

THE KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
DEPARTMENT OF LAND DEVELOPMENT

THE MASTER PLAN STUDY
ON
THE INTEGRATED RURAL DEVELOPMENT
OF SALT-AFFECTED LAND IN NORTHEAST THAILAND

APPENDIX

OCTOBER 1991

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APPENDIX-A METEOROLOGY AND HYDROLOGY

A-1. GENERAL CLIMATE FACTOR

Table A-1 General Climate Factor

1. Climatological Data at A. Muang, Khon Kaen for the Period 1956 - 1985

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Pressure(+1000 or 900 mbs.)													
Mean	14.10	11.68	9.72	7.97	6.48	5.21	5.17	5.14	7.23	10.68	13.28	14.52	9.27
Ext. Max.	28.13	24.72	24.74	21.68	14.90	13.70	12.62	13.92	15.46	19.70	23.77	25.08	28.13
Ext. Min.	2.51	0.56	99.98	97.40	97.40	94.92	95.05	95.58	94.32	1.87	4.18	3.44	94.32
Mean Daily Range	5.57	5.93	5.97	5.68	5.12	4.23	4.04	4.11	4.56	4.71	4.78	5.11	4.98
Temperature(°C)													
Mean	22.8	25.6	28.7	30.1	29.2	28.6	28.0	27.6	27.0	26.5	24.8	22.8	26.8
Mean Max.	30.3	32.7	35.5	36.5	34.8	33.3	32.6	32.0	31.5	31.3	30.8	29.9	32.6
Mean Min.	15.7	19.1	22.2	24.4	24.7	24.7	24.2	24.1	23.6	22.3	19.3	16.3	21.7
Ext. Max.	37.2	41.0	41.8	42.8	41.2	39.4	38.0	38.0	35.9	35.4	35.4	35.8	42.8
Ext. Min.	5.7	10.4	10.3	16.4	19.8	20.7	20.2	20.8	19.3	14.0	9.4	5.6	5.6
Relative Humidity(%)													
Mean	63.9	62.4	59.3	63.0	72.0	75.4	77.4	79.7	82.0	77.1	70.5	66.5	70.8
Mean Max.	85.9	82.9	80.4	82.2	88.0	89.1	90.4	91.6	93.5	91.4	88.8	87.3	87.6
Mean Min.	41.4	40.8	38.6	42.5	52.8	58.7	61.1	64.0	65.6	58.3	49.4	44.1	51.5
Ext. Min.	11.0	10.0	10.0	14.0	26.0	33.0	34.0	37.0	45.0	26.0	21.0	15.0	10.0
Dew Point(°C)													
Mean	15.0	17.0	19.1	21.5	23.0	23.6	23.5	23.6	24.3	21.9	18.6	15.7	20.6
Evaporation(mm)													
Mean - Pan	154.2	161.4	211.7	216.6	196.5	171.4	165.5	150.0	137.0	152.3	151.0	152.4	2020.0
Cloudiness(0-10)													
Mean	3.0	3.4	3.6	5.0	6.9	8.0	6.0	8.5	7.8	5.7	4.2	3.5	5.6
Sunshine Duration(hr)													
Mean	285.5	252.8	255.2	252.5	244.6	186.1	182.4	159.5	165.2	236.6	262.3	283.3	2766.0
Wind(knots)													
Prevailing Wind	NE	NE	NE	SW	SW	SW	SW	SW	SW	NE	NE	NE	-
Mean Wind Speed	2.0	2.1	2.4	2.4	2.4	2.7	2.8	2.6	1.8	2.1	2.4	2.4	-
Max. Wind Speed	33	33	40	46	47	49	55	40	33	34	33	35	55
Rainfall(mm)													
Mean	4.6	13.2	31.1	60.7	167.7	176.9	163.4	192.7	262.0	87.2	13.9	3.3	1176.7
Mean Rainy Days	0.9	2.6	3.8	6.9	13.6	14.4	15.7	17.7	18.2	9.3	1.7	0.7	105.5
Greatest in 24 hr	29.2	63.4	51.8	65.7	87.7	133.4	92.8	134.8	146.6	124.5	81.0	26.6	146.6
Day/Year	24/69	3/66	2/82	6/65	5/71	26/83	26/63	12/78	7/82	26/69	10/74	20/71	7/82
Number of Days With													
Haze	22.5	23.5	26.5	18.3	2.4	0.0	0.1	0.0	0.2	2.1	7.0	14.3	116.9
Fog	0.3	0.4	0.2	0.1	0.0	0.0	0.0	0.1	0.0	0.4	0.1	0.4	2.0
Thunderstorm	0.2	1.7	4.8	11.8	18.6	14.7	14.0	13.1	14.4	6.3	0.5	0.1	100.2

Note Station : A. Muang, Khon Kaen Elevation of Station Above MSL 165 m
 Index Station : 48381 Height of Barometer Above MSL 166 m
 Latitude : 16° 26' N Height of Thermometer Above Ground 1.25 m
 Longitude : 102° 50' E Height of Wind Vane Above Ground 10.55 m
 Height of Raingauge 1.00 m
 Sunshine Duration 1957 - 1985
 Evaporation 1962 - 1985

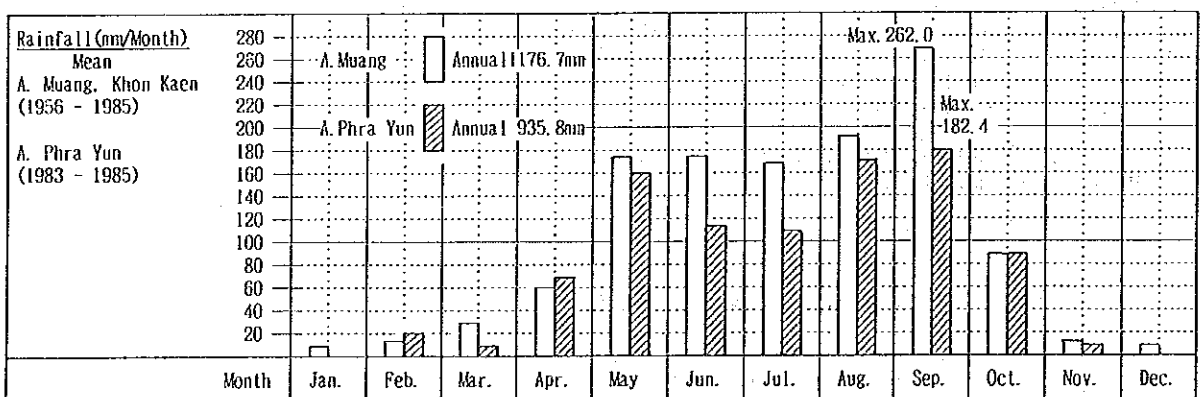
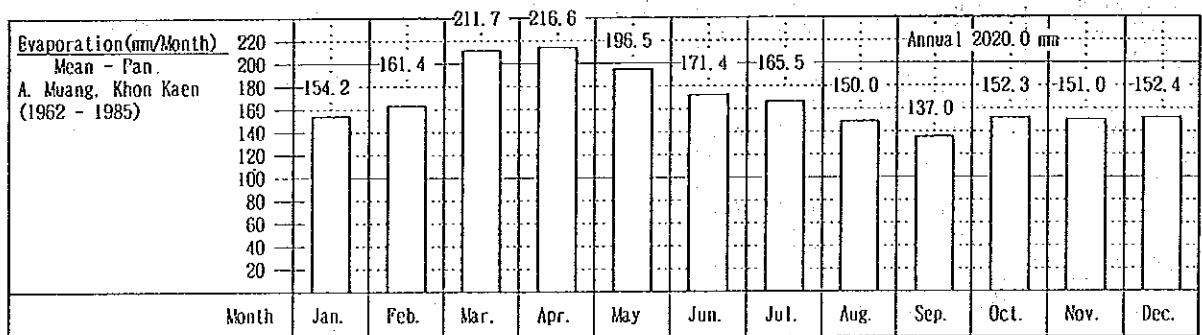
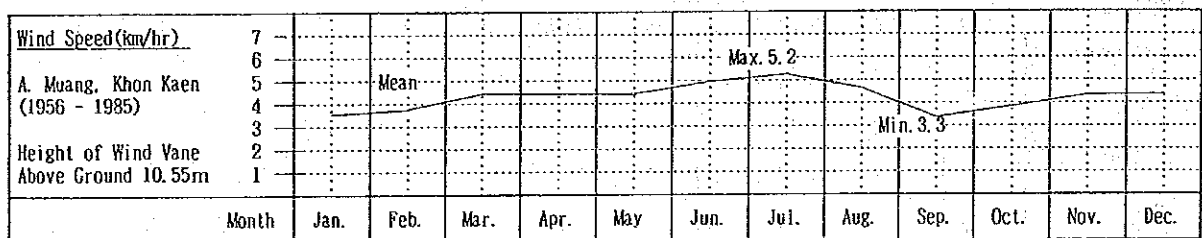
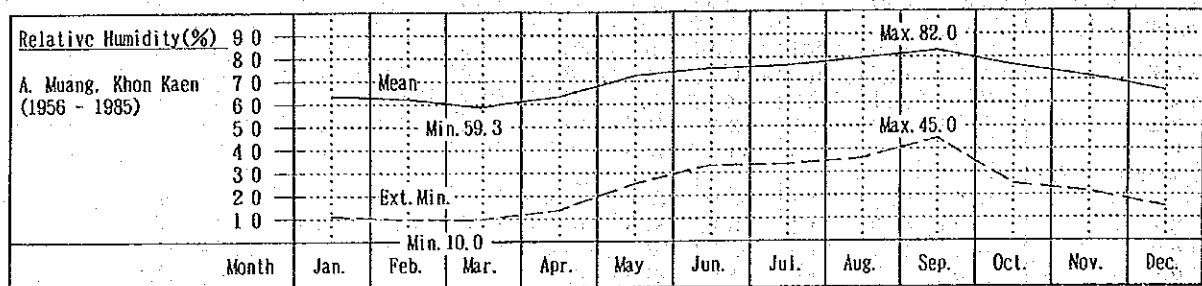
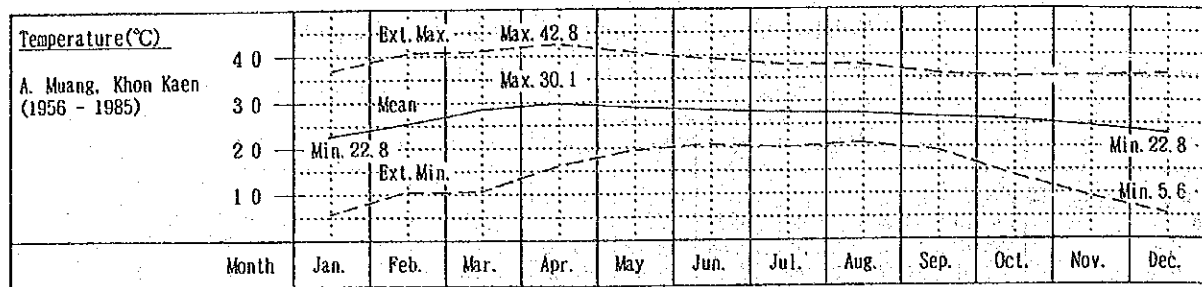
Source : Climatological Data of Thailand 30-Year Period (1956-1985)
 Meteorological Department

2. Rainfall Data at A. Phra Yun for the Period 1983 - 1988

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Rainfall(mm)													
Mean	0.0	20.4	8.1	70.0	161.0	115.8	109.4	171.5	182.4	87.7	9.4	0.0	935.8

Source : Rainfall Record Notebook
 A. Phra Yun Agricultural Extension Office

Figure A-1 Variation in General Climate Factor



Source A. Muang, Khon Kaen : Climatological Data of Thailand 30-Year Period [1956-1985], Meteorological Department

A. Phra Yun : A. Phra Yun Agricultural Extension Office

A-2. RAINFALL ANALYSIS
 A-2-1 Rainfall Stations

FIGURE A-2 LOCATION MAP OF RAINFALL AND STREAM GAUGING STATIONS

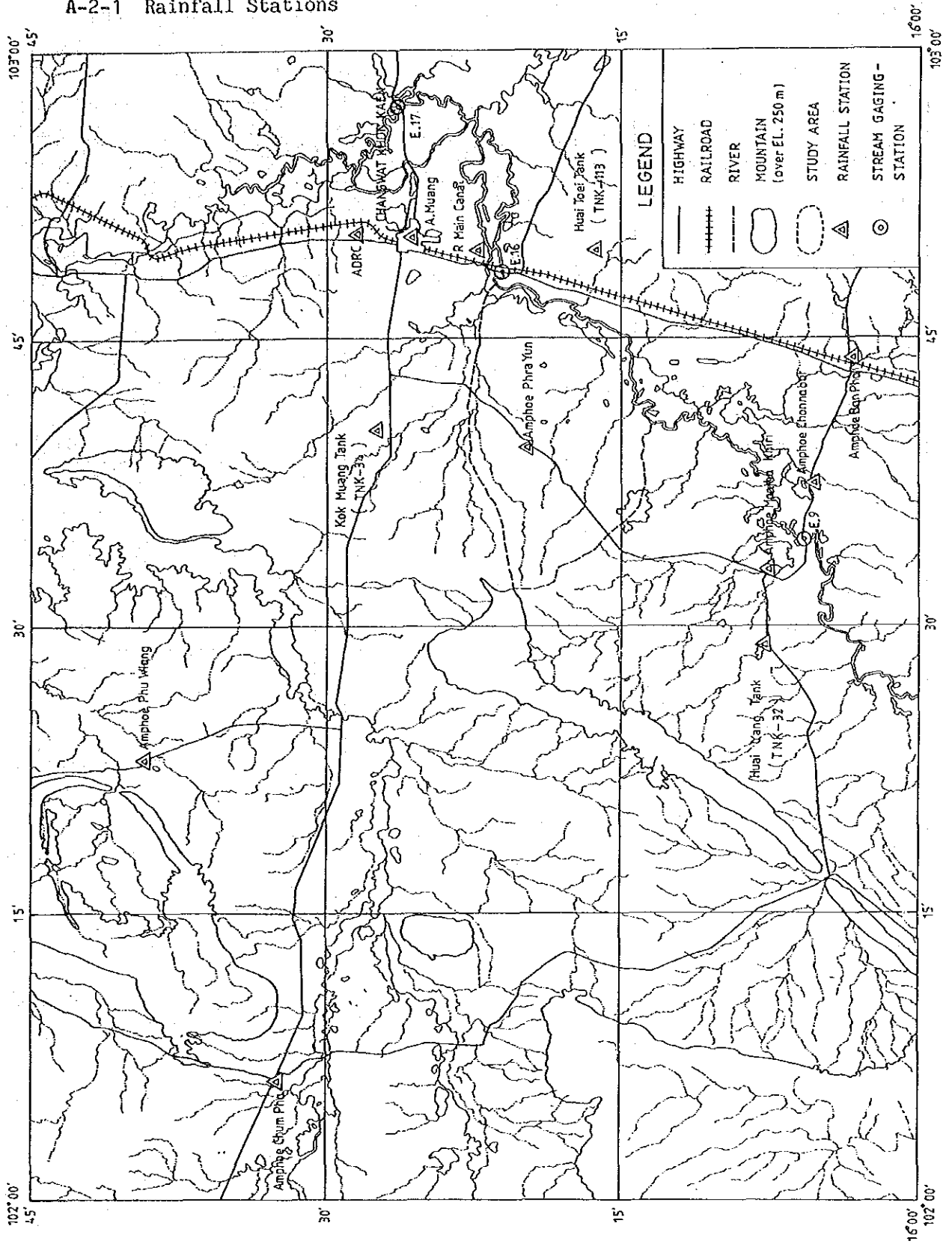


Table A-2 List of Rainfall Stations in the Vicinity of the Study Area

Code No.	Station Name and Organization	Observed Period and Location	Collected Period																													
			1950S							1960S							1970S							1980S							1990S	
			1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
(1) 14013	A. Muang, Khon Kaen (M. D.)	Apr. 1952-cont. Lati: 16 25 40 Long: 102 50 17	Apr. 1952																												Mar. 1989	
(2) 14022	A. Mancha Khiri, Khon Kaen (M. D.)	Apr. 1952-cont. Lati: 16 07 30 Long: 102 32 50	Apr. 1952																												Mar. 1989	
(3) 14042	A. Ban Phai, Khon Kaen (M. D.)	Apr. 1954-cont. Lati: 16 03 32 Long: 102 44 02	Apr. 1954							No Record Jul. 1955 Jul. 1958														No Record Aug. 1986							Mar. 1989	
(4) 14052	A. Phu Wiang, Khon Kaen (M. D.)	Apr. 1952-cont. Lati: 16 39 10 Long: 102 22 52	Apr. 1952							No Record							Oct. 1977-Mar. 1978							Oct. Dec. 1983 Apr. 1987-Mar. 1988							Mar. 1989	
(5) 14073	A. Chum Phae, Khon Kaen (M. D.)	Apr. 1952-cont. Lati: 16 32 35 Long: 102 06 12	Apr. 1952							No Record							Apr. 1977-Mar. 1979														Mar. 1989	
(6) 14143	A. Chonnabot, Khon Kaen (M. D.)	Oct. 1956-cont. Lati: 16 05 15 Long: 102 37 27								Oct. 1966																					Mar. 1989	
(7) 14170	Huai Yang Tank (TNK-32) (R. I. D.)	Apr. 1957-cont. Lati: 16 07 50 Long: 102 29 00	Apr. 1957																					No Record Apr. 1987-Mar. 1988							Mar. 1989	
(8) 14190	Kok Muang Tank (TNK-34) (R. I. D.)	Apr. 1957-cont. Lati: 16 27 30 Long: 102 40 10	Apr. 1957							No Record Jul. - Sep. 1957														No Record Apr. 1987-Mar. 1988							Mar. 1989	
(9) 14320	Huai Toei Tank (TNK113) (R. I. D.)	Apr. 1971-cont. Lati: 16 16 15 Long: 102 49 40															Apr. 1971							No Record Apr. 1987-Mar. 1988							Mar. 1989	
(10) 14370	R Main Canal (R. I. D.)	Jan. 1976-cont. Lati: 16 22 12 Long: 102 49 37															Jan. 1976							No Record Oct. Nov. 1978							Mar. 1989	
(11) 14320	A. Phra Yun, Agricultural Extension Department	Jan. 1983-cont. Lati: 16 20 Long: 102 40																						Jan. 1983							16th Sep. 1990	
(12) 14370	ADRC	Sep. 1985-cont. Lati: 16 30 Long: 102 50																						Sep. 1985							Jul. 1990	
																								No Record Sep. Dec. 1988							Mar. - May, Sep. 1989 Mar. - Jun. 1990	

Note : 1) Recording Rain Gage (1), (5), (6), (12) 2) Standard Rain Gage (2), (3), (4), (7), (8), (9), (10), (11)
3) M. D. : Meteorological Department

Source : 1) List of Rainfall Stations in Thailand, Hydrology Division, RID
2) Daily rainfall Data, (1)-(10) : Hydrology Division, RID (12) : ADRC
(11) : A. Phra Yun, Agricultural Extension Office

Table A-3 Monthly Rainfall at Various Stations

MONTHLY RAINFALL AT (1) A. MUANG, KHON KAEN (UNIT : MM)												MONTHLY RAINFALL AT (2) A. MANCHA KHIRI, KHON KAEN (UNIT : MM)																	
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL		
1953	0.0	0.0	10.1	147.7	208.0	201.9	144.7	168.9	357.7	95.8	24.3	0.0	1359.1	1953	125.1	45.1	52.8	182.9	168.6	244.7	39.6	72.0	211.1	75.7	5.1	0.0	1222.7		
1954	30.7	81.8	0.0	40.6	176.7	194.6	111.7	123.4	486.7	70.0	0.0	0.4	1316.6	1954	0.0	0.0	1.4	52.4	58.2	99.4	104.6	182.7	401.4	56.3	0.0	0.0	956.4		
1955	0.0	0.0	13.5	70.5	112.2	415.4	62.4	233.4	181.3	7.8	2.9	0.0	1099.4	1955	0.0	3.6	38.7	30.7	238.5	448.6	118.8	139.4	179.6	46.4	4.9	0.0	1249.2		
1956	0.0	24.8	39.6	80.4	87.4	104.1	185.6	166.3	158.6	34.0	0.0	0.0	880.8	1956	0.0	36.1	59.1	11.0	269.7	51.8	333.7	204.3	132.6	67.4	0.0	0.0	1165.7		
1957	0.0	0.0	109.0	58.0	141.2	174.2	125.9	203.3	272.2	24.5	0.0	0.0	1308.3	1957	0.0	0.0	97.9	58.0	118.1	173.7	128.7	193.3	272.6	25.1	0.0	0.0	1067.4		
1958	37.5	6.8	193.4	0.0	153.6	217.0	138.7	160.3	278.7	67.1	0.0	0.0	1243.1	1958	0.4	11.0	4.8	55.0	192.9	217.1	97.4	261.0	572.2	35.0	0.0	0.0	1424.8		
1959	0.0	8.7	16.6	33.3	192.6	90.5	192.9	104.0	501.5	13.1	0.0	0.0	1552.2	1959	0.0	12.0	65.7	81.5	102.9	109.6	249.8	126.6	363.4	28.3	0.0	0.0	1363.8		
1960	0.0	0.0	88.2	4.9	189.0	192.4	123.4	200.0	105.7	77.2	0.0	0.0	961.3	1960	0.0	0.0	20.1	30.1	164.1	10.6	81.0	52.7	283.5	66.0	0.0	0.0	708.1		
1961	0.0	0.0	0.0	60.7	161.1	121.5	39.8	295.4	367.3	195.3	0.2	0.0	1322.3	1961	0.0	10.4	16.8	271.0	274.1	103.4	41.1	274.6	144.0	195.5	144.0	0.0	0.0	1494.9	
1962	0.6	0.0	28.7	66.8	235.7	178.2	174.5	182.6	422.3	34.5	5.3	0.0	1353.3	1962	0.0	0.0	0.0	13.7	154.6	25.3	196.4	135.8	482.4	132.1	0.0	0.0	1261.3		
1963	0.0	0.0	0.0	28.9	47.9	102.9	193.7	248.7	215.2	201.3	167.9	83.7	1304.2	1963	0.0	0.0	50.9	52.2	110.5	253.0	310.6	105.1	100.1	117.6	75.2	0.0	0.0	1261.3	
1964	0.0	13.9	23.1	87.4	249.4	103.8	154.2	91.3	270.2	286.9	26.8	0.0	1214.0	1964	0.0	54.6	20.7	57.7	381.1	98.0	295.3	57.7	369.2	258.9	33.6	0.0	0.0	1515.7	
1965	0.0	3.9	27.6	111.9	82.8	71.9	123.3	207.9	180.0	110.1	0.0	0.0	919.4	1965	0.0	0.0	14.1	57.7	165.3	86.0	79.3	293.3	163.2	36.9	0.0	0.0	936.0		
1966	0.0	76.5	56.1	58.0	354.9	137.1	124.7	228.9	187.0	106.2	11.3	18.4	1338.8	1966	0.0	0.0	21.9	20.0	193.6	132.1	70.7	177.9	182.3	165.8	0.0	0.0	992.1		
1967	0.0	49.3	0.0	34.9	30.3	157.3	149.3	211.4	258.5	11.9	21.3	0.0	1712.2	1967	0.0	37.2	0.0	60.6	66.0	262.1	91.2	52.4	433.2	82.2	5.8	0.0	1089.7		
1968	22.8	10.8	26.0	37.3	148.4	215.3	239.4	205.0	158.8	34.3	0.0	0.0	1466.2	1968	5.4	8.3	0.0	146.9	112.8	173.9	72.0	101.4	162.3	41.5	0.0	0.0	823.6		
1969	62.6	0.4	35.6	34.8	60.0	310.1	173.6	96.2	277.3	132.0	38.6	0.0	1283.3	1969	5.6	2.8	19.4	44.6	92.8	190.5	136.6	28.6	423.3	166.7	28.4	0.0	0.0	1099.2	
1970	0.4	0.8	17.2	110.8	156.2	466.5	64.6	134.1	517.4	41.9	1.6	0.0	1339.8	1970	0.0	0.0	11.1	43.2	151.2	145.3	34.0	57.2	207.3	73.1	0.0	0.0	745.6		
1971	0.0	37.4	20.4	53.0	199.2	112.1	241.5	256.2	185.9	58.3	7.7	26.8	1981.5	1971	0.0	35.5	0.0	91.9	110.7	94.6	147.7	248.8	194.5	39.6	0.0	0.0	987.9		
1972	0.0	4.7	20.8	138.6	17.5	292.6	91.0	150.9	123.3	164.7	61.1	11.9	1077.1	1972	0.0	0.0	37.3	102.8	31.8	119.4	5.8	72.6	148.6	95.7	8.4	0.0	717.2		
1973	0.0	0.0	5.0	14.4	62.5	67.1	171.4	186.2	268.4	3.8	0.1	0.0	778.9	1973	0.0	0.0	43.0	0.0	60.2	192.8	139.0	125.2	174.6	10.0	0.0	0.0	744.8		
1974	1.0	1.4	36.0	63.8	102.7	86.5	151.3	300.5	214.6	90.6	102.0	0.0	1150.6	1974	0.0	26.4	56.1	64.2	46.2	2.3	120.1	119.8	120.7	124.5	30.7	0.0	0.0	711.0	
1975	27.1	3.7	54.2	4.0	381.1	171.4	233.7	198.7	291.5	74.6	0.0	0.0	1450.0	1975	0.0	0.0	0.0	0.0	206.2	106.8	101.9	80.4	183.6	89.4	0.0	0.0	800.6		
1976	0.0	5.6	46.0	75.1	124.6	39.1	178.0	174.2	283.1	160.4	0.8	0.0	1096.9	1976	0.0	0.0	61.0	111.8	248.9	0.0	126.1	184.3	216.3	154.6	8.2	0.0	0.0	1111.2	
1977	0.2	0.0	19.5	70.6	58.0	141.4	85.6	207.0	403.8	9.3	2.5	18.5	1216.4	1977	0.0	0.0	1.7	74.6	168.4	81.4	56.8	172.5	288.5	11.0	0.0	0.0	854.9		
1978	0.7	6.3	12.1	55.0	182.7	112.9	346.9	219.9	378.4	73.2	2.1	0.0	1390.2	1978	0.0	0.0	37.2	19.4	75.7	99.9	282.5	209.3	467.1	12.8	8.8	0.0	0.0	1250.0	
1979	0.0	19.4	0.0	89.4	243.8	282.6	80.5	212.3	249.2	0.0	0.0	0.0	1177.2	1979	0.0	65.2	0.0	161.7	81.2	162.0	149.3	263.9	329.7	0.0	0.0	0.0	0.0	1213.0	
1980	0.0	3.3	21.0	46.7	211.1	357.6	97.3	159.4	333.4	97.6	0.0	0.0	1387.4	1980	0.0	0.0	0.0	38.6	29.2	130.9	538.5	92.8	155.0	336.3	141.4	0.0	0.0	1462.7	
1981	0.0	8.3	14.0	34.0	248.2	151.7	246.4	173.3	29.0	139.2	19.6	0.0	1063.7	1981	0.0	0.0	46.5	52.4	155.2	32.7	168.2	134.9	79.7	59.8	35.8	0.0	0.0	765.2	
1982	0.0	0.0	49.8	90.7	69.4	128.2	119.1	207.3	76.1	593.4	431.1	5.7	1479.9	1982	0.0	37.0	131.9	60.5	79.4	58.0	144.0	158.0	384.9	104.5	0.0	0.0	0.0	1158.2	
1983	14.0	3.9	0.0	52.0	106.8	337.1	113.3	384.5	121.1	135.1	17.9	1.0	1286.7	1983	0.0	0.0	0.0	0.0	69.2	236.1	121.5	218.3	115.0	131.8	13.8	0.0	0.0	905.4	
1984	0.2	4.9	10.2	38.3	159.7	214.4	279.0	211.4	207.2	96.4	3.6	0.0	1245.3	1984	0.0	0.0	56.1	44.3	90.7	130.7	73.4	73.4	271.0	123.8	0.0	0.0	0.0	863.4	
1985	1.4	5.0	18.6	39.2	126.1	202.4	72.2	124.3	184.8	128.2	0.2	0.0	992.4	1985	0.0	17.7	28.5	39.1	174.2	46.7	125.9	26.7	207.5	111.8	0.0	0.0	0.0	778.1	
1986	0.0	0.0	55.4	125.7	280.0	178.5	79.4	160.1	145.5	58.2	1.1	2.5	1085.4	1986	0.0	0.0	44.7	114.0	119.1	75.4	43.2	196.0	203.5	40.3	0.0	0.0	0.0	589.5	
1987	0.0	26.8	100.8	82.6	143.4	128.9	133.9	281.4	215.3	137.7	33.3	0.0	1284.1	1987	0.0	13.5	44.7	114.0	119.1	75.4	43.2	196.0	203.5	40.3	0.0	0.0	0.0	905.3	
1988	0.0	17.5	23.4	67.2	245.0	200.8	302.9	101.5	106.9	187.3	0.4	0.0	1255.1	1988	0.0	85.6	1.2	64.6	114.6	133.6	71.5	31.6	49.2	213.5	0.0	0.0	0.0	767.6	
MEAN	5.5	13.2	34.3	62.6	169.0	184.0	158.3	189.7	259.3	88.2	13.2	2.8	1180.1	MEAN	4.2	14.0	30.6	71.2	148.4	137.9	124.2	141.4	247.1	89.1	13.1	4.1	0.0	1025.4	
MAX	62.6	81.8	193.4	147.7	381.1	466.5	346.9	364.5	593.4	195.3	102.0	26.8	1479.9	MAX	125.1	85.8	131.9	271.0	381.1	538.5	333.7	293.3	572.2	258.8	144.0	94.8	0.0	1515.7	
MIN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	778.9	MIN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	589.5

