TABLES

Table 1 MEMBERS OF ADVISORY COMMITTEE AND STUDY TEAM

Name	Assignment	
Advisory Committee		
Mr. S. Ohno	Leader, MOC	
Mr. K. Taguchi	Member, WRDPC	
Mr. Y. Sakurada	Coordinator, JICA	
Study Team		
Mr. K. Endo	Team Leader/Water Supply Planner ,	NK
Mr. M. Takasugi	Water Conveyance Planner (A) ,	NK
Mr. Y. Motoki	Water Conveyance Planner (B) ,	NK
Mr. K. Osakabe	Survey Guidance Engineer ,	NIKKEN
Mr. M. Nakagami	Geologist ,	NIKKEN
Mr. Y. Oyama	Hydrologist/Hydraulic Engineer ,	NK
Mr. H. Yamane	Economist ,	NK
Mr. N. Matsui	Construction Planner ,	NK

Note: MOC : Ministry of Construction
WRDPC : Water Resources Development Public Corporation
NK : Nippon Koei Co., Ltd.
NIKKEN: Nikken Consultant, Inc.

Table 2 TYPE OF INDUSTRY AND NUMBER OF PLANT TO BE INTRODUCED TO THE LAEM CHABANG INDUSTRIAL ESTATE BY 1991

Category	Type of Industry	Number of Plant
Resource based	Animal feeds production	1/1
	Leather goods manufacture	5
	Rubber products	2
	Plywood and veneer	3
Export processing	Electronics	5
	Machinery	1
	Aluminum products	1
	Pharmaceutical	1
	Cosmetics	1
	Jewelry	1
	Watch and clock	1
	Toys and games	1
	Sports goods	1
Downstream	Plastic products	7
Ship services and repairs	-	1
Other light industry	Small scale energy intensive industry/2	26

/1 : Large scale

/2 : Includes structural product such as brick and clay, ice, noodles, bread, cake and confectionery, paper product, joint materials, general engineering works hand and edge tools and metal household utensils.

Data Source : IOS

Table 3 RECORD OF WATER CONSUMPTION PER CAPITA AND UNACCOUNTED FOR WATER IN 1982

Water Works	Produced Water (m^3/d)	Consumed Water/1 (m^3/d)	Unaccounted for Water		Served Population	Consumed Water per Capita (lcd)
			Amount (m^3/d)	Rate (%)		
1. Chon Buri	37,871	20,758	17,113	45.2	110,122	189
2. Ban Bung	284	241	43	15.1	2,220	109
3. Phanat Nikhom	1,326	1,136	190	14.3	8,010	142
4. Naklua Pattaya	9,118	8,162	956	10.5	12,855/2	635
5. Chachoengsao	6,335	3,824	2,531	39.8	23,514	163
6. Bang Kla	822	690	132	16.1	4,360	158
7. Panom Sarakam	1,204	661	543	45.1	4,296	154
8. Bang Pakong	1,930	1,271	659	34.1	6,450	197
9. Rayong	6,072	4,127	1,945	32.0	21,360	193
10. Paknam Prasae	559	504	55	9.8	6,720	75
11. Chantaburi	9,719	7,274	2,445	25.2	48,210	151
12. Klung	1,100	852	248	22.5	8,620	99
13. Trad	2,277	1,838	439	19.3	15,150	121
14. Khlong Yai	601	464	137	22.8	3,140	148
Total	79,238	51,802	27,436	34.6	275,027	188

/1 : This includes water sold to private and public consumers and supplied free of charge to public facilities.

/2 : This does not include tourist.

Note: Water works in the Region 1 according to the classification of PWWA are listed.

Date Source: PWWA

Table 4 SUMMARY OF CLIMATE

(Recorded at Chon Buri Observatory, except evaporation and rainfall)

Climatological Features	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual	Data Source
Air Temperature (°c)														(1)
Mean	25.9	27.4	28.8	29.6	29.3	28.9	28.6	28.3	27.9	27.3	26.7	25.8	27.9	
Mean Ma.	31.3	32.1	33.2	34.1	33.3	32.5	31.9	31.6	31.2	31.3	31.1	31.0	32.0	
Mean Min.	20.1	22.4	24.2	25.4	25.4	25.5	25.0	24.9	24.4	23.8	22.1	20.3	23.6	
Extreme Max.	36.2	36.6	37.0	38.0	37.8	37.1	35.5	34.7	34.4	34.8	35.2	36.1	38.0	
Extreme Min.	9.9	16.5	17.5	20.4	21.2	21.0	20.5	20.9	20.6	18.2	14.2	12.0	9.9	
Relative Humidity (%)														(1)
Mean	67.0	71.0	71.0	71.0	75.0	75.0	75.0	76.0	80.0	80.0	73.0	66.0	73.0	
Mean Max.	85.0	88.2	87.8	87.6	88.8	87.6	88.5	90.0	92.3	93.0	89.5	85.1	88.6	
Mean Min.	52.0	56.2	56.6	56.7	60.8	61.8	62.9	64.0	67.1	66.7	57.2	50.1	59.3	
Extreme Min.	20.0	25.0	23.0	29.0	32.0	42.0	43.0	45.0	46.0	42.0	29.0	22.0	20.0	
Wind Velocity (km/hr)	11.9	13.0	13.2	11.9	10.9	13.2	12.2	12.0	9.8	9.3	11.5	12.2	11.7	(1)
Cloud Cover (Oktas)	3.9	3.8	4.0	4.7	6.1	6.5	6.7	6.9	6.7	5.8	4.5	3.6	5.2	(1)
Evaporation (mm) (Bang Phra)	72.8	75.0	100.0	110.4	110.6	100.7	99.7	93.9	80.9	89.8	82.6	80.7	1,097	(2)
Rainfall (mm)														(2)
Chon Buri	13.9	23.3	34.1	77.6	158.8	119.4	152.2	162.4	295.2	210.9	53.9	6.0	1,310	
Bang Phra	15.9	38.7	53.1	125.1	149.9	122.6	117.8	137.9	269.2	202.5	51.5	14.3	1,299	
Si Racha	11.1	31.4	38.7	88.3	150.6	110.8	113.6	131.7	257.7	218.1	51.3	13.7	1,217	
Bang Lamung	10.4	36.9	48.7	102.6	158.6	89.6	94.5	113.6	220.1	252.7	61.5	9.3	1,198	

Data Source : (1) Climatological Data of Thailand, 25-Year Period (1951 - 1975), MD
(2) RID

Table 5 MONTHLY RUNOFF AT NONG KHO DAMSITE

(Unit: m^3/s)

Water Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Mean
1968	0.35	0.69	0.85	0.26	0.41	1.58	3.50	0.78	0.17	0.28	0.08	0.21	0.77
1969	0.19	0.46	0.73	0.11	0.71	5.88	2.52	0.66	0.10	0.09	0.11	0.08	0.97
1970	0.28	0.31	0.92	0.36	0.27	0.60	2.85	0.25	1.33	0.14	0.19	0.08	0.64
1971	0.47	0.94	1.14	0.48	1.79	5.55	4.40	0.75	0.16	0.02	0.12	0.07	1.32
1972	0.34	0.02	0.08	0.06	0.03	2.62	3.86	2.73	0.85	0.15	0.10	0.19	0.92
1973	0.04	0.22	0.20	0.10	0.63	1.45	2.64	0.26	0.09	0.07	0.07	0.13	0.50
1974	0.64	0.62	0.12	0.11	0.32	1.25	6.67	1.03	0.29	0.51	0.28	0.24	1.02
1975	0.46	0.23	0.05	0.20	0.50	1.73	1.36	0.95	0.18	0.10	0.24	0.13	0.51
1976	0.19	0.17	0.14	0.16	0.45	3.85	2.15	1.26	0.20	0.15	0.14	0.06	0.74
1977	0.27	0.16	0.22	0.11	0.13	0.19	0.65	0.08	0.04	0.01	0.40	0.07	0.19
1978	0.24	0.91	1.11	1.86	0.45	1.67	1.02	0.32	0.02	0.05	0.25	0.03	0.66
1979	0.20	0.10	0.42	0.25	0.33	0.70	0.36	0.09	0.01	0.02	0.07	0.05	0.22
1980	0.45	0.06	0.87	0.68	0.48	1.64	2.52	0.58	0.10	0.06	0.24	0.22	0.66
1981	1.71	1.40	0.47	0.45	0.36	1.91	0.96	0.85	0.22	0.13	0.04	0.20	0.73
1982	0.42	0.39	0.69	0.83	0.22	0.65	1.14	1.03	0.34	0.00	0.05	0.66	0.54
Average	0.42	0.45	0.53	0.40	0.47	2.08	2.44	0.77	0.27	0.12	0.16	0.16	0.69

River System : Khlong Bang Lamung
Catchment Area: 59 km^2
Note : Estimated from those at Bang Phra Damsite.

Table 6 MONTHLY RUNOFF AT MAP PRACHAN DAMSITE

(Unit: m^3/s)

Water Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Mean
1968	0.23	0.44	0.55	0.17	0.26	1.02	2.25	0.50	0.11	0.18	0.05	0.14	0.48
1969	0.12	0.30	0.47	0.07	0.46	3.78	1.62	0.43	0.06	0.06	0.07	0.05	0.61
1970	0.18	0.20	0.59	0.23	0.17	0.38	1.83	0.16	0.85	0.09	0.12	0.05	0.40
1971	0.30	0.60	0.73	0.31	1.15	3.57	2.82	0.48	0.10	0.01	0.08	0.05	0.83
1972	0.22	0.01	0.05	0.04	0.02	1.68	2.48	1.75	0.55	0.10	0.06	0.12	0.58
1973	0.03	0.14	0.13	0.07	0.41	0.93	1.70	0.17	0.05	0.04	0.05	0.08	0.31
1974	0.41	0.40	0.08	0.07	0.21	0.80	4.29	0.66	0.19	0.33	0.18	0.16	0.64
1975	0.29	0.15	0.03	0.13	0.32	1.11	0.87	0.61	0.12	0.06	0.16	0.08	0.32
1976	0.12	0.11	0.09	0.10	0.29	2.48	1.38	0.81	0.13	0.10	0.09	0.04	0.47
1977	0.17	0.10	0.14	0.07	0.09	0.12	0.42	0.05	0.02	0.01	0.26	0.04	0.12
1978	0.15	0.58	0.71	1.19	0.29	1.07	0.66	0.20	0.01	0.03	0.16	0.02	0.41
1979	0.13	0.06	0.27	0.16	0.21	0.45	0.23	0.06	0.01	0.01	0.04	0.03	0.14
1980	0.29	0.04	0.56	0.44	0.31	1.05	1.62	0.37	0.07	0.04	0.15	0.14	0.41
1981	1.10	0.90	0.30	0.29	0.23	1.23	0.62	0.55	0.14	0.08	0.03	0.13	0.46
1982	0.27	0.25	0.44	0.53	0.14	0.42	0.73	0.66	0.22	0.00	0.03	0.43	0.34
Average	0.27	0.29	0.34	0.26	0.30	1.34	1.57	0.50	0.18	0.08	0.10	0.10	0.44

River System : Huai Nong Pru
Catchment Area: 37.9 km^2
Note : Estimated from those at Bang Phra Damsite.

Table 7 RESULTS OF WATER QUALITY ANALYSIS

Water Sample	Unit	1	2	3	4	5	6
River/Reservoir		Huai Yai	K. Bang Lamung Khlong	Huai Sael	Nong Kho Res.	Huai Sael	Nong Kho Res.
Sampling point		Chock krapurok	Bang Lamung	Chom Phon	Dam	Chom Phon	Dam
Date of Sampling		Sep. 26, '83	Sep. 26, '83	Oct. 25, '83	Oct. 25, '83	Nov. 15, '83	Nov. 15, '83
Physical Analysis							
True color	Pt units	15	14	9	16	9	31
Odour		Unobjection-able	Unobjection-able	Unobjection-able	Objection-able	Unobjection-able	Objection-able
Turbidity in Silica units	FTU	17	39	66	39	18	17
pH Value	pH	6.9	7.1	7.4	6.9	7.4	6.7
EC at 25°C	mmho/cm	100	100	98	95	106	106
Chemical Analysis							
Total solids	mg/l	145	170	273	124	267	141
Suspended solids	mg/l	20	49	26	25	35	15
Dissolved solids	mg/l	125	121	247	99	232	126
Total hardness ($CaCO_3$)	mg/l	54	56	58	68	380	540
Carbonate hardness ($CaCO_3$)	mg/l	32	44	36	44	36	52
Non-carbonate hardness ($CaCO_3$)	mg/l	22	12	22	24	344	488
Nitrogen (total)	mg/l	-	-	0.84	1.0	0.84	1.5
Nitrogen (organic)	mg/l	-	-	0.56	0.72	0.73	1.3
Nitrogen (ammonia)	mg/l	-	-	0.28	0.28	0.11	0.17
Nitrate, expressed as nitrogen	mg/l	-	-	0.10	Nil	0.40	Trace
Nitrite, expressed as nitrogen	mg/l	-	-	0.02	0.01	0.01	0.01
Total alkalinity	mg/l	-	-	36	44	36	52
Total acidity	mg/l	-	-	3.0	15	4.0	10
Phosphorus (phosphate)	mg/l	-	-	0.20	0.25	0.24	0.26
Chloride	mg/l	16	12	-	-	-	-
Iron (Fe)	mg/l	1.7	1.6	1.6	1.7	1.3	3.8
Chromium (Cr)	mg/l	-	-	0.005	0.004	-	-
Zinc (Zn)	mg/l	0.21	0.21	0.22	0.28	0.15	0.14
Magnesium (Mg)	mg/l	2.8	2.4	2.8	2.8	3.3	2.8
Sulfate $(SO)_4$	mg/l	Nil	Nil	Trace	Nil	3.0	Nil
Fluoride (F)	mg/l	0.20	0.20	-	-	-	-
Dissolved oxygen (DO)	mg/l	-	-	7.3	0.90	6.6	1.3
Chemical oxygen demand (COD)	mg/l	-	-	15	68	13	74
Biochemical oxygen demand (BOD at 20°C)	mg/l	-	-	0.8	6.0	1.6	5.6
Biological Analysis							
Bacterial Count per ml	MPN	-	-	75,200	9,300	57,700	8,600
Bacteria Coli. Group per 100 ml	MPN	-	-	24,000	7,900	35,000	54,000
E. Coli. per ml	MPN	-	-	13,000	1,300	28,000	7,500

Table 8 RESULTS OF SOIL TESTS

Pit/ Borehole No.	Location	Depth (m ∿ m)	Classification by Observation	Gradation Percent Passing % (40) 420μ	(200) 74μ	Classification by Soil Test	Moisture Content %	Specific Gravity	PH	Nacl p.p.m.
T.1	0k + 155m	0.50 ∿ 0.75	Sand	97.84	30.62	SM	9.48	2.66	5.05	
"	"	1.25 ∿ 1.50	Sand						4.70	
T.2	1k + 851m	0.25 ∿ 0.50	Clayey sand						6.40	
"	"	1.75 ∿ 2.00	Sand	95.00	18.97	SM	11.02	2.69	5.65	
"	"	2.50 ∿ 2.75	Sand						5.80	
T.3	3k + 932m	0.25 ∿ 0.50	Sand	100.00	13.46	SM	13.27	2.64	4.50	
T.4	5k + 450m	0.50 ∿ 0.75	Sand						5.85	
"	"	2.75 ∿ 3.00	Sand	85.29	18.47	SM	12.29	2.50	4.70	
T.5	7k + 170m	0.50 ∿ 0.75	Sand						5.50	
"	"	1.50 ∿ 1.75	Sand	100.00	12.42	SM	10.05	2.57	5.15	
T.6	9k + 452m	0.25 ∿ 0.50	Sand						4.95	
"	"	1.00 ∿ 1.25	Sand	100.00	15.81	SM	12.77	2.69	5.45	
T.7	10k + 807m	0.60 ∿ 0.75	Sand						5.00	
"	"	1.50 ∿ 1.75	Sand	100.00	9.59	SM-SW	12.15	2.62	5.35	
T.8	13k + 598m (South)	0.25 ∿ 0.50	Clayey sand						6.05	
"	"	1.50 ∿ 1.75	Sandy clay	100.00	46.98	SM	14.33	2.70	5.65	
T.9	1k + 035m	0.50 ∿ 0.75	Sand						6.05	
T.10		0.75 ∿ 1.00	Sand	100.00	8.90	SM-SP	17.06	2.55	5.45	
"		2.25 ∿ 2.50	Sand	96.56	20.75	SM	7.47	2.57	5.20	
"		2.75 ∿ 3.00	Sand						5.50	
T.11	4k + 340m (South)	0.25 ∿ 0.50	Sand						6.05	
"	"	1.25 ∿ 1.50	Sand						5.30	
"	"	2.50 ∿ 2.75	Sand	87.57	11.93	SM-SW	17.59	2.65		
T.12	7k + 717m (South)	0.25 ∿ 0.50	Sand						5.50	
"	"	1.75 ∿ 2.00	Sand	100.00	15.91	SM	15.37	2.65	5.75	
T.13	9k + 400m (South)	0.50 ∿ 0.75	Sand						4.90	
"	"	1.75 ∿ 2.00	Sand	94.75	9.61	SM-SP	6.60	2.62	5.15	
"	"	2.50 ∿ 2.75	Sand						4.75	
T.14	12k + 505m (South)	0.50 ∿ 0.75	Sand						5.40	
"	"	1.50 ∿ 1.75	Sand	99.52	25.48	SM	25.15	2.56	5.25	
A.1	1k + 0.56m	1.90 ∿ 2.00	Sand	91.90	21.95	SM	14.11	2.61	5.85	
"	"	2.90 ∿ 3.00	Sand						5.10	
A.2	3k + 482m	2.70 ∿ 3.00	Sand	91.28	17.06	SM	13.80	2.76	5.15	
A.3	6k + 450m	2.50 ∿ 2.60	Sand	91.03	14.34	SM	12.34	2.54	5.25	
A.5	9k + 798m	1.60 ∿ 1.70	Sand	100.00	28.97	SM	23.87	2.60	5.00	
A.6	11k + 220m	2.20 ∿ 2.30	Sand	100.00	29.30	SM	10.70	2.60	5.85	
R.1	Borrow pit RAYONG		Sand	99.99	0.44	SP	2.47	2.54	5.90	49
R.2			Sand	100.00	1.05	SP	3.07	2.77	6.00	66
R.3			Sand	99.98	1.15	SP	1.98	2.62	6.1	49

Table 9 HISTORICAL WATER SUPPLY AND USE BY WATERWORKS

Description	Water Works	Fiscal Year						Data Source
		1977	1978	1979	1980	1981	1982	
1. Total Quantity	Ao Udom	NA	NA	NA	NA	NA	NA	
of Water Supplied	Pattaya	259	302	323	294	916	3,328	(1)
(10^3m^3/year)	Total	-	-	-	-	-	-	
2. Total Quantity	Ao Udom	184	114	75	168	NA	NA	(2)
of Water Metered	Pattaya	194	205	267	261	733	2,977	(1)
(10^3m^3/year)	Total	378	309	342	429	-	-	
3. Nos. of Consumer	Ao Udom	NA	NA	381	437	456	714	(2)
	Pattaya	734	798	886	966	1,342	2,571	(1)
	Total	-	-	1,267	1,403	1,798	3,285	
4. Population in	Ao Udom	52.8	61.7	64.7	63.3	62.3	64.4	(3)
Service Area	Pattaya	23.0	29.7	31.8	34.9	36.5	38.5	(3)
(10^3)	Total	75.8	91.4	96.5	98.2	98.8	102.9	
5. Estimated Served	Ao Udom	NA	NA	2.3	2.6	2.7	4.3	
Population (10^3)	Pattaya	NA	NA	NA	NA	NA	NA	
6. Pipe Water Use	Ao Udom	-	-	90	176	-	-	
Per Capita (l/d)	Pattaya	-	-	-	-	-	-	
7. Service Factor (%)	Ao Udom	-	-	3.6	4.1	4.3	6.7	
	Pattaya	-	-	-	-	-	-	
8. Ratio of Water	Ao Udom	-	-	-	-	-	-	
Supply Loss (%)	Pattaya	25.0	32.0	17.2	11.5	19.9		

Data Source: (1) PWWA
(2) Ao Udom Sanitary District Office
(3) DOLA

Table 10 LIST OF PRIVATE WATER SUPPLY FACILITIES

Institutions/ Enterprises	Water Consumption ($10^3 m^3/yr$)	Supply by Own Facilities ($10^3 m^3/yr$)	Water Source	Facilities
1. Government Institutions				
Bang Lamung Police Resort Center	55	55	Surface water	2 pondages (210,000 m^3)
Bang Lamung Home for Aged	91	91	Surface water	2 pondages (29,000 m^3)
Djittabhawan College	37	37	Groundwater	Tube-well
2. Private Enterprises				
2.1 Oil Refinery				
Thai Oil Refinery	860	860	Bang Phra reservoir	ø10" with 15km long pipeline
ESSO Oil Refinery	790	790	Sea water	Sea water purifier
2.2 Si Racha Park Estate				
Thai President Foods	110	55	Groundwater	Tube-well
Thai Power Net	55	18	Groundwater	Tube-well
Pan Asia Footwear	55	55	Groundwater	Tube-well
Sriracha Lion Industry	33	33	Groundwater	Tube-well
Thai Auchio Co., Ltd.	88	88	Groundwater	Tube-well
2.3 Agro-processing				
Sri Racha Sugar Factory	800	800	Surface water	Headwork in Huai Lek river
Khao Chang Cassava Industry	Nil	860	Map Prachan reservoir	ø6" with 600 m long pipeline

Table 11 PROJECTION OF INDUSTRIAL WATER DEMAND FOR INDUCED INDUSTRIES IN 2001

Types of Industries	En	Uc	Rn	Uw	Projected Demand ($10^3 m^3$/yr)
Downstream Industry					6,778
1. Plastic product for export/1	3,000	4.26	0.40	0.15	3,293
2. Plastic (feedstock processing)/2	500	14.93	0.20	0.15	2,564
3. Plastic (for packing)	500	7.15	0.40	0.15	921
Light Industry					4,690
1. Leather product	1,040	0.35	0.30	0.15	109
2. Rubber product	470	9.60	0.80	0.15	388
3. Wooden product/3	650	1.62	0.30	0.15	317
4. Structural product/4	470	1.74	0.20	0.15	281
5. Ice	470	4.90	0	0.15	989
6. Noodles	470	2.30	0.10	0.15	418
7. Bread	470	2.38	0.70	0.15	144
8. Cake and confectionery	470	3.13	0.30	0.15	442
9. Paper product	470	3.00	0.30	0.15	424
10. Joint materials/5	470	1.14	0.30	0.15	161
11. General engineering works	470	1.56	0.30	0.15	220
12. Hand and edge tools	470	1.56	0.30	0.15	220
13. Metal household effects	470	1.45	0.20	0.15	234
14. Motor vehicle parts	470	7.30	0.90	0.15	147
15. Marine engines and parts	470	3.23	0.70	0.15	196
Export Processing Industry					4,291
1. Electronics	4,600	3.22	0.80	0.15	1,272
2. Machinery	800	1.17	0.50	0.15	201
3. Aluminium product	800	2.73	0.30	0.15	657
4. Pharmaceutical	800	12.02	0.70	0.15	1,239
5. Cosmetics	800	1.53	0.40	0.15	315
6. Jewelry	800	0.33	0	0.15	113
7. Watch and clock	800	1.08	0.60	0.15	148
8. Toys and games	800	0.38	0.10	0.15	118
9. Sports goods	800	0.95	0.30	0.15	228
Agro-processing Industry	250	15.77	0.10	0.15	1,520
Total					17,279

/1 : Such as plastic flower, toys and sports goods
/2 : Artificial leather etc.
/3 : Veneer and plywood
/4 : Brick, tiles and clay
/5 : Bolts, nuts, rivets and screw machine parts

Note; En: number of employee
Uc: water consumption per employee, m^3/employee/day
Rn: rate of recycling
Uw: rate of unaccounted for water

Table 12 PROJECTION OF DOMESTIC WATER DEMAND

Description	Unit	1982	1986	1991	1996	2001
Laem Chabang Basin						
1. Development area						
Population	10^3	23.9	30.2	47.4	75.3	119.5
Consumption rate	lcd	-	190	200	210	220
Service factor	%	-	100	100	100	100
Unaccounted for water	%	-/1	15	15	15	15
Water demand	10^3m^3/yr	437	2,464	4,071	6,790	11,289
2. Non-development area						
Population	10^3	30.8	34.0	37.2	36.4	35.3
Consumption rate	lcd	-	148	155	163	170
Service factor	%	-	10	15	20	30
Unaccounted for water	%	-	15	15	15	15
Water demand	10^3m^3/yr	0	216	371	509	773
3. Bang Lamung S/D						
Population	10^3	8.2	8.4	9.1	10.4	11.4
Consumption rate	lcd	-	190	200	210	220
Service factor	%	-	100	100	100	100
Unaccounted for water	%	-	15	15	15	15
Water demand	10^3m^3/yr	0	685	781	938	1,077
Pattaya Basin						
1. Development area						
Population	10^3	38.4	51.4	67.9	85.8	103.0
Consumption rate	lcd	-	265	280	290	300
Service factor	%	-	100	100	100	100
Unaccounted for water	%	-/2	15	15	15	15
Water demand	10^3m^3/yr	1,748	5,849	8,164	10,685	13,269
2. Non-development area						
Population	10^3	15.6	18.1	20.0	20.1	18.0
Consumption rate	lcd	-	148	155	163	170
Service factor	%	-	10	15	20	30
Unaccounted for water	%	-	15	15	15	15
Water demand	10^3m^3/yr	0	115	200	281	394
Total Water Demand	10^3m^3/yr	2,185	9,329	13,587	19,203	26,802

/1 : Actual water supply by Ao Udom waterworks
/2 : Actual water supply by Naklua-Pattaya waterworks

Data Source: IOS, ESS

Table 13 PROJECTED OVERALL WATER DEMAND

(Unit: $10^6 m^3/yr$)

Description	1982	1986	1991	1996	2001
Laem Chabang Basin	3.3	8.9	18.0	26.0	35.5
Industry, induced	0	2.6	7.7	12.7	17.3
existing	2.9	3.6	5.6	5.6	5.6
Domestic, development area	0.4	2.5	4.1	6.8	11.3
non-development area	0	0.2	0.4	0.5	0.8
Port	0	0	0.2	0.4	0.5
Pattaya Basin	3.3	9.7	13.2	17.1	21.0
Industry, existing	0	0.9	0.9	0.9	0.9
Domestic, development area	1.7	5.8	8.2	10.7	13.3
non-development area	0	0.1	0.2	0.3	0.4
Bang Lamung S/D	0	0.7	0.8	0.9	1.1
Tourism	1.6	2.2	3.1	4.3	5.3
Study Area	6.6	18.6	31.2	43.1	56.5
Industry, induced	0	2.6	7.7	12.7	17.3
existing	2.9	4.5	6.5	6.5	6.5
Domestic, development area	2.1	8.3	12.3	17.5	24.6
non-development area	0	0.3	0.6	0.8	1.2
Bang Lamung S/D	0	0.7	0.8	0.9	1.1
Port	0	0	0.2	0.4	0.5
Tourism	1.6	2.2	3.1	4.3	5.3

Note: Figures are indicated in terms of consumer demand.

