KINGDOM OF THAILAND

FEASIBILITY STUDY ON SEBAI-SEBOK BASIN DEVELOPMENT PROJECT

VOLUME 2 APPENDIX

FEBRUARY 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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FEASIBILITY STUDY

ON

SEBAI-SEBOK BASIN DEVELOPMENT PROJECT

IN

THE NORTHEAST REGION

VOLUME 2 : APPENDIX

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APPENDIX A. METEOROLOGY AND HYDROLOGY

A-1. Meteorology

The Sebai-Sebok basin has a tropical monsoon climate with a pronounced dry season. The rainy season extends from May to October. Annual rainfall varies from about 1,800 mm in the southeastern part to about 1,400 mm in the northwestern part of the basin with an average of 1,600 mm. Monthly average rainfall is highest in August and lowest in January.

Cyclonic storms originated in the South Chaina Sea and the Pacilic Ocean sometimes enter Thailand mostly during the period of September through November. The storms diminish in intensity as they come across the Indochina Peninsula, but bring heavy rainfall to the basin as tropical storms or tropical depressions.

The mean monthly temperature varies from 30°C in April to 23°C in December (Ubon Ratchathani), a range of only 7°C. The monthly mean relative humidity of Ubon Ratchathani for 30 years had an average of 73 percent with the lowest in March of 62 percent, while the highest took place in September, 83 percent. Maximum mean monthly evaporation of 216 mm occurs in March and minimum of 129 mm in September in Ubon Ratchathani, respectively. A list of meteorological stations is given in Table A-2.

Reference crop evapotranspiration (ETo) is computed as shown below, based on the Modified Penman Method as recommended by FAO (1977), applying it to the Ubon Ratchathani climatological data.

Reference Crop Evapotranspiration (ETo)

Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
mm/day	4.5	5.2	6.4	6.6	5.6	4.8	5.1	4.6	4.4	5.0	5.0	4.3	-
mm/mon.	140	146	199	197	172	143	157	143	132	153	148	132	1,862

A-2. Hydrology

A-2-1. Rainfall

A number of the rainfall gauging stations are located in the Sebai-Sebok basin as shown in Figure A-2. However, most of rainfall stations have only observation of daily rainfall, and a few rainfall stations locating in Muang Ubon Ratchathani have observation of hourly rainfall. Thus it is rather difficult to grasp the hourly rainfall in the catchment area of the proposed reservoir for the estimation of the flood discharge.

(1) Annual and Monthly Rainfall

The rainfall stations for each project were selected by the Thiessen polygon, and some missing data were supplemented with the available daily record at nearby other station. The annual and monthly rainfall of each project for 20 years (1968-1987) is tabulated in Table A-3 and summarized as below;

Selected Rainfall Station

Project	Rainfall Station (Code Number) for Catchment Area		for Service Area	
Lam Se	Loeng Nok Tha	(72042)	Loeng Nok Tha	(72042)
Huai Khum Kham	Trakan Phutphon	(67082)	Trakan Phutphon	(67082)
Huai Kham Phak Wan	-do-	(67082)	-do-	(67082)
Huai Na Khai	Si Muang Mai	(67112)	Sa Saming Tank	(67270)
Huai Soob	-do-	(67112)	Si Muang Mai	(67112)

Average Monthly Rainfall

(Unit: mm)

Rainfall Station	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
72042	60	219	283	294	389	275	87	7	0.4	6.0	6.0	17	1,641
67082	71	231	295	284	406	286	99	15	1.1	1.1	5.2	19	1,714
67112	66	196	324	301	395	267	82	13	1.0	2.2	13	11	1,799
67270	71	198	290	264	403	302	101	19	3.3	2.9	7.7	13	1,673

A noticeable feature of rainfall in the project area is its poor correlation at different gauges, showing that on daily basis one gauge may have heavy rainfall, but another nearby none. Even on a seasonal or annual basis, the rainfall correlations are still poor. Particular attention is paid to the dry periods which frequently occur in June or July normally lasting 15 to 20 days and cause shortage of water in the basin.

(2) Daily Rainfall

The frequency analysis of the daily rainfall records is normally required for the estimation of floods for designing the spillway of the storage dams. The computed probable rainfalls by Iwai's Method for each project are as follows;

Probable 1-day Rainfall

(Unit: mm)

Project	Return Period (year)					
	5	10	20	50	100	500
BA-5: Lam Se	151	174	196	225	248	301
BO-11: Huai Khum Kham BO-13: Huai Kham Phak Wan	150	179	208	248	281	362
BO-18: Huai Na Khai TL-6: Huai Soob	155	180	202	232	253	304

Probable Consecutive Rainfall with a Return Period of 500-year

(Unit : mm)

Project	1 - day	2 - day	3 - day
BA-5: Lam Se	301	351	354
BO-11; Huai Khum Kham BO-13: Huai Kham Phak Wan	362	444	458
BO-18: Huai Na Khai TL-6 : Huai Soob	304	407	477

(3) Hourly Rainfall

In order to estimate the design flood for the dam of each Project, the hourly data at Muang Ubon Ratchathani synoptic station were analyzed and

rainfall intensity equation has been derived by applying specific coefficient method as described below;

$I^n_t = R^n_{24} / 24 \times a' / (t+b)$
$b = (24 - \beta'^n_t \times t) / (\beta'^n_t - 1)$
$\beta'^n_t = 24R^n_t / R^n_{24}$
$a' = b + 24$
where

I^n_t	:	rainfall intensity for t hour with a return period of n-year (mm/hr)
R^n_{24}	:	rainfall intensity with a return period of n-year for 24 hours (mm/24hr)
R^n_t	:	rainfall intensity with a return period of n-year for t hours (mm/hr)
β'^n_t	:	specific coefficient defined by the ratio of R^n_t and R^n_{24} with a return period of n-year

When the data of 1-day and 1-hour rainfall are available, the above equations are expressed below;

$I^n_t = R^n_{24} / 24 \times a' / (t+b)$
$b = (24 - \beta^n_t) / (\beta^n_t - 1)$
$\beta^n_1 = 24R^n_1 / R^n_{24}$
$a' = b + 24$

then, $\beta = a' / (t+b)$ $I^n_t = R^n_{24} / 24 \times \beta$
where, β: specific coefficient equation

Thus, various specific coefficient equations were derived as shown below and were applied to the estimation of hourly rainfall over the catchment area by utilizing the data of probable 1-day rainfall.

Specific Coefficient Equation (β)

Return Period (yrs)	R^n_{24} (mm/day)	R^n_1 (mm/hr)	$24R^n_1$	β'^n_1	b	a'	β
5	135	71	1,704	12.6	1.0	25.0	25.0 / (t+1.0)
10	158	80	1,920	12.2	1.1	25.1	25.1 / (t+1.1)
20	181	87	2,088	11.5	1.2	25.2	25.2 / (t+1.2)
50	214	95	2,280	10.7	1.4	25.4	25.4 / (t+1.4)
100	240	101	2,424	10.1	1.5	25.5	25.5 / (t+1.5)
500	306	113	2,712	8.9	1.9	25.9	25.9 / (t+1.9)

A-2-2. River Runoff

(1) Rainfall - Runoff Relation

Observed river runoff and annual runoff coefficients with a basin wide areal rainfall at six stream gauging stations are compiled on water year basis from April to March in Table A-4, and are summarized as follows;

Annual Rainfall and Annual Runoff Coefficient

Stream Gauging Station	Catchment Area (sq.km)	Average Annual Rainfall (mm)	Average Annual Runoff (mm)	Aberage Annual Runoff Coefficient (%)	Observed Period of Runoff
M.32	1,654	1,527	455	30	1965-'85
M.32A	1,535	1,422	343	24	1968-'72
M.69	2,132	1,567	642	41	1971-'86
M.132	101	1,545	390	25	1986
M.141	382	1,808	839	46	1987
M.127	414	1,794	649	36	1987

It should be noted that the rainfall during the period of April to July would be completely absorbed into the ground and paddy field. Due to this absorption and rare occurrence of highly intensive rainfall in the early rainy season, peak runoff would mostly occur during the period of August to September. The response of the catchment area to rainfall is rather insensitive and river runoff would continue for two or three days after stop of rainfall.

(2) Runoff Analysis

There are 10 water gauging stations in the three basins, and discharge data are available at the six stations, of which three stations of M32 and M32 A are in the Sebai basin and M69 in Sebok basin covering a big watershed area of more than 1,500 sq.km. They have discharge data for a relatively long period. But the data length of discharge of the other three stations of M127, M132 and M141 which have smaller watershed areas in the Sebok basin is quite short.

The direct runoff measurement for a long term at the five proposed damsites is not available to date. The runoff at the five proposed damsites has been synthesized by establishing the proper runoff model and then applying a rainfall to the model. In this study, 10-day runoff on the basis of daily rainfall has been reconstructed.

The catchment areas of proposed reservoirs are less than 40 sp. km as shown in the table below and lie in hilly land with gentle slope covered with sparse and tall trees. The catchments have a characteristic of big variations in discharge on a daily , seasonal and annual bases.

Feature of Catchment

Project	Catchment Area (sq.km)	River Length (km)	River Slope
BA- 5 : Lam Se	22.4	6.0	1/270
BO-11 : Huai Khum Kham	36.8	12.1	1/230
BO-13 : Huai Kham Phak wan	13.5	5.0	1/330
BO-18 : Huai Na Khai	31.3	7.8	1/180
TL- 6 : Huai Soob	18.5	8.2	1/100

For the development of the runoff model, discharge data at M132 stream gauging station with a record length of one year in 1986 and catchment area of 101 sq. km, the smallest among the catchment areas of existing six stream gauging stations was adopted considering the similarity of basin characteristics such as the size of catchment, land use, topography and geology.

As a runoff model, the Tank-model method developed by Dr. Sugawara was adopted. The runoff module of tank-model was decided after several trials as shown in Figure A-4. The runoff estimated by applying the tank model method was illustrated in Figure A-5. As seen in the figure, there is not much difference between estimated and observed runoff in the observation period. The long-term runoff at each dam site was estimated on a daily basis by applying rainfall data selected by Thiessen polygon as shown in Figure A-2. The annual rainfall, runoff and runoff coefficient for last 20 years at each proposed damsite are summarized as follows;

Annual Runoff Coefficient

Project	Average Rainfall	Annual Run off	Runoff Coefficient (%)	
			Range	Average
	(mm)	(MCM)		
Lam Se	1,641	13.5	26.5-45.2	36.7
Huai Khum Kham	1,714	23.3	25.8-49.0	37.0
Huai Kham Phak Wan	1,714	8.5	25.8-49.0	37.0
Huai Na Khai	1,670	20.1	22.2-55.7	38.4
Huai Soob	1,670	11.9	22.2-55.7	38.4

The annual and monthly runoff at each proposed damsite are tabulated on Table A-5 and Figure A-6.

A-2-3. Flood Discharge Analysis

(1) Criteria on Frequency of Design Flood

Observed flood records at the stream gaugung station were not available because record length is too short to estimate the design flood. Thus, it has been made by analytical method using rainfall record. The flood analysis has been made by applying the runoff-function method which is a kind of unit-hydrograph metnod. Return period of the design flood in accordance with the type of structure was dicided based upon RID's criteria as shown below;

Criteria of Frequency on Design Flood

Type of Structure	Frequency (year)
Emergency Spillway	500
Service Spillway	100

(2) Design Flood

a) Estimation Method of Design Flood

Runoff-function method by Dr. Seiichi Satho was applied for the estimation of probable flood. In the method, the direct flood discharge caused by rainfall of r (mm/hr) during a unit time (t_o hr),can be expressed by the following equations.

$$Q = 0.2778 \cdot A \cdot f \cdot r \cdot [e^{-at'}(at'+1) - e^{-at}(at+1)]$$
$$= 0.2778 \cdot A \cdot f \cdot r \cdot D$$
$$t' = t - t_o$$

Where;

A: catchment area (sq.km)
f: runoff coefficient
r: rainfall in unit time (t_o) for calculation
a: flood modulus definited by the following equation

$$a = 2.30 \log [t_p/(t_p-1)]$$

t_p : flood concentration time (hr) obtained by Luziha formula

$$t_p = L/(3{,}600V)$$
$$V = 20(H/L)^{0.6}$$

L: river length from the origin (m)
V: average velocity of river flow(m/sec)
H: height difference in the section of L (m)
D: distribution rate of discharge
t_o: unit time for calculation(=1.0 hr)

And the runoff caused by a long-term rainfall can be produced by synthesizing direct runoff in unit time expressed in the above equations.

b) Flood Concentration Time (tp) and Flood Modulus (a)

Flood concentration time for the each damsite which is obtained by Luziha formula and flood modulus computed are shown as follows;

Flood Concentration Time (tp) and Flood Modulus (a)

Project	River Length (km)	Elevation E_H (m)	Elevation E_L (m)	V (m/s)	t_p (hr)	a (hr^{-1})
Lam Se	6.0	196	174	0.69	2.4	0.538
Huai Khum Kham	12.0	208	155	0.77	4.3	0.264
Huai Kham Phak Wan	5.0	160	145	0.61	2.3	0.570
Huai Na Khai	7.7	168	125	0.89	2.4	0.538
Huai Soob	8.3	230	150	1.23	1.9	0.746

c) Design Rainfall

- Daily Arrangement of Design Rainfall

3-day consecutive rainfall and 1-day rainfall were used for the estimation of design flood with a return period of 500-year and 100-year respectively, then the former rainfall was arranged on a daily basis in the most critical pattern for the safety of dam as follows, taking into consideration lasting period of flood caused by a unit rainfall.

First day : (3-day rainfall less 2-day rainfall)
Second day : (2-day rainfall less 1-day rainfall)
Third day : (1-day rainfall)

Daily Arrangement of 3-day Consecutive Design Rainfall

(unit : mm)

Project	1st Day	2st Day	3rd Day	Total
Lam Se	3	50	301	354
Huai Khum Kham	14	82	362	458
Huai Kham Phak Wan	14	82	362	458
Huai Na Khai	70	103	304	477
Huai Soob	70	103	304	477

- Hourly Arrangement of Design Rainfall

For the estimation of hourly rainfall, the specific coefficient equation (β) obtained in the previous paragraph of A-2-1 was applied to the development of rainfall intensity equations for each project. The calculated results are as follows;

In the hourly arrangement of a maximum 1-day rainfall, central heading type's distribution was adopted , and for the other 2-day in a maximum 3-day consecutive rainfall, rear-heading type's one was adopted as shown in Figure A-7.

Rainfall Intensity Equations

(Unit : mm)

Project	R.P. = 100yrs.	R.P. = 500yrs.
Lam Se	264 / (t+1.5)	325 / (t+1.9)
Huai Khum Kham Huai Kham Phak Wan	298 / (t+1.5)	391 / (t+1.9)
Huai Na Khai Huai Soob	269 / (t+1.5)	328 / (t+1.9)

d) Design Flood at Proposed Dam Site

Design flood hydrograph with a return period of 500- and 100-year derived from the previously obtained unit hydrograph and rainfall are shown in Table A-6 and A-7, and Figure A-7 and A-8.

The other probable floods with the same runoff coefficient of peak discharge of design computed by the runoff-function method are obtained by the rational formula as shown in the next table.

Peak Discharge for Each Project

(Unit :cu.m/s)

Return Period (yrs)	Lam Se	Huai Khum Kham	Huai Kham Phak Wan	Huai Na Khai	Huai Soob
5	151	137	95	217	168
10	171	161	110	246	189
20	188	184	125	270	207
50	205	214	142	297	225
100	222	239	157	316	239
500	257	308	192	362	270

A-2-4. Design Sediment

There is no sediment data observed in the Sebai-Sebok basin. While, in the basin, there exist two medium scale irrigation projects under construction ; Huai Sabaek and Huai Ling Jhon. The design sediment yields of both dams are around 120 cu.m per sq.km per year.

Since the watershed areas are smaller than those of above projects, the design sediment yield of 150 cu.m per sq.km per year is adopted for each project and the useful life of each reservoir has been taken at 100 years in accordance with the criteria of above two reservoirs.

Design Sediment Yield of under-Construction Dam

Reservoir	Catchment Area (sq.km)	Dead Storage (MCM)	Sediment Yield (cu.m/s/sq.km/yr)
Huai Sabaek	49	0.6	122
Huai Ling Jhon	52	0.6	115

A-2-5. Water Quality

In the course of field survey, the water quality investigation of surface water at five proposed dam sites was carried out. The observed figures are as follws. As a result, there is no problem for irrigation use in terms of electric conductivity (EC) and pH.

Water Quality of Surface Water at Five Dam Sites

Project	Tur. (PPM)	EC (μ mho/cm)	pH	DO (PPM)	T (°C)
Standard	-	L.T.250	6.5-9.2	M.T.5	-
Lam Se	48	73	7.5	6.13	37.5
Huai Khum Kham	4	55	7.2	7.02	33.0
Huai Kham Phak Wan	45	35	8.1	8.91	37.5
Huai Na Khai	5	57	7.6	5.70	36.0
Huai Soob	2	35	6.9	5.68	30.5

(Note) Tur : Turbidity EC : Electric conductivity
DO : Dissolved oxygen T : Temperature
Sampling was made for period June 19 to June 22, 1989.

TABLE A-1 : CLIMATOLOGICAL DATA AT UBON RATCHATHANI

Station	UBON RATCHATHANI	Elevation of station above MSL	123 meters
Index Station	48407	Height of barometer above MSL	127 meters
Latitudes	15°15'N.	Height of thermometer above ground	1.50 meters
Longitude	104°52'E.	Hight of wind vane above ground	15.00 meters
		Height of raingauge	0.80 meters

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Pressure (+1000 or 900 mbs.)													
Mean	13.56	11.59	09.99	08.37	07.06	06.07	06.02	05.89	07.44	10.13	12.43	13.68	09.35
Ext. Max	25.20	23.32	23.28	20.56	14.63	13.35	13.45	13.73	16.13	18.36	21.46	23.45	25.20
Ext. Min.	03.41	01.05	00.99	98.90	99.82	96.15	96.57	97.33	97.46	01.35	01.75	04.14	96.15
Mean daily range	5.14	5.60	5.74	5.56	4.96	4.28	4.10	4.21	4.51	4.52	4.42	4.64	4.81
Temperature (°C)													
Mean	23.5	25.9	28.6	29.6	28.8	28.1	27.6	27.2	27.0	26.5	25.0	23.4	26.8
Mean Max	30.9	33.3	33.4	35.9	34.4	32.7	32.0	31.4	31.2	31.3	30.7	30.1	32.4
Mean Min.	16.8	19.4	22.4	24.3	24.6	24.4	24.1	23.9	23.7	22.4	20.0	17.6	22.0
Ext. Max	36.0	38.6	40.2	41.3	41.0	38.5	36.2	37.8	34.6	34.8	35.3	34.9	41.3
Ext. Min.	8.5	11.7	13.0	15.9	19.4	21.0	20.2	20.7	20.5	15.7	13.0	8.5	8.5
Relative Humidity (%)													
Mean	65.0	63.2	62.1	66.1	75.2	79.5	80.5	82.7	83.2	77.4	71.8	68.5	72.9
Mean Max	86.7	83.7	81.2	63.1	89.8	92.2	92.5	93.7	94.2	90.3	87.3	87.2	88.5
Mean Min.	41.1	40.8	41.3	45.8	55.6	62.3	64.5	66.9	67.3	60.4	53.1	47.1	53.9
Ext. Min.	22.0	23.0	20.0	21.0	32.0	37.0	47.0	46.0	42.0	30.0	26.0	25.0	20.0
Dew Point (°C)													
Mean	15.7	17.6	19.9	21.9	23.5	23.8	23.7	23.7	23.6	21.9	19.6	16.7	20.9
Evaporation (mm.)													
Mean - Pan	174.9	174.3	216.1	210.8	184.0	161.9	163.9	151.7	129.1	164.1	173.1	173.0	2076.9
Cloudiness (0-10)													
Mean	3.9	4.3	4.9	6.2	7.5	8.3	8.3	8.8	8.3	6.6	5.2	4.4	6.4
Sunshine Duration (hr.)													
Mean	292.5	261.3	269.6	257.2	244.3	194.4	201.5	170.5	165.2	233.8	260.8	269.0	2820.1
Visibility (km.)													
0700 L.S.T.	7.5	6.3	5.9	7.5	10.4	11.0	10.8	10.4	10.2	10.7	10.4	9.1	9.2
Mean	10.5	8.5	7.4	8.9	11.7	12.0	11.9	11.5	11.5	12.2	12.4	11.9	10.9
Wind (knots)													
Prevailing wind	NE	N	S	S	S	S	S	SW	S	N	NE	NE	-
Mean wind speed	3.7	3.2	3.1	3.0	3.1	3.8	3.9	4.0	2.6	3.9	5.7	5.1	-
Max. wind speed	32 NE	46 NE	42 W	56 SW	60 ENE	60 WSW ,W	41 WSW	68 S	46 E	55 NE	40 NE	50 NE	60 ENE, WSW, W
Rainfall (mm.)													
Mean	0.6	12.6	40.9	85.6	213.6	261.9	274.6	322.6	294.3	100.5	22.4	1.8	1631.4
Mean rainy days	0.4	1.3	3.6	7.5	15.2	18.5	19.6	22.2	20.1	10.8	3.6	0.7	123.5
Greatest in 24 hr.	4.8	62.0	124.1	100.2	138.5	189.4	203.9	141.1	130.3	113.4	71.8	8.2	203.9
Day / Year	27/64	27/85	14/60	12/78	18/56	4/72	7/70	18/70	5/68	9/67	5/64	15/66	7/70
Number of days with													
Haze	17.0	23.1	27.3	17.9	1.5	0.0	0.1	0.0	0.4	3.3	5.0	9.5	105.1
Fog	1.3	0.9	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.8	4.1
Hail	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thunderstorm	0.1	0.7	3.4	9.8	16.9	12.7	12.8	11.4	11.0	6.0	1.4	0.1	86.3
Squall	0.0	0.0	0.0	0.0	0.1	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.4

