GOVERNMENT OF THE KINGDOM OF THAILAND

THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT

SUPPORTING REPORT

MARCH 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT

SUPPORTING REPORT

SURVEYING
HYDROLOGY
REGIONAL DEVELOPMENT PLAN
AGRICULTURAL DEVELOPMENT
WATER RESOURCES DEVELOPMENT
DAM
FLOOD CONTROL
PIPELINE
IRRIGATION AND DRAINAGE
PROJECT ECONOMY

MARCH 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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I . SURVEYING

1. GENERAL

This survey has been conducted to prepare the fundamental data with regard to the East Coast Water Resources Development Project. The survey works were carried out fron February 16 to May 1, 1981, and the results are described in details as follows. General map for the project surveying is shown in Fig.1-1.

2. SURVEYING FOR DAMS

2.1 SURVEYING AREA

- Along the axis of the proposed Nong Pla Lai Dam and the channel of the Rayong River from the dam site down to the river mouth (refer to Fig. 1-2).

- Along the axis of the Ban Bung Dam and reservoir, and the channel of the Ban Bung River from the dam site down to the river mouth (refer to Fig. 1-3).

- The results of the cross-sectional servey are shown in VII FLOOD CONTROL of this report.

2.2 COLLECTION OF MAPS

- Topographical maps of the project area to a scale of 1:5,000.

- Aerial maps of the proposed Nong Pla Lai Dam axis and the existing Ban Bung Dam axis both to a scale of 1:1,000 prepared by SPI of USA, and submitted to RID (set of 2 sheets each).

- Existing map of the Ban Bung Reservoir to a scale of 1:4,000 by RID (1 sheet).

- Existing map of proposed Nong Pla Lai Reservoir to a scale of 1:20,000 by RID (1 sheet).

- Topographic maps of the downstream area of the proposed Nong Pla Lai Dam to a scale of 1:20,000 by RID (set of 5 sheets).

2.3 GROUND SURVEY WORKS

The survey works in detail are as follows.

2.3.1 Longitudinal Leveling along the Axis of the Nogn Pla Lai Dan and Ban Bung Dan

This longitudinal leveling of the axis of the abovementioned two dams has been conducted with constant reference to the aerial maps and longitudinal profiles.

In the servey, the existing bench-marks as mentioned below are used.

- Nong Pla Lai Area (Longitudinal Leveling Intervals 4.1 km.)

SPI MON 057	EL. = 44.006 m
PID MON M-4	EL. = 30.545 m
SPI MON 064	EL. = 30.401 m
SPI MON 059	EL. = 31.257 m
SPI MON 060	EL. = 34.816 m

- Ban Bung Area (Longitudinal Leveling Intervals 3.8 km)

BMP 54	EL. = 78.533 m
SPI MON 085	EL. = 79.493 m
SPI MON 084	EL. = 75.999 m
SPI MON 082	EL. = 93.615 m
SPI MON 081	EL. = 97.003 m

Note: Bench-marks mentioned above are confirmed at the time of on-the-spot survey between February 16 and May 1, 1981.

2.3.2 Cross-Leveling along River Channel

The purpose of this cross-leveling is to obtain data on topographic configuration of the area downstream of the proposed dam site.

The longitudinal profile of the river is based on the lowest river bed elevation obtained from the cross-leveling.

The interval of the cross-leveling is fixed somewhere between 1.0 and 3.0 km, and the respective distance is based on the read off from the topographic maps to a scale of 1:50,000.

The route of cross-leveling is as below.

- Rayong River

Cross-leveling is performed starting at SPI MON 059 on the axis of the Nong Pla Lai Dam and ending at the mouth of the rayong River over a distance of about 40.0 km. Number of cross-leveling stations is 28 (refer to Fig.1-2).

- Ban Bung River

Cross-leveling is performed starting at BMP 54 located in the Ban Bung Reservoir and ending at the spot near Amphoe Panat Nikhom over the distance of about 30.0 km. Number of cross-leveling stations is 20 (refer to Fig.1-3).

2.3.3 Sounding in Ban Bung Reservoir

Sounding in the Ban Bung Reservoir was performed at 100.0 m in grid intervals using the topographic map of the Ban Bung Reservoir for reference. The bench-mark, BMP-54, is the datum of the elevation. Number of sounding stations is about 100.

3. SURVEYING FOR PIPELINE

3.1 SURVEYING AREA

The longitudinal and cross-leveling were carried out from Nong Pla Lai Dam to Sattahip via Mab Ta Pud along the Route-3191 and Route-3.

3.2 LONGITUDINAL LEVELING

The longitudinal leveling was carried out from the datum station RID 222394 as the starting point to the proposed site of the receiving well at the station RID 222382 located in Sattahip. The distance between these stations are about 45 km.

Concrete bench-marks were placed in 1.0 km intervals for temporary purposes. The origin of the elevation is fixed at BM8 (EL. = 54.776 m) established by the then NGOT, now known as PPT.

Temporary bench-marks at 1.0 km intervals are plotted on the longitudinal profile.

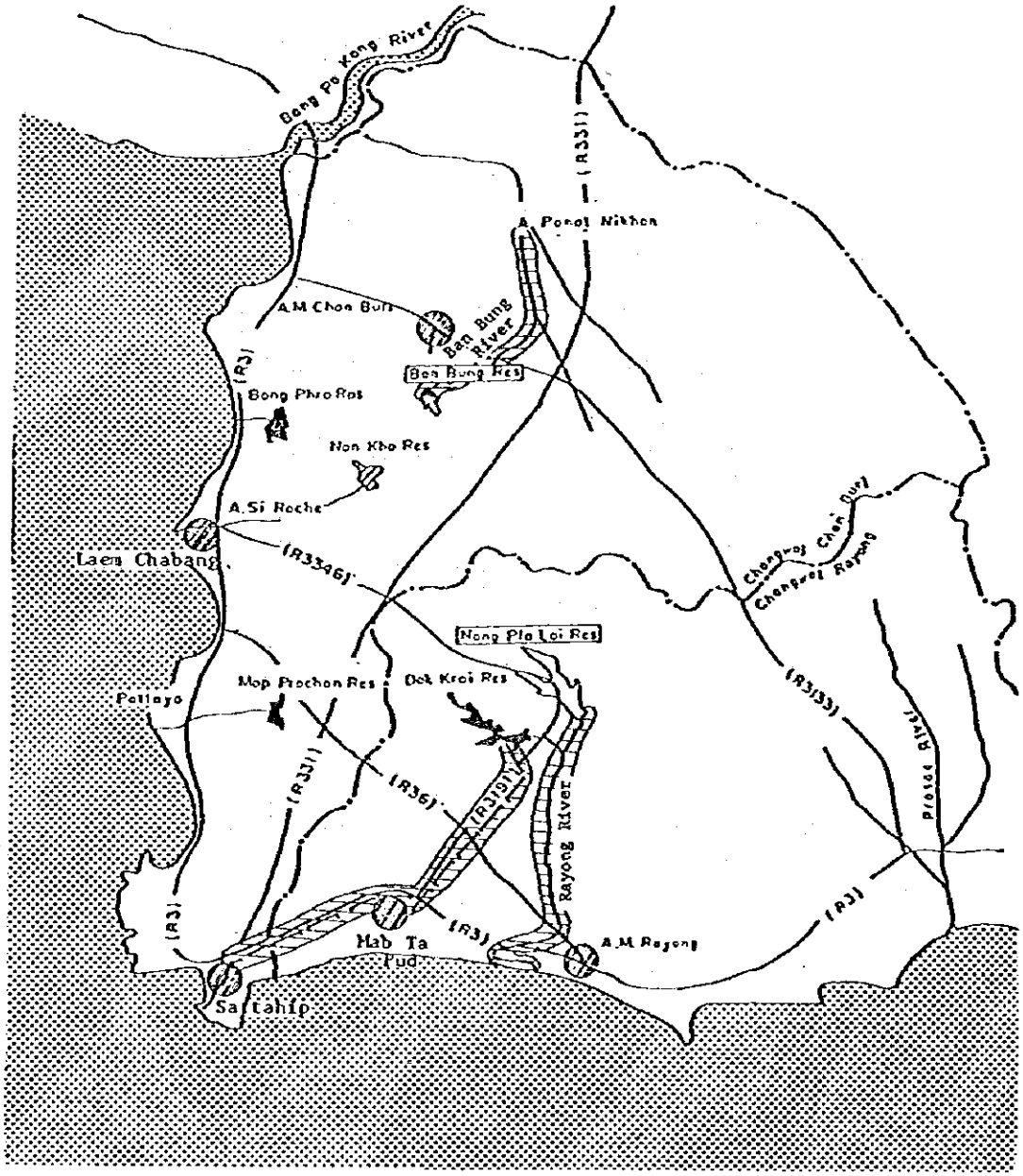
3.3 CROSS-LEVELING

Cross-leveling was performed at the respective temporary bench-marks located at 1.0 km intervals. The widths of cross-leveling is 25.0 m each on either side of the centerline of the road. The number of cross-leveling is 47.

3.4 STRUCTURAL SITE LEVELING

For the proposed head tank location, leveling at several prospective sites was carried out to obtain their respective elevation above the bench-mark established by NGDT. The topographic maps, to a scale of 1/50,000, mentioned elsewhere in the foregoing was also used for reference.

Fig. 1-1 General Map for the Surveying



Regend ;

- Existing Reservoir
- Under Construction Reservoir
- Proposed Reservoir
- Center of Water Demand
- Propose Water Transmission Line
- Surveying Area

Fig. 1-2 River Cross Section Point

(Rayong River)

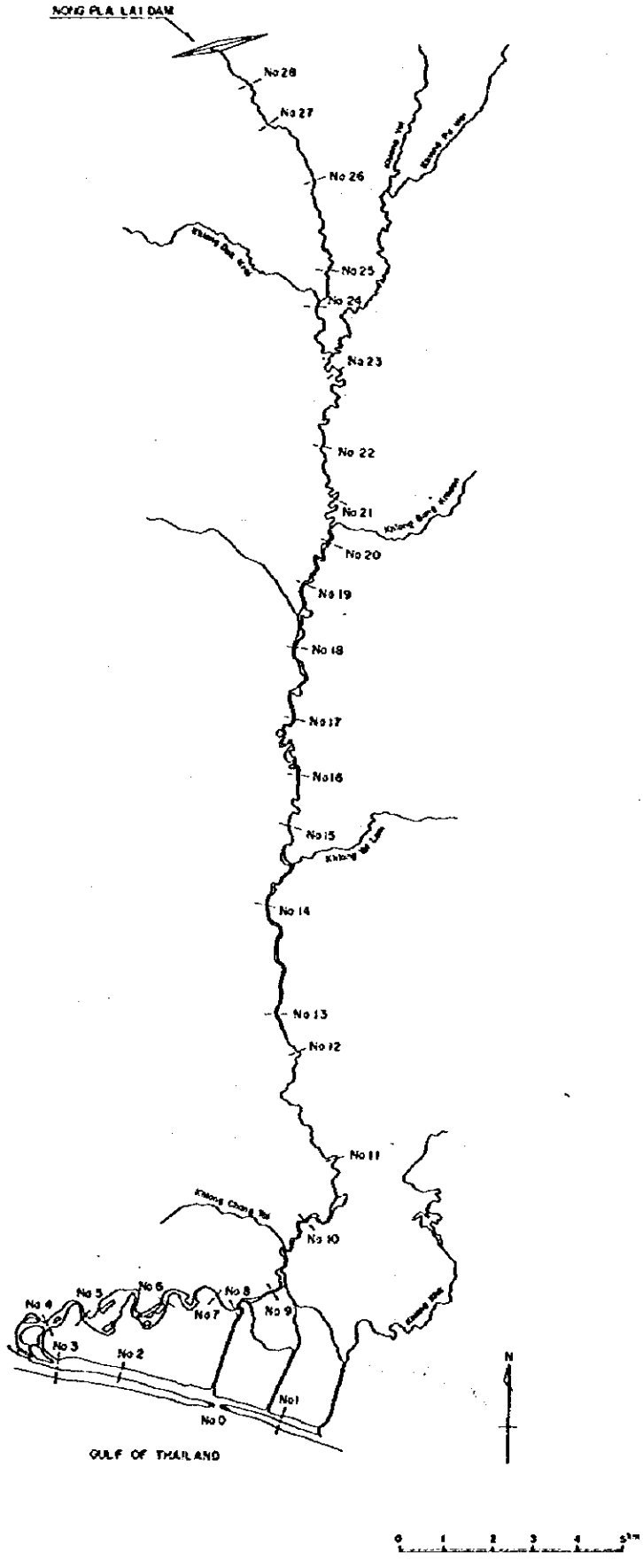
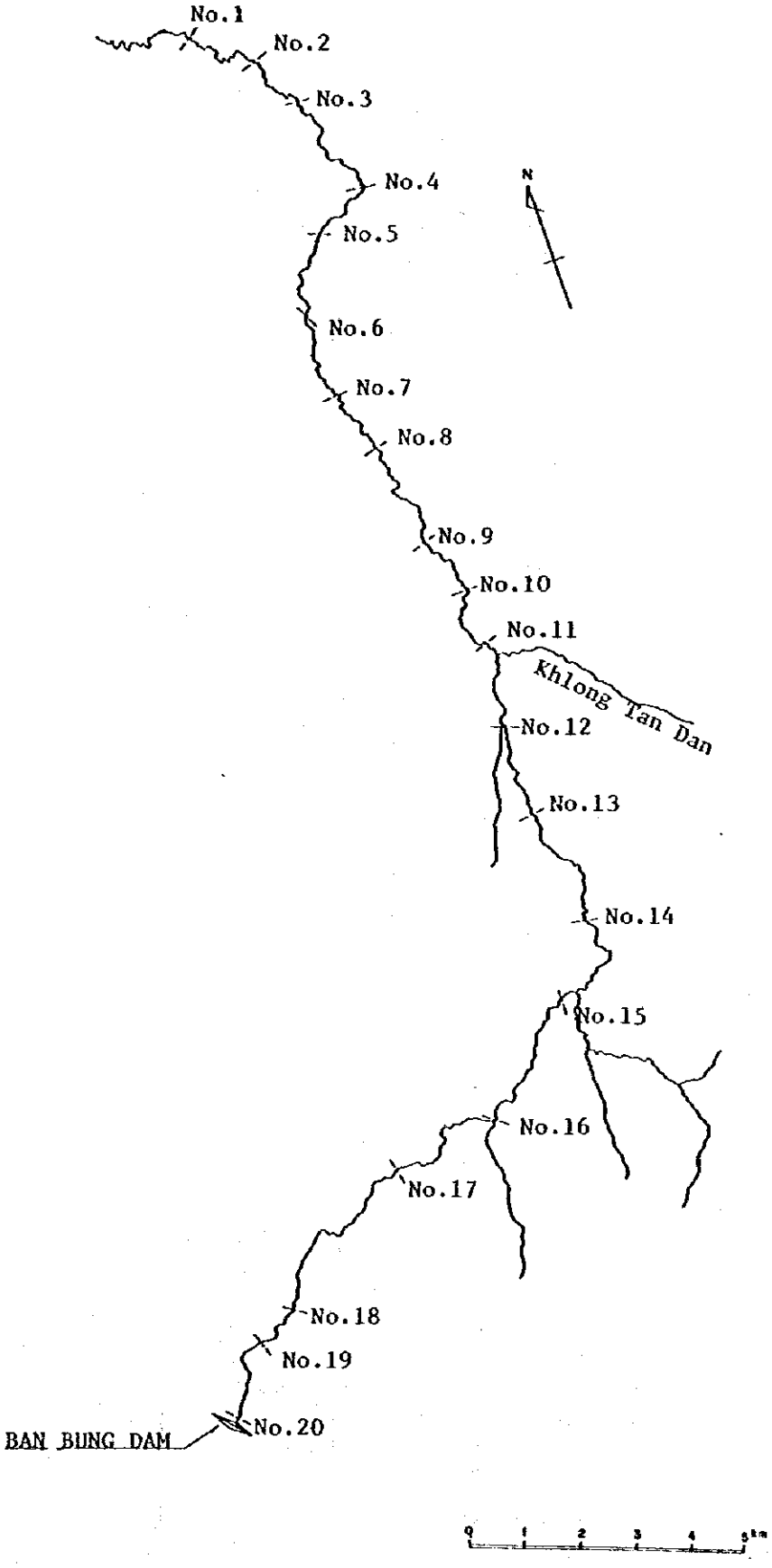


Fig. 1-3 River Cross Section Point
(Ban Bung River)



II. HYDROLOGY

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1. RAINFALL CHARACTERISTICS

1.1 RAINFALL GAUGING STATION

The rainfall gauging stations located in the project area are shown in Fig. 1-1. They are maintained by either the RID or the MD (Meteorological Dept.) The data collected for the present study is shown in Table 1-1.

1.2 ANNUAL RAINFALL

The annual rainfall in the project area is around 1,300 mm, which is small, comparing to other areas. (Refer to Fig. 1-2)

Table 1-2-(1) to 1-2-(3) shows the annual rainfall for the past 30 years. The maximum and the minimum annual rainfall are tabulated below.

Changwat	Max. (mm)	Min. (mm)	Record Period
Rayong	1,660 (1970)	800 (1965)	1956 - '79
Chon Buri	1,570 (1974)	810 (1979)	1952 - '79
{OUTSIDE PROJECT AREA}			
Chachoensao	1,680 (1956,'57)	880 (1979)	1952 - '79

The data for the years 1952-'55 from Ban Khai Station in Changwat Rayong is excluded from the above due to its less reliability.

Fig. 1-3 shows year-to-year change in rainfall by simple average and 5-year moving average of observation.

The figure shows repetitive characteristics of rainfall that has interval of several years. The figure also tells that the past few years have seen less rainfall.

1.3 MONTHLY RAINFALL

The monthly rainfall on the 20-year average at principal stations are shown in Fig. 1-4. It is learnt from the figure that May to October is the rainy season, while November to April is the dry season. The peaks of rainfall can be observed in May and September - October.

1.4 DAILY RAINFALL

Little correlation among the stations for their daily rainfall can be observed. Local rainfall distribution characteristic is believed to be strong.

Tables 1-3-(1) to 1-3-(4) show the rainfall of 1 - 4 consecutive days at principal stations. The recorded maximum rainfall for the past 30 years are as follows:

Station	1-day	2-days	3-days	4-days
Rayong	210(1952)	258(1968)	310(1969)	310(1969)
Ban Bung	117(1957)	182(1957)	182(1957)	212(1968)

2. RUN-OFF

2.1 WATER LEVEL AND DISCHARGE GAUGING STATION

The principal location of water level and discharge gauging station by RID is tabulated in Fig. 2-1 and Table 2-1. Table 2-1 shows discharge data collected for this study.

2.2 ACCURACY AND MODIFICATION OF DISCHARGE RECORD

Discharge gauging station of ten-odd times a year as well as cross-section survey at gauging station sites once in a few years are carried out to keep up the rating curve (Refer to Figs. 2-2-(1) to 2-2-(8). Discharge gauging are conducted only for low water stage of dry season and discharge for high water level is estimated by extrapolation from low water gauging.

Nong Pla Lai

At Nong Pla Lai Station, some errors are expected from this extrapolation and the rating curve, that is, underestimation the discharge for a certain height of stream flow. Observed data shows that water level exceeds bank height in 3 to 5 days a year. Therefore, some modification of rating curve for this extrapotation was conducted as follows on the basis of Manning's Formula.

$$Q = 16.97\ (H - 2.89)^2 \quad \ldots\ldots\ H > 5.35\ m$$
$$Q = 4.07\ (H - 0.85)^2 \quad \ldots\ldots\ 2.85 < H < 5.35$$

where;

Q : Discharge at Nong Pla Lai (m^3/s)
H : Observed water stage (m)

Dok Krai

After construction of Dok Krai Dam in 1975 dicharge at Dok Krai Station was caluculated from the rating curve of the morning glory, free over-flow spillway and intake gate. As for the discharge capacity of the morning glory, the rating curve prepared by RID was modified as follows because of some difference of dimension of the morning glory. Thus, the run-off at Dok Krai Station after 1975 is some what different from the record of RID.

- Overflow discharge through the morning glory

$$Qm = 62.80\ H^{1.5}$$

where;

Qm : Overflow discharge through the morning-glory
H : Overflow depth (m)

- Outflow through the sluice gate

H-Q relationship based on the observed water stage (H) at downstream site of the dam and outflow (Qm) from the reservoir is adopted to estimate outflow (Qs) through the sluice gate

- Inflow to Dok Krai Reservoir

$$Qin = (S_2 - S_1/2) + Qout/T$$

where;

Qin : Inflow to Dok Krai Reservoir (m^3/s)
S_1, S_2: Reservoir storaged water (m^3/s)
Qout: Outflow from Reservoir (m^3/s)
T : Second in a month

Ban Khai

Ban Khai discharge was modified in natural condition based on the observed data at Ban Khai and outflow from Dok Krai Dam from 1975 to 1980.

$$Q = Q_{ob} + \Delta Q$$
$$Q = (S_2 - S_1) / T$$

where;

Qob : Observed discharge at Ban Khai (m^3/s)
ΔQ : Controlled discharge at Dok Krai (m^3/s)
S_2, S_1 : Reservoir storaged water in Dok Krai reservoir (m^3)
T : Second in a month

2.3 RUN-OFF

The monthly average inflow to reservoir and discharge at main station are listed in Tables 2-2-(1) to 2-3-(3).

Missing data and data in pre-observation period is estimated as following fomula.

1) Khlong Yai

$$Q_{yai} = Q_{non} \times (A\ yai/A\ non) \times (F\ yai/F\ non)$$

where;

Q yai, Q non: Discharge at Khlong Yai and Nong Pla Lai respectively (m^3/s)
A : Catchment area (km^3)
(A yai = 244 km^2,
A non = 429 km^2)
F : Anual run-off ratio
(F yai/F non = 0.85)

2) Dok Krai (1968 - 1972)

Q dok = Q noe x (A noe / A dok)

where;

Q dok, Q noe : Discharge at Dok Krai and Ban Noe Num Khu respectively
A : Catchment area
A noe = 291 km^2,
A dok = 279 km^2)

3) Dok Krai (1973 - 1974)

Q dok = Q kho x (A dok / A kho)

where;

Q dok, Q khai : Discharge at Dok Krai and Ban Khai
A : Catchment area
(A dok = 279 km^2,
Q khai = 1255 km^2)

3. RESERVOIR SEDIMENTATION

3.1 ESTIMATION OF RESERVOIR SEDIMENTATION

Flow of sediment into reservoir is subject of condition of upstream, such as topography, geology, vegetation, and other hydrological conditions as run-off characteristics.

The volume of sediment that would settle in the reservoir depends on topography, the ratio of inflow to reservoir capacity and fluctuation of storage level.

3.2 EXISTING SEDIMENTATION AT BAN BUNG RESERVOIR

To estimate the sedimentation, sounding survey of Ban Bung reservoir was conducted in the present study because no observation data of reservoir sedimentation exists in the project area and the vicinity (refer to Fig. 3-1).

Table below is presented for comparison of storage capacity in 1958 (completion of dam) and 1981 (present). The difference is assumed to be the sedimentation.

Unit: 10^3 m^3

Reservoir Stage (m)	1958	1981
73.0	115	50
74.0	300	210
75.0	650	500
75.5	920	750

The annual average sedimentation may be estimated by formula below.

$$(920{,}000 - 750{,}000)\ m^3/53\ km^2/23\ year = 139 \approx 150\ m^3/km^2/year$$

3.3 DESIGN UNIT SEDIMENTATION

Normally, for a given catchment area, the sedimentation increases as the reservoir capacity increases. The ratio of storage capacity to catchment area for present Ban Bung, proposed Ban Bung and Nong Pla Lai Dam is 0.03, 0.22 and 0.34, respectively. The design unit sedimentation based on actual sediment at Ban Bung Reservoir including increase by the ratio of storage capacity difference of the two and overall allowance would be 300 $m^3/km^2/year$.