Table 14 SALIENT FEATURES OF NONG KHO, MAP PRACHAN AND NONG PLA LAI DAMS

Description	Unit	Nong Kho	Map Prachan	Nong Pla Lai
1. Year of Completion		1983	1979	-
2. Hydrology				
Name of river		Huai Yai	Huai Nong Pru	Nong Pla Lai
Catchment area	km^2	59.0	37.9	408
Average annual inflow	10^6m^3	21.8	13.9	126.1
3. Reservoir				
Gross storage capacity	10^6m^3	26.0	17.0	200.7
Surcharge capacity	10^6m^3	7.0	2.2	43.5
Active storage capacity	10^6m^3	18.0	14.0	144.4
Dead storage capacity	10^6m^3	1.0	0.8	12.8
Flood water level	El.m	66.5	45.7	47.0
High water level	El.m	65.0	45.0	45.0
Low water level	El.m	57.5	36.0	33.3
Reservoir surface area at HWL	km^2	4.4	2.8	20.2
4. Dam				
Type		Earth-fill	Earth-fill	Earth-fill
Height	m	17.0	17.0	31.0
Crest	El.m	68.0	47.0	49.0
Crest length	m	2,060	2,000	4,000
Volume	10^6m^3	NA	NA	3.2
5. Spillway				
Type		Open-chute	Morning glory	Open-chute
Discharge capacity	m^3/s	10.8	NA	700
Crest elevation	El.m	65.0	37.0	38.0
Crest length	m	40.0	6.0	20.0

Data Source : RID

Table 15 WATER BALANCE

(Unit: $10^6 m^3/yr$)

	1982	1986	1991	1996	2001
Laem Chabang Basin					
1. Water demand	3.6	9.8	19.7	28.6	39.1
2. River maintenance flow	1.3	1.3	1.3	1.3	1.3
3. Available local water	2.0	2.8	4.1	4.1	4.1
Groundwater : Si Racha Park Estate	0.2	0.2	0.2	0.2	0.2
Surface water : Thai Oil Refinery	0.9	0.9	2.2	2.2	2.2
Sea water : ESSO Oil Refinery	0.9	1.7	1.7	1.7	1.7
4. Water withdrawal (1 + 2 - 3)	2.9	8.3	16.9	25.8	36.3
5. Supply by Nong Kho dam	0	13.9	13.9	13.9	13.9
6. Balance (5 - 4)	-2.9	+5.6	-3.0	-11.9	-22.4
Pattaya Basin					
1. Water demand	3.7	10.7	14.5	18.8	23.0
2. River maintenance flow	0.9	0.9	0.9	0.9	0.9
3. Available local water	0.1	0.1	5.1	5.1	5.1
Surface water : Police Resort center and Home for Aged	0.1	0.1	0.1	0.1	0.1
Huai Kong Dai	0	0	5.0	5.0	5.0
4. Water withdrawal (1 + 2 -3)	4.5	11.5	10.3	14.6	18.8
5. Supply by Map Prachan dam	9.8	9.8	9.8	9.8	9.8
6. Balance (5 - 4)	5.3	-1.7	-0.5	-4.8	-9.0
Study Area					
1. Water demand	7.3	20.5	34.2	47.4	62.1
2. River maintenance flow	2.2	2.2	2.2	2.2	2.2
3. Available local water	2.1	2.9	9.2	9.2	9.2
4. Water withdrawal	7.4	19.8	27.2	40.4	55.1
5. Supply by dams	9.8	23.7	23.7	23.7	23.7
6. Balance	+2.4	+3.9	-3.5	-16.7	-31.4

Note: Water demand is expressed in terms of source water demand.

Table 16 CALCULATION OF RAW WATER TRANSMISSION

	Laem Chabang Basin								Pattaya Basin							
	Laem Chabang				Ao Udom				Naklua Pattaya				Kho Chang			
	1986	1991	1996	2001	1986	1991	1996	2001	1986	1991	1996	2001	1986	1991	1996	2001
1. Water Demand																
Domestic, DA	2.8	4.5	7.5	12.4	0	0	0	0	6.4	9.0	11.8	14.6	0	0	0	0
Bang Lamung	-	-	-	-	-	-	-	-	0.8	0.9	1.0	1.2	-	-	-	-
Industry, existing	2.6	3.9	3.9	3.9	1.3	2.2	2.2	2.2	0	0	0	0	1.0	1.0	1.0	1.0
induced	2.9	8.5	14.0	19.1	0	0	0	0	0	0	0	0	0	0	0	0
Port	0	0.2	0.4	0.6	-	-	-	-	-	-	-	-	-	-	-	-
Tourism	-	-	-	-	-	-	-	-	2.4	3.4	4.7	5.8	0	0	0	0
Total									9.6	13.3	17.5	21.6	1.0	1.0	1.0	1.0
2. Available Local Water																
Domestic, DA																
Groundwater	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0	0	0	0
Surface water	0	0	0	0	0	0	0	0	0	5.0	5.0	5.0	0	0	0	0
Industry, existing																
Groundwater	0	0	0	0	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0
Surface water	0.9	2.2	2.2	2.2	0	0	0	0	0	0	0	0	0	0	0	0
Sea water	1.7	1.7	1.7	1.7	0	0	0	0	0	0	0	0	0	0	0	0
Total	2.6	3.9	3.9	3.9	0.2	0.2	0.2	0.2	0.1	5.1	5.1	5.1	0	0	0	0
3. Water Transmission by Pipeline																
Domestic & tourism	2.8	4.5	7.5	12.4	0	0	0	0	7.8*	7.7*	7.6*	7.5*	0	0	0	0
Industry	2.9	8.5	14.0	19.1	1.1	2.0	2.0	2.0	0	0	0	0	1.0	1.0	1.0	1.0
Port	0	0.2	0.4	0.6	0	0	0	0	0	0	0	0	0	0	0	0
Total	5.7	13.2	21.9	32.1	1.1	2.0	2.0	2.0	7.8	7.7	7.6	7.5	1.0	1.0	1.0	1.0

Note: * Calculated by deducting the river maintenance flow (0.9×10^6 m^3/yr) and industrial water (1.0×10^6 m^3/yr) from the water supply capacity of Nong Kho dam (9.8×10^6 m^3/yr).

Table 17 10 DEVELOPMENT ALTERNATIVES AND THEIR PRINCIPAL FEATURES

Description		Alternatives									
		A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	B-1	B-2
1. Project Configulation											
1.1 Receiving Well											
Location		A	A	A	A	A	A	A	A	B	B
Designated HWL	El.m	35	45	35	40	45	35	40	45	30	30
1.2 Development Sequence		I	I	II	II	II	II	II	II	I	II
1.3 Hydraulic Condition		1	1	1	1	1	2	2	2	1	1
2. Project Features											
2.1 Annual Transmission Quantity											
1st Stage	10^6 m^3/yr	43.1	43.1	21.6	21.6	21.6	21.6	21.6	21.6	43.1	21.6
2nd Stage	10^6 m^3/yr	-	-	21.5	21.5	21.5	43.1	43.1	43.1	-	21.5
2.2 Length of Pipeline											
Nong Kho-Turnout	km	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95
Turnout-Receiving Well	km	3.49	3.49	3.49	3.49	3.49	3.49	3.49	3.49	5.40	5.40
2.3 Inside Diameter of Pipe, 1st Stage											
Nong Kho-Turnout	mm	1,500	1,500	1,000	1,000	1,200	1,000	1,000	1,200	1,500	1,000
Turnout-Receiving Well	mm	1,000	1,200	900	1,000	900	900	1,000	900	1,000	900
2.4 Inside Diameter of Pipe, 2nd Stage											
Non Kho-Turnout	mm	-	-	1,000	1,000	1,200	-	-	-	-	1,000
Turnout-Receiving Well	mm	-	-	900	1,000	900	-	-	-	-	900
2.5 Row of Pipeline	nos.	1	1	2	2	2	1	1	1	1	2
2.6 Pumping Facilities											
Type		-	-	-	-	-	H.Volute	H.Volute	H.Volute	-	-
Gross Head	m	-	-	-	-	-	64	55	42	-	-
Design Discharge per Unit	m^3/min.	-	-	-	-	-	19.7	19.7	19.7	-	-
Required Power	kW/unit	-	-	-	-	-	295	255	195	-	-
Nos. of Unit	unit	-	-	-	-	-	6(1)	6(1)	6(1)	-	-
Length of Power Cable	km	-	-	-	-	-	13	13	13	-	-
3. Hydraulic Property											
3.1 Design Intake WL	El.m	58.9	58.9	58.9	58.9	58.9	58.9	58.9	58.9	58.9	58.9
3.2 Pipe Discharge, 1st Stage											
Nong Kho-Turnout	m^3/s	1.64	1.64	0.82	0.82	0.82	0.82	0.82	0.82	1.64	0.82
Turnout-Receiving Well	m^3/s	1.56	1.56	0.74	0.74	0.74	0.74	0.74	0.74	1.56	0.74
3.3 Pipe Discharge, 2nd Stage											
Nong Kho-Turnout	m^3/s	-	-	0.82	0.82	0.82	1.64	1.64	1.64	-	0.82
Turnout-Receiving Well	m^3/s	-	-	0.82	0.82	0.82	1.56	1.56	1.56	-	0.82
3.4 Pipe Velocity, 1st Stage											
Nong Kho-Turnout	m/s	0.93	0.93	1.04	1.04	0.73	1.04	1.04	0.73	0.93	1.03
Turnout-Receiving Well	m/s	1.99	1.38	1.16	0.94	1.16	1.16	0.94	1.16	1.99	1.16
3.5 Pipe Velocity, 2nd Stage											
Nong Kho-Turnout	m/s	-	-	1.04	1.04	0.71	2.09	2.09	1.45	-	1.04
Turnout-Receiving Well	m/s	-	-	1.29	1.04	1.26	2.45	1.99	2.45	-	1.29
3.6 Head Losses											
1st Stage	m	22.33	13.99	20.88	18.49	12.91	20.88	18.49	12.91	29.69	24.65
2nd Stage	m	-	-	22.12	19.23	14.16	77.46	67.96	48.75	-	26.69
3.7 WL of Receiving Well											
1st Stage	El.m	36.5	44.9	36.7	39.6	44.7	36.7	39.6	44.7	29.2	32.2
2nd Stage	El.m	-	-	36.7	39.6	44.7	36.7	39.6	44.7	-	32.2

Notes; (1) Development Sequence, I: full scale development
II: stage-wise development

(2) Hydraulic Condition, 1: Gravity flow
2: Gravity flow in first stage and pump flow in second stage

Table 18 PRELIMINARY ESTIMATE OF INVESTMENT COST OF 10 DEVELOPMENT ALTERNATIVES

(Unit: ₱10^6)

Description	A-1	A-2	A-3			A-4			A-5			A-6			A-7			A-8			B-1	B-2		
			1st	2nd	Total	1st	2nd	Total	1st	2nd	Total	1st	2nd	Total	1st	2nd	Total	1st	2nd	Total		1st	2nd	Total
1. Construction Cost	321.3	327.8	169.3	167.6	336.9	180.6	179.0	359.6	221.3	219.7	441.0	169.3	98.8	268.1	180.6	94.9	275.5	221.3	90.3	311.6	333.2	186.1	184.5	370.6
Preparatory Works	29.2	29.8	14.9	14.8	29.7	16.4	16.3	32.7	20.1	20.0	40.1	15.4	9.0	24.4	16.4	8.6	25.0	20.1	8.2	28.3	30.3	16.9	16.8	33.7
Pipeline	271.5	282.7	142.6	141.8	284.4	151.7	150.9	302.6	189.5	188.7	378.2	142.4	4.1	146.5	151.7	4.1	155.8	189.5	4.5	194.0	282.3	157.7	156.9	314.6
Turnout	0.9	0.9	0.9	0.1	1.0	0.9	0.1	1.0	0.9	0.1	1.0	0.9	-	0.9	0.9	-	0.9	0.9	-	0.9	0.9	0.9	0.1	1.0
Aqueduct	1.8	2.2	1.7	1.7	3.4	1.8	1.8	3.6	1.7	1.7	3.4	1.7	-	1.7	1.8	-	1.8	1.7	-	1.7	1.8	1.7	1.7	3.4
Receiving Well	17.9	12.2	9.2	9.2	18.4	9.8	9.9	19.7	9.1	9.2	18.3	8.9	8.2	17.1	9.8	8.2	18.0	9.1	8.2	17.3	17.9	8.9	9.0	17.9
Building Works	-	-	-	-	-	-	-	-	-	-	-	-	11.6	11.6	-	11.6	11.6	-	11.6	11.6	-	-	-	-
Electric Works	-	-	-	-	-	-	-	-	-	-	-	-	17.6	17.6	-	15.9	15.9	-	14.2	14.2	-	-	-	-
Pumping Facilities	-	-	-	-	-	-	-	-	-	-	-	-	44.2	44.2	-	42.4	42.4	-	39.5	39.5	-	-	-	-
Tele-communication System	-	-	-	-	-	-	-	-	-	-	-	-	4.1	4.1	-	4.1	4.1	-	4.1	4.1	-	-	-	-
2. Engineering Services	53.5	53.5	53.4	36.3	89.7	53.5	36.3	89.8	53.5	36.3	89.8	53.5	41.4	94.9	53.5	41.4	94.9	53.5	41.4	94.9	53.5	53.5	36.3	89.8
3. Government Administration	12.9	13.1	6.8	6.7	13.5	7.2	7.2	14.4	8.9	8.8	17.7	6.8	4.0	10.8	7.2	3.8	11.0	8.9	3.6	12.5	13.3	7.4	7.4	14.8
4. Land Acquisition and Compensation	18.9	18.9	21.4	-	21.4	21.4	-	21.4	21.4	-	21.4	18.9	-	18.9	18.9	-	18.9	18.9	-	18.9	21.3	24.1	-	24.1
Base Cost	406.6	413.3	250.9	210.6	461.5	262.7	222.5	485.2	305.1	264.8	569.9	248.5	144.2	392.7	260.2	140.1	400.3	302.6	135.3	437.9	421.3	271.1	228.2	499.3
5. Physical Contingency	81.3	82.7	50.1	42.2	92.3	52.6	44.5	97.1	61.0	53.0	114.0	49.7	28.8	78.5	52.1	28.0	80.1	60.5	27.1	87.6	84.3	54.2	45.6	99.8
Total	487.9	496.0	301.0	252.8	553.8	315.3	267.0	582.3	366.1	317.8	683.9	298.2	173.0	471.2	312.3	168.1	480.4	363.1	162.4	525.5	505.6	325.3	273.8	599.1

Table 19 OUTLAY OF INITIAL INVESTMENT, REPLACEMENT COST AND O & M COST OF 10 DEVELOPMENT ALTERNATIVES (1/3)

ALTERNATIVE: A-1

(Unit: ¥10^6)

Year	Water Transmission System			Water Dist. System	Total Cost	Present Worth
	Capital Cost	Replace Cost	O&M Cost	Running Cost		
1985	51.8				51.8	41.3
1986	7.0				7.0	5.0
1987	234.6				234.6	149.1
1988	194.5		1.9	1.8	198.2	112.5
1989			1.9	2.3	4.2	2.1
1990			1.9	2.9	4.8	2.2
1991			1.9	3.4	5.3	2.2
1992			1.9	4.0	5.9	2.1
1993			1.9	4.5	6.4	2.1
1994			1.9	5.0	6.9	2.0
1995			1.9	5.6	7.5	1.9
1996			1.9	6.1	8.0	1.8
1997			1.9	6.7	8.6	1.8
1998			1.9	7.2	9.1	1.7
1999			1.9	7.8	9.7	1.6
2000			1.9	8.3	10.2	1.5
2001			1.9	8.8	10.7	
⋮			⋮	⋮	⋮	
2005			1.9	8.8	10.7	
⋮			⋮	⋮	⋮	
2010			1.9	8.8	10.7	12.6
⋮			⋮	⋮	⋮	
2018			1.9	8.8	10.7	
⋮			⋮	⋮	⋮	
2026			1.9	8.8	10.7	
Total	487.9	0	74.1	294.4	856.4	343.5

ALTERNATIVE: A-2

(Unit: ¥10^6)

Year	Water Transmission System			Water Dist. System	Total Cost	Present Worth
	Capital Cost	Replace Cost	O&M Cost	Running Cost		
1985	51.8				51.8	41.3
1986	7.0				7.0	5.0
1987	239.1				239.1	151.9
1988	198.2		2.0	1.4	201.5	114.4
1989			2.0	1.8	3.8	1.9
1990			2.0	2.2	4.2	1.9
1991			2.0	2.7	4.7	1.9
1992			2.0	3.1	5.1	1.8
1993			2.0	3.5	5.5	1.8
1994			2.0	3.9	5.9	1.7
1995			2.0	4.3	6.3	1.6
1996			2.0	4.8	6.8	1.5
1997			2.0	5.2	7.2	1.5
1998			2.0	5.6	7.6	1.4
1999			2.0	6.0	8.0	1.3
2000			2.0	6.4	8.4	1.2
2001			2.0	6.9	8.9	
⋮			⋮	⋮	⋮	
2005			2.0	6.9	8.9	
⋮			⋮	⋮	⋮	
2010			2.0	6.9	8.9	10.3
⋮			⋮	⋮	⋮	
2018			2.0	6.9	8.9	
⋮			⋮	⋮	⋮	
2026			2.0	6.9	8.9	
Total	496.0	0	78.0	230.3	804.3	342.4

ALTERNATIVE: A-3

(Unit: ¥10^6)

Year	Water Transmission System			Water Dist. System	Total Cost	Present Worth
	Capital Cost	Replace Cost	O&M Cost	Running Cost		
1985	55.2				55.2	44.0
1986	7.0				7.0	4.9
1987	129.9				129.9	82.5
1988	108.9		1.0	1.8	111.7	63.3
1989			1.0	2.3	3.3	1.7
1990			1.0	2.9	3.9	1.8
1991			1.0	3.4	4.4	1.8
1992	13.3		1.0	3.9	18.2	6.6
1993	150.2		1.0	4.5	155.7	50.1
1994	89.3		2.0	5.0	96.3	27.7
1995			2.0	5.6	7.6	2.0
1996			2.0	6.1	8.1	1.9
1997			2.0	6.7	8.7	1.8
1998			2.0	7.2	9.2	1.7
1999			2.0	7.8	9.8	1.6
2000			2.0	8.3	10.3	1.5
2001			2.0	8.8	10.8	
⋮			⋮	⋮	⋮	
2005			2.0	8.8	10.8	
⋮			⋮	⋮	⋮	
2010			2.0	8.8	10.8	12.6
⋮			⋮	⋮	⋮	
2018			2.0	8.8	10.8	
⋮			⋮	⋮	⋮	
2026			2.0	8.8	10.8	
Total	553.8	0	72.0	294.3	920.1	307.5

ALTERNATIVE: A-4

(Unit: ¥10^6)

Year	Water Transmission System			Water Dist. System	Total Cost	Present Worth
	Capital Cost	Replace Cost	O&M Cost	Running Cost		
1985	55.2				55.2	44.0
1986	6.9				6.9	4.9
1987	138.1				138.1	87.8
1988	115.5		1.1	1.6	118.2	67.1
1989			1.1	2.1	3.2	1.6
1990			1.1	2.5	3.6	1.6
1991			1.1	3.0	4.1	1.7
1992	13.5		1.1	3.5	18.2	6.5
1993	159.4		1.1	4.0	164.5	52.9
1994	94.2		2.2	4.5	100.9	29.0
1995			2.2	4.9	7.1	1.8
1996			2.2	5.4	7.6	1.7
1997			2.2	5.9	8.1	1.6
1998			2.2	6.4	8.6	1.6
1999			2.2	6.8	9.0	1.5
2000			2.2	7.3	9.5	1.4
2001			2.2	7.8	10.0	
⋮			⋮	⋮	⋮	
2005			2.2	7.8	10.0	
⋮			⋮	⋮	⋮	
2010			2.2	7.8	10.0	11.5
⋮			⋮	⋮	⋮	
2018			2.2	7.8	10.0	
⋮			⋮	⋮	⋮	
2026			2.2	7.8	10.0	
Total	582.8	0	79.2	260.7	922.7	318.2

Table 19 OUTLAY OF INITIAL INVESTMENT, REPLACEMENT COST AND O & M COST OF 10 DEVELOPMENT ALTERNATIVES (2/3)

ALTERNATIVE: A-5

(Unit: ₱10^6)

Year	Water Transmission System			Water Dist. System	Total Cost	Present Worth
	Capital Cost	Replace Cost	O&M Cost	Running Cost		
1985	55.2				55.2	44.0
1986	7.0				7.0	5.0
1987	166.0				166.0	105.5
1988	138.4		1.3	1.4	141.1	80.1
1989			1.3	1.8	3.1	1.6
1990			1.3	2.2	3.5	1.6
1991			1.3	2.7	4.0	1.6
1992	13.5		1.3	3.1	17.9	6.4
1993	192.2		1.3	3.5	197.0	63.4
1994	112.1		2.7	3.9	118.7	34.1
1995			2.7	4.3	7.0	1.8
1996			2.7	4.8	7.5	1.7
1997			2.7	5.2	7.9	1.6
1998			2.7	5.6	8.3	1.5
1999			2.7	6.0	8.7	1.4
2000			2.7	6.4	9.1	1.3
2001			2.7	6.9	9.6	
⋮			⋮	⋮	⋮	
2005			2.7	6.9	9.6	
⋮			⋮	⋮	⋮	
2010			2.7	6.9	9.6	11.1
⋮			⋮	⋮	⋮	
2018			2.7	6.9	9.6	
⋮			⋮	⋮	⋮	
2026			2.7	6.9	9.6	
Total	684.4	0	96.9	230.3	1,011.5	363.7

ALTERNATIVE: A-6

(Unit: ₱10^6)

Year	Water Transmission System				Water Dist. System	Total	Present Worth
	Capital Cost	Replace Cost	O&M Cost	Running Cost	Running Cost		
1985	51.7					51.7	41.2
1986	6.9					6.9	4.9
1987	130.4					130.4	82.9
1988	109.2		1.0		1.8	112.0	63.5
1989			1.0		2.3	3.3	1.7
1990			1.0		2.9	3.9	1.8
1991			1.0		3.4	4.4	1.8
1992	19.7		1.0		3.9	24.6	8.9
1993	70.1		1.0		4.5	75.6	24.4
1994	83.2		9.7	12.0	5.0	109.9	31.6
1995			9.7	13.2	5.6	28.5	7.3
1996			9.7	14.3	6.1	30.1	6.9
1997			9.7	15.6	6.7	32.0	6.5
1998			9.7	16.9	7.2	33.8	6.2
1999			9.7	18.2	7.8	35.7	5.8
2000			9.7	19.4	8.3	37.4	5.5
2001			9.7	20.7	8.8	39.2	
⋮			⋮	⋮	⋮	⋮	
2005			9.7	20.7	8.8	39.2	
⋮			⋮	⋮	⋮	⋮	
2010		47.9	9.7	20.7	8.8	87.1	47.3
⋮			⋮	⋮	⋮	⋮	
2018			9.7	20.7	8.8	39.2	
⋮			⋮	⋮	⋮	⋮	
2026			9.7	20.7	8.8	39.2	
Total	471.2	47.9	326.1	647.8	294.3	1,787.3	348.2

ALTERNATIVE: A-7

(Unit: ₱10^6)

Year	Water Transmission System				Water Dist. System	Total	Present Worth
	Capital Cost	Replace Cost	O&M Cost	Running Cost	Running Cost		
1985	51.7					51.7	41.2
1986	6.9					6.9	4.9
1987	138.1					138.1	87.8
1988	115.6		1.1		1.6	118.3	67.1
1989			1.1		2.1	3.2	1.6
1990			1.1		2.5	3.6	1.6
1991			1.1		3.0	4.1	1.7
1992	19.7		1.1		3.5	24.3	8.8
1993	67.1		1.1		4.0	72.2	23.2
1994	81.3		9.9	10.4	4.5	106.1	30.5
1995			9.9	11.4	4.9	26.2	6.7
1996			9.9	12.4	5.4	27.7	6.3
1997			9.9	13.5	5.9	29.3	6.0
1998			9.9	14.6	6.4	30.9	5.6
1999			9.9	15.7	6.8	32.4	5.3
2000			9.9	16.8	7.3	34.0	5.0
2001			9.9	17.9	7.8	35.6	
⋮			⋮	⋮	⋮	⋮	
2005			9.9	17.9	7.8	35.6	
⋮			⋮	⋮	⋮	⋮	
2010		47.0	9.9	17.9	7.8	82.6	43.2
⋮			⋮	⋮	⋮	⋮	
2018			9.9	17.9	7.8	35.6	
⋮			⋮	⋮	⋮	⋮	
2026			9.9	17.9	7.8	35.6	
Total	480.4	47.0	333.3	560.2	260.7	1,681.6	346.5