Remark : Evaporation 1962 - 1985

TABLE A-2 : METEOROLOGICAL STATION

STATION	CODE	PERIOD	MISSING
UBON RATCHATHANI PROVINCE			
A.MUANG	67013	1952-86	-
A.PHIBUN MANGSAHAN	67022	1955-86	-
A.AMNAT CHAROEN	67032	1952-86	1979-80
A.HUA TAPHAN	67042	1974-86	1974
A.KHEMARAT	67052	1952-86	-
A.KHUANG NAI	67062	1952-86	1966,84
A.WARIN CHAMRAP	67072	1952-86	1981-84
A.TRAKAN PHUTPHON	67082	1952-86	1966-67
A.UBON AGR. STATION	67092	1977-86	1977
HUAI MONG TANK	67102	1977-86	1978,83-84
A.SI MUANG MAI	67112	1952-86	1977,79
A.MUANG SAMSIP	67122	1952-86	-
A.CHANUMAN	67152	1959-86	1966-67,75
UBON SERICULTURAL ST.	67182	1959-86	1959,63
A.KHONG CHIAM	67192	1966-86	1966
A.PHANA	67202	1966-86	1966
LAM DOM NOI	67211	1979-86	1979
R.I.D. OFFICE UNIT 5	67220	1951-86	1968-69
HUAI PHO TANK	67230	1954-86	1954,69,76
NONG CHANG YAI TANK	67240	1955-86	1955,69,76,81
HUAI WANG DAENG TANK	67250	1957-86	1957,69
HUAI WANG NONG TANK	67260	1961-86	1961,78
SA SAMING TANK	67270	1961-86	1961,69
RONG NAMSAP TANK	67280	1961-86	1961,69
PHUTTHA UTTHAYAN TANK	67290	1962-86	1962,69,78
U.R.ANIMALS CONSER.	67302	1970-86	-
HUAI PHO TANK (LOWER)	67390	1982	1982 (HALTED)
LAM DOM YAI SELF-S.S.	67402	1984-86	-
YASOTHON PROVINCE			
A.MUANG	72012	1952-78	1979-86
A.KHAM KHUAN KAEO	72022	1952-86	-
A.MAHA CHANA CHAI	72032	1952-86	1965-66
LOENG NOK THA	72042	1952-86	-
A.KUT CHUM	72052	1970-86	1970
PHA YAT	72061	1976-86	1976
A.PA THIU	72072	1976-86	1976
A.KHO WANG	72082	1984-86	-
A.SAI MUN	72092	1985-86	1985

TABLE A-3 : MONTHLY RAINFALL OVER THE CATCHMENT AREA AND SERVICE AREA (1/2)

Rainfall over the Watershed Area and Service Area of Lam Se (BO-5)

Rainfall Station : Loeng Nok Tha (72042)

Year	Apr. (mm)	May (mm)	Jun. (mm)	Jul. (mm)	Aug. (mm)	Sep. (mm)	Oct. (mm)	Nov. (mm)	Dec. (mm)	Jan. (mm)	Feb. (mm)	Mar. (mm)	Total (mm)
1968	16.2	223.0	170.0	106.3	529.5	427.3	76.0	0.0	0.0	0.0	0.0	60.5	1,608.8
1969	39.5	180.0	230.0	383.0	79.0	324.5	134.0	0.0	0.0	0.0	0.0	0.0	1,370.0
1970	33.0	332.0	263.0	289.0	465.5	167.0	0.0	0.0	0.0	0.0	0.0	0.0	1,549.5
1971	0.0	250.5	395.5	530.0	310.0	291.5	0.0	0.0	0.0	0.0	28.0	13.0	1,818.5
1972	63.0	63.5	202.0	400.0	293.0	168.0	194.0	0.0	0.0	0.0	15.5	23.5	1,422.5
1973	0.0	224.2	247.2	333.2	287.7	270.0	0.0	0.0	0.0	70.0	0.0	45.5	1,477.8
1974	98.5	294.5	127.5	307.5	643.5	147.5	73.0	0.0	0.0	33.0	48.0	0.0	1,773.0
1975	53.5	252.5	342.5	252.0	286.5	212.5	139.0	0.0	0.0	0.0	0.0	0.0	1,538.5
1976	122.5	132.5	120.5	590.5	339.0	271.5	38.0	0.0	0.0	0.0	0.0	81.5	1,614.5
1977	34.0	202.5	161.5	156.7	352.4	304.1	29.5	0.0	0.0	0.0	0.0	0.0	1,322.2
1978	44.0	280.2	222.2	320.0	523.4	516.5	44.3	0.0	0.0	0.0	0.0	0.0	1,950.6
1979	84.6	227.6	428.0	281.5	377.9	362.0	0.0	0.0	0.0	0.0	0.0	0.0	1,761.6
1980	63.3	191.1	244.7	289.6	342.8	407.0	60.7	0.0	0.0	0.0	0.0	0.0	1,599.2
1981	79.1	170.6	503.7	448.3	476.5	24.4	233.3	25.0	0.0	0.0	0.0	60.5	2,021.4
1982	39.0	298.6	210.2	114.4	380.2	402.9	110.0	38.8	0.0	5.0	0.0	6.5	1,605.6
1983	72.1	96.2	356.4	139.8	411.6	193.4	226.0	0.0	0.0	0.0	0.0	25.3	1,520.8
1984	119.9	271.4	192.0	272.2	373.9	266.6	98.5	53.7	0.0	12.9	15.9	0.0	1,676.1
1985	93.7	162.8	500.4	231.9	331.9	240.9	121.9	0.0	0.0	0.0	0.0	6.0	1,689.5
1986	70.9	383.5	271.0	291.5	561.1	122.0	142.6	8.0	8.0	0.0	7.0	12.2	1,877.8
1987	65.8	135.9	462.6	142.1	411.1	373	16.5	21.6	0	0	0.8	0	1,629.4
Ave.	59.6	218.7	282.5	294.0	388.8	274.6	86.9	7.4	0.4	6.0	5.8	16.7	1,641.4

Rainfall over the Watershed Area and Service Area of Huai Khum Kham (BO-11) and Huai Kham Phak Na (BO-13)

Rainfall Station : Trakhan Phutaphon (67082)

Year	Apr. (mm)	May (mm)	Jun. (mm)	Jul. (mm)	Aug. (mm)	Sep. (mm)	Oct. (mm)	Nov. (mm)	Dec. (mm)	Jan. (mm)	Feb. (mm)	Mar. (mm)	Total (mm)
1968	76.8	132.5	178.9	209.1	272.3	364.8	64.1	0.0	0.3	0.0	8.8	41.0	1,348.6
1969	18.8	305.0	295.5	208.1	210.4	332.9	117.3	0.0	0.0	0.0	0.0	3.1	1,491.1
1970	35.8	249.2	258.1	256.9	561.4	246.9	32.3	4.2	4.7	0.0	2.5	0.0	1,652.0
1971	59.4	105.3	263.3	441.3	207.8	165.1	71.8	1.0	0.0	0.0	20.2	20.3	1,355.5
1972	76.4	44.9	381.4	370.4	430.7	193.3	201.4	27.3	6.2	0.0	10.9	1.5	1,744.4
1973	24.3	323.8	245.8	233.5	322.3	201.0	14.6	0.5	0.0	0.0	0.0	5.2	1,371.0
1974	93.7	175.8	277.8	243.5	488.8	197.2	94.8	23.6	2.8	16.8	5.4	6.2	1,626.4
1975	28.6	338.8	590.8	227.6	351.8	309.0	158.0	35.6	0.0	0.0	0.0	15.4	2,055.6
1976	104.4	351.9	190.5	598.1	322.5	185.5	84.8	0.0	0.0	0.0	0.0	19.6	1,856.4
1977	77.4	111.2	66.4	239.6	342.5	637.1	10.3	0.0	4.6	0.0	6.2	47.4	1,602.7
1978	165.6	162.7	223.6	374.8	796.1	382.0	77.6	0.0	0.0	0.0	9.0	13.6	2,205.0
1979	78.1	567.1	583.9	146.7	441.9	378.1	0.0	0.0	0.0	0.0	0.0	71.1	2,266.9
1980	54.2	313.3	416.1	327.9	297.2	280.7	68.6	12.4	0.0	0.0	7.8	8.1	1,786.3
1981	126.6	220.7	250.5	291.4	582.4	48.3	153.7	0.0	0.0	0.0	0.0	0.0	1,673.6
1982	31.1	214.4	171.3	102.3	315.1	487.0	157.8	89.5	0.0	0.0	0.0	0.0	1,568.5
1983	13.2	123.0	384.5	186.3	408.0	291.3	155.5	6.2	0.0	0.0	0.0	70.3	1,638.3
1984	109.6	251.2	145.4	357.3	624.8	142.9	118.4	79.6	0.0	4.6	21.8	39.8	1,895.4
1985	114.2	219.9	349.5	223.2	409.1	291.3	150.5	0.0	0.0	0.0	8.6	21.1	1,787.4
1986	80.8	315.0	209.2	230.2	340.9	154.5	203.6	4.6	3.8	0.0	0.0	0.0	1,543.3
1987	54.0	85.7	424.6	409.3	396.1	377.9	35.1	23.2	0.0	0.0	3.5	0.0	1,809.4
Ave.	71.2	230.5	295.4	283.9	406.1	286.3	98.5	15.4	1.1	1.1	5.2	19.2	1,713.9

Rainfall over the Watershed Area of Huai Na Khai (BO-18) and Huai Soob (TL-6) and Rainfall over the Service Area of TL-6

Rainfall Station : Si Muang Mai (67112)

Year	Apr. (mm)	May (mm)	Jun. (mm)	Jul. (mm)	Aug. (mm)	Sep. (mm)	Oct. (mm)	Nov. (mm)	Dec. (mm)	Jan. (mm)	Feb. (mm)	Mar. (mm)	Total (mm)
1968	54.1	147.5	281.4	303.8	439.9	577.3	49.8	0.0	0.0	0.0	0.0	5.0	1,858.8
1969	31.0	259.5	260.9	581.8	198.4	368.1	61.0	0.0	0.0	0.0	0.0	27.8	1,788.5
1970	83.1	252.3	452.4	241.2	483.8	184.7	28.2	3.5	1.9	0.0	0.0	55.9	1,787.0
1971	82.5	158.6	321.0	339.1	325.9	153.1	23.6	0.0	0.0	0.0	56.4	37.3	1,497.5
1972	96.3	112.1	412.7	240.0	240.6	92.5	206.0	37.4	0.0	0.0	29.8	0.0	1,467.4
1973	48.4	349.2	265.0	321.5	246.8	268.0	21.5	2.7	0.0	0.0	5.2	9.8	1,538.1
1974	86.1	264.4	182.9	314.7	360.8	118.7	42.4	46.1	0.0	28.7	7.2	0.0	1,452.0
1975	11.0	234.0	383.9	229.8	292.0	331.9	170.2	34.8	17.9	0.0	0.0	9.9	1,715.5
1976	130.9	134.0	247.9	229.7	193.1	244.3	83.8	0.0	0.0	0.0	0.0	0.0	1,263.7
1977	88.7	56.9	234.1	372.0	312.4	487.8	21.1	0.0	0.0	0.0	0.0	0.0	1,573.0
1978	91.3	44.6	125.4	400.3	852.7	207.0	16.5	0.0	0.0	0.0	8.4	13.8	1,760.0
1979	17.3	119.9	885.6	72.6	516.9	499.7	0.0	0.0	0.0	0.0	0.0	3.5	2,115.5
1980	0.0	135.3	327.6	292.2	318.8	307.5	108.9	12.7	0.0	0.0	49.0	0.0	1,602.0
1981	76.3	437.6	409.8	132.3	250.4	26.6	66.3	0.0	0.0	0.0	0.0	5.3	1,404.6
1982	0.0	22.9	186.3	241.0	381.3	334.0	0.0	0.0	0.0	0.0	0.0	0.0	1,165.5
1983	28.9	239.1	392.7	312.7	318.8	177.7	195.3	2.4	0.0	0.0	0.0	16.2	1,683.8
1984	128.9	324.1	251.8	293.6	722.6	336.7	137.7	37.1	0.0	15.4	98.2	11.9	2,358.0
1985	160.0	174.3	342.4	241.5	430.2	83.4	125.8	19.3	0.0	0.0	0.0	15.5	1,592.4
1986	40.9	322.5	242.9	372.3	553.3	266.7	152.1	15.6	0.0	0.0	0.0	15.3	1,981.6
1987	64.5	72.3	271.2	485.1	450.8	277.6	126	51.6	0	0	0	0	1,799.1
Ave.	66.0	195.6	323.9	300.9	394.5	267.2	81.8	13.2	1.0	2.2	12.7	11.4	1,670.2

TABLE A-3 : MONTHLY RAINFALL OVER THE CATCHMENT AREA AND SERVICE AREA (2/2)

Rainfall over the Service Area of 80-18

Rainfall Station : Sa-Saming (67270)

Year	Apr. (mm)	May (mm)	Jun. (mm)	Jul. (mm)	Aug. (mm)	Sep. (mm)	Oct. (mm)	Nov. (mm)	Dec. (mm)	Jan. (mm)	Feb. (mm)	Mar. (mm)	Total (mm)
1968	74.3	124.5	192.0	155.2	444.7	485.0	46.9	8.3	0.0	0.0	9.9	47.6	1,588.4
1969	59.8	245.8	304.5	374.5	186.6	443.2	65.9	0.8	0.0	0.0	0.0	1.6	1,682.7
1970	32.9	140.1	343.2	176.5	464.8	101.6	32.0	19.1	10.4	0.0	0.0	0.2	1,320.8
1971	26.1	155.5	264.8	360.9	320.7	247.8	69.1	0.0	0.7	0.0	7.1	12.0	1,464.7
1972	37.6	77.1	313.6	434.7	400.1	154.7	69.2	40.0	29.3	0.0	0.0	0.0	1,556.3
1973	39.4	284.3	215.7	261.7	200.9	218.2	17.5	2.2	0.0	0.0	4.2	8.0	1,252.1
1974	217.9	279.5	284.6	299.8	378.0	234.5	158.8	32.0	5.4	39.1	11.5	38.3	1,979.4
1975	11.1	235.1	385.7	230.9	293.4	333.4	171.0	35.0	18.0	0.0	0.0	9.9	1,723.5
1976	100.7	258.1	307.2	318.5	333.8	238.3	76.3	0.0	0.0	0.0	0.0	24.8	1,657.7
1977	40.5	26.0	106.9	197.3	318.3	587.9	10.8	0.0	2.5	0.7	1.5	52.9	1,345.3
1978	57.2	81.4	201.2	350.5	584.9	496.4	136.6	44.5	0.0	0.0	0.0	0.0	1,952.7
1979	98.2	320.7	753.8	72.6	555.0	311.7	0.0	0.0	0.0	0.0	7.4	2.3	2,121.7
1980	56.4	215.6	240.2	318.7	256.7	330.3	63.0	27.5	0.0	0.0	11.2	16.3	1,535.9
1981	92.6	340.6	413.1	219.6	552.6	82.8	129.6	20.0	0.0	0.0	0.0	0.0	1,850.9
1982	55.2	189.9	242.3	235.9	246.9	504.2	212.4	41.3	0.0	0.0	0.0	0.0	1,728.1
1983	28.1	232.7	382.2	304.3	310.3	173.0	190.1	2.3	0.0	0.0	0.0	15.8	1,638.8
1984	164.0	209.3	118.2	317.3	662.5	223.9	156.7	37.3	0.0	18.5	101.5	8.3	2,017.5
1985	153.7	173.0	348.1	179.2	468.3	277.1	133.6	13.0	0.0	0.0	0.0	14.0	1,760.0
1986	40.0	256.3	175.2	190.8	673.6	298.0	230.8	0.0	0.0	0.0	0.0	0.0	1,864.7
1987	27.5	104.9	210.8	285.4	398.2	287.1	41.4	62.6	0.0	0.0	0.0	0.0	1,417.9
Ave.	70.7	197.5	290.2	264.2	402.5	301.5	100.6	19.3	3.3	2.9	7.7	12.6	1,673.0

TABLE A-4 : ANNUAL RUNOFF COEFFICIENT

WATER YEAR	A.32 (WA=1654sq.km)			A.32A (WA=1535sq.km)			A.59 (WA=2132sq.km)		
	ANNUAL① RAINFALL (MM)	ANNUAL RUNOFF (MM)	RUNOFF COEFFI-CIENT(%)	ANNUAL② RAINFALL (MM)	ANNUAL RUNOFF (MM)	RUNOFF COEFFI-CIENT(%)	ANNUAL③ RAINFALL (MM)	ANNUAL RUNOFF (MM)	RUNOFF COEFFI-CIENT(%)
1965	1337	317	24	-	-	-	-	-	-
1966	1737	562	32	-	-	-	-	-	-
1967	1188	215	18	-	-	-	-	-	-
1968	1445	306	21	1450	365	25	-	-	-
1969	1357	322	24	1357	314	23	-	-	-
1970	1483	406	27	1488	362	24	-	-	-
1971	1727	525	30	1731	-	-	1173	596	51
1972	1393	401	29	1392	330	24	1417	-	-
1973	1323	268	20	-	-	-	1048	233	22
1974	1678	525	31	-	-	-	1637	530	32
1975	1547	649	42	-	-	-	1622	870	54
1976	1472	-	-	-	-	-	1532	745	49
1977	1467	-	-	-	-	-	1484	451	30
1978	1845	793	43	-	-	-	1888	1132	60
1979	1652	-	-	-	-	-	2063	971	47
1980	1598	513	32	-	-	-	1844	983	53
1981	1719	532	31	-	-	-	1582	537	34
1982	1469	427	29	-	-	-	1527	561	37
1983	1416	-	-	-	-	-	1360	600	44
1984	1537	423	28	-	-	-	1705	519	30
1985	1576	550	35	-	-	-	1560	546	35
1986	1615	-	-	-	-	-	1475	351	24
AVE.	1527	455	30	1422	343	24	1567	642	41

(NOTES)

① Areal rainfall = 0.58 x (72042) + 0.09 x (72052) + 0.09 x (72072) +0.24 x (67032)

② Areal rainfall = 0.63 x (72042) + 0.08 x (72052) + 0.04 x (72072) +0.25 x (67032)

③ Areal rainfall = 0.18 x (67032) + 0.10 x (67042) + 0.01 x (67052) +0.07 x (67082)
+ 0.18 x (67122) + 0.41 x (67202) + 0.05 x (67272)

WATER YEAR	A.132 (WA = 101sq.km)			A.141 (WA = 382sq.km)			A.127 (WA = 414sq.km)		
	ANNUAL④ RAINFALL (MM)	ANNUAL RUNOFF (MM)	RUNOFF COEFFI-CIENT(%)	ANNUAL⑤ RAINFALL (MM)	ANNUAL RUNOFF (MM)	RUNOFF COEFFI-CIENT(%)	ANNUAL⑥ RAINFALL (MM)	ANNUAL RUNOFF (MM)	RUNOFF COEFFI-CIENT(%)
1986	1545	390	25	-	-	-	-	-	-
1987	-	-	-	1808	839	46	1794	649	36
AVE.	1545	390	25	1808	839	46	1794	649	36

(NOTES)

④ Spot rainfall = 1.00 x (67082)

⑤ Spot rainfall = 1.00 x (67082)

⑥ Areal rainfall = 0.68 x (67202) + 0.24 x (67082) + 0.08 x (67052)

