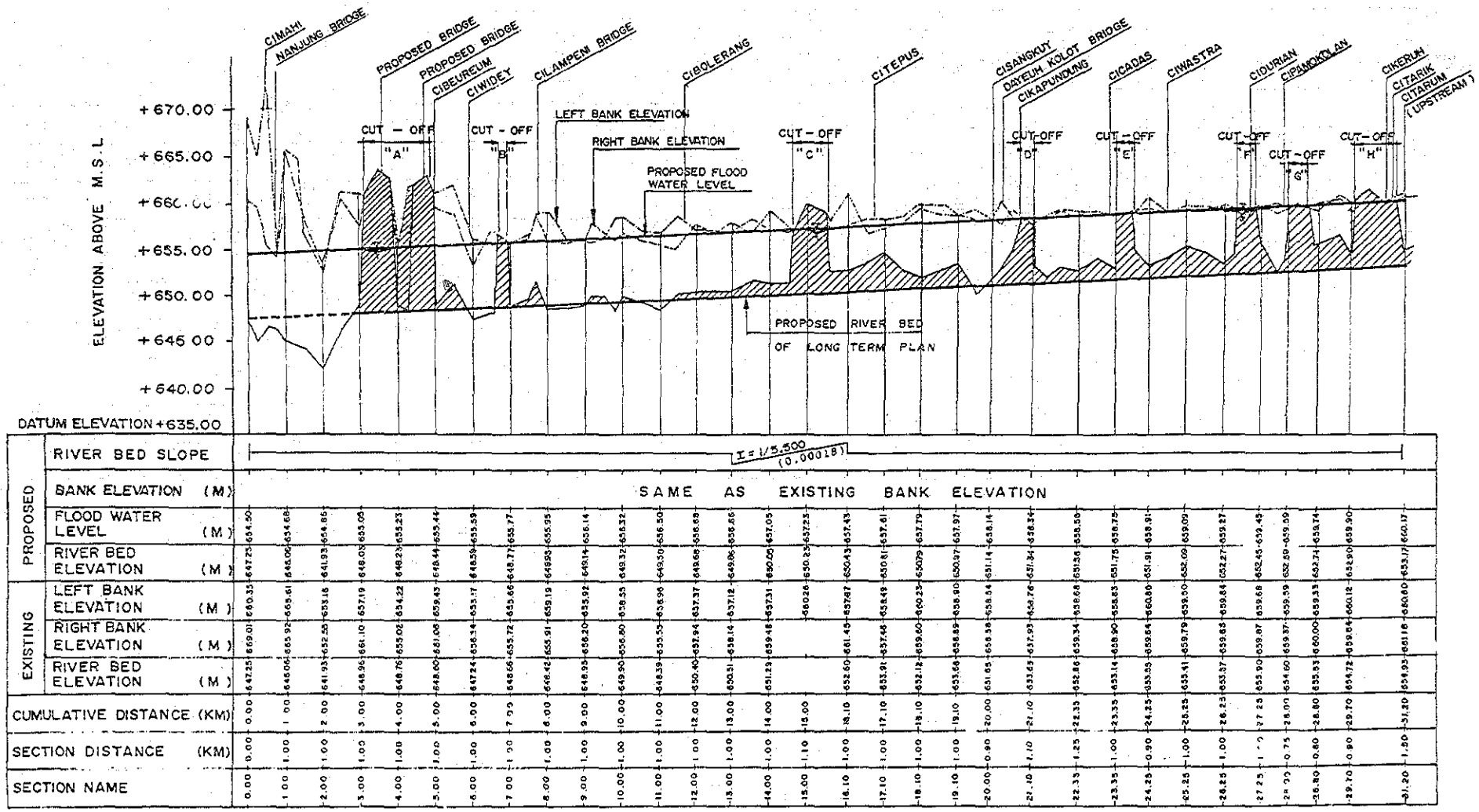
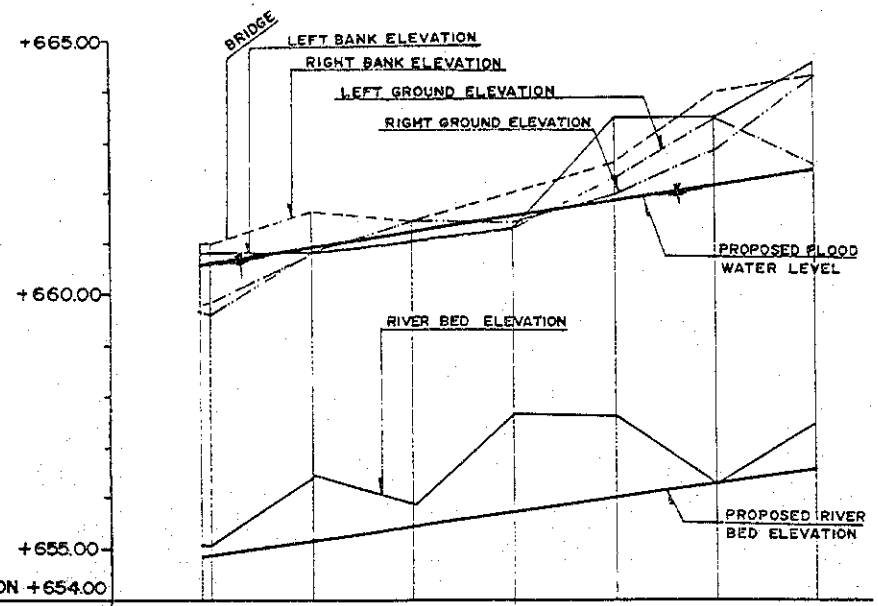


FIG. 6.13 LONG-TERM RIVER PROFILE OF CITARUM RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

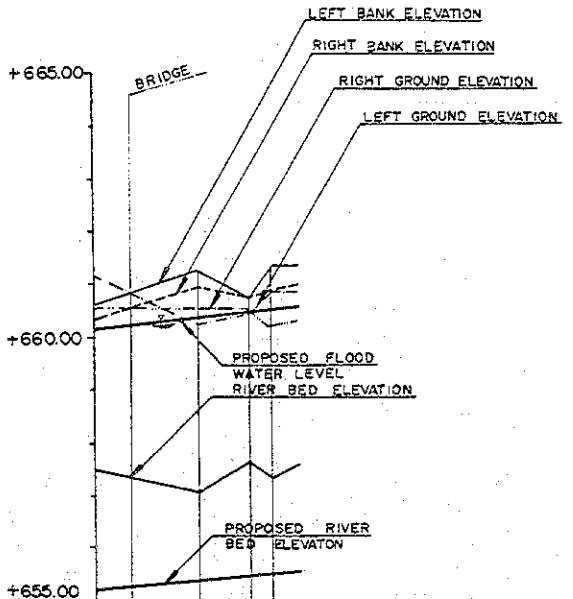
JICA



DATUM ELEVATION +654.00

PROPOSED	BED SLOPE		1/3,600 (0.00028)											
	BANK ELEVATION (M)													
	FLOOD WATER LEVEL (M)		660.43	660.45	660.72		661.00		661.28		661.56		661.84	662.12
	RIVER BED ELEVATION (M)		654.82	654.85	655.12		655.40		655.68		655.96		656.24	656.52
EXISTING	LEFT BANK ELEVATION (M)		660.80	659.80	660.80		661.00		661.30		663.09		663.12	663.50
	RIGHT BANK ELEVATION (M)		654.16	659.60	661.00		661.40		661.90		662.56		662.94	662.90
	RIVER BED ELEVATION (M)		654.83		655.50		656.91		657.67		657.65		656.30	657.50
CUMULATIVE DISTANCE (KM)		31.10	31.20	32.20		33.20		34.20		35.20		36.20		37.20
SECTION DISTANCE (KM)		0.00	0.10	1.00		1.00		1.00		1.00		1.00		1.00
SECTION NAME		No.0	No.1	No.2		No.3		No.4		No.5		No.6		No.7

LONGITUDINAL PROFILE CIKERUH RIVER



DATUM ELEVATION +655.00

PROPOSED	BED SLOPE		1/4,500 (0.00022)											
	BANK ELEVATION (M)													
	FLOOD WATER LEVEL (M)		660.17	660.25		660.39		660.50	660.55		660.61			
	RIVER BED ELEVATION (M)		655.17	655.28		655.39		655.50	655.55		655.61			
EXISTING	LEFT BANK ELEVATION (M)		660.80	660.80		661.24		660.88	661.21					
	RIGHT BANK ELEVATION (M)		657.35	660.80		660.86		660.87	660.89					
	RIVER BED ELEVATION (M)		657.35			657.13		657.00	656.39					
CUMULATIVE DISTANCE (KM)		0.35			1.00		1.50	1.70		2.00				
SECTION DISTANCE (KM)		0.35			0.65		0.50	0.20		0.30				
SECTION NAME		0.35			1.00		1.50	1.70		2.00				

FIG. 6.14 LONG-TERM RIVER PROFILES OF CITARUM (UPSTREAM) AND CIKERUH RIVERS

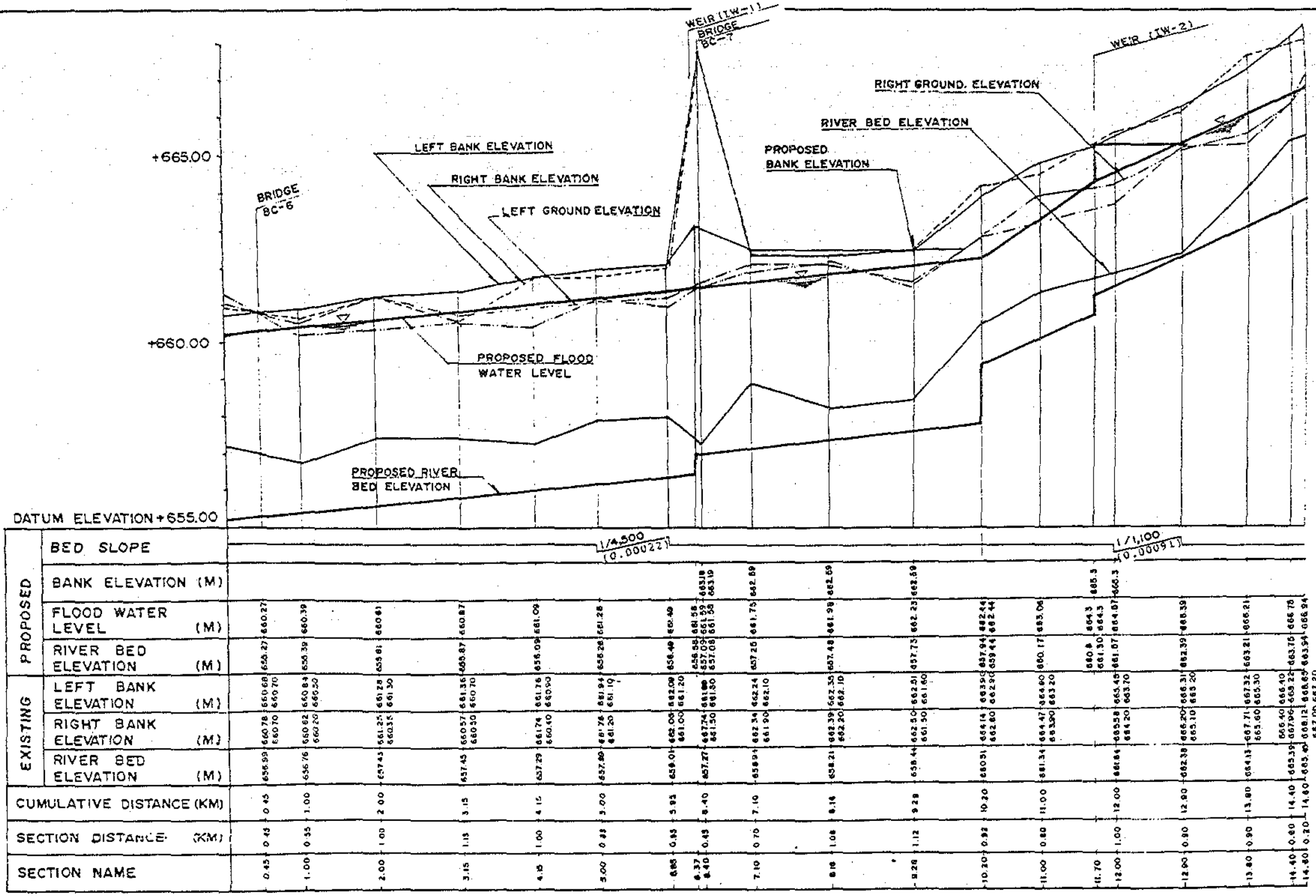
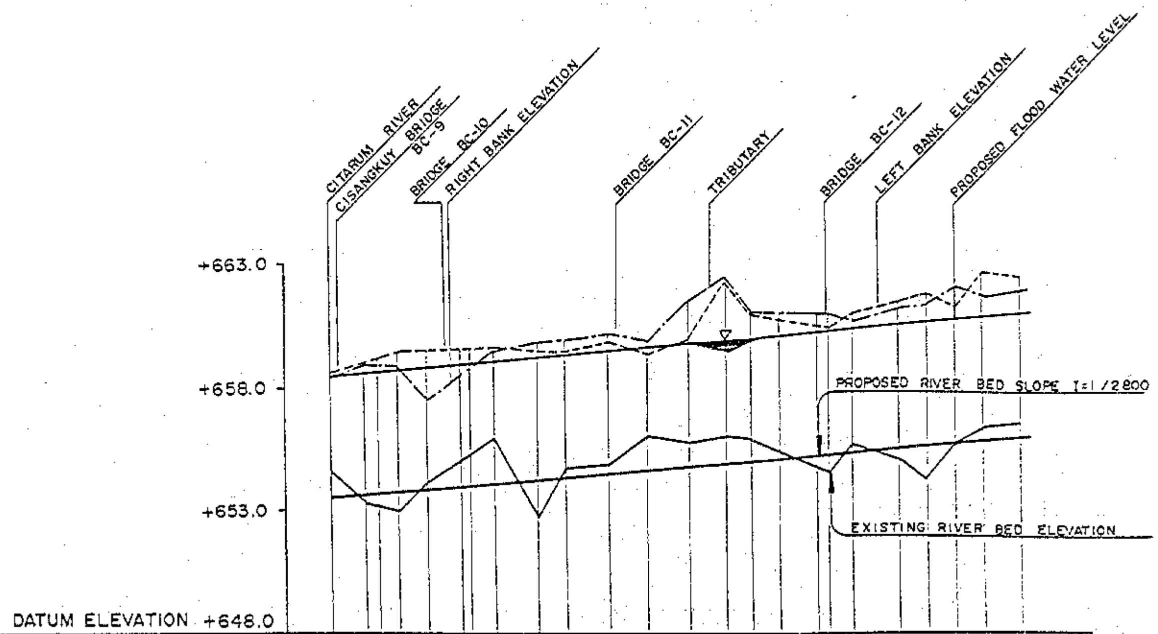


FIG. 6.15 LONG-TERM RIVER PROFILE OF CITARIK RIVER

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



BED SLOPE: 1/2,800 (0.00036)

SECTION NAME	SECTION DISTANCE (KM)	COMULATIVE DISTANCE (KM)	EXISTING RIVER BED ELEVATION (M)	EXISTING RIGHT BANK ELEVATION (M)	EXISTING LEFT BANK ELEVATION (M)	PROPOSED RIVER BED ELEVATION (M)	PROPOSED FLOOD WATER LEVEL (M)	PROPOSED BANK ELEVATION (M)
BM17	0.00	0.00	654.61	658.47	658.64	653.50	658.50	658.47
17	0.35 / 0.15	0.35 / 0.50	653.26	658.97	658.99	653.63 / 653.69	658.63 / 658.68	658.97
28	0.20	0.70	652.59	658.87	659.43	653.76	658.75	658.87
32	0.30	1.00	654.15	657.55	659.45	653.86	658.86	657.53
	0.33 / 0.12	1.33 / 1.45				653.96 / 654.02	658.98 / 659.02	
50	0.25	1.70	655.10	659.62	659.69	654.11	659.11	659.52
59	0.45	2.15	652.72	659.65	659.47	654.27	659.27	659.47
65	0.30	2.45	654.82	659.99	659.58	654.38	659.38	659.68
73	0.45	2.90	654.98	660.26	659.94	654.54	659.54	659.94
82	0.40	3.30	656.13	659.91	658.38	654.68	659.68	659.38
88	0.45	3.75	655.78	661.56	660.01	654.84	659.84	660.01
96	0.40	4.15	658.18	662.57	662.52	654.98	659.98	662.52
BM18	0.25	4.40	656.06	661.21	661.12	655.07	660.07	661.12
	0.30	4.70				655.18	660.18	
S/32	0.40 / 0.10	5.10 / 5.20	654.65	661.05	660.54	655.32 / 655.36	660.32 / 660.36	660.54
S/40	0.25	5.45	653.88	660.80	661.10	655.45	660.45	660.80
S/55	0.50	5.95	655.17	661.31	661.56	655.85	660.63	661.36
S/62	0.30	6.25	654.34	661.44	661.90	655.73	660.73	661.44
S/71	0.30	6.55	655.87	662.26	661.40	655.84	660.84	661.40
S/78	0.30	6.85	656.52	661.83	662.92	655.95	660.95	661.83
S/90	0.40 / 0.15	7.25 / 7.40	656.72	662.08	662.62	656.09 / 656.14	661.09 / 661.14	662.08