Monthly Rainfall at Various Stations (continued)

MONTHLY RAINFALL AT (3) A. BAN PHAL, KHON KAEN												MONTHLY RAINFALL AT (4) A. PHU WIANG, KHON KAEN																
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	
1953	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1953	39.6	69.9	19.6	98.3	314.8	170.1	191.1	64.3	331.3	98.0	100.5	0.0	1497.5	
1954	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1954	20.7	12.4	0.0	66.8	260.8	248.7	101.2	302.8	294.7	45.6	0.0	0.0	1353.7	
1955	0.0	18.2	79.4	25.7	76.8	432.7	*****	147.8	287.0	73.5	5.5	0.0	*****	1955	0.0	0.0	17.1	83.9	126.0	367.9	131.1	190.7	139.4	11.3	0.0	0.0	1067.4	
1956	0.0	4.5	257.6	129.7	97.6	172.0	103.1	170.0	309.0	89.9	0.0	0.0	1242.1	1956	0.0	42.3	43.9	84.3	227.5	136.7	294.6	235.9	211.1	24.1	0.0	0.0	1300.4	
1957	0.0	17.0	15.8	49.4	309.7	265.3	*****	225.0	459.4	65.8	0.0	0.0	1333.4	1957	0.0	13.0	115.9	75.6	151.0	175.8	229.4	204.5	322.8	42.0	0.0	0.0	1308.0	
1958	17.0	41.2	15.8	49.4	309.7	265.3	*****	225.0	459.4	65.8	0.0	0.0	1333.4	1958	3.3	39.3	37.2	6.0	107.2	142.2	131.8	299.7	182.3	220.8	0.0	0.0	1169.8	
1959	0.0	14.5	43.5	57.9	137.2	76.1	279.4	117.5	286.3	34.2	1.4	0.0	1048.0	1959	0.0	17.9	0.2	37.3	258.3	28.1	258.1	86.6	317.3	10.0	3.6	0.0	1017.4	
1960	0.0	10.1	3.0	12.3	199.0	191.5	158.3	78.3	211.9	104.5	2.0	0.0	970.9	1960	0.0	0.0	4.7	41.8	332.0	88.7	274.1	133.6	183.8	148.8	11.5	0.0	1217.4	
1961	0.0	8.1	19.9	38.7	200.9	83.6	72.9	287.7	163.2	259.8	0.0	0.0	1134.8	1961	0.0	45.9	14.0	85.9	191.0	160.5	70.1	215.0	242.9	162.1	3.9	0.0	1191.3	
1962	1.7	0.0	7.4	17.4	71.3	180.3	207.2	150.8	471.1	91.8	0.0	3.5	1200.4	1962	1.9	7.2	26.0	74.5	250.7	68.3	224.5	141.4	302.7	145.9	1.9	0.0	1244.9	
1963	0.0	0.0	112.3	44.4	134.8	225.1	141.4	160.2	169.0	87.8	1.3	1189.3	1963	0.0	0.0	76.9	54.5	156.0	203.7	189.0	197.4	232.1	110.3	103.8	0.0	1338.7		
1964	0.0	20.0	44.3	86.1	189.1	38.6	213.1	82.6	259.1	198.1	39.3	0.0	1191.4	1964	0.0	0.0	114.6	43.3	429.9	74.3	233.6	179.6	155.1	143.8	0.0	0.0	1286.2	
1965	10.7	0.0	82.7	163.2	151.6	87.6	91.1	181.4	125.4	46.4	0.0	0.0	940.1	1965	1.9	13.7	13.9	64.7	189.9	174.7	93.4	268.1	199.0	61.5	0.0	0.0	1082.8	
1966	0.0	32.9	170.2	67.0	427.9	105.7	172.4	160.0	216.9	89.3	36.6	27.8	1506.7	1966	0.0	13.3	107.7	74.3	295.3	114.0	144.8	297.3	324.7	122.6	0.0	26.9	1520.9	
1967	0.0	7.8	0.0	13.4	50.9	152.3	132.5	117.0	248.0	43.7	10.8	0.0	759.5	1967	0.0	0.0	0.0	0.0	191.7	98.9	149.0	118.9	415.1	122.9	30.9	0.0	1529.0	
1968	9.0	0.0	13.4	173.5	124.3	115.1	133.3	159.7	282.0	103.6	0.0	0.0	1038.5	1968	0.0	1.0	51.3	17.2	183.3	192.5	263.2	208.0	145.7	92.0	0.0	0.0	1219.4	
1969	54.9	11.9	48.1	48.0	137.9	196.3	189.8	159.7	282.1	259.2	0.0	0.0	1382.4	1969	73.3	0.0	46.3	64.7	114.5	171.7	233.0	108.7	316.9	50.5	27.5	0.0	1267.2	
1970	0.0	0.0	7.0	51.2	130.6	244.9	210.3	75.1	237.8	9.5	0.0	0.0	1006.2	1970	2.8	3.7	6.1	180.7	133.6	293.1	121.7	175.0	319.8	82.9	0.0	5.8	1507.3	
1971	0.0	0.0	7.0	241.0	211.0	156.9	150.8	204.8	136.7	33.9	0.0	19.5	1203.6	1971	0.0	59.8	0.0	62.4	148.7	225.4	166.8	311.4	240.8	81.0	2.8	25.7	1324.8	
1972	0.0	0.0	46.2	98.9	42.1	203.8	17.2	82.7	324.7	123.8	31.0	44.3	836.9	1972	0.0	2.5	47.5	108.2	37.5	203.8	47.3	115.3	165.0	174.1	24.8	59.6	945.8	
1973	0.0	0.0	37.9	7.4	59.4	78.1	150.1	88.0	321.8	19.1	0.0	0.0	721.9	1973	0.0	0.0	29.3	0.0	8.1	135.6	157.8	119.7	352.5	10.9	0.0	0.0	1105.0	
1974	0.0	9.4	34.7	86.1	143.0	30.8	142.5	103.6	139.0	142.0	38.2	0.0	873.8	1974	0.0	29.3	0.0	8.1	135.6	157.8	119.7	352.5	10.9	0.0	0.0	0.0	1084.4	
1975	44.8	8.1	52.0	62.7	189.5	156.8	160.0	93.5	249.0	83.7	0.0	0.0	1039.9	1975	18.4	20.1	70.2	32.6	282.7	148.6	134.2	131.6	267.8	144.8	34.3	0.0	1305.6	
1976	0.0	37.5	34.5	122.0	113.8	33.6	184.6	224.9	235.1	203.7	0.0	0.0	1211.7	1976	0.0	19.4	41.2	132.3	183.9	124.6	234.8	88.6	302.3	280.6	10.4	0.0	1418.1	
1977	0.0	9.0	51.0	71.7	136.0	61.6	23.4	211.0	187.1	28.3	0.0	10.9	761.0	1977	0.0	0.0	13.4	135.8	152.3	36.5	130.4	196.9	279.6	*****	*****	*****	*****	
1978	12.2	0.0	22.0	96.2	139.7	389.3	418.0	163.4	380.9	24.3	23.4	0.0	1496.9	1978	*****	*****	*****	*****	48.3	154.3	204.2	393.2	237.2	386.9	72.0	0.0	*****	
1979	0.0	48.0	0.0	80.9	234.4	265.6	78.3	203.2	285.1	0.0	0.0	0.0	1213.5	1979	0.0	21.0	0.0	110.4	177.1	240.5	110.0	208.7	274.1	0.0	0.0	0.0	1141.8	
1980	0.0	1.9	59.9	41.4	138.8	408.9	90.8	120.8	276.2	220.2	1.8	0.0	1360.7	1980	0.0	0.0	45.3	80.9	390.0	400.4	174.7	167.4	383.8	139.4	0.0	0.0	1781.9	
1981	0.0	0.5	50.3	81.2	245.0	34.3	173.1	143.2	52.2	59.2	16.1	0.0	855.1	1981	0.0	1.0	30.4	49.2	143.9	165.0	204.4	160.9	38.5	138.6	30.0	0.0	1041.9	
1982	0.0	51.8	80.3	24.2	94.7	92.9	131.4	118.5	355.8	130.7	3.3	15.2	1098.8	1982	0.0	0.0	22.9	52.2	132.0	153.8	162.6	70.2	381.8	164.0	2.3	0.0	1141.8	
1983	3.7	51.2	0.0	20.6	33.5	209.7	94.0	164.4	102.2	114.9	12.1	8.3	794.6	1983	0.0	0.0	0.0	8.7	137.9	335.3	197.7	240.3	221.4	*****	12.4	*****	*****	
1984	0.0	5.9	30.7	113.7	104.5	85.3	74.7	101.6	250.7	59.1	18.4	0.0	844.6	1984	0.0	0.0	0.0	14.5	97.8	176.7	124.4	107.2	160.0	160.9	156.4	0.0	998.4	
1985	16.7	36.7	7.6	83.1	224.6	70.0	114.7	45.5	210.3	243.1	11.6	0.0	1063.9	1985	0.8	40.2	0.0	92.6	227.5	212.4	139.3	133.7	240.9	175.5	0.0	0.0	1282.7	
1986	0.0	0.0	0.0	144.6	33.0	75.5	*****	105.8	47.8	0.0	0.0	0.0	*****	1986	0.0	0.0	1.8	216.4	290.0	87.9	143.0	187.7	193.3	78.2	0.0	0.0	1189.0	
1987	0.0	42.3	27.7	114.8	112.8	143.3	59.5	190.3	379.0	76.6	72.7	0.0	1189.0	1987	0.0	17.0	135.6	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	
1988	0.0	42.0	119.5	116.1	192.5	218.3	174.7	53.4	88.0	299.5	0.0	0.0	1304.0	1988	*****	*****	*****	*****	59.1	153.5	121.9	174.8	141.4	171.3	244.9	0.0	0.0	*****
MEAN	5.0	16.2	47.5	73.6	154.9	147.2	141.8	136.2	247.6	105.3	11.9	3.7	1090.3	MEAN	4.8	14.4	35.1	76.9	194.0	175.1	174.5	181.9	255.4	108.7	13.0	3.0	1229.6	
MAX	54.9	92.1	257.6	241.0	427.9	432.7	418.0	287.7	482.1	299.5	87.8	44.5	1506.7	MAX	73.3	69.9	135.6	216.4	390.0	400.4	393.2	311.4	415.1	280.6	103.8	39.6	1781.9	
MIN	0.0	0.0	0.0	7.4	12.1	30.6	17.2	21.3	52.2	0.0	0.0	0.0	721.9	MIN	0.0	0.0	0.0	6.0	37.5	28.1	47.5	64.3	98.5	0.0	0.0	0.0	965.8	

Monthly Rainfall at Various Stations (continued)

TABLE MONTHLY RAINFALL AT (5) A. CHUM PHAE, KHON KAEN													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1953	0.0	0.0	4.6	109.7	201.8	141.7	175.9	35.3	155.0	90.9	63.9	0.0	978.3
1954	3.8	0.0	1.0	59.6	371.9	126.7	132.6	61.7	370.8	118.7	0.0	0.0	1126.8
1955	0.0	0.0	50.0	62.7	84.7	289.4	46.5	154.5	241.1	12.7	0.0	0.0	941.4
1956	0.0	42.1	102.0	66.7	66.8	118.5	220.5	128.5	256.1	12.3	0.0	0.0	1013.5
1957	0.0	0.0	107.5	50.1	151.9	101.6	309.8	113.1	323.3	93.6	6.5	0.0	1259.4
1958	6.8	50.5	37.7	19.5	69.5	161.0	102.4	238.8	363.1	78.5	0.0	0.0	1149.8
1959	0.0	16.8	27.3	39.3	208.3	123.4	187.6	118.2	585.6	0.0	9.0	0.0	1115.5
1960	0.0	0.0	28.7	32.5	285.9	115.5	177.9	49.6	58.7	96.2	0.0	0.0	825.0
1961	0.0	9.5	24.9	101.0	195.1	103.8	174.4	136.5	135.2	287.1	3.4	0.0	1150.9
1962	0.0	0.0	70.5	82.9	197.9	67.5	132.4	143.8	428.3	111.5	0.0	0.0	1236.8
1963	0.0	0.0	97.8	49.1	164.5	129.2	135.4	156.9	221.9	143.9	43.7	0.0	1142.4
1964	0.0	4.3	18.5	56.5	260.4	122.6	149.0	115.1	350.7	265.4	13.7	0.0	1356.2
1965	0.0	15.5	8.5	10.5	122.0	43.2	59.2	156.2	171.8	52.2	1.7	0.0	640.6
1966	0.0	0.0	64.1	57.6	233.6	129.9	175.9	159.3	269.9	214.2	19.0	58.3	1381.8
1967	0.0	1.2	1.5	108.4	41.5	111.5	116.0	65.4	414.6	41.7	14.5	0.0	914.3
1968	0.0	7.4	46.6	50.2	156.6	98.5	132.2	126.1	174.0	56.5	0.0	0.0	848.1
1969	16.8	0.0	50.7	54.4	162.0	126.7	127.1	43.6	301.2	59.5	18.0	0.0	960.0
1970	2.2	0.0	25.9	148.3	188.7	174.1	51.8	76.0	255.5	110.9	3.2	3.7	1040.3
1971	0.0	0.0	0.8	77.4	165.4	127.7	101.2	157.6	211.2	163.8	9.3	36.0	1050.4
1972	0.0	21.0	21.7	81.7	25.6	135.4	28.9	108.8	154.4	150.4	21.9	107.5	837.3
1973	0.0	0.0	14.8	14.0	182.1	90.6	185.4	96.1	540.8	12.7	0.0	0.0	1136.5
1974	6.3	31.3	17.9	56.3	165.3	58.8	75.4	119.6	146.3	138.3	58.3	0.0	873.8
1975	30.2	64.3	67.0	12.9	161.0	167.1	115.2	70.0	106.5	176.9	0.0	0.0	971.1
1976	0.0	0.0	35.5	18.8	99.1	66.9	68.0	138.2	137.0	212.9	7.1	0.0	953.5
1977	0.0	0.0	45.0	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1978	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1979	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1980	0.0	0.0	5.7	40.7	219.0	287.4	153.4	175.7	297.3	118.4	15.4	0.0	1343.0
1981	0.0	0.0	10.5	14.0	45.0	78.5	78.4	50.1	135.4	156.9	20.0	0.0	586.8
1982	0.0	0.0	24.7	51.3	182.6	109.2	122.1	99.3	297.1	175.7	0.0	28.7	1090.7
1983	11.4	0.0	0.0	0.0	181.1	349.4	141.4	282.2	151.8	142.1	7.9	0.0	1247.3
1984	13.0	21.4	44.2	34.2	143.0	169.6	81.0	119.1	252.1	138.2	0.0	0.0	995.8
1985	2.6	10.0	0.0	35.4	217.1	68.7	146.1	96.5	307.1	207.0	2.1	0.0	992.6
1986	0.0	0.0	10.8	45.4	184.4	95.7	82.3	71.6	176.6	56.9	4.2	9.1	736.8
1987	0.0	28.4	108.5	47.2	132.9	61.0	44.6	294.5	253.6	37.4	38.8	0.0	1036.9
1988	0.0	28.5	1.5	127.2	154.6	132.7	150.2	170.2	166.2	396.0	0.0	0.0	1382.7
MEAN	2.7	11.2	34.1	58.6	158.0	134.3	125.5	130.2	247.7	120.3	11.2	7.2	1039.9
MAX	30.2	64.3	108.5	148.3	265.9	349.4	309.8	294.5	540.8	396.0	63.9	107.5	1382.7
MIN	0.0	0.0	0.0	0.0	25.6	43.2	15.9	35.3	58.7	0.0	0.0	0.0	586.8

TABLE MONTHLY RAINFALL AT (6) A. CHORNABOJ, KHON KAEN
(UNIT : MM)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1953	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1954	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1955	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1956	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1957	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1958	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1959	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1960	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1961	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1962	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1963	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1964	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1965	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1966	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1967	0.0	35.4	0.0	58.7	34.2	137.2	99.1	84.3	372.7	87.1	46.5	0.0	905.2
1968	22.8	0.0	11.2	122.3	30.0	179.6	115.8	92.6	211.3	10.0	0.0	0.0	795.6
1969	23.5	0.0	81.5	75.7	69.2	282.9	170.1	74.9	415.0	149.1	36.2	0.0	1576.1
1970	0.0	3.0	5.5	55.6	166.4	139.0	73.4	214.6	142.2	59.8	0.0	0.0	859.5
1971	0.0	75.3	0.0	58.1	352.4	109.7	148.3	251.4	112.6	93.9	0.0	37.4	1219.1
1972	0.0	2.3	77.7	140.6	28.9	219.8	28.0	87.9	258.8	152.9	29.5	75.1	1101.5
1973	0.0	0.0	0.0	4.3	106.5	97.1	180.5	62.8	187.4	25.9	0.9	0.0	665.0
1974	2.6	3.5	95.0	43.2	99.4	11.2	167.7	143.7	128.8	185.5	46.3	0.0	926.9
1975	57.5	2.4	39.0	18.2	241.9	100.5	95.4	49.8	207.7	143.5	47.8	0.0	1021.5
1976	0.0	7.6	118.5	98.8	162.4	80.6	73.9	185.3	291.1	187.5	15.5	0.0	1221.2
1977	0.0	0.0	26.4	120.9	241.6	62.9	89.1	192.1	267.2	15.2	0.8	2.7	1020.9
1978	15.4	10.0	56.5	47.4	100.7	114.8	359.1	166.8	487.3	18.3	13.4	0.0	1389.7
1979	0.0	50.7	0.0	163.6	216.0	164.6	65.6	205.4	331.3	0.0	0.0	0.0	1197.2
1980	0.0	1.5	29.1	61.7	153.2	537.8	89.8	204.1	307.6	168.2	3.4	0.0	1556.4
1981	0.0	0.0	90.7	66.6	115.3	19.1	161.8	253.2	50.8	63.8	27.3	0.0	848.6
1982	0.0	47.0	105.8	75.1	44.4	91.9	156.5	119.4	417.0	113.1	4.6	16.9	1171.7
1983	14.9	6.6	0.0	11.6	52.4	244.0	220.1	109.1	117.1	15.7	9.9	93.1	951.2
1984	0.0	23.2	32.1	92.6	122.9	110.3	76.6	54.5	239.3	95.4	4.3	0.0	841.2
1985	11.2	48.6	10.0	42.2	234.3	35.9	117.4	24.8	203.1	130.4	2.6	0.0	880.5
1986	0.0	0.0	0.0	107.2	183.2	99.2	126.5	158.9	72.3	59.8	6.1	1.4	814.7
1987	0.0	17.1	44.0	67.2	163.6	155.7	77.9	216.5	242.7	59.8	43.4	0.0	1089.3
1988	0.0	104.9	0.0	56.4	130.9	114.3	172.8	99.9	55.5	248.8	0.0	0.0	983.3
MEAN	6.7	20.0	37.5	71.2	137.7	141.3	125.1	144.7	232.8	96.3	15.2	6.9	1037.1
MAX	57.5	104.9	118.5	163.6	332.4	537.8	559.1	253.2	487.3	248.8	47.8	75.1	1556.4
MIN	0.0	0.0	0.0	4.3	28.9	11.2	28.0	24.8	50.8	0.0	0.0	0.0	665.0

Monthly Rainfall at Various Stations (continued)

MONTHLY RAINFALL AT (7) HUAL YANG TANK (INK-32)												MONTHLY RAINFALL AT (8) KOK MUANG TANK (INK-34)															
TABLE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
	(UNIT : MM)												(UNIT : MM)														
1953	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1954	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1955	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1956	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1957	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1958	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1959	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1960	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1961	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1962	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1963	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1964	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1965	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1966	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1967	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1968	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1969	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1970	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1971	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1972	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1973	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1974	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1975	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1976	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1977	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1978	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1979	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1980	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1981	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1982	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1983	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1984	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1985	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1986	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
MEAN	3.1	5.9	25.8	73.8	149.3	132.0	141.2	143.5	278.1	112.3	11.9	3.8	1084.4	4.5	10.5	25.6	67.8	144.6	157.8	160.1	160.9	255.9	104.5	12.0	4.3	1122.3	
MAX	27.0	35.5	110.9	226.6	316.6	426.1	328.7	279.0	594.5	314.6	100.0	65.2	1624.6	35.8	53.8	93.3	258.1	334.4	419.5	396.7	375.6	521.1	273.5	86.1	52.3	1595.3	
MIN	0.0	0.0	0.0	0.0	0.0	34.0	30.9	12.4	53.4	0.0	0.0	0.0	609.2	0.0	0.0	0.0	0.0	0.0	0.0	11.2	20.0	49.8	72.3	0.0	0.0	363.9	

Monthly Rainfall at Various Stations (continued)

TABLE		MONTHLY RAINFALL AT (9) HUAI TOEI TANK (THK-113)												MONTHLY RAINFALL AT (10) R MAIN CANAL													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
	< UNIT : MM >													< UNIT : MM >													
1953	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1953	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1954	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1954	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1955	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1955	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1956	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1956	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1957	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1957	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1958	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1958	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1959	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1959	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1960	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1960	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1961	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1961	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1962	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1962	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1963	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1963	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1964	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1964	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1965	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1965	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1966	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1966	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1967	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1967	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1968	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1968	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1969	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1969	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1970	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1970	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1971	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1971	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1972	0.0	0.0	41.0	45.1	0.0	105.6	47.0	65.1	103.8	39.0	59.5	631.2	1972	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	
1973	0.0	0.0	0.4	58.5	87.0	112.7	206.5	140.0	235.5	13.8	0.0	856.0	1973	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	
1974	0.0	0.0	41.5	67.4	118.5	116.5	150.5	194.7	124.2	47.9	0.0	879.0	1974	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	
1975	54.5	0.0	100.5	0.0	278.6	197.1	161.5	94.8	258.9	121.1	0.0	1226.6	1975	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	
1976	0.0	0.0	30.0	82.4	117.3	64.1	106.0	204.1	151.0	116.8	0.0	851.7	1976	0.0	2.4	52.6	18.0	207.6	74.4	140.0	157.1	145.2	159.8	0.0	0.0	937.1	
1977	0.0	0.0	0.0	45.0	72.6	58.1	72.6	114.8	265.4	43.4	0.0	669.9	1977	0.0	0.0	4.3	53.2	160.2	108.2	60.1	255.7	262.4	10.3	0.0	56.9	969.3	
1978	0.0	2.2	0.0	81.6	87.5	166.7	390.6	122.4	460.5	48.0	0.0	1367.5	1978	15.0	5.2	10.5	111.9	202.0	197.8	371.0	214.7	326.0	*****	*****	*****	*****	
1979	0.0	5.2	0.0	105.3	135.3	136.5	78.1	259.1	282.5	0.0	0.0	1000.0	1979	0.0	10.1	0.0	133.6	144.5	214.4	43.2	260.5	354.8	0.0	0.0	0.0	1160.9	
1980	0.0	0.0	10.0	20.6	221.4	251.2	104.0	206.6	515.0	180.9	0.0	1509.7	1980	0.0	0.5	19.8	89.9	226.2	256.2	48.8	211.2	316.6	75.2	0.0	0.0	1224.4	
1981	0.0	0.0	14.1	75.0	111.6	264.7	274.0	110.0	226.7	127.1	43.0	1243.2	1981	0.0	6.0	8.0	15.7	203.3	145.4	211.2	59.5	56.1	86.0	18.7	0.0	809.9	
1982	0.0	63.6	88.5	26.0	88.2	90.0	72.0	164.0	505.0	214.9	0.0	1322.2	1982	0.0	41.5	106.9	55.2	134.7	80.2	122.8	67.0	438.2	60.4	0.0	3.2	1089.9	
1983	8.0	0.0	0.0	0.0	67.0	245.8	204.2	236.3	132.0	214.2	10.1	1117.6	1983	0.0	0.0	0.0	1.7	32.8	242.5	46.7	232.1	159.8	114.0	12.9	0.0	842.3	
1984	0.0	28.0	27.1	35.8	87.5	84.5	129.5	178.2	169.0	132.4	0.0	869.8	1984	0.0	22.7	11.6	81.8	122.0	208.2	197.4	251.1	202.8	47.8	5.7	0.0	1151.1	
1985	0.0	32.7	0.0	110.9	94.1	91.6	179.6	156.2	254.1	137.6	6.1	1042.9	1985	0.0	5.5	16.2	74.3	210.8	153.5	163.8	102.4	186.8	75.8	0.0	0.0	969.1	
1986	0.0	0.0	0.0	135.0	150.0	132.7	62.1	158.5	111.0	111.5	22.0	862.6	1986	0.0	0.0	20.0	114.2	187.4	183.2	72.6	97.7	66.1	59.7	0.0	0.0	803.5	
1987	0.0	62.7	4.1	*****	*****	*****	*****	*****	*****	*****	*****	*****	1987	0.0	31.2	18.6	49.8	143.2	82.5	20.8	178.4	237.1	91.3	58.8	0.0	911.5	
1988	*****	*****	*****	104.5	237.9	197.9	130.0	56.3	143.7	246.6	0.0	*****	1988	0.0	15.8	18.0	17.2	216.7	290.7	116.4	75.0	141.4	241.9	0.0	0.0	1151.1	
MEAN	2.6	12.1	22.3	65.1	133.7	136.0	144.9	161.9	237.6	117.5	10.4	4.1	1030.0	MEAN	1.2	10.7	22.0	61.0	168.6	169.0	124.2	164.6	222.6	85.2	8.0	5.1	1000.0
MAX	34.3	63.6	100.5	321.2	264.7	390.6	375.3	515.0	246.6	47.9	59.5	1509.7	MAX	15.0	41.3	106.9	133.6	226.2	290.7	371.0	260.5	438.2	241.9	58.8	56.9	1224.4	
MIN	0.0	0.0	0.0	0.0	0.0	18.5	47.0	56.3	65.1	0.0	0.0	631.2	MIN	0.0	0.0	0.0	1.7	32.8	74.4	20.8	59.5	56.1	0.0	0.0	0.0	803.5	

Monthly Rainfall at Various Stations (continued)

TABLE MONTHLY RAINFALL AT (11) A. PHKA YUN

(UNIT : MM)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1966	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1967	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1968	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1969	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1970	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1971	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1972	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1973	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1974	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1975	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1976	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1977	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1978	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1979	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1980	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1981	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1982	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1983	0.0	0.0	0.0	0.0	76.9	171.0	79.5	329.3	190.6	132.7	12.3	0.0	992.3
1984	0.0	0.0	0.0	39.0	98.0	159.2	180.9	182.4	176.9	69.3	0.0	0.0	875.7
1985	0.0	0.0	0.0	17.9	235.3	79.8	141.2	88.1	212.6	124.0	0.0	0.0	898.7
1986	0.0	0.0	48.2	160.7	161.1	83.1	74.9	130.8	117.0	8.0	0.0	0.0	753.8
1987	0.0	30.1	20.0	64.8	281.1	104.2	91.1	226.1	216.1	63.2	43.9	0.0	1140.6
1988	0.0	92.3	10.5	137.8	113.9	127.4	89.0	78.6	181.4	128.8	0.0	0.0	953.7
1989	0.0	0.0	15.2	55.6	112.7	34.3	149.1	67.6	132.6	203.4	0.0	0.0	770.5
1990	0.0	48.8	62.0	76.0	282.7	145.7	93.3	243.9	CONTINUE	----->	----->	----->	----->
(1983 - 1985)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
MEAN	0.0	20.4	8.1	70.0	161.0	115.8	109.4	171.5	182.4	87.7	9.4	0.0	935.8
MAX	0.0	92.3	20.0	160.7	281.1	171.0	180.9	329.3	216.1	132.7	43.9	0.0	1140.6
MIN	0.0	0.0	0.0	0.0	76.9	79.8	74.9	72.6	117.0	8.0	0.0	0.0	753.8
(1983 - 1990)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
MEAN	0.0	21.4	15.7	69.0	170.2	109.3	112.4	167.8	175.3	104.2	8.0	0.0	912.2
MAX	0.0	92.3	62.0	160.7	282.7	171.0	180.9	329.3	216.1	132.7	43.9	0.0	1140.6
MIN	0.0	0.0	0.0	0.0	76.9	74.9	72.6	117.0	8.0	0.0	0.0	0.0	753.8

TABLE MONTHLY RAINFALL AT (12) ADCR

(UNIT : MM)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
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	0.0	0.0	28.5	131.5	175.0	144.0	51.0	205.5	137.5	51.5	0.0	10.5	935.0
1987	0.0	20.0	112.0	61.0	114.0	111.5	70.0	292.0	223.5	134.5	21.0	0.0	1159.5
1988	0.0	19.0	15.0	45.0	192.5	139.0	188.0	73.0	*****	181.5	0.0	*****	*****
1989	0.0	0.0	*****	*****	*****	207.5	79.0	239.0	*****	242.0	0.0	3.0	*****
1990	0.0	76.5	*****	*****	*****	*****	231.0	CONTINUE	----->	----->	----->	----->	----->
(1983 - 1990)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
MEAN	0.0	23.1	51.8	79.2	160.5	150.5	123.8	202.4	176.8	139.6	4.2	3.4	1047.3
MAX	0.0	76.5	112.0	131.5	192.5	207.5	231.0	292.0	223.5	242.0	21.0	10.5	1159.5
MIN	0.0	0.0	15.0	45.0	114.0	111.5	51.0	73.0	137.5	51.5	0.0	0.0	935.0

A-2-2 Complement of Rainfall Data

Daily rainfall data for 12 rain gauging stations, in and around the Study area were collected from the Meteorological Department, RID, Agricultural Extension Department and ADRC. Location of the stations are shown in Figure A-2. Name of the stations, sources and data period are shown in Table A-2.

