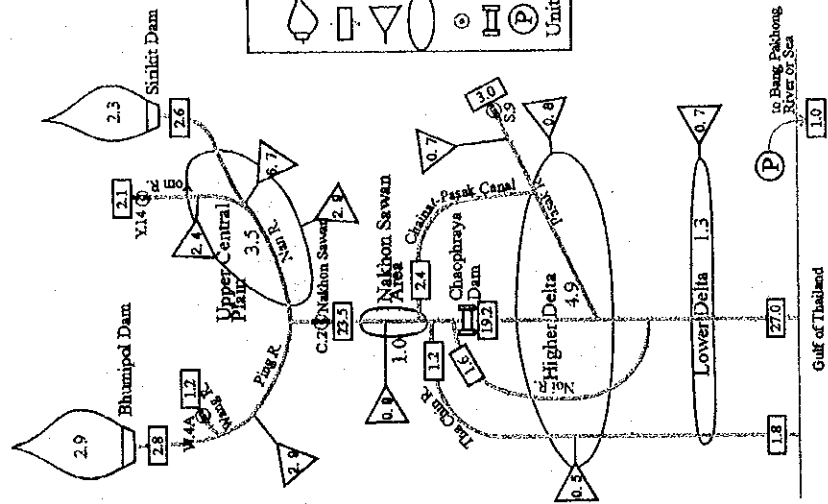
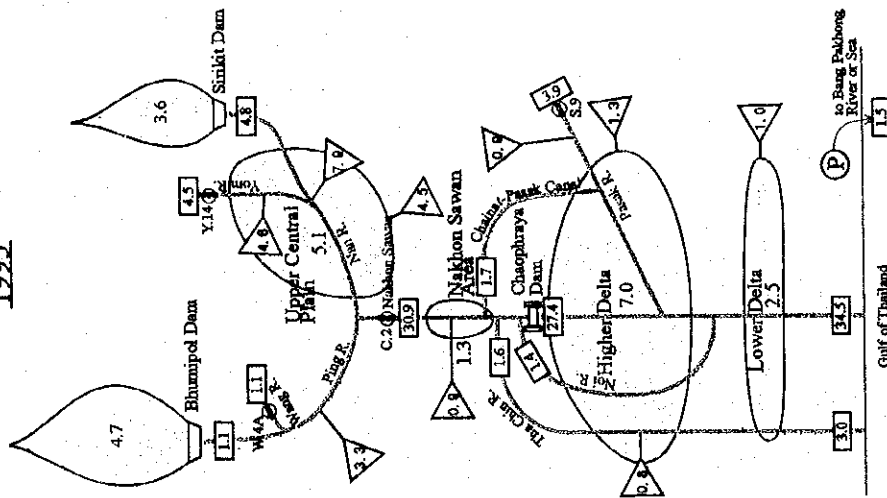


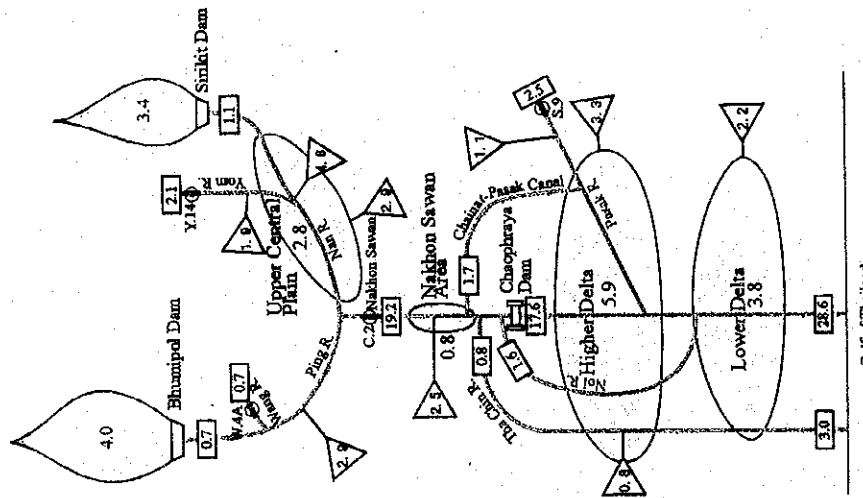
1996



1995



1983

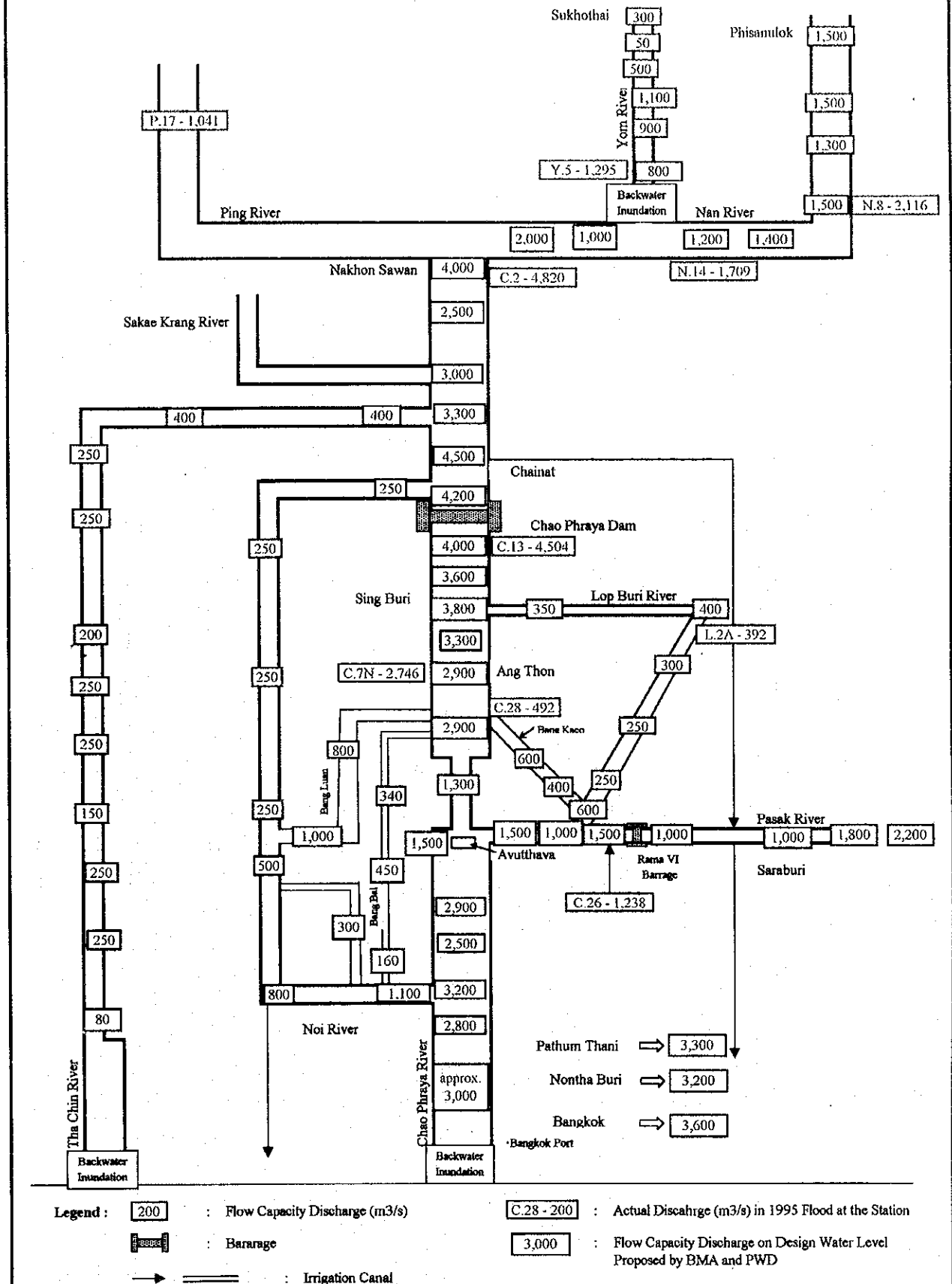


STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig 3.3.1 ESTIMATED WATER BALANCE FROM JULY TO DECEMBER

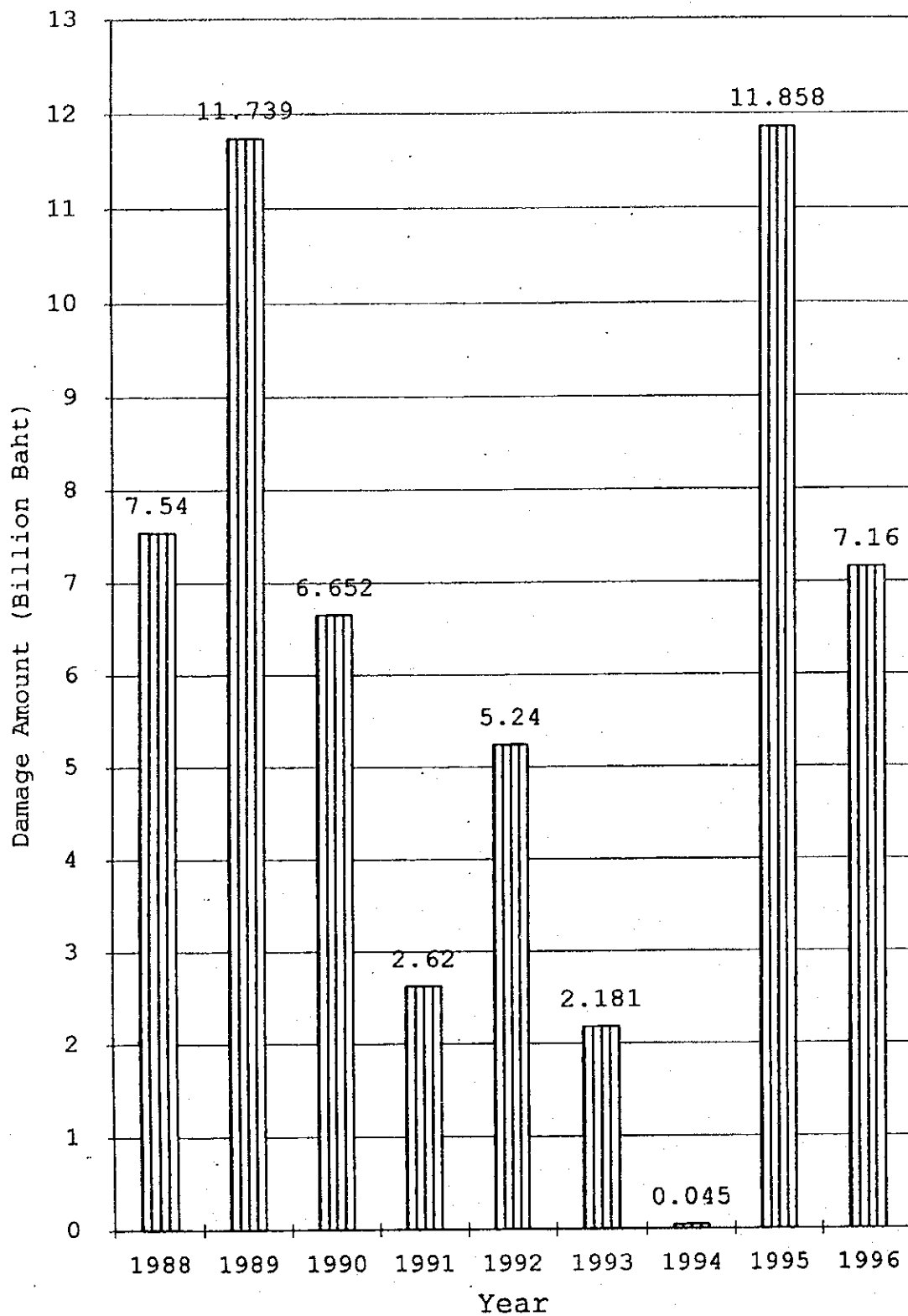
Flow Capacity of Present River Condition in Chao Phraya River Basin in High Tide



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

Fig.3.3.2 FLOW CAPACITY OF PRESENT RIVER CONDITION

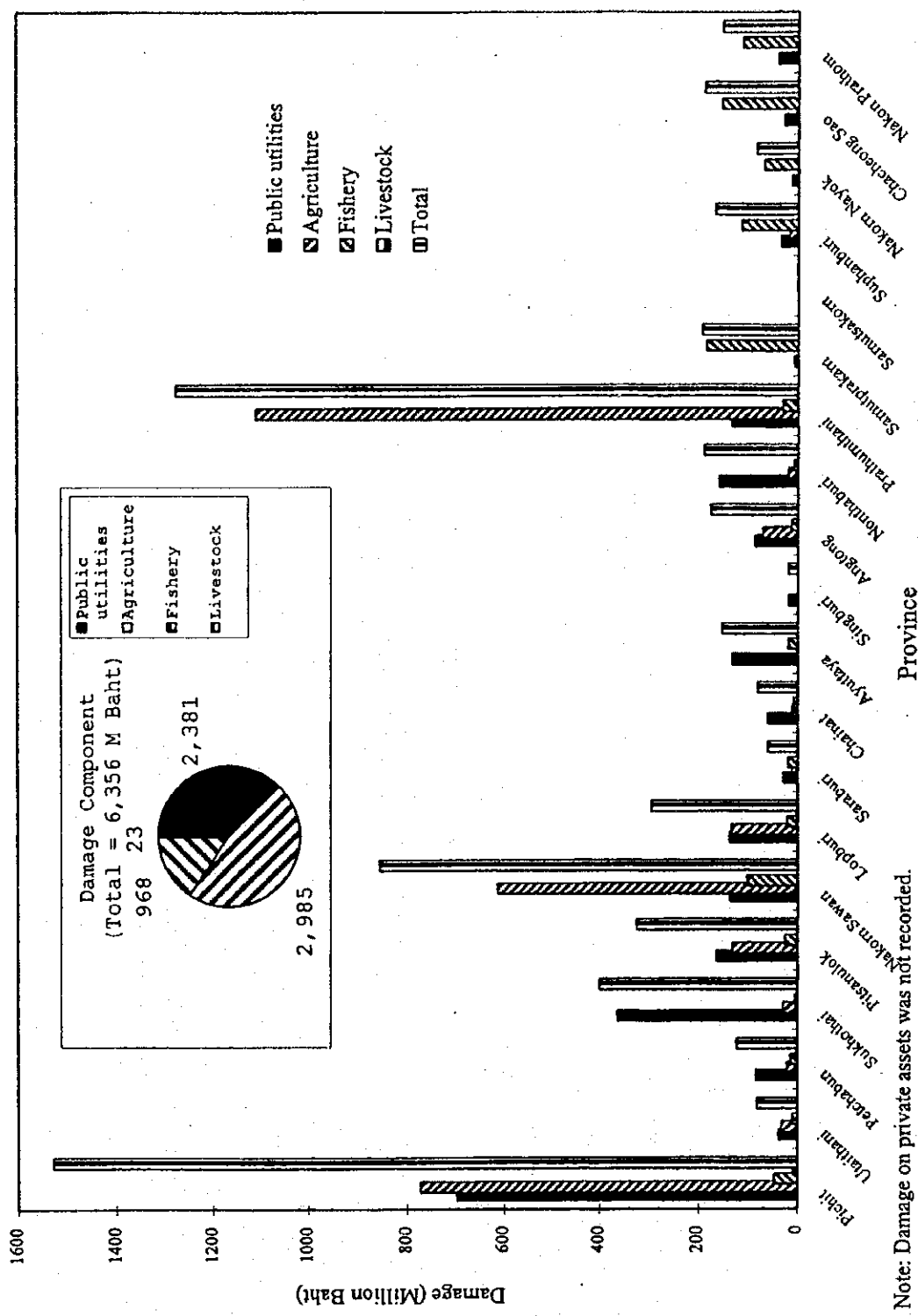
CTI ENGINEERING CO., LTD AND INA CORPORATION



(Source: Dept. of Local Administration ('88 - '96))

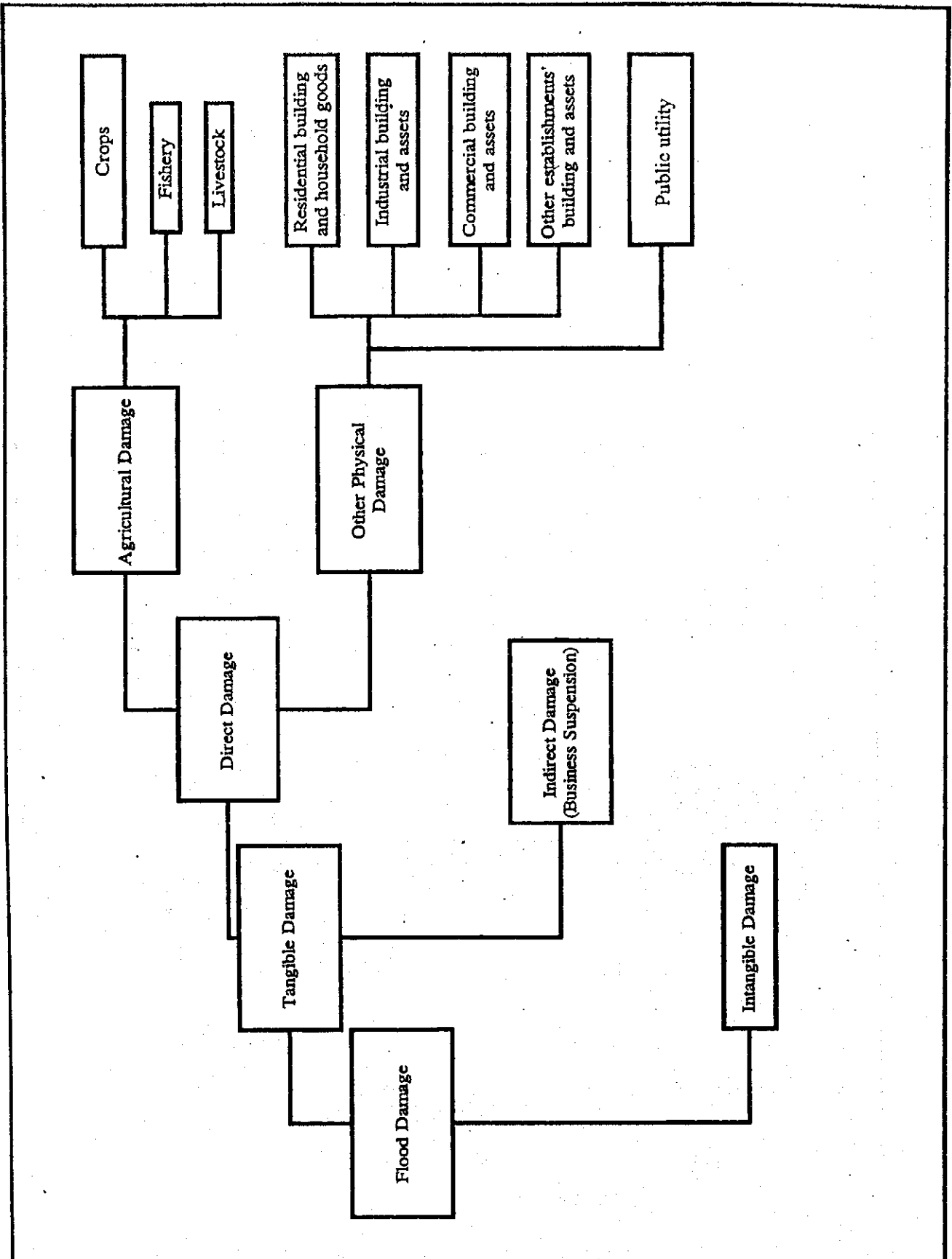
STUDY ON ON INTEGRATED PLAN FOR FLOOD
 MITIGATION IN CHAOPHRAYA RIVER BASIN
 CTI ENGINEERING CO., LTD & INA CORPORATION

Fig.3.4.1 RECORDED ANNUAL FLOOD
 DAMAGE ON INFRASTRUCTURE



Note: Damage on private assets was not recorded.
Source: Dept. of Local Administration

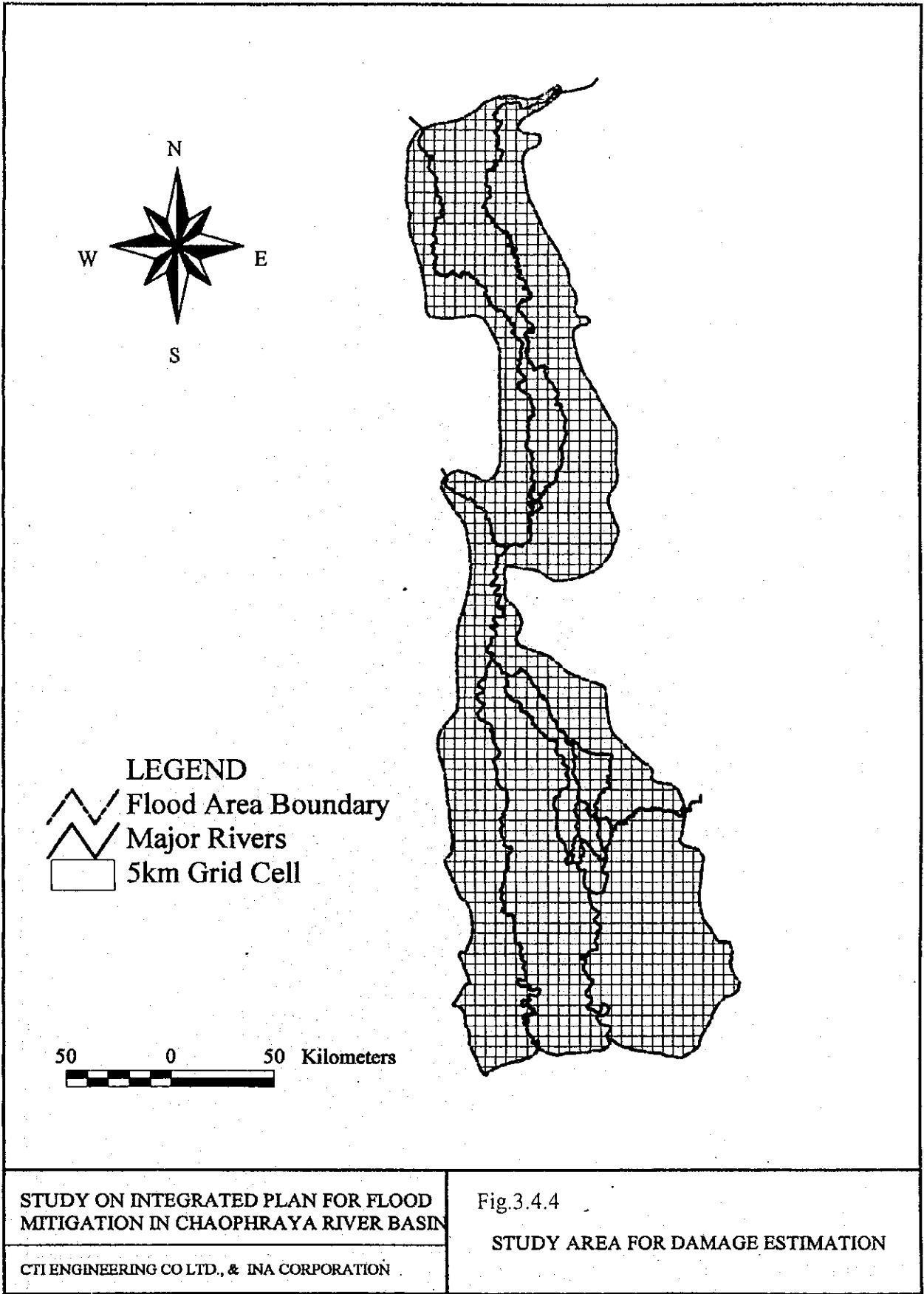
Fig.3.4.2 COMPONENTS OF FLOOD DAMAGE IN 1995 BY PROVINCE