FIG. 6.16 LONG-TERM RIVER PROFILE OF CISANGKUY RIVER

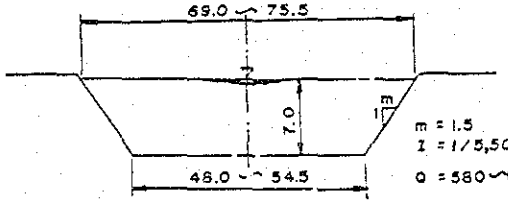
STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

CITARUM RIVER

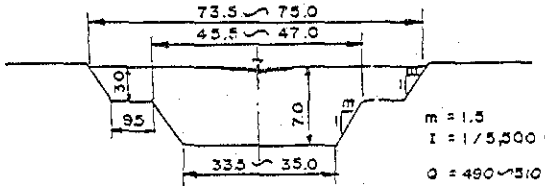
SECTION

NANJUNG (1.00 Km)
TO
CIWIDEY (5.90 Km)



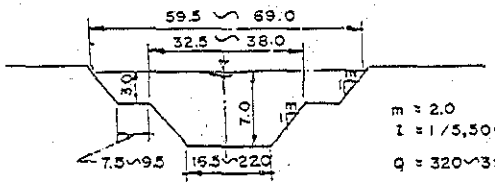
m = 1.5
I = 1/5,500 (0.00018)
Q = 580 ~ 650 m³/s

CIWIDEY (5.90 Km)
TO
CISANGKUY (20.00 Km)



m = 1.5
I = 1/5,500 (0.00018)
Q = 490 ~ 510 m³/s

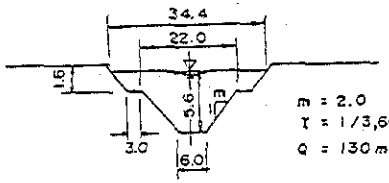
CISANGKUY (20.00 Km)
TO
CITARIK (31.10 Km)



m = 2.0
I = 1/5,500 (0.00018)
Q = 320 ~ 390 m³/s

CITARUM (UPSTREAM) RIVER

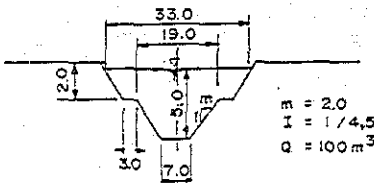
CITARIK (31.10 Km)
TO
BOJONG RANGKAS (35.20 Km)



m = 2.0
I = 1/3,600 (0.00028)
Q = 130 m³/s

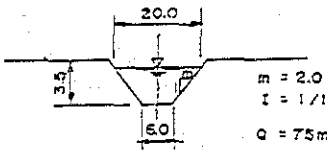
CITARIK RIVER

CITARUM (0.00 Km)
TO
CIUNGGALA (10.00 Km)



m = 2.0
I = 1/4,500 (0.00022)
Q = 100 m³/s

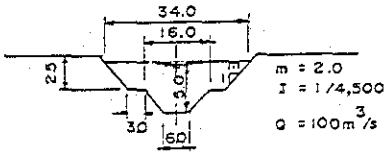
CIUNGGALA (10.00 Km)
TO
CIBODAS (15.00 Km)



m = 2.0
I = 1/1,100 (0.00091)
Q = 75 m³/s

CIKERUH RIVER

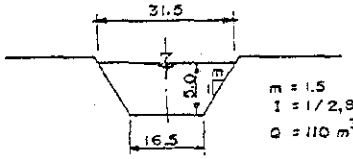
CITARUM (0.00 Km)
TO
CIPANJALU (2.00 Km)



m = 2.0
I = 1/4,500 (0.00022)
Q = 100 m³/s

CISANGKUY RIVER

CITARUM (0.00 Km)
TO
RANCAENGANG (8.50 Km)



m = 1.5
I = 1/2,800 (0.00036)
Q = 110 m³/s

FIG. 6.17 DESIGN RIVER CROSS SECTIONS FOR LONG-TERM PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

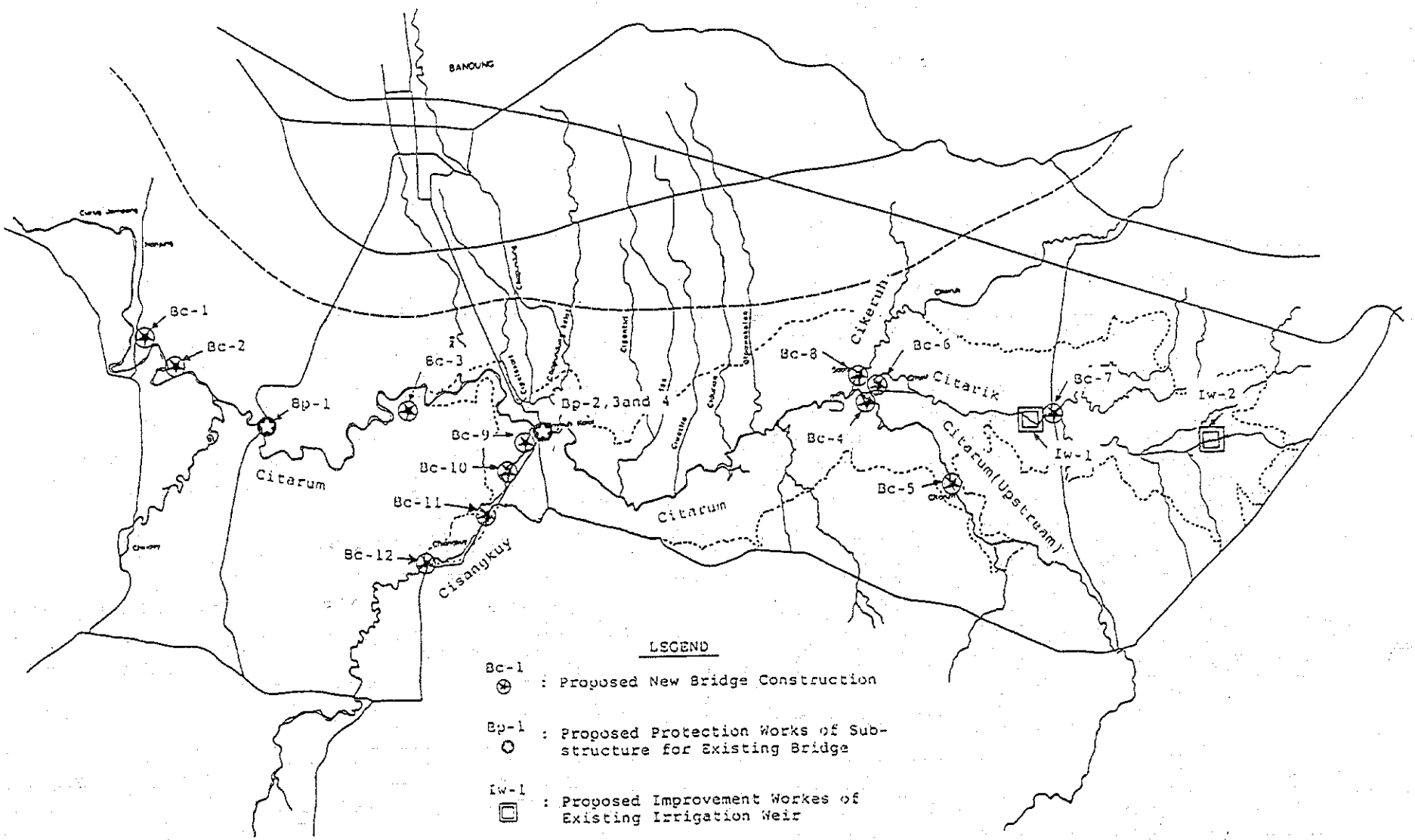


FIG. 6.18 LOCATION OF MAJOR STRUCTURES FOR LONG-TERM PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

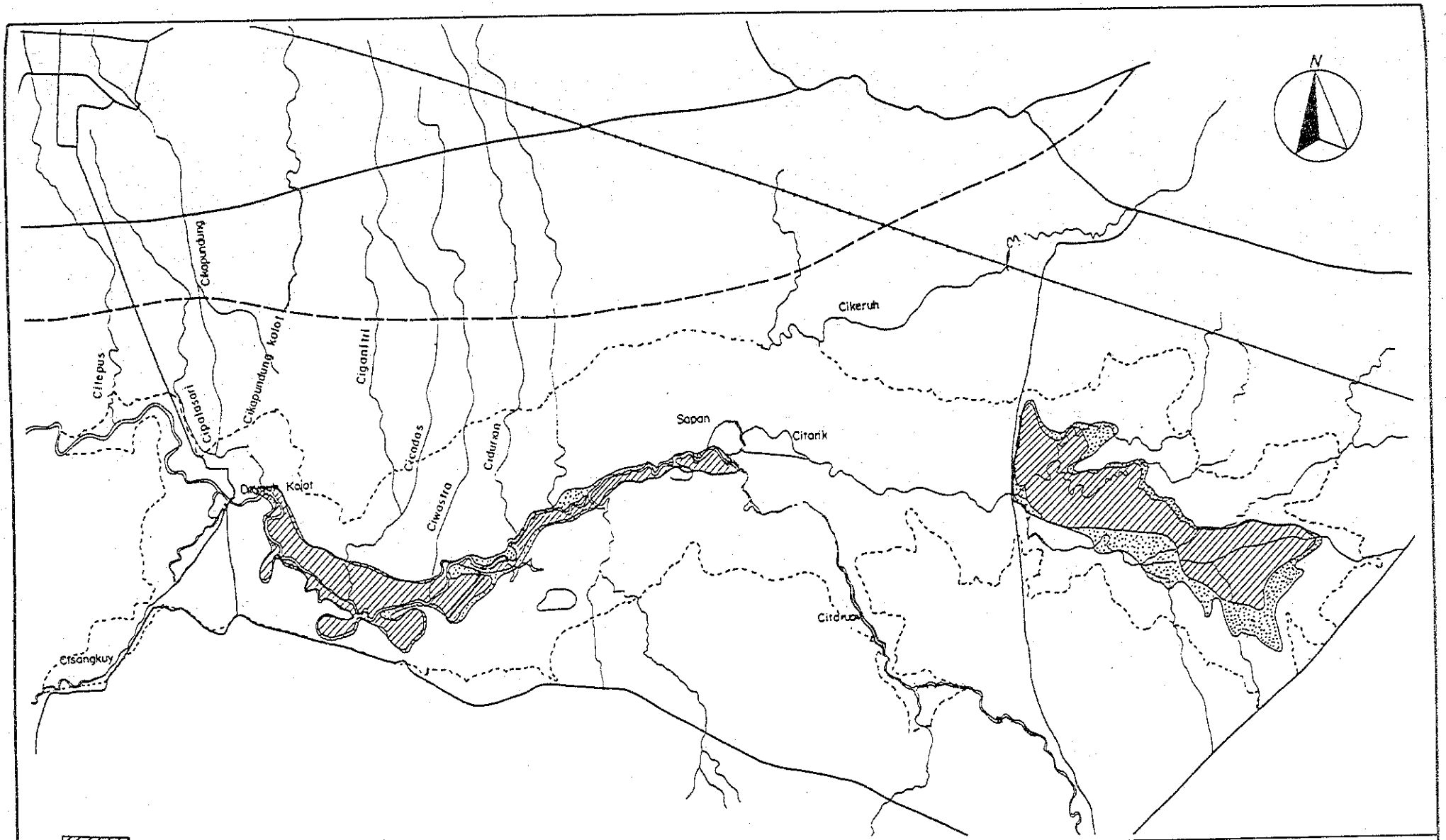


FIG. 6.19 FLOOD RISK MAP BY 20 AND 50-YEAR FLOOD AFTER COMPLETION OF LONG-TERM PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

CHAPTER 7

URGENT FLOOD CONTROL PLAN

Chapter 7. URGENT FLOOD CONTROL PLAN

7.1 General

Since the proposed overall flood control project requires much fund and a long period of project implementation, an urgent flood control project is selected from the overall one to meet the urgent requirements of flood control. The scale of the urgent project shall be determined in due consideration to economic efficiency and financial constraints. The construction works of the urgent project shall be formulated within the frame-work of the overall project and in conformity with it.

7.2 Improvement Reaches

The estimated average annual flood damage of the Citarum River is approximately Rp.16.14 billion in economic price. Its distribution by region is shown below. Location of each zone is shown in Fig.4.11.

Zone	Average Annual Flood Damage (Million ERp.)	Ratio (%)
A	3,664	22.7
B	3,960	24.6
C	5,357	33.2
D	1,234	7.6
E	1,921	11.9
Total	16,136	100%

The river reaches between Curug Jompong and Sapan are selected at the target reaches of the urgent plan based on the following considerations:

(1) The prime aim of the urgent plan shall be to eliminate the frequent flooding that occurs two (2) or three (3) times a year.

(2) Such frequent flood mostly occur in A, B and C zones between Dayeuh Kolot and Sapan. (See Fig 4.1 and Fig 4.11).

(3) The average annual flood damage of the upstream of Sapan (D and E zones) is low, compared to that of the downstream (A, B and C zones).

(4) More than 70% of the flood damage of D zone will be eliminated by the river improvements at downstream of Sapan.

The target river reaches of the urgent plan are given below and their locations are shown in Fig. 7.1.

- Citarum River : Curung Jompong - Sapan (existing river length : 40.2 km)
- Cisangkuy River : Dayeuh Kolot - Rancoengang (existing river length : 8.5 km

7.3 Alternative Study of Design Flood Frequency

The design flood frequency of the urgent plan is determined, comparing the achievement rates of 2-year and 5-year plans to that of the long-term plan (20-year) in terms of the following factors.

(1) River discharge capacity at Dayeuh Kolot
(2) Flood depth at Dayeuh Kolot for the 20-year frequency flood
(3) Number of house relieved from the 20-year frequency flood
(4) Produced average annual flood damage reduction
(5) Required construction cost

The comparison is shown below.

Comparison of Design Flood Alternatives

Item	Design Flood		
	2-year	5-year	20-year
(1) Discharge Capacity (m^3/s)	320 (65%)	390 (80%)	490 (100%)
(2) Flood Depth (m)	1.3	0.6	0
(3) No. of Relieved House (houses)	4,200 (17%)	15,900 (64%)	24,900 (100%)
(4) Annual Flood Damage Reduction (Million ERp.)	13,457 (84%)	15,211 (95%)	16,006 (100%)
(5) Construction Cost (Million Rp.)	65,311 (60%)	81,465 (75%)	108,747 (100%)

Note: 1. For details on item (1) and (2) refer to Fig. 6.6.
2. For item (3) and (4) refer to Table K.21 and K.25 of Supporting Report K.
3. For item (5) refer to Table 7.1.

The 2-year plan is economically more efficient. However, it will attain only 17% of the long-term plan in house relief from flood and will inundate Dayeuh Kolot in 1.3 m depth when the 20-year frequency flood occurs, as shown in Fig. 6.6.

From the above considerations, 5-year frequency flood is proposed to apply as the design flood of the urgent river improvement plan.

7.4 Proposed Urgent River Improvement Plan

7.4.1 Planning Policy and Design Criteria

The urgent river improvement is planned and designed in accordance with the following policy and criteria.

(1) Planning policy and design criteria in long-term plan will be basically followed.

(2) The plans are to be especially prepared to mitigate flood damage between Dayeuh Kolot and Sapan.

(3) Design flood and rainfall pattern are applied to a 5-year frequency flood and the March 1986 Storm respectively.

(4) A feature of the proposed river improvement will be determined within the proposed one in the long-term plan.

(5) Other design criteria adopted are the same as that of long-term plan.

7.4.2 Design Discharge

The design discharge hydrograph at Dayeuh Kolot and design peak discharge distribution of both rivers are shown in Fig. 7.2.

7.4.3 River Alignment, Profile and Cross Section

(1) Citarum River

The design river alignment is the same as that of the long-term plan. The proposed plans of the urgent river channel improvement are illustrated in Fig. 7.3 to Fig. 7.9.

The design flood water level and river bed slope are also proposed to be the same as that of the long-term plan. The river bed elevation is, however, set 1.0 m above that of the long-term plan, in order to reduce the dredging cost for the stiff soil or soft rock located under the existing river bed between Curug Jompong and Dayeuh Kolot. The design river profile is shown in Fig. 7.10.

The design cross sections are planned to obtain a enough flow area for the design flood within that of the long-term plan. Fig. 7.11 shows the design river cross sections.

(2) Cisangkuy River

The design river alignment and profile are proposed to be the same as that of the long-term plan. As to the design cross sections, the bank slope is proposed to be more gentle than that of the long-term plan. The proposed plan, profile and cross sections are illustrated in Fig. 7.12 to Fig. 7.14.

7.4.4 Construction Works

The required major construction works are summarized as follows:

- River dredging : $6{,}953 \times 10^3$ m^3
  - Existing channel : $4{,}351 \times 10^3$ m^3
  - Cut-off channel : $2{,}602 \times 10^3$ m^3
- Bank clearing and grubbing : 3.0 km
- Bank protection : 6.1 km
- Bridge improvement : 11 place
  - New construction : 7 place
  - Strengthening : 4 place
- Maintenance/Connection Road : 2.15 km

Break-down of the construction works is shown in Table 7.2.
Typical designs of related river structures are illustrated from Fig. 7.15 to Fig. 7.18.