Table 1-1 Rainfall Observatory Stations & Period of Availability

STATION NO.	NAME
48121	Nong Pla Lai
092	K.A.Pluak Daeng
141	
022	Ban Kai Rayong
012	Muang Rayong
09073	A.Sattahip Chonburi
052	A.Bang Lamung
042	A. Si Racha
062	Ban Bung
013	A. Muang
022	A. Phanat Nikhom
032	A. Plan Thong
08042	A. Ban Pho
052	A. Bong Khla
022	A. Phanom Sarakham

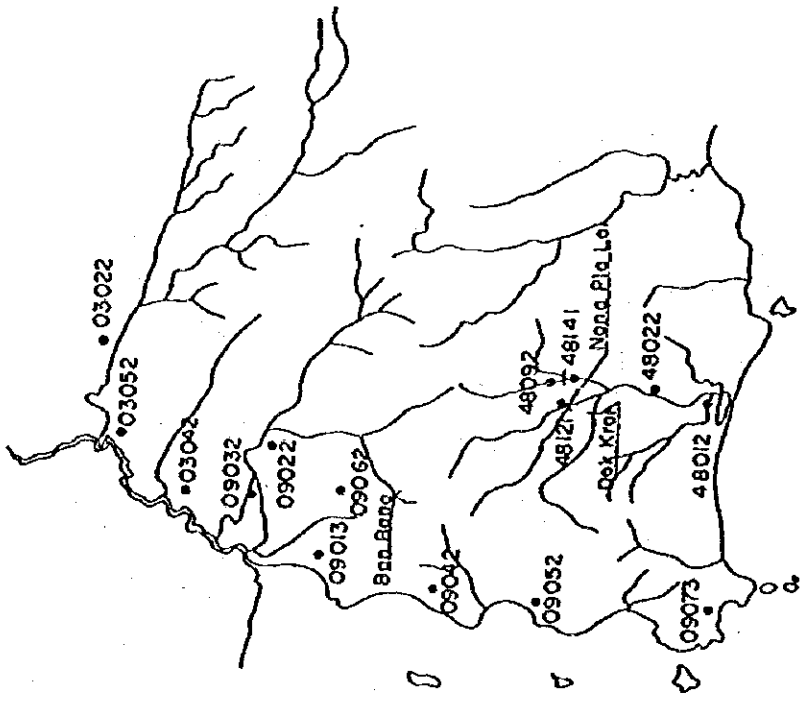


Fig. 1-1 Rainfall Stations East Coast Area

Table 1-2-(1)Annual Rainfall (Changwat Chon Buri)

(unit:mm)

	Chon Buri	Phanat Nikhom	Phang Thong	Si Racha	Bang Lamung	Sattahip	Ban Bung	Simple Average	5-year Moving Average
1952	1323.6		1580.9	1810.9	(346.9)	1615.8	1432.3	1545.5	
53	1641.4		1833.3	1260.7	(646.3)	1047.0	1212.4	1290.4	
54	1259.3	1407.9	1383.3	1515.9	968.3	1183.3	1408.0	1341.6	
55	1720.9	1568.9	1263.7	1424.7	1498.0	757.5	1228.8	1283.0	
56	1416.1	1108.0		1247.2	1386.1	1012.2	1006.8	1170.6	1326.2
57	1618.4	1013.0		1373.8	1681.6	1581.8	876.1	1362.5	1289.6
58	1193.5	934.1	1089.8	984.2	1236.3	1158.4	1173.1	1127.3	1257.0
59	1080.4	849.4	834.3	779.6	1416.1	1079.2	1157.7	1034.2	1195.5
60	1277.4	1270.7	1032.2	1225.7	1511.6	1321.8	1111.3	1234.1	1185.7
61	1229.3	1125.3	1384.4	1195.8	946.1	873.3	987.2	1071.4	1165.9
62	1020.1	1329.5	1167.3	865.9	1028.2	1031.0	902.7	954.9	1084.4
63	1707.3	1301.6	964.4	1280.0	1275.1	997.9	1385.2	1342.6	1127.4
64	1537.4	1228.4	1148.7	1197.2	1457.3	1160.0	1121.2	1256.0	1171.4
65	1254.1	806.6	624.5	1193.9	1136.3	1021.9	1420.6	1222.6	1169.1
66	1589.9	1312.8	764.4	1278.6	1443.3	1052.0	1153.3	1268.5	1208.5
67	893.2	913.8	(703.6)	824.2	1098.5	1242.3	957.6	979.3	1213.4
68	1114.7	1002.2	849.4	736.7	1070.5	1357.5	1449.1	1164.5	1177.8
69	1049.4	(261.8)	1155.0	1293.5	1158.2	1631.6	1171.7	1286.6	1184.3
70	1261.2		1346.6	1368.5	1743.1	2089.4	1385.1	1526.1	1245.0
71	1325.8		1127.1	1380.3	843.4	1773.3	1207.4	1421.7	1275.7
72	1194.7	(726.3)	767.0	1123.3	1060.3	1593.8	1238.3	1287.5	1337.3
73	1232.0	1490.4	994.9	1001.5	967.3	1168.6	1396.3	1199.6	1344.3
74	1759.7	1567.8	1410.5	1574.0	1470.3	1293.7	1649.5	1569.2	1400.8
75	1234.3	1217.9	1136.4	1150.5	(890.1)	1133.0	1100.0	1154.5	1326.5
76	1473.7	1368.8	965.9	1756.2	1326.3	1280.8	889.1	1350.0	1312.2
77	1066.3	1241.5	196.4	894.4	1252.0	912.8	(746.1)	957.8	1246.2
78	1303.8	1114.5	640.1	1410.1	1289.7		870.0	933.9	1193.1
79	802.5	933.6	597.9	818.1	742.3		(679.2)	810.3	1041.3
80									

Table 1-2-(2) Annual Rainfall (Changwat Rayong)

(unit:mm)

	Dok Krai	Rayong	Ban Krai	Nong Pla Lai	Pluak Daeng	Rayong Ban Krai	Rayong Ban Krai
						Simple Average	5-year Moving Average
1952		1221.7	2614.7			1918.2	
53		1618.4	3248.0			2433.2	
54		1421.6	2444.7			1933.2	
55		1510.3	3058.8			2284.6	
56		1504.4	1796.5			1650.5	2043.9
57		(1618.1)	1694.3			1656.5	1991.5
58		1171.5	1692.5			1432.0	1791.3
59		1509.0	1238.3			1373.7	1679.4
60		1434.3	1139.4			1286.9	1479.8
61		1212.6	1186.3			1199.5	1389.6
62		1043.7	1285.3			1164.5	1291.3
63		1062.1	1221.5			1141.8	1233.3
64		654.0	1183.9			919.0	1142.3
65		887.6	706.6			797.1	1044.4
66		928.2	1319.9			1124.1	1029.3
67		1090.9	725.4	(790.1)		908.2	978.0
68	1532.5	1677.8	1458.8	2245.2		1568.3	1063.3
69	1523.2	1475.8	1643.7	1658.7		1559.8	1191.5
70	1431.4	1672.7	1642.5	1514.1		1657.6	1363.6
71	1335.3	1214.9	1148.9	1345.9		1181.9	1375.2
72	1328.0	1020.8	1241.8	1462.7		1131.3	1419.8
73		1110.4	1552.5	1759.9		1331.5	1372.4
74		1272.3	1863.3	1405.9		1567.8	1374.0
75		1130.8	1432.5	1261.3		1281.7	1298.8
76		884.7	1308.4	1463.2	1308.4	1096.6	1281.8
77		1088.6	1288.4	1003.1	538.4	1188.5	1293.2
78		(518.5)	1178.5	1177.6		1178.1	1262.5
79		(404.2)	926.8	972.1		949.5	1138.8
80							
81							

Talbe 1-2-(3) Annual Rainfall (Changwat Chachoensao)

(unit:mm)

	Bang Khla	Ban Pho	Bang Nam Prieo	Pharom Sarakram	Simple Average	5-year Moving Average
1952	1741.4	1351.8	1374.9	1663.2	1532.8	
53	1519.9	1425.0	1646.5	1600.8	1548.1	
54	1674.5	1278.0	1102.4	1317.0	1343.0	
55	1794.0	1193.5	1388.8	1760.3	1534.2	
56	1874.1	1330.1	1405.8	2127.6	1684.4	1528.5
57	1895.7	1529.5	1518.8	1784.2	1682.1	1558.3
58	1502.6	1102.4	1441.7	1194.5	1310.3	1510.8
59	1108.9	901.7	1449.0	1448.2	1227.0	1487.6
60	1696.1	1180.4	1881.6	1661.5	1604.9	1501.7
61	1665.6	1251.2	1335.5	1877.9	1532.6	1471.4
62	1653.7	1286.6	1349.8	1879.2	1542.3	1443.4
63	1686.4	1171.5	535.5	1628.2	1255.4	1432.4
64	1704.8	1366.5	1177.2	968.4	1304.2	1447.9
65	1561.3	852.1	1569.3	1465.1	1362.0	1399.3
66	1739.8	1424.1	1478.0	1738.4	1595.1	1411.8
67	1391.0	952.8	1417.2	1109.8	1217.7	1346.9
68	881.2	973.1	1450.3	1297.3	1150.5	1325.9
69	1262.1	1139.9	1553.8	1729.5	1421.3	1349.3
70	1743.6	1344.0	1491.7	1715.6	1573.7	1391.7
71	1193.0	1486.9	1747.7	1617.0	1511.2	1374.9
72	1047.7	953.0	1318.3	1448.5	1191.9	1369.6
73	1162.6	1063.4	1452.6	1235.9	1228.6	1385.3
74	1193.5	1279.4	1336.4	1743.3	1388.2	1378.6
75	1403.6	803.8	1423.7	1699.5	1332.7	1330.4
76	996.5	929.8	1108.9	1325.8	1090.3	1246.2
77	1360.8	1119.5	1140.8	1318.8	1235.0	1254.8
78	1054.0	1097.9		1237.9	1129.9	1235.1
79	802.5	768.2		1072.9	881.2	1133.7
80						

Table 1-3-(1) Maximum Daily Rainfall

K.A. PLUAK DAENG RAYONG (48092)

(unit:mm)

Year	Max. 1 Day	Max. 2 Day	Max. 3 Day	Max. 4 Day
1976	94.7	148.2	201.6	201.6
1977	120.2	240.4	260.5	269.8
1978	121.7	154.5	154.5	168.9
1979	72.3	72.3	86.6	86.6

NONG PLA LAI (48121)

(unit:mm)

Year	Max. 1 Day	Max. 2 Day	Max. 3 Day	Max. 4 Day
1967	97.0	110.7	110.7	115.7
68	140.9	182.4	217.6	234.0
69	60.3	77.8	95.5	96.9
70	54.5	79.1	86.2	91.2
71	69.7	69.7	83.2	83.7
72	106.4	130.0	212.0	218.7
73	102.8	124.5	141.9	146.2
74	90.9	137.2	157.8	201.4
75	44.0	87.0	110.0	111.4
76	92.5	132.0	142.5	142.5
77	128.0	130.2	130.2	130.2
78	67.0	95.8	102.9	117.3
79	52.8	71.4	86.4	106.4

Table 1-3-(2) Maximum Daily Rainfall

A. BAN BUNG (09062)

(unit:mm)

Year	Max. 1 Day	Max. 2 Day	Max. 3 Day	Max. 4 Day
1952	97.6	135.8	164.1	164.1
53	64.0	98.0	116.5	130.5
54	76.5	111.0	113.4	134.6
55	60.0	84.5	84.5	84.5
56	99.8	110.9	110.9	110.9
57	116.5	181.5	181.5	197.8
58	84.5	84.5	136.8	136.8
59	73.5	114.2	132.0	132.0
60	36.2	138.5	172.0	180.6
61	72.5	87.1	87.1	87.1
62	63.5	84.7	84.7	98.4
63	103.8	120.8	175.2	175.2
64	95.2	123.6	123.6	123.6
65	69.7	92.2	136.7	155.1
66	75.9	101.7	125.8	125.8
67	90.7	125.5	127.8	127.8
68	67.4	129.5	165.3	211.6
69	71.8	118.2	130.6	141.8
70	72.2	87.6	94.7	97.2
71	54.1	71.9	91.1	100.7
72	78.0	122.0	153.5	158.8
73	82.3	83.8	99.4	120.5
74	87.0	122.4	149.2	167.4
75	51.7	53.4	56.7	81.1
76	48.6	80.4	90.4	90.4
77	69.0	69.0	74.1	91.5
78	62.0	72.5	80.7	93.5
79	-	-	-	-

Table 1-3-(3) Maximum Daily Rainfall

A. BAN KHAI, RAYONG (48022)

(unit:mm)

Year	Max. 1 Day	Max. 2 Day	Max. 3 Day	Max. 4 Day
1952	168.5	192.8	229.2	229.2
53	86.8	142.2	208.4	265.5
54	70.1	94.6	150.1	184.8
55	159.4	295.0	346.3	359.7
56	302.6	344.7	376.8	396.8
57	108.2	144.4	144.4	191.7
58	103.4	103.4	186.8	186.8
59	127.2	161.5	161.5	165.7
60	172.2	172.2	240.8	240.8
61	72.4	72.4	94.4	111.2
62	77.7	129.2	160.0	167.2
63	115.2	151.5	231.9	269.3
64	96.4	96.4	96.4	106.8
65	56.2	88.8	114.0	121.1
66	123.3	125.6	159.7	159.7
67	84.2	137.8	137.8	137.8
68	115.8	202.8	208.1	208.1
69	93.4	125.7	174.0	193.6
70	87.2	136.8	145.0	148.6
71	65.9	82.7	145.9	160.0
72	120.3	153.5	182.1	195.3
73	82.3	112.4	186.6	190.2
74	98.0	154.3	172.8	190.9
75	60.2	71.6	117.6	125.8
76	77.3	124.4	155.7	165.9
77	96.3	101.2	118.8	126.1
78	130.2	154.5	154.5	156.9
79	112.5	112.5	112.5	129.0

Table 1-3-(4) Maximum Daily Rainfall

A. MUANG RAYONG (48012)

Year	Max. 1 Day	Max. 2 Day	Max. 3 Day	Max. 4 Day
1952	210.5	226.6	226.6	226.6
53	98.1	120.8	120.8	149.2
54	70.6	117.1	142.5	164.4
55	91.8	115.6	118.8	118.8
56	115.7	142.3	145.7	145.7
57	103.6	136.0	168.6	220.8
58	93.2	131.0	162.2	230.3
59	84.4	117.8	142.4	144.1
60	81.8	135.7	172.5	220.7
61	66.6	112.6	116.1	118.8
62	72.4	132.6	155.7	165.8
63	113.2	164.0	208.1	213.9
64	57.0	101.2	101.2	144.2
65	78.8	125.3	125.3	132.3
66	153.2	194.5	194.5	194.5
67	116.3	132.3	170.5	170.5
68	126.8	167.9	170.7	240.7
69	156.0	258.0	310.2	310.2
70	130.0	192.3	200.5	232.7
71	66.1	94.3	117.8	132.5
72	119.2	119.2	127.7	127.7
73	52.7	83.0	94.1	94.1
74	100.4	140.6	159.1	174.8
75	126.3	196.8	233.0	250.6
76	72.3	96.5	113.0	114.8
77	107.6	143.6	143.6	143.6
78	80.0	80.0	80.0	86.1
79	-	-	-	-

Table 2-1 Discharge Gauging Stations & Period of Availability

Station		River	Location	Drainage Area (km^2)	Available Period	
Code	Name					
Z1	Wat Phai Lom	Rayong	Ban Khai	1,225	1946 ~ 58	
Z3	Ban Moe Nam Khu	Ko Moe Nam Khu	Ban Moe Nam Khu	291	1967 ~ 72	/1
Z4	Ban Nong Mapring	K. Nong Pla Lai	Ban Nong Mapring	429	1968 ~ 80	
Z15	Ban Pak Phak	Khlong Yai	-	-	1977 ~ 78	
Z5	Ban Yong Ngam	K. Prasae	Ban Yong Ngam	1,164	1967 ~ 78	
Kgt19	Ban Mai	K. Luang	Ban Mai	535	1965 ~ 79	
	Dok Krai Res.	K. Dok Krai		291	1969 ~ 80	
	Ban Phra Res.			130	1969 ~ 80	

/1: Transferred to Dok Krai Res.

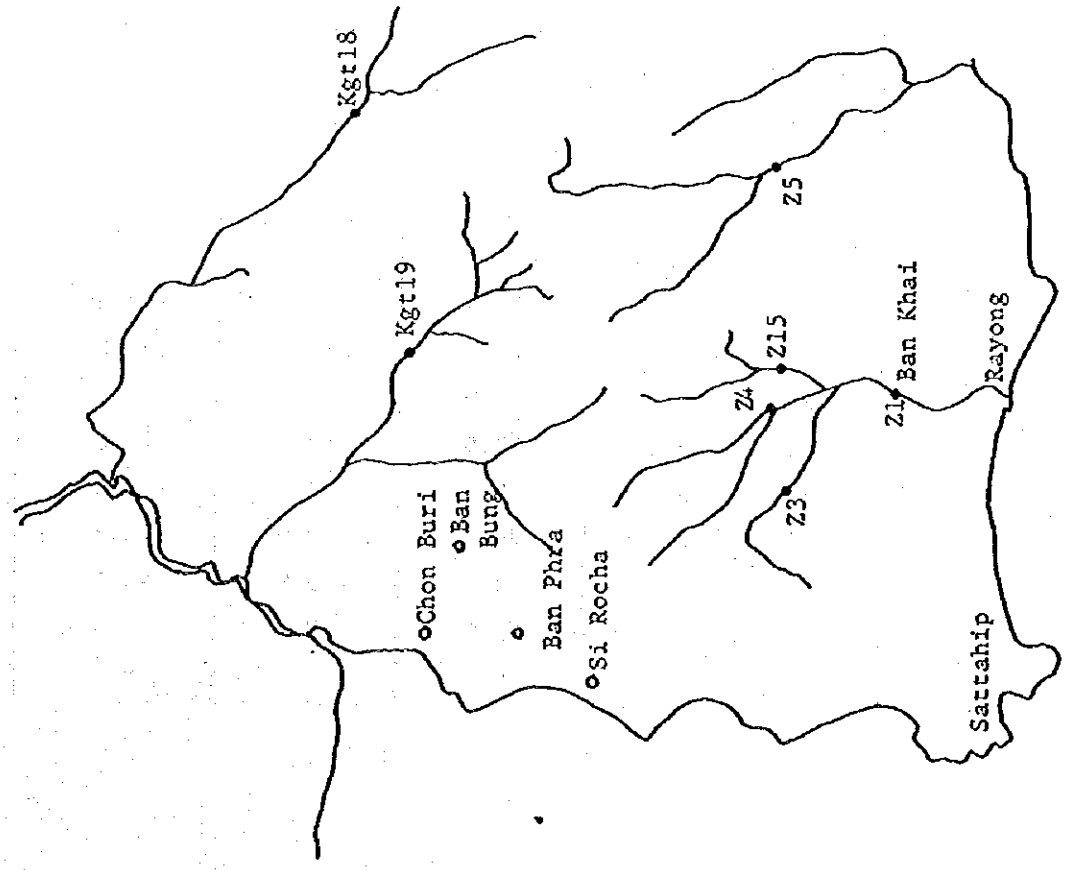


Fig. 2-1 Discharge Gauging Station

Table 2-2-(1) Monthly Average Inflow (Ban Phra Dam)

(Unit: m^3/s)

Year	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1963	0.12	0.11	0.96	0.75	1.72	14.97	13.63	6.25	1.49	0.71	0.41	0.45
1964	1.35	6.05	2.20	2.88	1.34	6.40	13.78	2.58	1.23	0.45	0.84	1.19
1965	0.73	5.23	1.62	2.99	0.49	9.26	9.34	4.63	0.52	0.49	0.58	0.45
1966	0.89	8.48	3.59	1.31	2.73	12.54	15.65	2.78	0.75	0.11	0.33	0.04
1967	1.47	0.04	0.23	0.07	0.07	0.73	4.14	0.66	0.19	0.15	0.50	0.45
1968	0.93	1.68	1.85	0.82	1.00	3.55	5.34	1.23	5.23	0.90	0.28	0.90
1969	0.39	0.78	2.08	0.60	1.64	10.61	2.88	1.12	0.37	0.30	0.25	0.45
1970	0.81	0.45	2.16	0.75	0.82	1.70	6.42	0.39	3.36	0.37	0.45	0.11
1971	1.20	2.05	2.74	1.23	0.78	12.04	10.04	1.35	0.41	0.07	0.33	0.00
1972	0.81	0.00	0.08	0.00	0.07	5.98	8.14	6.10	1.90	0.30	0.08	0.45
1973	0.00	0.07	0.69	0.22	1.64	3.20	5.94	0.46	0.00	0.07	0.41	0.49
1974	1.39	1.34	0.00	0.00	0.52	2.74	16.06	2.31	0.04	0.75	0.00	0.41
1975	0.96	0.22	0.00	0.37	1.72	4.24	3.32	1.85	0.04	0.04	0.79	0.22
1976	0.00	0.00	0.08	0.11	1.31	10.22	0.00	0.00	0.07	0.22	0.08	0.00
1977	0.39	0.34	0.15	0.15	0.07	0.23	1.72	0.16	0.00	0.00	0.99	0.00
1978	0.31	1.98	1.23	3.59	1.19	4.17	2.32	0.66	0.04	0.00	0.50	0.00
1979	0.58	0.04	0.39	0.15	0.07	2.16	0.41	0.00	0.00	0.00	0.00	0.00
1980	0.89	0.56	1.81	0.67	0.93	3.67	5.64					

Table 2-2-(2) Monthly Average Inflow (Dok Krai Dam)

(unit: m^3/s)

Year	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1968	1.92	7.29	8.60	4.94	3.08	3.39	8.42	5.37	1.50	1.43	0.54	0.65
1969	0.25	1.06	3.50	1.41	1.96	6.86	7.79	6.45	1.95	1.19	2.19	0.27
1970	1.65	7.89	5.62	2.29	1.73	2.34	6.44	2.03	9.97	2.54	1.27	1.25
1971	1.72	2.13	1.38	0.44	0.99	4.07	7.95	4.01	1.35	0.65	0.89	0.57
1972	4.92	0.77	0.71	0.22	0.12	13.14	17.06	7.71	2.52	0.80	0.82	1.15
1973	0.52	3.68	4.94	4.44	4.24	9.83	15.20	5.43	2.10	0.88	0.62	0.76
1974	3.97	3.34	3.16	0.88	1.96	6.69	21.32	9.55	2.49	1.85	1.21	0.90
1975	1.34	5.50	2.36	2.50	1.25	1.49	13.29	9.56	3.51	0.76	1.05	2.24
1976	2.17	3.50	2.42	0.56	5.82	3.70	11.12	10.83	2.76	0.90	0.63	0.67
1977	0.72	1.44	0.48	1.84	0.40	1.10	11.57	2.64	0.55	0.51	2.55	0.22
1978	0.39	5.15	3.93	1.59	2.43	5.37	7.00	1.84	0.23	0.83	0.55	0.14
1979	0.79	0.51	1.70	0.55	0.37	5.56	1.28	0.58	0.74	0.17	0.33	0.37
1980	0.37	0.74	4.51	1.14	2.09	2.24	17.60	5.79	1.36	-	-	-

Table 2-3-(1) Monthly Average Discharge (Nong Pla Lai)

(unit: m^3/s)

Year	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1968	1.82	5.31	9.38	5.16	3.54	5.59	13.28	5.79	1.52	1.34	0.68	0.67
1969	0.59	2.46	2.62	1.81	3.16	12.10	17.20	12.10	2.74	1.33	1.87	1.07
1970	3.16	7.89	9.31	5.93	3.50	3.58	8.48	2.99	6.07	2.10	1.43	1.88
1971	2.08	4.28	2.92	1.09	3.85	8.26	11.20	4.14	1.68	0.87	2.18	1.67
1972	7.37	2.00	2.96	1.25	0.46	10.24	14.91	10.20	4.01	1.51	1.32	1.73
1973	0.85	4.80	6.11	5.73	5.96	10.18	14.65	7.24	2.61	1.28	1.02	1.25
1974	5.58	5.14	2.02	1.42	2.72	8.62	24.97	11.42	3.51	2.67	2.20	1.62
1975	1.57	3.65	2.16	2.07	2.30	12.44	15.85	8.50	3.35	1.59	1.62	1.42
1976	2.31	4.99	2.37	0.94	3.86	14.60	10.70	10.60	3.22	1.56	1.21	0.59
1977	1.03	2.71	2.08	2.43	1.75	1.39	5.62	2.23	0.90	0.89	2.26	0.72
1978	2.14	3.64	5.74	7.13	3.50	7.23	9.52	3.23	1.37	0.94	0.67	0.37
1979	0.85	2.65	3.08	0.86	0.62	3.61	3.47	0.78	0.52	0.26	0.73	0.79
1980	0.67	0.95	5.95	3.16	3.33	3.16	13.14	5.50	2.12	-	-	-

Table 2-3-(2) Monthly Average Discharge (Khlong Yai)

(unit: m^3/s)

Year	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1968	0.88	2.57	4.53	2.49	1.71	2.70	6.42	2.80	0.73	0.65	0.33	0.32
1969	0.29	1.18	1.26	0.88	1.53	5.89	8.13	5.84	1.32	0.64	0.90	0.52
1970	1.53	3.81	4.50	2.68	1.69	1.73	4.50	1.44	2.93	1.02	0.69	0.91
1971	1.01	2.07	1.41	0.53	1.86	3.99	5.41	2.00	0.81	0.42	1.05	0.81
1972	3.56	0.97	1.43	0.60	0.22	4.95	7.20	4.93	1.94	0.73	0.64	0.84
1973	0.41	2.32	2.95	2.77	2.88	4.92	7.08	3.50	1.26	0.62	0.49	0.60
1974	2.70	2.48	0.98	0.69	1.31	4.17	12.07	5.52	1.67	1.29	1.06	0.78
1975	0.76	1.76	1.04	1.00	1.11	6.01	7.66	4.10	1.62	0.77	0.78	0.69
1976	1.12	2.41	1.15	0.45	1.87	7.06	5.17	5.12	1.56	0.75	0.58	0.29
1977	0.29	0.17	1.14	2.16	0.76	0.69	5.02	0.62	0.16	0.12	0.70	0.15
1978	0.29	7.40	2.47	3.51	1.38	5.29	4.40	0.71	0.17	0.17	0.05	0.00
1979	0.24	0.32	0.46	0.88	0.24	1.76	2.70	0.22	0.16	0.09	0.07	0.43
1980	0.28	0.29	2.12	1.56	2.34	0.94	6.33	2.41	0.29	-	-	-

Table 2-3-(3) Monthly Average Discharge (Ban Khai)

(unit: m^3/s)

Year	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1968	6.09	20.00	29.67	16.60	10.71	15.39	37.06	22.96	4.94	4.51	2.04	2.16
1969	1.32	6.20	9.70	5.40	10.33	48.85	59.87	35.98	7.76	5.73	5.60	2.45
1970	7.56	24.18	27.01	16.62	17.31	16.74	34.35	8.93	27.54	7.57	4.67	4.71
1971	6.12	12.89	10.26	2.12	10.42	24.02	44.01	18.36	5.55	2.90	5.43	4.02
1972	20.85	4.93	7.09	2.74	1.65	49.33	64.07	32.71	12.70	3.44	3.66	4.90
1973	2.34	16.52	23.30	20.06	18.01	53.61	63.84	26.65	9.81	3.46	2.09	2.46
1974	16.43	12.30	7.25	3.94	8.25	30.36	105.38	46.44	10.86	7.46	5.14	4.11
1975	3.97	21.15	10.09	7.12	9.09	41.56	68.41	35.80	11.43	4.11	4.54	5.73
1976	7.38	28.58	9.12	3.33	25.10	33.34	35.38	42.92	9.94	4.23	3.19	2.04
1977	2.69	6.91	6.30	12.97	5.54	3.25	32.34	6.95	2.12	2.00	7.26	1.44
1978	3.72	34.79	23.49	22.72	9.64	23.58	27.57	6.52	2.33	2.55	1.67	0.67
1979	2.05	4.59	6.90	4.12	1.62	15.07	16.66	2.08	1.87	3.83	2.59	1.87
1980	1.74	2.30	20.31	10.25	19.33	13.15	61.87	17.50	4.76	-	-	-

