REPORTS
on
DESIGN METHOD OF IRRIGATION DITCH
and
ROTATIONAL IRRIGATION SCHEDULE
MAE KLONG PILOT PROJECT

KAZUHIRO HISAMOTO

IRRIGATION & DRAINAGE EXPERT

MARCH 1985

THAI IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

JAPAN INTERNATIONAL COOPERATION AGENCY

Technical Report No. MK-3

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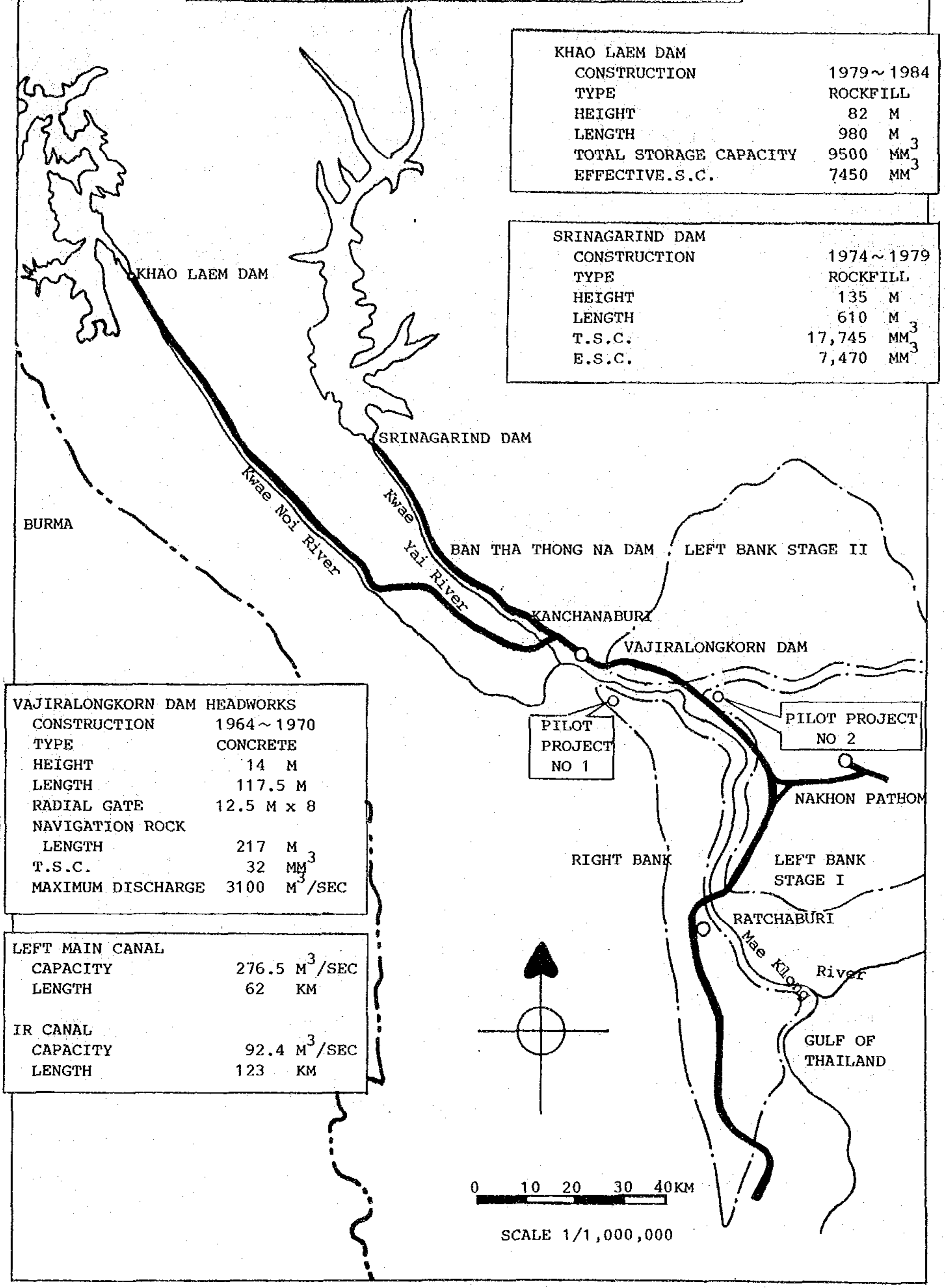

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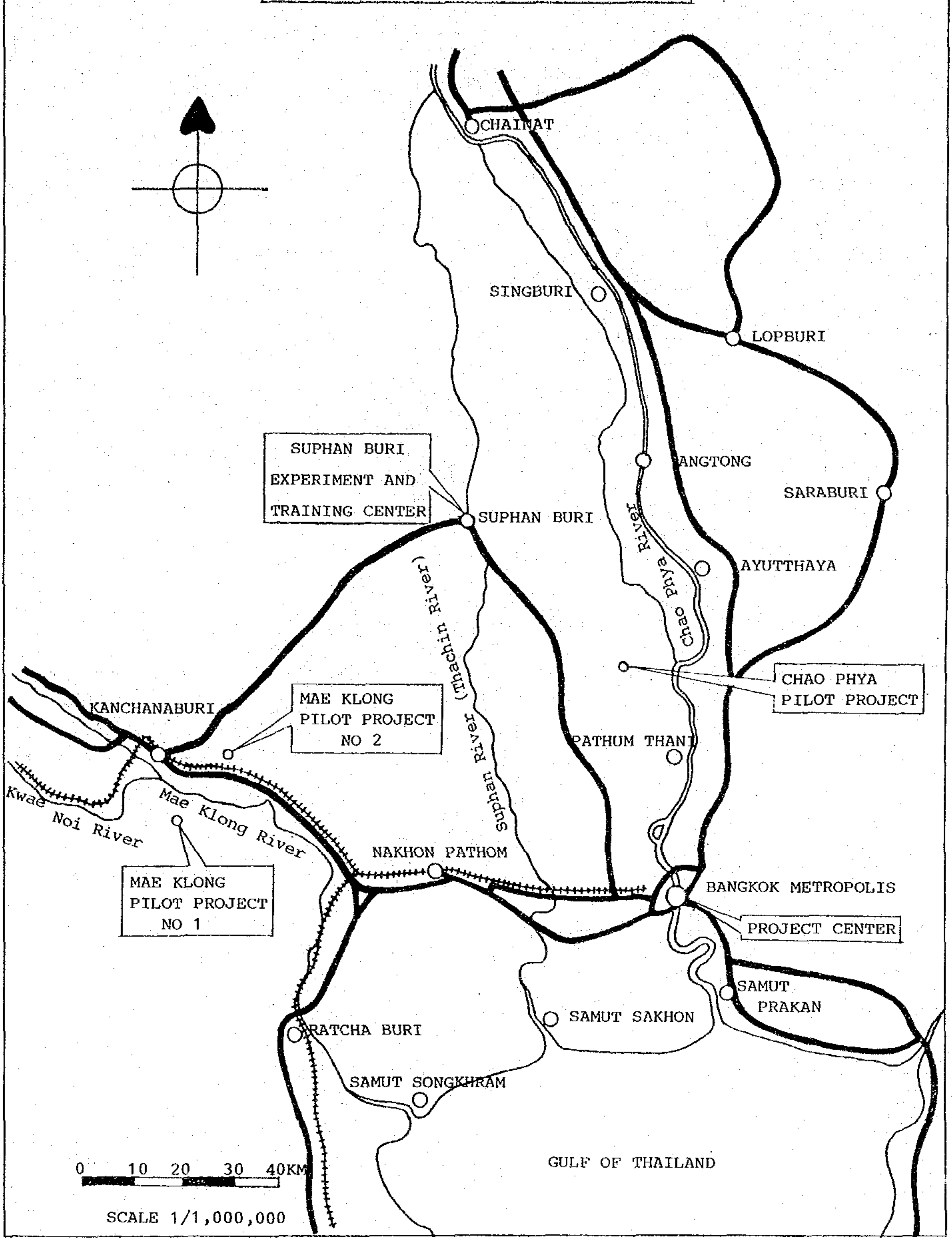


I. SUGGESTIONS ON DESIGN METHOD OF IRRIGATION DICTH

I-1 Introduction

The land consolidation work of Mae Klong Pilot Project No.1 was carried out in 1979 ~ 1981 by intensive method. However, after the work, some parts of the pilot area couldn't get irrigation water adequately or at all. It was the main problem for setting farmer's organization and water management work.

According to the survey and researching works about unirrigable area, the main reason was from the design method. The orginal plan was made by JICA (Japan International Cooperation Agency), however, after the joint discussion between Thailand and Japan, the design was changed in accordance with RID (Royal Irrigation Department)'s design criteria. The original design by JICA wouldn't make any problems. When the work had been done with RID's design, the irrigation facilities had some functional faults. Therefore, the improvement work was done on January ~ March 1984, and all of the facilities problems in Pilot Project No.1 were solved out.

The land consolidation of Mae Klong Project Right Bank has been set from 1983 to 1987 in the approximately area of 65,000 ha, by extensive land consolidation method. Presently the work continues by the construction cost from World Bank loan. The designers are from ILACO/EMPIRE M&T, which is joint consultant company between Netherland and Thailand, they draw the design according to RID's design criteria. After the first year's land consolidation work 1983, some farm plots couldn't get irrigation water adequately or at all. So, the farmers in these areas had to find many methods to get enough water for their dry season's crops.

Through the survey and researching works of the construction, the functional faults of irrigation ditches could be indicated as in Pilot Project No.1 area.

The purpose of this report is to demonstrate the reason of unirrigable area, and to suggest the way of improving.

I-2 Unirrigable Area

I-2-1 Maps of the Area

Fig I-1 shows the command area of 1L-1R Canal.

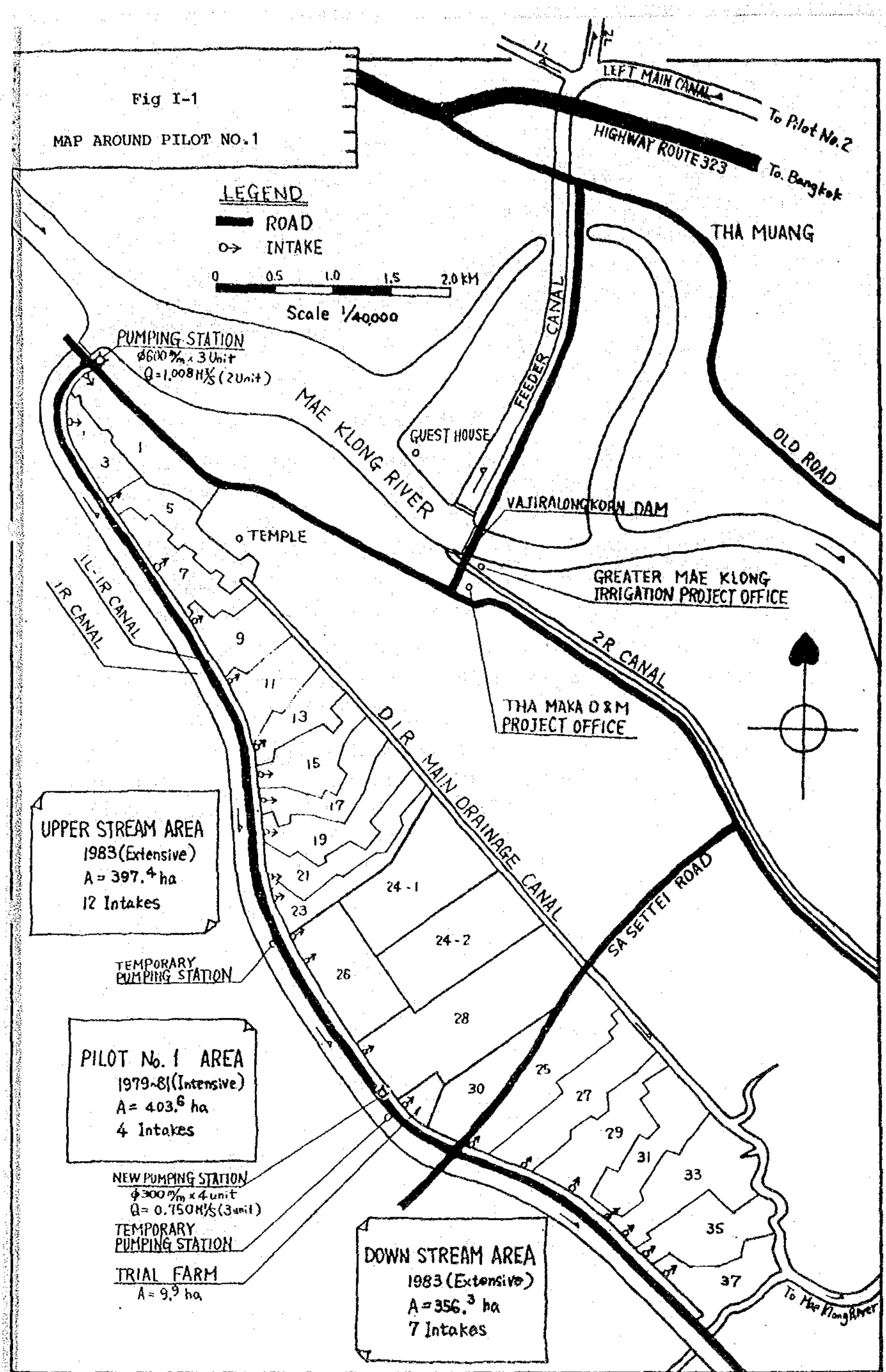
The upperstream area is 397.4 ha, and land consolidation work was completed in 1983 by extensive method. This area has 12 intakes from No.1 to No.23 and 12 irrigation service units.

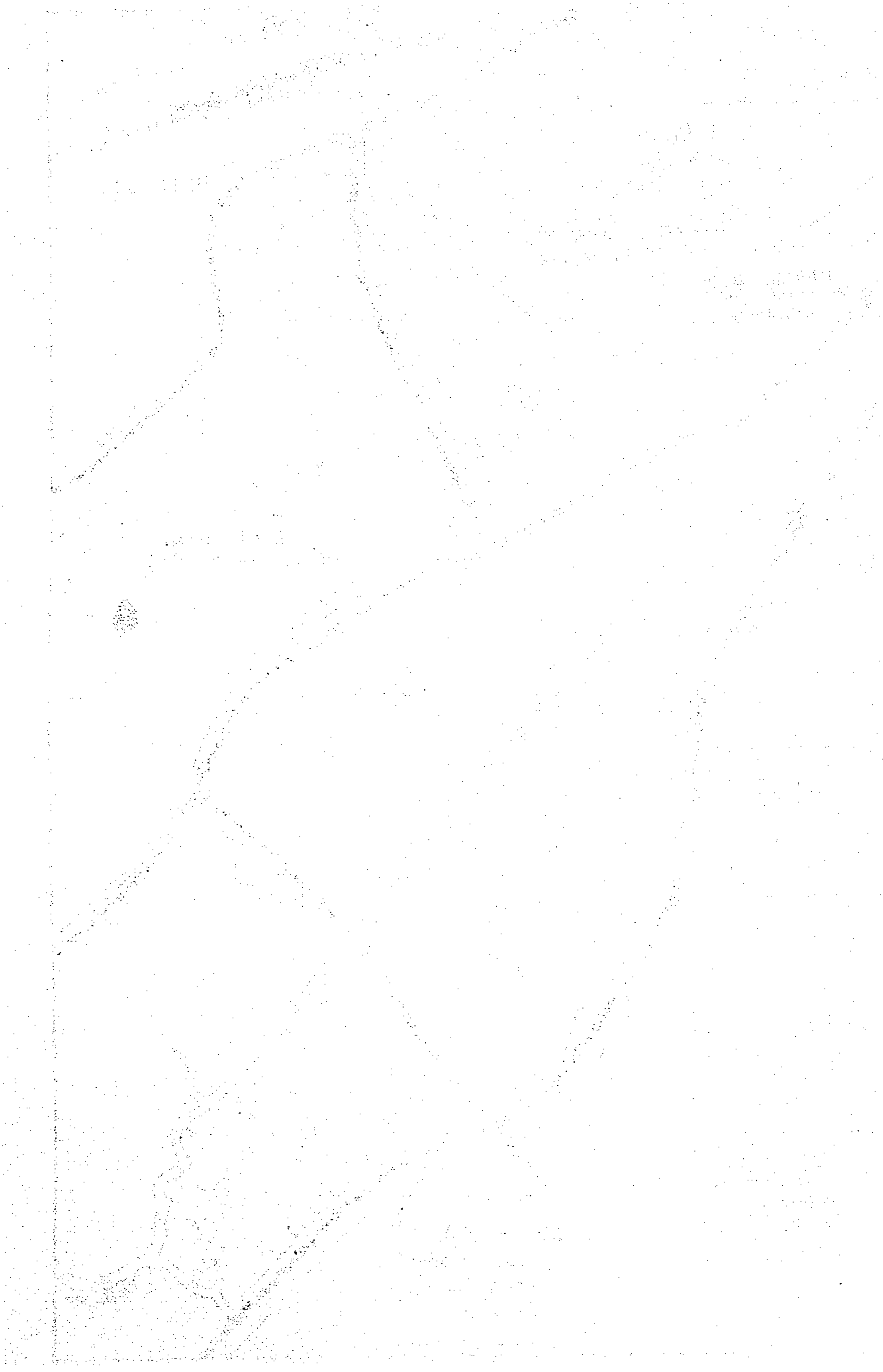
The down-stream area is 365.3 ha and land consolidation work was finished in 1983 in the same way of upperstream area.

This area has 7 intakes from No.25 to No.37 and 7 irrigation service units.

Fig I-1

MAP AROUND PILOT NO.1





I-2-2 Unirrigable Area in Dry Season 1983

Table I-1 shows the cultivation area and unirrigable area in dry season 1983. The cultivation was done only in Pilot Project No.1 while upper and down stream areas were under construction. Presently 1984, Pilot Project No.1 has 4 intakes from No.24 to No.30, but in 1983, there were only 2 intakes: No.1 and No.2. The unirrigable area was 83 rai (13.2 ha) in the command area of Intake No.1.
(See Fig I-2)

I-2-3 Unirrigable Area in Dry Season 1984

Table I-2 shows the cultivation area and unirrigable area in dry season 1984. The upper stream area had 142 rai (22.7 ha) of unirrigable area which was 5.7 % of all area, 2474.42 rai. In Pilot Project No.1 area, there isn't any unirrigable area after the improvement work, which cost about two millions baht. The down stream area had 234 rai (37.4 ha) of unirrigable area which was 10.3 % of all area.

Fig I-3, Fig I-4 and Fig I-5 show the location of unirrigable area. Those area couldn't been done any cultivation because they couldn't get water at all in dry season.

Moreover, there were considerable area which had shortage of water, farmers in such a plot had to find many methods of irrigation water for their paddies,or had to plant sugarcane.

Table I-1 CULTIVATION AREAS

DRY SEASON'S CROPS IN 1983

1L-1R Canal

(Mae Klong Pilot Project No.1

Zone	Intake	Total Area (rai)	Paddy Field (rai)	Sugar Cane (rai)	Upland Crops (rai)	Others (rai)	Unirrigable Area (rai)
Upper Stream		2483.97	Under Construction				
Pilot No.1	1	1384.75	1250.99	8.07	1.87	40.82	83.00
	2	954.00	922.76	15.06	-	16.18	-
	S.Total	2338.75	2173.75	23.13	1.87	57.00	83.00
Down Stream		2226.77	Under Construction				
TOTAL		7049.49	2173.75	23.13	1.87	57.00	83.00

Fig I-2 · Unirrigable Area in Pilot Project No.1

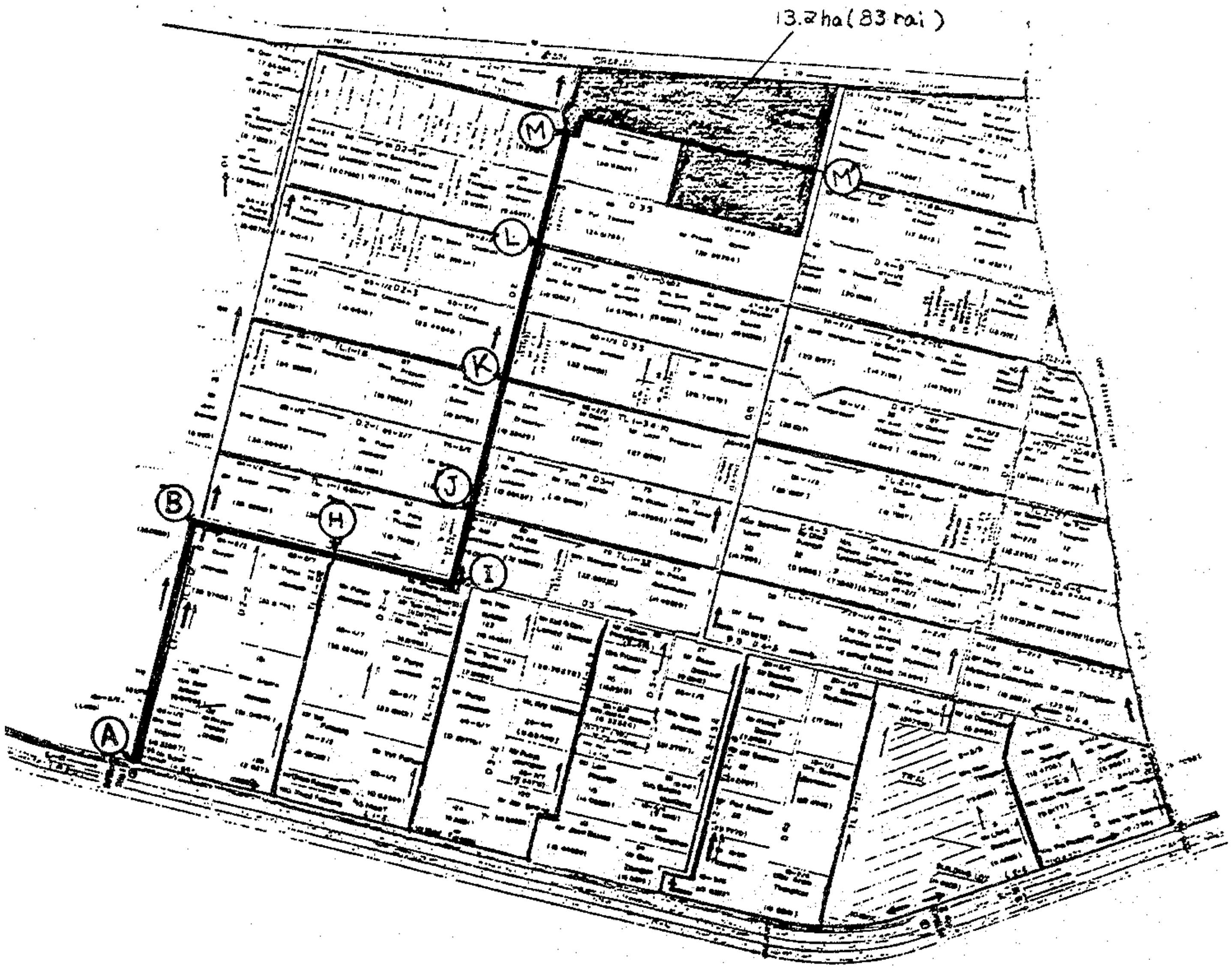


Table I-2 CULTIVATION AREAS

DRY SEASON'S CROPS IN 1984

1L-1R Canal

(Mae Klong Pilot Project No.1)

Zone	Intake	Total Area (rai)	Paddy Field (rai)	Sugar Cane (rai)	Upland Crops (rai)	Others (rai)	Unirrigable Area (rai)
Upper Stream	1	198.71	-	122.61	65.09	11.01	-
	3	175.63	80.83	52.28	8.96	9.56	24.00
	5	162.33	123.26	27.06	8.96	3.05	-
	7	228.34	209.05	-	0.50	2.79	16.00
	9	192.43	168.09	24.34	-	-	-
	11	209.60	209.60	-	-	-	-
	13	210.15	190.15	-	-	-	20.00
	15	182.79	161.29	-	-	1.50	20.00
	17	207.30	202.30	-	-	-	5.00
	19	226.44	203.94	-	-	1.50	21.00
	21	247.52	228.77	-	-	3.75	15.00
	23	233.18	212.18	-	-	-	21.00
	S.Total	2474.42	1989.46	226.29	83.51	33.16	142.00
Pilot No.1	24(1)	483.62	472.06	8.75	-	2.81	-
	24(2)	480.69	454.57	-	-	26.12	-
	26	420.44	399.89	-	-	20.55	-
	28	698.94	693.43	-	-	5.51	-
	30	255.06	253.18	-	-	1.88	-
	S.Total	2338.75	2273.13	8.75	-	56.87	-
Down Stream	25	316.90	210.65	-	-	1.25	105.00
	27	416.93	361.49	37.37	16.07	1.00	1.00
	29	332.92	185.57	128.29	17.81	0.25	1.00
	31	264.49	218.42	37.82	1.25	-	7.00
	33	346.60	205.03	120.17	6.40	5.00	10.00
	35	322.73	159.43	62.81	18.99	1.50	80.00
	37	263.90	142.44	70.74	20.47	0.25	30.00
	S.Total	2264.47	1483.03	457.20	80.99	9.25	234.00
TOTAL		7077.64	5745.62	692.24	164.50	99.28	376.00