7.4.5 Land Acquisition and Compensation

Land acquisition and house resettlement compensation are required prior to the implementation of the construction works. The quantities of land acquisition and compensation are summarized below.

- Land acquisition : 110.6 ha
- House compensation : 223 houses

Break-down of land acquisition and compensation is shown in Table 7.2.

7.5 Flood Plain Management

Flood plain management of the urgent flood control plan consists of the land-use regulation in the flood risk area, and of the establishment of the flood forecasting and warning system.

7.5.1 Flood Risk Map

Flood risk areas affected by a 5, 20 and 50-year flood are identified in the flood prone area after completion of the proposed urgent plan. The estimated flood risk areas and number of flood risk houses under the above three (3) conditions are as follows:

Flood	Flood Risk Area (ha)	Number of Flood Risk House	
		Inundation Depth>0cm	Inundation Depth>50cm
5-year	3,160	8,047	3,200
20-year	4,710	15,054	7,100
50-year	5,640	20,011	10,400

The flood risk maps for above three (3) conditions are shown in Fig. 7.19.

7.5.2 Target Area of Flood Plain Management

The flood risk area of 50-year flood is considered as the target area of the flood plain management. This area is 5,640 ha for the period after completion of the urgent plan, in which 27 desas are included. However, it will decrease to, 1,260 ha after completion of the long-term plan.

7.5.3 Land-use Regulation

A proper land-use regulation by the government is required to curb the increase of the flood damage potential. The conceivable land use regulation includes :

- Restriction of housing development in critical flood prone areas.
- Guidance for flood-proof housing development

The following non-structural measures will be required to relieve the existing houses in the flood prone areas.

- Land filling of house yard
- Raising of house floor
- Construction of flood wall surrounding house

7.5.4 Flood Forecasting, Warning, and Evacuation System

(1) Existing System

There are two (2) systems exist for the flood forecasting, warning and evacuation activities of the Upper Citarum River Basin. One is "Flood Forecasting and Warning System for Saguling Hydropower Project" and the other is "Evacuation System Coordinated by SATKORLAK".

The flood forecasting and warning system for the Sauguling hydropower project functions for the operation of the dam and to transmit warning concerning water release from dam to downstream. The existing real-time hydrological data collection system shown in Fig. 7.20 covers the Upper Citarum Basin.

The evacuation system coordinated by SATKORLAK, which is composed of the members of the concerning agencies such as the Public Works Service, Department of Agriculture and Indonesian Red Cross, etc, directly functions for the Upper Citarum Basin. Based on the information conveyed from Desas, judgment on suitable refuge places and other required action is done by SATKORLAK. Refuge places are mosque, railway station (Dayeuh Kolot), Desa office, school, settlement, warehouse, etc.

The existing flood information and evacuation system is shown in Fig. 7.21.

(2) Proposed Flood Forecasting and Warning System

A flood forecasting and warning system will be established to support the flood evacuation activities of the Upper Citarum Basin. The required hydrological data collection and transmission system will be accomplished fully by providing the existing system of the Saguling Hydropower Project with additional six (6) water level stations with telemetering system.

As a result, the Upper Citarum Basin will be covered by a real-time hydrological data collection and transmission system consisting of the following stations.

- Eight (8) existing rainfall stations
- One (1) existing and six (6) additional telemeters at the existing water level stations
- One (1) existing repeater station
- One (1) expansion of existing monitoring station (IHE)
- One (1) additional master station (DPUP)

The proposed flood forecasting and warning system is shown in Fig. 7.20.

The Upper Citarum River Project will be responsible for providing hydrological information required for flood warning and flood evacuation activities of the Upper Citarum River Basin.

Table 7.1 COST COMPARISON OF DESIGN FLOOD ALTERNATIVES

(Unit : Million Rp.)

Item	2-Year Plan	5-Year Plan	20-Year Plan
I. Civil Work Cost			
(a)Citarum (main)	42,528.8	53,161.0	73,234.3
(b)Cisangkuy	2,074.4	2,593.0	3,010.6
II. Flood Warning System	1,265.2	1,265.2	1,265.2
III. Land Acquisition/ Compensation	5,316.0	6,645.0	7,715.0
IV. Administration Cost	2,559.2	3,183.2	4,261.3
V. Engineering Service Cost	5,630.3	7,211.9	9,374.8
Total	59,373.9	74,059.3	98,861.2
VI. Physical Contingency	5,937.4	7,405.9	9,886.1
Grand Total	65,311.3	81,465.2	108,747.3

Note 1. Civil work, flood warning system, and land acquisition/ compensation cost of the citarum(main) in 2-year plan is assumed as 80% of that of 5-year plan based on the design discharge rate at Dayeu Kolot (310m3/s/390m3/s)

2. Civil work, flood warning system, and land acquisition/ compensation cost of the Cisangkuy river in 2-year plan is also assumed as 80% of that of 5-year plan based on the design rate at Dayeu Kolot (310m3/s/390m3/s)

3. Administration and engineering costs are assumed as 5% and 11% of the construction cost respectively

4. Physical contingency is assumed 10% of the sum of civil work, flood warning system, land acquisition/compensation, administration, and engineering service costs.

Table 7.2 BREAKDOWN OF CONSTRUCTION WORKS

Item	Unit	0.0 - 9.0 (km)	9.0 - 20.0 (km)	20.0 - 31.2 (km)	Citarum Total	Citangkuy	Total
I. Civil Work							
A. Existing River							
(a) Preparatory Work							
(b) Dredging							
(1) Common Soil (i)	x 10^3m3	342	758	1,269	2,369	373	2,742
(2) Stiff Soil (i)	x 10^3m3	210	374	20	674		674
(3) Soft Rock	x 10^3m3	267	668		935		935
(c) Bank Clearing/Grubbing	m2	118,800			118,800		118,800
(d) Bank Protection	m	1,650	2,450	2,000	6,100		6,100
(e) Bridge Improvement							
Strengthening (Gabion)	place	1		3	4		4
New bridge construction	m2 (place)					1024 (4)	1024 (4)
(f) Maintenance/Connection Rd.	m		250		250		250
B. Cut-off Channel							
(a) Preparatory Work							
(b) Dredging							
(1) Common Soil	x 10^3m3				1,032	77	1,109
Common Soil (i)	x 10^3m3			654	654	77	731
Common Soil (ii)	x 10^3m3	281	97		378		378
(2) Stiff Soil	x 10^3m3				1,147		1,147
Stiff Soil (i)	x 10^3m3			32	32		32
Stiff Soil (ii)	x 10^3m3	881	234		1,115		1,115
(3) Soft Rock	x 10^3m3	225	121		346		346
(c) New Bridge Construction	m2 (place)	1440 (1)	576		2,016		2,016
(d) Maintenance/Connection Rd.	m	1,050	1,100		2,150		2,150
C. Total							
II. Flood Warning System					1		1
III.Land Acquisition/Compensation							
A. Land Aquisition							
(a) Existing River	x 10^3m3	152	293	234	679	71	750
(b) Cut-off Channel	x 10^3m3	145	78	110	333	29	362
B. House Resettlement							
(a) Existing River	house		81	33	114	23	137
(b) Cut-off Channel	house		70	10	80		80

Note: Commom soil (i) and Stiff Soil (i): dredged by pump dredger
Common soil (ii) and Stiff Soil (ii): dredged by backhoe and bulldozer

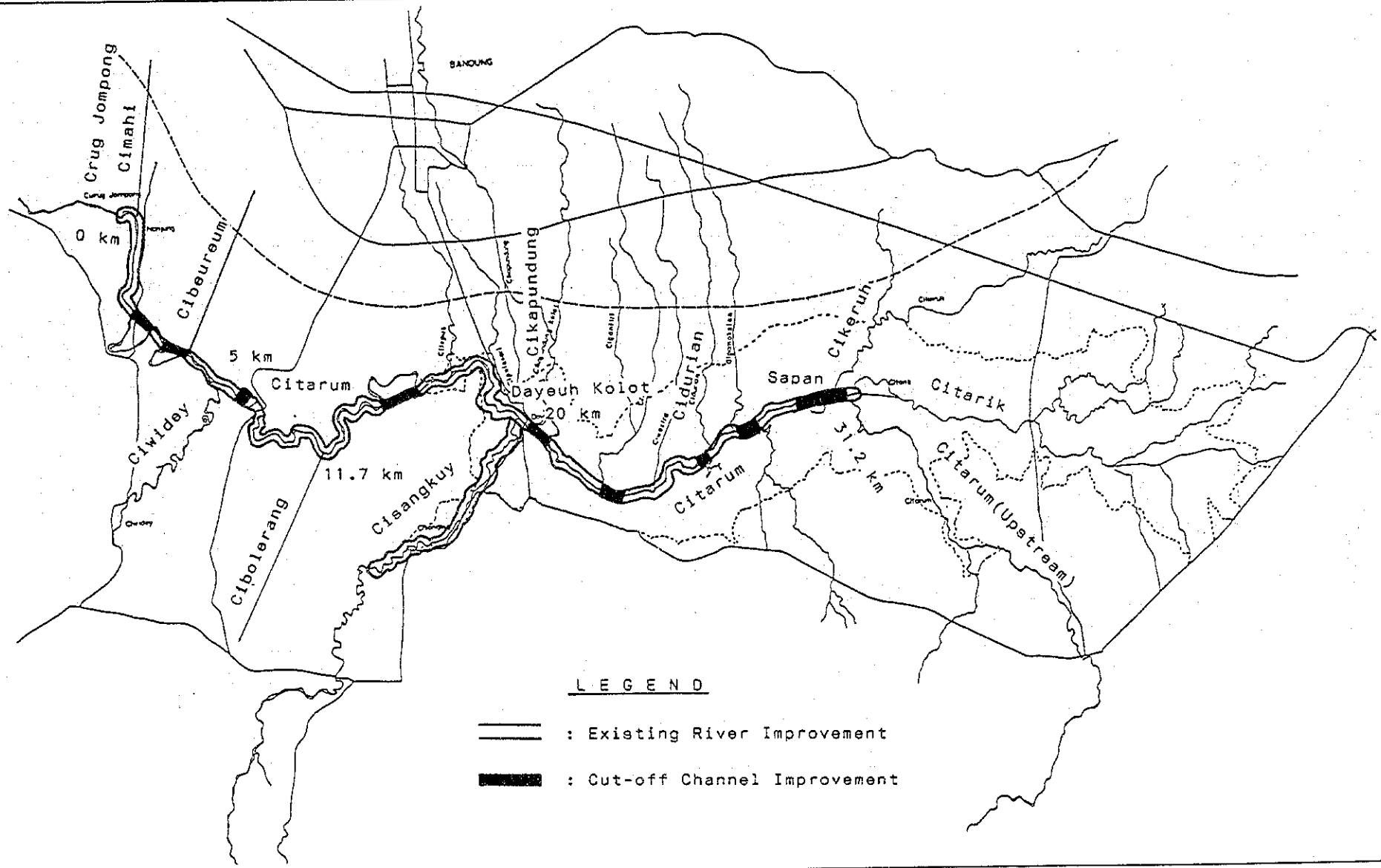
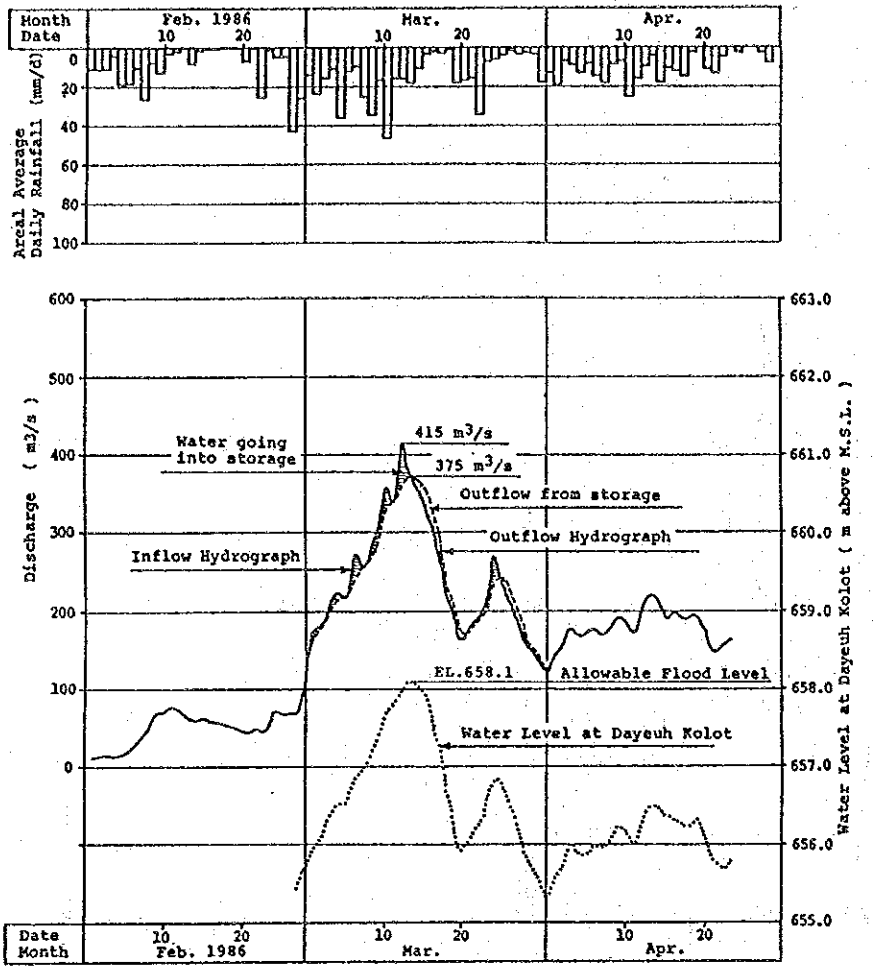


FIG. 7.1 PROPOSED RIVER IMPROVEMENT REACHES OF URGENT PLAN

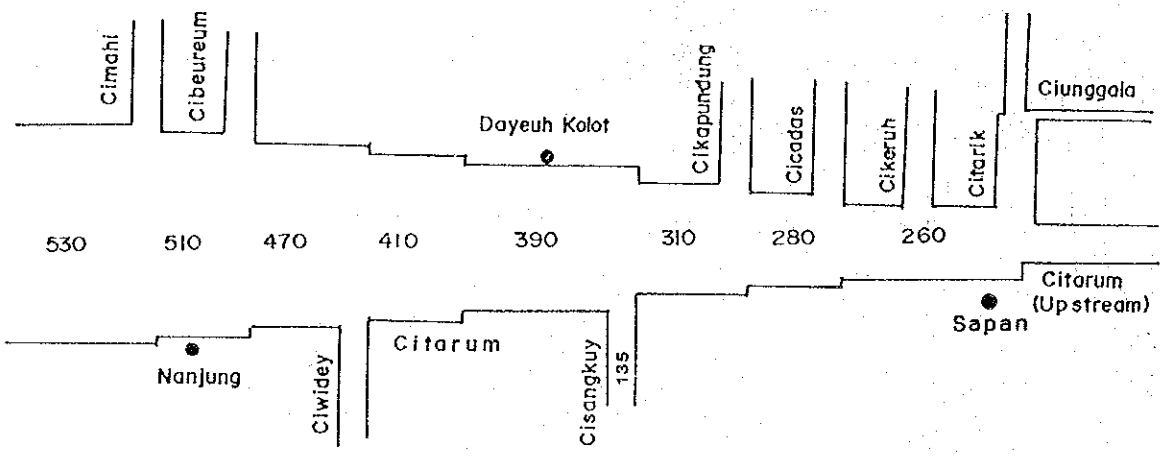
STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA



