Alternative Plan 2 is recommendable based on the above comparison of the three alternatives.

1.4.7. Improvement Plan of Pulau Gambar Canal.

It was planned to improve the lower reaches of Pulau Gambar Canal, ranging from the confluence with the Ular river up to the spillway at Sennah. On the basis of the study mentioned in the previous paragraph 1.4.6, it was decided from the economic viewpoint to take an enclosing levee system for protecting the lower part of the Pulau Gambar area and back-water levees on the lower reaches of the canal for confining the back-water from the Ular. The back-water levees were planned on a stretch downstream from 10.8 km. The longitudinal profile is shown in Fig.1-4-21.

The cross section of this canal was planned in such a way that 20 m^3/s out of 25 m^3/s can be carried by the low-water channel providing for the future. Typical cross sections are shown in Fig.1-4-22.

1.5. Proposed River Improvement Works.

General location of construction works is shown in Fig.1-4-1 and the main works for proposed river improvement are as follows.

a. Ular river.

Dredging works ; from -12.25 to 19.00 km; length = 31,040 m.

Excavation works ; from -11.25 to 19.00 km; length = 29,980 m.

Embankment works are listed in the following table.

Section	Left Side		Right Side	
	New levee	Heightening	New levee	Heightening
- 12.25 km to - 11.25 km	1,060m	-	1,060m	-
- 11.25 km to - 7.5 km	3,795m	-	3,795m	-
- 7.5 km to - 2.5 km	-	4,860m	4,860m	-
- 2.5 km to 0.0 km	-	2,720m	-	2,720m
0.0 km to 10.0 km	-	9,820m	-	9,820m
10.0 km to 15.0 km	-	5,115m	5,115m	-
15.0 km to 19.0 km	-	-	3,670m	-
19.0 km to 22.65 km	-	-	-	3,545m
Total length	4,855m	22,515m	18,500m	16,085m

Revetment works ; total length = 1,800 m.

b. Pulau Gambar Canal.

Dredging works ; length = 3,500 m.

Embankment works; length = 3,500 m.

Quantity of works estimated based on the above-mentioned lengths and the proposed cross sections are shown in Fig.1-4-26 by section shown in the figure. The total quantity of works are summarized as follows.

a. Ular river.

Dredging works	:	727,400 m^3
Excavation works	:	934,700 m^3
Embankment works	:	1,243,400 m^3
Drains works	:	135,000 m^3
Revetment works	:	1,800 m^3

b. Pulau Gambar Canal.

Dredging works	:	5,600 m^3
Embankment works	:	95,200 m^3
Sluice	:	1 place

Note :

Embankment	1,338,400 m^3
Ular river	
New	874,500 m^3
Heightening	368,900 m^3
Pulau Gambar canal	
New	0
Heightening	95,200 m^3

Table 1-3-1 Monthly Rainfall

(Unit: mm)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	1972										125	258	100
	1973	183	39	296	146	180	130	188	106	39	-	101	86
Tiga	1974	72	207	97	129	207	146	214	33	326	34	221	74
Runggu	1975	91	107	179	-	117	50	160	31	202	54	176	203
	1976	66	213	128	-	117	120	40	138	100	175	100	213
	1977	63	135	8	109	17	40	70					
	1972												
	1973				260	215	129	142	101	134	502	151	422
Sarang	1974												
Padang	1975	106	211	233	260	71	94	149	15	281	-	254	193
	1976	153	306	154	246	140	300	86	206	78	255	230	-
	1977	-	-	-	-	60	154	-	70				
	1972									248	214	-	163
	1973	319	197	403	356	254	183	159	168	197	390	159	-
Gunung	1974	172	143	-	-	148	204	259	75	625	112	370	185
Mariah	1975	134	198	374	287	-	60	584	42	273	192	419	208
	1976	214	373	227	495	255	190	143	383	112	-	364	296
	1977	181	259	253	163	319	200	136					
	1972									53	312	368	152
	1973	265	107	263	314	185	189	19	124	289	624	199	526
Negeri	1974	146	319	250	344	190	185	160	343	187	110	257	57
Dolok	1975	98	149	357	334	218	92	185	102	242	376	229	248
	1976	109	53	142	64	-	48	293	445	323	132	300	389
	1977	118	153	134	222	171	71	54					
	1972										166	237	
	1973	237	67	151	149	188	212	192	122	159	261	172	692
Kota-	1974	95	141	-	-	25	25	106	93	94	122	169	49
rih	1975	41	53	48	39	64	54	111	80	221	140	99	93
	1976	17	139	60	66	31	125	89	80	196	80	-	143
	1977	4	66	26	28	25	160	67					
	1972								71	134	75	251	243
	1973	99	59	128	84	192	133	202	77	260	337	230	503
Perbau	1974	34	221	31	5	199	98	102	122	268	129	143	6
ngan	1975	217	63	73	37	71	8	35	98	367	290	224	343
	1976	50	19	11	112	160	78	162	87	109	113	125	155
	1977	15	158	65	38	28	133	55					

Table 1-3-2(1) Observed Data on Tide Level

	Pantai Labu[1]		Pantai Labu[2]		Sialang Buah	
	Reading	EL(U P m)	Reading	EL(U P m)	Reading	EL(U P m)
23,Dec.						
11	2.20	-0.58			1.05	-0.75
12	2.47	-0.31	0.82	-0.33	1.40	-0.40
13	2.59	-0.19	0.90	-0.25	1.57	-0.23
14	2.53	-0.25	0.84	-0.31	1.59	-0.21
15	2.37	-0.41	0.65	-0.50	1.44	-0.36
16	2.20	-0.58	0.40	-0.75	1.23	-0.57
17	2.08	-0.70	0.28	-0.87		
18	2.02	-0.76	0.25	-0.90		
19	1.99	-0.79				
20	1.96	-0.82				
21	2.04	-0.74				
22	2.33	-0.45			1.18	-0.62
23	2.62	-0.16			1.47	-0.33
24,Dec.						
0	2.86	0.08			1.78	-0.02
1	2.93	0.15			1.94	0.14
2	2.83	0.05			1.90	0.10
3	2.60	-0.18			1.70	-0.10
4	2.38	-0.40			1.40	-0.40
5	2.16	-0.62			1.10	-0.70
6	2.04	-0.74				
7	1.97	-0.81	0.22	-0.93		
8	1.93	-0.85	0.20	-0.95		
9	1.90	-0.88	0.18	-0.97		
10	1.89	-0.89	0.18	-0.97	0.72	-1.08
11	2.08	-0.70	0.48	-0.67	0.88	-0.92
12	2.39	-0.39	0.75	-0.40	1.25	-0.55
13	2.60	-0.18	0.97	-0.18	1.55	-0.25
14	2.66	-0.12	0.98	-0.17	1.70	-0.10
15	2.49	-0.29	0.80	-0.35	1.63	-0.17
16	2.30	-0.48	0.56	-0.59	1.45	-0.35
17	2.08	-0.70	0.32	-0.83	1.17	-0.63
18	1.75	-1.03	0.23	-0.92	0.91	-0.89
19	1.93	-0.85			0.78	-1.02
20	1.92	-0.86			0.74	-1.06
21	1.91	-0.87			0.72	-1.08
22	2.11	-0.67			0.85	-0.95

Table 1-3-2(2) Observed Data on Tide Level

	Pantai Labu[1]		Pantai Labu[2]		Sialang Buah	
	Reading	EL(U P m)	Reading	EL(U P m)	Reading	EL(U P m)
24,Dec						
23	2.40	-0.38			1.20	-0.60
25,Dec						
0	2.72	-0.06			1.57	-0.23
1	2.93	0.15			1.87	0.07
2	2.99	0.21			2.00	0.20
3	2.82	0.04			1.91	0.11
4	2.55	-0.23			1.67	-0.13
5	2.28	-0.50			1.27	-0.53
6	2.10	-0.68	0.32	-0.83	1.03	-0.77
7	2.01	-0.77	0.25	-0.90	0.88	-0.92
8	1.95	-0.83	0.21	-0.94	0.80	-1.00
9	1.90	-0.88	0.20	-0.95	0.74	-1.06
10	1.90	-0.88	0.18	-0.97	0.73	-1.07
11	2.03	-0.75	0.25	-0.90	0.71	-1.09
12	2.19	-0.59	0.60	-0.55	1.03	-0.77
13	2.52	-0.26	0.89	-0.26	1.39	-0.41
14	2.70	-0.08	1.03	-0.12	1.68	-0.12
15	2.63	-0.15	0.95	-0.20	1.74	-0.06
16	2.45	-0.33	0.73	-0.42	1.60	-0.20
17	2.21	-0.57	0.48	-0.67	1.35	-0.45
18	2.04	-0.74	0.27	-0.88	1.04	-0.76
19	1.95	-0.83			0.84	-0.96
20	1.90	-0.88			0.76	-1.04
21	1.89	-0.89			0.72	-1.08
22	1.88	-0.90			0.70	-1.10

Table 1-3-3 Observed Tide Level and Predicated One at Belawan Deli

(Unit: cm)

Date	Observed			Predicted	
	Time	Reading	Tide Level	Time	Tide Level
April, 13	1	266	226	0	220
1976	7	74	34	6	60
	13	303	263	12	240
	19	93	53	18	60
14	1	280	240	0	230
	8	61	21	7	40
	14	315	275	13	260
	20	69	29	19	40
15	2	281	241	1	240
	8	62	22	7	40
	14	313	273	13	260
	21	62	22	19	40
16	3	281	241	2	240
	9	70	30	8	40
	15	314	274	14	270
	21	56	16	20	40
17	3	270	230	3	240
	9	94	54	8	50
	16	302	262	14	260
	22	69	29	21	40
18	4	257	217	3	230
	10	117	77	9	60
	17	280	240	15	250
	23	74	34	21	50
19	4	236	196	3	210
	10	138	98	9	80
	16	262	222	15	230
	23	104	64	22	60

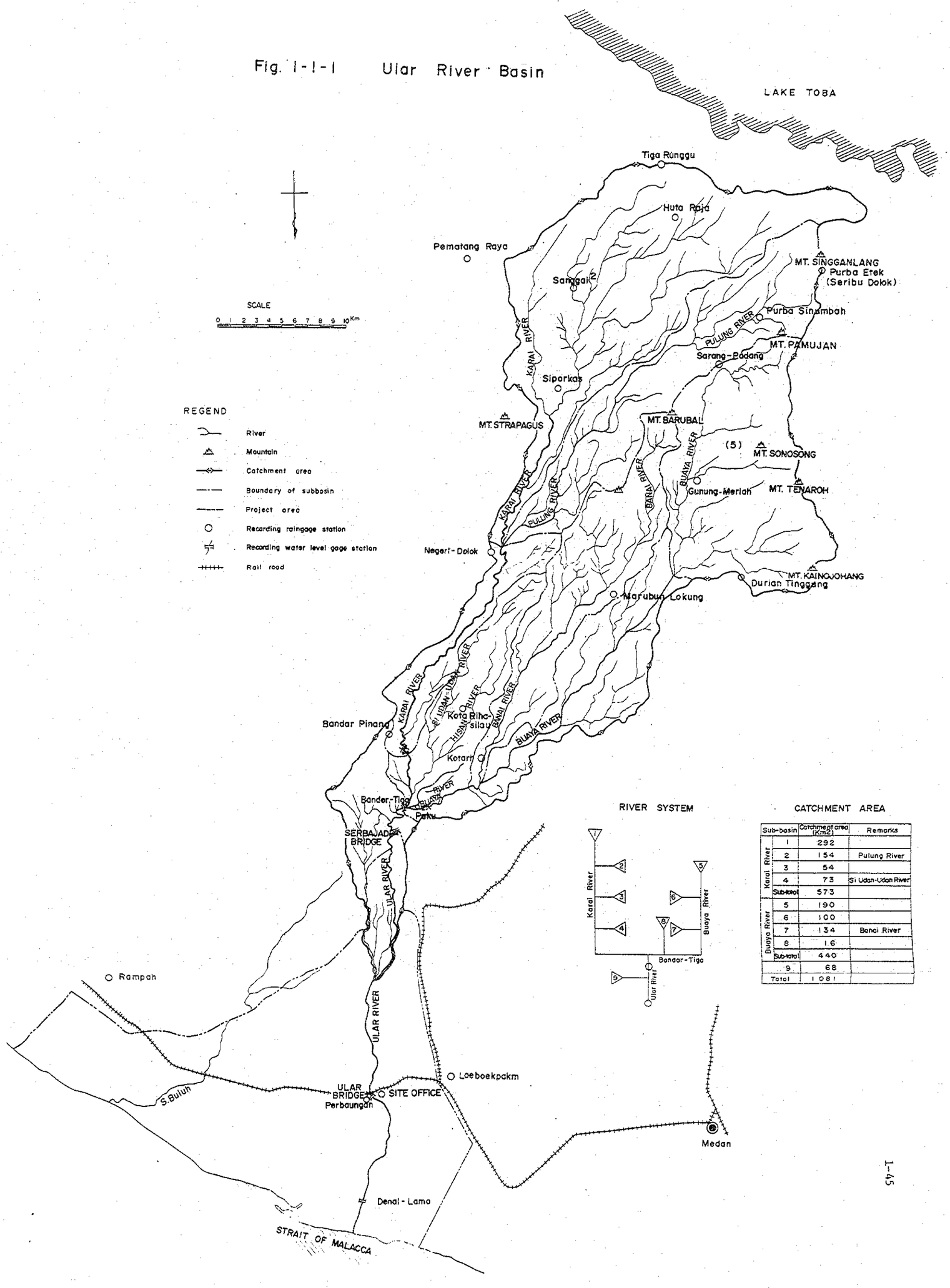
Table 1-3-4 Estimated Tide Level at the River Mouth of S. Pantai Labu

Date	At the tax office	At the River Mouth	Calculation	Date	At the tax office	At the River Mouth	Calculation
23, Dec				25, Dec			
22	-0.45		-0.54	9	-0.88	-0.95	-0.96
23	-0.16		-0.19	10	-0.88	-0.97	-0.96
24, Dec							
0	0.08		0.08	11	-0.75	-0.90	-0.88
1	0.15		0.15	12	-0.59	-0.55	-0.71
2	0.05		0.05	13	-0.26	-0.26	-0.26
3	-0.18		-0.22	14	-0.08	-0.12	-0.09
4	-0.40		-0.48	15	-0.15	-0.20	-0.18
5	-0.62		-0.75	16	-0.33	-0.42	-0.40
6	-0.74		-0.88	17	-0.57	-0.67	-0.69
7	-0.81	-0.93	-0.92	18	-0.74	-0.88	-0.87
8	-0.85	-0.95	-0.95	19	-0.83		-0.93
9	-0.88	-0.97	-0.96	20	-0.88		-0.96
10	-0.89	-0.97	-0.97	21	-0.89		-0.97
11	-0.70	-0.67	-0.86	22	-0.90		-0.97
12	-0.39	-0.40	-0.47				
13	-0.18	-0.18	-0.22				
14	-0.12	-0.17	-0.14				
15	-0.29	-0.35	-0.35				
16	-0.48	-0.59	-0.58				
17	-0.70	-0.83	-0.86				
18	-1.03	-0.92	-0.93				
19	-0.85		-0.94				
20	-0.86		-0.95				
21	-0.87		-0.96				
22	-0.67		-0.81				
23	-0.38		-0.46				
25, Dec							
0	-0.06		-0.07				
1	0.15		0.15				
2	0.21		0.21				
3	0.04		0.04				
4	-0.23		-0.27				
5	-0.50		-0.61				
6	-0.68	-0.83	-0.83				
7	-0.77	-0.90	-0.89				
8	-0.83	-0.94	-0.93				

Table 1-3-5 Observed Tide Level at Belawan Deli

Date	Record	T.L. (L.W.S)	Date	Record	T.L. (L.W.S)
23, Dec			24, Dec		
11	1.91	1.51	23	2.31	1.91
			25, Dec		
12	2.13	1.73	0	2.50	2.10
13	2.27	1.87	1	2.60	2.20
14	2.28	1.88	2	2.49	2.09
15	2.08	1.68	3	2.17	1.77
16	1.77	1.37	4	1.75	1.35
17	1.45	1.05	5	1.32	0.92
18	1.27	0.87	6	1.02	0.62
19	1.16	0.76	7	0.79	0.39
20	1.20	0.80	8	0.66	0.26
21	1.52	1.12	9	0.86	0.46
22	1.90	1.50	10	1.28	0.88
23	2.18	1.78	11	1.65	1.25
24, Dec					
0	2.42	2.02	12	1.97	1.57
1	2.61	2.21	13	2.22	1.82
2	2.64	2.24	14	2.23	1.93
3	2.42	2.02	15	2.25	1.85
4	2.00	1.60	16	1.98	1.58
5	1.59	1.19	17	1.60	1.20
6	1.25	0.85	18	1.30	0.90
7	0.95	0.55	19	1.17	0.77
8	0.85	0.45	20	1.14	0.74
9	1.18	0.78	21	1.34	0.94
10	1.51	1.11	22	1.73	1.33
11	1.85	1.45			
12	2.13	1.73			
13	2.21	1.81			
14	2.13	1.73			
15	1.89	1.49			
16	1.61	1.21			
17	1.39	0.99			
18	1.30	0.90			
19	1.28	0.88			
20	1.46	1.06			
21	1.78	1.38			
22	2.07	1.67			

Fig. I-1-1 Ular River Basin



RIVER SYSTEM

CATCHMENT AREA

Sub-basin		Catchment area (Km2)	Remarks
Karai River	1	292	
	2	154	Pulung River
	3	54	
	4	73	Si Udan-Udan River
	Sub-total	573	
Buaya River	5	190	
	6	100	
	7	134	Banai River
	8	16	
	Sub-total	440	
	9	68	
Total		1081	

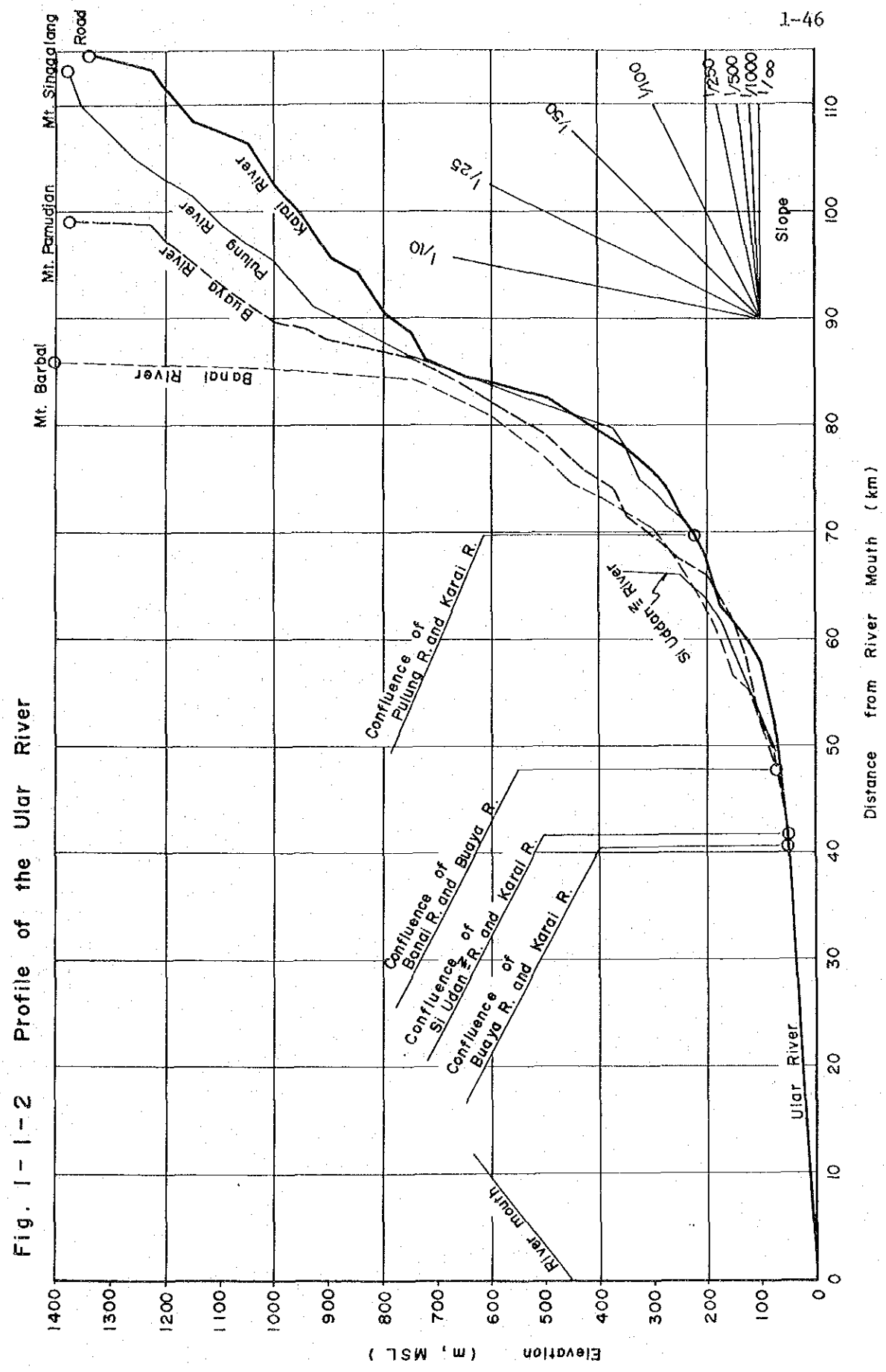
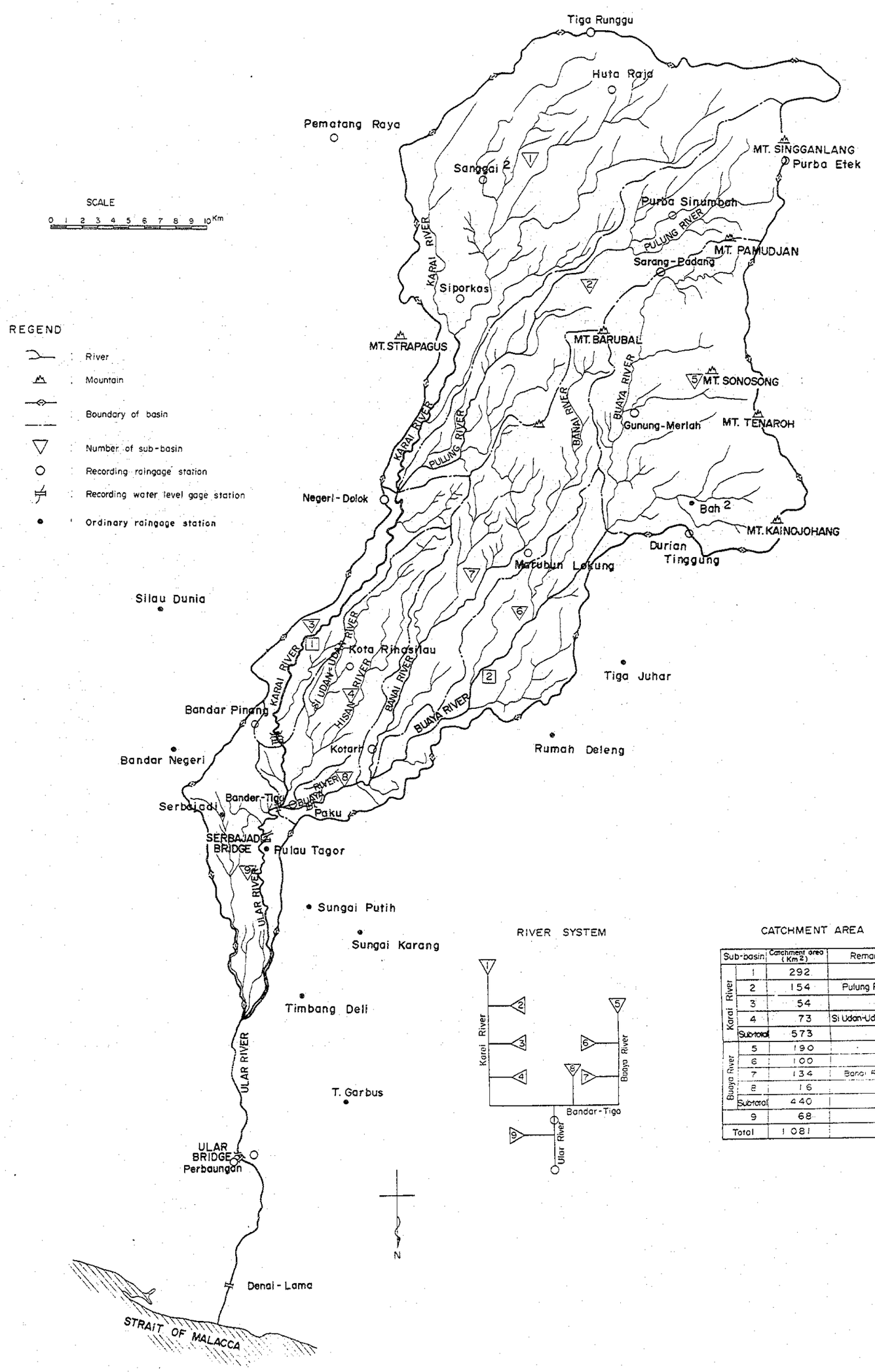


Fig. I-I-2 Profile of the Ular River

Fig. 1-3-1 Ular River Basin



RIVER SYSTEM

CATCHMENT AREA

Sub-basin		Catchment area (Km2)	Remarks
Karai River	1	292	
	2	154	Pulung River
	3	54	
	4	73	Si Udan-Udan River
	Subtotal	573	
Buaya River	5	190	
	6	100	
	7	134	Banai River
	8	16	
	Subtotal	440	
	9	68	
Total		1081	

Fig. I-3-2 Mean Annual Rainfall in the Northern Part of Sumatra

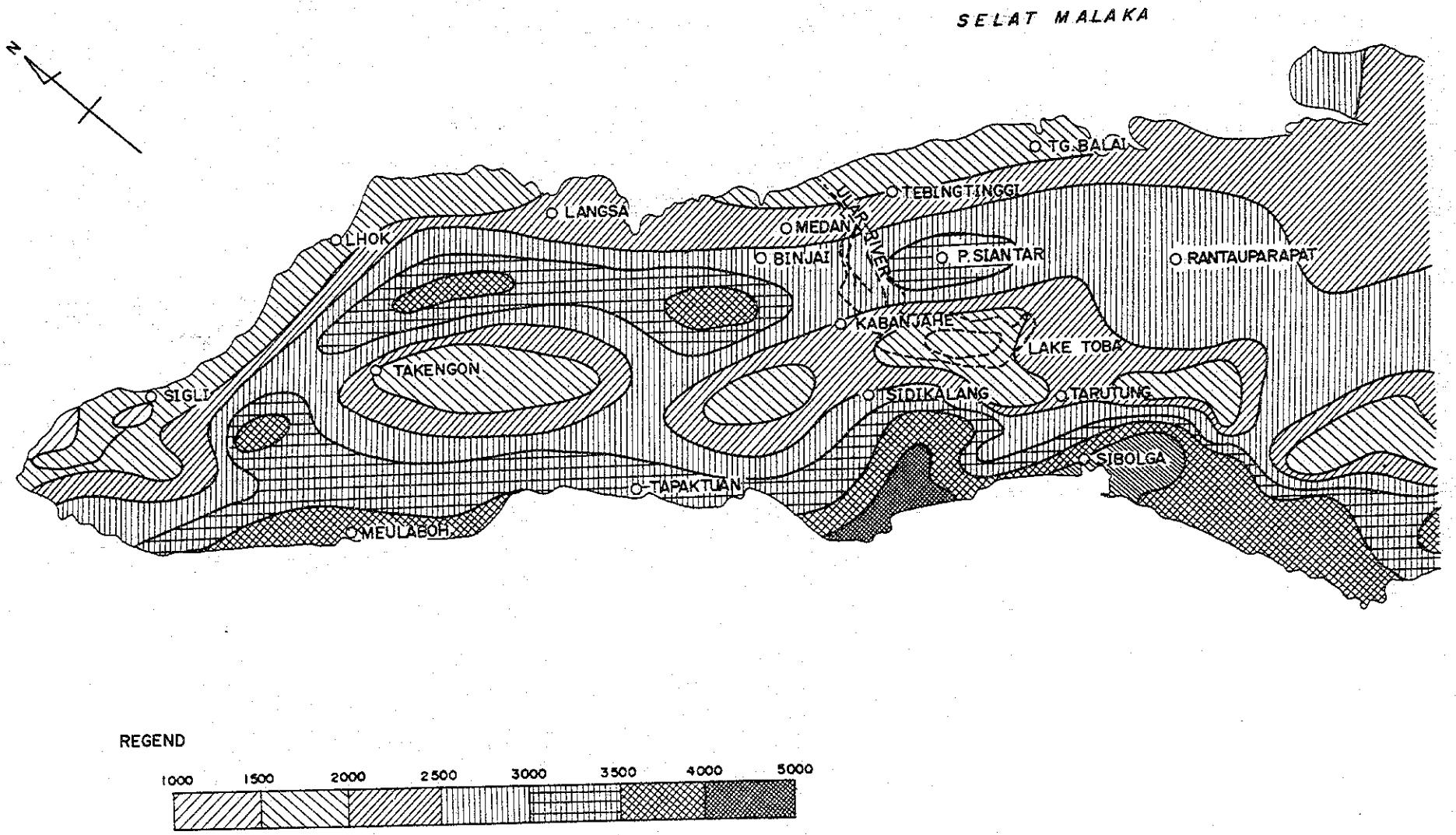


Fig. 1-3-3 Mean Monthly Rainfall (D.P.U)

