F.1.2. Seismology

According to the seismological report of Thailand seismic activities compiled by the network headquarters studies and research division of the Meteorological Department during 1975 to 1983, earthquakes mainly distribute in the north of Thailand.

Figure F-1-16 shows distribution of earthquake epicenters of Thailand and from this map, there is no earthquake in the Lower Northeast Province. The majority of earthquakes occur in neighbouring countries. Earthquake epicenters are shown in Figure F-1-17 and are mostly distributed in the following places:

1. Burma from the South to the North.
2. Along the border between Burma and Thailand
3. Andawan Sea

Figure F-1-17 shows the probabilities of seismic occurrence in Thailand by zones. Each zone show approximate destructive intensity of earthquakes. The Lower North East project area is included in Zone 0. Zone 0 means "No Damage". The coefficient of earthquake force for the design was decided by using the maximum acceleration based on the data observed during the period of 1975 to 1983.

The maximum acceleration was calculated by the Okamoto's formula. There are formulae submitted by the Gutenberg-Richter and Esteva-Rosenblueth, but the maximum acceleration estimated by these formulae is small in comparison with the Okamoto's formula.

Okamoto's formula is as follows:

$$\text{Log}_{10}\ \frac{Ac}{640} = \frac{(D + 40)}{100} \times (-7.604 + 1.7244M - 0.1036M^2)$$

Where, Ac: Maximum acceleration (Gal)
M: Magnitude
D: Distance from the dam site to the earthquake epicenters (km)

In case that M = 8 and D = 400 km were substituted in the above formula, the maximum acceleration becomes 7.5 Gal, and the ratio K of seismological acceleration to gravity acceleration is 0.008. This value is too small to affect the Lower Northeast Project area. The maximum acceleration at the dam site was calculated by using the seismological data occurred within 400 km from the dam site. The results are shown in Table F-1-6. The maximum value of them is 1.4×10^{-2} Gal and the ratio K of seismological acceleration to gravity acceleration is 1.4×10^{-5}. It is sufficient to apply K = 0.05 for the design of dam and structures in consideration of safety.

Figure F-1-16.

Earthquake Epicenters in Thailand

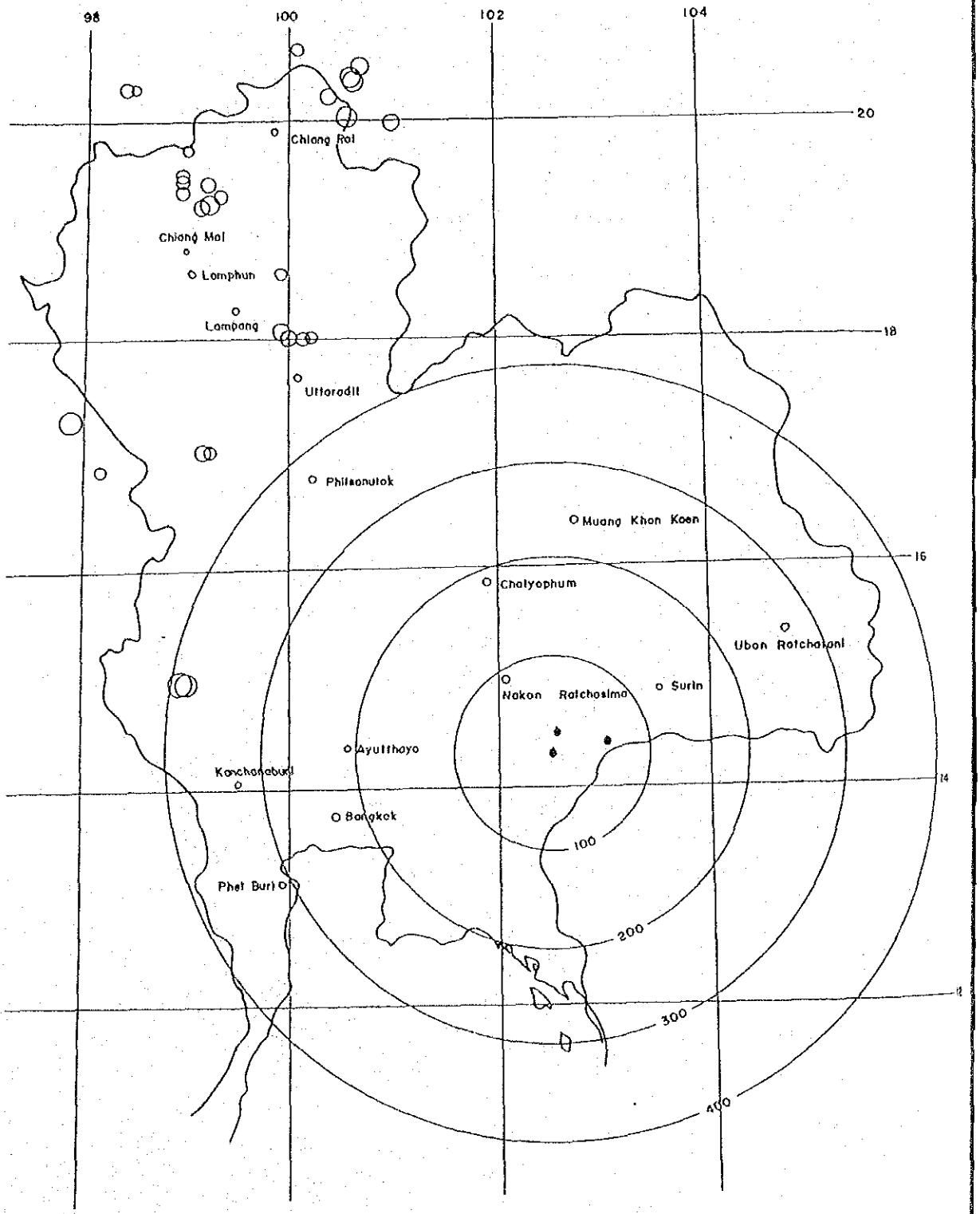


Figure F-1-17.

A Seismic Probability Map For Thailand And Neighbouring Countries

Distribution Of Earthquake Epicenters : 1975 - 1981

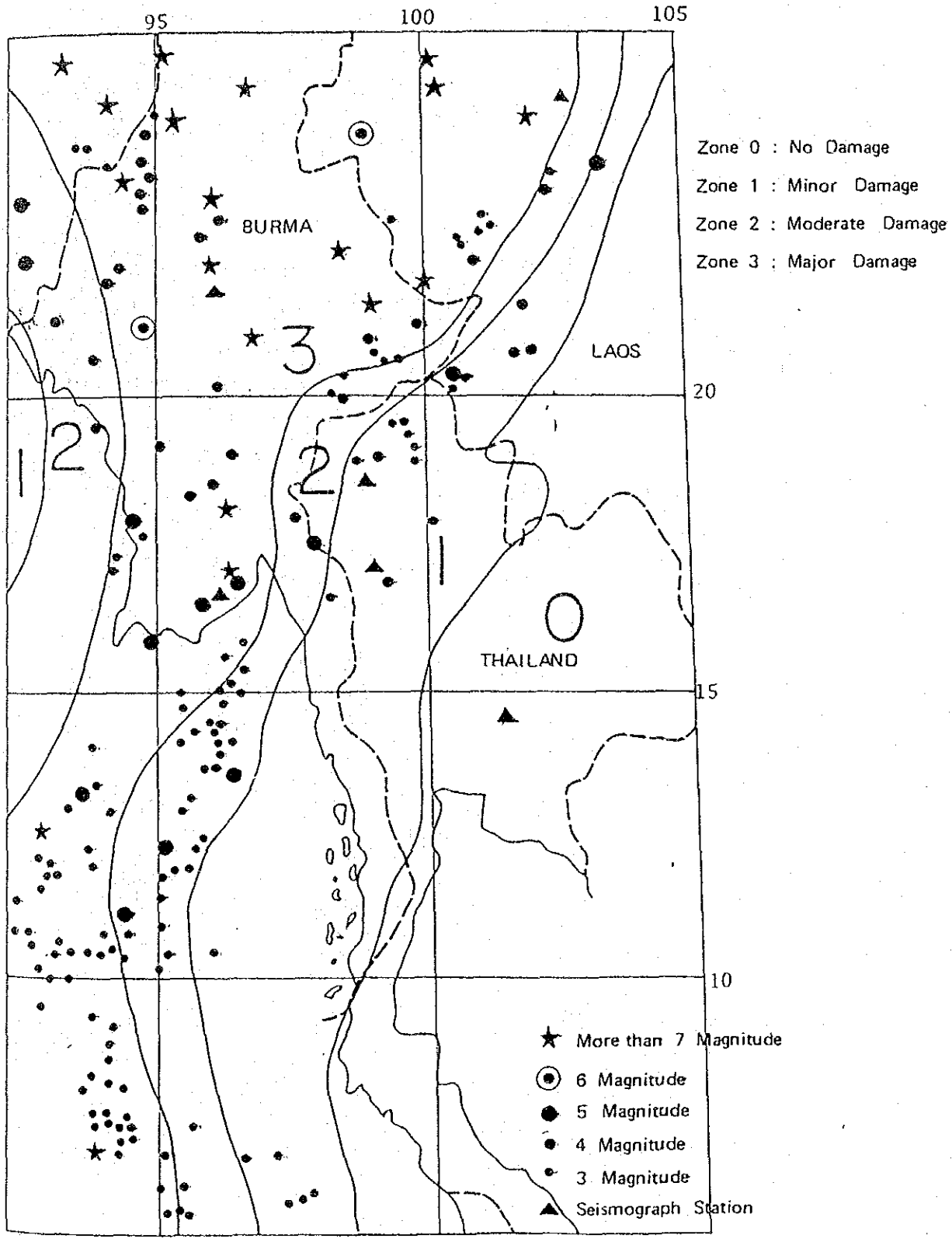


Table F-1-6. Maximum Acceleration

Cordinate of Dam Site

Latitude: 14°15'

Longitude: 102°30'

Date	Epicenter		Magnitude	Distance from Damsite	Acceleration
	Latitude (N)	Longitude (E)	(M)	(km)	(Gal)
Apr 15, 1983	14.91	99.20	5.0	374.6	1.9×10^{-4}
Apr 22, 1983	14.92	99.06	5.5	390.1	2.6×10^{-3}
"	14.98	99.16	5.3	380.6	1.1×10^{-3}
"	14.95	99.07	5.8	389.7	1.4×10^{-2}
"	15.03	99.21	4.8	376.4	4.0×10^{-5}
Apr 27, 1983	14.99	98.99	4.7	399.3	0
Apr 30, 1983	14.99	99.16	4.6	380.8	0
May 1, 1983	15.00	99.18	4.0	378.9	0
June 9, 1983	14.97	99.18	4.4	378.2	0

F.1.3. Stability Analysis

Fig. F-1-18. Flow Chart of Stability Analysis
- Sliding Surface Method -

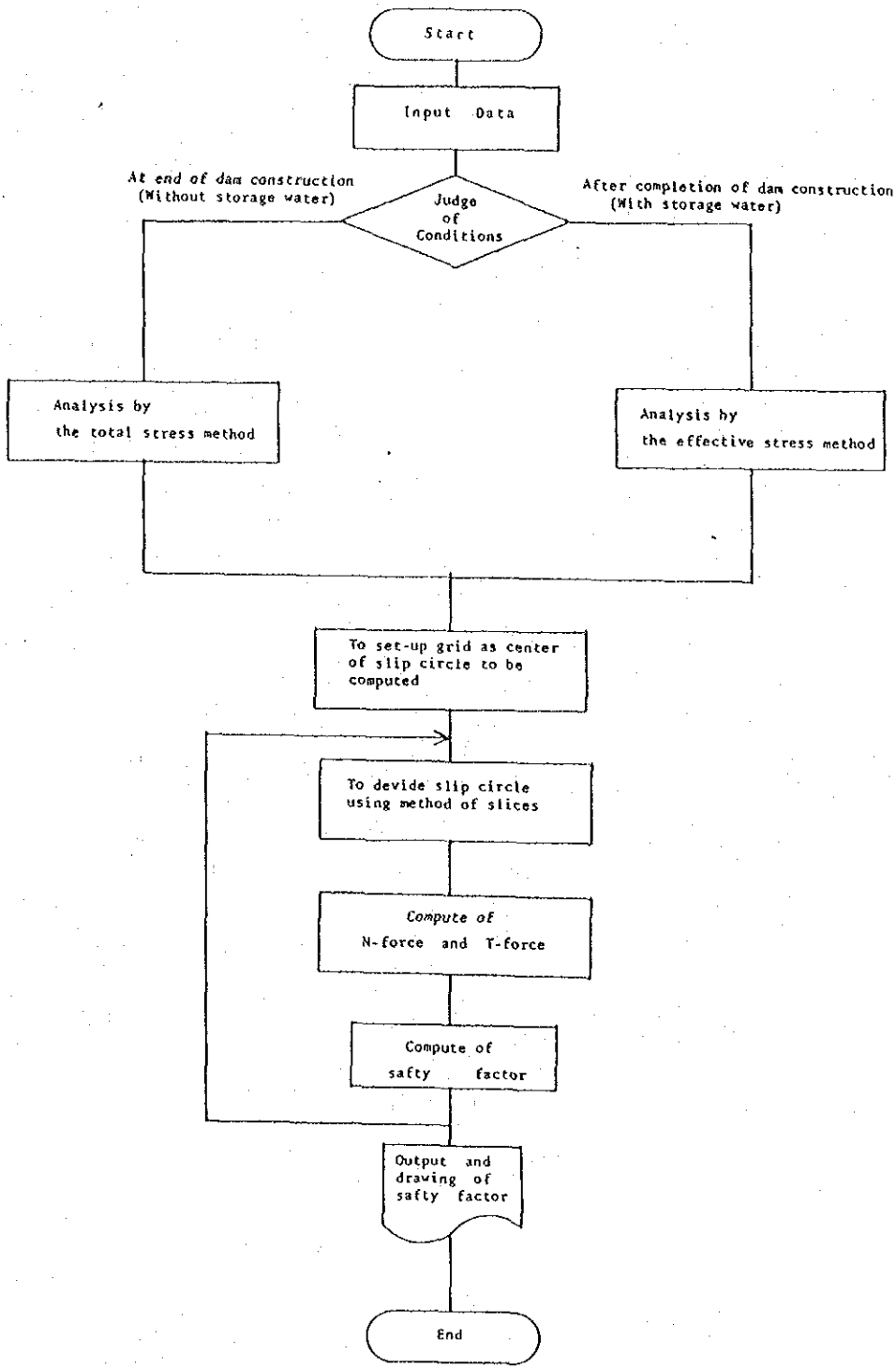
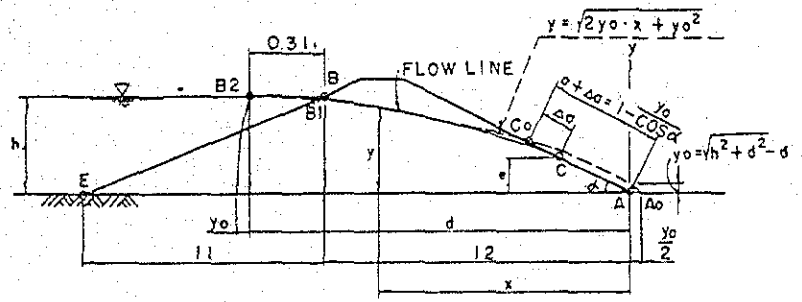


Fig. F-1-19. Seepage Line of Lam Plai Mat Dam



W.L.	h	l_1	l_2	d	$y = \sqrt{2yox + yo^2}$	yo	a+Δa
EL. 261.80	28.80	6.44	10.37	12.31	$y = \sqrt{38.02x + 361.38}$	19.01	24.31
EL. 256.80	23.80	5.32	11.49	13.09	$y = \sqrt{28.14x + 197.96}$	14.07	18.00
EL. 251.80	18.80	4.20	12.61	13.87	$y = \sqrt{18.98x + 90.06}$	9.49	12.14
EL. 246.60	13.60	3.04	13.77	14.69	$y = \sqrt{10.66x + 28.41}$	5.33	6.82

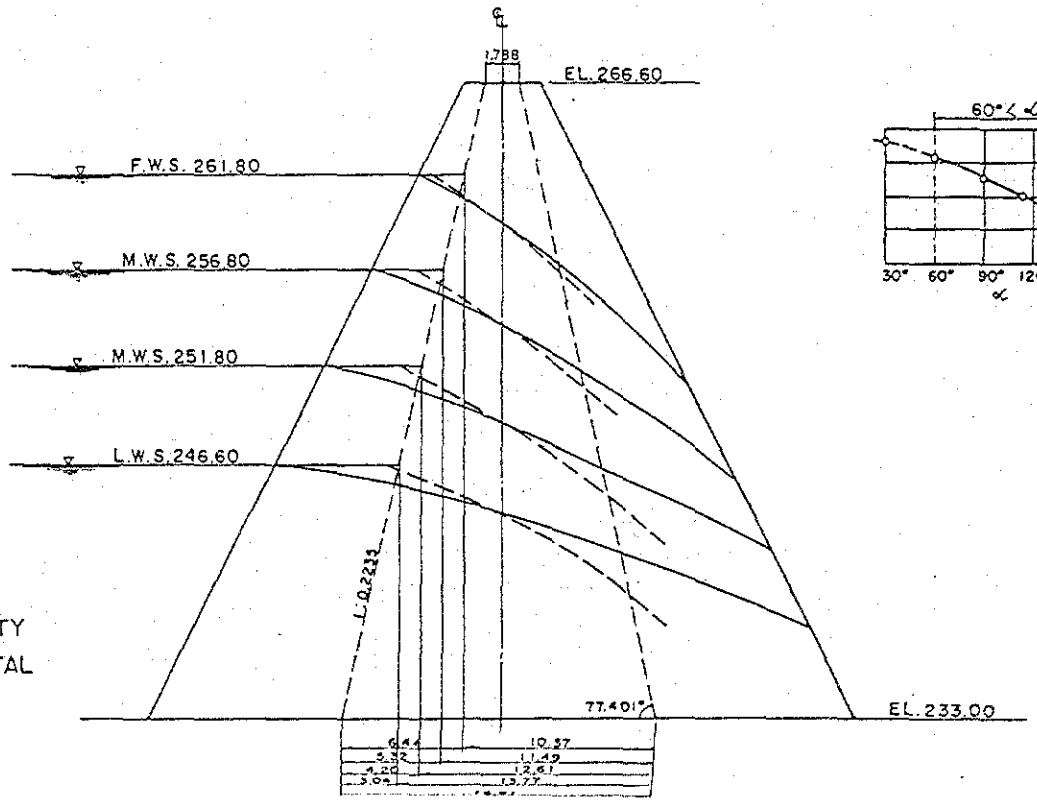
NOTES: $d = 0.31_1 + l_2$

$y_o = \sqrt{h^2 + d^2} - d$

$a + \Delta a = \frac{y_o}{1 - \cos\alpha} (\alpha = 77.401)$

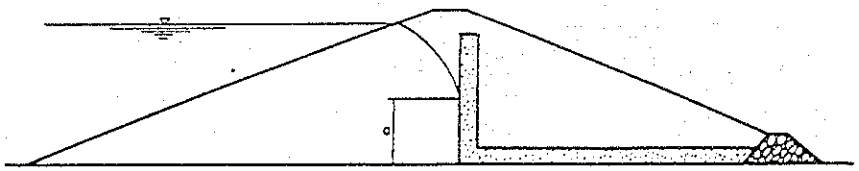
$\Delta a = C(a + \Delta a)$

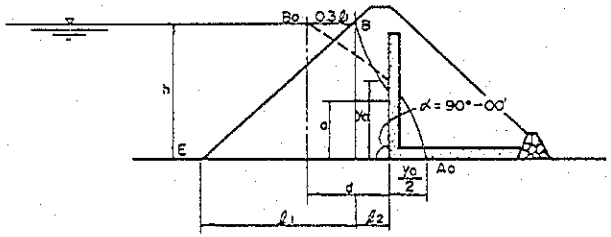
A CASAGRANDE METHOD



NOTES: K_H/K_V = THE RATIO OF THE PERMEABILTY COEFFICIENTS IN THE HORIZONTAL AND VERTICAL DIRECTIONS.
REDUCED SCALE $\sqrt{K_V/K_H} = 1/5$

Fig. F-1-20. Seepage Line of Huai Phlu Dam





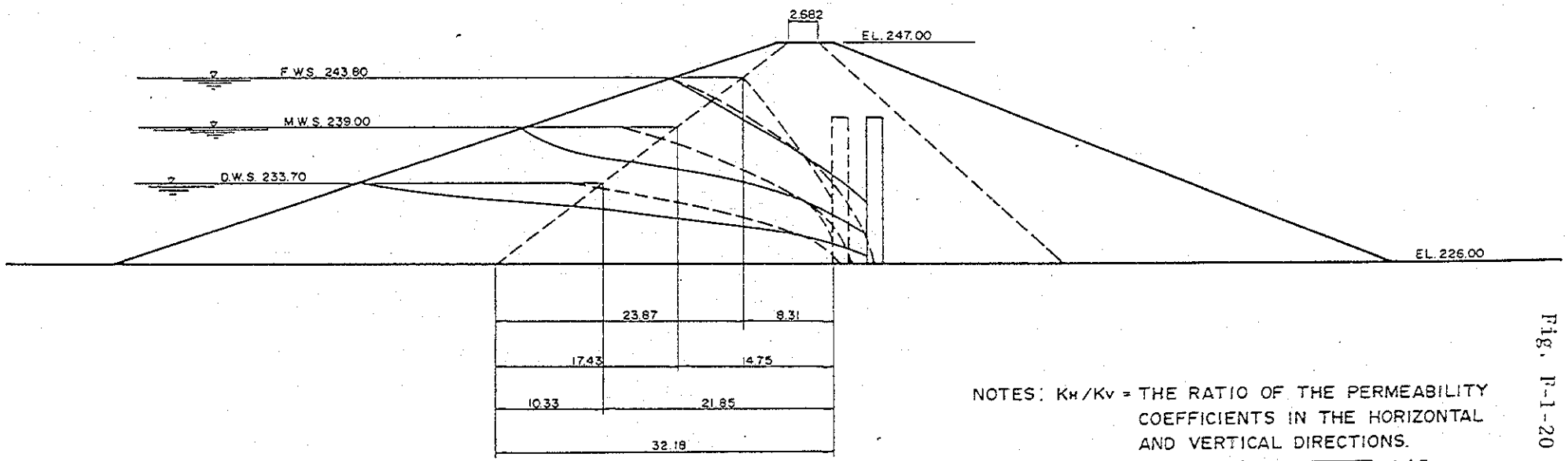
A CASAGRANDE METHOD

WL	h	ℓ1	ℓ2	d	$y=\sqrt{2y_0x+y_0^2}$	yo	a
EL. 243.80	17.8	23.87	8.31	15.47	$y=\sqrt{16.22x+65.77}$	8.11	6.08
EL. 239.00	13.0	17.43	14.75	19.98	$y=\sqrt{7.72x+14.90}$	3.86	2.90
EL. 233.70	7.7	10.33	21.85	24.95	$y=\sqrt{2.32x+1.35}$	1.16	0.87

$d = 0.3\ell_1 + \ell_2$

$y_0 = \sqrt{h^2+d^2} - d$

$a = \frac{3}{4}y_0 \quad (\alpha = 90°-00')$



NOTES: KH/KV = THE RATIO OF THE PERMEABILITY COEFFICIENTS IN THE HORIZONTAL AND VERTICAL DIRECTIONS.
REDUCED SCALE $\sqrt{KV/KH}$ = 1/5

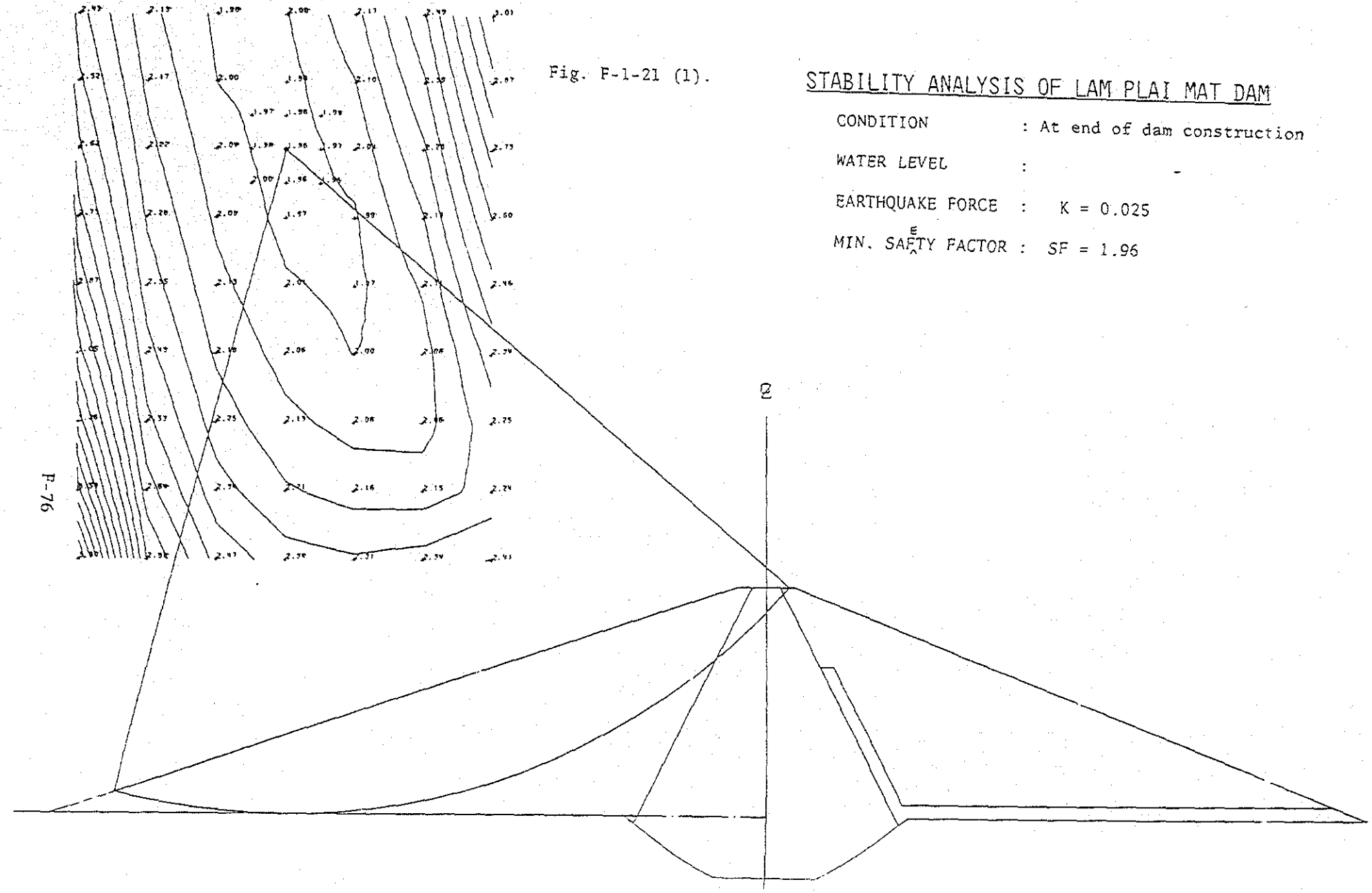


Fig. F-1-21 (1).

STABILITY ANALYSIS OF LAM PLAI MAT DAM

CONDITION : At end of dam construction

WATER LEVEL :

EARTHQUAKE FORCE : K = 0.025

MIN. SAFETY FACTOR : SF = 1.96

Fig. F-1-21 (1)

Fig. F-1-21 (2)

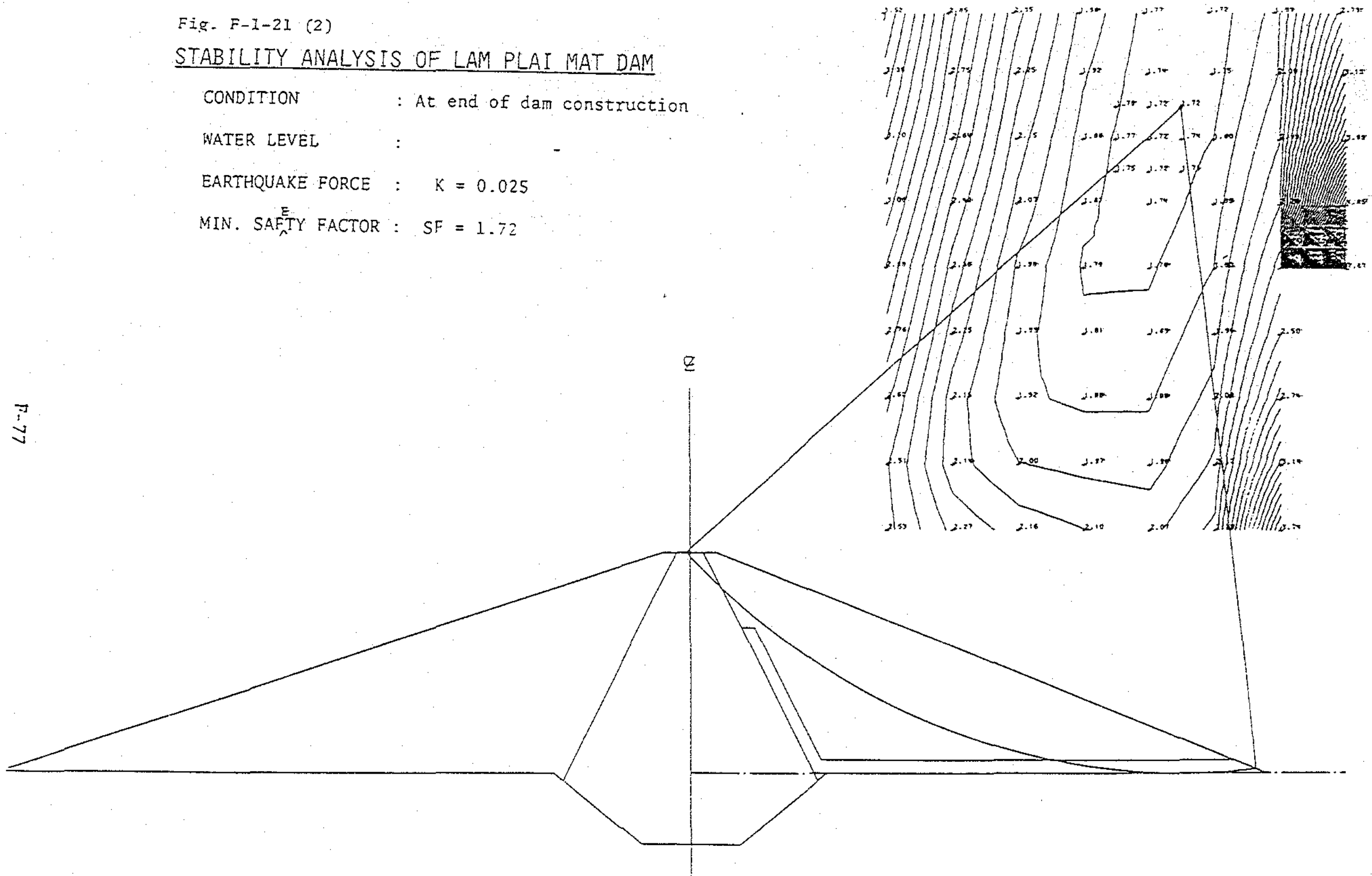
STABILITY ANALYSIS OF LAM PLAI MAT DAM

CONDITION : At end of dam construction

WATER LEVEL :

EARTHQUAKE FORCE : K = 0.025

MIN. SAFETY FACTOR : SF = 1.72



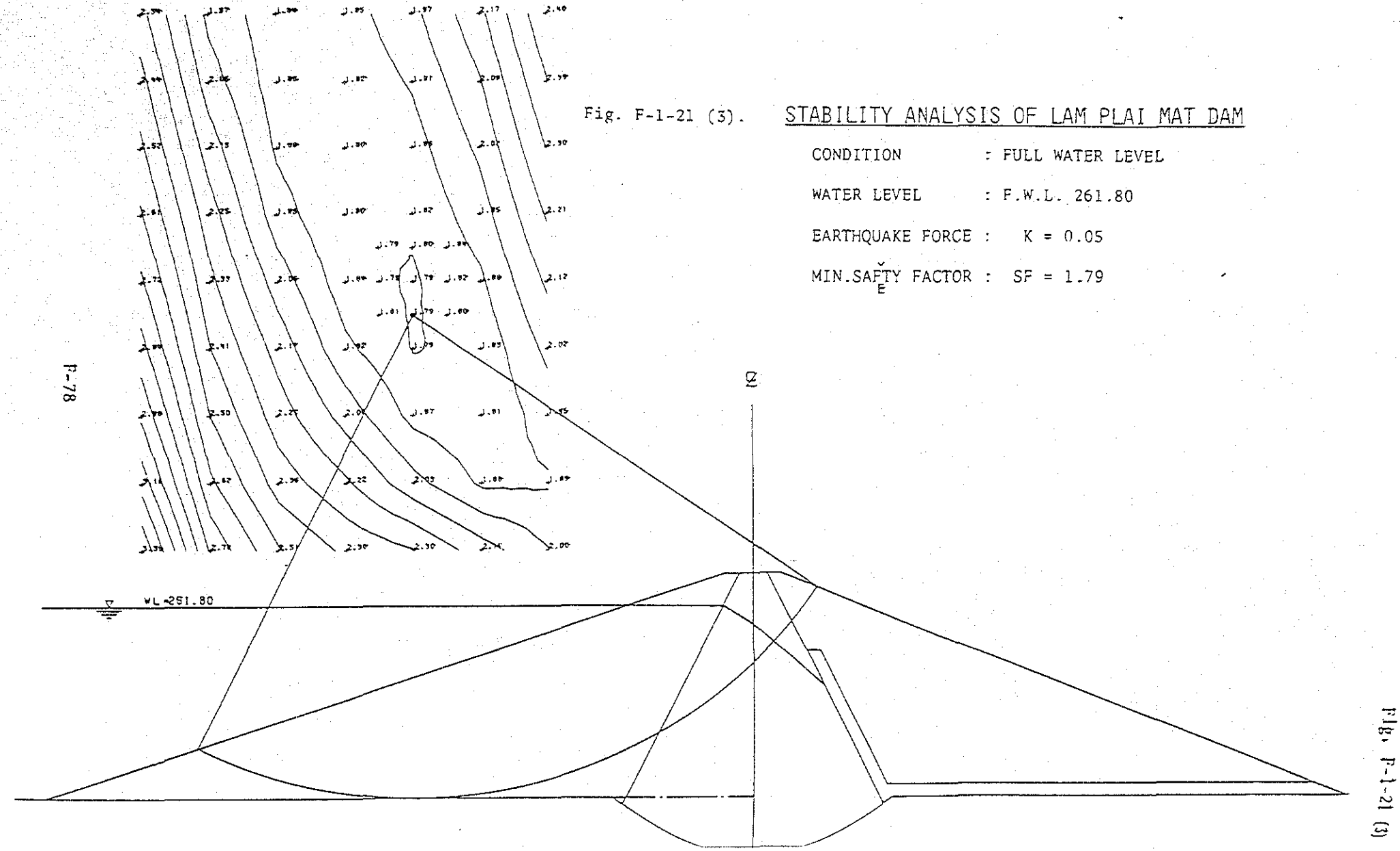


Fig. F-1-21 (3). STABILITY ANALYSIS OF LAM PLAI MAT DAM

CONDITION : FULL WATER LEVEL

WATER LEVEL : F.W.L. 261.80

EARTHQUAKE FORCE : K = 0.05

MIN.SAFTY FACTOR : SF_E = 1.79

Fig. F-1-21 (3)

Fig. F-1-21 (4).

