Table RC-1 EXISTING MAJOR RIVER STRUCTURE IN PORONG AND BRANTAS RIVERS

Bridge

Name	Purpose	Location	Administrative office	Specification		
				Length (m)	Width (m)	Lowest elevation of girder (m, SHVP)
-	Highway	-	-	-	-	-
Porong	Railway	-	PJKA, Porong	151	4.4	-
Porong	Highway	-	-	-	-	-
-	Railway	-	PJKA, Mojokerto	235	4.4	-
New Mojokerto	Highway	47.5 + 50				
Mojokerto	Highway	50.8 + 180	Binamarga, Mojokerto	163	7.5	21.78
Watudakon	Trolly	54.6 + 180	Sugar Factory, Gempolkrep	123	3.8	24.34
Ploso	Highway	77.8 + 130	Binamarga, Jombang	152	6.0	33.36
Ploso	Railway	77.8 + 190	PJKA, Madiun	169	4.6	33.31
Kertosono	Railway	100.0 + 40	PJKA, Kertosono	179	4.7	45.00
Kertosono	Highway	100.6 + 40	Binamarga, Kediri	169	7.0	46.17
Jongbiru	Trolly	127.6 + 160	Sugar Factory, Mrican	127	4.5	61.10
Kediri	Highway	131.8 + 120	Binamarga, Kediri	161	7.7	63.92
New Kediri	Highway	133.6 + 100	Binamarga, Kediri	153	9.0	67.00
Jeli	Trolly					
-	Railway					
-	Highway					

Intake

Name	Purpose	Location	Specification		
			Type	Width (m)	Crest elevation (m, SHVP)
Voor II		- (L)	Open channel	-	-
Voor I		- (L)	Open channel	-	-
Jatikulon		47.4 + 170 (R)	Culvert	0.8	15.19
Mlirip		47.6 + 51 (L)	Open channel	8.0	13.10
Lesari		54.2 + 140 (L)	Culvert	2.0	18.09
Gedek		55.4 + 99 (L)	Culvert	1.0	19.02
Gumbongan		58.0 + 100 (L)	Culvert	1.0	19.63
Sotowuluh		58.8 + 150 (R)	Culvert	1.2	20.79
Kedungsari		60.0 + 60 (L)	Culvert	2.0	19.06
Watespinggir		62.6 + 33 (L)	Culvert	1.0	21.17
Keboan		64.2 + 82 (L)	Culvert	0.5	22.65
Bebekan		68.4 + 49 (L)	Culvert	1.25	23.62
Gotan		73.0 + 79 (L)	Culvert	1.8	25.97
Jatimlerek		84.0 + 186 (L)	Culvert	1.5	30.83
Tunggorono		89.6 + 13 (R)	Open channel	9.5	33.57
Turipinggir		89.6 + 118 (R)	Open channel	2.0	32.70
Pengkol		93.2 + 179 (L)	Culvert	1.0	35.19
Kedungkudi		95.4 + 170 (L)	Culvert	0.9	36.22
Besuk		101.0 + 38 (L)	Culvert	1.15	40.13
Banjarsari		110.8 + 181 (L)	Culvert	2.0	46.32
Mrican		128.4 + 60 (L)	Opeb channel	20.0	54.36

Note : (L) or (R) : Left side or Right side

Pumping station

Name	Location	Administrative Office	Specification			
			Type	Nos	Capacity (m^3/min)	Inlet Elevation of suction pipe (m,SHVP)
Ajinomoto	49.4 + 114	Ajinomoto Factory	Centrifugal	3	3 x 5.6	15.40
Gempolkerep	56.6 + 111	Sugar Factory	Centrifugal	2	2 x 26.6	18.73
Menturus	66.2 + 35	Sugar Factory	Centrifugal	1	1 x 18.0	23.80
Tapen	69.4 + 31	Sugar Factory	Centrifugal	2	2 x 25.0	23.71
Bunder I	86.2 + 100	Irrigation	Centrifugal	3	3 x 10.5	30.41
Bunder II	95.6 + 98	Irrigation	Centrifugal	3	3 x 10.5	37.83

Note : Source : REF. RC 04

Table RC-2 EXISTING MAJOR RIVER STRUCTURE IN THE WIDAS BASIN

Bridge

Name	Purpose	Location	k	Administrative office	Specification Length (m)	Width (m)	Lowest elevation of girder (m, SHVP)
Widas R.							
Leangkong	Highway				63.40		40.38
	Highway	W-51			50.30	-	44.20
-	Highway	W- 4 + 380	2.18				
-	Highway	W-12 + 280	6.28		42.15		47.50
-	Highway	W-22 + 120	11.12		31.80		50.92
-	Highway	W-25 + 190	12.69		58.80		53.22
-	Highway	W-34 + 220	17.22		51.25		59.04
-	Railway	W-44 + 180	22.18		46.70		65.93
-	Highway	W-45 + 250			45.45		64.74
Ulo R.							
-	Highway	U- 3 + 240	1.74		15.50		44.76
-	Highway	U-10 + 350	5.35		16.60		47.16
-	Highway	U-12 + 330	6.33		21.80		48.14
-	Highway	U-19 + 100	9.5		13.70		49.76
-	Highway	U-25 + 200	12.70		23.95		52.80
-	Highway	U-27 + 220	13.72		44.00		53.49
-	Highway	U-28 + 270	14.27	PJKA	56.50		54.58
-	Highway	U-31 + 320	15.82		24.50		55.74
-	Highway	U-35 + 300	17.80		26.40		58.88
-	Highway	U-36 + 50	18.05		11.40		57.275
-	Highway	U-38 + 250	19.25				
-	Highway	U-40 + 250	20.25				
Kuncir R.							
-	Highway	Kc- 5 + 120	2.62		14.20		47.67
-	Highway	Kc- 7 + 130	3.63				
-	Highway	Kc- 8 + 250	4.25		14.40		49.06
-	Highway	Kc-11	5.50		10.80		49.47
-	Highway	Kc-16 + 200	8.20		19.00		52.39
-	Highway	Kc-16 + 470	8.47		14.80		52.26
-	Highway	Kc-19 + 150	9.65		9.50		53.36
-	Highway	Kc-21	10.50		20.45		55.82
-	Highway	Kc-21 + 310	10.81		23.50		56.55
-	Highway	Kc-24 + 120	12.12		23.55		59.10
-	Highway	Kc-25 + 40	12.54		21.95		60.18
-	Highway	Kc-26 + 70	13.07		33.20		62.40
-	Highway	Kc-29	14.50		17.20		66.81
-	Highway	Kc-33 + 170	16.67				
-	Highway	Kc-34 + 250	17.25				
-	Highway	Kc-34 + 410	17.41				
-	Highway	Kc-37 + 150	18.65				
-	Highway	Kc-41	20.50				
Kedungsoko R.							
-	Highway	K - 7 + 170	3.67	Binamarga	51.20		45.62
-	Railway	K - 7 + 200	3.70	PJKA	80.10		45.29
-	Highway	K -14 + 260	7.26		40.00		48.76
-	Highway	K -20 + 130	10.13		40.80		48.61

Gate or Dam

Name	Purpose	Location		Specification Total width (m)	Gate height (m)	Nos. of span	Crest elevation (m,SHVP)
Widas R.							
Ngudikan		W-49	24.5	45	2.50	1	
Gelatik		W-49 + 1.95	26.4	54	3.75	14	74.61
Ulo R. & Kuncir Kiri							
Kedunggedet		U-26 + 470	13.47	21	2.30	1	
Tiripan		U-40 + 250	21.25	10.04	-	4	
Kaliparan		Winong r.	38.00	24.05	2.00		
Kuncir							
Kuncir R.							
Kapas		Kc-13	6.50	17.80	2.20	3	
Kedunggerit		Kc-35 + 75	17.58	17.85	3.10	1	
Kuncir		Kc-41	20.50	33.0	1.90	4	

Note :

Source : Topo map with a scale of 192500

Table RC-3 EXISTING MAJOR RIVER STRUCTURE IN THE NGROWO BASIN

BRIDGE

Name	Purpose	Location	Administrative Office	Specification: Length (m)	Width (m)	Lowest Elevation of girder (m, SHVP)
Parit Agung & Ngrowo						
Kendal	Highway	at 7 + 105	BMTA/TA Irr.	110.6	7	83.68
Campurdarat	Highway	54 + 175	-"-	90.8	7	82.06
Tambangan	Highway	62 + 100	-"-	25	5.42	81.80
Geraikan	Highway	81 + 28	-"-	56.1	5.5	82.30
Gantung I	Highway	86 + 100	-"-	60	2	83.89
Gantung II	Highway	95	-"-	42	5.42	83.005
Cluwok	Highway	97 + 188	-"-	42	5.42	81.68
Tulungagung	Highway	114 + 157	-"-	41.5	9	83.445
Sembung	Highway	124 + 50	-"-	24.6	3	82.120
Grobogan	Highway	129	-"-			
Gantung	Highway	134	-"-	42	5.5	82.57
Cluwok I	Highway	Near confluence	-"-	20	5.42	84.17
Cluwok II	Highway	with Parit Agung	-"-	20	5.42	84.17
Parit Raya						
Tanggulwelahan	Highway	CBK 45 1.4[k]	TA Irr	70	3	78.37
Singkil	Highway	CBK 35 2.4	-"-			79.03
Suwaru	Highway	CBK 7 5.2	-"-	70	3	82.03
Bandung	Highway	CNB 0 5.9	-"-			83.03
Meragayu	Highway	CNB 47 6.2	-"-	54	3	83.69
Srikandi	Highway	CNB 26 8.3	-"-	54	3	84.37
Sukorame	Highway*	CSR 17 13.2	-"-	40		
Bendo	Highway	CSR 5 15.15	-"-	50	10	85.37

DROP STRUCTURE

Name	Location	Drop Height (m)
Parit Agung		
Drop I	at 9 + 100 (confluence with Parit Raya)	0.69
Drop II	91 + 90 (confluence with Dawir R)	0.82
Drop III	101 + 102 (confluence with Ngasinan Kiri)	0.67
Drop IV	120 + 150 (upper end of Parit Agung)	4.30
Drop A	8 + 39 (lower end of Parit Raya)	7.79
Drop B	57 + 150 (lower end of Ngasinan Kanan)	8.81
Drop C	90 + 112 (lower end of Dawir R.)	8.92
Drop D	100 + 57 (lower end of Ngasinan Kiri)	7.47
Drop E	120 + 50 (lower end of Song R.)	5.30

TUNNEL

Name	Type	Specification: Elevation of Inlet (m,SHVP)	Elevation of outlet (m,SHVP)	Length (m)	Diameter (m
South Tulungagung I	Circle	64.5		950	7.0
South Tulungagung II	Horse shoe	63.5	43.8	1,160	7.5

GATE

Name	Purpose	Location	Specification: Total width (m)	Gate height (m)	Nos of span	Crest elevation (m,SHVP)
Ngepen	Irrigation	Ngepen r.	-	-	-	-
Jabung	Irrigation	Jati r.	-	-	-	-
Widro	Irrigation, Flood control	Tawing r.	29.6	4.28	4	95.25
Bagong	Flood control	Bagong	-	-	-	-
Bendo	Irrigation, Flood control	Ngasinan	36.6	7.21	2	86.29
Sumbergayam	Irrigation, Flood control	Ngasinan Ngrowo	13.2	7.0	3	81.00
		Ngasinan Kanan	20.0	6.0	5	81.00
Cluwok	Irrigation, Flood control	Ngasinan Kiri	8.0	5.3	2	75.70
Tulungagung	Flood control	Ngrowo r.	12.0	3.0	3	79.30
Inlet Tunnel (I)	Water supply	Parit Agung C	7.5	7.5	1	63.75
Inlet Tunnel (II)	Water supply	Parit Agung C	7.5	7.5	1	63.3

Note

Source : Ref. RC 05

Table RC-4 EXISTING DRAINAGE PUMPS IN SURABAYA URBAN AREA

I. GUNUNGSARI PUMP STATION

1. Drainage Area : about 75 ha
2. Pumps : 2 units, Nominal total capacity is 1.4 m^3/s

Pump No.	Type	Diameter (mm)	Capacity (m^3/s)	Power	Installation	Remarks
1.	Horizontal-two-way-centrifugal pump	600	0.7	Electric motor (29.5kw)	Before the world war II	965 rpm.
2.	- do -	600	0.7	- do -	- do -	965 rpm.

Remarks

a. Existing drainage area is about 4 ha.

b. Estimated existing pump capacity is about 0.5 m^3/s.

II. DARMO PUMP STATION

1. Drainage Area : about 150 ha
2. Pumps : 4 units, Nominal total capacity is 4.13 m^3/s

Pump No.	Type	Diameter (mm)	Capacity (m^3/s)	Power	Installation	Remarks
1.	Horizontal-one-way-centrifugal pump	400	0.26	Electric motor	Before the world war II	
2.	Vertical-axial-flow-pump	600	1.1	- do -	- do -	
3.	- do -	900	1.3	- do -	- do -	
4.	- do - (Ingersoll-Rand)	900	1.47	-do- (145kw)	1969	417 rpm. H. 10ft

Remarks

a. Existing drainage area is about 245 ha.

b. Estimated existing pump capacity is about 2.97 m^3/s.

III. KUPANG PUMP STATION

1. Drainage Area : about 230 ha.
2. Pumps : 6 units, Nominal total capacity is 5.62 m^3/s.

Pump No.	Type	Diameter (mm)	Capacity (m^3/s)	Power	Installation	Remarks
1.	Horizontal-two-way-centrifugal pump	400	0.67	Electric motor	Before the world war II	
2.	- do -	400	0.67	- do -	- do -	
3.	- do -	400	0.67	- do -	- do -	
4.	- do -	400	0.67	- do -	- do -	
5.	Vertical-axial-flow pump	900	1.47	-do- (145 kw)	1969	417 rpm, H. 10 ft
6.	- do -	900	1.47	-do- (145 kw)	1969	417 rpm, H. 10 ft

Remarks

a. Existing drainage area is about 214 ha.

b. Estimated existing pump capacity is about 3.94 m^3/s

IV. KEPUTRAN PUMP STATION

1. Drainage Area : about 15 ha
2. Pumps : 1 unit, Nominal total capacity is 0.12 m^3/s.

Pump No.	Type	Diameter (mm)	Capacity (m^3/s)	Power	Installation	Remarks
1.	Horizontal-one-way-centrifugal pump (Indra type)	250	0.12	Diesel engine	1965	30 hp, 200 rpm.

Cont'd.

Remarks

a. Existing drainage area is about 29 ha

b. Estimated existing pump capacity is about 0.12 m^3/s

V. PESAPEN PUMP STATION

1. Drainage Area : 74 ha
2. Pumps : 3 units, Nominal total capacity is 1.51 m^3/s

Pump No.	Type	Diameter (mm)	Capacity (m^3/s)	Power	Installation	Remarks
1.	Horizontal-one-way-centrifugal pump (Indra type)	250	0.12	Diesel engine	1965	
2.	- do -	250	0.12	- do -	1965	
3.	Vertical-axial-flow pump	750	1.27	Electric motor	1978 (under installation)	485 rpm.

Remarks

a. Existing drainage area is about 88 ha

b. Estimated existing pump capacity is about 1.51 m^3/s.

Note : Source : Ref. RC 12

Table RC-5 DISCHARGE RATING CURVES INCLUDING FLOOD PLAIN

(1) Main Brantas

Section No.	Discharge (m^3/sec) 200	500	1000	1300	1500
10 Km	5.07	5.74	6.36	6.60	6.77
20 Km	8.49	8.64	9.54	9.95	10.19
30 Km	11.13	12.17	12.83	13.17	13.27
40 Km	15.83	16.36	17.17	17.50	17.61
50 Km	19.21	19.84	20.50	20.87	21.07
60 Km	24.33	24.97	25.70	26.00	26.21
70 Km	29.06	29.65	30.37	30.70	30.90
80 Km	35.61	36.36	37.09	31.45	37.68
90 Km	41.50	42.07	42.83	43.00	43.10
100 Km	47.87	48.71	49.08	49.39	49.57
120 Km	55.63	56.75	57.46	57.62	57.74
130 Km	63.86	65.03	66.38	66.83	67.09
140 Km	72.50	73.55	74.84	75.34	75.61
150 Km	81.61	82.25	82.98	83.22	83.53

(Unit: EL.m)

(2) K. Widas

	Discharge (m^3/sec) 150	300	450	600	900
5 Km	42.26	42.77	43.05	43.27	43.67
10 Km	44.05	44.40	44.72	44.91	45.24
15 Km	47.54	47.71	47.87	47.99	48.23
20 Km	54.03	54.11	54.27	54.33	54.43

(Unit: EL.m)

Table RC- 6 (1) ESTIMATED ANNUAL FLOOD DAMAGE
(Main Brantas up to 139 K)

(UNIT: 10**6 RP.)

YEAR	RETURN PERIOD (YEAR) 1	2	5	10	25	50	100
1984		38225.	86035.	102233.	112223.	115661.	117422.
1985		40426.	89699.	106576.	117010.	120584.	122419.
1986		42151.	93524.	111131.	121555.	125724.	127238.
1987		43952.	97519.	115877.	127209.	131093.	133088.
1988		45832.	101692.	120834.	132649.	136659.	138779.
1989		47792.	106050.	126011.	138332.	142556.	144724.
1990		49850.	110602.	131418.	144267.	148670.	150932.
1991		51994.	115356.	137067.	150485.	155059.	157418.
1992		54233.	120323.	142967.	156942.	161732.	164192.
1993		56572.	125512.	149131.	163708.	168703.	171269.
1994		59016.	130933.	155571.	170776.	175987.	178663.
1995		61570.	136596.	162259.	178151.	183556.	186358.
1996		64235.	142514.	169329.	185876.	191542.	194459.
1997		67027.	148698.	176675.	193939.	199855.	202893.
1998		69926.	155160.	184352.	202364.	208536.	211706.
1999		72955.	161914.	192374.	211169.	217609.	220917.
2000		76188.	165972.	200758.	220371.	227091.	230542.
2001		79273.	172653.	206327.	226490.	233400.	236949.
2002		80457.	179509.	212101.	232832.	239944.	243595.
2003		82723.	183548.	218095.	239421.	246731.	250487.
2004		85072.	187770.	224310.	246251.	253772.	257632.
2005		87510.	194190.	230758.	253335.	261076.	265055.
2006		90035.	199912.	237446.	260694.	268653.	272749.
2007		92642.	205644.	244384.	268308.	276513.	280731.
2008		95383.	211595.	251582.	276218.	284668.	289012.
2009		98206.	217972.	259050.	284424.	293128.	297603.
2010		101136.	224695.	266797.	292937.	301905.	306536.
2011		104174.	231741.	274835.	301769.	311011.	315764.
2012		107327.	235252.	283175.	310934.	320459.	325358.
2013		110599.	245520.	291828.	320442.	330262.	335313.
2014		113963.	253023.	300807.	330376.	340433.	345653.
2015		117515.	260904.	310123.	340545.	350987.	356361.
2016		121170.	269026.	319796.	351148.	361939.	367452.
2017		124952.	277462.	329821.	362196.	373303.	379023.
2018		128852.	286212.	340231.	373623.	385096.	390999.
2019		132981.	295292.	351033.	385499.	397334.	403427.
2020		137215.	304736.	362243.	397832.	410034.	416324.
2021		140723.	312525.	371509.	407599.	420531.	426983.
2022		144333.	320530.	381055.	418485.	431365.	437966.
2023		148051.	328792.	390890.	429295.	442426.	449278.
2024		151353.	337316.	401023.	440428.	453964.	460934.
2025		155870.	346072.	411463.	451695.	465790.	472949.
2026		159257.	355126.	422219.	463715.	477974.	485316.
2027		164057.	364450.	433301.	475895.	490528.	498064.
2028		168465.	374049.	444220.	488441.	503483.	511200.
2029		172534.	381940.	456485.	501369.	516790.	524734.
2030		177438.	394122.	468609.	514690.	530526.	538680.
2031		182161.	404633.	481101.	528416.	544674.	553050.
2032		187029.	415455.	493974.	542560.	559256.	567855.
2033		192044.	426606.	507239.	557135.	574292.	583117.
2034		197213.	438097.	520906.	572155.	589767.	598841.
2035		202540.	449929.	534995.	587635.	605724.	615045.
2036		208029.	462143.	549512.	603594.	622156.	631744.
2037		213696.	474720.	564472.	620022.	639115.	648953.
2038		219516.	487671.	579891.	636963.	656580.	666629.
2039		225524.	501039.	595781.	654422.	674579.	684967.
2040		231737.	514807.	612355.	672418.	693135.	703806.
2041		237637.	527969.	627815.	689620.	710867.	721817.
2042		243726.	541509.	643921.	707317.	729115.	740366.
2043		249991.	555436.	660459.	725521.	747878.	759402.
2044		256424.	569763.	677531.	744242.	767186.	779006.
2045		263043.	584501.	695083.	763511.	787044.	799174.
2046		269883.	599663.	713095.	783325.	807474.	819921.
2047		276895.	615261.	731654.	803715.	828492.	841264.
2048		284116.	631301.	750742.	824689.	850115.	863222.
2049		291541.	647817.	770381.	846257.	872361.	885813.
2050		299181.	664802.	790586.	868461.	895242.	909055.
2051		307040.	682278.	811374.	891309.	918796.	932967.
2052		315127.	700256.	832762.	914810.	943024.	957570.
2053		323448.	718755.	854769.	938990.	967953.	982885.
2054		332010.	737793.	877413.	963870.	993502.	1008932.
2055		340819.	757380.	900712.	989470.	1019995.	1035733.
2056		349885.	777534.	924687.	1015812.	1047152.	1063311.
2057		359212.	798273.	949357.	1042539.	1075097.	1091689.
2058		368810.	819614.	974743.	1070813.	1103856.	1120891.
2059		378688.	841575.	1000867.	1099517.	1133446.	1150942.
2060		388853.	864176.	1027751.	1129156.	1163999.	1181867.
2061		399313.	887433.	1055418.	1159654.	1195238.	1213691.
2062		410079.	911369.	1083890.	1190739.	1227421.	1246443.
2063		421158.	936003.	1113195.	1222935.	1260686.	1280150.

Table RC- 6 (2) ESTIMATED ANNUAL FLOOD DAMAGE
(Main Brantas up to 159 K)

(UNIT: 10**6 RP.)

RETURN PERIOD (YEAR)

YEAR	1	2	5	10	25	50	100
1984		40972.	91037.	106222.	115893.	122545.	124423.
1985		42714.	94855.	112820.	123523.	127754.	129718.
1986		44532.	98524.	117221.	129206.	133159.	135236.
1987		46426.	103141.	122635.	134712.	138665.	140999.
1988		48435.	107546.	127870.	140462.	144752.	147016.
1989		50487.	112145.	133338.	146467.	150952.	153301.
1990		52696.	117969.	139065.	152779.	157446.	159465.
1991		54910.	121967.	145013.	159290.	164199.	166720.
1992		57276.	127229.	151264.	166133.	171252.	173881.
1993		59726.	132674.	157752.	173250.	178619.	181361.
1994		62312.	138404.	164551.	180748.	186316.	189175.
1995		65004.	144350.	171655.	188547.	194357.	197339.
1996		67816.	150624.	179076.	196699.	202758.	205869.
1997		70754.	157147.	186831.	205215.	211535.	214781.
1998		73824.	163964.	194934.	214114.	220708.	224093.
1999		77033.	171096.	203401.	223413.	230292.	233824.
2000		80396.	178523.	212250.	233131.	240309.	243994.
2001		82615.	183475.	218156.	239625.	247006.	250796.
2002		84924.	188580.	224252.	246320.	253951.	257851.
2003		87324.	193977.	230634.	253345.	261155.	265168.
2004		89811.	199513.	237224.	260590.	268627.	272752.
2005		92390.	205255.	244059.	268100.	276377.	280629.
2006		95066.	211210.	251148.	275921.	284416.	288794.
2007		97842.	217396.	258502.	283927.	292754.	297264.
2008		100721.	223757.	266130.	292324.	301404.	306050.
2009		103707.	230444.	274044.	301075.	310378.	315164.
2010		106805.	237343.	282253.	310191.	319656.	324619.
2011		110019.	244495.	290769.	319465.	329343.	334427.
2012		113354.	251917.	299604.	329180.	339361.	344603.
2013		116813.	259617.	308770.	339252.	349755.	355160.
2014		120402.	267506.	318250.	349715.	360528.	366113.
2015		124176.	275895.	328146.	360563.	371726.	377477.
2016		127928.	284695.	338383.	371826.	383334.	389268.
2017		131992.	293478.	349005.	383499.	395379.	401502.
2018		136152.	302677.	360026.	395617.	407876.	414196.
2019		140473.	312226.	371463.	408192.	420844.	427367.
2020		144952.	322253.	383329.	421240.	434309.	441035.
2021		148658.	330502.	393148.	432035.	445435.	452343.
2022		152476.	338959.	403263.	443156.	456902.	463992.
2023		156409.	347754.	413654.	454614.	468717.	475952.
2024		160461.	356773.	424419.	466437.	480889.	488356.
2025		164676.	366065.	435479.	478577.	493429.	501093.
2026		168937.	375634.	446874.	491106.	506349.	514216.
2027		173363.	385501.	458614.	504013.	519660.	527736.
2028		177923.	395663.	470710.	517312.	533375.	541665.
2029		182635.	406123.	483172.	531015.	547505.	556018.
2030		187486.	416921.	496014.	545133.	562064.	570806.
2031		192479.	428037.	509265.	559680.	577086.	586043.
2032		197625.	439491.	522876.	574670.	592524.	601744.
2033		202927.	451294.	536926.	590115.	608452.	617922.
2034		208391.	463455.	551403.	606031.	624865.	634592.
2035		214022.	475988.	566320.	622432.	641778.	651771.
2036		219824.	488902.	581692.	639233.	659207.	669474.
2037		225804.	502211.	597523.	656749.	677168.	687716.
2038		231966.	515926.	613858.	674698.	695677.	706516.
2039		238316.	530041.	630682.	693195.	714752.	725890.
2040		244861.	544627.	648020.	712258.	734410.	745857.
2041		251112.	558541.	664582.	730466.	753187.	764929.
2042		257542.	572853.	681616.	749195.	772501.	784546.
2043		264156.	587573.	699136.	768459.	792366.	804725.
2044		270955.	602715.	717161.	788224.	812800.	825478.
2045		277937.	618291.	735700.	808657.	833820.	846627.
2046		285155.	634313.	754771.	829624.	855461.	868788.
2047		292560.	650794.	774388.	851192.	877683.	891379.
2048		300177.	667765.	794569.	872380.	900564.	914618.
2049		308014.	685191.	815330.	896205.	924192.	938526.
2050		316076.	703135.	836658.	919637.	948312.	963121.
2051		324370.	721596.	858671.	943845.	973229.	988424.
2052		332903.	740528.	881267.	968699.	998859.	1014456.
2053		341692.	760126.	904525.	994269.	1025228.	1041239.
2054		350714.	780233.	928455.	1020578.	1052358.	1068794.
2055		360002.	800918.	953076.	1047646.	1080272.	1097146.
2056		369575.	822201.	978408.	1075497.	1108993.	1126317.
2057		379419.	844100.	1004474.	1104155.	1138545.	1156335.
2058		389532.	866633.	1031294.	1133642.	1168952.	1187218.
2059		399953.	889820.	1058892.	1163984.	1200241.	1218998.
2060		410670.	913679.	1087291.	1195206.	1232438.	1251760.
2061		421700.	938232.	1116515.	1227334.	1265570.	1285351.
2062		433052.	963492.	1146555.	1260357.	1299665.	1319981.
2063		444736.	989496.	1177535.	1294421.	1334751.	1355617.

Table RC- 6 (3) ESTIMATED ANNUAL FLOOD DAMAGE
(K.Widas River Basin)

(UNIT: 10**6 RP.)

YEAR	RETURN PERIOD (YEAR) 1	2	5	10	25	50	100
1984		2382.	5353.	6516.	7639.	8016.	8202.
1985		2455.	5793.	7110.	8020.	8364.	8555.
1986		2592.	6043.	7417.	8366.	8724.	8924.
1987		2705.	6305.	7738.	8728.	9101.	9310.
1988		2823.	6578.	8073.	9106.	9495.	9712.
1989		2946.	6864.	8423.	9500.	9907.	10133.
1990		3074.	7163.	8789.	9913.	10337.	10573.
1991		3208.	7475.	9172.	10344.	10786.	11032.
1992		3349.	7801.	9572.	10794.	11255.	11512.
1993		3495.	8141.	9989.	11265.	11746.	12014.
1994		3645.	8498.	10426.	11757.	12259.	12538.
1995		3804.	8870.	10882.	12271.	12794.	13086.
1996		3970.	9259.	11359.	12808.	13355.	13659.
1997		4151.	9666.	11858.	13370.	13940.	14258.
1998		4334.	10093.	12379.	13957.	14552.	14884.
1999		4525.	10536.	12924.	14571.	15192.	15538.
2000		4725.	11001.	13494.	15213.	15862.	16223.
2001		4940.	11271.	13825.	15593.	16259.	16630.
2002		4958.	11551.	14175.	15987.	16670.	17051.
2003		5081.	11841.	14534.	16394.	17096.	17488.
2004		5208.	12142.	14906.	16816.	17538.	17940.
2005		5339.	12453.	15292.	17254.	17995.	18409.
2006		5476.	12776.	15691.	17707.	18469.	18895.
2007		5617.	13110.	16105.	18177.	18960.	19398.
2008		5763.	13457.	16533.	18663.	19469.	19919.
2009		5915.	13815.	16976.	19166.	19996.	20459.
2010		6072.	14188.	17435.	19690.	20543.	21019.
2011		6235.	14573.	17915.	20231.	21109.	21599.
2012		6404.	14972.	18409.	20792.	21695.	22200.
2013		6579.	15386.	18921.	21374.	22303.	22823.
2014		6760.	15815.	19452.	21976.	22933.	23468.
2015		6947.	16259.	20002.	22600.	23585.	24137.
2016		7142.	16719.	20572.	23247.	24262.	24830.
2017		7344.	17197.	21162.	23917.	24963.	25548.
2018		7553.	17691.	21774.	24612.	25659.	26293.
2019		7769.	18203.	22408.	25332.	26442.	27064.
2020		7994.	18733.	23066.	26078.	27222.	27864.
2021		8226.	19195.	23636.	26725.	27899.	28557.
2022		8379.	19670.	24223.	27392.	28596.	29272.
2023		8596.	20159.	24829.	28079.	29315.	30008.
2024		8809.	20663.	25453.	28788.	30056.	30767.
2025		9028.	21183.	26097.	29516.	30819.	31550.
2026		9255.	21719.	26760.	30271.	31602.	32357.
2027		9488.	22272.	27444.	31047.	32418.	33188.
2028		9729.	22841.	28149.	31847.	33255.	34045.
2029		9977.	23428.	28875.	32672.	34117.	34929.
2030		10232.	24033.	29624.	33522.	35006.	35840.
2031		10496.	24657.	30396.	34398.	35923.	36779.
2032		10768.	25300.	31192.	35302.	36867.	37747.
2033		11048.	25963.	32013.	36234.	37841.	38745.
2034		11337.	26646.	32859.	37194.	38846.	39774.
2035		11635.	27351.	33731.	38184.	39881.	40835.
2036		11942.	28078.	34631.	39205.	40948.	41929.
2037		12258.	28827.	35558.	40257.	42049.	43057.
2038		12585.	29599.	36514.	41343.	43184.	44220.
2039		12921.	30396.	37500.	42462.	44354.	45419.
2040		13269.	31217.	38516.	43615.	45560.	46655.
2041		13626.	32022.	39488.	44718.	46713.	47836.
2042		13941.	32809.	40487.	45853.	47899.	49052.
2043		14292.	33640.	41516.	47020.	49120.	50303.
2044		14654.	34495.	42575.	48222.	50377.	51590.
2045		15026.	35375.	43664.	49458.	51670.	52915.
2046		15408.	36281.	44785.	50731.	53000.	54278.
2047		15802.	37213.	45939.	52040.	54370.	55682.
2048		16205.	38172.	47126.	53388.	55779.	57126.
2049		16625.	39160.	48348.	54775.	57230.	58612.
2050		17056.	40176.	49606.	56203.	58723.	60142.
2051		17496.	41222.	50901.	57673.	60259.	61717.
2052		17951.	42299.	52234.	59185.	61841.	63337.
2053		18420.	43407.	53605.	60742.	63469.	65006.
2054		18902.	44548.	55017.	62345.	65145.	66723.
2055		19398.	45722.	56471.	63995.	66870.	68490.
2056		19909.	46931.	57967.	65693.	68645.	70310.
2057		20434.	48175.	59507.	67441.	70473.	72183.
2058		20976.	49456.	61092.	69243.	72355.	74111.
2059		21533.	50774.	62725.	71093.	74292.	76096.
2060		22107.	52132.	64405.	73000.	76286.	78139.
2061		22697.	53529.	66135.	74964.	78340.	80243.
2062		23305.	54968.	67916.	76985.	80453.	82409.
2063		23931.	56445.	69749.	79067.	82629.	84639.

Table RC-7 REQUIRED WORK QUANTITY OF ONGOING BRANTAS MIDDLE REACH RIVER IMPROVEMENT PROJECT

Item	Unit	Stage I	Stage II	Total
1. Dredging works	10^3 m^3	7,160	8,700	15,860
2. Excavation in high water channel	10^3 m^3	194	1,005	1,199
3. Embankment works	10^3 m^3	485	731	1,216
4. Revetment works				
- Wet massonry	m	8,837	26,000	34,837
- Gabion mattress	m	5,316	10,000	15,316
- Groyne	m	4,658	6,500	11,185
5. Modification works				
- Irrigation intakes	places	3	-	3
- Syphons	places	1	-	1
- Minor roads	m	2,225	7,650	9,875
- Irr. & drainage channel	m	4,450	7,650	12,106

Table RC-8(1) CONSTRUCTION COST FOR KUNCIR DAM SCHEME

K. Vides

(Unit : Rp. 10^6)

Item	Unit Cost (Rp)	Scheme 1 Quantity	Scheme 1 Cost	Scheme 2 Quantity	Scheme 2 Cost
Excavation ($10^3 m^3$)	2,000/m^3	7,440	14,880	7,669	15,338
Embankment ($10^3 m^3$)	1,900/m^3	1,248	2,372	1,248	2,372
Revetment					
- Wetmasonry (m^2)	22,000/m^2	29,080	640	29,080	640
Bridge					
- Highway W = 5 m	1 x 10^6/m	5,750	5,750	5,750	5,750
Land ($10^3 m^2$)	1,500/m^2	7,466	11,199	7,466	11,199
Building class III (nos)	0.5x10^6/nos	130	65	130	65
Total			34,906		35,364

K. Kedungsoko

(Unit : Rp. 10^6)

Item	Unit Cost (Rp)	Scheme 1 Quantity	Scheme 1 Cost	Scheme 2 Quantity	Scheme 2 Cost
Excavation ($10^3 m^3$)	2,000/m^3	818	1,636	986	1,972
Embankment ($10^3 m^3$)	1,900/m^3	329	626	329	626
Revetment					
- Wetmasonry (m^2)	22,000/m^2	1,670	37	1,670	37
Bridge					
- Highway W = 9 m (m^2)	1.33x10^6/m^2	1,350	1,796	1,350	1,796
- Railway (m)	24 x 10^6/m	150	3,600	150	3,600
Land ($10^3 m^2$)	1,500/m^2	547	821	547	821
Building class III (nos)	0.5x10^6/nos	45	23	45	23
Total			8,539		8,875

K. Ulo

(Unit : Rp. 10^5)

Item	Unit Cost (Rp)	Scheme 1 Quantity	Scheme 1 Cost	Scheme 2 Quantity	Scheme 2 Cost
Excavation ($10^3 m^3$)	2,000/m^3	434	868	1,135	2,270
Embankment ($10^3 m^3$)	1,900/m^3	270	513	340	646
Revetment					
- Wetmasonry (m^2)	22,000/m^2	8,890	196	8,880	195
Bridge					
- Highway W = 5 m	1 x 10^6/m	2,500	2,500	2,500	2,500
Sluice (m)	80 x 10^6/m	30	2,400	30	2,400
Land ($10^3 m^2$)	1,500/m^2	1,340	2,010	1,340	2,010
Building class III (nos)	0.5 x10^6/nos	65	33	65	33
Total			8,520		10,055

K. Kuncir

(Unit : Rp. 10^6)

Item	Unit Cost (Rp)	Scheme 1 Quantity	Scheme 1 Cost	Scheme 2 Quantity	Scheme 2 Cost
Excavation ($10^3 m^3$)	2,000/m^3	326	652	712	1,424
Embankment ($10^3 m^3$)	1,900/m^3	296	563	355	675
Revetment					
- Wetmasonry (m^2)	22,000/m^2	4,690	104	4,690	104
Bridge					
- Highway W = 5 m (m^2)	1 x 10^6/m^2	2,750	2,750	2,750	2,750
Sluice (m)	80 x 10^6/m	30	2,400	30	2,400
Land ($10^3 m^2$)	1,500/m^2	1,013	1,520	1,013	1,520
Building class III (nos)	0.5x10^6/nos	45	23	45	23
Total			8,012		8,896

Note : Price level in Sept. 1984 is adopted, US$ 1 = Rp. 1030

Table RC-8 (2). CONSTRUCTION COST FOR KUNCIR DAM SCHEME

Kuncir dam (Unit : Rp 10^6)

I t e m	Unit cost (Rp)	Scheme 1	
		Quantity	Cost
Excavation (10^3 m^3)	2,000/m^3	4	8
Dam concrete ($10^3 m^3$) (including all facilities)	83,000/m^3	310	25,730
T o t a l			25,738

Backwater levee in K. Widas (Unit : Rp 10^6)

I t e m	Unit cost (Rp)	Scheme 1 and 2	
		Quantity	Cost
Excavation (10^3 m^3)	2,000/m^3	284	568
Embankment (10^3 m^3)	1,900/m^3	95	181
T o t a l			749

Note : Price level in Sept. '84 is adopted,
US$ 1 = Rp. 1030

Table RC-9 ECONOMIC PRICE OF PADDY (FOR EXPORT)

	Economic Price					
	1984			1995		
	US$/ton	Rp./ton	Balance	US$/ton	Rp./ton	Balance
1. FOB Bangkok	285	293,550		411	423,330	
2. External Transportation Cost (Bangkok-Surabaya)	27	27,810	265,740	27	27,810	395,520
3. Handling Charge & Warehouse Cost		7,600	258,140		7,600	387,920
4. Inland Transportation Cost (Surabaya-Mojokerto) /1		2,750	255,390		2,750	385,170
Selling Price of Rice at Ex-mill gate			255,390			385,170
Sealing Price of Paddy (1 : 0.68)			173,665			261,916
5. Milling Charge		5,875	167,790		5,875	256,041
6. Transportation Cost		1,970	165,820		1,970	254,071
Farm Gate Price of Paddy			165,820			254,071

Source : "Price Prospects for Major Primary Commodities" December 1983

Notes : Projected price at 1984 constant price

Exchange rate US$ 1 = Rp. 1,030

/1 : Surabaya-Mojokerto 50 km which reflects the average distance between Surabaya and Brantas Basin.

Table RC-10 ECONOMIC PRICE OF MAIZE (FOR IMPORT SUBSTITUTION)

	Economic Price					
	1984			1995		
	US$/ton	Rp./ton	Balance	US$/ton	Rp./ton	Balance
1. Projected Price	132	135,960		139	143,170	
2. External Trans-portaiton Cost (CIF Surabaya)	34	35,020	170,980	34	35,020	178,190
3. Port Handling and Warehouse Cost		8,870	179,850		8,870	187,060
4. Inland Trans-portation Cost (Surabaya-Mojokerto)		2,750	182,600		2,750	189,810
5. Transportation Cost (Farm to Wholesalers)		-1,960	180,640		-1,960	187,850
Farm Gate Prices			180,640			187,850

Source : "Price Prospects for Major Primary Commodities" December, 1983

Wonorejo Dam and Irrigation Project (Tulungagung II) November, 1984.

Table RC-11 ECONOMIC PRICE OF SOYBEANS

	Economic Price					
	1984			1995		
	US$/ton	Rp./ton	Balance	US$/ton	Rp./ton	Balance
1. Projected Price	300	309,000		330	339,900	
2. External Transportation Cost (CIF Surabaya)	34	35,020	344,020	34	35,020	374,920
3. Port Handling and Warehouse Cost		8,870	352,890		8,870	383,790
4. Inland Transportation Cost (Surabaya - Mojokerto)		2,750	355,640		2,750	386,540
5. Transportation Cost (Farm to Wholesalers)		-1,960	353,680		-1,960	384,580
Farm gate Prices			353,680			384,580

Source : Price Prospects for Major Primary Commodities by IBRD December, 1983.

Table RC-12 ECONOMIC PRICE OF PEANUTS

	Economic Price					
	1984			1995		
	US$/ton	Rp./ton	Balance	US$/ton	Rp./ton	Balance
1. Projected Price				451 /1	464,530	
2. External Transportation Cost (CIF Surabaya)				34	35,020	499,550
3. Port Handling and Warehouse Cost					8,870	508,420
4. Inland Transportation Cost (Surabaya-Mojokerto)					2,750	511,170
5. Transportation Cost (Farm to Wholesalers)					-1,960	509,210
Farm Gate Price			985,700 /2			509,210

Notes: /1 Wonorejo Dam and Irrigation Project (Tulungagung II) Because of no data on peanuts in "Price Prospects for Major Primary Commodities" by IBRD, the above report is referred to.

/2 Owing to no data on world price of peanuts, 985,700 Rp. are average price in East Java in August, 1984. Therefore, it must be treated as financial price.

Table RC-13 FUTURE PROJECTION OF UNIT COST PER m^2

Year	Mortgage (10^6) Rp. per Household	House Rural (10^3) Rp.	House Urban (10^3) Rp.	Industry (10^3) Rp.	Commercial Sector (10^3) Rp.	Hotel Store (10^3) Rp.	Deflator
1979	2.3						62.8
1980	2.6						68.9
1981	2.6						72.8
1982	2.8						81.8
1983	3.7			370			88.8
1984	4.04	32.9	39.1	220	180	145	100.0
1990	7.93	64.9	76.7	432	353	285	167.0
2000	24.5	199.5	237.1	1,334	1,091	879	397.0

Notes: Mortage rate is tentatively applied to projection of future increase of unit cost.
Price deflator is derived from Combined CPI of 17 cities (Statistik Indonesia 1983).

Table RC-14 FUTURE UNIT COST PER m^2 AT 1984 CONSTANT PRICE

Year	House Rural (10^3) Rp.	House Urban (10^3) Rp.	Industry (10^3) Rp.	Commercial Sector (10^3) Rp.	Hotel/Restaurant and Store (10^3) Rp.
1984	32.9	39.1	220	180	145
1990	38.6	45.9	258	211	171
2000	50.3	59.7	336	275	221
2020	80.9	96.1	541	442	356
2040	124.3	147.6	831	679	547
2060	182.9	217.1	1,222	999	805

Table RC-15 FUTURE INCREASE OF BUILDING COST AT 1984 CONSTANT PRICE

Unit: (10^3) Rp.

Year	House		Industry	Commercial	Hotel
	Rural	Urban			
1984	905	2,580	302,500	107,910	23,925
1990	1,062	3,030	354,750	126,500	28,200
2000	1,383	3,940	462,000	164,860	36,470
2020	2,230	6,340	743,875	264,980	58,740
2040	3,420	9,740	1,142,630	407,060	90,260
2060	5,030	14,330	1,680,250	598,900	132,830

Table RC-16 PROJECTION OF POPULATION AND HOUSES

	1985	2000	2020	2060
(1) East Java (2)+(3)				
Population	31,328,400	37,587,700	45,727,600	64,920,424
(2) Other Area				
Population	28,160,600	33,895,100	41,235,400	45,481,820
(3) SMA				
Population	3,465,000	6,119,000	13,056,000	19,438,604
Brantas Basin exc. SMA				
Urban (Population)	1,819,700	2,635,400	4,318,400	5,271,877
Accommodated person	4.88	5.55	6.00	6.00
No. of Houses	372,889	479,163	719,733	878,645
	(1.68%)	(2.05%)	(0.5%)	
Rural (Population)	6,436,400	6,701,600	7,671,600	7,977,468
Accommodated person	4.88	5.00	5.55	5.55
No. of Houses	1,318,934	1,340,320	1,394,836	1,451,731
	(0.11%)	(0.19%)	(0.1%)	
U + R (Population	8,256,100	9,337,000	11,990,000	13,249,345

Note: Parentheses indicates an annual increase rate of houses.

Table RC-17 FUTURE INCREASE OF BUILDINGS

Annual rate of Increase (Building)

Unit: %

Year	House		Industry	Commercial	Hotel
	Rural	Urban			
1984					
	0.11	1.68	1.5	1.5	2.0
2000					
	0.19	2.05	1.0	1.5	1.0
2020					
	0.1	0.5	0.5	1.5	1.0
2040					
	0.1	0.5	0.5	1.5	1.0
2060					

Table RC-18 ESTIMATED VALUE OF HOUSEHOLD EFFECT IN 1983

Unit: Rp.

Particular	Percent (%)	Monthly Expenditure	Estimated Amount of Household Effect
1. Food, Beverage, and Tobacco	79.01	36,557	1,219
2. Household furnishing & equipment	6.05	2,800	504,000
3. Clothing & other wear	5.63	2,607	62,570
4. Personal effects	4.02	1,860	111,600
5. Others	5.29	2,448	-
Total	100.0	46,274	679,390

Notes: Amount of household effects was estimated by assuming the following;

- Food, beverage and tobacco: Equivalent to one day family expenditure to these things
- Household furnishing and equipment: Equivalent to fifteen years family expenditure to these things
- Clothing and other wear: Equivalent to two years family expenditure to these things
- Personal effects: Equivalent to five years family expenditure to these things.

Source: PBME Widas and PBME Tulungagung in 1982/83

Table RC-19 FUTURE INCREASE OF HOUSEHOLD EFFECT

Year	Properties	Deflator	Adjusted Deflator	Properties const., price 1984 = 100
1981	530,551	112.2	75.5	
1982	547,121	122.9	82.6	
1983	679,390	137.4	92.4	
1984	745,403	148.7	100.0	745,403
1990	2,053,531		236.0	870,140
2000	11,117,787		989	1,124,144
2020				1,778,412
2040				2,684,390
2060				3,888,407

Note: It is assumed that value of properties (current price) will increase at a growth rate of 18.4% up to 2000 year. CPI (Consumer Price Index) is assumed to increase at a rate of 15.4% p.a. up to 2000, which is based on rate of increase of CPI between 1970 and 1983.

Table RC-20 PROJECTION OF FUTURE PER CAPITA INCOME

Year	GRDP of East Java (const, price 1984 = 100) 10^9 Rp.	Population (East Java) 10^3	Monthly per Capita Income (const, price 1984 = 100) Rp.	No. of Buildings
1984	11,324	30,868	30,500	454,016
1990	15,792	33,139	38,730	511,296
2000	25,723	37,153	57,680	623,267
2020	56,346	46,184	101,748	760,504
2040	112,116	56,757	164,614	927,959
2060	223,087	69,117	268,973	1,132,286

Note: GRDP of East Java is assumed to grow at about 15.2% p.a. nominally from that of East Java (8,532.8 x 10^9 Rp.) in 1982.
The number of buildings is assumed to increase at rate of 2% annually during 1984 - 2000 and at 1% p.a. during 2000 - 2060.

The population projection (East Java) in 1990 and 2000 is shown in section of 3.4. The estimation of GRDP of East Java up to 2000 is already shown in section of 2.3.

Table RC-21 ESTIMATED VALUE OF PROPERTIES PER BUILDING BY SECTOR

per 1984 constant price

Year	Household Effect	Hotel/Restaurant and Store	Industry	Commercial
1984	745,403	1.82×10^6 Rp.	7.2×10^6 Rp.	32×10^6
1990	870,140	2.39×10^6	14.16×10^6	37.4×10^6
2000	1,124,144	3.27×10^6	17.87×10^6	42.0×10^6
2020	1,778,412	5.14×10^6	34.1×10^6	68.0×10^6
2040	2,684,390	7.47×10^6	64.4×10^6	98.0×10^6
2060	3,888,407	10.84×10^6	95.3×10^6	145×10^6

Table RC-22 PROJECTION OF UNIT VALUE OF FISH PER HA IN EAST JAVA

Year	Deflator	Value of Fish (10^6) Rp.	ha	Unit Yield (ton/ha)	Value/ha (10^6) Rp. current	Value/ha (10^6) Rp. 1984 = 100
1977	58.1	9,099	33,700	0.73	0.27	0.46
1978	62.8					
1979	67.8					
1980	75.6	18,604	37,566	0.64	0.49	0.65
1981	84.6	26,213	38,958	0.79	0.67	0.79
1982	90.2		¦			
1983	92.5		¦			
1984	100.0	32,945	38,958	0.84	0.84	0.84
¦						
1990						0.94
¦						
2000				1.15		1.15
2020						1.65
2040						2.28
2060						3.06

Source: Statistik Indonesia, 1979 and 1983.

