the sediment are 23.4 x 10^6, 35.6 x 10^6, and 55.6 x 10^6 m^3 respectively. They correspond to 3.6, 41.4 and 12.0% of the total storage volume of the each reservoir, respectively. The sediment levels of the each reservoir are EL. 191, 246, and 294m respectively, on the assumtion that the sedement lies in horizontal.

4.6 Flood Analysis

Probable Maximum Precipitation analysis has been already performed in the Yuam river basin. The value of PMF (Probable Maximum Flood) 6,200m^3/s at Lower Yuam project site is obtained as a result of it. Flood discharge of each dam site is calculated with Creager's method in this study. PMF at Lower Yuam site was taken into consideration for this analysis. PMF 6,200m^3/s at Lower Yuam site is in the case of the coefficient C of Creager equation being 40. The comparison of design flood of various dam sites in Thailand is shown in Fig. 4-20.

The Ngao river has a lot of discharge and specific run-off is 4.95m^3/s -day/100km^2. This is almost the same as 4.69 of Khao Laem site.

Coefficient C of Creager's equation at this site is 56. Design flood of the Ngao river basin is calculated by assuming the coefficient C 55. That of the Yuam river and the Rit river basin is assumed to be 30. Design flood of each dam site is shown in Table 4-19.

Table 4–1 Gaging and Observatory Stations of Nam Yuam River Basin

NO.	River	Station	Location	Code	Drainage Area (km^2)	Period
1	Nam Mae Yuam	Sop Han	Lat. 18°12.2' N Long. 97°56.1' E	NEA	2496	1966-
2	Nam Mae Yuam	Ban Tha Rua Pha Lae	Lat. 17°50' N Long. 97°54.8' E	NEA	5770	1968-
3	Nam Mae Rit	Ban Mae Suat	Lat. 17°53'30"N Long. 97°57'48"E	EGAT	1376	ARR.1.1983-
4	Nam Mae Ngao	Ban Mae Ngao	Lat. 17°51'18"N Long. 97°58'12"E	EGAT	935	MAY 1.1984-
5	Nam Mae Yuam	Ban Wang Khan	Lat. 18°23'18"N Long. 97°58'12"E	EGAT	1974	MAY 12.1984-
6	Nam Mae Yuam	Rid Weir	Lat. 18°21'56"N Long. 97°56'06"E	RID	2617	1976-
7		Mae Sariang	Lat. 18°9.8' N Long. 97°58' E	MD	—	1950-

Table 4–2 Monthly List of Daily Average Precipitation at Each Observatory Station

(Unit: mm)

Mon. / Obs. Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total	Annual Average
Mae La Luang ('67 - '84)	0.44	0.07	0.18	1.47	5.95	6.13	6.92	9.57	7.40	3.68	1.25	0.53	1,334.9	3.66
Sop Han ('67 - '84)	0.38	0.13	0.21	1.03	5.36	5.84	6.48	7.13	7.22	3.51	0.62	0.33	1,173.1	3.21
Chom Chaeng ('69 - '84)	0.35	0.12	0.25	1.16	5.26	5.91	5.92	7.28	5.60	3.68	0.58	0.34	1,115.8	3.06
Ban Tha Rua ('69 - '84)	0.54	0.08	0.20	1.48	7.35	10.46	10.46	11.90	6.95	3.81	0.97	0.33	1,669.7	4.57
Mae Sariang ('52 - '84)	0.30	0.16	0.15	1.17	5.23	6.06	6.13	7.58	6.41	3.81	0.58	0.28	1,161.2	3.18

Table 4–3 Monthly List of Daily Average Evaporation at Each Observatory Station

(Unit: mm)

Mon. / Obs. Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total	Annual Average
Mae La Luang ('70 - '83)	3.29	4.38	5.48	6.22	4.76	3.59	3.31	2.55	3.61	3.47	3.25	3.28	1,442.24	3.95
Sop Han ('68 - '83)	2.72	4.19	5.65	6.55	5.10	3.20	2.66	2.57	3.27	3.15	2.75	2.47	1,344.69	3.68
Ban Tha Rua ('68 - '83)	2.78	3.36	4.92	6.06	4.57	2.99	2.55	23.0	2.93	3.34	2.80	2.68	1,254.62	3.44

Table 4–4 Estimated River Runoffs of The Yuam River at Sop Han in 1979 in cms. day, CA = 2496 sq. km

Month	Runoffs in 1979 cms. day
Jan	375.90
Feb	206.35
Mar	118.53
Apr	117.65
May	308.45
Jun	364.23
Jul	524.51
Aug	1106.00
Sep	907.28
Oct	919.22
Nov	312.59
Dec	182.35
Total	5443.06

****
Estimated & Observed Monthly Runoff of Nam Yuam at Sop Han cms 2496km2 1960-84(60-66&79 estimated)
****

Table 4–5 Estimated and Observed Monthly Runoff of The Yuam River at Sop Han

cms. day

Note:

1) 1967-78 & 1980-84: Observed runoff at Sop Han.
2) 1979: Estimated runoff by regression on river runoff measured at RID weir, Mae Sariang.
3) CA=2496 km2 unit=cms.day

Subfile Totals

Y1960		1963	1966	1969	1972	1975	1978	1981	1984
MRJAN	284.100	278.300	281.900	189.600	276.250	388.600	434.720	216.490	176.320
MRFEB	133.500	223.600	167.000	132.350	187.530	191.250	238.100	136.770	128.830
MRMAR	95.300	155.200	139.500	123.600	151.800	136.000	171.480	104.950	72.970
MRAPR	96.300	110.700	88.000	104.100	157.590	90.000	125.310	84.120	114.540
MRMAY	327.200	113.500	238.800	172.350	144.520	194.450	175.090	108.240	129.930
MRJUN	407.300	333.200	355.200	359.850	264.690	389.050	212.260	262.890	536.940
MRJUL	727.800	737.000	859.900	643.300	721.020	734.300	1459.600	657.910	864.800
MRAUG	2936.200	1427.500	2287.600	3260.500	2158.400	2410.200	2427.800	1735.300	1596.400
MRSEP	1889.300	1991.800	1436.400	2360.800	1056.500	3829.100	3050.800	1222.700	1431.900
MROCT	2249.400	1765.300	915.000	1844.000	842.300	2243.800	2000.600	759.000	1171.100
MRNOV	1103.100	1025.600	428.800	757.900	792.500	928.100	867.100	538.600	523.100
MRDEC	694.900	579.500	283.100	468.700	342.600	593.500	434.700	313.400	283.380

Y1961		1964	1967	1970	1973	1976	1979	1982
MRJAN	424.100	293.900	221.100	307.580	266.740	344.870	375.900	197.200
MRFEB	246.500	211.300	141.090	197.120	160.100	223.470	206.350	118.420
MRMAR	207.300	163.800	111.390	166.280	128.720	161.320	118.530	95.450
MRAPR	145.900	131.600	91.720	167.940	94.080	115.620	117.650	124.010
MRMAY	252.800	233.100	213.410	583.640	268.220	181.620	303.450	172.380
MRJUN	358.300	276.200	338.400	604.330	325.740	198.360	364.230	576.510
MRJUL	751.300	1009.700	532.820	790.700	1211.800	447.140	524.510	573.620
MRAUG	2518.100	1795.600	1527.000	2246.700	3316.700	1118.500	1106.000	1510.800
MRSEP	2446.700	2395.800	2778.200	2276.000	3356.700	1577.100	907.280	2082.500
MROCT	1119.600	1085.100	1163.300	1523.800	1596.800	1425.100	919.220	1700.600
MRNOV	539.200	611.900	518.400	706.700	584.500	678.100	312.590	633.500
MRDEC	598.100	394.000	280.980	575.300	332.380	512.300	182.350	383.880

Y1962		1965	1968	1971	1974	1977	1980	1983
MRJAN	469.100	213.200	196.590	313.480	318.800	326.100	134.710	260.750
MRFEB	205.200	251.700	123.980	207.140	211.070	167.300	91.820	168.160
MRMAR	141.800	173.400	111.040	186.110	156.780	127.080	72.820	120.600
MRAPR	119.000	126.200	127.360	136.350	123.480	158.020	67.510	87.200
MRMAY	307.100	216.800	250.850	365.100	276.510	183.340	306.970	76.090
MRJUN	412.900	366.200	408.980	606.560	339.020	240.700	585.730	175.210
MRJUL	847.000	607.400	801.000	1982.000	543.000	550.700	815.900	263.190
MRAUG	1773.900	1820.800	1629.100	2308.800	1347.100	1267.000	1323.300	574.200
MRSEP	2475.400	1396.200	1290.700	2019.500	1524.000	2837.800	2927.500	773.100
MROCT	1761.900	1601.200	1405.700	1262.600	882.600	1570.000	1343.400	828.200
MRNOV	959.800	835.100	543.400	570.400	896.800	816.500	539.200	524.600
MRDEC	535.400	500.400	299.540	417.700	375.690	545.000	394.210	311.860

****
Estimated & Restored Monthly Runoff of Nam Yuam at Ban Tha Rua cms 5770km2 1960-84(1960-68estimated)
****

Table 4–6 Estimated and Observed Monthly Runoff of The Yuam River at Ban Tha Rua

cms. day

Note:

1) 1976-84: Observed runoff at Ban Tha Rua + Irrigation water-take at RID weir, Mae Sariang.
2) 1969-75: Observed runoff at Ban Tha Rua.
3) 1960-68: Estimated runoff by Time Variant Unit Hydrograph method.
4) CA=5770 km2 unit=cms.day

Subfile Totals

Y1960		1963	1966	1969	1972	1975	1978	1981	1984
MRJAN	891.800	1152.300	970.300	884.500	1026.800	1204.100	1034.750	1024.740	786.250
MRFEB	568.300	951.300	710.800	586.600	697.700	717.600	696.740	555.290	525.890
MRMAR	405.800	660.500	593.700	466.500	593.600	660.100	550.590	453.260	419.330
MRAPR	403.000	460.000	374.600	420.230	575.800	456.500	413.000	383.580	425.970
MRMAY	1084.300	444.400	811.900	865.200	533.600	774.300	706.340	477.670	415.130
MRJUN	1721.700	2094.900	1716.100	2675.200	1090.200	2140.800	722.010	1743.780	3463.410
MRJUL	3339.700	4174.800	4529.500	4334.100	6112.900	4361.700	4204.310	4302.350	3797.370
MRAUG	9796.700	5703.200	8357.200	19382.200	9627.000	6357.900	7639.340	8152.960	7584.320
MRSEP	6570.300	6221.800	5923.000	11475.000	5853.000	8244.000	6393.410	4553.120	6119.850
MROCT	5372.200	4014.000	3233.600	5524.000	3986.600	5669.000	4428.870	3421.530	4260.690
MRNOV	2847.400	2523.800	1402.400	3291.000	2862.100	2578.900	1831.320	2286.430	1932.940
MRDEC	2079.900	1685.900	1074.200	2200.300	1868.000	1557.900	1076.710	1451.270	1219.470

Y1961		1964	1967	1970	1973	1976	1979	1982
MRJAN	1475.400	1073.800	742.000	1490.700	1241.800	1116.200	778.620	935.990
MRFEB	1029.500	898.900	458.000	970.300	743.290	761.500	535.900	575.420
MRMAR	860.100	690.900	383.400	781.200	679.500	577.900	412.100	466.800
MRAPR	586.300	525.500	344.200	739.400	481.500	418.400	363.350	436.950
MRMAY	886.800	824.300	743.100	1526.800	980.500	827.800	587.000	835.720
MRJUN	1719.200	1277.800	1224.800	2076.900	1922.700	1526.800	728.860	3390.670
MRJUL	3858.200	5858.800	3872.200	4498.900	4131.700	3578.400	1912.340	5447.160
MRAUG	8754.800	7432.300	8522.000	7661.000	8200.000	6854.000	7560.640	12434.700
MRSEP	7541.100	7940.300	6837.900	7878.000	8674.000	5659.000	3629.250	8222.560
MROCT	4723.600	3814.900	4111.400	4519.000	5585.000	4802.100	3451.070	5427.610
MRNOV	1880.300	1864.100	1949.200	2316.200	2649.100	2503.040	1456.540	2284.930
MRDEC	1512.900	1427.000	1405.100	1727.500	1715.400	1520.090	890.570	1356.620

Y1962		1965	1968	1971	1974	1977	1980	1983
MRJAN	1190.900	920.300	1054.600	1105.200	1093.100	1652.810	614.920	905.270
MRFEB	862.000	968.700	658.400	714.600	703.400	720.930	441.550	547.680
MRMAR	591.000	621.200	462.500	620.200	531.600	592.240	410.930	429.190
MRAPR	493.100	404.400	508.000	441.300	475.500	543.090	352.280	320.290
MRMAY	1050.700	750.300	775.500	924.300	964.600	633.690	1052.600	324.890
MRJUN	1910.100	1870.700	1900.200	2519.300	2166.000	901.710	1548.230	778.260
MRJUL	4205.600	2942.700	3861.700	10030.000	3957.600	2270.460	2989.790	904.870
MRAUG	6709.400	6383.800	6565.700	11150.000	7053.400	5343.940	4531.920	2902.270
MRSEP	7296.200	4834.600	5705.200	8043.300	5245.000	8753.240	9866.020	3578.590
MROCT	4855.500	3684.700	3396.600	4403.600	3596.200	3639.530	5814.770	3732.290
MRNOV	2338.900	1984.700	1710.200	2281.500	2494.100	2221.300	2532.960	2214.450
MRDEC	1701.300	1420.000	1202.800	1486.700	1283.900	1391.020	1643.310	1232.610

Table 4–7 Scattergram and Regression, Nam Mae Rit

Nam Mae Rit

Scattergram

Y=Daily Runoff o
f Nam Mae Rit at
Ban Mae Suat cm
s EGAT APR83-MAR
85

X1=Daily Runoff
of Nam Yuam at S
op Han cms CA=24
96sqkm JAN1983-D
EC1984 (4days in
1984 is estimat
ed)

X2=Recovered Dai
ly Runoff of Nam
Yuam at Ban Tha
Rua cms CA=5770
sqkm JAN1983-MAR
1985

Period used for
Scattergram Plot
2 years
No of points=
641

Range of Y (cms)
1.84 - 76.4
Range of X1 (cms
)
.68 - 217
Range of X2 (cms
)
7.3 - 580.041

Y file:DRRit
X1 file:DR113H
X2 file:DR114W

Regression

Model:
Y=b0+b1*X1+b2*X2

Coeffs of Normal
Equations:

A11= 641
A12= 10643.86
A13= 46939.115
B1= 7331.24
A21= 10643.86
A22= 399635.8064
A23=
1536443.63865
B2= 218666.112
A31= 46939.115
A32=
1536443.63865
A33=
7169910.36788
B3= 995177.57162

Solution

b0= 2.3450941098
b1= .05734496051
b2= .11115810224

Error

Err1= .00000002
Err2= .000001
Err3= .000006

Correlation
Coefficient
R2=
.816817446532
Corr. coeff.=
.903779534266

Table 4–8 Scattergram and Regression, Nam Mae Ngao

Nam Mae Ngao

Scattergram

Y=Daily Runoff of Nam Mae Ngao at Ban Mae Ngao cms EGAT CA=935sqkm May1984-Mar1985

X1=Daily Runoff of Nam Yuam at Sop Han cms NEA CA=2496sqkm JAN1984-DEC1984

X2=Recovered Daily Runoff of Nam Yuam at Ban Tha Rua cms CA=5770sqkm JAN1984-MAR1985

Period used for Scattergram Plot
1 years
No of points=
245

Range of Y (cms)
4 - 419
Range of X1 (cms)
2.15 - 217
Range of X2 (cms)
9.88 - 580.041

Y file:DRNgao
X1 file:DR113y
X2 file:DR114Y

Regression

Model:
Y=b0+b1*X1+b2*X2

Coeffs of Normal Equations:

A11= 245
A12= 6537.55
A13= 28793.171
B1= 15724.64
A21= 6537.55
A22= 319823.9567
A23= 1194144.48182
B2= 633339.139
A31= 28793.171
A32= 1194144.48182
A33= 5592099.61498
B3= 3134175.9769

Solution

b0=-2.089383883
b1=-.54183348322
b2= .68692685984

Error

Err1=-.0000003
Err2=-.000012
Err3=-.00005

Correlation Coefficient
R2=
.911485981406
Corr. coeff.=
.954717749614

Table 4–9 Scattergram and Regression, Wang Khan

Wang Khan

```
Scattergram                Regression

Y=Daily Runoff o           Model:
f Nam Mae Yuam a           Y=b0+b1*X
t Ban Wang Kan c
ms EGAT CA=1173s           Coeffs of Normal
qkm 12MAY1984-MA            Equations:
R1985
                           A11= 234
X=Daily Runoff o           A12= 6486.57
f Nam Yuam at So           B1= 4900.93
p Han cms NEA CA           A21= 6486.57
=2496sqkm JAN198           A22= 319574.4865
4-DEC1984                  B2= 226957.126

Period used for
Scattergram Plot           Solution
 1 years
                           b0= 2.8753818955
Range of Y (cms)           b1= .65182224758
 1.42 - 142
Range of X (cms)           Error
 2.15 - 217
                           Err1=-.00000004
Y file:DRWKan              Err2=-.000002
X file:DR113y
                             Correlation
                             Coefficient
                           R2=
                            .886285621289
                           Corr.coeff.=
                            .941427438149
```

Table 4–10 Estimated and Observed Monthly Runoff of The Rit River at Ban Mae Suat

Estimated & Observed Monthly Runoff of Nam Mae Rit at Ban Mae Suat cms CA=1376sq km JAN1960-DEC1984

File:MR7

	Y1960	Y1963	Y1966	Y1969	Y1972	Y1975	Y1978	Y1981	Y1984
JAN	186.42	214.87	194.97	181.89	202.67	228.83	212.65	199.02	146.81
FEB	141.49	189.32	159.28	138.46	156.31	156.39	156.76	135.23	110.13
MAR	121.19	153.00	144.66	131.64	147.38	153.87	143.73	129.10	75.95
APR	120.95	128.13	117.30	123.03	143.39	126.26	123.45	117.81	115.02
MAY	210.33	126.57	174.83	178.75	140.30	169.92	161.25	132.00	88.03
JUN	285.69	322.45	281.90	388.36	206.71	330.63	162.78	279.26	462.82
JUL	484.10	577.00	623.70	591.36	793.54	599.64	623.74	588.66	415.58
AUG	1332.45	788.02	1133.82	2414.13	1266.59	917.64	1061.09	1078.47	875.20
SEP	911.99	879.69	812.86	1481.27	781.54	1206.32	955.98	646.58	908.80
OCT	801.41	621.77	483.75	746.60	564.14	831.52	679.72	496.55	898.60
NOV	452.49	411.99	251.69	479.63	433.94	410.24	323.64	355.39	394.00
DEC	342.79	292.20	206.53	344.15	299.99	279.90	217.31	251.99	251.89
Sum	5391.30	4705.01	4585.29	7199.27	5136.50	5411.16	4822.10	4410.06	4742.83

	Y1961	Y1964	Y1967	Y1970	Y1973	Y1976	Y1979	Y1982
JAN	259.47	207.14	166.02	256.04	226.03	216.55	180.80	188.05
FEB	199.36	182.78	129.75	184.82	157.46	165.47	137.06	136.41
MAR	178.24	156.89	119.70	169.07	155.61	146.18	125.30	130.06
APR	144.23	136.64	114.17	162.17	129.27	123.49	117.49	126.03
MAY	183.96	175.85	165.68	275.88	197.07	175.13	155.63	175.48
JUN	282.43	228.62	226.55	335.87	302.75	251.44	172.26	480.31
JUL	542.87	779.81	531.12	618.13	601.46	496.10	315.34	711.08
AUG	1191.80	1001.61	1105.77	1053.11	1174.39	898.71	976.55	1541.55
SEP	1053.25	1094.30	995.65	1076.57	1227.02	789.83	525.80	1103.77
OCT	660.96	558.38	595.93	662.40	785.08	688.21	509.02	773.54
NOV	311.25	313.88	317.60	368.34	398.34	387.47	250.18	360.67
DEC	274.20	252.29	242.99	297.71	282.44	271.04	182.15	245.51
Sum	5282.02	5088.19	4710.93	5460.11	5636.92	4609.62	3647.58	5972.46

	Y1962	Y1965	Y1968	Y1971	Y1974	Y1977	Y1980	Y1983
JAN	230.75	185.26	199.10	213.52	212.48	275.12	148.77	188.28
FEB	178.33	192.95	150.87	156.97	155.95	155.39	122.35	136.18
MAR	144.50	149.76	128.42	152.31	140.78	145.82	122.55	127.32
APR	132.29	122.92	134.45	127.22	130.29	139.78	113.38	104.04
MAY	205.39	166.68	171.54	196.38	195.77	153.65	207.30	118.76
JUN	306.86	299.66	305.53	385.17	330.56	184.39	276.04	166.77
JUL	587.10	432.88	546.28	1301.27	543.75	356.66	451.82	147.83
AUG	920.35	887.20	895.66	1444.50	933.99	739.37	652.34	418.70
SEP	1027.91	690.06	779.92	1080.24	740.77	1206.08	1334.91	483.90
OCT	714.62	575.38	531.63	634.59	523.05	567.29	796.09	540.00
NOV	387.54	340.79	292.69	357.13	399.02	364.09	382.83	416.65
DEC	291.22	257.99	221.75	261.91	236.96	258.57	277.97	191.76
Sum	5126.86	4301.53	4357.84	6311.21	4543.37	4546.21	4886.35	3040.19

Table 4—11 Estimated and Observed Monthly Runoff of The Ngao River at Ban Mae Ngao

Estimated & Observed Monthly Runoff of Nam Mae Ngao at Ban Mae Ngao cms CA=935sq km JAN1960-DEC1984

File:MR8

	Y1960	Y1963	Y1966	Y1969	Y1972	Y1975	Y1978	Y1981	Y1984
JAN	394.21	576.91	449.51	440.10	490.90	551.81	410.49	521.86	379.80
FEB	254.02	468.45	333.81	272.75	317.08	330.82	291.11	248.85	230.86
MAR	163.02	305.63	268.22	188.72	260.75	314.99	220.54	189.73	183.75
APR	160.54	191.91	145.53	169.59	247.48	202.15	153.14	155.24	167.88
MAY	503.18	179.62	364.04	436.19	223.48	361.77	325.58	204.72	188.60
JUN	898.42	1196.31	923.18	1580.02	542.80	1197.10	318.29	992.74	2163.94
JUL	1837.33	2407.75	2584.66	2563.89	3743.68	2533.54	2032.43	2534.17	2417.70
AUG	5073.67	3081.64	4438.03	11482.60	5378.80	2996.73	3867.45	4595.48	4714.20
SEP	3425.47	3129.00	3228.22	6540.66	3385.47	3535.62	2676.11	2402.49	3006.00
OCT	2402.01	1732.01	1661.37	3164.15	2217.36	2613.67	1893.56	1874.33	1807.50
NOV	1291.89	1111.47	666.57	1787.35	1473.98	1205.97	725.49	1216.11	878.60
DEC	987.26	779.15	520.45	1192.73	1032.79	683.83	439.33	762.35	548.10
Sum	17391.02	15159.85	15583.59	29818.75	19314.57	16528.00	13353.52	15698.07	16686.93

	Y1961	Y1964	Y1967	Y1970	Y1973	Y1976	Y1979	Y1982
JAN	719.46	514.24	325.59	792.59	643.74	515.13	266.42	471.35
FEB	509.76	439.10	173.84	501.23	365.35	341.43	197.82	272.62
MAR	414.56	321.86	138.75	381.77	332.26	244.81	154.10	204.18
APR	259.61	225.57	122.54	354.25	217.11	162.09	123.18	170.29
MAY	407.96	375.71	330.57	667.81	463.44	405.47	171.34	415.92
JUN	923.62	664.55	593.85	1036.56	1081.59	878.65	240.65	1954.10
JUL	2181.72	3418.40	2311.40	2597.23	2116.83	2151.07	964.68	3366.23
AUG	4585.38	4070.96	4969.45	3980.45	3770.95	4037.40	4529.58	7658.41
SEP	3788.23	4091.29	3121.53	4115.73	4076.96	2970.12	1938.76	4457.26
OCT	2575.74	1968.50	2129.86	2213.82	2906.53	2461.77	1807.81	2742.17
NOV	935.25	884.15	994.16	1145.48	1440.37	1289.32	768.50	1163.66
DEC	649.71	702.64	749.64	810.19	933.50	701.85	448.20	659.14
Sum	17951.00	17676.97	15961.18	18597.11	18348.63	16159.11	11611.04	23535.33

	Y1962	Y1965	Y1968	Y1971	Y1974	Y1977	Y1980	Y1983
JAN	498.69	452.80	554.47	524.58	513.39	293.91	284.65	415.81
FEB	417.02	465.00	321.34	320.15	310.33	346.08	192.98	226.61
MAR	265.10	268.55	193.45	260.43	215.46	273.21	178.06	164.72
APR	210.16	145.08	215.84	166.59	197.06	224.77	142.74	110.10
MAY	491.07	333.67	332.33	372.35	448.03	271.20	491.97	117.19
JUN	1025.17	1023.68	1020.50	1339.25	1241.52	426.32	683.48	377.00
JUL	2368.54	1629.90	2156.83	5751.21	2359.61	1196.49	1546.93	414.22
AUG	3584.72	3334.58	3565.25	6343.49	4050.51	2919.63	2331.33	1617.77
SEP	3603.70	2500.28	3158.18	4368.26	2714.51	4412.55	5128.34	1976.67
OCT	2313.77	1595.24	1504.11	2276.07	1927.35	1584.66	3201.67	2050.30
NOV	1020.21	844.63	815.72	1191.16	1164.68	1020.80	1385.14	1174.25
DEC	813.99	639.37	600.04	730.17	613.63	595.47	850.48	612.98
Sum	16612.14	13232.78	14438.06	23643.71	15756.08	14165.09	16417.77	9257.62

Table 4–12 Estimated and Observed Monthly Runoff of The Yuam River at Wang Khan

Estimated & Observed Monthly Runoff of Nam Yuam at Wang Khan cms CA=1173sqkm JAN 1960-DEC1984

File:MR9

	Y1960	Y1963	Y1966	Y1969	Y1972	Y1975	Y1978	Y1981	Y1984
JAN	271.90	268.11	270.46	212.71	269.19	342.42	372.49	230.24	204.05
FEB	173.44	232.35	195.34	166.77	205.61	205.16	235.70	169.65	167.35
MAR	148.47	187.63	177.37	169.69	188.07	177.77	200.90	157.53	136.69
APR	149.12	158.54	143.70	154.11	188.97	144.91	167.93	141.08	160.91
MAY	300.08	160.37	242.28	201.47	183.33	215.87	203.25	159.68	105.18
JUN	352.44	304.00	318.38	320.81	258.78	339.84	224.61	257.61	338.06
JUL	561.98	567.99	648.34	508.44	559.10	567.76	1040.52	517.97	636.33
AUG	2005.75	1019.41	1581.72	2214.39	1496.02	1660.15	1671.62	1220.23	1102.60
SEP	1321.32	1388.33	1025.23	1625.07	774.90	2582.14	2074.83	883.23	1114.60
OCT	1556.74	1240.26	684.36	769.63	638.16	1551.68	1393.16	583.86	1009.50
NOV	807.33	756.67	366.50	580.27	602.82	691.21	651.45	437.32	414.80
DEC	540.47	465.02	271.25	394.63	312.44	475.98	372.47	293.41	244.72
Sum	8189.04	6748.68	5924.93	7317.99	5677.39	8954.89	8608.93	5051.81	5634.79

	Y1961	Y1964	Y1967	Y1970	Y1973	Y1976	Y1979	Y1982
JAN	363.43	278.31	233.24	289.61	262.99	313.92	334.15	217.66
FEB	247.32	224.31	172.47	208.99	184.86	229.04	215.01	157.69
MAR	221.69	193.25	161.73	197.51	173.03	194.28	166.39	151.34
APR	181.55	172.20	146.04	195.72	147.57	161.61	162.94	167.08
MAY	251.44	238.56	228.23	469.56	263.96	207.51	290.18	201.49
JUN	320.41	266.74	306.83	480.17	298.57	215.55	323.66	462.03
JUL	577.34	746.27	436.43	604.52	879.00	380.58	431.01	463.02
AUG	1732.41	1260.07	1084.46	1553.57	2251.02	818.19	810.04	1073.90
SEP	1685.73	1652.46	1897.14	1569.80	2274.22	1114.24	677.64	1443.67
OCT	818.12	795.57	847.39	1082.37	1129.95	1018.04	688.29	1197.61
NOV	438.68	486.20	424.16	546.89	467.24	528.25	290.00	499.18
DEC	477.18	343.75	272.27	464.12	305.78	423.05	207.98	339.35
Sum	7315.30	6657.69	6210.39	7662.83	8638.19	5604.26	4597.29	6374.02

	Y1962	Y1965	Y1968	Y1971	Y1974	Y1977	Y1980	Y1983
JAN	392.85	225.55	217.27	293.46	296.93	301.68	176.93	259.09
FEB	220.32	250.72	164.19	215.52	218.08	189.55	143.23	190.11
MAR	178.87	199.53	161.50	210.44	191.32	171.96	136.59	167.74
APR	163.96	168.67	169.27	175.13	166.74	189.25	130.26	143.09
MAY	286.94	227.90	252.64	327.11	269.36	208.63	289.22	138.72
JUN	356.11	325.57	352.83	481.62	307.23	243.14	468.04	200.46
JUL	639.90	483.26	611.23	1381.04	443.06	448.08	620.95	260.68
AUG	1245.88	1276.54	1151.01	1594.05	967.20	914.98	951.68	463.40
SEP	1704.49	998.95	927.56	1402.60	1079.63	1935.99	1994.46	590.17
OCT	1238.03	1132.97	1005.39	912.12	664.42	1112.49	964.78	628.96
NOV	713.65	632.12	440.45	463.26	670.80	618.46	437.71	428.20
DEC	436.19	413.31	284.37	361.39	334.01	444.37	346.08	292.40
Sum	7577.19	6335.09	5737.71	7817.74	5608.78	6778.58	6659.93	3763.02

Table 4–13 Monthly Comparison of Daily Average Runoff, Observed and Estimated (by Tank Model)

(Unit: m^3/s, excp. Ann. Total (m^3/s.day))

Mon. / Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total (m^3/s.day)	Annual Average
1970	48.09	34.65	25.20	24.65	49.25	69.23	145.13	247.13	262.60	145.77	77.21	55.73	36,186	99.14
	30.03	23.25	16.53	12.05	26.10	43.88	54.76	163.55	258.70	219.09	111.33	64.93	31,254	85.63
1971	35.65	25.52	20.01	14.71	29.82	83.98	323.55	359.68	268.10	142.05	76.05	47.96	43,720	119.78
	40.90	33.16	29.04	20.41	14.81	18.36	154.76	181.15	230.67	133.48	64.29	39.31	29,338	80.38
1972	33.12	24.06	19.15	19.19	17.21	36.34	197.19	310.55	195.10	128.60	95.40	60.26	34,827	95.16
	31.56	24.31	17.32	13.40	13.20	12.70	24.17	116.09	129.23	159.28	92.61	55.62	21,078	57.59
1973	40.03	26.55	21.92	16.05	31.63	64.09	133.28	264.52	289.13	180.16	88.30	55.34	37,004	101.38
	32.43	26.15	19.56	13.59	16.58	22.38	51.21	147.37	196.02	136.46	65.19	36.94	23,305	63.85
1974	35.26	25.12	17.15	16.18	31.12	72.20	127.66	227.53	174.83	116.01	83.14	41.42	29,574	81.03
	28.89	22.15	15.54	12.70	12.50	30.84	87.48	191.97	142.29	116.48	70.65	40.30	23,603	64.66
1975	38.84	25.63	21.92	15.22	24.98	71.36	140.70	205.09	274.80	182.87	85.96	50.25	34,723	95.13
	41.86	28.53	22.70	15.79	13.95	36.55	83.14	113.47	132.39	94.92	51.15	31.57	20,325	55.69
1976	36.01	26.26	18.64	13.95	26.70	50.89	115.43	221.10	188.63	154.91	82.99	48.36	30,111	82.27
	25.97	20.24	14.84	12.82	12.70	14.53	44.54	112.68	104.83	75.40	46.11	26.90	15,639	42.73
1977	52.73	24.76	18.37	17.57	20.02	29.29	71.02	170.48	290.53	115.72	72.43	44.48	28,265	77.44
	31.45	20.60	15.45	15.62	12.14	15.01	30.71	77.67	174.65	119.01	63.53	39.28	18,738	51.34
1978	32.31	23.49	15.80	11.67	21.91	23.35	133.64	244.19	211.10	140.91	58.89	34.66	29,134	79.82
	30.03	24.60	19.17	13.38	13.53	13.96	83.26	133.52	184.34	171.03	82.15	44.01	24,835	68.04
1979	24.92	19.14	13.29	12.11	18.94	23.24	58.62	241.01	116.29	108.15	47.23	28.17	21,788	56.69
	32.19	24.84	17.75	12.72	12.00	27.33	32.79	129.39	144.22	130.45	59.01	32.84	20,004	54.80
1980	17.96	13.29	10.92	9.06	32.84	51.58	94.70	143.79	327.37	185.26	82.61	52.57	31,183	85.20
	25.58	19.04	13.25	12.00	66.20	47.05	69.28	110.32	279.99	197.98	106.01	63.82	30,843	84.27

Note: Upper line is observed runoff.
Lower line is estimated runoff.

From : "Nam Mae Yuam Hydroelectric Development Project, Feasibility Report". Volume I, Mar. 1984, JICA, Table 3-19.

Table 4–14 Monthly Runoffs Estimated by Time Variant Unit Hydrograph Method

	Runoff Estimate of NAM YUAM at Ban Tha Rua (CA=4890km²), m³/s day										
	1970	1971	1972 L	1973	1974	1975	1976 L	1977	1978	1979	1980 L
JAN	31.99 991.7	32.97 1022.2	26.73 828.6	39.98 1239.4	28.02 868.5	38.89 1205.5	24.61 762.8	32.21 998.5	32.31 1001.7	27.42 850.0	22.89 709.7
FEB	23.91 669.5	25.37 710.4	19.97 579.2	23.45 656.7	21.90 613.2	25.67 718.8	18.90 548.0	24.66 690.5	27.00 756.0	21.21 593.8	15.94 462.2
MAR	17.01 527.4	27.84 863.0	15.48 479.9	21.91 679.2	13.86 429.7	19.31 598.5	14.43 447.2	21.55 668.1	17.36 538.2	14.51 449.9	11.53 357.3
APR	15.79 473.7	19.35 580.5	14.38 431.5	16.04 481.2	14.72 441.7	16.36 490.8	12.62 378.7	19.01 570.4	14.07 422.2	13.26 397.7	10.58 317.4
MAY	36.25 1123.9	28.83 893.8	17.16 532.1	29.20 905.3	24.71 766.1	27.26 845.1	20.99 650.6	27.68 858.1	25.10 778.2	22.51 697.9	32.87 1018.9
JUN	59.58 1787.5	62.63 1878.9	43.24 1297.3	49.15 1474.4	52.14 1564.3	59.53 1786.0	47.00 1409.9	45.71 1371.4	43.04 1291.2	47.01 1410.4	51.51 1545.2
JUL	102.19 3167.8	178.55 5535.1	158.85 4924.3	108.50 3363.5	111.53 3457.3	104.01 3224.4	119.85 3715.4	102.37 3173.4	133.65 4143.0	68.79 2132.4	109.04 3380.1
AUG	230.27 7138.3	242.39 7514.2	268.39 8320.2	219.09 6791.8	213.92 6631.4	204.47 6338.7	220.91 6848.1	179.90 5576.9	255.83 7930.8	240.99 7470.7	135.92 5763.6
SEP	247.19 7415.7	170.97 5129.1	174.07 5222.1	295.99 8879.7	187.15 5614.5	217.02 6510.6	188.65 5659.6	255.67 7670.2	218.27 6548.6	180.77 5423.1	327.32 9819.5
OCT	152.11 4715.5	114.75 3557.3	124.32 3853.8	157.15 4871.7	119.17 3694.2	128.41 3980.8	128.04 3969.1	156.92 4864.4	140.94 4369.1	108.26 3356.0	192.20 5958.3
NOV	74.73 2241.9	65.40 1961.9	95.45 2863.6	78.64 2359.3	85.17 2555.2	64.07 1922.2	66.15 1984.6	72.44 2173.2	68.74 2062.3	52.91 1587.4	89.91 2697.3
DEC	50.80 1574.7	42.10 1305.0	60.24 1867.5	35.88 1112.2	46.05 1427.5	35.84 1110.9	48.38 1499.7	53.56 1660.5	39.93 1237.7	28.11 871.5	51.35 1591.7
Total											

From: Long Term Rainfall-Runoff Analysin, Proc of JSCE, NO. 336 Aug 1983, pp 47–53.

