Tables

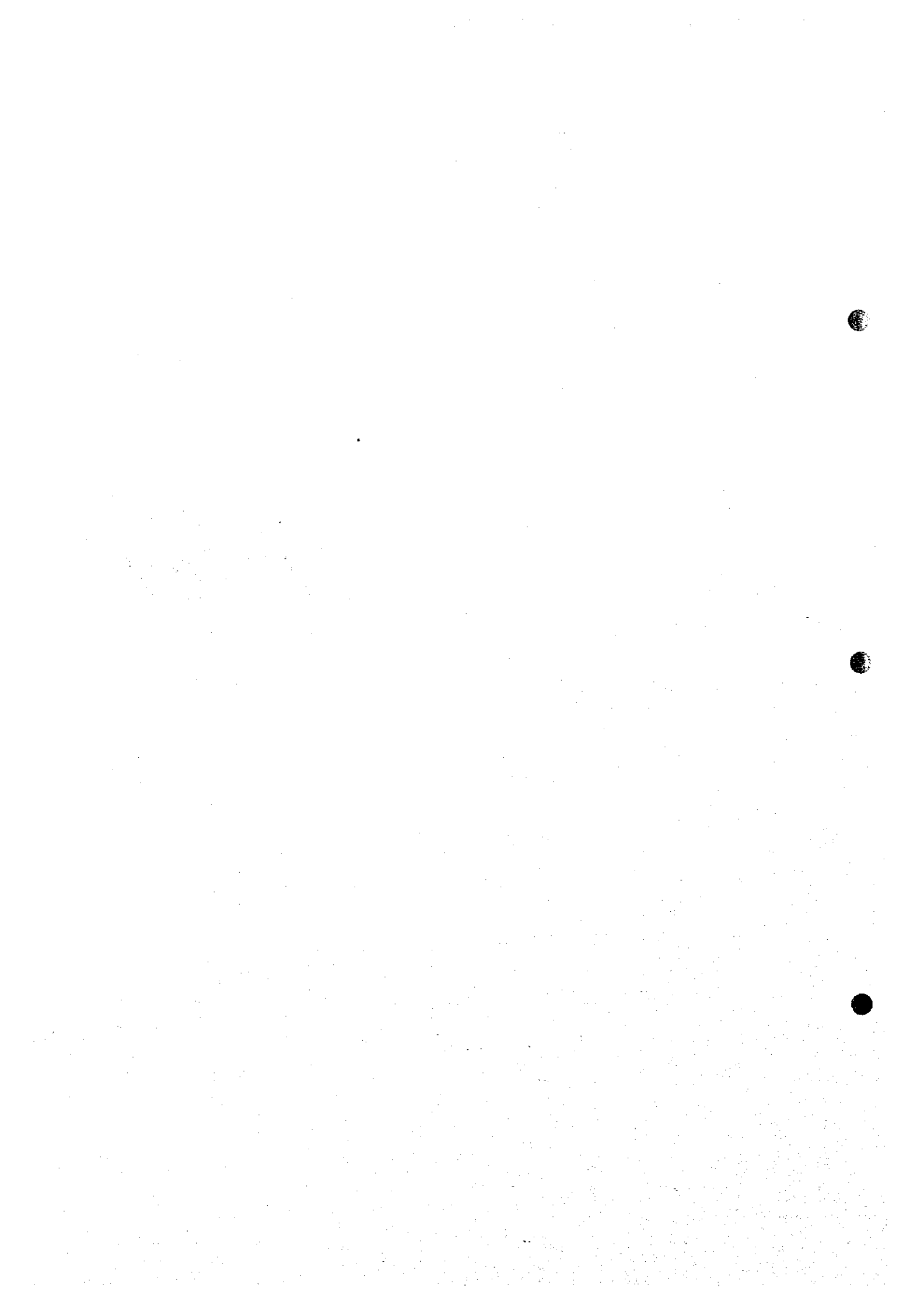**Table 2.1.1   GENERAL FEATURES OF DAMS IN CHAO PHRAYA RIVER BASIN**

LARGE SCALE DAMS

Name of Dam	Bhumibol	Sirikit	Mae Ngat	Mae Kuang	Kiu Lom	Mae Chang	Krasieo	Pasak	Kaeng Sua Ten	Kwae Noi	Mae Wong	Kiu Kho Ma	Mae Khan	Nam Khek
Purpose	I;P;F	I;P;F	I	I	I	I	I	I;P	I;F;P	I;F;P	I	I;S	I;F	I
Under operation by	EGAT	EGAT	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID
River	Ping	Nan	Ping	Ping	Wang	Ping	Chao Phraya	Pasak	Yom	Kwae Noi	Sale Krung	Wang	Mae Khan	Nam Khek
Drainage area (km2)	26,386	13,130	1,281	569	2,700	426	1,200	12,929	3,585	4,254	612	1,275	1,085	854
Active storage volume (million m3)	9,662	6,660	255	249	106	30	201	772	1,125	733	250	180	165	345
- ditto - (mm)	366	508	199	438	39	70	168	60	314	172	409	150	152	404
Existing/under constructing/proposed	E	E	E	E	E	E	E	E	P	P	P	P	P	P

Note: I = Irrigation; P = Power Generation; F = Flood Control; S = Water Supply

MEDIUM SCALE DAMS

Name of Dam	Mae Tub	Mae Yao	Mae Arb	Mae Phit	Mae Kam	Wang Daeng	Khlong Khang	Huai Head	Khlong Tron	Nam Haeng	Huai Mae Khon	Huai Mae Kon	Khlong Khayang	Khlong Pai	Nam Lai	Khlong Khlung	Mae Song
Purpose	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Under operation by	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID
River	Ping	Yom	Wang	Wang	Yom	Yom	Yom	Nan	Nan	Nan	Ping	Ping	Ping	Ping	Ping	Ping	Yom
Drainage area (km2)	126	35	35	45	59.2	28	40	265	277	34	44	20	51	74	95	305	
Active storage volume (million m3)	39	3.2	7.5	3.8	9.6	9.5	2.7	52	10.2	3.7	4.85	4.6	13	15	18	53.2	174
- ditto - (mm)	309	91	214	84	162	339	67.5	196	37	109	110	230	254.9	202.7	189.5	174	
Existing/under constructing/proposed	E	E	E	E	E	E	E	E	E	E	P	P	P	P	P	P	P

Note: I = Irrigation; P = Power Generation; F = Flood Control; S = Water Supply

SMALL SMALL SCALE DAMS

Name of Dam	Mae Tang	Huai Mae Song	Huai Ta Pae	Mae Moei	Wang Daeng	Mae Sai	Huai Suang	Mae Khong	Mae Kharing	Huai Nam Khung	Khlong Chomphu	Mae Chaery	Khlong Pho	Huai Nam Dung	Huai Nam Kan Yao
Purpose	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Under operation by	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID	RID
River	Yom	Yom	Yom	Yom	Yom	Yom	Yom	Yom	Nan	Nan	Nan	Nan	Sakae Krung	Sakae Krung	Sakae Krung
Drainage area (km2)	120	60	287	728	179	177	47	70	229	148.2	364	18	376	45	65
Active storage volume (million m3)	28.1	11.4	58	80	12	24.3	5.6	7.7	62	12.4	43	4.3	67.5	5	5
- ditto - (mm)	234	190	202	110	67	137	119	110	271	84	118	239	180	111	77
Existing/under constructing/proposed	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P

Note: I = Irrigation; P = Power Generation; F = Flood Control; S = Water Supply

Table 2.1.2 PRINCIPAL FEATURES OF EXISTING/PROPORSED LARGE DAMS

Project Name	(unit)	iBhumibol	iSirindhr	Mae Ngat	Mae Kuang	iKiu Lom	Mae Chang	Thun Salao	Peak	Kaeng Sua Ten	iKwae Noi	Mae Wong	iKiu Kho Ma	Mae Khan
Purpose		I.P.F	I.P.F	RID	I	RID	RID	RID	RID	I.F.P	RID	RID	RID	I.F
Under operation by		EGAT	EGAT	RID	I	RID	RID	RID	RID	RID	RID	RID	RID	RID
Location														
Local Community		A.Sam Ngao C Tak Ping	A.Tha Pla C Ubonrdti Nan	A.Mae Taeng C Chiang Mai Mae Ngat	A.Do Saket C C.Chiang Mai Ping	A.Muang C Lampang Wang	A.Mae Moh C Lampang Mae Chang	A.Lan Sak C Ubai Thanei Satuse Krwae	A.Phuttaera Nikhom c Lopun Pasak	A.Song C Phrae Yom	A.Wat Bot C Phitsanulok Kwae Noi	A.Ladwao c Nakom Sawan Satue Krwng	A.Chae Ham Lampang Wang	A.sam Pa Tong C Chiang Mai Mae Khan
Latitude		17~14~31	17~16~05	19~09~45	18~55~02	18~31~19	1#~18~14							
Longitude		94~48~31	100~31~15	99~02~35	66~07.11	99~37~14	66~49~42							
Hydrology														
Drainage area	(km2)	26,386	13,130	1,281	569	2,700	426	534		11,929	4,254	3,583	615	1,085
Annual inflow	(MCM)	5,236	5,600	293	205	558	54.3	202		2,100	1,440	933	223	181
	(mm)	199.2	427.5	229.9	360.0	217.9	199.1	379.3		162.4	340.6	260.4	361.1	164.8
Reservoir														
Max. water level	(m.M.S.L)	260.0	166.0	400.0	385.0	285.0	354.0	159.0		43.3	132.5	262.7	207.5	381.5
Normal water level	(m.M.S.L)	260.0	162.0	396.0	385.0	285.0	352.0	157.0		42.0	130.0	258.0	204.5	380.0
Min. water level	(m.M.S.L)	213.0	128.0	360.0	350.0	263.0	340.0	140.0		32.5	90.0	210.0	180.0	328.8
power operation irrigation		213.0	128.0	360.0	350.0	263.0	340.0	142.0		32.5	90.0	210.0	180	328.8
		202.5	105.75											
Storage														
max. water level	(MCM)	13,462	10,508	325	263	113		191		785	769	1,175	250	75
normal water level	(MCM)	13,462	9,510	265	263	112	109	160		13	36	50	20	4
min. water level	(MCM)	3,800	2,850	11	14	4	16	8		772	733	1,125	230	71
Active storage volume	(MCM)	9,662	6,660	255	249	166	20	152		314	172.3	375.8	141.1	152.1
	(mm)	266.2	508.4	199.1	437.6	39.3	70.4	284.7		39.7	40.5	65.0	17.6	13.0
	(km2)	316.0	260.0	15.0	12.0	16.0	12.3	19.0		148.8				
Surface area														
Dam														
Type		Gravity arch	Earthfill	Earthfill	Earthfill	Gravity	Rockfill	Rockfill	Earthfill	Concrete	Rockfill	Rockfill	Rockfill	Earthfill
Height	(m)	154.0	113.6	59.0	61.0	26.5	40.0	26.8	26.8	46.2	80.0	83.0	57.0	65.0
Crest elevation	(m.M.S.L.)	261.0	169.0	404.0	400.0	296.5	356.0		(23.5)		135.0	263.7	211.0	285.0
Crest length	(m)	486.0	800.0								2630.0	545.0		
Spillway														
Type		Tunnel type	2 Tunnels						over flow	over flow	over flow	over flow	over flow	
Crest elevation	(m.M.S.L.)	242.9	150.5	393.8			347.0			32.5	118.5	253.0		380.0
Control gate		Radial Gate 11.0m(w)× 17.4m(h)×4	Radial Gate 11.85m(w)× 15.0m(h)×2								Radial G. 13.0m (W) ×12.0m ×3	Radial G. 13.5m (h) ×12.0m ×3		
Design flood peak inflow	(m3/s)	7,670	10,500	3,174	1,470	2,000	1,056			2,947	7,045	2,600	1,770	1,610
Design flood volume	(MCM)		4,043	261							7,045	3,300		
Max. discharge capacity	(m3/s)	6,000	3,250	1,035		3,000	440			1,407			2,384	
Intake structure														
Intake gate		Fixed Wheel 4.2m(w)× 6.7m(h)×4	Fixed Wheel 6.0m(w)× 8.5m(h)×2							Pavel Wheel 3.0m/hr 3.5m(h)×1				Earwell
Gate size										200.0	90.0		
Base elevation of inlet		201.0	105.75											
Power station														
Installed capacity		70MW×6 ×12MW	125MW×4							14MW×1	19MW×2			
Discharge of power outlet														
– At max. head	(m3/s/CNTT)	75.8	194.3							107.0	44.0			
– At nor. head	(m3/s/CNTT)	69.5	175.0											
– At min. head	(m3/s/CNTT)	61.0												
Produced Annual Energy	(GWh)	1,500	1,200							94	150			

Note: I = Irrigation, P = Power Generation, F = Flood Control
Source: RID

Table 3.3.1   SELECTION OF EFFECTIVE DAM FOR FLOOD MITIGATION (CATCHMENT AREA GREATER THAN 1,600 KM2)

Name of Dam		Bhumibol	Sirikit	Kwae Noi	Kaeng Sua Ten	Pasak	Kiu Lom & Kiu Kho Ma *3
Name of River		Ping	Nan	Kwae Noi	Yom	Pasak	Wang
Catchment Area (km2)		26,386	13,130	4,254	3,583	12,929	2,700
Active Storage (mm)		366	508	298	279	61	107
Annual Inflow (mm)		199	428	341	260	162	218
Active Storage/Annual Inflow (%)		184	119	87	107	38	49
Area Contribution Factor *1 (%)	A) Tributary	51.6	41.3	13.4	15.2	71.0	24.0
	B) Nakhon Sawan	23.9	11.9	3.8	3.2	-	2.5
	C) Bangkok	16.3	8.1	2.6	2.2	8.0	1.7
Distance from Referrence Point (km)	A) Tributary	220	370	270	230	70	180
	B) Nakhon Sawan	220	300	230	440	-	370
	C) Bangkok	470	550	480	710	180	620
Irrigation Area (ha)		384,000	265,000	24,900	48,800	37,000	30,018
Active Storage/Irrigation Area (m3/ha)		25,000	25,000	29,000	20,000	21,000	9600 *4
Purpose *2		F,I,P	F,I,P	F,I,P	F,I,P	I,P	I
Result of Selection		Selected	Selected	Selected	Selected	Selected	Rejected

*1 ;   Area Contribution Factor = Dam Catchment Area / Catchment Area of Reference Point
*2 ;   F : Flood Mitigation, I : Irrigation, P : Hydropower
*3 ;   Kiu Lom and Kiu Kho Ma dams are treated as a conbined dam.
*4 ;   Water demand for irrigation is less than 10,000 m3/ha.

Table 3.5.1 IDEAL VACANT CAPACITY FOR FLOOD CONTROL

(Unit : million m3)

Name of dam	Probability of Drought	Ideal Vacant Capacity					
		Jul.1	Aug.1	Sep.1	Oct.1	Nov.1	Dec.1
Kwae Noi	0/45	731	597	418	149	16	0
	1/10	733	677	528	161	84	0
	1/5	733	727	588	228	105	0
	1/3	733	733	631	280	70	0
	1/2	733	733	733	403	109	0
Pasak	0/45	765	658	572	219	18	0
	1/10	772	772	703	396	57	0
	1/5	772	772	772	481	82	0
	1/3	772	772	772	596	144	0
	1/2	772	772	772	772	216	0
Kaeng Sua Ten	0/45	1045	575	437	178	38	0
	1/10	1122	975	571	268	75	0
	1/5	1123	1017	660	288	107	0
	1/3	1124	1064	783	358	147	0
	1/2	1125	1090	871	554	286	0

Table 3.5.2 PROPOSED UPPER RULE CURVES FOR SELECTED DAMS

(Unit : million m3)

Name of dam	Case	Total Storage Volume of Upper Rule Curve										
		Jul.1	Jul.15	Aug.1	Aug.15	Sep.1	Sep.15	Oct.1	Oct.15	Nov.1	Nov.15	Dec.1
Bumibol	1	10500	10600	10700	10900	11000	11900	12800	13100	13460	13462	13462
	2	9500	9550	9600	10000	10300	11100	12000	12750	13460	13462	13462
	3	8000	8250	8500	9000	9500	10550	11200	12350	13460	13462	13462
Sirikit	1	6700	6800	7000	7500	8000	8700	9300	9400	9510	9510	9510
	2	4900	5200	5500	6250	7000	8150	9250	9380	9505	9510	9510
	3	3000	3500	4000	5000	6000	7600	9200	9350	9500	9505	9510
Kwae Noi	1	172	172	172	290	415	530	650	769	769	769	769
	2	105	105	105	240	375	505	640	769	769	769	769
	3	36	36	36	185	335	480	625	769	769	769	769
Pasak	1	213	213	213	213	213	400	595	785	785	785	785
	2	115	115	115	115	115	335	565	785	785	785	785
	3	13	13	13	13	13	270	530	785	785	785	785
Kaeng Sua Ten	1	600	600	600	795	985	1175	1175	1175	1175	1175	1175
	2	325	325	325	610	895	1175	1175	1175	1175	1175	1175
	3	50	50	50	425	800	1175	1175	1175	1175	1175	1175

Table 3.6.1   FLOOD MITIGATION EFFECT OF FIVE DAMS

(Stored volume during flood period   unit: million m3)

Name of dam	Case	Flood year				Average
		1975	1981	1995	1996	
Bhumibol	Observed	4,071	2,128	4,465	2,977	3,410
	1	2,716	1,272	2,793	2,810	2,398
	2	3,900	1,272	3,284	2,867	2,831
	3	4,412	2,767	4,635	3,388	3,800
Sirikit	Without *1	4,229	2,981	4,340	3,387	3,734
	1	4,194	2,356	4,283	3,387	3,555
	2	4,410	2,690	4,526	3,388	3,789
	3	4,412	2,767	4,635	3,388	3,801
Kwae Noi	Without *2	685	335	555	603	545
	1	685	558	597	608	612
	2	690	599	661	671	655
	3	729	637	728	741	709
Pasak	Without *2	356	0	0	492	212
	1	437	437	437	492	451
	2	605	605	605	605	605
	3	772	772	772	772	772
Kaeng Sua Ten	Without *2	691	419	1,015	368	623
	1	691	419	1,015	368	623
	2	691	419	1,023	368	625
	3	691	419	1,063	368	635

