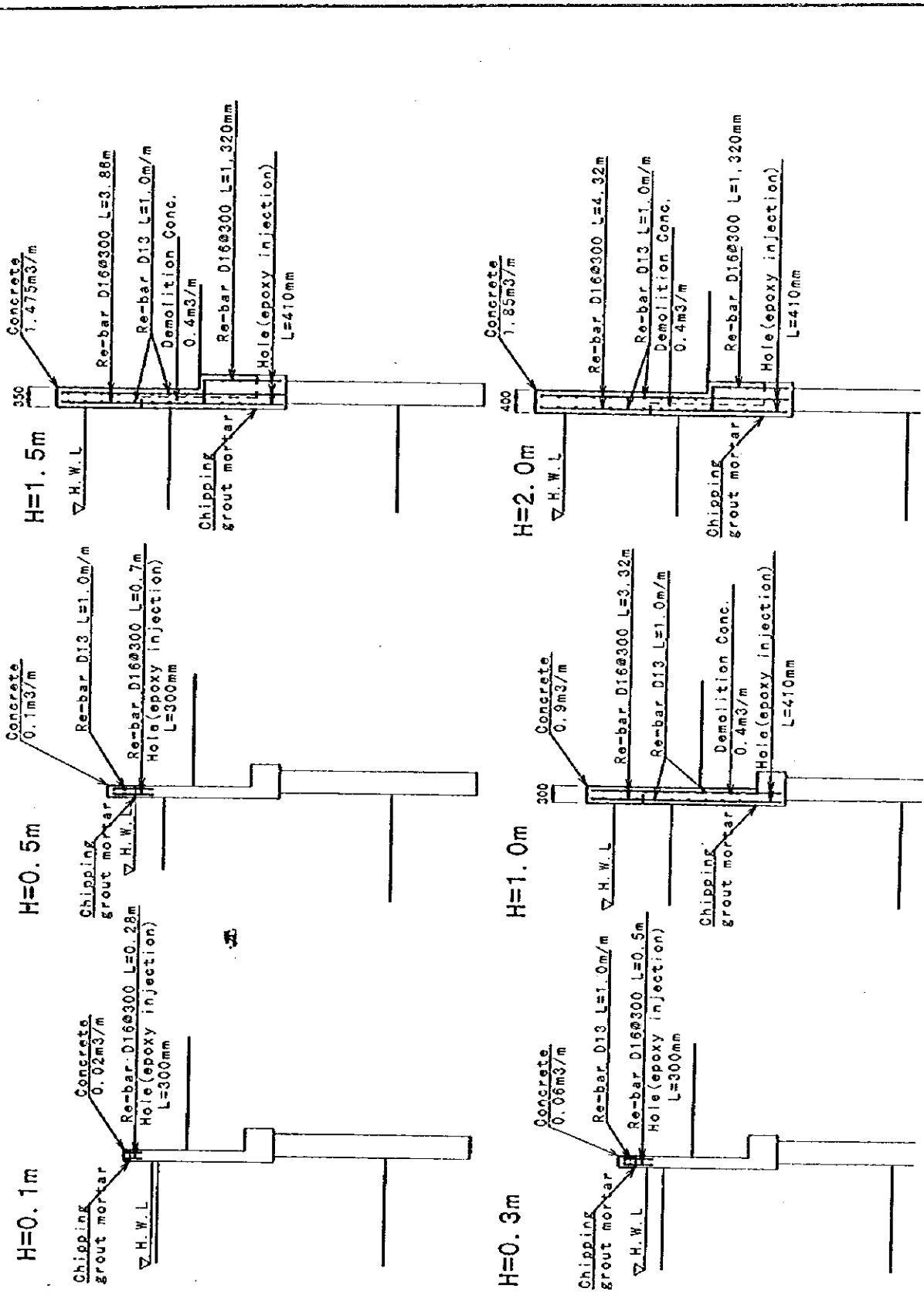
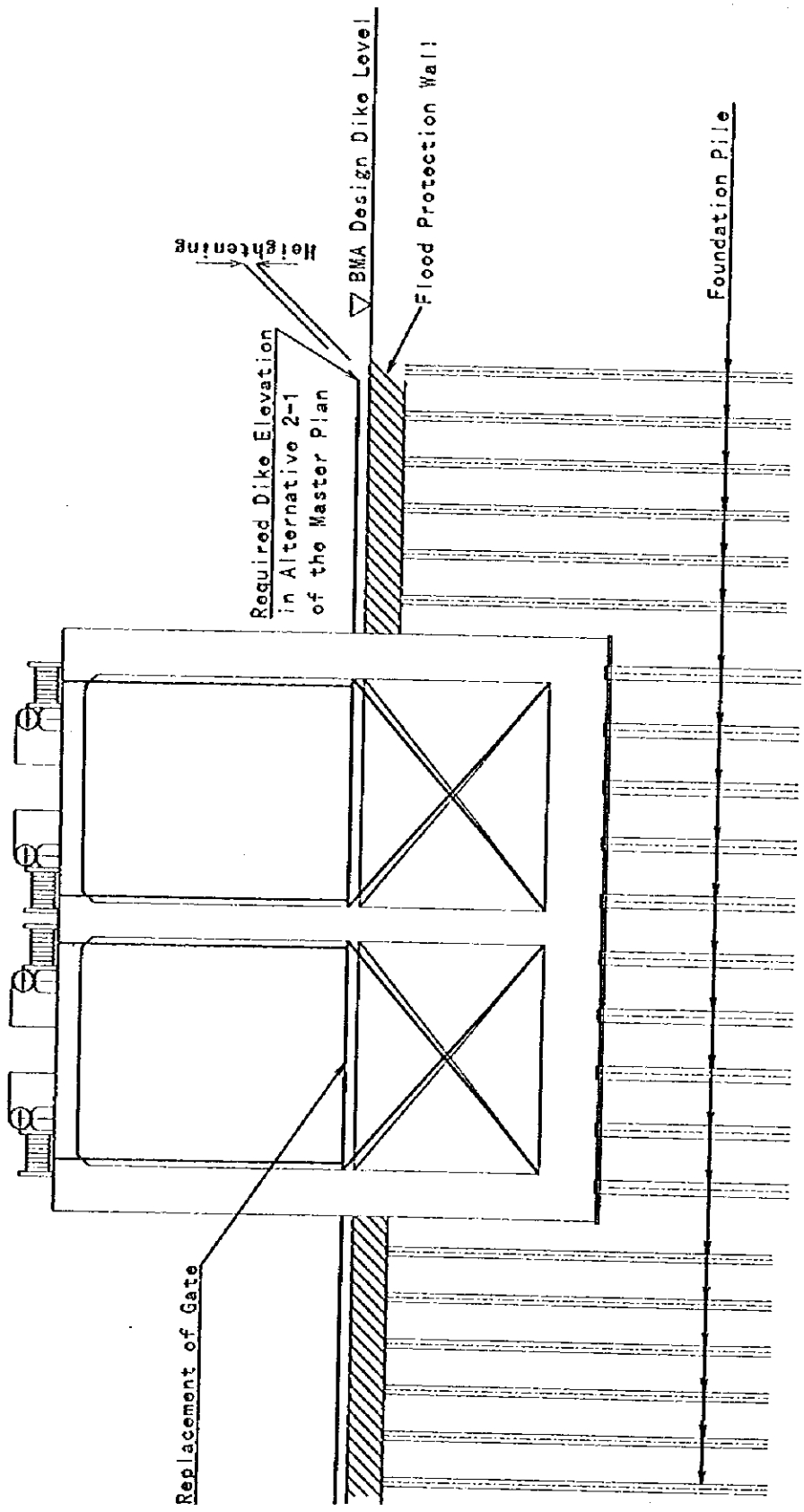
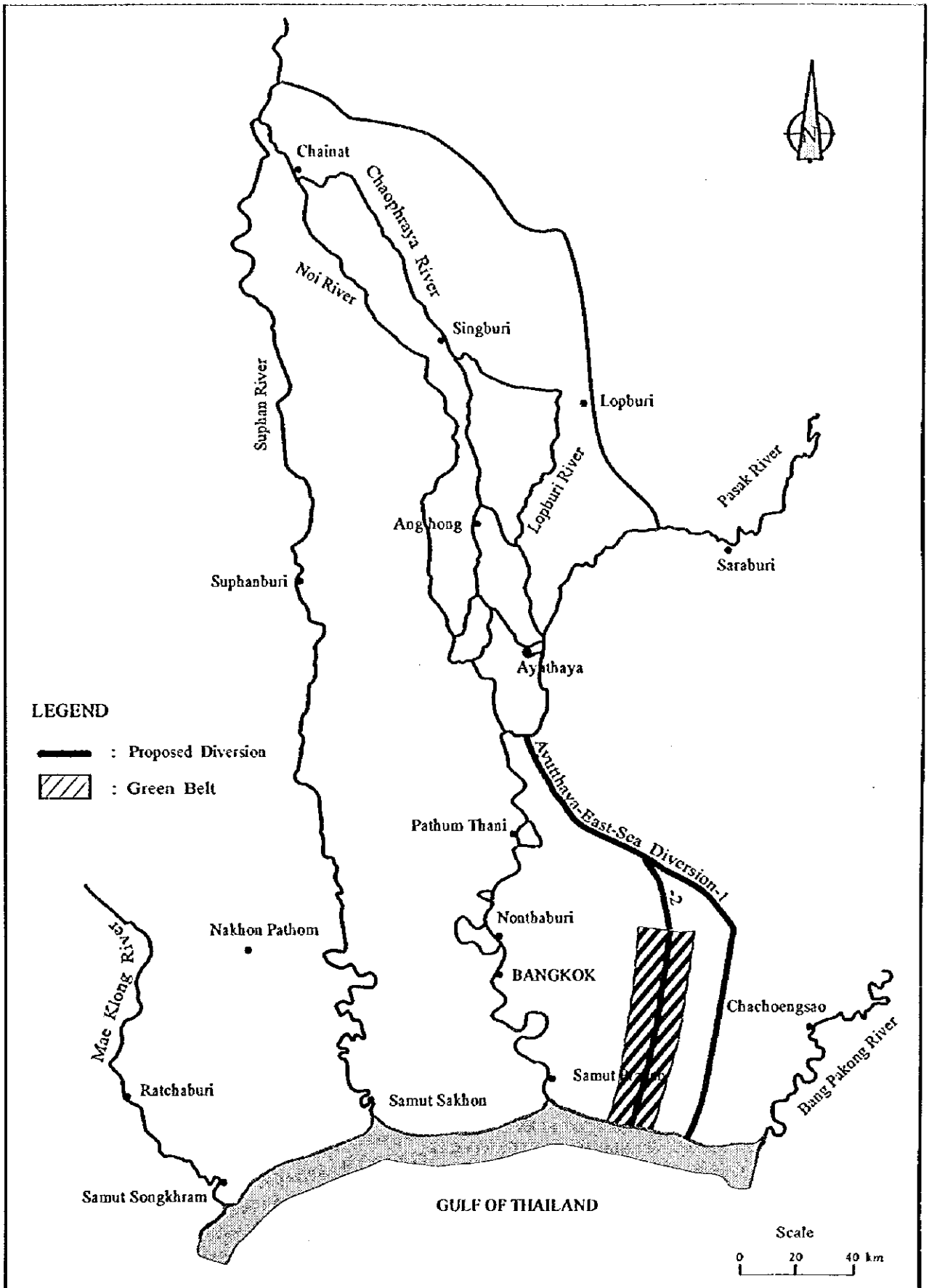
Figures



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig 2.1.1 HEIGHTENING OF FLOOD BARRIER IN BANGKOK
CTI ENGINEERING CO., LTD AND INA CORPORATION	



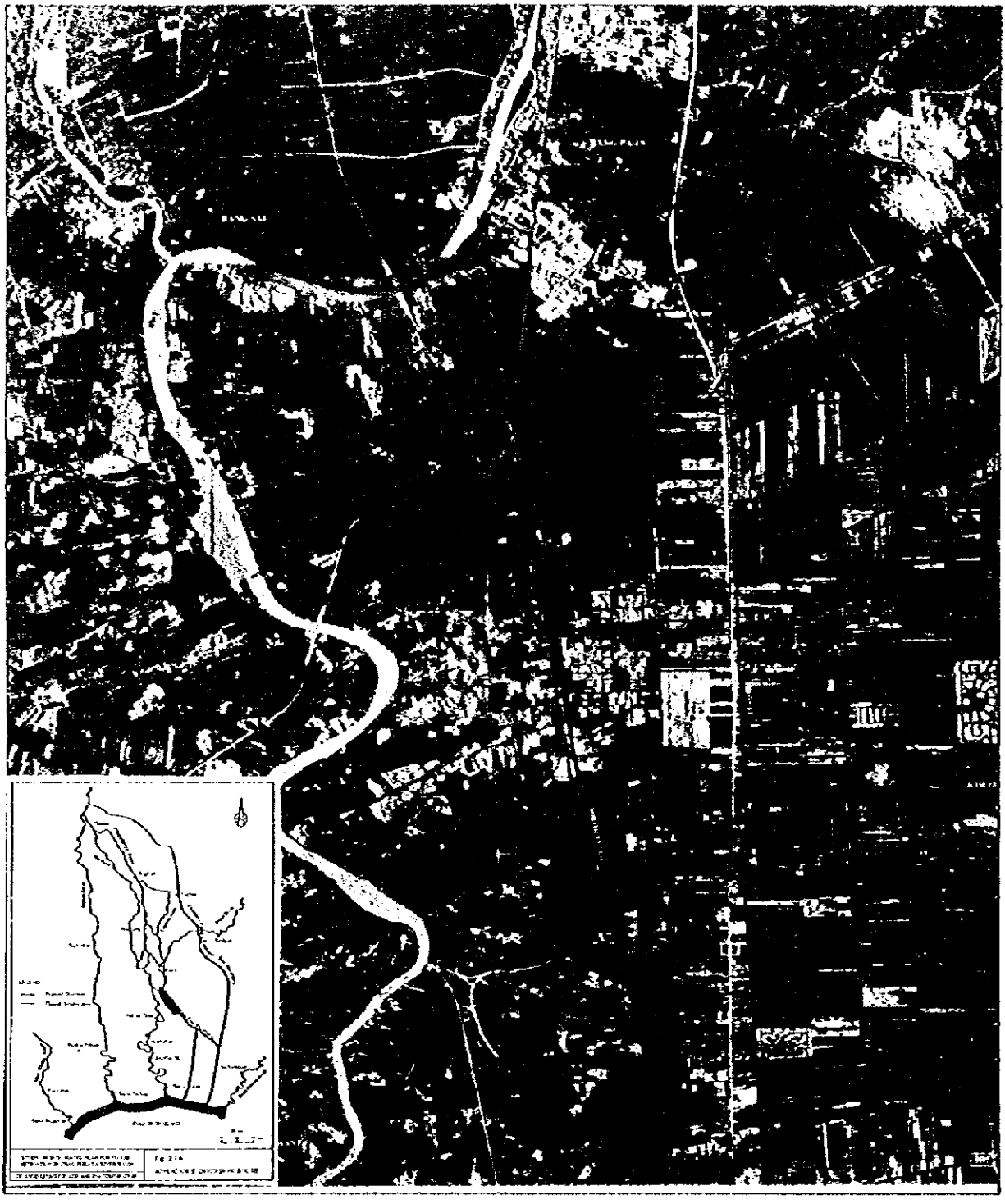
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.2 REPLACEMENT OF GATE IN BANGKOK
CTI ENGINEERING CO., LTD AND INA CORPORATION	



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

CTI ENGINEERING CO., LTD. AND INA CORPORATION

Fig. 2.1.3
ROUTE OF AYUTTHAYA-EAST-SEA DIVERSION



Legend

——— : Diversion Channel Route

——— : Large Scale Road & Railway

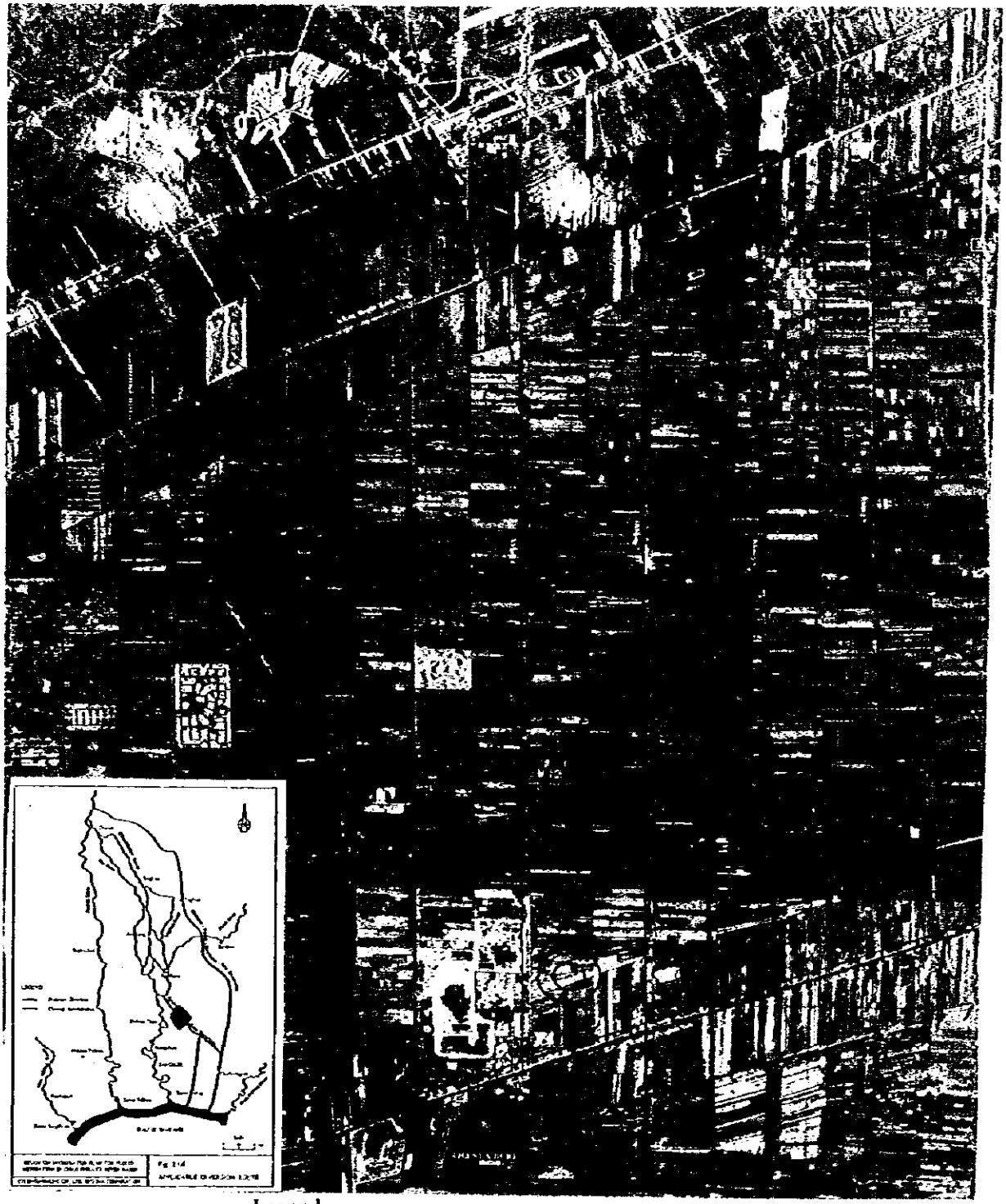
◎ : Built-up Area

——— : Large Scale Canal

Scale

0 2.5 5 km

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.4 (1/6)
CTI ENGINEERING CO., LTD AND INA CORPORATION	ALIGNMENT OF DIVERSION



Legend

—— : Diversion Channel Route

—— : Large Scale Road & Railway

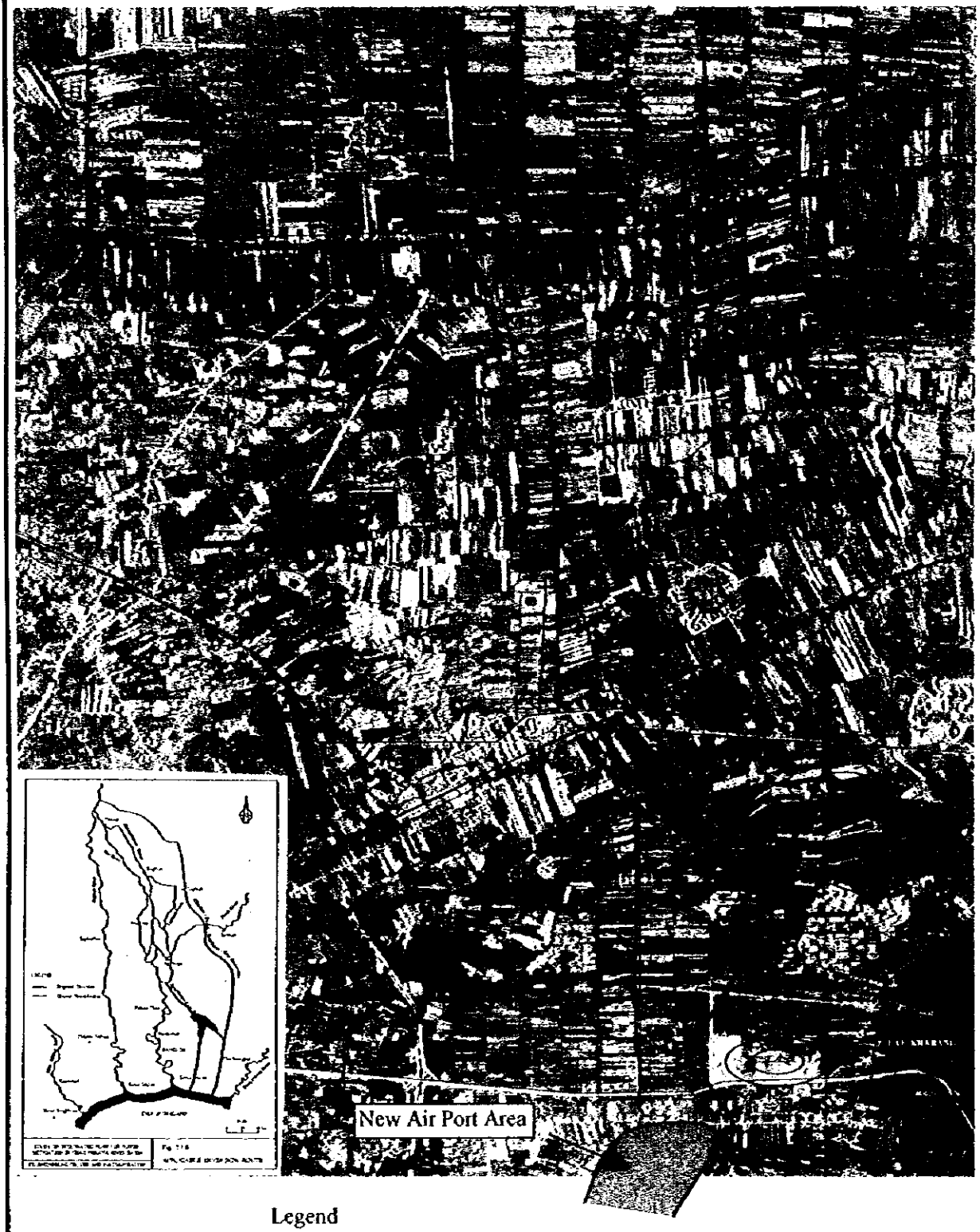
◎ : Built-up Area

—— : Large Scale Canal

Scale

0 2.5 5 km

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.4 (2/6)
CTI ENGINEERING CO., LTD AND INA CORPORATION	ALIGNMENT OF DIVERSION