There were suite a few stations which did not have enough length of data period for a good statistical analysis. Therefore, to generate the missing daily rainfall data a correlation study and a regression analysis were done. In the analysis monthly data were used as shown in Table A-4. The equations and procedures followed are given below;

- a) Equation of linear regression obtained through the correlation study is expressed as;

$$Y = aX + b$$

where X : monthly rainfall at the key station which keeps perfect daily record of rainfall during period under consideration

Y : expected monthly rainfall at the object station which involves missing data

a.b.: coefficient and constant

- b) Applying the ratio of the monthly amount of rainfall between stations X and Y. Showing the highest correlation, the daily rainfall at the object station was generated by the following equation : $y = (Y/X) \cdot x$

where x : daily rainfall actually measured at the key station

y : synthetic daily rainfall at the object station

Shown below are the regression equations developed and used in the completion of daily rainfall for different stations.

Regression Equations for Daily Rainfall

Key Station (X)	Object Station (Y)	Equation
-	(1) A. Muang	Perfect Record Observed Data
-	(2) A. Mancha Khiri	- do -
(2) A. Mancha Khiri	(3) A. Ban Phai	Y = 0.865X + 18.614 (R:90.4%) y = 1.036x
(1) A. Muang	(4) A. Phu Wiang	Y = 0.884X + 19.083 (R:89.1%) y = 1.044x
(1) A. Muang	(5) A. Chum Phae	Y = 0.857X + 13.345 (R:86.2%) y = 0.982x
(2) A. Muncha Khiri	(6) A. Chonnabot	Y = 0.929X + 15.351 (R:93.0%) y = 1.071x
(2) A. Muncha Khiri	(7) TNK-32	Y = 0.943X + 15.168 (R:91.0%) y = 1.074x
(1) A. Muang	(8) TNK-34	Y = 0.919X + 7.327 (R:90.9%) y = 0.980x
(1) A. Muang	(9) TNK-113	Y = 0.853X + 14.087 (R:87.2%) y = 0.974x
(1) A. Muang	(10) R Main Canal	Y = 0.866X + 5.128 (R:88.6%) y = 0.910x
(1) A. Muang	(11) A. Phra Yun	Y = 0.731X + 14.797 (R:81.7%) y = 0.845x

Note R : Correlation Coefficient

Annual rainfalls and mean monthly rainfalls of 11 stations for the period of 36 years (1953-1988) are shown in Table A-7 and A-8. Mean annual rainfall at A. Phra Yun in the central part of the study area is 970 mm. And the same at the stations of A. Muang and A. Mancha Khiri are 1,180 mm and 1,030 mm, respectively. The former locates in the northeast of the study area and the latter locates in the south of the study area.

Table A-4 The Correlation Coefficient and Regression Line of Monthly Rainfall

(1953 ---> 1988 : 36YEARS / UNIT : MM/MONTH)

STATION ---> X		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Y		A.MUANG	A.MANCHA KHIRI	A.BAN PHAI	A.PHU WIANG	A.CHUM PHAE	A.CHON- NABOT	TNK-32	TNK-34	TNK-113	R MAIN CANAL	A.PHRA YUN
(1)	R	1.000	0.859	0.888	0.891	0.862	0.869	0.888	0.909	0.872	0.886	0.817
	A	0.000	0.854	0.915	0.898	0.866	0.937	0.859	0.901	0.893	0.905	0.914
	B	0.000	23.352	12.207	7.503	15.824	9.056	18.013	14.054	15.146	20.382	29.461
	Q	1.000	1.079	1.032	0.958	1.018	1.033	1.020	1.021	1.027	1.098	1.183
	N	*****	253	272	271	264	185	224	236	116	108	41
(2)	R	0.859	1.000	0.904	0.862	0.860	0.930	0.910	0.834	0.811	0.863	0.812
	A	0.864	1.000	0.945	0.910	0.890	0.931	0.878	0.841	0.789	0.775	0.911
	B	7.059	0.000	2.245	-4.639	7.502	0.257	6.530	9.753	17.020	23.298	3.045
	Q	0.927	1.000	0.965	0.874	0.957	0.933	0.931	0.931	0.938	0.976	0.940
	N	253	*****	259	233	240	179	227	187	115	96	42
(3)	R	0.888	0.904	1.000	0.871	0.858	0.905	0.896	0.868	0.846	0.890	0.695
	A	0.863	0.865	1.000	0.865	0.865	0.903	0.888	0.861	0.811	0.817	0.722
	B	11.430	18.614	0.000	4.314	13.527	6.249	14.195	10.182	14.912	20.076	27.807
	Q	0.969	1.036	1.000	0.900	0.987	0.965	0.969	0.951	0.945	0.996	0.981
	N	272	259	*****	240	250	188	229	208	121	103	39
(4)	R	0.891	0.862	0.871	1.000	0.883	0.872	0.881	0.889	0.830	0.871	0.746
	A	0.884	0.815	0.878	1.000	0.951	0.888	0.851	0.862	0.775	0.850	0.648
	B	19.083	36.894	26.328	0.000	18.542	24.063	30.813	25.375	39.425	29.879	64.099
	Q	1.044	1.144	1.111	1.000	1.120	1.104	1.102	1.064	1.093	1.078	1.193
	N	271	233	240	*****	248	156	213	219	109	80	31
(5)	R	0.862	0.860	0.858	0.883	1.000	0.792	0.855	0.853	0.780	0.868	0.794
	A	0.857	0.831	0.851	0.819	1.000	0.831	0.771	0.791	0.810	0.878	0.855
	B	13.345	22.840	17.616	9.085	0.000	16.810	24.024	16.325	16.574	16.867	27.181
	Q	0.982	1.044	1.013	0.893	1.000	1.004	0.984	0.933	0.961	1.038	1.100
	N	264	240	250	248	*****	163	210	202	107	78	44
(6)	R	0.869	0.930	0.905	0.872	0.792	1.000	0.888	0.851	0.875	0.870	0.806
	A	0.806	0.929	0.906	0.855	0.754	1.000	0.841	0.846	0.826	0.787	0.865
	B	15.797	15.351	12.706	6.147	23.719	0.000	15.036	15.054	17.238	26.519	20.398
	Q	0.968	1.071	1.036	0.906	0.996	1.000	0.983	0.988	0.973	1.030	1.055
	N	185	179	188	156	163	*****	174	156	124	106	40
(7)	R	0.888	0.910	0.896	0.881	0.855	0.888	1.000	0.879	0.855	0.892	0.711
	A	0.918	0.943	0.947	0.912	0.948	0.938	1.000	0.906	0.850	0.826	0.929
	B	7.130	15.168	9.600	-0.621	7.613	8.324	0.000	8.651	16.750	12.743	17.895
	Q	0.980	1.074	1.031	0.908	1.016	1.018	1.000	0.982	0.992	0.937	1.094
	N	224	227	229	213	210	174	*****	211	117	73	30
(8)	R	0.909	0.834	0.868	0.889	0.853	0.851	0.879	1.000	0.887	0.887	0.756
	A	0.919	0.826	0.876	0.917	0.920	0.855	0.854	1.000	0.840	0.854	0.788
	B	7.327	24.941	18.711	2.938	16.276	16.402	18.428	0.000	18.632	24.384	49.921
	Q	0.980	1.074	1.051	0.939	1.071	1.012	1.019	1.000	0.996	1.073	1.208
	N	236	187	208	219	202	156	211	*****	110	86	26
(9)	R	0.872	0.811	0.846	0.830	0.780	0.875	0.855	0.887	1.000	0.878	0.772
	A	0.853	0.833	0.882	0.890	0.751	0.928	0.861	0.936	1.000	0.836	0.725
	B	14.087	24.866	18.504	3.433	30.525	11.312	17.141	7.967	0.000	18.970	39.930
	Q	0.974	1.066	1.058	0.915	1.041	1.027	1.008	1.004	1.000	0.989	1.057
	N	116	115	121	109	107	124	117	110	*****	84	32
(10)	R	0.886	0.863	0.890	0.871	0.868	0.870	0.892	0.887	0.878	1.000	0.837
	A	0.866	0.960	0.970	0.892	0.859	0.961	0.963	0.921	0.922	1.000	0.832
	B	5.128	7.358	3.805	5.018	11.312	1.112	11.148	1.276	10.885	0.000	16.639
	Q	0.910	1.025	1.004	0.928	0.963	0.971	1.067	0.932	1.011	1.000	0.980
	N	108	96	103	80	78	106	73	86	84	*****	42
(11)	R	0.817	0.812	0.695	0.746	0.794	0.806	0.711	0.756	0.772	0.837	1.000
	A	0.731	0.724	0.668	0.858	0.737	0.752	0.544	0.725	0.822	0.842	1.000
	B	14.797	33.813	37.064	-2.721	20.946	22.267	43.796	14.799	15.708	19.719	0.000
	Q	0.845	1.064	1.020	0.838	0.909	0.948	0.914	0.828	0.946	1.021	1.000
	N	41	42	39	31	44	40	30	26	32	42	*****

NOTE R: CORRELATION COEFFICIENT
 REGRESSION LINE: Y=A·X+B
 Q: TOTAL RAINFALL RATIO (Y/X)
 N: SAMPLE SIZE

Table A-5 Complemented Monthly Rainfall at Various Stations

COMPLEMENTED MONTHLY RAINFALL AT (S) A. BAN PHAL, KHON KHAEN												COMPLEMENTED MONTHLY RAINFALL AT (L) A. PHU WIANG, KHON KHAEN																
(UNIT : MM)												(UNIT : MM)																
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	
1953	129.6	46.8	54.7	189.4	174.7	253.4	41.1	74.6	218.8	78.4	5.3	0.0	1266.8	1953	39.6	69.9	19.6	98.3	314.8	170.1	191.1	64.3	331.3	98.0	100.5	0.0	1497.5	
1954	0.0	0.0	1.5	11.0	136.6	102.6	57.1	143.9	292.7	54.5	0.0	0.0	801.9	1954	20.7	12.4	0.0	66.8	260.8	248.7	101.2	302.8	294.7	45.6	0.0	0.0	1353.7	
1955	0.0	18.2	79.4	25.7	76.8	432.7	123.2	147.8	287.0	73.5	5.5	0.0	1269.8	1955	0.0	0.0	17.1	83.9	126.0	367.9	131.1	190.7	139.4	11.3	0.0	0.0	1067.4	
1956	0.0	0.0	4.5	257.6	129.7	97.6	172.0	103.1	170.0	309.0	89.9	0.0	1342.1	1956	0.0	42.3	43.9	84.3	227.5	136.7	294.6	235.9	211.1	24.1	0.0	0.0	1300.4	
1957	0.0	0.0	17.0	41.2	15.8	49.4	309.7	265.3	100.9	223.0	459.4	65.8	1547.5	1957	0.0	13.0	115.9	73.6	131.0	175.8	229.4	204.5	322.8	42.0	0.0	0.0	1308.0	
1958	17.0	0.0	14.2	15.8	49.4	309.7	265.3	100.9	223.0	459.4	65.8	1547.5	1958	3.3	39.3	37.2	6.0	107.2	142.2	131.8	299.7	182.3	230.8	0.0	0.0	1169.8		
1959	0.0	14.5	43.5	57.9	137.2	76.1	279.4	117.5	286.3	54.2	1.4	0.0	1048.0	1959	0.0	17.9	0.2	37.3	258.3	28.1	238.1	86.6	317.3	10.0	3.6	0.0	1017.4	
1960	0.0	10.1	3.0	12.3	199.0	191.5	158.3	78.3	211.9	104.5	2.0	0.0	970.9	1960	0.0	0.0	4.7	41.8	332.0	86.7	274.1	133.6	183.8	148.8	11.5	0.0	1217.0	
1961	0.0	8.1	19.9	38.7	200.9	83.6	72.9	287.7	163.2	259.8	0.0	0.0	1134.0	1961	0.0	45.9	14.0	85.9	191.0	160.5	70.1	215.0	242.9	162.1	3.9	0.0	1191.3	
1962	1.7	0.0	7.4	15.3	71.3	180.3	207.2	150.8	471.1	91.8	0.0	3.5	1200.4	1962	1.9	7.2	26.0	74.5	250.7	68.3	224.5	141.4	302.7	146.9	1.9	0.0	1246.0	
1963	0.0	0.0	112.3	44.4	134.4	134.8	225.1	141.4	140.2	160.6	87.8	1.3	1182.3	1963	0.0	0.0	0.0	76.9	54.5	156.0	203.7	189.0	197.4	232.1	110.3	0.0	1323.7	
1964	0.0	20.0	46.3	86.1	199.1	38.4	213.6	92.6	259.1	198.1	0.0	0.0	1191.6	1964	0.0	0.0	0.0	116.6	43.3	329.9	74.3	233.6	179.6	155.1	163.8	0.0	1082.2	
1965	10.7	0.0	82.7	163.2	151.6	87.6	91.1	181.4	125.4	46.4	0.0	0.0	940.1	1965	1.9	13.7	15.9	64.7	189.9	174.7	93.4	268.1	199.0	61.5	0.0	0.0	1082.8	
1966	0.0	32.9	170.2	67.0	427.9	105.7	172.4	160.0	216.9	89.3	36.6	27.8	1306.7	1966	0.0	13.3	107.7	74.3	295.3	114.0	144.8	297.3	324.7	122.6	0.0	26.9	1520.9	
1967	0.0	7.8	0.1	14.4	50.9	152.3	35.5	21.3	405.0	42.7	16.5	0.0	746.5	1967	0.0	0.0	0.0	19.1	98.9	126.8	149.0	118.9	413.1	34.3	30.9	0.0	1093.0	
1968	9.0	0.0	13.6	172.5	124.5	115.1	133.6	149.0	204.6	103.6	0.0	0.0	1025.5	1968	0.0	1.0	51.3	47.2	183.3	192.5	233.4	206.0	161.7	92.0	0.0	0.0	1218.4	
1969	54.9	11.5	48.1	46.0	137.9	196.2	89.8	59.7	482.1	256.2	0.0	0.0	1382.4	1969	73.3	0.0	46.5	64.7	114.5	171.7	233.0	108.7	316.9	50.5	27.5	0.0	1227.3	
1970	0.0	0.0	7.0	51.2	130.6	264.9	210.3	75.1	257.6	9.5	0.0	0.0	1006.2	1970	2.8	3.7	6.1	180.7	133.6	295.1	121.7	175.0	318.8	82.9	0.0	5.8	1307.2	
1971	0.0	0.0	7.0	241.0	211.0	156.9	150.8	206.8	156.7	53.9	0.0	19.5	1203.6	1971	0.0	59.8	0.0	62.4	148.7	225.4	166.8	311.4	240.8	81.0	2.8	25.7	1324.8	
1972	0.0	0.0	46.2	98.9	12.1	201.8	17.2	22.7	254.7	123.8	31.0	44.5	854.9	1972	0.0	2.5	47.5	108.2	37.5	203.8	147.5	115.3	185.0	174.1	24.8	39.6	965.8	
1973	0.0	0.0	37.0	7.4	80.4	98.1	150.1	98.0	231.8	19.1	0.0	0.0	721.9	1973	0.0	0.0	0.0	0.0	6.1	142.6	313.0	157.6	119.7	352.5	10.9	0.0	1105.0	
1974	0.0	9.4	34.7	86.1	143.0	30.6	142.5	108.3	139.0	142.0	38.2	0.0	873.8	1974	0.0	29.3	45.6	98.8	118.1	73.0	133.8	249.4	164.7	79.0	40.5	0.0	1004.4	
1975	44.8	8.1	52.0	62.7	169.5	156.8	160.0	55.3	219.0	83.7	0.0	0.0	1039.9	1975	18.4	20.1	70.2	32.6	282.7	148.6	134.2	131.6	267.8	144.8	34.6	0.0	1305.6	
1976	0.0	37.5	54.5	122.0	115.8	33.6	184.6	224.9	235.1	203.7	0.0	0.0	1211.7	1976	0.0	19.4	41.2	132.3	183.9	124.6	234.8	88.6	302.3	280.6	10.4	0.0	1418.1	
1977	0.0	0.0	31.0	71.7	130.0	61.6	23.4	211.0	157.1	28.3	0.0	10.9	741.0	1977	0.0	0.0	13.4	135.8	192.3	158.5	110.7	192.9	272.9	29.7	2.6	19.3	1033.4	
1978	12.2	5.0	22.0	94.2	159.7	189.8	418.0	165.4	380.9	24.3	23.4	0.0	1496.9	1978	0.7	6.6	12.6	48.2	152.3	204.2	333.2	257.2	386.9	72.0	0.0	0.0	1356.0	
1979	0.0	48.0	0.0	80.9	254.4	265.6	76.3	203.2	285.1	0.0	0.0	0.0	1313.5	1979	0.0	21.0	0.0	110.4	177.1	240.5	110.7	508.7	274.1	0.0	0.0	0.0	1141.8	
1980	0.0	1.9	59.9	41.4	138.8	408.9	90.8	120.8	276.2	220.2	1.8	0.0	1360.7	1980	0.0	0.0	0.0	45.3	80.9	390.0	400.4	174.7	167.4	383.8	139.4	0.0	0.0	1781.9
1981	0.0	0.5	50.3	81.2	245.0	34.3	173.1	143.3	52.2	59.2	16.1	0.0	855.1	1981	0.0	1.0	30.4	49.2	143.9	165.0	204.4	160.9	98.5	158.6	30.0	0.0	1041.9	
1982	9.9	51.8	80.3	24.2	34.7	22.9	131.4	118.3	355.8	130.7	8.3	15.2	1928.3	1982	0.0	0.0	22.9	52.2	132.0	153.8	162.6	70.2	381.8	164.0	2.3	0.0	1161.8	
1983	3.7	31.2	0.0	20.9	33.3	289.7	74.9	186.4	102.3	114.9	12.1	8.3	974.6	1983	0.0	0.0	0.0	8.7	137.9	352.3	197.7	240.3	221.4	141.0	12.4	1.0	1282.7	
1984	0.0	3.9	50.7	113.7	104.5	85.5	74.7	101.6	250.3	59.1	11.6	0.0	844.6	1984	0.0	0.0	14.5	97.8	176.7	124.4	107.2	160.0	160.9	156.4	0.3	0.0	998.4	
1985	16.7	36.7	7.6	83.1	224.6	70.0	114.7	45.5	210.3	243.1	11.4	0.0	1063.9	1985	0.8	40.2	0.0	92.6	227.3	212.4	139.3	133.7	240.9	175.5	0.0	0.0	1262.7	
1986	0.0	0.0	0.0	96.2	144.6	33.0	75.5	107.8	195.8	47.8	0.0	0.0	610.7	1986	0.0	0.0	0.0	1.8	216.4	290.0	87.9	143.0	187.7	193.3	78.2	0.0	0.0	1198.3
1987	0.0	12.3	27.7	114.8	112.8	143.3	59.3	190.3	379.0	76.6	72.7	0.0	1389.0	1987	0.0	17.0	135.6	86.2	149.7	136.6	139.8	224.8	224.8	143.8	34.8	0.0	0.0	1360.1
1988	0.0	42.0	119.5	116.1	192.5	218.3	174.7	53.4	88.0	299.5	0.0	0.0	1504.0	1988	0.0	18.3	28.5	59.1	153.5	121.9	174.8	141.4	171.3	244.9	0.0	0.0	0.0	1111.7
MEAN	8.3	16.6	46.4	76.8	155.4	150.2	137.4	133.7	246.8	104.5	11.7	3.6	1091.5	MEAN	4.5	14.3	34.3	77.2	192.7	174.0	173.5	185.0	254.5	107.8	13.3	3.3	1234.5	
MAX	129.6	92.1	257.6	241.0	427.9	432.7	418.0	287.7	482.1	299.5	87.8	44.5	1547.5	MAX	73.3	69.9	135.6	216.4	390.0	400.4	393.2	311.4	415.1	280.6	103.8	39.6	1781.9	
MIN	0.0	0.0	0.0	7.4	12.1	30.6	17.2	21.3	52.2	0.0	0.0	0.0	610.7	MIN	0.0	0.0	0.0	6.0	37.5	28.1	47.5	64.3	98.5	0.0	0.0	0.0	965.8	

Complemented Monthly Rainfall at Various Stations (continued)

COMPLEMENTED MONTHLY RAINFALL AT (S) A. CHUM PHAE, KHON KAEN													COMPLEMENTED MONTHLY RAINFALL AT (S) A. CHONNABOJ, KHON KAEN															
(UNIT : MM)													(UNIT : MM)															
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	
1953	0.0	0.0	4.6	109.7	201.8	141.2	175.9	35.3	135.0	90.9	63.9	0.0	978.3	1953	134.0	48.4	56.6	195.9	180.5	262.2	42.4	77.1	225.9	81.0	5.5	0.0	1309.5	
1954	3.8	0.0	1.0	39.6	171.9	126.7	132.6	161.7	370.8	118.7	0.0	0.0	1126.8	1954	0.0	0.0	1.5	56.1	62.4	106.4	112.0	195.7	430.1	60.4	0.0	0.0	1024.6	
1955	0.0	0.0	50.0	62.7	84.7	289.4	46.5	154.3	241.1	12.7	0.0	0.0	941.4	1955	0.0	3.9	41.4	32.8	255.5	480.6	127.1	149.3	192.3	49.8	5.2	0.0	1537.9	
1956	0.0	42.1	102.0	66.7	66.8	118.5	220.5	128.5	256.1	12.3	0.0	0.0	1013.5	1956	0.0	38.5	63.3	11.8	289.0	55.6	357.5	218.6	141.9	72.3	0.0	0.0	1248.5	
1957	0.0	0.0	10.5	50.1	151.9	101.6	309.8	115.1	335.3	93.6	6.5	0.0	1259.4	1957	0.0	104.8	62.1	126.6	185.9	137.7	207.1	291.8	37.0	0.0	0.0	1143.0		
1958	6.8	50.5	37.7	19.5	69.5	161.0	102.4	258.8	345.1	78.5	0.0	0.0	1149.8	1958	0.4	11.8	5.1	37.5	206.7	232.5	106.4	279.5	612.8	37.5	0.0	0.0	1528.2	
1959	0.0	16.8	27.3	39.3	208.3	125.4	187.6	118.2	383.6	0.0	9.0	0.0	1115.5	1959	0.0	12.8	70.4	87.3	328.7	117.4	289.1	135.6	389.1	30.3	0.0	0.0	1460.7	
1960	0.0	0.0	28.7	32.5	265.9	115.5	177.9	49.6	38.7	96.2	0.0	0.0	825.0	1960	0.0	0.0	21.5	32.2	175.7	11.4	86.8	56.5	303.7	70.7	0.0	0.0	758.5	
1961	0.0	9.5	24.9	101.0	195.1	103.8	174.4	136.5	135.2	267.1	3.4	0.0	1150.9	1961	0.0	11.1	18.0	290.3	293.5	110.7	65.4	294.2	154.1	209.4	154.1	0.0	1600.8	
1962	0.0	0.0	70.5	82.9	197.9	67.5	132.4	145.8	428.3	111.5	0.0	0.0	1236.8	1962	0.0	0.0	0.0	153.8	145.6	27.1	210.5	145.4	516.7	131.8	0.0	0.0	1350.9	
1963	0.0	0.0	97.8	49.1	164.5	129.2	135.4	156.9	221.9	113.9	43.7	0.0	1124.4	1963	0.0	0.0	54.5	21.6	118.3	271.0	333.7	112.6	107.2	232.3	80.6	0.0	1336.1	
1964	0.0	4.3	18.5	56.5	240.4	122.6	139.0	115.1	350.7	265.4	13.7	0.0	1356.2	1964	0.0	58.5	47.9	21.6	408.0	102.8	219.5	61.8	386.8	277.2	36.0	0.0	1623.1	
1965	0.0	15.5	10.5	122.0	43.2	59.2	156.2	171.8	82.2	1.7	1.7	0.0	640.6	1965	0.0	0.0	15.0	104.6	177.3	92.1	84.9	344.0	174.8	59.5	0.0	0.0	1002.2	
1966	0.0	0.0	64.1	57.6	333.6	129.9	175.9	159.3	269.9	214.2	19.0	58.3	1381.8	1966	0.0	0.0	23.5	21.4	207.5	141.5	75.7	190.5	195.2	28.7	35.1	16.4	935.5	
1967	0.0	1.2	18.2	108.7	141.5	111.5	114.0	63.7	414.6	41.7	14.5	0.0	974.3	1967	0.0	35.4	0.0	38.7	34.2	137.2	98.1	84.2	372.7	87.1	14.5	0.0	905.2	
1968	0.9	7.2	46.9	29.2	151.2	198.3	137.2	126.1	171.0	56.5	0.0	0.0	848.1	1968	23.8	0.0	11.2	123.7	20.6	179.9	113.8	92.6	211.3	10.0	0.0	0.0	795.2	
1969	14.9	0.0	50.9	24.2	142.0	126.7	137.1	73.2	301.5	59.5	18.0	0.0	940.1	1969	23.5	0.0	81.5	52.6	69.2	282.9	179.1	74.8	415.0	149.1	36.2	0.0	8372.1	
1970	2.2	0.0	25.9	148.3	188.7	174.1	31.6	76.0	253.5	110.9	3.2	3.7	1040.3	1970	0.0	3.0	3.0	53.6	166.4	189.0	73.4	214.6	142.2	59.8	0.0	0.0	859.5	
1971	0.0	0.0	0.0	77.4	165.4	127.7	101.2	157.6	211.2	163.8	8.3	36.0	1050.4	1971	0.0	75.3	0.0	58.1	332.4	109.7	148.3	231.4	112.6	93.9	0.0	0.0	1219.1	
1972	0.0	21.0	0.0	81.7	35.4	135.4	138.9	108.8	151.8	130.2	21.9	10.5	887.3	1972	0.0	0.0	21.3	140.0	184.9	219.8	138.3	27.8	258.8	152.9	29.5	0.0	1101.3	
1973	0.9	0.0	17.8	54.9	182.1	120.4	132.4	198.1	540.8	132.7	0.0	0.0	1124.2	1973	0.0	0.0	0.0	4.3	184.3	97.1	139.3	62.8	187.4	151.9	0.0	0.0	1665.0	
1974	6.9	31.3	17.8	56.3	185.3	38.8	132.1	119.1	146.3	138.3	58.3	0.0	921.8	1974	2.9	3.5	95.0	43.2	189.2	111.2	164.7	143.7	126.8	183.5	46.3	0.0	926.9	
1975	30.2	64.3	87.0	121.9	161.0	187.1	113.2	70.0	108.5	176.9	0.0	0.0	971.1	1975	57.5	2.4	39.0	18.2	241.9	100.5	93.4	69.8	207.7	143.3	47.8	0.0	1021.5	
1976	0.0	33.5	18.8	99.1	66.9	68.0	138.2	137.0	172.0	212.9	7.1	0.0	933.5	1976	0.0	0.0	7.6	118.5	98.8	142.4	80.6	73.9	185.3	291.1	187.5	15.5	0.0	1321.2
1977	0.9	0.0	43.0	149.4	255.2	138.9	184.2	203.5	306.5	146.2	2.5	18.2	1230.9	1977	0.0	0.0	28.5	120.9	241.6	62.6	89.1	152.1	587.2	15.2	10.8	2.7	1621.2	
1978	0.7	8.2	11.9	34.0	179.7	111.1	340.8	248.0	371.7	72.0	2.1	0.0	1366.2	1978	13.4	10.9	56.5	47.4	100.7	114.8	339.1	168.8	487.3	18.3	13.4	0.0	1589.7	
1979	0.0	19.1	0.0	117.5	161.7	239.3	131.9	178.4	297.2	0.0	0.0	0.0	1047.1	1979	0.0	50.7	0.0	165.9	259.0	164.6	83.6	203.4	351.3	0.0	0.0	0.0	1177.2	
1980	0.0	0.0	5.7	40.7	249.0	287.4	153.4	175.7	297.3	118.4	13.4	0.0	1383.0	1980	0.0	1.5	29.1	61.7	153.2	357.8	89.8	204.1	307.6	168.2	3.4	0.0	1556.4	
1981	0.0	0.0	10.5	14.0	45.0	78.5	78.4	50.1	133.4	156.9	20.0	0.0	586.8	1981	0.0	0.0	90.7	66.6	115.3	19.1	161.8	253.2	50.8	63.8	27.3	0.0	848.6	
1982	0.0	0.0	24.7	51.3	182.6	109.2	122.1	99.3	297.1	175.7	0.0	0.0	1090.7	1982	0.0	47.0	105.8	75.1	44.4	91.9	136.5	119.4	417.0	115.1	4.6	16.9	1171.7	
1983	11.4	0.0	0.0	0.0	161.1	349.4	141.4	282.2	151.8	142.1	7.9	0.0	1247.3	1983	14.9	6.6	0.0	11.6	52.4	244.0	129.8	220.1	109.1	117.1	15.7	9.9	931.2	
1984	13.0	21.4	44.2	34.2	143.0	169.6	81.0	119.1	232.1	138.2	0.0	0.0	995.8	1984	0.0	23.2	32.1	92.6	122.9	110.3	76.6	54.5	249.3	95.4	4.3	0.0	861.2	
1985	2.6	10.0	0.0	35.4	217.1	68.7	146.1	96.5	207.1	207.0	2.1	0.0	992.6	1985	11.2	48.6	10.0	40.2	234.3	55.9	117.4	24.8	203.1	130.4	2.6	0.0	880.5	
1986	0.0	0.0	10.8	45.4	184.4	95.7	82.3	71.4	176.6	56.9	4.2	9.1	734.8	1986	0.0	0.0	0.0	107.2	183.2	99.2	126.5	159.9	72.3	59.9	6.1	1.4	814.7	
1987	0.0	28.4	108.5	47.2	122.9	61.0	44.6	294.5	253.6	37.4	38.8	0.0	1036.9	1987	0.0	17.1	44.0	67.2	163.9	135.7	77.9	217.5	242.7	59.9	43.4	0.0	1069.3	
1988	0.0	24.3	1.3	127.2	194.6	152.7	150.2	170.2	166.2	386.0	0.0	0.0	1382.7	1988	0.0	104.9	0.0	56.4	150.9	114.3	172.8	99.9	55.3	248.8	0.0	0.0	983.3	
MEAN	2.6	11.3	32.5	58.8	161.2	133.8	130.3	134.6	255.2	115.8	10.7	7.3	1054.2	MEAN	7.8	17.3	37.5	75.1	167.4	147.4	138.8	156.2	256.7	98.1	17.5	4.4	1124.3	
MAX	30.2	64.3	108.5	148.3	265.9	349.4	340.8	294.5	540.8	396.0	65.9	107.5	1382.7	MAX	134.0	104.9	118.5	290.3	408.0	537.8	359.1	314.0	612.8	277.2	154.1	75.1	1623.1	
MIN	0.0	0.0	0.0	0.0	25.6	43.2	13.9	35.3	58.7	0.0	0.0	0.0	586.8	MIN	0.0	0.0	0.0	4.3	28.9	11.2	28.0	24.8	50.8	0.0	0.0	0.0	0.0	665.0