*1 ; Operation with Kon-Ing-Nan project proposed upper rule curve (after Kok-Ing-Nan diversion)

Table 3.6.2 REDUCTION OF IRRIGATION AREA AND HYDRO-POWER GENERATION

REDUCTION OF IRRIGATION AREA

Name of dam	Case	Reseased volume in dry season (MCM)	Reduction from 'without/observed' case	
			Released volume (MCM)	Irrigation area (1000 ha)
Bhumibol	Observed	3,079	-	-
	1	3,107	-	-
	2	3,098	-	-
	3	2,937	145	5.8
Sirikit	Without *1	5,610	-	-
	1	5,693	-	-
	2	5,638	-	-
	3	5,606	4	0.1
Kwae Noi	Without *2	784	-	-
	1	784	0	-
	2	781	3	0.1
	3	769	15	0.5
Pasak	Without *2	1,446	0	-
	1	1,446	0	-
	2	1,442	4	0.2
	3	1,427	19	0.9
Kaeng Sua Ten	Without *2	929	-	-
	1	929	-	-
	2	919	10	0.5
	3	856	70	3.5

REDUCTION OF HYDRO-POWER GENERATION

Name of dam	Case	Annual average power generation (Gwh)	Reduction from 'without/observed' case (Gwh)
Bhumibol	Observed	1,208	-
	1	1,215	-
	2	1,214	-
	3	1,208	-
Sirikit	Without *1	1,170	-
	1	1,175	-
	2	1,171	-
	3	1,062	108
Kwae Noi	Without *2	147	-
	1	147	0
	2	144	3
	3	141	6
Pasak	Without *2	-	-
	1	-	-
	2	-	-
	3	-	-
Kaeng Sua Ten	Without *2	82	-
	1	82	0
	2	82	0
	3	79	3

*1 ; Operation with Kon-Ing-Nan project proposed upper rule curve (after Kok-Ing-Nan diversion)
*2 ; Operation with non-upper rule curve

Table 3.6.3 PROPOSED UPPER RULE CURVE

Name of dam	Total Storage Volume of Upper Rule Curve (Unit : MCM)											
	Jul.1	Jul.15	Aug.1	Aug.15	Sep.1	Sep.15	Oct.1	Oct.15	Nov.1	Nov.15	Dec.1
Bumibol	8,000	8,250	8,500	9,000	9,500	10,350	11,200	12,350	13,460	13,462	13,462
Sirikit	3,000	3,500	4,000	5,000	6,000	7,600	9,200	9,350	9,500	9,505	9,510
Kwae Noi	36	36	36	185	355	480	625	769	769	769	769
Pasak	13	13	13	13	13	270	530	785	785	785	785
Kaeng Sua Ten	50	50	50	425	800	1,175	1,175	1,175	1,175	1,175	1,175

Table 3.7.1 FLOOD MITIGATION EFFECT OF KWAE NOI AND KAENG SUA TEN DAM

Area	Reservoir Operation of Kwae Noi and Kaeng Sua Ten Dam *	Flood			
		1995 flood		1983 flood	
		Inundation Volume (MCM)	Reoducation ** (MCM)	Inundation Volume (MCM)	Reduction ** (MCM)
Upper Central Plain	(a) Case-0	5646	-	3013	-
	(b) Case-1	5534	112	2980	33
	(c) Case-2	4880	766	2814	199
	(d) Case-3	4774	872	2785	228
Higher Delta	(a) Case-0	6587	-	5719	-
	(b) Case-1	6471	116	5545	174
	(c) Case-2	6221	366	5559	160
	(d) Case-3	6147	440	5423	296
Lower Delta	(a) Case-0	1205	-	1854	-
	(b) Case-1	1204	1	1854	-
	(c) Case-2	1203	2	1854	-
	(d) Case-3	1203	2	1853	1

* (a) Case-0 : Without-case of Kwae Noi and Kaeng Sua Ten

* (b) Case-1 : Without-case of Kaeng Sua Ten

* (c) Case-2 : Without-case of Kwae Noi

* (d) Case-3 : With-case of Kwae Noi and Kaeng Sua Ten

** (a)-[(b) or (c) or (d)]

Table 4.3.1 CALCULATION RESULT OF WATER BALANCE SIMULATION FOR MAJOR FLOODS

(Unit : MCM)

Name of Dam	Stored Volume	Flood year						
		1975	1978	1980	1981	1994	1995	1996
Bumibol (Vmax =13,460)	Maximum	13,950*	10,920	9,530	10,070	10,610	12,240	11,660
	Flood control	3,490	1,810	2,090	350	1,080	2,350	1,260
Sirikit (Vmax =9,510)	Maximum	10,790*	8,140	7,880	8,410	9,390	11,820*	7,980
	Flood control	3,380	1,840	1,490	370	1,030	4,460	610

* : Selected flood (Maximum stored volume exceeds the maximum capacity - Vmax-.)

(Unit : MCM)

Name of dam	Flood year	Storage transition curve (adjusted curve)								
		Aug.1	Aug.15	Sep.1	Sep.15	Oct.1	Oct.15	Nov.1	Nov.15	Dec.1
Bumibol	1975	9,950	10,100	10,400	10,800	11,750	12,900	13,460*	13,400	13,250
Sirikit	1975	5,000	5,060	6,090	6,790	7,700	8,220	8,450	7,990	6,780
	1995	5,000	5,780	6,980	8,310	8,890	9,320	9,500*	8,840	8,050

* : Maximum storege volume (after adjusting)

Table 4.3.3 PROPOSED UPPER RULE CURVE

BHUMIBOL and SIRIKIT RESERVOIR

Name of dam	Total Storage Volume (million m3)											
	Jan.1	Feb.1	Mar.1	Apr.1	May 1	Jun 1	Jul.1	Aug.1	Sep.1	Oct.1	Nov.1	Dec.1
Bhumibol	13,050	12,250	11,300	10,500	10,100	10,050	10,000	9,950	10,400	11,750	13,462	13,460
Sirikit	8,800	7,800	6,650	5,700	5,250	5,100	5,050	5,000	7,000	8,900	9,510	9,300

PASAK RESERVOIR

Case	Total Storage Volume (million m3)										
	Jul.1	Jul.15	Aug.1	Aug.15	Sep.1	Sep.15	Oct.1	Oct.15	Nov.1	Nov.15	Dec.1
1	226	226	226	226	226	226	655	785	785	785	785
2	123	123	123	123	123	120	525	785	785	785	785
3	13	13	13	13	13	13	400	785	785	785	785

Table 4.4.1 FLOOD MITIGATION EFFECT FOR FIVE BIG FLOODS

Name of dam	Operation Case	Reduced inundation Volume (million m3)					
		1975 flood	1981 flood	1983 flood	1995 flood	1996 flood	Average
Bhumibol	Without(Observed)	3,436	342	1,615	3,681	918	1,998
	Proposed Operation	4,477	342	1,615	3,773	956	2,232
Sirikit	Without(KIN project proposed)	2,323	348	113	2,725	506	1,180
	Proposed Operation	2,813	348	113	3,510	506	1,458
Pasak	Without(without Operation)	0	0	0	0	0	0
	Proposed Operation(Case-1)	175	0	0	288	51	103
	Proposed Operation(Case-2)	370	0	0	587	109	213
	Proposed Operation(Case-3)	438	0	0	695	129	252

Table 4.4.2
INFLUENCE FOR IRRIGATION WATER SUPPLY AND ANNUAL POWER GENERATION
(BHUMIBOL AND SIRIKIT DAM)

Year	Bhumibol Dam						Sirikit Dam					
	Water Supply in dry season (MCM)			Annual Power Generation (Gwh)			Water Supply in dry season (MCM)			Annual Power Generation (Gwh)		
	Observed (A)	Proposed (B)	Difference (B)-(A)	Observed (A)	Proposed (B)	Difference (B)-(A)	Without* (A)	Proposed (B)	Difference (B)-(A)	Without* (A)	Proposed (B)	Difference (B)-(A)
1952	-	-		-	-		3117	3117	0	913	892	-20
1953	-	-		-	-		4686	4572	-114	1106	1097	-8
1954	-	-		-	-		3008	3009	0	686	679	-7
1955	-	-		-	-		2006	2006	0	662	628	-34
1956	-	-		-	-		4513	4521	9	1508	1501	-7
1957	-	-		-	-		4554	4535	-19	1214	1188	-26
1958	-	-		-	-		4513	4513	0	1063	1083	21
1959	-	-		-	-		2006	2006	0	852	789	-63
1960	-	-		-	-		4513	4525	13	1208	1208	1
1961	-	-		-	-		4588	4539	-48	1585	1609	24
1962	-	-		-	-		4835	4640	-195	1111	1084	-27
1963	-	-		-	-		2006	2006	0	615	609	-7
1964	-	-		-	-		4011	4012	0	975	966	-9
1965	2801	5800	3000	866	1462	596	3008	3009	0	696	688	-8
1966	2474	4096	1623	1105	1406	301	1504	1504	0	487	482	-6
1967	2585	3971	1386	1337	1276	-60	3008	3009	0	754	745	-9
1968	2569	3728	1158	1095	890	-205	3008	3009	0	741	730	-11
1969	2672	5485	2814	1129	921	-208	1504	1504	0	463	458	-5
1970	3651	5800	2149	1551	1377	-174	2006	2006	0	884	840	-44
1971	3901	5800	1899	1974	1966	-8	4513	4521	8	1295	1313	18
1972	3118	5800	2682	1463	1476	14	4011	4012	0	908	878	-30
1973	4154	5800	1646	1818	1736	-82	2006	1504	-501	612	556	-56
1974	2963	5800	2837	1346	1477	131	4011	4012	0	963	1025	62
1975	3746	5800	2054	1961	2072	111	3008	3009	0	1152	1029	-123
1976	3605	5800	2195	1618	1475	-143	4513	4513	1	1130	1224	94
1977	3658	5800	2142	1620	1414	-207	4209	4012	-198	1046	1015	-31
1978	3122	5800	2678	1229	1363	143	3008	3009	0	814	789	-25
1979	3007	4051	1044	1410	1329	-81	4011	4012	0	1035	991	-44
1980	2091	4149	2058	603	884	281	2006	2006	0	701	675	-26
1981	3417	5556	2139	1176	1150	-26	4011	4012	0	1393	1421	28
1982	3439	4120	681	1321	1129	-192	4011	3009	-1003	956	906	-50
1983	2963	4040	1077	906	1126	220	4011	4012	0	907	890	-17
1984	2835	3845	1010	981	899	-83	3008	3009	0	1015	996	-19
1985	2624	4007	1383	838	896	58	4011	4012	0	986	962	-23
1986	3250	3846	596	1239	1004	-235	4011	4012	0	957	959	2
1987	2979	3840	861	1055	875	-180	3008	2006	-1003	675	549	-126
1988	3773	4399	626	943	925	-18	1504	2006	502	481	550	69
1989	3705	3927	222	1272	1105	-166	2006	2006	0	624	648	24
1990	2996	3700	705	956	875	-81	2006	2006	0	651	658	7
1991	2594	3736	1142	722	854	132	2006	2006	0	624	557	-67
1992	2634	3700	1066	633	851	218	2006	2006	0	539	532	-8
1993	1659	1806	147	667	772	105	1504	1504	0	465	459	-7
1994	2328	5151	2823	724	490	-235	1504	1504	0	885	853	-33
1995	4131	5800	1669	1325	1367	42	4011	4012	0	1568	1464	-103
1996	4700	5800	1100	1880	1410	-470	4513	4538	26	1180	1269	89
Average	3129	4710	1581	1208	1195	-13	3218	3162	-56	913	899	-14

* Without : Proposed by Kok-Ing-Nan Project

VIII-T-13

Table 4.4.3
INFLUENCE FOR IRRIGATION WATER SUPPLY OF PASAK DAM

(Unit : MCM)

Year	Pasak Dam					
	Case-1		Case-2		Case-3	
	Storage at Nov.30	Reduction from 'without'	Storage at Nov.30	Reduction from 'without'	Storage at Nov.30	Reduction from 'without'
1952	772	0	772	0	772	0
1953	772	0	772	0	772	0
1954	772	0	772	0	772	0
1955	772	0	772	0	772	0
1956	772	0	772	0	717	-55
1957	772	0	772	0	772	0
1958	772	0	772	0	772	0
1959	772	0	772	0	772	0
1960	296	0	251	-44	131	-164
1961	772	0	772	0	772	0
1962	772	0	772	0	772	0
1963	772	0	772	0	772	0
1964	772	0	772	0	772	0
1965	772	0	582	-190	462	-310
1966	772	0	772	0	772	0
1967	772	0	772	0	772	0
1968	335	0	240	-96	120	-216
1969	772	0	772	0	772	0
1970	772	0	772	0	772	0
1971	772	0	772	0	727	-45
1972	772	0	772	0	772	0
1973	771	0	771	0	761	-10
1974	772	0	772	0	772	0
1975	772	0	772	0	772	0
1976	772	0	772	0	772	0
1977	772	0	755	-17	721	-52
1978	772	0	772	0	772	0
1979	636	0	541	-94	421	-214
1980	772	0	772	0	772	0
1981	772	0	772	0	772	0
1982	772	0	772	0	772	0
1983	772	0	772	0	772	0
1984	772	0	772	0	772	0
1985	772	0	772	0	772	0
1986	745	0	436	-309	316	-429
1987	772	0	772	0	772	0
1988	772	0	772	0	772	0
1989	772	0	720	-52	600	-172
1990	772	0	772	0	772	0
1991	772	0	772	0	772	0
1992	772	0	717	-55	597	-175
1993	465	0	465	0	345	-120
1994	772	0	772	0	772	0
1995	772	0	772	0	772	0
1996	772	0	772	0	772	0
Average	741	0	722	-19	698	-43

Without : Operation with non-upper rule curve

Figures
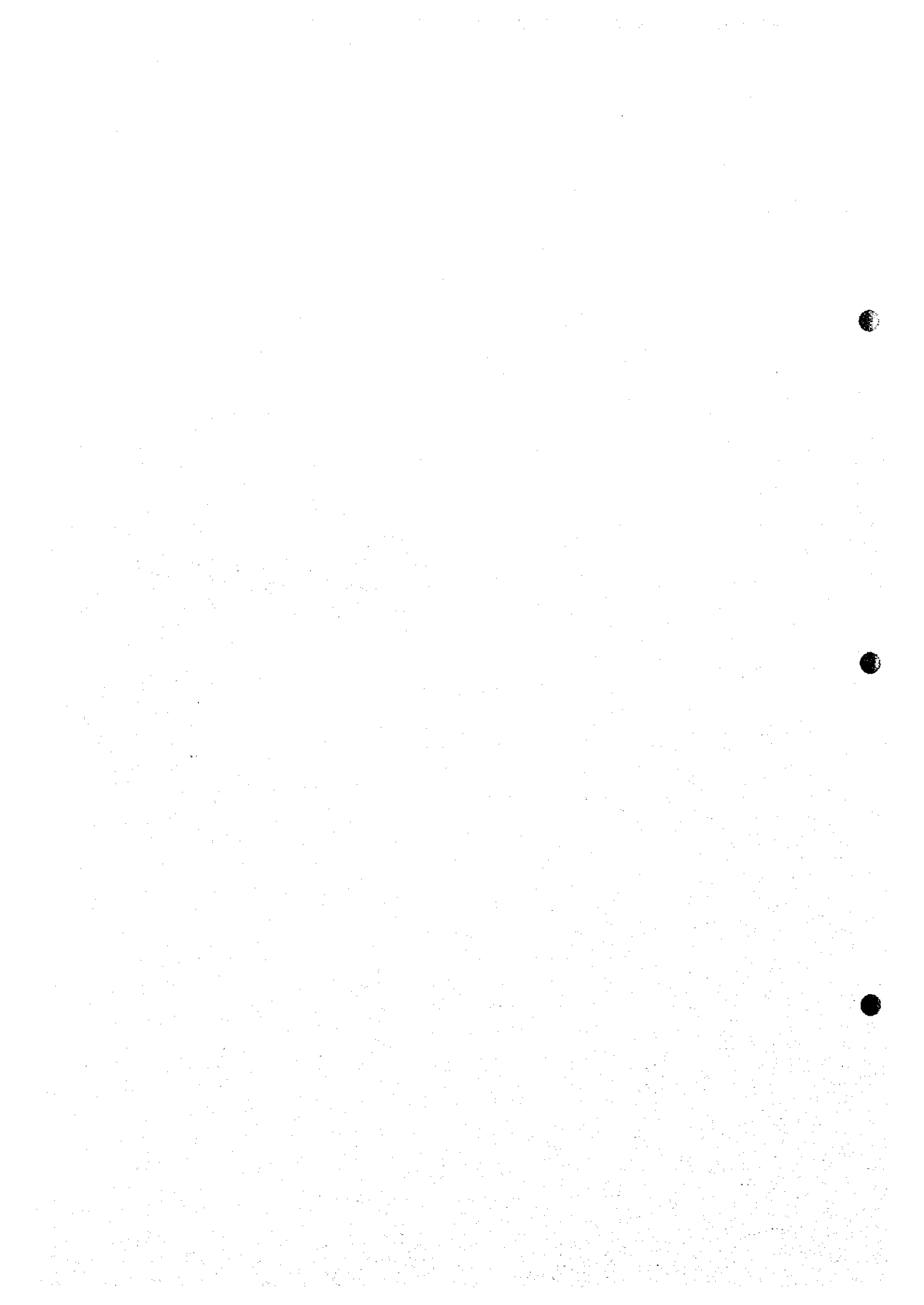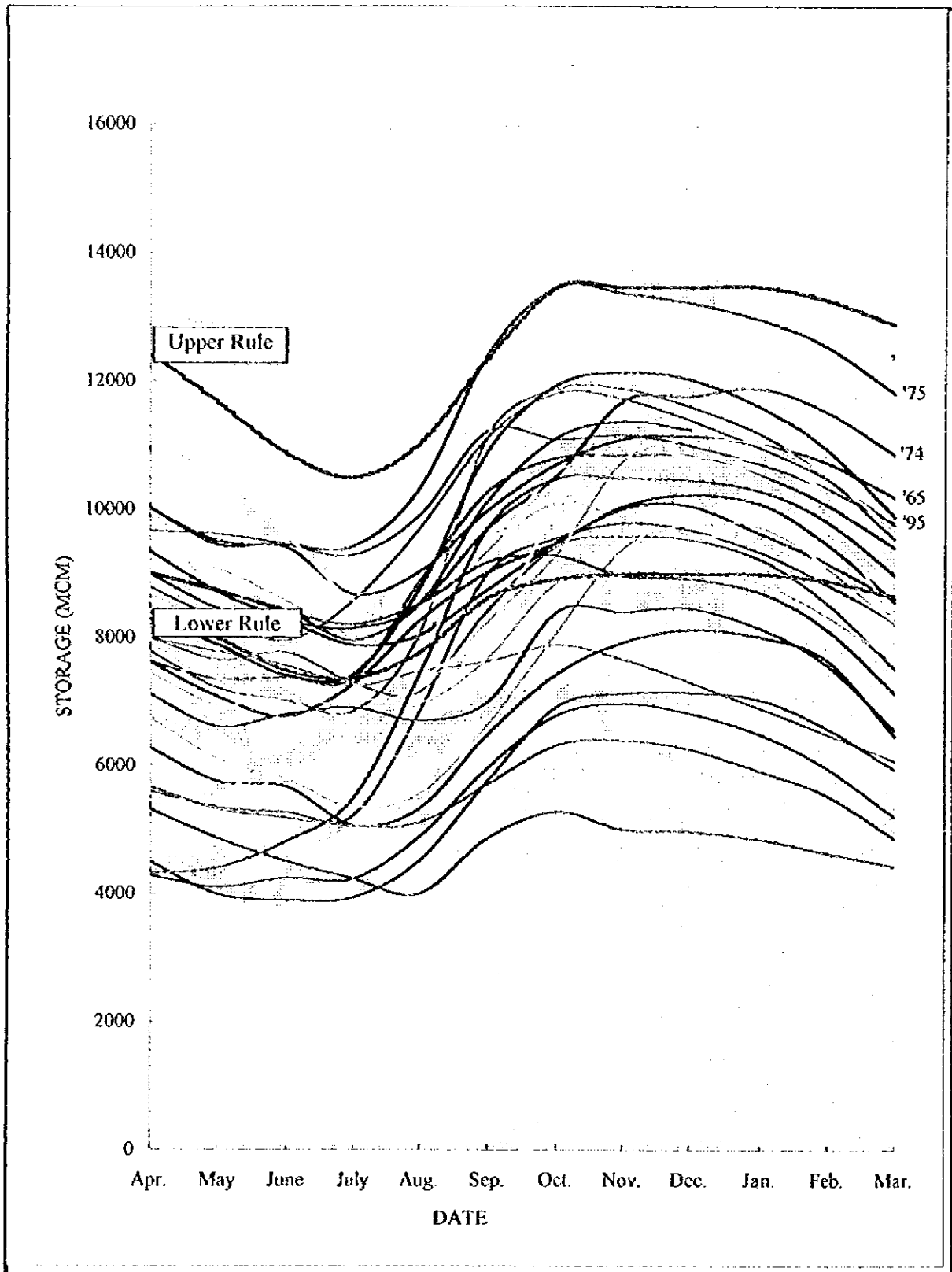
LEGEND