Legend

——— : Diversion Channel Route

——— : Large Scale Road & Railway

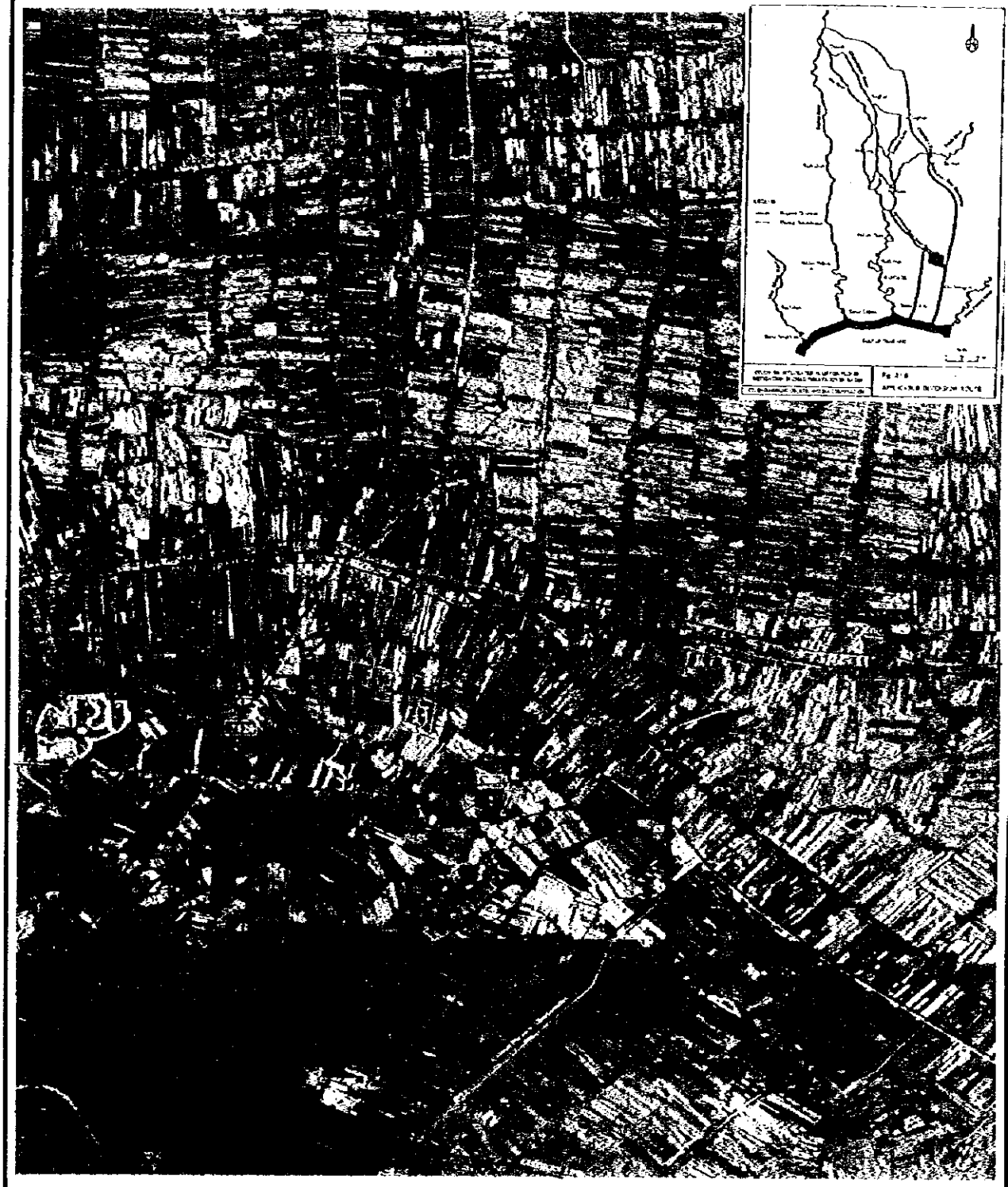
◎ : Built-up Area

——— : Large Scale Canal

Scale

0 2.5 5 km

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.4 (3/6)
CTI ENGINEERING CO., LTD AND INA CORPORATION	ALIGNMENT OF DIVERSION



Legend

——— : Diversion Channel Route

——— : Large Scale Road & Railway

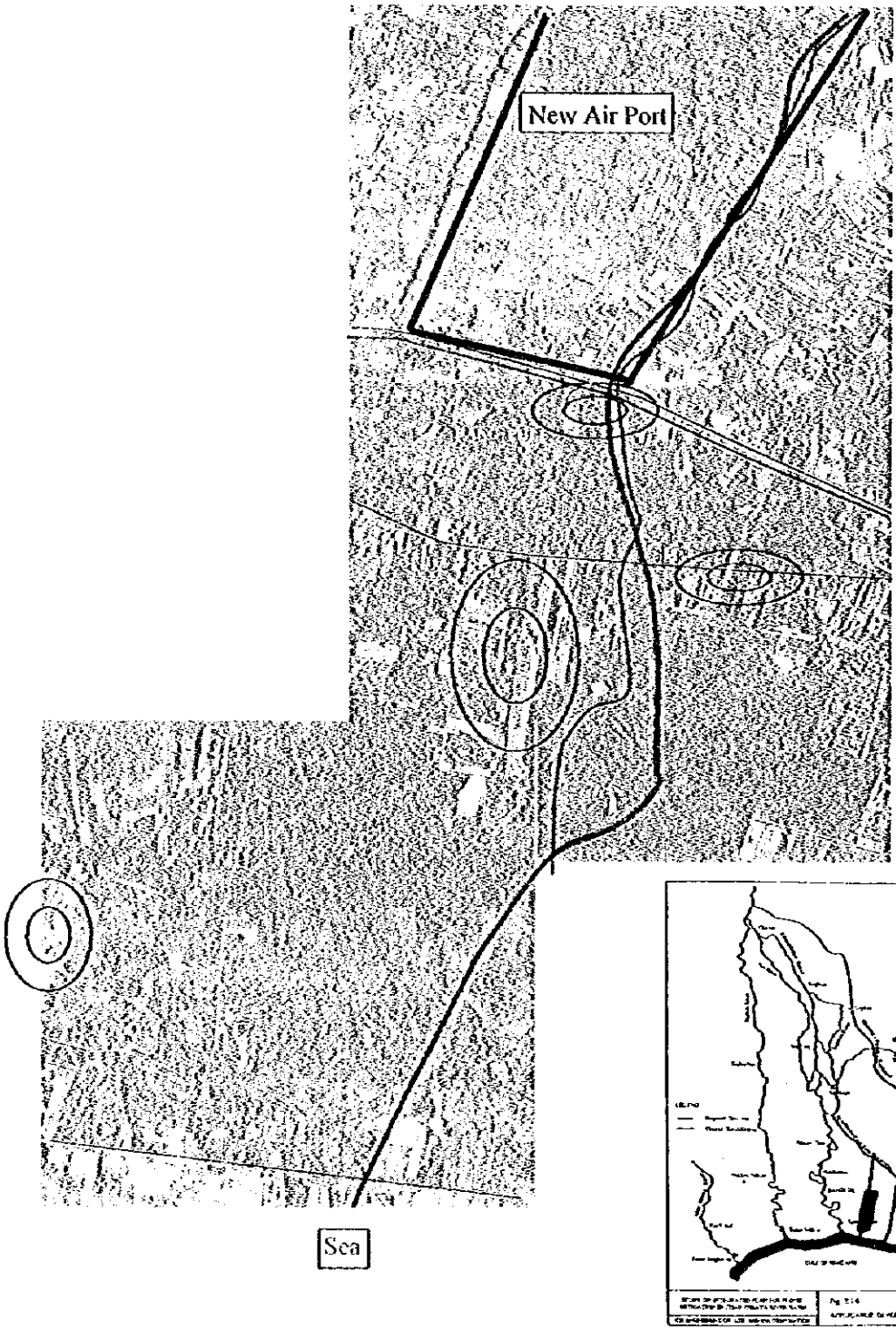
◎ : Built-up Area

——— : Large Scale Canal

Scale

0 2.5 5 km

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.4 (4/6)
CTI ENGINEERING CO., LTD AND INA CORPORATION	ALIGNMENT OF DIVERSION



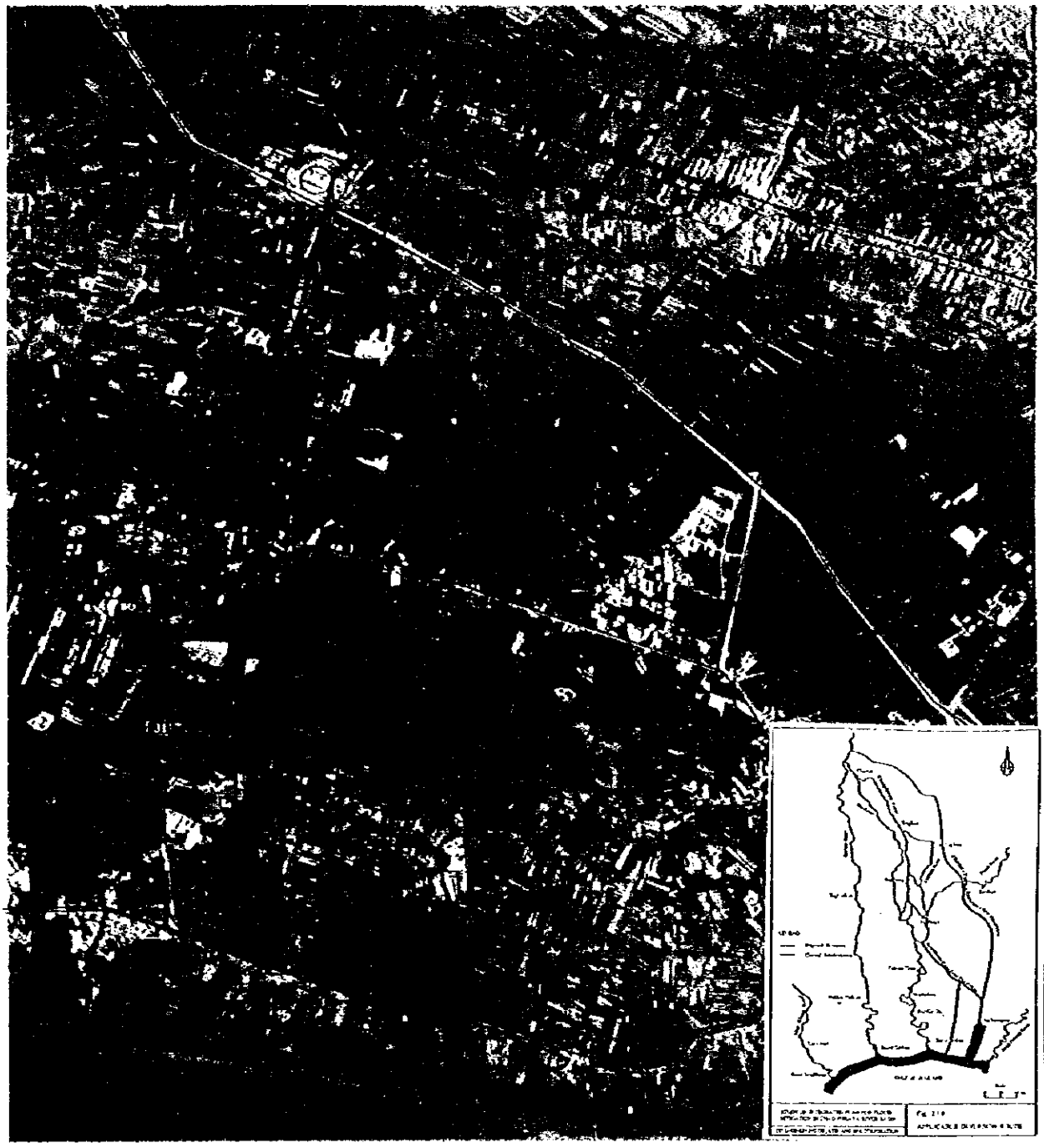
Legend

- Diversion Channel Route
- Large Scale Road & Railway
- Built-up Area
- Large Scale Canal

Scale

0 2.5 5 km

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.4 (5/6)
CTI ENGINEERING CO., LTD AND INA CORPORATION	ALIGNMENT OF DIVERSION



Legend

——— : Diversion Channel Route

——— : Large Scale Road & Railway

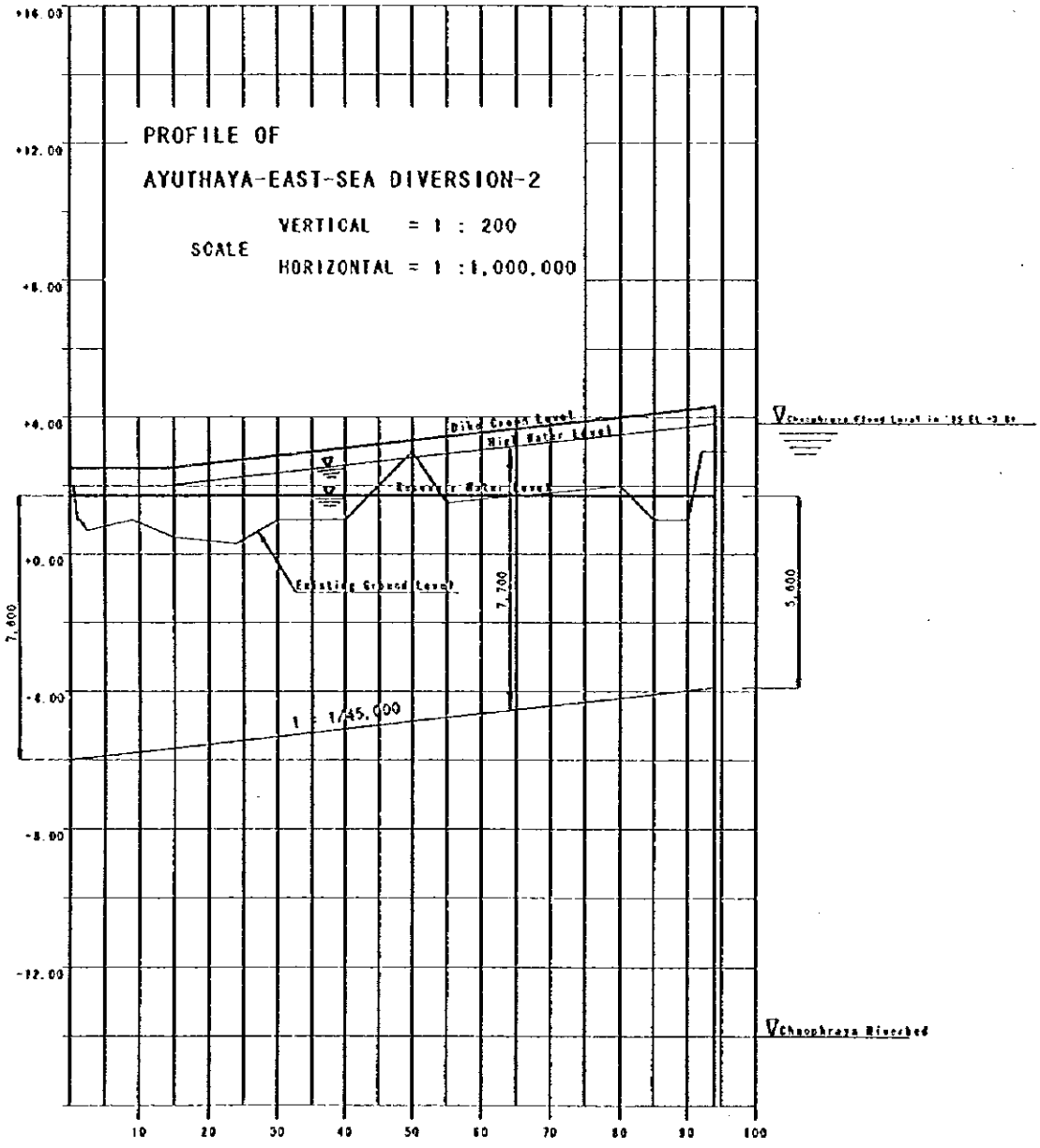
◎ : Built-up Area

——— : Large Scale Canal

Scale

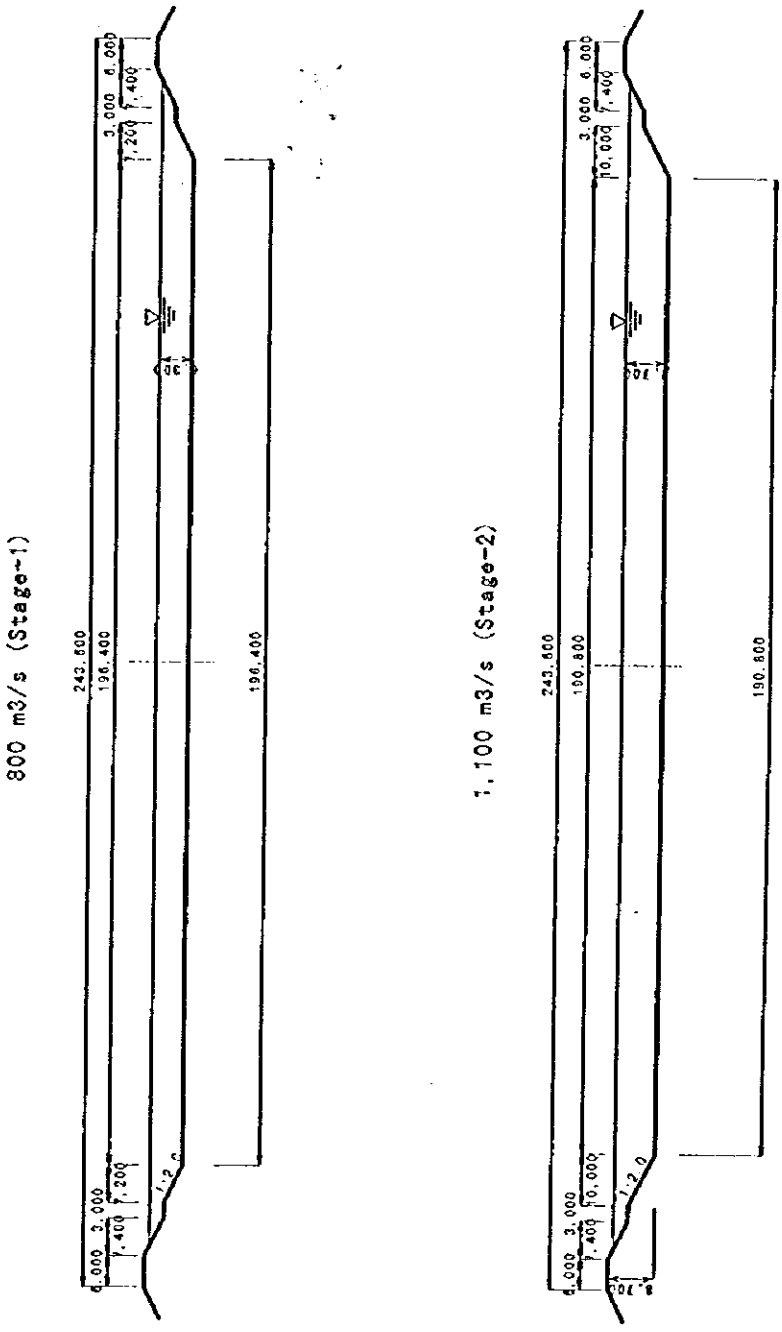
0 2.5 5 km

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.4 (6/6)
CTI ENGINEERING CO., LTD AND INA CORPORATION	ALIGNMENT OF DIVERSION

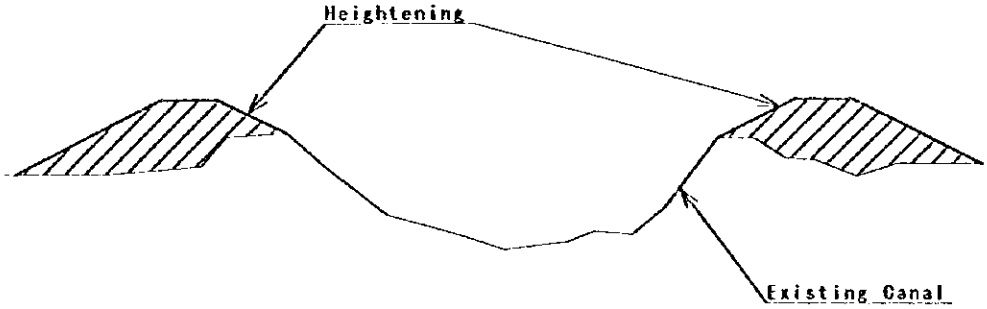


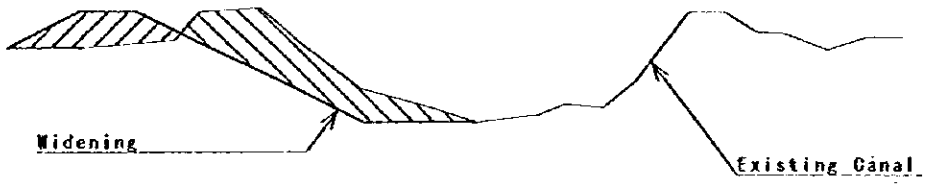
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.5 LONGITUDINAL PROFILE OF AYUTHAYA-EAST-SEA DIVERSION 2
CTI ENGINEERING CO., LTD AND INA CORPORATION	

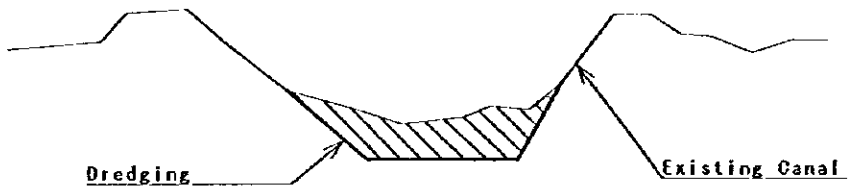
Standard Cross-section of Ayuthaya-East-Sea Diversion 2



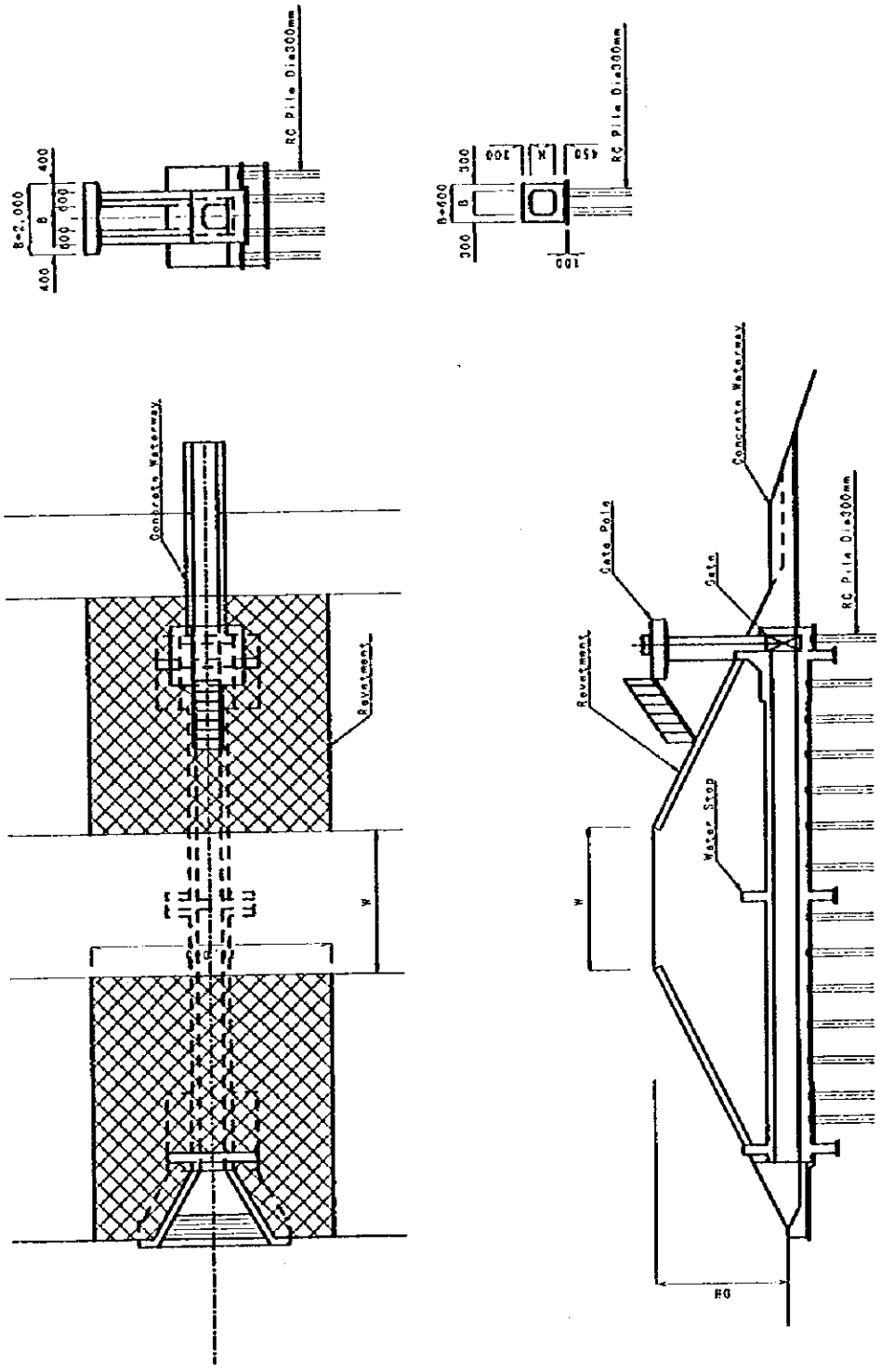
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.6 STANDARD CROSS SECTION OF PROPOSED AYUTHAYA-EAST-SEA DIVERSION 2
CTI ENGINEERING CO., LTD AND INA CORPORATION	