Complemented Monthly Rainfall at Various Stations (continued)

COMPLEMENTED MONTHLY RAINFALL AT (7) HUAI YANG TANK (INK-52)

(UNIT : MM)

COMPLEMENTED MONTHLY RAINFALL AT (8) KOK MIANG TANK (INK-54)

(UNIT : MM)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1953	134.4	48.5	56.6	196.4	181.1	262.8	42.4	77.4	226.7	81.4	5.5	0.0	1313.2
1954	0.0	0.0	1.5	56.3	62.5	106.8	112.3	196.1	431.3	60.5	0.0	0.0	1027.3
1955	0.0	3.9	41.6	33.0	256.2	481.6	127.6	149.7	192.7	49.9	5.3	0.0	1341.5
1956	0.0	38.8	63.5	11.8	289.7	55.6	358.4	219.6	142.3	72.3	0.0	0.0	1252.0
1957	0.0	0.0	105.2	64.5	90.7	229.4	196.1	125.4	307.8	77.1	0.0	0.0	1156.2
1958	0.0	0.0	2.8	0.0	117.9	67.1	58.3	279.0	447.0	71.1	0.0	0.0	1053.2
1959	0.0	0.0	0.0	14.8	253.6	100.8	230.4	183.3	328.0	0.0	0.0	0.0	1090.9
1960	0.0	0.0	0.0	0.0	220.9	48.1	108.5	43.9	180.1	72.4	0.0	0.0	675.9
1961	0.0	0.0	0.0	41.5	201.0	62.8	59.3	174.3	205.0	146.0	0.0	0.0	889.9
1962	0.0	0.0	23.1	209.2	184.7	40.3	183.6	182.9	430.9	74.0	0.0	0.0	1328.7
1963	0.0	0.0	21.6	14.0	30.4	247.8	237.1	141.9	137.8	218.6	60.9	0.0	1150.0
1964	0.0	14.9	44.5	64.4	311.4	13.4	232.5	59.5	425.9	314.6	30.5	0.0	1624.6
1965	0.0	9.0	1.9	73.3	167.9	65.6	108.0	252.4	265.8	55.8	0.0	0.0	997.7
1966	0.0	0.0	58.1	33.2	316.6	105.8	149.6	213.7	170.3	132.1	13.2	8.8	1232.4
1967	0.0	15.3	0.0	32.2	123.5	123.6	198.7	90.3	504.3	43.8	18.0	0.0	1510.8
1968	21.0	4.0	21.0	121.2	103.5	183.2	168.1	82.2	268.2	21.2	9.0	0.0	1001.8
1969	21.7	0.0	31.0	189.7	154.1	201.6	184.5	84.0	281.3	267.5	7.9	0.0	1440.5
1970	0.0	0.0	9.0	30.4	100.3	190.9	35.2	114.9	263.3	63.3	0.0	6.4	865.7
1971	0.0	8.5	0.0	0.0	112.2	174.9	171.2	215.8	109.3	98.5	0.0	35.5	925.9
1972	0.0	0.0	80.4	142.8	99.1	102.3	301.9	48.8	206.0	123.4	23.8	65.2	934.9
1973	0.0	0.0	54.3	43.2	81.4	62.0	153.3	133.3	144.3	51.1	0.0	0.0	861.9
1974	1.0	0.0	33.7	121.7	85.4	67.0	172.7	106.7	220.0	98.4	100.0	0.0	1006.6
1975	27.0	13.2	18.0	9.3	265.0	172.0	202.0	77.1	257.5	125.1	18.1	0.0	1184.3
1976	0.0	0.0	110.9	144.0	197.2	48.4	146.0	201.1	275.6	276.7	11.9	0.0	1438.9
1977	0.0	0.0	10.0	155.3	229.4	116.3	38.6	219.9	377.7	38.2	0.0	0.4	1186.0
1978	0.0	2.0	49.1	17.1	90.6	139.6	328.7	185.2	457.7	23.5	10.5	0.0	1304.0
1979	0.0	5.0	0.0	39.0	239.8	79.2	148.4	241.1	306.2	0.0	0.0	0.0	1038.7
1980	0.0	0.0	65.5	92.8	83.6	416.1	91.0	204.4	417.9	227.4	6.5	0.0	1605.2
1981	0.0	0.0	4.5	41.0	52.6	34.0	164.1	66.3	187.0	47.0	12.5	0.0	609.2
1982	0.0	6.5	75.0	60.7	86.6	57.0	160.8	167.5	349.7	293.5	2.0	0.0	1259.3
1983	7.5	0.0	0.0	30.0	66.6	299.8	103.0	228.0	166.7	79.7	37.5	0.0	1048.8
1984	43.5	20.5	35.0	190.0	128.9	123.5	69.1	99.7	212.0	161.6	15.0	0.0	1088.8
1985	0.0	32.5	0.0	0.0	122.7	50.5	130.6	56.0	181.6	213.5	0.0	0.0	747.4
1986	0.0	0.0	0.0	226.6	214.8	48.0	41.0	165.1	23.4	61.0	0.0	0.0	809.9
1987	0.0	35.5	39.5	122.5	128.0	81.1	45.3	210.6	218.7	64.8	39.4	0.0	995.4
1988	0.0	92.1	1.3	174.0	207.0	160.2	115.4	12.4	69.5	180.1	0.0	0.0	1012.0
MEAN	6.3	10.0	29.0	75.2	154.0	141.1	140.7	147.3	273.1	105.9	11.6	3.3	1097.4
MAX	134.4	92.1	110.9	226.6	316.6	481.6	358.4	279.0	594.5	314.6	100.0	65.2	1624.6
MIN	0.0	0.0	0.0	0.0	0.0	34.0	30.9	12.4	53.4	0.0	0.0	0.0	609.2

Complemented Monthly Rainfall at Various Stations (continued)

COMPLEMENTED MONTHLY RAINFALL AT (9) HUAI T0E1 TANK (INK-113)													
(UNIT : MM)													
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1953	0.0	0.0	9.8	143.9	202.6	196.8	140.9	164.9	348.4	93.4	23.7	0.0	1324.4
1954	29.9	79.7	0.0	39.6	172.0	189.6	108.9	120.2	474.2	68.2	0.0	0.4	1282.7
1955	0.0	0.0	13.1	68.7	109.2	404.6	60.8	227.5	176.6	7.6	2.9	0.0	1071.0
1956	0.0	24.2	38.6	78.4	85.1	101.4	180.8	162.1	154.6	33.2	0.0	0.0	858.4
1957	0.0	0.0	106.2	56.5	137.5	169.7	122.7	198.0	265.0	23.9	0.0	0.0	1079.5
1958	36.5	6.6	188.3	0.0	149.6	211.5	125.5	156.2	271.5	65.6	0.0	0.0	1211.3
1959	0.0	8.5	16.2	32.4	187.4	88.2	187.9	103.2	488.5	12.8	0.0	0.0	1125.1
1960	0.0	0.0	66.1	4.8	184.2	187.5	120.1	194.9	103.1	75.3	0.5	0.0	936.8
1961	0.0	0.0	1.0	59.1	137.6	118.4	38.9	287.7	357.8	190.3	0.2	0.0	1191.0
1962	0.6	0.0	28.0	64.9	229.5	76.7	170.2	177.9	411.5	33.7	5.2	3.4	1101.6
1963	0.0	0.0	28.2	46.6	101.3	188.7	242.3	209.7	196.1	163.5	86.4	0.0	1242.8
1964	0.0	12.6	11.8	85.2	262.4	101.1	150.2	91.9	263.3	182.2	22.2	0.0	1182.9
1965	0.0	3.8	26.9	109.1	80.7	70.0	120.1	202.5	175.5	107.3	0.0	0.0	895.9
1966	0.0	74.6	0.0	54.6	345.7	133.7	121.6	225.0	162.6	103.6	11.0	17.9	1304.6
1967	0.0	48.3	0.0	14.4	49.1	133.8	145.4	205.7	278.1	11.5	21.0	0.0	307.3
1968	22.2	10.6	25.4	85.0	144.6	209.9	235.2	197.7	154.7	33.4	0.0	0.0	1114.7
1969	61.0	0.4	34.7	34.0	58.5	302.1	169.1	95.6	272.5	148.2	37.6	0.0	1311.5
1970	0.4	0.8	16.8	107.9	152.2	434.3	63.0	150.1	308.9	40.8	1.6	8.1	1304.9
1971	0.0	36.4	19.9	86.4	321.2	94.2	129.3	375.3	109.8	0.0	0.0	0.0	1172.5
1972	0.0	0.0	41.0	45.1	0.0	105.6	47.0	65.1	65.1	163.8	39.0	59.5	451.2
1973	0.0	0.0	0.4	58.5	87.0	112.7	206.5	140.0	235.3	15.6	0.0	0.0	854.0
1974	0.0	0.0	41.5	67.4	118.5	118.5	116.0	150.3	194.7	124.2	47.9	0.0	879.0
1975	34.3	0.0	100.5	0.0	278.6	197.1	161.3	94.8	238.9	121.1	0.0	0.0	1268.6
1976	0.0	0.0	0.0	82.4	117.3	64.1	106.0	204.1	131.0	116.8	0.0	0.0	851.7
1977	0.0	0.0	0.0	0.0	72.6	58.1	72.6	114.8	265.4	43.6	0.0	0.0	841.6
1978	0.0	2.2	0.0	81.6	87.5	144.7	390.6	123.4	440.5	48.0	8.0	0.0	1867.3
1979	0.0	0.0	0.0	105.3	135.3	136.5	78.1	259.1	292.5	0.0	0.0	0.0	1000.0
1980	0.0	0.0	10.0	20.6	221.4	231.2	104.0	208.6	515.0	180.9	0.0	0.0	1509.7
1981	0.0	0.0	14.1	72.0	111.6	264.7	374.0	110.0	236.7	127.1	43.0	0.0	1243.2
1982	0.0	63.6	88.5	26.0	83.2	80.0	72.0	144.0	569.6	217.6	0.0	0.0	1324.2
1983	8.0	0.0	0.0	49.0	245.8	201.2	238.2	192.0	214.2	0.0	10.0	0.0	1242.6
1984	0.0	28.0	27.1	33.8	87.5	84.5	129.5	178.2	195.0	114.2	10.1	0.0	1117.6
1985	0.0	32.7	0.0	110.9	94.1	91.6	179.6	138.2	234.1	137.6	6.1	0.0	869.8
1986	0.0	0.0	0.0	35.0	150.0	132.7	62.1	138.3	111.9	111.5	22.0	0.0	862.6
1987	0.0	62.7	4.1	80.5	132.7	162.5	130.5	274.3	209.7	134.2	32.5	0.0	1953.7
1988	0.0	17.1	24.7	104.5	237.9	137.9	130.0	56.5	143.7	246.6	0.0	0.0	1158.7
MEAN	5.4	14.4	29.7	62.2	144.5	160.4	141.5	172.0	253.1	98.0	11.7	2.8	1095.6
MAX	61.0	79.7	188.3	143.9	345.7	454.3	390.6	375.3	515.0	246.6	86.4	59.5	1509.7
MIN	0.0	0.0	0.0	0.0	0.0	18.5	38.9	56.3	65.1	0.0	0.0	0.0	631.2

COMPLEMENTED MONTHLY RAINFALL AT (10) R MAIN CANAL

(UNIT : MM)

(UNIT : MM)

COMPLEMENTED MONTHLY RAINFALL AT (10) R MAIN CANAL														
(UNIT : MM)														
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	
1953	0.0	0.0	9.2	134.4	189.3	183.7	131.7	153.7	325.5	87.2	22.1	0.0	1236.8	
1954	27.9	74.4	0.0	36.9	160.8	177.1	101.6	112.3	442.9	63.7	0.0	0.4	1198.1	
1955	0.0	0.0	12.3	64.2	102.1	378.0	56.8	212.4	165.0	7.1	2.6	0.0	1000.5	
1956	0.0	22.6	36.0	75.2	79.5	94.7	188.9	151.3	144.3	30.9	0.0	0.0	801.5	
1957	0.0	0.0	99.2	52.8	128.5	158.5	114.6	185.0	247.7	22.3	0.0	0.0	1008.2	
1958	34.1	6.2	174.0	0.0	139.8	197.5	117.1	145.9	253.6	61.1	0.0	0.0	1131.2	
1959	0.0	6.9	15.1	30.3	175.3	82.4	175.5	96.5	454.4	11.9	0.0	0.0	1051.2	
1960	0.0	0.0	62.1	4.5	172.0	175.1	112.3	182.0	98.2	70.3	0.5	0.0	874.8	
1961	0.0	0.0	0.9	55.2	128.4	110.6	36.2	268.8	334.2	177.7	0.2	0.0	1112.3	
1962	0.5	0.0	26.1	60.8	214.5	171.5	158.8	166.2	384.5	11.4	4.8	3.2	1123.2	
1963	0.0	0.0	26.3	43.6	94.5	174.3	224.3	195.8	183.2	172.8	80.7	0.0	1159.2	
1964	0.0	11.7	11.0	79.5	245.2	94.5	110.3	85.8	242.9	170.1	20.7	0.0	1104.2	
1965	0.0	3.5	25.1	101.8	75.3	65.4	112.2	189.2	163.8	100.2	0.0	0.0	856.7	
1966	0.0	69.6	51.1	52.8	322.7	124.8	113.5	308.3	152.0	96.6	10.3	16.7	1218.3	
1967	0.0	45.0	0.0	11.5	45.8	124.9	135.9	192.4	257.6	10.7	19.6	0.0	1047.4	
1968	20.7	9.8	23.7	79.1	135.0	194.1	217.8	163.7	127.5	31.2	9.0	0.0	1045.1	
1969	57.0	0.4	33.4	31.8	54.6	285.2	158.0	87.5	254.3	138.2	39.1	0.0	1131.6	
1970	0.4	0.7	15.7	100.8	142.1	424.5	58.8	140.2	288.3	38.1	1.5	7.8	1219.2	
1971	0.0	34.0	18.6	48.2	181.3	102.0	218.8	333.1	169.2	53.1	7.0	24.6	1090.6	
1972	0.0	4.3	18.9	126.1	115.9	268.3	182.8	137.3	112.2	142.9	55.4	10.8	780.2	
1973	0.0	0.0	0.5	17.1	57.6	91.7	159.0	167.4	244.2	3.5	0.1	0.0	708.8	
1974	0.0	0.9	1.3	37.8	58.1	63.5	127.9	623.5	192.3	82.4	92.8	0.0	1047.0	
1975	24.7	3.4	43.3	3.6	346.8	156.0	250.9	180.8	265.3	67.9	0.0	0.0	1328.6	
1976	0.0	0.0	2.6	52.6	18.0	207.6	74.4	140.0	137.1	145.2	199.8	0.0	937.1	
1977	0.0	0.0	4.3	1.3	51.2	160.2	108.2	60.1	233.7	262.4	10.3	0.0	56.9	969.3
1978	15.0	3.2	10.3	11.9	202.0	197.8	371.0	214.7	326.0	66.6	1.9	0.0	1522.6	
1979	0.0	10.1	0.0	133.6	144.3	214.4	43.2	260.5	354.8	0.0	0.0	0.0	1160.9	
1980	0.0	0.0	19.8	89.9	226.2	256.2	48.8	211.2	316.6	75.2	0.0	0.0	1224.4	
1981	0.0	0.0	8.0	15.7	203.3	145.4	211.2	59.5	56.1	86.0	18.7	0.0	809.9	
1982	0.0	41.3	106.9	35.2	134.7	80.2	122.8	67.0	438.2	60.4	0.0	3.2	1089.9	
1983	0.0	0.0	0.0	1.7	32.8	242.3	46.7	232.1	159.8	114.0	12.9	0.0	842.3	
1984	0.0	22.7	11.6	81.8	42.0	208.2	177.4	202.8	202.8	47.8	5.7	0.0	1151.1	
1985	0.0	5.5	16.2	74.3	210.8	133.5	163.8	101.4	186.8	75.8	0.0	0.0	969.1	
1986	0.0	0.0	20.0	111.2	187.4	183.2	72.6	97.7	66.1	59.7	0.0	5.6	803.5	
1987	0.0	31.2	18.6	49.8	143.2	82.3	20.8	178.4	237.1	91.3	58.8	0.0	911.5	
1988	0.0	13.8	18.0	17.2	216.7	290.7	116.4	75.0	141.4	241.9	0.0	0.0	1131.1	
MEAN	5.0	12.0	28.7	57.2	152.5	166.1	132.7	169.2	233.9	76.3	12.5	3.6	1049.9	
MAX	57.0	74.4	176.0	134.4	346.8	424.5	371.0	273.5	456.4	241.9	92.8	56.9	1522.6	
MIN	0.0	0.0	0.0	0.0	15.9	61.1	20.8	59.5	66.1	0.0	0.0	0.0	708.8	

Table A-6 Complemented Monthly Rainfall at (11) A. Phra Yun
(Monthly Areal Rainfall of the Study Area)

(UNIT : MM)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	MAY-SEP	OCT-APR
1953	0.0	0.0	8.5	124.8	175.6	170.7	121.6	109.7	502.4	80.9	20.6	0.0	1114.8	880.0	234.8
1954	25.9	69.1	0.0	34.3	141.1	164.5	90.1	104.3	411.3	59.1	0.0	0.3	1100.0	911.3	188.7
1955	0.0	0.0	11.3	59.6	93.8	351.1	53.0	197.2	153.0	6.6	2.4	0.0	928.0	848.1	79.9
1956	0.0	21.0	29.5	67.7	73.8	88.0	154.6	119.8	134.2	28.7	0.0	0.0	717.3	570.4	146.9
1957	0.0	0.0	92.1	48.9	119.2	147.0	103.3	151.5	229.9	20.7	0.0	0.0	912.6	750.9	161.7
1958	0.0	5.7	163.5	0.0	150.0	185.3	107.6	134.3	235.4	56.7	0.0	0.0	1016.3	790.6	225.7
1959	0.0	7.4	14.0	28.1	159.8	78.4	162.1	89.4	423.8	11.2	0.0	0.0	972.2	911.5	60.7
1960	0.0	0.0	57.7	4.1	159.8	162.5	102.8	168.9	89.4	65.2	0.4	0.0	810.8	683.4	127.4
1961	0.0	0.0	0.8	51.3	119.2	102.7	33.7	206.0	310.3	145.1	0.2	0.0	989.3	771.9	217.4
1962	0.5	0.0	24.3	56.3	179.6	66.3	147.5	152.1	357.1	29.2	4.5	0.0	1017.6	902.6	115.0
1963	0.0	0.0	24.5	40.7	85.7	165.8	210.2	174.2	170.1	141.9	74.9	0.0	1086.0	804.0	282.0
1964	0.0	10.9	10.2	73.8	227.5	87.8	128.6	76.1	228.2	157.9	19.3	0.0	1020.3	748.2	272.1
1965	0.0	3.5	16.9	94.5	69.9	60.7	103.7	170.2	152.1	85.9	0.0	0.0	757.2	556.6	200.6
1966	0.0	64.8	35.9	49.1	298.3	115.9	105.3	189.4	141.2	84.6	9.6	15.6	1107.7	850.1	257.6
1967	0.0	41.8	0.0	12.6	42.4	116.2	126.3	160.1	241.1	10.0	18.2	0.0	788.7	686.1	82.6
1968	19.3	9.2	21.8	73.8	108.3	182.1	202.4	171.6	134.4	29.1	0.0	0.0	952.0	798.8	153.2
1969	52.9	0.3	30.1	29.5	44.9	262.1	146.6	81.4	236.2	128.5	32.7	0.0	1045.2	771.2	274.0
1970	0.3	0.7	14.6	93.7	108.2	394.1	52.0	128.0	248.2	35.5	1.4	7.1	1103.8	950.5	153.3
1971	0.0	31.6	17.3	44.8	188.3	94.8	203.1	172.0	157.0	49.4	6.5	22.7	867.5	795.2	172.3
1972	0.0	4.0	8.2	17.2	11.5	247.1	73.1	127.5	104.2	139.1	51.7	10.0	895.4	565.2	330.2
1973	0.0	0.0	4.2	12.1	52.8	56.7	137.1	157.0	227.0	3.2	0.1	0.0	650.2	630.6	19.6
1974	0.8	1.2	24.8	54.0	85.4	73.1	125.7	222.2	181.5	76.6	86.2	0.0	931.5	687.9	243.6
1975	22.9	3.1	45.8	3.4	261.7	144.7	158.2	167.8	246.3	63.0	0.0	0.0	1116.9	978.7	138.2
1976	0.0	4.7	37.6	63.5	105.2	33.0	148.7	147.2	247.7	125.4	0.7	0.0	913.7	681.8	231.9
1977	0.2	0.0	15.0	59.7	218.0	119.3	72.3	170.3	341.1	7.9	2.1	15.7	1021.6	921.0	100.6
1978	0.6	5.3	10.2	46.5	152.8	95.5	288.0	185.3	319.9	61.9	1.8	0.0	1167.8	1041.5	126.3
1979	0.0	16.4	0.0	75.5	155.6	238.9	68.1	179.4	210.6	0.0	0.0	0.0	944.5	852.6	91.9
1980	0.0	2.8	17.8	39.4	178.2	302.2	82.3	121.3	281.6	82.7	0.0	0.0	1108.3	965.6	142.7
1981	0.0	7.0	1.1	28.8	207.1	128.2	196.7	135.6	24.7	117.7	16.6	0.0	865.5	692.3	171.2
1982	0.0	42.1	76.7	58.8	108.4	100.7	175.2	62.8	501.4	110.8	4.8	7.7	1249.4	948.3	300.9
1983	0.0	0.0	0.0	0.0	76.9	171.0	79.5	329.3	190.6	132.7	12.3	0.0	992.3	847.3	145.0
1984	0.0	0.0	0.0	39.0	98.0	129.2	180.9	182.4	176.9	69.3	0.0	0.0	875.7	767.4	108.3
1985	0.0	0.0	0.0	17.9	235.3	79.8	141.2	88.1	232.4	124.0	0.0	0.0	898.7	756.8	141.9
1986	0.0	0.0	18.2	160.7	141.1	83.1	74.9	130.8	117.0	8.0	0.0	0.0	753.8	566.9	186.9
1987	0.0	30.1	20.0	64.8	281.1	104.2	91.1	226.1	216.1	63.2	43.9	0.0	1140.6	918.6	222.0
1988	0.0	92.3	10.5	137.8	113.9	127.4	89.0	72.6	181.4	128.8	0.0	0.0	953.7	584.3	369.4
MEAN	3.4	13.2	23.9	54.6	139.1	145.1	126.1	151.7	226.5	71.1	11.4	2.2	968.5	788.6	179.9
MAX	52.9	92.3	163.3	160.7	298.3	394.1	288.0	329.3	501.4	165.1	86.2	22.7	1249.4	1041.5	369.4
MIN	0.0	0.0	0.0	0.0	11.5	33.0	33.7	62.8	24.7	0.0	0.0	0.0	650.2	556.6	19.6

Table A-7 Annual Rainfall in the Vicinity of the Study Area

(Unit : mm)

Year	(1) A. Muang	(2) A. Mancha Khiri	(3) A. Ban Phai	(4) A. Phu Wiang	(5) A. Chum Phae	(6) A. Chonnabot	(7) TNK-32	(8) TNK-34	(9) TNK-113	(10) R Main Canal	(11) A. Phra Yun
1953	1359	1223	(1267)	1498	978	(1310)	(1313)	(1332)	(1324)	(1237)	(1115)
1954	1317	956	(802)	1354	1127	(1025)	(1027)	(1291)	(1283)	(1198)	(1100)
1955	1099	1249	(1270)	1067	941	(1338)	(1342)	(1078)	(1071)	(1001)	(928)
1956	881	1186	1242	1300	1014	(1249)	(1252)	(863)	(858)	(802)	(717)
1957	1108	1067	1333	1308	1259	(1143)	(1126)	(795)	(1080)	(1009)	(913)
1958	1243	1427	1548	1170	1150	(1528)	1043	364	(1211)	(1131)	(1016)
1959	1155	1364	1048	1017	1116	(1461)	1091	1011	(1125)	(1051)	(972)
1960	961	708	971	1217	825	(759)	674	1155	(937)	(875)	(811)
1961	1222	1495	1135	1191	1151	(1601)	890	1034	(1191)	(1112)	(989)
1962	1233	1261	1200	1246	1237	(1351)	1329	1449	(1202)	(1122)	(1018)
1963	1296	1248	1182	1324	1142	(1336)	1160	961	(1263)	(1180)	(1086)
1964	1214	1516	1192	1286	1356	(1623)	1625	1201	(1183)	(1105)	(1020)
1965	919	936	940	1083	641	(1002)	998	985	(896)	(837)	(757)
1966	1339	992	1507	1521	1382	(936)	1222	1063	(1305)	(1218)	(1108)
1967	931	1070	747	1093	914	905	1241	891	(907)	(847)	(769)
1968	1146	826	1026	1218	848	796	1002	1096	(1117)	(1043)	(952)
1969	1244	1099	1382	1227	960	1376	1450	1311	(1212)	(1132)	(1045)
1970	1340	746	1006	1307	1040	860	866	1218	(1305)	(1219)	(1104)
1971	1199	988	1204	1325	1050	1219	926	1595	(1173)	(1091)	(968)
1972	1077	717	855	966	837	1102	925	976	631	(980)	(895)
1973	779	745	722	1105	1137	665	662	906	856	(709)	(650)
1974	1151	711	874	1004	874	927	1007	950	879	(1047)	(932)
1975	1460	801	1040	1306	971	1022	1184	1365	1227	(1329)	(1117)
1976	1097	1111	1212	1418	954	1221	1439	1204	852	937	(914)
1977	1216	855	761	(1023)	(1221)	1021	1186	1110	670	969	(1022)
1978	1390	1230	1497	(1536)	(1366)	1390	1304	1416	1368	(1523)	(1168)
1979	1177	1213	1214	1142	(1049)	1197	1059	1018	1000	1161	(945)
1980	1327	1463	1361	1782	1343	1556	1605	1461	1510	1224	(1108)
1981	1064	765	855	1042	587	849	609	974	1243	810	(864)
1982	1480	1158	1099	1142	1091	1172	1259	1100	1322	1090	(1249)
1983	1287	905	795	(1293)	1247	931	1049	1559	1118	842	992
1984	1245	863	845	998	996	861	1069	1189	870	1151	876
1985	902	778	1064	1263	993	881	767	768	1043	969	899
1986	1085	590	(611)	1198	737	815	810	1220	863	804	754
1987	1284	906	1189	(1360)	1037	1069	(985)	(1258)	(1194)	912	1141
1988	1255	768	1304	(1112)	1383	983	(1012)	(1025)	(1159)	1131	954
Mean	1180	1025	1092	1235	1054	1124	1097	1116	1096	1050	969
Max.	1480	1516	1548	1782	1383	1623	1625	1595	1510	1523	1249
Min.	779	590	611	966	587	665	609	364	631	709	650

Note 1) () : Complemented Data

- 2) Station Name (1) A. Muang, Khon Kaen
(2) A. Mancha Khiri, Khon Kaen
(3) A. Ban Phai, Khon Kaen
(4) A. Phu Wiang, Khon Kaen
(5) A. Chum Phae, Khon Kaen
(6) A. Chonnabot, Khon Kaen
(7) Huai Yang Tank (TNK-32), A. Mancha Khiri, Khon Kaen
(8) Kok Muang Tank (TNK-34), A. Muang, Khon Kaen
(9) Huai Toei Tank (tnk-113), A. Muang, Khon Kaen
(10) R Main Canal, A. Muang, Khon Kaen
(11) A. Phra Yun, Khon Kaen

Table A-8 Mean Monthly Rainfall in the Vicinity of the Study Area

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual	MAY. - Sep.	Oct. - Apr.
(1) A. Muang	6 (1)	13 (1)	34 (3)	63 (5)	169 (14)	184 (16)	158 (13)	190 (16)	259 (22)	88 (7)	13 (1)	3 (1)	1180 (100)	960 (81)	220 (19)
(2) A. Mancha Khiri	4 (1)	14 (1)	31 (3)	71 (7)	149 (15)	138 (13)	124 (12)	141 (14)	247 (24)	89 (8)	13 (1)	4 (1)	1025 (100)	799 (78)	226 (22)
(3) A. Ban Phai	8 (1)	17 (1)	46 (4)	77 (7)	155 (14)	150 (14)	137 (12)	134 (12)	247 (23)	105 (10)	12 (1)	4 (1)	1092 (100)	823 (75)	269 (25)
(4) A. Phu Wiang	5 (1)	14 (1)	34 (3)	77 (6)	193 (15)	174 (14)	174 (14)	185 (15)	255 (21)	108 (8)	13 (1)	3 (1)	1235 (100)	981 (79)	254 (21)
(5) A. Chum Phae	3 (1)	11 (1)	32 (3)	59 (5)	161 (15)	134 (13)	130 (12)	135 (13)	255 (24)	116 (11)	11 (1)	7 (1)	1054 (100)	815 (77)	239 (23)
(6) A. Chon- nabot	8 (1)	17 (1)	38 (3)	75 (7)	167 (15)	147 (13)	139 (12)	156 (14)	257 (23)	98 (9)	18 (1)	4 (1)	1124 (100)	866 (77)	258 (23)
(7) TNK-32	6 (1)	10 (1)	29 (2)	75 (7)	154 (14)	141 (13)	141 (13)	147 (13)	273 (25)	106 (9)	12 (1)	3 (1)	1097 (100)	856 (78)	241 (22)
(8) TNK-34	5 (1)	12 (1)	27 (2)	70 (6)	144 (13)	164 (14)	154 (14)	166 (15)	259 (23)	99 (9)	12 (1)	4 (1)	1116 (100)	887 (79)	229 (21)
(9) TNK-113	5 (1)	14 (1)	30 (2)	62 (5)	145 (13)	160 (15)	142 (13)	172 (16)	253 (23)	98 (9)	12 (1)	3 (1)	1096 (100)	872 (80)	224 (20)
(10) R Main Canal	5 (1)	12 (1)	29 (3)	57 (5)	152 (14)	166 (16)	133 (13)	169 (16)	234 (22)	76 (7)	13 (1)	4 (1)	1050 (100)	854 (81)	196 (19)
(11) A. Phra Yun	3 (1)	13 (1)	24 (2)	55 (6)	139 (14)	145 (15)	126 (13)	152 (16)	227 (23)	71 (7)	12 (1)	2 (1)	969 (100)	789 (81)	180 (19)

Note

— Mean Monthly Rainfall (mm)
() — Ratio (%) to Annual Rainfall

A-2-3 Areal Rainfall

Areal rainfall of the study area was estimated using the rainfall of A. Phra Yun Station by Thiessen method as shown in Appendix Figure 1-3. Monthly areal rainfall is shown in Appendix Table A-6. Mean monthly areal rainfall is shown below ;

Monthly Areal Rainfall of the Study Area

(Unit : mm)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
3 (1)	13 (1)	24 (2)	55 (6)	139 (14)	145 (15)	126 (13)	152 (16)
Sep.	Oct.	Nov.	Dec.	Annual	Wet	Dry	
227 (23)	71 (7)	12 (1)	2 (1)	969 (100)	789 (81)	180 (19)	

Note Wet : Wet Season (May - Sept.)