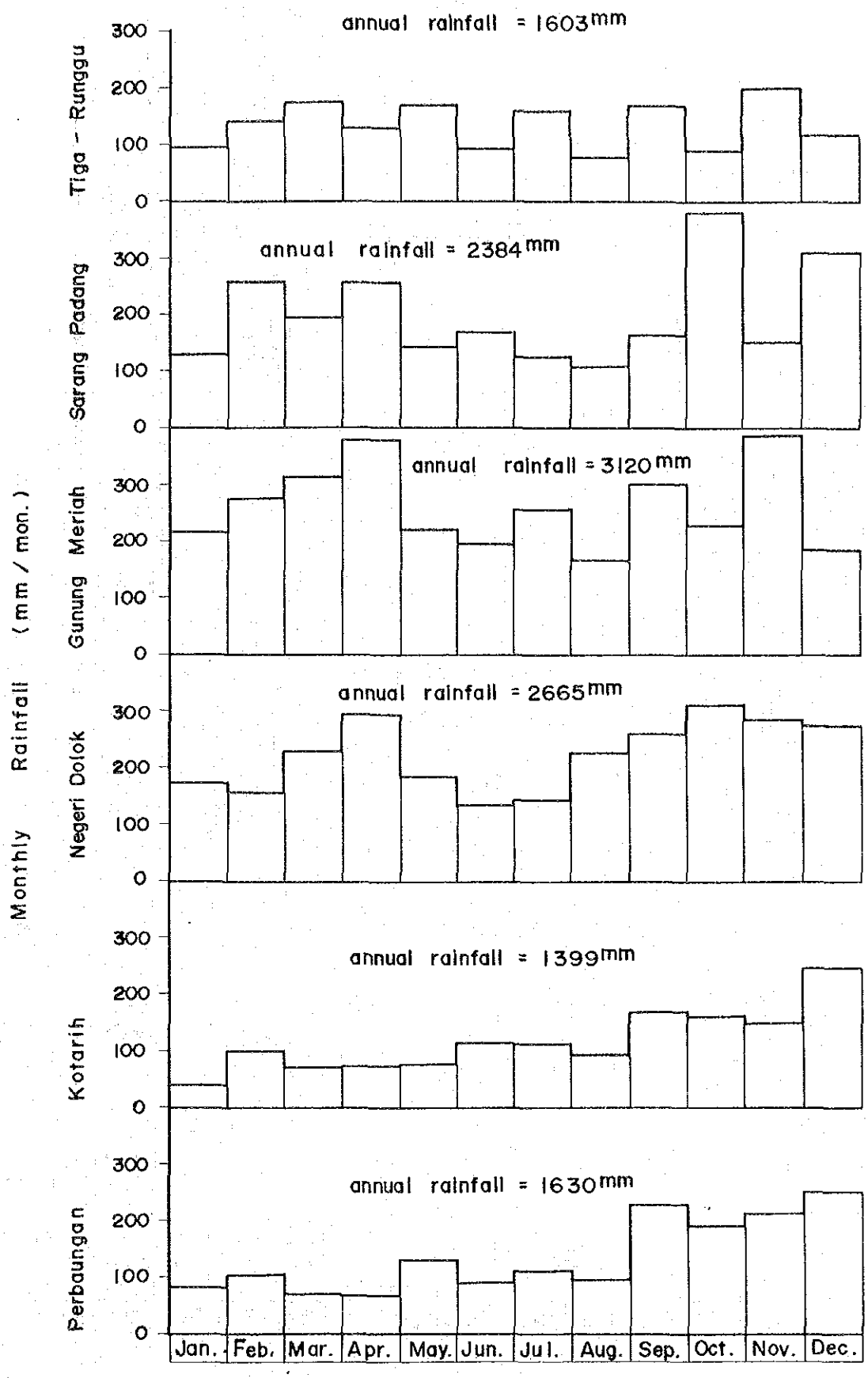


Fig. I-3-4 Mean Monthly Rainfall (P.N.P)

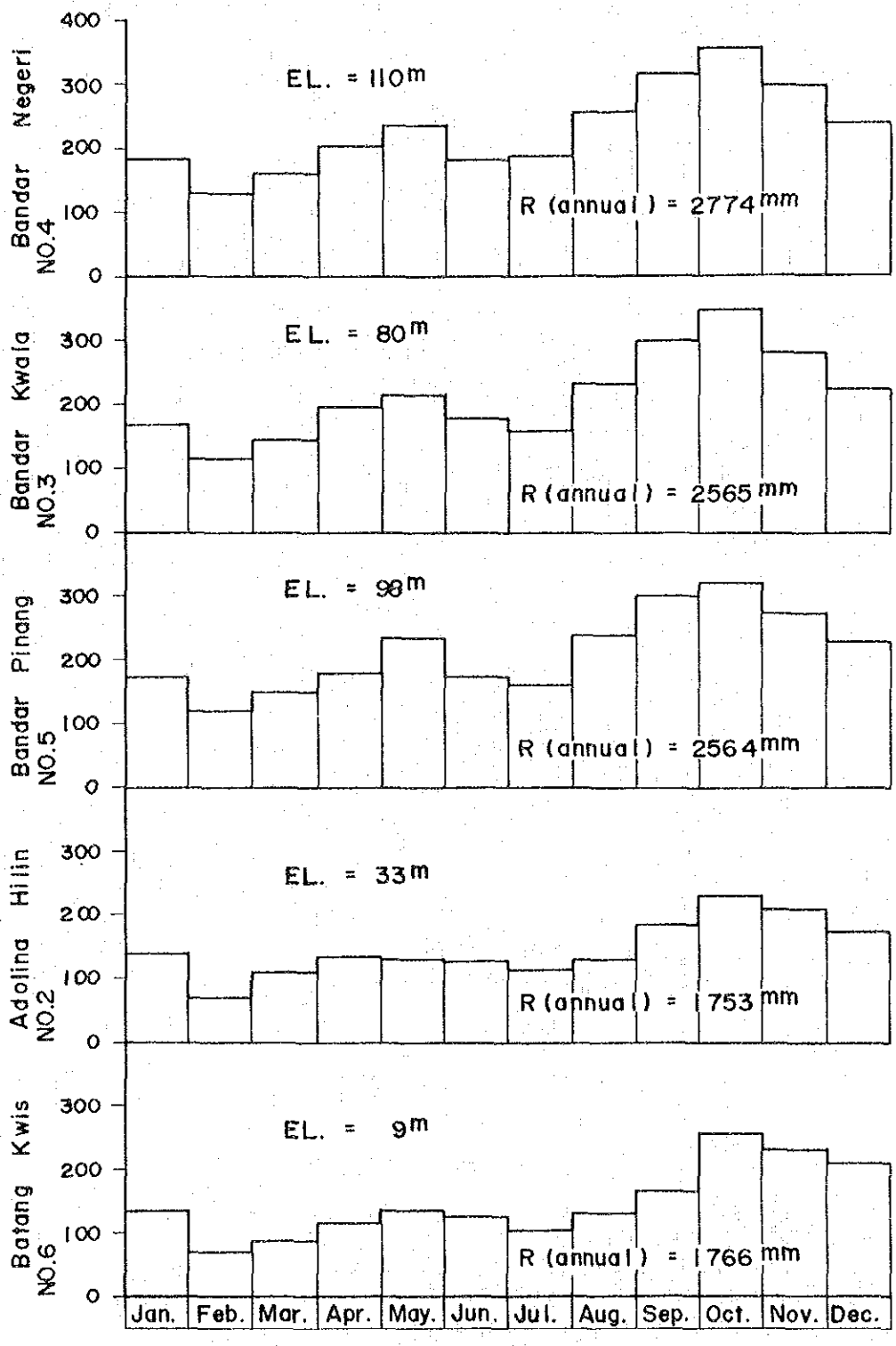


Fig. 1-3-5 Correlation of Daily Rainfall between Bandar Pinang and Bandar Kuala

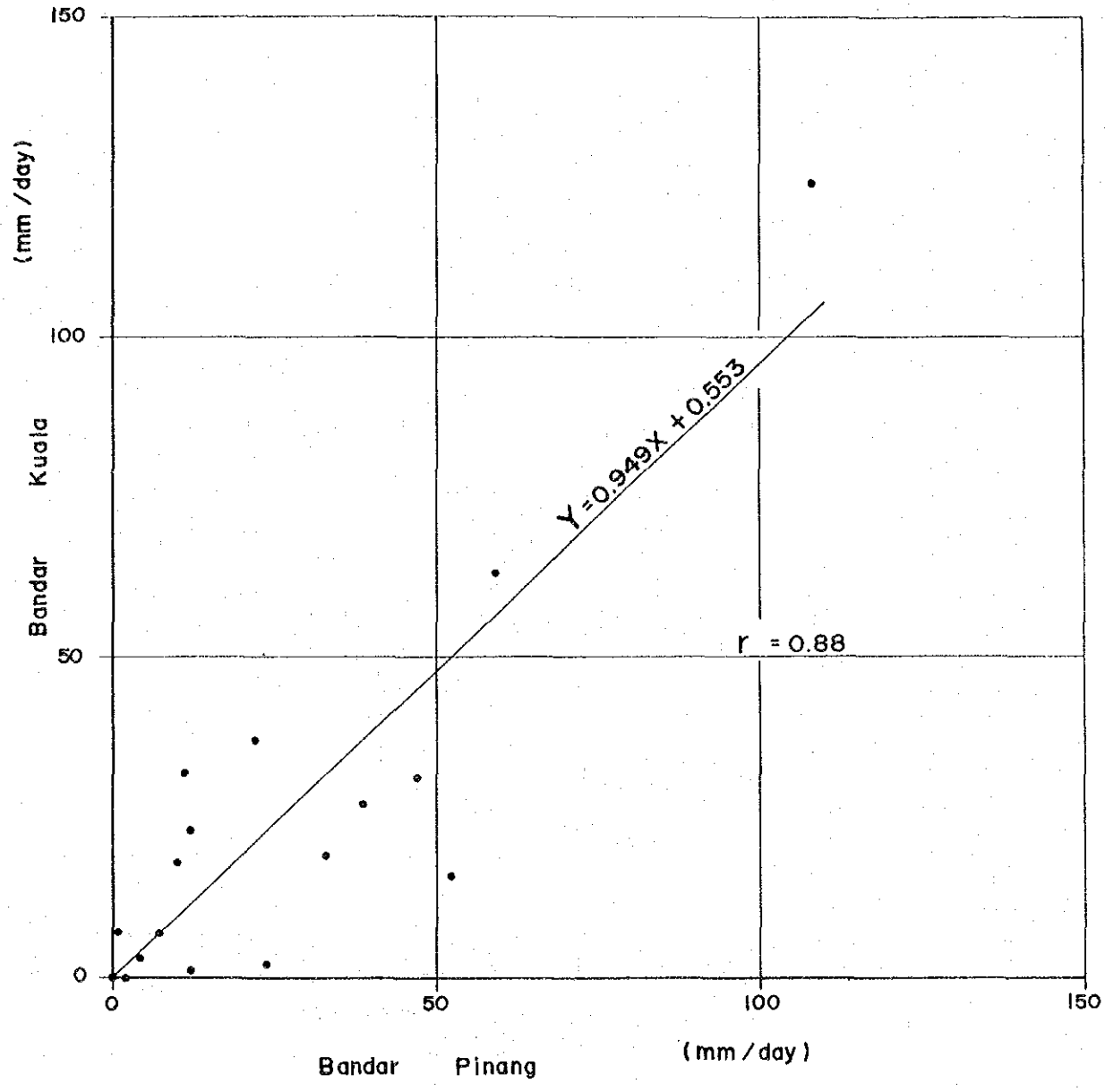


Fig.1-3-6 Correlation of Daily Rainfall between Siporkas and Sanggai-Sanggai

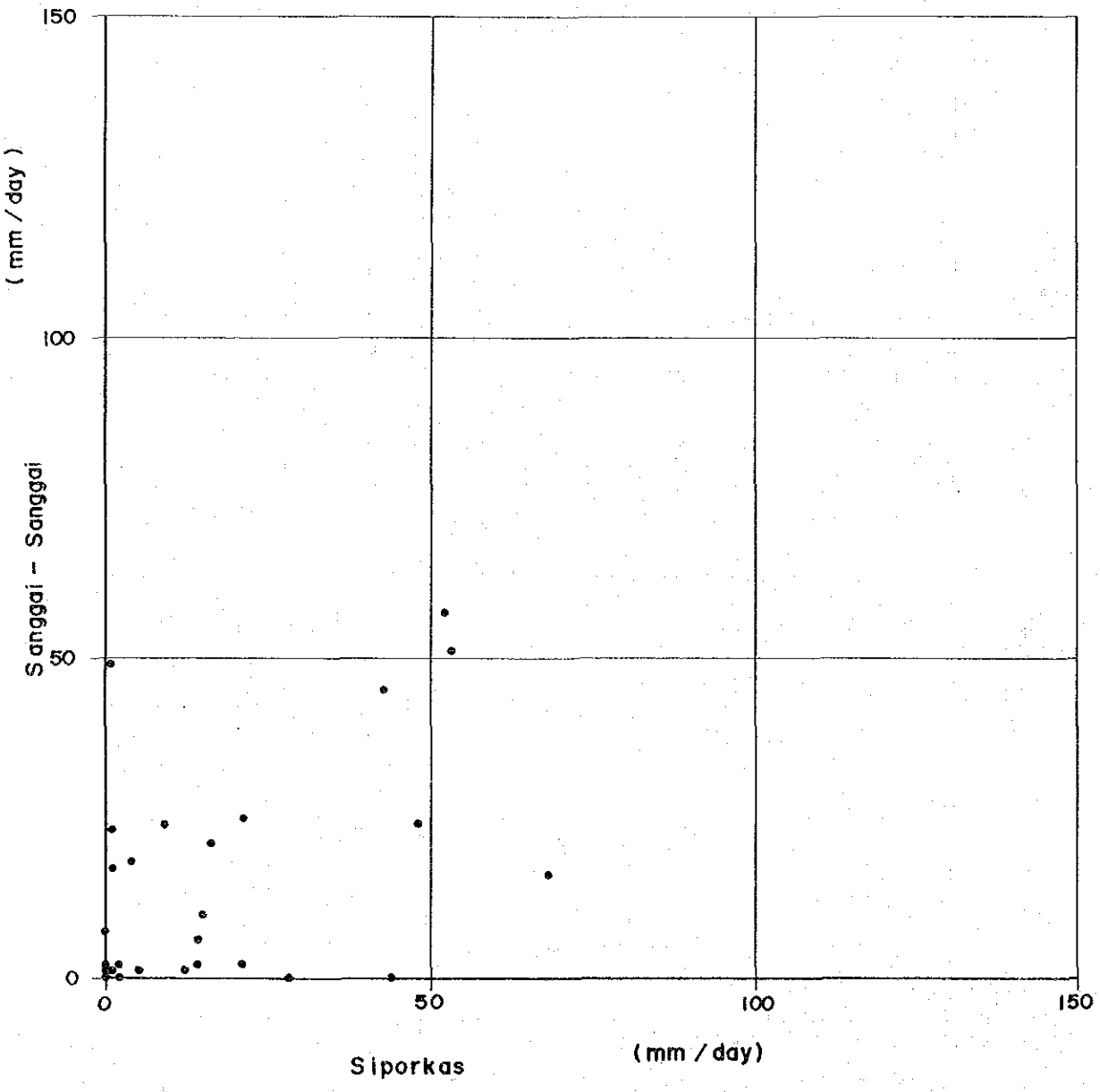


Fig. 1-3-7 Correlation of Daily Rainfall between Purba Etek and Purba Sinumbah

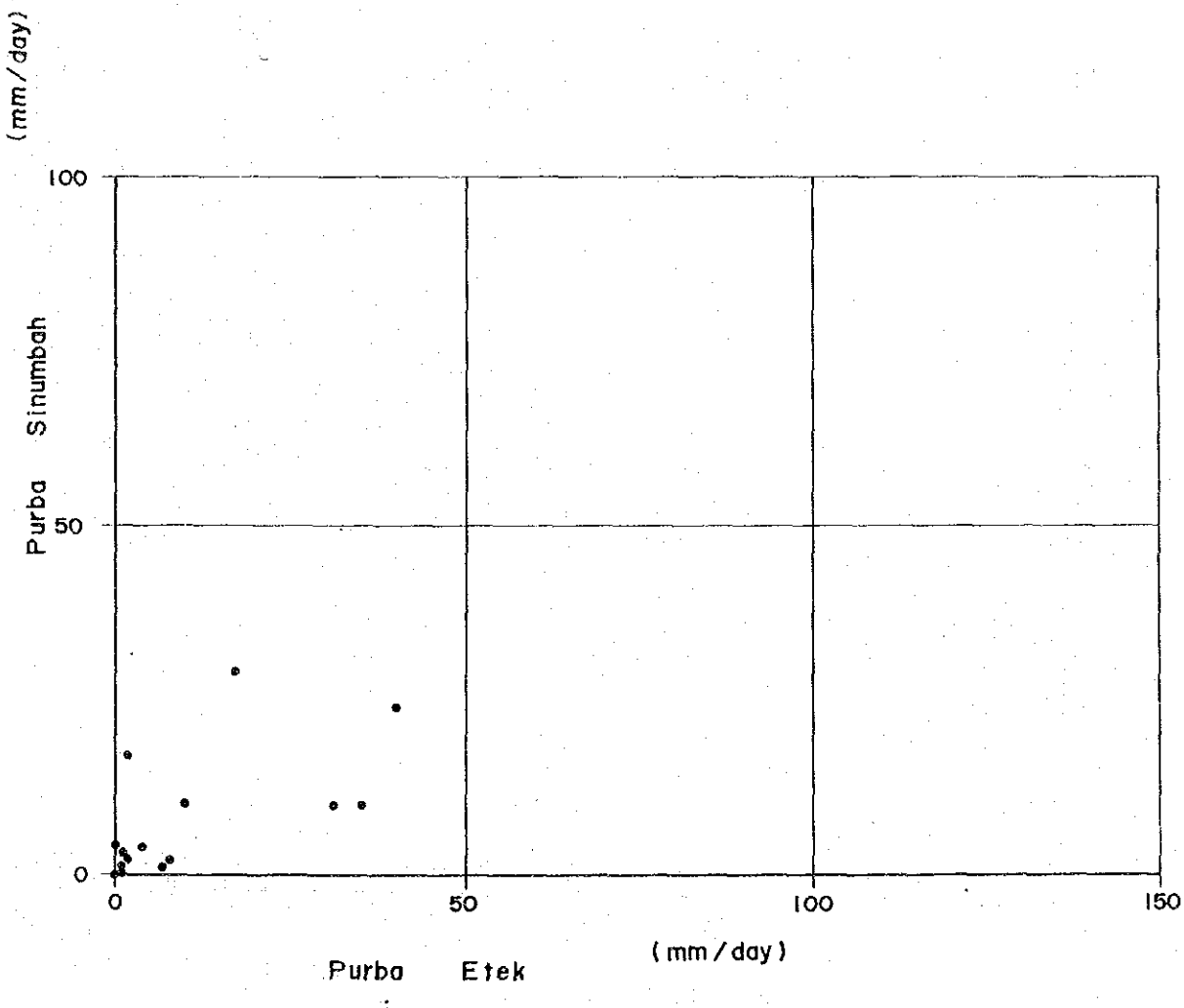


Fig. I-3-8 Correlation of Daily Rainfall between Durian Tinggung and Marubun - Lokung

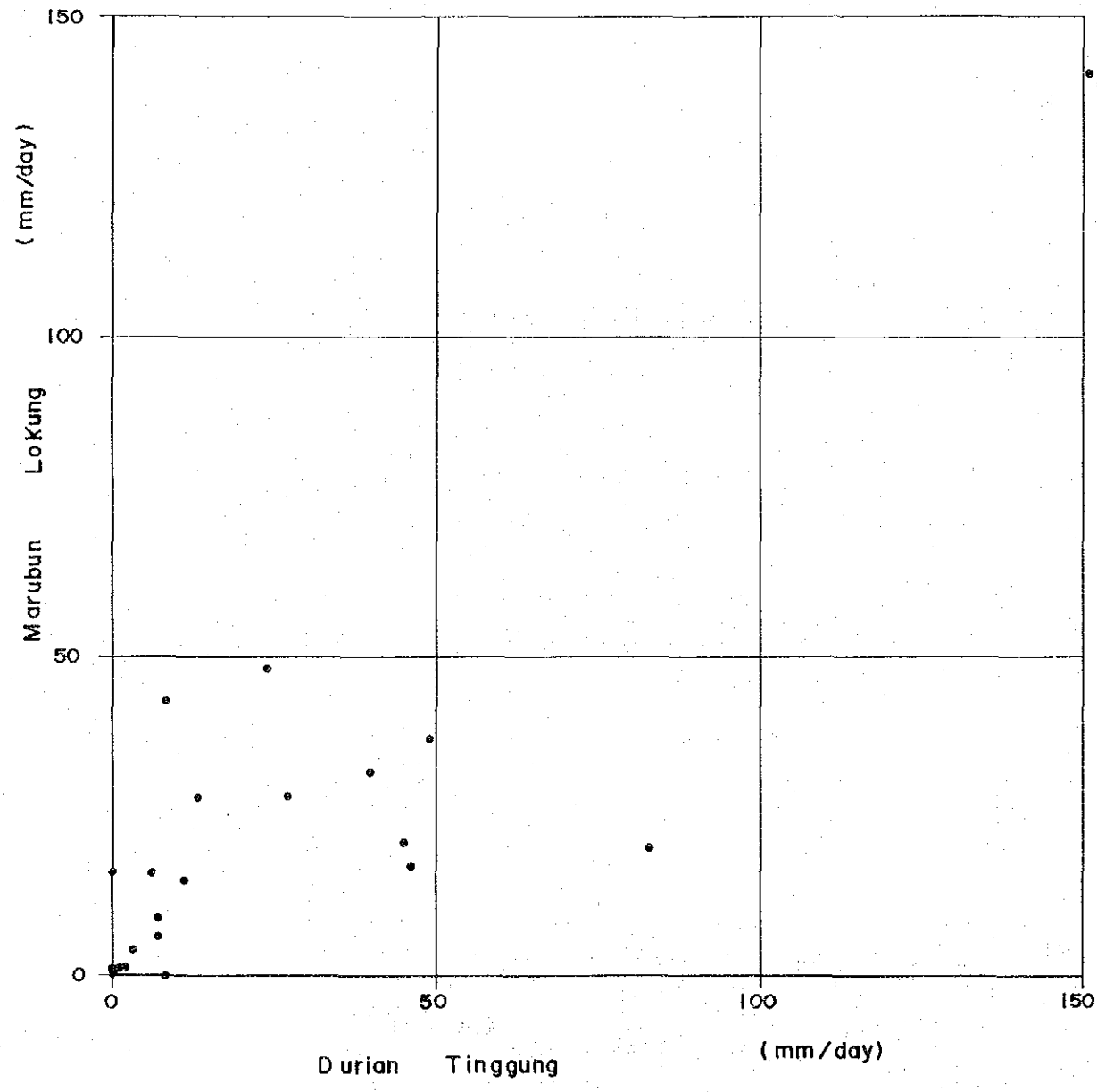


Fig. I-3-9 Correlation of Daily Rainfall between Durian Tinggung and Negeri Dolok

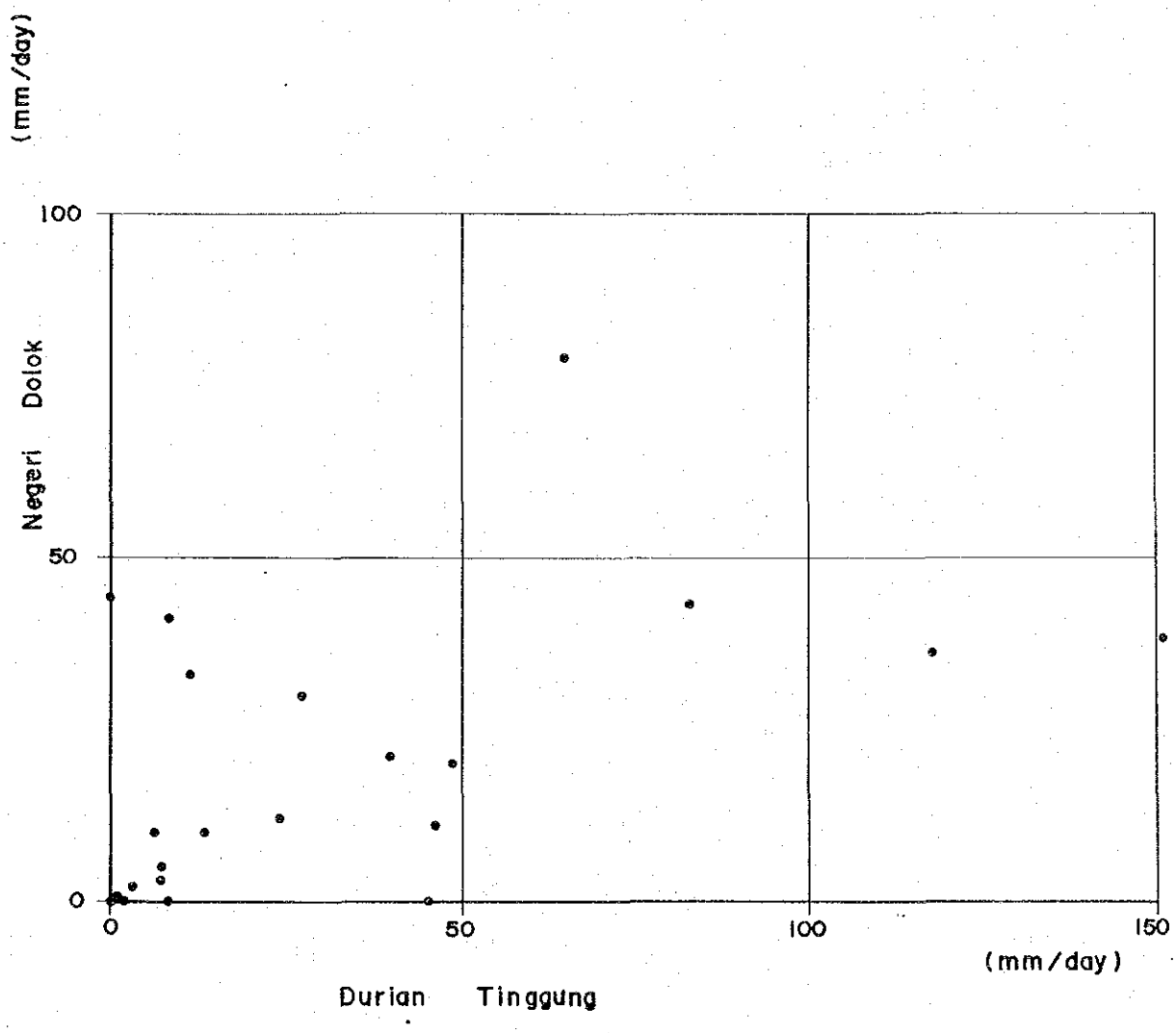
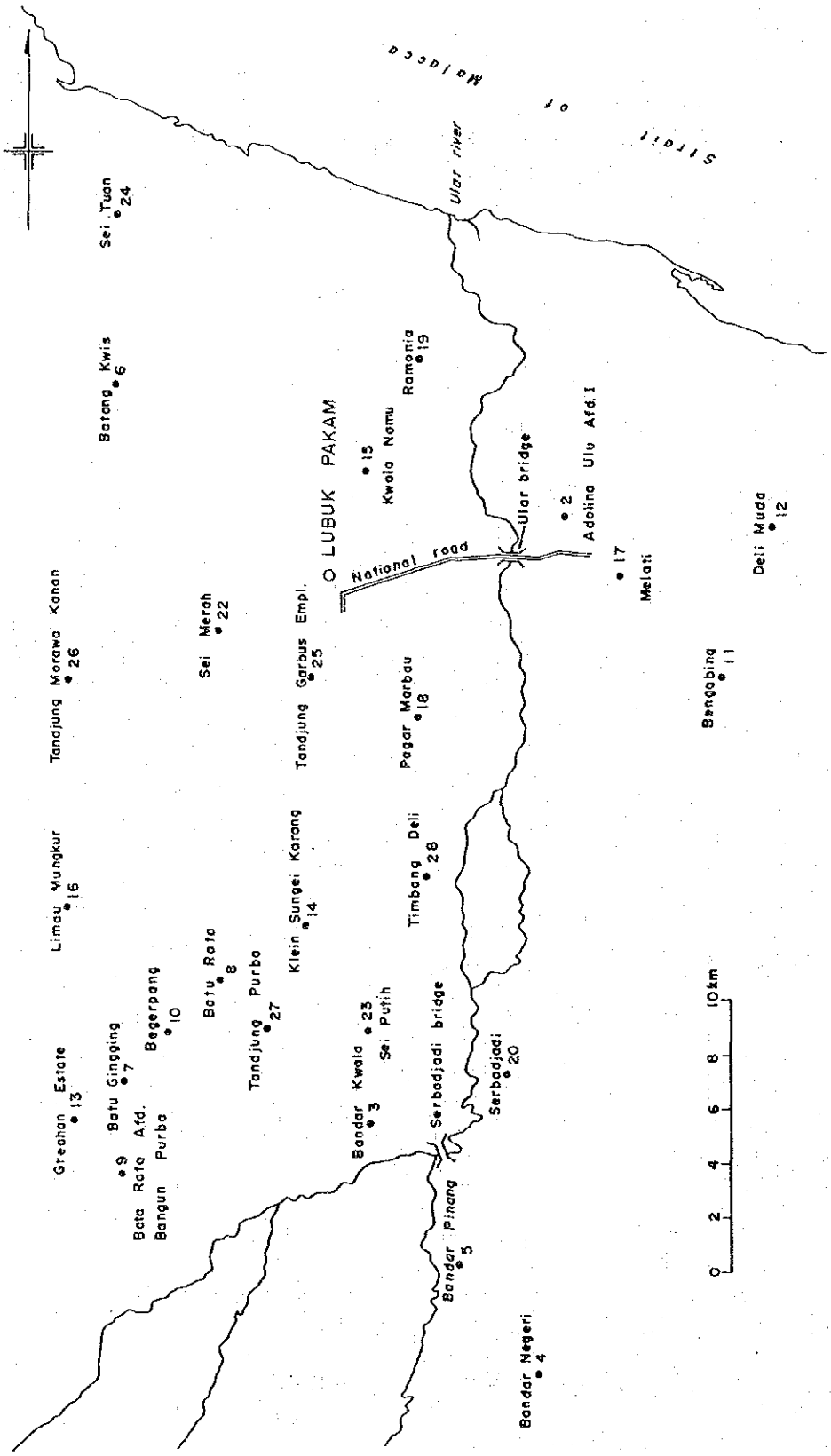


