(check accounts)

$$A = 0.500 \times 0.277 = 0.1385\ m^2$$

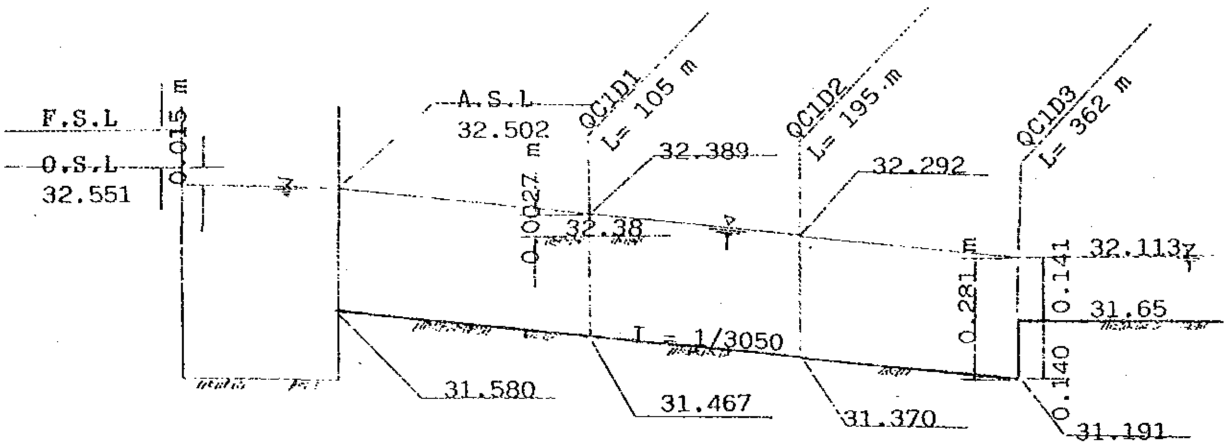
$$P = 0.277 \times 2 + 0.500 = 1.054\ m$$

$$R^{2/3} = 0.258$$

$$V = \frac{1}{0.015} \times 0.258 \left(\frac{1}{2275} \right)^{\frac{1}{2}} = 0.361\ m/sec$$

$$Q = 0.361 \times 0.139 = 0.050\ m^3/sec \quad \ldots \quad O.K$$

Fig- 25 Longitudinal section of case 7



the water slope of case 7 is same as case 2, that is 1:3050, therefore the most effective cross-section is also same as case 2.

Consequently, the case 6 gives more economical cross-section, that is the width of the QC1 is 0.55m to 0.50m. Now, the design for water supply at QC1D1 which is the highest place of QC1, is calculated as follows.

viii) Calculation of the most effective cross-section between off-take and QC1D1 (case 8,9 and 10)

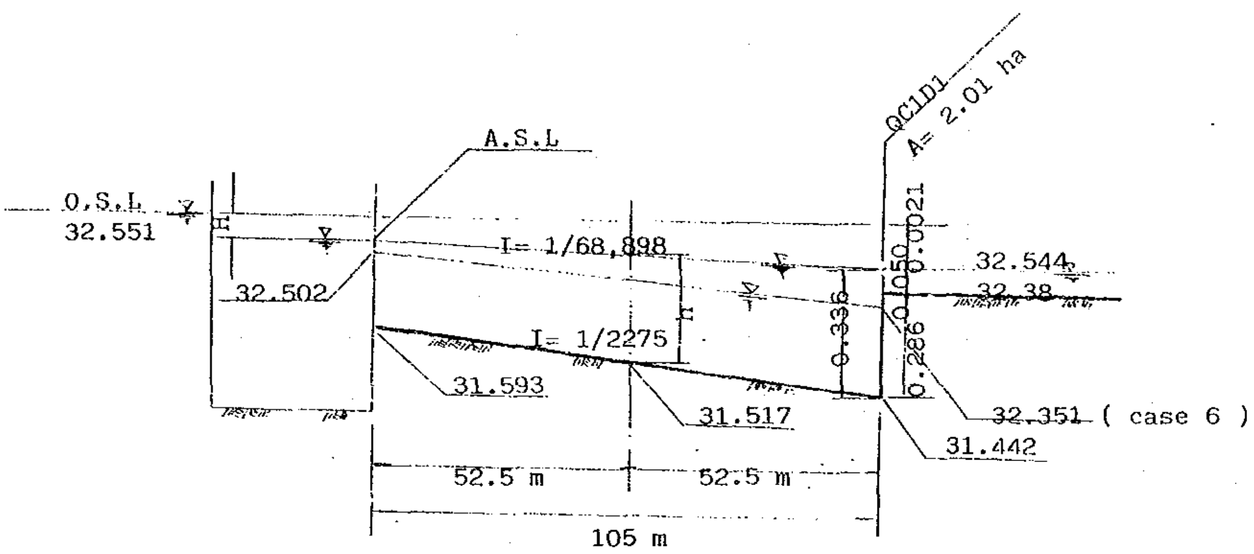
So far, the most effective cross-section is given by case 6, that is, the width of QC1 is 0.50 m and it's water slope is 1:2275, however, it is still necessary to make a dam up wair to take the irrigation water eventhough the water level in the QC1D1 can lift up from 32.257 (ft) to 32.351 (ft) due to the re-construction of the off-take.

In this case, there are two ways to take the water from the QC1, that is, one is from the O.S.L and the other is from the F.S.L.

Now, the former is given as case 8 and the latter is given as case 9.

The longitudinal section of case 8 is shown in Fig-26 and case 9 is in Fig-27.

Fig-26: Longitudinal section of case 8



The water level in the paddy field is given 32.544 (ft) which is at least necessary water layer for rice caltivation.

The trial calculation to get the actual water quantity from the off-take is shown in table-23.

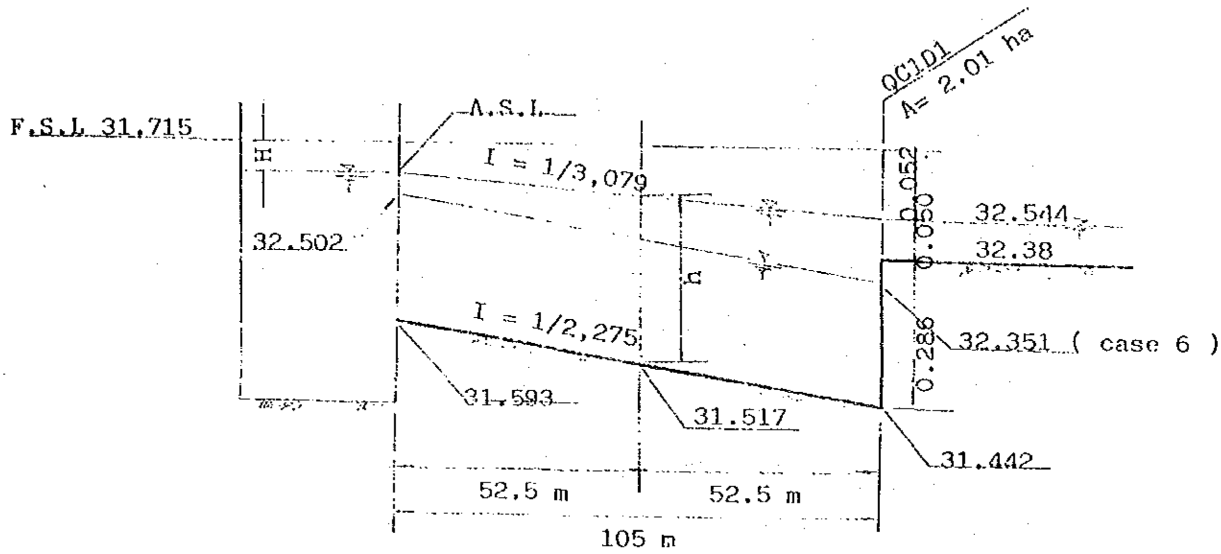
In case of eight, it is clear the water quantity is too small, that is 10.7 l/sec, therefore eventhough the off-take is reconstructed the A.S.L is depended on the F.S.L.

80/-

Table-23: Trial calculation for dam up weir of QC1D1 (Case 8)

assumed H(m)	A.S.L (ft)	Water level in paddy field (ft)	assumed Q(m^3/sec)	I	h(m)	A(m^2) 0.50xh	P(m)	$R^{2/3}$	V(m/sec)	Q(m^3/sec)	Remarks
0.0010	32.5477	32.544	0.0129	1/93,105	0.3136	0.1568	1.1272	0.268	0.059	0.0093	less
0.0008	32.5484	"	0.0115	1/78,293	0.3137	0.1569	1.1274	0.269	0.064	0.0100	"
0.0007	32.5487	"	0.0108	1/73,295	0.3137	0.1569	1.1274	0.269	0.066	0.0104	"
0.0006	32.5490	"	0.0100	1/68,898	0.3138	0.1569	1.1276	0.269	0.068	0.0107	over
0.0005	32.5494	"	0.0091	1/63,794	0.3139	0.1570	1.1278	0.269	0.071	0.0111	"

Fig-27: Longitudinal section of case 9.



the trial calculation is carried out as well as case 8.
The result is shown in table-24.

It is clear in table-24, when the water layer in the paddy field is given 5 cm which is at least necessary depth for rice cultivation, the water requirement is able to expect by 0.054 m^3/sec as a result.

However, the expected water requirement for within days presaturation is supposed 0.050 m^3/sec, therefore in case of nine has a possibility to lift up more the A.S.L in order to give higher water supply level to the paddy field.

As above-mentioned, the most effective cross-section for QC1D1 is carried out as case 10.

The expected water requirement, that is 0.050 m^3/sec, is able to take from 1.5 cm below the F.S.L.

The A.S.L is decided as below:-

The F.S.L	32.715 ft
- 1.5 cm	-0.049 ft
The A.S.L	32.666 ft

Table-24: Trial calculation for dam up wair of QC1D1 (Case 9)

assumed H(m)	A.S.L (ft)	water level in paddy field (ft)	assumed $Q(m^3/sec)$	I	h(m)	$A(m^2)$ 0.50xh	P(m)	$R^{2/3}$	V(m/sec)	$Q(m^3/sec)$	Remarks
0.010	32.6822	32.544	0.0407	1/2493	0.3341	0.1671	1.1682	0.274	0.366	0.061	over
0.013	32.6723	"	0.0464	1/2685	0.3326	0.1663	1.1652	0.273	0.351	0.058	"
0.014	32.6691	"	0.0482	1/2754	0.3321	0.1661	1.1642	0.273	0.347	0.058	"
0.015	32.6658	"	0.0499	1/2828	0.3316	0.1658	1.1632	0.273	0.342	0.057	"
0.016	32.6625	"	0.0515	1/2907	0.3311	0.1656	1.1622	0.273	0.338	0.056	"
0.017	32.6592	"	0.0531	1/2990	0.3306	0.1653	1.1612	0.273	0.333	0.055	"
0.018	32.6559	"	0.0546	1/3079	0.3301	0.1651	1.1602	0.273	0.328	0.054	less
0.019	32.6527	"	0.0561	1/3169	0.3296	0.1643	1.1592	0.272	0.322	0.053	"
0.020	32.6494	"	0.0576	1/3268	0.3291	0.1646	1.1582	0.272	0.317	0.052	"

83/-

- 83 -

The trial calculation is shown as below:-

Table-25: Trial calculation for dam up wair of QC1D1 (Case 10)

A.S.L (ft)	water level in paddy field (m,ft)		depth of dam up (m)	I	$A(m^2)$	P(m)	$R^{2/3}$	V	Q	Remarks
32.666	0.0585	32.572	0.3359	1/3665	0.1680	1.1718	0.274	0.302	0.0507	over
"	0.0588	32.573	0.3360	1/3704	0.1680	1.1720	0.274	0.300	0.0504	"
"	0.0591	32.574	0.3362	1/3744	0.1618	1.1724	0.274	0.299	0.0503	"
"	0.0594	32.575	0.3363	1/3786	0.1682	1.1726	0.274	0.297	0.0500	equal
"	0.0597	32.576	0.3365	1/3823	0.1683	1.1730	0.274	0.295	0.0496	less
"	0.0600	32.577	0.3367	1/3871	0.1684	1.1734	0.274	0.294	0.0495	"

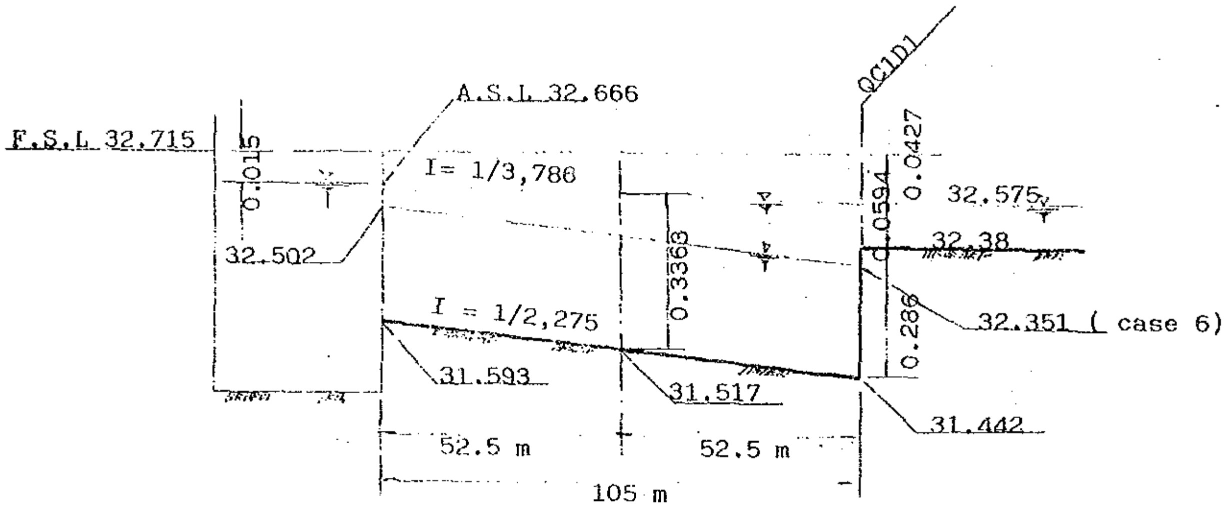
21/--

Consequently, the water level of QC1D1 is able to increase up to 32.575 ft due to re-construct of the off-take.

Thus, the planner should try to find out the economical cross-section and try to make an effort to decrease the head losses, especially like this less surplus design is not to speak.

The longitudinal section of case 10 is shown in Fig-28.

Fig-28: Longitudinal section of case 10.



ix) Regarding to the Field Block No. 3-1

So far, the A.S.L is given 5.6 cm below the F.SL, however after re-constuction of the off-take the A.SL. is able to be lifted up, that is:-

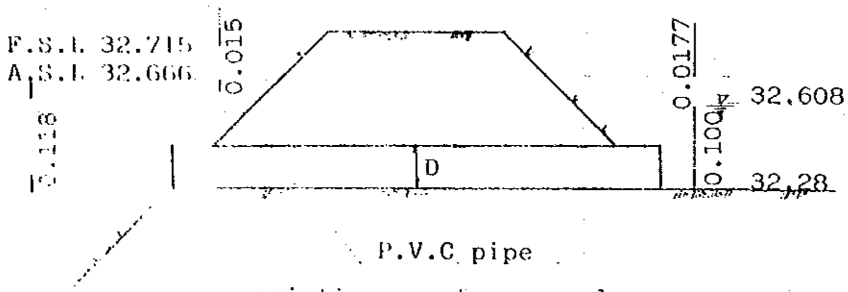
expected water quantity	0.050 m^3/sec	
it's head loss	0.015 m	
the A.S.L	32.666 ft	$32.715-(\frac{0.015}{0.3048})$
paddy field elevation	32.28 ft.	
water layer	0.100 m	
water level in paddy field	32.608 ft.	$32.28+(\frac{0.100}{0.3048})$

the difference of head losses between the A.S.L and the water level in paddy field is:-

$$H = (32.666 - 32.608) \times 0.3048 = 0.0177 \text{ m}$$

Fig-29 shows the cross-section of inlet facilities of Field Block No. 3-1.

Fig.-29: Cross-section of inlet facilities at Field Block No. 3-1



the diameter of the P.V.C pipe is calculated as well as before, that is:-

V = .g.H

= 9.8x0.0177 = 0.589 m/sec

Q =

0.010 = 0.589

D = (x0.010 / x0.589)$^{\frac{1}{2}}$ = 0.147

≒ 0.15 m

≒ 6"

Though last calculation couldn't get the 10 cm water layer in the field, in this case the water layer is given 10 cm as a result of the re-construction of the off-take.

x) Final arrangement of QC1

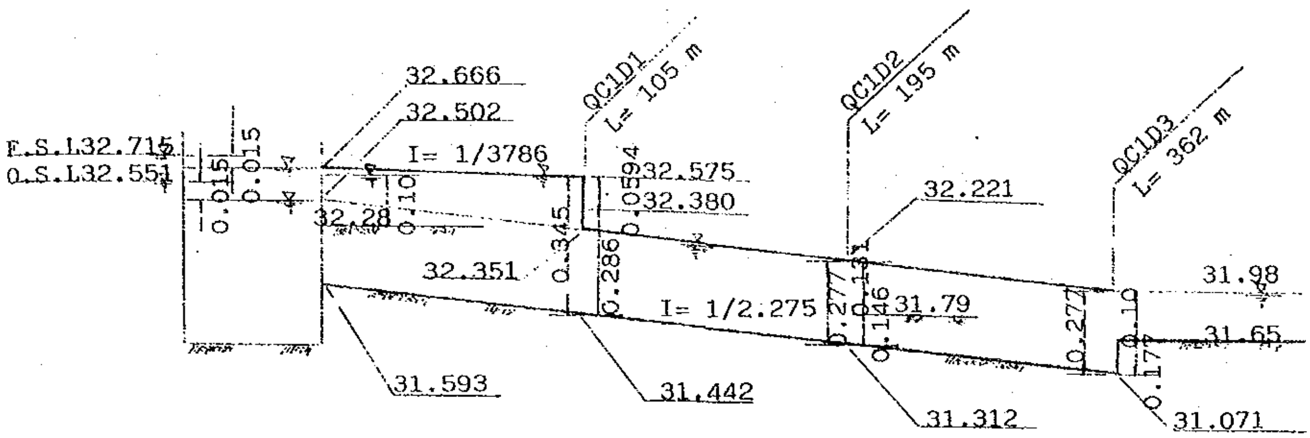
The most effective cross-section of QC1 in relation to each diversion box, that is, QC1D1, QC1D2, QC1D3 and direct draw from the off-take, is tried to find out up to here considering many cases. The table- 26 shows the final determination of QC1 and it's longitudinal section is shown as in Fig- 30.

86/-

Table-26: Final determination of QC1

name	$Q(m^3/sec)$	V(m/sec)	Bed slope	Water slope	A.S.L (ft)	conditions of Secondary canal	Supply level (ft)	water layer (m)
Direct	0.050	0.589	level	pipe	32.666	F.S.L	32.608	0.100
QC1D1	0.050	0.297	1/2275	1/3786	32.666	F.S.L	32.572	0.059 - 0.100
QC1D2	0.050	0.361	1/2275	1/2275	32.502	O.S.L	32.221	0.131
QC1D3	0.050	0.361	1/2275	1/2275	32.502	O.S.L	31.930	0.100

Fig-30: Final longitudinal section of QC1



Now, the expected water requirement that is 0.050 m^3/sec, is satisfied with the best cross-section of QC1.

Hereinafter, the inlet box for diverting the water to each Field Block is designed as follows.