TABLE A-5 : ESTIMATED MONTHLY RUNOFF (1/3)

Monthly Runoff at Lam Se Damsite W.A.= 22.4 sq.km

(MCM)

Month	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Apr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
May	0.000	0.000	0.019	0.003	0.000	0.002	0.006	0.001	0.000	0.001
Jun	0.027	0.002	2.109	2.928	0.008	0.057	0.665	2.146	0.000	0.000
Jul	0.000	2.808	2.177	6.576	1.057	1.818	2.029	2.111	3.132	0.002
Aug	7.018	0.208	5.358	3.924	4.371	2.915	8.424	2.699	7.543	2.966
Sep	4.194	3.182	2.745	2.489	4.609	4.609	3.623	3.196	3.416	5.001
Oct	0.341	0.913	0.193	1.734	1.449	0.421	0.361	1.081	0.826	0.135
Nov	0.000	0.003	0.000	0.005	0.011	0.000	0.000	0.011	0.003	0.000
Dec	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	14.483	8.129	13.028	17.915	9.384	9.823	15.108	11.245	14.921	8.105

(MCM)

Month	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Average
Apr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
May	0.013	0.025	0.000	0.000	0.034	0.000	0.004	0.000	1.090	0.000	0.060
Jun	0.196	2.539	0.071	4.070	0.140	0.731	0.186	4.114	2.040	0.686	1.136
Jul	1.529	2.781	0.924	5.118	0.005	0.623	1.657	1.041	2.516	2.386	2.015
Aug	8.793	6.169	3.997	7.105	4.654	4.662	4.246	4.756	7.465	5.114	5.119
Sep	8.018	4.483	7.346	0.634	5.812	2.340	4.474	3.383	3.708	6.424	4.180
Oct	1.182	0.579	0.419	1.609	0.918	3.094	0.673	0.651	0.382	0.237	0.855
Nov	0.008	0.000	0.002	0.021	0.007	0.005	0.035	0.008	0.015	0.000	0.007
Dec	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	19.739	16.576	12.760	18.557	11.569	11.456	11.196	13.952	17.216	14.847	13.496

Monthly Runoff at Huai Khum Khan Damsite W.A.= 36.8 sq.km

(MCM)

Month	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Apr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
May	0.000	0.009	0.000	0.000	0.000	0.057	0.000	0.054	1.328	0.000
Jun	0.000	3.738	0.252	0.640	0.253	2.493	0.984	11.121	1.798	0.000
Jul	0.000	1.067	3.593	5.056	4.228	1.326	1.021	3.196	9.715	0.031
Aug	3.421	3.075	13.502	4.649	12.260	5.427	12.363	6.761	9.496	5.109
Sep	8.979	5.698	2.840	4.788	4.555	4.555	3.904	8.078	3.999	20.259
Oct	0.473	0.674	0.561	1.277	2.307	0.422	1.922	3.292	0.999	0.569
Nov	0.000	0.030	0.002	0.001	0.058	0.000	0.004	0.075	0.010	0.000
Dec	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	12.874	16.841	23.609	13.862	23.895	14.280	20.198	32.577	27.346	25.968

(MCM)

Month	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Average
Apr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
May	0.000	6.454	0.030	0.000	0.001	0.000	0.001	0.005	0.057	0.000	0.480
Jun	0.021	11.337	5.768	0.845	0.003	1.781	0.075	4.324	2.036	1.632	2.425
Jul	1.593	2.847	4.337	2.754	0.000	2.530	1.214	2.315	1.595	6.177	2.730
Aug	22.953	10.497	6.316	15.997	3.247	9.375	15.137	7.743	5.620	10.006	9.148
Sep	11.288	8.746	7.695	1.152	12.153	5.092	6.528	8.098	4.151	10.414	7.149
Oct	1.273	1.031	0.621	0.947	1.562	3.474	0.811	1.131	1.162	0.730	1.262
Nov	0.038	0.003	0.015	0.004	0.613	0.024	0.244	0.023	0.028	0.008	0.059
Dec	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	37.165	40.915	24.782	21.699	17.579	22.275	24.009	23.639	14.649	28.966	23.346

TABLE A-5 : ESTIMATED MONTHLY RUNOFF (2/3)

Monthly Runoff at Huai Kham Phak Wan Damsite W.A.= 13.5 sq.km

(MCM)

Month	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Apr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
May	0.000	0.003	0.000	0.000	0.000	0.021	0.000	0.020	0.487	0.000
Jun	0.000	1.371	0.093	0.015	0.093	0.915	0.361	4.080	0.660	0.000
Jul	0.000	0.391	1.318	1.855	1.551	0.487	0.375	1.173	3.564	0.011
Aug	1.255	1.128	4.953	1.705	4.498	1.991	4.535	2.480	3.483	1.874
Sep	3.294	2.090	1.042	1.757	1.671	1.671	1.432	2.963	1.467	7.432
Oct	0.173	0.247	0.206	0.468	0.846	0.155	0.705	1.208	0.367	0.209
Nov	0.000	0.011	0.001	0.000	0.021	0.000	0.001	0.027	0.004	0.000
Dec	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	4.723	6.105	8.661	5.085	8.766	5.239	7.410	11.951	10.032	9.526

(MCM)

Month	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Average
Apr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
May	0.000	2.368	0.011	0.000	0.001	0.000	0.000	0.002	0.021	0.000	0.147
Jun	0.008	4.159	2.116	0.310	0.001	0.653	0.028	1.586	0.747	0.599	0.890
Jul	0.584	1.944	1.591	1.910	0.000	0.928	0.445	0.849	0.585	2.266	1.001
Aug	3.420	3.851	2.317	5.868	1.191	3.439	5.553	2.841	2.062	3.671	3.356
Sep	4.141	3.208	2.823	0.423	4.458	1.868	2.395	2.971	1.523	3.820	2.622
Oct	0.467	0.378	0.228	0.348	0.573	1.274	0.298	0.415	0.426	0.268	0.463
Nov	0.014	0.001	0.005	0.001	0.225	0.009	0.089	0.008	0.010	0.003	0.022
Dec	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	13.634	15.809	9.091	7.960	6.449	8.172	8.808	8.672	5.374	10.626	8.565

Monthly Runoff at Huai Na Khai Damsite W.A.= 31.3 sq.km

(MCM)

Month	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Apr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
May	0.001	0.000	0.016	0.002	0.000	0.038	0.007	0.003	0.001	0.000
Jun	0.001	0.732	5.486	0.432	4.224	3.080	0.196	2.251	0.030	0.000
Jul	1.141	9.804	3.130	3.484	0.742	3.900	3.972	2.611	0.939	4.735
Aug	10.849	3.783	8.857	6.076	4.764	2.087	8.627	3.940	3.229	4.344
Sep	13.879	3.354	2.593	0.363	6.035	6.035	1.431	7.761	4.172	12.371
Oct	0.000	0.575	0.478	0.530	0.171	2.067	0.513	2.470	0.427	0.292
Nov	0.003	0.007	0.004	0.000	0.002	0.000	0.000	0.036	0.000	0.000
Dec	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	26.448	23.315	21.377	12.757	12.163	15.654	13.779	19.070	8.797	21.743

(MCM)

Month	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Average
Apr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
May	0.000	0.000	0.000	1.960	0.000	0.005	0.744	0.063	0.029	0.000	0.143
Jun	0.000	11.589	0.105	6.769	0.000	3.256	3.231	3.064	2.431	0.009	2.344
Jul	1.655	3.360	2.752	0.917	0.015	5.144	2.083	1.712	3.805	5.977	3.049
Aug	21.196	10.595	5.380	4.081	5.640	6.662	14.719	7.828	11.452	10.188	7.715
Sep	3.890	10.305	7.096	0.219	7.959	2.104	10.749	2.004	7.037	6.772	5.806
Oct	0.868	0.953	0.750	0.027	0.354	2.297	1.234	0.754	1.315	1.439	0.876
Nov	0.004	0.002	0.013	0.000	0.000	0.034	0.049	0.002	0.039	0.023	0.011
Dec	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	27.614	36.805	16.096	13.972	13.969	19.501	32.809	15.429	26.107	24.408	20.091

TABLE A-5 : ESTIMATED MONTHLY RUNOFF (3/3)

Monthly Runoff at Huai Soob Damsite W.A.= 31.3 sq.km

(MCM)

Month	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Apr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
May	0.001	0.000	0.016	0.002	0.000	0.038	0.007	0.003	0.001	0.000
Jun	0.001	0.732	5.486	0.432	4.224	3.080	0.196	2.251	0.030	0.000
Jul	1.141	9.804	3.130	3.484	0.742	3.900	3.072	2.611	0.939	4.735
Aug	10.849	3.783	8.857	6.076	4.764	2.087	0.627	3.940	3.229	4.344
Sep	13.879	3.354	2.593	0.363	6.035	6.035	1.431	7.761	4.172	12.371
Oct	0.000	0.575	0.478	0.530	0.171	2.067	0.513	2.470	0.427	0.292
Nov	0.003	0.007	0.004	0.000	0.002	0.000	0.000	0.036	0.000	0.000
Dec	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	26.448	23.315	21.377	12.757	12.163	15.654	13.779	19.070	8.797	21.743

(MCM)

Month	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Average
Apr	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
May	0.000	0.000	0.000	1.960	0.000	0.085	0.744	0.063	0.029	0.000	0.143
Jun	0.000	11.589	0.185	6.769	0.000	3.256	3.231	3.064	2.431	0.009	2.344
Jul	1.655	3.360	2.752	0.917	0.015	5.144	2.083	1.712	3.805	5.977	3.049
Aug	21.196	10.595	5.380	4.081	5.640	6.662	14.719	7.828	11.452	10.188	7.715
Sep	3.890	10.305	7.096	0.219	7.959	2.164	10.749	2.004	7.037	6.772	5.806
Oct	0.868	0.953	0.750	0.027	0.354	2.297	1.234	0.754	1.315	1.439	0.876
Nov	0.004	0.002	0.013	0.000	0.000	0.034	0.049	0.002	0.039	0.023	0.011
Dec	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Feb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	27.614	36.805	16.096	13.972	13.969	19.581	32.809	15.429	26.107	24.408	20.091

TABLE A-6 : HYDROGRAPH OF DESIGN FLOOD WITH A RETURN PERIOD OF 500-YEAR (1/2)

BA-5: Lae So

Unit- hydrograph

Time (hr)	Distribution Rate
0	0.000
1	0.102
2	0.190
3	0.187
4	0.154
5	0.116
6	0.083
7	0.057
8	0.039
9	0.026
10	0.017
11	0.011
12	0.007
13	0.004
14	0.003
15	0.002
16	0.001
17	0.001

Design Flood (R.P.= 500yrs.)

Time (hr)	Rainfall (mm)	Discharge (cms)
1	0.0	0.000
2	0.0	0.000
3	0.0	0.000
4	0.0	0.000
5	0.0	0.000
6	0.0	0.000
7	0.0	0.000
8	0.0	0.000
9	0.0	0.000
10	0.0	0.000
11	0.0	0.000
12	0.0	0.000
13	0.1	0.063
14	0.1	0.182
15	0.1	0.298
16	0.1	0.394
17	0.1	0.466
18	0.1	0.518
19	0.1	0.553
20	0.2	0.641
21	0.2	0.775
22	0.3	0.966
23	0.5	1.314
24	1.1	2.124
25	0.1	2.581
26	0.2	2.462
27	0.2	2.213
28	0.2	1.959
29	0.2	1.750
30	0.2	1.590
31	0.2	1.480
32	0.3	1.463
33	0.3	1.528
34	0.3	1.671
35	0.4	1.861
36	0.5	2.097
37	0.6	2.420
38	0.7	2.819
39	0.8	3.283
40	0.9	3.799
41	1.2	4.473
42	1.5	5.413
43	1.9	6.665
44	2.5	8.365
45	3.6	10.886
46	5.4	14.879
47	9.1	21.826
48	18.6	36.230
49	1.0	43.722
50	1.1	39.853
51	1.3	32.986
52	1.6	26.517
53	2.0	21.700
54	2.6	18.826
55	3.4	17.966
56	4.8	19.094
57	7.0	22.727
58	11.3	30.290
59	21.4	46.184
60	54.6	87.689
61	112.1	181.963
62	32.3	252.528
63	15.2	256.785
64	8.8	226.323
65	5.7	184.194
66	4.0	143.028
67	3.0	107.879
68	2.3	80.396
69	1.8	59.275
70	1.5	43.533
71	1.2	32.030
72	1.0	23.632
73	0.0	17.027
74	0.0	12.163
75	0.0	8.327
76	0.0	5.464
77	0.0	3.614
78	0.0	1.778
79	0.0	1.188
80	0.0	0.723
81	0.0	0.439
82	0.0	0.264
83	0.0	0.157
84	0.0	0.091
85	0.0	0.054
86	0.0	0.029
87	0.0	0.014
88	0.0	0.060

BQ-11: Huai Khum Khan

Unit- hydrograph

Time (hr)	Distribution Rate
0	0.000
1	0.029
2	0.070
3	0.090
4	0.096
5	0.095
6	0.090
7	0.081
8	0.072
9	0.063
10	0.054
11	0.046
12	0.039
13	0.032
14	0.027
15	0.022
16	0.018
17	0.015
18	0.012
19	0.010
20	0.008
21	0.006
22	0.005
23	0.004
24	0.003
25	0.003
26	0.002
27	0.002
28	0.001
29	0.001
30	0.001
31	0.001
32	0.001
33	0.001

Design Flood (R.P.= 500yrs.)

Time (hr)	Rainfall (mm)	Discharge (cms)
1	0.0	0.000
2	0.0	0.000
3	0.1	0.030
4	0.1	0.101
5	0.1	0.193
6	0.1	0.291
7	0.1	0.388
8	0.1	0.480
9	0.1	0.563
10	0.1	0.637
11	0.1	0.701
12	0.1	0.756
13	0.2	0.833
14	0.2	0.945
15	0.2	1.069
16	0.3	1.225
17	0.3	1.416
18	0.4	1.648
19	0.5	1.945
20	0.7	2.351
21	1.0	2.940
22	1.5	3.828
23	2.5	5.271
24	5.2	8.919
25	0.2	10.604
26	0.3	11.664
27	0.3	11.796
28	0.3	11.443
29	0.4	10.830
30	0.4	10.061
31	0.5	9.352
32	0.5	8.710
33	0.6	8.156
34	0.6	7.732
35	0.7	7.424
36	0.8	7.232
37	0.9	7.233
38	1.1	7.373
39	1.3	7.735
40	1.6	8.347
41	1.9	9.212
42	2.4	10.436
43	3.1	12.107
44	4.1	14.439
45	5.8	17.825
46	8.8	22.944
47	14.9	31.396
48	30.5	47.572
49	1.2	62.708
50	1.4	68.807
51	1.6	69.323
52	2.0	67.157
53	2.5	63.614
54	3.1	59.393
55	4.1	55.220
56	5.7	53.609
57	8.4	53.209
58	13.6	56.374
59	25.7	66.298
60	65.7	94.504
61	134.8	163.125
62	38.9	248.855
63	18.2	288.307
64	10.6	307.731
65	6.9	307.994
66	4.8	295.235
67	3.6	273.100
68	2.8	247.677
69	2.2	221.866
70	1.8	194.359
71	1.5	169.286
72	1.2	146.231
73	0.0	124.357
74	0.0	105.463
75	0.0	88.001
76	0.0	73.352
77	0.0	61.008
78	0.0	50.154
79	0.0	41.270
80	0.0	33.320
81	0.0	26.343
82	0.0	21.410
83	0.0	17.252
84	0.0	13.929
85	0.0	11.728
86	0.0	9.222
87	0.0	7.566
88	0.0	5.583
89	0.0	4.755
90	0.0	4.233
91	0.0	3.812
92	0.0	3.361
93	0.0	2.566
94	0.0	1.101
95	0.0	0.644
96	0.0	0.42
97	0.0	0.281
98	0.0	0.195
99	0.0	0.134
100	0.0	0.097
101	0.0	0.068
102	0.0	0.046
103	0.0	0.028
104	0.0	0.012

BQ-13: Huai Khum Phak Wan

Unit- hydrograph

Time (hr)	Distribution Rate
0	0.000
1	0.112
2	0.203
3	0.194
4	0.155
5	0.113
6	0.078
7	0.052
8	0.034
9	0.022
10	0.014
11	0.009
12	0.005
13	0.003
14	0.002
15	0.001
16	0.001
17	0.001
18	0.001

Design Flood (R.P.= 500yrs.)

Time (hr)	Rainfall (mm)	Discharge (cms)
1	0.0	0.000
2	0.0	0.000
3	0.1	0.042
4	0.1	0.118
5	0.1	0.191
6	0.1	0.249
7	0.1	0.291
8	0.1	0.321
9	0.1	0.340
10	0.1	0.353
11	0.1	0.361
12	0.1	0.366
13	0.2	0.412
14	0.2	0.490
15	0.2	0.564
16	0.3	0.665
17	0.3	0.783
18	0.4	0.928
19	0.5	1.124
20	0.7	1.412
21	1	1.859
22	1.5	2.568
23	2.5	3.791
24	5.2	6.360
25	0.2	7.566
26	0.3	6.711
27	0.3	5.388
28	0.3	4.154
29	0.4	3.225
30	0.4	2.603
31	0.5	2.241
32	0.5	2.059
33	0.6	2.007
34	0.6	2.036
35	0.7	2.117
36	0.8	2.287
37	0.9	2.521
38	1.1	2.840
39	1.3	3.278
40	1.6	3.847
41	1.9	4.559
42	2.4	5.468
43	3.1	6.724
44	4.1	8.469
45	5.8	11.042
46	8.8	15.143
47	14.9	22.380
48	30.5	37.557
49	1.2	44.575
50	1.4	39.377
51	1.6	31.391
52	2	24.171
53	2.5	18.908
54	3.1	15.668
55	4.1	14.312
56	5.7	14.766
57	8.4	17.285
58	13.6	22.948
59	25.7	35.067
60	65.7	67.328
61	134.8	140.413
62	38.9	192.278
63	18.2	191.604
64	10.6	165.091
65	6.9	131.265
66	4.8	99.469
67	3.6	73.422
68	2.8	53.522
69	2.2	38.871
70	1.8	28.259
71	1.5	20.651
72	1.2	15.011
73	0.0	10.795
74	0.0	7.487
75	0.0	5.022
76	0.0	3.540
77	0.0	2.536
78	0.0	1.716
79	0.0	0.854
80	0.0	0.490
81	0.0	0.298
82	0.0	0.173
83	0.0	0.103
84	0.0	0.064
85	0.0	0.040
86	0.0	0.025
87	0.0	0.017
88	0.0	0.010
99	0.0	0.005

TABLE A-6 : HYDROGRAPH OF DESIGN FLOOD WITH A RETURN PERIOD OF 500-YEAR (2/2)

BO-18: Huai Na Khai

Unit- hydrograph

Time (hr)	Distribution Rate
0	0.008
1	0.102
2	0.19
3	0.187
4	0.154
5	0.116
6	0.083
7	0.057
8	0.039
9	0.026
10	0.017
11	0.011
12	0.007
13	0.004
14	0.003
15	0.002
16	0.001
17	0.001

Design Flood (R.P.= 500yrs.)

Time (hr)	Rainfall (mm)	Discharge (cms)
1	0.1	0.089
2	0.3	0.431
3	0.3	0.924
4	0.3	1.383
5	0.3	1.752
6	0.3	2.026
7	0.4	2.308
8	0.4	2.607
9	0.5	2.948
10	0.5	3.307
11	0.6	3.699
12	0.7	4.184
13	0.8	4.766
14	1.0	5.521
15	1.1	6.417
16	1.4	7.533
17	1.6	8.894
18	2.0	10.580
19	2.7	12.953
20	3.5	16.291
21	5.0	21.204
22	7.5	28.946
23	12.7	42.467
24	26.0	70.618
25	0.3	84.292
26	0.4	74.917
27	0.4	59.435
28	0.4	44.454
29	0.5	32.347
30	0.5	23.354
31	0.6	17.230
32	0.6	13.027
33	0.7	10.309
34	0.7	8.642
35	0.9	7.784
36	1.0	7.550
37	1.2	7.775
38	1.4	8.666
39	1.6	9.633
40	2.0	11.105
41	2.4	12.899
42	3.0	15.498
43	3.9	19.012
44	5.2	23.939
45	7.3	31.160
46	11.0	42.489
47	18.7	62.369
48	38.3	103.853
49	1.0	124.525
50	1.1	111.631
51	1.4	89.951
52	1.7	69.337
53	2.1	53.225
54	2.6	42.094
55	3.5	35.932
56	4.8	33.978
57	7.1	36.658
58	11.4	45.705
59	21.6	67.031
60	55.1	124.832
61	113.1	257.391
62	32.6	356.573
63	15.3	362.311
64	8.9	319.257
65	5.8	259.739
66	4.1	201.795
67	3.0	152.262
68	2.3	113.458
69	1.8	83.616
70	1.5	61.368
71	1.2	45.116
72	1.0	33.257
73	0.9	23.945
74	0.8	17.097
75	0.0	11.708
76	0.0	7.675
77	0.0	5.075
78	0.0	2.775
79	0.0	1.667
80	0.0	1.014
81	0.0	0.615
82	0.0	0.370
83	0.0	0.219
84	0.0	0.128
85	0.0	0.076
86	0.0	0.041
87	0.0	0.019
88	0.0	0.009

TL-6:Huai Soob

Unit- hydrograph

Time (hr)	Distribution Rate
0	0.000
1	0.172
2	0.268
3	0.215
4	0.144
5	0.088
6	0.051
7	0.029
8	0.016
9	0.008
10	0.004
11	0.002
12	0.001
13	0.001
14	0.001

Design Flood (R.P.= 500yrs.)