5-Year Frequency

DESIGN DISCHAREGE HYDROGRAPH AT DAYEUH KOLOT



DESIGN PEAK DISCHARGE DISTRIBUTION

FIG. 7.2 DISCHARGE HYDROGRAPH AT DAYEUH KOLOT AND PEAK DISCHARGE DISTRIBUTION

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

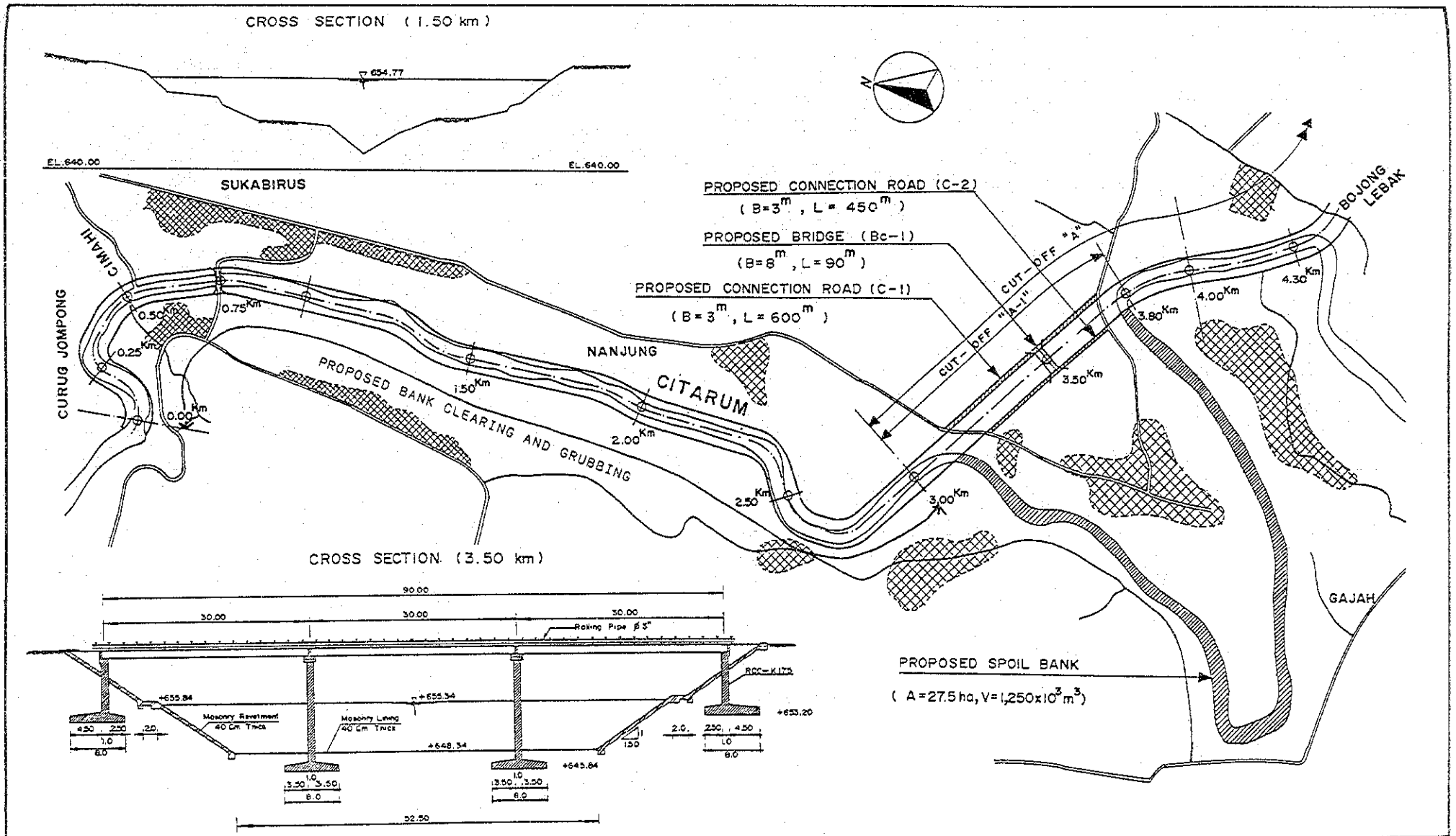


FIG. 7.3 PLANE OF PROPOSED URGENT RIVER CHANNEL IMPROVEMENT (1) (CITARUM RIVER)

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

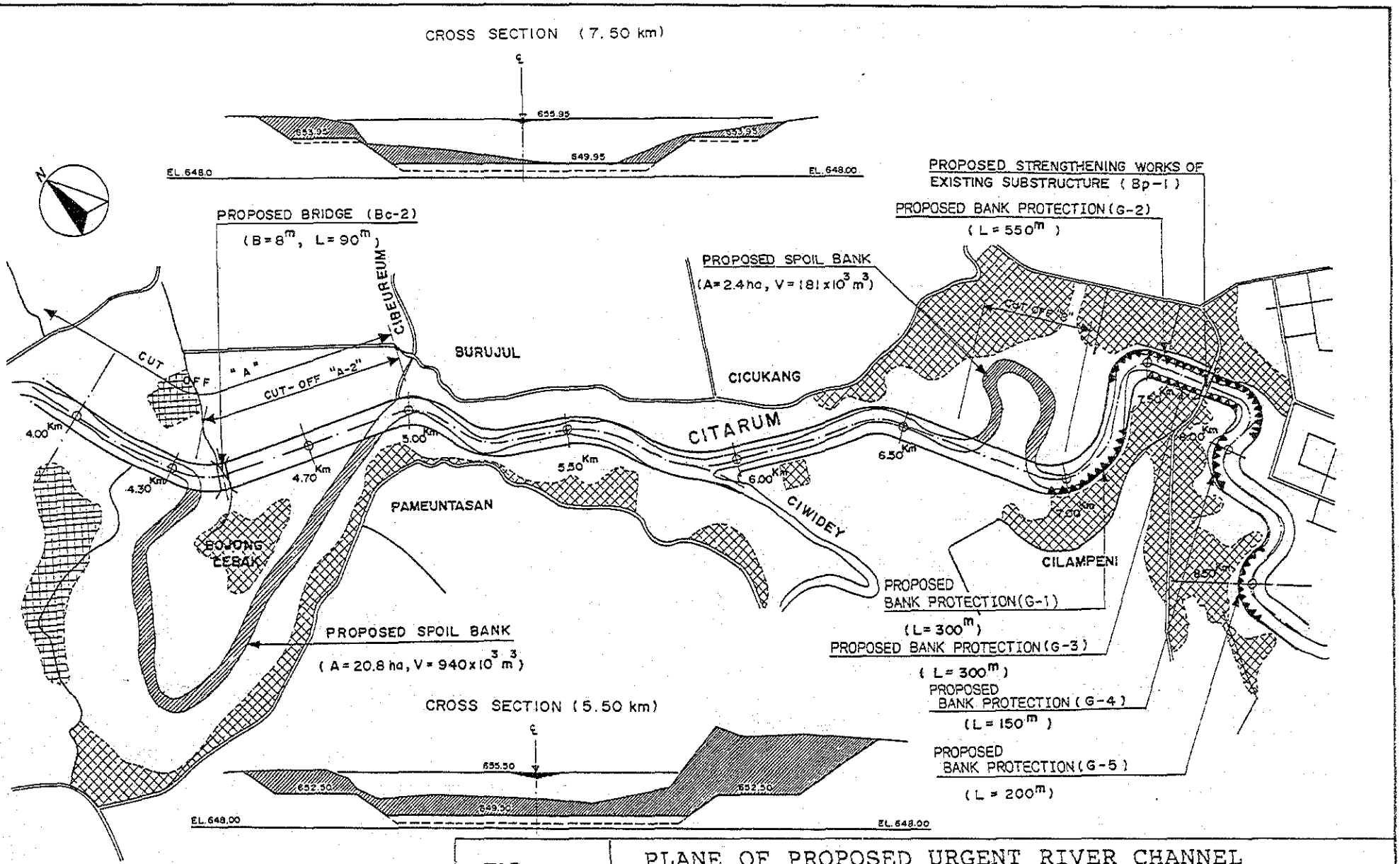


FIG. 7.4 PLANE OF PROPOSED URGENT RIVER CHANNEL IMPROVEMENT (2) (CITARUM RIVER)

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

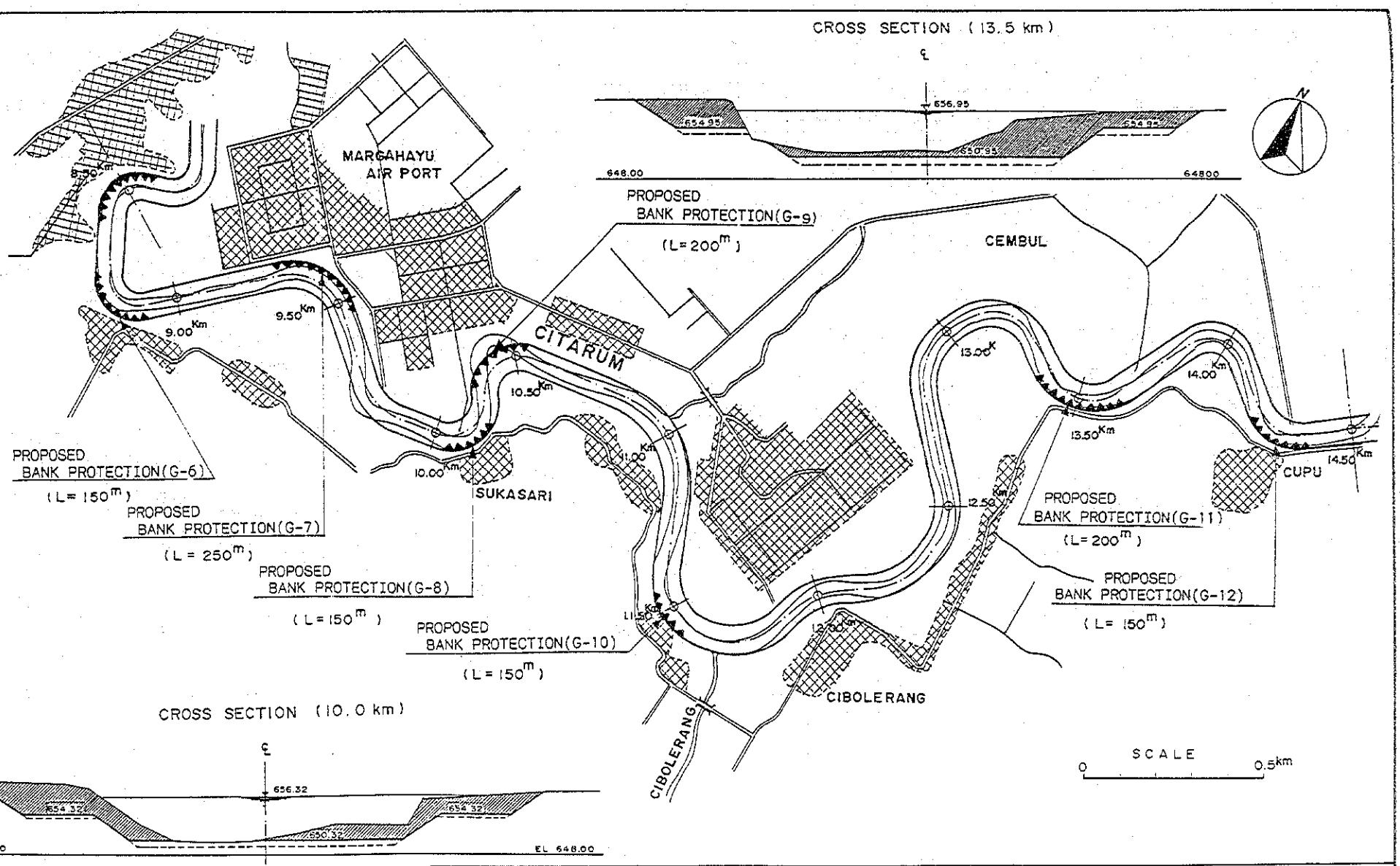


FIG. 7.5 PLANE OF PORPOSED URGENT RIVER CHANNEL IMPROVEMENT (3) (CITARUM RIVER)

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

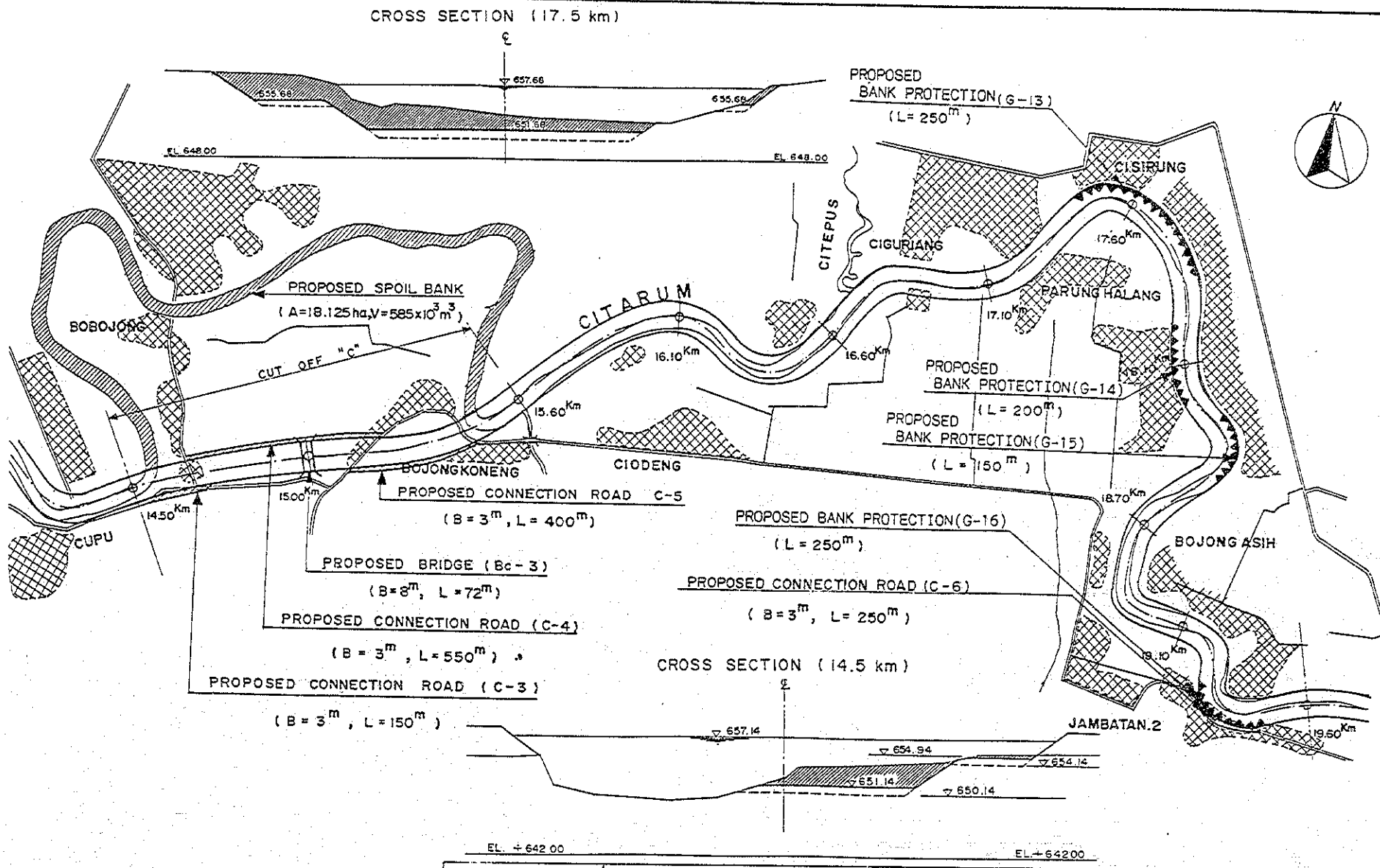


FIG. 7.6 PLANE OF PORPOSED URGENT RIVER CHANNEL IMPROVEMENT (4) (CITARUM RIVER)