Fig. 1-2 Annual Ishohyetal Map

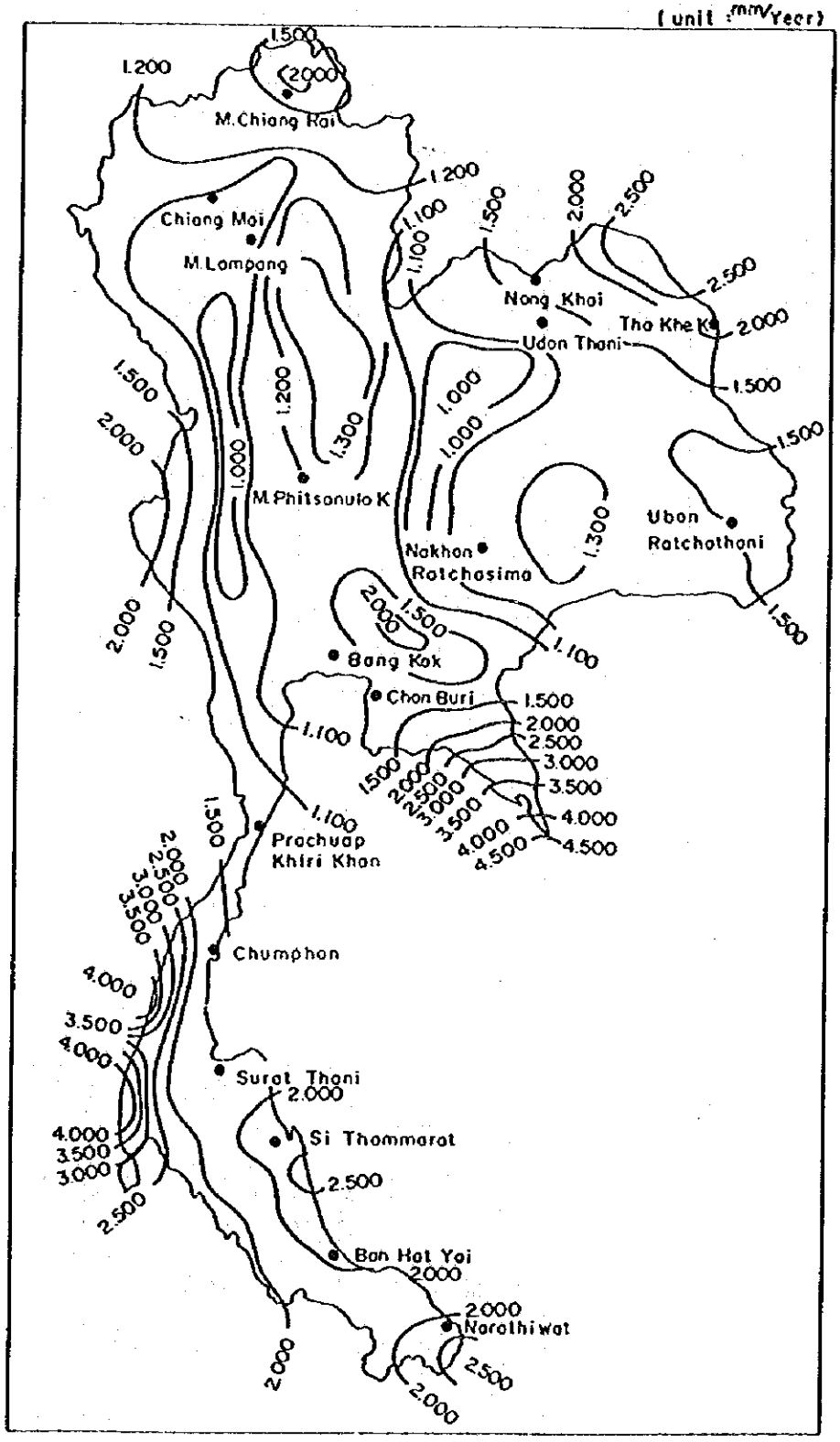


Fig. 1-3 Year to Year Change of Rainfall

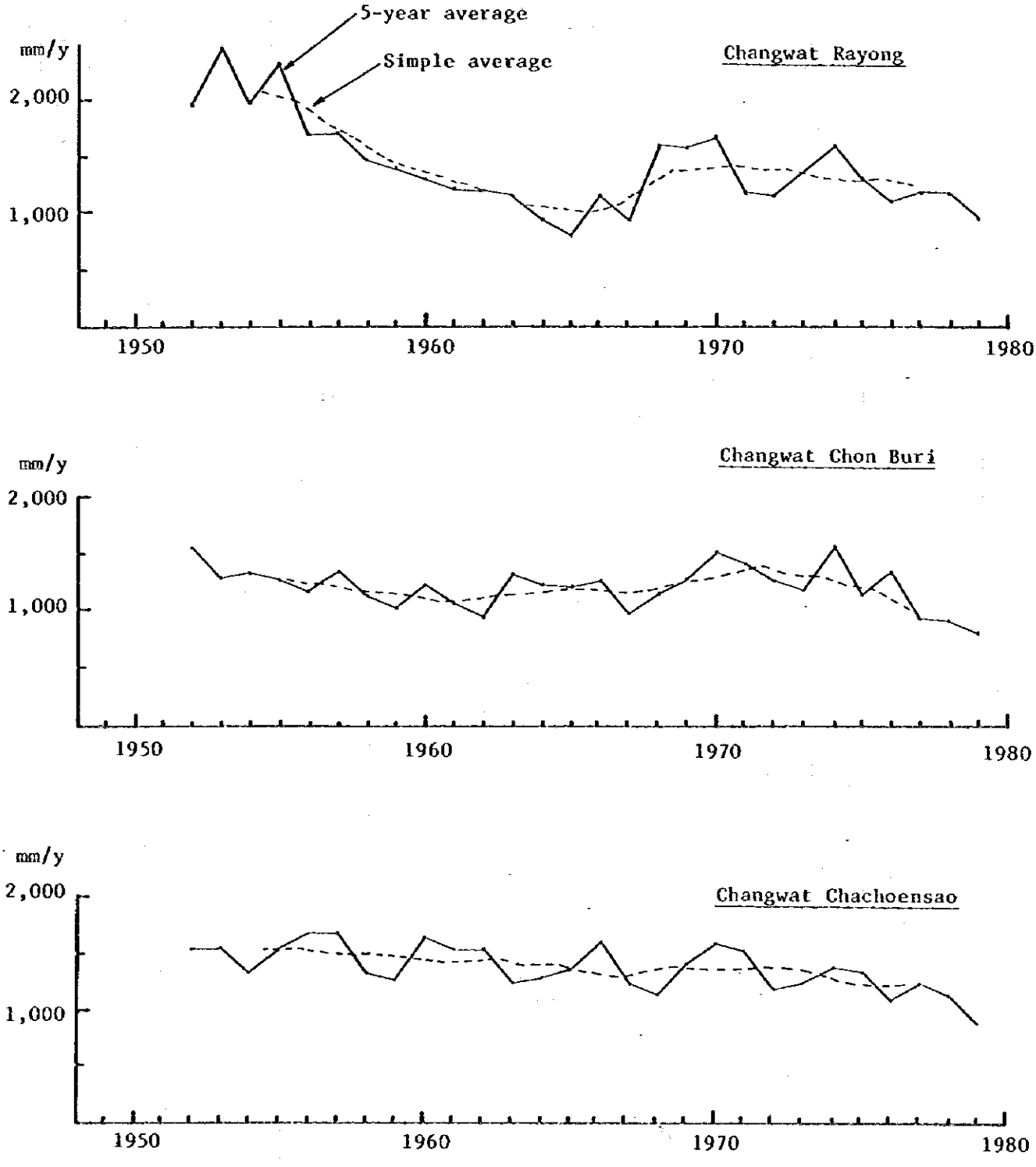
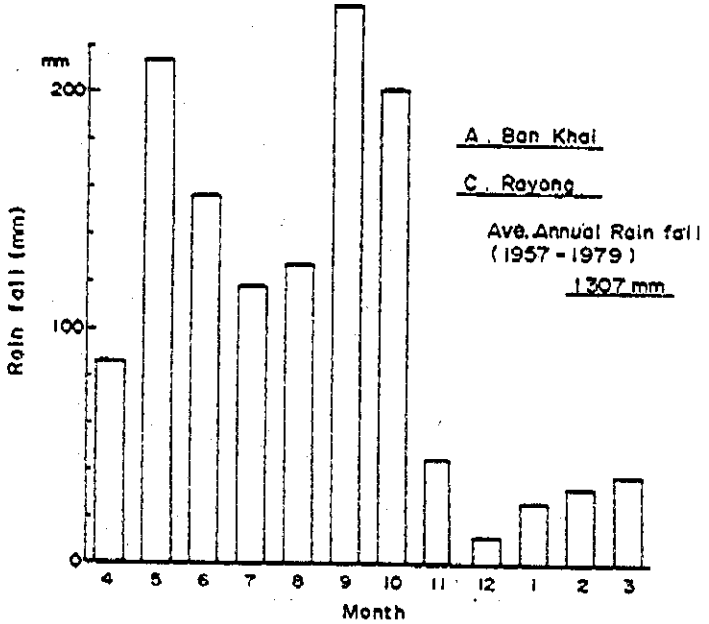
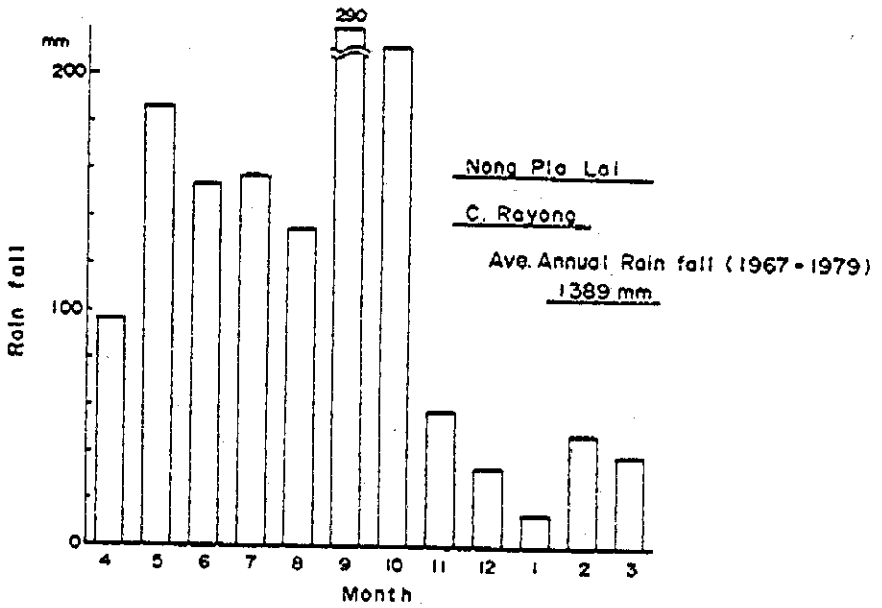
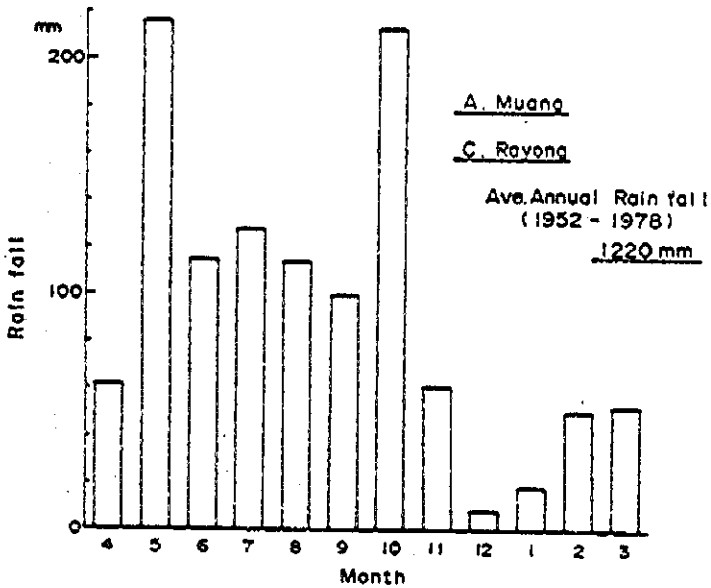


Fig.1-4 Average Monthly Rainfall







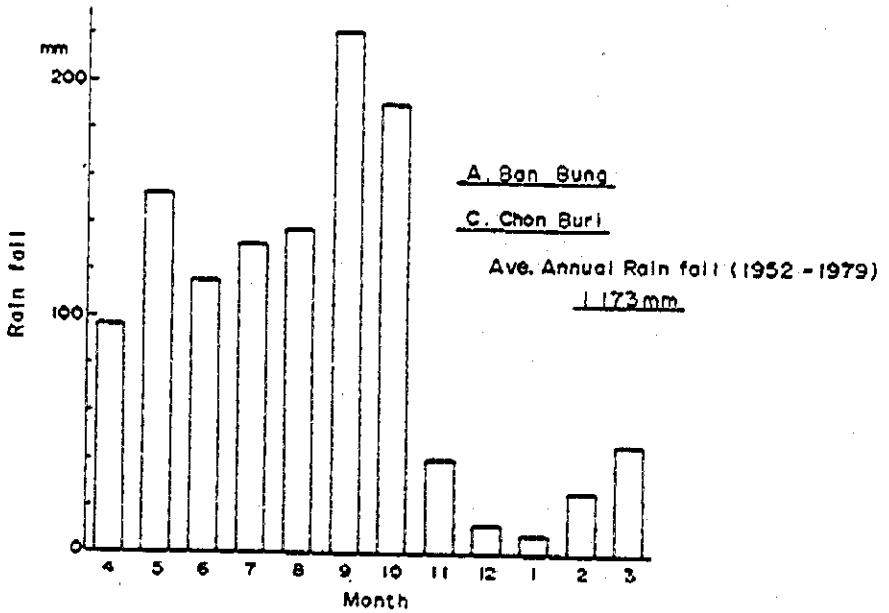


Fig.2-2-(1) Cross Section at Discharge Gauging Station
[Khlong Nong Pla Lai (Z. 4)]

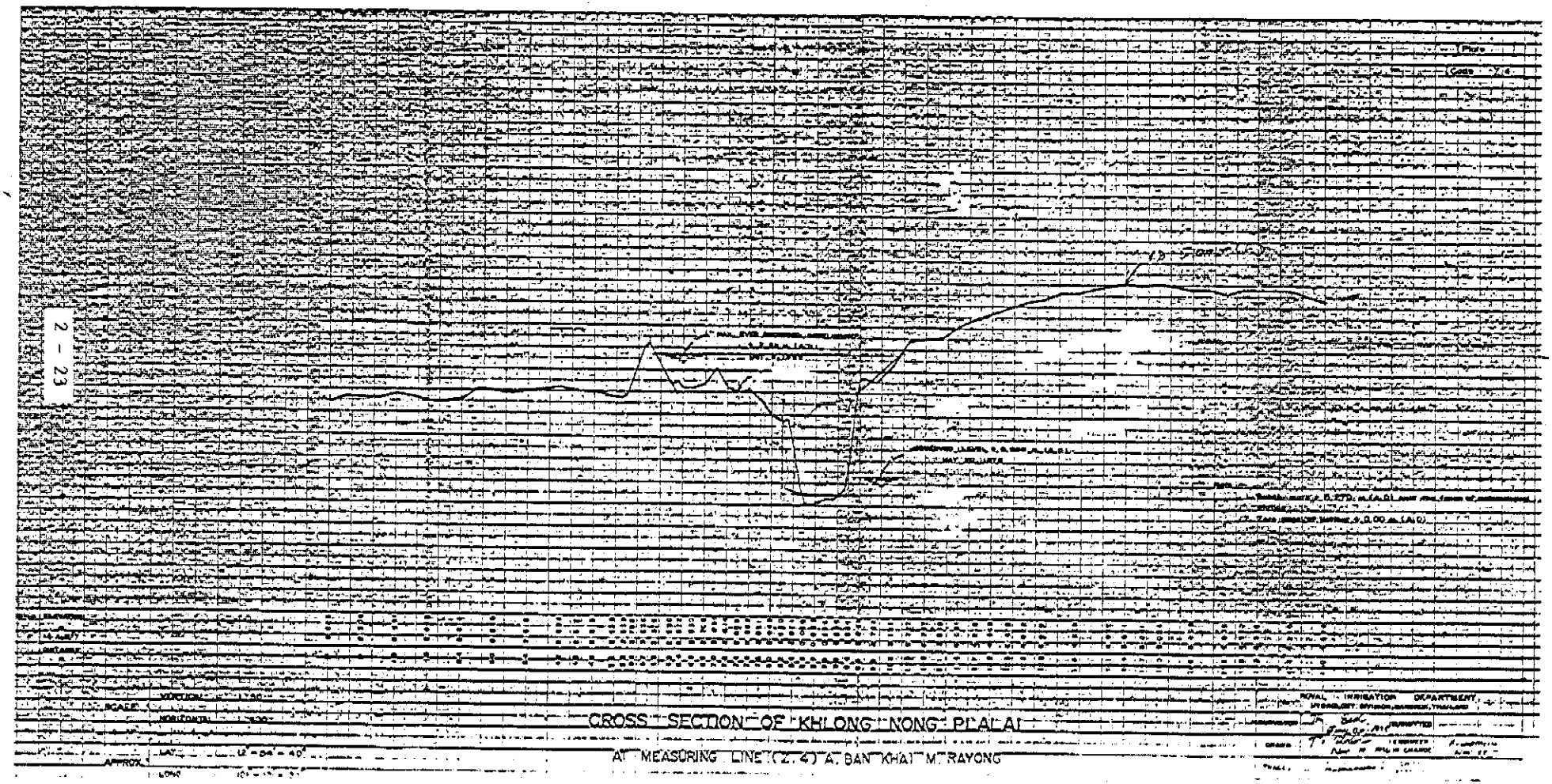


Fig.2-2-(2) Rating Curve at the Discharge Gauging Station
[Khlong Nong Pla Lai (2. 4)]

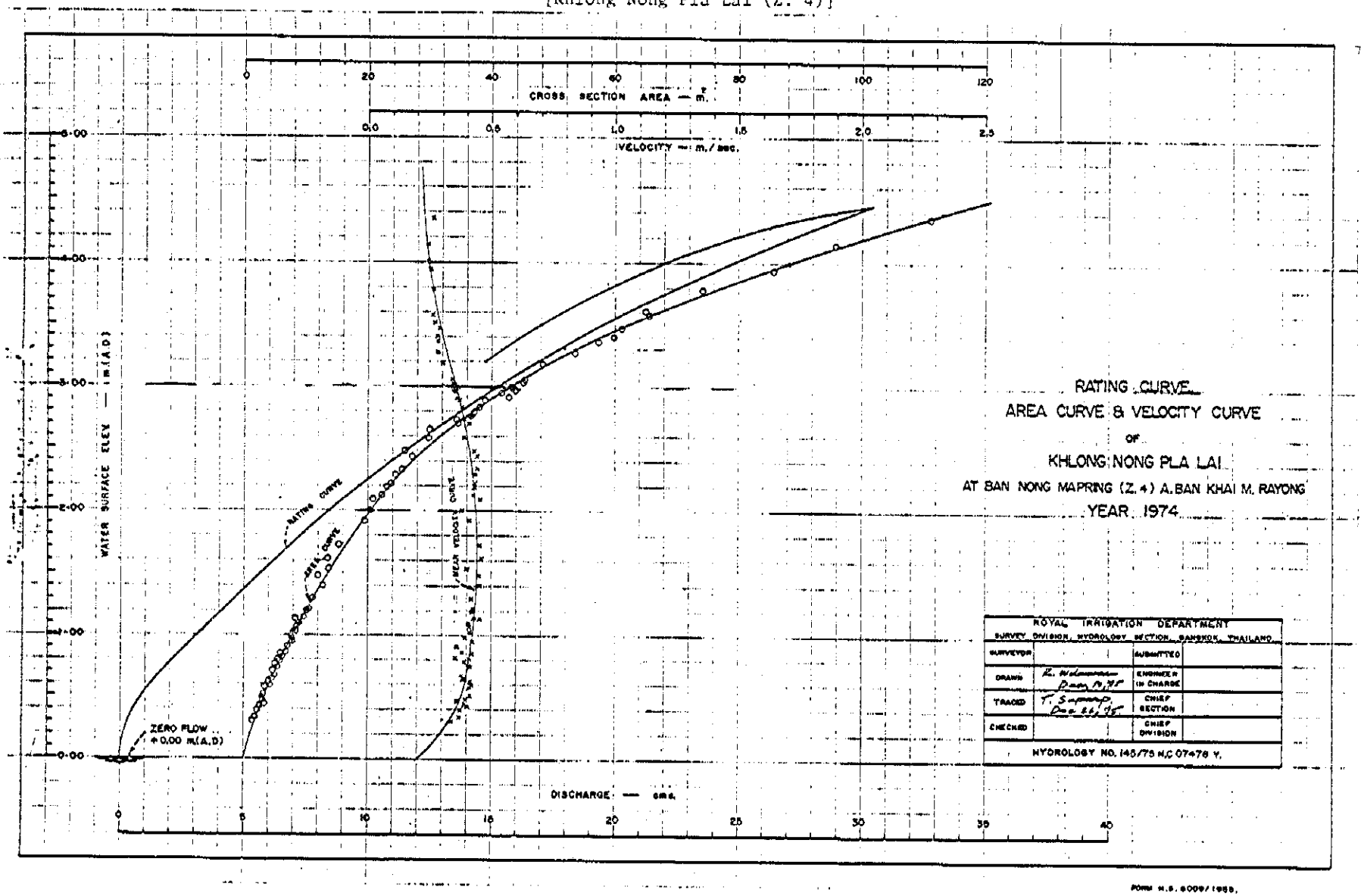


Fig. 2-2-(3) Cross Section at Discharge Gauging Station
[Khlong Dok Krai (Z. 3)]

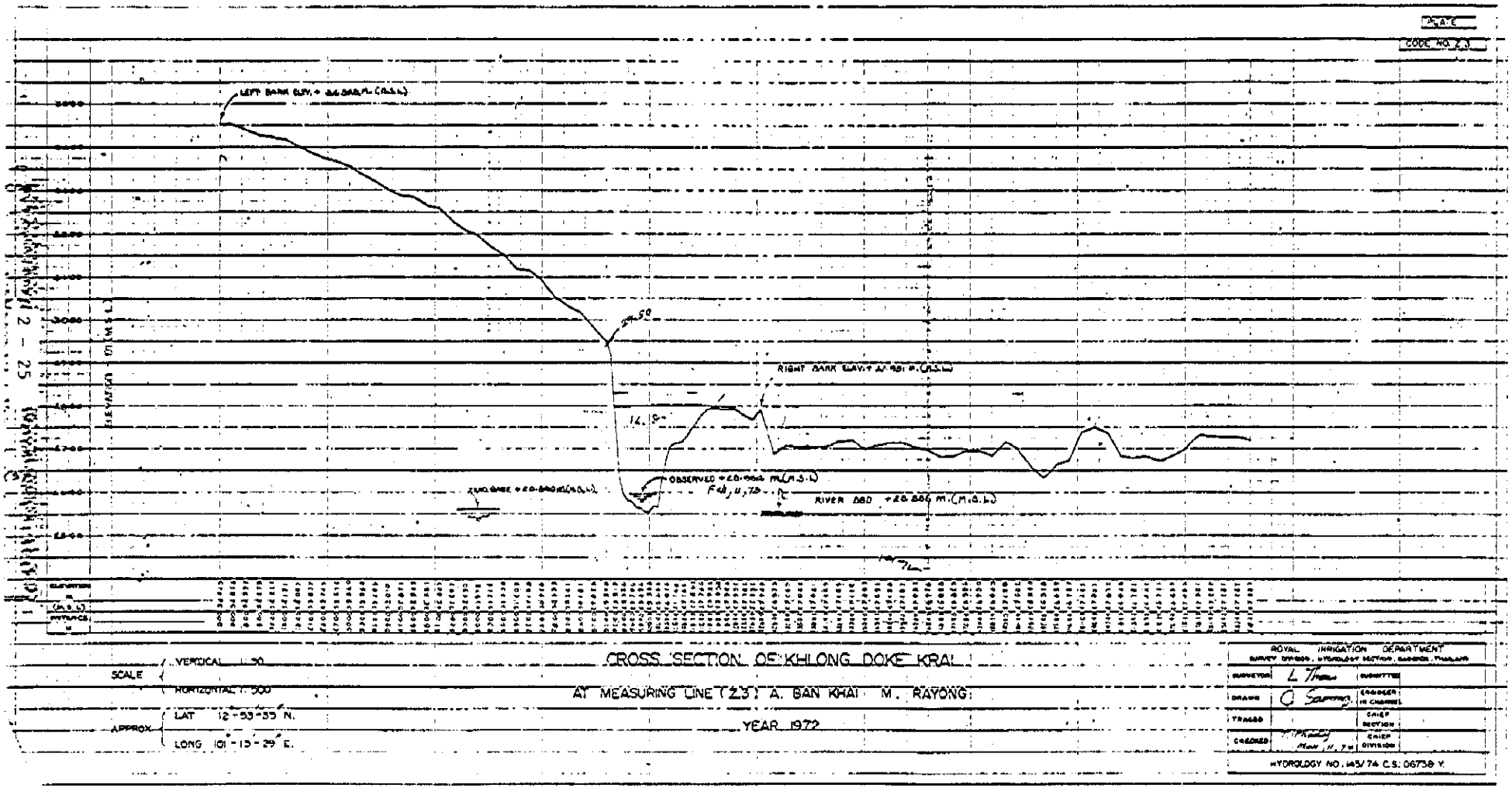


Fig. 2-2-(4) Rating Curve at Discharge Gauging Station
[Khlong Dok Krai (Z. 3)]

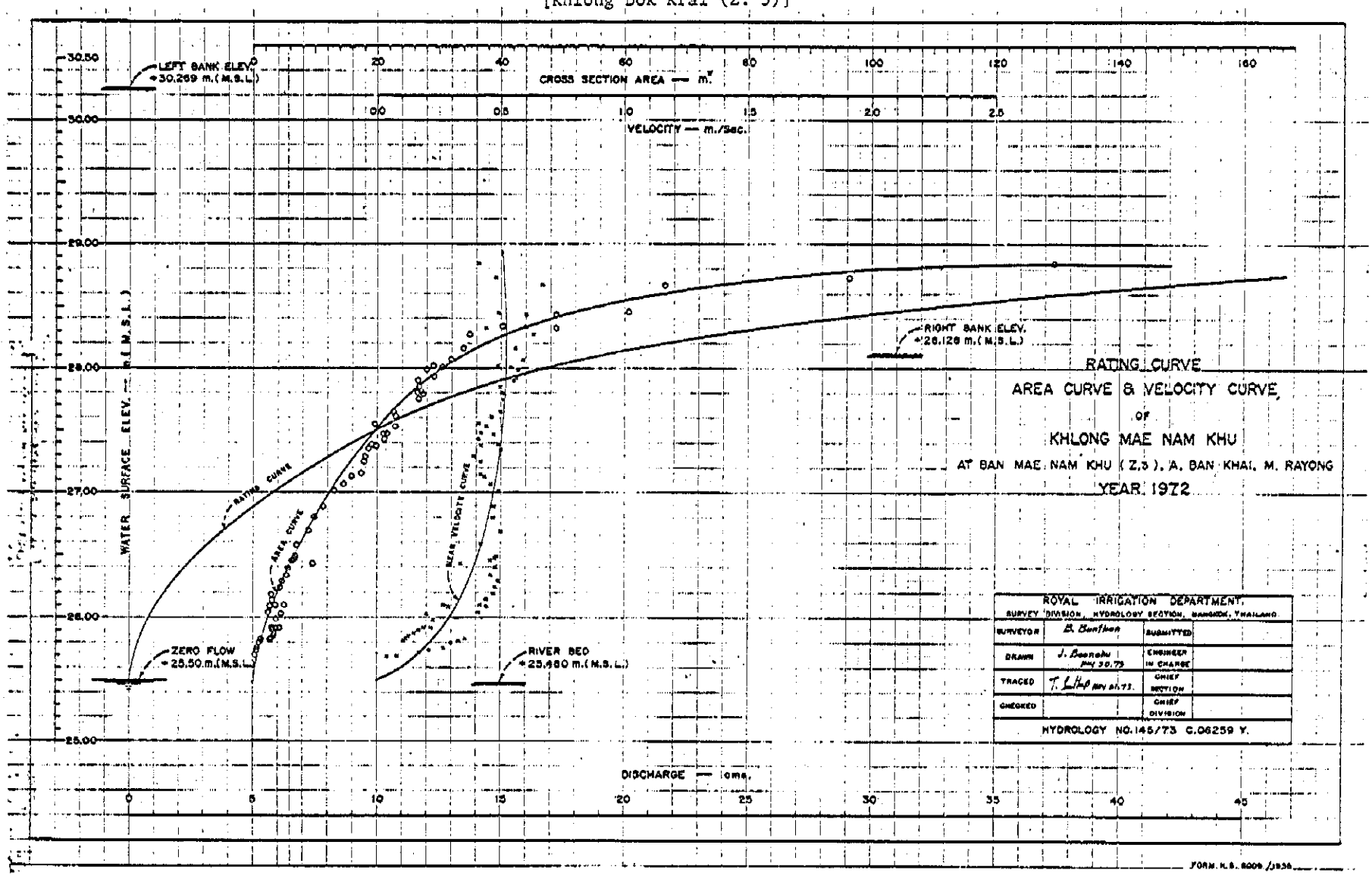


Fig. 2-2-(5) Cross Section at Discharge Gauging Station
[Khlong Yai (Z. 15)]