Fig I-3 Unirrigable Area

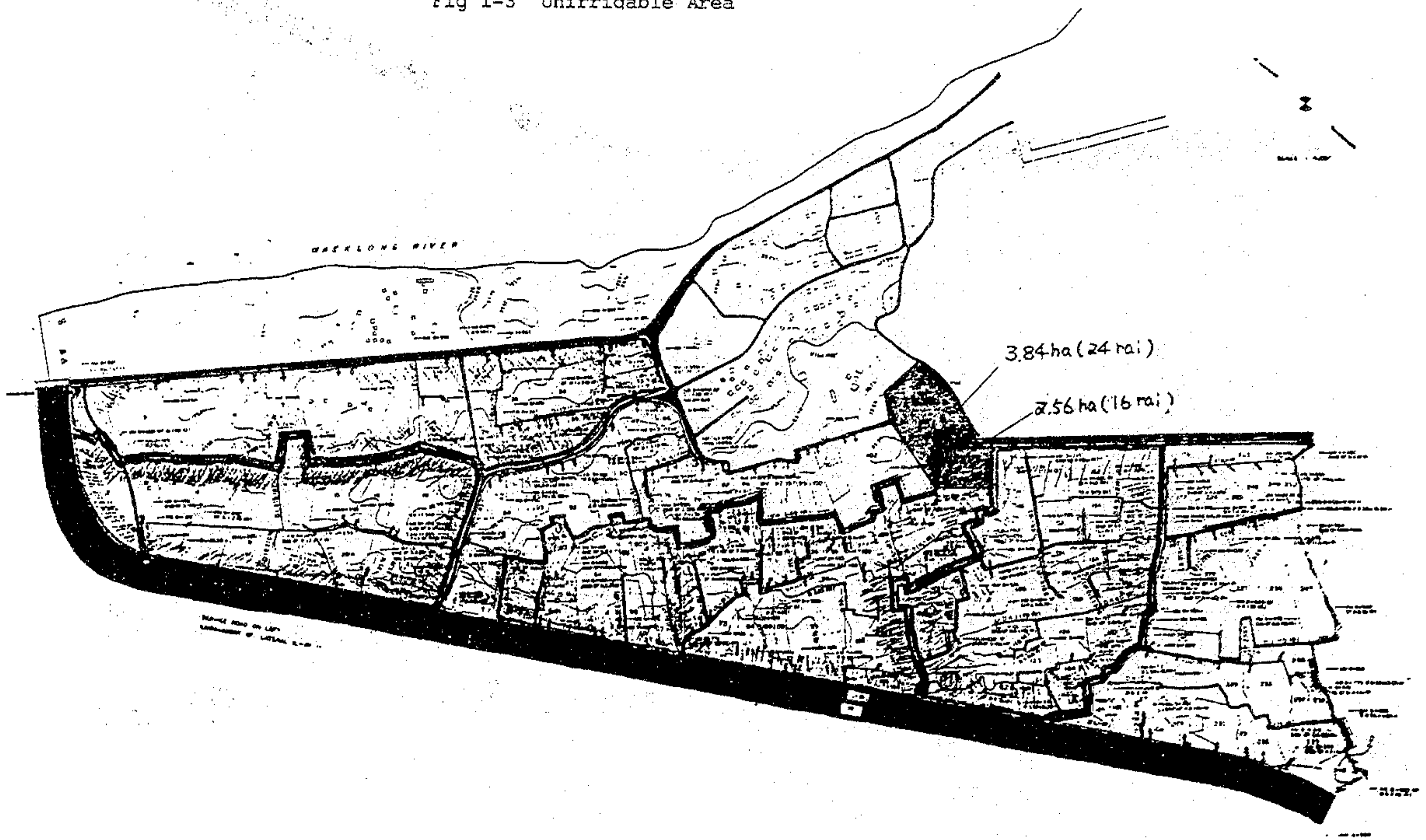


Fig I-5 Unirrigable Area

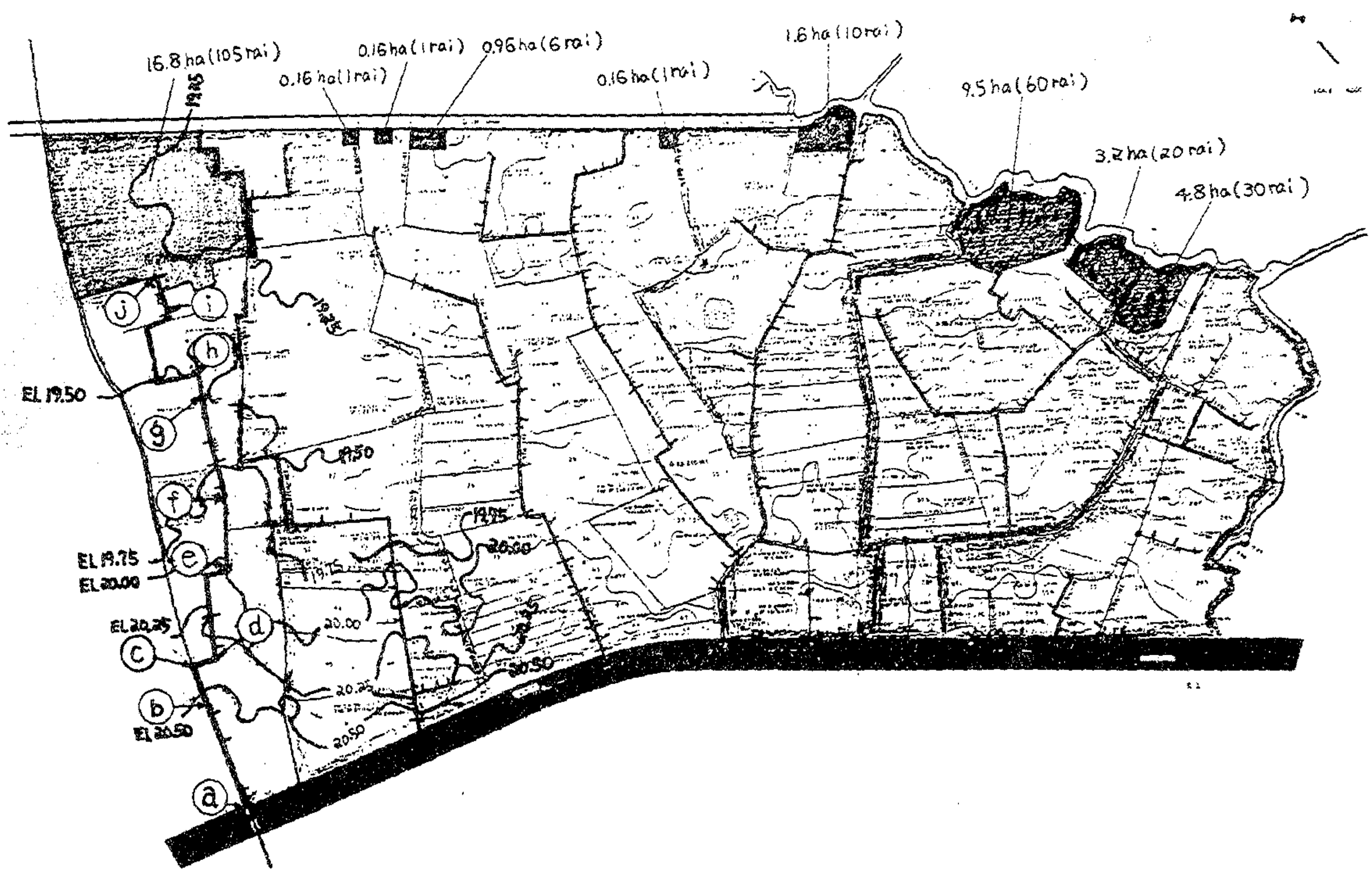


Fig I-4 Unirrigable Area

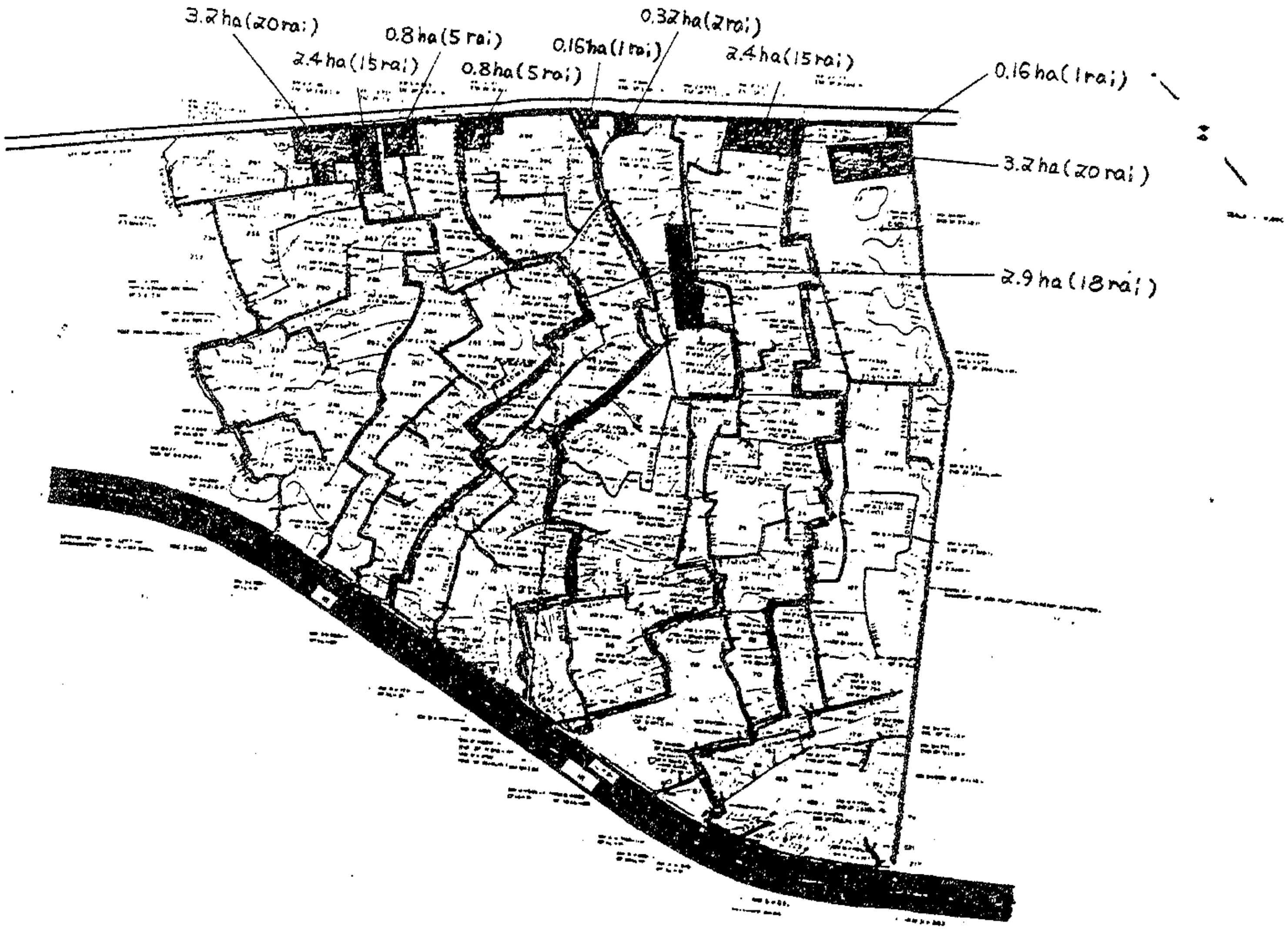
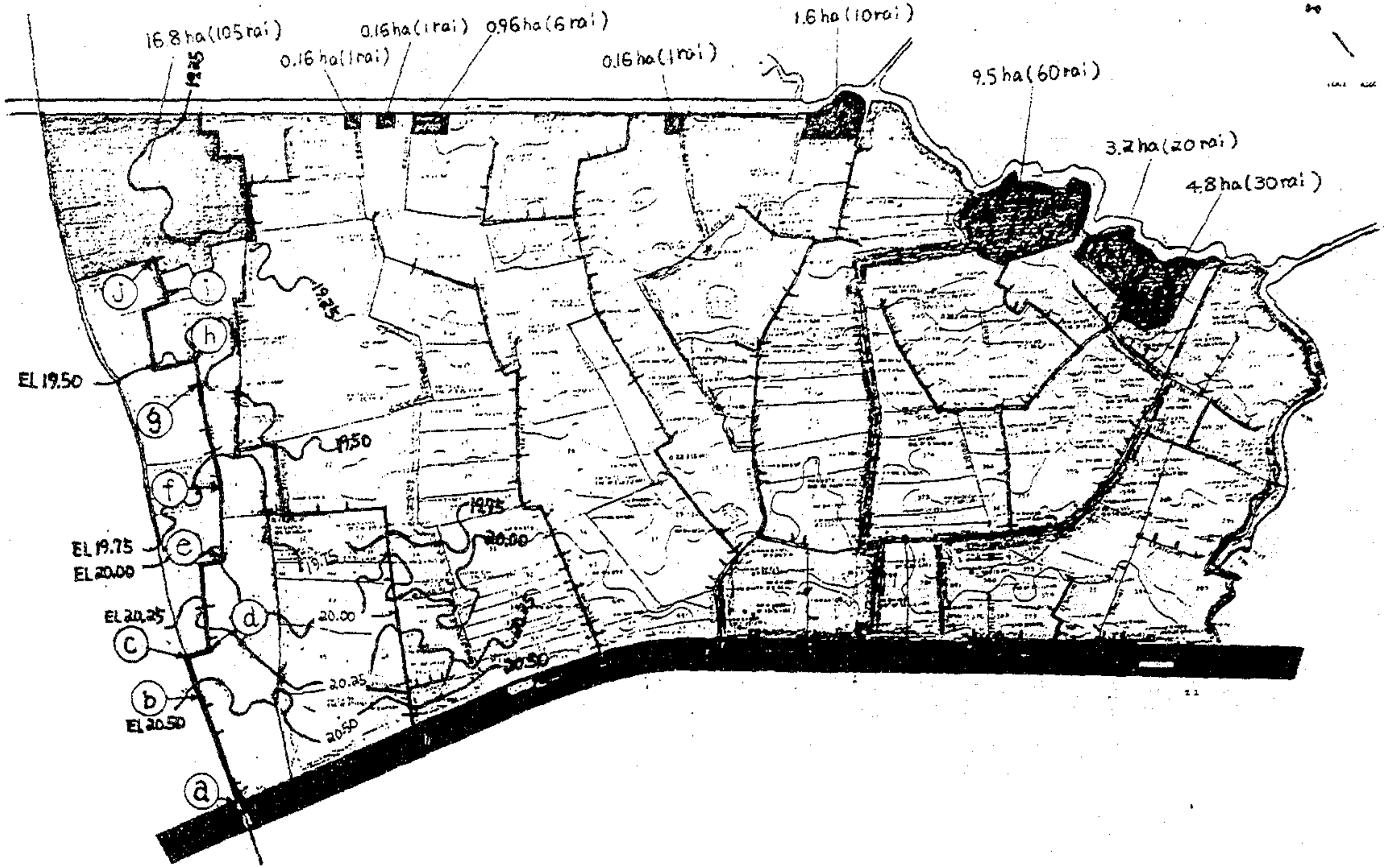


Fig I-5 Unirrigable Area



I-3 Reason for Unirrigable Area

(Intensive Land Consolidation Area)

I-3-1 Existing Design Method

Fig I-6 shows the profile (longitudinal) section of irrigation ditch in Pilot Project No.1, which isn't JICA's design. The design changed after the joint discussion between Thailand and Japan, and followed the RID's design criteria.B.L. line (bottom level of ditch) and F.W.S.L.line (full water supply level) are lower than in the first design by JICA. It might be that RID designers would like to decrease the amount of soil to emback the ditches and roads. The design method was the same as RID's existing one, but water discharge value was kept to JICA's original design.

Existing design method by RID

i) Set F.W.S.L around the tail of ditch as follows:

The highest elevation of paddy field + 0.10 m ※ Note 1

(See point Ⓜ-Ⓜ' in Fig I-6, EL 19.73)

then draw F.W.S.L.line from downstream to upperstream. Longitudinal slope should be set according to topography, and standard slope is 1/4000. However, when the standard slope can't be taken, it sets many slope scales as 1/5,000, 1/8,000, 1/12,000 as shown in Fig I-6.

※ Note 1 : The adding number was 0.10 m in Pilot Project No.1, but mostly adding 0.20 m in other area.

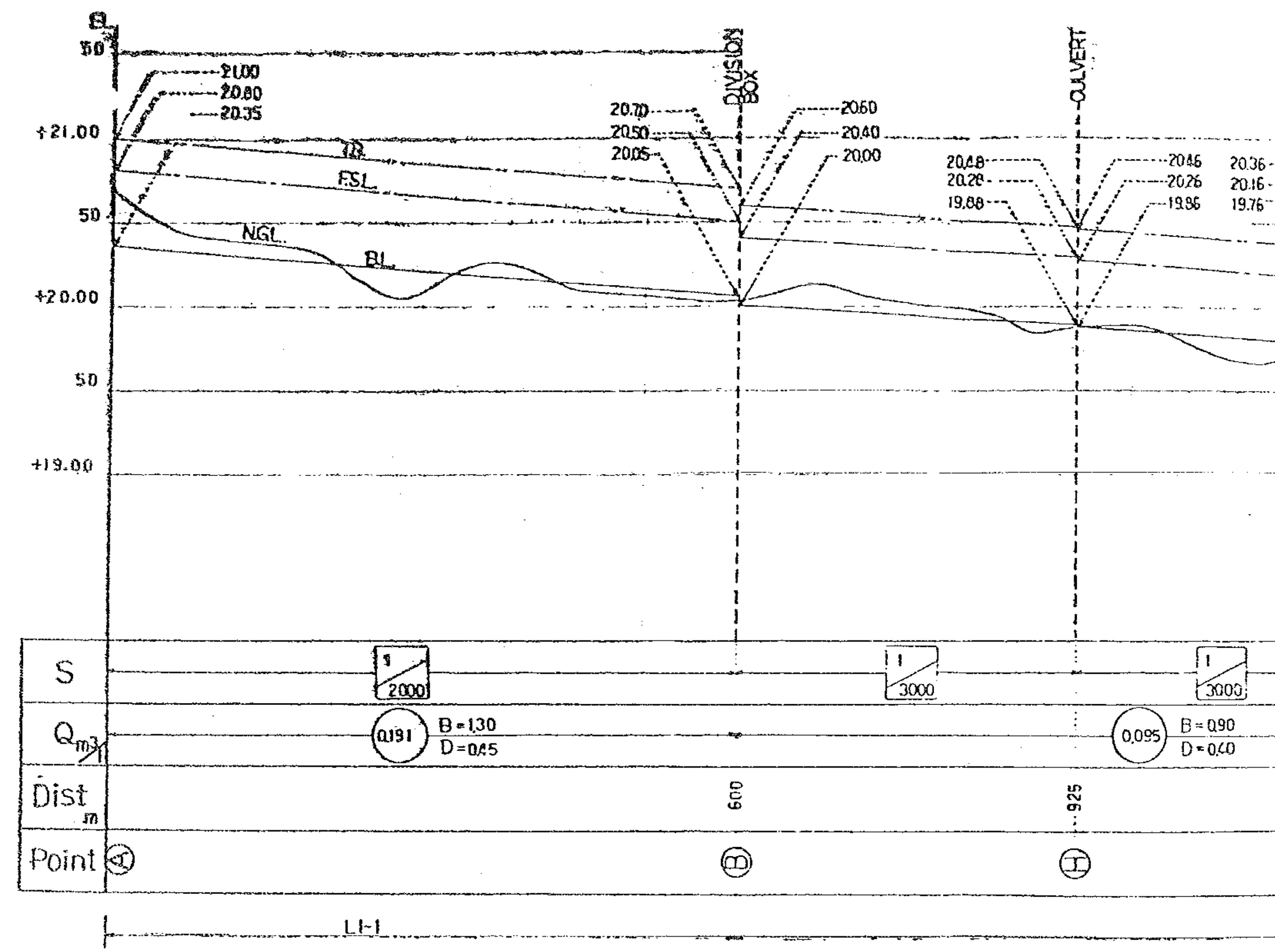
ii) Using Water Discharge Calculating Table (which is the table ※ Note2 to calculate water discharge from the typical cross section and longitudinal slope scale values by using the Manning Formular), the cross section is decided according to design water discharge. It means to set F.W.S.L.line before decide B.L.line.

※ Note 2 : Typical cross section

Width of ditch's bottom (B) = Min 0.30 m
(if more than 0.30 m, increase 0.10 m by 0.10 m)

Slope gradient = Standard 1:1

Water depth (D) = Min 0.30 m
(if more than 0.30 m, increase 0.05 m by 0.05 m)



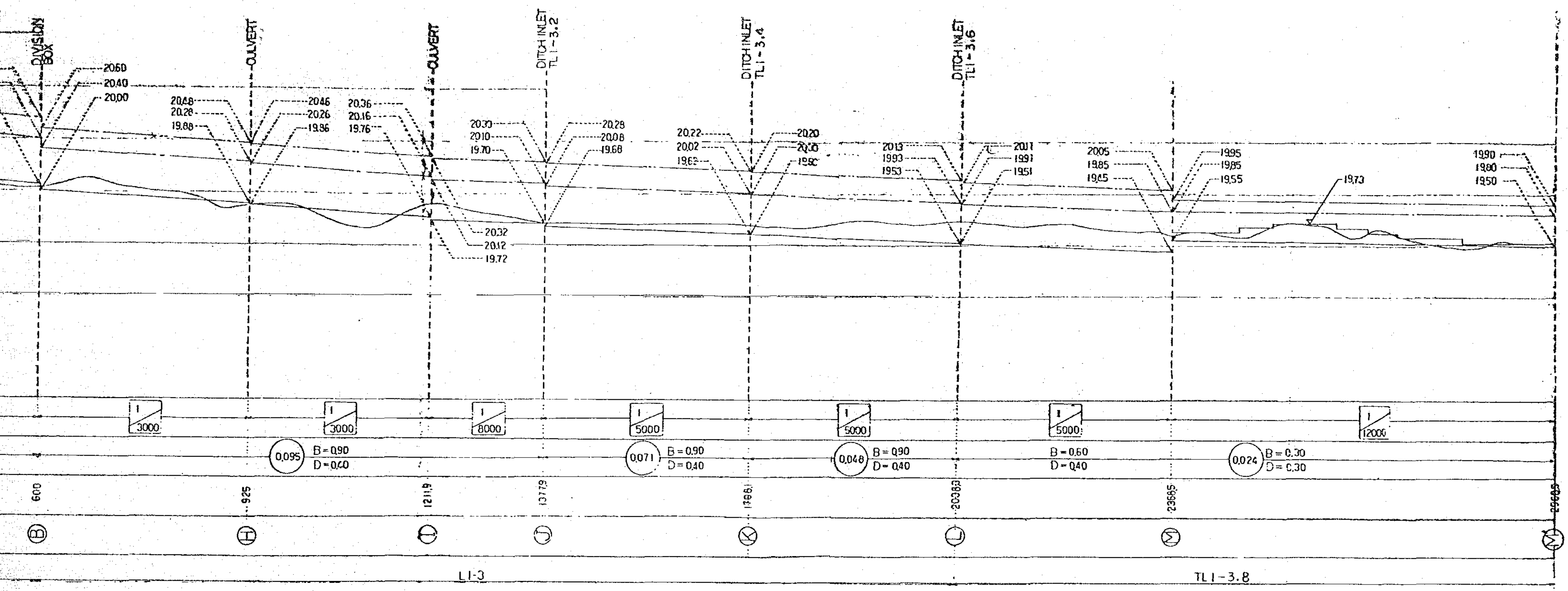


Fig I-6 Profile Section of Ditch in Pilot No.1

Free board

Lateral ditch = 0.20 m

Farm ditch = 0.10 m

Coefficient of roughness (n) = 0.035 (earth ditch)

(in pilot No.1, n = 0.035 according to JICA's design, but in other area, it's different from this)

I-3-2 Consideration

After the land consolidation work, all command area of the farm ditch TL 1-3.8 was an unirrigable area. Some inlets were changed to the upper stream of ditch, which made some area the irrigable area, but still had a shortage of irrigated water. The remaining area, 13.2 ha (83 rai), had been unirrigable area since first time. The reasons are considered as the following items:

i) Ditch slope

The minimum ditch slope rate of Pilot Project No.1 was 1/8,000 ~ level, which was too small. The topographic slope of the Pilot area was 1/1,000 ~ 1/5,000. The feeder ditch slope should be adjusted as the topographic slope, which should be 1/5,000 in minimum. And the farm ditch slope should be 1/3,000 in minimum because it lacked of good maintenance and water discharge was small.

ii) Fall of F.W.S.L.

Fig I-7 Farm Ditch

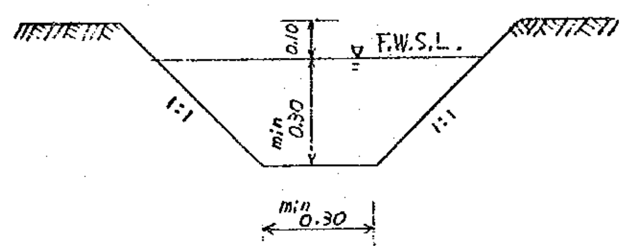


Fig I-7 shows the smallest typical section (B = 0.30 m, D = 0.30 m) unconcerned in slope. The design water discharge of standard irrigation unit (= 19.2 ha) in Pilot Project No.1, Q = 0.024 m^3/sec.

Calculating the slope by Manning Formular, it's about 1/4,000 (coefficient of roughness n = 0.035). It means that if the slopewas more than 1/4,000, design water discharge could not keep F.W.S.L. So irrigated water could not flow to the paddy fields through inlets.

And the bottom of ditch is apt to be wider by the construction or maintenance works. (See Fig I-8) The water would not reach F.W.S.L. making the water surface lower also.

In order to solve these problems and keep F.W.S.L., water discharge should be increased more than design, or the check gates should be built at the necessary points.

Fig I-8 Fall of F.W.S.L.

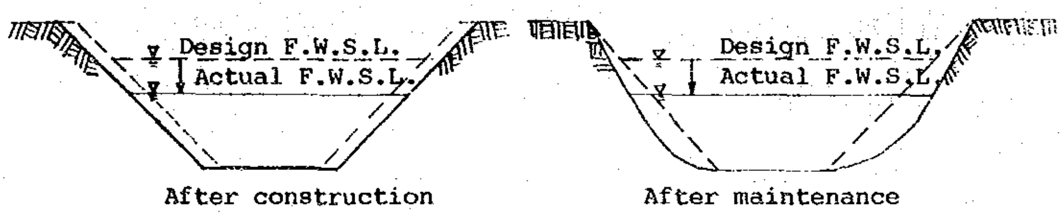
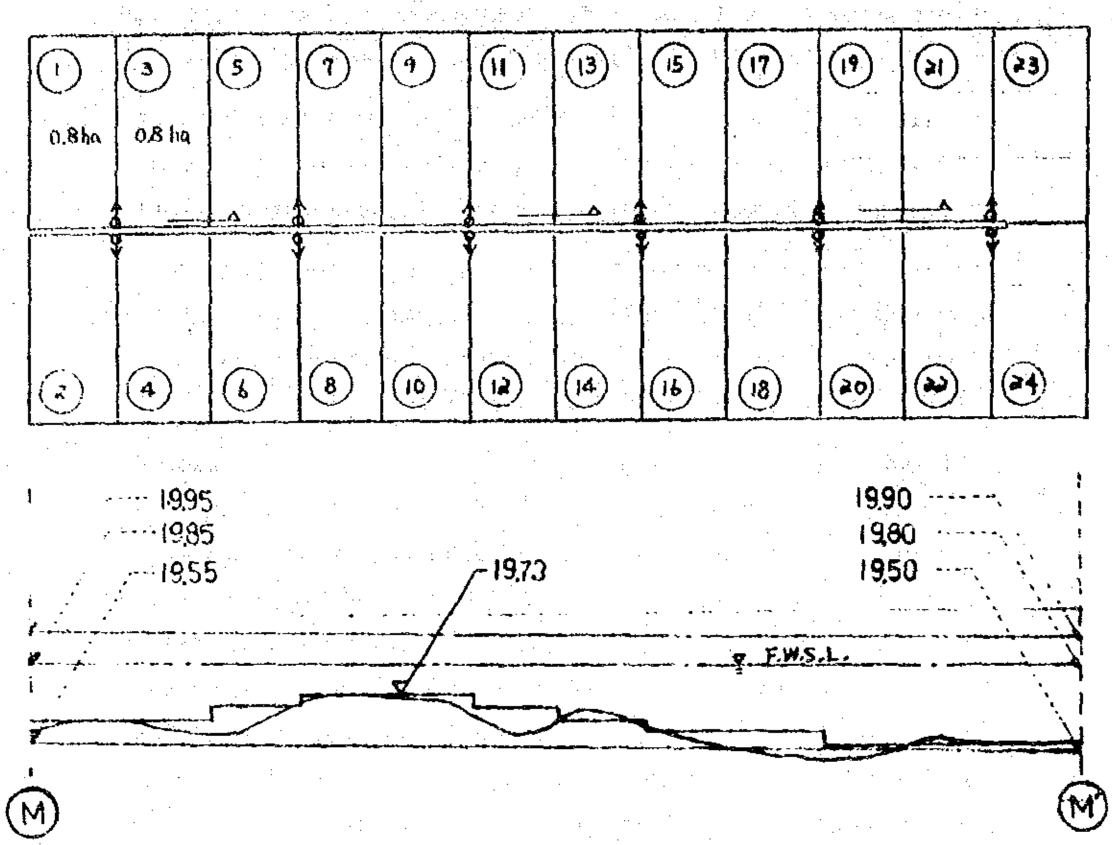


Fig I-9 Rotational Irrigation Plan



iii) Reference of Hight between ditch and paddy field

Even though we could keep design F.W.S.L. by those methods, some problems still remained.Rotational irrigation plan was made in one irrigation unit (19.2 ha). (See Fig I-9)

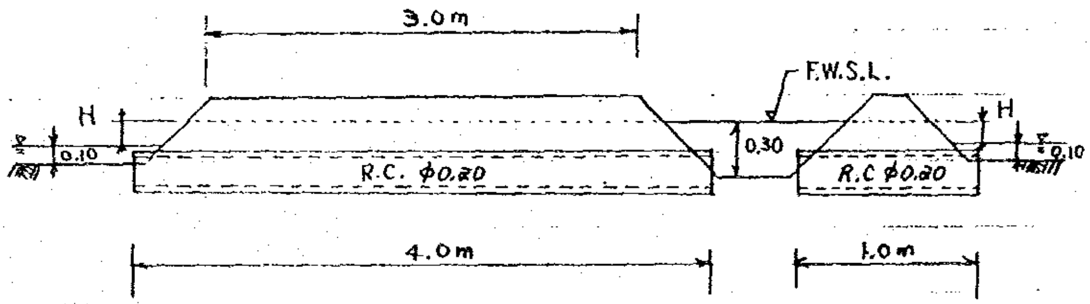
One irrigation unit had 24 standard farmplots (0.8 ha x 24 = 19.2 ha) at point Ⓜ-Ⓜ'. In puddling period, it would irrigate 1 plot per two days, totally 48 days for 24 plots.