STABILITY ANALYSIS OF LAM PLAI MAT DAM

CONDITION : FULL WATER LEVEL

WATER LEVEL : F.W.L. 261.80

EARTHQUAKE FORCE : K = 0.05

MIN. SAFETY FACTOR : SF = 1.61

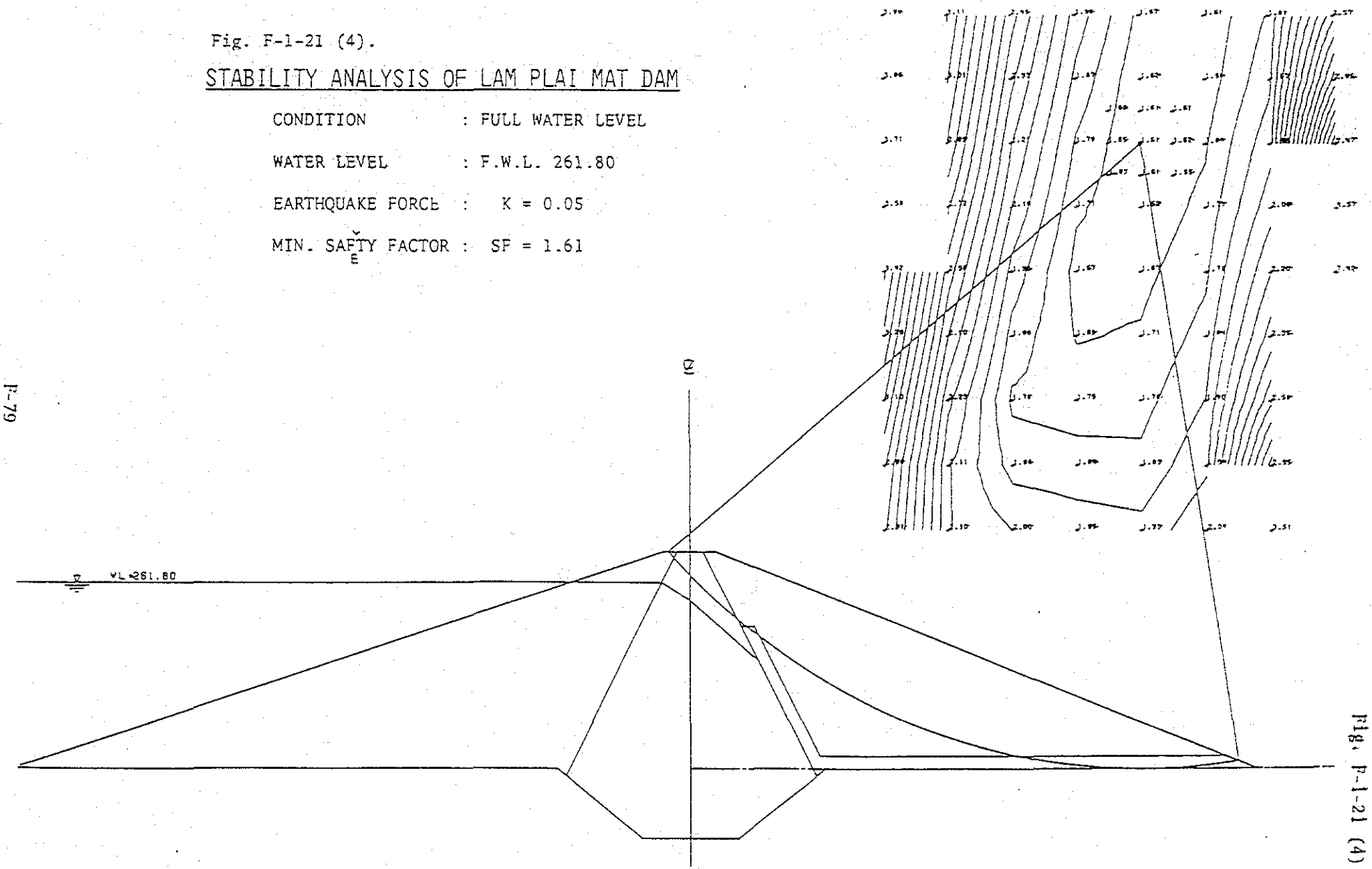


Fig. F-1-21 (4)

Fig. F-1-21 (5).

STABILITY ANALYSIS OF LAM PLAI MAT DAM

CONDITION : MIDDLE WATER LEVEL

WATER LEVEL : M.W.L. 256.80

EARTHQUAKE FORCE : K = 0.05

MIN. SAFETY FACTOR : SF = 1.66

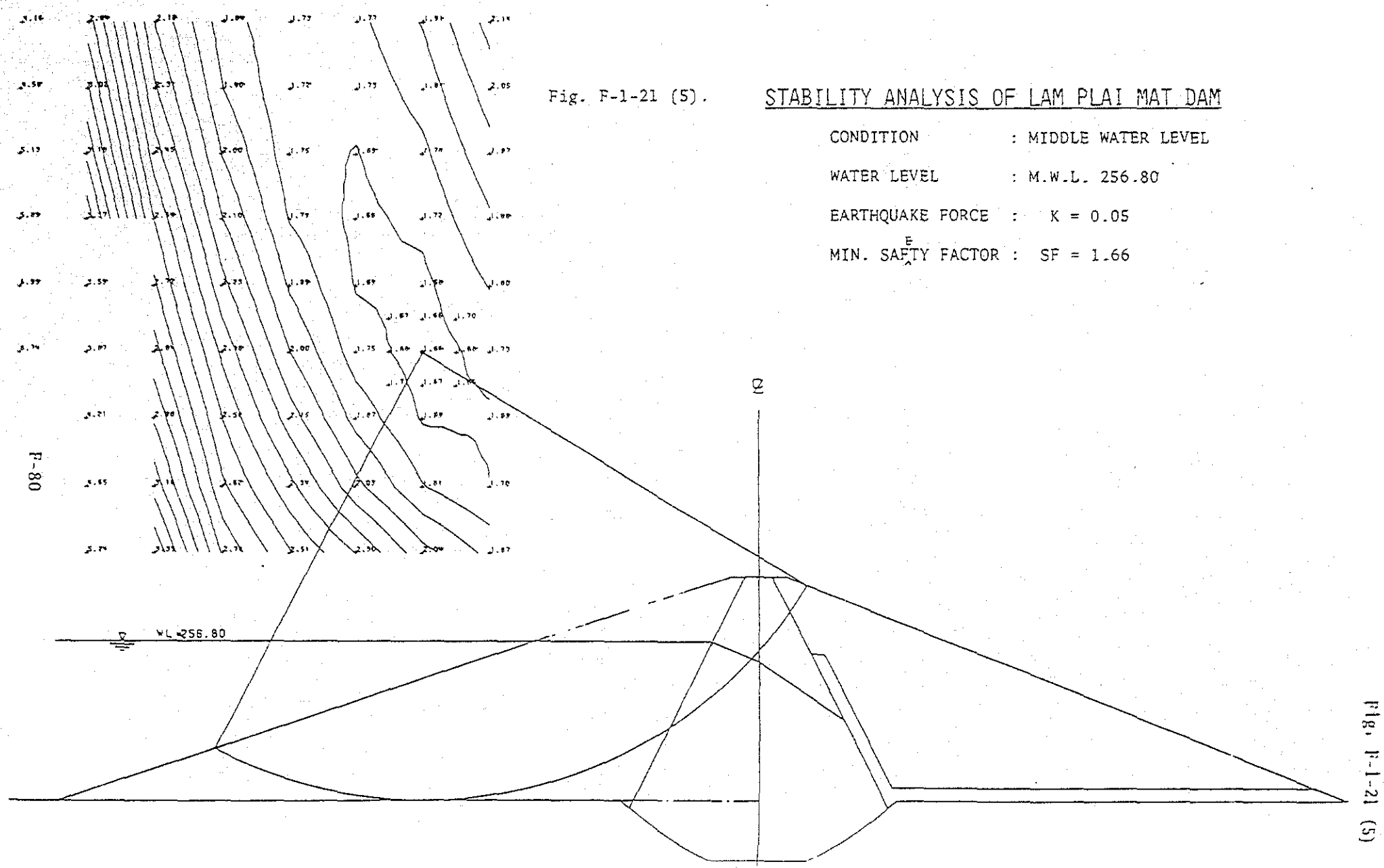


Fig. F-1-21 (5)

Fig. F-1-21 (6). STABILITY ANALYSIS OF LAM PLAI MAT DAM

CONDITION : MIDDLE WATER LEVEL

WATER LEVEL : M.W.L. 251.80

EARTHQUAKE FORCE : K = 0.05

MIN. SAFTY FACTOR : SF = 1.57

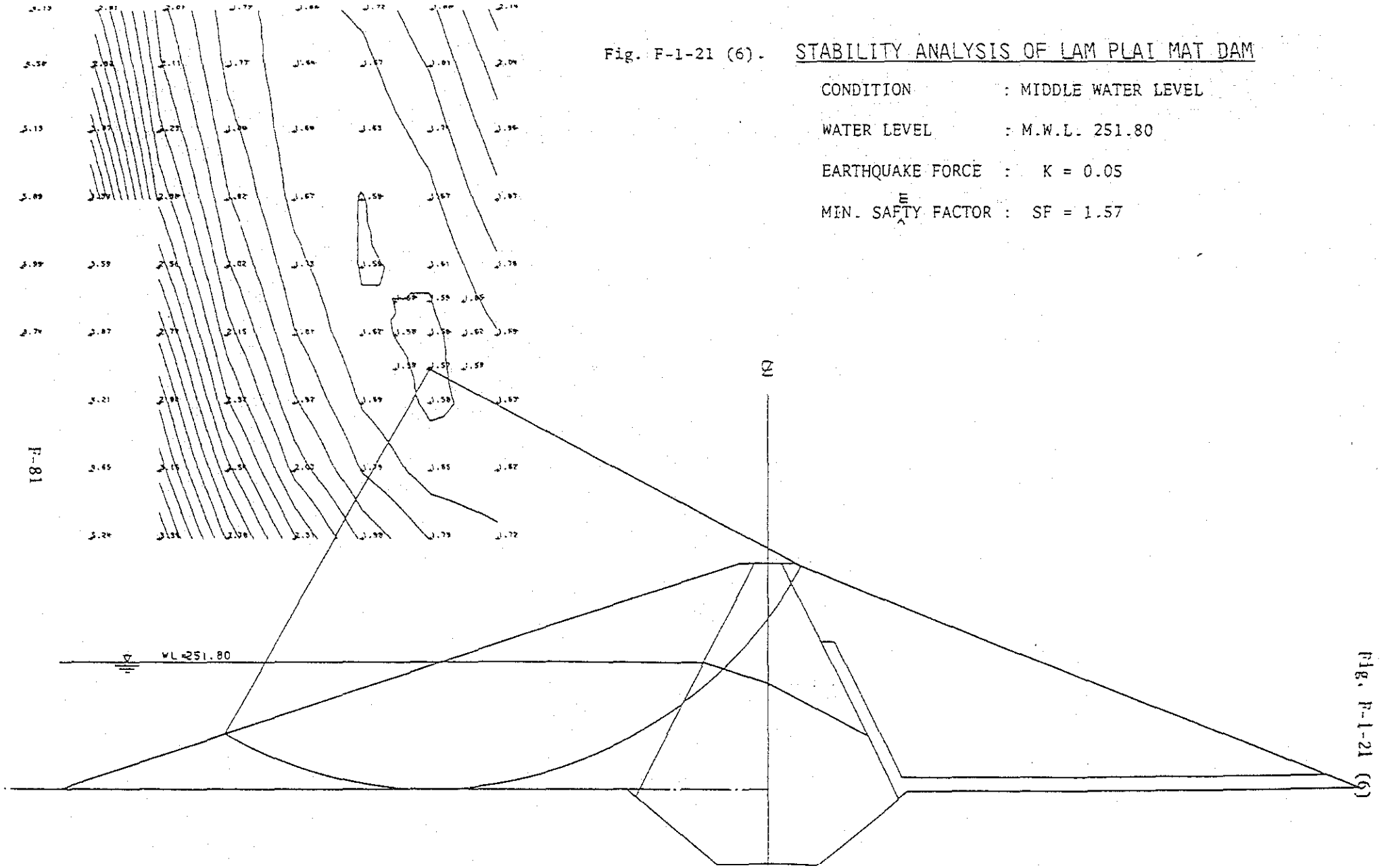


Fig. F-1-21 (6)

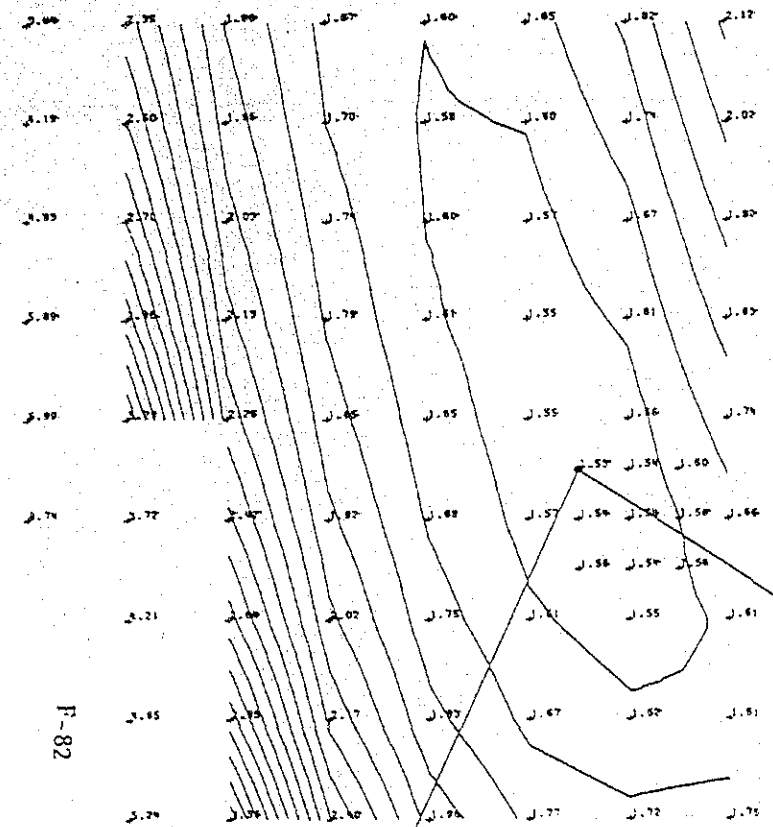


Fig. F-1-21 (7). STABILITY ANALYSIS OF LAM PLAI MAT DAM

CONDITION : RAPID DRAWDOWN

WATER LEVEL : F.W.L. 261.80 TO L.W.L. 246.80

EARTHQUAKE FORCE : K = 0.05

MIN. SAFETY FACTOR : SF = 1.53

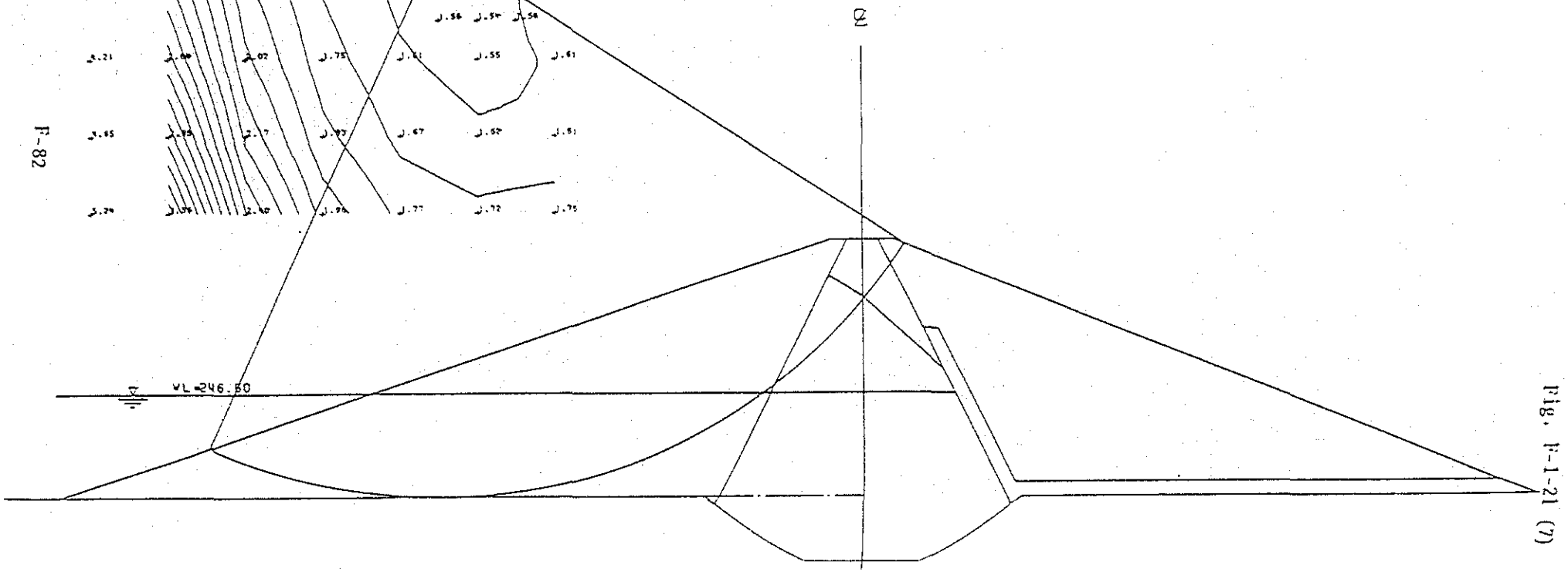


Fig. F-1-21 (7)

Fig. F-1-22 (1)

STABILITY ANALYSIS OF HUAI PHLU DAM

CONDITION : At end of dam construction

WATER LEVEL : -

EARTHQUAKE FORCE : K_E = 0.025

MIN. SAFTY FACTOR : SF = 2.51

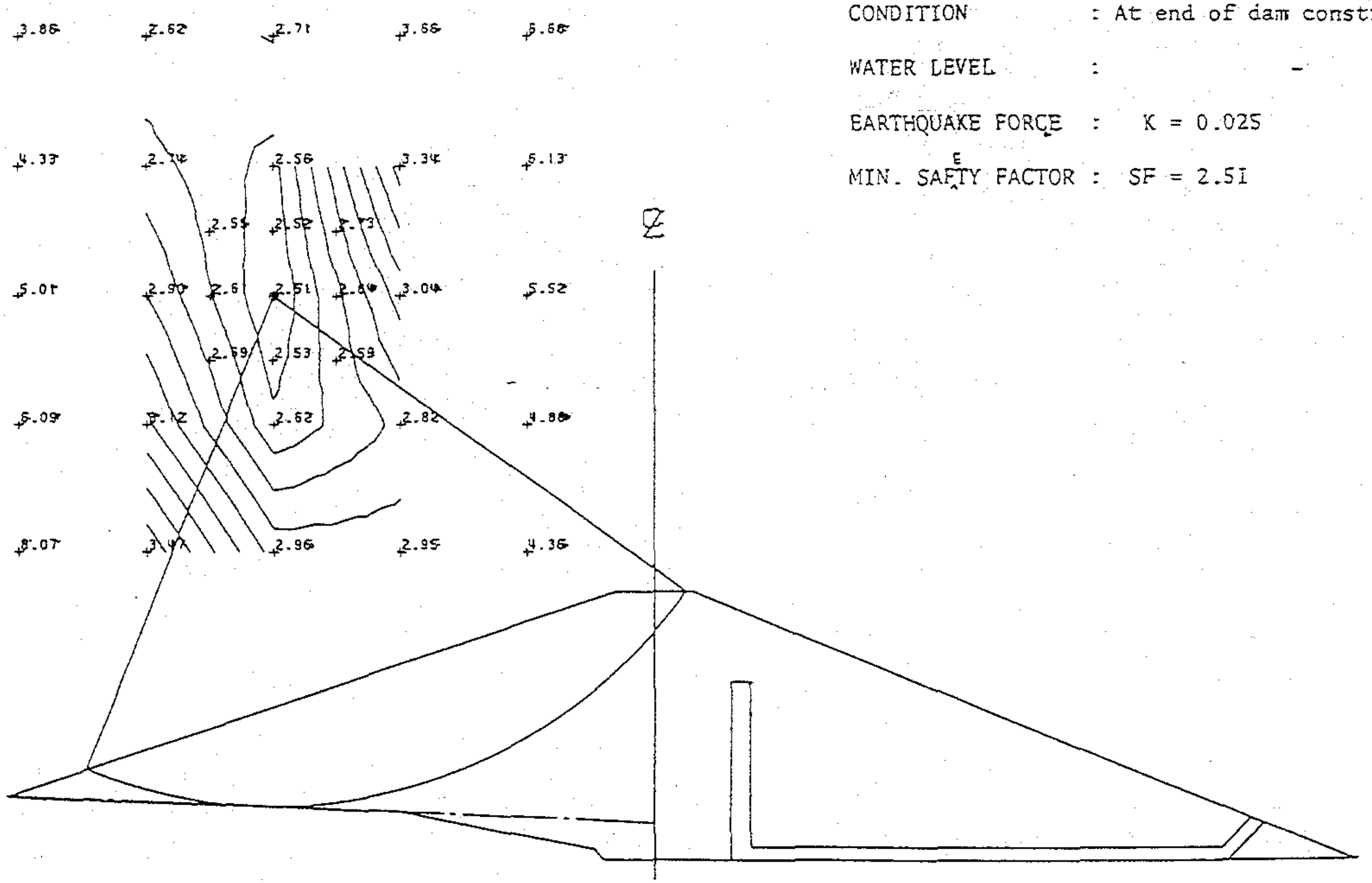


Fig. F-1-22 (2).

STABILITY ANALYSIS OF HUAI PHLU DAM

CONDITION : At end of dam construction

WATER LEVEL : -

EARTHQUAKE FORCE : K = 0.025

MIN. SAFETY FACTOR : SF = 2.00

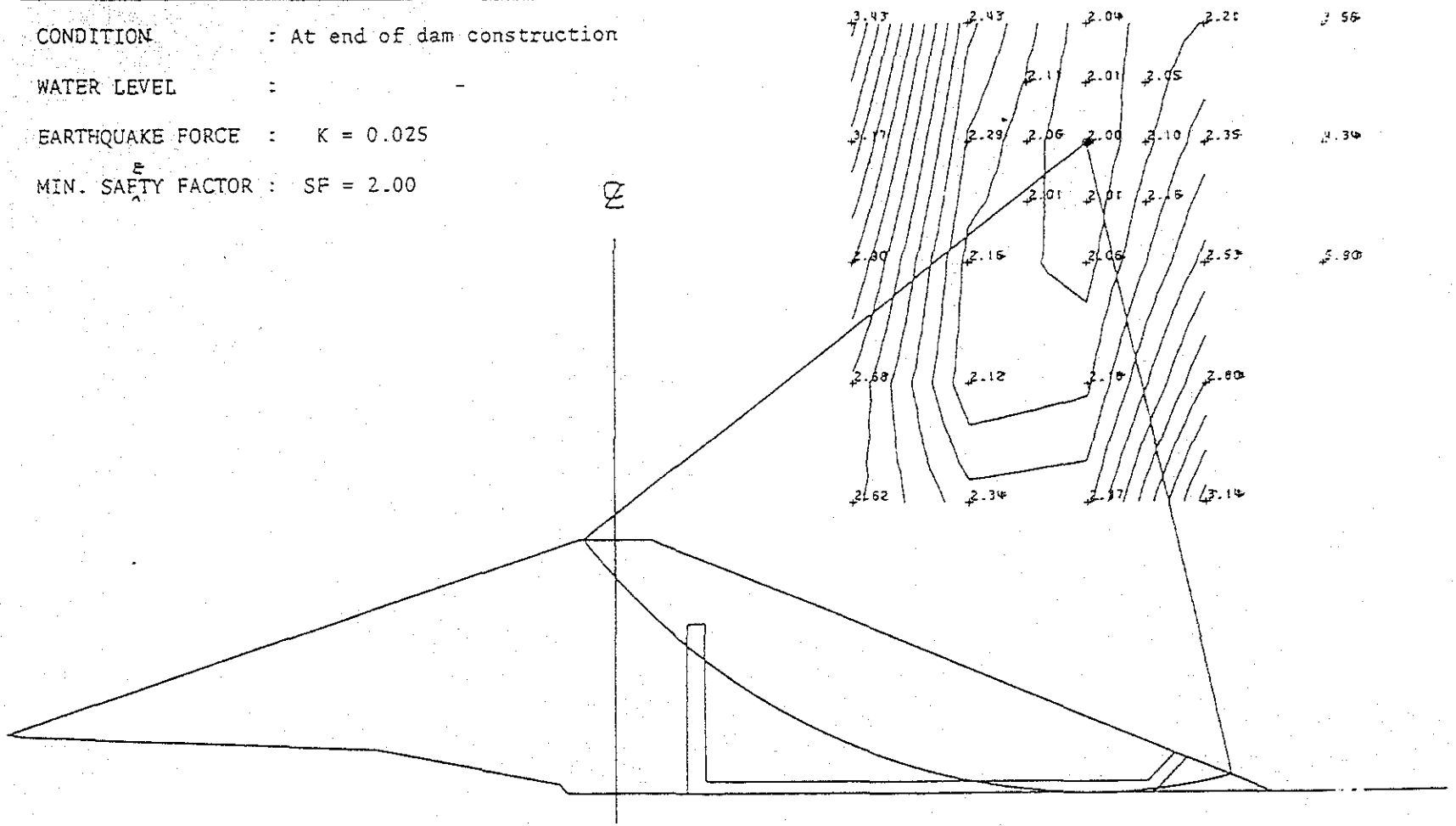


Fig. F-1-22 (3). STABILITY ANALYSIS OF HUAI PHLU DAM

CONDITION : FULL WATER LEVEL

WATER LEVEL : F.W.L. 243.80

EARTHQUAKE FORCE : K = 0.05

MIN. SAFETY FACTOR : SF = 2.11

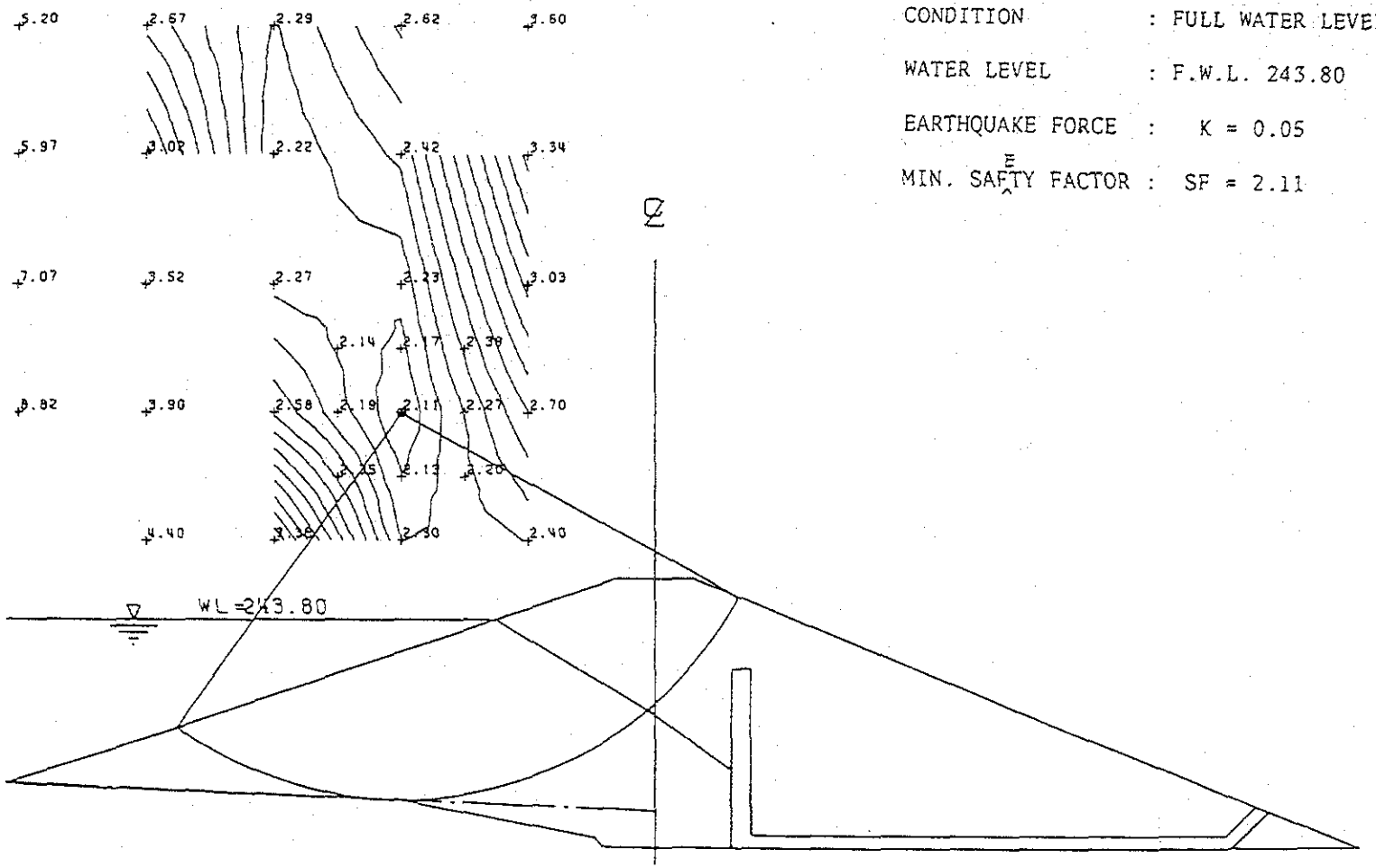


Fig. F-1-22 (4).