Table 4–15 Ordinates of Time Variant Unit Hydrographs The Yuam River at Sop Han (R13336)

(CA = 2496 km²)

	01	02	03	04	05	06	07	08	09	10	11	12		Diagonal sums
01	K0101 .06704													
02	K0201 .11686	K0202 .01044												
03	K0301 .01598	K0302 .08747	K0303 .01044											
04	K0401 .01389	K0402 .01044	K0403 .05348	K004 .01044										
05	K0501 .02625	K0502 .01389	K0503 .01044	K004 .01044	K005 .01044									
06	K0601 .02478	K0602 .02625	K0603 .01044	K004 .01044	K005 "	K006 .01044								
07	K0701 .08136	K0702 .01433	K0703 .02625	K004 .01044	K005 "	K006 .01044	K712 .00241							
08	K0801 .20242	K0802 .07054	K0803 .01044	K004 .01044	K005 "	K006 .01044	K712 .00241	" .00241						
09	K0901 .18925	K0902 .04737	K0903 .07054	K004 .01044	K005 "	K006 .01044	K712 .00241	"	" .00241					
10	K1001 .17303	K1002 .01044	K1003 .04737	K004 .01044	K005 "	K006 .01044	K712 .00241	"	"	" .00241				
11	K1101 .01044	K1102 .09643	K1103 .01044	K004 .01044	K005 "	K006 .01044	K712 .00241	"	"	"	" .00241			
12	K1201 .09664	K1202 .01044	K1203 .04051	K004 .01044	K005 "	K006 .01044	K712 .00241	"	"	"	"	K712 .00241		
13		K0102 .09091	K0103 .01044	K004 .01044	K005 "	K006 .01044	K712 .00241	"	"	"	"	K712 .00241	↘	.13370
14			K0203 .01044	K004 .01044	K005 "	K006 .01044	K712 .00241	"	"	"	"	K712 .00241	↘	.30359
15				K004 .01044	K005 "	K006 .01044	K712 .00241	"	"	"	"	K712 .00241	↘	.08264
16					K005 .01044	K006 .01044	K712 .00241	"	"	"	"	K712 .00241	↘	.08400
17						K006 .01044	K712 .00241	"	"	"	"	K712 .00241	↘	.12453
18							K712 .00241	"	"	"	"	K712 .00241	↘	.09533
19								" .00241	"	"	"	K712 .00241	↘	.26822
20									" .00241	"	"	K712 .00241	↘	.34294
21										" .00241	"	K712 .00241	↘	.25591
22											" .00241	K712 .00241	↘	.35575
23												K712 .00241	↘	.07710
													↘	.24377

Table 4–16 Ordinates of Time Variant Unit Hydrographs The Yuam River at Ban Tha Rua (R13336)

(CA = 5 770 km²)

	01	02	03	04	05	06	07	08	09	10	11	12	Diagonal sums
01	K0101 .02082												
02	K0201 .14923	K0202 .01921											
03	K0301 .01921	K0302 .08602	K0303 .01921										
04	K0401 .01921	K0402 .01921	K0403 .01921	K004 .01921									
05	K0501 .03427	K0502 .01921	K0503 .01921	K004 .01921	K005 .01921								
06	K0601 .07754	K0602 .03427	K0603 .01921	K004 .01921	K005 〃	K006 .01921							
07	K0701 .23488	K0702 .01921	K0703 .01921	K004 .01921	K005 〃	K006 .01921	K712 .00444						
08	K0801 .25679	K0802 .17862	K0803 .01921	K004 .01921	K005 〃	K006 .01921	K712 .00444	〃 .00444					
09	K0901 .14704	K0902 .08910	K0903 .17862	K004 .01921	K005 〃	K006 .01921	K712 .00444	〃	〃 .00444				
10	K1001 .05758	K1002 .09424	K1003 .08190	K004 .01921	K005 〃	K006 .01921	K712 .00444	〃	〃	〃 .00444			
11	K1101 .16976	K1102 .05758	K1103 .02629	K004 .01921	K005 〃	K006 .01921	K712 .00444	〃	〃	〃	〃 .00444		
12	K1201 .01921	K1202 .06619	K1203 .04025	K004 .01921	K005 〃	K006 .01921	K712 .00444	〃	〃	〃	〃	K712 .00444	
13		K0102 .01921	K0103 .04879	K004 .01921	K005 〃	K006 .01921	K712 .00444	〃	〃	〃	〃	K712 .00444	.14351
14			K0203 .01921	K004 .01921	K005 〃	K006 .01921	K712 .00444	〃	〃	〃	〃	K712 .00444	.33873
15				K004 .01921	K005 〃	K006 .01921	K712 .00444	〃	〃	〃	〃	K712 .00444	.14190
16					K005 .01921	K006 .01921	K712 .00444	〃	〃	〃	〃	K712 .00444	.14190
17						K006 .01920	K712 .00444	〃	〃	〃	〃	K712 .00444	.17202
18							K712 .00444	〃	〃	〃	〃	K712 .00444	.20023
19								〃 .00444	〃	〃	〃	K712 .00444	.67639
20									〃 .00444	〃	〃	K712 .00444	.51926
21										〃 .00444	〃	K712 .00444	.35184
22											〃 .00444	K712 .00444	.23968
23												K712 .00444	.36901
													.14190

Table 4–17 Evaporation Extracted Inflow at Mae Rit Dam

Unit: $m^3/s \cdot day$

	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
JAN.	172	239	213	198	191	171	180	153	183	168	236	197	187	208	196	211	200	254	196	167	137	183	173	174	135
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2
	170	237	211	196	189	169	178	151	181	166	234	195	185	206	194	209	197	252	194	165	135	181	171	172	133
FEB.	130	184	164	174	168	178	147	120	139	128	170	145	144	145	144	144	152	143	144	126	113	125	126	125	101
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3
	128	182	162	176	166	176	145	118	137	126	168	143	142	143	142	142	150	141	142	124	111	123	124	123	98
MAR.	112	164	133	141	145	138	133	110	118	121	156	140	136	143	130	142	135	134	132	115	113	119	120	117	70
	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	4	4	4	3	3	3	4
	109	161	130	138	142	135	130	107	115	118	154	137	133	140	127	139	132	131	128	111	109	116	117	114	66
APR.	111	133	122	118	126	113	108	105	124	113	149	117	132	119	120	116	114	129	114	108	104	109	116	96	106
	3	3	3	4	3	3	3	3	2	3	3	3	4	3	3	4	3	3	4	4	4	3	4	4	4
	108	130	119	114	123	110	105	102	122	110	146	114	128	116	117	112	111	126	110	104	100	106	112	92	102
MAY	194	170	189	117	162	154	161	153	158	165	254	181	129	182	180	157	161	142	149	143	191	122	162	109	81
	3	3	3	3	3	3	3	3	3	2	3	4	2	2	2	2	3	2	3	3	3	3	3	4	3
	191	167	186	114	159	151	158	150	155	163	251	177	127	180	178	155	158	140	146	140	188	109	159	105	78
JUN.	263	260	283	297	211	276	260	209	282	358	310	355	190	279	305	305	232	170	150	159	254	257	443	154	426
	2	2	2	2	2	2	2	2	2	1	2	2	2	1	1	2	2	2	2	2	1	2	2	2	2
	261	258	281	295	209	274	258	207	280	357	308	353	188	278	304	303	230	168	148	157	253	255	441	152	424
JUL.	446	500	541	532	719	399	575	489	503	545	570	1199	731	554	501	553	457	329	575	291	416	542	655	136	383
	1	1	1	1	1	1	1	1	1	1	2	1	2	1	2	1	2	1	2	1	1	1	2	2	2
	445	449	540	531	718	398	574	488	502	544	568	1198	729	553	499	552	455	328	573	290	415	541	653	134	381
AUG.	1228	1098	848	726	923	818	1045	1019	825	2225	970	1331	1167	1082	861	846	828	681	978	900	601	994	1421	386	807
	2	2	1	1	1	2	2	2	2	2	1	1	2	1	2	2	2	1	1	2	1	2	2	2	1
	1226	1096	847	725	922	816	1043	1017	823	2223	969	1330	1165	1081	859	844	826	680	977	898	600	992	1419	384	806
SEP.	840	971	947	811	1008	636	749	918	719	1365	992	995	720	1131	683	1112	728	1111	881	485	1230	596	1017	446	837
	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
	838	969	945	809	1006	634	747	916	717	1363	990	993	718	1130	681	1110	726	1109	879	483	1228	594	1015	444	835
OCT.	739	609	659	573	515	530	446	549	490	688	610	585	520	723	482	766	634	523	626	469	734	458	713	498	828
	2	2	2	2	2	2	2	2	2	2	3	2	3	3	2	2	3	2	3	2	2	3	2	2	2
	737	607	657	571	513	528	444	547	488	686	607	583	517	720	480	764	631	521	623	467	732	455	711	496	826
NOV.	417	287	357	380	289	314	232	293	270	442	339	329	400	367	368	378	357	336	298	231	353	327	332	384	363
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	415	285	355	378	287	312	230	291	268	440	337	327	398	365	366	376	355	334	296	229	351	325	330	382	361
DEC.	316	253	268	269	232	238	190	224	204	317	274	241	276	260	218	258	250	238	200	168	256	232	226	177	232
	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2
	314	251	266	267	230	236	188	222	202	214	272	239	274	258	216	255	248	236	198	166	254	230	224	175	230
Total																									

Note: Upper figure show raw inflow, middle figure show evaporation loss and lower figure show net inflow in each of the monthly cells.

Table 4–18 Evaporation Extracted Inflow at Mae Ngao Dam

Unit: $m^3/s \cdot day$

	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
JAN.	352 11 341	643 11 632	445 11 434	515 11 504	459 11 448	404 11 393	401 11 390	291 11 280	495 11 484	393 11 382	708 13 695	468 12 456	438 10 428	575 10 565	458 10 448	493 10 483	460 16 444	798 12 786	367 9 358	238 11 227	254 11 243	466 12 454	421 11 410	371 12 359	339 11 328
FEB.	227 12 215	455 12 443	372 11 361	418 12 406	392 12 380	415 12 403	298 12 286	155 11 144	287 12 275	244 11 233	448 11 437	286 13 273	283 11 272	326 11 315	277 11 266	295 11 284	305 13 292	309 9 300	260 12 248	177 14 163	172 12 160	222 12 210	243 12 231	202 12 190	206 12 194
MAR.	146 18 128	370 18 352	237 17 220	273 18 255	287 18 269	240 18 222	240 18 222	124 18 106	173 15 158	169 17 152	341 13 328	233 17 216	233 18 215	297 19 278	192 17 175	281 18 263	219 16 203	244 16 228	197 21 176	138 22 116	159 21 138	169 20 149	182 18 164	147 19 128	164 17 147
APR.	143 20 123	232 20 212	188 19 169	171 20 151	201 20 181	130 20 110	130 20 110	109 20 89	193 16 177	151 17 134	316 20 296	149 19 130	221 23 198	194 18 176	176 19 157	181 21 160	145 18 127	201 18 183	137 21 116	110 23 87	127 24 103	139 20 119	152 21 131	98 21 77	150 20 130
MAY	449 15 434	364 14 350	439 14 425	160 14 146	336 15 321	298 14 284	325 14 311	295 15 280	297 15 282	390 12 378	596 15 581	333 19 314	200 12 188	414 13 401	400 12 388	323 10 313	362 16 346	242 11 231	291 16 275	153 18 135	439 16 423	183 15 168	371 19 352	105 15 90	168 14 154
JUN.	802 9 793	825 9 816	916 9 907	1068 9 1059	593 9 584	914 9 905	824 9 815	530 9 521	911 10 901	1411 8 1403	926 9 917	1196 12 1184	485 9 476	966 7 959	1109 7 1102	1069 9 1060	785 9 776	381 10 371	284 11 273	215 9 206	610 6 604	887 9 878	1745 9 1736	337 9 328	1933 9 1924
JUL.	1641 8 1633	1948 8 1930	2115 8 2107	2150 9 2141	3053 9 3044	1456 8 1488	2308 8 2300	2064 8 2056	1926 7 1919	2290 6 2284	2319 8 2311	5136 7 5129	3343 9 3334	1890 7 1883	2107 11 2096	2263 7 2256	1921 12 1909	1069 7 1062	1815 10 1805	862 6 856	1381 6 1375	2263 8 2255	3006 12 2994	370 8 362	2159 8 2151
AUG.	4531 9 4522	4095 9 4086	3201 9 3192	2752 9 2743	3636 9 3627	2978 9 2969	3963 9 3954	4438 9 4427	3184 10 3174	10255 11 10244	3555 8 3547	5665 9 5656	4804 9 4795	3368 8 3360	3617 10 3607	2676 11 2665	3606 10 3596	2607 8 2599	3454 8 3446	4045 10 4035	2082 5 2077	4104 9 4095	6839 11 6828	1445 8 1437	4210 6 4204
SEP.	3059 12 3047	3383 12 3371	3218 12 3206	2794 12 2782	3654 12 3642	2233 12 2221	2883 12 2871	2788 12 2776	2820 13 2807	5841 12 5829	3676 13 3663	3901 13 3888	3023 13 3010	3641 11 3630	2424 12 2412	3157 9 3148	2652 10 2642	3941 11 3930	2390 15 2375	1731 11 1720	4580 12 4568	2146 13 2133	3981 14 3967	1765 11 1754	2685 12 2673
OCT.	2145 15 2130	2300 15 2285	2066 15 2051	1547 15 1532	1758 15 1743	1425 15 1410	1484 15 1469	1902 15 1887	1343 15 1328	2826 15 2811	1977 16 1961	2033 12 2021	1980 15 1965	2596 16 2580	1721 15 1706	2334 13 2321	2198 16 2182	1415 14 1401	1691 16 1675	1614 13 1601	2859 13 2846	1674 20 1654	2449 12 2437	1831 14 1817	1614 12 1602
NOV.	1154 12 1142	835 12 823	911 12 899	993 12 981	790 12 778	754 12 742	595 12 583	888 12 876	728 13 715	1596 11 1585	1023 11 1012	1064 10 1054	1316 9 1317	1286 10 1276	1040 13 1027	1077 15 1062	1151 14 1137	912 10 902	648 13 635	686 12 674	1237 10 1227	1086 14 1072	1039 12 1027	1049 12 1037	785 12 773
DEC.	882 12 870	580 11 569	727 11 716	696 11 685	627 11 616	571 11 560	465 11 454	669 11 658	536 11 525	1065 16 1049	724 11 713	652 10 642	922 10 912	834 11 823	548 10 538	611 16 595	627 10 617	532 9 523	392 11 381	400 12 388	760 10 750	681 12 669	589 11 578	547 11 536	489 11 478
Total																									

Note: Upper figure show raw inflow, middle figure show evaporation loss and lower figure show net inflow in each of the monthly cells.

Table 4–19 Design Flood of Each Dam Site

Project Name	C. A. (km^2)	Design Flood (m^3/s)	Specific Runoff $m^3/s/100\ km^2$	Value of Coefficient C
Lower Yuam	5,920	6,200	1.49	40
Nam Mae Ngao	835	3,600	4.95	55
Upper Mae Ngao	490	2,700	-ditto-	-ditto-
Nam Mae Rit	1,268	2,400	0.99	30
Upper Mae Rit 1	686	1,800	-ditto-	-ditto-
Upper Mae Rit 2 (a)	525	1,500	-ditto-	-ditto-
Upper Mae Rit 3	349	1,200	-ditto-	-ditto-
Upper Mae Yuam 1	1,967	2,900	0.92	30
Upper Mae Yuam 2	1,149	2,300	-ditto-	-ditto-
Upper Mae Yuam 3	447	1,400	-ditto-	-ditto-
c.f.				
Khao Laem	3,720	7,100	4.69	56
Nam Chon	4,908	5,900	1.92	42

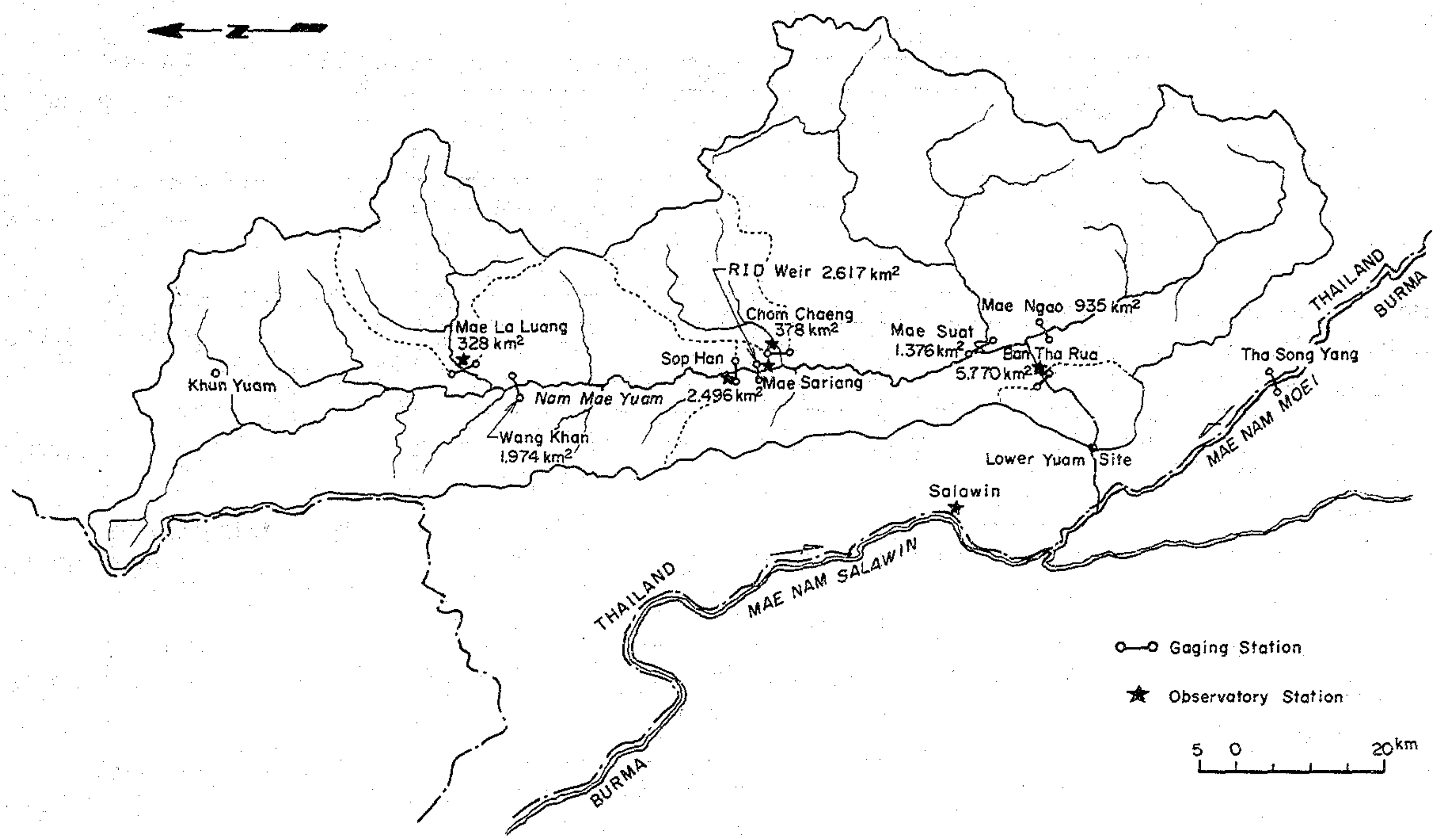

Fig. 4–1 Gaging and Observatory Stations

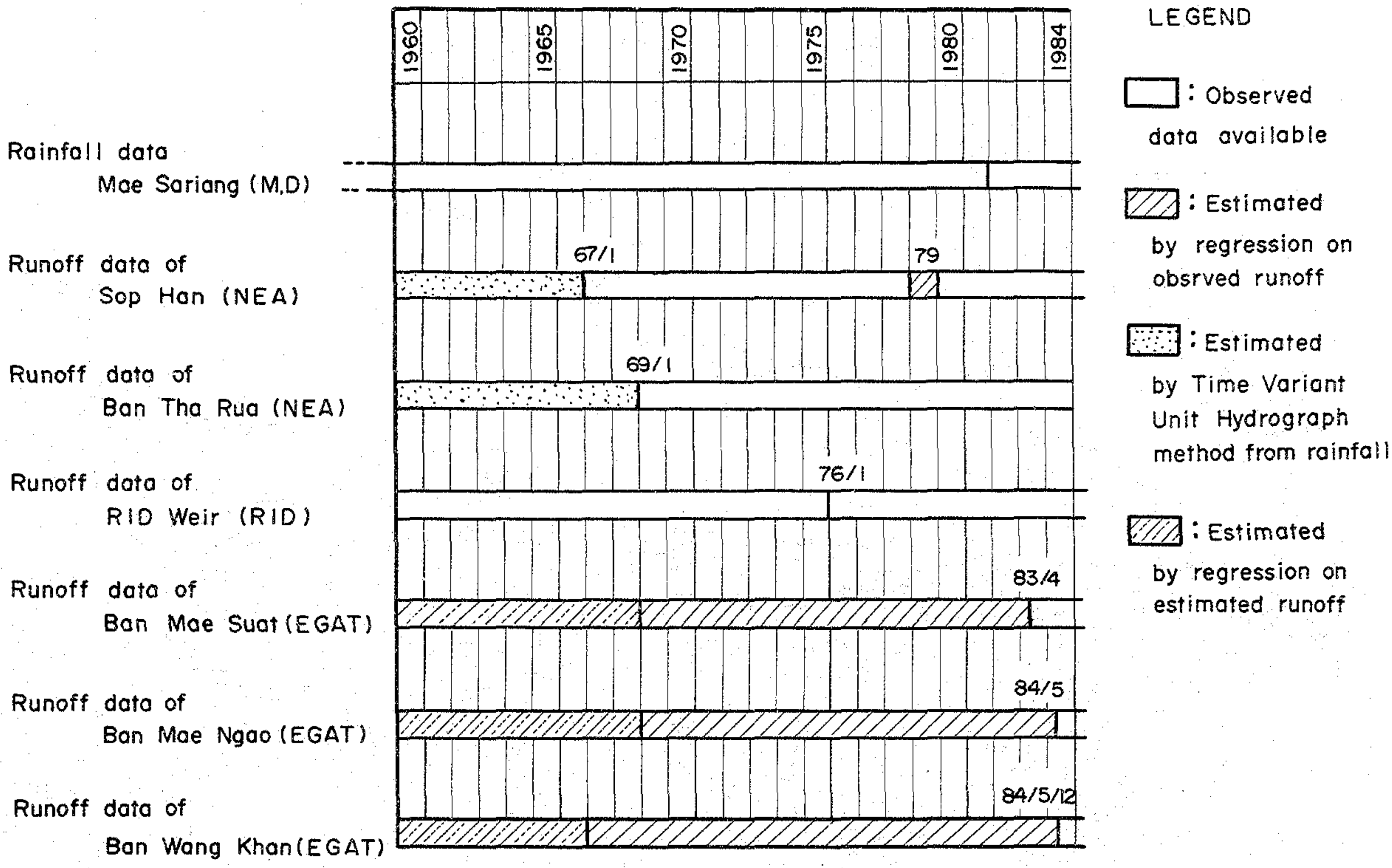

Fig. 4–2 Observed & Estimated Periods of Runoff Data, Nam Yuam River Basin

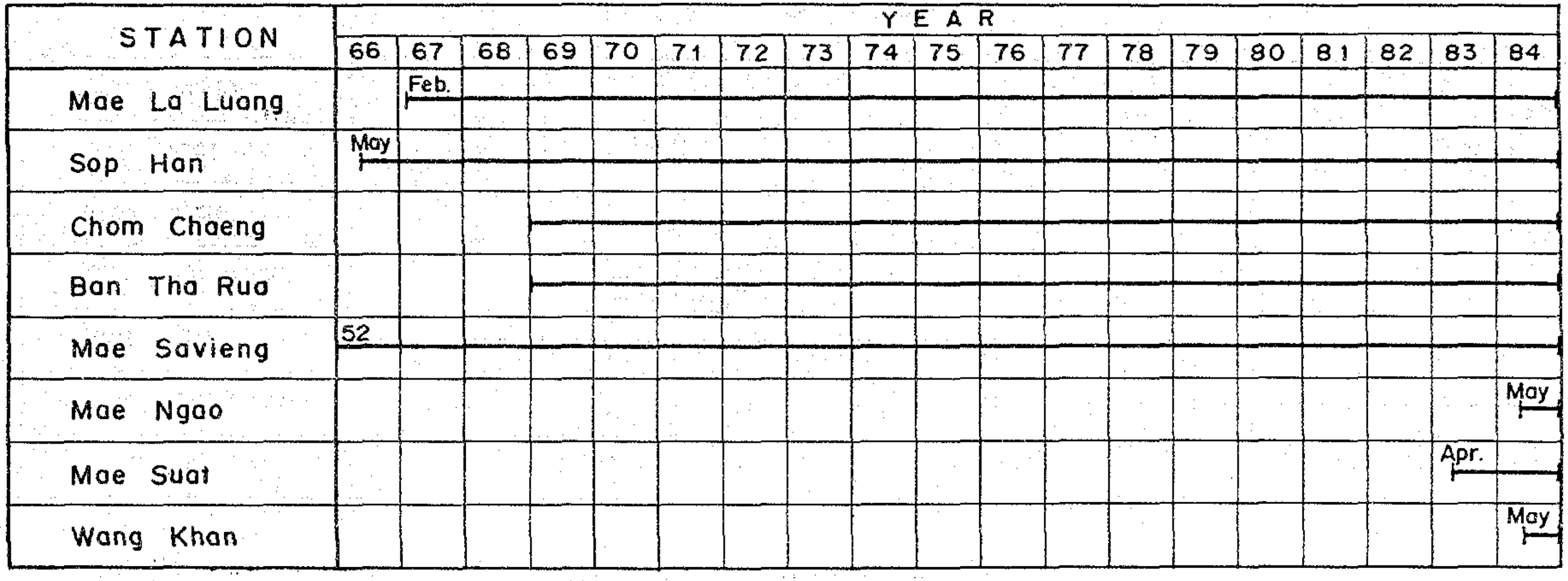

Fig. 4–3 Available Daily Precipitation

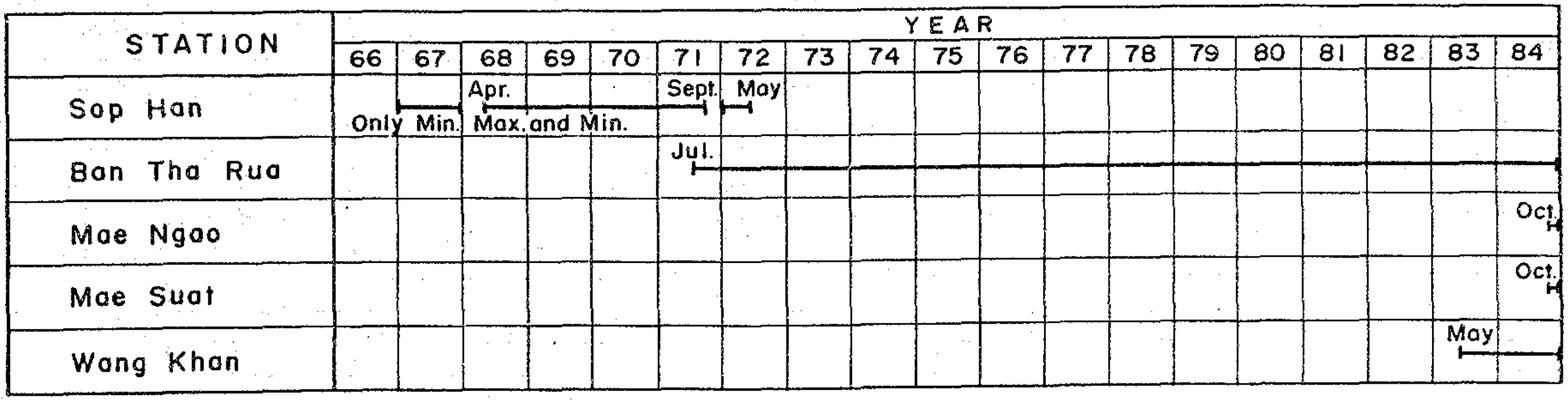

Fig. 4–4 Available Daily Temperature

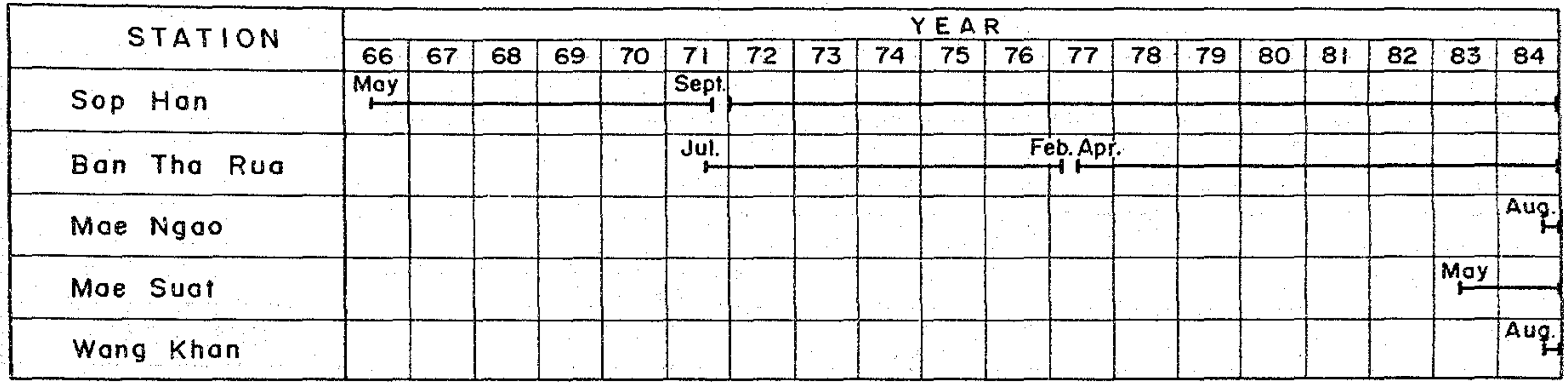

Fig. 4–5 Available Daily Relative Humidity

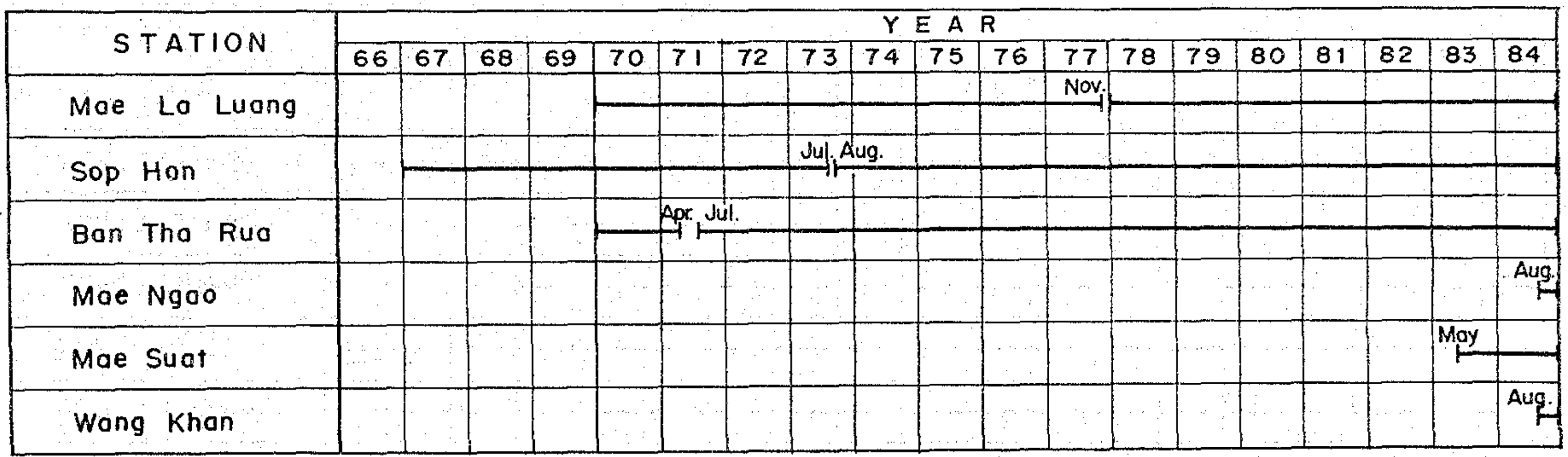

Fig. 4–6 Available Evaporation

Y : Daily Runoff of The Yuam River at Sop Han, cms, NEA, $CA=2496\ km^2$
Jan. 1976 - Dec. 1978 & Jan. 1980 - Dec. 1984

X : Daily Inflow to RID Weir, Mae Sariang, cms, RID, (Spill over Weir + Irrigation intake)
Jan. 1976 - Dec. 1978 & Jan. 1980 - Dec. 1984

Regression model : $Y=-2.096+1.05096X$

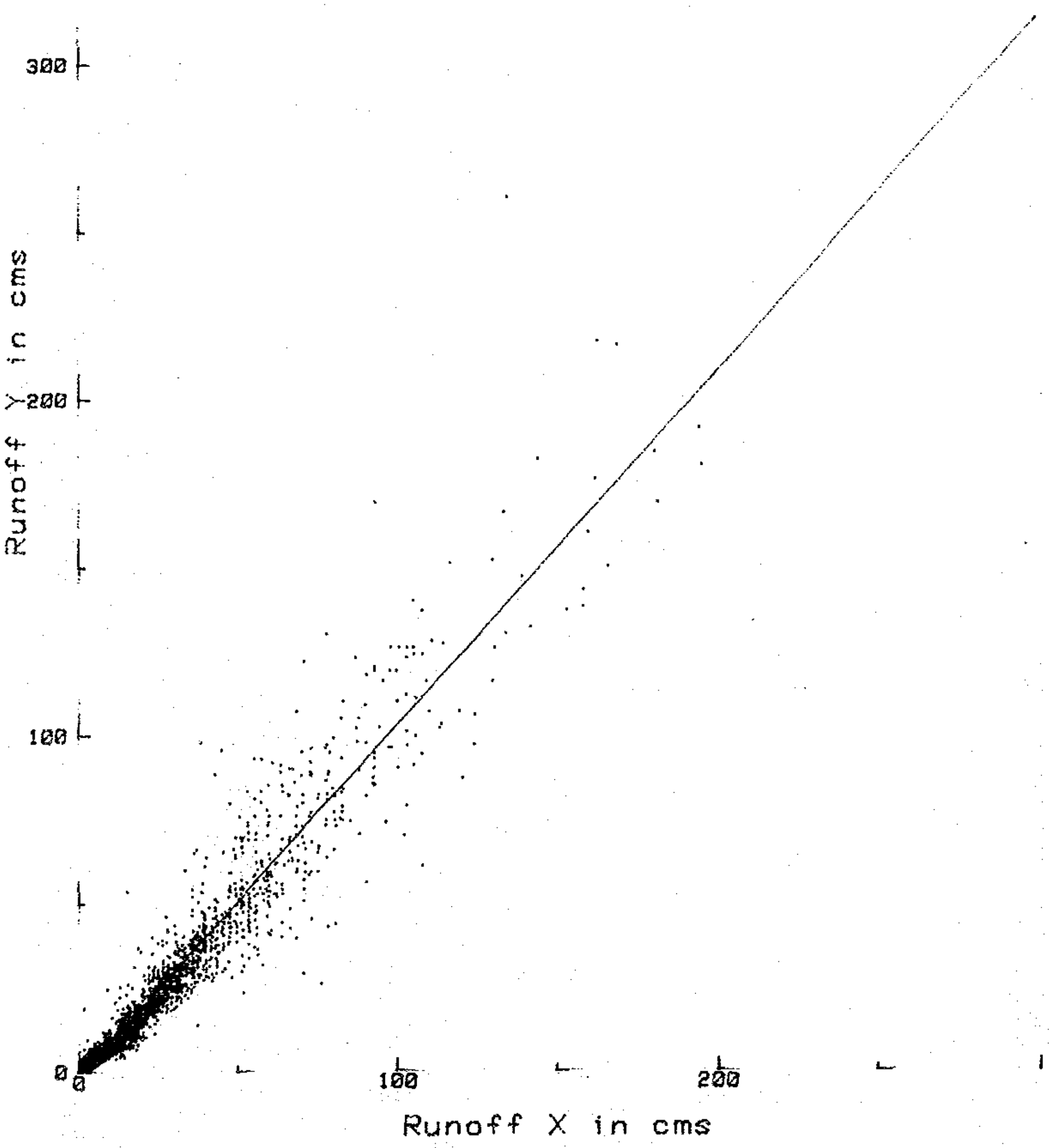

Fig. 4–7 Regression Y : X (Sop Han: RID Weir)

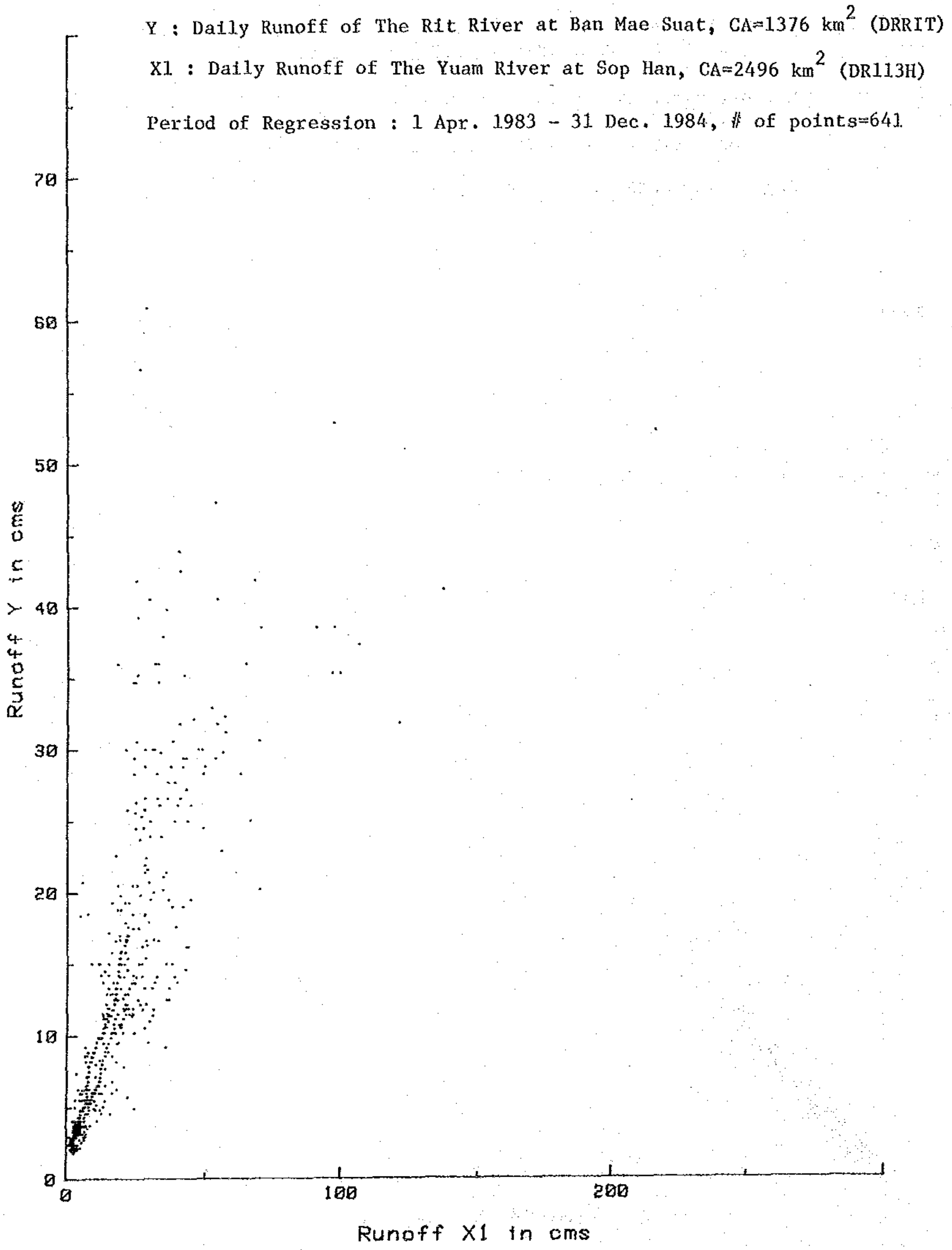

Fig. 4–8 Regression Y : X1 (Nam Mae Rit: Sop Han)