But the construction work of each farm plot (0.8 ha) was not well enough in land levelling, so farmers could not get water thoroughly. They had to make borders for irrigation, and divide one plot into three or four parts.

Although F.W.S.L. could be kept as plan, some paddy fields (plot ⑦-⑩) could not get enough water for puddling by rate of one plot per two days, because the difference of elevation between F.W.S.L. and paddy field level (EL.19.73) would be only 0.10 m.※ Note 1 Therefore, the rotational irrigation schedule could not finish in 48 days. When the farmers at the down stream plots could not get water, they would find other methods, such as making the coffer dam in the drainage ditch and using the pump, to get water for their crops.

※ Note 1 : In order to get irrigated water $Q = 0.024\ m^3/s$, the difference between F.W.S.L. and paddy field level should be minimum 0.20 m as the following calculation (Fig I-10)

Fig I-10 Farm Inlet



$$H = \frac{8}{\pi^2 g} (1 + fi + f\frac{L}{D}) \cdot \frac{Q^2}{D^4}$$

H : Total head

fi : Coefficient of inlet loss = 0.50

f : Coefficient of friction loss

$f = f' . D$

$f' = 124.5 \frac{n^2}{D^{4/3}} = 0.2086$ (circular section, n=0.014)

$\therefore f = 0.2086 \times 0.20 = 0.04172$

Q : Water discharge = 0.024 m^3/sec

L : Length of pipe = 1.0 m, 4.0 m

D : Diameter of pipe = 0.20 m

In case of supply water to right side (L = 1.0 m)

H = 0.05 (m)

In case of supply water to left side (L = 4.0 m)

H = 0.07 (m) ≑ 0.10 (m)

So necessary difference between F.W.S.L. and paddy field level is

0.10 (H) + 0.10 (Water depth in paddy field) = 0.20 m

iv) Length of Earth Ditch

This ditch (Fig I-6) consisted of lateral ditch ((A)-(L), L = 2038.3 m) and farm ditch ((L)-(M), L = 930.2m), total length was 2968.5 m, all the line was the earth ditch. The maintenance work in the section between (A) and (B) was not well, for example, the side slope dropped down into the ditch, there were many holes made by crabs, rats and snakes, many coffer dams which farmers made for catching fish. The irrigation water could not flow smoothly because of much obstruction and leaking. The section between (B) and the end of the ditch, the cross section was smaller, was the same condition.

Especially the section between (A) and (J), the cross section of ditch was too big for farmers to maintain.

Considering the maintenance work, the maximum length of ditch should be 1,000 m, and the longer line than 1,000 m should be lined by concrete.

I-4 Reason for Unirrigable Area
(Extensive Land Consolidaiton Area)

I-4-1 Existing Design Method

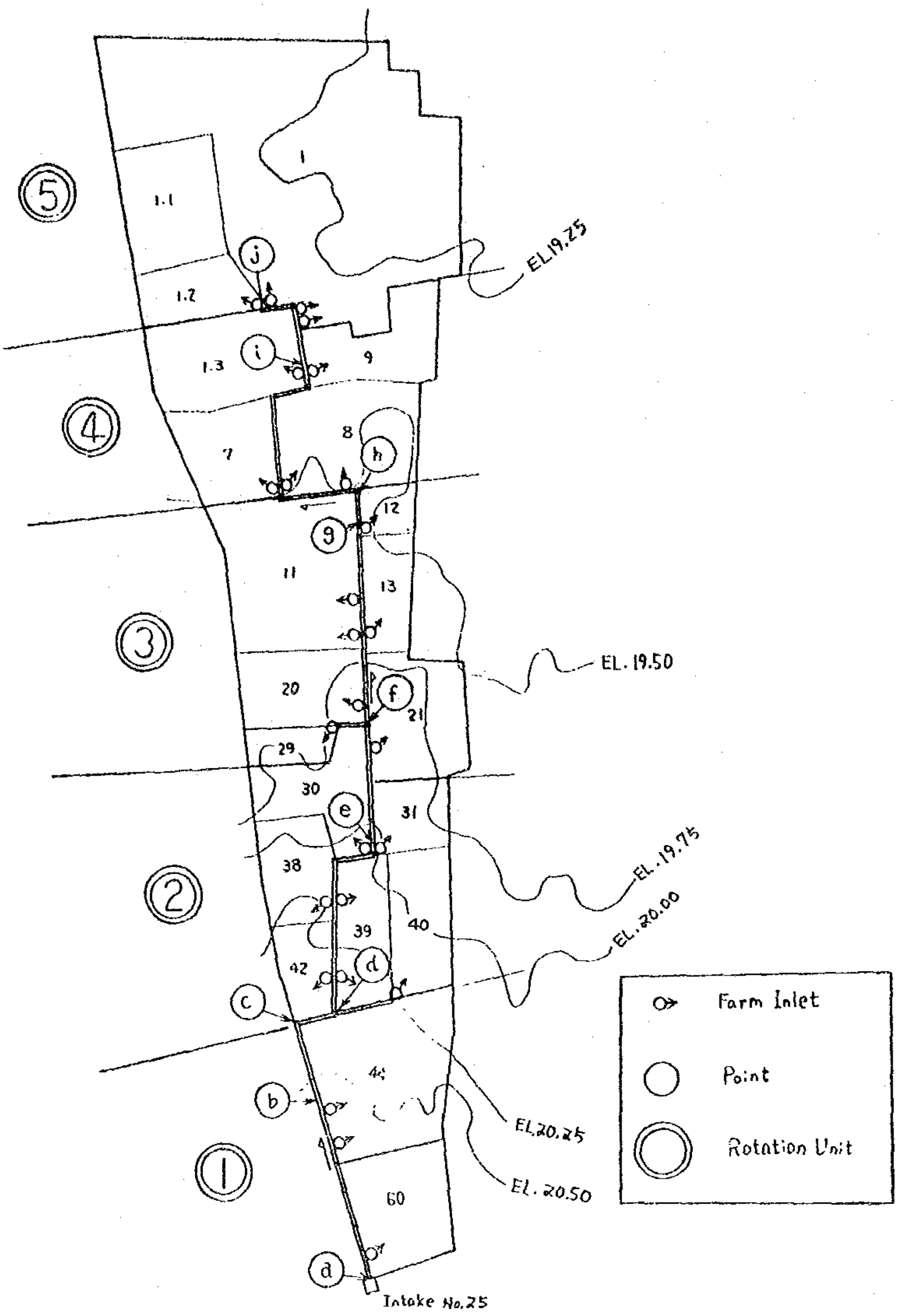
Fig I-11 shows the map of Intake No.25 at the downstream part, and Fig I-12 shows the longitudinal section of irrigation ditch No.25 (1L-1R). This area was constructed in 1983 by the extensive land consolidation method. It means that irrigation & drainage ditches and roads are constructed on the boundary of owners without block reformation and reploting. The reduction rate of farmland for ditches and roads is less than 7 %, which farmers have to offer without charge.

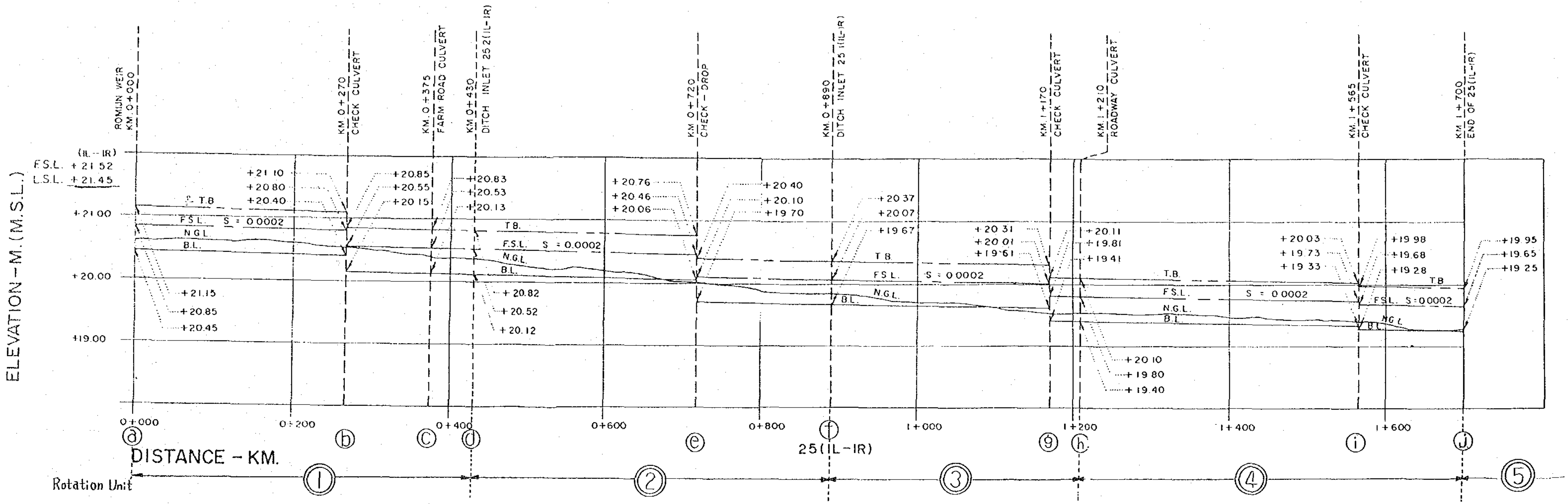
This area was designed by ILACO/EMPIRE according to the RID's design criteria. The design method is shown as follows:

i) The standard service unit is about 300 ~ 400 rai (48~64 ha). In Fig I-11, the service unit area of Intake No.25 (1L-1R) has 327 rai (52 ha).

ii) Every owner's plot should be contiguous to irrigation & drainage ditch and road as much as possible. (The number of each plot on Fig I-11 is owner's number, not farmplot's number. So each number has many farmplots.) The irrigation ditch should be designed on the higher part of area. In the case that high embankment or long line is necessary, or soil property is not suited to earth ditch, the ditch should be lined by concrete.

Fig I-11 Service Unit No.25 (1L-1R)





DITCH	DISTANCE – KM.		BED SLOPE	C.A.	Q	B	D	P.L.	TYPICAL SECTION
	FROM	TO	cm/km	(rai)	(m^3/s)	(m)	(m)	(m)	
25(IL-IR)	0+000	0+375	20	327	0.090	0.45	0.40	4.4	TYPE T_{C4}
	0+375	0+430	20	327	0.090	0.45	0.40	7.4	TYPE T_{C4}-R
	0+430	1+700	20	327	0.090	0.45	0.40	4.4	TYPE T_{C4}

Fig I-12 Profile Section of Ditch 25 (1L-1R)

iii) The longitudinal section of irrigation ditch is decided from the contour line on map and the existing longitudinal section. The minimum bed slope is 20 cm/km (1/5,000). The capacity of irrigation ditch should be decided from the following table (Table I-3) depending on the service unit area.

Table I-3 Ditch Capacity

Service unit area		Capacity of irrigation ditch
rai	ha	m^3/sec
0 ~ 130	0 ~ 20.8	0.030
131 ~ 260	20.9 ~ 41.6	0.060
261 ~ 391	41.7 ~ 62.5	0.090
392 ~	62.6 ~	0.120

※ Note 1 : Water duty (Unit duty of water) is 0.23 l/s/rai in this area.

※ Note 2 : The cross section of irrigation ditch should be the same from beginning to end, because of rotational irrigation in each service unit.

iv) Water discharge calculating table is used to decide the cross section of irrigation ditch.

※ Note 3 : Typical cross section (See Fig I-15)
Width of ditch's bottom (B) = Min 0.30 m
(if moer than 0.30m, increase 0.05 m by 0.05 m)
Slope gradient = Standard 1:1
Water depth (D) = Min 0.30 m
(if more than 0.30m, increase 0.05m by 0.05 m)
Free board = 0.15 m
(in addition to free board, more 0.15 m from the top of concrete lining to the top of embankment)
Coefficient of roughness (n)

Earth ditch	Feeder ditch	n = 0.030
	Farm ditch	n = 0.050
Concrete lining ditch		n = 0.016

I-4-2 Consideration

Plot No.60, 44, 1, 1-1, 1-2 had been unirrigable since just after the land consolidation work. Thereafter only plot No.60 and 44 were changed to be irrigable because of land cutting by motor grader. The remained plot No.1, 1-1 and 1-2 are still unirrigable. The reasons are considered as the following items.

i) Fall of F.W.S.L.

When irrigation water (0.23 l/s/rai x area) actually flows through ditch, it cannot keep F.W.S.L., because the capacity of ditch is decided each 0.030 m^3/sec.

For example, in Intake No.25, the service unit area is 327 rai, so the ditch capacity calculated from Table I-3 is 0.090 m^3/sec. The F.W.S.L. in the longitudinal section map is calculated from this 0.090 m^3/sec. However, the actual water discharge is 0.00023 m^3/s/rai x 327 rai = 0.075 m^3/sec, the difference between design and actuality is 0.015 m^3/sec. The solution method is the same, which increase water discharge to 0.090 m^3/sec or make some checkgates at the suitable places.

ii) Reference of Hight between ditch and paddy field

The rotational irrigation in the extensive area is planned in one service unit (in the intensive area, it is planned in one irrigation unit).

The service unit is divided into 5~7 rotation units. In the example by Intake No.25 (1L-1R), it is divided into 5 rotation units. When unit No.① is irrigated, unit No. ②~⑤ do not get water at all, continuing in order until the end of one rotation schedule,which is one round for one week.

In case to irrigate unit No. ①, the difference between F.W.S.L. and N.G.L, from Fig I-12, is only 0.20 m, which is the minimum of necessity. N.G.L. shows natural grand level before construction work, does not mean only paddy field elevation. In order to know the existing elevation of paddy, we have to read the contour map which shows the elevation each 0.25 m. It gives only rough result. In spite of that, the differences of water head was set only 0.20 m, ※ Note 1 so

F.W.S.L. was lower than the paddy after construction. Fortunately, the higher area than F.W.S.L. was only near the irrigation ditch and inlets, it was eassy to modify the land elevation.

Even if all inlet-gates in unit ①~④ were closed, unit ⑤ would be unirrigable. The elevation around ⓙ point was about EL 19.40 m from Fig I-11, F.W.S.L. was designed 19.65 m, which difference was 0.25 m. It looks as if there will be no problem to irrigate 0.030 m^3/sec through inlet but, according to the survey after construction, EL around ⓙ point is neary the same or a little higher than F.W.S.L. so this unit is unirrigable. The causes for unirrigable area are mainly the rough method which get paddy field elevation from contour map, and the accuracy of surveying and construciton. Moreover, it is because of the lack of designing in view of safety margin.

※ Note 1 : Calculation of pipe inlet's loss

$$H = \frac{8}{\pi^2 g} \left(1 + fi + f\frac{L}{D}\right) \cdot \frac{Q^2}{D^4}$$

H : Total head

fi: Coefficient of inlet loss = 0.50

f : Coefficient of friction loss = 0.04172

Q : Water discharge = 0.030 m^3/sec

L : Length of pipe = 1.0 m, 5.0 m.

D : Diameter of pipe = 0.20 m

In case of supply water to right side (L=1.0m)

H = 0.08 (m)

In case of supply water to left side (L = 4.0 m)

H = 0.12 (m) ≒ 0.15 (m)

So necessary difference between F.W.S.L. and paddy field level is

0.15 (H) + 0.10 (Water depth in paddy field)

= 0.25 m.

I-5 Suggestions

The reason for unirrigable area is mainly design which is the very economical without safety margin. To design F.W.S.L. at first, it is possible to irrigate theoretically, little mistake makes the unirrigable area or the shortage of irrigation water, because of not so good surveying and construction. Moreover it is very difficult to control irrigation water.

The suggestion is that the irrigation ditch of on-farm work should be designed from the bottom of ditch (B.L.) first. B.L. should be set the same level as the highest paddy field or 5 cm lower than that at least. Then draw B.L. from upper-stream to downstream including the head loss of pipe culvert. In that case, because B.L. of upperstream is always higher than downstream, water flows easily without keeping F.W.S.L. and it is very easy to control water.

The suggestion could be applicable to feeder and farm ditch on on-farm development work only. Of course, it is in applicable to main or lateral canal.

Fig I-13

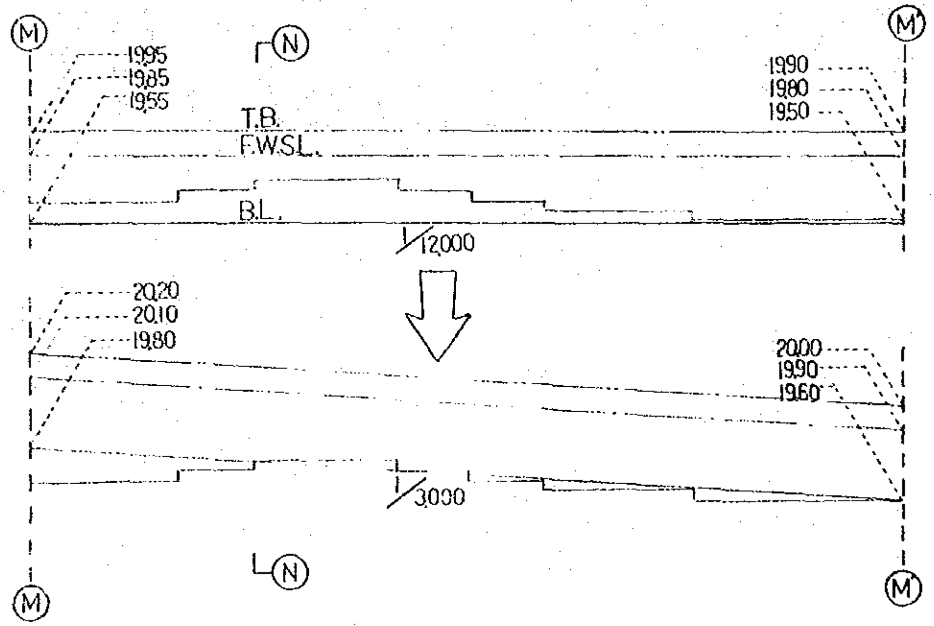


Fig I-13 shows the farm ditch TL 1-3.8 in Pilot Project No.1, the upper figure is the design which sets F.W.S.L. first, the lower is set B.L. first. Bed slope of farm ditch should be more than $^1/3000$ (feeder ditch should be more than $^1/5000$)

Comparing upper and lower map, difference at Ⓜ point is 0.25 m, Ⓜ point is 0.10 m, the average is 0.175 m. Every irrigation ditch in Pilot NO.1 had already been improved as the lower plan since March,1984. Presently it is possible to irrigate water to each farmplot.

Fig I-14 (N) - (N) Cross Section

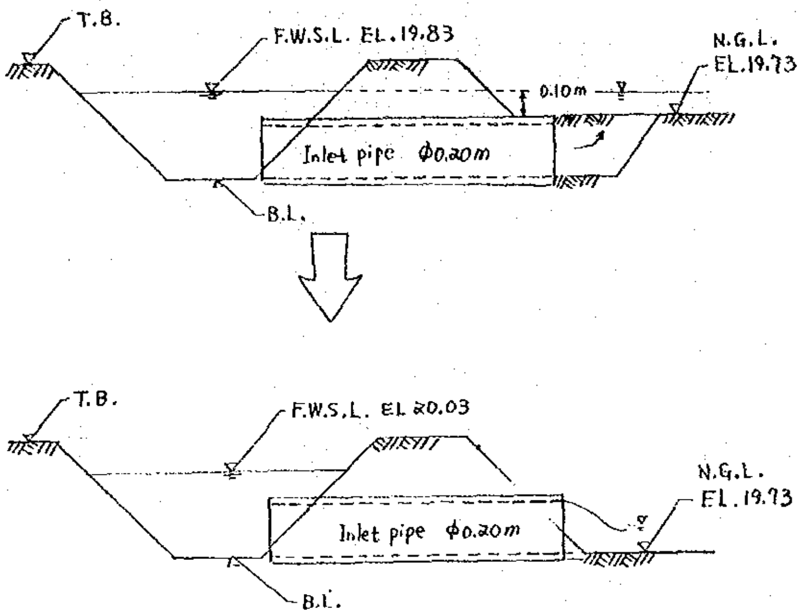
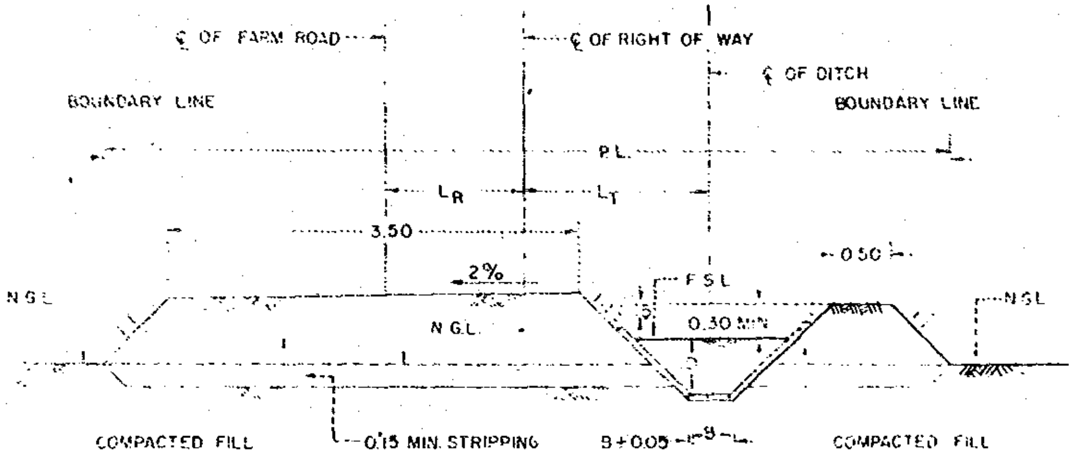


Fig III-14 shows the cross section of (N)-(N) in TL1-3.8, the lower map shows B.L. equally to N.G.L. Even if F.W.S.L. fall down less than design, it is not only irrigable but also easy for water-management.

Similarly, if irrigation ditch in extensive land consolidation area, Intake No.25 (1L-1R), would be designed by the method which B.L was set first, it should be increased to 0.20 m (average) all through the ditch. According to the typical section map (See Fig III-15), the free board is 0.15 m, in addition to that, more 0.15 m from the top of concrete lining to the top of embankment. Generally, the free board is 0.15~0.20 m just enough. To increase To encrease the B.L. about 0.20 m sould cost only less amount of embankment, would not increase. too much construction cost. Presently this service unit (No.25) is taking irrigation water more than design, water surface is higher than the top of concrete lining, but unit No(5) is still unirrigable in dry season. It seems that not only this area but also all the area of land consolidation face such problems.

Fig I-15 Typical Section (Extensive)



In order to solve them, it would be better to set B.L. higher than N.G.L. about -5 ~ 0 cm. Then every area could get full utilities from the irrigation system and on-farm development work, and it is very effective to control water and to organize the water user's groups.

II. ROTATIONAL IRRIGATION SCHEDULE

– Mae Klong Pilot Project No. 1 (Intensive Method)–

II-1 Original Plan

Referring to the Design Report of Mae Klong Pilot Project in the Technical Co-operation Project on the Irrigated Agriculture Development in Thailand, dated December 1977, by Japan International Cooperation Agency (JICA), the original irrigation plan was as the following.

II-1-1 Farm Plot

From the viewpoints of exchange and consolidation of the farmland, operation efficiency of farming machines and effective water management, the shape of plots should be informed rectangle. So far as conditions permit in water management and leveling accuracy, the possibly longer length of run will be advantageous for reducing, the deduction rate of land and efficient operation of farming machines. It is deemed resonable to take a length of run at 160 m in the area. The width of plot will be reasonably taken at 50 m in the area, which extends flat and has no restriction from the topographical conditions.

With the completion of the project, 461 of farmplots will be formed in the area except the Trial Farm.

II-1-2 Irrigation Unit

For a consideration of the water management, the suitable length of the farm ditch should be 600 m in maximum. One irrigation unit should be composed of 24 plots as illustrated below.

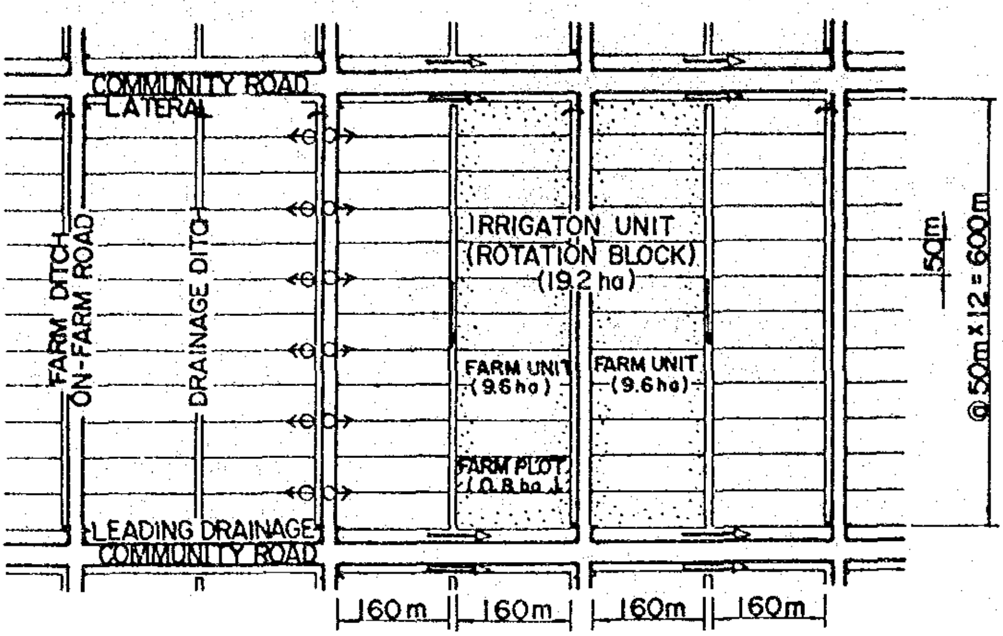


Fig II-1

Farm Plot	160m x 50m	=	0.8ha (5 rai)
Irrigation Unit	0.8ha x 24 plots	=	19.2ha(120 rai)
Farm Inlet	↻		12 units

II-1-3 Irrigation Plan

The distribution sub-system is the terminal system and each sub-system commands one irrigation unit which is composed of 24 farmplots. One sub-system consists of one farm ditch and twelve farm inlets that distribute the water from the farm ditch into the farm plots. Each of farm inlets covers four farm plots.

During the land preparation period of paddy fields, the rotational irrigation method is proposed to irrigate one distribution sub-system (24 farm-plots) for 48 days, supplying water at the rate of two days per a farm plot.

II-2 Consideration

Considering of the design report (see I), the construction work had been different from design, and there are a lot of problems in cooperations among the farmers. The difficulties and problems are shown as the following items.

1. Buldozer work, first the land levelling technic was not well and second the work time was not enough because of the less cost estimation, could not work out following the design. After the levelling work, the levelling accuracy was about ± 0.15 m (it means 0.30 m average differency between the lowest and the highest). To get the available land for the paddies (± 0.05 m), farmers had to make many small borders for irrigation on their farm plots. Namely, existing farm plots are divided into three or four plots, the irrigation method is plot-to-plot irrigation.

2. The construction work was different from the design report and followed the design criteria of R.I.D.(Royal Irrigation Department), which used one inlet pipe per 20 rai, the density of the inlet was only half of the design report's plan (one inlet pipe per 10 rai).

3. After the land consolidation, the water users groups were set, the ditch presidents were chosen from the farmers. However, the water users groups could not cooperate well, they did not follow the irrigation schedule, and operated the inlet or turnout gates freely.

4. Even if the upper-stream plots' farmers do not need the irrigation water, they do not close the inlet gates and drain water through the drainage ditch directly. The irrigating and draining are existing at the same time, so irrigation water can't reach adequately to the down-stream plots' farmers.

In solving their problems, the down-stream farmers took the water from drainage ditch by using coffer dam and the engine-pump. Continuously, they did not want to pay for the maintenance fee.