STABILITY ANALYSIS OF HUAI PHLU DAM

CONDITION : FULL WATER LEVEL

WATER LEVEL : F.W.L. 243.80

EARTHQUAKE FORCE : K = 0.05

MIN. SAFTY FACTOR : SF = 1.86

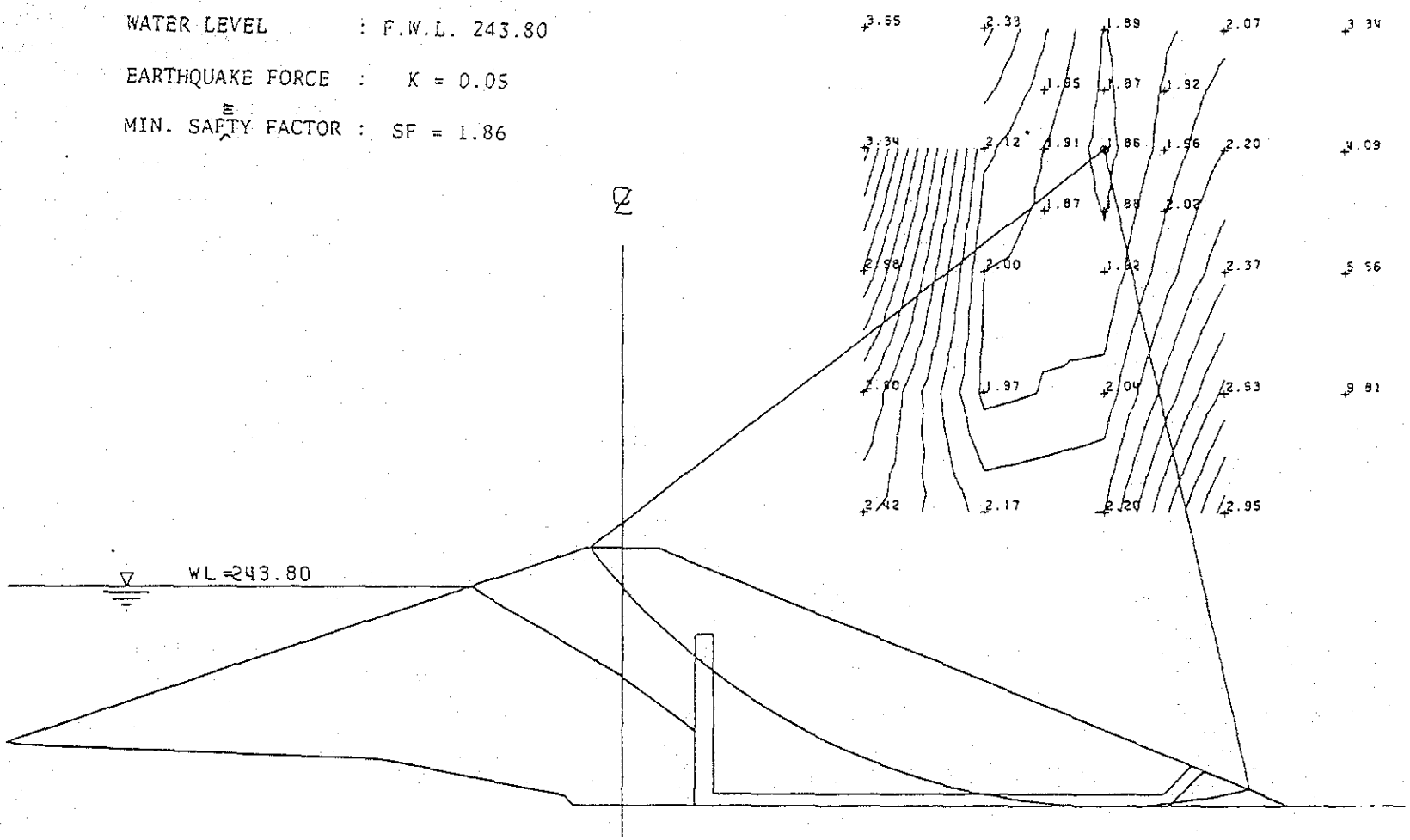


Fig. F-1-22 (4)

Fig. F-1-22 (5). STABILITY ANALYSIS OF HUAI PHLU DAM

CONDITION : MIDDLE WATER LEVEL

WATER LEVEL : M.W.L. 239.00

EARTHQUAKE FORCE : K = 0.05

MIN. SAFTY FACTOR : SF = 1.99

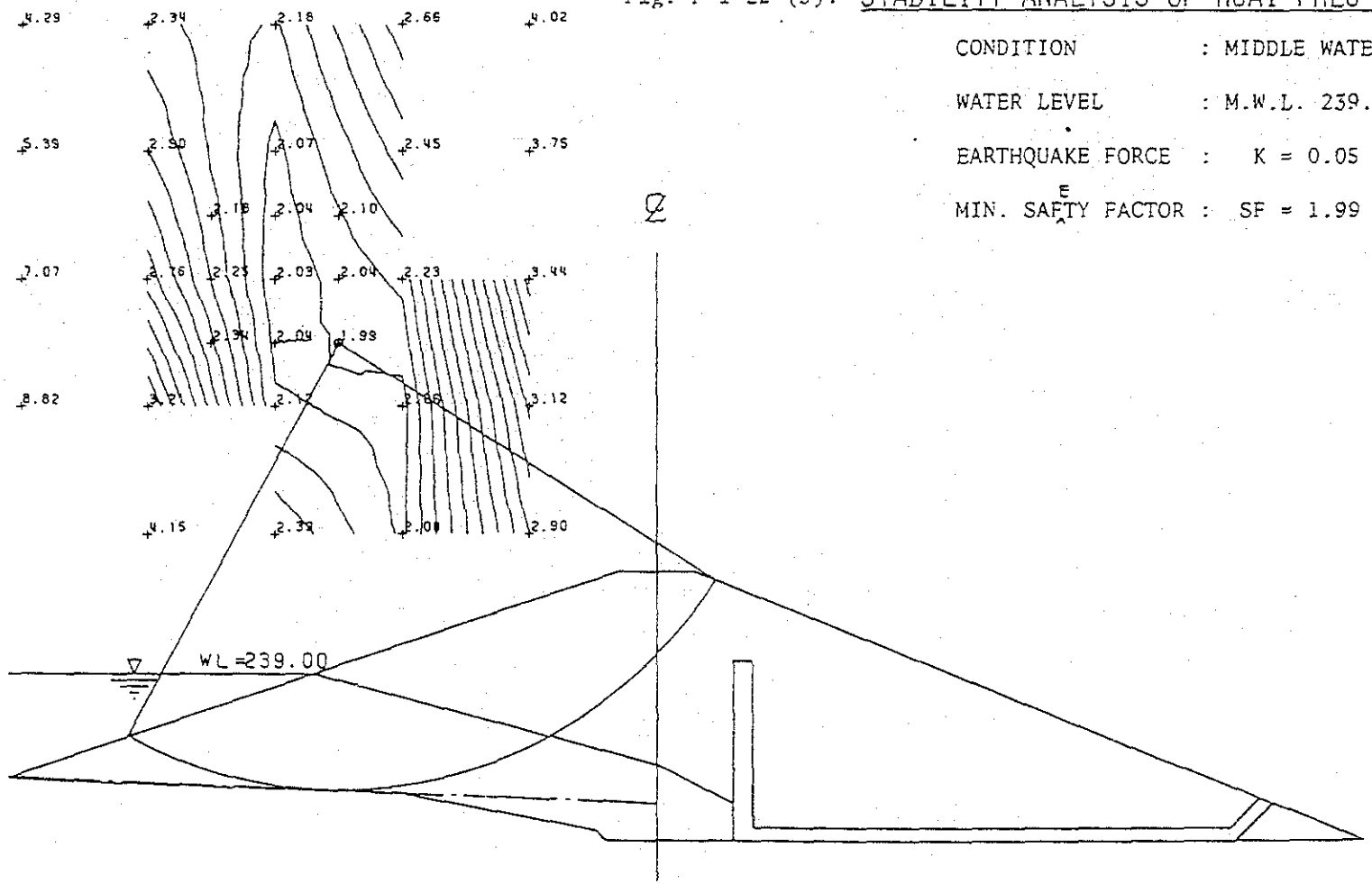


Fig. F-1-22 (5)

Fig. F-1-22 (6). STABILITY ANALYSIS OF HUAI PHLU DAM

CONDITION : RAPID DRAWDOWN

WATER LEVEL : F.W.L. 243.80 TO L.W.L. 233.70

EARTHQUAKE FORCE : K = 0.05

MIN. SAFETY FACTOR : SF = 1.71

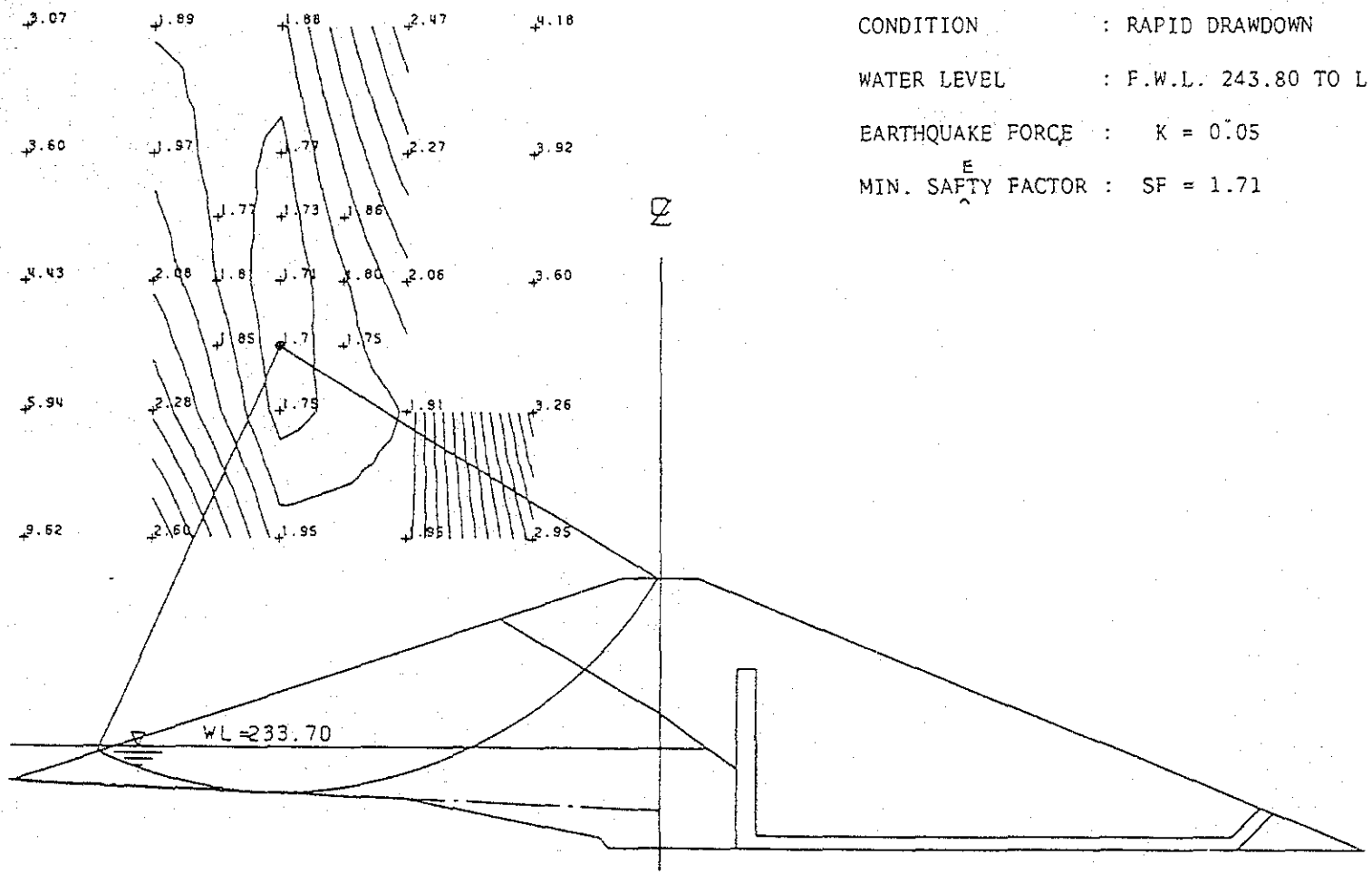


Fig. F-1-22 (6)

F.1.4. Spillway

(1) Spillway Capacity

For the spillway design purpose, 500-year probability flood discharge hydrograph was established (refer to Annex A).

The running discharge through the spillway in peak can be decreased from the design flood discharge due to storage effect above full water surface level in reservoir at the entrance of spillway.

The calculation has been carried out by using the following formula considering the relationship between the flow-out capacity of spillway and the storage effect in reservoir provided by; the dam with a 1,000-year probability flood flow into the reservoir.

$$1/2\ (I_1 + I_2)\ \Delta t + S_1 - 1/2 \cdot O_1 \cdot \Delta t = S_2 + 1/2 \cdot O_2 \cdot \Delta t$$

where, I_1 : inflow discharge at t_1 hour in m^3/sec
I_2 : inflow discharge at t_2 hour in m^3/sec
O_1 : outflow discharge at t_1 hour in m^3/sec
O_2 : outflow discharge at t_2 hour in m^3/sec
S_1 : storage volume at t_1 hour in m^3
S_2 : storage volume at t_1 hour in m^3

$$\Delta t = t_2 - t_1\ ,\ (t_2 < t_1)$$

A rise of water surface level in the reservoir and flow-out discharge through the spillway due to various length of crest at the spillway are shown in Figure F-1-23.

For the spillways for the Lam Plai Mat and Huai Phlu, Harrold's standard type weir is adopted, and for the spillway of the Nong Lum Puk, simple weir of trapezoidal shape is adopted. Discharge coefficient is taken 2.1 and 1.7 respectively. Judging from the

figure, the overflow depth and weir crest length is decided as follows:

	Lam Plai Mat	Nong Lum Puk	Huai Phlu
Overflow Depth (m)	2.8	1.0	1.2
Weir Crest Length (m)	100	60	30
Peak Discharge (m^3/sec)	1,366	100	83

Inflow and outflow discharge hydrograph is shown in Figure F-1-24.

Fig. F-1-23 (1).

Relation : Crest Length–Overflow Depth
Lam Plai Mat Dam

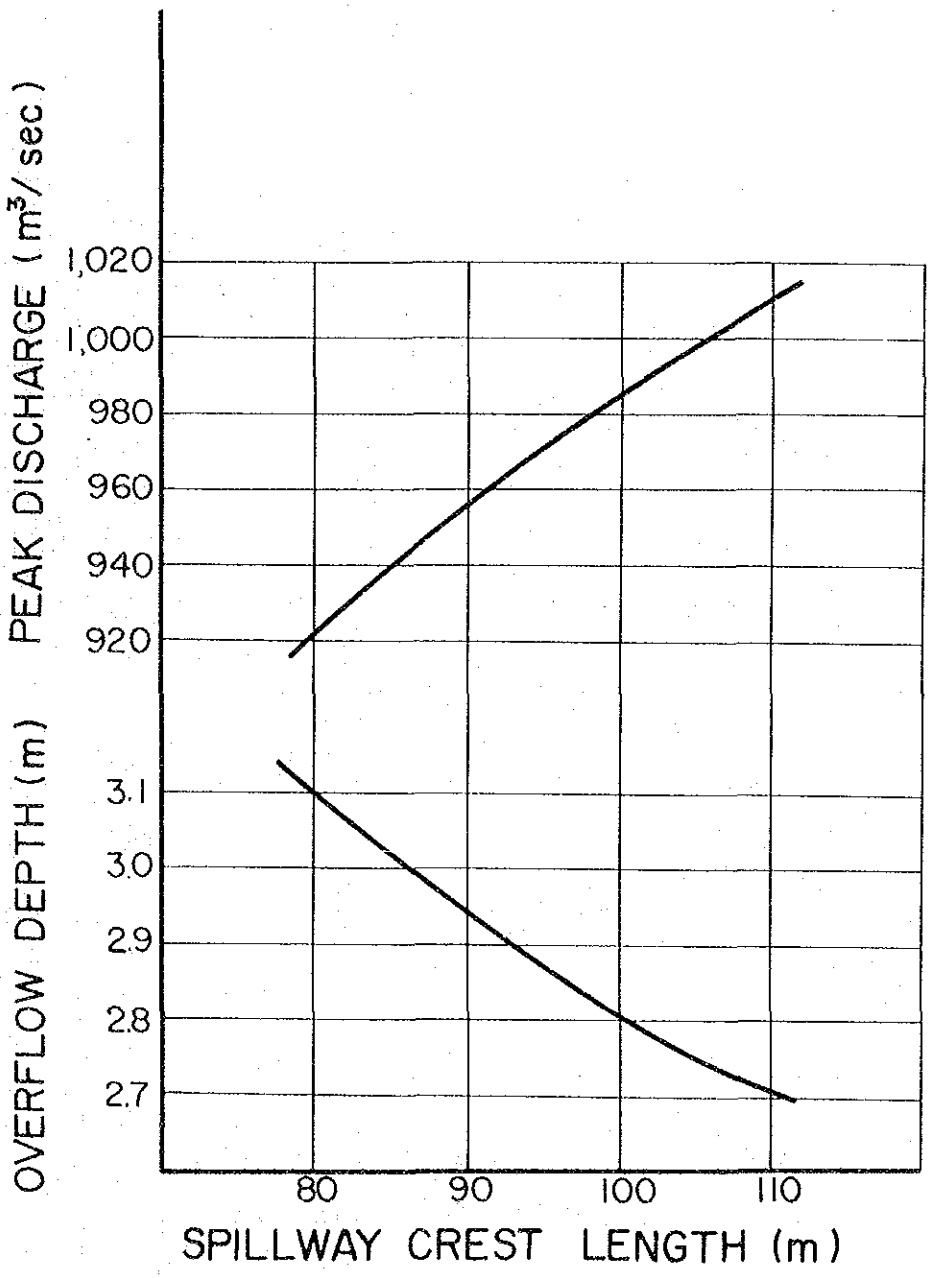


Fig. F-1-23 (2).

Relation : Crest Length — Overflow Depth
Nong Lum Puk Dam

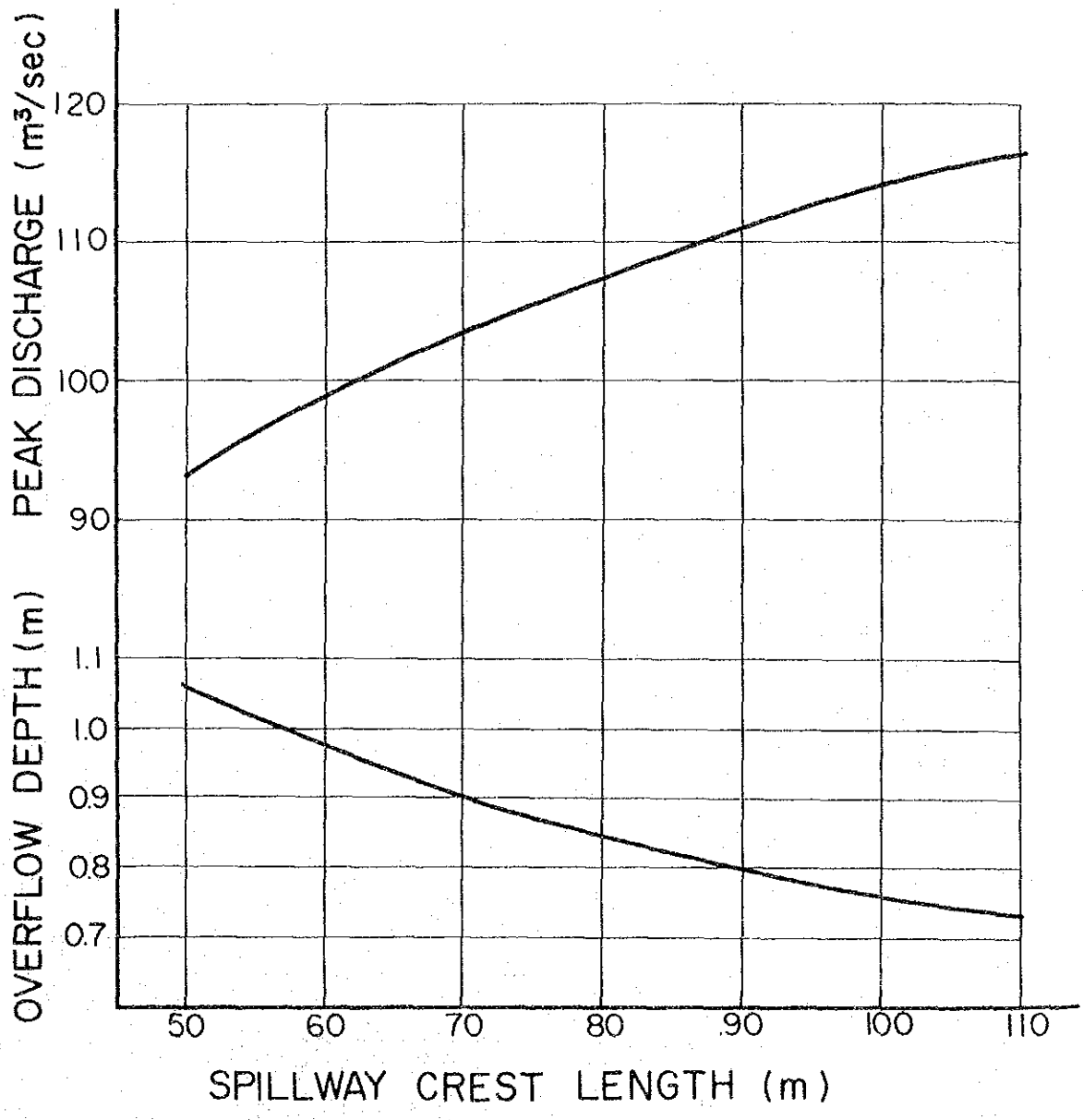


Fig. F-1-23 (3).

Relation : Crest Length–Overflow Depth
Huai Phlu Dam

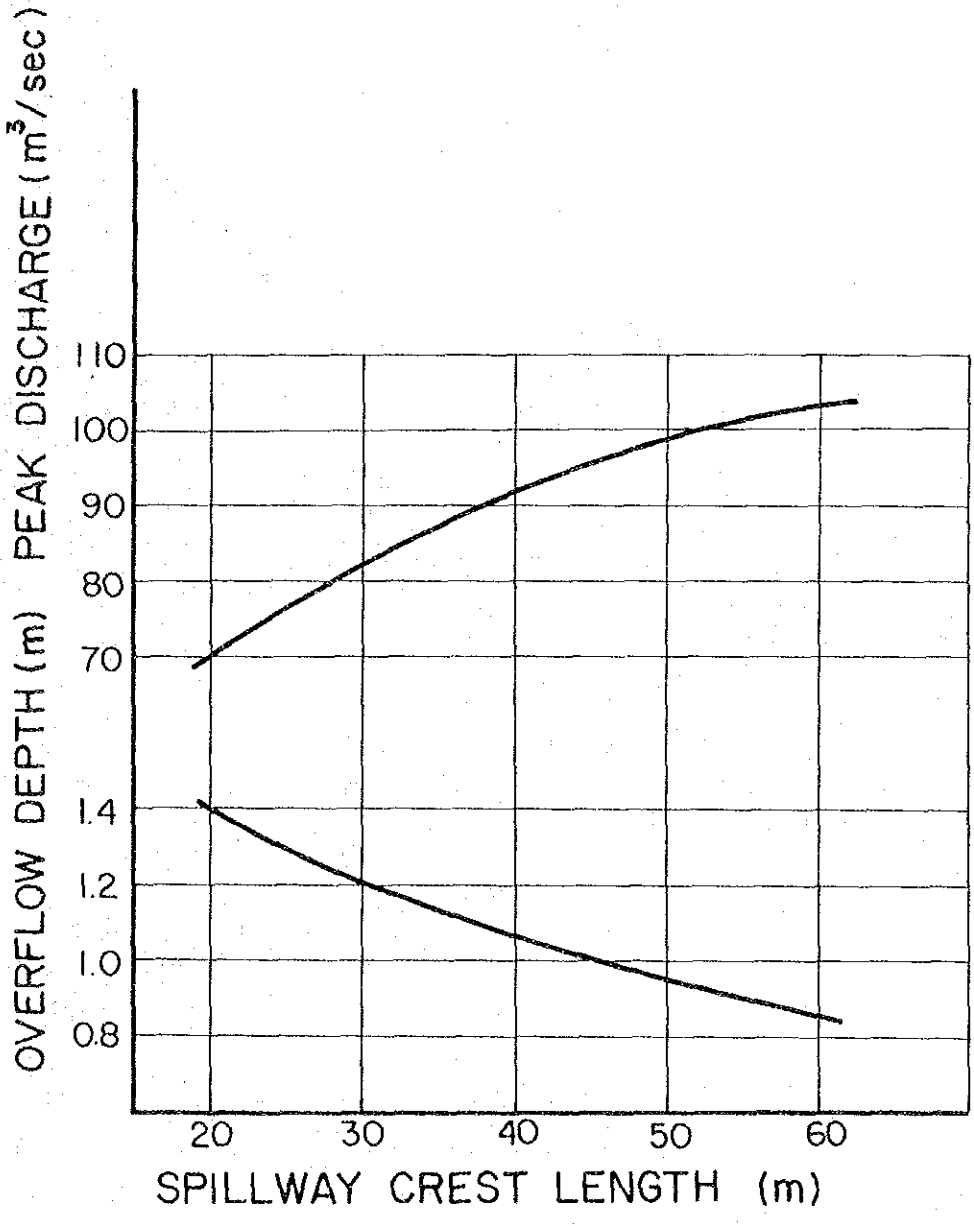


Fig. F-1-24 (1).

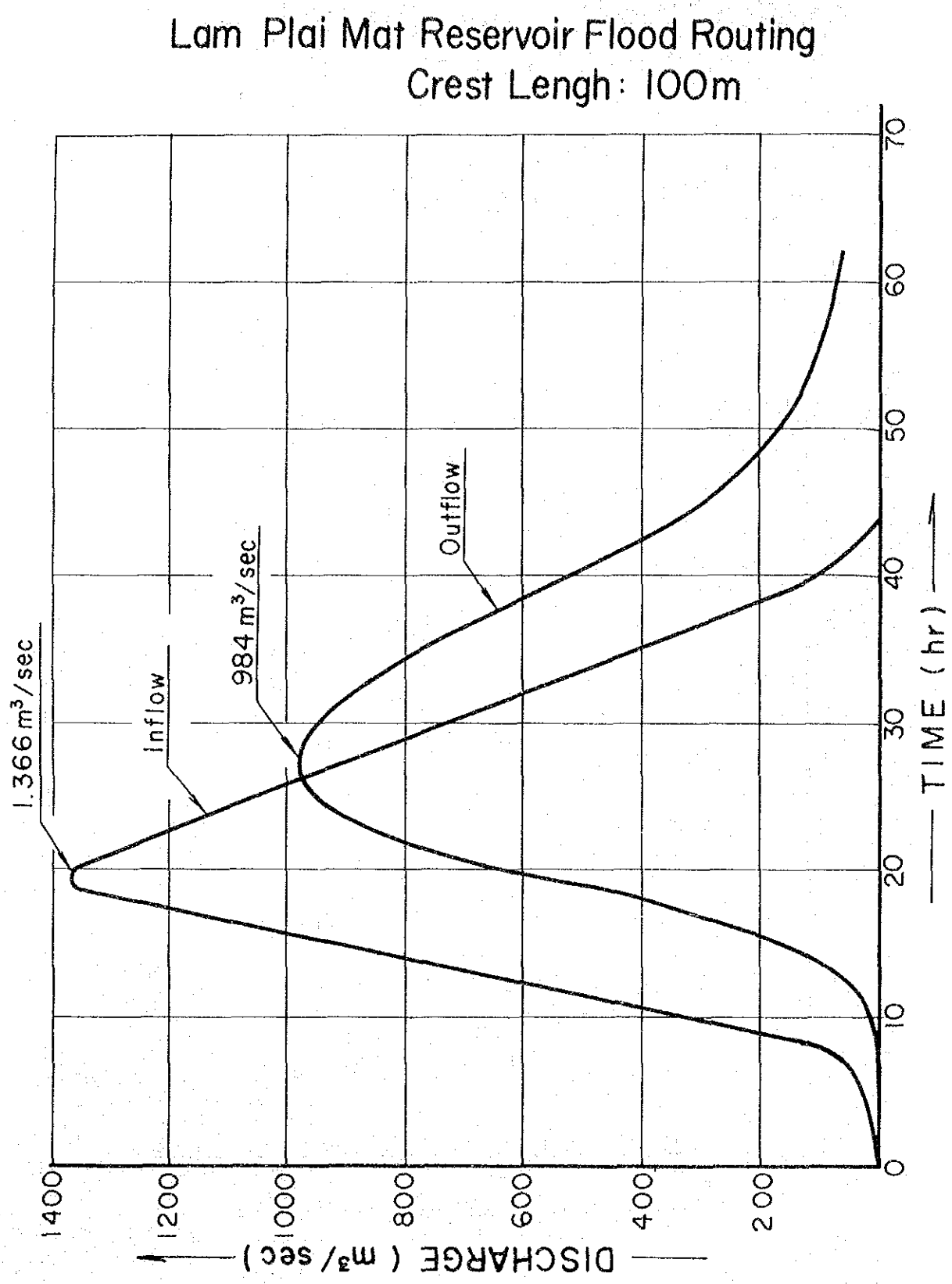

Lam Plai Mat Reservoir Flood Routing
Crest Lengh: 100m
1,366 m³/sec
Inflow
984 m³/sec
Outflow
DISCHARGE (m³/ sec)
1400
1200
1000
800
600
400
200
0
10
20
30
40
50
60
70
TIME (hr)

Fig. F-1-24 (2).