Fig. I-3-10 Location of Rainfall-Gauge Stations in the Downstream Area of the Ular River



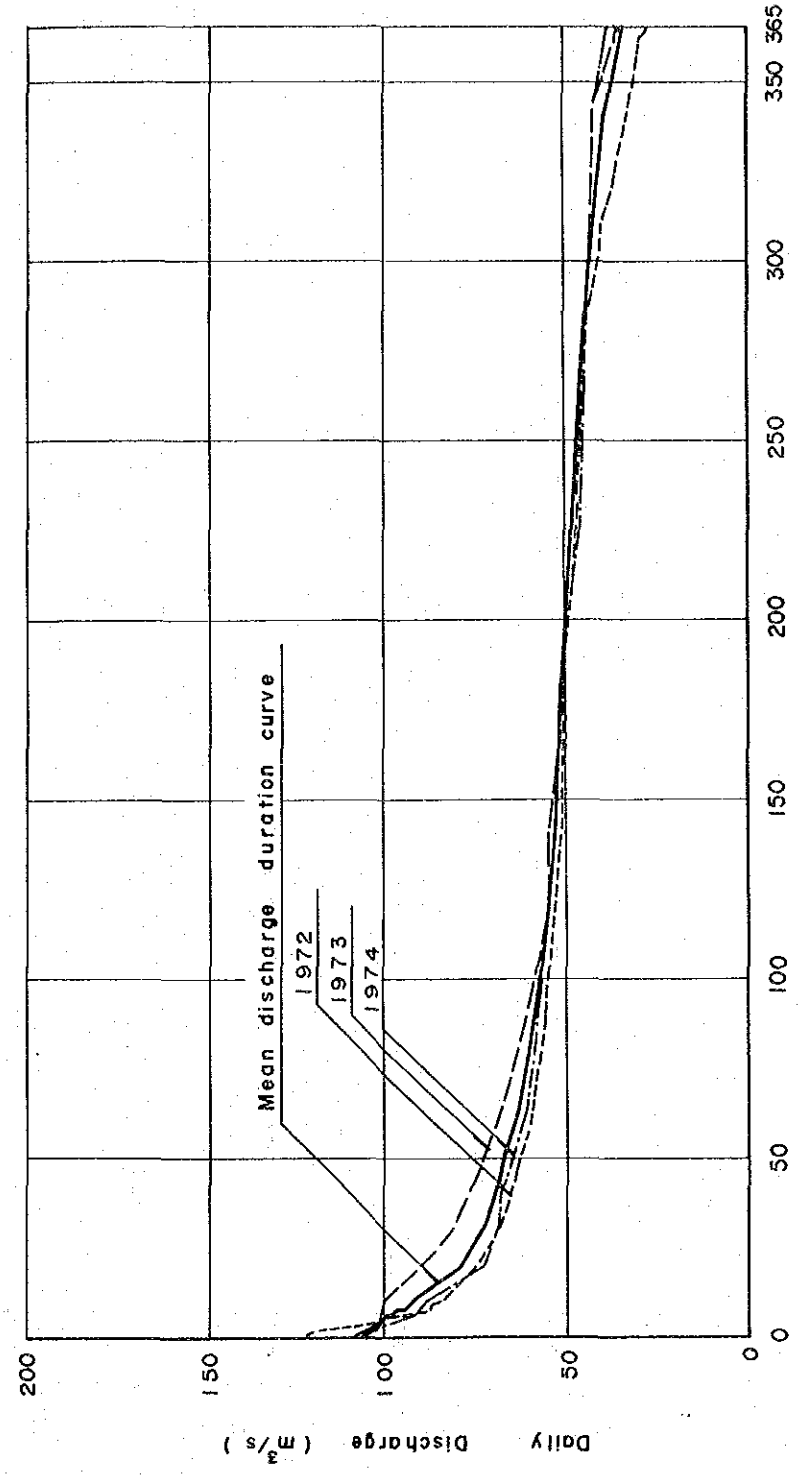


Fig. I - 3 - 11 Discharge Duration at Pulau-Tagor

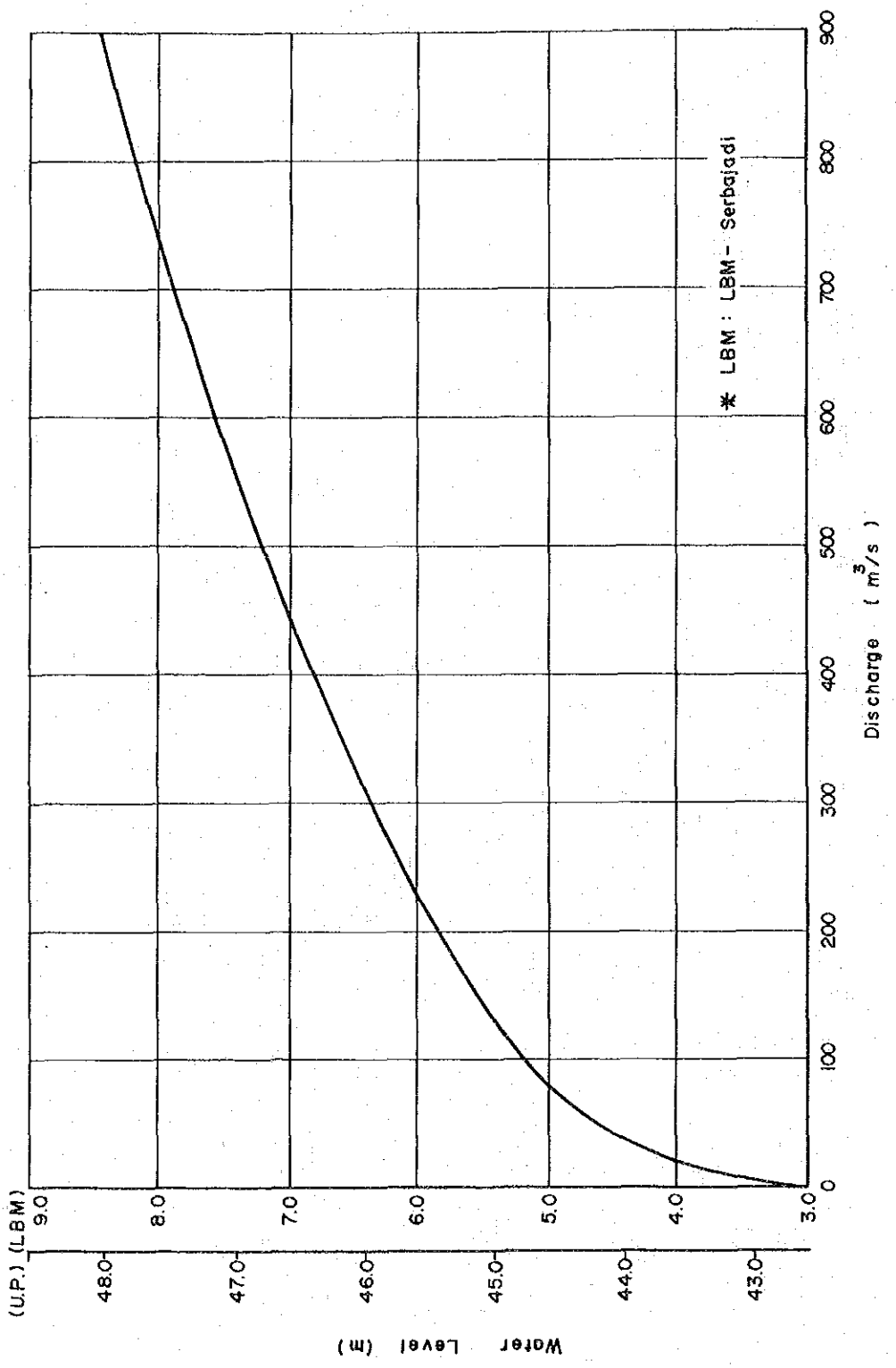
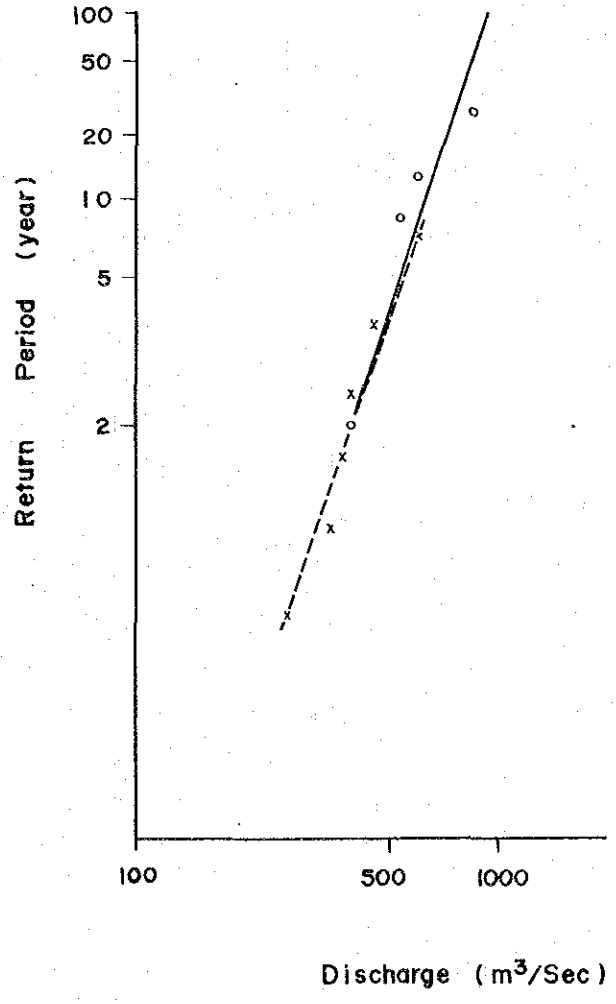


Fig. I - 3 - 12 Discharge Rating Curve at Serbajadi Bridge

Fig. I-3-13 Return Period of Discharge at Serbajadi Bridge (by Thomas Plot)



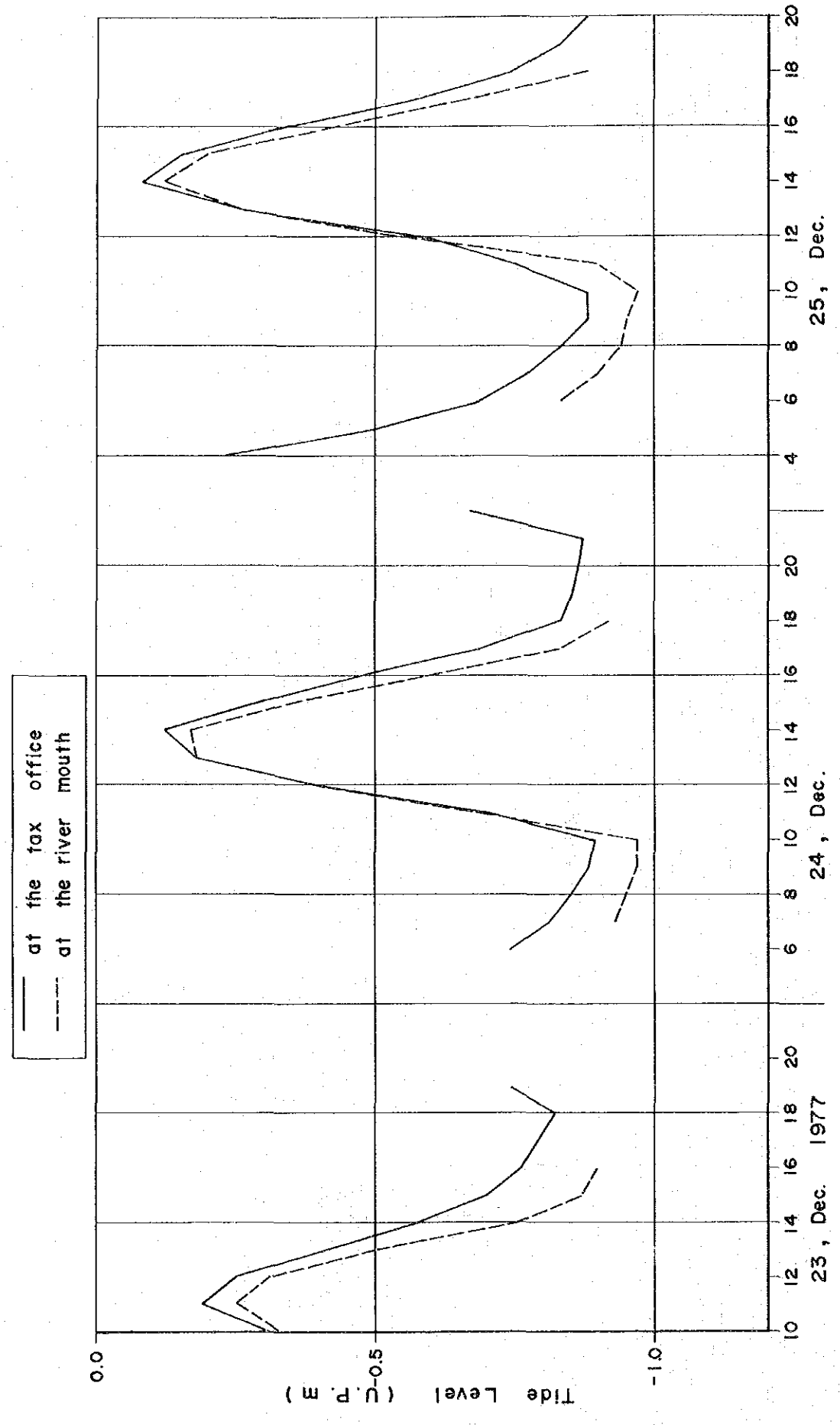
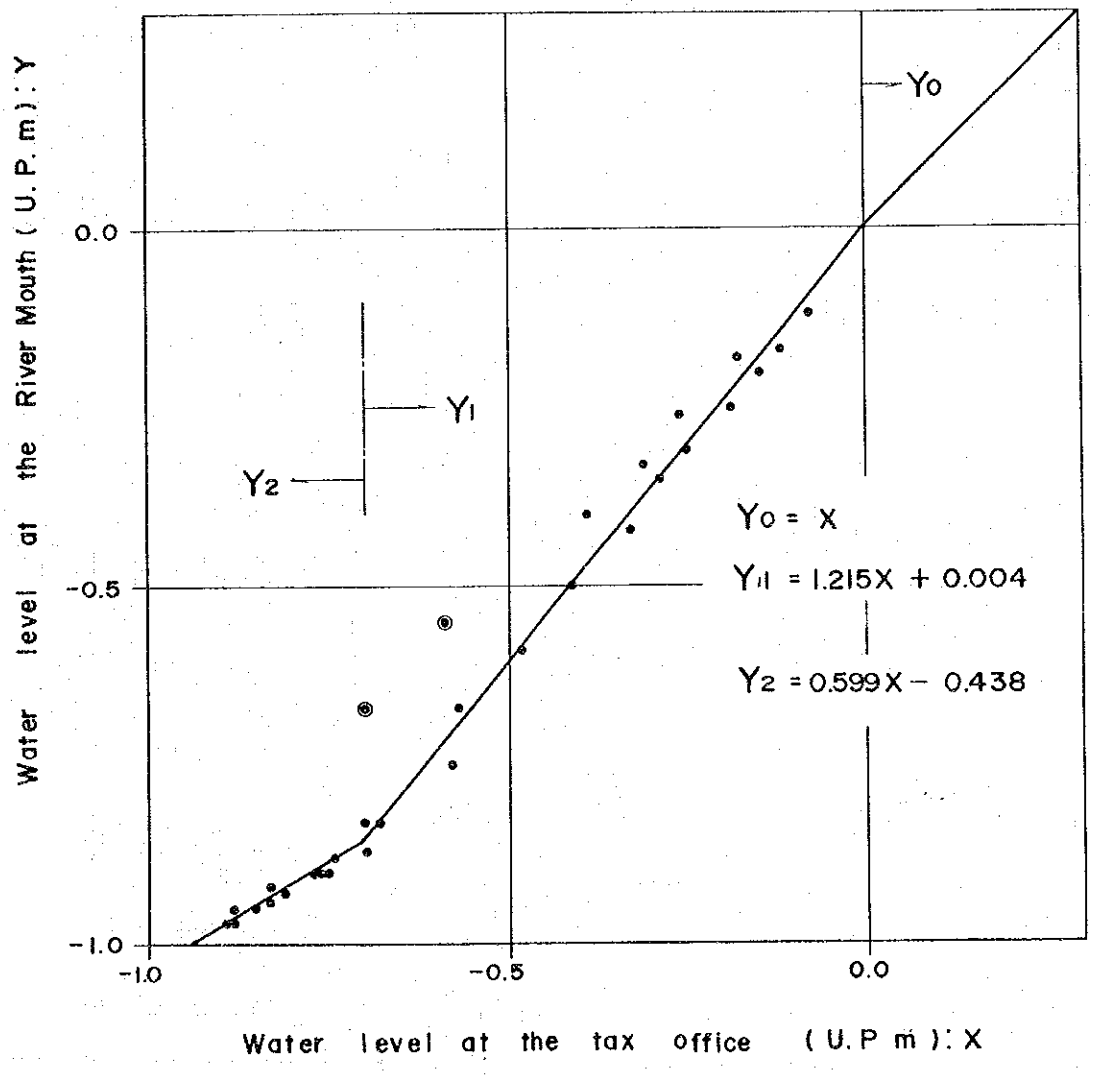


Fig. I-3-14 Tide Level at S. Pantai Labu

Fig. I-3-15 Water Level Correlation between at the River Mouth and at the Tax Office of S. Pantai Labu



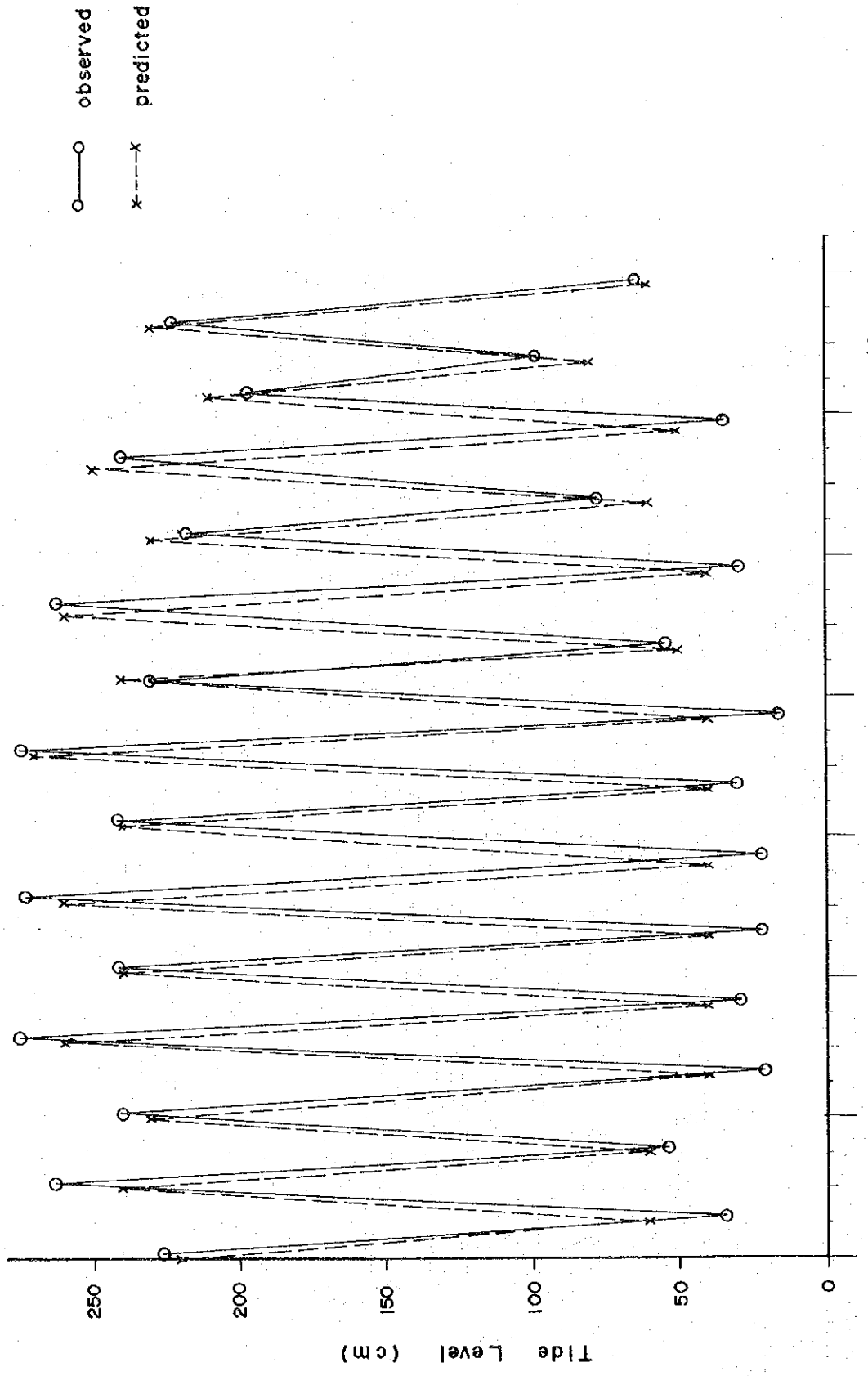


Fig. I-3-16 Tide Level at Belawan Deli

Fig. I-3-17 Correlation between Observed Tide Level and Predicted One at High Water Springs and at Low Water Springs at Balawan Deli

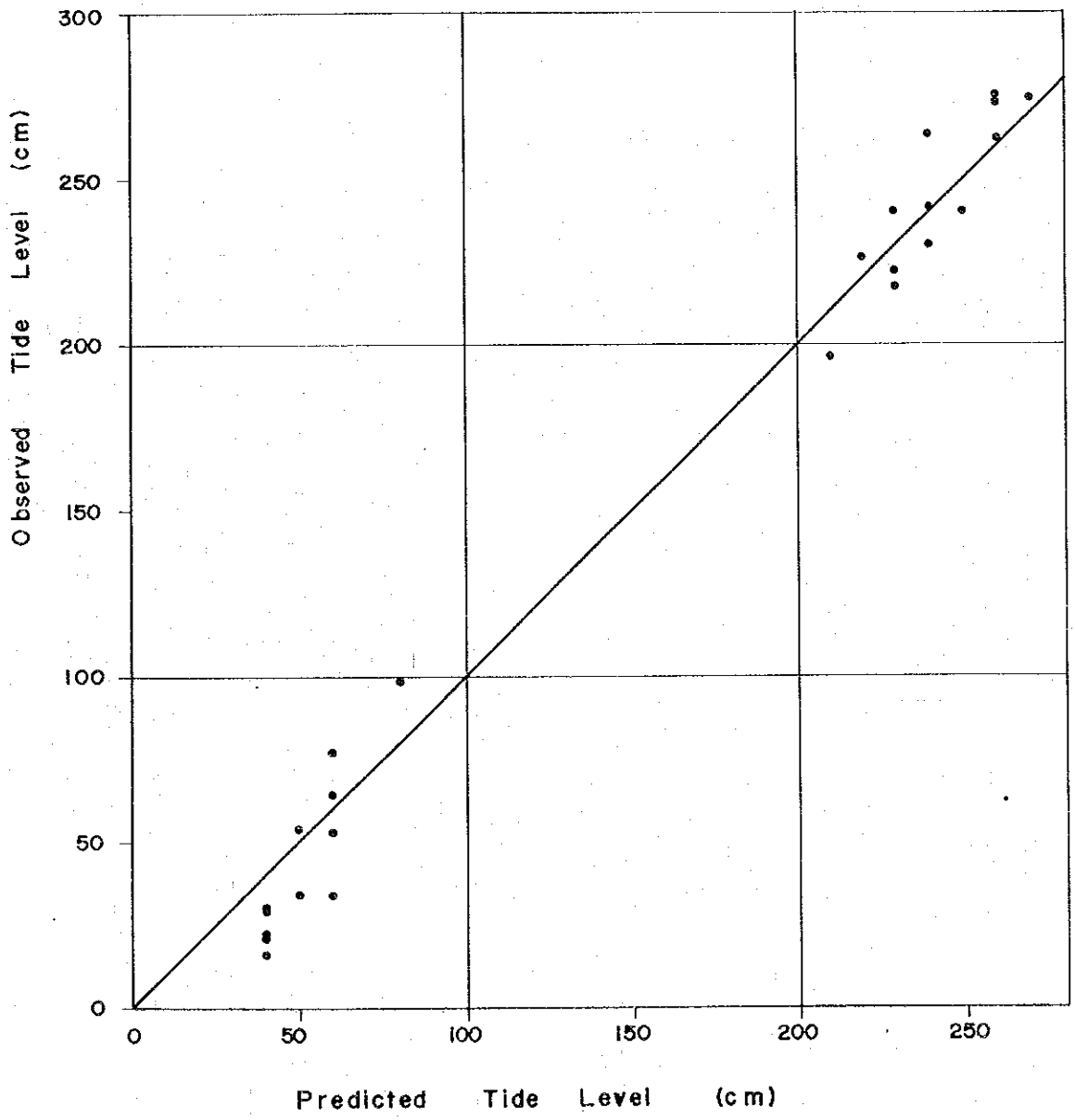


Fig. 1-3-18 Tide Range Correlation betwen Belawan Deli and S. Asahan

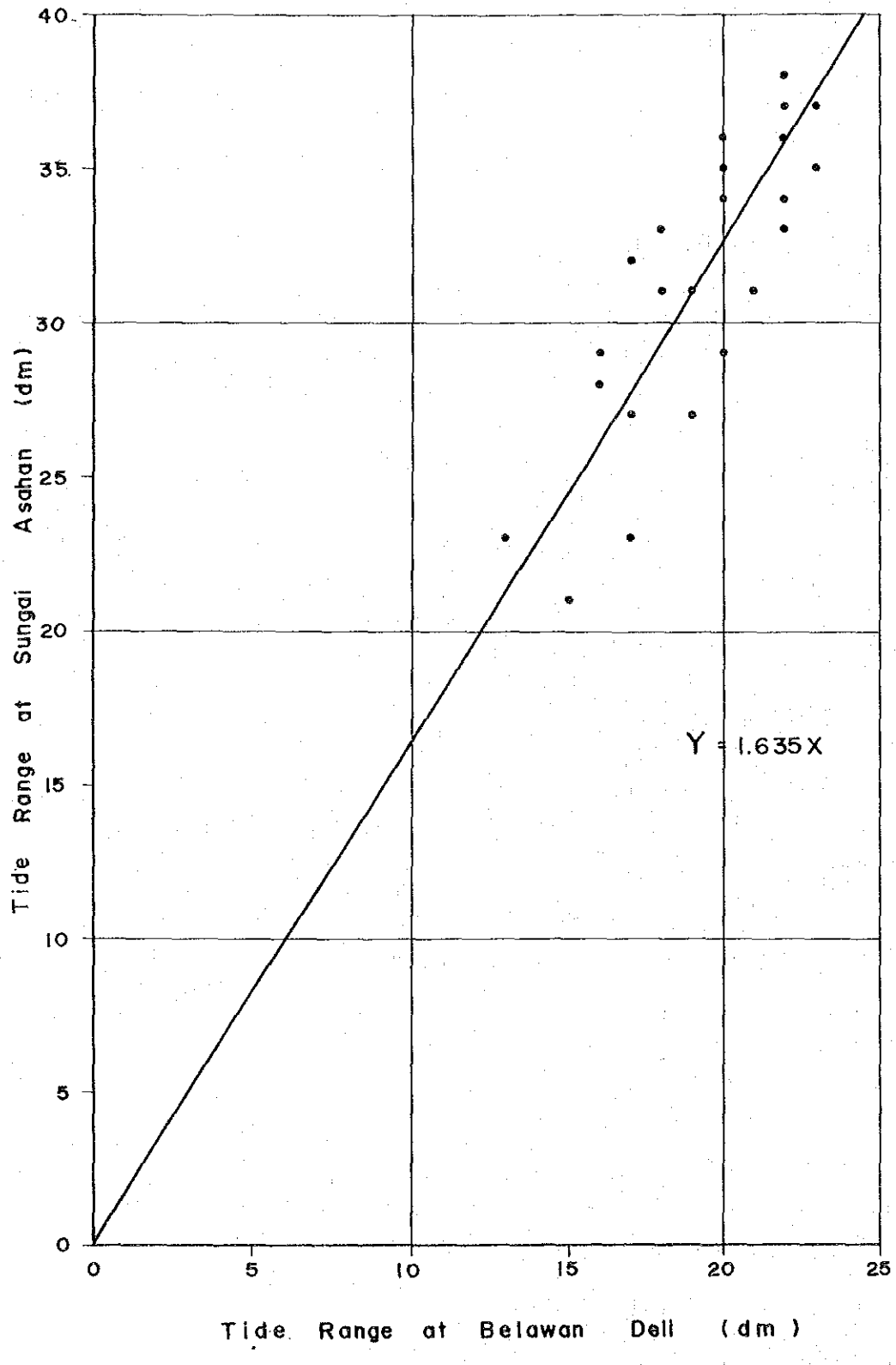
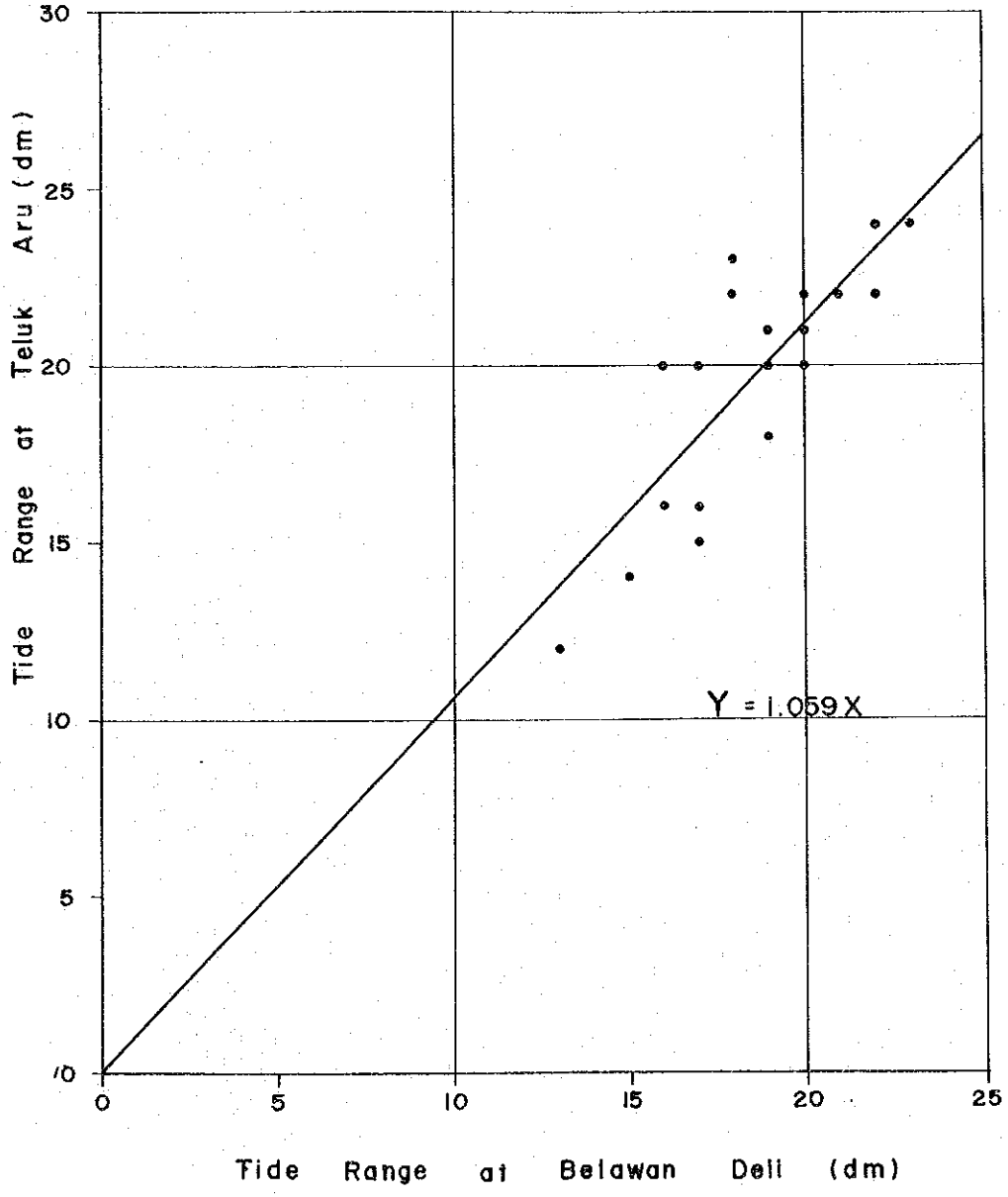