ALTERNATIVE: A-8

(Unit: ₱10^6)

Year	Water Transmission System				Water Dist. System	Total	Present Worth
	Capital Cost	Replace Cost	O&M Cost	Running Cost	Running Cost		
1985	51.7					51.7	41.2
1986	7.0					7.0	5.0
1987	166.0					166.0	105.5
1988	138.4		1.3		1.4	141.1	80.1
1989			1.3		1.8	3.1	1.6
1990			1.3		2.2	3.5	1.6
1991			1.3		2.7	4.0	1.6
1992	19.7		1.3		3.1	24.1	8.7
1993	63.3		1.3		3.5	68.1	21.9
1994	79.4		11.2	7.9	3.9	102.4	29.6
1995			11.2	8.7	4.3	24.2	6.2
1996			11.2	9.5	4.8	25.5	5.8
1997			11.2	10.3	5.2	26.7	5.5
1998			11.2	11.2	5.6	28.0	5.1
1999			11.2	12.0	6.0	29.2	4.8
2000			11.2	12.9	6.4	30.5	4.4
2001			11.2	13.7	6.9	31.8	
⋮			⋮	⋮	⋮	⋮	
2005			11.2	13.7	6.9	31.8	
⋮			⋮	⋮	⋮	⋮	
2010		45.2	11.2	13.7	6.9	77.0	38.6
⋮			⋮	⋮	⋮	⋮	
2018			11.2	13.7	6.9	31.8	
⋮			⋮	⋮	⋮	⋮	
2026			11.2	13.7	6.9	31.8	
Total	525.5	45.2	377.4	428.7	230.3	1,607.1	367.2

Table 19 OUTLAY OF INITIAL INVESTMENT, REPLACEMENT COST AND O & M COST OF 10 DEVELOPMENT ALTERNATIVES (3/3)

ALTERNATIVE: B-1

(Unit: ₱10^6)

Year	Water Transmission System			Water Dist. System	Total Cost	Present Worth
	Capital Cost	Replace Cost	O&M Cost	Running Cost		
1985	54.7				54.7	43.6
1986	7.0				7.0	5.0
1987	242.7				242.7	154.3
1988	201.2		2.0	2.0	205.2	116.4
1989			2.0	2.6	4.6	2.3
1990			2.0	3.2	5.2	2.4
1991			2.0	3.8	5.8	2.3
1992			2.0	4.4	6.4	2.3
1993			2.0	5.0	7.0	2.3
1994			2.0	5.6	7.6	2.2
1995			2.0	6.2	8.2	2.1
1996			2.0	6.8	8.8	2.0
1997			2.0	7.4	9.4	1.9
1998			2.0	8.0	10.0	1.8
1999			2.0	8.6	10.6	1.7
2000			2.0	9.2	11.2	1.6
2001			2.0	9.8	11.8	
⋮			⋮	⋮	⋮	
2005			2.0	9.8	11.8	
⋮			⋮	⋮	⋮	
2010			2.0	9.8	11.8	13.7
⋮			⋮	⋮	⋮	
2018			2.0	9.8	11.8	
⋮			⋮	⋮	⋮	
2026			2.0	9.8	11.8	
Total	505.6	0	78.0	327.6	911.2	357.9

ALTERNATIVE: B-2

(Unit: ₱10^6)

Year	Water Transmission System			Water Dist. System	Total Cost	Present Worth
	Capital Cost	Replace Cost	O&M Cost	Running Cost		
1985	57.9				57.9	46.2
1986	6.9				6.9	4.9
1987	141.9				141.9	90.2
1988	118.6		1.1	2.0	121.7	69.1
1989			1.1	2.6	3.7	1.9
1990			1.1	3.2	4.3	2.0
1991			1.1	3.8	4.9	2.0
1992	13.4		1.1	4.4	18.9	6.8
1993	163.8		1.1	5.0	169.9	54.7
1994	96.6		2.2	5.6	104.4	30.0
1995			2.2	6.2	8.4	2.2
1996			2.2	6.8	9.0	2.1
1997			2.2	7.4	9.6	2.0
1998			2.2	8.0	10.2	1.9
1999			2.2	8.6	10.8	1.8
2000			2.2	9.2	11.4	1.7
2001			2.2	9.8	12.0	
⋮			⋮	⋮	⋮	
2005			2.2	9.8	12.0	
⋮			⋮	⋮	⋮	
2010			2.2	9.8	12.0	14.0
⋮			⋮	⋮	⋮	
2018			2.2	9.8	12.0	
⋮			⋮	⋮	⋮	
2026			2.2	9.8	12.0	
Total	599.1	0	79.2	327.6	1,005.9	333.5

Table 20 PRINCIPAL FEATURES OF 3 CASES OF DEVELOPMENT ALTERNATIVE "A-3"

Description		Case I		Case II		Case III	
		1st Stage	2nd Stage	1st Stage	2nd Stage	1st Stage	2nd Stage
1. Commissioning Year		1988	1993	1988	1994	1988	1995
2. Project Features							
2.1 Annual transmission quantity	10^6m^3	20.4	22.7	21.6	21.5	24.0	19.1
2.2 Length of pipeline							
Nong Kho - Turnout	km	10.95	10.95	10.95	10.95	10.95	10.95
Turnout - Receiving well	km	3.49	3.49	3.49	3.49	3.49	3.49
2.3 Inside diameter of pipe							
Nong Kho - Turnout	ø mm	1,000	1,000	1,000	1,000	1,200	1,000
Turnout - Receiving well	ø mm	800	1,000	900	900	800	800
2.4 Row of pipeline		1	1	1	1	1	1
3. Hydraulic Property							
3.1 Design intake W.L.	El.m	58.9	58.9	58.9	58.9	58.9	58.9
3.2 Pipe discharge							
Nong Kho - Turnout	m^3/s	0.78	0.86	0.82	0.82	0.91	0.73
Turnout - Receiving well	m^3/s	0.70	0.86	0.74	0.82	0.84	0.73
3.3 Pipe velocity							
Nong Kho - Turnout	m/s	0.99	1.09	1.04	1.04	0.80	0.93
Turnout - Receiving well	m/s	1.39	1.09	1.16	1.29	1.67	1.45
3.4 Head losses		23.14	21.0	22.88	22.12	21.8	22.34
3.5 W.L. of receiving well		35.7	35.7	36.7	36.7	36.5	36.5

Table 21 PRELIMINARY ESTIMATE OF INVESTMENT COST OF 3 CASES OF DEVELOPMENT ALTERNATIVE "A-3"

(Unit: ₱10^6)

Description	Case 1			Case 2			Case 3		
	1st	2nd	Total	1st	2nd	Total	1st	2nd	Total
1. Construction Cost	164.7	179.0	343.7	169.3	167.6	336.9	216.0	163.0	379.0
Preparatory works	15.0	16.3	31.3	14.9	14.8	29.7	19.6	14.8	34.4
Pipeline	139.0	150.9	289.9	142.6	141.8	284.4	185.0	138.2	323.2
Turnout	0.9	0.1	1.0	0.9	0.1	1.0	0.9	0.1	1.0
Aqueduct	1.5	1.8	3.3	1.7	1.7	3.4	2.2	1.5	3.7
Receiving well	8.3	9.9	18.2	9.2	9.2	18.4	8.3	8.4	16.7
2. Engineering Services	53.5	36.3	89.8	53.4	36.3	89.7	53.5	36.3	89.8
3. Government Administration	6.6	7.2	13.8	6.8	6.7	13.5	8.6	6.5	15.1
4. Land Acquisition and compensation	21.4	-	21.4	21.4	-	21.4	21.4	-	21.4
Base Cost	246.2	222.5	468.7	250.9	210.6	461.5	299.5	205.8	505.3
5. Physical Contingency	49.2	44.5	93.7	50.1	42.2	92.3	59.9	41.2	101.1
Total	295.4	267.0	562.4	301.0	252.8	553.8	359.4	247.0	606.4

Table 22 OUTLAY OF INITIAL INVESTMENT, REPLACEMENT COST AND O & M COST OF 3 CASES OF DEVELOPMENT ALTERNATIVE "A-3"

ALTERNATIVE: CASE-1

(Unit: ¥10^6)

Year	Water Transmission System			Water Dist. System	Total Cost	Present Worth
	Capital Cost	Replace Cost	O&M Cost	Running Cost		
1985	55.2				55.2	44.0
1986	6.9				6.9	4.9
1987	127.2				127.2	80.8
1988	106.6		1.0	1.8	109.4	62.1
1989			1.0	2.3	3.3	1.7
1990			1.0	2.9	3.9	1.7
1991	13.4		1.0	3.4	17.8	7.2
1992	159.4		1.0	4.0	164.4	59.2
1993	94.2		2.1	4.5	100.8	32.4
1994			2.1	5.0	7.1	2.0
1995			2.1	5.6	7.7	2.0
1996			2.1	6.1	8.2	1.9
1997			2.1	6.7	8.8	1.8
1998			2.1	7.2	9.3	1.7
1999			2.1	7.8	9.9	1.6
2000			2.1	8.3	10.4	1.5
2001			2.1	8.8	10.9	
⋮			⋮	⋮	⋮	
2005			2.1	8.8	10.9	
⋮			⋮	⋮	⋮	
2010			2.1	8.8	10.9	12.6
⋮			⋮	⋮	⋮	
2018			2.1	8.8	10.9	
⋮			⋮	⋮	⋮	
2026			2.1	8.8	10.9	
Total	562.9	0	76.4	294.4	933.7	319.1

ALTERNATIVE: CASE-2

(Unit: ¥10^6)

Year	Water Transmission System			Water Dist. System	Total Cost	Present Worth
	Capital Cost	Replace Cost	O&M Cost	Running Cost		
1985	55.2				55.2	44.0
1986	7.0				7.0	4.9
1987	129.9				129.9	82.5
1988	108.9		1.0	1.8	111.7	63.3
1989			1.0	2.3	3.3	1.7
1990			1.0	2.9	3.9	1.8
1991			1.0	3.4	4.4	1.8
1992	13.3		1.0	3.9	18.2	6.6
1993	150.2		1.0	4.5	155.7	50.1
1994	89.3		2.0	5.0	96.3	27.7
1995			2.0	5.6	7.6	2.0
1996			2.0	6.1	8.1	1.9
1997			2.0	6.7	8.7	1.8
1998			2.0	7.2	9.2	1.7
1999			2.0	7.8	9.8	1.6
2000			2.0	8.3	10.3	1.5
2001			2.0	8.8	10.8	
⋮			⋮	⋮	⋮	
2005			2.0	8.8	10.8	
⋮			⋮	⋮	⋮	
2010			2.0	8.8	10.8	12.6
⋮			⋮	⋮	⋮	
2018			2.0	8.8	10.8	
⋮			⋮	⋮	⋮	
2026			2.0	8.8	10.8	
Total	553.8	0	72.0	294.3	920.1	307.5

ALTERNATIVE: CASE-3

(Unit: ¥10^6)

Year	Water Transmission System			Water Dist. System	Total Cost	Present Worth
	Capital Cost	Replace Cost	O&M Cost	Running Cost		
1985	55.2				55.2	44.0
1986	7.0				7.0	5.0
1987	162.3				162.3	103.2
1988	135.4		1.3	1.8	138.5	78.6
1989			1.3	2.3	3.6	1.8
1990			1.3	2.9	4.2	1.9
1991			1.3	3.4	4.7	1.9
1992			1.3	3.9	5.2	1.9
1993	13.4		1.3	4.5	19.2	6.2
1994	146.4		1.3	5.0	152.7	43.9
1995	87.2		2.3	5.6	95.1	24.4
1996			2.3	6.1	8.4	1.9
1997			2.3	6.7	9.0	1.8
1998			2.3	7.2	9.5	1.7
1999			2.3	7.8	10.1	1.6
2000			2.3	8.3	10.6	1.5
2001			2.3	8.8	11.1	
⋮			⋮	⋮	⋮	
2005			2.3	8.8	11.1	
⋮			⋮	⋮	⋮	
2010			2.3	8.8	11.1	12.9
⋮			⋮	⋮	⋮	
2018			2.3	8.8	11.1	
⋮			⋮	⋮	⋮	
2026			2.3	8.8	11.1	
Total	606.9	0	82.7	294.3	983.9	334.2

Table 23 WORK QUANTITY OF MAJOR WORKS

Work Items	Unit	Quantity	
		1st Stage	2nd Stage
1. Raw Water Pipeline			
Stripping	m^2	15,400	15,400
Trench excavation, without sheet piling	m^3	98,400	98,400
with sheet piling	m^3	4,700	4,700
Backfill	m^3	103,800	103,700
Embankment	m^3	8,100	250
Installation of steel pipe, ø1,000 mm	ton	2,580	2,580
ø 900 mm	ton	600	600
ø 400 mm	ton	5	4
Installation of air valve, ø150 mm (incl. ø150 mm sluice valve)	unit	6	6
Installation of butterfly valve, ø1,000 mm	unit	4	4
ø 900 mm	unit	5	5
Installation of sluice valve, ø400 mm	unit	4	4
Installation of flow meter, ø1,000 mm	set	1	1
2. Turnout			
Installation flow meter, ø250 mm	set	1	-
Installation of sluice valve, ø250mm	unit	2	-
3. Aqueduct			
Open excavation	m^3	360	360
Concrete	m^3	250	250
Backfill	m^3	110	110
Installation of pipe beam, ø900 mm	ton	16	16
Installation air valve, ø150 mm	unit	1	1
4. Receiving Well			
Excavation, incl. open and trench	m^3	1,800	1,900
Concrete	m^3	330	330
Backfill	m^3	1,300	1,400
Installation of in-plant pipe	ton	19	23
Installation of flow meter, ø900 mm	set	1	1
Installation of sleeve valve, ø900 mm	set	1	1
Installation of butterfly valve, ø900 mm	unit	4	4
Installation of sluice valve, ø200 mm	unit	3	3
Gate control station	m^2	30	-

Tale 24 MAJOR CONSTRUCTION EQUIPMENT & PLANTS

	Equipment/Plants	Capacity	Unit	Quantity
1.	Bulldozer	12 or 16 t	unit	2
2.	Back hoe	0.6 m^3	unit	3
3.	Wheel loader or dozer shovel	1.2 - 1.8 m^3	unit	1
4.	Dump truck	6 or 8 t	unit	12
5.	Vibration roller	2.5 t	unit	6
6.	Vibration roller	0.7 t	unit	6
7.	Hand rammer	60 - 80 kg	unit	6
8.	Hydraulic crane	10 t	unit	1
9.	Crawler crane	20 t	unit	6
10.	Arc welder	300 A	set	3
11.	Automatic welder	500 A	set	3
12.	Diesel engine generator	60 kVA	unit	3
13.	Maintenance car	6 t	unit	3
14.	Concrete vibrator		set	10
15.	Portable concrete mixer	0.2 m^3	unit	2
16.	Portable concrete mixer	0.3 m^3	unit	2

Table 25 REQUIRED MANPOWER

	Classification	Required Manpower (man/month)
1.	Foreman	3
2.	Heavy equipment operator	14
3.	Heavy equipment helper	14
4.	Dump truck driver & other driver	15
5.	Operator for other equipment	22
6.	Diesel engine generator operator	3
7.	Steel bender	15
8.	Carpentor	10
9.	Skilled labor	38
10.	Common labor	95
11.	Electrician	2
12.	Welder	9
13.	Mechanic	5

Table 26 INVESTMENT COST

(Unit: ¥10^6)

Description	1st Stage			2nd Stage			Overall		
	FC	LC	Total	FC	LC	Total	FC	LC	Total
1. Construction Cost	108.4	60.9	169.3	107.3	60.3	167.6	215.7	121.2	336.9
2. Engineering Services	39.0	14.4	53.4	24.4	11.9	36.3	63.4	26.3	89.7
3. Land Acquisition and Compensation	0	21.4	21.4	0	0	0	0	21.4	21.4
4. Government Administration	0	6.8	6.8	0	6.7	6.7	0	13.5	13.5
Base Cost	147.4	103.5	250.9	131.7	78.9	210.6	279.1	182.4	461.5
5. Physical Contingency	29.5	20.6	50.1	26.4	15.8	42.2	55.9	36.4	92.3
6. Price Contingency	35.4	30.1	65.5	22.6	18.7	41.3	58.0	48.8	106.8
Total	212.3	154.2	366.5	180.7	113.4	294.1	393.0	267.6	660.6
7. Tax on Construction Work	0	9.0	9.0	0	8.2	8.2	0	17.2	17.2
Grand Total	212.3	163.2	375.5	180.7	121.6	302.3	393.0	284.8	677.8

Note: FC; Foreign currency
LC; Local currency

Table 27 DISBURSEMENT SCHEDULE OF FINANCIAL INVESTMENT COST

1st Stage

(Unit: ₱10⁶)

Item	1985			1986			1987			1988			Total		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1. Construction Cost	0.0	0.0	0.0	0.0	0.0	0.0	59.6	20.2	79.8	48.8	16.5	65.3	108.4	36.7	145.1
2. Engineering Services	18.0	4.3	22.3	4.3	1.1	5.4	8.6	3.0	11.6	8.1	3.2	11.3	39.0	11.6	50.6
3. Government Administ.	0.0	1.0	1.0	0.0	0.1	0.1	0.0	2.3	2.3	0.0	2.0	2.0	0.0	5.4	5.4
Base Cost	18.0	5.3	23.3	4.3	1.2	5.5	68.2	25.5	93.7	56.9	21.7	78.6	147.4	53.7	201.1
4. Physical Contingency	3.6	1.1	4.7	0.9	0.2	1.1	13.6	5.1	18.7	11.4	4.3	15.7	29.5	10.7	40.2
Grand Total	21.6	6.4	28.0	5.2	1.4	6.6	81.8	30.6	112.4	68.3	26.0	94.3	176.9	64.4	241.3

2nd Stage

(Unit: ₱10⁶)

Item	1992			1993			1994			Total		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1. Construction Cost	0.0	0.0	0.0	69.4	23.5	92.9	37.9	12.8	50.7	107.3	36.3	143.6
2. Engineering Services	8.6	1.9	10.5	7.9	3.8	11.7	8.0	3.8	11.8	24.5	9.5	34.0
3. Government Administ.	0.0	0.3	0.3	0.0	3.2	3.2	0.0	1.9	1.9	0.0	5.4	5.4
Base Cost	8.6	2.2	10.8	77.3	30.5	107.8	45.9	18.5	64.4	131.8	51.2	183.0
5. Physical Contingency	1.7	0.4	2.1	15.5	6.1	21.6	9.2	3.7	12.9	26.4	10.2	36.6
Grand Total	10.3	2.6	12.9	92.8	36.6	129.4	55.1	22.2	77.3	158.2	61.4	219.6

Table 28 DISBURSEMENT SCHEDULE OF ECONOMIC INVESTMENT COST

1st Stage

(Unit: ¥10^6)

Item	1985			1986			1987			1988			Total		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1. Construction Cost	0	0	0	0	0	0	59.6	33.5	93.1	48.8	27.4	76.2	108.4	60.9	169.3
2. Engineering Services	18.0	5.4	23.4	4.3	1.3	5.6	8.6	3.7	12.3	8.1	4.0	12.1	39.0	14.4	53.4
3. Land Acquisition and Compensation	0	21.4	21.4	0	0	0	0	0	0.0	0	0	0	0	21.4	21.4
4. Government Administ.	0	1.2	1.2	0	0.2	0.2	0	2.9	2.9	0	2.5	2.5	0	6.8	6.8
Base Cost	18.0	28.0	46.0	4.3	1.5	5.8	68.2	40.1	108.3	56.9	33.9	90.8	147.4	103.5	250.9
5. Physical Contingency	3.6	5.6	9.2	0.9	0.3	1.2	13.6	8.0	21.6	11.4	6.7	18.1	29.5	20.6	50.1
6. Price Contingency	1.3	2.7	4.0	0.6	0.3	0.9	15.6	12.5	28.1	17.9	14.6	32.5	35.4	30.1	65.5
Total	22.9	36.3	59.2	5.8	2.1	7.9	97.4	60.6	158.0	86.2	55.2	141.4	212.3	154.2	366.5
7. Tax on Construction Work	0	0	0	0	0	0	0	4.8	4.8	0	4.2	4.2	0	9.0	9.0
Grand Total	22.9	36.3	59.2	5.8	2.1	7.9	97.4	65.4	162.8	86.2	59.4	145.6	212.3	163.2	375.5

2nd Stage

Item	1992			1993			1994			Total		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1. Construction Cost	0	0	0	69.4	39.0	108.4	37.9	21.3	59.2	107.3	60.3	167.6
2. Engineering Services	8.5	2.3	10.8	7.9	4.8	12.7	8.0	4.8	12.8	24.4	11.9	36.3
3. Land Acquisition and Compensation	0	0	0	0	0	0	0	0	0	0	0	0
4. Government Administ.	0	0.3	0.3	0	4.0	4.0	0	2.4	2.4	0	6.7	6.7
Base Cost	8.5	2.6	11.1	77.3	47.8	125.1	45.9	28.5	74.4	131.7	78.9	210.6
5. Physical Contingency	1.7	0.5	2.2	15.5	9.6	25.1	9.2	5.7	14.9	26.4	15.8	42.2
6. Price Contingency	0.6	0.3	0.9	11.5	9.5	21.0	10.5	8.9	19.4	22.6	18.7	41.3
Total	10.8	3.4	14.2	104.3	66.9	171.2	65.6	42.1	108.7	180.7	113.4	294.1
7. Tax on Construction Work	0	0	0	0	5.2	5.2	0	3.0	3.0	0	8.2	8.2
Grand Total	10.8	3.4	14.2	104.3	72.1	176.4	65.6	46.1	111.7	180.7	121.6	302.3

Note: FC; Foreign currency
LC; Local currency

Table 29 PROJECTED BENEFIT

Year	Water Sold (10^6 m^3)					Water Charge (฿/m^3)		Revenue ($฿10^6$)		
	Domestic	Industrial				Domestic	Industrial	Domestic	Industrial	Total
		Laem Chabang	/1 Port	/1 Pattaya	Total					
1989	2.9	6.7	0.1	0	6.8	1.5	2.5	4.4	17.0	21.4
1990	3.2	7.5	0.1	0	7.6	1.5	2.5	4.8	19.0	23.8
1991	3.5	8.4	0.2	0.4	9.0	1.5	2.5	5.3	22.5	27.8
1992	4.0	9.3	0.2	1.1	10.6	1.5	2.5	6.0	26.5	32.5
1993	4.4	10.1	0.2	1.7	12.0	1.5	2.5	6.6	30.0	36.6
1994	4.8	11.0	0.2	2.4	13.6	1.5	2.5	7.2	34.0	41.2
1995	5.3	11.8	0.2	3.0	15.0	1.5	2.5	8.0	37.5	45.5
1996	5.8	12.7	0.3	3.7	16.7	1.5	2.5	8.7	41.8	50.5
1997	6.6	13.5	0.3	4.4	18.2	1.5	2.5	9.9	45.5	55.4
1998	7.3	14.3	0.3	5.0	19.6	1.5	2.5	11.0	49.0	60.0
1999	8.1	15.0	0.3	5.7	21.0	1.5	2.5	12.2	52.5	64.7
2000	8.8	15.8	0.3	6.3	22.4	1.5	2.5	13.2	56.0	69.2
2001	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2002	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2003	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2004	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2005	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2006	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2007	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2008	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2009	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2010	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2011	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2012	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2013	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2014	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2015	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2016	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2017	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2018	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2019	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2020	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2021	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2022	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2023	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4
2024	9.6	16.6	0.4	7.0	24.0	1.5	2.5	14.4	60.0	74.4

/1: Water supplied for port and tourism use in Pattaya is treated as industrial water since its water consumption is bulky and induced water charge at ฿5/m^3.