— ·· — : BASIN BOUNDARY

— · — · — : SUBBASIN BOUNDARY

‾‾‾‾ : RIVER

○ : CHANGWAT (CITY)

: Existing Reservoir

: Proposed Reservoir

Scale

0   50   100 Km

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 2.1.1
CTI ENGINEERING CO., LTD. AND INA CORPORATION	LOCATION OF EXISTING/PROPOSED DAMS IN THE CHAO PHRAYA RIVER BASIN

STORAGE (MCM)

Upper Rule

Lower Rule

'75
'74
'65
'95

DATE

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 2.3.1(1/2)
	RULE CURVE AND ACTUAL RESERVOIR OPERATION OF THE
CTI ENGINEERING CO, LTD. AND INA CORPORATION	BHUMIBOL RESERVOIR
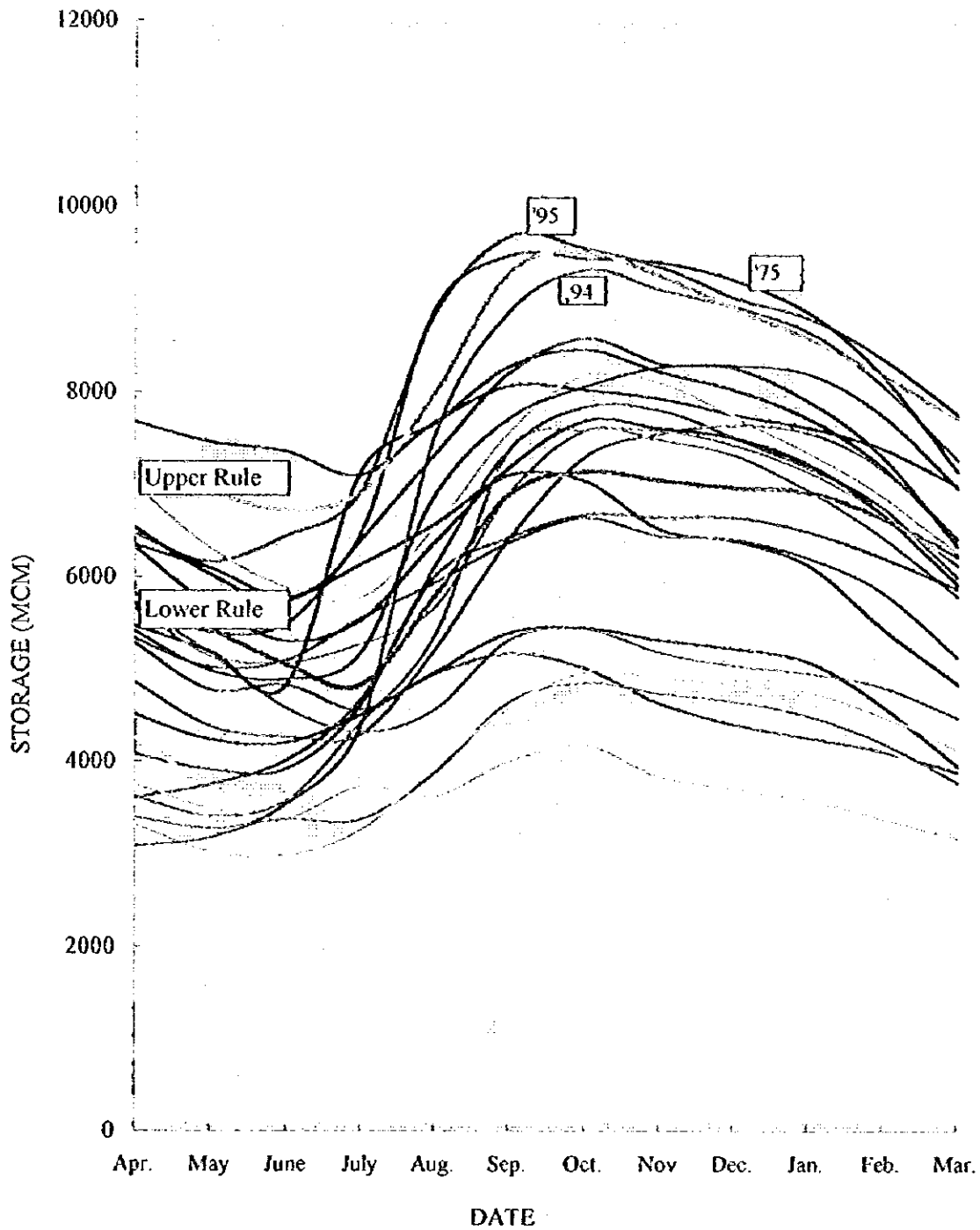
STORAGE (MCM)

'95
'94
'75
Upper Rule
Lower Rule

Apr. May June July Aug. Sep. Oct. Nov Dec. Jan. Feb. Mar.

DATE

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 2.3.1 (2/2)
	RULE CURVE AND ACTUAL RESERVOIR OPERATION OF THE
CTI ENGINEERING CO, LTD. AND INA CORPORATION	SIRIKIT RESERVOIR

LEGEND

- ▬ ▪ ▬ : Basin Boundary
- ▬ ▪ ▬ : Sub-basin Boundary
- ─── : River
- ○ : City (Changwat)

Bhumipol Dam
C.A. = 26,386 km²

Kaeng Sua Ten
C.A. = 3,583 km²

Sirikit Dam
C.A. = 13,130 km²

Kwae Noi Dam
C.A. = 4,254 km²

Pasak Dam
C.A. = 12,929 km²

SCALE
50   100 km

GULF OF THAILAND
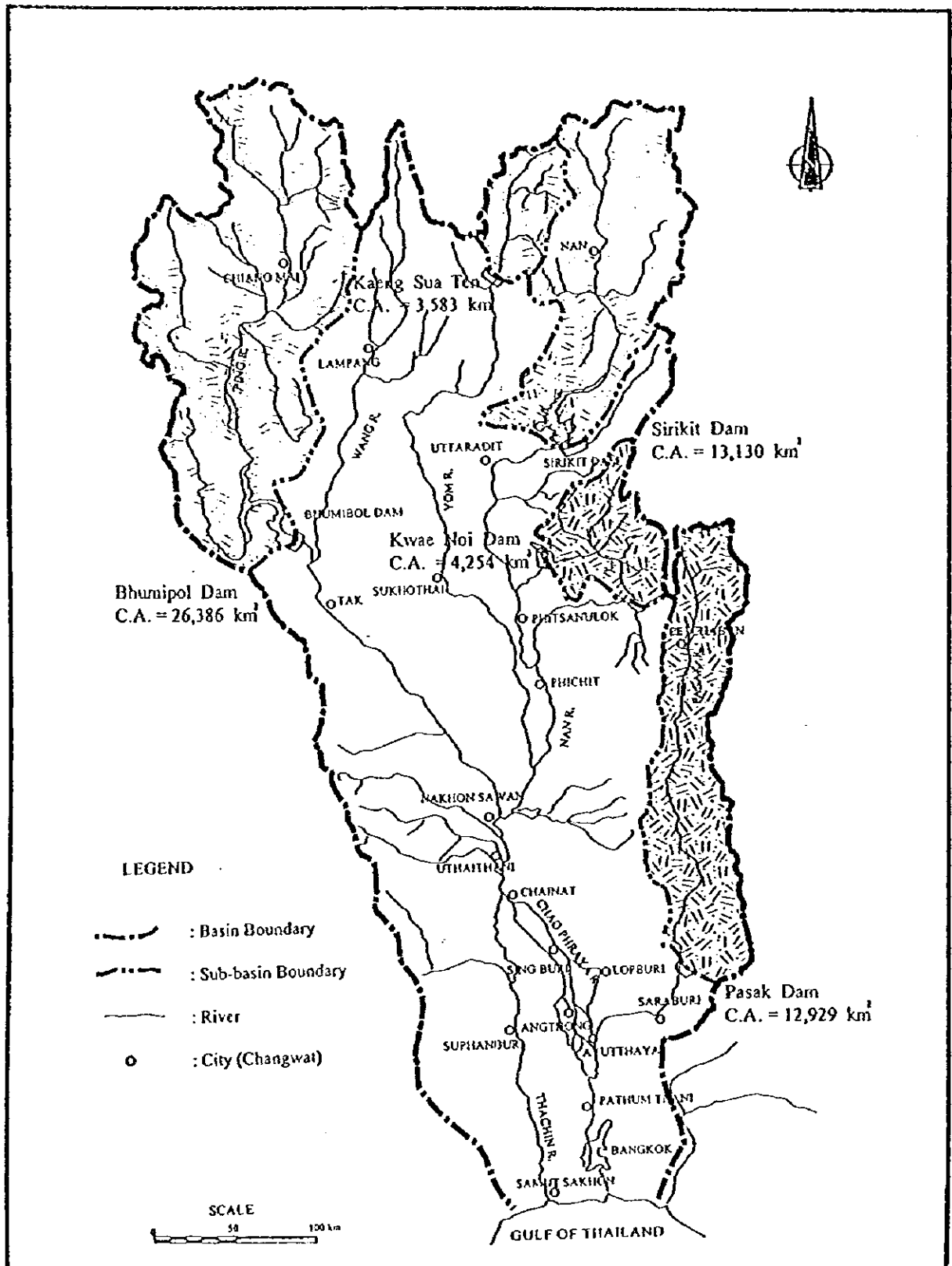
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 3.3.1
CTI ENGINEERING CO., LTD. AND INA CORPORATION	LOCATION OF SELECTED FIVE DAMS

TYPICAL DRY SEASON AREA REDUCTION RELATIONSHIP
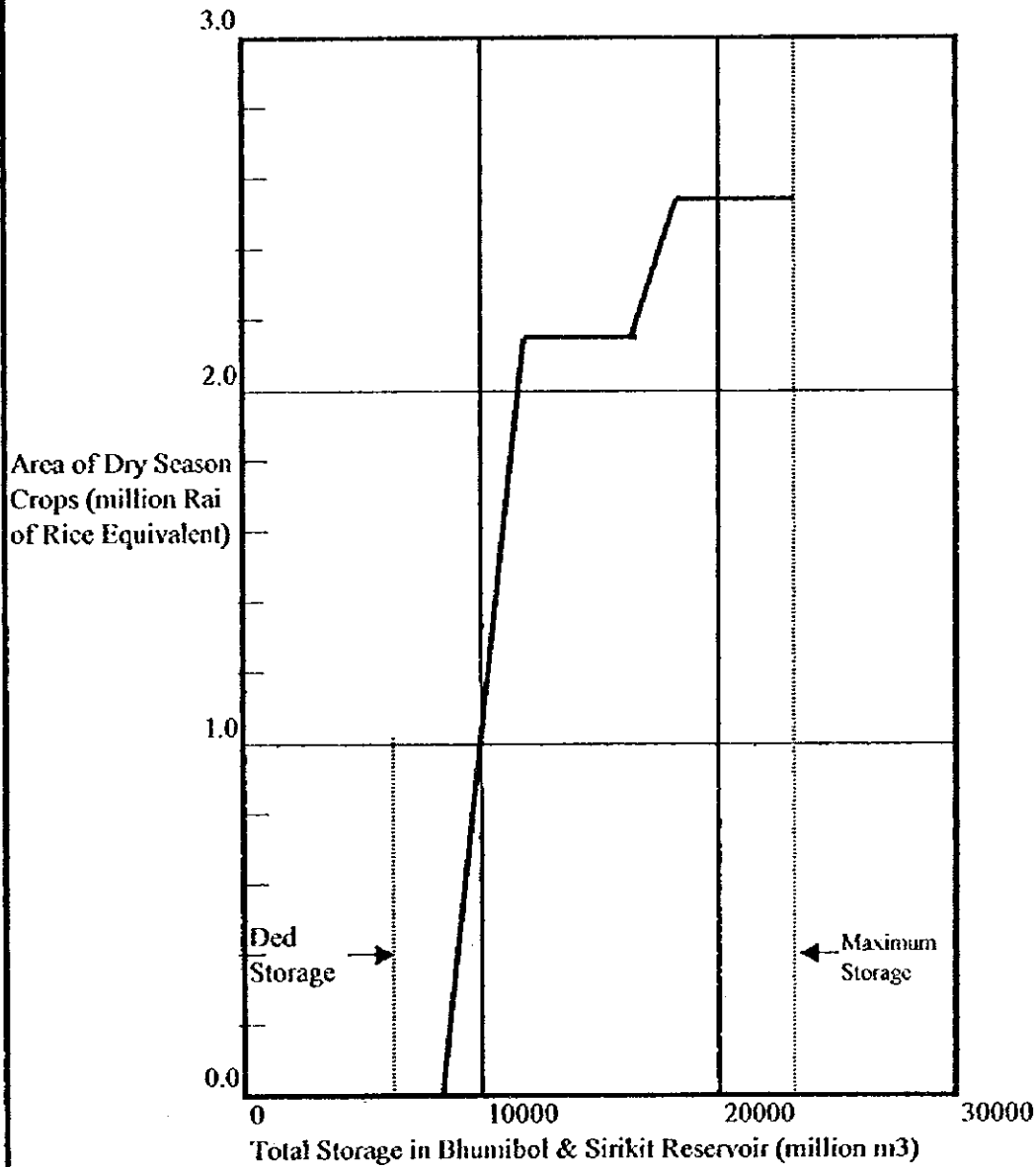
note : Rice equivalent area is computed by adding rice area + 0.4*field crop area

Souse : CHAO PHRAYA-MEKLONS BASIN STUDY

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 3.4.1
	RELATION BETWEEN STORAGE VOLUME AND IRRIGATION AREA
CTI ENGINEERING CO, LTD. AND INA CORPORATION	

NAKHON SAWAN

FREQUENCY

JUL.1 to 15 JUL.16 to 31 AUG.1 to 15 AUG.16 to 31 SEP.1 to 15 SEP.16 to 31 OCT.1 to 15 OCT.16 to 31 NOV.1 to 15 NOV.16 to 30 DEC.1 to 15 DEC.16 to 31