5) Design of inlet box of QC1

Generally speaking, the inlet box should be constructed 0 to 10 cm above the paddy field excepting an obstruction due to the topographical conditions, that is, the water from the inlet box can draw for the jet flow. In this case this inlet box is called as jet flow diversion works.

However, as stated above, P/F No.2 is located higher place of Kadok district therefore it is impossible to design as the jet flow one.

In this case, the structures design is calculated by using the formula of submerged weir, that is shown as below:-

- Complete overflow

$$Q = m.b.h1.\sqrt{2.g.h1}$$

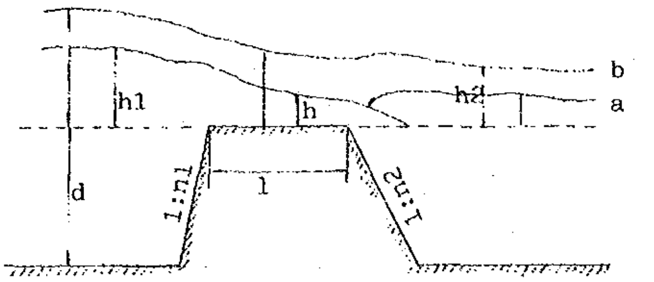
- Incomplete overflow

$$Q = (\alpha - \frac{h2}{h1} + \beta).b.h1.\sqrt{2.g.h1}$$

- Submerged weir

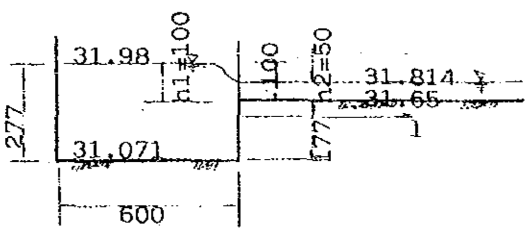
$$Q = m'.b.h2.\sqrt{2.g.(h1 - h2)}$$

The general cross-section of submerged weir is shown as below and it's coefficient is shown in table-27.



i) *In case of QC1D3*

The expected cross-section is shown as below:-



The suitable water layer for rice cultivation is expected 5 cm above the paddy field and the width of inlet is decided at that time, that is, the water quantity of **0.050** m^3/sec from the QC1 can draw to the paddy field. The width is given as below using the formula of submerged weir.

$$\frac{h1}{l} = \frac{0.100}{\infty} < \frac{1}{2}$$

$$\frac{h2}{h1} = \frac{0.050}{0.100} = 0.50 < 2/3 \quad \text{..... complete overflow}$$

$$Q = m.b.h1.\sqrt{2.g.h1}$$

Table-27: Coefficient table of submerged weir

n1 and n2	complete overflow	border of	incompleted overflow		border of	submerged weir
	m	$\frac{h2}{h1}$	$\frac{\alpha}{m}$	$\frac{\beta}{m}$	$\frac{h2}{h1}$	$\frac{m'}{m}$
n1 = 0 - 4/3 n2 < 5/3	$0.31 + 0.23 \frac{h1}{d}$	0.60	-0.030	1.018	0.7	2.6
n1 = 0 - 2/3 n2 ≒ 1	$0.29 + 0.32 \frac{h1}{d}$	0.45	-0.200	1.090	0.8	2.6
n1 = 0 - 1/3 n2 ≒ 2/3	$0.28 + 0.37 \frac{h1}{d}$	0.25	-0.125	1.032	0.8	2.6
rectangle $\frac{h1}{\lambda} < \frac{1}{2}$	0.35	2/3	-	-	2/3	2.6

70/--

where; m : coefficient of discharge 0.35
b : width of inlet x m
hl: up-stream water height 0.100 m
g : acceleration of gravity $9.8\ m.sec^{-2}$

$0.050 = 0.35 \times b \times 0.100 \times \sqrt{2 \times 9.8 \times 0.100}$

$b = 1.02$ m

Consequently, the width of the inlet is given as above, however QC1D3 is located at the end of the QC1 therefore Field Block No. 1-2 is able to irrigate at the same time. This means the total area of Field Block No. 1-2 and No. 1-3, that is 2.69 ha, is irrigated by the expected water discharge $0.050\ m^3/sec$.

Now, the distributed water discharge to each Field Block can separate as below:-

to Field Block No. 1-2

$0.83\ ha/2.69\ ha \times 0.050\ m^3/sec = 0.016\ m^3/sec.$

to Field Block No. 1-3

$1.85\ ha/2.69\ ha \times 0.050\ m^3/sec = 0.034\ m^3/sec$

thus, Each inlet width is decided as follows:

to Field Block No. 1-2

$0.016 = 0.35 \times b \times 0.100 \times \sqrt{2 \times 9.8 \times 0.100}$

$b = 0.327$

$= 0.33$ m

to Field Block No. 1-3

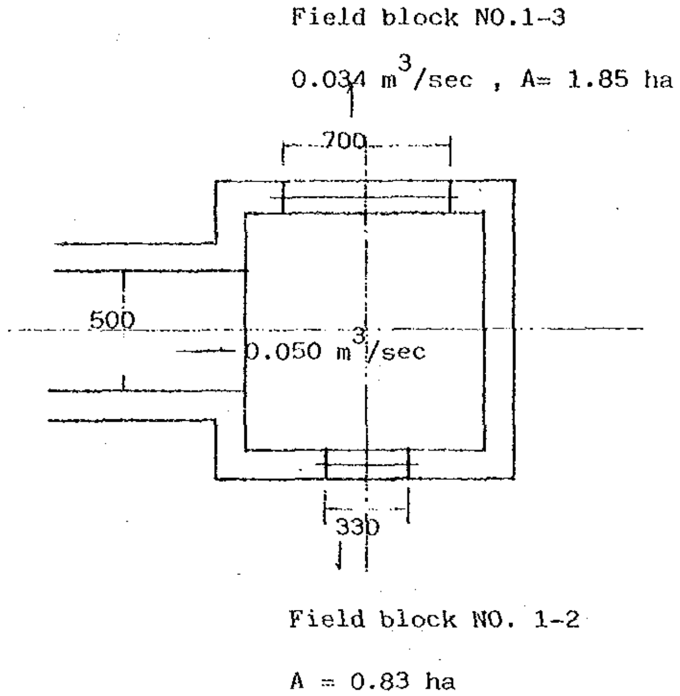
$0.034 = 0.35 \times b \times 0.100 \times \sqrt{2 \times 9.8 \times 0.100}$

$= 0.694$

$\fallingdotseq 0.70$ m

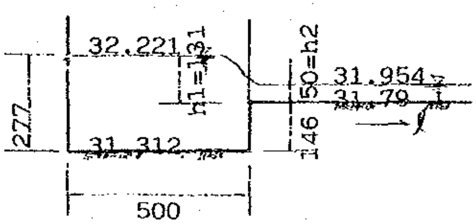
91/-

The expected inlet box of QC1D3 is shown as below:-



ii) In case of QC1D2

the expected cross-section is shown as below:-



the wedth of inlet is calculated as well as QC1D3 by using the formula of submerged weir.

92/-

$$\frac{h1}{l} = \frac{0.131}{60} < \frac{1}{2}$$

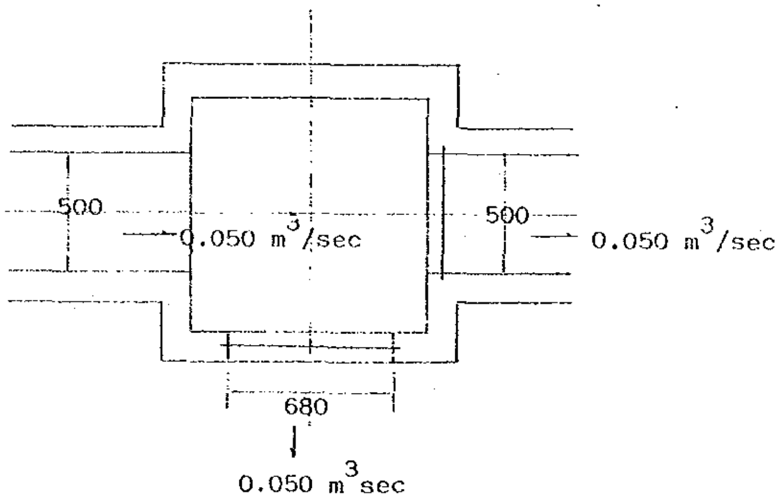
$$\frac{h2}{h1} = \frac{0.050}{0.131} = 0.38 < 2/3 \quad \text{..... complete overflow}$$

$$Q = m.b.h1.\sqrt{2.g.h1}$$

$$0.050 = 0.35 \times b \times 0.131 \times \sqrt{2 \times 9.8 \times 0.131}$$

$$b = 0.68 \text{ m}$$

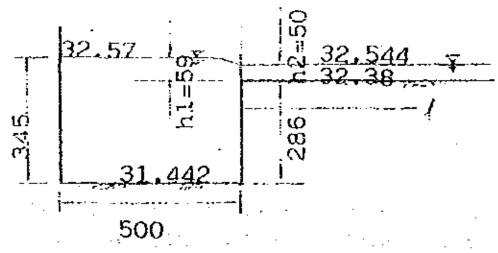
the expected inlet box of QC1D2 is shown as below:-



Field block No.1-1 , A= 1.23 ha

iii) In case of QC1D1

the expected cross-section is shown as below:-



the wedth of inlet is calculated as well as QC1D3 and QC1D2 by using the formula of submerged weir.

93/-

$$\frac{h1}{l} = \frac{0.059}{\infty} < \frac{1}{2}$$

$$\frac{h2}{h1} = \frac{0.050}{0.059} = 0.847 > 2/3 \quad \text{..... submerged weir}$$

$$Q = m'.b.h2.\sqrt{2.g.(h1-h2)}$$

$$\frac{m'}{m} = \frac{m'}{0.35} = 2.6$$

$$m' = 0.91$$

$$0.050 = 0.91 \times b \times 0.050 \times \sqrt{2 \times 9.8 \times (0.059-0.050)}$$

$$b = 2.616$$

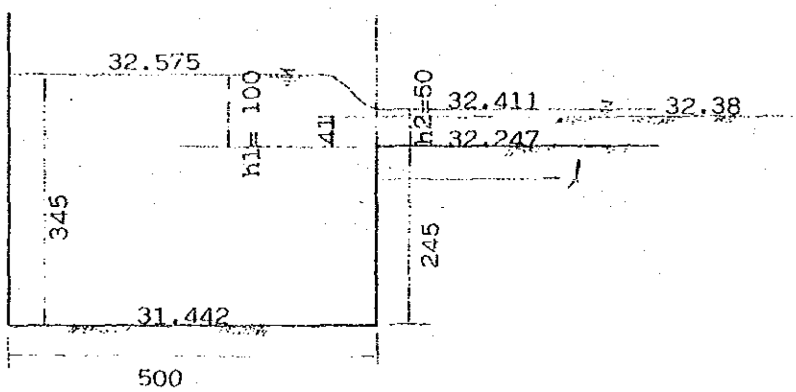
$$= 2.62 \text{ m}$$

Though the wedth of inlet is given, that is 2.62 m, however it is not fit in with the reality. So far, the most effective cross-section is calculated by many cases and it's best longitudinal section is decided as in Fig-30.

On the other hand, the QC1D1 is still not satisfied with the distribution of the water requirement to the paddy field. In spite of the re-construction of the off-take in order to lift up the water level in the QC1.

In this case, it is impossible to take the irrigation water from QC1D1 without decrease the paddy field elevation or otherwise the bigger wedth of inlet has to be provided. Therefore, this AC1D1 should be considered to replace the same conditions as well as others.

The improved expected cross-section is shown as below:-



the existing paddy field elevation should be decreased up to 32.247 ft. that is 4.1 cm below the existing ground level. This moving soil will be applied to the farm road.

The improved width of the inlet box is given as below:-

$$\frac{h1}{l} = \frac{0.100}{\infty} < \frac{1}{2}$$

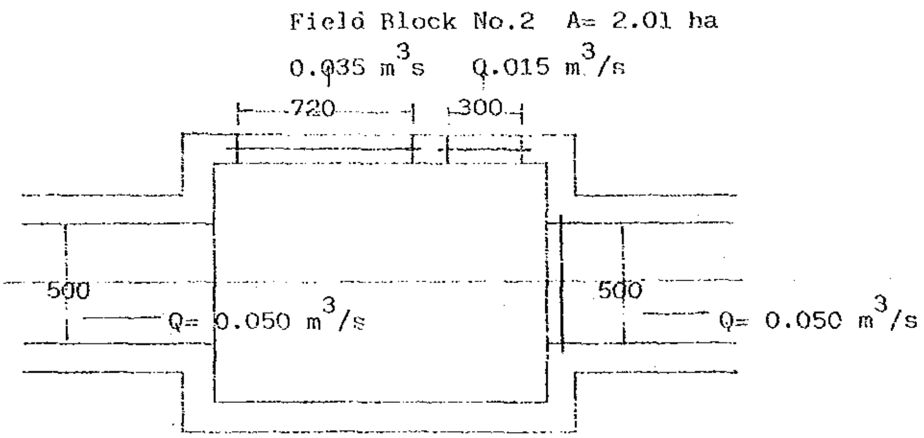
$$\frac{h2}{h1} = \frac{0.050}{0.100} = 0.5 < 2/3 \quad ..... \quad \text{complete overflow.}$$

$$Q = m.b.h1.\sqrt{2.g.h1}$$

$$0.050 = 0.35 \times b \times 0.100 \times \sqrt{2 \times 9.8 \times 0.100}$$

$$b = 1.02 \ m$$

Accordingly, the width of inlet is given as above, however if the width is more than 1.0 m, the water control of the supplementary and growing period is anticipated difficulty to take the water from inlet box due to a little water discharge. Therefore, it is better to separate the width to 30 cm and 72 cm, that is 30 cm is used for the supplementary and growing period not only the presaturation period.



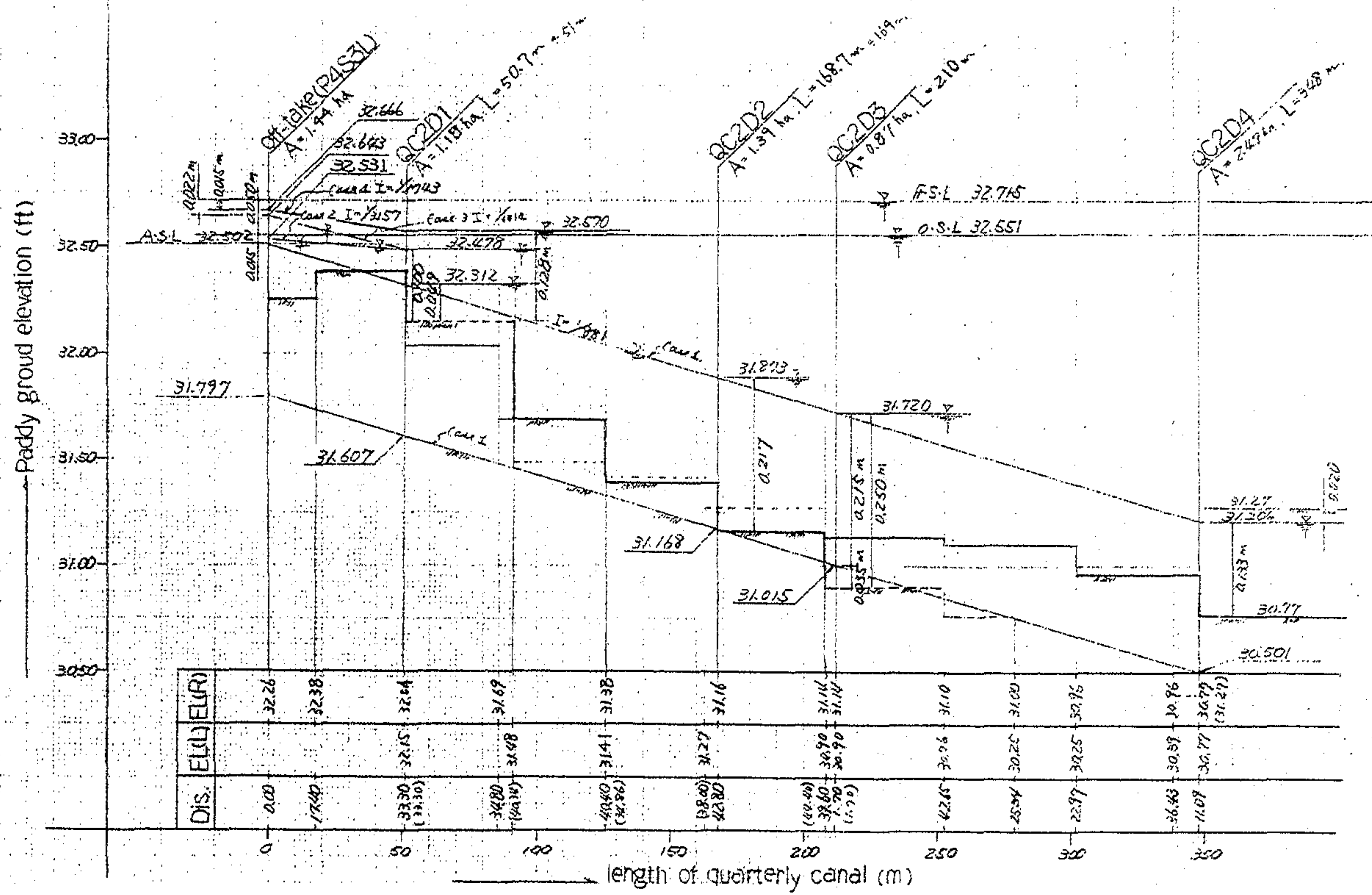
the expected inlet box of QC1D1 is shown as below:-

6) Design of QC2.

The design procedure for QC2 is the same as for the QC1. Now, the longitudinal section of the existing paddy field is shown in Fig-31, it is clear that the topographical conditions is steeper than QC1.

95/-

Fig -31 : LONGITUDINAL SECTION AND DESIGN OF QC 2



In this case, the water depth is able to give 25 cm above the paddy field at QC2D3, where is assumed the middle point of QC2, for the best conditions as below ;-

the A.S.L	32.502ft	below the O.S.L by 1.5 cm	
paddy field elevation	30.90 ft	middl of QC2	
conveied water depth	0.82 ft	0.25/0.3048	
water level in paddy field	31.72ft	30.90 + 0.82	32.502

the water slope is given as below:-

(32.502 - 31.72) x 0.302/210 = 1/881

i) Calculation of the most effective cross-section (Case 1)

The most effective cross-section is calculated using the program No. 2 and 3 as in table-28.

Table-28: the most effective cross-section of QC2 (Case 1)

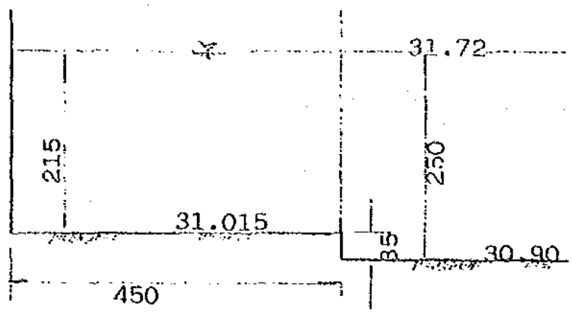
B(m)	A	B	C	H(m)	P(m)	F(ft)
0.35	0.00840	0.00294	0.00026	0.281	0.912	30.798
0.40	0.00431	0.00172	0.00017	0.243	0.886	30.923
0.45	0.00239	0.00108	0.00012	0.215	0.880	31.015
0.50	0.00141	0.00071	0.00009	0.195	0.890	31.080
5.55	0.00088	0.00048	0.00007	0.179	0.908	31.133

where, B : width of QC2
H : depth of QC2
P : wetted perimeter
F : foundation height
A, B, C : coefficient

97/-

Consequently, the expected most effective cross-section is shown in Fig-32.