5. All of the area Pilot Project No.1, the upper and lower part of Pilot Project No.1 is higher than another land consolidation area, the pumping station is necessary for the irrigation at the beginning point of 1L-1R canal. The pumping station's problems, such as motor trouble and a stoppage of the

electric power, occur many difficulties, especially in the puddling period which needs much irrigation water continuously.

6. Pilot project No.1 is situated in the border of the two villages, Tambon Moungchum and Tambon Banmai. The labour-farmers are from both villages, such a long distance. It's inconvinient to have the meeting or cooperation of the farmers, so the water users groups cannot go on well.

7. Some of the farmers who are engaged in farm work practically are the land owners but some are tenants and some are employed to work. It's impossible to list up the exact names of ones who work in each season, to ask or inform them the cooperations for the maintenance work such as maintaining the ditches, cutting weeds, informing the irrigation rotation schedules and so on.

II-3 Practically Plan

To forward the water management work practicably, the improved plan should be made as the following items.

II-3-1 Rotation Unit

Referring to the design report (see II-1), the rotation irrigation time in puddling period is two days per one farm plot, totally 48 days in each of the irrigation unit. In existence, the different design from the design report made the rotational schedule unsuccessful. In the case that minute rotational schedule is made according to the original plan, operation time is sometimes night time. And the unwell cooperation among the farmers makes it more difficult to manage the rotational irrigation.

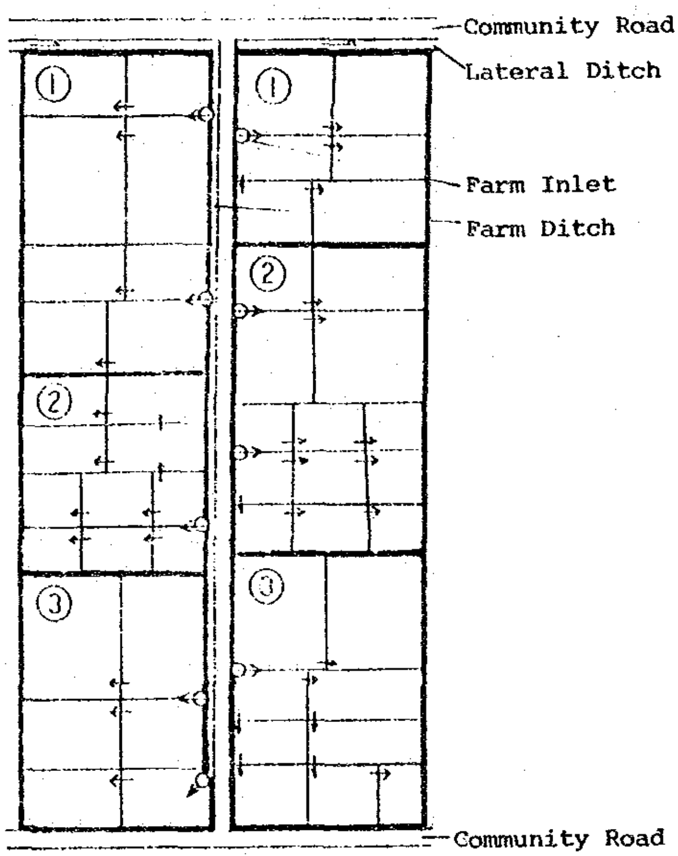


Fig II-2

In improving the rotation method practically, the irrigation unit should be divided into three rotation units (see Fig II-2), which is the flexibly way of the water management work and easily understanding for the farmers.

The irrigation unit should be divided into three rotation units according to the following three items.

1. Division by Length

The standard length of farm ditch is 600 m. Divide the farm ditch length into 3 parts each 200 m. The command area of the inlets in each rotation unit should be in the 200 m length.

2. Division by Area

Divide the farm plots' area into the same or nearly the same area to make each rotation unit's area same size.

3. Division by Owner

Divide the rotation unit by the owners. The area of one owner should belong to the same rotation unit.

The rotation unit should fulfill the above three items as far as possible.

In the case that it should not be divided into three rotation units, it is possible to have two or four rotation units.

II-3-2 Rotation Irrigation Time

When the irrigation starts, each unit could be supplied water by the three cases as following.

Case 1. Supply water to rotation unit ① , No water would be lost at all. The rotation unit ① could get water fully 100 %.

Case 2. Supply water to rotation unit ② , some water would leak to the paddy (but it is the useful water) through the near inlets of holes made by animals to rotation unit ① . According to the experimental water management study, the leaking water would be about 7.5 % of full irrigated water and remaining 92.5 % would be supplied to rotation unit ②

Case 3. Supply water to rotation unit ③ , the leaking water to rotation unit ① and ② would be 15 % (7.5 % + 7.5 %) of full irrigated water, remaining 85 % to rotation unit ③ . (See Fig II-3)

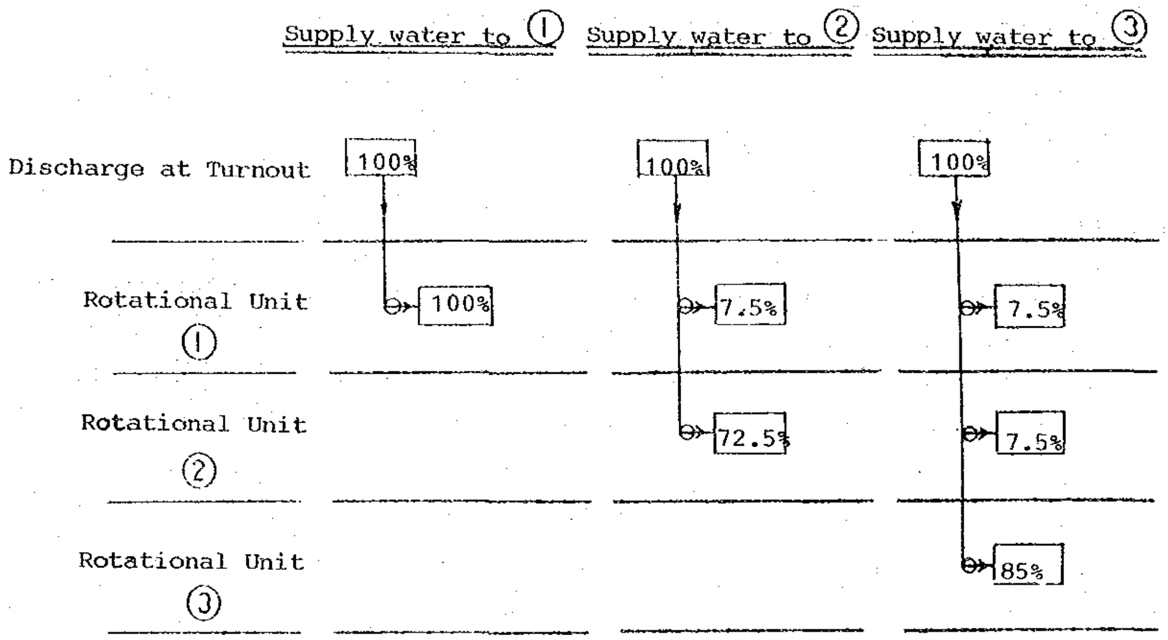


Fig II-3

The peak of water requirement is constant, the irrigated water to each rotation unit is various quantity. In order to irrigate water quantity equally to each of all rotation units, irrigation time should be set as the below calculation formulars.

i) Irrigation time of the irrigated water to ③ : T_3

$$T_3 = 7 \times 24 \times \frac{1}{3} \times \frac{1}{0.85} = 65.9 \text{ (hr)}$$

ii) Irrigation time of the irrigated water to ② : T_2

$$T_2 = (7 \times 24 \times \frac{1}{3} - 65.9 \times 0.075) \times \frac{1}{0.925}$$

$$= 55.3 \text{ (hr)}$$

iii) Irrigation time of the irrigated water (1) : T_1

$$T_1 = (7 \times 24 \times \frac{1}{3} - 55.3 \times 0,075 - 65.9 \times 0.075) \times \frac{1}{1.00}$$

$$= 46.9 \text{ (hr)}$$

Comparing the rotation unit 2 with 1, the irrigation time in (2) is 1.2 times of (1) (55.3/46.9 = 1.18 = 1.2).

And the rotation unit (3) with (1), the irrigation time in (3) is 1.4 times of 1 (65.9/46.9 = 1.4).

II-3-3 Operation Time of Inlet Gate

According to the rotation schedule of R.I.D. (Operation and Maintenance Project's staffs), the rotation blocks are separated into 6-9 blocks, too many units. The calculation result includes operation period which are very late in the night or very early morning. So no one comes to open or close the farm inlet gates. It's difficult to separate the farm plots area equally because of too many units (6-9 blocks). And the farmers could not follow that schedule because of the inconvenience operation time. The operation time should be only in the day time.

From the experimental work, the operation time should have four periods (each 6 hours) in one day 24 hours. And the existence should set only three times in the day time as:

6:00 a.m.
12:00 a.m.(noon)
6:00 p.m.

The farmers in Pilot Project No.1 mostly go to their fields by motorcycles or bicycles, about 2-4 kms distance. On 6:00 a.m. would be the starts of their works , at 12:00 a.m. it's lunch time and on 6:00 p.m. they would stop their works. They could easily open or close the inlets or turnouts' gates in those times.

In some cases as follows:

From the calculation of rotation unit in one week 168 hrs, if the period is exactly on 0:00 a.m.(midnight), it should be postponed to be 6:00 a.m. The time for adjustment is the maximum twelve hours.

In the case of separating the irrigation unit into three rotation units, the calculation form is as follows:

168 hr - (3 rotation units - 1) x 6 hr = 156 hrs

The 156 hrs is the Effective Irrigation Time which should divide into three periods, and the remaining 12 hrs is the flexible time for adjustment. The sample of the calculation of irrigation time is shown in Fig II-4 and in Table II-1.

In the case of separating the irrigation unit into two rotation units, the calculation form is as follows:

168 hr - (2 rotation units - 1) x 6 hr = 162 hrs

The 162 hrs is the Effective Irrigation Time.

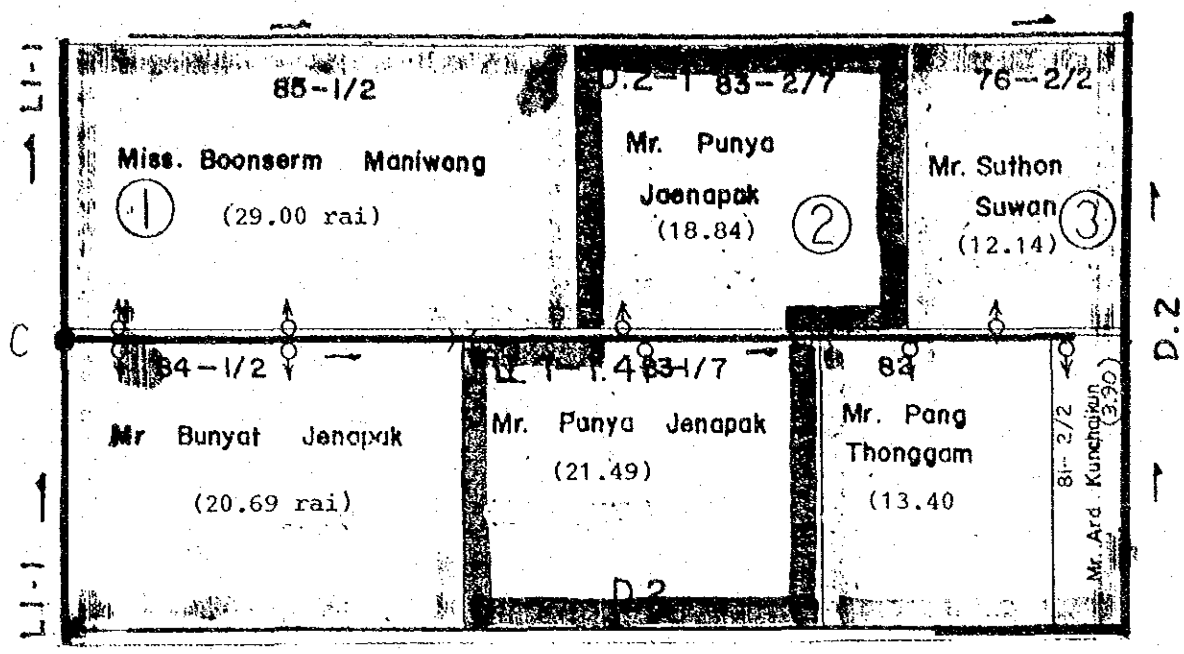


Fig II-4

ROTATIONAL IRRIGATION SCHEDULE

TL 1 - 1.4

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a′ (rai)	E.I.T. (hr)	Irrigation time (hr)
①	84 - ½ 85 - ½	2 2	Mr. Bunyat Miss Boonserm	20.69 29.00	a x 1.0	$\frac{a'}{A'} \times 156$	Mon 6:00 ∫ Wed 18:00
Total		4		49.69	49.69	56	60
②	83 - 1/7 83 - 2/7	1 2	Mr. Punya Mr. Punya	21.49 18.84	a x 1.2	$\frac{a'}{A'} \times 156$	Wed 18:00 ∫ Sat 6:00
Total		3		40.33	48.40	55	60
③	76 - 2/2 81 - 2/2 82	1 1 1	Mr. Suthon Mr. Ard Mr. Pang	12.14 3.90 13.40	a x 1.4	$\frac{a'}{A'} \times 156$	Sat 6:00 ∫ Mon 6:00
Total		3		29.44	41.22	46	48
Grand Total		10		A=119.46	A′=139.31	156	168

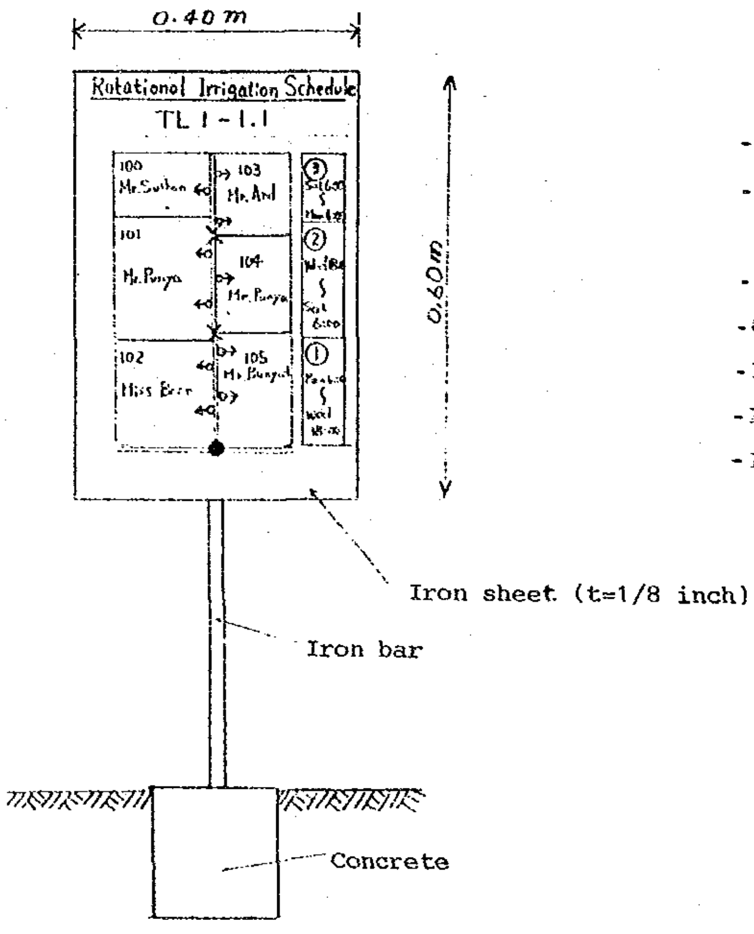
Irrigation time 7 days x 24 hr = 168 hr

E.I.T. (Effective Irrigation Time) 168 hr - (3 unit - 1) x 6 hr = 156 hr

Table II-1

II-4 Extension

The farmers in more than half of the Pilot Project No.1 area are tenants. Sometimes the farmers employ the other farmers for ploughing, puddling or harvesting. To develop and promote the water users groups for the water management, the official staffs from many departments could not inform or suggest the methods to the concerning farmers. The farmers could not know or understand the method well and could not cooperate each others well. To forward the work, the rotation irrigation schedule boards are needed at the beginning point of each farm ditch. The board indicates the irrigation unit, irrigation time, ditches' names, plots' number, owners' names, farm inlets and pipe culvert as shown in Fig II-5.



Items

- Ditch Name
- Maximum Water Discharge (Ditch Capacity)
- Farm Plot No.
- Owners' Name
- Farm Inlet
- Pipe Culvert
- Irrigation Time

Annex 1

FLOWCHART OF THE INTAKES

Peak Irrigation Requirement

The peak irrigation requirement determines the capacities of the irrigation systems. The peak irrigation requirement will occur in the last day of puddling periods for dry season's crop, and is designed as shown below:

Water requirement in depth 7.72 mm/day (Design Report, Dec. 1977)

Irrigation Efficiency

$$f = f_1 \times f_2 \times f_3 = 0.70 \times 0.95 \times 0.90 = 0.60$$

f : Irrigation Efficiency

f_1 : Field Efficiency = 0.70

f_2 : Conveyance Efficiency = 0.95

f_3 : Operation Efficiency = 0.90

Peak requirement 11.03 mm/day

$$7.72 \times \frac{1}{f_1} = 7.72 \times \frac{1}{0.70} = 11.03$$

f_1 : Field Efficiency = 0.70

Diversion requirement 12.90 mm/day

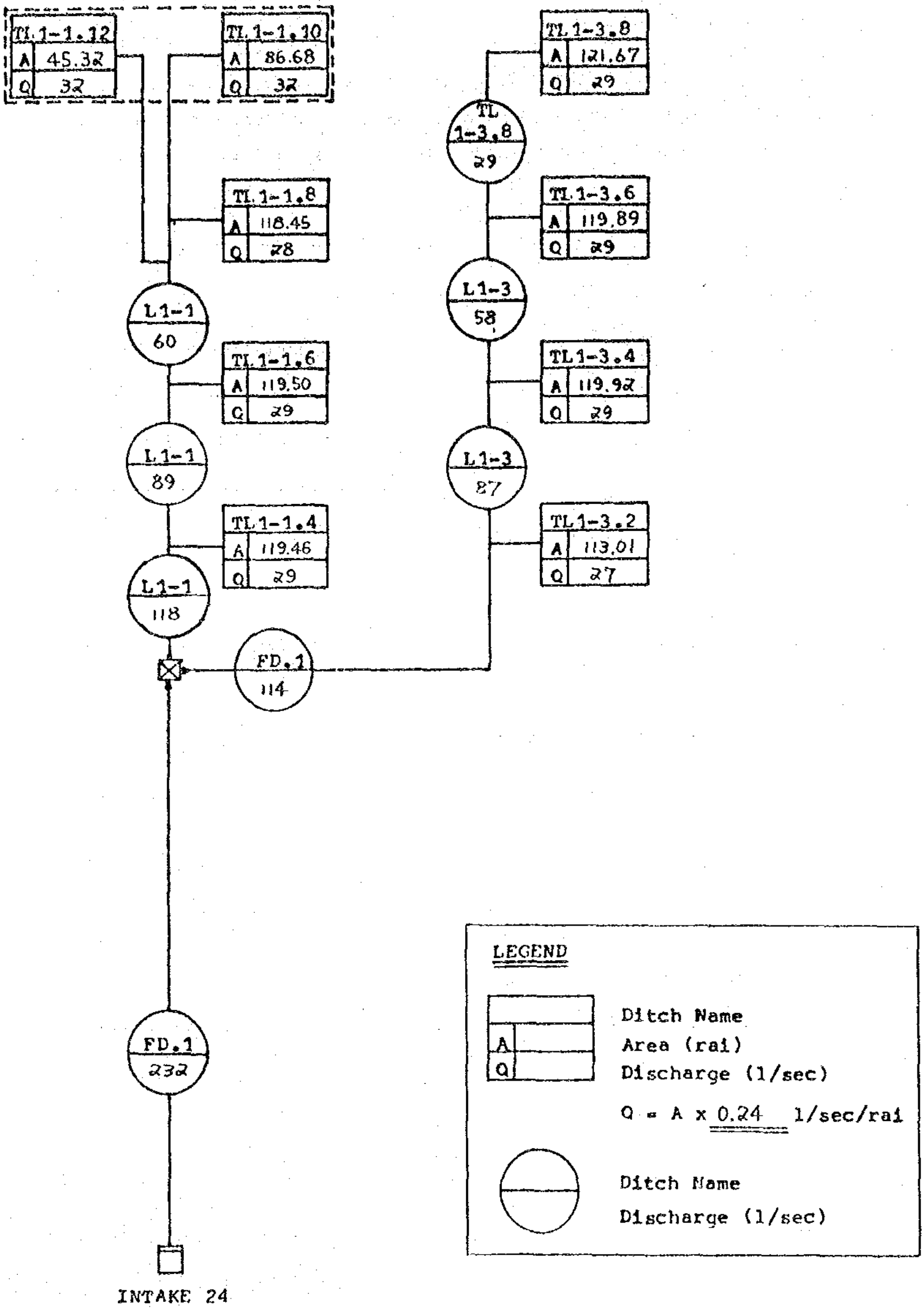
$$11.03 \times \frac{1}{f_2 \times f_3} = 11.03 \times \frac{1}{0.95 \times 0.90} = 12.90$$

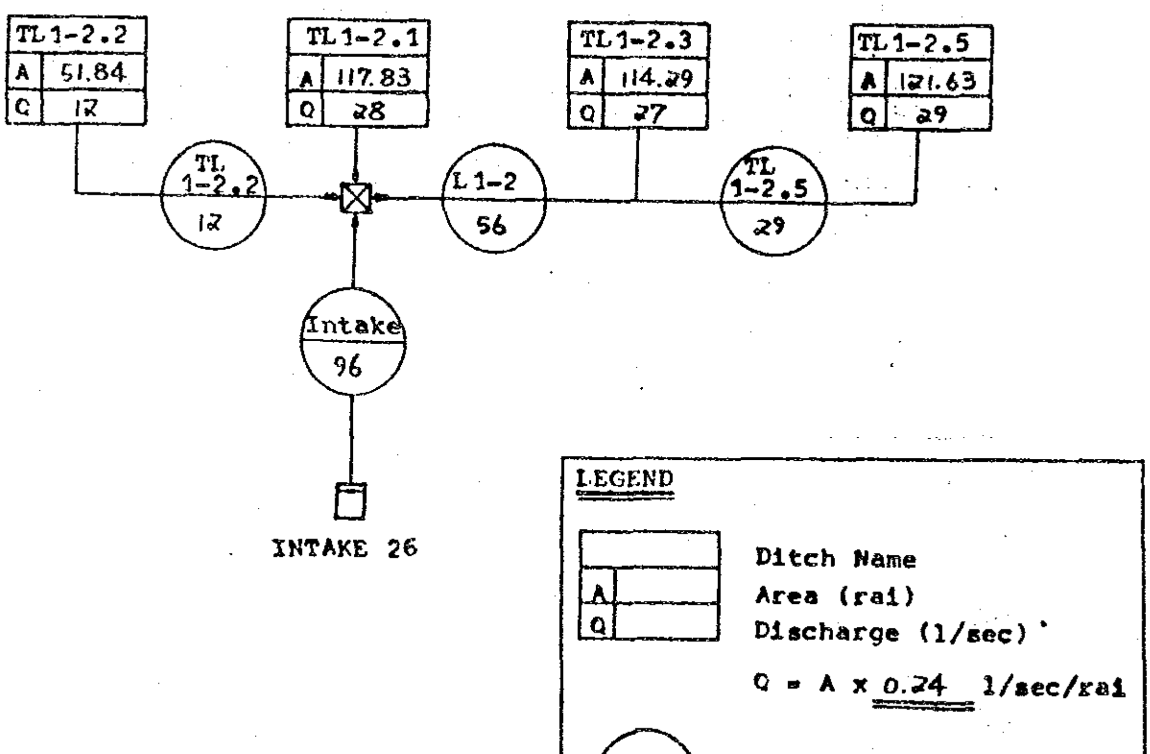
f_2 : Conveyance Efficiency = 0.95

f_3 : Operation Efficiency = 0.90

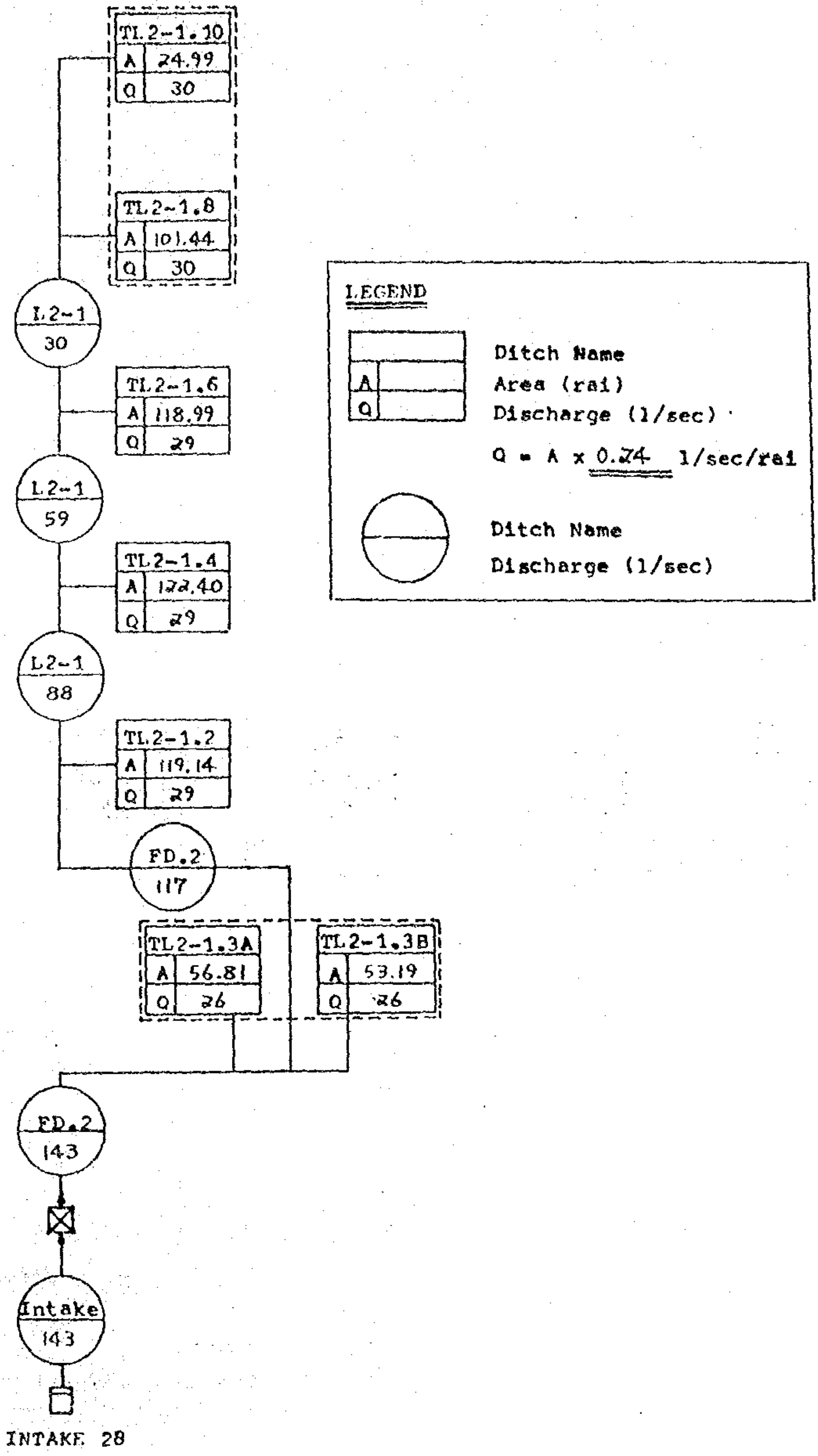
Diversion requirement per rai

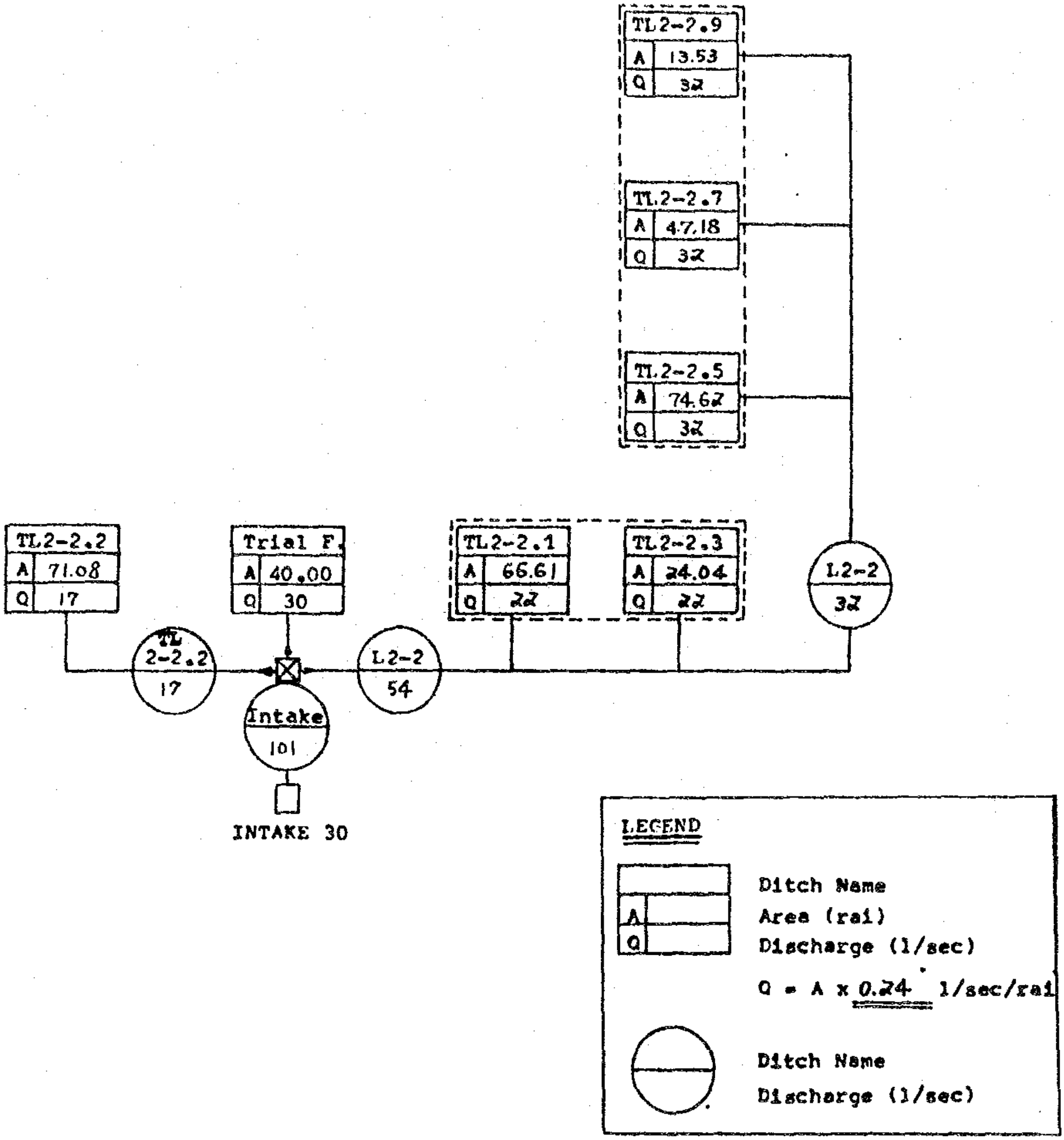
$$12.90 \text{ mm/day} \times \frac{40 \times 40}{1000} \times 1000 \times \frac{1}{24 \times 60 \times 60} = 0.24 \text{ l/sec/rai}$$