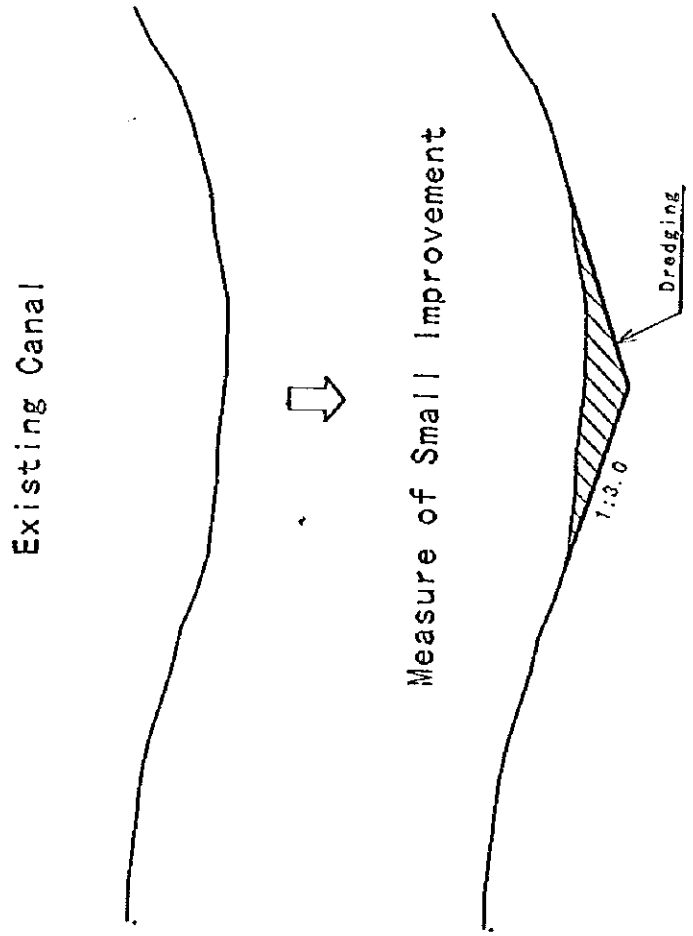




STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.7 MEASURES OF CANAL IMPROVEMENT
CTI ENGINEERING CO., LTD AND INA CORPORATION	



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.8 TYPICAL REGULATOR INSTALLED FOR DISTRIBUTION SYSTEM IMPROVEMENT
CTI ENGINEERING CO., LTD AND INA CORPORATION	

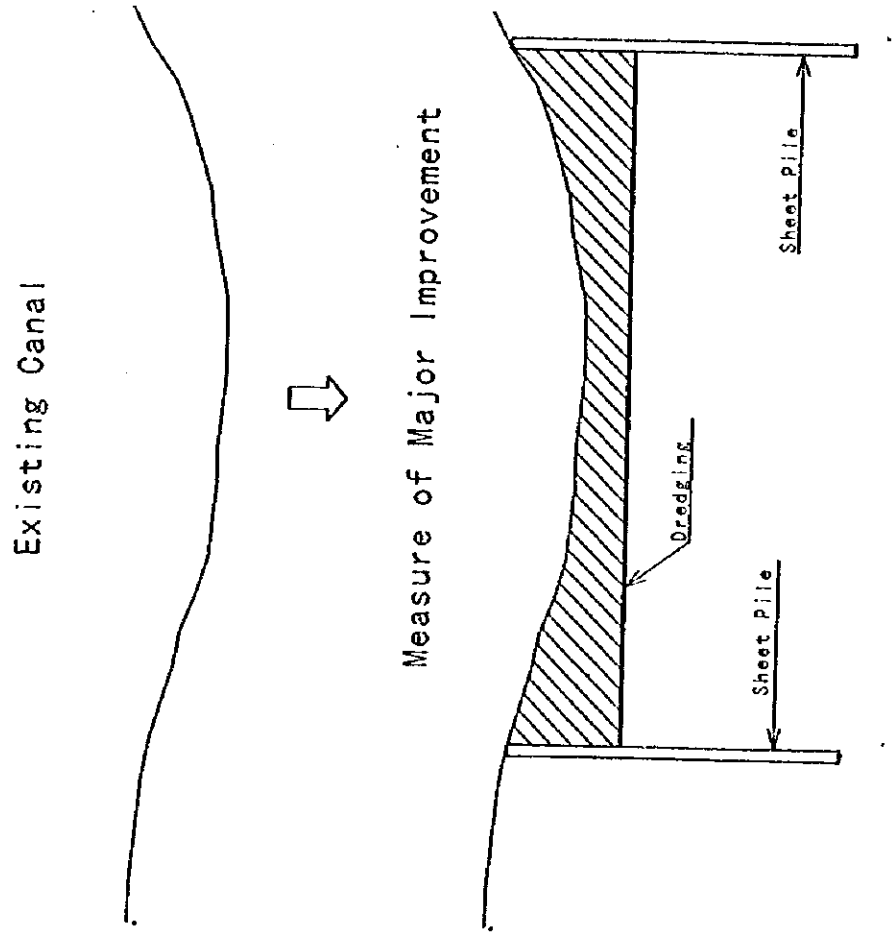


STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

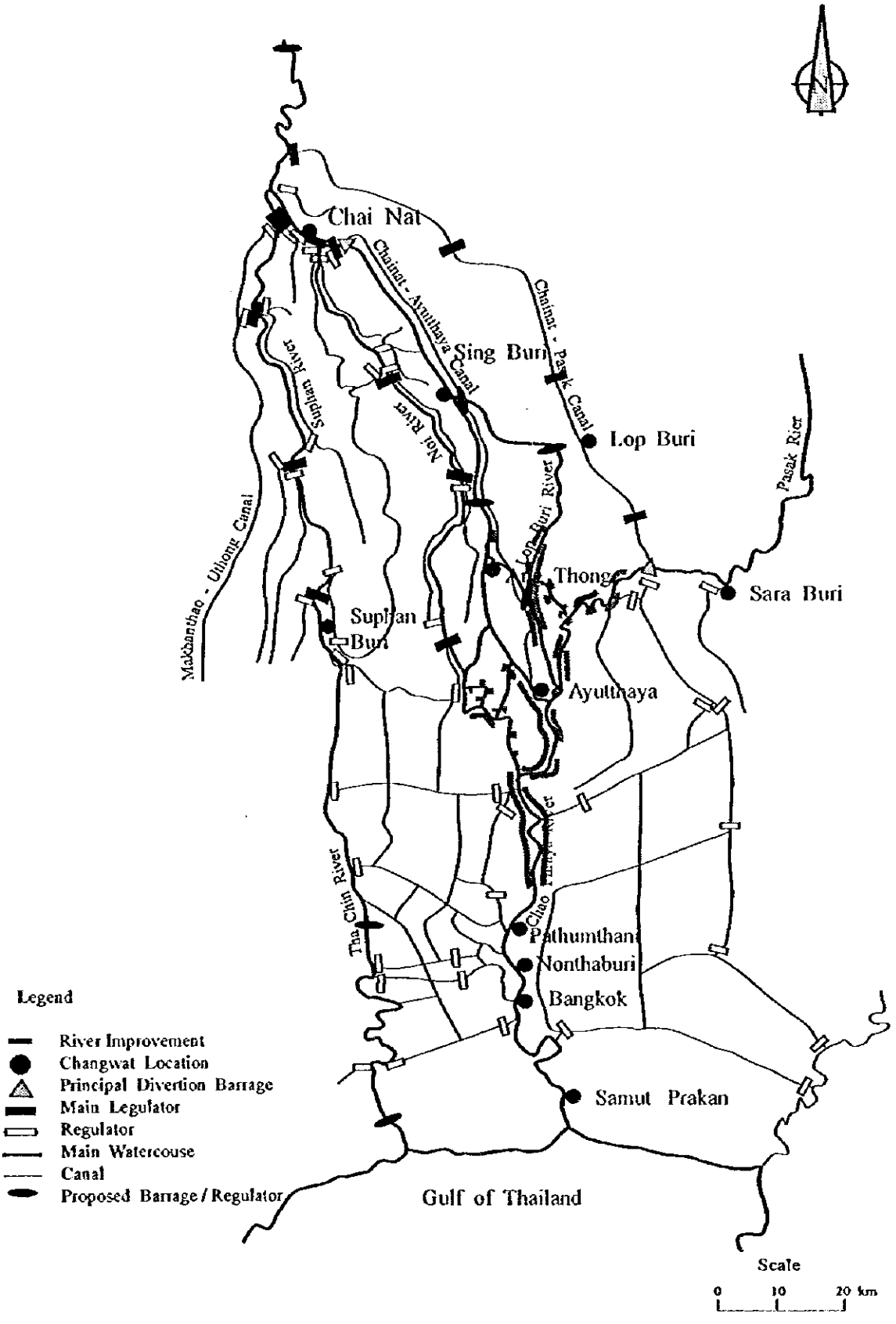
CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig.2.1.9

MINOR IMPROVEMENT FOR DRAINAGE



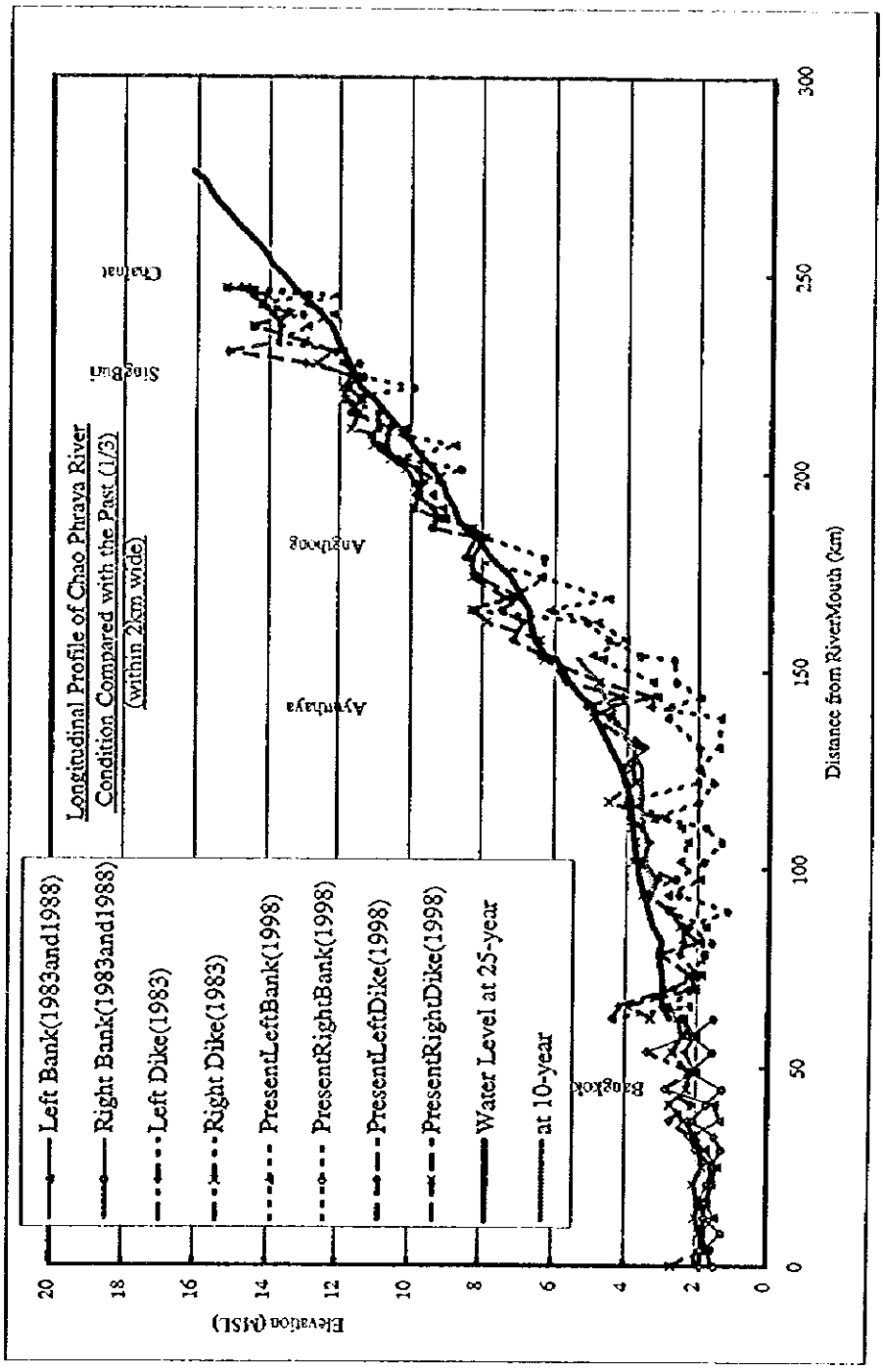
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.10
CTI ENGINEERING CO., LTD AND INA CORPORATION	MAJOR IMPROVEMENT FOR DRAINAGE



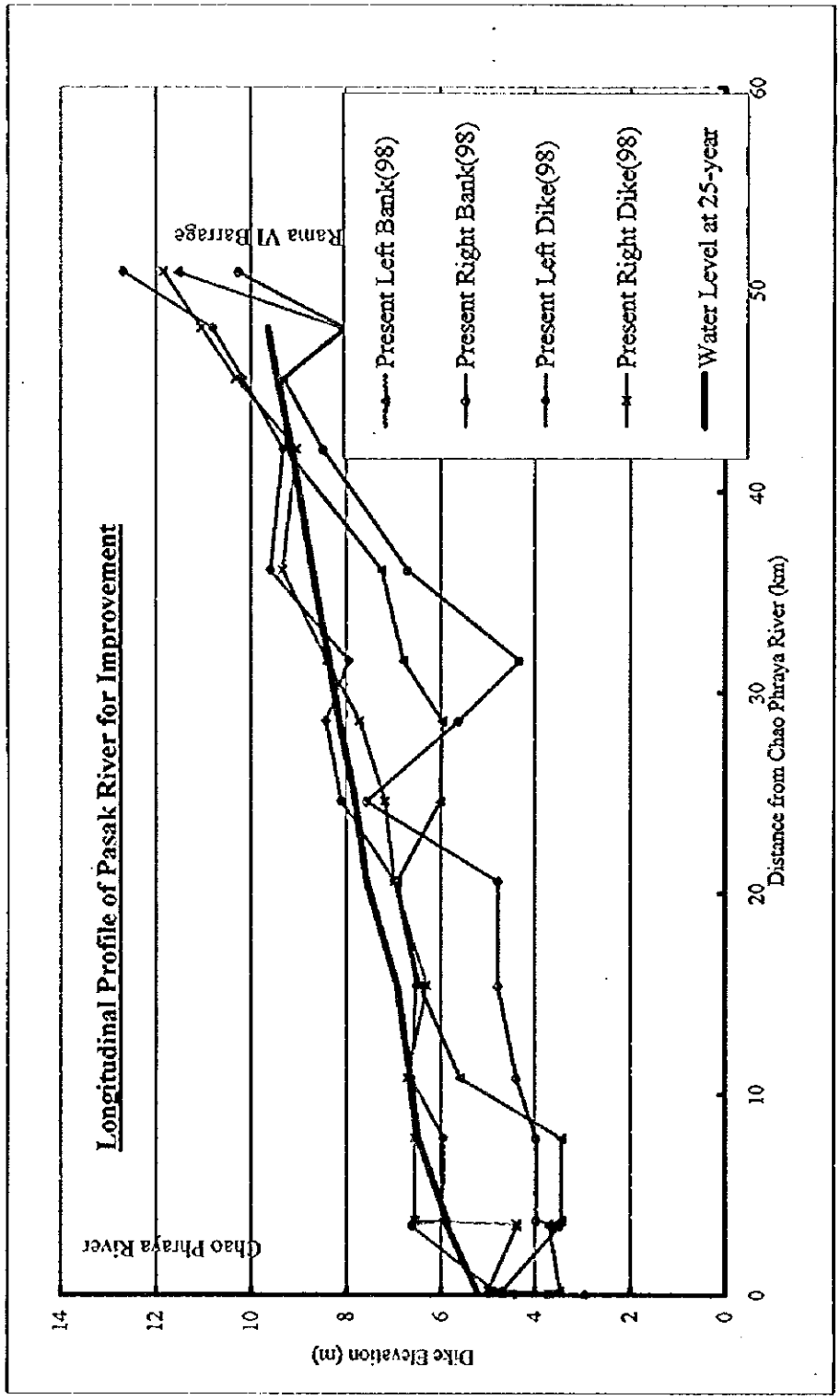
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

CTI ENGINEERING CO., LTD AND INA CORPORATION

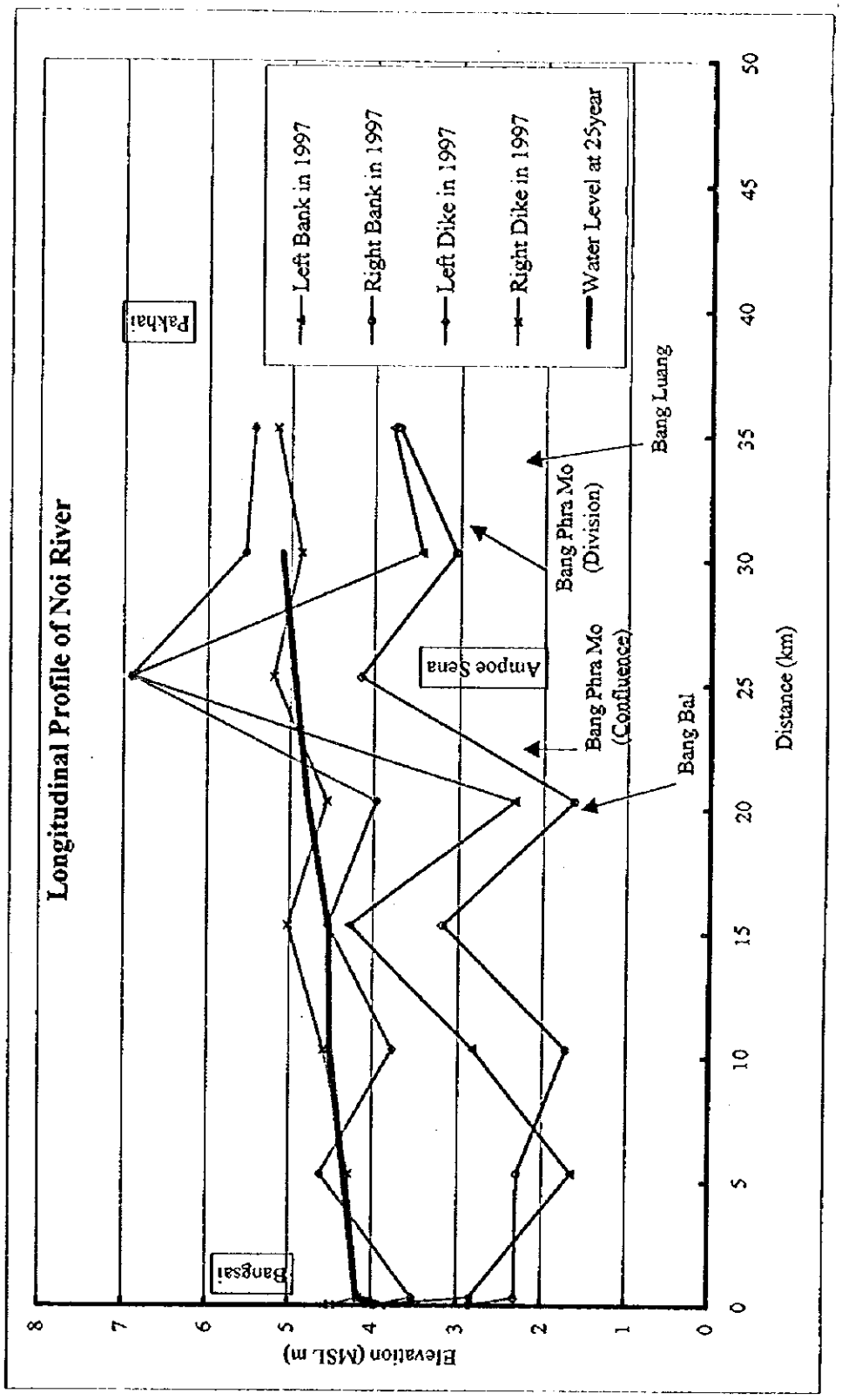
Fig . 2.1.11
ALIGNMENT OF RIVER IMPROVEMENT OF ALTERNATIVE 2-2 IN THE MASTER PLAN