Fig. I-3-19 Tide Range Correlation between Belawan Deli and Teluk Aru



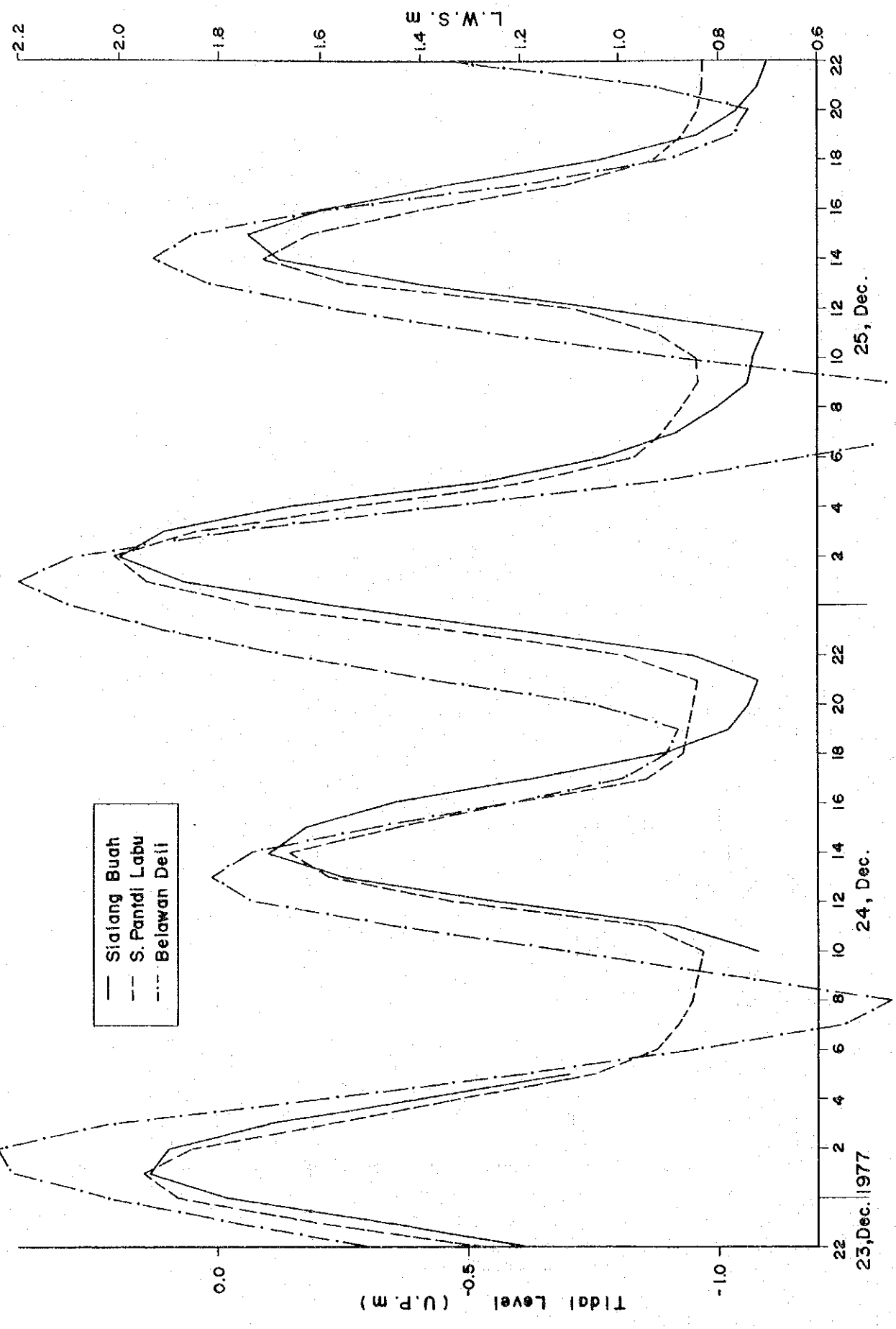
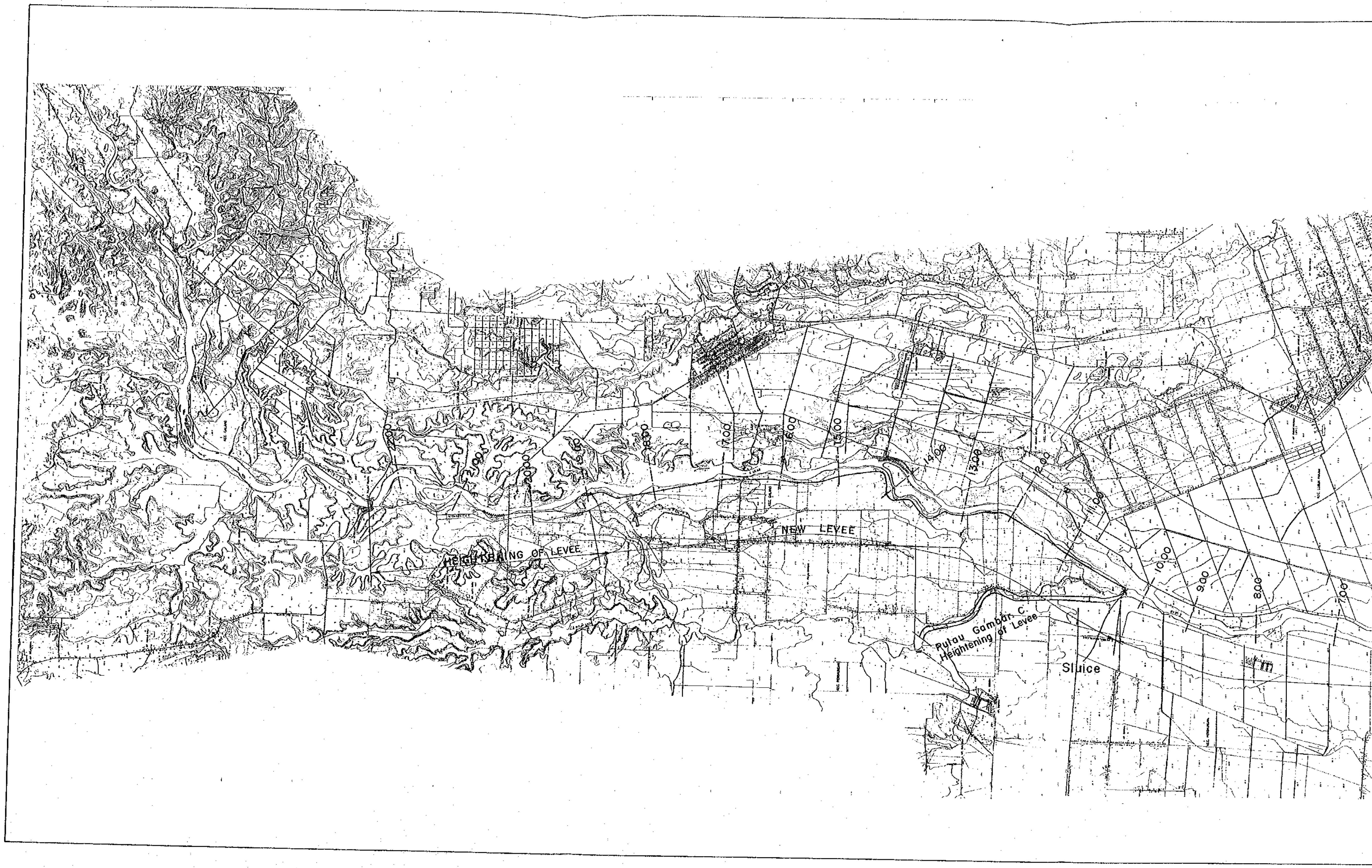


Fig. I-3-20 Tide Level at Belawan Deli, S. Pantai Labu and Sialang Buah


NEW LEVEE
HEIGHTENING OF LEVEE
Pulau Gambar C.
Heightening of Levee
Sluice
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
16.00
17.00
18.00
19.00
20.00
21.00
22.00


HEIGHTENING OF LEVEE
HEIGHTENING OF LEVEE
HEIGHTENING OF LEVEE
NEW LEVEE
NEW LEVEE
Sluice
Putau Gambar C.
Heightening of Levee
1600
1500
1400
1300
1200
1000
900
800
700
600
500
400
300
200
100
500
600
700
800
900
1000

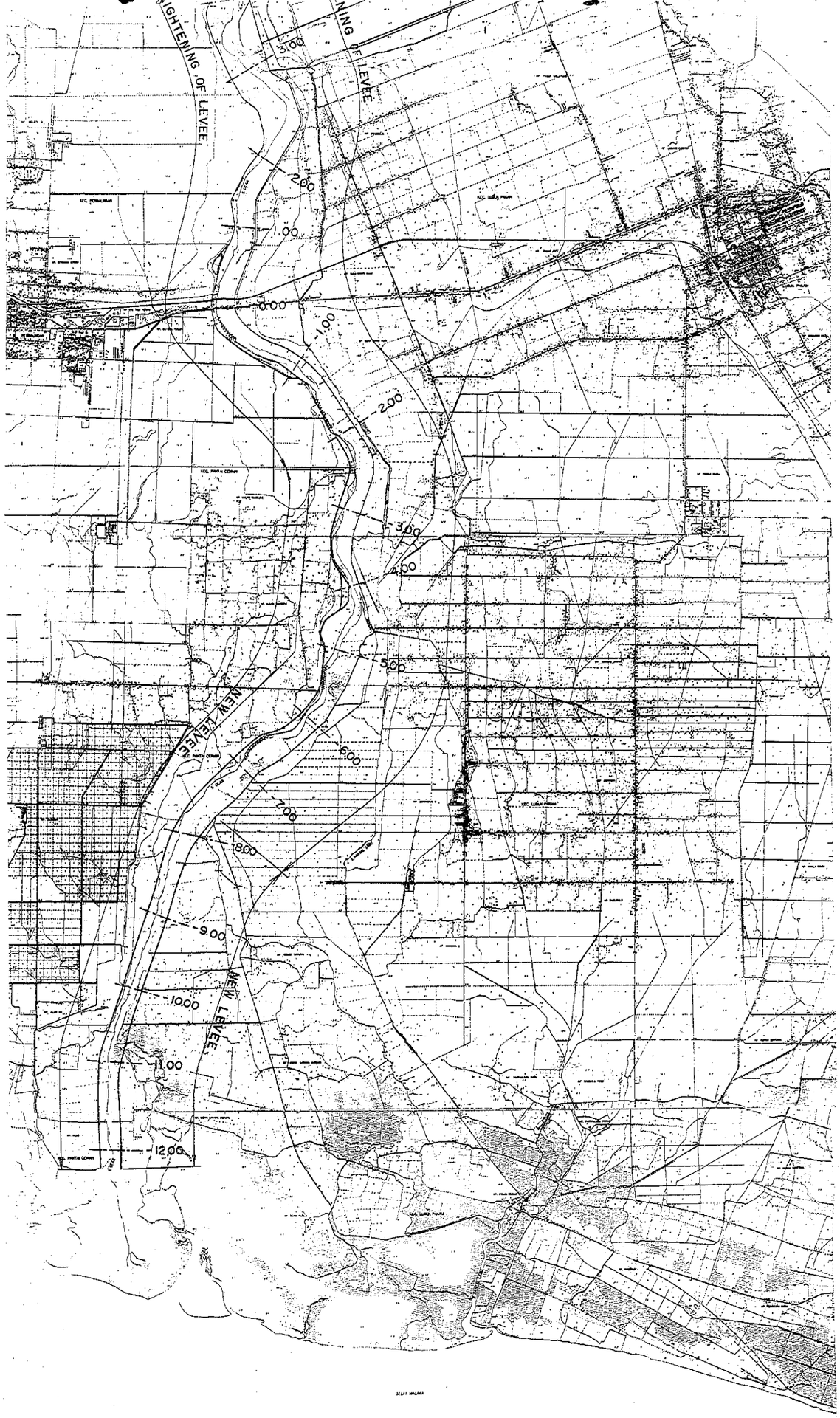


Fig. I-4-1 Plan of River Improvement

Scale
0 500 1000 2000
1/50,000

Revetment

This map a reduced copy from the maps (scale 1:10,000) made by JICA, 1977

Fig. I-4-2 Longitudinal Profile of the Existing Ular River

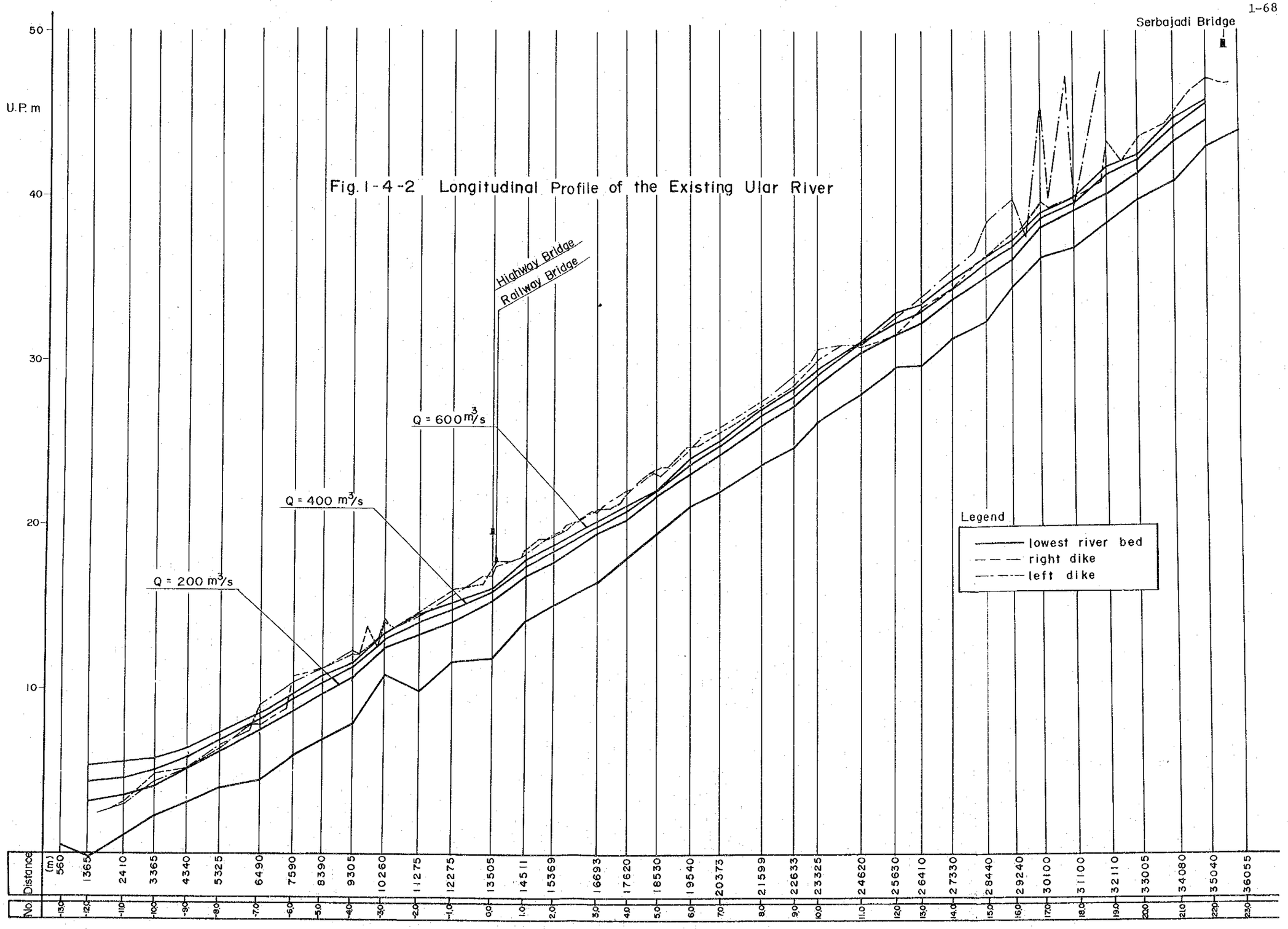


Fig. 1-4-3 Disharge Hydrograph

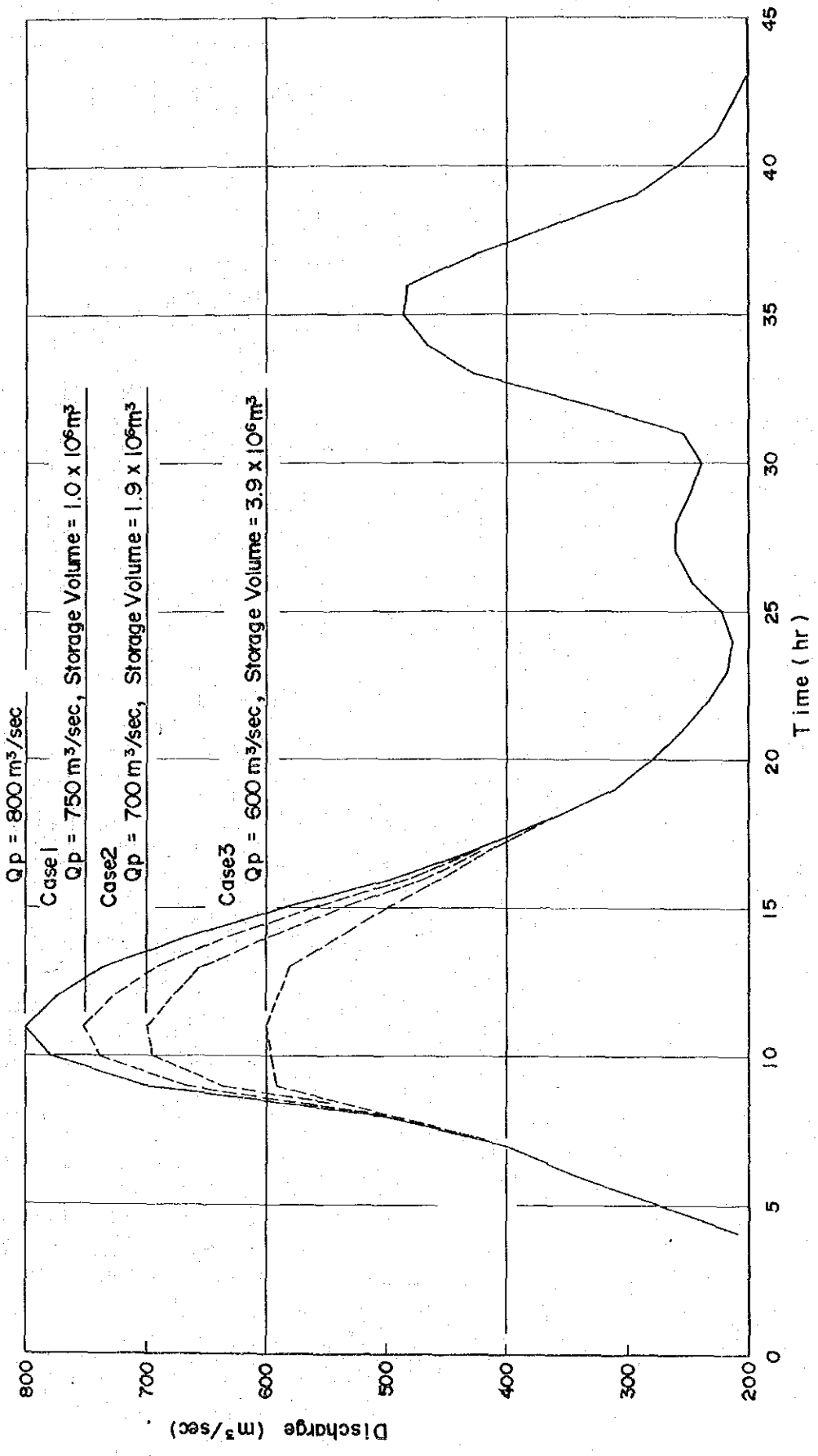


Fig. 1-4-4 Storage Capacity Curve

H (m.u.D)	A (km^2)	V ($\times 10^3 m^3$)
28.0	0.02	0
28.5	0.15	40
29.0	0.41	180
29.5	0.63	440
30.0	0.79	800
30.5	1.41	1350
31.0	1.89	2170
32.0	2.29	4260
33.0	2.66	6740

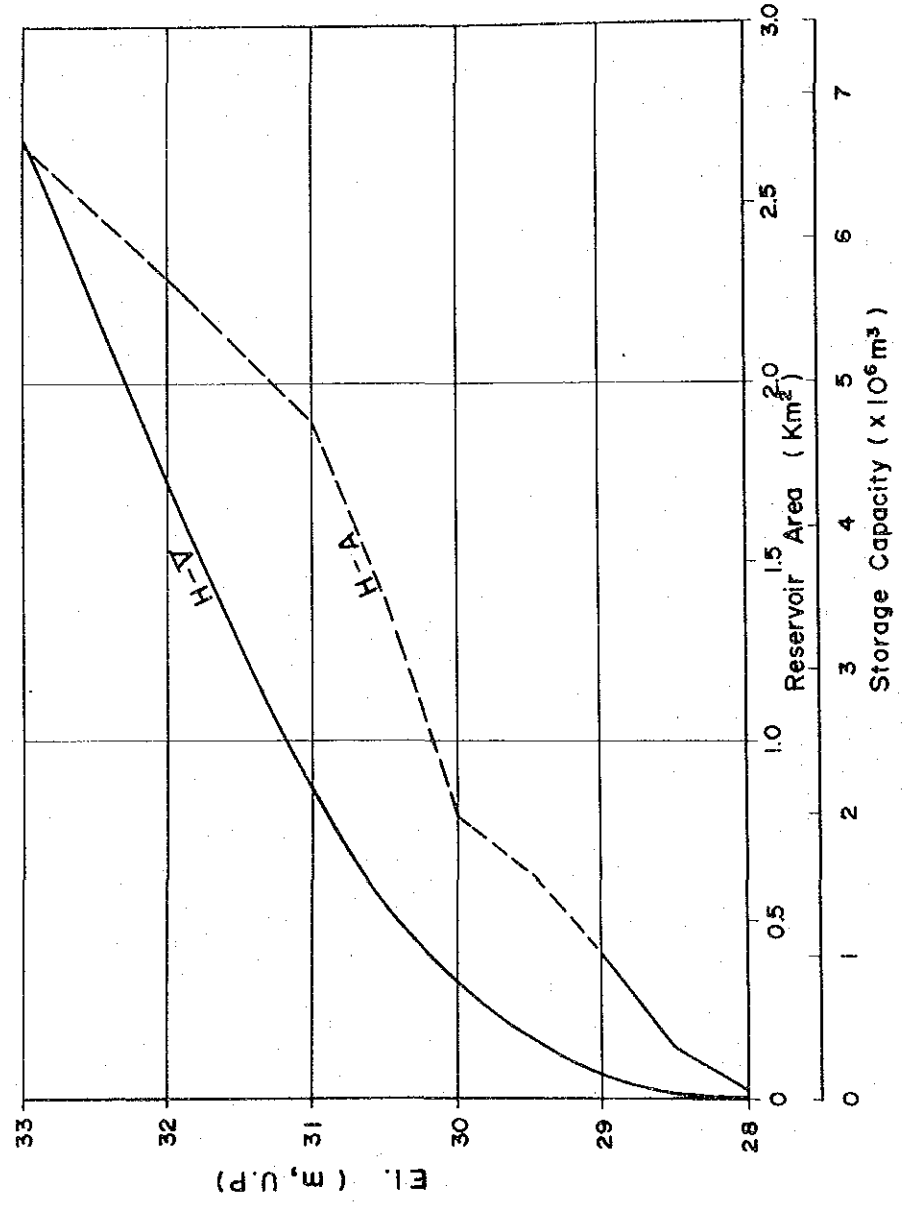
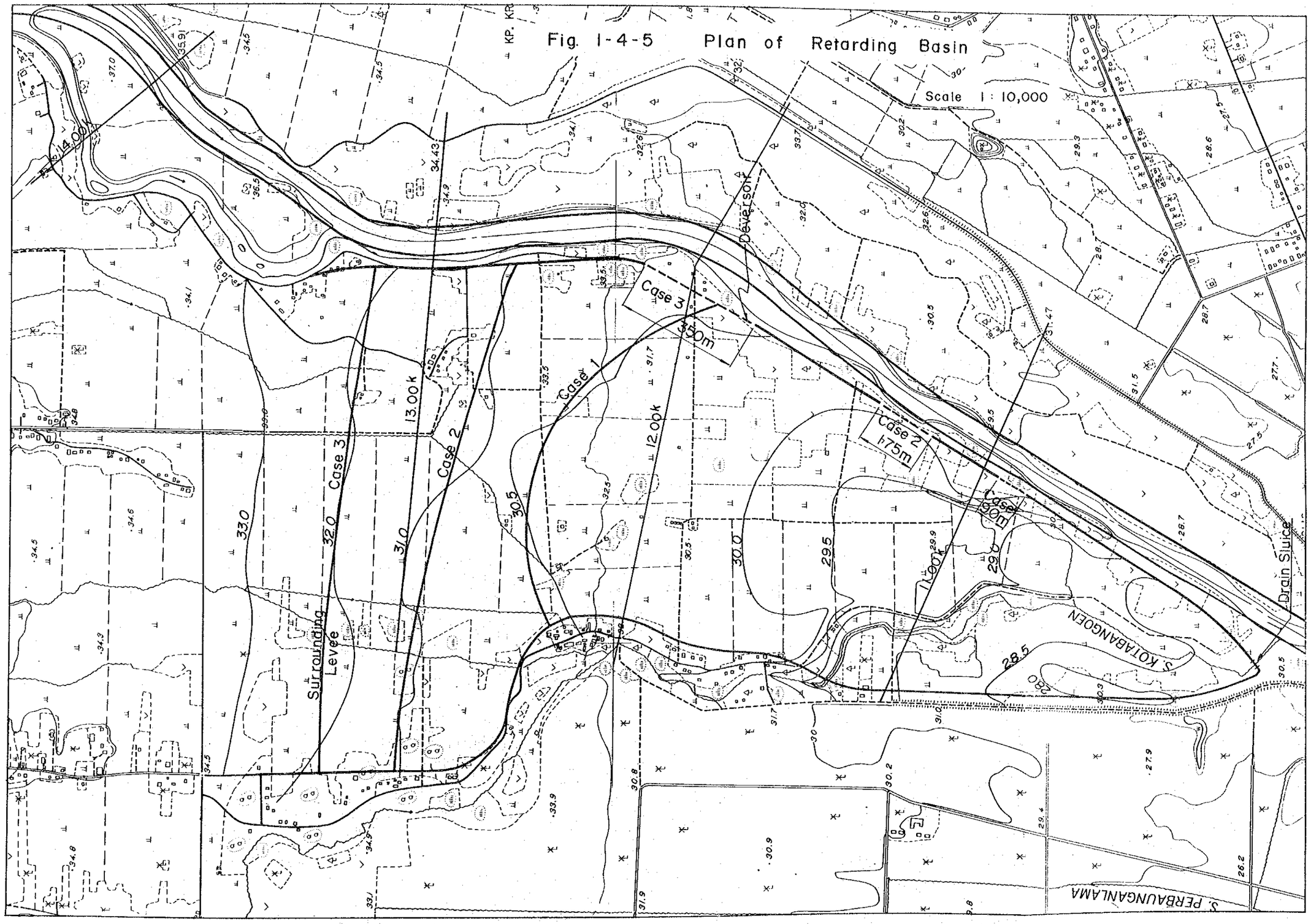