TL 1-1.12
A 45.32
Q 32
TL 1-1.10
A 86.68
Q 32
TL 1-3.8
A 121.67
Q 29
TL 1-3.8
29
TL 1-1.8
A 118.45
Q 28
TL 1-3.6
A 119.89
Q 29
L1-1
60
L1-3
58
TL 1-1.6
A 119.50
Q 29
TL 1-3.4
A 119.92
Q 29
L1-1
89
L1-3
87
TL 1-1.4
A 119.46
Q 29
TL 1-3.2
A 113.01
Q 27
L1-1
118
FD.1
114
FD.1
232
INTAKE 24
LEGEND
A
Q
Ditch Name
Area (rai)
Discharge (l/sec)
Q = A x 0.24 l/sec/rai
Ditch Name
Discharge (l/sec)



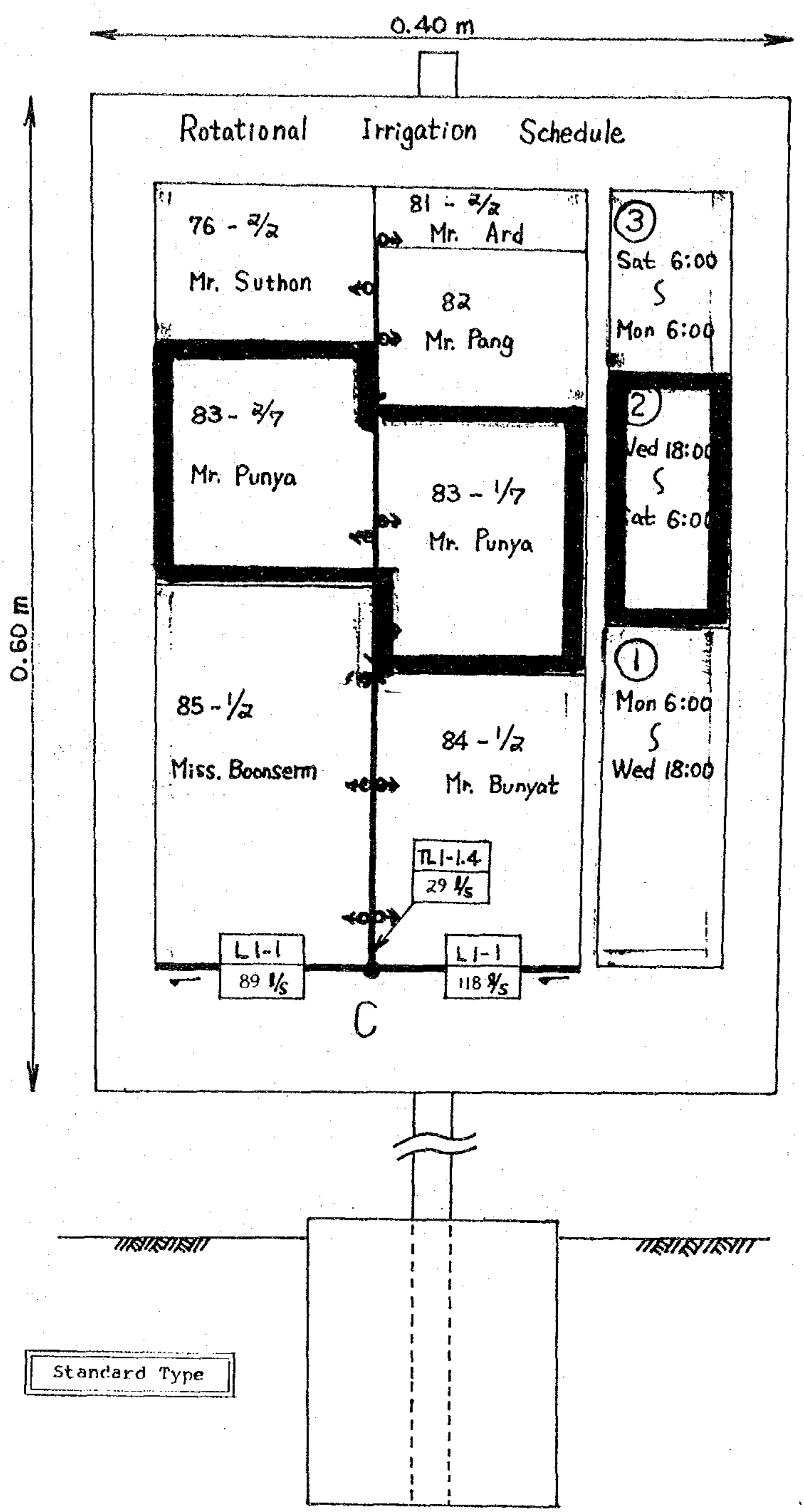
TL 1-2.2
A 51.84
Q 12
TL 1-2.1
A 117.83
Q 28
TL 1-2.3
A 114.29
Q 27
TL 1-2.5
A 121.63
Q 29
TL 1-2.2
12
L 1-2
56
TL 1-2.5
29
Intake
96
INTAKE 26
LEGEND
A
Q
Ditch Name
Area (rai)
Discharge (l/sec)
Q = A x 0.24 l/sec/rai
Ditch Name
Discharge (l/sec)


TL2-1.10
A 24.99
Q 30
TL2-1.8
A 101.44
Q 30
L2-1
30
TL2-1.6
A 118.99
Q 29
L2-1
59
TL2-1.4
A 122.40
Q 29
L2-1
88
TL2-1.2
A 119.14
Q 29
FD.2
117
TL2-1.3A
A 56.81
Q 26
TL2-1.3B
A 53.19
Q 26
FD.2
143
Intake
143
INTAKE 28
LEGEND
A
Q
Ditch Name
Area (rai)
Discharge (l/sec)
Q = A x 0.24 l/sec/rai
Ditch Name
Discharge (l/sec)


TL2-2.9
A 13.53
Q 32
TL2-2.7
A 47.18
Q 32
TL2-2.5
A 74.62
Q 32
TL2-2.2
A 71.08
Q 17
Trial F.
A 40.00
Q 30
TL2-2.1
A 66.61
Q 22
TL2-2.3
A 24.04
Q 22
L2-2
32
TL 2-2.2
17
Intake
101
L2-2
54
INTAKE 30
LEGEND
A
Q
Ditch Name
Area (rai)
Discharge (l/sec)
Q = A x 0.24 l/sec/rai
Ditch Name
Discharge (l/sec)

Annex 2

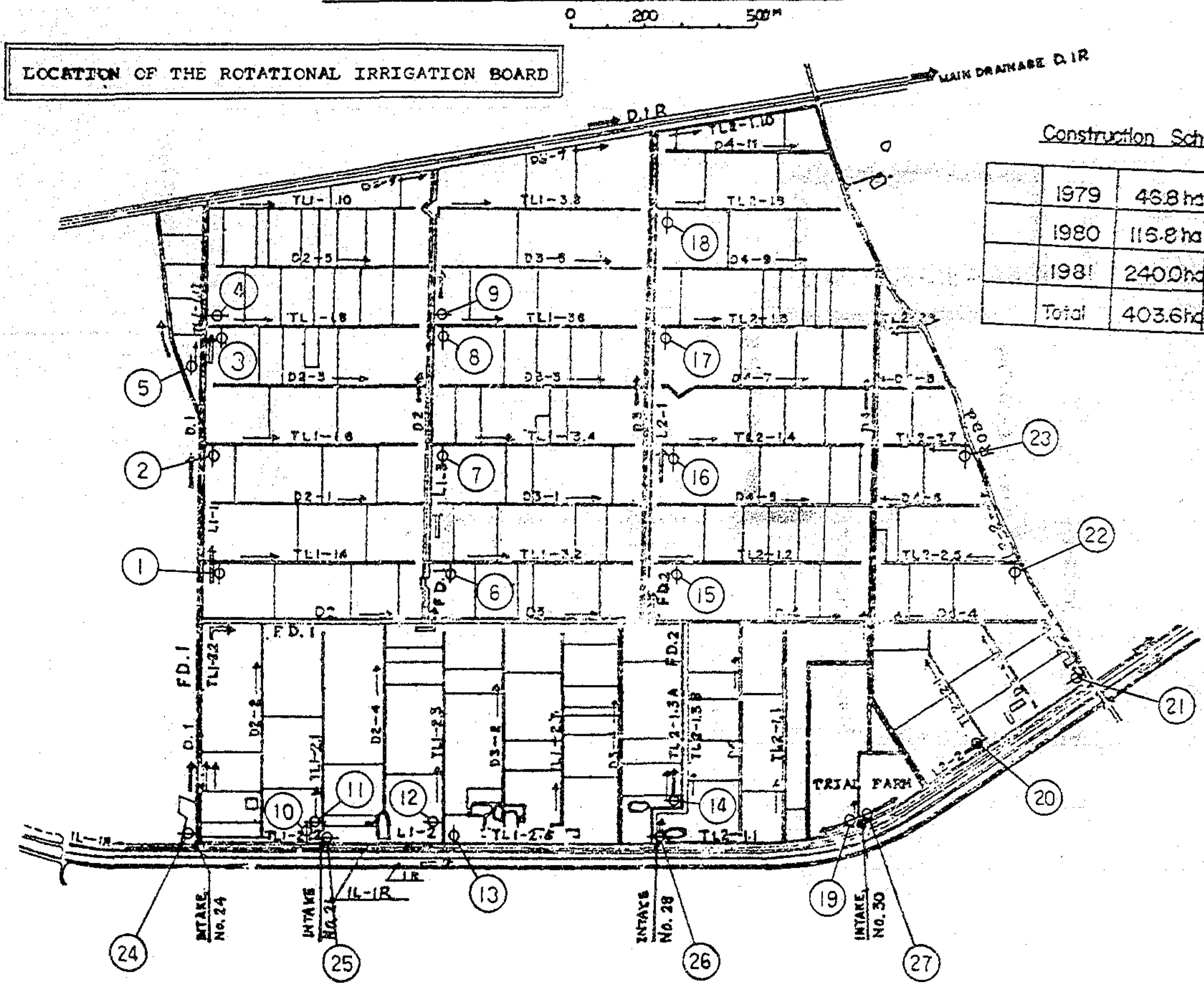
ROTATIONAL IRRIGATION SCHEDULE BOARD



Standard Type

Mae-Klong Pilot Project No. 1

LOCATION OF THE ROTATIONAL IRRIGATION BOARD

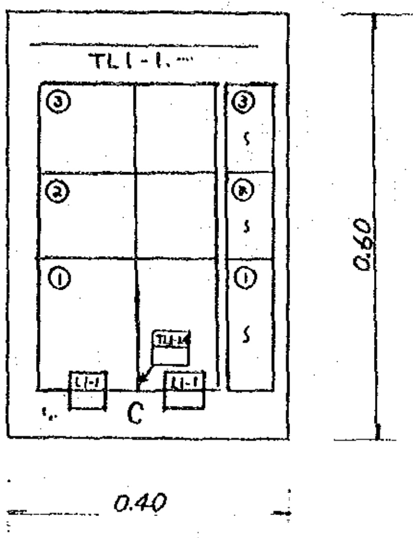


Construction Schedule

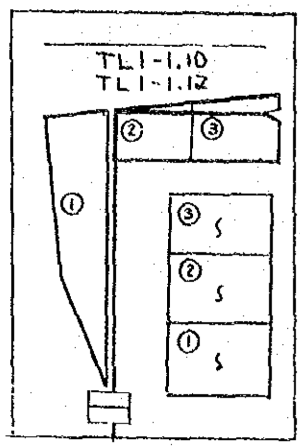
	1979	46.8 ha	Include Trial Farm 9.9ha
	1980	116.8 ha	
	1981	240.0 ha	
	Total	403.6 ha	

ROTATIONAL IRRIGATION SCHEDULE BOARD

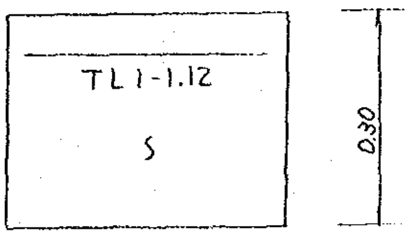
(1) (2) (3) Standard Type



(4)



(5)



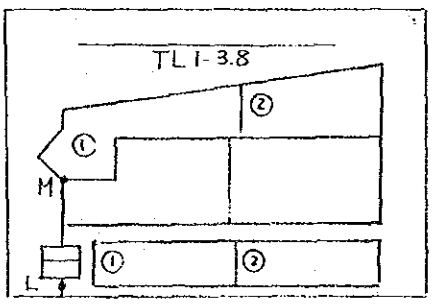
(6) (7) (8) Standard Type

TL1-3.2

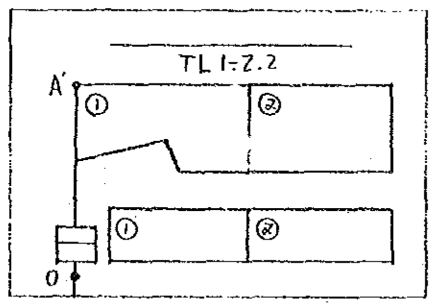
TL1-3.4

TL1-3.6

(9)



(10)

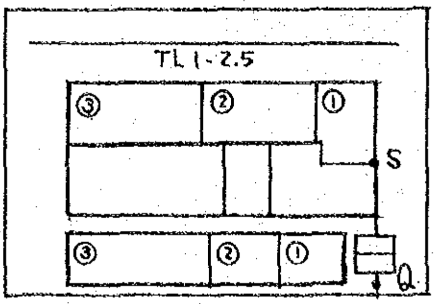


(11) (12) Standard Type

TL1-2.1

TL1-2.3

(13)



(14) (15) (16) (17) **Standard Type**

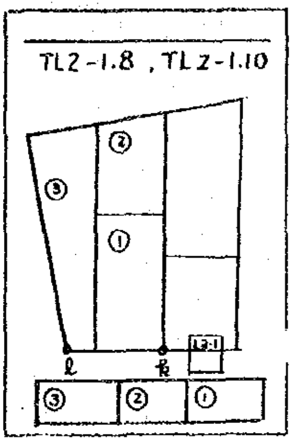
TL 2 - 1.3 A , TL 2 - 1.3 B

TL 2 - 1.2

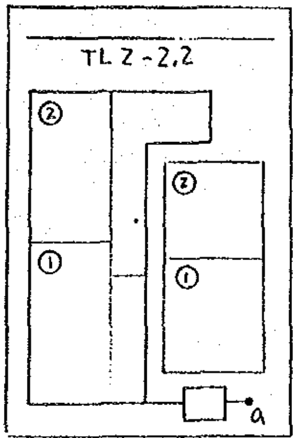
TL 2 - 1.4

TL 2 - 1.6

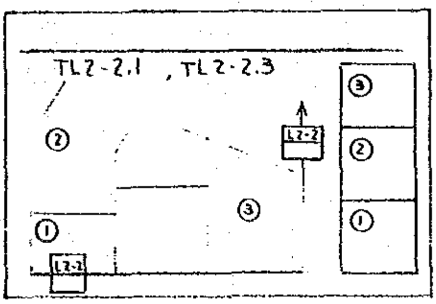
(18)



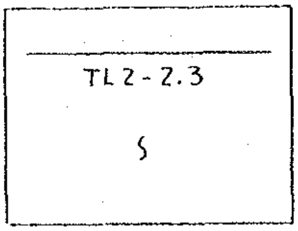
(19)



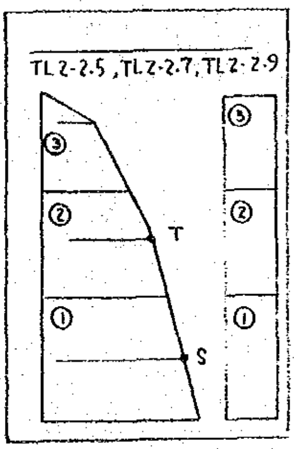
(20)



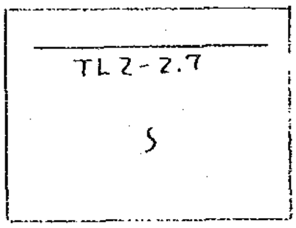
(21)



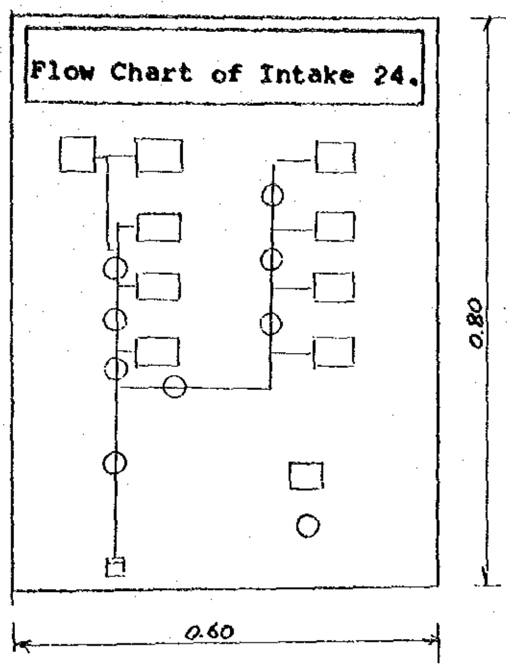
(22)



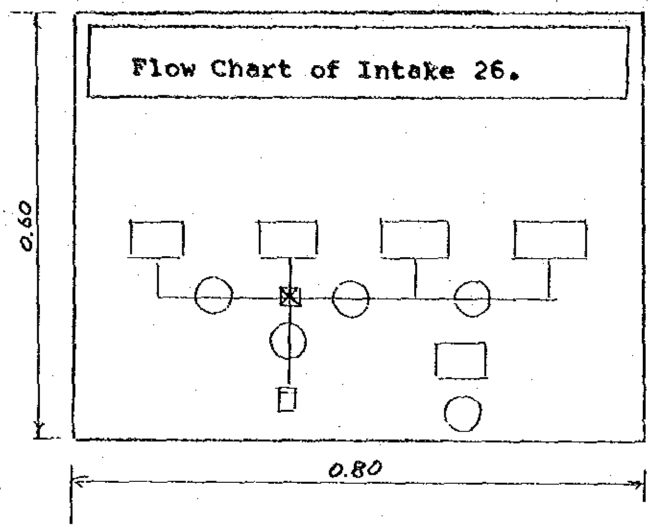
(23)



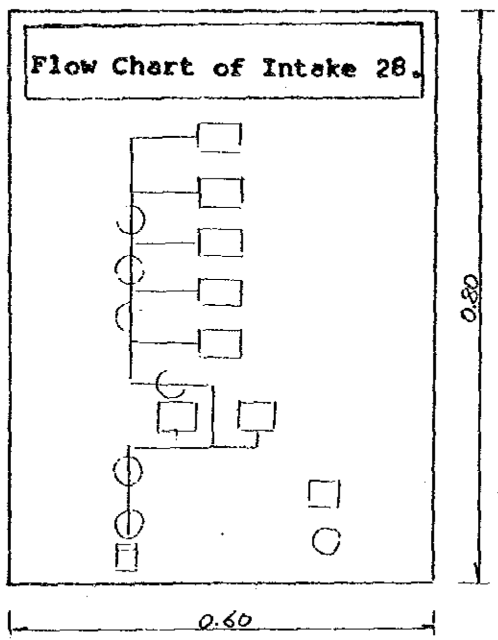
(24) INTAKE 24



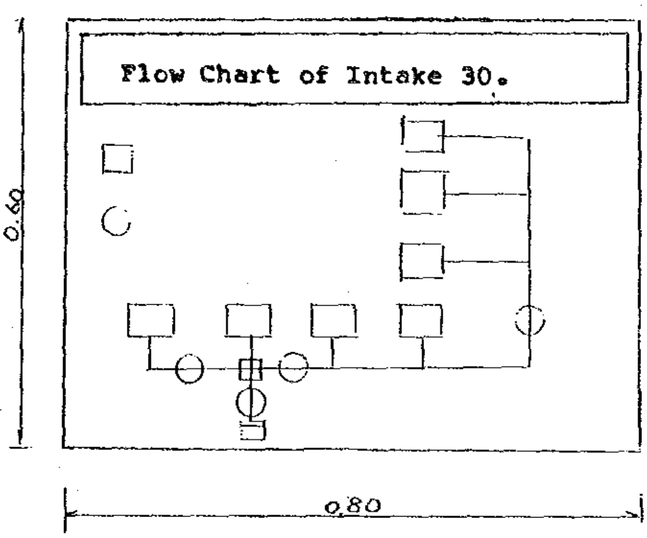
(25) INTAKE 26



(26) INTAKE 28

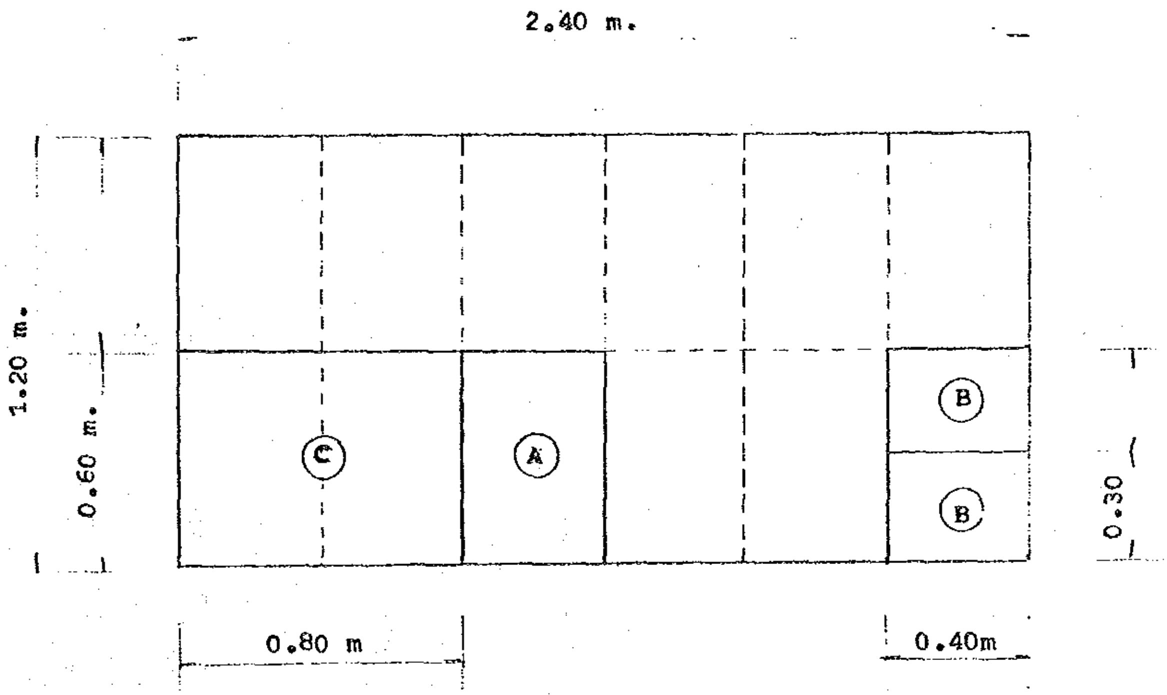


(27) INTAKE 30



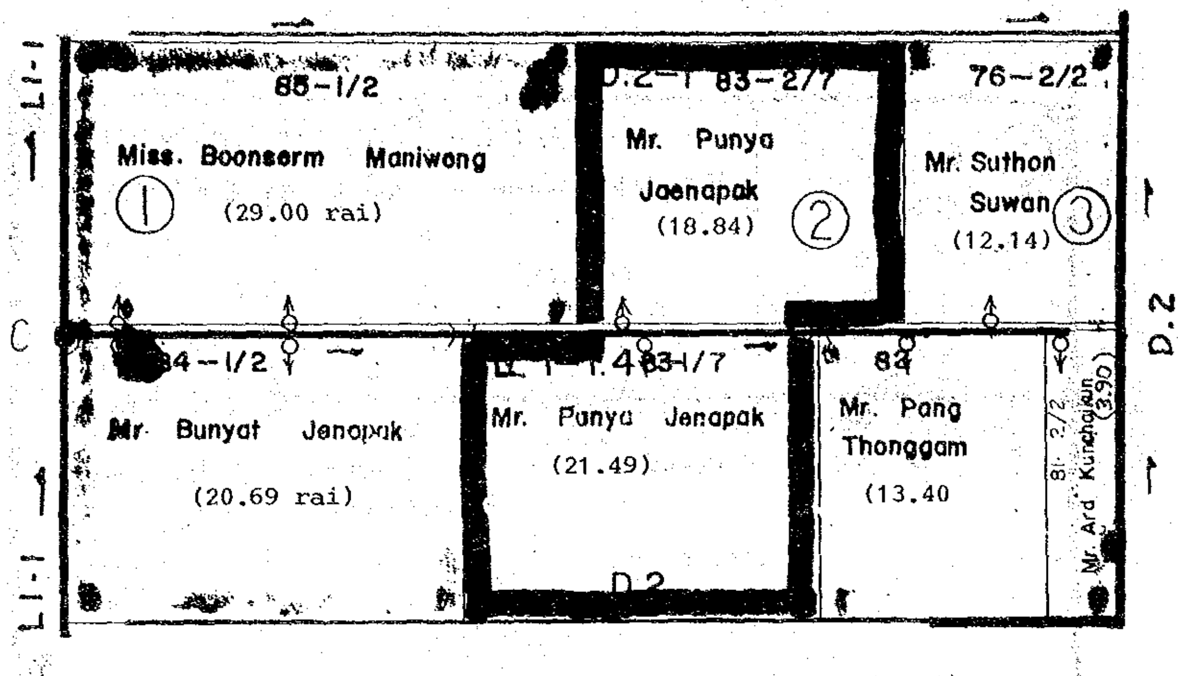
SIZE

Type	Size	Board No.
(A)	0.40 x 0.60 m. (20 ps)	(1) (2) (3) (4) (6) (7) (8) (9) (10) (11) (12) (13) (14) (15) (16) (17) (18) (19) (20) (22)
(B)	0.40 x 0.30 m. (3 ps)	(5) (21) (23)
(C)	0.60 x 0.80 m. (4 ps)	(24) (25) (26) (27)