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

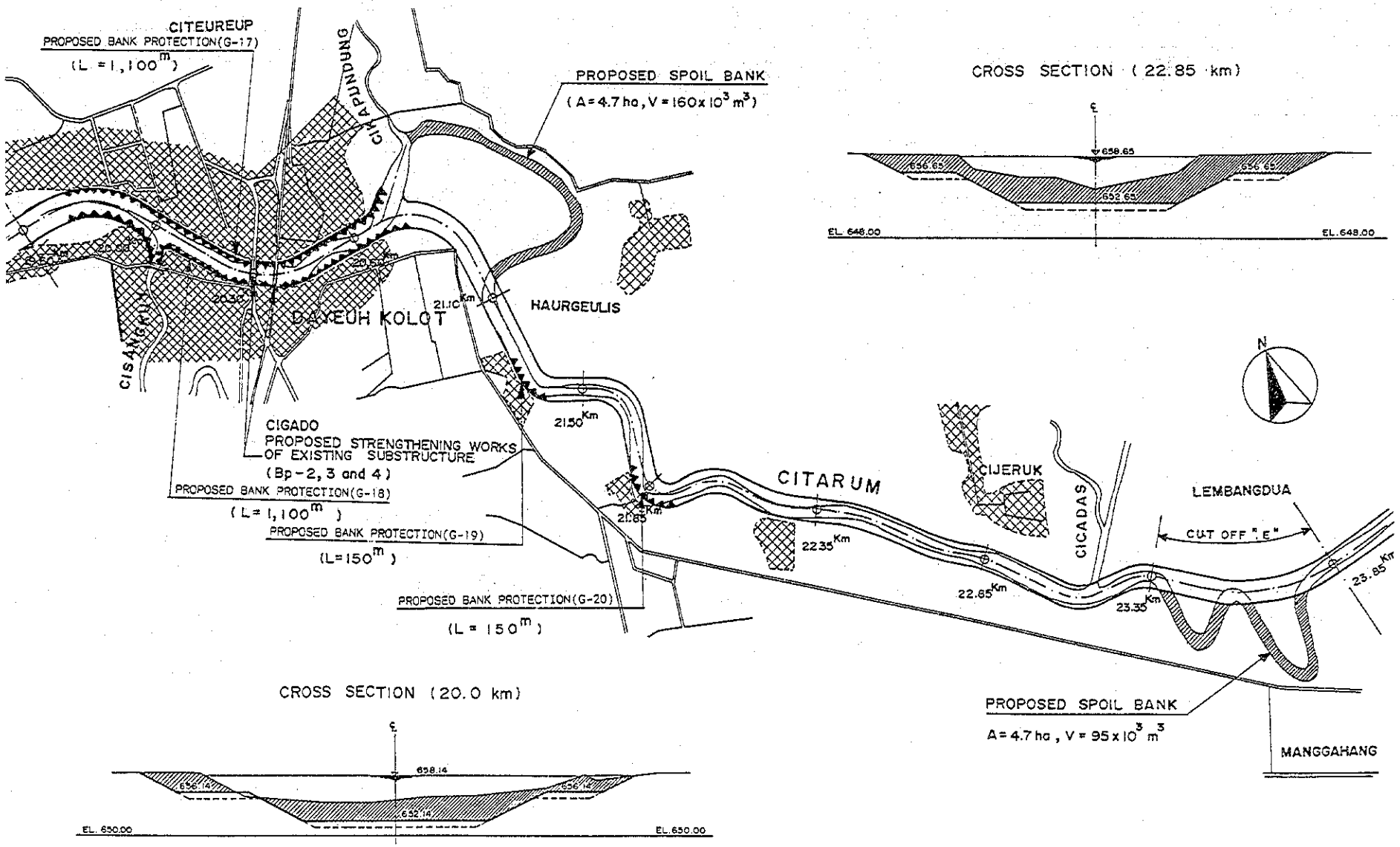
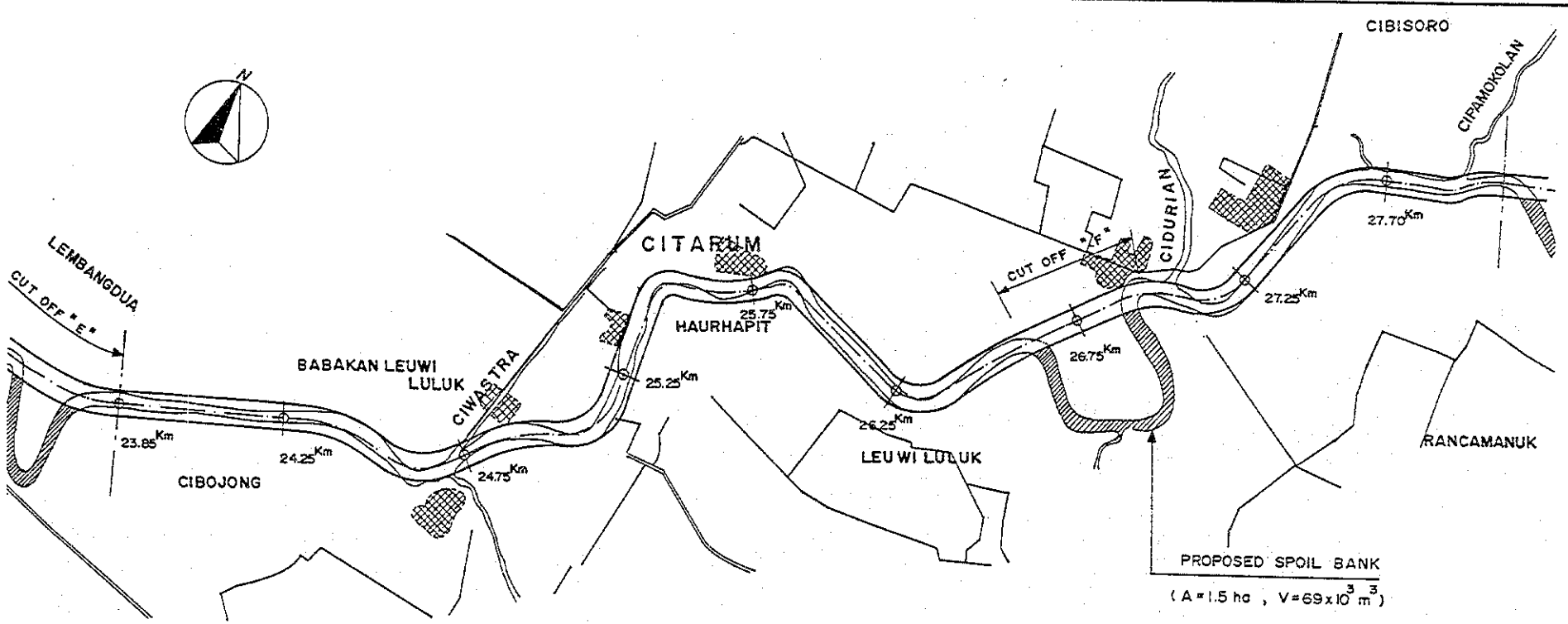
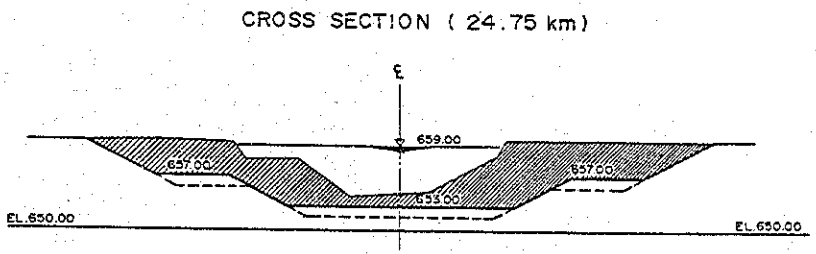


FIG. 7.7	PLANE OF PROPOSED URGENT RIVER CHANNEL IMPROVEMENT (5) (CITARUM RIVER)
	STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN





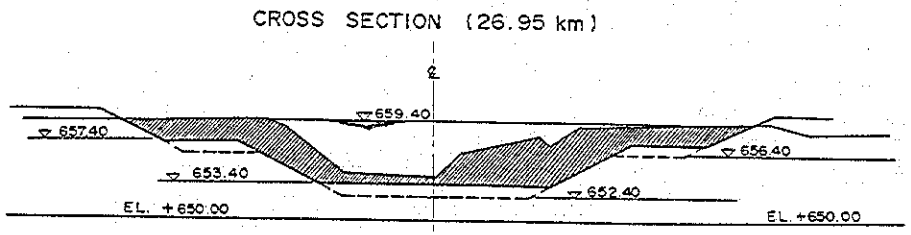


FIG. 7.8 PLANE OF PROPOSED URGENT RIVER CHANNEL IMPROVEMENT (6) (CITARUM RIVER)

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

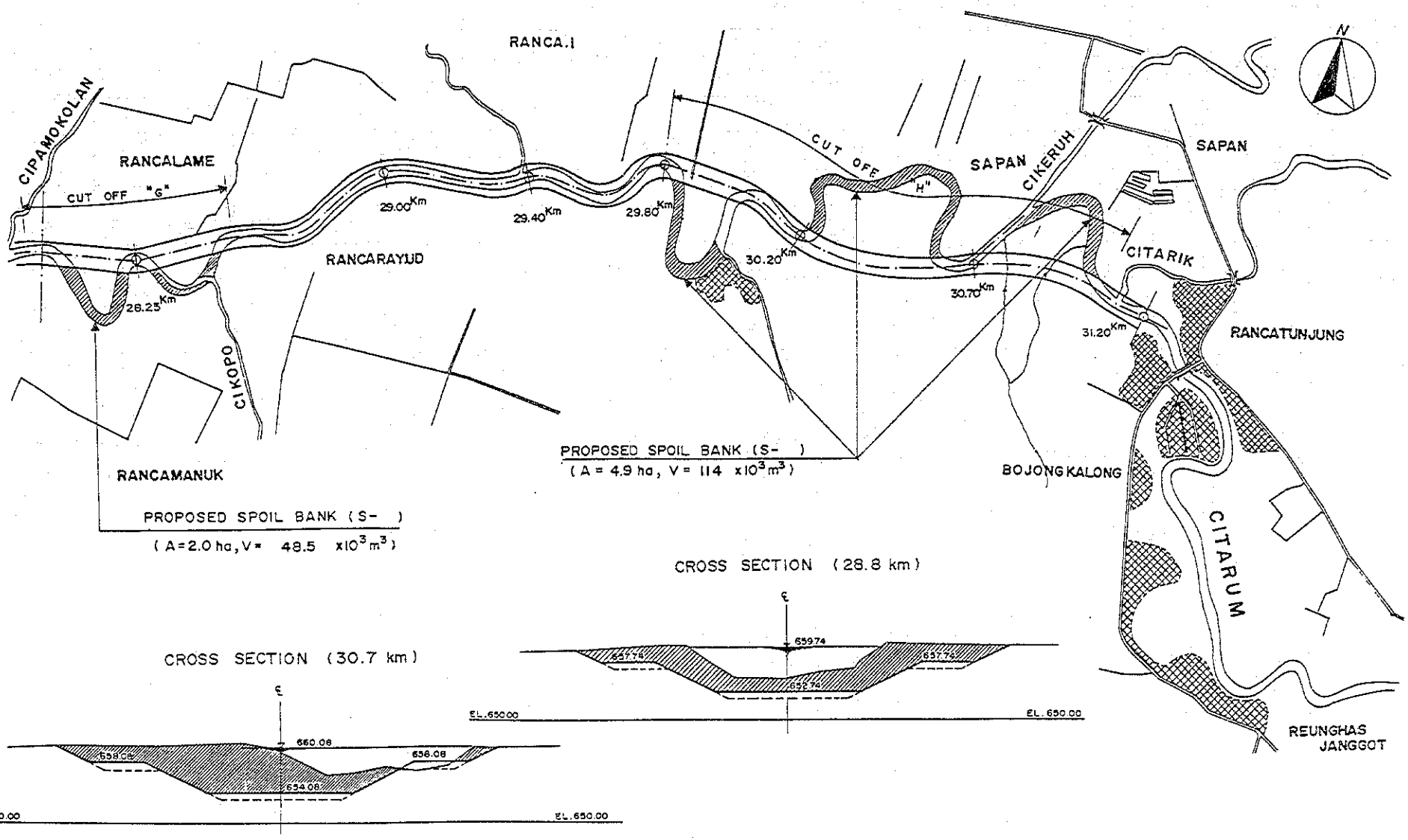


FIG. 7.9 PLANE OF PROPOSED URGENT RIVER CHANNEL IMPROVEMENT (7) (CITARUM RIVER)

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA

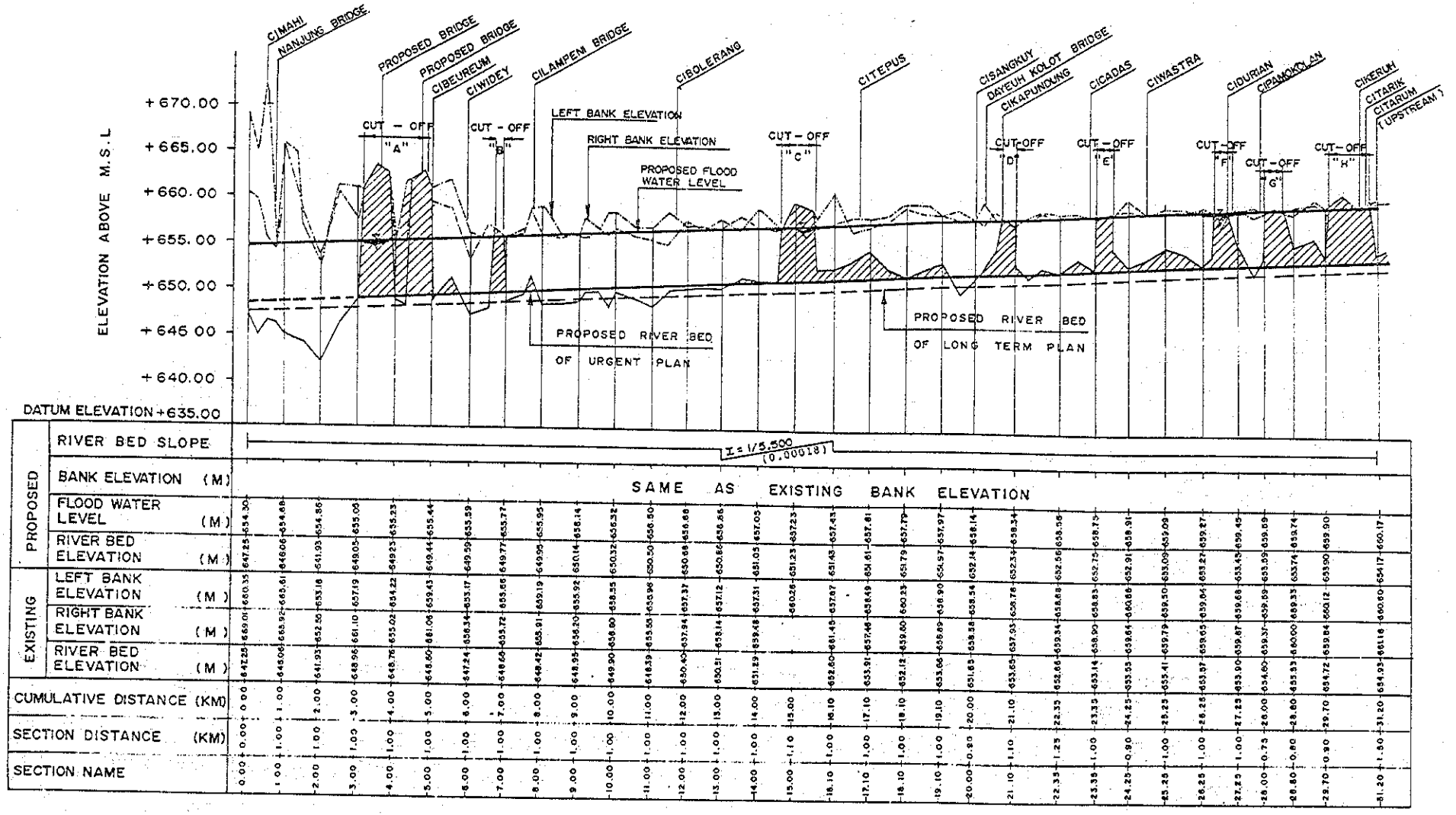


FIG. 7.10 PROPOSED PROFILE OF CITARUM RIVER FOR URGENT PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

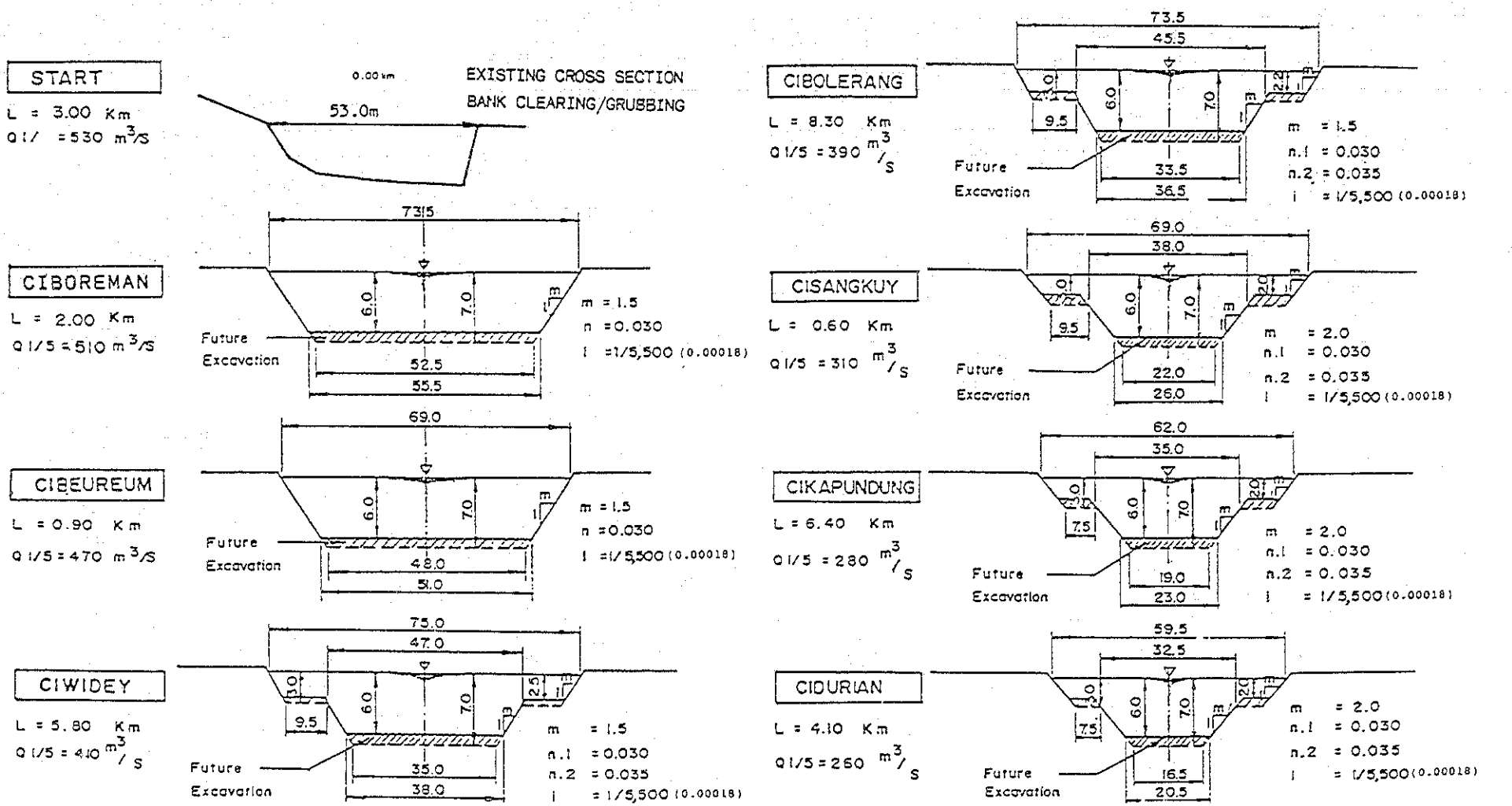
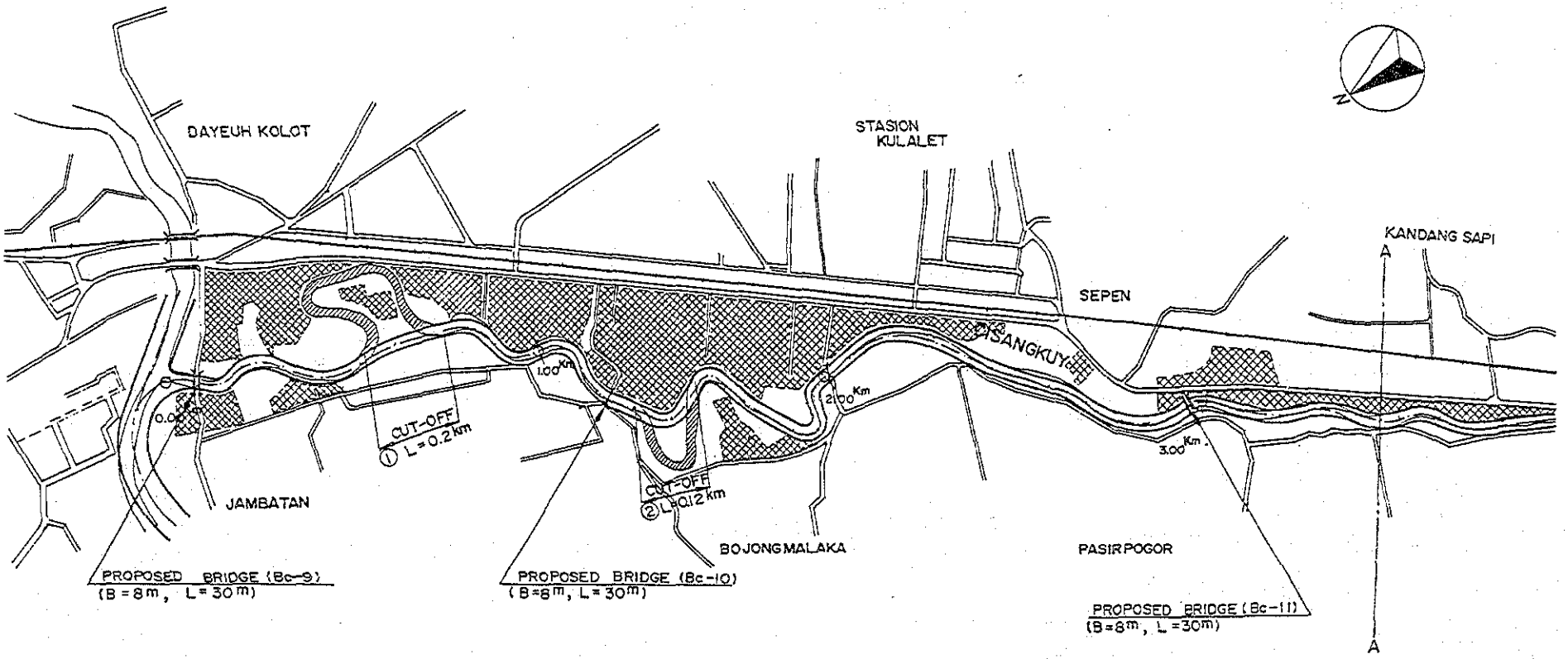