Fig. 1-4-5 Plan of Retarding Basin

Scale 1 : 10,000



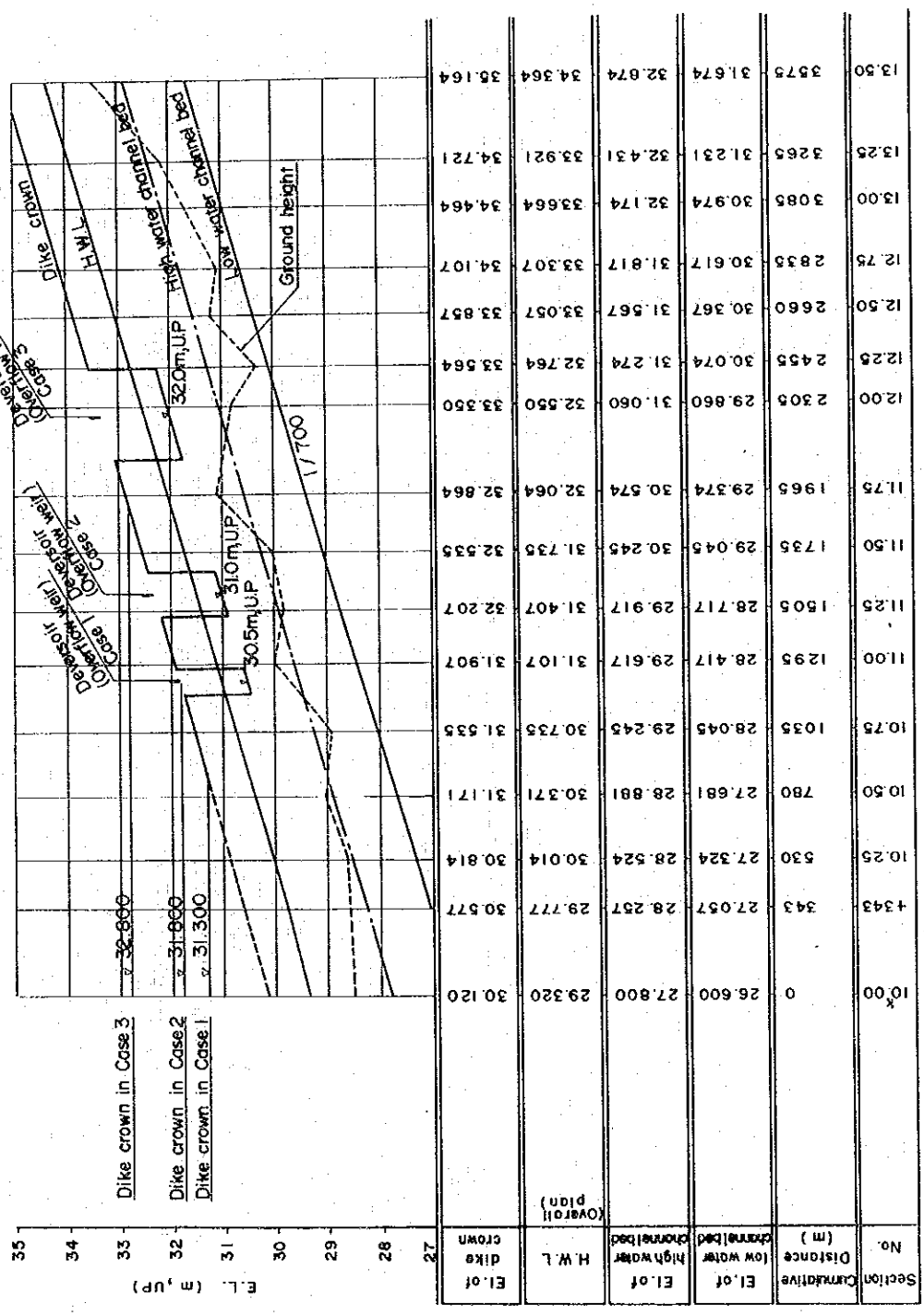


Fig. I - 4 - 6 Longitudinal Profile of the Ular River

Section No.	Cumulative Distance (m)	El. of low water channel bed	El. of high water channel bed	H.W.L. (Overall plan)	El. of dike crown
10*00	0	26.600	27.800	29.320	30.120
+343	343	27.057	28.257	29.777	30.577
10.25	530	27.324	28.524	30.014	30.814
10.50	780	27.681	28.881	30.371	31.171
10.75	1035	28.045	29.245	30.735	31.535
11.00	1295	28.417	29.617	31.107	31.907
11.25	1505	28.717	29.917	31.407	32.207
11.50	1735	29.045	30.245	31.735	32.535
11.75	1965	29.374	30.574	32.064	32.864
12.00	2305	29.860	31.060	32.550	33.350
12.25	2455	30.074	31.274	32.764	33.564
12.50	2660	30.367	31.567	33.057	33.857
12.75	2835	30.617	31.817	33.307	34.107
13.00	3085	30.974	32.174	33.664	34.464
13.25	3265	31.231	32.431	33.921	34.721
13.50	3575	31.674	32.874	34.364	35.164

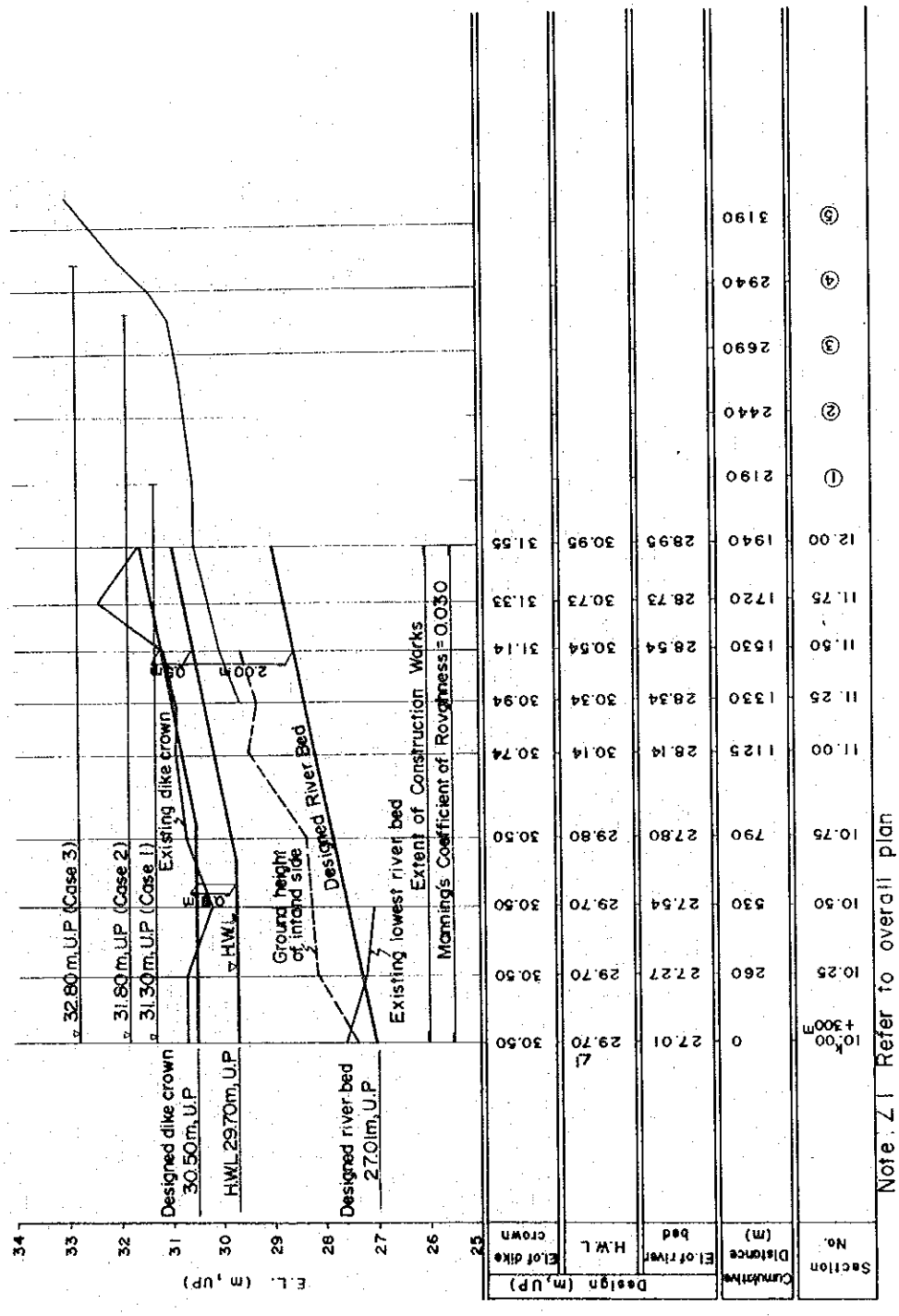
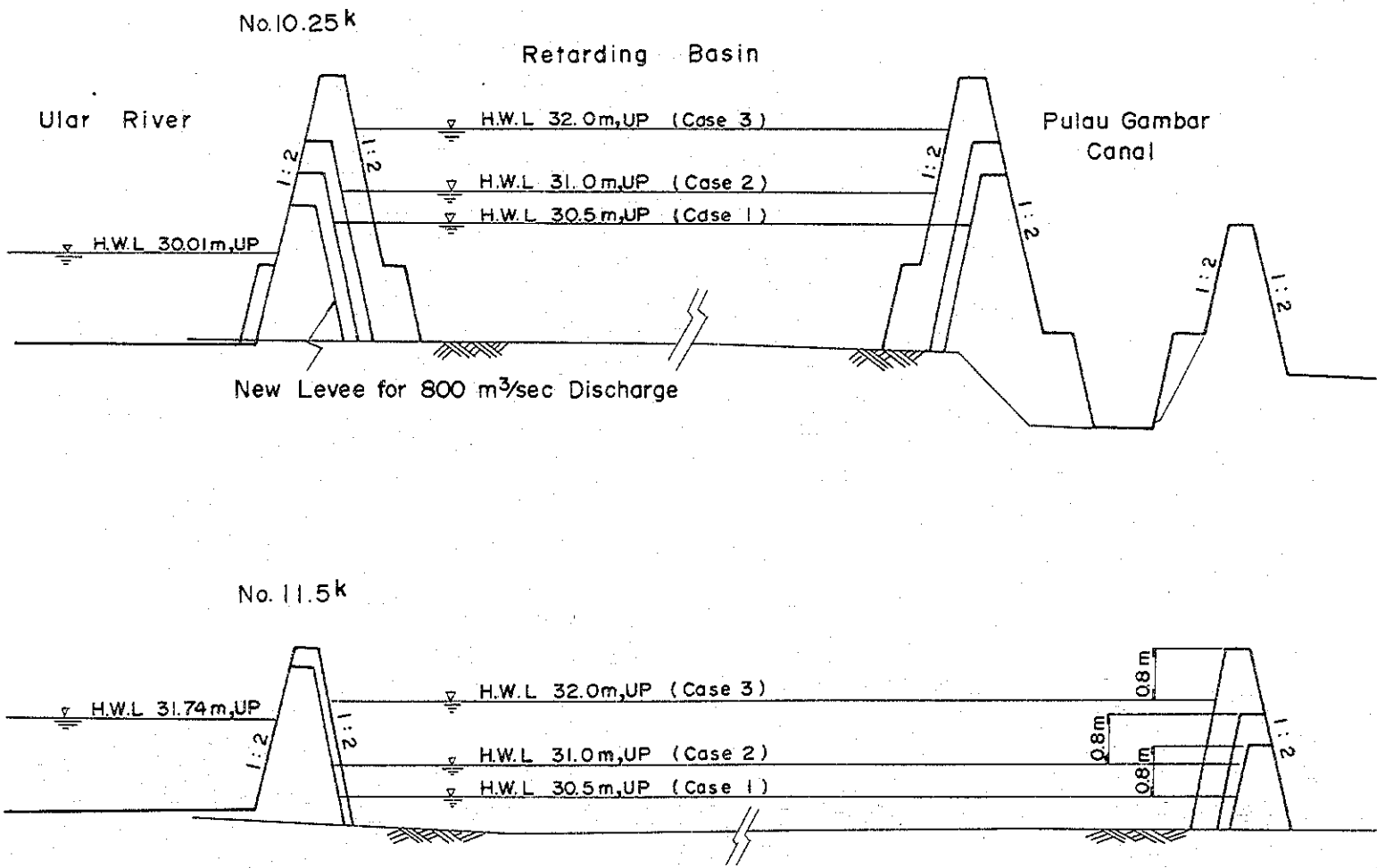


Fig. I-4-7 Longitudinal Profile of Enclosing Levee on Pulau Gambar Canal Side

Note: 21 Refer to overall plan

Fig. I-4-8 Typical Cross-Section of Levee (Scale ; H ; 1/1000, V ; 1/100)



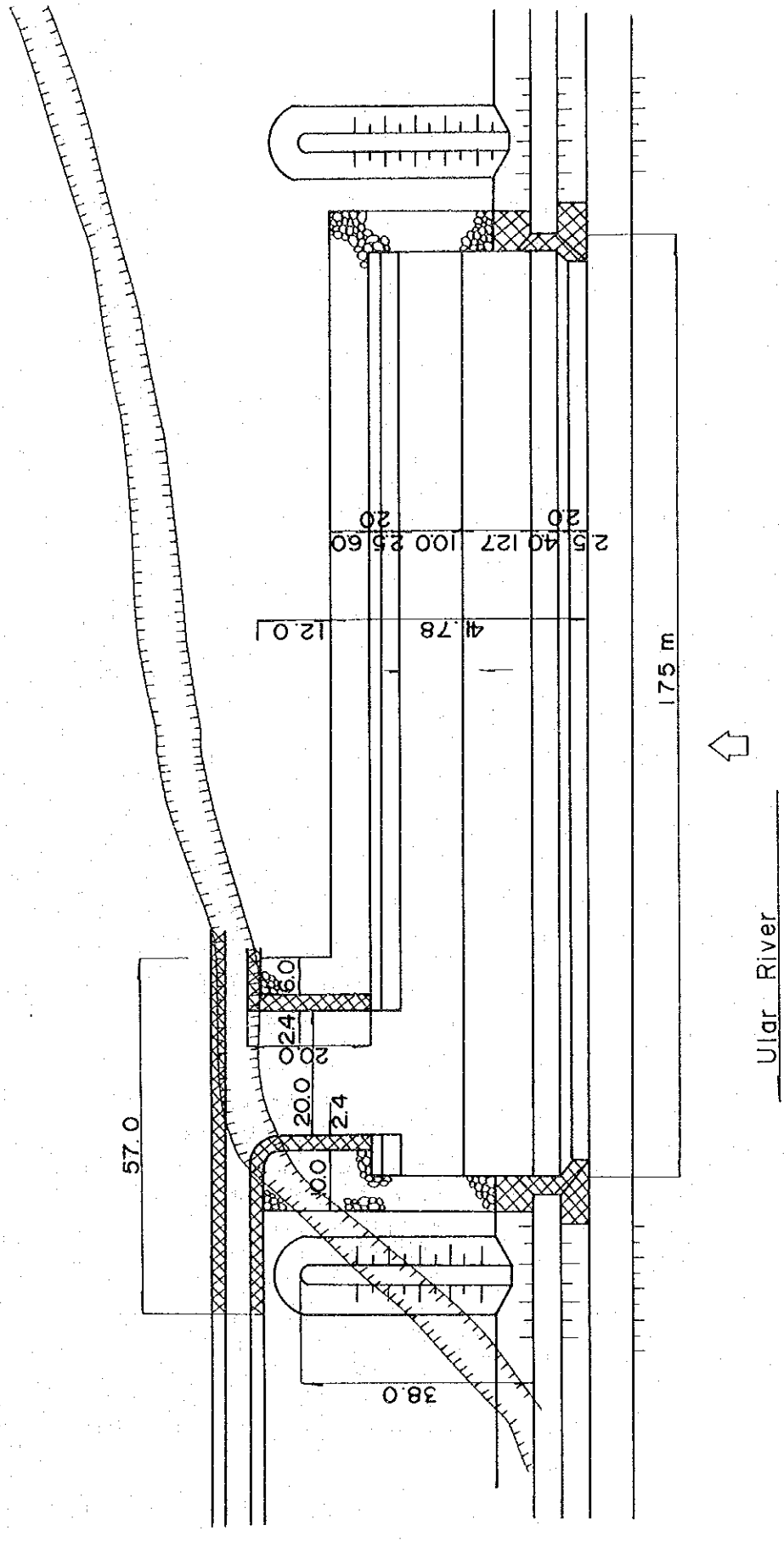


Fig. I-4-9 General Plan of Deversoir (Overflow Levee) Case 2

Scale 1 : 1000

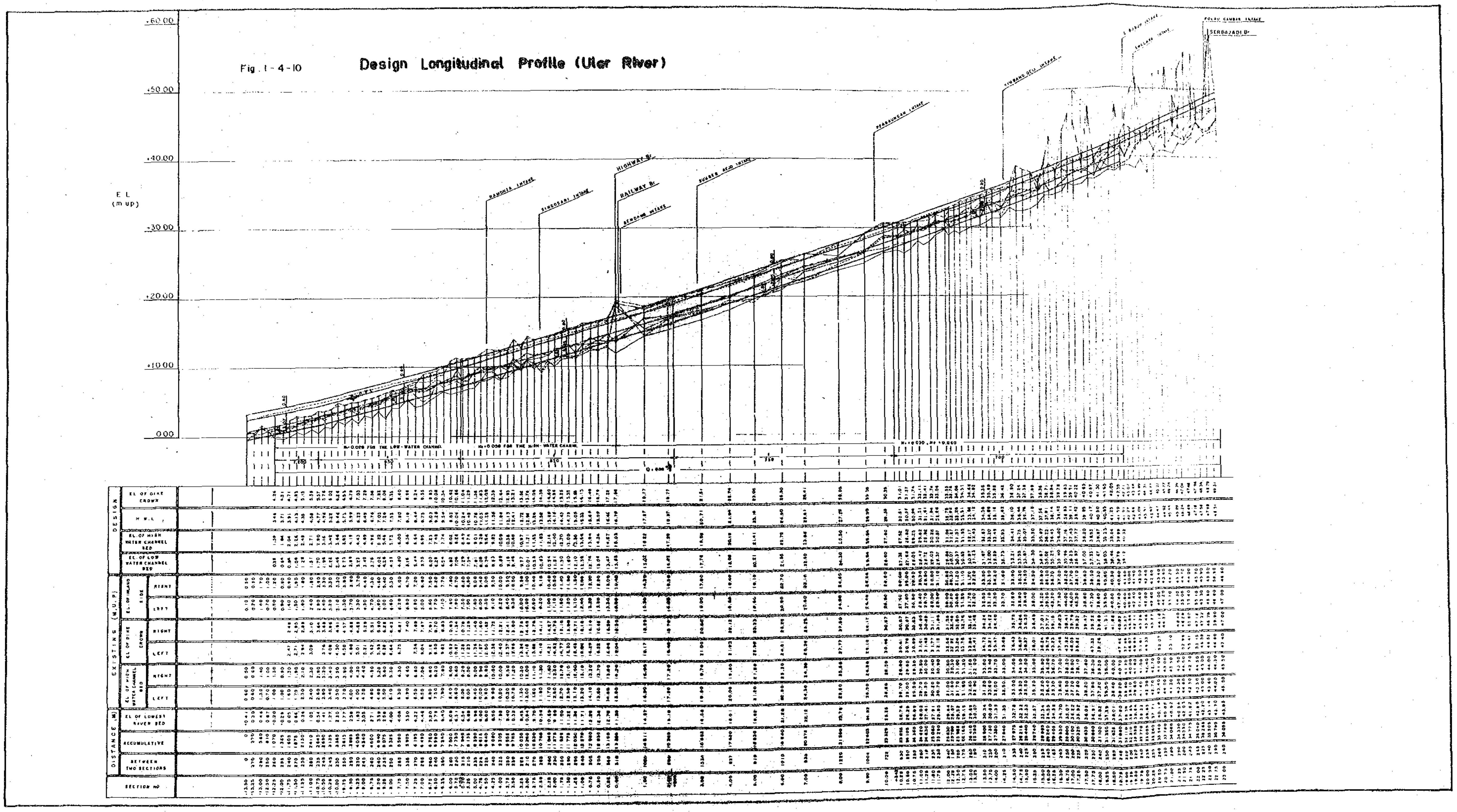
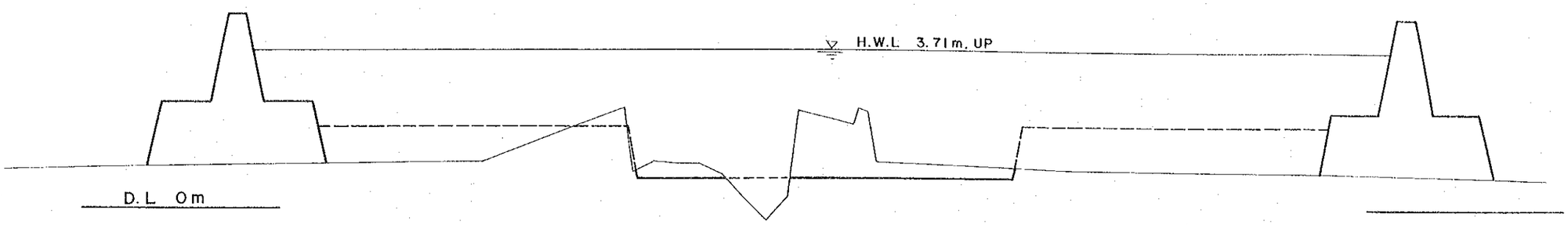


Fig. I-4-10 Design Longitudinal Profile (Uler River)

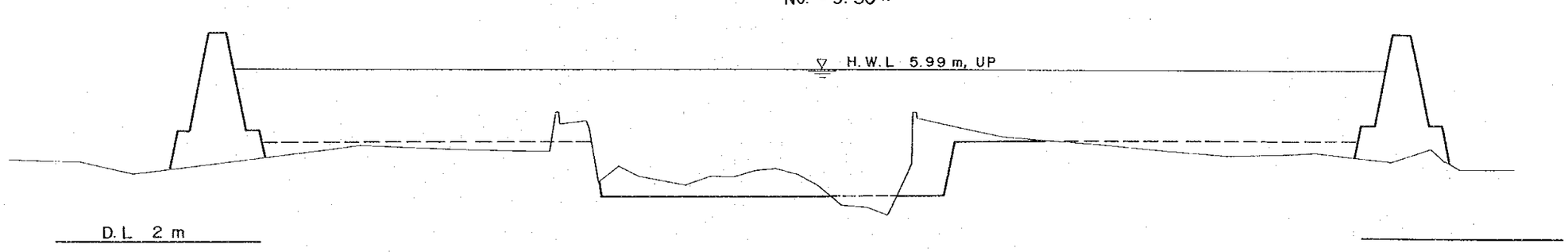
Fig. 1-4-11 Typical Cross-Section (Ular River)

Scale ; V = 1/100
H = 1/1000

No. - 12.00 k



No. - 9.50 k



No. - 6.50 k

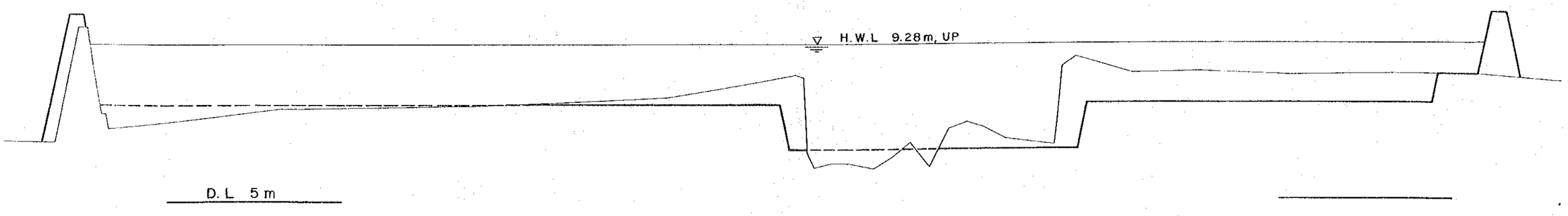
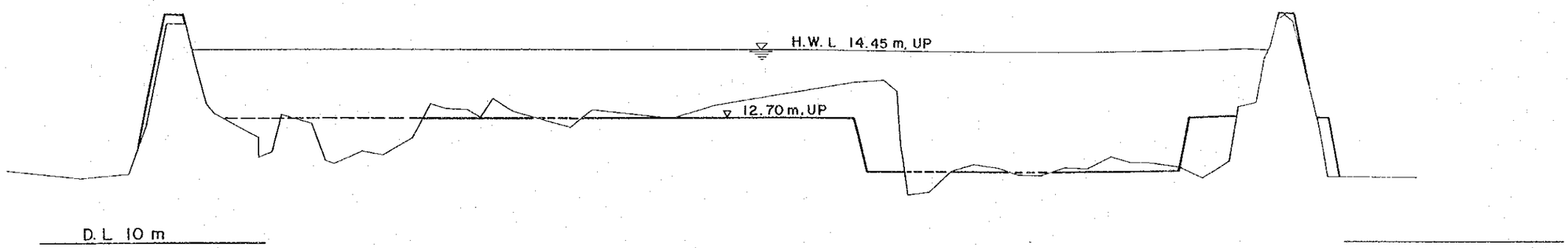


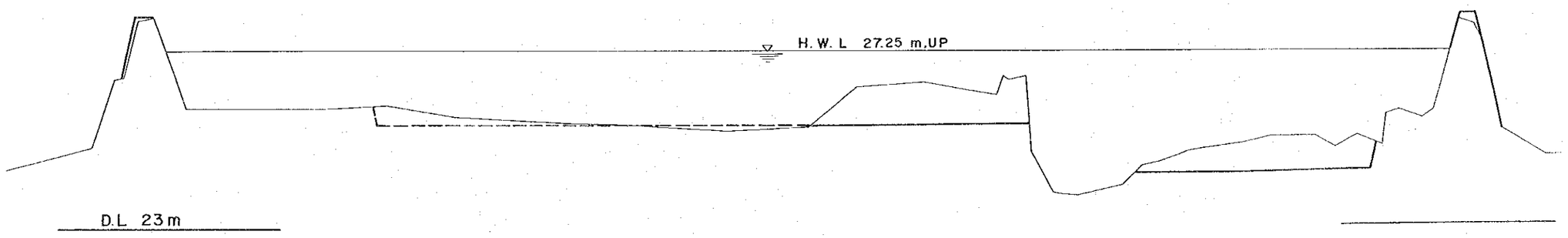
Fig. 1-4-12 Typical Cross-Section (Ular River)

Scale ; V = 1/100
H = 1/1000

No. - 1.75 k



No. 8.00 k



No. 11.50 k

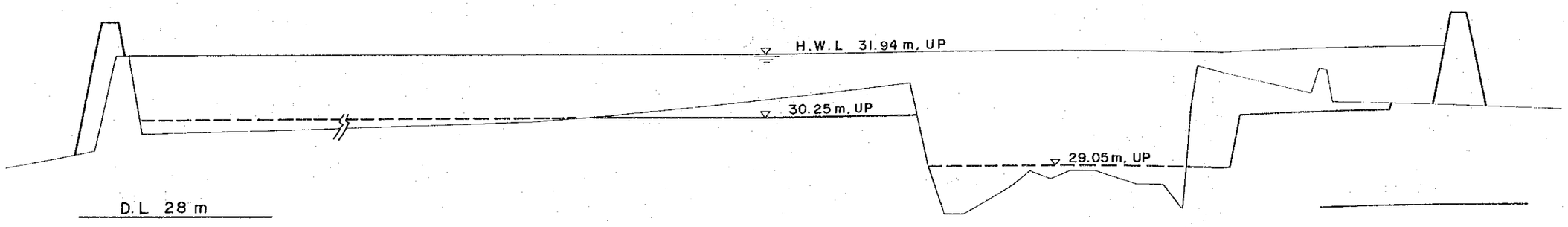


Fig. I-4-13 Typical Cross-Section of Embankment (Ular River)