Dry : Dry Season (Oct.- Apr.)

(): Ratio to Annual Rainfall %

The results of the analysis for probable rainfalls are presented in Table A-9 only 2 years, 3 years, 5 years and 10 years probable rainfalls are presented below ;

Probable Areal Rainfalls of the Study Area

Probable Years	Approximate Year	Annual Rainfall mm
1/2	1988	954
1/3	1984	876
1/5	1981	864
1/10	1960	811

Areal ratio by Thiessen method and mean areal rainfall in the upperreach of Huai Yai outside of the study area is as follows;

Areal Ratio by Thiessen

Station	Drainage Area	Areal Ratio
(8) TNK-34	57.6 km ²	47.4%
(11) A. Phra Yun	60.4 km ²	52.6%
Total	121.6 km ²	100.0%

Monthly Areal Rainfall in the Upperreach of Huai Yai Outside
of the Study Area

(Unit : mm)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
4	13	25	62	142	154	139	159
Sep.	Oct.	Nov.	Dec.	Annual	Wet	Dry	
242	84	12	3	1039	836	203	

Note Wet : Wet Season (May - Sept.)

Dry : Dry Season (Oct.- Apr.)

Areal rainfall in the upperreach of Huai Yai outside of the study area is shown in Table A-10.

FIGURE A-3 THIESEN POLYGON

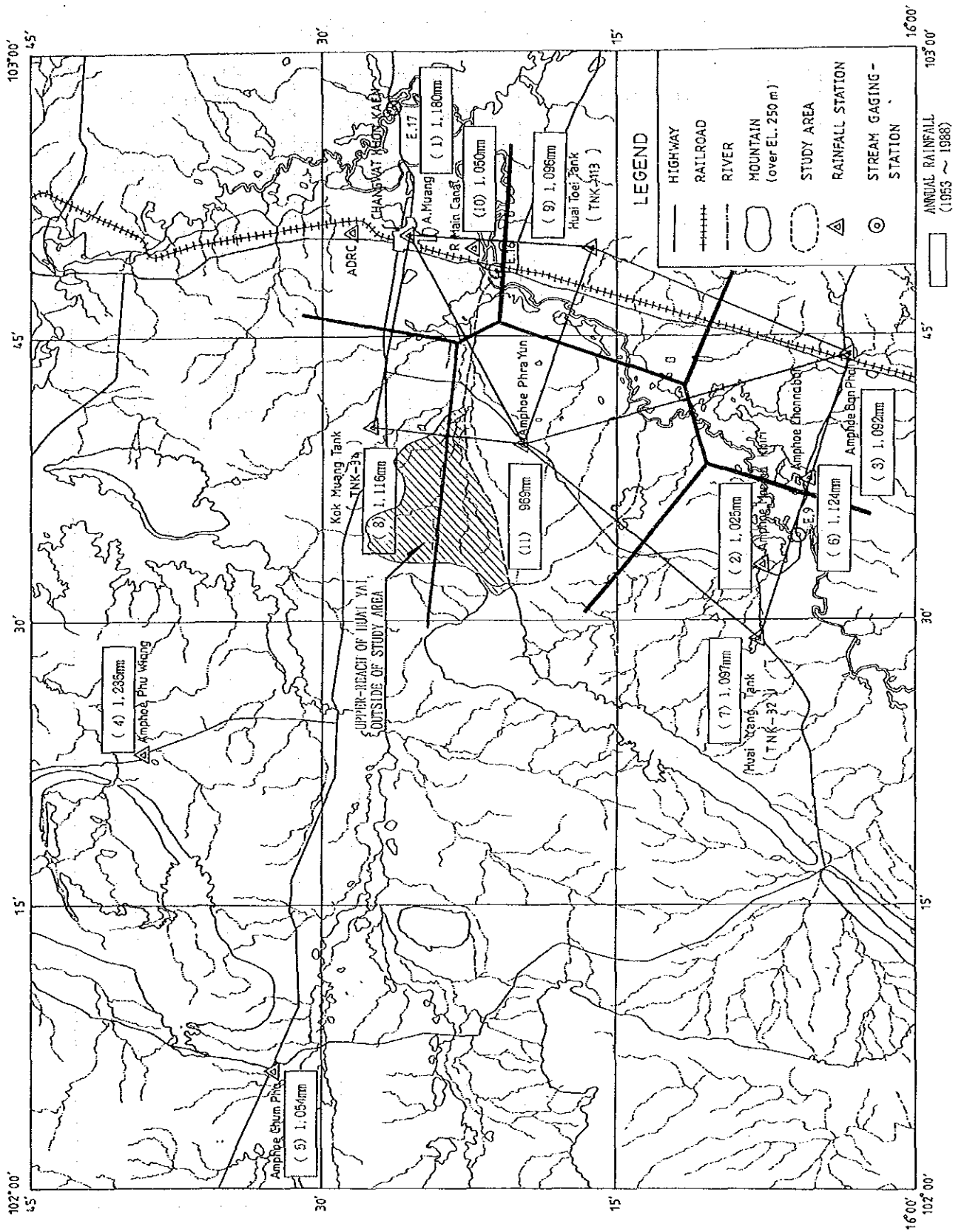


Table A-9 The Result of Probable Rainfall Analysis

	Annual Rainfall		Wet Season Rainfall (May. - Sep.)		Dry Season Rainfall (Oct. - Apr.)	
	Rainfall (mm)	Probable Year	Rainfall (mm)	Probable Year	Rainfall (mm)	Probable Year
1953	1115		880		235	
1954	1100		911		189	
1955	928	2.5	848		80	11.5
1956	717	39.7	570	26.4	147	2.7
1957	913	2.8	751	2.5	162	2.2
1958	1016		791		226	
1959	972		912		61	24.5
1960	811	7.8	683	4.4	127	3.6
1961	989		772	2.1	217	
1962	1018		903		115	4.5
1963	1086		804		282	
1964	1020		748	2.5	272	
1965	757	18.0	557	36.3	201	
1966	1108		850		258	
1967	769	14.7	686	4.3	83	10.5
1968	952	2.1	799		153	2.5
1969	1045		771	2.1	274	
1970	1104		951		153	2.5
1971	968		795		172	
1972	895	3.1	565	29.7	330	
1973	650	232.4	631	8.7	20	327.6
1974	932	2.5	688	4.2	244	
1975	1117		979		138	3.0
1976	914	2.8	682	4.5	232	
1977	1022		921		101	6.2
1978	1168		1042		126	3.6
1979	945	2.2	853		92	7.9
1980	1108		966		143	2.8
1981	864	4.2	692	4.0	171	
1982	1249		949		301	
1983	992		847		145	2.7
1984	876	3.7	767	2.2	108	5.2
1985	899	3.0	757	2.4	142	2.8
1986	754	19.1	567	28.6	187	
1987	1141		919		222	
1988	954	2.1	584	19.7	369	

Table A-10 Areal Rainfall in Upper-Reach of Huai Yai Outside of the Study Area

(UNIT : MM)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	MAY-SEP	OCT-APR	
1953	0.0	0.0	9.2	134.2	188.7	183.7	131.1	136.2	325.0	87.0	22.1	0.0	0.0	1217.2	964.7	252.5
1954	27.8	74.3	0.0	37.0	156.2	176.8	99.0	112.2	442.4	63.6	0.0	0.3	1189.6	986.6	203.0	
1955	0.0	0.0	12.2	64.1	101.4	377.6	56.9	211.8	168.8	7.0	2.6	0.0	998.4	912.5	85.9	
1956	0.0	22.6	33.8	72.8	79.4	94.6	167.3	140.3	144.1	30.8	0.0	0.0	785.7	625.7	160.0	
1957	0.0	0.0	99.0	25.8	74.5	108.4	112.7	174.1	247.2	14.9	0.0	0.0	856.6	716.9	139.7	
1958	0.0	3.0	102.1	0.0	77.7	121.3	66.1	94.3	213.0	30.0	0.0	0.0	707.5	572.4	135.1	
1959	0.0	5.4	7.4	55.4	84.1	79.0	174.0	107.1	468.9	7.9	0.0	0.0	990.2	914.1	76.1	
1960	0.0	0.0	47.4	5.9	209.3	155.0	242.2	116.1	109.5	79.8	9.0	0.0	974.2	832.1	142.1	
1961	0.0	1.6	6.5	62.1	128.1	109.9	50.3	175.7	284.0	192.1	0.1	0.0	1010.4	748.0	262.4	
1962	0.3	0.0	27.5	105.8	167.6	97.0	172.8	195.2	392.6	60.8	2.4	0.0	1222.0	1025.2	196.8	
1963	0.0	0.0	17.1	36.9	104.1	94.1	215.8	151.5	189.5	137.8	80.2	0.0	1027.0	755.0	272.0	
1964	0.0	12.8	33.0	51.4	234.6	118.9	147.8	86.9	242.8	158.1	19.7	0.0	1106.0	831.0	275.0	
1965	0.0	7.8	8.9	78.8	139.2	57.7	122.8	201.1	165.6	83.6	0.0	0.0	865.5	686.4	179.1	
1966	0.0	44.8	62.1	34.6	304.3	112.4	77.8	177.9	140.7	101.2	7.9	23.4	1087.1	813.1	274.0	
1967	0.0	47.4	0.0	34.5	42.5	135.8	107.1	139.4	283.3	16.9	19.8	0.0	826.7	708.1	118.6	
1968	10.2	4.8	21.5	102.6	144.6	202.0	178.7	168.5	140.8	46.7	0.0	0.0	1020.4	854.6	185.8	
1969	43.8	1.9	27.7	49.3	104.8	270.9	179.1	98.9	273.8	99.3	26.7	0.0	1171.2	925.5	245.7	
1970	0.2	0.4	7.6	103.1	95.5	331.7	63.1	215.8	293.9	59.2	0.7	7.1	1158.3	1000.0	158.3	
1971	0.0	17.9	9.1	50.7	192.6	195.4	239.5	219.5	228.1	85.9	7.0	18.2	1264.9	1075.1	189.8	
1972	0.0	17.7	4.3	107.9	32.5	235.0	69.4	156.4	156.6	117.5	27.3	8.9	933.5	649.9	283.6	
1973	0.0	0.0	13.1	6.4	79.5	101.6	154.7	147.1	258.6	10.3	0.1	0.0	771.6	741.5	30.1	
1974	10.6	0.9	41.6	76.0	73.9	43.7	132.4	211.5	190.1	82.2	75.8	0.0	940.4	653.6	286.8	
1975	27.1	1.7	31.3	6.3	243.4	166.7	168.1	143.1	300.1	116.7	30.2	0.0	1234.7	1021.4	213.3	
1976	0.0	12.7	38.7	72.9	155.9	22.9	176.7	125.4	298.8	147.6	0.4	0.0	1052.0	779.7	272.3	
1977	0.1	0.0	7.9	89.1	182.0	107.3	78.1	226.9	323.4	14.9	1.2	33.1	1064.0	917.7	146.3	
1978	2.7	3.3	18.5	45.3	205.5	121.0	323.0	174.3	343.2	43.5	3.5	0.0	1285.8	1169.0	116.8	
1979	0.0	17.4	0.0	93.0	151.9	232.2	69.1	164.8	228.7	0.0	0.0	0.0	979.1	866.7	112.4	
1980	0.0	1.5	30.2	66.3	202.8	300.3	78.1	120.9	368.9	107.1	0.0	0.0	1276.1	1071.0	205.1	
1981	0.0	3.7	4.4	51.2	142.3	177.9	207.1	130.7	79.6	101.9	17.3	0.0	916.1	737.6	178.5	
1982	0.0	44.1	70.0	55.6	83.8	79.8	158.8	82.0	424.1	172.2	6.1	12.3	1178.8	818.5	360.3	
1983	14.8	0.0	0.0	3.9	87.5	288.5	145.1	351.1	193.4	167.8	6.5	0.0	1260.6	1067.6	193.0	
1984	5.2	13.2	3.5	73.8	80.9	139.1	212.7	183.6	137.8	166.2	8.3	0.0	1024.3	754.1	270.2	
1985	0.0	6.2	0.0	9.4	136.9	120.1	91.3	149.2	197.2	127.2	0.0	0.0	837.5	694.7	142.8	
1986	0.0	0.0	44.8	207.0	238.6	98.5	100.5	128.6	95.8	51.9	8.1	1.2	975.0	662.0	313.0	
1987	0.0	34.4	51.2	72.5	214.4	114.6	110.0	249.7	213.7	97.4	38.5	0.0	1196.4	902.4	294.0	
1988	0.0	56.7	17.3	87.6	145.6	160.8	140.4	83.0	141.6	176.5	0.0	0.0	987.5	649.4	338.1	
MEAN	4.0	12.7	25.2	61.9	141.6	154.2	139.4	158.6	241.8	84.5	11.7	2.9	1038.7	835.7	203.0	
MAX	43.8	74.3	102.1	207.0	304.3	377.6	323.0	351.1	469.9	192.1	80.2	33.1	1285.8	1169.0	360.3	
MIN	0.0	0.0	0.0	0.0	32.5	22.9	50.3	62.0	79.6	0.0	0.0	0.0	707.5	572.4	30.1	

A-3 HYDROLOGICAL CONDITION

A-3-1 Study Area

1) Drainage Area

Basin	In the Study Area (km ²)	Out of the Study Area (km ²)	Total (km ²)
Huai Yai Basin	101.0	126.8	227.8
Huai Yang Basin	80.3	-	80.3
Huai Phra Nao Basin	79.4	-	79.4
Swamp	70.1	-	70.1
Chi River Basin	<u>10.7</u>	<u>-</u>	<u>10.7</u>
Total	341.5	126.8	468.3

2) Stream Gradient

River	Upper Stream	Middle Stream	Down Stream	Mean
Huai Yai	1/370	1/570	1/680	1/590
Huai Yang	1/350	1/630	1/620	1/520
Huai Phra Nao	1/320	1/380	1/320	1/340

3) Installation and Observation of Staff Gauges

20 staff gauges were installed in the study area as shown in Table A-11. The location is shown in Figure A-4. After the installation, the water level at 11 points of the rivers and 9 points of the points were observed a few times and the observation will be continued to the next dry season at intervals of one time of every week.

The results of the observation are shown in Table A-12 and A-13.

4) Existing Ponds

21 existing ponds in the Study area were investigated for surface area, mean water depth and reservoir capacity in dry and wet seasons. Location of these ponds are presented in Figure A-4. Only total amount of these data are presented below:

Results of the Investigation of Ponds

	Total Surface Area (km ²)	Mean Water Depth (m)		Total Reservoir Capacity (MCM)	
		Dry	Wet	Dry	Wet
Swamp in Lower-reach	12.6	1.9	2.6	23.5	32.7
Pond	1.1	1.7	2.4	1.4	2.6
Total	13.7	1.8	2.6	24.9	35.3

Average discharge loss is estimated at about 10 mm/day according to observed records of staff gauges and water depth in dry and wet season as shown in Table A-14.

5) Existing Diversion Structures

In the study area, there are many existing diversion structures. Existing S.S.I.P. project in Changwat Khon Kaen is presented in Table A-16. According to the data, irrigable area per the watershed area is 6 rai/km² (1 ha/km²), and average irrigable area per structure is about 300 rai (48 ha).

Therefore, irrigable areas covered by the existing diversion structures of Huai Yai with 5,400 rai (864 ha). Huai Yang with 1,500 rai (240 ha) and Huai Phra Nao with 3,000 rai (480 ha) are estimated as follows;

Estimation of the Exiting Irrigable Area and
Pond Reservoir Capacity of 3 Rivers Basin

Basin	Drainage Area km ²		Number of Structures	Estimated Irrigable Area		Pond Reservoir Capacity MCM	
	Section	Total		rai	ha	Dry	Wet
Huai Yai Basin		(227.8)	(18)(Weirs)	(5,400)	(864)	(0.014)	(0.145)
Upper-stream in study area	47.6	169.2	(10)	(3,000)	(480)	(0.008)	(0.054)
out of study area	121.6	-	10	3,000	480	0.008	0.054
Middle-stream	14.1	183.3	-	-	-	-	-
Huai Si Phung	17.0	-	2	600	96	0.005	0.068
Down-stream	27.5	227.8	-	-	-	-	-
			6	1,800	288	0.001	0.023
Huai Yang Basin		(80.3)	(5)(Weirs)	(1,500)	(240)	(1.141)	(1.891)
Upper-stream	23.6	23.6	1	300	48	0.008	0.079
Middle-stream	32.5	56.1	3	900	144	0.484	1.116
Huai Wang Hin	7.7	-	-	-	-	-	-
Down-stream	16.5	80.3	1	300	48	0.649	0.696
Huai Phra Nao Basin		(79.4)	(10)(Weirs)	(3,000)	(480)	(0.075)	(0.182)
Upper-stream	30.1	30.1	2	600	96	-	-
Middle-stream	49.3	65.4	6	1,800	288	-	-
Down-stream	14.0	79.4	2	600	96	0.075	0.182

Note : Irrigable Area = Number of Structures × 300 rai (or 48 ha)

FIGURE A-5 LONGITUDINAL PROFILE OF HUAI YAI

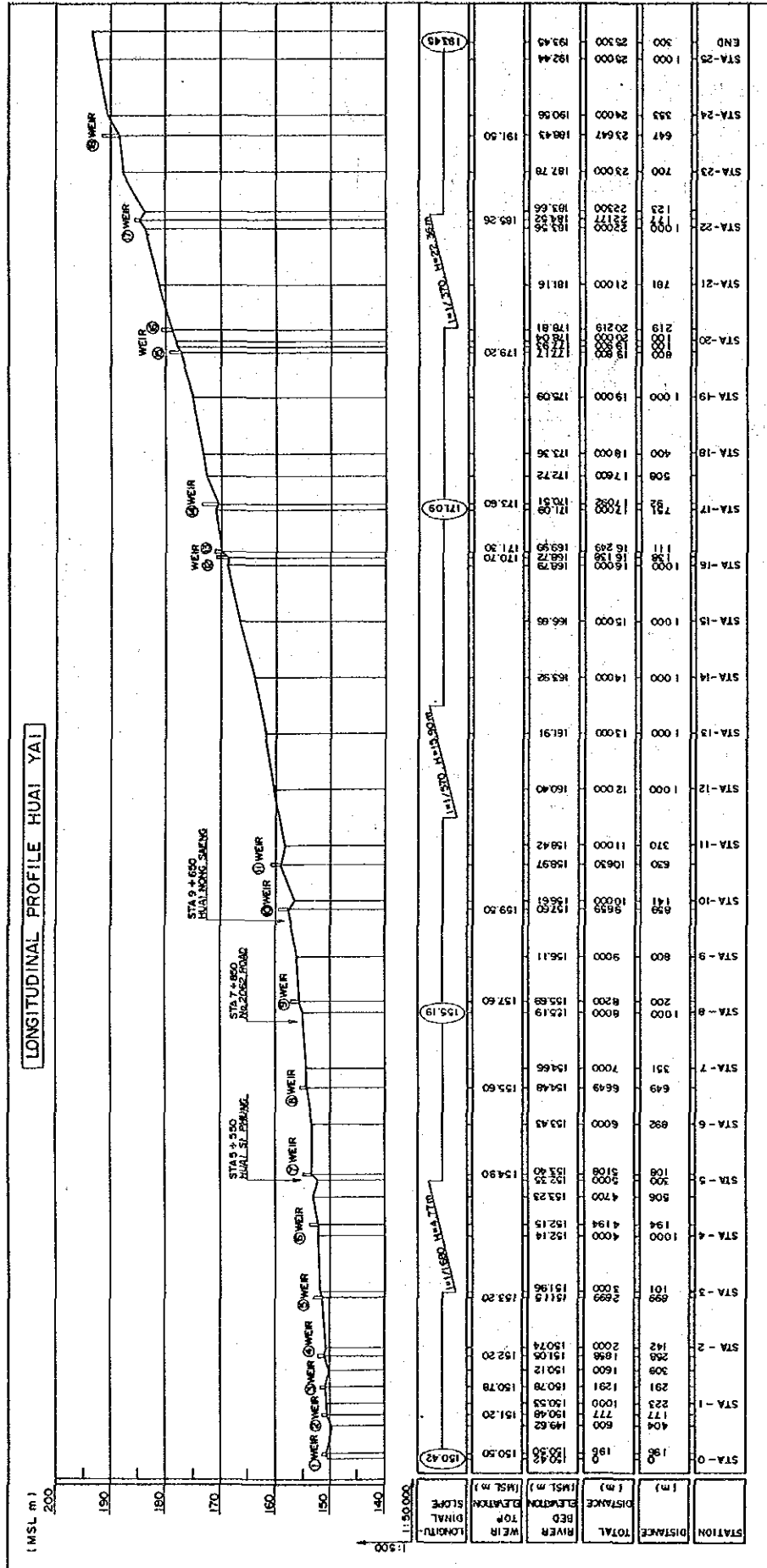


FIGURE A-6 LONGITUDINAL PROFILE OF HUAI YANG

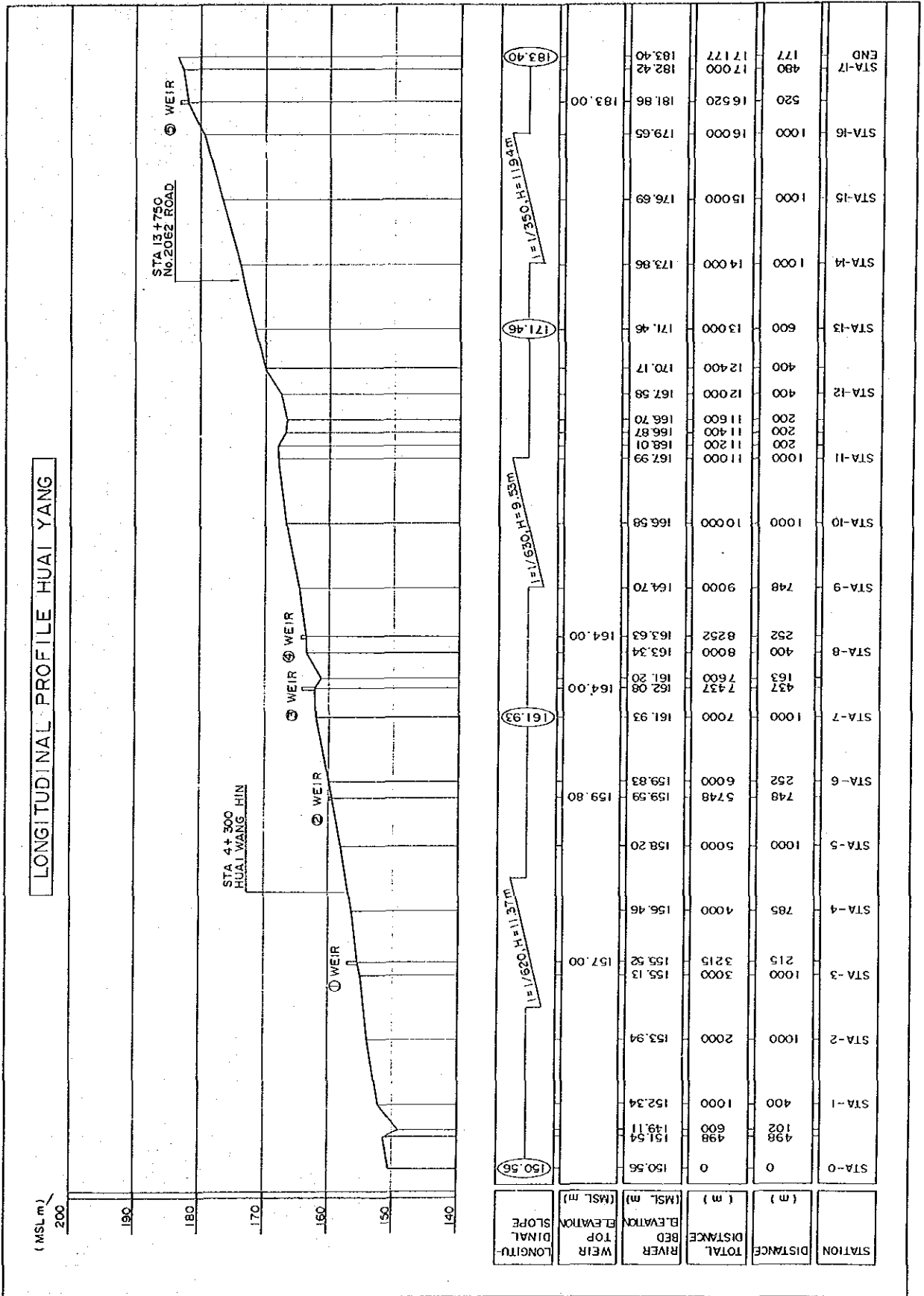


FIGURE A-7 LONGITUDINAL PROFILE OF HUAI PHRA NAO

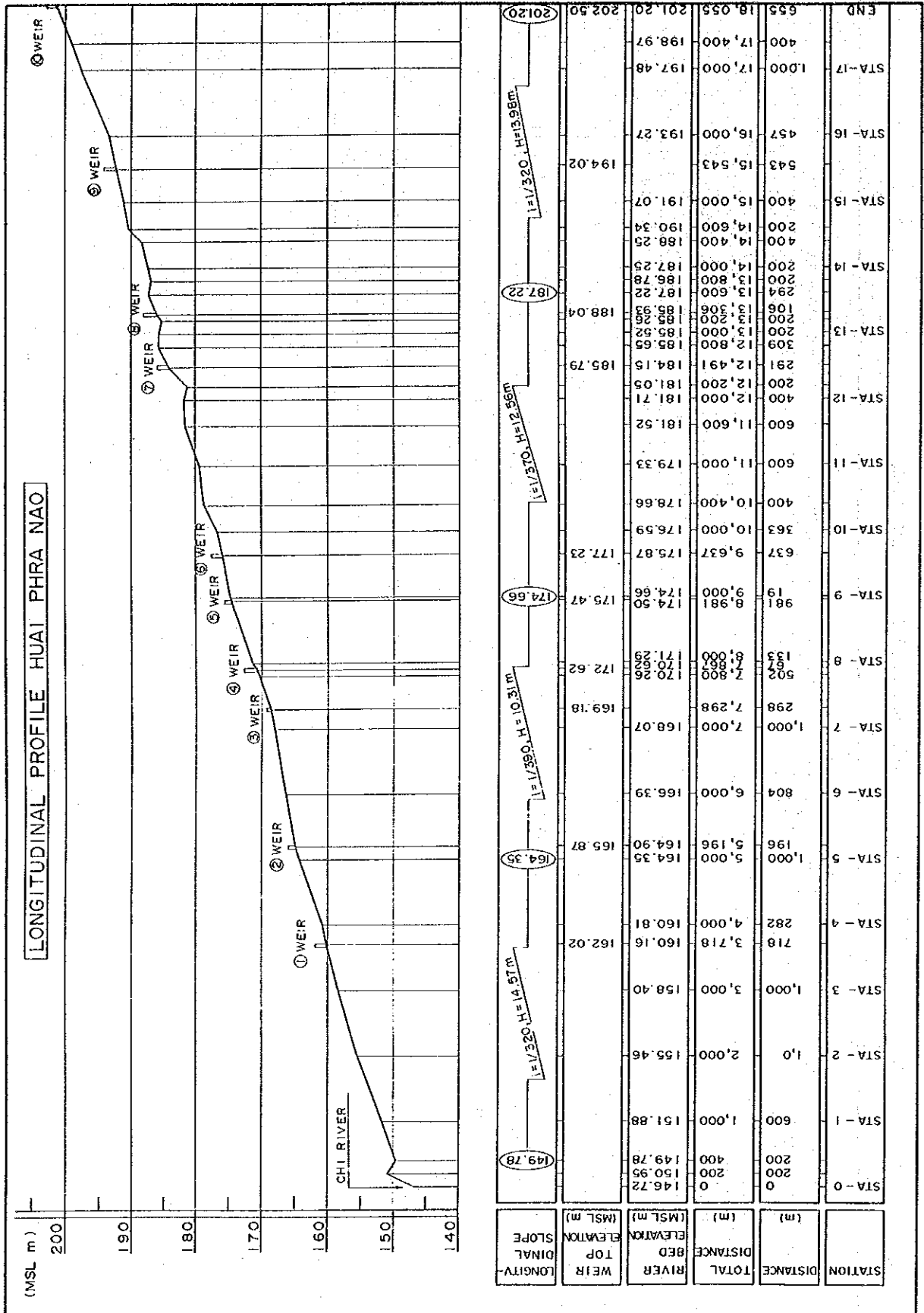


Table A-11 List of 20 Staff Gauges

NAME OF STATION	NAME OF RIVER OR POND	NAME OF VILLAGE	NUMBER OF STAFF GAUGE	ZERO GAUGE AT BOTTOM ELEVATION (MSL m)
S-1	UPSTREAM OF HUAI YAI	BAN NONG KHU	2	184.608
S-2	MIDDLE-STREAM OF HUAI YAI	BAN NON BO	1	165.527
S-3	MIDDLE-STREAM OF HUAI YAI	BAN THONG LANG	2	158.833
S-4	DOWNSTREAM OF HUAI YAI	BAN DON CHANG	2	147.651
S-5	NONG KAM	BAN PA MO	1	187.016
S-6	NONG BO YAI	BAN NON BO	1	162.000
S-7	NONG PHRA YUN	BAN PHRA YUN	1	171.728
S-8	NONG BUA	BAN PHRA YUN	1	164.128
S-9	NONG WAENG HI	BAN NONG WAENG HI	1	170.811
S-10	NONG YA KHAD NOK	BAN NONG YA KHAD NOK	1	151.015
NAME OF STATION	NAME OF RIVER OR POND	NAME OF VILLAGE	NUMBER OF STAFF GAUGE	ZERO GAUGE AT BOTTOM ELEVATION (MSL m)
S-11	MIDDLE-STREAM OF HUAI YANG	BAN BO KAE	1	173.830
S-12	MIDDLE-STREAM OF HUAI YANG	BAN KHAM POM	1	163.073
S-13	MIDDLE-STREAM OF HUAI YANG	BAN JOTYAI	1	161.737
S-14	DOWNSTREAM OF HUAI YANG	BAN PHO	1	157.327
S-15	DOWNSTREAM OF HUAI YANG	BAN TON	1	151.964
S-16	NONG LAT KHMAI	BAN PA SAN	1	184.936
S-17	NONG KHONG	BAN BO KAE	1	170.415
S-18	NONG PHRA BU	BAN PHRA BU	1	159.034
S-19	MIDDLE-STREAM OF HUAI PHRA NAO	BAN THA SALA	1	189.807
S-20	MIDDLE-STREAM OF HUAI PHRA NAO	BAN NON NIGIU	1	163.965