Nong Lum Puk Reservoir Flood Routing
Crest Length : 60m

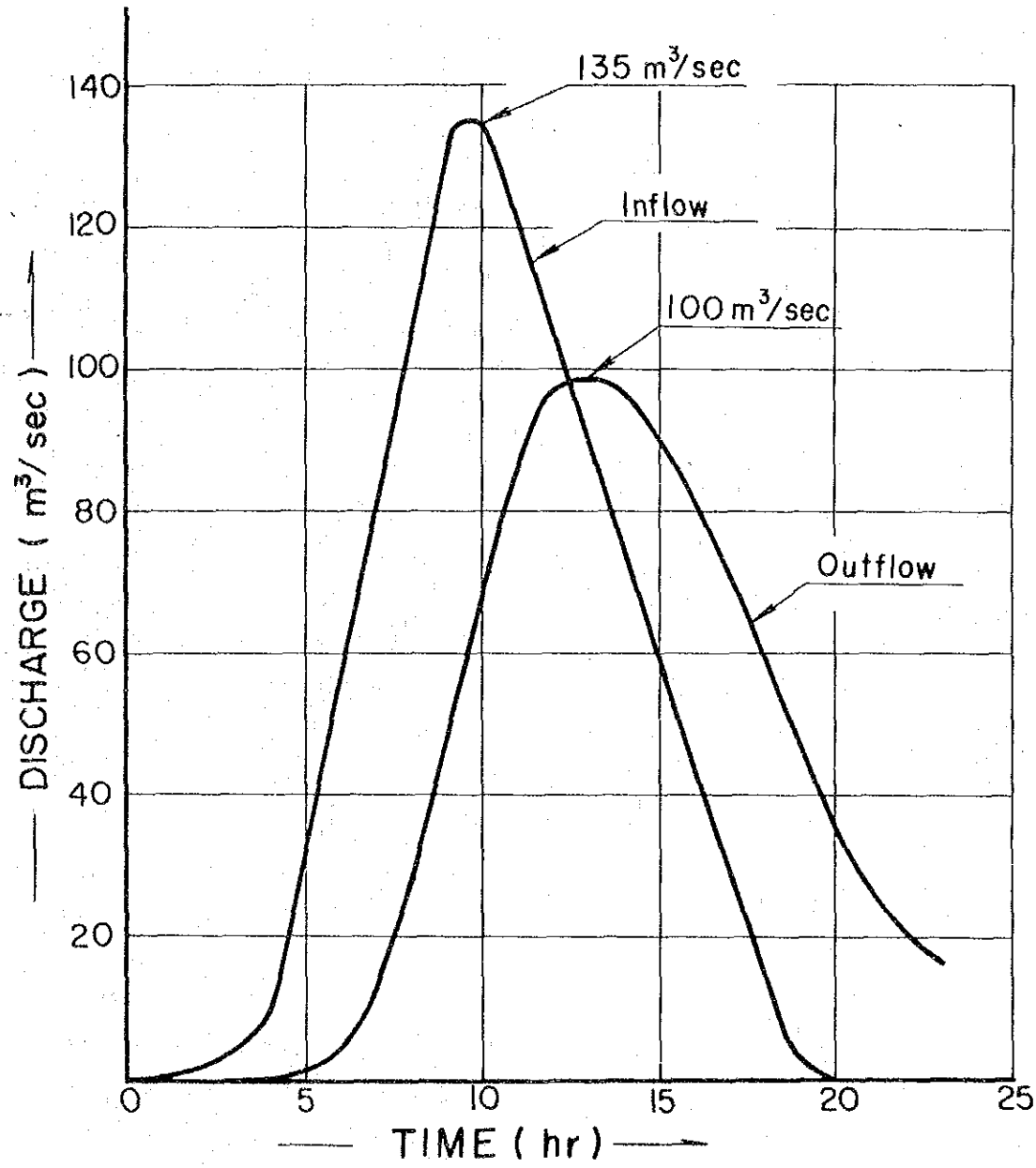
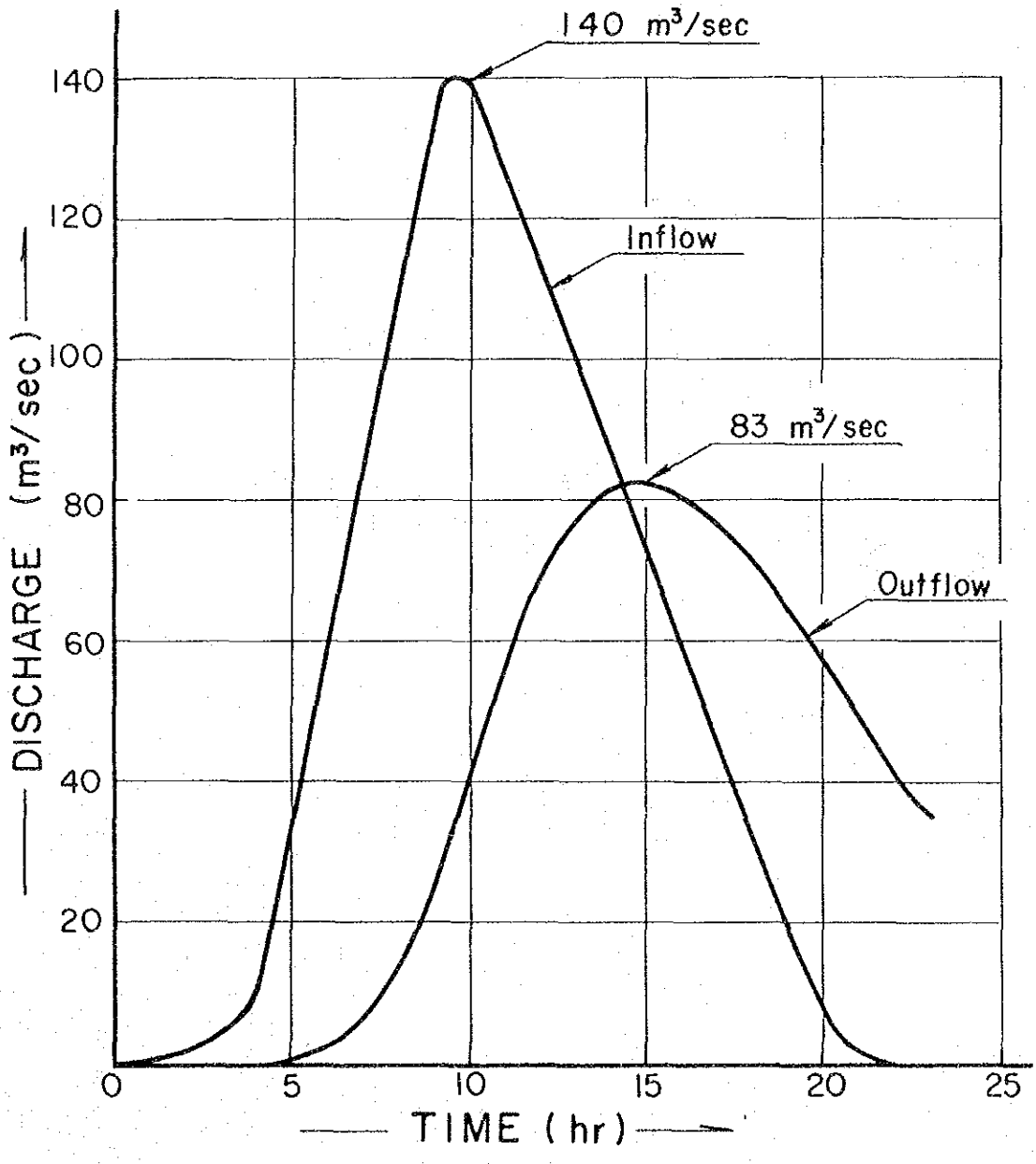


Fig. F-1-24 (3).

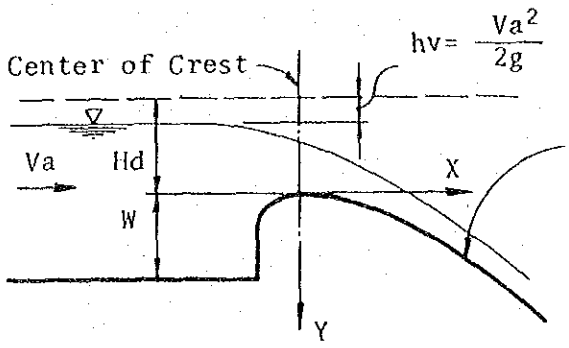
Huai Phlu Reservoir Flood Routing

Crest Length : 30m



(2) Hydraulic Design

The dimensions of weir in complete overflow condition have a close relation with a shape of weir. In case Harrold's standard type as shown in the following figure is adopted the shape of overflow crest can be obtained from the following equations:



For the spillway for Lam Plai Mat Dam and Huai Phlu Dam, hydraulic calculation of water depth and velocity at side channel and chute is carried out by applying the Bernoulli's formula as follows:

$$Z + d + \frac{v^2}{2g} + \frac{n^2 v^2}{R^{\frac{4}{3}}} \cdot l = \text{const.}$$

where, Z : elevation of the channel bottom
d : water depth
v : velocity
g : gravitational acceleration
R : hydraulic radius
n : manning's coefficient
l : distance

Judging from the velocity and Froude number of the running water, intensive hydraulic jump shall occur in the energy dissipator, therefore, the USBR (United States Department of Interior, Bureau of Reclamation) type II in providing chute and end sill in the stilling basin should be adopted. The conjugate depth in

the stilling basin d_2 can be obtained by the following formula:

$$d_2 = 1/2\ d_1\ (\sqrt{1 + 8\ Fr^2} - 1), \quad Fr = V_1/\sqrt{g.d_1}$$

where, d_2 : conjugate depth in the stilling basin
d_1 : water depth at the end of chute
Fr : Froude number
V_1 : velocity at the end of chute
g : gravitational acceleration

The result is shown in Table F-1-7 and Table F-1-8 respectively.

Table F-1-7 (1) *** Hydraulic calculation *** Lam Plai Mat

Ordinary flow channel

Q= 984.000 (M**3/SEC) N=0.015

SECTION	SIGNAX	DELTAL	EL.	WL	D	B	A	V
1	0.0	0.0	250.000	257.276	7.276	16.000	116.416	8.452
2	10.000	10.000	250.000	257.643	7.643	16.000	122.289	8.047
3	20.000	10.000	250.000	257.784	7.784	16.000	124.539	7.901
4	30.000	10.000	250.000	257.893	7.893	16.000	126.289	7.792
5	40.000	10.000	250.000	257.987	7.987	16.000	127.789	7.700
6	50.000	10.000	250.000	258.065	8.065	16.000	129.039	7.626
7	60.000	10.000	250.000	258.139	8.139	16.000	130.227	7.556
8	70.000	10.000	250.000	258.209	8.209	16.000	131.352	7.491
9	80.000	10.000	250.000	258.272	8.272	16.000	132.352	7.435
10	90.000	10.000	250.000	258.331	8.331	16.000	133.289	7.382
11	100.000	10.000	250.000	258.385	8.385	16.000	134.164	7.334
12	110.000	10.000	250.000	258.440	8.440	16.000	135.039	7.287
13	120.000	10.000	250.000	258.491	8.491	16.000	135.852	7.243
14	130.000	10.000	250.000	258.538	8.538	16.000	136.602	7.203
15	140.000	10.000	250.000	258.584	8.584	16.000	137.352	7.164
16	150.000	10.000	250.000	258.627	8.627	16.000	138.039	7.128
17	160.000	10.000	250.000	258.670	8.670	16.000	138.726	7.093
18	164.354	4.354	250.000	258.686	8.686	16.000	138.976	7.080

FROUDE-NUMBER= 0.438

Table F-1-7 (2). ********** *** Hydraulic calculation *** ********** Lam Plai Mat

Side channel

Q= 984.000 (M**3/SEC) Slope 1/16.000

SIGMAX	FL	WL	DELTAY	D	B	A	Q	V
50.000	250.000	260.720		10.721	16.000	251.983	984.000	3.905
40.000	250.625	261.189	0.469	10.564	14.000	226.020	787.200	3.483
30.000	251.250	261.668	0.479	10.418	12.000	200.982	590.400	2.938
20.000	251.875	262.127	0.459	10.252	10.000	176.085	393.600	2.235
10.000	252.500	262.508	0.381	10.008	8.000	150.166	196.800	1.311
0.0	253.125	262.683	0.176	9.558	6.000	121.303	0.0	0.0

Table F-1-7 (3-1). *** Hydraulic calculation *** Lam Plai Mat

Chute

Q= 984.000 (M**3/SEC) N=0.015

	SIGMAX	DELTAL	EL	D	B	P	A	R	V
STA.2+14.353	0.0		250.000	7.276	16.000	30.552	116.415	3.810	8.453
STA.2+14.353	0.000	0.000	250.000	7.020	16.000	30.041	112.328	3.739	8.760
STA.2+24.353	10.000	10.020	249.375	6.816	16.000	27.631	93.049	3.368	10.575
STA.2+34.353	20.000	10.020	248.750	6.351	16.000	26.701	85.611	3.206	11.494
STA.2+44.353	30.000	10.020	248.125	6.035	16.000	26.070	80.562	3.090	12.214
STA.2+54.353	40.000	10.020	247.500	4.793	16.000	25.587	76.695	2.997	12.830
STA.2+64.353	50.000	10.020	246.875	4.598	16.000	25.197	73.574	2.920	13.374
STA.2+74.353	60.000	10.020	246.250	4.435	16.000	24.870	70.958	2.853	13.867
STA.2+84.353	70.000	10.020	245.625	4.294	16.000	24.589	68.711	2.794	14.321
STA.2+94.353	80.000	10.020	245.000	4.172	16.000	24.344	66.752	2.742	14.741
STA.3+ 4.353	90.000	10.020	244.375	4.063	16.000	24.127	65.013	2.695	15.135
STA.3+14.353	100.000	10.020	243.750	3.966	16.000	23.933	63.461	2.652	15.506
STA.3+24.353	110.000	10.020	243.125	3.879	16.000	23.758	62.063	2.612	15.855
STA.3+34.353	120.000	10.020	242.500	3.800	16.000	23.599	60.793	2.576	16.186
STA.3+44.353	130.000	10.020	241.875	3.727	16.000	23.454	59.631	2.542	16.501
STA.3+54.353	140.000	10.020	241.250	3.660	16.000	23.320	58.564	2.511	16.802
STA.3+64.353	150.000	10.020	240.625	3.599	16.000	23.197	57.580	2.482	17.089
STA.3+74.353	160.000	10.020	240.000	3.542	16.000	23.084	56.669	2.455	17.364
STA.3+84.353	170.000	10.020	239.375	3.489	16.000	22.978	55.827	2.430	17.626

Table F-1-7 (3-2).

	SIGMAX	DELTAL	EL	D	B	P	A	R	V
STA.3+94.353	180.000	10.020	238.750	3.440	16.000	22.881	55.046	2.406	17.676
STA.4+ 4.353	190.000	10.020	238.125	3.395	16.000	22.789	54.315	2.383	18.116
STA.4+14.353	200.000	10.020	237.500	3.352	16.000	22.703	53.628	2.362	18.349
STA.4+24.353	210.000	10.020	236.875	3.311	16.000	22.623	52.982	2.342	18.572
STA.4+34.353	220.000	10.020	236.250	3.273	16.000	22.547	52.376	2.323	18.787
STA.4+44.353	230.000	10.020	235.625	3.238	16.000	22.476	51.808	2.305	18.993
STA.4+54.353	240.000	10.020	235.000	3.205	16.000	22.409	51.272	2.288	19.192
STA.4+64.353	250.000	10.020	234.375	3.173	16.000	22.346	50.767	2.272	19.383
STA.4+74.353	260.000	10.020	233.750	3.143	16.000	22.286	50.285	2.256	19.568
STA.4+84.353	270.000	10.020	233.125	3.115	16.000	22.229	49.832	2.242	19.746
STA.4+94.353	280.000	10.020	232.500	3.088	16.000	22.175	49.402	2.228	19.918
STA.5+ 4.353	290.000	10.020	231.875	3.062	16.000	22.124	48.993	2.214	20.084
STA.5+14.353	300.000	10.020	231.250	3.038	16.000	22.076	48.606	2.202	20.245
STA.5+24.353	310.000	10.020	230.625	3.015	16.000	22.029	48.236	2.190	20.400
STA.5+34.353	320.000	10.020	230.000	2.993	16.000	21.985	47.884	2.178	20.550
STA.5+44.353	330.000	10.020	229.375	2.972	16.000	21.944	47.549	2.167	20.694
STA.5+54.353	340.000	10.020	228.750	2.952	16.000	21.904	47.231	2.156	20.834
STA.5+64.353	350.000	10.020	228.125	2.933	16.000	21.866	46.926	2.146	20.969
STA.5+74.353	360.000	10.020	227.500	2.915	16.000	21.829	46.635	2.136	21.100
STA.5+84.353	370.000	10.020	226.875	2.897	16.000	21.795	46.357	2.127	21.227
STA.5+94.353	380.000	10.020	226.250	2.881	16.000	21.761	46.092	2.118	21.349
STA.6+ 4.353	390.000	10.020	225.625	2.865	16.000	21.730	45.837	2.109	21.467
STA.6+14.353	400.000	10.019	225.000	2.849	16.000	21.699	45.592	2.101	21.583

Table F-1-7 (4).

*** Stilling basin *** Lam Plai Mat

EL.	D1	V1	FROUDE NUMBER	D2	FB	Wall hight
225.000	2.849	21.583	4.084	15.095	3.668	18.763

Sub dam

EL.	H	FL.
225.000	5.021	230.021

Table F-1-8 (1).

****
*** Hydraulic calculation ***
****

Huai Phlu

Ordinary flow channel

Q= 83.000 (M**3/SEC)

N= 0.015

SECTION	SIGMAX	DELTAL	EL	WL	D	B	A	V
1	0.0	0.0	239.000	241.691	2.691	6.000	16.146	5.141
2	10.000	10.000	239.000	241.949	2.949	6.000	17.693	4.691
3	20.000	10.000	239.000	242.050	3.050	6.000	18.302	4.535
4	30.000	10.000	239.000	242.128	3.128	6.000	18.771	4.422
5	40.000	10.000	239.000	242.191	3.191	6.000	19.146	4.335
6	50.000	10.000	239.000	242.246	3.246	6.000	19.474	4.262
7	60.000	10.000	239.000	242.296	3.296	6.000	19.779	4.196
8	70.000	10.000	239.000	242.343	3.343	6.000	20.060	4.138
9	80.000	10.000	239.000	242.386	3.386	6.000	20.318	4.085
10	90.000	10.000	239.000	242.425	3.425	6.000	20.552	4.038
11	100.000	10.000	239.000	242.462	3.462	6.000	20.775	3.995
12	106.370	6.370	239.000	242.486	3.486	6.000	20.915	3.968

FROUDE-NUMBER= 0.497

Table F-1-8 (1)

Table F-1-8 (2).

****
*** Hydraulic calculation ***
****

Huai Phlu

Side channel

Q= 83.000 (M**3/SEC)

Slope 1/15.000

SIGMAX	EL	WL	DELTAY	D	B	A	Q	V
30.000	239.000	242.957		3.957	6.000	29.225	83.000	2.840
20.000	239.667	243.358	0.400	3.691	5.000	23.224	55.333	2.383
10.000	240.333	243.787	0.430	3.454	4.000	17.992	27.667	1.538
0.0	241.000	244.030	0.242	3.030	3.000	12.301	0.0	0.0

Table F-1-8 (3)

****
*** Hydraulic calculation ***
****

Huai Phlu

Chute

Q= 83.000 (M**3/SEC)

N=0.015

	SIGMAX	DELTAL	EL	D	B	P	A	R	V
STA.1+36.370	0.0		239.000	2.691	6.000	11.382	16.146	1.419	5.140
STA.1+36.370	0.0	0.0	239.000	2.544	6.000	11.089	15.267	1.377	5.437
STA.1+41.370	5.000	5.025	238.500	1.950	6.000	9.901	11.703	1.182	7.092
STA.1+51.370	15.000	10.050	237.500	1.606	6.000	9.211	9.633	1.046	8.616
STA.1+61.370	25.000	10.050	236.500	1.430	6.000	8.861	8.582	0.969	9.672
STA.1+71.370	35.000	10.050	235.500	1.316	6.000	8.632	7.895	0.915	10.513
STA.1+81.370	45.000	10.050	234.500	1.234	6.000	8.468	7.405	0.874	11.208
STA.1+91.370	55.000	10.050	233.500	1.172	6.000	8.345	7.034	0.843	11.800
STA.2+ 1.370	65.000	10.050	232.500	1.124	6.000	8.248	6.743	0.818	12.309
STA.2+11.370	75.000	10.050	231.500	1.085	6.000	8.169	6.508	0.797	12.753
STA.2+21.370	85.000	10.050	230.500	1.053	6.000	8.105	6.316	0.779	13.141
STA.2+31.370	95.000	10.050	229.500	1.026	6.000	8.052	6.157	0.765	13.480
STA.2+41.370	105.000	10.050	228.500	1.004	6.000	8.008	6.024	0.752	13.778
STA.2+51.370	115.000	10.050	227.500	0.985	6.000	7.970	5.911	0.742	14.041
STA.2+61.370	125.000	10.050	226.500	0.969	6.000	7.938	5.815	0.733	14.273
STA.2+71.370	135.000	10.050	225.500	0.955	6.000	7.911	5.732	0.725	14.479
STA.2+81.370	145.000	10.050	224.500	0.944	6.000	7.887	5.662	0.718	14.660
STA.2+86.370	150.000	5.025	224.000	0.938	6.000	7.877	5.630	0.715	14.741

Table F-1-8 (4).

Huai Phlu

*** Stilling basin ***

EL.	D1	V1	FROUDE NUMBER	D2	FB	Wall hight
224.000	0.938	14.741	4.861	5.999	2.074	8.073

Sub dam

EL.	H	EL.
224.000	2.231	226.231

F.1.5. Intake Facilities

The top of the drop inlet is designed at the elevation corresponding to the capacity of 100-year sediment. However, sediment does not take place horizontally. And, moreover, dead storage capacity can be utilized as effective storage in the several ten years after the completion of the dam if proper facilities are installed. The relation between water stage and dead storage capacity is illustrated in Figure F-1-25. Effective storage capacity will be increased by locating intake facilities as low as possible in the elevation under the condition of preventing them from being buried by sediment.

Judging from the figure, the intake facilities should be provided at the elevation corresponding to the capacity of 40-year sediment. Below this elevation, sedimentation would be accelerated around the intake facilities whereas the storage capacity does not increase very much.

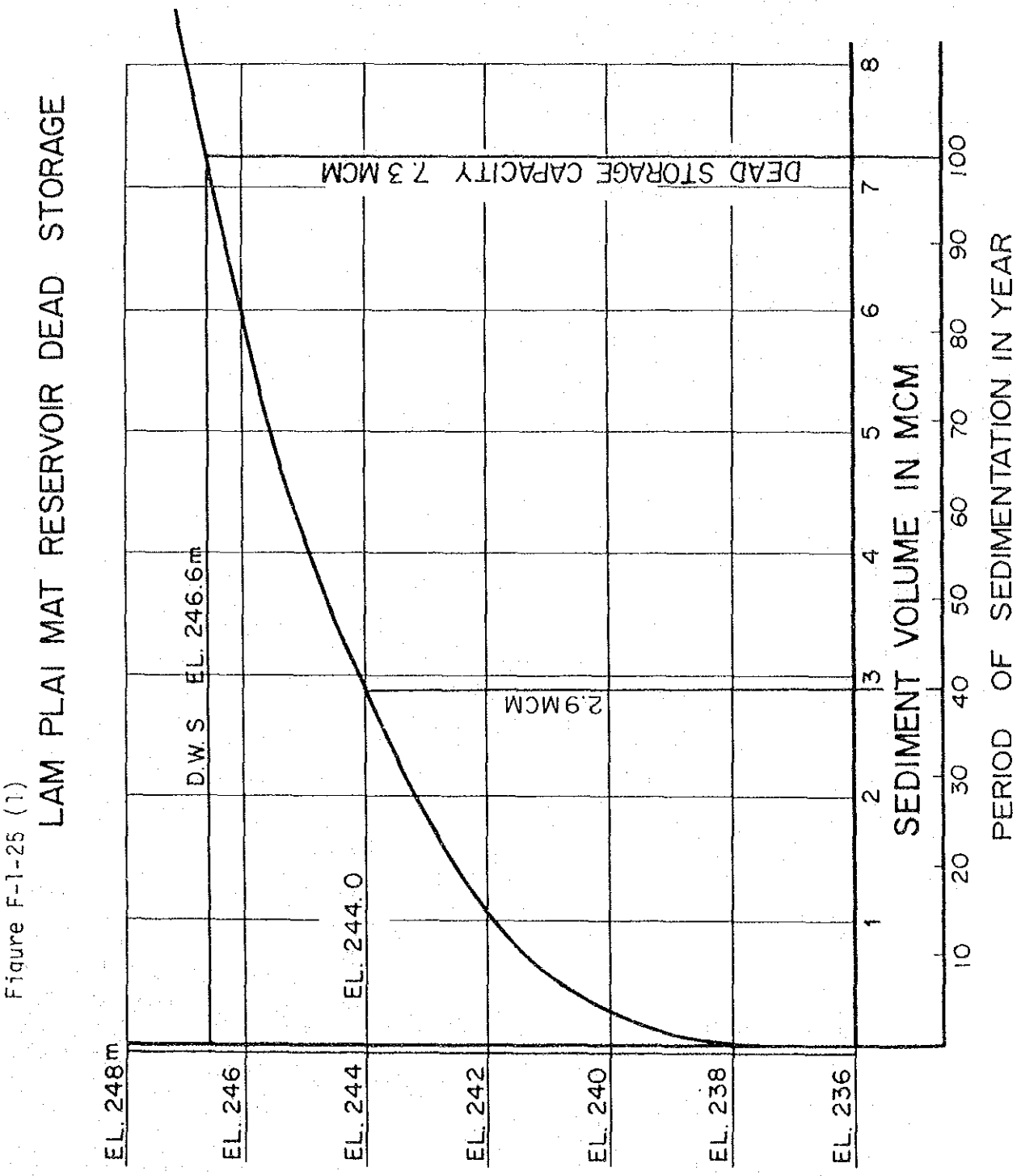
The elevation and capacity of each reservoir is listed below:

		Lam Plai Mat	Nong Lum Puk	Huai Phlu
100-year Sediment	Volume (MCM)	7.3	0.38	0.32
	Elevation (m)	246.6	228.6	233.7
40-year Sediment	Volume (MCM)	2.9	0.15	0.13
	Elevation (m)	244.0	227.3	231.8

The downstream outlet shall be provided with regulating gate, guard gate, and stilling basin. Major dimensions of the intake facilities are as follows:

	Lam Plai Mat	Nong Lum Puk	Huai Phlu	
Elevation of Inlet (m)	246.6	228.6	233.7	233.7
Elevation of Conduit (m)	234.0	224.0	229.5	229.5
Discharge Capacity (m^3/sec)	11.8	0.39	0.53	0.38
Diameter of Conduit (m)	2.0	0.6	0.6	0.6
Regulating Gate (Jet flow) (m)	ϕ 1.3	ϕ 0.25	ϕ0.30	ϕ0.25
Guard Gate (slide) (m)	ϕ 1.3	ϕ 0.25	ϕ0.30	ϕ0.25

Figure F-1-25 (1)



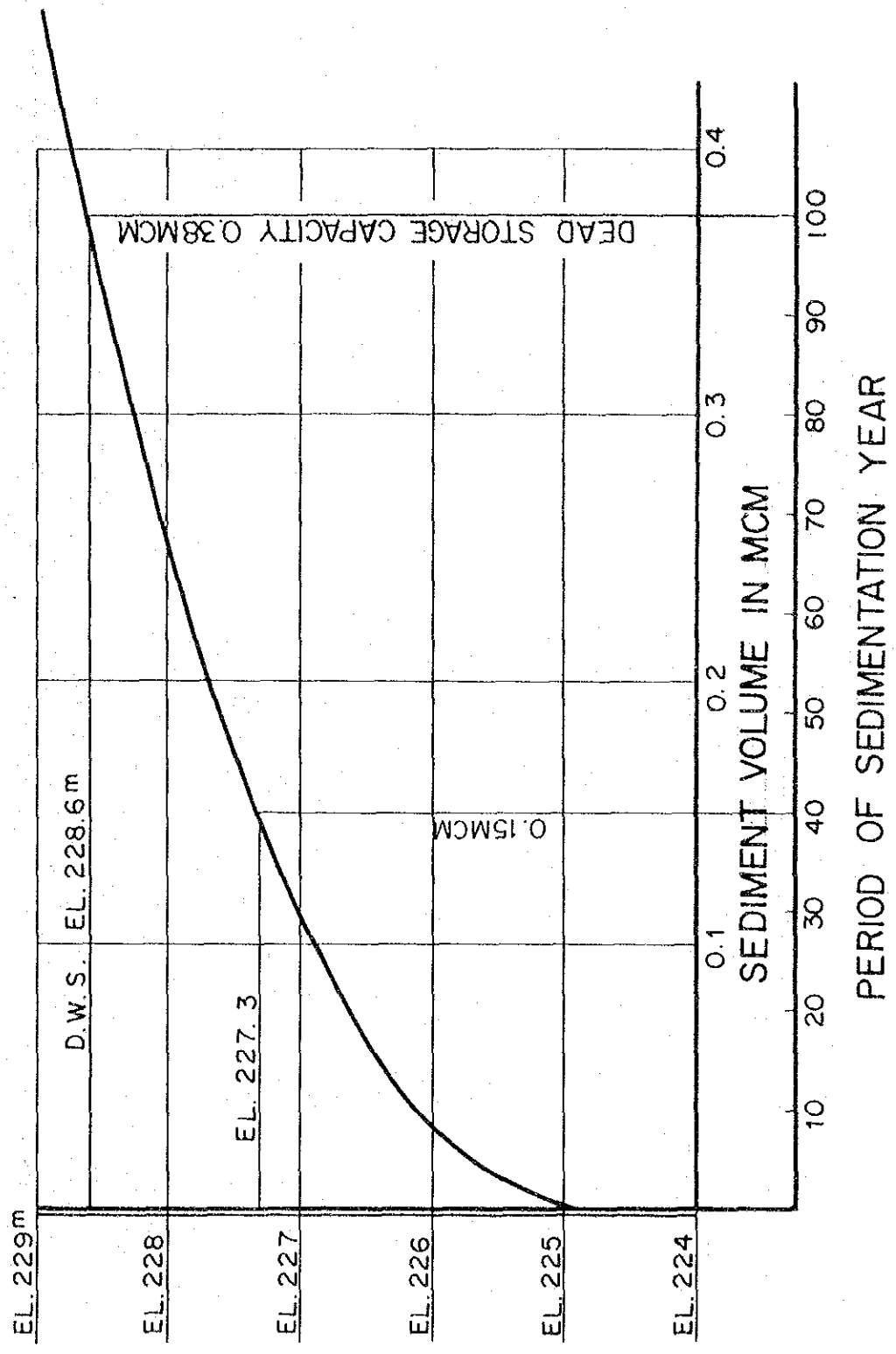
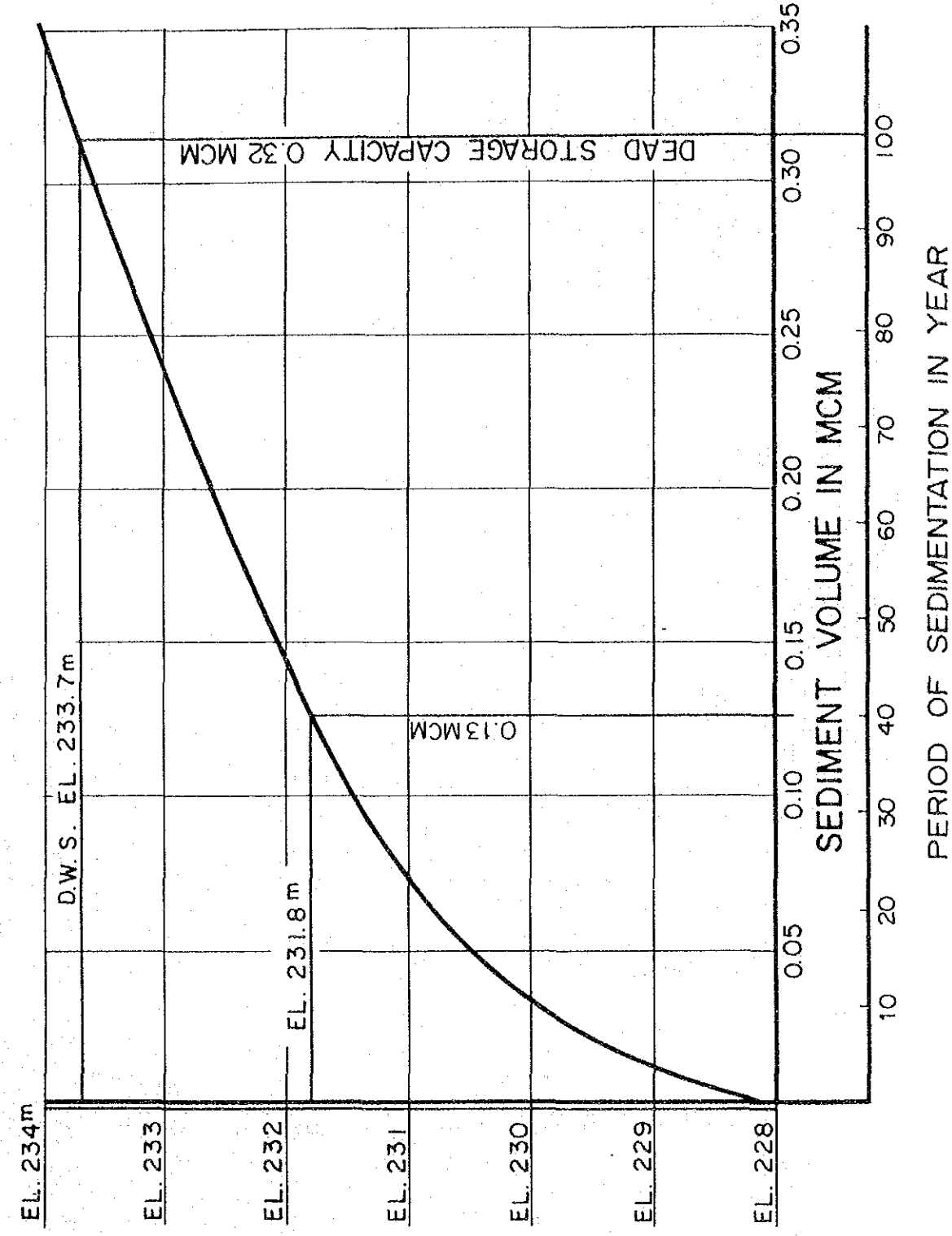


Figure F-1-25 (2)

Figure F-1-25 (3)

