Table 6.1.8 (1/3) MEASURES SELECTED FOR MASTER PLAN
Alternative-1

Areas	Major Flood Problems	Conceivable Measures		Proposed Measures		Remarks
		Structural Measures	Non-structural Measures	Structural Measures	Non-structural Measures	
Upper Central Plain	- Flood damage in urban Areas	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Based on PWD Plan (100-year)
	- Flood damage in agricultural areas	River improvement	Land use control and guidance, modification of reservoir operation and others	Not applicable	Land use control and guidance, modification of reservoir operation and others	(2 ~ 10-year)
Nakon Sawan Area	- Flood damage in urban Areas	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Based on PWD Plan (100-year)
	- Flood damage in agricultural areas	River improvement	Land use control and guidance, modification of reservoir operation and others	Not applicable	Land use control and guidance, modification of reservoir operation and others	(2 ~ 10-year)
Higher Delta in Lower Central Plain (Chainat-Ayuthaya)	- Flood damage in urban Areas	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Based on PWD Plan (100-year)
	- Flood damage in agricultural areas	River improvement, distribution system improvement* and diversion channel	Land use control and guidance, modification of reservoir operation and others	River improvement and distribution system improvement*	Land use control and guidance, modification of reservoir operation and others	10-year
Lower Delta in Lower Central Plain (Down stream of Ayuthaya)	- Flood damage in urban Areas and Bangkok	Ring levee with drainage pump, diversion channel and heightening of flood barrier at Bangkok	Land use control and guidance, modification of reservoir operation and others	Parcial protection of Nonthaburi and Pathum thani by ring levee with drainage pump and Ring levee with drainage pump of other PWD and BMA	Land use control and guidance, modification of reservoir operation and others	Based on PWD Plan (100-year) and BMA Plan
	- Flood damage in agricultural areas	River improvement and distribution system improvement*	Land use control and guidance, modification of reservoir operation and others	River improvement and distribution system improvement*	Land use control and guidance, modification of reservoir operation and others	10-year

*: Damage mitigation measures in agriculutral area are included.

Table 6.1.8 (2/3) MEASURES SELECTED FOR MASTER PLAN
Alternative-2-1

Areas	Major Flood Problems	Conceivable Measures		Proposed Measures		Remarks
		Structural Measures	Non-structural Measures	Structural Measures	Non-structural Measures	
Upper Central Plain	- Flood damage in urban Areas	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Based on PWD Plan (100-year)
	- Flood damage in agricultural areas	River improvement	Land use control and guidance, modification of reservoir operation and others	Not applicable	Land use control and guidance, modification of reservoir operation and others	(2 ~ 10-year)
Nakon Sawan Area	- Flood damage in urban Areas	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Based on PWD Plan (100-year)
	- Flood damage in agricultural areas	River improvement	Land use control and guidance, modification of reservoir operation and others	Not applicable	Land use control and guidance, modification of reservoir operation and others	(2 ~ 10-year)
Higher Delta in Lower Central Plain (Chainat-Ayuthaya)	- Flood damage in urban Areas	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Based on PWD Plan (100-year)
	- Flood damage in agricultural areas	River improvement, distribution system improvement* and diversion channel	Land use control and guidance, modification of reservoir operation and others	River Improvement and distribution system improvement*	Land use control and guidance, modification of reservoir operation and others	10-year
Lower Delta in Lower Central Plain (Down stream of Ayuthaya)	- Flood damage in urban Areas and Bangkok	Ring levee with drainage pump, diversion channel and heightening of flood barrier at Bangkok	Land use control and guidance, modification of reservoir operation and others	Ring levee with drainage pump and heightening of flood barrier at Bangkok	Land use control and guidance, modification of reservoir operation and others	Based on PWD Plan (100-year) and BMA Plan
	- Flood damage in agricultural areas	River improvement and distribution system improvement*	Land use control and guidance, modification of reservoir operation and others	River improvement and distribution system improvement*	Land use control and guidance, modification of reservoir operation and others	10-year

*: Damage mitigation measures in agriculutral area are included.

Table 6.1.8 (3/3) MEASURES SELECTED FOR MASTER PLAN
Alternative-2-2

Areas	Major Flood Problems	Conceivable Measures		Proposed Measures		Remarks
		Structural Measures	Non-structural Measures	Structural Measures	Non-structural Measures	
Upper Central Plain	- Flood damage in urban Areas	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Based on PWD Plan (100-year)
	- Flood damage in agricultural areas	River improvement	Land use control and guidance, modification of reservoir operation and others	Not applicable	Land use control and guidance, modification of reservoir operation and others	(2 ~ 10-year)
Nakon Sawan Area	- Flood damage in urban Areas	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Based on PWD Plan (100-year)
	- Flood damage in agricultural areas	River improvement	Land use control and guidance, modification of reservoir operation and others	Not applicable	Land use control and guidance, modification of reservoir operation and others	(2 ~ 10-year)
Higher Delta in Lower Central Plain (Chainat-Ayuthaya)	- Flood damage in urban Areas	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Ring levee with drainage pump	Land use control and guidance, modification of reservoir operation and others	Based on PWD Plan (100-year)
	- Flood damage in agricultural areas	River improvement, distribution system improvement* and diversion channel	Land use control and guidance, modification of reservoir operation and others	River Improvement, distribution system improvement* and diversion channel	Land use control and guidance, modification of reservoir operation and others	First stage: 10-year, Second Stage: 25-year
Lower Delta in Lower Central Plain (Down stream of Ayuthaya)	- Flood damage in urban Areas and Bangkok	Ring levee with drainage pump, diversion channel and heightening of flood barrier at	Land use control and guidance, modification of reservoir operation and others	Ring levee with drainage pump and diversion channel	Land use control and guidance, modification of reservoir operation and others	Based on PWD Plan (100-year) and BMA plan
	- Flood damage in agricultural areas	River improvement and distribution system improvement*	Land use control and guidance, modification of reservoir operation and others	River Improvement and distribution system improvement*	Land use control and guidance, modification of reservoir operation and others	First stage: 10-year, Second Stage: 25-year

*: Damage mitigation measures in agriculutral area are included.

Table 6.1.9 (1/3) FEATURES OF SELECTED MEASURES FOR MASTER PLAN

(Altenative-1)

Measures	Location of Measures	Dimension	Cost (million bahts) *3	
			Initial	O & M
Modification of Reservoir Operation	Five dams	14,600 mil. m3 of storage capacity for flood control	Economic Cost	Economic Cost
	Bumipol	5,500 mil. m3	40	394
	Sirikit	6,500 mil. m3	Financial Cost	Financial Cost
	Pasak	772 mil. m3	46	451
	Kwae Noi	733 mil. m3		
	Kaeng Sua Teng	1,125 mil. m3		
River Training	Main Stretch between Phatum Thani and Chainat	400 km in total with 10-year return period	Economic Cost	Economic Cost
	Chao Phraya River (between Pathumthani and Chainat)	180 km	1,234	31
	Lop Buri River	100 km		
	Noi River (between Bang Sai and Pakhai)	30 km	Financial Cost	Financial Cost
	Pasak River (between Ayutthaya and Rama VI)	50 km	1,425	34
	Bang Bal Canal	15 km		
	Bang Luang Canal	15 km		
	Bang Keao Canal	15 km		
Distribution and Drainage System Improvement including Damage Mitigation Measures	Flood pron area in higher delta in lower central plain	5,600 km2 of paddy field with drainage channels*1 improvement of 75 m3/s each in total capacity and 80 km of stretch in west bank and 55 km of it in east bank	Economic Cost 5,632 Financial Cost 7,020	Economic Cost 39 Financial Cost 44
Parcial Protection by Ring Levee	Nanthaburi and Pathum Thani	Parcial protection by ring levee with drainage pump	-	-
Protection of Urban Area	Major urban areas: BMA, 12 provincial capitals and 16 municipalities exclusive of Nonthaburi and Pathum Thani	Ring levee with drainage pump to cope with 100-year return period flood in Chao Phraya River	-	-

*1 : Drainage channels are provided in lower delta in lower central plain both of east and west.

*2 : Apply the existing operation rule

Table 6.1.9 (2/3) FEATURES OF SELECTED MEASURES FOR MASTER PLAN

(Altenative-2-1)

Measures	Location of Measures	Dimension	Cost (million bahts) *3	
			Initial	O & M
Modification of Reservoir Operation	Five dams	14,600 mil. m3 of storage capacity for flood control	Economic Cost	Economic Cost
	Bumipol	5,500 mil. m3	40	394
	Sirikit	6,500 mil. m3	Financial Cost	Financial Cost
	Pasak	772 mil. m3	46	451
	Kwae Noi	733 mil. m3		
	Kaeng Sua Teng	1,125 mil. m3		
River Training	Main Stretch between Phatum Thani and Chainat	400 km in total with 10-year return period	Economic Cost	Economic Cost
	Chao Phraya River (between Pathumthani and Chainat)	180 km	1,234	31
	Lop Buri River	100 km		
	Noi River (between Bang Sai and Pakhai)	30 km	Financial Cost	Financial Cost
	Pasak River (between Ayutthaya and Rama VI)	50 km	1,425	34
	Bang Bal Canal	15 km		
	Bang Luang Canal	15 km		
	Bang Keao Canal	15 km		
Distribution and Drainage System Improvement including Damage Mitigation Measures	Flood pron area in higher delta in lower central plain	5,600 km2 of paddy field with drainage channels*1 improvement of 75 m3/s each in total capacity and 80 km of stretch in west bank and 55 km of it in east bank	Economic Cost 5,632 Financial Cost 7,020	Economic Cost 39 Financial Cost 44
Heightening of Flood Barrier	Bankok Metropolitan Area	Heightening of flood barrier with 30 cm on an average	EC 1,492 FC 1,840	EC 31 FC 34
Protection of Urban Area	Major urban areas: BMA, 14 provincial capitals and 18 municipalities	Ring levee with drainage pump to cope with 100-year return period flood in Chao Phraya River	-	-

*1 : Drainage channels are provided in lower delta in lower central plain both of east and west.

*2 : Apply the existing operation rule

Table 6.1.9 (3/3) FEATURES OF SELECTED MEASURES FOR MASTER PLAN

(Altenative-2-2)

Measures	Location of Measures	Dimension	Cost (million bahts) *3	
			Initial	O & M
Modification of Reservoir Operation	Five dams	14,600 mil. m3 of storage capacity for flood control	Economic Cost	Economic Cost
	Bumipol	5,500 mil. m3	40	394
	Sirikit	6,500 mil. m3	Financial Cost	Financial Cost
	Pasak	772 mil. m3		
	Kwae Noi	733 mil. m3	46	451
	Kaeng Sua Teng	1,125 mil. m3		
River Training (Stage-1)	Main Stretch between Phatum Thani and Chainat	400 km in total with 10-year return period	Economic Cost	Economic Cost
	Chao Phraya River (between Pathumthani and Chainat)	180 km	1,234	31
	Lop Buri River	100 km		
	Noi River (between Bang Sai and Pakhai)	30 km	Financial Cost	Financial Cost
	Pasak River (between Ayutthaya and Rama VI)	50 km	1,425	34
	Bang Bal Canal	15 km		
	Bang Luang Canal	15 km		
	Bang Keao Canal	15 km		
River Training (Stage-2)	Main Stretch between Phatum Thani and Chainat	400 km in total with 25-year return period	Economic Cost	Economic Cost
	Chao Phraya River (between Pathumthani and Chainat)	180 km	1,588	40
	Lop Buri River	100 km		
	Noi River (between Bang Sai and Pakhai)	30 km	Financial Cost	Financial Cost
	Pasak River (between Ayutthaya and Rama VI)	50 km	1,834	44
	Bang Bal Canal	15 km		
	Bang Luang Canal	15 km		
	Bang Keao Canal	15 km		
Distribution and Drainage System Improvement including Damage Mitigation Measures	Flood pron area in higher delta in lower central plain	5,600 km2 of paddy field with drainage channels*1 improvement of 75 m3/s each in total capacity and 80 km of stretch in west bank and 55 km of it in east bank	Economic Cost 5,632 Financial Cost 7,020	Economic Cost 39 Financial Cost 44
Diversion Channel (Stage-1)	Ayuthaya-East Bank-Sea	800 m3/s of flow capacity with the stretch of 95 km	EC 24,989 FC 33,684	EC 127 FC 141
Diversion Channel (Stage-2)	Ayuthaya-East Bank-Sea	Increase of flow capacity from 800 m3/s to 300 m3/s with the stretch of 95 km	EC 6,143 FC 8,645	EC 40 FC 45
Protection of Urban Area	Major urban areas: BMA, 14 provincial capitals and 18 municipalities	Ring levee with drainage pump to cope with 100-year return period flood in Chao Phraya River	-	-

*1 : Drainage channels are provided in lower delta in lower central plain both of east and west.

*2 : Apply the existing operation rule

Table 6.2.1 FINANCIAL AND ECONOMIC COST AND BENEFIT OF ALTERNATIVE-1

Benefit (million baht/yeawr)

General	Agriculture	Total
1,997	196	2,193

exclnding benefit of Dam

Cost Evaluation (Unit : baht 1,000,000)

Distribution System Improvement :Thai (Financial)

	Classification of cost	L.C.	F.C	Total
1	Constructioin cost	101	123	224
	1) Material and Equipment	86	123	208
	2)Skilled Labor	4	0	4
	3)Unskilled Labor	11	0	11
2	Land acquisition & House R	3	0	3
3	Administration	3	0	3
4	1)Engineering serviceD/D	1	5	6
	2)Engineering serviceS/V	1	11	13
5	Phisical contingency	4	7	11
	Sub-total	113	146	259
6	Price Contingency	12	14	26
	Grand total	125	160	285
	OM Cost			2

Distribution System Improvement :Thai (Economic)

	Classification of cost	L.C.	F.C	Total
1	Constructioin cost	88	112	199
	1) Material and Equipment	75	112	186
	2)Skilled Labor	4	0	4
	3)Unskilled Labor	10	0	10
2	Land acquisition & House Relox	2	0	2
3	Administration	2	0	2
4	1)Engineering serviceD/D	0	5	5
	2)Engineering serviceS/V	1	10	12
5	Phisical contingency	4	6	10
	Sub-total	98	133	231
6	Price Contingency	0	0	0
	Grand total	98	133	231
	OM Cost			2

Drainage Improvement :Thai (Financial)

	Classification of cost	L.C.	F.C	Total
1	Constructioin cost	2,112	2,327	4,439
	1) Material and Equipment	1,837	2,327	4,163
	2)Skilled Labor	92	0	92
	3)Unskilled Labor	184	0	184
2	Land acquisition & House R	612	0	612
3	Administration	61	0	61
4	1)Engineering serviceD/D	31	122	153
	2)Engineering serviceS/V	61	306	367
5	Phisical contingency	245	245	490
	Sub-total	3,122	3,000	6,123
6	Price Contingency	312	300	612
	Grand total	3,435	3,300	6,735
	OM Cost			42

Drainage Improvement : Thai (Economic)

	Classification of cost	L.C.	F.C	Total
1	Constructioin cost	1,838	2,117	3,955
	1) Material and Equipment	1,603	2,117	3,721
	2)Skilled Labor	80	0	80
	3)Unskilled Labor	155	0	155
2	Land acquisition & House Relox	486	0	486
3	Administration	53	0	53
4	1)Engineering serviceD/D	27	111	138
	2)Engineering serviceS/V	53	279	332
5	Phisical contingency	214	223	437
	Sub-total	2,671	2,730	5,401
6	Price Contingency	0	0	0
	Grand total	2,671	2,730	5,401
	OM Cost			37

River Improvement 10-year (Chainat~Pathum Thani : Thai (Financial)

	Classification of cost	L.C.	F.C	Total
1	Constructioin cost	507	602	1,109
	1) Material and Equipment	432	602	1,034
	2)(a) Skilled Labor	40		40
	(b) Unskilled Labor	35		35
2	Land acquisition	20		20
3	Administration	22		22
4	1)Engineering service D/D	8	59	66
	2)Engineering service S/V	6	56	62
5	Physical contingency	45	60	105
	Sub-total	607	776	1,384
6	Price Contingency	18	23	41
	Grand total	625	800	1,425
	OM Cost			34

River Improvement 10-year (Chainat~Pathum Thani : Thai (Economic)

	Classification of cost	L.C.	F.C	Total
1	Constructioin cost	441	548	989
	1) Material and Equipment	377	548	925
	2)(a) Skilled Labor	35	0	35
	(b) Unskilled Labor	29	0	29
2	Land acquisition	16	0	16
3	Administration	19	0	19
4	1)Engineering service D/D	7	53	60
	2)Engineering service S/V	5	51	56
5	Physical contingency	39	55	94
	Sub-total	528	707	1,234
6	Price Contingency	0	0	0
	Grand total	528	707	1,234
	OM Cost		31	31

Dam Compensation Cost : Thai (Financial)

	Classification of cost	L.C.	F.C	Total
1	Constructioin cost	0	0	0
	1) Material and Equipment	0	0	0
	2)(a) Skilled Labor	0	0	0
	(b) Unskilled Labor	0	0	0
2	Land acquisition	0	0	0
3	Administration	0	0	0
4	Engineering service	0	0	0
5	Physical contingency	46	0	46
	Sub-total	46	0	46
6	Price Contingency	0	0	0
	Grand total	46	0	46
	OM Cost	451	0	451

Dam Compensation : Thai (Economic)

	Classification of cost	L.C.	F.C	Total
1	Constructioin cost	0	0	0
	1) Material and Equipment	0	0	0
	2)(a) Skilled Labor	0	0	0
	(b) Unskilled Labor	0	0	0
2	Land acquisition	0	0	0
3	Administration	0	0	0
4	Engineering service	0	0	0
5	Physical contingency	40	0	40
	Sub-total	40	0	40
6	Price Contingency	0	0	0
	Grand total	40	0	40
	OM Cost	394	0	394

Note : Physical contingency of Dam means initial cost of necessary expenses for preparation.

Table 6.2.2 PROJECT EVALUATION OF ALTERNATIVE 1

Alt-1 (excluding Dams) Unit: million baht

		Economic cost			Economic benefit			
Year		Construction (A)	O&M (B)	Total (C)	General, etc. (D)	Agri. (E)	Tot Economic Benefit (F)	(F)-(C) Benefit-Cost (G)
1	1998	1	0	1	0	0	0	-1
2	1999	56	0	56	0	0	0	-56
3	2000	87	0	87	0	0	0	-87
4	2001	99	0	99	0	0	0	-99
5	2002	627	0	627	0	0	0	-627
6	2003	1,199	0	1,199	0	0	0	-1,199
7	2004	1,939	0	1,939	0	0	0	-1,939
8	2005	1,602	2	1,604	78	15	93	-1,511
9	2006	765	33	798	969	49	1,018	220
10	2007	479	33	512	969	49	1,018	506
11	2008	0	70	70	1,997	177	2,174	2,104
12	2009	0	70	70	1,997	177	2,174	2,104
13	2010	0	70	70	1,997	177	2,174	2,104
14	2011	0	70	70	1,997	177	2,174	2,104
15	2012	0	70	70	1,997	177	2,174	2,104
16	2013	0	70	70	1,997	196	2,193	2,123
17	2014	0	70	70	1,997	196	2,193	2,123
18	2015	0	70	70	1,997	196	2,193	2,123
19	2016	0	70	70	1,997	196	2,193	2,123
20	2017	0	70	70	1,997	196	2,193	2,123
21	2018	0	70	70	1,997	196	2,193	2,123
22	2019	0	70	70	1,997	196	2,193	2,123
23	2020	0	70	70	1,997	196	2,193	2,123
24	2021	0	70	70	1,997	196	2,193	2,123
25	2022	0	70	70	1,997	196	2,193	2,123
26	2023	0	70	70	1,997	196	2,193	2,123
27	2024	0	70	70	1,997	196	2,193	2,123
28	2025	0	70	70	1,997	196	2,193	2,123
29	2026	0	70	70	1,997	196	2,193	2,123
30	2027	0	70	70	1,997	196	2,193	2,123
31	2028	0	70	70	1,997	196	2,193	2,123
32	2029	0	70	70	1,997	196	2,193	2,123
33	2030	0	70	70	1,997	196	2,193	2,123
34	2031	0	70	70	1,997	196	2,193	2,123
35	2032	0	70	70	1,997	196	2,193	2,123
36	2033	0	70	70	1,997	196	2,193	2,123
37	2034	0	70	70	1,997	196	2,193	2,123
38	2035	0	70	70	1,997	196	2,193	2,123
39	2036	0	70	70	1,997	196	2,193	2,123
40	2037	0	70	70	1,997	196	2,193	2,123
41	2038	0	70	70	1,997	196	2,193	2,123
42	2039	0	70	70	1,997	196	2,193	2,123
43	2040	0	70	70	1,997	196	2,193	2,123
44	2041	0	70	70	1,997	196	2,193	2,123
45	2042	0	70	70	1,997	196	2,193	2,123
46	2043	0	70	70	1,997	196	2,193	2,123
47	2044	0	70	70	1,997	196	2,193	2,123
48	2045	0	70	70	1,997	196	2,193	2,123
49	2046	0	70	70	1,997	196	2,193	2,123
50	2047	0	70	70	1,997	196	2,193	2,123
51	2048	0	70	70	1,997	196	2,193	2,123
52	2049	0	70	70	1,997	196	2,193	2,123
53	2050	0	70	70	1,997	196	2,193	2,123
54	2051	0	70	70	1,997	196	2,193	2,123
55	2052	0	70	70	1,997	196	2,193	2,123
56	2053	0	70	70	1,997	196	2,193	2,123
57	2054	0	70	70	1,997	196	2,193	2,123
58	2055	0	70	70	1,997	196	2,193	2,123
59	2056	0	70	70	1,997	196	2,193	2,123
60	2057	0	70	70	1,997	196	2,193	2,123
61	2058	0	70	70	1,997	196	2,193	2,123
62	2059	0	70	70	1,997	196	2,193	2,123
63	2060	0	70	70	1,997	196	2,193	2,123
64	2061	0	70	70	1,997	196	2,193	2,123
65	2062	0	70	70	1,997	196	2,193	2,123
66	2063	0	70	70	1,997	196	2,193	2,123
67	2064	0	70	70	1,997	196	2,193	2,123
68	2065	0	70	70	1,997	196	2,193	2,123
69	2066	0	70	70	1,997	196	2,193	2,123
70	2067	0	70	70	1,997	196	2,193	2,123
71	2068	0	70	70	1,997	196	2,193	2,123
		6,853	4,332	11,185	123,833	11,957	135,790	124,605
	EIRR		21.10%					

		PV		
Discount rate(%)	B/C	Cost	Benefit	NPV
15	1.54	2,708	4,169	1,461
12	2.00	3,298	6,588	3,291
10	2.44	3,793	9,269	5,476
5	4.71	5,700	26,845	21,145
3	6.66	7,049	46,972	39,923

Table 6.2.3 FINANCIAL CONSIDERATION

Unit : million baht

Item	Amount	Remark
I. Budget :		
Gov.Thailand	984,000	
Ministry of Agriculture and Cooperative		
RID	44,436	
Ministry of Interior		
PWD	39,813	
BMA	12,264	
Other Related Agency		
HD (Harbour Dept.)	2,301	
DOH (Dept. of Highway)	78127	
(1) Total of RID, PWD and BMA	96,513	
(1)' Total of (1), HD and DOH	176,941	
II. Cost :		
(a) Cost Requirement (Alternative-1)		
Distrubution System Improvement	14	285/20=14
Drainage System Improvement	337	6,735/20=337
River Improvement	71	1425/20=71
Modification of Dam Operation Rule	*453*	40/20+451=453
(2) Total Cost requirement/year	875	
(2) / (1) %	0.9	
(2) / (1)' %	0.5	
(b) Cost Requirement (Alternative 2-1)		
Distrubution System Improvement	14	285/20=14
Drainage System Improvement	337	6,735/20=337
Heightening of Flood Barrier	92	1,840/20=92
River Improvement	71	1,425/20=71
Modification of Dam Operation Rule	*453*	40/20+451=453
(3) Total Cost requirement/year	967	
(3) / (1) %	1.0	
(3) / (1)' %	0.5	
(b) Cost Requirement (Alternative 2-2)	2,992	
Distrubution System Improvement	14	285/20=14
Drainage System Improvement	337	6,735/20=337
Diversion Channel	2,116	42,329/20=2116
River Improvement	71	1,425/20=71
Modification of Dam Operation Rule	*453*	40/20+451=453
(4) Total Cost requirement/year	2,992	
(4) / (1) %	3.1	
(4) / (1)' %	1.7	

Note : Budget for 1997 from the source of Statiatical Yearbook Thailand,1996.