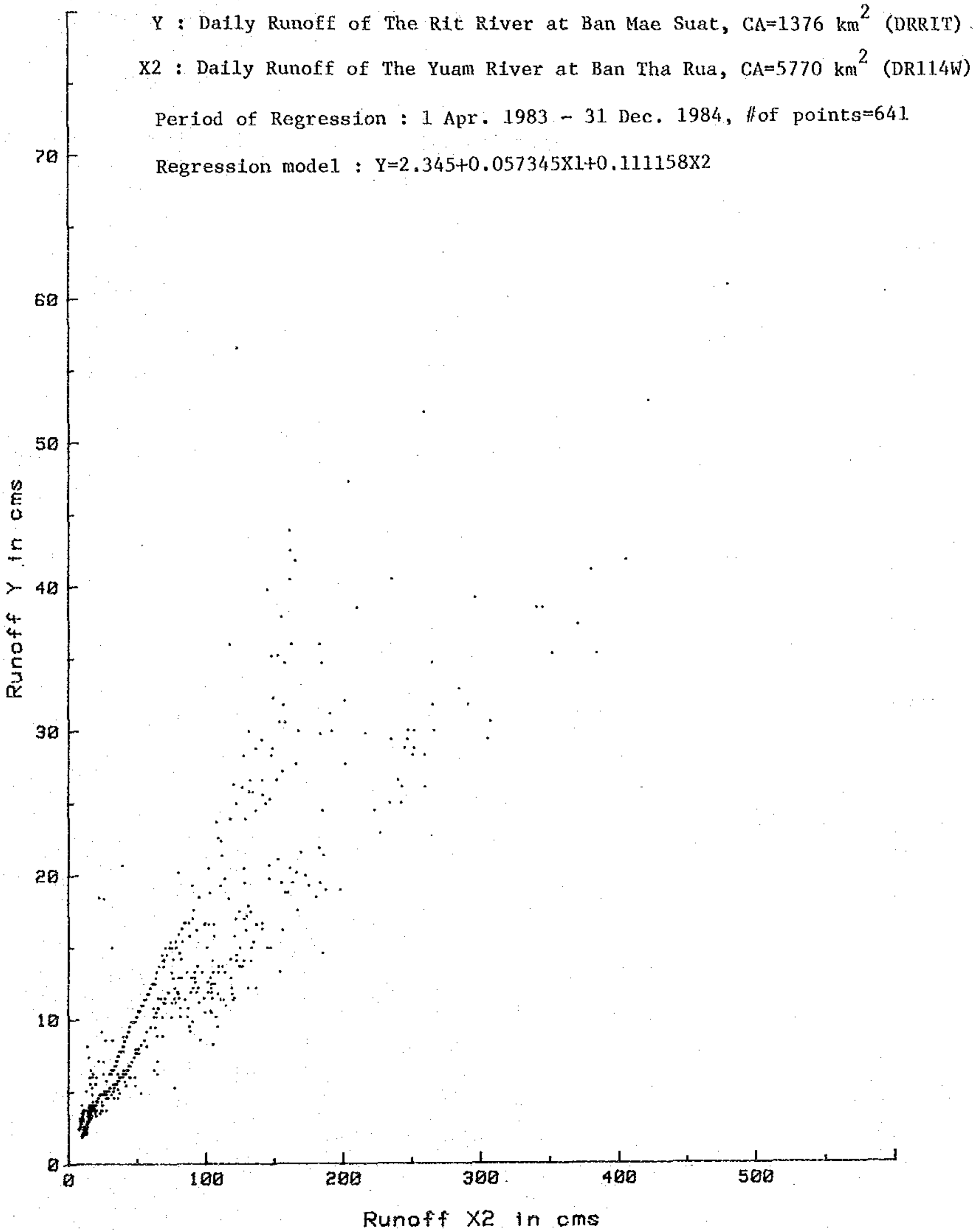

Fig. 4–9 Regression Y : X2 (Nam Mae Rit: Ban Tha Rua)

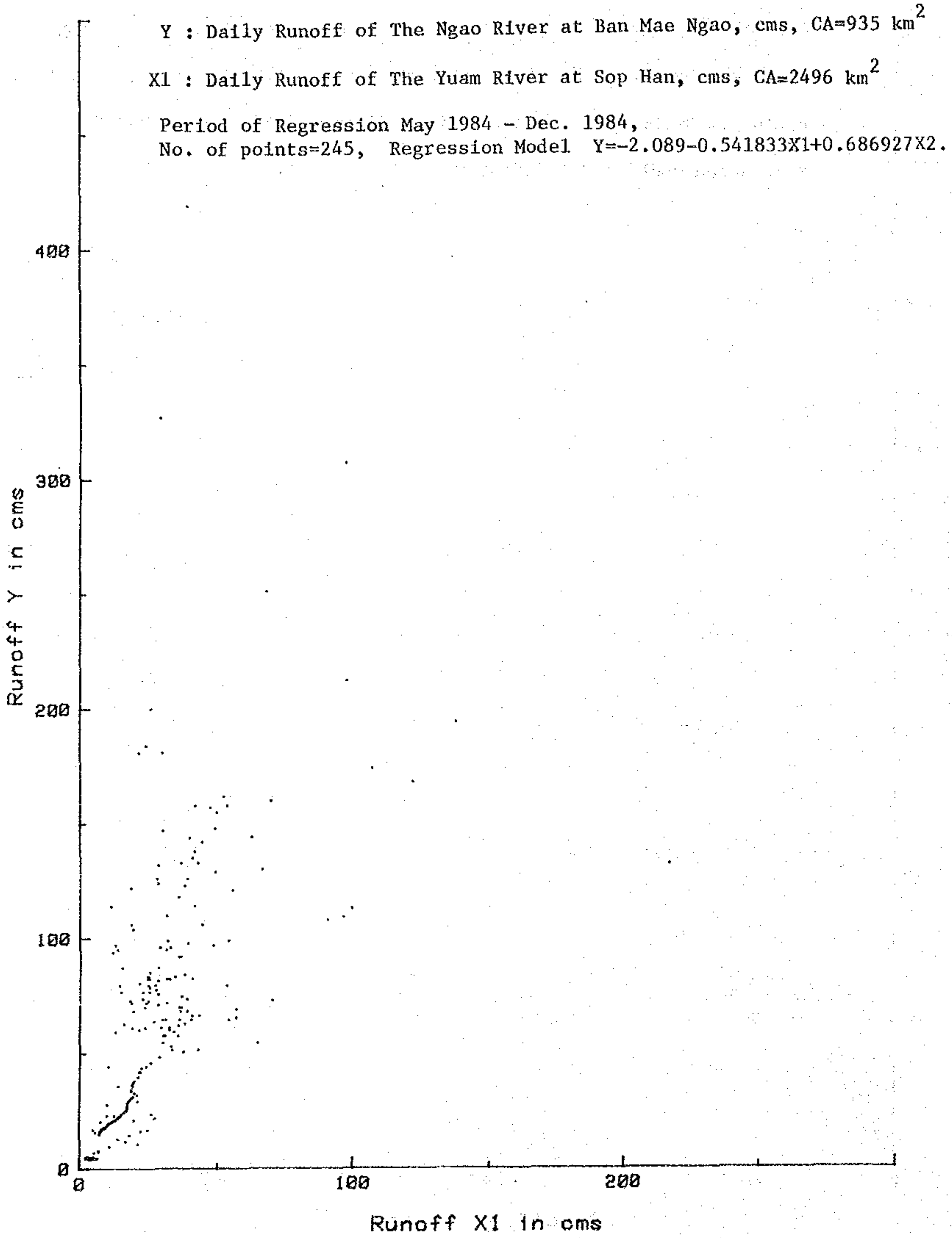

Fig. 4–10 Regression Y : X1 (Nam Mae Ngao: Sop Han)

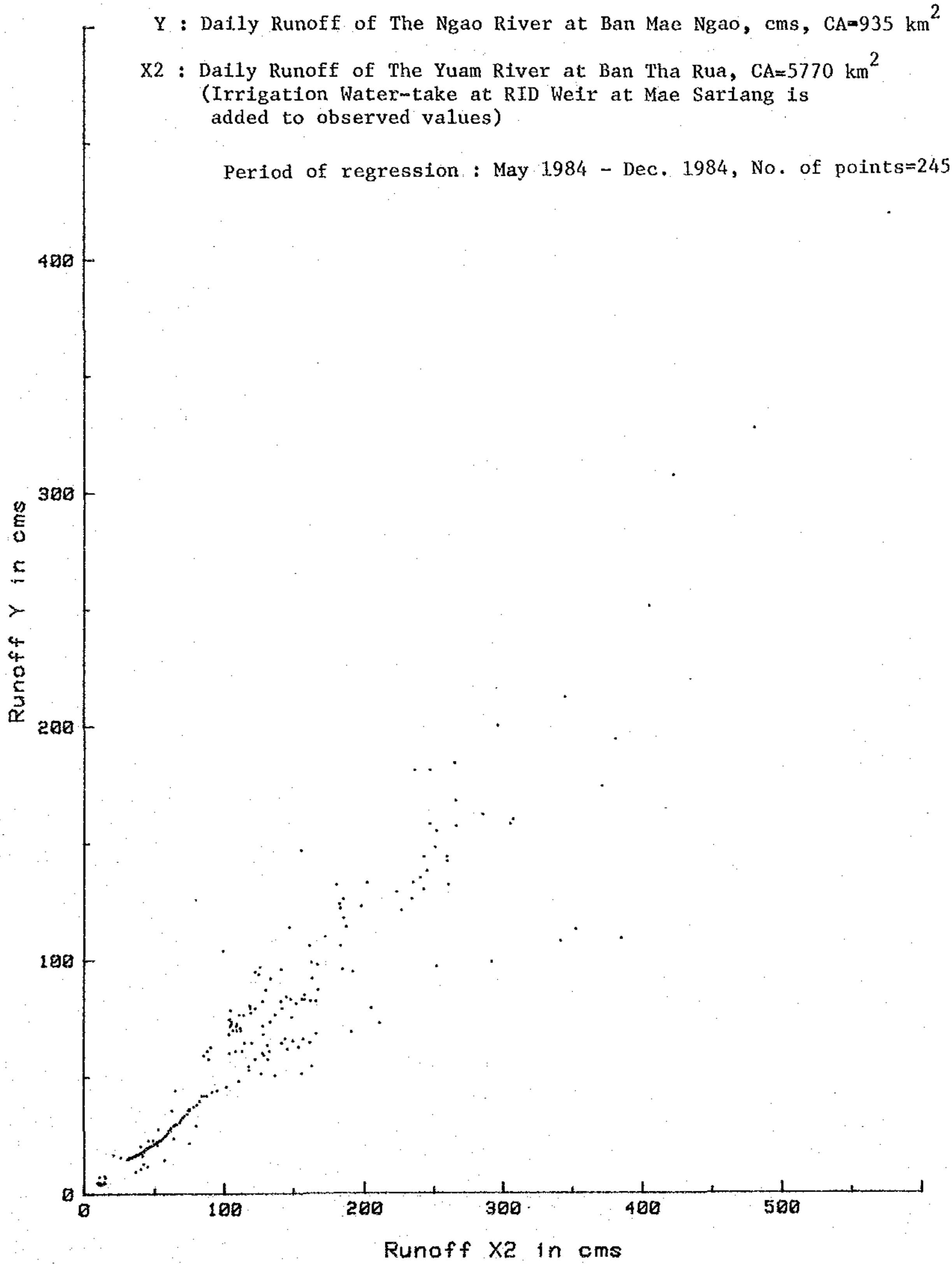

Fig. 4–11 Regression Y : X2 (Nam Mae Ngao: Ban Tha Rua)

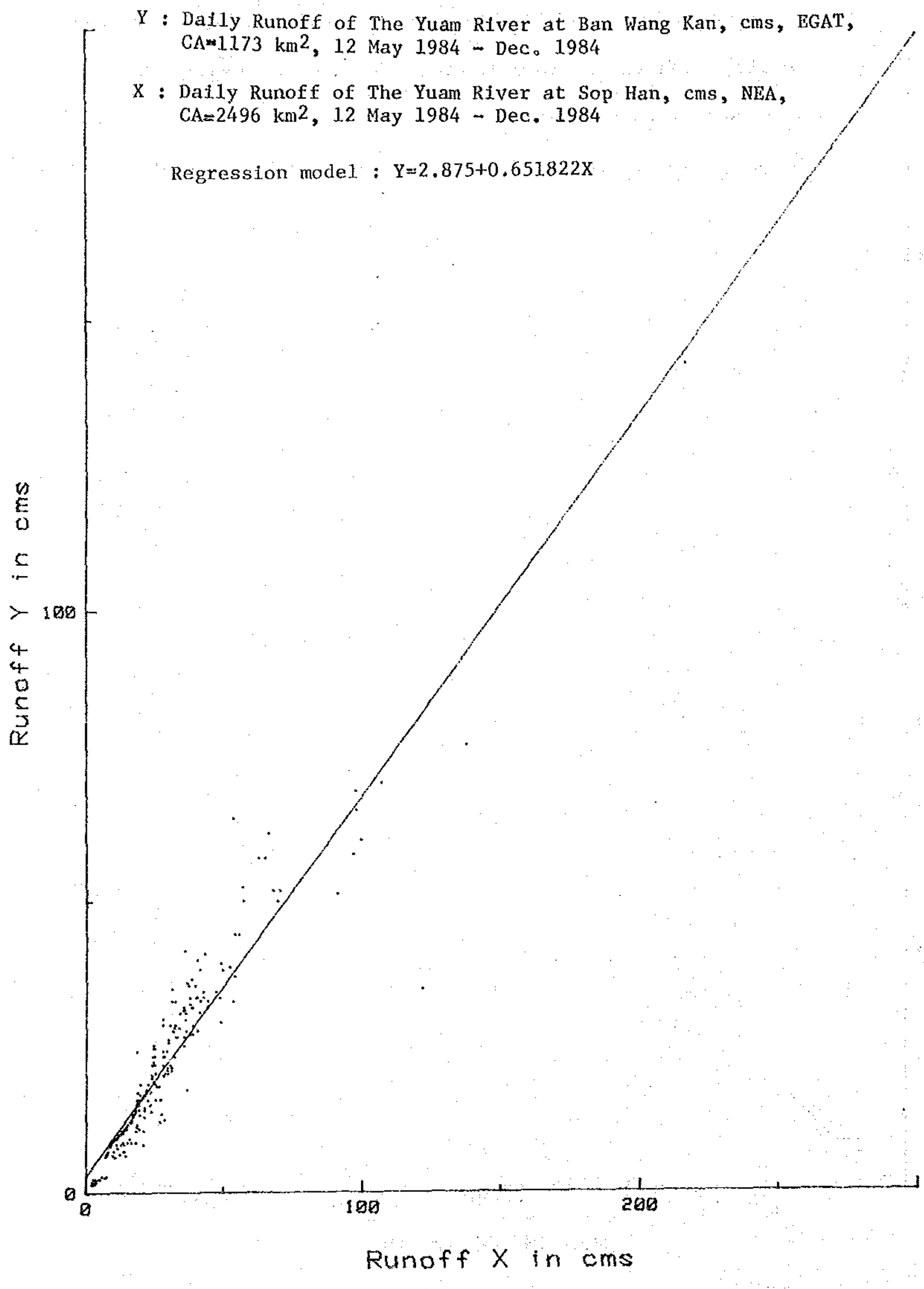

Fig. 4–12 Regression Y : X (Wang Khon: Soh Han)

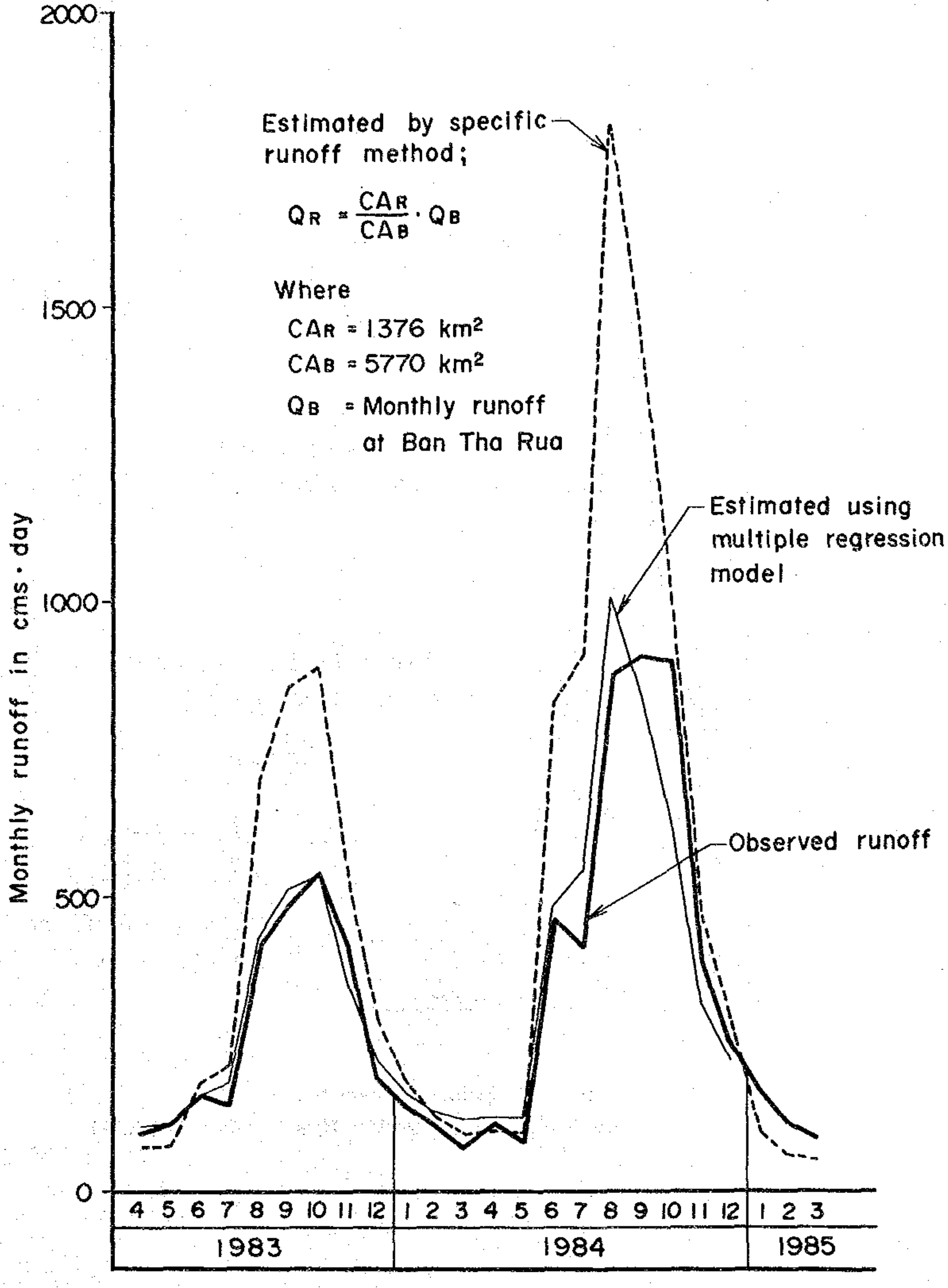

Fig. 4–13 Observed & Estimated Runoffs of The Rit River at Ban Mae Suat (CA = 1376 km²)

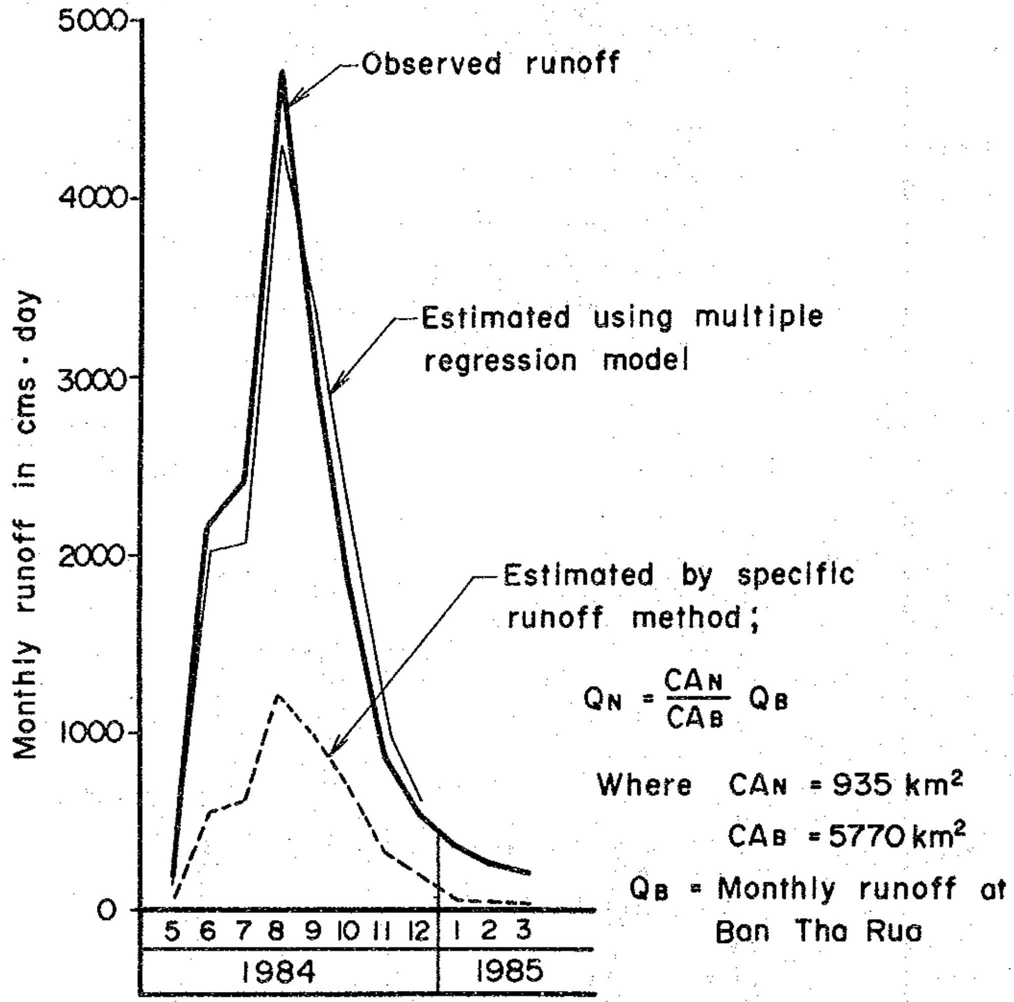

Fig. 4–14 Observed & Estimated Runoffs of The Ngao River at Ban Mae Ngao (CA = 935 km²)

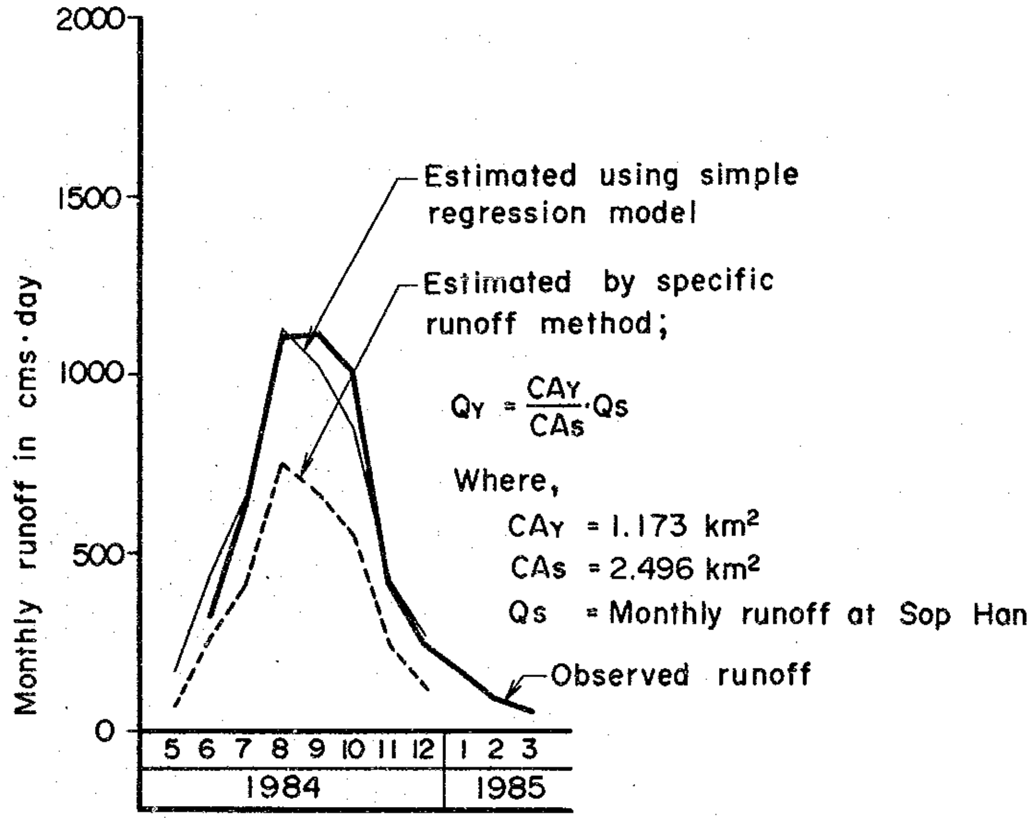

Fig. 4–15 Observed & Estimated Runoffs of The Yuam River at Wang Khan (CA = 1173 km^2)

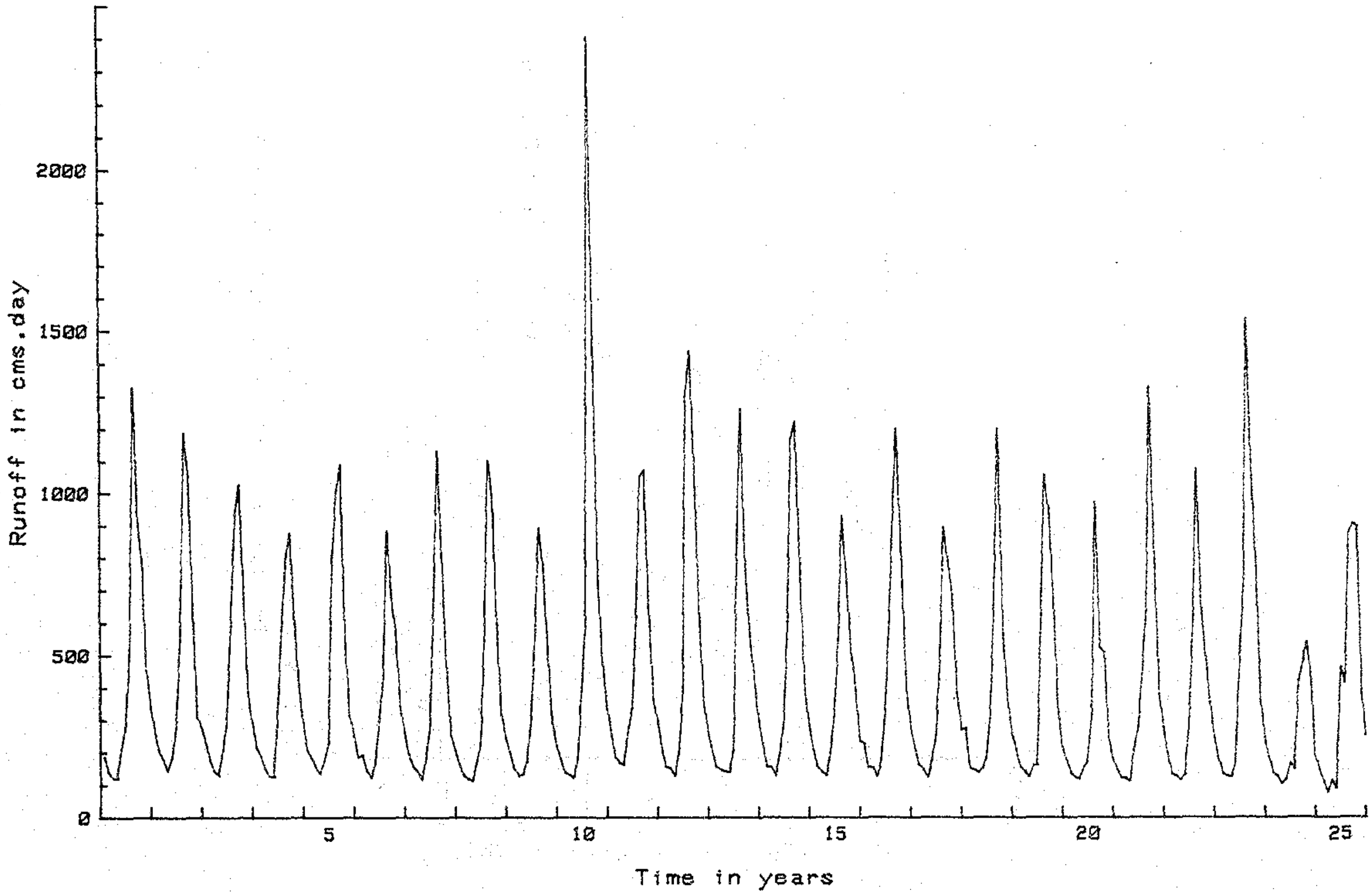

Fig. 4–16 Estimated & Observed Monthly Runoffs of The Rit River at Ban Mae Suat, CA=1376 sq. km, Jan. 1960 – Dec. 1984 (25 years)

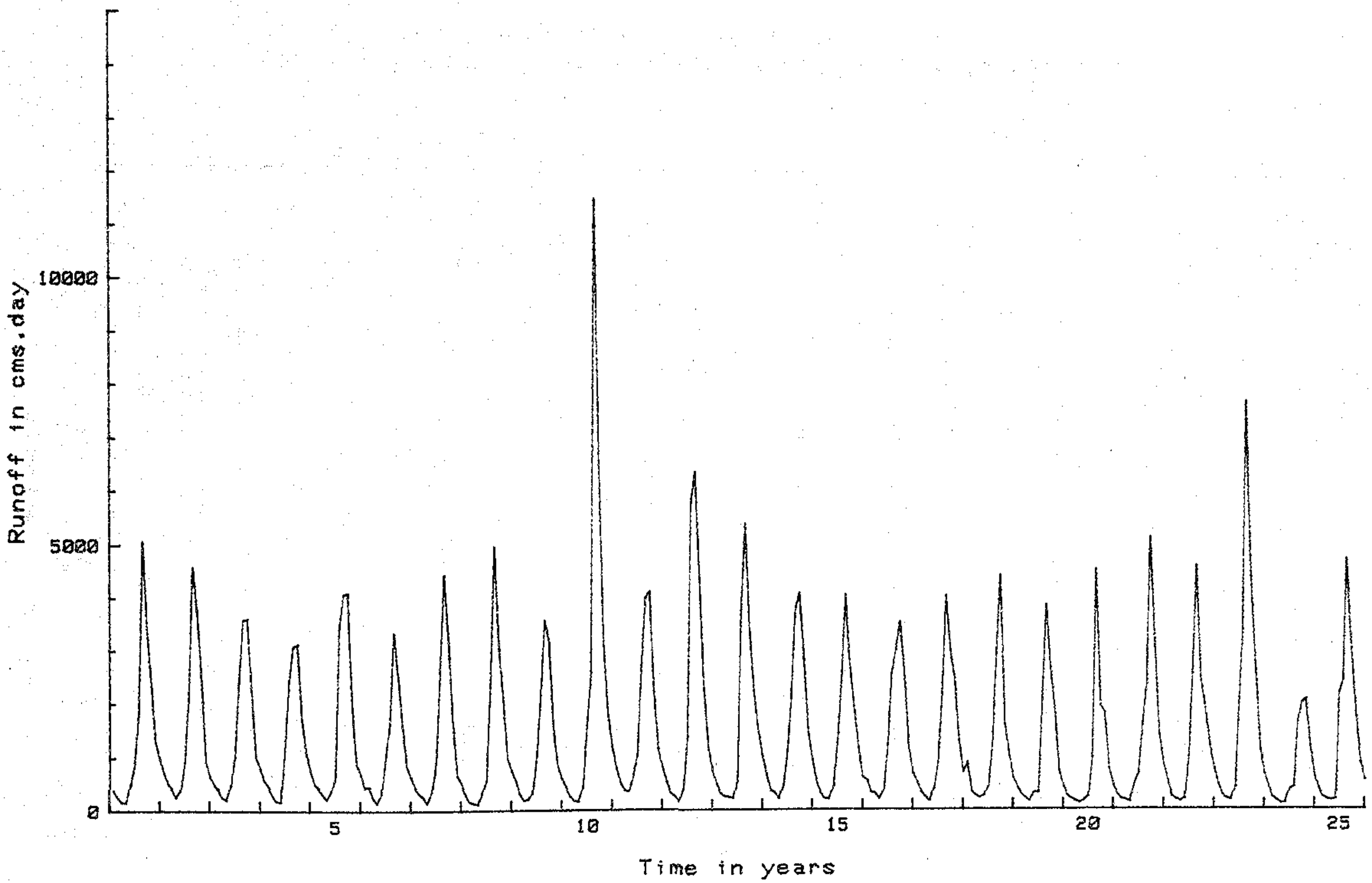

Fig. 4–17 Estimated & Observed Monthly Runoffs of The Ngao River at Ban Mae Ngao, CA=935 sq. km, Jan. 1960 – Dec. 1984 (25 years)

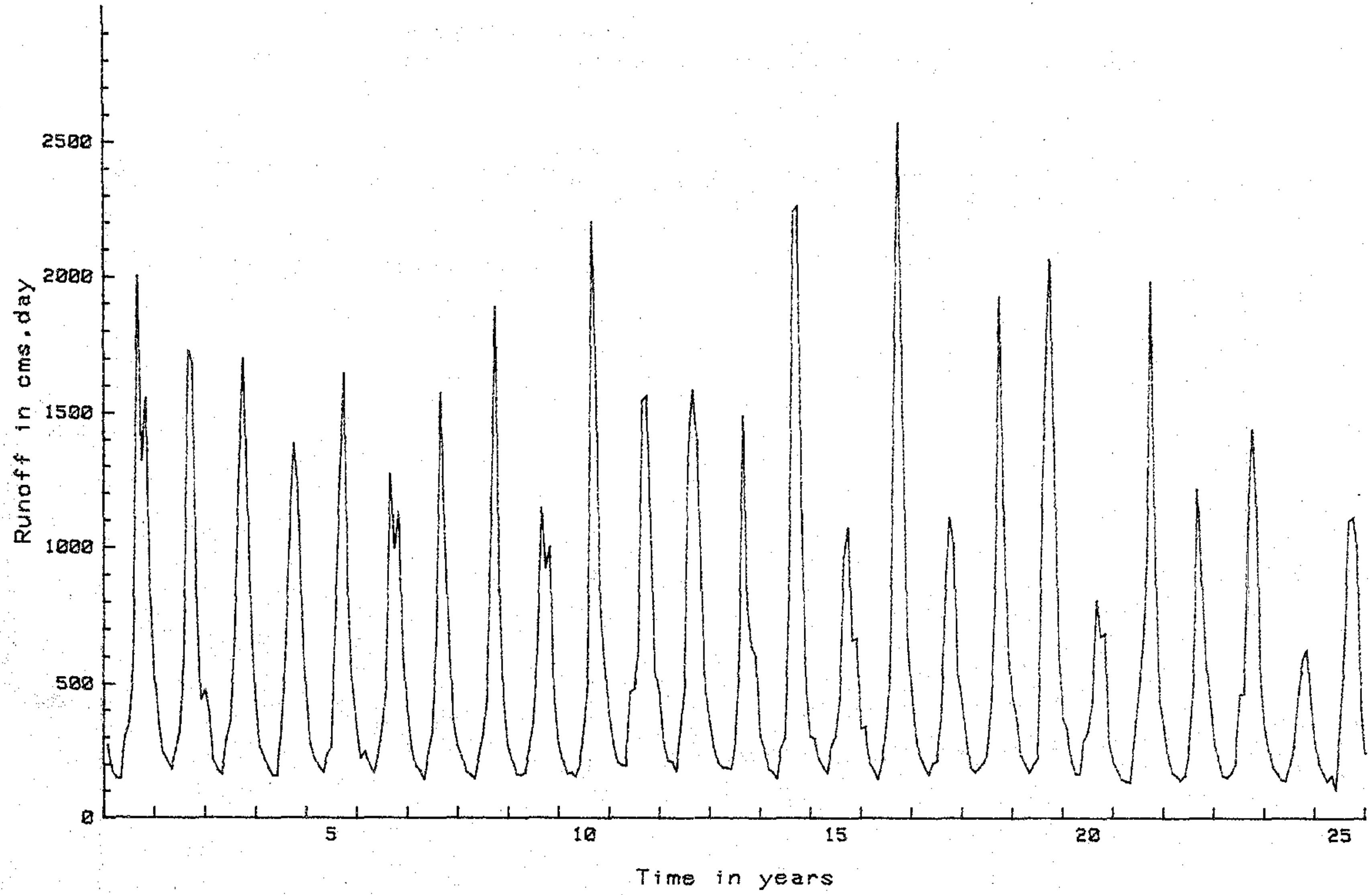

Fig. 4—18 Estimated & Observed Monthly Runoffs of The Yuam River at Wang Khan, CA=1173 sq. km, Jan. 1960 – Dec. 1984 (25 years)