Table A-12 The Observed Records of Staff Gauges

(Unit : m)

Staff Gauge No.	River or Pond	20th Aug. 1990	21st Aug. 1990	22nd Aug. 1990	23rd Aug. 1990	24th Aug. 1990	27th Aug. 1990	30th Aug. 1990	31st Aug. 1990	4th Sep. 1990	5th Sep. 1990	7th Sep. 1990	10th Sep. 1990	11th Sep. 1990	14th Sep. 1990	15th Sep. 1990	16th Sep. 1990
S-1	River	*	0.60	*	*	*	*	*	0.72	*	0.56	0.66	0.58	0.57	*	*	*
S-2	-do-	*	0.86	*	*	*	*	*	1.32	*	1.17	1.19	0.98	0.91	*	*	*
S-3	-do-	*	0.39	*	*	*	*	*	0.37	0.50	0.44	0.30	0.65	0.48	*	*	*
S-4	-do-	*	*	0.93	*	1.12	*	*	*	*	0.97	0.98	0.97	1.08	*	1.40	*
S-5	Pond	*	0.48	*	0.48	*	*	*	0.57	*	0.62	0.63	0.64	0.65	*	*	0.79
S-6	-do-	*	0.79	*	*	*	*	*	0.74	*	0.74	0.70	0.74	0.72	0.70	0.70	*
S-7	-do-	*	0.80	*	*	0.79	0.79	0.84	0.84	*	0.96	0.96	0.99	1.00	0.99	*	1.03
S-8	-do-	*	0.75	*	*	*	*	*	0.60	*	0.88	0.87	0.90	0.90	*	0.94	*
S-9	-do-	*	0.95	*	*	*	*	*	*	*	1.01	0.99	1.11	1.10	*	1.09	*
S-10	-do-	*	1.18	*	*	*	*	*	*	*	1.43	1.41	1.65	1.65	*	*	*
S-11	River	*	0.58	*	*	*	*	*	*	0.63	0.63	0.56	0.80	0.55	0.59	0.62	*
S-12	-do-	*	1.05	*	1.04	*	1.01	*	*	*	1.19	1.15	0.96	1.08	*	*	*
S-13	-do-	*	0.55	*	*	*	0.63	0.64	*	*	1.11	0.69	0.75	0.75	*	*	*
S-14	-do-	*	1.09	*	*	*	*	1.14	*	*	0.71	0.77	1.05	1.08	*	*	*
S-15	-do-	1.14	1.14	*	*	*	*	*	*	*	1.59	1.51	1.57	1.69	*	*	*
S-16	Pond	*	1.04	*	1.01	*	*	*	1.11	*	0.98	0.95	1.12	1.10	1.14	*	*
S-17	-do-	*	0.91	*	0.90	*	0.93	1.01	1.05	*	1.26	1.29	1.51	1.49	*	1.56	*
S-18	-do-	*	1.21	*	*	*	*	*	*	*	1.18	1.14	1.27	1.34	*	1.02	*
S-19	River	*	0.67	*	*	*	*	*	1.41	1.40	1.40	1.39	1.45	1.44	*	1.56	*
S-20	-do-	*	0.51	*	*	*	*	*	0.52	0.53	0.54	0.52	0.63	0.56	*	*	*

Staff Gauge No.	River or Pond	18th Sep. 1990	25th Sep. 1990	5th Oct. 1990	14th Oct. 1990	21st Oct. 1990	28th Oct. 1990	7th Nov. 1990	13th Nov. 1990	23rd Nov. 1990	5th Dec. 1990	11th Dec. 1990	25th Dec. 1990	8th Jan. 1991	25th Jan. 1991	10th Feb. 1991	26th Feb. 1991
S-1	River	0.62	0.55	0.69	0.54	0.70	0.50	0.78	0.83	0.75	0.68	0.65	0.58	0.45	0.40	-	-
S-2	-do-	1.17	0.98	0.99	1.03	1.13	1.07	1.15	1.10	1.18	1.16	1.10	0.96	0.97	0.79	0.72	0.35
S-3	-do-	1.01	0.48	0.95	0.49	1.00	0.55	0.41	0.24	0.04	-	-	-	-	-	-	-
S-4	-do-	1.33	1.25	1.75	1.48	1.78	1.35	1.21	0.95	0.70	0.66	0.63	0.55	0.48	0.40	0.36	*
S-5	Pond	0.86	1.06	1.47	*	*	*	*	*	*	*	*	*	*	*	*	*
S-6	-do-	0.73	0.72	0.73	0.77	0.82	0.75	0.74	0.72	0.64	0.60	0.59	0.55	0.47	0.40	0.35	0.20
S-7	-do-	1.12	1.13	1.29	1.45	1.54	1.54	1.60	1.61	1.57	1.53	1.50	1.45	1.41	1.34	1.27	1.19
S-8	-do-	1.00	1.20	1.32	1.33	1.34	1.24	1.14	1.12	1.08	1.04	1.03	0.98	0.93	0.87	0.79	0.72
S-9	-do-	1.13	1.12	1.25	1.30	1.42	1.42	1.42	1.40	1.36	1.30	1.29	1.24	1.18	1.12	1.29	1.68
S-10	-do-	1.63	1.67	1.78	1.68	1.76	1.67	1.58	1.55	1.48	1.44	1.42	1.35	1.32	1.25	1.20	1.12
S-11	River	0.67	0.47	0.59	*	*	*	*	*	*	*	*	-	-	-	-	-
S-12	-do-	1.28	0.75	1.04	0.80	1.35	0.79	0.85	0.82	0.62	0.54	0.49	0.49	1.58	0.59	0.50	0.45
S-13	-do-	0.84	0.78	0.89	0.87	0.92	0.82	0.75	0.70	0.37	0.83	0.24	-	-	-	-	-
S-14	-do-	1.62	0.75	1.87	0.56	0.95	0.71	0.73	0.76	0.86	0.24	0.76	0.59	0.48	0.38	0.37	0.10
S-15	-do-	1.97	1.27	1.64	1.71	1.77	1.49	1.33	1.30	0.97	0.94	0.91	0.82	0.76	0.67	0.50	0.42
S-16	Pond	1.10	1.06	1.07	1.02	1.07	0.98	0.98	0.93	0.88	0.81	0.80	0.74	0.67	0.63	0.51	0.45
S-17	-do-	1.65	1.65	1.73	1.78	1.71	1.63	1.59	1.56	1.52	1.45	1.44	1.37	1.31	1.24	1.16	1.08
S-18	-do-	1.42	1.15	1.17	1.18	1.34	1.31	1.32	1.32	1.29	1.25	1.20	1.17	1.14	1.02	1.01	0.85
S-19	River	1.65	1.40	1.52	1.42	1.67	1.58	1.60	1.50	1.28	1.18	1.15	1.07	0.96	0.89	0.81	0.68
S-20	-do-	0.79	0.55	0.61	0.54	0.67	0.54	0.54	0.54	0.48	0.48	0.49	0.49	0.45	0.35	0.34	*

Remarks

Amounts in this table are reading of staff gauges

* : no reading

- : zero gauge (no water)

Table A-13 Condition of the river Flow by Observated Records of Staff Gauges

(Unit : m)

Staff Gauge No.	1990							
	18th. Sep.	25th. Sep.	5th. Oct.	14th. Oct.	21st. Oct.	28th. Oct.	7th. Nov.	13th. Nov.
Huai Yai								
S-1			0.42m ³ /sec	slightly flow			non flow	
S-2			non flow					
S-3	7.56m ³ /sec		2.16m ³ /sec			0.68m ³ /sec		
S-4		2.64m ³ /sec	6.37m ³ /sec		8.90m ³ /sec	4.91m ³ /sec	4.40m ³ /sec	
Huai Yang								
S-11	1.28m ³ /sec	non flow	1.13m ³ /sec				slightly flow	
S-12		slightly flow						
S-13	1.09m ³ /sec		slightly flow					
S-14	3.57m ³ /sec	slightly flow					non flow	
S-15	7.00m ³ /sec		2.10m ³ /sec		2.26m ³ /sec		slightly flow	
Huai Phra Nao								
S-19	1.92m ³ /sec		slightly	non flow		slightly flow		
S-20	5.00m ³ /sec	slightly flow						

Staff Gauge No.	1990				1991			
	23rd. Nov.	5th. Dec.	11th. Dec.	25th. Dec.	8th. Jan.	25th. Jan.	10th. Feb.	26th. Feb.
Huai Yai								
S-1	non flow							no water
S-2	non flow							
S-3	non flow	no water						
S-4	non flow							
Huai Yang								
S-11	non flow			no water				
S-12	non flow							
S-13	non flow			no water				
S-14	non flow							
S-15	non flow							
Huai Phra Nao								
S-19	slightly flow							
S-20	slightly flow				non flow			

Table A-14 Lossed Discharge of Existing Ponds

Pond No.	Staff Gauge No.	August 1990						September 1990					
		Staff Gauge Read (m)				Loss		Staff Gauge Read (m)				Loss	
		21st	22nd	23rd	24th	(mm)	(mm/day)	4th	5th	6th	7th	(mm)	(mm/day)
⑳	S-5	0.48	-	0.48	-	0.0	0.0	-	0.62	-	0.63	10.0	5.0
⑯	S-6	0.79	-	-	-	-	-	-	0.74	-	0.70	40.0	20.0
⑰	S-7	0.80	-	-	0.79	10.0	3.3	-	0.96	-	0.96	0.0	0.0
⑧	S-8	0.75	-	-	-	-	-	-	0.88	-	0.87	10.0	5.0
⑥	S-9	0.95	-	-	-	-	-	-	1.01	-	0.99	20.0	10.0
	S-10	1.18	-	-	-	-	-	-	1.43	-	1.41	20.0	10.0
㉑	S-16	1.04	-	1.01	-	30.0	15.0	-	0.98	-	0.95	30.0	15.0
⑪	S-17	0.91	-	0.90	-	10.0	5.0	-	1.26	-	1.29	-	-
⑦	S-18	1.21	-	-	-	-	-	-	1.18	-	1.14	40.0	20.0
AVERAGE LOSS 10.8 mm/day													

Pond No.	Mean Depth(m)		Loss(mm/day)			Mean Depth(m)		Loss(mm/day)	
	Dry season /Wet	Balance	Oct-Jan 90days	Oct-Feb 120days		Dry season /Wet	Balance	Oct-Jan 90days	Oct-Feb 120days
⑤	0.4 / 1.5	1.1	12.2	9.2	⑭	0.0 / 2.0	2.0	22.2	16.7
⑦	1.0 / 2.0	1.0	11.1	8.3	⑮	0.0 / 1.2	1.2	13.3	10.0
⑧	0.0 / 1.0	1.0	11.1	8.3	⑯	0.8 / 2.0	1.2	13.3	10.0
⑨	3.0 / 4.0	1.0	11.1	8.3	⑰	0.5 / 2.0	1.5	16.7	12.5
⑩	0.6 / 2.0	1.4	15.6	11.7	⑱	3.0 / 5.0	2.0	22.2	16.7
⑪	0.5 / 2.0	1.5	16.7	12.5	⑲	1.0 / 2.5	1.5	16.7	12.5
⑫	0.5 / 2.0	1.5	16.7	12.5	㉑	0.5 / 2.0	1.5	16.7	12.5
⑬	1.5 / 3.0	1.5	16.7	12.5	㉒	0.6 / 1.5	0.9	10.0	7.5
					Average Loss			15.1	11.4

Table A-15 Water Balance Study of Existing Ponds

Date of Staff Gauge Observation	① Interval (days)	Pond No. 8 Staff Gauge S-8				Pond No. 16 Staff Gauge S-6			
		② Staff Gauge Reading (m)	③ Balance of Water Level (mm/day)	④ Evaporation (mm/day)	⑤ Total Balance (mm/day)	② Staff Gauge Reading (m)	③ Balance of Water Level (mm/day)	④ Evaporation (mm/day)	⑤ Total Balance (mm/day)
7th Nov. 1990		1.14				0.74			
13th Nov. 1990	6	1.12	3.3	3.5	- 0.2	0.72	3.3	3.5	- 0.2
23rd Nov. 1990	10	1.08	4.0	3.5	0.5	0.64	8.0	3.5	4.5
5th Dec. 1990	12	1.04	3.3	3.5	- 0.2	0.60	3.3	3.5	- 0.2
11th Dec. 1990	6	1.03	1.7	3.4	- 1.7	0.59	1.7	3.4	- 1.7
25th Dec. 1990	14	0.98	3.6	3.4	0.2	0.55	2.9	3.4	- 0.5
8th Jan. 1991	14	0.93	3.6	3.5	0.1	0.47	5.7	3.5	2.2
25th Jan. 1991	17	0.87	3.5	3.5	0.0	0.40	4.1	3.5	0.6
10th Feb. 1991	16	0.79	5.0	3.8	1.2	0.35	3.1	3.8	- 0.7
26th Feb. 1991	16	0.72	4.4	4.0	0.4	0.20	9.4	4.0	5.4

Date of Staff Gauge Observation	① Interval (days)	Pond No. 17 Staff Gauge S-7				Pond No. 21 Staff Gauge S-16			
		② Staff Gauge Reading (m)	③ Balance of Water Level (mm/day)	④ Evaporation (mm/day)	⑤ Total Balance (mm/day)	② Staff Gauge Reading (m)	③ Balance of Water Level (mm/day)	④ Evaporation (mm/day)	⑤ Total Balance (mm/day)
7th Nov. 1990		1.60				0.98			
13th Nov. 1990	6	1.61	- 1.7	3.5	- 5.2	0.93	8.3	3.5	4.8
23rd Nov. 1990	10	1.57	4.0	3.5	0.5	0.88	5.0	3.5	1.5
5th Dec. 1990	12	1.53	3.3	3.5	- 0.2	0.81	5.8	3.5	2.3
11th Dec. 1990	6	1.50	5.0	3.4	1.6	0.80	1.7	3.4	- 1.7
25th Dec. 1990	14	1.45	3.6	3.4	0.2	0.74	4.3	3.4	0.9
8th Jan. 1991	14	1.41	2.9	3.5	- 0.6	0.67	5.0	3.5	1.5
25th Jan. 1991	17	1.34	4.1	3.5	0.6	0.63	2.4	3.5	- 1.1
10th Feb. 1991	16	1.27	4.4	3.8	0.6	0.51	7.5	3.8	3.7
26th Feb. 1991	16	1.19	5.0	4.0	1.0	0.45	3.8	4.0	- 0.2

Note ⑤ = ③ - ④

④ : E × 0.70

E : Monthly Mean Evaporation at A. Muang, Khon Kaen for the Period 1962 - 1985

as Shown in Table A-1

Table A-16 List of Existing S.S.I.P. Project in changwat Khon Kaen

Project ID	Project Name	Type	Purpose ³	Watershed Area (km ²)	Storage Capacity (m ³)	Irrigable Area (Rai)
22042208	Ban Non Tun Res.	1-C ^{1/}	②③④⑤	8.00	20,000	200
24042202	Weir at B. Kra Duang	2-D(Weir)	①②③④	37.10		300
25042207	Weir at Ban Lao	2-D(Weir)	①②③	94.50		300
25042210	Res. at B. Nong Waeng	2-D(Weir)	①②	40.70		500
28042208	Huai Yai Weir	2-D(Weir)	①②③④	171.00		1,000
28042214	Sok Khum Pun Res.	1-C ^{1/}	①②③④⑤	0.30	60,000	200
29042202	Ban Tao Weir	2-D(Weir)		(195.00)		
29042213	Ban Khuen Weir	2-D(Weir)	②	51.00		300
30042202	Ban Pa Ma Nao Weir	2-D(Weir)	①②	25.00		200
31042250	Nong Khwai Yai Res.	4-E(Others)	②③⑤	1.00	116,000	50
31042251	Nong Khlong Noi Res.	4-E(Others)	②③⑤	1.00	22,000	45
31042253	Nong Hai Res.	4-E(Others)	①②③⑤	5.00	64,000	65
31042254	Nong Pra Yuen Res.	4-E(Others)	①②③⑤	1.00	100,000	30
3205	Nong Soke Kha Res.	1-C ^{1/}	②③④⑤	2.20	18,000	150
2301	Nong Kud Kwang Res.	1-C ^{2/}	③	774	500,000	
2901	Ban Wha Weir		②④	72		300
3236	Huai Lao Weir		②③④	42.50		
Average of 2-D(Weir)		2-D(Weir)		70.0 km ²		430 Rai (6 Rai/km ²) (1 ha/km ²)

Note ^{1/} Reservoir with Irrigable Area and Outlet

^{2/} Reservoir with Irrigable Area

^{3/} ① Irrigation
 ② Domestic Water Use
 ③ Live-stock Water Use
 ④ Irrigation for Garden Crops to Consume
 ⑤ Fish Catch / Culture

A-3-2 Chi River

Daily runoff discharges and water levels data for 4 hydrological stations, on the main course of the Chi River were collected from RID. Names of the stations and data period are shown in Table A-17. Location of the stations are shown in Figure A-2.

At E.16A Station of the Chi River which is nearest to the study area, the mean annual runoff discharge is 1,400 MCM and mean annual runoff coefficient is between 6% and 18%. They are estimated for 7 years from 1967 to 1973 as shown in Table A-18.

At E.16A Station, the river bed elevation is 141m above MSL and the bank top elevation is 153m in 1988. Annual maximum water level is MSL 154m in 1969 and 1980 as shown in Table A-19.

Table A-18 Runoff Coefficient of Chi River

Water Year	①	②	③	A. Muang Rainfall
	Ban Tha Hin E. 17 D. A=14, 426 km ²	Ban Tha Phra E. 16A D. A=13, 171 km ²	Ban Tha Nang Luan E. 9 D. A=13, 171 km ²	
	(MCM)	(MCM)	(MCM)	(mm)
1967	1,679	1,093	840	941
1968	1,188	505	487	1,185
1969	1,942	3,562	3,491	1,163
1970	2,338	1,419	1,172	1,379
1971	2,803	1,742	1,433	1,166
1972	968	778	661	1,057
1973	687	756	795	812
Mean	1,658	1,408	1,268	1,100

1) Chi River Basin between ① and ② (Drainage Area 1,255km²)

$$\text{Runoff Discharge}(\text{①}-\text{②}) = 250 \text{ MCM} = 199 \text{ mm}$$

$$\text{Runoff Coefficient} = 199\text{mm}/1,100\text{mm} = 18\%$$

2) Chi River Basin between ② and ③ (Drainage Area 2,151km²)

$$\text{Runoff Discharge}(\text{②}-\text{③}) = 140 \text{ MCM} = 65 \text{ mm}$$

$$\text{Runoff Coefficient} = 65\text{mm}/1,100\text{mm} = 6 \%$$

3) Chi River Basin between ① and ③ (Drainage Area 3,406km²)

$$\text{Runoff Discharge}(\text{①}-\text{③}) = 390 \text{ MCM} = 115 \text{ mm}$$

$$\text{Runoff Coefficient} = 115\text{mm}/1,100\text{mm} = 10\%$$

Table A-19 Water Level at E. 16A Station of Chi River

Water Year	Annual Max. of Momentary Gauge Height			Annual Min. of Daily Mean Gauge Height			River Bed Elevation (MSL m)	Left Bank Elevation (MSL m)	Right Bank Elevation (MSL m)
	Elevation (MSL m)	Depth (m)	Date	Elevation (MSL m)	Depth (m)	Date			
1966	152.12	10.30	SEP. 29	142.94	1.12	APR.	141.82	153.65	151.49
1967	151.06	9.24	OCT. 4	142.88	1.06	MAR. 31	141.82	153.65	151.49
1968	145.92	4.10	AUG. 3	142.71	0.89	MAR. 14	141.82	153.65	151.49
1969	153.80	11.98	SEP. 27	142.68	0.86	MAY 6	141.82	153.65	151.49
1970	149.21	7.39	OCT. 3	142.90	1.08	MAR. 30	141.82	153.65	151.49
1971	150.27	8.45	OCT. 12	142.89	1.07	APR. 4	141.82	153.65	151.49
1972	147.36	5.54	OCT. 23	142.87	1.05	MAR. 22	141.82	153.65	151.49
1973	147.87	6.05	OCT. 2	142.90	1.08	MAY 1	141.82	153.65	151.49
1974	146.74	4.92	OCT. 18	142.80	0.98	JUL. 25	141.82	153.65	151.49
1975	—	—	—	—	—	—	—	—	—
1976	—	—	—	—	—	—	—	—	—
1977	—	—	—	—	—	—	—	—	—
1978	—	—	—	—	—	—	—	—	—
1979	149.86	8.83	OCT. 1	142.80	1.77	MAR. 7	141.03	157.77	157.80
1980	153.70	12.67	OCT. 10	142.81	1.78	APR. 17	141.03	154.46	151.15
1981	145.46	4.43	JUL. 23	142.67	1.64	MAR. 17	141.03	157.77	157.77
1982	151.56	10.53	OCT. 8	142.76	1.73	AUG. 23	141.03	158.26	158.28
1983	149.20	10.46	AUG. 14	142.70	3.96	APR. 23	138.74	158.26	158.28
1984	147.72	10.32	NOV. 4	142.84	5.44	APR. 22	137.40	156.03	156.15
1985	147.31	9.91	OCT. 13	142.80	5.40	APR. 6	137.40	156.05	156.15
1986	145.49	6.88	MAY 18	142.59	3.98	MAR. 19	138.61	158.03	157.97
1987	149.58	10.88	OCT. 23	142.36	3.66	AUG. 15	138.70	153.67	152.83
1988	148.36	7.67	OCT. 31	142.43	1.74	MAR. 29	140.69	152.69	152.29

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Mean ¹	143.00	143.46	144.18	144.17	144.55	146.27	147.61	145.20	143.77	143.32	143.07	142.92
Max. ¹ (Year)	143.93 (1973)	147.25 (1966)	150.56 (1980)	150.18 (1980)	149.19 (1983)	153.79 (1969)	153.69 (1980)	151.14 (1980)	144.79 (1982)	143.85 (1980)	143.51 (1974)	143.52 (1968)

Note Stream : Chi
River : Chi
Station : Ban Tha Phra, Muang, Khon Kaen (E. 16A)
Drainage Area ; 13,171 km²
1975 - 1978 ; No Record

¹ ; Data Period 1966 - 1974, 1979 - 1988
Daily Mean Gauge Height

Source : Hydrology Division, R. I. D.

A-4 RUNOFF ANALYSIS

A-4-1 Runoff Coefficient

No discharge observations are available for Huai Yai, Huai Yang and Huai Phra Nao. In this study, runoff discharges were observed a few times as shown in Table A-20. According to the results of the observation and the rainfall records of A. Phra Yun Station, runoff coefficient for the period from 1st August to 18th September in 1990 is estimated that between 14.4% and 35.1%.

On the one hand, Runoff Estimation Chart in Thailand was collected by RID as shown Figure A-8. In this chart, the study area falls into the D-type terrain with the equation expressed as;

$$C = 0.13R - 3.12$$

where C : monthly runoff coefficient (%)

R : monthly rainfall (mm) $R \geq 24.0$ mm

Monthly rainfall of A. Phra Yun Station in August 1990 is 245.9 mm.

$$\begin{aligned} C &= 0.13 \times 245.9 \text{ mm} - 3.12 \\ &= 38.8\% \end{aligned}$$

The runoff coefficient of 38.8% falls between 14.4% and 35.1% from the observed. And the runoff coefficient is between 6% and 18% from the analysis of the Chi River.