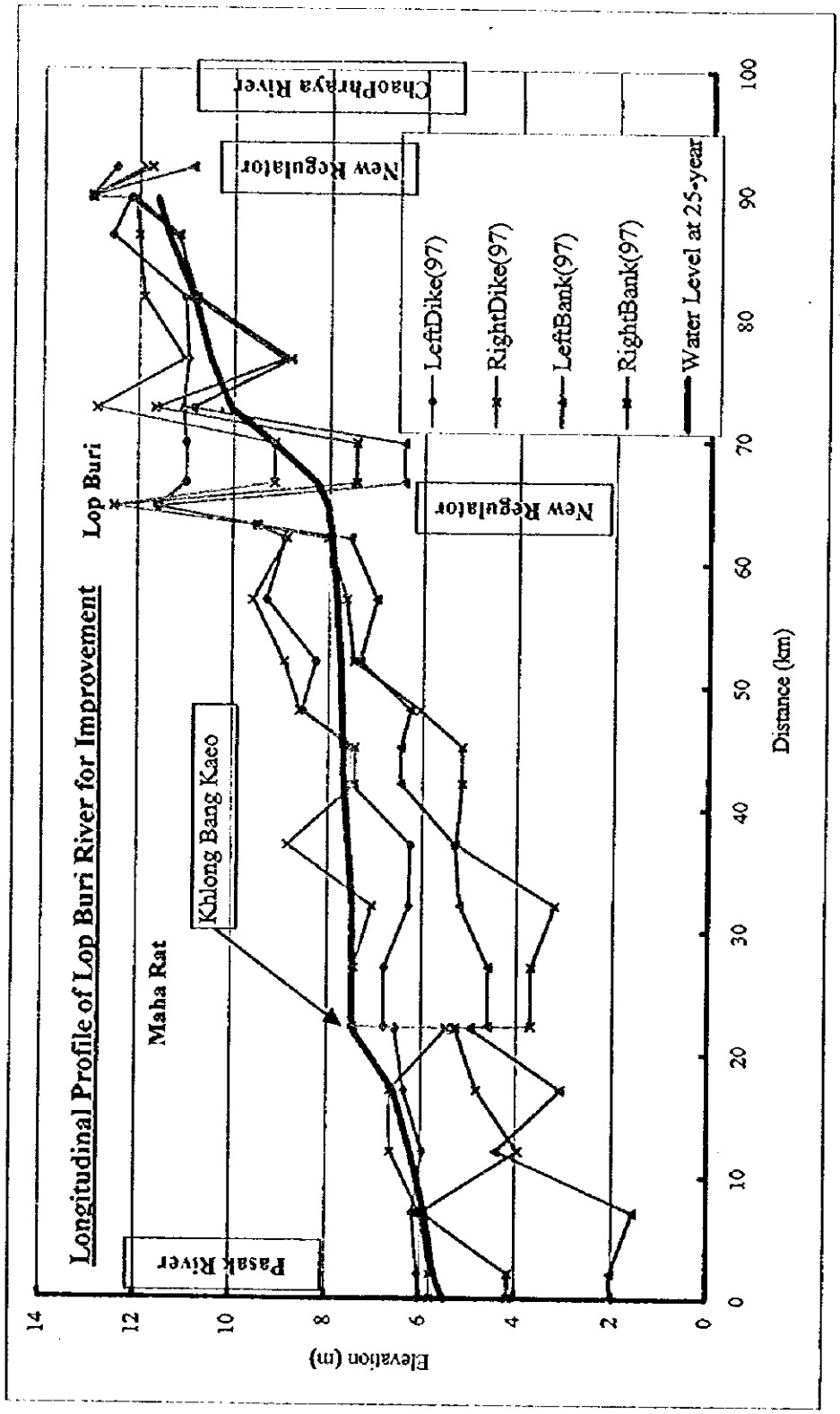
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.12 (1/7) LONGITUDINAL PROFILE OF THE CHAO PHRAYA RIVER FOR RIVER IMPROVEMENT OF ALTERNATIVE 2-2 IN THE MASTER PLAN
CTI ENGINEERING CO., LTD AND INA CORPORATION	



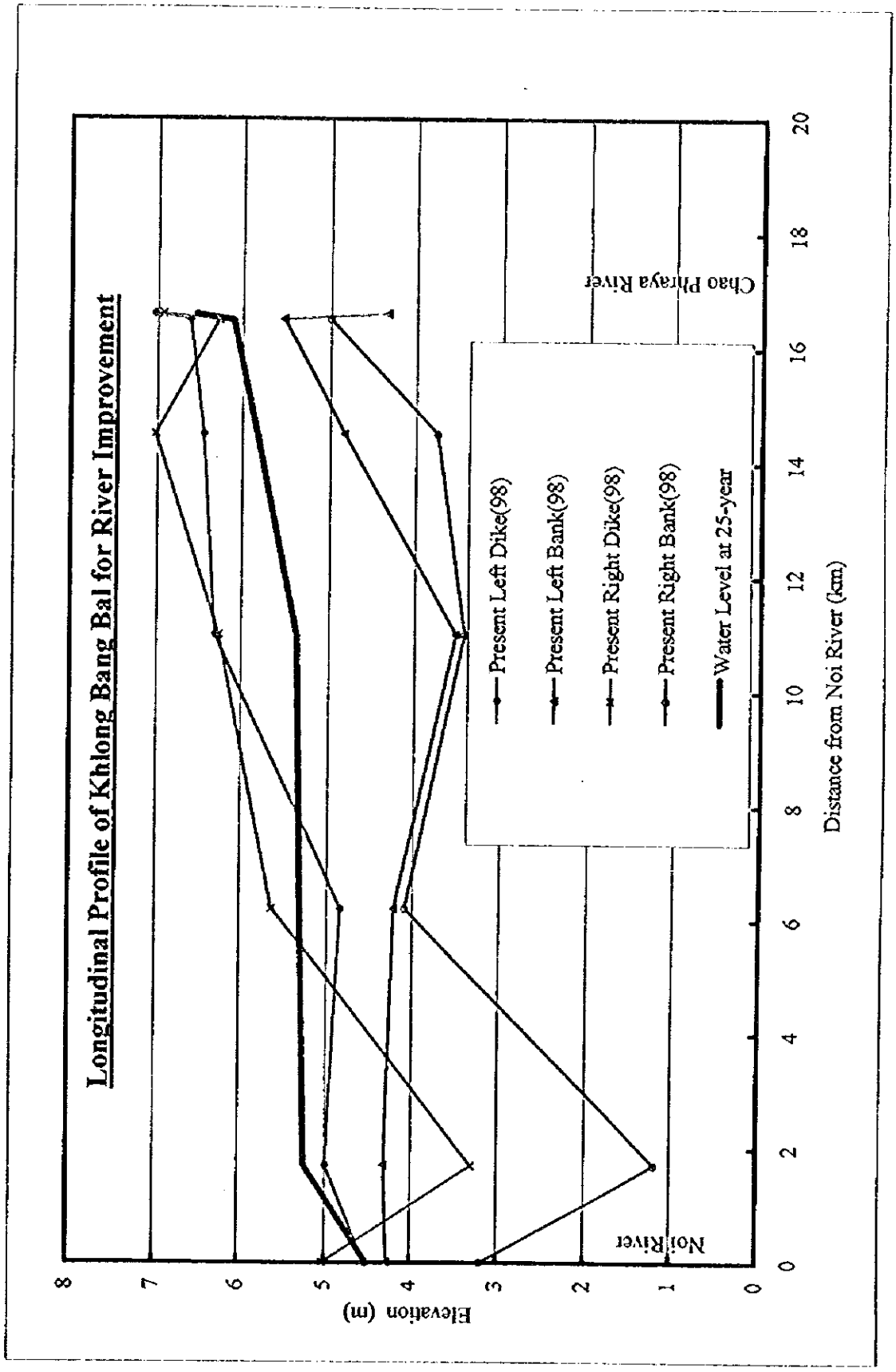
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.12 (2/7) LONGITUDINAL PROFILE OF THE CHAO PHRAYA RIVER FOR RIVER IMPROVEMENT OF ALTERNATIVE 2-2 IN THE MASTER PLAN
CTI ENGINEERING CO., LTD AND INA CORPORATION	



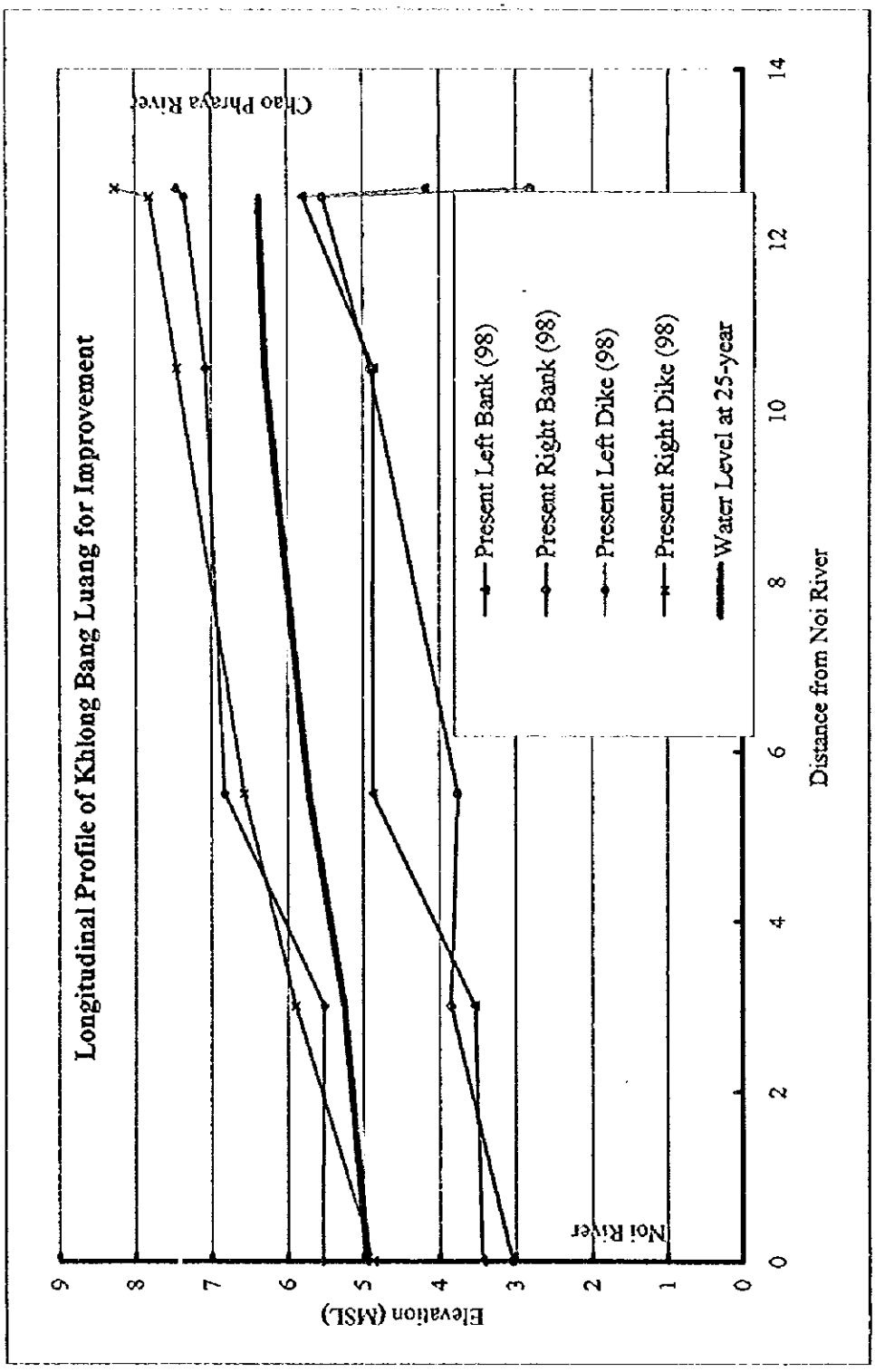
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.12 (3/7) LONGITUDINAL PROFILE OF THE CHAO PHRAYA RIVER FOR RIVER IMPROVEMENT OF ALTERNATIVE 2-2 IN THE MASTER PLAN
CTI ENGINEERING CO., LTD AND INA CORPORATION	



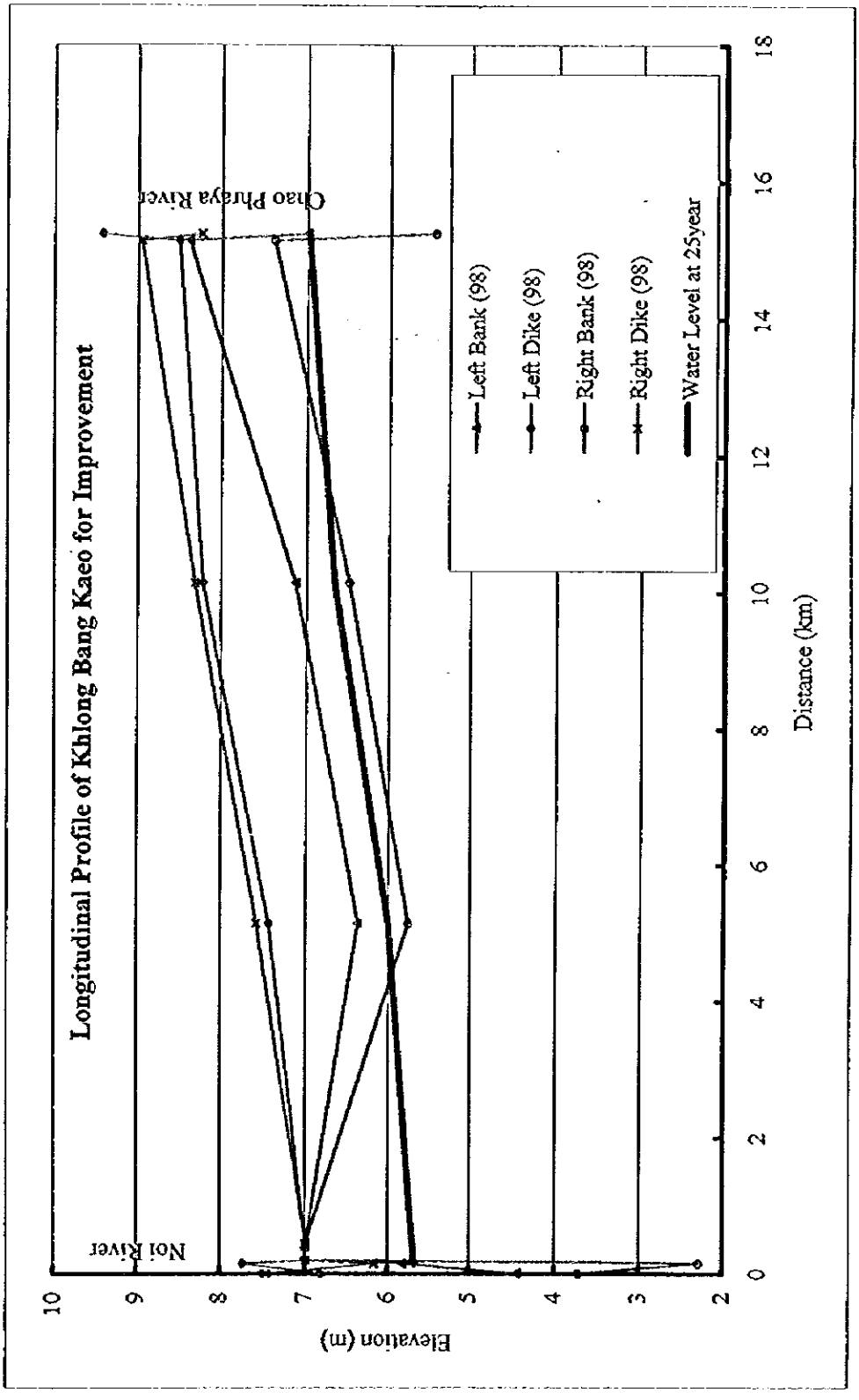
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.12 (4/7) LONGITUDINAL PROFILE OF THE CHAO PHRAYA RIVER FOR RIVER IMPROVEMENT OF ALTERNATIVE 2-2 IN THE MASTER PLAN
CTI ENGINEERING CO., LTD AND INA CORPORATION	



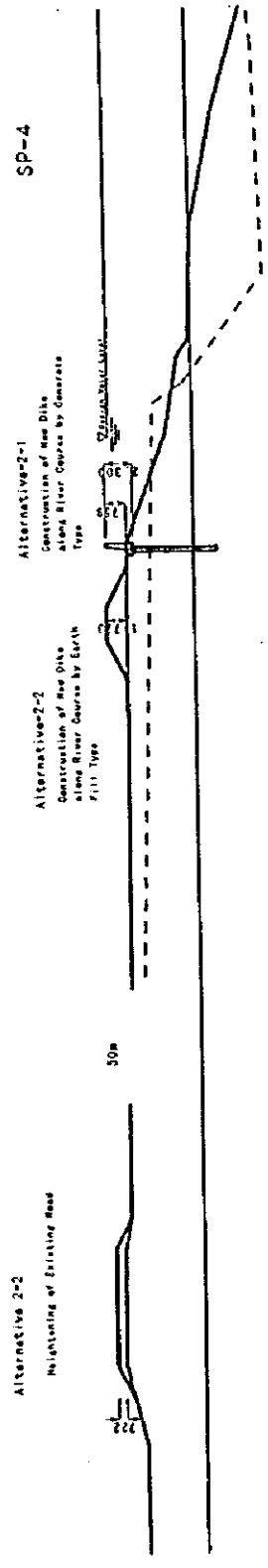
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.12 (5/7) LONGITUDINAL PROFILE OF THE CHAO PHRAYA RIVER FOR RIVER IMPROVEMENT OF ALTERNATIVE 2-2 IN THE MASTER PLAN
CTI ENGINEERING CO., LTD AND INA CORPORATION	



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.12 (6/7) LONGITUDINAL PROFILE OF THE CHAO PHRAYA RIVER FOR RIVER IMPROVEMENT OF ALTERNATIVE 2-2 IN THE MASTER PLAN
CTI ENGINEERING CO., LTD AND INA CORPORATION	



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.1.12 (7/7) LONGITUDINAL PROFILE OF THE CHAO PHRAYA RIVER FOR RIVER IMPROVEMENT OF ALTERNATIVE 2-2 IN THE MASTER PLAN
CTI ENGINEERING CO., LTD AND INA CORPORATION	



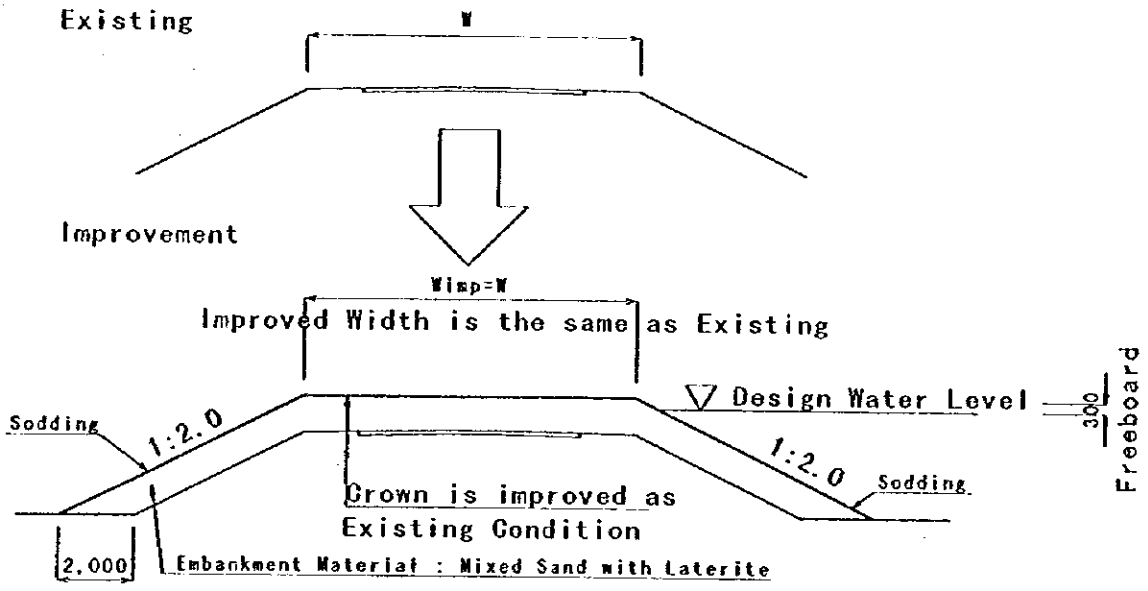
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

CTI ENGINEERING CO., LTD AND INA CORPORATION

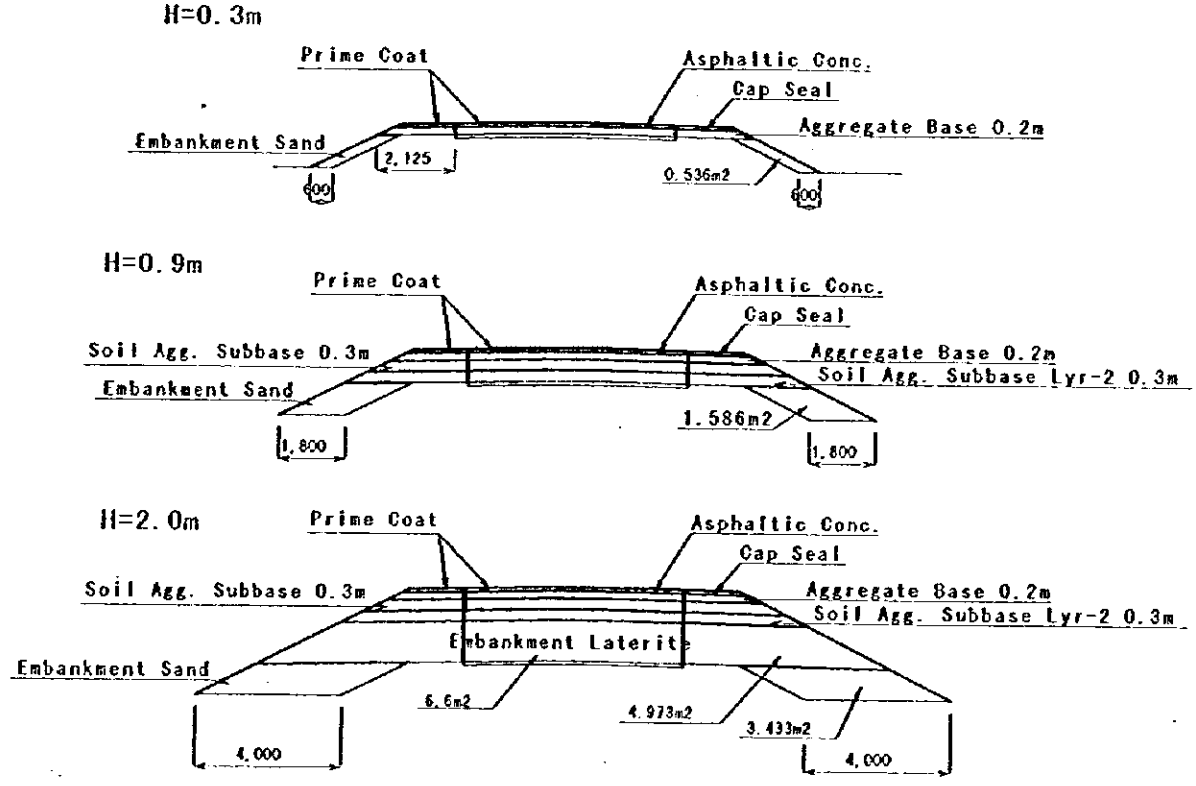
Fig.2.1.13

TYPICAL CROSS SECTION FOR RIVER IMPROVEMENT OF ALTERNATIVE 2-2 IN THE MASTER PLAN

Design Criteria for Alternative 1



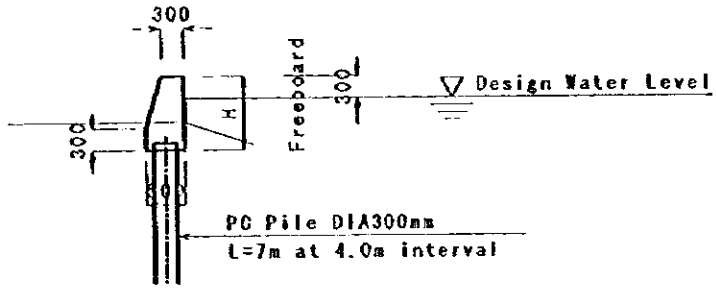
Example of Improvement of Existing Dike with Pavement



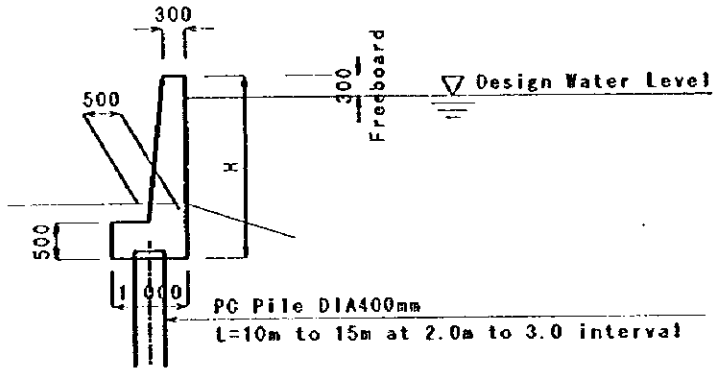
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.2.1 (1/3) STANDARD CROSS SECTIONS OF FLOOD PROTECTION DIKE
CTI ENGINEERING CO., LTD AND INA CORPORATION	