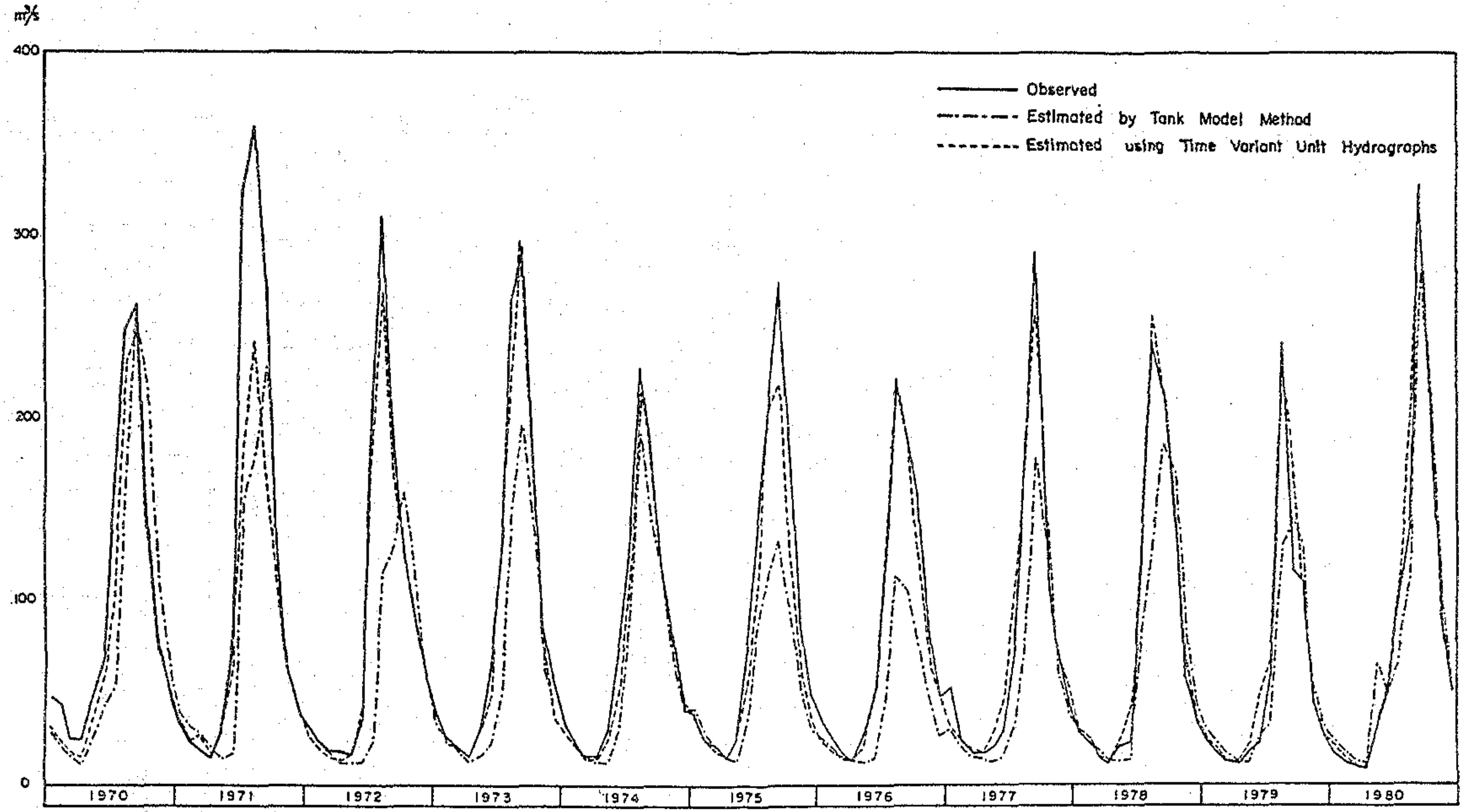

Fig. 4–19 Comparison of Runoffs Observed and Estimated for The Yuam River at Ban Tha Rua

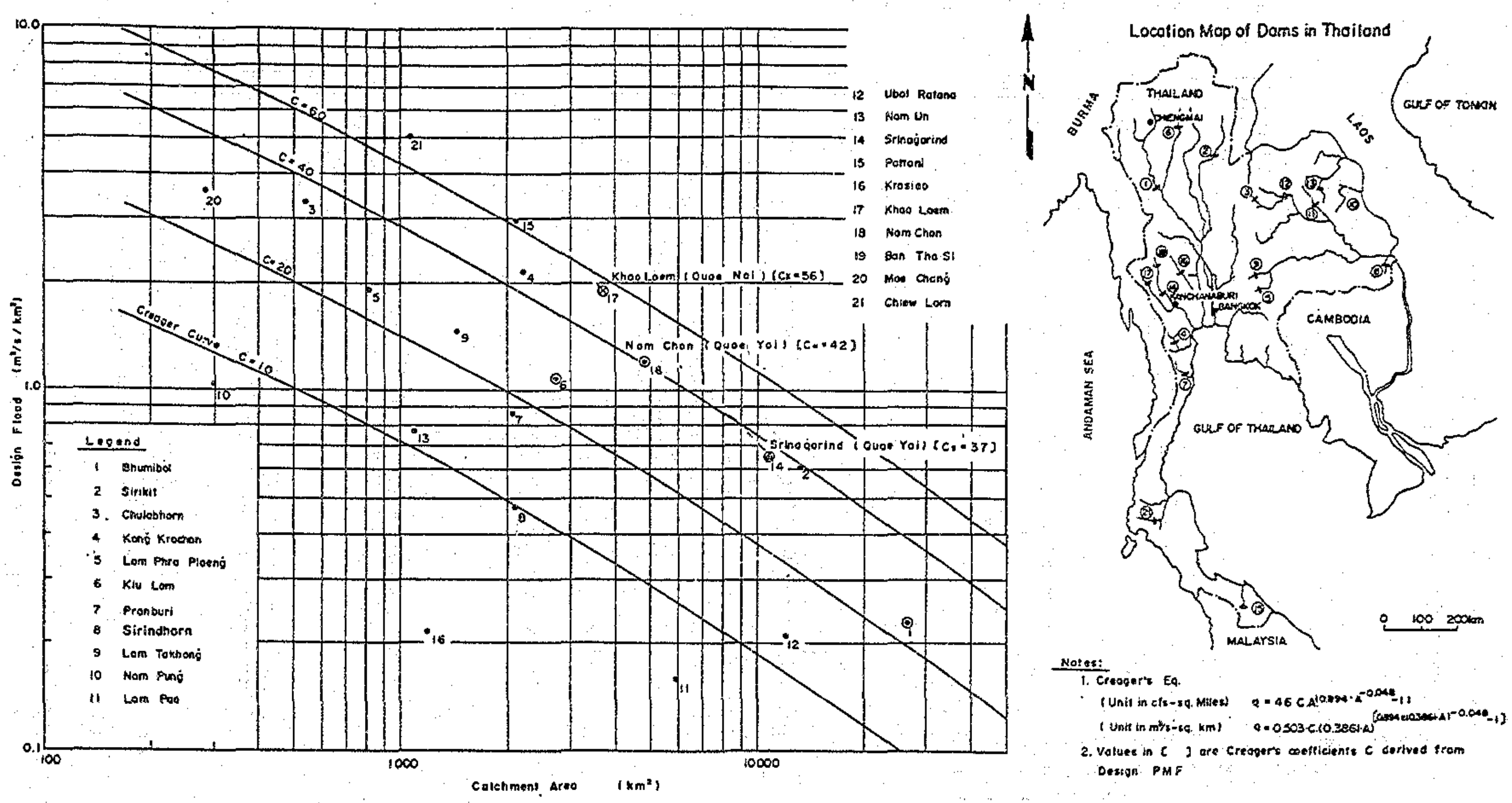

Fig. 4–20 Comparison of Design Floods in Thailand

CHAPTER 5. DEVELOPMENT PLAN

CHAPTER 5 DEVELOPMENT PLAN

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Table List

Figure List

CHAPTER 5. DEVELOPMENT PLAN

5.1 Basic Items

1) Location of the Dam Site

The projects to be studied in the Master Plan are nine (9) projects, illustrated on the Fig. 1-1.

The basic figures of the projects are shown on Table 5-1.

2) Catchment Area and Storage Capacity Curve

The three kinds of topographical map listed below can be utilized.

Scale	1:250,000	whole river basin
Scale	1:50,000	- ditto -
Scale	1:5,000	Nam Mae Ngao, Nam Mae Rit and Upper Mae Yuam 1

The measurement of both catchment area and storage capacity curve has been made by EGAT using 1:50,000 scale map and handed over to the JICA survey team during the first field survey.

The team checked the catchment area and the area-capacity curve of each project. The exactitude of the catchment area measured by EGAT has been confirmed and the value was adapted for the inflow calculation as shown on Table 5-1. Regarding to the area-capacity curves, some discrepancies have been found out. So the team checked the area-capacity curve again using 1:25,000 scale map, enlarged from 1:50,000.

However, final volumes were measured by 1:5,000 scale map for the major three planned reservoirs; Nam Mae Ngao, Nam Mae Rit, and Upper Mae Yuam 1 in the second stage.

Table 5–1 Basic Figures of Each Project

NO.	Project name		Coordinates				CA	Tailrace W.L.
			Dam site		Power house			
			N°	E°	N°	E°	(km²)	(m)
1	Upper Mae Yuam 1		18° 23' 52"	97°54' 48"			1,967	262.0
2	Upper Mae Yuam 2		18° 33' 20"	97°54' 41"			1,149	326.5
3	Upper Mae Yuam 3		18° 45' 27"	97°51' 21"			447	428.0
4	Nam Mae Rit		17°55' 11"	98°00' 07"			1,268	192.0
5	Upper Mae Rit 1		17°59' 55"	98°04' 10"	17°57' 04"	98°04' 00"	686	281.0
6	Upper Mae Rit 2	Original	18°04' 35"	98°05' 55"	18° 03' 28"	98° 05' 55"	525	491.0
		Alternative A			18° 01' 55"	98° 04' 49"		407.0
7	Upper Mae Rit 3		17°56' 24"	98°08' 17"	17° 57' 07"	98° 04' 18"	349	281.0
8	Nam Mae Ngao	Site 2	17°47' 24"	97°59' 42"			835	163.0
		Site 3	17°46' 14"	98°00' 38"			756	171.0
9	Upper Mae Ngao		17°35' 10"	98°06' 37"			159	271.1
	Lower Yuam (NEA)		17°49'	97°49'			5,920	73.2

5.2 Procedure for Study of Development Plan

1) Study Procedure

The study of the development plan is to be made divided into the three stages described below.

a. First Stage

The principal objective of the first stage is to find out the economical feasibility of the planned projects; Nam Mae Ngao, Nam Mae Rit, Upper Mae Yuam 1 and other six projects, at the preliminary study level.

Comparison studies are made for individual projects varying dam heights, effective storage capacities, installed capacities, etc.

The study results are described in Clause 5-3.

b. Second Stage

Taking into account the study result in the first stage, the selected projects are examined more in detail.

In the study, Lower Yuam on which the feasibility study was already completed in 1984, is regarded as if it is an existing power station therefore the increment of power and energy of the station is considered to be an additional benefit.

The study results are described in clause 5-4.

c. Additional Stage

In the additional stage, following studies have been made, based upon the third minutes of meeting.

i) Detailed optimization study of Nam Mae Ngao No.2, applying the up-dated fuel prices which were given by EGAT.

ii) Study of the incremental benefit of Lower Yuam due to the regulation effect of Nam Mae Ngao No.2, applying the same up-dated fuel prices.

The study results are described in the clause 5-5.

2) Reservoir operation and energy production

a) Reservoir Operation

To study operation of a reservoir and an output capacity, the 95% firm discharge will first be obtained. Herein, the mass curve of runoff is drawn, then on the assumption that past runoff is reproduced exactly the same way and that the future discharge is completely foreseeable, the 95% firm discharge is obtained from the probability distribution of the minimum discharge of each year, with operation of reservoir made most effectively.

In the annual inflow calculation to the dam site, evapotration loss has not been considered at the first stage study, since the effect of loss is small in the proposed reservoir simulation. However, the evaporation loss was considered in the second stage.

The various reservoir operations for the planned dam sites have been examined varying the dam height and the effective storage volume to find out the most optimized development scale.

b) Equivalent Peak Duration Hours

The first assumption to be made for the examination of output capacity is that of the peak duration hours to be supplied by the project. Since peak duration hours are closely related to load duration curves, and the latter is mostly dependent on the character demand, a discussion has been made with EGAT during the first field survey.

EGAT usually adopts a plant factor between 20% and 30% for planning a storage type hydro power plant depending upon the situations and conditions of the proposed hydro power project.

Since a power supply area of the Nam Yuam hydro power projects is most reasonably considered to be the Northern Region, the plant factor of the Nam Yuam hydro power plants should be determined based upon a daily load duration curve and a daily load factor, etc. of the Northern Region.

After the discussion, the plant factor of 25% has been adopted tentatively, and used for the first stage study of the Master Plan. However, in the second stage, three plant factors; 15, 20 and 25% have been adopted for the comparison study, based on "the Second Minutes of Meeting".

c) Maximum Discharge

The maximum discharge is to be obtained by the firm discharge of 95% probability and the equivalent peak duration hours of 6, 4.8 and 3.6 hours (Plant factor of 25, 20 and 15%) respectively.

d) Calculation of Energy Production

Energy production of each planned power station is calculated based on the monthly inflow for the 25 year period from 1960 to 1984 at each dam site.

e) Firm Capacity

The firm capacity is calculated by the maximum turbine discharge and the lowest reservoir water level.

f) Firm and Secondary Energy

Of the annual energy production, the part corresponding to firm discharge is taken as the firm energy, and any energy production other than the firm energy is taken to be the secondary energy.

5.3 Individual Development Plan (First Stage Study)

The projects to be studied in the first stage study of the Master Plan are nine pre-selected projects.

Number of main cases studied in this stage including some alternative cases are as following:

Upper Mae Yuam 1	.....	12 cases
Upper Mae Yuam 2	.....	12 cases
Upper Mae Yuam 3	.....	3 cases
Nam Mae Rit	.....	12 cases
Upper Mae Rit 1	.....	4 cases
Upper Mae Rit 2	.....	9 cases
Upper Mae Rit 2a	.....	3 cases
Upper Mae Rit 3	.....	4 cases
Nam Mae Ngao (Site No.2)	.....	16 cases
Nam Mae Ngao (Site No.3)	.....	8 cases
Upper Mae Ngao	.....	9 cases
Total:		92 cases

Reservoir operation study was performed for each case to maximize the firm capacity, firm energy and secondary energy given the various high water levels and low water levels (i.e., given the various effective heads and various effective reservoir capacities).

The details of the study results were included in the "Interim Report, Master Plan Study on Nam Yuam River Basin Hydroelectric Development Project, Nov. 1985" and the computer output volumes submitted and explained to EGAT in November 1985, so that those details have not been attached here.

The summary of the study results are shown on Table 5-14-1. On this table, only the most economical case among several cases studied is listed for each of the nine projects. (Note that either Upper Mae Rit 2 or Upper Mae Rit 2a constitutes one project, and either Nam Mae Ngao Site No.2 or Nam Mae Ngao Site No.3 will be Nam Mae Ngao Project.)

It is seen also that Nam Mae Ngao Site No.2 is the most promising project (B/C = 1.67, rank 1) followed by Upper Mae Rit 2a (rank 2), Nam Mae Rit (rank 3), Upper Mae Yuam 1 (rank 4), etc. in this order.

The B/C ratios of these four upper ranked projects are nearly equal to or greater than 1.0. Taking into account of these results and other relevant information as described in the following subsections, it is judged that the above four projects were deserved for the objects of the next stage of study. The explanation of the study results for the individual project are as follows.

1) Upper Mae Yuam 1

This project, planned on the upstream of the Yuam river, is located about 2 km upstream from Ban Wan Kang in the Mae La Noi District.

There are no alternative dam axes except the planned dam site according to the topographical condition.

The site location is shown on Table 5-1.

Rockfill type dam is adopted and the power station is planned on the left bank of the down stream considering the topographical condition.

To find out the economic feasibility and the optimized development scale, various comparison studies were made varying HWL, available reservoir capacity and installed capacity for twelve cases in total. The results are shown on Table 5-3.

Judging from the result, the project feasibility of the individual development plan is still uncertain unless the investigation works are carried out more, including the possibility of irrigation scheme. In addition to the above the studied project scale should be re-examined using 1:5,000 scale map of the planned reservoir, mapped out by EGAT.

Tentative design works are made at preliminaly study level using 1:50,000 scale map for the next investigation works.

2) Upper Mae Yuam 2

This project is planned on the Yuam river, about 17 km upstream from Upper Mae Yuam 1 project. There are no alternative dam axes except this dam site due to the topographical condition.

The site location is shown on Table 5-1.

Rockfill type dam is adopted and power station is planned on the left bank of the downstream from the dam site.

Various comparison studies were made varying HWL, available reservoir capacity and installed capacity for twelve cases in total.

The results are shown on Table 5-4.

Judging from the results, this project is not so promising so that further study need not be made in the next stage.

3) Upper Mae Yuam 3

This project is planned on the upper most reach of the Yuam river. There are no access roads so that any reconnaissance survey was not carried out during the first field investigation works.

The site location is shown on Table 5-1.

Comparison study was made varying HWL, available reservoir capacity and installed capacity for three cases in total.

The study results are shown on Table 5-5.

This project shows the poorest charactor in economy among those planned on the main stream of the Yuam river.

4) Nam Mae Rit

This project is located about 6 km upstream from the confluence of the Rit river and the Yuam river. Two alternative dam sites are planned for the project.

The reconnaissance survey to both dam sites was carried out during the first and second field survey. As the results, the downstream site has been selected for the study.

The location of the site is shown on Table 5-1.

This project is planned as a dam and waterway type power station. Rockfill type dam is adopted and power station is planned on the right bank of the down stream from the dam.

The comparison studies to find out the project feasibility were made varying HWL, available reservoir capacity and installed capacity for twelve cases in total.

The results are shown on Table 5-6.

The studied project scale should be re-examined using 1:5,000 scale map for the planned reservoir which will be mapped out by EGAT.

Tentative design works are made at preliminary study level using 1:50,000 scale map for the next investigation works.

5) Upper Mae Rit 1

This project is planned about 6 km upstream from the confluence of the Rit river and the Lap river, one of the tributary of the Rit river coming from the left bank.

There are no access roads to the site so that any reconnaissance survey was not carried out.

The site location is shown on Table 5-1.

Various comparison studies were made and the results are shown on the Table 5-7.

6) Upper Mae Rit 2

Upper Mae Rit 2

This project is planned on the upper most reach of the Rit river. Any reconnaissance survey was not carried out because of no access roads.

This project is planned as dam and waterway type power station. The location of the dam and power station are shown on Table 5-1.

The project consists of rockfill type dam, power tunnel with 2,100 m long and power station.

Comparison studies for the project feasibility were made varying HWL, available reserior capacity and installed capacity for nine cases in total.

The results are shown on Table 5-8.

Judging from the results, it can be said that the project could be advantageous provided the dam height is reduced.

In other word, run-of-river type power station would be more advantageous.

For making clear this tendency, an alternative plan (2a) was examined.

Upper Mae Rit 2a

The alternative 2a consists of intake dam, planned on the same site, power tunnel with 5,900 m long and power station located on the right bank, to utilize the steep gradient of the river.

Comparison study for the project feasibility was made for three cases in total. The results are shown on Table 5-9.

Judging from the results, run-of-river type power station seems to be suitable to the upper reach of the Rit river and the high project economy can be expected.

Therefore tentative design works are made at preliminary study level using 1:50,000 scale map.

7) Upper Mae Rit 3

This project is planned on the Lap river, one of the tributary of the Rit river.

The location of the project is shown on Table 5-1. Any reconnaissance survey was not carried out because of no access roads.

Various comparison studies were made and the results are on Table 5-10.

8) Nam Mae Ngao

This project is planned about 8 - 12 km upstream from the confluence of the Yuam river and the Ngao river.

Three alternative dam sites were studied.

The reconnaissance survey to the sites was carried out during the first and second field survey. As the results, alternative site of No.2 and No.3 were selected for the study.

The locations of two sites are shown on Table 5-1.

No. 2 Site

This project was planned as dam type power station. Main structures are rockfill type dam and power station planned on the left bank considering the topography and the geology.

Various comparision studies were made to find out the project feasibility and optimum development scale varying HWL, available reservoir capacity and installed capacity for sixteen cases in total.

The study results are shown in Table 5-11.

Judging from the results, this project is very promissing and the results show that the Ngao river has high potential.

In the next stage, the project should be re-examined using 1:5,000 scale map of the planned reservoir, mapped out by EGAT.

Tentative design works are made on preliminary study level for the next investigation works using 1:50,000 scale map.

The case with HWL 260 m is very attractive. However, judging from the topography, the case with HWL 250 m was conservatively adopted for the first stage study.

Therefore, tentative design drawings are based upon the figures described on Table 5-14.

No. 3 Site

The higher is HWL, the more is the benefit of the project. However, since the HWL of the No.2 site is restricted due to topographical and geological condition, the No. 3 dam axis is considered as an alternative dam site. The field reconnaissance was also made by the team.

The comparison study results are shown on Table 5-12.

According to the results, No.3 site also be very promising to construct high dam keeping the economy of the project.

Considering the study results of the above two sites, No. 2 site is preferred to No. 3 site.

However, due to the uncertainty of topographical and geological information, the investigation works in the next stage should be made for both No.2 and No.3 site.

9) Upper Mae Ngao

This project is planned upstream of Nam Mae Ngao.

Therefore the site was selected according to the study results of Nam Mae Ngao. The location of the site is shown on Table 5-1.

Comparison study results are shown on Table 5-13 and summarized on Table 5-14.

Table 5–2 Alternative Thermal Power Plant for Studying Optimum Scale of Development (First and Second Stage)

	Item	Calculaltion formula	Hydro power plant	Alternative Thermal Power Plant: for the first 25 yrs – Gas Turbine	for the first 25 yrs – Thermal	for the second 25 yrs – Gas Turbine	for the second 25 yrs – Thermal	for 50yrs – Lignite Thermal
Basic Criteria for Alternative Thermal	(a) Installed Capacity (MW)			25	600	25	600	150 ~ 300
	(b) Service life (yrs)		50	20	25	20	25	25
	(c) Station Service Use (%)		0.5	2	7	2	7	7
	(d) Scheduled Outage rate (%)		0.0	12	12	12	12	12
	(e) Forced Outage rate (%)		0.5	4	4	4	4	4
	(f) Adjustment factor (%)	$(1-C_T/100)(1-d_T/100)(1-e_T/100)$		84	79	84	79	79
		$(1-C_H/100)(1-d_H/100)(1-e_H/100)$						
	(g) O & M cost rate (%)			3	2.5	3	2.5	2.5
	(h) Unit Construction Cost							
	(h_1) Net Cost (US$/kW)			405	580	405	957	957
	(h_2) Cost with IDC (US$/kW)			—	—	—	—	—
	(i) Fuel			Natural Gas	Natural Gas	Diesel Oil	Imported Coal	Lignite
	(i_1) Calorific Value							
	(Btu/unit)			1,087.52 Btu/cuft	1,087.52 Btu/cuft	—	—	—
	(Kcal/unit)	1 Btu = 252 cal		274.06 Kcal/cuft	274.06 Kcal/cuft	9,317.41 Kcal/ℓ	6,717.3 Kcal/kg	2,700 Kcal/kg
	(i_2) Energy Equivalence	860 Kcal / kwh		—	—	—	—	—
	(i_3) Thermal Efficiency or heat rate			25 %	36 %	25 %	36 %	2,500 Kcal/kwh
	(i_4) Fuel Consumption	$i_2/(i_1 \times i_3)$ or i_3/i_1		12.55 cuft/kwh	8.72 cuft/kwh	0.37 ℓ/kwh	0.36 kg/kwh	0.93 kg/kwh
	(i_5) Unit fuel price			0.095 ฿/cuft	0.095 ฿/cuft	6.605 ฿/ℓ	0.075 US$/kg	0.534 ฿/kg
	(i_6) Fuel cost	$i_4 \times i_5$						
	(฿ / kwh)			1.19 ฿/kwh	0.83 ฿/kwh	2.44 ฿/kwh	0.73 ฿/kwh	0.50 ฿/kwh
	(US$ / kwh)	1 US$ = 27 ฿		0.044 US$/kwh	0.031 US$/kwh	0.090 US$/kwh	0.027 US$/kwh	0.019 US$/kwh
Basic Criteria for Optimal Combination of Alternative Thermal Plant	(j) Installed Capacity (MW)			0.84 G	0.79 T	0.84 G	0.79 T	0.79 L
	(k) Effective Capacity (MW)	(j) x (f)						
	(l) Annual Plant Factor (%)			X_G	X_T	X_G	X_T	X_L
	(m) Annual Energy Production (10^3kwh)	(j) x 24[H] x 365[Days] x (l)		8,760 GX_G	8,760 TX_T	8,760 GX_G	8,760 TX_T	8,760 LX_L
	(n) Station Service Use (%)		0.5	2	7	2	7	7
	(o) Adjustment Factor (%)	$(1-R_T/100)/(1-R_H/100)$		98	93	98	93	93
	(p) Annual Available Energy (10^3kwh)	(m) x (o)		8,584.8 GX_G	8,146.8 TX_T	8,584.8 GX_G	8,146.8 TX_T	8,146.8 LX_L
	(q) Capital Investment Cost (10^3US$)	(h_1) x (j)		405 G	580 T	405 G	957 T	957 L
	(r) Annual O & M Cost (10^3US$)	(q) x (g)		12.15 G	14.5 T	12.15 G	23.925 T	23.925 L
	(s) Annual Fuel Cost (10^3US$)	(i_6) x (m)		385.4 GX_G	271.6 TX_T	788.4 GX_G	236.5 TX_T	166.4 LX_L
	(t) Interest Rate	10 %						
	(u) Conversion Rate of Currency	US$ 1.00 = ฿ 27.0						

Table 5–3 1st Stage Planning Study Upper Mae Yuam 1

C.A 1,967 km^2
Annual Inflow 570 MCM

Description	Unit	H.W.L 325 m, Total Storage Capacity 455 MCM			H.W.L 325 m, Total Storage Capacity 455 MCM			H.W.L 310 m, Total Storage Capacity 194 MCM			H.W.L 310 m, Total Storage Capacity 194 MCM		
Case No.		①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫
Project Type		S.G	S.G	S.G	P.G	P.G	P.G	S.G	S.G	S.G	P.G	P.G	P.G
Dam Height	m	75	75	75	75	75	75	60	60	60	60	60	60
Tunnel Length		–	–	–	–	–	–	–	–	–	–	–	–
Available Drawdown	m	10	20	30	10	20	30	10	15	20	10	15	20
Effective Storage Capacity	$10^6 m^3$	190	318	395	190	318	395	103	134	158	103	134	158
N.H.W.L	m	319.7	318.1	316.3	319.7	318.1	316.3	304.5	302.7	301.3	304.5	302.7	301.3
L.W.L	〃	315	305	295	315	305	295	300	295	290	300	295	290
T.W.L	〃	262	262	262	262	262	262	262	262	262	262	262	262
Gross Head	〃	63	63	63	63	63	63	48	48	48	48	48	48
Effective Normal Head	〃	55.8	54.2	52.4	55.8	54.2	52.4	41.1	39.3	37.8	41.2	39.4	37.9
Firm Discharge (95%)	m^3/s	12.5	13.9	15.2	12.5	13.9	15.2	11.3	11.7	12.6	11.3	12.3	12.6
Max. Turbine Discharge	〃	50.1	55.5	63.6	29.9	29.9	29.9	45.1	49.2	50.3	29.9	29.9	29.9
Installed Capacity	MW	24.4	26.2	27.8	14.5	14.1	13.6	16.2	16.9	16.6	10.7	10.3	9.9
Firm Capacity	〃	22.3	19.9	16.5	7.0	6.2	5.2	14.4	13.6	11.7	4.5	4.2	3.6
Associated Capacity	〃	4.2	4.6	5.7	4.0	4.6	5.7	3.5	3.5	4.0	3.2	3.4	3.7
Annual Energy Production	GWH	76.0	74.0	73.0	75.0	74.0	73.0	55.0	53.0	52.0	53.0	52.0	50.0
Firm Energy	〃	49.0	44.0	36.0	49.0	44.0	36.0	32.0	30.0	26.0	32.0	30.0	26.0
Secondary Energy	〃	27.0	30.0	37.0	26.0	30.0	37.0	23.0	23.0	26.0	21.0	22.0	24.0
Construction Cost	10^6 ฿												
for Generating F.	〃	1,335.9	1,362.1	1,408.3	1,215.5	1,216.4	1,216.2	985.6	1,002.4	1,002.2	903.8	901.9	899.4
for Transmission F.	〃												
Benefit	10^6 ฿	141.1	133.5	125.6	100.8	98.7	96.9	98.3	94.2	89.2	70.6	69.4	66.2
for first kW	〃	56.6	50.5	41.9	17.8	15.7	13.2	36.6	34.5	29.7	11.4	10.7	9.1
for first kWH	〃	50.0	44.9	36.7	50.0	44.9	36.7	32.6	30.6	26.5	32.6	30.6	26.5
for Secondary kW	〃	15.9	17.4	21.5	15.1	17.4	21.5	13.2	13.2	15.1	12.1	12.9	14.0
for Secondary kWH	〃	18.6	20.7	25.5	17.9	20.7	25.5	15.9	15.9	17.9	14.5	15.2	16.6
Annual Cost	10^6 ฿												
for Generating F.	〃	148.3	151.2	156.3	134.9	135.0	135.0	109.4	111.3	111.2	100.3	100.1	99.8
for Transmission F.	〃												
B – C	10^6 ฿	Δ 7.2	Δ 17.7	Δ 30.7	Δ 34.1	Δ 36.3	Δ 38.1	Δ 11.1	Δ 17.1	Δ 22.0	Δ 29.7	Δ 30.7	Δ 33.6
B / C	〃	0.95	0.88	0.80	0.75	0.73	0.72	0.90	0.85	0.80	0.70	0.69	0.66
Annual Energy Cost	฿/kWH	1.95	2.04	2.14	1.80	1.82	1.85	1.99	2.10	2.14	1.89	1.93	2.00
Simulation Case No.		YIB325.10	YIB325.20	YIB325.30	YID325.10	YID325.20	YID325.30	YIB310.10	YIB310.15	YIB310.20	YID310.10	YID310.15	YID310.20

Project Type, SG : Storage Type, RR : Run-of River Type
PG : Pondage Type,

Table 5–4 1st Stage Planning Study Upper Mae Yuam 2

C. A 1, 149 km²
Annual Inflow 333 MCM

Description	Unit	H.W.L 417 m				H.W.L 400 m				H.W.L 380 m			
		Total Storage Capacity 830 MCM				Total Storage Capacity 432 MCM				Total Storage Capacity 178 MCM			
Case No.		①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫
Project Type		S.G	S.G	P.G	P.G	S.G	S.G	P.G	P.G	S.G	S.G	P.G	P.G
Dam Height	m	102	102	102	102	85	85	85	85	65	65	65	65
Tunnel Length	"	—	—	—	—	—	—	—	—	—	—	—	—
Available Drawdown	m	20	37	20	37	15	30	15	30	10	20	10	20
Effective Storage Capacity	$10^6 m^3$	447	652	447	652	205	329	205	329	75	124	75	124
N.I.W.L	m	410.9	408.4	410.9	408.4	393.9	392.2	393.9	392.2	374.2	371.5	374.3	371.5
L.W.L	"	397	380	397	380	385	370	385	370	370	360	370	360
T.W.L	"	326.5	326.5	326.5	326.5	326.5	326.5	326.5	326.5	326.5	326.5	326.5	326.5
Gross Head	"	90.5	90.5	90.5	90.5	73.5	73.5	73.5	73.5	53.5	53.5	53.5	53.5
Effective Normal Head	"	81.7	79.2	81.7	79.2	65.2	63.5	65.2	63.5	46.1	43.3	46.2	43.4
Firm Discharge (95%)	m^3/s	9.7	10.6	9.7	10.6	8.3	9.3	8.3	9.3	7.1	7.4	7.1	7.4
Max. Turbine Discharge	"	38.7	42.2	19.4	21.1	33.0	37.0	17.4	18.5	28.4	29.6	17.4	17.4
Installed Capacity	MW	27.6	29.2	13.8	14.6	18.8	20.5	9.9	10.2	11.4	11.2	7.0	6.6
Firm Capacity	"	22.9	18.7	11.4	9.3	16.2	13.3	8.1	6.7	10.4	8.2	5.2	4.1
Associated Capacity	"	2.8	4.0	2.8	4.0	2.6	3.5	2.6	3.5	2.1	2.6	1.8	2.4
Annual Energy Production	GWH	68.0	67.0	68.0	67.0	52.0	52.0	52.0	52.0	37.0	35.0	35.0	34.0
Firm Energy	"	50.0	41.0	50.0	41.0	35.0	29.0	35.0	29.0	23.0	18.0	23.0	18.0
Secondary Energy	"	18.0	26.0	18.0	26.0	17.0	23.0	17.0	23.0	14.0	17.0	12.0	16.0
Construction Cost	10^6 ฿												
for Generating F.	"	1,943	1,967	1,805	1,816	1,307	1,337	1,201	1,214	822	827	745	742
for Transmission F.	"												
Benefit	10^6 ฿	132.2	122.3	103.0	98.4	98.3	92.5	77.8	75.7	67.5	60.7	51.8	48.9
for first kW	"	58.2	47.5	29.0	23.6	41.1	33.8	20.6	17.0	26.4	20.8	13.2	10.4
for first kWH	"	51.0	41.8	51.0	41.8	35.7	29.6	35.7	29.6	23.5	18.4	23.5	18.4
for Secondary kW	"	10.6	15.1	10.6	15.1	9.8	13.2	9.8	13.2	7.9	9.8	6.8	9.1
for Secondary kWH	"	12.4	17.9	12.4	17.9	11.7	15.9	11.7	15.9	9.7	11.7	8.3	11.0
Annual Cost	10^6 ฿												
for Generating F.	"	215.7	218.3	200.4	201.6	145.1	149.4	133.3	134.8	91.2	91.8	82.7	82.4
for Transmission F.	"												
B – C	10^6 ฿	△ 83.5	△ 96.0	△ 97.4	△ 103.2	△ 46.8	△ 55.9	△ 55.5	△ 59.1	△ 23.7	△ 31.1	△ 30.9	△ 33.5
B / C	"	0.61	0.56	0.51	0.49	0.68	0.62	0.58	0.56	0.74	0.66	0.63	0.59
Annual Energy Cost	฿/kWH	3.17	3.26	2.95	3.01	2.79	2.85	2.56	2.59	2.46	2.62	2.36	2.42
Simulation Case No		Y2B417.20	Y2B417.37	Y2C417.20	Y2C417.37	Y2B400.15	Y2B400.30	Y2D400.15	Y2C400.30	Y2B383.10	Y2B380.20	Y2D380.10	Y2D380.20

Project Type. SG ; Storage Type , RR ; Run-of River Type
PG ; Pondage Type,

Table 5–5 1st Stage Planning Study Upper Mae Yuam 3

C. A 447 km^2
Annual Inflow 129.5 MCM

Description	Unit	H.W.L 477 m Total Storage Capacity 67.6 MCM			
Case No.		①	②	③	
Project Type		S.G	S.G	S.G	
Dam Height	m	62	62	62	
Tunnel Length	〃	—	—	—	
Available Drawdown	m	10	15	20	
Effective Storage Capacity	$10^6 m^3$	32.3	42.0	49.9	
N.I.W.L	m	470.7	469.8	468.7	
L.W.L	〃	467	462	457	
T.W.L	〃	428	428	428	
Gross Head	〃	49	49	49	
Effective Normal Head	〃	41.3	40.3	39.2	
Firm Discharge (95%)	m^3/s	2.8	2.9	2.9	
Max. Turbine Discharge	〃	11.3	11.4	11.7	
Installed Capacity	MW	4.1	4.0	4.0	
Firm Capacity	〃	3.7	3.2	2.8	
Associated Capacity	〃	0.7	0.9	0.9	
Annual Energy Production	GWH	13.0	12.7	12.4	
Firm Energy	〃	8.1	7.1	6.2	
Secondary Energy	〃	4.9	5.6	6.2	
Construction Cost	10^6 B				
for Generating F.	〃	475.0	476.4	477.9	
for Transmission F.	〃	——	——	——	
Benefit	10^6 B	23.7	22.6	21.1	
for first kW	〃	9.4	8.1	7.1	
for first kWH	〃	8.3	7.2	6.3	
for Secondary kW	〃	2.6	3.4	3.4	
for Secondary kWH	〃	3.4	3.9	4.3	
Annual Cost	10^6 B				
for Generating F.	〃	52.7	52.9	53.0	
for Transmission F.	〃	——	——	——	
B − C	10^6 B	△ 29.0	△ 30.3	△ 31.9	
B / C	〃	0.45	0.43	0.40	
Annual Energy Cost	B/kWH	4.05	4.17	4.27	
Simulation Case No		Y3B477.10	Y3B477.15	Y3B477.20	

Project Type. SG ; Storage Type, RR ; Run-of River Type
PG ; Pondage Type,

Table 5–6 1st Stage Planning Study Nam Mae Rit

C.A 1,268 km²
Annual Inflow 395 MCM

Description	Unit	H.W.L 332 m, Total Storage Capacity 360 MCM			H.W.L 300 m, Total Storage Capacity 178 MCM			H.W.L 270 m, Total Storage Capacity 79 MCM			H.W.L 240 m, Total Storage Capacity 27 MCM		
Case No.		①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫
Project Type		S.G	S.G	S.G	S.G	S.G	S.G	S.G	S.G	S.G	P.G	P.G	S.G
Dam Height	m	145	145	145	113	113	113	83	83	83	53	53	53
Tunnel Length	〃	—	—	—	—	—	—	—	—	—	—	—	—
Available Drawdown	m	10	20	30	10	15	20	10	15	20	10	15	20
Effective Storage Capacity	10^6m^3	63	127	172	44	62	75	22.5	33.0	40	9.5	13.8	17.1
N.H.W.L	m	326.9	322.5	320.4	294.6	292.5	290.7	265.5	263.1	261.2	235.6	233.6	231.8
L.W.L	〃	322	312	302	290	285	280	260	255	250	230	225	220
T.W.L	〃	192	192	192	192	192	192	192	192	192	192	192	192
Gross Head	〃	140	140	140	108	108	108	78	78	78	48	48	48
Effective Normal Head	〃	130.7	126.3	124.2	99.4	97.3	95.5	71.2	66.8	66.8	42.2	40.1	38.3
Firm Discharge (95%)	m³/s	7.83	9.40	9.95	6.82	7.81	8.32	5.55	6.17	6.58	4.63	4.95	5.02
Max. Turbine Discharge	〃	31.3	37.6	39.8	25.6	31.2	33.3	22.2	24.7	26.3	20.1	20.1	20.1
Installed Capacity	MW	35.7	41.4	43.1	23.7	26.5	27.7	13.8	14.8	15.3	7.4	7.0	6.7
Firm Capacity	〃	34.3	38.0	36.7	22.5	24.5	24.6	12.7	13.1	12.8	5.9	5.4	4.7
Associated Capacity	〃	7.2	5.5	5.8	6.4	5.6	5.3	5.1	4.9	4.9	3.4	3.1	3.2
Annual Energy Production	GWH	121	118	117	90.5	90.0	88.0	61.0	61.0	60.0	35.0	32.0	31.0
Firm Energy	〃	75	83	80	49	54	54	28.0	29.0	28.0	13.0	12.0	10.0
Secondary Energy	〃	46	35	37	41.5	36.0	34.0	33.0	32.0	32.0	22.0	20.0	21.0
Construction Cost	10^6฿												
for Generating F.	〃	2,889	2,941	2,957	1,671	1,710	1,722	968	987	997	562	560.3	559.3
for Transmission F.	〃												
Benefit	10^6฿	222.5	226.2	222.2	160.0	163.3	161.1	103.6	103.5	101.7	56.4	51.4	48.7
for first kW	〃	87.1	96.5	93.2	57.2	62.2	62.5	32.3	33.3	32.5	15.0	13.7	11.9
for first kWH	〃	76.5	84.7	81.6	50.0	55.1	55.1	28.6	29.6	28.6	13.3	12.2	10.2
for Secondary kW	〃	27.2	20.8	21.9	24.2	21.2	20.0	19.3	18.5	18.5	12.9	11.7	12.1
for Secondary kWH	〃	31.7	24.2	25.5	28.6	24.8	23.5	22.8	22.1	22.1	15.2	13.8	14.5
Annual Cost	10^6฿												
for Generating F.	〃	320.7	326.5	328.2	185.5	189.8	191.1	107.4	109.6	110.7	62.4	62.2	62.1
for Transmission F.	〃												
B − C	10^6฿	Δ 98.2	Δ100.3	Δ106.0	Δ 25.5	Δ 26.5	Δ 30.0	Δ 4.4	Δ 6.1	Δ 9.0	Δ 6.0	Δ 10.8	Δ 13.4
B / C	〃	0.69	0.69	0.68	0.86	0.86	0.84	0.96	0.94	0.92	0.90	0.83	0.78
Annual Energy Cost	฿/kWH	2.65	2.77	2.81	2.05	2.11	2.17	1.76	1.80	1.85	1.78	1.94	2.00
Simulation Case No.		RøB332.10	RøB332.20	RøB332.30	RøB300.10	RøB300.15	RøB300.20	RøB270.10	RøB270.15	RøB270.20	RøD240.10	RøD240.15	RøD240.20

Project Type, SG : Storage Type, RR ; Run-of River Type
PG : Pondage Type.