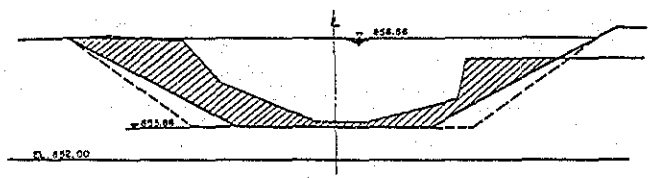
FIG. 7.11 PROPOSED CROSS SECTIONS OF CITARUM RIVER FOR URGENT PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

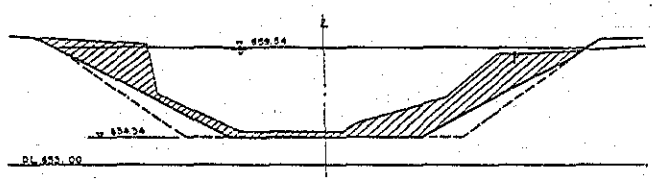
JICA



CROSS SECTION (1.00 km)



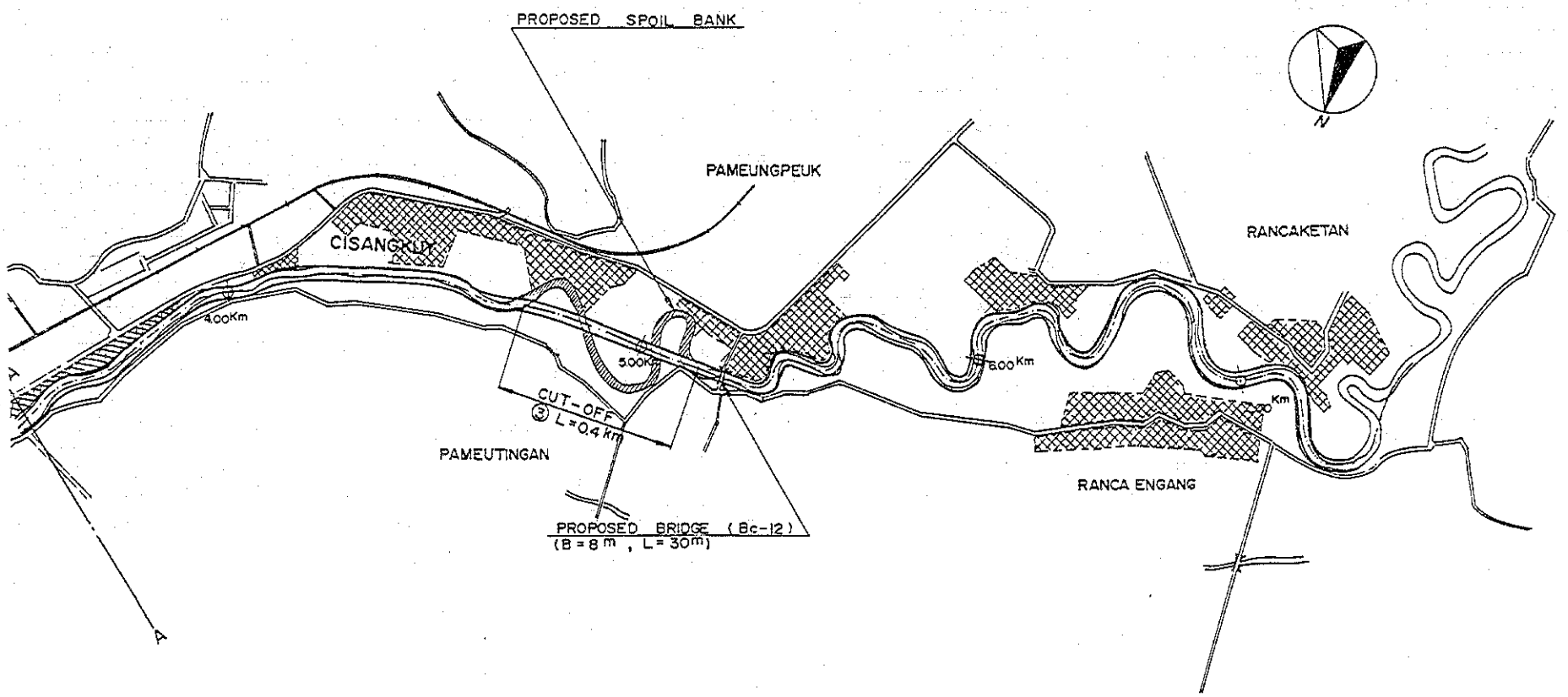
CROSS SECTION (2.90 km)



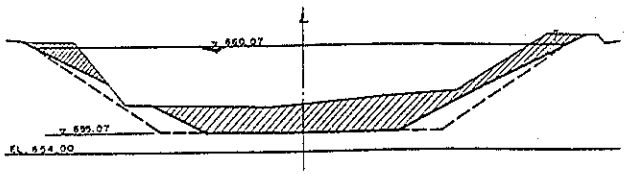
SCALE 0 0.5km

FIG. 7.12 PLANE OF PROPOSED URGENT RIVER CHANNEL IMPROVEMENT (1) (CISANGKUY RIVER)

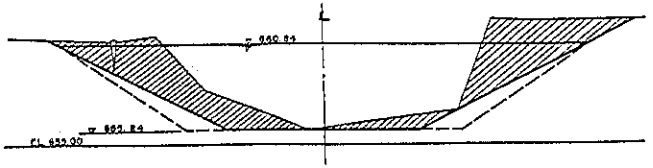
STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN



CROSS SECTION (4.40 km)



CROSS SECTION (6.55 km)

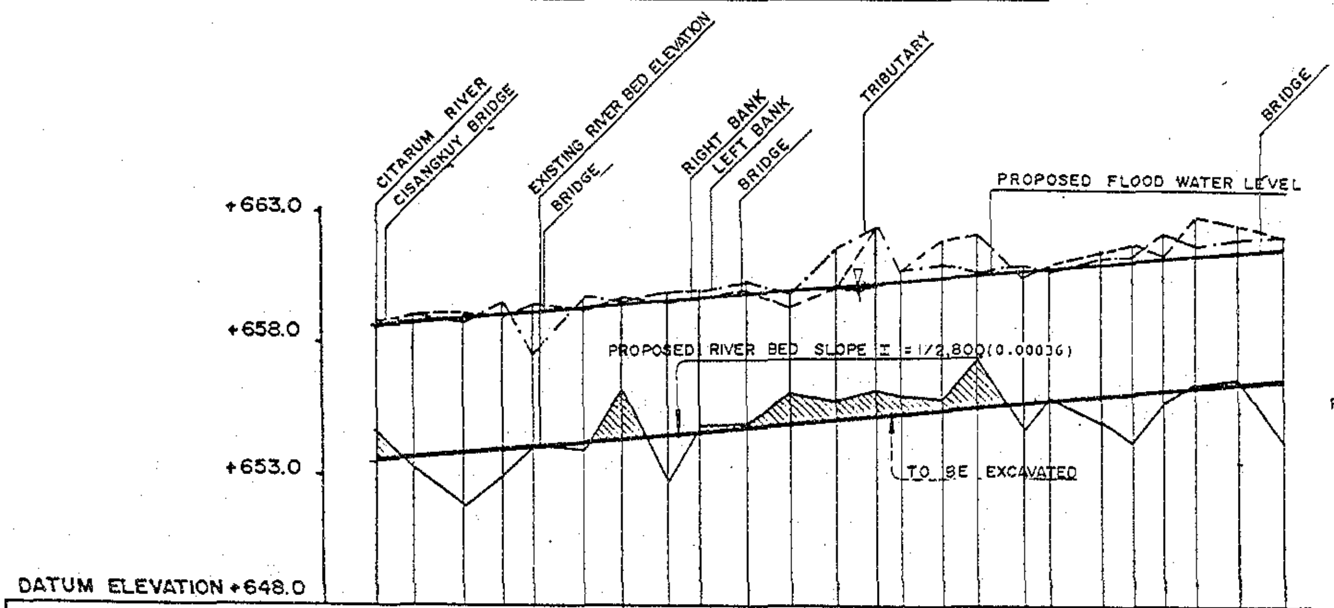


SCALE
0 0.5km

FIG. 7.13 PLANE OF PROPOSED URGENT RIVER CHANNEL IMPROVEMENT (2) (CISANGKUY RIVER)

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

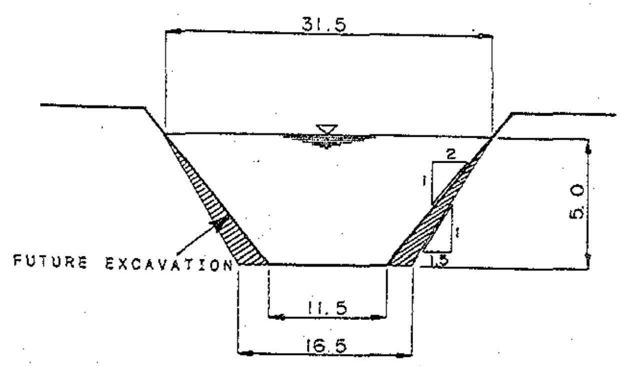
JICA



		BM17	17	19	26	32	41	50	59
PROPOSED	BANK ELEVATION (M)	658.47	658.97	658.67	658.67	657.53	659.17	659.62	659.47
	FLOOD WATER LEVEL (M)	658.80	658.63	658.79	658.96	659.04	659.21	659.34	659.50
	RIVER BED ELEVATION (M)	653.50	653.65	653.79	653.98	654.04	654.21	654.34	654.50
EXISTING	LEFT BANK ELEVATION (M)	658.84	658.98	659.01	659.43	659.45	659.17	659.69	659.47
	RIGHT BANK ELEVATION (M)	658.47	658.97	659.67	658.87	657.53	658.71	659.32	659.83
	RIVER BED ELEVATION (M)	654.61	653.26	651.73	652.99	654.15	655.93	656.10	652.72
COMULATIVE DISTANCE(KM)		0.00	0.35	0.82	1.20	1.50	2.00	2.35	2.80
SECTION DISTANCE (KM)		0.00	0.35	0.47	0.38	0.30	0.50	0.35	0.45
SECTION NAME		BM17	17	19	26	32	41	50	59

		65	73	85	88	95	BM18	5/10	5/29
PROPOSED	BANK ELEVATION (M)	659.58	659.94	659.38	660.01	662.52	661.12	661.11	660.72
	FLOOD WATER LEVEL (M)	659.61	659.77	659.91	660.07	660.21	660.30	660.48	660.57
	RIVER BED ELEVATION (M)	654.61	654.77	654.91	655.07	655.21	655.30	655.45	655.57
EXISTING	LEFT BANK ELEVATION (M)	658.58	659.94	659.38	660.01	662.52	661.12	662.19	662.25
	RIGHT BANK ELEVATION (M)	659.90	660.25	659.91	661.58	662.57	661.21	661.11	660.72
	RIVER BED ELEVATION (M)	654.02	654.96	656.15	655.70	654.18	656.04	655.95	657.42
COMULATIVE DISTANCE(KM)		3.10	3.55	3.95	4.40	4.80	5.05	5.45	5.80
SECTION DISTANCE (KM)		0.30	0.45	0.40	0.45	0.40	0.25	0.40	0.35
SECTION NAME		65	73	85	88	95	BM18	5/10	5/29

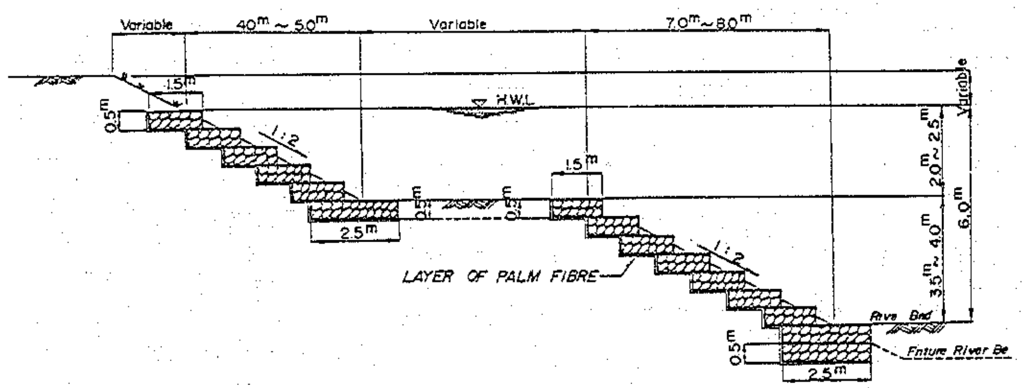
		5/32	5/40	5/63	5/67	5/71	5/78	5/90	5/101
PROPOSED	BANK ELEVATION (M)	660.54	660.80	661.31	661.44	661.40	661.63	662.08	662.23
	FLOOD WATER LEVEL (M)	660.73	660.82	661.00	661.11	661.21	661.32	661.48	661.63
	RIVER BED ELEVATION (M)	655.73	655.82	656.00	656.11	656.21	656.32	656.48	656.63
EXISTING	LEFT BANK ELEVATION (M)	660.54	661.10	661.56	661.90	661.40	658.82	662.62	662.24
	RIGHT BANK ELEVATION (M)	661.05	660.80	661.31	661.44	662.26	661.63	662.08	662.23
	RIVER BED ELEVATION (M)	654.60	655.86	656.17	654.34	655.67	658.82	654.72	654.25
COMULATIVE DISTANCE(KM)		6.25	6.50	7.00	7.30	7.60	7.90	8.30	8.75
SECTION DISTANCE (KM)		0.45	0.25	0.50	0.30	0.30	0.30	0.40	0.45
SECTION NAME		5/32	5/40	5/63	5/67	5/71	5/78	5/90	5/101