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

CTI ENGINEERING CO., LTD. AND INA CORPORATION

Fig.3.4.3 COMPONENTS OF DAMAGE
ESTIMATION



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAOPHRAYA RIVER BASIN

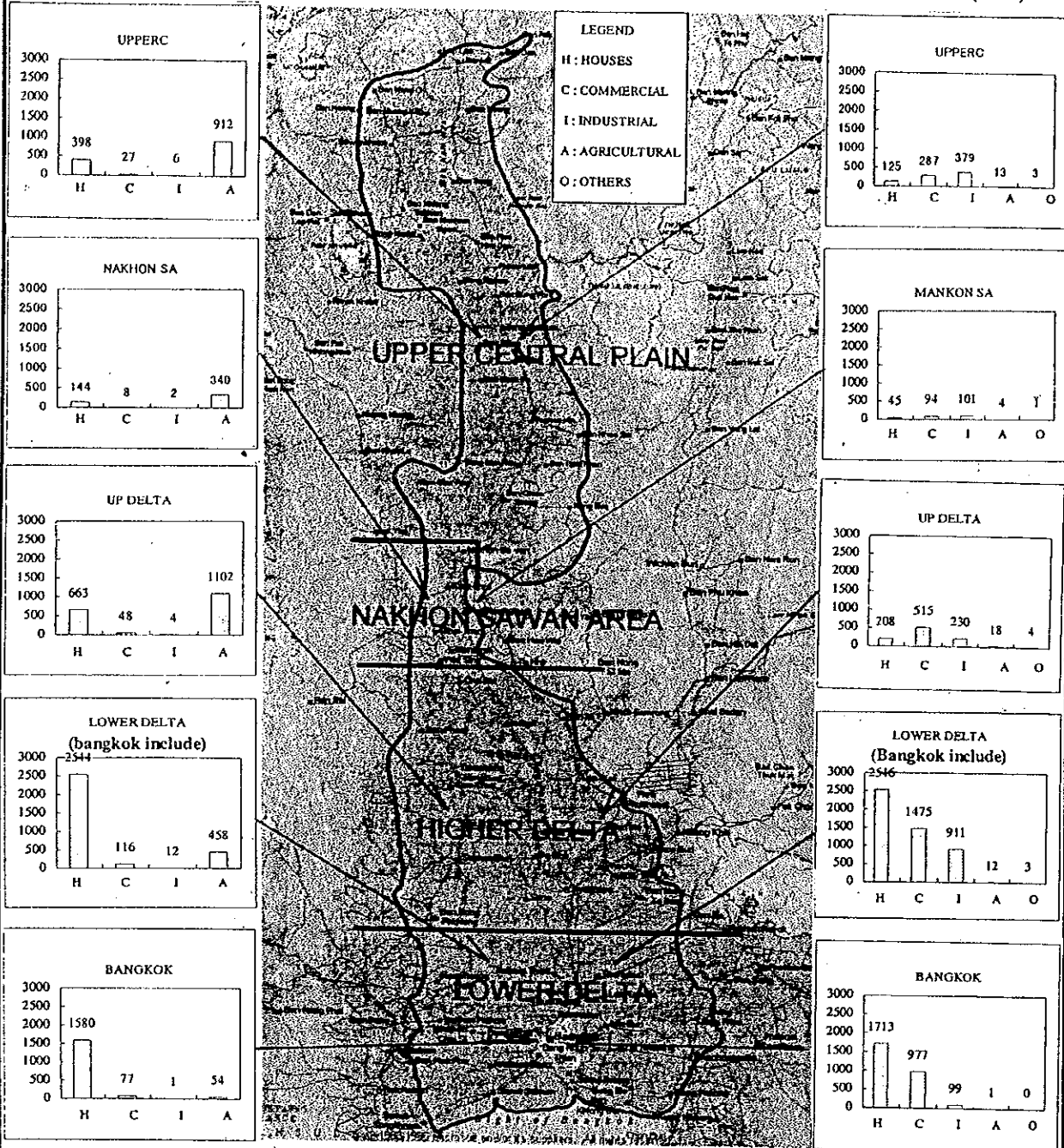
CTI ENGINEERING CO LTD., & INA CORPORATION

Fig.3.4.4

STUDY AREA FOR DAMAGE ESTIMATION

The Number of Houses and Agricultural Area (ha)

Assets Amount (bil Baht)

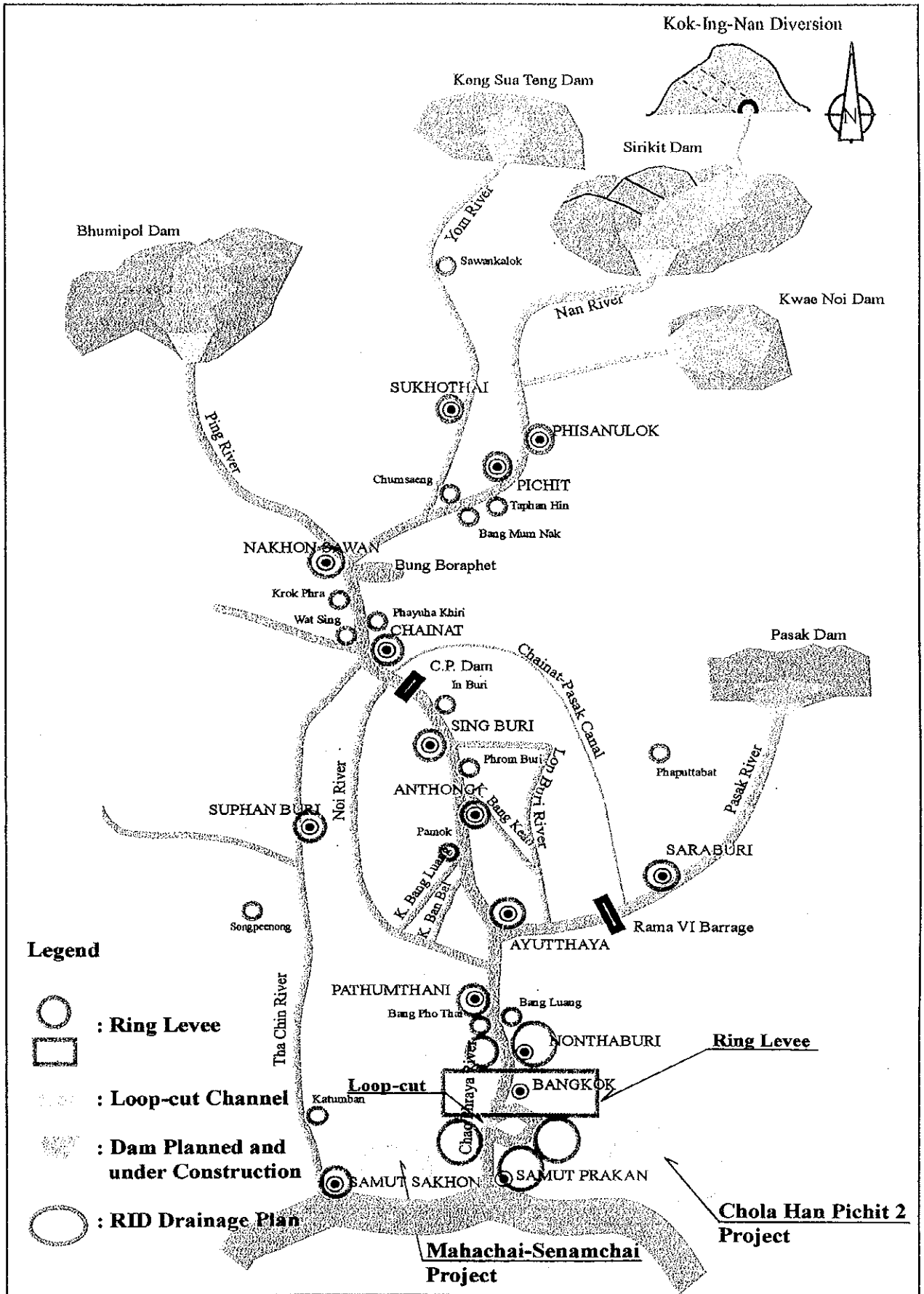


STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAOPHRAYA RIVER BASIN

Fig.3.4.5

WHOLE ASSET VALUE IN THE STUDY AREA

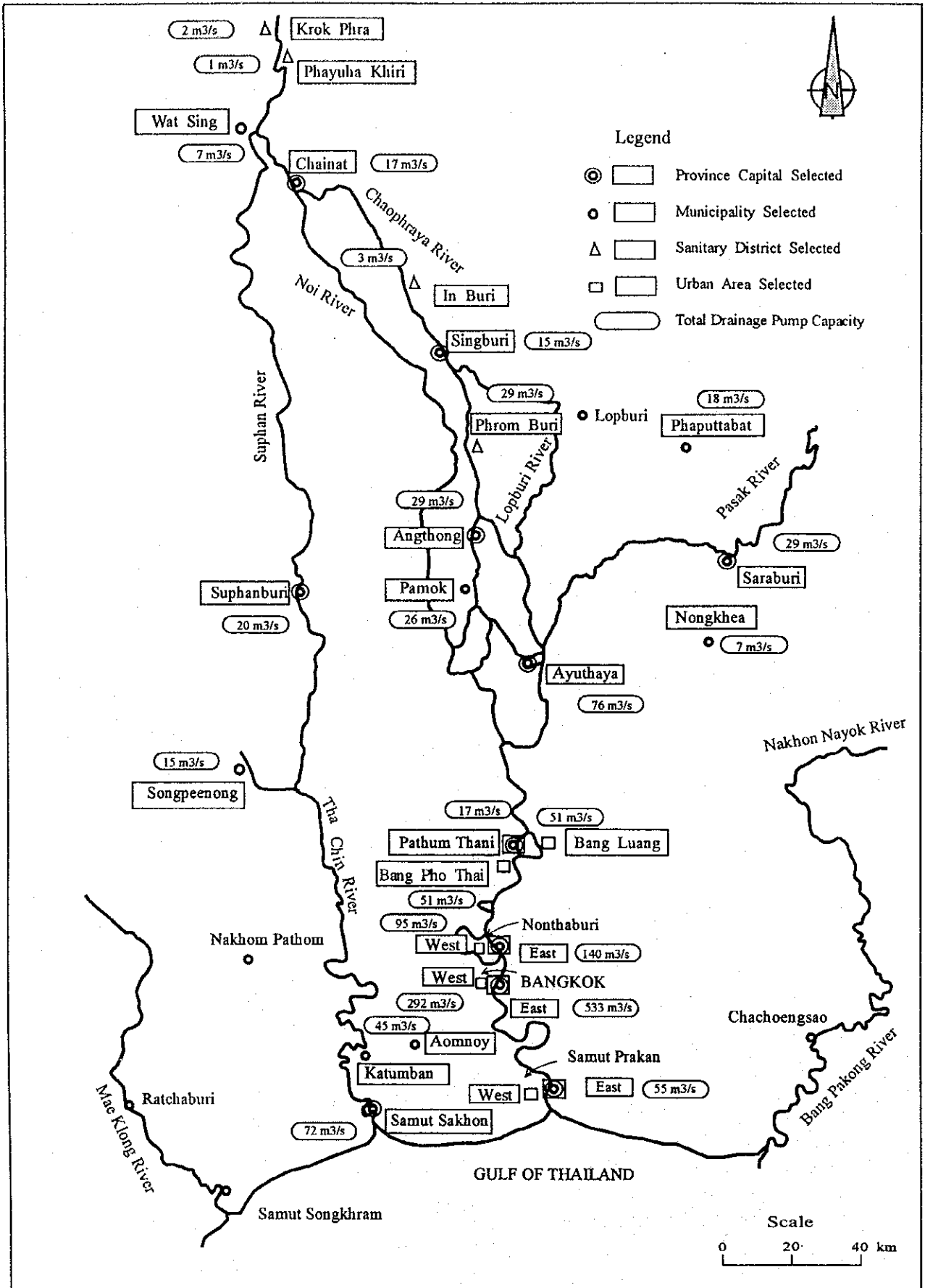
CTI ENGINEERING CO., LTD & INA CORPORATION



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

CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig. 4.2.1
 PROPOSED FLOOD MITIGATION AND PROTECTION WORKS BY AGENCIES CONCERNED

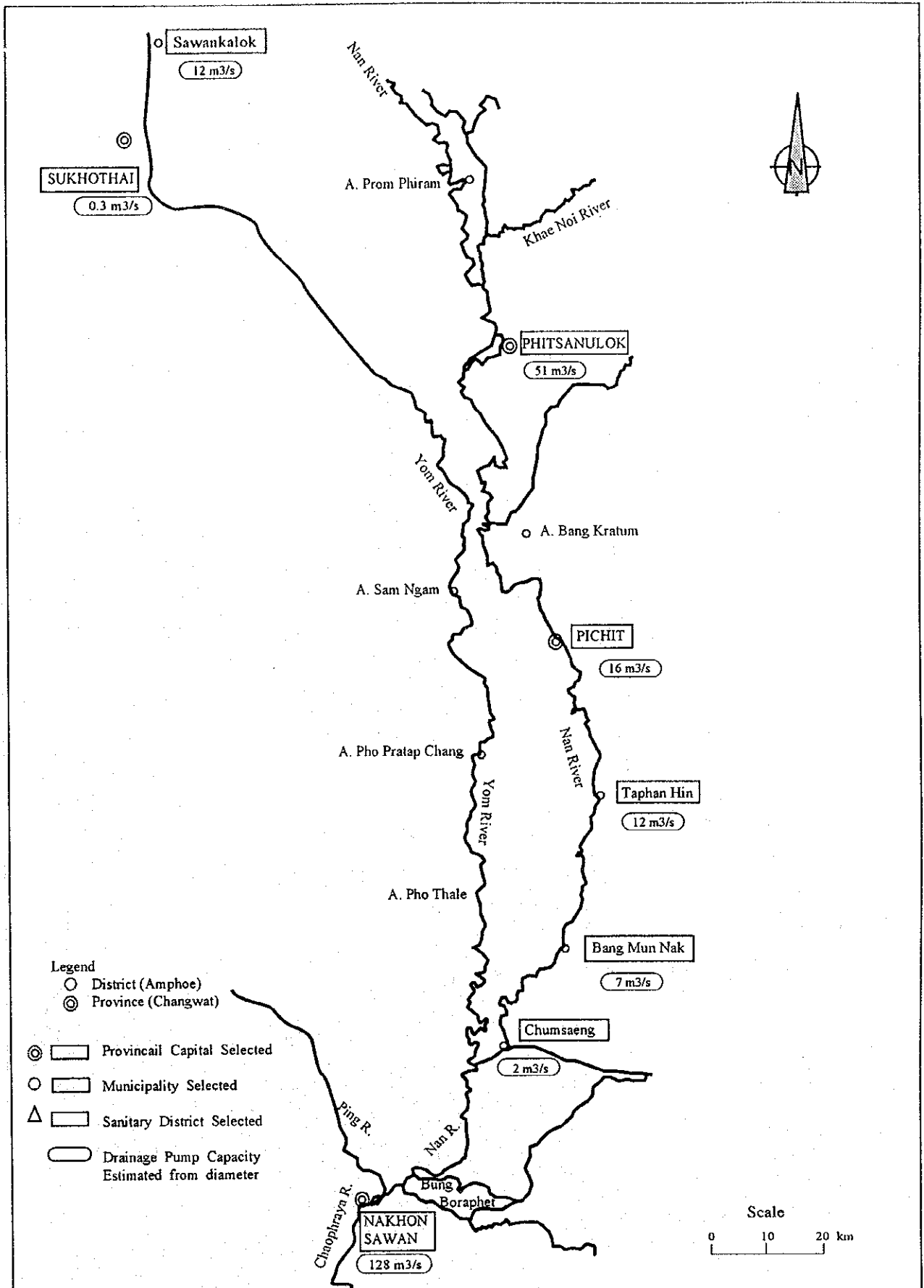


STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig. 4.2.2 (1/2)

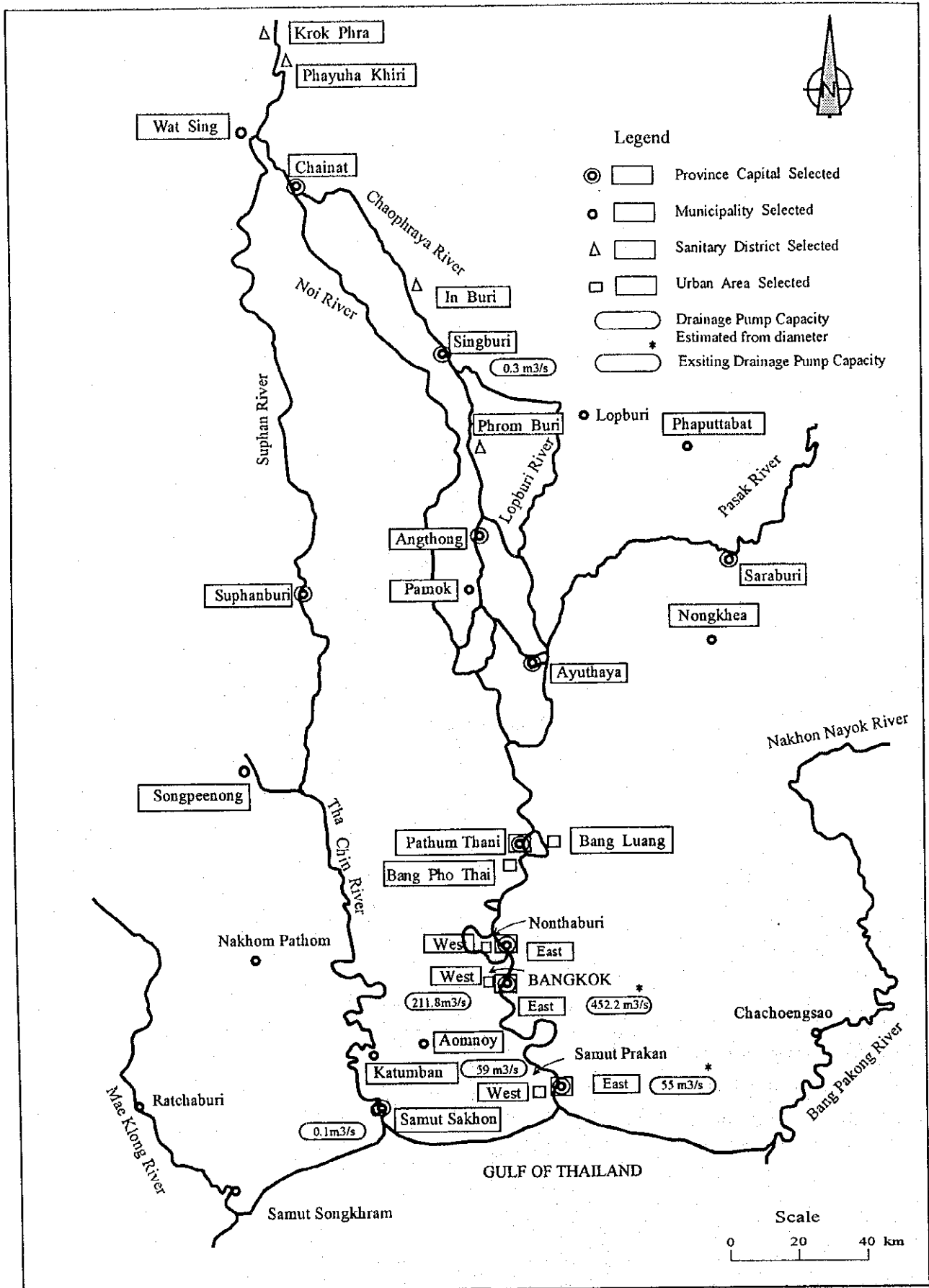
TOTAL DRAINAGE PUMP CAPACITY FROM URBAN AREAS IN TARGET COMPLETION YEAR



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

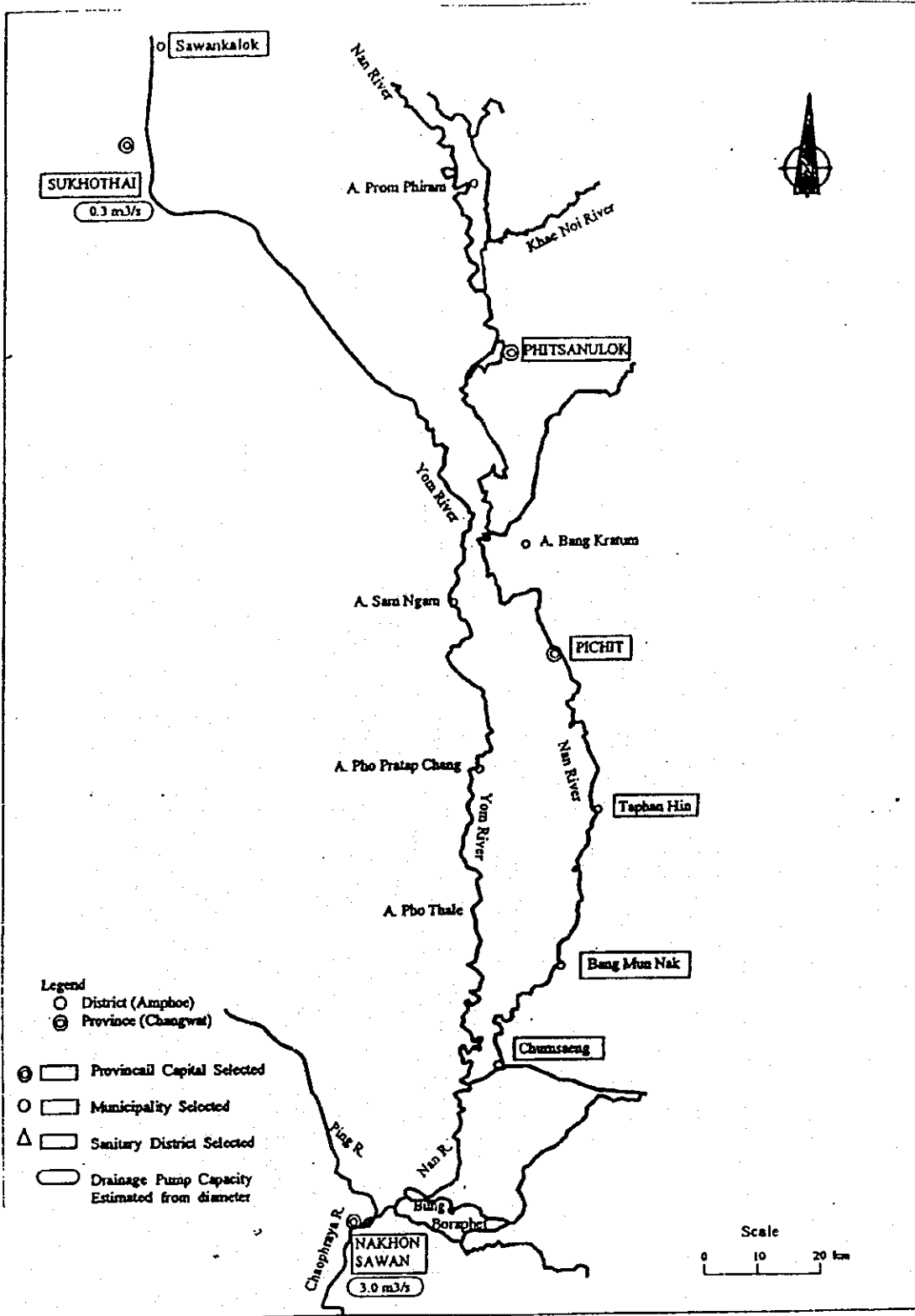
CTI ENGINEERING CO., LTD. AND INA CORPORATION