DATE
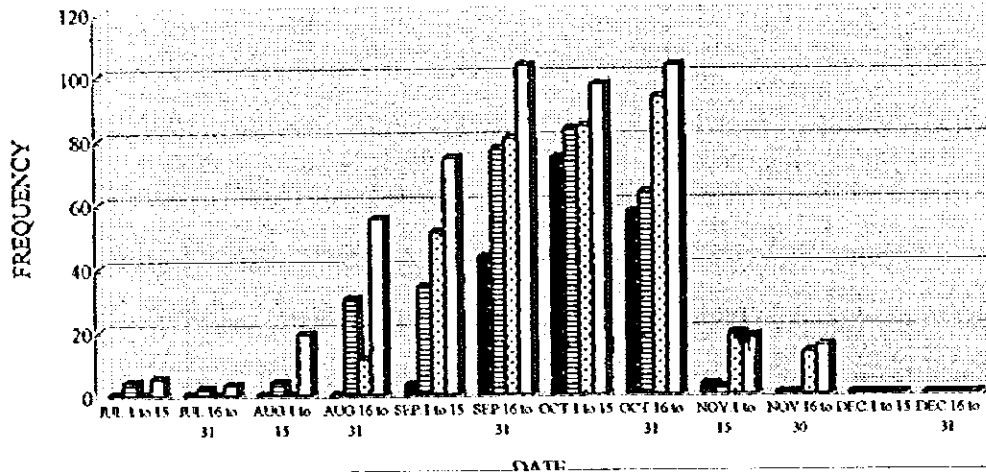
■ Observed   🖩 Without SIRIKIT DAM
🞔 Without BHUMIBOL DAM   ☐ Without BHUMIPOL and SIRIKIT DAM

SIRIKIT DAM
Q>1000 m3/s

FREQUENCY

JUL.1 to 15 JUL.16 to 31 AUG.1 to 15 AUG.16 to 31 SEP.1 to 15 SEP.16 to 31 OCT.1 to 15 OCT.16 to 31 NOV.1 to 15 NOV.16 to 30 DEC.1 to 15 DEC.16 to 31

DATE

BHUMIBOL DAM
Q>1000 m3/s

FREQUENCY

JUL.1 to 15 JUL.16 to 31 AUG.1 to 15 AUG.16 to 31 SEP.1 to 15 SEP.16 to 31 OCT.1 to 15 OCT.16 to 31 NOV.1 to 15 NOV.16 to 30 DEC.1 to 15 DEC.16 to 31

DATE
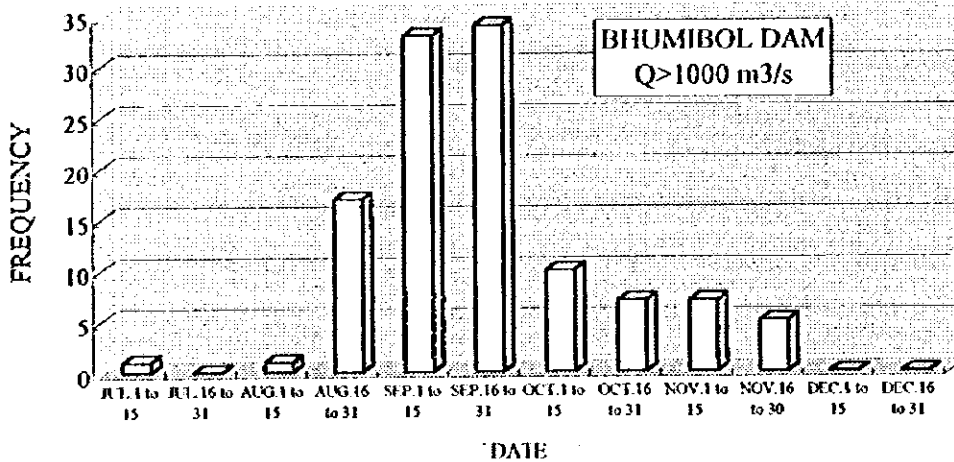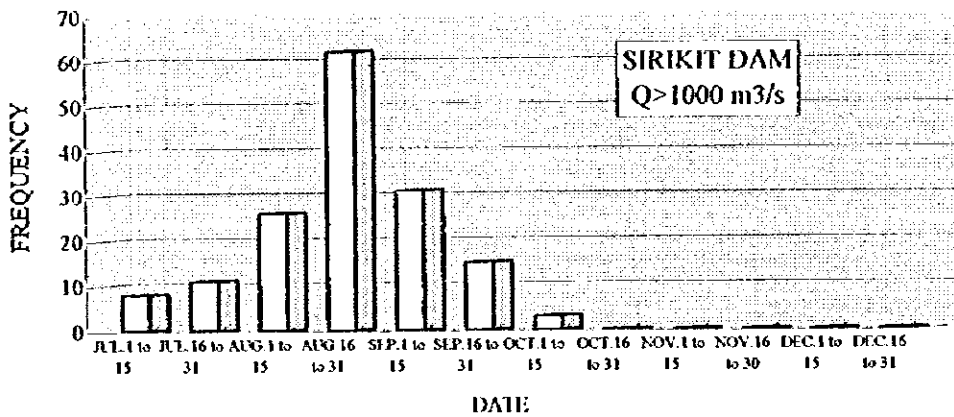
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 3.5.1 (1/2)
	FREQUENCIES OF FLOODS (1952 - 1996)
CTI ENGINEERING CO., LTD. AND INA CORPORATION	

PASAK DAM
Q>1000 m3/s

KWAE NOI DAM
Q>500 m3/s

KAEN SUA TEN DAM
Q>400 m3/s
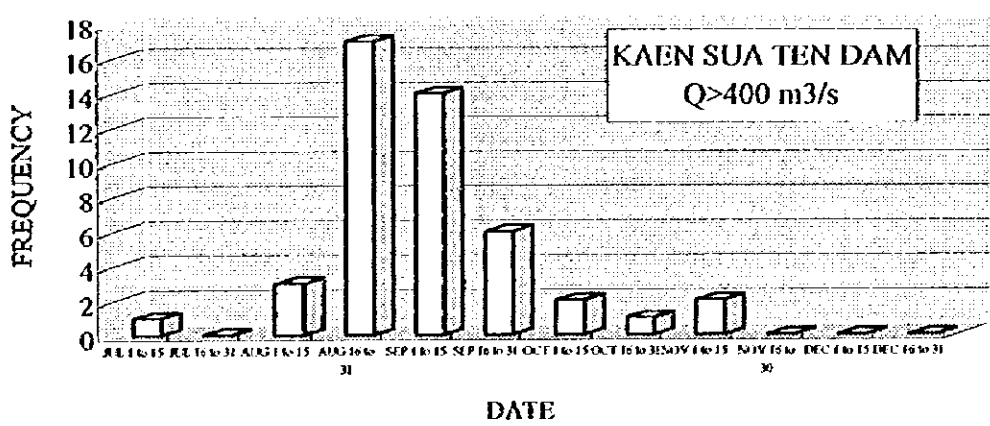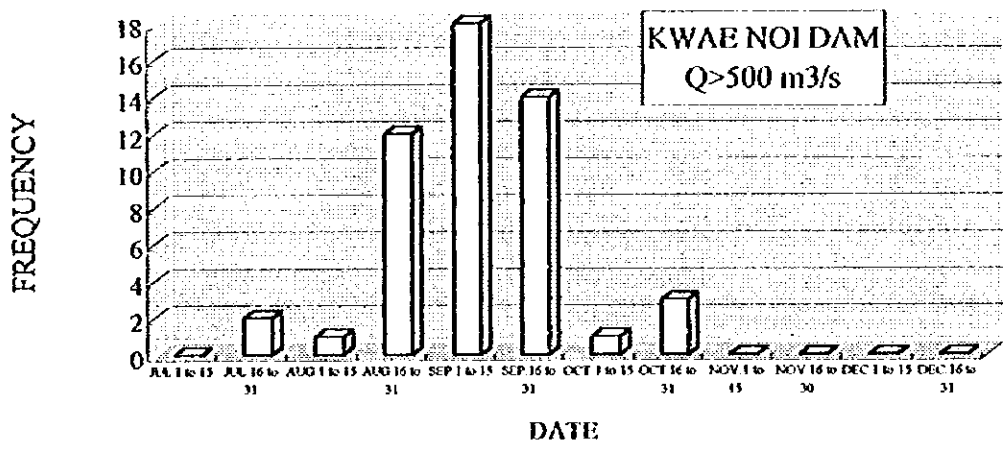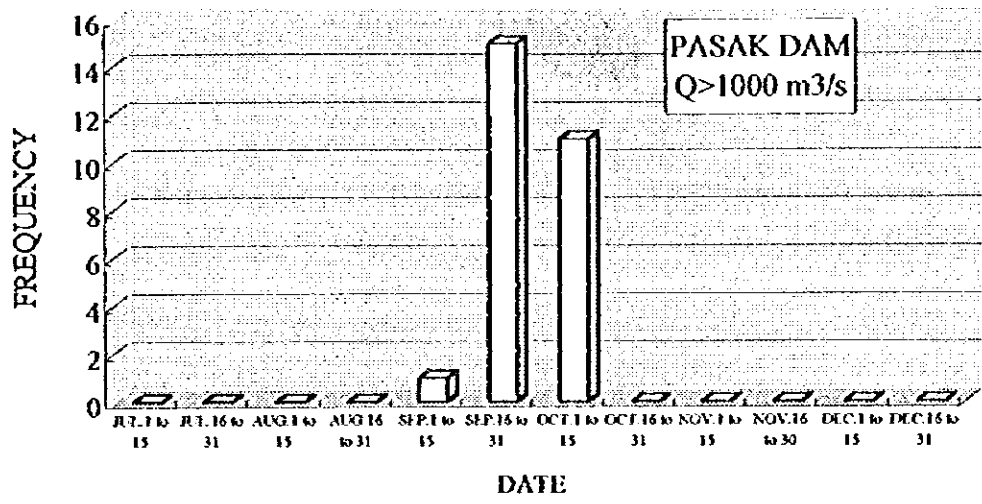
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 3.5.1 (2/2)
	FREQUENCIES OF FLOODS (1952 - 1996)
CTI ENGINEERING CO, LTD. AND INA CORPORATION	
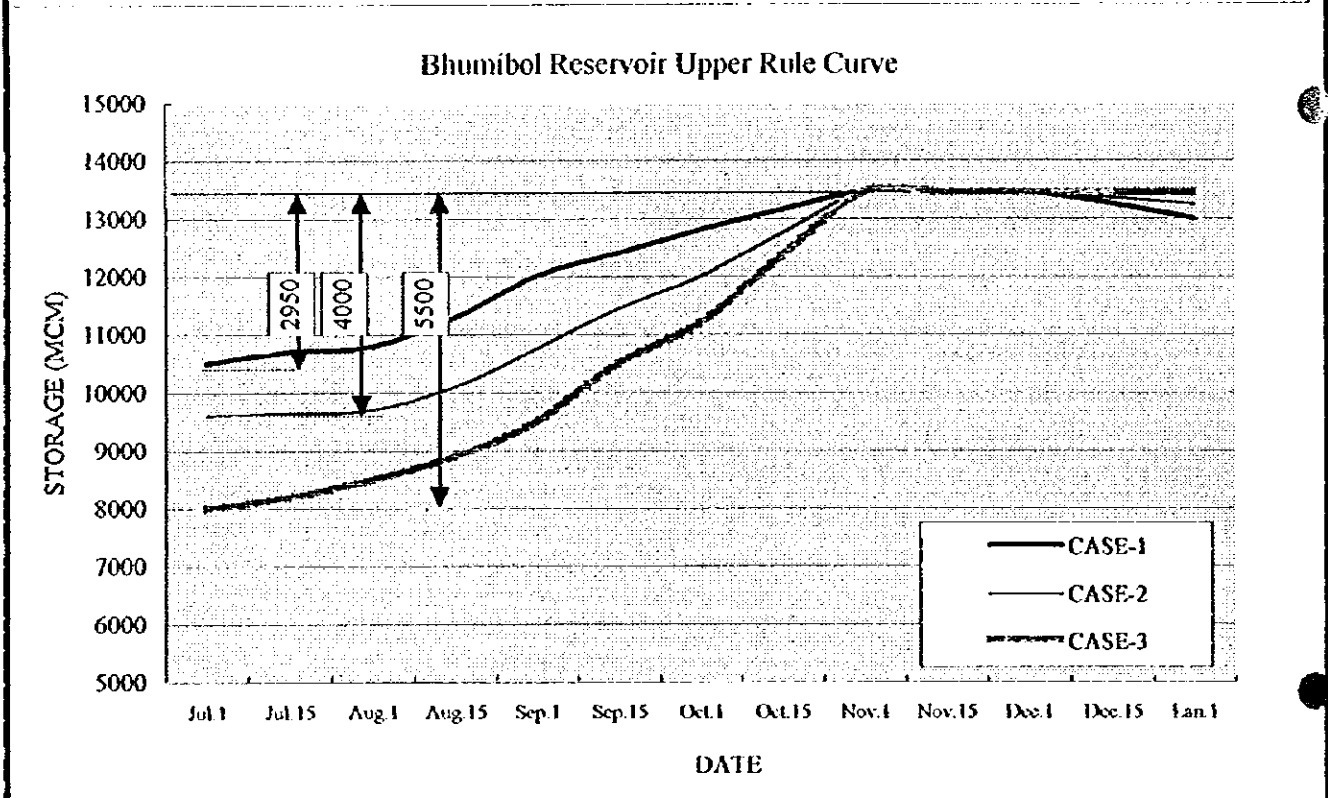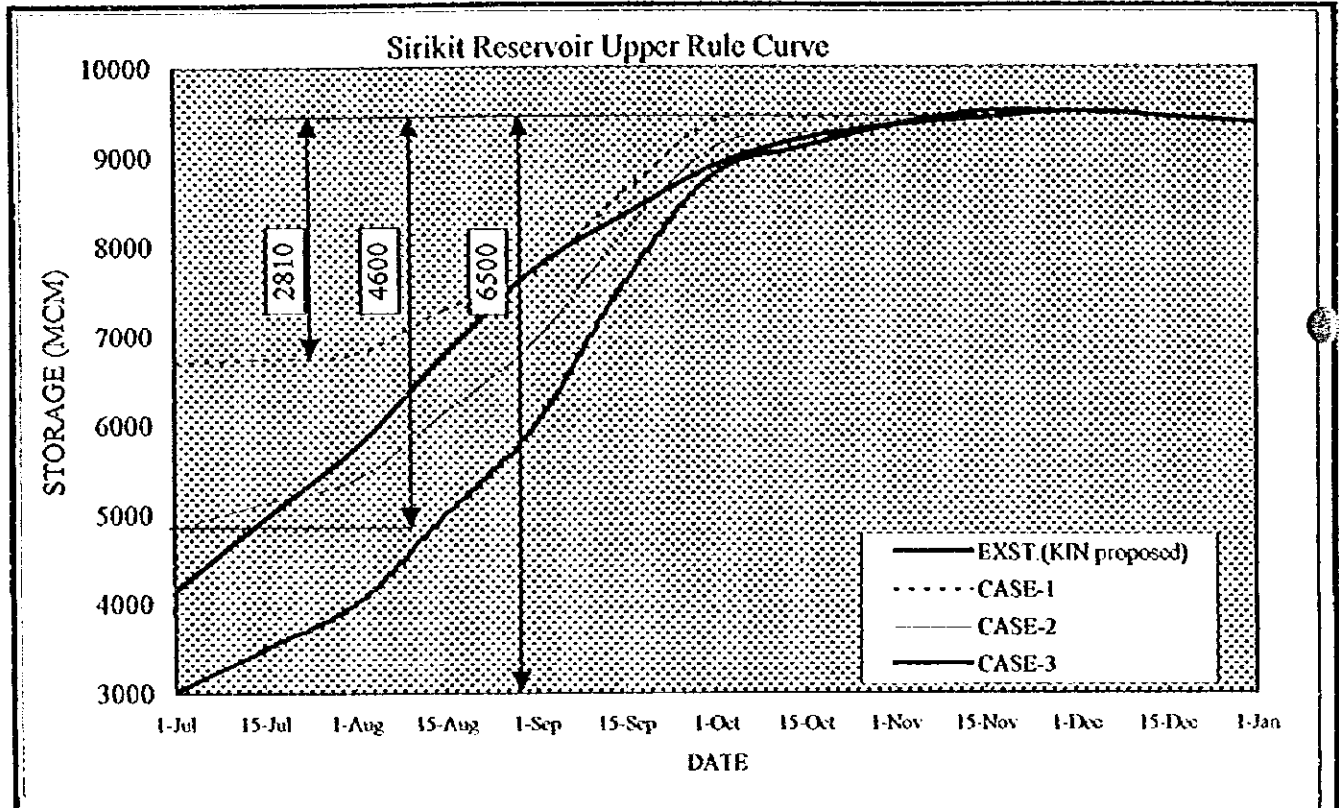
Sirikit Reservoir Upper Rule Curve

Bhumibol Reservoir Upper Rule Curve

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 3.5.2 (1/2)
	PROPOSED UPPER RULE CURVE
CTI ENGINEERING CO, LTD. AND INA CORPORATION	