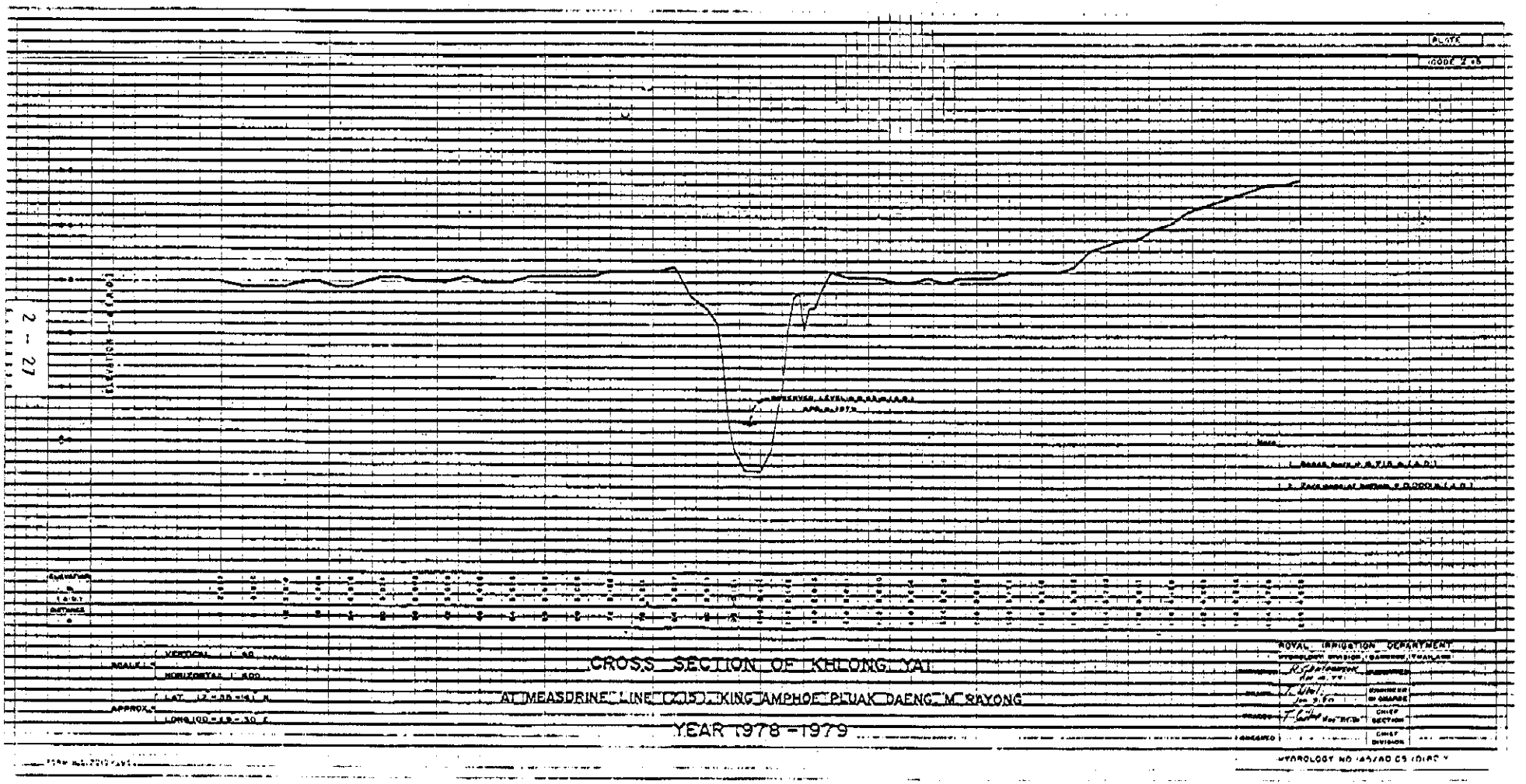


Fig. 2-2-(6) Rating Curve at Discharge Gauging Station
[Khlong Yai (Z. 15)]

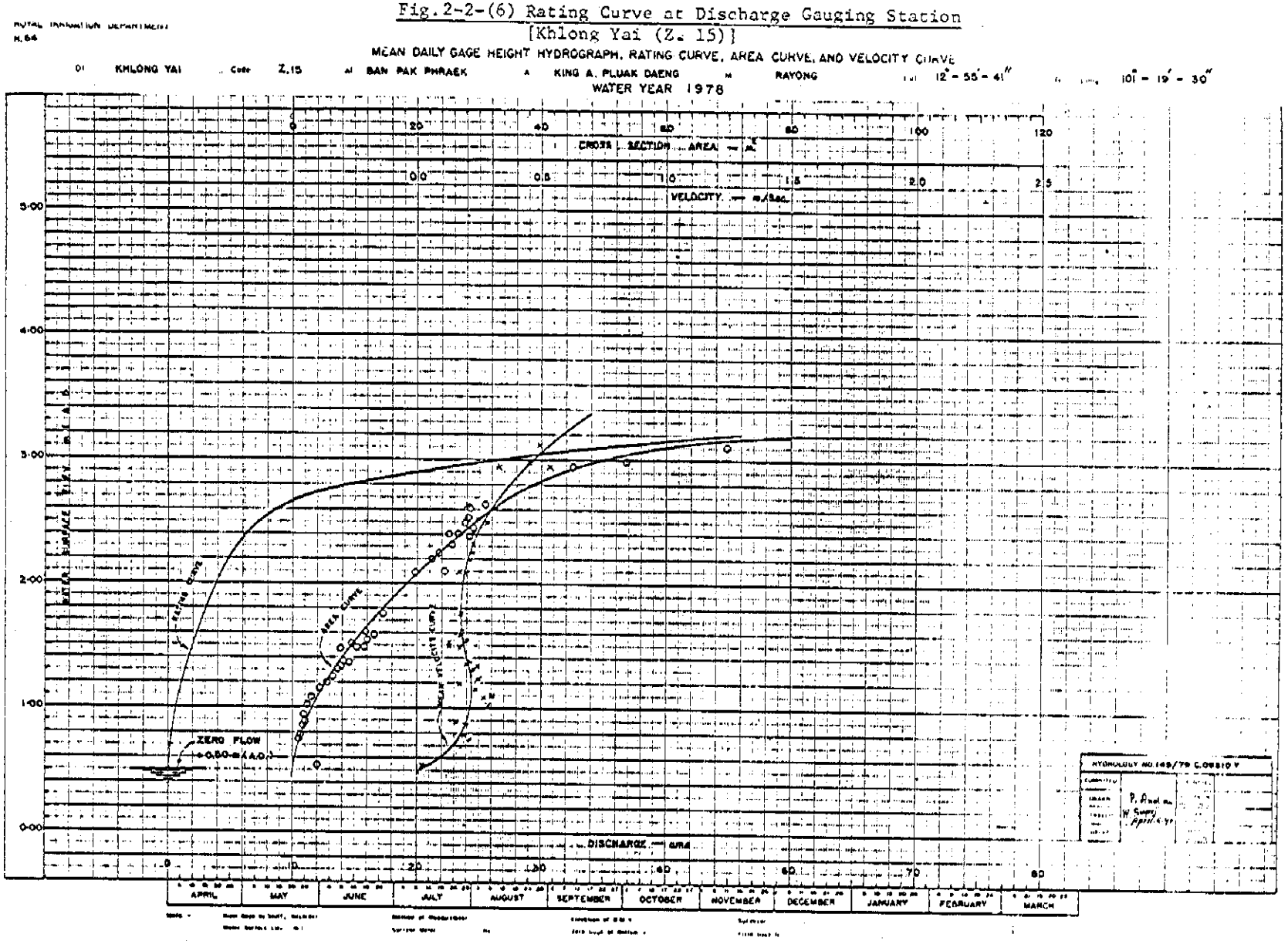


Fig 2-2-(7) Cross Section at Discharge Gauging Station
[Khlong Luang (Kgt. 19)]

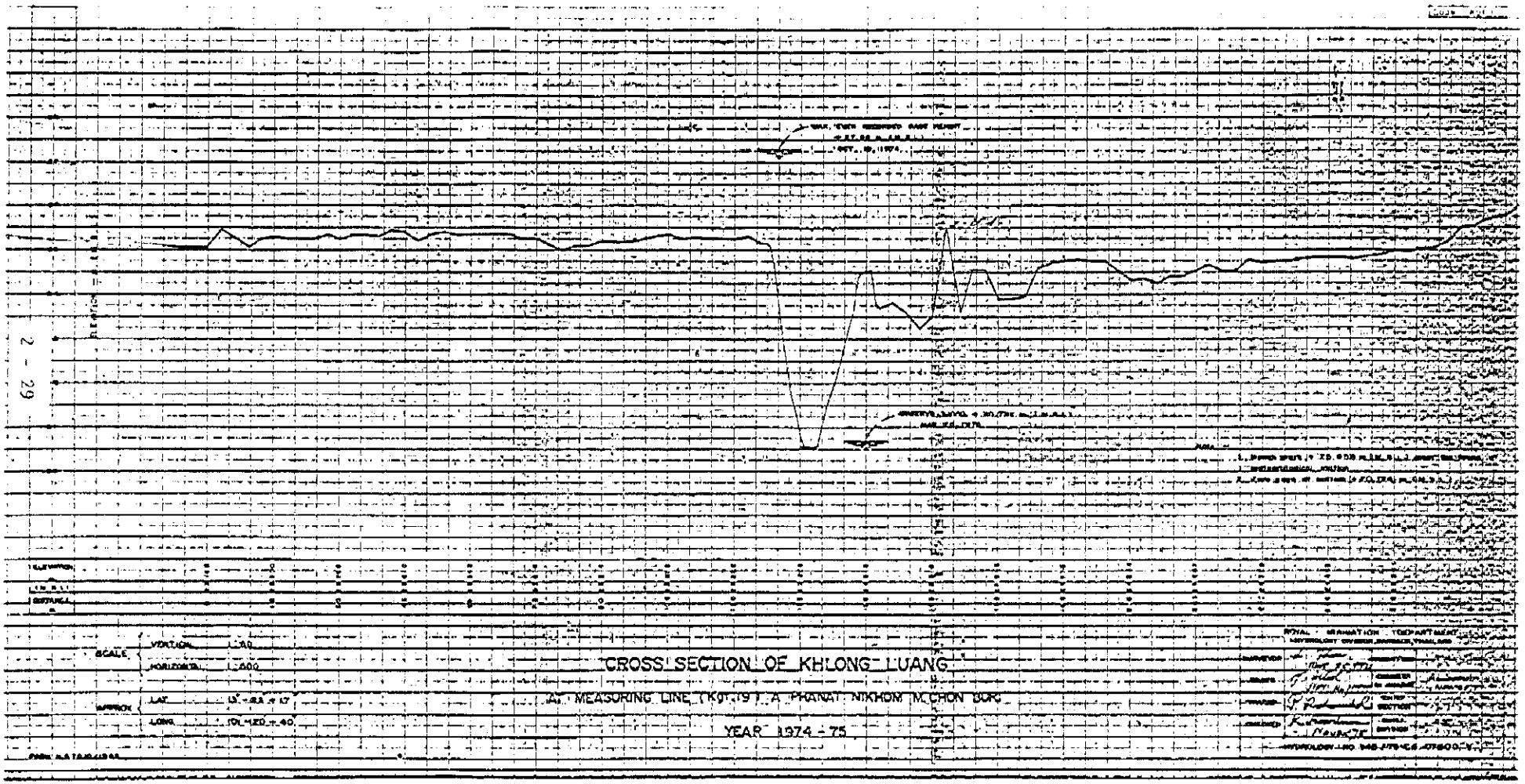


Fig. 2-2-(8) Rating Curve at Discharge Gauging Station
[Khlong Luang (Kgt. 19)]

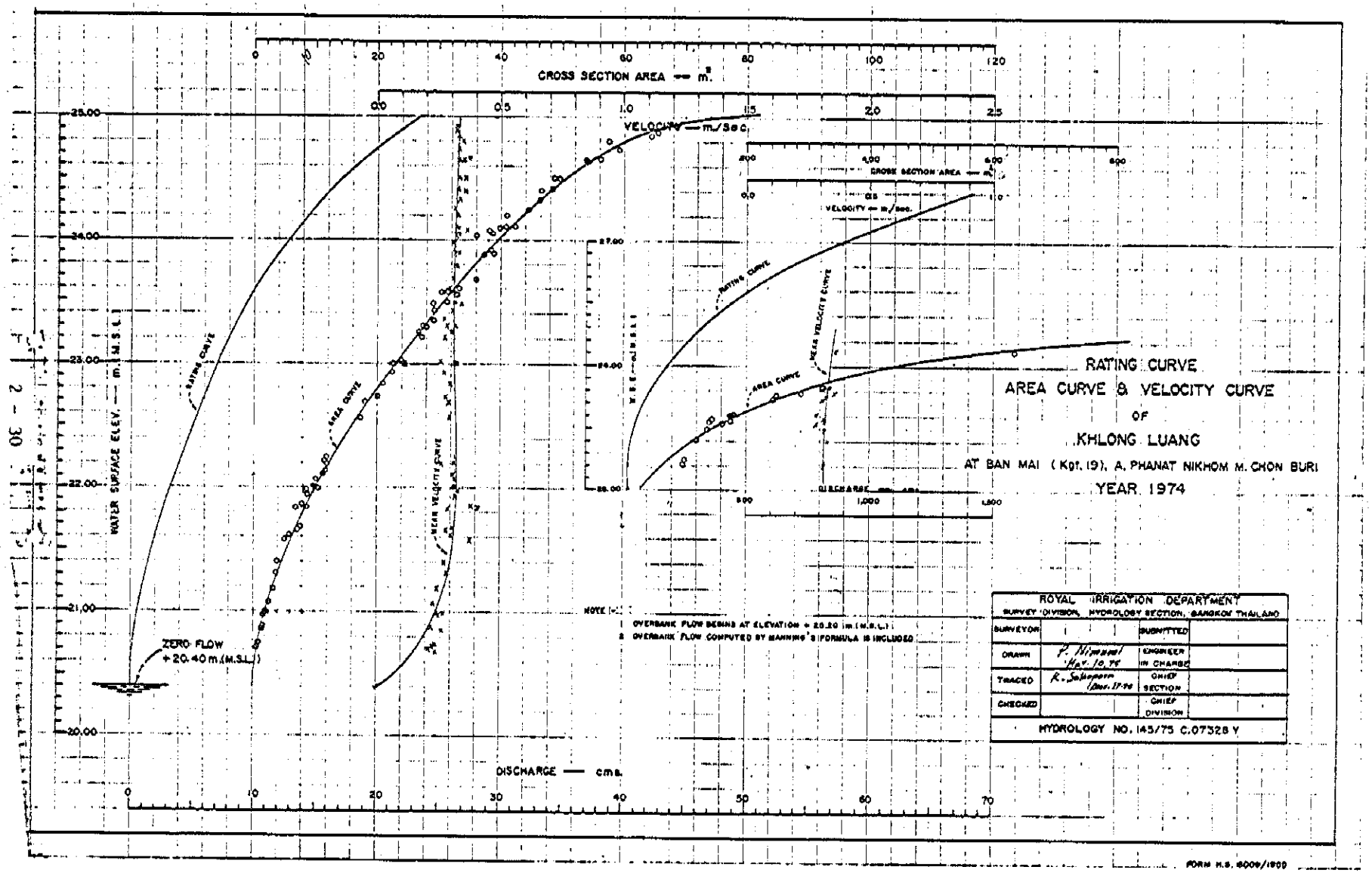
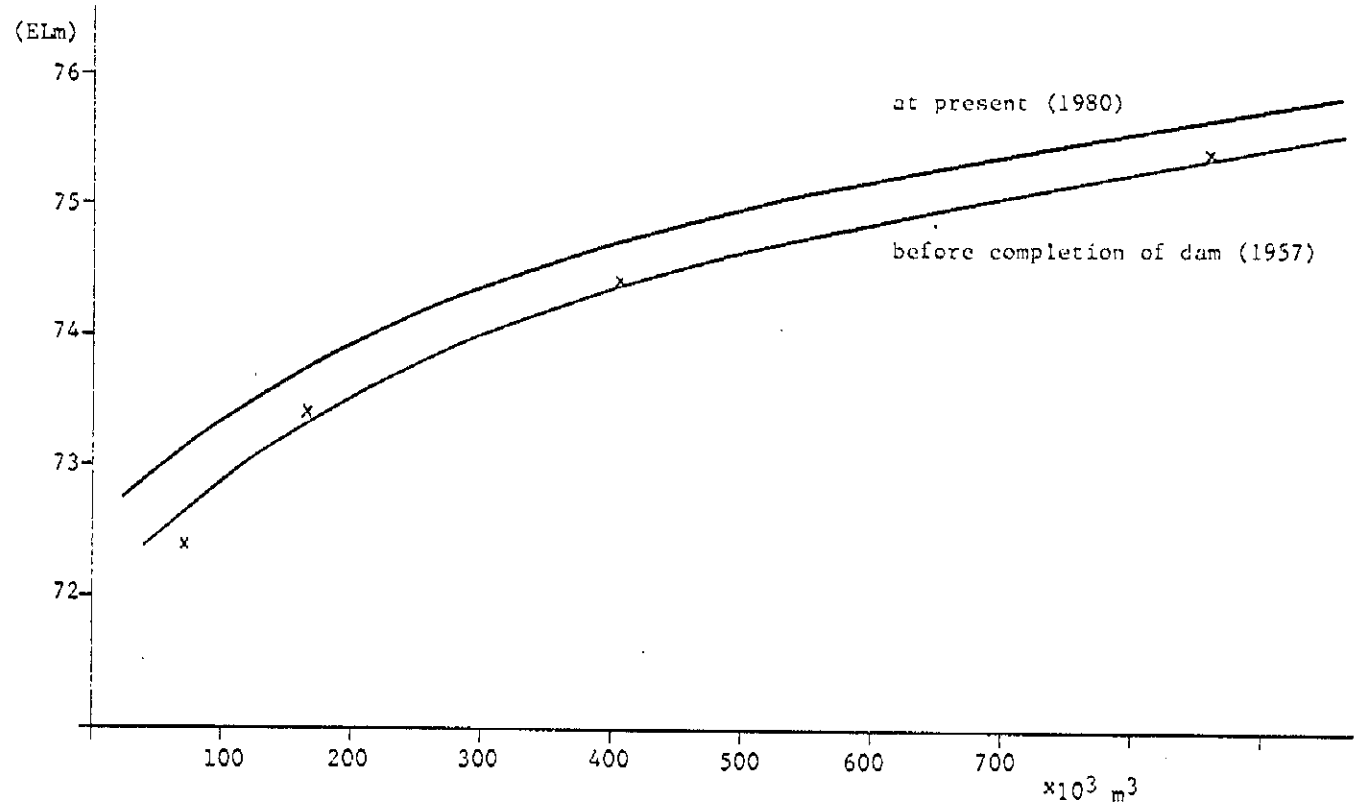


Fig. 3-1 Comparison of Water Storage Capacity of Ban Bung Reservoir



III. REGIONAL DEVELOPMENT PLAN

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CHAPTER 1

1. INFRASTRUCTURE

1.1 ROAD

The new projects under planning include the widening, improvement and/or new construction of a link road (about 12 km in length) between the Highways No. 3 and No. 36, which are running in parallel to the Highway No. 3191, from Ban Map Chalud onwards, as well as that of the trunk road running between Rayong and Sattahip. These are considered in order to meet the transport requirements arising from the development of the industrial complex at Rayong. Among the local road whose construction is under planning, there are 29 rural road projects (total length about 346 km, costing around 135 million Bahts) which are included in the Fifth Social and Economic Development Plan (refer to Fig.3-1).

1.2 PORT

In connection with the industrial development in the eastern coastal region, construction of deep sea port (with the minimum capacity of 100,000 DWT) is required, and the Government of Thailand adopted in April 1981 basic policy to meet such requirement through expansion of Sattahip port. According to this policy, it is expected that the detailed design of the immediately necessary facilities (9 berths including those for container wharf, multi purpose wharf and bulk-loading wharf) will be completed by 1982, so that their construction will follow to put them in actual services from 1986; since then, further expansion will take place after each five years until 2015.

Development plan of Laem Chabang as a commercial port mainly designed to handle container cargo was simultaneously decided upon. Its plan aims at constructing 2 berths of container wharf and one berth of multipurpose wharf as Phase I work, with a target of putting them into actual services from 1995; since then, further expansion will take place after each 5 years to meet with an increasing volume of cargoes to be handled (refer to Fig.3-2).

1.3 RAILWAY

New railway line extending over 143 km which links Chachoengsao - Chon Buri - Si Racha - Sattahip is under construction by State Railways of Thailand (S.R.T.) and is expected to be completed by 1983. This railway line will be extended to Laem Chabang port and Sattahip port, respectively. The survey on its extension from Sattahip to Rayong and further to Chanthaburi and Trad is under way and, in the meanwhile, construction of 22 km new railway line to Hab Ta Pud which has been designated as the core of industrial development of Rayong Complex will be completed by 1984 (refer to Fig.3-1).

1.4 COMMUNICATION AND ELECTRIC POWER GENERATION

Construction work to increase telephone circuits to 24,800, that is twice as many as those at present, is being undertaken to meet new demand arising from the future industrial development. There are TELEX exchange at Pattaya and Si Racha under the operation and maintenance of Communication Authority of Thailand (C.A.T.), and secondary automatic exchange station is planned to be established as soon as the centre of additional demand will be identified.

As far as electric power is concerned, Bang Pakong power generating station, which will be the largest thermal power plant in Thailand, has started a partial operation and construction work is going on aiming at expansion of its capacity to the ultimate target of 1,820 MW by 1984. No. 2 Rayong substation with the capacity of 230 kW which is to supply electric power to Map Ta Pud area is under construction for completion by 1984. This substation will be linked with the existing Ao Phai Station as well as with No. 3 Rayong substation with the capcity of 115 kW which will be built inside Mab Ta Pud industrial estate (refer to Fig3-3).

1.5 WATER SUPPLY

The Government of Thailand has decided on the basic policy for developing water resources and supply of industrial and municipal water, the demand for which will be added up on the current repeated water shortage ruling in this region, through the new development of industrial complex and ports, as follows:

1) Construction of Nong Pla Lai Dam, on which the Present study is being conducted, by 1985,

2) Preparation for feasibility study on the next development target, that is, Khlong Yai and Thap Ma Dams,

3) Immediate commencement of survey to be followed by designing of the water pipeline from Dok Krai Dam to Mab Ta Pud so that it will be completed by the time when PTT's Natural Gas Separation Plant will enter into operational stage in 1983. The minimum annual capacity of the pipeline will be 20 MCM/year for the time being, but it will be increased to the ultimate capacity of 60 MCM/year to fulfil the demands of Rayong-Sattahip areas,

4) Completion of the extension work of the pipeline from Mab Ta Pud to Sattahip by 1985,

5) Supply of industrial water from Nong Kho Dam (designed storage capacity being 19 MCM) whose completion is expected in 1983, in case of the water demand being generated earlier than expected in Laem Chabang area, and

6) Commencement of feasibility study to compare the two alternative plans, the one to further extend the pipeline from Sattahip, and the other to supply water from Dok Krai Dam by means of the similar pipeline, in case the water demand in Laem Chabang exceeds the supply capacity of Nong Kho Dam.

At present, the industrial project which has been finalized for actual implementation including the decision on the construction site is PTT's Natural Gas Separating Plant only; the other projects including the port projects will take some more time for finalization (refer to Fig.3-4).

1.6 HOUSING

Inflow of labour force from both inside and outside the area to the industrial and port development sites is inevitable, requiring provision of housing facilities to accommodate it. When it is assumed that 80 percent of the direct labor to be absorbed by industries and 20 percent of that for port activities are coming from outside the area, while 50 percent of the local workers will be intra-regional immigrants, the new housing scheme to accommodate them plus the land meant for road system and other public utilities will require a gross area of 1,584 ha by 1990, and it will have to be enlarged to 2,880 ha by the year 2000 (refer to Fig.3-5).

The above estimates are also based on the assumption that the people who will come to be engaged at the related industries following the industrial and port development will consist of the local residents and the family size of the immigrant laborers will be limited to 4 on an average because a considerable number of them will come unaccompanied. Thus, the areawise housing land requirements will be as follows:

(Unit: ha)

Area	1980 -1990	1980 - 2000
Sattahip	192 (70)	346 (113)
Laem Chabang	354 (246)	769 (510)
Rayong-Sattahip	1,036 (721)	1,759 (1,131)
Total	1,582 (1,037)	2,869 (175)

Notes: Figures in brackets stand for the land requirements for the "induced workers" alone.

2. INDUSTRIAL DEVELOPMENT PLAN

The group of industries which the Government of Thailand is seriously intending to introduce in this area consist of those based on natural gas processing which is one of the important local resources as well as important raw material for chemical industry, the capital-intensive heavy chemical industries, and labor intensive export oriented industries. Also these industries heavily depend on the overseas supply of their materials and foreign buyers for their marketing, on one hand, and on inland water and coastal transportation of their heavy and bulky products for distribution among the home markets, on the other. Accessibility to ports and harbours is one of the most important conditions in determining their location. In this sense, the type of industries proposed here would belong to the so-called "seashore based" one as in the case of Japan.

Judging from the natural condition and infrastructual point-of view, this area would provide, under the present and near future circumstances prevailing in Thailand, the optimum, or the most suitable site for starting this kind of industires in the whole country. The policies for industrial development in each area of this region will be described below based on the final report which was prepared by the Committee assigned with the policy-decision on the matters dealing with the basic industries and deep sea port development scheme. The regional development plans are summarized in Table 3-1, for their outlined descriptions.

2.1 RAYONG-SATTAHIP AREA

2.1.1 Soda-Ash Project

This project is one of the common industrial projects approved by the joint agreement among the member-countries of ASEAN and will be equipped with annual production capacity of 400,000 tons each of soda-ash and ammonium chloride. The raw material, that is rock salt, is available from the Northeastern part of Thailand and the surplus rock salt will be exported. The project's location is identified at either Ban Hong Yai or Ban Khanum Rai, on the northern side of the National Highway No. 3 in Sattahip District, but there is no final approval by the ASEAN investors. It is intended to start operation in 1985.

2.1.2 Natural Gas Separation Project

Its construction work is in progress at Hab Ta Pud District in Rayong as an enterprise of PTT. Its operation is scheduled to be started in 1983,/1 with the following production-targets:

Year	LPG Ton/year	Ethane Ton/year	Pentane Plus BBL/year	Residue Gas MS CF/D
1983-85	201,000	107,260	889,400	158
1986-91	360,000	287,000	1,235,200	258

/1 PPT changed the schedule to April 1984.

PTT is planning to implement, in succession to the above, a petro-chemical project aimed at production of ethylene and Vinyl Chloride Monomer (VCM) from ethane (refer to Fig.3-4).