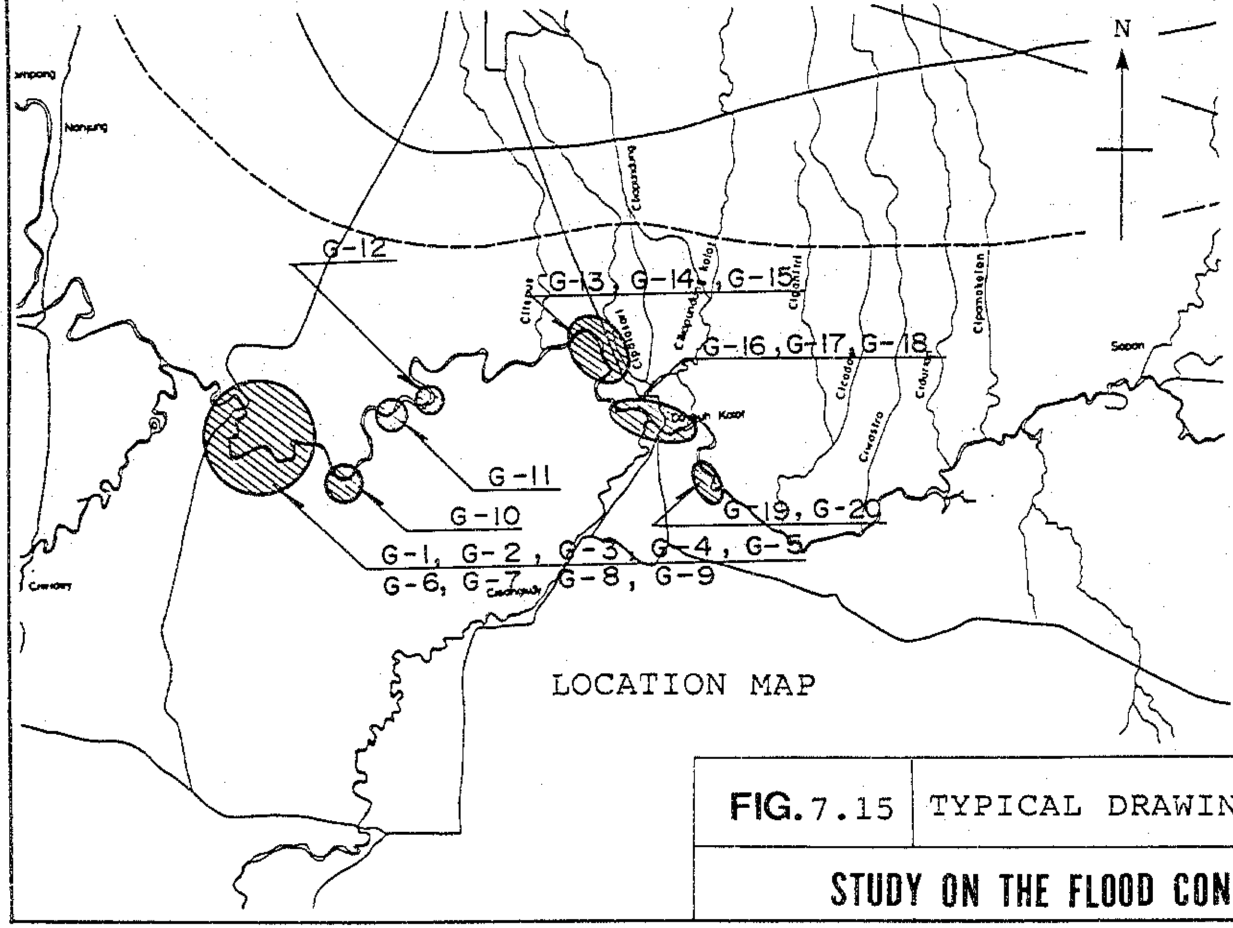


PROPOSED STANDARD CROSS SECTION

FIG. 7.14 PROPOSED PROFILE AND CROSS SECTION OF CISANGKUY RIVER FOR URGENT PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN



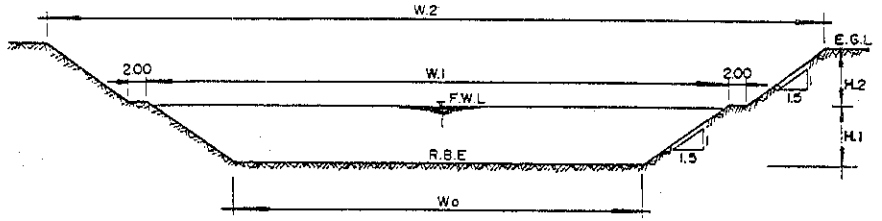


Name	Location		Length (m)
	Station	Bank	
G-1	Citarum River STA.6.95 - STA.7.25	Left	300
G-2	Citarum River STA.7.40 - STA.7.95	Right	550
G-3	Citarum River STA.7.50 - STA.7.80	Left	300
G-4	Citarum River STA.7.95 - STA.8.10	Left	150
G-5	Citarum River STA.8.40 - STA.8.60	Left	200
G-6	Citarum River STA.8.75 - STA.8.90	Left	150
G-7	Citarum River STA.9.30 - STA.9.55	Right	250
G-8	Citarum River STA.10.05 - STA.10.20	Left	150
G-9	Citarum River STA.10.35 - STA.10.55	Right	200
G-10	Citarum River STA.11.45 - STA.11.60	Left	150
G-11	Citarum River STA.13.40 - STA.13.60	Left	200
G-12	Citarum River STA.14.30 - STA.14.35	Left	150
G-13	Citarum River STA.17.45 - STA.17.70	Right	250
G-14	Citarum River STA.18.00 - STA.18.20	Left	200
G-15	Citarum River STA.13.85 - STA.18.50	Right	150
G-16	Citarum River STA.19.25 - STA.19.50	Left	250
G-17	Citarum River STA.17.95 - STA.20.85	Right	1,100
G-18	Citarum River STA.19.75 - STA.20.85	Left	1,100
G-19	Citarum River STA.21.25 - STA.21.40	Left	150
G-20	Citarum River STA.21.80 - STA.21.95	Left	150
Total			6,100

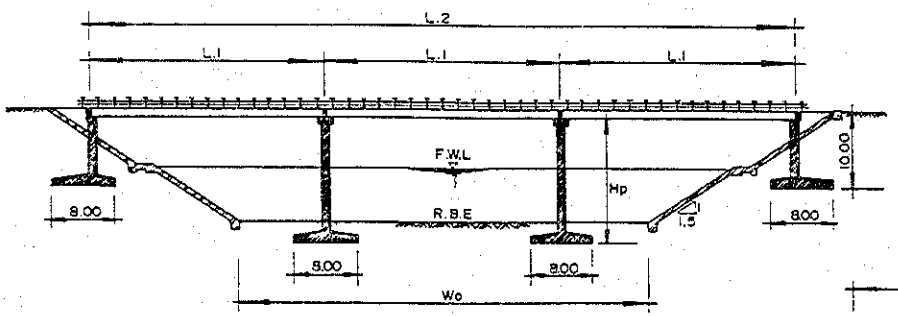
FIG. 7.15 TYPICAL DRAWING OF BANK PROTECTION BY GABION

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

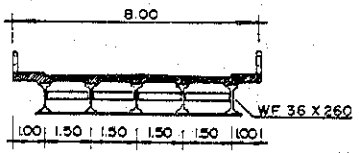
JICA

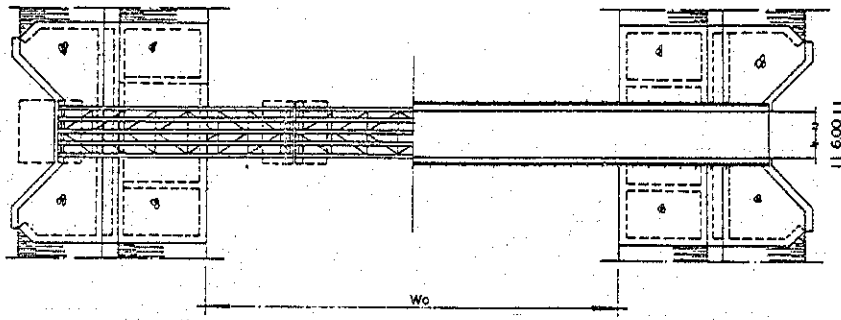


SECTION OF RIVER



SECTION OF BRIDGE





PLAN

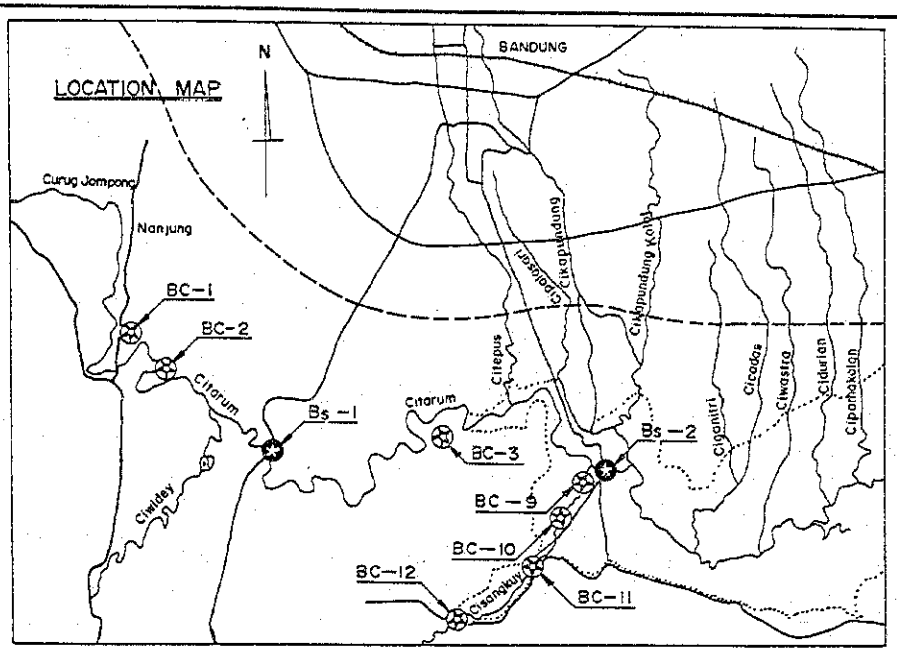
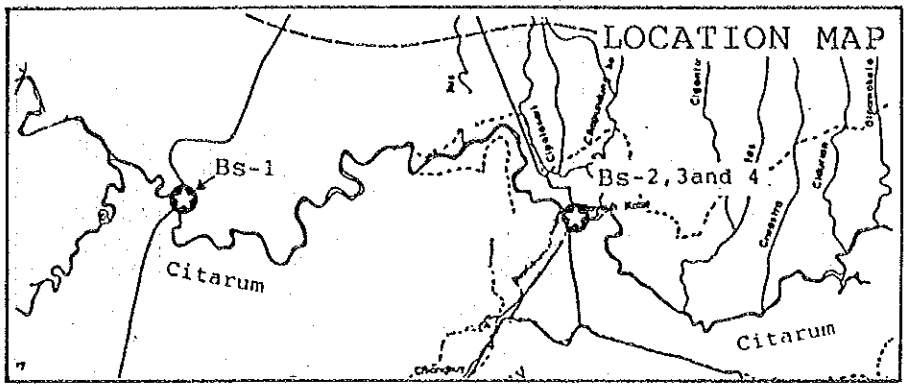


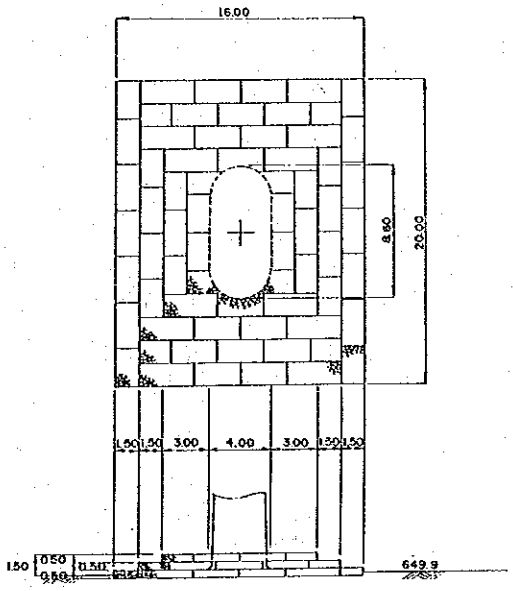
TABLE OF SECTION

NAME OF SECTION	SECTION OF RIVER								SECTION OF BRIDGE				REMARK
	R.B.E (m)	F.W.L (m)	E.G.L (m)	Wo (m)	W.1 (m)	W.2 (m)	H.1 (m)	H.2 (m)	Widm B (m)	L.1 (m)	L.2 (m)	Hp (m)	
BC.1	648.13	655.13	661.50	52.50	75.00	96.61	7.50	5.87	8.00	30.00	90.00	75.87	CITARUM RIVER
BC.2	648.34	655.34	662.90	52.50	75.00	100.00	7.50	7.06	8.00	30.00	90.00	17.06	CITARUM RIVER
BC.3	650.23	657.23	660.99	33.50	45.50	88.54	4.00	6.76	8.00	28.00	84.00	13.56	CITARUM RIVER

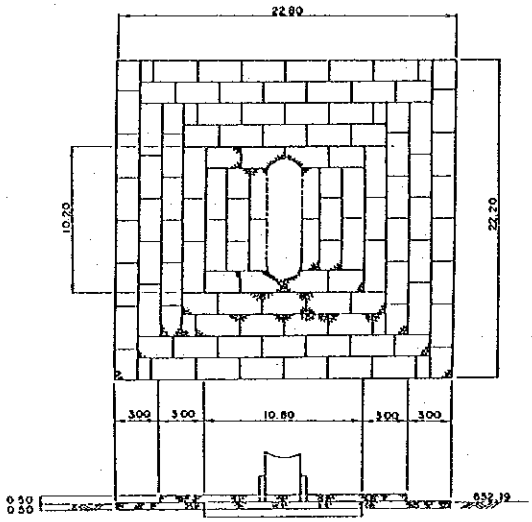
FIG. 7.16 TYPICAL DRAWING OF PROPOSED BRIDGE (CITARUM RIVER)

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

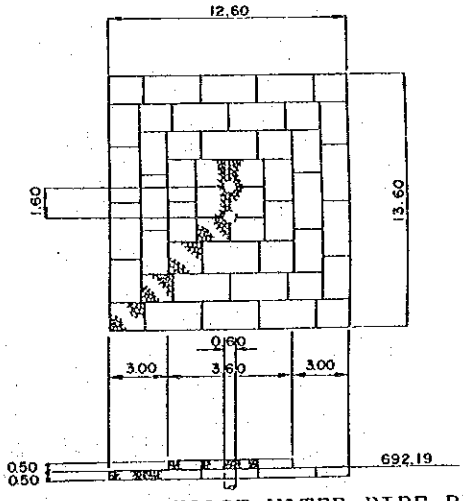




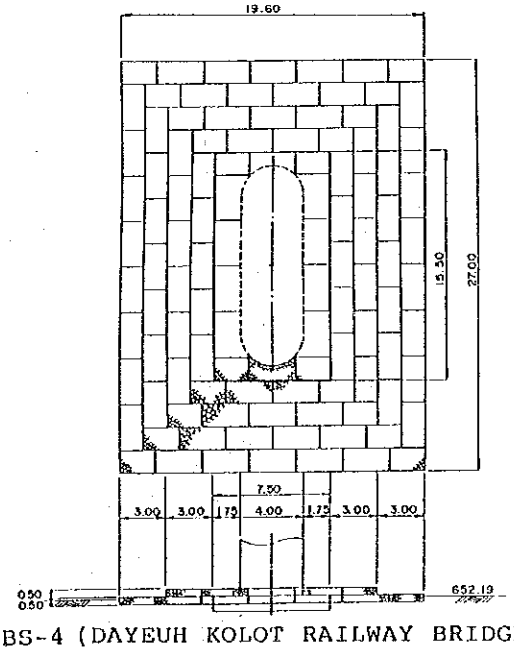
BS-1 (CIRANPENI ROAD BRIDGE)



BS-2 (DAYEUH KOLOT ROAD BRIDGE)



BS-3 (DAYEUH KOLOT WATER PIPE BRIDGE)

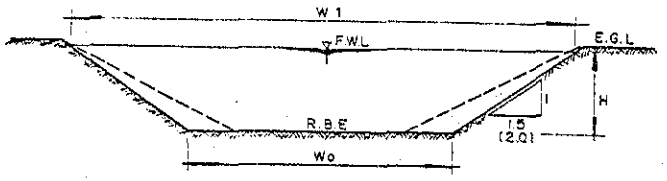


BS-4 (DAYEUH KOLOT RAILWAY BRIDGE)

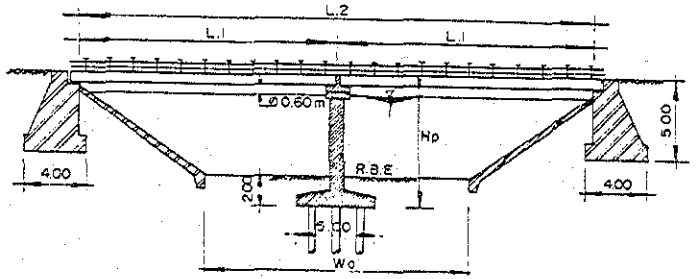
FIG. 7.17 TYPICAL BRIDGE STRENGTHENING (GABION)