Fig. 4.2.2 (2/2)
TOTAL DRAINAGE PUMP CAPACITY FROM URBAN AREAS IN TARGET COMPLETION YEAR



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

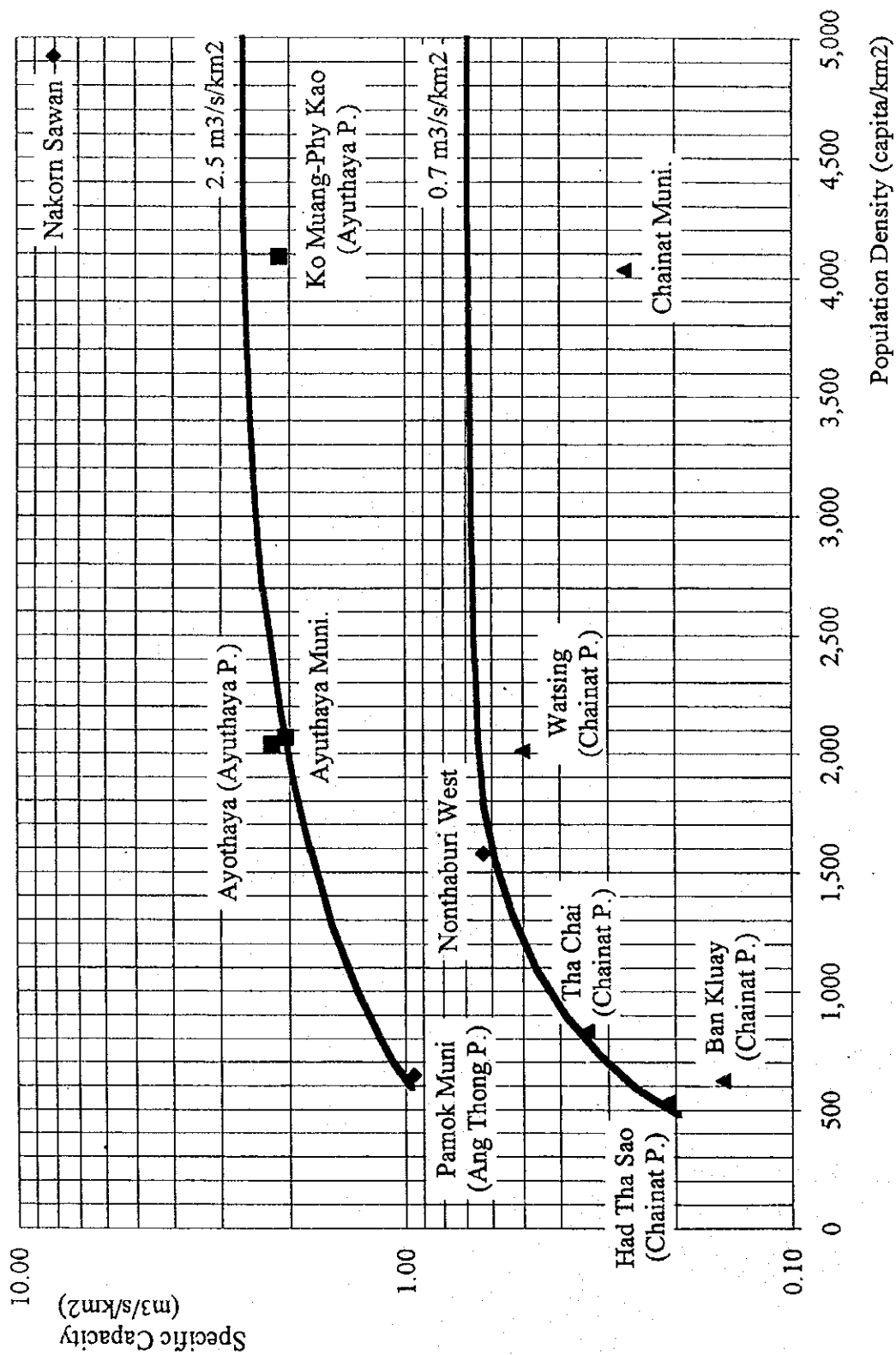
Fig. 4.2.3 (1/2)
 EXISTING DRAINAGE PUMP CAPACITY FROM URBAN AREAS



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

CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig. 4.2.3(2/2)
EXISTING DRAINAGE PUMP CAPACITY FROM URBAN AREAS

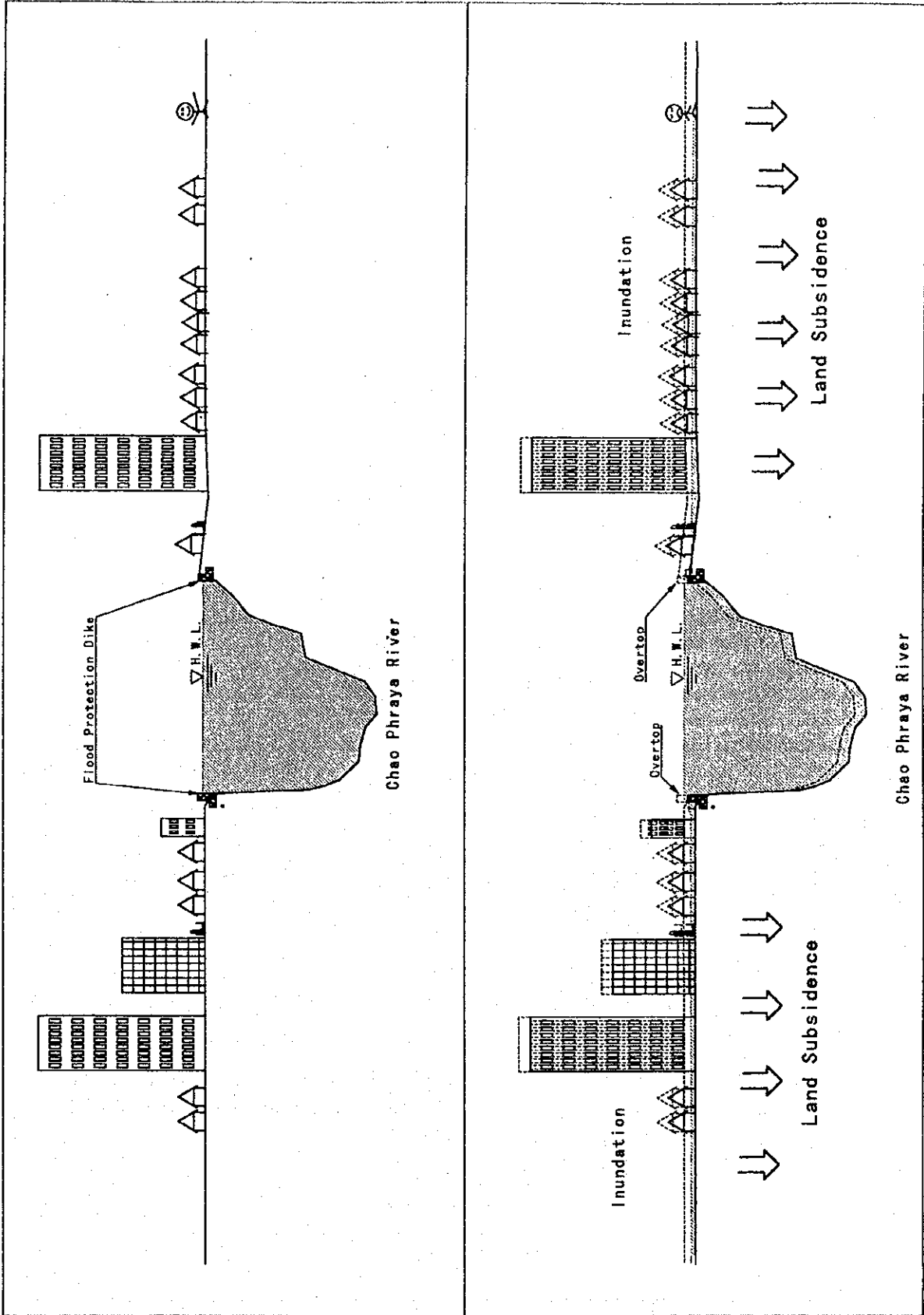


STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig. 4.2.4

SPECIFIC DRAINAGE CAPACITY PER POPULATION DENSITY

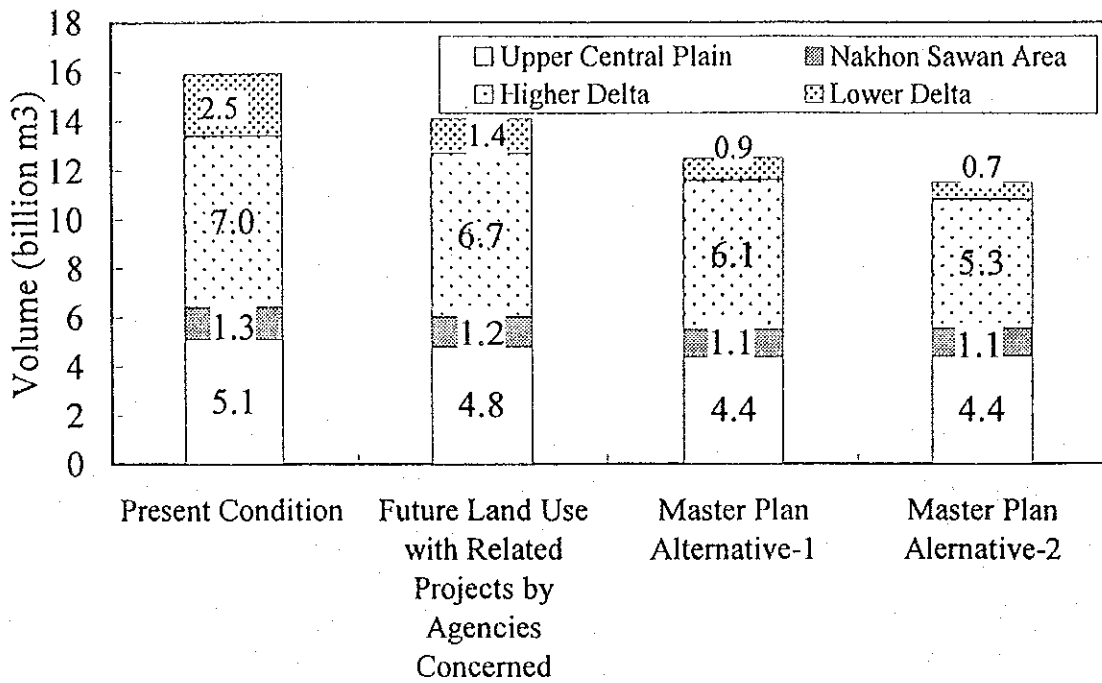


STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

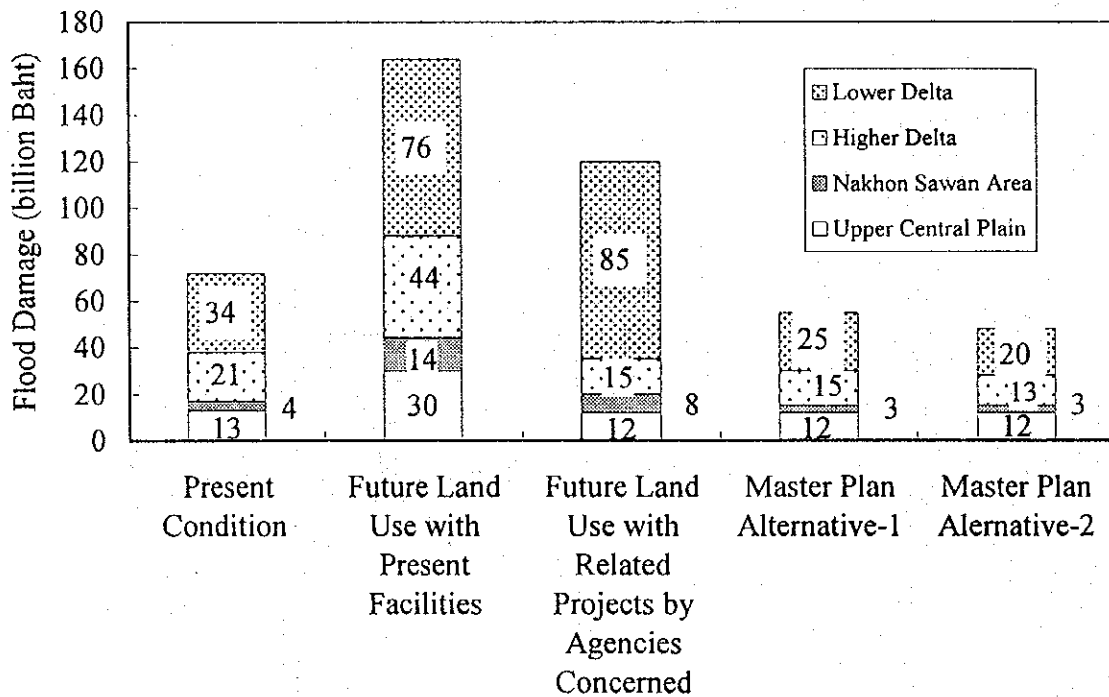
CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig. 4.2.5
INFLUENCE OF LAND SUBSIDENCE

Inundation Volume in 1995 Flood

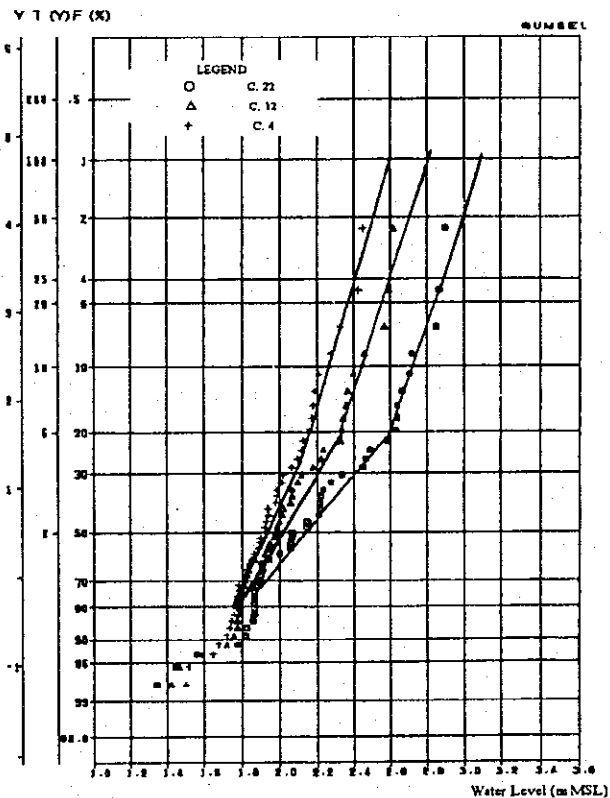


Flood Damage in 1995 Flood



River	Station	Probable Maximum Water Level by Return Period(m MSL)					
		2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Chao Phraya	C.22(Pak Kret)	2.15	2.61	2.72	2.86	2.96	3.07
	C.12(Samsen)	2.00	2.34	2.45	2.60	2.70	2.80
	C.4(Mem. Bridge)	1.92	2.16	2.25	2.39	2.48	2.57

C.22 , C.12 , C.4



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

CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig. 4.2.7

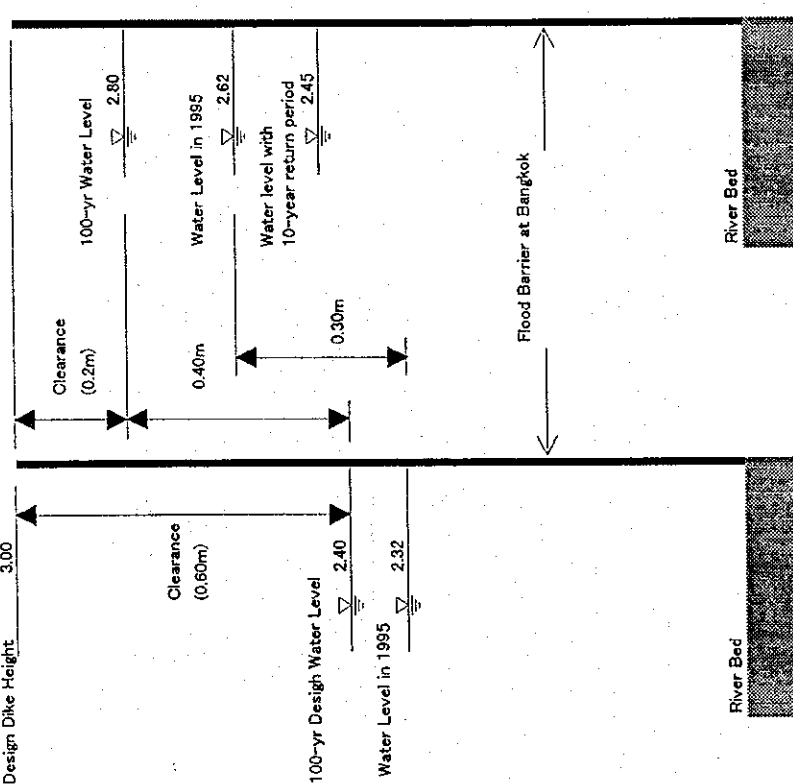
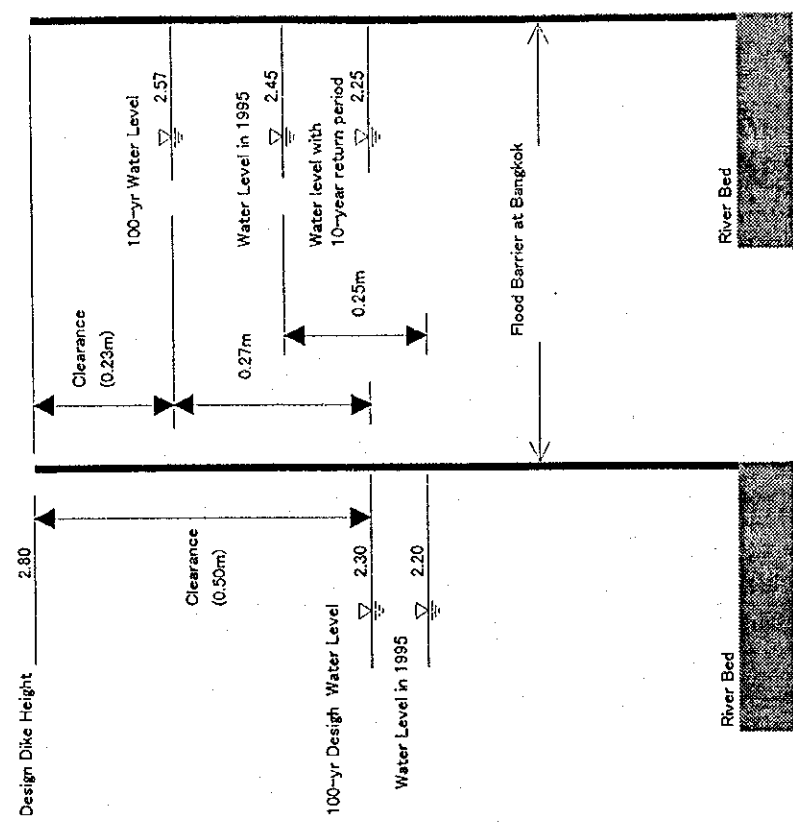
PROVABLE MAXIMUM WATER LEVEL IN FUTURE BASIN CONDITION

Future Basin Condition

Present Condition

Future Basin Condition

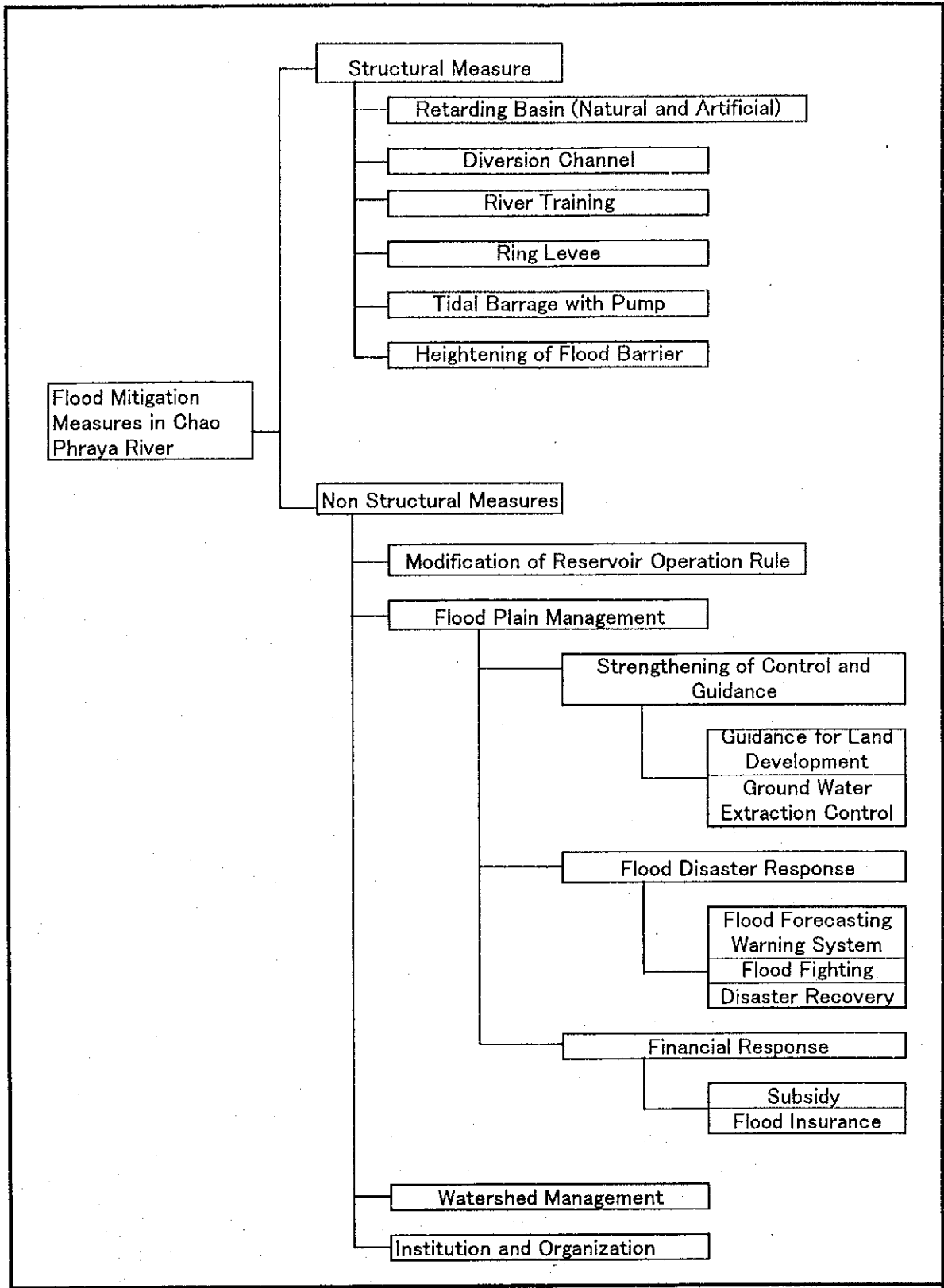
Present Condition



Memorial Bridge (C.4)

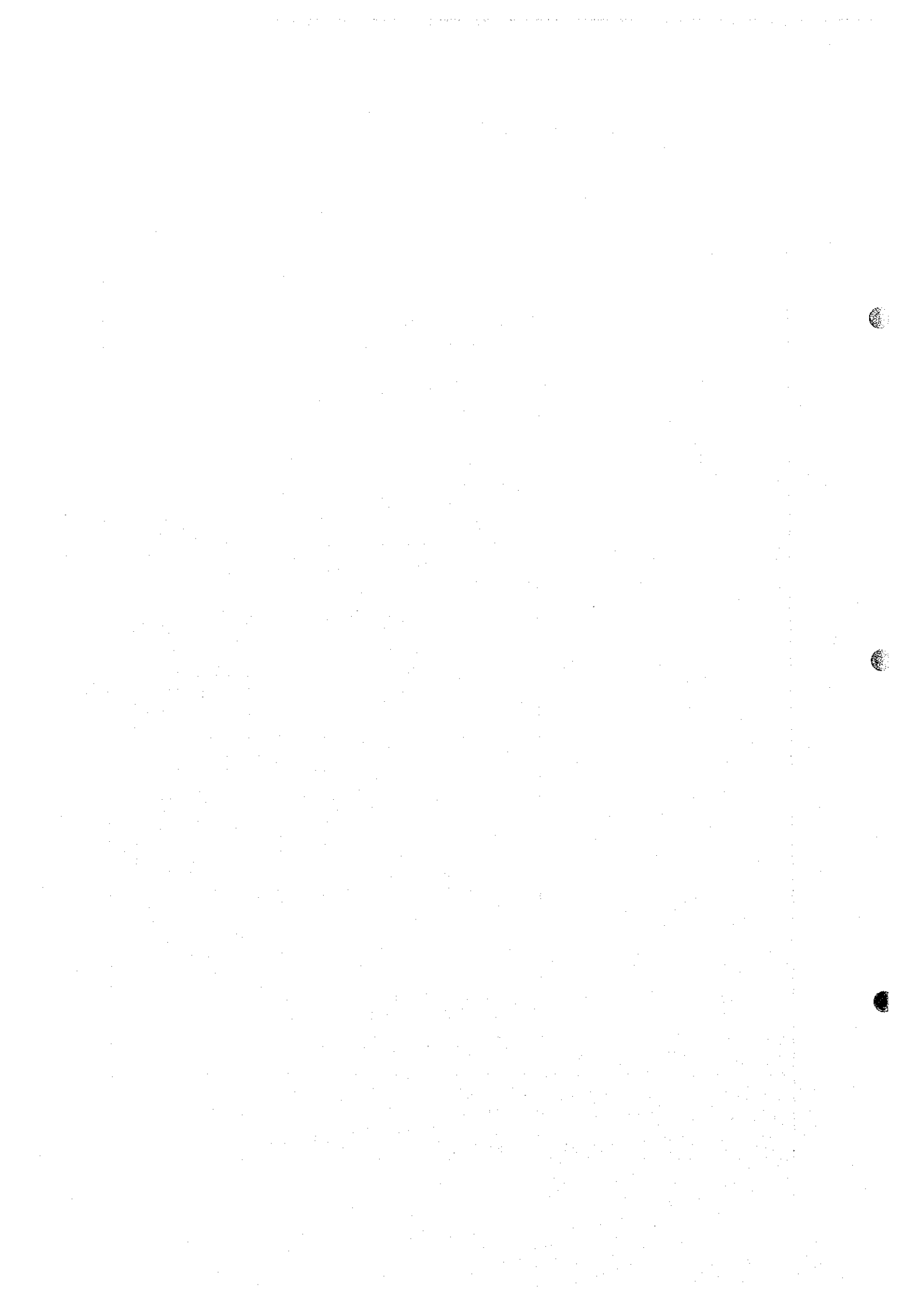
Samsen (C.12)