Time (hr)	Rainfall (mm)	Discharge (cms)
1	0.1	0.088
2	0.3	0.403
3	0.3	0.789
4	0.3	1.084
5	0.3	1.277
6	0.3	1.394
7	0.4	1.549
8	0.4	1.725
9	0.5	1.945
10	0.5	2.167
11	0.6	2.416
12	0.7	2.745
13	0.8	3.143
14	1	3.678
15	1.1	4.291
16	1.4	5.071
17	1.6	6.011
18	2	7.188
19	2.7	8.927
20	3.5	11.395
21	5	15.100
22	7.5	21.076
23	12.7	31.851
24	26	55.288
25	0.3	59.519
26	0.4	44.481
27	0.4	29.484
28	0.4	18.425
29	0.5	11.521
30	0.5	7.526
31	0.6	5.305
32	0.6	4.114
33	0.7	3.661
34	0.7	3.559
35	0.9	3.752
36	1	4.188
37	1.2	4.725
38	1.4	5.348
39	1.6	6.199
40	2	7.305
41	2.4	8.738
42	3	10.579
43	3.9	13.129
44	5.2	16.766
45	7.3	22.195
46	11	30.927
47	18.7	46.784
48	38.3	81.326
49	1	88.099
50	1.1	66.702
51	1.4	45.327
52	1.7	30.202
53	2.1	21.225
54	2.6	16.813
55	3.5	15.684
56	4.8	17.028
57	7.1	21.513
58	11.4	30.492
59	21.6	49.346
60	55.1	100.356
61	113.1	213.701
62	32.6	269.645
63	15.3	238.604
64	8.9	181.834
65	5.8	128.615
66	4.1	87.845
67	3	59.392
68	2.3	40.084
69	1.8	27.147
70	1.5	18.962
71	1.2	13.759
72	1	10.431
73	0	7.625
74	0	4.939
75	0	2.692
76	0	1.491
77	0	0.813
78	0	0.436
79	0	0.229
80	0	0.118
81	0	0.062
82	0	0.033
83	0	0.019
84	0	0.011
85	0	0.005

TABLE A-7 : HYDROGRAPH OF DESIGN FLOOD WITH A RETURN PERIOD OF 100-YEAR (1/2)

80-5: Lam Se

Unit- hydrograph

Time (hr)	Distribution Rate
0	0.000
1	0.102
2	0.190
3	0.187
4	0.154
5	0.116
6	0.083
7	0.057
8	0.039
9	0.026
10	0.017
11	0.011
12	0.007
13	0.004
14	0.003
15	0.002
16	0.001
17	0.001

Design Flood (R.P.= 100 yrs.)

Time (hr)	Rainfall (mm)	Discharge (cms)
1	0.6	0.381
2	0.7	1.154
3	0.9	2.097
4	1.1	3.152
5	1.4	4.340
6	1.8	5.755
7	2.3	7.495
8	3.3	9.902
9	4.9	13.577
10	8.1	19.785
11	16.8	32.208
12	45.5	66.681
13	105.6	153.897
14	25.1	219.501
15	11.1	222.017
16	6.2	193.491
17	4.0	155.542
18	2.8	119.208
19	2.0	88.640
20	1.5	65.094
21	1.2	47.217
22	1.0	34.082
23	0.8	24.633
24	0.7	17.855
25	0.1	12.656
26	0.2	9.033
27	0.2	6.158
28	0.2	3.997
29	0.2	2.666
30	0.2	1.368
31	0.2	0.812
32	0.3	0.492
33	0.3	0.297
34	0.4	0.179
35	0.4	0.106
36	0.5	0.062
37	0.6	0.037
38	0.7	0.020
39	0.8	0.009
40	0.9	0.004

80-11: Huai Khum Khan

Unit- hydrograph

Time (hr)	Distribution Rate
0	0.000
1	0.029
2	0.070
3	0.090
4	0.096
5	0.095
6	0.090
7	0.081
8	0.072
9	0.063
10	0.054
11	0.046
12	0.039
13	0.032
14	0.027
15	0.022
16	0.018
17	0.015
18	0.012
19	0.010
20	0.008
21	0.006
22	0.005
23	0.004
24	0.003
25	0.003
26	0.002
27	0.002
28	0.001
29	0.001
30	0.001
31	0.001
32	0.001
33	0.001

Design Flood (R.P.= 100 yrs.)

Time (hr)	Rainfall (mm)	Discharge (cms)
1	0.7	0.208
2	0.8	0.738
3	1.0	1.513
4	1.2	2.494
5	1.5	3.688
6	2.0	5.172
7	2.6	7.046
8	3.7	9.532
9	5.5	13.061
10	9.2	18.572
11	18.1	28.545
12	51.1	52.686
13	119.2	112.598
14	28.4	180.993
15	12.5	221.823
16	7.0	238.398
17	4.5	239.145
18	3.1	229.189
19	2.3	211.563
20	1.7	191.480
21	1.4	170.364
22	1.1	149.245
23	0.9	129.527
24	0.8	111.380
25	0.2	94.377
26	0.3	79.837
27	0.3	66.507
28	0.3	55.236
29	0.4	45.838
30	0.4	37.551
31	0.5	30.892
32	0.5	24.926
33	0.6	19.783
34	0.6	16.094
35	0.7	12.948
36	0.8	10.422
37	0.9	8.874
38	1.1	6.910
39	1.3	5.723
40	1.6	4.111
41	1.9	3.545
42	2.4	3.203
43	3.1	2.928
44	4.1	2.622
45	5.8	2.022
46	8.8	0.748
47	14.9	0.421
48	30.5	0.270

80-13: Huai Kham Phak Wan

Unit- hydrograph

Time (hr)	Distribution Rate
0	0.000
1	0.112
2	0.203
3	0.194
4	0.155
5	0.113
6	0.078
7	0.052
8	0.034
9	0.022
10	0.014
11	0.009
12	0.005
13	0.003
14	0.002
15	0.001
16	0.001
17	0.001
18	0.001

Design Flood (R.P.= 100 yrs.)

Time (hr)	Rainfall (mm)	Discharge (cms)
1	0.7	0.294
2	0.8	0.869
3	1.0	1.538
4	1.2	2.254
5	1.5	3.033
6	2.0	3.980
7	2.6	5.198
8	3.7	6.906
9	5.5	9.522
10	9.2	14.004
11	18.1	23.038
12	51.1	48.232
13	119.2	111.897
14	28.4	157.242
15	12.5	155.607
16	7.0	132.409
17	4.5	103.789
18	3.1	77.528
19	2.3	56.324
20	1.7	40.356
21	1.4	28.787
22	1.1	20.537
23	0.9	14.701
24	0.8	10.423
25	0.2	7.392
26	0.3	5.096
27	0.3	3.388
28	0.3	2.431
29	0.4	1.785
30	0.4	1.231
31	0.5	0.559
32	0.5	0.315
33	0.6	0.185
34	0.6	0.110
35	0.7	0.065
36	0.8	0.040
37	0.9	0.025
38	1.1	0.016
39	1.3	0.011
40	1.6	0.006
41	1.9	0.003

TABLE A-7 : HYDROGRAPH OF DESIGN FLOOD WITH A RETURN PERIOD OF 100-YEAR (2/2)

BO-18: Huai Na Khai

Unit- hydrograph

Time (hr)	Distribution Rate
0	0.000
1	0.102
2	0.19
3	0.187
4	0.154
5	0.116
6	0.083
7	0.057
8	0.039
9	0.026
10	0.017
11	0.011
12	0.007
13	0.004
14	0.003
15	0.002
16	0.001
17	0.001

Design Flood (R.P.= 100 yrs.)

Time (hr)	Rainfall (mm)	Discharge (cms)
1	0.6	0.532
2	0.8	1.701
3	0.9	3.095
4	1.1	4.566
5	1.4	6.198
6	1.8	8.142
7	2.4	10.633
8	3.3	14.051
9	5.0	19.257
10	8.3	28.145
11	16.3	45.880
12	46.1	94.521
13	107.6	219.051
14	25.6	312.475
15	11.3	316.077
16	6.3	275.451
17	4.0	221.347
18	2.8	169.515
19	2.1	126.016
20	1.6	92.636
21	1.2	67.263
22	1.0	48.552
23	0.8	35.066
24	0.7	25.384
25	0.3	17.969
26	0.4	12.816
27	0.4	8.732
28	0.4	5.664
29	0.5	3.778
30	0.5	1.935
31	0.6	1.147
32	0.6	0.694
33	0.7	0.420
34	0.7	0.252
35	0.9	0.150
36	1.0	0.087
37	1.2	0.051
38	1.4	0.028
39	1.6	0.013
40	2.0	0.006

TL-6:Huai Soob

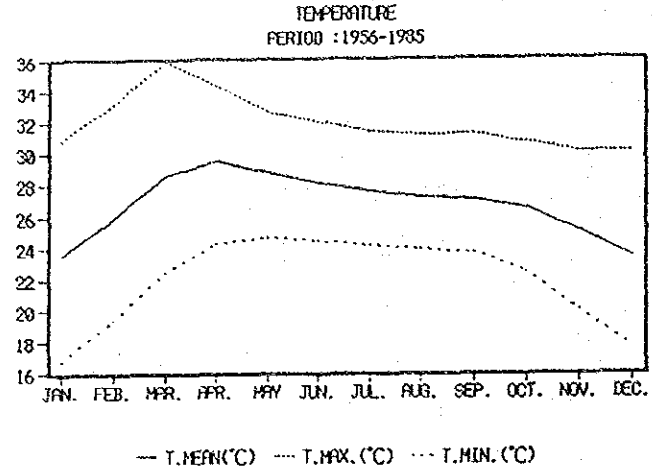
Unit- hydrograph

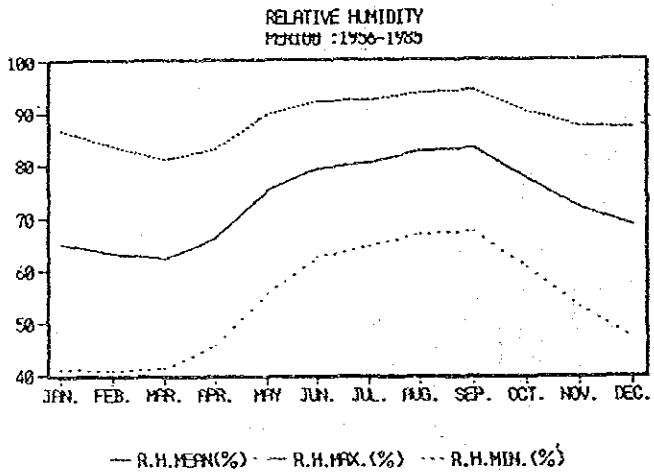
Time (hr)	Distribution Rate
0	0.000
1	0.172
2	0.268
3	0.215
4	0.144
5	0.088
6	0.051
7	0.029
8	0.016
9	0.008
10	0.004
11	0.002
12	0.001
13	0.001
14	0.001

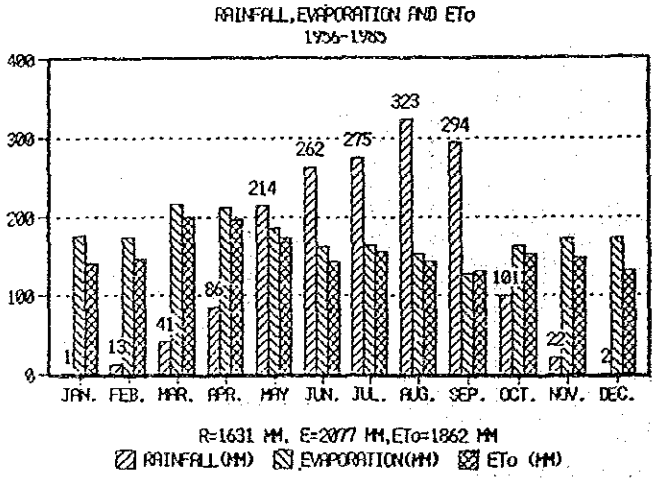
Design Flood (R.P.= 100 yrs.)

Time (hr)	Rainfall (mm)	Discharge (cms)
1	0.6	0.530
2	0.8	1.533
3	0.9	2.560
4	1.1	3.540
5	1.4	4.610
6	1.8	5.919
7	2.4	7.667
8	3.3	10.149
9	5.0	14.094
10	8.3	21.109
11	16.3	35.720
12	46.1	78.646
13	107.6	186.476
14	25.6	239.692
15	11.3	208.969
16	6.3	156.028
17	4.0	107.814
18	2.8	71.801
19	2.1	47.370
20	1.6	31.203
21	1.2	20.529
22	1.0	13.931
23	0.8	9.852
24	0.7	7.361
25	0.3	5.425
26	0.4	3.548
27	0.4	1.859
28	0.4	1.023
29	0.5	0.556
30	0.5	0.298
31	0.6	0.157
32	0.6	0.081
33	0.7	0.042
34	0.7	0.023
35	0.9	0.013
36	1	0.008
37	1.2	0.004

FIGURE A-1 : CLIMATE IN UBON RATCHATHANI







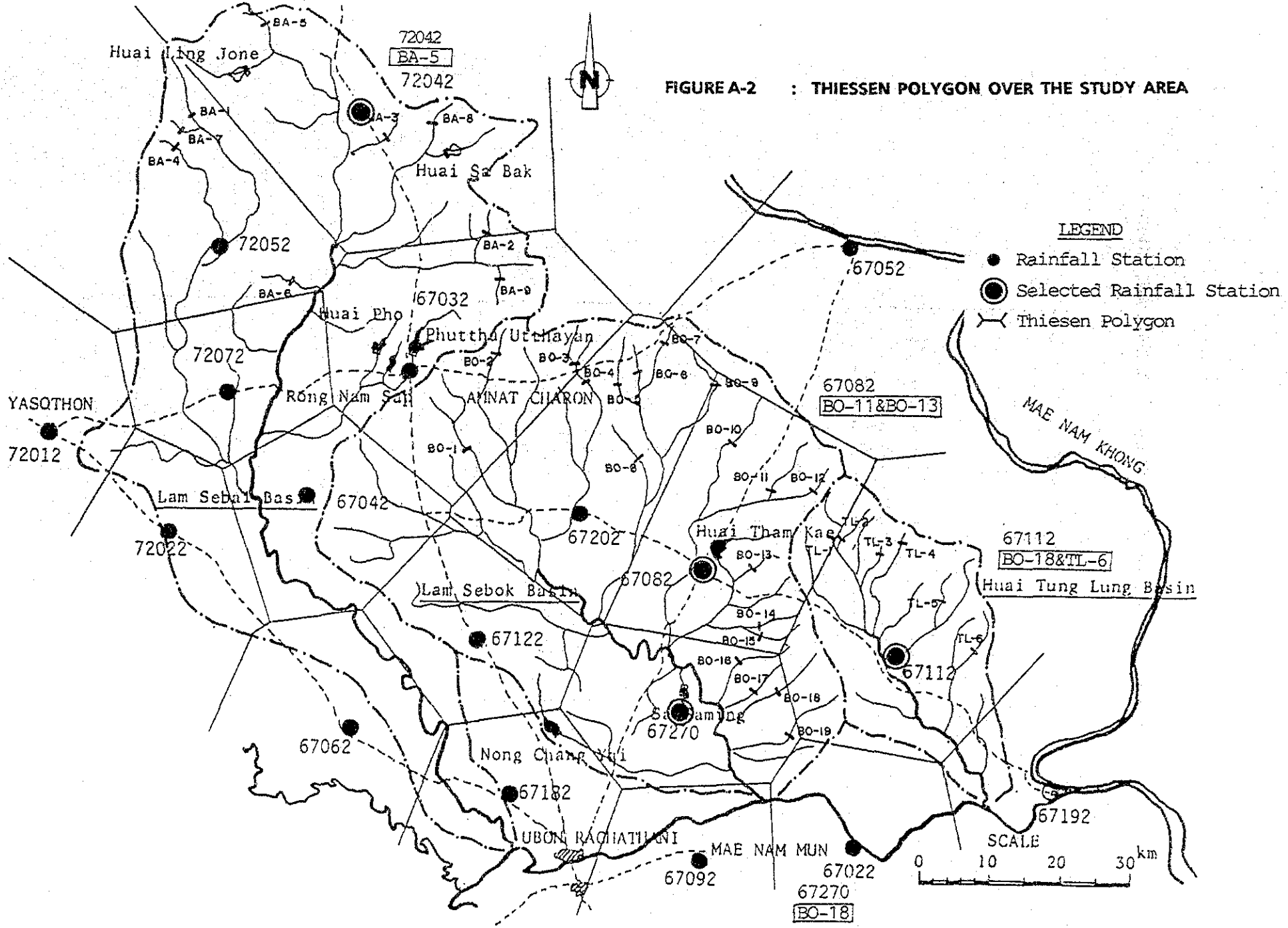
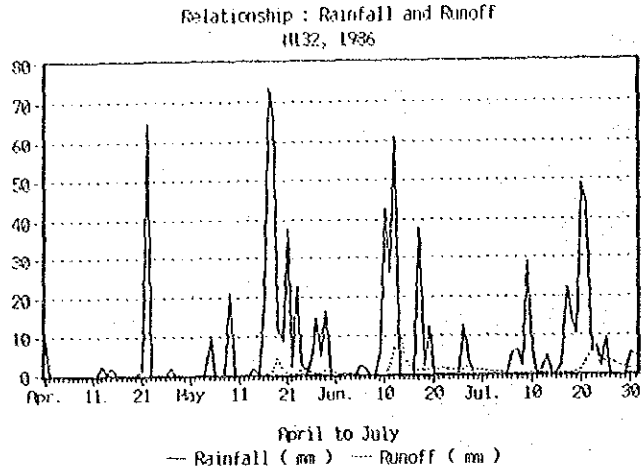
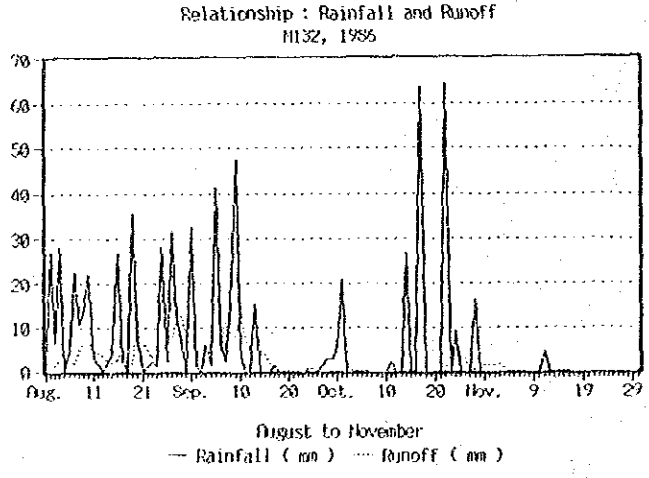