Table 5–7 1st Stage Planning Study Upper Mae Rit 1

C.A 686 km²
Annual Inflow 214 MCM

H.W.L.	m	445	490		
Total Strage Capacity	10⁶m³	0.3	15.8		
Case No.		①	②	③	④
Project Type		R.R	P.G	P.G	P.G
Dam Height	m	–	66	66	66
Tunnel Length	〃	5,100	5,100	5,100	5,100
Available Drawdown	m	–	10	15	5
Effective Storage Capacity	10⁶m³	–	8.1	11.2	4.7
N.I.W.L	m	365	401.8	399.9	403.8
L.W.L	〃	–	397	392	402
T.W.L	〃	281	281	281	281
Gross Head	〃	84	126	126	126
Effective Normal Head	〃	64	90.9	88.9	92.9
Firm Discharge (95%)	m³/s	2.01	2.72	2.90	2.46
Max. Turbine Discharge	〃	12.94	12.94	12.94	12.94
Installed Capacity	MW	7.2	10.3	10.0	10.5
Firm Capacity	〃	1.1	8.2	8.2	7.8
Associated Capacity	〃	2.3	3.9	3.7	3.9
Annual Energy Production	GWH	29.8	42.5	41.9	42.7
Firm Energy	〃	9.8	17.9	18.0	17.1
Secondary Energy	〃	20.0	24.6	23.9	25.6
Construction Cost	10⁶ ฿				
for Generating F.	〃	553.8	837.2	838.6	836.3
for Transmission F.	〃	—	—	—	—
Benefit	10⁶ ฿	34.0	70.8	69.7	69.6
for first kW	〃	2.8	20.8	20.8	19.8
for first kWH	〃	10.0	18.3	18.4	17.4
for Secondary kW	〃	10.2	14.7	14.0	14.7
for Secondary kWH	〃	11.0	17.0	16.5	17.7
Annual Cost	10⁶ ฿				
for Generating F.	〃	61.5	92.9	93.1	92.8
for Transmission F.	〃	—	—	—	—
B - C	10⁶ ฿	△27.5	△22.1	△23.4	△23.2
B / C	〃	0.55	0.76	0.75	0.75
Annual Energy Cost	฿/kWH	2.06	2.19	2.22	2.17
Simulation Case No		RIE365.0	RID407.10	RID407.15	RID407.50

Project Type. SG : Storage Type, RR : Run-of River Type
PG : Pondage Type.

Table 5–8 1st Stage Planning Study Upper Mae Rit 2

C. A 525 km^2
Annual Inflow 163 MCM

Description	Unit	H.W.L 645 m Total Storage Capacity 134 MCM				H.W.L 615 m Total Storage Capacity 48.6 MCM				H.W.L 585 m Total Storage Capacity 13.5 MCM			
Case No.		①	②	③		④	⑤	⑥		⑦	⑧	⑨	
Project Type		S.G	S.G	S.G		S.G	S.G	S.G		P.G.	P.G	S.G	
Dam Height	m	123	123	123		93	93	93		63	63	63	
Tunnel Length	〃	2,015	2,015	2,015		2,055	2,055	2,055		2,110	2,110	2,110	
Available Drawdown	m	10	20	30		10	15	20		5	10	15	
Effective Storage Capacity	$10^6 m^3$	34	63	85		15.7	22.4	27.9		3.2	5.3	7.2	
N. I. W. L	m	638.3	634.7	633.5		608.7	606.5	604.4		581.4	579.4	577.6	
L. W. L	〃	635	625	615		605	600	595		580	575	570	
T. W. L	〃	491	491	491		491	491	491		491	491	491	
Gross Head	〃	154	154	154		124	124	124		94	94	94	
Effective Normal Head	〃	139.6	136.0	134.8		111.5	109.3	107.2		85.7	83.7	81.9	
Firm Discharge (95%)	m^3/s	3.6	4.1	4.1		2.7	3.1	3.3		1.8	2.0	2.1	
Max. Turbine Discharge	〃	14.2	16.4	16.4		10.7	12.2	13.3		8.3	8.3	8.4	
Installed Capacity	MW	17.3	19.5	19.3		10.4	11.6	12.5		6.2	6.1	6.0	
Firm Capacity	〃	16.9	18.1	16.7		10.1	10.9	11.4		5.4	5.6	5.4	
Associated Capacity	〃	2.6	2.0	2.6		3.1	2.8	2.5		2.4	2.4	2.4	
Annual Energy Production	GWH	54.0	53.0	53.0		42.0	42.0	41.0		28.0	28.0	28.0	
Firm Energy	〃	37.0	40.0	36.0		22.0	24.0	25.0		12.0	12.0	12.0	
Secondary Energy	〃	17.0	13.0	17.0		20.0	18.0	16.0		16.0	16.0	16.0	
Construction Cost	10^6 ฿												
for Generating F.	〃	1,666	1,701.5	1,702.5		998.0	1,016.0	1,027.0		561.1	561.1	563.0	
for Transmission F.	〃												
Benefit	10^6 ฿	102.1	103.4	100.6		73.6	75.2	75.0		46.0	46.5	46.0	
for first kW	〃	42.9	46.0	42.4		25.7	27.7	29.0		13.7	14.2	13.7	
for first kWH	〃	37.7	40.8	36.7		22.4	24.5	25.5		12.2	12.2	12.2	
for Secondary kW	〃	9.8	7.6	9.8		11.7	10.6	9.5		9.1	9.1	9.1	
for Secondary kWH	〃	11.7	9.0	11.7		13.8	12.4	11.0		11.0	11.0	11.0	
Annual Cost	10^6 ฿												
for Generating F.	〃	184.9	188.9	189.0		110.8	112.8	114.0		62.3	62.3	62.5	
for Transmission F.	〃												
B − C	10^6 ฿	Δ82.8	Δ 85.5	Δ88.4		Δ 37.2	Δ 37.6	Δ 39.0		Δ16.3	Δ 15.8	Δ 16.5	
B / C	〃	0.55	0.55	0.53		0.66	0.67	0.66		0.74	0.75	0.74	
Annual Energy Cost	฿/kWH	3.42	3.56	3.57		2.64	2.69	2.78		2.22	2.22	2.23	
Simulation Case No		R28645.10	R28645.20	R28645.30		R28615.10	R28615.15	R28615.20		R20585.50	R20585.10	R28585.15	

Project Type. SG : Storage Type. RR : Run-of River Type
PG : Pondage Type.

Table 5–9 1st Stage Planning Study Upper Mae Rit 2a

C.A 525 km²
Annual Inflow 163 MCM

H.W.L.	m	445	490	535
Total Strage Capacity	$10^6 m^3$	0.3	15.8	—
Case No.		⑩	⑪	⑫
Project Type		PG	PG	RR
Dam Height	m	63	38	13
Tunnel Length	〃	5,500	5,845	5,960
Available Drawdown	m	5	5	—
Effective Storage Capacity	$10^6 m^3$	3.2	0.8	—
N.I.W.L	m	581.3	556.9	534.0
L.W.L	〃	575	555	—
T.W.L	〃	407	407	407
Gross Head	〃	178	153	128
Effective Normal Head	〃	151.4	126.9	104
Firm Discharge (95%)	m^3/s	1.8	1.6	1.5
Max. Turbine Discharge	〃	9.9	9.9	9.9
Installed Capacity	MW	13.1	11.0	9.0
Firm Capacity	〃	9.6	6.8	1.4
Associated Capacity	〃	4.9	4.4	2.8
Annual Energy Production	GWH	53.0	44.0	37.1
Firm Energy	〃	21.0	15.0	12.2
Secondary Energy	〃	32.0	29.0	24.9
Construction Cost	10^6 ฿			
for Generating F.	〃	745.1	599.9	433.7
for Transmission F.	〃	—	—	—
Benefit	10^6 ฿	86.4	69.2	42.1
for first kW	〃	24.4	17.3	3.6
for first kWH	〃	21.4	15.3	12.4
for Secondary kW	〃	18.5	16.6	12.4
for Secondary kWH	〃	22.1	20.0	13.7
Annual Cost	10^6 ฿			
for Generating F.	〃	82.7	66.6	48.1
for Transmission F.	〃	—	—	—
B − C	10^6 ฿	3.70	2.60	△ 6.0
B / C	〃	1.04	1.04	0.88
Annual Energy Cost	฿/kWH	1.56	1.51	1.30
Simulation Case No		R2aD 585.5	R2aD 560.5	R2aE 535.0

Project Type. SG ; Storage Type , RR : Run-of River Type
PG ; Pondage Type,

Table 5–10 1st Stage Planning Study Upper Mae Rit 3

C.A 349 km^2
Annual Inflow 108.6 MCM

H.W.L.	m	445	490		
Total Storage Capacity	10^6m^3	0.3	15.8		
Case No.		①	②	③	④
Project Type		R.R	P.G	P.G	S.G
Dam Height	m	—	64	64	64
Tunnel Length	〃	6,800	6,800	6,800	6,800
Available Drawdown	m	—	5	10	15
Effective Storage Capacity	10^6m^3	—	4.1	7.1	9.7
N.I.W.L	m	445	486.3	484.4	482.3
L.W.L	〃	—	485	480	475
T.W.L	〃	281	281	281	281
Gross Head	〃	164	209	209	209
Effective Normal Head	〃	138	176.1	174.2	172.0
Firm Discharge (95%)	m^3/s	0.27	1.38	1.59	1.73
Max. Turbine Discharge	〃	6.58	6.58	6.58	6.94
Installed Capacity	MW	7.9	10.1	10.0	10.4
Firm Capacity	〃	1.2	8.4	9.4	10.0
Associated Capacity	〃	2.5	3.6	3.3	3.2
Annual Energy Production	GWH	32.7	41.8	42.2	42.7
Firm Energy	〃	10.7	10.5	20.6	21.8
Secondary Energy	〃	22.0	23.3	21.6	20.9
Construction Cost	10^6B				
for Generating F.	〃	447.9	829.7	831.5	838.1
for Transmission F.	〃	—	—	—	—
Benefit	10^6B	37.1	61.7	72.3	74.1
for first kW	〃	3.0	21.3	23.9	25.4
for first kWH	〃	10.9	10.7	21.0	22.2
for Secondary kW	〃	11.1	13.6	12.5	12.1
for Secondary kWH	〃	12.1	16.1	14.9	14.4
Annual Cost	10^6B				
for Generating F.	〃	49.7	92.1	92.3	93.0
for Transmission F.	〃	—	—	—	—
B – C	10^6B	△ 12.6	△ 30.4	△ 20.0	△ 18.9
B / C	〃	0.75	0.67	0.78	0.80
Annual Energy Cost	B/kWH	1.52	2.20	2.19	2.18
Simulation Case No		R3E445.0	R30490.5	R30490.10	R3B490.15

Project Type. SG ; Storage Type, RR ; Run-of River Type
PG ; Pondage Type,

Table 5–11 1st Stage Planning Study Nam Mae Ngao (Site No. 2)

C.A 835 km^2
Annual Inflow 1,304 MCM

Description	Unit	H.W.L 260 m, Total Storage Capacity 669 MCM				H.W.L 240 m, Total Storage Capacity 345 MCM				H.W.L 250 m, Total Storage Capacity 478 MCM			
Case No.		⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯
Project Type		S.G	S.G	S.G	S.G	P.G	S.G	S.G	S.G	P.G	P.G	S.G	S.G
Dam Height	m	105	105	105	105	85	85	85	85	95	95	95	95
Tunnel Length	〃	–	–	–	–	–	–	–	–	–	–	–	–
Available Drawdown	m	10	15	20	25	10	15	20	25	10	15	20	25
Effective Storage Capacity	10^6m^3	191	262	325	388	118	166	206	245	133	197	251	299
N.I.W.L	m	255.2	253.1	251.1	248.8	235.3	233.4	231.3	229.2	245.2	243.0	240.8	238.7
L.W.L	〃	250	245	240	235	230	225	220	215	240	235	230	225
T.W.L	〃	163	163	163	163	163	163	163	163	163	163	163	163
Gross Head	〃	97	97	97	97	77	77	77	77	87	87	87	87
Effective Normal Head	〃	89.3	87.2	85.2	82.7	70.0	68.1	66.0	63.9	79.6	77.4	75.2	73.1
Firm Discharge (95%)	m^3/s	17.6	21.2	23.5	26.6	13.6	16.3	18.4	20.3	14.5	17.9	20.6	22.7
Max. Turbine Discharge	〃	70.5	84.8	93.8	106.5	73.4	65.0	73.5	81.3	73.4	73.4	82.6	90.9
Installed Capacity	MW	54.9	64.5	69.7	77.0	44.8	38.6	42.3	45.3	50.9	49.5	54.2	57.9
Firm Capacity	〃	51.7	58.5	60.6	64.2	30.7	33.8	35.0	35.2	37.6	43.4	46.4	47.1
Associated Capacity	〃					19.1	16.8	17.1	17.0	21.3	19.4	18.7	18.1
Annual Energy Production	GWH	251	255	255	251	190	182	187	186	218.6	219.0	220.7	218.0
Firm Energy	〃	113	128	133	141	67	74	77	77	82.3	95.0	101.5	103.1
Secondary Energy	〃	138	127	122	110	123	108	110	109	136.3	124.0	119.2	114.9
Construction Cost	10^6 ฿												
for Generating F.	〃	2,355	2,444	2,504	2,573	1,703	1,659	1,699	1,737	1,977	1,975	2,021	2,051
for Transmission F.	〃												
Benefit	10^6 ฿	341.8	366.8	373.8	382.8	303.4	299.4	307.9	307.4	353.9	366.0	374.3	372.5
for first kW	〃	131.3	148.6	153.9	163.1	78.0	85.9	88.9	89.4	95.5	110.2	117.9	119.6
for first kWH	〃	115.3	130.6	135.7	143.8	68.3	75.5	78.5	78.5	83.9	96.9	103.5	105.2
for Secondary kW	〃					72.2	63.5	64.6	64.3	80.5	73.3	70.7	68.4
for Secondary kWH	〃	95.2	87.6	84.2	75.9	84.9	74.5	75.9	75.2	94.0	85.6	82.2	79.3
Annual Cost	10^6 ฿												
for Generating F.	〃	261.4	271.3	277.9	285.6	189.0	184.1	188.6	192.8	219.4	219.2	224.3	227.7
for Transmission F.	〃												
B – C	10^6 ฿	80.4	95.5	95.9	97.2	114.4	115.3	119.3	114.6	134.5	146.8	150.0	144.8
B / C	〃	1.31	1.35	1.35	1.34	1.61	1.63	1.63	1.59	1.61	1.67	1.67	1.64
Annual Energy Cost	฿/kWH	1.04	1.06	1.09	1.14	0.99	1.01	1.01	1.04	1.00	1.00	1.02	1.04
Simulation Case No		N#B260.10	N#B260.15	N#B260.20	N#B260.25	N#D240.10	N#B240.15	N#B240.20	N#B240.25	N#D250.10	N#D250.15	N#B250.20	N#B250.25

Project Type. SG : Storage Type, RR : Run-of River Type
PG : Pondage Type.

Table 5–12 1st Stage Planning Study Nam Mae Ngao (Site No. 3)

C.A 756 km²
Annual Inflow 1,182 MCM

Description	Unit	H.W.L 280 m, Total Storage Capacity 947 MCM				H.W.L 260 m, Total Storage Capacity 538 MCM			
Case No.		①	②	③	④	⑤	⑥	⑦	⑧
Project Type		P.G	S.G.	S.G	S.G	P.G	P.G	S.G	S.G
Dam Height	m	120	120	120	120	100	100	100	100
Tunnel Length		—	—	—	—	—	—	—	—
Available Drawdown	m	10	15	20	25	10	15	20	25
Effective Storage Capacity	$10^6 m^3$	212	315	409	494	156	218	269	315
N.I.W.L	m	274.8	272.3	270.3	268.9	255.1	253.0	251.0	248.9
L.W.L	〃	270	265	260	255	250	245	240	235
T.W.L	〃	171	171	171	171	171	171	171	171
Gross Head	〃	109	109	109	109	89	89	89	89
Effective Normal Head	〃	100.6	98.1	96.0	94.7	81.4	79.3	77.3	75.2
Firm Discharge (95%)	m^3/s	17.9	22.7	25.5	26.5	15.0	18.2	20.5	22.7
Max. Turbine Discharge	〃	79.9	91.0	101.9	106.1	79.9	79.9	82.1	91.0
Installed Capacity	MW	70.0	77.8	85.4	87.6	56.7	55.2	55.4	59.7
Firm Capacity	〃	59.9	72.0	76.2	74.7	40.1	45.4	47.5	48.7
Associated Capacity	〃	21.9	17.5	15.9	16.1	20.0	17.7	16.5	15.4
Annual Energy Production	GWH	269.1	266.8	265.8	263.8	216.0	212.0	209.0	204.0
Firm Energy	〃	131.1	157.7	166.9	163.6	88.0	99.0	104.0	107.0
Secondary Energy	〃	138.0	109.1	98.9	100.2	128.0	113.0	105.0	96.0
Construction Cost	10^6 ฿								
for Generating F.	〃	2,927	2,998	3,072	3,115	2,140	2,139	2,151	2,201
for Transmission F.	〃	—	—	—	—	—	—	—	—
Benefit	10^6 ฿	463.8	485.3	492.0	486.6	355.6	361.2	361.7	358.6
for first kW	〃	152.1	182.9	193.5	189.7	101.9	115.3	120.7	123.7
for first kWH	〃	133.7	160.9	170.2	166.9	89.8	101.0	106.1	109.1
for Secondary kW	〃	82.8	66.2	60.1	60.9	75.6	66.9	62.4	58.2
for Secondary kWH	〃	95.2	75.3	68.2	69.1	88.3	78.0	72.5	67.6
Annual Cost	10^6 ฿								
for Generating F.	〃	324.9	332.8	341.0	345.8	237.5	237.4	238.8	244.3
for Transmission F.	〃	—	—	—	—	—	—	—	—
B − C	10^6 ฿	138.9	152.5	151.0	140.8	118.1	123.8	122.9	114.3
B / C	〃	1.43	1.46	1.44	1.41	1.50	1.52	1.51	1.47
Annual Energy Cost	฿/kWH	1.21	1.25	1.28	1.31	1.10	1.12	1.14	1.20
Simulation Case No		No30280.10	No38280.15	No38280.20	No38280.25	No30260.10	No30260.15	No38260.20	No38260.25

Project Type. SG : Storage Type, RR : Run-of River Type
PG : Pondage Type.

Table 5–13 1st Stage Planning Study Upper Mae Ngao

C. A 159 km^2
Annual Inflow 249 MCM

Description	Unit	H.W.L 420 m Total Storage Capacity 422 MCM			H.W.L 380 m Total Storage Capacity 161 MCM			H.W.L 340 m Total Storage Capacity 43.2 MCM		
Case No.		①	②	③	④	⑤	⑥	⑦	⑧	⑨
Project Type		S.G	S.G	S.G	P.G	S.G	S.G	P.G	P.G	P.G
Dam Height	m	160	160	160	120	120	120	80	80	80
Tunnel Length	〃	—	—	—	—	—	—	—	—	—
Available Drawdown	m	10	15	20	10	15	20	5	10	15
Effective Storage Capacity	10^6m^3	71	111	152	39.8	56.6	71.9	8	15.2	21.2
N. I. W. L	m	414.0	412.1	411.2	374.5	372.3	370.0	337.1	335.0	333.0
L. W. L	〃	410	405	400	370	365	360	335	330	325
T. W. L	〃	271.1	271.1	271.1	271.1	271.1	271.1	271.1	271.1	271.1
Gross Head	〃	148.9	148.9	148.9	108.9	108.9	108.9	68.9	68.9	68.9
Effective Normal Head	〃	138.4	136.6	135.7	100.2	97.9	95.7	63.9	61.8	59.8
Firm Discharge (95%)	m^3/s	5.0	5.6	5.9	3.5	4.3	5.0	1.5	2.2	2.5
Max. Turbine Discharge	〃	19.9	22.3	23.5	16.8	17.3	20.0	16.8	16.8	16.8
Installed Capacity	MW	24.0	26.6	27.9	14.7	14.7	16.7	9.4	9.1	8.8
Firm Capacity	〃	23.3	25.2	25.5	11.8	13.6	14.9	3.3	4.3	4.6
Associated Capacity	〃	4.4	3.9	3.9	4.7	4.0	3.5	4.0	3.6	3.5
Annual Energy Production	GWH	79.8	80.3	80.8	56.3	55.9	55.3	33.4	33.2	32.6
Firm Energy	〃	51.1	55.2	55.9	25.8	29.9	32.7	7.2	9.4	10.0
Secondary Energy	〃	28.7	25.1	24.9	30.5	26.0	22.6	26.2	23.6	22.6
Construction Cost	10^6 ฿									
for Generating F.	〃	4,940	4,963	4,973	2,402	2,406	2,428	908.8	909.1	907.9
for Transmission F.	〃									
Benefit	10^6 ฿	147.7	152.3	153.7	95.1	98.0	100.0	48.9	50.5	50.7
for first kW	〃	59.2	64.0	64.8	30.0	34.5	37.8	8.4	10.9	11.7
for first kWH	〃	52.1	56.3	57.0	26.3	30.5	33.4	7.3	9.6	10.2
for Secondary kW	〃	16.6	14.7	14.7	17.8	15.1	13.2	15.1	13.6	13.2
for Secondary kWH	〃	19.8	17.3	17.2	21.0	17.9	15.6	18.1	16.4	15.6
Annual Cost	10^6 ฿									
for Generating F.	〃	548.3	550.9	552.0	266.6	267.1	269.5	100.9	100.9	100.8
for Transmission F.	〃									
B − C	10^6 ฿	△ 400.6	△ 398.6	△ 398.3	△ 171.5	△ 169.1	△ 169.5	△ 52.0	△ 50.4	△ 50.1
B / C	〃	0.27	0.28	0.28	0.36	0.37	0.37	0.48	0.50	0.50
Annual Energy Cost	฿/kWH	6.87	6.86	6.83	4.74	4.78	4.87	3.02	3.04	3.09
Simulation Case No		N18420.10	N18420.15	N18420.20	N10380.10	N18380.15	N18380.20	N10340.50	N10340.10	N10340.15

Project Type. SG : Storage Type., RR : Run-of River Type
PG : Pondage Type.

Table 5–14–1 Summary of First Stage Study, Mater Plan of Nam Yuam River Basin

10 December, 1985

	Unit	Upper Mae Yuam 1	Upper Mae Yuam 2	Upper Mae Yuam 3	Nam Mae Rit	Upper Mae Rit 1	Upper Mae Rit 2	Upper Mae Rit 2a	Upper Mae Rit 3	Nam Mae Ngao (Site No.2)	Nam Mae Ngao (Site No.3)	Upper Mae Ngao 1
C.A.	Km^2	1967	1149	447	1268	686	525	525	349	835	756	159
Annual Inflow	MCM	570	333	129.5	395	214	163	163	108.6	1304	1182	249
Case No.		1	9	1	7	2	8	11	4	15	6	8
Project Type 1)		SG	SG	SG	SG	PG	PG	PG	SG	SG	PG	PG
Dam Height	m	75	65	62	83	66	63	38	64	95	100	80
Tunnel Length	m	-	-	-	-	5100	2110	5845	6800	-	-	-
HWL	m	325	380	477	270	407	585	560	490	250	260	340
NIWL	m	319.7	374.2	470.7	265.5	401.8	579.4	556.9	482.3	240.8	253	335
LWL	m	315	370	467	260	397	575	555	475	230	245	330
TWL	m	262	326.5	428	192	281	491	407	281	163	171	271.1
Total Storage	MCM	455	178	67.6	79	19.4	13.5	3.2	15.8	478	538	43.2
Draw down	m	10	10	10	10	10	10	5	15	20	15	10
Effective Storage	MCM	190	75	32.3	22.5	8.1	5.3	0.8	9.7	251	218	15.2
Gross Head	m	63	53.5	49	78	126	94	153	209	87	89	68.9
Effective Normal-Head	m	55.8	46.1	41.3	71.2	90.9	83.7	126.9	172	75.2	79.3	61.8
95% Firm Discharge	CmS	12.5	7.1	2.8	5.55	2.72	2.0	1.6	1.73	20.6	18.2	2.2
Max.Turbine Discharge	CmS	50.1	28.4	11.3	22.2	12.9	8.3	9.9	6.94	82.6	79.9	16.8
Installed Capacity	MW	24.4	11.4	4.1	13.8	10.3	6.1	11.0	10.4	54.2	55.2	9.1
Firm Capacity	MW	22.3	10.4	3.7	12.7	8.2	5.6	6.8	10.0	46.4	45.4	4.3
Associated Capacity	MW	4.2	2.1	0.7	5.1	3.9	2.4	4.4	3.2	18.7	17.7	3.6
Annual Energy-Production	GWH	76.0	37.0	13.0	61.0	42.5	28.0	44.0	42.7	220.7	212.0	33.2
Firm Energy	GWH	49.0	23.0	8.1	28.0	17.9	12.0	15.0	21.8	101.5	99.0	9.4
Secondary Energy	GWH	27.0	14.0	4.9	33.0	24.6	16.0	29.0	20.9	119.2	113.0	23.8
Capacity Factor 2)		0.36	0.37	0.36	0.50	0.47	0.52	0.46	0.47	0.46	0.44	0.42
Construction Cost	10^6฿	1335.9	822	475	968	837.2	561.1	599.9	838.1	2021	2139	909.1
Annual Benefit	10^6฿	141.1	67.5	23.7	103.6	70.8	46.5	69.2	74.1	374.3	361.2	50.5
for Firm KW	10^6฿	56.6	26.4	9.4	32.3	20.8	14.2	17.3	25.4	117.9	115.3	10.9
for Firm KWH	10^6฿	50.0	23.5	8.3	28.6	18.3	12.2	15.3	22.2	103.5	101.0	9.6
for Associated KW	10^6฿	15.9	7.9	2.6	19.3	14.7	9.1	16.6	12.1	70.7	66.9	13.6
for Secondary KWH	10^6฿	18.6	9.7	3.4	22.8	17.0	11.0	20.0	14.4	82.2	78.0	16.4
Annual Cost	10^6฿	148.3	91.2	52.7	107.4	92.9	62.3	66.6	93.0	224.3	237.4	100.9
B-C	10^6฿	Δ7.2	Δ23.7	Δ29.0	Δ4.4	Δ22.1	Δ15.8	2.6	Δ18.9	150	123.8	Δ50.4
B/C	10^6฿	0.95	0.74	0.45	0.96	0.76	0.75	1.04	0.80	1.67	1.52	0.50
Annual Energy Cost	฿/KWH	1.95	2.46	4.05	1.76	2.19	2.22	1.51	2.18	1.02	1.12	3.04
Simulation Case No.		Y1B325.10	Y2B380.10	Y3B477.10	ROB270.10	R1D407.10	R2D585.10	R2aD560.5	R3B490.15	N02B250.20	N03D260.15	N1D340.10
Rank of the Project		4	7	9	3	6	-	2	5	1	-	8
Selected Project for the Second Stage-Study		*			*			*		*		

1) Project Type, SG : Storage Type
PG : Pondage Type

2) Capacity Factor = $\dfrac{\text{Annual Energy Production (MWH)}}{\text{Installed Capacity (MW)} \times 8760\ \text{(hr)}}$

5.4 Selected Main Projects (Second Stage Study)

In this stage, further detailed studies were performed for the four main projects selected in the first stage study.

Main items studied more in detail are as following:

1) 1:5,000 scale map prepared by EGAT was used as against 1:50,000 scale map used for the first stage study.

2) Evaporation loss from the proposed reservoir surfaces was estimated and deducted from the inflow so that net inflow were input to the reservoir simulation program. In order to estimate the loss, however, pre-simulation of the reservoir operation was needed to obtain the monthly variation of the reservoir surface area.

3) Three daily plant factors, 0.15, 0.20 and 0.25 were adopted for comparison purpose as against only one daily plant factor of 0.25 in the first stage study.

4) High water levels and low water levels were varied with narrower intervals than those adopted in the first stage study taking into account the new information collected through the second field survey.

5) Runoff regulation effect of Nam Mae Ngao on Lower Yuam was newly studied. The incremental benefit due to this effect will be described in the later section.

6) Several transmission line routes were compared for formulating the optimal transmission scheme. The details of the study are contained in Chapter 7.

7) Irrigation benefit which would be expected to accrue from the development of Upper Mae Yuam 1 was studied. Although the details of the study are explained in Chapter 10, the result shows up a negligible incremental irrigation benefit.

However, following basic values were unchanged from those adopted in the first stage study.

a) Fuel prices, other relevant costs and coefficients of the alternative thermal power plants which were used for the economic evaluation of the hydro power projects.

b) Discount rate, 10%

Based upon the above new information and additional requests for the variation of basic values, the number of cases studied in the second stage excluding pre-run cases for evapolation loss estimation has come up to:

Upper Mae Yuam 1	....	3 cases
Nam Mae Rit	....	12 cases
Upper Mae Rit 2a	....	8 cases
Nam Mae Ngao	....	24 cases
Effect on Lower Yuam	....	8 cases
Total:		55 cases

Among these, only Upper Mae Rit 2a was studied using 1:50,000 scale map and Upper Mae Yuam 1 was studied belatedly to others after the 1:5,000 scale map was availed to the team on September 1986.

The reservoir operation study was performed for each case employing the same procedure as adopted in the first stage study.

The details of the results were included in the "Master Plan Study on Nam Yuam River Basin Hydroelectric Development Project, Study Result (Second Stage), June, 1986", "The Master Plan Study on Nam Yuam River Basin Hydroelectric Development Project, The Second Progress Report, August 1986" and in particular, the computer output volumes submitted and explained to EGAT in June 1986, so that those details have not been attached here except the summary results for all the cases as shown on Table 5-15 through Table 5-20.

From these results it is seen that Nam Mae Ngao (No.2 Site) Case (1) is most economical for individual development scheme (see Table 5-18), but from the view point of integrated development scheme, Nam Mae Ngao plus Lower Yuam, Case VI in Table 5-20 is most superior.

All the other projects, Upper Mae Yuam 1, Nam Mae Rit and Upper Mae Rit 2a resulted in the B/C ratios less than 1.0. Therefore, the key projects in the Nam Yuam river development planning should be Nam Mae Ngao and Lower Yuam which are to be further studied in the next stage of the study.

Table 5-14-2 Summary of Second Stage Study

	Unit	Mae Ngao (Site No.2)	Mae Rit	Mae Rit 2a	Upper Yuam 1
C.A.	Km^2	835	1,268	525	1,967
Annual Inflow	MCM	1,292	395	163	567
Case No.		3	2	3	1
Project Type 1)		SG	SG	PG	SG
Dam Height	m	114	87	38	62
Tunnel Length	m	-	-	5,845	-
HWL	m	260	270	560	325
NIWL	m	248.4	262.9	556.9	319.4
LWL	m	235	255.0	555	315
TWL	m	163	192	407	277
Total Storage	MCM	661.2	85.7	3.2	421.4
Draw down	m	25	10	5	10
Effective Storage	MCM	355.2	34.7	0.8	188.1
Gross Head	m	97	78	153	48.0
Effective Normal-Head	m	82.5	68.5	126.9	41.0
95% Firm Discharge	CmS	24.9	6.18	1.56	13.2
Max. Turbine Discharge	CmS	166.2	41.2	10.4	53.0
Installed Capacity	MW	116.9	24.0	11.2	18.5
Firm Capacity	MW	97.9	21.3	11.1	16.5
Annual Energy-Production	GWH	245.2	61.5	43.6	54.46
Firm Energy	GWH	128.6	28.0	14.5	36.17
Secondary Energy	GWH	116.5	33.5	29.1	18.29
Daily Plant Factor	%	15	15	15	25.0
Capacity Factor	%	23.9	29.2	44.5	33.6
Construction Cost	10M฿	3,373	1,273	698	1,791
Annual Benefit	10M฿	488.5	115.8	68.7	100
for Firm KW	10M฿	171.8	37.4	19.5	29
for Firm KWH	10M฿	197.5	43.0	22.3	55.6
for Secondary KWH	10M฿	119.2	35.4	26.9	15.4
Annual Cost	10M฿	374.4	141.3	77.5	198.8
B/C	10M฿	1.305	0.82	0.858	0.503
Simulation Case No.		No2A260.25b	ROA270.15b	R2aA560.5b	Y1V325.10b

1) Project Type, SG: Storage Type

PG: Pondage Type

Table 5-15 2nd Stage Study Upper Mae Yuam 1

C. A 1 967km²
Annual flow 567MCM

Available draw down	Unit m	HWL 325m PF=0.25		
		10	15	20
Case No.		①	②	③
Simulation case No.		YIV325·10b	YIV325·15b	YIV325·20b
Project type		SG	SG	SG
Dam height	m			
Tunnel length	m			
Total storage capacity	MCM	421.4	421.4	421.4
Effective storage capacity	MCM	188.1	257.4	311.9
HWL	m	325	325	325
NIWL	m	319.4	318.2	317.1
LWL	m	315	310	305
TWL	m	277	277	277
Gross head	m	48	48	48
Effective head	m	41.0	39.7	38.7
Daily plant factor	%	25	25	25
Capacity factor	%	33.6	32.4	31.8
95 % firm discharge	cms	13.2	13.7	13.9
Max. turbine discharge	cms	53.0	54.9	55.8
Installed capacity	MW	18.5	18.6	18.4
Firm capacity	MW	16.5	14.8	12.6
Annual energy production	GWH	54.5	52.7	51.3
firm energy	GWH	36.2	32.3	27.7
secondary energy	GWH	18.3	20.4	23.6
Construction cost	M฿			
for generating F.	M฿	1791	1791	1791
for transmission F.	M฿	—	—	—
Benefit	M฿	100.0	92.7	84.4
for firm kW	M฿	29.0	26.0	22.1
for firm kWH	M฿	55.6	49.6	42.5
for secondary kWH	M฿	15.4	17.1	19.8
Annual cost	M฿			
for generating F.	M฿	198.8	198.8	198.8
for transmission F.	M฿	—	—	—
B / C		0.503	0.466	0.425

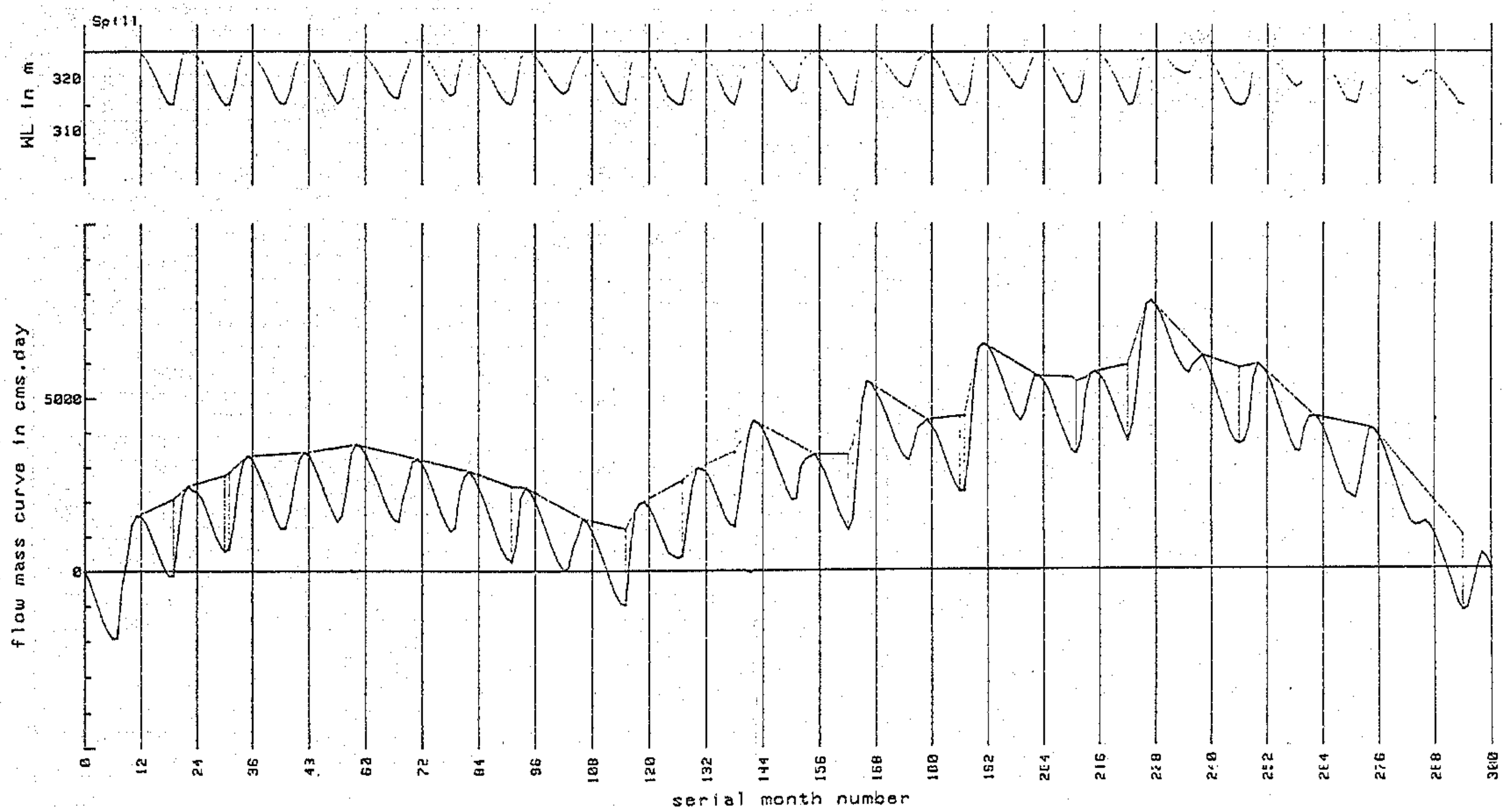


Fig. 5–1 Flow Mass Curve Upper Mae Yuam 1 (Case YIB 325.10)