Table 30 COST - BENEFIT FLOW

(Unit: ¥10^6)

No.	Year	(1) Cost			(2) Benefit			(2)-(1)
		Investment	O&M	Total	Domestic	Industrial	Total	
1	1985	28.0	0	28.0	0	0	0	-28.0
2	1986	6.6	0	6.6	0	0	0	-6.6
3	1987	112.4	0	112.4	0	0	0	-112.4
4	1988	94.3	0.9	95.2	0	0	0	-95.2
5	1989	0	0.9	0.9	4.4	17.0	21.4	20.5
6	1990	0	0.9	0.9	4.8	19.0	23.8	22.9
7	1991	0	0.9	0.9	5.3	22.5	27.8	26.9
8	1992	12.9	0.9	13.8	6.0	26.5	32.5	18.7
9	1993	129.4	0.9	130.3	6.6	30.0	36.6	-93.7
10	1994	77.3	1.8	79.1	7.2	34.0	41.2	-37.9
11	1995	0	1.8	1.8	8.0	37.5	45.5	43.7
12	1996	0	1.8	1.8	8.7	41.8	50.5	48.7
13	1997	0	1.8	1.8	9.9	45.5	55.4	53.6
14	1998	0	1.8	1.8	11.0	49.0	60.0	58.2
15	1999	0	1.8	1.8	12.2	52.5	64.7	62.9
16	2000	0	1.8	1.8	13.2	56.0	69.2	67.4
17	2001	0	1.8	1.8	14.4	60.0	74.4	72.6
18	2002	0	1.8	1.8	14.4	60.0	74.4	72.6
19	2003	0	1.8	1.8	14.4	60.0	74.4	72.6
20	2004	0	1.8	1.8	14.4	60.0	74.4	72.6
21	2005	0	1.8	1.8	14.4	60.0	74.4	72.6
22	2006	0	1.8	1.8	14.4	60.0	74.4	72.6
23	2007	0	1.8	1.8	14.4	60.0	74.4	72.6
24	2008	0	1.8	1.8	14.4	60.0	74.4	72.6
25	2009	0	1.8	1.8	14.4	60.0	74.4	72.6
26	2010	0	1.8	1.8	14.4	60.0	74.4	72.6
27	2011	0	1.8	1.8	14.4	60.0	74.4	72.6
28	2012	0	1.8	1.8	14.4	60.0	74.4	72.6
29	2013	0	1.8	1.8	14.4	60.0	74.4	72.6
30	2014	0	1.8	1.8	14.4	60.0	74.4	72.6
31	2015	0	1.8	1.8	14.4	60.0	74.4	72.6
32	2016	0	1.8	1.8	14.4	60.0	74.4	72.6
33	2017	0	1.8	1.8	14.4	60.0	74.4	72.6
34	2018	0	1.8	1.8	14.4	60.0	74.4	72.6
35	2019	0	1.8	1.8	14.4	60.0	74.4	72.6
36	2020	0	1.8	1.8	14.4	60.0	74.4	72.6
37	2021	0	1.8	1.8	14.4	60.0	74.4	72.6
38	2022	0	1.8	1.8	14.4	60.0	74.4	72.6
39	2023	0	1.8	1.8	14.4	60.0	74.4	72.6
40	2024	0	1.8	1.8	14.4	60.0	74.4	72.6
	Total	460.9	61.2	522.1	442.9	1,871.3	2,314.2	1,792.1

Note: EIRR is 11.6%

Table 31 FINANCIAL CASH FLOW

(Unit: ¥10^6)

No.	Year	(1) Cost			(2) Revenue			(2)-(1)
		Investment	O&M	Total	Domestic	Industrial	Total	
1	1985	55.2	0	55.2	0	0	0	-55.2
2	1986	7.0	0	7.0	0	0	0	-7.0
3	1987	129.9	0	129.9	0	0	0	-129.9
4	1988	108.9	1.0	109.9	0	0	0	-109.9
5	1989	0	1.0	1.0	4.4	17.0	21.4	20.4
6	1990	0	1.0	1.0	4.8	19.0	23.8	22.8
7	1991	0	1.0	1.0	5.3	22.5	27.8	26.8
8	1992	13.3	1.0	14.3	6.0	26.5	32.5	18.2
9	1993	150.2	1.0	151.2	6.6	30.0	36.6	-114.6
10	1994	89.3	2.0	91.3	7.2	34.0	41.2	-50.1
11	1995	0	2.0	2.0	8.0	37.5	45.5	43.5
12	1996	0	2.0	2.0	8.7	41.8	50.5	48.5
13	1997	0	2.0	2.0	9.9	45.5	55.4	53.4
14	1998	0	2.0	2.0	11.0	49.0	60.0	58.0
15	1999	0	2.0	2.0	12.2	52.5	64.7	62.7
16	2000	0	2.0	2.0	13.2	56.0	69.2	67.2
17	2001	0	2.0	2.0	14.4	60.0	74.4	72.4
18	2002	0	2.0	2.0	14.4	60.0	74.4	72.4
19	2003	0	2.0	2.0	14.4	60.0	74.4	72.4
20	2004	0	2.0	2.0	14.4	60.0	74.4	72.4
21	2005	0	2.0	2.0	14.4	60.0	74.4	72.4
22	2006	0	2.0	2.0	14.4	60.0	74.4	72.4
23	2007	0	2.0	2.0	14.4	60.0	74.4	72.4
24	2008	0	2.0	2.0	14.4	60.0	74.4	72.4
25	2009	0	2.0	2.0	14.4	60.0	74.4	72.4
26	2010	0	2.0	2.0	14.4	60.0	74.4	72.4
27	2011	0	2.0	2.0	14.4	60.0	74.4	72.4
28	2012	0	2.0	2.0	14.4	60.0	74.4	72.4
29	2013	0	2.0	2.0	14.4	60.0	74.4	72.4
30	2014	0	2.0	2.0	14.4	60.0	74.4	72.4
31	2015	0	2.0	2.0	14.4	60.0	74.4	72.4
32	2016	0	2.0	2.0	14.4	60.0	74.4	72.4
33	2017	0	2.0	2.0	14.4	60.0	74.4	72.4
34	2018	0	2.0	2.0	14.4	60.0	74.4	72.4
35	2019	0	2.0	2.0	14.4	60.0	74.4	72.4
36	2020	0	2.0	2.0	14.4	60.0	74.4	72.4
37	2021	0	2.0	2.0	14.4	60.0	74.4	72.4
38	2022	0	2.0	2.0	14.4	60.0	74.4	72.4
39	2023	0	2.0	2.0	14.4	60.0	74.4	72.4
40	2024	0	2.0	2.0	14.4	60.0	74.4	72.4
	Total	553.8	68.0	621.8	442.9	1,871.3	2,314.2	1,692.4

Note: FIRR is 9.6%

Table 32 CASH FLOW STATEMENT (1/2)

(Unit: ฿10^3)

No.	Year	Investment Cost (L.C.)	Loan Repayment (F.C.)	OM Cost	Revenue	Cash Flow	Accumulated Surplus
1	1985	33,600	0	0	0	-33,600	-33,600
2	1986	1,800	648	0	0	-2,448	-36,048
3	1987	48,100	804	0	0	-48,904	-84,952
4	1988	40,600	3,258	1,000	0	-44,858	-129,810
5	1989	0	5,307	1,000	21,400	15,093	-114,717
6	1990	0	5,307	1,000	23,800	17,493	-97,224
7	1991	0	5,307	1,000	27,800	21,493	-75,731
8	1992	3,100	5,307	1,000	32,500	23,093	-52,638
9	1993	57,400	5,613	1,000	36,600	-27,413	-80,051
10	1994	34,200	8,997	2,000	41,200	-3,997	-84,048
11	1995	0	10,050	2,000	45,500	33,450	-50,598
12	1996	0	16,633	2,000	50,500	31,867	-18,731
13	1997	0	16,633	2,000	55,400	36,767	18,036
14	1998	0	16,633	2,000	60,000	41,367	59,403
15	1999	0	16,633	2,000	64,700	46,067	105,470
16	2000	0	16,633	2,000	69,200	50,567	156,037
17	2001	0	16,633	2,000	74,400	55,767	211,804
18	2002	0	16,633	2,000	74,400	55,767	267,571
19	2003	0	22,517	2,000	74,400	49,883	317,454
20	2004	0	22,517	2,000	74,400	49,883	367,337
21	2005	0	22,517	2,000	74,400	49,883	417,220
22	2006	0	22,517	2,000	74,400	49,883	467,103
23	2007	0	22,517	2,000	74,400	49,883	516,986
24	2008	0	22,517	2,000	74,400	49,883	566,869
25	2009	0	22,517	2,000	74,400	49,883	616,752
26	2010	0	22,517	2,000	74,400	49,883	666,635
27	2011	0	22,517	2,000	74,400	49,883	716,518
28	2012	0	22,517	2,000	74,400	49,883	766,401
29	2013	0	22,517	2,000	74,400	49,883	816,284
30	2014	0	22,517	2,000	74,400	49,883	866,167
31	2015	0	22,517	2,000	74,400	49,883	916,050
32	2016	0	10,627	2,000	74,400	61,773	977,823
33	2017	0	10,627	2,000	74,400	61,773	1,039,596
34	2018	0	10,627	2,000	74,400	61,773	1,101,369
35	2019	0	10,627	2,000	74,400	61,773	1,163,142
36	2020	0	10,627	2,000	74,400	61,773	1,224,915
37	2021	0	10,627	2,000	74,400	61,773	1,286,688
38	2022	0	10,627	2,000	74,400	61,773	1,348,461
Total		218,800	534,139	64,000	2,165,400	1,348,461	-

Note: Interest rate; 3%
Repayment period; 30 years (Grace period 10 years)

Table 32 CASH FLOW STATEMENT (2/2)

(Unit: ฿10^3)

No.	Year	Investment Cost (L.C.)	Loan Repayment (F.C.)	OM Cost	Revenue	Cash Flow	Accumulated Surplus
1	1985	33,600	0	0	0	-33,600	-33,600
2	1986	1,800	1,728	0	0	-3,528	-37,128
3	1987	48,100	2,144	0	0	-50,244	-87,372
4	1988	40,600	8,688	1,000	0	-50,288	-137,660
5	1989	0	14,152	1,000	21,400	6,248	-131,412
6	1990	0	14,152	1,000	23,800	8,648	-122,764
7	1991	0	20,667	1,000	27,800	6,133	-116,631
8	1992	3,100	20,667	1,000	32,500	7,733	-108,898
9	1993	57,400	21,483	1,000	36,600	-43,283	-152,181
10	1994	34,200	28,907	2,000	41,200	-23,907	-176,088
11	1995	0	33,315	2,000	45,500	10,185	-165,903
12	1996	0	33,315	2,000	50,500	15,185	-150,718
13	1997	0	33,315	2,000	55,400	20,085	-130,633
14	1998	0	39,137	2,000	60,000	18,863	-111,770
15	1999	0	39,137	2,000	64,700	23,563	-88,207
16	2000	0	39,137	2,000	69,200	28,063	-60,144
17	2001	0	39,137	2,000	74,400	33,263	-26,881
18	2002	0	39,137	2,000	74,400	33,263	6,382
19	2003	0	39,137	2,000	74,400	33,263	39,465
20	2004	0	39,137	2,000	74,400	33,263	72,908
21	2005	0	39,137	2,000	74,400	33,263	106,171
22	2006	0	18,470	2,000	74,400	53,930	160,101
23	2007	0	18,470	2,000	74,400	53,930	214,031
24	2008	0	18,470	2,000	74,400	53,930	267,961
25	2009	0	18,470	2,000	74,400	53,930	321,891
26	2010	0	18,470	2,000	74,400	53,930	375,821
27	2011	0	18,470	2,000	74,400	53,930	429,751
28	2012	0	18,470	2,000	74,400	53,930	483,681
Total		218,800	674,919	44,000	1,421,400	483,681	-

Note: Interest rate; 8%
Repayment period; 20 years (Grace period 5 years)

FIGURES

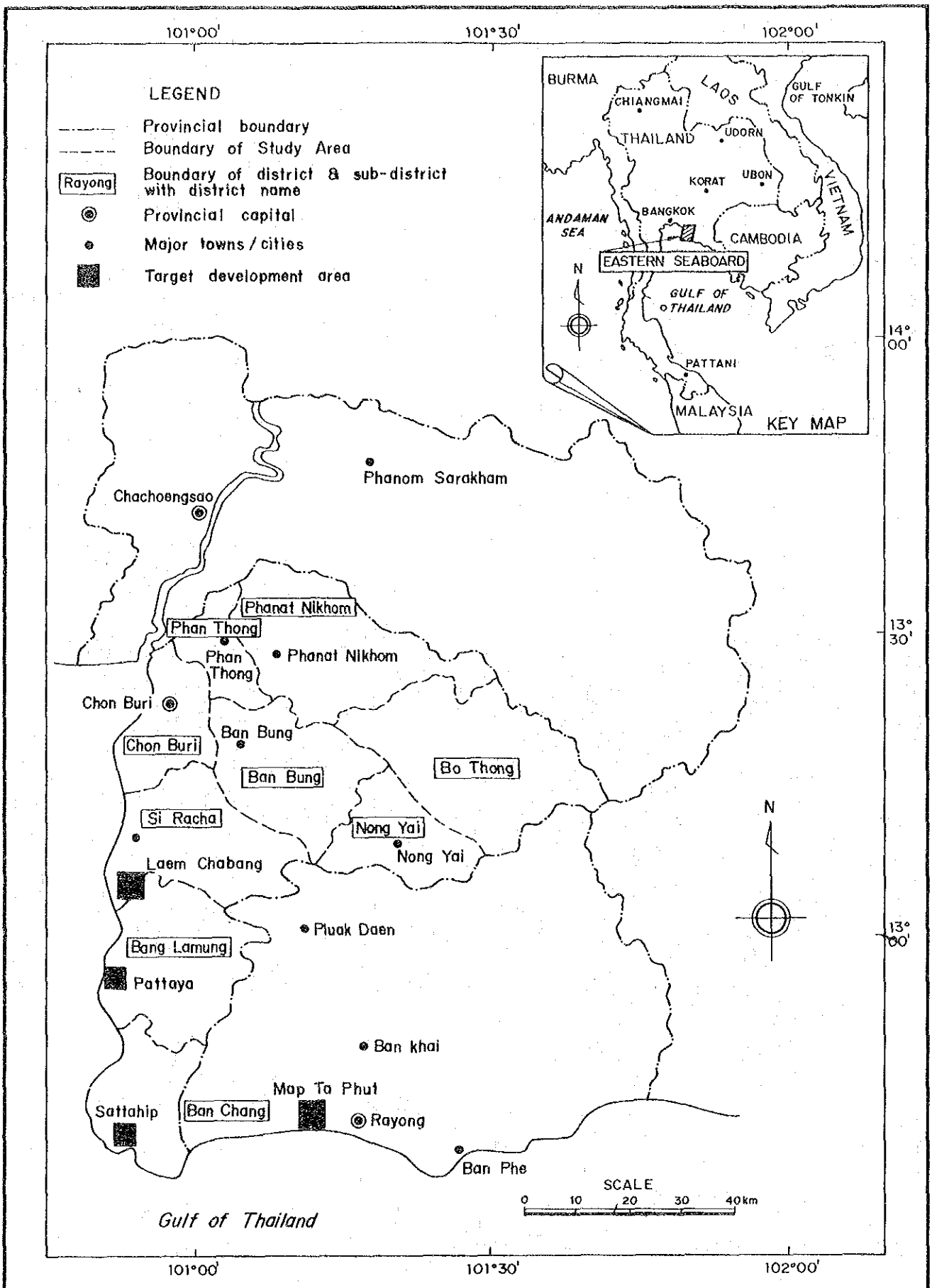

Fig.1 Map of Eastern Seaboard

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NONG KHO – LAEM CHABANG
WATER PIPELINE PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

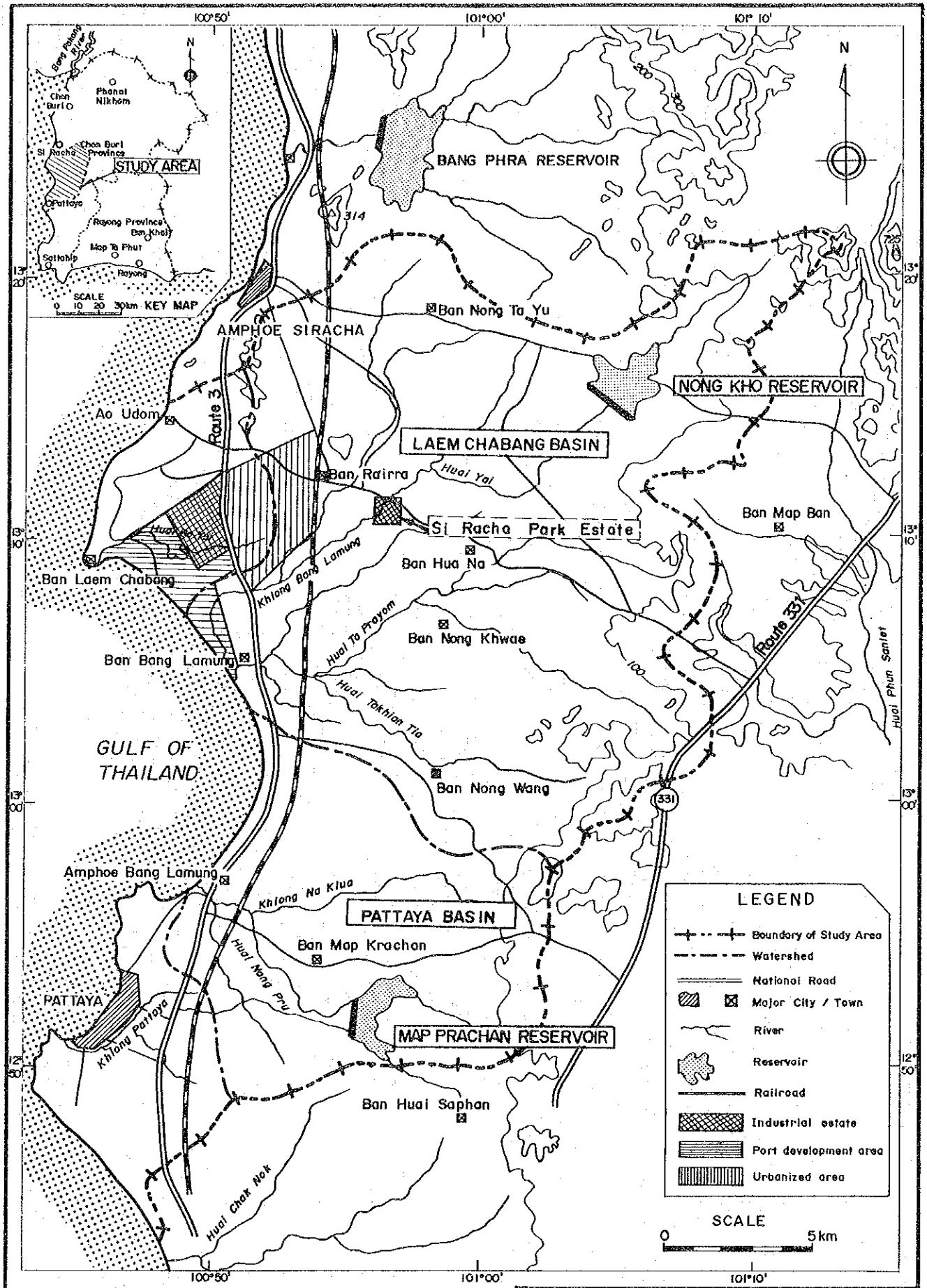

Fig. 2 Map of Study Area

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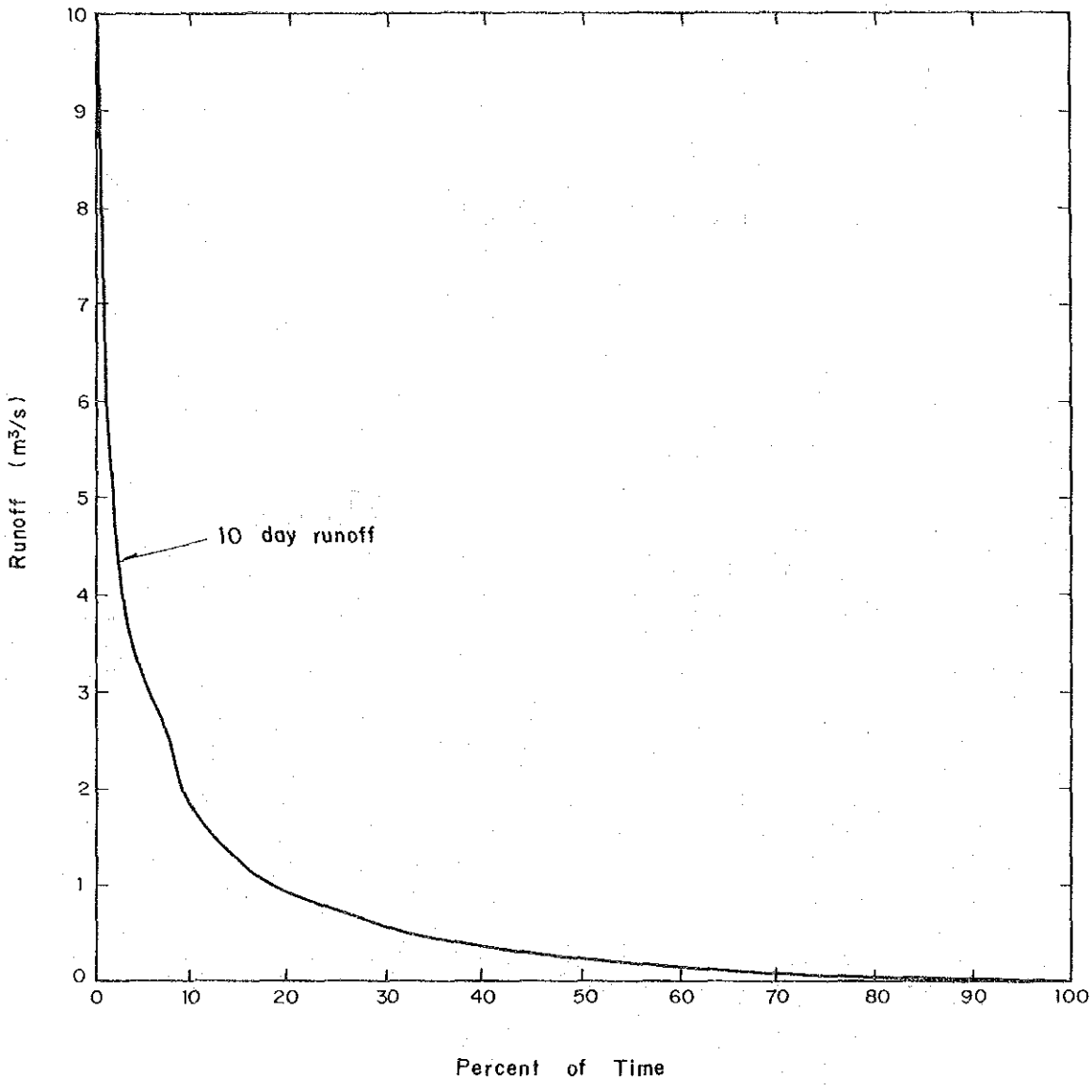

Fig.3 Flow Duration Curve at Nong Kho Damsite, 1968 to 1983

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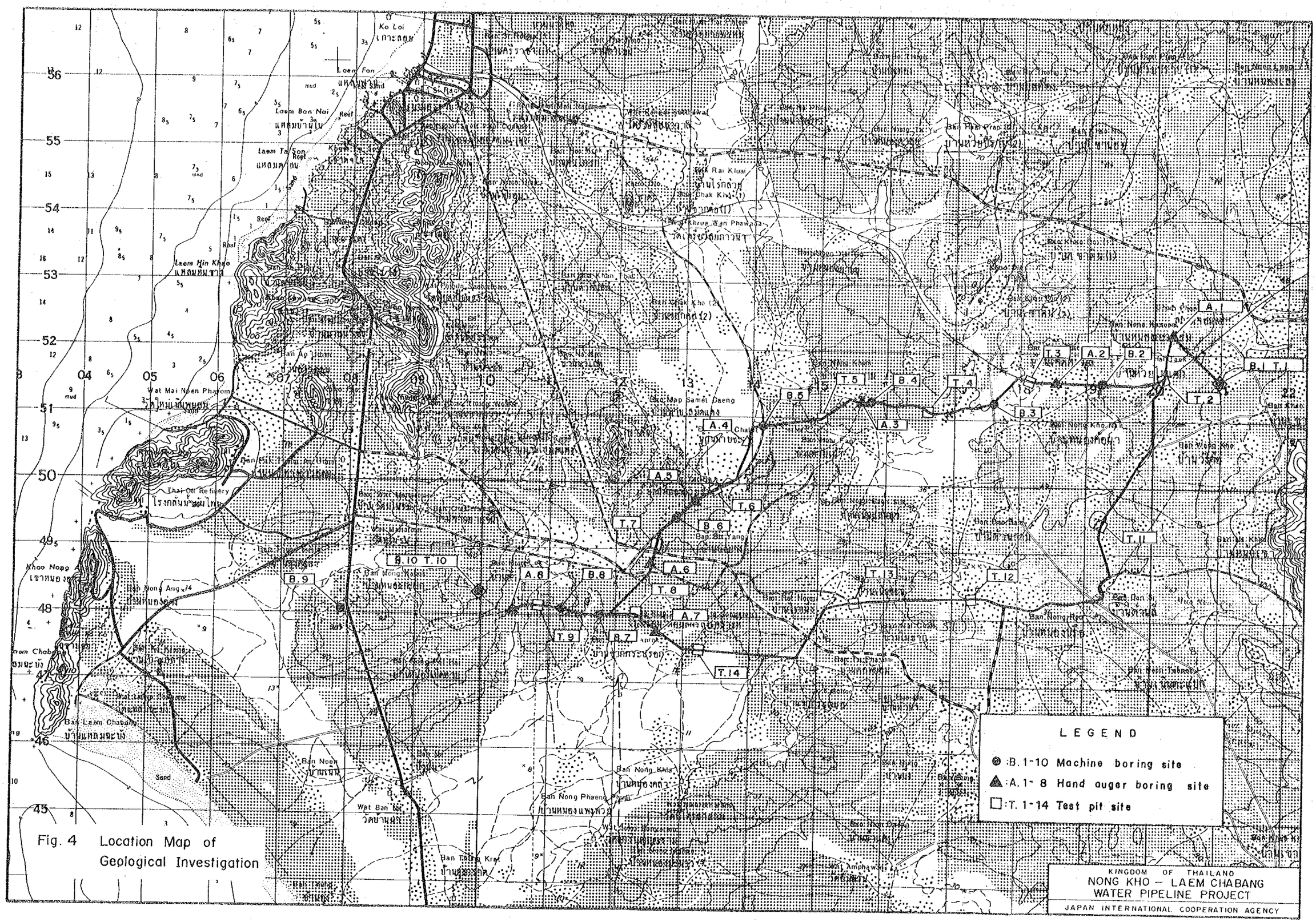
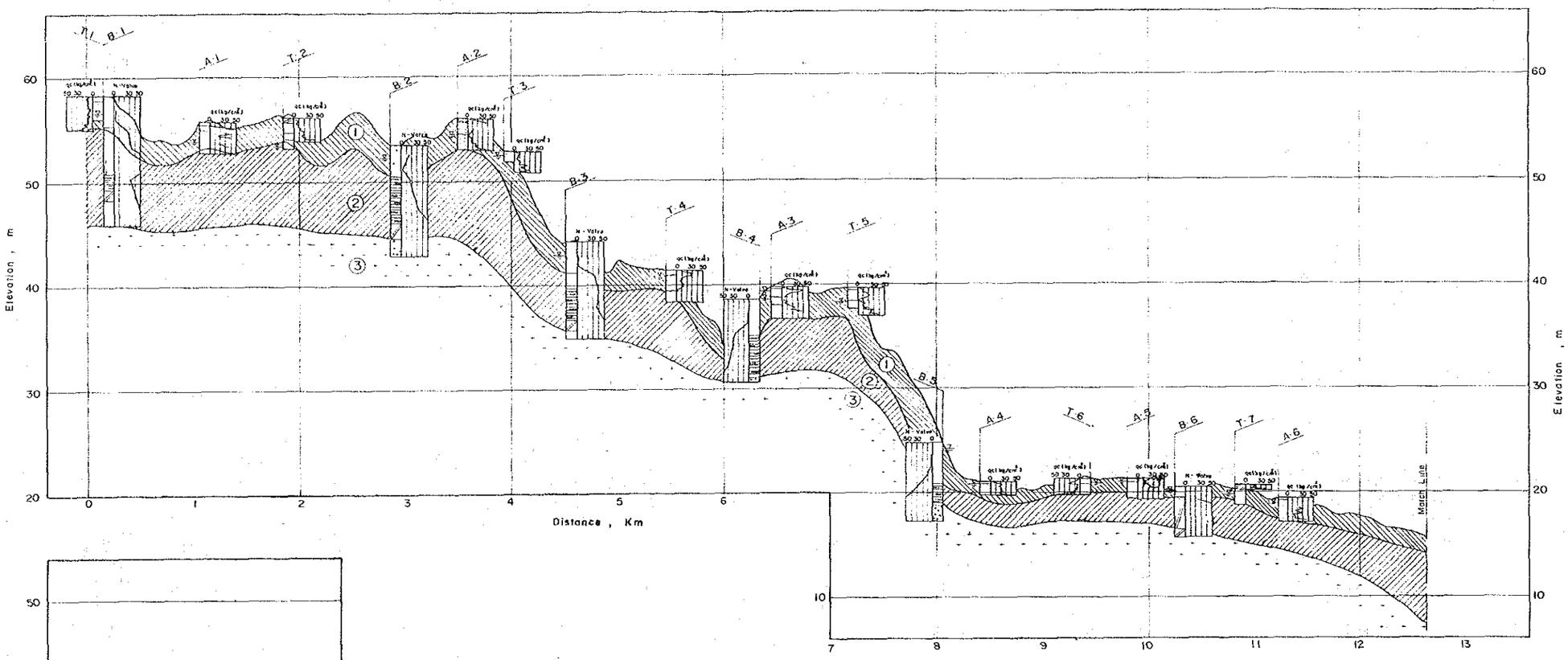
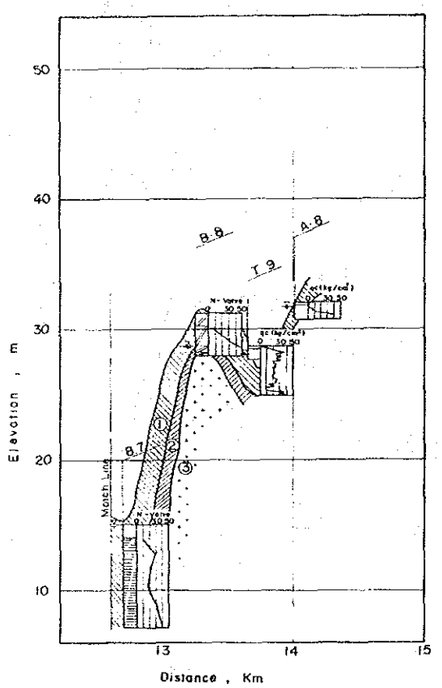