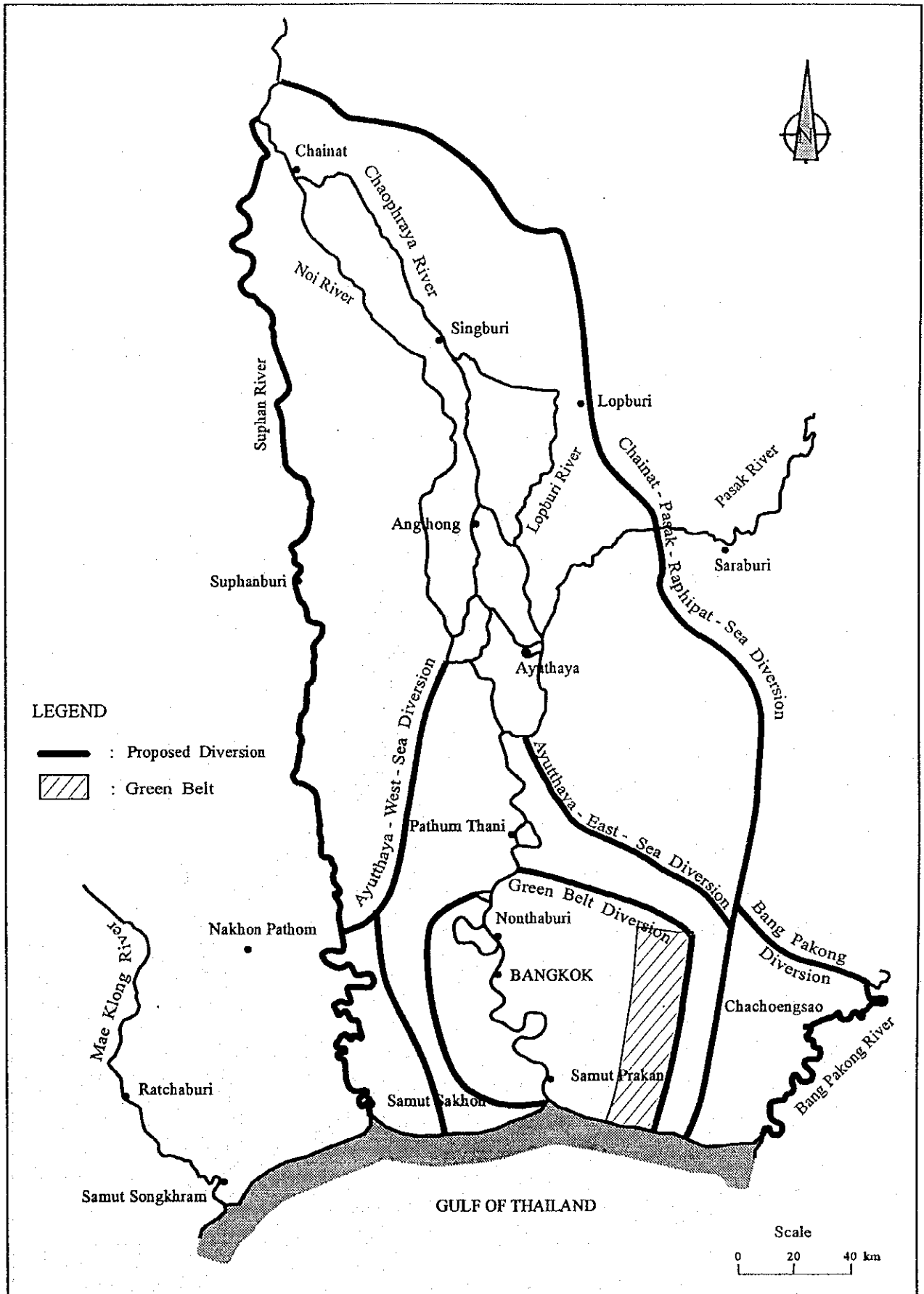
unit : (m MSC)





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

Fig. 4.4.1
 CONCEIVABLE MEASURES FOR COMPREHENSIVE FLOOD MITIGATION IN THE CHAO PHRAYA





LEGEND

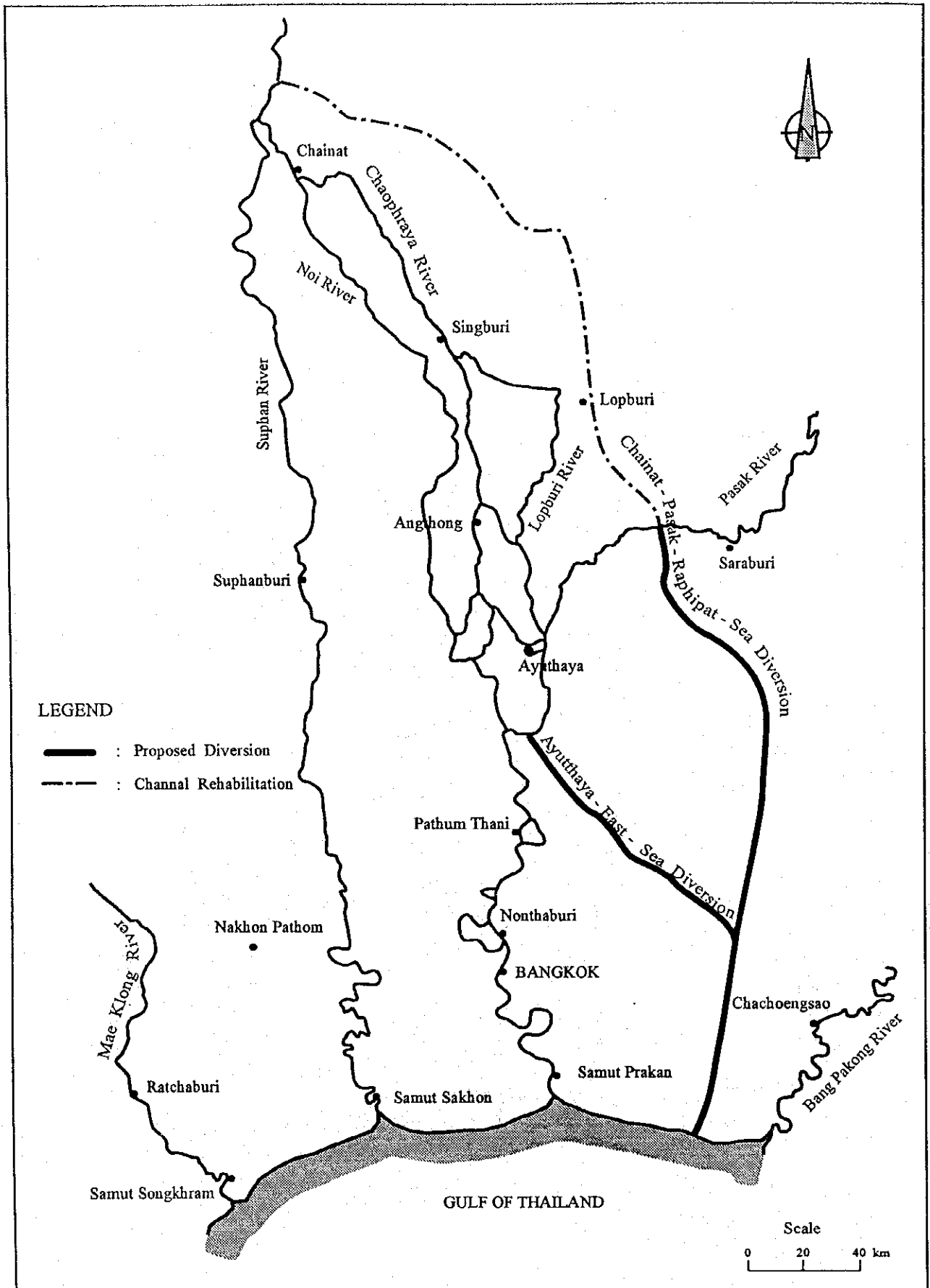
-  : Proposed Diversion
-  : Green Belt

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

CTI ENGINEERING CO., LTD. AND INA CORPORATION

Fig. 5.1.1

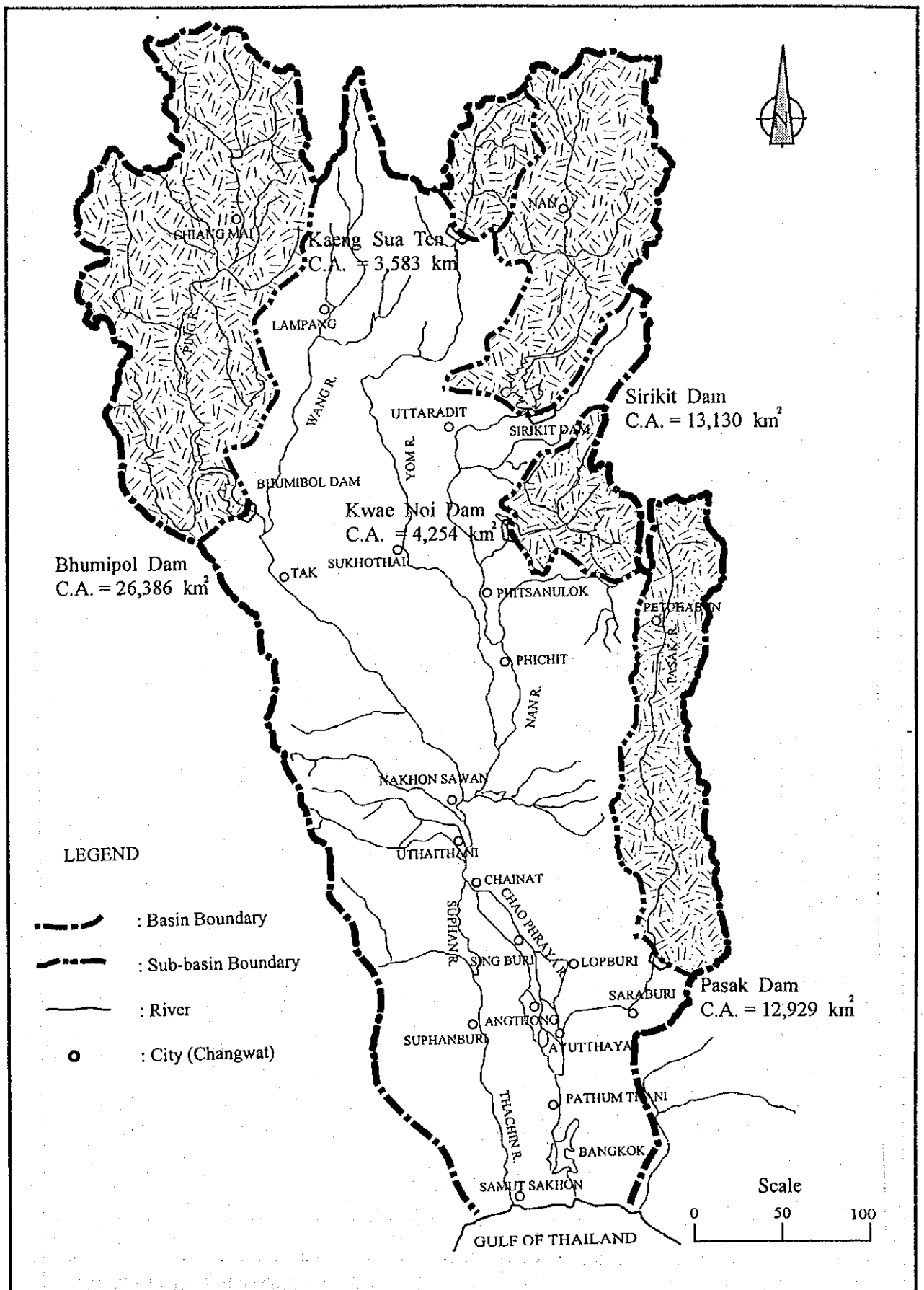
CONCEIVABLE DIVERSION CHANNEL ROUTES



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

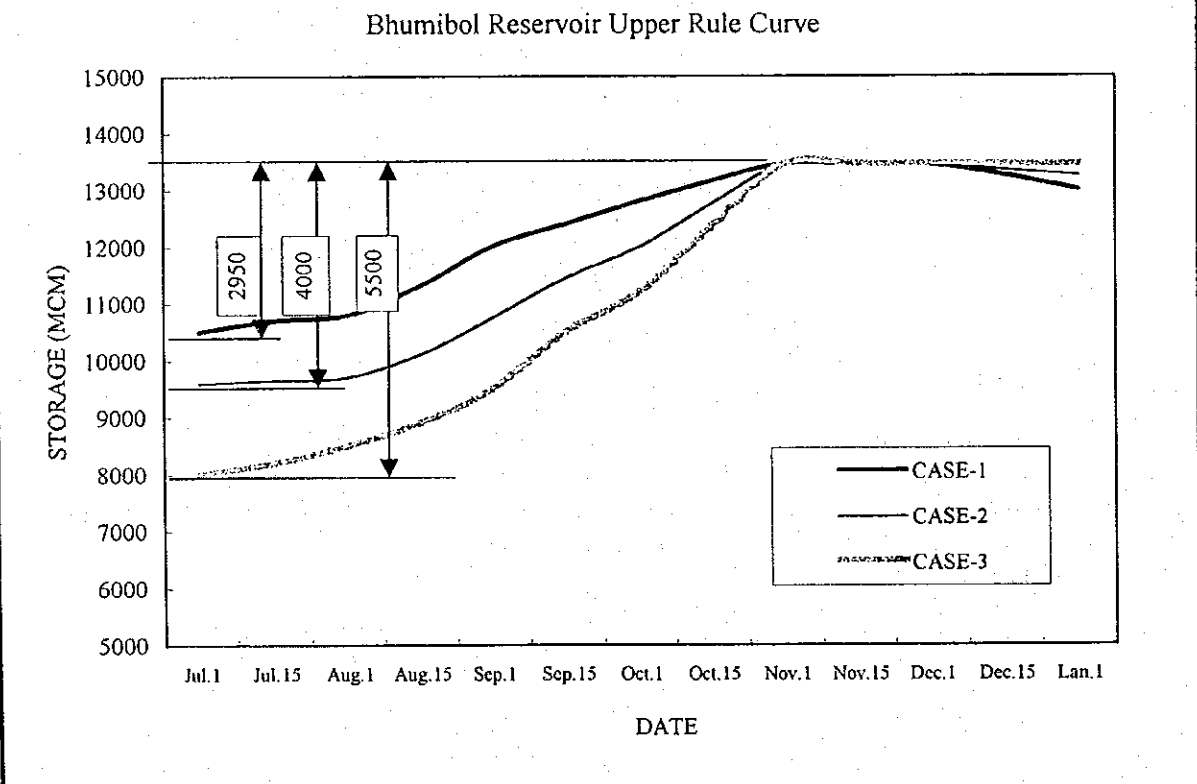
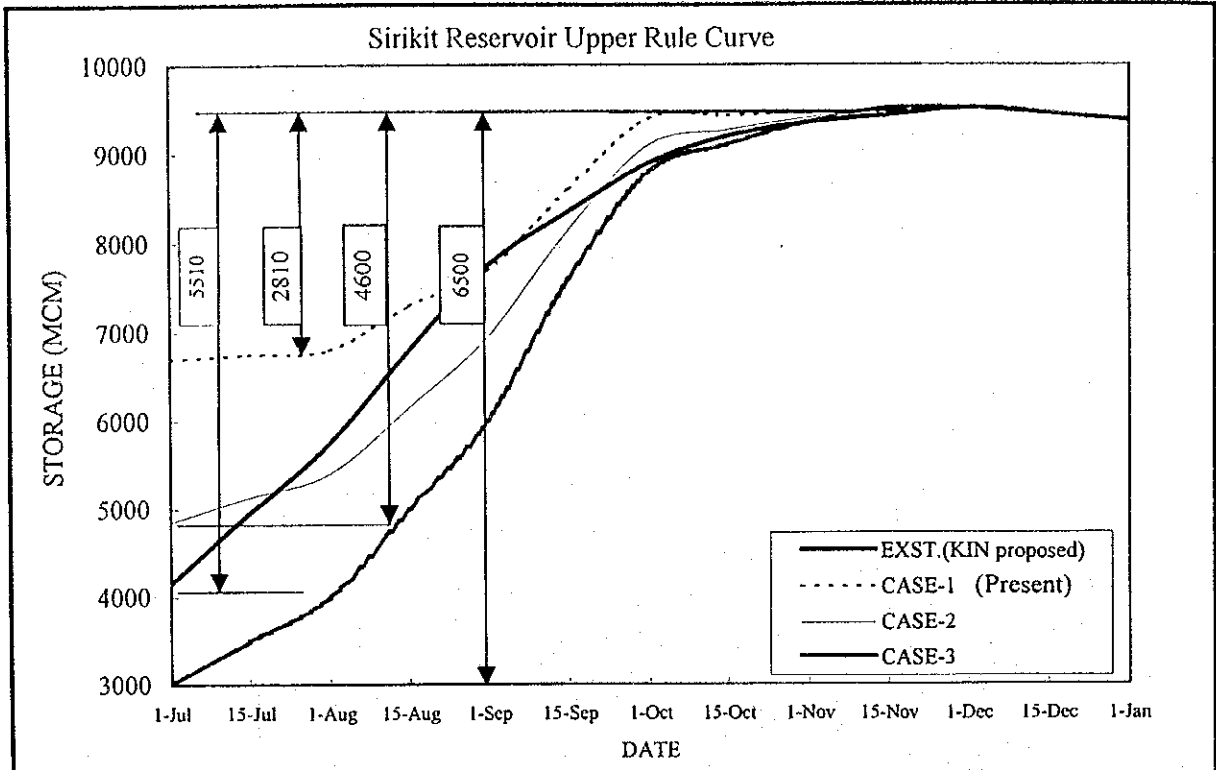
CTI ENGINEERING CO., LTD. AND INA CORPORATION

Fig. 5.1.2
APPLICABLE DIVERSION ROUTE

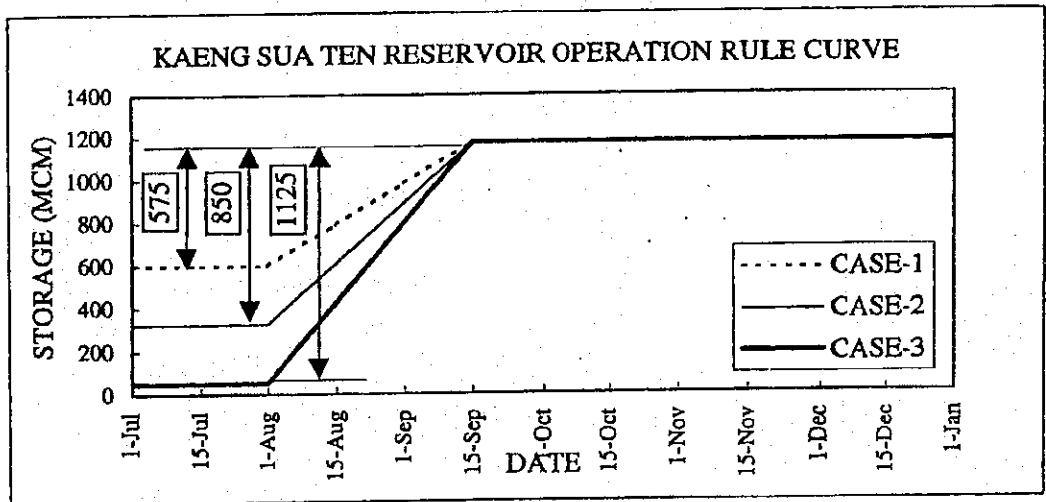
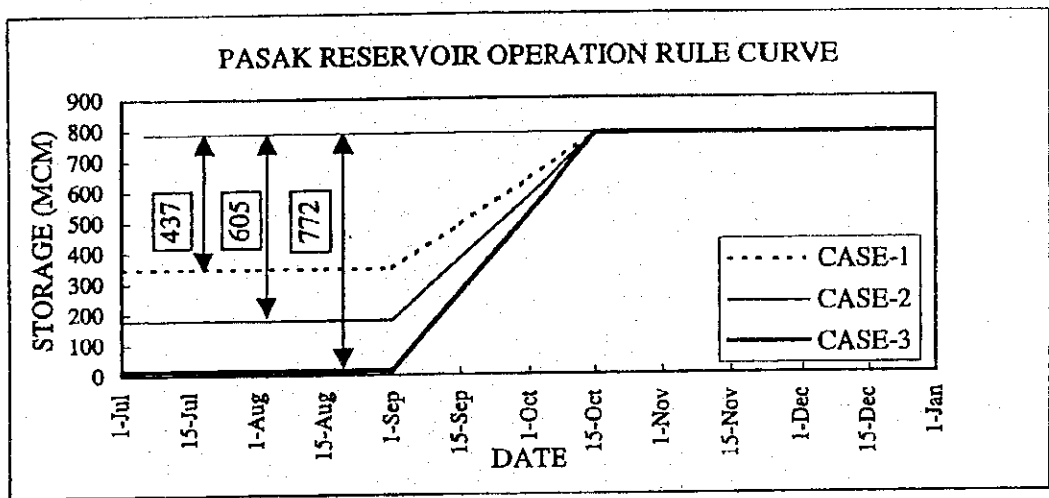
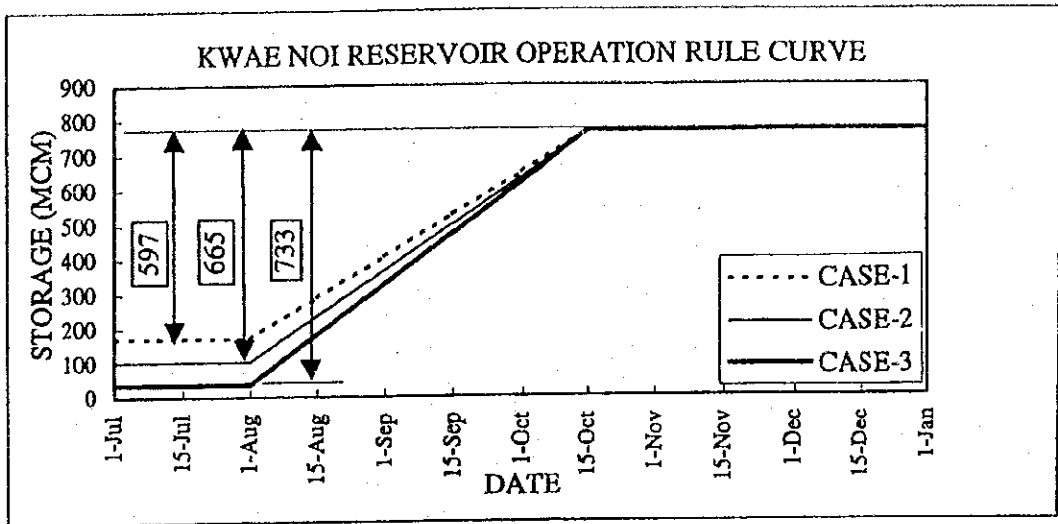