Table 6.2.4 FINANCIAL AND ECONOMIC COST AND BENEFIT OF ALTERNATIVE-2-1

Benefit (million baht/yeawr)

General	Agriculture	Total
3,568	196	3,764

excluding benefit of Dam

Cost Evaluation (Unit : baht 1,000,000)

Distribution System Improvement :Thai (Financial)

	Classification of cost	L.C.	F.C	Total
1	Construction cost	101	123	224
	1) Material and Equipment	86	123	208
	2)Skilled Labor	4	0	4
	3)Unskilled Labor	11	0	11
2	Land acquisition & House R	3	0	3
3	Administration	3	0	3
4	1)Engineering serviceD/D	1	5	6
	2)Engineering serviceS/V	1	11	13
5	Phisical contingency	4	7	11
	Sub-total	113	146	259
6	Price Contingency	12	14	26
	Grand total	125	160	285
	OM Cost			2

Distribution System Improvement :Thai (Economic)

	Classification of cost	L.C.	F.C	Total
1	Construction cost	88	112	199
	1) Material and Equipment	75	112	186
	2)Skilled Labor	4	0	4
	3)Unskilled Labor	10	0	10
2	Land acquisition & House Relo	2	0	2
3	Administration	2	0	2
4	1)Engineering serviceD/D	0	5	5
	2)Engineering serviceS/V	1	10	12
5	Phisical contingency	4	6	10
	Sub-total	98	133	231
6	Price Contingency	0	0	0
	Grand total	98	133	231
	OM Cost			2

Drainage Improvement :Thai (Financial)

	Classification of cost	L.C.	F.C	Total
1	Construction cost	2,112	2,327	4,439
	1) Material and Equipment	1,837	2,327	4,163
	2)Skilled Labor	92	0	92
	3)Unskilled Labor	181	0	184
2	Land acquisition & House R	612	0	612
3	Administration	61	0	61
4	1)Engineering serviceD/D	31	122	153
	2)Engineering serviceS/V	61	306	367
5	Phisical contingency	245	245	490
	Sub-total	3,122	3,000	6,123
6	Price Contingency	312	300	612
	Grand total	3,435	3,300	6,735
	OM Cost			42

Drainage Improvement : Thai (Economic)

	Classification of cost	L.C.	F.C	Total
1	Construction cost	1,838	2,117	3,955
	1) Material and Equipment	1,603	2,117	3,721
	2)Skilled Labor	80	0	80
	3)Unskilled Labor	155	0	155
2	Land acquisition & House Relo	486	0	486
3	Administration	53	0	53
4	1)Engineering serviceD/D	27	111	138
	2)Engineering serviceS/V	53	279	332
5	Phisical contingency	214	223	437
	Sub-total	2,671	2,730	5,401
6	Price Contingency	0	0	0
	Grand total	2,671	2,730	5,401
	OM Cost			37

Bangkok Dike along Chao Phraya River (Heightening=0.3m): Thai (Financial)

	Classification of cost	L.C.	F.C	Total
1	Construction cost	653	791	1,445
	1) Material and Equipment	552	791	1,344
	2)Skilled Labor	28	0	28
	3)Unskilled Labor	74	0	74
2	Land acquisition & House R	18	0	18
3	Administration	18	0	18
4	1)Engineering serviceD/D	4	33	37
	2)Engineering serviceS/V	9	74	83
5	Phisical contingency	28	44	72
	Sub-total	731	942	1,673
6	Price Contingency	75	92	167
	Grand total	806	1,034	1,840
	OM Cost			13

Bangkok Dike along Chao Phraya River (Heightening=0.3m): Thai (Economic)

	Classification of cost	L.C.	F.C	Total
1	Construction cost	568	720	1,288
	1) Material and Equipment	482	720	1,202
	2)Skilled Labor	24	0	24
	3)Unskilled Labor	62	0	62
2	Land acquisition & House Relo	15	0	15
3	Administration	16	0	16
4	1)Engineering serviceD/D	3	30	33
	2)Engineering serviceS/V	8	67	75
5	Phisical contingency	24	40	64
	Sub-total	634	858	1,492
6	Price Contingency	0	0	0
	Grand total	634	858	1,492
	OM Cost			12

River Improvement 10-year (Chainat~Pathum Thani : Thai (Financial)

	Classification of cost	L.C.	F.C	Total
1	Construction cost	507	602	1,109
	1) Material and Equipment	432	602	1,034
	2)(a) Skilled Labor	40		40
	(b) Unskilled Labor	35		35
2	Land acquisition	20		20
3	Administration	22		22
4	1)Engineering service D/D	8	59	66
	2)Engineering service S/V	6	56	62
5	Physical contingency	45	60	105
	Sub-total	607	776	1,384
6	Price Contingency	18	23	41
	Grand total	625	800	1,425
	OM Cost			34

River Improvement 10-year (Chainat~Pathum Thani : Thai (Economic)

	Classification of cost	L.C.	F.C	Total
1	Construction cost	441	548	989
	1) Material and Equipment	377	548	925
	2)(a) Skilled Labor	35	0	35
	(b) Unskilled Labor	29	0	29
2	Land acquisition	16	0	16
3	Administration	19	0	19
4	1)Engineering service D/D	7	53	60
	2)Engineering service S/V	5	51	56
5	Physical contingency	39	55	94
	Sub-total	528	707	1,234
6	Price Contingency	0	0	0
	Grand total	528	707	1,234
	OM Cost			31

Dam Compensation Cost : Thai (Financial)

Dam Compensation Cost : Thai (Financial)

	Classification of cost	L.C.	F.C	Total
1	Construction cost	0	0	0
	1) Material and Equipment	0	0	0
	2)(a) Skilled Labor	0	0	0
	(b) Unskilled Labor	0	0	0
2	Land acquisition	0	0	0
3	Administration	0	0	0
4	Engineering service	0	0	0
5	Physical contingency	46	0	46
	Sub-total	46	0	46
6	Price Contingency	0	0	0
	Grand total	46	0	46
	OM Cost	451	0	451

Dam Compensation : Thai (Economic)

Dam Compensation : Thai (Economic)

	Classification of cost	L.C.	F.C	Total
1	Construction cost	0	0	0
	1) Material and Equipment	0	0	0
	2)(a) Skilled Labor	0	0	0
	(b) Unskilled Labor	0	0	0
2	Land acquisition	0	0	0
3	Administration	0	0	0
4	Engineering service	0	0	0
5	Physical contingency	40	0	40
	Sub-total	40	0	40
6	Price Contingency	0	0	0
	Grand total	40	0	40
	OM Cost	394	0	394

Note : Physical contingency of Dam means initial cost of necessary expences for preparation.

Table 6.2.5 PROJECT EVALUATION OF ALTERNATIVE 2-1

Alt-2-1 (excluding Dams)

Unit: million baht

		Economic cost			Economic benefit			
Year		Construction (A)	O&M (B)	Total (C)	General, etc. (D)	Agri. (E)	Total Economic Benefit (F)	(F)-(C) Benefit-Cost (G)
1	1998	1	0	1	0	0	0	-1
2	1999	56	0	56	0	0	0	-56
3	2000	87	0	87	0	0	0	-87
4	2001	103	0	103	0	0	0	-103
5	2002	640	0	640	0	0	0	-640
6	2003	1,216	0	1,216	0	0	0	-1,216
7	2004	2,097	0	2,097	0	0	0	-2,097
8	2005	2,109	2	2,111	78	15	93	-2,018
9	2006	1,270	33	1,303	285	48	333	-970
10	2007	768	33	801	285	48	333	-468
11	2008	0	82	82	3,037	177	3,214	3,132
12	2009	0	82	82	3,446	177	3,624	3,542
13	2010	0	82	82	3,446	177	3,624	3,542
14	2011	0	82	82	3,446	177	3,624	3,542
15	2012	0	82	82	3,446	177	3,624	3,542
16	2013	0	82	82	3,568	196	3,764	3,682
17	2014	0	82	82	3,568	196	3,764	3,682
18	2015	0	82	82	3,568	196	3,764	3,682
19	2016	0	82	82	3,568	196	3,764	3,682
20	2017	0	82	82	3,568	196	3,764	3,682
21	2018	0	82	82	3,568	196	3,764	3,682
22	2019	0	82	82	3,568	196	3,764	3,682
23	2020	0	82	82	3,568	196	3,764	3,682
24	2021	0	82	82	3,568	196	3,764	3,682
25	2022	0	82	82	3,568	196	3,764	3,682
26	2023	0	82	82	3,568	196	3,764	3,682
27	2024	0	82	82	3,568	196	3,764	3,682
28	2025	0	82	82	3,568	196	3,764	3,682
29	2026	0	82	82	3,568	196	3,764	3,682
30	2027	0	82	82	3,568	196	3,764	3,682
31	2028	0	82	82	3,568	196	3,764	3,682
32	2029	0	82	82	3,568	196	3,764	3,682
33	2030	0	82	82	3,568	196	3,764	3,682
34	2031	0	82	82	3,568	196	3,764	3,682
35	2032	0	82	82	3,568	196	3,764	3,682
36	2033	0	82	82	3,568	196	3,764	3,682
37	2034	0	82	82	3,568	196	3,764	3,682
38	2035	0	82	82	3,568	196	3,764	3,682
39	2036	0	82	82	3,568	196	3,764	3,682
40	2037	0	82	82	3,568	196	3,764	3,682
41	2038	0	82	82	3,568	196	3,764	3,682
42	2039	0	82	82	3,568	196	3,764	3,682
43	2040	0	82	82	3,568	196	3,764	3,682
44	2041	0	82	82	3,568	196	3,764	3,682
45	2042	0	82	82	3,568	196	3,764	3,682
46	2043	0	82	82	3,568	196	3,764	3,682
47	2044	0	82	82	3,568	196	3,764	3,682
48	2045	0	82	82	3,568	196	3,764	3,682
49	2046	0	82	82	3,568	196	3,764	3,682
50	2047	0	82	82	3,568	196	3,764	3,682
51	2048	0	82	82	3,568	196	3,764	3,682
52	2049	0	82	82	3,568	196	3,764	3,682
53	2050	0	82	82	3,568	196	3,764	3,682
54	2051	0	82	82	3,568	196	3,764	3,682
55	2052	0	82	82	3,568	196	3,764	3,682
56	2053	0	82	82	3,568	196	3,764	3,682
57	2054	0	82	82	3,568	196	3,764	3,682
58	2055	0	82	82	3,568	196	3,764	3,682
59	2056	0	82	82	3,568	196	3,764	3,682
60	2057	0	82	82	3,568	196	3,764	3,682
61	2058	0	82	82	3,568	196	3,764	3,682
62	2059	0	82	82	3,568	196	3,764	3,682
63	2060	0	82	82	3,568	196	3,764	3,682
64	2061	0	82	82	3,568	196	3,764	3,682
65	2062	0	82	82	3,568	196	3,764	3,682
66	2063	0	82	82	3,568	196	3,764	3,682
67	2064	0	82	82	3,568	196	3,764	3,682
68	2065	0	82	82	3,568	196	3,764	3,682
69	2066	0	82	82	3,568	196	3,764	3,682
70	2067	0	82	82	3,568	196	3,764	3,682
71	2068	0	82	82	3,568	196	3,764	3,682
		8,346	5,064	13,410	217,278	11,955	229,233	215,823

EIRR 24.02%

Discount rate(%)	B/C	PV Cost	PV Benefit	NPV
15	1.95	3,184	6,204	3,020
12	2.58	3,900	10,073	6,173
10	3.20	4,503	14,432	9,929
5	6.41	6,825	43,725	36,901
3	9.20	8,457	77,771	69,313

Table 6.2.6 FINANCIAL AND ECONOMIC COST AND BENEFIT OF ALTERNATIVE-2-2

Cost Evaluation (Unit : baht 1,000,000)

Benefit (million baht/yeawr)

General	Agriculture	Total
3,568	196	3,764

excluding benefit of Dam

Ayuthaya-East-Sea-2 Diversion(1,100m3/s) Thai (Financial)

Classification of cost	L.C.	F.C	Total
1 Constructioin cost	7,152	12,289	19,441
1) Material and Equipment	6,335	12,289	18,624
2)Skilled Labor	341	0	341
3)Unskilled Labor	476	0	476
2 Land acquisition & House F	15,186	0	15,186
3 Administration	759	0	759
4 1)Engineering serviceD/D	10	87	97
2)Engineering serviceS/V	97	875	972
5 Phisical contingency	130	223	353
Sub-total	23,334	13,474	36,808
6 Price Contingency	3,500	2,021	5,521
Grand total	26,834	15,495	42,329
OM Cost			186

Ayuthaya-East-Sea Diversion(1,100m3/s) Thai (Economic)

Classification of cost	L.C.	F.C	Total
1 Constructioin cost	6,229	11,183	17,412
1) Material and Equipment	5,531	11,183	16,714
2)Skilled Labor	298	0	298
3)Unskilled Labor	400	0	400
2 Land acquisition & House Relo	12,043	0	12,043
3 Administration	663	0	663
4 1)Engineering serviceD/D	8	80	88
2)Engineering serviceS/V	85	796	881
5 Phisical contingency	113	203	316
Sub-total	19,141	12,262	31,402
6 Price Contingency	0	0	0
Grand total	19,141	12,262	31,402
OM Cost			167

Distribution System Improvement :Thai (Financial)

Classification of cost	L.C.	F.C	Total
1 Constructioin cost	101	123	224
1) Material and Equipment	86	123	208
2)Skilled Labor	4	0	4
3)Unskilled Labor	11	0	11
2 Land acquisition & House F	3	0	3
3 Administration	3	0	3
4 1)Engineering serviceD/D	1	5	6
2)Engineering serviceS/V	1	11	13
5 Phisical contingency	4	7	11
Sub-total	113	146	259
6 Price Contingency	12	14	26
Grand total	125	160	285
OM Cost			2

Distribution System Improvement :Thai (Economic)

Classification of cost	L.C.	F.C	Total
1 Constructioin cost	88	112	199
1) Material and Equipment	75	112	186
2)Skilled Labor	4	0	4
3)Unskilled Labor	10	0	10
2 Land acquisition & House Relo	2	0	2
3 Administration	2	0	2
4 1)Engineering serviceD/D	0	5	5
2)Engineering serviceS/V	1	10	12
5 Phisical contingency	4	6	10
Sub-total	98	133	231
6 Price Contingency	0	0	0
Grand total	98	133	231
OM Cost			2

Drainage Improvement :Thai (Financial)

Classification of cost	L.C.	F.C	Total
1 Constructioin cost	2,112	2,327	4,439
1) Material and Equipment	1,837	2,327	4,163
2)Skilled Labor	92	0	92
3)Unskilled Labor	184	0	184
2 Land acquisition & House F	612	0	612
3 Administration	61	0	61
4 1)Engineering serviceD/D	31	122	153
2)Engineering serviceS/V	61	306	367
5 Phisical contingency	245	245	490
Sub-total	3,122	3,000	6,123
6 Price Contingency	312	300	612
Grand total	3,435	3,300	6,735
OM Cost			42

Drainage Improvement : Thai (Economic)

Classification of cost	L.C.	F.C	Total
1 Constructioin cost	1,838	2,117	3,955
1) Material and Equipment	1,603	2,117	3,721
2)Skilled Labor	80	0	80
3)Unskilled Labor	155	0	155
2 Land acquisition & House Relo	486	0	486
3 Administration	53	0	53
4 1)Engineering serviceD/D	27	111	138
2)Engineering serviceS/V	53	279	332
5 Phisical contingency	214	223	437
Sub-total	2,671	2,730	5,401
6 Price Contingency	0	0	0
Grand total	2,671	2,730	5,401
OM Cost			37

River Improvement 10-year (Chainat~Pathum Thani : Thai (Financial)

Classification of cost	L.C.	F.C	Total
1 Constructioin cost	507	602	1,109
1) Material and Equipment	432	602	1,034
2)(a) Skilled Labor	40		40
(b) Unskilled Labor	35		35
2 Land acquisition	20		20
3 Administration	22		22
4 1)Engineering service D/D	8	59	66
2)Engineering service S/V	6	56	62
5 Physical contingency	45	60	105
Sub-total	607	776	1,384
6 Price Contingency	18	23	41
Grand total	625	800	1,425
OM Cost			34

River Improvement 10-year (Chainat~Pathum Thani : Thai (Economic)

Classification of cost	L.C.	F.C	Total
1 Constructioin cost	441	548	989
1) Material and Equipment	377	548	925
2)(a) Skilled Labor	35	0	35
(b) Unskilled Labor	29	0	29
2 Land acquisition	16	0	16
3 Administration	19	0	19
4 1)Engineering service D/D	7	53	60
2)Engineering service S/V	5	51	56
5 Physical contingency	39	55	94
Sub-total	528	707	1,234
6 Price Contingency	0	0	0
Grand total	528	707	1,234
OM Cost		31	31

River Improvement 25-year (Chainat~Pathum Thani : Thai (Financial)

Classification of cost	L.C.	F.C	Total
1 Constructioin cost	652	775	1,427
1) Material and Equipment	556	775	1,330
2)(a) Skilled Labor	52	0	52
(b) Unskilled Labor	45	0	45
2 Land acquisition	26	0	26
3 Administration	28	0	28
4 1)Engineering service D/D	10	75	85
2)Engineering service S/V	8	71	79
5 Physical contingency	58	78	135
Sub-total	782	999	1,781
6 Price Contingency	23	30	53
Grand total	805	1,029	1,834
OM Cost			44

River Improvement 25-year (Chainat~Pathum Thani : Thai (Economic)

Classification of cost	L.C.	F.C	Total
1 Constructioin cost	568	705	1,273
1) Material and Equipment	485	705	1,190
2)(a) Skilled Labor	45	0	45
(b) Unskilled Labor	38	0	38
2 Land acquisition	20	0	20
3 Administration	25	0	25
4 1)Engineering service D/D	9	69	77
2)Engineering service S/V	7	65	72
5 Physical contingency	51	71	121
Sub-total	679	909	1,588
6 Price Contingency	0	0	0
Grand total	679	909	1,588
OM Cost		39	40

Dam Compensation Cost : Thai (Financial)

Classification of cost	L.C.	F.C	Total
1 Constructioin cost	0	0	0
1) Material and Equipment	0	0	0
2)(a) Skilled Labor	0	0	0
(b) Unskilled Labor	0	0	0
2 Land acquisition	0	0	0
3 Administration	0	0	0
4 Engineering service	0	0	0
5 Physical contingency	46	0	46
Sub-total	46	0	46
6 Price Contingency	0	0	0
Grand total	46	0	46
OM Cost	451	0	451

Dam Compensation : Thai (Economic)

Classification of cost	L.C.	F.C	Total
1 Constructioin cost	0	0	0
1) Material and Equipment	0	0	0
2)(a) Skilled Labor	0	0	0
(b) Unskilled Labor	0	0	0
2 Land acquisition	0	0	0
3 Administration	0	0	0
4 Engineering service	0	0	0
5 Physical contingency	40	0	40
Sub-total	40	0	40
6 Price Contingency	0	0	0
Grand total	40	0	40
OM Cost	394	0	394

Note : Physical contingency of Dam means initial cost of necessary expences for preparation.

Table 6.2.7 PROJECT EVALUATION OF ALTERNATIVE 2-2

Alt-2-2 (excluding Dams)

Unit: million baht

		Economic cost			Economic benefit			
Year		Construction (A)	O&M (B)	Total (C)	General, etc. (D)	Agri. (E)	Total Economic Benefit (F)	(F)-(C) Benefit-Cost (G)
1	1998	1	0	1	0	0	0	-1
2	1999	56	0	56	0	0	0	-56
3	2000	87	0	87	0	0	0	-87
4	2001	104	0	104	0	0	0	-104
5	2002	653	0	653	0	0	0	-653
6	2003	1,225	0	1,225	0	0	0	-1,225
7	2004	1,948	0	1,948	0	0	0	-1,948
8	2005	2,636	2	2,638	78	15	93	-2,545
9	2006	1,799	33	1,832	285	48	333	-1,499
10	2007	1,513	33	1,546	285	48	333	-1,213
11	2008	1,034	70	1,104	1,313	232	1,545	441
12	2009	2,245	70	2,315	1,313	232	1,545	-770
13	2010	2,422	70	2,492	1,313	232	1,545	-947
14	2011	4,169	70	4,239	1,313	232	1,545	-2,694
15	2012	6,120	70	6,190	1,313	232	1,545	-4,645
16	2013	6,109	70	6,178	1,313	232	1,545	-4,633
17	2014	2,303	70	2,373	4,634	201	4,835	2,462
18	2015	1,955	70	2,025	4,634	201	4,835	2,810
19	2016	2,193	70	2,263	4,634	201	4,835	2,572
20	2017	399	237	636	5,529	224	5,752	5,116
21	2018	133	237	370	5,863	229	6,092	5,722
22	2019	0	280	280	5,851	227	6,078	5,798
23	2020	0	280	280	5,851	227	6,078	5,798
24	2021	0	280	280	5,851	227	6,078	5,798
25	2022	0	280	280	5,851	227	6,078	5,798
26	2023	0	280	280	5,851	227	6,078	5,798
27	2024	0	280	280	5,851	227	6,078	5,798
28	2025	0	280	280	5,851	227	6,078	5,798
29	2026	0	280	280	5,851	227	6,078	5,798
30	2027	0	280	280	5,851	227	6,078	5,798
31	2028	0	280	280	5,851	227	6,078	5,798
32	2029	0	280	280	5,851	227	6,078	5,798
33	2030	0	280	280	5,851	227	6,078	5,798
34	2031	0	280	280	5,851	227	6,078	5,798
35	2032	0	280	280	5,851	227	6,078	5,798
36	2033	0	280	280	5,851	227	6,078	5,798
37	2034	0	280	280	5,851	227	6,078	5,798
38	2035	0	280	280	5,851	227	6,078	5,798
39	2036	0	280	280	5,851	227	6,078	5,798
40	2037	0	280	280	5,851	227	6,078	5,798
41	2038	0	280	280	5,851	227	6,078	5,798
42	2039	0	280	280	5,851	227	6,078	5,798
43	2040	0	280	280	5,851	227	6,078	5,798
44	2041	0	280	280	5,851	227	6,078	5,798
45	2042	0	280	280	5,851	227	6,078	5,798
46	2043	0	280	280	5,851	227	6,078	5,798
47	2044	0	280	280	5,851	227	6,078	5,798
48	2045	0	280	280	5,851	227	6,078	5,798
49	2046	0	280	280	5,851	227	6,078	5,798
50	2047	0	280	280	5,851	227	6,078	5,798
51	2048	0	280	280	5,851	227	6,078	5,798
52	2049	0	280	280	5,851	227	6,078	5,798
53	2050	0	280	280	5,851	227	6,078	5,798
54	2051	0	280	280	5,851	227	6,078	5,798
55	2052	0	280	280	5,851	227	6,078	5,798
56	2053	0	280	280	5,851	227	6,078	5,798
57	2054	0	280	280	5,851	227	6,078	5,798
58	2055	0	280	280	5,851	227	6,078	5,798
59	2056	0	280	280	5,851	227	6,078	5,798
60	2057	0	280	280	5,851	227	6,078	5,798
61	2058	0	280	280	5,851	227	6,078	5,798
62	2059	0	280	280	5,851	227	6,078	5,798
63	2060	0	280	280	5,851	227	6,078	5,798
64	2061	0	280	280	5,851	227	6,078	5,798
65	2062	0	280	280	5,851	227	6,078	5,798
66	2063	0	280	280	5,851	227	6,078	5,798
67	2064	0	280	280	5,851	227	6,078	5,798
68	2065	0	280	280	5,851	227	6,078	5,798
69	2066	0	280	280	5,851	227	6,078	5,798
70	2067	0	280	280	5,851	227	6,078	5,798
71	2068	0	280	280	5,851	227	6,078	5,798
		39,103	15,166	54,268	326,370	13,908	340,277	286,009

EIRR 12.10%

Discount rate(%)	B/C	PV Cost	PV Benefit	NPV
15	0.77	7,306	5,658	-1,648
12	1.01	9,944	10,036	92
10	1.24	12,395	15,345	2,950
5	2.40	23,120	55,511	32,390
3	3.40	31,116	105,851	74,735