Fig-32: cross-section by 0.45 m width of QC2.



(check accounts)

$A = 0.45 \times 0.215 = 0.0968\ m^2$

$P = 0.215 \times 2 + 0.45 = 0.880\ m$

$R^{2/3} = 0.230$

$V = \frac{1}{0.015} \times 0.230 \times \left(\frac{1}{831}\right)^{\frac{1}{2}} = 0.517\ m/sec$

$Q = 0.0968 \times 0.517 = 0.050\ m^3/sec$ ...... o.k

At the same time, the water depth in the QC2D2 and QC2D4 are keeping enough water level eventhough it is lower than 25 cm, that is 21.7 and 13.3 cm, therefore there is no difficulty to take the expected water from QC2D2 and QC2D4.

ii) Calculation of the most effective cross-section at QC2D1.

The water level at QC2D1 is shown 32.312 ft, that is 4.9 cm above the paddy field elevation, however the supposed water layer is expected 10 cm which will carry out the good result for the decision of the width of inlet box i.e. the complete overflow is expected.

To meet the above, it is necessary to dam up QC1D1.

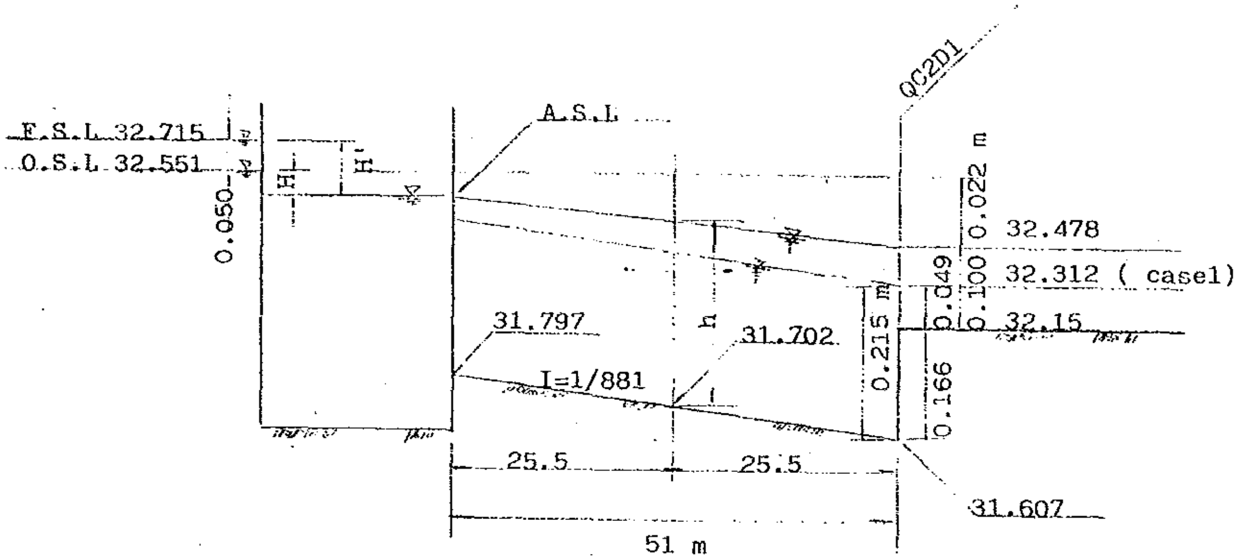
98/-

The expected water level in the paddy field is shown as below:-

the A.S.L.	32.502 ft	below the O.S.L by 1.5 cm	
paddy field elevation	32.15 ft		
expected water layer	0.328 ft	0.10/0.3048	
water level in paddy field	32.478 ft	32.15 + 0.328	32.502

The longitudinal section between the off-take and QC2D1 is shown in Fig-33.

Fig-33: Longitudinal section for dam up weir of QC2D1



The trial calculation to get the most effective cross-section of QC2D1 which is from the O.S.L is shown in table-29 as case 2.

In this case, the maximum water discharge is shown as 0.031 m^3/sec, however this water discharge is not satisfied with the expected water requirement, that is 0.050 m^3/sec.

Therefore, the A.S.L should be lifted up by 1.5 cm below the F.S.L. The assumed head losses, that is H', is also shown in Fig-33 and it's trial calculation to get the most effective cross-section is shown in table-30 as case 3.

The assumed water discharge is shown in table-30, that is 0.060 m^3/sec, however the expected water requirement for within 9 days presaturation is supposed 0.050 m^3/sec, therefore in case of three has a possibility to lift more up the A.S.L in order to give higher water supply level to the paddy field.

94/-

Table-29: Trial calculation for dam up wair of QC2D1 (case 2)

assumed H(m)	A.S.L (ft)	water level in paddy field (ft)	assumed Q(m^3/sec)	I	h(m)	A(m^2) 0.45xh	P(m)	$R^{2/3}$	V(m/sec)	Q(m^3/sec)	Remarks
0.010	32.518	32.478	0.041	1/4183	0.2426	0.1092	0.9352	0.2389	0.2463	0.027	less
0.009	32.521	"	0.039	1/3891	0.2431	0.1094	0.9362	0.2390	0.2554	0.028	"
0.008	32.525	"	0.036	1/3560	0.2437	0:1097	0.9374	0.2393	0.2674	0.029	"
0.007	32.528	"	0.034	1/3346	0.2441	0.1098	0.9382	0.2393	0.2758	0.030	"
0.006	32.531	"	0.032	1/3157	0.2446	0.1101	0.9392	0.2395	0.2842	0.031	"
0.005	32.535	"	0.029	1/2935	0.2452	0.1103	0.9404	0.2396	0.2948	0.033	over

100/-

Table-30: Trial calculation for dam up weir of QC2D1 (case 3)

assumed H(m)	A.S.L (ft)	water level in paddy field (ft)	assumed Q(m^3/sec)	I	h(m)	A(m^2) 0.45xh	P(m)	$R^{2/3}$	V (m/sec)	Q(m^3/sec)	Remarks
0.018	32.656	32.478	0.0546	1/940	0.2637	0.1187	0.9774	0.2452	0.5332	0.063	over
0.019	32.653	"	0.0561	1/956	0.2632	0.1184	0.9764	0.2450	0.5283	0.063	"
0.020	32.649	"	0.0576	1/978	0.2626	0.1182	0.9752	0.2449	0.5221	0.062	"
0.021	32.646	"	0.0590	1/996	0.2621	0.1179	0.9742	0.2447	0.5169	0.061	"
0.022	32.643	"	0.0604	1/1014	0.2617	0.1178	0.9734	0.2447	0.5123	0.060	equal
0.023	32.640	"	0.0618	1/1033	0.2612	0.1175	0.9724	0.2444	0.5069	0.060	less

As above-mentioned the cross-section of QC2D1 is carried out as case 4. (table-31)

The expected water requirement, that is 0.050 m^3/sec, is able to take from 1.5 cm below the F.S.L

The A.S.L is decided as below:-

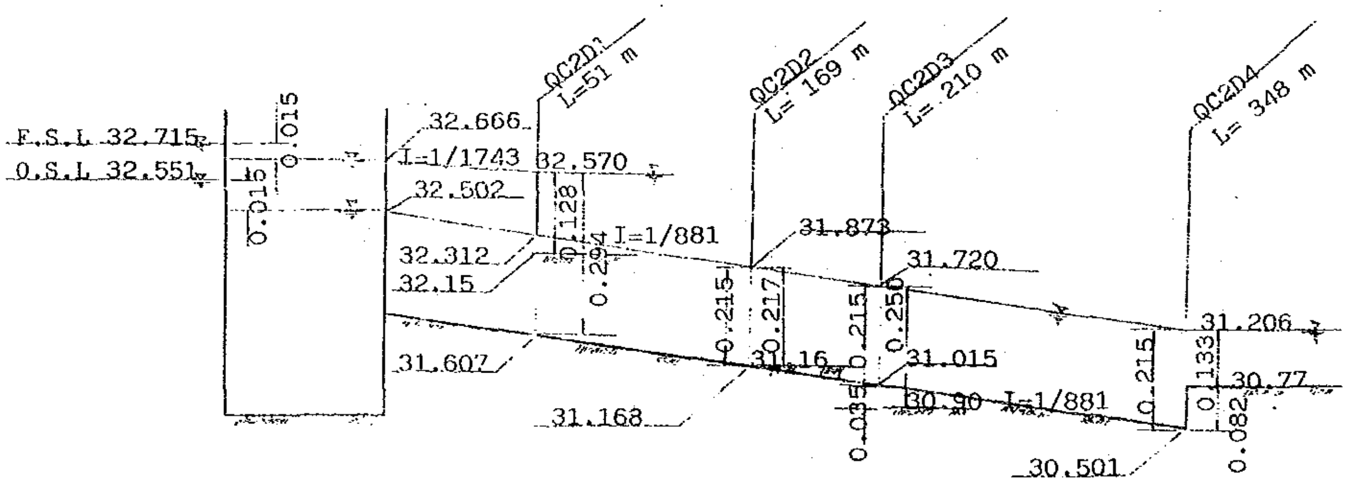
The F.S.L	32.715 ft
- 1.5 cm	- 0.049 ft
The A.S.L	32.666 ft

Consequently, the water of QC2D1 is able to increase up to 32.570 ft, that is 0.128 m above the paddy elevation.

iii) Final arrangement of QC2

The most effective cross-section of QC2 in relation to each diversion box is arranged in table-32, and final longitudinal section is shown in Fig-34.

Fig-34: Final longitudinal section of QC2



Finally, the expected water requirement, that is 0.050 m^3/sec is satisfied with the best cross-section of QC2 as well as the QC1.

Hereinafter, the inlet box for diverting the water to each field Block is designed as follows.

102/-

The trial calculation is shown below:-

Table-31: **Trial** calculation for dan up wair of QC2D1 (case 4)

A.S.L (ft)	water level in paddy field (m, ft)		depth of dam up(m)	I	$A(m^2)$	P(m)	$R^{2/3}$	V	Q	Remarks
32.666	0.1268	32.566	0.2787	1/1683	0.1254	1.0074	0.2493	0.4051	0.0508	over
"	0.1271	32.567	0.2787	1/1690	0.1254	1.0074	0.2493	0.4043	0.0507	"
"	0.1274	32.568	0.2789	1/1707	0.1255	1.0078	0.2494	0.4024	0.0505	"
"	0.1277	32.569	0.2790	1/1725	0.1256	1.0080	0.2495	0.4005	0.0503	"
"	0.1280	32.570	0.7292	1/1743	0.1256	1.0084	0.2494	0.3983	0.0500	equal
"	0.1283	32.571	0.2793	1/1761	0.1257	1.0086	0.2495	0.3964	0.0498	less
"	0.1286	32.572	0.2795	1/1780	0.1258	1.0090	0.2496	0.3944	0.0496	"

103/-

Table-32: Final determination of QC2

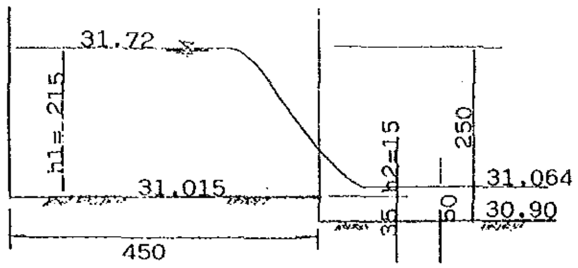
name	$Q(m^3/sec)$	V(m/sec)	Bed slope	water slope	A.S.L (ft)	Conditions of secondary canal	Supply level (ft)	water layer (m)
QC2D1	0.050	0.398	1/881	1/1743	32.666	F.S.L	32.570	0.128
QC2D2	0.050	0.517	1/881	1/881	32.502	O.S.L	31.873	0.217
QC2D3	0.050	0.517	1/881	1/881	32.502	O.S.L	31.702	0.25
QC2D4	0.050	0.517	1/881	1/881	32.502	o.S.L	31.206	0.133

104/-

7) Design of inlet box of QC2

i) In case of QC2D3

The expected cross-section is shown as below:-



The width of inlet box is given as below using the formula of submerged wair.

$$\frac{h1}{l} = \frac{0.215}{\infty} < \frac{1}{2}$$

$$\frac{h2}{h1} = \frac{0.015}{0.215} = 0.070 < 2/3$$ ..... complete overflow

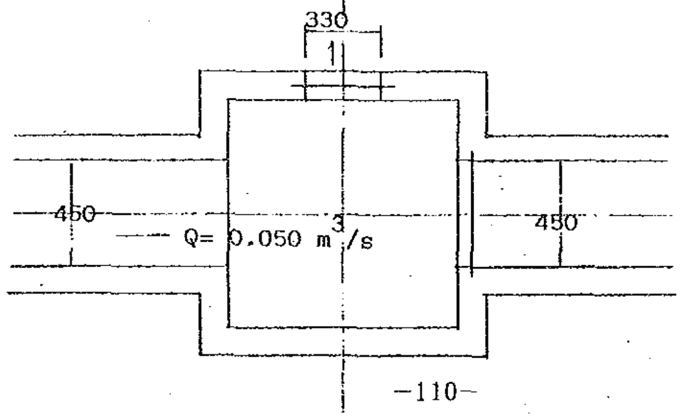
$$Q = m.b.h1.\sqrt{2.g.h1}$$

$$0.050 = 0.35 \times b \times 0.215 \times \sqrt{2 \times 9.8 \times 0.215}$$

$$b = 0.324$$

$$= 0.33 \text{ m}$$

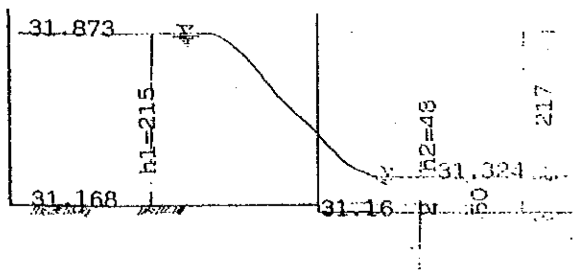
Consequently, the expected inlet box of QC2D3 is shown as below:-



105/-

ii) In case of QC2D2

The expected cross-section is shown as below:-



The width of inlet box is given as well as the QC2D3.

$\frac{h1}{l} = \frac{0.215}{\infty} < \frac{1}{2}$

$\frac{h2}{h1} = \frac{0.048}{0.215} = 0.223 < 2/3$ ..... complete overflow

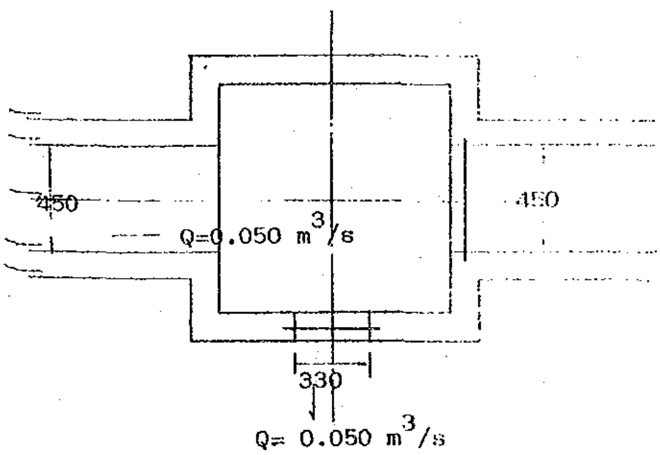
$Q = m.b.h1.\sqrt{2.g.h1}$

$0.050 = 0.35 \times b \times 0.215 \times \sqrt{2 \times 9.8 \times 0.215}$

$b = 0.324$

$= 0.33$ m

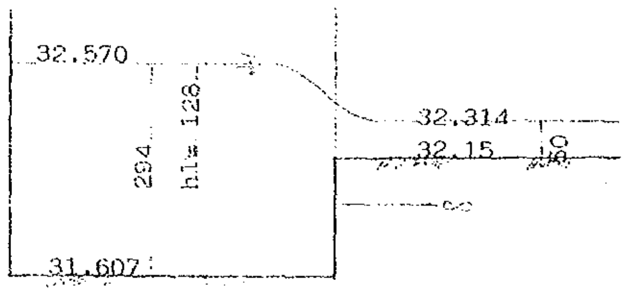
The expected inlet box of QC2D2 is shown as below:-



Field Block No.3-2, A=1.39 ha

iii) In case of QC2D1

The expected cross-section is shown as below



The width of inlet box is given as below:-

$\frac{h1}{1} = \frac{0.128}{\infty} < \frac{1}{2}$

$\frac{h2}{h1} = \frac{0.050}{0.128} = 0.391 < 2/3$ ..... complete overflow.

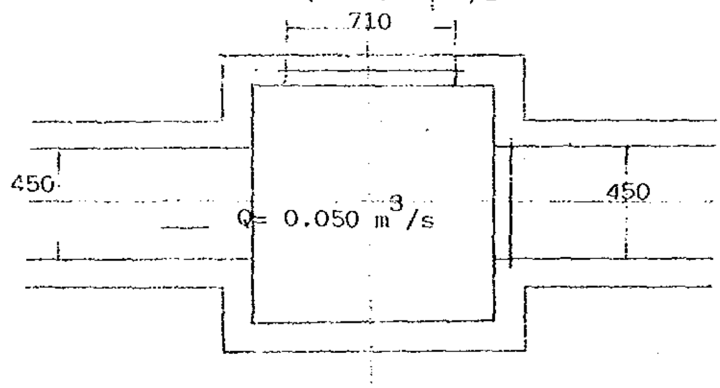
$Q = m.b.h1.\sqrt{2.g.h1}$

$0.050 = 0.35 \times b \times 0.128 \times \sqrt{2 \times 9.8 \times 0.128}$

$b = 0.705$

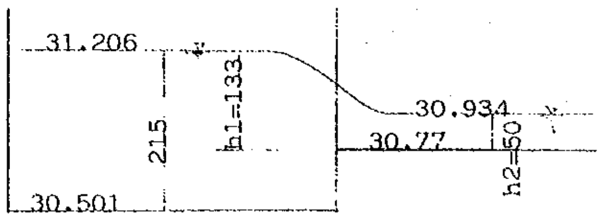
$= 0.71\ m$

The expected inlet box of QC2D1 is shown as below:-



iv) In case of QC2D4

The expected cross-section is shown as below ;-



The width of in-let box is given as below ;-

$$\frac{h1}{l} = \frac{0.133}{\infty} < \frac{1}{2}$$

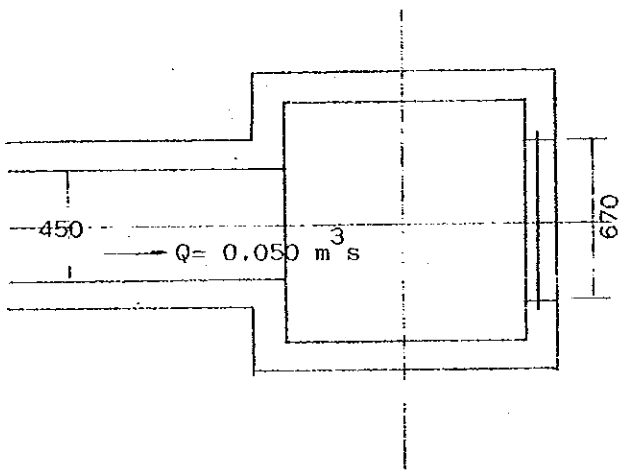
$$\frac{h2}{h1} = \frac{0.050}{0.133} = 0.376 < \frac{2}{3}$$ .....complete over flow

$$Q = m.b.h1.\sqrt{2.g.h1}$$

$$0.050 = 0.35 x b x 0.133 x \sqrt{2x9.8x0.133}$$

b = 0.665 = 0.67 m

The expected in-let box of QC2D4 is shown as below ;-



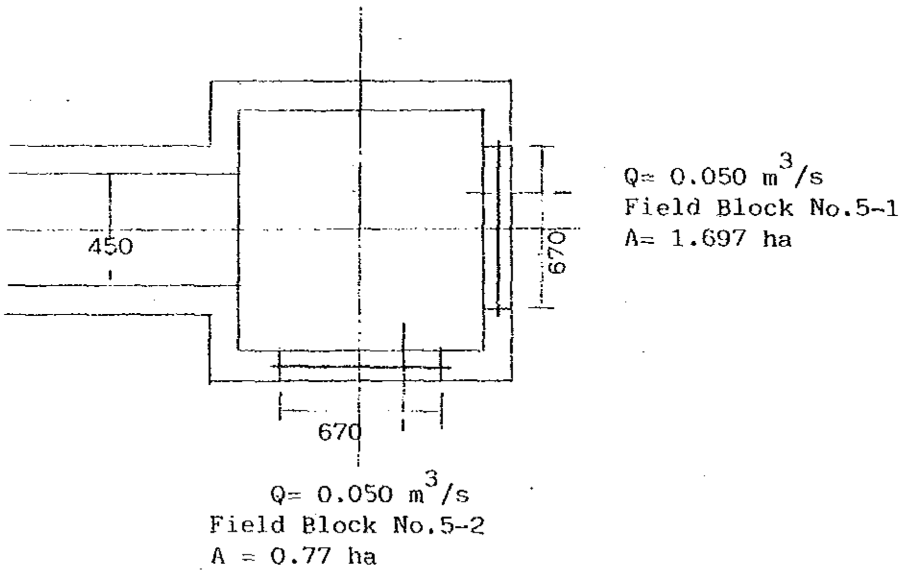
Field Block No.5-1
A = 1.697 ha

108/-

Taking into consideration of field block NO.5-2, the paddy elevation is higher than field block No.5-1 , that is, E.L 31.27 (ft) however, if the QC2 is designed to supply the irrigation water into field block No.5-2, the size of irrigation canal become biger and high cost due to the water slope of the irrigation canal become more gently slope.