Table 5–16 2nd Stage Study Upper Mae Rit

C.A 1268 km²
Annual flow 395 MCM

Available draw down	Unit	HWL 270m PF=0.15		HWL 265m PF=0.15		HWL 270m PF=0.20		HWL 265m PF=0.20		HWL 270m PF=0.25		HWL 265m PF=0.25	
	m	10	15	10	15	10	15	10	15	10	15	10	15
Case No.		①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫
Simulotation case No.		ROA270.10b	ROA270.15b	ROA265.10b	ROA265.15b	ROB270.10b	ROB270.15b	ROB265.10b	ROB265.15b	ROC270.10b	ROC270.15b	ROC265.10b	ROC265.15b
Project type		SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG
Dam height	m												
Tunnel length	m												
Total storage capacity	MCM	85.7	85.7	73.5	73.5	85.7	85.7	73.5	73.5	85.7	85.7	73.5	73.5
Effective storage capacity	MCM	25.4	34.7	22.5	32.9	25.4	34.7	22.5	32.9	25.4	34.7	22.5	32.9
HWL	m	270	270	265	265	270	270	265	265	270	270	265	265
NIWL	m	264.9	262.9	260.2	257.9	264.9	262.8	260.2	257.9	265.0	262.9	260.3	258.0
LWL	m	260	255	255	250	260	255	255	250	260	255	255	250
TWL	m	192	192	192	192	192	192	192	192	192	192	192	192
Gross head	m	78	78	73	73	78	78	73	73	78	78	73	73
Effective head	m	70.5	68.5	66.0	63.7	70.5	68.5	66.0	63.7	70.6	68.5	66.1	63.8
Daily plant factor	%	15	15	15	15	20	20	20	20	25	25	25	25
Capacity factor	%	31.6	29.2	32.9	29.6	41.4	38.4	42.6	38.9	49.5	46.9	50.3	47.3
95% firm discharge	cms	5.65	6.18	5.44	6.06	5.65	6.18	5.44	6.06	5.65	6.18	5.44	6.06
Max. turbine discharge	cms	37.7	41.2	36.3	40.4	28.3	30.9	27.2	30.3	22.6	24.7	21.8	24.2
Installed capacity	MW	22.7	24.0	20.4	22.0	17.0	18.0	15.3	16.5	13.6	14.4	12.3	13.2
Firm capacity	MW	21.1	21.3	18.8	19.2	15.8	16.0	14.1	14.4	12.7	12.8	11.3	11.5
Annual energy production	GWH	62.8	61.5	58.7	57.1	61.6	60.6	57.1	56.2	58.9	59.2	54.3	54.7
firm energy	GWH	27.7	28.0	24.7	25.2	27.7	28.0	24.7	25.2	27.7	28.0	24.7	25.2
secondary energy	GWH	35.1	33.5	34.0	31.9	33.9	32.6	32.4	31.0	31.2	31.2	29.6	29.5
Construction cost	M฿												
for generating F.	M฿	1297	1273	1235	1305	1223	1216	1142	1121	1075	1151	1098	1090
for transmission F.	M฿												
Benefit	M฿	115.1	115.8	105.1	106.2	97.6	97.3	88.9	89.0	86.3	86.9	76.5	77.4
for firm kW	M฿	37.0	37.4	33.0	33.7	45.8	46.4	40.9	41.8	36.8	37.1	32.8	33.4
for firm kWH	M฿	42.5	43.0	37.9	38.7	23.3	23.5	20.8	21.2	23.3	23.5	20.8	21.2
for secondary kWH	M฿	35.6	35.4	34.2	33.8	28.5	27.4	27.2	26.1	26.2	26.2	23.0	22.9
Annual cost	M฿												
for generating F.	M฿	144.0	141.3	137.1	144.9	135.8	135.0	126.8	124.4	119.3	127.8	121.9	121.0
for transmission F.	M฿												
B - C	M฿												
B / C		0.799	0.820	0.767	0.733	0.719	0.721	0.701	0.715	0.723	0.680	0.628	0.640
Annual energy cost	฿/kWH												

SG : Storage, PG : Pondage, RR : Run-of-River   Capacity factor annual energy / (installed capacity x 8760)

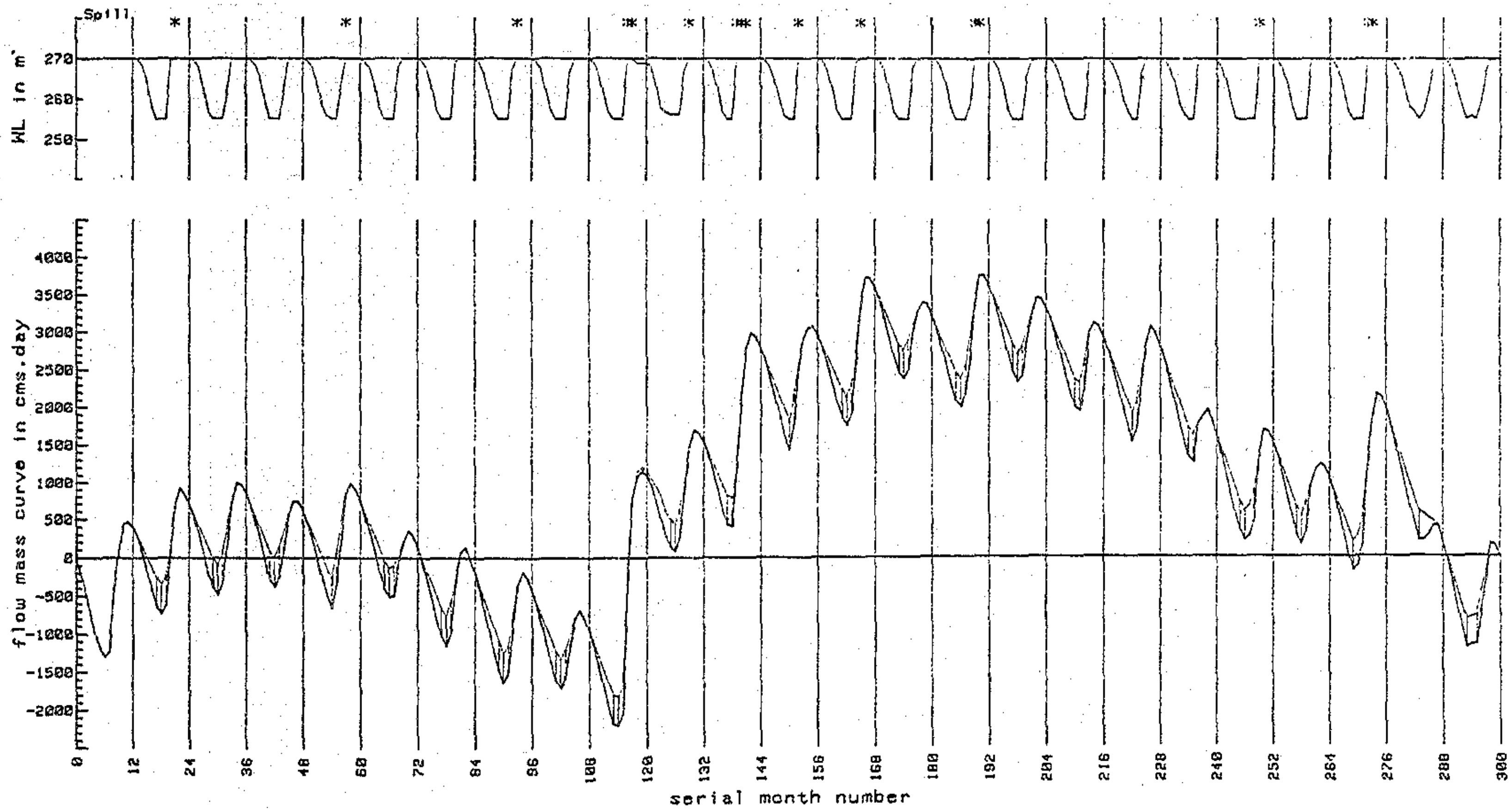


Fig. 5–2 Flow Mass Curve Nam Mae Rit (Case ROB 270.15)

Table 5–17 2nd Stage Study Upper Mae Rit 2a

C.A 525 km²
Annual flow 163MCM

Available draw down	Unit m	HWL 580m PF=0.15		HWL 560m PF=0.15		HWL 580m PF=0.20		HWL 560m PF=0.20	
		10	15	5	10	10	15	5	10
Case No.		①	②	③	④	⑤	⑥	⑦	⑧
Simulation case No.		R2aA580 10b	R2aA580 15b	R2aA560 5b	R2aA560 10b	R2aB580 10b	R2aB580 15b	R2aB560 5b	R2aB560 10b
Project type		SG	SG	PG	PG	SG	SG	PG	PG
Dam height	m	58	58	38	38	58	58	38	38
Tunnel length	m	5 510	5 510	5 845	5 845	5 510	5 510	5 845	5 845
Total storage, capacity	MCM	10.3	10.3	3.2	3.2	10.3	10.3	3.2	3.2
Effective storage capacity	MCM	4.1	5.4	0.8	1.6	4.1	5.4	0.8	1.6
HWL	m	580	580	560	560	580	580	560	560
NIWL	m	574.5	572.3	556.9	555.4	574.6	572.3	556.9	555.3
LWL	m	570	565	555	550	570	565	555	550
TWL	m	407	407	407	407	407	407	407	407
Gross head	m	173	173	153	153	173	173	153	153
Effective head	m	144.5	142.3	126.9	125.5	144.5	142.3	126.9	125.4
Daily plant factor	%	15.0	15.0	15.0	15.0	20.0	20.0	20.0	20.0
Capacity factor	%	38.0	36.6	44.5	42.7	47.4	46.3	53.5	51.3
95% firm discharge	cms	1.94	2.03	1.56	1.66	1.94	2.03	1.56	1.66
Max. turbine discharge	cms	12.9	13.5	10.4	11.1	9.68	10.1	7.78	8.30
Installed capacity	MW	15.9	16.4	11.2	11.8	11.9	12.3	8.4	8.9
Firm capacity	MW	15.4	15.6	11.1	11.3	11.3	11.7	8.3	8.5
Annual energy production	GWH	52.9	52.6	43.6	44.1	49.4	49.9	39.3	40.0
firm energy	GWH	20.2	20.4	14.5	14.9	20.2	20.5	14.5	14.9
secondary energy	GWH	32.7	32.2	29.1	29.2	29.2	29.4	24.8	25.1
Construction cost	M฿								
for generating F.	M฿	883	896	698	713	806	824	613	646
for transmission F.	M฿	—	—	—	—	—	—	—	—
Benefit	M฿	89.3	90.0	68.7	70.1	74.9	75.9	57.1	58.3
for firm kW	M฿	27.0	27.4	19.5	19.8	33.4	33.9	24.1	24.7
for firm kWH	M฿	31.0	31.3	22.3	22.9	17.0	17.2	12.2	12.5
for secondary kWH	M฿	31.2	31.3	26.9	27.4	24.5	24.7	20.8	21.1
Annual cost	M฿								
for generating F	M฿	98.0	99.5	77.5	79.1	89.5	91.5	68.0	71.7
for transmission F	M฿	—	—	—	—	—	—	—	—
B/C		0.899	0.899	0.858	0.872	0.803	0.812	0.796	0.771

SG: Storage, PG: Pondage, RR: Run-of-Rive. Capacity factor annual energy/(Installed capacity x 8760)

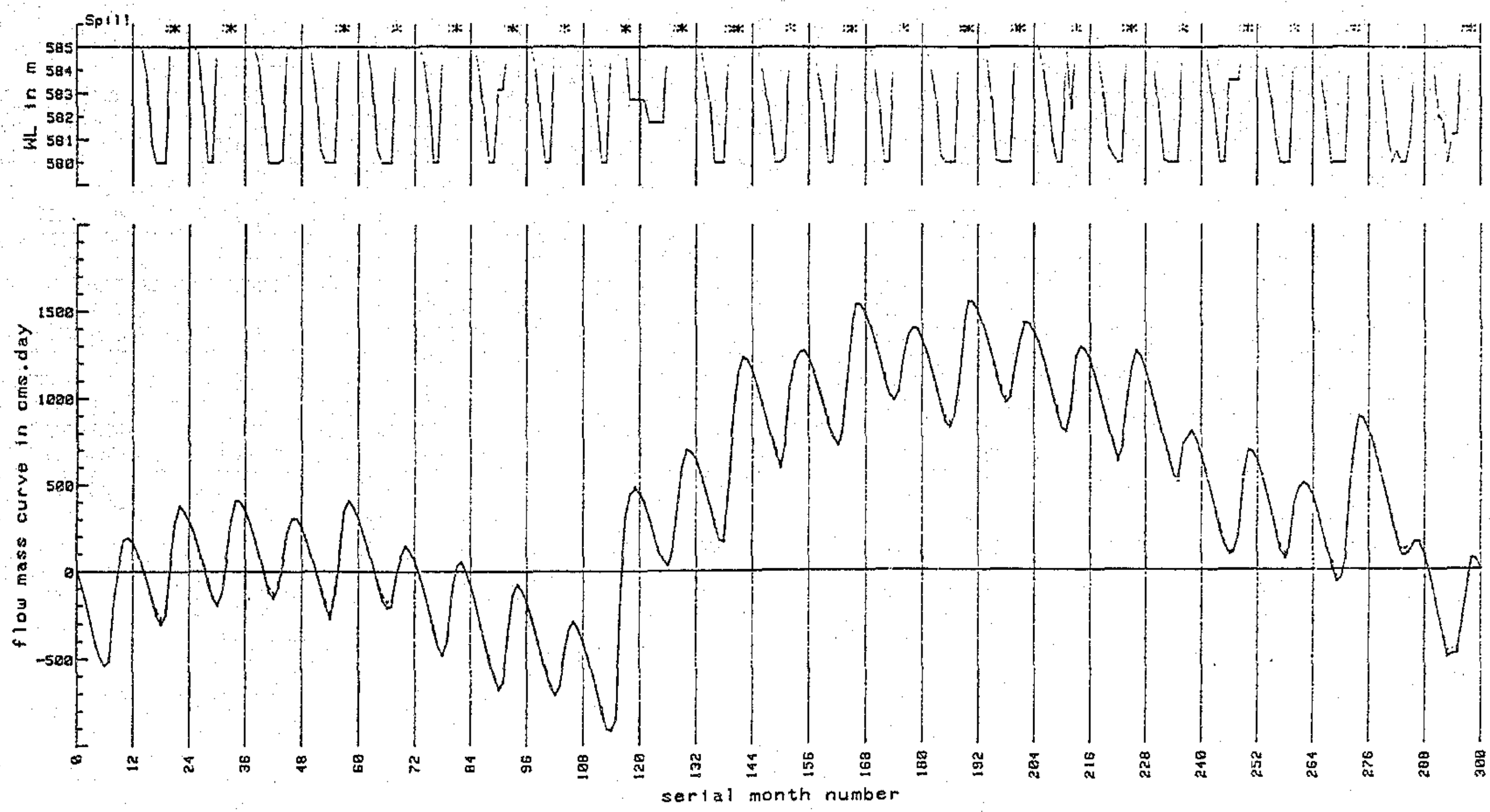


Fig. 5–3 Flow Mass Curve Upper Mae Rit 2a (Case R2a D 585.5)

Table 5–18 2nd Stage Study Nam Mae Ngao (No. 2 Site)

C.A , 835 km²
Annual flow 1292 MCM

Available draw down	Unit	HWL 260m PF = 0.15					HWL 255m PF = 0.15					HWL 260m PF = 0.20			
	m	15	20	25	30	35	15	20	25	30	35	15	20	25	30
Case No.		①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭
Simulation case No.		NO2A26015b	NO2A26020b	NO2A26025b	NO2A26030b	NO2A26035b	NO2A25515b	NO2A25520b	NO2A25525b	NO2A25530b	NO2A25535b	NO2B26015b	NO2B26020b	NO2B26025b	NO2B26030b
Project type		SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG	SG
Dam height	m	105	105	105	105	105	100	100	100	100	100	105	105	105	105
Tunnel length	m	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total storage capacity	MCM	661.2	661.2	661.2	661.2	661.2	578.0	578.0	578.0	578.0	578.0	661.2	661.2	661.2	661.2
Effective storage capacity	MCM	230.2	295.2	355.2	407.3	454.7	212.0	272.0	324.0	371.4	414.2	230.2	295.2	355.2	407.3
HWL	m	260	260	260	260	260	255	255	255	255	255	260	260	260	260
NIWL	m	252.8	250.6	248.4	246.4	244.9	247.9	245.7	243.7	241.5	239.6	252.9	250.6	248.3	246.4
LWL	m	245	240	235	230	225	240	235	230	225	220	245	240	235	230
TWL	m	163	163	163	163	163	163	163	163	163	163	163	163	163	163
Gross head	m	97	97	97	97	97	92	92	92	92	92	97	97	97	97
Effective head	m	86.9	84.7	82.5	80.5	79.0	82.1	79.9	230	75.8	73.9	86.9	84.6	82.5	80.5
Daily plant factor	%	15	15	15	15	15	15	15	15	15	15	20	20	20	20
Capacity factor	%	30.8	26.9	23.9	22.4	21.7	32.2	27.8	26.0	23.4	22.3	40.2	35.4	31.6	29.6
95% firm discharge	cms	19.1	22.2	24.9	26.8	27.8	18.2	21.2	23.0	25.5	27.0	19.1	22.2	24.9	26.8
Max. turbine discharge	cms	127.6	147.7	166.2	178.7	185.0	121.5	141.3	153.2	170.2	180.0	95.7	110.7	124.7	134.0
Installed capacity	MW	94.6	106.7	116.9	122.7	124.5	85.1	96.3	101.8	110.0	113.4	71.0	79.9	87.6	92.0
Firm capacity	MW	86.1	93.3	97.9	97.6	93.2	76.9	83.4	83.9	86.0	83.2	64.6	70.0	73.4	73.2
Annual energy production	GWH	255.4	251.5	245.2	240.8	236.2	240.1	234.7	232.1	225.8	221.3	250.3	247.6	242.5	238.6
firm energy	GWH	113.1	122.6	128.6	128.3	122.5	101.1	109.6	110.3	113.0	109.4	113.1	122.6	128.6	128.3
secondary energy	GWH	142.3	128.9	116.5	112.5	113.7	139.0	125.0	121.9	112.8	111.9	137.2	125.0	113.9	110.3
Construction cost	M฿														
for generating F.	M฿	3141	3286	3373	3438	3472	2897	3035	3094	3190	3236	2911	3002	3101	3157
for transmission F.	M฿	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Benefit	M฿	460.4	478.9	488.5	484.4	471.3	423.5	439.5	442.6	446.6	437.8	397.0	410.2	415.6	411.8
for firm kW	M฿	151.1	163.7	171.8	171.3	163.6	135.0	146.4	147.2	150.9	146.0	161.6	173.8	181.3	181.0
for firm kWH	M฿	173.7	188.3	197.5	197.1	188.2	155.3	168.3	169.4	173.6	168.0	120.1	131.4	138.6	138.1
for secondary KWH	M฿	135.6	126.9	119.2	116.0	119.6	133.3	124.8	125.9	122.1	123.8	115.3	105.1	95.7	92.7
Annual cost	M฿														
for generating F.	M฿	348.7	364.7	374.4	381.6	385.4	321.6	336.9	343.4	354.1	359.2	323.1	333.2	344.2	350.4
for transmission F.	M฿	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B / C		1.320	1.313	1.305	1.269	1.223	1.317	1.305	1.289	1.261	1.219	1.229	1.231	1.207	1.175

Table 5–18 (Continued) 2nd Stage Study Nam Mae Ngao (No. 2 Site)

C. A. 835km²
Annual flow 1292 MCM

Available draw down	Unit m	HWL 255m PF = 0.20				HWL 260m PF = 0.25			HWL 255m PF = 0.25		
		15	20	25	30	15	20	25			
Case No.		15	16	17	18	19	20	21	22	23	24
Simulation case No.		NO2B255-15b	NO2B255-20b	NO2B255-25b	NO2B255-30b	NO2C260-15b	NO2C260-20b	NO2C260-25b	NO2C255-15b	NO2C255-20b	NO2C255-25b
Project type		SG	SG	SG	SG	SG	SG	SG	SG	SG	SG
Dam height	m	100	100	100	100	105	105	105	100	100	100
Tunnel length	m	—	—	—	—	—	—	—	—	—	—
Total storage capacity	MCM	578.0	578.0	578.0	578.0	661.2	661.2	661.2	578.0	578.0	578.0
Effective storage capacity	MCM	212.0	272.0	324.0	371.4	230.2	295.2	355.2	212.0	272.0	324.0
HWL	m	255	255	255	255	260	260	260	255	255	255
NtWL	m	247.9	245.6	243.7	241.5	252.9	250.6	248.3	248.0	245.7	243.7
LWL	m	240	235	230	225	245	240	235	240	235	230
TWL	m	163	163	163	163	163	163	163	163	163	163
Gross head	m	92	92	92	92	97	97	97	92	92	92
Effective head	m	82.2	79.9	77.9	75.8	87.0	84.7	82.4	82.2	80.0	77.9
Daily plant factor	%	20	20	20	20	25	25	25	25	25	25
Capacity factor	%	42.0	36.4	34.3	30.9	49.0	43.6	39.0	50.6	44.7	42.2
95% firm discharge	cms	18.2	21.2	23.0	25.5	19.1	22.2	24.9	18.2	21.2	23.0
Max. turbine discharge	cms	91.1	106.0	114.9	127.7	76.6	88.6	99.7	72.9	84.8	91.9
Installed capacity	MW	63.8	72.2	76.3	82.5	56.8	64.0	70.1	51.1	57.8	61.1
Firm capacity	MW	57.7	62.6	62.9	64.5	51.6	56.0	58.7	46.2	50.1	50.4
Annual energy production	GWH	234.7	230.5	229.1	223.5	243.9	244.2	239.5	226.7	226.4	225.8
firm energy	GWH	101.1	109.6	110.3	113.0	113.1	122.6	128.6	101.1	109.6	110.3
secondary energy	GWH	133.7	120.9	118.9	110.6	130.8	121.6	110.8	125.6	116.8	122.5
Construction cost	M฿										
for generating F.	M฿	2691	2768	2831	2918	2774	2859	2932	2566	2646	2684
for transmission F.	M฿	—	—	—	—	—	—	—	—	—	—
Benefit	M฿	364.2	374.6	374.4	374.3	354.6	367.7	371.4	324.5	335.6	341.8
for firm kW	M฿	146.2	157.1	158.2	161.5	149.6	162.4	170.2	134.0	145.3	146.2
for firm kWH	M฿	105.6	116.0	116.3	119.8	95.1	103.0	108.1	85.0	92.1	92.7
for secondary kWH	M฿	112.4	101.6	99.9	93.0	109.9	102.2	93.1	105.6	98.2	103.0
Annual cost	M฿										
for generating F.	M฿	298.7	309.5	314.2	323.9	307.9	317.3	325.5	284.8	293.7	297.9
for transmission F.	M฿	—	—	—	—	—	—	—	—	—	—
B/C		1.219	1.210	1.192	1.156	1.152	1.159	1.141	1.139	1.143	1.147

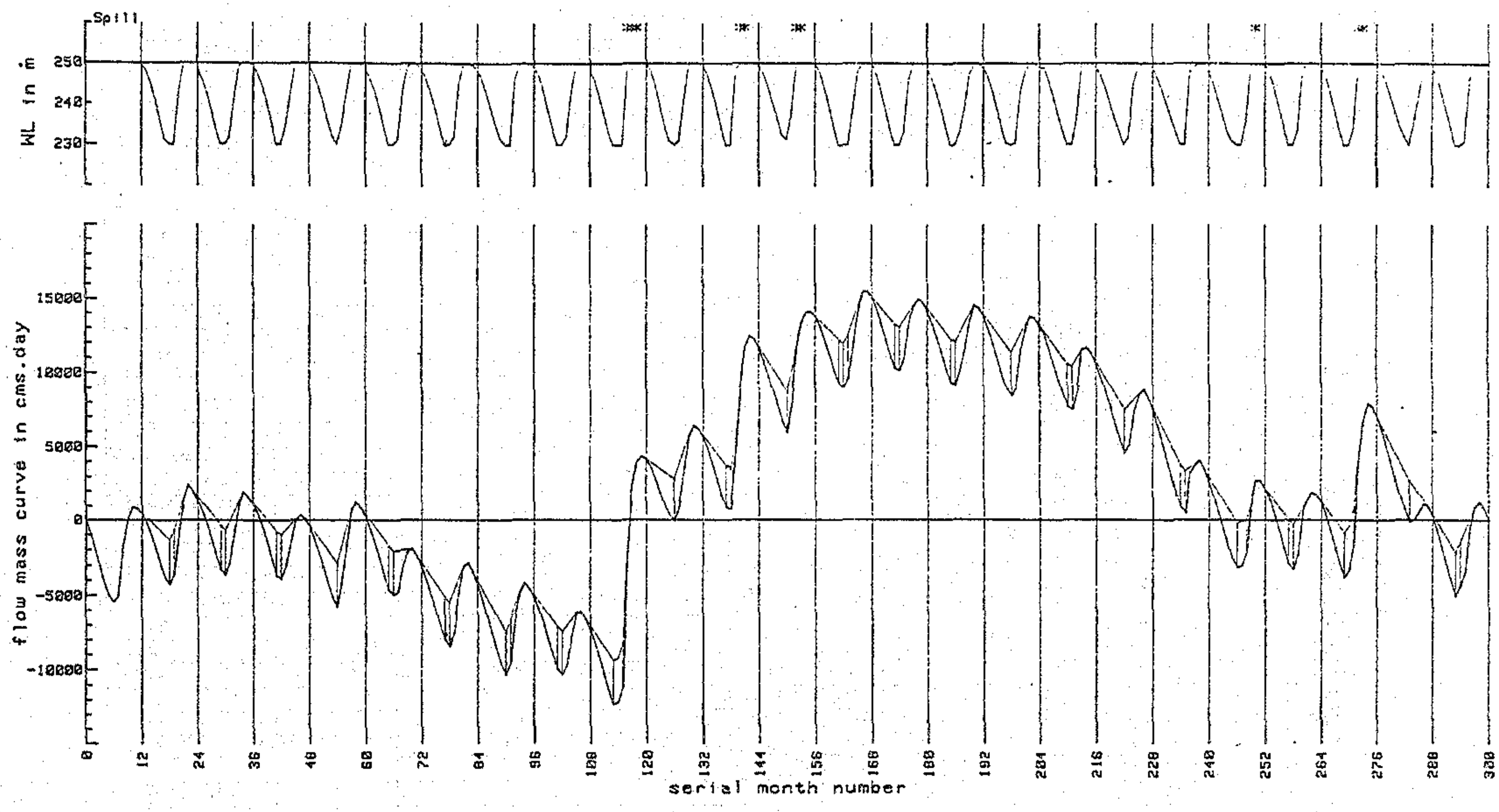


Fig. 5–4 Flow Mass Curve Nam Mae Ngao (Case NOB 250.20b)

Table 5–19 2nd Stage Study Lower Yuam

C.A 5,920 km²
Annual flow 2,820MCM

	Unit	Individual development without upstream projects			Integrated development							
					Installed capacities are fixed at 162MW 1)				Installed capacities are estimated			
Case No.		⓪ 1)	①	②	③	④	⑤	⑨	⑥	⑦	⑧	⑩
Simulation case No.		—	YøVI70·20δ	YøAI70·20δ	YøVI70·20c	YøVI70·20b	YøVI70·20a	YøVI70·20d	YøAI70·20c	YøAI70·20b	YøAI70·20a	YøAI70·20d
Upstream Projects												
Name		None	None	None	Ngao No.2	Ngao No.2	Ngao No.2	Ngao No.2	Ngao No.2	Ngao No.2	Ngao No.2	Ngao No.2
Simulation case No.		—	—	—	Nø2A260·25b	Nø2A260·30b	Nø2A260·35b	Nø2A260·20b	Nø2A260·25b	Nø2A260·30b	Nø2A260·35b	Nø2A260·20b
Lower Nam Yuam after upstream projects												
Total storage capacity	MCM	444	444	444	444	444	444	444	444	444	444	444
Effective strage capacity	MCM	260	260	260	260	260	260	260	260	260	260	260
HWL	m	170	170	170	170	170	170	170	170	170	170	170
NIWL	m		161.4	161.4	161.4	161.4	161.4	161.4	161.4	161.4	161.4	161.4
TWL	m	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2	73.2
Gross head	m	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8
Effective head	m	87.3	85.6	85.6	85.3	85.3	85.3	85.3	85.3	85.3	85.3	
Daily plant factor		NA	0.148	0.15	0.239	0.247	0.254	0.225	0.15	0.15	0.15	0.15
Annual capacity factor		NA	0.380	0.384	0.389	0.387	0.388	0.386	0.248	0.239	0.233	0.261
95% firm discharge	cms	29.5	32.5	32.5	52.4	54.4	55.9	49.7	52.4	54.4	55.9	49.7
Max. turbine discharge	cms	215	219.5	216.9	219.5	220.2	220.2	220.2	349.3	362.8	372.4	331.0
Installed capacity	MW	162 1)	162 1)	160.1	162 1)	162 1)	162 1)	162 1)	257.1	267.0	274.0	243.6
Firm capacity	MW	128	139.9	138.2	139.7	140.3	140.3	140.3	222.6	231.2	237.3	210.9
Annual energy production	GWH	565	538.9	538.1	550.0	549.8	550.9	547.4	559.3	558.5	559.0	557.5
firm energy	GWH	NA	181.6	181.6	292.5	303.8	311.8	277.2	292.5	303.8	311.8	277.2
secondary energy	GWH	NA	357.3	356.5	257.5	246.0	239.1	270.2	266.8	254.7	247.1	270.2

Table 5–20 Integrated Development including Transmission Line
Nam Mae Ngao No. 2 + Lower Yuam

Case No.	Unit	Individual	Lower Yuam : Dam & Installed capacity are fixed.				Lower Yuam : Dam fixed. Installed capacity optimized			
		0	I	II	III	IV	V	VI	VII	VIII
Case No. of Ngao No.2			②N#2A260-20b	③N#2A260-25b	④N#2A260-30b	⑤N#2A260-35b	②N#2A260-20b	③N#2A260-25b	④N#2A260-30b	⑤N#2A260-35b
Case No. of Lower Nam Yuam		①Y#VI70-20a	⑨Y#VI70-20d	③Y#VI70-20c	④Y#VI70-20b	⑤Y#VI70-20a	⑩Y#AI70-20d	⑥Y#AI70-20c	⑦Y#AI70-20b	⑧Y#AI70-20a
Installed capacity	MW		268.7	278.4	284.7	286.5	350.3	374.0	389.7	398.5
Ngao No.2	MW	—	106.7	116.9	122.7	124.5	106.7	116.9	122.7	124.5
Lower Nam Yuam	MW	162.0	162.0	161.5	162.0	162.0	243.6	257.1	267.0	274.0
Firm capacity	MW		233.6	237.6	237.9	233.5	304.2	320.5	328.8	330.5
Ngao No.2	MW	—	93.3	97.9	97.6	93.2	93.3	97.9	97.6	93.2
Lower Nam Yuam	MW	139.9	140.3	139.7	140.3	140.3	210.9	222.6	231.2	237.3
Annual firm energy	GWH		399.8	421.1	432.1	434.3	399.8	421.1	432.1	434.3
Ngao No.2	GWH	—	122.6	128.6	128.3	122.5	122.6	128.6	128.3	122.5
Lower Nam Yuam	GWH	181.6	277.2	292.5	303.8	311.8	277.2	292.5	303.8	311.8
Annual secondary energy	GWH		399.1	374.0	358.5	352.8	399.1	383.3	367.2	360.8
Ngao No.2	GWH	—	128.9	116.5	112.5	113.7	128.9	116.5	112.5	113.7
Lower Nam Yuam	GWH	357.3	270.2	257.5	246.0	239.1	270.2	266.8	254.7	247.1
Construction cost for generating f.	M฿	4340	7628	7712.7	7780	7814	8307	8528.2	8656.1	8740.7
Ngao No.2	M฿	—	3286	3373	3438	3472	3286	3373	3438	3472
Lower Nam Yuam	M฿	4340	4342	4339.7	4342	4342	5021	5155.2	5216.1	5268.7
Construction cost for transmission f.	M฿	400	465.5	465.5	465.5	465.5	745.5	745.5	745.5	745.5
Ngao No.2	M฿	—	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5
Lower Nam Yuam	M฿	400	400.0	400.0	400.0	400.0	680.0	680.0	680.0	680.0
Total benefit	M฿	824.7	1320.6	1331.6	1331.2	1318.9	1460.8	1504.4	1519.7	1520.3
unit benefit for firm capacity	฿/KW	1755	2271	2309	2336	2365	2060	2071	2077	2078
benefit for total firm capacity	M฿	245.5	530.5	548.6	555.8	552.3	625.6	663.8	682.8	686.7
unit benefit for firm energy	฿/KWH	1.536	1.137	1.113	1.097	1.082	1.248	1.231	1.223	1.221
benefit for total firm energy	M฿	278.9	454.7	468.7	474.1	470.1	498.8	518.4	528.3	530.3
unit cost for secondary energy	฿/KWH	0.8405	0.8405	0.8405	0.8405	0.8405	0.8405	0.8405	0.8405	0.8405
benefit for total secondary energy	M฿	300.3	335.4	314.3	301.3	296.5	335.4	322.2	308.6	303.3
Total annual cost		543.0	925.2	934.8	942.3	945.9	1034.8	1060.2	1074.7	1084.1
for generation facilities 0.111	M฿	481.7	846.7	856.1	863.6	867.4	922.1	946.6	960.8	970.2
for transmission facilities 0.112	M฿	44.8	52.1	52.1	52.1	52.1	83.5	83.5	83.5	83.5
for transmission losses Benefit x2%	M฿	16.5	26.4	26.6	26.6	26.4	29.2	30.1	30.4	30.4
B − C	M฿	281.7	395.4	396.8	388.9	373.0	426.0	444.2	445.0	436.2
B/C		1.519	1.427	1.424	1.413	1.394	1.412	1.419	1.414	1.402
Annual energy cost	฿/KWH	1.01	1.16	1.18	1.19	1.20	1.30	1.32	1.34	1.36
Case to be adapted				△				○		

Table 5–21 Incremental Benefit of Lower Yuam due to the Effect of Nam Mae Ngao No. 2 Development (Lower Yuam: Dam & Installed Capacity are Fixed at F/S Levels-Second Stage)

		Individual Development			Integrated Development	Increase
		Nam Mae Ngao	Lower Yuam	Total	Nam Mae Ngao & Lower Yuam	
Case No.		③ NØ2A 260-25b	① YØV170-200	(1)+(2)	Case II	(4)−(3)
	Unit	(1)	(2)	(3)	(4)	(5)
Installed Capacity	MW	116.9	162.0	278.9	278.9	0
Firm Capacity	MW	97.9	139.9	237.8	237.6	− 0.2
Annual Energy Production						
Firm Energy	GWH	128.6	181.6	310.2	421.1	110.9
Secondary Energy	GWH	116.5	357.3	473.8	374.0	−99.8
Total	GWH	245.1	538.9	784.0	795.1	11.1
Construction Cost						
Generating F.	M฿	3373.	4340.	7713	7713	0
Transmission F.	M฿	65.5	400.	465.5	465.5	0
Total	M฿	3438.5	4740.	8178.5	8178.5	0
Annual Benefit						
for Firm Capacity	M฿	171.8	245.5	417.3	548.6	131.3
for Firm Energy	M฿	197.5	278.9	476.4	468.7	− 7.7
for Secondary Energy	M฿	119.2	300.3	419.5	314.3	−105.2
Total	M฿	488.5	824.7	1313.2	1331.6	18.4
Annual Cost						
for Generating F.	M฿	374.4	481.7	856.1	856.1	0
for Transmission F.	M฿	7.3	44.8	52.1	52.1	0
for Transmission Losses	M฿	9.8	16.5	26.3	26.6	0.3
Total	M฿	391.5	543.0	934.5	934.8	0.3
B − C	M฿	97.0	281.7	378.7	396.8	18.1
B/C		1.248	1.519	—	1.424	—
Energy Cost	฿/kwh	1.60	1.01	—	1.18	—
Incremental Benefit	M฿					18.1

Table 5–22 Incremental Benefit of Lower Yuam due to the Effect of Nam Mae Ngao No. 2 Development (Lower Yuam: Dam is Fixed at F/S Level, Installed Capacity is Optimized-Second Stage)

		Individual Development			Integrated Development Nam Mae Ngao & Lower Yuam	Increase
		Nam Mae Ngao	Lower Yuam	Total		
Case No.		③ Nø2A 260-25b	① YøV170-200	(1)+(2)	Case VI	(4)−(3)
	Unit	(1)	(2)	(3)	(4)	(5)
Installed Capacity	MW	116.9	162.0	278.9	374.0	95.1
Firm Capacity	MW	97.9	139.9	237.8	320.5	82.7
Annual Energy Production						
Firm Energy	GWH	128.6	181.6	310.2	421.1	110.9
Secondary Energy	GWH	116.5	357.3	473.8	383.3	−90.5
Total	GWH	245.1	538.9	784.0	804.4	20.4
Construction Cost						
Generating F.	M฿	3373.	4340.	7713	8528.2	815.2
Transmission F.	M฿	65.5	400.	465.5	745.5	280.0
Total	M฿	3438.5	4740.	8178.5	9273.7	1095.2
Annual Benefit						
for Firm Capacity	M฿	171.8	245.5	417.3	663.8	246.5
for Firm Energy	M฿	197.5	278.9	476.4	518.4	42.0
for Secondary Energy	M฿	119.2	300.3	419.5	322.2	−97.3
Total	M฿	488.5	824.7	1313.2	1504.4	191.2
Annual Cost						
for Generating F.	M฿	374.4	481.7	856.1	946.6	90.5
for Transmission F.	M฿	7.3	44.8	52.1	83.5	31.4
for Transmission Losses	M฿	9.8	16.5	26.3	30.1	3.8
Total	M฿	391.5	543.0	934.5	1060.2	125.7
B − C	M฿	97.0	281.7	378.7	444.2	65.5
B/C		1.248	1.519	—	1.419	—
Energy Cost	฿/kwh	1.60	1.01	—	1.32	—
Incremental Benefit	M฿					65.5