Annex 3

THE CALCULATION OF IRRIGATION TIME



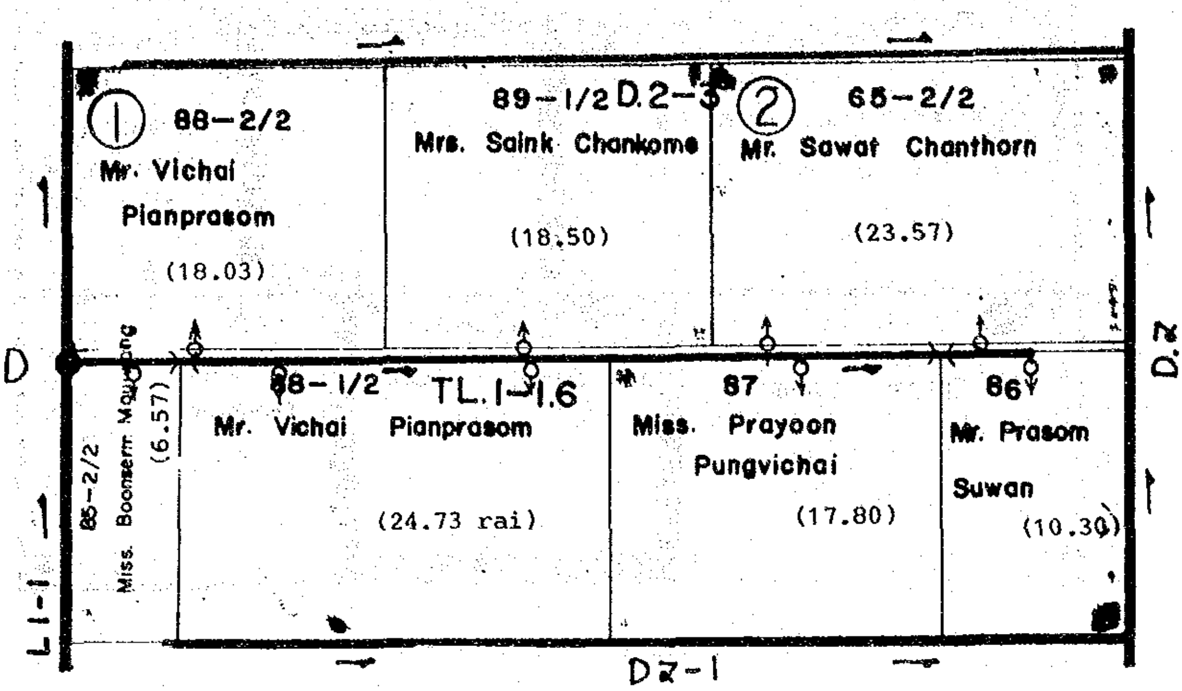
ROTATIONAL IRRIGATION SCHEDULE

TL 1 - 1.4

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a' (rai)	E.I.T. (hr)	Irrigation time (hr)
①	84 - ½ 85 - ½	2 2	Mr. Bunyat Miss Boonserm	20.69 29.00	a x 1.0	$\frac{a'}{A'} \times 156$	Mon 6:00) Wed 18:00
Total		4		49.69	49.69	56	60
②	83 - 1/7 83 - 2/7	1 2	Mr. Punya Mr. Punya	21.49 18.84	a x 1.2	$\frac{a'}{A'} \times 156$	Wed 18:00) Sat 6:00
Total		3		40.33	48.40	55	60
③	76 - 2/2 81 - 2/2 82	1 1 1	Mr. Suthon Mr. Ard Mr. Pang	12.14 3.90 13.40	a x 1.4	$\frac{a'}{A'} \times 156$	Sat 6:00) Mon 6:00
Total		3		29.44	41.22	46	48
Grand Total		10		A=119.46	A'=139.31	156	168

Irrigation time 7 days x 24 hr = 168 hr

E.I.T. (Effective Irrigation Time) 168 hr - (3 unit - 1) x 6 hr = 156 hr



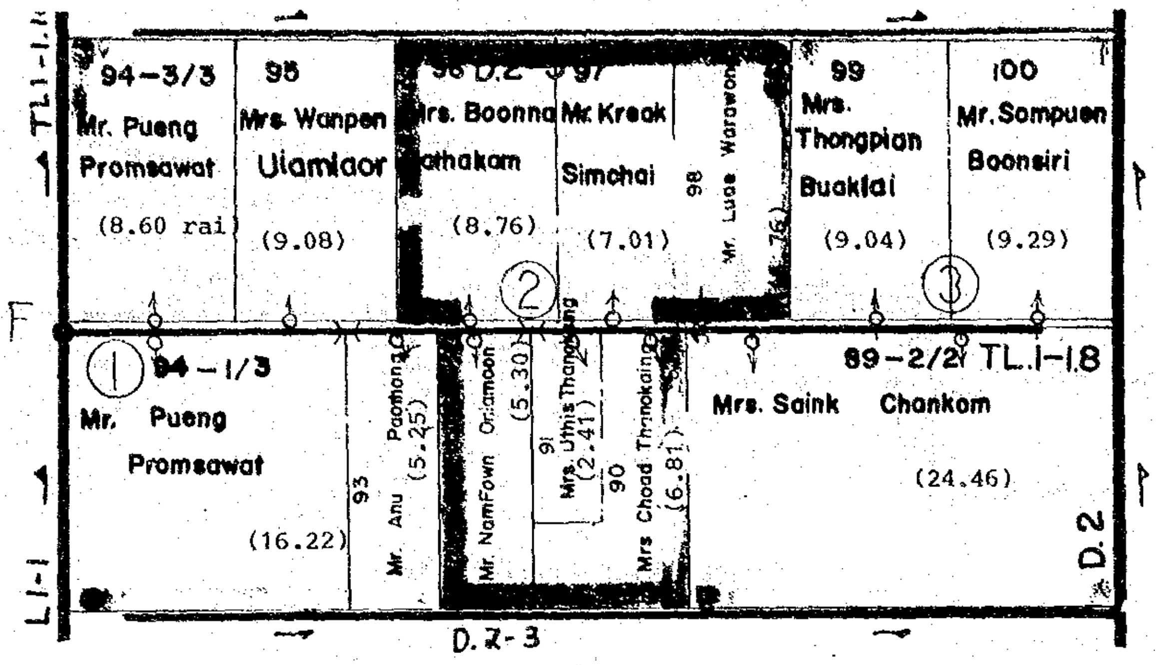
ROTATIONAL IRRIGATION SCHEDULE

TL 1 - 1.6

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a' (rai)	E.I.T. (hr)	Irrigation time (hr)
①	88 - 2/2	1	Mr. Vichai	18.83	a x 1.0	$\frac{a'}{A'} \times 162$	Mon 6:00
	89 - ½	1	Mrs.Saink	18.50			~
	85 - 2/2	1	Miss Boonserm	6.57			Thu 12:00
	88 - ½	2	Mr. Vichai	24.73			
Total		5		67.83	67.83	78	78
②	65 - 2/2	2	Mr. Sawat	23.57	a x 1.4	$\frac{a'}{A'} \times 162$	Thu 12:00
	87	1	Miss Prayoon	17.80			~
	86	1	Mr. Prasom	10.30			Mon 6:00
Total		4		51.67	72.34	84	90
Grand Total		9		A=119.50	A'=140.17	162	168

IRRIGATION TIME   7 days x 24 hr = 168 hr

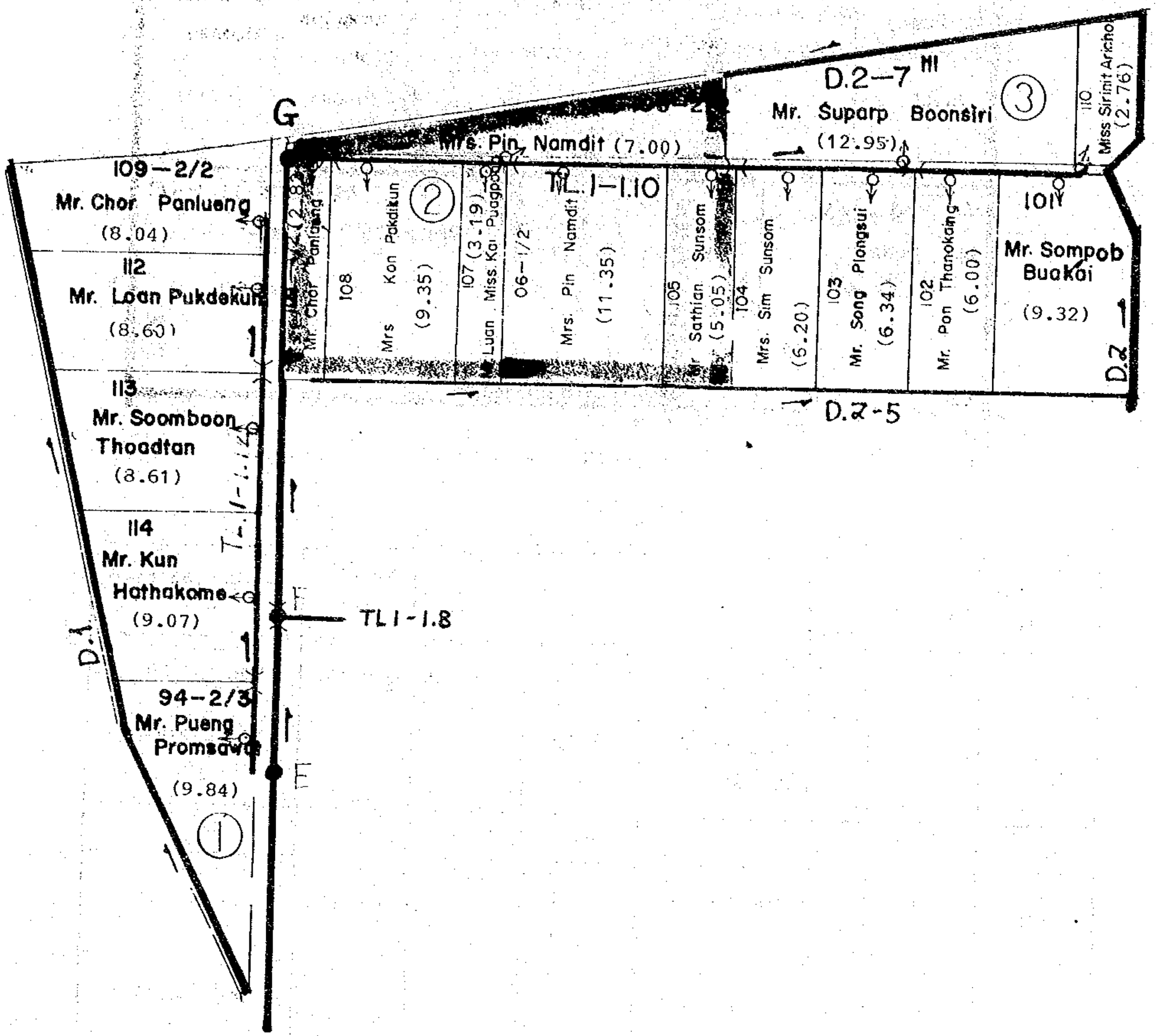
E.I.T. (Effective Irrigation Time)   168 hr - (2 unit - 1) x 6 hr = 162 hr



ROTATIONAL IRRIGATION SCHEDULE

TL 1 - 1.8

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a' (rai)	E.I.T. (hr)	Irrigation time (hr)
(1)	94 - 3/3	1	Mr. Pueng	8.06	a x 1.0	$\frac{a'}{A'} \times 156$	Mon 6:00
	95	1	Mrs. Wanpen	9.08			
	94 - 1/3	1	Mr. Pueng	6.22			Wed 6:00
	93	1	Mr. Anu	5.25			
Total		4		38.61	38.61	42	48
(2)	96	1	Mrs.Boonna	8.76	a x 1.2	$\frac{a'}{A'} \times 156$	Wed 6:00
	97		Mr. Kreak	7.01			
	98	1	Mr. Luae	6.76			
	92	1	Mr. Namfown	5.30			Fri 12:00
	91	1	Mrs.Uthis	2.41			
	90	1	Mrs.Choad	6.81			
Total		5		37.05	44.46	49	54
(3)	99	1	Mrs.Thongpian	9.04	a x 1.4	$\frac{a'}{A'} \times 156$	Fri 12:00
	100	1	Mr. Sompuen	9.29			
	89 - 2/2	3	Mrs.Saink	24.46			Mon 6:00
Total		5		42.79	59.91	65	66
Grand Total		14		A=118.45	A'=142.98	156	168


G
109-2/2
Mr. Chor Panlueng
(8.04)
112
Mr. Loan Pukdekun
(8.60)
113
Mr. Soomboon
Thoadtan
(8.61)
114
Mr. Kun
Hathakome
(9.07)
94-2/3
Mr. Pueng
Promsawa
(9.84)
1
D.1
TL1-1.8
Mrs. Pin Namdit (7.00)
D.2-7
Mr. Suparp Boonsiri
(12.95)
3
110
Miss Sirinit Aricho
(2.76)
TL.1-1.10
2
108
Mrs Kon Pakdikun
(9.35)
107 (3.19)
Miss Luan Kai Puagpo
06-1/2
Mrs. Pin Namdit
(11.35)
105
Mr Sathian Sunsom
(5.05)
104
Mrs. Sim Sunsom
(6.20)
103
Mr. Song Plongsui
(6.34)
102
Mr. Pon Thanokaing
(6.00)
101
Mr. Sompob
Buakai
(9.32)
D.2
D.2-5

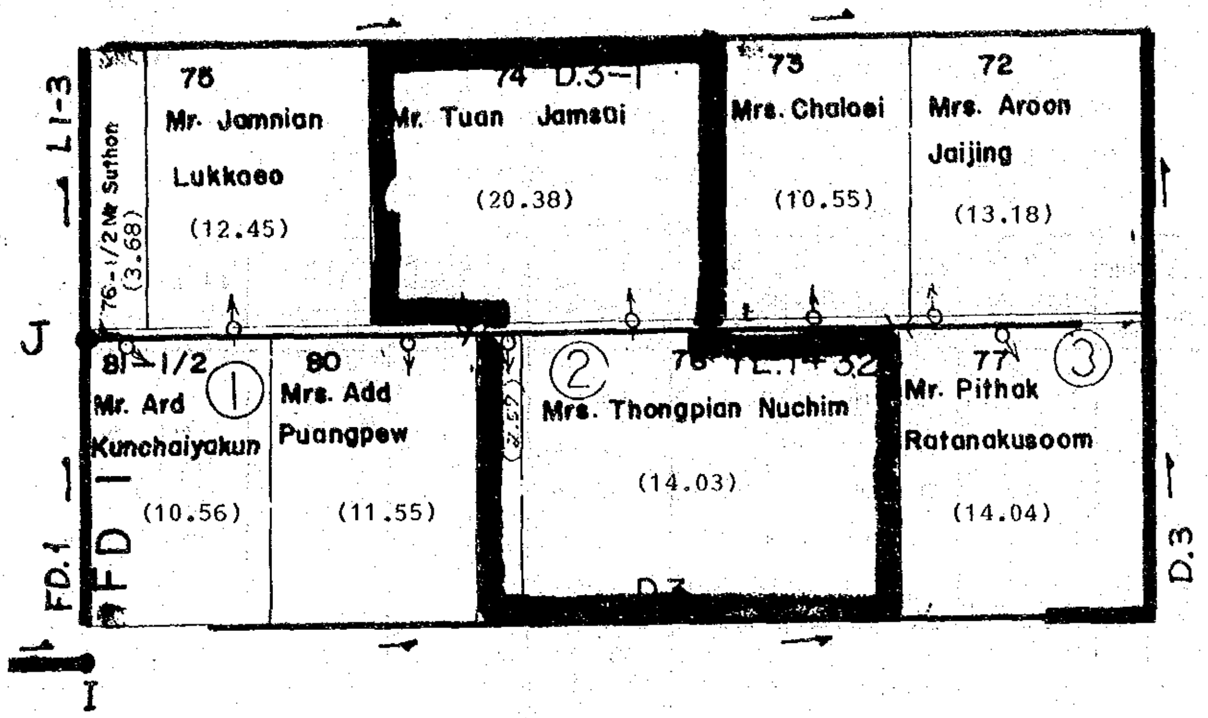
ROTATIONAL IRRIGATION SCHEDULE

TL 1 - 1.10, TL 1 - 1.12

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a' (rai)	E.I.T. (hr)	Irrigation time (hr)
①	94 - 2/3	1	Mr. Pueng	16.22	a x 1.0	$\frac{a'}{A'}$ x 156	Mon 6:00 ∫ Wed 6:00
	114	1	Mr. Kun	9.07			
	113	1	Mr. Soomboon	8.61			
	112	1	Mr. Loan	8.60			
	109-2/2	1	Mr. Chor	2.82			
Total		5		45.32	45.32	45	48
②	106-2/2	1	Mrs. Pin	11.35	a x 1.2	$\frac{a'}{A'}$ x 156	Wed 6:00 ∫ Fri 12:00
	109 - ½	1	Mr. Chor	2.82			
	108	1	Mr. Kon	9.35			
	107	1	Mr. Luan	3.19			
	106 - ½	1	Mrs. Pin	11.35			
	105	1	Mr. Sathian	5.05			
Total		6		43.11	51.73	51	54
③	111	1	Mr. Suparp	12.95	a x 1.4	$\frac{a'}{A'}$ x 156	Fri 12:00 ∫ Mon 6:00
	110	1	Miss Sirinit	2.76			
	104	1	Mrs. Sim	6.20			
	103	1	Mr. Song	6.34			
	102	1	Mr. Pon	6.00			
	101	1	Mr. Sompob	9.32			
Total		6		43.57	60.70	60	66
Grand Total		17		A=132.00	A'=157.75	156	168

IRRIGATION TIME 7 days x 24 hr = 168 hr

E.I.T.(Effective Irrigation Time) 168 hr - (3 unit - 1) x 6 hr = 156 hr



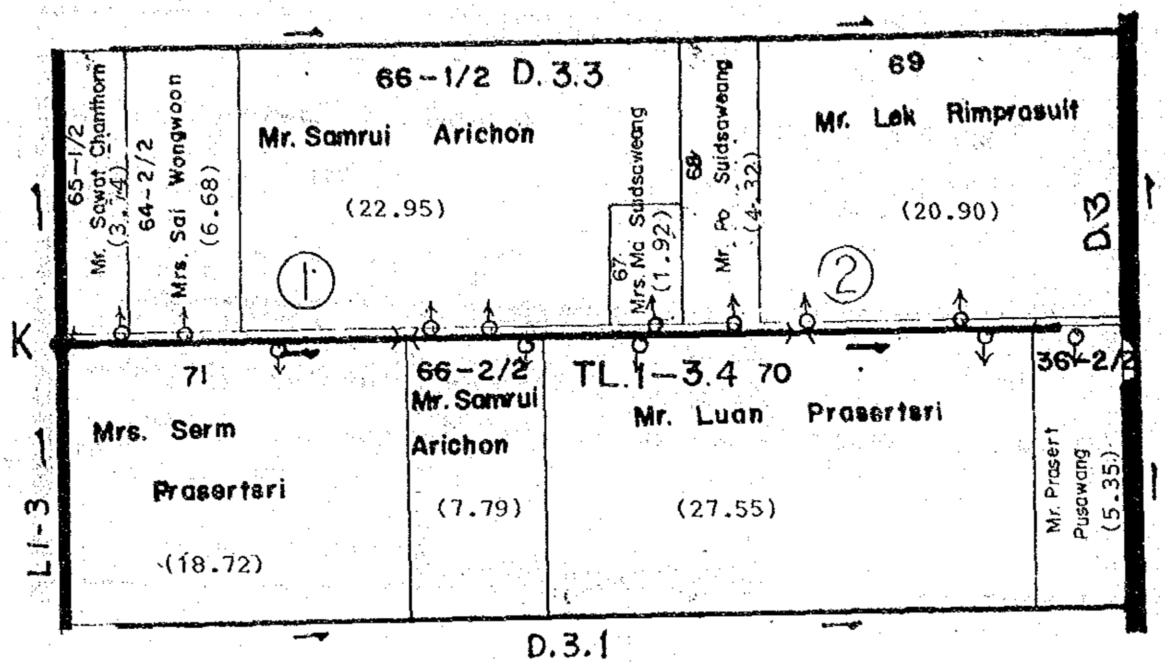
ROTATIONAL IRRIGATION SCHEDULE

TL 1 - 3.2

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a' (rai)	E.I.T. (hr)	Irrigation time (hr)
①	76 - ½		Mr. Suthon	3.68	a x 1.0	$\frac{a'}{A'}$ x 156	Mon 6:00 ~
	75	1	Mr. Jamnian	12.45			Wed 6:00
	81 - ½	1	Mr. Ard	10.56			
	80	1	Mrs. Add	11.55			
Total		3		38.24	38.24	44	48
②	74	2	Mr. Tuan	20.38	a x 1.2	$\frac{a'}{A'}$ x 156	Wed 6:00 ~
	79	1	Miss Ari	2.59			Fri 12:00
	78	2	Mrs.Thongpian	14.03			
Total		5		37.00	44.40	51	54
③	73	1	Mrs. Chaloei	10.55	a x 1.4	$\frac{a'}{A'}$ x 156	Fri 12:00 ~
	72	1	Mrs. Aroon	13.18			Mon 6:00
	77	1	Mr. Pithak	14.04			
Total		3		37.77	52.88	61	66
Grand Total		11		A=113.01	A'=135.52	156	168

IRRIGATION TIME 7 days x 24 hr = 168 hr

E.I.T.(Effective Irrigation Time) 168 hr - (3 unit - 1) x 6 hr = 156 hr



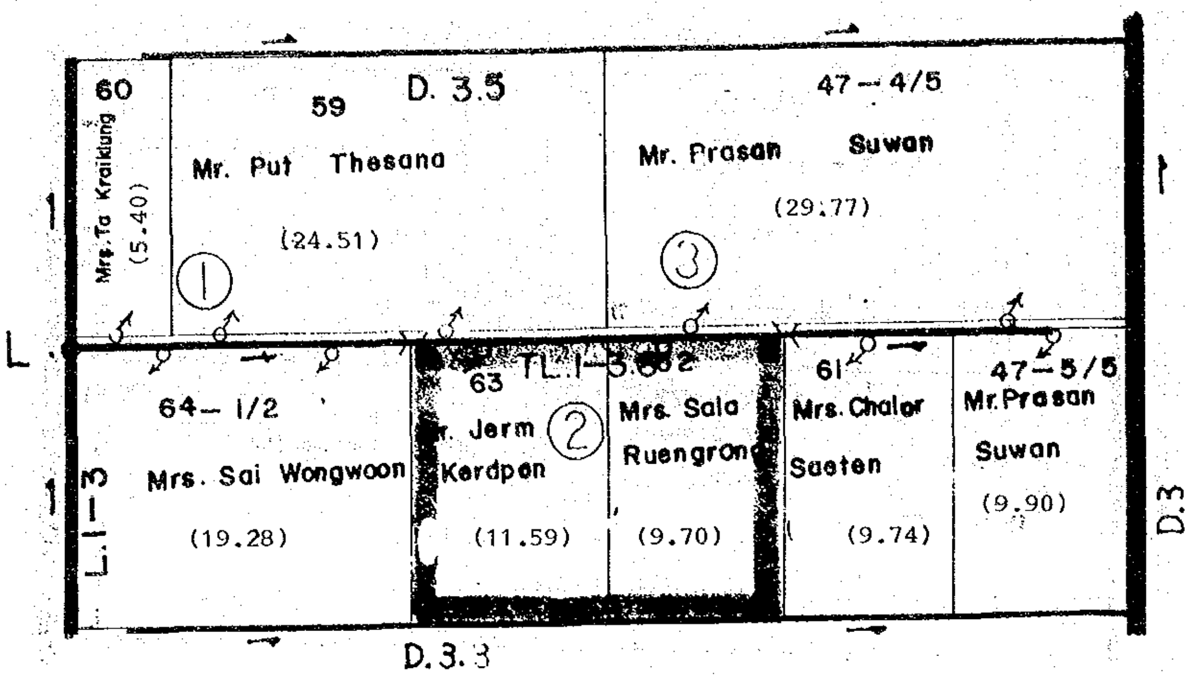
ROTATIONAL IRRIGATION SCHEDULE

TL 1 - 3.4

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a' (rai)	E.I.T. (hr)	Irrigation time (hr)
①	65 - ½		Mr. Sawat	3.74	a x 1.0	$\frac{a}{A'}$ x 162	Mon 6:00
	64-2/2	1	Mrs. Sai	6.68			∫
	66 - ½	1	Mr. Samrui	22.95			Tue 6:00
	71	2	Mrs. Serm	18.72			
	66-2/2	1	Mr. Samrui	7.79			
Total		5		59.88	59.88	67	72
②	67	1	Mrs. Ma	1.92	a x 1.4	$\frac{a'}{A'}$ x 162	Tue 6:00
	68		Mr. Po	4.32			)
	69	2	Mr. Lek	20.90			Mon 6:00
	70	3	Mr. Luan	27.55			
	36-2/2		Mr. Prasert	5.35			
Total		6		60.04	84.06	95	96
Grand Total		11		A=119.92	A'=143.94	162	168