Table RC-23 PROJECTION OF FISH POND FACILITY VALUE

Year	Deflator	Value/ha 10^3 Rp. (current price)	Value/hr 10^3 Rp. (const, price 1984 = 100)
1984	100	130	130
1990	236	333	142
2000	989	1,602	162
2020			207
2040			262
2060			320

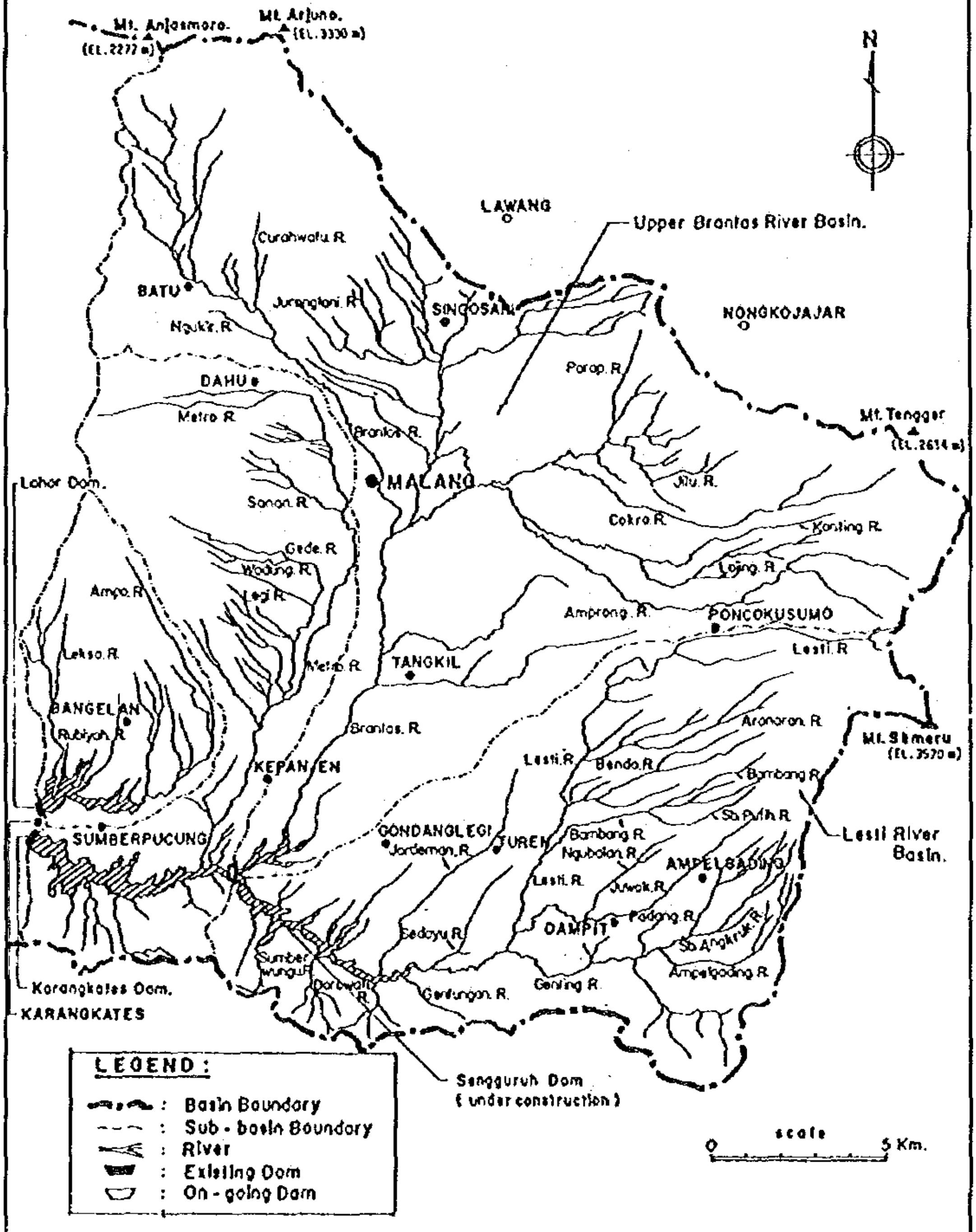


Fig. RC-1 **RIVER SYSTEM OF THE UPPER BRANTAS BASIN**

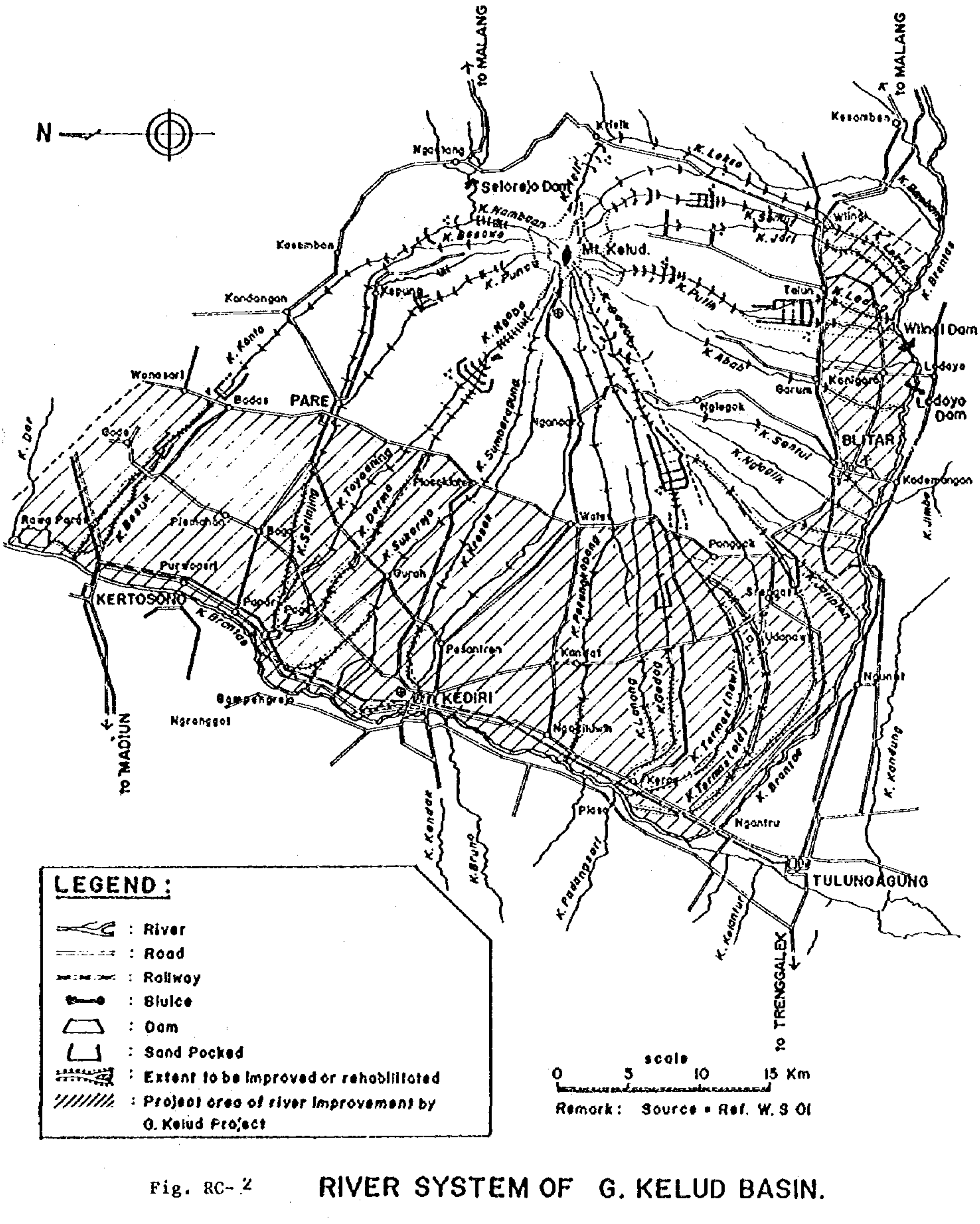
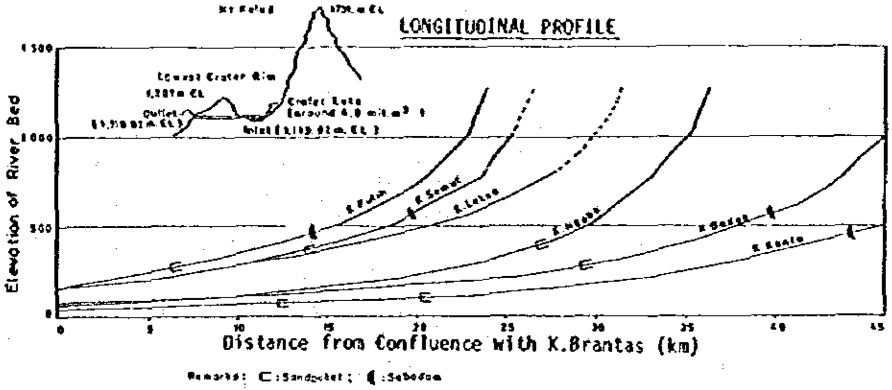


Fig. RC-2 RIVER SYSTEM OF G. KELUD BASIN.



RIVER SLOPE

River \ Elevation (m)	-100	-200	-300	-400	-500	-600	-700	-800	-900	-1,000	-1,100	-1,200
Lekso	-	160-1/137.5	1/61	1/50	1/36.5	1/31.5	1/18.5	1/15.5	1/14	1/8	1/8	1/5
Semut	-	-	215 1/55.9	1/42.5	1/32.5	1/17.5	1/20.5	1/13	1/6	1/8.5	-	-
Putih	-	150-1/60	1/55	1/40	1/30	1/22.5	1/17	1/13	1/9.5	1/8	1/4	1/4
Badak	75-1/480	1/136	1/56.5	1/42.5	1/30	1/28.5	1/15.5	1/10.5	1/9	1/9	1/8	1/3.5
Gedok	75-1/390	1/112.5	1/50	1/42.5	1/32.5	1/25.5	1/11.95	1/7.5	-	-	-	-
Petung-Kobong	75-1/220	1/120	1/50	1/37.5	1/27.5	1/22.5	1/17	-	-	-	-	-
Sukorejo	55-1/188.9	1/99	1/41	1/30	1/30	1/15	1/18.5	1/17	1/13	1/4.5	-	-
Ngobo	55-1/216.7	1/97.5	1/43	1/34.5	1/22.5	1/18.5	1/12.5	1/8	1/8.5	1/10	1/6	1/4.5
Serinjing	40-1/300	1/102.5	1/42.5	1/29	1/21	1/15.5	1/16.5	1/13	1/7.5	1/2.5	1/4	1/4
Konto	40-1/381.7	1/106	1/51.5	1/45	1/30.5	1/6.5	1/10.5	1/10	1/7	1/4	1/8	1/8

Remark.
Source: Ref.WS03

Basin No.	River	Catchment Area(Km²)
I	Lekso	93.5
II	Jari	59.6
III	Putih	77.6
IV	Abab	106.0
V	Badak	505.2
VI	Putungkobong	112.4
VII	-	174.0
VIII	Sukorejo	155.2
IX	Ngobo	204.8
X	Serinjing	247.2
XI	Konto	267.6
Total		2,003.1

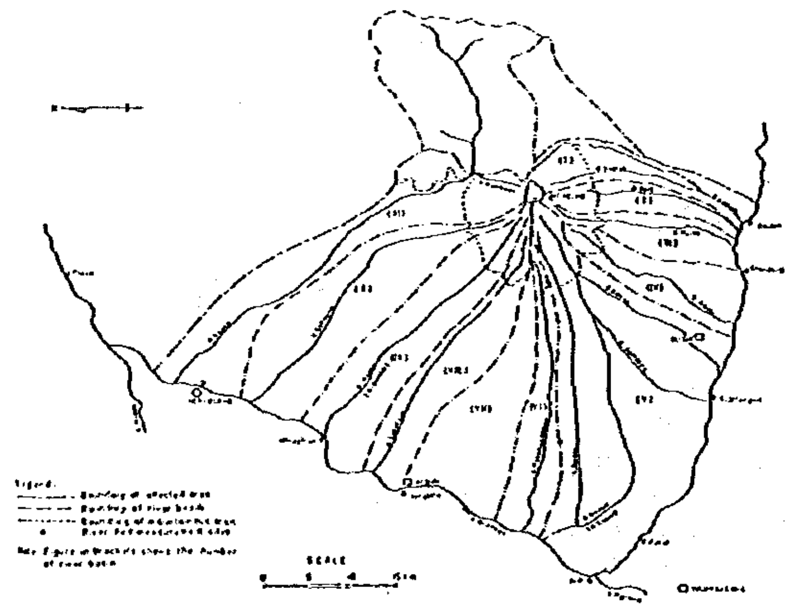


Fig.RC - 3 RIVERS ORIGINATING ON MT.KELUD

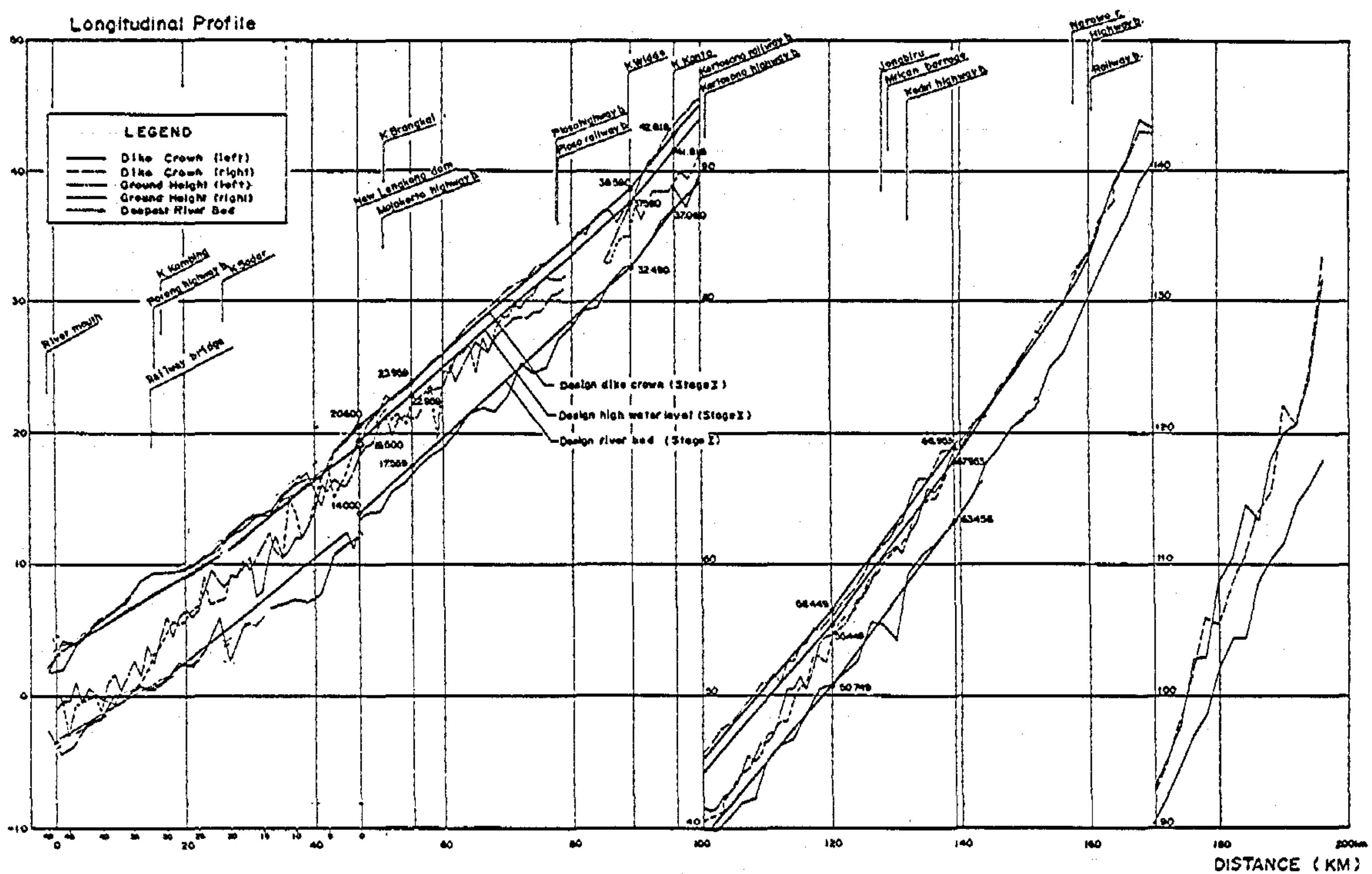


Fig. RC-- 4 (1) CHARACTERISTICS OF EXISTING CHANNEL OF K. BRANTAS AND PORONG.