This is the reason why the water slope of the QC2 is adapted to I = 1/881 . Afterwards, the land leveling of the field block No.5-2 supposed to be taken at the construction time by the same elevation of field block No.5-1, that is, E.L= 30.77 (ft) for using the soil for the farm road or another earth works.

So, the irrigation canal of QC2 is designed as I= 1/881 and after construction the field block No.5-2 is able to supply the water as well as field block No.5-1 and it is shown as below ;-



109/-

8) Determination of the free board.

So far, the water level on design which will supply the irrigation water to each Field Block is calculated. However to determine the freeboard, besides, the cross-sectional area of flow, the changing of the coefficient of roughness, velocity head and waving water in the canal, should also be considered. The standard consideration of the freeboard is said as follows.

i) Earth and lining canal.

$$Fb = 0.005d + hv + (0.05 \sim 0.15)$$

where, Fb: freeboard (m)
d: water depth on design (m)
hv: velocity head (m)
0.05 ~ 0.15: half wave-height (m)

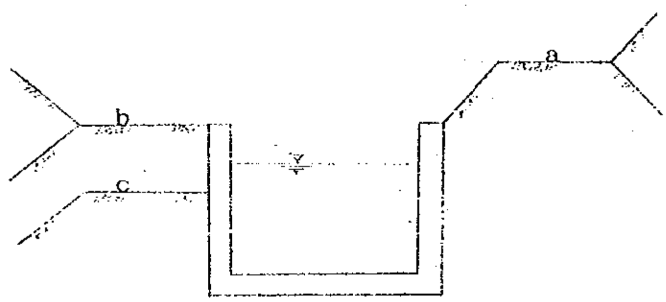
As above mentioned, the freeboard is given using above formula but the least freeboard should be supposed by 0.10 m.

ii) Flume canal.

$$Fb = 0.07d + hv + (0.05 \sim 0.15)$$

where, the function is the same as above formula.

In this case, the three ways are able to consider as shown below:-



a) in case of the levee crown is higher than the crown of the lining canal.

b) in case of the levee crown is situated the same level of the lining canal.

c) in case of the levee crown is lower than the crown of the lining canal.

The tipical cross-section of the QC1 and QC2 is expected like case a.

In this case, the standered consideration to get the freeboard will be adapted to the i) formula, because of the canal is supported already by the bound and also the least freeboard should be supporsed by 0.10 m.

Now, the freeboard of QC1 and QC2 are calculated as below:-

Fb = 0.05 d + hv + 0.05

name	0.05d	hv	0.05	Fb	Remarks
QC1	0.014	0.007	0.05	0.071	0.100
QC2	0.011	0.014	0.05	0.075	0.100

The volume obtained after adding the freeboard and water depth in the canal can be rounded up for ease of construction provided the freeboard should not be less than 0.10 m.

The tipical cross-section of QC1 and QC2 is shown in fig. 35 and 36.

Fig-35: Tipical cross-section of QC1

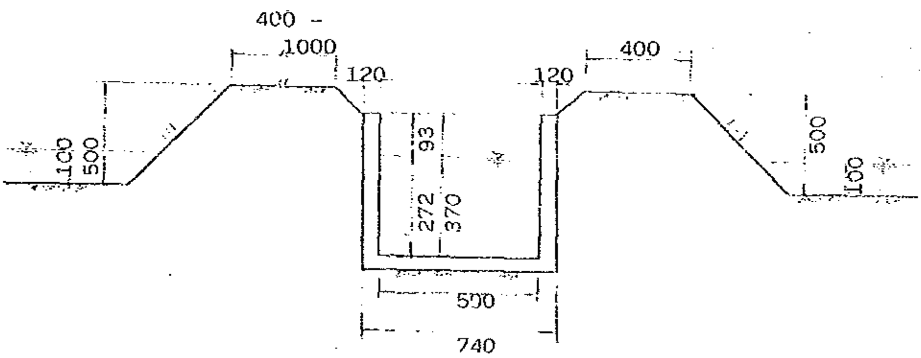
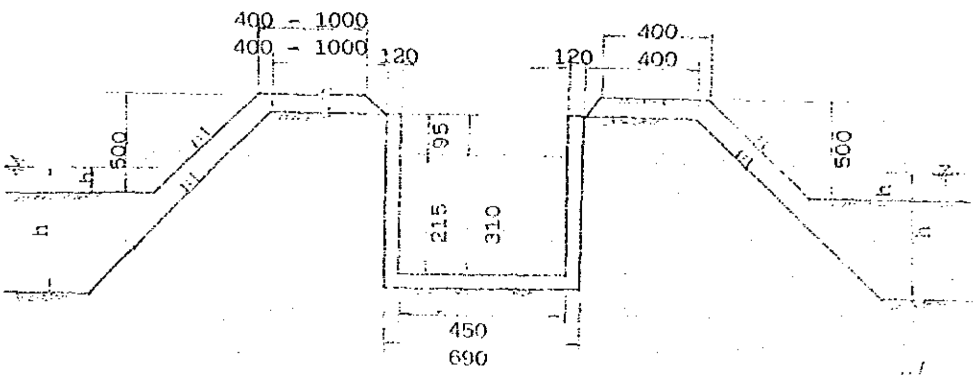


Fig-36: Tipical cross-section of QC2



It is clear as in Fig-35 and 36 that the QC1 and QC2 are supported/covered by the 0.40 - 1.0 m width of border, that is called ditch-side border. The ditch-side border is used not only support/cover the irrigation canal but also used as the path for operation the wair and maintaing the irrigation canal as_ one of the on farm facilities.

note

112/-

9) Design of Farm Road

The main farm road is located through the center of P/F No. 2 and this farm road should be connected with the city road and existing kanpong road for conveniently transfer of agricultural equipment, machinery and harvested rice.

On the other hand, the road which is located belong the irrigation canal, that is the ditch-side border is very useful to maintain and operating the irrigation canal as if the small farm road.

i) Width of farm road

Generally speaking, the width of the farm road is decided due to the varieties of vehicles which are concerned to the agricultural activities such as tractor, combine, truck and so on. The width of the main farm road include the space for pass each other (0.5 m), out side surplus width (0.3m) and road shoulder (0.5 - 0.75 m).

The effective width of main farm road is said 5 - 6 m in order to pass each truck (2.4 m) and tractor (2.0 m) and also the branch road is 3 - 4 m for the combine width (3.5 m) as usual.

THe vehicles width which are seemed to run on the farm road are shown as follows ;-

passenger car	2.0 m
truck (5 t)	2.4 m
tractor (40 ps)	2.0 m
trailer	1.9 m
combine (cutting width 3.0 m)	3.5 m

In this design, the expected farm road width is seemed 5.0 m, howevere it is said that wider farm road width is not able to require to the land acquisition now in Malaysia, because of existing conditions which have no on farm facilities, therefore it is given 4.0 m width for the alternative way.

ii) Height of farm road

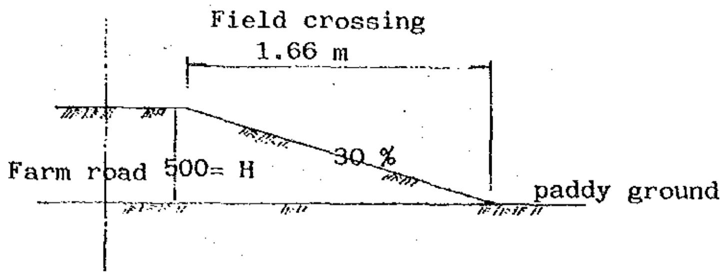
Height of the farm road from the paddy ground is said more than 50 cm for main farm road and 30 cm for branch road. It must be careful to decide the height from the paddy ground because of the field crossing.

The width of field crossing is said 4.0 m as standerd, and it's slope is determined less than 32.5 % because of the limited slope of tractor is seemed by 18°.

All the paddy field which along the farm road will be possessed the field crossing at least one place to one paddy lot, and the location of field crossing is supposed to be left side of the paddy field due to the combine used to work right revolution as usual.

In this design, the field crossing slope is given 30 % and it's tipical cross section is shown as in fig.–37

Fig.–37 Tipical cross section of field crossing.



iii) Longitudinal slope

The max. longitudinal slope of the main farm road is said less than 8 % as usual and also 12 % as special case. If the longitudinal slope is given more than 8 % , at that time the length should be limited by 100 m with the control distance which consisted by the appropriate slope , that is less than 2.5 % and more than 30 m length.

iv) Cross section

The cross section of the farm road should be constructed that the center of the farm road is higher than road shoulder in order to drain out the rain fall water immediately. The cross section slope of the farm road which is made of soil and gravel is supposed to be 3 – 6 % and concrete or asphalt one is 1.5 – 2 %.

v) Corner cut–off

The corner cut–off is able to situated in the intersection of the farm road if necessary, the size of the corner cut–off is seemed 1.5 – 2.0 m for one corner.

In this design, the longitudinal slope is given as in fig.–38 . The slope from the city road to farm road and end of the farm road is given 5 % slope for the approach. Especially, the control distance is consisted by level and 4.0 m distance for one vehicle is designed at the first approach from the city road.

The most of the middle parts of the farm road is designed to level and also the height from the paddy ground is given around 0.5 m. The tipical cross section of the farm road is shown as in fig. – 39 .

114/–

Fig.- 38 Longitudinal Section of Farm Road and FD2

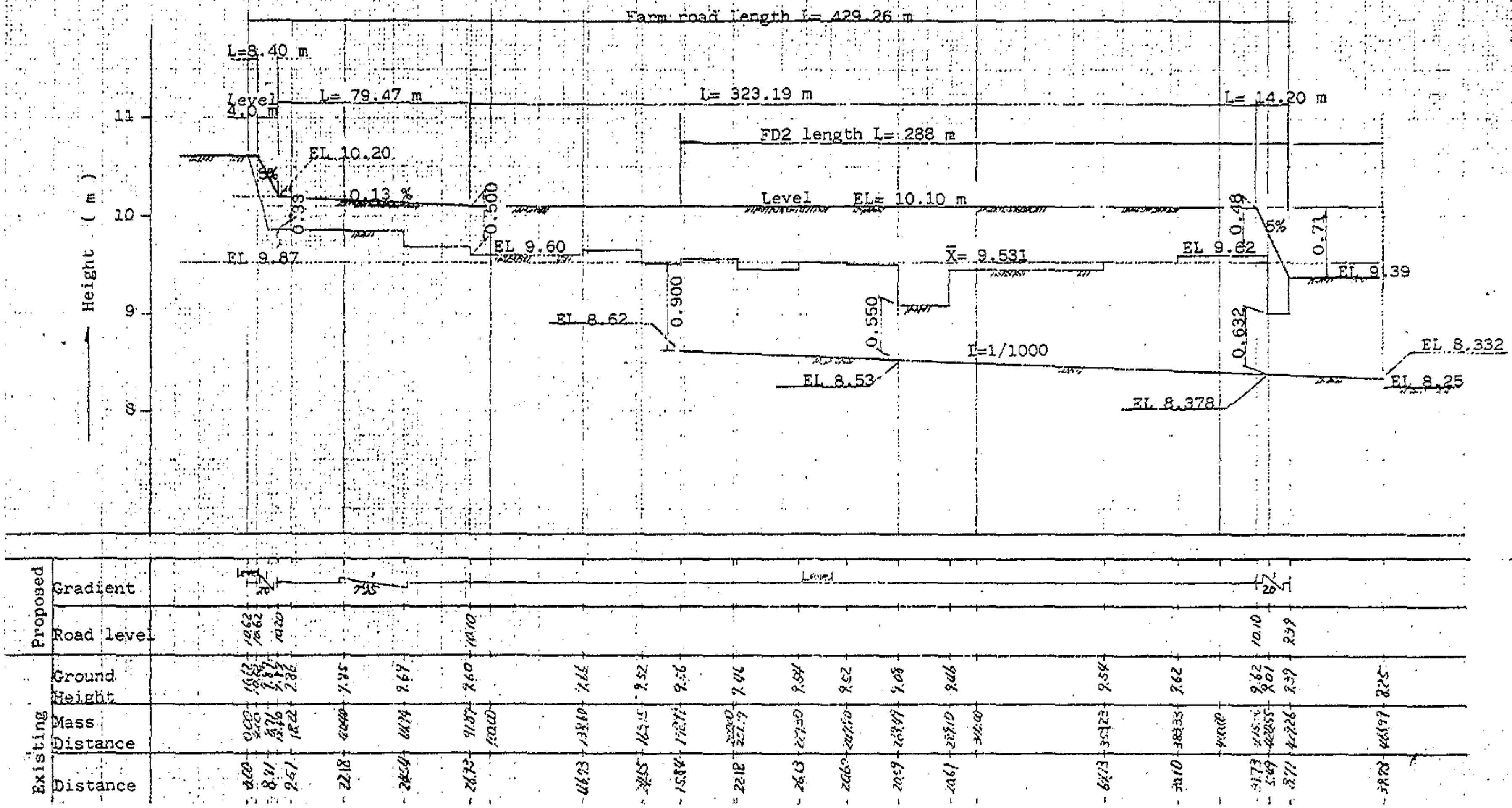
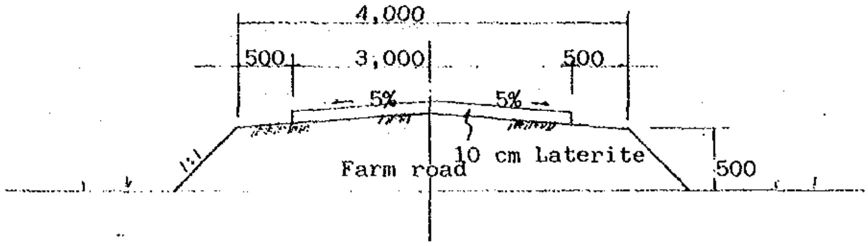


Fig. - 39 The cross section of farm road



10) Design of field drainage canal

i) Standerd daily precipitation

The daily precipitation which probability is seemed 5 year is adapted to the daily drainage from the terminal paddy field. The rainfall data from 1970 to 1977 at Kota Bharu are shown as in table- 33 and it's probability graph is also shown as in fig.- 40 .

In fact, 351.0 mm/day precipitation is given the max. data of them and it shows 5-year probability.

ii) Drainage discharge

The drainage discharge is calculated by following equation.

$$Q = \frac{1}{86,400} \times t1 \times 10^{-3} \times A \times 10^{4} \times f$$

where,

Q : drainage discharge (m^3/sec)
t1 : standerd daily precipitation 351 mm/day
A : catchment area (ha)
f : run-off ratio (0.7)

a) In case of FD 2

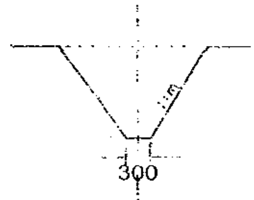
The catchmentarea of the FD 2 is calculated by the sum of the field block No.2,3-1,3-2,1-3 and 5-2, that is , A = 7.47 ha.
Consequently, the drainage discharge is given as follows;-

$$Q = \frac{1}{86,400} \times 351 \times 10^{-3} \times 7.47 \times 10^{4} \times 0.7$$
$$= 0.212 \ m^3/sec$$

The most effective cross section is calculated as follows;-

(calculation)

drainage discharge Q = 0.212 m^3/sec
side slope gradient 1 : m = 1 : 1
bed slope I = 1/1000
base width b = 0.300 m
coefficient of roughness n = 0.03