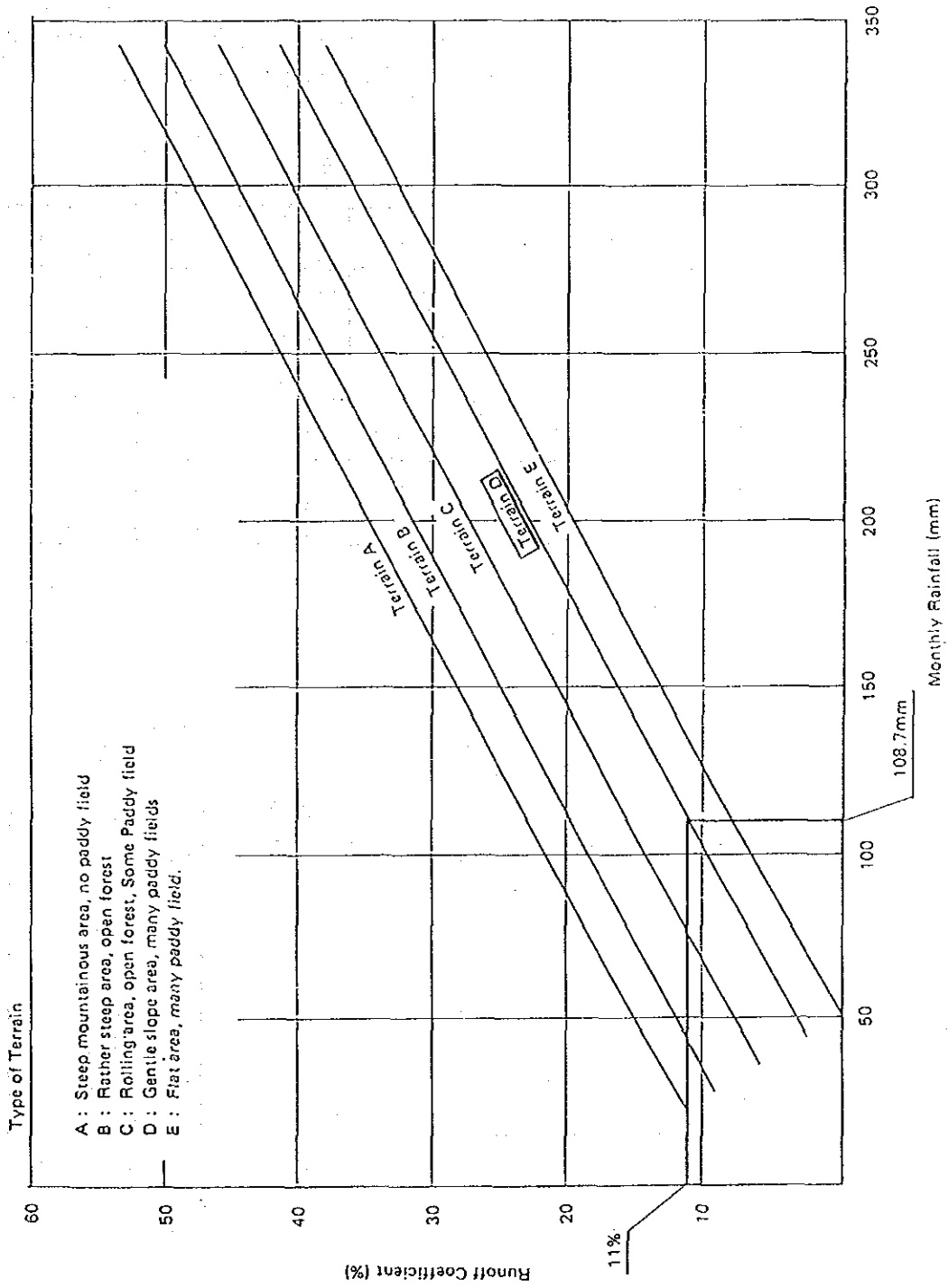
Therefore, runoff discharges is computed with Runoff Estimation Chart in Thailand by RID.

Table A-20 Runoff Discharge and Runoff Coefficient

Location	River Name	Drainage Area km ²	Runoff Discharge		Applied Period		Total m ³ /sec	Runoff Coefficient
			Date	m ³ /sec	Period	Days		
S-3	Huai Yai	180.4	Aug. 10	1.12	Aug. 1- Aug. 16	16	17.92	Q=133.24m ³ /s =63.8 mm Rain=444.2mm C=63.4/444.2 =14.4 %
			Aug. 21	1.91	Aug. 17- Aug. 28	12	22.92	
			Sep. 3	2.82	Aug. 29- Sep. 11	14	39.48	
			Sep. 18	7.56	Sep. 12- Sep. 18	7	52.92	
					Total	49	133.24	
S-19	Huai Phra Nao	30.1	Aug. 11	0.20	Aug. 1- Aug. 16	16	3.20	Q= 29.44m ³ /s =84.5 mm Rain=444.2mm C=84.5/444.2 =19.0 %
			Aug. 21	0.32	Aug. 17- Aug. 28	12	3.84	
			Sep. 4	0.64	Aug. 29- Sep. 11	14	8.96	
			Sep. 18	1.92	Sep. 12- Sep. 18	7	13.44	
					Total	49	29.44	
Under-stream of S-20	Huai Phra Nao	70.6	Aug. 10	0.50	Aug. 1- Aug. 16	16	8.00	Q= 62.04m ³ /s =75.9 mm Rain=444.2mm C=75.9/444.2 =17.1 %
			Aug. 21	0.63	Aug. 17- Aug. 28	12	7.56	
			Sep. 4	0.82	Aug. 29- Sep. 11	14	11.48	
			Sep. 18	5.00	Sep. 12- Sep. 18	7	35.00	
					Total	49	62.04	
S-11	Huai Yang	23.6	Aug. 11	0.16	Aug. 1- Aug. 16	16	2.56	Q= 21.26m ³ /s =77.8 mm Rain=444.2mm C=77.8/444.2 =17.5 %
			Aug. 21	0.24	Aug. 17- Aug. 28	12	2.88	
			Sep. 3	0.49	Aug. 29- Sep. 11	14	6.86	
			Sep. 18	1.28	Sep. 12- Sep. 18	7	8.96	
					Total	49	21.26	
S-13	Huai Wang Hin (Huai Yang)	7.7	Aug. 11	0.10	Aug. 1- Aug. 16	16	1.60	Q= 13.91m ³ /s =156.1 mm Rain=444.2mm C=156.1/444.2 =35.1 %
			Aug. 21	0.18	Aug. 17- Aug. 28	12	2.16	
			Sep. 4	0.18	Aug. 29- Sep. 11	14	2.52	
			Sep. 18	1.09	Sep. 12- Sep. 18	7	7.63	
					Total	49	13.91	
S-14	Huai Yang	53.1	Aug. 11	0.22	Aug. 1- Aug. 16	16	3.52	Q= 45.41m ³ /s =73.9 mm Rain=444.2mm C=73.9/444.2 =16.6 %
			Aug. 21	0.37	Aug. 17- Aug. 28	12	4.44	
			Sep. 4	0.89	Aug. 29- Sep. 11	14	12.46	
			Sep. 18	3.57	Sep. 12- Sep. 18	7	24.99	
					Total	49	45.41	
S-15	Huai Yang	78.2	Aug. 11	1.21	Aug. 1- Aug. 16	16	19.36	Q=113.08m ³ /s =124.9 mm Rain=444.2mm C=124.9/444.2 =28.1 %
			Aug. 21	0.81	Aug. 17- Aug. 28	12	9.72	
			Sep. 4	2.50	Aug. 29- Sep. 11	14	35.00	
			Sep. 18	7.00	Sep. 12- Sep. 18	7	49.00	
					Total	49	113.08	

Note Period : 1st Aug.1990 - 18th Sep.1990 (49 Days)
Rainfall : by A. Phra Yun Agricultural Extension Office (Total Rainfall 444.2 mm)

FIGURE A-8 RUNOFF ESTIMATION CHART



Source : Project Planning Section, RID

A-4-2 Runoff Discharge

Monthly unit runoff discharges of the study area and the upper-reach of Huai Yai outside of the study area are shown from Table A-21 to A-24. Average annual runoff discharges and subdivided drainage area are shown Figure A-9. Average, and 2 years, 3 years, 5 years and 10 years probable runoff discharges of the study area are presented below:

Monthly Average Runoff Discharges of the study Area
(Unit : MCM)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
0.0 (0)	0.2 (0)	0.4 (1)	1.4 (2)	9.1 (14)	10.7 (16)	7.0 (11)	9.8 (15)

Sep.	Oct.	Nov.	Dec.	Annual	Wet	Dry
24.6 (37)	2.6 (4)	0.1 (0)	0.0 (0)	65.9 (100)	61.2 (93)	4.7 (7)

Note Wet : Wet Season (May - Sept.)

Dry : Dry Season (Oct.- Apr.)

(): Ratio to Annual Amount %

Average Annual Runoff Discharges of the Study Area

Basin	In the Study Area (MCM)	Out of the Study Area (MCM)	Total (MCM)
Huai Yai Basin	19.49	27.47	46.96
Huai Yang Basin	15.50	-	15.50
Huai Phra Nao Basin	15.32	-	15.32
Swamp	13.52	-	13.52
Chi River Basin	<u>2.07</u>	<u>-</u>	<u>2.07</u>
Total	65.90	27.47	93.37

Probable Runoff Discharges of the Study Area

Probable Years	Approximate Year	Annual Runoff Discharge MCM
1/2	1988	42.9
1/3	1984	48.3
1/5	1981	49.5
1/10	1960	38.7

Table A-21 Monthly Runoff Discharge in the Study Area (D.A.=341.5km²)

(UNIT : MM)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	MAY-SEP	OCT-APR
1953	0.0	0.0	0.0	16.3	34.6	32.5	15.4	12.2	109.3	6.0	0.0	0.0	226.4	204.1	22.3
1954	0.1	4.0	0.0	0.5	21.5	30.0	7.7	10.9	206.9	2.7	0.0	0.0	284.2	277.0	7.3
1955	0.0	0.0	0.0	2.8	8.5	149.1	2.0	44.4	25.6	0.0	0.0	0.0	232.1	229.6	2.8
1956	0.0	0.0	0.2	3.8	4.8	7.3	26.2	14.9	19.2	0.2	0.0	0.0	76.6	72.4	4.2
1957	0.0	0.0	8.1	1.6	14.7	23.5	10.6	25.1	61.5	0.0	0.0	0.0	145.1	135.4	9.7
1958	0.0	0.0	29.5	0.0	17.9	37.9	11.7	19.2	64.6	2.4	0.0	0.0	183.3	151.4	32.0
1959	0.0	0.0	0.0	0.1	28.2	5.2	29.1	7.6	220.0	0.0	0.0	0.0	290.2	290.1	0.1
1960	0.0	0.0	2.5	0.0	28.2	29.2	10.5	31.8	77.6	3.5	0.0	0.0	113.3	107.3	6.0
1961	0.0	0.0	0.0	1.8	14.7	10.5	0.4	48.7	115.4	30.3	0.0	0.0	221.8	189.7	32.1
1962	0.0	0.0	0.0	2.4	36.5	3.6	23.7	25.3	154.5	0.2	0.0	0.0	246.0	243.4	2.6
1963	0.0	0.0	0.0	0.9	29.7	50.8	34.0	32.3	32.3	21.7	5.0	0.0	181.3	153.7	27.6
1964	0.0	0.0	0.0	4.8	60.1	7.5	17.5	5.1	60.5	27.5	0.0	0.0	182.8	150.5	32.2
1965	0.0	0.0	0.0	8.7	4.2	2.9	10.7	32.3	25.3	6.9	0.0	0.0	91.0	75.4	15.6
1966	0.0	3.4	0.4	1.6	106.3	13.8	11.1	40.7	21.5	6.7	0.0	0.0	205.5	193.4	12.1
1967	0.0	1.0	0.0	0.0	1.0	13.9	16.8	28.3	68.0	0.0	0.0	0.0	128.9	128.0	1.0
1968	0.0	0.0	0.0	4.8	11.9	37.4	46.9	32.9	19.3	0.2	0.0	0.0	153.3	148.3	5.0
1969	2.0	0.0	0.2	0.2	1.2	81.0	23.3	6.1	65.1	17.4	0.4	0.0	197.0	176.8	20.2
1970	0.0	0.0	0.0	8.5	11.8	189.4	1.9	17.3	85.1	0.5	0.0	0.0	314.5	305.5	9.0
1971	0.0	0.3	0.0	1.2	31.5	8.7	47.2	33.1	27.1	1.6	0.0	0.0	150.8	147.7	3.2
1972	0.0	0.0	0.0	14.2	0.0	71.6	5.0	17.1	10.9	20.8	1.9	0.0	141.3	104.5	36.8
1973	0.0	0.0	0.0	0.0	2.0	2.4	20.1	27.1	59.8	0.0	0.0	0.0	111.5	111.5	0.0
1974	0.0	0.0	0.0	2.1	6.8	4.7	16.6	57.2	37.1	5.2	7.0	0.0	136.7	122.4	14.3
1975	0.0	0.0	1.3	0.0	80.8	22.7	27.6	31.3	71.1	3.2	0.0	0.0	238.0	233.5	4.5
1976	0.0	0.0	0.7	3.3	11.1	0.4	24.1	23.6	72.0	16.5	0.0	0.0	151.5	131.1	20.4
1977	0.0	0.0	0.0	2.8	54.9	14.8	4.5	32.4	140.5	0.0	0.0	0.0	249.8	247.1	2.8
1978	0.0	0.0	0.0	1.4	23.6	8.9	98.7	38.8	122.9	3.0	0.0	0.0	299.3	294.9	4.4
1979	0.0	0.0	0.0	5.0	26.6	66.7	3.9	36.2	51.0	0.0	0.0	0.0	189.5	184.4	5.0
1980	0.0	0.0	0.0	0.8	35.7	109.2	6.2	15.3	94.2	6.3	0.0	0.0	267.7	260.6	7.1
1981	0.0	0.0	0.0	0.2	49.2	17.3	44.1	19.7	0.0	14.3	0.0	0.0	144.9	130.4	14.5
1982	0.0	1.0	3.2	2.7	11.9	10.0	34.4	33.2	310.9	12.5	0.0	0.0	591.7	570.3	21.4
1983	0.0	0.0	0.0	0.0	5.3	32.6	5.7	130.6	41.2	18.7	0.0	0.0	234.2	215.5	18.7
1984	0.0	0.0	0.0	0.8	9.4	17.7	36.9	37.5	35.1	4.1	0.0	0.0	141.4	136.6	4.8
1985	0.0	0.0	0.0	0.0	64.6	5.8	21.5	7.3	52.0	16.1	0.0	0.0	167.3	151.1	16.1
1986	0.0	0.0	0.0	28.5	28.7	6.4	5.0	18.1	14.1	0.0	0.0	0.0	100.8	72.3	28.5
1987	0.0	0.2	0.0	3.4	93.9	10.9	7.9	59.3	53.9	3.2	1.1	0.0	233.9	225.9	8.0
1988	0.0	8.2	0.0	20.4	13.3	17.1	7.5	4.6	37.1	17.5	0.0	0.0	125.7	79.6	46.1
MEAN	0.1	0.5	1.3	4.0	26.8	31.5	20.4	28.6	72.0	7.5	0.4	0.0	193.0	179.2	13.8
MAX	2.0	8.2	29.5	28.5	106.3	189.4	98.7	130.6	310.9	30.3	7.0	0.0	391.7	370.3	46.1
MIN	0.0	0.0	0.0	0.0	0.0	0.4	0.4	3.2	0.0	0.0	0.0	0.0	76.6	72.3	0.0

Table A-22 Monthly Runoff discharge in the Study Area (D.A.=341.5km²)

(UNIT : MCM)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	MAY-SEP	OCT-APR
1953	0.0	0.0	0.0	5.6	11.8	11.1	5.3	4.2	37.3	2.0	0.0	0.0	77.3	69.7	7.6
1954	0.0	1.4	0.0	0.2	7.3	30.3	2.6	7.3	70.6	0.9	0.0	0.0	97.1	94.6	2.5
1955	0.0	0.0	0.0	0.9	2.9	50.9	0.7	15.1	8.8	0.0	0.0	0.0	79.4	78.4	0.9
1956	0.0	0.0	0.1	1.3	1.6	2.5	9.0	5.1	6.6	0.1	0.0	0.0	26.2	24.7	1.4
1957	0.0	0.0	2.8	0.5	5.0	8.0	3.6	8.6	21.0	0.0	0.0	0.0	49.6	46.2	3.3
1958	0.0	0.0	10.1	0.0	6.1	13.0	4.0	6.6	22.1	0.8	0.0	0.0	62.6	51.7	10.9
1959	0.0	0.0	0.0	0.1	9.6	1.8	9.9	2.6	75.1	0.0	0.0	0.0	99.1	99.1	0.1
1960	0.0	0.0	0.9	0.0	9.6	10.0	3.6	10.9	2.6	1.2	0.0	0.0	38.7	36.6	2.1
1961	0.0	0.0	0.0	0.6	5.0	3.6	0.1	16.6	39.4	10.3	0.0	0.0	75.7	64.8	11.0
1962	0.0	0.0	0.0	0.8	12.4	1.2	8.1	8.6	52.8	0.1	0.0	0.0	84.0	83.1	0.9
1963	0.0	0.0	0.0	0.3	2.3	10.2	17.4	11.6	11.0	7.4	1.7	0.0	61.9	52.5	9.4
1964	0.0	0.0	0.0	1.6	20.5	2.5	6.0	1.8	20.7	9.4	0.0	0.0	62.4	51.4	11.0
1965	0.0	0.0	0.0	3.0	1.4	1.0	3.7	11.0	8.6	2.4	0.0	0.0	31.1	25.8	5.3
1966	0.0	1.3	0.1	0.5	36.3	4.7	3.8	13.9	7.3	2.3	0.0	0.0	70.2	66.0	4.1
1967	0.0	0.3	0.0	0.0	0.3	4.8	5.7	19.7	23.2	0.0	0.0	0.0	44.0	43.7	0.3
1968	0.0	0.0	0.0	1.6	4.0	12.8	16.0	11.2	6.6	0.1	0.0	0.0	52.3	50.6	1.7
1969	0.7	0.0	0.1	0.4	2.1	27.7	8.0	2.1	22.2	6.0	0.1	0.0	67.3	60.4	6.9
1970	0.0	0.0	0.0	2.9	4.0	64.7	0.6	5.9	29.0	0.2	0.0	0.0	107.4	104.3	3.1
1971	0.0	0.1	0.0	0.4	10.8	3.0	16.1	11.3	9.3	0.6	0.0	0.0	51.5	50.4	1.1
1972	0.0	0.0	0.0	4.8	0.0	24.4	1.7	5.8	3.7	7.1	0.6	0.0	48.3	35.7	12.6
1973	0.0	0.0	0.0	0.0	0.7	0.8	6.9	9.3	20.4	0.0	0.0	0.0	38.1	38.1	0.0
1974	0.0	0.0	0.0	0.7	2.5	1.6	5.7	19.5	12.7	1.8	2.4	0.0	46.7	41.8	4.9
1975	0.0	0.0	0.4	0.0	0.0	7.7	9.4	10.7	24.3	1.1	0.0	0.0	81.3	79.7	1.5
1976	0.0	0.0	0.2	1.1	3.8	0.1	8.2	8.0	24.6	5.6	0.0	0.0	51.7	44.8	7.0
1977	0.0	0.0	0.0	0.9	18.8	5.0	1.5	11.0	48.0	0.0	0.0	0.0	85.3	84.4	0.9
1978	0.0	0.0	0.0	0.5	8.7	3.0	35.7	15.3	42.0	1.0	0.0	0.0	102.2	100.7	1.5
1979	0.0	0.0	0.0	1.7	9.1	32.8	1.3	13.4	17.4	0.0	0.0	0.0	64.7	63.0	1.7
1980	0.0	0.0	0.0	0.3	12.2	37.3	2.1	5.2	32.2	2.2	0.0	0.0	91.4	89.0	2.4
1981	0.0	0.0	0.0	0.1	16.8	5.9	15.1	6.7	0.0	4.9	0.0	0.0	45.5	44.5	5.0
1982	0.0	0.3	1.8	0.9	4.1	3.4	11.7	1.1	106.2	4.3	0.0	0.0	133.8	126.5	7.3
1983	0.0	0.0	0.0	0.0	1.8	11.1	2.0	44.6	14.1	6.4	0.0	0.0	80.0	73.6	6.4
1984	0.0	0.0	0.0	0.3	3.2	6.0	12.6	12.8	12.0	1.4	0.0	0.0	48.3	46.6	1.7
1985	0.0	0.0	0.0	0.0	22.1	2.0	7.5	2.5	17.7	5.5	0.0	0.0	57.1	51.6	5.5
1986	0.0	0.0	0.0	9.7	9.8	2.2	1.7	6.2	4.8	0.0	0.0	0.0	34.4	24.7	9.7
1987	0.0	0.1	0.0	1.2	32.1	3.7	2.7	20.3	18.4	1.1	0.4	0.0	79.9	77.1	2.7
1988	0.0	2.8	0.0	7.0	4.5	5.8	2.6	1.6	12.7	6.0	0.0	0.0	42.9	27.2	15.7
MEAN	0.0	0.2	0.5	1.4	9.1	10.7	7.0	9.8	24.6	2.6	0.1	0.0	65.9	61.2	4.7
MAX	0.7	2.8	10.1	9.7	36.3	64.7	33.7	44.6	106.2	10.3	2.4	0.0	133.8	126.5	15.7
MIN	0.0	0.0	0.0	0.0	0.0	0.1	0.1	1.1	0.0	0.0	0.0	0.0	26.2	24.7	0.0

Table A-23 Monthly Runoff Discharge in Upper-Reach of Huai Yai Outside of the Study Area

(UNIT : MM)

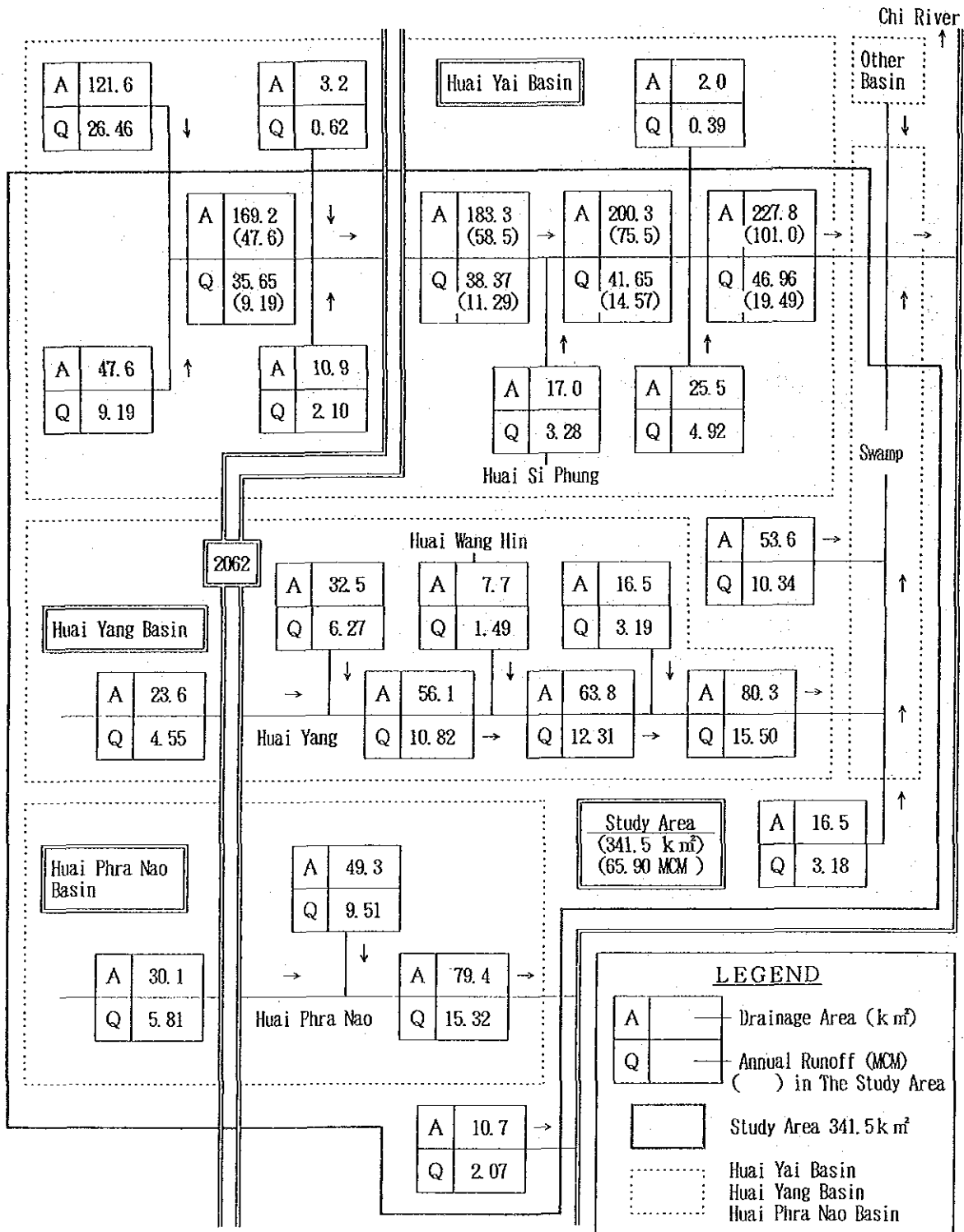
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	MAY-SEP	OCT-APR
1953	0.0	0.0	0.0	19.2	40.4	38.1	18.2	19.8	127.0	7.1	0.0	0.0	249.9	243.6	26.3
1954	0.1	4.9	0.0	0.6	26.8	35.1	9.6	12.9	240.4	3.3	0.0	0.0	333.7	524.8	8.9
1955	0.0	0.0	0.0	3.3	10.2	173.4	2.4	51.7	30.1	0.0	0.0	0.0	271.2	267.8	3.3
1956	0.0	0.0	0.4	4.6	5.7	8.7	31.1	21.2	22.5	0.3	0.0	0.0	94.5	89.2	5.3
1957	0.0	0.0	9.6	0.1	4.9	11.9	13.0	33.9	71.7	0.0	0.0	0.0	145.0	135.3	9.7
1958	0.0	0.0	10.4	0.0	5.4	15.3	3.6	8.6	52.3	0.2	0.0	0.0	93.8	85.3	10.6
1959	0.0	0.0	0.0	2.3	6.6	3.6	33.9	11.6	272.1	0.0	0.0	0.0	332.0	329.8	2.3
1960	0.0	0.0	1.4	0.0	50.4	26.4	68.6	13.9	12.2	5.8	0.0	0.0	178.6	171.4	7.2
1961	0.0	0.0	0.0	3.1	17.3	12.3	1.7	34.6	95.9	41.9	0.0	0.0	206.8	161.8	45.0
1962	0.0	0.0	0.1	11.2	31.3	9.2	33.4	43.4	187.9	2.9	0.0	0.0	319.5	305.2	14.3
1963	0.0	0.0	0.0	0.6	10.8	8.6	53.8	25.1	40.7	20.4	5.9	0.0	165.8	139.0	26.8
1964	0.0	0.0	0.4	1.8	64.2	14.7	23.8	7.1	69.0	27.5	0.0	0.0	208.4	178.7	29.7
1965	0.0	0.0	0.0	5.6	20.8	2.5	15.8	46.3	30.5	6.5	0.0	0.0	127.9	115.8	12.1
1966	0.0	1.2	3.1	0.5	110.8	12.9	5.4	35.6	21.3	10.1	0.0	0.0	200.9	186.0	14.9
1967	0.0	1.4	0.0	0.5	1.0	19.7	11.6	20.9	95.4	0.0	0.0	0.0	150.5	148.6	1.9
1968	0.0	0.0	0.0	10.3	22.6	46.7	35.9	31.6	21.4	1.4	0.0	0.0	170.1	138.2	11.8
1969	1.1	0.0	0.1	1.3	11.0	86.9	36.1	9.2	88.8	9.7	0.1	0.0	244.3	231.9	12.4
1970	0.0	0.0	0.0	10.6	8.9	132.6	3.2	53.8	103.0	0.8	0.0	0.0	312.8	301.4	11.4
1971	0.0	0.0	0.0	1.8	42.2	43.5	67.0	55.7	60.5	6.9	0.0	0.0	277.6	268.9	8.7
1972	0.0	0.0	0.0	11.8	0.6	64.4	4.1	26.9	26.5	14.3	0.1	0.0	148.8	122.7	26.1
1973	0.0	0.0	0.0	0.0	5.7	10.2	26.3	23.5	78.8	0.0	0.0	0.0	144.5	144.5	0.0
1974	0.0	0.0	1.0	5.1	1.1	18.6	51.5	41.0	6.2	5.1	0.0	0.0	134.8	117.4	17.4
1975	0.1	0.0	0.3	0.0	69.4	30.9	31.5	22.1	107.6	14.0	0.2	0.0	276.1	261.4	14.7
1976	0.0	0.0	0.7	4.6	26.7	0.0	35.0	16.5	106.6	23.7	0.0	0.0	214.0	184.9	29.1
1977	0.0	0.0	0.0	7.5	37.3	11.6	25.5	59.8	125.7	0.0	0.0	0.4	247.9	240.0	7.9
1978	0.0	0.0	0.0	1.3	48.4	15.2	125.4	34.0	144.0	1.1	0.0	0.0	369.5	367.1	2.4
1979	0.0	0.0	0.0	8.8	23.2	74.7	4.0	30.1	60.8	0.0	0.0	0.0	203.7	195.0	8.8
1980	0.0	0.0	0.2	3.6	47.1	107.8	5.5	15.2	165.2	11.6	0.0	0.0	356.2	340.8	15.4
1981	0.0	0.0	0.0	1.8	21.9	35.6	49.2	18.1	5.7	10.3	0.0	0.0	142.6	130.5	12.1
1982	0.0	1.2	4.2	2.3	8.5	5.8	27.8	33.1	220.4	33.1	0.0	0.0	308.3	285.5	40.8
1983	0.0	0.0	0.0	0.0	7.2	99.1	22.8	149.1	43.5	31.3	0.0	0.0	353.1	321.8	31.3
1984	0.0	0.0	0.0	4.8	6.0	20.8	52.1	38.1	20.4	30.7	0.0	0.0	172.8	137.3	35.5
1985	0.0	0.0	0.0	0.0	20.1	15.0	8.0	24.3	44.4	17.0	0.0	0.0	128.7	111.7	17.0
1986	0.0	0.0	1.2	49.2	66.5	9.5	10.0	17.5	8.9	1.9	0.0	0.0	166.7	112.4	52.3
1987	0.0	0.5	1.8	4.6	53.0	13.5	12.3	73.2	52.6	9.3	0.7	0.0	221.5	204.6	16.8
1988	0.0	2.4	0.0	7.2	22.3	28.6	21.2	3.2	21.6	33.0	0.0	0.0	141.5	96.9	44.6
MEAN	0.0	0.3	1.0	5.3	26.7	34.7	25.8	31.7	81.0	10.7	0.3	0.0	217.6	199.9	17.6
MAX	1.1	4.9	10.4	49.2	110.8	173.4	125.4	149.1	272.1	41.9	5.9	0.4	369.5	367.1	52.3
MIN	0.0	0.0	0.0	0.0	0.4	0.0	1.7	3.1	5.7	0.0	0.0	0.0	94.5	85.3	0.0