KWAE NOI RESERVOIR OPERATION RULE CURVE

PASAK RESERVOIR OPERATION RULE CURVE

KAENG SUA TEN RESERVOIR OPERATION RULE CURVE
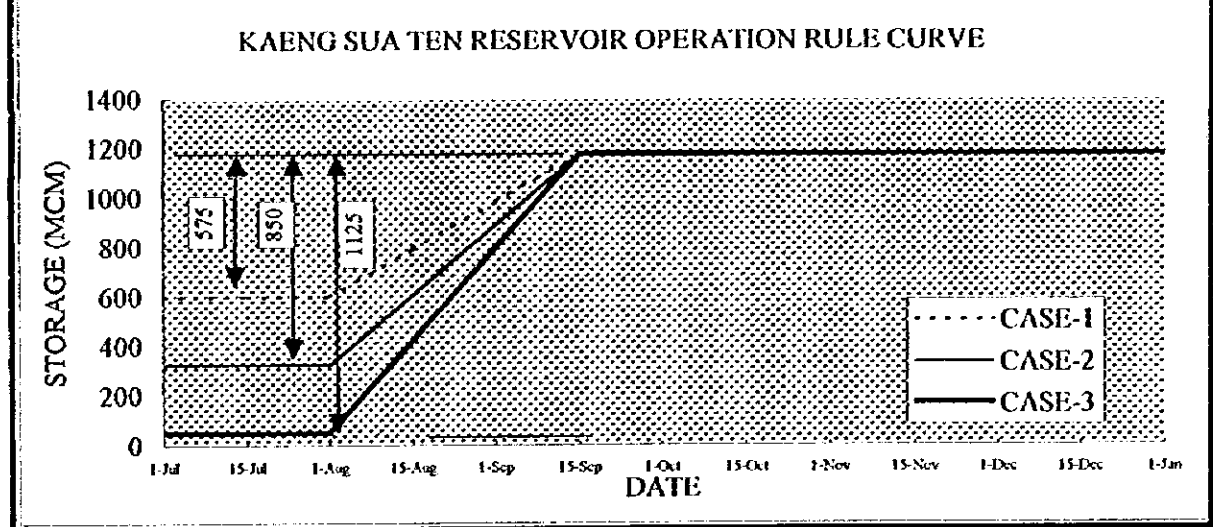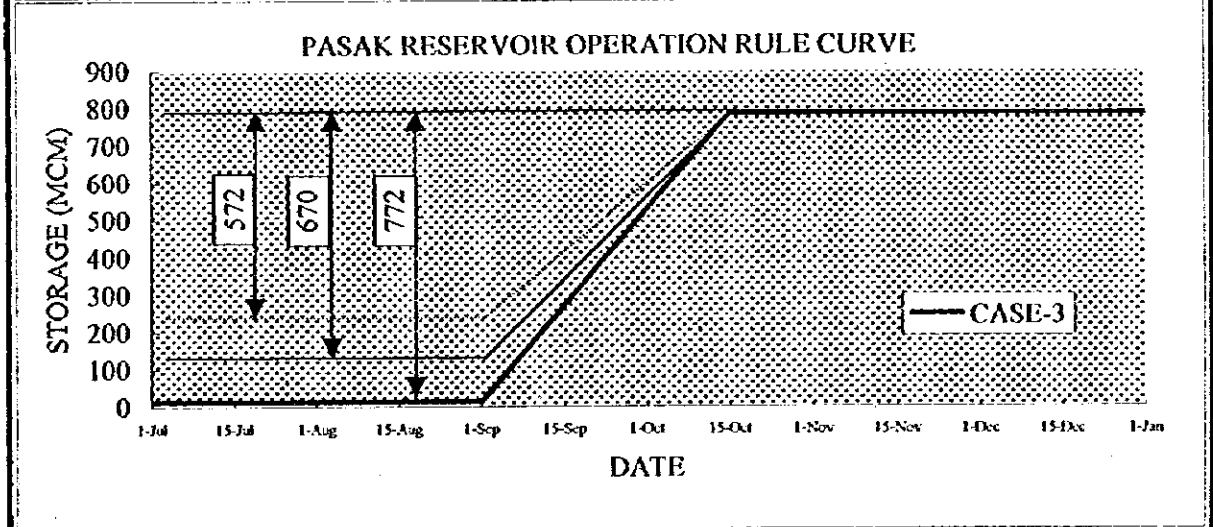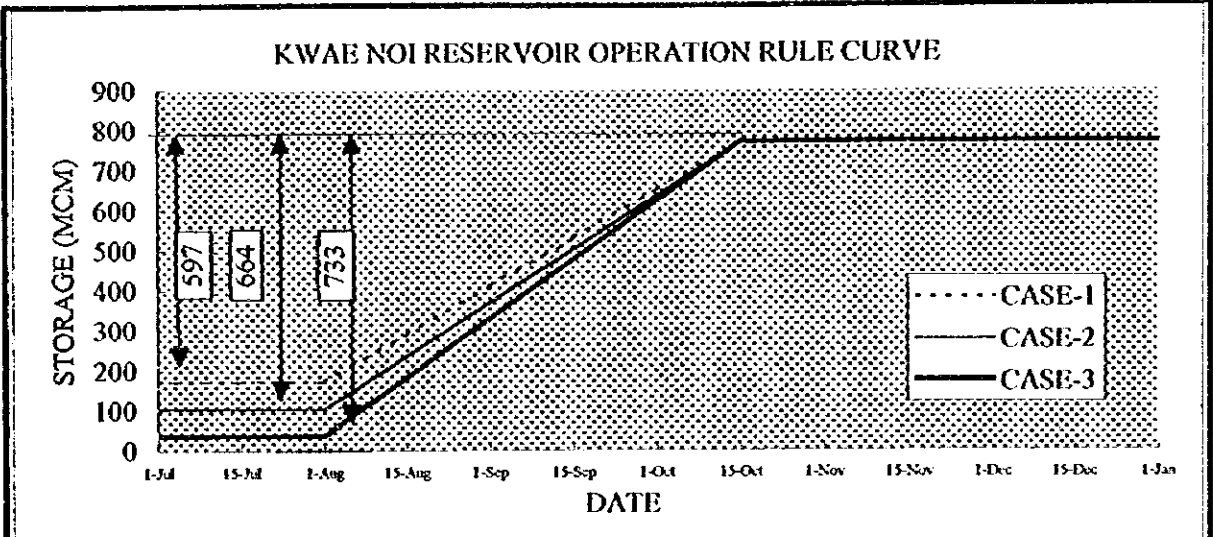
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 3.5.2 (2/2)
	PROPOSED UPPER RULE CURVE
CTI ENGINEERING CO, LTD. AND INA CORPORATION	

Rating Curve of Bhumipol Hydro-Power Plant
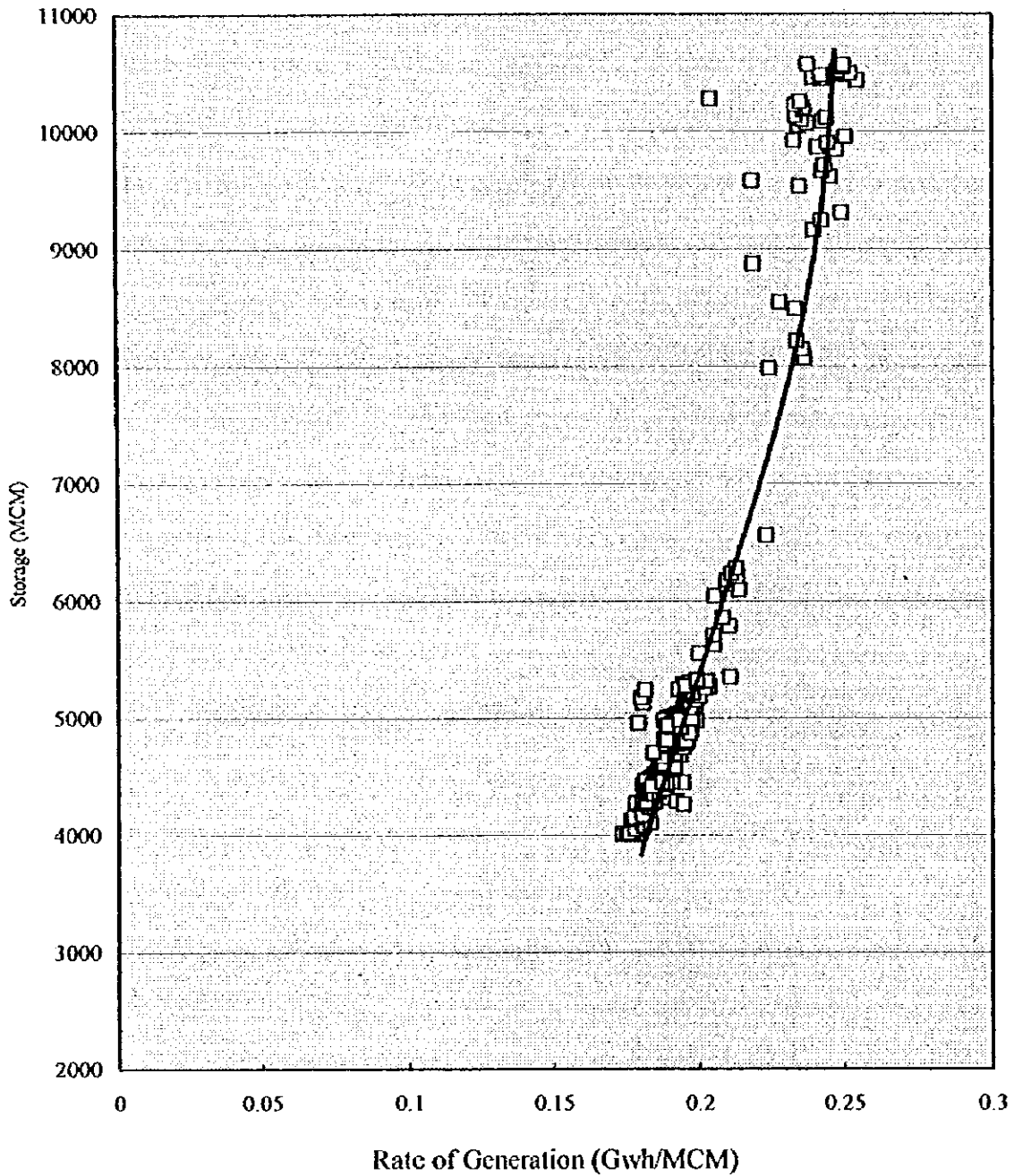
$$\text{Rate}=14.782 \times 10^{-3} \text{Storage}^{0.3018}$$

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 3.6.1
	RATING CURVE OF BHUMIBOL HYDRO-POWER PLANT
CTI ENGINEERING CO, LTD. AND INA CORPORATION	

Rate=2.8435E-03*Storage**0.4708
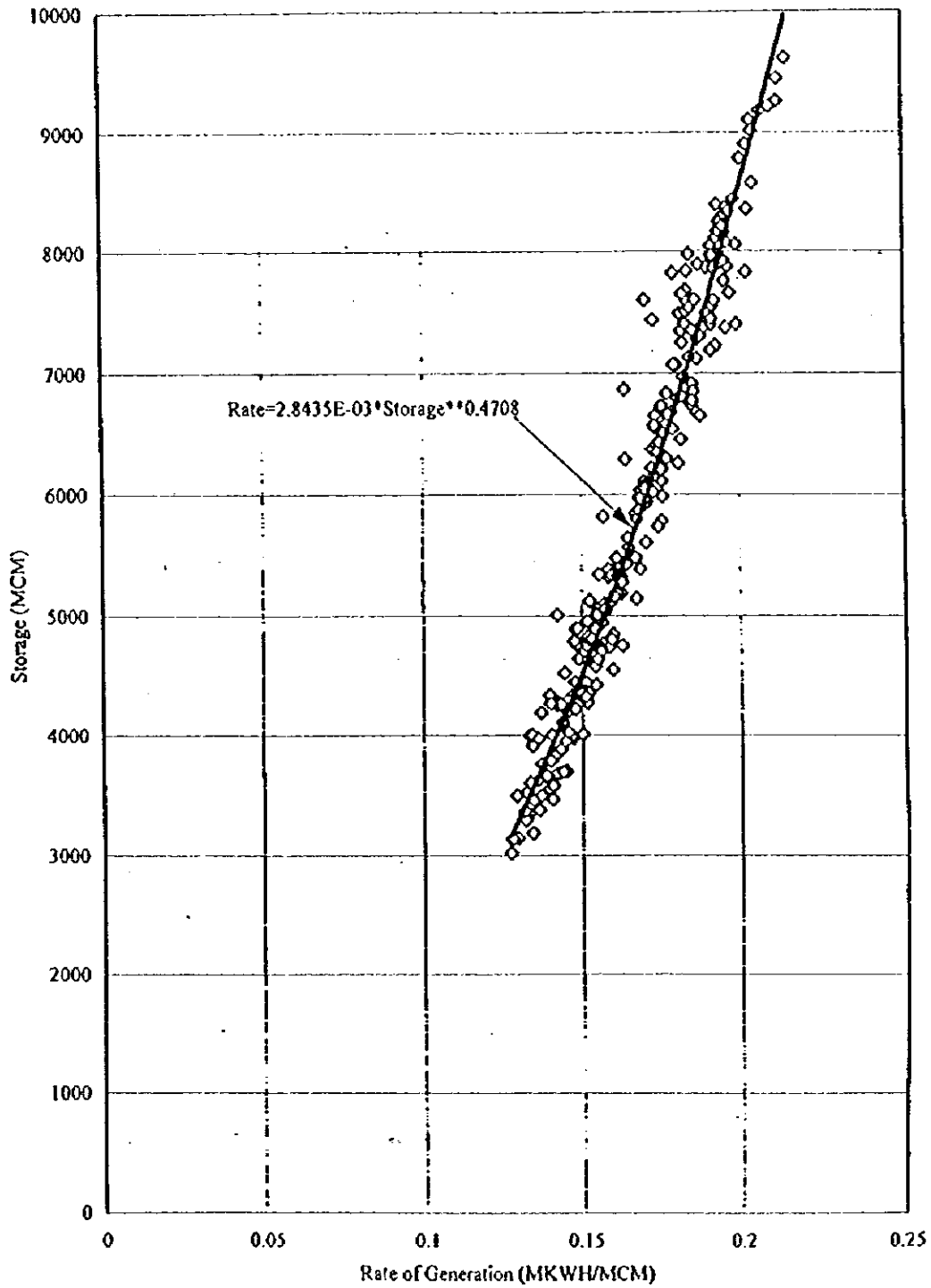
Source : The Study on Kok-Ing-Nan Water Diversion Project, Progress Report ,1997 JICA

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 3.6.2
	RATING CURVE OF SIRIKIT HYDRO-POWER PLANT
CTI ENGINEERING CO, LTD. AND INA CORPORATION	
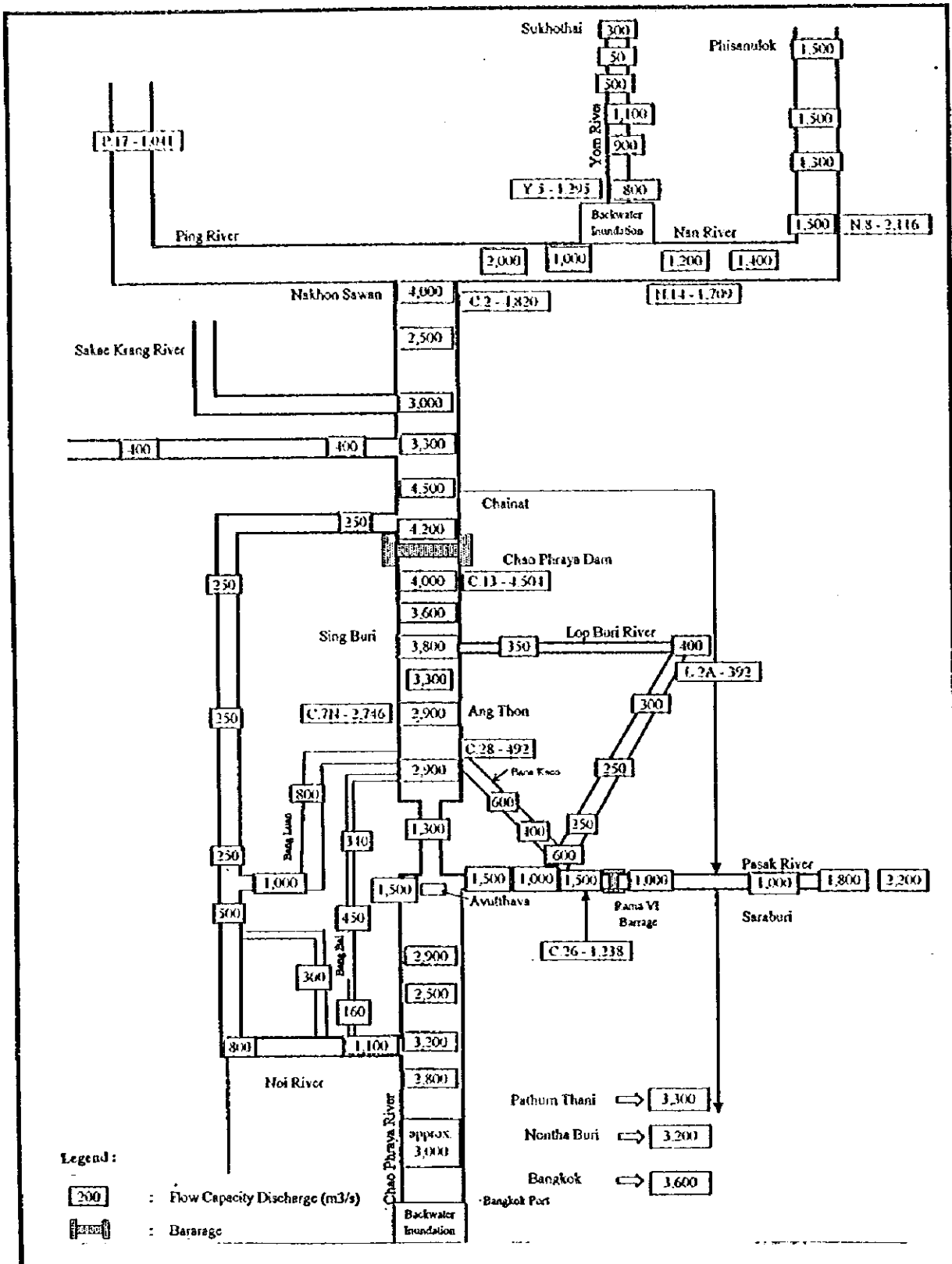
Sukhothai [300]
[50]
[500]
[1,100]
[200]

Phisanulok [1,500]

Yom River

[1,500]

[1,300]

Y.5 - 1,295   [800]

[1,500]   N.8 - 2,116

Backwater Inundation

Nan River

P.17 - 1,941

Ping River

[2,000] [1,000]   [1,200] [1,400]

N.14 - 1,709

Nakhon Sawan   [4,000]

C.2 - 1,820

[2,500]

Sakae Krang River

[3,000]

[3,300]

[400]   [400]

[4,500]

Chainat

[350]   [4,200]

Chao Phraya Dam

[250]

[4,000]   C.13 - 4,501

[3,600]

Sing Buri

[3,800]   [350]   Lop Buri River   [400]

L.2A - 392

[250]

[3,300]

C.7N - 2,746   [2,900]   Ang Thon   [300]

C.28 - 492

[350]