Design Criteria for Alternative 2-1

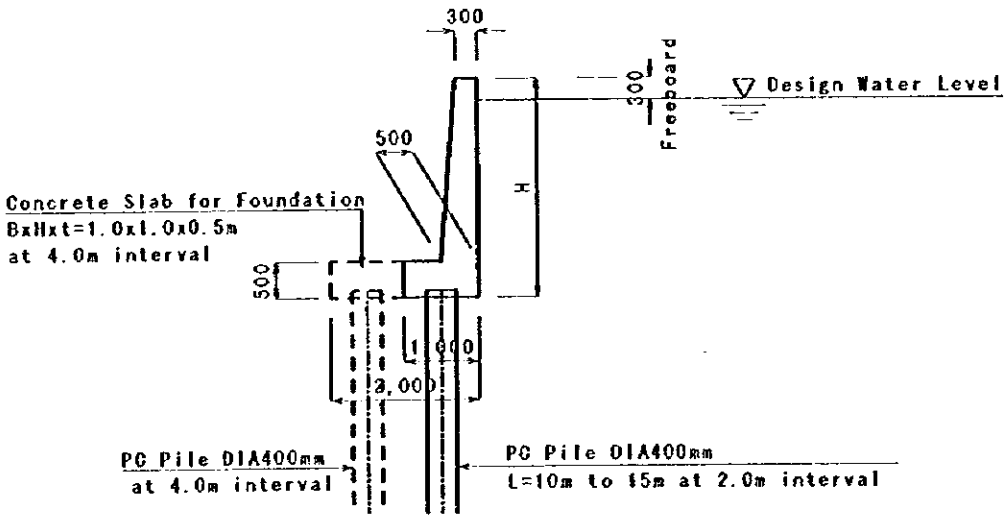
Wall Height less than 1.0m



Wall Height 1.0m to 3.0m



Wall Height more than 3.0m

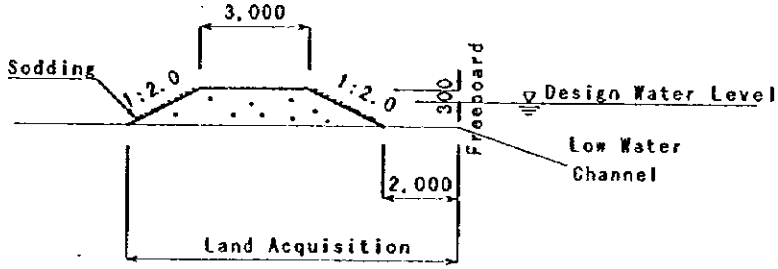


Note; Design Compressive Strength of Concrete : more than 210kg/cm2

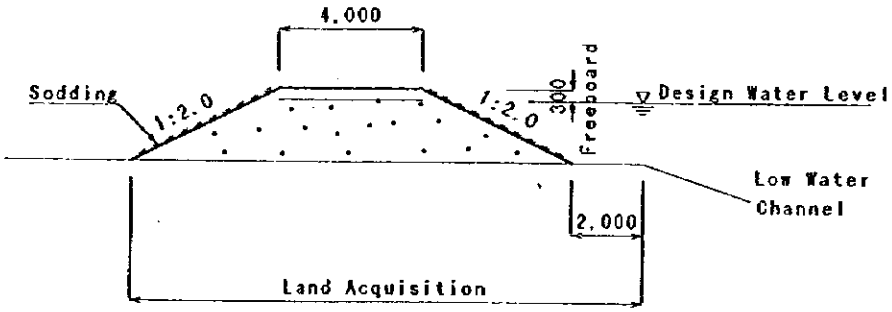
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.2.1 (2/3) STANDARD CROSS SECTIONS OF FLOOD PROTECTION DIKE
CTI ENGINEERING CO., LTD AND INA CORPORATION	

Design Criteria for Alternative 2-2

Dike Height : 1.0m or less

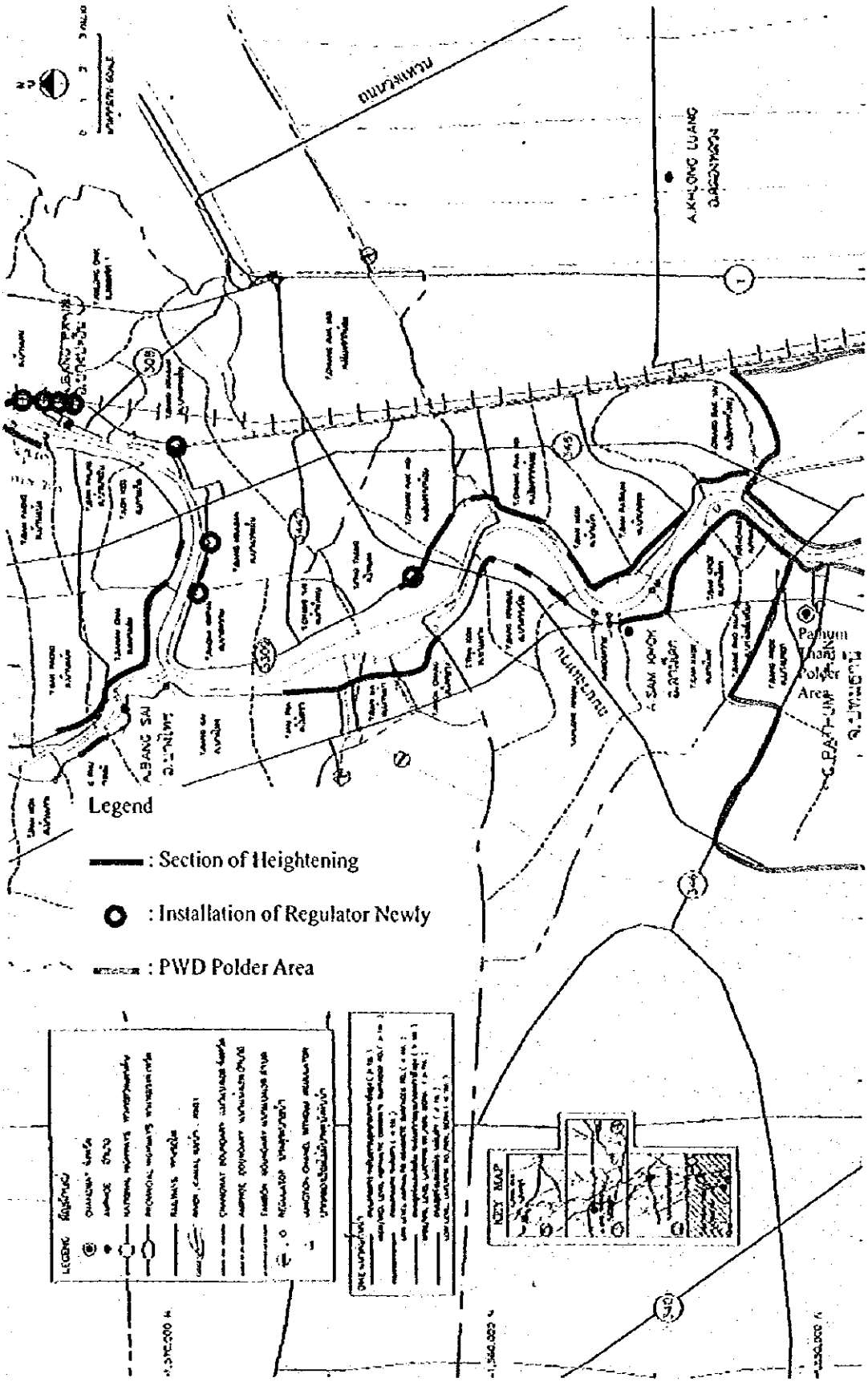


Dike Height : 1.0m or less



Note: Embankment Material:Mixed Laterite-80% with Fine Sand-20%

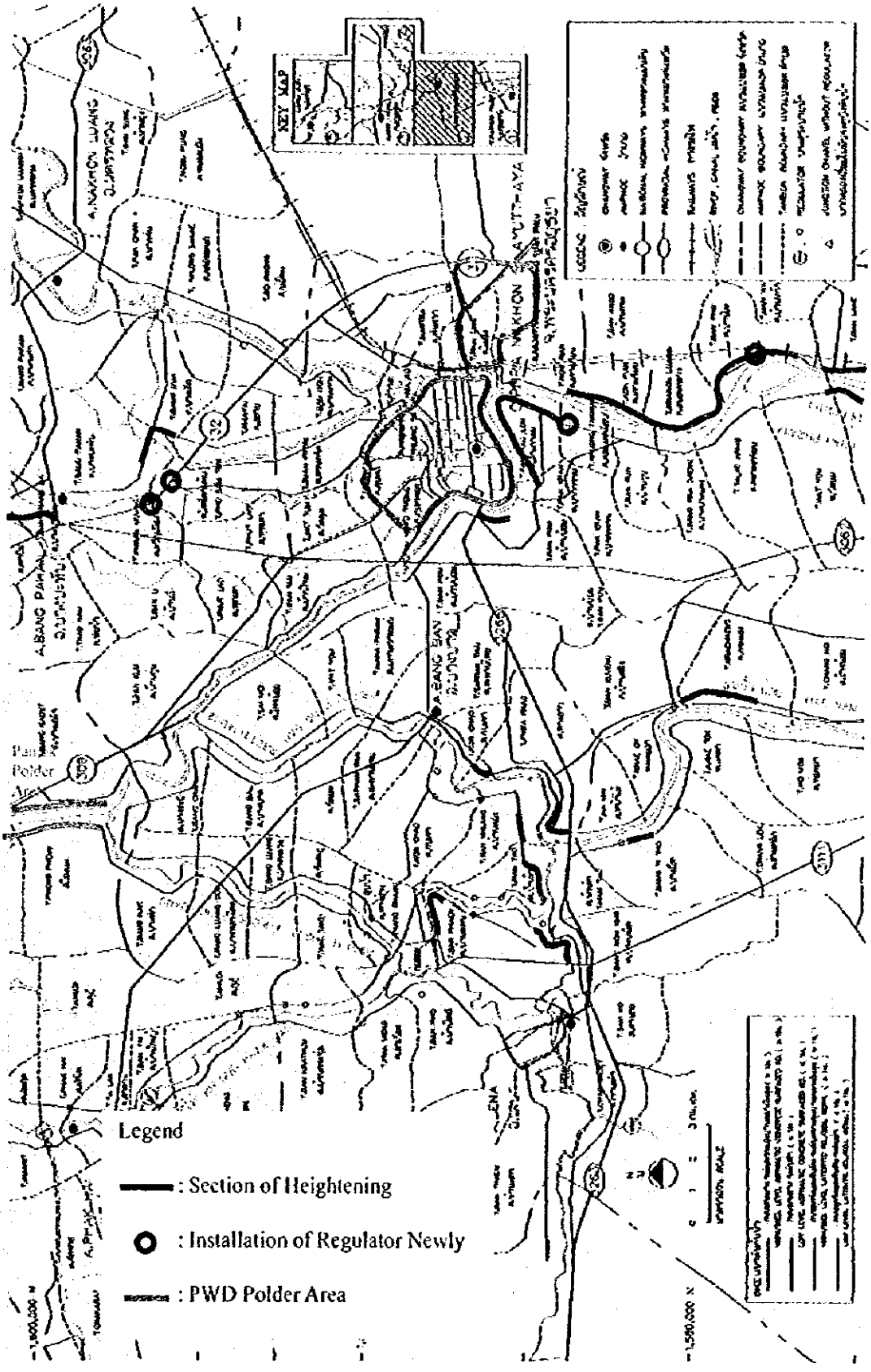
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.2.1 (3/3) STANDARD CROSS SECTIONS OF FLOOD PROTECTION DIKE
CTI ENGINEERING CO., LTD AND INA CORPORATION	



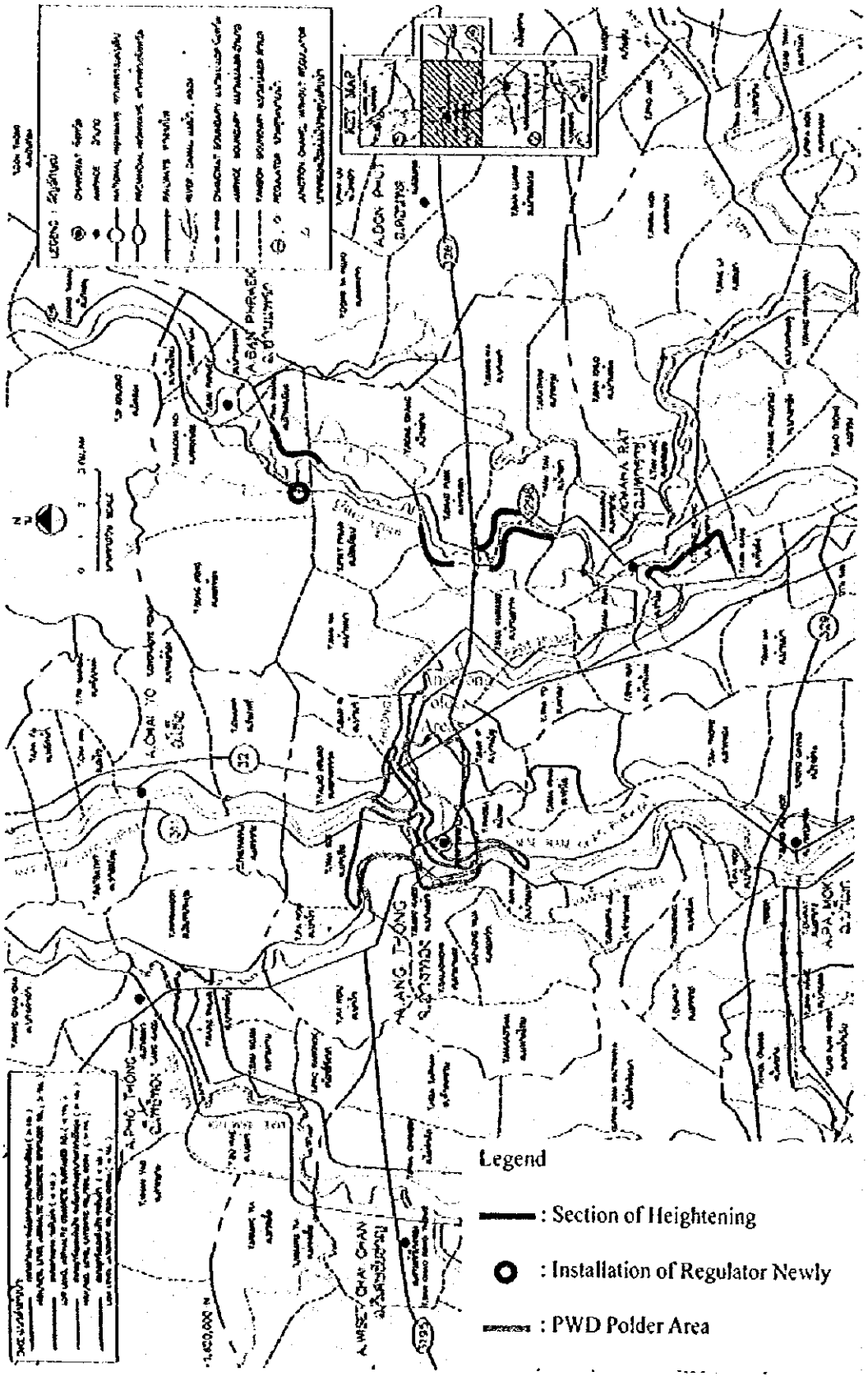
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig .2.2.2 (1/3)
ALIGNMENT OF RIVER IMPROVEMENT



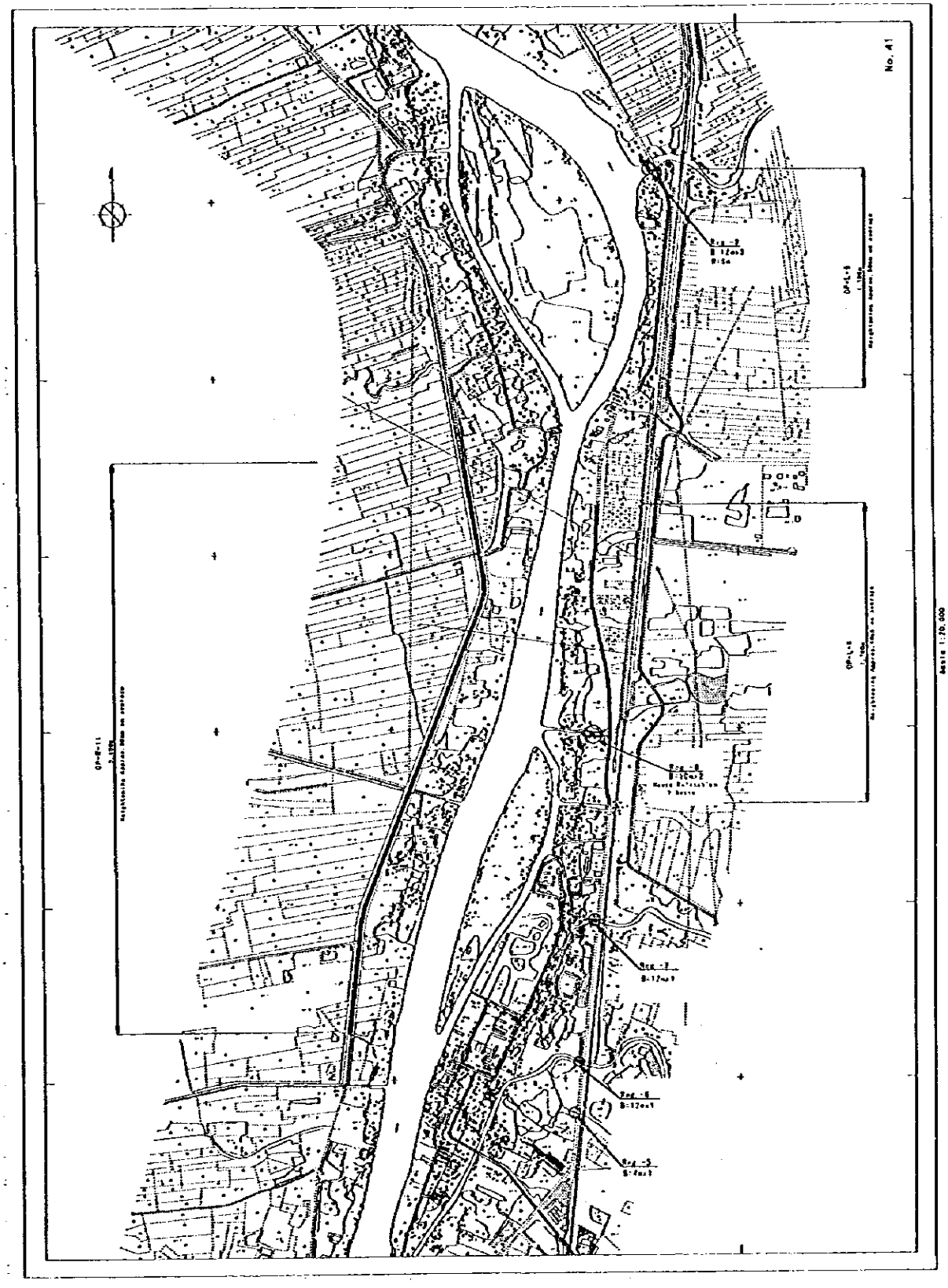
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig .2.2.2 (2/3) ALIGNMENT OF RIVER IMPROVEMENT
CTI ENGINEERING CO., LTD AND INA CORPORATION	



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

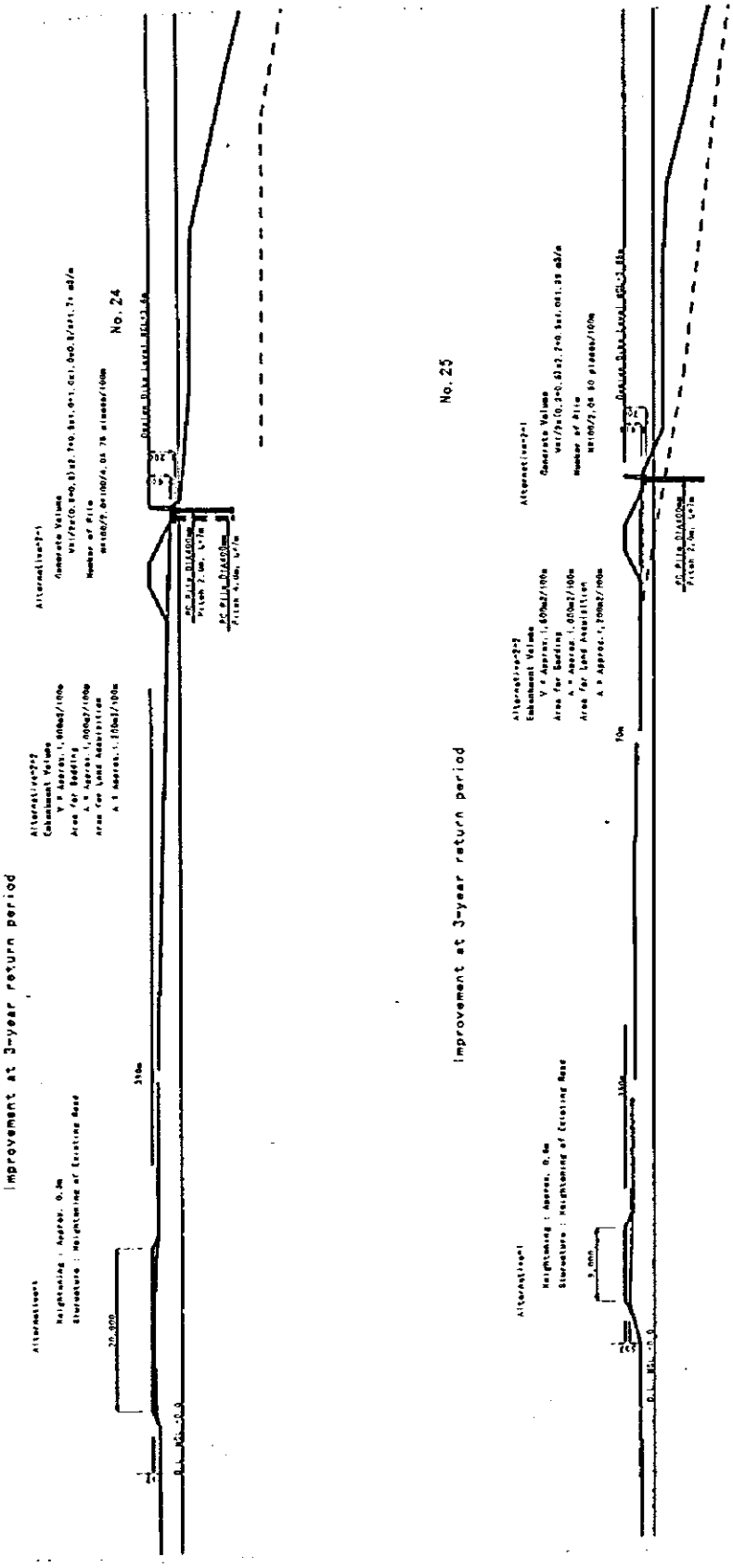
CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig.2.2.2 (3/3)
ALIGNMENT OF RIVER IMPROVEMENT