Fig. 4 Location Map of Geological Investigation





LEGEND

SOIL SYMBOLS			GEOLOGICAL SYMBOLS
Gravel	Gravely	Gravel mixed	Completely weathered granite
Sand	Sandy	Sand mixed	Highly weathered granite
Silt	Silty	Silt mixed	Slightly weathered granite
Clay	Clayey	Clay mixed	
Groundwater table		A-1 Hand augar hole	
B-1 Bore hole		T-2 Test pit	

Fig. 5 Geological Profile along Proposed Pipeline Route

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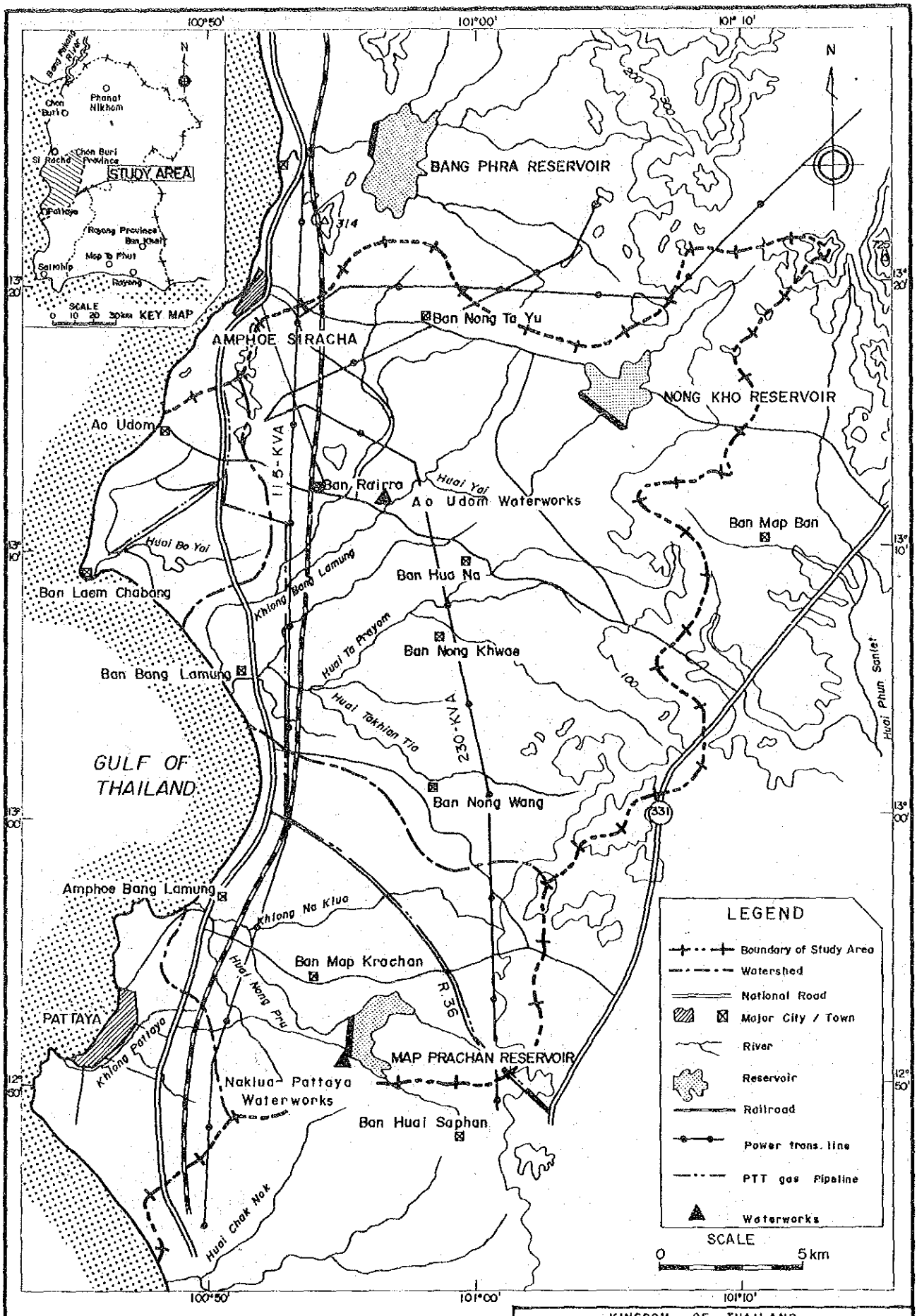

Fig. 6 Major Infrastructures

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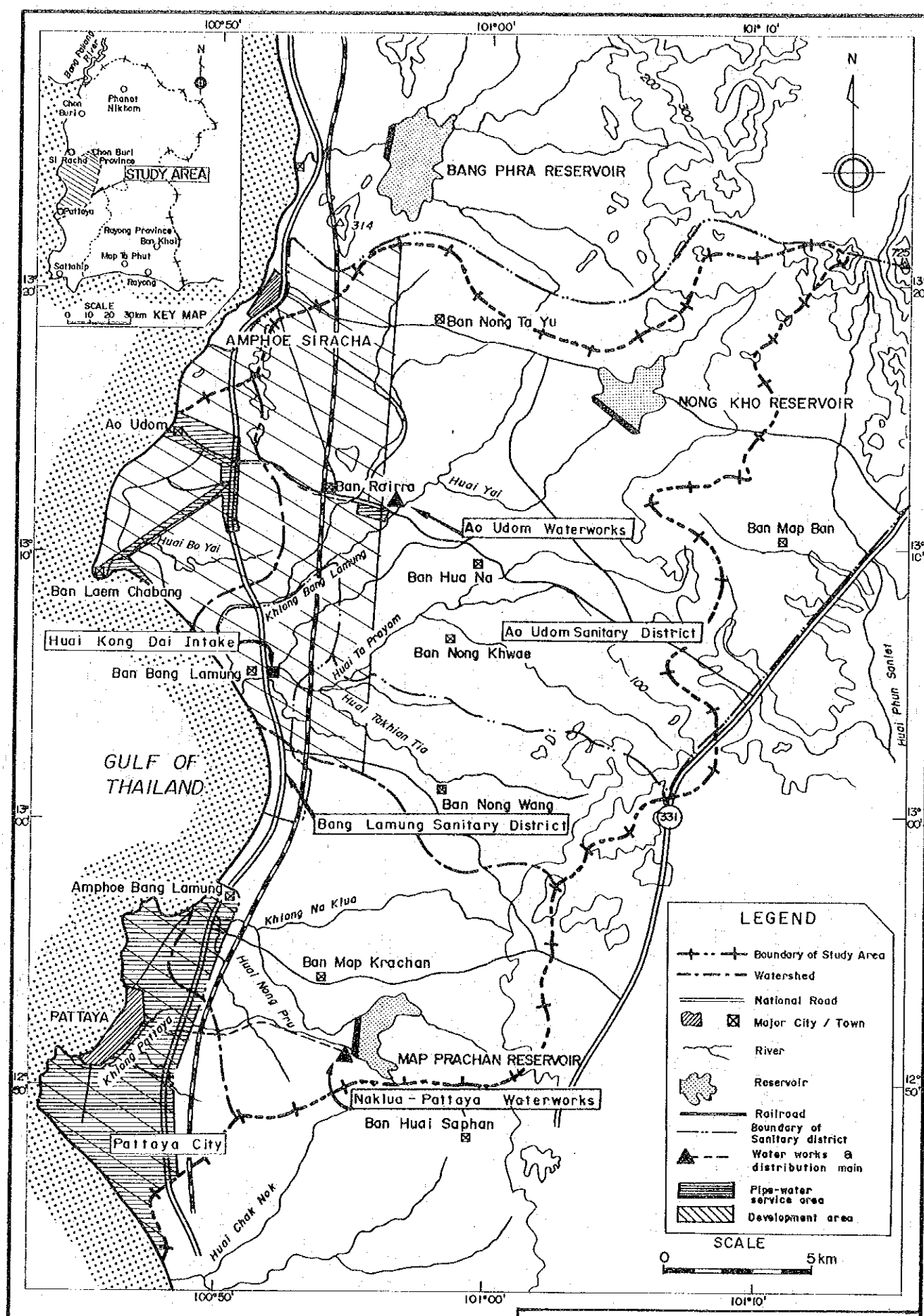

Fig. 7 Sanitary Districts & Waterworks

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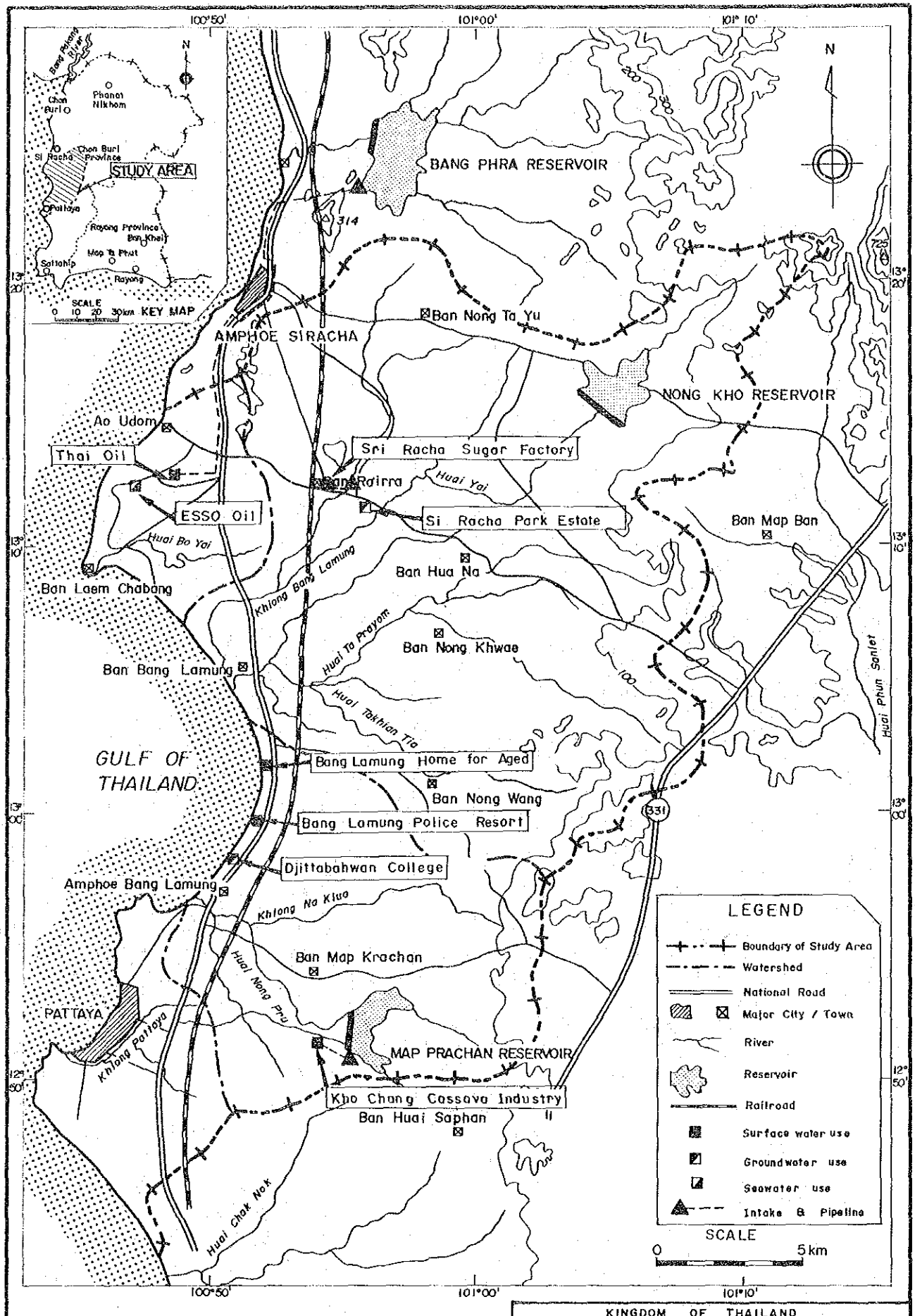

Fig. 8 Private Water Supply Facilities

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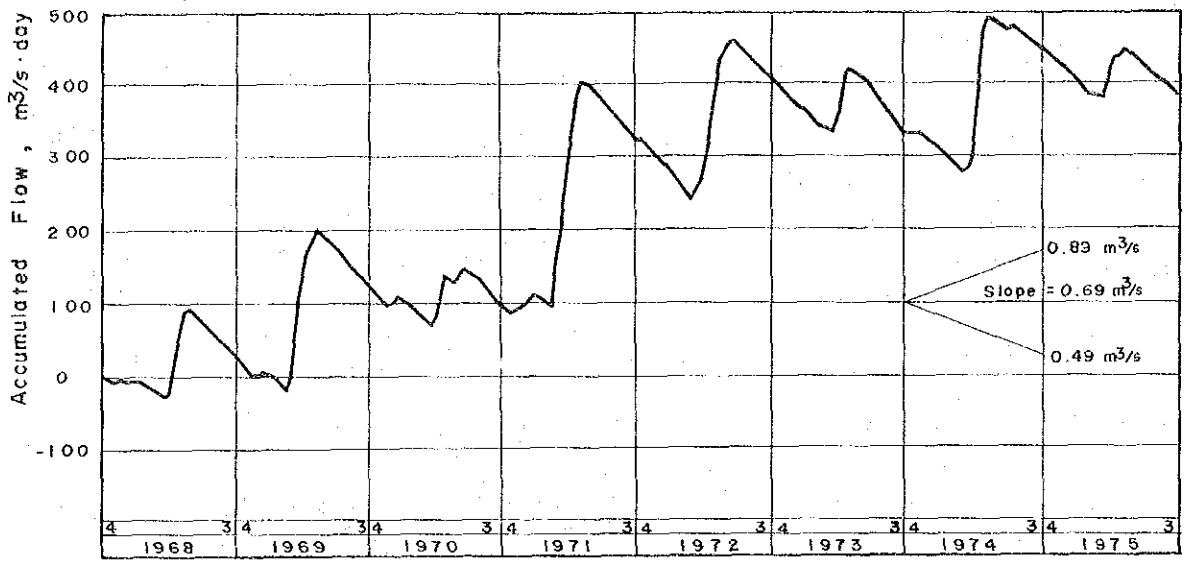

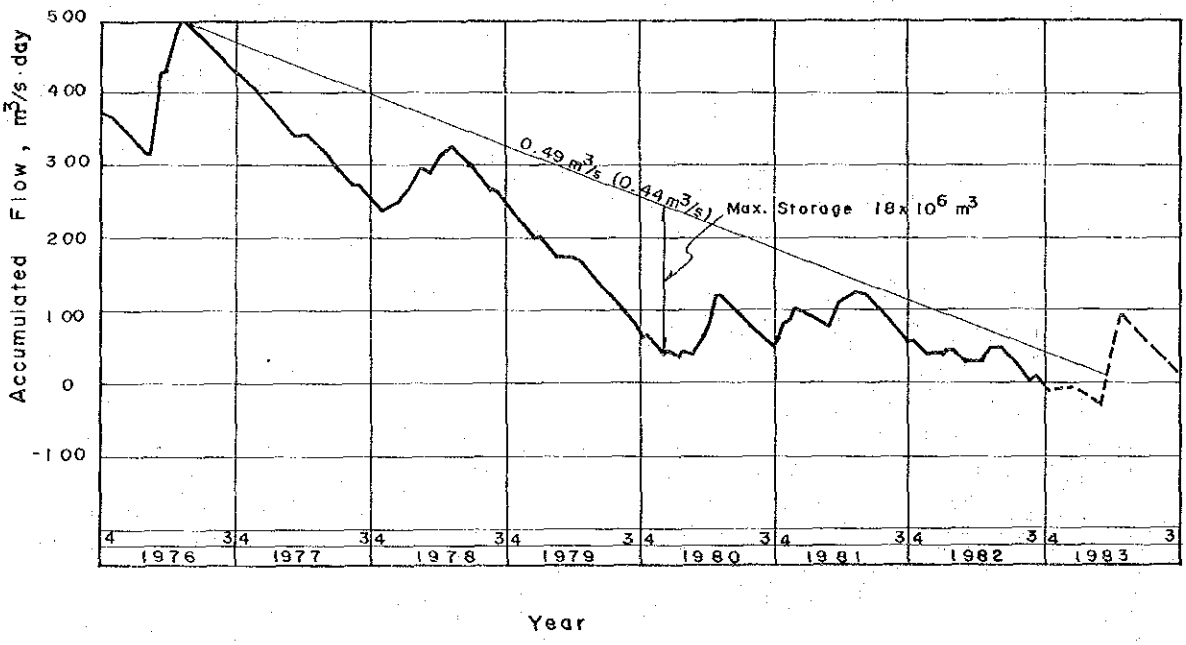

Note : Draft rate with and without parenthesis indicates net and gross respectively.

Fig. 9 Mass Curve of Nong Kho Reservoir

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NONG KHO – LAEM CHABANG
WATER PIPELINE PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

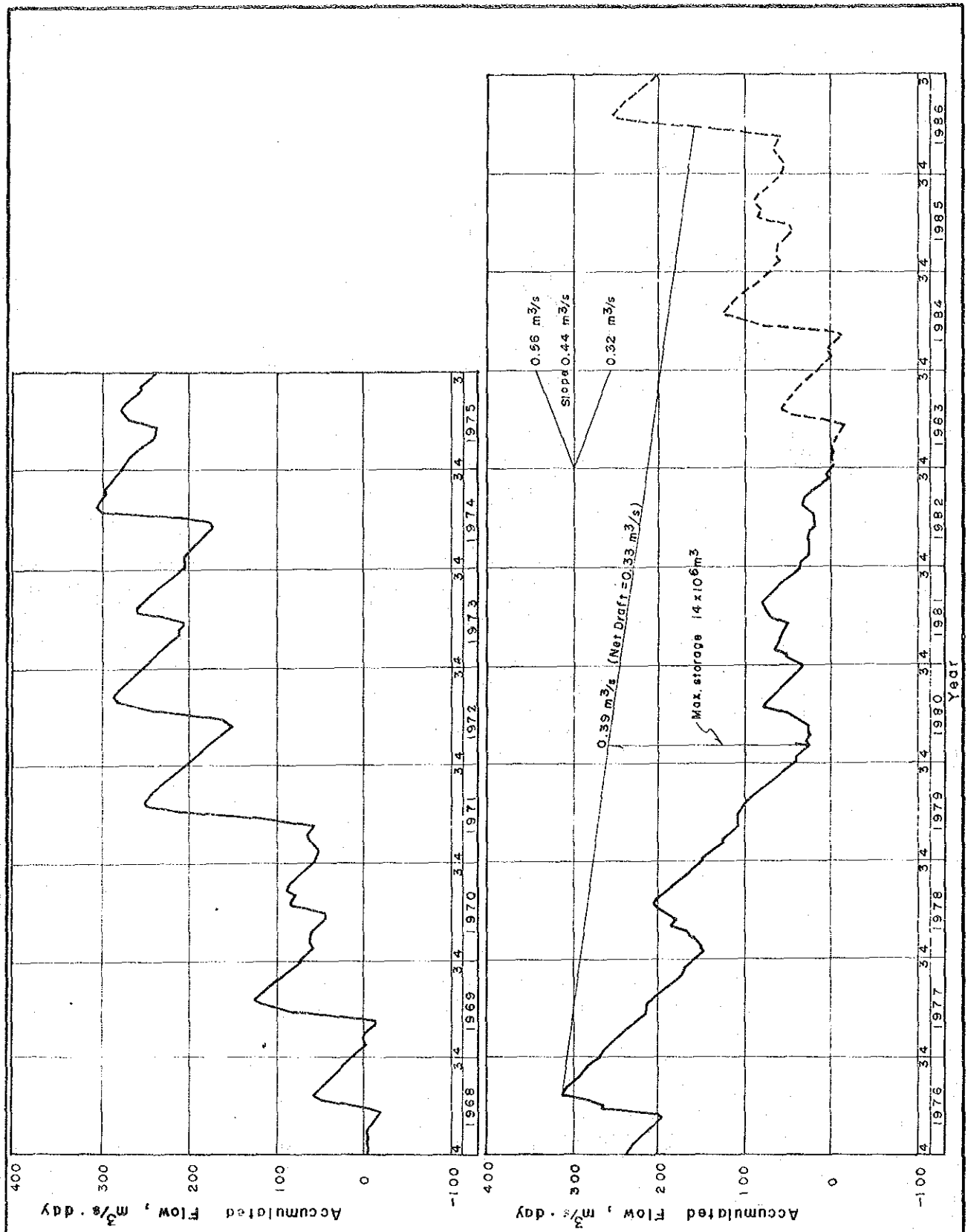

Fig. 10 Mass Curve of Map Prachan Reservoir

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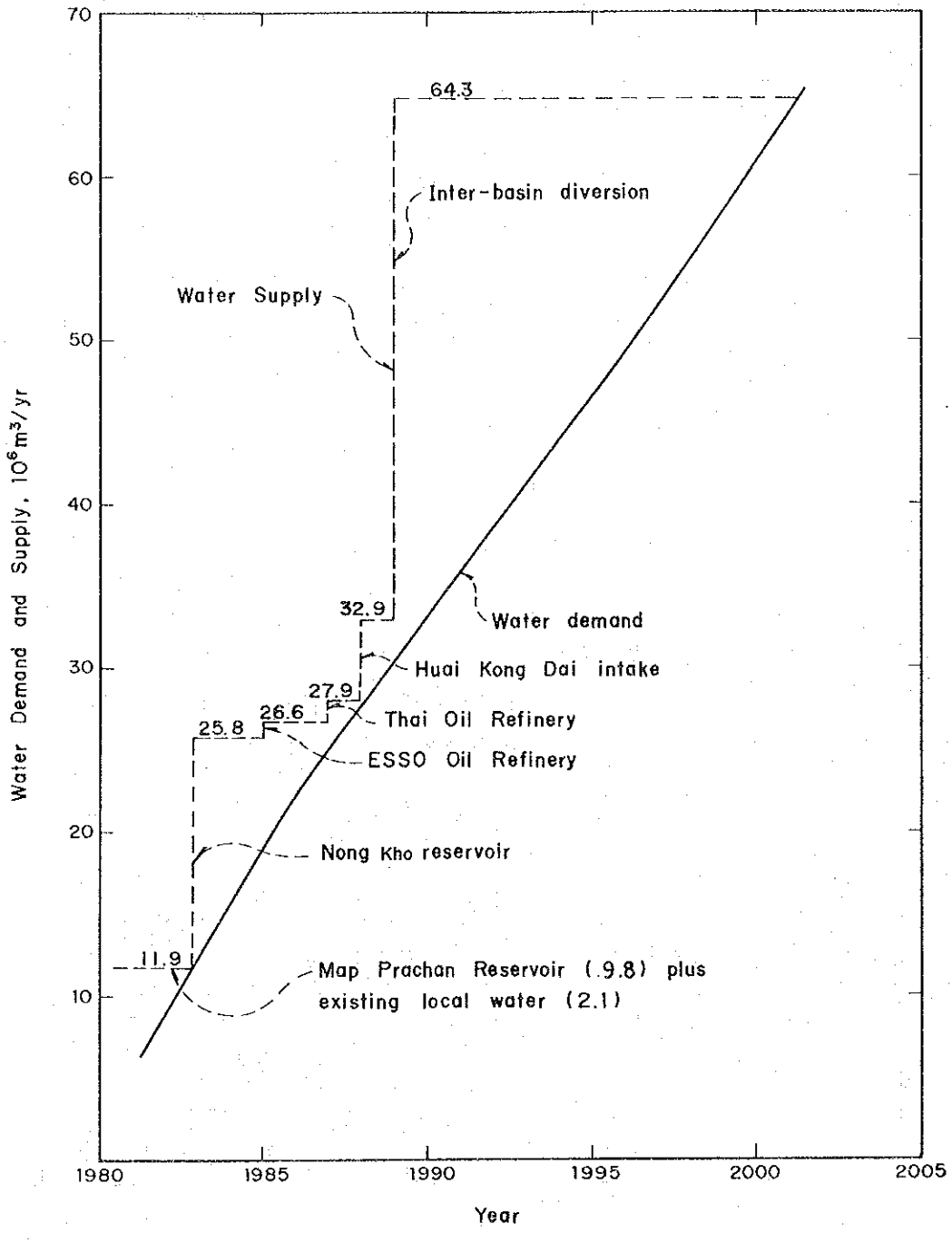

Note : Water demand includes the river maintenance flow.