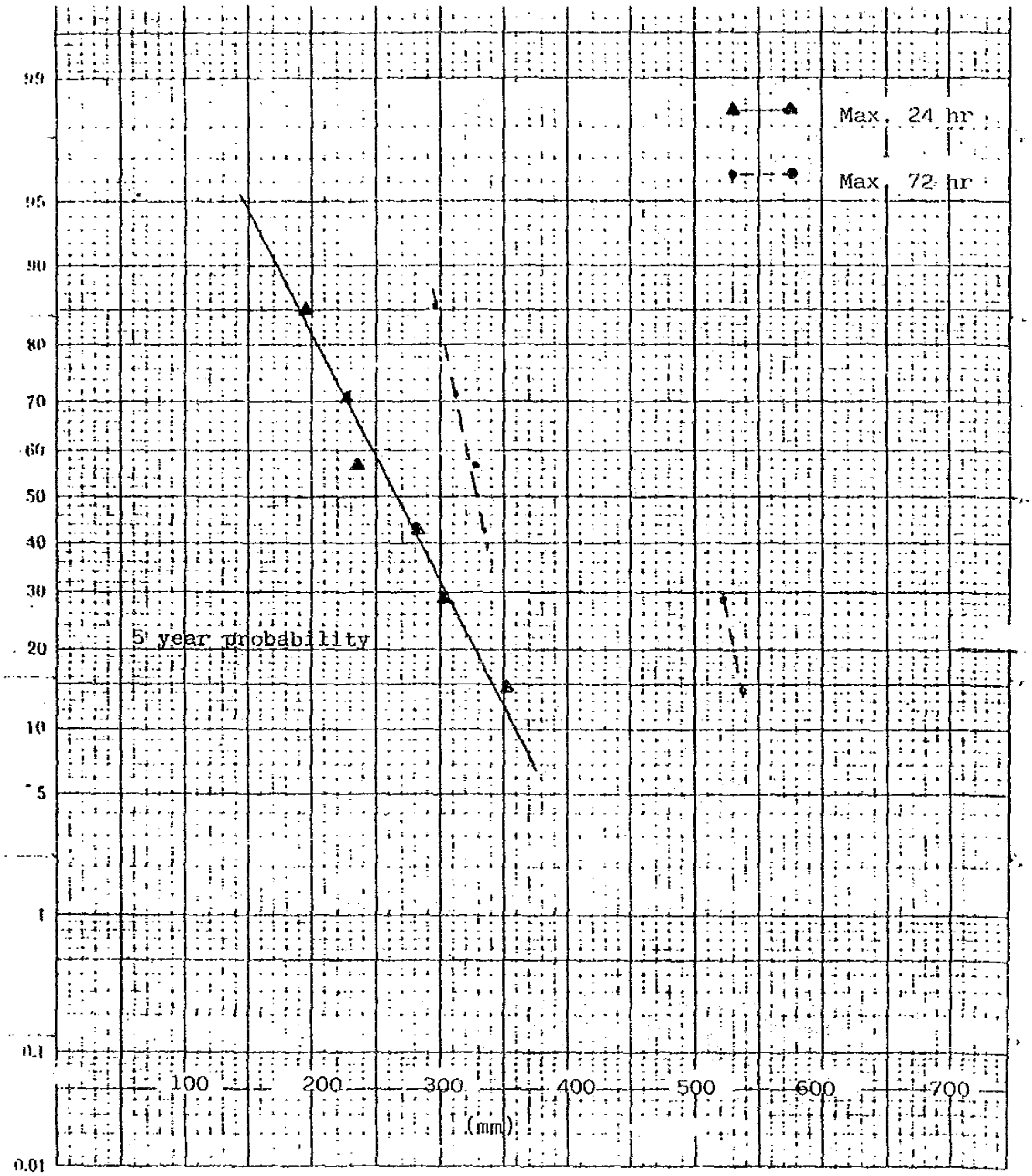
116/-

Table- 33 The max. precipitation from 1970 - 1977

	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77
Max. 24 hr	228.6	187.7	282.2	302.3	235.5	194.0	351.0
Max. 48 hr	268.7	300.5	292.1	431.5	287.5	269.5	470.0
Max. 72 hr	279.9	313.4	297.2	522.2	332.5	329.5	535.0

(DID store, Kota Bharu) unit : mm

Fig. 40 The probability graph of precipitation



$$\frac{Q.n}{I^{1/2}.b^{8/3}} = \frac{0.212 \times 0.03}{(1/1,000)^{1/2} \times 0.30^{8/3}}$$

$$= 4.9866$$

d/b	$\frac{Q.n}{I^{1/2}.b^{8/3}}$
1.800	4.4420
1.80 + x	4.9866
1.900	5.0000

$$(1.900 - 1.800) : x = (5.0000 - 4.4420) : (4.9866 - 4.4420)$$

$$x = 0.098$$

$$d/b = 1.800 + 0.098 = 1.898$$

$$d = 0.30 \times 1.898$$

$$= 0.569$$

(check account)

$$V = \frac{1}{n} . R^{2/3} . I^{1/2}$$

$$A = (1.438 + .30) \times 0.569 \times 0.5$$

$$= 0.494 \ m^2$$

$$P = 0.569 \times 2^{1/2} \times 2 + 0.30 = 1.909 \ m$$

$$R^{2/3} = \left(\frac{A}{P}\right)^{2/3} = \left(\frac{0.494}{1.909}\right)^{2/3} = 0.406$$

$$V = \frac{1}{0.03} \times 0.406 \times \left(\frac{1}{1,000}\right)^{1/2}$$

$$= 0.428 \ m/sec$$

$$Q = 0.428 \times 0.494 = 0.211 \ m^3/sec \ \ \ldots\ldots\ldots \ O.K$$

The freeboard of the drainage canal is designed to give the cross section at least 1.2 times drainage discharge can flow than the supposed discharge, therefore the final cross section is given as follows ;-

(coditions)

$Q = 0.212 \times 1.2 = 0.254 \ m^3/sec$
$1 : m = 1 : 1$
$I = 1/1,000$
$b = 0.300$
$n = 0.030$

$$\frac{Q.n}{I^{1/2}.b^{8/3}} = \frac{0.254 \times 0.030}{(1/1,000)^{1/2} \times 0.30^{8/3}} = 5.974$$

d/b	$\frac{Q.n}{I^{1/2}.\ b^{8/3}}$
2.000	5.5985
2.0 + x	5.974
2.100	6.2384

$$(2.100 - 2.000) : x = (6.2384 - 5.5985) : (5.974 - 5.5985)$$
$$x = 0.059$$

$$d/b = 2.000 + 0.059 = 2.059$$
$$d = 0.30 \times 2.059 = 0.618 = 0.62$$

(check account)

$$V = \frac{1}{n} . R^{2/3} . I^{1/2}$$

$$A = (1.536 + 0.30) \times 0.618 \times 0.5$$
$$= 0.567\ m^2$$

$$P = 2^{1/2} \times 0.618 \times 2 + 0.30 = 2.048$$

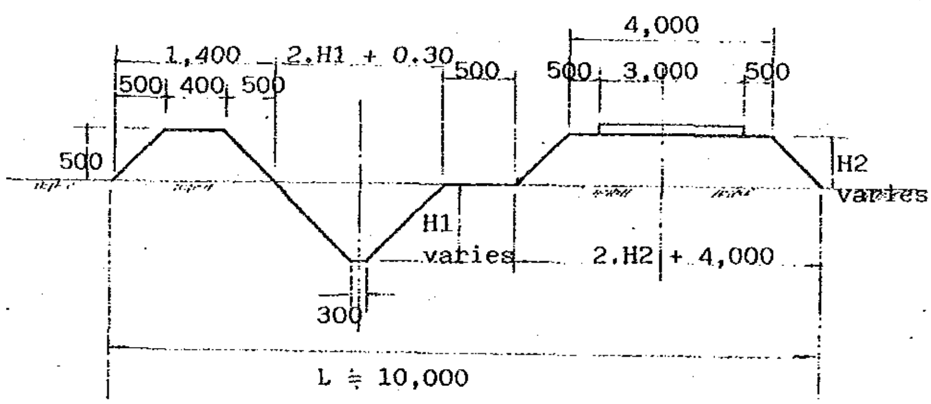
$$R^{2/3} = (\frac{A}{P})^{2/3} = (\frac{0.567}{2.048})^{2/3} = 0.425$$

$$V = \frac{1}{0.03} \times 0.425 \times (\frac{1}{1,000})^{1/2}$$
$$= 0.448\ m/sec$$

$$Q = 0.448 \times 0.567 = 0.254\ m^3/sec \quad .... \quad O.K$$

Actually, the existing paddy field is uneven, therefore the depth of the drainage canal should be kept more than 0.62 m.
The longitudinal section of FD 2 is shown as in Fig.-38 .
It is clear that the some places are impossible to cover the 0.62 m depth due to the topographical coditions, therefore this place will be counter measured by filling up the soil for the protection band. The tipical cross section of FD 2 is shown as in fig.-41 .

Fig. -41 Tipical cross section of FD 2



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b) In case of FD 1

The supposed catchment area for field block No.1-1 and 1-2, that is, A = 2.06 ha. However, this drainage canal is affected to drain the excess water from the housing area, so the size of the drainage canal is designed as well as FD 2.
The longitudinal section and supposed cross section of FD 1 are shown as in fig.-42

c) In case of FD 3

The supposed catchment area for field block No.4-1, 4-2, and 5-1 are calculated, that is, A = 3.75 ha.
However, this drainage canal is affected to drain the excess water from the neighbor paddy field which are located in the P5S3L area.

Consequently, the drainage size of FD 3 is designed as well as FD 2. The longitudinal section is shown as in fig.-43 . Here, it is clear the all most of the paddy fields are situated lower places than the average elevation, that is, $\bar{x}$ = 9.531 m, because these paddy fields which are covered by FD 3 are located the lowest places of P/F No. 2.

Therefore, some paddy fields are not able to keep the supposed depth of the drainage canal, that is H = 0.62 m, but as the given depth are shown such as H = 0.57 m , it is mostly the same of the H = 0.569 m that is calculated the least necessary depth of drainage canal.
Consequently, the lowest part of FD 3 is expected to fill up the soil for the protection border.
The tipical cross section is shown as in fig.-44

Fig.-44 Tipical cross section of FD 3

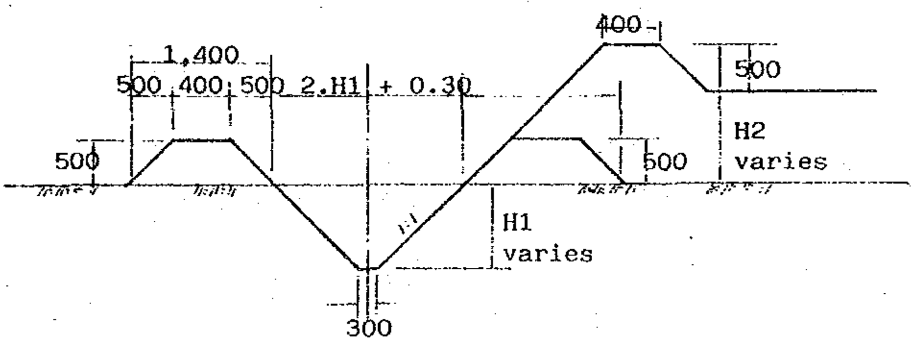

Fig.—42. Longitudinal Section of FD1

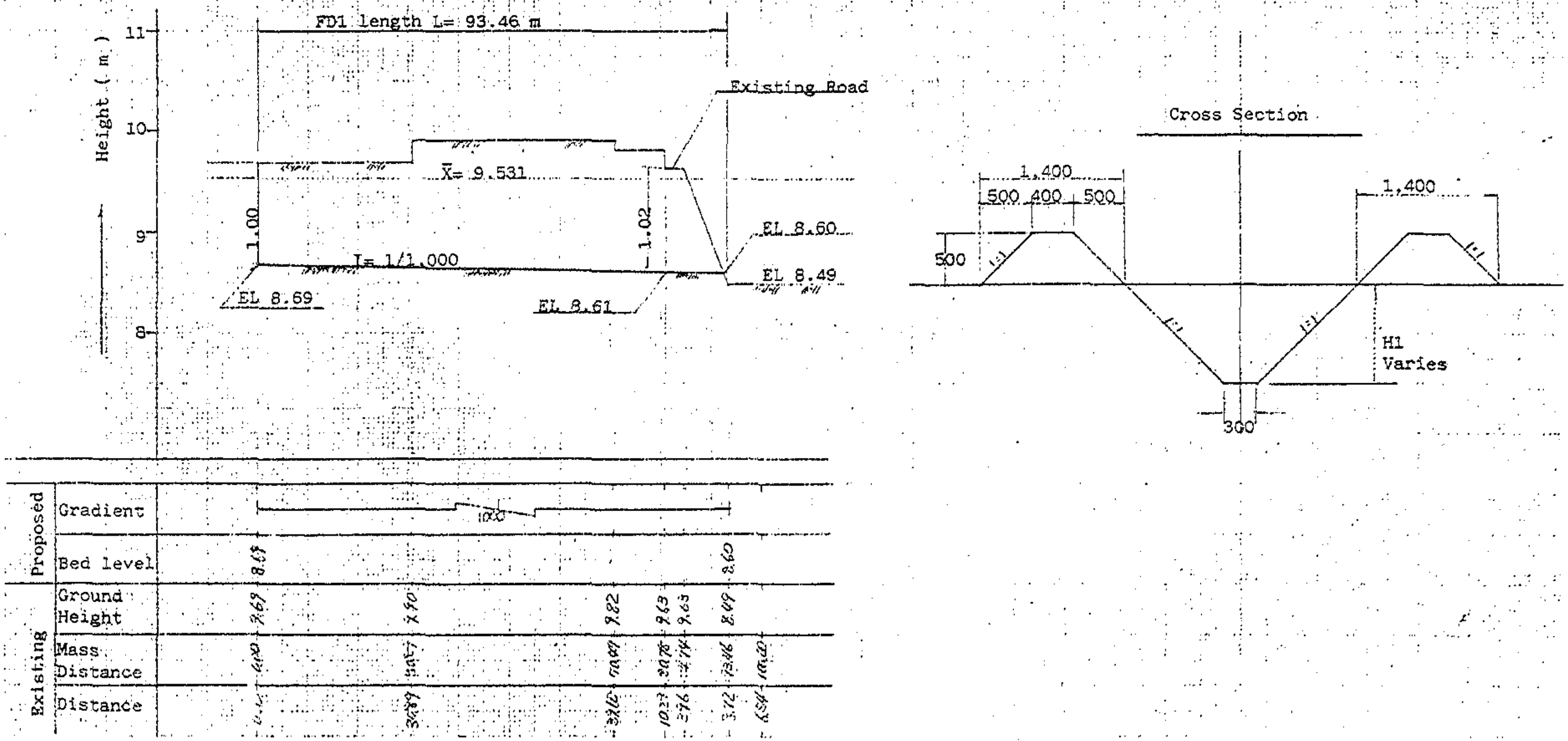

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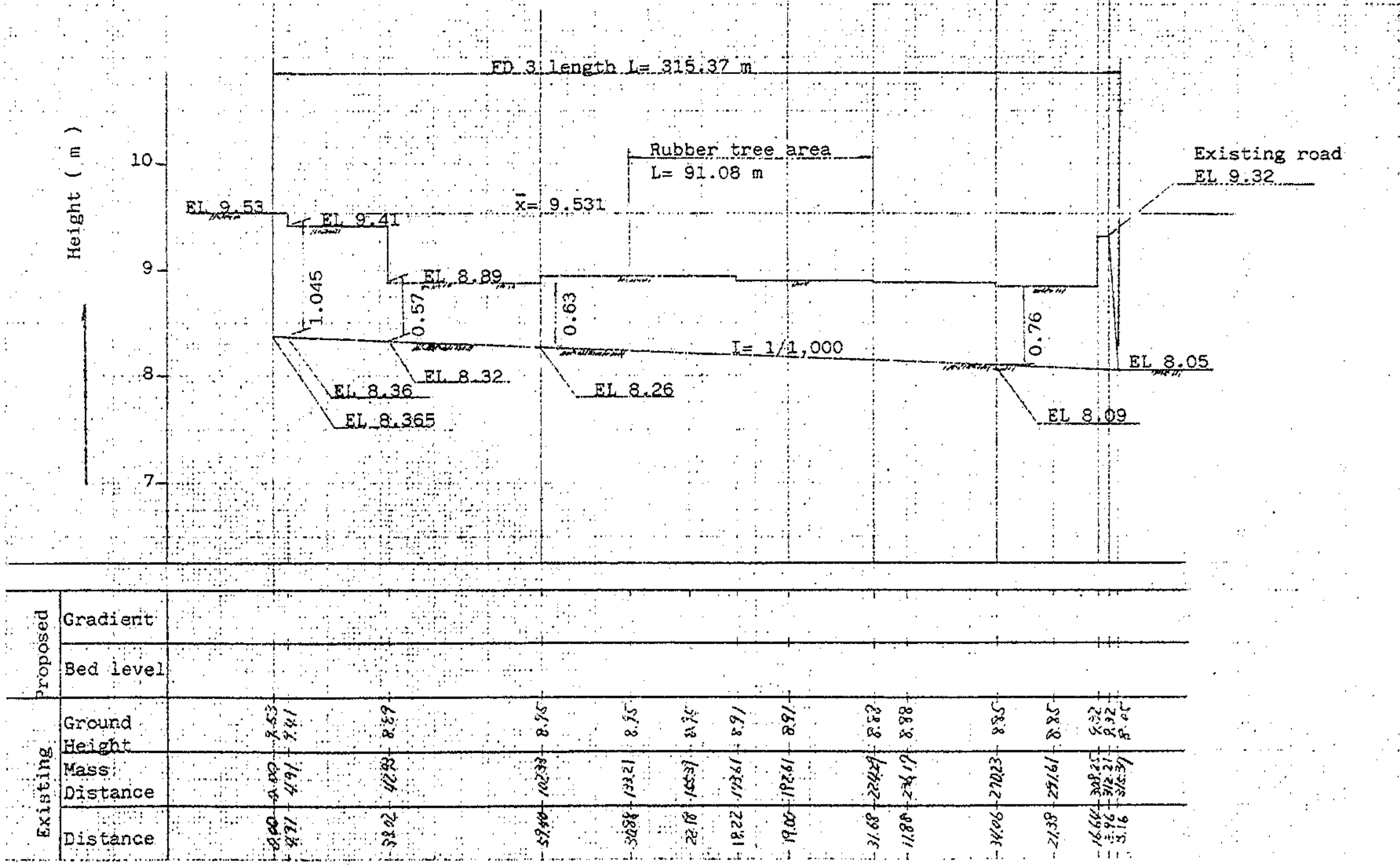
Fig.-43 Longitudinal Section of FD 3



(5) Rotational Irrigation

So far, the P/F No.2 has been irrigated the area after take the water through the off-take P4S3L, however there was no quarterly canal to convey the water to each paddy field without lot-to-lot irrigation.

Therefore, the presaturation period is always delayed in spite of the expected period is shown 30 days by KADA. How to shorten the presaturation period and deriver the water when the farmers want to get it ?

There is no doubt to make a quarterly canal in the field as on farm facilities and connected to the drainage canal, so that the well achieved water management will be expected. Now , the design of P/F No.2 is assumed to divid into 10 field blocks as shown in Fig-10 and the each field block possess the in-let box and out-let box as if one of the paddy lots. But it is unavoidable the lot-to-lot irrigation is still remain in the field block at presence.

The existing irrigation system and proposed system, that is a rotational irrigation system, are shown in Fig-45, and Fig-46 .

Fig-45 : Existing irrigation system.