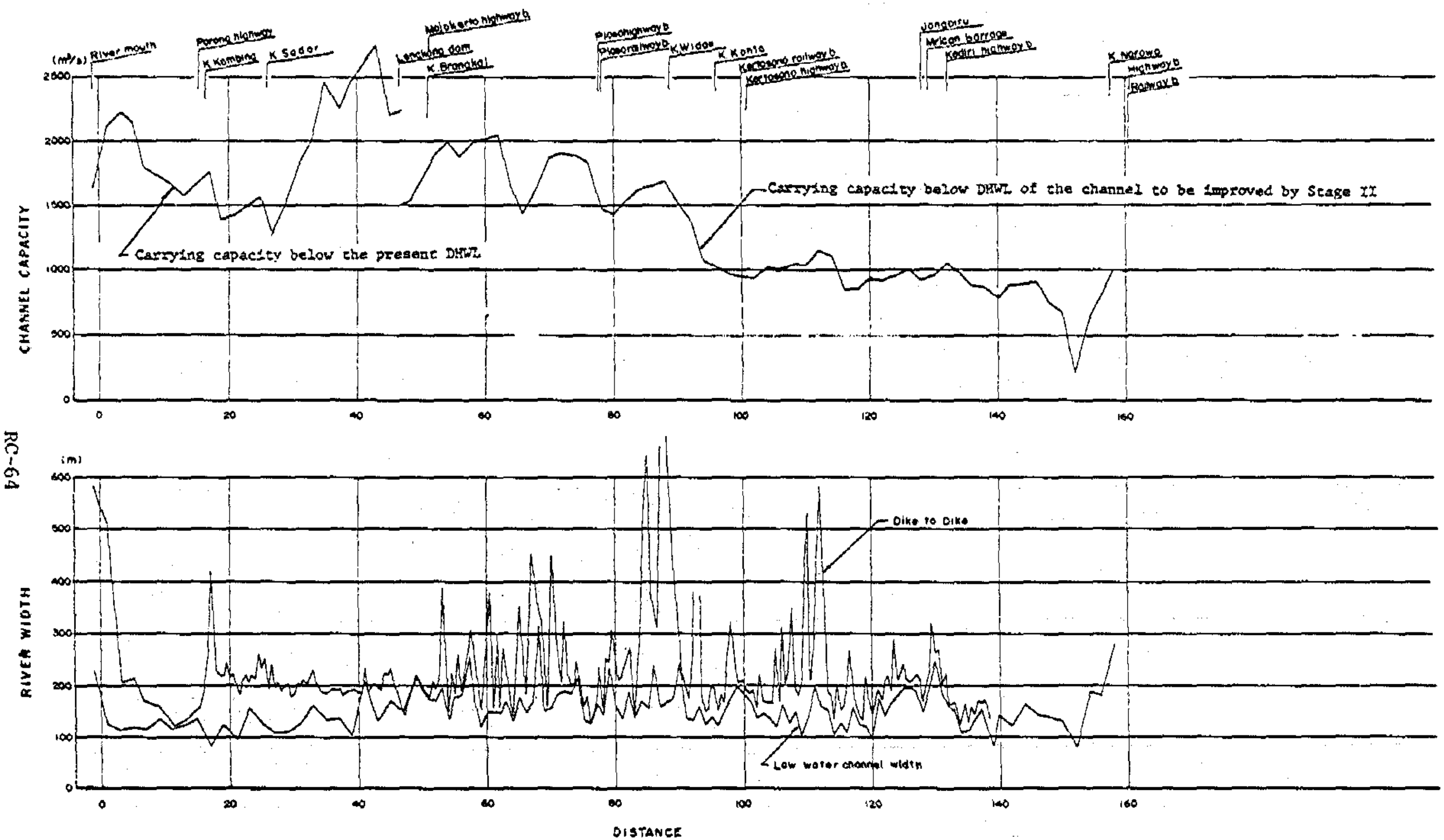


Fig. RC-4 (2) CHARACTERISTICS OF EXISTING CHANNEL IN BRANTAS AND PORONG

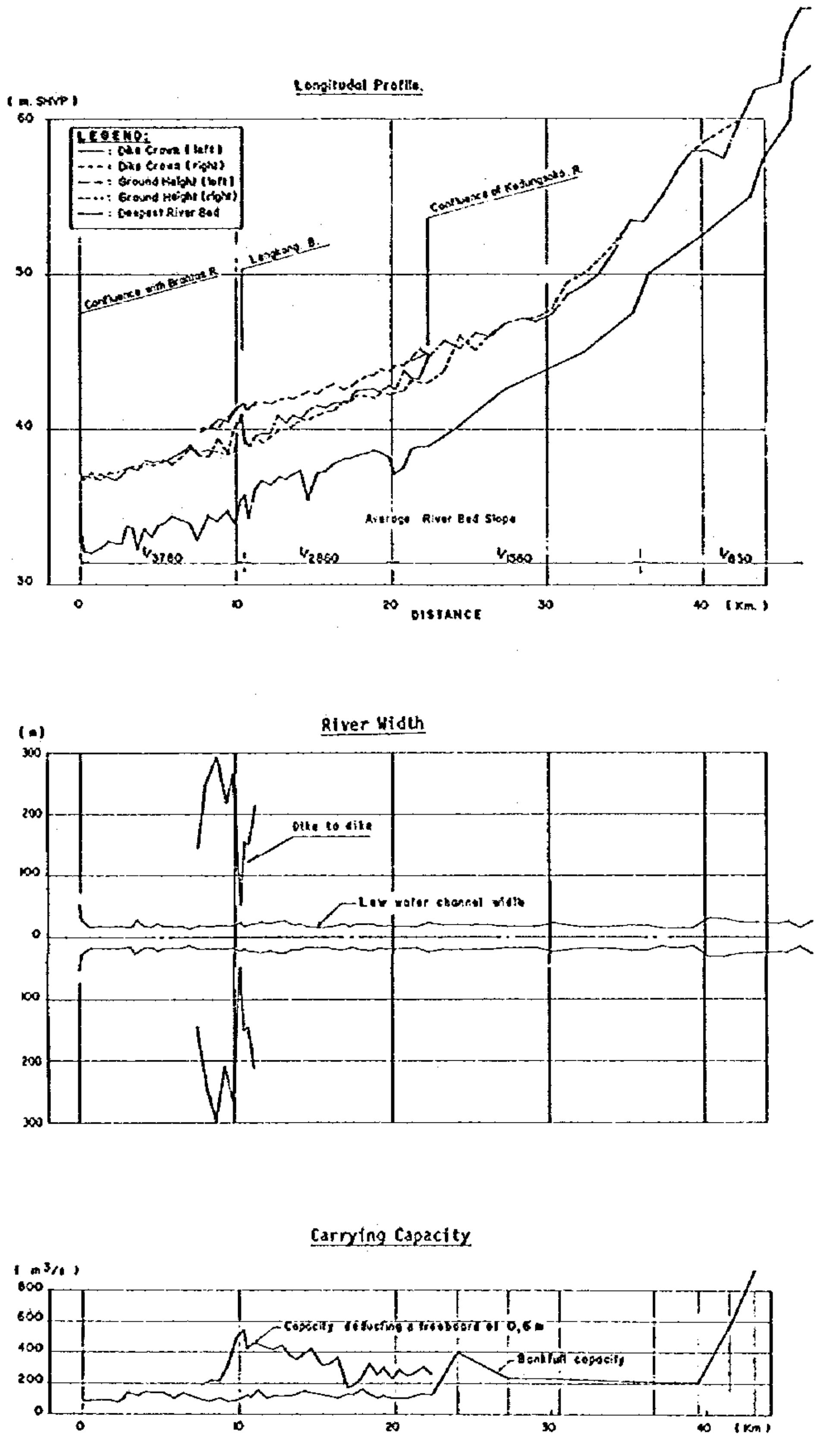


Fig. RC-5 CHARACTERISTIC OF EXISTING CHANNEL IN WIDAS RIVER

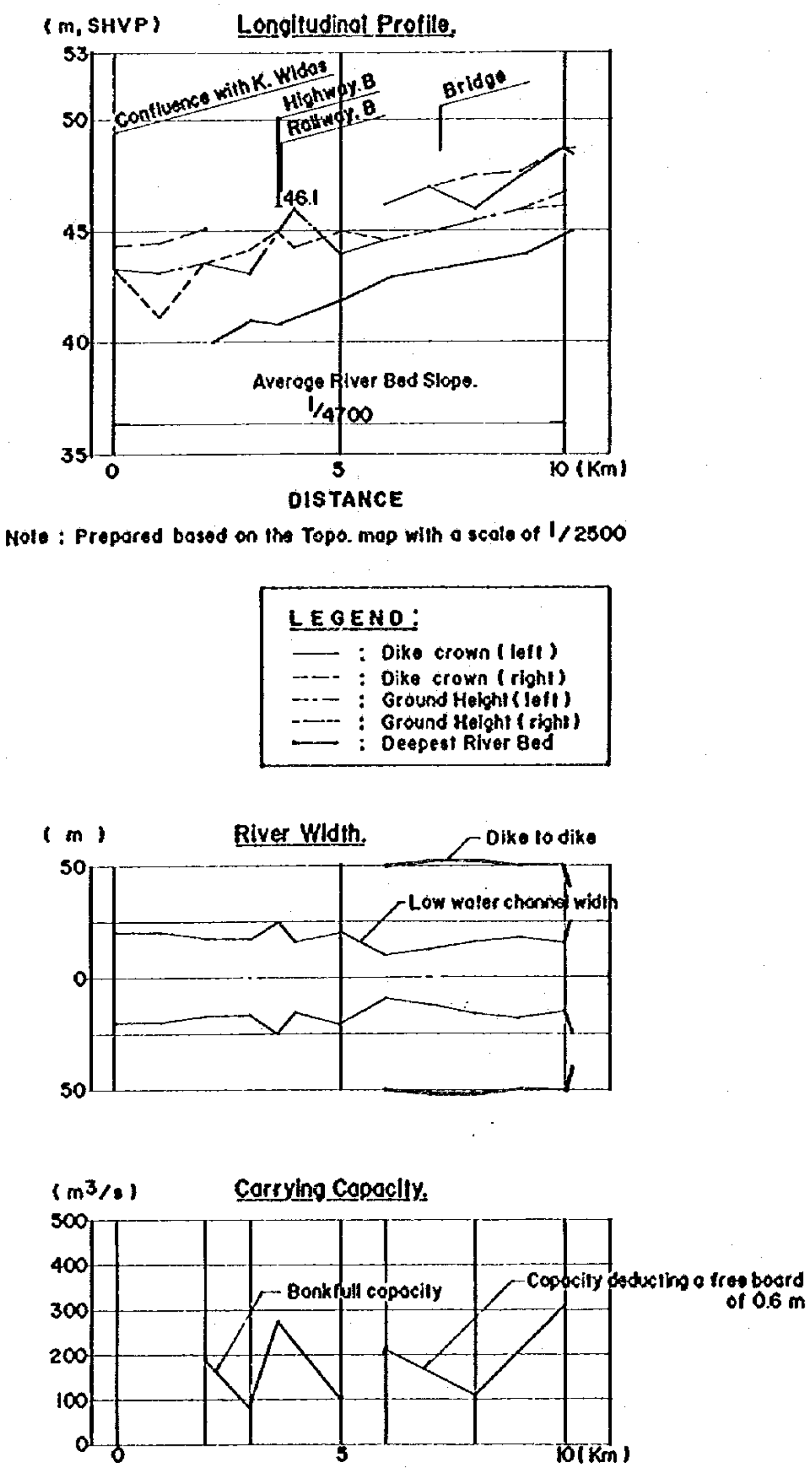


Fig. RC- 6 CHARACTERISTIC OF EXISTING CHANNEL IN K. KEDUNGSOKO

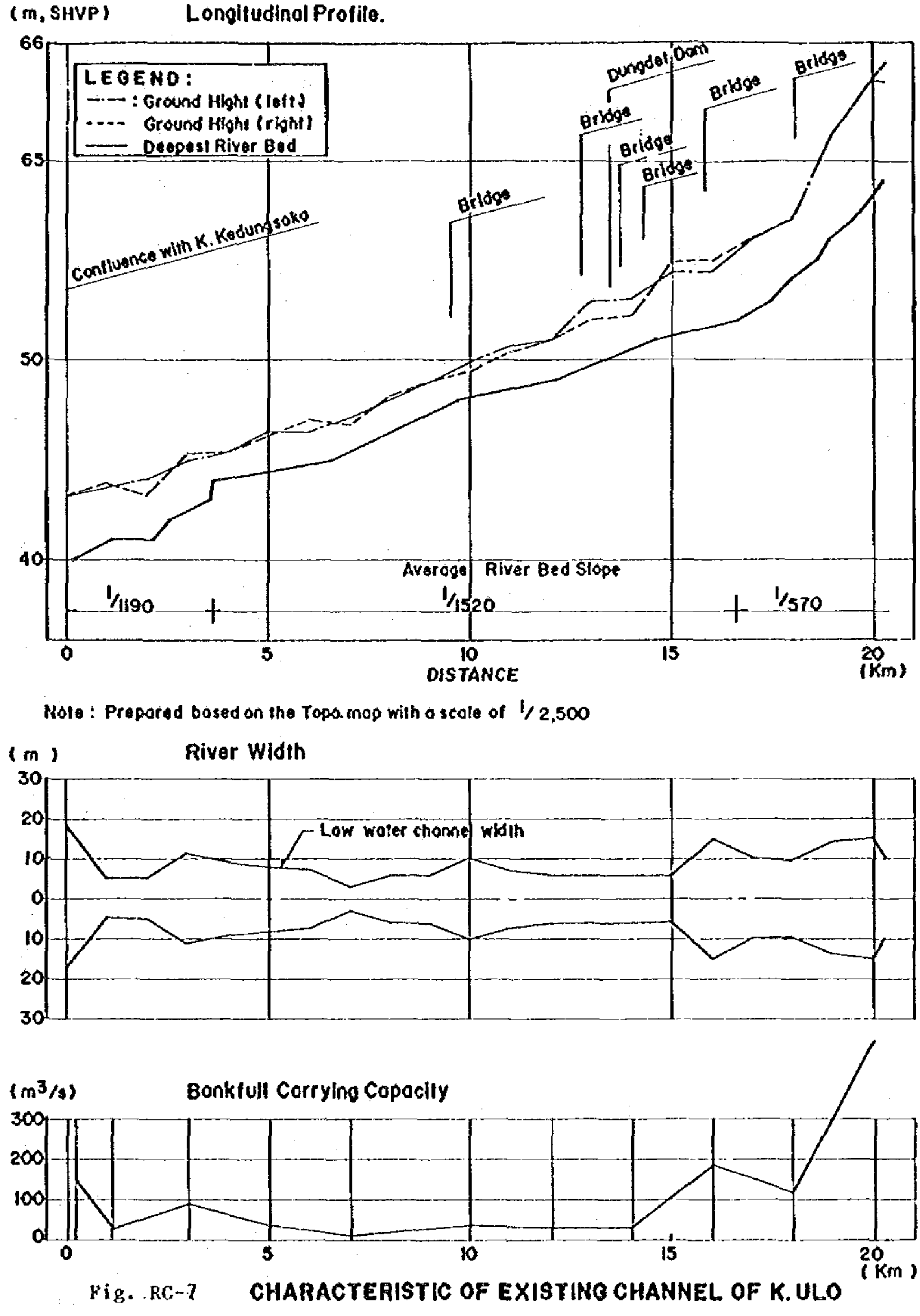


Fig. RC-7 CHARACTERISTIC OF EXISTING CHANNEL OF K. ULO

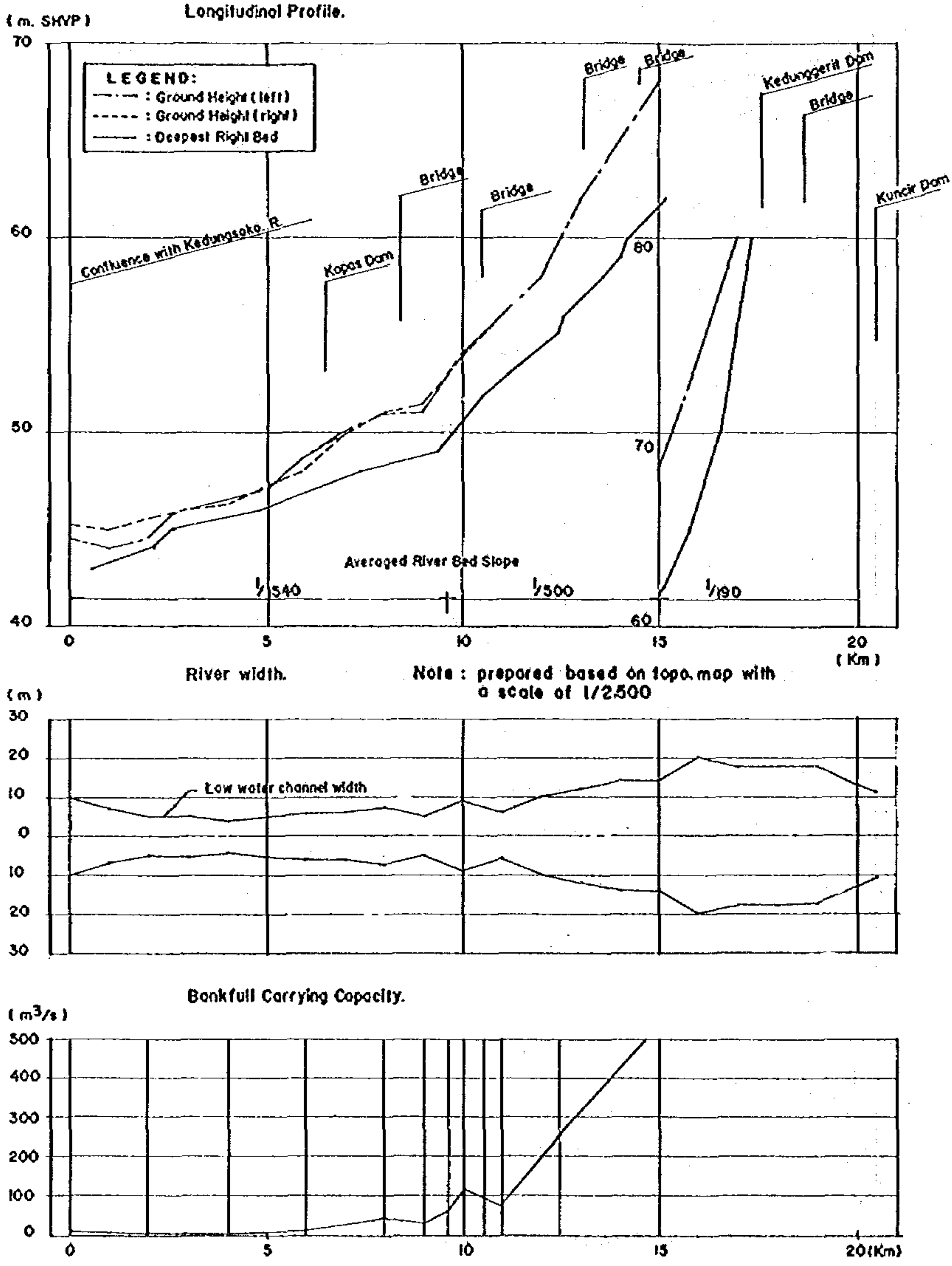


Fig. RC-8 **CHARACTERISTIC OF EXISTING CHANNEL IN KUNCIR RIVER**

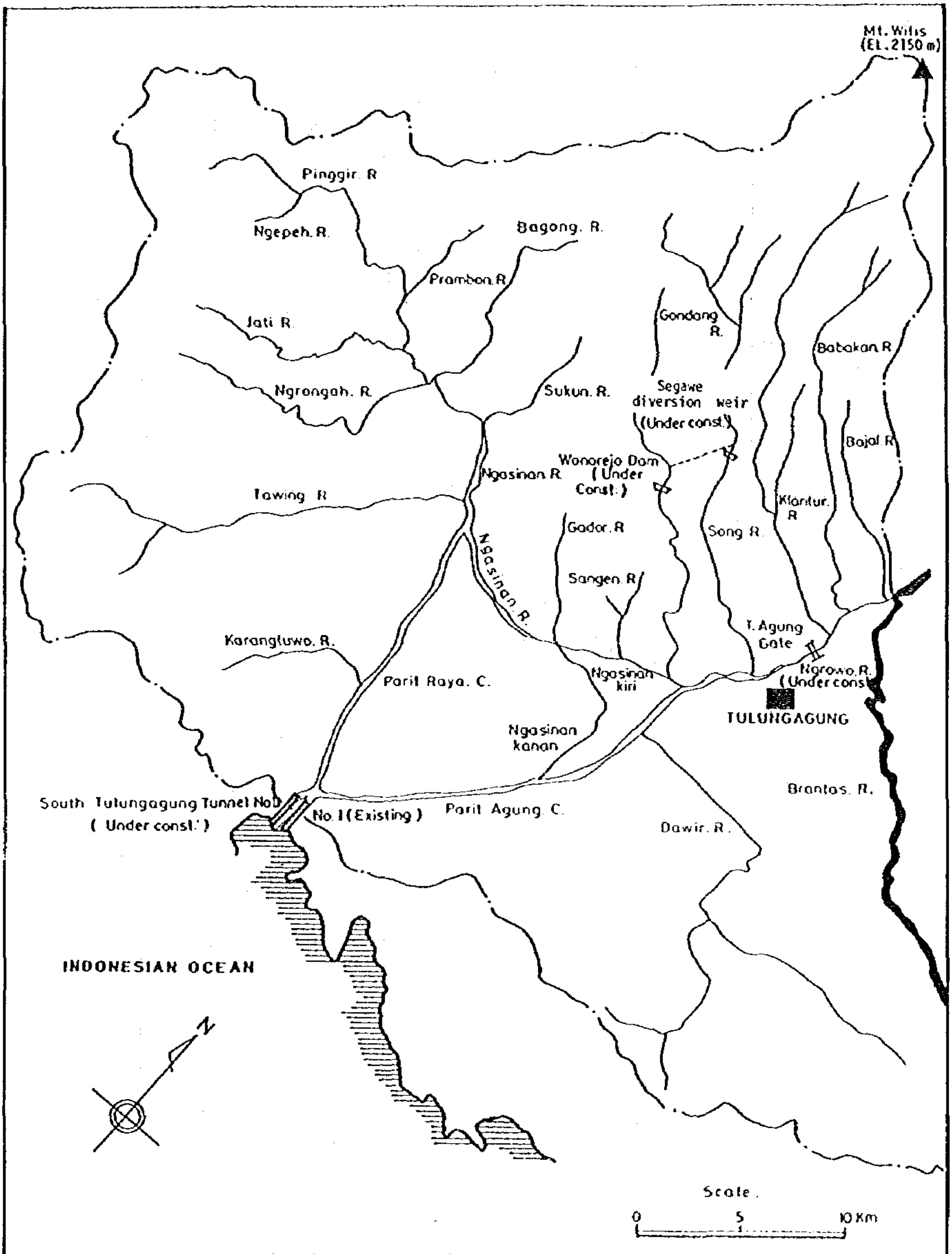


Fig. RC-9 RIVER SYSTEM OF THE NGROWO BASIN

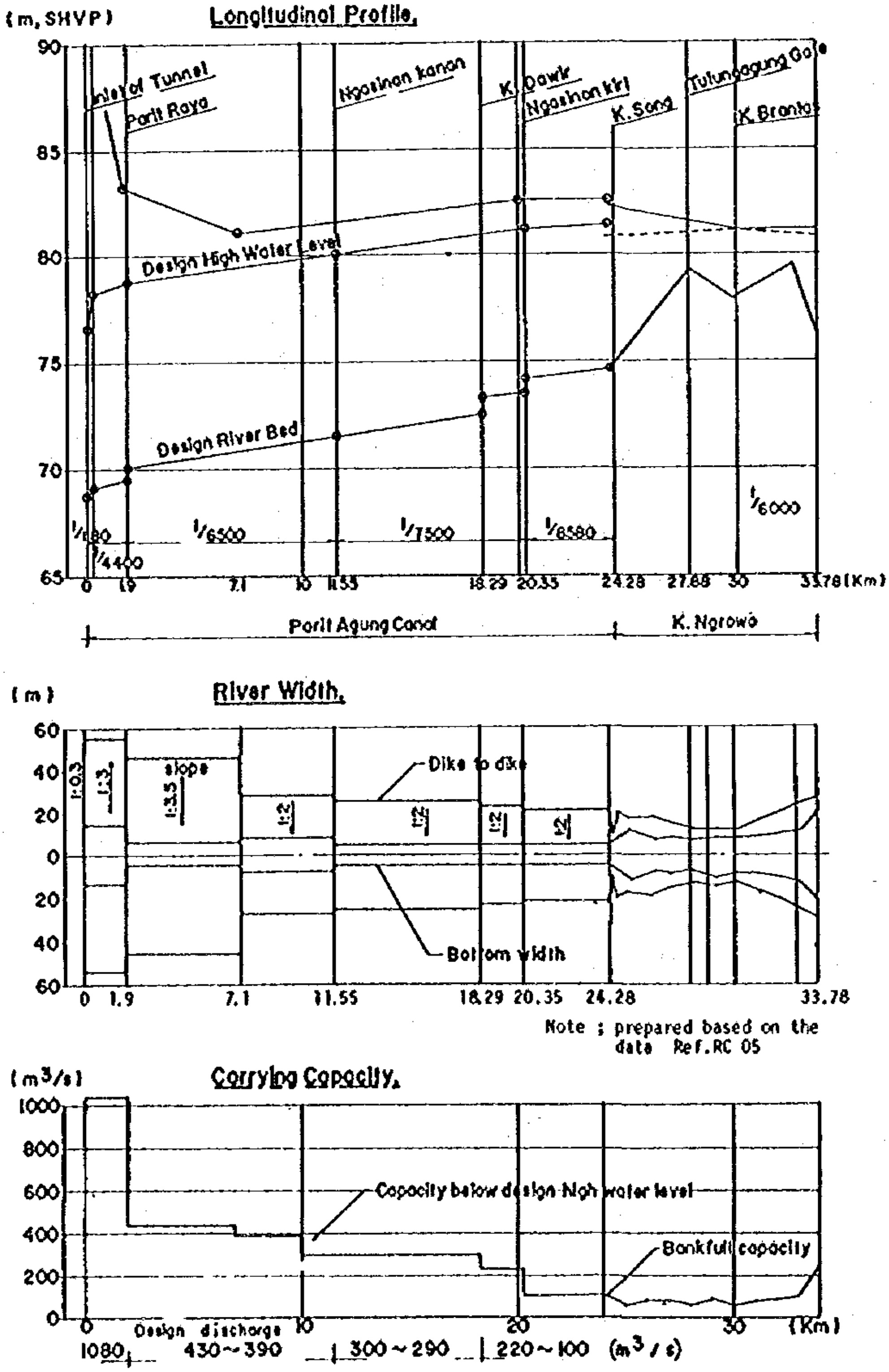


Fig. RC-10 **CHARACTERISTIC OF EXISTING CHANNEL OF PARITAGUNG**

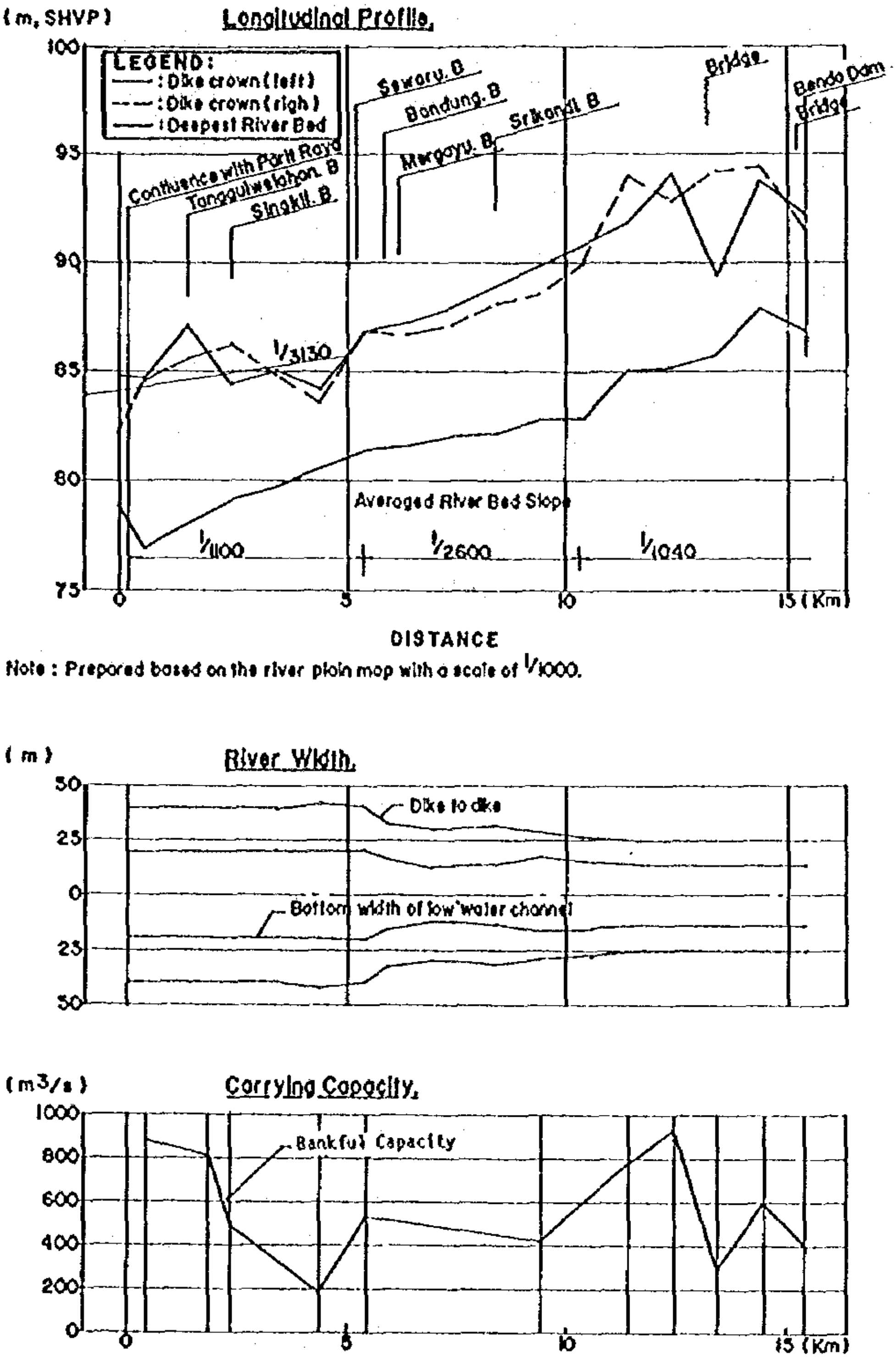


Fig. RC-11 CHARACTERISTICS OF EXISTING CHANNEL OF PARIT RAYA

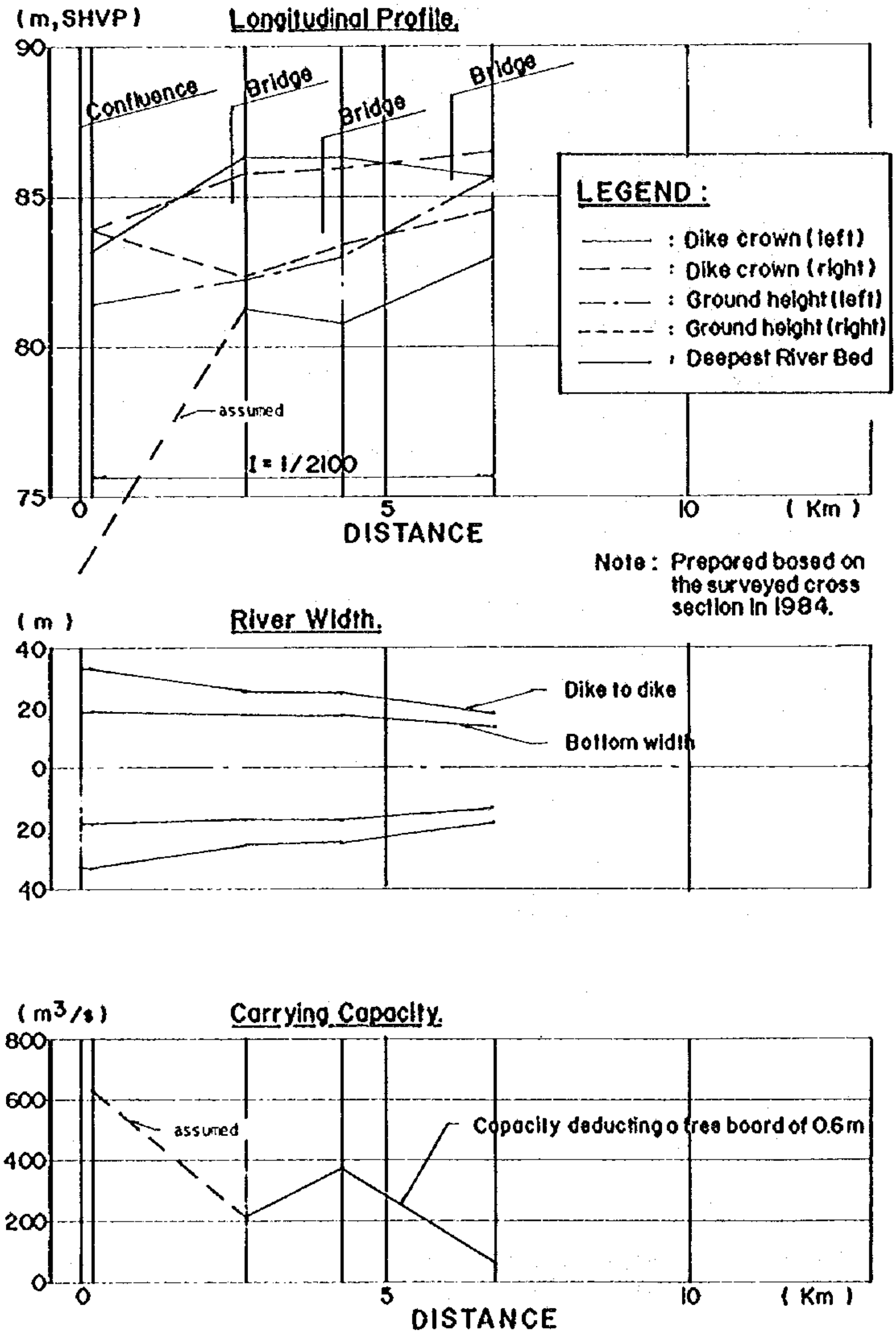


Fig. RC-12 **CHARACTERISTICS OF EXISTING CHANNEL OF K.DAWIR**

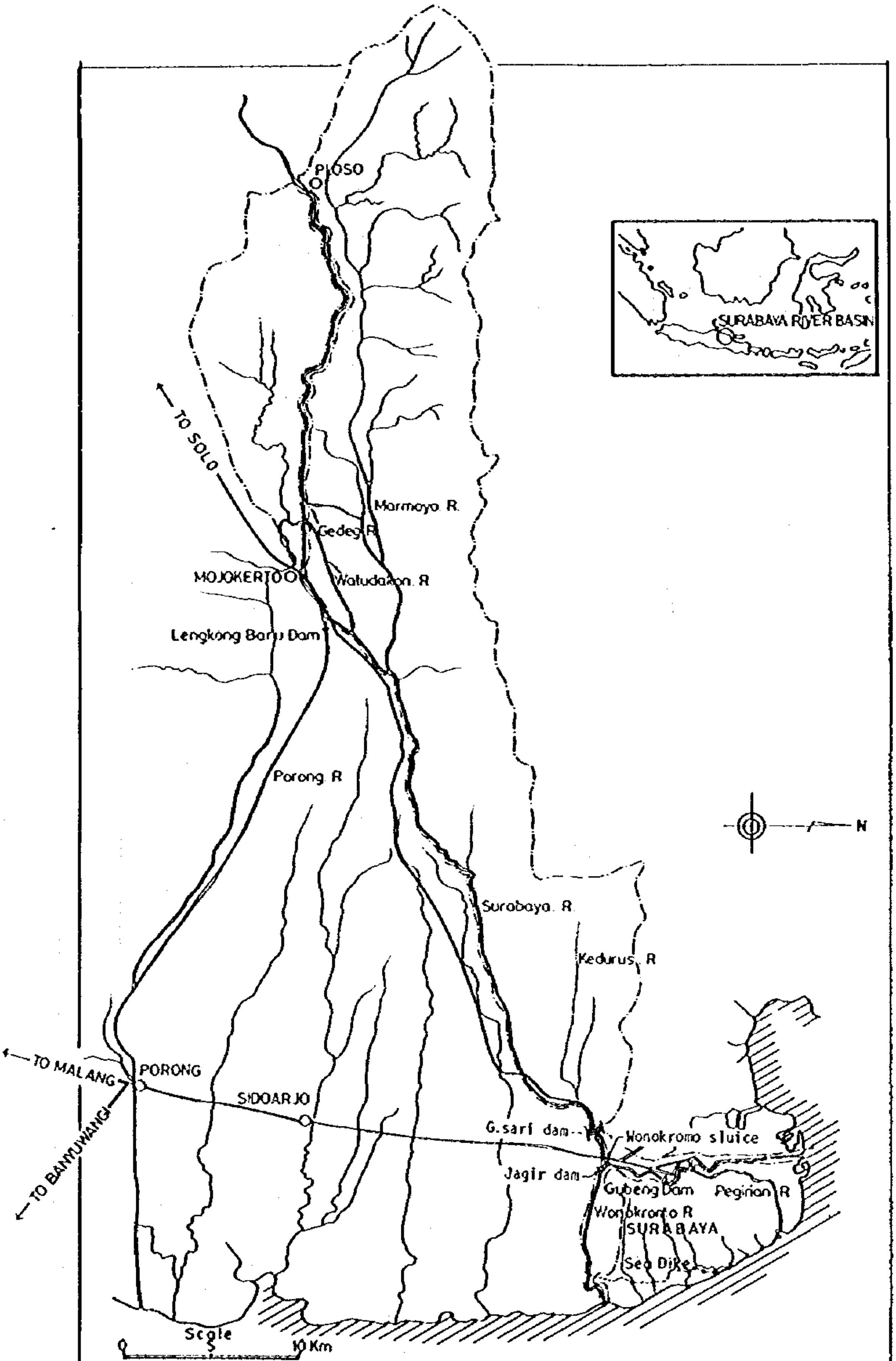


Fig. RC-13 RIVER SYSTEM OF THE SURABAYA BASIN

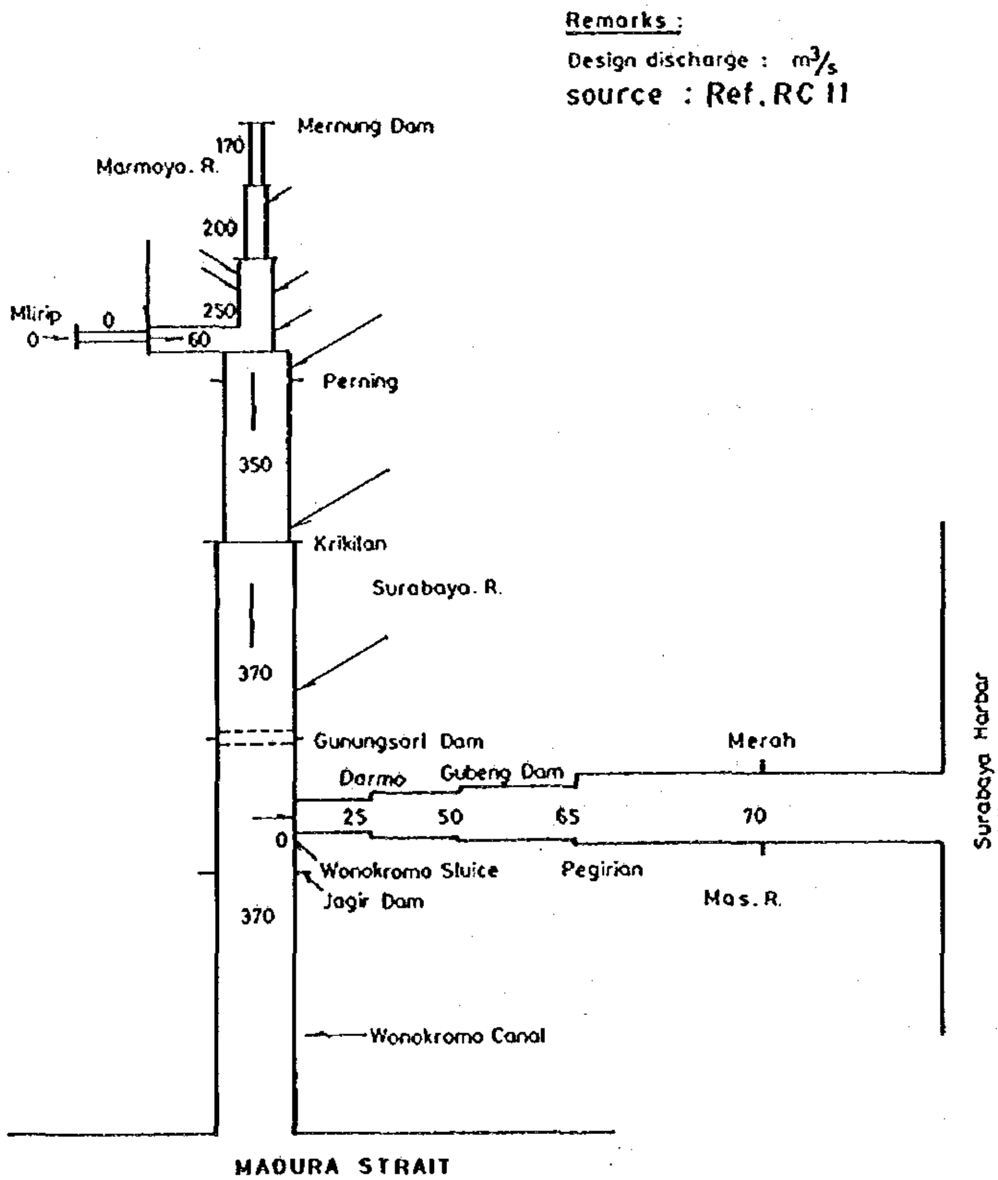


Fig. RC- 14 DESIGN DISCHARGE DISTRIBUTION OF SURABAYA BASIN

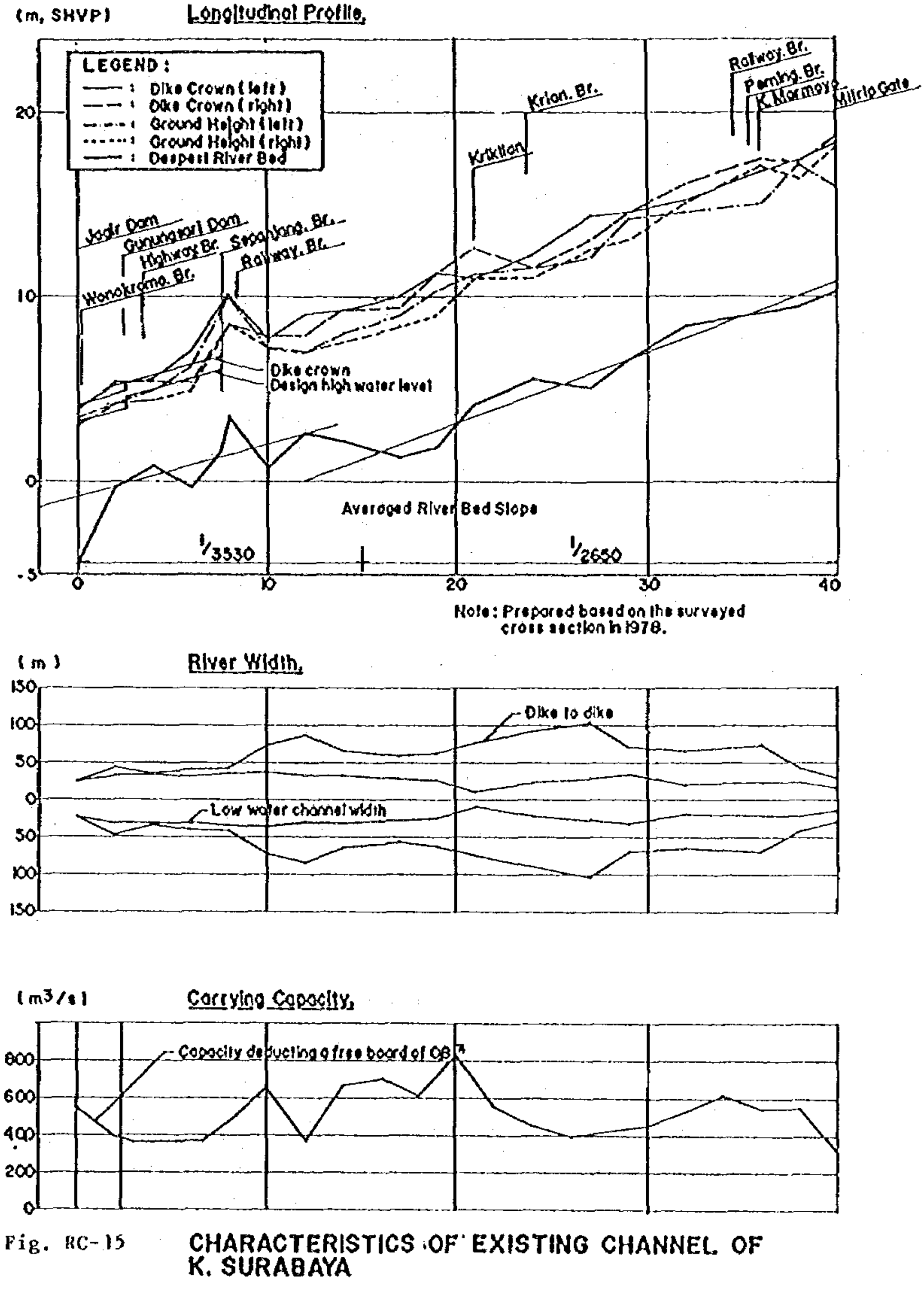
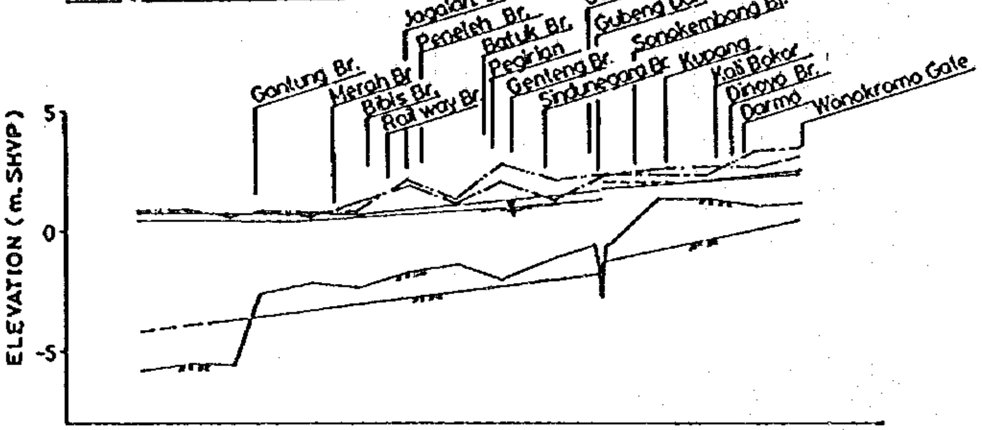


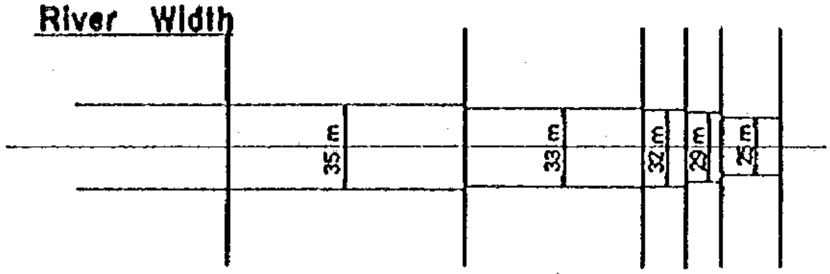
Fig. RC-15 **CHARACTERISTICS OF EXISTING CHANNEL OF K. SURABAYA**

Longitudinal Profil



Design Elevation (m, SHVP)	River Bank	0.40	0.40	0.80	0.40	0.80	0.82	1.00	1.17	1.34	1.54	2.10	2.10	2.21	2.40	2.50
	High Water Level	0.50	0.50	0.50	0.50	0.57	0.71	0.85	0.98	1.11	1.27	1.43	1.57	2.11	2.35	2.38
	River Bed	-4.13	-3.86	-3.61	-3.48	-3.21	-2.95	-2.70	-2.45	-2.21	-1.93	-1.12	-0.72	-0.30	0.10	0.48
Distance (m)		0	1040	2080	2620	3687	4720	5910	6715	7675	8808	9910	10925	11960	12960	13940
NO.		KP28	KP26	KP24	P110	P100	P 90	P 80	P 70	P 60	P 50	P 40	P 30	P 20	P 10	P 1

River Width



Typical Cross Section

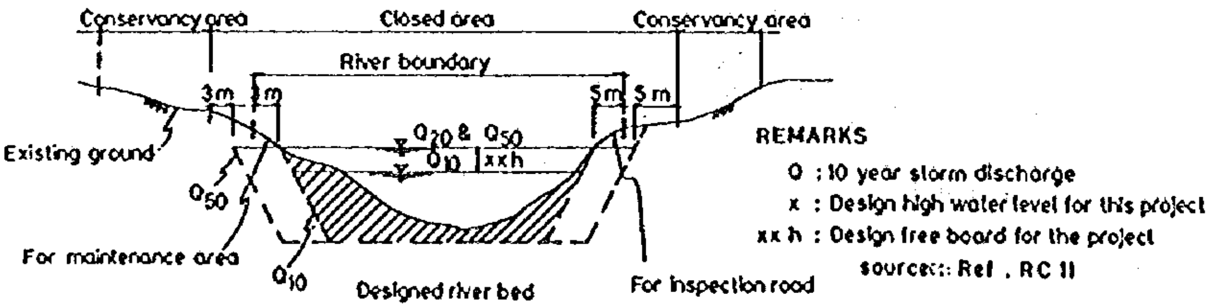
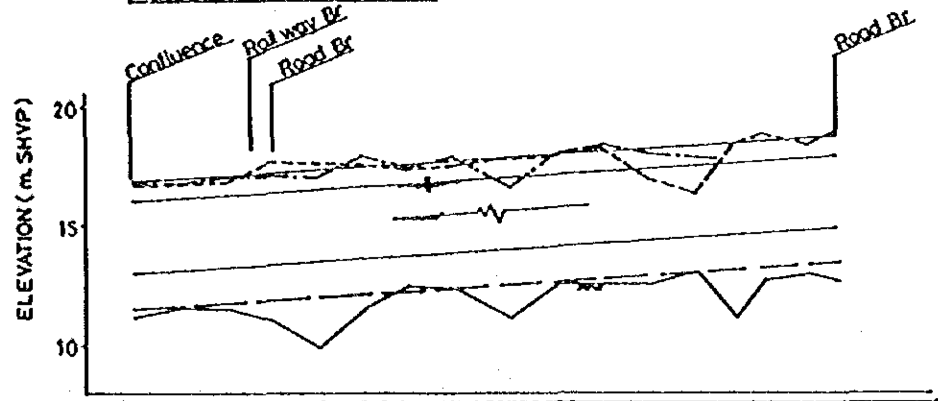


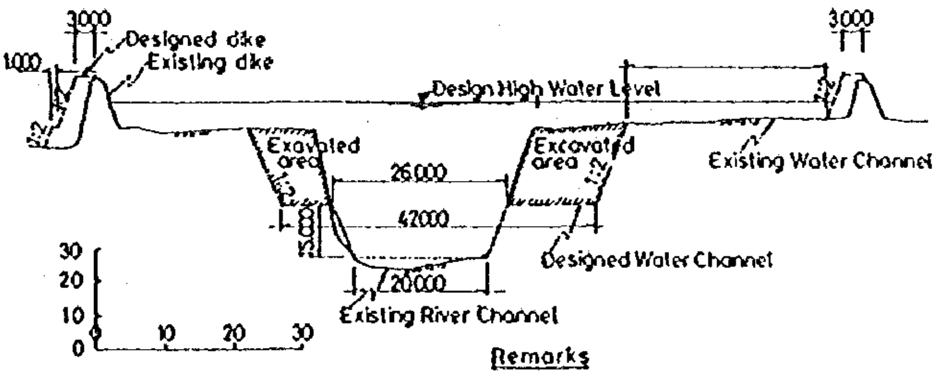
Fig. RC-16 **OUTLINE OF IMPROVED K.MAS**

Longitudinal Profile



NO.	Distance (m)	Design Elevation (m.SHVP) River Bed	Design Elevation (m.SHVP) High Water Level	Design Elevation (m.SHVP) Dike Crown
MR 0	0	11.50	16.00	16.80
MR 5	504	11.63	16.13	16.93
MR 10	1000	11.75	16.25	17.05
MR 15	1434	11.86	16.36	17.16
MR 20	1940	11.99	16.49	17.29
MR 25	2409	12.10	16.60	17.40
MR 30	2890	12.22	16.72	17.54
MR 35	3331	12.33	16.83	17.63
MR 40	3920	12.46	16.98	17.78
MR 45	4380	12.60	17.10	17.90
MR 50	4870	12.72	17.22	18.02
MR 55	5337	12.83	17.33	18.13
MR 60	5850	12.96	17.46	18.26
MR 65	6262	13.07	17.57	18.37
MR 70	6550	13.14	17.64	18.44
MR 75	7035	13.25	17.75	18.55
MR 74	7332	13.33	17.83	18.63
MR 80	7520			

Typical Cross Section



Remarks

I.) In the case that L is longer than 20 the dike is constructed at river side

II.) In the case that L is shorter than 20 the dike is constructed at land side

Source : Ref. RC 11

Fig. RC-17 **OUTLINE OF IMPROVED K.MARMOYO**

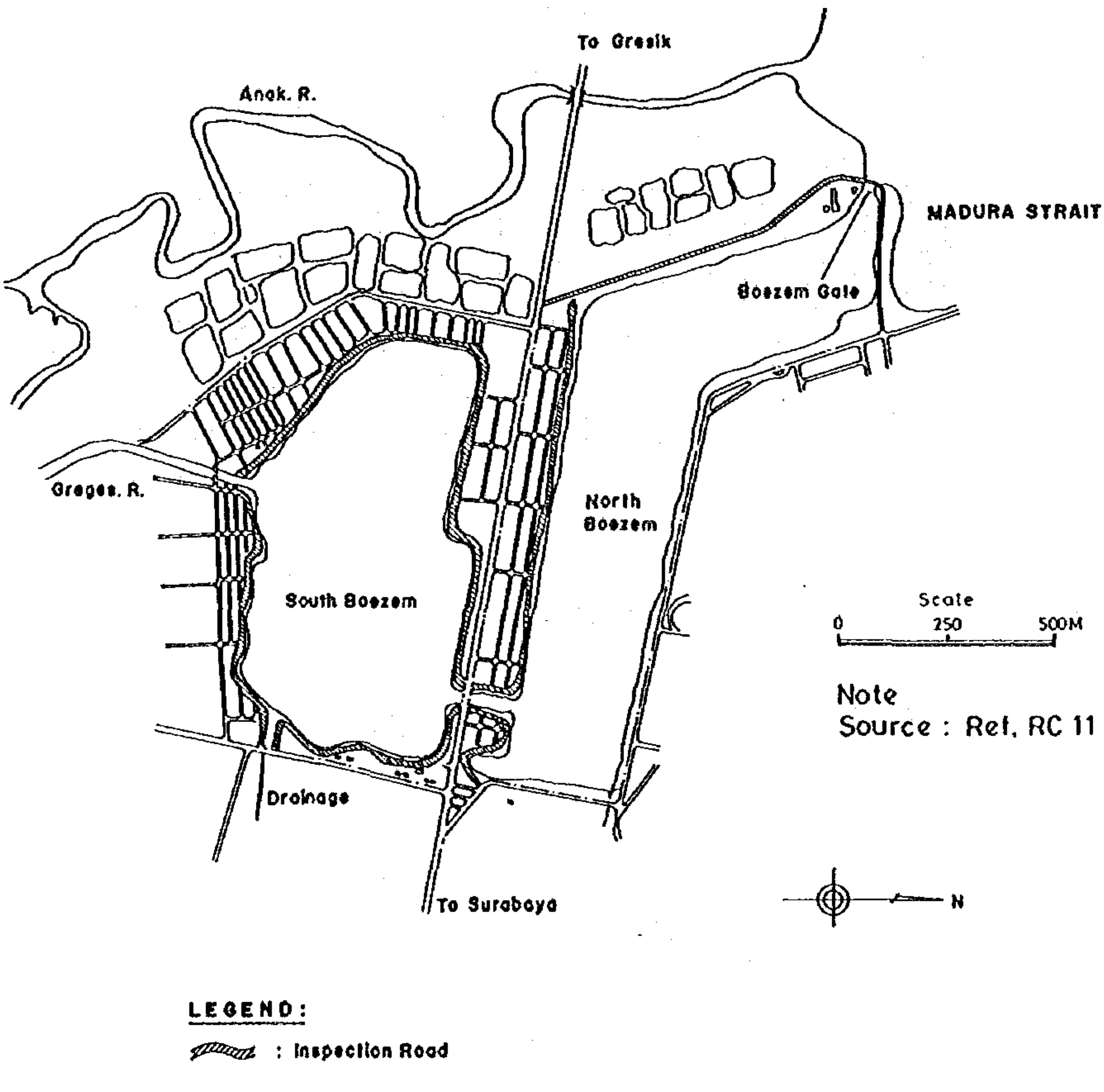
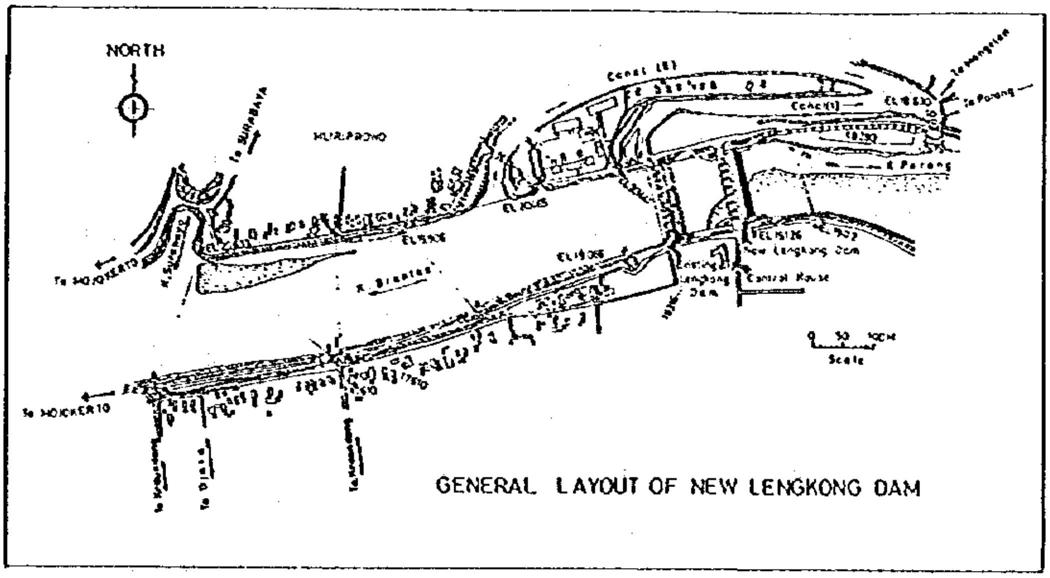
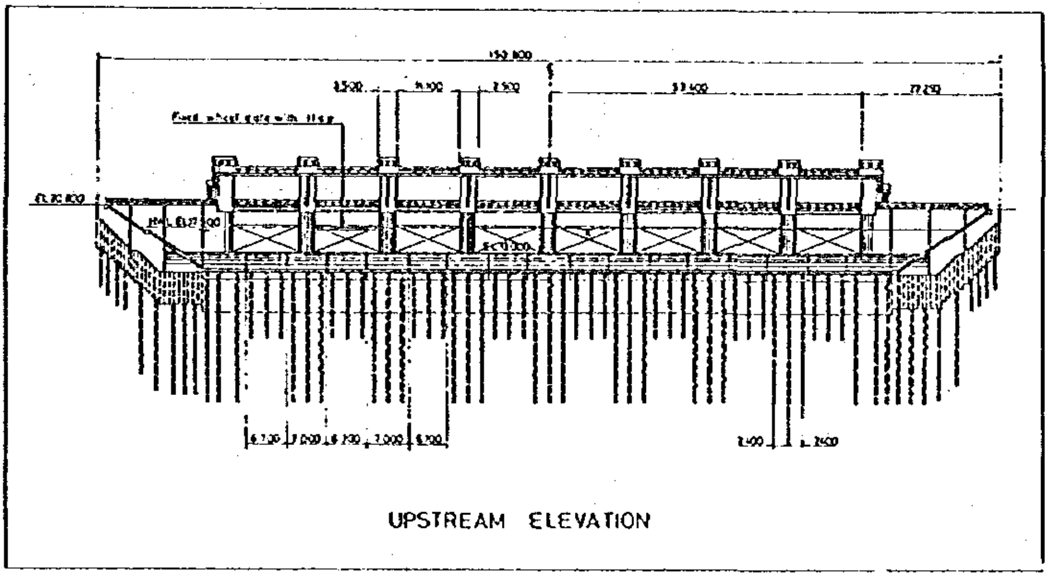


Fig. RC- 18 OUTLINE OF MOROKREMBANGAN BOEZEM





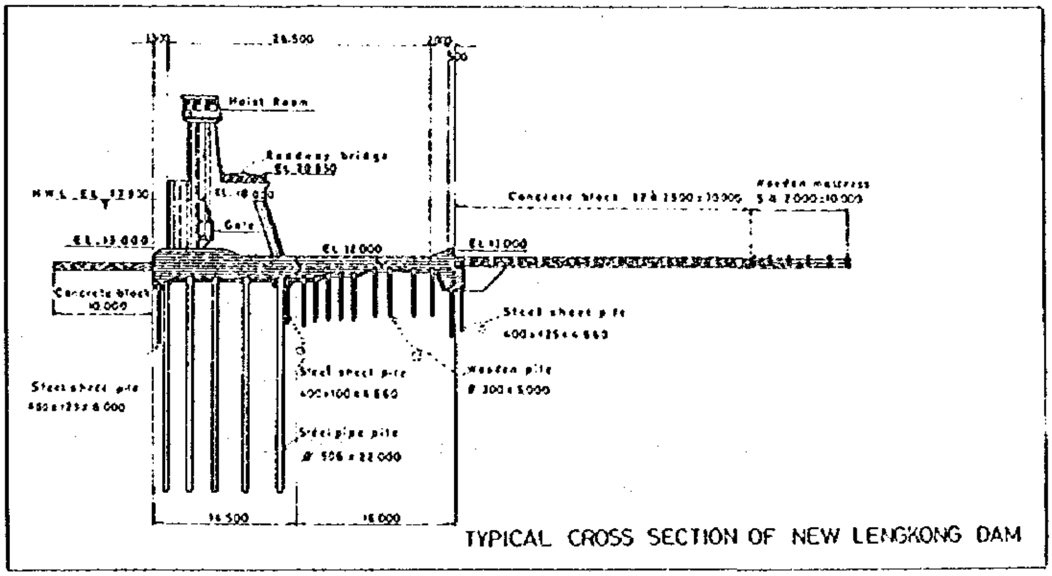
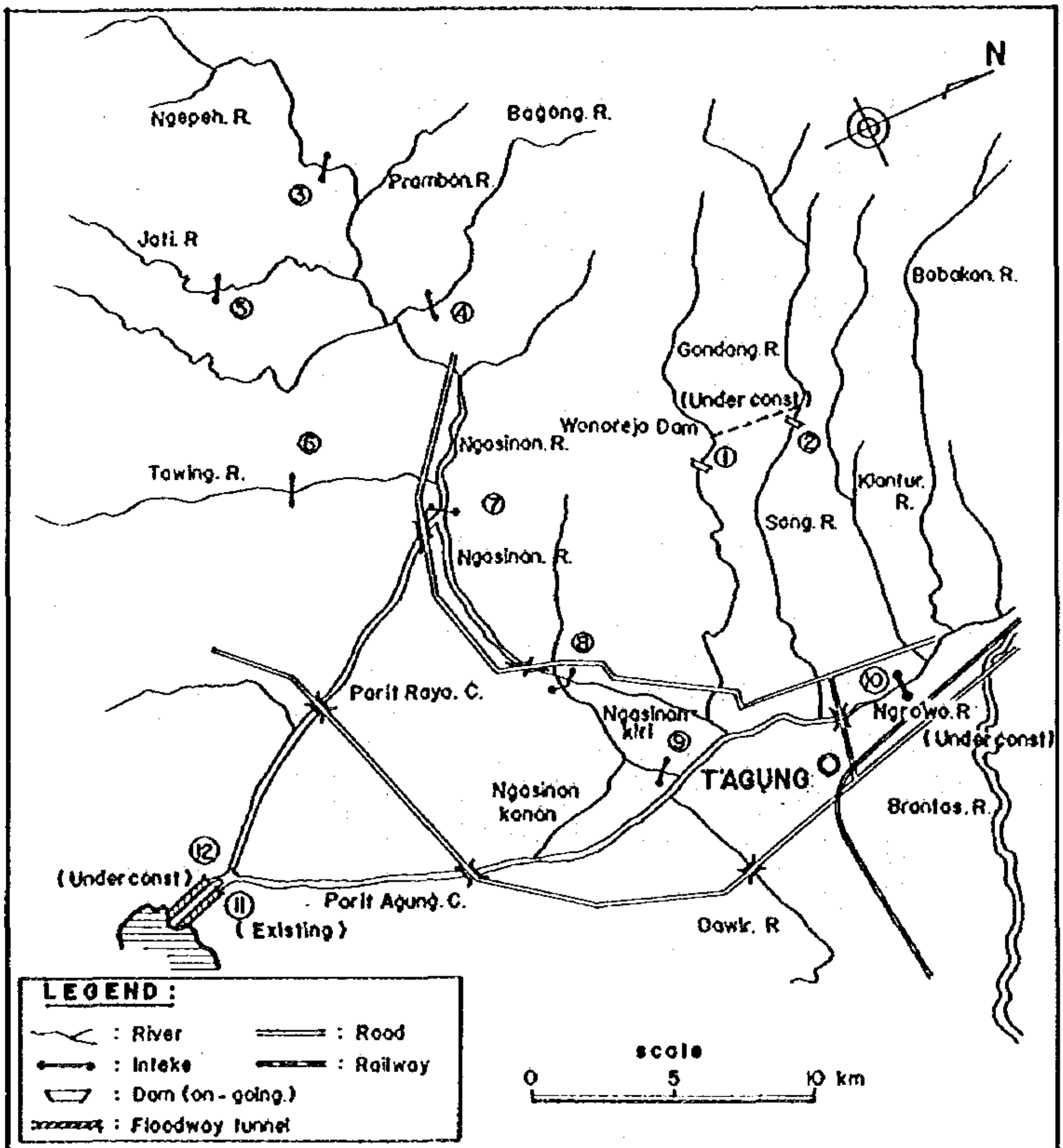


Fig. RC-19 OUTLINE OF NEW LENGKONG DAM



REMARKS :

Dam

① Wonorejo Dam

② Segawe Intake Weir with connection tunnel

Head work or Intake

③ Ngepeh

④ Bagong

⑤ Jabung

⑥ Widoro

⑦ Bendo

⑧ Sumbergayam

⑨ Cluwok

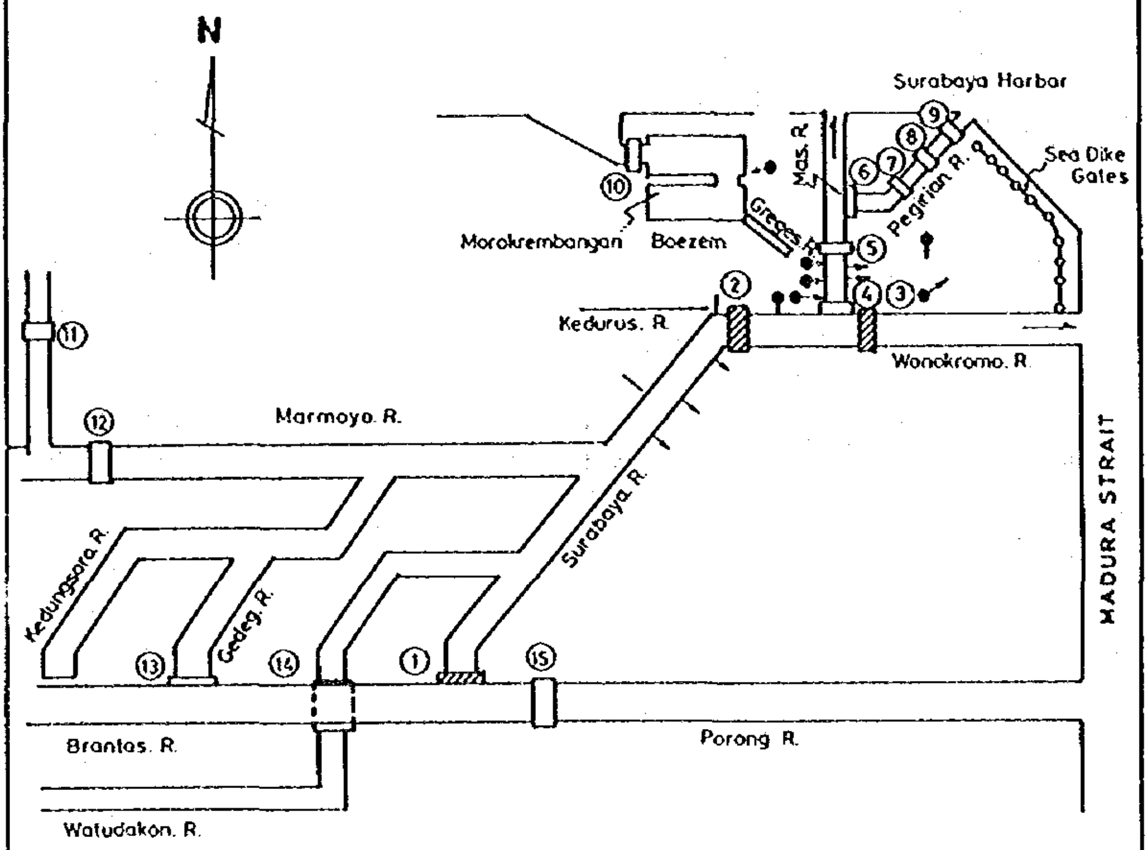
⑩ Tulungagung

Flood diversion tunnel

⑪ Tulungagung I (old)

⑫ Tulungagung II (new)

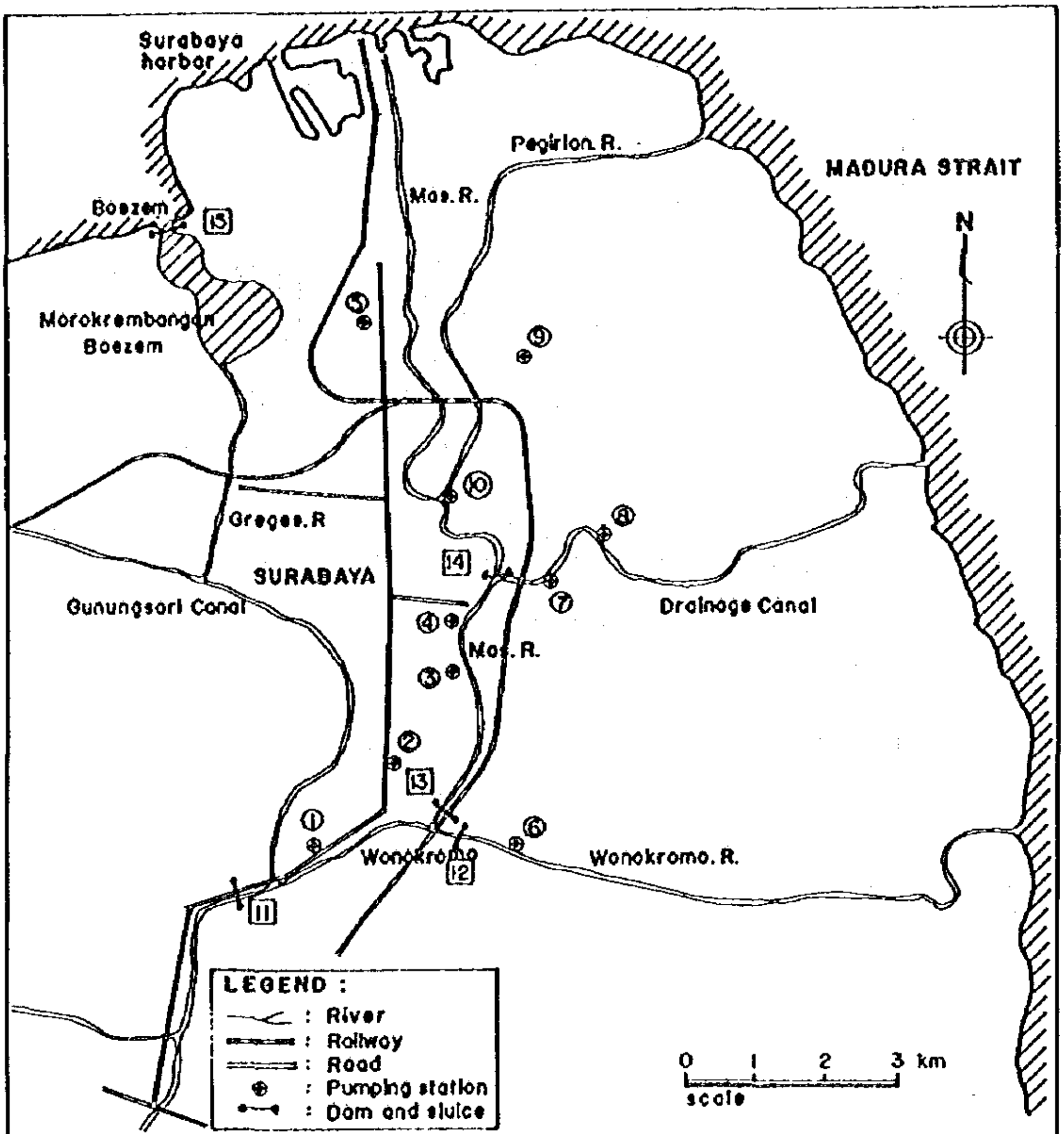
Fig. RC-20 **LOCATION MAP OF EXISTING RIVER STRUCTURE IN NGROWO BASIN.**



REMARKS :

(1) Mlirip Sluice	(6) Pegirian Gate	(11) Kabuh Dam	(14) Watudakon Syphon
(2) Gunungsari Dam	(7) Gembong Gate	(12) Mernung Dam	(15) Lengkong Dam
(3) Jagir Dam	(8)	(13) Gedeg Sluice	
(4) Wonokromo Sluice	(9) Tambak Wedi Gate	o Sea Dike Gates	
(5) Gubeng Dam	(10) Morokrembangan Gates	Pump Station	
		Irrigation Canal	

Fig. RC-21 LOCATION MAP OF EXISTING RIVER STRUCTURE IN SURABAYA BASIN.