Fig.11 Water Demand and Supply Balance (Case 1, With Pattaya Basin)

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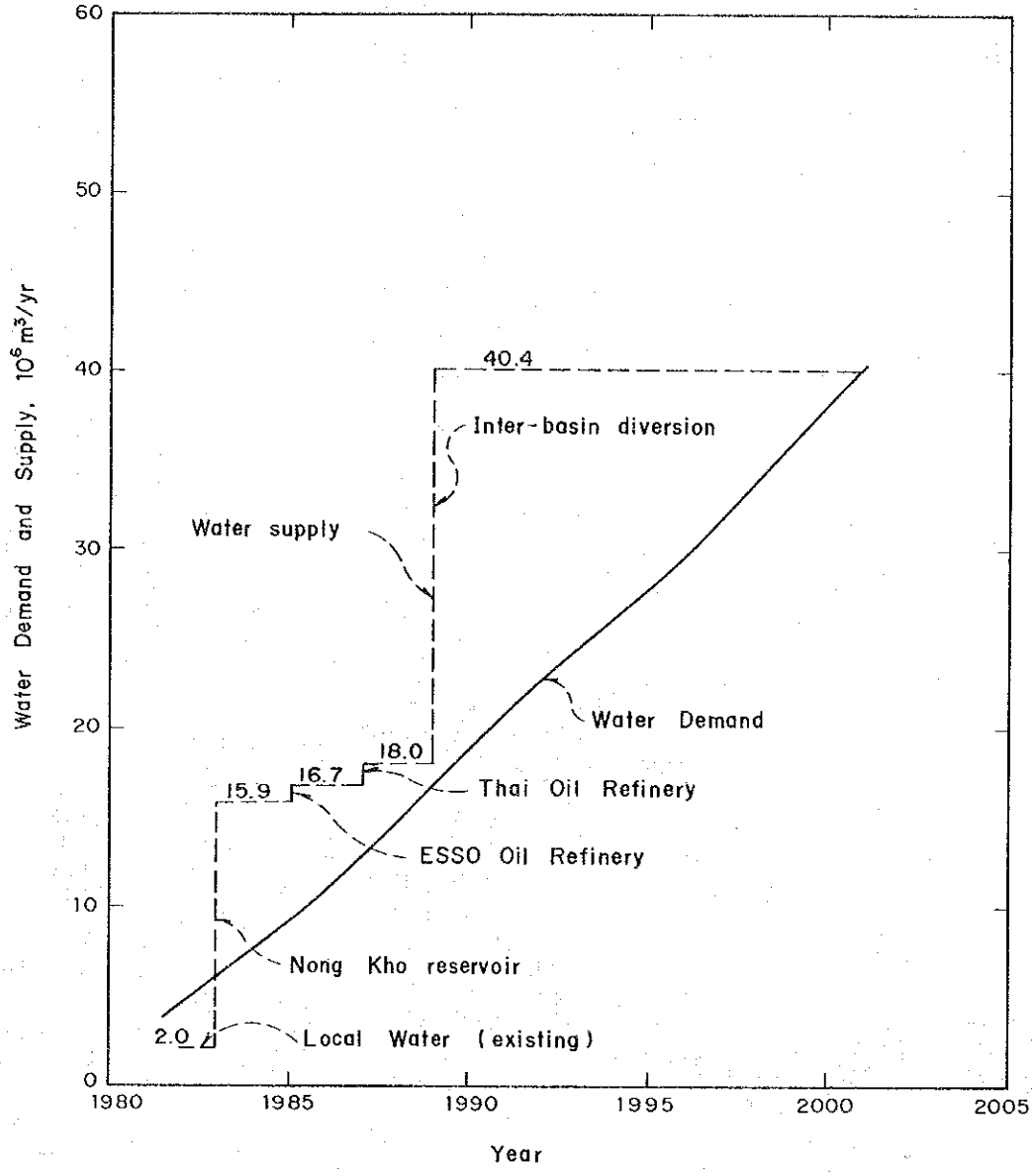

Note : Water demand includes the river maintenance flow

Fig.12 Water Demand and Supply Balance (Case 2, Without Pattaya Basin)

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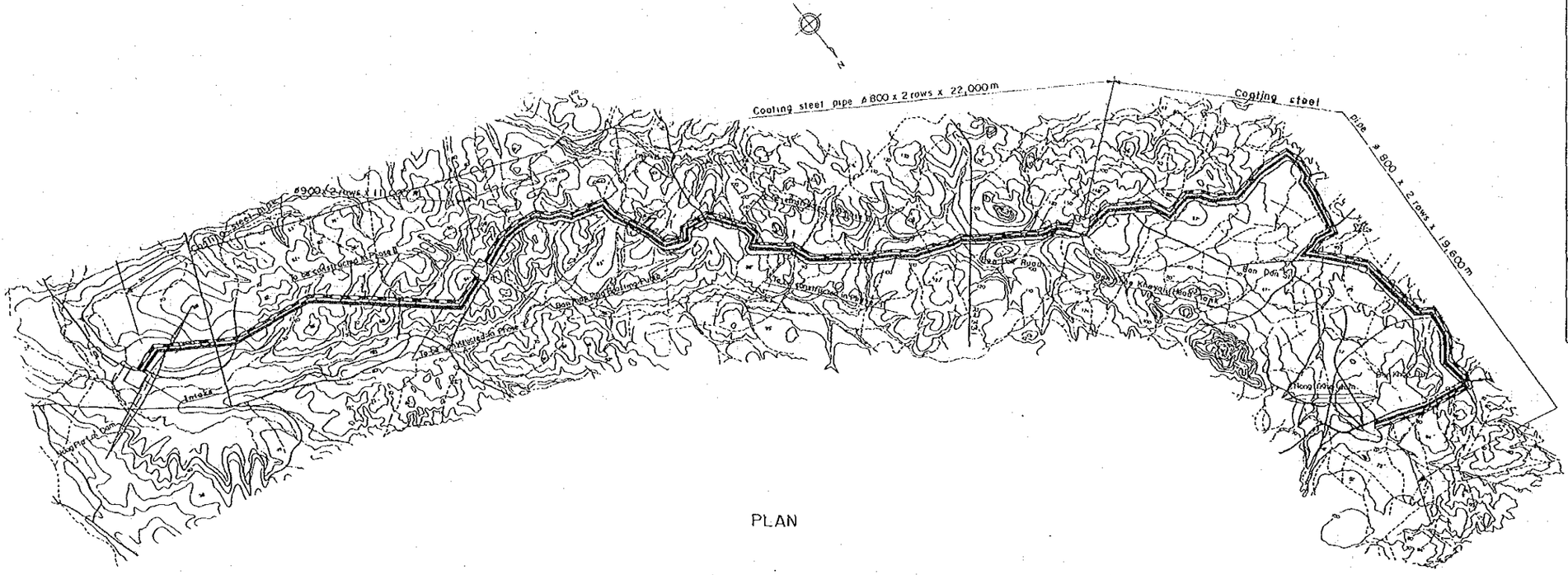

PLAN

PROFILE

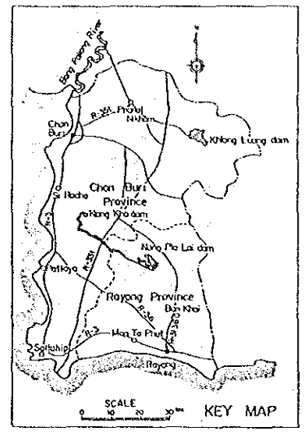

Fig. 13 Inter-basin Water Diversion between Nong Pla Lai and Nong Kho Dams

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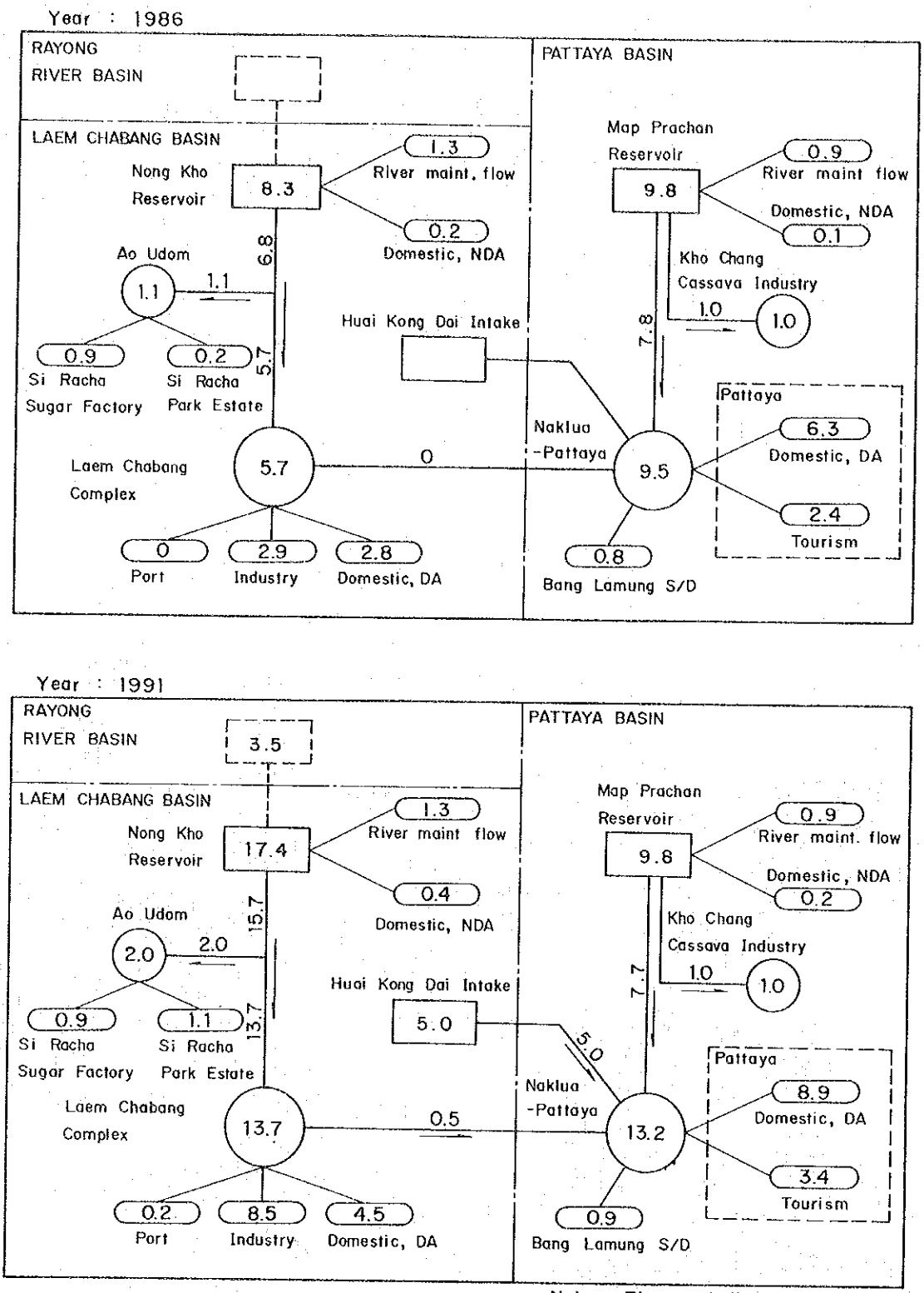

Fig. 14 Raw Water Distribution Plan (1/2)

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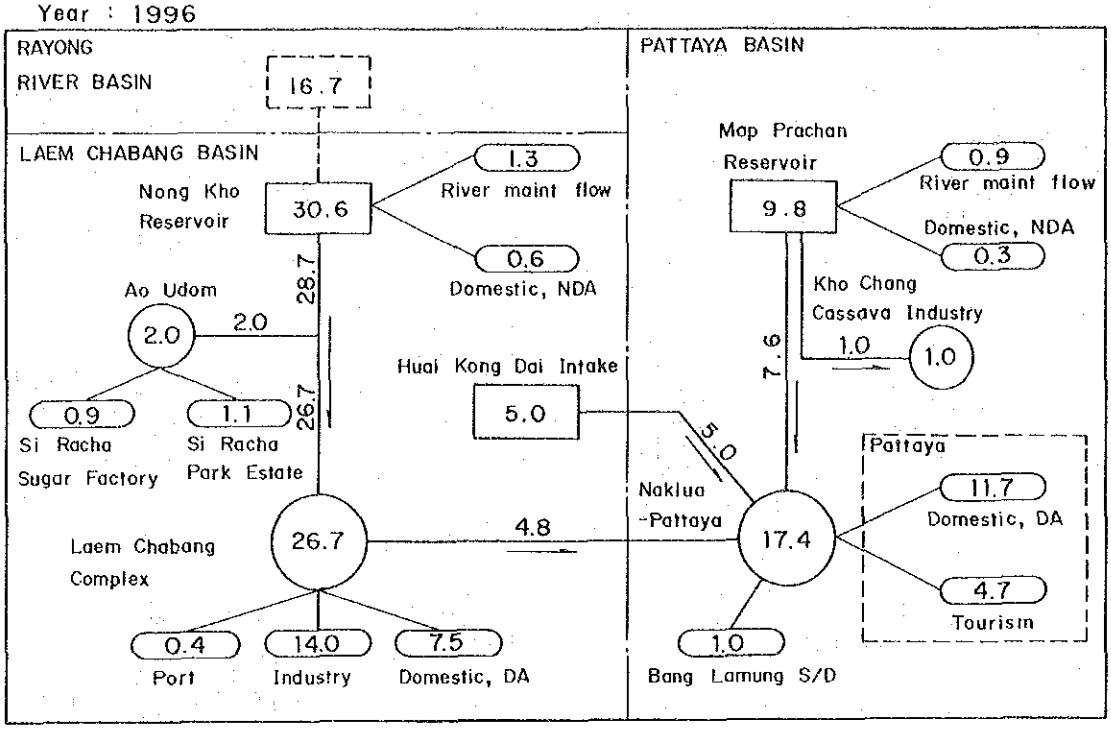

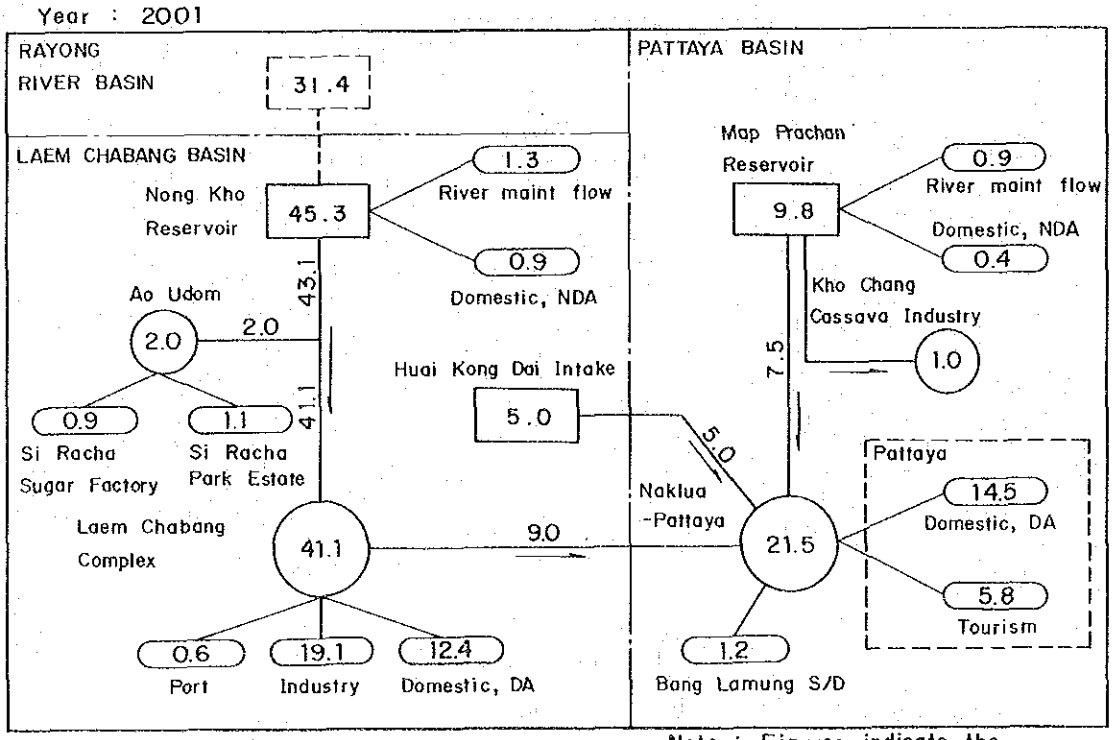

LEGEND

- Water source facilities
- Water use
- Demand center

Note : Figures indicate the annual water withdrawal or water supply amount in $10^6 m^3$

Fig. 14 Raw Water Distribution Plan (2/2)

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NONG KHO — LAEM CHABANG
WATER PIPELINE PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY

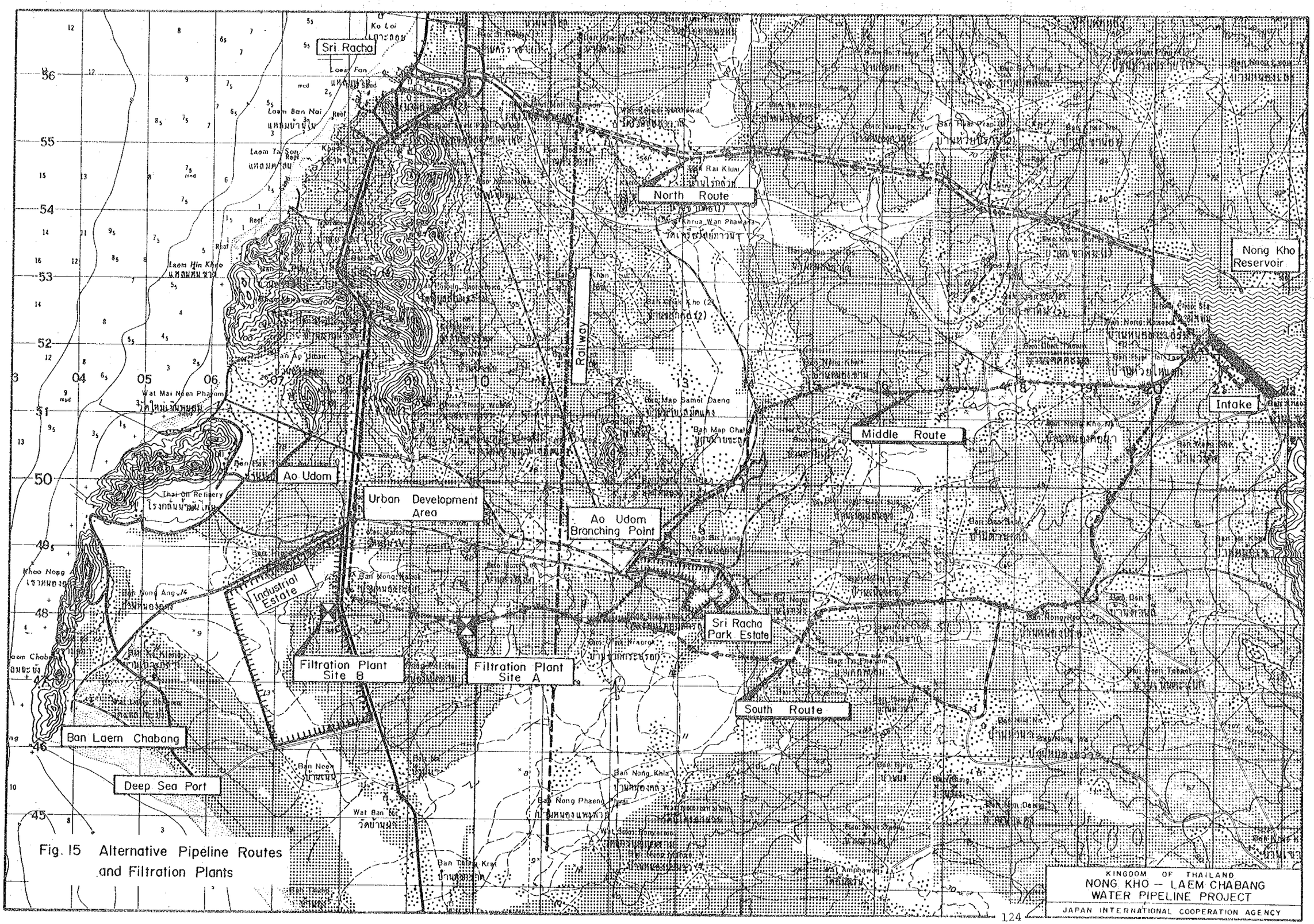

Fig. 15 Alternative Pipeline Routes and Filtration Plants

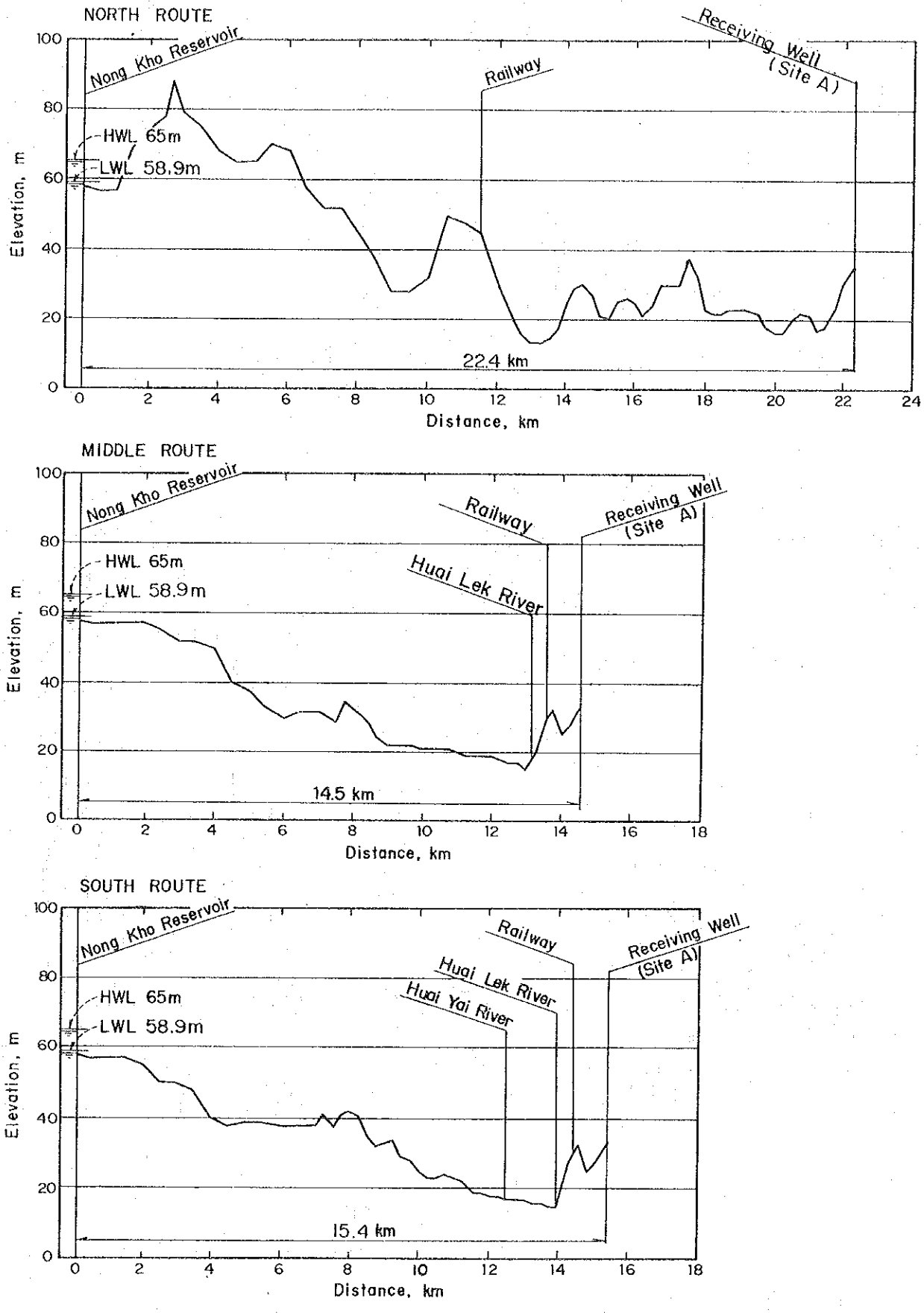

Fig. 16 Longitudinal Profile along Alternative Pipeline Routes

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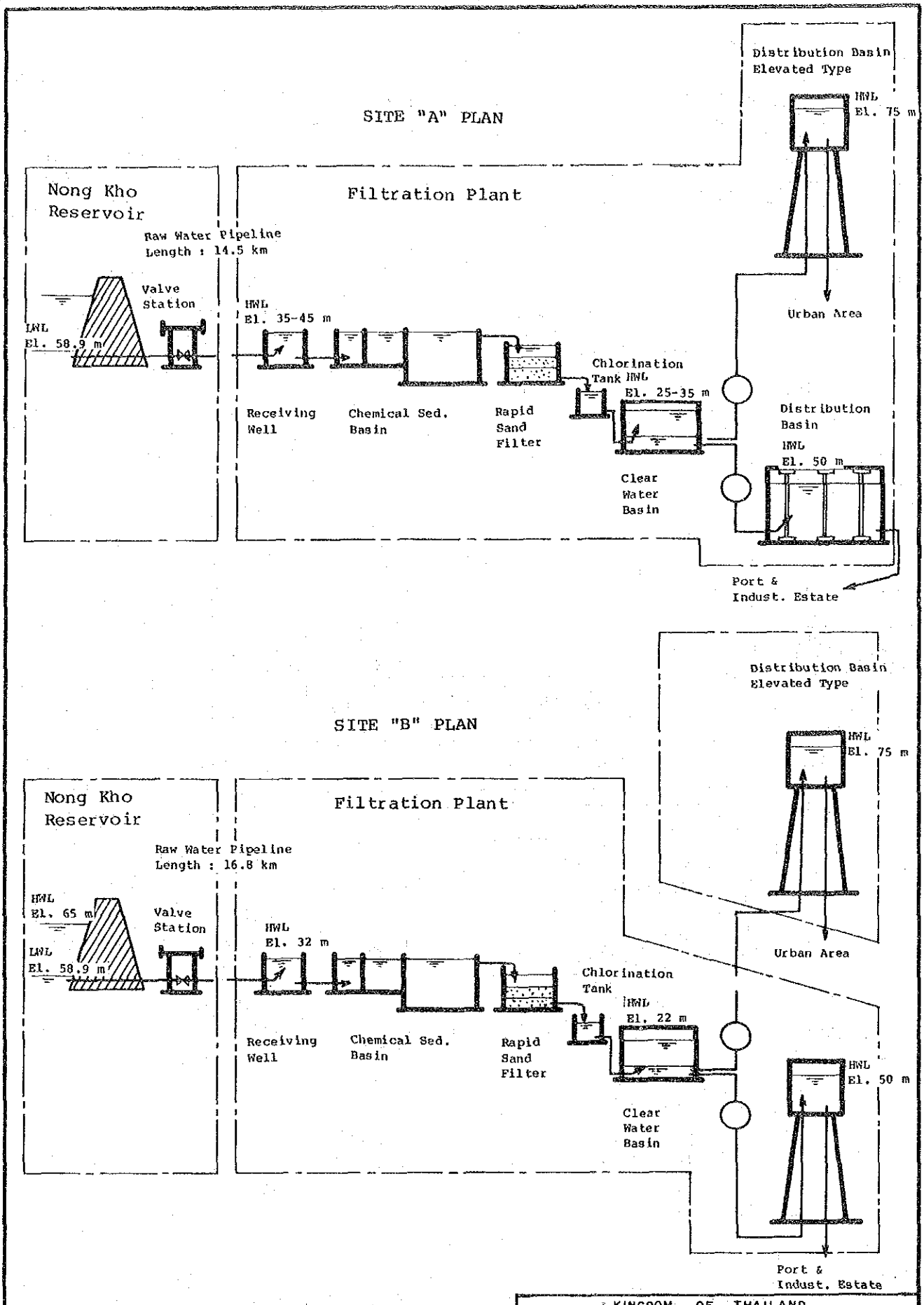

Fig. 17 Conceptual Layout of Water Transmission and Distribution

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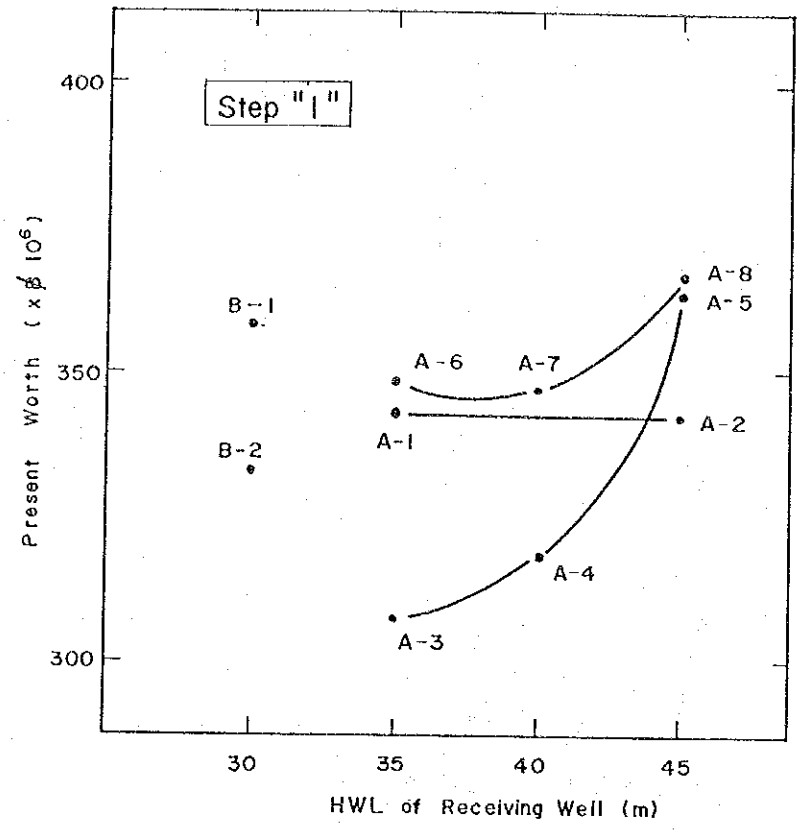

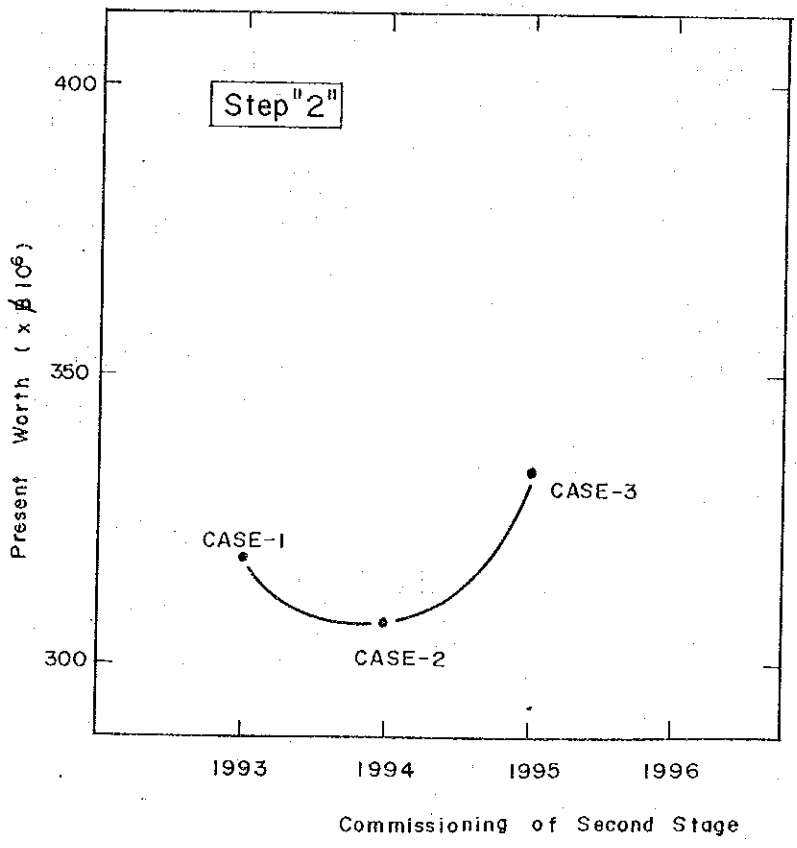

Fig. 18 Summary of Optimization Study for Step "1" and Step "2"

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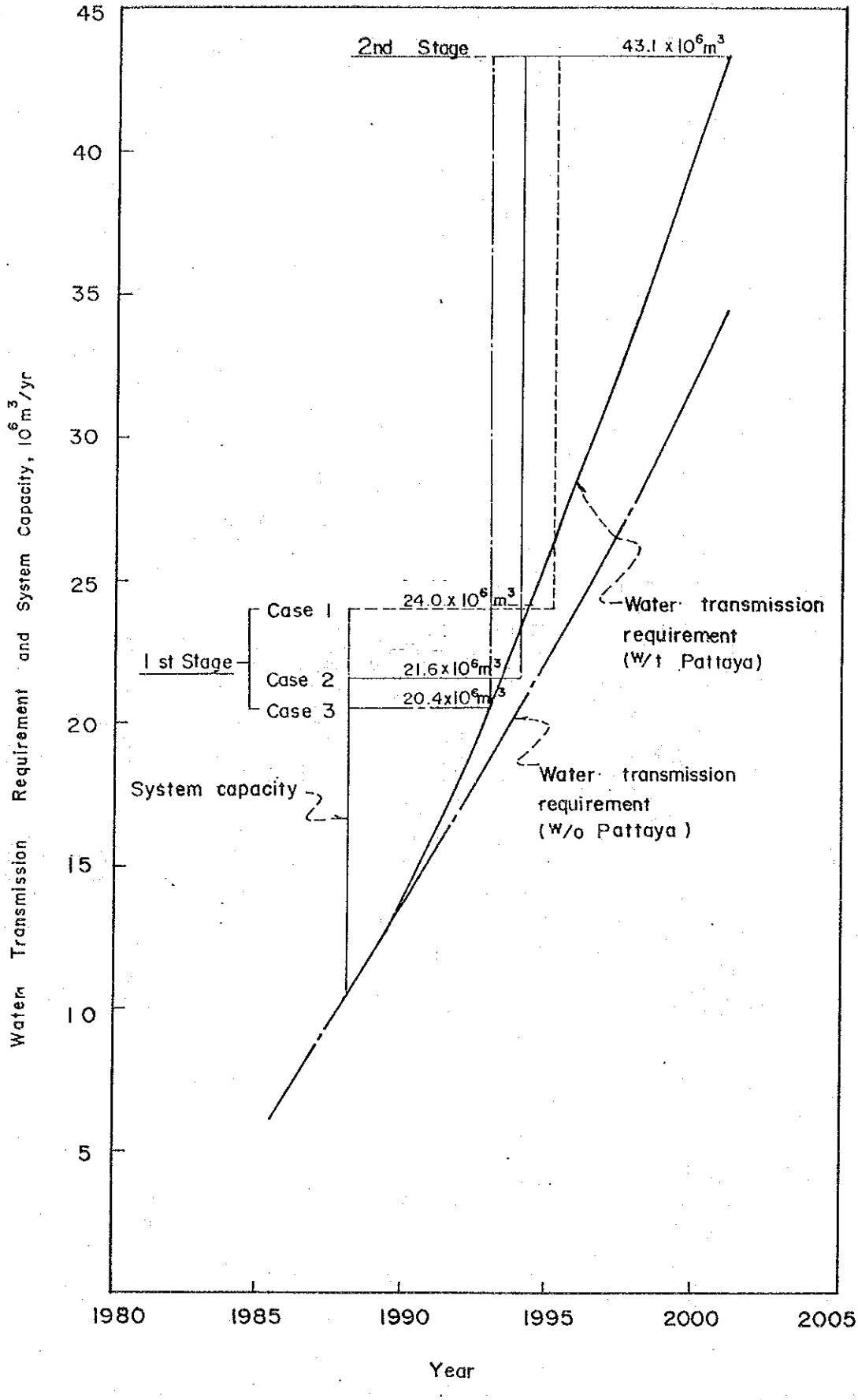

Fig. 19 Alternatives of Second Stage Commissioning

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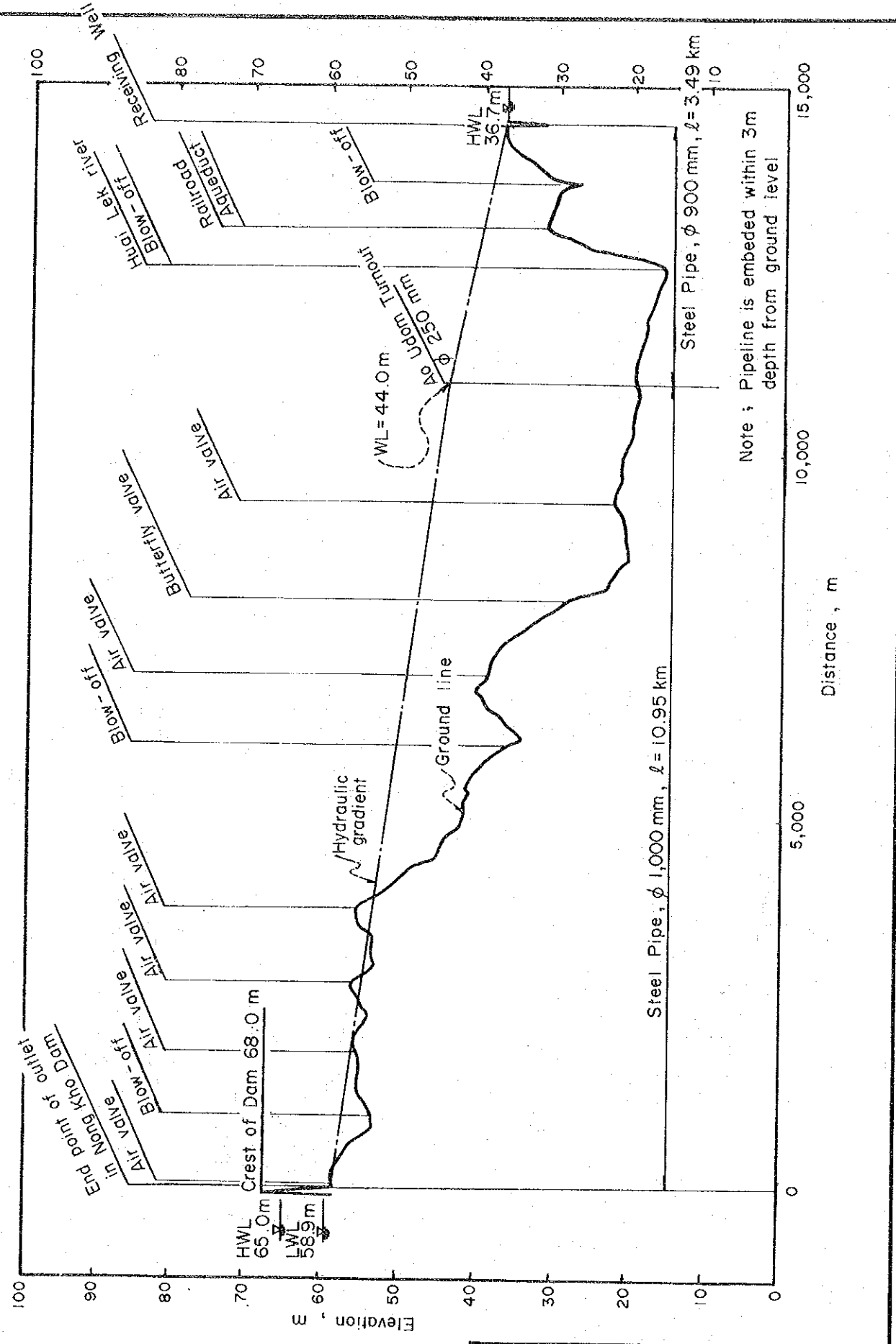

Fig. 20 Longitudinal Profile of Pipeline

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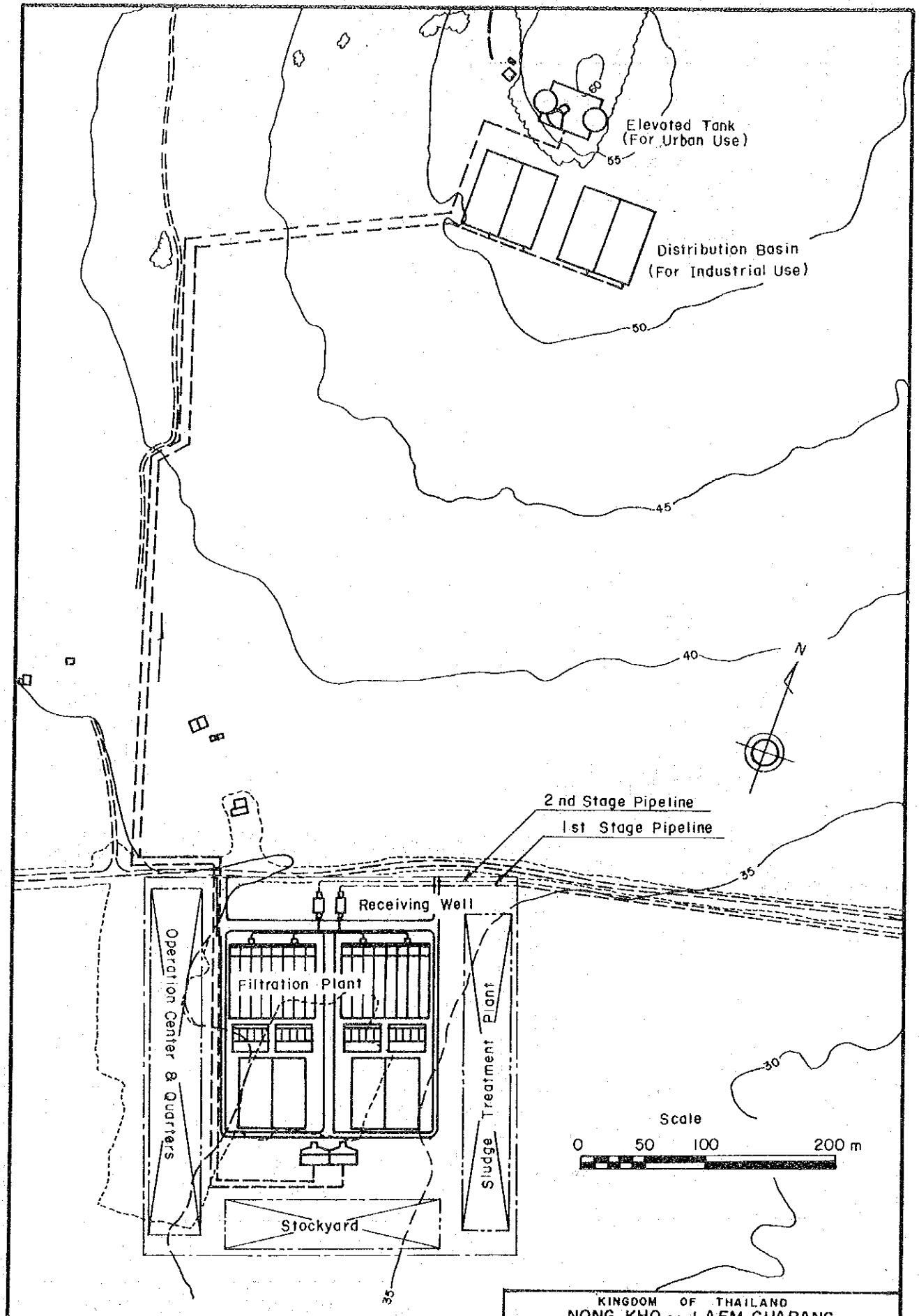

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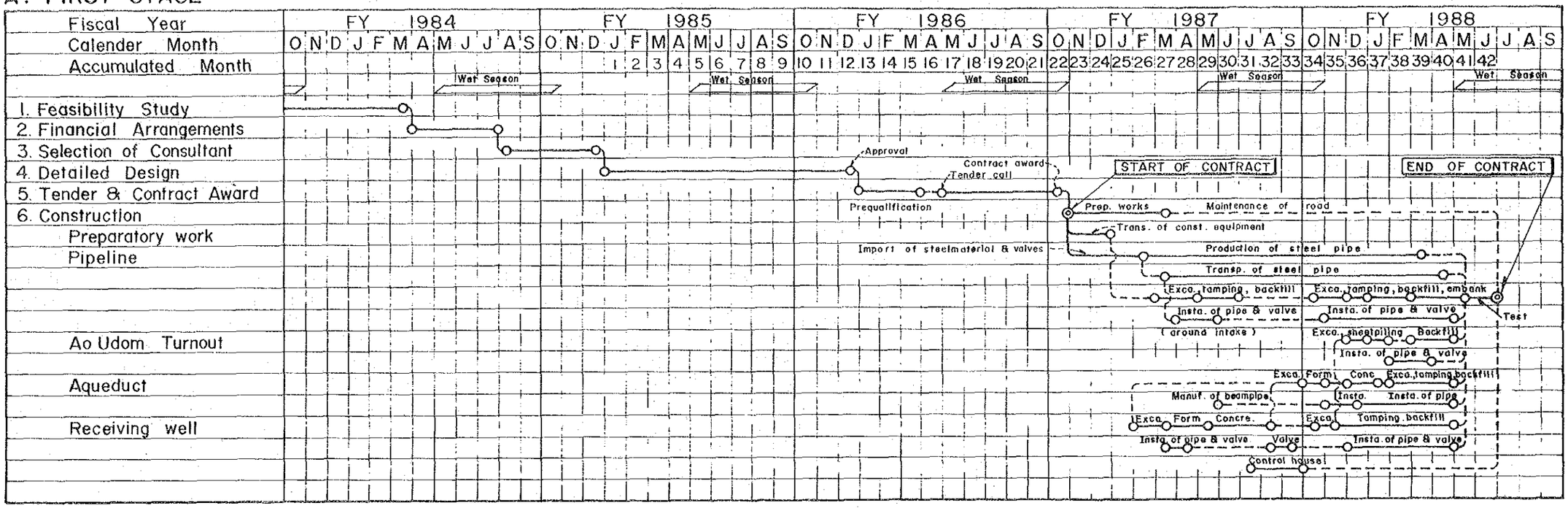
Fig. 21 Preliminary Layout Plan of Water Treatment and Distribution Facilities