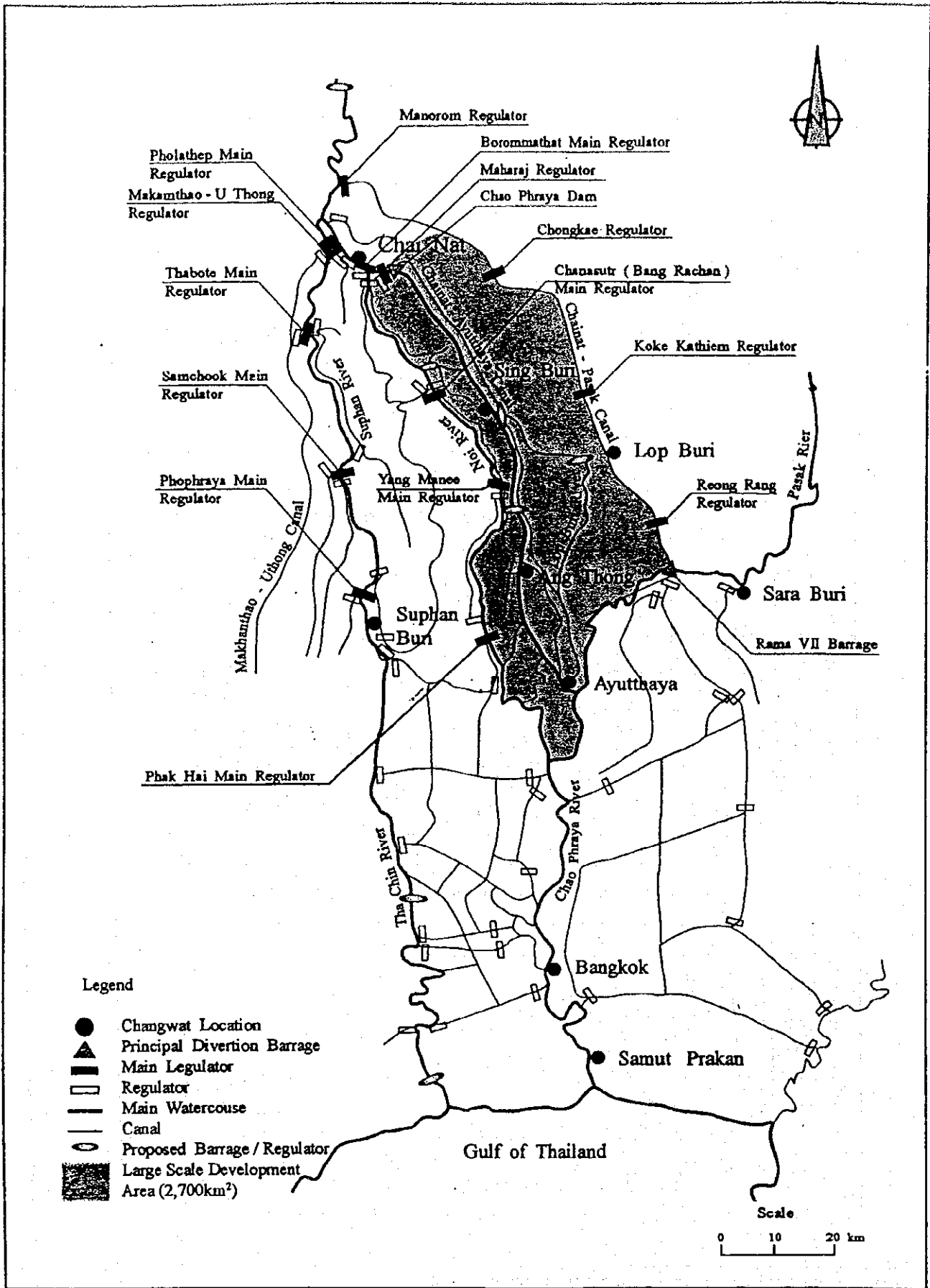
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN
 CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig. 5.2.1
 PROPOSED FLOOD MITIGATION DAM



<p style="text-align: center;">STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN</p>	<p style="text-align: center;">Fig. 5.2.2</p> <p style="text-align: center;">PROPOSED UPPER RULE CURVE (SIRIKIT AND BHUMIBOL RESERVOIR)</p>
<p>CTI ENGINEERING CO, LTD. AND INA CORPORATION</p>	

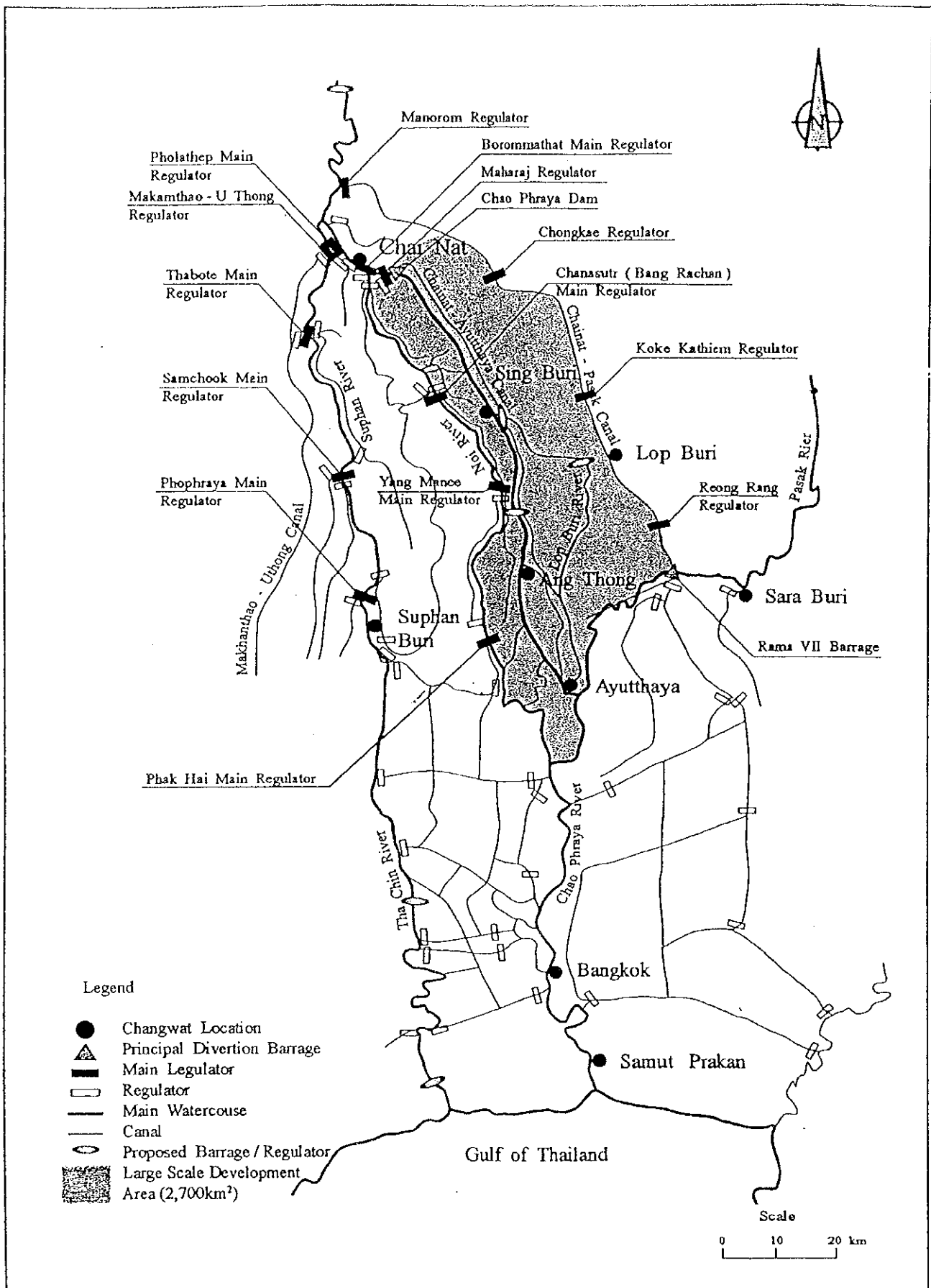




STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig. 5.3.1
LARGE SCALE DEVELOPMENT AREA

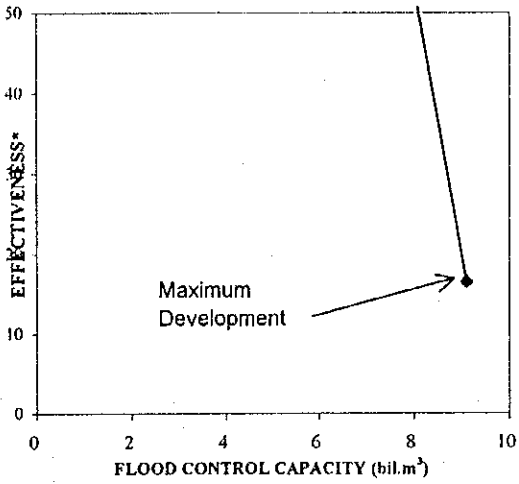


STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

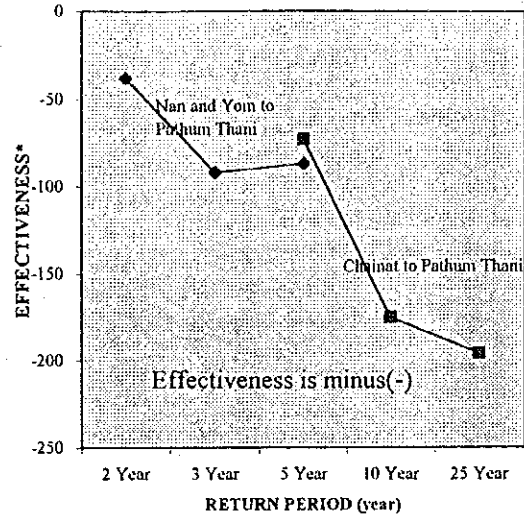
Fig. 5.3.1
LARGE SCALE DEVELOPMENT AREA

CTI ENGINEERING CO., LTD AND INA CORPORATION

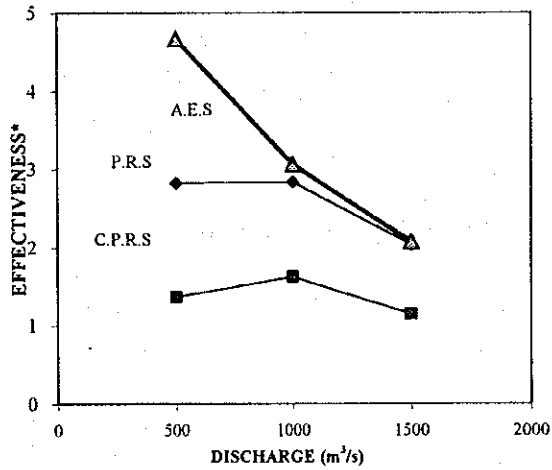
MODIFICATION OF DAM OPERATION CURVE



RIVER IMPROVEMENT



DIVERSION



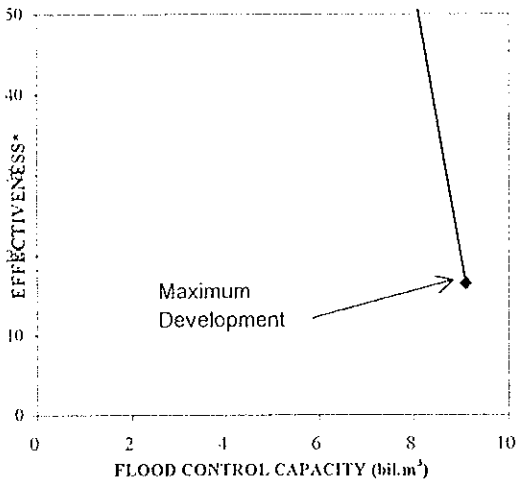
*:Effectiveness is expressed in a manner of decrease of flood damage in 1995 by cost.

STUDY ON ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAOPHRAYA RIVER BASIN

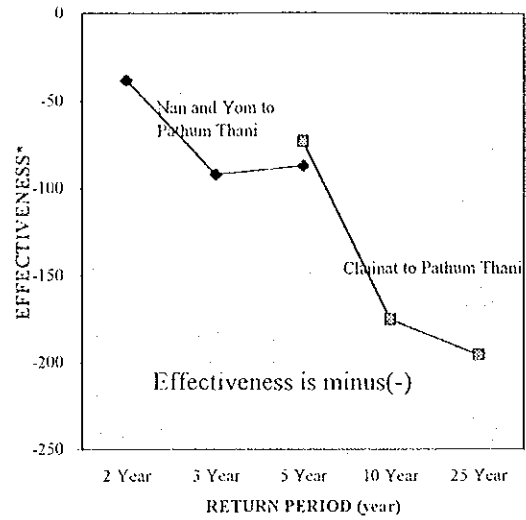
CTI ENGINEERING CO., LTD & INA CORPORATION

Fig. 5.3.2(1/2) EFFECTIVENESS OF EACH MEASURE (BY SCALE)

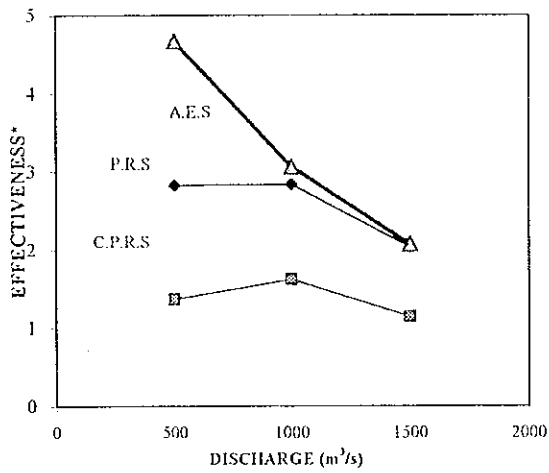
MODIFICATION OF DAM OPERATION CURVE



RIVER IMPROVEMENT



DIVERSION

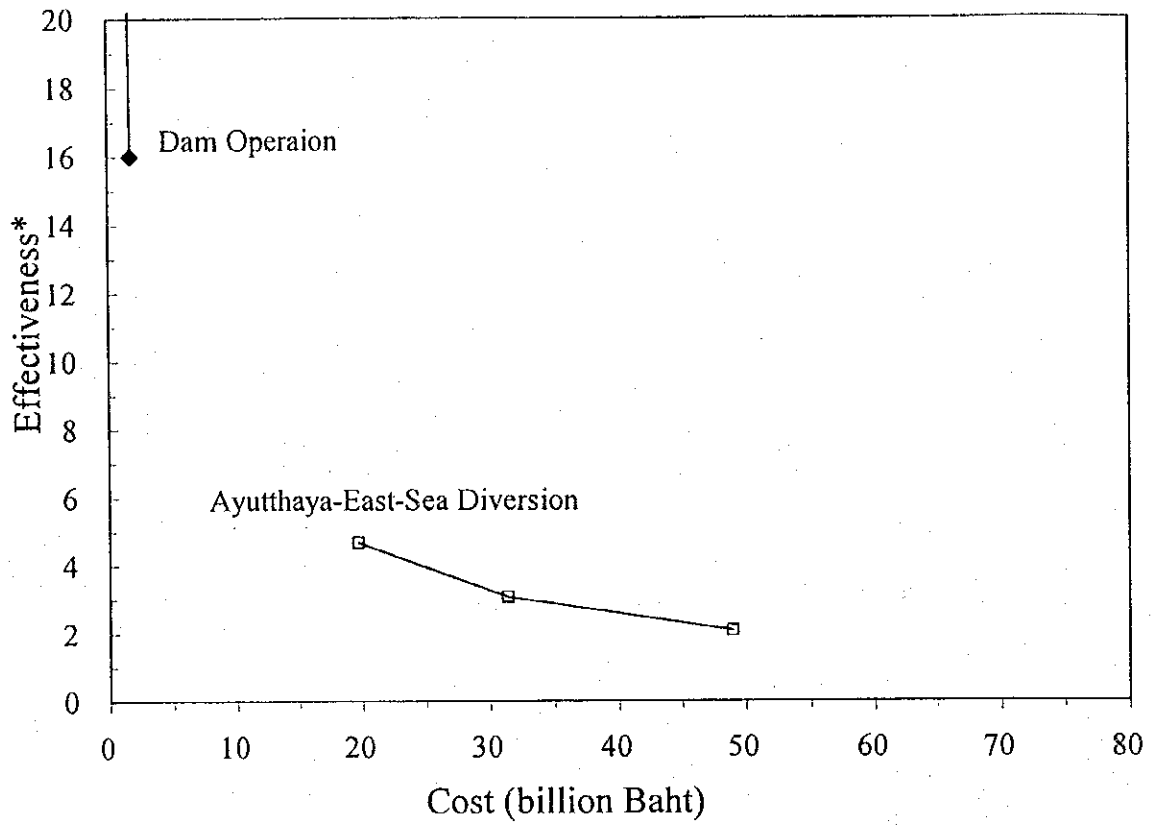


*:Effectivness is expressed in a manner of decrease of flood damage in 1995 by cost.

STUDY ON ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAOPHRAYA RIVER BASIN

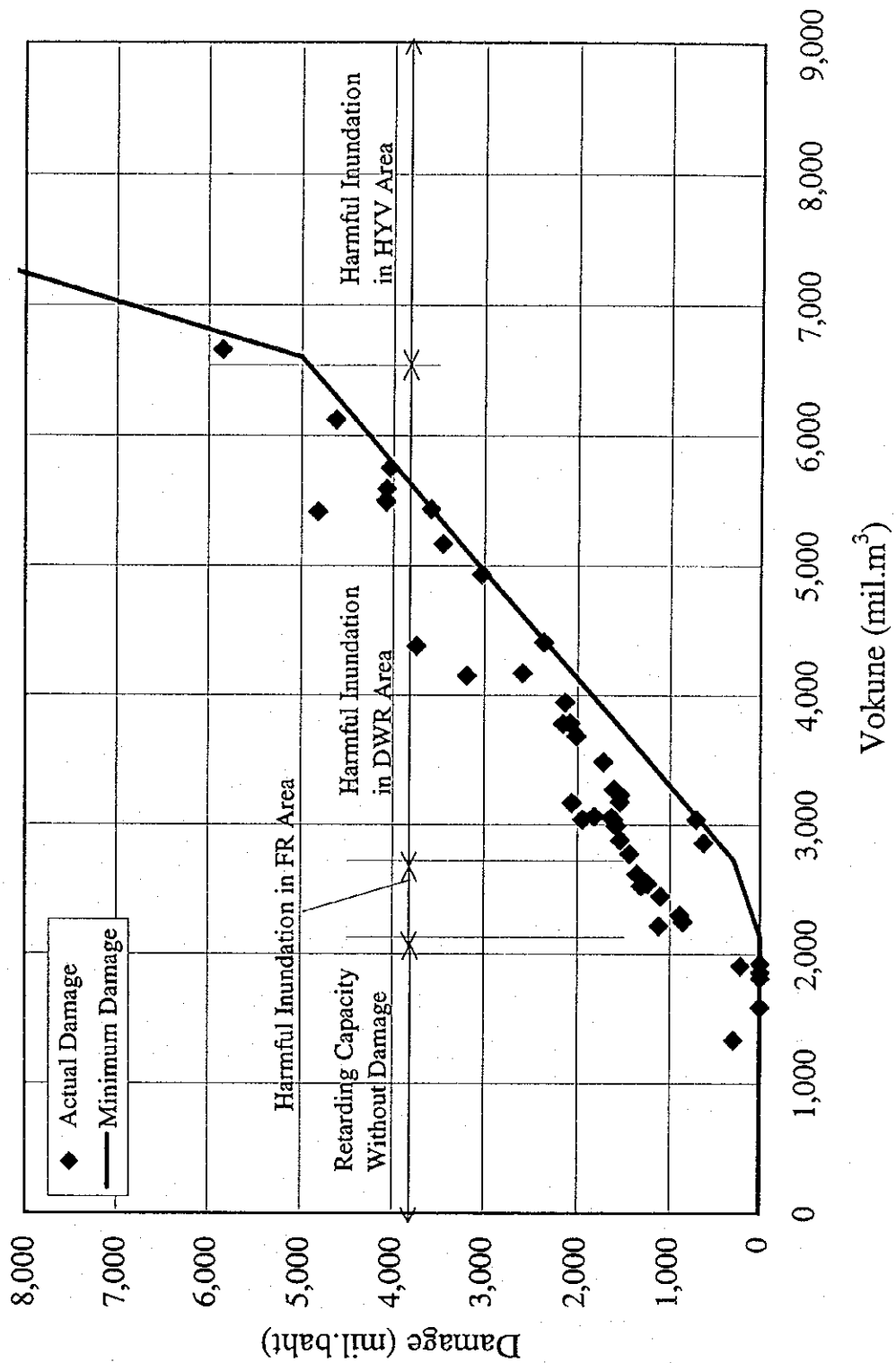
CTI ENGINEERING CO., LTD & INA CORPORATION

Fig. 5.3.2(1/2) EFFECTIVENESS OF EACH MEASURE (BY SCALE)



* : Effectiveness is expressed in a manner of decrease of damage in 1995 flood by cost

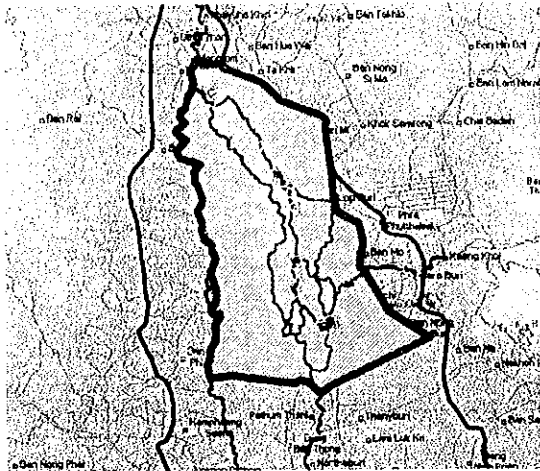
Relation Between Inundation Volume and Flood Damage



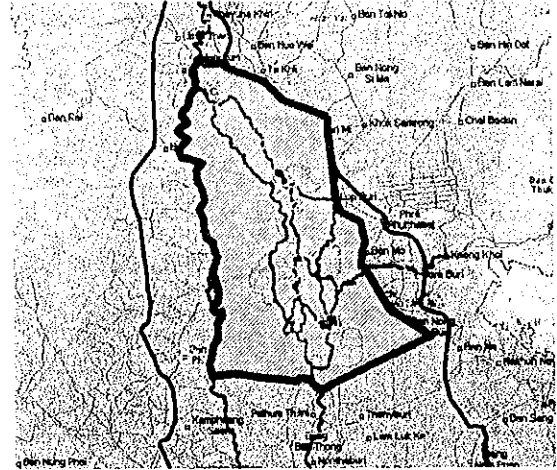
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAOPHRAYA RIVER BASIN
 CTI ENGINEERING CO., LTD. AND INA CORPORATION