REMARKS :

Pumping station

1. Gunungsari. PS
2. Darmo. PS
3. Kupang. PS
4. Keputran. PS
5. Pesapen. PS
6. Bratanggede. PS
7. Darmahusada. PS
8. Kalikepiting. PS
9. Sumolawang. PS
10. Ngemplak. PS

Dam and sluice

11. Gunungsari Dam
12. Jagir Dam
13. Wonokromo sluice
14. Gubeng Dam
15. Morokrembangan Boezem Gate

Fig. RC-22 **LOCATION MAP OF EXISTING DRAINAGE FACILITY IN SURABAYA URBAN AREA.**

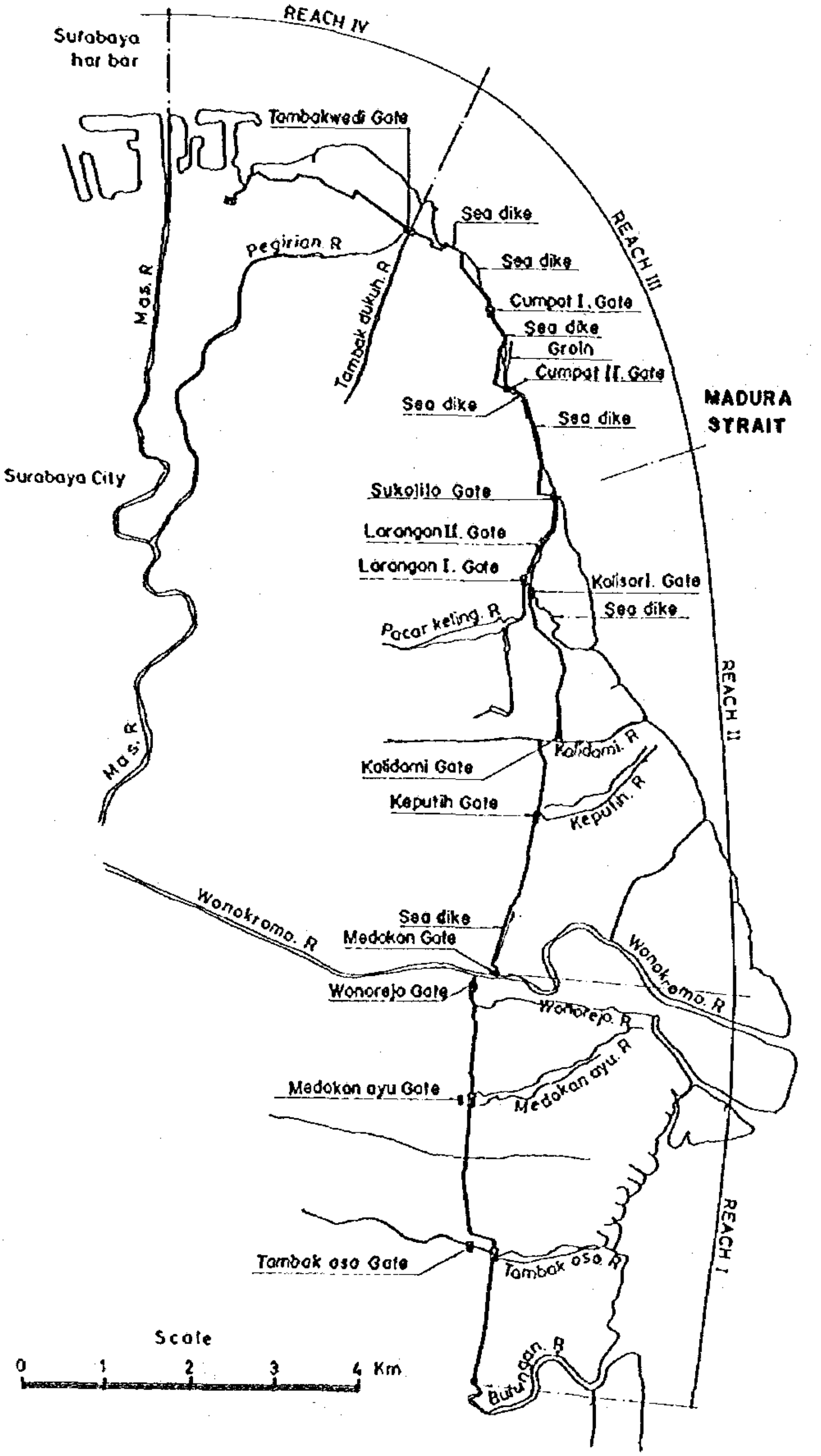
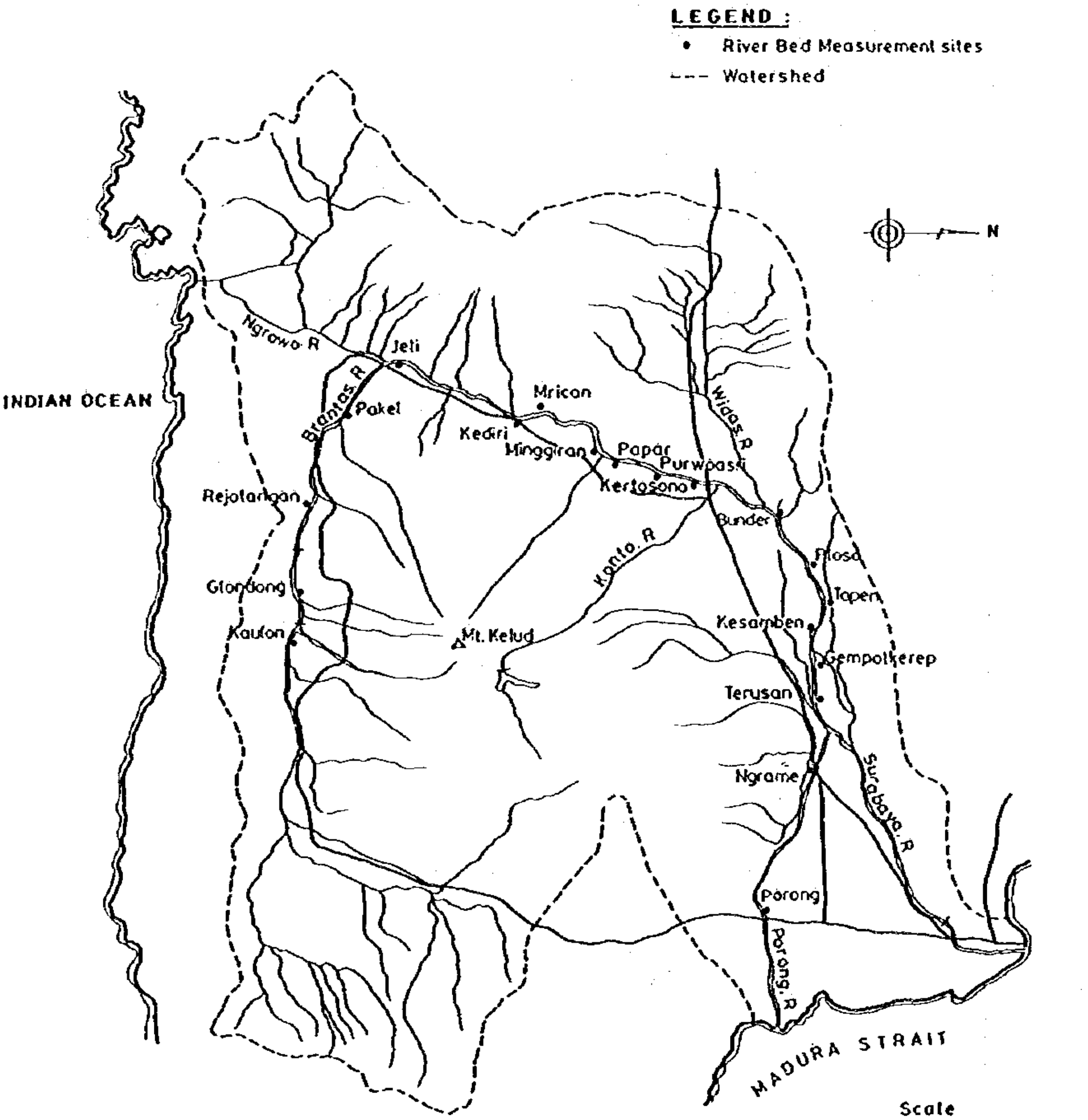
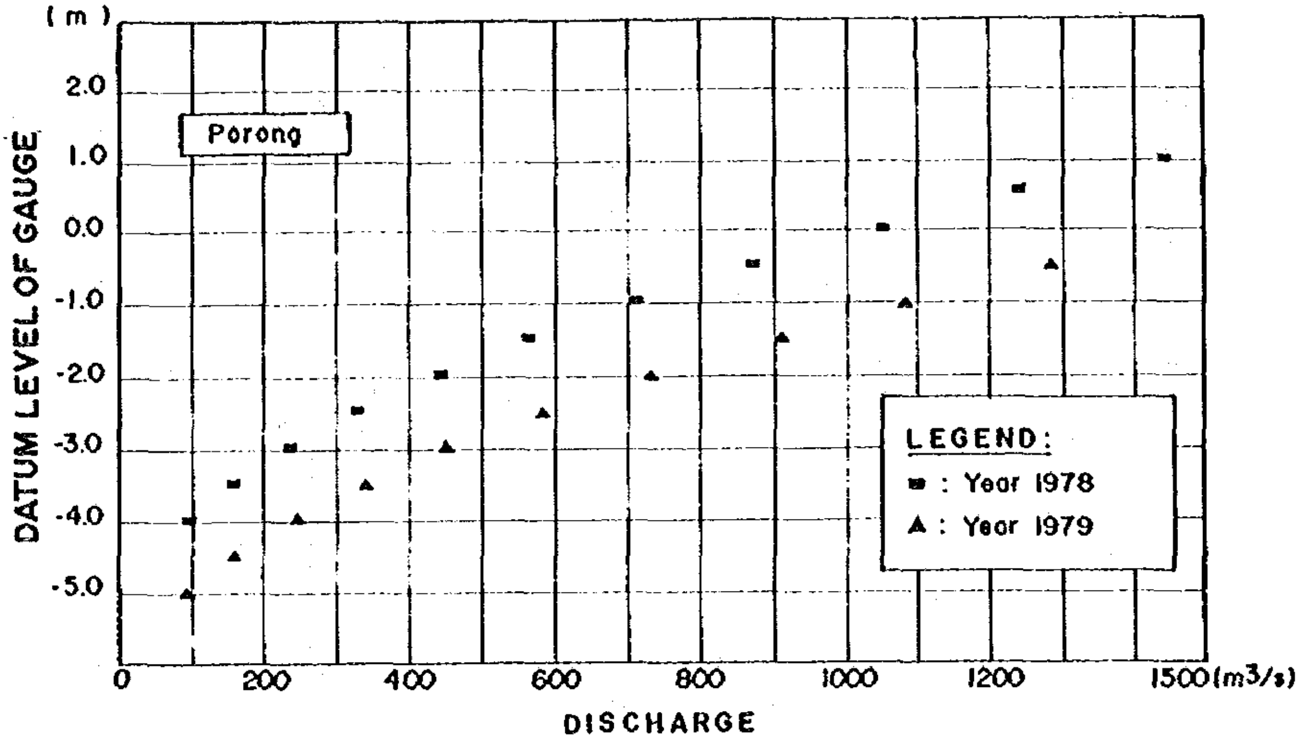


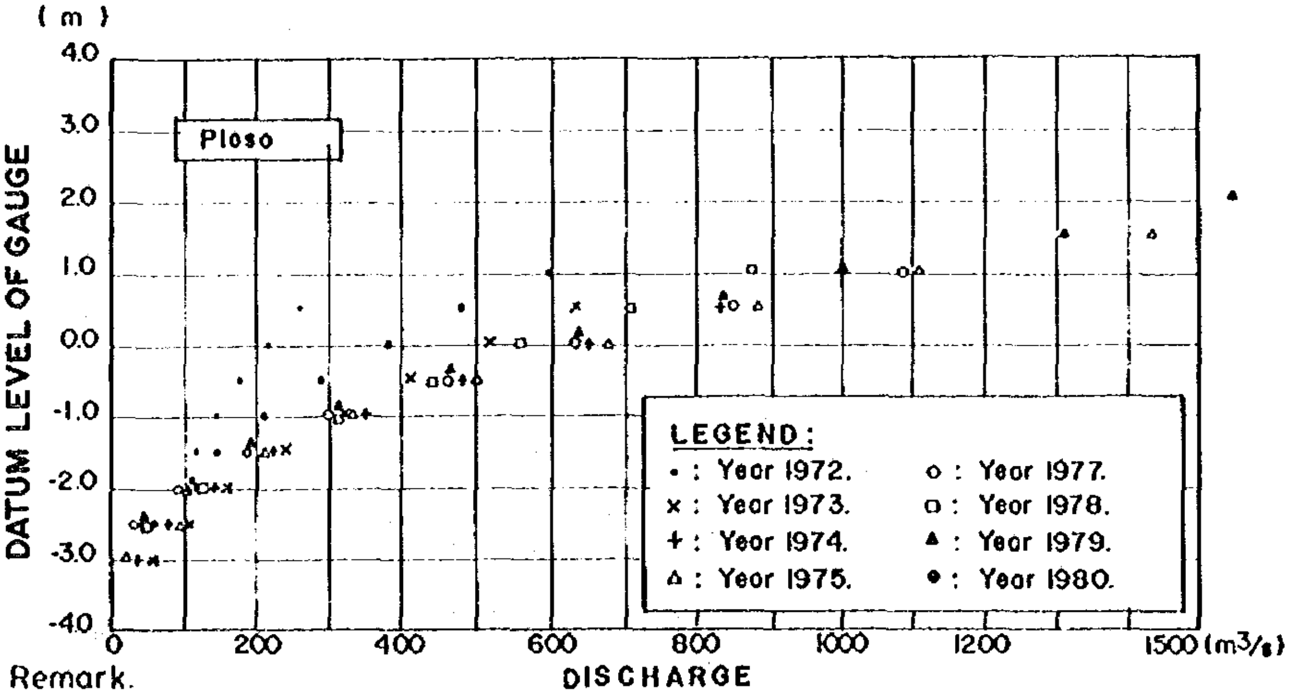
Fig. RC-23 **LOCATION MAP OF SEA DIKE WORKS**



Note,
Source : Ref. RC 01

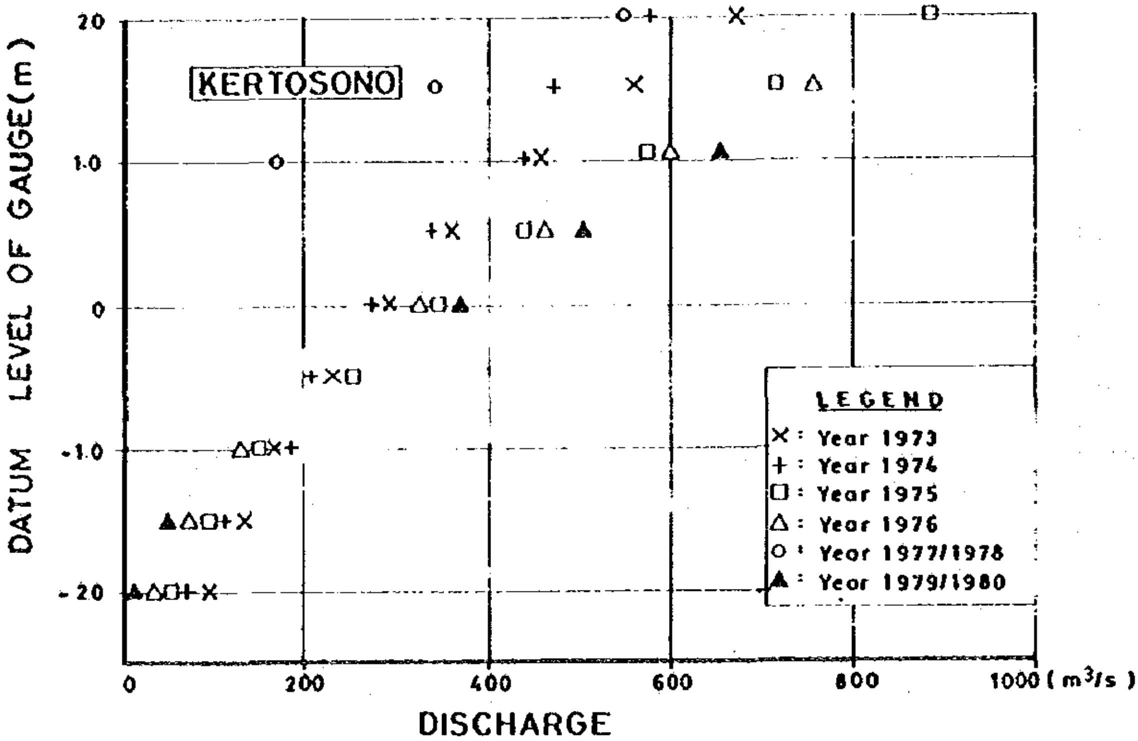
Fig. RC-24 **LOCATION MAP OF MEASUREMENT SITE OF RIVER BED ELEVATION**

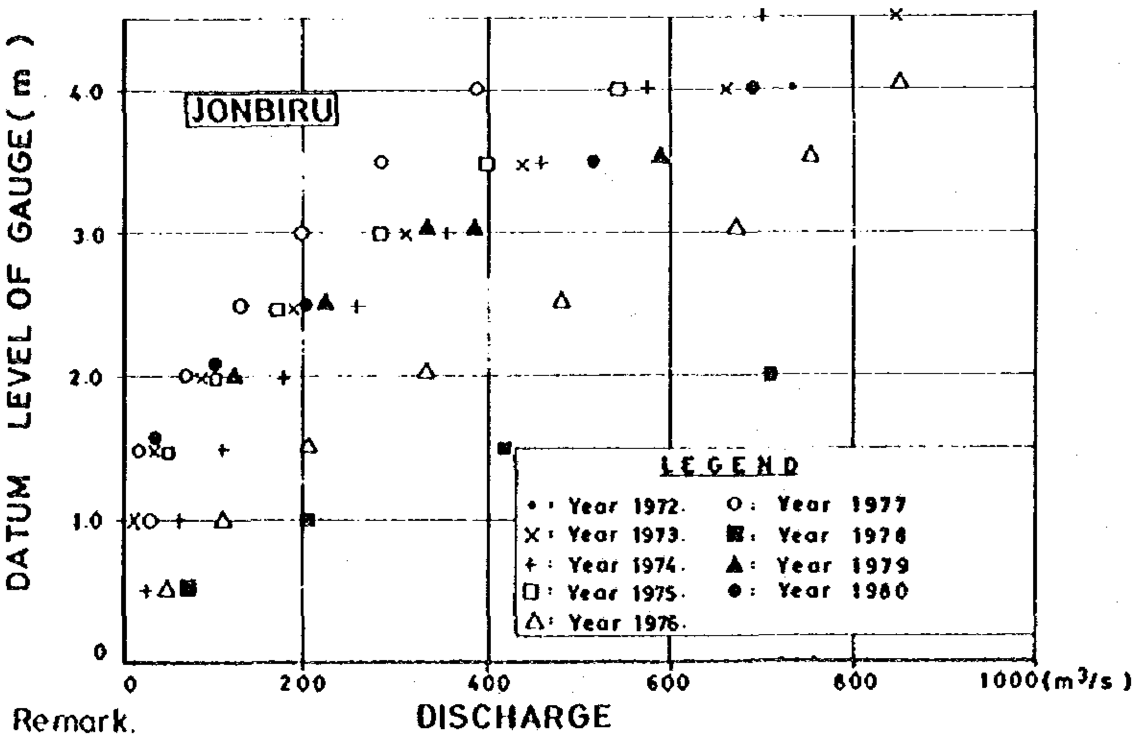




Remark.
Source: Ref. HY 38.39

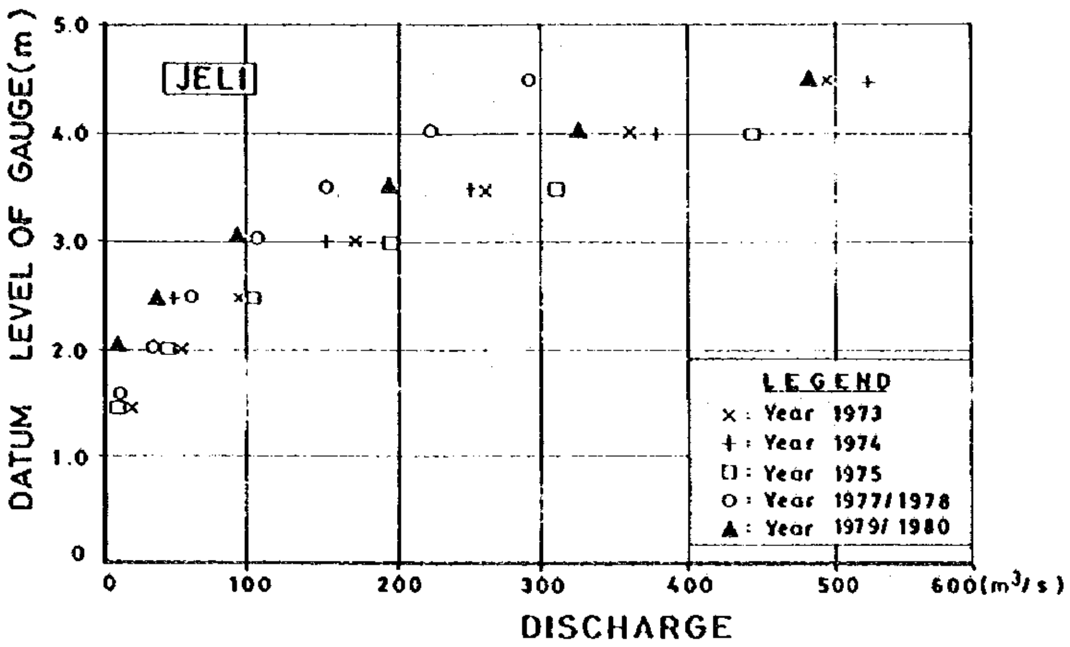
Fig. RC-25 (1) **COMPARISON OF DISCHARGE RATING CURVE IN THE K. BRANTAS.**

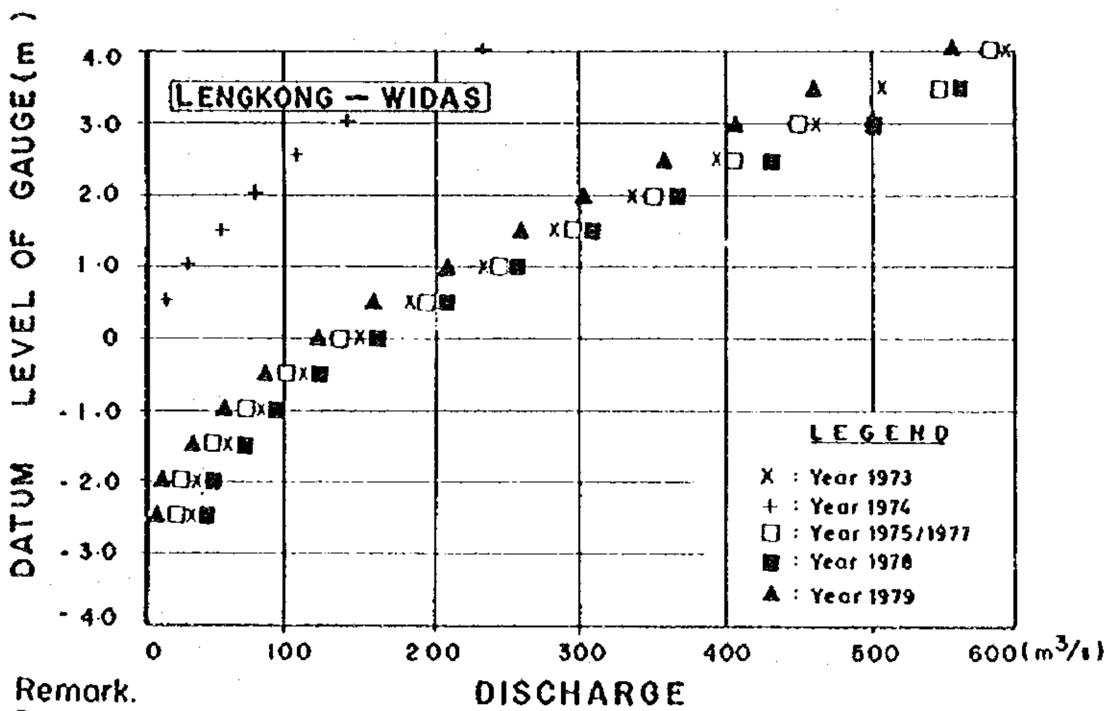




Remark.
Source : Ref.HY 37.49

Fig. RC-25 (2) COMPARISON OF DISCHARGE RATING CURVE IN THE BRANTAS RIVER





Remark.
Source : Ref.HY 50,51

Fig. RC-25 (3) COMPARISON OF DISCHARGE RATING CURVE IN THE BRANTAS RIVER

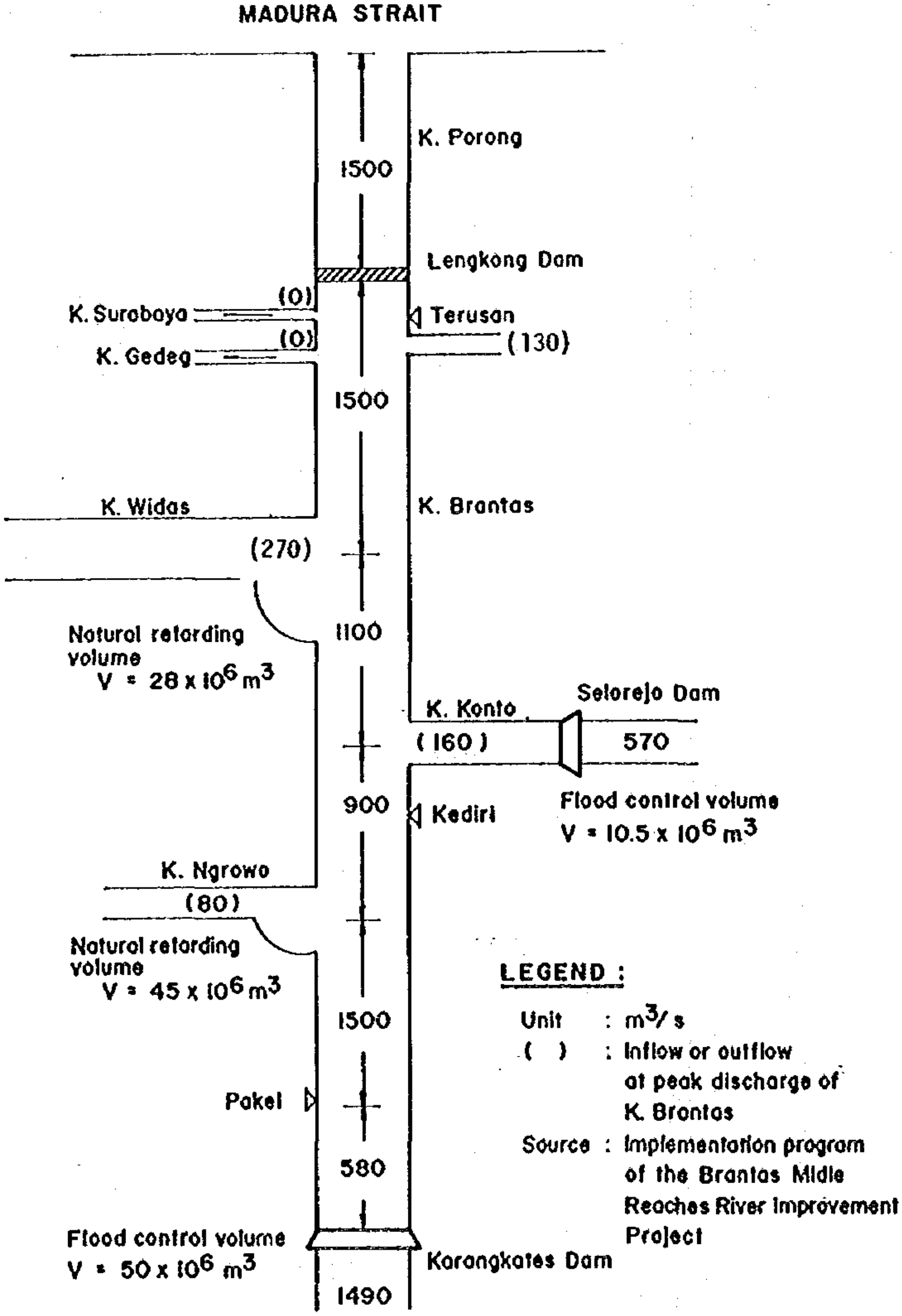
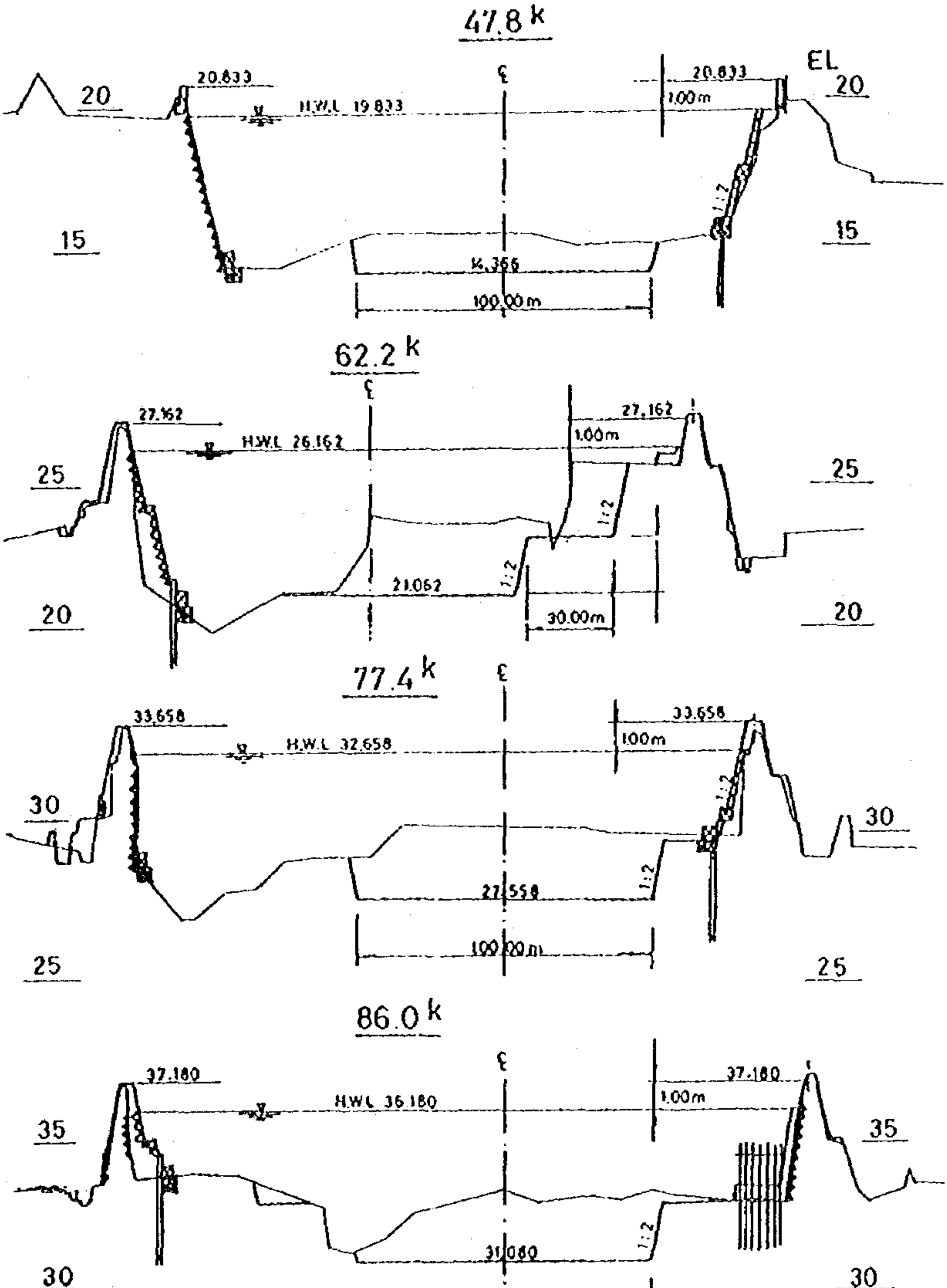
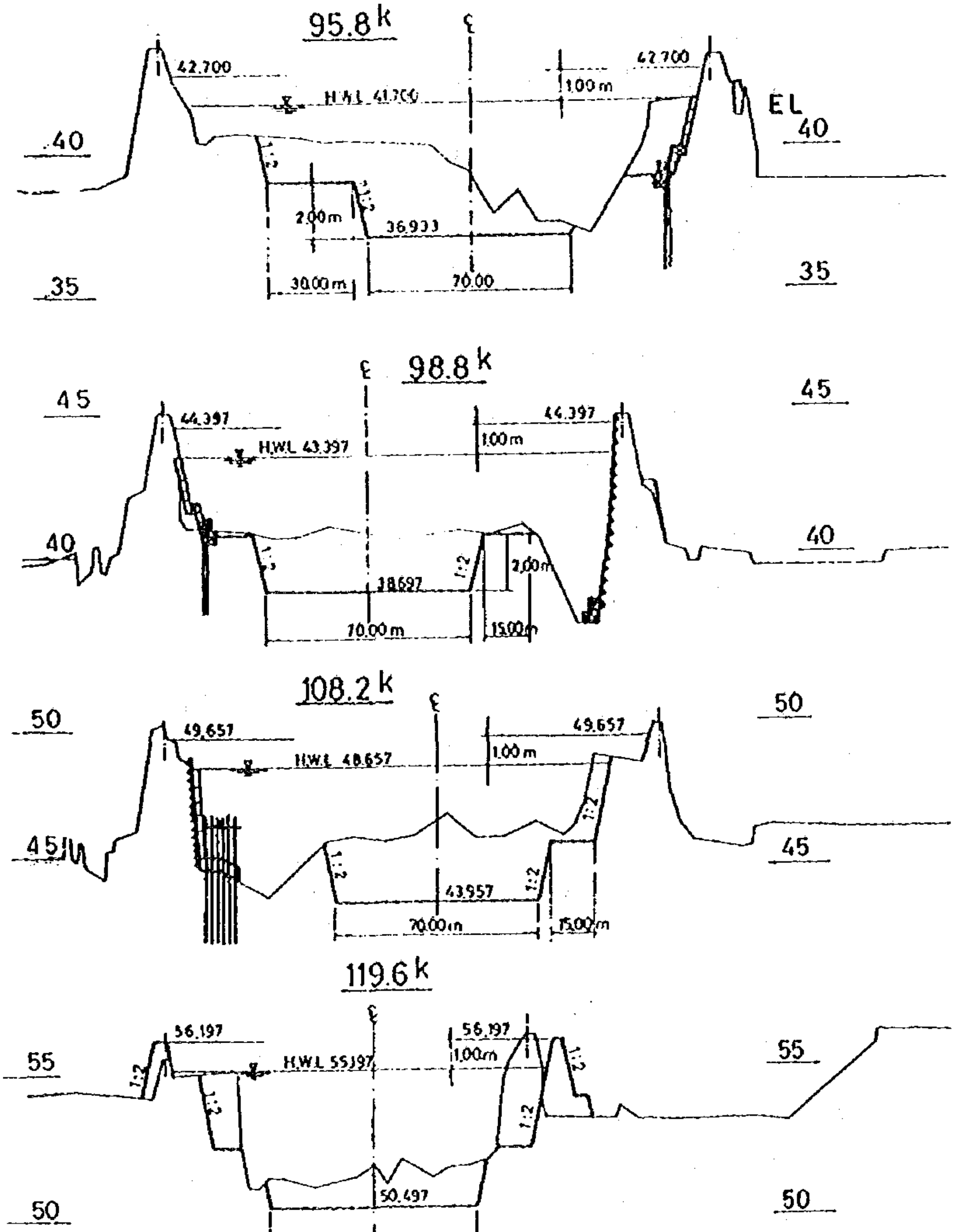


Fig. RC- 26 EXISTING DESIGN DISCHARGE DISTRIBUTION OF K. BRANTAS AND K. PORONG (50yr Probable flood)



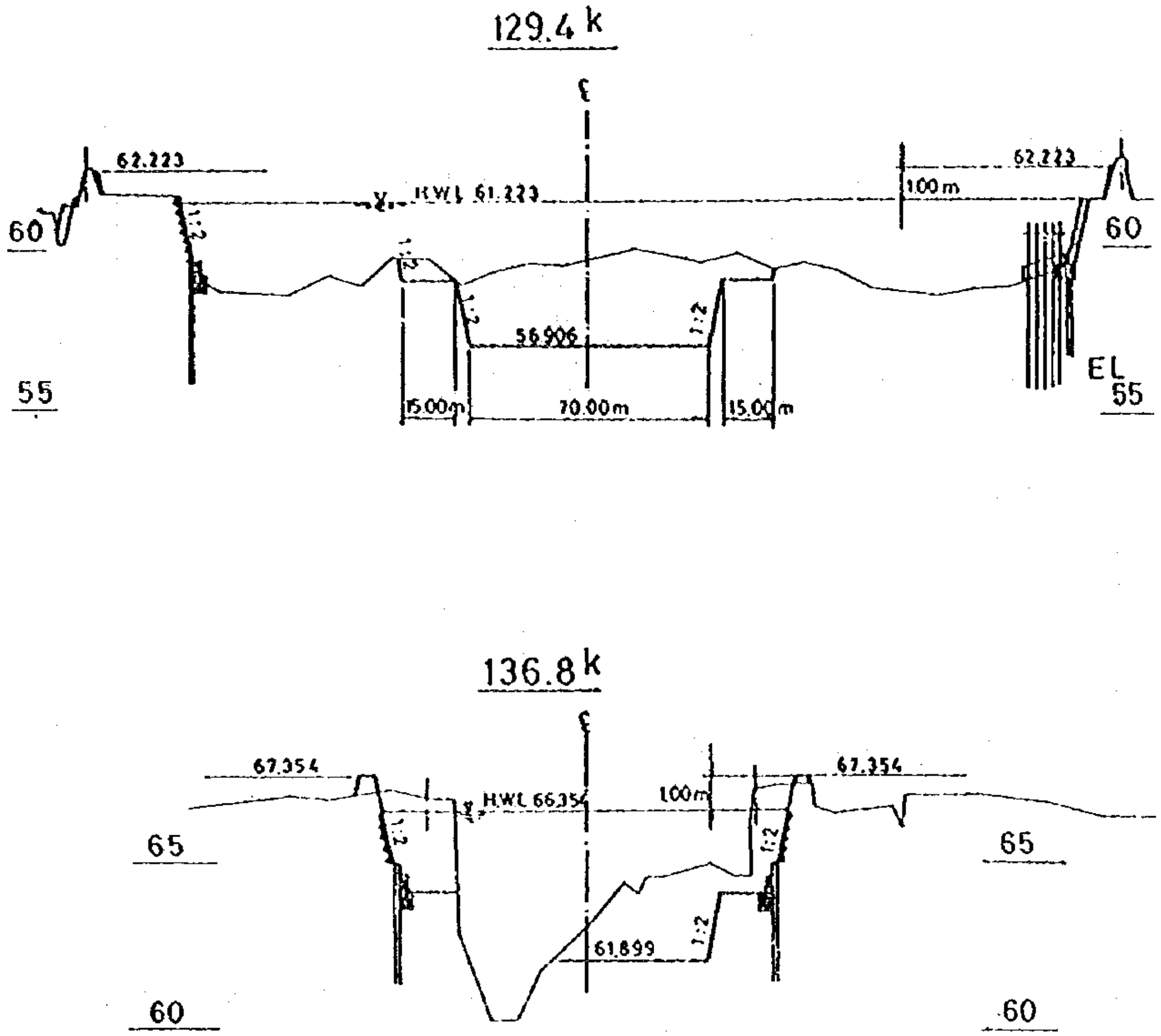
Note.
Source : Ref.RC04

Fig. RC-27 (1) **TYPICAL DESIGN CROSS SECTION**



Note
Source : Ref, RC 04

Fig. RC-27 (2) **TYPICAL DESIGN CROSS SECTION**



Note
Source : Ref. RC 04

Fig. RC-27(3) **TYPICAL DESIGN CROSS SECTION**

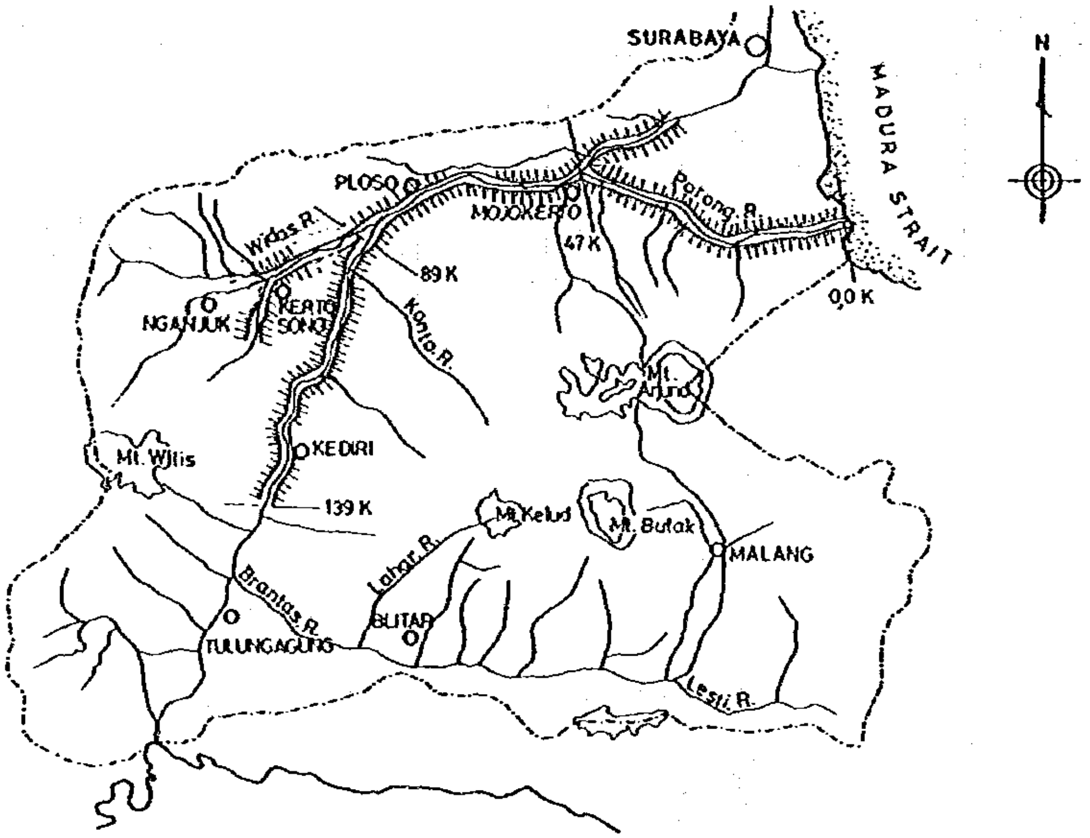


Fig. RC-28 EXTENT OF EXISTING LEVEE OF PORONG AND BRANTAS RIVER

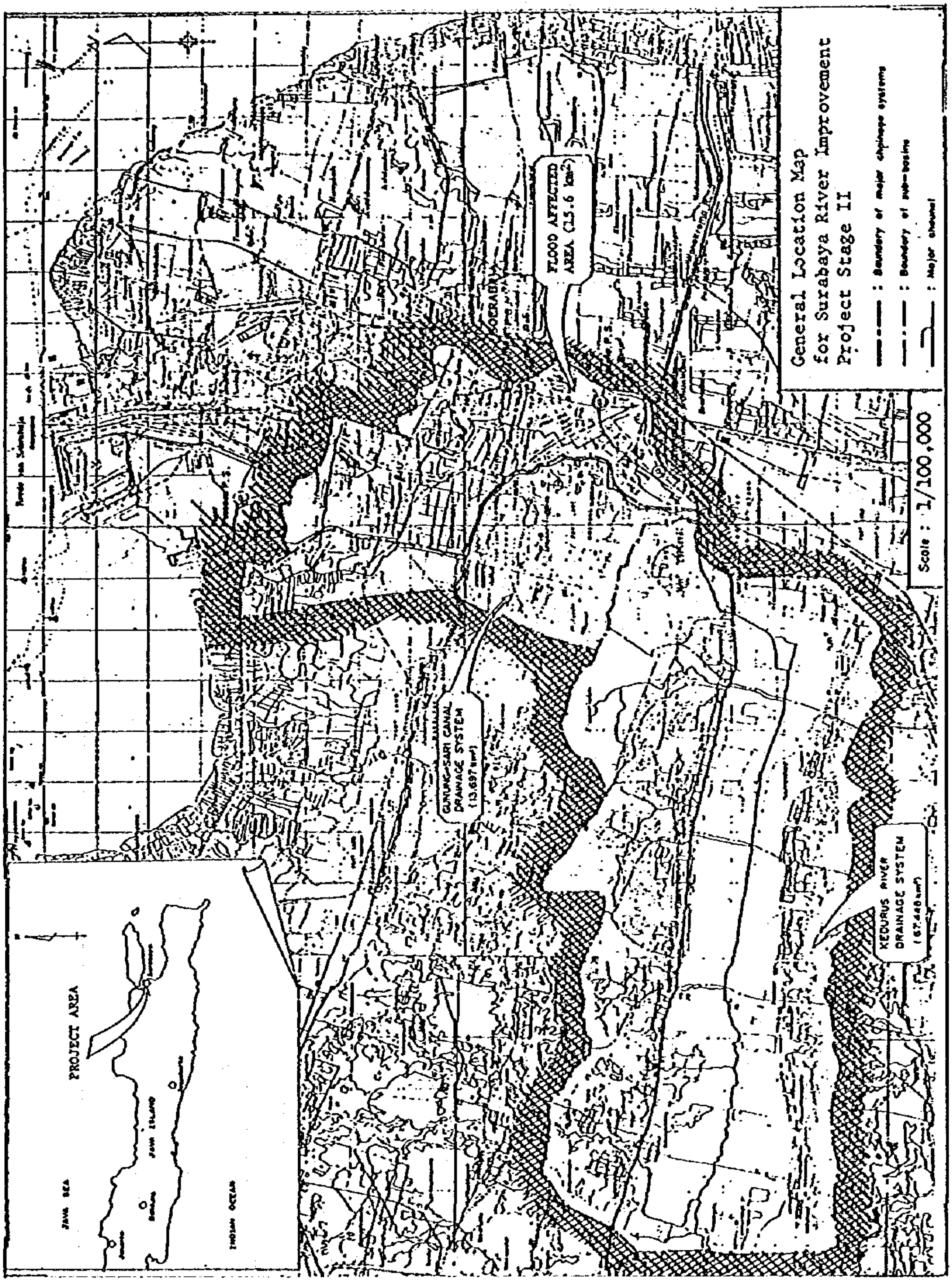


Fig. RC-29 **LOCATION MAP OF SURABAYA RIVER IMPROVEMENT PROJECT. Stage II.**

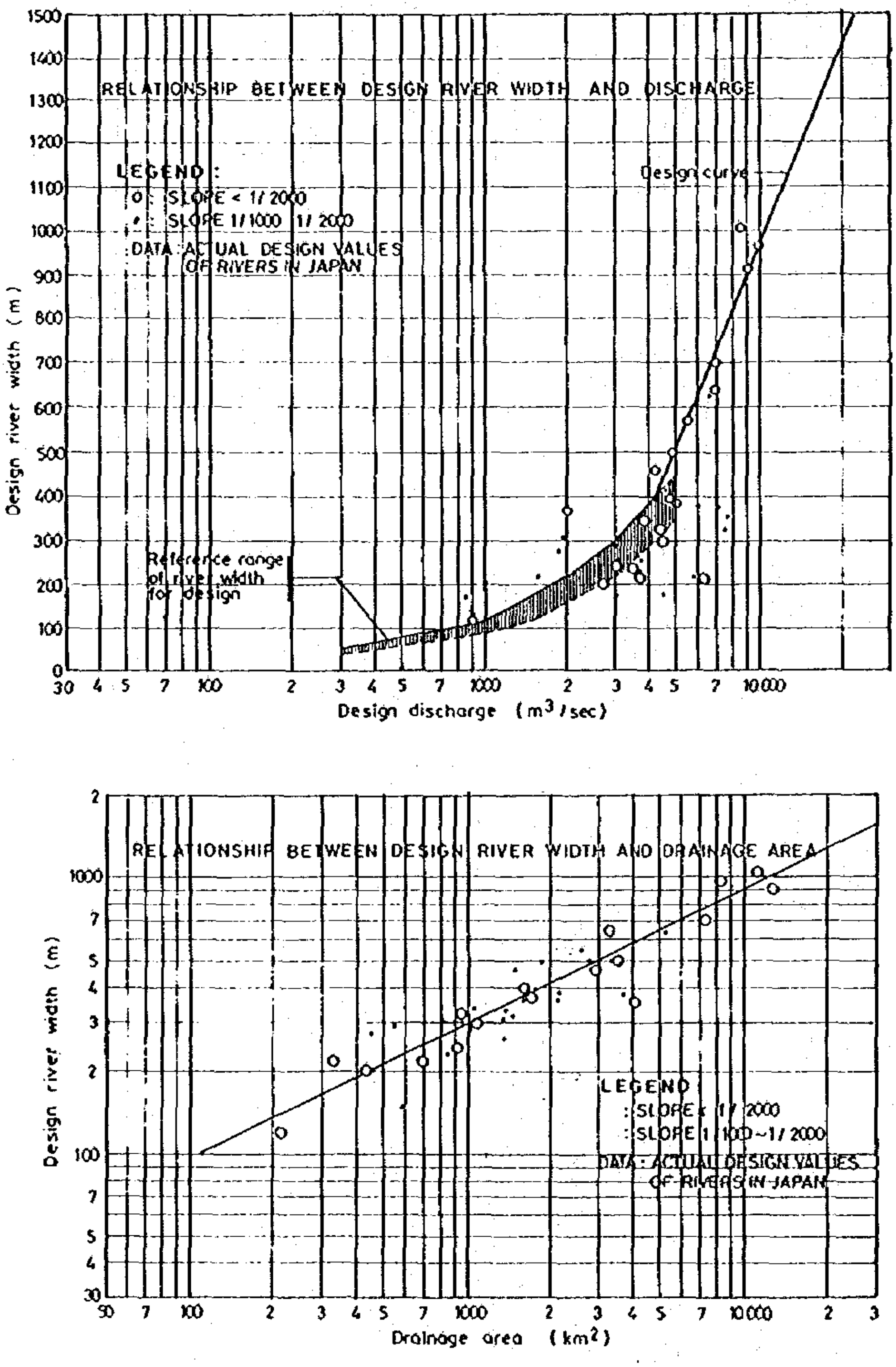


Fig. Rc-30 DESIGN STANDARD OF RIVER WIDTH

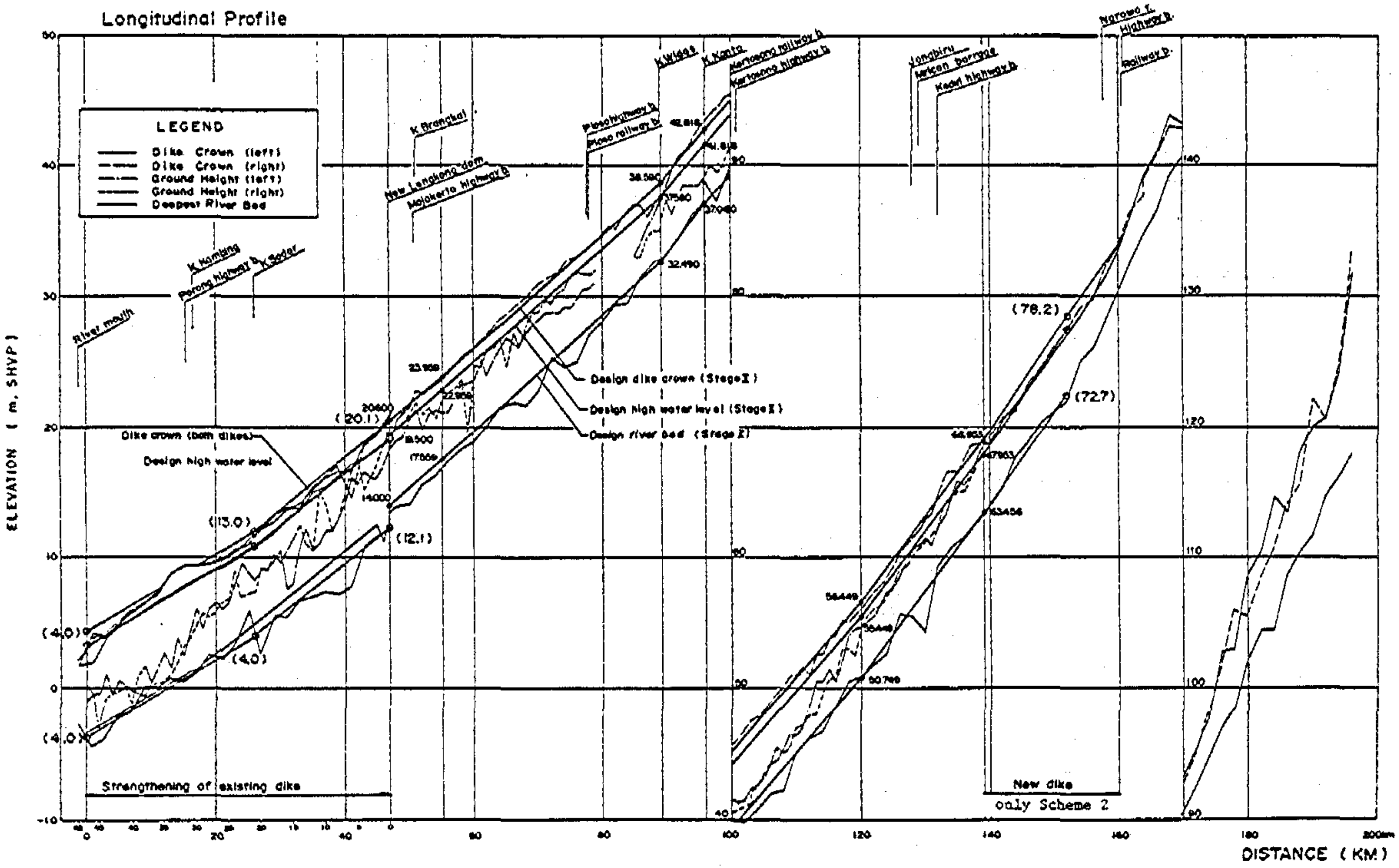


Fig. RC-.31 **DESIGN PROFILE OF K. BRANTAS AND K. PORONG**

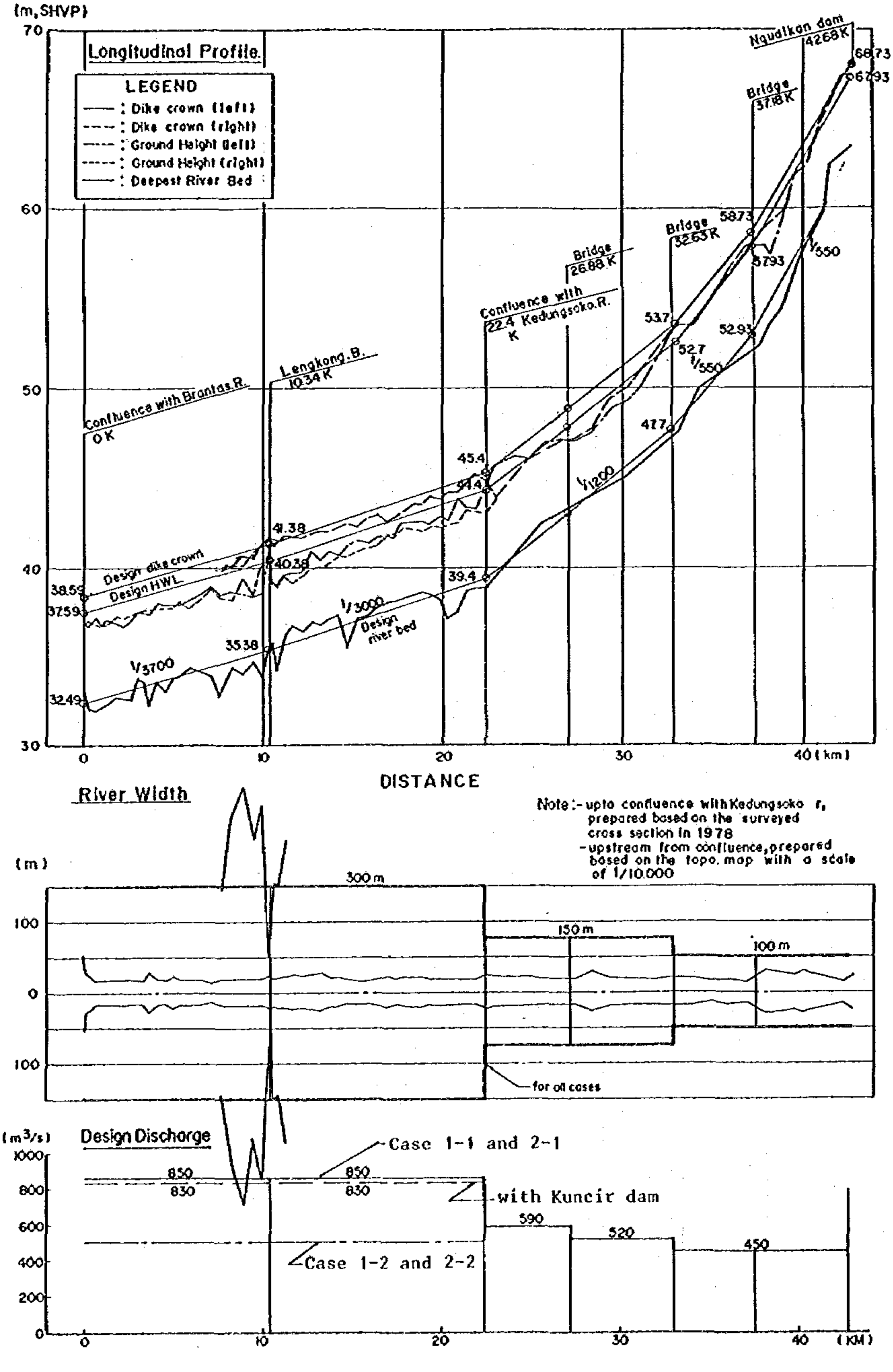


Fig. RC-32 DESIGN PROFILE OF K. WIDAS.