Table 6.4.1 Features of Draiange Area

Study Area	Division of Area	Name of Project Area	Features of the Drainage Area						
			Catchment Area (km2)	Slope Gradient	Main Drainage Outlet	Drainage Capacity of pump (m3/s)	Possibility to receive flood water from Rivers	Flood Damage Magnitude (based on Interview)	Main Land Use
Higer Delta	Norhtern Part surrounded by Thachin and Noi Rivers	Borommathad, Samdhuk, Chanasutr, Yamanee and Phak Hai, etc.	1,850	1/4,000	Thachin and Noi Rivers	24	Less Possibility	Not so serious	HYV
	Area surrounded by Noi and Chao Phraya Rivers	Borommathad, Yamanee and Phak Hai, Bang Bal	930	1/4,000	Noi and Chao Phraya Rivers	–	Chao Phraya River	Relatively Serious due to overflow from river	HYV, F/R and DWR
	Area surrounded by Chao Phraya and Lop Buri Rivers	Maharat and Khok Katiem	500	1/5,000	Chao Phraya and Lop Buri Rivers	–	Chao Phraya and Lop Buri Rivers	Relatively serious due tp overflow from rivers	F/R and DWR
	Area surrounded by Lop Buri and Pasak Rivers	Khok Katiem and Roeng Rang	530	1/5,000	Lop Buri and Pasak Rivers	–	Lop Buri and Pasak Rivers	Serious	F/R and HYV
Lower Delta	East Bank Area	Nakhon Luang, Pasak Tai, Rangsit Nua, Rangsit Tai, Khlong Dan and Phra Ong Chai Ya Nuchit	4,374	1/50,000	Choa Phraya, Nakhon Nayok and Bang Pakon Rivers and Sea	303	Chao Phraya and Pasak Rivers	Serious	HYV and Fruits Tree
	West Bank Area	Chao Ched Bang Yeehon, Phrayahantue, Phraypimol and Pashichargan	2,385	1/60,000	Choa Phraya and Thachin Rivers and Sea	140	Chao Phraya and Tha Chin Rivers	Serious	HYV and Fruits Tree

Table 6.4.2 Main Drainage Issues of the Area (Yes* : Yes, but not so severe)

Study Area	Division of Area	Name of Project Area	Mian Cause of Flood			Drainage Condition			Main Issure
			Local Rainfall	Water from Upstream Area	Overflow From Rivers	Drainage System	Collection of Water to Outlet	Continuation of Higher Water Level at Outlet	
Higer Delta	Norhtern Part surrounded by Thachin and Noi Rivers	Borommathad	Yes *	No	No	Fair	Good	Not much	Drainage problem may not be severe in general, but due to water from upstream area, it is seriouse in the downstream project area.
		Samdhuk	〃	Yes *	〃	〃	〃	〃	
		Chanasut	〃	Yes	〃	〃	〃	〃	
		Phak Hai	〃	〃	〃	〃	〃	〃	
	Area surrounded by Noi and Chao Phraya Rivers	Borommathad	Yes *	no	Yes	Fair	Good	Yes	Drainage problem may not be severe in general, but it is very serious when overflow from rivers occurs
		Yamanee	〃	Yes	〃	〃	〃	〃	
		Phak Hai	〃	〃	〃	〃	〃	〃	
		Bang Bal	〃	no	〃	〃	〃	〃	
	Area surrounded by Chao Phraya and Lop Buri Rivers	Maharat	Yes *	no	Yes	Fair	Good	Yes	– do –
		Khok Katiem	〃	〃	〃	〃	〃	〃	
	Area surrounded by Lop Buri and Pasak Rivers	Khok Katiem	Yes *	no	Yes	Fair	Good	Yes	– do –
		Roeng Rang	〃	Yes	〃	〃	〃	〃	
Lower Delta	East Bank Area	Nakhon Luang	Yes *	No	Yes	Fair	Fair	Yes	Drainage issue is emphasized with the following points: difficulty of collection of inudation water, continuation of higher water level at outlet, overflow from rivers and water from upstream area
		Pasak Tai	〃	〃	No	〃	〃	〃	
		Rangsit Nua	〃	Yes*	〃	Good	Poor	〃	
		Rangsit Tai	〃	〃	〃	〃	〃	〃	
		Khlong Dan	〃	Yes	Yes	Poor	〃	〃	
		Phra Ong Chai Ya Nuchit	〃	〃	〃	〃	〃	〃	
	West Bank Area	Chao Ched Bang Yeehon	Yes *	no	Yes	Fair	Fair	Yes	– do –
		Phrayahantue	〃	Yes*	〃	Poor	Poor	〃	
		Phraypimol	〃	〃	〃	〃	〃	〃	
		Pashicharoen	〃	Yes	〃	〃	〃	〃	

Table 6.4.3 Conceivable Measures for Drainage System Improvement (yes) : Conceivable but not recommendable

Study Area	Division of Area	Name of Project Area	Possible Concievable Measure in Individual Project Area						General Consideration
			Channel Improve-ment	Installation of Pump	Provision of Retarding Basin	Construction of New Channel	Drainage to downstream Area	Heightening of Dike	
Higer Delta	Norhtern Part surrounded by Thachin and Noi Rivers	Borommathad	yes	no	(yes)	no	no	no	As a whole, drainage channel improvement is one of the conceivable measures and retarding basin is considered by project areas.
		Samdhuk	〃	〃	〃	〃	〃	〃	
		Chanasut	〃	〃	〃	〃	〃	〃	
		Phak Hai	〃	〃	yes	〃	〃	〃	
	Area surrounded by Noi and Chao Phraya Rivers	Borommathad	yes	no	no	no	no	(yes)	Channel improvement is one of the measures. Heightening of dike along rivers is not recommendable due to adverse influence.
		Yamanee	〃	〃	〃	〃	yes	〃	
		Phak Hai	〃	yes	yes	〃	yes	〃	
		Bang Bal	〃	〃	yes	〃	no	〃	
	Area surrounded by Chao Phraya and Lop Buri	Meharat	yes	no	yes	no	no	(yes)	〃
		Khok Katiem	〃	〃	〃	〃	〃	〃	
	Area surrounded by Lop Buri and Pasak Rivers	Khok Katiem	yes	no	yes	no	yes	(yes)	〃
		Roeng Rang	〃	〃	〃	〃	〃	〃	
Lower Delta	East Bank Area	Nakhon Luang	yes	yes	yes	yes	yes	(yes)	The combination of these conceivable measures are considered, but heightening of dike of Chao Phraya River may not be preferable due to adverse influence to the urban areas.
		Pasak Tai	〃	〃	〃	〃	〃	〃	
		Rangsit Nua	〃	〃	〃	〃	〃	〃	
		Rangsit Tai	〃	〃	〃	〃	〃	〃	
		Khlong Dan	〃	〃	〃	〃	no	〃	
		Phra Ong Chai Ya Nuchit	〃	〃	〃	〃	〃	〃	
	West Bank Area	Chao Ched Bang Yeehon	yes	yes	yes	yes	yes	yes	The same conceivable measures to East Bank are considered. Besides, improvement of Tha Chin river to increase the capacity to receive the inundation water is also considered.
		Phrayahantue	〃	〃	〃	〃	〃	〃	
		Phraypimol	〃	〃	〃	〃	〃	〃	
		Pashicharoen	〃	〃	〃	〃	no	〃	

Table 6.4.4 Priority of Drainage System Improvement

Study Area	Priority	Division of Area	Priority	Name of Project Area	Prioriy
Higer Delta	2	Norhtern Part surrounded by Thachin and Noi Rivers	2-4	Borommathad	2-4-4
				Samdhuk	2-4-3
				Chanasut	2-4-2
				Phak Hai	2-4-1
		Area surrounded by Noi and Chao Phraya Rivers	2-3	Boremathad	2-3-4
				Yamanee	2-3-3
				Phak Hai	2-3-2
				Bang Bal	2-3-1
		Area surrounded by Chao Phraya and Lop Buri	2-1	Maharat	2-1-2
				Khok Katiem	2-1-2
		Area surrounded by Lop Buri and Pasak Rivers	2-2	Khok Katiem	2-2-2
				Roeng Rang	2-2-1
Lower Delta	1	East Bank Area	1-1	Nakhon Luang	1-1-5
				Pasak Tai	1-1-6
				Rangsit Nua	1-1-4
				Rangsit Tai	1-1-3
				Khlong Dan	1-1-1
				Phra Ong Chai Ya Nuchit	1-1-2
		West Bank Area	1-2	Chao Ched Bang Yeehon	1-2-4
				Phrayahantue	1-2-3
				Phraypimol	1-2-2
				Pashicharoen	1-2-1

Table 7.2.1 **FLOOD MITIGATION EFFECT FOR FIVE BIG FLOODS**

Name of dam	Operation Case	Reduced inundation Volume from without dam (million m^3)					
		1975 flood	1981 flood	1983 flood	1995 flood	1996 flood	Average
Bhumibol	(a) Without(Present Operation)	3,436	342	1,615	3,681	918	1,998
	(b) Proposed Operation	4,477	342	1,615	3,773	956	2,232
	(b)-(a) Effect of Proposed Operation	1,041	0	0	92	38	234
Sirikit	(a) Without(KIN project proposed)	2,315	348	113	2,377	506	1,132
	(b) Proposed Operation	2,813	348	113	3,510	506	1,458
	(b)-(a) Effect of Proposed Operation	498	0	0	1,133	0	326
Pasak	(a) Without(without Operation)	0	0	0	0	0	0
	(b) Proposed Operation(Case-1)	175	0	0	288	51	103
	(c) Proposed Operation(Case-2)	370	0	0	587	109	213
	(d) Proposed Operation(Case-3)	438	0	0	695	129	252
Total	(a) Without	5,751	690	1,728	6,058	1,424	3,130
	(b) Proposed (Pasak : Case-3)	7,728	690	1,728	7,978	1,591	3,942
	(b)-(a) Effect of Proposed Operation	1,977	0	0	1,920	167	812

Table 7.2.2 **RELEASE PLAN FOR IRRIGATION WATER SUPPLY**

Wet season (Monthly Minimum Release from the Reservoir) (unit: MCM/month)

Name of dam	Jun.	July	Aug.	Sep.	Oct.	Nov.	note
Sirikit	350	400	200	120	80	200	Proposed by Kok-Inn-Nan project
Bhumibol	90	125	125	60	30	30	5-year probable drought release discharge

Dry season

Name of dam	Storage at the end of Nov. (MCM)	Release discharge for irrigation water supply (MCM/month)						note
		Dec.	Jan.	Feb.	Mar.	Apr.	May.	
Sirikit	>6000	600	1150	1350	1150	550	200	Proposed by Kok-Inn-Nan project
	6000 to 5000	540	1035	1215	1035	495	180	
	5000 to 4000	420	805	945	805	385	140	
	4000 to 3000	300	575	675	575	275	100	
	<3000	240	460	540	460	220	80	
Bhumibol	>10600	700	1330	1570	1330	640	230	Present release plan
	10600 to 9800	600	1150	1350	1150	550	200	
	9800 to 7500	450	850	1000	850	400	150	
	7500 to 0	450 to 0	850 to 0	1000 to 0	850 to 0	400 to 0	150 to 0	

Table 7.2.3 (1/2) FLOOD DAMAGE AMOUNT WITH AND WITHOUT MODIFICATION OF DAM OPERATION

(1) Without Modification of Dam Operation (mil.baht)

YEAR	BMA			Others			Grand Total
	General	Agriculture	Total	General	Agriculture	Total	
1964	0	0	0	20,752	4,130	24,882	24,882
1965	0	0	0	6,909	1,375	8,284	8,284
1966	0	0	0	9,722	1,935	11,657	11,657
1967	0	0	0	9,950	1,980	11,930	11,930
1968	0	0	0	3,879	772	4,652	4,652
1969	0	0	0	10,272	2,045	12,317	12,317
1970	0	0	0	18,530	3,688	22,219	22,219
1971	0	0	0	9,592	1,909	11,502	11,502
1972*	0	0	0	7,631	1,519	9,150	9,150
1973	0	0	0	12,033	2,395	14,428	14,428
1974	0	0	0	9,961	1,983	11,944	11,944
1975	0	0	0	23,329	4,643	27,972	27,972
1976	0	0	0	12,068	2,402	14,469	14,469
1977	0	0	0	7,620	1,517	9,137	9,137
1978*	22,763	23	22,786	22,980	4,574	27,553	50,340
1979*	0	0	0	4,215	839	5,054	5,054
1980	0	0	0	21,916	4,362	26,278	26,278
1981	0	0	0	8,016	1,596	9,611	9,611
1982	0	0	0	6,487	1,291	7,778	7,778
1983*	4,108	4	4,112	19,061	3,794	22,855	26,967
1984*	0	0	0	6,146	1,223	7,369	7,369
1985*	0	0	0	8,755	1,743	10,498	10,498
1986	0	0	0	5,778	1,150	6,928	6,928
1987*	0	0	0	10,024	1,995	12,020	12,020
1988	0	0	0	9,449	1,881	11,330	11,330
1989	0	0	0	5,312	1,057	6,370	6,370
1990	0	0	0	7,865	1,565	9,430	9,430
1991	0	0	0	5,155	1,026	6,181	6,181
1992*	0	0	0	6,191	1,232	7,423	7,423
1993	0	0	0	4,524	900	5,424	5,424
1994	0	0	0	13,363	2,660	16,023	16,023
1995*	43,418	43	43,462	27,749	5,523	33,272	76,734
1996*	0	0	0	15,725	3,130	18,854	18,854
Total of 33 floods	70,290	70	70,360	370,959	73,836	444,795	515,155
Total of Representative 10 Floods	70,290	70	70,360	128,477	25,572	154,049	224,409
Average Annual Damage**	2,130	2	2,132	11,241	2,237	13,479	15,611
Average of 10 Floods	7,029	7	7,036	12,848	2,557	15,405	22,441

*: Representative 10 Floods

**: Average of 33 Floods

Note: Flood damage amounts are under the future basin condition in 2005.

(2) With Modification of Bhumibol Dam Operation (mil.baht)

YEAR	BMA			Others			Grand Total
	General	Agriculture	Total	General	Agriculture	Total	
1972	0	0	0	7,534	1,500	9,033	9,033
1978	22,349	22	22,372	22,764	4,531	27,295	49,667
1979	0	0	0	4,171	830	5,001	5,001
1983	4,108	4	4,112	19,060	3,794	22,854	26,967
1984	0	0	0	6,141	1,222	7,364	7,364
1985	0	0	0	8,755	1,743	10,498	10,498
1987	0	0	0	10,013	1,993	12,007	12,007
1992	0	0	0	6,191	1,232	7,423	7,423
1995	43,016	43	43,059	27,709	5,515	33,225	76,284
1996	0	0	0	15,724	3,130	18,854	18,854
Total of 10 floods	69,474	70	69,544	128,063	25,490	153,553	223,097
Average of 10 floods	6,947	7	6,954	12,806	2,549	15,355	22,310
Average Damage Reduction in 10 floods	82	0	82	41	8	50	131
Damage Reduction Rate (%)	1.2	1.2	1.2	0.3	0.3	0.3	0
Average Annual Damage Reduction under Future Basin Condition in 2005	25	0	25	36	7	43	68
Average Annual Damage Reduction under Future Basin Condition in 2001	19	0	19	34	6	40	59

(3) With Modification of Pasak Dam Operation (mil.baht)

YEAR	BMA			Others			Grand Total
	General	Agriculture	Total	General	Agriculture	Total	
1972	0	0	0	7,623	1,517	9,140	9,140
1978	21,522	22	21,543	22,013	4,381	26,394	47,937
1979	0	0	0	4,215	839	5,054	5,054
1983	4,108	4	4,112	18,813	3,745	22,557	26,670
1984	0	0	0	6,135	1,221	7,356	7,356
1985	0	0	0	8,665	1,725	10,390	10,390
1987	0	0	0	9,706	1,932	11,638	11,638
1992	0	0	0	5,952	1,185	7,137	7,137
1995	40,202	40	40,243	26,119	5,199	31,318	71,560
1996	0	0	0	14,737	2,933	17,670	17,670
Total	65,832	66	65,898	123,978	24,677	148,655	214,553
Average	6,583	7	6,590	12,398	2,468	14,865	21,455
Average Damage Reduction in 10 floods	446	0	446	450	90	539	986
Damage Reduction Rate (%)	6.3	6.3	6.3	3.5	3.5	3.5	0.4
Average Annual Damage Reduction under Future Basin Condition in 2005	135	0	135	394	78	472	607
Average Annual Damage Reduction under Future Basin Condition in 2001	103	0	103	369	71	440	543

(4) With Modification of Sirikit Dam Operation (mil.baht)

YEAR	BMA			Others			Grand Total
	General	Agriculture	Total	General	Agriculture	Total	
1972	0	0	0	7,631	1,519	9,150	9,150
1978	22,185	22	22,207	22,770	4,532	27,302	49,509
1979	0	0	0	4,215	839	5,054	5,054
1983	4,108	4	4,112	19,058	3,793	22,851	26,963
1984	0	0	0	6,167	1,227	7,394	7,394
1985	0	0	0	8,755	1,743	10,498	10,498
1987	0	0	0	10,022	1,995	12,017	12,017
1992	0	0	0	6,154	1,225	7,378	7,378
1995	36,564	37	36,601	25,401	5,056	30,457	67,058
1996	0	0	0	15,723	3,130	18,853	18,853
Total	62,858	63	62,921	125,895	25,058	150,954	213,875
Average	6,286	6	6,292	12,590	2,506	15,095	21,387
Average Damage Reduction in 10 floods	743	1	744	258	51	310	1,053
Damage Reduction Rate (%)	10.6	10.6	10.6	2.0	2.0	2.0	0.5
Average Annual Damage Reduction under Future Basin Condition in 2005	225	0	225	226	45	271	496
Average Annual Damage Reduction under Future Basin Condition in 2001	171	0	171	212	41	253	424

Note: Benefits in 2005 is discounted to those in 2001 considering the increase of GDP, population, etc.

Table 7.2.3 (2/2) FLOOD DAMAGE AMOUNT WITH AND WITHOUT MODIFICATION OF DAM OPERATION

(1) Damage Amount

(a) Without Modification of Dam Operation (mil.baht)

YEAR	BMA			Others		
	General	Agriculture	Total	General	Agriculture	Total
1964	0	0	0	20,752	4,130	24,882
1965	0	0	0	6,909	1,375	8,284
1966	0	0	0	9,722	1,935	11,657
1967	0	0	0	9,950	1,980	11,930
1968	0	0	0	3,879	772	4,652
1969	0	0	0	10,272	2,045	12,317
1970	0	0	0	18,530	3,688	22,219
1971	0	0	0	9,592	1,909	11,502
1972	0	0	0	7,631	1,519	9,150
1973	0	0	0	12,033	2,395	14,428
1974	0	0	0	9,961	1,983	11,944
1975	0	0	0	23,329	4,643	27,972
1976	0	0	0	12,068	2,402	14,469
1977	0	0	0	7,620	1,517	9,137
1978	22,763	23	22,786	22,980	4,574	27,553
1979	0	0	0	4,215	839	5,054
1980	0	0	0	21,916	4,362	26,278
1981	0	0	0	8,016	1,596	9,611
1982	0	0	0	6,487	1,291	7,778
1983	4,108	4	4,112	19,061	3,794	22,855
1984	0	0	0	6,146	1,223	7,369
1985	0	0	0	8,755	1,743	10,498
1986	0	0	0	5,778	1,150	6,928
1987	0	0	0	10,024	1,995	12,020
1988	0	0	0	9,449	1,881	11,330
1989	0	0	0	5,312	1,057	6,370
1990	0	0	0	7,865	1,565	9,430
1991	0	0	0	5,155	1,026	6,181
1992	0	0	0	6,191	1,232	7,423
1993	0	0	0	4,524	900	5,424
1994	0	0	0	13,363	2,660	16,023
1995	43,418	43	43,462	27,749	5,523	33,272
1996	0	0	0	15,725	3,130	18,854

(b) With Modification of the 3 Dams (mil.baht)

YEAR	BMA			Others		
	General	Agriculture	Total	General	Agriculture	Total
1964	0	0	0	19,302	3,842	23,144
1965	0	0	0	6,862	1,366	8,228
1966	0	0	0	9,375	1,866	11,241
1967	0	0	0	9,612	1,913	11,525
1968	0	0	0	3,810	758	4,569
1969	0	0	0	9,987	1,988	11,974
1970	0	0	0	15,439	3,073	18,512
1971	0	0	0	9,592	1,909	11,502
1972	0	0	0	7,524	1,498	9,021
1973	0	0	0	11,621	2,313	13,934
1974	0	0	0	9,859	1,962	11,821
1975	0	0	0	18,369	3,656	22,025
1976	0	0	0	11,646	2,318	13,964
1977	0	0	0	7,409	1,475	8,884
1978	21,363	21	21,385	21,743	4,328	26,071
1979	0	0	0	4,183	833	5,016
1980	0	0	0	20,724	4,125	24,849
1981	0	0	0	8,016	1,596	9,611
1982	0	0	0	6,466	1,287	7,753
1983	4,108	4	4,112	18,837	3,749	22,587
1984	0	0	0	6,146	1,223	7,369
1985	0	0	0	8,666	1,725	10,390
1986	0	0	0	5,778	1,150	6,928
1987	0	0	0	9,703	1,931	11,634
1988	0	0	0	8,974	1,786	10,761
1989	0	0	0	5,248	1,044	6,292
1990	0	0	0	7,578	1,508	9,086
1991	0	0	0	5,155	1,026	6,181
1992	0	0	0	5,976	1,189	7,165
1993	0	0	0	4,524	900	5,424
1994	0	0	0	12,451	2,478	14,930
1995	34,976	35	35,011	21,748	4,329	26,077
1996	0	0	0	14,752	2,936	17,688

(2) Damage Reduction Amount (mil.baht)

YEAR	BMA			Others			Grand
	General	Agriculture	Total	General	Agriculture	Total	Total
1964	0	0	0	1,450	289	1,738	1,738
1965	0	0	0	47	9	57	57
1966	0	0	0	347	69	416	416
1967	0	0	0	338	67	405	405
1968	0	0	0	69	14	83	83
1969	0	0	0	286	57	343	343
1970	0	0	0	3,091	615	3,706	3,706
1971	0	0	0	0	0	0	0
1972	0	0	0	108	21	129	129
1973	0	0	0	412	82	495	495
1974	0	0	0	103	20	123	123
1975	0	0	0	4,960	987	5,948	5,948
1976	0	0	0	422	84	506	506
1977	0	0	0	211	42	253	253
1978	1,400	1	1,401	1,237	246	1,483	2,884
1979	0	0	0	32	6	39	39
1980	0	0	0	1,192	237	1,429	1,429
1981	0	0	0	0	0	0	0
1982	0	0	0	21	4	25	25
1983	0	0	0	224	45	268	268
1984	0	0	0	0	0	0	0
1985	0	0	0	89	18	107	107
1986	0	0	0	0	0	0	0
1987	0	0	0	321	64	385	385
1988	0	0	0	475	95	570	570
1989	0	0	0	65	13	78	78
1990	0	0	0	287	57	344	344
1991	0	0	0	0	0	0	0
1992	0	0	0	215	43	258	258
1993	0	0	0	0	0	0	0
1994	0	0	0	912	182	1,094	1,094
1995	8,442	8	8,451	6,001	1,194	7,195	15,646
1996	0	0	0	973	194	1,166	1,166
Average Annual Damage Reduction in Future Basin Condition in 2005	298	0	299	724	144	868	1,166
Average Annual Damage Reduction in Future Basin Condition in 2001	226	0	227	680	131	811	1,038

Note : Damage amounts are under the future basin condition in 2005.

Note: Benefits in 2005 is discounted to those in 2001 considering the increase of GDP, population, etc.