[2,900]

Bang Kaeo   [250]

[800]

[600]

[350]

[250]

[100]

[310]   [1,300]

Bang Luang

[600]

[1,000]

Pasak River   [1,800]   [2,200]

[500]   [1,500]   [1,500] [1,000] [1,500]   [1,000]   [1,000]

Ayutthaya

Rama VI Barrage

Saraburi

[450]

Bang Ban

C.26 - 1,238

[300]

[2,900]

[160]

[2,500]

[800]   [1,100]   [3,200]

Noi River

[2,800]

Pathum Thani ⇒ [3,300]

Chao Phraya River

Nontha Buri ⇒ [3,200]

approx. 3,000

Legend:

[200] : Flow Capacity Discharge (m3/s)

[===] : Barrage

Bangkok ⇒ [3,600]

Bangkok Port

Backwater Inundation
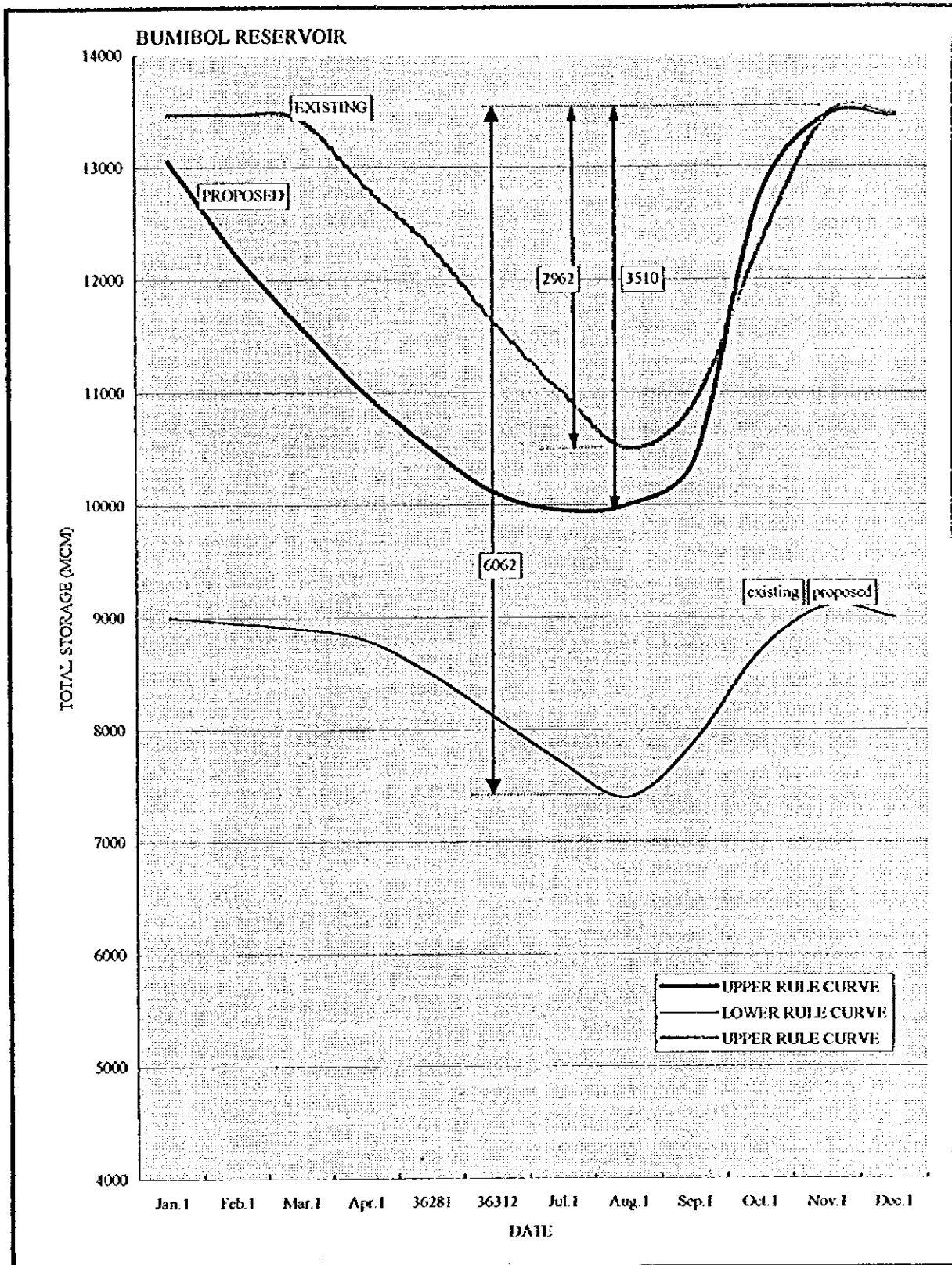
BUMIBOL RESERVOIR

PROPOSED UPPER RULE CURVE FOR BHUMIBOL RESERVOIR
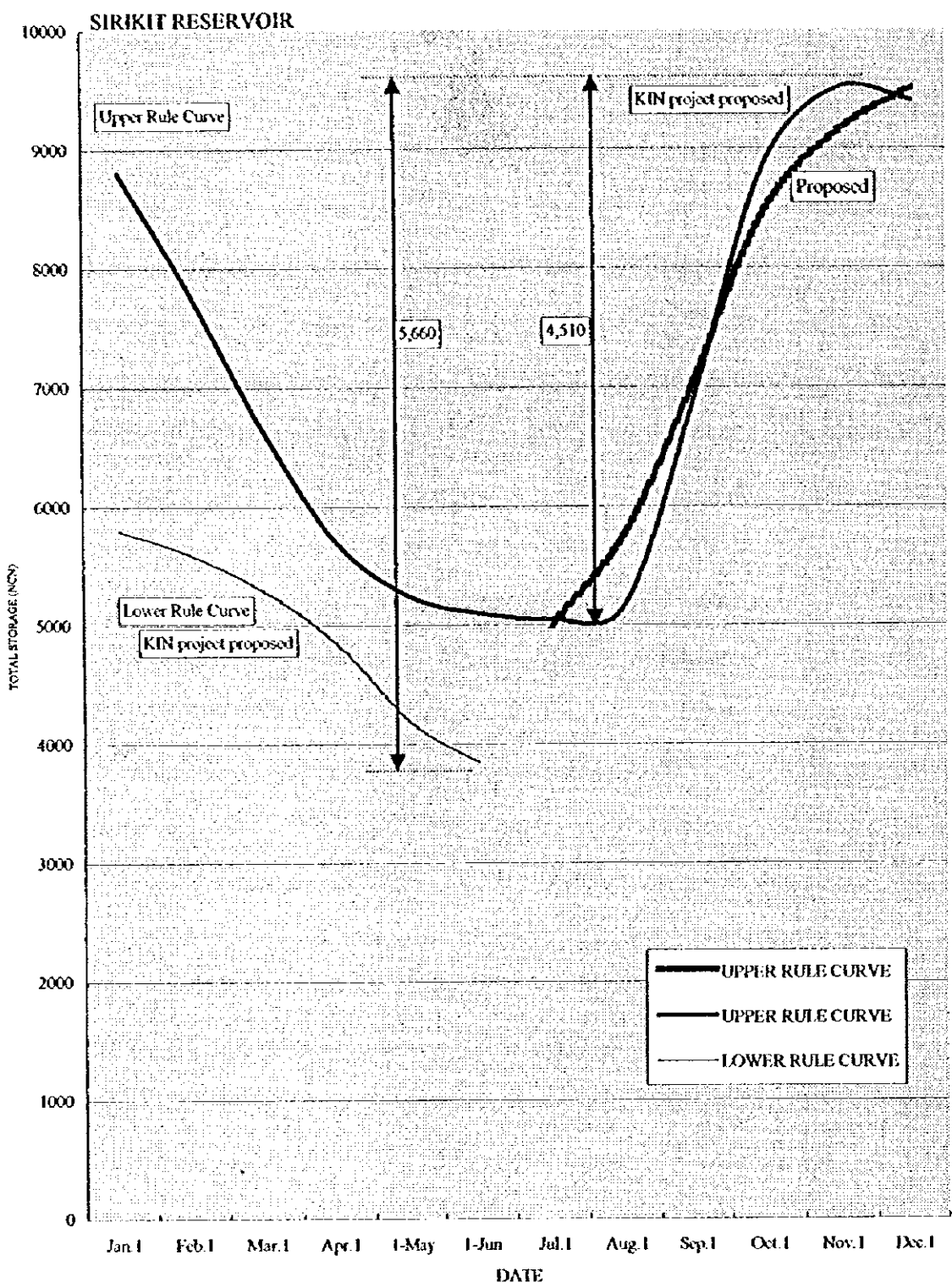
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN

FIG. 4.3.2

CTI ENGINEERING CO, LTD. AND INA CORPORATION

SIRIKIT RESERVOIR

	UPPER RULE CURVE	
	UPPER RULE CURVE	
	LOWER RULE CURVE	

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 4.3.3
CTI ENGINEERING CO, LTD. AND INA CORPORATION	PROPOSED UPPER RULE CURVE FOR SIRIKIT RESERVOIR
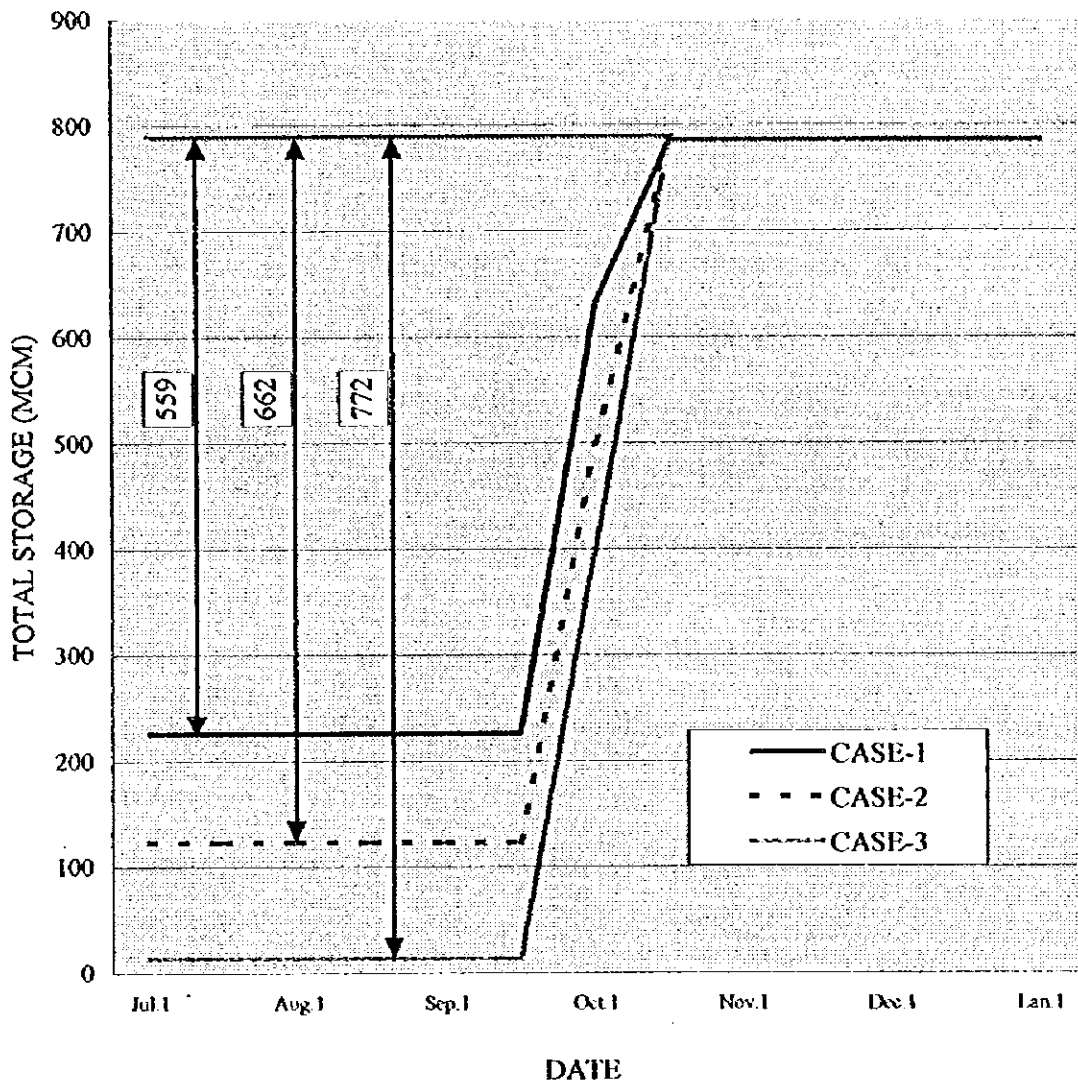
900

800

700

600

TOTAL STORAGE (MCM)

500

400

300

200

100

0

559   662   772

Jul.1   Aug.1   Sep.1   Oct.1   Nov.1   Dec.1   Jan.1

CASE-1
CASE-2
CASE-3

DATE

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 4.3.4
	PROPOSED UPPER RULE CURVES FOR PASAK RESERVOIR
CTI ENGINEERING CO, LTD. AND INA CORPORATION	

Siriki dam annual power generation
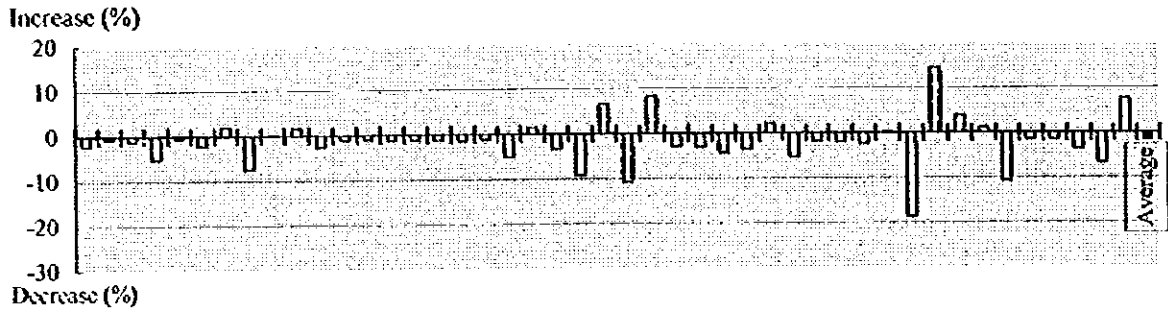
Sirikit dam irrigation water supply in dry season
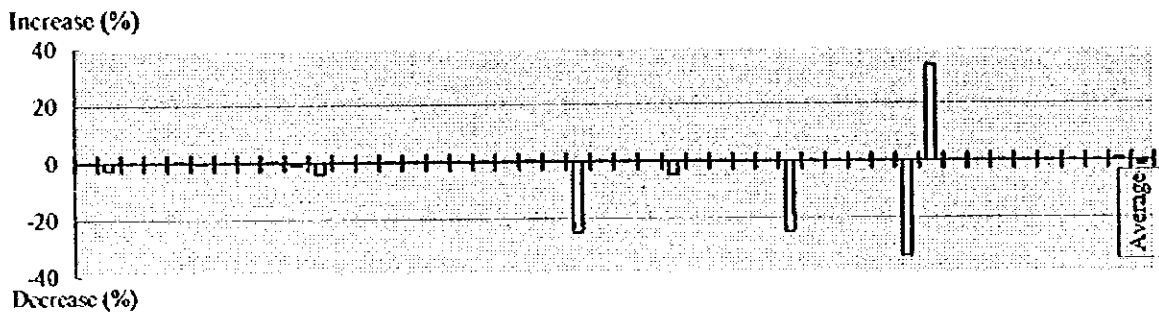
Bumibol dam annual power generation
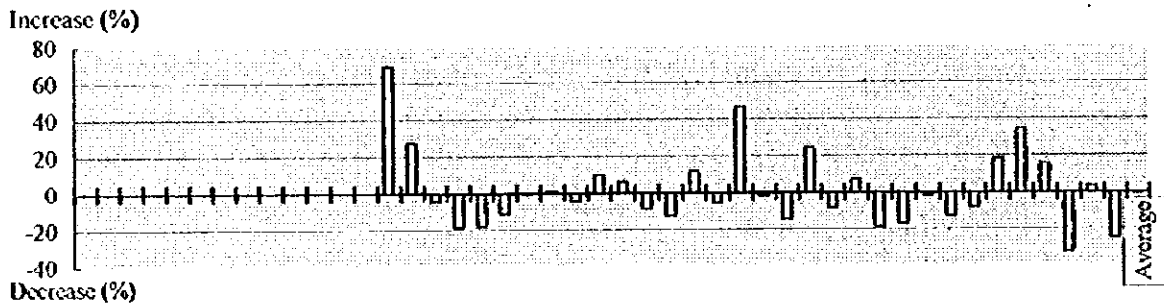
Bumubol dam irrigation water supply in dry season
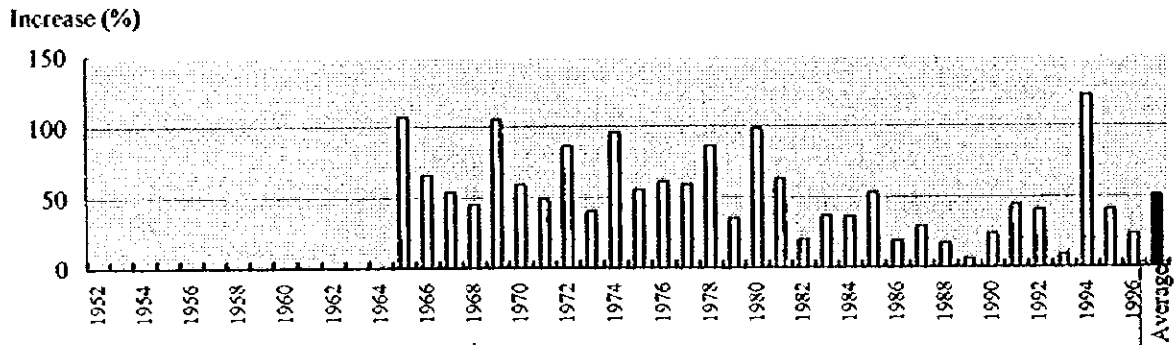
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 4.4.1 (1/2) INFLUENCE BY MODIFICATION OF RESERVOIR OPERATION
CTI ENGINEERING CO, LTD. AND INA CORPORATION	(BHUMIBOL AND SIRIKIT)