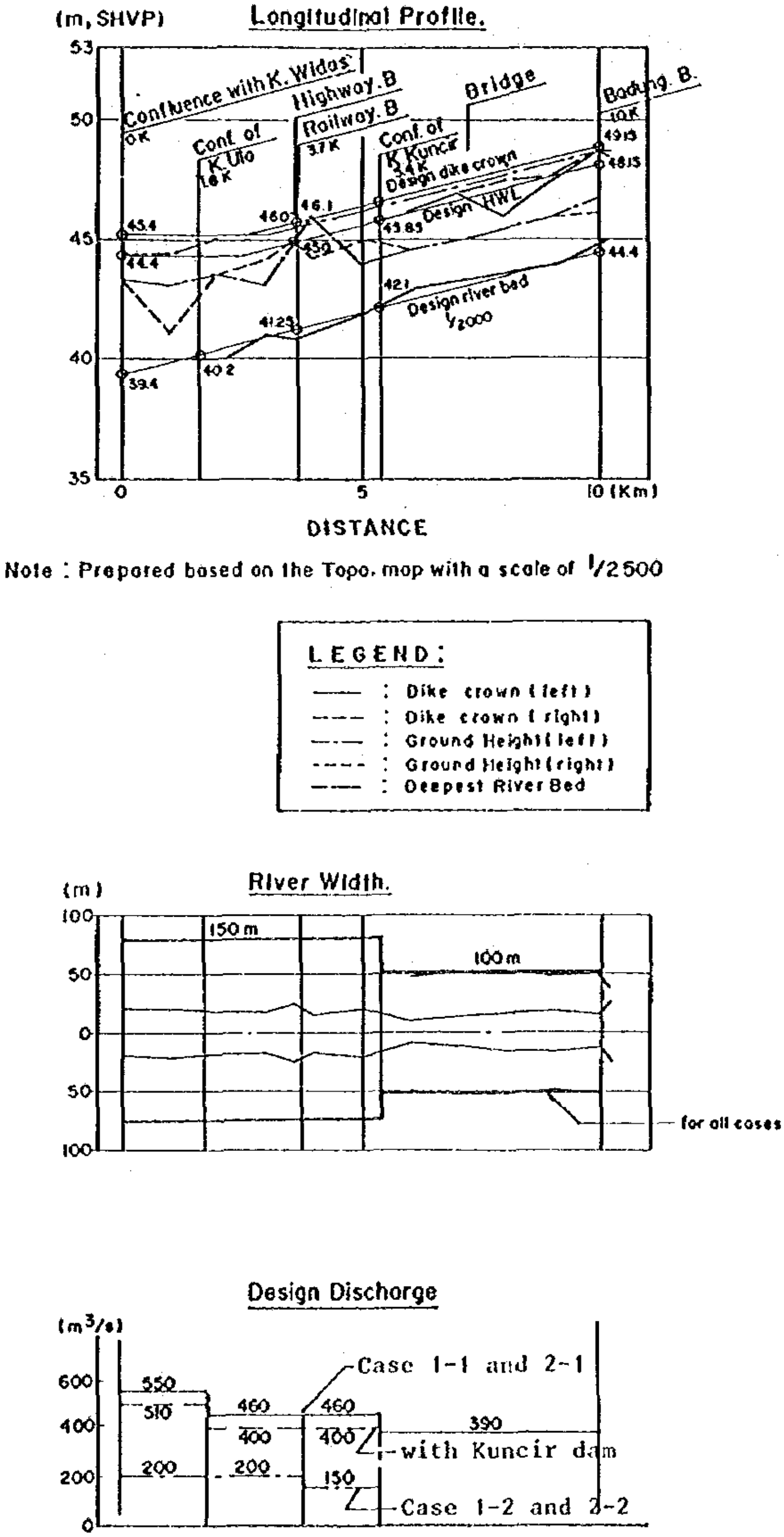


Fig. RC- 33 DESIGN PROFILE OF K. KEDUNGSOKO

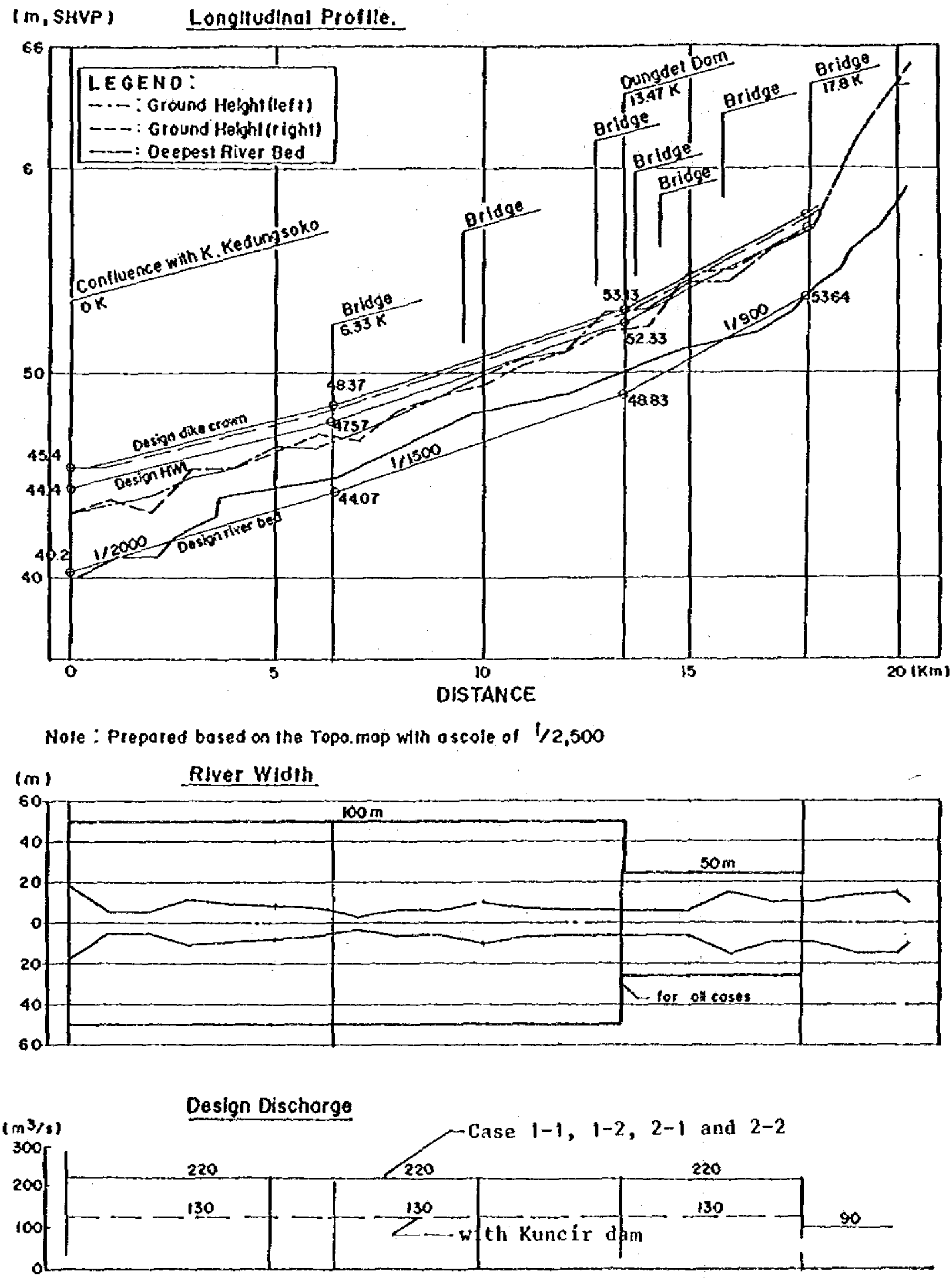


Fig. RC-34 DESIGN PROFILE OF K. ULO.

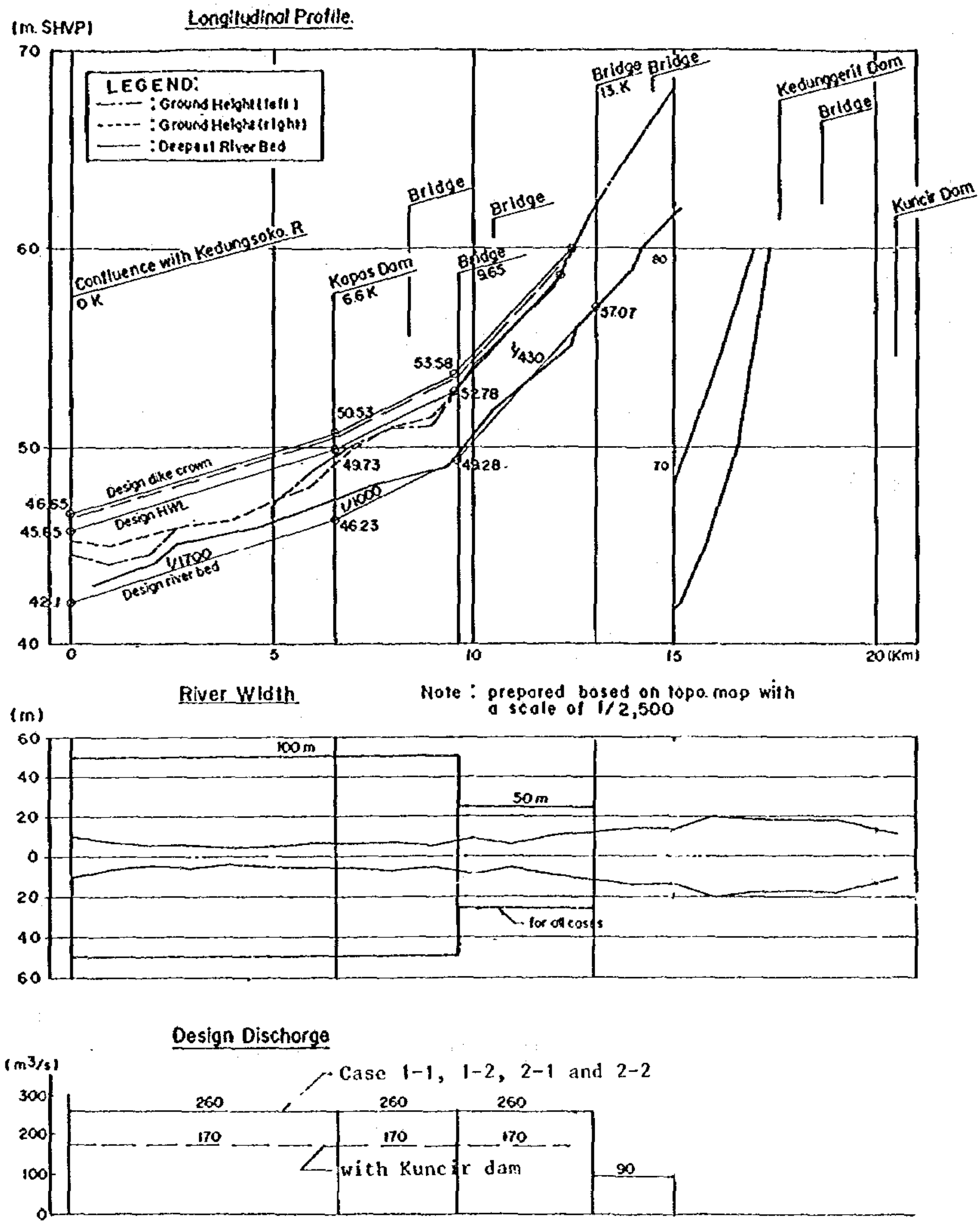
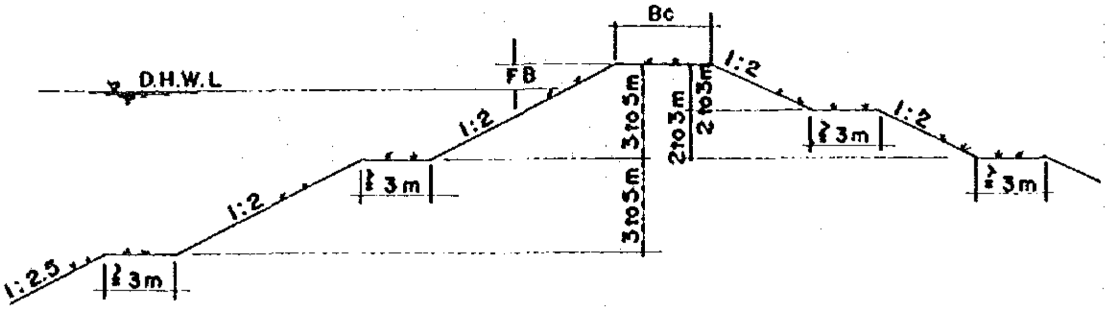


Fig. RC-35 DESIGN PROFILE OF K. KUNCIR.



Designed Discharge Q (m3/s)	Free-board FB (m) not less than	Crown width Bc (m) not less than
< 200	0.6	3
200 to 500	0.8	3
500 to 2.000	1.0	4
2.000 to 5.000	1.2	5
5.000 to 10.000	1.5	6
10.000 <	2.0	7

Fig. RC-36 STANDARD DIKE SECTION.

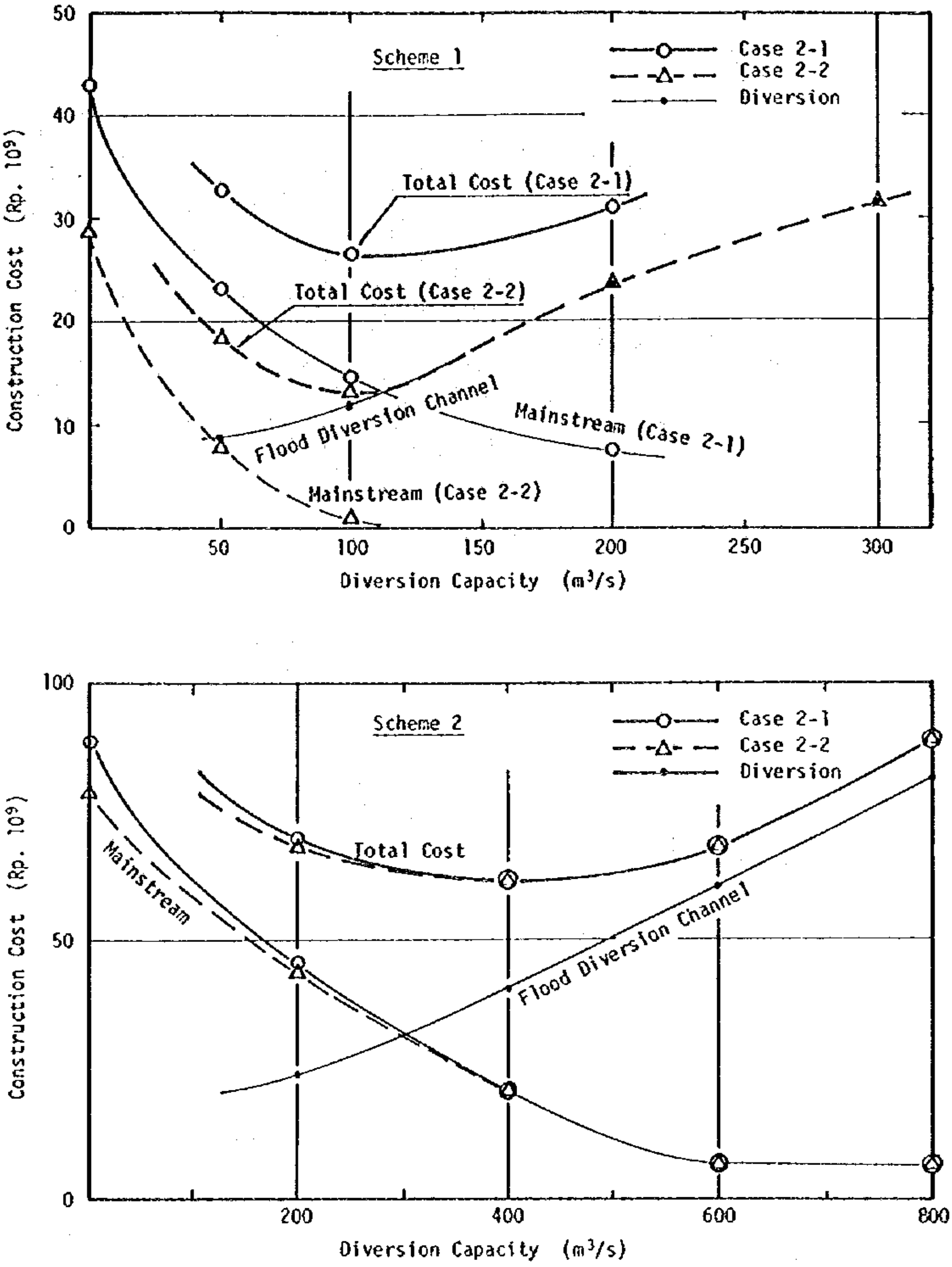
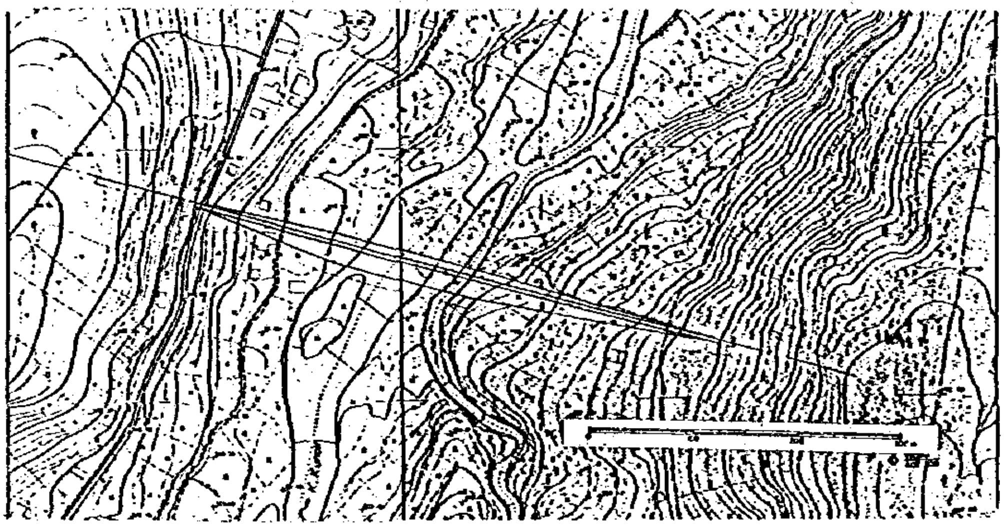
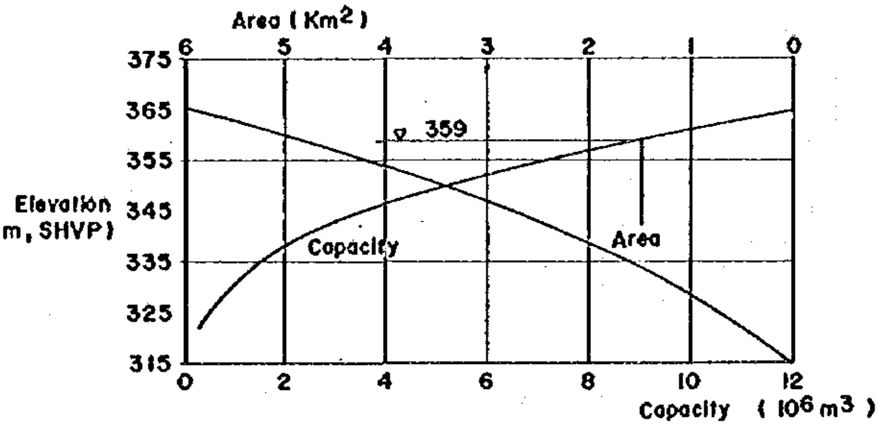


Fig. RC- 37 COST COMPARISON OF LTERNATIVE FLOOD DIVERSION CAPACITY

Location of Dam Axis.



Elevation - Capacity.



Dam body profile.

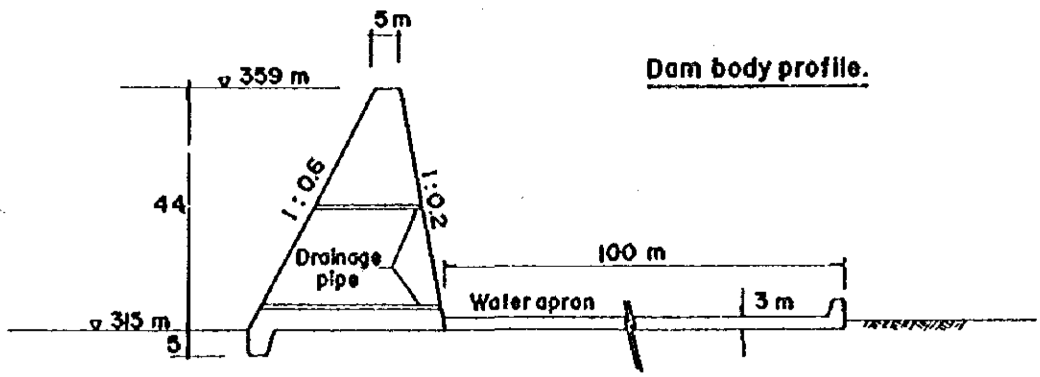


Fig. RC-38 GENERAL FEATURES OF PROPOSED KUNCIR DAM.

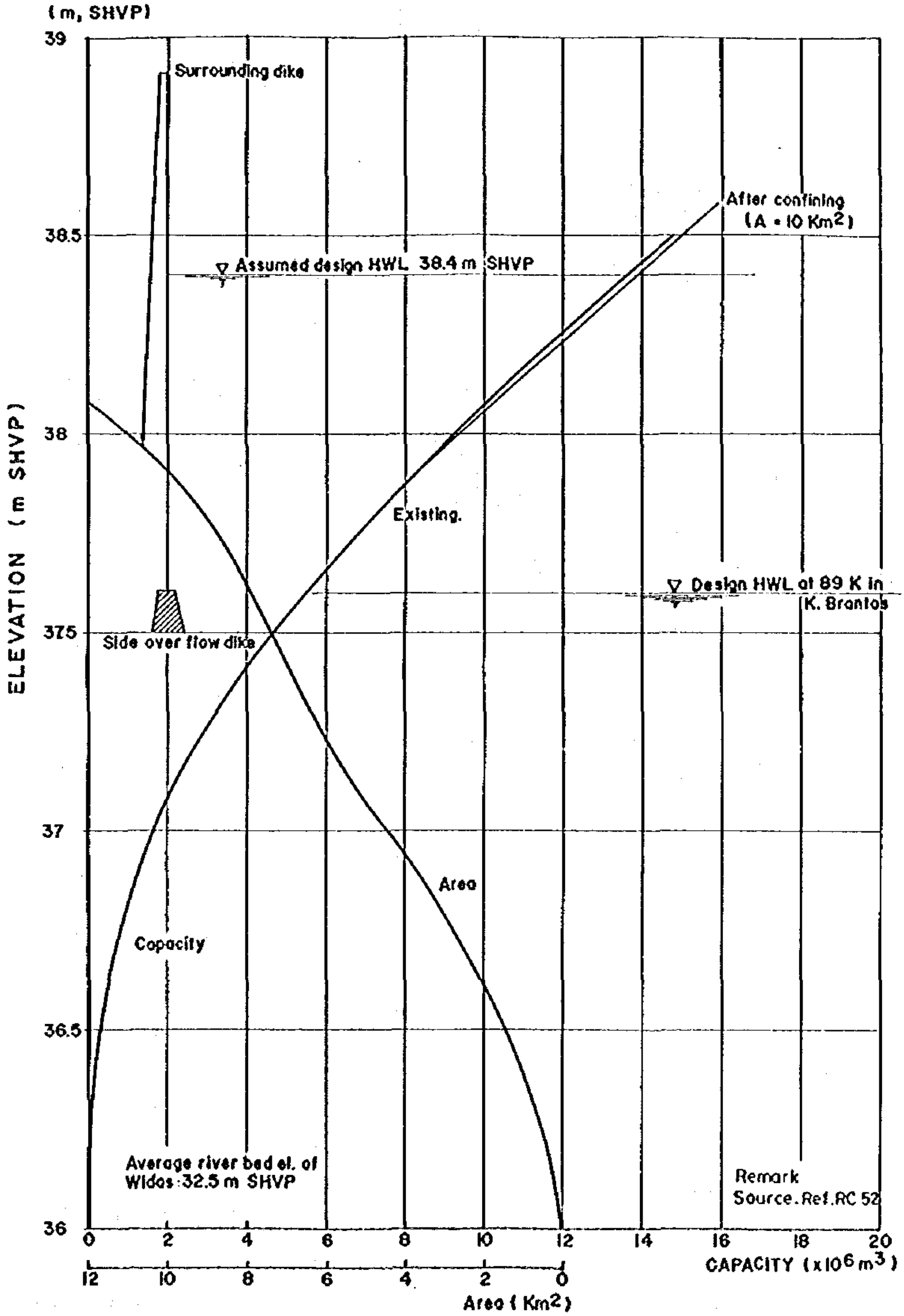


Fig. RC-39 (1) RELATIONSHIP AMONG AREA CAPACITY AND ELEVATION IN WIDAS RETARDING BASIN

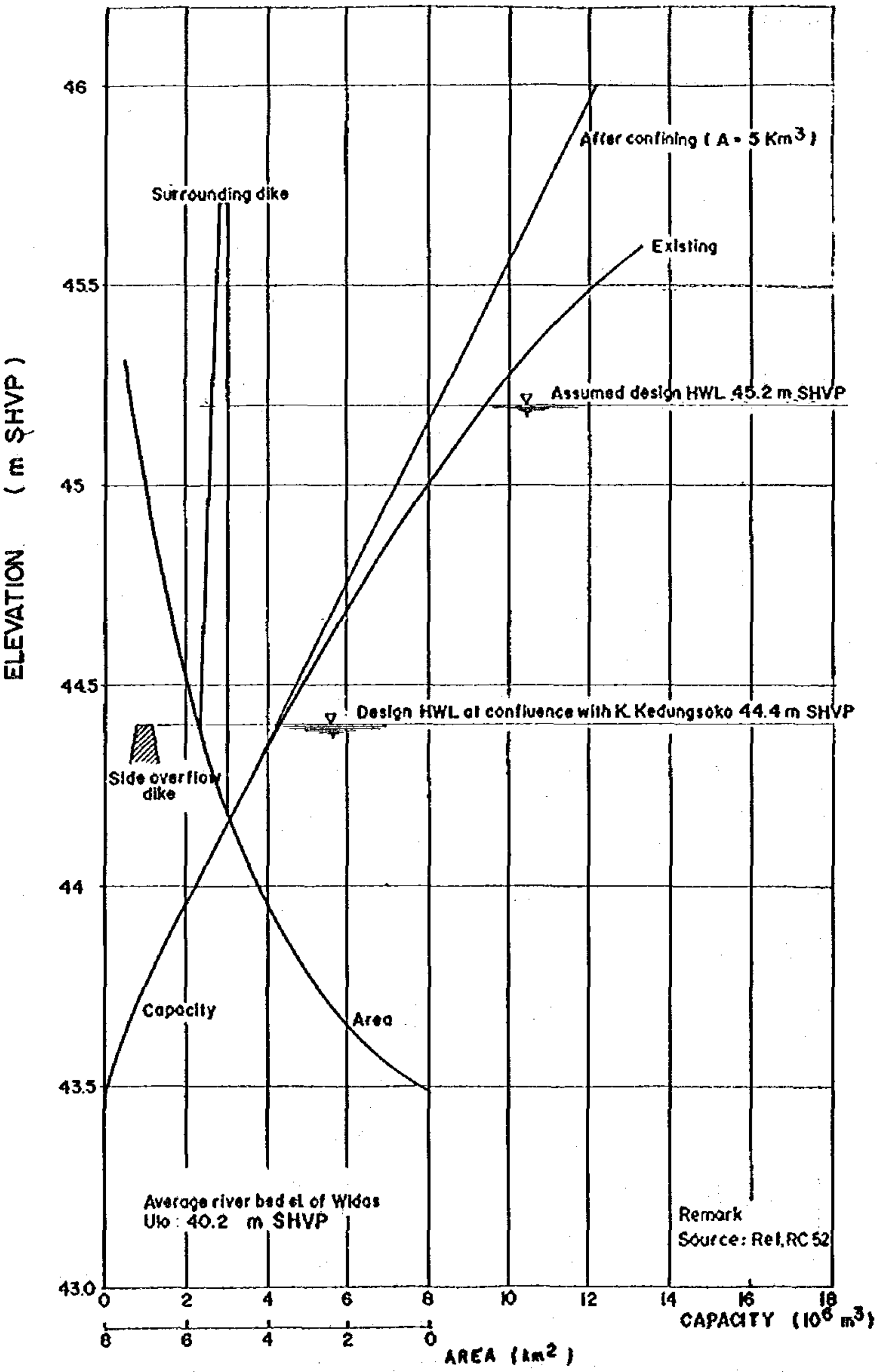


Fig. RC-ν.39 (2) RELATIONSHIP AMONG AREA CAPACITY AND ELEVATION IN ULO RETARDING BASIN

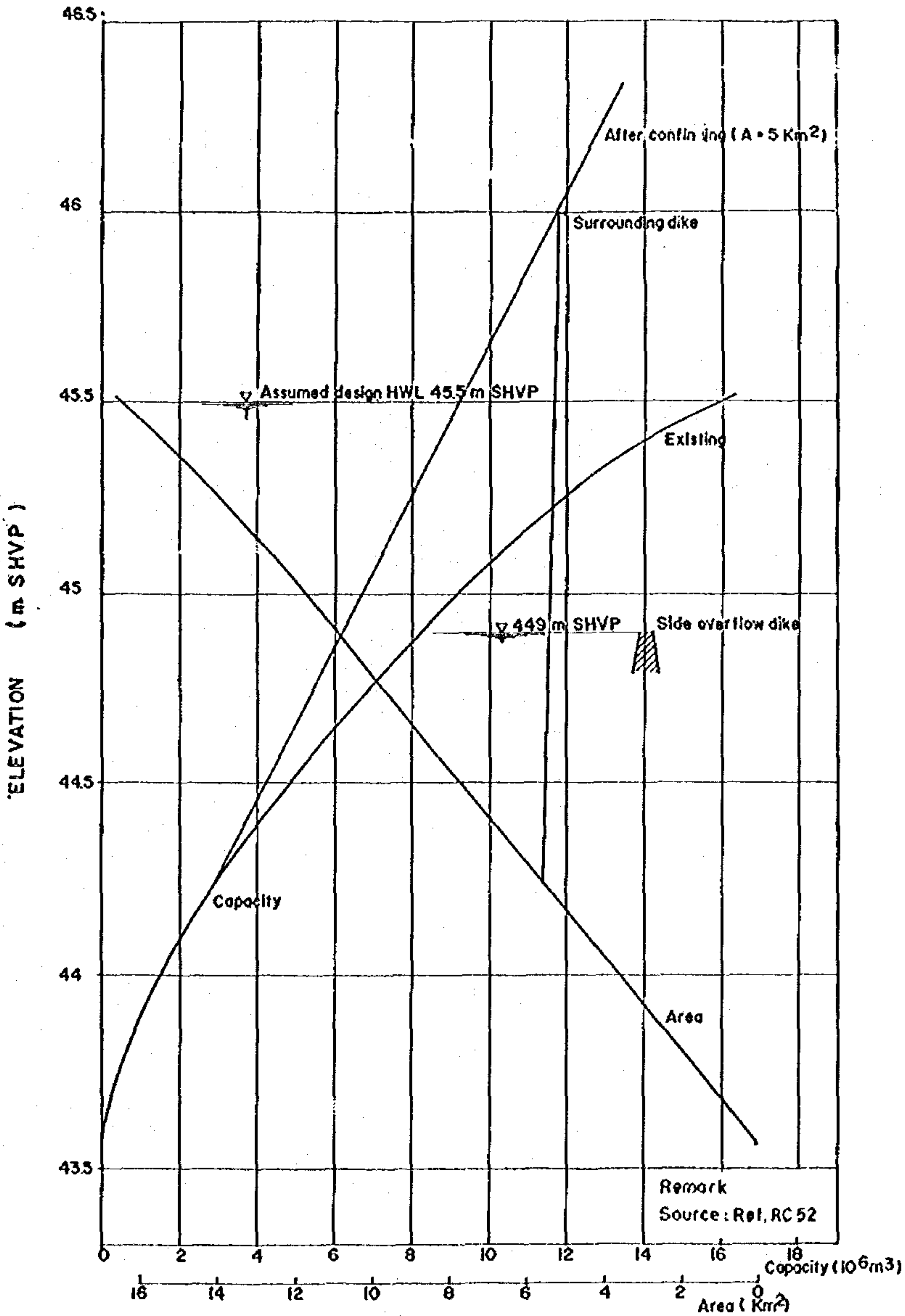


Fig. RC- 39 (3) **RELATIONSHIP AMONG AREA CAPACITY AND ELEVATION IN KEDUNGSOKO RETARDING BASIN.**

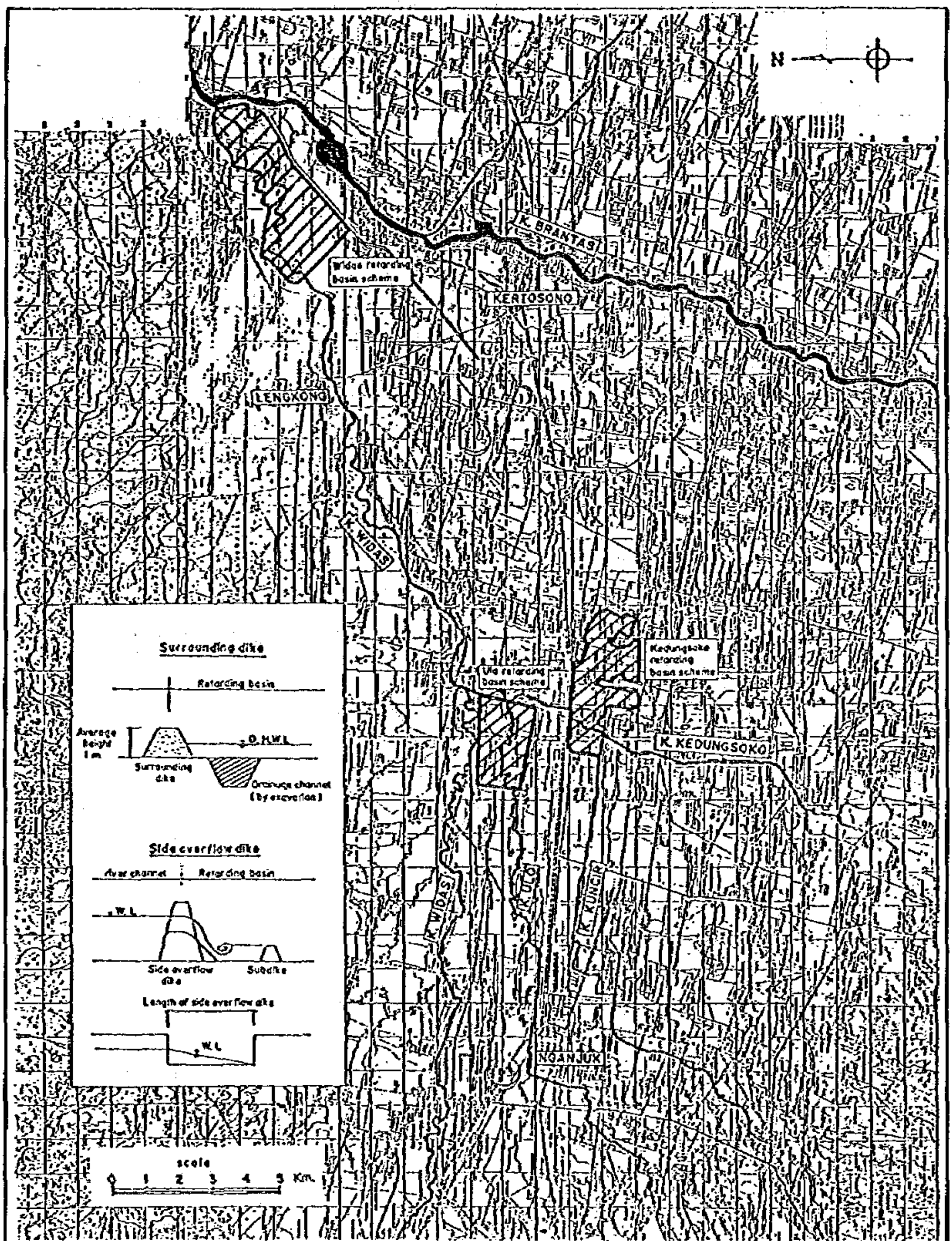


Fig. RC-40 RETARDING BASIN SCHEME IN THE K.WIDAS BASIN

ANNEX WS

WATERSHED MANAGEMENT STUDY

ANNEX WS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

NOTE WS-1 SOIL CONSERVATION

1. Soil Conservation

Taking into consideration decrease in the storage capacity in the Karangkates reservoir due to sedimentation, several experimental and demonstration plots were started since 2 to 4 years ago for obtaining data on soil erosion under different vegetation covers and conditions of terracing and for demonstration of effects of terracing to the inhabitants. The plots are at Dampit, Wajak, Wagir and Gabes in the upper Brantas basin and at Bantur and Donomulya in the southern hilly range as shown in Fig. WS-13.

The plots are operated by BRBDEO through the Brawijaya University and results are reported annualy. According to the reports, the following findings are presented in the reports.

For assessing the effect of soil conservation works, the following Universal Soil Loss is used;

$$A = \alpha \times R \times K \times L \times S \times C \times P$$

Where,
- A : avearge annual soil loss in Mg/ha (metric tons/ha)
- α : constant
- R : rainfall and runoff erodibility index
- K : soil-erodibility factor, which is average soil loss in t/a per unit erosion index for a particular soil (if K is Mg/ha; $\alpha = 0.1$)
- LS : topographic factor
- C : cropping-management factor, which is the ratio of soil loss for given conditions
- P : conservation practice factor, which is ratio of soil loss for a given practice to that for the slope farming.

The rain erosivity index (R) is obtained by the following equation which was improved by Utomo et.al. (1983).

$$R = 2.80 + 4.15 M$$

Where,
- R : Rain erosivity index
- M : Monthly rainfall (cm)

From the monthly rainfall shown in Table WS-10, the rain-erosivity index is estimated as shown in Table WS-11.

The soil erodibility index (K) is obtained by soil erodibility monograph after Wishmeir et.al. (1971), soil erodibility monograph is shown in Fig. WS-14. The soil erodibility index of the soils in the basin is estimated as follows;

Soil Type	K	Total Measurement
Grey regosol	0.22	2
Brown regosol	0.36	2
Association of yelowish brown andosol and brown regosol	0.11	5
Association of brown latosol and grey regosol	0.24	4
Brown andosol	0.21	4
Association of brown andosol and gley humus	0.24	4
All of brown andosol, yelowish brown andosol and litosol	0.08	3

Location	Value (K)	Class
Wagir	0.22	moderate
Donomulyo	0.14	low
Bantur	0.24	moderate
Wajak	0.12	low
Dampit	0.20	moderate
Gabes	0.10	very low

The topographic factor LS is given by the following equations;

$$L = (\ell/22)^2$$

and

$$S = \frac{(0.43 + 0.30s + 0.040\ s^2)}{6.574}$$

Where, x = a constant, 0.5 for slope 4 percent, 0.4 for 4 percent, and 0.3 for 3 percent.

ℓ = slope length in m,

s = field slope in percent

CP values are measured as shown below.

Location	Crop	Conservation Practice	Observation Period	R	K	LS	CP
Wagir	maize	W/O terrace	Nov.25-Feb.17	378.5	0.22	0.98	0.209
	maize	W/ terrace	- do-	378.5	0.22	0.98	0.101
Donomulyo	cassava	W/O terrace	Nov.25-Feb.21	376.5	0.14	0.95	0.200
	cassava	W/ terrace	- do -	376.5	0.14	0.95	0.120
Bantur	maize + cassava	W/O terrace	Nov.25-Feb.29	267.3	0.24	0.98	0.170
	maize + cassava	W/ terrace	- do -	267.3	0.24	0.99	0.083
Dampit	maize + cassava	W/O terrace	Nov.25-Feb19	308.0	0.20	0.95	0.168
	maize + cassava	W/ terrace	- do -	308.0	0.20	0.95	0.062
W a j a k	sweet	W/O terrace	Nov.25-Feb.22	368.0	0.12	0.95	0.223
	sweet	W/ terrace	- do -	368.0	0.12	0.95	0.097
G a b e s		raised bed	Nov.25-Feb.22	384.6	0.10	1.0	0.087
		W/ terrace	- do -	384.6	0.10	1.0	0.085

NOTE WS-2 SEQUENCE OF SABO AND REFORESTATION WORKS IN THE UPPER BRANTAS

Sediment inflow in the Sengguruh reservoir is examined in detail as shown in Fig. WS-15, in relation to the distribution of erodible areas in the Brantas and Lesti arms. The sediment yield rates are assumed at 3.94 mm/year in the Brantas arm and 8.72 mm/year in the Lesti arm. (further breakdown of 6.5 mm/year in the Main Report)

Table WS-12 shows changes in the trap efficiency in the Sengguruh reservoir according to the progress of sedimentation, in case of no sabo and reforestation works in the upstream area. The objective of the sabo and reforestation works is to elongate the reservoir life up to 50 years. Fig. WS-16 and 17 show variation of sediment inflow according to implementation of the works. Order of construction of sabo dams is from bigger storage capacity. Timing of construction of sabo dams is examined through trial and error. Finally, by implementation of the sabo and reforestation works as shown in Fig. WS-16 and 17, the sediment deposit in the reservoir can be controlled as shown in Fig. WS-18.

NOTE WS-3 Balance of Erupted Material

1. Sediment Yield from Lahar Area

The sediment yield from the Lahar area in a certain period can be calculated through estimation of the following value;

(1) Increase or decrease of river deposit in the river stretches concerned.

(2) Inflow of sediment into the river stretches from the upstream end and from the side.

(3) Outflow from the downstream end of the river stretches.

Then, the sediment yield from the Lahar area can be calculated as;

(a) + (o) - (b)

The following is citation from the study made by the Brantas Middle Reaches River Improvement Project.

The river bed movement in the main reaches of Brantas river is as shown in Fig. WS-19 and Table WS-13. The river deposit in the section between Kaulon and Jabon for 15 years after the 1951 eruption is estimated as follows; (see Table WS-14).

1951 - 1955	$22.88 \times 10^6\ m^3$
1956 - 1960	$2.34 \times 10^6\ m^3$
1961 - 1966	$3.58 \times 10^6\ m^3$
Total	$28.8 \times 10^6\ m^3$

The sediment volume transported downstream from the Lahar area which is composed of bed load, suspended load and wash load, has been estimated between Kaulon and Jabon. Brantas Middle Reaches River Improvement Project has formulated the equations showing the relations between the sediment loads and discharge using the sediment record from 1972 to 1977. The equation for each kind of sediment load is shown below.

Suspended load $qs = 2.323 \times 10^{-3}\ (HU)^{0.562}$

Wash load $Qw = 278 \times 10^{-7}\ Q^{2.156}$

Bed load $qb = (0.5297 \times ToU) / (SG/P - 1) / Pg$

Where, Qs : Suspended load (m^3/sec/m) - (see Fig. N2-1)

Qw : Wash load (m^3/sec) - (see Fig. N2-2)

qb : Bed load (m^3/sec/m) - (see Fig. N2-3)

H	:	Water depth	(m)
U	:	Friction velocity	(m^3/sec)
Q	:	Discharge	(m^3/sec)
To	:	Shearing stress on bed	
SG	:	Spesific gravity	(m^3/sec)
P	:	Density of water	
g	:	Gravity acceleration	(m/sec^2)

Wash load is defined as a fine sand smaller than 0.1 mm in diameter.

The sediment inflow from the area outside the Lahar area is estimated as shown in Table WS-15.

The estimated sediment inflow and outflow to and from the stretches between Kaulon and Jabon is as shown in Table WS-16. From this table, the sediment yield can be calculated for the period from 1951 to 1965, as follows;

Deposit Increase) + Outflow from Jabon) - Inflow from non-Lahar area)

$$28.8 \times 10^6\ m^3 + 24.6 \times 10^6\ m^3 + 70.5 \times 10^6\ m^3 - 19.95 \times 10^6\ m^3$$

$$- 48.30 \times 10^6\ m^3 = 55.65 \times 10^6\ m^3$$

Bed and suspended loads	;	$33.45 \times 10^6\ m^3$
Wash load	;	$22.20 \times 10^6\ m^3$

2. Balance of Erupted Materials

For planning of the debris control in the southern and western areas of Mt. Kelud and the river improvement in the Brantas Middle Reaches, balance of the material erupted from Mt. Kelud has been examined by Mt. Kelud Project and BRBDEO. The results are as shown in Fig. WS-20 and WS-21. Procedures and assumptions for these balances are reffered to RECCOMENDATION REPORT ON SEDIMENT AND DEBRIS CONTROL IN THE BRANTAS RIVER AND THE AREA AFFECTED BY MT. KELUD ERUPTION, as explained hereunder.

(1) Modelled cycle period of one eruption

Taking the average of intervals of the recent three eruptions, 15 years is set as the modelled cycle period.

(2) Volume of eruption products

Taking the average of the total estimated volume of the recent three eruptions, $200 \times 10^6\ m^3$ is set as the modelled volume of one eruption.

(3) Classification between ladu/lahar materials and pyroclastics

Based on the investigation by GOI on the 1966 eruption, two thirds of the total volume are assumed as ladu and lahar materials and the remaining as pyroclastics. Then,

Ladu and lahar materials	:	130×10^6 m^3
Pyroclastics	:	70×10^6 m^3

(4) Distribution of pyroclastics

BRBDEO assumed that two thirds of the total pyroclastics fall uniformly in the area within 25 km from the crater and the remaining in the area between 25 and 50 km. From this assumption, the pyroclastics are assumed to fall in 36.8×10^6 m^3 in the lahar area and in 33.2×10^6 m^3 in the area outside of the lahar area.

(5) Total amount in lahar area

Adding the pyroclastics of 36.8×10^6 m^3 to the ladu and lahar materials of 130×10^6 m^3, the total amount in the lahar area is estimated at 166.8×10^6 m^3.

(6) Sediment carried off to Brantas river

Based on the sediment discharge analysis for the period from 1951 to 1966 as previously mentioned, the sediment volume carried off to Brantas river is estimated at 59.1×10^6 m^3 in total, cosisting of the wash load of 25.6×10^6 m^3 and the bed and suspended load of 33.5×10^6 m^3. Difference of 3.6×10^6 m^3 between 22.0×10^6 m^3 and 25.6×10^6 m^3 in the wash load comes from inclusion of the upstream area of Konto and Semut river, outside of lahar area.

(7) Amount retained in lahar area

Subtracting the sediment carried off to Brantas river from the total amount in the lahar area, the amount retained temporarily and/or permanently in the lahar area is estimated at 107.7 x 10 10^6 m^3.

(8) Uncontrollable amount

BRBDEO assumes that one third of the total eruption products will remain permanently in the lahar area, reffering to the cases in Japan. This amount will not come out to the control facility sites and is named as "Uncontrollable deposit".
The controllable deposit which will move to the control facility sites is calculated by subtracting the uncontrollable deposit from the amount retained in the lahar area.

(9) Amount brought to deposit zone

Summing up the bed and suspended load of 33.5×10^6 m^3 and the controllable deposit of 42.7×10^6 m^3, the amount broght to the deposit zone is estimated at 76.2×10^6 m^3.