Scale ; 1/200

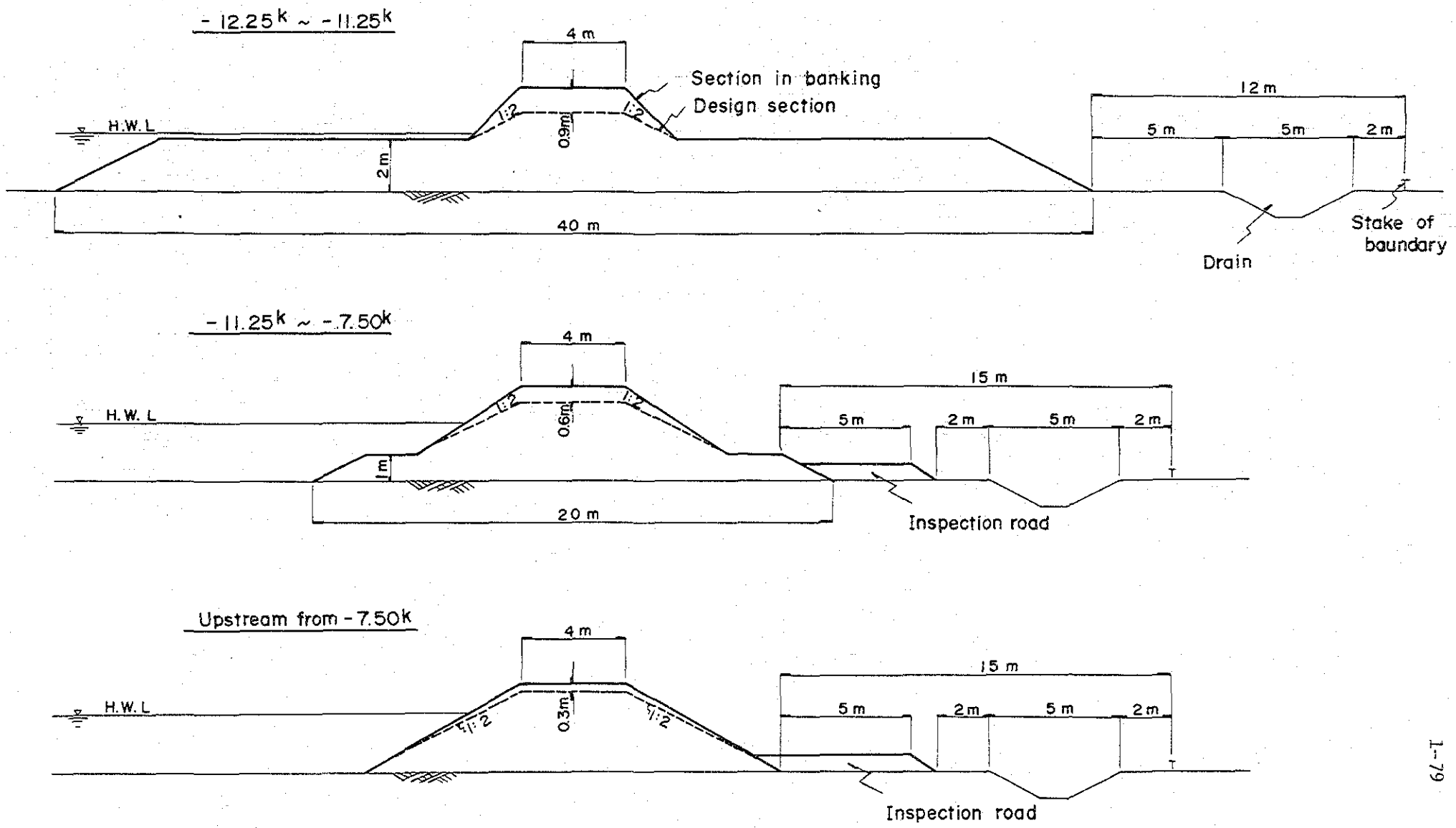
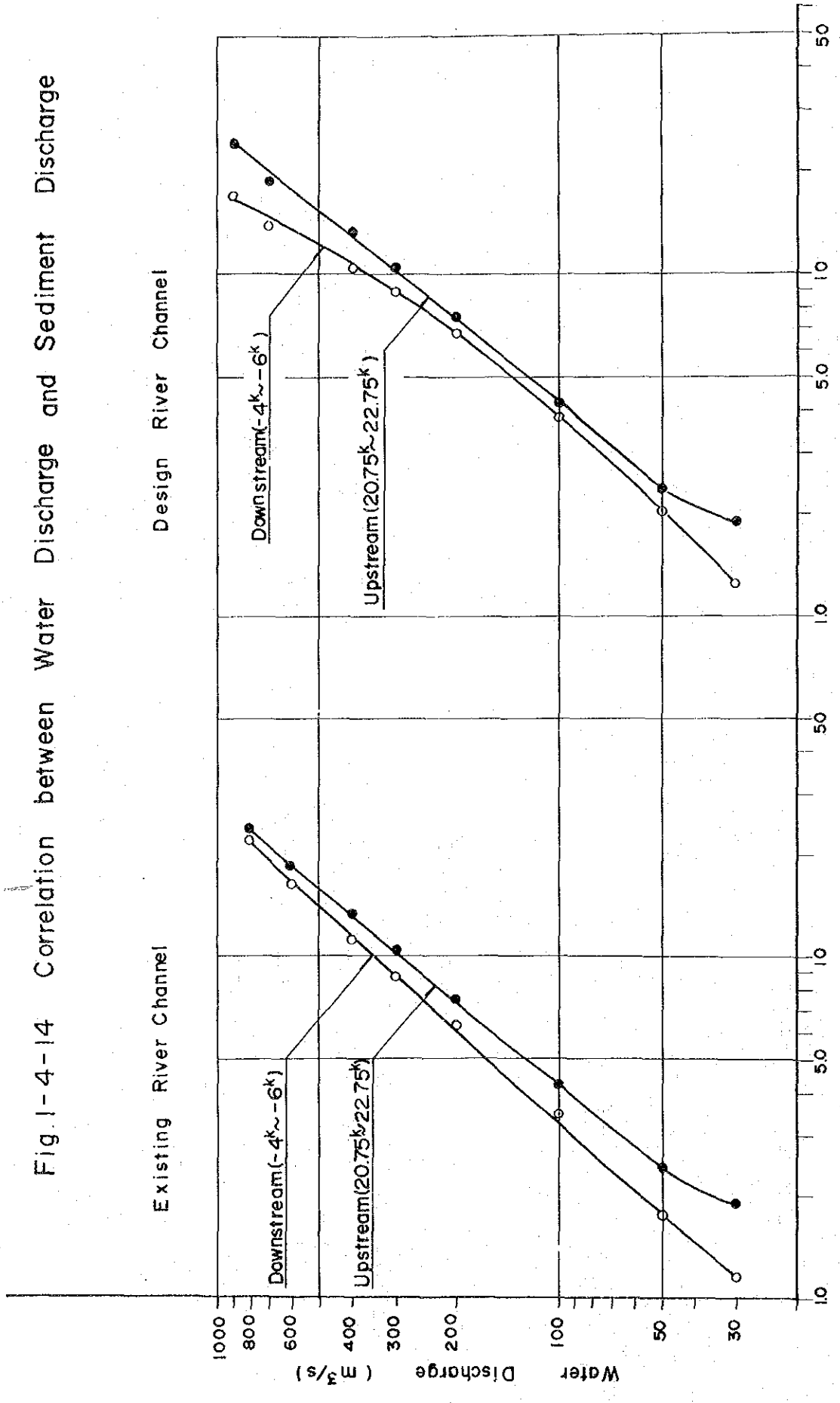


Fig. 1-4-14 Correlation between Water Discharge and Sediment Discharge



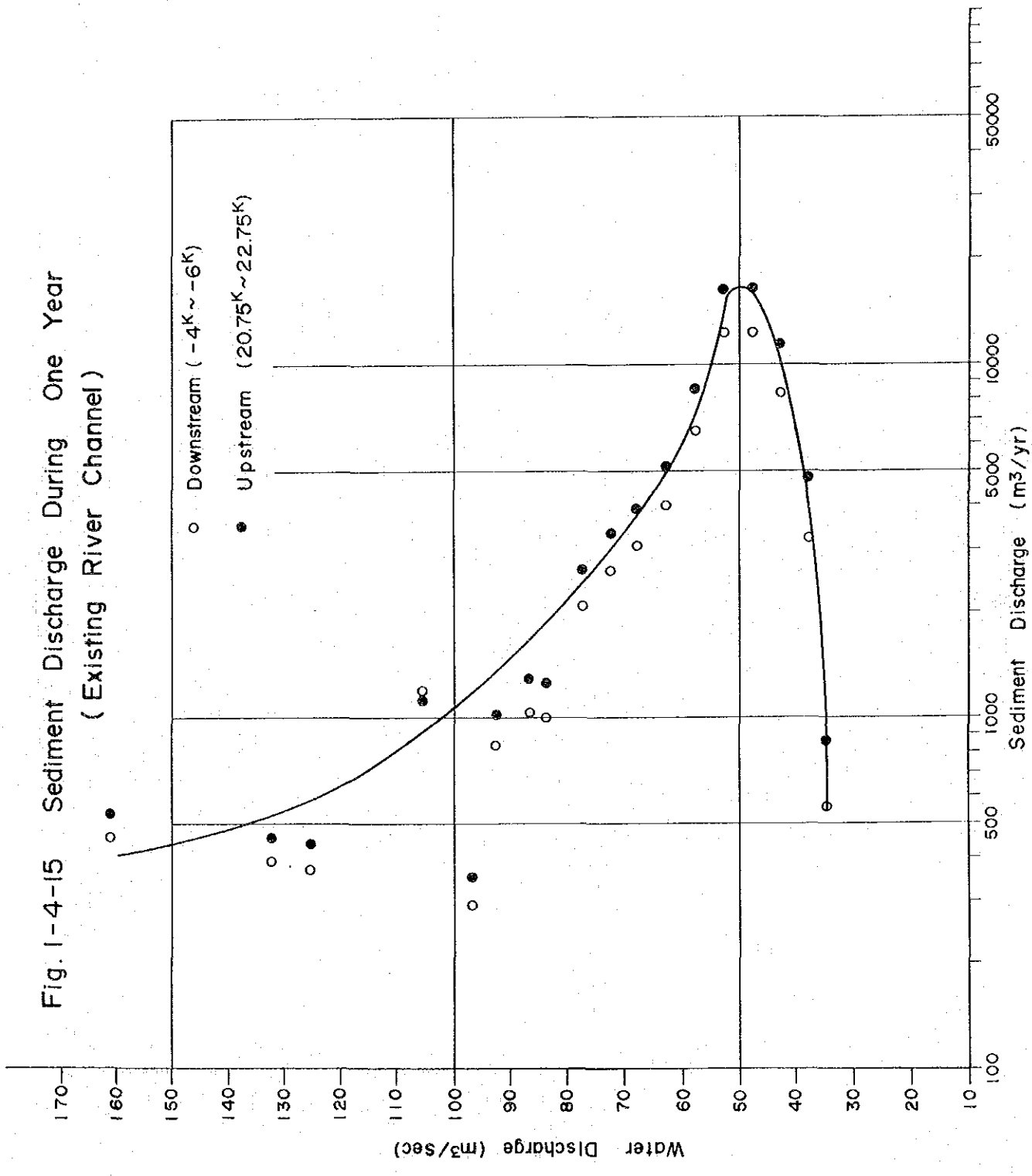


Fig. I-4-15 Sediment Discharge During One Year
(Existing River Channel)

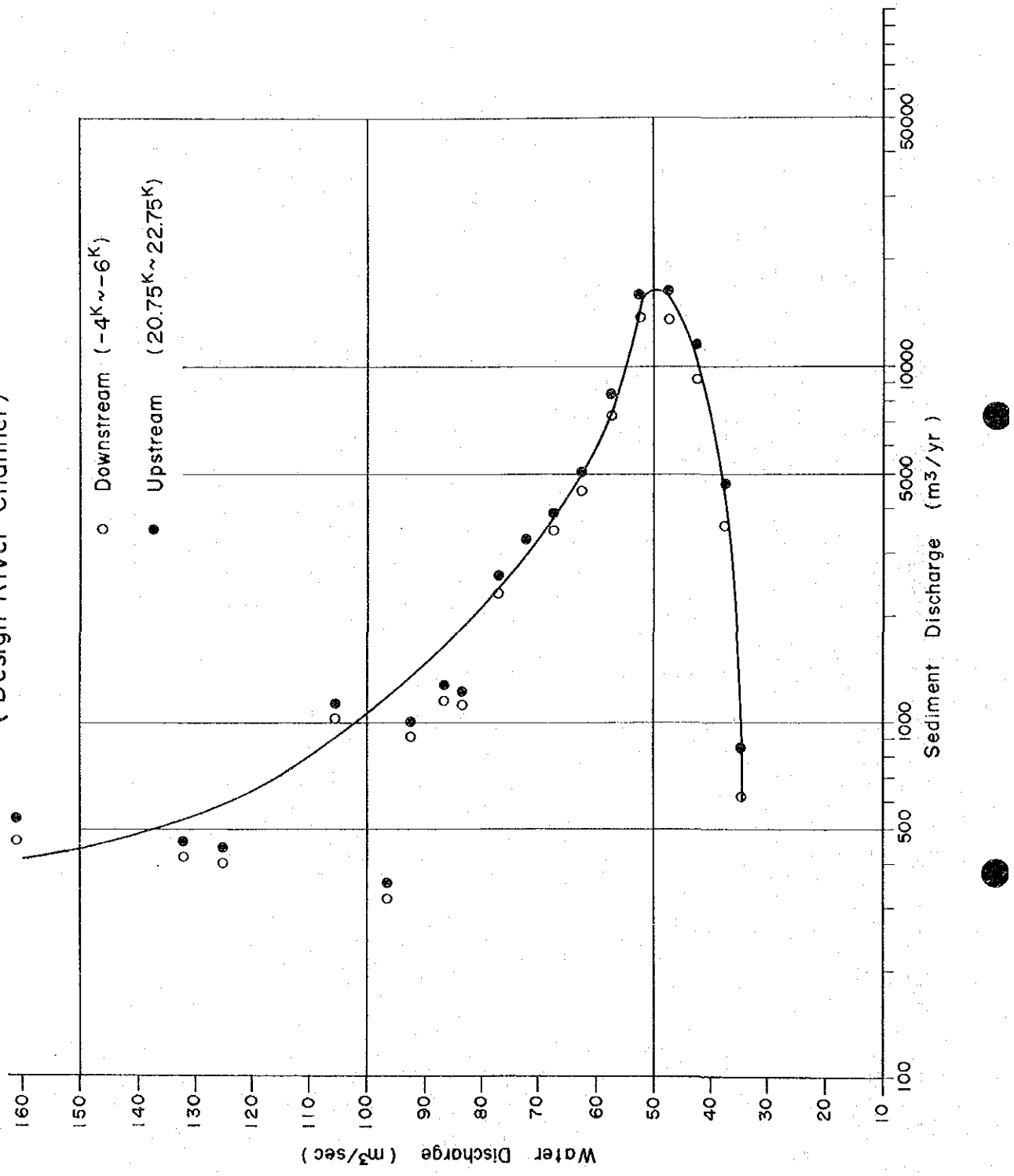


Fig. I-4-16 Sediment Discharge during One Year
(Design River Channel)

Fig. I-4-17 Longitudinal Profile of Sediment Discharge at Water Discharge 50 m³/s

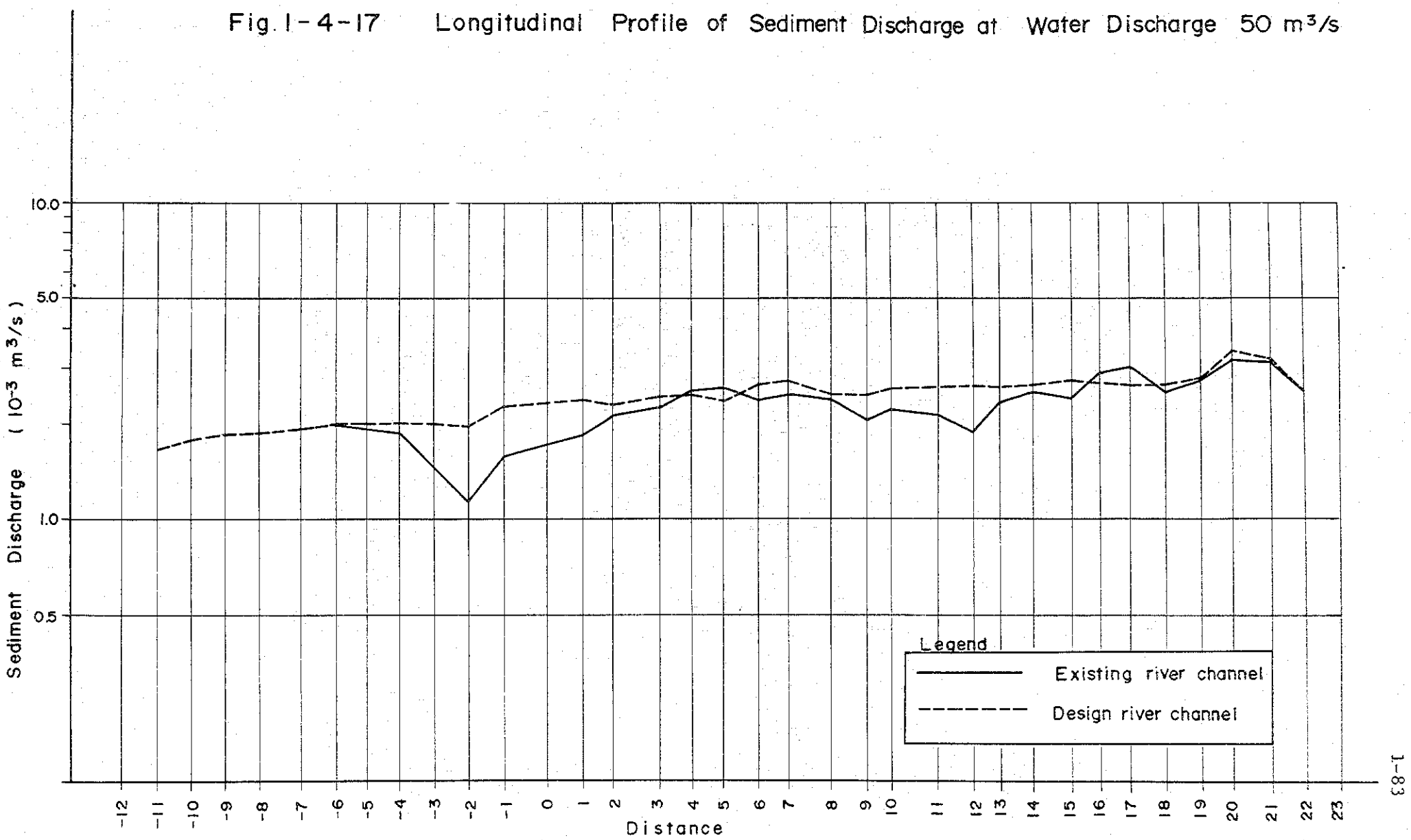


Fig. 1-4-18 Revetment Work (Ular River)

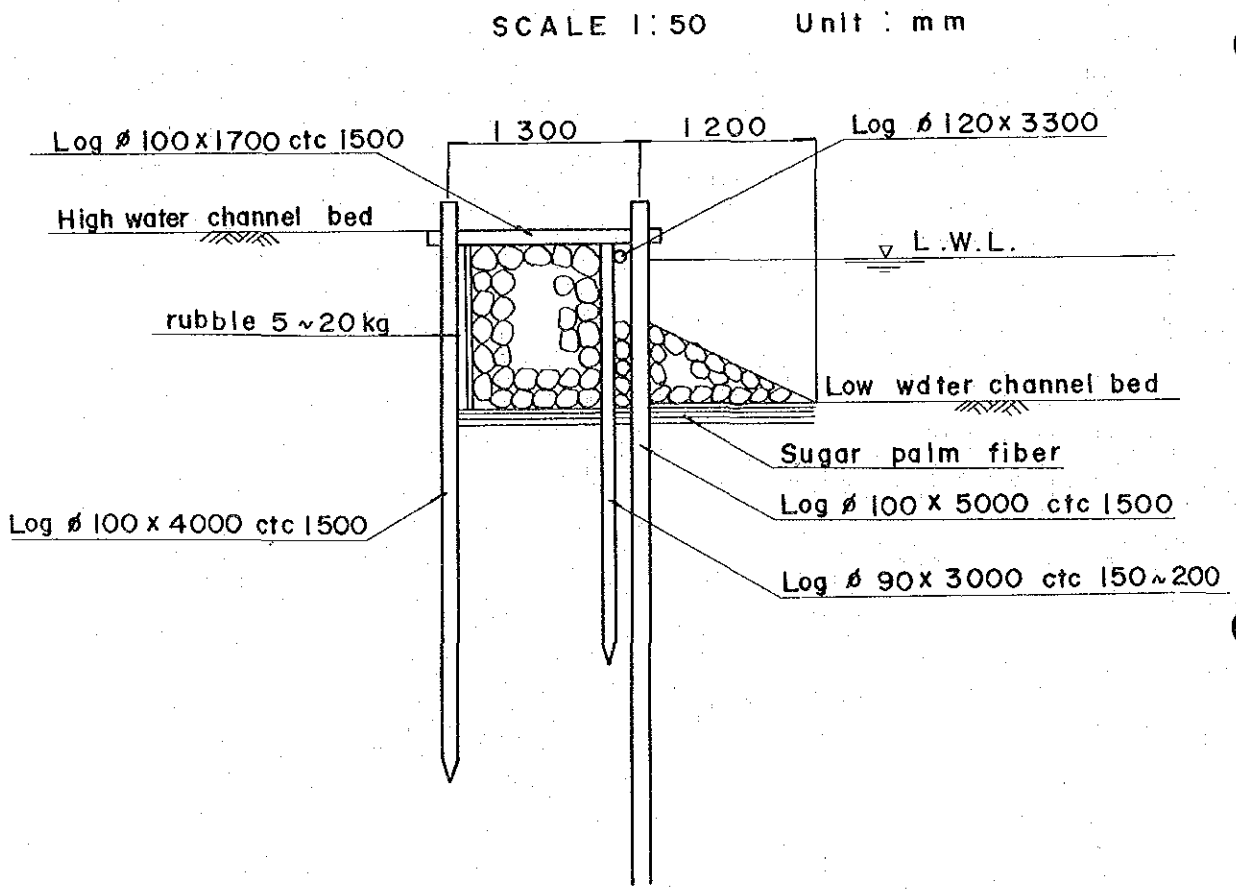


Fig. I - 4 - 19 Location of Pulau Gambar Area

Scale 1 : 50,000

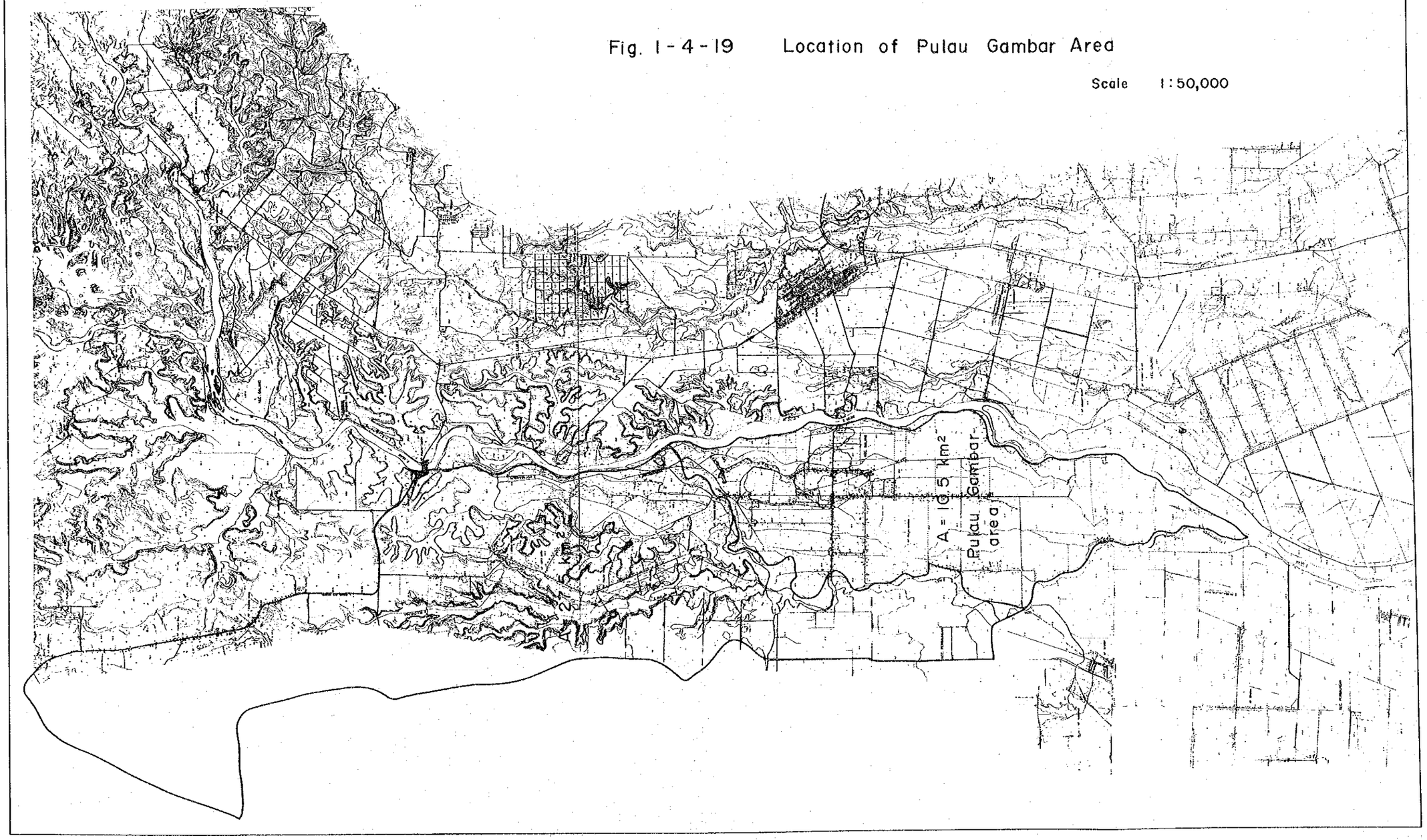
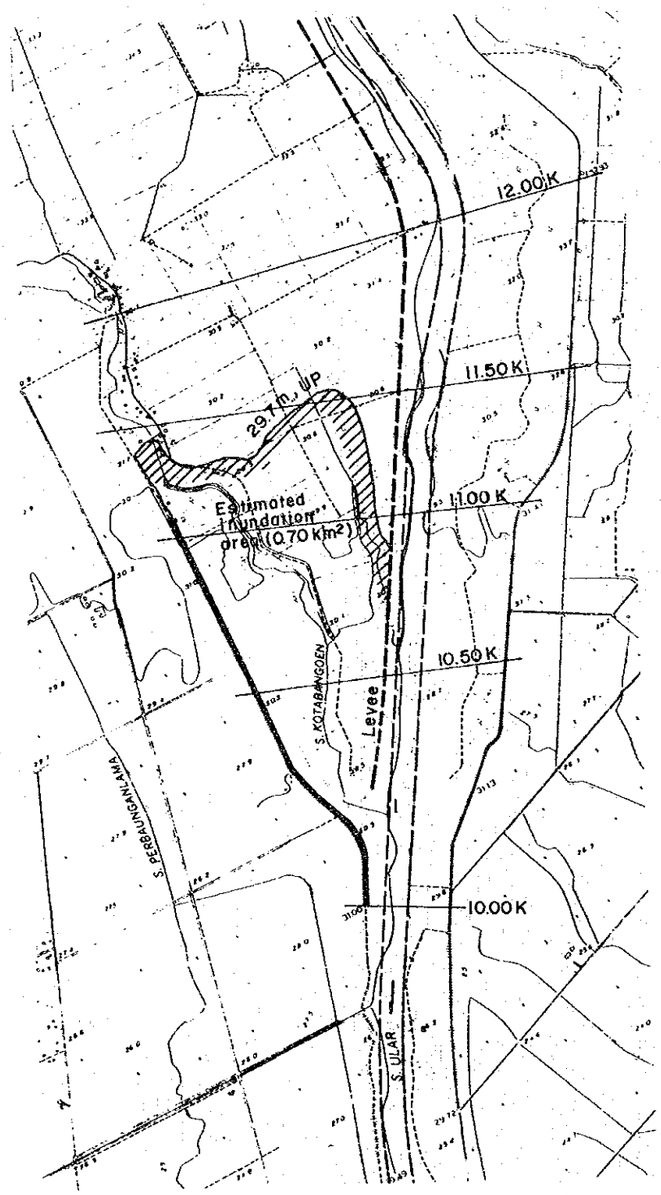
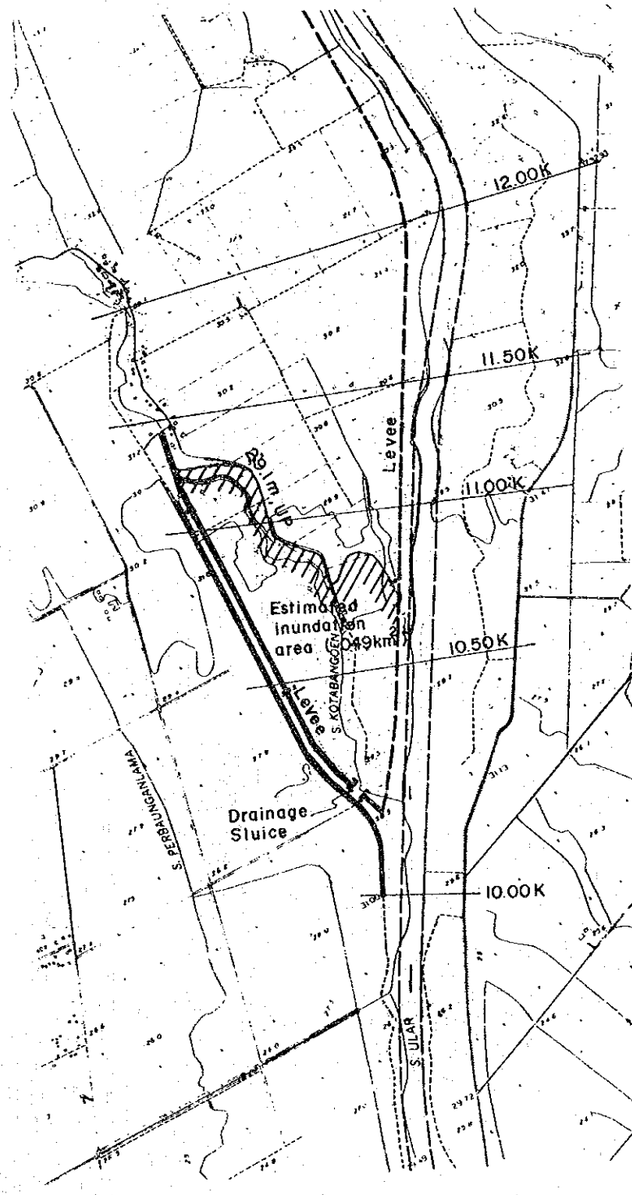