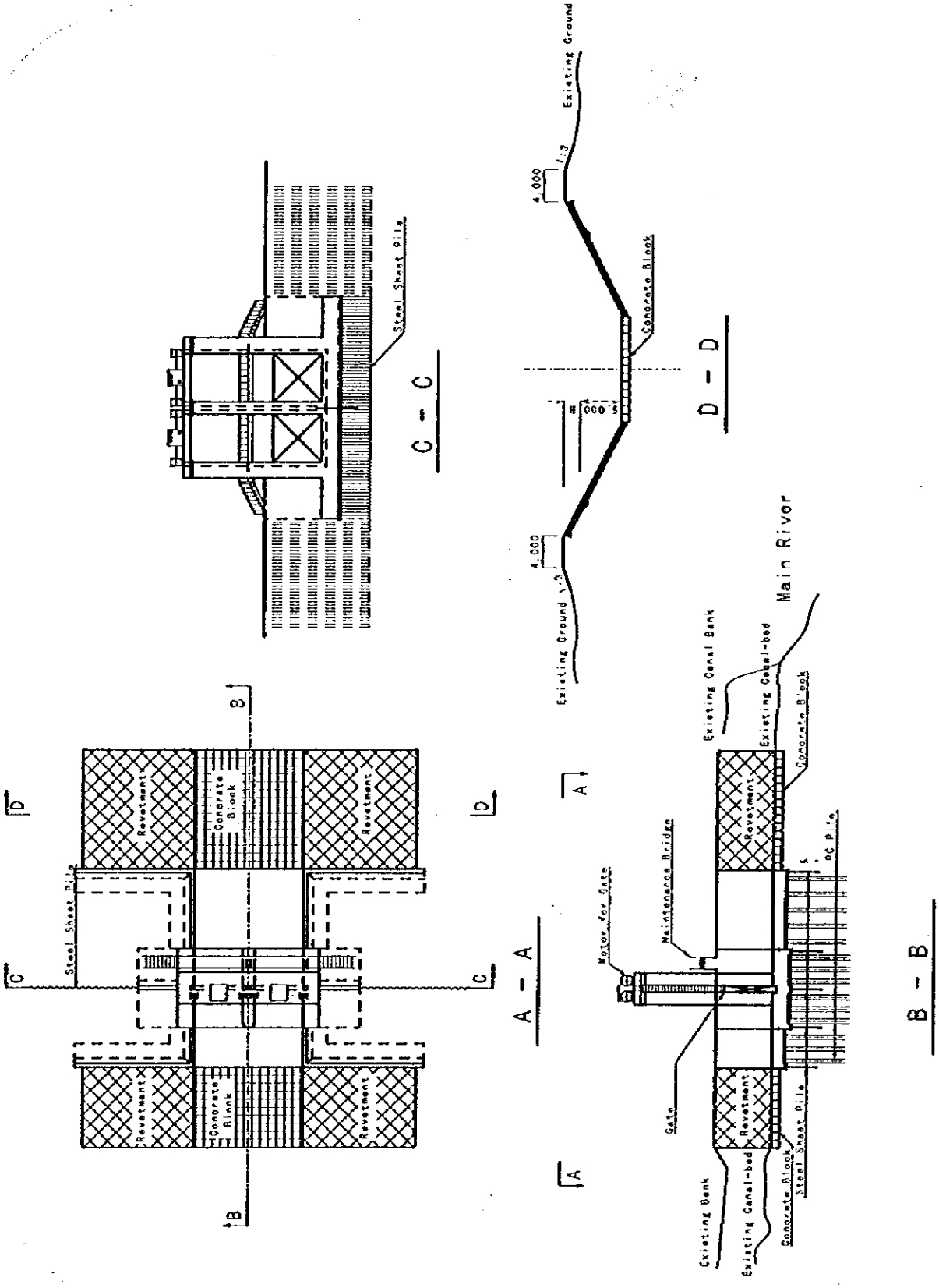
SEE DRAWINGS FOR RIVER IMPROVEMENT IN DETA BOOK

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig 2.2.3
CTI ENGINEERING CO., LTD AND INA CORPORATION	SAMPLE OF DESIGN PLAN FOR RIVER IMPROVEMENT

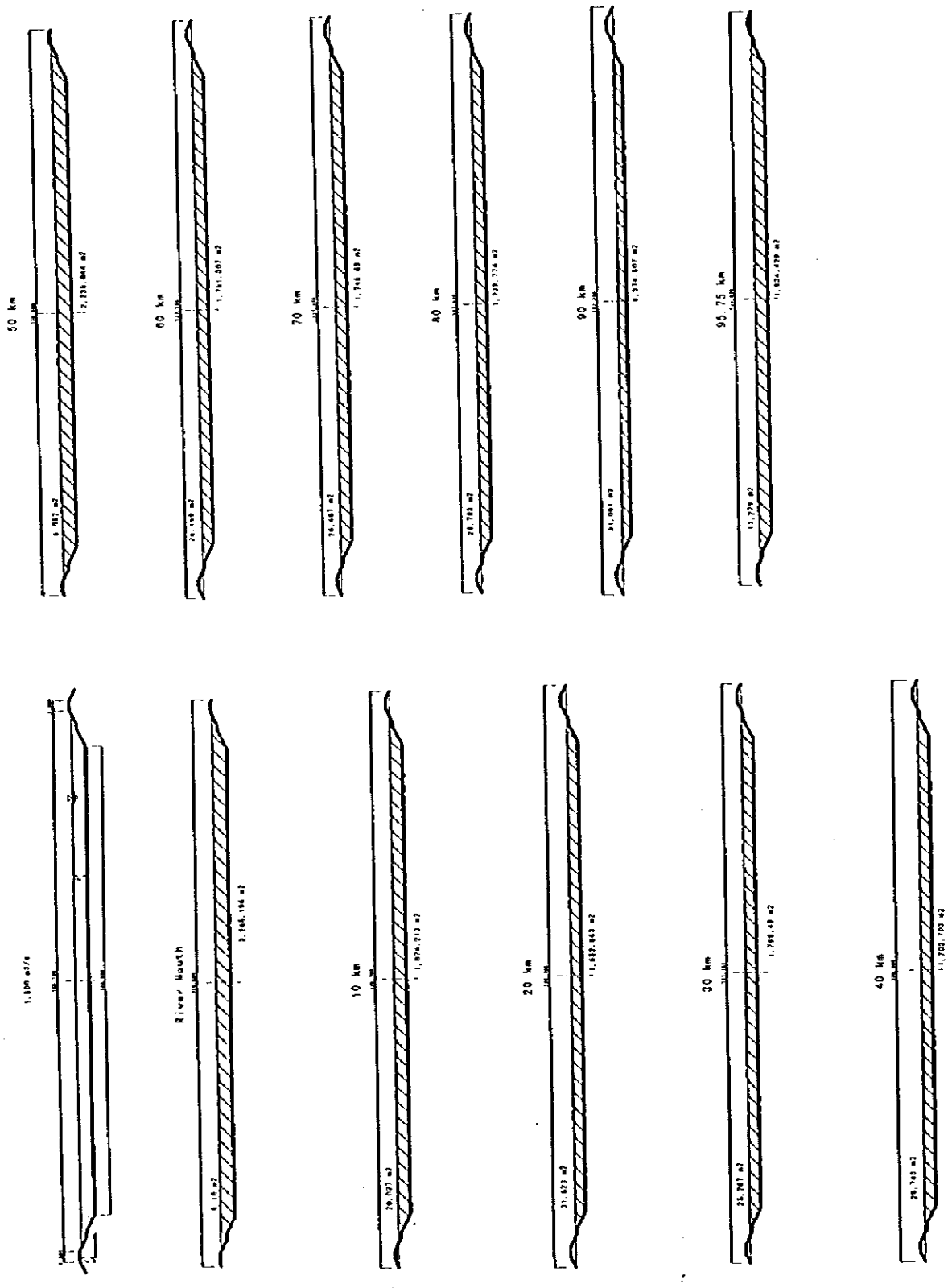


SEE DRAWINGS FOR RIVER IMPROVEMENT IN DATA BOOK

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.2.4 SAMPLE OF DESIGN CROSS SECTION FOR RIVER IMPROVEMENT
CTI ENGINEERING CO., LTD AND INA CORPORATION	

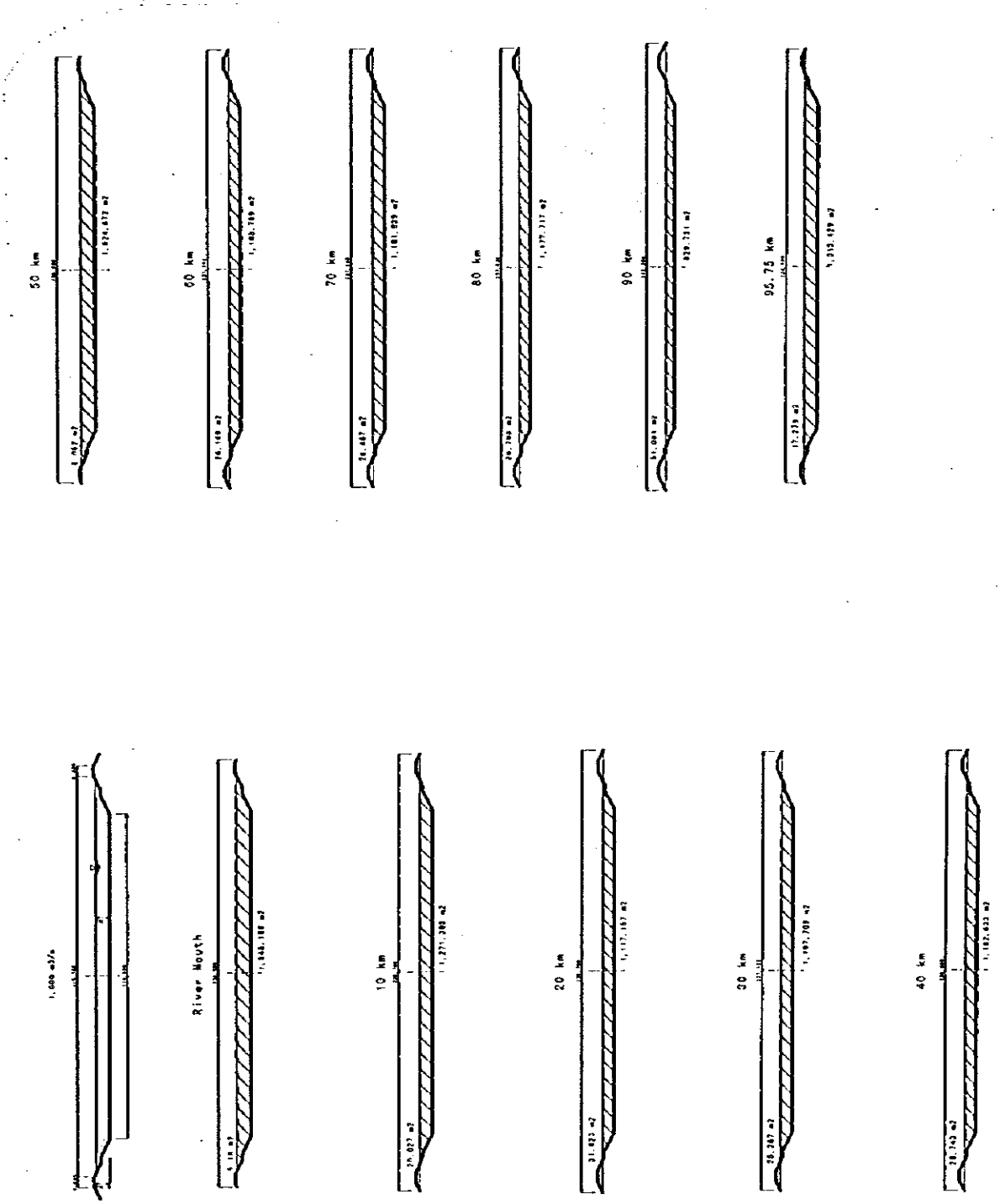


STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.2.2.5 TYPICAL STRUCTURAL DESIGN OF REGULATOR FOR RIVER IMPROVEMENT
CTI ENGINEERING CO., LTD AND INA CORPORATION	



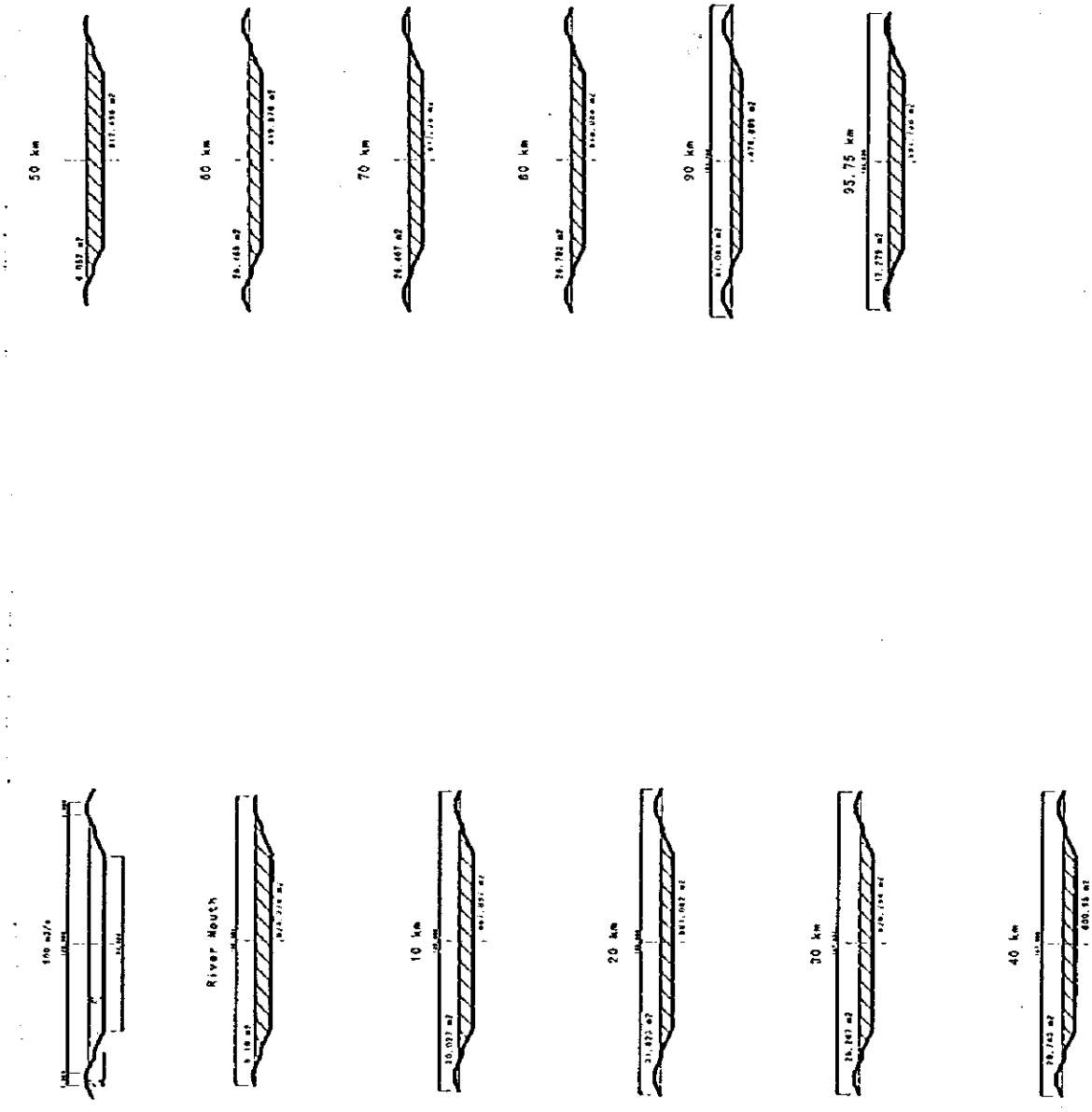
Ayutthaya-East-Sea Diversion-2 at 1,500m3/s as Samples

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.3.1.1 (1/3) QUANTITY CALCULATION FOR DIVERSION PROJECT
CTI ENGINEERING CO., LTD AND INA CORPORATION	



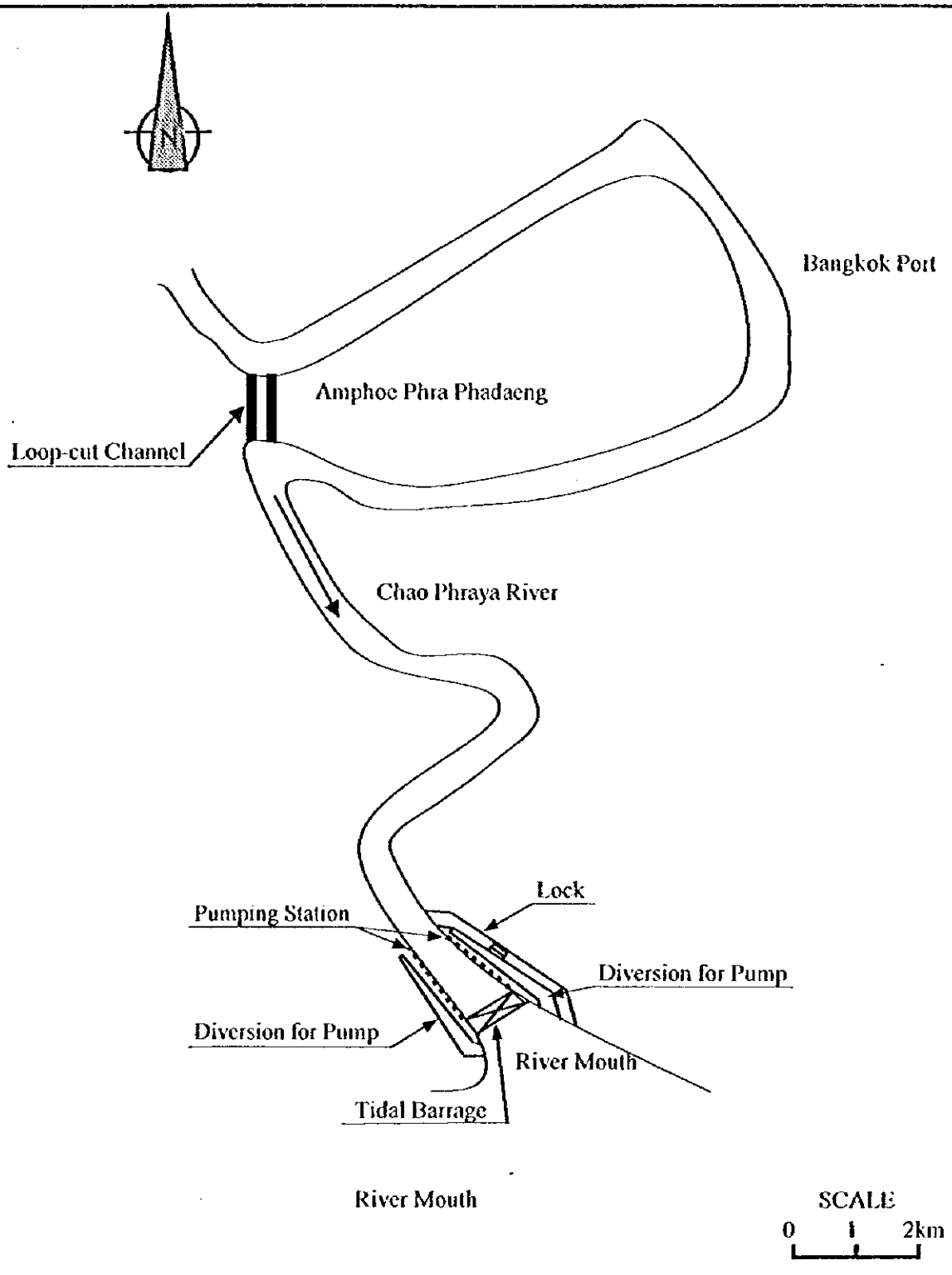
Ayutthaya-East-Sea Diversion-2 at 1,000m3/s as Samples

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.3.1.1 (2/3)
CTI ENGINEERING CO., LTD AND INA CORPORATION	QUANTITY CALCULATION FOR DIVERSION PROJECT

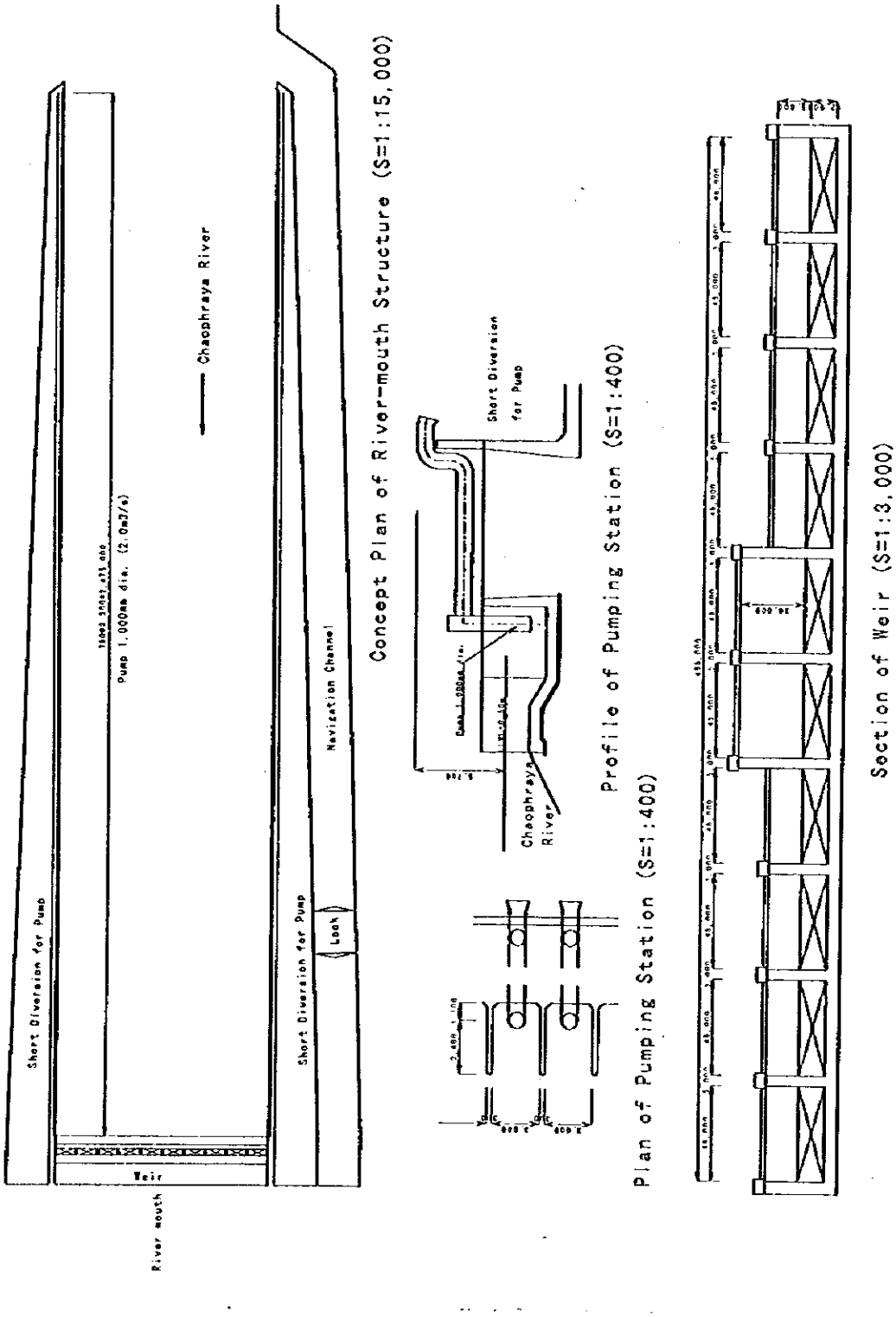


Ayuthaya-East-Sea Diversion-2 at 500m3/s as Samples

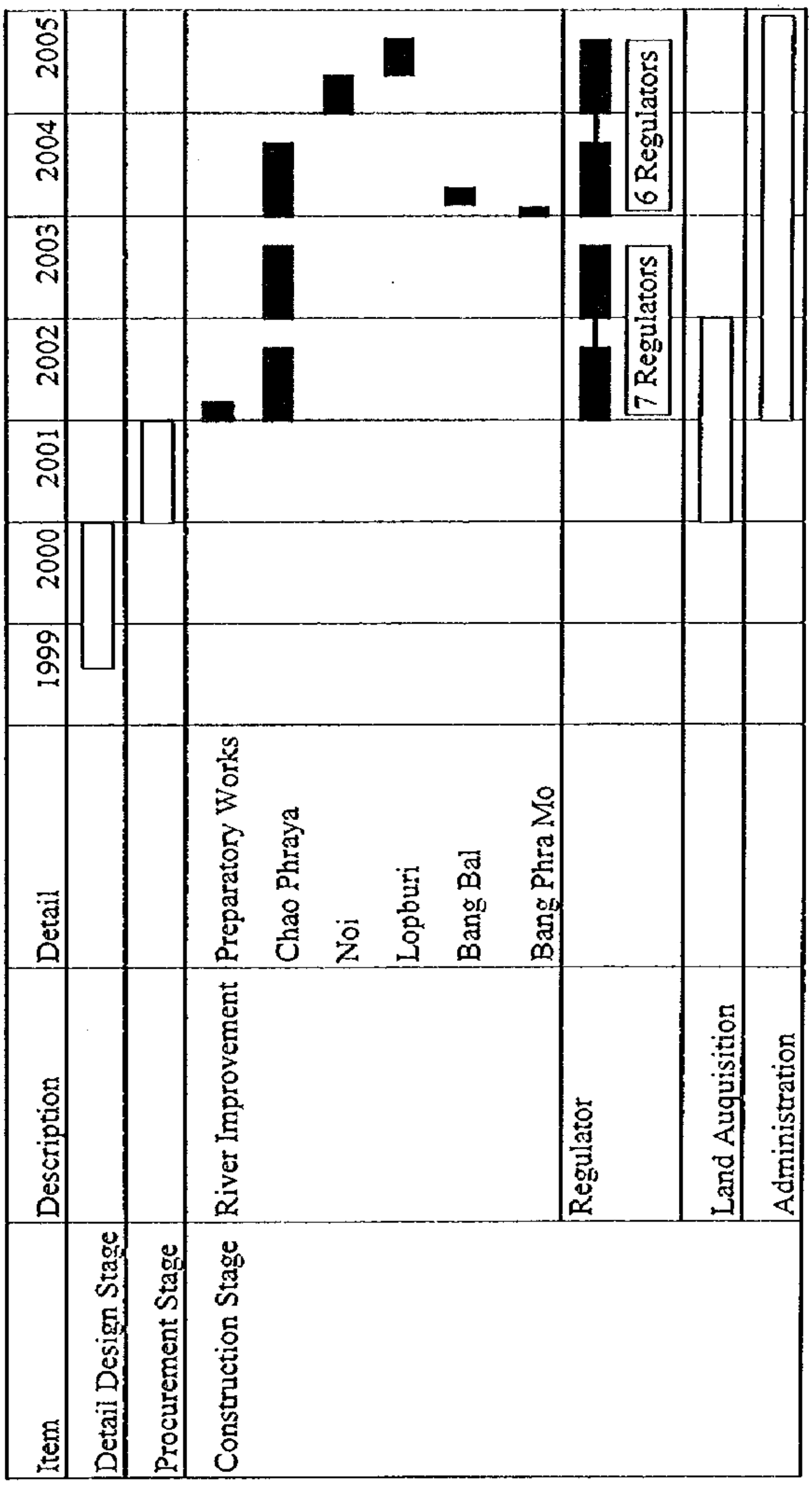
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.3.1.1 (3/3)
CTI ENGINEERING CO., LTD AND INA CORPORATION	QUANTITY CALCULATION FOR DIVERSION PROJECT