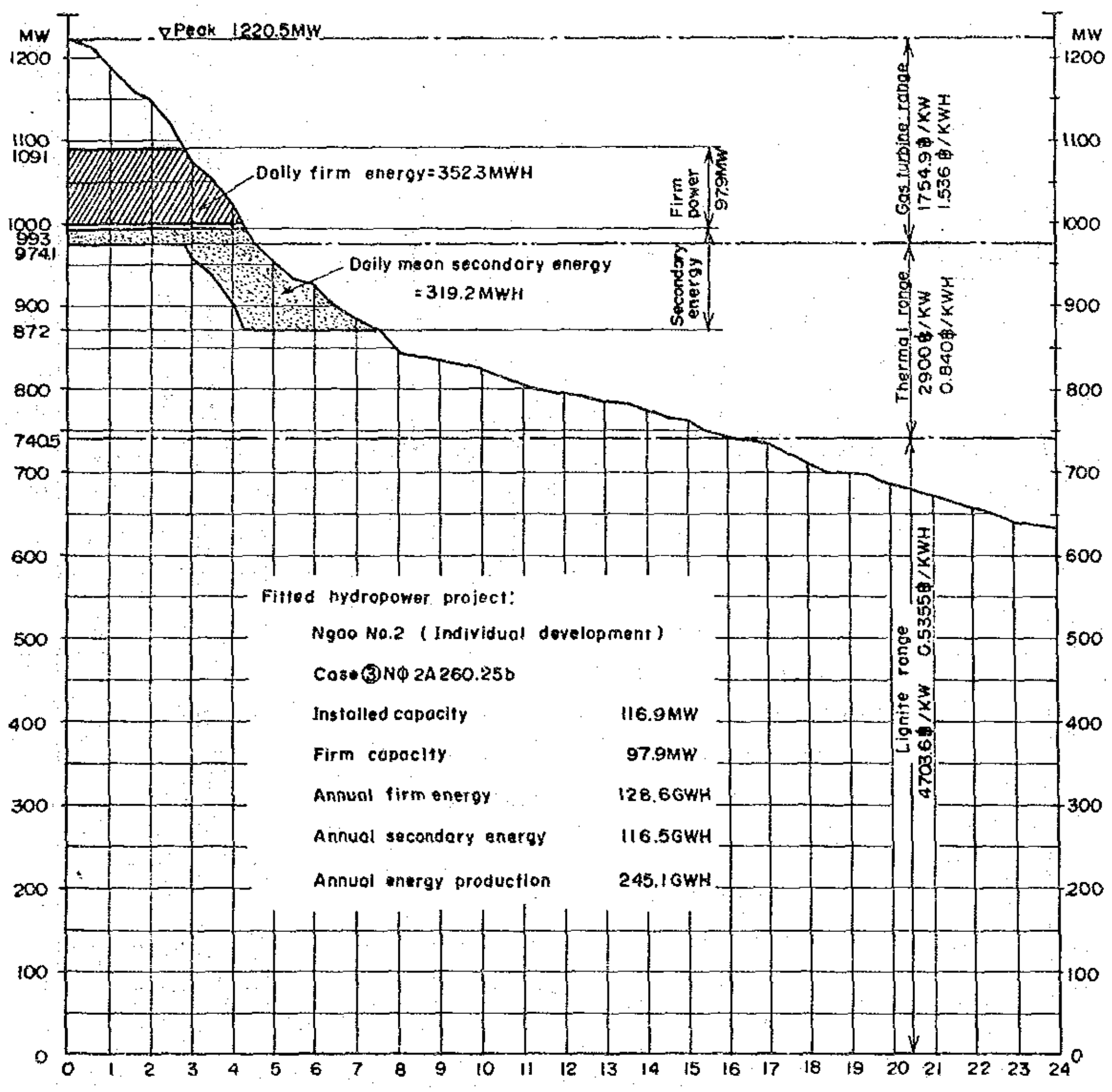


Fig. 5–7 Load Duration Curve, Northern Region, 2000 with Nam Mae Ngao Hydro Power Fitted

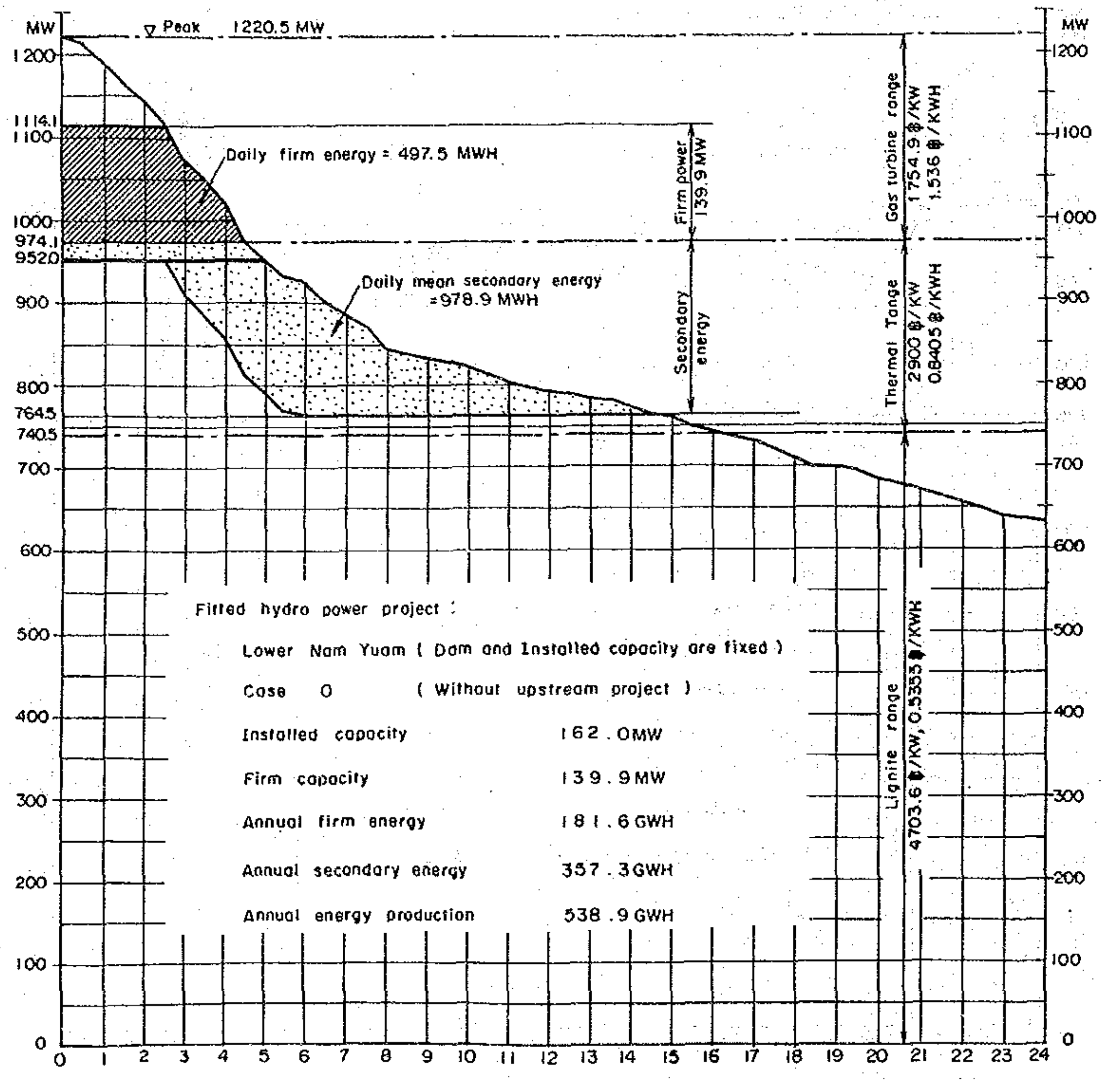


Fig. 5–8 Load Duration Curve, Northern Region, 2000 with Lower Yuam Hydro Power (Case 0) Fitted

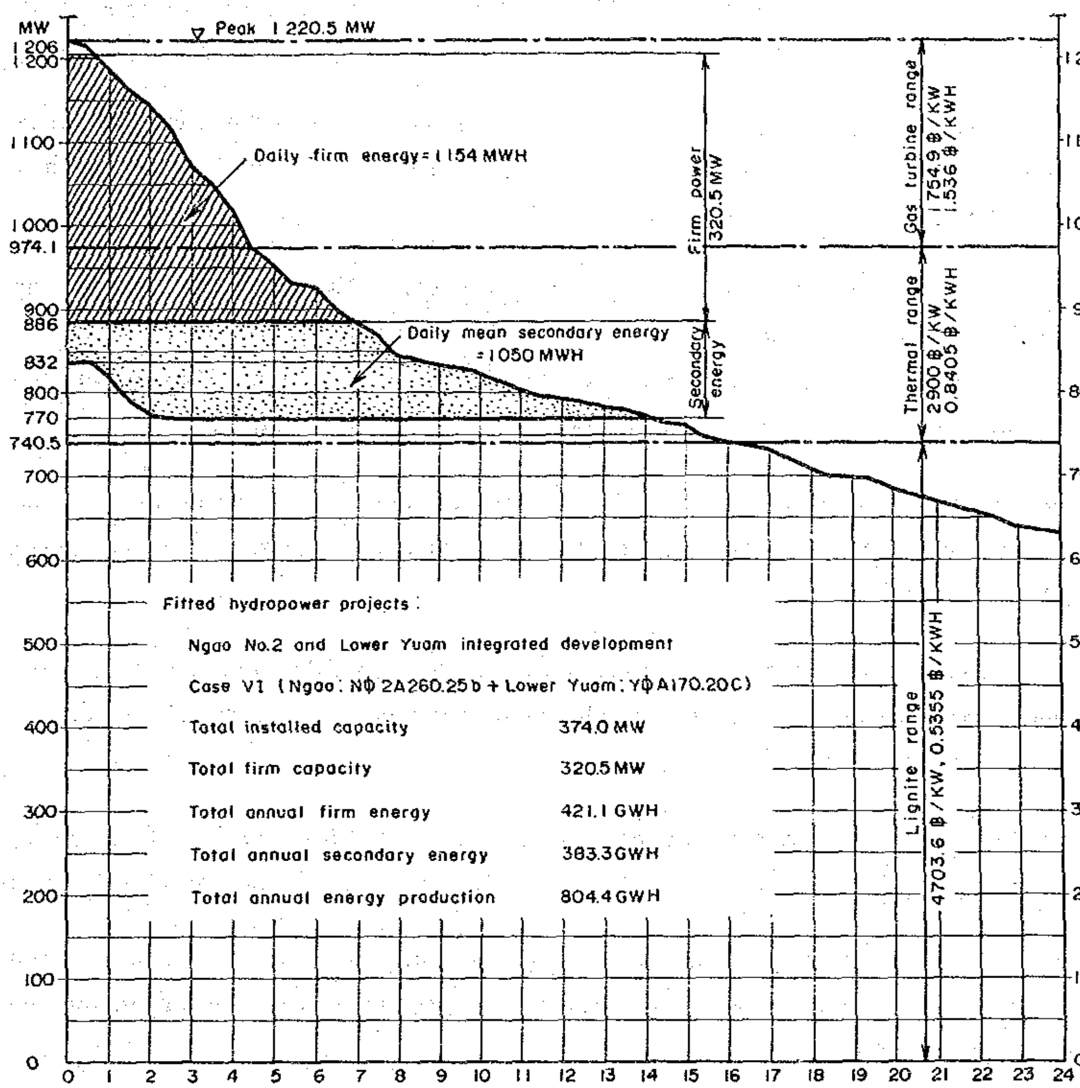


Fig. 5–9 Load Duration Curve, Northern Region, 2000 with Nam Mae Ngao and Lower Yuam Integrated Development Projects (Case VI) Fitted

5.5 Additional Study

When the first stage and the second stage studies were being proceeded in 1985, the world oil price was at its highest level so that the evaluations of the benefit of the hydropower projects were made based upon that highest price level.

However, from the beginning of 1986 to around July 1986 the oil price has come down drastically to the present low price level and remains, it seems, calmly at this price level.

Although there are no assurances the price level would rocket up again, it was requested that the benefits of the hydro power projects selected in the previous stages should be re-evaluated based on the present low price level from a conservative view point.

Discussion was held between EGAT officials and team members at the end of the June 1986 on the fuel costs which would be adopted in the additional stage of study.

The finally concluded fuel costs are shown on Table 5-23 as base case and summarized and compared with those adopted in the previous stages in the same table.

It is seen that the adopted diesel oil price at 3.68 ฿/lit of the base case is only 56% of the one at 6.6 ฿/lit adopted in the previous stage.

Moreover, it is requested also that the fuel prices should be varied on several levels to see the impact of the oil price reduction on the project economy.

Table 5–23 Fuel Price Variations for Alternative Thermal Plants

Fuels	Unit	Case #			Fuel prices adopted in the second stage of study 4)
		No.1 1) Base Case	No.2 2)	No.3 3)	
Natural Gas	฿/MBtu	71.09 5)	75.16	79.24	87.38
Diesel Oil	฿/lit	3.68 6)	4.41	5.14 5)	6.60
Imported Coal	฿/kg	1.484	1.619	1.755	2.025
Lignite	฿/kg	0.5332	0.5332	0.5332	0.5332

1) Given by EGAT on July 3, 1986

2), 3) Assumed by the JICA team

4) Given by EGAT on Oct. 7, 1985 (Letter No. EGAT 32004/51394)

5) 83 ฿/MBTu - Tax 11.9053 ฿/MBTu = 71.0947 ฿/MBTu

6) 6.17 ฿/lit - Tax 2.525 ฿/lit + Transport by ship 0.035 ฿/lit = 3.68 ฿/lit

1 US$ = 26.5 ฿

Accordingly, in the additional stage, following number of cases were studied

Nam Mae Ngao (Individual Development) ..... 6 cases
Lower Yuam (Individual Development) ..... 6 cases
Nam Mae Ngao & Lower Yuam
(Integratd Development) .... 6 cases
Total: 18 cases

However, the reservoir operations themselves undergo no change from the ones studied in the second stage. Among all the cases of the reservoir operation studied, only the ones of the finally adopted cases of Nam Mae Ngao individual development project and Nam Mae Ngao & Lower Yuam integrated development project are listed in Table 5-24 and Table 5-25 respectively.

The mass curves corresponding to these cases are also shown on Fig. 5-5 and Fig. 5-6 respectively.

Using these results, economic evaluation of the projects were performed for the various fuel cost cases as above described.

The result of the base case calculation shows that the B/C ratio of Nam Mae Ngao individual development project has come down to 1.2 from that of 1.3 attained in the second stage of study.

Also, the B/C ratio of the Nam Mae Ngao and Lower Yuam integrated development scheme reduced from the previous stage value of 1.4 to 1.3.

Even these reduced values, however, are well above the ballance point of B/C=1, especially when the integrated development scheme will be realized.

As for the proposed dam site of Nam Mae Ngao project, further survey and investigation works based on the topographical and geological conditions are needed towards the start of the feasibility study.

Table 5–24 Reservoir Simulation Nam Mae Ngao

Case No.	N02A260.25b		Project	Nam Mae Ngao 3

CA at dam	835 Km^2
Annual inflow at dam	1292 MCM (40.95 cms)
Project type	Storage

NHWL 260 m	LWL 235 m	Draw down 25 m
MWL 248.38 m	TWL 163 m	Head loss 2.9 m
Maxhead 97 m	Eff normal head 82.45 m	
Total storage 661.2 MCM	Eff storage 355.2 MCM	

Effective storage / annual inflow	27 %
Installed capacity	116.9 MW
Firm capacity	97.9 MW
Annual energy production (100%)	252.734 GWH
Annual energy production (97%)	245.152 GWH
Annual firm energy	128.647 GWH
Annual secondary energy (100%)	124.087 GWH
Annual secondary energy (97%)	116.505 GWH
Daily plant factor 0.15	Machine efficiency 0.87
Capacity factor = $\frac{\text{annual energy (97\%)}}{\text{installed capacity} \times 8760}$ = 0.239	
Flow utilizability = (inflow − spill) / inflow =	99.5%
Energy produced by $1 m^3$ of discharge	0.198 KWH
Daily firm energy production	352.459 MWH
Dam Ht	Tunnel length

	Total	Present w	Levelized
Construction cost			
Transmission line			
Total cost			
KW benefit			
KWH benefit			
Total benefit			

B−C	B/C	EOR
Power production cost		
Discount rate	Price year	

Referenced gaging station

CA= 935 km^2 file : MR8

Annual min discharges obtained by reservoir simulation in cms

Yr	Min discharge	Yr	Min discharge
2	32.935	14	34.872
3	32.935	15	33.690
4	32.692	16	32.359
5	32.126	17	32.045
6	30.996	18	28.539
7	26.976	19	24.894
8	26.976	20	24.894
9	31.120	21	28.109
10	31.120	22	32.101
11	33.913	23	25.111
12	30.651	24	25.111
13	30.651		

Least minimum discharge	24.894 cms
95% firm discharge	24.931 cms
95% firm dis / mean inflow =	60.9%
Parameters of uniform distribution for min discharges : $Y = a + bX$,	$a = -2.17806$ $b = 0.08937$
Maximum discharge	166.205 cms
Max dis / mean inflow =	4.06

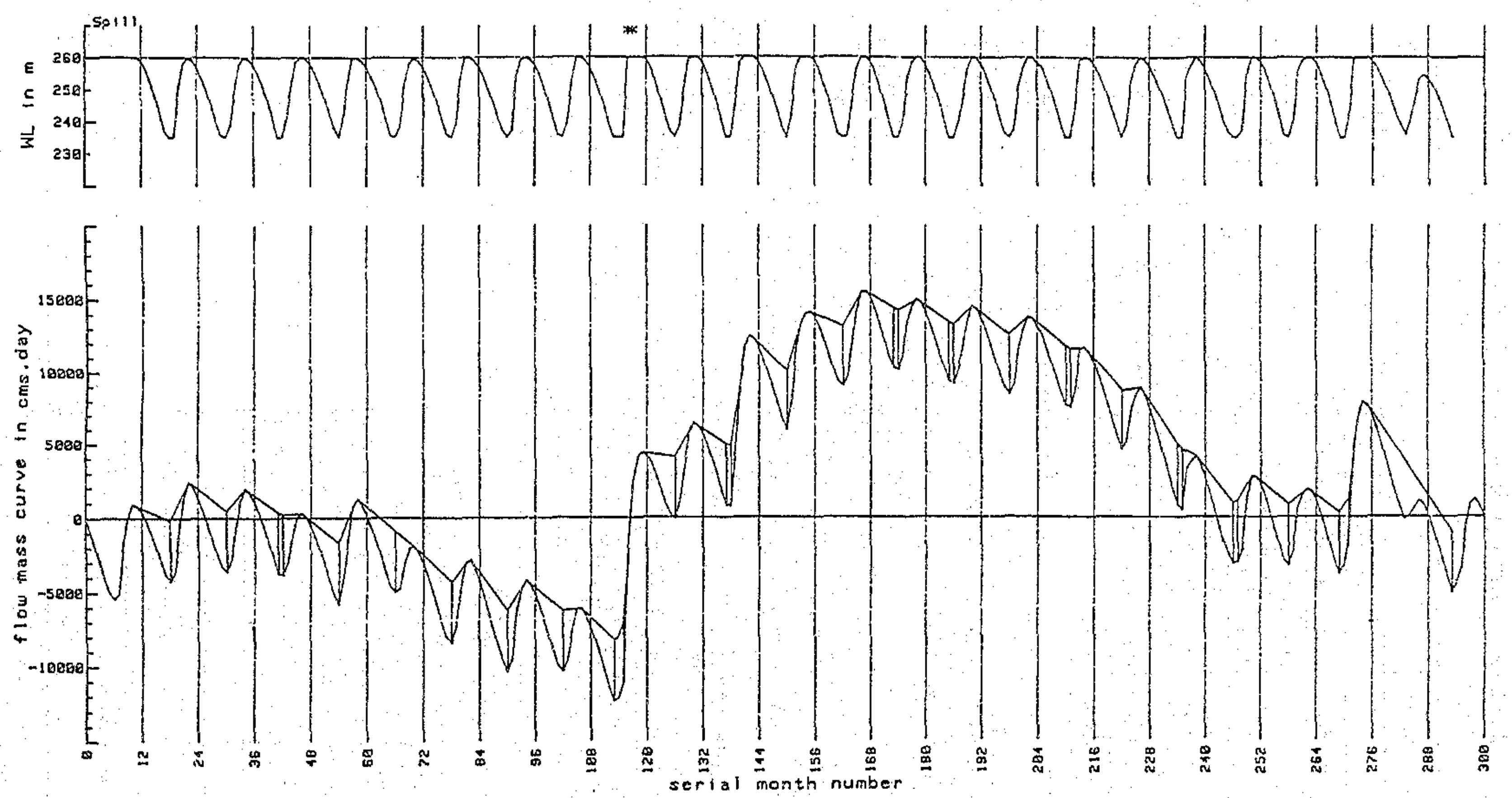


Fig. 5–5 Flow Mass Curve Nam Mae Ngao (Case NO2A 260.25b)

Table 5-25 Reservoir Simulation Lower Yuam

Case No.	YØA170.20b		Project	Lower Nam Yuam

CA at dam			5,920 Km2		
Annual inflow at dam			2,816 MCM		
Project type			Storage		
NHWL	170 m	LWL	150 m	Draw down	20 m
MWL	161.4 m	TWL	73.2 m	Head loss	2.9 m
Maxhead	96.8 m	Eff normal head	85.3 m		
Total storage	444 MCM	Eff storage	260 MCM		
Effective storage / annual inflow			9 %		
Installed capacity			267.0 MW		
Firm capacity			231.2 MW		
Annual energy production (100%)			575.819 GWH		
Annual energy production (97%)			558.544 GWH		
Annual firm energy			303.839 GWH		
Annual secondary energy (100%)			271.980 GWH		
Annual secondary energy (97%)			254.705 GWH		
Daily plant factor	0.15	Machine efficiency	0.88		
Capacity factor = annual energy (97%) / installed capacity x8760 =			0.239		
Flow utilizability = (inflow - spill) / inflow =			99.8 %		
Energy produced by 1m³ of discharge			0.199 KWH		
Daily firm energy production			832.437 MWH		
Dam Ht	120 m	Tunnel length	240 m		

	Total	Present w	Levelized
Construction cost			
Transmission line			
Total cost			
KW benefit			
KWH benefit			
Total benefit			
B-C	B/C	EOR	

Power production cost	
Discount rate	Price year

Referenced gaging station

CA= km² file :

Annual min discharges obtained by reservoir simulation in cms

Yr	Min discharge	Yr	Min discharge
2	70.054	14	71.186
3	69.395	15	68.617
4	69.395	16	67.221
5	64.456	17	66.770
6	64.456	18	60.913
7	56.892	19	56.210
8	56.892	20	56.210
9	63.788	21	57.064
10	63.788	22	64.680
11	71.098	23	66.717
12	63.541	24	51.202
13	63.541		

Least minimum discharge	51.202 cms
95% firm discharge	54.426 cms
95% firm dis / mean inflow =	61.0 %

Parameters of uniform distribution for min discharges : Y = a + bX,
a = -2.73183 b = 0.051112

Maximum discharge	362.843 cms
Max dis / mean inflow =	4.07

Effect of upstream project, Ngao No. 2 (Case NØ2A260.30b) is considered. Installed capacity, etc. are determined based on the estimated plant factor.

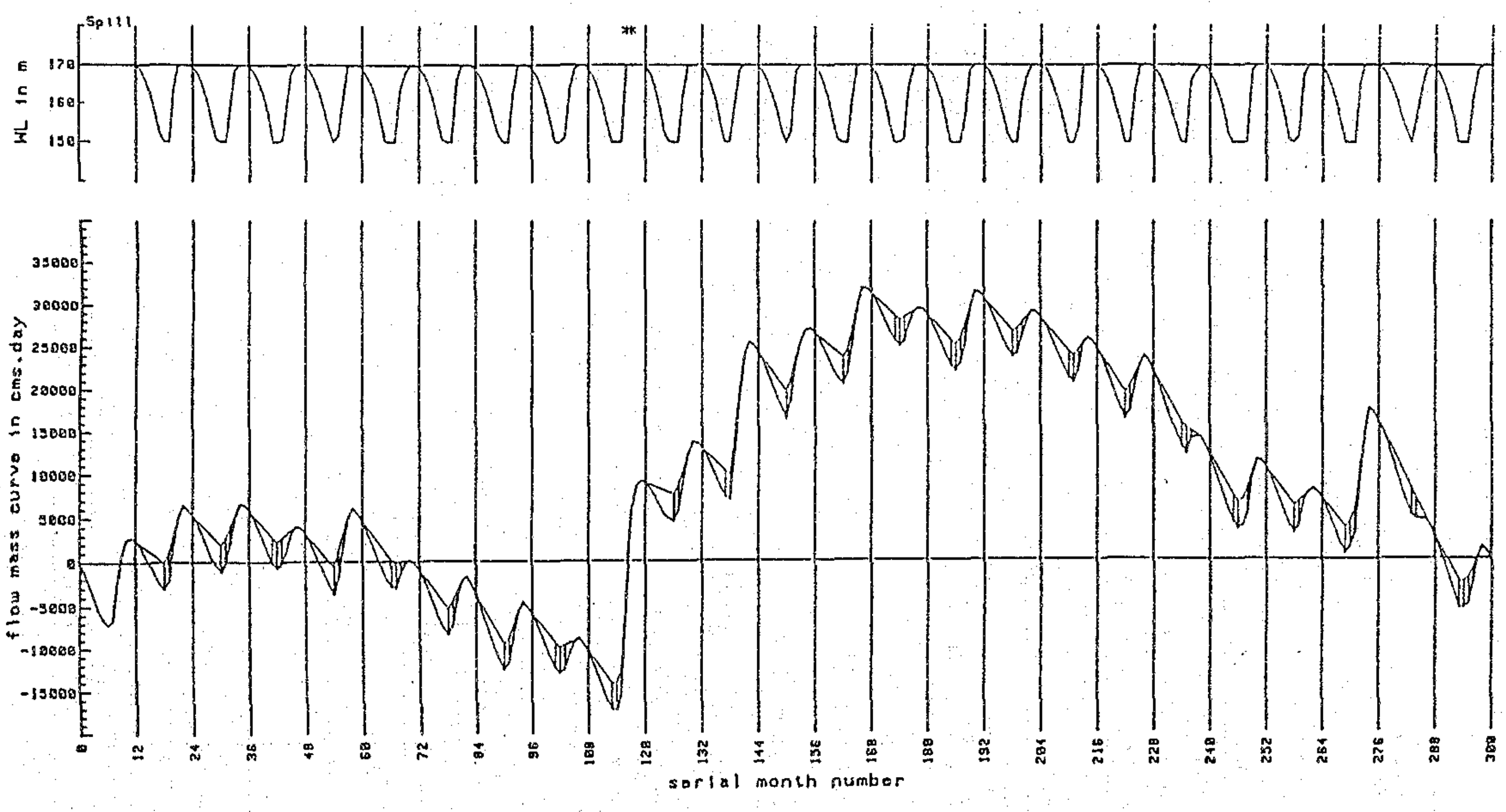


Fig. 5–6 Flow Mass Curve Lower Yuam (Case YOA 170.20b)

5.6 Incremental Benefit of the Lower Yuam Project

1) Combination of the Projects

The situation of Lower Yuam, which has been studied by JICA in response to the request of NEA in 1984, is considered in the Master Plan Study as if it is the existing power station.

The incremental benefit of Lower Yuam, accruing from the effects of the upstream projects, have to be examined systematically in relation with the upstream projects.

As described in the previous clause 5-4 "Selected Main Projects (Second Stage Study)", the selected four projects in the first stage study have also been restudied further by using 1:5,000 scale map except Upper Mae Rit 2a.

According to the study results, Nam Mae Ngao is the most pro-missing project.

Strictly speaking, for the incremental benefit study of Lower Yuam Project, the effects of Nam Mae Rit and Upper Mae Yuam 1 have to be taken into account together with Nam Mae Ngao, because both projects are planned as reservoir type power station.

However, the Nam Mae Ngao project is the most important and superior among the four projects in terms of both the scale and the feasibility. Therefore outline of the basin development plan can be obtained almost definitely in the integrated development plan of Nam Mae Ngao and Lower Yuam.

Accordingly, the following cases were studied.

- Dam and installed capacity are fixed at Feasibility Study level.
- Dam is fixed at Feasibility Study level but installed capacity is optimized.

2) River Runoff Data

The river runoff data for 11 years at Ban Tha Rua, spanned between 1970 and 1980, have been used in the feasibility study made by JICA in 1984.

However, in the present study, as described in Chapter 4 "Meteorology and Hydrology", the runoff data of Ban Tha Rua have been extended from 11 years to 25 years, spanning between 1960 and 1984, by means of the regression analyses.

Accordingly, the extended runoff data for 25 years were adopted for the reservoir simulation study and the power and energy calculation of Lower Yuam.

3) Construction Cost

The construction cost of Lower Yuam has been reviewed applying the same work quantities of the feasibility study and the same unit price of the master plan study.

4) Incremental Benefit

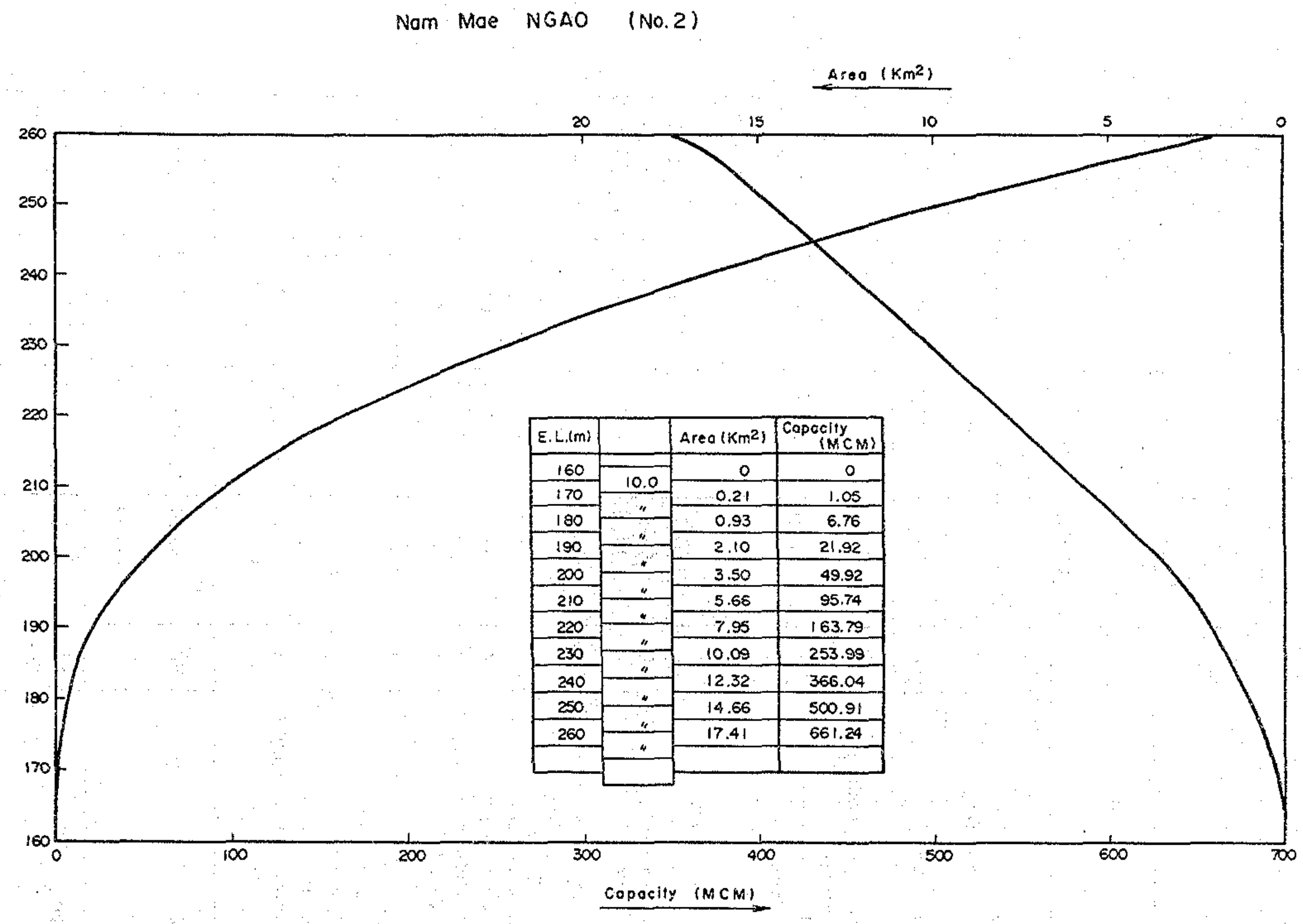
As mentioned above, the incremental benefit was studied based upon the combination with Nam Mae Ngao and the reservoir operation using the extended runoff data. The results are shown in Table 5-20, 5-21 and 5-22 in the previous section 5-4 for the second stage of study, and in Table 5-26 for the additional stage of study. (More detailed results corresponding to the additional stage of study are contained in the later chapter 9, in Table 9-10 and 9-11). Note that in the additional stage, only the incremental benefit that accrues from the later case above (i.e. Dam is fixed but installed capacity optimized) was studied because this case is more realistic than the former case (i.e. Dam and installed capacity are fixed).

The leftest column in Table 5-20, designated by case 0 corresponds to the values of the feasibility study made by JICA in 1984 which is the individual development plan without any effect from the upstream projects.

In this case, the economic feasibility is still dominant in terms of Benefit-Cost ratio (B/C); 1.519.