Table A-24 Monthly Runoff Discharge in Upper-Reach of Huai Yai Outside of
the Study Area

(UNIT : MCM)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	MAY-SEP	OCT-APR
1953	0.0	0.0	0.0	2.3	4.9	4.6	2.2	2.4	15.4	0.9	0.0	0.0	32.8	29.6	3.2
1954	0.0	0.6	0.0	0.1	3.3	4.3	1.2	1.6	29.2	0.4	0.0	0.0	40.6	39.5	1.1
1955	0.0	0.0	0.0	0.4	1.2	21.1	0.3	6.3	3.7	0.0	0.0	0.0	33.0	32.6	0.4
1956	0.0	0.0	0.1	0.6	0.7	1.1	3.8	2.6	2.7	0.0	0.0	0.0	11.5	10.8	0.6
1957	0.0	0.0	1.2	0.0	0.6	1.4	1.6	4.1	8.7	0.0	0.0	0.0	17.5	16.5	1.0
1958	0.0	0.0	1.3	0.0	0.7	1.9	0.4	1.0	6.4	0.0	0.0	0.0	11.7	10.4	1.3
1959	0.0	0.0	0.0	0.3	0.8	0.7	4.1	1.4	33.1	0.0	0.0	0.0	40.4	40.1	0.3
1960	0.0	0.0	0.2	0.0	6.1	3.2	8.3	1.7	1.5	0.7	0.0	0.0	21.7	20.8	0.9
1961	0.0	0.0	0.0	0.4	2.1	1.5	0.2	4.2	11.7	5.1	0.0	0.0	25.1	19.7	5.5
1962	0.0	0.0	0.0	1.4	3.8	1.1	4.1	5.3	22.9	0.4	0.0	0.0	38.8	37.1	1.7
1963	0.0	0.0	0.0	0.1	1.3	1.0	6.5	3.1	5.0	2.5	0.0	0.0	20.2	16.9	3.3
1964	0.0	0.0	0.0	0.2	7.8	1.8	2.9	0.9	8.4	3.3	0.0	0.0	23.3	21.7	1.6
1965	0.0	0.0	0.0	0.7	2.5	0.3	1.9	5.6	3.7	0.8	0.0	0.0	15.6	14.1	1.5
1966	0.0	0.1	0.4	0.1	13.5	1.6	0.7	4.3	2.6	1.2	0.0	0.0	26.4	22.6	3.8
1967	0.0	0.2	0.0	1.0	0.1	2.4	1.4	2.5	11.6	0.2	0.0	0.0	18.1	18.1	0.2
1968	0.0	0.0	0.0	1.3	2.8	5.7	4.4	3.8	2.6	0.2	0.0	0.0	20.7	19.2	1.4
1969	0.1	0.0	0.0	0.0	1.3	10.6	4.4	1.1	10.8	1.2	0.0	0.0	29.7	28.2	1.5
1970	0.0	0.0	0.0	1.3	1.1	16.1	0.4	6.5	12.5	0.1	0.0	0.0	38.0	36.6	1.4
1971	0.0	0.0	0.0	0.2	5.1	5.3	8.2	6.8	7.4	0.8	0.0	0.0	33.8	32.7	1.1
1972	0.0	0.0	0.0	1.4	0.0	7.8	0.3	3.3	3.3	1.7	0.0	0.0	18.1	14.9	3.2
1973	0.0	0.0	0.0	0.0	0.7	1.2	3.2	2.9	9.6	0.0	0.0	0.0	17.6	17.6	0.0
1974	0.0	0.0	0.1	0.6	0.6	0.1	2.3	6.3	5.0	0.8	0.6	0.0	16.4	14.3	2.1
1975	0.0	0.0	0.0	0.0	8.4	3.8	3.8	2.7	13.1	1.7	0.0	0.0	33.6	31.8	1.8
1976	0.0	0.0	0.1	0.6	3.2	0.0	4.3	2.0	13.0	2.9	0.0	0.0	26.0	22.5	3.5
1977	0.0	0.0	0.0	0.2	4.5	1.4	0.7	7.3	13.3	0.0	0.0	0.0	30.1	29.2	1.0
1978	0.0	0.0	0.0	0.2	3.9	1.9	13.3	4.1	17.3	0.1	0.0	0.0	44.9	44.6	0.3
1979	0.0	0.0	0.0	1.1	3.1	9.1	0.5	3.7	7.4	0.0	0.0	0.0	24.8	23.7	1.1
1980	0.0	0.0	0.0	0.4	5.7	13.1	0.7	1.9	20.1	1.4	0.0	0.0	43.3	41.4	1.9
1981	0.0	0.0	0.0	0.2	2.7	4.3	6.0	2.2	0.7	1.3	0.0	0.0	17.3	15.9	1.5
1982	0.0	0.1	0.5	0.3	1.0	0.7	2.4	0.4	28.8	4.0	0.0	0.0	37.3	32.3	5.0
1983	0.0	0.0	0.0	0.0	0.9	12.1	2.8	18.1	3.3	3.8	0.0	0.0	42.9	39.1	3.8
1984	0.0	0.0	0.0	0.6	0.7	2.3	6.3	4.6	2.5	3.7	0.0	0.0	21.0	16.7	4.3
1985	0.0	0.0	0.0	0.0	2.4	1.8	1.0	2.9	5.4	2.1	0.0	0.0	15.7	13.6	2.1
1986	0.0	0.0	0.1	6.0	8.1	1.2	1.2	2.1	1.1	0.2	0.0	0.0	20.0	13.7	6.4
1987	0.0	0.1	0.2	0.6	6.4	1.6	1.3	8.9	8.4	1.1	0.1	0.0	26.9	24.9	2.0
1988	0.0	0.3	0.0	0.9	2.7	3.3	2.6	0.4	2.6	4.3	0.0	0.0	17.2	11.8	5.4
MEAN	0.0	0.0	0.1	0.6	3.2	4.2	3.1	3.9	9.9	1.3	0.0	0.0	26.5	24.3	2.1
MAX	0.1	0.6	1.3	6.0	13.5	21.1	15.3	18.1	33.1	5.1	0.7	0.0	44.9	44.6	6.4
MIN	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.7	0.0	0.0	0.0	11.5	10.4	0.0

FIGURE A-9 DRAINAGE AREA AND ANNUAL RUNOFF (AVERAGE YEAR)



APPENDIX B HYDROGEOLOGY AND GROUNDWATER

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B-1. Topography and Geology of the Study Area

B-1-1. Topography

The study area can be subdivided into four physiographic units: mountainous terrain, undulating rolling hill, terrace and alluvial flood plain.

The mountainous terrain extends along the western edge of the study area with width of less than 500 m and an altitude attains a maximum of more than 260 m.

The undulating rolling hill is distributed both west and east sides of the study area with an altitude ranging from 180 to 220 mamsl. In general, it shows monotonous to gentle undulating terrain, but small-scale, shallow and broad valleys are also observed in various places.

The terrace largely covers in a center of the study area with an altitude ranges from 160 m to 180 mamsl and it forms two distinct flat topographic features, an upper terrace and a lower terrace.

The alluvial flood plain extends along the river courses in the undulating rolling hill and the eastern edge of the study area.

B-1-2. Geology

The study area comprises of three main geologic units: the Khorat Group, the Pleistocene and the Holocene.

The Khorat Group in the area are divided into the Soa Khua, Phu Phan, Khok Kruat and Maha Sarakham Formations in ascending order and the last is overlain by the gravel bed and terrace deposits of Pleistocene age. The Group consists of mudstone, siltstone and sandstone, and it crops out in the western edge of the study area.

Although the question arises whether the Maha Sarakham Formation includes the rock salt beds is assigned the Khorat Group or more younger formation no out-crops of the rock salt have been observed in the study area.

The Pleistocene gravel bed which named the Pa Mo Gravel Formation underlie in the undulating rolling hill and the thickness attains more than 30 meters. The formation thins eastward from the undulating rolling hill due to erosion and it finally underlies the terrace deposits. The beds is mainly composed of well-rounded pebbles of white chert and it can be traced to the base of the terrace deposits.

The terrace deposits consists of fine grained sediments of clay, silt and thin sand, but contains some intercalated laterite grave beds. The deposits is extensively overlain buy thick loam. From the lithological point of vies, the question arises whether this sediments are of terracial origin or lake deposits, this study adopt a term of the terrace deposits for the convenience of future discussion.

The alluvial deposits are distributed in the recent flood plain of Lam Chi, Huai Yai, Huai Yan and Huai Phra Nao. The deposits consists of organic clay with laterite gravels in the base, clayed fine sand and fine to medium siliceous sand in the middle, and loam in the uppermost.

The geological map of the study area and the table of formations are shown in figure B-1 and Table B-1 in APPENDIX B.

B-2 . RESULTS OF THE FIELD INVESTIGATION

B-2-1 Geo-resistivity survey

(1) Purpose of the Survey

The vertical sounding with Wenner array were applied in determining the boundary of layers based on their apparent resistivities. A depth of sounding ranges from 150 to 190 meters in extensive study area and 30 meters in the proposed Pilot area. Total number of soundings in above areas are 61 and 77 respectively. Location of the sites is shown in Figure B-2, Location Map of Hydrogeological Study.

The survey provided information on lithologic characteristics of surficial beds and the surface topography of the Siltstone. Furthermore, approximate rate of salt water concentration in the respective beds, especially in the Siltstone, can be inferred form the relationship between apparent resistivity and electrical conductance.

(2) Surface Topography of the Siltstone

The survey reveals that depth of the siltstone which is correlative with the Maha Sarakham or the Tertiary formations, ranges from 4 to 18 mbgs and an altitude of its surface ranges from 180 to 150 mamsl as shown in Figure B-3.

The Figure shows that the surface of siltstone decreases altitude to the east of Ban Phra Yun with a gradient of 1 to 220 and it forms narrow platform from Ban Phra Yun to Ban Non Tun. Two broad valleys from both sides of the platform trending northeast and southeast

directions and their locations are identical with Huai Si Phung, a tributary of Huai Yai, and Huai Yan respectively.

(3) Resistivity of the Siltstone

The resistivity-spacing curve (ρ -a curve) of the Siltstone varies in horizontal and vertical direction. The resistivity in a deeper part of the Siltstone may indicate proper resistivity of the rock because resistivity in a shallow part shows effect of saturated groundwater in the surface unconsolidated beds on the whole. In attempt to understand the distribution of resistivity of the Siltstone, the resistivity distribution contour at depth of 140 m is delineated in the map as shown in Figure B-4.

As easily visualized from the figure, a zone of low resistivity forms obviously in the west of Ban Phra Yun with north-south trending.

In addition to the above results, a low resistivity zone with depth to more than 150m is identified by means of ρ -a curve analysis. The location of low resistivity zone is identical with the zone delineated by resistivity distribution contour at a depth of 140 m (see figure B-4, Resistivity Contour Map at Depth of 140 m and Figure B-5, Resistivity Profiles).

These facts support the ideas that under lying layer is subjected to saltwater infiltration throughout the sounding depth of more than 150 meters due to upward flow potential through joints, cracks and coarse grain facies in the siltstone. The low resistivity zone trending north-south direction in the west of Ban Phra Yun can be identified the zone of salt water discharge.

Provided ρ -a curves are attached at the end of APPENDIX-B.

B-2-2. Electrical Conductance Survey in Ponds and Streams

The electrical conductance (EC) and pH were measured in July and August, 1990 and January, 1991 in the river courses of Huai Yai, Huai Yang and Huai Phra Nao, and selected ponds. Number of measured sites in the surface river and ponds are 47 and 33 respectively.

The EC of the surface river in the rainy season increases moderately toward the lower stream ranging from 230 to 720 μ S/cm in the Huai Yai, however it increases rapidly toward the down stream ranging from 240 to 1,400 μ S/cm in the Huai Yang and Huai Phra Nao. The rapid increment were observed especially in the river course of Huai Yang from Ban Pa Mo to Highway 2067 and in the Huai Phra Nao from Ban Hua-Na Nua to Ban Non Ngiu.

The Ponds in the rolling hill in the west part of the study area and in the central terraced terrain from Ban Phra Yun to Ban Non Tun indicate comparatively low EC ranging from 40 to 2,000 $\mu\text{S}/\text{cm}$ in opposition to the tributary of Huai Phra Nao in the southern part of the study area where EC indicates more than 5,000 $\mu\text{S}/\text{cm}$.

Observed EC of the surface rivers and reservoirs in the dry season generally indicate more larger than data in the rainy season (see Table B-2 Electrical Conductance in Stream and Reservoir).

In general, water quality of stream represents it of drainage area, however, field evidence shows that the quality of the ponds on the drainage are quite differ form it of related stream. From this, it may be inferred that the ponds act a part of salt accumulation/evaporation basin.

Distribution of EC in the surface rivers and ponds is delineated in Figure B-6.

Measured EC, PH and water temperature in the end of July and August, 1990 and January, 1991 are shown in Table B- and location of measured sites is shown in Figure B-2, Location Map of Hydrogeology and Groundwater Study.

B-2-3. Existing Well Survey

The well structure and water quality (EC and pH) of the existing wells were investigated on July, 1990 and February, 1991 in the study area. The wells comprise of 19 shallow dug wells and 36 deep tube wells.

The depth and water table in the dug wells ranges from 2.5 to 9.5 m and from 0.5 to 7.1 mbgs respectively. On the contrary, depth of the tube wells ranges from 12 to 54 m.

Groundwater from 17 dug wells indicates comparatively low EC, especially in a western rolling hilly area and a central terraced terrain, from Ban Phra Yunt of Ban Non Tun, and it increases EC toward the north from Ban Phra Yun.

Groundwater from 34 tube wells indicates more high EC compare with the dug wells ranging from 800 to 11,600 $\mu\text{S}/\text{cm}$ on the rainy season and it increases in the dry season. A zone of high concentration of EC locates on the west of Ban Phra Yun trending north-south direction

which is quite identical with a zone of low resistivity in the Siltstone.

Observed data of sell structure and water quality are shown in Table B-3.

B-2-4. Drilling of The Exploratory Wells

Two exploratory wells and ten observation wells were constructed in the study area. The objectives of drilling are to obtain the information of subsurface geology and groundwater potential for the formulation of the project.

The work commenced on 1st August and it completed in 15th of September, 1990.

The standard design of the exploratory and observation wells are shown in Figure B-7 and B-8 respectively.

The location of wells is shown in Figure B-2, Location map of Hydrogeology and Groundwater Study.

Two exploration wells with 30 meters depth are located in the both east and west sides of the study area. Ten observation wells with 15 meters depth are scattered in the area.

The works of exploration well drilling comprises of well drilling, borehole logging, aquifer test and installation of automatic water level recorder, and the observation wells install 50mm PVC casing for manual water level monitoring.

The obtained geologic samples from the well drillings reveal that the study area is underlain mainly by the siltstone less than 10mbs depth. The depth to the siltstone increases more than 15 meters in W-1, P-3, P-5 and P-10 where ancient river courses or major tectonic zone are supposedly underlain.

The drilling logs of the exploratory and observation wells with geology, borehole logging and screen schedule are shown in Figure B-9 ~ B-20.

After installation of the well casings, an aquifer test was conducted in the exploratory wells of W-1 and W-2. Obtained specific capacity of W-1 and W-2 are 25.0 and 0.5 lit/min/m respectively. Calculated transmissivities for W-1 and W-2 are 70.4 and 0.74 m²/day respectively.

Results of the test is summarized in Table B-4, and time-drawdown and time-recovery curves are shown in Figures B-21, -22 and -23.

B-2-5. Electrical Magnetic (EM) survey on the Pilot Area

The electromagnetic induction, using Geonics EM 38 and EM 34-3 instruments, measured apparent electrical conductivity on an approximately 800 m square grid to survey the lateral variation of salt content of the soil by the 1,10 and 20 m coil spacing on the Pilot Area. The results are shown in the conductivity contour map.

Location of EM survey is shown in Figure B-24, Location Map of Hydrogeological Survey Pilot Area.

The contour map at nominal depth from 0.75 to 1.5 mugs shows that high conductivity with more than 100 mS/m (less than 10 Ω m in resistivity) concentrates at 2.1 km southwest of Ban Phra Yun where a tributary of the Huai Yan across the highway. The high conductivity zone extends to the southeast along the alluvial plain. The same tendency obtains until a depth of 7.5 m. The conductivity of surface have an effect on this depth.

The apparent conductivity at nominal depth 15 m varies moderately in contrast with shallow depth. It indicates about 70mS/m except the rolling hill in the east and south where it shows less than 50mS/m.

The apparent conductivity contour map at the coil spacing 1,10 and 20 m are shown in Figure B-25 ~ B-27. Observed field data is listed in Table B-5.

To compare with the contour maps of EM, the apparent resistivity contour maps at depth of a=1 m, a=10 m, a=16 m and a=30 m are drawn in Figures B-28 and -29.

B-2-6. Permeability Test on the Pilot Area

The permeability test was conducted in the different lithology of unconsolidated beds of the Quaternary Formation on the Pilot Area. The open hole method was applied for the test to identify the aquifer permeability overlying the Siltstone. The sites located at the same of the piezometer on the terrace where the soil texture were observed by this study. A total number of holes and soil samples are 15 and 18 respectively.

Measured permeability indicate 1.1×10^{-4} cm/sec in SiC and sgSC in a maximum and 6.1×10^{-8} cm/sec in gSL in a minimum.

In general, the permeability of the unconsolidated beds in the area indicates low in spite of gravelly and sandy composition. The results of a laboratory test reveals same conclusion as shown in APPENDIX C.

Location of the test is shown in Figure B-24, Location Map of Hydrogeological Survey on Pilot Area.

Summarized results of the permeability test is listed in Table B-6.

B-2-7. Aquifer Test in the Existing Dug Wells on the Pilot Area

Three dug wells were selected for the aquifer test to evaluate shallow groundwater potential. A well of DW-1, located on the rolling hill, indicates 3.8 lit/min/m of specific capacity and the rest, DW-3 and DW-5 on the terrace indicate 5.2 lit/min/m of specific capacity.

Based on above results, expected well yield of shallow dug wells ranges 1.8 to 2.5 cu.m/day by 8 hours pumping and 1 m drawdown.

The results of aquifer test is summarized in Table B-7. The time-drawdown and time-recovery curves for DW-1, DW-3, and DW-5 are shown in Figures B-30, -31 and -32. Location of the tested wells is shown in Figure B-24, Location Map of Hydrogeological on Pilot Area.

B-2-8. Existing Pond Survey on the Pilot Area

The EC in the existing ponds on the pilot area was investigated to analyze an aquifer system of the unconsolidated beds. Total Number of investigated ponds is about 150.

The results of investigation reveals that a distinct break of EC value in the ponds was observed between terrace and alluvial flood plain. The former indicates EC less than 600 $\mu\text{S}/\text{cm}$ and the latter indicates more than 3,000 $\mu\text{S}/\text{cm}$. From this fact it is inferred that a different manner of salt water contamination from the siltstone aquifer take place in the terrace deposits and the alluvial deposits as described in the following chapters.

Investigated EC in the existing ponds is shown in Figure B-33, EC in Existing Ponds on the pilot Area.

B-2-9. Groundwater Monitoring in the Exploratory Wells

The water tables and PH in the two exploratory wells and ten observation wells have been continuously monitored twice a month since November 1990.

The exploratory well, W-1 on Ban Pa Mo indicates 1.29 m water level depression by two months and W-2 on Ban Non Tun indicates 0.15 m depression during observation period. The former penetrate in the sand and gravel aquifer and the latter penetrate in the siltstone.

The seasonal fluctuation in the observation wells which penetrate in the siltstone ranges from 0 to 4.8 m.

Observed water levels in the exploratory wells and observation wells are shown in Figures B-34 to B-37, and location of the exploratory wells is shown in Figure B-2.

B-2-10. Hydrogeological Field Survey

The W-1 well, drilled in Ban Pa Mo, reveals that the unconsolidated gravel bed has a thickness of more than 30 meters and it thins to the east. The bed unconformably overlies the Khok Kruat and the Maha Sarakham Formation.

Although the boundary of the Khok Kruat and the Maha Sarakham locates on the basement of the gravel bed, no outcrops of the boundary were observed in this area. However, in view of general geologic knowledge, a kind of tectonic zone which is represented by a zone of cracks, fractures and coarse grained sandstone, may be expected near the formation boundary, especially if these two formations has an unconformable relationship. There is a large possibility that the boundary of these formation play the most important role for the discharge of the dissolved salt water from rock salt. The salt water can easily disperse through the permeable gravel bed after it discharged to the surface of the siltstone. Data from geo-resistivity sounding and EC distribution in the existing wells support this idea because heavily concentrated salt water is mainly located at the eastern limit of the gravel bed (see Figure B-4, Resistivity Contour Map at Depth of 140 m and B-38, Groundwater Conductivity Map in Siltstone Aquifer).

The salt concentration was observed on a surface of the siltstone in a riverbed of the Chi River near Ban Non Bua Di Mi where new bridge is under construction. The salt crystallization was found on the cores grained sandstone and, along joints and cracks of the siltstone.

These field evidences suggest that the dissolved salt water from the rock salt discharge vertically into the overlying unconsolidated beds through its cracks, fractures and cores grained sandstone beds, then it flows horizontally through the permeable layers.

As already stated, detailed hydrogeological surveys were carried out in the pilot area (see B-24, Location Map of Hydrogeological Survey on Pilot Area).

Based on the survey, the hydrogeological map is prepared as shown in Figure B-39.

B-3. Hydrogeology and Groundwater of the Study Area

B-3-1. Hydrogeological Units

Two major aquifer systems, the Quaternary and Siltstone, are distributed in the study area. The Siltstone forms the basement of the study area and depth to it ranges from 3 to more than 30 m. The Quaternary is subdivided into two, the Pa Mo gravel bed and the terrace deposits.

The Pa Mo gravel bed forms the undulating rolling hill near Ban Pa Mo trending north-south direction with an altitude of about 200 m and 2 km width. The maximum thickness attains more than 30 m and it thins eastward where the terrace deposits unconformably overlies it.

The beds are composed of mainly well rounded white colored gravel of quartz with minor amount of fine sand and silt.

The terrace deposits are widely distributed in the study area and the thickness attains a maximum of about 15 m. Although detailed investigation of the deposits is not conducted by the study team, field investigation in these deposits was conducted at 20 hand augering holes by the soil survey crew of the study team during the 1st stage field survey. The augering reveals that the deposits were composed of a silty and/or clayey material with fine sand with lateritic gravel. From this it may be inferred that the deposits act slightly impermeable than the Pa Mo gravel bed.

As already stated, the Siltstone is practically impermeable basement but the fractures and coarse grained sandstone facies in the rock acts as a kind of aquifer.

B-3-2. Groundwater Flow

The contour map for the piezometric head on the end of September, 1990 in the Siltstone aquifer is drawn by the use of water level records of the exploration wells (see B-34, -35, -36 and -37, Well Hydrograph for the Exploratory Wells). The map shows that the piezometric head decreases monotonously toward the east from the rolling hill to the east of Ban Phra Yun and from this point, it forms a narrow groundwater mound toward Ban Non Tun.

This feature suggests that the groundwater flows monotonously from the rolling hill to the east of Ban Phra Yun and it changes direction of flow toward two, the northeast and southeast (see Figure B-40, Piezometric Surface of the Siltstone Aquifer).

A large number of the Piezometric head in the Siltstone aquifer in the existing wells were also observed by GREP (Groundwater Resources Evaluation Pilot Project, Thai-Australia northeast water resource project). Same feature of the contour map is obtained by the data of GREP.

The groundwater in the Siltstone aquifer shows the confined condition but it could not flow out to the ground surface except a few wells. Among the exploratory wells, only one observation well, P-5, shows an artesian condition.

The water tables in the Quaternary aquifer were also observed in the exploratory wells, W-1 and P-7, during the survey period. The fluctuation of water tables in W-1 which penetrated into the Pa Mo Gravel Bed, indicates 45 cm between the rainy and dry months in comparison with it of the Siltstone which indicates more than 75 cm at W-2.

B-3-3. Groundwater Potential

(1) Aquifer System

The hydrogeological study reveals that two kinds of aquifer systems, the Siltstone and the Quaternary, are distributed in the study area. The Siltstone is practically impermeable, but infiltration and/or discharge may occur in concentrated points, fracture zone or formation boundary for example, or more generally. It is widely distributed in the study area. The unconsolidated Quaternary aquifers unconformable overlies the Siltstone in the study area and it is distributed in the undulating rolling hill, terrace terrain and alluvial plain. The aquifers in the former two assign to the Pleistocene and the last assign to the Holocene.

(2) The siltstone Aquifer

The aquifer potential of the Siltstone depends on presence of fractures in the rock because well consolidated siltstone is basically impermeable. Although the fractures develop irregularly, in view of general geologic knowledge, these fractures develop concentrically at a kind of tectonic zone which is represented by faults and unconformable formation boundary. It is natural that greater yield can be expected if water well is located on these zones.

Based on the aquifer test in the existing wells conducted by GREP, specific capacity of the Siltstone on a central part of terracial terrain which extends from Ban Tao near the middle of Huai Yai to Huai

Wan Hin, a tributary of Huai Yai, indicates less than 5 lit/min/m in contrast with the west of Ban Phra Yun where specific capacity ranges from 5 to 10 lit/min/m

Based on above specific capacity of 5 lit/min/m, well yield can be calculated at 12 cu.m/day if pumping duration apply to 8 hours with drawdown of 5 m. It is natural that, well with specific capacity of 10 lit/min/m can Yield 24 cu.m/day if pumping apply to same condition.

In general, the specific capacity of the Siltstone tends to increase on the northwestward and eastward of the study area. Furthermore, a zone of high specific capacity is located on Ban Phra Yun with north-south trending (see Figure B-41 Specific Capacity of the Existing Wells in Siltstone Aquifer in APPENDIX B)

Water quality of the Siltstone aquifer varies with location of wells. Distribution of EC in the existing wells are shown in Figure B-38, Groundwater Conductivity Map of Siltstone Aquifer in APPENDIX B.

As easily visualized in the figure, a zone of high EC forms obviously at 2 km west of Ban Phra Yun with north-south trending where EC ranges from 10,000 to 20,000 $\mu\text{S}/\text{cm}$ and it decreases toward both sides from the zone.

A location of low resistivity zone is quite identical with zone of high EC because resistivity is reciprocal with conductivity (see Figure B-4 Resistivity Contour Map at Depth of 140 m in APPENDIX B).

Based on the water quality test of groundwater in W-2, which drilled at Ban Non Tun on the rolling hill, EC and TDS indicated 1,600 $\mu\text{S}/\text{cm}$ and 810mg/lit respectively, however high concentration of total iron and hardness provided to be inadequate for drinking purpose (see Table B-8, The results of Water Quality Test in The Exploratory Wells in APPENDIX B).

Based on the drinking standard of WHO, permissive limit of TDS is 1,500mg/lit which can probably express 2,300 $\mu\text{S}/\text{cm}$ in EC, consequently only the groundwater in the siltstone aquifer on the rolling hill, about 5 km east of Ban Phra Yun, is acceptable for the drinking purpose.

EC of the siltstone aquifer in newly excavated drainage at 3 km south-west of Ban Phura Yun, indicates more than 20,000 $\mu\text{S}/\text{cm}$. There is a large possibility that overlying aquifer is more subject to contaminate by a high concentration of EC when water table of the siltstone aquifer ascends through cracks to the surface of the siltstone.

As mentioned before, groundwater yield of the siltstone aquifer estimates about 20 cu.m/day in promise potential areas, however considering qualitative assessment for drinking purposes, the maximum

yield attains 10 cu.m/day on the limited area of rolling hill in the east of the study area.

(3) The Quaternary Aquifers

1) The Pa Mo Gravel Bed.

The Pa Mo Gravel Bed on the rolling hill in the west of the study area is about 30 meters in maximum thickness and it forms exploitable potable aquifer in consideration of quantity and quality (see Table S-8 The Results of Water Quality Test in the Exploratory Wells in APPENDIX B).

The aquifer test in the exploratory well of W-1 reveals that calculated specific capacity and transmissivity are 20 lit/min/m and 70m²/day respectively by 21.4 lit/min pumping rate. It can lead to an yield of 48 cu.m/day by 8 hours pumping and 5 m drawdown.

Groundwater from this aquifer is utilized in Ban Non Khu, the north of Ban Pa Mo, for the source of village water supply system.

Recommendable area for the development of this aquifer is restricted on a center of the rolling hill where underlies thick gravel bed. The thickness of bed thins toward both sides of the hill.

2) The Terrace Deposit

The Terrace Deposit is widely distributed in the area and the permeability of it indicates comparatively low due to lithological composition. The thickness attains less than 10 m and expected potential in this aquifer is low due to its permeability. Although many dug wells are utilized for domestic purposes, depth of the wells is not so deep ranging from 5 to 8 m to prevent vertical seepage of groundwater from the siltstone aquifer.

Based on the aquifer test conducted by the study, the groundwater yield of this aquifer estimates from 2 to 2.5 cu.m/day by 8 hours pumping and 1 m drawdown.

Measured EC in this aquifer indicates less than 600 μ S/cm in extensive area but it increases to more than 2,000 μ S/cm in the comparatively low land where the aquifer is subject to contaminate by the siltstone aquifer of high concentration of EC. EC of the ponds located in alluvial plain where the siltstone is just underlying, indicates extremely high in comparison with it of ponds located in more higher place. This fact leads to the following idea that the groundwater in the terrace aquifer is contaminated by the groundwater in siltstone aquifer. This aquifer is not utilized by the villagers for drinking purpose because of high concentration of