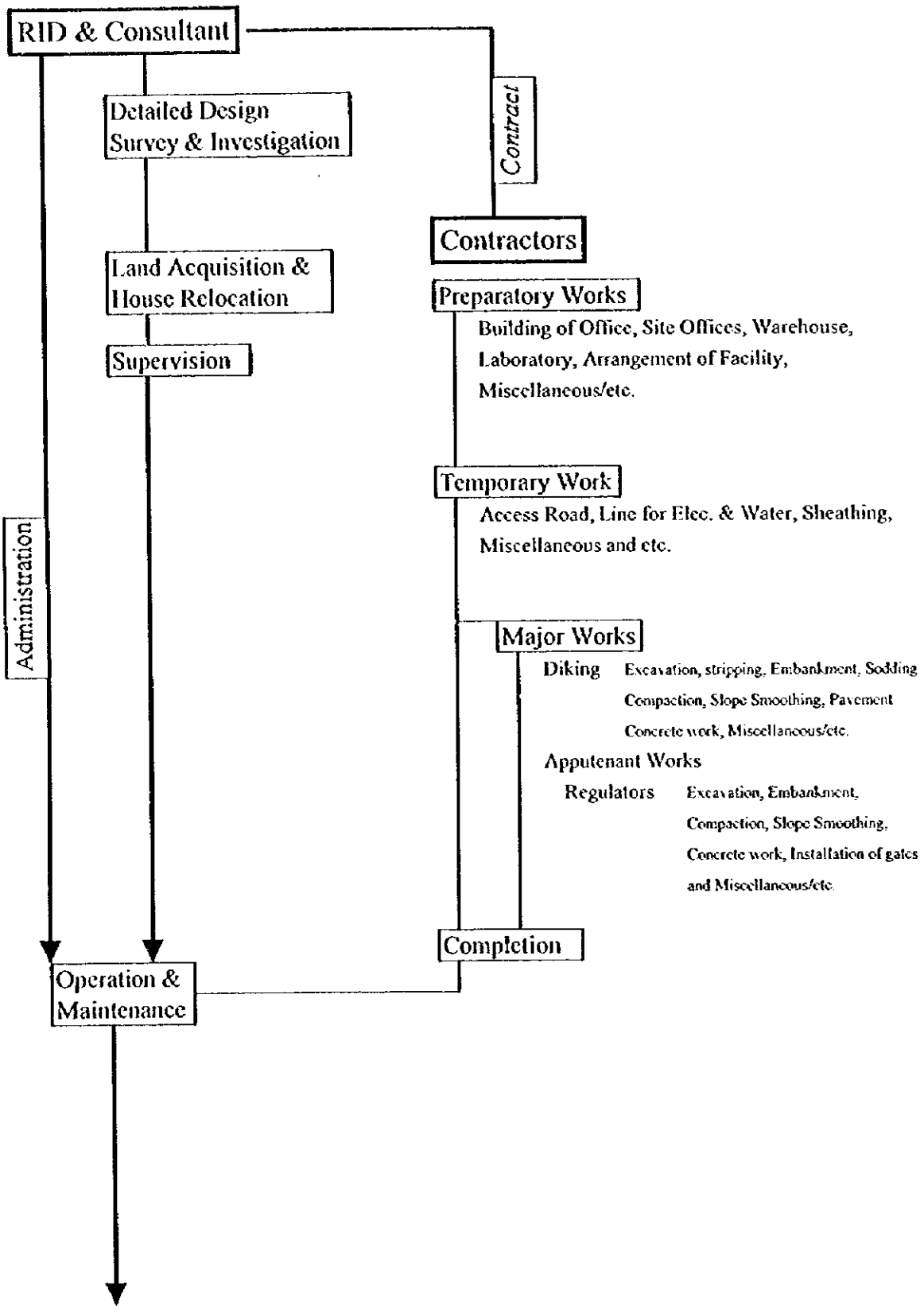
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.3.6.1
CTI ENGINEERING CO., LTD AND INA CORPORATION	LOCATION OF TIDAL BARRAGE



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.3.6.2 GENERAL DRAWING OF TIDAL BARRAGE AND PUMP
CTI ENGINEERING CO., LTD AND INA CORPORATION	



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 4.2.1
CTI ENGINEERING CO., LTD AND INA CORPORATION	CONSTRUCTION PLAN OF PROPOSED RIVER IMPROVEMENT PROJECT



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig.5.1.1 FLOW CHART OF PROJECT CONSTRUCTION FOR COST ESTIMATION
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SECTOR XIII

ECONOMIC EVALUATION

SECTOR XIII: ECONOMIC EVALUATION

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1. GENERAL

1.1 Structural Measure

One of the objectives in the present study would be aiming to formulate the project so as to reduce the flood damage by executing the project, and the effects are generally evaluated from the technical, economic, financial and, social and natural environmental points of view.

Effects of the flood control project could be divided into four categories; (1) direct-tangible effect, (2) direct-intangible effect, (3) indirect-tangible effect, and (4) indirect-intangible effect. Further, respective effects may have two factors of positive and negative facet.

(1) Among them, the direct-tangible effect would be the most significant factor for the project evaluation. Out of the direct-tangible effect, the positive effect would be given as an economic benefit, that would be evaluated by a reduction in the flood damage to assets in the flood prone area.

The reduction in the flood damage would be mainly formulated in the structural measures. (On the other hand, the non-structural measures will be adopted as a parallel or subordinate effect of structural measures, provided that the effect of the non-structural measures has accuracy equal or higher than that of the structural measures.)

A negative aspect in the direct-tangible effect is, for example, destruction of natural environment such as deformation of land, decrease in forest, and water and air pollution. The flood control project, however, aims basically as well to improve the natural environment in the region, therefore, the change for the worse natural environment should be avoided at the stage of project formulation, taking deliberately the opinions of inhabitants into consideration.

(2) Direct-intangible effects could be expected such positive effects as a stability of popular mind due to the relief from the menace of floods, an improvement of social communications, etc. by implementing the structural measures.

(3) The indirect-tangible effect could be expected such positive effects as promotion of regional economic development, improvement of land use, increase in agricultural production, increase in GDP, decrease in disease, etc. The positive effects above will not be estimated in this study, because it is difficult to have the necessary accuracy for the estimates.

(4) The indirect-intangible effect could be expected such as the improvement of social environment by decreasing idle laborers and facilitating the communication among inhabitants.

1.2 Non-Structural Measure

Regarding the non-structural measures, they could introduce such measures as modification of reservoir operation rule, control and guidance for land development together with the flood hazard map, ground water extraction control, flood forecasting and warning system, flood fighting, disaster recovery, education of inhabitants on flood, financial response of subsidy and flood insurance, watershed management, establishment and modification of institutional organization, and so on.

These non-structural measures would be expected to reduce the flood damage directly and indirectly, and to maintain usually at a lower cost than the structural measures. It is, generally speaking, however, difficult to estimate in the accuracy equal to the benefit introduced from the structural measures. Therefore, in the present study, the non-structural measures except the modification of reservoir dam operation rule would be discussed in the categories of the direct- and indirect-intangible effect.

1.3 Procedure of Economic Evaluation

At the present study, the project economic evaluation is made in two stages; the master plan stage and the feasibility study stage. In the master plan, economic evaluation was carried out for the conceivable structural measures as well as for the non-structural measure of modification of dam operation rule. And in the feasibility study stage, economic evaluation for the selected structural measures of the river improvement, and for non-structural measure of modification of dam operation rule is carried out.

With regard to the costs for Modification of Dam Operation Rule, they are described in Sector VIII as being equivalent to the compensation costs for the reduction of water supply for hydropower and irrigation on the current economic prices. The economic analysis is carried out being based on those costs.

Meanwhile, it might be first acknowledged to be so difficult to have the necessary accuracy for the estimate of the real economic per value water cost of concerned dams at the present prices, and then, the present actual electricity sales price instead of the assumed higher shadow price is used as the unit of per value water cost. Secondly, it would be also hard to allocate properly the appropriate portion of construction cost of the concerned dams as to the initial cost of Modification of Dam Operation Rule, which is therefore not taken into account in the evaluation. That is, the cost would be taken into account as conservative side. Eventually, the benefit would accrue larger than the cost from the beginning and continue to keep this cost-benefit relation in parallel.

Accordingly, in the case of Economic Evaluation of Modification of Dam Operation Rule, B-C and B/C are adopted, because the EIRR indicates some infinite figure when the cost is comparatively much smaller than the benefit from the beginning and continue to accrue in parallel during the project life.

1.4 Sensitivity Analysis

In addition, an EIRR sensitivity test would be made to confirm further the economic viability of the priority project.

1.5 Financial Consideration

Meanwhile, the financial aspects about the affordability for the projects shall be discussed for the master plan as well as for the feasibility study of structural measures.

2. CONDITION OF ECONOMIC EVALUATION

The economic evaluation of the flood control project is made by comparing the two present values of economic benefit and cost of the project.

The major economic benefit of the flood control project is presented as an expected reduction in flood damage by implementing the project, that is, an economic difference between "with-project" and "without-project" situations. The comparison on economic benefit and cost was carried out using such indicators as Economic Internal Rate of Return (EIRR), together with Benefit-Cost Ratio (B/C) and Net Present Value (NPV).

Both economic values of benefit and cost would be presented by shadow prices which be obtained by converting the financial values of benefit and cost at market prices, under the conditions and assumptions as described below (refer to Table 2.1.1 and 2.1.2) :

- Transfer payments, such as value added tax of 10 %, shall not be included in the economic cost and benefit.
- Standard conversion rate (SCR) applied to equipment and materials procured locally is assumed to be 96 %, taking the export and import situations of Thailand in usual years into consideration.
- Opportunity cost of wages for unskilled laborers is assumed to be 97 % of existing cost, taking unemployment situations in usual years into consideration.
- Economic cost of land to be acquired for the project is assumed to be 90 % of the existing cost, taking into the vacant condition of land to be acquired for the project.
- Inflation factor is not taken account for economic evaluation.
- Economic life of the project (hereinafter referred to as the "project life") is taken as 50 years after the completion of construction works for structural measures.
- Construction period is assumed to be from 5 to 10 years according to the conceivable projects.
- The benefit of the project and OM cost (operating and maintenance cost) are expected to accrue every year during the period of the project life after completion of the construction works.
- The economic benefit of respective project at the next year of its completion is derived from that of the year 2018 for Master Plan and of the year 2005 for Feasibility Study, discounting or increasing the amount grown during the period (refer to Table.2.1.3). That is, the economic benefit is taken to grow until the completion year of implementation. And after that, it would be set to accrue every year at the fixed amount obtained above.
- Opportunity cost of capital is assumed to be 12 %.

3. FINANCIAL CONDITION OF CONCERNED AGENCIES

3.1 Budgetary Allocation of Large Scale Project

A large scale project with the estimated cost, generally in the order of more than 200 million baht project, is to be predominantly discussed and approved by the Cabinet Council which is composed of all the ministers and is chaired by Prime Minister.

In the course of the procedure, first, the proposed plan shall be formed up by the ministry which hold the intention to execute their project, secondly, the Cabinet Council summons beforehand to the ministries concerned (NESDB, Budget Bureau of Prime Minister's Office, Ministry of Environment,etc.) the pre-consideration and their opinions for that proposed plan , and then deliberate it.

And once the approval is made by the Cabinet Council, the yearly budget will be allocated precedingly under the priority negotiation with the ministry by which the plan had been submitted to the Cabinet Council.

After the allocation to the ministry, the budget shall be independently set up besides the ordinary budget and be carried out under the administration and execution of that approved ministry. Usually, the project team headed by Director-General shall be formulated within the ministry to supervise and execute the large project.

Henceforth, it is basically a very important and necessary task for the said ministry to work out deliberately the nationwide beneficial and attractive proposed plan by which they could fully explain to the important persons in charge of the ministries concerned and make them understood the importance and necessity of that proposed plan to be adopted.

3.2 Construction Project Budget of RID

(1) Large Scale Project

A large scale project in the case of RID to be submitted to the Cabinet Council is conditioned as follows :

- Project cost of more than 200 million baht, and/or
- Project of irrigation area of more than 80,000 Rai, and/or
- Project of reservoir capacity of more than 100 mcm, and/or
- Project of reservoir surface area of more than 15 km^2
- Project of any other kind equivalent to or more than scale of above mentioned one

Table 3.2.1 shows the RID Budget for Construction Project from 1995 to 1998 fiscal year and the large scale project is categorized in (2) Budget # 2 (Large Scale Project). For instance, a comparatively big figure of 12,265 million baht in 1996 budget means that much more approval of the Cabinet Council to RID had been done for this year.

Meantime, the 11(eleven) large scale projects are on-going as of in 1998 budget, which are shown in Table 3.2.2. The largest one is Pak Phanang River Basin Development Project with the total cost of project of 13,380 million baht, being followed by the second largest one of Khlong Ta Dan Dam Project Initiated By H. M. the King with 10,193 million baht, the third one of Pak Phanang River Basin Development Project Initiated By H. M. the King, Bang Pakong Diversion & Barrage Project with 4,342 million baht, Khlong Si yat Project with 4,016 million baht, and so on.

In addition, in the past, they have had the experience of having constructed such large scale dams of Bumibol Dam with the construction cost of 2,900 million baht on that days' current prices basis (construction started 1958 and finished 1964) and Sirikit Dam with 2,600 million baht on that days' current prices basis (started 1963 and finished 1972), both of which are certainly considered to be the very large scale of the projects if would be counted on present prices basis, for a reference, amounting to be the individual total amount of 17 to more than 20 times.

(2) Medium and Small Scale Project, and Operation and Maintenance Project

Medium and small scale project, and operation and maintenance project shall be executed in the categories of concerned budget of RID, that is, Budget # 3 (Medium & Small Scale Project) , Budget # 4 (Operation and Management of Project)) and Budget # 5 (Others) of Table 3.2.1 .

As of in 1998 budget, they have 49 medium and small scale projects and, 150 OM projects (among them, 24 of OM projects in Region 7; West side of the Chao Phraya river and 16 of OM projects in Region 8 ; East side of the Chao Phraya river), all of which account for 21,019 million baht. In the meantime, these projects shall be replaced by newly proposed projects in the course of years, that is, the more beneficial and attractive new projects have the possibilities of being adopted and carried out with the ordinary budget.

On the other hand , the medium scale project might be classified in the cost of ranging 50~200 million baht and the small scale project of 10~50 million baht respectively. And the operation and maintenance project is managed by the necessary cost basis.

3.3 Public Work Department (PWD) of Ministry of Interior:

In the case of PWD, a project with the cost over 200 million baht is considered to be a large scale project, and that is submitted to the Cabinet Council for the deliberation and approval.

Once approved and if the project is spread over the works of many concerned divisions of PWD, a project team is formulated under the direct control of Director-General, and the project is to be carried out.

Table 3.3.1 shows the total budget of PWD of the past 5 years, which ranges from 17,259 to 37,538 million baht, and the budget appropriation by programmes in 1999 is given in Table 3.3.2.

In this appropriation, the flood related budgets are involved in the items of No.11 of Flood Control of Samut Prakan, 12 and 14 of Protections for Along-Rivers in Municipalities with phase I & II, and 15 of Flood Control of Nontaburi in Category I. They are amounted to be 1,357 million baht in 1999 fiscal year (5.5 % of total budget), and 24,153 million bahts in total construction cost (16.8 % of total construction coast as of 1999 fiscal year).

Meanwhile, PWD defines that the medium scale project ranges in the cost from 50 upto 200 million baht, and the small scale project falls in the cost from 1 to 50 million baht.

3.4 Bangkok Metropolitan Authority (BMA)

In Thailand, Bangkok Metropolitan and Pataya City have the authorization of collecting the tax for their own budget.

In the case of BMA, when a large project is raised up, it must be first submitted to the Governor of BMA in order to obtain the approval on the comprehensive judgement for the further procedure. Then, the proposed plan shall be deliberated at the Assembly of Bangkok Metropolitan Authority. The Assembly is consisted of 60 numbers of representatives who are elected from 50 districts of Bangkok Metropolitan.

A large project is usually executed as the joint work with the Central Government, and the share of BMA shall range from 25 to 40 % for the total cost. The scale of a large project is recognized differently on the activity of respective division, that is, Public Work, Sewerage and Flood, Traffic and Transportation, Medical Service, Public Cleaning, Education, and so on.

The largest one of the recent flood related project was Dike Construction after 1995 flood. The total cost was 748 million baht which had been shared 40 % (299 million baht) by BMA and 60 % (449 million baht) by Central Government. Meanwhile, for instance, the large project of the recent sewerage one amounted to be 6,000 million baht, which had been shared by BMA and the Central Government. The largest recent project of traffic and transportation was accounted for 2,567 million baht which was shared 40 % (1,027 million baht) by BMA and 60 % (1,541 million batht) by the

Central Government, and the second largest was 1,106 million baht of which 40 % (442 million baht) shared by BMA and 60 % (664 million baht) by the Central Government.

Table 3.4.1 shows the budget appropriation by Office and Division of BMA from 1992 to 1996.

4. ECONOMIC EVALUATION OF MASTER PLAN

4.1 Economic Cost

The economic cost is a converted value from the financial project costs under the conditions and assumptions described in above Section 2.

As a result of the conversion, the economic cost and annual OM cost are estimated , and the result is shown as below (refer to Table 4.1.1, 4.1.2 and 4.1.3):

(1) Economic Cost of Alternative-1

Financial Cost of Alternative-1

Unit: million baht

Flood Control Measures	Project Cost	Annual OM Cost
(1) Distribution System Improvement	285	2
(2) Drainage System Improvement	6,735	42
(3) River Improvement (I)	1,834	44
(4) Alt-1: (1) -(3) combined.	8,445	78
(a) Dam Operation	46	451
(b) Combination of (4) and (a)	8,491	529

Economic Cost of Alternative-1

Unit: million baht

Flood Control Measures	Project Cost	Annual OM Cost
(1) Distribution System Improvement	231	2
(2) Drainage System Improvement	5,402	37
(3) River Improvement (I)	1,227	31
(4) Alt-1: (1) -(3) combined.	6,868	70
(a) Dam Operation	40	394
(b) Combination of (4) and (a)	7,169	480

Note: (1) Representative OM cost of each project is listed and the sum of combination does not coincide with the addition., (2) Modification of Dam Operation Rule (non-structural measure), 139,000 mcm, Bumibol, Sirikit,Pasak, Kwae Noi and Kaeng Sua Ten Dam

(2) Economic Cost of Alternative 2-1

Financial Cost of Alternative 2-1

Unit: million baht

Flood Control Measures	Project Cost	Annual OM Cost
(1) Distribution System Improvement	285	2
(2) Drainage System Improvement	6,735	42
(3) Heightening of Flood Barrier	1,840	23
(4) River Improvement (I)	1,425	34
(5) Alt 2-1 : (1) -(4) combined.	10,285	101
(a) Dam Operation	*46*	*451*
(b) Combination of (5) and (a)	*10,331*	*552*

Economic Cost of Alternative 2-1

Unit: million baht

Flood Control Measures	Project Cost	Annual OM Cost
(1) Distribution System Improvement	231	2
(2) Drainage System Improvement	5,402	37
(3) Heightening of Flood Barrier	1,493	12
(4) River Improvement (I)	1,227	31
(5) Alt 2-1 : (1) -(4) combined.	8,363	82
(a) Dam Operation	*30*	*394*
(b) Combination of (5) and (a)	*8,393*	*476*

Note: (1) Representative OM cost of each project is listed and the sum of combination does not coincide with the addition., (2) Modification of Dam Operation Rule (non-structural measure), 139,000 mcm, Bumibol, Sirikit,Pasak, Kwae Noi and Kaeng Sua Ten Dam

(3) Economic Cost of Alternative 2-2

Financial Cost of Alternative 2--2

Unit: million baht

Flood Control Measures	Project Cost	Annual OM Cost
(1) Distribution System Improvement	285	2
(2) Drainage System Improvement	6,735	42
(3) Diversion Channel	42,329	186
(4) River Improvement (I)	1,425	34
(5) River Improvement (II)	1,834	44
(5) Alt 2-2 : (1) -(5) combined.	52,608	308
(a) Dam Operation	*46*	*451*
(b) Combination of (5) and (a)	*52,700*	*759*

Economic Cost of Alternative 2--2

Unit: million baht

Flood Control Measures	Project Cost	Annual OM Cost
(1) Distribution System Improvement	231	2
(2) Drainage System Improvement	5,402	37
(3) Diversion Channel	31,402	167
(4) River Improvement (I)	1,234	31
(5) River Improvement (II)	1,587	40
(5) Alt 2-2 : (1) -(5) combined.	39,117	280
(a) Dam Operation	*40*	*394*
(b) Combination of (5) and (a)	*39,157*	*671*

Note: (1) Representative OM cost of each project is listed and the sum of combination does not coincide with the addition., (2) Modification of Dam Operation Rule (non-structural measure), 139,000 mcm, Bumibol, Sirikit,Pasak, Kwae Noi and Kaeng Sua Ten Dam.