(10) Amount carried out off to Brantas river

At the time of preparation of balance, the debouches of rivers flowing out from the lahar area were narrow and shallow owing to sedimentation and majority of the runoff in the upstream of the rivers was diverted for irrigation use. Taking into account these conditions, it was difficult to expect large sediment discharge capacity at each debouch. Then, assuming possible channel improvement at the debouches, the following annual sediment discharge capacities are taken;

		with channel improvement
K. Lekso/K.Semut	0.06×10^6 m^3	
K. Putih	0.06	
K. Badek	0.08	+ 0.08×10^6 m^3
K. Gedek		0.10
K. Pantungkobang	0.04	
K. Sukorejo	0.02	
K. Ngobo	0.03	+ 0.12
K. Serinjing	0.03	
K. Konto	0.04	+ 0.11
Total	0.36	0.41

Then, the total amount to be carried off to Brantas river in the modelled cycle period is calculated at 11.6×10^6 m^3.

(11) Deposit retained in deposit zone

Then, the deposit to be ratined in the deposit zone or amount to be controlled by the sabo facilities is calculated at 64.6×10^6 m^3.

Distribution of volcanic debris among the major 5 rivers is estimated based on GOI investigation data on the 1966 eruption as shown in Table WS-17, and as summarized below.

DISTRIBUTION OF VOLCANIC DEBRIS

River	Distribution (%)
K. Semut	17.5
K. Putih	24.9
K. Badak	31.9
K. Ngobo	16.2
K. Konto	9.5

The sediment balance during 15 years in lahar area divided into main 5 tributaries has been proposed as shown in Table WS-21. The amount to be controlled by the control facilities then, becomes 64.6 x 10^6 m^3 per once modelled cycle period.

3. Check of Balance of 1966 Eruption

Check of the balance of materials erupted by the 1966 eruption is made hereunder.

The riverbed movement in the period from 1977 to 1983 is as shown in Table WS-18. From this table, the changes in the river deposit are calculated as shown in Table WS-19. Combined with the changes in the river deposit before 1966, the following figures are obtained.

1966 - 1970	9.80 x 10^6 m^3
1970 - 1977	-4.6 x 10^6 m^3
1977 - 1983	-8.96 x 10^6 m^3
Total	-3.76 x 10^6 m^3

Of the above, decrease in 1977 - 1983 is considered to include the dredged volume in 1981, 1982 and 1983 by the Middle Reaches Project. The dredged volume is reported as 4.37 x 10^6 m^3 in total (0.57 x 10^6 m^3 in 1981, 1.87 x 10^6 m^3 in 1982 and 1.93 x 10^6 m^3 in 1983).

The sediment discharges through the Jabon site are calculated using the discharge - sediment discharge relationships and the ten-day mean discharge at Jabon as shown in Table WS-20. The total sediment inflow into the stretch between Kaulon and Jabon is calculated as sum of the change in the river deposit and the sediment discharge through Jabon. This figure should not be minus. Then, if minus value appears, it is assumed as zero.

The sediment inflow from the lahar area is calculated by subtracting the sediment inflow from the area outside of the lahar area. This figure also should not be minus. If minus volume appears, it is assumed as zero. The results are as shown in Table WS-21. The sediment discharge from the lahar area after the 1966 eruption is estimated at 27.54 x 10^6 m^3 of the bed and sediment loads and 25.65 x 10^6 m^3 of the wash load.

According to Mt. Kelud Project, the sediment deposit kept by the lahar pockets, sabo dams, etc. is reported as 14.55 x 10^6 m^3 as of the end of 1983.

Using the above figures, the sediment balance after the 1966 eruption is drawn as shown in Fig. WS-22. In this case, the uncontrollable deposit is calculated as an end result.

NOTE WS-4 REFERENCE

LIST OF REFERENCE (1/2)

Number	Name of Report	Author	Date of Issue
WS 01	MT. KELUD VOLCANIC DEBRIS CONTROL PROJECT FEASIBILITY REPORT	DGWRD	May 1969
WS 02	REPORT ON THE FIELD STUDY IN GN. KELUD INTERIM REPORT PART-II	K. TAKANASHI (Colombo Plan Expert)	Aug. 1978
WS 03	REPORT ON THE BASIC CONCEPTS FOR DEBRIS CONTROL WORK IN GN. KELUD PROJECT AREA	K. TAKANASHI (Colombo Plan Expert)	Nov. 1978
WS 04	RECOMMENDATION REPORT ON SEDIMENT AND DEBRIS CONTROL IN THE BRANTAS RIVER AND IN THE AREA AFFECTED BY MT. KELUD ERUPTION (REVISED)	NIPPON KOEI CO., LTD. IN ASSOCIATION WITH C.T.I. ENGINEERING CO., LTD.	Jan. 1979
WS 05	SANDPOCKETS IN PROYEK GUNUNG KELUD (PART - I)	K.S. DJASMANI BIE K. TAKANASHI	Mar. 1980
WS 06	REPORT ON THE TECHNICAL COOPERATION IN THE FIELD OF SABO WORKS AT MT. KELUD PROJECT IN INDONESIA (FINAL REPORT)	T. TAKANASHI (Colombo Plan Expert)	Mar. 1981
WS 07	VOLCANIC ACTIVITY OF MOUNT KELUD AND ASSOCIATED DISASTER PREVENTION WORKS	VOLCANIC DISASTER PREVENTION PROJECT OF MOUNT KELUD	May 1983
WS 08	KANTONG LAHAR DI DAERAH LAHARAN GUNUNG KELUD	PROJECT PENANG-GULANGAN AKIBAT BENCANA ALAM GUNUNG KELUD	Oct. 1983
WS 09	RENCANA PELITA IV	PROYEK PENANGAKIBAT LETUSSN GUNUNG KELUD	May 1984
WS 10	THE BASIC CONCEPT FOR OVERALL PLAN IN MT. KELUD PROJECT	VOLCANIC DISASTER PREVENTION PROJECT OF MOUNT KELUD	1984

LIST OF REFERENCE (2/2)

Number	Name of Report	Author	Date of Issue
WS 11	LAPORAN AKHIR PROYEK SABO DAM TOKOL	BRBDO	Feb. 1979
WS 12	LAPORAN AKHIR PROYEK SABO DAM MENDALAN	BRBDO	Oct. 1979
WS 13	STUDI PENGEMBANGAN DAN PENGENDALIAN EROSI KARANGKATES BAGIAN HULU PROYEK BENDUNGAN KARANGKATES	UNIVERSITAS BRANWIJAYA	Apr. 1982
WS 14	PENELITIAN VEGETASI, HIDRO LOGY DAN SEDIMENTASI PROYEK BENDUNGAN KARANGKATES	UNIVERSITAS BRAWIJAYA	Sept. 1983
WS 15	PETAK PERCONTOHAN PENGEM-BANGAN SUMBER-SUMBER AIR DAN PENGENDALIAN EROSI DI GUBUK KLAKAH KABUPATEN MALANG	BADAN PELAKSANA PROYEK INDUK PENGEM-BANGAN WILAYAH SUNGAI KALI BRANTAS	
WS 16	PENELITIAN HYDRO-OROLOGI DI PROYEK BENDUNGAN SELOREJO (BUKU I)	LAPORAN KEMAJUAN	1983
WS 17	PENELITIAN HIDRO-OROLOGI DI PROYEK BENDUNGAN KARANGKATES (BUKU I - BUKU III)	LAPORAN AKHIR	1983
WS 18	PENELITIAN VEGETASI, HIDROLOGI DAN SEDIMENTASI PADA PROYEK PENGEMBANGAN KARANGKATES HULU	UNIVERSITAS BRAWIJAYA	Jun. 1984
WS 19	PENELITIAN VEGETASI, HIDROLOGI DAN SEDIMENTASI PADA PROYEK PENGEMBANGAN KALI KONTO HULU	LAPORAN AKHIR	Jun. 1984
WS 20	EVALUATION OF FOREST LAND KALI KONTO UPPER WATERSHED, EAST JAVA (VOLUME I - VOLUME VI)	RESEARCH INSTITUTE FOR NATURE MANAGE-MENT LOERSUM, THE NETHER-LAND	Apr. 1984

Table WS-1 REFORESTATION IN THE K. LESTI BASIN

(Ha)

Management area	PELITA I (1969-'74)	II ('74-'79)	III (79-'84)	IV ('84-89)	Naturalforest
Poncokusumo	10.5	42.1	101.0	53.0	579.2
Bambangan Utara	68.0	82.0	72.0	43.5	2214.5
Bambangan Selatan	41.0	71.5	169.0	112.8	2361.7
Dampit	82.5	18.0	105.8	308.0	3013.7
Total	208.0	213.6	447.8	517.8	8169.1

Note : Ref. Fig. WS-3.

Source : Information from Perum Perhutani Unit II Jawa Timur.

Table WS-2 SPECIES OF REFOREST AREA IN THE K. LESTI BASIN

(%)

Kind of tree	Poncokusumo	Bambangan Utara	Bambangan Selatan	Dampit	Total
Tectona grandis	-	-	-	6.17	6.17
Pinus SPP	-	-	-	0.96	0.96
Swietenia madagoni	4.26	5.48	5.06	6.22	21.02
Agathis Splp	-	1.93	-	-	1.93
Michelia Velutina	15.11	10.07	15.17	12.44	52.79
Pterospermum SPP	0.77	3.14	2.60	2.92	9.43
Calliandra calytirrus	-	1.18	4.76	-	5.94
Others	0.21	0.39	0.39	0.77	1.76
Total	20.35	22.19	27.98	29.48	100.

Source : Information from Perum Perhutani Unit II Jawa Timur.

Table WS-3 RECORD OF ERUPTION OF G. KELUD SINCE YEAR 1000

Year of Eruption	Volume of Crater Water	Erupted Materials	Lahar Travel Balance	Damage
1000				
1311				
1334				
1376				
1385	No data			
1395				
1411				
1451				
1462				
1481				
1586				Life; 10,000
May 1, 1752				
Jun. 10, 1771	No data			
June 5, 1891				
Oct. 13, 1826				65 desa
1835	No data			
May 16, 1848				Life 21, 11 desa Coffee tree 100,000
Jan. 3, 1964				Life; many
May 22, 1901				Life; many
May 19, 1919	$38 \times 10^6 m^3$	$323 \times 10^6 m^3$	37.5 km	Life; 5,110, 104 desa 9,000 houses, 1,571 cattle 135 km^2 - crop land
Aug. 31, 1951	$1.8 \times 10^6 m^3$	$200 \times 10^6 m^3$	6.5 km	Life; 7 70 km^2 - crop land
Apr. 26, 1966	$20.5 \times 10^6 m^3$	$90 \times 10^6 m^3$	31 km	Life; 286, 138 desa 2,620 houses, 21 bridges 86 dams 11,581 km^2 crop land

Table WS-4 DESIGN SEDIMENT CAPACITY

(10^6 m^3)

Name of River	Sabo dam		Check dam		Consolization dam		Lahar pocket		Total
	Nos	Capacity	Nos	Capacity	Nos	Capacity	Nos	Capacity	
K. Konto	1	0.58	5	0.032	1	0.007	2	1.31	1.93
K. Serinjing	-	-	3	0.095	2	0.044	1	0.32	0.46
K. Ngobo	-	--	9	0.72	-	-	1	1.12	1.84
K. Dermo + Toyoaning	-	-	-	-	10	0.12	-	-	0.12
K. Sukorejo	-	-	1	0.02	-	-	-	-	0.02
K. Petung Ko-bong	-	-	1	0.02	-	-	-	-	0.02
K. Gedog	-	-	1	0.09	1	0.007	1	0.15	0.167
K. Badak + Termas + Jatiplen	1	0.28	2	0.061	6	0.35	2	8.45	9.14
K. Putih	1	0.5	1	0.032	5	0.092	1	2.57	3.19
K. Semut	1	0.47	-	-	4	0.1	1	1.66	2.23
K. Lekso	-	-	2	0.29	-	-	-	-	0.29
Total	4	1.33	25	1.279	29	0.718	9	15.58	19.407

Source : WS 12

Table WS-5 SEDIMENT VOLUME EXISTING LAHAR POCKETS AND OTHER STRUCTURES

Area	Name	Completed (Y)	Design capacity (10^6 m^3)	Present retained (m^3)	Volume (%)
1. Lahar pocket					
K.Konto	Badas	1977	0.665	355,133	53
K.Konto	Rolag 70	1979	0.645	416,217	64
K.Serinjing	K.Serinjing	1973	0.32	227,500	71
K.Ngebo	Pulo	1970	1.12	839,882	75
K.Gedog	Gedog	1970	0.15	131,215	87
K.Badak	Salam	1970	4.69	3,340,845	71
K.Jatiplen	Jatilengger	1968	3.76	2,821,550	75
K.Putih	K.Putih	1971	2.57	1,985,480	77
K.Semut	K.Semut	1972	1.66	1,251,985	75
Sub-total			15.58	11,369,788	73
2. Other structure			3.83	3,183,542	83
Total			19.41	14,553,330	75

Source : 1 WS 10
2 Information from Project of G. Kelud.

Table WS-6 LAND USE IN THE UPPER KALI KONTO BASIN

Land categories	Area (ha)	Propotional extent (%)
1. Forest land		
Natural forest	12,975	54.51
Reforest area	2,465	10.36
Sub-total	15,400	64.87
2. Upland field		
Upland field with annual crops	3,783	15.89
Upland field with perennial crops	757	3.18
Sub-total	4,500	19.07
3. Paddy field		
Technical irrigation	748	3.14
Semi-technical irrigation	678	2.85
Traditional irrigation	368	1.55
Sub-total	1,794	7.54
4. Grass land	4	0.02
5. Homestead/settlement	1,268	5.33
6. Miscellaneous	754	3.17
Total	23,800	100

Source : WS - 22

Table WS-7 EXISTING SABO FACILITIES IN THE UPPER K.KONTO BASIN

Name of facilities		Completed (y)	Design storage capacity (m^3)	Existing sediment volume (m3)	Remarks
Sabo dam					
Tokol		1975	183,800	187,600	K. Konto
Sub-total			183,800	187,600 .	
Check dam					
K. Konto					
1. Mantung	1	1973	35,025	35,025	
2.	2	1973	50,400	50,400	
3.	3	1973	8,550	8,550	
4.	4	1973	39,200	39,200	
5.	5	1973	65,080	65,080	
6. Lebaksari	1	1973	52,650	52,650	
7.	2	1973	49,800	49,800	
8.	3	1973	15,840	15,840	Heightening 1978
9.	4	1973	92,245	92,255	1980
10. Kedungrejo	1	1973	23,100	23,100	1978
11.	2	1973	64,350	64,350	1978
12.	3	1973	95,555	95,555	1980
13.	4	1973	51,330	51,330	1978
14.	5	1973	33,075	33,075	1978
15.	6	1973	21,750	21,750	1980
16. Ngeprih	1	1973	10,555	10,555	1978
17.	2	1973	31,620	31,620	1978
18.	3	1973	26,220	26,220	
19. Kaweden		1973	63,375	63,375	1980
20. Tokol	1	1979	1,125	1,125	
21.	2	1979	5,340	5,340	
22.	3	1979	23,840	23,840	
23.	4	1981	12,500	12,500	
24.	5	1979	22,835	22,835	1981
25.	6	1979	52,205	52,205	
Sub-total			947,575	947,575	
K. Pinjal					
26. Pinjal	1	1981	2,220	2,210	
Sub-total			2,210	2,210	
K. Kwayangan					
27. Kwayangan	I	1973	16,720	16,720	Heightening 1979
28.	II	1973	27,940	27,940	
29.	III	1973	24,192	24,192	
30.	IV	1973	18,910	18,910	
Sub-total			87,762	87,762	
Total			1,221,347	1,225,147	

Table WS-8 LAND USE IN ERODIBLE AREA IN THE UPPER K. KONTO BASIN

Land use in erodible area	Area (km^2)	Percent (%)
Reforest area	8.78	47.59
Upland field	7.67	41.57
Homestead / settlement	1.02	5.53
Paddy field	0.98	5.31
Total	18.45	100.0

Table WS-9 SPECIES OF REFOREST AREA IN THE UPPER KALI KONTO BASIN

Management area / Species	Kawi Utara (ha)	Kawi Barat (ha)	Kelud L. (ha)	Anjasmoro (ha)	Total (ha)	Total (%)
a. Pulp wood						
Pinus merkusii	178	80	258	231	747	30
b. Fuel wood						
Calliandra calothyrsus	105	2	-	407	514	21
c. Timber						
Agathis loranthifolia	28	167	-	90	285	12
Swietenia spp.	-	51	203	4	258	10
Eucalyptus deglupta	207	-	-	12	219	9
Maesopsis eminii	4	22	157	9	192	8
Anthocephalus cadamba	-	-	120	3	123	5
Other species	24	5	90	8	127	5
TOTAL	546	327	828	764	2,465	100

Table WS-10 MEAN MONTHLY RAINFALL IN THE K. LESTI BASIN

(mm)

Month	Mean monthly rainfall		
	K. Lesti basin	Upper part of K.Lesti basin	Lower part of K.Lesti basin
JAN.	277.29	293.60	254.35
FEB.	257.78	261.74	252.21
MAR.	252.62	264.65	235.70
APR.	186.89	170.14	210.44
MAY	158.00	156.68	159.85
JUN.	67.31	71.43	61.49
JUL.	45.99	51.29	38.55
AUG.	17.35	19.39	14.49
SEP.	58.25	57.84	58.82
OCT.	124.01	125.25	122.26
NOV.	247.29	259.87	229.63
DEC.	291.23	296.15	284.30
Total	1,984.00	2,028.03	1,922.09

Remarks : Rainfall data from 1974 to 1983

Table WS-11 AVERAGE RAIN EROSIVITY IN 10 YEARS

Rata-rata Erosivitas Hujan di Daerah Penelitian selama 10 tahun.

Month	Rain Erosivity Index					
	Wagir	D. Mulyo	Bantur	Dampit	Wajak	Gabes
Jan.	139.08	156.27	142.98	138.00	151.12	150.33
Feb.	127.44	126.72	94.14	116.63	128.34	107.33
Mar.	104.06	119.66	91.90	117.09	115.05	113.81
Apr.	86.92	44.38	45.05	79.99	107.71	50.07
May	49.15	66.71	70.24	69.78	84.14	40.27
June	16.04	34.01	34.01	40.60	30.23	15.20
July	15.46	13.38	22.22	19.08	18.77	11.80
Aug.	11.85	9.31	6.28	10.89	9.35	11.22
Sept.	28.98	19.85	32.14	26.91	42.01	15.29
Oct.	43.51	64.14	78.74	45.13	74.05	41.18
Nov.	98.49	61.02	85.30	96.09	98.66	76.05
Dec.	112.94	99.74	91.85	107.63	95.67	93.72
Total	833.92	815.19	794.85	867.82	955.1	726.27

Table WS-12 TRAP EFFICIENCY OF THE SENGGURUH RESERVOIR

Period	Capacity $(10^6 m^3)$ (1)=21.5(7)	Inflow $(10^6 m^3/Y)$ (2)	C/I (3)=(1)/(2)	Trap efficiency (%) (4)	Sedimed inflow $(10^6 m^3/Y)$ (5)	Accumulated sediment inflow $(10^6 m^3)$ (6)	Deposit volume $(10^6 m^3/Y)$ (7)=(4)x(5)	Accumulated deposit volume $(10^6 m^3)$ (8)
0-1	21.5	1740.79	0.0124	61	2.26		1.379	1.379
1-2	20.121	1740.79	0.0116	60	2.26	4.52	1.356	2.735
2-3	18.765	1740.79	0.0108	58.5	2.26	6.78	1.322	4.057
3-4	17.443	1740.79	0.01	57	2.26	9.04	1.288	5.345
4-5	16.155	1740.79	0.0093	55	2.26	11.3	1.243	6.588
5-6	14.912	1740.79	0.0086	54	2.26	13.56	1.22	7.808
6-7	13.692	1740.79	0.0079	52	2.26	15.82	1.175	8.983
7-8	12.517	1740.79	0.0072	50	2.26	18.08	1.13	10.113
8-9	11.387	1740.79	0.0065	47.5	2.26	20.34	1.047	11.187
9-10	10.313	1740.79	0.0059	45.5	2.26	22.6	1.028	12.215
10-11	9.285	1740.79	0.0053	43	2.26	24.86	0.972	13.187
11-12	8.313	1740.79	0.0048	41	2.26	27.12	0.927	14.114
12-13	7.386	1740.79	0.0042	38	2.26	29.38	0.859	14.973
13-14	6.527	1740.79	0.0037	34.5	2.26	31.64	0.780	15.753
14-15	5.747	1740.79	0.0033	32	2.26	33.9	0.723	16.476
15-16	5.024	1740.79	0.00029	29	2.26	36.16	0.655	17.131
16-17	4.369	1740.79	0.0025	25	2.26	38.42	0.656	17.696
17-18	3.804	1740.79	0.0022	22	2.26	40.68	0.497	18.193
18-19	3.307	1740.79	0.0019	18	2.26	42.94	0.407	18.6
19-20	2.90	1740.79	0.0017	15	2.26	45.2	0.339	18.939
20-21	2.561	1740.79	0.0015	12	2.26	47.46	0.271	19.21
21-22	2.290	1740.79	0.0013	7.5	2.26	49.72	0.170	19.38
22-23	2.120	1740.79	0.0012	5	2.26	51.98	0.113	19.493
23-24	2.007	1740.79	0.0012	5	2.26	54.24	0.117	19.606
24-25	1.894	1740.79	0.0011	3	2.26	56.5	0.068	19.674
25-26	1.826	1740.79	0.001	0	2.26	58.76	-	-

Table . WS-13 RIVER BED MOVEMENT

(Unit: EL. in meter)

Gauge / Year	Kaulon	Golondong	Rejotangen	Pankel	Jeli	Jongbiru	Minggiran	Kertosono	Ploso	Kesmaben	Terusan (Jabon)	Porong	Remarks
	(D=10.7, W=50)	(D=14.5, W=70)	(D=15.5, W=150)	(D=15.0, W=165)	(D=27.7, W=125)	(D=11.2, W=150)	(D=16.0, W=125)	(D=23.1, W=140)	(D=15.3, W=160)	(D=13.8, W=150)	(D=32.0, W=130)		
1950	149.90	124.70	107.50	90.50	76.60	55.95		39.30	26.90			0.60	
1951	150.20	125.00	107.80	90.55	76.80	56.05		39.55	27.00			0.80	
1952	150.92	126.52	108.30	90.90	77.30	56.35		40.10	27.20			1.79	
1953	150.22	126.87	108.50	91.40	77.27	56.80		40.36	27.40			1.89	
1954	150.92	126.40	108.80	91.26	77.32	56.66		40.40	27.60			2.15	
1955	151.05	126.11	108.50	91.40	77.20	56.68		40.64	27.90			2.50	
1956	150.92	126.50	109.00	91.70	76.90	56.63		40.57	27.80			2.60	
1957	150.91	126.31	109.20	91.48	76.74	56.56	49.41	40.40	27.61	21.25	16.61	2.62	
1958	150.58	126.30	109.40	91.74	77.04	56.56	49.65	40.87	27.54	21.37	16.60	2.69	
1959	150.60	126.18	109.60	91.61	77.10	56.71	49.40	40.97	27.37	21.15	16.64	2.60	
1960	150.51	125.99	109.80	91.64	77.40	56.70	49.61	41.25	27.21	21.03	16.64	2.63	D : Distance (km)
1961	150.64	125.68	109.70	91.65	77.27	56.94	49.80	41.04	27.00	21.21		2.71	
1962	150.50	126.20	109.60	91.60	77.16	56.64	49.77	40.46	27.42	20.91		2.75	W : River width (m)
1963	150.50	126.10	109.60	91.69	77.17	56.81	49.67	41.25	27.42	21.24		2.80	
1964	150.30	126.21	109.40	91.42	77.10	56.95	49.92	40.45	27.31	21.44		2.81	
1965	150.18	126.56	109.88	91.20	77.31	57.23	50.00	41.10	27.55	21.08		2.90	o : Assumed figure
1966	150.37	127.88	109.60	91.37	77.48	56.81	49.90	41.46	27.72	21.98	16.91	2.95	
1967	150.50	128.52	109.70	91.57	77.31	57.14	49.95	40.66	27.89	21.93	16.68	3.10	
1968	150.90	127.81	110.00	91.45	77.72	57.12	50.56	41.30	28.64	21.55	16.92	3.50	
1969	150.55	128.25	109.61	91.53	78.22	57.31	50.05	42.18	28.30	22.28	16.96	3.79	
1970	150.21	128.24	110.08	91.66	78.25	57.39	50.10	42.16	28.12	21.93	16.76	3.96	
1971	149.88	128.21	109.94	91.61	78.06	57.33	49.78	41.99	28.33	21.24	o 16.88	o 3.50	
1972	150.41	128.08	109.97	o 91.60	o 77.98	57.34	49.98	o 41.85	27.86	21.12	17.01	o 3.00	
1973	150.53	126.79	110.67	91.57	77.90	57.58	49.97	41.70	28.31	21.57	16.95	o 2.50	
1974	150.45	126.28	110.12	91.64	77.86	57.44	49.59	42.13	28.16	21.62	16.65	2.00	
1975	150.22	126.03	110.03	91.58	77.56	57.33	49.99	41.90	28.08	21.58	16.35	1.93	
1976	150.40	125.51	110.73	o 91.68	77.68	57.26	50.07	41.63	27.06	21.73	16.22	1.59	
1977	150.53	125.18	110.63	91.79	77.81	57.54	50.39	41.73	27.60	21.73	16.21	1.82	

Table WS-14 ANNUAL DEPOSIT VARIATION

(Unit: $10^6 m^3$)

	Kaulon - Pakel	Pakel - Jongbiru	Jongbiru - Kertosono	Kertosono - Ploso	Ploso - Porong	Total	Kaulon - Jongbiru	Kaulon - Kertosono	Kaulon - Ploso	Kaulon Jabon
1951	0.83	0.84	0.66	0.58	1.33	4.24	1.67	2.33	2.91	3.60
1952	2.63	2.45	1.58	1.23	5.32	13.21	5.08	6.66	7.89	10.66
1953	0.99	1.32	1.32	0.74	1.33	5.70	2.31	3.63	4.37	5.06
1954	0.16	-0.29	-0.18	0.39	2.04	2.12	-0.13	-0.31	0.08	1.14
1955	-0.53	-0.15	0.48	0.87	3.37	4.04	-0.68	-0.20	0.67	2.42
Sub total	4.08	4.17	3.86	3.81	13.39	29.31	8.25	12.11	15.92	22.88
1956	1.46	-0.62	-0.22	-0.29	0	0.33	0.84	0.62	0.33	0.33
1957	-0.06	-0.89	-0.44	-0.58	-0.80	-2.77	-0.95	-1.39	-1.97	-2.39
1958	0.54	1.21	0.92	0.65	0.31	3.63	1.75	2.67	3.32	3.51
1959	0.10	0.28	-0.24	-0.13	-0.80	-0.79	0.38	0.14	0.01	-0.67
1960	0.22	0.94	0.67	0.19	-0.38	1.64	1.16	1.83	2.02	1.56
Sub total	2.26	0.92	0.69	-0.16	-1.67	2.04	3.18	3.87	3.71	2.34
1961	-0.38	0.06	0.35	-0.68	0.78	0.13	-0.32	0.03	-0.65	-0.43
1962	0.12	-0.93	-0.80	-0.26	-0.68	-2.55	-0.81	-1.61	-1.87	-1.99
1963	0.04	0.43	1.14	1.29	1.64	4.54	0.47	1.61	2.90	3.72
1964	-0.64	0.56	-0.22	-1.49	0.83	-0.96	-0.08	-0.30	-1.79	-1.44
1965	0.79	0.85	1.04	1.46	-0.98	3.16	1.64	2.68	4.14	3.72
Sub total	-0.07	0.97	1.51	0.32	1.59	4.32	0.90	2.41	2.73	3.58
1966	0.29	-0.03	-0.18	0.87	4.40	5.35	0.26	0.68	0.95	3.29
1967	0.94	0.33	-0.44	-0.87	-0.19	-0.23	1.27	0.83	-0.04	-0.06
1968	-0.09	1.06	1.76	2.26	1.66	6.65	0.97	2.73	4.49	4.82
1969	-0.31	1.93	0.11	0.87	2.01	4.61	1.62	1.73	2.60	3.90
1970	0.83	0.46	0.16	-0.32	-1.16	-0.03	1.29	1.45	1.13	-0.11
Sub total	1.66	3.75	1.41	2.81	6.72	16.35	5.41	6.82	9.13	11.84
1971	-0.42	-0.75	-0.82	0.06	-1.90	-3.83	-1.17	-1.99	-1.93	-3.12
1972	0.08	-0.26	0.24	-1.00	-1.50	-2.44	-0.18	0.06	-0.94	-1.65
1973	0.17	0.13	0.04	0.49	0.35	1.18	0.30	0.34	0.83	2.34
1974	-1.09	-0.26	-0.38	0.45	-1.69	-2.97	-1.35	-1.73	-1.28	-1.31
1975	-0.49	-1.18	0.43	-0.52	-1.29	-3.05	-1.67	-1.24	-1.76	-2.26
1976	0.93	0.37	-0.18	-2.10	-2.06	-3.04	1.30	1.12	-0.98	-2.04
1977	-0.25	1.03	0.92	1.03	1.10	3.83	0.78	1.70	2.73	3.37
Sub total	-1.07	-0.92	0.25	-1.53	-6.99	-10.32	-1.99	-1.74	-3.33	-4.67
TOTAL	6.86	8.89	7.72	5.19	13.04	41.70	15.75	23.47	28.16	35.97

Table WS-15 **UNIT SEDIMENT YIELD OF KAULON CATCHMENT AND KAULON TO JABON CATCHMENT**

Site		Jabon		Kaulon		Karangkates
Catchment basin area	Total (km^2)	8,218		2,620		2,05 (A_1)
"	Difference (")		5,598		570(A_2)	
Bed and suspended load						
Sediment discharge ($10^6 m^3$/year)	At site	1.50		0.87		
	Difference		0.71			
Unit sediment yield (m^3/km^2/year)			130		330 (q_B) Applied to the basin upstream from Kaulon	
Wash load						
Sediment discharge ($10^6 m^3$/year)	At site	4.60		0.41 (Q_w)		
	Difference		4.19			
Unit sediment Yield			750		440 (q_w) (refer to Remarks)	

Remarks : Unit sediment yield for was load in the basin upstream from Kaulon, q_w was obtained through the following calculation. Where, the trap efficiency of Karangkates reservoir was assumed to be 90%.

$$Q_w = q_w \times A_2 + (q_w + q_B) \times A_1 \times (1 - 0.9)$$

then, $q_w = (Q_w - 0.1 . q_B . A_1)/(A_2 + 0.1 . A_1)$

$$= \frac{0.41 \times 10^6 - 0.1 \times 350 \times 2050}{570 + 0.1 \times 2050} = 440$$

Source : WS - 04

Table WS-16 . AN ESTIMATION OF ANNUAL SEDIMENT YIELD BETWEEN KAULON AND JABON

(Unit: $10^6 m^3$)

	Bed and suspended load material					Wash load material			Lahar area yield Total (9)=(5)+(8)
	Deposit increase (1)	Through Jabon (2)	Sub total (3)=(1)+(2)	Non-lahar area yield (4)	Lahar area yield (5)=(3)-(4)	Through Jabon (6)	Non-lahar area yield (7)	Lahar area yield (8)=(6)-(7)	
1950 - 1951	3.60	1.64	5.24	1.33	3.91	4.70	3.22	1.48	5.39
1951 - 1952	10.40	1.64	12.04	1.33	10.71	4.70	3.22	1.48	12.19
1952 - 1953	4.50	1.64	6.14	1.33	4.81	4.70	3.22	1.48	6.29
1953 - 1954	2.00	1.64	3.64	1.33	2.31	4.70	3.22	1.48	3.79
1954 - 1955	1.30	1.64	2.94	1.33	1.61	4.70	3.22	1.48	3.09
Sub total	21.60	8.20	30.00	6.65	23.35	23.50	16.10	7.40	30.75
1955 - 1960	3.50	8.20	11.70	6.65	5.05	23.50	16.10	7.40	12.45
1960 - 1965	3.50	8.20	11.70	6.65	5.05	23.50	16.10	7.40	12.45
Sub total	7.00	16.40	23.40	13.30	10.10	47.00	32.20	14.80	24.90
Total (1950-1965)	28.60	24.60	53.40	19.95	33.45	70.50	48.30	22.20	55.65
1965 - 1966	2.00	1.64	3.64	1.33	2.31	4.70	3.22	1.48	3.79
1966 - 1967	3.00	1.64	4.64	1.33	3.31	4.70	3.22	1.48	4.79
1967 - 1968	3.00	1.64	4.64	1.33	3.31	4.70	3.22	1.48	4.79
1968 - 1969	3.00	1.64	4.64	1.33	3.31	4.70	3.22	1.48	4.79
1969 - 1970	0.80	1.64	2.44	1.33	1.11	4.70	3.22	1.48	2.59
Sub total	11.80	8.20	20.00	6.65	13.35	23.50	16.10	7.40	20.75
1970 - 1971	-1.00	1.64	0.64	1.33	-0.69	4.70	3.22	1.48	0.79
1971 - 1972	-2.00	1.64	-0.36	1.33	-1.69	4.70	3.22	1.48	-0.21
1972 - 1973	-1.10	1.58	0.48	0.65	-0.17	4.60	3.11	1.49	1.32
1973 - 1974	-0.70	1.58	0.88	0.65	0.23	4.60	3.11	1.49	1.72
1974 - 1975	-0.80	1.58	0.78	0.65	0.13	4.60	3.11	1.49	1.62
1975 - 1976	-0.50	1.58	1.08	0.65	0.43	4.60	3.11	1.49	1.92
1976 - 1977	1.50	1.58	3.08	0.65	2.43	4.60	3.11	1.49	3.92
Sub total	-4.60	11.18	6.58	5.91	0.67	32.40	21.99	10.41	11.08
Total (1965-1977)	7.20	19.38	26.58	12.56	14.02	55.90	38.09	17.81	31.83
Total (1950-1977)	36.00	43.98	79.98	32.51	47.47	126.40	86.39	40.01	87.48

Table WS-17 AMOUNT OF VOLCANIC DEBRIS TO MAIN 5 RIVERS

(10^6 m^3)

River	Catchment basin area (Km^2)	Flow distance (Km)	Amount of volcanic debris: Ladu	Primary lahar	Secondary lahar	Total	Percentage (%)
K. Semut	93.5	19.30	1.5	2.35	6.13	9.98	17.5
K. Putih	77.6	23.7	3.0	3.70	7.50	14.20	24.9
K. Badak	505.2	47.2	2.7	11.50	4.0	18.20	31.9
K. Ngobo	204.8	37.0	0.35	3.60	5.30	9.25	16.2
K. Konto	267.6	53.0	0.2	0.7	4.50	5.40	9.5
Total	1,148.7		7.75	21.85	27.43	57.03	100.0

Remarks; (1) The amounts show those derived from G. Kelud eruption in 1966 until the end of 1966, investigated by GOI.

Source : WS 04

Table WS-18. RIVER BED MOVEMENT ON THE K. BRANTAS BETWEEN KAULON AND JABON (1977 ~ 1983)

(Elevation in meter)

	1977	1978	1979	1980	1981	1982	1983
Kaulon	150.53	* 150.51	* 150.49	* 150.47	* 150.45	* 150.43	* 150.41
Balance		-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Gelondong	125.18	124.69	124.92	124.47	123.16	123.06	123.03
Balance		-0.79	0.23	-0.45	-1.31	-0.10	-0.03
Rejotangan	110.63	111.46	110.03	111.41	110.81	110.61	110.69
Balance		-0.17	-0.43	0.38	-0.60	-0.20	0.08
Pakel	91.79	* 91.72	* 91.65	* 91.58	91.52	91.57	* 91.57
Balance		-0.07	-0.07	-0.07	-0.06	0.05	0.00
Jeli	77.81	* 77.83	* 77.85	* 77.87	77.89	77.62	* 77.62
Balance		0.02	0.02	0.02	0.02	-0.27	0.00
Mrican (Jong biru)	57.54	57.49	57.73	57.47	57.19	57.00	56.70
Balance		-0.05	0.24	-0.26	-0.28	-0.19	-0.30
Minggiran	50.39	50.21	50.50	50.78	51.05	50.53	51.27
Balance		-0.18	0.29	0.28	0.27	-0.52	0.74
Kertosono	41.73	41.44	41.42	41.56	41.37	41.27	41.26
Balance		-0.29	-0.02	0.14	-0.19	-0.10	-0.01
Ploso	27.60	27.13	27.03	27.42	28.30	28.12	27.51
Balance		-0.47	-0.10	0.39	0.88	-0.18	-0.61
Kesamben	21.73	21.53	21.52	21.66	21.30	20.84	21.41
Balance		-0.20	-0.01	0.14	-0.36	-0.46	0.57
Tersan (Jabon)	16.21	16.16	15.80	15.17	14.97	14.70	14.62
Balance		-0.05	-0.36	-0.63	-0.20	-0.27	-0.08

Remarks: Balance : Between river bed elevation and that in the next year

* : Assumed figure based on river bed movement of 1950 to 1977

Source : Based on measured record by Irrigation Section, DPU, East Java

Table WS-19 ANNUAL DEPOSIT VARIATION BETWEEN KAULON AND JABON (1977 - 1983)

($10^6 m^3$)

	1978	1979	1980	1981	1982	1983	Total
Kaulon D=10.7 D=50	-0.22	-0.06	-0.13	-0.36	-0.03	-0.01	-0.69
Glondong D=14.5 W=70	-0.49	-0.10	-0.04	-0.97	-0.15	0.03	-1.72
Rejotangan D=15.5 W=150	-0.28	-0.58	0.36	-0.77	-0.17	0.09	-1.35
Pakel D=15.0 W=165	-0.06	-0.06	-0.06	-0.05	-0.27	0.00	-0.50
Jeli D=27.7 W=125	-0.05	0.45	-0.42	-0.45	-0.80	-0.52	-1.79
Jongbiru D=11.2 W=150	-0.19	0.45	0.02	-0.01	-0.60	0.37	0.04
Minggiran D=16.0 W=125	-0.47	0.27	0.42	0.08	-0.62	0.73	0.41
Kertosono D=23.1 W=140	-1.23	-0.19	0.86	1.12	-0.45	-1.00	-0.89
Ploso D=15.3 W=160	-0.82	-0.13	0.65	0.64	-0.78	-0.05	-0.49
Kesamben D=13.8 W=150	-0.26	-0.38	-0.51	-0.58	-0.76	-0.51	-1.98
Jabon							
Total (Kaulon to Jabon)	-4.07	-0.21	1.15	-1.35	-4.63	0.15	-8.96

Remarks: D: Distance of site to site (km)

W: Mean width of river (m)

Table WS-20 ANNUAL SEDIMENT LOAD THROUGH JABON

(Unit: 1,000m^3)

Year	Suspended Load	Wash load	Bed Load	Total Load
1951	1,427	3,820	175	5,422
1952	1,822	6,357	241	8,421
1953	1,568	4,399	198	6,166
1954	1,969	5,660	256	7,886
1955	2,506	9,038	345	11,889
1956	1,736	3,751	214	5,701
1957	1,720	5,813	223	7,756
1958	1,795	4,806	228	6,831
1959	1,980	7,911	270	10,163
1960	1,806	5,750	236	7,793
1961	1,213	2,048	140	3,402
1962	1,634	4,148	205	5,989
1963	1,605	6,392	214	8,213
1964	1,413	2,265	164	3,843
1965	1,084	1,939	124	3,148
1966	1,400	3,474	171	5,047
1967	1,196	2,245	140	3,581
1968	2,019	5,112	259	7,390
1969	1,310	3,007	158	4,476
1970	1,485	3,097	180	4,763
1971	1,800	5,013	231	7,045
1972	942	1,111	101	2,155
1973	1,807	4,702	228	6,738
1974	1,713	4,130	214	6,058
1975	2,336	9,871	328	12,536
1976	1,388	4,838	176	6,404
1977	1,149	1,884	131	3,165
1978	1,943	4,396	245	6,586
1979	1,806	5,818	237	7,862
1980	1,303	2,321	153	3,778
1981	1,533	3,275	189	4,997
1982	1,284	2,991	155	4,431
1983	1,552	2,823	187	4,562
Mean	1,613	4,370	204	6,188

Based on 10-day mean discharge.

Table WS-21 **SEDIMENT BALANCE DURING 15 YEARS**

BY BRDDEO

(10^6 m^3)

Basin	(1) Total volcanic product	(2) * Sediment carried off to the Brantas	(3) Controllable sediment retained in tributaries	(4)=(2)+(3) Sub total	(5) Sediment to be carried off to the Brantas under proposed condition	(6)=(4)+(5) Excess over proposed amount to be arrested
Lekso	29.6	4.9	7.5	12.4	0.9	11.5
Putih	34.2	6.9	10.6	17.5	0.9	16.6
Badak	53.1	8.8	13.6	22.4	4.5	17.9
Ngobo	30.5	6.1	6.9	13.0	3.0	10.0
Konto	21.4	6.8	4.1	10.9	2.3	8.6
Total	166.8	33.5	42.9	76.2	11.6	64.6

Remarks : * Bed and suspended load

Source : WS 04

BY G. KELD PROJECT

Name of river (Area)	Length (km)	Excess ($10^6 m^3$)	Sediment (%)
K. Konto	40	6.54	9.90
K. Serinjing	39	0.84	1.27
K. Ngobo	37.5	9.14	13.85
K. Dermo-Sukorejo	39	5.24	7.94
K. Gedog	25	1.21	1.83
K. Badak-Termas	40	18.20	27.58
K. Putih	26	13.54	20.52
K. Semut	18	7.14	10.82
K. Lekso	7	4.15	6.29
Total		66.00	100.00