Fig.5.3.3
 RELATION BETWEEN INUNDATION VOLUME AND FLOOD DAMAGE

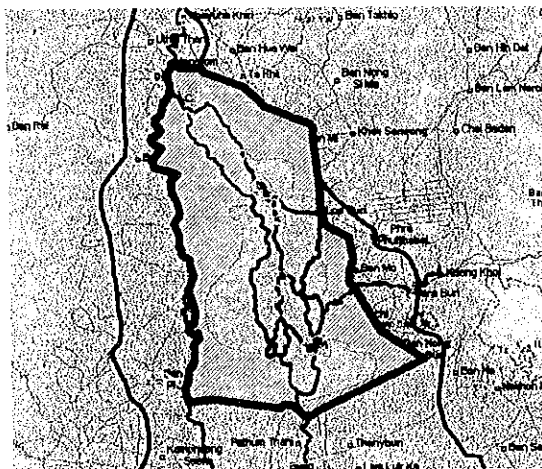
Priority 1



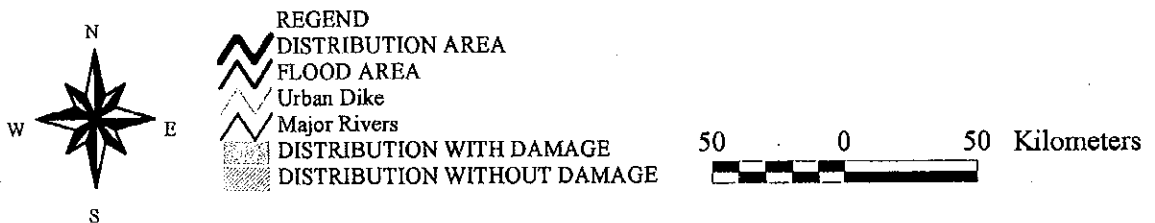
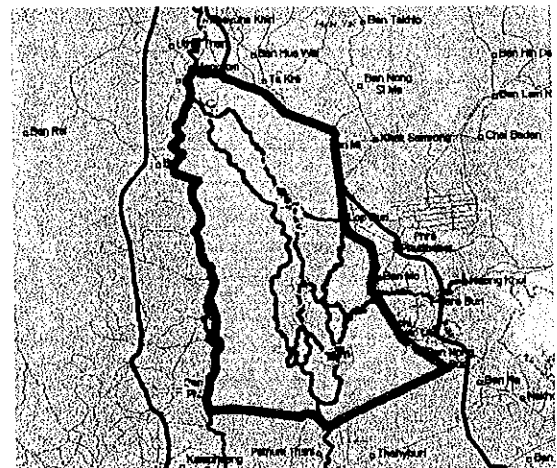
Priority 2



Priority 3



Priority 4



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAOPHRAYA RIVER BASIN

CTI ENGINEERING CO LTD., & INA CORPORATION

Fig.5.3.4

PRIORITY AREA FOR FLOOD WATER DISTRIBUTION

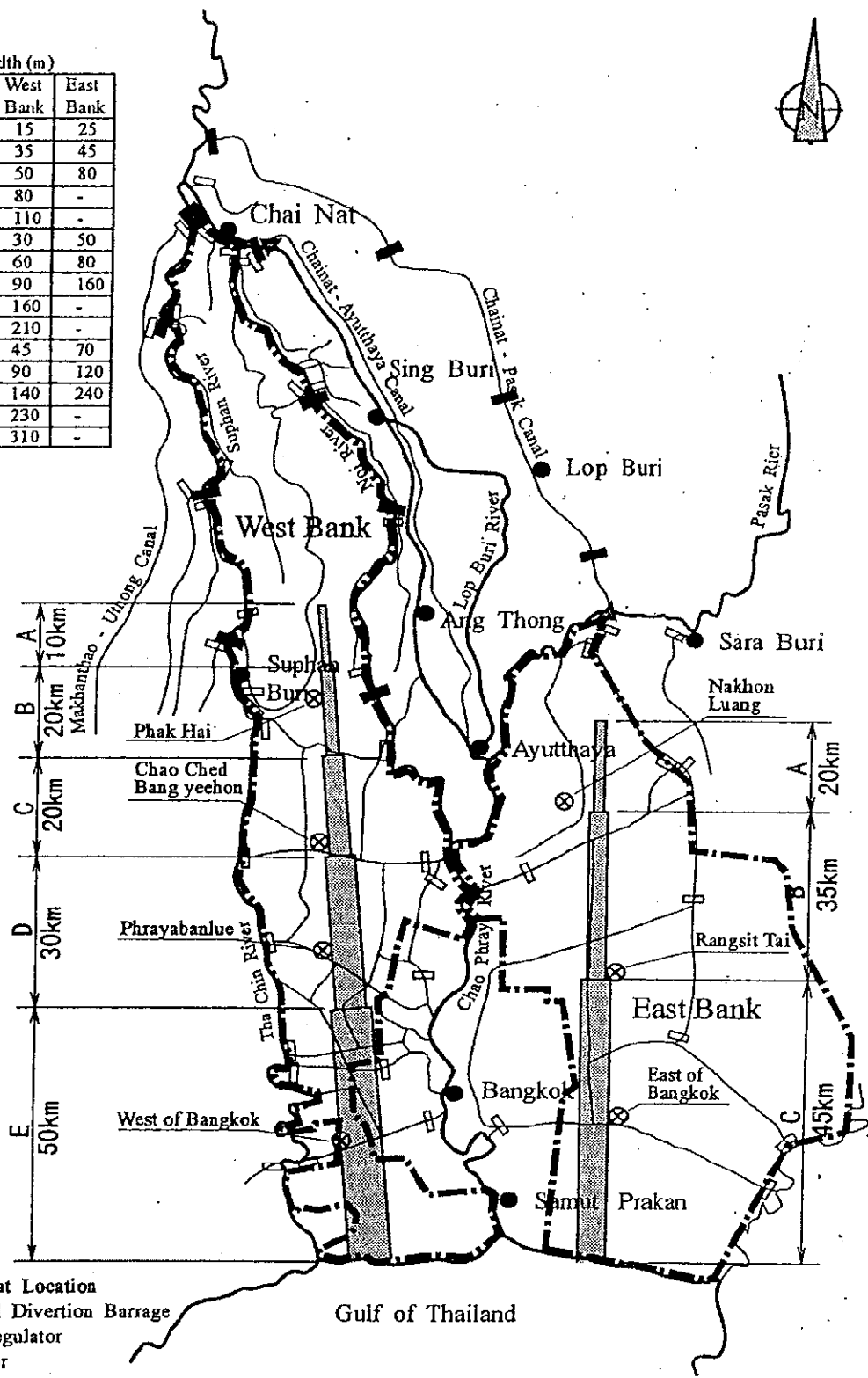
CASE A

Case	Stretch	Channel width (m)	
		West Bank	East Bank
Case-A1 (Q=100 m ³ /s)	A	15	25
	B	35	45
	C	50	80
	D	80	-
	E	110	-
Case-A2 (Q=200 m ³ /s)	A	30	50
	B	60	80
	C	90	160
	D	160	-
	E	210	-
Case-A3 (Q=300 m ³ /s)	A	45	70
	B	90	120
	C	140	240
	D	230	-
	E	310	-

Channel Depth = 3m

Legend

- Changwat Location
- ▲ Principal Diversion Barrage
- ▬ Main Legulator
- ▭ Regulator
- Main Watercourse
- Canal
- ⊗ Water Level Check Point
- ▭ Assumed Drainage Channel
- ⬭ Drainage Area



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

Fig.5.3.5 (1/2)

ASSUMED DRAINAGE CHANNEL

CTI ENGINEERING CO., LTD AND INA CORPORATION

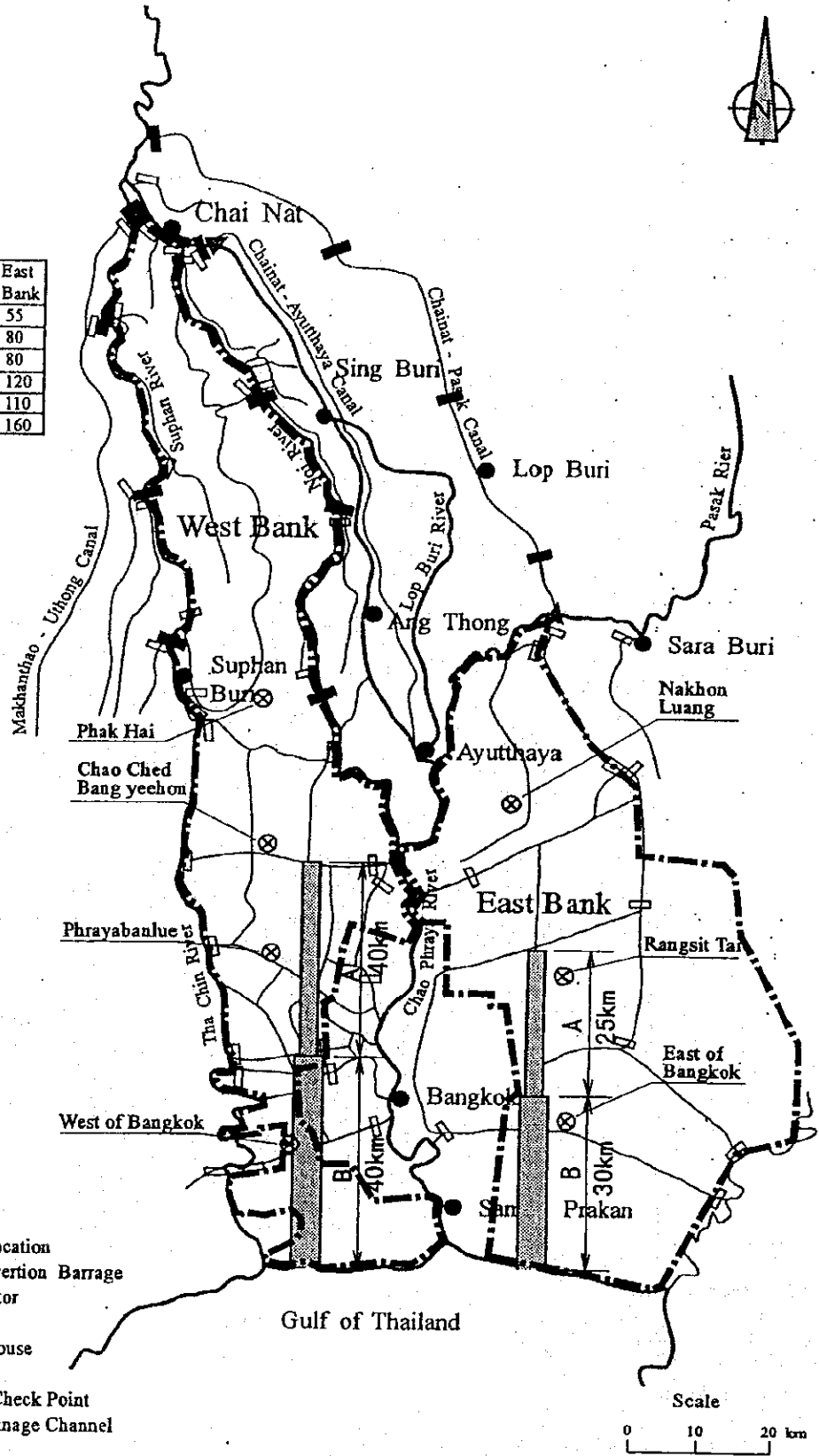
CASE B

Channel width (m)			
Case	Stretch	West Bank	East Bank
Case-B1 ($Q=75m^3/s$)	A	45	55
	B	60	80
Case-B2 ($Q=100m^3/s$)	A	60	80
	B	90	120
Case-B3 ($Q=150m^3/s$)	A	80	110
	B	120	160

Channel Depth = 3m

Legend

- Changwat Location
- ▲ Principal Diversion Barrage
- Main Legulator
- Regulator
- Main Watercourse
- Canal
- ⊗ Water Level Check Point
- ▨ Assumed Drainage Channel
- ⊞ Drainage Area



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

CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig.5.3.5 (2/2)

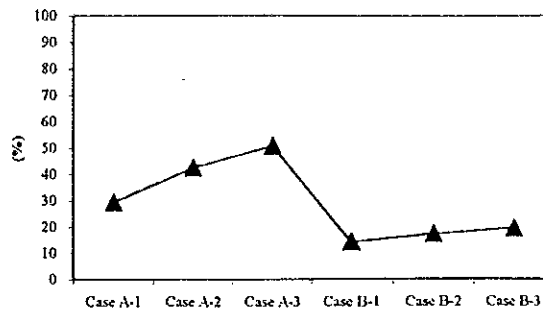
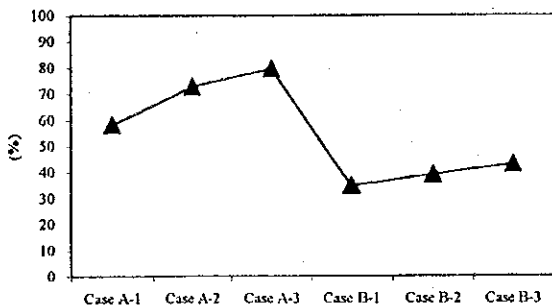
ASSUMED DRAINAGE CHANNEL

West Bank

East Bank

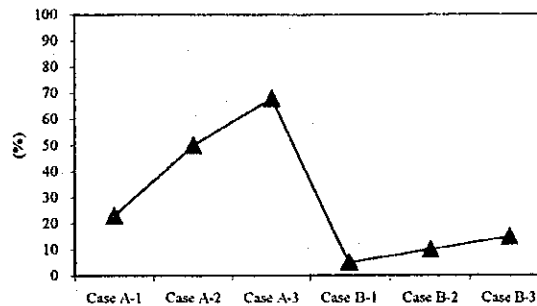
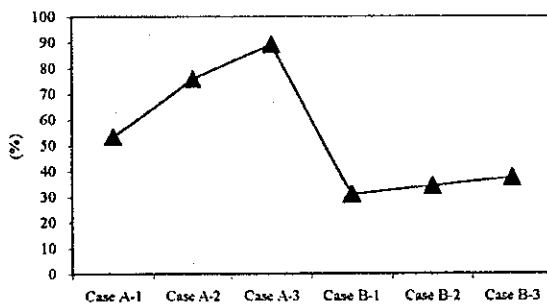
Decrease of Inundation Volume

Decrease of Inundation Volume



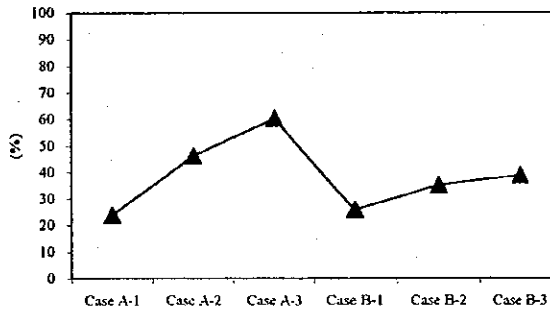
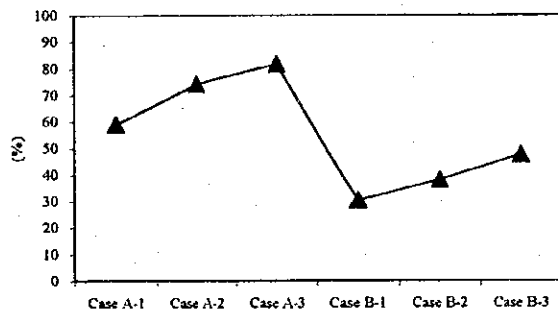
Decrease of Inundation Duration

Decrease of Inundation Duration



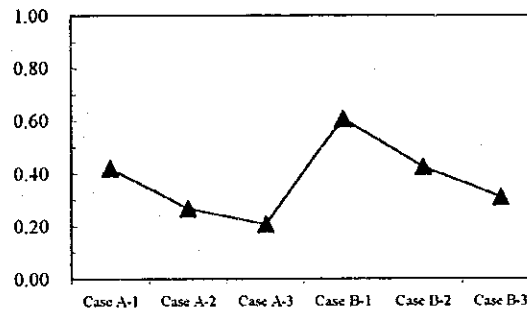
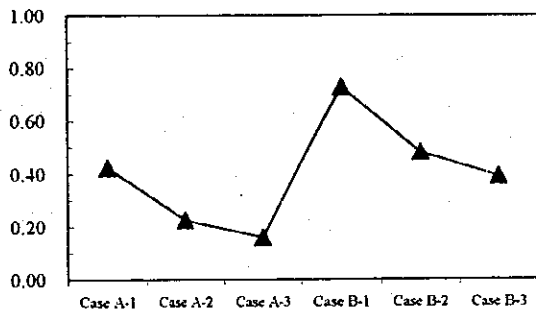
Decrease of Flood Damage

Decrease of Flood Damage



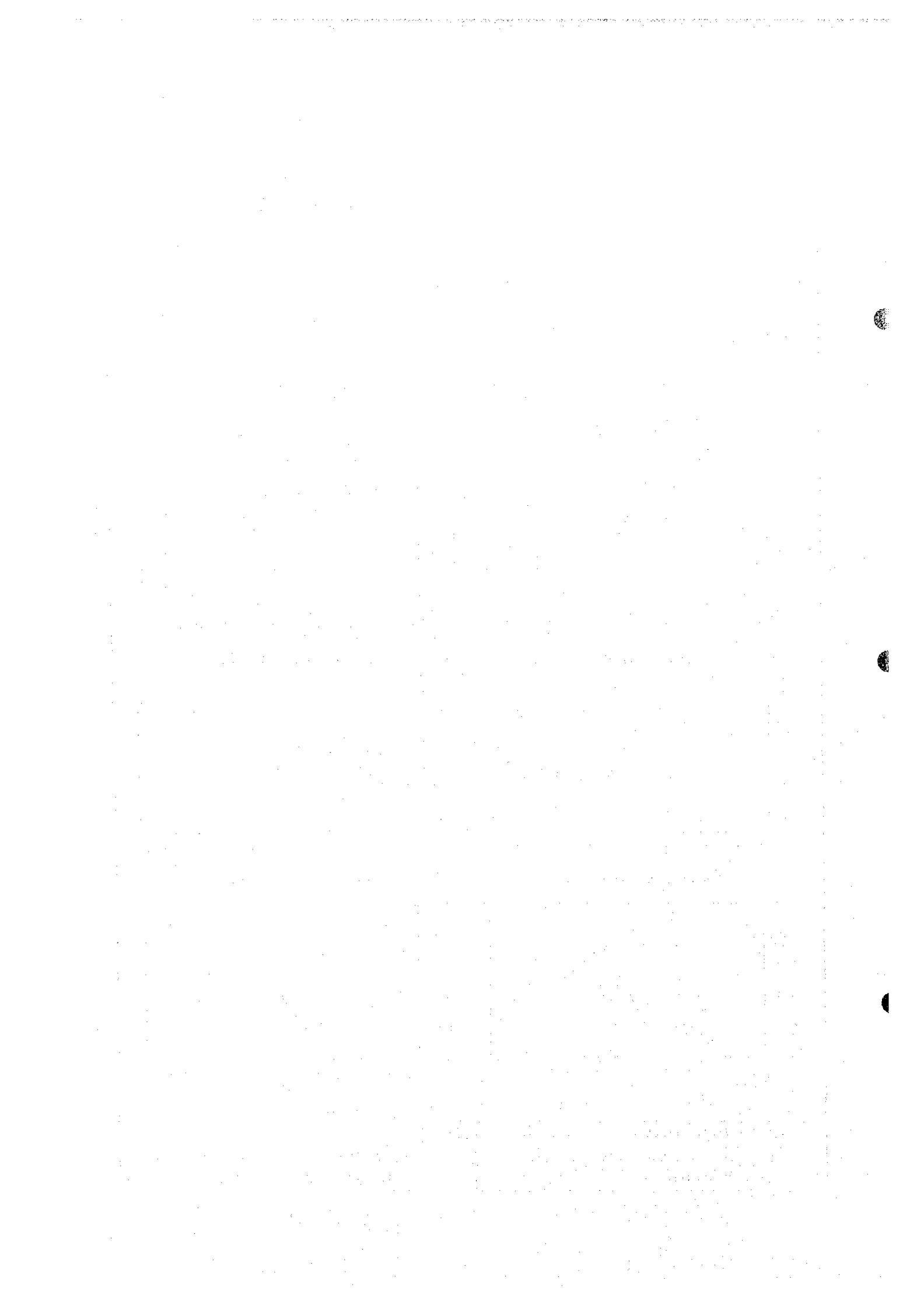
Decreased Damage by Cost

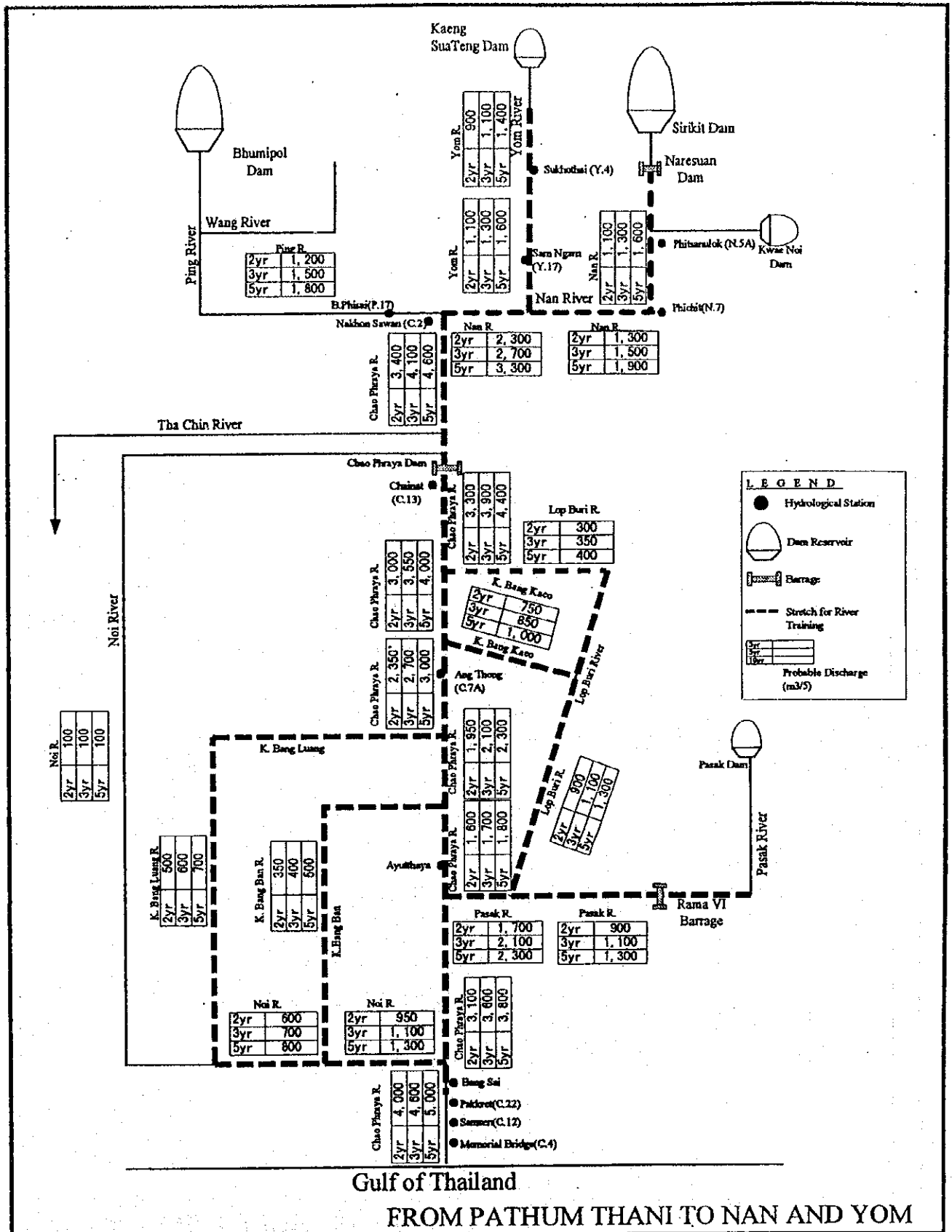
Decreased Damage by Cost



STUDY ON ON INTEGRATED PLAN FOR FLOOD
MITIGATION IN CHAOPHRAYA RIVER BASIN
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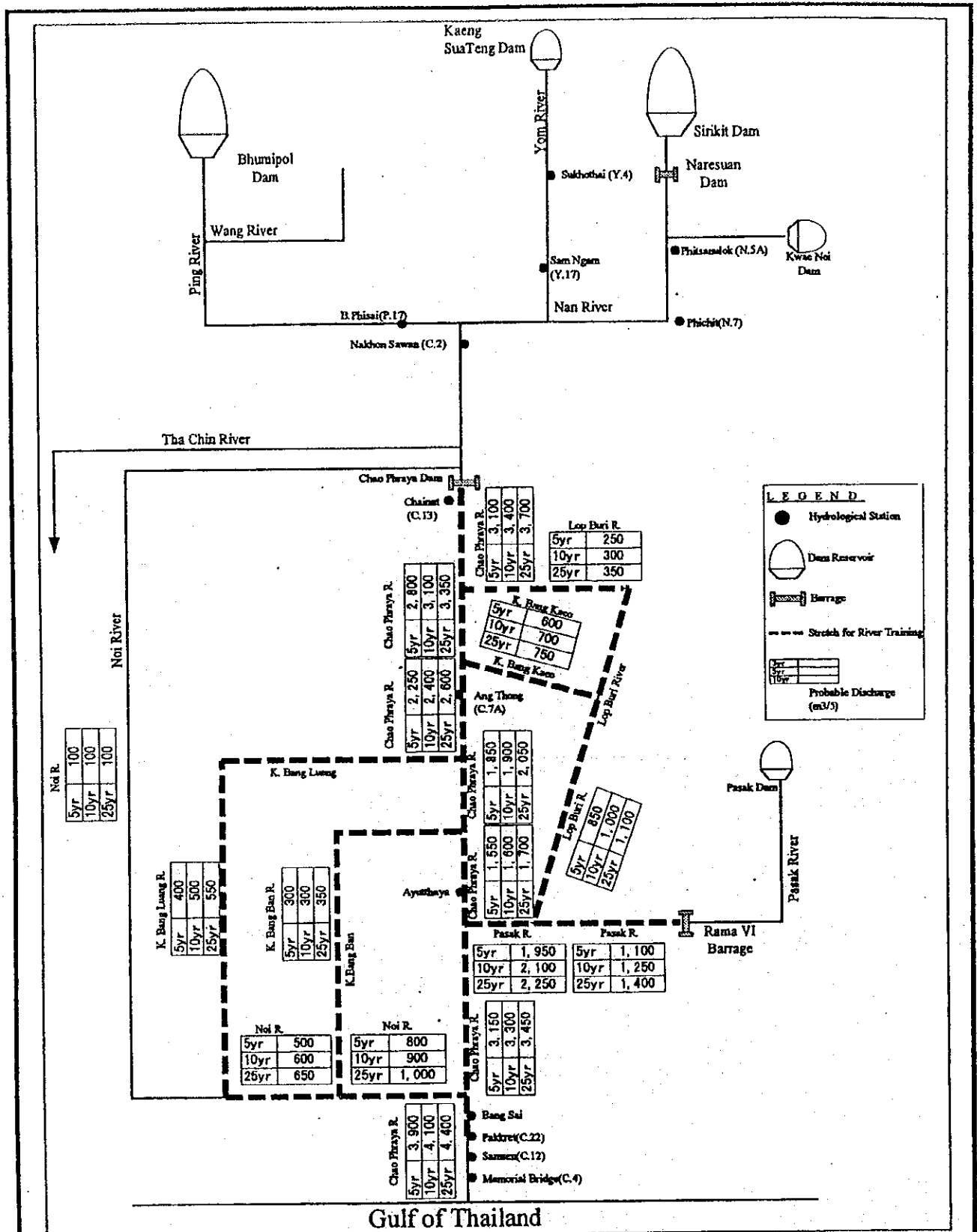
Fig.5.3.6
EFFECTIVENESS OF DRAINAGE
CHANNEL IMPROVEMENT