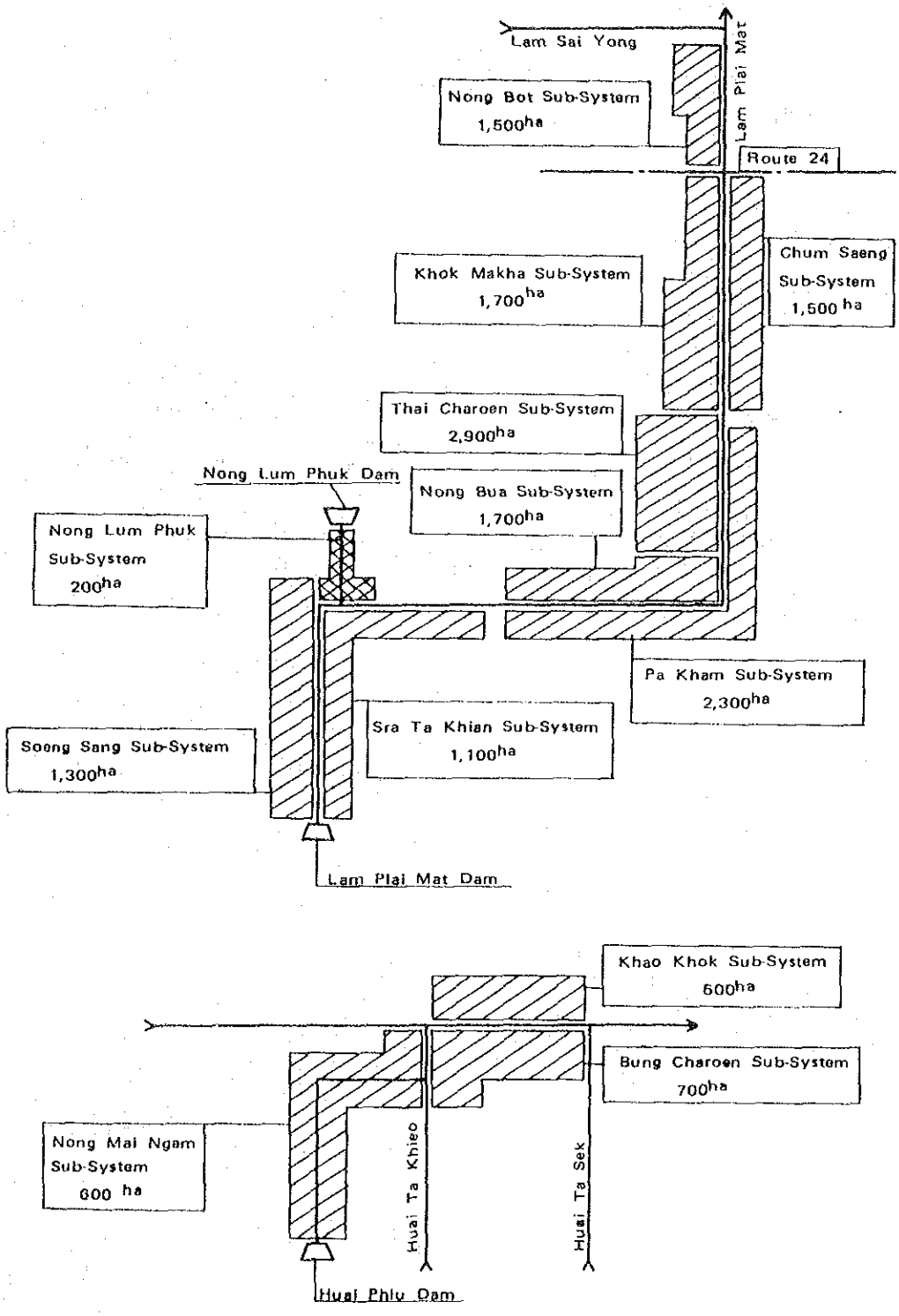
HUAI PHLU RESERVOIR DEAD STORAGE

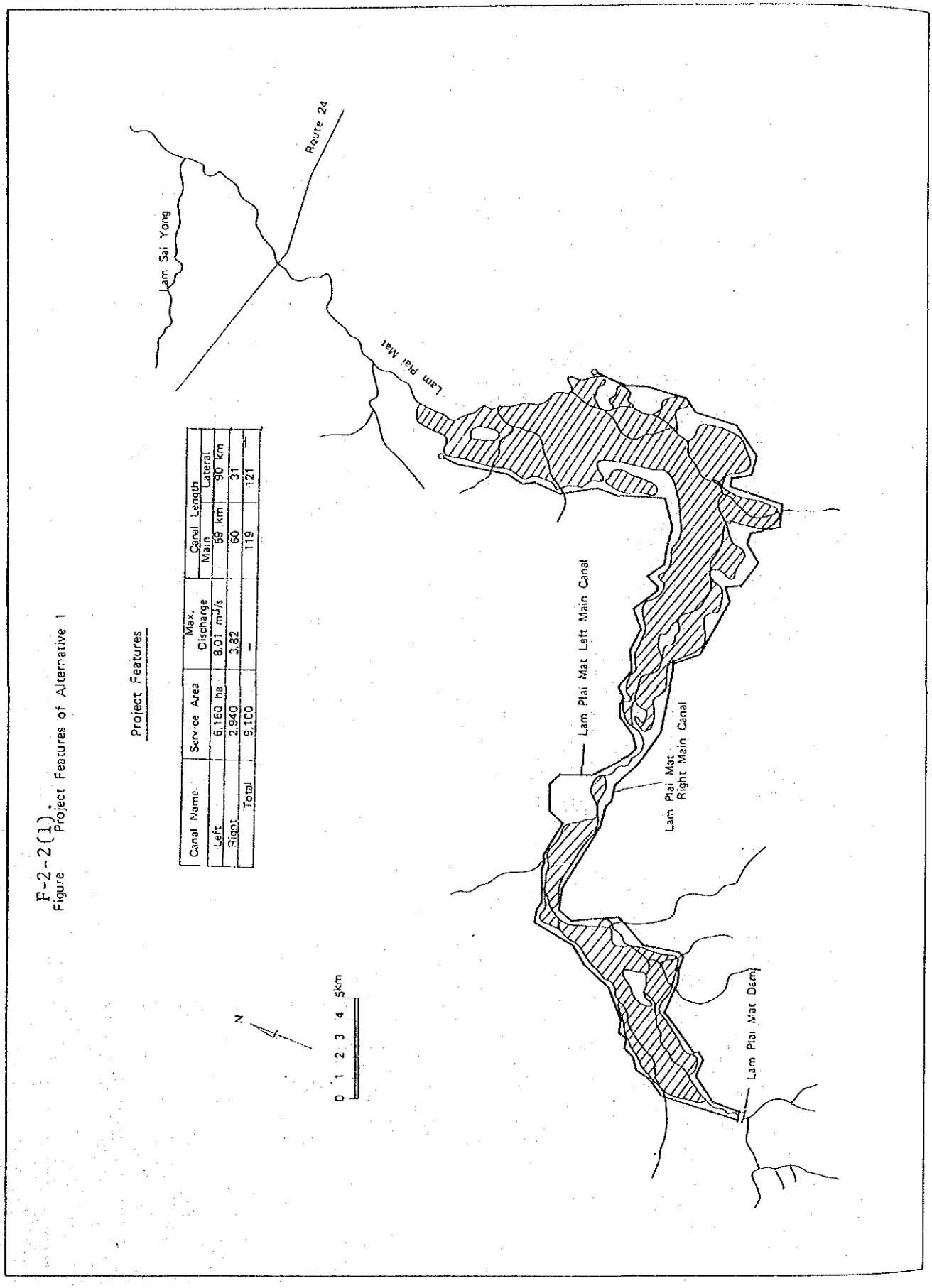


F.2. Canal

F.2.1. Alternative Studies

Figure F-2-1.
Location Maps Showing The Proposed Each Sub-Systems

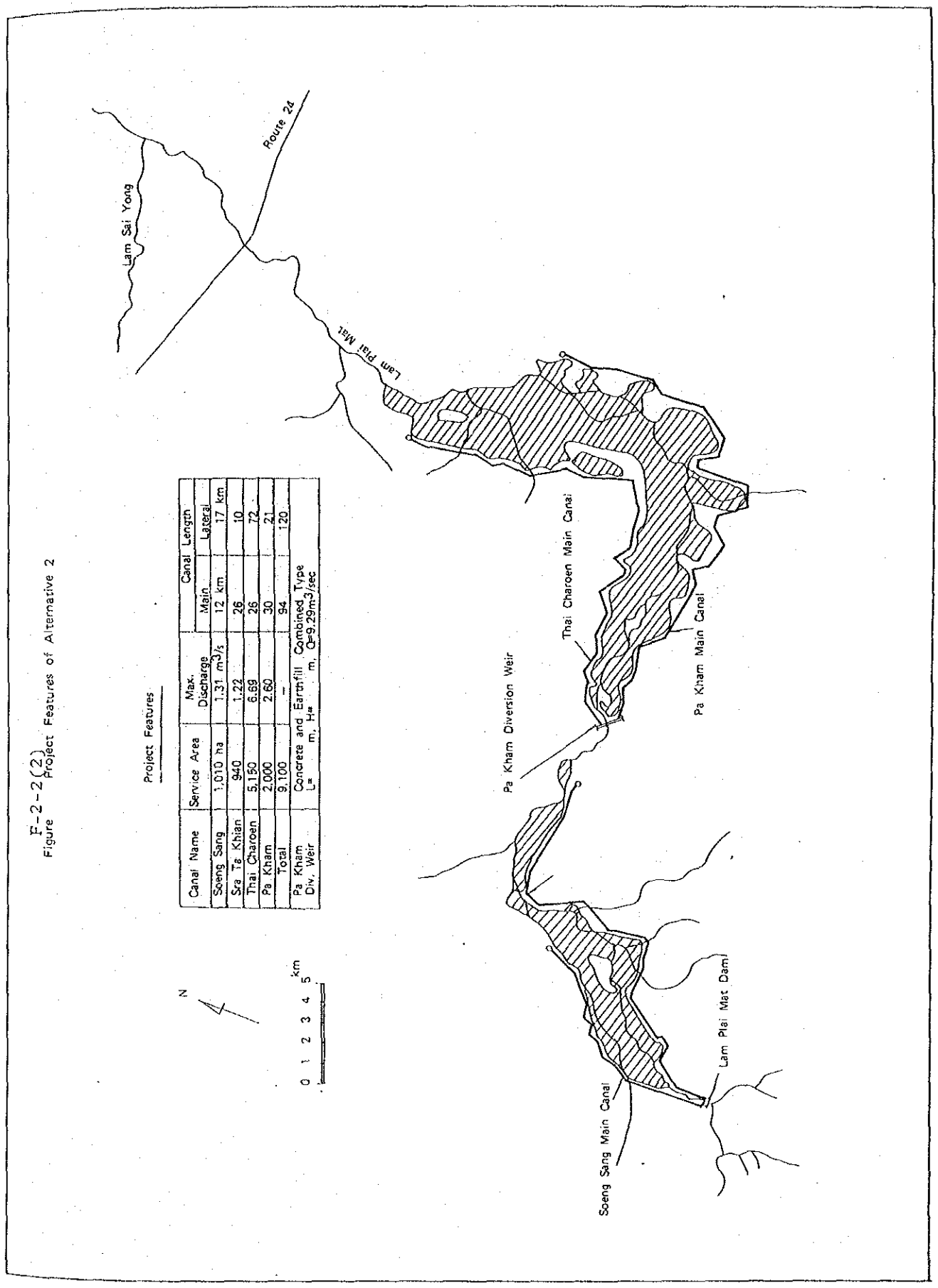




Project Features

Canal Name	Service Area	Max. Discharge	Canal Length Main	Canal Length Lateral
Left	6,160 ha	8.01 m³/s	59 km	90 km
Right	2,940	3.82	60	31
Total	9,100	–	119	121

F-2-2(1)
Figure Project Features of Alternative 1



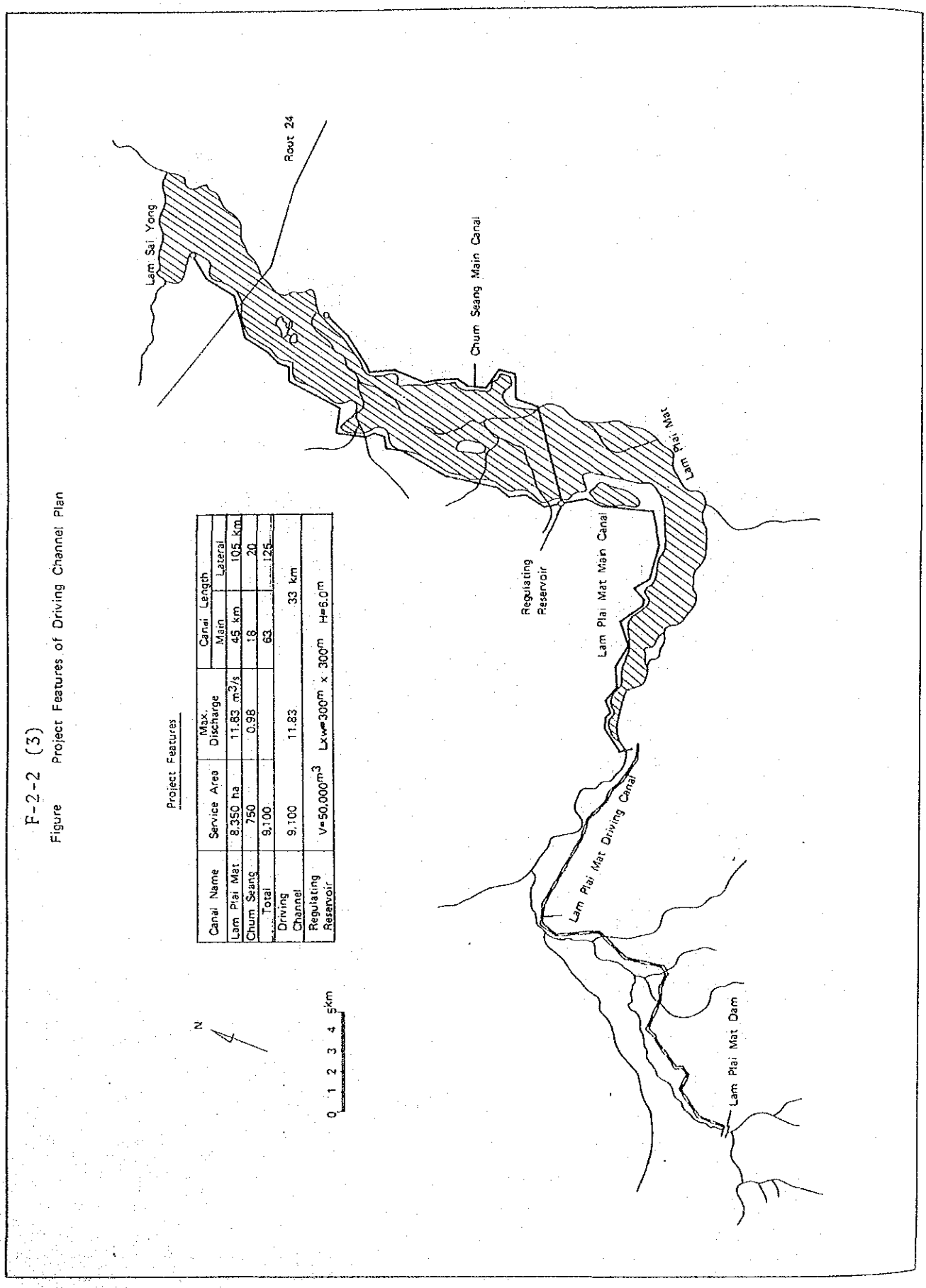
F-2-2(2)
Figure Project Features of Alternative 2

Project Features

Canal Name	Service Area	Max. Discharge	Canal Length	
			Main	Lateral
Soeng Sang	1,010 ha	1.31 m^3/s	12 km	17 km
Sra Te Khian	940	1.22	26	10
Thai Charoen	5,150	6.69	26	72
Pa Kham	2,000	2.60	30	21
Total	9,100	–	94	120
Pa Kham Div. Weir	Concrete and Earthfill Combined Type L= m, H= m, Q=9.29m3/sec			

F-2-2 (3)

Figure Project Features of Driving Channel Plan



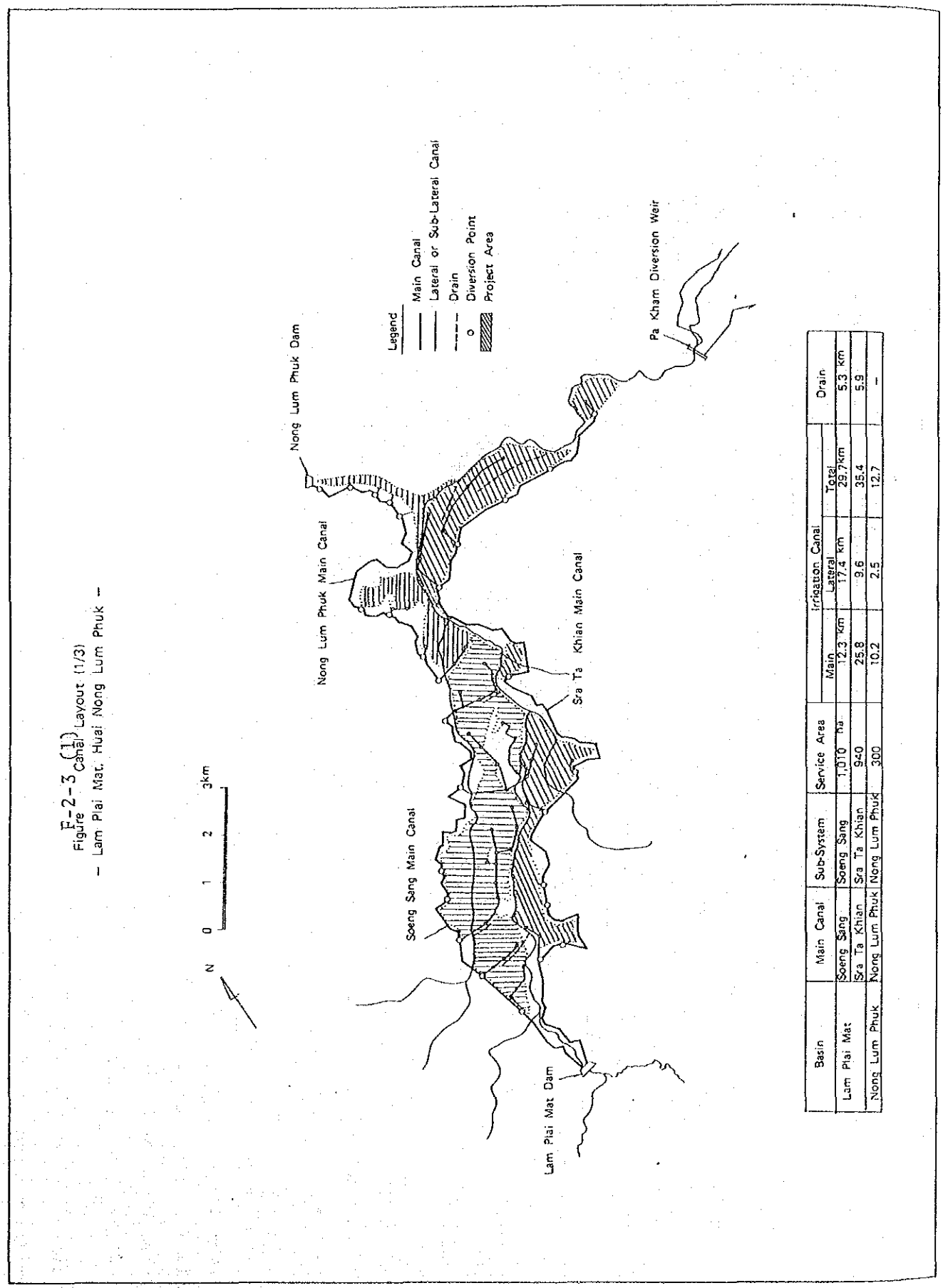
Project Features

Canal Name	Service Area	Max. Discharge	Canal Length	
			Main	Lateral
Lam Plai Mat	8,350 ha	11.83 m³/s	45 km	105 km
Chum Seang	750	0.98	18	20
Total	9,100		63	125
Driving Channel	9,100	11.83	33 km	
Regulating Reservoir	V=50,000m³	Lx=300m x 300m H=6.0m		

Table F-2-1 Comparison of the Construction Cost

Item		Unit Cost	Alternative 1		Alternative 2		Driving Channel Plan	
			Quantities	Cost	Quantities	Cost	Quantities	Cost
		฿		x10^3 ฿				
Canals								
Embankment	m	50	1,395,000	69,750	1,131,000	56,550	1,311,000	65,550
Excavation	m	30	908,000	27,240	736,000	20,080	1,007,000	30,210
Lining concrete	m	2,700	35,000	94,500	28,000	75,600	46,000	124,200
Laterite	m	160	248,000	39,680	201,000	32,160	227,000	36,320
Related structure	L.S.	-	L.S.	69,351	L.S.	55,917	L.S.	51,256
Sub-Total				300,521		242,307		307,536
Div. Weir								
Earth work	m	50	-	-	43,000	2,150		-
Concrete	m	2,500	-	-	10,000	25,000		-
Miscellaneous	L.S.	-	-	-	L.S.	13,575		-
Sub-Total				-		40,725		-
Regulating Reservoir								
Embankment	m	85	-	-	-	-	100,000	8,500
Excavation	m	60	-	-	-	-	303,000	18,180
Miscellaneous	L.S.	-	-	-	-	-	L.S.	5,400
Sub-Total				-		-		32,080
Total				300,521		283,032		339,616

F.2.2. Irrigation Canals



Basin	Main Canal	Sub-System	Service Area	Irrigation Canal			Drain
				Main	Lateral	Total	
Lam Plai Mat	Soeng Sang	Soeng Sang	1,010 ha	12.3 km	17.4 km	29.7km	5.3 km
	Sra Ta Khian	Sra Ta Khian	940	25.8	9.6	35.4	5.9
Nong Lum Phuk	Nong Lum Phuk	Nong Lum Phuk	300	10.2	2.5	12.7	-

F-2-3 (2)
Figure Canal Layout (2/3)
- Lam Plai Mat -

Basin	Main Canal	Sub-System	Service Area	Irrigation Canal			Drain
				Main	Lateral	Total	
Lam Plai Mat	Thai Charoen	Nong Bua	1,740 ha	26.4 km	72.3 km	98.7 km	27.4 km
		Thai Charoen	3,410				
	Pa Kham	Pa Kham	2,000	30.4	20.9	51.3	5.9

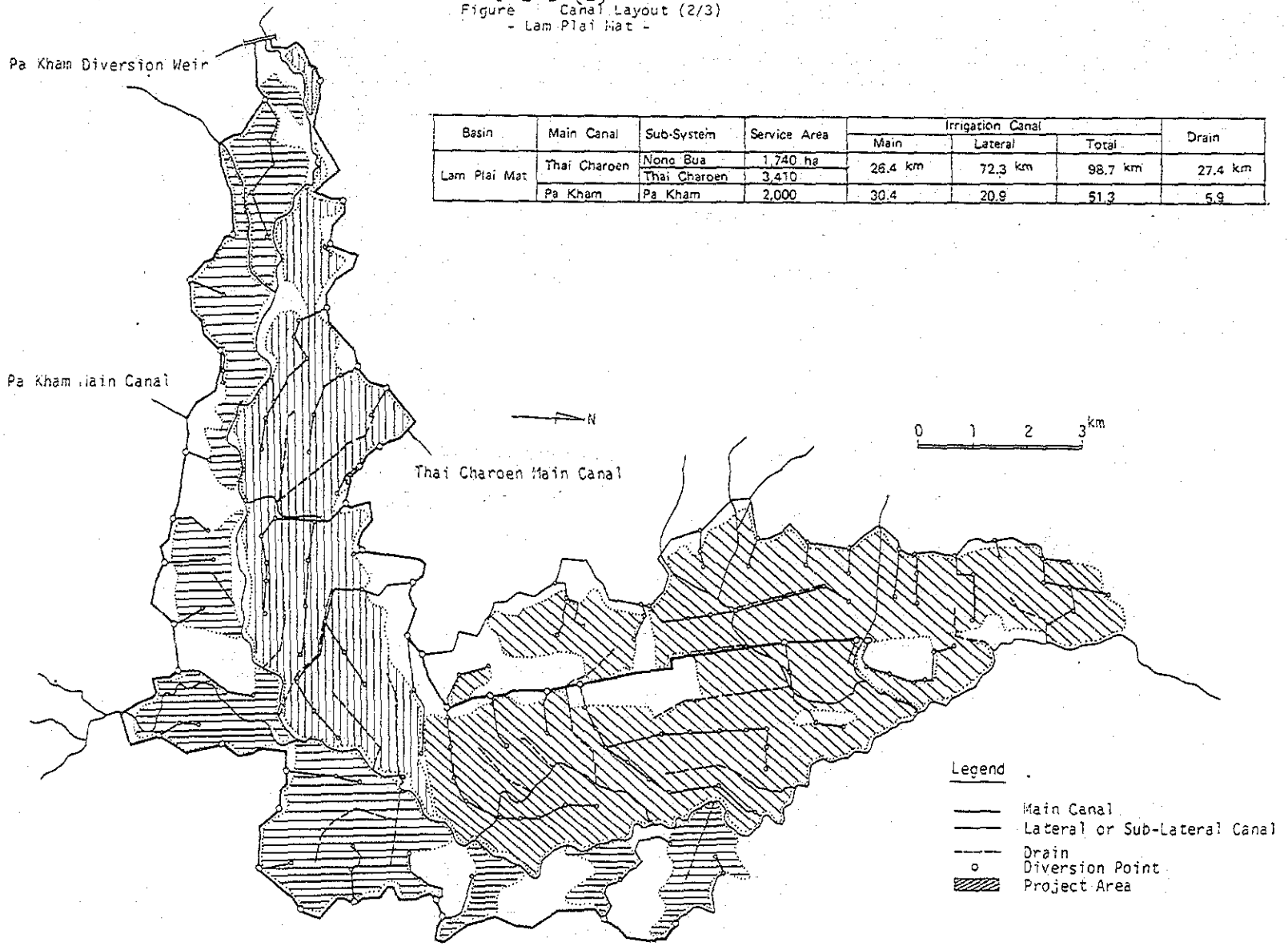
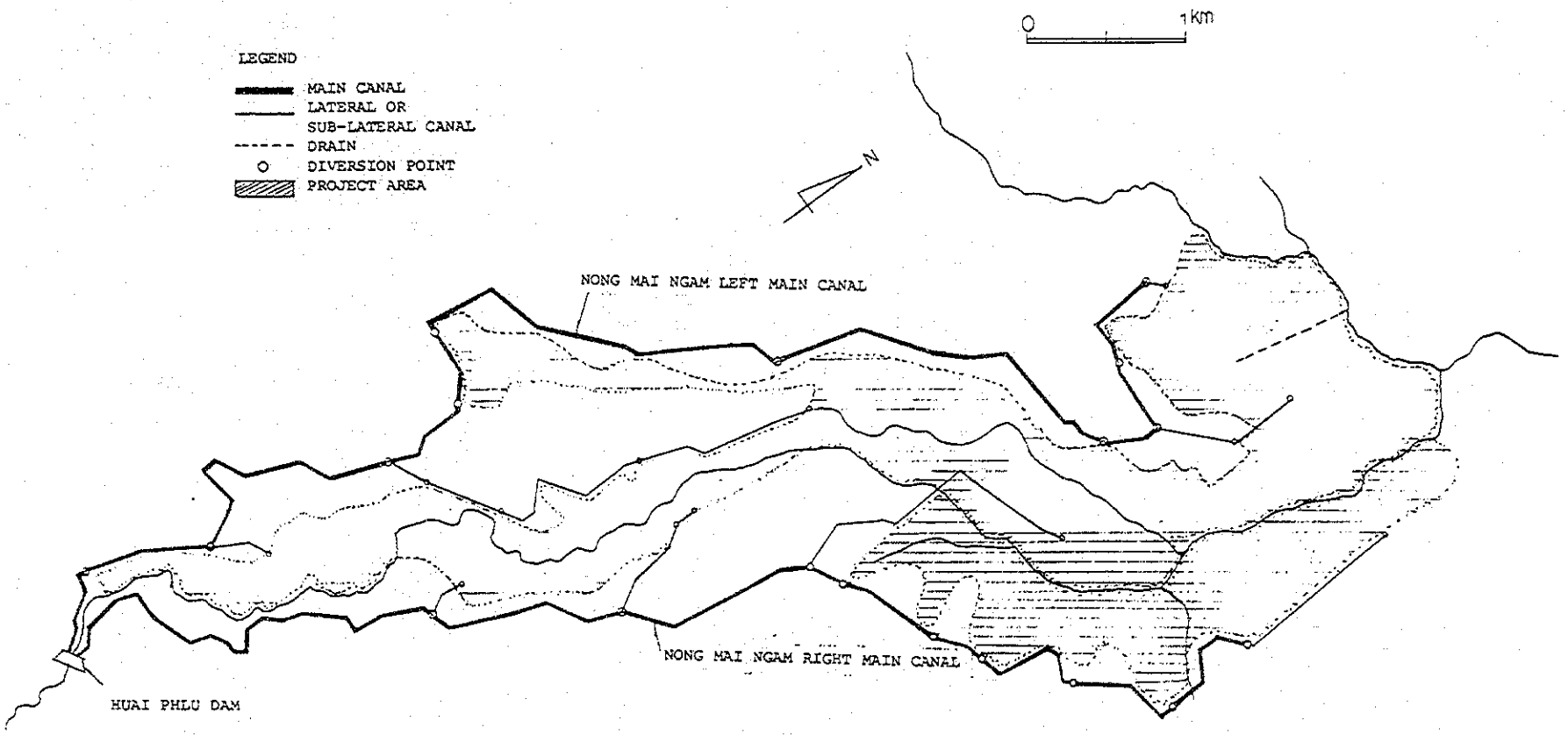


Fig. F-2-3 (2)

Figure F-2-3 (3) CANAL LAYOUT (3/3)

-HUAI PHLU-



BASIN	MAIN CANAL	SUB-SYSTEM	SERVICE AREA	IRRIGATION CANAL			DRAIN
				MAIN	LATERAL	TOTAL	
HUAI PHLU	LEFT	NONG MAI NGAM	700 ha	11.0 km	5.5 km	16.5 km	0.7 km
	RIGHT			8.8	3.3	12.1	-

Table F-2-2 (1)
General Features of Canals (1/2)

Project	P-1				
Name of Main Canal	Sra Ta Khian	Soeng Sang	Pa Kham	Thai Charoen	
Intake Point	Lam Plai Mat Dam	Lam Plai Mat Dam	Pa Kham Diversion Weir	Pa Kham diversion Weir	
Related sub-system	Sra Ta Khian	Soeng Sang	Pa Kham	Nong Bua	Thai Charoen
Service area (Area)	940 ha	1,010 ha	2,000 ha	1,740 ha	3,410 ha
" (Elevation)	233 m∿212 m	236 m∿221 m	208 m∿189 m	208 m ∿ 183 m	
Number of service unit	37 Nos.	39 Nos.	76 Nos.	58 Nos.	126 Nos.
Main Canal					
- Design discharge	1.22 m^3/sec	1.31 m^3/sec	2.60 m^3/sec	6.69 m^3/sec	
- Type of canal	Trapezaidal lined	Trapezaidal lined	Trapezaidal lined	Trapezaidal lined	
- Length	25.8 km	12.3 km	30.4 km	26.4 km	
- Slope	1/2,000	1/3,000	1/4,000	1/5,000	
- Width of O & M road	6.0 m	6.0 m	6.0 m	6.0 m	
Lateral Canal					
- Type of canal	Trapezaidal unlined	Trapezaidal unlined	Trapezaidal unlined	Trapezaidal unlined	
- Total Length	9.6 km	17.4 km	20.9 km	72.3 km	
- Width of O & M road	3.5 m	3.5 m	3.5 m	3.5 m	
Related Structures					
- Head Regulator	9 Nos.	7 Nos.	19 Nos.	32 Nos.	
- Farm Turnout	37	39	76	184	
- Check structure	19	19	29	71	
- Drop Structure	6	5	10	28	
- Syphon	2	5	1	2	
- Spill way	2	5	1	5	
- Crossing Structure	4	4	7	13	
- Cross drain	3	4	7	13	
Drain					
- Total Length	5.9 km	5.3 km	5.9 km	27.4 km	

Table F-2-2 (2) General Features of Canals (2/2)

Project	P-5	C-3		
Name of Main Canal	Nong Lum Phuk	Nong Mai Ngam Left	Nong Mai Ngam Right	Total
Intake Point	Nong Lum Phuk Dam	Huai Phlu Dam		
Related sub-system	Nong Lum Phuk	Nong Mai Ngam		
Service Area (Area)	300 ha	530 ha		
" (Elevation)	225 - 217 m	232 - 196 m	222 - 201 m	
Number of service unit	13 Nos.	19 Nos.	7 Nos	26 Nos.
Main Canal				
- Design discharge	0.39 m^3/sec	0.53 m^3/sec	0.15 m^3/sec	
- Type of canal	Trapezaidal lined, unlined	Trapezaidal lined, unlined		
- Length	10.2 km	11.0 km	8.8 km	19.8 km
- Slope	1/4,000	1/2,000	1/5,000	
- Width O & M road	3.5 m	3.5 m	3.5 m	
Laleral canal				
- Type of canal	Trapezaidal unlined	Trapezaidal unlined		
- Total Length	2.5 km	5.5 km	3.3 km	8.8 km
- Width of O & M road	3.5 m	3.5 m	3.5 m	
Related structures				
- Head Regulator	3 Nos.	4 Nos.	6 Nos.	10 Nos.
- Farm Turnout	13	19	18	37
- Check structure	6	12	9	21
- Drop structure	4	14	11	25
- Syphon	1	2	-	2
- Spill way	1	3	-	3
- Crossing structure	3	4	4	8
- Cross drain	5	5	5	10
Drain				
- Total Length	-	0.7 km		0.7 km

TABLE F-2-3 DEFINITION OF TERMS FOR CANAL SYSTEMS

1. Canals and ditches

Main canal	- Canals which convey water from the intake structure to the headreach of lateral canals
Lateral canal	- Canals which are diverted from the main canal to distribute water to either the sub-lateral canal or main farm ditch.
Sub-lateral canal	- Canals which are diverted from the lateral canal to distribute water to main farm ditch.
Main farm ditch	- Ditches which are diverted from either the lateral canal or sub-lateral canal to distribute water to each service unit.
Farm ditch	- Ditches which are diverted from lateral canal or sub-lateral canal or main farm ditch to each farm plot.