2.1.3 Petro-Chemical Project

PTT is planning to develop a petro-chemical complex which will have an ultimate scale of production of 230,000 tons/year of ethylene, with 80,000 tons/year of VCM as its derivate and 51,600 tons/year of caustic soda as its by-product. The production target of ethylene by this complex during the initial period after commencement of its operation in 1985 is set at 170,000 tons/year. This is to meet the demand expected at that future date.

As for VCM and caustic soda, a new company is being proposed to manage this part of the production process. This petro-chemical complex will be located at Mab Ta Pud, which is situated in the neighbourhood of the above-said Natural Gas Separating Project. A low density polyethylene plant with annual production capacity of 80,000 tons/year is under construction about 20 km to the east of the Natural Gas Separation Project by a private enterprise named Thai Petrochemical Industry Co. Ltd., which is intending to start operation since mid-1982.

2.1.4 Chemical Fertilizer Project

Another group of industries related to the natural gas processing which has been taken up by a private concern for implementation consist of the chemical fertilizers with the following production targets:

Ammonia	1,200 tons/day
Urea	2,000 tons/day
Supphuric acid	2,200 tons/day
Sulphuric phosphate	800 tons/day
Mono-ammonium	350 tons/day
Di-ammonia sulphuric acid	1,500 tons/day

Among these production-items proposed, however, urea will have to enter into competition with other ASEAN common projects which have already been started in Indonesia and Malaysia, and readjustment efforts which have been continuing on since some time back among the countries concerned are expected to bring about some conclusions by July 1981. At this moment, the operation is set to be commenced in 1986 at Ban Mab Chalud adjacent to the Natural Gas Separation Plant.

2.1.5 Sponge Iron Project

This project has been worked out in view of producing sponge iron for direct reduction by use of the natural gas and supply it to the domestic electric furnaces in lieu of scrap iron whose price is most unstable. This enterprise is supposed to be operated in the form of a joint-venture between Thai Government and private sector. Commencement of its operation would be since 1985, as its construction should require 3 years after finalization of its site.

2.1.6 Integrated Steel Mill Project

The scale of production proposed in the first phase starting from 1985 is 1,300,000 tons and that in the second phase from 1990 onward, 2,000,000 tons. Various kinds of steel plates and sheets through hot and cold strip will be produced by use of sponge iron and iron scraps. Laem Chabang is proposed as its site. However, the final report by the comittee recommends further study due to the facts that the project requires quite large capital investments as well as vast area having deep waterfront.

2.1.7 Other Miscellaneous Projects

Apart from those projects referred to so far, some under construction and the others in the preparatory stages, development of an industrial estate covering 96-160 ha is being proposed to accommodate various industries which are related to what have already been mentioned in the above.

The following type of industries would be potentially related ones: the downstream enterprises flowing out of the two important parent industries of the petro-chemical and iron and steel, the food processing industries including sugar refinery, tapioca processing, alcohol, fruits and marine products canning, the ceramic industry, particularly glass manufacturing by use of locally available high-quality silica, soda-ash and natural gas, the service industries consisting of repairing of machinery and vehicles and supply of their parts and accessories, etc. Detailed study on the kinds and scales of these industries suggested for introduction to this area will be jointly conducted by IEAT, BOI and TPO.

2.2 LAEM CHABANG AREA

Area-wise allocation of the industies to be developed in the eastern coastal area according to the decision made by the Government of Thai in April 1981 specifies that the basic industries should be located in Rayong-Sattahip Area and the small-medium enterprises and export-oriented processing industries, in Laem Chabang Area. Accordingly, Laem Chabang port was redirected as commercial rather than industrial.

Sattahip port having been given priority in the order of development, it is anticipated that the development of Laem Chabang Area will follow with some time lag that in Rayong-Sattahip Area. Judging from the Government directives to IEAT to the effect of continuing on procurement of land as originally planned (approx. 448 ha in total), Laem Chabang Area is expected to invariably occupy an important position for industrial development though type of industry introduced would be quite different from those in Rayong-Sattahip Area.

In addition to its geographic advantage of being located within the reach from Bangkok in 2 hours and 1 hour from Sattahip, this Area can expect to have supply of water from Nong Kho Dam currently under construction. It will not be too optimistic to expect that this area may be selected by the existing industrial enterprises in Bangkok as the well-qualified site for their relocation and expansion. Natural condition, the foundation geology in particular/1, which is far superior to that in Bangkok, and the construction of a commercial port in the near future plus the existence of a rich source of labour supply in its neighbourhood will not fail to attract attention of the investors looking for favourable site for their industrial ventures.

2.3 BAN BUNG AND OTHER AREAS

Ban Bung situated approximately 20 km southeast of Chon Buri municipality is considered as one of the four satellite towns of the latter composed of Si Racha, Ban Bung, Panat Nikhom and Pan Thong. The topographical, soil and limited water supply situations of the area lead to upland farming of sugarcane, cassava and pineapple. The existing major industries there are sugar mill owned by the government, foods cannery and distillery.

However, the geographical proximity to the mother town of Chon Buri municipality coupled by the better infrastructure (road network), it is expected to be urbanized rapidly due to the expansion of the existing industries, relocation of factories from Bangkok and Chon Buri, and new location of the other industries. The area which will be encircled by the trunk roads such as R3131, R3138 and R331 is promising and is expected to be developed as the inland type of industrial center.

Another potential area for inland type of industrial center is the area situated at the crossing of R311 and R36. Both are surrounded by the agricultural lands producing cassava, pineapple and sugarcane and are situated at the transit-point on the supply route of fruits from the Eastern deep inland area to the Bangkok Metropolitan Area; these advantages taken into account they may be jointly utilized as an important basis of agro-industries.

/1: Because of weak foundation, even an ordinary factory building needs to be built on the foundation piles over 30 m deep in Bangkok which reportedly claims 30% of the construction cost.

In the Fifth Plan, Chon Buri is designated as one of the five prospective industrial centers. As the Satellite area of Chon Buri, Ban Bung and its vicinity have high probability to develop.

Other industries with high development potential may include the marine products processing industry along a 200 km-long beach and the tourism. The former is promised with a bright future by promotion of aqua culture utilizing brackish water at the estuaries of the rivers, while the latter will be able to better respond to the more diversified needs of the tourists through developing tourist centres in the now under developed interior and linking them to Pattaya, the internationally reputed resort centre.

Table 3-1 East Coast Industrial Development Project

Type of Project	Name	Participating Agencies	Investment Amount	Location	Present Status	Scheduled Completion	Remarks
INDUSTRIES	Natural Gas Separation Plant	P.T.T.	18,000 MB	Mab Ta Pud	Under Construction	1st Stage, 1984, April	Financed by: IBRD, ADB & OECF
	Soda Ash Factory	ASEAN Joint Investment	8,100 MB			1985	OECF
	Chemical Fertilizer Plant	Private Parties, Partial Investment by Government	10,000 MB	Marb Chalood	Restudy of F/S Required	1984, Nov.	AGRICO-MITSUI is strong.
	Sponge Iron Plant	Joint Venture - Gov. & Private	1,534 MB	Marb Chalood	Restudy of F/S Required	1985	F/S-Austria
	Steel Mill	Private	36,000 MB	---	Complete Restudy Required	---	F/S-JICA
	Petro-Chemical Plant Ethylene Complex	P.T.T. & Private	20,000 MB	Mab Ta Pud	F/S only	1985	F/S-JICA IPC, Others
	Raw Material Processing Industry	Private	Unknown	Mab Ta Pud Marb Chalood	---	Unknown	---
	Export Products Processing Factory	Private	Unknown	Laem Chabang Rayon	---	Unknown	---
	Polyethylene Chemical Plant	Private Thai Petro-Chemical Ind. Corp.	2,000 MB	Muang Rayon	Under Construction	1982	Joint Venture of Private Thai, Singapore and West German Parties
	Sugar Refinery, Alcohol Plant, Food Processing Factory, Glass Works, etc.	Private Parties	---	---	---	---	---
INFRASTRUCTURES	Sattahip Deep-Sea Port	P.A.T.	---	Sattahip	Detail Design of 9-Berth Pier - 1982	1st Stage, 1986	---
	Laem Chabang Deep-Sea Port	P.A.T.	---	---	---	1st Stage, 1995	---
	Railroad: Chachoeng Sao - Sattahip Sattahip - Rayong Chachoeng Sao - Saraburi	S.R.T.	1,590 MB 80 MB	---	Under Construction	1983 1984 1985	Rolling Stock - OECF
	Water: Pipeline Nong Pla Lai Dam	R.I.D.	---	Dok Krai - M.P - St'p	Design Preparation Formation of F/S	1984 - 1985	JICA-F/S, D/D JICA-F/S
	Power: High Tension Transmission Line, 230kV Rayong Sub-Station	E.G.A.T.	---	Ao Phai-Rayong Rayong	---	1983 1983	---
	New Town: Sattahip Rayong	Planning T.P.O. NESDB	---	---	---	---	---
	Industrial Complex: Laem Chabang Rayong	I.E.A.T.	---	Laem Chabang Mab Ta Pud	---	---	---

Fig. 3-1 Road Network and Railway System in the East Coast Region

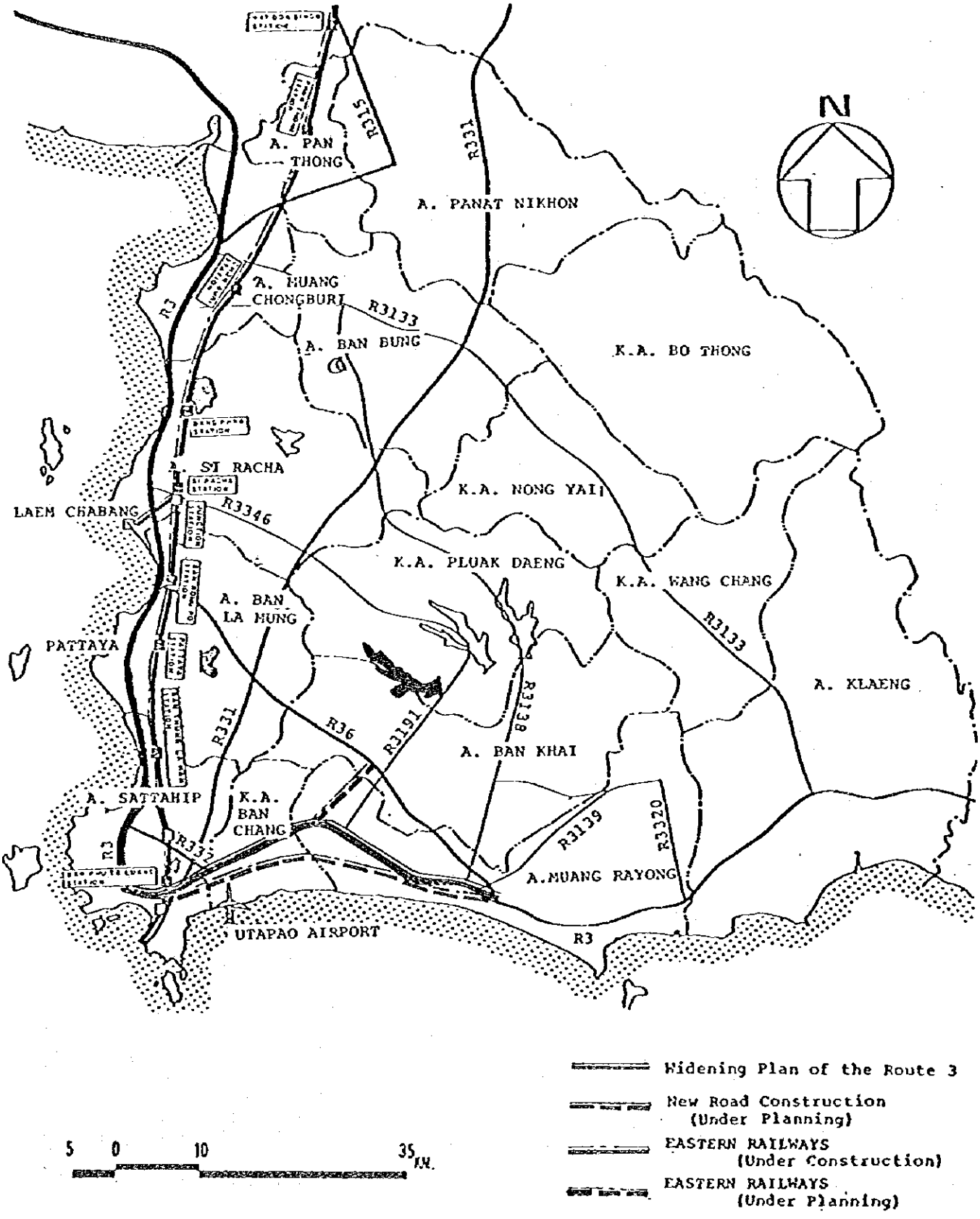
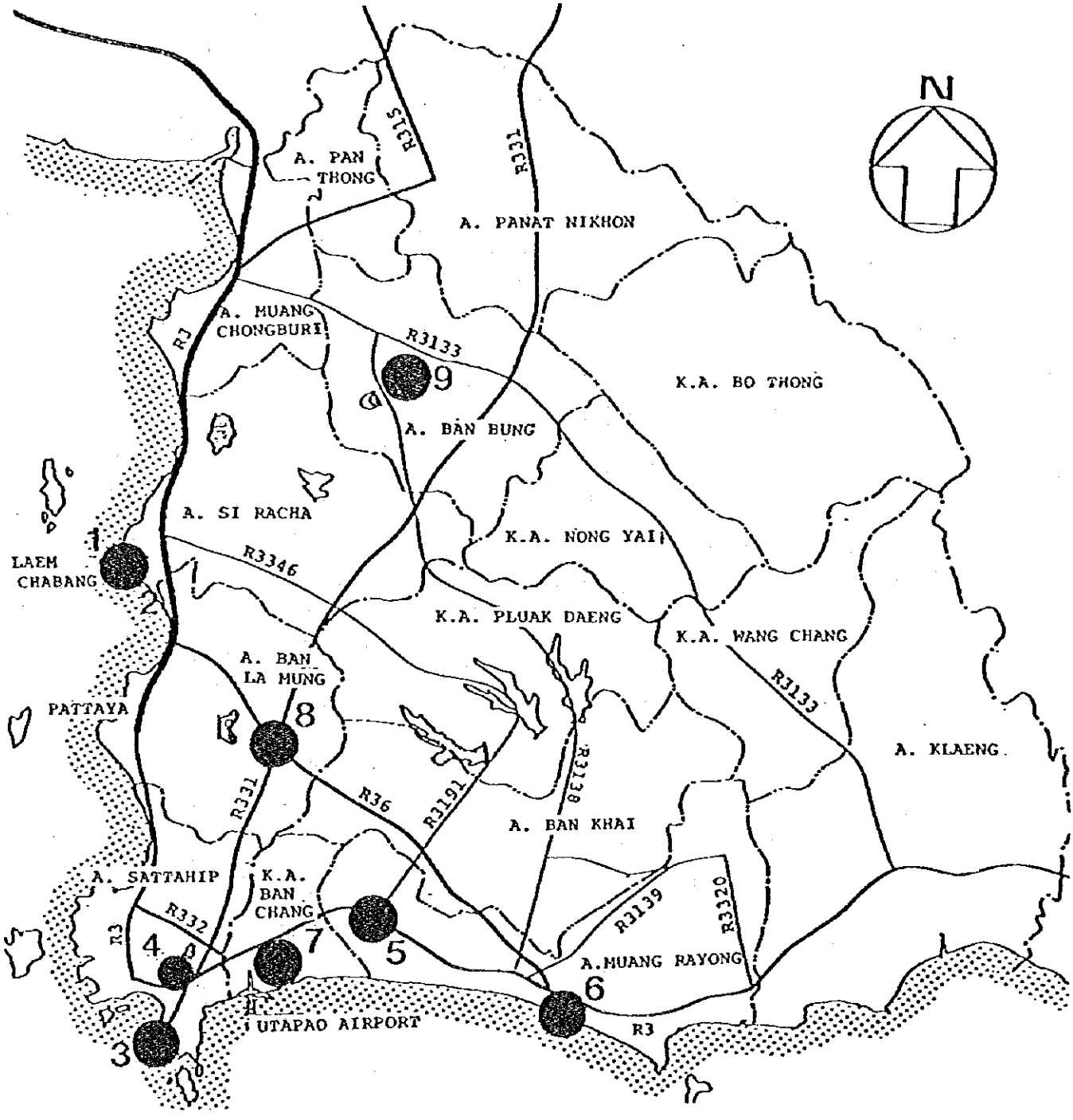
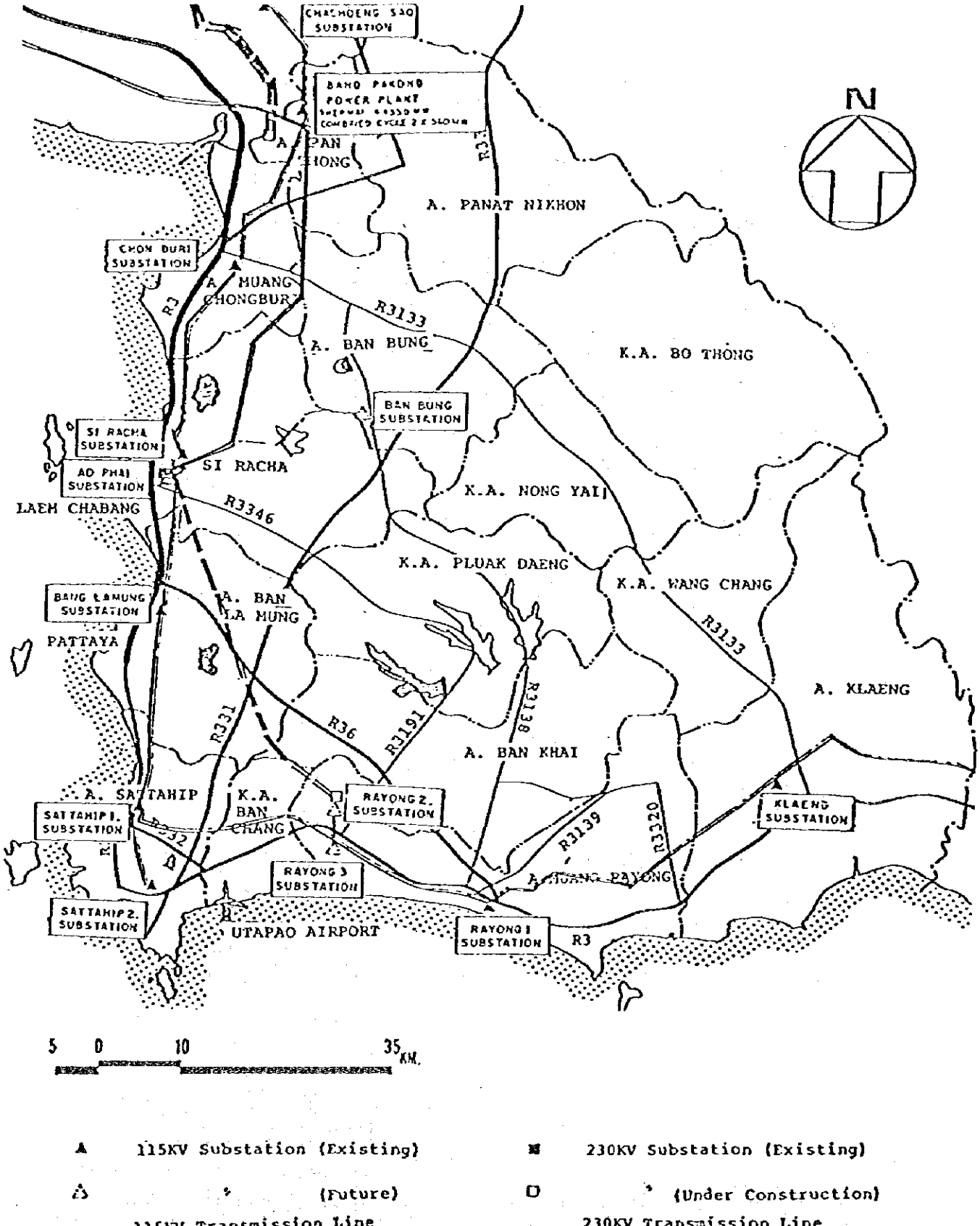


Fig. 3-2 Industrial & Deep Seaports Development Projects in the East Coast Region



1 Leam Chabang Commercial Port
2 Leam Chabang Industrial Estate, EPZ
3 Sattahip Industrial & Commercial Port
4 Soda Ash Project-Ban Non Yai
5 Gas Separation
Petro Chemical
Chemical Fertilizer Ban Hab Ta Pud
Sponge Iron Ban Mab Chalud
Related Industrial Estate
6 Thai Petro Chemical Co. (LDPE)
7 Air Ports Oriented Industrial Estate
8 Agro Industrial & Distribution Center
9 Agro Industrial & Distribution Center

Fig. 3-3 Electric Power Network in the East Coast Region



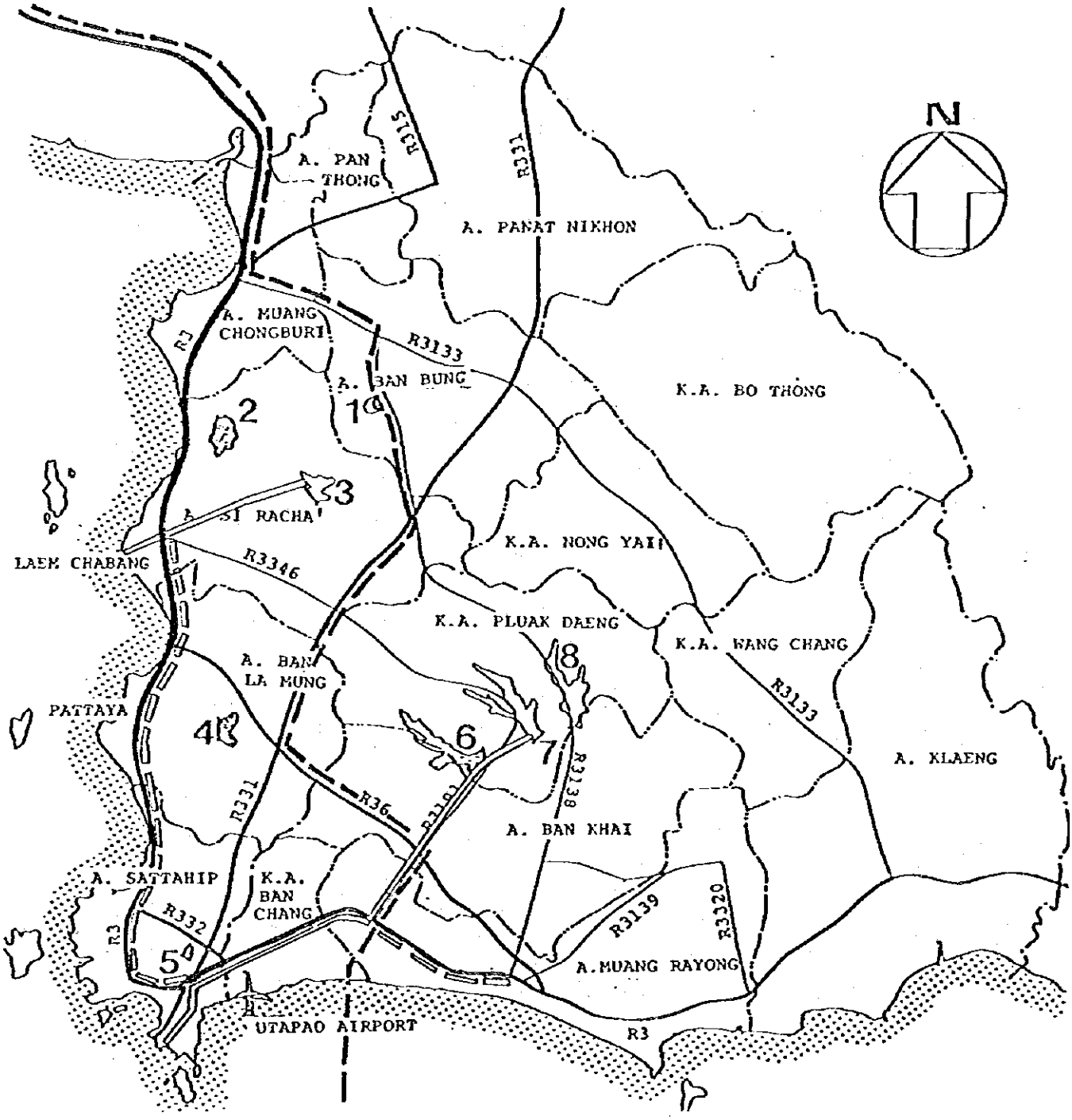
▲ 115KV Substation (Existing) ■ 230KV Substation (Existing)

△ " (Future) □ " (Under Construction)

115KV Transmission Line (Existing) 230KV Transmission Line (Existing)

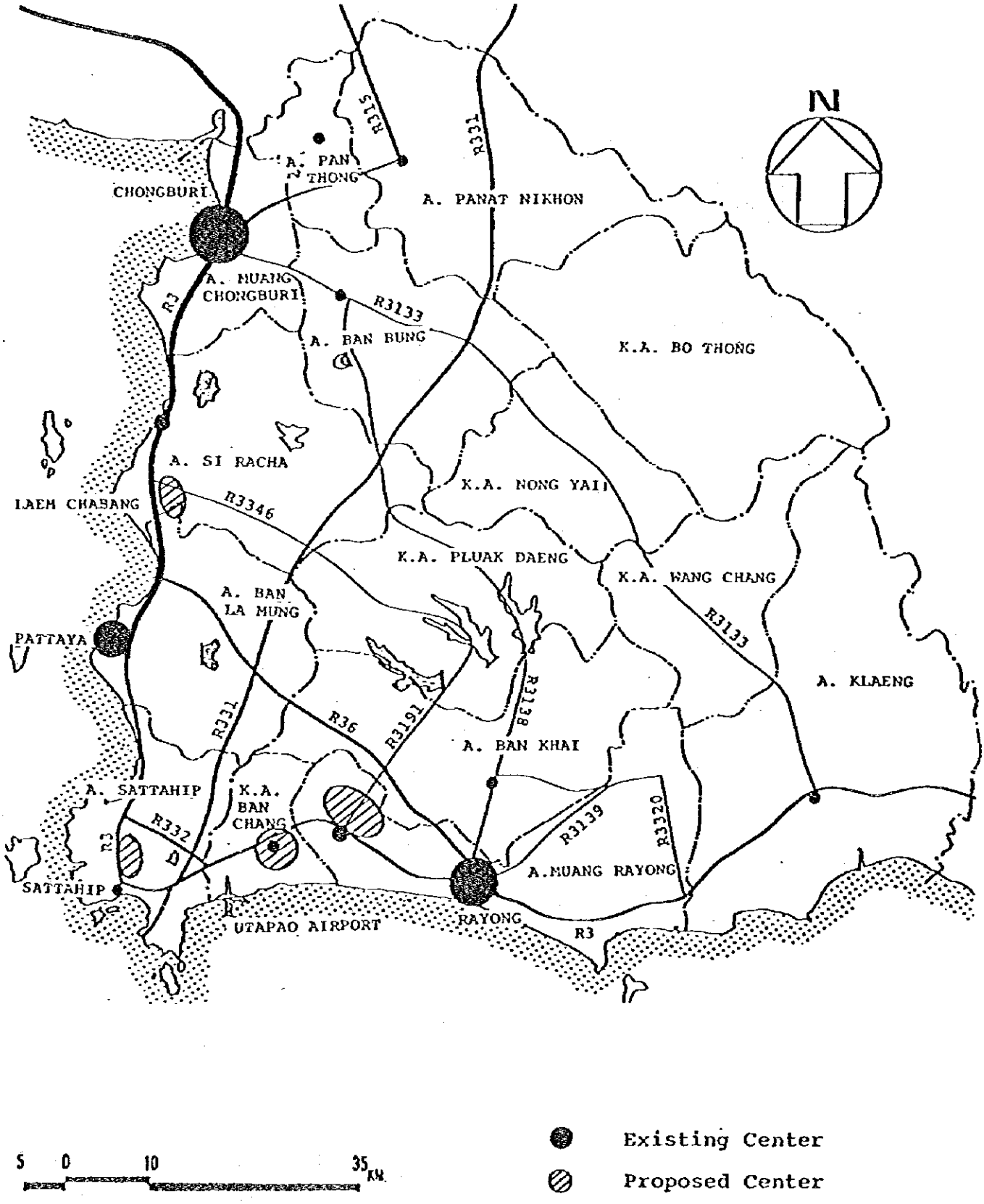
" (Future) " (Under Construction)

Fig. 3-4 Natural Gas & Water Pipeline and Water Resources in the East Coast Region



RESERVOIRS		
NO.	NAME	QUANTITY M.m³
1	BAN BUNG	2.0
2	BANG PHRA	100
3	NON KHO	20
4	MAP PRACHAN	15
5	PHLU TA LUANG	2.8
6	DOK KRAI	50
7	NONG PLA-LAI	100
8	KHLONG YAI	45

Fig. 3-5 Major Population Centers in the East Coast Region



IV. AGRICULTURAL DEVELOPMENT

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CHAPTER 2

1. SOIL

1.1 BACKGROUND OF THE STUDY

The study on soils of the east coast water resources development Project at this stage has been based on the followings:

- Presently available detailed reconnaissance soil survey map of Changwat Rayong and Chon Buri conducted by Land Development Department.