STUDY ON ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAOPHRAYA RIVER BASIN
 CTI ENGINEERING CO., LTD & INA CORPORATION

Fig. 6.1.1 (1/2) DISCHARGE DISTRIBUTION FOR RIVER IMPROVEMENT

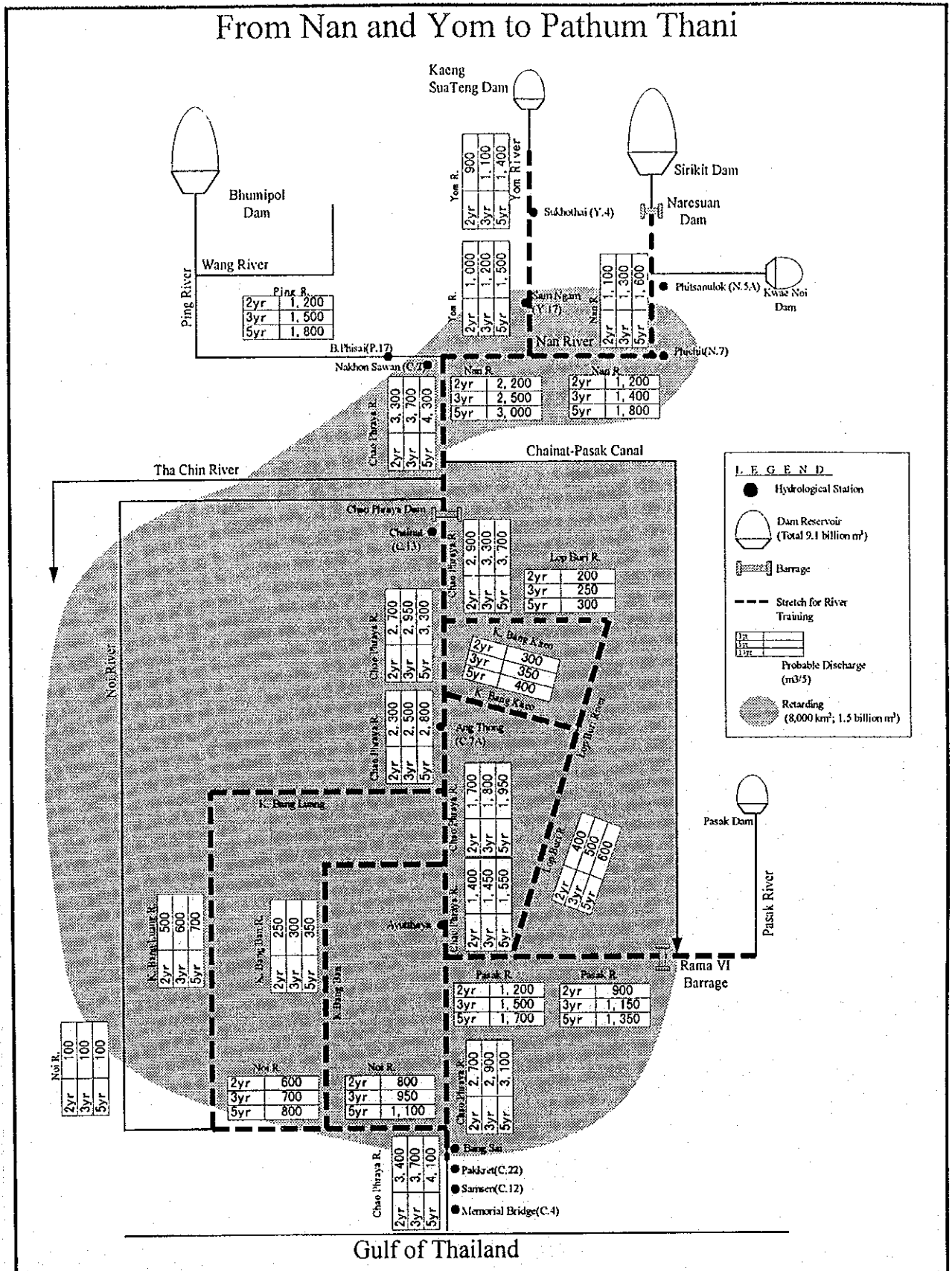


FROM PATHUM THANI TO CHAINAT

STUDY ON ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAOPHRAYA RIVER BASIN
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Fig. 6.1.1(2/2) DISCHARGE DISTRIBUTION FOR RIVER IMPROVEMENT

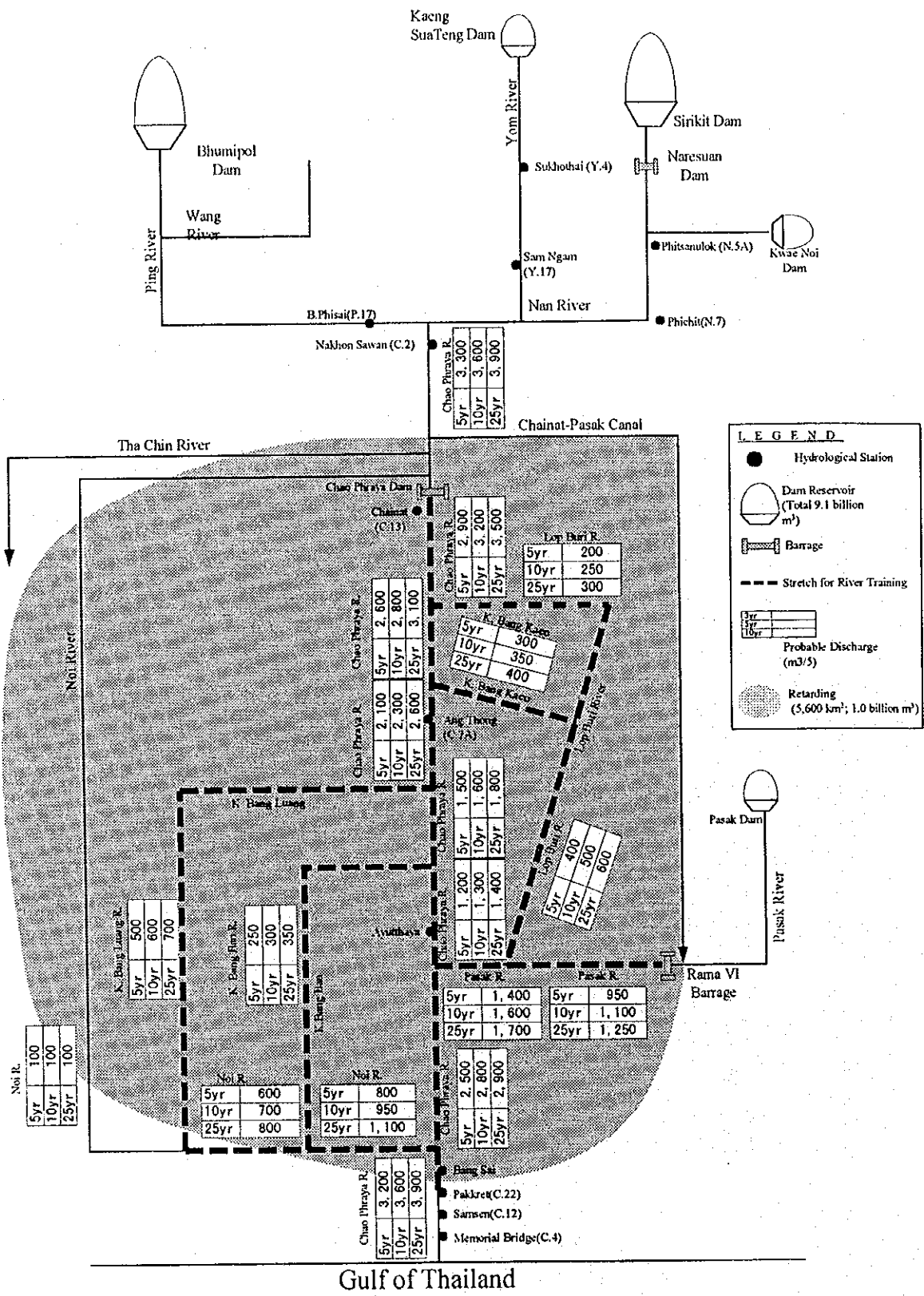
From Nan and Yom to Pathum Thani



STUDY ON ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAOPHRAYA RIVER BASIN
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Fig. 6.1.2(1/2)
 DISCHARGE DISTRIBUTION FOR RIVER IMPROVEMENT WITH RETARDING

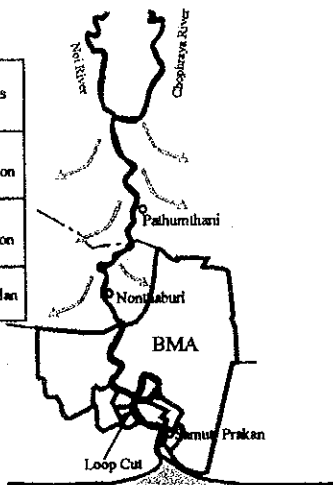
From Chainat to Pathum Thani



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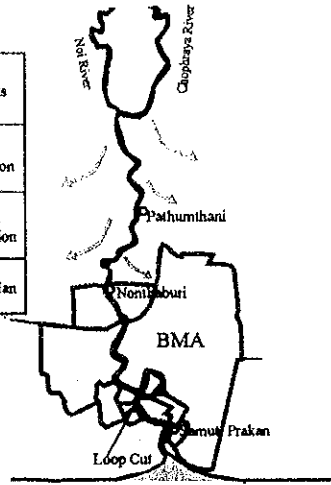
Fig. 6.1.2 (2/2)
 DISCHARGE DISTRIBUTION FOR RIVER IMPROVEMENT WITH RETARDING

Protection Level		
Area	Return Period (year)	Remarks
Pathum Thani (P.T.)	2 to 3	Present Condition
Northa Buri (N.B.)	2 to 3	Present Condition
BMA	125	BMA Plan



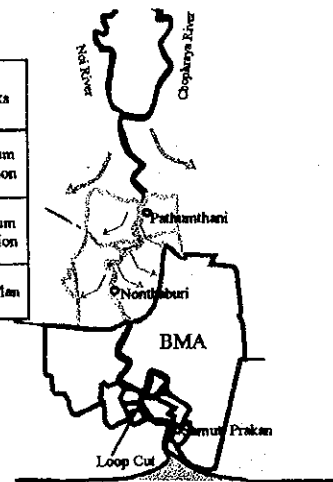
Option 1: Suspension of P.T. & N.B. Protection Works

Protection Level		
Area	Return Period (year)	Remarks
Pathum Thani (P.T.)	2 to 3	Present Condition
Northa Buri (N.B.)	2 to 3 and 100	Partial Protection
BMA	100	BMA Plan



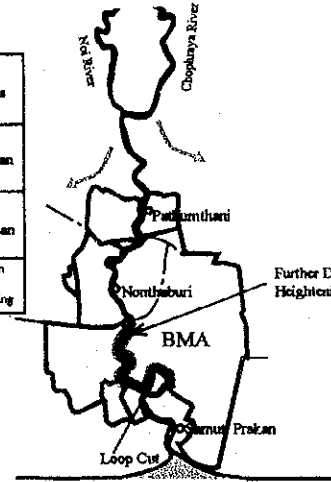
Option 4: Partial Protection of N.B.

Protection Level		
Area	Return Period (year)	Remarks
Pathum Thani (P.T.)	5	Minimum Protection
Northa Buri (N.B.)	5	Minimum Protection
BMA	100	BMA Plan



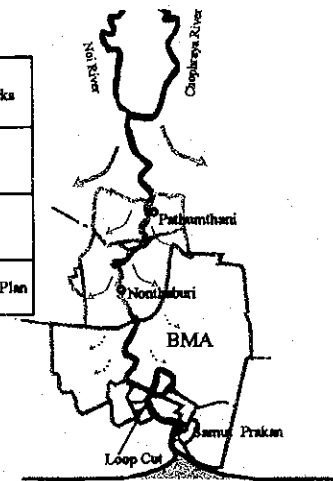
Option 2: Minimum Protection of P.T. & N.B.

Protection Level		
Area	Return Period (year)	Remarks
Pathum Thani (P.T.)	100	PWD Plan
Northa Buri (N.B.)	100	PWD Plan
BMA	100	BMA Plan + Dike Heightening



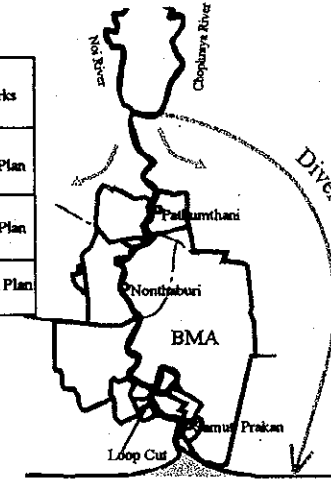
Option 5: 100-year Protection of P.T. & N.B. with Further Dike Heightening in BMA

Protection Level		
Area	Return Period (year)	Remarks
Pathum Thani (P.T.)	7	
Northa Buri (N.B.)	7	
BMA	50	BMA Plan



Option 3: Lowering of Protection Level in BMA with Higher Protection in P.T. & N.B.

Protection Level		
Area	Return Period (year)	Remarks
Pathum Thani (P.T.)	100	PWD Plan
Northa Buri (N.B.)	100	PWD Plan
BMA	100	BMA Plan



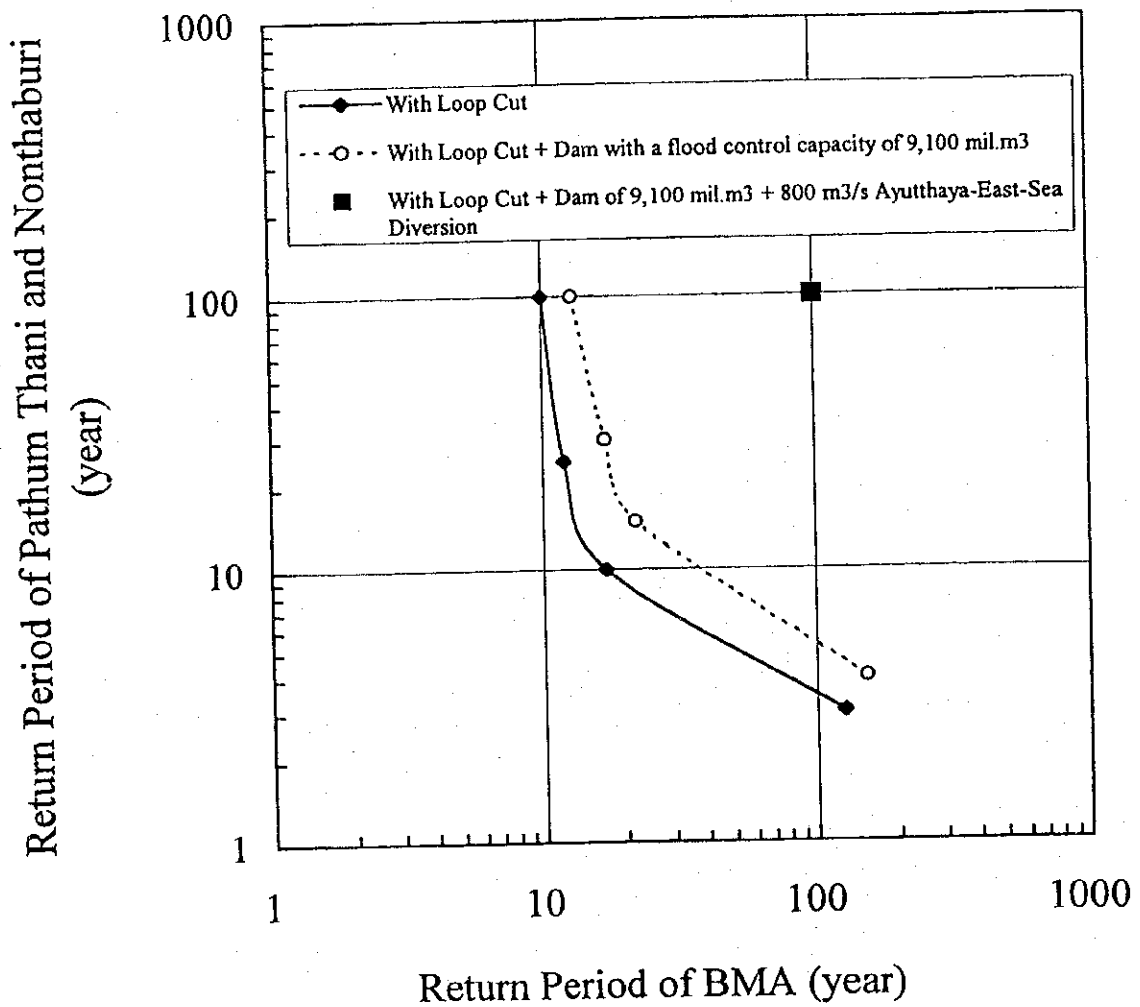
Option 6: 100-year Protection of P.T. & N.B. with Diversion Channel

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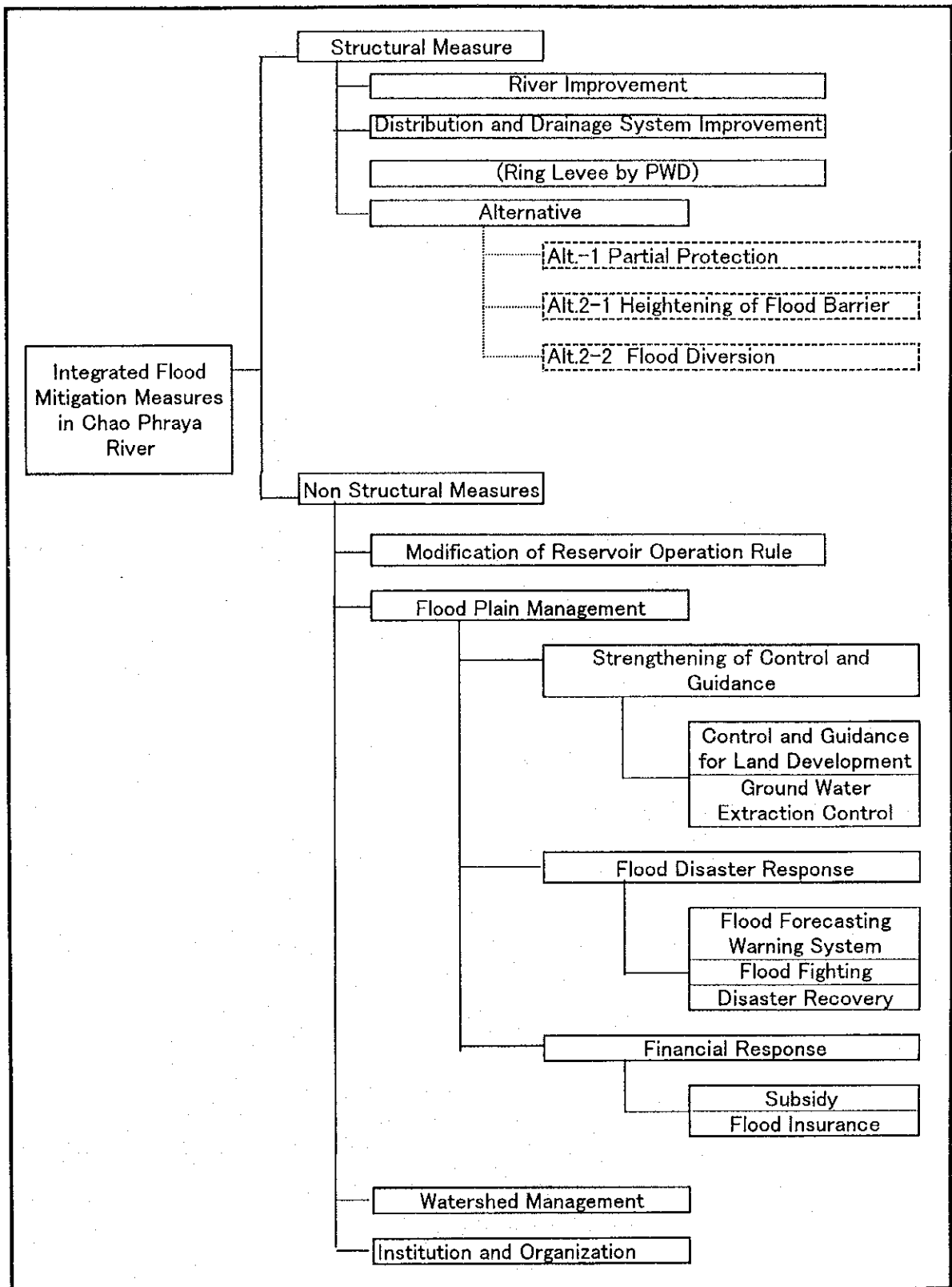
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Fig. 6.1.3
COMBINATION OF OPTIONS FOR PROTECTION OF BMA, NONTHABURI AND PATHUM THANI