Source ; Information from G. Kelud Project

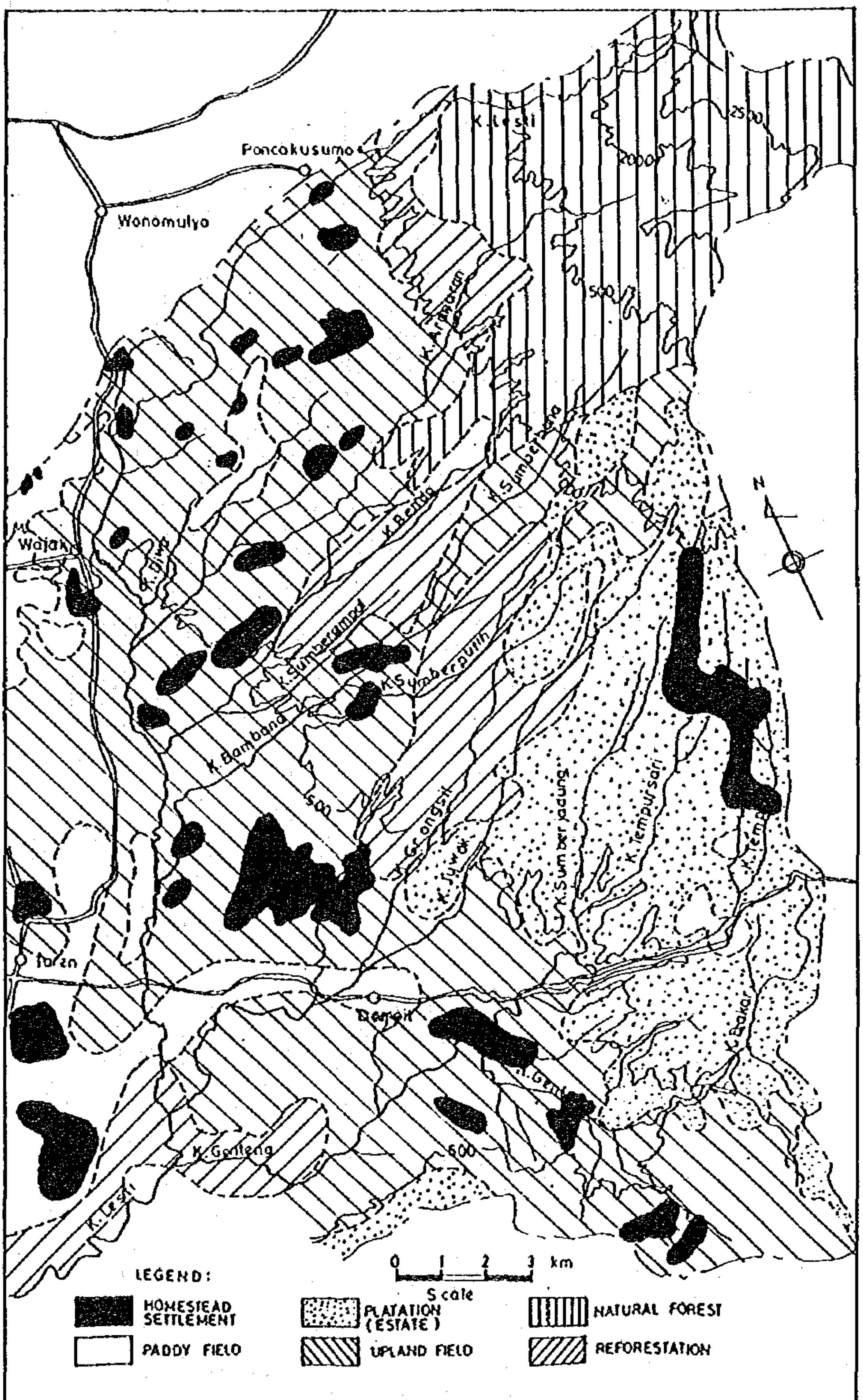


Fig. WS-1 LAND USE IN THE K.LESTI BASIN

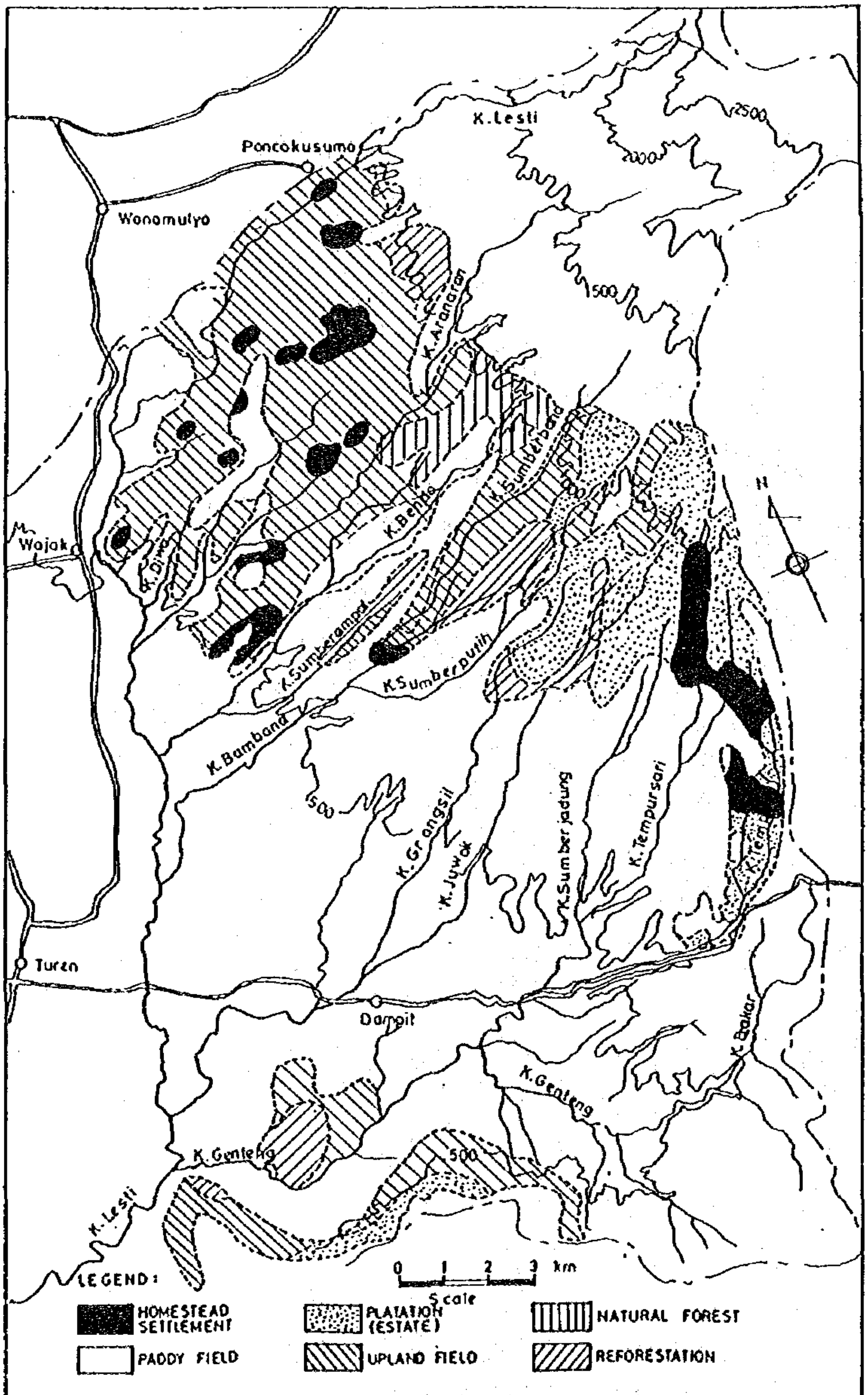


Fig. WS-2 LAND USE IN ERODIBLE AREA IN THE K.LESTI BASIN

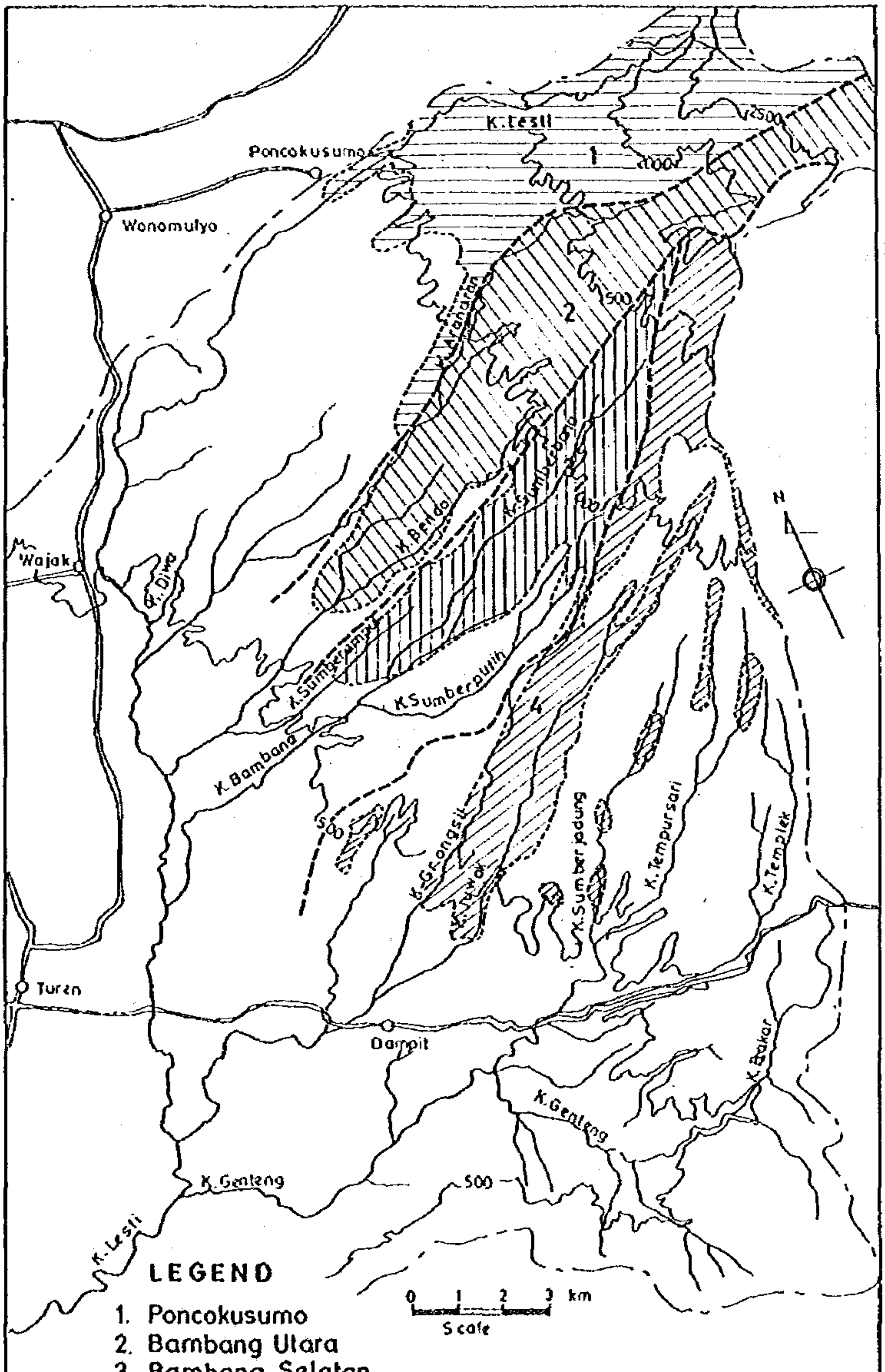


Fig. WS-3 REFORESTATION/NATURAL FOREST AREA IN THE K. LESTI BASIN

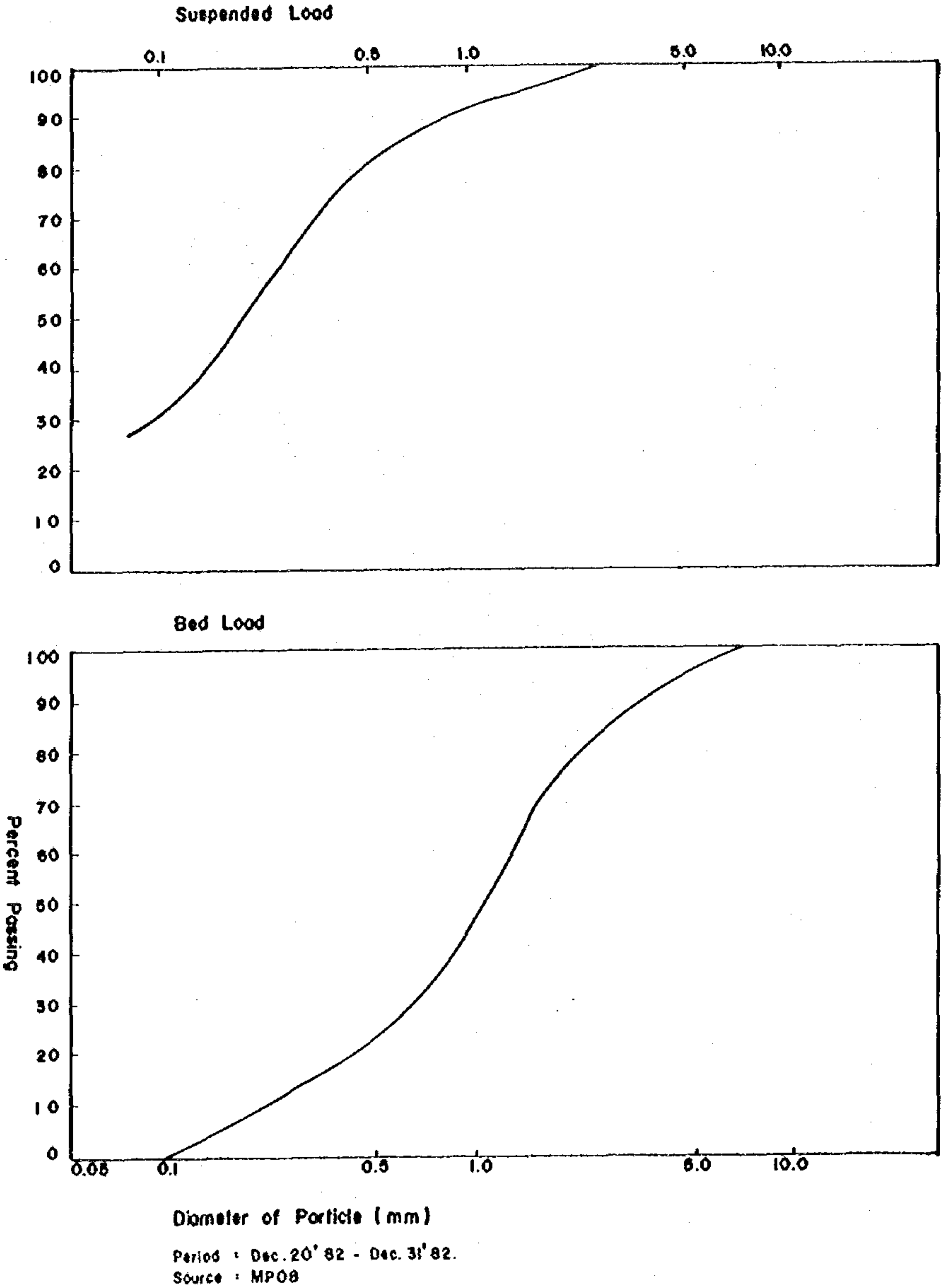


Fig. WS-4 **GRADIATION OF SEDIMENT LOAD IN K.LESTI AT CLUMPRIT**

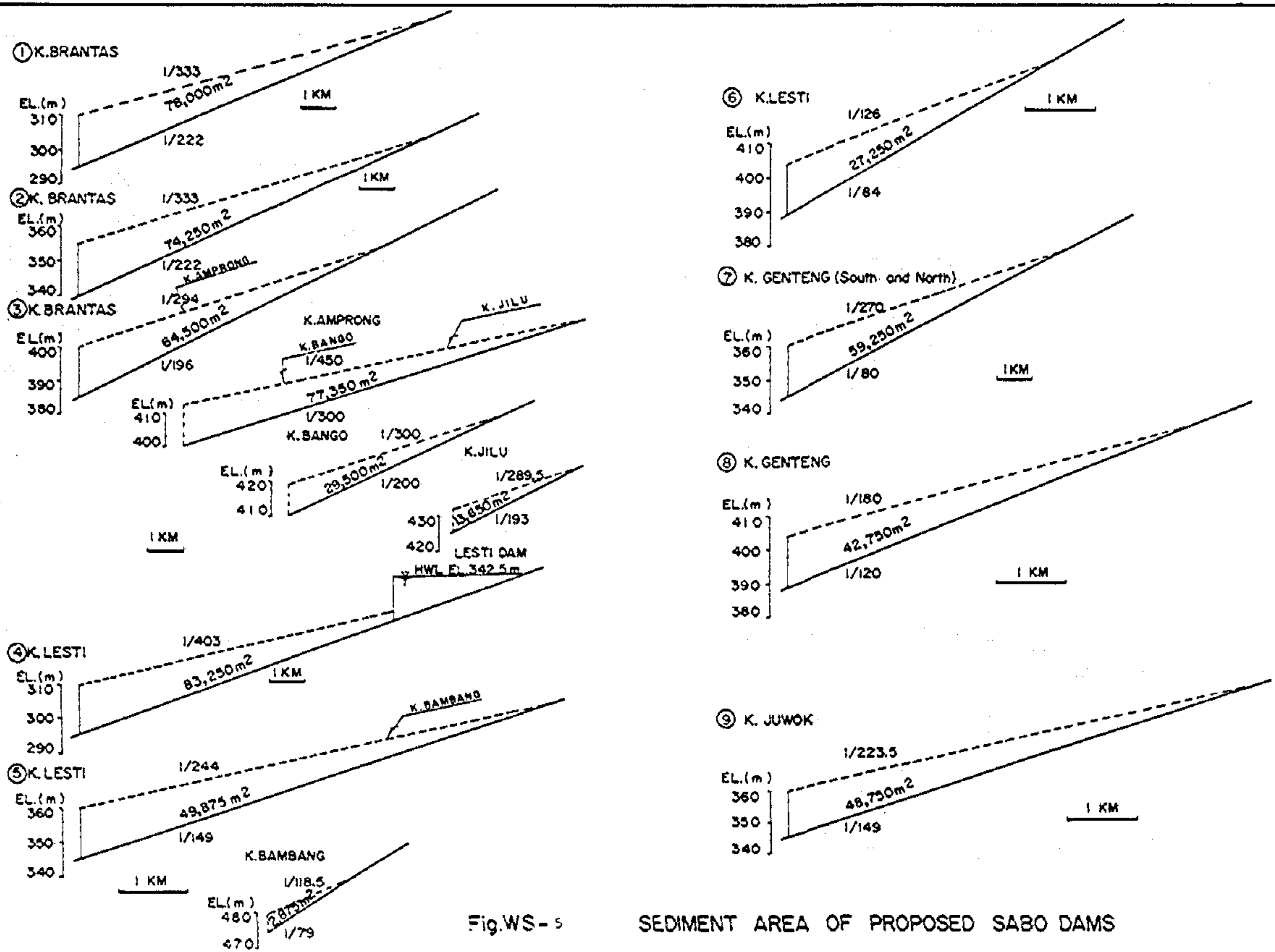


Fig.WS-5 SEDIMENT AREA OF PROPOSED SABO DAMS

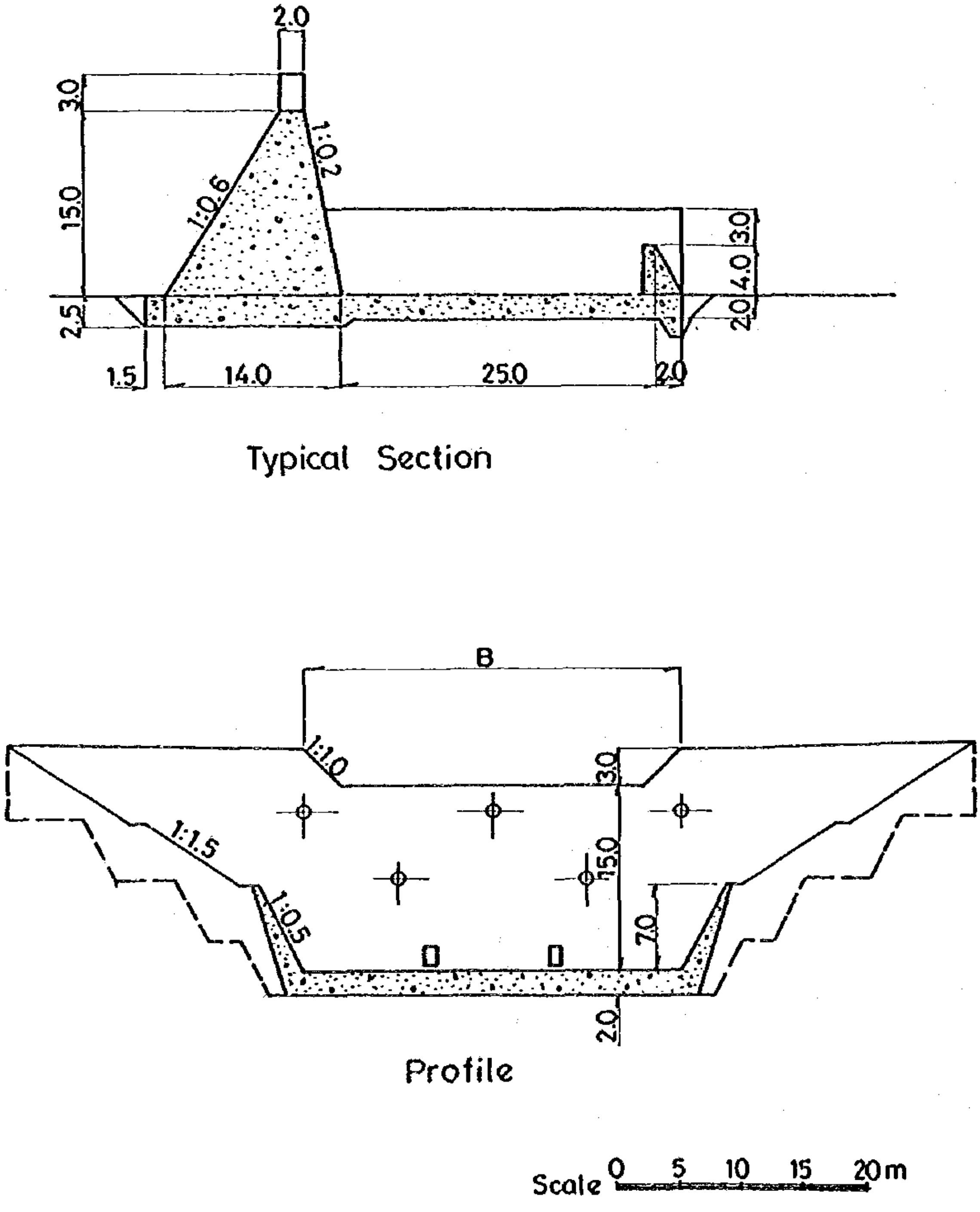


Fig. WS-6 TYPICAL DESIGN OF SABO DAM

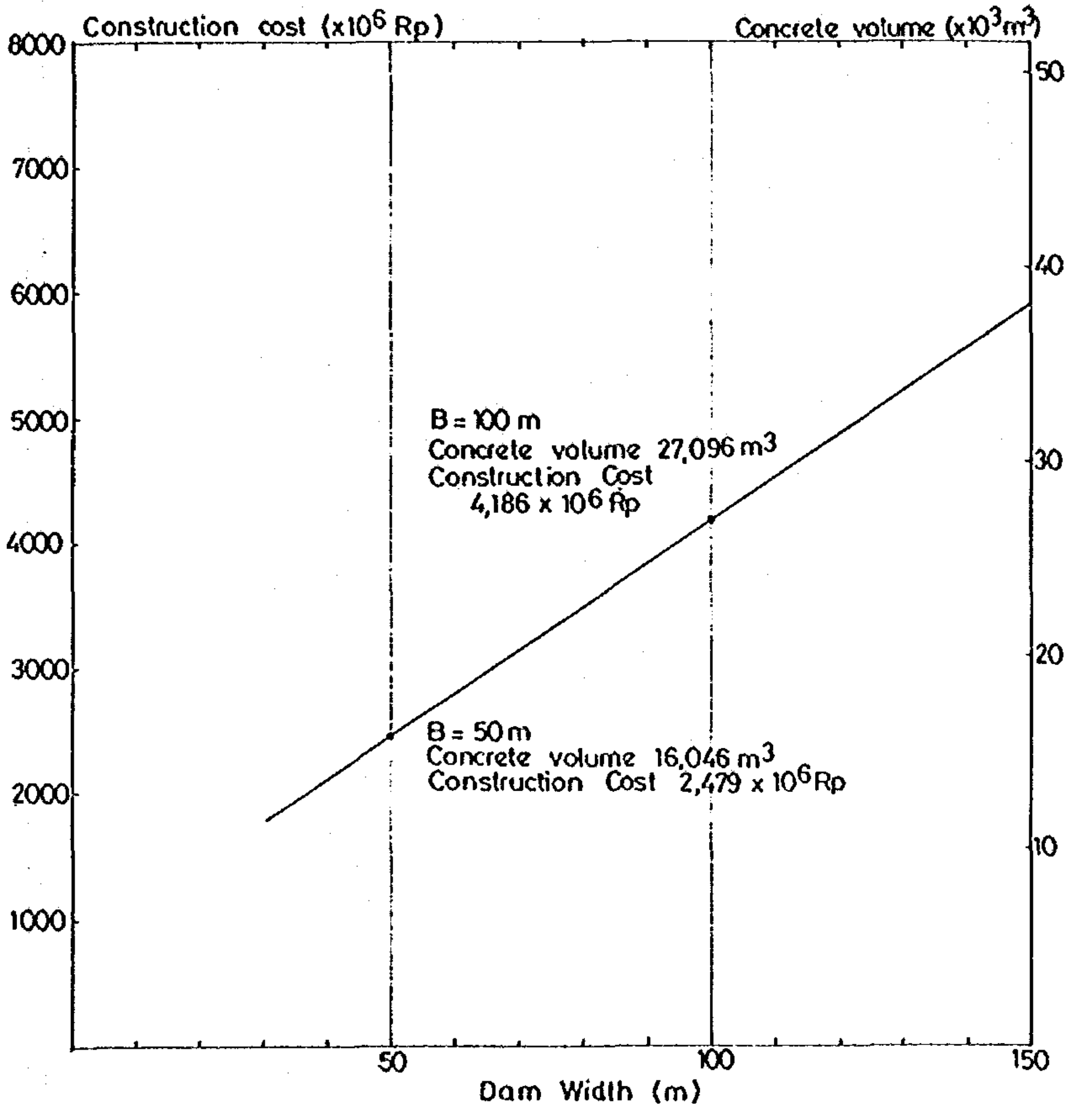


Fig. WS-7 RELATION BETWEEN DAM WIDTH AND CONSTRUCTION COST

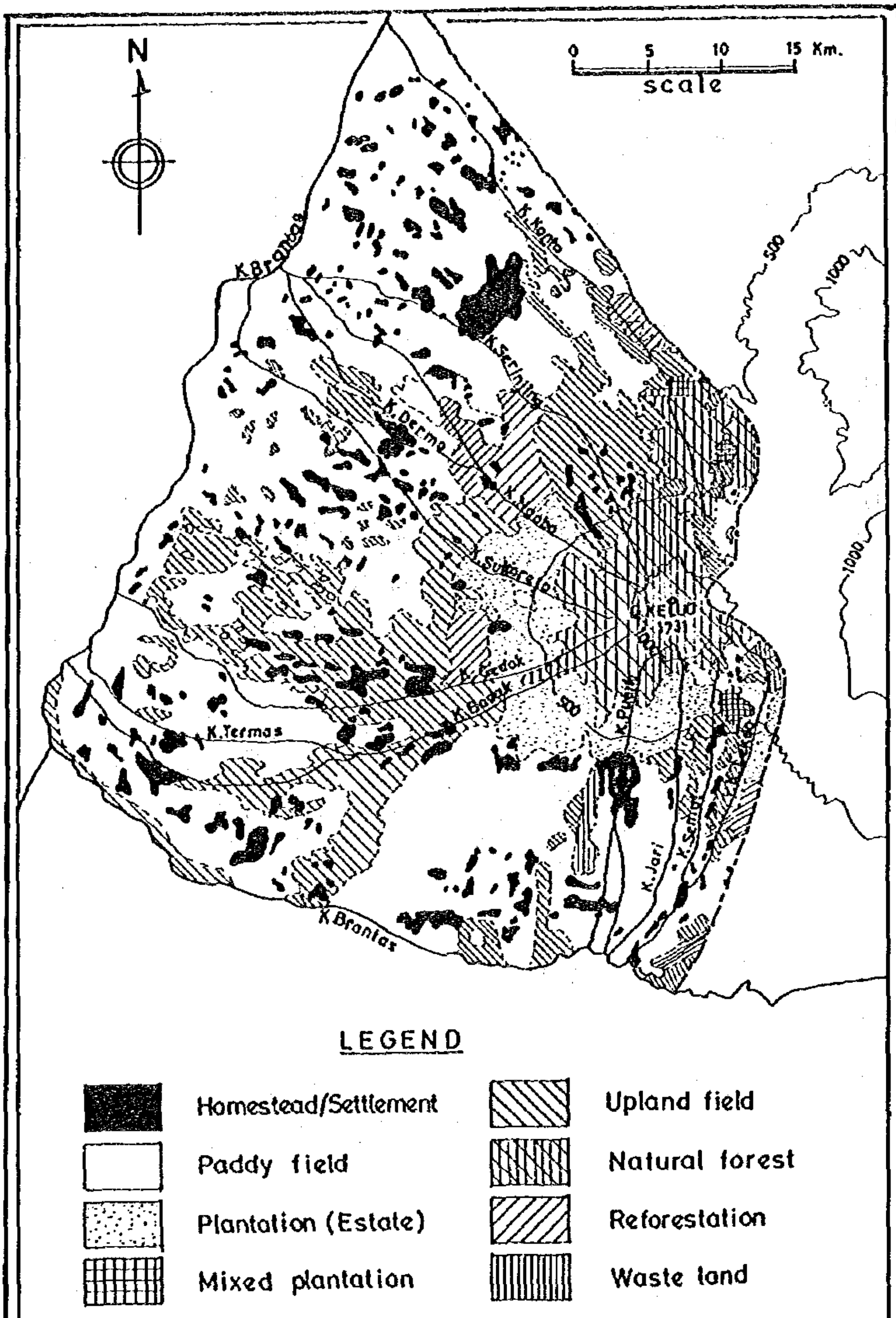


Fig. WS-8 LAND USE IN THE LAHAR AREA

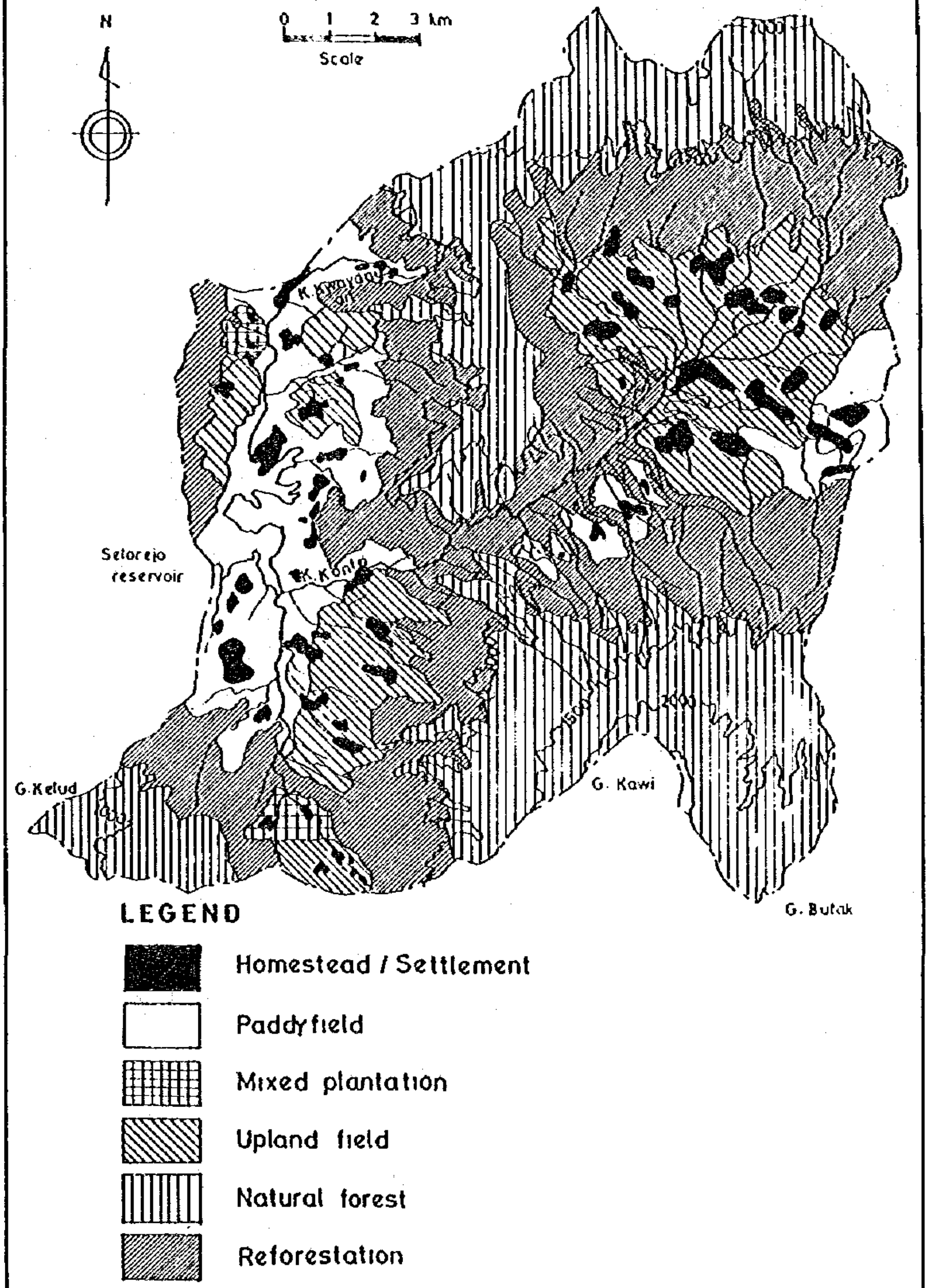


Fig. WS-9 LAND USE IN THE UPPER K. KONTC BASIN

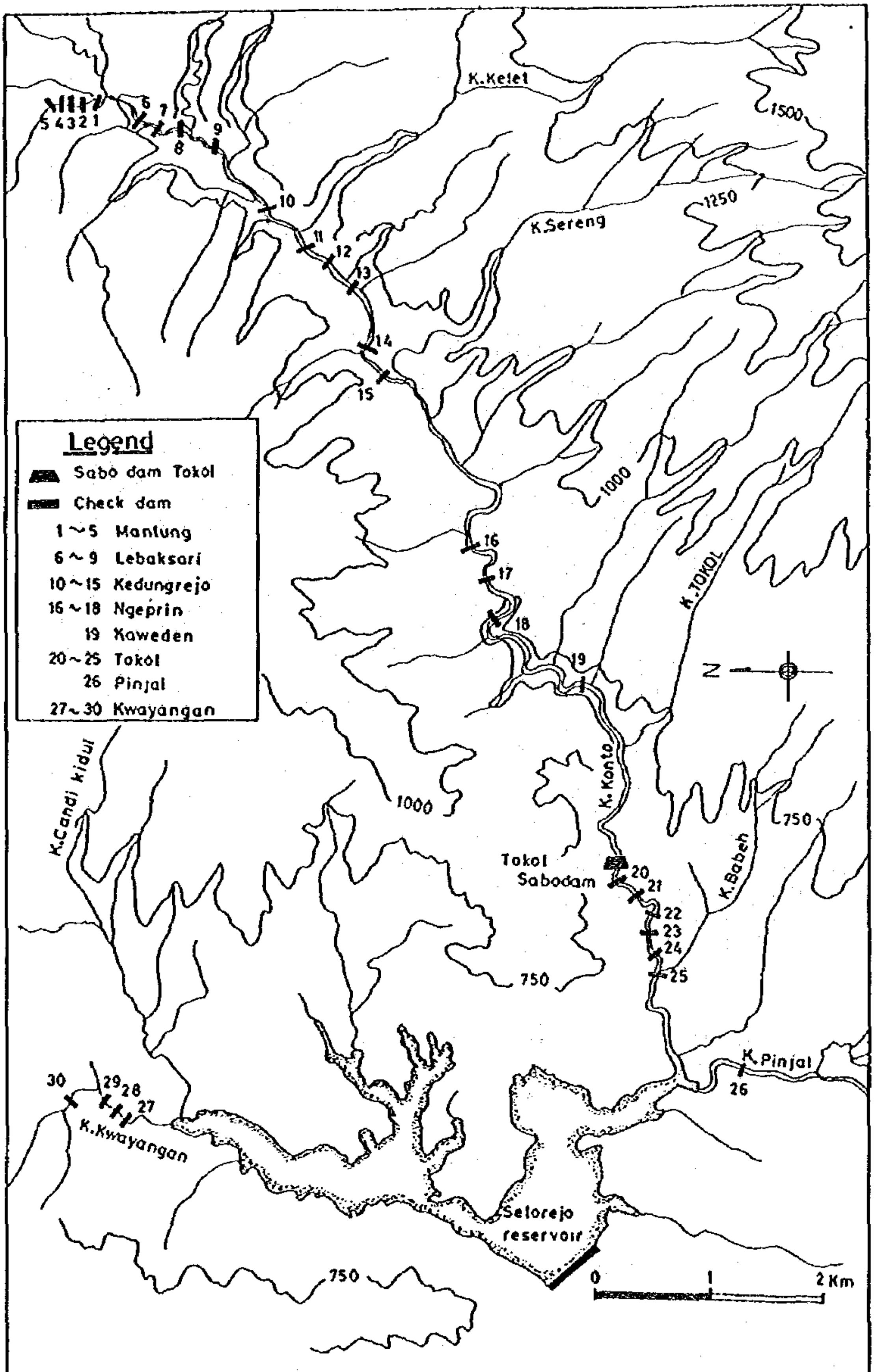


Fig. WS-10 EXISTING SABO FACILITIES IN THE UPPER K.KONTO BASIN

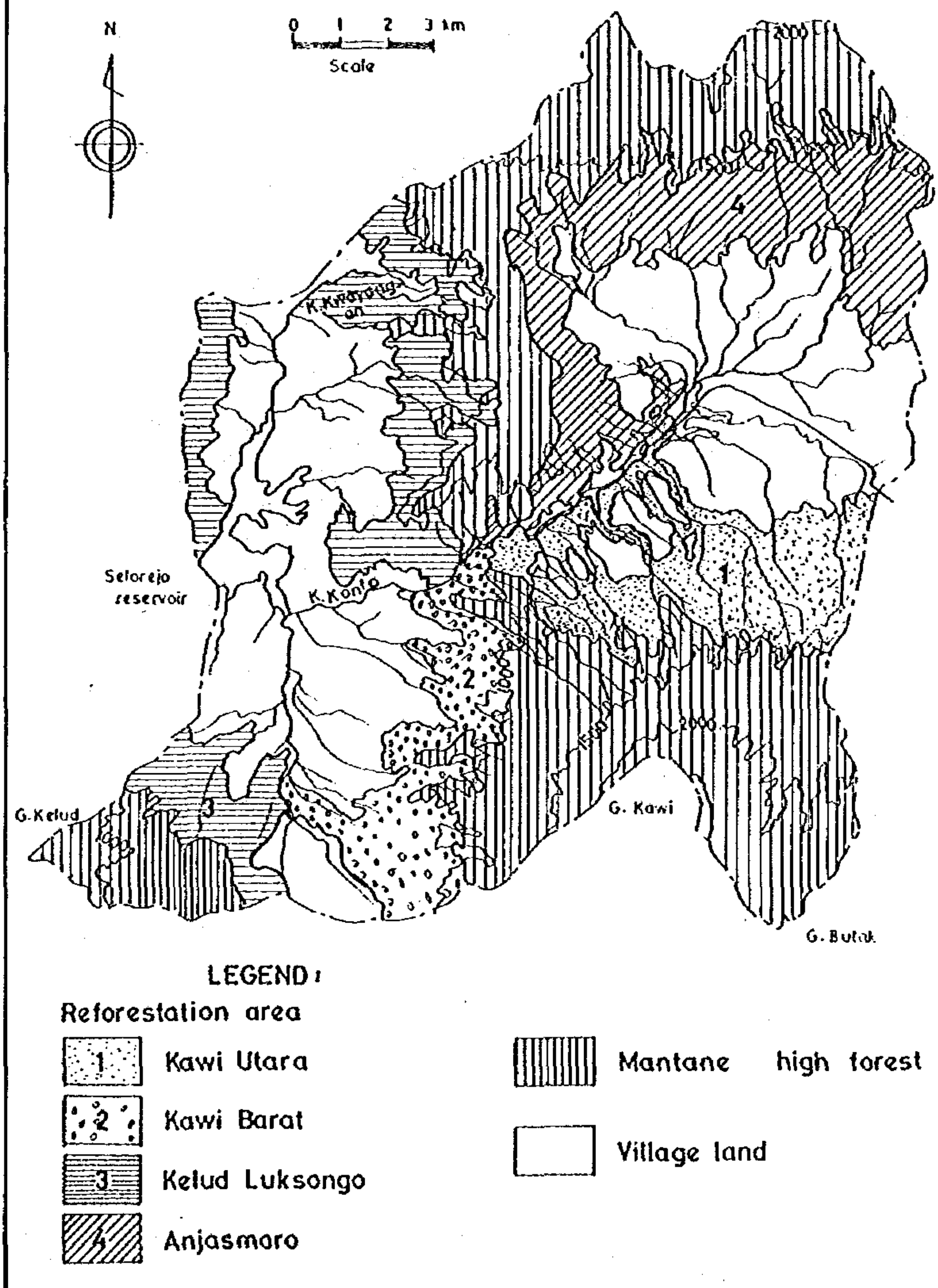


Fig. WS-11 REFORESTATION AREA IN THE UPPER K. KONTO BASIN

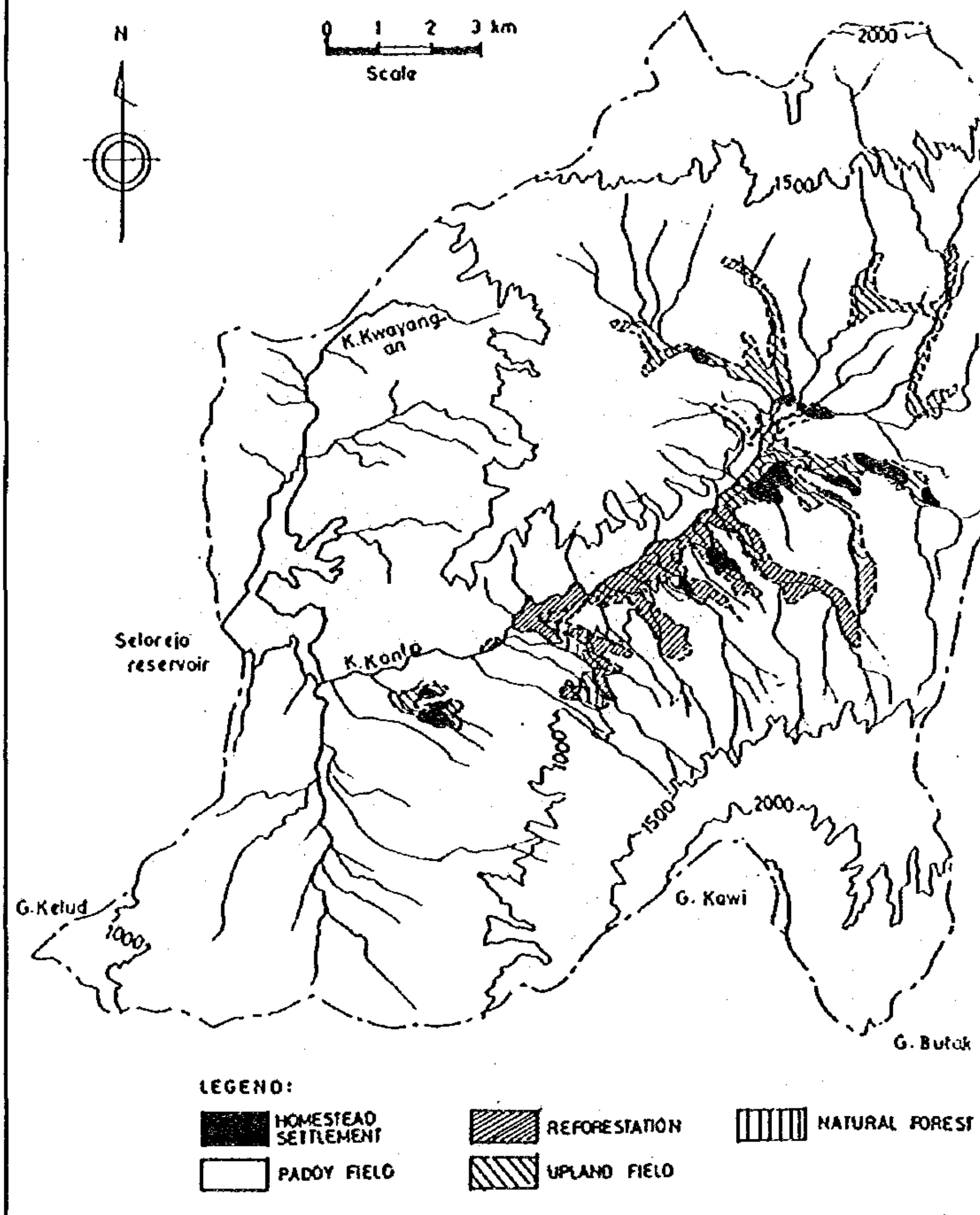


Fig. WS-12 LAND USE IN ERODIBLE AREA IN THE UPPER K.KONTO BASIN

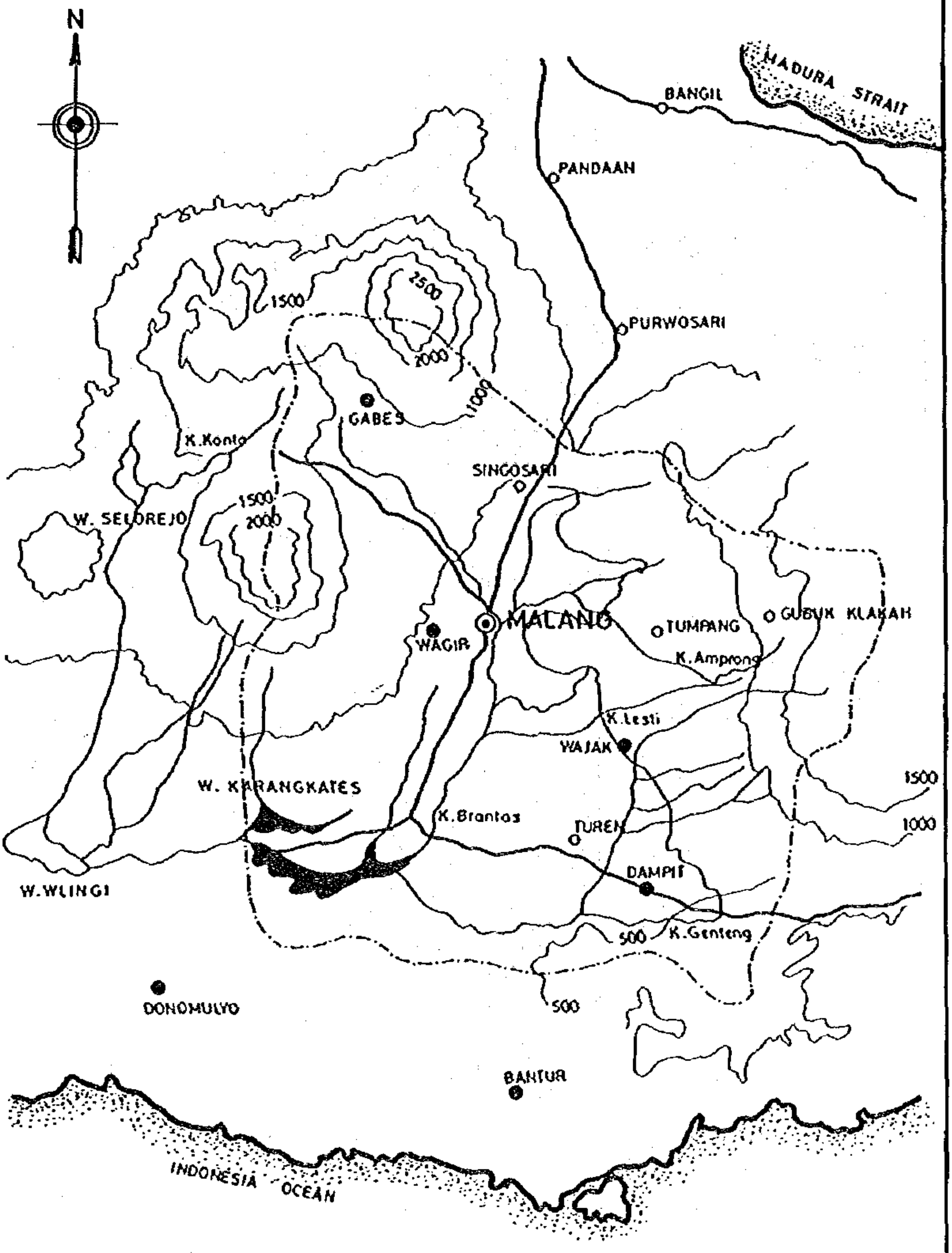


Fig. WS-13 LOCATION OF DEMONSTRATION PLOT IN THE UPPER K. BRANTAS AREA

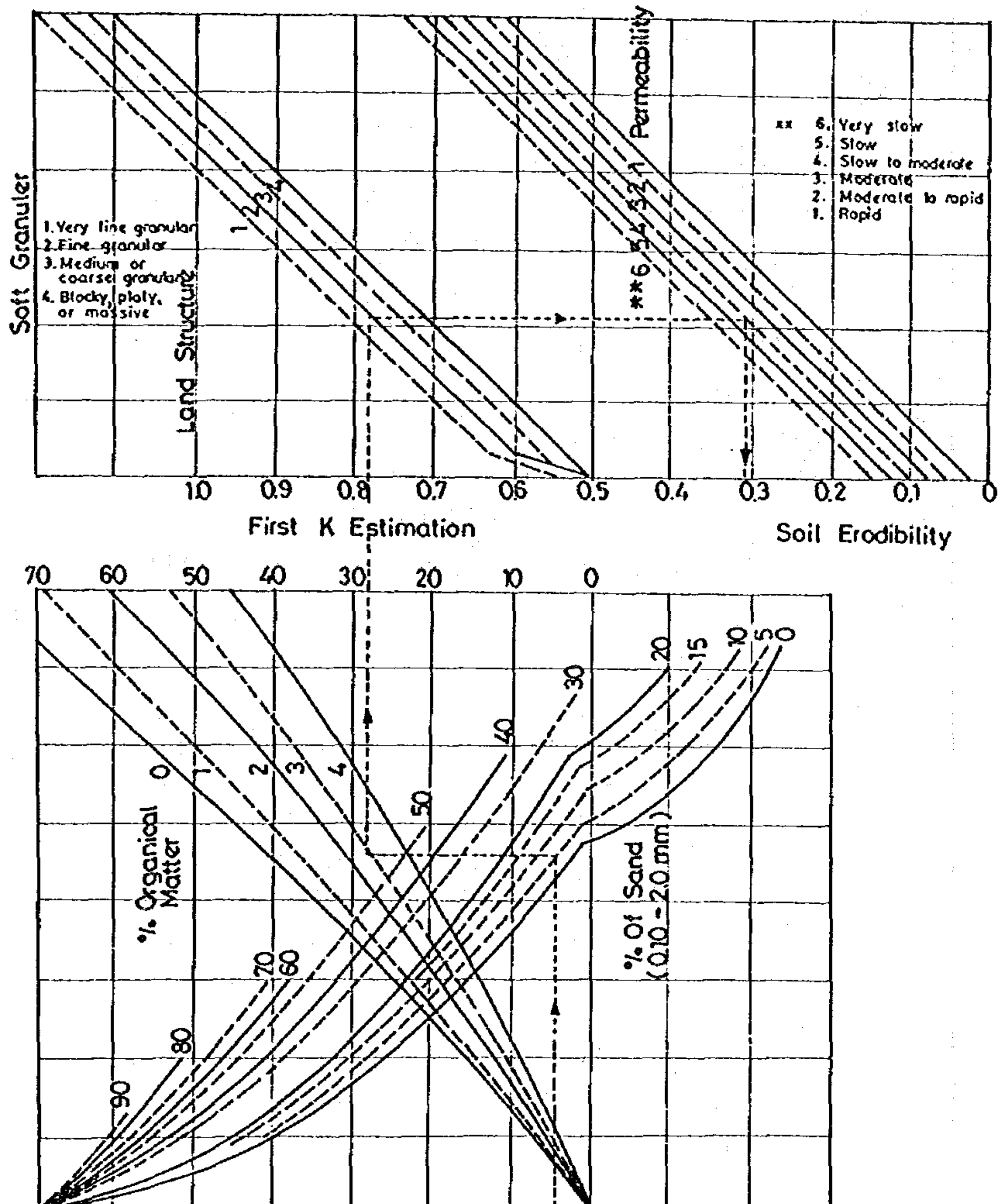
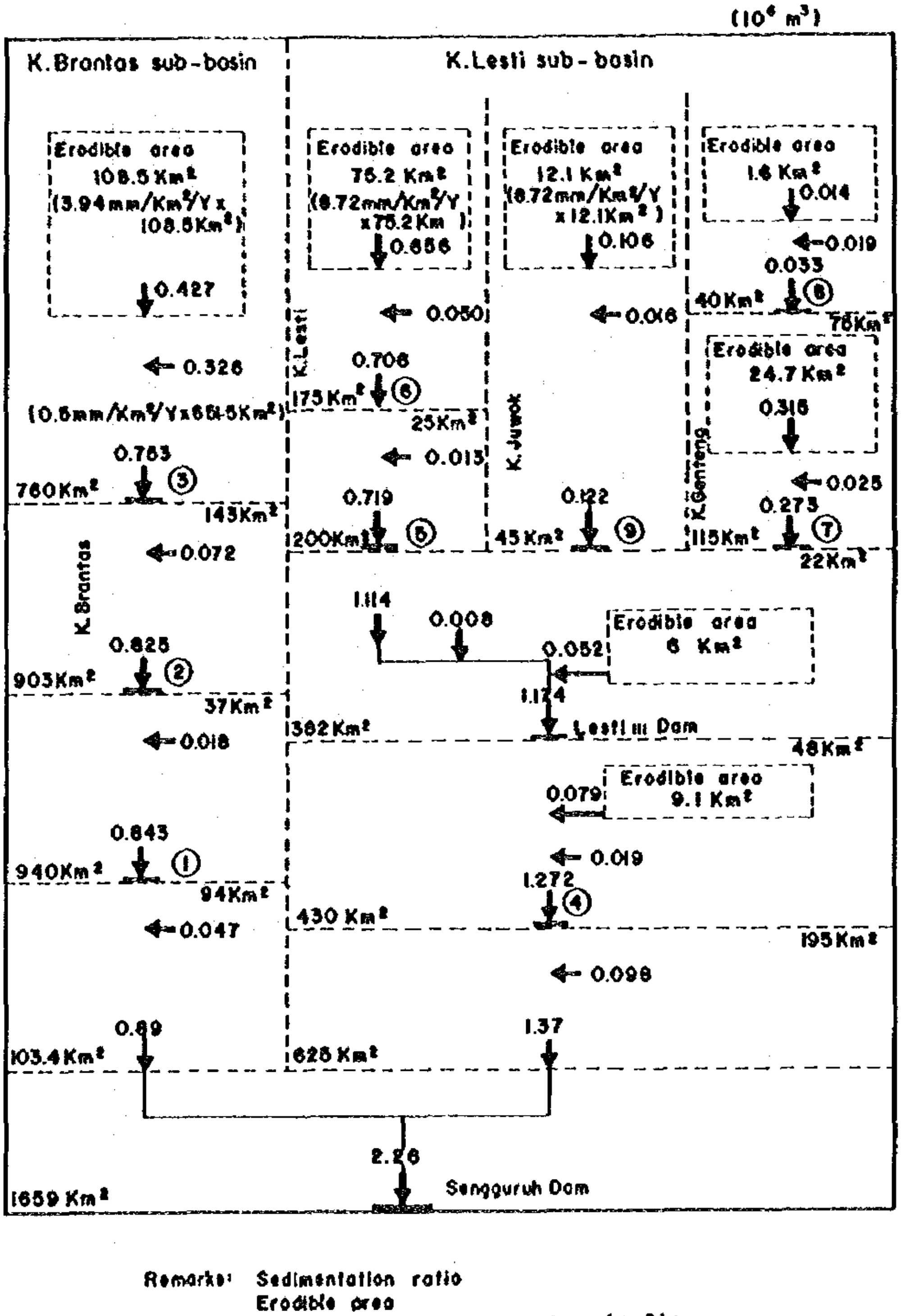