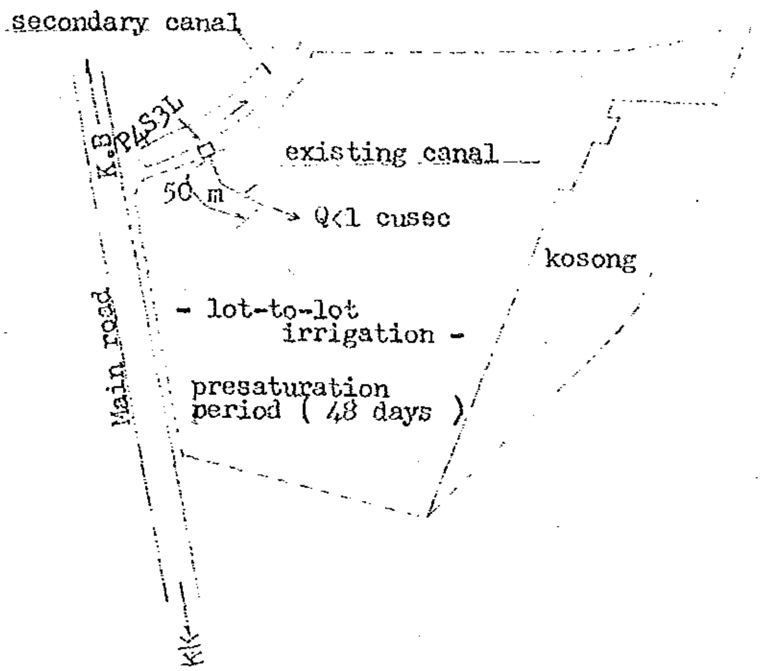


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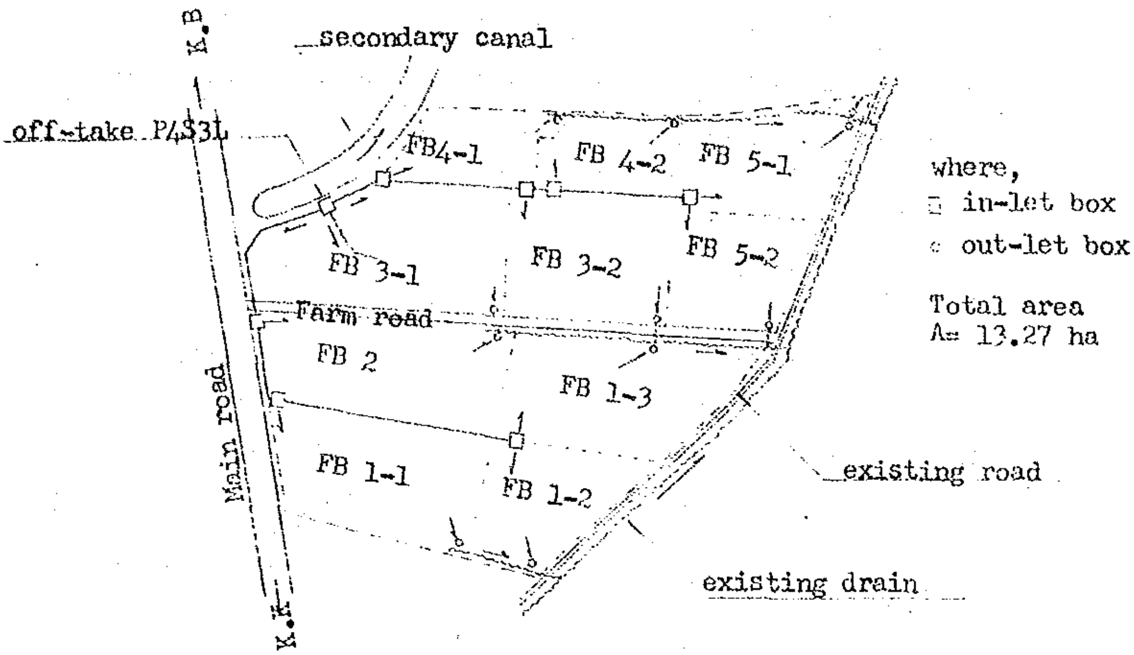
Fig- 46 : Proposed rotational irrigation system



1) Arrangement of the land

Presently, the field lots are an irregular, narrow shapes and the topographical feature is also complicated. Grouping of farmland, substitution of lots and the construction of land readjustment are impossible owing to the existing institution of land and farmers unawareness to agricultural improvement.

However, establishing the water management the Field Block should be devided by channels, drains and farm roads as the irrigation units in order to make the rational farming works, mechanization of cultivation, systematic irrigation and so on.

2) Water rights.

Regarding to the water rights of Malaysia, it is not sure to establish already or not, however farmers who have his own paddy land at higher place can use the water firstly and gradually flow down to the lower paddy land as usual. At that time, the farmers who situated higher place don't want to flow down the irrigation water before their paddy land have enough water and finish the land preparation, moreover after irrigated their paddy lots they also don't want to flow much water for lower paddy land through their already irrigated paddy lots.

Thus, the farmers will try to close or wring the irrigation water from the off-take, therefore it is natural the presatutation period will delay so much due to the both reason, that is one of them is no on farm facilities and the other is the human troubles.

3) The order for the rotational irrigation.

Now, the proposed rotational irrigation system on P/F No. 2 is supposed as follows. The rotational water use for pre-saturation period is seemed that the Field Blocks which can draw the irrigation water from the O.S.L are the first order, that is Field Block No. 1-2, 1-3, 1-1, 5-1, 5-2, 4-2 and No. 3-2 then the Field Blocks which belongs to the F.S.L should be followed. This means the water level control in the secondary canal will be able to become easier.

The supporsed order for the roational irrigation is shown in table- 34

Table- 34 : Supposed order for the rotational irrigation.

Order	Field Block	area (ha)	QC	Remarks
1st	No. 1-2 No. 1-3	2.69	1	combine O.S.L together O.S.L
2nd	No. 1-1	1.23	1	O.S.L
3rd	No. 5-1	1.69	2	O.S.L
4th	No. 5-2	0.77	2	O.S.L
5th	No. 4-2	0.87	2	O.S.L
6th	No. 3-2	1.39	2	O.S.L
7th	No. 3-1	1.44	direct	F.S.L
8th	No. 2	2.01	1	F.S.L dam up
9th	No. 4-1	1.18	2	F.S.L dam up

The operation of the water control in QC1 and QC2 is shown in Fig- 47.

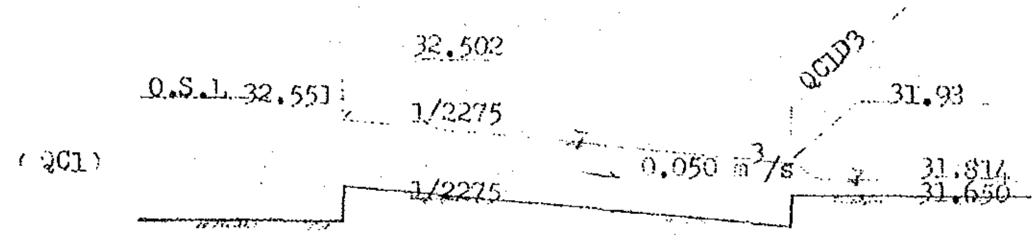
Using this rotational system, the each Field Block will be satisfied with the presaturation water and the supplementary one at the same time.

Most probably the total supplementary water for one or two days duration will be drawn at the same time due to the small water, that is 0.0008 m^3/sec/ha, and the farmers don't supply the supplementary water continuously in that duration.

In this case, the presaturation water can be given up to 0.050 m^3/sec not 0.050 - $\sum q_i$ m^3/sec. Anyway, the most important thing is the operation for the rotational irrigation that is considered systematically.

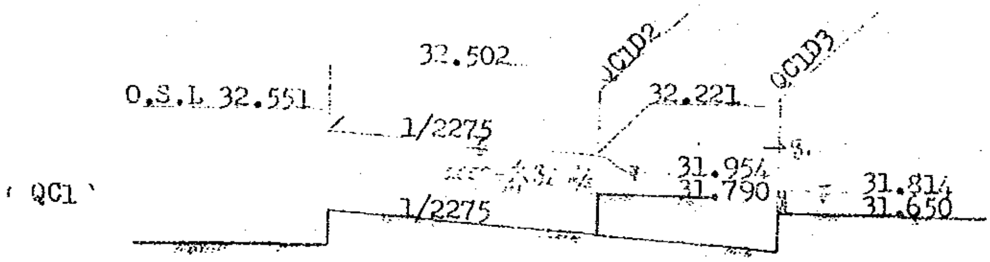
Fig- 47 : The water control of QC1 and QC2 for the presaturation period

1st. Field Block No. 1-2 and No. 1-3



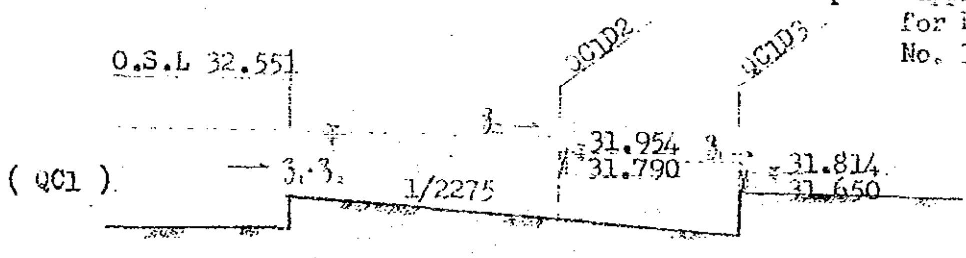
2nd. Field Block No. 1-1

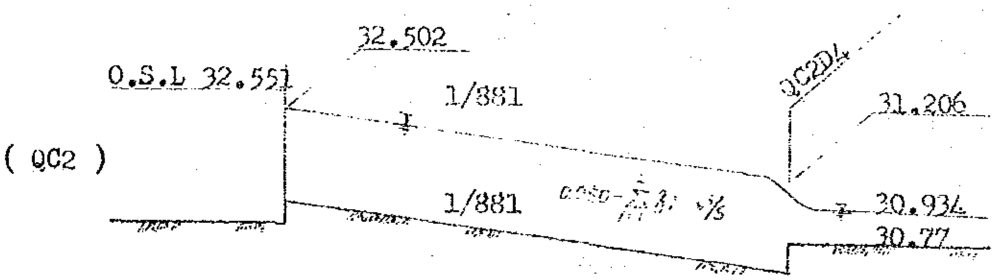
q1: Supplementary water for Field Block No. 1-2/1-3.



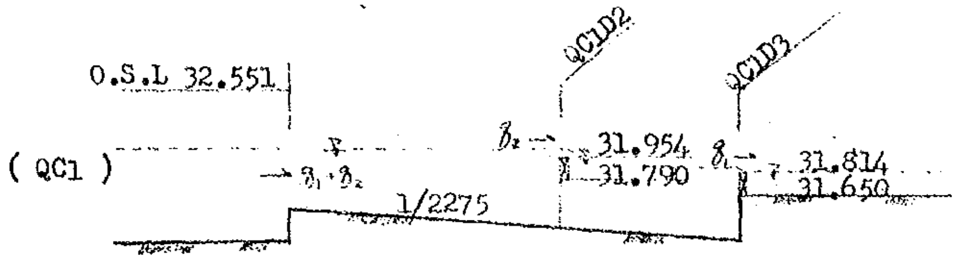
3rd. Field Block No. 5-1

q2: Supplementary water for Field Block No. 1-1

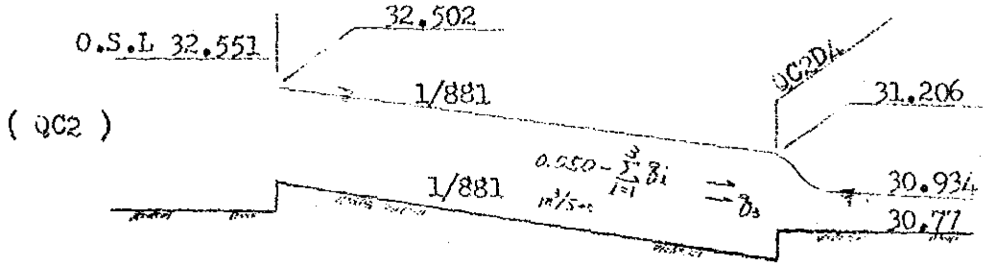




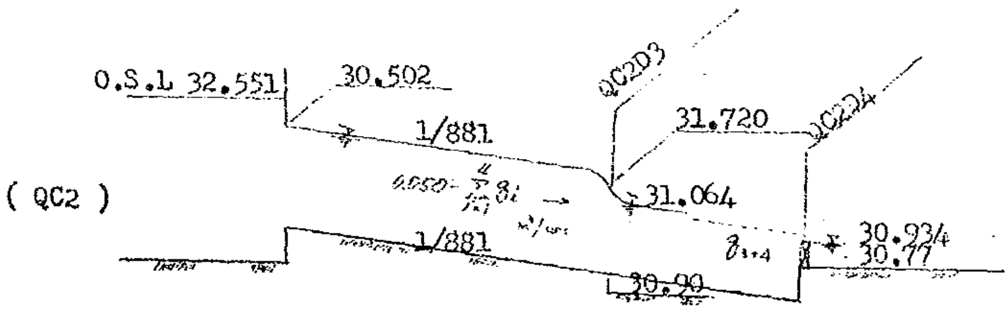
4th. Field Block No. 5-2



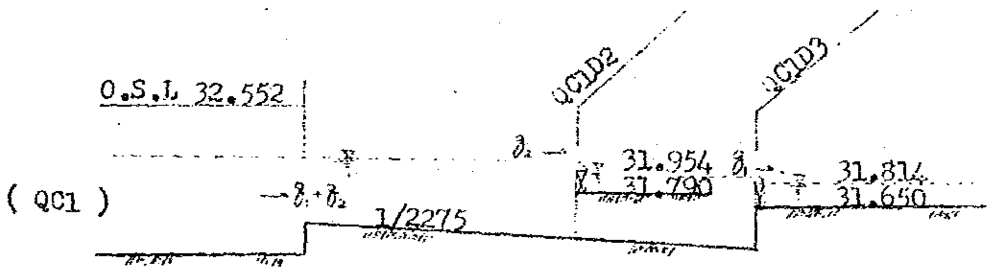
q3: Supplementary water for Field Block No. 5-1



5th. Field Block No.4-2



q4: Supplementary water for Field Block No. 5-2



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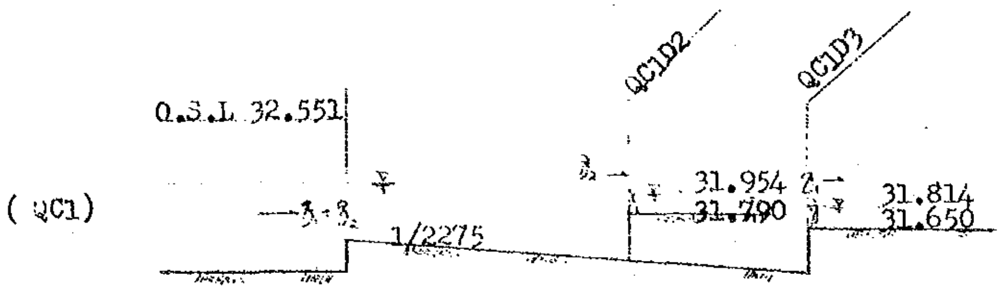
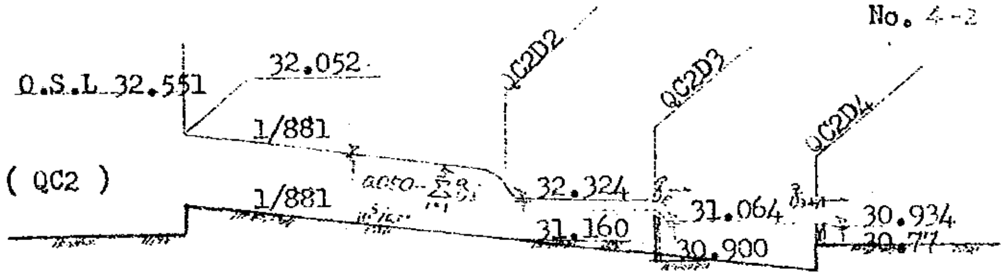
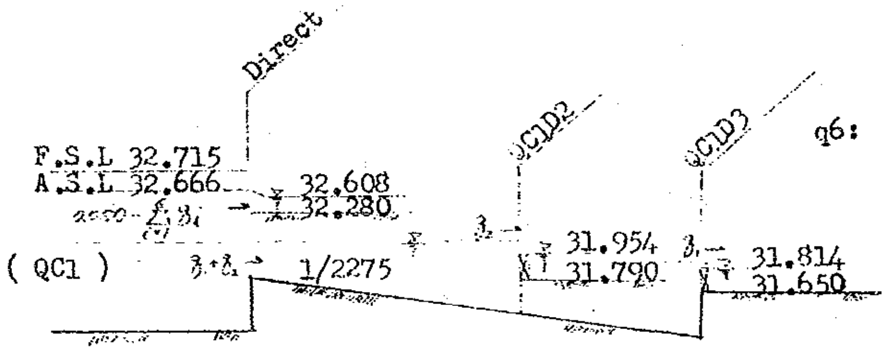
6th. Field Block No. 3-2



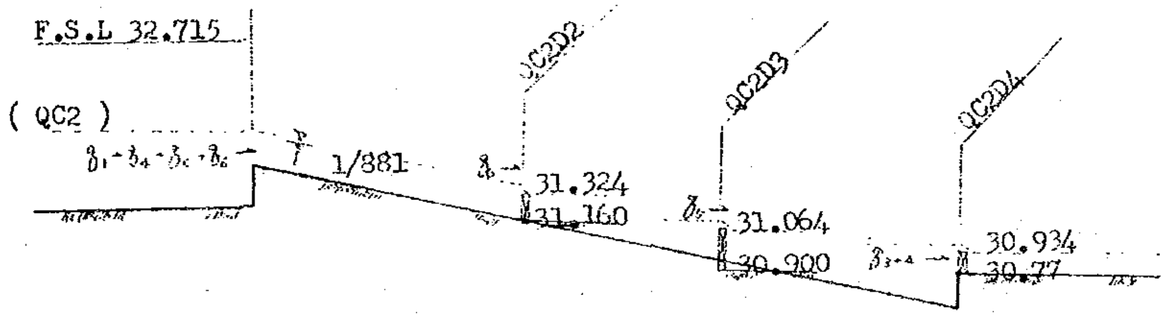
q5: Supplementary water for Field Block No. 4-2



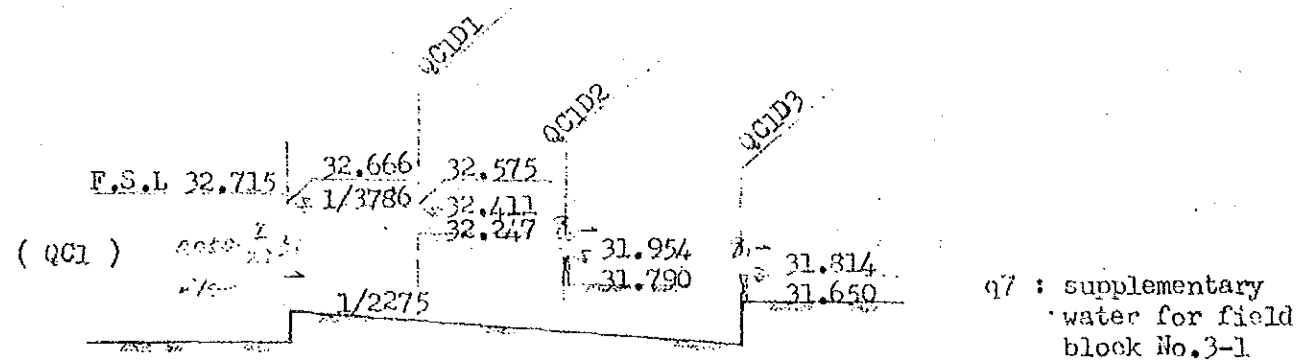
7th. Field Block No. 3-1

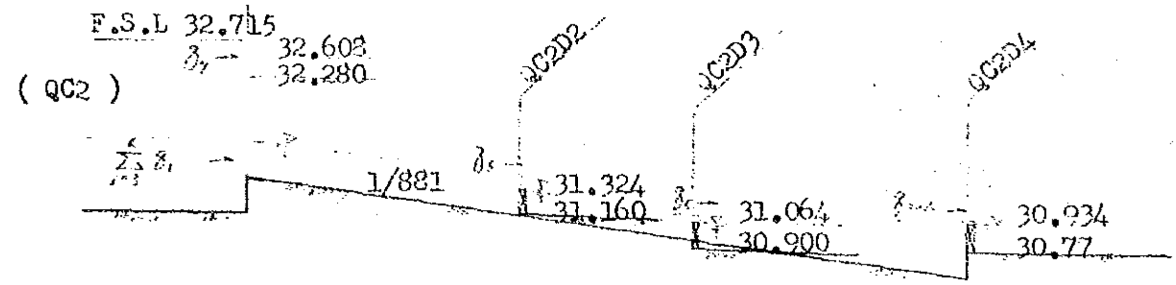


q6: Supplementary water for Field Block No. 3-2 .