FIGURE A-2 : THIESSEN POLYGON OVER THE STUDY AREA

FIGURE A-3 : RELATION BETWEEN DAILY RAINFALL AND RUNOFF





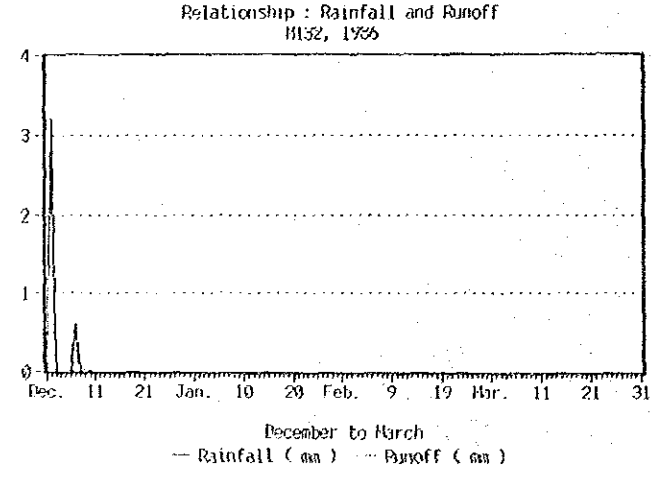


FIGURE A-4 : DEVELOPED TANK MODEL

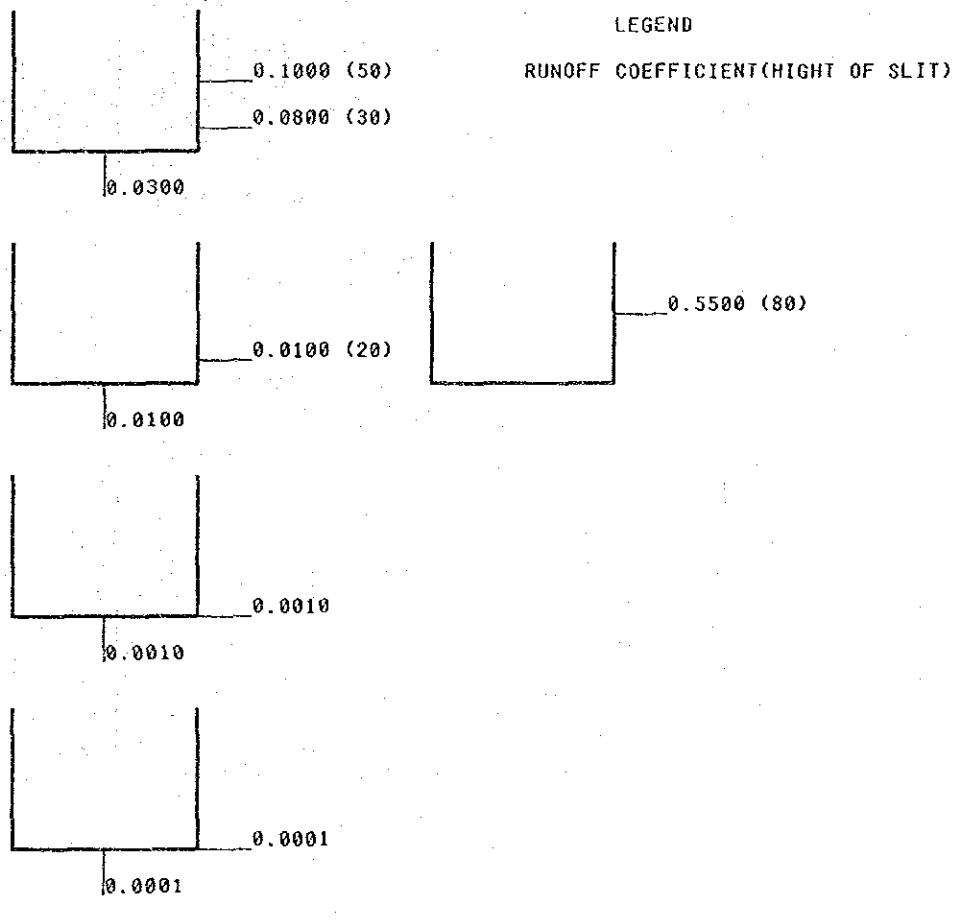
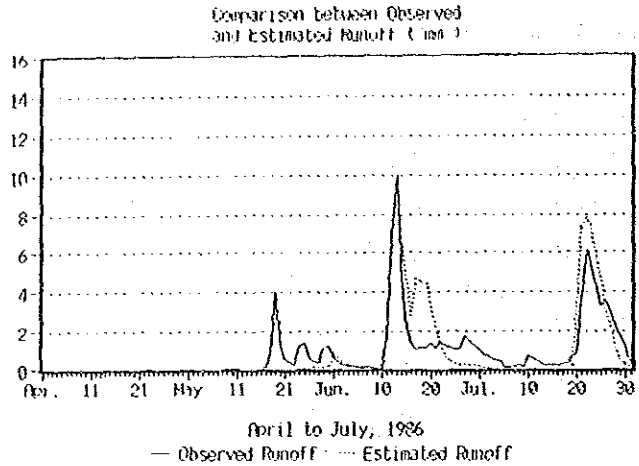
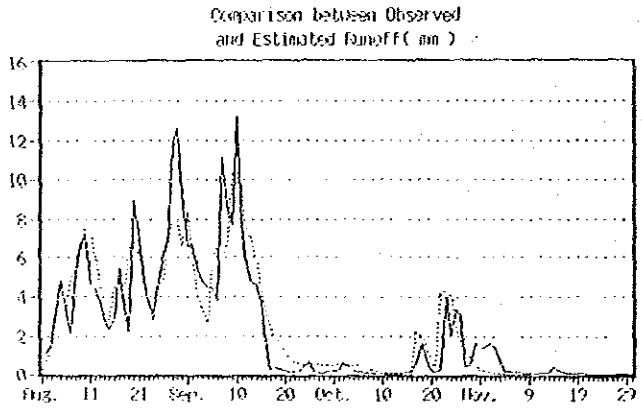


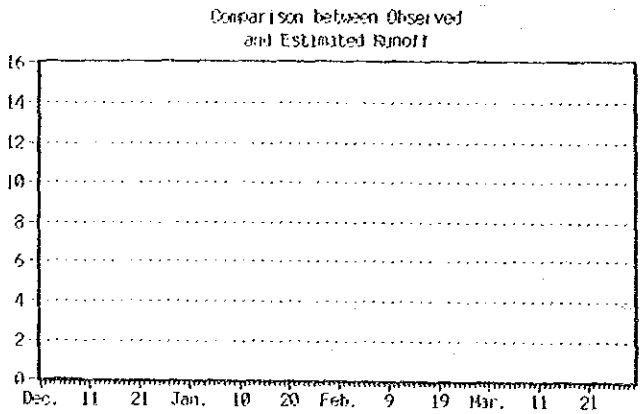
FIGURE A-5 : COMPARISON BETWEEN OBSERVED AND ESTIMATED RUNOFF



April to July, 1986
— Observed Runoff ··· Estimated Runoff



August to November, 1986
— Observed Runoff ··· Estimated Runoff



December to March, 1986
— Observed Runoff ··· Estimated Runoff

FIGURE A-6 : ESTIMATED ANNUAL RUNOFF

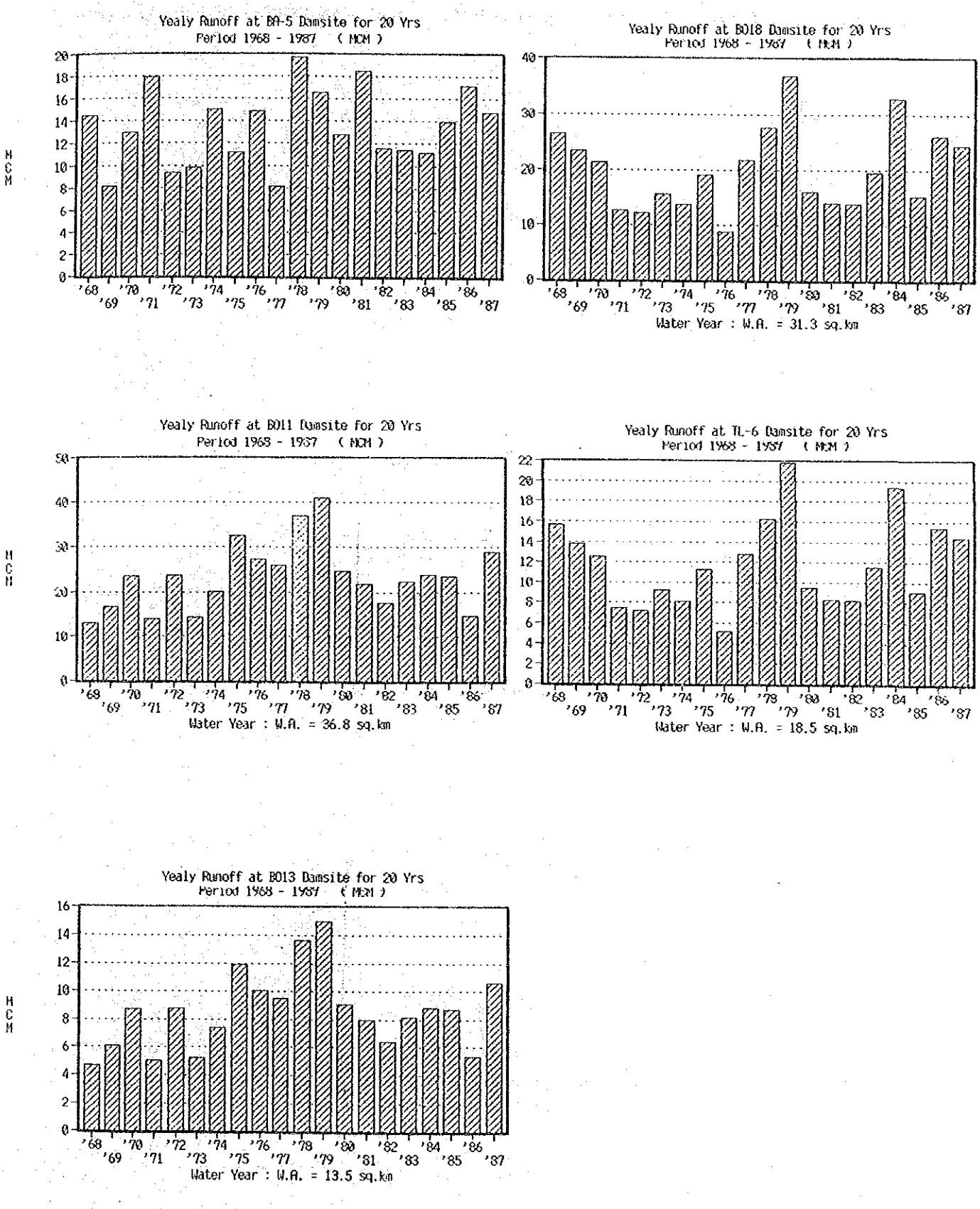
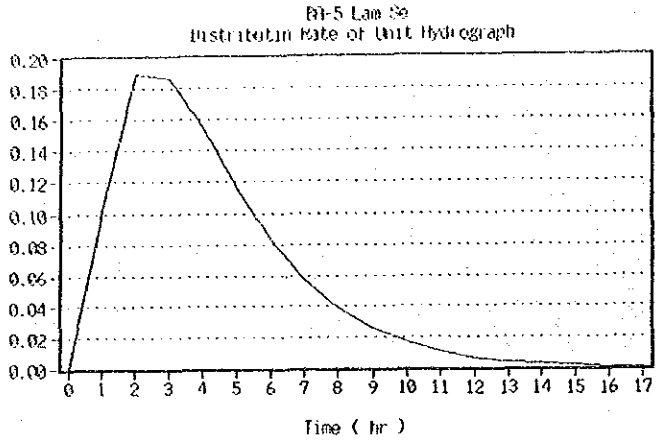
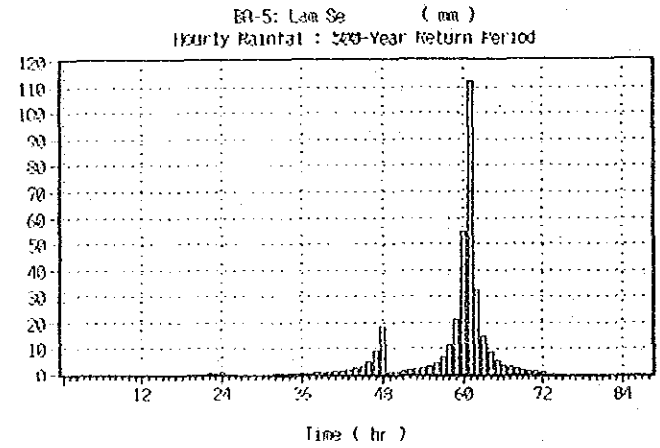


FIGURE A-7 : HYDROGRAPH OF DESIGN FLOOD WITH A RETURN PERIOD OF 500-YEAR (1/5)





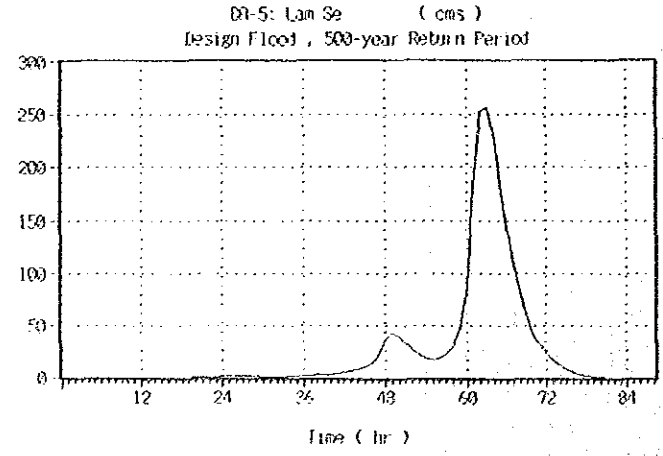
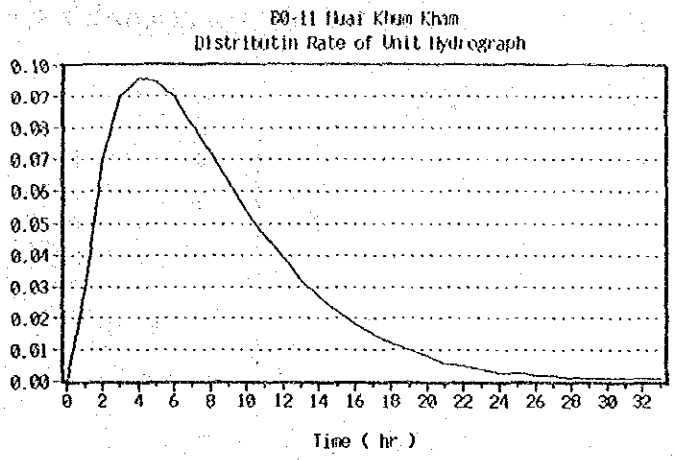
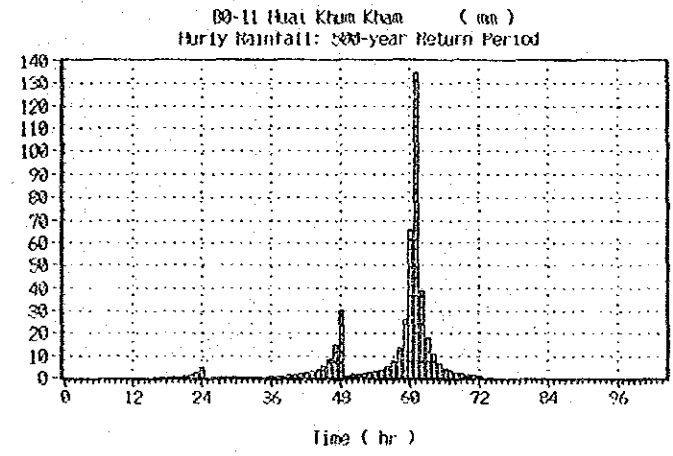


FIGURE A-7 : HYDROGRAPH OF DESIGN FLOOD WITH A RETURN PERIOD OF 500-YEAR (2/5)





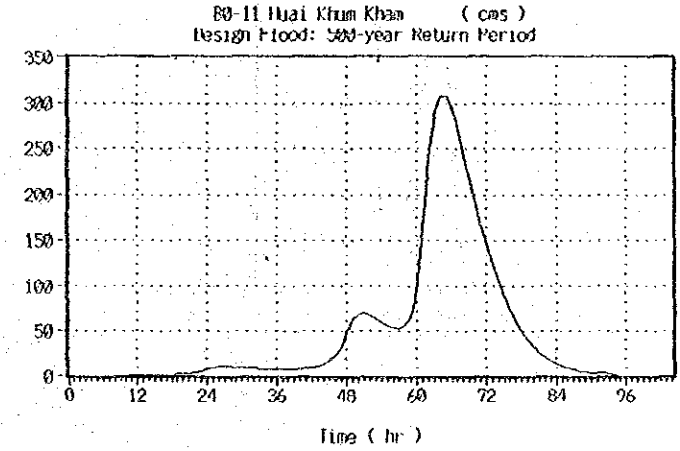
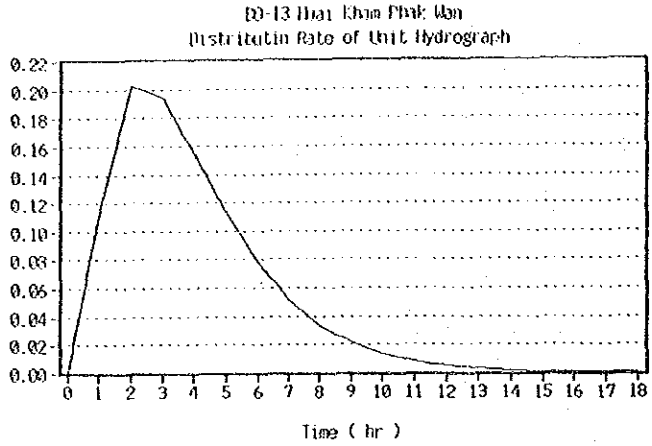
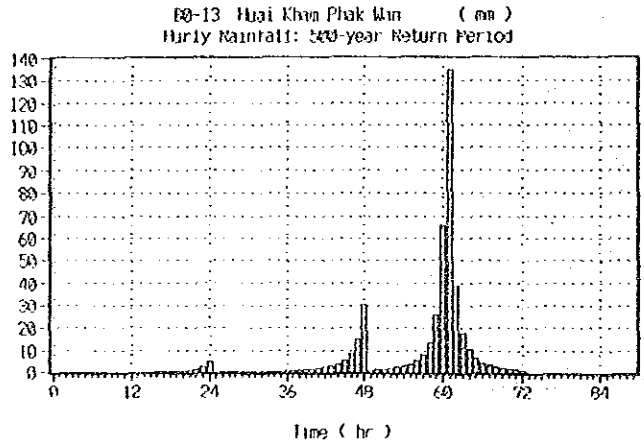


FIGURE A-7 : HYDROGRAPH OF DESIGN FLOOD WITH A RETURN PERIOD OF 500-YEAR (3/5)





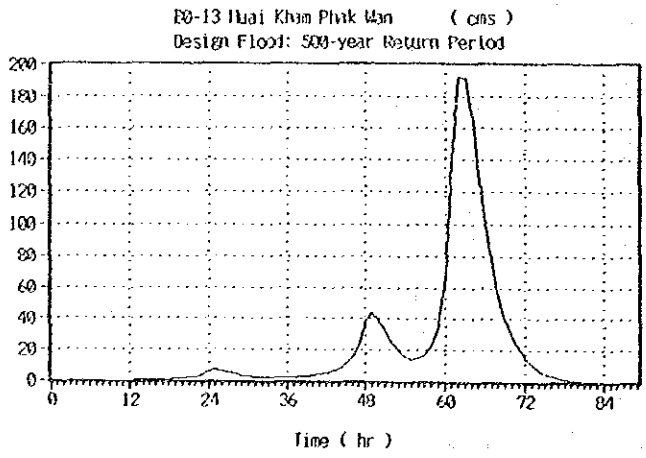
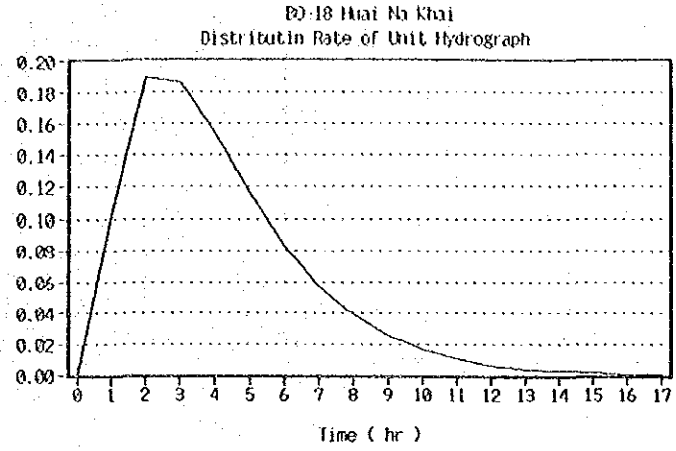
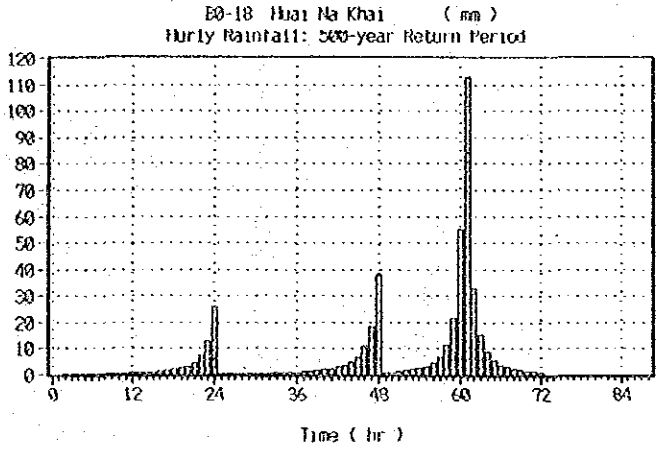