Pasak dam irrigation water supply in dry season
Case-2

Pasak dam irrigation water supply in dry season
Case-3
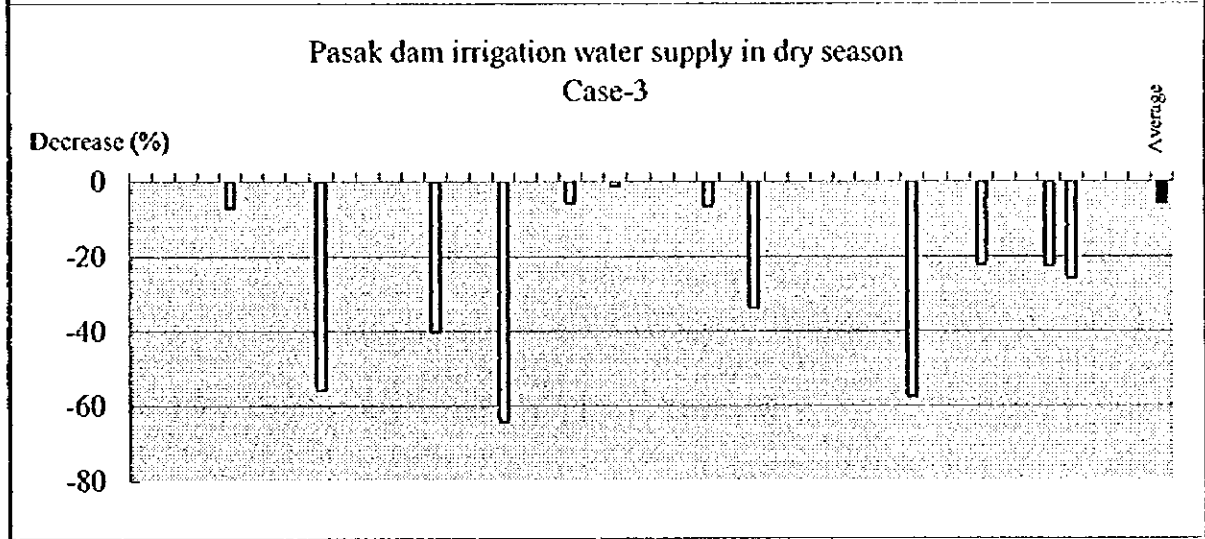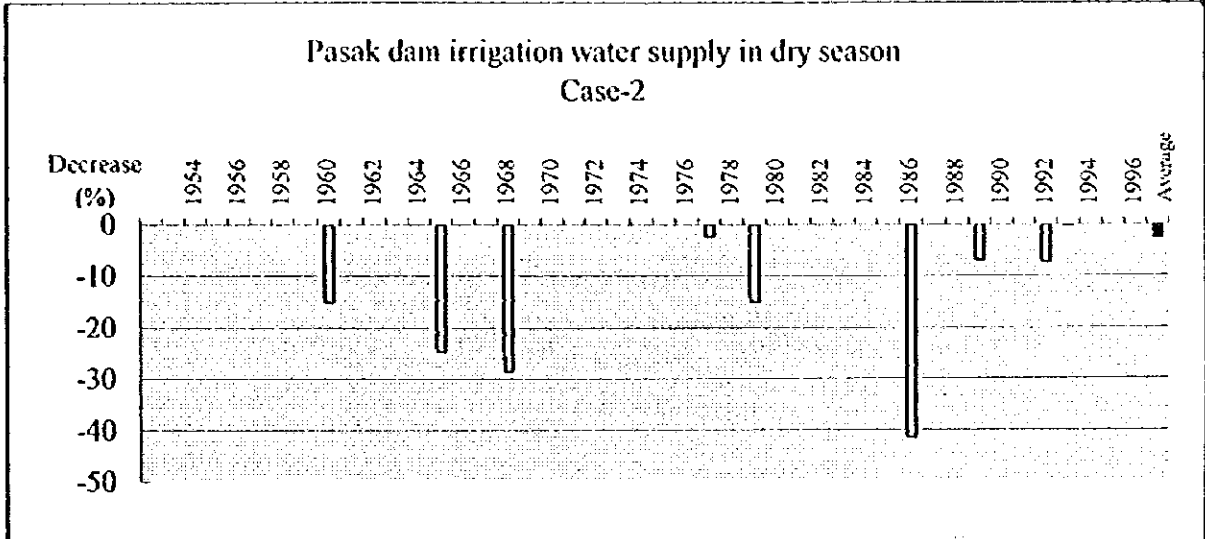
STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 4.4.1 (2/2) INFLUENCE BY MODIFICATION OF RESERVOIR OPERATION (PASAK DAM)
CTI ENGINEERING CO, LTD. AND INA CORPORATION	

UPPER RULE CURVE

LOWER RULE CURVE

TOTAL STORAGE (MCM)

16000

14000

12000

10000

8000

6000

4000

2000

0

JAN.1 FEB.1 MAR.1 APR.1 MAY.1 JUN.1 JUL.1 AUG.1 SEP.1 OCT.1 NOV.1 DEC.1

DATE
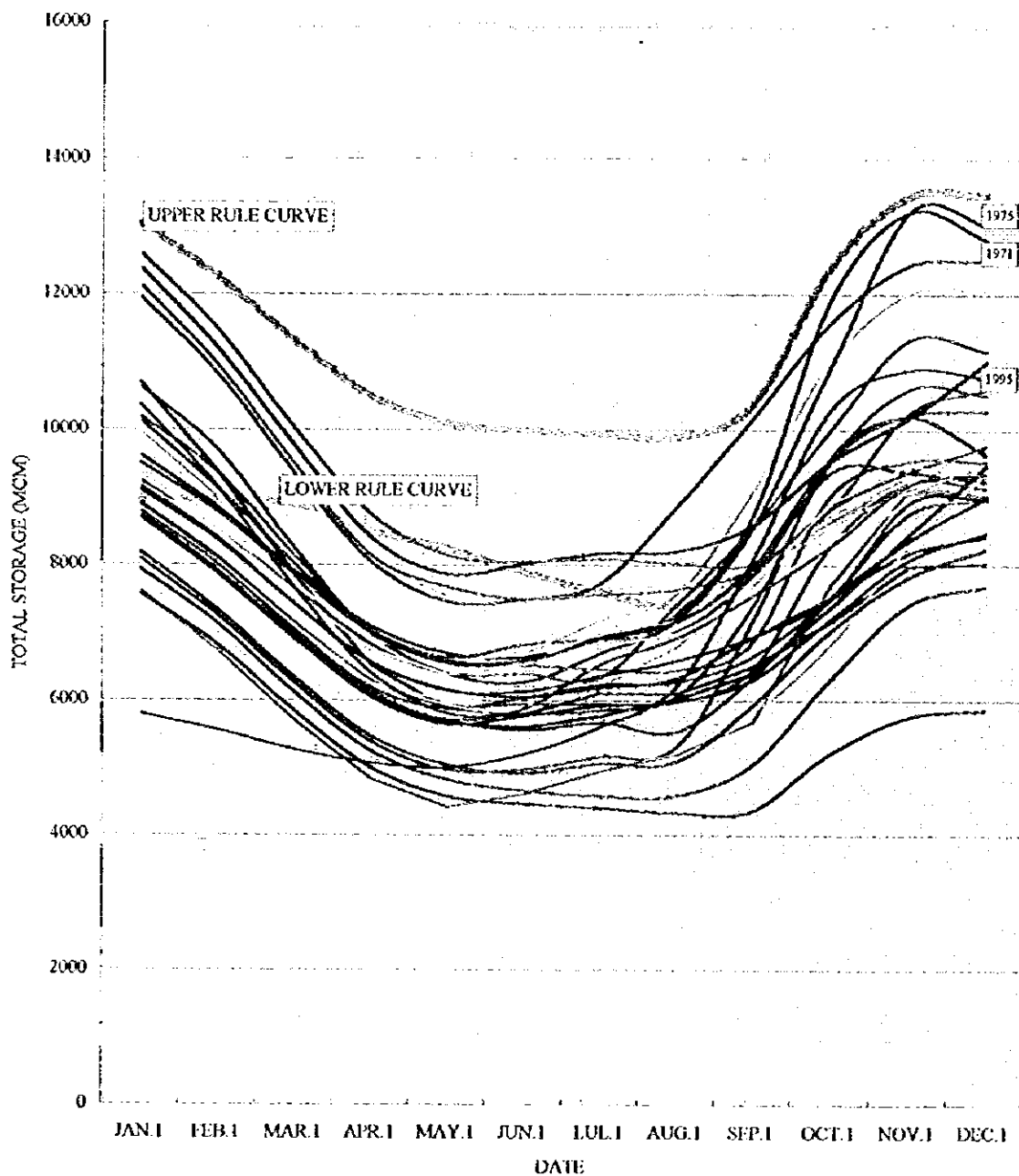
1975
1971
1995

UPPER RULE CURVE	LOWER RULE CURVE	1965	1966
1967	1968	1969	1970
1971	1972	1973	1974
1975	1976	1977	1978
1979	1980	1981	1982
1983	1984	1985	1986
1987	1988	1989	1990
1991	1992	1993	1994
1995	1996		

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 4.4.2(1/3)
CTI ENGINEERING CO, LTD. AND INA CORPORATION	OPERATION RESULT WITH PROPOSED OPERATION RULE - BUMIBOL RESERVOIR-
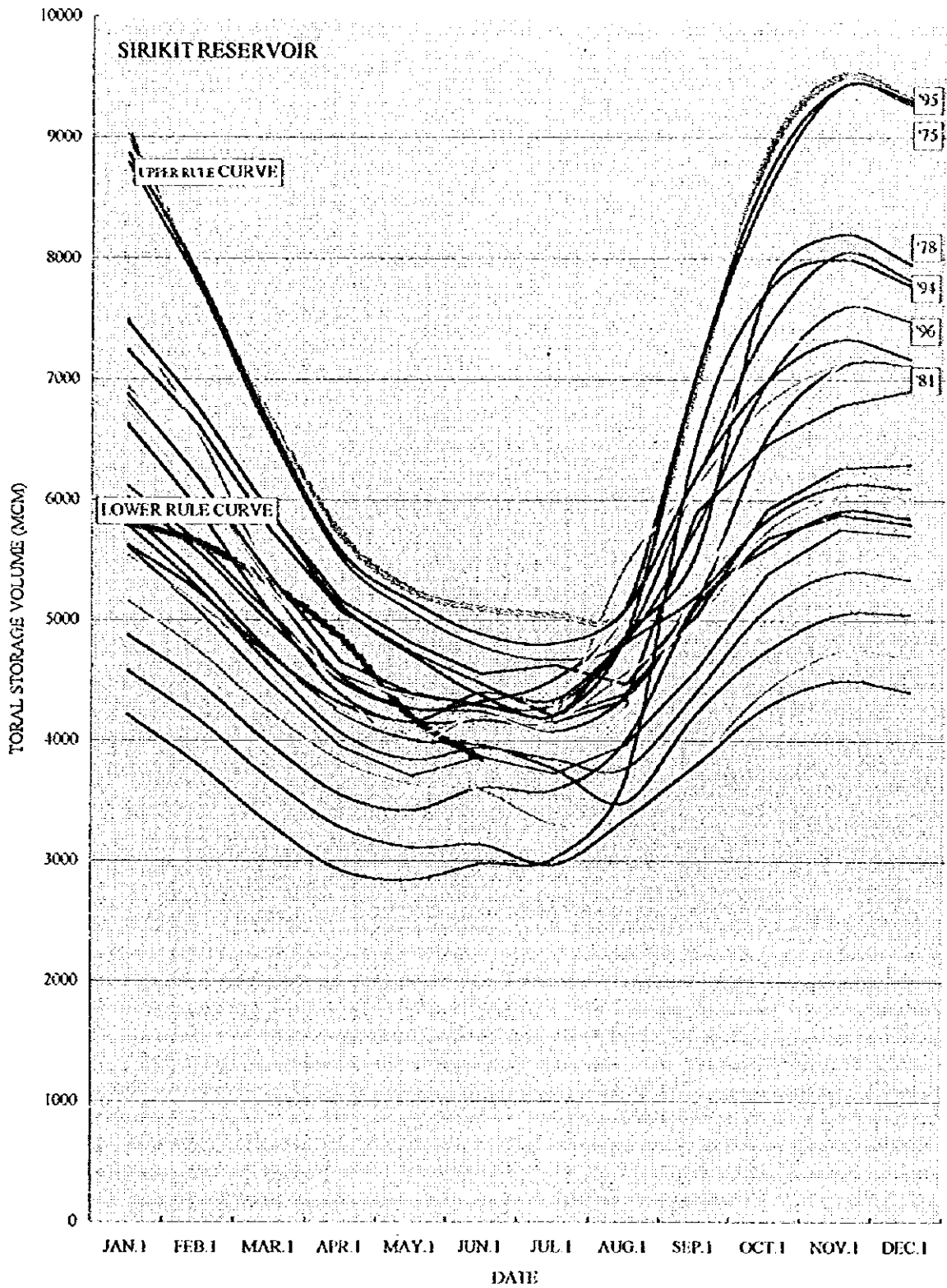
SIRIKIT RESERVOIR

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 4.4.2(2/3)
CTI ENGINEERING CO., LTD. AND INA CORPORATION	OPERATION RESULT WITH PROPOSED OPERATION RULE - SIRIKIT RESERVOIR -
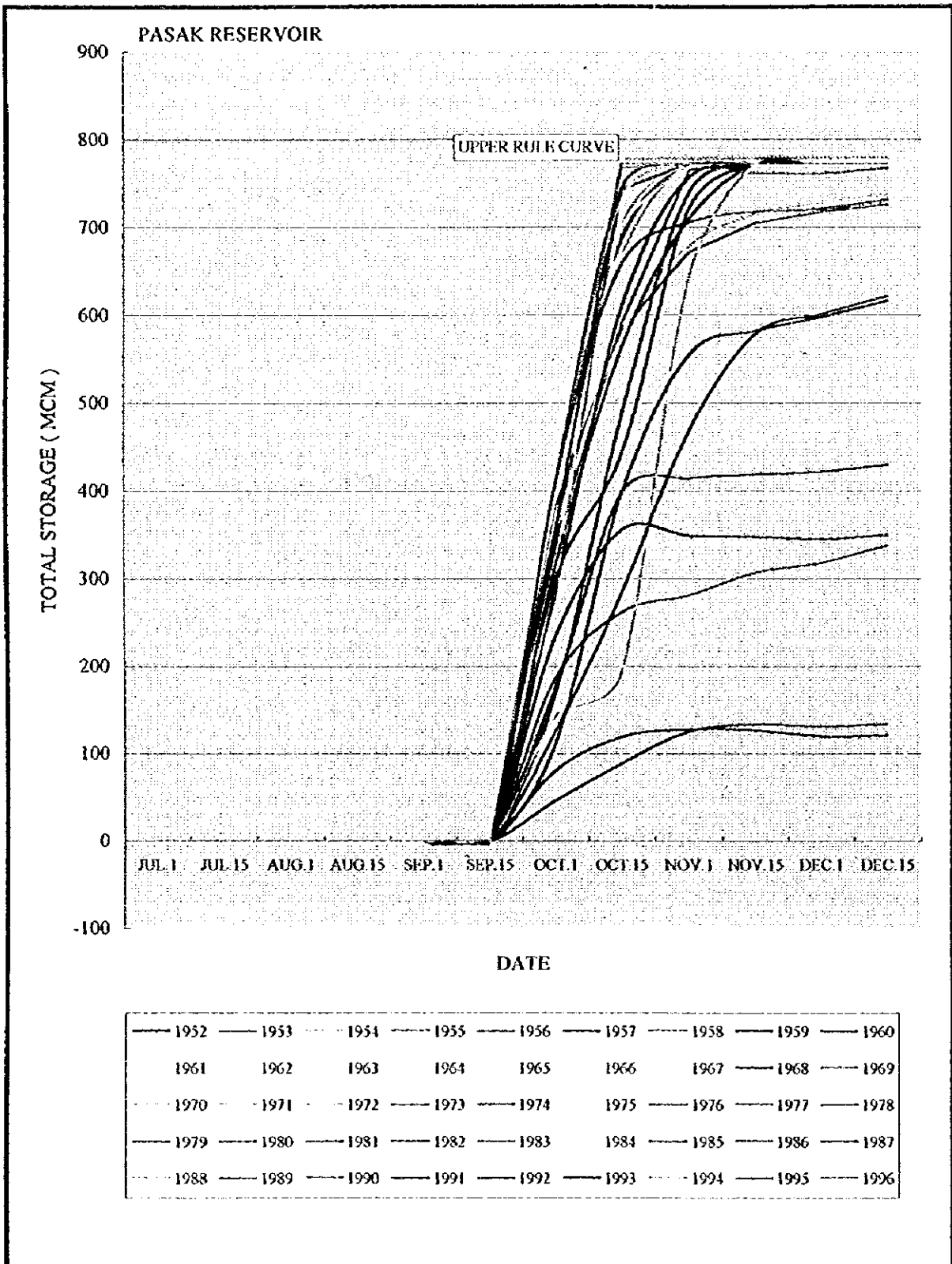
PASAK RESERVOIR

UPPER RULE CURVE

Legend:
— 1952 — 1953 ···· 1954 ---- 1955 — 1956 — 1957 ···· 1958 — 1959 — 1960
1961 1962 1963 1964 1965 1966 1967 — 1968 ···· 1969
··· 1970 ·· 1971 · ·· 1972 — 1973 — 1974 1975 — 1976 — 1977 — 1978
— 1979 — 1980 — 1981 — 1982 — 1983 1984 — 1985 — 1986 — 1987
··· 1988 — 1989 — 1990 — 1991 — 1992 — 1993 ··· 1994 — 1995 — 1996