Table 7.4.1 Possibility of Realization of Measures

Measures		Agencies concerned	Present Situation	Issues	Remarks
Category	Measures				
Non-structural Measures	Land use control and Guidance	DTCP, Local Government, LDD	Currengly executing	Needs to strengthen	Additional Legal arrangement is necessary
	Modification of Operation Rule	EGAT, RID	Newly introduced	Coordination is necessary	-
	Control of Ground Water Sunction	DMR	Currengly executing	Need to strengthen	-
	Flood Forecasting	EGAT, RID, BMA, MED	Currengly executing	Need to improve	ONWRC is to establish a flood forecasting system.
	Flood Fighting	Civil Defence, BMA, RID and Provincial Gov.	Currengly executing	Coordination is necessary	-
	Disaster Recovery	RID, BMA, PWD, Provincial Gov. and Min. of Health	Currengly executing	Coordination is necessary	-
	Subsidy	MOAC, RID	Currengly executing	Need to strengthen	-
	Flood Insurance	MOAC, RID	Newly introduced	-	To be introduced in 8th Agricultural Development Plan
	Watershed Management	RFD	Currently Executing	Need to strengthen	-
Structural Measures	Preservation of Retarding Area with Flood Mitigation*	RID	Currently Executing	Need to improve	Establishment of new organization is necessary
	River Improvement	RID	Currently Executing	Need to improve	
	Heightening of Flood Barrier at Bangkok	BMA	Currently Executing	Need to improve	
	Construction of Diversion C	RID, BMA and PWD	Newly introduced	Coordination is necessary	

*: Distribution system and drainage system improvement in the agricultural area

Table.7.4.2 (1/2) OUTLINE OF RIVER BASIN MANAGEMENT IN FOREIGN COUNTRIES

Countries	Historical Background of Flood Mitigation	Present Institutional Setup for Flood Mitigation
Japan	Since the beginning of history, the Japanes people has struggled against floods and the Government has had the responsibility for flood mitigation.	The basic policies for river administration in Japan today may be summarized as "flood control," "water use," and "conservation and creation of river environments."
	The occurrence of major floods between 1885 and 1893 prompted a demand on the new regime to carry out measures for flood control. ,	The River Law, the basic law governing matters relating to the administration of rivers, was enacted in 1964. The River Law lays down the types of rivers to be governed.
	This led to the enactment of the "River Law" in 1896, whereby the central government was made responsible for the administration of rivers.	River administration of central government for major rivers falls under the jurisdiction of the River Bureau of Ministry of Construction.
	Since 1945, the occurrence of floods prompted the construction of flood control reservoirs throughout Japan. Recent years have seen the planning and construction of diversion tunnels as a flood control measure in urban areas.	In prefecture governments, river administration falls mainly under the jurisdiction of the River Division of the Public Works Department
USA	Flood mitigation has been under the responsibility of local people living along riverside areas and not under the responsibility of Federal, State and local governments.	Flood prone area management including land use control, flood forecasting, post-flood response, etc., is undertaken by state governments and local autonomous bodies.
	The Federal Government has been concerned with flood mitigation only in such case as the works are related to commerce over state borders.	The Federal Government is concerned with flood mitigation in the manner like provision of flood insurance.
	In the USA, historically, the Army Corps of Engineers and the Bureau of Reclamation have contributed to flood mitigation works.	At present, the Federal Government is concerned with the flood mitigation of large-scale rivers, while the State and local autonomous bodies are concerned with the other rivers.
UK	Flood mitigation has been under the responsibility of local people living along the riverside areas.	Flood control and water resources management for major rivers are undertaken by the National River Authority (NRA)
	Traditionally, livestock farming has been the basic agricultural industry, and land development in the flood prone areas has recently been promoted.	The flood control union (IDBs) and the local governments undertake projects on flood control under the financial support of MAFF.
		Operation and maintenance of flood control projects in major rivers are the responsibilities of NRA, while those of minor rivers are under the responsibility of IDBs and municipalities.
France	Since 1800's, flood mitigation has been under the responsibility of local people living along the riverside areas	For the major six (6) river basins, the River Basin Committee consisting of the Water Management Bureau, the local governments and the riverside landowners' union are involved in water management providing the comprhensive plan (SDAGE).
	Such a situation has not changed at present, and the local government or community undertake flood mitigation works	As for flood mitigation, the inhabitants along the riverside have responsibility
	The central government provides financial support for the works.	The central government does not have responsibility on flood protection works, while local governments are concerned in a manner of land use control and guidance.
	The basic concept for flood mitigation is emphasized on localized protection works for urban centers and utilization of agricultural lands as natural retarding basin.	

Table 7.4.2(2/2) OUTLINE OF RIVER BASIN MANAGEMENT IN FOREIGN COUNTRIES

Countries	Historical Background of Flood Mitigation	Present Institutional Setup for Flood Mitigation
Germany	Flood mitigation has been under the responsibility of local people living along the riverside areas under the jurisdiction of provincial governments, and the Federal Government is not concerned.	The rivers are classified into Federal Channel and others, which are further ranked from one to three classes
	The flood mitigation system is mainly attributed with less population in flood prone areas. Residence in flood prone areas has been recently started.	The framework of water management including flood mitigation is designated by the Federal Water Management Act
	In case of the Rijn River, a retarding basin has been provided upstream and downstream. To provide the retarding basin, Federal and local Gov. share the cost.	The management of federal channels and first class rivers is undertaken by the provincial government, while that for second and third class rivers is by counties, municipalities and dike unions
Netherlands	Water Board has been organized since 1600's as a local autonomy organization to cope with the flood mitigation.	The former zone is fully managed by the central government from planning to implementation. The former zone is fully managed by the central government from planning to implementation
	The central government has a responsibility for planning and management for flood mitigation, while the responsibility for implementation and management of facilities is burdened by the Water Board.	The management of the latter area depends on the scale of river basin. For a large scale river basin, the central government has a responsibility for planning, but implementation and management are undertaken by provincial government or Water Board. .
		For the other river basins, provincial government or Water Board has the responsibility from planning to implementation
Republic of China	Until the enactment of the Water Law of the People's Republic of China in 1988, there had not been any law to stipulate the overall management of river water	The Ministry of Water Resources (MWR) undertakes water management including flood control.
	The Water Law was enacted for the effective utilization of water resources, mitigation of flood damage	The water management of seven major river basins is undertaken by the central government,
	In 1997, the Flood Protection Law, which specified the role of central and local governments on flood mitigation, was enacted	Tributaries of major rivers that flow in two provinces is undertaken by the river basin authority like a water committee.
	After the 1998 flood, the Central Gov. decided to return the area of about 1,000 km2 to the retarding area in Chang Jiang Yangtze River.	Flood mitigation is undertaken by the National General Command of Flood Protection under the command of the Vice Prime Minister
		In the local government the flood control authority provided in each local level
Thailand	Since 1903, several large-scale projects were carried out, as multi-purpose projects including reservoir construction for flood control purpose.	Royal Irrigation Department (RID) has been mainly engaged in the flood mitigation works in major rivers, while BMA has been concerned with the flood mitigation works in Bangkok Metropolitan Area
	Since 1970's, river basin development focused more on medium and small-scale projects mainly for single purposes	Flood protection works of major urban areas are undertaken by Public Works Department (PWD)
	Through the past experiences, a new system of water resources management in the country was introduced classifying all the river basins into 25 river basins.	There is no law enacted to comprehensively manage the river basin
		To comprehensively manage the river basin including flood mitigation, enactment of Water Resources Act is under process

Table 7.4.3 Riverbasin Management Organization in Foreign Countries

Countries	Governmental Frame Work		Existence of Special River Management Organization	Existence of River Management Law	Classificaiton of Rivers	Responsibility of Flood Mitigation			
	Centralization	Decentralization				Central Gov.	Local Gov.	Local Communities	Agencies
Japan	Yes, but toward to decentraliza-tion	-	-	River Law	Class-A	Yes	-	-	-
					Class-B	-	Yes	-	-
					Equivalent Rivers	-	Yes	-	-
USA	-	Yes	Mississippi River Commission, Tennessee Valley	Flood Control Act, Water Code	Large Scale Rivers	Provision of Flood Insurance	-	-	-
					Other Rivers	-	Yes		-
UK	Yes	-	National River Authority	Water Act	Major River	-	-	-	Yes(NRA)
					Minor River	-	-	Yes (IDBs)	-
France	-	At present decetralization has settled down.	River Basin Committee	Civil Code	Six major basin	No existence*			-
					Other Rivers	Financial Support	Yes		-
Germany	-	Yes	-	Federal Water Management Act	Federal Channel and Class-1	-	Yes	-	-
					Class-2 and 3	-	-	Yes	-
Netherlands	Yes	-	Water Board		Major River	Planning	Implementation and management		
					the Other River	-	Yes		
People's Republic of China	Yes	-	River Basin Authority	Water Law and Flood Protection Law	Seven Major Rivers	Yes	-	-	-
					Other Rivers	-	Yes	-	-
Kingdom of Thailand	Yes	-	No organization at present but river basin committee is under process	No law at present but Water Resources Act is under process	25 river basins	Yes (Agricultural Area and Major Urban areas)	Yes (BMA)	-	-

* : No existence for flood mitigation, but for water management, River Basin Committee has been set up.

Table 7.4.4 COMPARISON OF FLOOD FIGHTING ACTIVITIES

Item			Thailand (Chao Phraya River)	Japan	China (Yanzhe River)	USA (Missisippi River)	Netherlands	Germany	UK
Region			• Asia Monsoon Region	• Asia Monsoon Region	• Asia Monsoon Region	• North America	• Europe	• Europe	• Europe
Flood Fighting	Institution	Legislation	• No legislation	• Flood Fighting Law	• Flood Defense Law • Flood Fighting Law	• Federal Response Plan •	• Disaster Act • Fire Service Act	• No legislation	• No legislation
		Responsible Organization	• RID (Agricultural area), BMA (BMA area) and local governments (province, district and municipal levels)	• Flood fighting managing body (mainly municipal government) is primarily responsible • Prefectural government (secondary) •	• Local people's governments • Department of State • Flood Defense Command Offices are organized at national, river basin, provincial and local government levels.	• Municipal government • State and/or Federal governments support municipal government if necessary.	• Municipal government • Provincial government (if a provincial scale coordination is necessary) • Ministry of Home Affair (if a national level coordination is necessary)	• Municipal government	• Municipal government
		Organization for Field Operations	• RID, BMA and local governments (province, district and municipal levels)	• Flood fighting brigades, fire brigades under supervision by of flood fighting managing body • Self Defense Force if requested.	• Every organization and individual must participate in flood fighting. • People's Liberation Army and armed police • Flood fighting brigades are organized from militiamen, local people, by local people's government.	• Municipal governments • NGO • State police and armed force	• Police, fire brigades, health services, other municipal services, water boards, army, Red Cross, and volunteers • Coordination Centers (regional, provincial and national levels)	• Fire service, police, soldiers and volunteers are engaged.	• Local people under direction of municipal government.
	Finance		• RID, BMA • Local Governments • Subsidy from Central Government	• Local Governments • Subsidy from Prefecture or Central Government	• Local people's governments • Costs for large flood is dealt with in accordance with related regulation.	• Local governments • Subsidy from Federal Government	n.a.	n.a.	n.a.
	Actual Event		• In 1995 flood 2,000 RID stuff and some 400 from BMA and provinces were engaged in flood fighting.	• 18 thousand and 967 thousand people are registered in flood fighting and fire fighting brigades.	• In 1998 flood a total of 13 million people were engaged in flood fighting.	n.a.	n.a.	n.a.	n.a.
Basic Background	Social Condition	Government Framework	• Unitary State • Constitutional Monarchy • Centralized	• Unitary State • Constitutional Monarchy • Centralized	• Socialist State • Centralized System	• Federal System • Decentralized	• Unitary State • Constitutional Monarchy • Decentralized	• Federal System • Decentralized	• Unitary State • Constitutional Monarchy • Fairly centralized
		Land Use in Flood Plain	• Huge population and developed land use n flood Plain • The capital, Bangkok is in flood plain	• 50 % of the national population and 70 % of the national total assets are in flood plains.	• Huge population and developed land use n flood Plain • Giant cities are in flood plains.	• Urban areas occupy only 2 % of flood plain areas. • Most of flood plains are farm land and swamp areas.	• Huge population and developed land use in polders surrounded by high dikes.	• Flood plains are limitted to riversides except for downstream of Rhine River. • Less developed	• Flood plains are limited to riversides. • Less developed
	Physical Condition	Flooding Condition	• Frequent flooding • Extensive and prolonged inundation	• Frequent flooding • Flash flood • Localized and short inundation	• Frequent flooding flood • Extensive and prolonged inundation	• Extensive and prolonged inundation	• Extensive and prolonged inundation • Tidal flooding by storm surge	• Flood risk is not so high except for Rhine River area. • Extensive and prolonged inundation in riverside	• Flood risk is not so high.
		Protection Level	• Agricultural Area: 3-year return period or less • Bangkok : 10 year return period	• Large rivers: 30 to 40 year return Period	• Yangtze River: 10 to 20 year return Period	• Mississippi River: 500 year return Period (70% completed)	• More than 1000 year return period	• Rhine River Dikes : More than 1000 year return period	• Sea dikes against storm surges : 1,000 year return period

Table 7.4.5 Organization of Office of River Basin Committee

Organization	Number of Persons			
	Director General	Director	Chief	Staff
Office of River Basin Committee	1			1
Policy and Planning		1	3	10
Coordination, Operation and Disaster Management Division		1	3	10
Flood Information Division		1	2	15
Training, Reserch and Public Awareness Division		1	3	10
Legal and General Administraion Division		1	2	10
Total	1	5	13	56

Table 7.4.6 Necessary Facility and Equipment

Items	Break Down	Unit	Nos.
Office Space including Facilities	Office Space	Lump	1
	Desk, Chair and Cabinet	Lump Sum	1
	Meeting Table with Chairs	Lump Sum	1
	Telephone/Facsimile	Set	20
	Copy Machine	Set	2
	Miscellaneous	Lump	1
Data Management Facilities	Computer	Set	15
	Display Equipment	Set	2
	Data Filing	Lump	1
	Miscellaneous	Lump	1
Installation of Data Transmission System	Transmission Equipment	Lump Sum	1
	Rental of Transmission Line	Lump Sum	1
Training and Public Advertisement Equipment	Audio Equipment	Set	3
Transportation Facilities	Sedan	Nos.	3
	4 W/D		3
	Micro-Bus		2

Table 7.5.1 IMPLEMENTATION SCHEDULE OF FLOOD PROTECTION AND DRAINAGE SYSTEM OF MAJOR URBAN AREA (NAKHON SAWAN TO NONTHABURI)

No.	Protection Area	Description	Exist. Facility			Flood Protection Plan				P. Area (km^2)	Implementation plan 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018	C. Cost (Mil. Baht)	Remarks
			Facilit	Return Period	Dike El.(msl)	Facility	Return Period	Dike El.(msl)	F. board (m)				
1	N. Sawan (West Bank)	P. Muni.	Dike		24.4~28.7	Polder	100	28.0~29.0	0.4	21.0		1,475.1	
	Muang N. Sawan									103.8		2,690.0	
	Chumsaeng	Muni.				Polder	100	-	-	2.4		90.0	F/S, D/D required
	Krok Phra	S. D.				Polder	100	-	-	2.8		48.7	F/S, D/D required
	Phayuha Khiri	S. D.				Polder	100	-	-	1.8		48.6	F/S, D/D required
2	Chai Nat / East								0.5	11.2		136.2	
	A. Muang Chai Nat	P. Muni.	Dike		17.6~18.7	Polder	100	18.7~19.0		4.0		82.0	
	Ban Kluay	East bank	Dike		17.0~17.8	Polder	100	18.1~18.6		7.2		54.2	
	Chai Nat / West		Dike		17.5~18.6					6.4		120.4	
	Tha Chai	West bank	Dike		17.6~18.2	Polder	100	18.5~18.9		3.1		63.5	
	Had Tha Sao	West bank	Dike		18.2~19.2	Polder	100	19.0~19.15		3.3		56.9	
	Wat Sing	Muni.	Road		18.5~18.6	Polder	100	20		0.5		62.4	
3	Sing Buri	P. Muni.	Dike		13.06 *	Polder	100	13.25	0.5	11.98		2,009.8	
	Sub-area	1&5								6.15		1,144.0	
	Sub-area	7&8								4.99		636.0	
	Sub-area	2&6								0.69		82.5	
	Sub-area	3								0.15		147.3	
	In Buri					Polder	100	-	-	3.32		754.8	F/S, D/D required
	Sub-area	2&3								1.71		474.1	
	Sub-area	4								0.51		135.4	
	Sub-area	1								1.10		145.3	
	Phrom Buri									2.37		465.4	
	Bang Nam Chio		Dike		RID D.								
	Sub-area	1,2				Polder	100	-	-	1.23		165.0	F/S, D/D required
	Pak Bang												
	Sub-area	2				Polder	100	-	-	0.51		147.1	F/S, D/D required
	Sub-area	1&3								0.63		153.3	
4	Ang Thong									12.87		2,000.6	
	Talat Luang (W. bank)	P. Muni.	Dike		8.3~8.75	Polder	100	9.0	0.2	5.28		726.7	
	Bang Kaeo (E. bank)	P. Muni.			8.3~8.4	Polder	100	9.0	0.2	6.07		949.8	
	Talat Kruat	P. Muni.				Polder	100	9.0	0.2	1.52		324.1	D/D required
	Pamok (S.D)	Pamok				Polder	100	-	-	7.88		804.2	F/S, D/D required
	Bang Plakot (S.D)					Polder	100	-	-	7.80		1,029.8	F/S, D/D required
5	Ayuthaya									18.4		591.4	
	Ko Muang	P. Muni.	Road		4.6~6.1	Road	100	6.0		13.0		419.4	
						Dike	100	6.3~6.5	0.3~0.5				
	Ayothaya		Road		4.7~6.1	Road	100	6.0		5.4			
						Dike	100	6.3~6.5	0.3~0.5			172.0	
6	Pathum Thani									119.4		1,636.8	
	Muang Pathum T.	Polder	Rd., Dike		2.0~2.6	Polder	100	3.7~4.0	0.4/0.6**	8.8		292.9	
	B. Luang / Chieng Rak	Polder	Road		2.5~3.4	Polder	100	3.7~4.0	0.4/0.6**	39.5		725.5	
	B. Pho Tai / B. Luang	Polder	Road		2.4~2.7	Polder	100	3.7~3.8	0.4/0.6**	71.1		618.4	
7	Nonthaburi									232.5		3,715.3	
	Pak Kret	East bank	Road		2.6					82.5*			Completed 1997
	Pak Kret	East bank	D / W	100	3.15								
	Nonthaburi	East bank	Road										
	Nonthaburi	East bank	-		1.33~1.98	Polder	100	2.85~3.0	0.5**	3.0		275.5	
	B. Kruai, B. Bua Thong	West bank	-		1.43~2.23	Polder	100	2.85~3.15	0.5**	150.0		2,681.6	
	Extra Area	West bank								-		758.2	
8									total	566.4	total	17,679.5	

Note; ▬ Detailed Design, ▭ Bidding, ▬ Under Construction, ▭ Implementation, * Total area of East Bank, ** 0.4 : Concrete dike, 0.6 : Ear *** Including land subsidence : 0.2m

P. Area = Polder Area, P.Mini. = Provincial Municipality, Muni.= Municipality, S.D. = Sanitary District, D / W = Dike & Wall, C.Cost = Costruction Cost(Price level : 1997), F. board is depends on the local situation along the dikes

Table 7.5.2 IMPLEMENTATION SCHEDULE OF FLOOD PROTECTION AND DRAINAGE SYSTEM OF SECONDARY URBAN AREA

o	Location	Description	Flood Protection Plan					Implementation plan																		C. Cost	Remarks
			Facility	Return Period		No. of	P. Capa.	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	(Mil. Bahts)	
				Drain.	Flood	Pump St.	(cms)																						
1	Sukhothai	P. Muni.	Polder	5	100	3	24.0																					312.3	
	Sawankhalok	Muni.	Dike	5	100	2	16.0																					331.2	
2	Uttaradit	P. Muni.	Polder	5	100	1	10.0																					341.3	
3	Phitsanulok	P. Muni.	Polder	5	100	3	59.0																					766.5	
	B. Rakham	S.D.	Polder	5	100	2	6.0																					141.2	
	B.Krathum	S.D.	Polder	5	100	1	8.5																					137.3	
	Phrom Phiram	S.D.	Polder	5	100	1	1.0																					81.5	
4	Phichit	P. Mini.	Polder	5	100	2	14.0																					275.1	
	Taphan Hin	Muni.	Polder	5	100	2	10.0																					312.7	
	B. Mun Nak	Muni.	Polder	5	100	3	14.0																					325.4	
	Pho Thale	S.D.	Polder	5	100	3	12.0																					174.3	
5	Uthai Thani	P. Muni.	Polder	5	100	1	14.0																					230.1	
6	Suphan Buri	P. Muni.	Polder	5	100	*	*																					645.0	
	Songpeenong	Muni.	Polder	5	100	3	6.0																					317.0	
	Phai Khong Din	S.D.	Polder	5	100	2	2.0																					95.8	
	Ban Leam	S.D.	Polder	5	100	2	2.0																					85.6	
	B. Pla Ma	S.D.	Polder	5	100	2	2.0																					136.9	
	Khok Khram	S.D.	Polder	5	100	3	2.5																					174.9	
7	Nakhon Phathom	P. Muni.	-	5	100	1	3.0																					332.5	
	Rang Krathum	S.D.	Polder	5	100	Nil	-																					34.6	
	B. Luang	S.D.	Polder	5	100	Nil	-																					14.9	
	B. Leng	S.D.	Polder	5	100	Nil	-																					49.5	
8	Samut Sakhon	P. Muni.	Polder	5	100	?	-																					3,968.2	
	Om Noi		Dike	5	100	Nil	-																					58.7	
9	Lop Buri	P. Muni.	Dike	5	100	**	**																					393.4	
	Tha Wung	S.D.	Polder	5	100	Nil	-																					40.7	
	Tha Khlong	S.D.	Polder	5	100	Nil	-																					32.5	
10																										total	9,809.1	

Note; ▬ Feasibility Study & Detailed Design, □ ▭ Implementation, P. Muni. = Provincial Municipality, Muni. = Municipality, S.D. = Sanitary District,
C.Cost = Construction Cost (Price level : 1998)

Table 7.5.3 COMPARISON OF WATER LEVELS AT MAJOR URBAN AREAS

Design Level by Current PWD and BMA Plan (m MSL)			100-year Water Levels by this Study (m MSL)			
Urban Area	Dike Crest	Water Level	Station	Alt.1*	Alt. 2-1*	Alt. 2-2
Sukhothai	n.a.	n.a.	Y.4	50.9	50.9	50.9
Phitsanulok	n.a.	n.a.	N.5A	46.8	46.8	46.8
Pichit	n.a.	n.a.	N.7	57.2	57.2	57.2
Nakhon Sawan	28.0 to 29.0	27.6 to 28.6	C.2	25.9	25.9	25.9
Chainat	18.7 to 19.0	18.2 to 18.5	C.13	17.5	17.5	17.6
Ang Thong	9.0	8.8	C.7A	8.2	8.2	8.5
Ayutthaya	6.0 to 6.5	6.0	C.34	6.3	6.3	6.4
Nonthaburi	2.85 to 3.15	2.35 to 2.65	C.22	2.8	3.1	2.8
Samsen, BMA	3.0	2.4	C.12	2.4	2.7	2.4
Mem. Bridge, BMA	2.8	2.3	C.4	2.3	2.6	2.3

* : Water levels in Alternative 1, 2-1 are guessed from the 100-year water levels in Alt.2-2.

Table 7.5.4 DESCRIPTION OF PROTECTION AREA

No.	Location	Area (km2)	Return Period of Existing Flow Capacity			Protection Level of Area (yr)	Main Land Use
			River Stretch	Left/Right	(yr)		
1	Area surrounded by Lop Buri and Pasak Rivers, Chainat-Pasak Canal and Khlong Bang Phra Khru	410	Lop-1	Left	2 to 3	2 to 3	Rice (HYV, DWR, FR)
			BPK	Left	5 to 10		
			Pas-1	Right	3 to 5		
2	Area surrounded by Pasak River and RID left dike of Chao Phraya River	850	Pas-1	Left	3 to 5	3 to 5	Rice (HYV, DWR, FR)
			Pas-2	Left	5 to 10		
3	Area surrounded by Lop Buri and Pasak Rivers and Khlong Bang Phra Khru	70	Lop-2	Left	3 to 5	3 to 5	Rice (DWR)
			BPK	Right	5 to 10		
			Pas-2	Right	5 to 10		
4	Area surrounded by Chao Phraya and Lop Bur Rivers, and Khlong Bang Kaeo	180	Chao-3	Left	3 to 5	less than 2	Rice (DWR)
			Lop-2	Right	less than 2		
			BK	Right	2 to 3		
5	Area surrounded by Chao Phraya and Noi Rivers, and Khlong Bang Luang and Bang Bal	45	Chao-4	Right	10 to 25	less than 2	Rice (DWR)
			Noi-3	Left	less than 2		
			BL	Left	5 to 10		
			BB	Right	less than 2		
6	Area surrounded by Chao Phraya and Noi Rivers, and Khlong Bang Bal	180	Chao-5	Right	less than 2	less than 2	Rice (DWR, FR)
			Chao-6	Right	2 to 3		
			Noi-4	Left	2 to 3		
			BB	Left	5 to 10		
7	Area surrounded by Chao Phraya River and RID right dike of Chao Phraya River	120	Pas-3	Left	3 to 5	less than 2	Rice (DWR)
			Chao-6	Left	2 to 3		
			Chao-7	Left	less than 2		
8	Area surrounded by Chao Phraya and Thachine Rivers and Khlong Phraya Ban Lu	1,100	Chao-7	Right	less than 2	2 to 3	Rice (HYV)

Table 7.5.5 EFFECTIVENESS OF RIVER IMPROVEMENT

Case	Protection Level	Protection Area	Benefit (mil.baht)*			Economic Capital Cost (mil.baht)	Benefit by Capital Cost	Remarks
			Protected Area	Unprotected Area	Total			
5-1	5-yr	Area-1	120	-40	80	390	0.21	Economically Viable
5-2	5-yr	Area-1 to 2	201	-60	141	500	0.28	Economically Viable
5-3	5-yr	Area-1 to 3	201	-60	141	630	0.22	Economically Viable
5-4	5-yr	Area-1 to 4	203	-96	107	910	0.12	
3	3-yr	All Areas	221	0	221	1234	0.18	Economically Viable

* : Average Annual Damage Reduction under Future Basin Condition in 2006

Table 7.5.6 FLOOD DAMAGE AMOUNT IN 1957 FLOOD

Case	Item	Area-1	Area-2	Area-3	Area-4	Area-5	Area-6	Area-7	Area-8	Total
Without River Improvement	Inundation Volume (mil. m3)	187	674	30	114	137	225	87	275	1,729
	Damage Amount (mil. baht)	558	1,389	19	70	140	256	135	1,436	4,002
With 3-yr River Improvement	Inundation Volume (mil. m3)	112	674	30	104	90	172	82	209	1,473
	Damage Amount (mil. baht)	319	1,389	19	53	91	140	88	924	3,023
Difference	Inundation Volume (mil. m3)	75	0	0	10	47	53	5	66	256
	Damage Amount (mil. baht)	239	0	0	17	49	116	47	512	979

Note: Flood damage amount is estimated under the future basin condition in the target year 2005.