Relationship of Protection Level between BMA and Pathum Thani & Nonthaburi

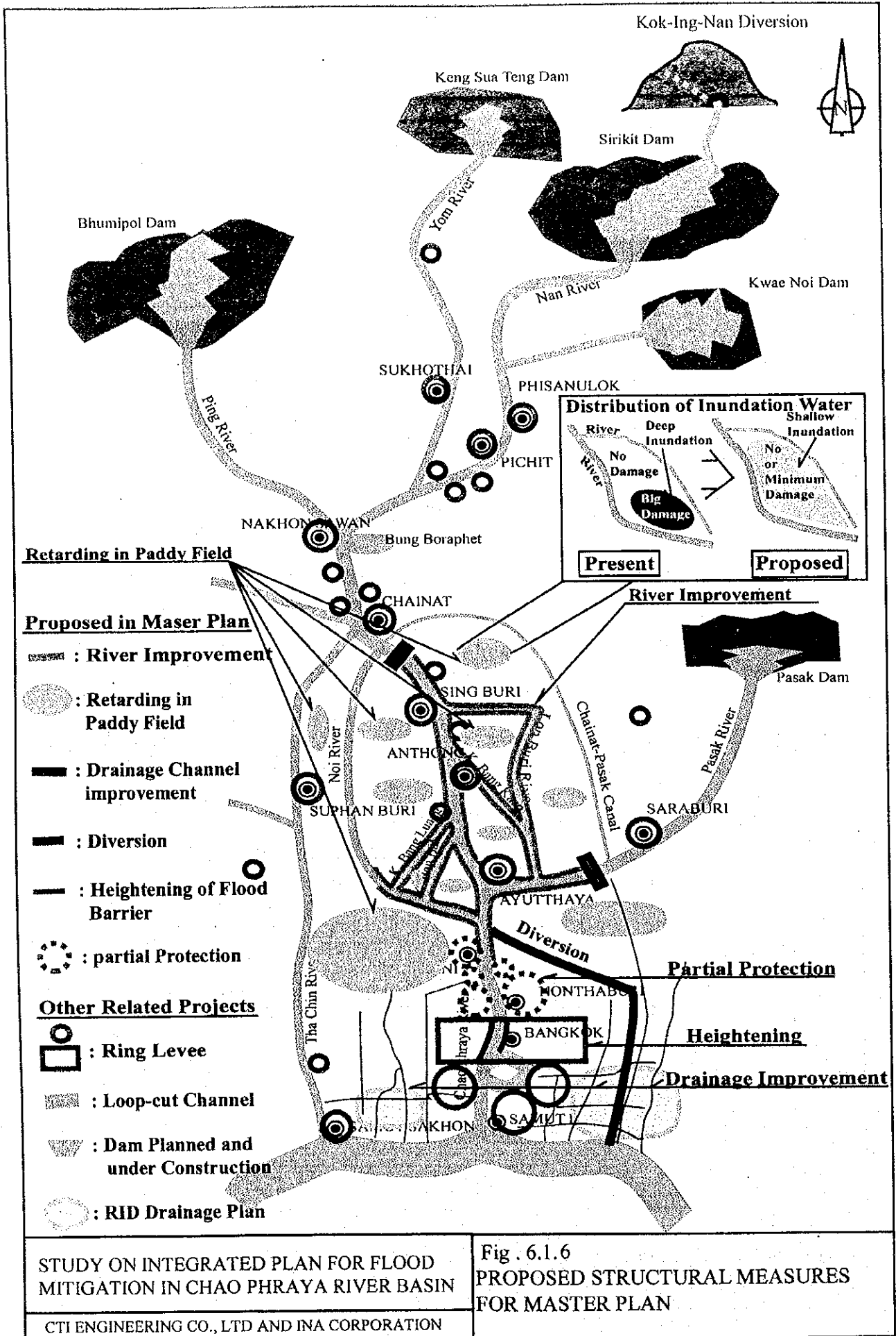


Note : BMA Area is assumed to have been protected by the flood barrier dike which is currently under construction.



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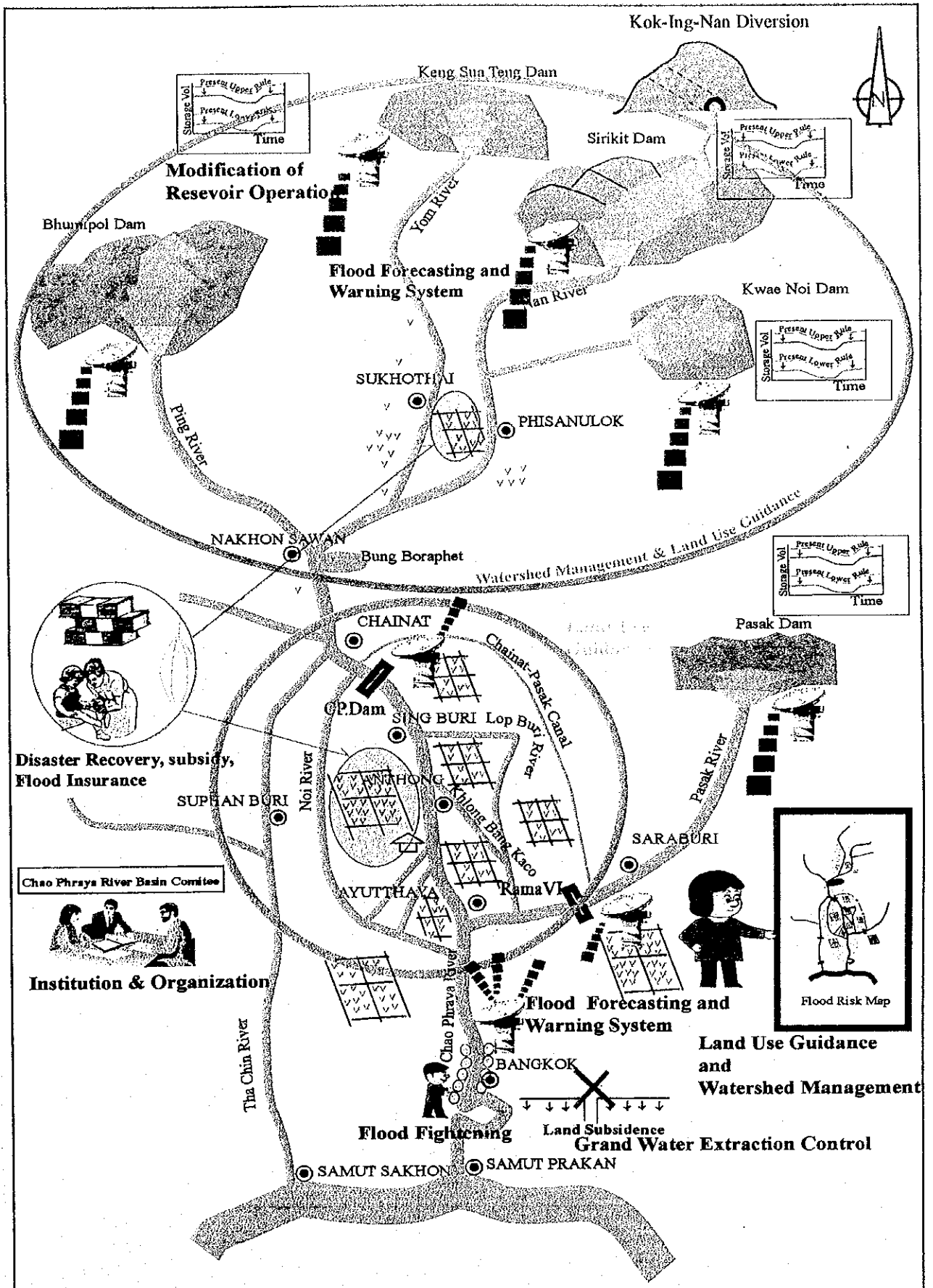
Fig.6.1.5
 COMPOSITION OF MASTER PLAN



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

Fig. 6.1.6 PROPOSED STRUCTURAL MEASURES FOR MASTER PLAN

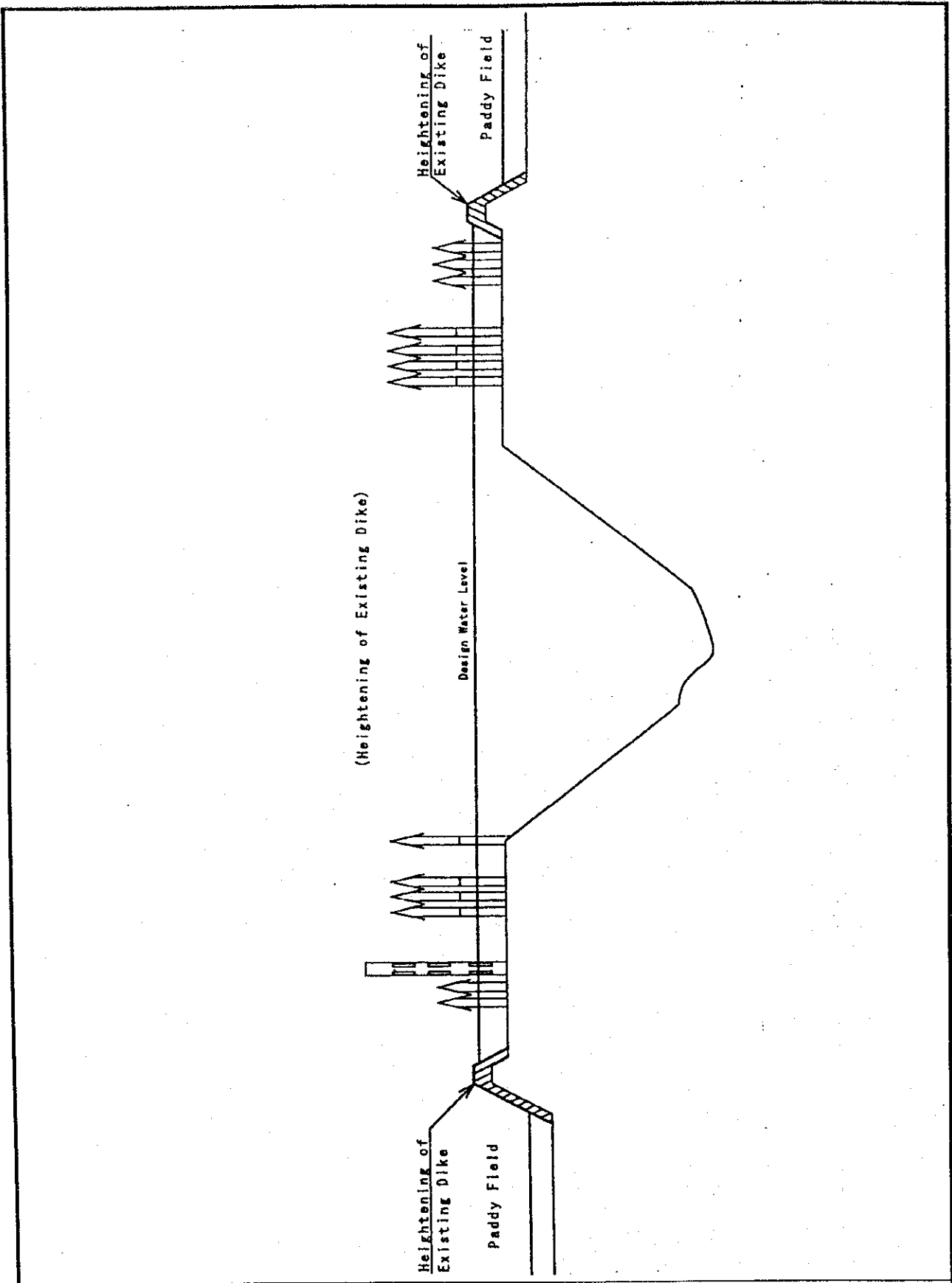
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STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

Fig. 6.1.7 PROPOSED NON-STRUCTURAL MEASURES FOR MASTER PLAN

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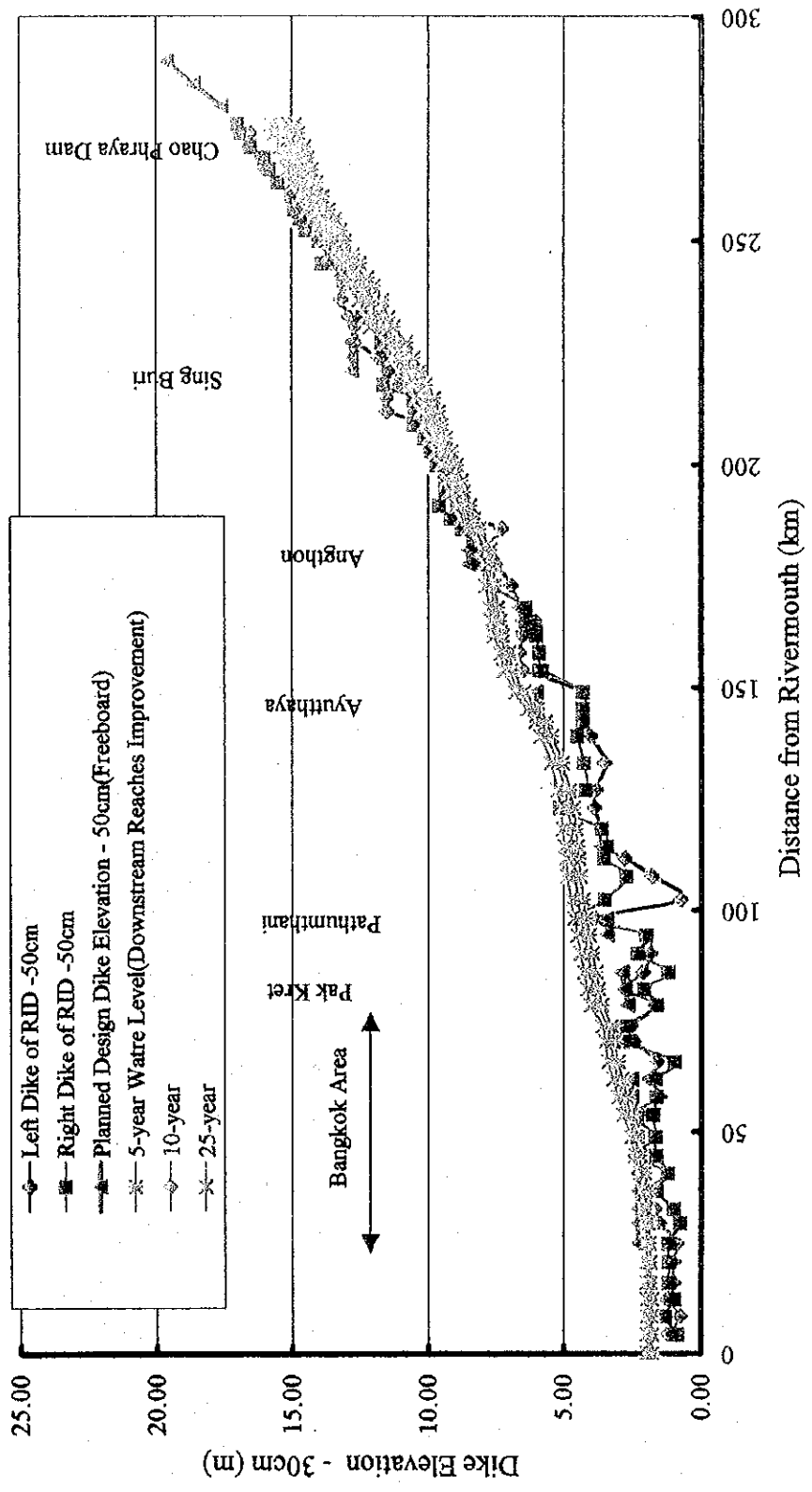


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MITIGATION IN CHAO PHRAYA RIVER BASIN

CTI ENGINEERING CO., LTD. AND INA CORPORATION

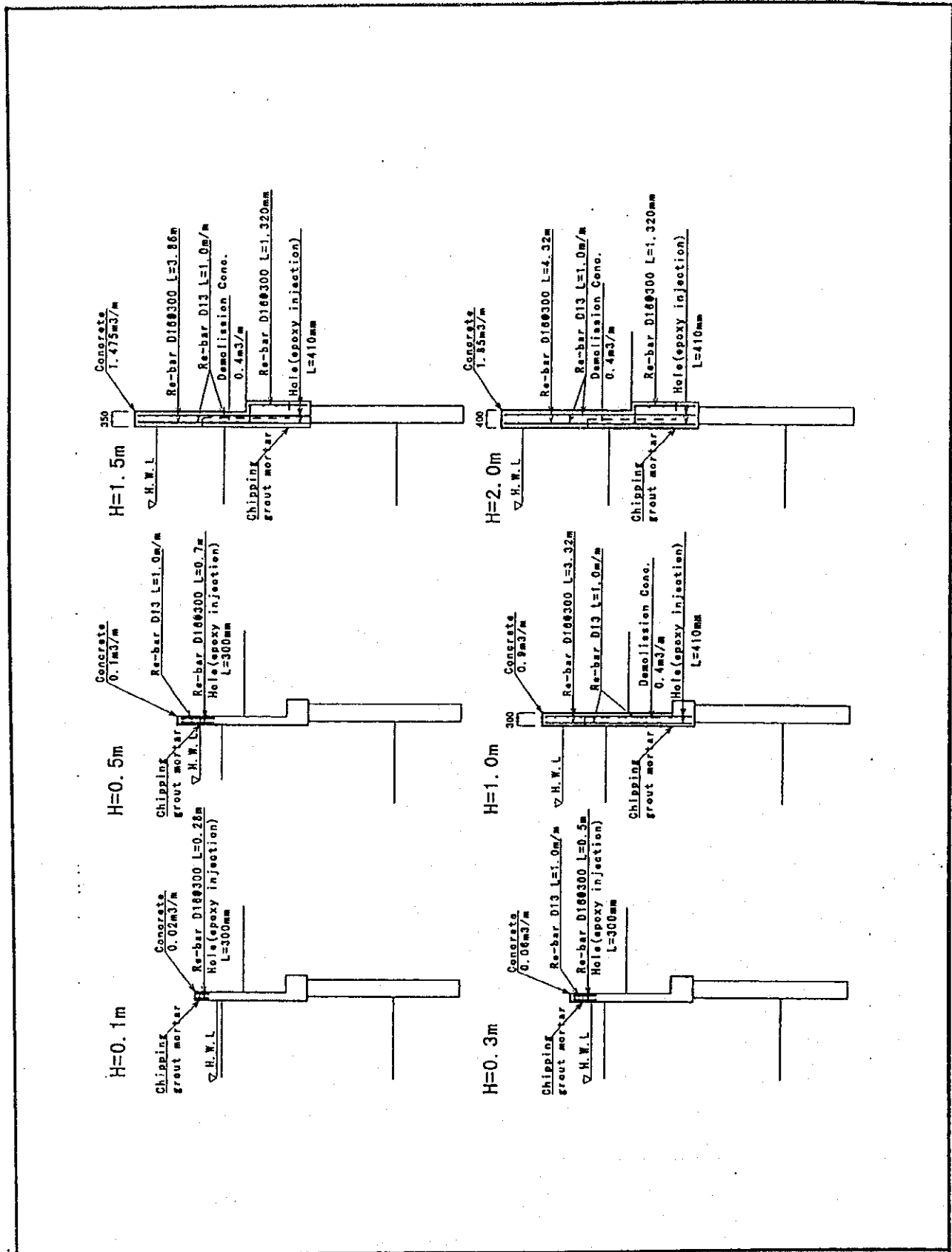
Fig. 6.2.1
TYPICAL CROSS SECTION

Water Level Corresponding to Provable Discharge and Dike Elevation (MSL) - 50cm Improvement Reaches: Up to Chainat



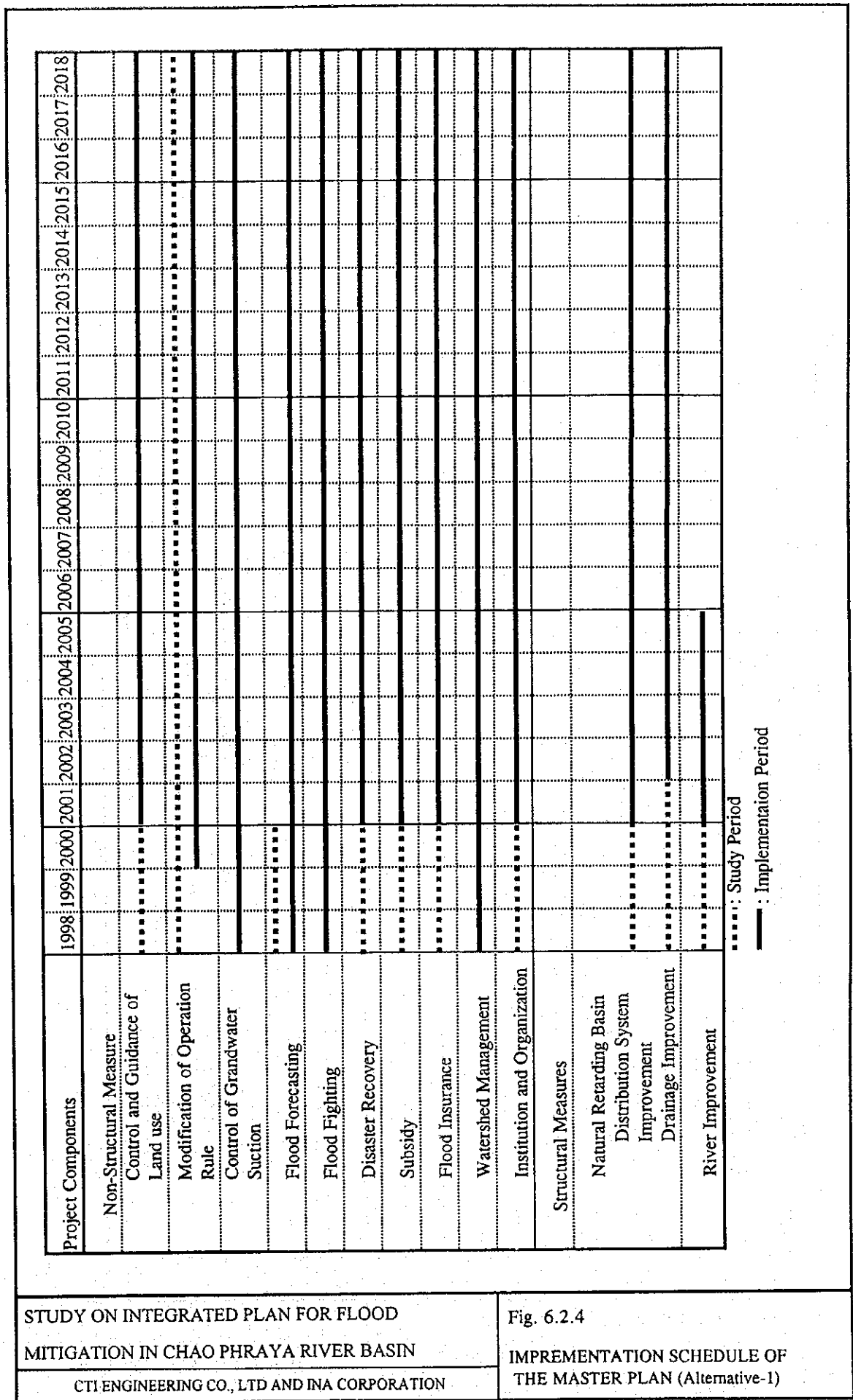
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN
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Fig .6.2.2
 LONGITUDINAL PROFILE FOR RIVER TRAINING OF CHAO PHRAYA RIVER



STUDY ON ON INTEGRATED PLAN FOR FLOOD
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Fig. 6.2.3
 DETAIL OF IMPROVEMENT FOR BMA FLOOD
 PROTECTION WALL



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN
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Fig. 6.2.4
 IMPREMENTATION SCHEDULE OF THE MASTER PLAN (Alternative-1)

Project Components	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Structural Measure																					
Control and Guidance of Land use
Modification of Operation Rule
Control of Grandwater Suction
Flood Forecasting
Flood Fighting
Disaster Recovery
Subsidy
Flood Insurance
Watershed Management
Institution and Organization
Structural Measures																					
Natural Retarding Basin																					
Distribution System Improvement
Drainage Improvement
River Improvement
Heightening of Flood Barrier in Bangkok																					

..... : Study Period
 — : Implementation Period

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

Fig. 6.2.5
 IMPLEMENTATION SCHEDULE OF THE MASTER PLAN (Alternative2-1)