Fig. I-4-20 Confluence of Pulau Gambar Canal with the Ular River

(Alternative plan - 1)



(Alternative plan - 2)



(Alternative plan - 3)

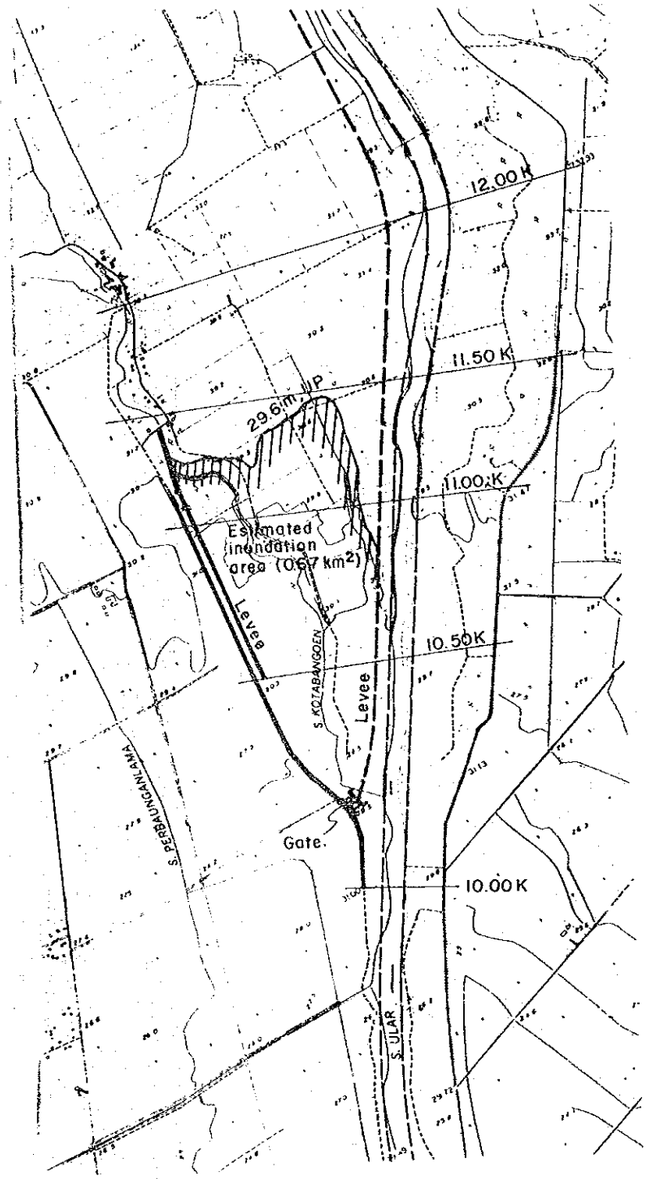
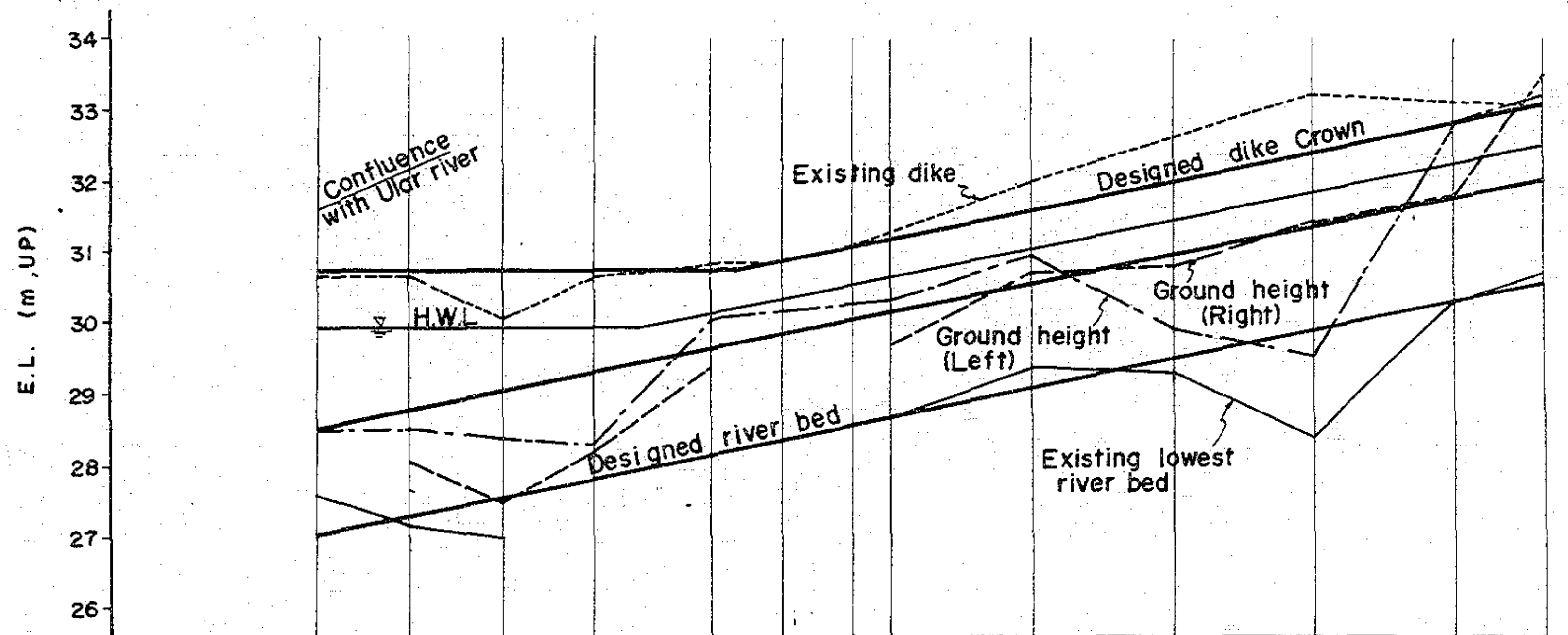


Fig. 1-4-21 Design Longitudinal Profile of Pulau Gambar Canal



		Section No.	10.00 k +300m	10.25	10.50	10.75	11.00	11.25	11.50	PC-10	PC-12	PC-14	PC-16	PC-18	PC-19
Design (m, UP)	El. of dike Crown		30.75	30.75	30.75	30.75	30.75	30.94	31.14	31.25	31.65	32.05	32.45	32.85	33.11
	H.W.L		29.95	29.95	29.95	29.95	30.14	30.34	30.54	30.65	31.05	31.45	31.85	32.25	32.51
	El. of high water channel bed		28.51	28.77	29.04	29.30	29.64	29.84	30.04	30.15	30.55	30.95	31.35	31.75	32.01
	El. of low water channel bed		27.01	27.27	27.54	27.80	28.14	28.34	28.54	28.65	29.05	29.45	29.85	30.25	30.51
Distance (m)	Cumulative		0	260	530	790	1 125	1 330	1 530	1 640	2 040	2 440	2 840	3 240	3 500
	Between two sections		0	260	270	260	335	205	200	110	400	400	400	400	260

Fig. I-4-22 Typical Cross-Sections of Pulau Gambar Canal

Scale ; 1/200

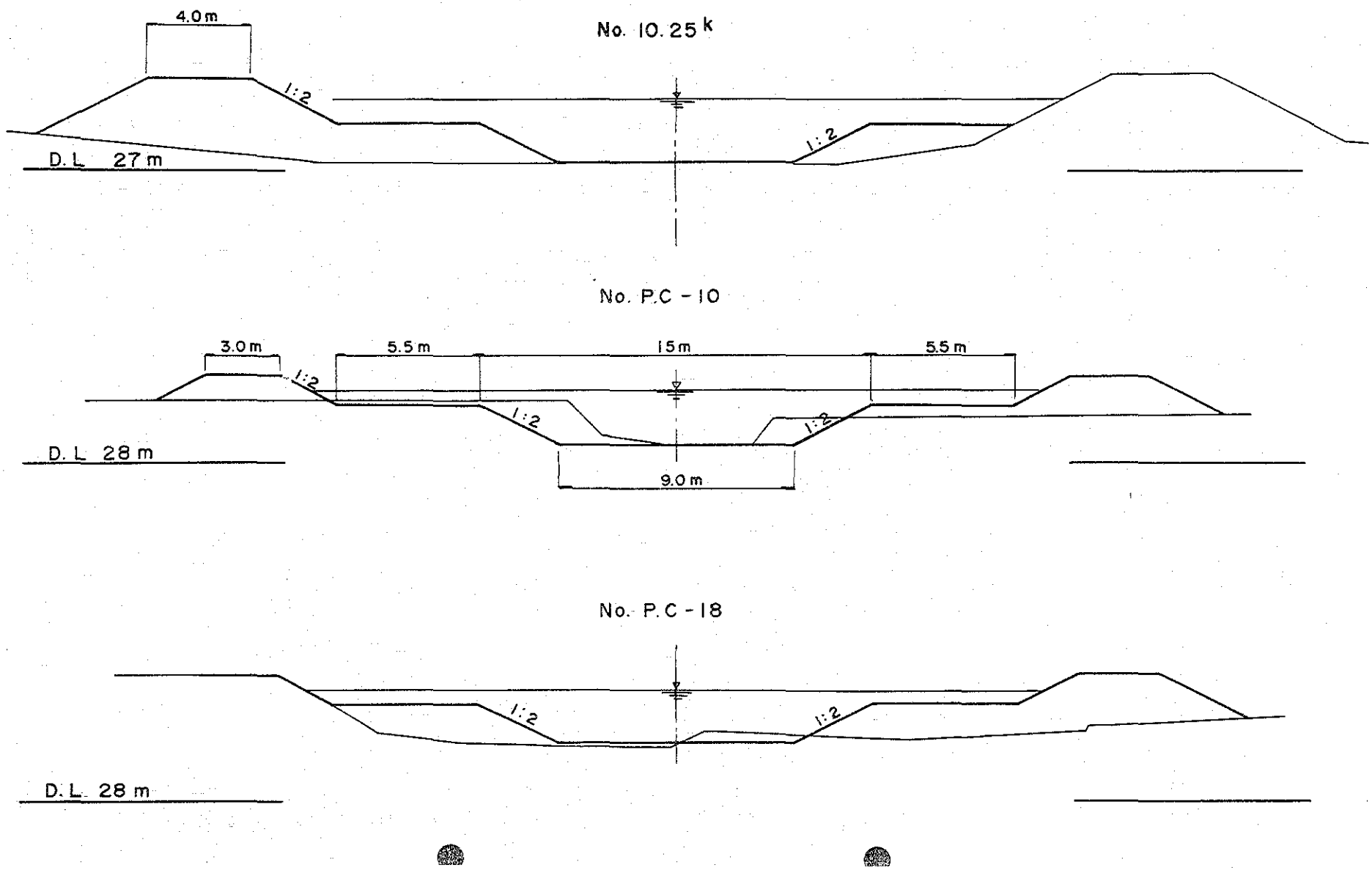
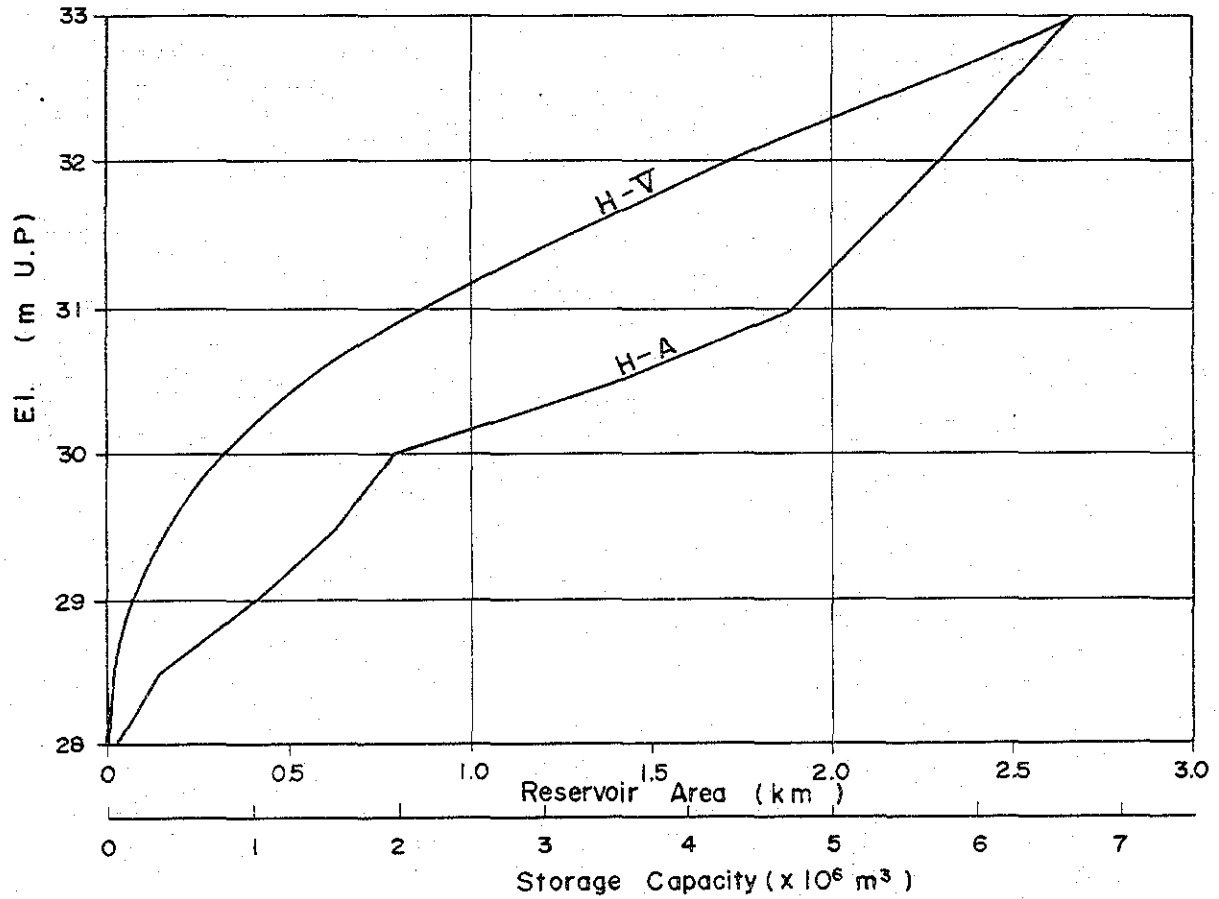


Fig. I-4-23 Storage Capacity Curve



H (m.u.p)	A (km^2)	V ($10^3 m^3$)
28.0	0.02	0
28.5	0.15	40
29.0	0.41	180
29.5	0.63	440
30.0	0.79	800
30.5	1.41	1350
31.0	1.89	2170
32.0	229	4260
33.0	266	6740

Design Stage and Discharge Hydrograph of the Ular River

Fig. I-4-24 Stage (t-H)

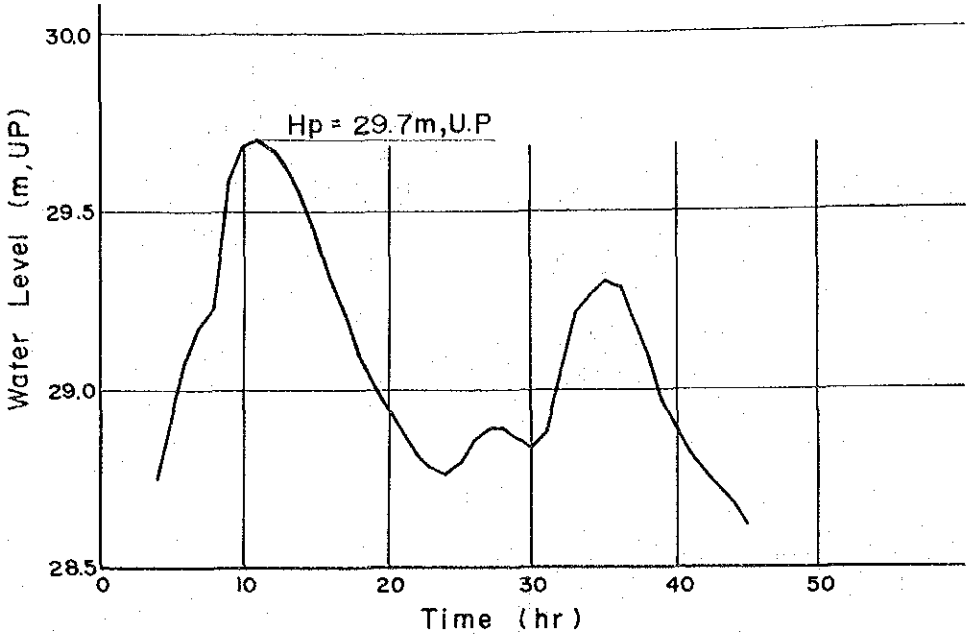


Fig. I-4-25 Hydrograph

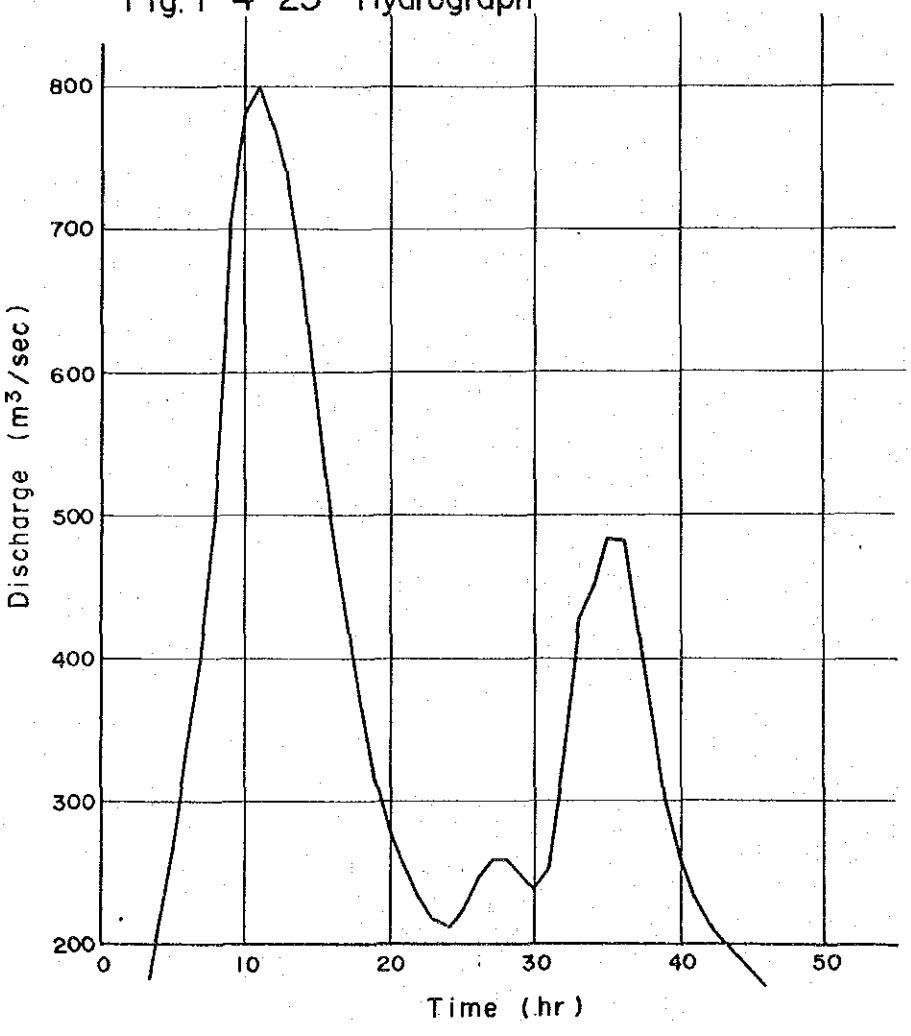
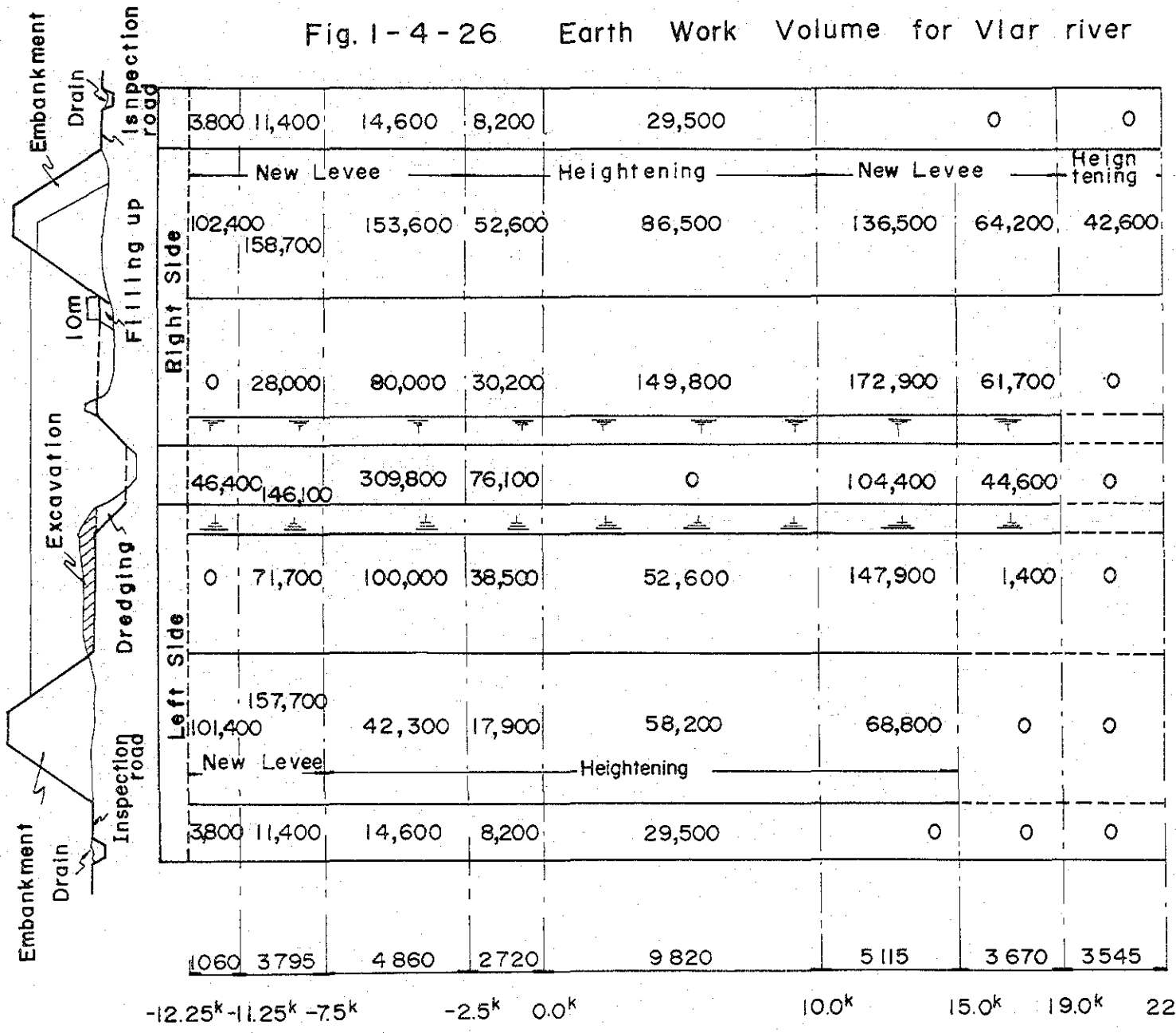


Fig. I-4-26 Earth Work Volume for Vlar river



CHAPTER II

IMPROVEMENT OF IRRIGATION AND DRAINAGE

2.1. Project Area.

2.1.1. Location.

The project area which was set on the occasion of the Overall Plan Study was taken also in the present study. This is a triangular area in the lower Ular plain with its vertex at Serbajadi Bridge, surrounded by the Serdang river on the west, the Rampah river on the east and the Strait of Malacca from east to west. A national highway and a national railway connecting Medan with other major towns run through the central part of the project area forming the important routes for supplying foodstuff and other commodities to the towns including Medan.

The project area administratively belongs to Deli/Serdang District and it covers a part of or whole of seven Subdistricts of Lubuk Pakam, Pantai Cermin, Perbaungan, Galang, Tg. Beringin, S. Rampah and Teluk Mengkudu.

The project area encloses an area of 45,000 ha, of which 18,500 ha of paddy field was taken out as the object of the present study on improvement of irrigation and drainage.

2.1.2. Physical Features.

(1) Topography and soils.

The project area is an alluvial plain formed by the Ular river. The elevation ranges from about 1 m near the sea to the maximum of about 50 m near the Serbajadi intake. The area has a flat topography sloping from south to north with a gradient ranging 1/600 at the upper part to 1/1,200 near the sea. There are undulations corresponding to natural drainage channels or hydromorphic depressions.

In spite of the relatively steep gradient, a number of minor elevations and depressions have been formed due to the actions of the sea and rivers. Especially, the marine action has produced a distinctive topography characterized by several sand dunes along the coastal line, which inhibits surface drainage into the sea combined with the tidal action. The area enclosed between sand dunes turns to swampy land during the rainy season. In addition, roads and railways also inhibit surface drainage.

These topographical features are closely related to soil formation. Most of soils in the project area have been influenced by hydromorphic soil formation and are classified as gray hydro-

morphic soils in great soil group level. In addition, red yellow podzolic soils are scattered over the isolated hilly land in the upstream area of the Ular river. The hydromorphic soils have moderate pH value ranging from 5.1 to 6.8 for water. Cation exchange capacities are 10 to 30 me/100 gr. Base saturation degree shows a relatively high value. The soils generally have deep to moderately deep effective soil depths. As regards soil particle distribution, soils on the right side of the Buluh river consist of light to heavy clay. Soils in the area extending over the left side of the Buluh have been affected by sediments from the Ular river, and the soil texture is different depending on locations. Generally soils in such area are medium to fine in texture which are composed of intermittent layers. These soils are mostly used as paddy field at present and have low permeability in general. On the other hand, red yellow podzolic soils have relatively low pH value of about 5.5. Cation exchange capacities show less than 10 me/100 gr. Base saturation degree ranges from 40 to 60 %. The soils have generally large effective depths. The soil texture varies from sand to clay depending on locations. These soils are now under cultivation of upland crops or estate crops. Soil profiles and results of soil analyses are shown in tables 2-1-1 and 2-1-2. The locations of soil pits are shown in Fig.2-1-1.

The area extending over the coastal zone with a width of about 1 km is affected by sea water. The influence of salt is due to overtopping of sea water or sea water mixed with river water discharged from upstream in time of high tide. The results of water quality test of river water, ground water, canal water and water in paddy field are shown in Table 2-1-3. It seems that the values of chloride (Cl^-) content will probably reach to several times of those given in the table in time of highest tide owing to overtopping of salt water. The locations of water sampling sites are illustrated in Fig.2-1-1.

Consequently, with the exception of the area strongly affected by salt water (more than 300 ppm of chloride content), the project area will promise to become highly productive land if proper fertilization, drainage improvement and strict control of irrigation water can be provided.

(2) Climate.

The climate in the project area is characterized by no definite distinction between the dry and the wet seasons. Annual rainfall averages 2,060 mm ranging from 1,700 mm to 2,400 mm depending on locations.

There are considerable variations in annual precipitations. Rainfall occurs irregularly in the form of intense local storm. Soil moisture, therefore, is not kept on propoer condition and vigorous growth of paddy is not expected. It is indispensable to control water properly for successful cultivation of paddy. Mean monthly temperature is about 26°C which only slightly varies during year. Mean monthly relative humidity is about 87 % during year. N and NE winds prevail in the project area all the year

round. No strong wind nor typhoon occurs with the exception of the seasonal wind which is incidental to the tropical climate. Sunshine duration averages 49 % ranging from 37 % to 57 %. The period from March to August except April, since it has a relatively high value of 55 %, is an important period for increasing rice production from the viewpoint of photosynthetic efficiency. Table 2-1-4 gives the summary of climate in the project area. Fig.2-1-2 shows locations of climatological and rainfall stations. The available daily rainfall records at those stations are summarized in Fig.2-1-3.

(3) Water resources and water quality.

(i) Water resources.

Water sources for irrigation in the project area depend on the Ular river though a little amount of water of some streams flowing down the area are used as supplement.

On the Ular river, there are two gaging stations which are available for the study of the existing irrigation systems and also for planning of improvement of them. One is the Pulau-Tagor (Serbajadi Bridge) station and the other is the Bandar Tiga station. The records obtained by the DPMA at the Serbajadi station give smaller values compared with those at Bandar Tiga; hence the former were used for the study of irrigation for the sake of safety.

Table 2-1-5 shows mean ten-day discharge from August 1971 to December 1977 at the Serbajadi station. This table shows that the Ular river has discharges more than 40 m^3/s throughout the observation period except from the middle of July to the beginning of September in 1972 and the mean discharges in the wet season from August to January and in the dry season from February to July are 57.3 m^3/s and 50.4 m^3/s respectively. This fact shows that the Ular river has comparatively sufficient discharge for the irrigation development in the project area.