FIGURE A-7 : HYDROGRAPH OF DESIGN FLOOD WITH A RETURN PERIOD OF 500-YEAR (4/5)





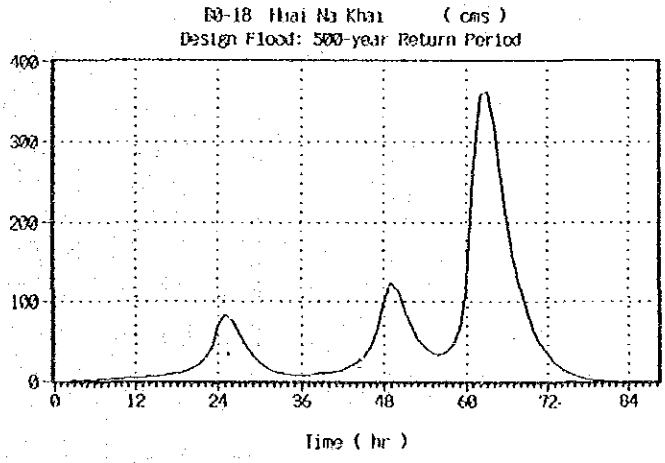
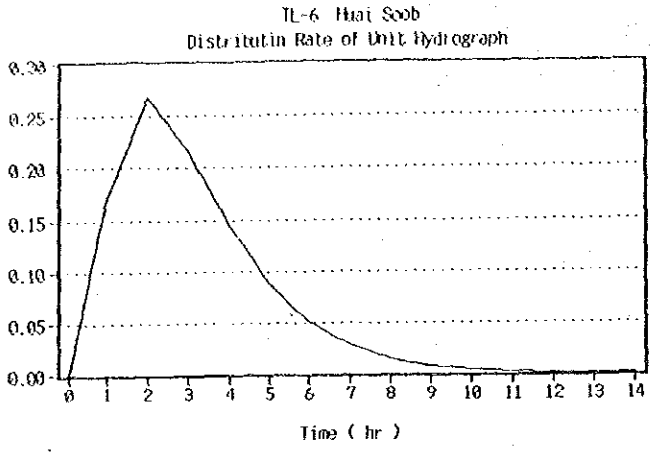
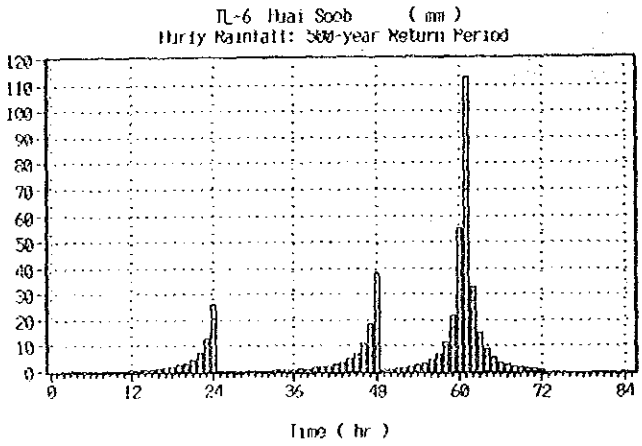


FIGURE A-7 : HYDROGRAPH OF DESIGN FLOOD WITH A RETURN PERIOD OF 500-YEAR (5/5)





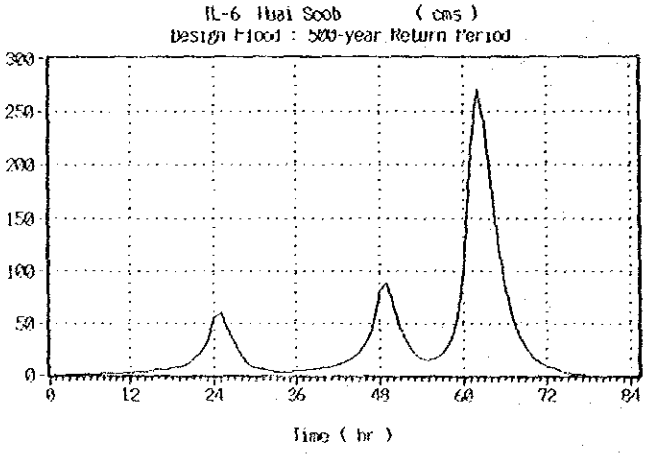
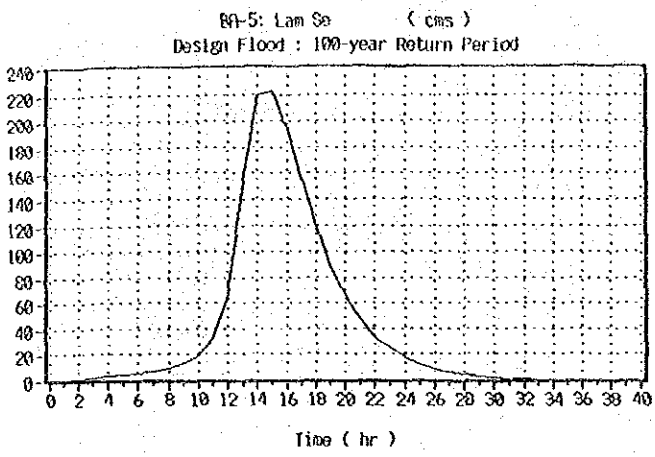
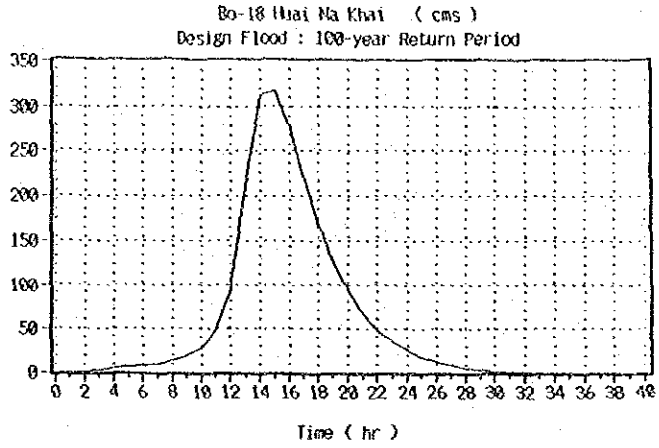
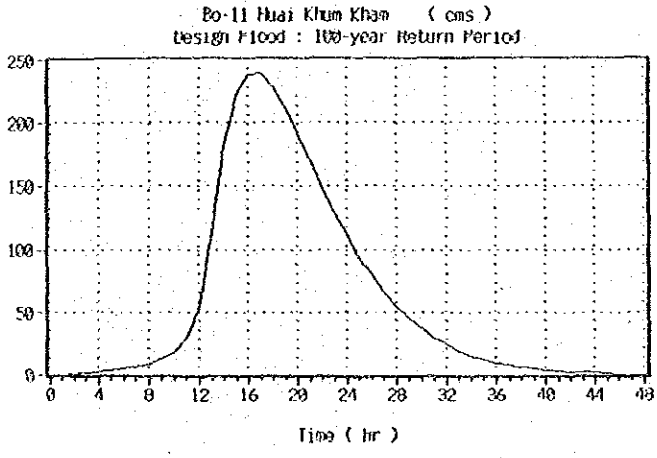
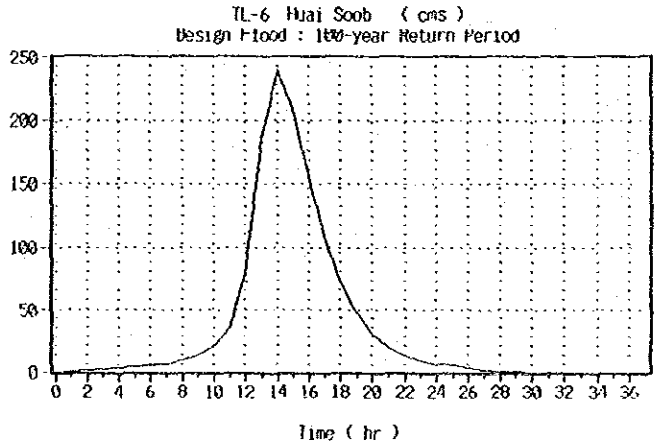


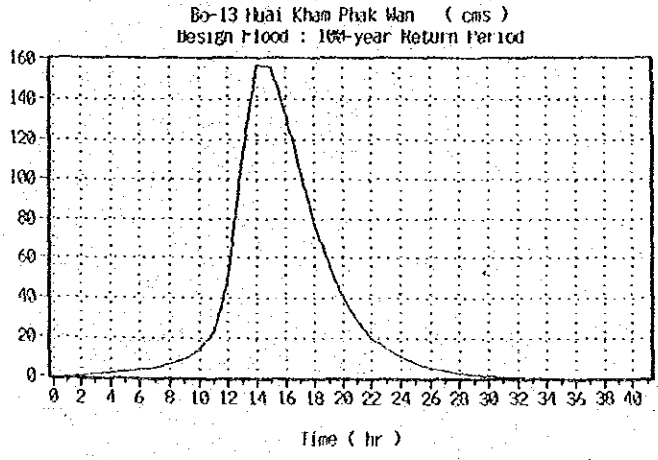
FIGURE A-8 : HYDROGRAPH OF DESIGN FLOOD WITH A RETURN PERIOD OF 100-YEAR











APPENDIX B. SOIL

APPENDIX B. SOIL

B-1. General

B-1-1. Soil Survey

Based on a soil map (1/100,000) produced by DLD, the soil survey was conducted in two phases. The first survey was carried out at 27 sites by excavating 27 pits and by soil auger boring of 52 sites, a total of 79 sites mainly at existing paddy fields (as shown in Figure B-1). The second survey was done by auger boring with the objective of confirming the distribution of the soil series in the project area.

B-1-2. Soil Parent Material

Most soils in the study area are formed from alluvial sediments derived from sandstone and conglomerate. The alluvium has been deposited by rivers that have meandered over the land. The present surface materials are very low in plant nutrients and contain few easily weatherable minerals because of the intense weathering, leaching, and repeated cycles of geological erosion and deposition. The parent material of most of these soils is not true residuum, because the unconsolidated material over the bedrock has moved downhill and these materials are mainly colluvium.

B-1-3. Landforms

Landforms of the project area are small alluvial lowlands formed with repeated cycles of soil erosion and sedimentation in rivers and streams, and low and middle terraces with mostly flat or undulating surface.

The alluvial lowland forms long natural levees along both river-sides. The surface layer of these levees is usually composed of silty and / or loamy soil. The subsoil is loam, clay and / or silty clay.

The low terrace is flat or somewhat undulating landform. The terrace has sand or loam on its surface layer. The subsoil is of fine particle size, containing laterite somewhere. A sand layer of more than 50 cm thickness is often observed at the higher part of this terrace.

The middle terrace alternates with the low terrace forming a flat or an undulating land. This terrace usually has a laterite layer at 50-100cm depth, occasionally appearing on the surface. A strongly mottled grey clay layer is commonly seen beneath the laterite layer.

The soil slope characteristics of each project area are shown in Table B-1.

B-2. Soil Description

Within the project area, 8 soil series were found, as shown in the following table:

Soil Series	Symbol	Percent (%)
Roi Et Series	Re	35.8
Korat-Phon Phi Sai Association	Kt/Pp	24.9
Borabu Complex	Bbc	16.5
Korat Series	Kt	8.3
Roi, Et-On Association	Re/On	7.8
Korat, high-phon Phi Sai Assoc.	Rt-h/Pp	4.6
Sithon Series	St	1.9
Roi Et, loamy	Re-1	0.2

Soil characteristics are described as below. Figure B-2 shows soil columnar section.

Re: Roi Et Series ;

This is an old alluvial soil formed on low or middle terraces with flat or undulating surface. It is sand or soil of clear color with poor or slightly poor drainage. The soil is commonly observed on the low terraces. Soil profile is as follows;

1st layer: 10-15 cm thickness; grey-brown or dark brown; sandy loam with no pebbles and almost no organic content.

2nd layer: 10-30 cm thickness; grey-brown or reddish grey; sandy loam or fine sandy loam, unprogressed structure with almost no organic content.

3rd layer: reddish grey, light brown or grey-brown subsoil; sandy loam or clay loam; at about 75 cm, mottled laterite layer with brown and reddish brown complex color appears.

Re-1: Roi Et, Loamy Series

The soil is generally finer grained than the Roi Et Series distributed on flat low terraces nearby rivers. Soil profile is described as follows;

1st layer: 10-15 cm thickness; grey-brown or clear brown; loam or fine sandy loam.

2nd layer: 15-25 cm thickness; dark brown or light yellow-brown; loam or fine sandy loam with few pebbles.

3rd layer: more than 20 cm thickness; slightly reddish clear brown or reddish brown; clay loam or clay with fine grain quality.

Re/On: Roi Et - On Association Series

This soil is on the flat part of low terraces. A laterite layer appears somewhere below 30cm generally at more than 1 m depth. Soil profile is as follows;

1st layer: 10-20 cm thickness; dark brown or yellow-brown; loamy sand like soil or sandy loam; drainage.

2nd layer: 15-30 cm thickness; light grey or reddish grey; clay loam or clay with almost no organic content.

3rd layer: more than 20-40 cm thickness; yellow-orange or reddish brown; clay loam or clay containing pebbles somewhere within the sample.

Kt: Korat Series

This soil is sand or sandy loam with good drainage. It is distributed on mild undulating or rolling parts of low terraces. It was formed by old alluvial. Soil profile is as follows;

1st layer: 10-20 cm thickness; light grey-brown; loamy sand like soil or sandy loam with low organic content and few pebble.

2nd layer: 10-30 cm thickness; dark red-brown or light orange; loamy sand or sandy loam with no pebbles.

3rd layer: relatively thick layer of more than 1 m; brown or yellowish brown; sandy loam, loam, or clay loam. Distinct mottled

yellow-brown and red-brown laterite layer appears at somewhere below 60 cm depth.

K_t/P_p: Korat-Phon Phi Sai Association Series

This soil is distributed on higher parts of middle terraces, and soil profile is as follows;

1st layer: 10-15 cm thickness; grey-brown; or yellowish brown; fine sandy loam or sandy loam with few pebbles.

2nd layer: 20-50 cm thickness; brown or reddish brown; clay loam or fine sandy loam. Laterite layer appears somewhere below 40 cm depth.

3rd layer: 20-50 cm thickness; reddish brown or brown; clay loam or clay; deep soil layer with no laterite layer.

Kt-h/ Pp: Korat, High-Phon Phi Say Association Series

This soil is distributed at higher parts of mildly undulating middle terraces, and soil profile is as follows;

1st layer: 10-15 cm thickness; dark brown or reddish brown; sandy loam of fine sandy loam.

2nd layer: 25-35 cm thickness; clearer reddish brown or orange; sandy clay loam-like. Sandy loam or fine sandy loam.

3rd layer: more than 30 cm thickness; brown or orange; sandy clay loam or clay loam. Laterite layer appears somewhere below 60 cm depth.

B_bC: Borabu Complex Series

This soil is distributed at middle and high terraces, and soil profile is described as follows;

1st layer: 9-20 cm thickness; dark orange or reddish brown; sandy loam or loam with almost no pebbles.

2nd layer: 10-40 cm thickness; brown or reddish brown; fine sandy loam of clay loam. Laterite layer or base rock appears somewhere below 30 cm depth.

St: Sithon Series

This soil is distributed among almost flat and narrow flood plain lowlands, and soil profile is as follows;

1st layer: 10-20 cm thickness; dark brown or yellowish brown; loam or fine sandy loam with no pebbles

2nd layer: 10-50 cm thickness; orange of dark brown; fine sandy loam or loam; thin sand-like layer is interposed somewhere in it.

3rd layer: more than 30 cm thickness; yellow-orange or clear brown; clay loam or clay with few pebbles.

B-3. Physical and Chemical Properties

To study physical and chemical properties of soil, sampling of each layer was done at excavated pit sites. Soil Science Branch Research and Laboratory Division, RID carried out the analyses of samped soils.

Results of analyses are shown in Table B-2 and B-3.

TABLE B-1. SOIL SLOPE CHARACTERISTICS

PROJECT	SOIL SYMBOL	LANDFORM	SLOPE	PRESENT LAND USE
Lam se	Re	Low terrace	flat, undulating 1 percent	Paddy field
	Kt-h/Pp	Middle terrace	undulating 1 to 2 percemt	Paddy field
	St	Alluvial plain	flat less than 1 percent	Paddy field
	Kt	Lower parts of Middle terrace or Middle terrace	undulating 2 percent	Paddy field
Huai Khum Kham	Re	Low terrace or higher parts of Low terrace	flat, undulating 1 percent	Paddy field
	Kt	Lower parts of Middle terrace or Middle terrace	undulating 1 to 2 percent	Paddy field
	St	Alluvial plain	flat less than 1 percent	Paddy field
Huai Kham Phak Wan	Re	Low terrace or higher Parts of Low terrace	flat, undulating 1 to 2 percent	Paddy field
	Re/On	Low terrace	flat 1 percent	Paddy field
	Kt/Pp	Higher parts of the Middle terrace	undulating 1 to 3 percent	Paddy field
Huai Na Khai	Re	Low terrace or higher parts of Low terrace	flat, undulating 1 to 3 percent	Paddy field
	Re/On	Low terrace	flat 1 to 3 percent	Paddy field
	Kt/Pp	Higher parts of the Middle terrace	undulating 1 to 3 percent	Paddy field
Huai Soob	BbC	Higher parts of the Middle terrace	uneulating 1 to 2 percent	Paddy field

TABLE B-2. : PHYSICAL AND CHEMICAL PROPERTIES 1-1

Soil Map Symbol	PIT No.	Horizon	Depth cm	Particle Size %			Texture	Handness cm^2/Kg	Bulk Density g/cm^3	Porosity %	Moisture Content %		Avail. Moisture %
				Sand	Silt	Clay					Moisture Equivalent	Wilting Point	
Re	4	1	0 - 15	67.9	27.9	4.2	SL	22	1.53	41	7.1	2.0	5.1
		2	15 - 40	65.0	30.6	4.4	SL	21	1.61	38	5.4	1.6	3.8
		3	40 - 60	60.2	25.0	14.8	SL	-	-	-	19.3	7.7	11.6
		4	60 -	50.4	23.6	26.0	SCL	-	-	-	29.6	15.8	13.8
	5	1	0 - 12	69.7	27.8	2.5	SL	20	1.58	38	6.1	1.3	4.8
		2	12 - 23	67.5	27.3	5.2	SL	24	1.70	36	7.6	1.9	5.7
		3	23 - 80	73.2	24.7	2.1	LS	15	-	-	5.0	1.0	4.0
		4	80 -	60.4	30.4	9.2	SL	15	-	-	10.3	4.1	6.2
	6	1	0 - 10	74.4	21.0	4.6	SL	14	1.47	46	7.0	1.7	5.3
		2	10 - 35	74.4	21.5	4.1	SL	21	1.52	43	7.0	1.5	5.5
		3	35 - 65	72.0	25.6	2.4	SL	15	-	-	4.1	0.8	3.3
		4	65 - 95	72.9	24.5	2.6	LS	-	-	-	5.6	0.9	4.7
	8	1	0 - 18	62.4	32.9	4.7	SL	19	1.57	40	8.7	2.0	6.7
		2	18 - 48	61.1	33.0	5.9	SL	22	1.72	35	10.6	1.9	8.7
		3	48 - 65	59.2	29.0	11.8	SL	-	-	-	14.9	4.7	10.2
		4	65 -	Welling Water									
	9	1	0 - 12	62.0	31.9	6.1	SL	20	1.55	41	10.5	2.3	8.2
		2	12 - 25	63.9	30.9	5.2	SL	21	1.61	39	8.2	1.4	6.8
		3	25 - 40	67.7	27.7	4.6	SL	20	-	-	7.0	1.6	5.4
		4	40 - 80	63.6	26.2	10.2	SL	15	-	-	11.2	4.1	7.1
	11	1	0 - 13	61.2	29.4	9.4	SL	19	1.59	39	14.7	4.2	10.5
		2	13 - 35	60.2	30.4	9.4	SL	21	1.64	38	12.7	3.9	8.8
		3	35 - 60	54.4	25.0	20.6	SCL	19	-	-	18.3	8.0	10.3
		4	60 - 85	47.4	23.0	29.6	SCL	17	-	-	21.8	11.1	10.7