STUDY ON INTEGRATED PLAN FOR FLOOD MITIGATION IN CHAO PHRAYA RIVER BASIN	FIG. 4.4.2(3/3)
	OPERATION RESULT WITH PROPOSED OPERATION RULE - PASK RESERVOIR -
CTI ENGINEERING CO, LTD. AND INA CORPORATION	

SECTOR IX

FARMLAND WATER MANAGEMENT PLAN
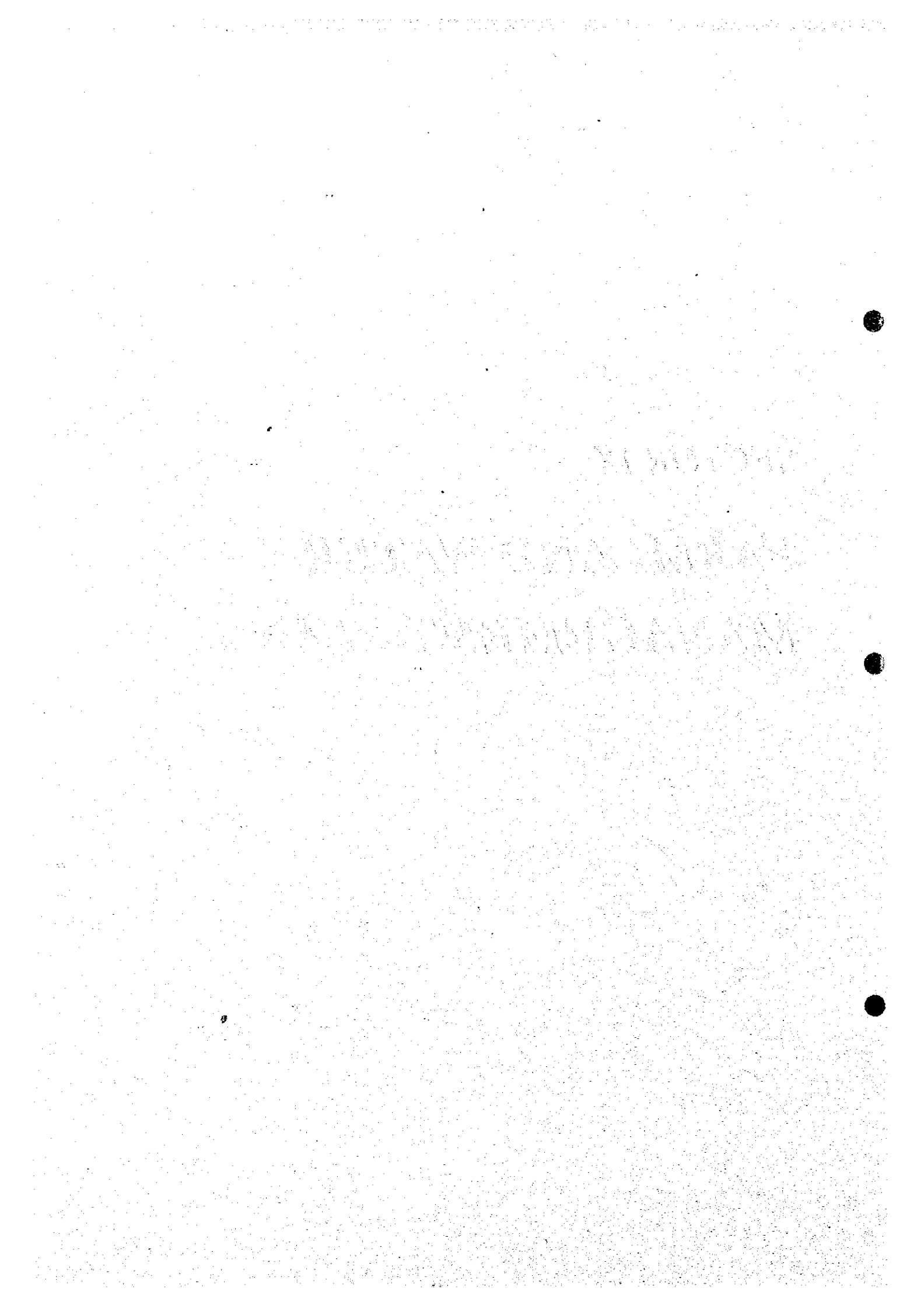
SECTOR IX: FARMLAND WATER MANAGEMENT PLAN

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7. FARMLAND DRAINAGE IMPROVEMENT IN THE CHAO PHRAYA DELTA

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1. INTRODUCTION

1.1 General

"FARM WATER MANAGEMENT" deals here with flood mitigation measures studied from a "flood and agriculture" standpoint taking into account past and present agricultural development situation.

1.2 Contents of Study

In the master plan (M/P) study, investigations on the existing agricultural policies, present status of the agricultural sector in the national agricultural development plan, conditions of the existing irrigation and drainage facilities in the project area and flood and drought damages as related to agriculture were carried out.

In the Feasibility Study (F/S), which followed the M/P study, drainage improvement measures as related to flood caused by local rains and river water were examined.

The following summarizes the content of the study in each chapter of the report, starting from chapter 2.

In chapter 2, the study evaluated target and strategies set forth in the 7th Agricultural development Plan that ended in 1996 and confirmed the main policies set forth in the following 8th Plan. Incidentally, the said policies were adjusted owing to the monetary crisis that occurred in 1997. The study also confirmed the contents of these adjusted policies.

In chapter 3, in addition to agriculture, matters related to forestry, marine and stock raising industries in the project area were also dealt with.

It can be said that agriculture, which is constantly being improved, remains the major activity in Thailand.

For example, the lower delta area, which is called a granary area, used to grow a single annual crop using a variety of floating rice. Today, the introduction of a high yielding variety (HYV) coupled with irrigation made it possible to grow several crops a year, contributing mainly to the stable supply of food in the said area.

Furthermore, the study investigated the conditions of irrigation and drainage facilities in the area, which is necessary when dealing with water management. In the same way and through data collection, the study investigated the present conditions related to forestry, fishery and animal husbandry.

Also, in this chapter , the study addressed the occurrence of flood and examined the damages it caused particularly in the year 1995.

In Chapter 4, the study looked into the area proposed as the flood retarding basin and examined retarding ability and flood control effect.

In Chapter 5, potential flood diversion channels were studied and their alternative use as irrigation channels in the dry season for the purpose to supplement irrigation water was considered.

Also, the study examined the effectiveness of using existing lakes, swamps and old river courses as flood retarding basins.

In chapter 6, the study divided an objective area of 29, 000km2, which was selected as a potential flooding area, into 11 areas based on topography, existing river systems, drainage facilities and land use. It then looked into the drainage system improvement of these areas.

Data were collected in 4 areas selected as model areas where the improvement of drainage system was studied to be applied to other subsequent areas.

In chapter 7, the study proceeded to the more detailed examination of the drainage system improvement for the agricultural land in the Chao Phraya Delta because of the high social and economic implication of the area, which is considered a priority area.

2.   TREND OF AGRICULTURAL DEVELOPMENT PLAN

2.1   Evaluation of the 7ᵗʰ Agricultural Development Plan (1992-1996)

The 7ᵗʰ Agricultural Development Plan (7ᵗʰ Plan hereafter) focuses on the following 4 strategies that can be evaluated as follows:

(1)   Reorganization of Agricultural Production Structure

The reorganization of the production structure and the reinforcement of the planning ability of farmers in the production scheme were targeted in the plan. These targets have been reached.

(2)   Improvement of productivity

This strategy was adopted for improvement of agricultural productivity. The set targets are not completely reached.

(3)   Agricultural marketing and price

This strategy did not offer much benefit to the farmers.

(4)   Conservation and development of natural resources as related to agriculture

In 1994, a conservation area of 77.55 million rai of forest was designated as reserve area, which was equivalent to 24.18% of the national land. This figure is slightly below 25%, the figure officially targeted in the plan.

As regard to water resources conservation and development projects, 26.69 million rai or 24.18% of farmland was developed as irrigated area by 1994. As a result of the development, the irrigation area belonging to medium and large-scale projects was slightly increased.

The land use ratio in the proposed project area was lower than the target figure of 150% set by RID, and lower than the figure reached in the sixth plan. The ratio in the seventh plan was only 101.03% due to the long drought and serious water shortage. As a result, the acreage devoted to irrigation was increased to the detriment of other. Therefore, development project in future must effort to beneficialy and closely related with local association and fundamental data management.

Range of Irrigation Area

(Unit: million rai, %)

	Farmland Area	Irrigation Area	Irrigation Ratio
Thailand	132.05	28.09	21.73
1.North	29.11	7.56	25.97
2.North-east	57.70	4.80	8.32
3.Central	28.01	13.37	47.73
4.South	17.13	2.95	17.12

(Source: RID)

Landuse Ratio in Medium and Large Irrigation Project

(Unit; %)

	Sixth Plan (1987-91)	Seventh Plan (1992-96)
Rainy Season	83.74	81.35
Dry Season	29.62	19.68
Annual	113.36	101.03

(Source: RID)

2.2 Strategies of the 8ᵗʰ Agricultural Development Plan (1997-2001)

The target of the 8ᵗʰ plan is to contribute in the whole economy, through the increase of farmers' income and the development of the agricultural sector. The target annual growth rate of the agricultural sector is set at around 2.9%. The target economic growth rate is set at 8.0%.

2.2.1 Strategies of Agricultural Development

As strategies of the 8ᵗʰ plan, the following three items are stressed.

(1) Strengthening of international competitiveness

Liberalization of agricultural trade will affect growth. Thailand has the advantage of being rich in natural resources and having cheep labor force. But these factors are reducing the merit due to the agricultural situation.

For the strengthening of competitiveness, it is necessary to secure stable growth, adapt to global economic fluctuation and farmers' demand for better income and living standard.

(2) Preservation of natural resources and sustainability of agricultural development

It is necessary to use the available resources efficiency and set up limits for this utilization. It is also necessary to take into consideration the effects on the environment.

(3) Development of human resources and farmers' organization

The difference of income between the agricultural sector and other sectors is still large. Agricultural people have generally less employment opportunity and their living standard is still low compared with other sectors. Farmers' association is still weak with very few successes observed.

Therefore, the strategies aiming at the development of human resources and farmers' organization seek to raise living standard, provide stable occupation, increase income and distribute profits generated through the utilization of various natural resources.

2.2.2 Supporting strategy

For the purpose of implementing the above-mentioned strategies, the following policy will be carried out.

(1)   Strengthening of international competitiveness

- Set up a suitable interest rate for agricultural credit
- Establish cooperative banks
- Promote research and development in governmental and private sectors
- Consolidate agricultural market
- Expand agricultural crops insurance
- Set up standards and quality improvement of agricultural products
- Develop agricultural processing

(2)   Preservation of natural resources and sustainability of agricultural development

- Develop community forest law
- Develop a management system for river basin
- Properly manage coastal areas and marine resources
- Set up economic production areas for agricultural products

(3)   Development of human resources and farmers' association

- Resolve labor force problems and protect agricultural labors
- Prepare a network for transfer of traditional technical information
- Solve debt problems of farmers

2.2.3 Summary of the investment scheme in the 8th Agricultural Development Plan

The investment plans related to the 8th plan strategies are shown below. The total investment including fund is around 370 billion baht.

Summary of Investment Budgets under the Agricultural Development Plan

(Unit: million bath)

Strategy	Investment Plan	Project			Budget (1997-2000)	
		New	Extension	Total	Amount	Percentage
1.Competitive Ability	5	16	14	30	102,951.9	27.8
2.Conservation of Natural Resources and Sustainable Development	7	15	13	28	216,241.7	58.3
3.Development of Human Resources and Agricultural Organizations	4	4	1	5	13,459.1	3.6
4.Fund and Operating Capital	-	-	-	-	38,250.9	10.3
Total	16	35	28	63	370,902.0	100.0

(Source: RID)

2.3 Agriculture Restructuring Policy of the 8ᵗʰ Agricultural Development Plan (1997-2000)

The adjusted policies in Agricultural Sector of the 8ᵗʰ plan are shown below.

2.3.1 Agriculture Restructuring Policy

(1) Designate large areas for establishing specialized agriculture production activities, focusing on integrated production linked to markets and processing, similar to production of important agricultural products for agroindustries, including for example: jasmine rice, shrimp, field corn, fast-growing trees, cane sugar, cotton, soybeans, cassava, livestock, and fisheries. Investment opportunities in these areas area available to the private sector or to foreign investors. Incentives to encourage investments are offered, including tax measures and the revision of laws making them more amenable to investors interested in the designated areas. Investment promotion will be focused on cooperative land settlement, land reform areas, and land consolidation areas.

(2) Reduce risks for small farmers, and ensure food security at the farm level focusing on support for: activities in mixed (or integrated) agriculture; sustainable agriculture; conserving natural resources; and, the "New Theory" of agricultural development under Royal initiative; as well as increasing the value of products produced locally.

2.3.2 Policy on Increasing Productivity and Reducing Production Costs

(1) Research and develop appropriate technologies, including biotechnology for crops, livestock, and fisheries, to increase productivity and reduce production costs.

(2) Implement an Products Champion Pilot Project under the Ministry of Agriculture and Cooperatives, that includes para-rubber, durian, longan and orchids; emphasizing yield, marketing, and integrated processing.

(3) Expand the base for producing raw materials for agroindustries. Negotiate with neighboring countries in an effort to reduce obstacles to investing in production of raw materials for agroindustries.

2.3.3 Policy to Improve Quality

(1) Establish appropriate quality standards for agricultural products for export. Focus on operating a "One Stop Service", with private sector participation in providing services and issuing certificates to entrepreneurs who volunteer to adhere to quality standards.

(2) Develop agricultural production systems that have fully integrated quality controls, from production at the field level, to packing and packaging, and to consumers, by focusing on quality and standards of products that conform to international sanitary and phyto-sanitary standards.

(3) Encourage agricultural organizations to expand their participation in inspecting and guaranteeing product quality, through Government promotion of infrastructure that will facilitate marketing and ensure the quality of products being held for sale; such as warehouses and cool store units.

(4) Support safe agriculture and natural agriculture for domestic consumption and for export to specific markets.

2.3.4 Policy to Restructure the Ministry of Agriculture and Cooperatives

(1) Restructure administration of the Ministry of Agriculture and Cooperatives, to enable it to: provide services in an integrated manner; efficiently maintain and rehabilitate natural resources; directly provide information to farmers; and, more efficiently undertake research with academic institutions and the private sector.

(2) Reduce the official role in providing services at the sub-district level, through the decentralization of authority to local organizations.

2.3.5 Policy on Rural Savings

Campaign to promote rural savings through agricultural cooperatives, with the objective of increasing the potential for farmer groups to help themselves through simple processing of farm products and engagement f alternative occupations at the household level. The campaign will be undertaken in collaboration with the Government Savings Bank, operating the savings program in as a community bank. Parallel financing will be arranged if necessary to support group activities. Farmers will participate in administering deposits and by formulating policies for utilization and recovery.

2.3.6 Policy on Fertilizer and Agricultural Chemicals

(1) Use chemical fertilizers and agricultural chemicals more efficiently by applying them with organic and biological fertilizers, in order to

improve soils and to increase yields. Employ natural methods to control crop pests to reduce imports of fertilizers and agricultural chemicals. Improve soils and the environment in rural communities over the long-term.

(2) Utilize refuse and wastes from agriculture, by encouraging private sector production of organic fertilizer and bio-fertilizers, and other products used in the agriculture sector, helping to reduce farmers' expenditures on imported fertilizers.

2.3.7 Policy for Management of Forest, Soil, Water, Coastal Area, and Biological Resources

(1) Identify vacant land and extend land tenure rights, to solve the problem of availability of land for subsistence. By revising the Land Tax Act, taxes will be collected at a higher rare from land owners not engaged in agricultural activities; with the exception of those in compliance with the Rental of Paddy Land Act. The government will promulgate a decree that will allow the private sector to rent land to the State, for on-renting to farmers on a yearly basis.

(2) Implement a project to reserve and control conservation areas, including appropriate activities related to land allocation, forest fire prevention, rehabilitation of natural resources, and surveying and utilizing forest resources.

(3) Conserve and rehabilitate degraded ecosystems in coastal areas, and resolve coastal aquaculture problems, particularly those impacting on coastal environments. Take precautions to prevent problems that may arise from environmental actions linked to the export of Thai agricultural products to foreign markets.

(4) Undertake appropriate development of natural resources for nature-based tourism (ecotourism), and promote tourism in agricultural areas, including developing local products for production and marketing.

(5) Develop agricultural potential in irrigation command areas, by producing agriculture products more efficiently, while mitigating pollution problems impacting on the environment in these areas.

2.3.8 Policy for Preparing for Global Climate Change

(1) Prevent impacts from natural disaster, for example from drought and flooding, by establishing a centrally coordinated advance warning system. Prepare plans to fully utilize surface water and underground water resources throughout the country, while addressing specific situations during periods of water shortage.

(2) Provide assistance to farmers impacted by natural disasters in the form of flood, inputs important to their occupations, and consumer goods.

(3) Ensure food security for the country to prevent impacts from natural disasters, by accelerating production of agricultural products in areas with production potential, as well as in areas that are adequately served with water resources; particularly in areas that have sources of natural surface water, irrigation system infrastructure, underground water supplies, and irrigated areas serviced by electric pumps.

(4) Undertake rehabilitation of occupations and livelihoods following natural disasters, by providing assistance in the form of production inputs, including plant material and breeding animals, to support agricultural production activities.

2.3.9 Policy for Preparing for the 21st Century

(1) Accelerate undertaking of surveys and preparing of inventories of Thailand's biological resources. Establish a database network to manage forest, soils, and coastal resources; and to control utilization of biological resources, ensuring equality in sharing their use.

(2) Monitor the resolution of issues related to the implementation of agreements that employ non-tariff barriers to trade, particularly those issues related to the environment, restrictions on crops and livestock, and to the quality and origin of products, in order to protect the country's interests and to prevent placing the country at a disadvantage.