2. Diversion structure

Intake	- As the generic term of main diversion structure.
Head regulater	- Diversion structure with measuring device, which regulates the discharge from intake to main canal, or from either the main canal or lateral canal to lateral canal or sub-lateral canal.
Farm turnout	- Diversion structure with measuring device, which regulates the discharge from either lateral canal or sub-lateral canal to main farm ditch or farm ditch.
Farm inlet	- Diversion structure which regulates the discharge from either main farm ditch or farm ditch to farm plot.

3. Others

Service unit	- Agricultural units, about 25 hectares in size, which is supplied with water through farm turnout.
Farm Plot	- The smallest agricultural unit which forms the service unit.
Drain	- As the generic terms of drainage canals.
O & M road	- Roads which provide along the canals for operation and maintenance.

F.2.3. Pa Kham Diversion Weir

(1) River Water Level during Design Flood

River water levels during design flood before and after weir construction should be calculated in order to examine the backwater effect along upstream after construction.

a) Design conditions:

Design flood discharge: Qf = 1,067 cu.m/sec
Slope of river bed: S = 1/1,600
Coefficient of roughness: I = 0.045

b) River water level before weir construction

A = 1,327.2 (sq.m) where A : water area
P = 765.2 (m) P : wetted perimeter
R = 1,735 (m) R : hydraulic radius
n = 0.045 n : coefficient of roughness
I = 1/1,600 I : river bed slope

hence,

$$V = \frac{1}{0.045} \times 1.735^{2/3} \times (1/1,600)^{1/2} = 0.80 \text{ (m/sec)}$$

$$Q = 1,327.2 \times 0.80 = 1,062 \text{ (cu.m/sec)} = 1,067 \text{ (cu.m/sec)}$$ ok

where V : water velocity
Q : discharge

The river water level durign design flood before weir construction is at 211.7 m MSL.

c) River water level after weir construction (see Fig. F-2-4).

i) Discharge capacity of sluiceway

$A_1 = 20.0 \times 4.5 = 90.0$ (sq.m)

$P_1 = 3.0 + 20.1 + 2.1 = 25.1$ (m)

$R_1 = 90.0 \div 25.1 = 3.586$ (m)

$n_1 = 0.045$

$I_1 = 1/1,600$

$V_1 = \frac{1}{0.045} \times 3.586^{2/3} \times (1/1,600)^{1/2}$

$= 1.30$ (m/sec)

$Q_1 = 90.0 \times 1.30 = 117$ (cu.m/sec)

where,

A: water area

P: wetted perimeter

R: hydraulic radius

I: river bed slope

V: velocity

Q: discharge

n: coefficient of roughness

ii) Discharge capacity of fixed weir

$A_2 = 240.0 \times 2.4 = 576.0$ (sq.m)

$P_2 = 0.9 + 240.0 = 240.9$ (m)

$R_2 = 576.0/240.9 = 2.391$ (m)

$n_2 = 0.045$

$I_2 = 1/1,600$

$V_2 = 1/0.045 \times 2.391^{2/3} \times (1/1,600)^{1/2} = 0.99$ (m/sec)

$Q_2 = 576.0 \times 0.99 = 570$ (cu.m/sec)

iii) Discharge capacity of flood bed

$A_3 = 1/2(365.0 + 371.0) \times 1.5 = 552.0$ (sq.m)

$P_3 = 3.35 \times 2 + 365.0 = 371.7$ (m)

$R_3 = 552.0/371.7 = 1.485$ (m)

$n_3 = 0.045$

$I_3 = 1/1,600$

$V_3 = 1/0.045 \times 1.485^{2/3} \times (1/1,600)^{1/2} = 0.72$ (m/sec)

$Q_3 = 552.0 \times 0.72 = 397$ (cu.m/sec)

$Q_f = Q_1 + Q_2 + Q_3 = 117 + 570 + 397 = 1,084$ (cu.m/sec) $\fallingdotseq 1,067$ (cu.m/sec)

The high water level afte weir construction is at 212.0 m MSL.

(2) Sluiceway

a) Design condition

Discharge of irrigation peirod : Q = 9.29 cu.m/sec

Maximum size of sediment : d = 0.10 m

b) Required velocity for sediment flush

$$V_c = \sqrt{20.d} = \sqrt{20 \times 0.10} = 1.41 \text{ (m/sec)}$$

c) Slope

Critical depth : $h_c = 20d/g = \frac{20 \times 0.1}{9.8} = 0.20(m)$

Critical slope : $I_c = \left(\frac{n.Vc}{h_c^{2/3}}\right)^2 = \left(\frac{0.020 \times 1.41}{0.20^{2/3}}\right)^2$

$$= 0.00680 = 1/147$$

$$\text{Say } I_c = 1/100$$

d) Width

Capacity per one meter: $q = \sqrt{(20/d)^3/g^2} = \sqrt{(20 \times 0.1)^3/9.8^2}$

$$= 0.289 \text{ (cu.m/sec/m)}$$

Width, $B \leqq Q/q = 9.29/0.289$

$$= 32 \text{ (m)}$$

The width of sluiceway is designed at 20 m same as the width of existing water route.

(3) Design of Weir

a) Sluiceway

i) Length of apron $La = 0.9.C.\sqrt{H}$

where,

C: percolation coefficient, 15

H: dam-up height

WL 209.60 - EL 207.0 = 2.60 (m)

$La = 0.9 \times 15 \times \sqrt{2.60} = 21.8\ m < 22.0\ m$ ok

ii) Piping of apron

* By Bligh method

$L = C.H$

where, C: Blight's percolation coefficient, 15

H: dam-up height, 2.60 (m)

$L = 15 \times 2.6 = 39.0$ (m)

Design length

$L_1 = 1.5 + 7.0 \times 2 + 24.0 = 39.5$ (m) $\rangle$ 39.0 (m) ok

* By Lane method

$L = C'.H$

where, C' : weighted-creep ratios, 7.0

H : 2.60 (m)

$L = 7.0 \times 2.6 = 18.2$ (m)

Design length

$L_1 = 1.5 + 7.0 \times 2 + 1/3 \times 24.0 = 23.5$ (m)

> 18.2 (m) ok

iii) Thickness of apron

$$T_i = 4/3 \cdot \frac{H - hf}{\gamma - 1}$$

$$hf = H/L \times L_i$$

where T_i = required thickness of apron at point "i" (m)

H = dam-up height, 2.6 m

Hf = loss-head to point "i" (m)

γ = unit weight of apron concrete, 2.35 t/cu.m

L = design length, 39.5 m

L_i = infiltration length (m)

$$hf = 2.6/39.5 \times (1.5 + 7.0 \times 2 + 2.0) = 1.15 \text{ (m)}$$

$$T_i = 4/3 \cdot \frac{2.6 - 1.15}{2.35 - 1} = 1.43(m) < 1.5 \text{ (m) ok}$$

iv) Length of riprap

$$L_B = 0.67C \sqrt{H.q.f}$$

where, C: 15

H: 2.6 m

q: 117 (cu.m/sec) ÷ 20 (m) = 5.9 (cu.m/sec/m)

f: 1.5

$$L_B = 0.67 \times 15 \times \sqrt{2.6 \times 5.9} \times 1.5 = 59.0 \text{ (m)}$$

$$L_R = L_B - L_a = 59.0 - 22.0 = 37.0 \text{ (m)}$$

say $L_R = 40.0$ (m)

b) Fixed weir

i) Length of apron

$$La = 0.6C\sqrt{H}$$

where, C: 15

H: 2.6 (m)

$$La = 0.6 \times 15 \times \sqrt{2.6} = 14.5 \text{ (m)} < 15.4\text{(m)} \quad \text{ok}$$

ii) Piping of apron

* By Bligh method

$$L = C.H$$

where, C: 15

H: 2.6 (m)

$$L = 15 \times 2.6 = 39.0 \text{ (m)}$$

Design length

$$L_1 = 1.6 + 9.0 \times 2 + 20.0 = 39.6\text{(m)} > 39.0\text{(m)} \quad \text{ok}$$

* By Lane method

$$L = C'.H$$

where C': 7.0

H : 2.6(m)

$$L = 7.0 \times 2.6 = 18.2 \text{ (m)}$$

Design Length

$$L_1 = 1.6 + 9.0 \times 2 + 1/3 \times 20.0 = 26.3\text{(m)} > 18.2\text{(m)} \quad \text{ok}$$

iii) Thickness of apron

$$T_i = 4/3 \cdot \frac{H - hf}{\gamma - 1}$$

$$hf = H/L \times L_i$$

where, T_i : required thickness of apron at point "i" (m)
H : dam-up height, 2.6 m
hf : loss-head to pint "i" (m)
γ : unit weight of apron concrete, 2.35 t/cu.m
L : design length, 39.6 (m)
L_i : infiltration length (m)

$$hf = 2.6/39.6 \times (1.6 + 9.0 \times 2 + 4.6) = 1.59 \text{ (m)}$$

$$T_i = 4/3 \cdot \frac{2.6 - 1.59}{2.35 - 1} = 1.0 \text{ (m)} < 1.1 \text{ (m) ok}$$

iv) Length of riprap

$$L_B = 0.67 \ (\sqrt{H.q} \ .f$$

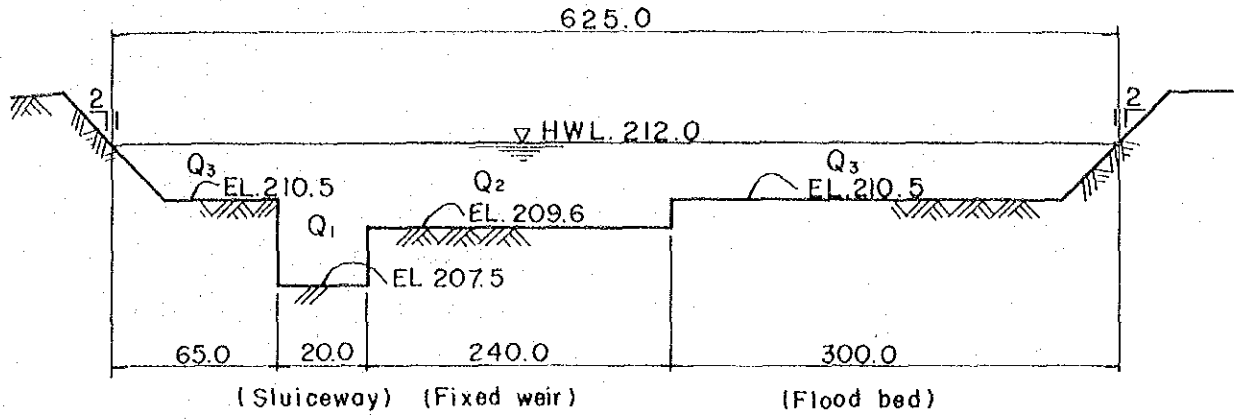
where, C: 15
H: 2.6 (m)
q: 570/240 = 2.4 (cu.m/sec/m)
f: 1.0

$$L_B = 0.67 \times 15 \times \sqrt{2.6 \times 2.4} \times 1.0 = 25.1 \text{ (m)}$$

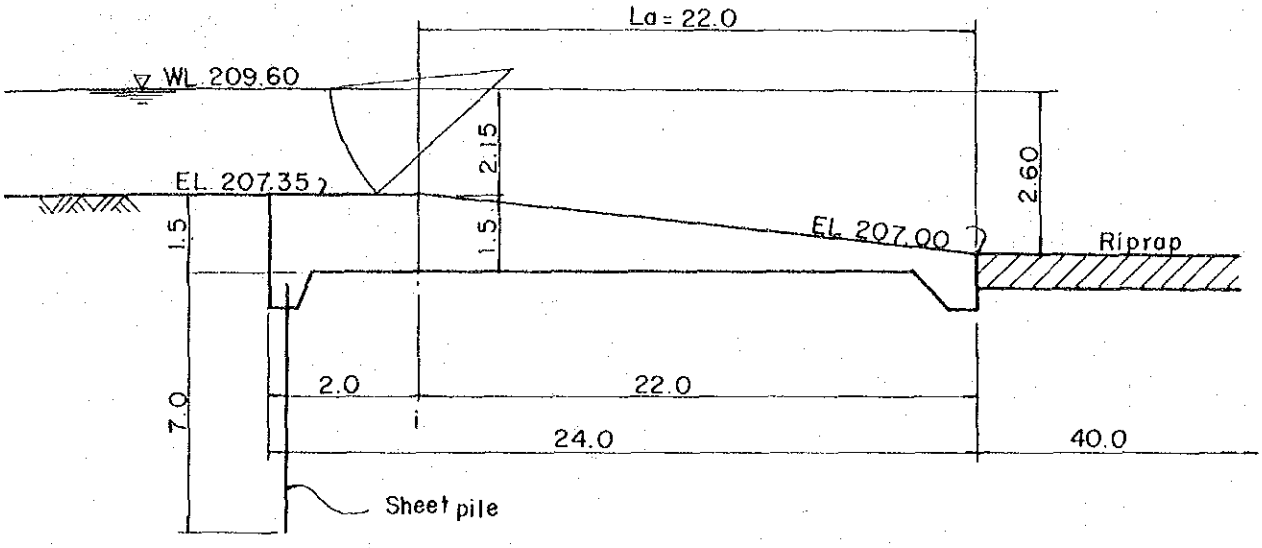
$$L_R = L_B - L_a = 25.1 - 15.4 = 9.7 \text{ (m)}$$

say $L_R = 10$ (m)

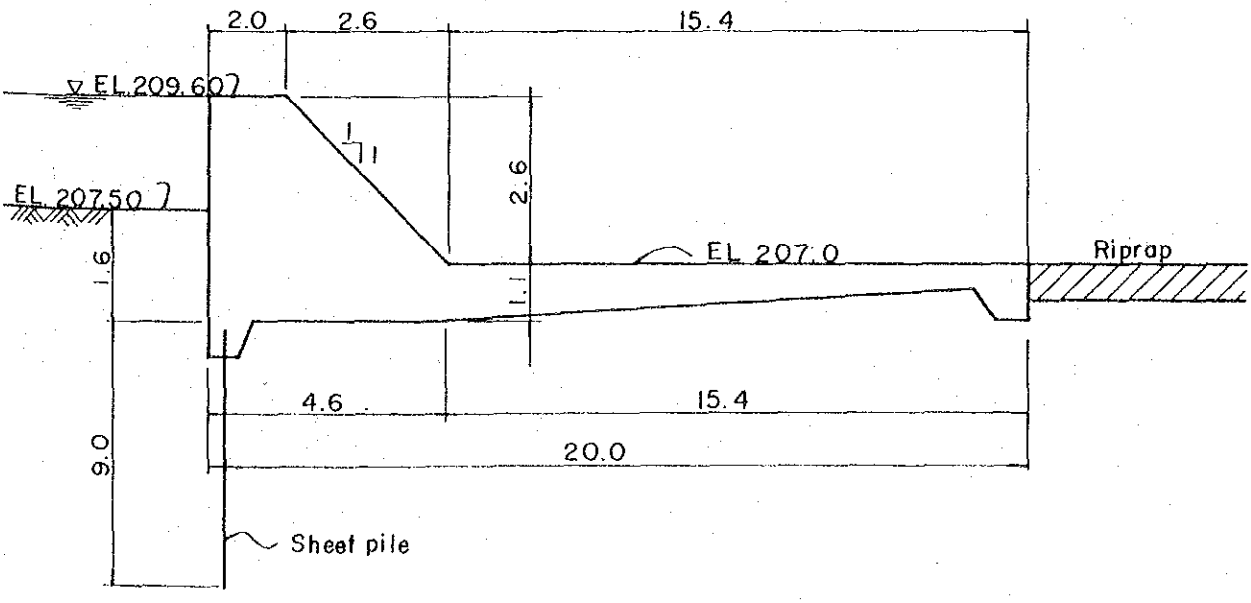
Figure F - 2 - 4 Pa Kham Diversion Weir



PROFILE



SLUICEWAY



FIXED WEIR

F.3. On-Farm Works

F.3.1. Comparison of the Service Unit Size

A comparative study for the size of service unit is carried out in 20 ha, 30 ha and 50 ha, respectively. Alignment of the facilities for each size are shown in Fig. F-3-1. Canal length and number of structures in each size are tabulated as follows:

Size of Service Unit (ha)	Total Area (ha)	Canal Length (m)				No. of Structure	
		Lateral	Farm Ditch	Farm Ditch (m/ha)	Drain	Farm Turnout	Farm Inlet
50	50	-	1,880	38	2,480	-	8
30	60	630	2,040	34	3,480	2	10
20	60	800	1,760	29	3,560	3	10

In order to obtain the construction quantity, construction cost and cost allotment, the following criteria is adopted:

- A water depth on the highest spot of a field of 0.20 m.
- Losses of 0.10 m in farm inlets.
- Losses of 0.20 m in farm turnouts.
- Both of irrigation canals and drains are unlined canal.
- Operation and maintenance road provides along the lateral or sub-lateral canals.
- Slopes of 20-50 cm/km in farm ditches within the service unit.

Based on Fig. F-3-1, major quantities and construction cost are as follows:

1) Construction by the farmers

Size of service unit in 50ha

Unit Price			Excavation 1,910m³	Embankment 4,679m³	Laterite - m³	Concrete 6.59m³	Total
Labour	Excavation	7 ฿	13,370				13,370
	Embankment	7		32,753			32,753
	Laterite	3			-		-
	Concrete	269				1,772	1,772
Sub-total							47,895 ฿
Material & Machinery	Excavation	17	32,470				32,470
	Embankment	29		135,691			135,691
	Laterite	120			-		-
	Concrete	2,568				1,6923	16,923
Sub-total							185,084 ฿
Total							232,979 ฿

Size of service unit in 30ha

Unit Price			Excavation 2,680m³	Embankment 5,078m³	Laterite - m³	Concrete 8.24m³	Total
Labour	Excavation	7	18,760				18,760
	Embankment	7		35,546			35,546
	Laterite	3			-		-
	Concrete	269				2,217	2,217
Sub-total							56,523 ฿
Material & Machinery	Excavation	17	45,560				45,560
	Embankment	29		147,262			147,262
	Laterite	120			-		-
	Concrete	2,568				21,160	21,160
Sub-total							213,982 ฿
Total							270,505 ฿

Size of service unit in 20ha

Unit Price			Excavation 2,741m^3	Embankment 4,380m^3	Laterite -	Concrete 8.24m^3	Total
Labour	Excavation	7 ฿	19,187				19,187 ฿
	Embankment	7		30,660			30,660
	Laterite	3			-		-
	Concrete	269				2,217	2,217
Sub-total							52,064 ฿
Material & Machinery	Excavation	17	46,597				46,597
	Embankment	29		127,020			127,020
	Laterite	120			-		-
	Concrete	2,568				21,160	21,160
Sub-total							194,777 ฿
Total							246,841 ฿

ii) Construction by the R.I.D.

Size of Service Unit	Item	Quantity	Excavation 24 ฿/m^3	Embankment 36 ฿/m^3	Laterite 123 ฿/m^3	Concrete 2,837 ฿/m^3	Total
ha							
50	Excavation	-					-
	Embankment	-					-
	Laterite	-					-
	Concrete	-					-
	Total						
30	Excavation	450	10,800				10,800
	Embankment	4,053		145,908			145,908
	Laterite	591			72,693		72,693
	Concrete	2.7				7,660	7,660
	Total						237,061 ฿
20	Excavation	490	11,760				11,760
	Embankment	4,413		158,868			158,868
	Laterite	150			92,250		92,250
	Concrete	4.1				11,632	11,632
	Total						274,510 ฿

iii) Cost per ha

Size of Service unit	Total Area	Farmers		R.I.D.		Remarks
		Total Amount	฿/ha	Total Amount	฿/ha	
ha	ha	฿	฿	฿	฿	
50	50	232,979	4,659	-	-	
30	60	270,505	4,508	237,061	3,951	
20	60	246,841	4,114	274,510	4,575	

Figure F-3-1 (1) Comparison of Service Unit Size
(in case of 20 ha)

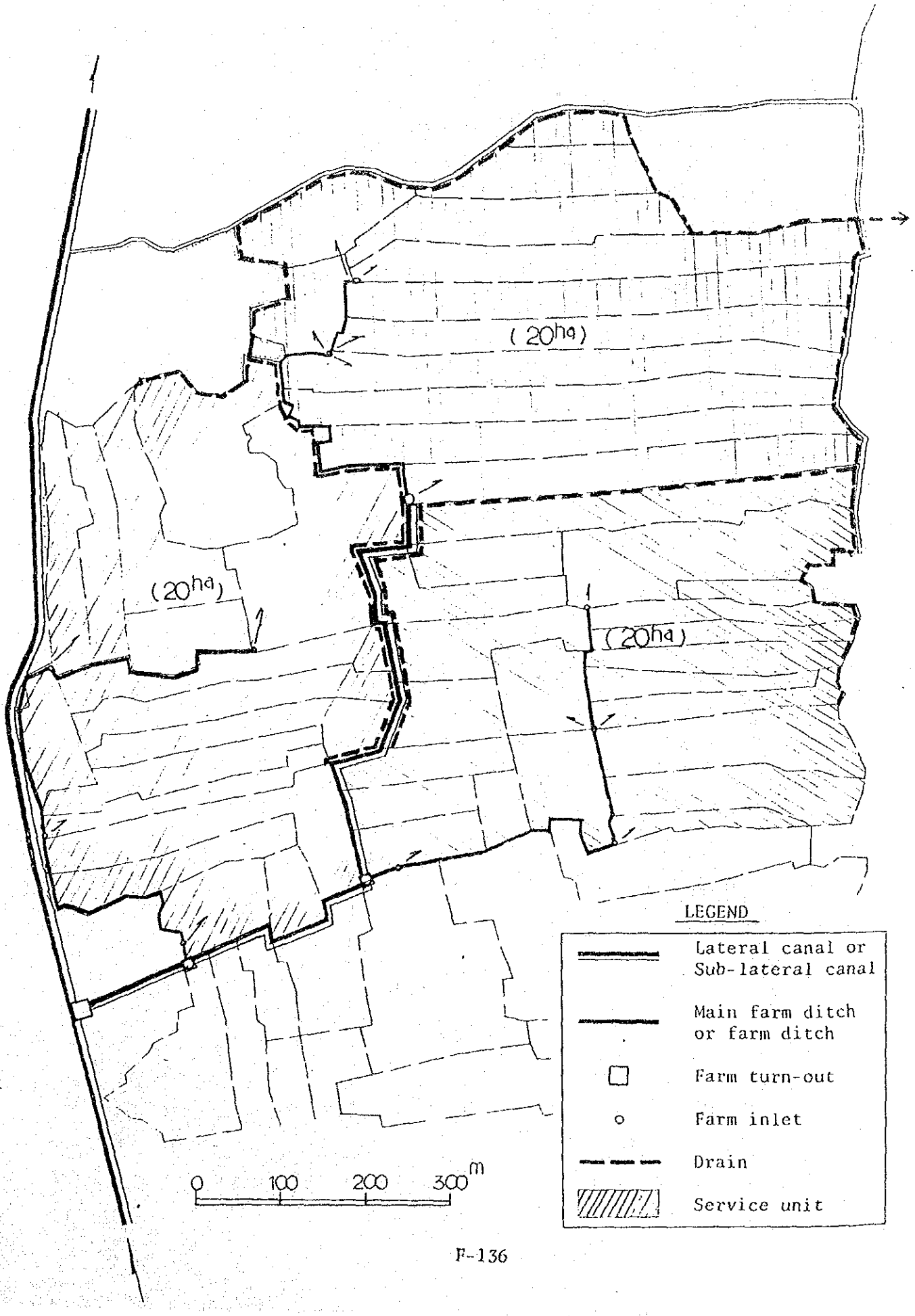


Figure F-3-1 (2) Comparison of Service Unit Size
(in case of 30 ha)

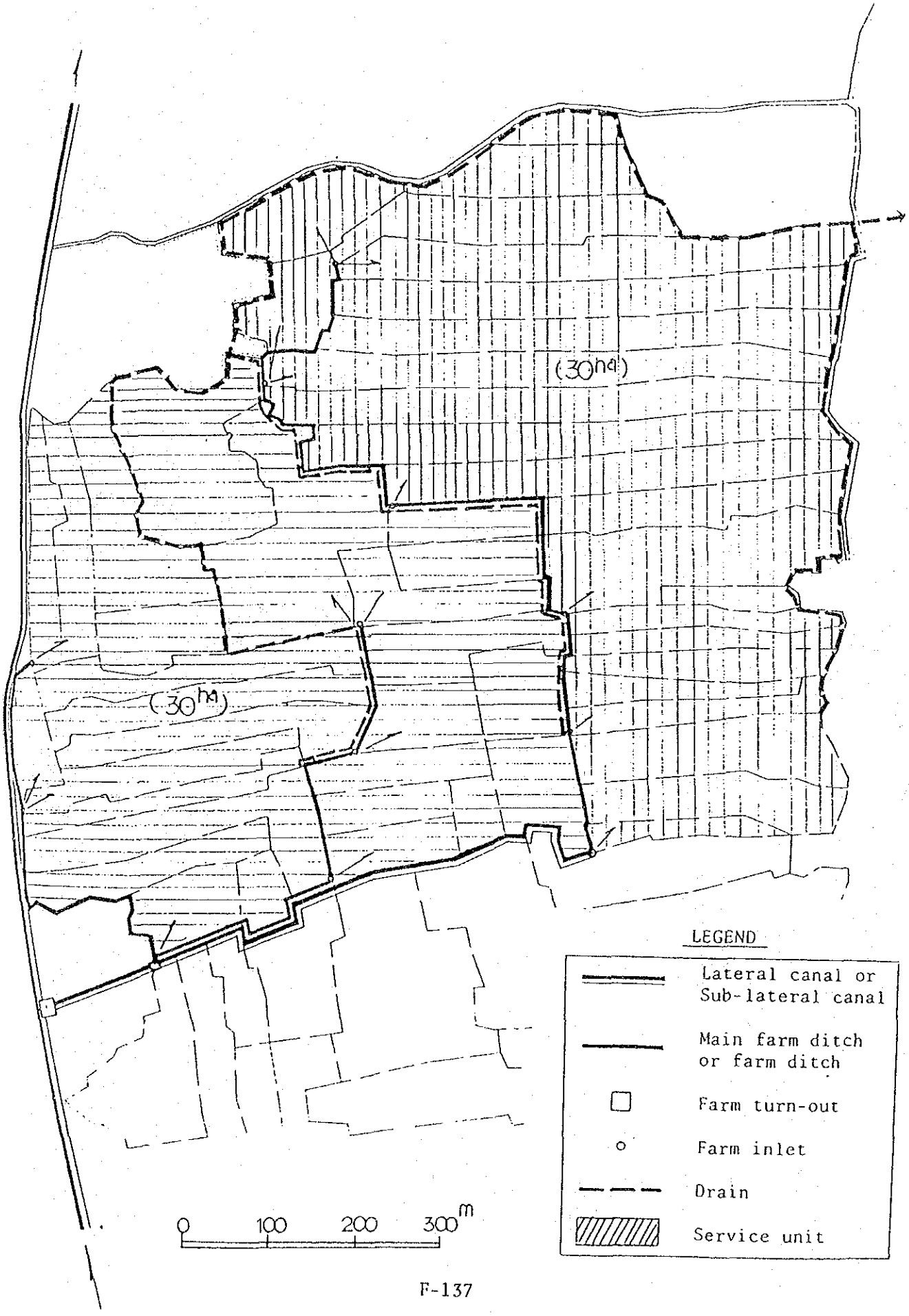


Figure F-3-1 (3) Comparison of Service Unit Size
(in case of 50 ha)

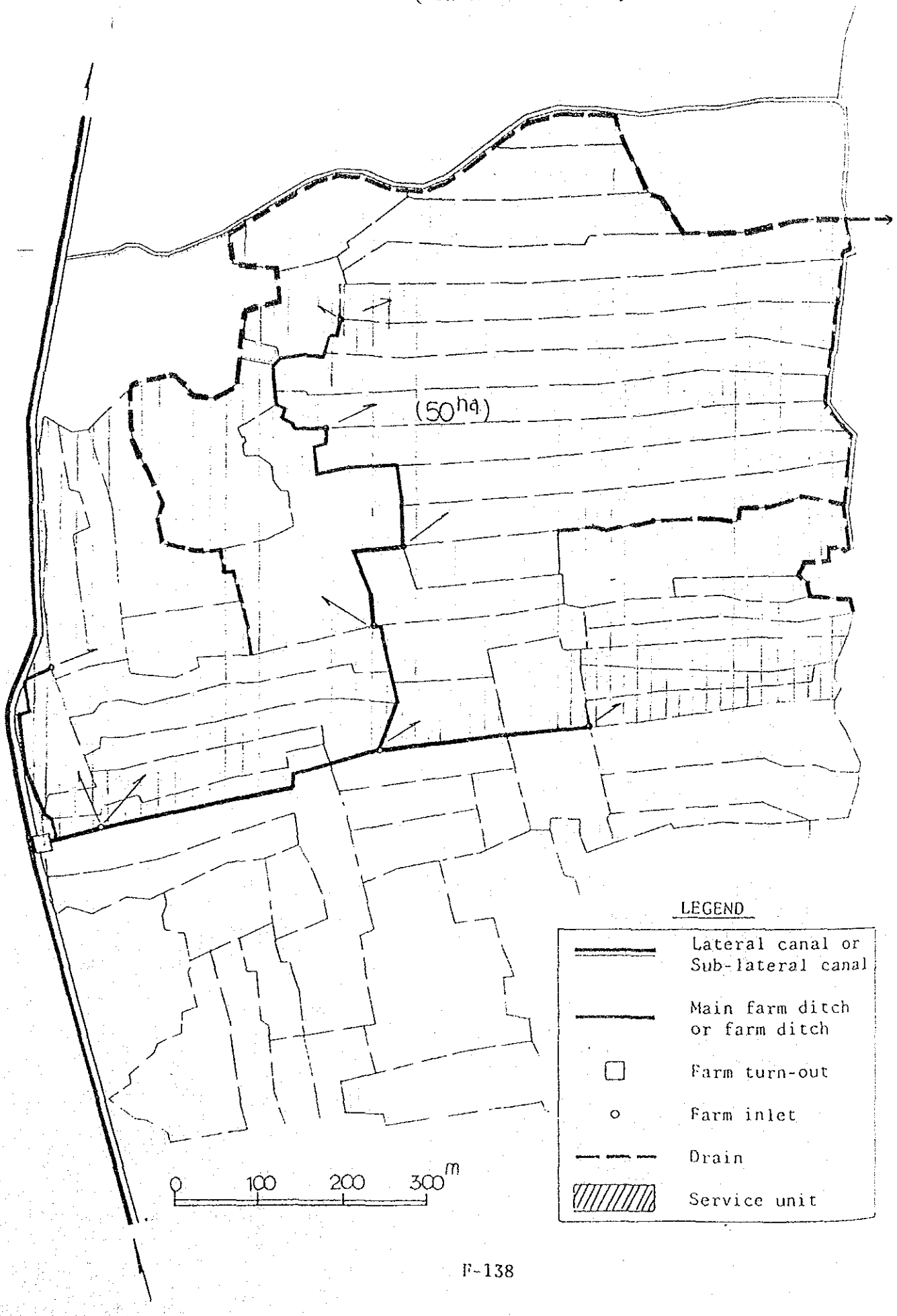


Figure F-3-2(1) Typical Layont of On-farm Facilities (1/2)