IRRIGATION TIME 7 days x 24 hr = 168 hr

E.I.T.(Effective Irrigation Time) 168 hr - (2 unit - 1) x 6 hr= 162 hr



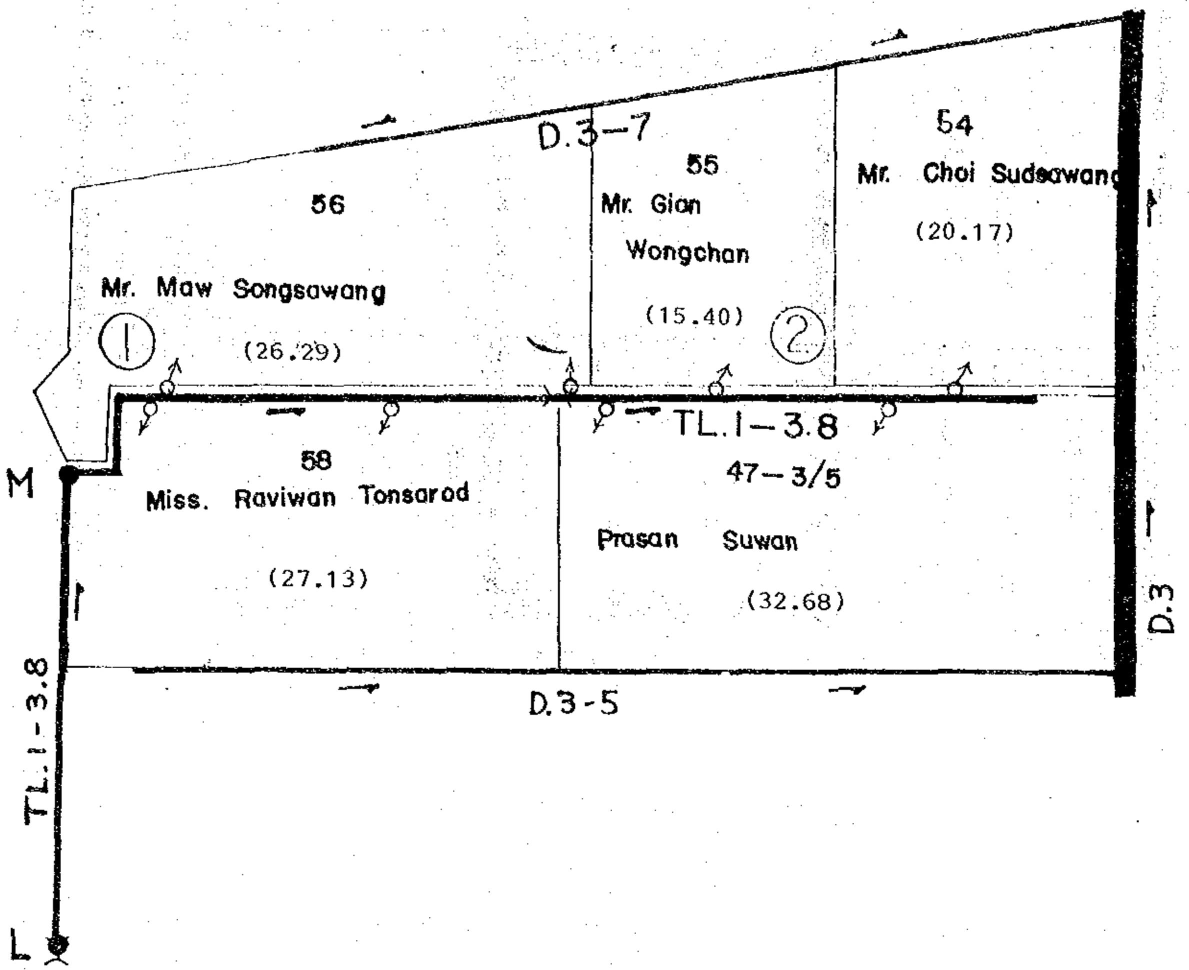
ROTATIONAL IRRIGATION SCHEDULE

TL 1 - 3.6

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a' (rai)	E.I.T. (hr)	Irrigation time (hr)
①	60 59 64 - ½	1 2 2	Mrs. Ta Mr. Put Mrs. Sai	5.40 24.51 19.28	a x 1.0	$\frac{a'}{A'} \times 156$	Mon 6:00 ↓ Wed 12:00
Total		5		49.19	49.19	53	54
②	63 62	1 1	Mr. Jerm Mrs. Sala	11.59 9.70	a x 1.2	$\frac{a'}{A'} \times 156$	Wed 12:00 ↓ Thu 18:00
Total		2		21.29	25.55	28	30
③	47 - 4/5 61 47 - 5/5	2 1	Mr. Prasan Mrs. Chalor Mr. Prasan	29.77 9.74 9.90	a x 1.4	$\frac{a'}{A'} \times 156$	Thu 18:00 ↓ Mon 6:00
Total		3		49.41	69.17	75	84
Grand Total		10		A=119.89	A'=143.91	156	168

IRRIGATION TIME 7 days x 24 hr = 168 hr

E.I.T.(Effective Irrigation Time) 168 hr - (3 unit - 1) x 6 hr = 156 hr



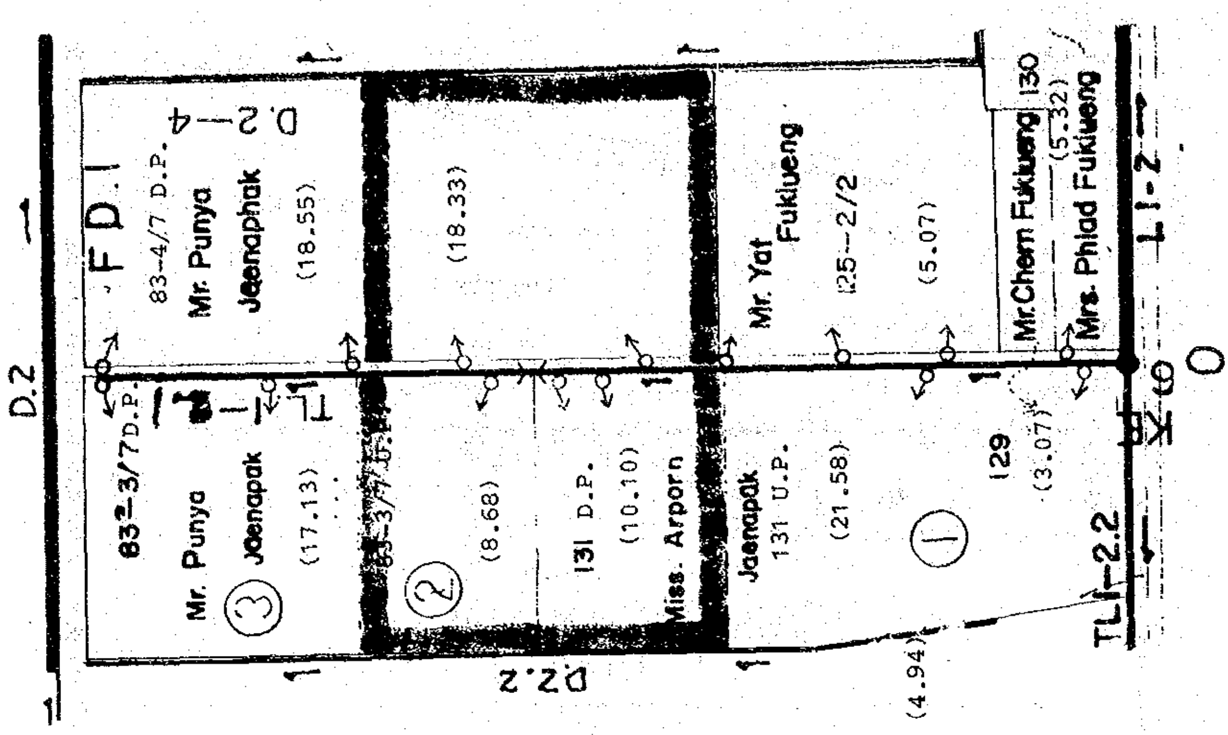
ROTATIONAL IRRIGATION SCHEDULE

TL 1 - 3.8

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a' (rai)	E.I.T. (hr)	Irrigation time (hr)
①	56 58	2 2	Mr. Maw Miss Raviwan	26.29 27.13	a x 1.0	$\frac{a'}{A'}$ x 162	Mon 6:00 ∫ Wed 18:00
Total		4		53.42	53.42	58	60
②	55 54 47-3/5	1 1 3	Mr. Gian Mr. Choi Mr. Prasan	15.40 20.17 32.68	a x 1.4	$\frac{a'}{A'}$ x 162	Wed 18:00 ∫ Mon 6:00
Total		5		68.25	95.55	104	108
Grand Total		9		A=121.67	A'=148.97	162	168

IRRIGATION TIME 7 days x 24 hr = 168 hr

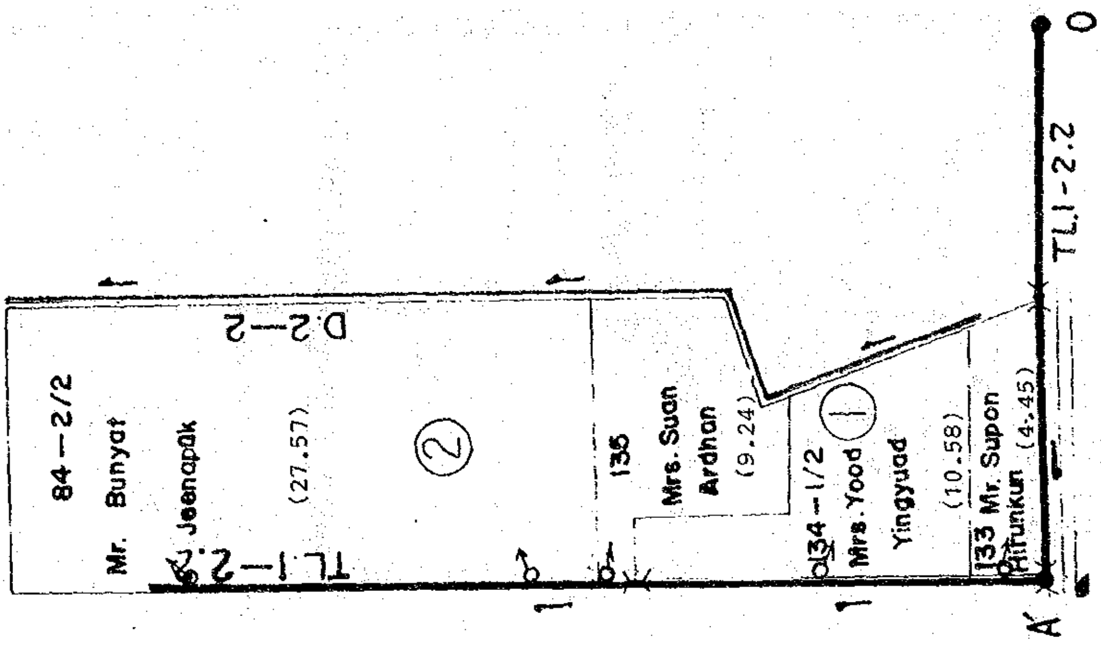
E.I.T.(Effective Irrigation Time) 168 hr - (2 unit - 1) x 6 hr = 162 hr



ROTATIONAL IRRIGATION SCHEDULE

TL 1 - 2.1

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a′ (rai)	E.I.T. (hr)	Irrigation time (hr)
①	131 D.P. 130 129 125-2/2	2 1 - 3	Miss Arporn Mrs. Phlad Mr. Chern Mr. Yat	21.58 5.32 3.07 15.07	a x 1.0	$\frac{a'}{A'}$ x 156	Mon 6:00 ∫ Wed 12:00
Total		6		45.04	45.04	50	(9) 54
②	131 U.P 83-3/7DP 83-4/7DP	2 1 2	Miss Arporn Mr. Punya Mr. Punya	10.10 8.68 18.33	a x 1.2	$\frac{a'}{A'}$ x 156	Wed 12:00 ∫ Fri 18:00
Total		5		37.11	44.53	50	(9) 54
③	83-3/7UP 83-4/7UP	2 2	Mr. Punya Mr. Punya	17.13 18.55	a x 1.4	$\frac{a'}{A'}$ x 156	Fri 18:00 ∫ Mon 6:00
Total		4		35.68	49.95	56	(10) 60
Grand Total		15		A=117.83	A′=139.52	156	(28) 168

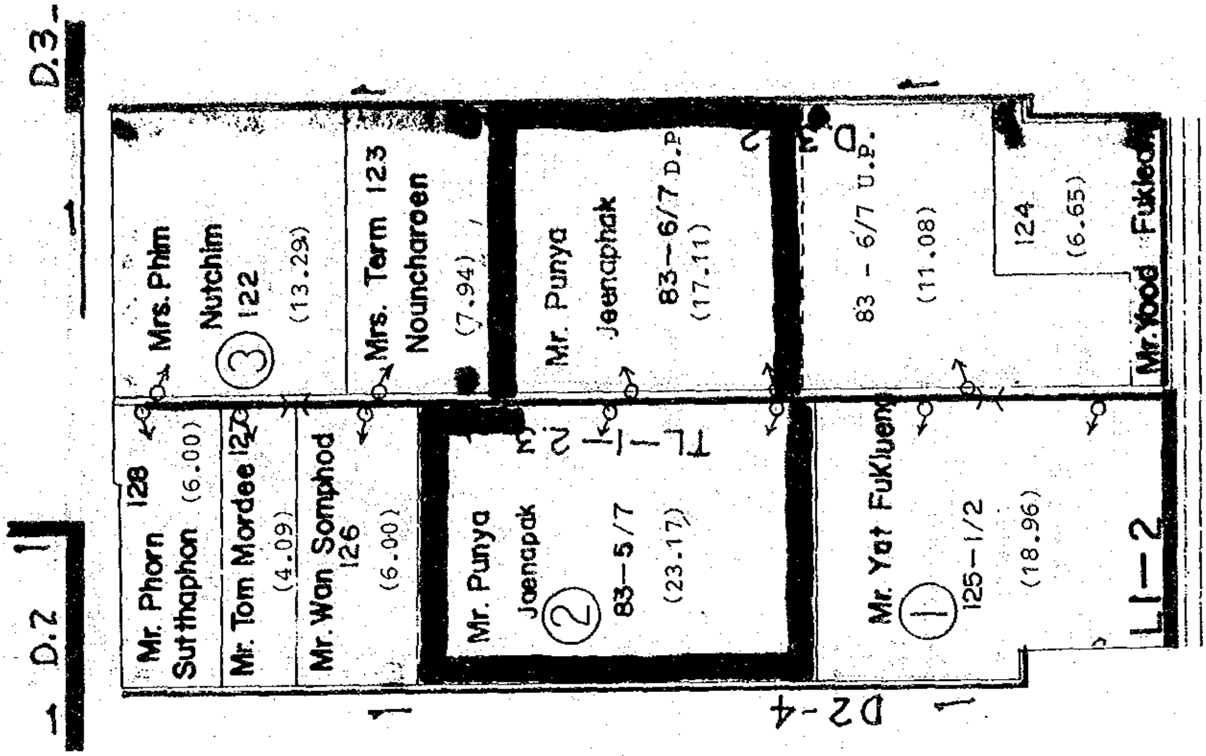


ROTATIONAL IRRIGATION SCHEDULE

TL 1 - 2.2

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a' (rai)	E.I.T. (hr)	Irrigation time (hr)
①	133 134 - ½ 135	1 1 1	Mr. Supon Mrs. Yood Mrs. Suan	4.45 10.58 9.24	a x 1.0	$\frac{a'}{A'}$ x 162	Mon 6:00) Thu 6:00
Total		3		24.27	24.27	63	72
②	84-2/2	2	Mr. Bunyat	27.57	a x 1.4	$\frac{a'}{A'}$ x 162	Thu 6:00) Mon 6:00
Total		2		27.57	38.60	99	96
Grand Total		5		A= 51.84	A'= 62.87	162	168

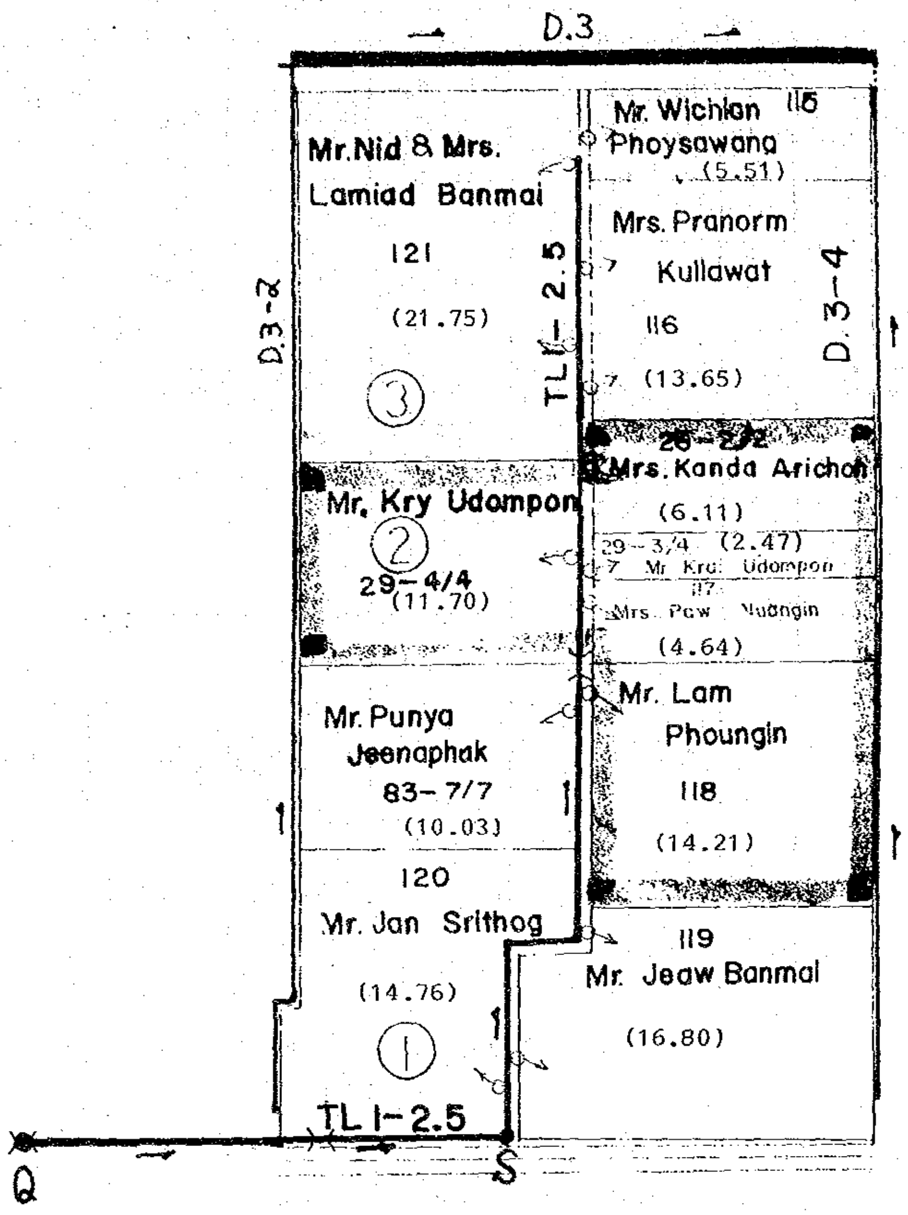
IRRIGATION TIME	7 days x 24 hr	=	168 hr
E.I.T.(Effective Irrigation Time)	168 hr - (2 unit - 1) x 6 hr	=	162 hr



ROTATIONAL IRRIGATION SCHEDULE

TL 1 - 2.3

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a' (rai)	E.I.T. (hr)	Irrigation time (hr)
①	125 - ½ 124 83-6/7UP	2 1	Mr. Yat Mr. Yood Mr. Punya	18.96 6.65 11.08	a x 1.0	$\frac{a'}{A'}$ x 156	Mon 6:00 ∫ Wed 6:00
Total		3		36.69	36.69	42	(8) 48
②	83-5/7 83-6/7DP	3 2	Mr. Punya Mr. Punya	23.17 17.11	a x 1.2	$\frac{a'}{A'}$ x 156	Wed 6:00) Fri 18:00
Total		5		40.28	48.34	55	(10) 60
③	126 127 128 123 122	1 1 1 1 1	Mr. Wan Mr. Tom Mr. Phorn Mrs. Term Mrs. Phim	6.00 4.09 6.00 7.94 13.29	a x 1.4	$\frac{a'}{A'}$ x 156	Fri 18:00 ∫ Mon 6:00
Total		5		37.32	52.25	59	(10) 60
Grand Total		13		A=114.29	A'=137.28	156	(28) 168


D.3
Mr. Wichian 115
Phoysawang
(5.51)
Mr.Nid & Mrs.
Lamiad Banmai
121
(21.75)
3
TL I-2.5
Mrs. Pranorm
Kullawat
116
(13.65)
D.3-4
D.3-2
Mrs. Kanda Arichon
(6.11)
Mr. Kry Udompon
2
29-4/4
(11.70)
29-3/4 (2.47)
Mr Kru Udompon
117
(4.64)
Mr. Punya
Jeenaphak
83-7/7
(10.03)
Mr. Lam
Phoungin
118
(14.21)
120
Mr. Jan Srithog
(14.76)
1
119
Mr. Jeaw Banmal
(16.80)
TL I-2.5
Q
S

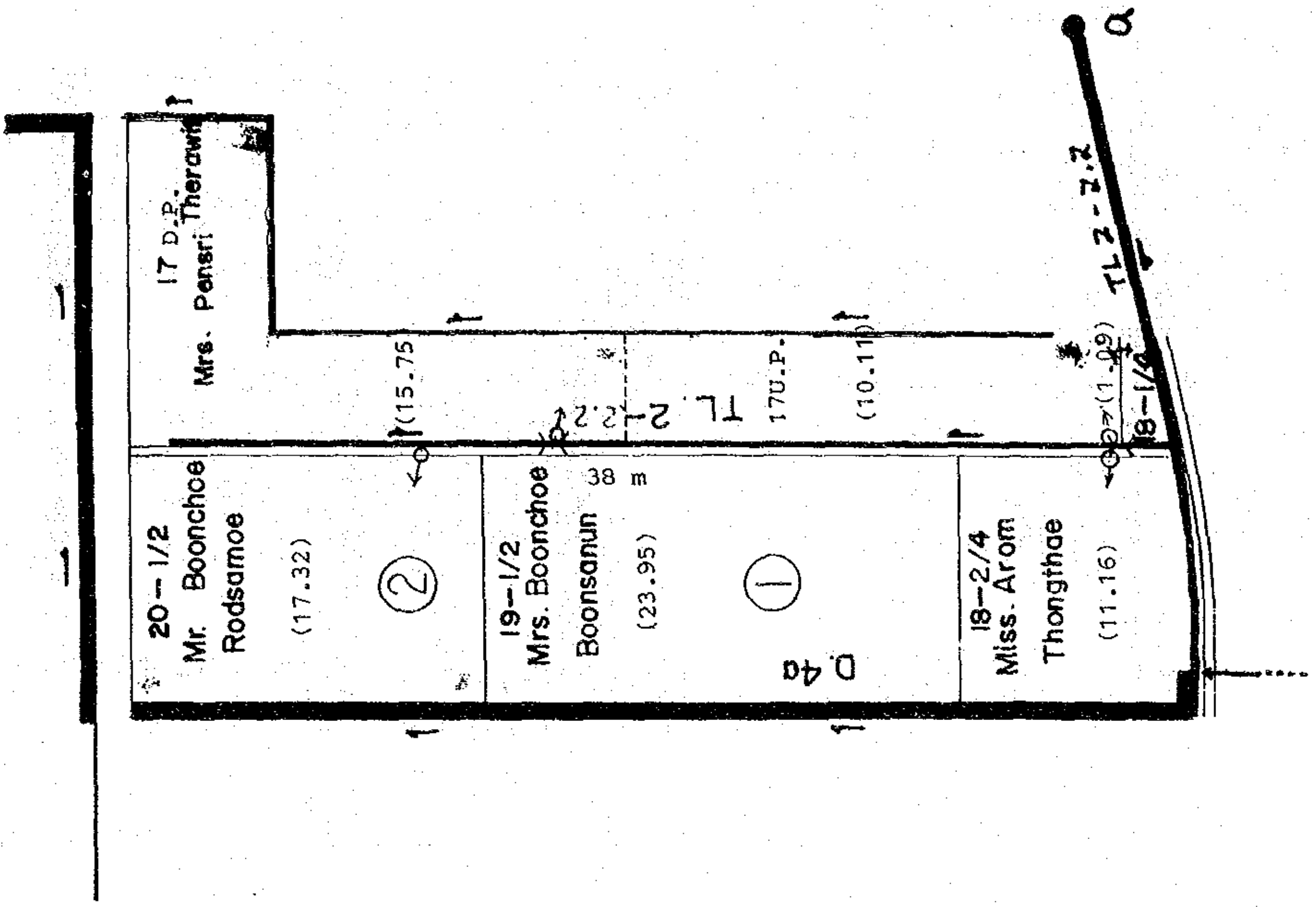
ROTATIONAL IRRIGATION SCHEDULE

TL 1 - 2.5

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a′ (rai)	E.I.T. (hr)	Irrigation time (hr)
①	120	1	Mr. Jan	14.76	a x 1.0	$\frac{a'}{A'}$ x 156	Mon 6:00
	83-7/7	1	Mr. Punya	10.03			∫
	119	2	Mr. Jeaw	16.80			Wed 6:00
Total		4		41.59	41.59	45	48
②	29-4/4	1	Mr. Krai	11.70	a x 1.2	$\frac{a'}{A'}$ x 156	Wed 6:00
	118	1	Mr. Lam	14.21			∫
	117	1	Mrs. Paw	4.64			Fri 12:00
	29 - ¾	1	Mr. Krai	2.47			
	26-2/2	1	Mrs. Kanda	6.11			
Total		5		39.13	46.96	50	54
③	121	2	Mr. Nid	21.75	a x 1.4	$\frac{a'}{A'}$ x 156	Fri 12:00
	116	2	Mrs. Pranorm	13.65			∫
	115	1	Mr. Wichlan	5.51			Mon 6:00
Total		5		40.91	57.27	61	66
Grand Total		14		A=121.63	A′=145.82	156	168

IRRIGATION TIME 7 days x 24 hr = 168 hr

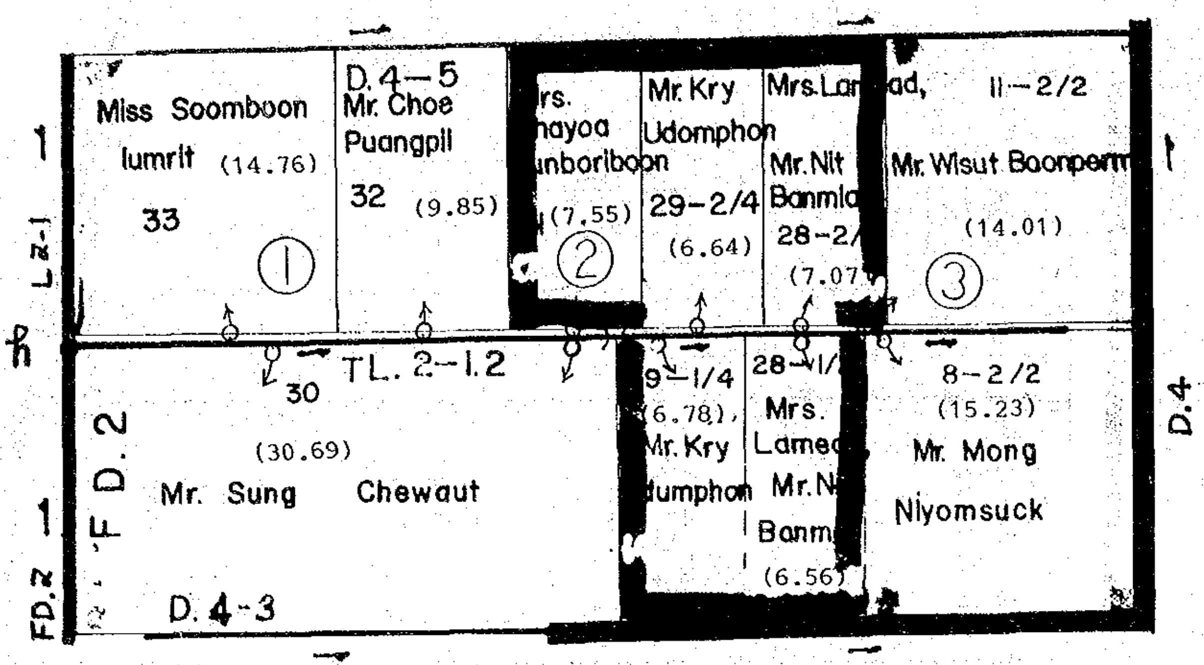
E.I.T.(Effective Irrigation Time) 168 hr - (3 unit - 1) x 6 hr = 156 hr



ROTATIONAL IRRIGATION SCHEDULE

TL 2 - 1.1

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a′ (rai)	E.I.T. (hr)	Irrigation time (hr)
①	18-2/4 19-1/2 17 U.P. 18-1/4	1	Miss Arom Mrs.Boonchoe Mrs. Pensri Miss Arom	11.16 23.95 10.11 1.09	a x 1.0	$\frac{a'}{A'}$ x 162	Mon 6:00) Fri 6:00
Total		1		46.31	46.31	91	(16) 96
②	20-1/2 17 D.P.		Mr. Boonchoe Mrs. Pensri	10.11 15.75	a x 1.4	$\frac{a'}{A'}$ x 162	Fri 6:00) Mon 6:00
Total				25.86	36.20	71	(12) 72
Grand Total		1		A= 71.08	A′= 82.51	162	(28) 168