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

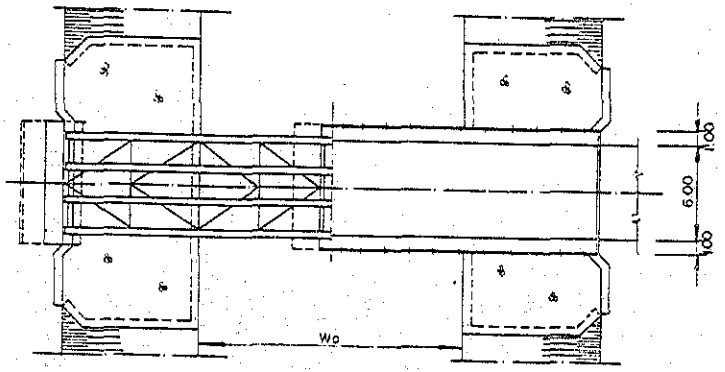
JICA



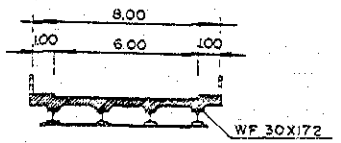
SECTION OF RIVER



SECTION OF BRIDGE



PLAN



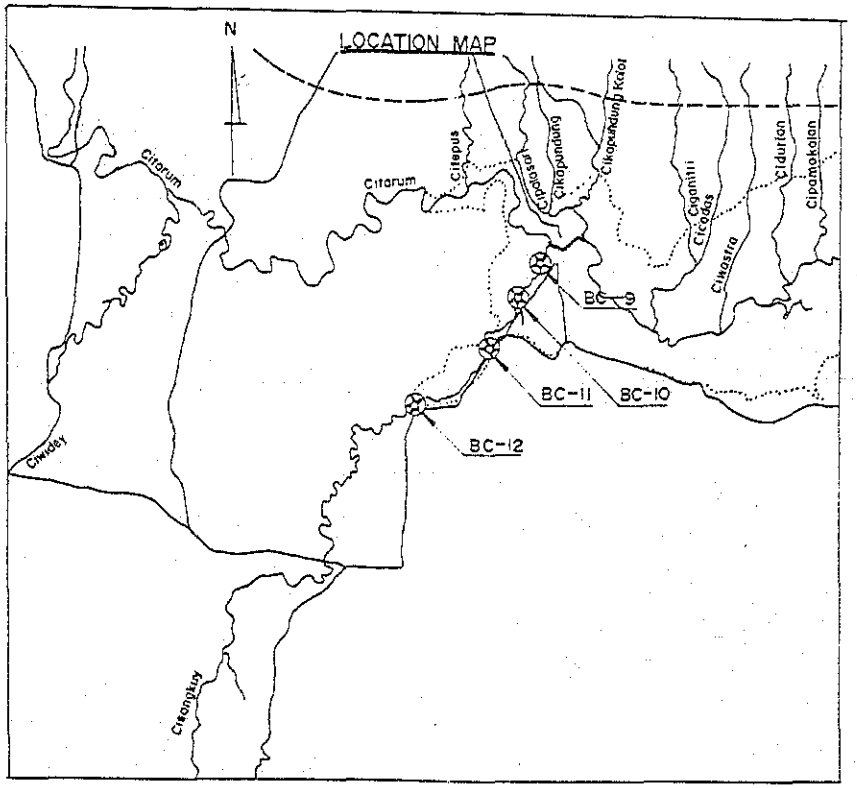


TABLE OF SECTION

NAME OF SECTION	SECTION OF RIVER						SECTION OF BRIDGE				REMARK
	R.B.E (m)	F.W.L (m)	E.G.L (m)	Wo (m)	W.I (m)	H (m)	Width B (m)	L.1 (m)	Span L.2 (m)	Hp (m)	
BC.9	653.536	658.536	658.536	(1:1.5) 30.00	31.50	5.00	8.00	16.00	32.00	7.60	CISANGKUY RIVER
BC.10	653.328	658.328	658.650	(1:1.5) 30.00	31.50	5.00	8.00	16.00	32.00	7.60	CISANGKUY RIVER
BC.11	654.571	659.571	659.940	(1:1.5) 30.00	31.50	5.00	8.00	16.00	32.00	7.60	CISANGKUY RIVER
BC.12	655.357	660.357	660.540	(1:1.5) 30.00	31.50	5.00	8.00	16.00	32.00	7.60	CISANGKUY RIVER

FIG. 7.18 TYPICAL DRAWING OF PROPOSED BRIDGE (CISANGKUY RIVER)

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

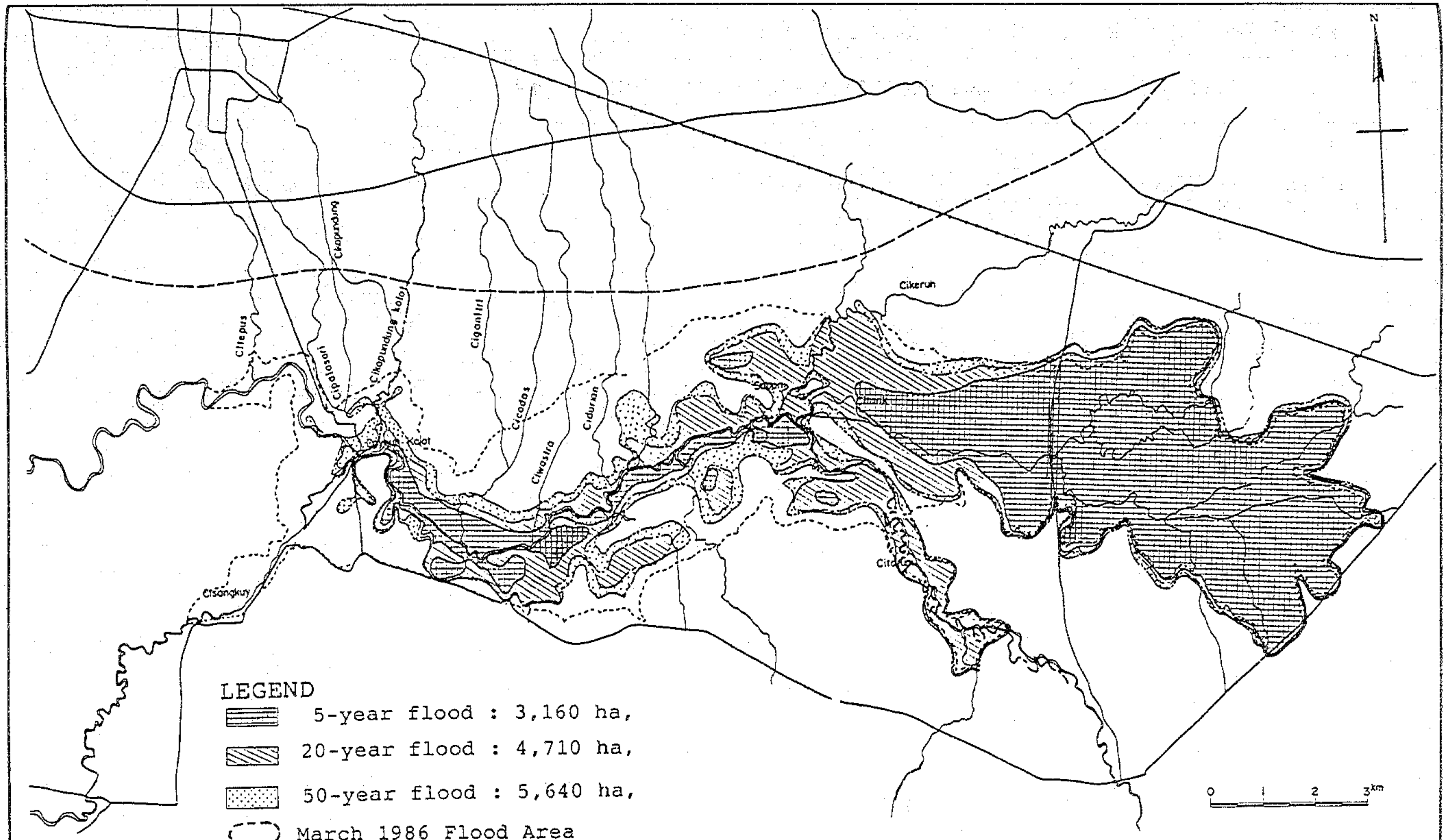
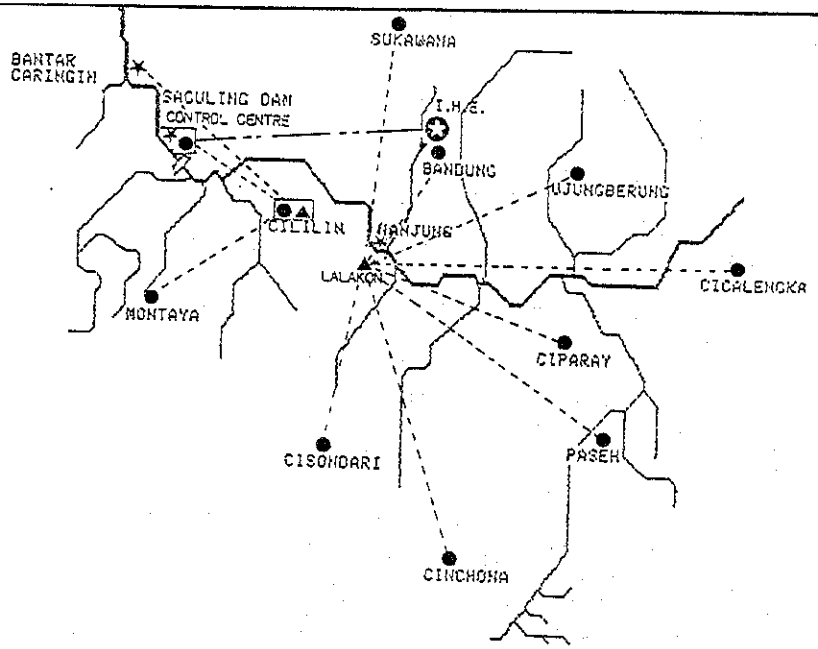
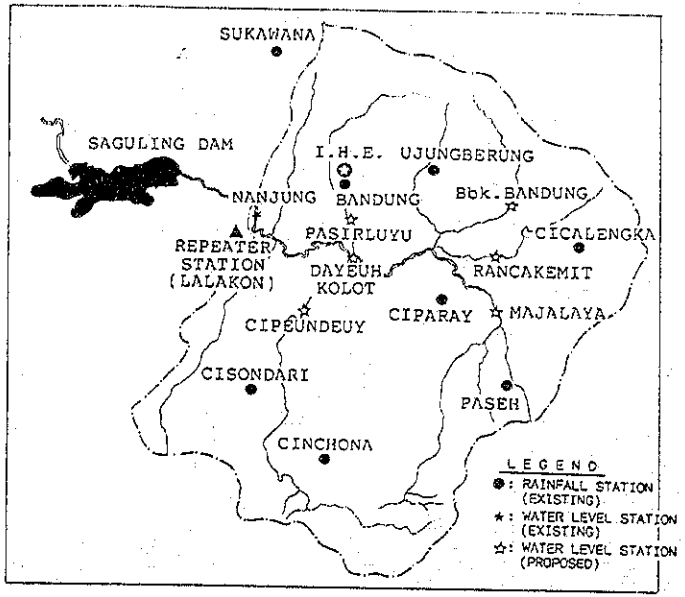


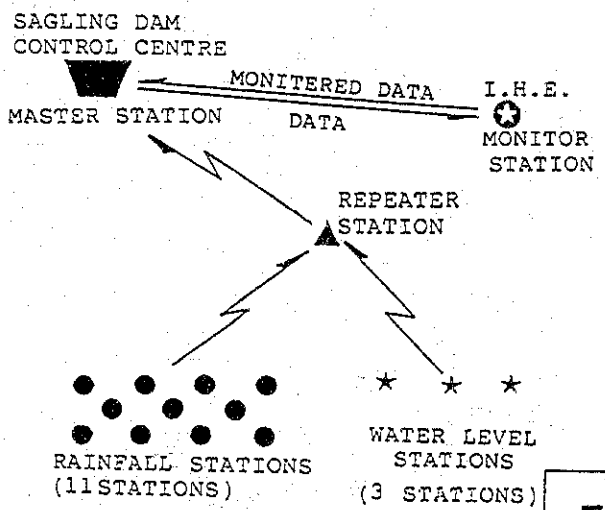
FIG. 7.19 FLOOD AREA MAP BY 5,20,50-YEAR FLOODS AFTER URGENT PLAN

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

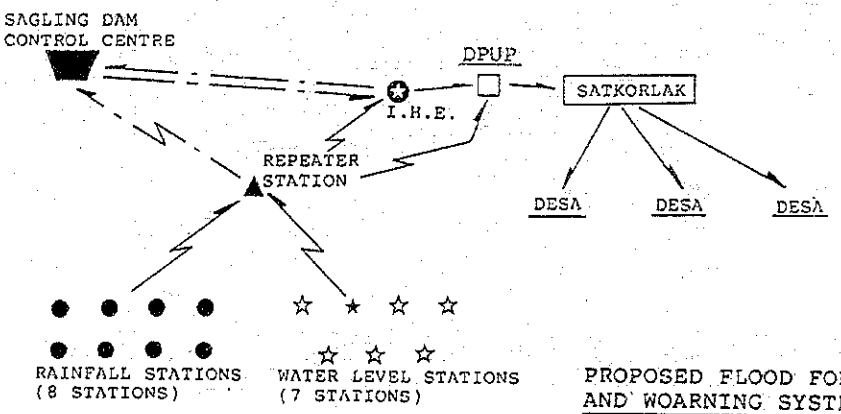
JICA







EXISTING FLOOD FORECASTING & WARNING SYSTEM (SAGULING HYDROPOWEL PROJECT)



PROPOSED FLOOD FORECASTING AND WOARNING SYSTEM

FIG. 7.20 FLOOD FORECASTING AND WARNING SYSTEM

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

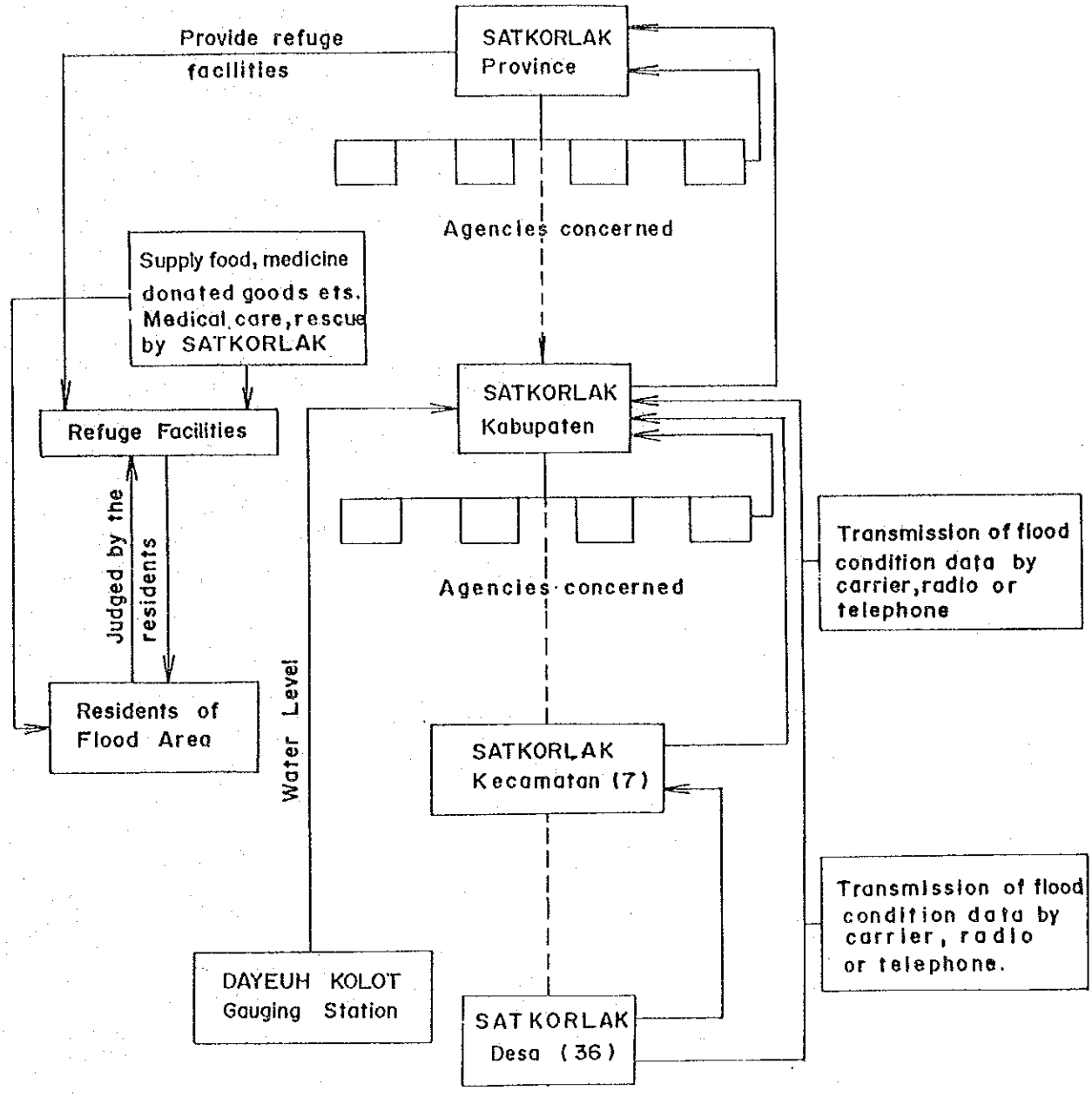


FIG.7.21 EXISTING FLOOD INFORMATION AND EVACUATION SYSTEM

STUDY ON THE FLOOD CONTROL PLAN OF THE UPPER CITARUM BASIN

JICA