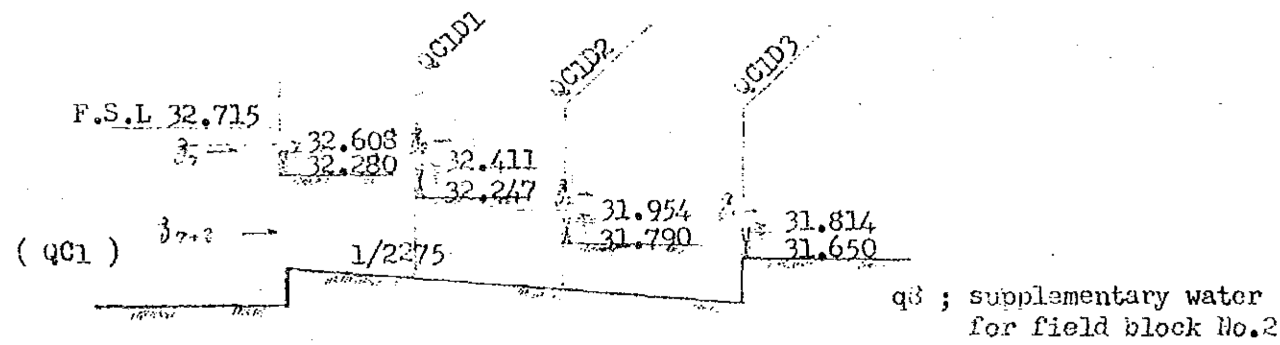


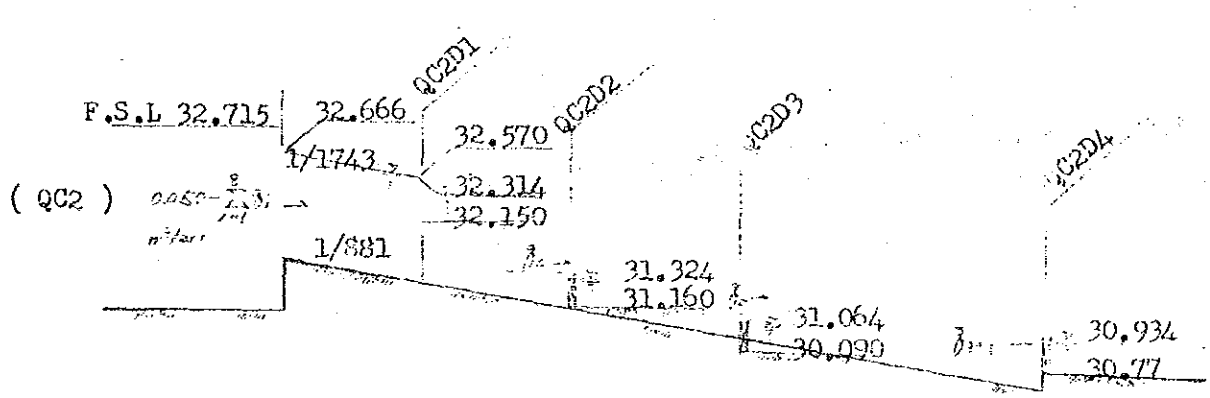
8th. Field Block No.2





9th.Field Block No.4-1





4) Water Requirement.

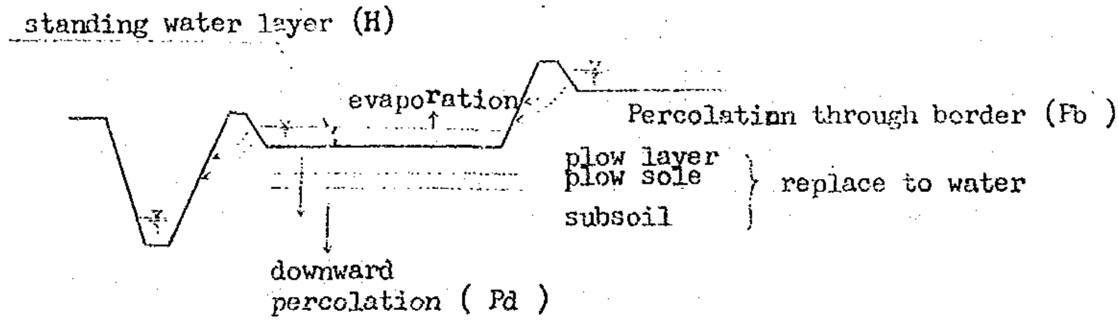
Following assumed values for the calculation of water requirement will necessary be revised according to the result of the investigation in field and Demonstration Farm. The water requirement for the presaturation period as the water requirement for preparation of paddy field is shown as below:-

$$Q = H + Ap + As + Es + Pd + Pb$$

where,
- Q: water requirement for preparation of paddy field.
- H: standing water layer.
- Ap: air volume replace to water in plow layer.
- As: air volume replace to water in subsoil.
- Es: evaporation from water surface.
- Pd: downward percolation.
- Pb: percolation through border.

The model of the water requirement in presaturation period is shown in Fig.48.

Fig.48 Model of the water requirement



i) Presaturation Period

a) Evaporation (E)

Es: water losses from saturated soil and water surface

$Es = 0.70 \times Ep$ ....DID information No. 2

Where, Ep: pan evaporation.

The record of the evaporation using a black pan at Pasir Mas Station from April to September in 1972 to 1976 is shown in table- 35 .

Table- 35 : Record of pan evaporation at Pasir Mas (Black pan)

year	total evaporation (m/m)	measured total days	average evaporation(m/day)	remarks.
1972	775.5	* 152	5.10	*except May
1973	778.5	* 153	5.09	*except April
1974	1015.2	183	5.55	
1975	1020.5	183	5.58	
1976	1035.1	183	5.66	

Where, the excepting two months are omitted from the calculation due to the observation errors. Generally speaking the conversion coefficient from pan evaporation to field one is reported 0.70 by U.S Weather Bureau when the evaporation pan is used a white one, however here in Pasir Mas Station one is a black pan therefore it is necessary to change the coefficient, that is 0.66.

The arranged Es is shown as follows:

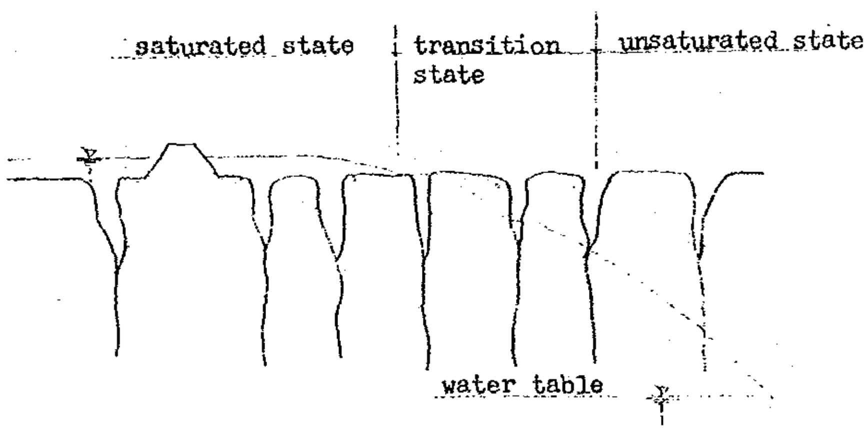
$$Es = 0.66 \times Ep$$
$$= 0.66 \times 5.66 = 0.37$$
$$= 0.4 \text{ cm/day}.$$

Eu: Water losses from unsaturated soil.

Eu = 0.4 cm/day .... DID information No. 2

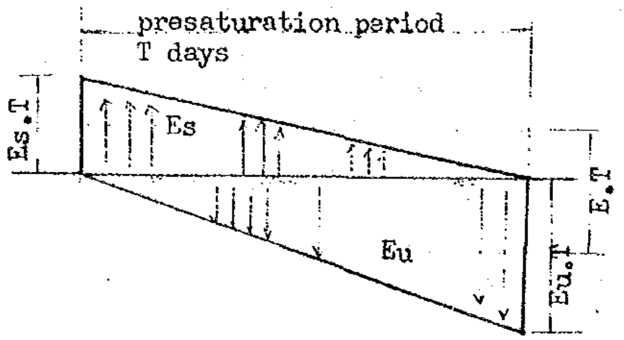
After harvesting, the soil surface is bare and constantly loosing water by evaporation. The movement of irrigation water in the field during presaturation is shown in Fig.49.

Fig-49 : Movement of irrigation water in the field during presaturation.



Therefore, the average evaporation (E) between Es and Eu during the presaturation is shown in Fig-50

Fig-50 : Average evaporation during the presaturation



Where, $ET = \frac{Es + Eu}{2} . T$

$E = \frac{Es + Eu}{2}$

Consequently, the average evaporation is calculated as below:-

$E = \frac{0.4 + 0.4}{2} = 0.4$ cm/day

b) Infiltration losses (P)

The results of soil samples analysis on Demonstration Farm is shown in Table- 36 . It is clear that the percentage of clay is shown over 50%, and the percolation coefficient is shown $10^{-4} - 10^{-6}$ cm/sec in Fig-51 . In this case, the infiltration losses like this soil is considered below 1mm/day, however for the safety the value of the ilfiltration losses is given 1 mm/day.

P = 0.1 cm/day.

c) Water requirement for puddling (S)

The role of puddling works is to crush soils of paddy field into optimum conditions for border painting and transplanting. At presence, the farmers here in Malaysia never painting the border and no readjustment is made on the borders which was destroyed by buffaloes, rats and so on. This action is very important to reduce the percolation through border that seems to cause a lot of water losses during the presaturation period.

Results of Soil Samples Analysis Conducted on D/F Lots at Panji (10th. October, 1979)

No. Bag.	Ke-dalaman (in)	No. makmal	pH air-dry H_2O	Conductivity (air-dry) um/hos/cm	%N	P	K	% C	% Organic matter	C.E.C. meq/100gm	M.A.			
											% clay	% silt	% fine sand	% Coarse sand
SAA 489	0 – 6"	SL 39/1	5.0	31.2	0.14	2	31.5	1.23	2.12	7.30	51.8	43.1	4.18	0.84
SAA 449	0 – 6"	SL 39/3	4.8	42.1	0.10	2	52.7	0.88	1.52	7.12	50.9	42.9	4.46	1.72
SV 208	0 – 6"	SL 39/4	4.85	48.0	0.12	2	57.4	1.00	1.72	7.14	49.9	43.7	4.59	1.80
SAA 450	0 – 6"	SL 39/7	4.8	41.8	0.14	3	66.9	1.23	2.12	7.35	52.8	43.0	2.37	0.79
SAA 42	0 – 6"	SL 39/8	4.9	33.2	0.14	3	65.0	1.29	2.22	7.11	51.9	43.4	3.66	1.02
SAA 448	0 – 6"	SL 39/11	5.1	28.3	0.15	2	79.5	1.35	2.33	7.00	50.6	44.6	4.17	0.65
SV 350	0 – 6"	SL 39/12	5.0	36.9	0.17	4	91.1	1.46	2.52	7.16	51.2	44.4	4.14	0.48
TOTAL			34.45	261.50	0.96	18.00	497.10	8.44	14.55	50.18	359.10	305.10	28.57	7.30
Avg.	0 – 6"		4.92	37.36	0.14	2.57	71.01	1.21	2.08	7.17	51.30	43.59	4.08	1.04

No. Bag	Ke-dalaman (in)	No. makmal	pH air-dry H_2O	Conductivity (air-dry) um/hos/cm	%N	P	K	% C	% Organic matter	C.E.C. meq/100gm	M.A.			
											% clay	% silt	%fine sand	% Coarse sand
SAA 490	6 - 12"	SL 39/2	4.9	35.3	0.05	2	59.5	0.33	0.57	7.21	51.3	42.9	4.30	1.42
SAA 412	6 - 12"	SL 39/5	5.0	29.5	0.05	1	42.01	0.32	0.55	7.17	49.0	44.3	4.42	2.13
SAA 488	6 - 12"	SL 39/6	5.0	12.7	0.05	1	43.2	0.37	0.64	7.05	50.3	45.4	3.22	1.00
SAA 423	6 - 12"	SL 39/9	4.9	43.5	0.06	2	42.0	0.49	0.84	7.09	53.4	43.7	2.85	0.18
SV 263	6 - 12"	SL 39/10	4.9	44.7	0.06	2	40.8	0.47	0.81	7.09	57.0	40.1	2.68	0.25
SAA 444	6 - 12"	SL 39/13	4.9	41.8	0.08	2	72.2	0.61	1.05	7.19	54.2	42.2	3.52	0.16
SAC 591	6 - 12"	SL 39/14	4.9	45.1	0.14	2	71.1	0.67	1.15	7.28	53.5	42.5	3.50	0.27
TOTAL			34.50	252.60	0.49	12.0	370.80	3.26	5.61	50.08	368.70	301.10	24.49	5.46
Avg.	6 - 12"		4.93	36.09	0.07	1.71	52.97	0.47	0.80	7.15	52.67	43.01	3.50	0.78

Cone Penetration Test Data Sheet

(No 29)

Date	8 Sep 1980	Weather	fine
Place	Field Lot 10, Plot No 9	Time	AM 9:10 ~
Surveyor	IMAI, MANSOR		
Lot Condition	Presaturation rotovate harrow puddling harvesting		
Implement	cone angle 30°	cone area	6.45 cm²

1st Depth	1st Dial Gage	2nd Depth	2nd Dial Gage	3rd Depth	3rd Dial Gage	ave. Dial Gage	Cone Index qc (kg/cm²)	Remark
0 ~ 5 cm	8	0 ~ 5	31	0 ~ 5	8	15.67	0.97	
5 ~ 10	14	5 ~ 10	53	5 ~ 10	24	30.33	1.74	
10 ~ 15	68	10 ~ 15	52	10 ~ 15	120	80.00	4.34	
15 ~ 20	176	15 ~ 20	103	15 ~ 20	204	161.00	8.59	initial number 10.61/15cm
20 ~ 25	185	20 ~ 25	212	20 ~ 25	222	206.33	10.96	
25 ~ 30	220	25 ~ 30	210	25 ~ 30	226	218.67	11.61	
30 ~ 35	198	30 ~ 35	238	30 ~ 35	218	218.00	11.57	
35 ~ 40	182	35 ~ 40	211	35 ~ 40	185	192.67	10.24	
40 ~ 45	185	40 ~ 45	201	40 ~ 45	152	179.33	9.55	
45 ~ 50	172	45 ~ 50	182	45 ~ 50	184	179.33	9.55	
50 ~ 55	162	50 ~ 55	182	50 ~ 55	204	182.67	9.72	
55 ~ 60	162	55 ~ 60	183	55 ~ 60	194	179.67	9.56	
60 ~ 65	158	60 ~ 65	172	60 ~ 65	190	173.33	9.23	
65 ~ 70	165	65 ~ 70	163	65 ~ 70	204	177.33	9.44	
70 ~ 75	179	70 ~ 75	163	70 ~ 75	205	182.33	9.70	
75 ~ 80	175	75 ~ 80	178	75 ~ 80	207	186.67	9.93	
80 ~ 85	176	80 ~ 85	194	80 ~ 85	208	192.67	10.24	
85 ~ 90	178	85 ~ 90	194	85 ~ 90	200	190.67	10.14	
90 ~ 95	152	90 ~ 95	210	90 ~ 95	182	181.33	9.65	
95 ~ 100	132	95 ~ 100	218	95 ~ 100	179	176.33	9.39	

Initial Number	10.61/15	Soil Hardness Type	A
Suffix Number	2	Judgment Mark	10.61/15 A2

Soil Hardness Type

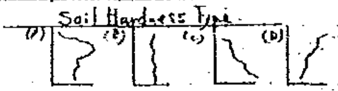
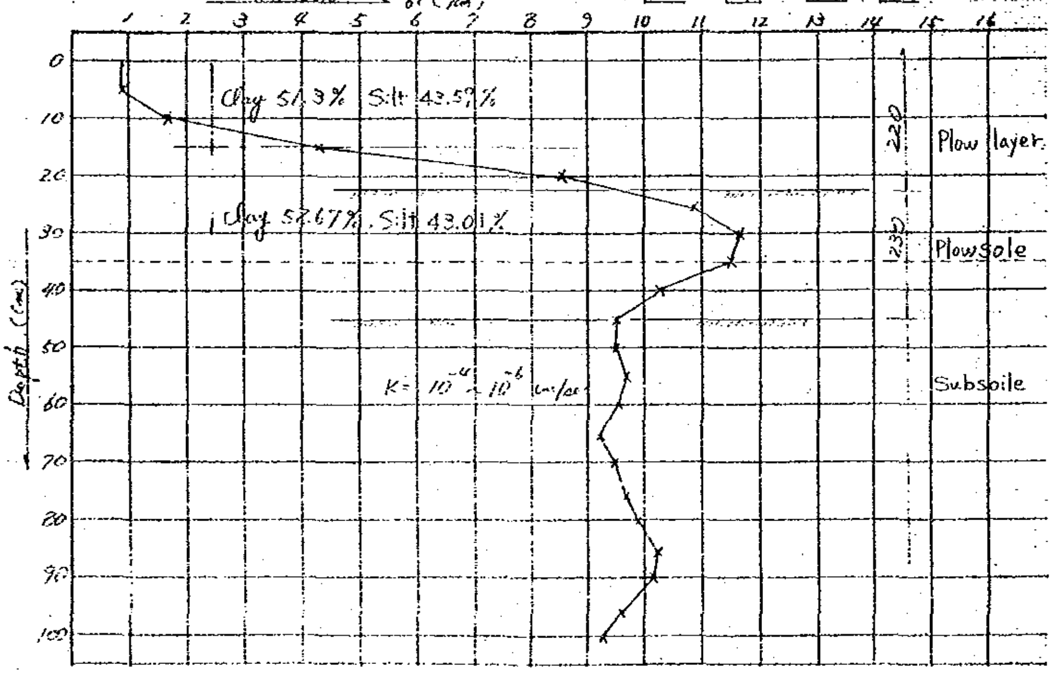


Figure - Soil Hardness



It goes without saying that to save the water in paddy field at the necessary period without lossing uselessness, that is a good water management.

Consequently, the puddling water is consisted as follows:

$$S = Ap + As + Pd + Pb$$

Where, S: puddling water

Ap : air volume replace to water in plow layer

As : air volume replace to water in subsoil

Pd : downward percolation

Pb : percolation through border.

The standing water layer and evaporation from saturated and unsaturated soil are excepted, because of both of value are given by the actual data.

Now, the assumed similar value of "S" is given below as well as the Muda area where also have the heavy clay soil.

$$S = 15 \text{ cm}$$

In this assumed value involve the downward percolation already, therefore the infiltration losses (F) should be neglected during the presaturation period.

d) Standing water layer (H)

The standing water layer is supplied after puddling. Though a desirable value is within 5 cm, however due to variation of land surface in the paddy lot, 10 cm depth of standing water is considered so that farmers can have better control of the water depth .

$$H = 10 \text{ cm}$$

e) Field losses (L)

Neglected for saturation.
20% of losses is adopted in supplementary water.

ii) Growing period.

a) Evaporation losses (Es)

$$Es = 0.4 \text{ cm/day.}$$

b) Transpiration losses (Et)

$$Et = 0.1 \text{ cm/day}$$

c) Infiltration losses (F)

$$F = 0.1 \text{ cm/day}$$

d) Field losses (L)

$L = 20\%$

Consequently, the water requirement per hectare (q) is shown as below:-

$$q = \frac{(Es + Et + P).L}{864} = 0.00083 \ m^3/sec$$

$$Q = 0.00083 \times 13.27 = 0.011 \ m^3/sec$$

iii) Formula for rational irrigation in presaturation period.

a) Calculation method for rational irrigation to irregular field block is as follows:

(1) Field Blocks are saturated gradually from the area which belongs to the O.S.L and followed by areas with the F.S.L conditions of the secondary canal because water control is easier and more economical.

(2) A saturated block is supplied with supplemented water succeedingly.