Table 7.5.7 ANNUAL DAMAGE REDUCTION WITH RIVER IMPROVEMENT

Return Period (year)	Flood Damage Amount		Damage Reduction (mil. Baht)	Mean Damage Reduction (mil. Baht)	Probability of Occurrence	Expected Damage Reduction (mil. baht/year)
	Without River Improvement	With 3-yr River Improvement				
1.3	-	-	0			
				490	0.436	213
3	4,002	3,023	979			

Annulal Damage Reduction under Future Basin Condition in 2005	213
↓	
Annulal Damage Reduction under Future Basin Condition in 2006	221

Note: The amount in 2006 is estimated by increasing that in 2005 considering the increase of GDP, population, etc.

Table 7.6.1(1/3) PROJECT EVALUATION (RIVER IMPROVEMENT)

River Improvement-1 (P/S) Unit: million baht

		Economic cost			Economic benefit			
Year		Construction (A)	O&M (B)	Total (C)	General, etc. (D)	Agri. (E)	Tot Economic Benefit (F)	(F)-(C) Benefit-Cost (G)
1	1998	0	0	0	0	0	0	0
2	1999	12	0	12	0	0	0	-12
3	2000	30	0	30	0	0	0	-30
4	2001	26	0	26	0	0	0	-26
5	2002	294	0	294	0	0	0	-294
6	2003	293	0	293	0	0	0	-293
7	2004	293	0	293	0	0	0	-293
8	2005	286	0	286	0	0	0	-286
9	2006	0	31	31	185	36	221	190
10	2007	0	31	31	185	36	221	190
11	2008	0	31	31	185	36	221	190
12	2009	0	31	31	185	36	221	190
13	2010	0	31	31	185	36	221	190
14	2011	0	31	31	185	36	221	190
15	2012	0	31	31	185	36	221	190
16	2013	0	31	31	185	36	221	190
17	2014	0	31	31	185	36	221	190
18	2015	0	31	31	185	36	221	190
19	2016	0	31	31	185	36	221	190
20	2017	0	31	31	185	36	221	190
21	2018	0	31	31	185	36	221	190
22	2019	0	31	31	185	36	221	190
23	2020	0	31	31	185	36	221	190
24	2021	0	31	31	185	36	221	190
25	2022	0	31	31	185	36	221	190
26	2023	0	31	31	185	36	221	190
27	2024	0	31	31	185	36	221	190
28	2025	0	31	31	185	36	221	190
29	2026	0	31	31	185	36	221	190
30	2027	0	31	31	185	36	221	190
31	2028	0	31	31	185	36	221	190
32	2029	0	31	31	185	36	221	190
33	2030	0	31	31	185	36	221	190
34	2031	0	31	31	185	36	221	190
35	2032	0	31	31	185	36	221	190
36	2033	0	31	31	185	36	221	190
37	2034	0	31	31	185	36	221	190
38	2035	0	31	31	185	36	221	190
39	2036	0	31	31	185	36	221	190
40	2037	0	31	31	185	36	221	190
41	2038	0	31	31	185	36	221	190
42	2039	0	31	31	185	36	221	190
43	2040	0	31	31	185	36	221	190
44	2041	0	31	31	185	36	221	190
45	2042	0	31	31	185	36	221	190
46	2043	0	31	31	185	36	221	190
47	2044	0	31	31	185	36	221	190
48	2045	0	31	31	185	36	221	190
49	2046	0	31	31	185	36	221	190
50	2047	0	31	31	185	36	221	190
51	2048	0	31	31	185	36	221	190
52	2049	0	31	31	185	36	221	190
53	2050	0	31	31	185	36	221	190
54	2051	0	31	31	185	36	221	190
55	2052	0	31	31	185	36	221	190
56	2053	0	31	31	185	36	221	190
57	2054	0	31	31	185	36	221	190
58	2055	0	31	31	185	36	221	190
59	2056	0	31	31	185	36	221	190
60	2057	0	31	31	185	36	221	190
61	2058	0	31	31	185	36	221	190
62	2059	0	31	31	185	36	221	190
63	2060	0	31	31	185	36	221	190
64	2061	0	31	31	185	36	221	190
65	2062	0	31	31	185	36	221	190
66	2063	0	31	31	185	36	221	190
67	2064	0	31	31	185	36	221	190
68	2065	0	31	31	185	36	221	190
69	2066	0	31	31	185	36	221	190
70	2067	0	31	31	185	36	221	190
71	2068	0	31	31	185	36	221	190
		1,234	1,953	3,187	11,655	2,268	13,923	10,736
	EIRR		12.5%					

Discount rate(%)	B/C	PV Cost	PV Benefit	NPV
15	0.82	588	482	-106
12	1.04	715	743	28
10	1.24	826	1,028	202
5	2.18	1,309	2,853	1,544
3	2.87	1,714	4,912	3,198

Table 7.6.1(2/3) PROJECT EVALUATION (RESERVOIR OPERATION RULE)

3 Dams (F/S)

Unit: million baht

Year		Economic cost			Economic benefit			
		Construction (A)	O&M (B)	Total (C)	General, etc. (D)	Agri. (E)	TB Economic Benefit (F)	(F)-(C) Benefit-Cost (G)
1	1998	0	0	0	0	0	0	0
2	1999	15	0	15	0	0	0	-15
3	2000	15	0	15	0	0	0	-15
4	2001	0	74	74	908	130	1,038	964
5	2002	0	74	74	908	130	1,038	964
6	2003	0	74	74	908	130	1,038	964
7	2004	0	74	74	908	130	1,038	964
8	2005	0	74	74	908	130	1,038	964
9	2006	0	74	74	908	130	1,038	964
10	2007	0	74	74	908	130	1,038	964
11	2008	0	74	74	908	130	1,038	964
12	2009	0	74	74	908	130	1,038	964
13	2010	0	74	74	908	130	1,038	964
14	2011	0	74	74	908	130	1,038	964
15	2012	0	74	74	908	130	1,038	964
16	2013	0	74	74	908	130	1,038	964
17	2014	0	74	74	908	130	1,038	964
18	2015	0	74	74	908	130	1,038	964
19	2016	0	74	74	908	130	1,038	964
20	2017	0	74	74	908	130	1,038	964
21	2018	0	74	74	908	130	1,038	964
22	2019	0	74	74	908	130	1,038	964
23	2020	0	74	74	908	130	1,038	964
24	2021	0	74	74	908	130	1,038	964
25	2022	0	74	74	908	130	1,038	964
26	2023	0	74	74	908	130	1,038	964
27	2024	0	74	74	908	130	1,038	964
28	2025	0	74	74	908	130	1,038	964
29	2026	0	74	74	908	130	1,038	964
30	2027	0	74	74	908	130	1,038	964
31	2028	0	74	74	908	130	1,038	964
32	2029	0	74	74	908	130	1,038	964
33	2030	0	74	74	908	130	1,038	964
34	2031	0	74	74	908	130	1,038	964
35	2032	0	74	74	908	130	1,038	964
36	2033	0	74	74	908	130	1,038	964
37	2034	0	74	74	908	130	1,038	964
38	2035	0	74	74	908	130	1,038	964
39	2036	0	74	74	908	130	1,038	964
40	2037	0	74	74	908	130	1,038	964
41	2038	0	74	74	908	130	1,038	964
42	2039	0	74	74	908	130	1,038	964
43	2040	0	74	74	908	130	1,038	964
44	2041	0	74	74	908	130	1,038	964
45	2042	0	74	74	908	130	1,038	964
46	2043	0	74	74	908	130	1,038	964
47	2044	0	74	74	908	130	1,038	964
48	2045	0	74	74	908	130	1,038	964
49	2046	0	74	74	908	130	1,038	964
50	2047	0	74	74	908	130	1,038	964
51	2048	0	74	74	908	130	1,038	964
52	2049	0	74	74	908	130	1,038	964
53	2050	0	74	74	908	130	1,038	964
54	2051	0	74	74	908	130	1,038	964
55	2052	0	74	74	908	130	1,038	964
56	2053	0	74	74	908	130	1,038	964
57	2054	0	74	74	908	130	1,038	964
58	2055	0	74	74	908	130	1,038	964
59	2056	0	74	74	908	130	1,038	964
60	2057	0	74	74	908	130	1,038	964
61	2058	0	74	74	908	130	1,038	964
62	2059	0	74	74	908	130	1,038	964
63	2060	0	74	74	908	130	1,038	964
64	2061	0	74	74	908	130	1,038	964
65	2062	0	74	74	908	130	1,038	964
66	2063	0	74	74	908	130	1,038	964
67	2064	0	74	74	908	130	1,038	964
68	2065	0	74	74	908	130	1,038	964
69	2066	0	74	74	908	130	1,038	964
70	2067	0	74	74	908	130	1,038	964
71	2068	0	74	74	908	130	1,038	964
		30	5,032	5,062	61,744	8,840	70,584	65,522

EIRR 707.88%

Discount rate(%)	B/C	PV Cost	PV Benefit	NPV
15	13.17	346	4,550	4,204
12	13.34	461	6,154	5,693
10	13.45	579	7,787	7,208
5	13.73	1,259	17,283	16,025
3	13.83	1,983	27,421	25,439

Table 7.6.1(3/3) PROJECT EVALUATION (COMBINED)

3 Dams + River Improvement (F/S) Unit: million baht

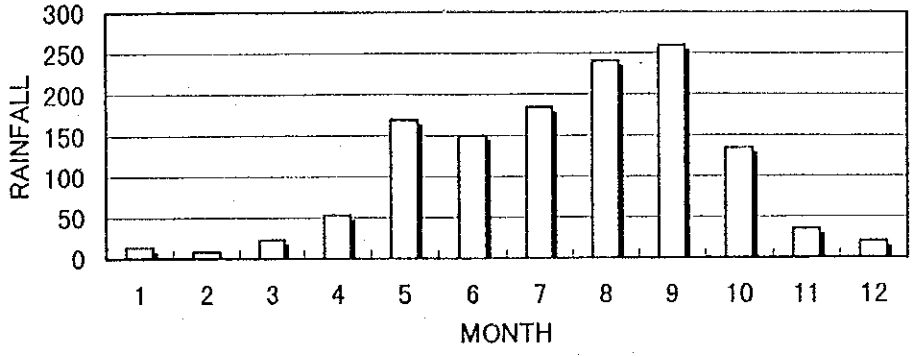
Year		Economic cost: Construction (A)	O&M (B)	Total (C)	Economic benefit: General, etc. (D)	Agri. (E)	Total Economic Benefit (F)	(F)-(C) Benefit-Cost (G)
1	1998	0	0	0	0	0	0	0
2	1999	27	0	27	0	0	0	-27
3	2000	45	0	45	0	0	0	-45
4	2001	26	74	100	908	130	1,038	938
5	2002	294	74	368	908	130	1,038	670
6	2003	293	74	367	908	130	1,038	671
7	2004	293	74	367	908	130	1,038	671
8	2005	286	74	360	908	130	1,038	678
9	2006	0	105	105	1,257	184	1,441	1,336
10	2007	0	105	105	1,257	184	1,441	1,336
11	2008	0	105	105	1,257	184	1,441	1,336
12	2009	0	105	105	1,257	184	1,441	1,336
13	2010	0	105	105	1,257	184	1,441	1,336
14	2011	0	105	105	1,257	184	1,441	1,336
15	2012	0	105	105	1,257	184	1,441	1,336
16	2013	0	105	105	1,257	184	1,441	1,336
17	2014	0	105	105	1,257	184	1,441	1,336
18	2015	0	105	105	1,257	184	1,441	1,336
19	2016	0	105	105	1,257	184	1,441	1,336
20	2017	0	105	105	1,257	184	1,441	1,336
21	2018	0	105	105	1,257	184	1,441	1,336
22	2019	0	105	105	1,257	184	1,441	1,336
23	2020	0	105	105	1,257	184	1,441	1,336
24	2021	0	105	105	1,257	184	1,441	1,336
25	2022	0	105	105	1,257	184	1,441	1,336
26	2023	0	105	105	1,257	184	1,441	1,336
27	2024	0	105	105	1,257	184	1,441	1,336
28	2025	0	105	105	1,257	184	1,441	1,336
29	2026	0	105	105	1,257	184	1,441	1,336
30	2027	0	105	105	1,257	184	1,441	1,336
31	2028	0	105	105	1,257	184	1,441	1,336
32	2029	0	105	105	1,257	184	1,441	1,336
33	2030	0	105	105	1,257	184	1,441	1,336
34	2031	0	105	105	1,257	184	1,441	1,336
35	2032	0	105	105	1,257	184	1,441	1,336
36	2033	0	105	105	1,257	184	1,441	1,336
37	2034	0	105	105	1,257	184	1,441	1,336
38	2035	0	105	105	1,257	184	1,441	1,336
39	2036	0	105	105	1,257	184	1,441	1,336
40	2037	0	105	105	1,257	184	1,441	1,336
41	2038	0	105	105	1,257	184	1,441	1,336
42	2039	0	105	105	1,257	184	1,441	1,336
43	2040	0	105	105	1,257	184	1,441	1,336
44	2041	0	105	105	1,257	184	1,441	1,336
45	2042	0	105	105	1,257	184	1,441	1,336
46	2043	0	105	105	1,257	184	1,441	1,336
47	2044	0	105	105	1,257	184	1,441	1,336
48	2045	0	105	105	1,257	184	1,441	1,336
49	2046	0	105	105	1,257	184	1,441	1,336
50	2047	0	105	105	1,257	184	1,441	1,336
51	2048	0	105	105	1,257	184	1,441	1,336
52	2049	0	105	105	1,257	184	1,441	1,336
53	2050	0	105	105	1,257	184	1,441	1,336
54	2051	0	105	105	1,257	184	1,441	1,336
55	2052	0	105	105	1,257	184	1,441	1,336
56	2053	0	105	105	1,257	184	1,441	1,336
57	2054	0	105	105	1,257	184	1,441	1,336
58	2055	0	105	105	1,257	184	1,441	1,336
59	2056	0	105	105	1,257	184	1,441	1,336
60	2057	0	105	105	1,257	184	1,441	1,336
61	2058	0	105	105	1,257	184	1,441	1,336
62	2059	0	105	105	1,257	184	1,441	1,336
63	2060	0	105	105	1,257	184	1,441	1,336
64	2061	0	105	105	1,257	184	1,441	1,336
65	2062	0	105	105	1,257	184	1,441	1,336
66	2063	0	105	105	1,257	184	1,441	1,336
67	2064	0	105	105	1,257	184	1,441	1,336
68	2065	0	105	105	1,257	184	1,441	1,336
69	2066	0	105	105	1,257	184	1,441	1,336
70	2067	0	105	105	1,257	184	1,441	1,336
71	2068	0	105	105	1,257	184	1,441	1,336
		1,264	6,985	8,249	83,731	12,242	95,973	87,724

EIRR 456.07%

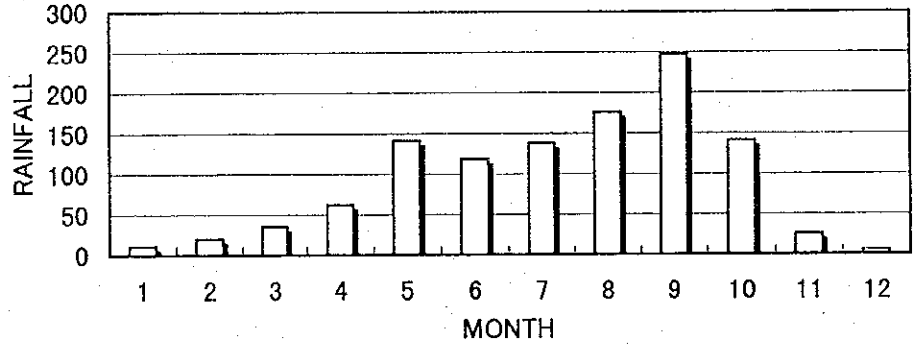
Discount rate(%)	B/C	PV Cost	PV Benefit	NPV
15	5.82	933	5,428	4,495
12	6.38	1,176	7,509	6,333
10	6.88	1,405	9,662	8,257
5	8.76	2,568	22,486	19,919
3	9.84	3,697	36,379	32,682

Figures

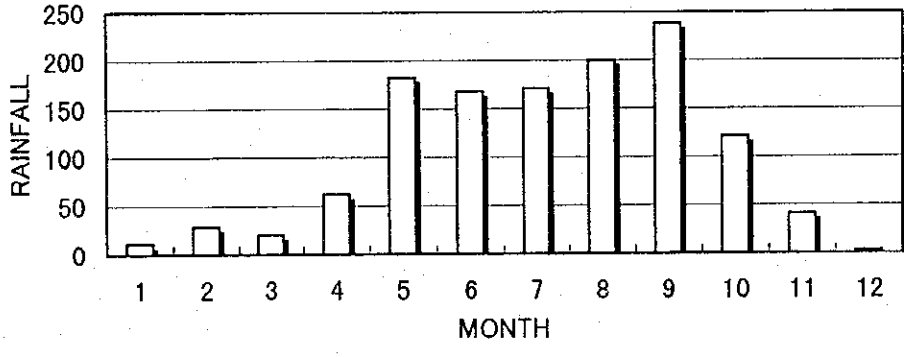
CHIANG MAI



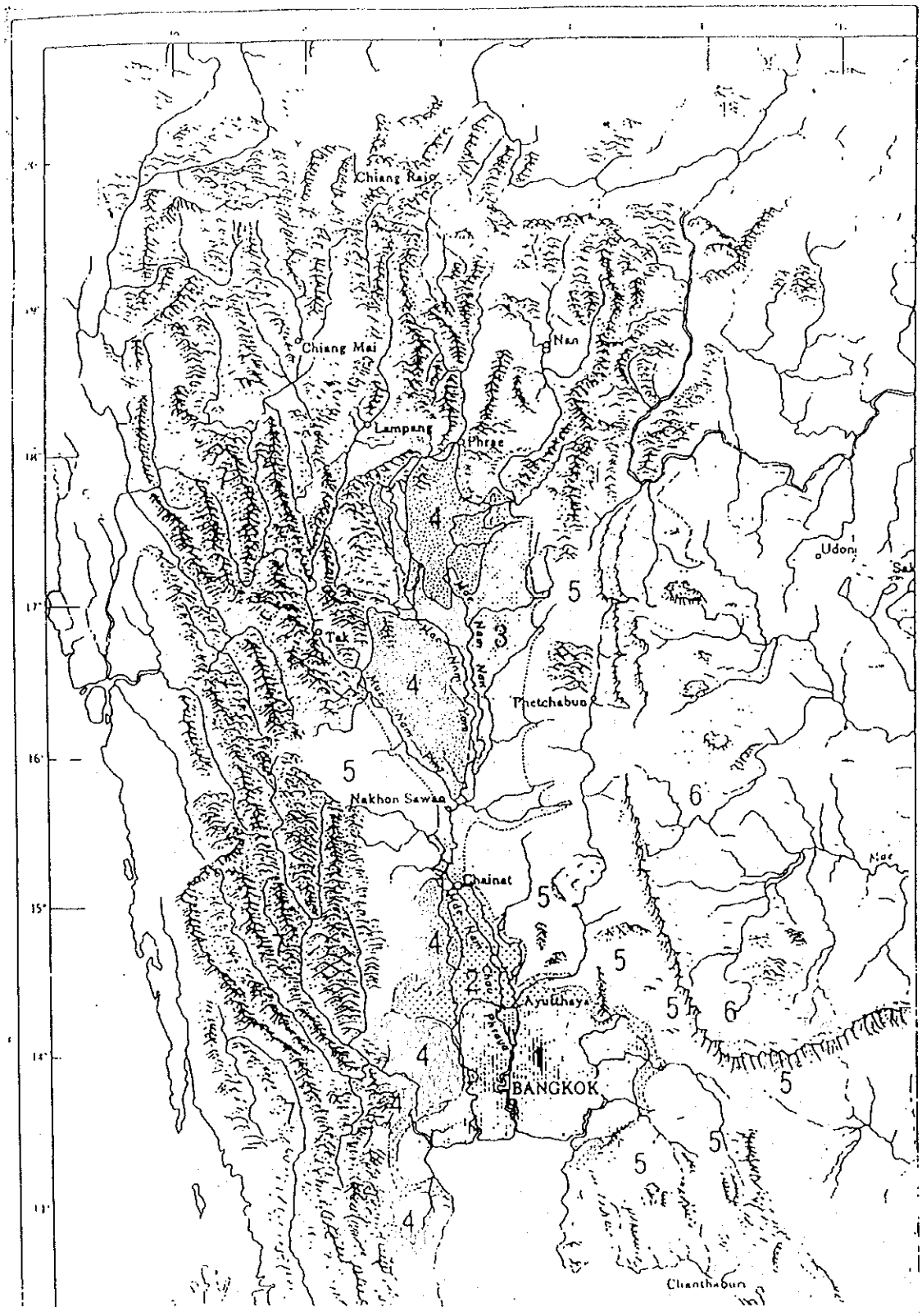
NAKHON SAWAN



BANGKOK METROPOLIS



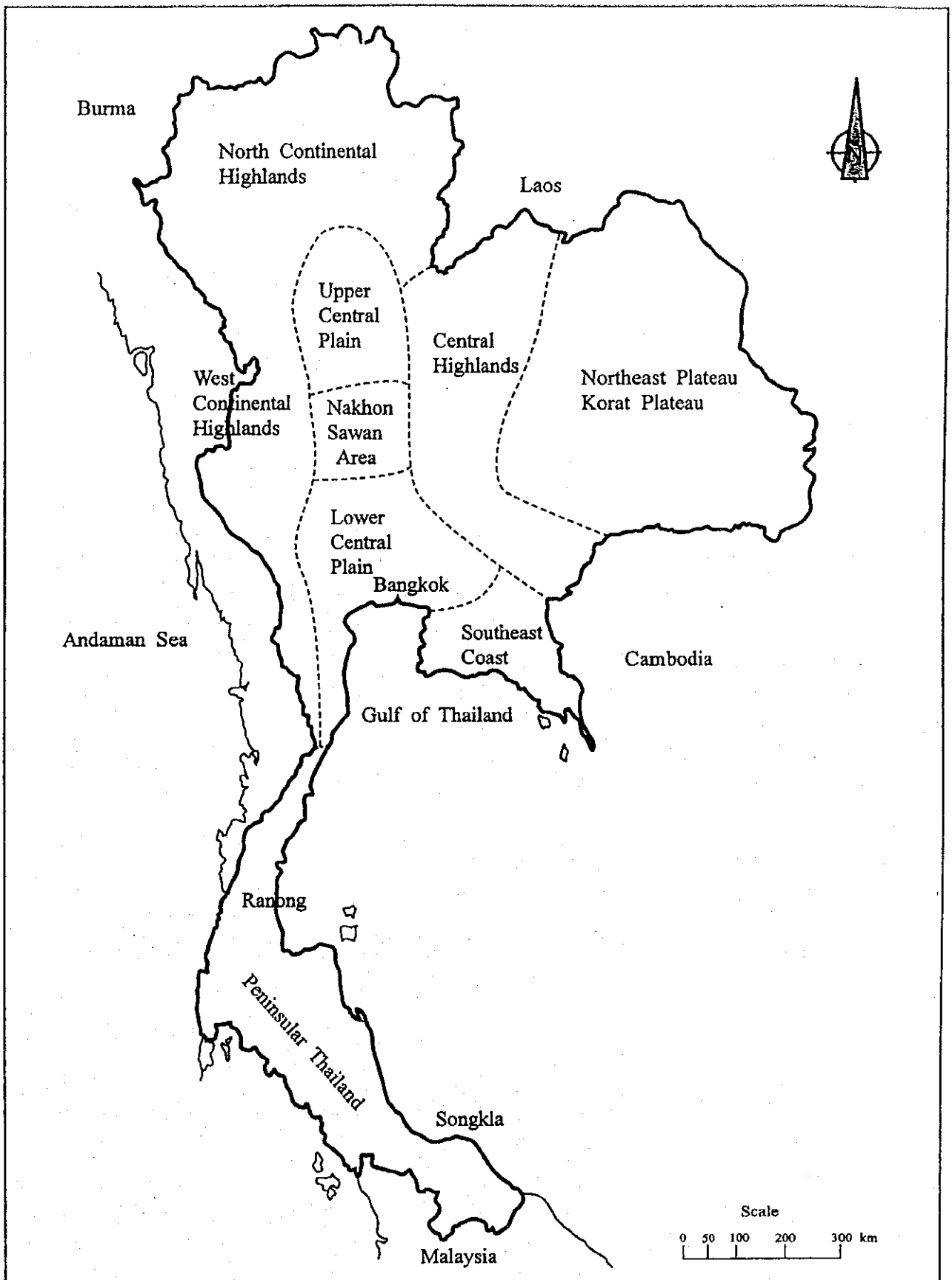
STUDY ON ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAOPHRAYA RIVER BASIN	Fig. 2.1.1 MONTHLY VARIATION OF AVERAGE RAINFALL (1951 - 1980)
CTI ENGINEERING CO., LTD & INA CORPORATION	