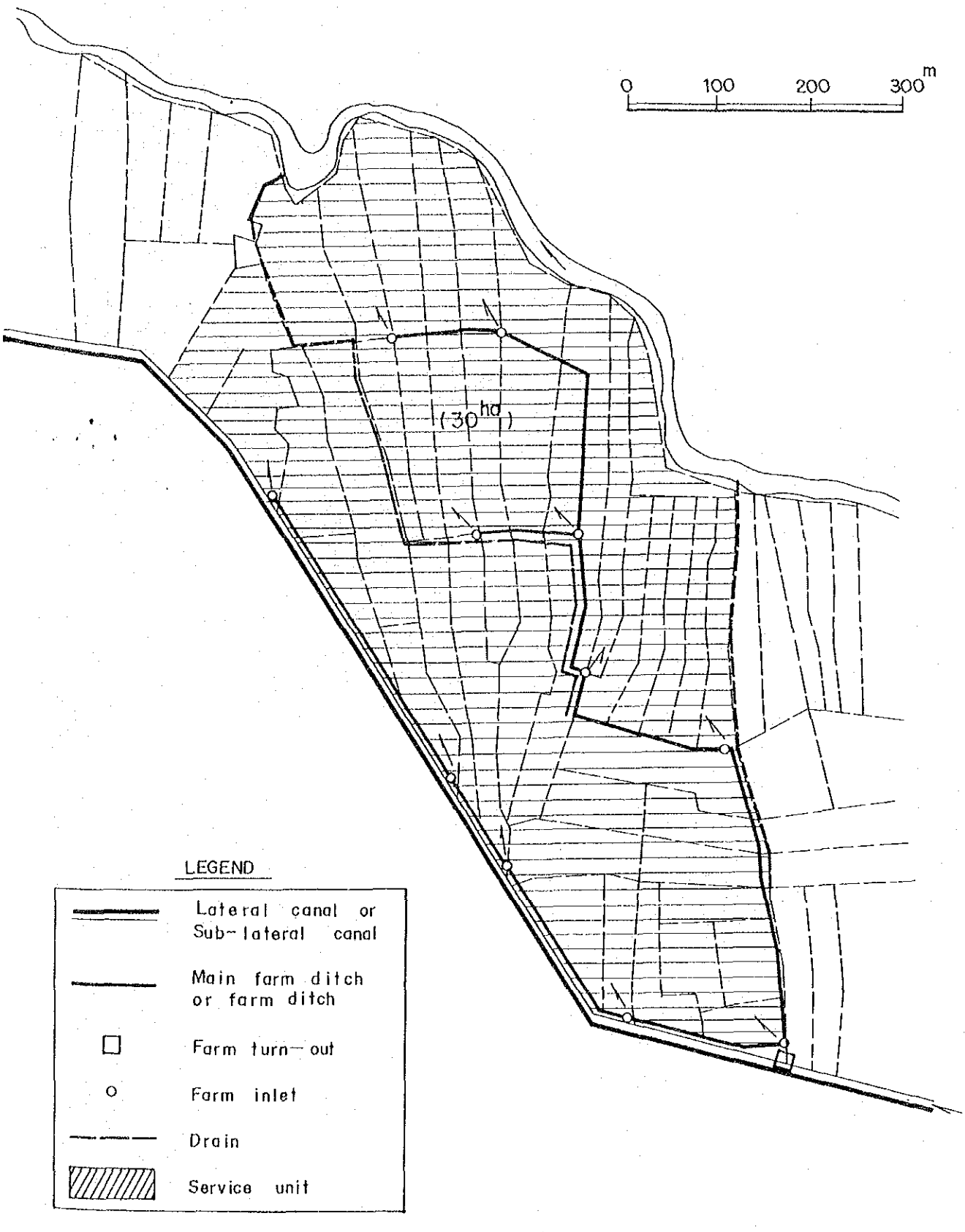


Figure F-3-2(2) Typical Layont of On-farm Facilities (2/2)

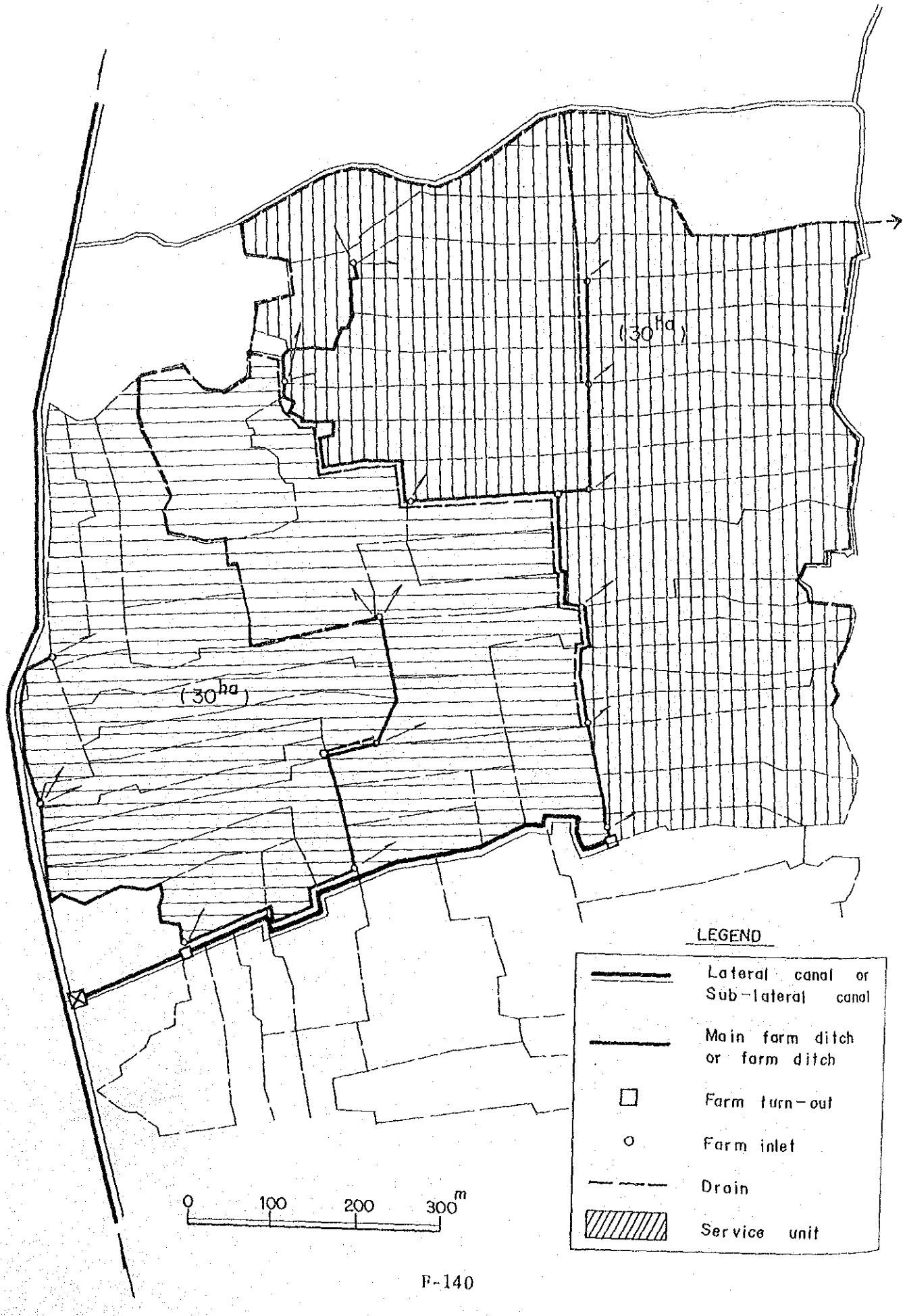
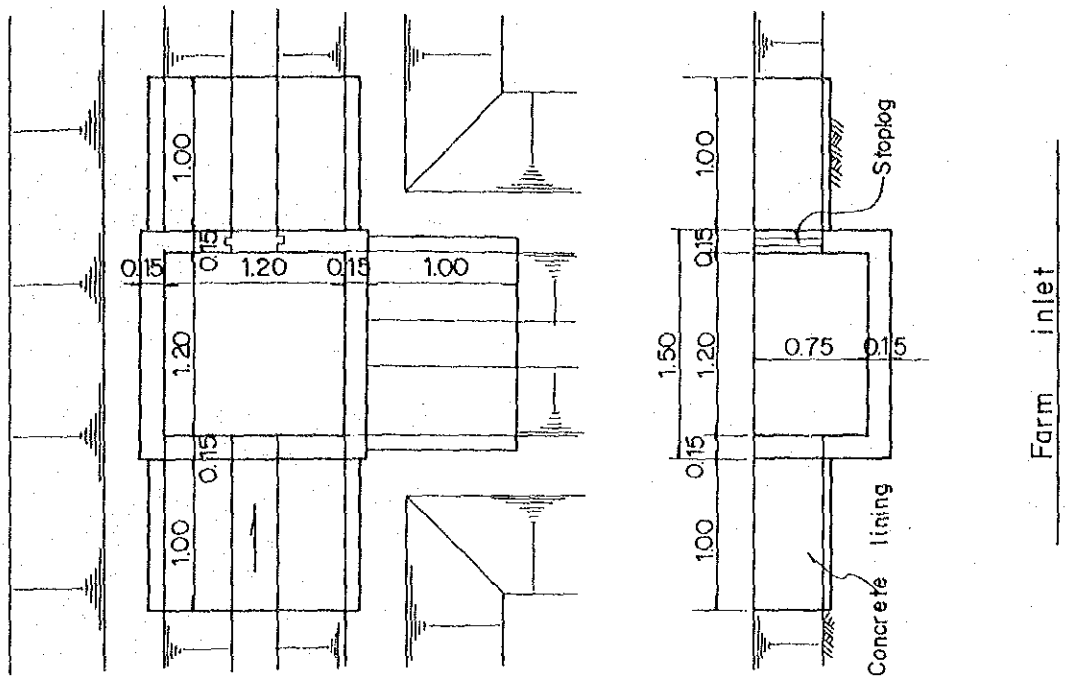
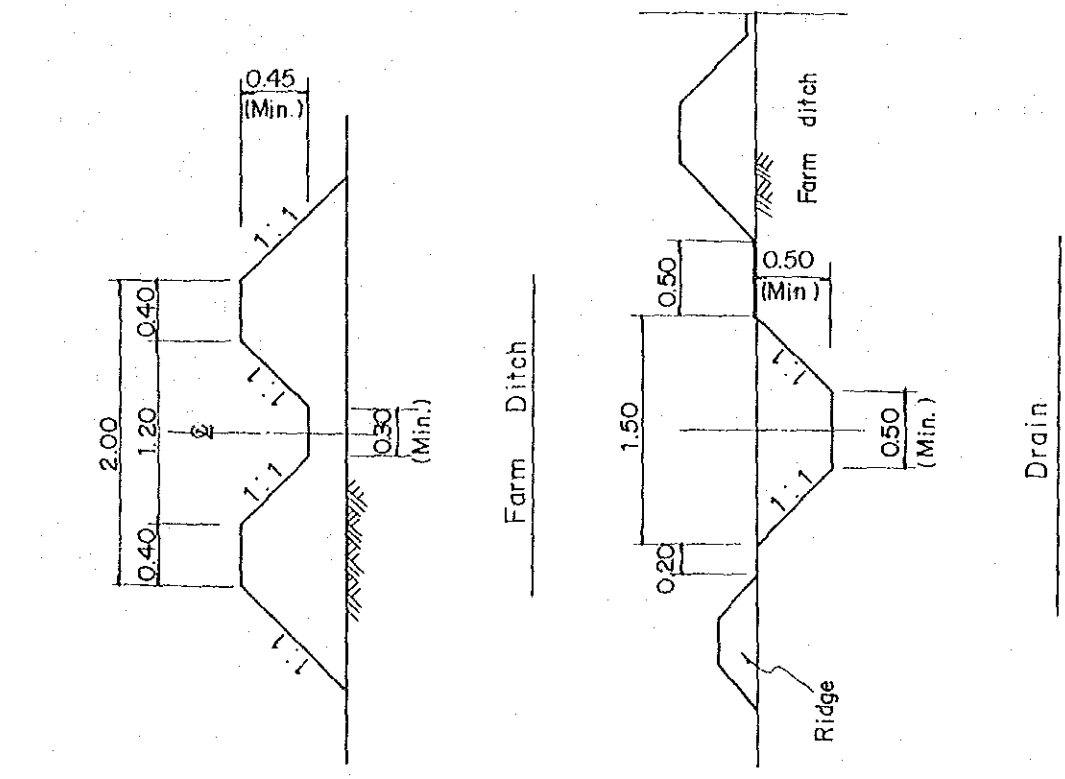


Figure F-3-3. On-farm Development Facilities





F.4. Muban Cooperative Pond

Muban cooperative pond consists of intake structure, drain and domestic water supply structure and off-take structure.

The water taken from the RID canal though the farm turnout is stored inthe pond for the fish breeding and partly delivered to the farm land to irrigate the Muban cooperative service unit through the off-take structure.

The pond has also the function of the regulating reservoir to solve the time difference between irrigation water supply and demand in the dry season. These regulating capacity at each pond is shown in ANNEX F-2.

The shape of thepond is designed as a square with water depth in 2.0 m in view of fish breeding.

To prevent from overtopping of the dike, spillway section will be provided at the drain structure and domestic water intake will be combined with the drain structure to minimize the construction cost.

As the domestic water intake structure, the tap will be provided at the outlet tank of the drain and domestic water supply structure and shallow well will be installed around the pond for the drinking water.

Table F-4-1 (1) Proposed Village Pond

Basin	Sub-System	Muban Name	Scale of Pond (ha)	Area for Upland (ha)	Regulating Capacity: Domestic (m3)	Crop (m3)	Total (m3)	Regulating Water Depth (m)	Remarks
Lam Plai Mat	Sra Ta Khiam	Rat Phattana	2.4	36	300	1,180	1,480	0.061	improvement
		Khok Sung	0.8	7	50	230	280	0.035	
		Bu Ngin	0.8	6	50	200	250	0.031	
		Nong Him	0.8	12	100	400	500	0.062	
		Sra Ta Khim	1.6	29	230	950	1,180	0.073	
	Soeng	Non Sombun	1.6	29	230	950	1,180	0.074	
		Wang Khla	0.8	12	100	400	500	0.063	
		Non Samran	1.6	17	150	560	710	0.044	
		Nong Chai Nam	0.8	8	70	260	330	0.041	
		Khok Mai Tai	0.8	14	110	460	570	0.071	
	Pa Kham	Khok Suk Samran	2.4	46	250	1,500	1,750	0.073	
		Khok Wan	1.6	33	190	1,100	1,290	0.081	
		Khong Phra Sai	2.4	51	280	1,700	1,980	0.083	
		Pa Kham	1.6	32	180	1,050	1,130	0.071	
		Pa Kham	1.6	24	140	800	940	0.059	
		Khok Ngin	1.6	34	200	1,200	1,400	0.088	
	Nong Bua	Khok Mamuang	2.4	42	230	1,400	1,630	0.068	
		Thep Pattana	2.4	23	130	750	880	0.037	
		Dong Nong Ngam	2.4	74	410	2,450	2,850	0.119	
		Khok Klang	1.6	41	230	1,350	1,580	0.098	
	Thai Charoen	Khok Prasat	0.8	6	40	200	240	0.030	
		Tanon Hak	0.8	9	50	300	350	0.044	improvement
		Thai Charoen	1.6	27	150	900	1,050	0.066	

Table F-4-1 (2) Proposed Village Pond

Basin	Sub-System	Muban Name	Scale of Pond	Area for Upland	Regulating Capacity			Regulating Water Depth	Remarks
					Domestic	Crop	total		
Lam Plai Mat	Thai Charoen	Khock Loi	2.4	58	320	1,900	2,220	0.092	improvement
		Phang Sri	1.6	41	230	1,350	1,580	0.099	
		Tung Saen Tong	0.8	12	70	450	470	0.059	
		Nong Ta Si	1.6	26	150	850	1,000	0.063	
		Nong Na	0.8	9	50	300	350	0.044	
		Khok Yang	0.8	7	40	250	290	0.036	
		Nong Wa	1.6	35	200	1,150	1,350	0.084	
		Khok Makha	0.8	19	110	650	760	0.095	
Nong Lum Puk	Nong Lum Puk	Nong Lum Puk	2.4	19	140	650	790	0.033	
		Soeng Sang	2.4	41	300	1,350	1,650	0.069	improvement
Huai Phlu	Huai Phlu	Nong Mai Ngam Kao	1.6	7	50	250	300	0.019	
		Sai Tri 11	0.8	8	60	250	310	0.039	
		Nong Pru	0.8	5	40	150	190	0.024	
		Sai Tri 9	0.8	2	20	150	120	0.015	
		Bung Charo-en	0.8	9	70	300	370	0.046	
		Sai Tri 9	0.8	5	40	200	240	0.030	
		Bung Kao	0.8	4	30	150	180	0.023	

ANNEX G COST ESTIMATE

ANNEX G. COST ESTIMATE

LIST OF TABLES

LIST OF FIGURES

G.1. Construction Plan

Table G-1-1 (1) OUTPUT OF MAJOR WORK

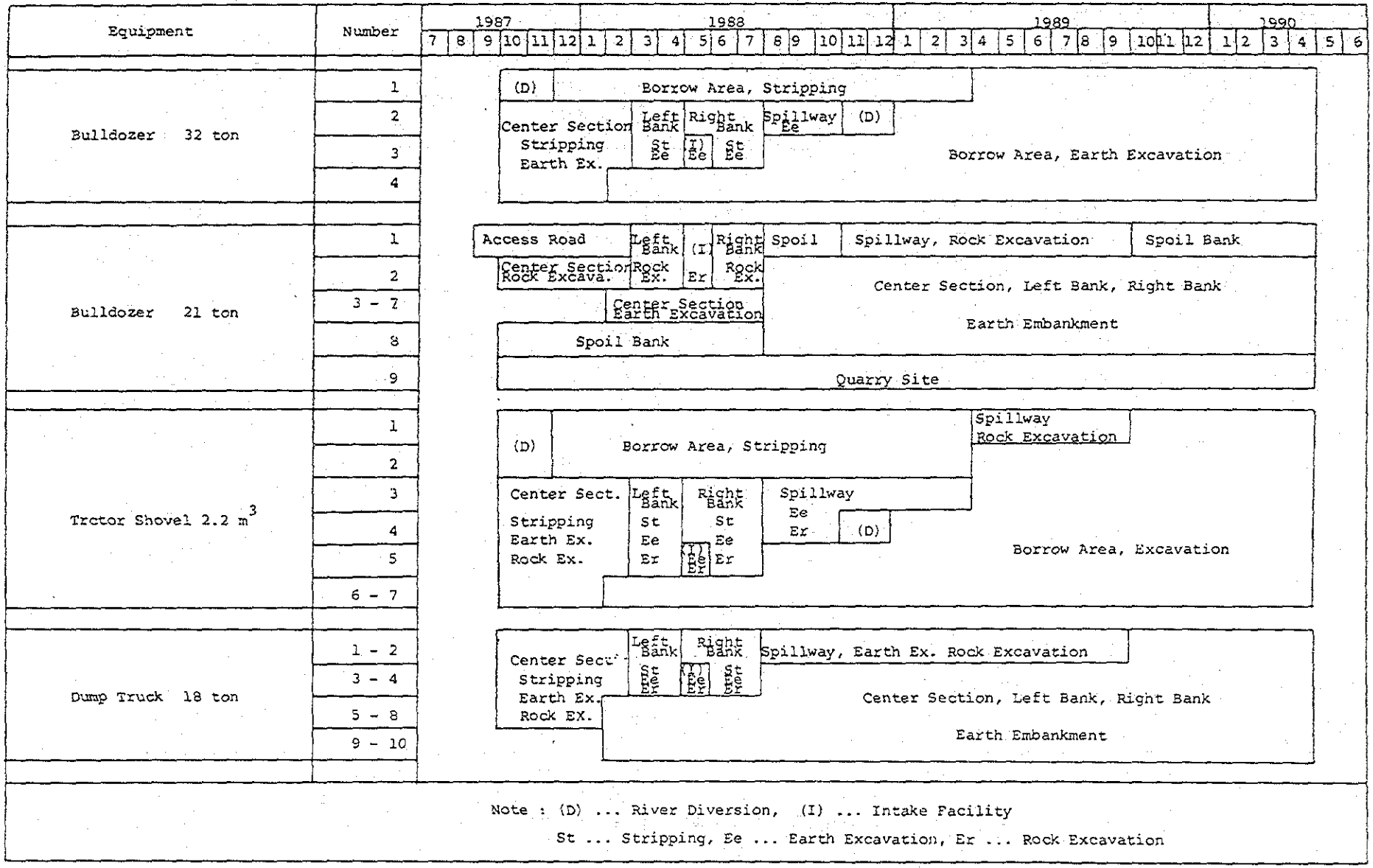
Description of Works	Unit	Quantity	Daily Output	Monthly Working Days	Equipment Set	Working Month
I. Lam Plai Mat Sub-Project						
1. Dam						
1) Temporary Works						
- Stripping for Borrow Area	cu.m	300,000	960	20	1	16.0
- Access Road	km	7	0.2	20	1	2.0
- River Diversion	cu.m	66,000	810	20	1	4.0
2) Foundation Treatment at Central Section						
- Stripping	cu.m	48,000	960	20	1	2.5
- Trench Excavation (Earth)	cu.m	124,000	810	20	2	4.0
- - ditto - (Rock)	cu.m	3,000	200	25	1	1.0
- Curtain Grouting	m	3,000	5.5	20	6	4.5
- Backfill Embankment	cu.m	130,000	840	15	2	5.5
3) Foundation Treatment at Left Bank						
- Stripping	cu.m	33,000	960	20	1	2.0
- Trench Excavation (Earth)	cu.m	22,000	810	20	1	1.5
- - ditto - (Rock)	cu.m	5,000	200	25	1	1.0
- Curtain Grouting	m	4,000	5.5	20	3	12.5
- Blanket Grouting	m	1,000	10	20	1	5.0
4) Foundation Treatment at Right Bank						
- Stripping	cu.m	46,000	960	20	1	2.5
- Trench Excavation (Earth)	cu.m	18,000	810	20	1	1.0
- - ditto - (Rock)	cu.m	12,000	200	25	2	1.5
- Curtain Grouting	m	4,100	5.5	20	3	12.5
- Blanket Grouting	m	1,000	10	20	1	5.0
5) Dam Body Embankment						
- Earth	cu.m	1,420,000	840	20	4	21.0
- Horizontal & Vertical Drain	cu.m	34,700	130	20	1	13.0
- Riprap	cu.m	67,000	600	25	1	4.5
6) Spillway & Intake Facility						
- Earth Excavation	cu.m	53,700	960	20	1	3.0
- Rock Excavation	cu.m	161,100	200	25	3	11.0
- Concrete Work	cu.m	20,000	90	20	1	11.0
2. Canal System						
1) Diversion Weir						
- Earth Excavation	cu.m	32,000	600	20	1	3.0
- Fill & Backfill	cu.m	10,000	350	20	1	1.5
- Concrete Work	cu.m	10,300	90	15	1	8.0
2) Sra Ta Kien Sub-System						
- Main Canal, Excavation	cu.m	91,000	200	20	2	12.0
- -ditto- , Fill	cu.m	64,000	350	20	1	9.0
- -ditto- , Concrete Work	cu.m	4,700	10	15	3	10.5
- Lateral Canal, Excavation	cu.m	22,000	200	20	1	6.0
- -ditto- , Fill	cu.m	57,000	350	20	1	8.0
- Drainage Channel, Excavation	cu.m	35,000	200	20	1	9.0
3) Soeng Sang Sub-System						
- Main Canal, Excavation	cu.m	35,000	200	20	1	9.0
- -ditto- , Fill	cu.m	103,000	350	20	2	8.0
- -ditto- , Concrete Work	cu.m	2,100	10	15	2	7.0
- Lateral Canal, Excavation	cu.m	45,000	200	20	1	12.0
- -ditto- , Fill	cu.m	142,000	350	20	2	10.0
- Drainage Channel, Excavation	cu.m	24,000	200	20	1	6.0

Table G-1-1 (2) OUTPUT OF MAJOR WORK

Description of Works	Unit	Quantity	Daily Output	Monthly Working Days	Equipment Set	Working Month
4) Pa Kham Sub-System						
- Main Canal, Excavation	cu.m	148,000	200	20	2	19.0
- -ditto- , Fill	cu.m	106,000	350	20	1	15.0
- -ditto- , Concrete Work	cu.m	7,700	10	15	3	17.0
- Lateral Canal, Excavation	cu.m	43,000	200	20	1	11.0
- -ditto- , Fill	cu.m	66,000	350	20	1	9.5
- Drainage Channel, Excavation	cu.m	33,000	200	20	1	8.0
5) Thai Charoen Sub-System						
- Main Canal, Excavation	cu.m	215,000	200	20	3	18.0
- -ditto- , Fill	cu.m	221,000	350	20	2	16.0
- -ditto- , Concrete Work	cu.m	12,800	10	15	4	21.5
- Lateral Canal, Excavation	cu.m	137,000	200	20	3	12.0
- -ditto- , Fill	cu.m	371,000	350	20	4	14.0
- -ditto- , Concrete Work	cu.m	600	10	15	1	4.0
- Drainage Channel, Excavation	cu.m	123,000	200	20	2	15.0
II. Nong Lum Puk Sub-Project						
1. Dam						
- Stripping for Borrow Area	cu.m	12,000	600	20	1	1.0
- Earth Excavation	cu.m	28,000	600	20	1	2.3
- Earth Embankemnt	cu.m	172,000	540	20	2	8.0
- Horizontal & Vertical Drain	cu.m	7,600	130	20	1	3.0
- Riprap	cu.m	24,000	240	25	1	4.0
- Spillway & Intake, Excavation	cu.m	148,000	600	20	2	6.0
- -ditto- , Concrete Work	cu.m	630	50	20	1	1.0
2. Canal System						
- Main Canal, Excavation	cu.m	27,000	200	20	1	7.0
- -ditto- , Fill	cu.m	31,000	350	20	1	4.5
- Lateral Canal, Excavation	cu.m	6,000	200	20	1	1.5
- -ditto- , Fill	cu.m	10,000	350	20	1	1.5
III. Huai Phlu Sub-Project						
1. Dam						
- Stripping for Borrow Area	cu.m	20,000	600	20	1	2.0
- Earth Excavation	cu.m	64,100	600	20	2	3.0
- Rock Excavation	cu.m	5,400	200	25	2	0.5
- Curtain Grouting	m	2,700	5.5	20	3	8.0
- Blanket Grouting	m	2,500	10	20	2	6.0
- Earth Embankment	cu.m	256,000	540	20	2	12.0
- Horizontal & Vertical Drain	cu.m	8,700	130	20	1	3.5
- Riprap	cu.m	9,400	240	25	1	2.0
- Spillway & Intake, Earth Excava.	cu.m	18,200	600	20	1	1.5
- -ditto- , Rock Excava.	cu.m	14,700	200	25	2	1.5
- -ditto- , Concrete Work	cu.m	2,330	50	20	1	2.5
2. Canal System						
- Main Canal, Excavation	cu.m	51,000	200	20	2	6.5
- -ditto- , Fill	cu.m	62,000	350	20	1	9.0
- Lateral Canal, Excavation	cu.m	20,000	200	20	2	2.5
- -ditto- , Fill	cu.m	20,000	350	20	1	3.0
- Drainage Channel, Excavation	cu.m	2,000	200	20	1	0.5

Fig. G-1-1 CONSTRUCTION EQUIPMENT PLAN

- Lam Plai Mat Dam -



Note : (D) ... River Diversion, (I) ... Intake Facility

St ... Stripping, Ee ... Earth Excavation, Er ... Rock Excavation

Table G-2-1 (1) CONSTRUCTION COST OF LAM PLAI MAT SUB-PROJECT

Description of Works	Unit	Quantity	Unit Rate (฿)			Amount (฿ '000)		
			F/C	L/C	Total	F/C	L/C	Total
A. Dam								
1. Temporary Work								
- Contractor Camp & Office	L.S.	-	-	-	-	3,000	9,000	12,000
- Access Road	km	7	80,000	620,000	700,000	560	4,340	4,900
- Transmission Line	km	5	150,000	150,000	300,000	750	750	1,500
- River Diversion	m	550	5,400	1,200	6,600	2,970	660	3,630
- Stripping for Borrow Area	cu.m	300,000	18	4	22	5,400	1,200	6,600
Sub - total						12,680	15,950	28,630
2. Foundation Treatment								
- Stripping	cu.m	127,000	36	8	44	4,572	1,016	5,588
- Trench Excavation(Earth)	cu.m	164,000	45	10	55	7,380	1,640	9,020
- - ditto - (Rock)	cu.m	20,000	104	37	141	2,080	740	2,820
- Drilling for Blanket Grout	m	1,900	168	37	205	319	70	389
- Drilling for Curtain Grout	m	11,100	616	208	824	6,838	2,309	9,147
- Drilling for Pilot Hole	m	650	1,118	432	1,550	727	281	1,008
- Cement for Grouting	ton	650	2,970	3,204	6,174	1,931	2,083	4,014
Sub - total						23,847	8,139	31,986
3. Dam Embankment								
- Imprevious Zone	cu.m	480,000	62	14	76	29,760	6,720	36,480
- Random Zone from Excavation	cu.m	200,000	17	3	20	3,400	600	4,000
- Random Zone from Borrow	cu.m	874,000	59	13	72	51,566	11,362	62,928
- Vertical Drain	cu.m	22,000	48	541	589	1,056	11,902	12,958
- Horizontal Drain	cu.m	2,700	124	305	429	335	823	1,158
- Riprap Filter	cu.m	10,000	48	541	589	480	5,410	5,890
- Riprap	cu.m	67,000	64	16	80	4,288	1,072	5,360
- Sodding	sq.m	55,000	0	12	12	0	660	660
Sub - total						90,885	38,549	129,434

Table G-2-1 (2) CONSTRUCTION COST OF LAM PLAI MAT SUB-PROJECT

Description of Works	Unit	Quantity	Unit Rate (฿)			Amount (฿ '000)		
			F/C	L/C	Total	F/C	L/C	Total
4. Spillway								
- Excavation (Earth)	cu.m	50,000	45	10	55	2,250	500	2,750
- Excavation (Rock)	cu.m	151,500	107	38	145	16,211	5,757	21,968
- Fill & Backfill	cu.m	11,600	20	17	37	232	197	429
- Reinforced Concrete	cu.m	17,250	1,432	1,670	3,102	24,702	28,808	53,510
Sub - total						43,395	35,262	78,652
5. Intake Facilities								
- Excavation (Earth)	cu.m	3,700	45	10	55	167	37	204
- Excavation (Rock)	cu.m	9,100	104	37	141	946	337	1,283
- Fill & Backfill	cu.m	9,500	20	17	37	190	162	352
- Reinforced Concrete	cu.m	3,100	1,432	1,670	3,102	4,439	5,177	9,616
- Steel Pipe & Screen	L.S.	-	-	-	-	1,282	558	1,840
- Sluice & Jet Flow Gate Ø 1,300 mm	L.S.	-	-	-	-	3,849	332	4,181
Sub - total						10,873	6,603	17,476
Total						181,700	104,500	286,200

Table G-2-1 (3) CONSTRUCTION COST OF LAM PLAI MAT SUB-PROJECT

Description of Works	Unit	Quantity	Unit Rate (฿)			Amount (฿ '000)		
			F/C	L/C	Total	F/C	L/C	Total
B. Canal								
1. Diversion Weir								
- Temporary Works	L.S.	-	-	-	-	3,070	2,830	5,900
- Excavation (Earth)	cu.m	32,500	27	6	33	878	195	1,073
- Fill & Backfill	cu.m	10,100	20	17	37	202	172	374
- Reinforced Concrete	cu.m	2,270	1,232	1,495	2,727	2,797	3,394	6,191
- Plain Concrete	cu.m	8,000	638	844	1,482	5,104	6,752	11,856
- Sheet Pile L= 9 m	sheet	600	6,499	119	6,618	3,899	71	3,970
- - ditto - L= 7 m	sheet	50	4,830	93	4,923	241	47	288
- - ditto - L= 2 m	sheet	650	1,469	36	1,505	955	23	978
- R.C. Pile Ø 300 mm,L= 10 m	stick	240	691	3,290	3,981	166	790	956
- R.C. Pipe Ø 1,500 mm	m	267	132	3,692	3,824	35	986	1,021
- Radial Gate 2.25 x 6 m	set	3	107,520	61,440	168,960	323	184	507
- Sluice Gate 1.8 x 1.7 m	set	2	21,252	12,708	33,960	43	25	68
- Sluice Gate 2.2 x 1.7 m	set	3	29,232	16,848	46,080	88	50	138
- Riprap	cu.m	220	134	40	174	29	9	38
- Stone Pitching	sq.m	4,400	237	389	626	1,043	1,712	2,755
- Miscellaneous Works	L.S.					927	860	1,787
Sub - total						19,800	18,100	37,900
2. Main Canal								
- Stripping	cu.m	209,895	7	2	9	1,469	420	1,889
- Excavation (Earth)	cu.m	279,110	11	15	26	3,070	4,187	7,257
- Embankment	cu.m	493,945	20	17	37	9,879	8,397	18,276
- Laterite	cu.m	104,122	11	110	121	1,145	11,453	12,598
- Sodding	sq.m	603,698	0	12	12	0	7,245	7,245
- Linning Concrete	cu.m	27,260	818	1,274	2,092	22,299	34,729	57,028
- Related Structure	L.S.	-	-	-	-	6,857	5,961	12,828
- Miscellaneous Works	L.S.	-	-	-	-	4,481	7,208	11,689
Sub - total						49,200	79,600	128,800