TABLE B-2. : PHYSICAL AND CHEMICAL PROPERTIES 1-2

Soil Map Symbol	PIT No.	Horizon	Depth cm	Particle Size %			Texture	Handness cm^2/Kg	Bulk Density g/cm^3	Porosity %	Moisture Content %		Avail. Moisture %
				Sand	Silt	Clay					Moisture Equivalent	Wilting Point	
Re	12	1	0 - 13	57.2	33.2	9.6	SL	21	1.72	36	15.7	3.6	12.1
		2	13 - 40	47.2	32.2	20.6	L	21	1.73	36	18.1	6.5	11.6
		3	40 - 70	48.0	30.2	21.8	L	14	-	-	18.1	7.1	11.0
		4	70 -	45.4	32.4	22.2	L	13	-	-	18.6	7.6	11.0
	14	1	0 - 10	58.0	25.0	17.0	SL	15	1.38	49	17.4	8.1	9.3
		2	10 - 18	53.6	35.8	10.6	SL	19	1.49	44	13.2	4.5	8.7
		3	18 - 30	62.7	32.0	5.3	SL	24	-	-	9.7	2.8	6.9
		4	30 - 58	64.0	32.3	3.7	SL	20	-	-	6.7	1.6	5.1
		5	58 - 80	55.4	31.0	13.6	SL	10	-	-	13.8	5.6	8.2
	18	1	0 - 15	60.8	31.4	7.8	SL	23	1.57	41	13.2	3.2	10.0
		2	15 - 28	51.2	36.2	12.6	L	25	1.61	39	13.6	4.7	8.9
		3	28 - 50	37.6	42.8	19.6	L	23	-	-	22.5	7.3	15.2
		4	50 - 100	41.6	28.8	29.6	C	19	-	-	27.5	12.7	14.8
	19	1	0 - 10	82.8	14.9	2.3	LS	18	1.63	39	5.7	1.2	4.5
		2	10 - 30	81.2	17.0	1.8	LS	16	1.61	38	3.7	0.9	2.8
		3	30 - 45	81.6	15.9	2.5	LS	8	-	-	3.6	0.9	2.7
		4	45 -	Welling Water									
	20	1	0 - 10	67.7	29.5	2.8	SL	16	1.39	47	4.5	1.2	3.3
		2	10 - 25	60.2	37.6	2.2	SL	18	1.52	42	3.3	1.0	2.3
		3	25 - 47	42.6	34.8	22.6	L	20	-	-	20.9	7.6	13.3
		4	47 - 75	31.4	33.0	35.6	CL	19	-	-	24.3	12.1	12.2
		5	75 -	30.4	29.2	40.4	C	23	-	-	25.6	14.8	10.8
	23	1	0 - 16	71.3	21.5	3.6	SL	17	1.64	37	7.3	1.9	5.4
		2	16 - 60	67.8	26.0	6.2	SL	20	1.63	38	6.8	2.7	4.1
		3	60 - 90	64.8	26.1	9.1	SL	18	-	-	8.7	3.7	5.0
		4	90 -	Hardpan									

TABLE B-2. : PHYSICAL AND CHEMICAL PROPERTIES 1-3

Soil Map Symbol	PIT No.	Horizon	Depth cm	Particle Size %			Texture	Handness cm^2/Kg	Bulk Density g/cm^3	Porosity %	Moisture Content %		Avail. Moisture %
				Sand	Silt	Clay					Moisture Equivalent	Wilting Point	
Re	26	1	0 - 10	79.5	16.0	4.5	LS	19	1.73	36	6.3	2.2	4.1
		2	10 - 30	73.2	14.8	12.0	SL	15	1.65	39	11.0	4.5	6.5
		3	30 - 51	73.6	11.2	15.2	SL	-	-	-	14.9	5.4	9.5
		4	51 -						Hardpan				
	27	1	0 - 10	78.6	18.9	2.5	LS	15	1.45	46	4.1	1.9	2.2
		2	10 - 35	73.6	21.9	4.5	SL	19	1.73	35	5.3	1.9	3.4
		3	35 - 75	68.2	20.8	11.0	SL	16	-	-	10.1	5.0	5.1
		4	75 -						-	-			
Kt/Pp	21	1	0 - 10	34.4	54.2	11.4	SiL	17	1.57	41	15.1	5.0	10.1
		2	10 - 30	30.2	47.6	22.2	L	18	1.55	43	20.7	7.9	12.8
		3	30 - 67	31.4	41.0	27.6	CL	16	-	-	22.9	9.7	13.2
		4	67 - 80	31.4	39.2	29.4	CL	17	-	-	23.4	10.7	12.7
		5	80 -	22.2	36.8	41.0	C	22	-	-	26.8	14.5	12.3
BbC	2	1	0 - 10	68.6	28.1	3.3	SL	21	1.54	40	7.0	1.7	5.3
		2	10 - 43	70.0	27.0	3.0	SL	15	1.63	37	5.5	1.3	4.2
		3	43 - 50	67.4	28.5	4.1	SL	9	-	-	6.8	1.8	5.0
		4	50 - 65	46.2	21.2	32.6	SCL	23	-	-	29.8	13.9	15.9
	22	1	0 - 9	78.0	16.7	5.3	LS	20	1.52	43	8.9	1.8	7.1
		2	9 - 25	76.3	18.0	5.7	LS	23	1.49	43	6.5	1.7	4.8
		3	25 - 53	70.4	12.6	17.0	SL	21	-	-	13.2	6.5	6.7
		4	53 - 70	65.6	13.0	21.4	SCL	23	-	-	15.1	8.7	6.4
		5	70 -						Hardpan				

TABLE B-2. : PHYSICAL AND CHEMICAL PROPERTIES 1-4

Soil Map Symbol	PIT No.	Horizon	Depth cm	Particle Size %			Texture	Handness cm^2/Kg	Bulk Density g/cm^3	Porosity %	Moisture Content %		Avail. Moisture %
				Sand	Silt	Clay					Moisture Equivalent	Wilting Point	
Kt	15	1	0 - 13	75.2	21.0	3.8	LS	13	1.56	41	6.1	2.2	3.9
		2	13 - 22	75.0	19.9	5.1	SL	17	1.65	38	8.7	2.2	6.5
		3	22 - 40	77.7	19.5	2.8	LS	19	-	-	4.7	1.4	3.3
		4	40 - 70	78.2	19.1	2.7	LS	13	-	-	3.7	1.1	2.6
		5	70 -	71.0	16.8	12.2	SL	17	-	-	12.2	4.8	7.4
	17	1	0 - 20	65.6	28.1	6.3	SL	20	1.56	41	8.8	2.4	6.4
		2	20 - 50	36.2	28.0	15.8	SL	17	1.62	39	14.9	5.6	9.3
		3	50 - 72	47.2	28.2	24.6	L	15	-	-	19.6	7.8	11.6
		4	72 -	43.2	29.2	27.6	CL	13	-	-	19.9	8.7	11.2
Re/On	7	1	0 - 10	45.2	47.0	7.8	L	18	1.73	36	14.7	-	-
		2	10 - 24	38.6	36.2	25.2	L	26	1.60	39	23.2	-	-
		3	24 - 44	56.6	20.0	23.4	SCL	22	-	-	20.0	-	-
		4	44 - 100	14.2	39.0	46.8	C	22	-	-	33.0	-	-
	24	1	0 - 15	63.5	30.8	5.7	SL	20	1.77	33	7.9	2.5	5.4
		2	15 - 30	66.8	23.0	10.2	SL	18	1.77	35	10.4	4.2	6.2
		3	30 - 40	37.4	22.6	40.0	C	21	-	-	28.1	15.3	12.8
		4	40 - 80	27.6	23.4	49.0	C	24	-	-	31.0	17.7	13.3
		5	80 - 105	24.6	23.2	52.2	C	26	-	-	29.6	16.6	13.0
Re-1	10	1	0 - 20	42.8	41.8	15.4	L	23	1.47	45	19.2	6.1	13.1
		2	20 - 34	43.8	39.8	16.4	L	19	1.50	44	18.9	6.4	12.5
		3	34 - 60	47.6	35.8	16.6	L	21	-	-	16.4	5.7	10.7
		4	60 - 90	48.0	36.8	15.2	L	15	-	-	16.8	5.4	11.4

TABLE B-2. : PHYSICAL AND CHEMICAL PROPERTIES 1-5

Soil Map Symbol	PIT No.	Horizon	Depth cm	Particle Size %			Texture	Handness cm^2/Kg	Bulk Density g/cm^3	Porosity %	Moisture Content %		Avail. Moisture %
				Sand	Silt	Clay					Moisture Equivalent	Wilting Point	
Re-1	13	1	0 - 10	76.5	20.4	3.1	LS	15	1.54	42	5.9	1.3	4.6
		2	10 - 25	75.0	22.0	3.0	LS	15	1.58	41	5.7	1.1	4.6
		3	25 - 42	67.5	24.8	7.7	SL	12	-	-	10.1	2.8	7.3
		4	42 -	Welling Water									
	25	1	0 - 14	51.8	39.0	9.2	L	16	1.48	45	14.0	4.0	10.0
		2	14 - 33	56.0	37.0	7.0	SL	15	1.62	38	10.7	3.5	7.2
		3	33 - 46	57.6	34.4	8.0	SL	12	-	-	12.8	2.9	9.9
		4	46 - 55	61.9	33.1	5.0	SL	17	-	-	7.0	1.4	5.6
		5	55 - 80	52.8	32.2	15.0	SL	26	-	-	15.3	5.4	9.9
		6	80 -	44.0	25.4	30.6	CL	22	-	-	23.6	12.0	11.6

TABLE B-3. : PHYSICAL AND CHEMICAL PROPERTIES 2-1

Soil Map Symbol	PIT No.	Horizon	pH (H_2O)		E.C.	Ca Titration		C.E.C.	Base	Exchangeable Cation				O.M.	Total-C	Total-N	Phosphorus P		Total	Sat. Ext.	
						mg Ca/100g		m.e./	Saturation	m.e./100g							Sorpt.	Avail.	Ext. K	ppm	
			1:1	1:5	x10^3 mmho/cm	pH 6.0	pH 7.0	100g	%	Na	Mg	Ca	K	%	%	%	ppm	ppm	ppm	Fe	Mn
Re	4	1	5.1	5.2	< 0.20	0.40	1.5	3.5	11	0.01	0.05	0.25	0.07	0.35	0.20	0.02	48	6.1	27	0.38	0.09
		2	5.5	5.8	< 0.20	0.10	1.4	2.0	29	0.01	0.11	0.38	0.09	0.10	0.06	0.005	24	4.6	35	0.23	0.06
		3	6.0	6.5	< 0.20	-	-	9.4	20	0.01	0.92	0.78	0.16	-	-	0.01	250	1.7	63	0.52	0.01
		4	5.4	6.2	< 0.20	-	-	21.0	19	0.01	2.20	1.60	0.22	-	-	0.01	413	1.9	86	0.05	0.05
	5	1	5.1	5.4	< 0.20	0.10	0.80	1.1	52	0.01	0.05	0.39	0.12	0.28	0.13	0.01	19	9.8	47	4.00	0.93
		2	5.9	6.3	< 0.20	0	0.50	2.7	42	0.01	0.06	0.94	0.12	0.29	0.17	0.008	20	12.0	47	0.04	0.33
		3	6.5	6.7	< 0.20	0	0.40	0.92	68	0.01	0.06	0.44	0.12	0.10	0.06	0.005	14	8.2	47	0.33	0.05
		4	6.2	6.7	< 0.20	-	-	4.9	52	0.01	0.70	1.70	0.14	-	-	0.02	27	4.9	55	0.06	0.11
	6	1	5.1	5.5	< 0.20	0.40	1.5	3.9	23	0.01	0.19	0.56	0.12	0.30	0.17	0.02	29	9.5	47	0.20	0.29
		2	5.5	5.9	< 0.20	0.10	1.2	3.6	20	0.01	0.14	0.51	0.07	0.23	0.13	0.01	35	12.0	27	0.43	0.06
		3	5.7	5.8	< 0.20	-	-	1.1	44	0.01	0.06	0.37	0.05	-	-	0.005	18	7.8	19	0.51	0.04
		4	5.8	5.9	< 0.20	-	-	1.0	49	0.01	0.12	0.29	0.07	-	-	0.005	19	3.9	27	0.47	0.03
	8	1	4.9	5.0	< 0.20	0.10	0.90	3.2	14	0.01	0.05	0.28	0.10	0.64	0.37	0.03	51	14.0	39	4.30	0.95
		2	4.9	5.0	< 0.20	0.30	1.4	2.0	21	0.01	0.19	0.11	0.12	0.12	0.07	0.01	43	3.9	47	0.52	0.52
		3	4.9	5.1	< 0.20	-	-	4.3	21	0.01	0.21	0.54	0.14	-	-	0.02	88	1.6	55	0.59	0.22
		4	Welling Water																		
	9	1	5.0	5.2	< 0.20	0.6	2.0	3.9	21	0.01	0.23	0.49	0.09	0.23	0.13	0.03	67	7.9	35	0.50	1.30
		2	5.5	5.7	< 0.20	0.10	0.90	2.0	32	0.01	0.09	0.47	0.07	0.12	0.07	0.02	37	4.9	27	0.33	0.57
		3	5.6	5.8	< 0.20	0.10	0.60	2.4	29	0.01	0.10	0.54	0.05	0.10	0.06	0.01	19	4.4	19	0.05	0.23
		4	4.8	5.1	< 0.20	-	-	4.9	22	0.01	0.45	0.55	0.09	-	-	0.01	82	2.1	35	0.15	0.15
	11	1	5.3	5.5	< 0.20	0.20	2.1	6.8	32	0.01	0.30	1.70	0.14	1.60	0.93	0.07	54	4.8	55	0.46	0.30
		2	5.6	5.8	< 0.20	0	0.70	5.3	31	0.01	0.30	1.30	0.05	0.58	0.34	0.03	37	7.8	19	0.34	0.25
		3	5.0	5.2	< 0.20	0	-	8.1	15	0.01	0.38	0.72	0.10	-	-	0.05	88	7.0	39	0.38	0.09
		4	4.5	4.7	< 0.20	-	-	11.0	7	0.01	0.28	0.37	0.10	-	-	0.03	124	6.9	39	0.49	0.16

TABLE B-3. : PHYSICAL AND CHEMICAL PROPERTIES 2-2

Soil Map Symbol	PIT No.	Horizon	pH (H_2O) 1:1	pH (H_2O) 1:5	E.C. $\times 10^3$ mmho/cm	Ca Titration mg Ca/100g pH 6.0	Ca Titration mg Ca/100g pH 7.0	C.E.C. m.e./100g	Base Saturation %	Exchangeable Cation m.e./100g Na	Mg	Ca	K	O.M. %	Total-C %	Total-N %	Phosphorus P Sorpt. ppm	Phosphorus P Avail. ppm	Total Ext.K ppm	Sat.Ext. ppm Fe	Sat.Ext. ppm Mn
Re	12	1	5.2	5.6	< 0.20	0.40	1.7	5.2	28	0.01	0.40	1.00	0.07	0.69	0.40	0.04	67	18.0	27	0.42	1.30
		2	4.9	5.2	< 0.20	0.50	2.4	7.8	18	0.01	0.43	0.87	0.12	0.54	0.31	0.03	52	30.0	47	0.54	0.27
		3	4.8	5.3	< 0.20	-	-	7.6	16	0.01	0.42	0.59	0.09	-	-	0.03	106	20.0	35	0.03	0.09
		4	4.9	5.0	< 0.20	-	-	7.2	15	0.01	0.48	0.47	0.10	-	-	0.02	112	11.0	39	0.07	0.12
	14	1	4.8	5.0	< 0.20	0.40	2.9	8.3	18	0.01	0.40	1.00	0.10	1.10	0.63	0.05	177	6.9	39	0.75	0.54
		2	4.8	5.3	< 0.20	0.60	2.3	5.1	19	0.01	0.25	0.63	0.07	0.42	0.24	0.03	108	4.0	27	0.48	0.91
		3	5.1	5.2	< 0.20	0.70	1.9	2.9	18	0.01	0.12	0.32	0.07	0.24	0.14	0.01	46	8.5	27	0.82	1.00
		4	5.4	5.6	< 0.20	-	-	1.1	48	0.01	0.11	0.36	0.05	-	-	0.01	18	5.9	19	0.12	1.50
		5	5.6	6.1	< 0.20	-	-	6.6	41	0.01	0.40	2.20	0.12	-	-	0.02	39	5.0	47	0.06	0.19
	18	1	5.0	5.3	< 0.20	0.60	1.9	5.5	14	0.01	0.18	0.48	0.12	0.42	0.24	0.03	84	9.0	47	0.71	0.60
		2	5.6	5.8	< 0.20	0.10	1.3	6.6	41	0.01	0.60	2.60	0.12	0.42	0.24	0.02	74	3.4	47	0.12	0.15
		3	5.7	6.0	< 0.20	0	2.0	11.0	47	0.01	1.00	4.00	0.12	0.74	0.43	0.04	126	6.7	47	0.45	0.17
		4	5.2	5.3	< 0.20	-	-	13.0	27	0.01	1.00	2.30	0.19	-	-	0.03	206	3.3	74	0.52	0.05
	19	1	5.2	5.8	< 0.20	0.20	1.0	1.2	32	0.01	0.07	0.22	0.09	0.46	0.27	< 0.01	24	6.6	35	0.45	0.16
		2	5.2	5.3	< 0.20	0.30	1.1	1.0	31	0.01	0.06	0.12	0.12	0.11	0.06	0.01	20	11.0	47	0.29	0.36
		3	5.2	5.6	< 0.20	-	-	0.7	54	0.01	0.05	0.15	0.09	-	-	< 0.01	16	5.3	35	0.76	0.44
		4	Welling Water																		
	20	1	5.3	5.5	< 0.20	0	0.70	1.2	49	0.01	0.19	0.30	0.09	0.17	0.10	0.01	31	11.0	35	0.44	0.12
		2	5.6	5.9	< 0.20	0	0.80	1.0	59	0.01	0.14	0.32	0.12	0.12	0.07	< 0.01	19	2.8	47	0.14	0.02
		3	5.7	6.2	< 0.20	0	1.4	8.3	35	0.01	0.50	2.20	0.17	0.24	0.14	0.02	205	1.1	66	0.57	0
		4	5.3	5.6	< 0.20	-	-	13.0	30	0.01	1.20	2.50	0.17	-	-	0.01	367	4.9	66	0.02	0.02
		5	5.4	5.9	< 0.20	-	-	17.0	48	0.01	3.50	4.50	0.24	-	-	0.02	190	1.4	94	0.06	0.15
	23	1	4.9	5.0	< 0.20	0.2	1.5	5.2	28	0.01	0.40	1.00	0.07	0.69	0.40	0.04	67	18.0	27	6.20	0.83
		2	5.1	5.5	< 0.20	0.2	0.8	7.8	18	0.01	0.43	0.87	0.12	0.54	0.31	0.03	52	30.0	47	0.13	0.08
		3	4.9	5.2	< 0.20	-	-	7.6	16	0.01	0.42	0.59	0.09	-	-	0.03	106	20.0	35	0.13	0.06
		4			< 0.20	-	-	7.2	15	0.01	0.48	0.47	0.10	-	-	0.02	112	11.0	39	-	-