(3) Presaturation period calculated for one block is to be corrected to a whole round-up number so as to facilitate easy water management.

(4) Evaporation losses from unsaturated soil are calculated only for presaturation period of one Field Block.

(5) Infiltration losses during presaturation period of whole area are neglected, because the losses are already assumed in the water requirement for puddling.

b) Calculation formula.

The calculation of the presaturation period is carried out as follows:

$$Q = Q1 + Q2 \qquad \text{---- (1)}$$

$$Q1 = \frac{(S + H + E.T) A}{864.T} \qquad \text{---- (2)}$$

$$Q2 = \frac{Es.T.L.B}{864.T} \qquad \text{---- (3)}$$

In this case Q is fixed from above formula,

$$T = \frac{(S + H).A}{864.Q - (L.Es.B + E.A)} \qquad \text{---- (4)}$$

137/-

Where,	Q:	total water requirement for presaturation period	m^3/sec
	Q1:	water requirement for presaturation	m^3/sec
	Q2:	water requirement for supplement	m^3/sec
	T:	presaturation period	day
	A:	presaturation area	ha
	B:	supplemental area	ha

iv.) Calculation for presaturation period by rotational irrigation.

Using the above formula, the presaturation period is given as in table-37.

At the first time, the expected presaturation period is supposed within 9 days, however the calculation results are shown the actual operating day for the presaturation period becomes 12 days because of the round-up days to facilitate easy water management for the farmers.

At the first time, the water requirement is calculated to finish the irrigation period within 9 days, that is 0.052 m^3/sec, however it is assumed to 0.050 m^3/sec due to the presaturation period will be rounded in order to make easy water management.

It is clear in the result in table-37 that the presaturation period finished within 9 days, that is 8.38 days, but this operation of the water management is very difficult. After corrected day is given to the calculation the expected presaturation period is shown to be 12 days and also the maximum water discharge is shown as 0.047 m^3/sec which is less than the expected 0.050 m^3/sec.

However, it is not so much different with the expected water discharge, that is 0.050 m^3/sec and considering about the unexpected losses, the size of facilities is able to decide using this expected water discharge for the safety.

The water usage during the presaturation period is supposed to be of the same discharge as the expected water discharge. To meet the above, the most important things is to arrange each Field Blocks fitted by the investigation result as the best consideration though not the same area due to the existing conditions.

Therefore, now some period show the water discharge is not necessary by 0.050 m^3/sec, but in relation to the future plan if the farmers become better to operate the water management, make better land conditions and to counter measure the increasing of water requirement, the size of the quarterly canal should be designed by the expected water discharge, that is 0.050 m^3/sec.

138/-

Table-37 : Calculation table for presaturation period

Field Block	A(ha)	B(ha)	(S+H)A	E.A	L.Es.B	denominator	T (day)
			25.A	0.4A	0.48.B		
1-2 1-3	2.69	-	67.25	1.08	-	42.12	1.60
1-1	1.23	2.69	30.75	0.49	1.29	41.42	0.74
5-1	1.69	3.92	42.25	0.68	1.88	40.64	1.04
5-2	0.77	5.61	19.25	0.31	2.69	40.20	0.48
4-2	0.87	6.38	21.75	0.35	3.06	39.79	0.55
3-2	1.39	7.25	34.75	0.56	3.48	39.16	0.89
3-1	1.44	8.64	36.00	0.58	4.15	38.47	0.94
2	2.01	10.08	50.25	0.80	4.84	37.56	1.34
4-1	1.18	12.09	29.50	0.47	5.80	36.93	0.80
Total	13.27						8.38

Where, $Q = Q1+Q2 = 0.050\ m^3/sec$

denominator = 864.Q-(L.Es.B+E.A0)

= 43.2-(L.Es.B+E.A)

T = (S+H)A/(43.2-(L.Es.B+E.A))

137/-

The calculation table for presaturation period
using the corrected round-up T value is shown as below:-

Table-38 : Corrected calculation table for presaturation period

Field Block	A(ha)	T(day)	Q1'(m^3)	B(ha)	Q2'(m^3)	Q1'+Q2'(m^3)	$T=\frac{Q1'+Q2'}{Q}$	corrected presaturation period
1-2 1-3	2.69	2	6.940	-	-	6.940	1.61	2
1-1	1.23	1	3.124	2.69	129	3.253	0.75	1
5-1	1.69	2	4.360	3.92	376	4.736	1.10	2
5-2	0.77	1	1.956	5.61	269	2.225	0.52	1
4-2	0.87	1	2.210	6.38	306	2.516	0.58	1
3-2	1.39	1	3.531	7.25	348	3.879	0.90	1
3-1	1.44	1	3.658	8.64	415	4.073	0.94	1
2	2.01	2	5.186	10.08	968	6.154	1.42	2
4-1	1.18	1	2.997	12.09	576	3.573	0.83	1
Total	13.27	12	33.962		3,387	37.349	8.65	12

Where, Q1': total water requirement for presaturation.
(S + H + E.T).A.100 m^3

Q2': total water requirement for supplement.
Es.T.L.B.100 m^3

Q : total supply water per day
0.050 x 86400 = 4.320 m^3

The water discharge in the presaturation period when it is expected 12 days is shown in table-39 .

Table-39 : Water discharge in the presaturation period

Field Block	A (ha)	T (day)	Q1(1/sec)	B (ha)	Q2(1/sec)	Q1+Q2(1/sec)
1-2 1-3	2.69	2	40.16	-	-	40.16
1-1	1.23	1	36.16	2.69	1.49	37.65
5-1	1.69	2	25.23	3.92	2.18	27.41
5-2	0.77	1	22.64	5.61	3.12	25.76
4-2	0.87	1	25.58	6.38	3.54	29.12
3-2	1.39	1	40.86	7.25	4.03	44.89
3-1	1.44	1	42.33	8.64	4.80	47.13
2	2.01	2	30.01	10.08	5.60	35.61
4-1	1.18	1	34.69	12.09	6.72	41.41
Total	13.27	12				

141/-

The conveied water to each diversion box is shown in table-40 .

Table-40 . Conveied water to each diversion box

Period	rotation number	Field Block		date	off-take direct No.3-1 (1.44 ha)	QC 1 (5.93)	D1 No. 2 (2.01)	D2 No.1-1 (1.23)	D3 No.1-2, 3 (2.69)	QC2 (5.90)	D1 No. 4-1 (1.13)	D2 No.3-2 (1.39)	D3 No.4-2 (0.87)	D4 No.5-2 (0.77)	D4 No.5-1 (1.69)	Total (1/sec)
Presaturation Period	1	1-2 1-3	2.69	2	-	40.16	-	-	[40.16]	-	-	-	-	-	-	40.16
	2	1-1	1.23	1	-	37.65	-	[36.16]	1.49	-	-	-	-	-	-	37.65
	3	5-1	1.69	2	-	2.18	-	0.68	1.50	25.23	-	-	-	-	[25.23]	27.41
	4	5-2	0.77	1	-	2.13	-	0.68	1.50	23.58	-	-	-	[22.64]	0.94	25.76
	5	4-2	0.87	1	-	2.17	-	0.68	1.49	26.95	-	-	[25.58]	0.43	0.43	29.12
	6	3-2	1.39	1	-	2.18	-	0.68	1.50	42.71	-	[40.86]	0.48	0.43	0.94	44.89
	7	3-1	1.44	1	[42.33]	2.17	-	0.68	1.49	2.62	-	0.77	0.48	0.43	0.94	47.13
	8	2	2.01	2	0.80	32.18	[30.01]	0.68	1.49	2.62	-	0.77	0.48	0.43	0.94	35.61
	9	4-1	1.18	1	0.80	3.30	1.12	0.68	1.50	37.31	[34.69]	0.77	0.48	0.43	0.94	41.41
Normal Period	All the area				1.15	4.74	1.61	0.98	2.15	4.72	0.94	1.11	0.70	0.62	1.35	10.61

The arrangement of the rotational irrigation is shown in Fig-52.
and the water usage during the presaturation period is shown in Fig-53 .

Incidentally, the total amount of water requirement during presaturation period is to be 37,349 +87,136 = 124,485 m^3 and the operation cost of Kemubu Pumping Station is seemed roughly to be 0.5 cent per one cubic metre. Therefore, the irrigation water to be approximately M$47/ha.

To obtain the required pumping water in Kemubu Scheme, a vast amount of money were to be spent. Thus, it is very important that good water management should be achieved so as not waste water unnecessarily. To meet the above requirement, farming schedule should not be delayed and more systematical use of water should be observed in the whole of Kemubu area immediately after the construction of on farm facilities.

Fig. 52. Arrangement of the rotational irrigation of F/F No.2

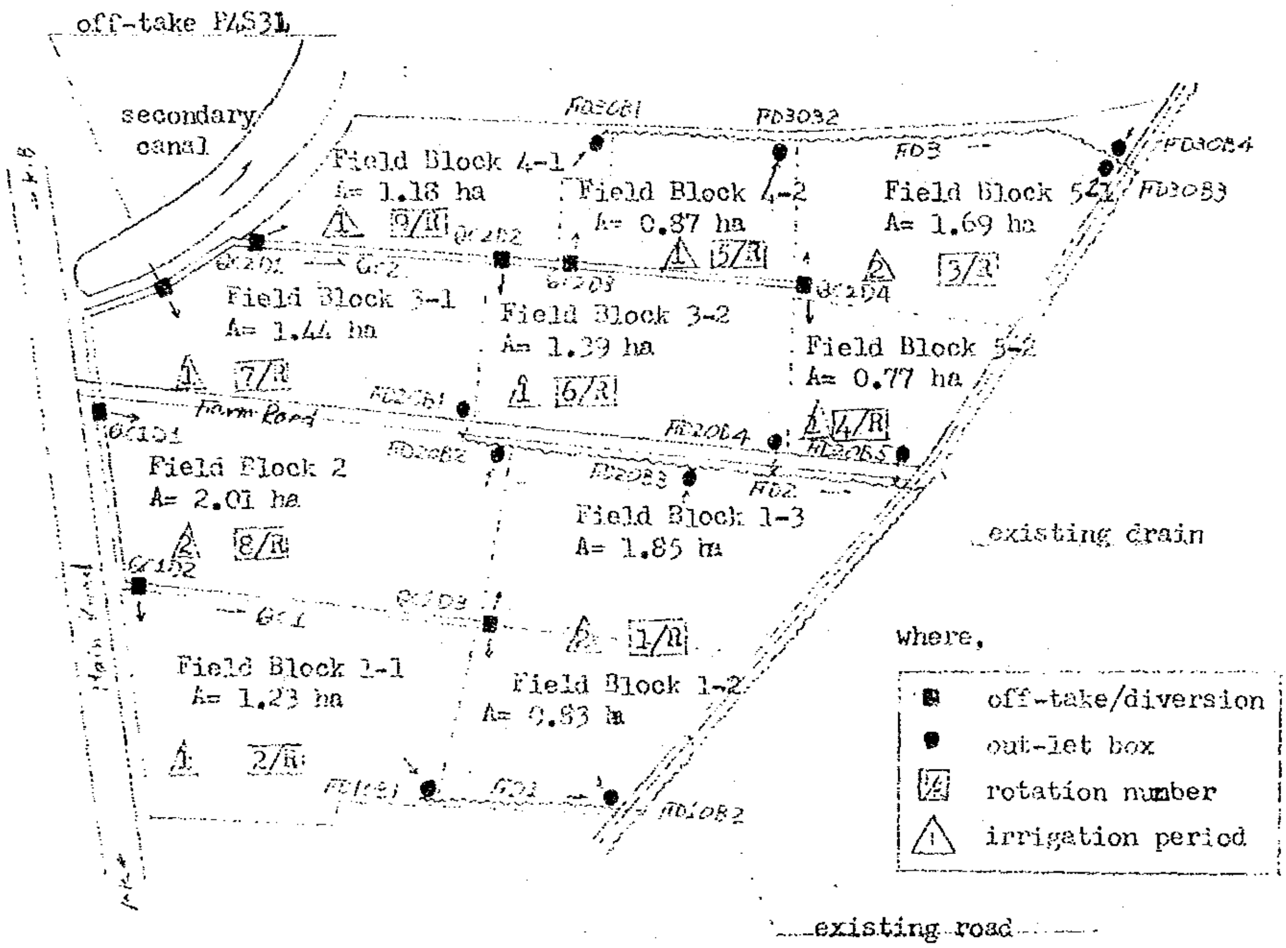
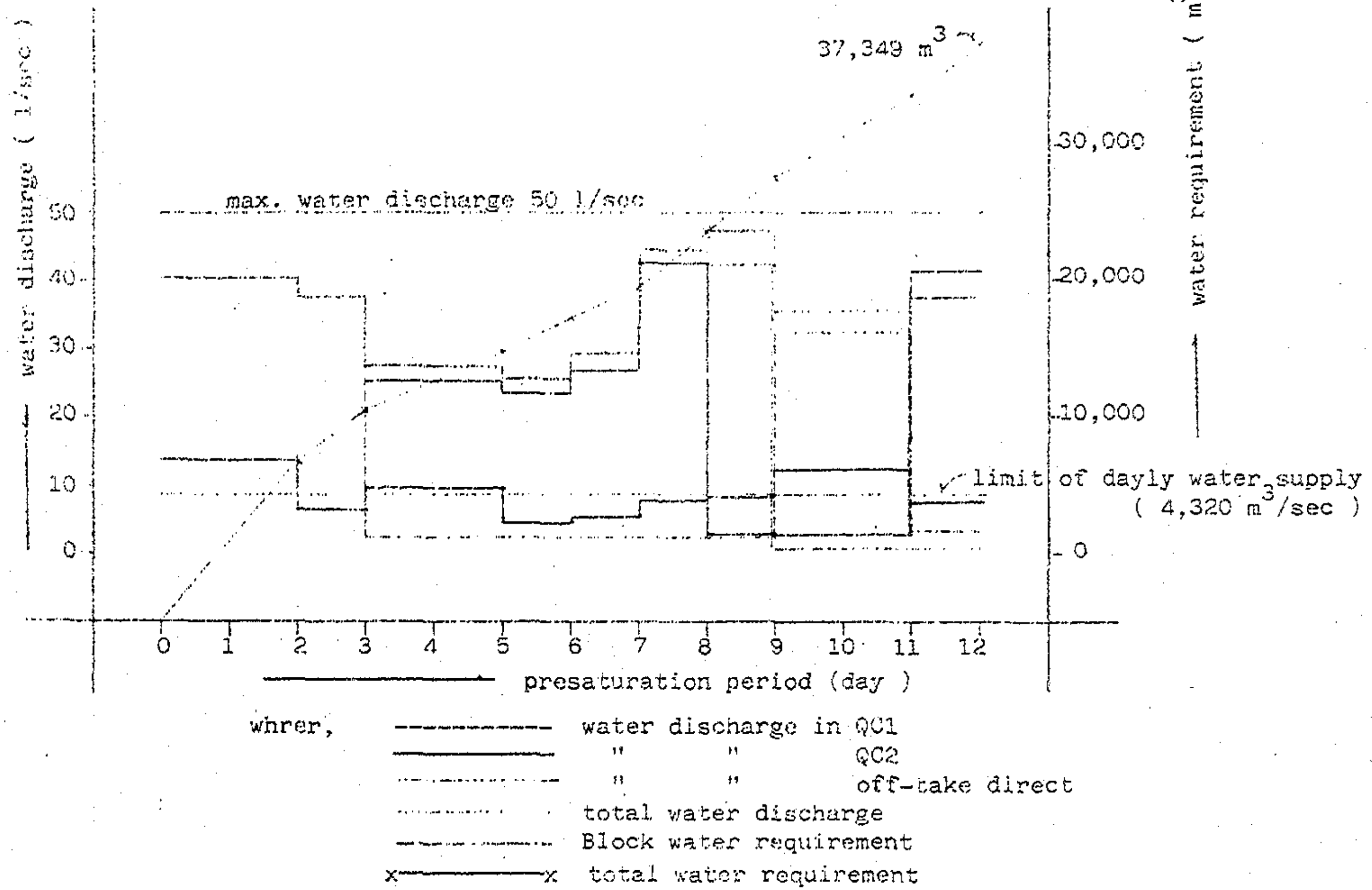


Fig.-[illegible] Water Usage During The Presaturation Period



5) Border Improvement

Now, looking around the existing paddy field conditions, it is clear that the on farm facilities such as irrigation, drainage canal and farm road are very few or nothing.

Under like this conditions, it is natural that the well achieved water management is seemed very difficult, besides that most of all the irrigation facilities are operated and maintained by the government not the farmers, therefore the farmers sometimes try to broke the irrigation gate to get the irrigation water in the inexpected period that is not on program, because of the farmers not used to keep the farming schedule.

Concequently, the on farm facilities should be promoted into the paddy field to shorten the presaturation period and also to make the farmers associetions in order to control the terminal irrigation and drainage systems by their own hand under the government farming schedule.

These Pilot Farm projects are able to so called " The Tertiary Groups ", however these tertiary groupe still have a lot-to-lot irrigation systems due to the difficulties to promote the land consolidation project now in Malaysia.

This means, the government should organize the paddy field conditions promoting the available irrigation and drainage schemes for the extensive way.

Moreover, the farmers should be changed their maind to enhance the paddy farming techniques which will be got by ever-progressing rice cultivation techniques.

Lot-to-lot irrigation is unavoidable things under existing conditions, however there is one of the ways of control the irrigation water for better water management in it. That is a " Border Improvement " .

Existing paddy field have many parts of in-let which are made by a baffalos and so on at the same border and also some of the borders are consisted by the rice straw not the soil, therefore it is an usual way that the percolation through the border will be happen , so these uncontroled border prevent to serve the irrigation water in paddy field and there is no doubt that these border cause a long presaturation period.

In conclusion, the in-let should be situated only one place at one border and at the same time this in-let is to be an out-let of the higher paddy field . Like this, each border of the paddy field should be given one in-let and out-let and the water control should be done within a rotational unit as if one of the field lot.
To obtain like this operation system, the farmers who are situated in the same rotational unit should be cooperated together in order to have a responsibility in their unit, besides that they must keep the irrigation order and must follow the government farming schedule.
Not only the big irrigation schemes but also like this terminal operations are very important for the well achieved water management and well use of the water resources.

6) Finalized on farm facilities of P/F No.2

i) Name of the off-take P4S3L

ii) Area

	$A = 13.27$ ha	(32.79 acre)
paddy area	$A = 11.83$ ha	
kosong area	$A = 1.44$ ha	

iii) Altitude average $\bar{X} = 9.531$ m (31.269 ft.)

iv) Topographical slope
west to east, approximately $I = 1/1,000$

v) Farm lot

number of field lot	106
number of farmers	26
max. area	$A = 2,839\ m^2$
min. area	$A = 179\ m^2$
average area	$A = 1,120\ m^2$

vi) Field facilities

a) Irrigation canal L = 760 m

QC 1	L = 362 m	(concrete)
QC 2	L = 348 m	(")
existing	L = 50 m	(earth canal)

irrigation canal density
760/13.27 = 57 m/ha

b) Drainage canal L = 696 m

FD 1	L = 93 m
FD 2	L = 288 m
FD 3	L = 315 m

drainage canal density
696/ 13.27 = 52 m/ha

c) Farm road L = 429 m
farm road density
429/13.27 = 32 m/ha

vii) Water supply for irrigation

a) Presaturation period $Q = 0.050\ m^3/sec$

b) Normal period $Q = 0.011\ m^3/sec$

viii) Rotational irrigation

irrigation period for presaturation 12 days

LIST OF TABLES

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" 2	Calculation of uniform flow in the rectangular canal (No. 1)
" 3	Calculation of uniform flow in the rectangular canal (No. 2)

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