- 10 soil profile descriptions and collection of soil samples at different locations that represent major soil units by Land Classification Branch staffs of RID (7 pits in Nong Pla Lai area and 3 pits in Khlong Yai area).

- Result of soil analysis to determine textural, physical and chemical properties by Soil Chemistry and Physics laboratory of RID.

- Topography

  To simplify the distribution and nature of soils encountered within these two sub-projects, only the major soil units, their main characteristics for land use planning and soil resource potential will be discussed here.

1.2 NONG PLA LAI SUB-PROJECT

According to the soil survey map, 15 soil series are mapped within the project area. For better and quick understanding of the major soils and their main characteristics, soil series are grouped into following soil units.

Soils of Beach and Sand Bar

This soil unit comprises of Rayong, Pattaya, Ban Thon series with its extent of 2,011 ha. It dominantly occupies the southern portion of the project area along the coast. Physiographically, the unit is slightly elevated than the surroundings with a flattish to slightly undulating and slope ranging from 1 - 4%. Natural drainage ranges from moderately well drained to excessively drained and natural ground water level is generally below 1.5 meter. Textural profile is evidently very coarse (sand, loamy sand, occasionally sandy loam), leading to very low water holding capacity, very low cation exchange capacity, very low base saturation and

very low natural fertility. Due to their soil and topographic limitation, this soil unit is unsuitable for irrigated agriculture. Coconut, banana, bamboo are grown on this soil unit on rainfed basis. No soil samples have been collected from the unit.

Soil of Alluvial Plain

This soil unit comprises of three soil series; namely Kokkian, Chon Buri and poorly drained alluvial soil complex. Relief is flat to almost flat, and slope is less than 2% which generally favors to rice farming. Extent of this soil unit is relatively (3,029) ha and it is subdivided into sub-soil unit as below.

1) Soils Confined to Flood Plain and Semi-recent Terraces

This sub-soil unit occupies the lowest position of land-form except marsh so it is subjected to occasional flood. Generally, textural profile is finer comparing with other soil unit and clayey texture would be encounted at the upper or middle portion. Due to its low physiographic position, and finer texture, it is naturally poorly drained. The result of soil analysis collected from 2 pits tells that this sub-soil unit has relatively high water holding capacity (more than 0.15 cm/cm) and cation exchange capacity but low percent base saturation, moderately low to moderate organic matter content, low available phosphorus and free from salt-sodium affected reaction. The upper portion is very strongly acidic (PH = 4.2 - 4.8). This sub-soil unit is commonly well adapted to rice cultivation if sufficient drainage is provided.

2) Soils of Low Terrace

This sub-soil unit comprises of Kokkian and Chon Buri series which occupying slightly higher position above 1). Textural profile ranges from sandy loam to sandy clay loam with 15 to 60 cm thick sandy loam commonly appearing on upper portion. Natural drainage is somewhat poor to poor. The result of soil analysis collected from 3 pits tells that this sub-soil unit has moderately high water holding capacity (ranging from 0.08 -0.15 cm/cm), moderate to moderately low cation exchange capacity, very low percent base saturation, and moderately low organic matter content. Reaction is strongly acidic throughout the profile. This sub-soil unit is moderately suited for wet season rice and upland crop during dry season if irrigation and drainage is properly provided.

Soil of transported material and residuum from granite and gneiss

This unit comprises of Ban Bung, Huai Pong, Thungi Wa, Chalong, Phangnga series and some soil associations but the most dominant are Ban Bung and Huai Pong.

Ban Bung is confined to the area higher than 2) but lower than Huai Pong with slightly undulating topography. Textural profile ranges from sandy loam to loamy sand or even sand. Due to its severe soil limitations namely very poor natural fertility, low cation exchange capacity, poor water holding capacity and slight topographic limitation, whether this portion may or may not be suitable for irrigated agriculture development is subject to further study.

Huai Pong and other series occupy high lying lands. These soils are better drained and water table remains relatively deep during rainy season. There are some soil limitations but characteristically better than Ban Bung series, especially for upland cropping, if irrigation is properly provided. Due to unfavorable topography, gravitational irrigation is difficult and conservative measures should be taken to prevent soil erosion.

1.3 BAN BUNG SUB-PROJECT

According to soil survey map, 4 soil series are mapped namely Ban Bung, Sattahip, Hup Kapong and Nong Mot within the project area. Ban Bung series, being confining to low terrace, is largest in extent of 1,598 ha. Relief is slightly undulating to undulating with slope of 1 - 3%. Drainage characteristics is from moderately well drained to somewhat poorly drained. Ground water falls below 1.5 meters during the peak of dry season. The result of soil analysis collected from 3 pits tells that its textural profile is loamy sand or sandy loam throughout the profile, with characteristically low water holding capacity (0.03 - 0.06 cm/cm), low cation exchange capacity (2 - 3.7 meq/100 g) low organic matter (less than 0.5%), low salt content, low base saturation, and low natural fertility. Due to its unfavorable soil characteristics and water holding capacity, it may be marginal or even unsuitable for development of irrigated agriculture.

The remainder which is higher lying lands has better natural drainage, deeper ground water table, greater slope and undulating topography. Textural profile is sandy loam to sandy clay loam that is capable of retaining moderate amount of water. Soil reaction is slightly acidic to neutral. This portion of the project area is more suitable for upland cropping or tree crops than rice. Topographic limitation should be taken into close attention in planning gravitational irrigation system and proper cultural practice and management.

Project area by soil series, soil profile, and soil analysis are tabulated in Table 1-1, 1-2 and 1-3.

2 PRESENT CONDITION

2.1 LAND USE

The land use of Nong Pla Lai Area and Ban Bung Area are as follows:

Nong Pla Lai Area which consists of Amphoe Muang and Ban Khai is located in the administrative district of Changwat Rayong, and Ban Bung Area including Amphoe Ban Bung belongs to Changwat Chon Buri. The land use of these two changwats and the related amphoes are shown in the Tables 2-1 and 2-2.

Land Use of Nong Pla Lai Area (Unit: ha, %)

Paddy	Upland Field	Orchard	Village	Forest Road, etc.	Total
3,840	-	3,090	1,010	420	8,360
(45.9)	-	(37.0)	(12.1)	(5.0)	(100)

Land Use of Ban Bung Area

Paddy	Upland Field	Orchard	Village	Forest Road, etc.	Total
490	1,710	-	-	120	2,320
(21.1)	(73.9)	-	-	(5.0)	(100)

2.2 LAND TENURE

2.2.1 Nong Pla Lai Area

The farm sizes per household in the Amphoe Muang and Ban Khai are estimated at 3.87 ha and 4.63 ha, respectively and its average size is 4.25 ha. This figure indicates 11% less compared to the 4.77 ha of average size of Changwat Rayong, and the landless farmer is only 1%.

According to the agricultural census, the farm size per household appears to be decreasing at the Amphoe level and increasing at the Changwat level during the period from 1963 to 1978 (refer to Tables 2-3 and 2-4).

2.2.2 Ban Bung Area

This area is located at the Amphoe Ban Bung, and the farm size per household in this area is 7.86 ha. This figure was bigger than that of Nong Pla Lai Area and it was also bigger than 73% as compared to the 4.54 ha of average size of Changwat Chon Buri.

Based on the comparison of average farm size between 1963 and 1978, there was an increase of 55% on the Amphoe level and slight increase on the Changwat level.

2.3 CROPPING PATTERN AND PRODUCTION

2.3.1 Nong Pla Lai Area

Amphoe Muan

There are no irrigation facilities in this Amphoe. Paddy field is merely utilized for rainfed cultivation. Upland crops are mainly cassava and sugarcane, and para rubber is grown in about 84% of the total area of orchard.

The average yield of paddy during the last three years (1977/78-1979/80) is 1,442 kg/ha which is lower than the average of Changwat (1,633 kg/ha).

The yields of the other crops are only indicated as Changwat averges, therefore, comparison of each amphoe can not be made. The average yield (1977/78-1979/80) for cassava, sugarcane and para rubber are 14.8 t/ha, 28 t/ha, and 0.86 t/ha, respectively. These yields, however, considerably fluctuate year after year (see Tables 2-5 to 2-16).

Amphoe Ban Khai

This amphoe belongs to the Ban Khai Irrigation Project so that the double cropping for paddy has been practised with stabilized yield of high figures.

Crops other than paddy are cultivated without irrigation. The cassava occupies 83.3% of all the upland crops. The para rubber occupies 46.2% and the coconut occupies 36.1% of the total area of the Amphoe Ban Khai area. Fruits and tree crops are grown in the remaining area.

The three years' average yield for paddy is indicated at 2,205 kg/ha, and the yield of the other crops are the same as the Amphoe Muan (see Tables 2-5 to 2-16).

Main Crop Production
(Three Years' Average: 1977/78-1979/80)

(Unit: ton)

	Paddy	Cassava	Sugarcane	Para Rubber	Coconut
Muan	7,219	136,556	49,744	19,049	4,858
Bankai	22,459	495,534	118,583	4,521	10,110

2.3.2 Ban Bung Area

There are no irrigation facilities in the Amphoe Ban Bung. Paddy field is only used for to rainfed cultivation. The upland crops are shared equally with cassava and sugarcane. The growing season of cassava lasts for about seven

months after planting, whereas harvesting should be done in dry season. The working period of sugar factory is limited only to four months from November to February, therefore, sugarcane will not be very attractive as cash crop, there are also very few rotational systems being adopted for cassava and sugarcane.

The average productivity (1977/78-1979/80) of main crops are 14,130 tons (2,446 kg/ha) for paddy, 709,097 tons (42,822 kg/ha) for sugarcane and 225,355 tons (15,177 kg/ha) for cassava, respectively (See Table 2-17).

2.4 STANDARD CULTURAL PRACTICE

2.4.1 Paddy

Practices	Month	Quantity, etc.
Land preparation	May-Jul	by machinery, or buffaloes
Seedling	Jun-Jul	Seed 62.5 kg/ha
Basal dressing	Jul-Aug	62.5 kg/ha (12:20:20)
Transplanting	Jul-Aug	by hand
Top dressing	Aug-Sept	125.0 kg/ha (12:20:20)
Chemical control	Aug-Oct	0-37.0 kg/ha
Weeding	Aug-Sept	by hand
Harvesting	Nov-Jan	by hand

2.4.2 Sugarcane

New Planting

Land preparation	Dec-Mar	by machinery or buffaloes
Planting	Jan-Feb	1.6 m x 0.5 m
Basal dressing	Jan-Feb	313 kg (15:15:15)
Chemical control	Mar-Jul	0-20 kg/ha
Weeding	May-Jun	by hand
Harvesting	Dec-Feb	by hand

Ratooning (1-2 times)

Basal dressing	Dec-Feb	313 kg (15:15:21)
Chemical control	Mar-Jul	0-20 kg/ha
Weeding	Feb-Jul	by hand
Harvesting	Nov-Feb	by hand

2.4.3 Cassava

Land preparation	May	by machinery or buffaloes
Planting	June	by hand, 1.0 m x 1.0 m
Basal dressing	June	260 kg/ha (14:14:21)
Weeding	Jul-Aug	by hand
Harvesting	Mar-May	by hand

2.5 AGRICULTURAL SUPPORTING SERVICES

2.5.1 Nong Pla Lai Area

In this Changwat, there exists one field crop experiment station under the Ministry of Agriculture and Cooperatives (MOAC) (Huai-Powag Field Crop Experiment Station). This station is mainly in-charge of research work for upland crops such as cassava, sugarcane, groundnuts, mungbean, etc.

The agricultural extension services in the whole Changwat are being provide by the Agricultural Office. The Agricultural Extension Office is set up in each Amphoe.

Present status of agricultural extension activities relating to the Project Area are stated as follows (Amphoe Muang and Ban Khai). Group activity is implemented as a main activity of extension services.

Existing Work of Agricultural Extension Office

Amphoe	Muang	Ban Khai
Tambon number	14	9
Mubang number	56	53
Extension staff	6	6
Motorcycles	6	6
Agricultural machinery	-	-
Agr. household	12,715	11,385
Farm Group	4 (248 persons)	5 (1,054 persons)
Wife Group	2 (85 persons)	2 (58 persons)
Youth Group	6 (127 persons)	5 (149 persons)

There exist at least one agricultural cooperatives in each Amphoe. The Cooperative Officer will be sent from MOAC to each Amphoe agricultural cooperative.

There are two Agricultural Cooperatives in the Amphoe Ban Khai which consists of 36 groups (2,413 persons), while two Agricultural Cooperatives and one Livestock Cooperative in the Amphoe Muang, consisting of 28 groups (3,619 persons). These groups are the motive forces of agricultural cooperative activities. The details are shown in Table 2-19.

2.5.2 Ban Bung Area

The Ban Bung Agricultural Extension Office is set up in Amphoe Office. At present, there are eight staff engaged in the extension works. However, the extension works are not smoothly progressing due to lack of transportation facilities.

Existing Work of Agricultural Extension Office

Amphoe	Ban Bung
Tambon number	7
Muban number	44
Cultivated area	45,460 ha
Extension staff	8
Pick-up	1
Motor cycles	0
Sprayer	12 shoulder type

One agricultural cooperative and one livestock cooperative are existing in the Amp. Ban Bung. However, the activities of livestock cooperative are stagnated. On the other hand, the agricultural cooperative is actively functioning through their group activities. The three groups; namely - 6 Farm Groups consisting of 625 persons, 3 wife group consisting of 59 persons and 3 youth group consisting of 102 persons are working in this Amphoes. The details are shown in Table 2-20.

3. AGRICULTURAL DEVELOPMENT

In the project, irrigation of Nong Pla Lai Area is included but in the first phase Nong Pla Lai area only is to be irrigable with the water from Nong Pla Lai dam. By this project, irrigation water will be supplied to Nong Pla Lai Area, and so the study is concentrated to it.

As far as Thap Ma Area, which will be developed by the completion of Khlong Yai dam and Thap Ma dam, the results of the study on Nong Pla Lai Area as the cropping pattern, water demand etc., are applied to the Thap Ma Area, but futher study will be required for the development of Thap Ma Area.

Irrigation of Ban Bung area is excluded from the project, because the first priority is set on municipal and industrial water for Ban Bung where they are suffiering from the severest shortage of water.

3.1 LAND USE

Paddy	Upland	Orchard	Village	Forest, Road etc.	Total
3,650	-	3,090	1,010	610	8,360

3.2 CROPPING PATTERN AND PRODUCTION

3.2.1 Selection of Crop

Paddy

The government has been emphasizing increased production of paddy in its Fourth Five-Year Social and Economic Development Plan as one of the major national targets.

The rice cultivation in this area is an old practice and its remarkable increase of production by the irrigation has been accredited to the neighbouring Ban Khai Project Area. Even if the agricultural population may decrease in the future, there will be a possibility to cope with this situation through agricultural mechanization.

Taking above facts into consideration, paddy has been selected as the main crop in this project area.

Groundnuts

As for the upland crops in dry season, there are cassava, soybean, groundnuts and maize to be grown in this area. However, the groundnut has been selected as the main upland crop based on the following table:

Item	Cassava	Soybean	Groundnuts	Maize	Mungbean
Soil	suitable	suitable	suitable	suitable	suitable
Experience of Farmer	experience	none	experience	none	experience
Harvesting	easy	easy	easy	very easy	very difficult
Mechanization	difficult	easy	easy	very easy	very difficult
Export	slightly decrease	slightly increase	slightly increase	constant	slightly increase
Growing Period (month)	7 - 10	3 - 4	3 - 4	5	3 - 4
Processing	easy	difficult	-	-	-

3.2.2 Cropping Pattern

Wet Season	Dry Season
Paddy Jul - Nov	Paddy Jan - May
	Groundnuts Jan - Apr

Note: Refer to Fig. 3-1.

3.2.3 Production

According to the data obtained from Agricultural Experiment Station and related authorities concerned, the target yield are the 4.0 ton/ha, 4.5 ton/ha and 1.9 ton/ha for wet season paddy, dry season paddy and groundnuts, respectively. It is also estimated that the five years' priod would be required to achieve the proposed target yield. After full development of the project, the total amount of production would be 18,988 tons and 3,696 tons for paddy and groundnuts, respectively. The proposed yearly production up to full development stage are shown in the Table 3-1.

3.3 ESTIMATION OF VEGETABLE CONSUMPTION BY INCREASE OF POPULATION

Per capita consumption: 80 kg/year/person

1) Consumption by increase of population

1990	80kg	x 230,000	= 18,400 tons
2000	80	x 429,000	= 34,320

2) Increased consumption by current occupant

1990	20 kg	x 605,000	= 12,100 tons
2000	20	x 605,000	= 12,100

3) Total Increment

1990	18,400 tons	+ 12,100 tons	=	30,500 tons
2000	34,320	+ 12,100	=	46,420

4) Necessity of cultivation area

1990	30,500 tons	-:100 tons/ha	=	305.0 ha
2000	46,420	-:100	=	464.2

5) Alloted to this Area (40%)

1990	305.0 ha	x 0.4	= 122.0 ha
2000	464.2	x 0.4	= 185.7

(See Table 3.2)

3.4 CULTURAL PRACTICES

The cultivation of paddy and groundnuts would be practised by machinery and manpower as shown in Fig. 3-2.

The required agricultural material are shown in Table 3-3. The seed for paddy and groundnuts, fertilizers and agricultural chemicals are estimated at 244.8 tons, 244.0 tons, 2,560.25 tons and 375.05 tons, respectively.

The agricultural machinery to be introduced are listed in the Table 3-4. The total number of machinery are estimated at 440 units including tractor, combine and others.

The farm operation efficiency for each machinery is also shown in the Table 3-5.

3.5 LABOR REQUIREMENT

The necessary labor requirement per ha for each crop is shown in Table 3-6, 3-7 and 3-8.

The monthly labor requirement is shown in Table 3-9. The peak labor demands culminates in November, accounting to 68,707 man-day and yearly labor requirement is estimated at 434,536 man-day.

3.6 SUPPORTING SERVICES

For the realization of the proposed agricultural development, supporting services by cooperatives are essential. The organization of the cooperative is shown in Fig. 3-4.

Table 1-1 Project Area by Soil Series

(1) Nong Pla Lai Area

No	Series Name	Area
1	Rayong Series	127 ha
2	Phattaya Series	1,348
3	Ban Thon Series	536
4	Ban Thon Deep Phase	419
8	Alluvial Soils	1,404
9	Chonburi Series	201
14	Khok Khian Series	1,424
30	Khlong Chak/Tha Sea Association	85
35	Ban Bung Series	876
37	Ban Bung and Sattahip Soils	33
42	Chalong	71
46	Huai Pong Series	1,279
59	Marsh	557
	Total	8,360

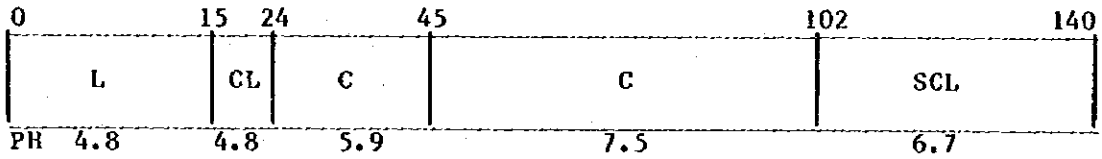
(2) Ban Bung Area

Series Name	Area
Ban Bung Series	1,958 ha
Sattahip Series	214
Hup Kapeng Series	50
Nong Mot Strong Brown Variant	98
Total	2,320

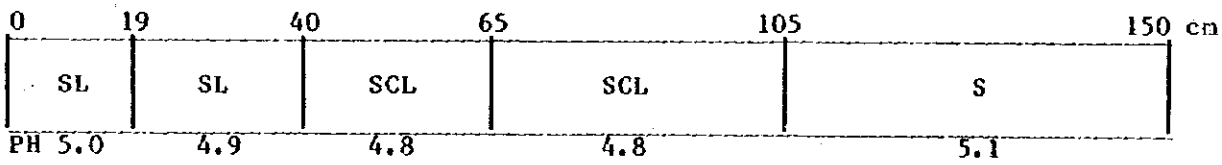
Table 1-2 Soil Profile

(1) Nong Pla Lai

No. 1 Alluvial Soil



No. 2 Khok Khian



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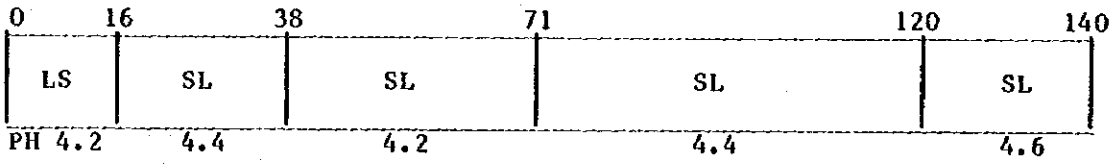

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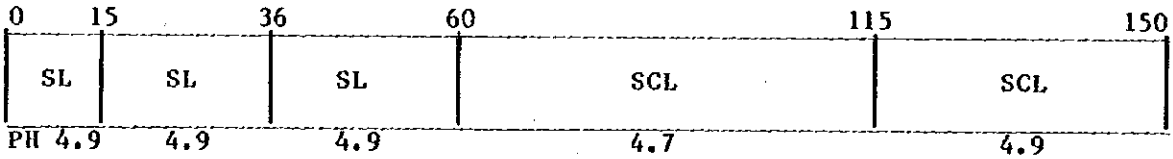


No. 5 Kohk Khian

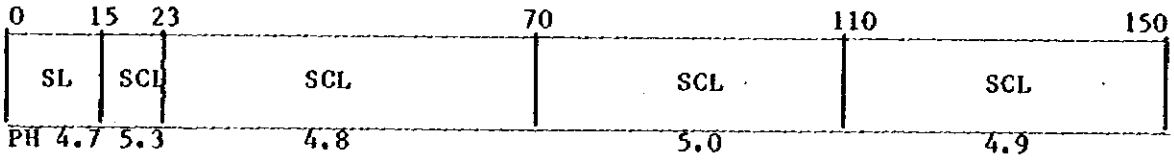
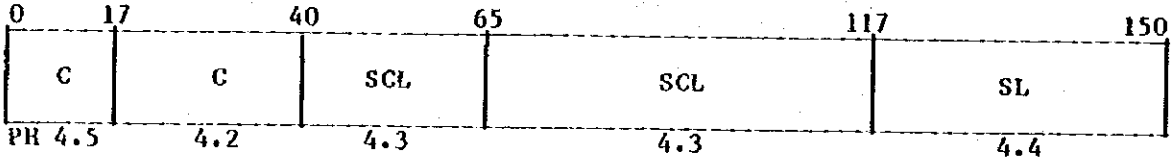
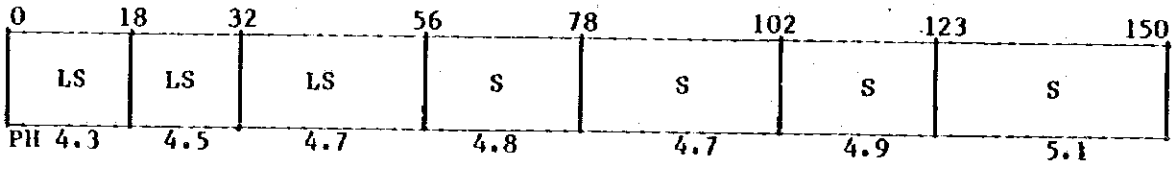


Table 1-2 Soil Profile (continued)

No. 6 Alluvial Soil

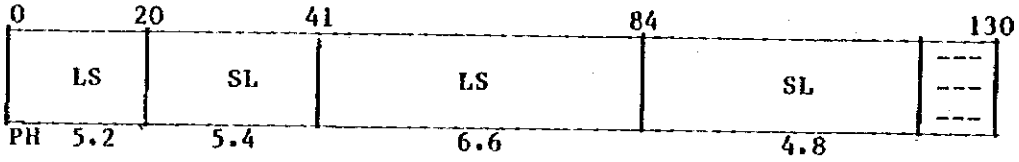


No. 7 Ban Bung

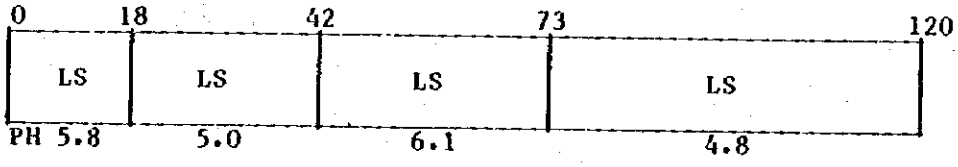


(2) Ban Bung

No. 1 Ban Bung



No. 2 Ban Bung



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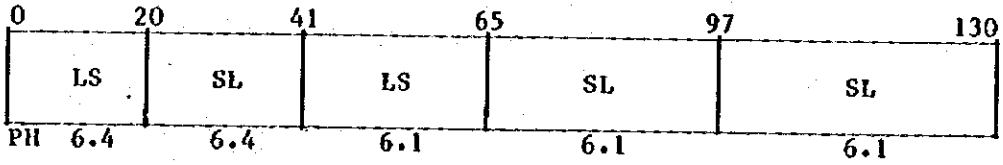

Table 1-3 Report on Soil Analyses

RESEARCH AND LABORATORY DIVISION

ROYAL IRRIGATION DEPARTMENT

Project Khlong Kui Reservoir (Chon Buri)

Report on Soil Analyses

Lab.No. ....29/2524 .....