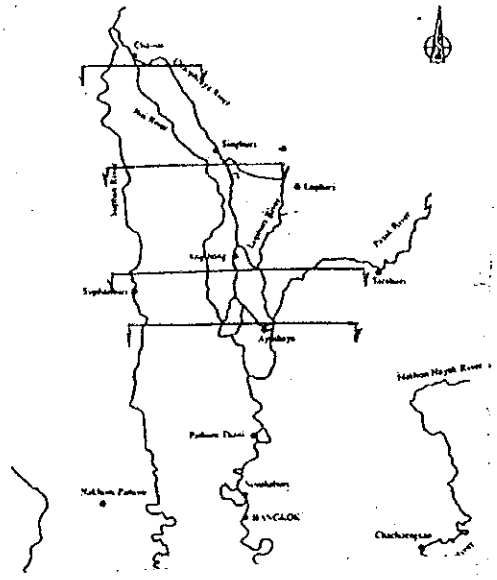
Topographic features of the Central plain: 1 – Bangkok plain; 2 – lower Central plain; 3 – upper Central plain; 4 – alluvial fans; 5 – pediments and/or pediplains; 6 – Khorat plateau; 7 – western mountain belt

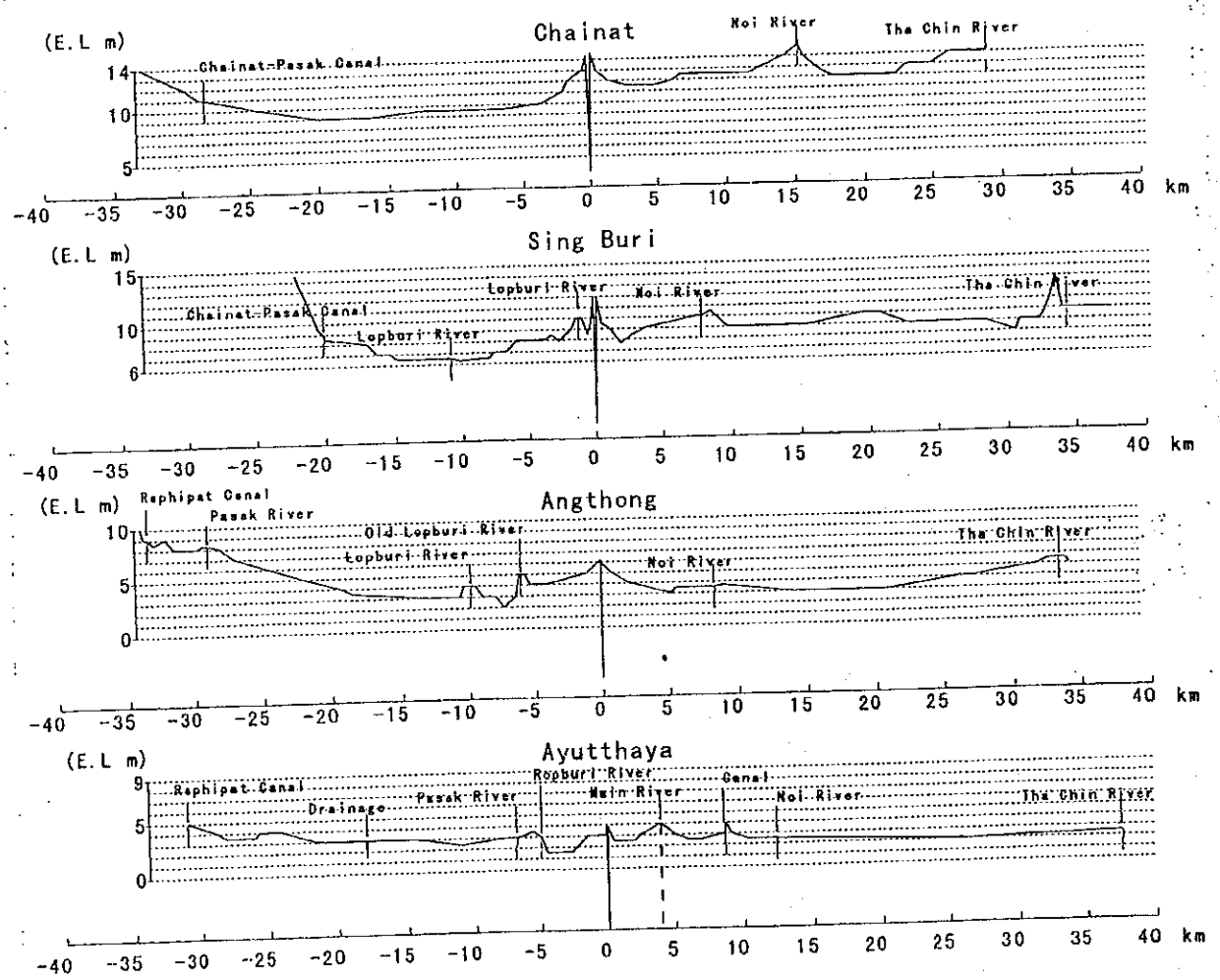
(Relief adapted from Brown, G.F. *et al.* 1951)

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.1.2 TOPOGRAPHIC FEATURES OF THE CENTRAL PLAIN
CTI ENGINEERING CO., LTD AND INA CORPORATION	

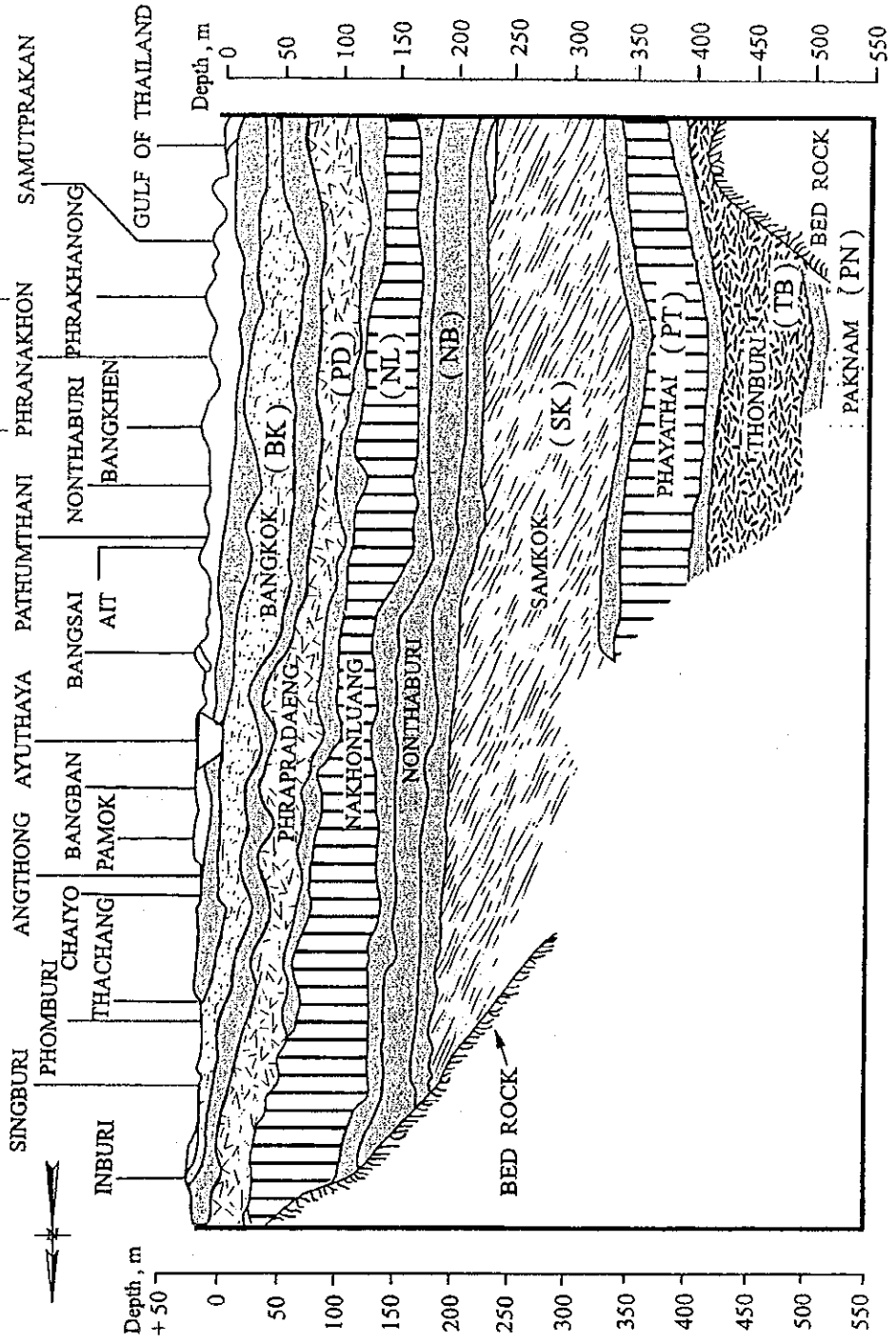


STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.1.3 GEOLOGICAL FORMATION ON THAILAND
CTI ENGINEERING CO., LTD AND INA CORPORATION	



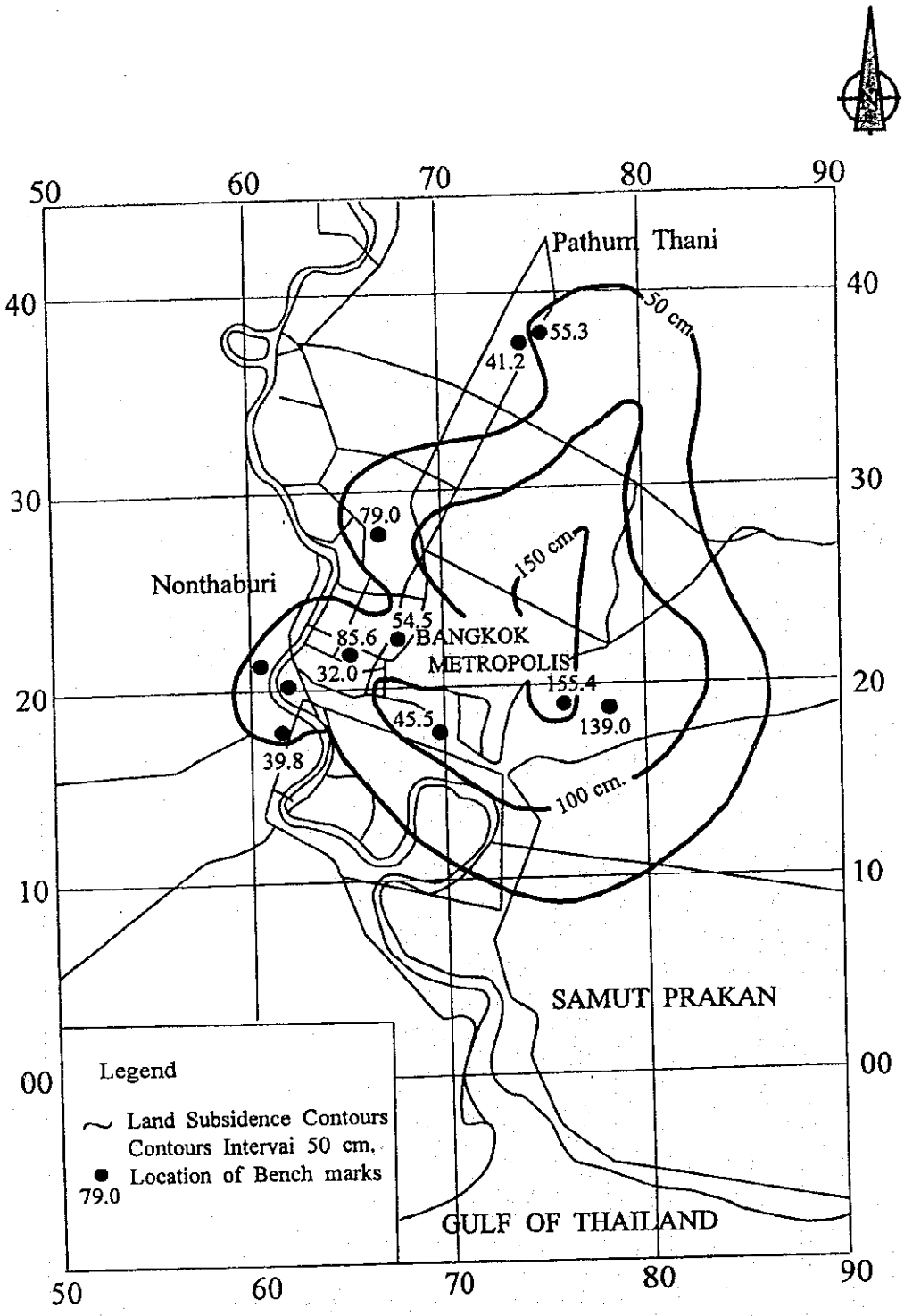


STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.1.4 NATURAL LEVEES AND BACK MARSHES
CTI ENGINEERING CO., LTD AND INA CORPORATION	



After Balasubrmaian et al, 1989

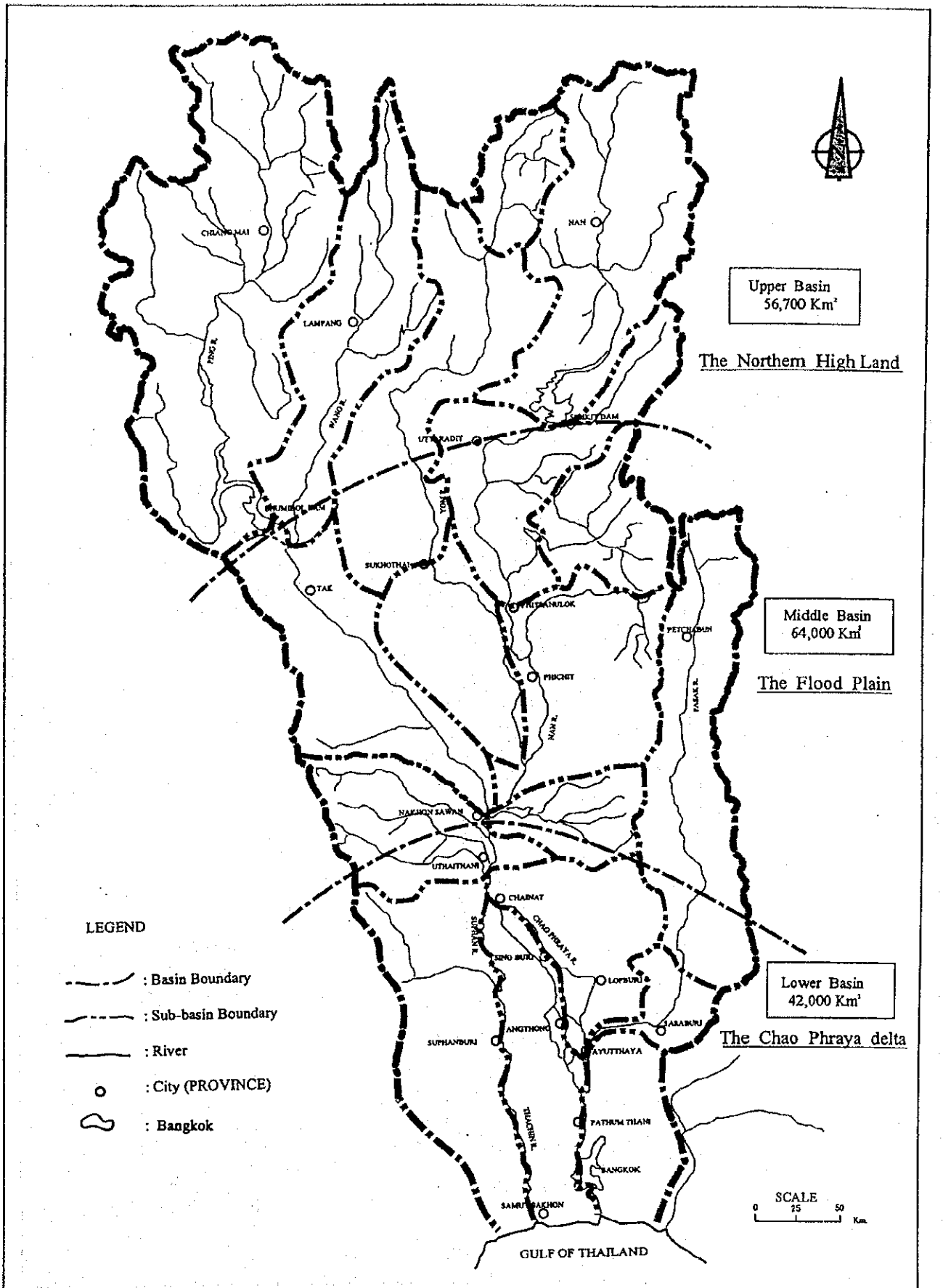
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.1.5
CTI ENGINEERING CO., LTD AND INA CORPORATION	SUBSOIL LAYERING SYSTEM OF THE CENTRAL PLAIN



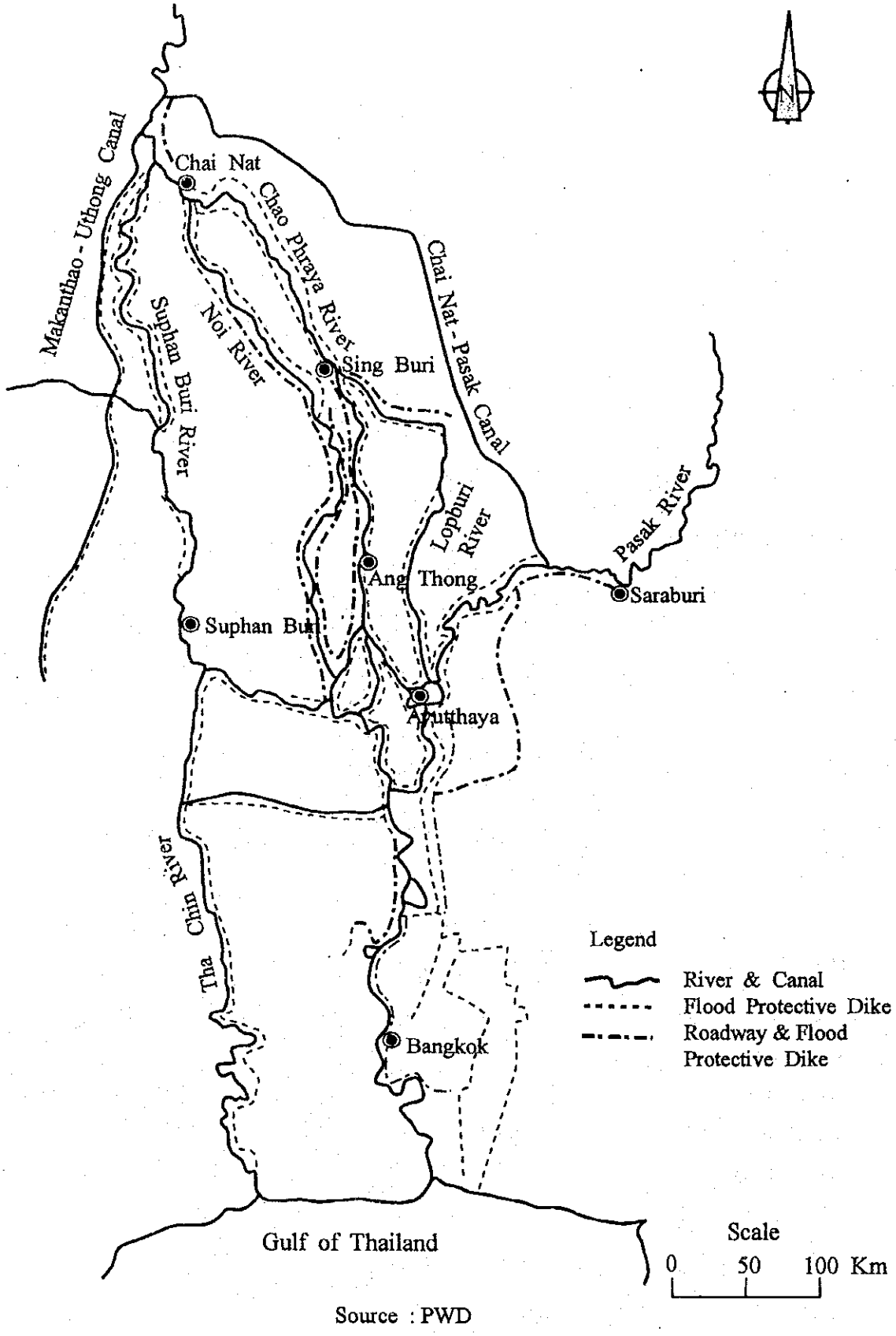
After The ESUB Project BMA / NEDECO , 1996

Scale
0 5 10 km

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.1.6 LAND SUBSIDENCE IN BANGKOK AREA AND VICINITY 1933 - 1986
CTI ENGINEERING CO., LTD AND INA CORPORATION	

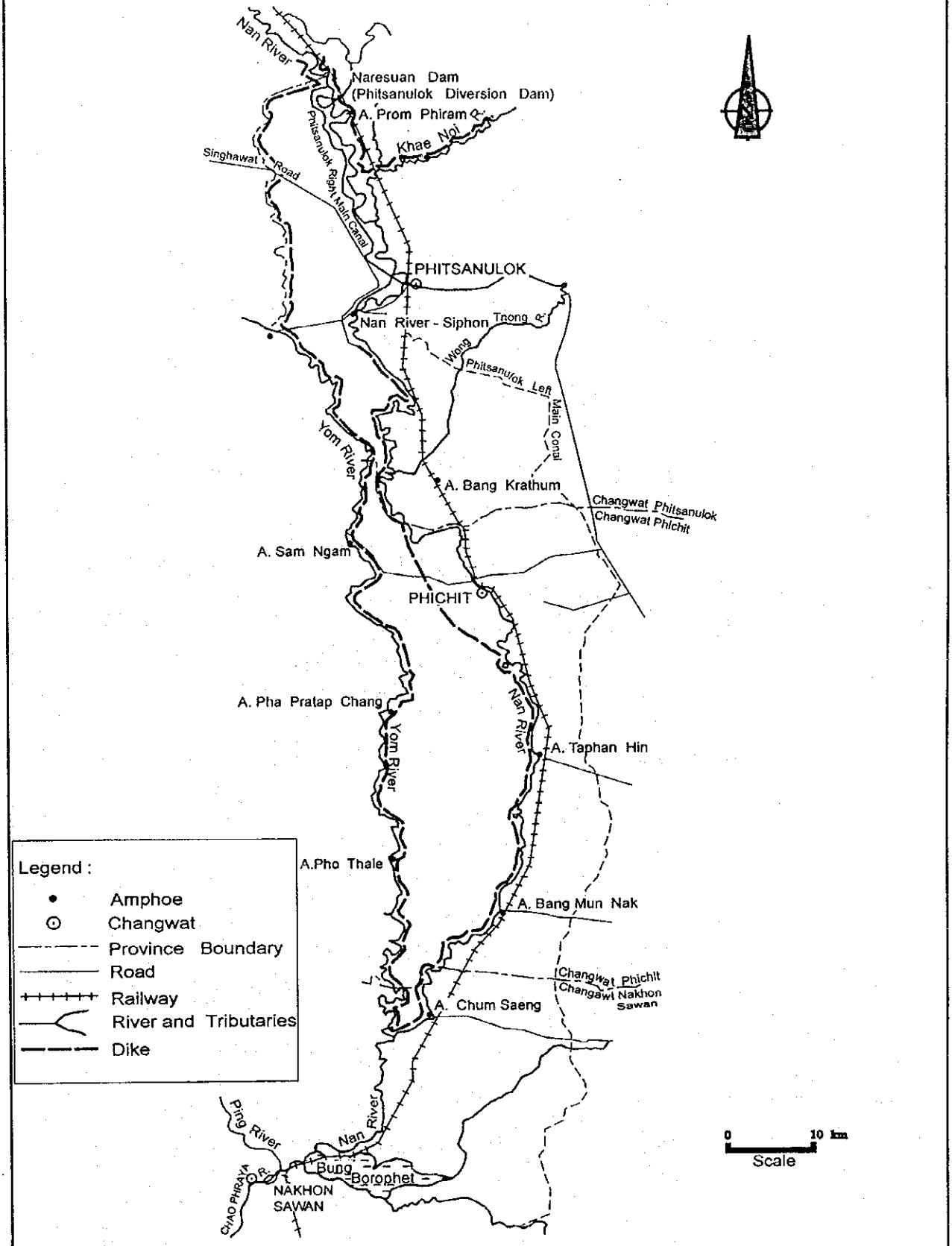


STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.3.1 THE DIVISION BY HYDROLOGICAL FEATURES IN CHAO PHRAYA RIVER BASIN
CTI ENGINEERING CO., LTD AND INA CORPORATION	