TABLE B-3. : PHYSICAL AND CHEMICAL PROPERTIES 2-3

Soil Map Symbol	PIT No.	Horizon	pH (H_2O) 1:1	pH (H_2O) 1:5	E.C. x10^3 mmho/cm	Ca Titration mg Ca/100g pH 6.0	Ca Titration mg Ca/100g pH 7.0	C.E.C. m.e./100g	Base Saturation %	Exchangeable Cation m.e./100g Na	Mg	Ca	K	O.M. %	Total-C %	Total-N %	Phosphorus P Sorpt. ppm	Phosphorus P Avail. ppm	Total Ext. K ppm	Sat. Ext. ppm Fe	Mn
Re	26	1	4.7	5.0	< 0.20	0.4	1.3	3.5	11	0.01	0.15	0.15	0.09	0.48	0.28	0.03	71	6.3	35	17.0	0.51
		2	5.3	5.4	< 0.20	0.7	2.0	5.4	18	0.01	0.51	0.37	0.07	0.31	0.18	0.03	170	4.8	27	0.19	0.07
		3	6.0	6.3	< 0.20	-	-	8.4	25	0.01	1.49	0.51	0.12	-	-	0.02	258	2.9	47	0.57	0
		4	Hardpan																		
	27	1	5.2	5.6	< 0.20	0.1	0.7	2.9	18	0.01	0.08	0.36	0.07	0.58	0.34	0.03	19	20.0	27	12.0	0.84
		2	5.2	5.5	< 0.20	0.2	1.0	1.4	34	0.01	0.08	0.29	0.09	0.10	0.06	0.01	29	23.0	35	0.05	0.28
		3	5.7	6.0	< 0.20	-	-	5.3	15	0.01	0.16	0.55	0.10	-	-	0.01	128	3.5	39	0.22	0.06
Kt/Pp	21	1	5.0	5.2	< 0.20	0	2.0	6.0	27	0.01	0.30	1.20	0.14	0.81	0.47	0.04	52	3.5	55	15.0	4.90
		2	5.1	5.3	< 0.20	0.9	2.8	8.0	15	0.01	0.21	0.79	0.19	0.30	0.17	0.03	195	1.9	74	0.56	0.17
		3	5.5	5.7	< 0.20	-	-	12.0	10	0.01	0.24	0.66	0.24	-	-	0.02	315	5.7	94	0.12	0.02
		4	5.6	5.8	< 0.20	-	-	12.0	13	0.01	0.30	1.00	0.22	-	-	0.02	325	1.9	86	0.06	0.02
		5	5.4	5.9	< 0.20	-	-	15.0	17	0.01	0.40	1.90	0.30	-	-	0.02	266	4.9	117	0.09	0.01
BbC	2	1	5.2	5.8	< 0.20	0.20	1.40	2.9	19	0.01	0.19	0.19	0.17	0.52	0.30	0.02	40	4.2	66	0.57	0.31
		2	5.5	5.8	< 0.20	0.10	0.70	2.2	14	0.01	0.01	0.23	0.07	0.12	0.07	0.02	24	7.1	27	0.14	0.07
		3	6.4	6.6	< 0.20	-	-	1.3	21	0.01	0.01	0.20	0.05	-	-	0.006	53	3.4	19	0.26	0.02
		4	6.0	6.9	< 0.20	-	-	15.0	14	0.01	0.20	1.70	0.17	-	-	0.01	201	2.0	66	0.55	0.03
	22	1	5.6	5.8	< 0.20	0.1	0.9	3.0	25	0.01	0.09	0.55	0.09	0.58	0.34	0.02	31	2.3	35	0.49	0.09
		2	5.4	5.7	< 0.20	0.1	0.9	1.5	39	0.01	0.06	0.39	0.12	0.30	0.17	0.01	21	3.1	47	0.08	0.14
		3	4.8	5.1	< 0.20	0.4	1.5	7.5	14	0.01	0.24	0.71	0.07	0.48	0.28	0.02	68	2.8	27	0.29	0.09
		4	4.8	5.0	< 0.20	-	-	9.3	7.6	0.01	0.22	0.41	0.07	-	-	0.02	107	2.1	27	0.09	0.07
		5	Hardpan																		
Kt	15	1	5.0	5.3	< 0.20	0.20	1.4	2.9	16	0.01	0.19	0.22	0.05	0.70	0.41	0.03	45	13.0	19	11.0	0.35
		2	5.0	5.3	< 0.20	0.60	1.7	2.8	15	0.01	0.17	0.19	0.05	0.67	0.39	0.02	26	14.0	19	0.65	0.34
		3	4.8	5.2	< 0.20	0.50	1.3	1.1	32	0.01	0.13	0.13	0.02	0.12	0.7	0.01	30	9.0	8	1.10	0.99
		4	5.4	5.5	0.24	-	-	0.8	36	0.01	0.06	0.16	0.05	-	-	0.01	14	5.0	19	0.35	0.26
		5	5.6	5.9	< 0.20	-	-	6.2	28	0.01	0.30	1.30	0.12	-	-	0.01	41	1.7	47	2.30	0.06

TABLE B-3. : PHYSICAL AND CHEMICAL PROPERTIES 2-4

Soil Map Symbol	PIT No.	Horizon	pH (H_2O) 1:1	pH (H_2O) 1:5	E.C. x10^3 mmho/cm	Ca Titration mg Ca/100g pH 6.0	Ca Titration mg Ca/100g pH 7.0	C.E.C. m.e./100g	Base Saturation %	Exchangeable Cation m.e./100g Na	Mg	Ca	K	O.M. %	Total-C %	Total-N %	Phosphorus P Sorpt. ppm	Phosphorus P Avail. ppm	Total Ext.K ppm	Sat.Ext. ppm Fe	Sat.Ext. ppm Mn
Kt	17	1	5.0	5.1	< 0.20	0.30	1.2	3.7	22	0.01	0.15	0.55	0.09	0.65	0.38	0.02	48	7.9	35	0.75	0.28
		2	5.6	5.8	< 0.20	0.10	0.8	6.3	42	0.01	0.40	2.10	0.14	0.12	0.07	0.02	134	2.8	55	0.05	0.11
		3	5.9	6.1	< 0.20	-	-	9.7	42	0.01	0.80	3.10	0.17	-	-	0.02	240	2.7	66	0.50	0.04
		4	5.7	5.9	< 0.20	-	-	11.0	39	0.01	0.60	3.50	0.19	-	-	0.02	248	4.1	74	0.04	0.02
Re/On	7	1	5.1	5.4	< 0.20	0.10	0.80	4.4	18	0.01	0.25	0.41	0.14	0.75	0.44	0.02	111	6.7	55	0.69	0.19
		2	5.9	6.3	< 0.20	0	0.50	10.0	14	0.01	0.46	0.84	0.12	0.52	0.30	0.03	356	2.3	47	0.08	0.03
		3	6.5	6.7	< 0.20	0	0.4	13.0	20	0.01	1.30	1.10	0.22	0.48	0.28	0.02	636	0.5	86	0.36	0.02
		4	-	-	< 0.20	-	-	22.0	22	0.01	2.20	2.30	0.24	-	-	0.02	349	1.2	94	0.48	1.9
	24	1	5.0	5.2	< 0.20	0.2	1.1	3.8	11	0.01	0.08	0.23	0.09	0.65	0.38	0.02	72	3.8	35	7.90	0.21
		2	5.3	5.6	< 0.20	0.1	0.9	4.7	15	0.01	0.16	0.48	0.07	0.12	0.07	0.02	152	1.9	27	0.07	0.01
		3	6.0	6.4	< 0.20	-	-	19.0	9.	0.01	0.20	1.30	0.19	-	-	0.02	378	1.9	74	0.13	0.01
		4	5.5	6.5	< 0.20	-	-	22.0	14	0.01	0.20	2.60	0.26	-	-	0.02	378	7.5	102	0.19	0.01
		5	5.4	6.1	< 0.20	-	-	26.0	26	0.01	0.30	6.10	0.36	-	-	0.02	176	3.7	141	0.22	0.02
Re-1	10	1	5.4	5.9	< 0.20	0	2.6	10.0	32	0.01	0.50	2.60	0.12	0.96	0.56	0.04	129	1.9	47	0.35	0.30
		2	5.1	5.5	< 0.20	0.70	3.4	9.4	23	0.01	0.30	1.80	0.10	0.91	0.53	0.05	137	1.9	39	0.32	0.17
		3	5.3	5.6	< 0.20	-	-	7.9	25	0.01	0.30	1.60	0.09	-	-	0.02	122	2.1	35	0.28	0.07
		4	5.1	5.4	< 0.20	-	-	7.8	12	0.01	0.27	0.56	0.12	-	-	0.02	154	4.8	47	0.59	0.09
	13	1	5.3	5.7	< 0.20	0.30	1.6	2.7	21	0.01	0.21	0.28	0.07	0.38	0.22	0.02	38	4.8	27	0.45	0.12
		2	5.1	5.4	< 0.20	0.40	1.6	2.0	26	0.01	0.18	0.28	0.05	0.44	0.26	0.01	28	5.6	19	0.54	0.48
		3	5.7	5.9	< 0.20	0	1.6	4.9	36	0.01	0.20	1.50	0.05	0.53	0.31	0.02	36	2.3	19	0.05	0.19
		4	Welling Water																		
	25	1	4.6	5.1	< 0.20	0	2.3	4.3	16	0.01	0.13	0.43	0.12	0.59	0.34	0.03	82	15.0	47	2.70	0.72
		2	5.3	5.4	< 0.20	0.3	1.4	3.8	32	0.01	0.29	0.81	0.10	0.18	0.11	0.01	54	3.5	39	0.05	0.90
		3	5.5	5.7	< 0.20	-	-	3.4	29	0.01	0.23	0.66	0.09	-	-	0.01	46	3.4	35	0.06	0.01
		4	6.8	7.1	< 0.20	-	-	1.3	48	0.01	0.10	0.42	0.09	-	-	0.01	18	9.4	35	0.52	0.01
		5	7.5	8.0	< 0.20	-	-	7.3	47	0.53	0.40	2.40	0.09	-	-	0.01	43	5.5	35	0.26	0.01
		6	8.0	8.7	< 0.20	-	-	14.0	95	1.20	1.00	11.0	0.12	-	-	0.01	154	3.7	47	-	-

FIGURE B-1 : LOCATION OF TEST PIT POINTS

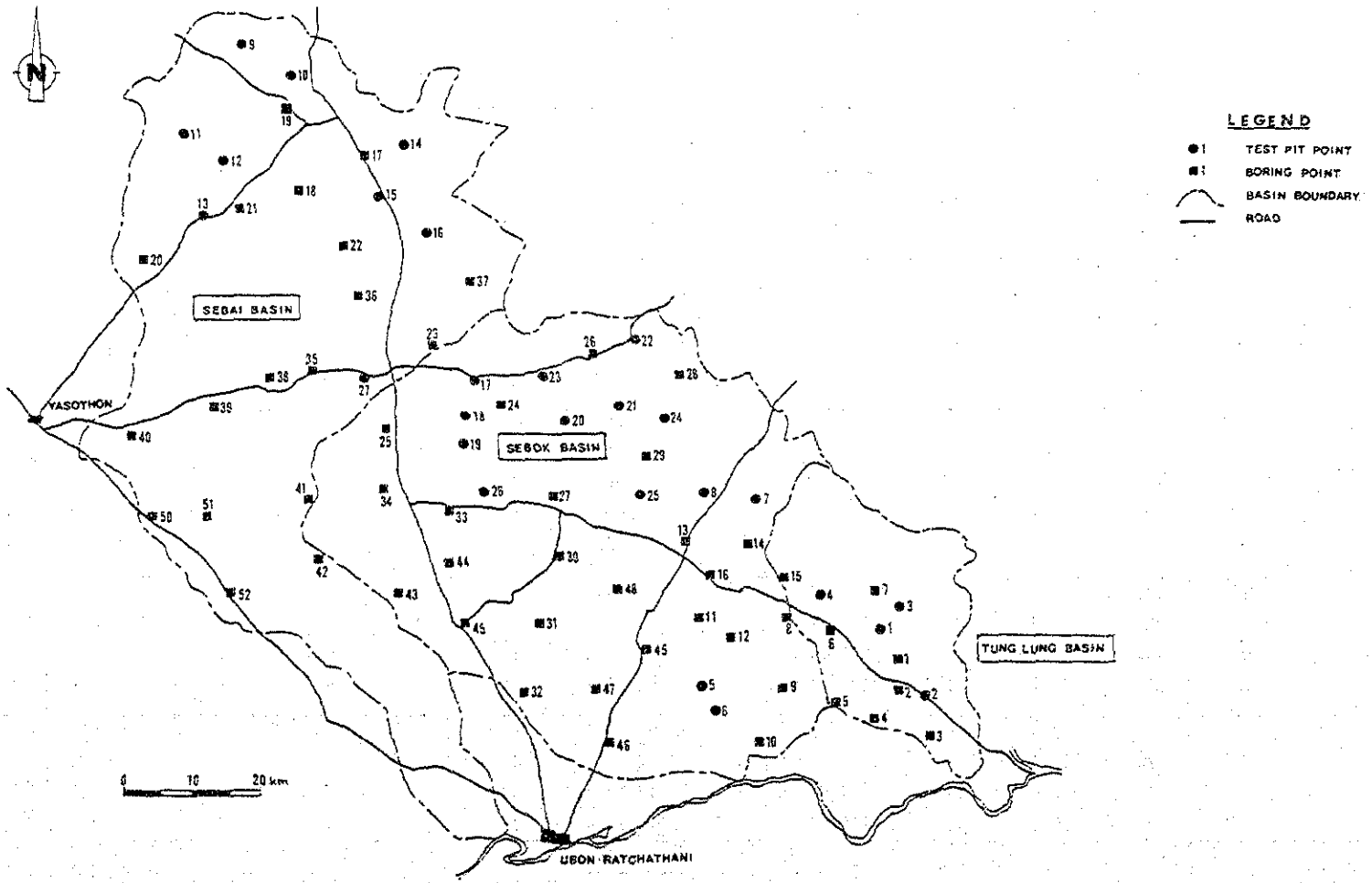
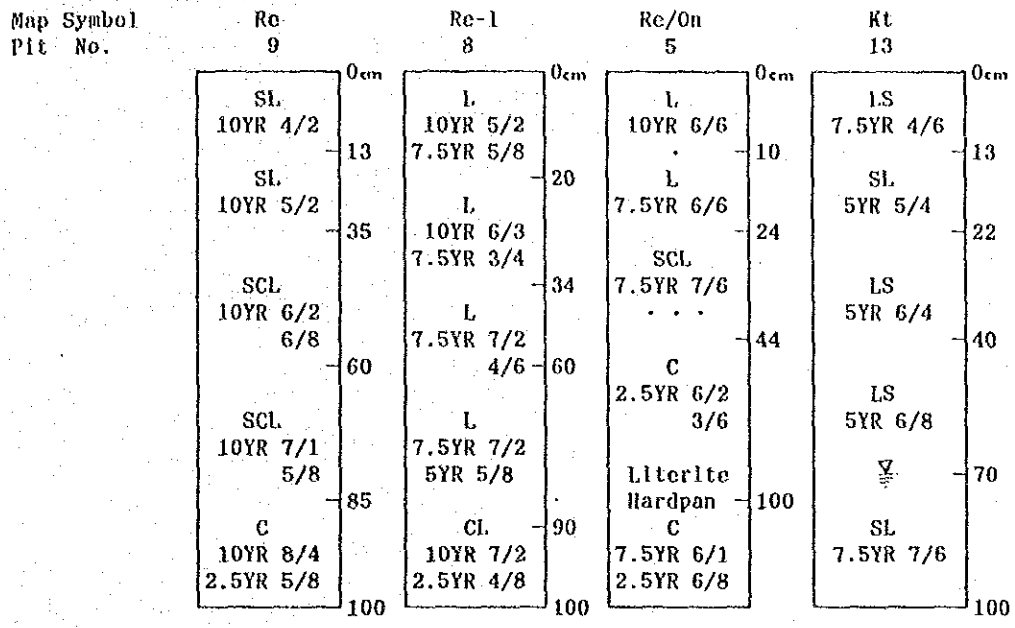
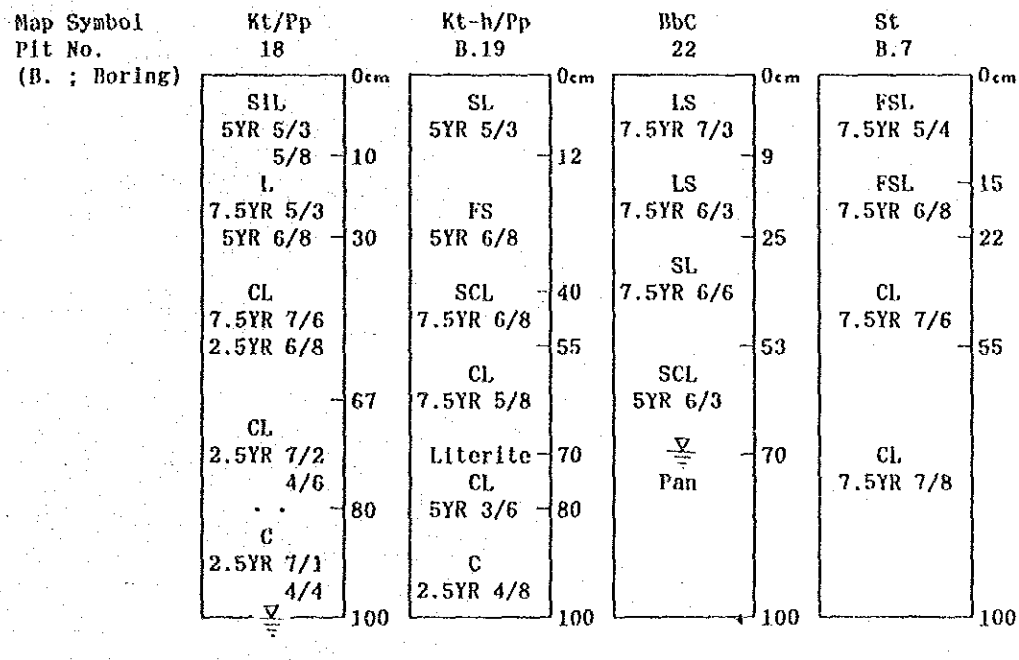


FIGURE B-2 : SOIL COLUMNAR SECTIONS





LEGEND

1.Color : Munsell's soil color name
Hue Value/Chroma
Example ; 10YR 3/1

2.Texture : clay C
silt, -y Si
sand, -y S
loam, -y L
(fine F)
Example ; Sandy clay loam
SCL

3.Rate of gravel content :
· < 5 %
· · 5 to 15 %
· · · 15 to 40 %

4.Groundwater Level : ▽

APPENDIX C. AGRICULTURE

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C-1. Present Practice of Rice Cultivation

Rice is the main crop in the project area and its technical improvement has top priority in agricultural development. To understand the present condition of rice cultivation, data in 1987/88 rainy season collected by DOAE were summarized in TableC-3 (1/3) ~ (3/3). No direct seeding was observed in the area so far.

(1) Planting Conditions

Most of the planted areas are under non-irrigable condition except a small area in Tambon Kradien where glutinous rice is cultivated.

Upland rice area was observed in two Tambons in Yasothon and all of them are glutinous rice. Ratio of glutinous rice and non-glutinous rice in the all related Tambons is 73 : 27 but the ratio in the field survey is 91 : 8. The difference is due to sampling size.

(2) Yield

The average yield in non-irrigable areas of related Tambons according to the data collected by DOAE is 324 kg/rai (2.0 tons/ha) including glutinous and non-glutinous but in our field survey it was 173 kg / rai (1.1tons/ha). The reason of the difference may be due to sampling method. No obvious difference is observed between the yield of glutinous and non-glutinous.

(3) Variety

Almost all farmers are using recommended photo-sensitive varieties such as RD6 (glutinous) and Khao Doak Mali 105 (non-glutinous). In the field survey 88 % of paddy field is covered by HYV, which includes these varieties (Table C-4). Newly released high yielding varieties such as Neo Ubon 1 (glutinous). RD 15, Khao Pak-Mawn 148, Khao Jao Chumpae-60 are not still popular.

(4) Seed Renewal and Others

Majority of farmers are changing seed within four seasons like Tambon Kham Lai in Amphoe Sri Muang Mai, Ubon Ratchathani. In case of self-supply, seeds are harvested from the plots specially prepared for that purpose from the beginning or separated plots just before harvesting. But some Tambons such as Na Khai, Tan Sum, Ubon Ratchathani, have no special plot for that purpose. Seeding rate per rai is between 4.2kg and 8.4kg according to the field survey with the average of 5.2kg.

(5) Starting Cultivation

Onset of rice cultivation in the Tambons of Yasothon is evenly distributed for two months, mid May to mid July but that of Tambons in Ubon Ratchathani varies with some concentrations. The difference may be due to the amount of rainfall.

(6) Fertilizer

All farmers are applying fertilizer. In some Tambons in the east and central south of Ubon Ratchathani, less than 20 kg/rai at one time is applied. In Yasothon, the amount of fertilizer and its application time look reasonable than that of Ubon Ratchathani. According to the field survey, an averaged sampled farmer in five project areas is applying 15.4 kg/rai. Recommendation of DOAE, Ubon Ratchathani, on fertilizer application to paddy is 20~30 kg/rai of compound fertilizer at the beginning and 10~15 kg/rai of urea at booting stage.

(7) Harvesting and Winnowing.

Almost all farmers are harvesting at right time and drying in the fields for 1~3 days except some areas in Yasothon. As for winnowing, screening of harvested paddy by wind or another method are popular except one Tambon in Yasothon.