Soil Chemistry and Physics Laboratory

Lab. Sample No.	Field Description		Particle Size Hydrometer			Text. Class Lab. Hyd.	Metric Tension % Moisture at Tension Bars			Avail. Moisture % to 15 bars	pH		Sat. Extract Elect. Cond. EC x10³	Sat. % S.P.	Ca(OH)₂ Titration meq Ca/100g.		CEC meq/100g. NH₄ Ext.	ESP NH₄ Ext. %	Exchangeable Cations meq/100g.				Base Saturation %	Organic Matter % O.M.	Total N %	Phosphorus P	
	Photo No. Field Site No.	Depth cm.	Sand %	Silt %	Clay <2 μ %		1/10	1/3	15		Water Paste	KCl 1:1			to pH 6.0	to pH 7.0			Na	Ca+Mg	Ca	K				Sorpt. ppm.	Extract (Bray II) ppm.
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1810	5235-IV	0-20	81.4	10.4	8.2	LS	8.3	5.5	2.9	5.4	5.2	4.3	0.40	13.9	0	0.50	3.7	2.7	0.20	0.99	0.86	0.10	32	0.57	0.06	34	2.8
1811	1	20-41	72.2	17.6	11.2	SL	-	8.7	1.9	1.8	5.4	4.3	0.24	12.5	0	0.30	2.5	4.0	0.10	0.44	0.44	0.10	26	0.06	0.01	32	2.8
1812	1469.6°	41-84	84.6	8.8	6.6	LS	4.5	3.8	2.2	2.3	6.6	6.1	0.22	12.6	-	-	2.7	4.4	0.10	1.0	0.88	0.10	44	0.06	0.002	60	2.0
1813	734°	84-130	80.1	7.8	12.1	SL	-	8.2	4.6	3.6	4.8	4.0	0.20	16.4	-	-	7.4	2.5	0.24	0.81	0.80	0.10	24	0.22	0.02	78	2.9
1814	5235-IV	0-18	82.6	13.8	3.6	LS	7.6	3.8	2.6	5.0	5.8	4.8	0.37	15.7	0	0.30	2.1	4.8	0.10	0.57	0.47	0.10	37	0.39	0.02	18	2.2
1815	2	18-42	82.6	11.3	6.1	LS	4.4	-	2.8	1.6	5.0	4.3	0.25	13.8	0	0.40	2.3	4.3	0.10	0.51	0.84	0.10	31	0.49	0.02	22	4.0
1816	1470.1°	42-73	85.4	10.9	3.7	LS	4.6	3.3	1.9	2.7	6.1	5.2	0.20	14.5	-	-	1.4	2.1	0.10	0.18	0.18	0.10	27	0.06	0.01	20	3.7
1817	732.1°	73-120	86.4	9.8	3.8	LS	3.8	3.0	1.7	2.1	4.8	4.7	0.40	12.1	-	-	1.3	9.2	0.12	0.07	0.02	0.10	22	0.11	0.005	8	3.0
1818	5235-IV	0-20	78.6	14.8	6.6	LS	7.8	5.9	2.0	5.8	6.4	5.5	0.22	15.8	-	-	2.3	8.2	0.20	0.85	0.80	0.10	50	1.0	0.03	20	2.8
1819	3	20-41	77.6	14.8	7.6	SL,LS	6.9	6.4	2.1	4.8	6.4	5.8	0.20	13.0	-	-	1.9	13.0	0.24	0.57	0.50	0.10	48	0.28	0.02	21	1.0
1820	1465.8°	41-65	77.6	15.8	6.6	LS	6.6	5.8	1.8	4.8	6.1	5.4	0.20	12.7	-	-	1.9	5.3	0.10	0.40	0.20	0.10	32	0.12	0.03	29	2.8
1821	733°	65-97	76.4	15.8	7.8	SL	-	5.7	2.2	3.5	6.2	5.1	0.20	13.6	-	-	2.2	4.5	0.10	0.35	0.35	0.10	25	0.06	0.02	33	2.2
1822		97-130	76.6	15.8	7.6	SL	-	6.5	2.3	4.2	6.1	5.3	0.20	13.7	-	-	2.0	6.0	0.12	0.40	0.35	0.10	31	0.06	0.02	38	3.0

See footnotes for report of soil analyses enclosed.

Table 1-3 Report on Soil Analyses

(Continued 2)

RESEARCH AND LABORATORY DIVISION
ROYAL IRRIGATION DEPARTMENT

Report on Soil Analyses

Lab.No. 29a/2524

Project Nong Pla Lai Reservoir (Rayong)

Soil Chemistry and Physics Laboratory

Lab. Sample No.	Field Description		Particle Size Hydrometer			Text. Class Lab. Hyd.	Matric Tension & Moisture at Tension Bars			Avail. Moisture % to 15 bars	pH		Sat. Extract Elect. Cond. CCx10³	Sat. % S.P.	Ca(OH)₂ Titration meq.Ca/100g.		CEC meq/100g. NH₄ Ext.	CSP NH₄ Ext.	Exchangeable Cations meq/100g.				Base Saturation %	Organic Matter % O.M.	Total N %	Phosphorus P	
	Photo No. Field Site No.	Depth cm.	Sand %	Silt %	Clay <2 %		1/10	1/3	15		Water Paste	KCl 1:1			to pH 6.0	to pH 7.0			Na	Ca+Mg	Ca	K				Sorpt. ppm.	Extract (Bray 2) ppm.
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1841	5234-1	0-15	40.6	39.4	20.0	L	-	24.3	7.6	16.5	4.7	3.7	0.22	25.3	0	2.1	5.2	<2	<0.10	0.87	0.55	0.20	22	1.5	0.07	50	4.5
1842	2	15-24	30.4	35.6	34.0	CL	-	23.5	9.4	14.1	4.8	3.8	0.20	36.7	0.20	1.5	15	<2	0.34	5.8	3.1	0.20	27	0.83	0.04	124	2.4
1843	N.1421.2	24-45	35.4	23.4	41.2	C	-	25.6	13.2	12.3	5.9	4.9	0.32	43.0	0	0	35	<2	0.62	12	8.6	0.20	36	0.50	0.03	154	2.5
1844	E.750.5	45-102	38.4	21.4	40.2	C	-	27.8	14.9	12.9	7.5	6.8	0.42	47.5	-	-	20	3.5	0.70	1/	1/	0.17	-	0.51	0.01	75	70.
1845	Alluvial Soil - poorly drained (28)	102-140	51.4	20.6	28.0	SCL	-	23.8	9.9	13.9	6.7	6.0	0.30	37.6	-	-	20	<2	0.30	14	12	0.20	72	0.31	0.03	44	25.
1846	5234-2	0-19	59.4	26.2	13.4	SL	-	13.8	3.8	10.1	5.8	4.1	0.48	22.4	0	1.1	5.2	<2	<0.10	1.0	0.51	<0.10	23	0.3	0.05	31	4.5
1847	2	19-40	59.2	22.0	18.8	SL	-	12.7	5.4	7.3	4.9	4.0	0.20	26.7	0.20	0.30	8.6	<2	<0.10	2.2	0.84	<0.10	26	0.54	0.04	46	3.6
1848	N.1418.9	40-65	56.6	21.0	22.4	SCL	-	15.0	6.8	8.2	4.8	3.7	0.20	35.6	-	-	12	<2	<0.10	1.1	0.68	<0.10	21	0.35	0.01	34	2.1
1849	E.751.1	65-105	59.0	20.6	21.0	SCL	-	15.1	7.6	7.5	4.8	3.7	0.20	37.8	-	-	12	<2	0.20	0.84	0.49	0.14	21	0.56	0.02	68	2.0
1850	Khok Kaja (4)	105-150	92.8	3.0	4.2	S	3.2	2.7	1.2	1.9	5.2	4.3	0.20	20.2	-	-	1.8	5.5	<0.10	0.22	0.09	<0.10	24	0.45	0.01	20	3.6
1851	5234-3	0-16	79.0	15.0	6.0	LS	10.2	9.5	3.0	7.2	4.2	3.8	0.32	16.9	0.70	1.7	3.0	5.3	<0.10	0.22	0.10	<0.10	15	0.98	0.04	34	5.5
1852	3	16-38	76.2	15.4	8.5	SL	-	9.1	3.8	5.3	4.4	3.8	0.20	18.6	0.30	2.2	2.7	3.7	<0.10	0.24	0.09	<0.10	16	0.71	0.02	40	4.5
1853	N.1417.5	38-72	72.0	13.2	14.8	SL	-	9.2	5.9	3.5	4.2	3.5	0.20	25.8	-	-	4.2	2.4	<0.10	0.46	0.11	<0.10	26	0.50	0.02	52	3.5
1854	E. 751.5	72-120	72.4	13.2	14.4	SL	-	9.4	6.2	3.2	4.4	3.5	0.20	30.1	-	-	4.2	2.4	<0.10	0.40	0.06	<0.10	34	0.45	0.02	54	3.5
1855	Ban Bung (35)	120-140	74.0	11.4	14.6	SL	-	8.3	5.9	2.4	4.6	3.7	0.20	30.8	-	-	4.8	2.1	<0.10	0.36	0.15	<0.10	32	0.53	0.01	94	2.0

1/ Sample No.1844, as lime is present by qualitative test, exchangeable Ca+Mg by NH_4 extract are not reported for report of soil analyses enclosed.

Table 1-3 Report on Soil Analyses

(continued 3)

RESEARCH AND LABORATORY DIVISION

ROYAL IRRIGATION DEPARTMENT

Report on Soil Analyses.

Lab.No. 29a/2524 .....

Project Nong Pla Lai Reservoir (Rayong)

Soil Chemistry and Physics Laboratory

Lab. Sample No.	Field Description		Particle Size Hydrometer			Text. Class	Matric Tension % Moisture at Tension Bars			Avail. Moisture % to 15 bars	pH		Sat. Extrac	Sat. % S.P.	$Ca(OH)_2$ Titration meq.Ca/100g.		CEC meq/100g. NH_4 Ext.	ESP NH_4 Ext.	Exchangeable Cations meq/100g.				Base Saturation %	Organic Matter % O.M.	Total N %	Phosphorus P	
	Photo No. Field Site No.	Depth cm.	Sand %	Silt %	Clay <2 μ %	Lab. Hyd.	1/10	1/3	15		Water Paste	KCl 1:1	Elect. Cond. (EC x 10³)		to pH 6.0	to pH 7.0			Na	Ca+Mg	Ca	K				Sorpt. ppm.	Extrac (Bray II) ppm.
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
2856	5234-I	0-25	76.0	16.0	8.0	SL	-	7.8	3.8	4.0	4.9	3.9	0.24	18.7	0.10	1.2	2.6	3.8	<0.10	0.5	0.29	<0.10	27	1.1	0.04	62	4.6
2857	" 4	25-36	70.0	13.6	16.4	SL	-	10.3	6.9	3.4	4.9	4.0	0.20	29.9	0.10	0.70	5.0	2.0	<0.10	1.2	0.69	<0.10	28	0.35	0.03	90	2.7
2858	K.2414.2	36-60	69.4	22.4	8.2	SL	-	11.8	8.2	3.6	4.9	3.8	0.20	33.8	-	-	7.3	<2	<0.10	1.3	0.62	<0.10	21	0.39	0.02	78	2.7
2859	K. 750.4	60-215	64.0	14.6	21.4	SCL	-	13.2	9.3	3.9	4.7	3.8	0.20	38.1	-	-	8.9	<2	<0.10	1.2	0.37	<0.10	16	0.40	0.03	133	3.9
2860	Khok Khian (14)	125-150	62.4	21.2	16.4	SCL	-	15.2	10.3	4.9	4.9	3.7	0.29	43.1	-	-	12	<2	<0.10	1.7	0.84	<0.10	16	0.54	0.02	96	3.7
2861	5234-II	0-25	60.4	25.2	14.4	SL	-	10.7	6.4	6.3	4.7	3.8	0.23	22.8	0.20	1.7	4.2	2.4	<0.10	0.91	0.55	<0.10	27	1.5	0.07	44	4.6
2862	" 5	25-23	54.8	21.8	23.4	SCL	-	14.5	7.3	7.2	5.3	4.2	0.20	33.3	0	0.60	10	<2	<0.10	2.1	1.2	<0.10	23	0.73	0.03	89	2.2
2863	K. 2410.2	23-70	53.4	20.0	26.6	SCL	-	15.2	10.7	4.5	4.8	3.7	0.20	37.8	0.70	1.9	78	<2	<0.10	1.3	0.52	<0.10	19	0.49	0.03	140	2.2
2864	K. 752.4	70-120	66.4	12.6	21.0	SCL	-	12.5	7.5	5.0	5.0	3.9	0.20	37.6	-	-	13	<2	<0.10	1.5	0.99	<0.10	13	0.61	0.02	116	5.3
2865	Khok Khian (14A)	120-150	63.4	9.6	27.0	SCL	-	25.3	10.9	4.4	4.9	3.6	0.20	40.9	-	-	25	<2	<0.10	1.5	0.40	<0.10	11	0.51	0.02	149	2.9
2866	5234-II	0-17	18.2	37.8	44.0	C	-	30.6	14.7	23.9	4.5	3.5	1.3	64.6	0.40	3.0	21	<2	0.42	3.5	1.9	0.20	20	2.9	0.10	149	2.9
2867	6	17-40	7.2	16.0	76.8	C	-	45.4	30.5	15.3	4.2	3.4	0.38	105.5	6.0	9.1	32	<2	0.44	4.5	2.2	<0.10	16	1.2	0.05	368	2.0
2868	K.1400.5	40-65	50.2	21.4	28.4	SCL	-	17.2	9.8	7.3	4.3	3.5	0.35	55.2	-	-	16	2.0	0.32	1.8	1.1	<0.10	14	0.50	0.02	89	2.0
2869	K.755.0	65-117	52.0	14.6	33.4	SCL	-	14.8	7.0	7.8	4.3	3.5	0.40	44.7	-	-	22	2.9	0.32	1.8	0.35	<0.10	13	0.20	0.01	64	2.8
2870	Alluvial Soils poorly drained	117-150	73.4	12.6	14.0	SL	-	9.7	4.8	4.9	4.4	3.7	0.52	32.3	-	-	8.4	2.3	0.20	0.86	0.35	<0.10	14	0.45	0.01	32	3.7

3.

See footnotes for report of soil analyses enclosed.

Table 1-3 Report on Soil Analyses

(Continued 4)

RESEARCH AND LABORATORY DIVISION
ROYAL IRRIGATION DEPARTMENT

Report on Soil Analyses

Project ..Nong Pla Lai Reservoir (Rayong)

Lab.No. 29a/2524
Soil Chemistry and Physics Laboratory

Lab. Sample No.	Field Description		Particle Size Hydrometer			Text. Class Lab. Hyd.	Metric Tension % Moisture at Tension Bars			Avail. Moisture % to 15 bars	pH		Sat. Extract Elect. Cond. EC x 10³	Sat. % S.P.	$Ca(OH)_2$ titration meq.Ca/100g.		CEC meq/100g. NH_4 Ext.	ESP NH_4 Ext.	Exchangeable Cations meq/100g.				Base Saturation %	Organic Matter % O.M.	Total N %	Phosphorus P	
	Photo No. Field Site No.	Depth cm.	Sand %	Silt %	Clay (2 μ) %		1/10	1/3	15		Water Paste	KCl 1:1			to pH 6.0	to pH 7.0			Na	Ca-Mg	Ca	K				Sorpt. ppm.	Extract (Bray II) ppm.
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1871	5234-II	0-18	78.1	16.7	5.2	LS	12.0	6.5	2.3	9.7	4.3	3.8	1.7	21.4	0.70	1.8	4.0	5.0	0.20	0.85	0.57	0.10	29	1.0	0.06	38	3.9
1872	7	18-32	84.7	11.1	4.2	LS	6.3	2.6	1.2	5.2	4.5	4.2	0.39	29.0	0.10	0.80	2.6	3.8	0.10	0.35	0.10	0.10	20	0.22	0.02	20	2.7
1873	K.1397.5	32-56	85.5	10.4	4.1	LS	9.5	5.0	2.9	6.6	4.7	4.4	0.40	22.2	-	-	5.9	12	0.10	1.3	0.60	0.10	25	0.96	0.03	294	5.4 a/
1874	K. 760.5	56-78	88.8	7.3	3.4	S	5.9	2.7	1.4	4.5	4.8	4.5	0.30	20.5	-	-	2.2	4.8	0.10	0.11	0.09	0.10	15	0.33	0.01	87	5.4 a/
1875		78-102	82.2	7.6	4.2	S	5.1	2.8	1.7	3.4	4.7	4.5	0.32	22.2	-	-	2.7	5.9	0.10	0.11	0.08	0.10	18	0.11	0.01	101	6.3 a/
1876		102-125	89.5	8.2	2.3	S	5.7	2.0	1.5	4.2	4.9	4.7	0.40	23.3	-	-	2.9	5.3	0.10	0.18	0.02	0.10	20	0.06	0.007	129	14 a/
1877	Sam Buri (35).1	125-150	88.0	8.8	3.2	S	5.6	3.0	1.4	4.2	5.2	4.6	0.30	21.5	-	-	2.5	6.7	0.10	0.14	0.12	0.10	25	0.45	0.005	112	7.2 a/

a/ very fine particles in the soil samples.

See footnotes for report of soil analyses enclosed.

Table 1-3 Report on Soil Analyses

(Continued 5)

RESEARCH AND LABORATORY DIVISION
ROYAL IRRIGATION DEPARTMENT

Report on Soil Analyses

Lab.No. 29/2524

Soil Chemistry and Physics Lab.

Project: Khlong Xui Reservoir (Ban Dung)

Lab. Sample No.	Field Description: Sample Core No.	Field Description: Depth (cm.)	Bulk Density g/cm³ (BD)	Particle Density g/cm³ (PD)	Porosity (P) % 1/	Moisture of Soil g/100 ml 2/	Matric Tension & moisture at tensions bars: 1/10	1/3	15	Available moisture: % to 15 bars	Available moisture: cm/cm 3/	Field Site No.
	Ban Dung 1											
1823	S1	22	1.83	2.62	30	11.40	-	-	-	-	-	Topo Map
1824	S2	22	1.75	2.68	35	11.37	-	-	-	-	-	5235-IV
1825	S3	22	1.77	2.63	33	11.86	-	-	-	-	-	Core No.1
	Average		1.78	2.62	32	11.54	-	3.7	1.8	1.9	0.03	
	Ban Dung 2											
1826	S4	90	1.85	2.62	29	27.75	-	-	-	-	-	
1827	S5	90	1.76	2.62	33	28.06	-	-	-	-	-	
1828	S6	90	1.84	2.63	30	26.69	-	-	-	-	-	
	Average		1.82	2.62	31	27.50	-	1.1	3.6	3.5	0.06	
	Ban Dung 2											
1829	S7	28	1.68	2.63	39	7.36	-	-	-	-	-	Topo Map
1830	S8	28	1.62	2.64	39	8.16	-	-	-	-	-	5235-IV
1831	S9	28	1.52	2.62	42	6.99	-	-	-	-	-	Core No. 2
	Average	28	1.58	2.63	40	7.50	8.5	5.2	2.0	6.5	0.05 0.10	Texture LS
	Ban Dung 2											
1832	S10	90	1.69	2.63	39	7.27	-	-	-	-	-	
1833	S11	90	1.66	2.63	37	7.02	-	-	-	-	-	
1834	S12	90	1.66	2.62	37	6.95	-	-	-	-	-	
	Average		1.64	2.63	38	7.08	5.8	3.1	1.1	4.7	0.03 0.08	Texture LS
	Ban Dung 3											
1835	S13	22	1.57	2.62	40	8.15	-	-	-	-	-	Topo Map
1836	S14	22	1.64	2.65	38	8.67	-	-	-	-	-	5235-IV
1837	S15	22	1.64	2.62	37	8.44	-	-	-	-	-	Core No.3
	Average		1.62	2.63	38	8.42	6.9	6.2	2.2	4.6	0.06 0.07	Texture SL, LS

1/ Porosity (P) = $(1 - \frac{BD}{PD}) \times 100$

2/ Moisture of soil = Percent moisture/Bulk volume of soil

3/ cm/cm = Available moisture percent to 15 bars x BD/100

Volume of soil core = 100 ml.

Table 1-3 Report on Soil Analyses

(Continued 6)

RESEARCH AND LABORATORY DIVISION
ROYAL IRRIGATION DEPARTMENT

Report on Soil Analyses

Lab.No. 29/2524

Project: Khlong Kui Reservoir (Ban Bung)

Soil Chemistry and Physics Lab.

Lab. Sample No.	Field Description: Sample Core No.	Field Description: Depth	Bulk Density g/cm³ (BD)	Particle Density g/cm³ (PD)	Porosity (P) % 1/	Moisture of Soil g/100 ml 2/	Matric Tension % moisture at tensions bars: 1/3	Matric Tension % moisture at tensions bars: 15	Available moisture: % to 15 bars	Available moisture: cm/cm 3/	Field Site No.
1838	S16	100	1.66	2.65	37	12.72	-	-	-	-	Topo Map
1839	S17	100	1.67	2.63	37	12.63	-	-	-	-	5235-IV
1840	S18	100	1.70	2.63	35	11.31	-	-	-	-	Core No.3
	Average		1.68	2.64	36	12.22	5.1	1.5	3.6	0.06	

1/ Porosity (P) = $(1 - \frac{BD}{PD}) \times 100$

2/ Moisture of soil = Percent moisture/Bulk volume of soil

3/ cm/cm = Available moisture percent to 15 bars x BD/100

Volume of soil core = 100 ml.

Table 1-3 Report on Soil Analyses

(Continued 7)

RESEARCH AND LABORATORY DIVISION
ROYAL IRRIGATION DEPARTMENT

Report on Soil Analyses

Lab.No. 29a/2524

Project: Nong Pla Lai Reservoir (Rayong)

Soil Chemistry and Physics Lab.

Lab. Sample No.	Field Description: Sample Core No.	Field Description: Depth (cm.)	*Bulk Density g/cm³ (BD)	Particle Density g/cm³ (PD)	Porosity (P) % 1/	Moisture of Soil g/100 ml 2/	Matric Tension % moisture at tensions bars: 1/3	Matric Tension % moisture at tensions bars: 15	Available moisture: % to 15 bars	Available moisture: cm/cm 3/	Field Site No.
	Nong Pla Lai #1										
1878	A.37	25	1.62	2.65	39	28.33	-	-	-	-	Topo Map
1879	A.38	25	1.64	2.64	38	27.99	-	-	-	-	5234-1
1880	A.39	25	1.47	2.67	45	26.89	-	-	-	-	Core No.1
	Average		1.58	2.65	40	27.74	23.2	10.5	12.7	0.20	
	NPL #1										
1881	A.40	90	1.30	2.68	49	24.47	-	-	-	-	
1882	A.41	90	1.35	2.67	49	23.13	-	-	-	-	
1883	A.42	90	1.30	2.71	52	22.55	-	-	-	-	
	Average		1.34	2.69	50	23.38	22.9	15.3	7.6	0.10	
	NPL #2										
1884	K.25	20	1.59	2.63	40	17.40	-	-	-	-	Topo Map
1885	K.26	20	1.61	2.65	40	18.63	-	-	-	-	5234-1
1886	K.27	20 (SCL)	1.63	2.63	38	17.88	-	-	-	-	Core No.2
	Average		1.61	2.64	39	17.97	10.7	3.9	6.8	0.11	
	NPL #2										
1887	K.28	85	1.63	2.65	39	28.37	-	-	-	-	
1888	K.29	85	1.69	2.63	36	30.35	-	-	-	-	
1889	K.30	85	1.66	2.64	37	29.79	-	-	-	-	
	Average		1.66	2.64	37	29.50	15.4	7.2	8.2	0.14	
	NPL #3										
1890	A.61	20	1.44	2.65	46	4.62	-	-	-	-	Topo Map
1891	A.62	20	1.52	2.67	43	4.57	-	-	-	-	5234-1
1892	A.63	20	1.44	2.64	45	5.29	-	-	-	-	Core No.3
	Average		1.47	2.65	45	4.83	7.0	2.2	4.8	0.07	

1/ Porosity (P) = $(1 - \frac{BD}{PD}) \times 100$

2/ Moisture of soil = Percent moisture/Bulk volume of soil

3/ cm/cm = Available moisture percent to 15 bars x BD/100

Volume of soil core = 100 ml.

Table 1-3 Report on Soil Analyses

(Continued 8)

RESEARCH AND LABORATORY DIVISION
ROYAL IRRIGATION DEPARTMENT

Report on Soil Analyses

Lab.No. 29*/2524
Soil Chemistry and Physics Lab.

Project: Nong Pla Lai Reservoir (Rayong)

Lab. Sample No.	Field Description: Sample Core No.	Field Description: Depth (cm.)	Bulk Density g/cm³ (BD)	Particle Density g/cm³ (PD)	Porosity (P) % 1/	Moisture of Soil g/100 ml 2/	Matric Tension % moisture at tensions bars: 1/3	Matric Tension: 15	Available moisture: % to 15 bars	Available moisture: cm/cm 3/	Field Site No.
	NPL #2										
1893	A.64	90	1.70	2.65	36	12.64	-	-	-	-	Topo Map
1894	A.65	90	1.67	2.64	37	13.12	-	-	-	-	5234-1
1895	A.66	90	1.64	2.63	38	11.62	-	-	-	-	Core No.3
	Average (Sec)		1.67	2.64	37	12.46	8.5	4.4	4.1	0.07	
	NPL # 1										
1896	X.19	20	1.75	2.65	34	17.03					Topo Map
1897	X.20	20	1.61	2.64	39	12.59					5234-1
1898	X.21	20	1.78	2.66	33	17.03					Core No.4
	Average (Sec)		1.71	2.65	35	15.55	10.0	5.1	4.9	0.08	
	NPL # 4										
1899	X.22	90	1.72	2.64	35	26.55	-	-	-	-	
1900	X.23	90	1.74	2.64	34	27.37	-	-	-	-	
1901	X.24	90	1.73	2.64	34	25.48	-	-	-	-	
	Average		1.73	2.64	34	26.47	14.7	8.1	6.6	0.11	
	NPL # 5										
1902	X.13	25	1.68	2.65	37	23.58	-	-	-	-	Topo Map
1903	X.14	25	1.71	2.66	36	25.18	-	-	-	-	5234-II
1904	X.15	25	1.64	2.68	39	23.92	-	-	-	-	Core No.3
	Average		1.68	2.66	37	24.23	14.9	7.2	7.7	0.15	
	NPL #5										
1905	X.16	90	1.61	2.66	39	24.28	-	-	-	-	
1906	X.17	90	1.67	2.66	37	26.58	-	-	-	-	
1907	X.18	90	1.67	2.67	37	26.18	-	-	-	-	
	Average		1.65	2.66	38	25.63	16.0	7.0	9.0	0.15	

1/ Porosity (P) = $(1 - \frac{BD}{PD}) \times 100$

2/ Moisture of soil = Percent moisture/Bulk volume of soil

3/ cm/cm = Available moisture percent to 15 bars x BD/100

Volume of soil core = 100 ml.