4.2 Economic Benefit

(1) Concept of Flood Control Benefit

The economic direct benefit of the flood control project would be mainly introduced quantitatively by structural measures. The direct benefit introduced from the non-structural measures will generally belong to the category of the indirect-intangible effect, because the benefits estimated are in lower accuracy than the benefits from the structural measures. In the present study, however, the benefit of Modification of Dam Operation Rule, the non-structural measure,

would be estimated in the certain accuracy. (refer to Sector VIII Integrated Dam Operation Plan).

The direct-tangible benefit could be presented as a reduction effect in flood damage to assets and economic activity in/around the flood prone area, that is, a difference between two flood damage of the "with-project" and the "without-project" situation.

The assets in flood prone area would be mainly be composed of building, household effects, livestock, agricultural field crops, and public facilities. The public facilities would contain transport and agricultural facilities, electric and water supply system, etc. The economic activities would be represented road traffic, business activities of inhabitants and enterprises in/around the flood area. The details of the methodology of the flood damage estimation and the calculation of average annual flood damage are described in Sector V Flood Damage.

(2) Average Annual Economic Benefit

The average annual damage reduction is equivalent to an expected average annual benefit. This benefit is expected to accrue every year during the project life of 50 years after the completion of the construction work. The average annual economic benefit for each project is obtained from the figures given in Sector V Flood Damage. That is, the given benefit of the fixed year is converted back to that of after-the completion year of each implementation. The result is summarized hereunder;

(a) Average Annual Economic Benefit of Alternative-1

Economic Benefit of Alternative-1

Unit: million baht

Flood Control Measures	Average Annual Economic Benefit
(1) Distribution System Improvement	93
(2) Drainage System Improvement	1,212
(3) River Improvement (I)	240
(4) Alt-1: (1) -(3) combined.	2,193
(a) Dam Operation	*1,038*
(b) Combination of (4) and (a)	*3,268*

Note: (1) The sum of benefit for combination does not coincide with the addition. due to respective benefit estimated according to hydrological analysis., (2) Modification of Dam Operation Rule (non-structural measure), 139,000 mcm, Bumibol, Sirikit,Pasak, Kwae Noi and Kaeng Sua Ten Dam

(b) Average Annual Economic Benefit of Alternative 2-1

Economic Benefit of Alternative 2-1

Unit: million baht

Flood Control Measures	Average Annual Economic Benefit
(1) Distribution System Improvement	93
(2) Drainage System Improvement	1,212
(3) Heightening of Flood barrier	2,258
(4) River Improvement (I)	240
(5) Alt-1: (1) -(4) combined.	3,764
(a) Dam Operation	*1,038*
(b) Combination of (5) and (a)	*4,838*

Note: (1) The sum of benefit for combination does not coincide with the addition. due to respective benefit estimated according to hydrological analysis., (2) Modification of Dam Operation Rule (non-structural measure), 139,000 mcm, Bumibol, Sirikit,Pasak, Kwae Noi and Kaeng Sua Ten Dam

(c) Average Annual Economic Benefit of Alternative 2-2

Economic Benefit of Alternative 2-2

Unit: million baht

Flood Control Measures	Average Annual Economic Benefit
(1) Distribution System Improvement	93
(2) Drainage System Improvement	1,212
(3) Diversion Channel	5,549
(4) River Improvement (II)	-15,968
(5) Alt-1: (1) -(4) combined.	6,078
(a) Dam Operation	*1,038*
(b) Combination of (5) and (a)	*6,300*

Note: (1) The sum of benefit for combination does not coincide with the addition. due to respective benefit estimated according to hydrological analysis., (2) Modification of Dam Operation Rule (non-structural measure), 139,000 mcm, Bumibol, Sirikit,Pasak, Kwae Noi and Kaeng Sua Ten Dam. (3) Adverse effect to Bangkok area of River Improvement (II) would be settled down by Diversion Channel.

4.3 Economic Evaluation

The economic evaluation of projects was conducted using the annual average economic benefit and cost. The results of the evaluation are summarized hereunder (from Table 4.3.1 to Table 4.3.13):

(1) Economic Evaluation of Alternative-1

Economic Evaluation of Alternative-1

Unit : million baht

Item	(1) Distribution System Improvement	(2) Drainage System Improvement	(3) River Improvement(I)	(4) Alt.-1 : (1)-(3) Combined	*(a) Dam Operation*	*(b) Combination of (4) and(a)*
Average Annual Economic Benefit	93	1,212	240	2,193	*1,038*	*3,268*
Economic Cost	231	5,402	1,234	6,853	*40*	*6,900*
Economic Annual OM Cost	2	37	31	70	*394*	*464*
EIRR (%)	27.1	14.9	13.5	21.1	-	*28.8*
B/C (Ratio)	2.7	1.3	1.1	2.0	*4.0*	*2.4*
NPV	220	784	96	3,291	*2,471*	*5,875*

Note: (1) B/C and NPV at discount rate of 12 %. (2) Dam is evaluated by B/C and NPV.

As a result, the EIRR of Alternative-1 indicates positive index of 21.1 % , which is enough over the assumed discount rate of 12 %.

In addition, all the positive figures of B/C and NPV at discount rate of 12 % support the feasibility of the Alternative-1.

Meanwhile, when Alternative-1 and Modification of Dam Operation Rule are carried out together, B/C would be 2.4 and NPV be 5,875 million baht.

Furthermore, the project involves many intangible benefits such as stabilization of people's living condition both physically and mentally, improvement of public health like decrease of waterborne diseases, multiplier effects of project cost investment including technology transfer, increase of work opportunity, expansion of land use, improvement of distribution and communication, and so on.

In conclusion, it is expected that the flood control project of Alt-1 of structural measures of Distribution System Improvement, Drainage System Improvement and River Improvement would make the high contributions not only to the flood mitigation, but also to the promotion of social and economic development in the region. Meanwhile, the combination of Alt.-1 and non-structural measure of Modification of Dam Operation Rule would also bring about same kind of high contributions.

(2) Economic Evaluation of Alternative 2-1

Economic Evaluation of Alternative 2-1

Unit : million baht

Item	(1) Distribution System Improvement	(2) Drainage System Improvement	(3) Heightening of Flood Barrier	(4) River Improvement(I)	(5) Alt. 2-1 : (1)-(4) Combined	(a) Dam Operation	(b) Combination of (5) and (a)
Average Annual Economic Benefit	93	1,212	2,258	240	3,764	1,038	4,838
Economic Cost	231	5,402	1,493	1,234	8,346	40	8,393
Economic Annual OM Cost	2	37	12	31	82	394	476
EIRR (%)	27.1	14.9	63.8	13.5	24.0	-	30.6
B/C (Ratio)	2.7	1.3	10.1	1.1	2.6	4.0	2.9
NPV	220	792	5,450	92	6,173	2,471	9,014

Note: (1) B/C and NPV at discount rate of 12 %. (2) Dam is evaluated by B/C and NPV.

As a result, the EIRR of Alternative 2-1 indicates positive index of 24.0 % , which is enough over the assumed discount rate of 12 %.

In addition, all the positive figures of B/C and NPV at discount rate of 12 % support the feasibility of the Alternative 2-1.

Meanwhile, when Alternative 2-1 and Modification of Dam Operation Rule are carried out together, B/C would be 2.9 and NPV be 9,014 million baht.

Furthermore, the project involves many intangible benefits such as stabilization of people's living condition both physically and mentally, improvement of public health like decrease of waterborne diseases, multiplier effects of project cost investment including technology transfer, increase of work opportunity, expansion of land use, improvement of distribution and communication, and so on.

In conclusion, it is expected that the flood control project of Alt.2-1 of structural measures of Distribution System Improvement, Drainage System Improvement, Heightening of Flood Barrier and River Improvement would make the high contributions not only to the flood mitigation, but also to the promotion of social and economic development in the region. Meanwhile, the combination of Alt.-1 and non-structural measure of Modification of Dam Operation Rule would also bring about same kind of high contributions.

(3) Economic Evaluation of Alternative 2-2

Economic Evaluation of Alternative 2-2

Unit : million baht

Item	(1) Distribution System Improvement	(2) Drainage System Improvement	(3) Diversion Channel	(4) River Improvement(I)	(5) River Improvement(II)	(6) Alt.2-2 : (1)-(5) Combined	*(a) Dam Operation*	*(b) Combination of (6) and (a)*
Average Annual Economic Benefit	93	1,212	5,549	240	-15,963	6,078	*1,038*	*6,300*
Economic Cost	231	5,402	31,402	1,234	1,587	38,856	*40*	*39,896*
Economic Annual OM Cost	2	37	167	31	40	227	*394*	*671*
EIRR (%)	27.1	14.9	12.7	13.5	n.a.	12.0	-	*13.8*
B/C (Ratio)	2.7	1.3	1.1	1.1	-61.9	1.0	*4.0*	*1.1*
NPV	220	792	516	92	-12,472	6	*2,471*	*1,427*

Note: (1) B/C and NPV at discount rate of 12 %. (2) Dam is evaluated by B/C and NPV. (3) Adverse effect to Bangkok area of River Improvement (II) would be settled down by Diversion Channel.

As a result, the EIRR of Alternative 2-2 indicates positive index of 12.0 % , which is around of the assumed discount rate of 12 %.

In addition, all the figures of B/C and NPV at discount rate of 12 % support the feasibility of the Alternative 2-2.

Meanwhile, when Alternative 2-2 and Modification of Dam Operation Rule are carried out together, B/C would be 1.1 and NPV be 1,427 million baht.

Furthermore, the project involves many intangible benefits such as stabilization of people's living condition both physically and mentally, improvement of public health like decrease of waterborne diseases, multiplier effects of project cost investment including technology transfer, increase of work opportunity, expansion of land use, improvement of distribution and communication, and so on.

In conclusion, it is expected that the flood control project of Alt.2-2 of structural measures of Distribution System Improvement, Drainage System Improvement would make the high contributions not only to the flood mitigation, but also to the promotion of social and economic development in the region. Meanwhile, the combination of Alt.-1 and non-structural measure of Modification of Dam Operation Rule would also bring about same kind of high contributions.

4.4 Financial Consideration

(1) Affordability

The proposed projects would be carried out by the budget categories of the large scale projects which be out under the approval of Cabinet Council.

RID as described in the above section of 3, they have had the experiences of having carried out the project scale of 10 to more than 50 billion baht on present prices basis including the Bumibol Dam Project (assumed to be 58 billion baht at present prices) and the Sirikit Dam Project (assumed to be 44 billion baht at present prices). In additin, as shown in Table 3.2.2 , their on-going large scale projects as of in 1998 would amount to 46 billion baht. Meantime, total cost of largest proposed plan would amount to be 53 billion baht , which would be implemented over the period of 20 years. Henceforth, collectively speaking, the financial affordability for the proposed projects might be said to fall in the manageable range.

(2) Cash Flow of the Project Cost and Affordability

Table 4.4.1 shows the overall cash flow of the largest projects of Alt-2-2, which would need the construction amount of 52,606 million baht in total. The peak year of annual cost expenditure would come at 2012 year amounting to be 8,286 million baht . This amount might be equivalent to 20.0 % of the budget allocation of Large Scale Project of RID on 1998 basis, taking growth rate of the nominal gross domestic products into account, and 5 % of total RID budget being derived in the same manner.

Therefore, the cash flow of these figures might be said within the financial affordability of the projects. (Table 3.2.1)

In addition, if PWD and/or BMA join with their own budget to share each of their appropriate portion of the construction cost according to 'the principle of beneficiary to pay', the burden of RID budget would be lessened accordingly.

(3) Overseas Loan Repayment

In the meantime, a further support for the financial viability of the big projects like Alternative 2-2 is examined for a reference as under;

The financial construction cost of structural measure for Alternative 2-2 was estimated at 52,602 million baht in total. This amount is scheduled to be disbursed over the construction period of 20 years (1998-2018) .

Considering that the projects will require such a substantial amount of fund for the period, the project cost would be supposed to be financed with the loan through the international agency. Then, the following scenario of conditions would be discussed ;

The scenario : under the loan terms of 1) interest rate of 0.75 % per annum, 2) a repayment of 40 years including a grace period of 10 years, and 3) paying only the interest of debt every year for the grace period, and the capital amount with interest in years after the grace period. And the loan amount is to be 60 % of financial cost of the structural measure. The loan would be actually executed according to the yearly construction cost. Meantime, as the purpose of this scenario is to find out the affordability of overseas repayment, then in this study, it is assumed that the overseas loan would be introduced to the big amount portion of construction cost, i.e. the total cost (amounting to 49,214 million baht) of 14 years from 2003 to 2016, during which the main part of Diversion Channel would be constructed. (Table 4.4.1).

Table 4.4.2 for this scenario gives the example of annual requirement of repayment schedule for the 60 % loan of the cost. The total refund with interest will amount to 33,958 million baht for the said loan portion of Alternative 2-2, and the maximum of annual repayment will amount to 1,198 million bath at 11th year (2013).

As for the loan repayment for overseas borrowing, such a repayment schedule might be manageable, judging from the following figures (Table 4.4.3);

The peak annual repayment shall amount at 1,198 million baht at 2013 for the Diversion Channel Project, this amount will account for 13.9 % of the overseas loan repayment for public sector and 2.7 % of total overseas repayment. Meanwhile, the dead coverage ratio for this project (percentage of peak loan repayment against total government expenditure) will account for 0.04 % at the same year of 2013.

In conclusion, taking the importance and necessity of the Large Projects of Alt.2-2 into consideration, such magnitude of the expected overseas loan repayment would be reasonable and possible, and fall in manageable range of the Government finance.

5. ECONOMIC EVALUATION OF PRIORITY PROJECT

5.1 General

As a result of the Master Plan Study and taking the social and economic situation under the recovery from the economic crisis into consideration, it has been recognized that the structural measure of the River Improvement and the non-structural measure of Modification of Dam Operation Rule (hereinafter called "the priority projects") are recognized as the priority projects for the Feasibility Study. Since the Feasibility Study is the more detailed study than Master Plan Study, the economic evaluation of the priority projects is carried out again hereunder.

The conditions of economic evaluation are described already in this chapter. The same way of thought, assumption and measures would be applied here.

And, the objective to conduct the economic evaluation is to examine the recognized priority projects in terms of economy.

In addition to this economic evaluation, the EIRR sensitivity analysis would be carried out.

Further, the financial aspect of the projects is also considered.

5.2 Economic Cost

The financial cost calculation was carried out more precisely and concretely in this stage for the selected priority projects of the structural measures of the River Improvement in Sector XII , and of the non-structural measure of Modification of Reservoir Dam Operation Rule in Sector VIII. Based on the result of the conversion from the financial costs, the economic cost and annual OM cost are estimated . The OM cost will accrue every year during the period of the project life after the completion of the construction life.

The result is shown as below (Table 5.1.1):

Financial Cost of the Priority Project

Unit: million baht

Flood Control Measures	Financial Project Cost	Annual OM Cost
(1) River Improvement	1,425	34
(a) Bhumibol	*11*	*23*
(b) Sirikit	*11*	*44*
(c) Pasak	*11*	*18*
(d) Dam combined	*33*	*85*
(e) Combination of (1) and (d)	*1,458*	*119*

Economic Cost of the Priority Project

Unit: million baht

Flood Control Measures	Economic Project Cost	Annual OM Cost
(1) River Improvement	1,234	31
(a) Bhumibol	*10*	*20*
(b) Sirikit	*10*	*38*
(c) Pasak	*10*	*16*
(d) Dam combined	*30*	*74*
(e) Combination of (1) and (d)	*1,264*	*105*

Note: (1) Modification of Dam Operation Rule (non-structural measure), 87,000 mcm, Bumibol, Sirikit,Pasak Dam.

5.3 Average Annual Economic Benefit

The expected annual average damage reduction is described for the structural measure of the River Training in Sector V Flood Damage, and for the non-structural measure of Modification of Reservoir Dam Operation Rule in Sector VIII Integrated Dam Operation Plan. Meanwhile, the annual average damage reduction is equivalent to an expected average annual benefit. This benefit is expected to accrue every year during the project life of 50 years after the completion of the construction work. The average annual economic benefit for the priority project is obtained from the figures given in Sector V Flood Damage. That is , the given benefit of the fixed year is converted back to that of after-the completion year of each implementation. The result is summarized hereunder :

Average Annual Economic Benefit of the Priority Project

Unit: million baht

Flood Control Measures	Average Annual Economic Benefit
(1) River Improvement	221
(a) Bhumibol	*59*
(b) Sirikit	*482*
(c) Pasak	*544*
(d) Dam combined	*1,035*
(e) Combination of (1) and (d)	*1,438*

Note: (1) The sum of benefit for combination does not coincide with the addition. due to respective benefit estimated according to hydrological analysis. (2) Modification of Dam Operation Rule (non-structural measure), 87, 000 mcm, Bumibol, Sirikit,Pasak:

5.4 Economic Evaluation

The economic evaluation of projects was conducted using the average annual economic benefit and cost mentioned above. The results of the evaluation are summarized as follows (from Table 5.4.1 to Table 5.4.6);

Economic Evaluation of the Priority Projects

Unit : million baht

Item	(1) River Improvement)	*(a) Bhumibol*	*(b) Sirikit*	*(c) Pasak*	*(d) Dam combined*	*(e) Combination of (1) and (d)*
Average Annual Economic Benefit	221	*59*	*386*	*527*	*1,038*	*1,441*
Economic Cost	1,234	*10*	*10*	*10*	*30*	*1,264*
Economic Annual OM Cost	31	*20*	*38*	*16*	*74*	*105*
EIRR (%)	12.5	-	-	-	-	-
B/C (Ratio)	1.0	*2.8*	*10.1*	*31.4*	*13.3*	*6.4*
NPV	28	*224*	*2,281*	*3,117*	*5,693*	*6,333*

Note: (1) B/C and NPV at discount rate of 12 % . (2) Dam is evaluated by B/C and NPV.

As a result, the EIRR of River Improvement indicates an index of 12.5 %, which is over the assumed discount rate of 12 %.

In addition, all the figures of B/C and NPV at discount rate of 12 % support the feasibility of the River Improvement.

Meanwhile, when River Improvement and Modification of Dam Operation Rule are carried out together, B/C would be 6.4 and NPV be 6,333 million baht, which support positively the feasibility of the projects.

5.5 Sensitivity Analysis of the Priority Projects

Sensitivity analysis for the Priority Project of River Improvement is to be conducted to assess whether the projects can maintain their viability, when supposed to be placed under the more unfavorable circumstances during and after implementation. A test is therefore carried out about the sensitivity of EIRR affected by variations in the economic costs and benefits.

EIRR sensitivity test has been examined under the conditions of the increase in 5 % and 10 % of economic costs and the decrease in 5 % and 10 % in the economic benefits.

Conditions, such as project life, construction period and so on, are assumed to be same as in the economic evaluation of the priority projects. The results are summarized as below ;

EIRR Sensitivity Analysis of River Improvement Project

Decrease in Benefit	Increase in Cost		
	0 %	5 %	10 %
0 %	12.5	11.9	11.3
5 %	11.9	11.3	10.8
10 %	11.2	10.7	10.2

Note: Unit of EIRR : %

As shown above, EIRR for the priority projects maintains the figures from near 10 % to over 12 % which mostly indicates the economic feasibility in comparison with the assumed opportunity cost of capital of 12 %, under the unfavorable case where the increase in cost and the decrease in benefit.

5.6 Financial Consideration

(1) Affordability

The River Improvement project would be carried out under the budget categories of the large scale projects which would be carried out under the approval of Cabinet Council.

The total financial construction cost for River Improvement would amount to 1,425 million baht, which would be 1/39 compared with the total project cost of 55,602 million baht of Alt. 2-2 in Master Plan. The affordability for the cost of master plan has discussed to be affirmative in section 4.4. Therefore, the much smaller amount of the cost for River Improvement might be said to be financially affordable in the same methodology of the consideration.

(2) Cash Flow of the Project Cost and Affordability

Table 5.6.1 shows the overall cash flow of River Improvement Project, which would need the cost amount of 1,425 million baht in total. The peak year of annual cost expenditure shall come at 2003 amounting to be 339 million baht.

This amount might be equivalent to 2.0 % of the budget allocation of Large Scale Project of RID on 1998 basis, taking growth rate of the nominal gross domestic products into account, and 0.5 % of total RID budget being derived in the same manner.

Therefore, the cash flow of these figures might be said within the financial affordability of the projects. (Table 3.2.1)

(3) Overseas Loan Repayment

The River Improvement Project as priority project would be linked to the package of the projects proposed by Master Plan in due course. Therefore, it would be preferable that the project cost is to be financed with the loan through the international agency by the same conditions and scenario as described in section 4.4.

Table 5.6.2 for this scenario gives the example of annual requirement of repayment schedule for the 60 % loan of the cost. The total refund with interest will amount to 983 million baht for the loan of River Improvement, and the maximum of annual repayment will amount to 35 million bath at 11th year (2009).

As for the loan repayment for overseas borrowing, such a repayment schedule might be manageable, judging from the following figures (Table 4.4.3);

The peak annual repayment shall amount at 35 million baht at 2009 for the River Improvement Project, this amount will account for 0.8 % of the overseas loan repayment for public sector and 0.2 % of total overseas repayment. Meanwhile, the dead coverage ratio for this project (percentage of peak loan repayment against total government expenditure) will account for 0.00 % at the same year of 2009.

In conclusion, taking the importance and necessity of the River Improvement into consideration, such magnitude of the expected overseas loan repayment would be reasonable and possible, and fall in manageable range of the Government finance.

5.7 Intangible Effects

Apart from the direct tangible effects of flood control , there will be indirect intangible effects during and after the project implementation. The direct tangible effects are examined quantitatively as discussed above, while the indirect intangible effects are examined qualitatively in the following (Table 5.7.1) .

Indirect effects of flood control measures of River improvement and Modification of Dam Operation Rule would extend mainly to the following items, contributing to the improvement of living conditions of the people.

(1) Multiplier Effects of Project Cost Investment

The project cost investment brings the multiplier effects to the project area and its vicinity. The employment opportunity is one aspect. During the construction period of the years, considerable amount of investment is executed in local portion of laborers and in engineering and administration which respond to the employment creation. Consequently, the consumption coming out from

those wages paid to the people concerned accelerates the commercial and economic activities in the surrounding area of the project sites.

(2) Technology Transfer

Technology transfer, during the construction and, operation and maintenance, may be categorized into the human resource development which is the formation and development of capabilities of personnel through knowledge and skills. The development of people is the most important aspect of social and economic development. On-the-job training during the construction period improves the abilities of the engineers and also creates the capable technicians. The technology transfer for the operation and maintenance brings not only improvement of engineers' abilities but also creates the men of talent for the administration and management system.

(3) Mental Damage to Sufferers

Floods cause not only damage to public infrastructure and properties but also to injury, disease and death of people. Once people have flood damage, mental anguish extends to the person himself, his relatives and neighbors. Even the people not suffered from flood have anxiety when water level of river raises due to heavy rain. Those mental damages cannot be compensated in terms of money, and have to be removed for the sound society.

(4) Public Health

Floods contain many things distributed in inundated areas, such as garbage, sewage, waste water and so on. This contaminated water may induce infectious diseases not only during inundation but also after a flood is drained.

Implementation of the Priority Projects is effective to mitigate those problems of public health.

(5) Distribution and Communication System

Submerged road and power failure by floods would suspend distribution and communication system in the inundated area. The damage influences those systems in other areas not suffered from floods. Although it is difficult to estimate the damage inclusive of influence to other areas quantitatively, the suspension of distribution and communication system induces stagnation of economic activities in the whole areas.

With implementation of the Priority Projects, the stagnation of economic activities would be mitigated.

(6) Land Use

Frequent floods would limit the land use in inundated areas. The potential of land use in inundated areas increase considerably by implementation of flood control measures because much less frequency of floods secures land from

enormous damage. Therefore, implementation of the Priority Projects would devote to the increase in value of currently inundated areas.

5.8 Conclusion

In conclusion, it is expected that the flood control project of River Improvement would make the high contributions not only to the flood mitigation, but also to the promotion of social and economic development in the region. Meanwhile, the combination of River Improvement and non-structural measure of Modification of Dam Operation Rule would also bring about same kind of high contributions.