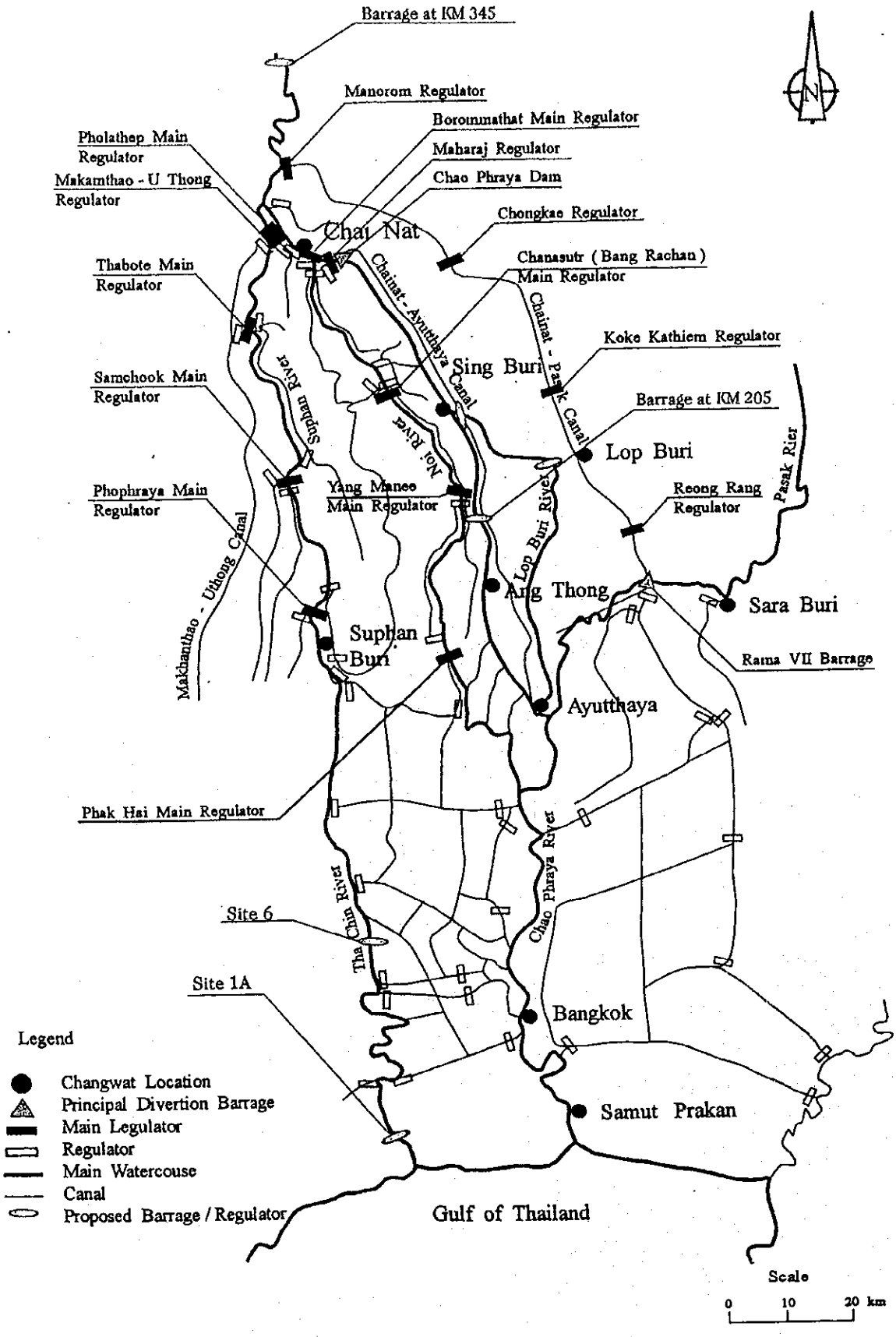


Source : PWD

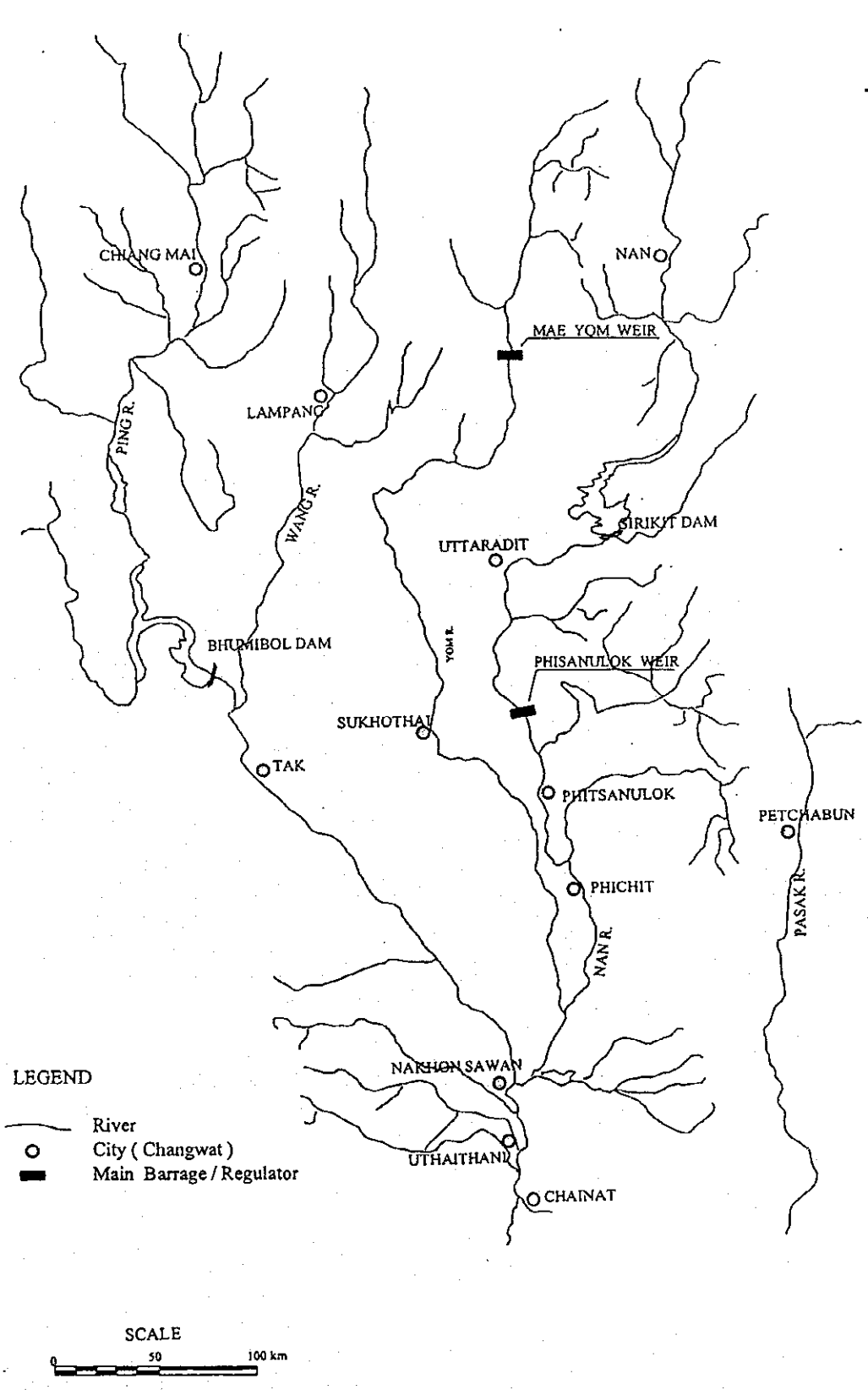
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.3.2 (1/2) EXISTING DIKE ALIGNMENT
CTI ENGINEERING CO., LTD AND INA CORPORATION	



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.3.2 (2/2)
CTI ENGINEERING CO., LTD AND INA CORPORATION	EXISTING DIKE ALIGNMENT

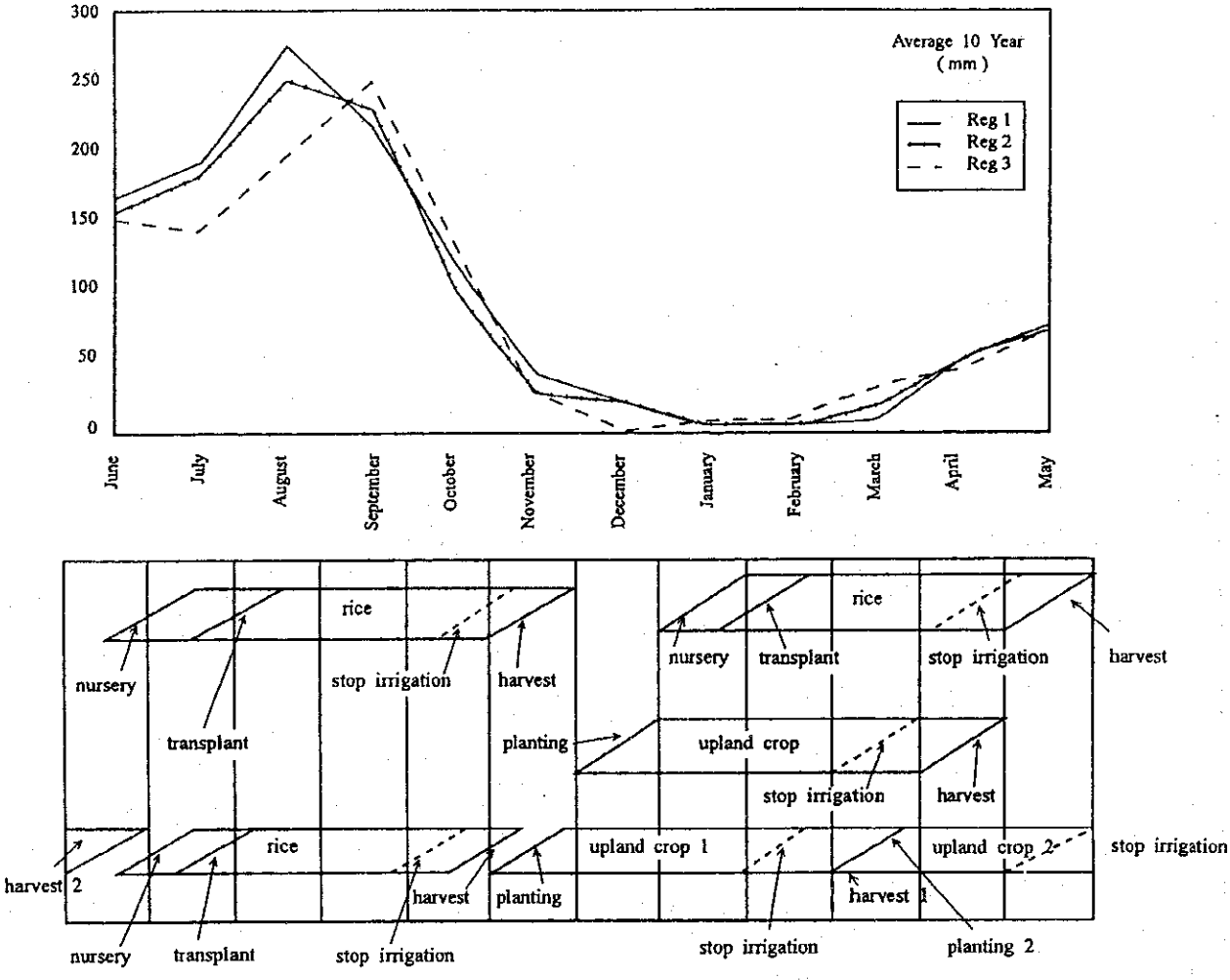


STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.3.3 LOCATION OF EXISTING AND PROPOSED WEIR / BARRAGE / REGULATORS (1/2)
CTI ENGINEERING CO., LTD AND INA CORPORATION	



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.3.3 LOCATION OF EXISTING AND PROPOSED WEIR / BARRAGE / REGULATORS (2/2)
CTI ENGINEERING CO., LTD AND INA CORPORATION	

NOTHERN REGION

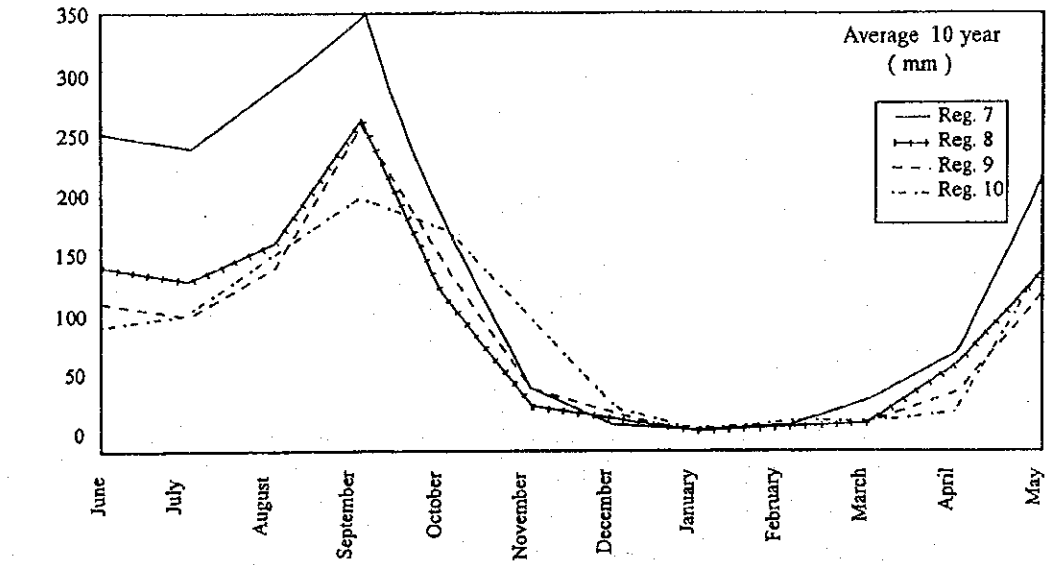


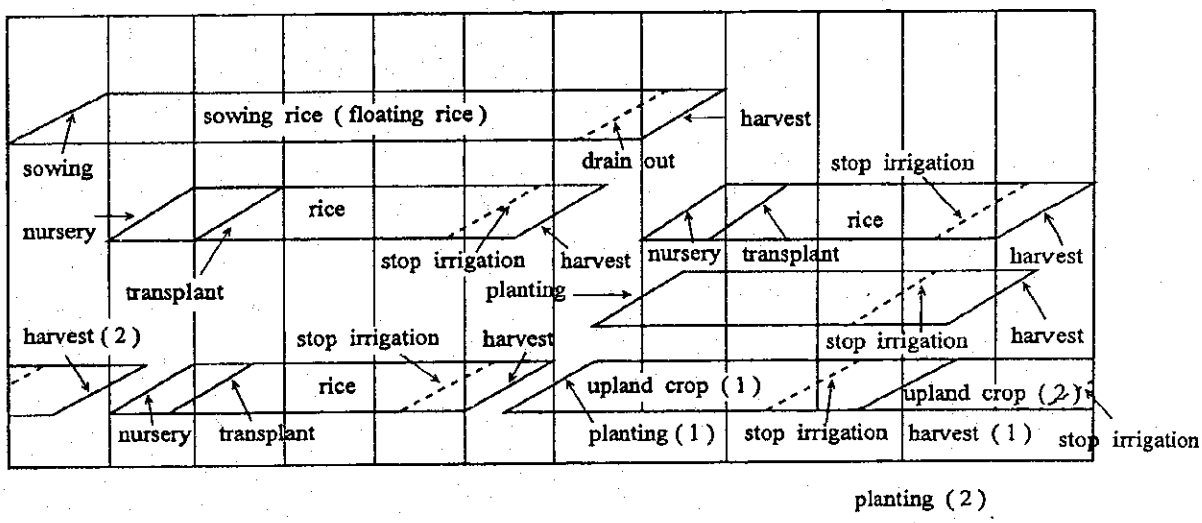
Upland crop e.g tobacco , groundnut , soybean , garlic , vegetables

Source : RID O & M

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN CTI ENGINEERING CO., LTD AND INA CORPORATION	Fig. 2.4.1 CROPPING PATTERNS IN IRRIGATION PROJECT (1/2)

CENTRAL REGION

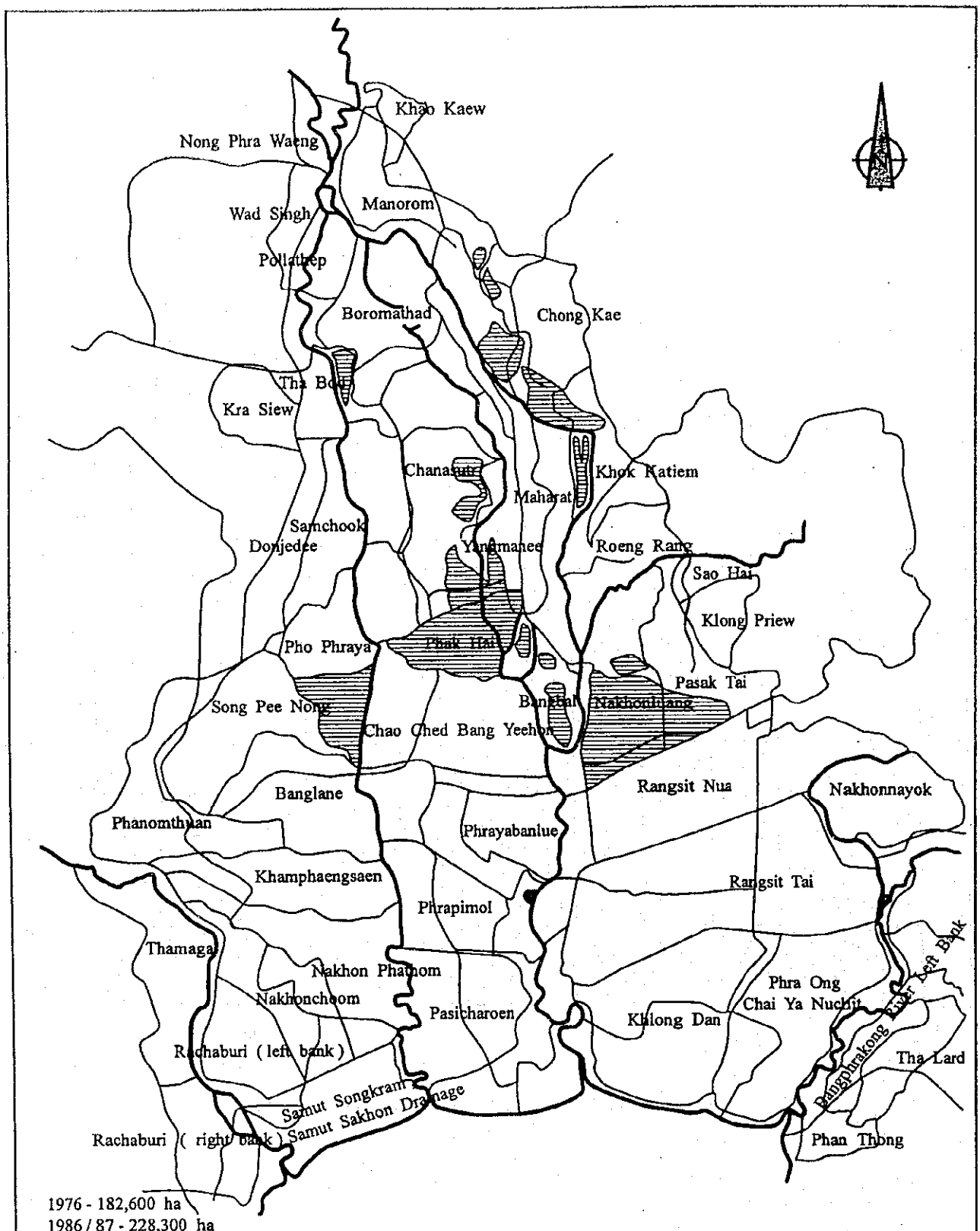




Upland crop e.g groundnut , mungbean , sesame , vegetables

Source : RID O & M

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN CTI ENGINEERING CO., LTD AND INA CORPORATION	Fig. 2.4.1 CROPPING PATTERNS IN IRRIGATION PROJECT (2/2)