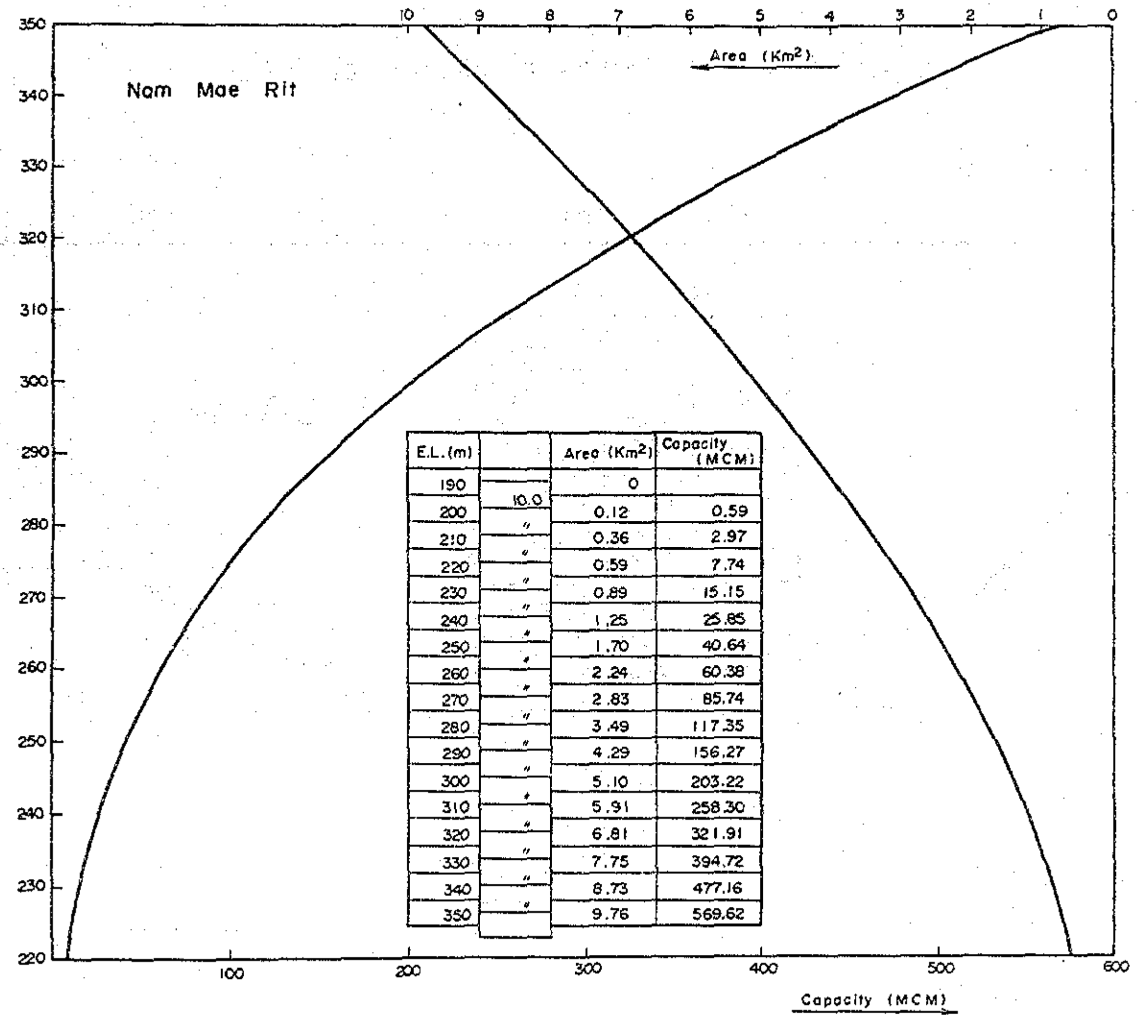
Table 5-26 Incremental Benefit of Lower Yuam due to the Effect of Nam Mae Ngao No. 2 Development (Lower Yuam: Dam & Installed Capacity are Fixed at F/S Level – Additional Stage)

Case No.		Individual development: Nam Mae Ngao (3) NØ2A 260.25b	Individual development: Lower Yuam (1) YØV170- 170.20o	Individual development: Total (1)+(2)	Integrated development Nam Mae Ngao & Lower Yuam Case VI	Increase (4)-(3)
	unit	(1)	(2)	(3)	(4)	(5)
Installed capacity	MW	116.9	162.0	278.9	278.9	0
Firm Capacity	MW	97.9	139.9	237.8	237.6	-0.2
Annual energy production						
Firm energy	GWH	128.6	181.6	310.2	421.1	110.9
Secondary energy	GWH	116.5	357.3	473.8	374.0	-99.8
Total	GWH	245.1	538.9	784.0	795.1	11.1
Construction cost						
Generating f.	M฿	3,373	4,340	7,713	7,713	0
Transmission f.	M฿	65.5	400	465.5	465.5	0
Total		3,438.5	4,740	8,178.5	8,178.5	0
Annual benefit						
for firm capacity	M฿	171.8	245.5	417.3	548.6	131.3
for firm energy	M฿	197.5	278.9	476.4	468.7	-7.7
for secondary energy	M฿	119.2	300.3	419.5	314.3	-105.2
Total	M฿	488.5	824.7	1,313.2	1,331.6	18.4
Annual cost						
for generating f.	M฿	374.4	481.7	856.1	856.1	0
for transmission f.	M฿	7.3	44.8	52.1	52.1	0
for transmission losses	M฿	9.8	16.5	26.3	26.6	0.3
Total	M฿	391.5	543.0	934.5	934.8	0.3
B-C	M฿	97.0	281.7	378.7	396.8	18.1
B/C		1.248	1.519	-	1.424	-
Energy cost	฿/KWH	1.60	1.01	-	1.18	-
Incremental benefit	M฿					18.1



E.L.(m)		Area (Km²)	Capacity (MCM)
160		0	0
170	10.0	0.21	1.05
180	"	0.93	6.76
190	"	2.10	21.92
200	"	3.50	49.92
210	"	5.66	95.74
220	"	7.95	163.79
230	"	10.09	253.99
240	"	12.32	366.04
250	"	14.66	500.91
260	"	17.41	661.24

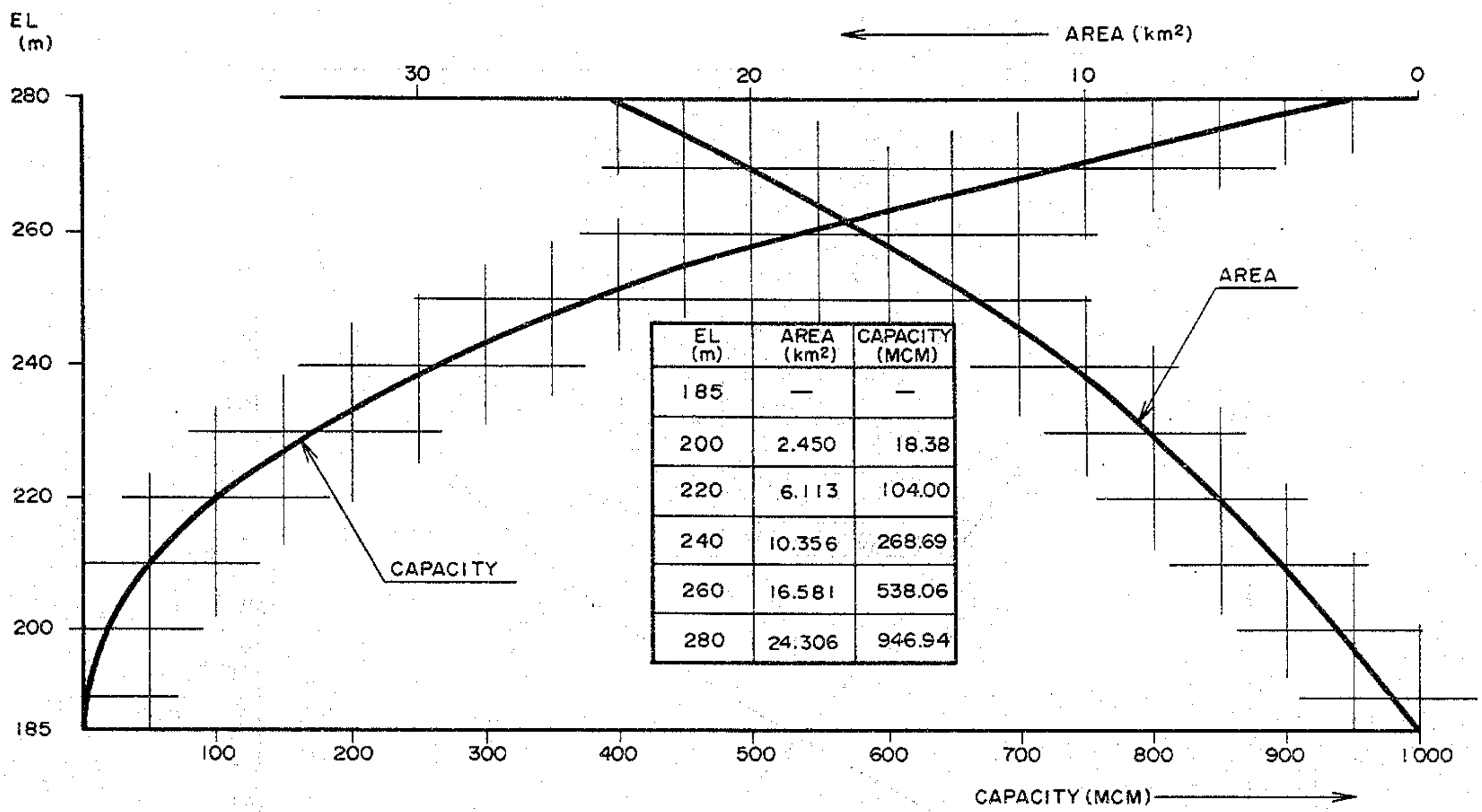
Fig. 5–10 Area–Capacity Curve, Nam Mae Ngao No. 2



E.L. (m)		Area (Km²)	Capacity (MCM)
190		0	
200	10.0	0.12	0.59
210	"	0.36	2.97
220	"	0.59	7.74
230	"	0.89	15.15
240	"	1.25	25.85
250	"	1.70	40.64
260	"	2.24	60.38
270	"	2.83	85.74
280	"	3.49	117.35
290	"	4.29	156.27
300	"	5.10	203.22
310	"	5.91	258.30
320	"	6.81	321.91
330	"	7.75	394.72
340	"	8.73	477.16
350	"	9.76	569.62

Fig. 5–11 Area–Capacity Curve, Nam Mae Rit

NAM MAE NGAO SITE No.3

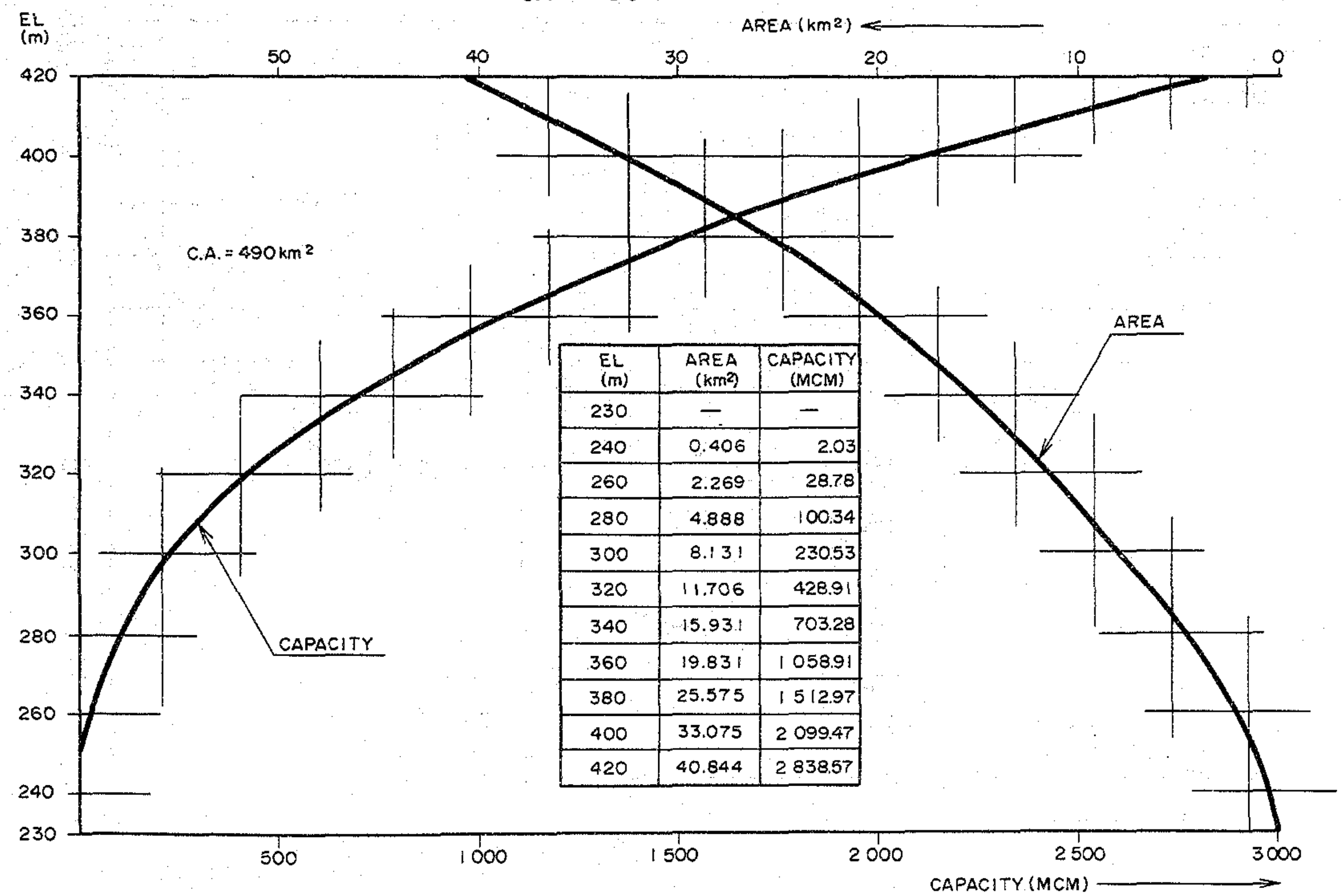


EL (m)	AREA (km^2)	CAPACITY (MCM)
185	—	—
200	2.450	18.38
220	6.113	104.00
240	10.356	268.69
260	16.581	538.06
280	24.306	946.94

Fig. 5–12 Area–Capacity Curve, Nam Mae Ngao No. 3

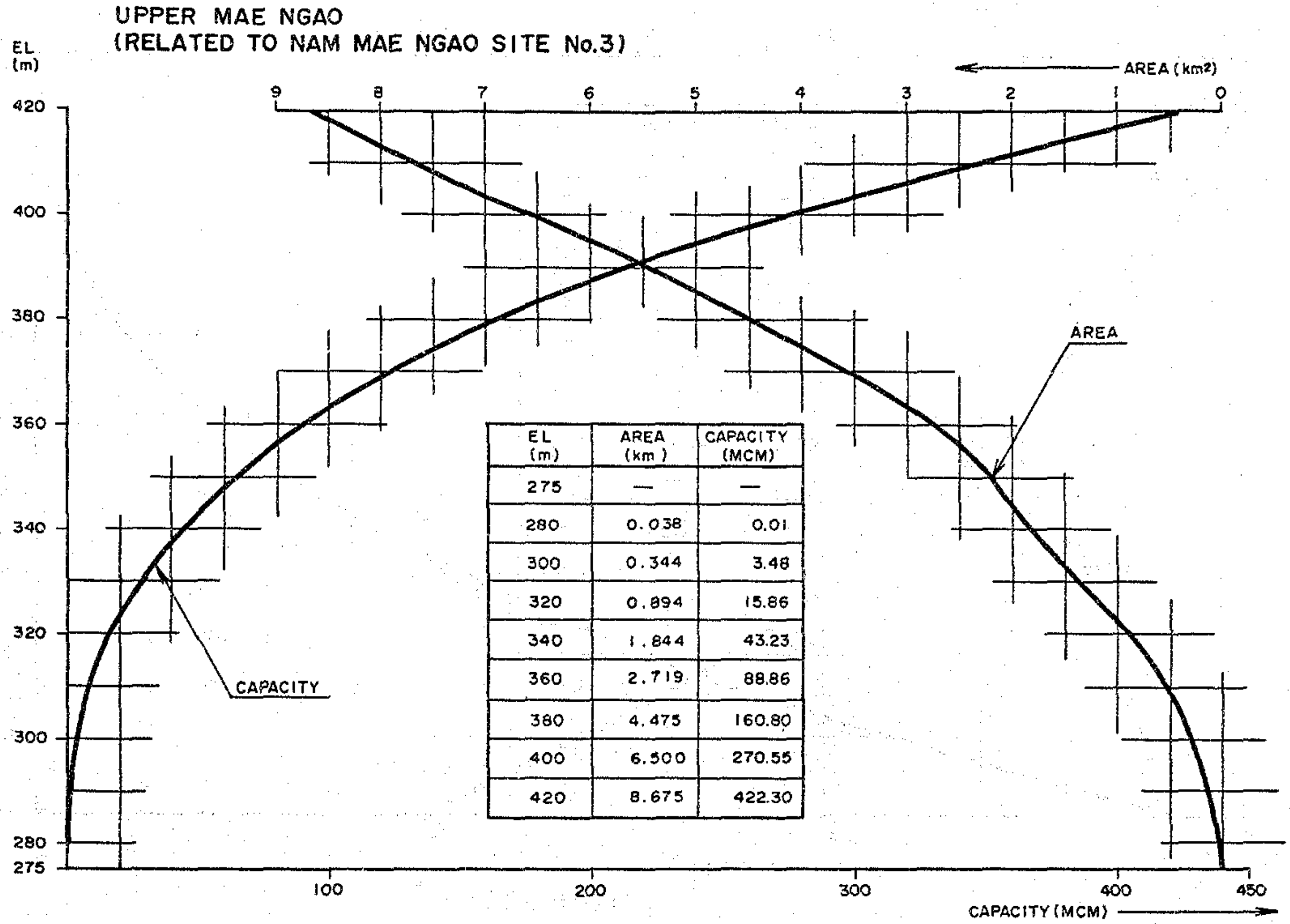
UPPER MAE NGAO
(RELATED TO NAM MAE NGAO SITE No.2)

CA = 490 km^2



EL (m)	AREA (km^2)	CAPACITY (MCM)
230	—	—
240	0.406	2.03
260	2.269	28.78
280	4.888	100.34
300	8.131	230.53
320	11.706	428.91
340	15.931	703.28
360	19.831	1 058.91
380	25.575	1 512.97
400	33.075	2 099.47
420	40.844	2 838.57

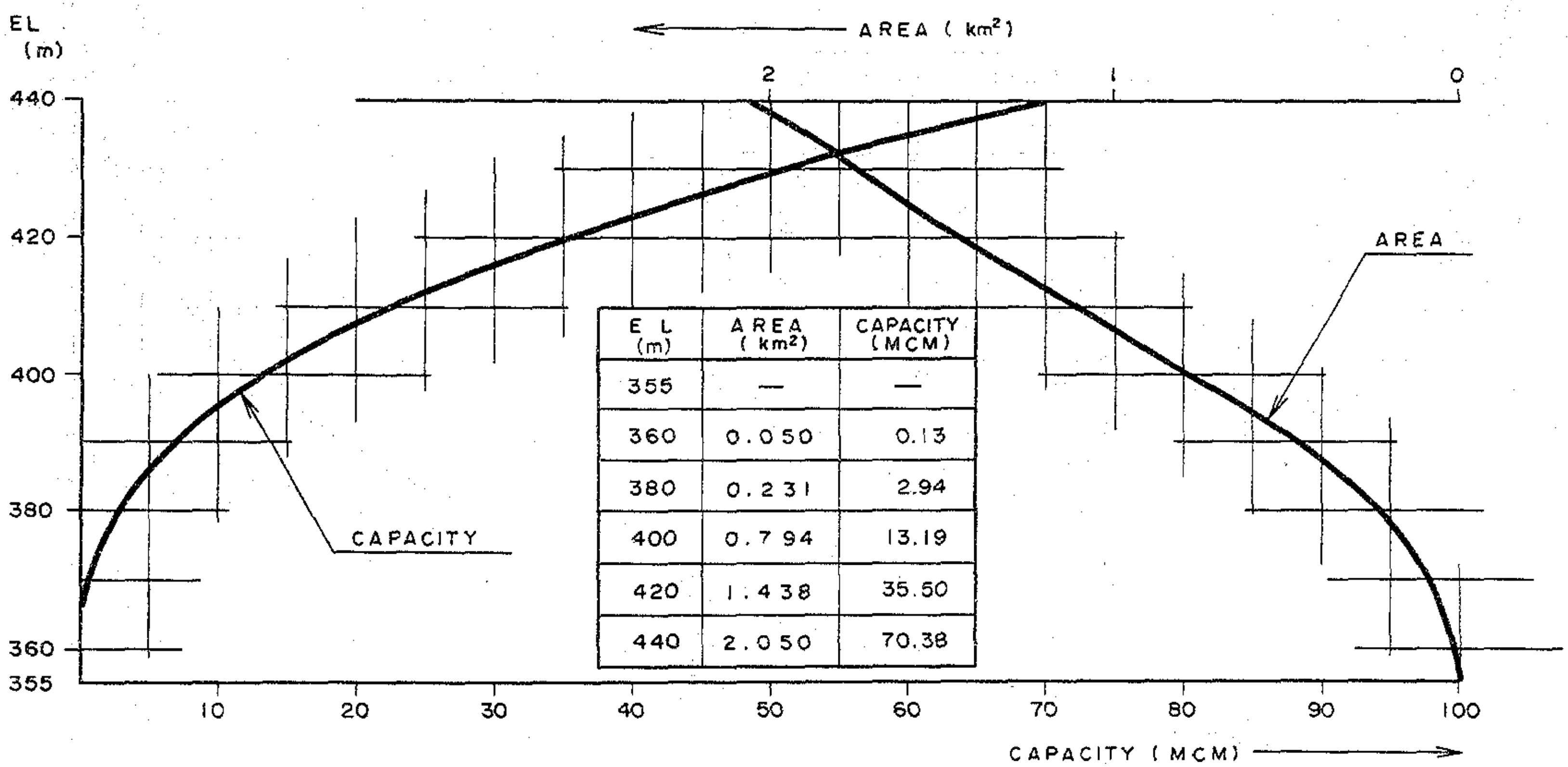
Fig. 5–13 Area–Capacity Curve, Upper Mae Ngao No. 2



EL (m)	AREA (km)	CAPACITY (MCM)
275	—	—
280	0.038	0.01
300	0.344	3.48
320	0.894	15.86
340	1.844	43.23
360	2.719	88.86
380	4.475	160.80
400	6.500	270.55
420	8.675	422.30

Fig. 5–14 Area–Capacity Curve, Upper Mae Ngao No. 3

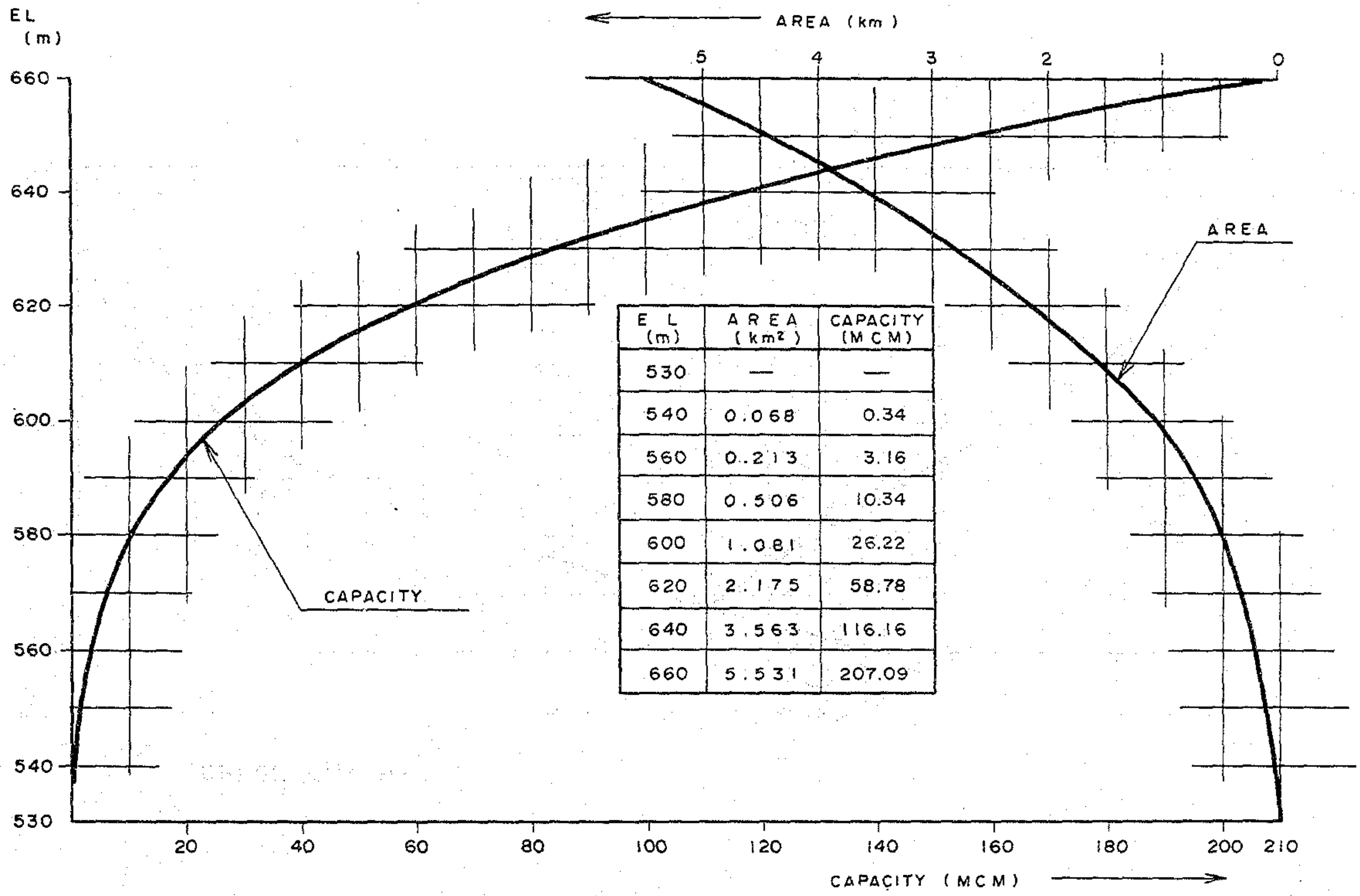
UPPER MAE RIT 1



E L (m)	AREA (km²)	CAPACITY (MCM)
355	—	—
360	0.050	0.13
380	0.231	2.94
400	0.794	13.19
420	1.438	35.50
440	2.050	70.38

Fig. 5–15 Area–Capacity Curve, Upper Mae Rit 1

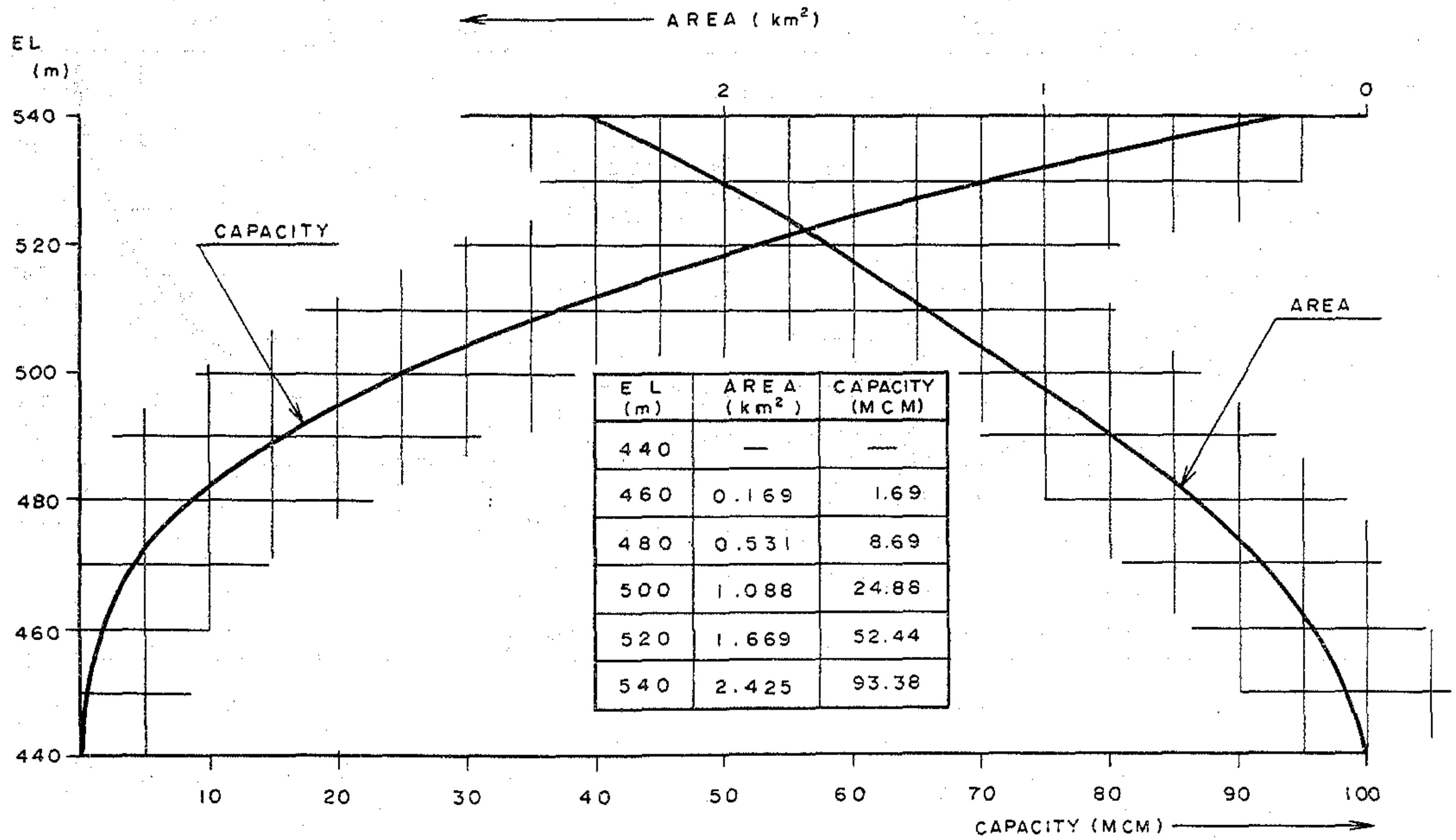
UPPER MAE RIT 2



E L (m)	AREA (km²)	CAPACITY (MCM)
530	—	—
540	0.068	0.34
560	0.213	3.16
580	0.506	10.34
600	1.081	26.22
620	2.175	58.78
640	3.563	116.16
660	5.531	207.09

Fig. 5–16 Area–Capacity Curve, Upper Mae Rit 2

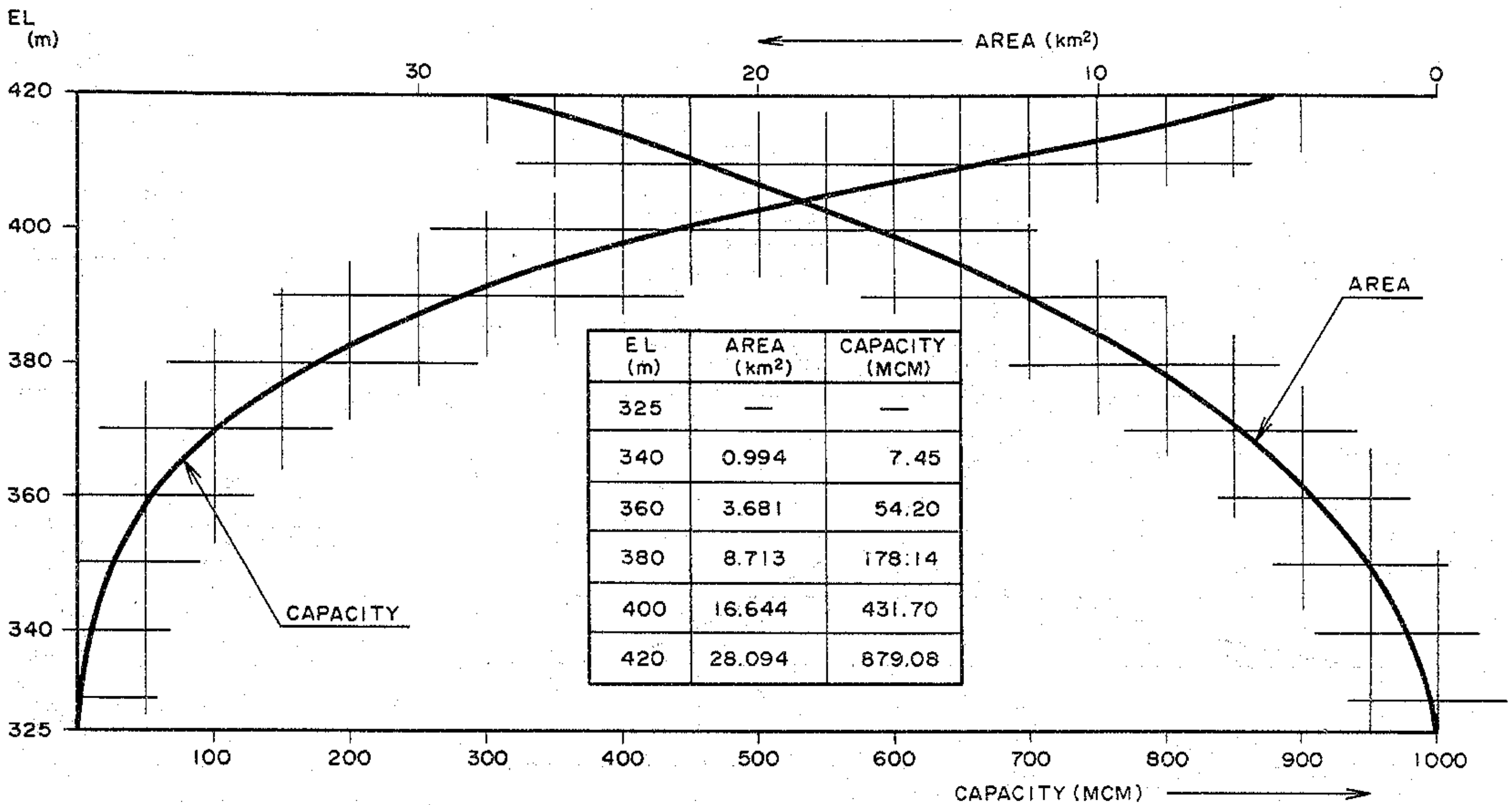
UPPER MAE RIT 3



E L (m)	AREA (km²)	CAPACITY (MCM)
440	—	—
460	0.169	1.69
480	0.531	8.69
500	1.088	24.88
520	1.669	52.44
540	2.425	93.38

Fig. 5–17 Area–Capacity Curve, Upper Mae Rit 3

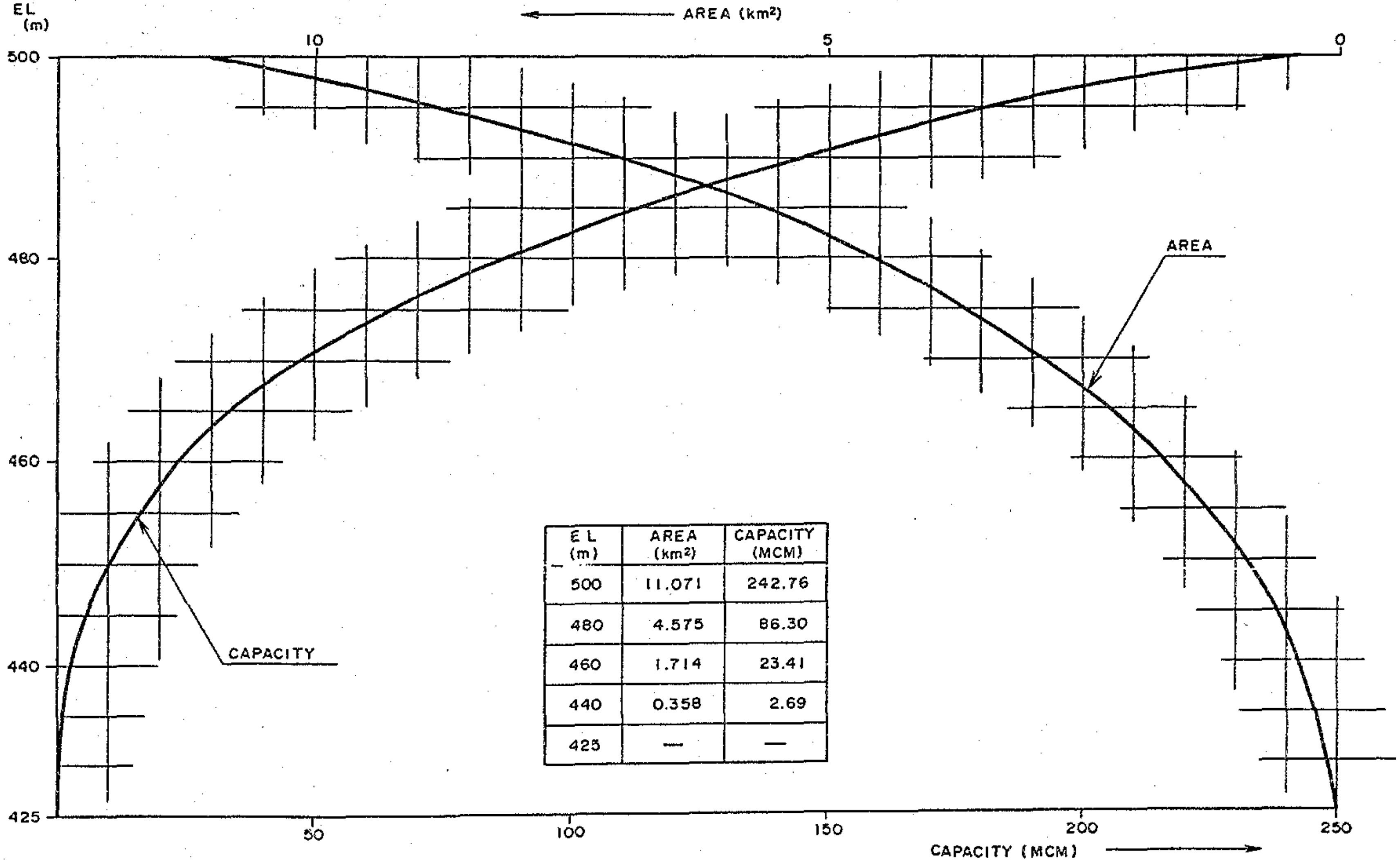
UPPER MAE YUAM 2



EL (m)	AREA (km²)	CAPACITY (MCM)
325	—	—
340	0.994	7.45
360	3.681	54.20
380	8.713	178.14
400	16.644	431.70
420	28.094	879.08

Fig. 5–18 Area–Capacity Curve, Upper Mae Yuam 2

UPPER MAE YUAM 3



E L (m)	AREA (km²)	CAPACITY (MCM)
500	11.071	242.76
480	4.575	86.30
460	1.714	23.41
440	0.358	2.69
425	—	—

Fig. 5–19 Area–Capacity Curve, Upper Mae Yuam 3

CHAPTER 6. PRELIMINARY DESIGN

CHAPTER 6 PRELIMINARY DESIGN

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CHAPTER 6. PRELIMINARY DESIGN

6.1 Civil Main Structure

Preliminary design has been carried out for the selected four projects; Nam Mae Ngao, Nam Mae Rit, Upper Mae Yuam 1 and Upper Mae Rit 2a, based upon the basic figures, studied in the previous Chapter 5 "Development Plan".

Topographic maps used for the preliminary design were 1:5,000 scale map for Nam Mae Ngao, Nam Mae Rit, and Upper Mae Yuam 1 and 1:50,000 scale map for Upper Mae Rit 2a.

Preliminary design drawings are shown on Fig. 6-1 through 6-13. However, those basic figures and preliminary design drawings should be required further review at the next feasibility study stage. Stated hereunder is the preliminary design outline at each project site.

1) Nam Mae Ngao

The project undertakes construction of rockfill dam of 114 m height, 545 m crest length and 5,360 x $10^3 m^3$ volume on the axis along site No. 2.

Upstream and downstream faces are sloped at 1:2.0 and 1:1.8 respectively. The left bank of dam is provided with a spillway, which is capable to release the design flood of 3,600 m^3/sec.

Two diversion tunnels are located on the left bank and one of them will be converted to an outlet structure in the future. An intake with the maximum intake quantity of 166.2 m^3/sec is provided on the right bank upstream of the dam.

From the intake, a headrace and penstock convey the water intake by 7.0 - 6.5 m inner diameter and the length of 700 m, leading to the powerhouse for power generation of maximum output of 116.9 MW.

2) Nam Mae Rit

The project undertakes construction of rockfill dam of 87 m height, 285 m crest length and 2,100 x $10^3 m^3$ volume on the axis along the proposed site. Upstream and downstream faces are sloped at 1:2.0 and 1:1.8 respectively.

The left bank of dam is provided with a spillway, which is capable to release the design flood of 2,400 m^3/sec. Two diversion tunnels are located on the right bank and one of them will be converted to an outlet structure in the future.

An intake with the maximum intake quantity of 41.2 m^3/sec is provided on the right bank upstream of the dam. From the intake, a headrace and penstock convey the water intake by 4.1 - 3.8 m inner diameter and the length of 417 m, leading to the powerhouse for power generation of maximum output of 24.0 MW.

3) Upper Mae Yuam 1

The project undertakes construction of rockfill dam of 62 m height, 520 m crest length and 2,307 x 10^3m^3 volume on the axis along the proposed site. Upstream and downstream faces are sloped at 1:2.0 and 1:1.8 respectively.

The left bank of dam is provided with a spillway, which is capable to release the design flood of 2,900 m^3/sec. Two diversion tunnels are located on the right bank and one of them will be converted to an outlet structure in the future.

An intake with the maximum intake quantity of 53.0 m^3/sec is provided on the right bank upstream of the dam axis. From the intake, a headrace and penstock convey the water intake by 4.5 - 4.2 m inner diameter and the length of 259.0 m, leading to the powerhouse for power generation of maximum output of 18.5 MW.

4) Upper Mae Rit 2a

The project undertakes construction of rockfill dam of 38 m height, 105 m crest length and 177 x 10^3m^3 volume on the axis along the proposed site. Upstream and downstream faces are sloped at 1:2.0 and 1:1.8 respectively.

The left bank of dam is provided with a spillway, which is capable to release the design flood of 1,500 m^3/sec. Two diversion tunnels are located on the right bank and one of them will be converted to an outlet structure in the future.

An intake with the maximum intake quantity of 10.4 m^3/sec is provided on the right bank upstream of the dam axis. From the intake, a headrace and penstock convey the water intake by 2.5 - 1.8 m inner diameter and the length of 6,280 m, leading to the powerhouse for power generation of maximum output of 11.2 MW.