Table G-2-1 (4) CONSTRUCTION COST OF LAM PLAI MAT SUB-PROJECT

Description of Works	Unit	Quantity	Unit Rate (฿)			Amount (฿ '000)		
			F/C	L/C	Total	F/C	L/C	Total
3. Lateral Canal								
- Stripping	cu.m	233,750	7	2	9	1,636	468	2,104
- Excavation (Earth)	cu.m	13,337	11	15	26	147	200	347
- Embankment	cu.m	636,698	20	17	37	12,734	10,824	23,558
- Laterite	cu.m	96,537	11	110	121	1,062	10,619	11,681
- Sodding	sq.m	633,607	0	12	12	0	7,603	7,603
- Linning Concrete	cu.m	610	818	1,274	2,092	499	777	1,276
- Related Structure	L.S.	-	-	-	-	6,294	6,481	12,775
- Miscellaneous Works	L.S.	-	-	-	-	2,228	3,728	5,956
Sub -total						24,600	40,700	65,300
4. Drainage Channel								
- Excavation (Earth)	cu.m	214,186	11	15	26	2,356	3,213	5,569
- Miscellaneous Works	L.S.	-	-	-	-	244	287	531
Sub - total						2,600	3,500	6,100
Total						96,200	141,900	238,100

Table G-2-2 (1) CONSTRUCTION COST OF NONG LUM PUK SUB-PROJECT

Description of Works	Unit	Quantity	Unit Rate (฿)			Amount (฿ '000)		
			F/C	L/C	Total	F/C	L/C	Total
A. Dam								
1. Temporary Work								
- Access Road	km	3	51,000	314,000	365,000	153	942	1,095
- Transmission Line	km	3	145,000	145,000	290,000	435	435	870
- Stripping for Borrow Area	cu.m	12,000	14	4	18	168	48	216
Sub - total						756	1,425	2,181
2. Foundation Treatment								
- Stripping	cu.m	22,000	24	6	30	528	132	660
- Trench Excavation	cu.m	6,000	27	6	33	162	36	198
Sub - total						690	168	858
3. Dam Embankment								
- Earth Embank from Exca.	cu.m	80,000	17	3	20	1,360	240	1,600
- Earth Embank from Borrow	cu.m	92,000	50	11	61	4,600	1,012	5,612
- Vertical Drain	cu.m	2,100	28	536	564	59	1,126	1,185
- Horizontal Drain	cu.m	2,500	86	296	382	215	740	955
- Riprap Filter	cu.m	3,000	28	536	564	84	1,608	1,692
- Riprap	cu.m	10,000	52	16	68	520	160	680
- Sodding	sq.m	18,000	0	12	12	0	216	216
Sub - total						6,838	5,102	11,940
4. Spillway								
- Excavation (Earth)	cu.m	145,400	27	6	33	3,926	872	4,798
- Reinforced Concrete	cu.m	440	1,406	1,664	3,070	619	732	1,351
- Riprap	cu.m	14,000	52	16	68	728	224	952
- Sheet Pile L = 3 m	sheet	150	2,160	43	2,203	324	6	330
Sub - total						5,597	1,834	7,431

Table G-2-2 (2) CONSTRUCTION COST OF NONG LÚM PUK SUB-PROJECT

Description of Works	Unit	Quantity	Unit Rate (฿)			Amount (฿ '000)		
			F/C	L/C	Total	F/C	L/C	Total
5. Intake Facility								
- Excavation (Earth)	cu.m	3,000	27	6	33	81	18	99
- Backfill	cu.m	2,800	20	17	37	56	48	104
- Reinforced Concrete	cu.m	185	1,406	1,664	3,070	260	308	568
- Steel Pipe & Screen	L.S.	-	-	-	-	157	69	226
- Sluice & Jet Flow Gate Ø 250 mm	L.S.	-	-	-	-	829	72	901
Sub - total						1,383	515	1,898
Total						15,270	9,030	24,300

Table G-2-2 (3) CONSTRUCTION COST OF NONG LUM PUK SUB-PROJECT

Description of Works	Unit	Quantity	Unit Rate (฿)			Amount (฿ '000)		
			F/C	L/C	Total	F/C	L/C	Total
B. Canal								
1. Main Canal								
- Stripping	cu.m	20,352	7	2	9	142	41	183
- Excavation (Earth)	cu.m	6,862	11	15	26	75	103	178
- Embankment	cu.m	30,650	20	17	37	613	521	1,134
- Laterite	cu.m	9,881	11	110	121	109	1,087	1,196
- Sodding	sq.m	53,797	0	12	12	0	646	646
- Linning Concrete	cu.m	450	709	1,240	1,949	319	558	877
- Related Structure	L.S.	-	-	-	-	577	593	1,170
- Miscellaneoys Works	L.S.	-	-	-	-	165	351	516
Sub - total						2,000	3,900	5,900
2. Lateral Canal								
- Stripping	cu.m	5,182	7	2	9	36	10	46
- Excavation (Earth)	cu.m	360	11	15	26	4	5	9
- Embankment	cu.m	9,680	20	17	37	194	165	359
- Laterite	cu.m	2,421	11	110	121	27	266	293
- Sodding	sq.m	13,960	0	12	12	0	168	168
- Related Structure	L.S.	-	-	-	-	370	453	823
- Miscellaneous Works	L.S.	-	-	-	-	69	133	202
Sub - total						700	1,200	1,900
Total						2,700	5,100	7,800

Table G-2-3 (1) CONSTRUCTION COST OF HUAI PHLU SUB-PROJECT

Description of Works	Unit	Quantity	Unit Rate (฿)			Amount (฿ '000)		
			F/C	L/C	Total	F/C	L/C	Total
A. Dam								
1. Temporary Work								
- Access Road	km	5	51,000	314,000	365,000	255	1,570	1,825
- Transmission Line	km	7	120,000	120,000	240,000	840	840	1,680
- Stripping for Borrow Area	cu.m	20,000	14	4	18	280	80	360
Sub - total						1,375	2,490	3,865
2. Foundation Treatment								
- Stripping	cu.m	20,000	24	6	30	480	120	600
- Trench Excavation(Earth)	cu.m	44,100	27	6	33	1,191	264	1,455
- - ditto - (Rock)	cu.m	5,400	64	30	94	346	162	508
- Drilling for Blanket Grout	m	2,700	168	37	205	454	100	554
- Drilling for Curtain Grout	m	2,500	616	208	824	1,540	520	2,060
- Drilling for Pilot Hole	m	260	1,118	432	1,550	291	112	403
- Cement for Grouting	ton	260	2,970	3,204	6,174	772	833	1,605
Sub - total						5,074	2,111	7,185
3. Dam Embankment								
- Earth Embank from Exca.	cu.m	45,000	17	3	20	765	135	900
- Earth Embank from Borrow	cu.m	211,000	50	11	61	10,550	2,321	12,871
- Vertical Drain	cu.m	4,500	28	536	546	126	2,412	2,538
- Horizontal Drain	cu.m	1,200	28	423	451	34	507	541
- Riprap Filter	cu.m	3,000	28	536	546	84	1,608	1,692
- Riprap	cu.m	9,400	52	16	68	489	150	639
- Sodding	sq.m	16,000	0	12	12	0	192	192
Sub - total						12,048	7,325	19,373

Table G-2-3 (2) CONSTRUCTION COST OF HUAI PHLU SUB-PROJECT

Description of Works	Unit	Quantity	Unit Rate (฿)			Amount (฿ '000)		
			F/C	L/C	Total	F/C	L/C	Total
4. Spillway								
- Excavation (Earth)	cu.m	16,100	27	6	33	435	97	532
- Excavation (Rock)	cu.m	11,700	64	30	94	749	351	1,100
- Fill & Backfill	cu.m	6,000	20	17	37	120	102	222
- Reinforced Concrete	cu.m	2,030	1,323	1,845	3,168	2,686	3,745	6,431
Sub - total						3,990	4,295	8,285
5. Intake Facilities								
- Excavation (Earth)	cu.m	2,050	27	6	33	55	12	67
- Excavation (Rock)	cu.m	3,000	64	30	94	192	90	282
- Fill & Backfill	cu.m	4,800	20	17	37	96	82	178
- Reinforced Concrete	cu.m	300	1,323	1,845	3,168	397	554	951
- Steel Pipe & Screen	L.S.	-	-	-	-	300	131	431
- Sluice & Jet Flow Gate Ø 300 mm	L.S.	-	-	-	-	998	86	1,084
- Sluice & Jet Flow Gate Ø 250 mm	L.S.	-	-	-	-	661	57	718
Sub - total						2,699	1,012	3,711
Total						25,180	17,220	42,400

Table G-2-3 (3) CONSTRUCTION COST OF HUAI PHLU SUB-PROJECT

Description of Works	Unit	Quantity	Unit Rate (฿)			Amount (฿ '000)		
			F/C	L/C	Total	F/C	L/C	Total
B. Canal								
1. Main Canal								
- Stripping	cu.m	39,756	7	2	9	278	80	358
- Excavation (Earth)	cu.m	11,567	11	15	26	127	174	301
- Embankment	cu.m	62,013	20	17	37	1,240	1,054	2,294
- Laterite	cu.m	19,181	11	110	121	211	2,110	2,321
- Sodding	sq.m	104,626	0	12	12	0	1,256	1,256
- Linning Concrete	cu.m	303	614	1,448	2,062	186	439	625
- Related Structure	L.S.	-	-	-	-	1,591	1,681	3,272
- Miscellaneous Works	L.S.	-	-	-	-	367	706	1,073
Sub - total						4,000	7,500	11,500
2. Lateral Canal								
- Stripping	cu.m	16,625	7	2	9	116	34	150
- Excavation (Earth)	cu.m	2,879	11	15	26	32	43	75
- Embankment	cu.m	20,398	20	17	37	408	347	755
- Laterite	cu.m	8,477	11	110	121	93	929	1,022
- Sodding	sq.m	44,320	0	12	12	0	532	532
- Related Structure	L.S.	-	-	-	-	917	1,304	2,221
- Miscellaneous Works	L.S.	-	-	-	-	134	311	445
Sub - total						1,700	3,500	5,200
3. Drainage Channel								
- Excavation (Earth)	cu.m	1,960	11	15	26	22	29	51
- Miscellaneous Works	L.S.	-	-	-	-	3	6	9
Sub - total						25	35	60
Total						5,720	11,040	16,760

Table G-2-4 CONSTRUCTION COST OF PREPARATORY WORK

Description of Works	Unit	Quantity	Unit Rate (฿)			Amount (฿ '000)		
			F/C	L/C	Total	F/C	L/C	Total
1. For RID Works								
- Office	sq.m	400	1,000	3,000	4,000	400	1,200	1,600
- Residence Grade II	unit	8	90,000	270,000	360,000	720	2,160	2,880
- Residence Grade III	unit	8	57,000	171,000	228,000	456	1,368	1,824
- Residence Grade IV	unit	5	36,400	109,100	145,500	182	546	728
- Dometory	sq.m	200	550	1,650	2,200	110	330	440
- Garage & Warehouse	sq.m	100	180	530	710	18	53	71
- Site Laboratory	sq.m	50	530	1,570	2,100	27	78	105
- O & M Cost	L.S.					577	1,725	2,302
Sub - total						2,490	7,460	9,950
2. For On-Farm Work and Muban Communal Facilities								
- Office	sq.m	300	1,000	3,000	4,000	300	900	1,200
- Residence Grade II	unit	3	90,000	270,000	360,000	270	810	1,080
- Residence Grade III	unit	4	57,000	171,000	228,000	228	684	912
- Residence Grade IV	unit	4	36,400	109,100	145,500	146	436	582
- Dometory	sq.m	300	550	1,650	2,200	165	495	660
- Garage & Warehouse	sq.m	100	180	530	710	18	53	71
- O & M Cost	L.S.					343	1,012	1,355
Sub - total						1,470	4,390	5,660
Total						3,960	11,850	15,810

Table G-2-5 ESTIMATION FOR SURVEY, INVESTIGATION AND TEST

Description of Works	Unit	Quantity	Rate (฿)	Amount (฿ '000)	F/C (฿ '000)	L/C (฿ '000)
1. Lam Plai Mat Project						
- Plane map by aero photo, Scale 1:2,000	sq.km	91.0	70,000	6,370	-	6,370
- Plane map by aero photo, Scale 1:10,000	sq.km	150.0	20,000	3,000	-	3,000
- Plane map survey at damsite, Scale 1:1,000	sq.km	2.0	120,000	240	-	240
- Profile survey at dam, spillway & intake	km	2.0	12,000	24	-	24
- Profile survey for main and lateral canal	km	215.0	10,000	2,150	-	2,150
- Core drilling at damsite & quarry site	m	400.0	4,000	1,600	1,120	480
- Test pit at borrow area	no.	30	3,000	90	-	90
- Laboratory test	L.S.	-	-	126	90	36
Sub - total				13,600	1,210	12,390
2. Nong Lum Puk Project						
- Plane map by aero photo, Scale 1:2,000	sq.km	3.0	70,000	210	-	210
- Profile survey at dam, spillway & intake	km	1.5	12,000	18	-	18
- Profile survey for main and lateral canal	km	13.0	10,000	130	-	130
- Core drilling at damsite & spillway	m	50.0	4,000	200	140	60
- Test pit at borrow area	no.	5	3,000	15	-	15
- Laboratory test	L.S.	-	-	27	20	17
Sub - total				600	160	440
3. Huai Phlu Project						
- Plane map by aero photo, Scale 1:2,000	sq.km	7.0	70,000	490	-	490
- Profile survey at dam, spillway & intake	km	1.5	12,000	18	-	18
- Profile survey for main and lateral canal	km	29.0	10,000	290	-	290
- Core drilling at damsite & spillway	m	60.0	4,000	240	168	72
- Test pit at borrow area	no.	8	3,000	24	-	24
- Laboratory test	L.S.	-	-	28	22	6
Sub - total				1,090	190	900
Total				15,290	1,560	13,730

Table G-2-6 ESTIMATION FOR CONSULTING SERVICES

Description	Unit	Quantity	Rate (¥)	Amount (¥ '000)
1. Detailed Design				
1) Foreign Currency				
- Remuneration of Foreign Experts	month	100	200,000	20,000
- Remuneration of Local Experts	month	70	80,000	5,600
- International Travel Expenses	trip	18	30,000	540
- Reimbursable Cost	L.S.	-	-	1,360
Sub - total				27,500
2) Local Currency				
- Consultants per Diem, Foreifn	month	88	21,000	1,848
- - ditto - , Local	month	70	21,000	1,470
- Living Allowance, Foreign	month	88	20,000	1,760
- - ditto - , Local	month	70	15,000	1,050
- Local Transportation (4-wheel drive car)	unit-month	50	50,000	2,500
- Printing of Reports	L.S.	-	-	1,200
- Miscellaneous	L.S.	-	-	72
Sub - total				9,900
Total				37,400
2. Construction Supervision				
1) Foreign Currency				
- Remuneration of Foreign Experts	month	116	200,000	23,200
- Remuneration of Local Experts	month	128	80,000	10,240
- International Travel Expenses	trip	10	30,000	300
- Reimbursable Cost	L.S.	-	-	260
Sub - total				34,000
2) Local Currency				
- Consultants per Diem, Foreign	month	116	21,000	2,436
- - ditto - , Local	month	128	21,000	2,688
- Printing of Reports	L.S.	-	-	500
- Miscellaneous	L.S.	-	-	276
Sub - total				5,900
Total				39,900
Grand-Total				77,300

Table G-2-7 ESTIMATION FOR CONSTRUCTION EQUIPMENT RATE

Description	Capital Cost (1) (฿ '000)	Life Time (2) (hr)	Depreciation Cost (3) (฿ /hr)	Repair Cost Rate (4) (%)	Repair Cost F/C (5) (฿ /hr)	Repair Cost L/C (6) (฿ /hr)	Administration (7) (฿ /hr)	Total F/C (8) (฿ /hr)	Total L/C (9) (฿ /hr)	Fuel & Lubricant Fuel (l/hr)	Fuel & Lubricant F/C (฿ /hr)	Fuel & Lubricant L/C (฿ /hr)	Operator (฿ /hr)
Bulldozer, 11 ton, 108 PS	1,100	6,600	150.0	1.00	133.3	33.3	11.7	283.3	45.0	14.0	97.4	24.4	30.7
-ditto- , 21 ton, 211 PS	2,240	6,600	305.5	1.05	285.1	71.3	24.9	590.6	96.2	26.0	181.0	45.2	30.7
-ditto- , 32 ton, 319 PS	3,500	7,200	437.5	1.05	408.3	102.1	35.7	845.8	137.8	40.0	278.4	69.6	30.7
Tractor Shovel, 1.2 m^3, 76 PS	1,000	6,000	150.0	0.90	120.0	30.0	10.5	270.0	40.5	8.7	60.6	15.1	30.7
- ditto - , 1.8 m^3, 138 PS	1,400	6,600	190.9	1.05	178.2	44.5	15.6	369.1	60.1	16.0	111.4	27.8	30.7
- ditto - , 2.2 m^3, 197 PS	1,960	7,200	245.0	1.05	228.7	57.2	20.0	473.7	77.2	20.7	144.1	36.0	30.7
Backhoe Shovel, 0.4 m^3, 85 PS	1,050	6,500	145.4	0.75	96.9	24.2	8.5	242.3	32.7	9.4	65.4	16.4	30.7
- ditto - , 0.8 m^3, 135 PS	1,900	6,500	263.1	0.75	175.4	43.8	15.3	438.5	59.1	15.0	104.4	26.1	30.7
Dump Truck, 8 ton, 260 PS	550	6,400	77.3	0.80	55.0	13.8	6.9	132.3	20.7	8.5	59.2	14.8	13.4
-ditto- , 11 ton, 320 PS	800	6,800	105.9	0.80	75.3	18.8	9.4	181.2	28.2	11.0	76.6	19.1	13.4
-ditto- , 18 ton, 230 PS	1,860	7,500	223.2	0.90	178.6	44.6	15.6	401.8	60.2	23.8	165.6	41.4	13.4
Tired Roller, 20 ton, 100 PS	750	6,300	107.1	0.80	76.2	19.0	6.7	183.3	25.7	5.6	39.0	9.7	30.7
Tamping Roller, 15 ton	650	6,300	92.9	0.75	61.9	15.5	3.9	154.8	19.4	-	-	-	-
Vibrating Roller, 8 ton, 86 PS	950	4,500	190.0	0.80	135.1	33.8	11.8	325.1	45.6	9.4	65.4	16.4	30.7

Table G-2-8 UNIT RATE OF ON-FARM WORK (per ha)

(unit : ₱)

Description	Unit	Quantity	F/C	L/C	Total
1. Ordinary Service Unit					
Farm Ditch	m	40	230	600	830
Drain	m	60	-	2	2
Related Structure	L.S.	-	245	273	518
Total			475	875	1,350
2. Muban Cooperative Service Unit					
Farm Ditch	m	48	276	720	996
Drain	m	72	-	3	3
Related Structure	L.S.	-	294	327	621
Total			570	1,050	1,620

Note : Common labor cost is excluded because on-farm work will be carried out by farmer association itself.

Table G-2-9 (1) CONSTRUCTION COST OF MUBAN COMMUNAL FACILITIES
FOR LAM PLAI MAT SUB- PROJECT

(฿ '000)

Description	Unit	Quantity	Unit Rate			Amount		
			F/C	L/C	Total	F/C	L/C	Total
1. Pond								
- Type I - A	place	7	254	199	453	1,778	1,393	3,171
- Type I - B	place	4	276	212	488	1,104	848	1,952
- Type I - C	place	1	150	168	318	150	168	318
- Type II - A	place	10	360	242	602	3,600	2,420	6,020
- Type II - B	place	2	376	255	631	752	510	1,262
- Type III - A	place	4	485	280	765	1,940	1,120	3,060
- Type III - C	place	3	208	203	411	624	609	1,233
Sub - total						9,948	7,068	17,016
2. Well for Drinking Water	place	354	0	3	3	0	1,062	1,062
3. Miscellaneous	L.S.	-	-	-	-	122	100	222
Total						10,070	8,230	18,300

Note : I ... Area 0.8 ha, II ... Area 1.6 ha, III ... Area 2.4 ha
A ... Upland Constructed, B ... Lowland Constructed, C ... Improved

Table G-2-9 (2) CONSTRUCTION COST OF MUBAN COMMUNAL FACILITIES
FOR NONG LUM PUK AND HUAI PHLU SUB-PROJECT

(฿ '000)

Description	Unit	Quantity	Unit Rate			Amount		
			F/C	L/C	Total	F/C	L/C	Total
I. Nong Lum Puk								
1. Pond								
- Type III - A	place	1	485	280	765	485	280	765
- Type III - C	place	1	208	203	411	208	203	411
Sub - total						693	483	1,176
2. Well for Drinking Water	place	30	0	3	3	0	90	90
3. Miscellaneous	L.S.	-	-	-	-	17	17	34
Total						710	590	1,300
II. Huai Phlu								
1. Pond								
- Type I - A	place	3	254	199	453	762	597	1,359
- Type I - B	place	3	276	212	488	758	636	1,464
- Type II - A	place	1	360	242	602	360	242	602
Sub - total						1,880	1,475	3,425
2. Well for Drinking Water	place	31	0	3	3	0	93	93
3. Miscellaneous	L.S.	-	-	-	-	50	32	82
Total						2,000	1,600	3,600

Table G-2-10 Disbursement Schedule of Lam Plai Mat Sub-Project

(Unit : ฿ '000)

Description	(T o t a l)			1 9 8 5			1 9 8 6			1 9 8 7			1 9 8 8		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
A. Major Work															
1. Preparatory Work	2,851	8,533	11,384	-	-	-	-	-	-	2,851	8,533	11,384	-	-	-
2. Dam															
- Temporary Work	10,144	12,760	22,904	-	-	-	-	-	-	6,086	7,656	13,742	4,058	5,104	9,126
- Foundation Treatment	19,078	6,510	25,588	-	-	-	-	-	-	3,816	1,302	5,118	11,447	3,906	15,353
- Dam Enbankment	72,707	30,839	103,546	-	-	-	-	-	-	-	-	-	29,085	12,355	41,418
- Sillway	34,716	28,210	62,926	-	-	-	-	-	-	-	-	-	5,472	2,821	6,293
- Intake Facility	8,699	5,283	13,982	-	-	-	-	-	-	-	-	-	4,350	2,642	6,992
Sub - Tatol	145,344	83,602	228,946	-	-	-	-	-	-	9,902	8,958	18,860	52,409	26,808	79,218
3. Canal System															
- Diversion Weir	15,840	14,480	30,320	-	-	-	-	-	-	-	-	-	-	-	-
- Sra Ta Kien	8,447	13,681	22,128	-	-	-	-	-	-	-	-	-	845	1,368	2,213
- Soeng Sang	7,912	12,822	20,734	-	-	-	-	-	-	-	-	-	792	1,282	2,074
- Pa Kham	14,055	22,780	36,835	-	-	-	-	-	-	-	-	-	4,217	6,833	11,050
- Thai Charoen	30,705	49,758	80,463	-	-	-	-	-	-	-	-	-	9,210	14,929	24,139
Sub - Total	76,959	113,521	190,480	-	-	-	-	-	-	-	-	-	15,064	24,412	39,476
4. Advanced Payment	28,145	25,707	53,852	-	-	-	-	-	-	28,145	25,707	53,852	-	-	-
5. Retension Money	28,145	25,706	53,851	-	-	-	-	-	-	-	-	-	-	-	-
Total	281,444	257,069	538,513	-	-	-	-	-	-	40,898	43,198	84,096	67,473	51,220	118,693
B. On-Farm and Muban	14,470	16,330	30,800	-	-	-	-	-	-	-	-	-	5,788	6,532	12,320
C. O/M Equipment	12,830	-	12,830	-	-	-	-	-	-	-	-	-	-	-	-
D. Right-of-way	-	1,880	1,880	-	-	-	-	-	-	-	940	940	-	940	940
E. Survey & Investigation	1,210	12,390	13,600	-	9,370	9,370	1,210	3,020	4,230	-	-	-	-	-	-
F. Detailed Design	24,761	8,914	33,675	2,476	891	3,367	22,285	8,023	30,308	-	-	-	-	-	-
G. Supervision	30,613	5,312	35,925	-	-	-	-	-	-	6,123	1,063	7,186	9,184	1,594	10,778
H. Administration	13,500	18,000	31,500	1,350	1,800	3,150	2,025	2,700	4,725	2,025	2,700	4,725	2,025	2,700	4,725
Base Cost	378,828	319,895	698,723	3,825	12,061	15,887	25,520	13,743	39,263	49,046	47,901	96,947	84,470	62,986	147,456
I. Physical Contingencies	37,883	31,990	69,873	383	1,206	1,589	2,552	1,374	3,926	4,905	4,790	9,695	8,447	6,299	14,746
Sub - Total	416,711	351,885	768,596	4,209	13,267	17,476	28,072	15,117	43,189	53,951	52,691	106,642	92,917	69,285	162,202
J. Price Contingencies	191,263	204,540	395,803	770	2,640	3,410	7,102	4,460	11,562	17,750	21,024	38,774	37,910	35,335	73,245
Grand - total	607,974	556,425	1,164,399	4,979	15,907	20,886	35,174	19,577	54,751	71,701	73,715	145,416	130,827	104,620	235,447

(Contn'd) Table G-2-10 Disbursement Schedule of Lam Plai Mat Sub-Project

(Unit : ฿ '000)

Description	1989			1990			1991		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
A. Major Work									
1. Preparatory Work	-	-	-	-	-	-	-	-	-
2. Dam									
- Temporary Work	-	-	-	-	-	-	-	-	-
- Foundation Treatment	3,816	1,302	5,118	-	-	-	-	-	-
- Dam Embankment	36,354	15,420	51,774	7,270	3,084	10,354	-	-	-
- Sillway	27,775	22,568	50,341	3,471	2,821	6,292	-	-	-
- Intake Facility	3,479	2,113	5,592	870	528	1,398	-	-	-
Sub - Tatol	71,422	41,403	112,825	11,611	6,433	18,044	-	-	-
3. Canal System									
- Diversion Weir	11,088	10,136	21,224	4,752	4,344	9,096	-	-	-
- Sra Ta Kien	5,912	9,577	15,489	1,690	2,736	4,426	-	-	-
- Soeng Sang	5,538	8,975	14,513	1,582	2,565	4,147	-	-	-
- Pa Kham	7,028	11,391	18,419	2,810	4,556	7,366	-	-	-
- Thai Charoen	15,353	24,878	40,231	6,142	9,951	16,093	-	-	-
Sub - Total	44,919	64,957	109,876	16,976	24,152	41,128	-	-	-
4. Advanced Payment	-	-	-	-	-	-	-	-	-
5. Retension Money	-	-	-	-	-	-	28,145	25,706	53,851
Total	116,341	106,360	222,701	28,587	30,585	59,172	28,145	25,706	53,851
B. On-Farm and Muban	5,788	6,532	12,320	2,894	3,266	6,160	-	-	-
C. O/M Equipment	6,415	-	6,415	6,415	-	6,415	-	-	-
D. Right-of-way	-	-	-	-	-	-	-	-	-
E. Survey & Investigation	-	-	-	-	-	-	-	-	-
F. Detailed Design	-	-	-	-	-	-	-	-	-
G. Supervision	9,183	1,593	10,776	6,123	1,062	7,185	-	-	-
H. Administration	2,025	2,700	4,725	2,025	2,700	4,725	2,025	2,700	4,725
Base Cost	139,752	117,185	256,937	46,044	37,613	83,657	30,170	28,406	58,576
I. Physical Contingencies	13,975	11,719	25,694	4,604	3,762	8,366	3,017	2,840	5,857
Sub - Total	153,727	128,904	282,631	50,648	41,375	92,023	33,187	31,246	64,433
J. Price Contingencies	75,787	81,338	157,125	29,477	31,528	61,005	22,467	28,217	50,684
Grand - total	229,514	210,242	439,756	80,125	72,903	153,028	55,654	59,463	115,117

Table G-2-11 Disbursement Schedule of Nong Lum Puk Sub-Project

(Unit : B '000)

Description	(TOTAL)			1985			1986			1987			1988			1989		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
A. Major Work																		
1. Preparatory Work	94	282	376	-	-	-	-	-	-	94	282	376	-	-	-	-	-	-
2. Dam	12,211	7,235	19,446	-	-	-	-	-	-	1,221	723	1,944	10,990	6,512	17,502	-	-	-
3. Canal System	2,160	4,080	6,240	-	-	-	-	-	-	-	-	-	2,160	4,080	6,240	-	-	-
4. Advance Payment	1,809	1,450	3,259	-	-	-	-	-	-	1,809	1,450	3,259	-	-	-	-	-	-
5. Retension Money	1,808	1,449	3,257	-	-	-	-	-	-	-	-	-	-	-	-	1,808	1,449	3,257
Total	18,082	14,496	32,578	-	-	-	-	-	-	3,124	2,455	5,579	13,150	10,592	23,742	1,808	1,449	3,257
B. On-Farm and Muban	856	854	1,710	-	-	-	-	-	-	-	-	-	856	854	1,710	-	-	-
C. O/M Equipment	430	-	430	-	-	-	-	-	-	-	-	-	430	-	430	-	-	-
D. Right-of-way	-	300	300	-	-	-	-	-	-	-	300	300	-	-	-	-	-	-
E. Survey & Investigation	160	440	600	-	-	-	160	440	600	-	-	-	-	-	-	-	-	-
F. Detailed Design	819	294	1,113	83	29	112	736	265	1,001	-	-	-	-	-	-	-	-	-
G. Supervision	1,011	176	1,187	-	-	-	-	-	-	101	18	119	910	158	1,068	-	-	-
H. Administration	450	600	1,050	23	30	53	112	150	262	135	180	315	135	180	315	45	60	105
Base Cost	21,808	17,160	38,968	106	59	165	1,008	855	1,863	3,360	2,953	6,313	15,481	11,784	27,265	1,853	1,509	3,363
I. Physical Contingencies	2,181	1,716	3,897	11	6	17	101	86	187	336	295	631	1,548	1,178	2,726	185	151	336
Sub - Total	23,989	18,876	42,865	117	65	182	1,109	941	2,050	3,696	3,248	6,944	17,029	12,962	29,991	2,038	1,660	3,699
J. Price Contingencies	9,471	9,246	18,717	21	13	34	281	278	559	1,216	1,296	2,512	6,948	6,611	13,559	1,005	1,048	2,053
Grand - Total	33,460	28,122	61,582	138	78	216	1,390	1,219	2,609	4,912	4,544	9,456	23,977	9,573	43,550	3,043	2,708	5,751

Table G-2-12 Disbursement Schedule of Huai Phlu Sub-Project

(Unit :B'000)

Description	(TOTAL)			1985			1986			1987			1988			1989			1990			1991		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
A. Major Work																								
1. Preparatory Work	222	666	888	-	-	-	-	-	-	-	-	-	222	666	888	-	-		-	-	-	-	-	-
2. Dam	20,148	13,788	33,936	-	-	-	-	-	-	-	-	-	2,015	1,379	3,394	16,119	11,030	27,149	2,014	1,379	3,393	-	-	-
3. Canal System	4,581	8,827	13,408	-	-	-	-	-	-	-	-	-	459	883	1,342	3,664	7,062	10,726	458	882	1,340	-	-	-
4. Advance Payment	3,119	2,910	6,029	-	-	-	-	-	-	-	-	-	3,119	2,910	6,029	-	-	-	-	-	-	-	-	-
5. Retension Money	3,119	2,909	6,028	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,119	2,909	6,028
Total	31,189	29,100	60,289	-	-	-	-	-	-	-	-	-	5,815	5,838	11,653	19,783	18,092	37,875	2,472	2,261	4,733	3,119	2,909	6,028
B. On-Farm and Muban	2,333	2,227	4,560	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2,333	2,227	4,560	-	-	-
C. O/M Equipment	1,000	-	1,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,000	-	1,000	-	-	-
D. Right-of-way	-	160	160	-	-	-	-	-	-	-	160	160	-	-	-	-	-	-	-	-	-	-	-	-
E. Survey & Investigation	190	900	1,090	-	-	-	190	900	1,090	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Detailed Design	1,921	692	2,613	192	69	261	1,729	623	2,352	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
G. Supervision	2,375	412	2,787	-	-	-	-	-	-	258	41	279	950	165	1,115	950	165	1,115	257	41	278	-	-	-
H. Administration	1,050	1,400	2,450	53	70	123	210	280	490	210	280	490	210	280	490	210	280	490	105	140	245	52	70	122
Base Cost	40,058	34,891	74,949	245	139	384	2,129	1,803	3,932	448	481	929	6,975	6,283	13,258	20,943	18,537	39,480	6,147	4,669	10,816	3,171	2,979	6,150
I. Physical Contingencies	4,006	3,489	7,495	25	14	39	215	180	393	45	48	93	698	628	1,326	2,094	1,854	3,948	614	467	1,081	317	298	615
Sub - Total	44,064	38,380	82,444	270	183	423	2,342	1,983	4,325	493	529	1,022	7,673	6,911	14,584	23,037	20,391	43,428	6,761	5,136	11,897	3,488	3,277	6,765
J. Price Contingencies	21,588	24,092	45,680	49	30	79	593	585	1,178	162	211	373	3,131	3,525	6,656	11,357	12,867	24,224	3,935	3,914	7,849	2,361	2,960	5,321
Grand - Total	65,652	62,472	128,124	319	183	502	2,935	2,568	5,503	655	740	1,395	10,804	10,436	21,240	34,394	33,258	67,652	10,696	9,050	19,746	5,849	6,237	12,086