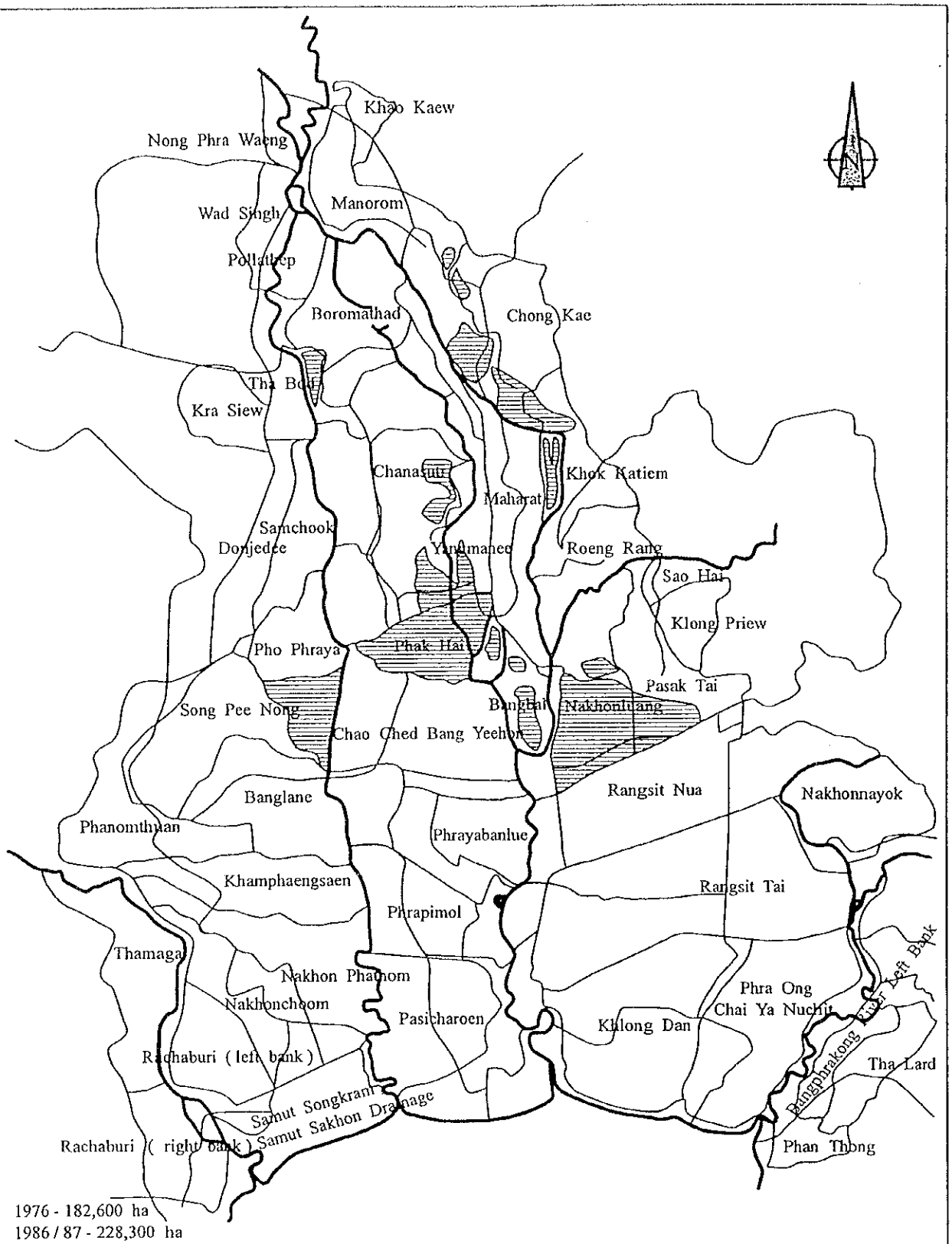
Source : JICA, 1989

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

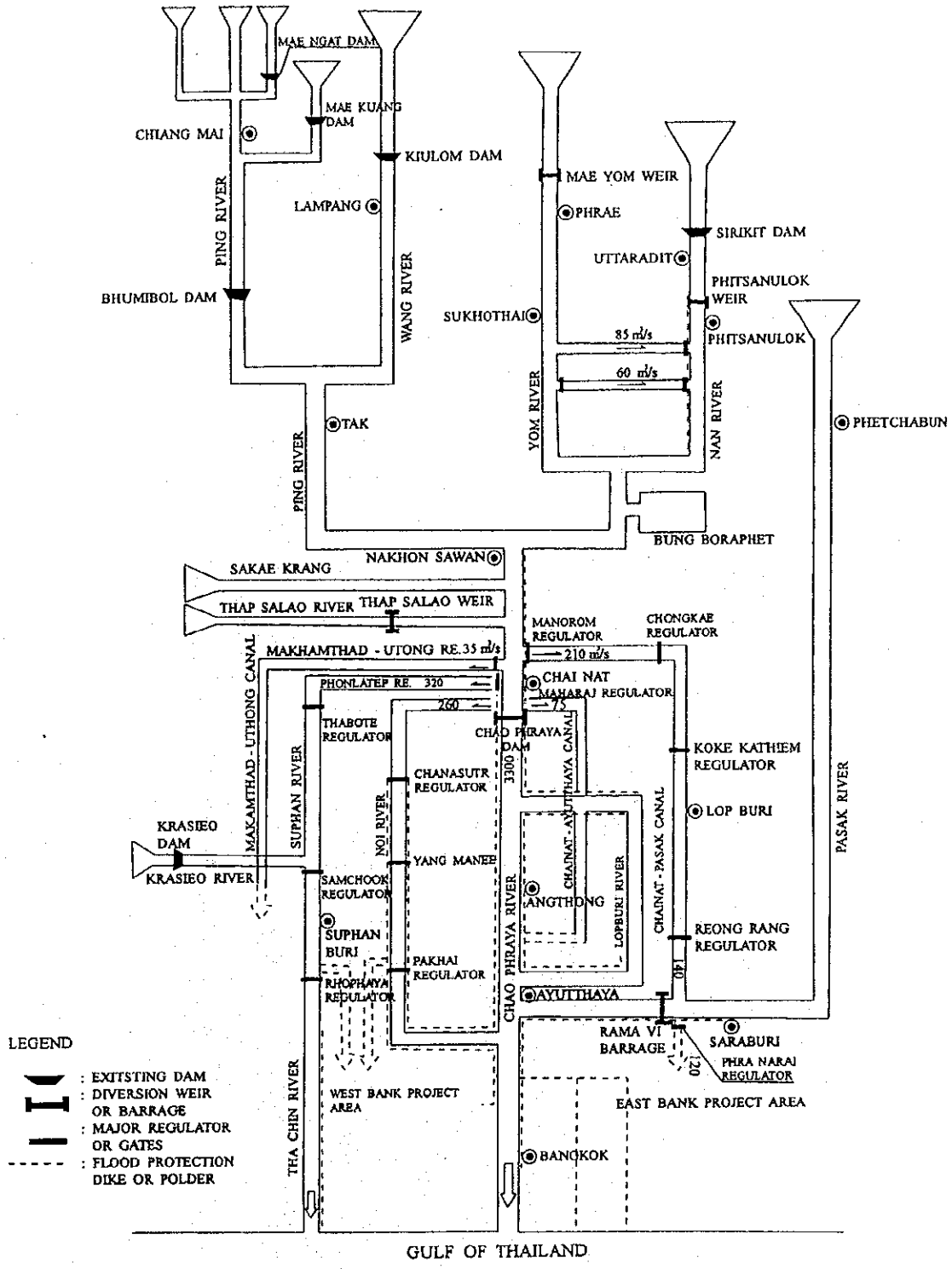
CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig. 2.4.2

DEEPWATER / FLOATING RICE CULTIVATION



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.4.2 DEEPWATER / FLOATING RICE CULTIVATION
CTI ENGINEERING CO., LTD AND INA CORPORATION	

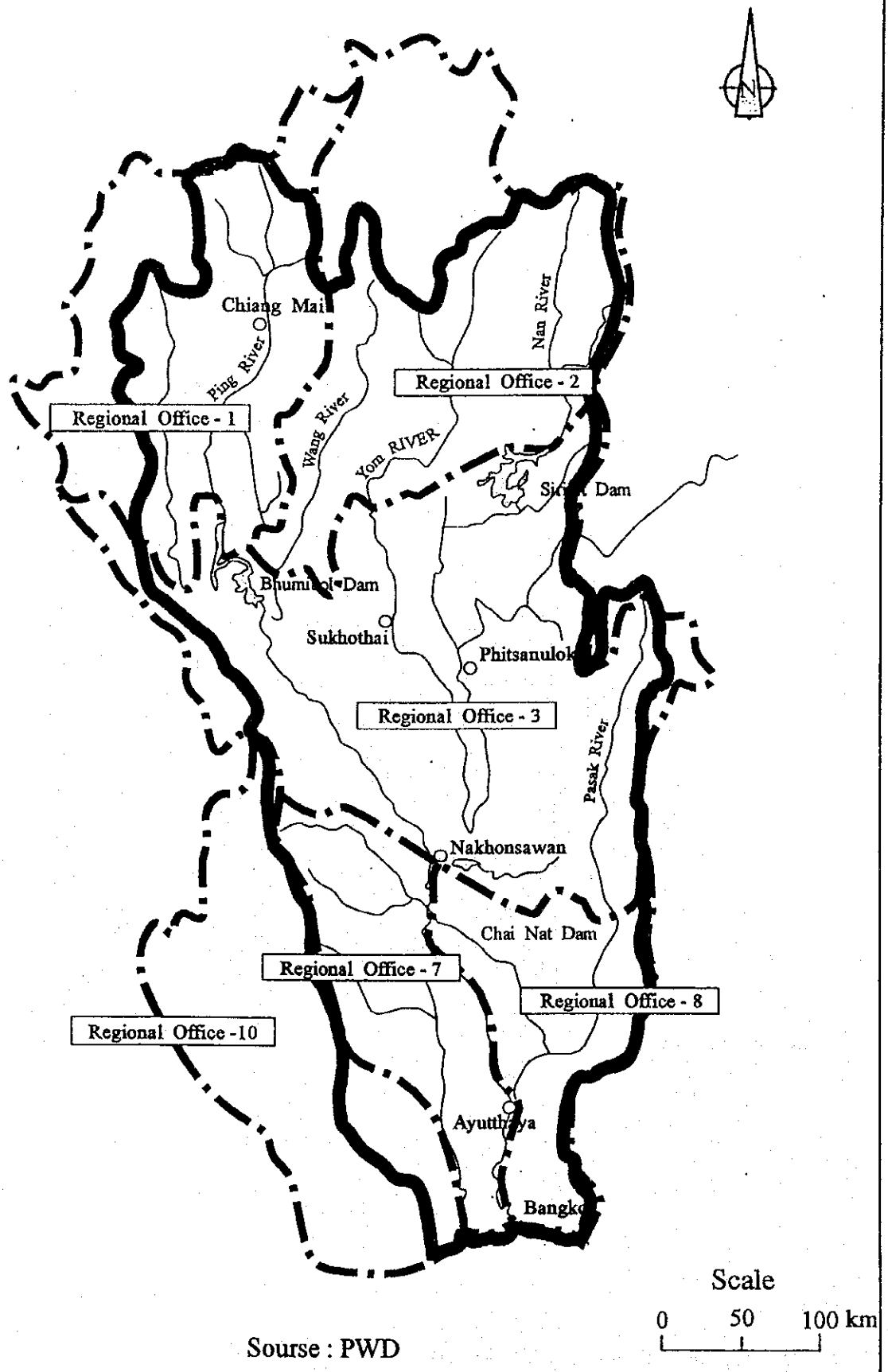


STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

CTI ENGINEERING CO., LTD. AND INA CORPORATION

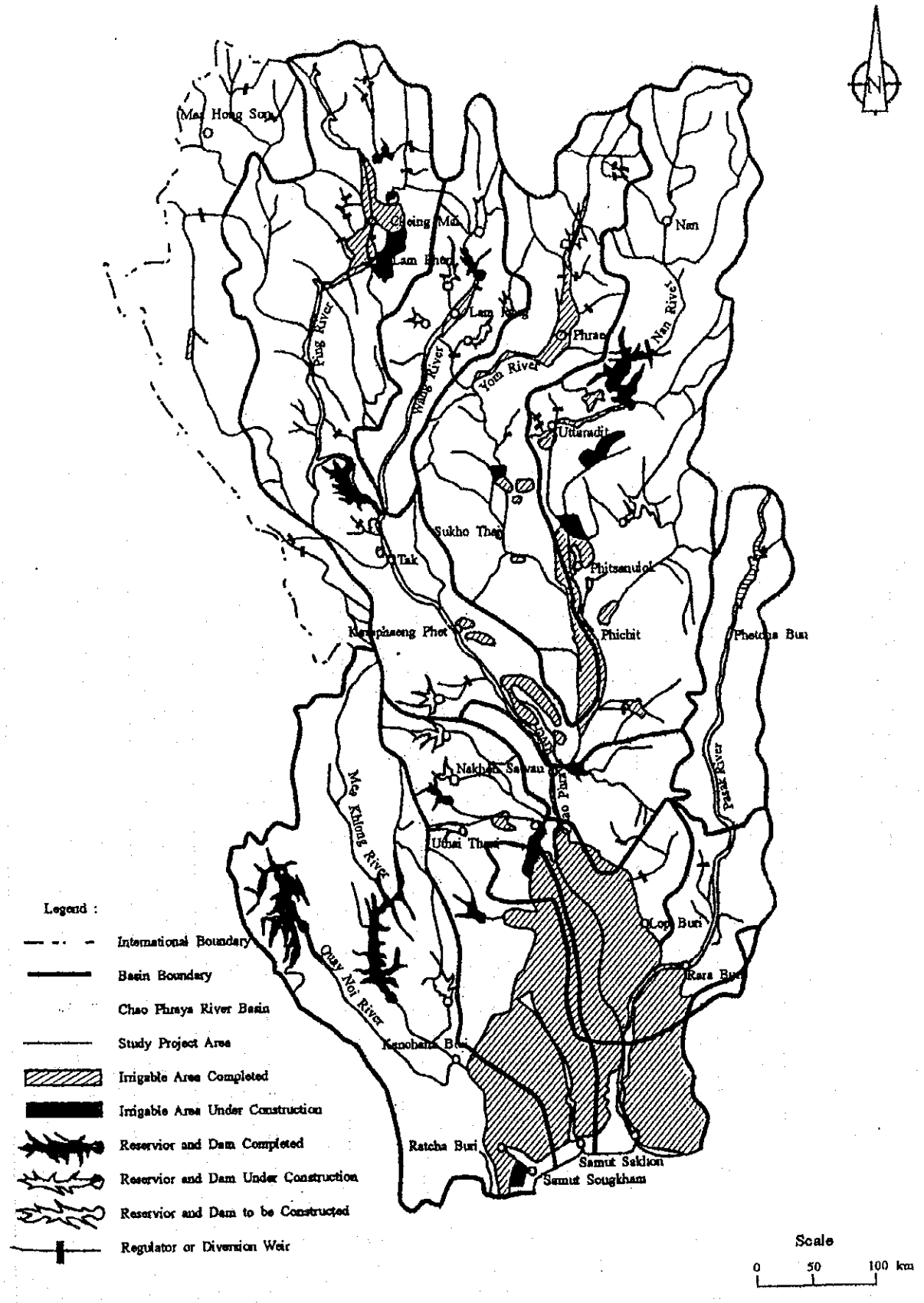
Fig. 2.4.3

CHAO PHRAYA RIVER AND CANAL SYSTEM

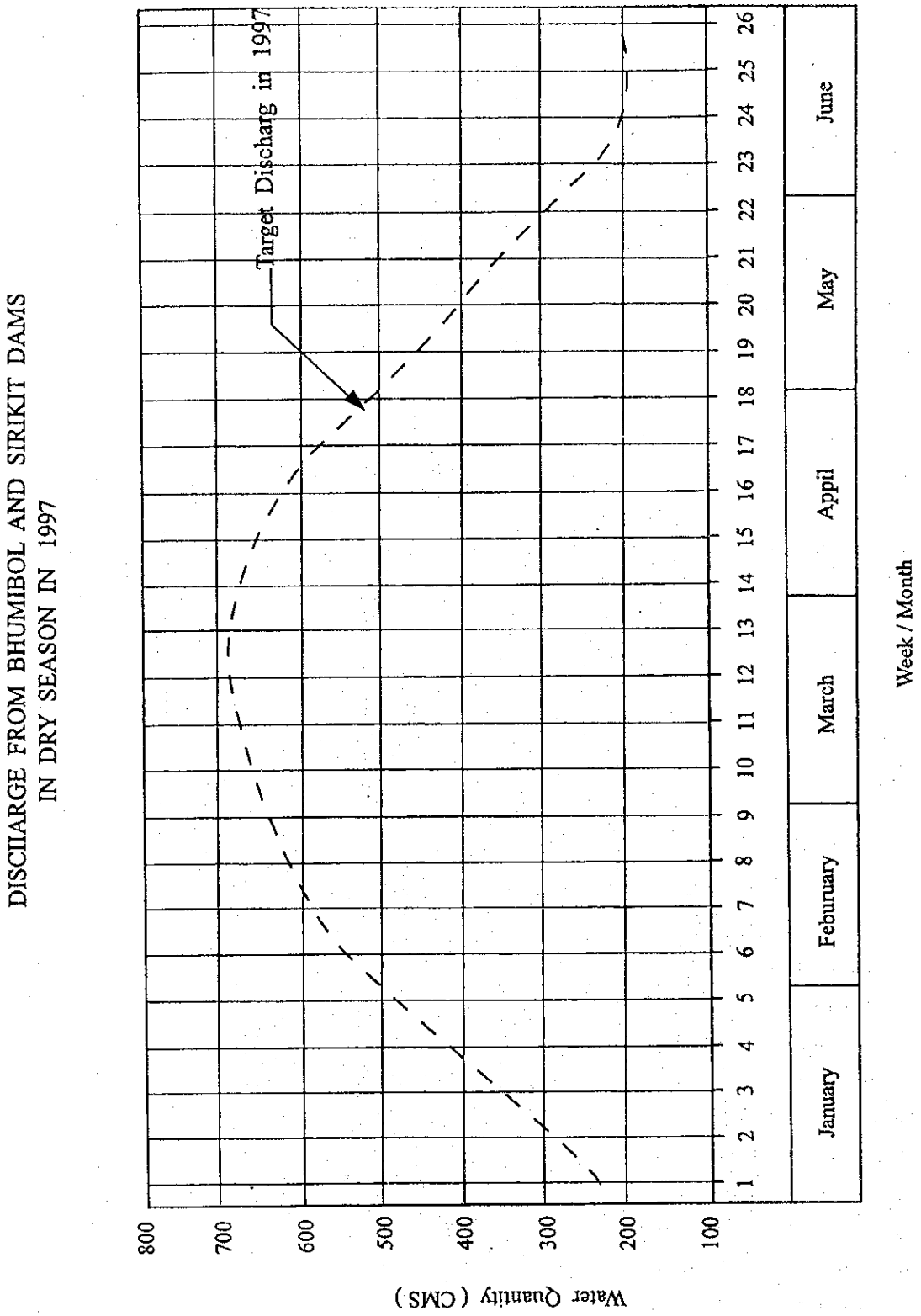


Sourse : PWD

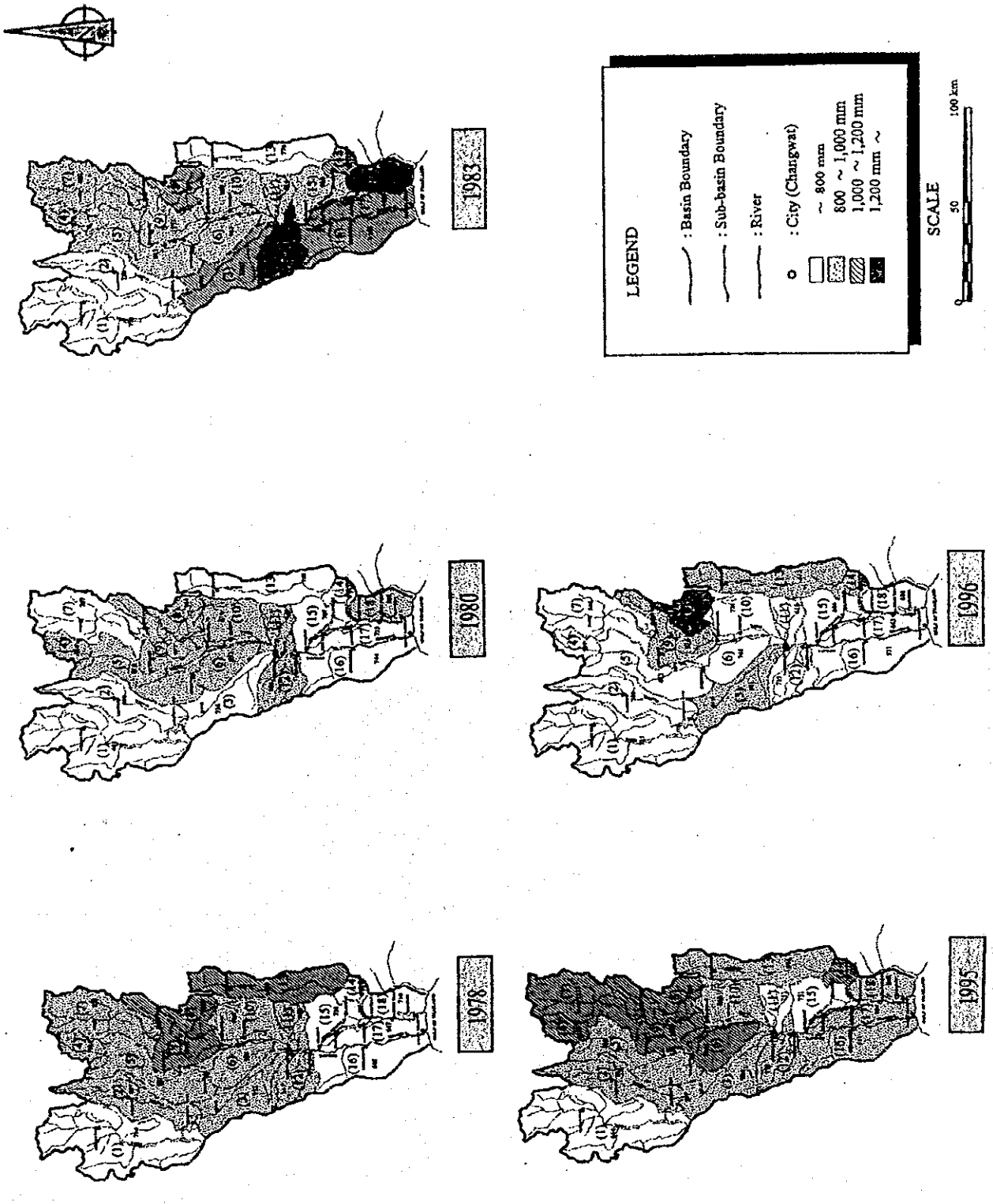
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.4.4 RID REGIONAL OFFICE BOUNDARIES
CTI ENGINEERING CO., LTD AND INA CORPORATION	



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.4.5 IRRIGATION PROJECTS IN THE BASIN
CTI ENGINEERING CO., LTD AND INA CORPORATION	



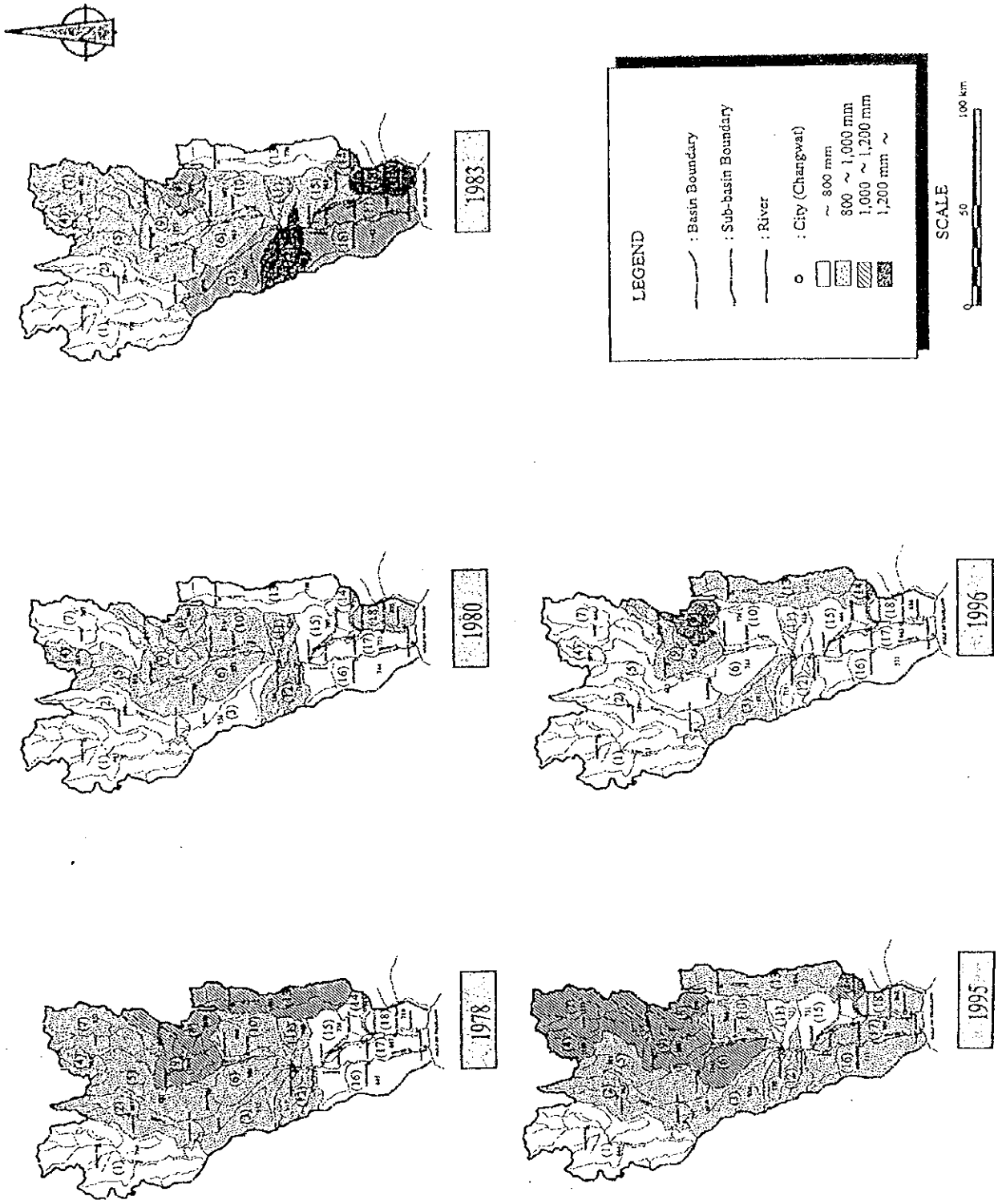
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.4.6 PROPOSED IRRIGATION WATER DEMAND TO BHUMIBOL AND SIRIKIT DAMS IN DRY SEASON IN 1997
CTI ENGINEERING CO., LTD AND INA CORPORATION	



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

CTI ENGINEERING CO., LTD AND INA CORPORATION

Fig. 2.5.1
SPATIAL DISTRIBUTION OF JULY - DECEMBER RAINFALL



STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	Fig. 2.5.1 SPATIAL DISTRIBUTION OF JULY - DECEMBER RAINFALL
CTI ENGINEERING CO., LTD AND INA CORPORATION	