A. FIRST STAGE



B. SECOND STAGE

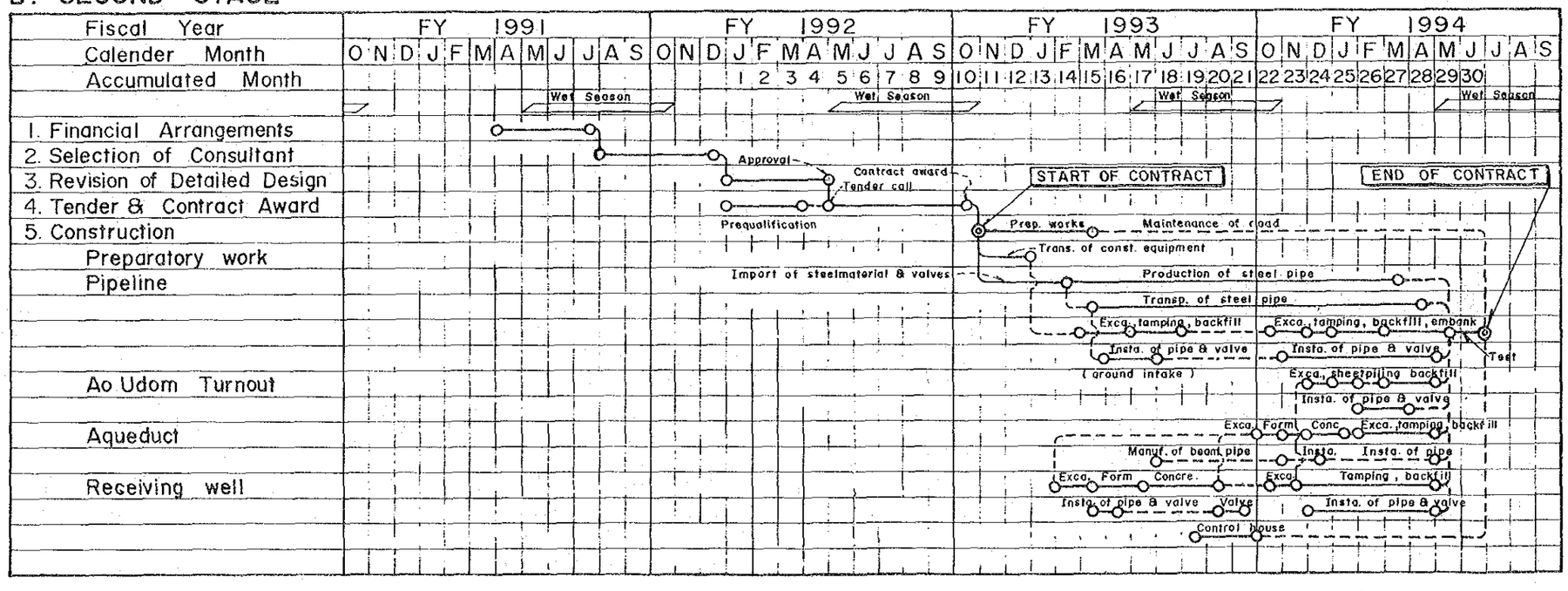


Fig.22 Project Implementation Programme

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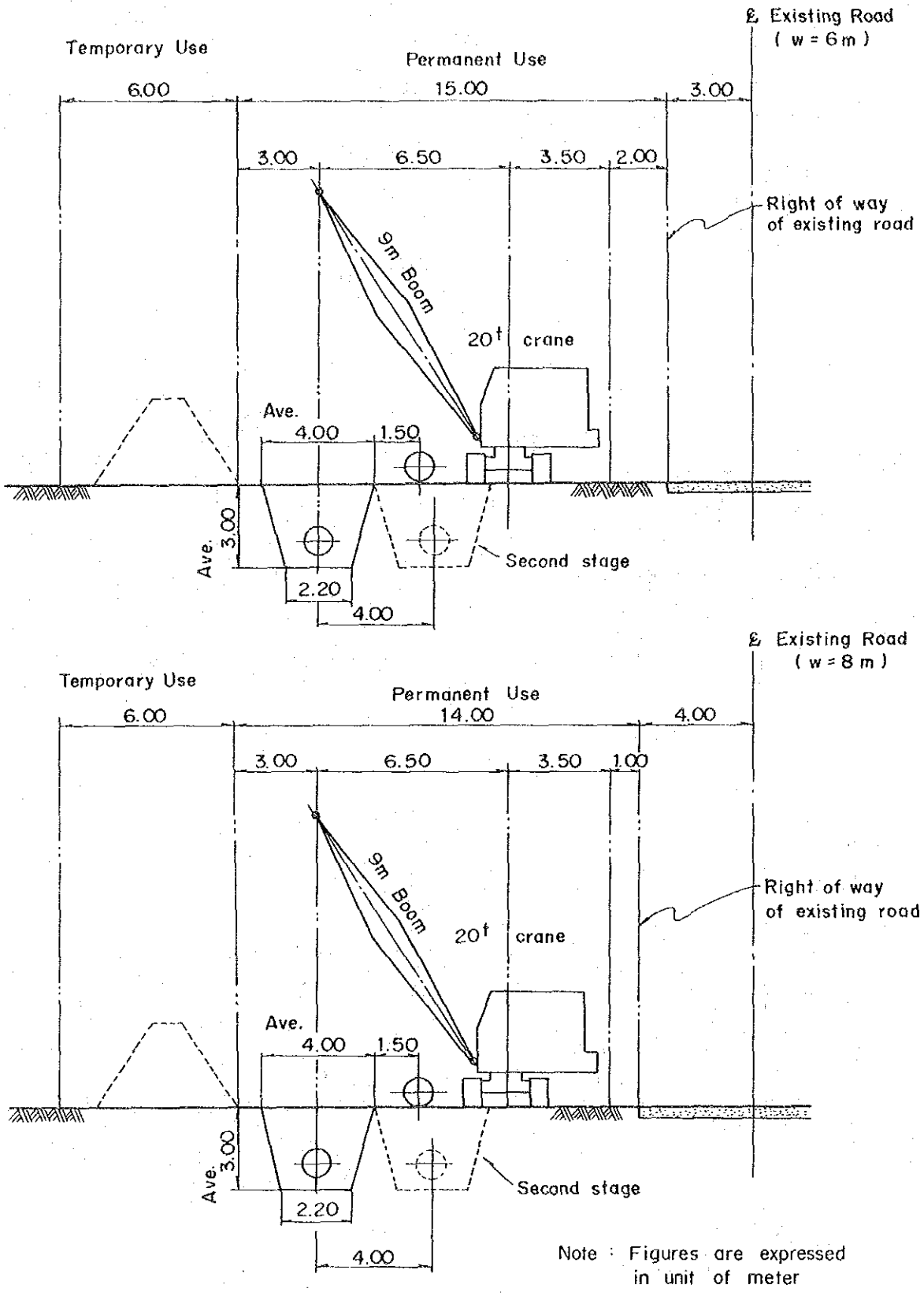

Fig. 23 Installation of Pipe

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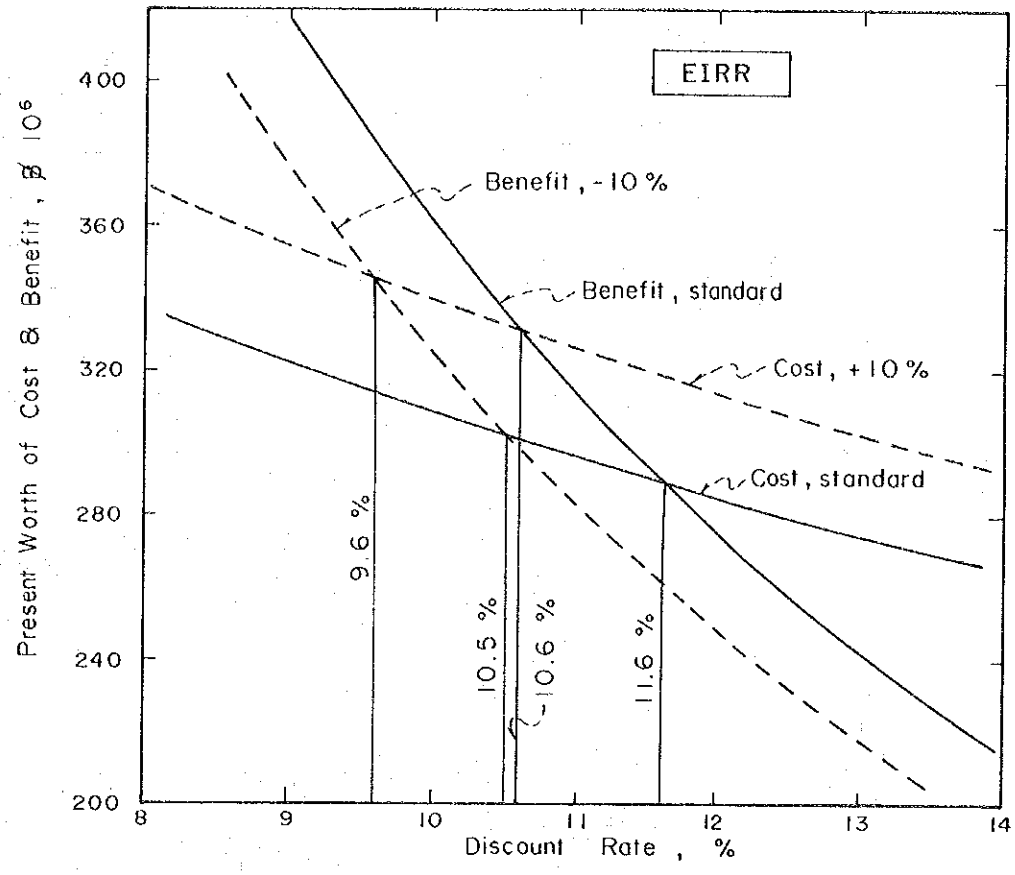

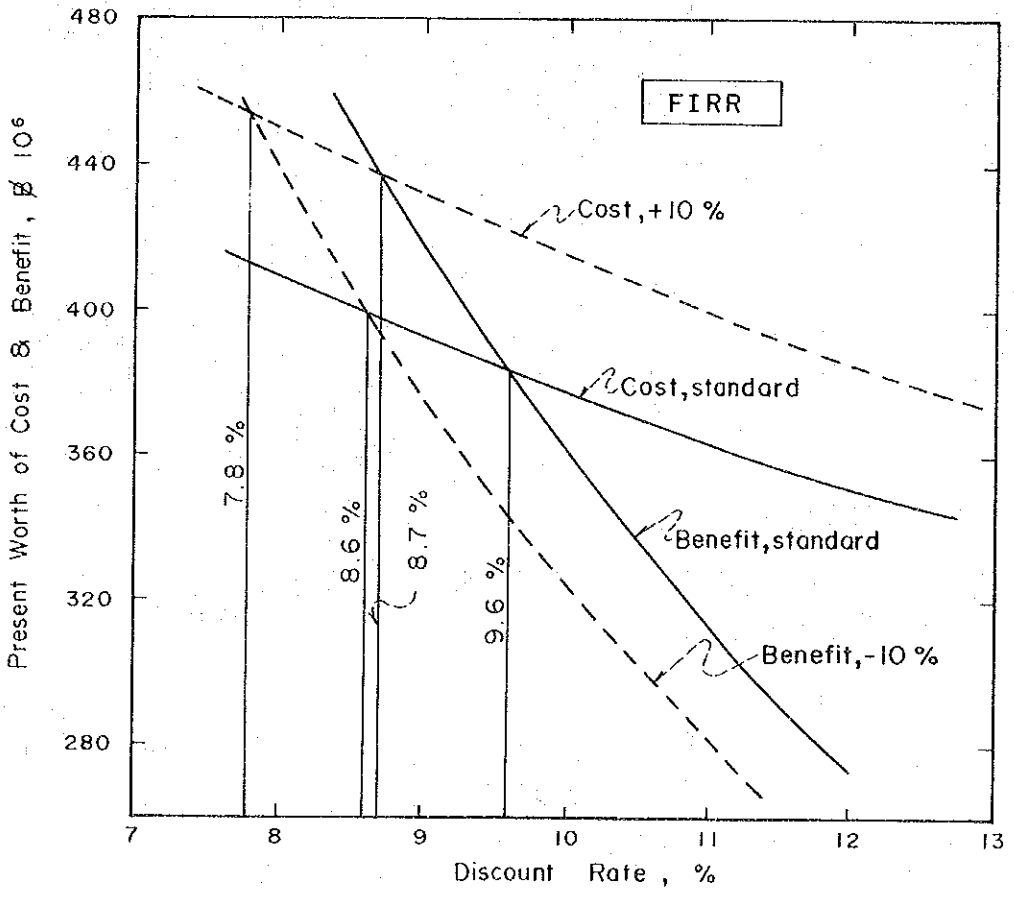

Fig.24 Economic and Financial Internal Rate of Return

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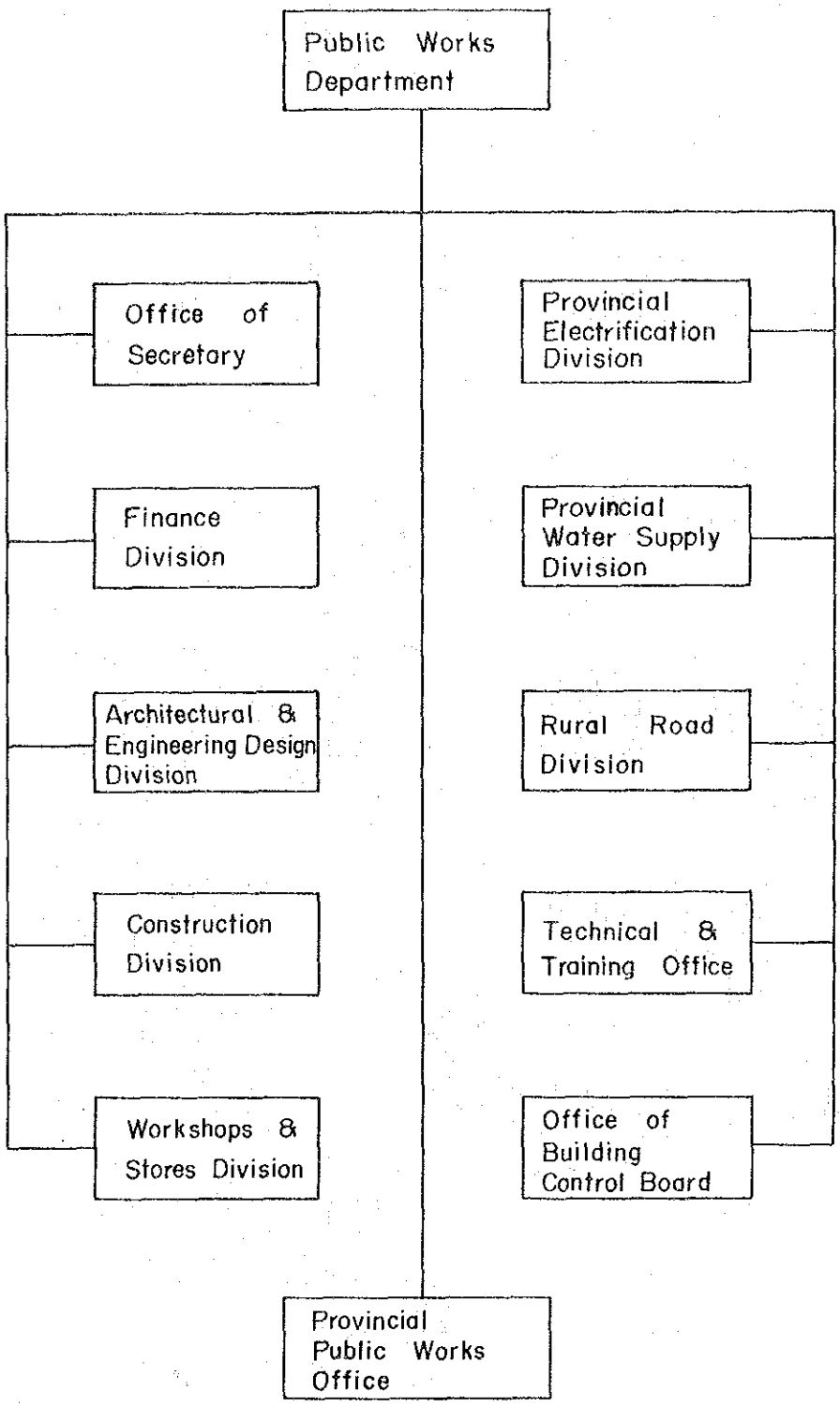

Fig.25 Organization Chart of PWD

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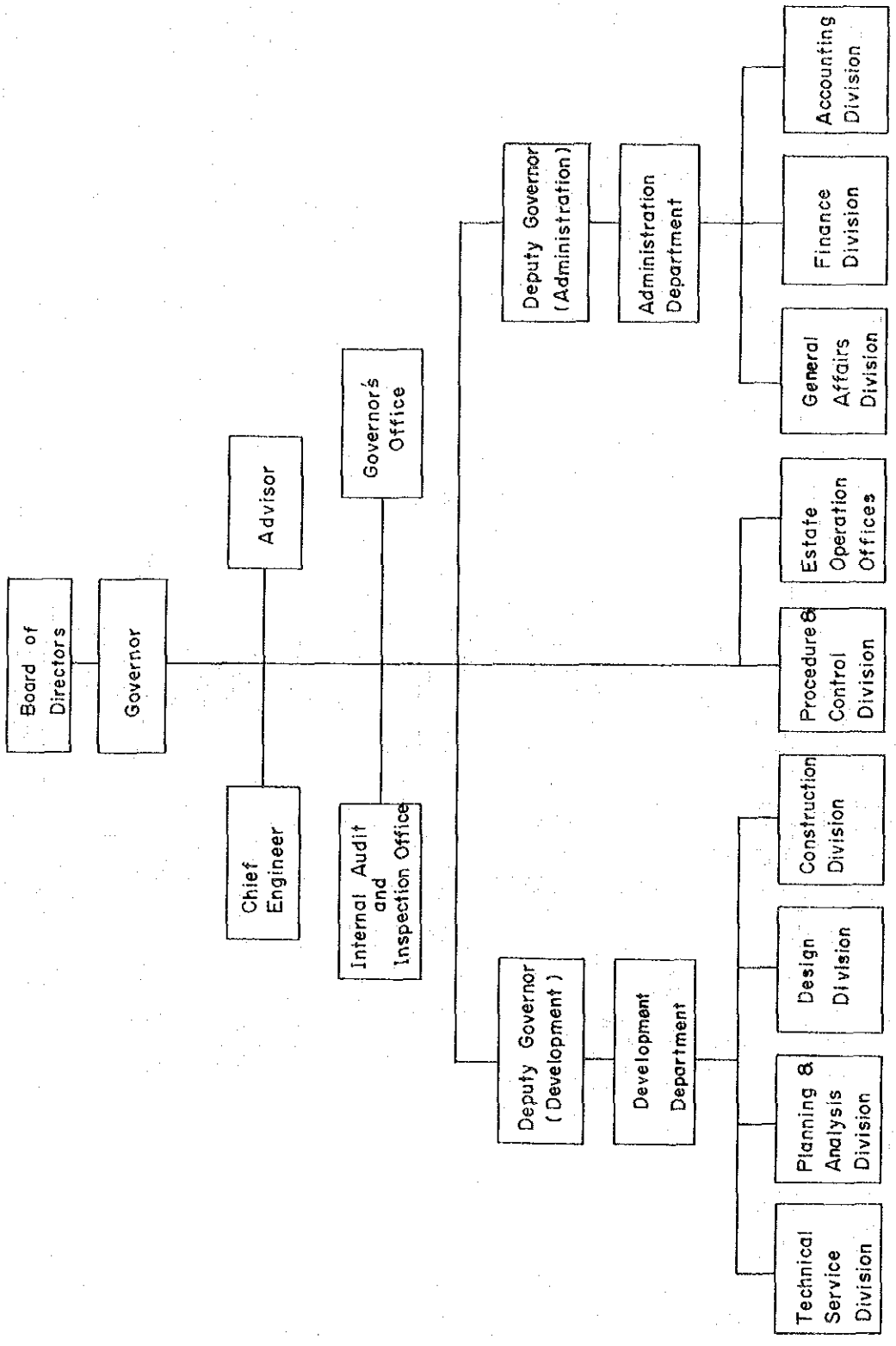

Fig. 26 Organization Chart of IEAT

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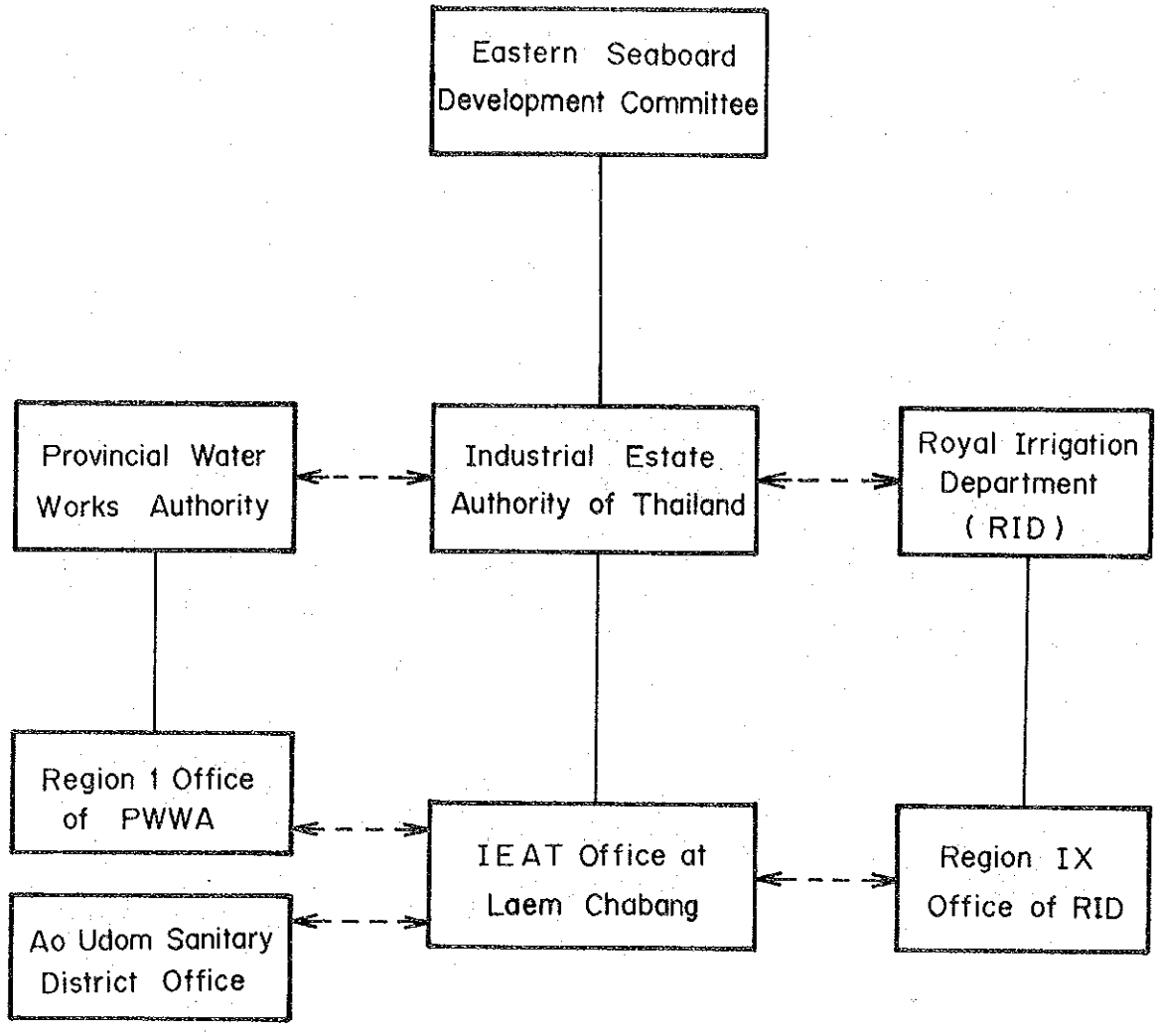

Fig. 27 Institutional Relationship for Operation and Maintenance

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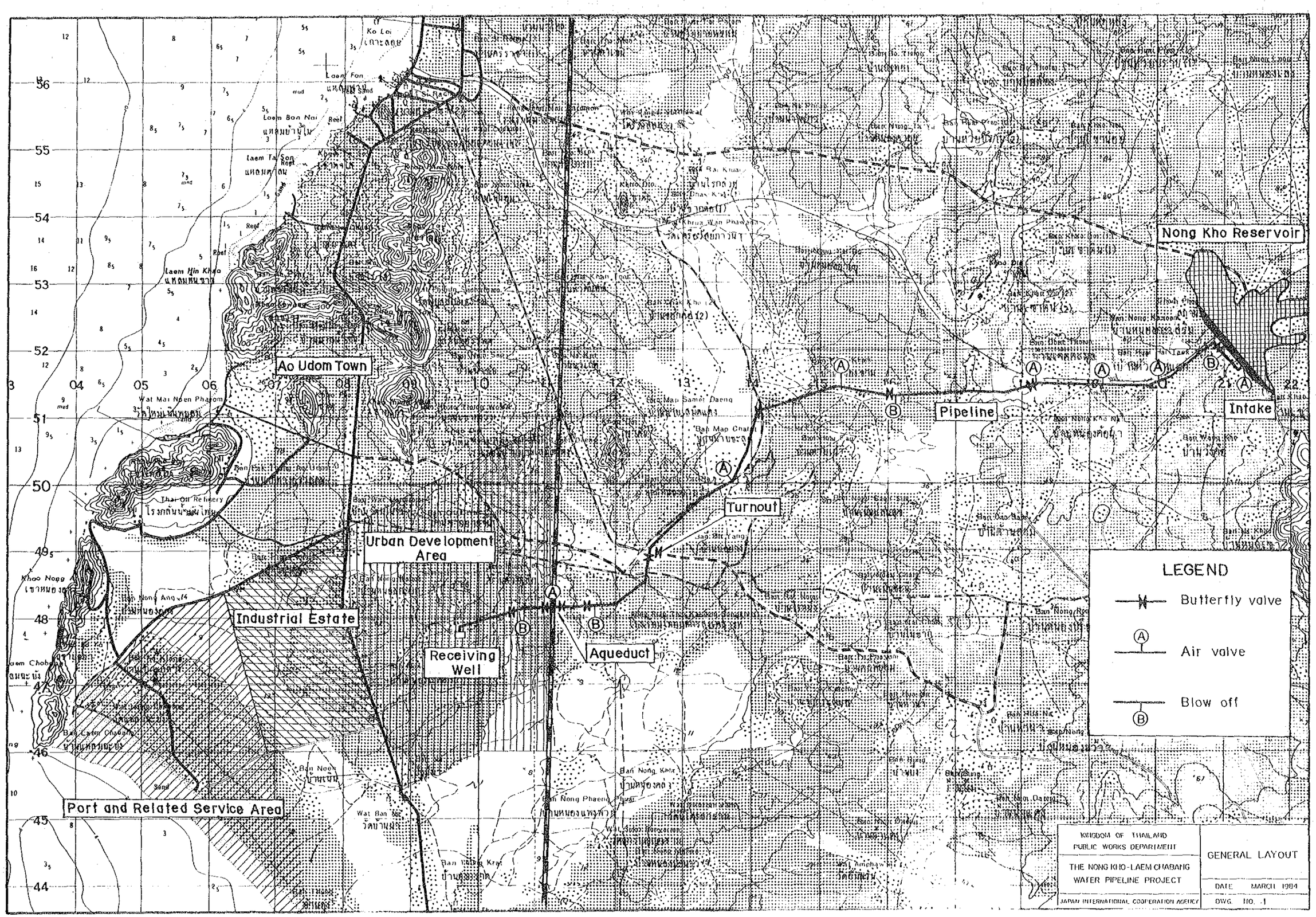
DRAWINGS


Nong Kho Reservoir
Intake
Pipeline
Turnout
Aqueduct
Receiving Well
Urban Development Area
Industrial Estate
Port and Related Service Area
Ao Udom Town
LEGEND
Butterfly valve
Air valve
Blow off
KINGDOM OF THAILAND
PUBLIC WORKS DEPARTMENT
THE NONG KHO-LAEM CHABANG WATER PIPELINE PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY
GENERAL LAYOUT
DATE MARCH 1984
DWG. NO. -1