Fig. WS-14 NOMOGRAPH FOR SOIL ERODIBILITY ESTIMATION (K). (WISCHMEIR, JOHSON AND CROSS, 1971)



Remarks: Sedimentation ratio
Erodible area
K.Brantas sub basin : 3.94 mm/Km²/Y
K.Lesti sub basin : 8.72 mm/Km²/Y
Non Erodible area : 0.50 mm/Km²/Y

Fig. WS-15 ANNUAL SEDIMENT YIELD IN THE SENGGURUH CATCHMENT AREA

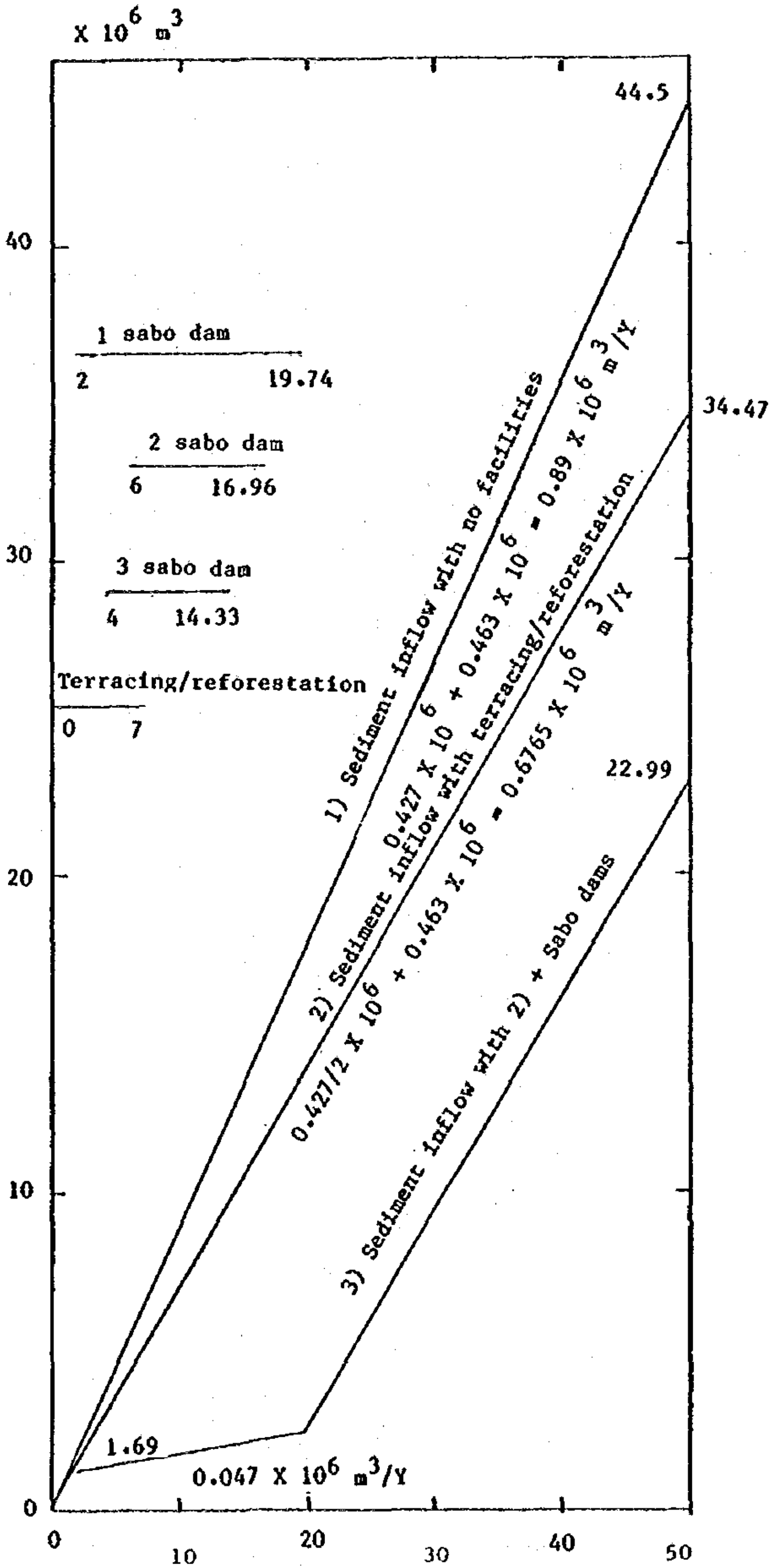


Fig. WS-16 SEDIMENT INFLOW INTO K.BRANTAS ARM

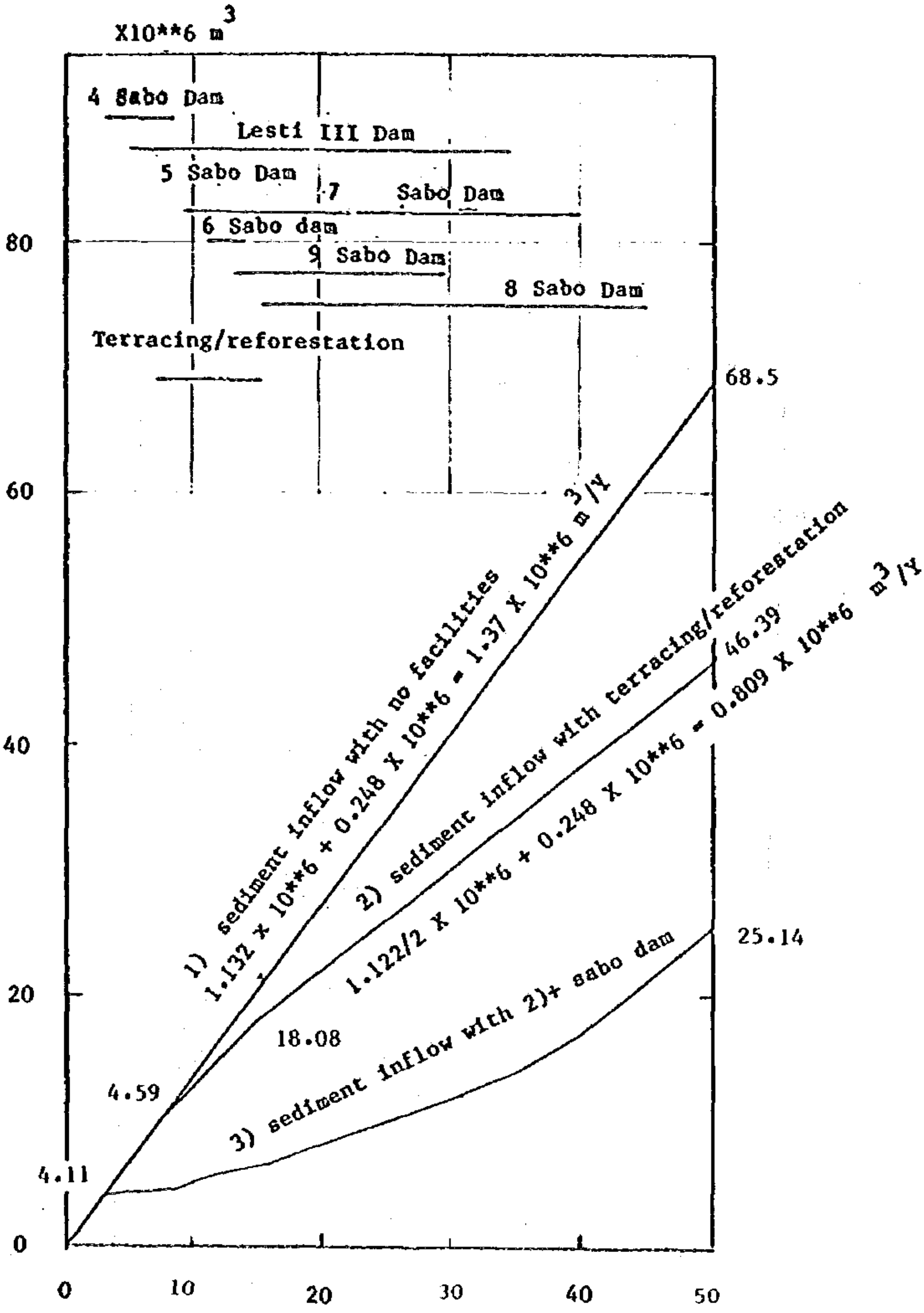


Fig. WS-17 SEDIMENT INFLOW INTO K:LESTI ARM

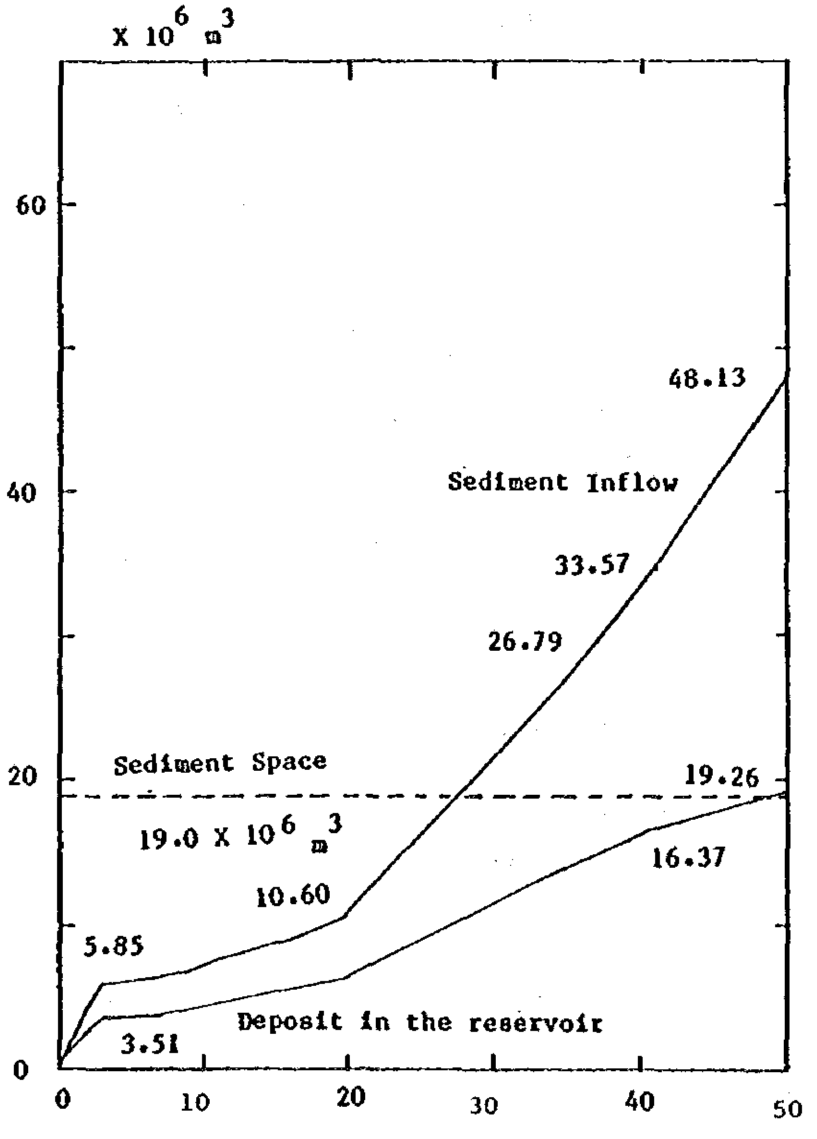
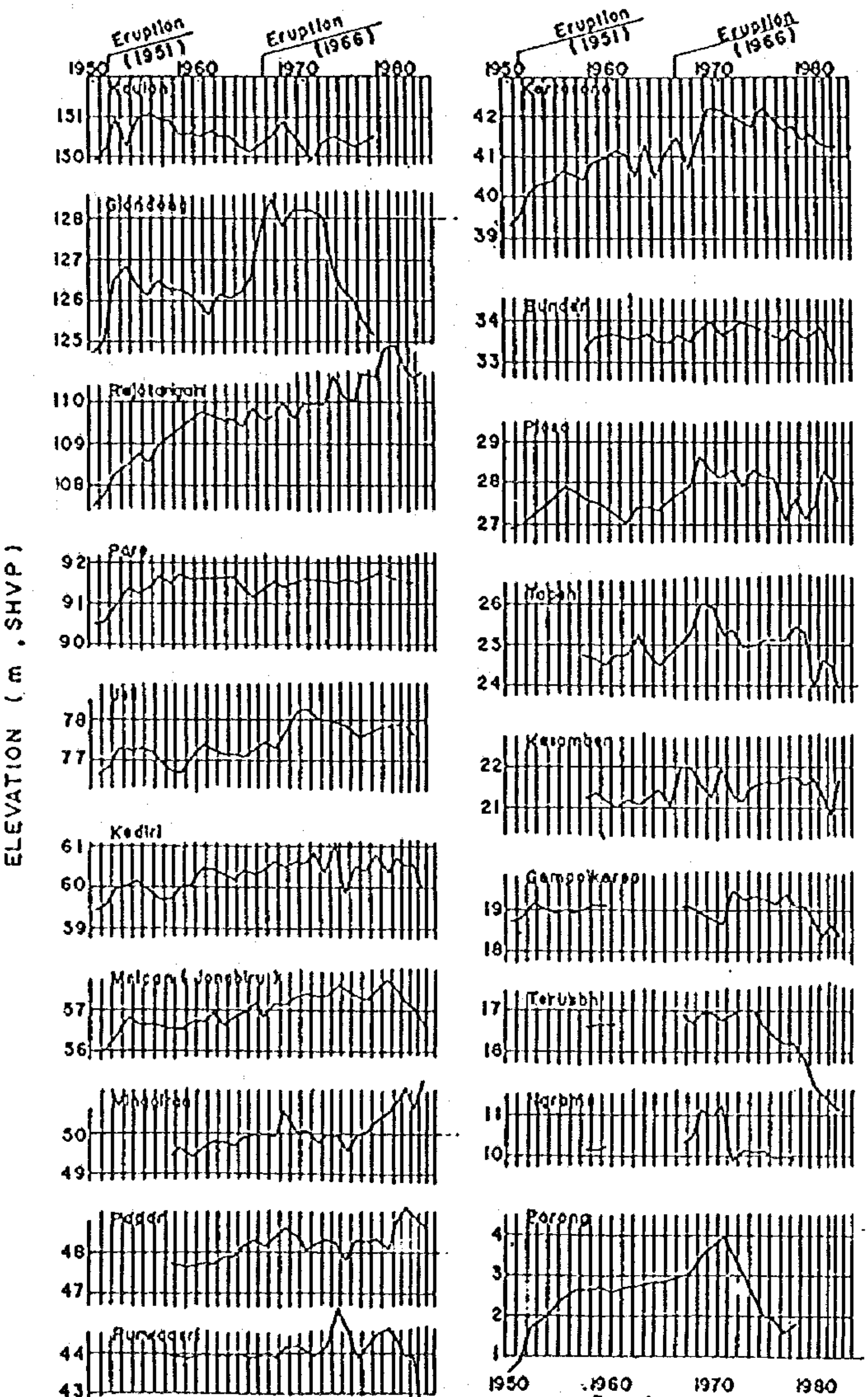


Fig. WS-18 DEPOSIT IN THE SENGGURUH RESERVOIR WITH WATERSHED MANAGEMENT WORK



Remarks :
Source : Ref. RC 53

Fig. WS-19 RIVER BED MOVEMENT ON THE K. BRANTAS.

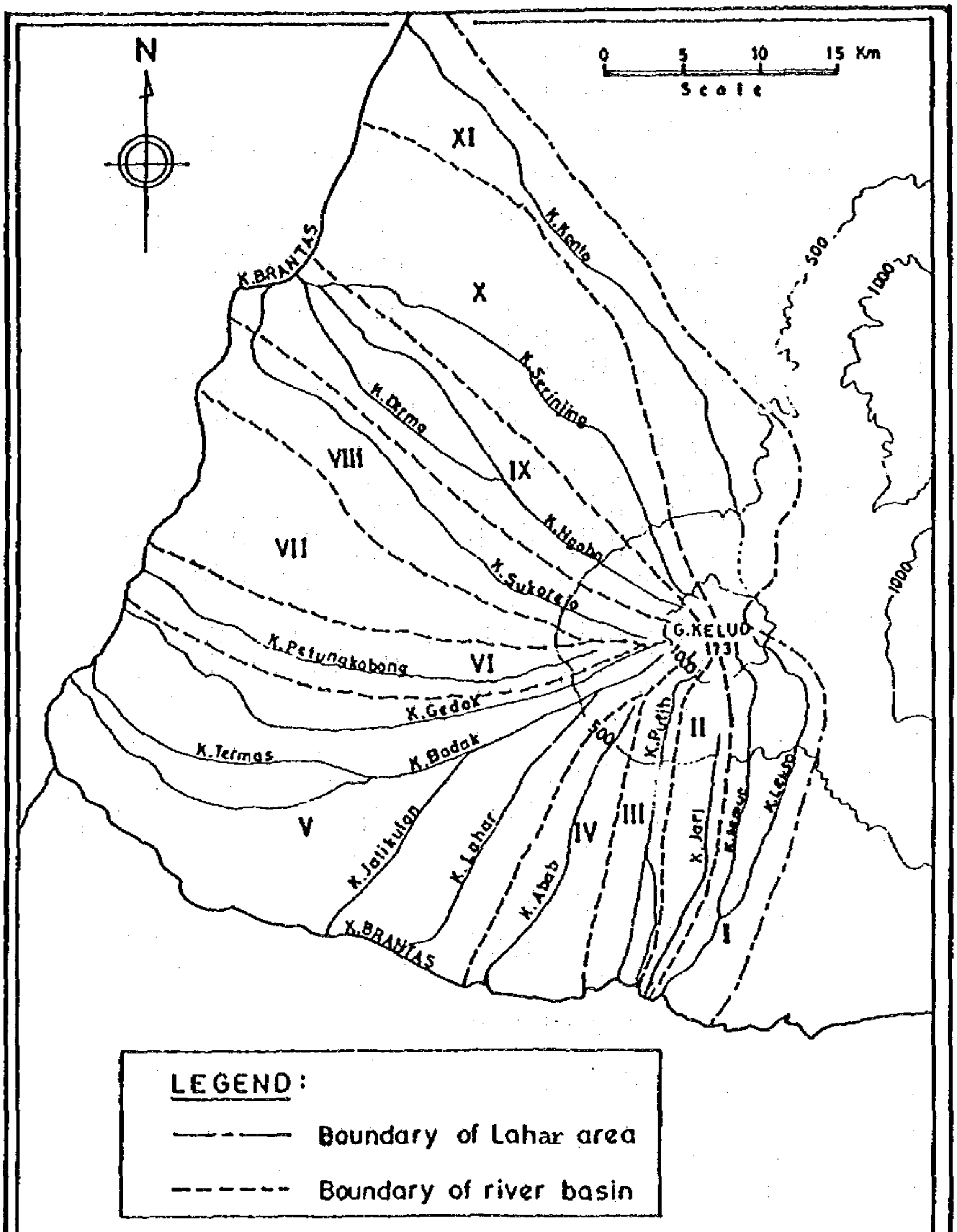
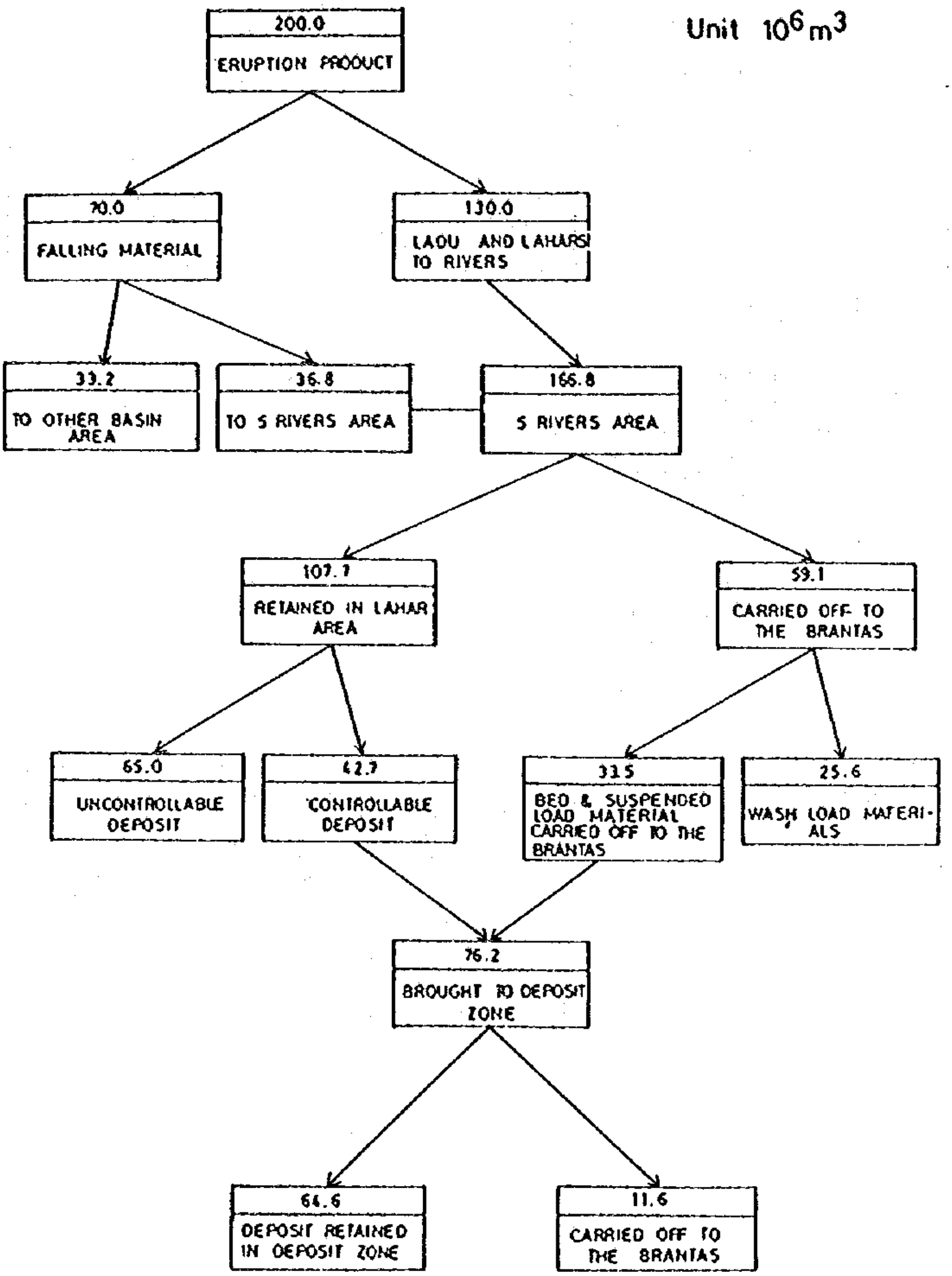


Fig. WS-20 CATCHMENT AREA AROUND G.KELUD



Source: WS 04

Fig. WS-21 PROPOSED SEDIMENT BALANCE DURING 15 YEARS

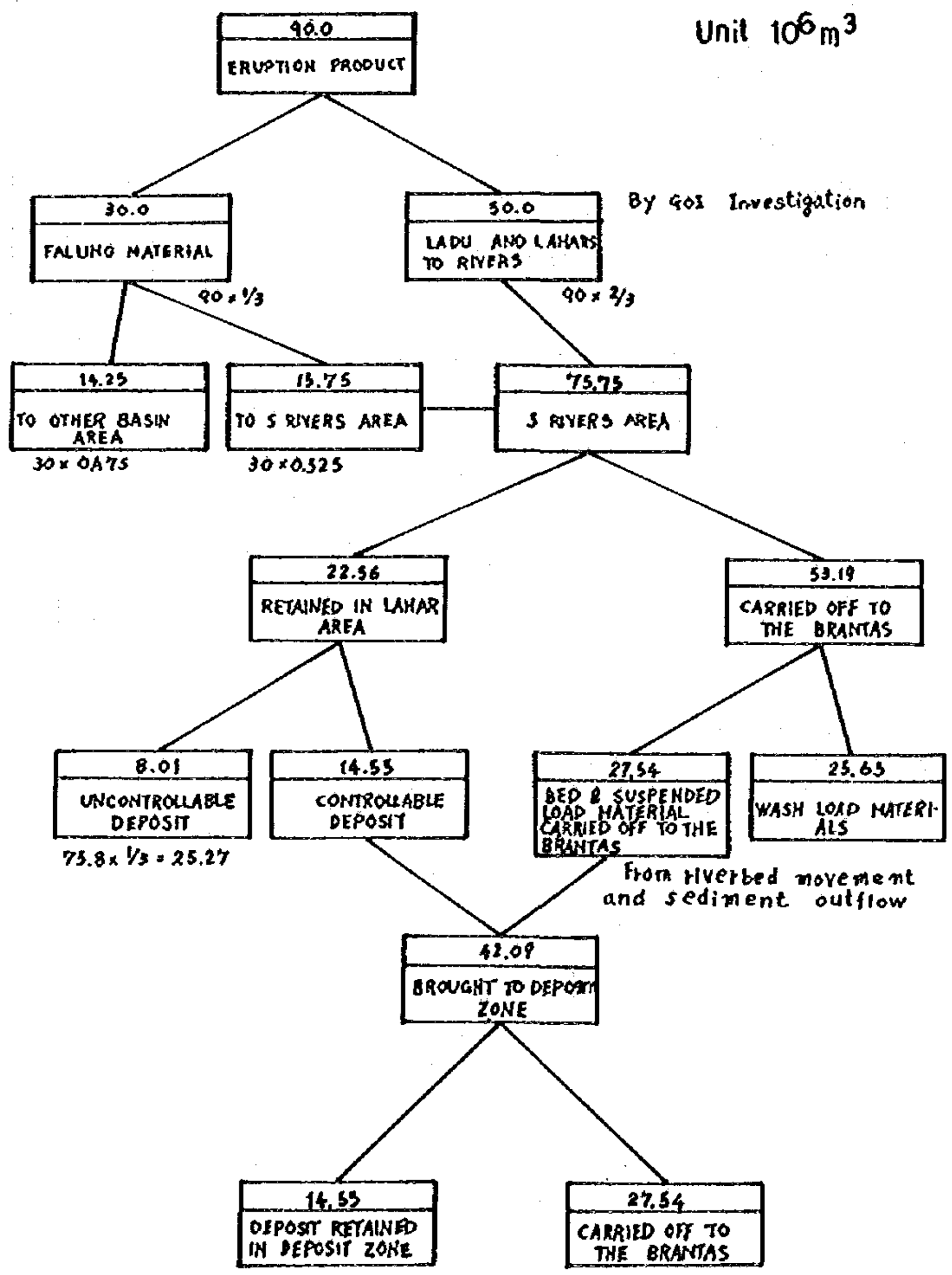


Fig. WS-22 SEDIMENT BALANCE BASD ON THE ERUPTION IN 1966

ANNEX EP

ELECTRIC POWER DEVELOPMENT STUDY

ANNEX EP

TABLE OF CONTENTS

LIST OF TABLES

NOTE EP-1

EVALUATION CRITERIA FOR HYDROPOWER PLANTS

1. Classification of Alternative Power Plants

To assess the selected hydro potential sites in Brantas river basin, various thermal power plants are considered as alternative power plants in this study as follows:

(a) Gas turbine plant is applied as a peak load supply with annual plant factor of 20% to 40%.

(b) Oil fired steam power plant is applied as a middle load supply with annual plant factor of 40% to 50%.

(c) Coal fired steam, geo-thermal, combined cycle and unclear power plants can be considered as a base load supply with annual plants factor of 60% to 70%. To simplify the case study, coal-fired steam plant is applied.

2. Capital Cost of Alternative Power Plants

The current unit construction costs which have been used in the thermal projects by PLN seem to be reasonable and the following is applied as the price level of Sept. 1984.

	Power Plant	Plant Size (MW)	Unit Cost/1 (US$/kW)	Unit Cost as of Sept. 1984/2 (US$/kW)
(a)	Gas turbine	100	300	310
(b)	Oil fired steam	200	699	720
(c)	Coal-fired steam	400	1,054	1,080
(d)	Coal-fired steam	600	944	970
(e)	Geo-thermal	55	1,096	1,120
(f)	Nuclear	1,000	1,698	1,740

Note: /1 - Price at April 1984 (Ref. EP-03)

/2 - Price escalation is assumed at 5% per annum

3. Fuel Cost

The current fuel prices as of April 1984 are summarized as follows:

Type of Fuel	US$/kl	S.G	US$/ton/1	Kcal/kg	US$/Kcal
H S D	224.53	0.844	266.03	11,000	74.2
I D O	227.17	0.87	261.11	10,000	61.1
M F O	163.52	0.99	165.17 (198.20)/2	10,000	19.8
Coal	-		45	5,300	8.5

Note: /1 - International market prices (Ref. EP-03)

/2 - Domestic market price which is ca. 20% higher than the International price (Ref. EP-03)

In this study, the domestic market price of MFO (Marine Fuel Oil) is reasonable to be applied.

4. Operation and Maintenance Costs and Service Life Years

Following operation and maintenance costs and service life years are assumed:

		Fixed Cost (%)	Variable Cost (US$/kWh)	Service Life Years
(a)	Coal-fired	2.0	0.06	25
(b)	Geo-thermal	2.0	0.06	25
(c)	Oil fired	2.0	0.06	25
(d)	Gas turbine	2.5	0.03	20
(e)	Hydro	1.0	-	50

5. Adjustment Factors of Thermal Plant against Hydropower Plant

Following assumption is made due to difference of the sites and characteristics of each power sources.

	Station Use (%)	T/L Loss (%)	Forced Outage (%)	Scheduled Outage (%)	Adjustment Factor (P.U)	
					for kW	for kWH
Coal-fired	7.0	2.0	8.0	12.0	1.252	1.039
Geo-thermal	5.0	5.0	6.0	8.0	1.171	1.049
Oil fired	6.0	2.0	7.0	10.0	1.198	1.028
Gas turbine	5.0	1.0	7.0	8.0	1.148	1.007
Hydro	0.3	5.0	0.5	2.0	-	-

6. Capacity and Energy Values

Based on the above assumption, the capacity and energy values of alternative power plants are summarized as follows:

(a) kW value at 12% discount rate

	Capital Cost (US$/kW)	Service Life (years)	Capital Recovery (%)	O & M Cost (%)	Annual Equiv. Cost (%)	Adjustment Factor (P.U)	kW Value (US$/kWh)
Coal-400	1,080	25	12.75	2.0	14.75	1.252	199.4
Coal-600	970	25	12.75	2.0	14.75	1.251	179.1
Geo-55	1,120	25	12.75	2.0	14.75	1.252	206.8
Oil-200	720	25	12.75	2.0	14.75	1.252	133.6
Gas-100	310	20	13.39	2.5	15.89	1.148	56.5

(b) kWh Value

	Fuel Cost (US$/ 10^6kcal)	Thermal/1 Efficiency (%)	Heat Value (Kcal/ kWh)	Fuel Coat (US$/ kWh)	O & M Cost (US$/ kWh)	Adjustment Factor (P.U)	kW Value (US$/ kWh)
Coal-400	8.5	33	2,606	0.0222	0.0006	1.039	0.0237
Coal-600	8.5	33	2,606	0.0222	0.0006	1.039	0.0237
Geo-55	-	-	-	-	-	-	0.0400/2
Oil-200	19.8	32	2,687.5	0.0532	0.0006	1.028	0.0553
Gas-100	24.2	24	3,583	0.0867	0.0003	1.007	0.0876

Note: /1 - Assumed plant factor is 50% for coal and oil and 15% for gas

/2 - Steam cost concluded between PLN and Pertamina (Ref. EP-03).

7. Disbursement for Capital Cost

Following disbursement rates are considered due to difference in construction period.

	Construction Period (Years)	Disbursement Rate (%)
Coal-400	6	5/ 20/ 35/ 25/ 10/ 5
Coal-600	6	5/ 20/ 35/ 25/ 10/ 5
Oil-200	5	5/ 25/ 40/ 20/ 10
Gas-100	2	40/ 60

Note EP-2 Extension/Improvement of Kali Konto River Basin Project

Improvement of the existing headrace tunnel of Mendalan power station has been considered to increase capacity from 9.25 m^3/s to 10.5 m^3/s but found difficult with low pressure grouting (Re. Review on the Installed Capacity of Selorejo Power Station, Nippon Koei, May 1969).

While, both Mendalan and Siman power stations were constructed in 1931 and 1932 respectively, of which service life time has been over 50 years. According to the result of investigation, both power plants were already improved with new parts in 1955.

Recently, spare parts such as turbine runners, wearing parts, etc., already procured for all units in both stations and some units were already overhauled with replacement of new runners and others except for generators. Other units are also scheduled to follow.

Operation and maintenance (O & M) cost in 1983/84 are summarized

	Mendalan (Rp. 10^6)	Siman (Rp. 10^6)	
O & M cost	28.1	12.8	
Repair cost /1	32.1	18.9	For overhaul
Personnel expense /2	6.0	3.2	
Total	66.2	34.9	

(Source : PLN KITLUR)

Note: /1 - Repair cost is annualised assuming that runner and wearing parts are replaced with new ones at a interval of 20 years.

/2 - Personnel expense is estimated for lack of data.

Assuming that construction costs of both power stations are Rp. 4,700 x 10^6 and Rp. 2,180 x 10^6 as a new plant, O & M cost will share 1.4% for Nendalan and 1.6% for Siman respectively, which intimates almost reasonable, taking account of superannuation.

There is no sufficient data to review the economical evaluation by the lowering of output and energy. However, the residual service life years will be surely prolonged by the replacement of turbine runners and wearing parts for more than 20 years.

No schedule of retirement is therefore considered within the year of 2003/04.

NOTE EP-3

KARANGKATES RESERVOIR WATER LEVEL HEIGHTENING BY 2 METERS

The present High Water Level (HWL) in Karangkates reservoir is EL. 272.5 and there is an idea to heighten HWL by 2 m from EL. 272.5 m to increase water storate to utilize it in the dry season.

As for power station equipment, it should be checked whether the existing fac-lities can be safely operated or not due to 2 m heightening of HWL.

As a result of review of the contract specifications and commissioning test data, followings are revealed:

1. Metal Works

   (a) Penstock and surge tanks

   Design pressure is 133 m and test result shows 125 m to 127 m. Heightening of 2 m will give a pressure of 127 m to 129 m, which is still less than the designed pressure.

   (b) Intake gates

   Following portions exceed allowable stress:

   - Skin plate : 2%
   - Roller : 13%
   - Concrete shearing stress for guide frame portion : 18%

   The above intimates some countermeasures to be taken up if 2 m heightening of HWL is done.

2. Generating Equipment

   (a) Maximum output

   Maximum output of turbines is designed at 36 MW and its operation shall be done so as not to exceed 36 MW at any head.

   (b) Performance of turbine - generator

   Performance test results are shown below:

		Guaranteed Value	Oscilograph	Instrument
Gen. output	(MW)	35.1	34.84 (34.65)	34.8 (34.65)
Voltage rise	(%)	30	28.26 (28.86)	26.36 (25.72)
Speed rise	(%)	35	28.8 (26.75)	28.0 (25.6)
Pressure rise	(m)	38	29.79 (30.38)	31.5 (31.0)
Max. pressure	(m)	133	125.4 (125.99)	127.11 (126.61)

It is estimated that maximum pressure will be 127 m to 129 m in case of 2 m heightening since the same pressure rise can be expected, which is still less than the designed pressure.

Regarding voltage rise and speed rise is expected to be slightly lower than the above data.

(c) Servomotors and thrust bearings

It seems that both servomotor has enough capacity to operate guide vanes and inlet valves respectively since some allowance must have been taken in the manufacturing desing. Thrust bearings seem to have enough strength for the same reason.

It is, however, recommended to confirm the above performances from the original manufactures beforehand.

(d) Cavitation and efficiency

It seems that there is no serious matter in cavitation. Turbine efficiency will be lower by ca. 0.2% at maximum output (36 MW) when compared with 89.7 m head efficiency.

Kesamben project is required to be reviewed at least in cost of dam foundation treatment due to the very poor geological condition.

Lesti III and Kepanjen projects which are under study by BREBDEO are also required to be reviewed in all respects.

Additional installation of 2 units in the Karangkates project utilizing the existing reservoir water is required to be reviewed as its entire peaking power station under some responsible discharge for irrigation and water supply. Especially, dependable output of additional units has to be reviewed in view of available inflow.

NOTE EP-4

LIST OF DATA: ELECTRICAL POWER DEVELOPMENT

Number	Name of Data	Author	Date of Issue
EP-01	Reveiw Feasibility Report on Kesamben Hydropower Development Project	Persero PT. Indra Karya	March, 1982
EP-02	Final Report for Hydropower Potential Study Vol. V Appendix-4 Power Demand Forecast	Nippon Koei, Tokyo in associated with PT. Indra Karaya Jakarta	June, 1983
EP-03	The Capacity Expansion Planning for The Electric Power System in Java (1984/85 - 1993/94) - Justification and Timing of Coal Fired Units No.1 and No.2 at Paiton -	Perusahaan Umum Listrik Negara (PLN)	May, 1984
EP-04	PLN Operation Statistics (74/75 - 82/83)	PLN	June, 1984
EP-05	ADB Appraisal Report for Power XVIII (For Sengguruh Hydropower Scheme)	ADB	1983
EP-06	Data Pembangkit, Area: IV	PLN, Unit Pengatur Beban Waru	23 Aug., 1983
EP-07	Laporan Pengusahaan, Area IV Periode: 1983 - 1984	PLN, Unit Pengatur Beban Waru	1984
EP-08	Hubungan Satukutub Transmisi Jatim	PLN, Unit Pengatur Beban Waru	17 June, 1984
EP-09	Feasibility Report on South Tulungagung Hydropower Project	BRBDEO assisted by Nippon Koei	July, 1984
EP-10	Feasibility Study on Five Hydro Electric Power Development Project Cibuni-3 Project (Draft)	Nippon Koei, Tokyo in associated with P.T. Indra Karya Jakarta	August, 1984

NOTE EP-5

SUMMARY OF THE PROJECT

KESAMBEN HYDROPOWER DEVELOPMENT PROJECT

REF: EP-01

1. BACKGROUND

- Need of Project

  The power demand in the East Java has been increasing due to the progress of industrialisation and the improvement of living standard of the people. According to the load demand forecast, peak power plants will be in short supply in 1988, for which Kesamben Hydropower plant will effectively contribute, along with development of large-scale steam power plants for base load operation.

- History of Project

  Hydropower development of the Brantas River Basin has carried out by the BRBDEO since 1960. Following Selorejo, Karangkates, Wlingi and Lodoyo hydropower projects (168.7 MW in total), the Project was formulated for the purpose of promoting the Project planning and its implementation through study report in 1977.

  Feasibility study was started by BRBDEO in August 1977 and completed in August 1978.

  Review feasibility study was done by Persero P.T. Indra Karya to update the load demand forecast based on the actual power supply and other data and submitted to BRBDEO in March 1982.

- Present Status of Project

  The Project has been proposed to GOI by BRBDEO for its implementation.

2. OBJECTIVES OF PROJECT

The purpose of the Project is hydropower development with dam. Kesamben power station is planned as a peak power station for 5 hours a day with a reservoir regulating the daily run-off and outflow from Karangkates power station.

3. PROJECT FEATURES

3.1 Project Area

- Location is 15 km downstream of Karangkates dam and 14 km upstream of Wlingi dam.

- Particular areas:

  The geology of the proposed dam site can be classified mainly into 2 strata by a horizontal line; the upper stratum is relatively soft and uncompacted and does not have suitable foundation for heavy structures, and the lower stratum is relatively hard and compacted.

3.2 Project Component

(1) Reservoir

Drainage area	:	2,488 km^2
Flood water level	:	El. 180.5 m
Low water level	:	El. 178.5 m
Storage capacity (gross)	:	20.4×10^6 m^3
Storage capacity (net)	:	4.182×10^6 m^3
Design flood peak	:	2,361 m^3/sec
Average run off	:	91.2 m^3/sec
90% dependable run-off	:	60.0 m^3/sec

(2) Dam

Type	:	Rockfill, centre core
Crest el.	:	El. 183.5 m
River bed el.	:	El. 160.0 m
Height	:	23.5 m
Crest length	:	190.0 m
Embankment volume	:	146,000 m^3

(3) Spillway

Type	:	OGEE
Design discharge	:	2,361 m^3/sec
Extra ordinary discharge	:	2,833 m^3/sec

(4) Diversion System

Type	:	Open canal
Design discharge	:	1,132 m^3/sec

(5) Power Station

Firm peak output	:	32,000 kW
Peaking operation hour	:	5 hours
Installed capacity	:	32,000 kW
Head	:	13.20 m - 14.55 m
Maximum peak discharge	:	288 m^3/sec
Annual energy	:	97.53 x 10^6 kWh
Turbine	:	16,400 kW x 2 units
Generator	:	18,000 kVA x 2 units

(6) Transmission Line : 70 kV, 1 cct, 14 km

3.3 Construction Cost (Unit: US$1,000)

	Domestic Currency	Foreign Currency	Total
- Economic cost	25,483	43,053	68,536
- Financial cost	27,259	43,841	71,010
- Direct cost	20,758	36,477	52,235
- Aministration cost	4,239	-	4,239
- Engineering service	186	3,716	3,902
- Land acquition	-	-	-
- Contingency (Physical)			
(a) For economic cost	1,914	3,576	5,490
(b) For financial cost	2,076	3,648	5,724
- Annual O&M cost	186	-	-
- Annual disbursement			
(a) 1st year (1982/83)	8,003	2,950	10,953
(b) 2nd year (1983/84)	3,978	2,498	6,476
(c) 3rd year (1984/85)	8,639	30,244	38,883
(d) 4th year (1985/86)	6,639	8,149	14,788

3.4 Benefit (12% interest rate) (Unit: US$1,000)

- Annual benefit : 12,106
- Capitalised benefit : 62,956
- Capitalised cost : 55,232
- Net benefit : 7,724

3.5 Economic Evaluation

- B/C (12% interest rate) : 1.14
- IRR : 14.12%

Note: /1 - 1982/83 price level

/2 - Exchange rate: US$1.0 = Rp. 625 = ¥208

/3 - Life period : 50 years

3.6 Implementation Schedule: 4 years from 1982/83 to 1985/86

4. WATER BALANCE: Not applicable

5. RECOMMENDATION

5.1 Problem Encountered

- Reliability of Project: Economic viability be confirmed

5.2 Recommendation

- Further study items be made:
  - (a) Dam foundation treatment due to poor geological condition
  - (b) Existing 70 kV transmission line capacity between Karangkates and Kebonagung
  - (c) Review of load demand forecast according to the actual power demand, if necessary.
- Other conceivable alternative be studied.

6. REFERENCES

- ANNEX MF List of Reports

  (1) MP-38

  (2) MP-39

  (3) MP-40

SUMMARY OF THE PROJECT

SOUTH TULUNGAGUNG HYDROPOWER PROJECT

REF.: EP-09

1. BACKGROUND

- Need of Project

  Tulungagung drainage project is under construction, to improve the drainage condition by additional canal and tunnel from Tulungagung town up to Indonesian Ocean. Utilizing the unused drainage water and hydropotential which is created in the drainage project, hydropower project is surely contribute the rapidly increasing power demand in the East Java.

- History of the Project

  The Tulungagung drainage project has been formulated in 1978/79. Implementation of the Project was started in 1980 to improve mal-drainage condition in the central part of the Ngrowo river basin. The project is now under construction and scheduled to be completed in 1985. The PROJECT is a sub-project arising from the drainage project, making the maximum use of the structures thereof along with the hydropotential and drainage water. Feasibility study was therefore implemented under ADB loan and completed in July 1984.

- Present Status of Project

  Detailed design was started in June 1984 under ADB loan. The PROJECT has been proposed to ADB by PLN for its construction implementation.

2. OBJECTIVES OF PROJECT

The purpose of the PROJECT is a single purpose of hydropower project with provision of intake in the drainage canal.

3. PROJECT FEATURES

3.1 Project Area

- Location

The project is located in the southern coast of the Java island. It is 30 km apart southward from Tulungagung town in the Ngrowo river basin, which is one of the major tributaries of the Brantas river in East Java Province.

- Particular Areas

The Gamping hills separate the Ngrowo river basin from the sea. The highest of the hills is around EL. 170 m and gently sloping down up to near the sea shore.

Tailrace of the Project may be affected by the tidal action. The on-going Tulungagung drainage project will separate the Ngrowo river basin at the Tulungagung gate from the Brantas river basin in 1985. About 90% of the run-off from the Brantas river basin will flow to the south and finally into Indian Ocean. Besides, some return flow from Lodoyo-Tulungagung project will flow into the drainage canals.

The Project area is in the submergence geomorphic coast of southern mountain range which is one of the inner arch mediterranean mountain belt. A series of limestone and sand stone, about 200 m thick, are laid in between G. Tanggal and G. Tumpakoyot and are surrounding the Popoh hay.

3.2 Project Component

(1) Intake

High water level	
in flood season	EL. 77.000 m
in off-flood season	EL. 79.000 m
Low water level	EL. 77.000 m
Aberage inflow	33.0 m^3/sec
Intake sill elevation	EL. 70.000 m
Intake width	7.5 m x 2
Peak intake discharge	53.4 m^3/sec
Firm discharge	1.7 m^3/sec

(2) Hedrace tunnel

Diameter/Length	4.7 m / 1,077.7 m
Shape	Circle

(3) Surge tank

Type	Port type
Diameter/height	12.0 m / 32.2 m

(4) Penstock

Type	underground
Diameter/Length	3.7 m / 634.6 m

(5) Power facilities

Net head	69.0 m
Peak discharge	53.4 m^3/sec
Tail water level	El. 1.94 m
Installed capacity	30,000 kW
Firm capacity output	6,100 kW
Annual energy output	130 GWh
Turbine	16,000 kW x 2
Generator	18,100 kVA x 2

(6) Transmission line — 70 kV, 2 cct, 35 km (connected with Trenggalek sub-station)

3.3 Construction Cost (Unit: US$1,000)

	Domestic Currency	Foreign Currency	Total
- Economic cost	-	-	40,603
- Financial cost	20,080	31,320	51,400
- Direct cost	9,288	19,475	28,763
- Engineering service	425	3,302	3,727
- Administration cost	2,800	-	2,800
- Land acquisition	-	-	-
- Contingency (Physical)	1,890	3,423	5,313
- Annual O & M cost	-	-	-
- Annual disbursement			
(a) 1st year (1985)	570	2,350	2,920
(b) 2nd year (1986)	2,710	5,500	8,210
(c) 3rd year (1987)	6,630	6,540	13,170
(d) 4th year (1988)	5,570	14,810	20,380
(e) 5th year (1989)	4,600	2,120	6,720

3.4 Benefit (12% interest rate) (Unit: US$1,000)

- Annual benefit : 3,745
- Capitalised benefit (annual) : 3,970
- Capitalised cost (annual) : 3,885
- Net benefit (annual) : 85

3.5 Economic Evalualtion

- B/C (12% interest rate) : 1.02
- EDR : 12.3%

Note: /1 - Price level : early 1984
/2 - Exchange rate : US$1.0 = Rp. 1,015 = ¥230
/3 - Life period : 50 years

3.6 Implementation Schedule: 5 years from 1985 to 1989

4. WATER BALANCE: None

5. RECOMMENDATION

5.1 Problem Encountered: None

5.2 Recommendation: None

6. REFERENCES

- ANNEX: RC-1 List of REports

  (1) RC-05

TABLE EP-1 (1) EXISTING POWER PLANTS IN EAST JAVA

(As of 1983/84)

Name		Installed Capacity (MW)	Year of Commissioning
(I) Hydropower Plants (PLTA)			
1.	Mendalan	23	
	- 1 x 5.6 MW		1930
	- 3 x 5.8 MW		1955
2.	Siman	10.8	
	- 3 x 3.6 MW		1955
3.	Selorejo	4.48	
	- 1 x 4.48 MW		1973
4.	Giringan	3.2	
	- 1 x 1.4 MW		1937
	- 2 x 0.9 MW		1955
5.	Golang	2.7	
	- 3 x 0.9 MW		1959
6.	Ngebel	2.2	
	- 1 x 2.2 MW		1968
7.	Sutami (Karangkates)	105	
	- 2 x 35 MW		1973
	- 1 x 35 MW		1976
8.	Wlingi	54	
	- 1 x 27 MW		1978
	- 1 x 27 MW		1980
9.	Lodoyo	4.5	
	- 1 x 4.5 MW		1983
10.	Widas (Micro st.)	0.62	
	- 1 x 0.62 MW		1984
	Sub-total (I)	210.6	

TABLE EP-1(2) EXISTING POWER PLANTS IN EAST JAVA

(As of 1983/84)

Name	Installed Capacity (MW)	Year of Commissioning
(II) Steam Power Plants (PLTU)		
1. Perak (oil-fired)	150	
- 2 x 25 MW		1964
- 2 x 50 MW		1978
2. Gresik (oil-fired)	200	
- 2 x 100 MW		1981
Sub-total (II)	350	
(III) Gas-turbine Power Plants (PLTG)		
1. Perak	27.5	
- 1 x 27.5 MW		1975
2. Gresik	40	
- 2 x 20 MW		1978
Sub-total (III)	67.5	
(IV) Diesel Power Plants (PLTG)	-	Diesel units (ca. 25 MW) in remote areas are being relocated or decommissioned.
Total	628.0	

(Source: Ref. EP-01 & EP-03)