Table 1-3 Report on Soil Analyses

RESEARCH AND LABORATORY DIVISION (Continued 9) Lab.No. 29a/2524

ROYAL IRRIGATION DEPARTMENT Report on Soil Analyses

Project: Wong Pla Lai Reservoir (Rayong) Soil Chemistry and Physics Lab.

Lab. Sample No.	Field Description: Sample Core No.	Field Description: Depth (cm.)	Bulk Density g/cm³ (BD)	Particle Density g/cm³ (PD)	Porosity (P) % 1/	Moisture of Soil g/100 ml 2/	Matric Tension % moisture at tensions bars: 1/10	1/3	15	Available moisture: % to 15 bars.	Available moisture: cm/cm 3/	Yield Site No.
	NPL #6											
1908	K.7	20	1.22	2.58	53	46.98	-	-	-	-	-	Topo Map
1909	K.8	20	1.14	2.60	56	48.61	-	-	-	-	-	5234-II
1910	K.9	20	1.20	2.62	54	46.12	-	-	-	-	-	Core No.6
	Average		1.19	2.60	54	47.24	-	41.0	25.8	25.2	0.18	
	NPL #6											
1911	K.10	90	1.69	2.66	36	33.57	-	-	-	-	-	
1912	K.11	90	1.71	2.64	35	32.53	-	-	-	-	-	
1913	K.12	90	1.73	2.65	35	31.73	-	-	-	-	-	
	Average		1.71	2.65	35	32.61	-	15.4	6.4	9.0	0.15	
	NPL #7											
1914	K.1	20	1.54	2.63	41	7.66	-	-	-	-	-	Topo Map
1915	K.2	20	1.56	2.63	41	8.88	-	-	-	-	-	5234-II
1916	K.3	20	1.51	2.67	43	8.16	-	-	-	-	-	Core No.7
	Average		1.54	2.64	42	8.23	7.0	3.5	1.3	5.7	0.09	Textual LS
	NPL #7											
1917	K.4	90	1.63	2.64	38	17.15	-	-	-	-	-	
1918	K.5	90	1.62	2.64	39	16.18	-	-	-	-	-	
1919	K.6	90	1.62	2.65	39	17.79	-	-	-	-	-	
	Average		1.62	2.64	39	17.04	5.5	2.9	1.6	3.9	0.06	Texture S

1/ Porosity (P) = $(1 - \frac{BD}{PD}) \times 100$

2/ Moisture of soil = Percent moisture/Bulk volume of soil

3/ cm/cm = Available moisture percent to 15 bars x BD/100

Volume of soil core = 100 ml.

Table 2-1 Area of Holdings by Area Utilized

Unit: ha, %

Province	Amphoe	Total Area of Holdings	Rice	Field/ Vegetable Crops	Tree Crops	Forest or Pasture	All Others
Rayong	Muang	30,001	4,536	12,792	10,936	1,026	711
	Ban Khai	36,413	23,985	5,661	4,966	721	1,080
	Sub Total	66,414 (100%)	28,521 (42.9)	18,453 (27.9)	15,902 (23.9)	1,747 (2.6)	1,791 (2.7)
	Whole Province	153,013 (100%)	19,935 13.0	93,894 61.3	29,795 19.5	5,462 3.6	3,927 2.6
Chon Buri	Ban Bung	35,168 (100%)	4,955 (14.1)	26,119 (74.2)	1,463 (4.2)	310 (0.9)	2,321 (6.6)
	Whole Province	195,780 (100%)	48,323 (24.7)	127,981 (65.4)	11,549 (5.9)	2,548 (1.3)	5,379 (2.7)

1978 Agricultural Census

Table 2-2 Total Area of Holdings by Land Use

Unit: ha, %

Province	Amphoe	Total area of holdings	Arable Land			Land in tree crops	Pasture land	Wood land	Other land
			Land in crop		Fallow and other arable land				
			Total area	Irrigated area					
Rayong	Muang	40,407 (100%)	22,874 (51.0)	3,076 (7.7)	4,104 (13.1)	9,528 (23.1)	1,101 (4.0)	1,846 (6.6)	954 (2.2)
	Ban Khai	31,699 (100%)	16,853 (53.1)	5,168 (16.3)	3,980 (12.6)	5,096 (16.1)	1,419 (4.5)	3,590 (11.3)	761 (2.4)
	Whole Province	110,269 (100%)	56,300 (51.0)	8,439 (7.7)	14,456 (13.1)	25,420 (23.1)	4,405 (4.0)	7,252 (6.6)	2,436 (2.2)
Chon Buri	Ban Bung	31,562 (100%)	25,910 (82.1)	2,998 (9.5)	2,646 (8.4)	911 (2.9)	182 (0.6)	676 (2.1)	1,237 (3.9)
	Whole Province	164,989 (100%)	124,418 (75.4)	42,077 (25.5)	16,963 (10.3)	12,248 (7.4)	724 (0.4)	4,747 (2.9)	5,889 (3.6)

Table 2-3 Number of Holdings & Area of Holdings

1978 Agricultural Census

Province	Amphoe	Number of holdings			Area of holdings (ha)				(2)/(1) ha
		Total (1)	Without land	With land	Total (2)	Owned by the holder	Rented from others	Others	
Rayong	Muang	7,762	154	7,608	30,001	28,059	356	1,586	3.87
	Ban Khai	7,870	31	7,839	36,413	31,833	691	3,889	4.63
	Sub Total	15,632	185	15,447	66,414	59,892	1,047	5,475	4.25
	Whole Province	32,065	288	31,777	153,013	138,954	4,060	9,999	4.77
Chon Buri	Ban Bung	4,475	58	4,417	35,168	27,891	5,420	1,857	7.86
	Whole Province	37,995	609	37,386	172,655	147,515	19,869	5,271	4.54

Table 2-4 Number and Area of Holdings

1963 Agricultural Census

Province	Amphoe	Number of holdings				Area of holdings			ha	
		Total (1)	Renter	Owner	Others	Total (2)	Rented	Owned	Others	(2)/(1) ha
Rayong	Muang	9,584	469	8,384	731	40,416	931	37,550	1,935	4.22
	Ban Khai	6,333	108	5,413	812	31,702	250	28,910	2,542	5.01
	Sub Total	15,917	577	13,797	1,543	72,118	1,181	66,460	4,477	4.53
	Whole Province	23,516	689	20,588	2,239	109,968	1,307	101,981	6,680	4.68
Chon Buri	Ban Bung	6,218	2,319	2,780	1,119	31,571	7,885	20,034	3,652	5.08
	Whole Province	38,866	6,570	27,308	4,988	165,085	18,177	130,315	16,593	4.25

Table 2-5 Agricultural Statistic (Wet Season)

No.	Item		1977/1980			1978/1979			1977/1978		
			/1 Whole Pro.	Muang	Ban Khai	Whole Pro.	Muang	Ban Khai	Whole Pro.	Muang	Ban Khai
1	Paddy	ha	37,764	5,006	7,324	37,422	5,006	7,324	37,422	5,006	7,324
2	Paddy farming area	ha	28,356	3,903	7,298	34,769	4,667	7,319	29,762	3,714	7,201
3	Transplanting	ha	28,287	3,903	7,298	34,769	4,667	7,319	29,745	3,714	7,201
4	Broadcasting	ha	69	--	--	--	--	--	107	--	--
5	Nonglutinous rice	ha	28,336	3,903	7,298	34,398	4,667	7,156	29,473	3,714	7,069
6	Glutinous rice	ha	20	--	--	371	--	163	289	--	131
7	Fertilizing area	%	75	70	80	75	60	60	70	60	80
8	Best variety rice	%	82	80	90	60	60	60	60	60	60
9	Damaged paddy /2	ha	3,286	1,626	1,561	501	--	26	566	480	80
10	Unsuitable for farming /3	ha	9,404	1,103 (47%)	25 (78%)	2,653	339 (93%)	5 (99.5%)	7,660	1,292 (65%)	38 (97.2%)
11	Harvested area /4	ha	25,147	2,350	5,737	34,264	4,667	7,293	29,196	3,234	7,121
12	Nonglutinous rice /5	ha	25,124	2,350	5,737	33,900	4,667	7,138	28,907	3,234	6,989
13	Glutinous rice /6	ha	23	--	--	363	--	155	289	--	131
14	Yield (15)/(11)	kg/ha	2,213	3,044	2,625	1,875	1,625	2,188	2,250	2,188	2,448
15	Provincial production	t	54,316	7,166	15,059	63,900	7,418	15,954	65,680	7,074	17,432
16	Yield (15)/(1)	kg/ha	1,438	1,431	2,059	1,706	1,482	2,178	1,755	1,413	2,380

Note: /1 Whole Province

/2 For shortage of water

/3 After planting insufficient rain

/4 = /5 + /6

Agricultural Office of Rayong Province

Table 2-5 Agricultural Statistic (Wet Season)
(continued)

No.	Item		Average					
			Whole Pro.	%	Muang	%	Ban Khai	%
1	Paddy	ha	37,536	100.0	5,006	100.0	7,324	100.0
2	Paddy farming area	ha	30,962	82.5	4,095	81.8	7,273	99.3
3	Transplanting	ha	30,934	82.4	4,095	81.8	7,273	99.3
4	Broadcasting	ha	59	0.2	-	-	-	-
5	Nonglutinous rice	ha	30,736	81.9	4,095	81.8	7,174	98.0
6	Glutinous rice	ha	227	0.6	-	-	98	1.3
7	Fertilizing area	%	73.3	-	63.3	-	73.3	-
8	Best variety rice	%	67.3	-	66.6	-	70.0	-
9	Damaged paddy	ha	1,453	3.9	702	14.0	556	7.6
10	Unsuitable for farming	ha	6,572	17.5	911	18.2	23	0.3
11	Harvested area	ha	29,536	78.7	3,417	68.3	6,717	91.7
12	Nonglutinous rice	ha	29,310	78.1	3,417	68.3	6,621	90.4
13	Glutinous rice	ha	226	0.6	-	-	95	1.3
14	Yield $\frac{(15)}{(11)}$	kg/ha	2,115	-	2,286	-	2,420	-
15	Provincial production	t	61,299	-	7,219	-	16,148	-
16	Yield $\frac{(15)}{(1)}$	kg/ha	1,633	-	1,442	-	2,205	-

Table 2-6 Agricultural Statistic 1980

(Paddy Field Dry Season)

Name of Plant	Whole Province			Muang			Ban Khai		
	Area ha	Product /1 t	Yield kg/ha	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha
Paddy	2,087	7,175	3,438	3	10	3,438	2,074	7,130	3,438
Maize	-	-	-	-	-	-	-	-	-
Sweet corn	117	293	2,500	19	48	2,500	78	195	2,500
Ground nut	141	176	1,250	5	6	1,250	94	118	1,250
Mung bean	-	-	-	-	-	-	-	-	-
Sweet poteto	456	4,275	9,375	18	169	9,375	418	3,919	9,375
Water melon	380	4,750	1,250	72	900	1,250	19	238	1,250
Others	5,964	33,548	5,625	381	2,143	5,625	487	2,739	5,625
Vegetables	752	4,700	6,250	129	806	6,250	429	2,681	6,250
Total	9,897	-	-	627	-	-	3,599	-	-

/1 : Production

Agricultural Office of Rayong Province

Table 2-7 Agricultural Statistic 1979

(Paddy Field Dry Season)

Name of Plant	Whole Province			Muang			Ban Khai		
	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha
Paddy	1,956	5,502	2,813	-	-	-	1,952	5,491	2,813
Maize	230	331	1,438	-	-	-	-	-	-
Sweet corn	382	478	1,250	24	30	1,250	71	89	1,250
Ground nut	862	809	938	115	108	938	123	115	938
Mung bean	67	71	1,063	-	-	-	-	-	-
Sweet potato	1,059	4,633	4,375	444	1,943	4,375	505	2,209	4,375
Water melon	541	676	12,500	96	120	12,500	50	63	12,500
Others	15,261	-	-	-	-	-	48	-	-
Vegetables	563	3,519	6,250	91	569	6,250	173	1,081	6,250
Total	20,921	-	-	770	-	-	2,922	-	-

Table 2-8 Agricultural Statistic Average

(Paddy Field Dry Season)

Name of Plant	Whole Province			Muang			Ban Khai		
	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha
Paddy	2,022	6,339	3,135	1.5	5	3,333	2,013	6,311	3,135
Maize	115	166	1,439	-	-	-	-	-	-
Sweet corn	250	386	1,542	22	39	1,773	75	142	1,893
Ground nut	502	493	981	60	57	950	109	117	1,069
Mung bean	34	36	532	-	-	-	-	-	-
Sweet poteto	758	4,454	5,876	231	1,056	4,571	462	3,064	6,632
Water melon	461	2,713	5,885	84	510	6,071	35	151	4,300
Others	10,613	-	-	191	1,072	5,610	268	-	-
Vegetables	658	4,110	6,245	110	688	6,250	301	1,881	6,249
Total	15,413	-	-	770	-	-	3,263	-	-

Table 2-9 Agricultural Statistic 1979/1980

(Up-land Field Crops)

Name of Plant	Whole Province			Muang			Ban Khai		
	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha
Maize	51	220	4,313	-	-	-	-	-	-
Ground nut	4,192	4,716	1,125	200	225	1,125	423	476	1,125
Mung bean	66	50	750	-	-	-	29	22	750
Soy bean	35	37	1,063	-	-	-	-	-	-
Cotton	438	493	1,125	-	-	-	341	384	1,125
Up-land rice	1,418	2,029	1,431	-	-	-	139	199	1,431
Castor bean	3	-	-	-	-	-	3	-	-
Sugar cane	24,161	528,522	21,875	3,520	77,000	21,875	2,976	65,100	21,875
Cassava	89,219	1,077,738	2,500	8,672	108,400	12,500	33,712	421,400	12,500
Pineapple	3,510	136,625	7,500	427	16,013	37,500	1,245	46,688	37,500
Sweet potato	758	7,106	9,375	258	2,419	9,375	416	3,900	9,375
Watermelon	1,024	16,000	5,625	60	938	15,625	146	2,281	15,625
Tabacco	10	19	1,875	-	-	-	10	19	1,875
Vegetables	2,570	2,585	1,006	22	22	1,006	168	169	1,006
Total	27,455	-	-	13,159	-	-	39,608	-	-

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Table 2-10 Agricultural Statistic 1978/1979

(Up-land Field Crops)

Name of Plant	Whole Province			Muang			Ban Khai		
	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha
Maize	258	484	1,875	-	-	-	10	19	1,875
Groundnut	9,460	16,555	1,750	125	219	1,750	942	1,649	1,750
Mung bean	203	190	938	-	-	-	83	78	938
Soy bean	9	8	938	-	-	-	9	8	938
Cotton	272	340	1,250	-	-	-	224	280	1,250
Up-land rice	2,025	4,050	2,000	-	-	-	103	206	2,000
Castor bean	2	2	1,000	-	-	-	2	2	750
Sugarcane	21,845	819,188	37,500	416	15,600	37,500	3,764	141,150	37,500
Cassava	78,722	1,303,872	16,563	5,035	83,394	16,563	32,464	537,701	16,563
Pineapple	2,420	143,688	59,375	8	475	59,375	532	31,588	59,375
Sweet potato	855	11,756	13,750	10	138	13,750	254	3,493	13,750
Watermelon	464	4,350	9,375	3	28	9,375	78	731	9,375
Tabacco	22	-	-	-	-	-	22	-	-
Vegetables	1,150	5,750	5,000	34	170	5,000	416	2,080	5,000
Others	184	359	1,950	7	140	1,950	83	162	1,950
Total	117,891	-	-	5,638	-	-	38,986	-	-

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Table 2-11 Agricultural Statistic 1977/1978

(Up-land Field Crops)

Name of Plant	Whole Province			Muang			Ban Khai		
	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha
Maize	141	220	1,563	-	-	-	-	-	-
Ground nut	3,692	5,771	1,563	244	381	1,563	947	1,480	1,480
Mung bean	213	200	-	-	-	-	141	132	132
Soy bean	21	20	938	-	-	-	13	12	923
Cotton	72	68	938	-	-	-	72	68	68
Up-land rice	1,867	3,034	1,625	-	-	-	70	114	114
Castor bean	3	-	-	-	-	-	-	-	-
Sugar cane	21,767	884,284	40,625	1,394	56,631	40,625	3,680	149,500	40,625
Cassava	111,723	1,745,672	15,625	13,944	217,875	15,625	33,760	527,500	15,625
Pineapple	1,314	49,275	37,500	-	-	-	416	15,600	37,500
Sweet potato	2,890	27,094	9,375	640	6,000	9,375	608	5,700	9,375
Watermelon	1,085	16,953	15,625	-	-	-	384	6,000	15,625
Tabacco	-	-	-	-	-	-	-	-	-
Vegetables	11,839	12,300	1,039	2,093	2,175	1,039	1,440	1,496	1,039
Total	156,627	-	-	18,315	-	-	41,531	-	-

Agricultural Office of Rayong Province

Table 2-12 Agricultural Statistic Average

(Up-land Field Crops)

Name of Plant	Whole Province			Muang			Ban Khai		
	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha
Maize	150	303	2,053	-	-	-	-	-	-
Ground nut	5,781	9,014	1,559	200	275	1,375	771	1,202	1,558
Mung bean	161	147	913	-	-	-	84	77	921
Soy bean	22	22	1,000	-	-	-	-	-	-
Cotton	261	300	1,151	-	-	-	212	244	1,151
Up-land rice	1,770	3,038	1,716	-	-	-	104	173	1,663
Castor bean	2	2	1,000	-	-	-	-	-	-
Sugar cane	22,591	743,998	32,933	1,777	49,744	27,993	3,473	118,583	34,144
Cassava	93,221	1,375,761	14,758	9,217	136,556	14,816	33,312	495,534	14,875
Pineapple	2,415	109,863	45,492	218	8,244	37,817	731	31,292	42,807
Sweet potato	1,501	15,319	10,206	303	2,852	9,414	426	4,364	10,245
Watermelon	858	12,434	14,492	32	483	15,094	203	3,000	14,798
Tabacco	10	19	1,875	-	-	-	-	-	-
Vegetables	5,186	6,878	1,326	716	789	1,102	675	1,748	2,590
Total	133,929	-	-	12,463	-	-	39,991	-	-

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Table 2-13 Agricultural Statistic 1979/1980

(Perennial and Fruit trees)

Name of Plant	Whole Province			Muang			Ban Khai		
	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha
Para rubber	61,792	57,961	938	28,182	26,435	938	4,617	4,331	938
Coco nut	10,839	27,098	2,500	1,549	3,873	2,500	4,333	10,833	2,500
Mango	1,109	3,466	3,125	415	1,297	3,125	312	975	3,125
Durain	7,228	36,140	5,000	927	4,635	5,000	243	1,215	5,000
Rambutan	4,409	22,045	5,000	280	1,400	5,000	243	1,215	5,000
Banana	4,828	27,158	5,625	412	2,318	5,625	600	3,375	5,625
Mimusop	863	1,079	1,250	61	76	1,250	500	625	1,250
Jackfruit	1,200	11,250	9,375	62	581	9,375	183	1,716	9,375
Gardenia	480	3,000	6,250	480	3,000	6,250		-	-
Others	7,208	24,075	3,340	111	371	3,340	98	2,051	3,340
Total	99,956	-	-	32,479	-	-	11,129	-	-

Agricultural Office of Rayong Province

Table 2-14 Agricultural Statistic 1978/1979

(Perennial and Fruit trees)

Name of Plant	Whole Province			Muang			Ban Khai		
	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha
Para rubber	55,595	52,148	938	21,669	20,326	938	7,656	7,181	938
Coco nut	10,728	26,820	2,500	2,928	7,320	2,500	3,466	8,665	2,500
Mango	763	2,861	3,750	166	623	3,750	250	938	3,750
Durain	5,064	28,485	5,625	589	3,313	5,625	228	1,283	5,625
Rambutan	4,216	26,350	6,250	100	625	6,250	230	1,438	6,250
Banana	3,288	19,524	5,938	285	1,692	5,938	139	825	5,938
Mimusop	743	929	1,250	85	106	1,250	105	131	1,250
Jackfruit	1,349	13,069	9,688	71	688	9,688	183	1,773	9,688
Gardenia	547	4,103	7,500	547	4,103	7,500		-	-
Others	13,573	38,303	2,822	219	618	2,822	66	186	2,822
Total	95,866	-	-	26,659	39,414	1,478	1 ,323	22,420	1,819

Agricultural Office of Rayong Province

Table 2-15 Agricultural Statistic 1977/1978

(Perennial and Fruit trees)

Name of Plant	Whole Province			Muang			Ban Khai		
	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha
Para rubber	38,697	24,186	625	16,617	10,386	625	3,281	2,051	625
Coco nut	10,244	25,610	2,500	1,352	3,380	2,500	4,333	10,833	2,500
Mango	892	3,345	3,750	322	1,208	3,750	312	1,170	3,750
Durain	5,846	32,884	5,625	890	5,006	5,625	243	1,367	5,625
Rambutan	4,061	25,381	6,250	120	750	6,250	228	1,425	6,250
Banana	4,620	28,875	6,250	412	2,575	6,250	765	4,781	6,250
Mimusop	1,042	1,303	1,250	61	76	1,250	730	913	1,250
Jackfruit	985	1,847	1,875	62	116	1,875	106	199	1,875
Gardenia	480	600	1,250	480	600	1,250		-	-
Others	6,619	13,860	2,094	110	230	2,094	202	423	2,094
Total	73,486	-	-	20,426	-	-	10,200	-	-

Agricultural Office of Rayong Province

Table 2-16 Agricultural Statistic Average

(Perennial and Fruit trees)

Name of Plant	Whole Province			Muang			Ban Khai		
	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha
Para rubber	52,028	44,765	860	22,156	19,049	860	5,185	4,521	872
Coco nut	10,604	26,509	2,500	1,943	4,858	2,500	4,044	10,110	2,500
Mango	921	3,224	3,501	301	1,043	3,464	291	1,028	3,532
Durain	6,046	32,504	5,376	802	4,318	5,384	238	1,288	5,413
Rambutan	4,229	24,592	5,815	167	925	5,539	234	1,359	5,809
Banana	4,245	25,186	5,933	370	2,195	5,932	501	2,994	5,975
Mimusop	883	1,104	1,250	69	86	1,246	445	556	1,250
Jackfruit	1,178	8,722	7,404	65	462	7,103	157	1,229	7,830
Gardenia	502	2,568	5,115	502	2,568	5,115		-	-
Others	9,133	25,413	2,783	147	406	2,764	122	887	7,268
Total	89,769	-	-	26,522	-	-	11,217	-	-

Agricultural Office of Rayong Province

Table 2-17 Agricultural Statistic

Ban Bung Main Crops.

	Item	1979/1980			1978/1979			1977/1978			Average		
		/1 Area ha	/2 Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha	Area ha	Product t	Yield kg/ha	Aren ha	Product t	Yield kg/ha
Ban Bung	Paddy Wet	6,076	17,092	2,813	4,978	7,781	1,563	5,904	16,608	2,813	5,653	13,827	2,446
	Dry	16	52	3,250	248	620	2,500	74	241	3,250	113	304	2,693
	Sugarcane	14,759	645,706	43,750	14,759	599,584	40,625	20,160	882,000	43,750	16,559	709,097	42,822
	Cassava	15,760	246,250	15,625	12,762	179,472	14,063	16,022	250,344	15,625	14,848	225,355	15,177
	Ground nuts	96	168	1,750	346	649	1,875	719	1,250	1,750	387	692	1,787
	Pineapple	2,324	43,575	18,750	2,316	123,038	53,125	2,418	45,338	18,750	2,353	70,650	30,026
	Coconuts	-	-	-	2,208	13,800	6,250	1,584	6,930	4,375	1,896	10,365	5,467
	Total	39,031	-	-	37,617	-	-	46,881	-	-	41,809	-	-
Whole Provice	Paddy Wet	-	-	-	51,348	99,294	1,938	51,519	65,687	1,275	51,384	82,491	1,605
	Dry	-	-	-	-	-	-	-	-	-	-	-	-
	Sugarcane	-	-	-	51,914	2,301,092	44,325	58,263	2,795,969	47,988	55,089	2,548,531	46,262
	Cassava	-	-	-	70,299	1,014,949	14,438	88,443	1,198,762	13,556	79,371	1,106,856	13,945
	Ground nuts	-	-	-	1,225	1,876	1,531	228	182	800	727	1,029	1,415
	Pineapple	-	-	-	-	-	-	-	-	-	-	-	-
	Coconuts	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	174,686	-	-	198,453	-	-	186,571	-	-

Agricultural Office of Chon Buri Province

/1 : Harvested area /2 : Production

Table 2-18 Holding Status of Agriculture Machinery by Province

Year	1975/76	1976/77	1977/78	1978/79	1979/80
Power Tiller					
Rayong	341	433	1,805	1,816	1,828
Chon Buri	1,541	1,957	2,610	3,487	4,398
Whole Country	90,001	113,286	151,504	192,004	230,591
4 Wheels Plough					
Rayong	474	535	585	612	676
Chon Buri	579	586	656	691	712
Whole Country	14,575	16,427	23,942	28,987	33,285
Tractor (70 - 90 ps)					
Rayong	81	106	138	176	202
Chong Buri	175	229	299	380	436
Whole Country	13,338	17,569	22,826	28,987	33,285
Pump					
Rayong	5,143	5,667	6,490	7,349	9,699
Chon Buri	3,459	3,811	4,364	4,941	6,522
Whole Country	251,288	277,084	317,328	359,308	473,975

Table 2-19 Existing Situation of Agricultural Cooperatives in Rayong Province (1980)

Amphoe	Muang			Ban Khai	
Cooperative	Muang Agri. Crop	Muang 1	Muang Livestock	Ban Khai	Layong Land Settlement Agri.
Coops official	4			4	
Coops staff	7	5	3		
Agriculture household	12,715			11,385	
Member's number	1,819	594	1,106	1,167	1,346
	Paddy 10% Upland 90	10% 90		50% 50	Upland 100%
Puchasing ฿				฿	฿
Agri-chemical				51,558	180,104
Chemi-fertilizer	2,288,332	2,706,017		1,764,228	491,628
Agri-machine					
Seeds (paddy)				7,920	Cotton 6,776
Others			Feed 1,323,673	28,100	9,262
Marketing					
Paddy					
Fruits					
Vegetable					
Livestock					
Others					
Storage house Capacity (ton)				500	400
Credit					
Short-term used 1 year number	95%	95%	95%	95%	95%
amount ฿	4,689,000	3,531,500	697,517	10,118,200	2,518,400
Middle-term used 3-years number					
amount	6,565,000	7,150,000		2,608,000	904,100
Long-term used number					
Rice mill					
Banana processing					
Agriculture household	12,715 (84.9%)			11,385 (97.0%)	
Total household	14,975			11,741	
Total population	119,709			71,091	
Agricultural population	117,771 (98.4%)			70,698 (99.4%)	