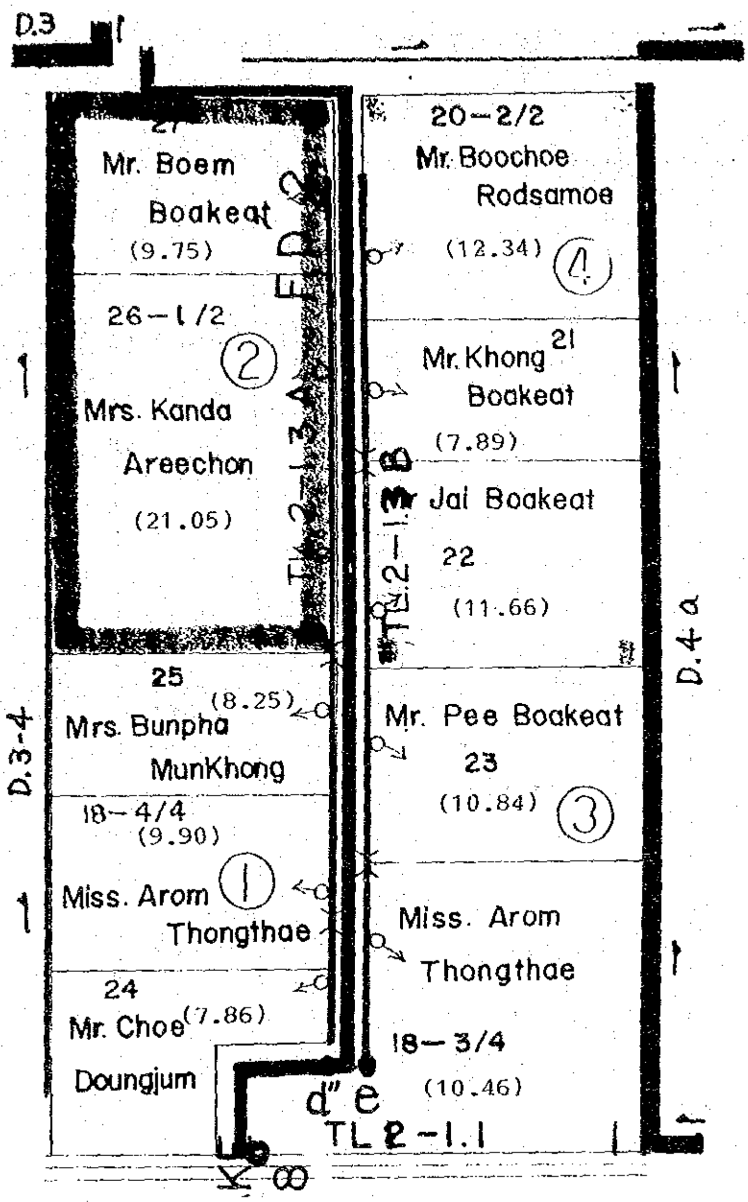
ROTATIONAL IRRIGATION SCHEDULE

TL 2 - 1.2

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a′ (rai)	E.I.T. (hr)	Irrigation time (hr)
①	33 32 30	1 1 2	Miss Soomboon Mr. Choe Mr. Sung	14.76 9.85 30.69	a x 1.0	$\frac{a'}{A'}$ x 156	Mon 6:00 ∫ Thu 6:00
Total		4		55.30	55.30	63	72
②	31 29-2/4 28-2/2 29-1/4 28-1/2	1 1 1 1 1	Mrs. Phayoa Mr. Kry Mr. Nit Mr. Kry Mrs. Lamead	7.55 6.64 7.07 6.78 6.56	a x 1.2	$\frac{a'}{A'}$ x 156	Thu 6:00 ∫ Sat 6:00
Total		5		34.60	41.52	47	48
③	11-2/2 8-2/2	1 1	Mr. Wisut Mr. Mong	14.01 15.23	a x 1.4	$\frac{a'}{A'}$ x 156	Sat 6:00 ∫ Mon 6:00
Total		2		29.24	40.94	46	48
Grand Total		11		A=119.14	A′=137.76	156	168

IRRIGATION TIME 7 days x 24 hr = 168 hr

E.I.T. (Effective Irrigation Time) 168 hr - (3 unit - 1) x 6 hr = 156 hr


D.3
27
Mr. Boem
Boakeat
(9.75)
26-1/2
2
Mrs. Kanda
Areechon
(21.05)
20-2/2
Mr. Boochoe
Rodsamoe
(12.34)
4
Mr. Khong 21
Boakeat
(7.89)
Mr Jai Boakeat
22
(11.66)
25
(8.25)
Mrs. Bunpha
MunKhong
18-4/4
(9.90)
Miss. Arom
1
Thongthae
24
Mr. Choe (7.86)
Doungjum
Mr. Pee Boakeat
23
(10.84)
3
Miss. Arom
Thongthae
18-3/4
(10.46)
D.3-4
D.4 a
d" e
TL 2-1.1

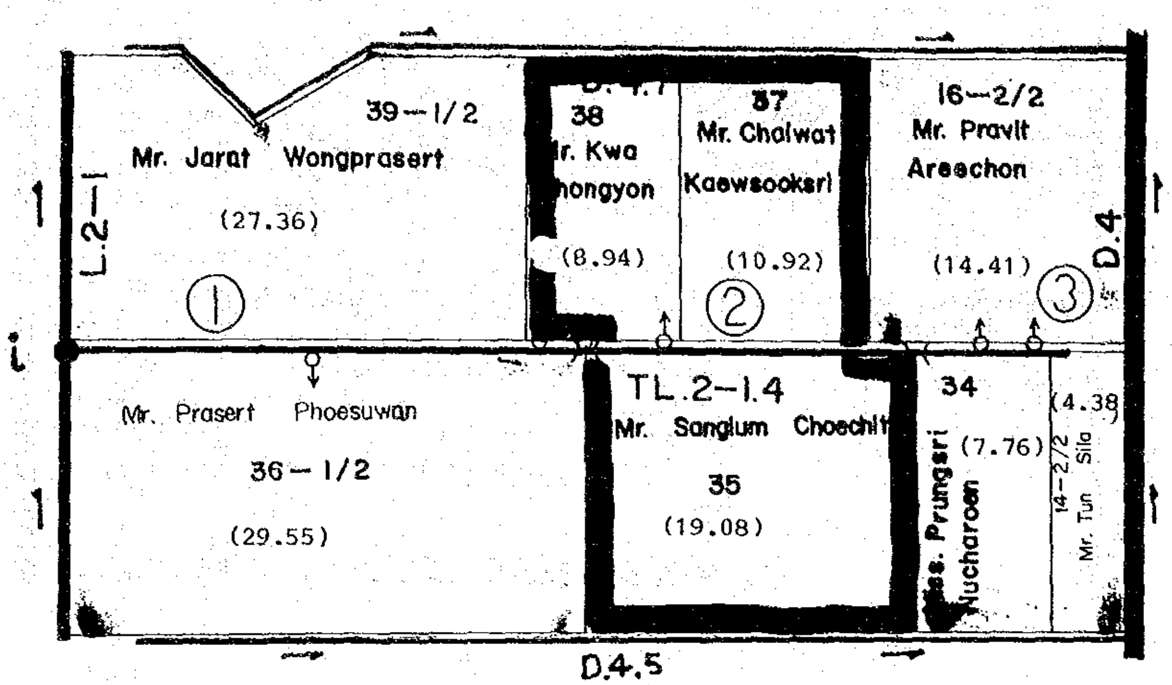
ROTATIONAL IRRIGATION SCHEDULE

TL 2 - 1.3 A, TL.2 - 1.3 B

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a' (rai)	E.I.T. (hr)	Irrigation time (hr)
①	24 18-4/4 25	1 1 1	Mr. Choe Miss Arom Mrs. Bunpha	7.86 9.90 8.25	a x 1.0	$\frac{a'}{A'}$ x 150	Mon 6:00 ∫ Tue 12:00
Total		3		26.01	26.01	29	(5) 30
②	26-1/2 27	1 1	Mrs. Kanda Mr. Boem	21.05 9.75	a x 1.4	$\frac{a'}{A'}$ x 150	Tue 12:00 ∫ Thu 18:00
Total		2		30.80	43.12	48	(9) 54
③	18-3/4 23	1 1	Miss Arom Mr. Pee	10.46 10.84	a x 1.0	$\frac{a'}{A'}$ x 150	Thu 18:00 ∫ Fri 18:00
Total		2		21.30	21.30	24	(4) 24
④	22 21 20-2/2	1 1 1	Mr. Jai Mr. Khong Mr. Boochoe	11.66 7.89 12.34	a x 1.4	$\frac{a'}{A'}$ x 150	Fri 18:00 ∫ Mon 6:00
Total		3		31.89	44.65	50	(10) 60
Grand Total		10		A=110.00	A'=135.08	150	168

IRRIGATION TIME 7 days x 24 hr = 168 hr

E.I.T.(Effective Irrigation Time) 168 hr -(4 unit - 1) x 6 hr = 150 hr



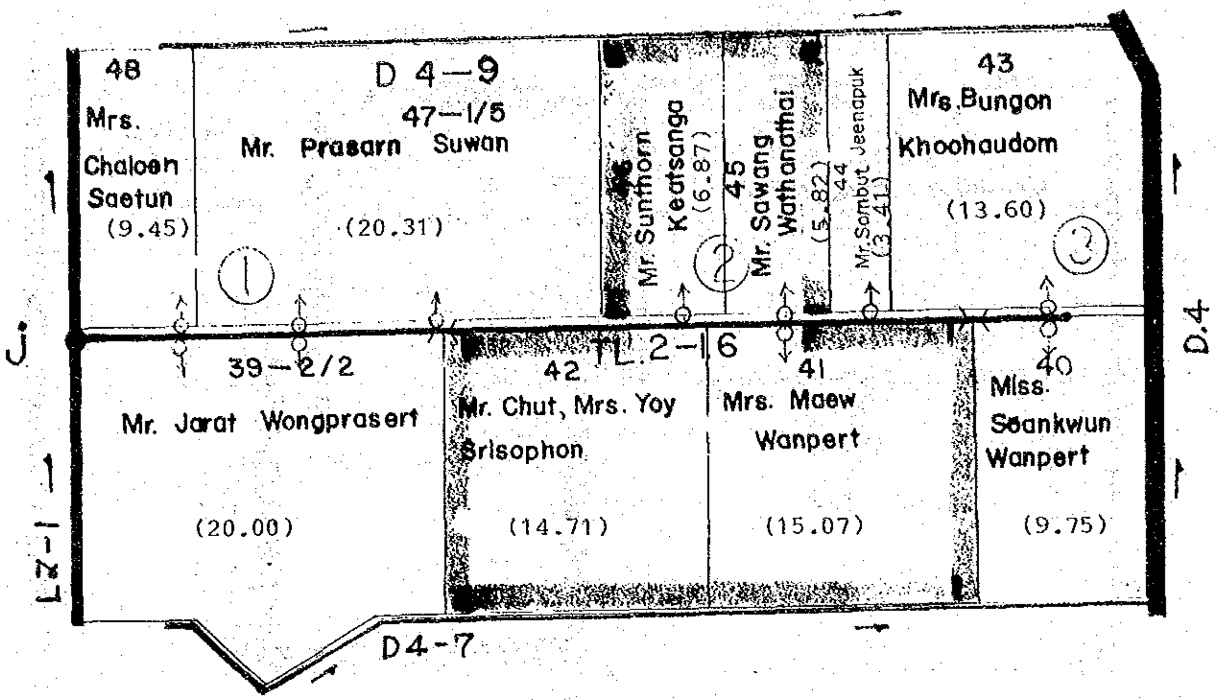
ROTATIONAL IRRIGATION SCHEDULE

TL 2 - 1.4

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a′ (rai)	E.I.T. (hr)	Irrigation time (hr)
①	39-1/2 36-1/2		Mr. Jarat Mr. Prasert	27.36 29.55	a x 1.0	$\frac{a'}{A'}$ x 156	Mon 6:00 ∫ Thu 6:00
Total				56.91	56.91	63	(17) 72
②	38 37 35		Mr. Kwa Mr. Chaiwat Mr. Sangium	8.94 10.92 19.08	a x 1.2	$\frac{a'}{A'}$ x 156	Thu 6:00 ∫ Sat 12:00
Total				38.94	46.73	52	(9) 54
③	16-2/2 34 14-2/2		Mr. Pravit Miss Prungsri Mr. Tun	14.41 7.76 4.38	a x 1.4	$\frac{a'}{A'}$ x 156	Sat 12:00 ∫ Mon 6:00
Total				26.55	37.17	41	(7) 42
Grand Total				A=122.40	A′=140.81	156	(28) 168

IRRIGATION TIME 7 days x 24 hr = 168 hr

E.I.T.(Effective Irrigation Time) 168 hr - (3 unit - 1) x 6 hr = 156 hr



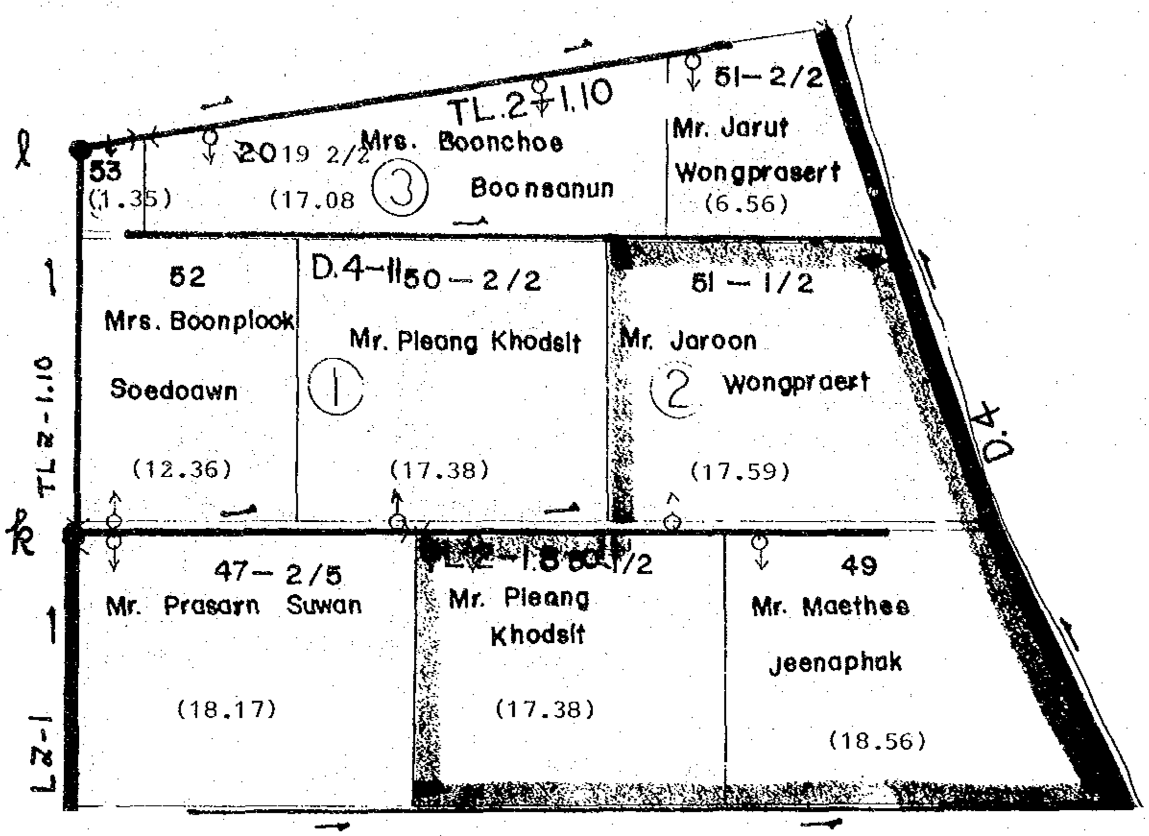
ROTATIONAL IRRIGATION SCHEDULE

TL2 - 1.6

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a' (rai)	E.I.T. (hr)	Irrigation time (hr)
①	48 47-1/5 39-2/2		Mrs. Chaloen Mr. Prasarn Mr. Jarat	9.45 20.31 20.00	a x 1.0	$\frac{a'}{A'}$ x 156	Mon 6:00 ∫ Wed 18:00
Total				49.76	49.76	56	60
②	46 45 42 41		Mr. Sunthorn Mr. Sawang Mr. chut Mrs. Maew	6.87 5.82 14.71 15.07	a x 1.2	$\frac{a'}{A'}$ x 156	Wed 18:00 ∫ Sat 6:00
Total				42.47	50.96	58	60
③	44 43 40		Mr. Sombut Mr. Bungon Miss Soankwun	3.41 13.60 9.75	a x 1.4	$\frac{a'}{A'}$ x 156	Sat 6:00 ∫ Mon 6:00
Total				26.76	37.46	42	48
Grand Total				A=118.99	A'=138.18	156	168

IRRIGATION TIME 7 days x 24 hr = 168 hr

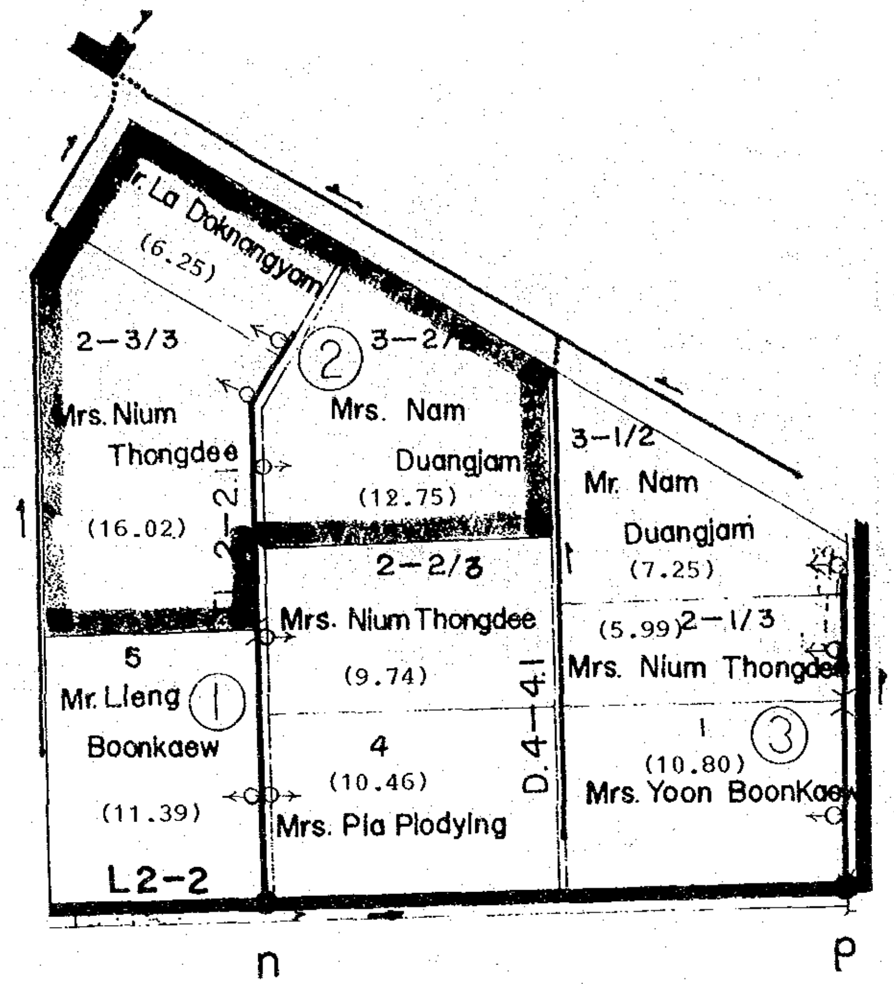
E.I.T.(Effective Irrigation Time) 168 hr - (3 unit - 1) x 6 hr = 156 hr



ROTATIONAL IRRIGATION SCHEDULE

TL 2 - 1.8, TL 2 - 1.10

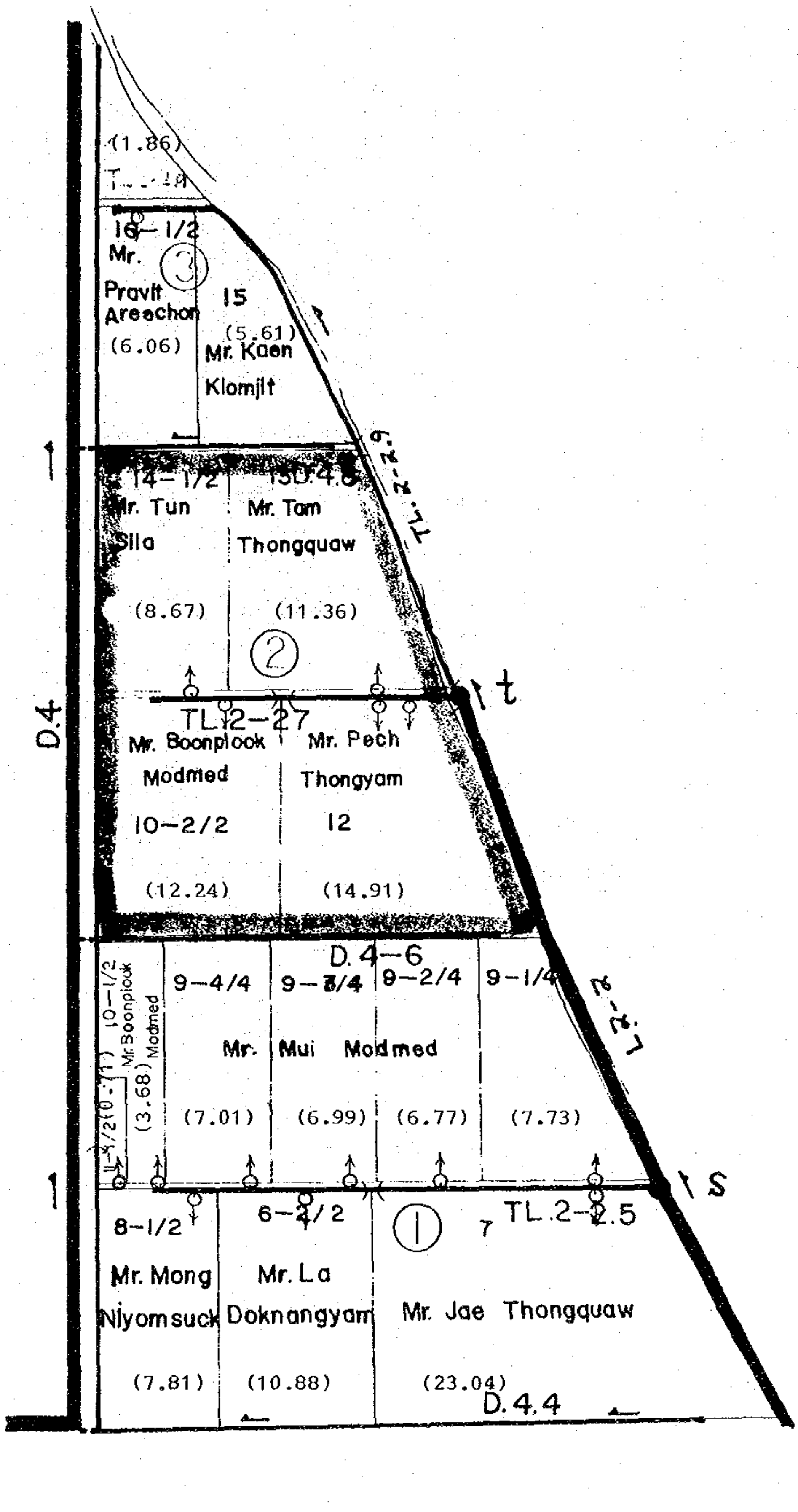
Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a′ (rai)	E.I.T. (hr)	Irrigation time (hr)
①	52 50 - 2/2 47 - 2/5	1 1 1	Mrs. Boonplook Mr. Pleang Mr. Prasarn	12.36 17.38 18.17	a x 1.0	$\frac{a'}{A'}$ x 156	Mon 6:00 } Wed 6:00
Total		3		47.91	47.91	47	48
②	51 - 1/2 50 - 1/2 49	1 1 1	Mr. Jaroon Mr. Pleang Mr. Maethee	17.59 17.38 18.56	a x 1.4	$\frac{a'}{A'}$ x 156	Wed 6:00 } Sat 12:00
Total		3		53.53	74.94	74	78
③	53 20 51 - 2/2		Mrs.Chaweewan Mrs.Boonchoe Mr. Jarut	1.35 17.08 6.56	a x 1.4	$\frac{a'}{A'}$ x 156	Sat 12:00 } Mon 6:00
Total				24.99	34.99	35	42
Grand Total		6		A=126.43	A′=157.84	156	168



ROTATIONAL IRRIGATION SCHEDULE

TL 2 - 2.1, TL 2 - 2.3

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a′ (rai)	E.I.T. (hr)	Irrigation time (hr)
①	5 4 2 - 2/3		Mr. Lieng Mrs. Pia Mrs. Nium	11.39 10.46 9.74	a x 1.0	$\frac{a'}{A'}$ x 156	Mon 6:00 ∫ Wed 12:00
Total				31.59	31.59	50	(9) 54
②	2 - 3/3 6 - 1/2 3 - 2/2		Mrs. Nium Mr. La Mrs. Nam	6.25 16.02 12.75	a x 1.2	$\frac{a'}{A'}$ x 156	Wed 12:00 ∫ Sat 12:00
Total				35.02	42.02	67	(12) 72
③	1 2 - 1/3 3 - 1/2		Mrs. Yoon Mrs. Nium Mr. Nam	10.80 5.99 7.25	a x 1.0	$\frac{a'}{A'}$ x 156	Sat 12:00 ∫ Mon 6.00
Total				24.04	24.04	39	(7) 42
Grand Total				A= 90.65	A′= 97.65	156	(28) 168


(1.86)
16-1/2
Mr.
Pravit
Areachon
(6.06)
15
(5.61)
Mr. Kaen
Klomjit
14-1/2
Mr. Tun
Sila
(8.67)
Mr. Tam
Thongquaw
(11.36)
TL.2-27
Mr. Boonplook
Modmed
10-2/2
(12.24)
Mr. Pech
Thongyam
12
(14.91)
D.4-6
9-4/4
9-2/4
9-1/4
Mr. Mui Modmed
(7.01)
(6.99)
(6.77)
(7.73)
10-1/2
Mr. Boonplook
Modmed
(3.68)
8-1/2
Mr. Mong
Niyomsuck
(7.81)
6-4/2
Mr. La
Doknangyam
(10.88)
7
Mr. Jae Thongquaw
(23.04)
D.4.4
D.4
TL.2-2.5
TL.2-2.9
t
s

ROTATIONAL IRRIGATION SCHEDULE

TL 2 - 2.5, TL 2 - 2.7, TL 2 - 2.9

Rotation Unit	Plot No.	No. of Inlet	Name	a (rai)	a' (rai)	E.I.T. (hr)	Irrigation time (hr)
①	9-¼ 4/4	4	Mr. Mui	28.50	a x 1.0	$\frac{a'}{A'}$ x 156	Mon 6:00 ∫ Thu 12:00
	10 - 1/2	1	Mr.Boonplook	3.68			
	11 - 1/2	1	Mr. Wisut	0.71			
	7	1	Mr. Jae	23.04			
	6 - 2/2	1	Mr. La	10.88			
	8 - 1/2		Mr. Mong	7.81			
Total		8		74.62	74.62	77	(13) 78
②	13	1	Mr. Tam	11.36	a x 1.2	$\frac{a'}{A'}$ x 156	Thu 12:00 ∫ Sun 6:00
	14 - 1/2	1	Mr. Tun	8.67			
	12	2	Mr. Pech	14.91			
	10 - 2/2	1	Mr.Boonplook	12.24			
Total		5		47.18	56.62	59	(11) 66
③	-		-	1.86	a x 1.4	$\frac{a'}{A'}$ x 156	Sun 6:00 ∫ Mon 6:00
	15		Mr. Kaen	5.61			
	16-1/2	1	Mr. Pravit	6.06			
Total		1		13.53	18.94	20	(4) 24
Grand Total		14		A=135.33	A'=150.18	156	168

IRRIGATION TIME 7 days x 24 hr = 168 hr

E.I.T.(Effective Irrigation Time) 168 hr - (3 unit - 1) x 6 hr = 156 hr

MEMO