(ii) Water quality.

The qualitative stability of water of the Ular river was examined on the basis of water quality analysis. The water samples were taken from the Pulau Gambar and Bendang intakes. The water quality analysis was made at the laboratory of RISPA in Medan. The results of analysis are summarized in Table 2-1-6. There are no problems in utilizing the river water for irrigation.

(iii) Sediment.

The existing irrigation systems are suffering from considerable amount of sediment and are losing their original capacities. Bed materials were sampled from all the intakes and main canals. The locations of sampling is shown in the following table. Grain size analyses were made at RISPA in Medan. The results are shown in Table 2-1-7 and Figs.2-1-6(1) to 2-1-6(7).

Name of Intake	Location of sampling	Observation
Pulau Gamber	1. Approach Canal A	fine sand
	2. Approach Canal B	fine sand
	3. After Intake	fine sand
S. Buluh	4. Approach Canal A	fine sand
	5. Approach Canal B	fine sand
	6. After Intake	coarse sand
Tinbang Deli	7. Approach Canal	coarse sand
	8. After Intake	coarse sand
	9. Main Canal	coarse sand
Perbaungan	10. Approach Canal	coarse sand
	11. After Intake	coarse sand
	12. Main Canal A	coarse sand
	13. Main Canal B	coarse sand
Sumber Rejo	14. Approach Canal	fine sand
	15. After Intake	coarse sand
	16. Main Canal A	coarse sand
	17. Main Canal B	coarse sand
Bendang	18. Approach Canal	coarse/fine sand
	19. After Intake	coarse sand
Ramonia	20. Approach Canal	fine sand

2.1.3. Population and Religion.

The population of the project area excluding estate area is estimated at 144,000 in 1976 as shown in Table 2-1-8. The population density is about 530 persons per km^2, which is very high compared with the average density of 180 persons per km^2 in Deli/Serdang District and of 100 persons per km^2 in the whole area of North Sumatra Province.

There are nc major cities in the project area, although there are a number of large towns, of which Lubuk Pakam and Perbaungan are the largest. Most of inhabitants live in villages and hamlets which are scattered all over the project area. They are mostly engaged in agriculture and the related activities based on cultivation of rice. The major towns are usually Subdistrict capitals, and they serve as commercial centers for the surrounding agricultural areas.

Ethnically, the majority of the people in the project area are Javanese clan (48.6 %), followed by Melayu clan (19.8 %), Batak clan (15.0 %), Banjar clan (11.0 %) as shown in Table 2-1-8.

From the religious viewpoint, most people are Moslem followed by protestant as shown in Table 2-1-9. Religious doctrines or tribal manners provide a comprehensive moral system to sustain the people's way of life and continue to affect the people's relationships, agriculture, rituals and arts. These factors should not impede the effective use of irrigation and adoption of innovations and development technics. The proper ceremonial propitiation will be needed for the construction and the use of facilities to distribute irrigation water without adverse reaction resulting from the spiritual deities believed in by the villagers.

2.2. Agricultural Activities.

2.2.1. Irrigation and Drainage.

(1) Irrigation.

The project area has paddy fields of 18,500 ha. Out of them, the existing irrigation area is estimated at about 7,000 ha which consists of the technical irrigation area/1 of 3,000 ha, the semi-technical irrigation area/2 of 1,500 ha and the non-technical irrigation area/3 of 2,500 ha. The remaining area of about 11,500 ha is a rain-fed area mostly extending over the coastal zone. No newly reclaimable area is found in the project area of 45,000 ha because the area has already been fully developed. The irrigation area coveres about 38 % of the paddy fields and the area for double cropping per year is about 4,500 ha or 24 % of the paddy fields.

The water sources for irrigation in the project area mostly depend on the Ular river except a small amount of drainage water also used for irrigation by dual-purpose canals in the project area.

At present, there are fourteen intake facilities which are installed on the Ular river along a distance of about 32 km between Serbajadi Bridge and near the river mouth of the Ular. All the intake facilities except a pumping station for PNP VI Adolina are being used for the irrigation of paddy fields and have recently constructed or rehabilitated after 1970. The present conditions of the intake facilities are outlined in Table 2-2-1.

The existing irrigation area of 7,000 ha is divided into nine blocks by the existing canal network with thirteen intakes. The existing irrigation blocks are shown in the following table and Fig.2-2-1.

/1, /2, /3 : See Subsection 2.2.6. (4) of this report.

Existing Irrigation Blocks

Block	Area	Intake
1. Pulau Gambar & Swadaya	1,200 ha	Pulau Gambar & Swadaya
2. S. Buluh	400	Buluh
3. Timbang Deli	400	Timbang Deli
4. Perbaungan	1,950	Perbaungan
5. Sumber Rejo	800	Sumber Rejo
6. Bendang	1,000	Bendang
7. Singosari	100	Singosari (2 places)
8. Ramonia	1,100	Ramonia
9. Wonosari	50	Wonosari (3 places)
Total	7,000	

The length of the existing main irrigation canals and secondary canals totals to 33.9 km and 168.9 km respectively. Table 2-2-2 shows length of irrigation canals and number of canal structures.

It is concluded on the basis of survey results that the project area has the following constraints on the existing irrigation system.

a. A considerably large amount of sediment deposits are found in the irrigation canals at present. These sediments reduce the capacities of canals and intakes.

b. Nevertheless the area has a steep slope of about 1/1,000 and most of the canal system in the area consists of earth canals, there are almost no drop structures to prevent erosion and failure of inside slope of the canals. On the contrary, there some cases in which the diverted water does not reach the objective area and aquatic plants grow in the canals because of the shortage of water head.

c. The water distribution system in the area generally exhibits a complicated canal network due to the dual-purpose of irrigation and drainage. This fact makes the water management in the area difficult.

d. In general, facilities on farm remain in an unconsolidated state. Especially, small density of tertiary canals seems to hamper the expansion of benefited area. In addition, complicated canal system without measuring divices and proper water management results in excessive water use in the upstream art of the benefited area and along canals.

e. One of the most important points for the irrigation water management in the project area is to properly coordinate the organizations for water management and operation and maintenance of the irrigation facilities.

In order to carry out successful paddy cultivation and produce the target yield of paddy, it is dispensable to improve the above problems.

(2) Drainage.

At present, eight natural rivers and drainage canals totaling about 250 km play important roles in the existing drainage system of the project area. Fig.2-2-2 and Table 2-2-3 show the existing drainage systems.

There are two different drainage conditions. One is the plantation area and the other is non-plantation area. In general, the plantation areas have well-developed and well-maintained drainage systems, but non-plantation areas have poor drainage conditions due to shortage of carrying capacities of natural river and drainage canals, constrictions formed by bridges and culverts on the national highway and the national railway, and sand dunes formed on the coastal zone and tidal action.

The left side of the Ular river, most of which were plantations in the past, has few problems on drainage. The right side which had almost no plantation except PNP Adolina located in the lower part from the national road is an area with poor drainage condition.

One of the most important problems on drainage system is the existence of canals used for both irrigation and drainage, though dual-purpose canal enables economical supplement of water for irrigation. Paddy cultivation, however, requires fresh water to control farm inputs, produce high yield and prevent some diseases.

Therefore, if separate irrigation and drainage canals are provided as many as possible and the existing drainage systems are improved, this will promise easier farming practice and successful paddy cultivation.

2.2.2. Land Tenure and Land Holding.

In Indonesia, the Basic Agrarian Law No.5 of 1960 known as "Land Reform Law" is applied to land tenure. It is executed under the responsibility of the Directorate General of Agrarian, Ministry of Interior. Local activities are carried out by the Provincial Agrarian Office.

According to the Land Reform Law, North Sumatra Province is classified as a less-crowded area. The limitation of private ownership of farm land was enacted on 10 ha for paddy field and

12 ha for upland-crop field. At present, there is no private large landlord, especially in paddy field in North Sumatra Province.

In the project area, public land, which is mostly under the cultivation of national plantation estates and several private plantation estates, occupies 17,800 ha or about 40 % of the gross project area of 45,000 ha, as seen in Table 2-2-6. The farm land of 19,700 ha including 500 ha of vegetable field and 700 ha of fruit gardens is owned by about 16,200 farmers that are more than 82 % of the total number of farmers. The tenant farmers account for only 6 % and number of farm laborers is about 12 % in the project area as shown in Table 2-2-4.

Average farming size in the project area is rather large compared with that in Java Island, but the problem for agricultural production is lack of well-irrigated paddy field. Technical and semi-technical paddy fields are only 0.258 ha on the average or account for only 24.3 % of the total area of paddy field as shown in Table 2-2-5.

2.2.3. Agricultural Production.

(1) Land use.

The project area of about 45,000 ha has already been fully developed; hence there leaves no room for further reclamation. The land under cultivation is estimated at 39,100 ha. The remaining area of 5,900 ha covers villages, roads, other infrastructures, etc.

The land under cultivation mainly consists of estate crop area and paddy field. Estate crop area including small holder system occupies an area of 17,800 ha or 40 % of the project area where oil palm, rubber and coconut trees are planted on 10,000 ha, 4,300 ha and 3,500 ha respectively. Paddy field totals 18,500 ha or 41 % of the project area. The paddy field is not always provided with good irrigation and drainage facilities. The irrigated paddy field presently accounts for 7,000 ha or 38 % of total paddy field, which consists of 3,000 ha of technical irrigation area, 1,500 ha of semitechnical area and 2,500 ha of non-technical area. The remaining 11,500 ha of paddy field is rain-fed paddy field that depends on natural rainfall. In addition, an area of 2,800 ha is being used as vegetable field, fruit gardens and forest.

Predominant crop in the project area except estate crops is paddy, which occupies about 100 % in the rainy season and about 25 % in the dry season. Second crops are polowijo crops cultivated in the paddy field after harvesting rainy season paddy which covers an area of 900 ha. As described in the previous paragraph of climate, even in the dry season, much excess rainfall in a short period or long drought period occurs. Consequently, polowijo crops are damaged by root-rot due to excess water or are not able to grow due to drought. Such area where polowijo crops are cultivated

is limited to only 5 % of the total paddy area.

Multi-cropping index for paddy field is about 1.3.[/1] The characteristics of the present land use are summarized in Table 2-2-6 and shown in Fig.2-2-3.

(2) Cropping pattern and farming practices.

As described before, the prominent crops in the project area are paddy, polowijo and estate crops.

Paddy cultivation generally depends on the onset of the rainy season and seedling period fluctuates from year to year. However, broadly speaking, planting is done during the period of October to December and harvesting from February to April for improved high-yielding varieties and from April to June for local varieties respectively. In the irrigated area, the dry season paddy is planted during the period of March to June.

As regards varieties of rice, improved high-yielding varieties such as IR-5, IR-26, IR-30, IR-34, etc. have widely spread in the project area as the result of the development projects promoted under PELITA I and PELITA II. In 1976, IR-32 and IR-36 varieties mainly prevailed in the project area because of its high resistance to "Wereng". In addition, local varieties such as Jambu, Kodok, Rendah Pisang, Manik are being cultivated in the project area. Their growing period ranges from 5 to 7 months.

Fertilizer dosage for paddy is estimated at 50 kg per ha of urea for rain-fed area and 150 kg per ha for irrigated land respectively. Triple super phosphate and chemicals application prevails into only irrigated land. Tables 2-2-7 and 2-2-8 are the summary of production cost of paddy.

Farming in the project area is labor intensive from seedling to harvesting. Land preparation is carried out by draft animals or sometimes by man power. Harvesting is done by sickles, not ani-ani equipment. Irrigation water control is not sufficiently conducted even in the irrigated area. In the light of such low farm inputs and improper water control, it appears that high yield of paddy cannot be expected.

As for polowijo crops, major crops are cassava and sweet potetoes followed by peanuts and beans. They are planted during March to May after harvesting of the rainy season paddy. No fertilizer and chemicals are applied and unit yield of the crops is low. Tables 2-2-9 to 2-2-11 are the summary of production cost of polowijo crops.

/1 Rainy season paddy area + dry season paddy area + polowijo area (upland crop) / 18,500 ha

$$= \frac{18,500 + 4,500 + 900}{18,500} = 1.29$$

(3) Agricultural production.

Production of crops in the project area was estimated based on the available data provided by the Agricultural Office of Deli/Serdan District, PNP and privately owned estates.

Unit yield of paddy and polowijo crops was estimated as an average yield for the period between 1971 and 1976. The unit yield of paddy under the condition of irrigation was estimated at 3.6 ton/ha on the basis of the result of activities of BIMAS and INMAS Program as shown in Table 2-2-12. The unit yield of paddy in rain-fed field was estimated at 2.9 ton/ha based on Tables 2-2-12 and 2-2-13/1.

Table 2-2-14 shows the unit yield of polowijo crops. Estate crop yield is the value in 1975. Total production of paddy is about 73,000 tons, while polowijo crops in the paddy field after harvesting rainy season paddy amounts to 8,000 tons. As for estate crops, about 168,000 tons of palm oil and 6,000 tons of rubber are produced.

Livestock breading and poultry raising are not popular in the project area, but they are important for the production of protein food and for provision of draft animals for land preparation. Table 2-2-15 shows the summary of crop productions.

2.2.4. Marketing.

(1) Distribution of agricultural requisites.

Distribution of chemical fertilizers in North Sumatra Province is handled by four enterprises, of which two are private and the other two are govenmental. Fertilizers are sold to seven distributors in Medan, then redistributed to sub-distributors at the District level. Sub-distributors provide necessary amount of chemical fertilizers and agricultural chemicals to retailers and/or KUD (Village Unit Cooperative) at the local level as illustrated in Fig.2-2-4.

/1 Table 2-2-13 indicates average yield (3.2 ton/ha) of total area of rain-fed area, and BIMAS and INMAS area. The unit yield of rain-fed area is estimated at 2.9 ton/ha as shown in the following calculation.

$$\frac{(\text{Rainy season (paddy area} + \text{Dry season paddy area}) \times \text{Average yield} - (\text{Rainy and wet season (paddy in irrigated area)} \times \text{Unit yield}}{\text{Rain-fed area}}$$

$$= \frac{(18{,}500 + 4{,}500) \times 3.2 - 4{,}500 \times 2 \times 3.6}{14{,}000} \approx 2.94 = 2.9$$

Distribution price of agricultural requisites for agricultural intensification program (BIMAS and INAS) is set by the Government with governmental subsidy. The quantity and the price of agricultural requisites for BIMAS Program is shown in Table 2-2-16.

As for the improved seed of rice, multiplication and distribution are wholly under the control of the Government. At present, 12 seed stations (Balai Benih) managed by respective District Agricultural Offices distribute certified seeds to farmers through KUD/PPL according to the BIMAS Program (see Seed Multiplication and Distribution, 2.2.7.(4)).

(2) Marketing of farm products.

Main marketing of farm products in the project area is rice. The amount of marketing of rice is varied annually according to the variation of the yield of rice produced in each year. However, the price of rice is stabilized by the Government through the price control by DOLOG (Depot Logistik) in North Sumatra.

The DOLOG would purchase and sell the rice when the price of medium-quality rice is down under the floor price or raised over the ceiling price at the central market in Medan.

The floor price and ceiling price, which are determined by the Government based on the price stabilization policy, were set at 110 Rp/kg and 145 Rp/kg in 1977 respectively. Recently, shortage of rice in North Sumatra owing to population increase and stagnation of paddy production caused to raise the market price of rice as seen in Table 2-2-17 and 2-2-18 though imported rice is increasing.

Paddy produced by farmers is sold to rice mill and/or KUD through brokers. And then rice mill sells it to wholesalers through middle brokers.

The market flow and composition of rice price in Medan is illustrated in Fig.2-2-5, and farm gate price is summarized in Table 2-2-19.

2.2.5. Farm Economy and Farmers' Intention.

(1) Farm economy.

According to the available data provided by the Agricultural Office of Deli/Serdan District and the field survey made by the Study Team, the farmers in the project area, at present, earn most of their incomes from the sale of rice produced in excess of their requirements for consumption of the families.

At present, the gross annual farm incomes of the typical owner farmers, Type I cultivating 1.45 ha of which 1.34 ha is rain-fed paddy field and 0.11 ha is upland-crop field and Type II

cultivating 1 ha of which 0.45 ha is irrigated paddy field, 0.5 ha is rain-fed paddy field and 0.05 ha is upland-crop field are estimated at about Rp 314,090 (US$ 757 equivalent) and Rp 347, 630 (US$ 838 equivalent) respectively as shown in Table 2-2-20.

In addition to the farm income, farmers get their incomes from non-farm activities such as temporary hired labor for the plantation estates, trade and others. The non-farm income is estimated to account for about 10 % of gross income for the average farmer in the project area.

The farming expenses except family labor cost is around Rp 25,250 (US$ 61 equivalent) in Type I and Rp 38,280 (US$ 92 equivalent) in Type II as shown in Table 2-2-20. Accordingly, the net income per farm household is estimated at about Rp 283,470 (US$ 683 equivalent) in Type I and Rp 302,450 (US$ 729 equivalent) in Type II respectively under the present condition which is nearly the same amount of living expense of typical farm household with 5.55 and 5.25 families respectively, according to the estimation by field survey as shown in Table 2-2-21.

(2) Farmers' intention.

A farm economic survey was carried out by a questionaire shown in Table 2-2-22 on the intention of the farmers in the project area with regard to increasing of farm production. In this survey, seventy-one heads of villages were selected from among seventy-three heads of all the villages in the project area and farmers' intention whether they will adopt double cropping of paddy per year after improvement of irrigation and drainage facilities was questioned by the staff of the Study Team.

The results of the survey are summarized in Tables 2-2-23 and 2-2-24. These tables tell us that most of the farmers in the project area want to cultivate double cropping of paddy per year through the improvement of irrigation and drainage facilities.

2.2.6. Rural Organization.

(1) General.

Indonesia is divided into 26 Provinces, 228 Districts (Kabupaten), 54 Municipalities (Kota Madya), 3,173 Sub-districts (Kecamatan) and 59,960 villages (Desa or Kampung).

North Sumatra Province is divided into 11 Districts and 6 Municipalities headed by Bupati and Walikota respectively nominated by the Government of the Province. These Districts and Municipalities are subdivided into 179 Subdistricts headed by Camat nominated by the Governor. Average number of Subdistricts per District is counted about 10. A Subdistrict covers about 31 villages on the average which are the basic units of administrative structure in Indonesia.

Head of village (Kepala Kampung/Penghulu), elected from among the people in the village every five years, has the responsibility of carrying out the following functions under the supervision and guidance of respective governmental authorities concerned.

a. Agricultural development.

b. Public health and sanitation.

c. Public education.

d. Village welfare and security.

e. Encouragement of industries and co-operatives.

f. Construction, maintenance and repair of public transportation facilities.

(2) BIMAS Program and Village Unit (WUD).

As for the agricultural development, the agricultural intensification program so called BIMAS (Bimbingan Massal) has been promoted by the Indonesian Government in the technical and semi-technical area in order to coordinate all the efforts of agricultural support services so as to provide a "package" of agricultural inputs to the farmers.

For further development of the BIMAS Program, the Government has initiated to organize a Village Unit (Wilayah Unit Desa) as the smallest executing unit of the program since 1973.

According to the Presidential Decree No.4 of 1973, the aims of establishing the Village Unit are (a) to assure the realization of agricultural products increasing program, particularly food production effectively and efficiently and (b) to give the certainty to producer farmers in particular and village community in general, that they have the responsibilities not only to take part in increasing the said production but also to raise their living standard and welfare.

Each Village Unit generally comprises 2,000 farmers in 6 villages with 600 to 1,000 ha of irrigated paddy field, and the following functions would be set up in each Village Unit.

a. At least one field Extension Worker (PPL) equiped with information appliances in order to diffuse the necessary information to the farmers within the Village Unit concerned. PPL would be technically responsible to the Executive Chairman of BIMAS of the Subdistrict.

b. Village Unit BRI (Indonesian People's Bank) having the main function to render banking services including BIMAS Credit Service as the branch office of BRI within its working area that may consist of more than one Village Unit area.

c. Retailer/stand/shop of Village Unit assigned to execute the function of distributing farm input such as fertilizer, pesticides, seeds and farm machinery and tools.

d. BUUD (Village Unit Executive Body)/KUD (Village Unit Cooperative) assigned to execute the function of processing and marketing of agricultural products.

The BUUD is established as an economic institution in the form of Cooperatives which may constitute joint undertaking merger of agricultural Cooperatives (PRIMER KOPERTA) found in the Village Unit area at its initial stage of growth, and be merged in one Village Unit Cooperative under the regulation of Ministry of Manpower, Transmigration and Cooperatives in a certain period of time according to its progress.

The Chairman of BIMAS Executive Body of Subdistrict is appointed the coordinator of Village Unit in the Subdistrict.

Following the direction of the policy, the Provincial Government established 571 Village Units covering whole province in 1977. Number of Village Units is counted 60 in Deli/Serdang District and 25 in the project area respectively.

Although all the villages in the project area are covered by this system, it is too varied among the Village Units in number of villages and farmers, and area of irrigated paddy field.

(3) Cooperative.

Supplies of agricultural inputs and processing and marketing of farm products are primarily made through the establishment of Cooperatives which had been promoted in the rural area by the Government through the District Cooperative Offices since 1945 when the Cooperative Act in Indonesia was enacted.

Inspite of the governmental efforts, the movement of Cooperative has not been well functioned yet, mainly because of weakness of management, shortage of operational fund and inadequate infrastructure such as road network in rurual area.

In North Sumatra, number of agricultural cooperatives was ever counted 754 with 14,500 members in 1965, but in 1975, it was only 43 with 2,000 members as shown in Table 2-2-25. In order to improve such stagnant condition of the Cooperative movement, establishment of Village Unit Cooperative (KUD) has been introduced by the Government in the area which adopted the intensification program since May 1973 when the Presidential Decree for Village Unit was enforced as mentioned previously. In North Sumatra Province, out of 304 Village Units (WUD), 265 or 87 % of KUD was established by August 1975; however the number of members is only 5.14 % of total number of farmers as shown in Table 2-2-26.

In the project area, out of 25 Village Units, 12 KUD were already organized and equiped with fairly well facilities as shown in Table 2-2-27, but their activities are hampered mainly due to the limitation of skillful leading farmers and lack of well-trained staff for management.

(4) Water management.

According to the criteria based on the design, construction of irrigation facilities and its network and also the water management system, there are three types of irrigation classification in Indonesia; namely technical irrigation, semi-technical irrigation and non-technical irrigation.

a. Technical Irrigation.

In technical irrigation, construction works are usually designed and executed up to the secondary canals by or through the Directorate General of Irrigation, Ministry of Public Works and Electric Power. The construction of the tertiary canals and distributary ditches with related structures on the fields is carried out by the farmers' organization at the village or community level under the guidance of the Provincial Department of Public Works.

b. Semi-technical Irrigation.

Construction works cover relatively smaller area which may be limited to a District. In this case, only the headworks are constructed by the Directorate of Irrigation, while the canals and their structures are constructed by the rural community. The management and supervision of the head works are generally transfered to the District authorities and the water distribution after the tertiary canals is managed by the farmers' organization.

c. Non-technical Irrigation.

Construction works are relatively very small and cover only one to two villages as they have limited water supply generally from a small stream. The construction of the headworks and canals is mainly executed by the villagers. The maintenance of the structures and also the distribution and management of water are entirely organized by the rural communities.

In the project area, there are 14 intakes along the Ular river of which six are constructed and managed by the Provincial Government, five by the District Government, one by PNP and two by farmers' groups.

The operation and maintenance of the irrigation facilities up to the secondary canals connected with the Ular river are under the responsibility of Deli/Serdang District Office of Prblic Works; however, daily works are only limited to the said six intakes and related secondary canals and not well carried

out at present mainly because there is no tertiary canal system completed and no interest of the farmers who could not get the irrigation water when they need because of shortage of water especially downstream of the canal.

In the project area, the Water User's Association (P3A) has been formally organized in each village as subbranch of the Village Agricultural Cooperation Association (BMTD) and District, Subdistrict and Tertiary Irrigation Committees have also been set up at each level. However, the activities of these organizations are not fully running yet. For example, operation and maintenance of the existing intake facilities are carried out partially by each foreman by own way at present. There is no record concerned about daily discharge, distributed area as well as planting calendar in any intake places. Even in the well-organized Water User's Association, it is hardly expected to realize more than 60 % of participation of the farmers for maintenance cooperation activities so called Gotong Royong.

2.2.7. Agricultural Support System.

(1) Agricultural research service.

The research activities of agriculture in Indonesia are centralized and undertaken by the Central Research Institute of Agriculture (CRIA) at Bogor in Java. One of the three branch stations is located in West Sumatra; that is only one branch station in whole Sumatra Island. The activities of this branch station cover various crops in paddy and upland crops for whole Sumatra; however, the research findings and the recommendations are made on the national basis. Therefore, it is hardly expected that the extension workers in the project area advise timely to the local farmers with the most suitable cultivation method based on the local natural conditions.

In recognition of the situation, the Ministry of Agriculture of the central government intends to establish a branch station of CRIA in North Sumatra Province. It is expected to commence the construction work since April in 1978 with construction period of five years. The proposed site of the branch station is located at Lubuk Pakam Subdistrict along the road to Galang Subdistrict with about 20 ha of experiment fields. The establishment of the branch station of CRIA at Lubuk Pakam would bring a lot of advantage for the local farmers not only in the project area but also in northern part of Sumatra.

(2) Agricultural Extension Service.

In 1974, Agricultural Extension Service in Indonesia was strengthened with establishment of the Agency for Agricultural Education, Training and Extension as one of the extraministerial bureaus under the Ministry of Agriculture. At the same time, the Government intended to establish an Agricultral Development Center (ADC) with an additional function of seed multiplication

center at the provincial level and several Rural Extension Center at the level between District and Subdistrict.

The function of the former is experiment and training at the provincial level and that of the latter is preparation of extension programs, dissemination of agricultural information and training for leading farmers at the local level.

Following the basic policy, North Sumatra Province has promoted to strengthen agricultural extension service year by year; however, Agricultural Development Center is not realized yet. The number of Rural Extension Centers, Subject-matter Specialists (PPS), Extension Supervisors (PPM), Extension Worker (PPL) is shown in Table 2-2-28.

In the project area, four rural extension centers were established by the end of 1977 fiscal year. Two PPS appointed in Deli/Serdang District would assist and advise the Extension Supervisors (PPM) and the Extension Workers (PPL). The qualification of PPM is required at least 5 years experience as PPL and should be successful in the provincial qualification examination which is at the level of Bachelors of Science. In 1977, there were only 3 PPM's in Deli/Serdang District; but in 1978, more 13 PPM's would be appointed. Two PPM's staying at each Rural Extension Center would assist and advise 8 to 9 PPL's on an average. The qualification of PPL is graduate of Agricultural High School. In the project area, the number of PPL's would be counted 25 by the end of 1977 fiscal year as shown in Table 2-2-29. In 1978, the final target year, each Extension Worker in the project area will cover one WUD, 3 villages and 786 farm household on an average.

Together with the consolidation of the extension system, the extension program has also been strengthened on training and systematic farm visit. Namely, every Extension Worker is requested to visit the key farmer (Kontak Tani) of each working area (16 areas make one WUD) 4 days a week and 2 working areas a day.

Twice a month, every Saturday of the second and fourth week, the Extension Workers attend to the training held at Rural Extension Center. All the problems which they might get from the farm visit will be discussed in the training meeting.

(3) Agricultural Credit.

The Indonesian People's Bank (Bank Rakyat Indonesia; BRI) is the state bank specialized in agricultural credit all over the country. To provide loan service, the Bank has established a broad network consisting of many regional offices and branch offices so called Unit Desa BRI.

The Bank is authorized to finance BIMAS Package Credit for qualified individual farmers. Besides using own credit funds, the Bank provides the loans to various agricultural associations including KUD. The loan condition is based on the monthly

interest of 1 % with 7-month maturity period under the BIMAS Program, 3-year repayment period in case of cattle credit and 7-year repayment period including 2-year grace period for the construction of on-farm irrigation service facilities.

In the project area, loan service is carried out through 4 branch offices of BRI with including 5 Village Units outside of the project area.

About Rp 3,500 million or 25 % of the total amount of loan in North Sumatra is provided for BIMAS Package loan in 1976. In Deli/Serdang District, the BIMAS loan has been rapdily increased on loan amount and number of render in recent few years as shown in Table 2-2-30. The trend of rate of outstanding is decreasing year by year. That would be the reflection of sound management of the BIMAS credit.

(4) Seed multiplication.

The Provincial Seed Center (Kebun Benih Sentral) located near the project area, at Tanjung Morawa in Deli/Serdang District was established as the stock seed farm. The stock seeds of imported varieties of rice produced in this Seed Center holding 17 ha of rice field are distributed to 12 Seed Stations (Balai Benih) managed by the District Agricultural Offices and many private seed growers who are generally progressive farmers managing more than 4 ha of rice field as a minimum unit of seed production. The Seed Stations produce the extension seeds and also carry out the seed test for certification of the seeds with their laboratories.

The seed test is usually done at the following standards; (a) less than 13 % of moisture, (b) more than 98 % of variety purity, (c) more than 80 % of germination rate and (d) no insects and diseases. The certified seeds produced and/or collected from seed growers by the Seed Station are distributed to the farmers through the KUD according to the BIMAS Program.

One of the 12 Seed Stations in North Sumatra Province is located at Lubuk Pakam Subdistrict in the project area. The Seed Station with 4 ha of rice field is growing recommended improved varieties of rice such as IR 32 and IR 36. The yield is 6 tons per hectare both in dry and wet seasons at the Station.

The improved seeds required for 37,000 ha of irrigated paddy field at the full development stage of the Project is estimated at about 185 tons annually under the seed renewal system of 5-year interval. The necessary hectarage of seed multiplication farm in future including seed grower's farm will be about 15 ha. This would attain without any difficulties by adequate management of the existing seed multiplication and distribution system.