FIGURAS

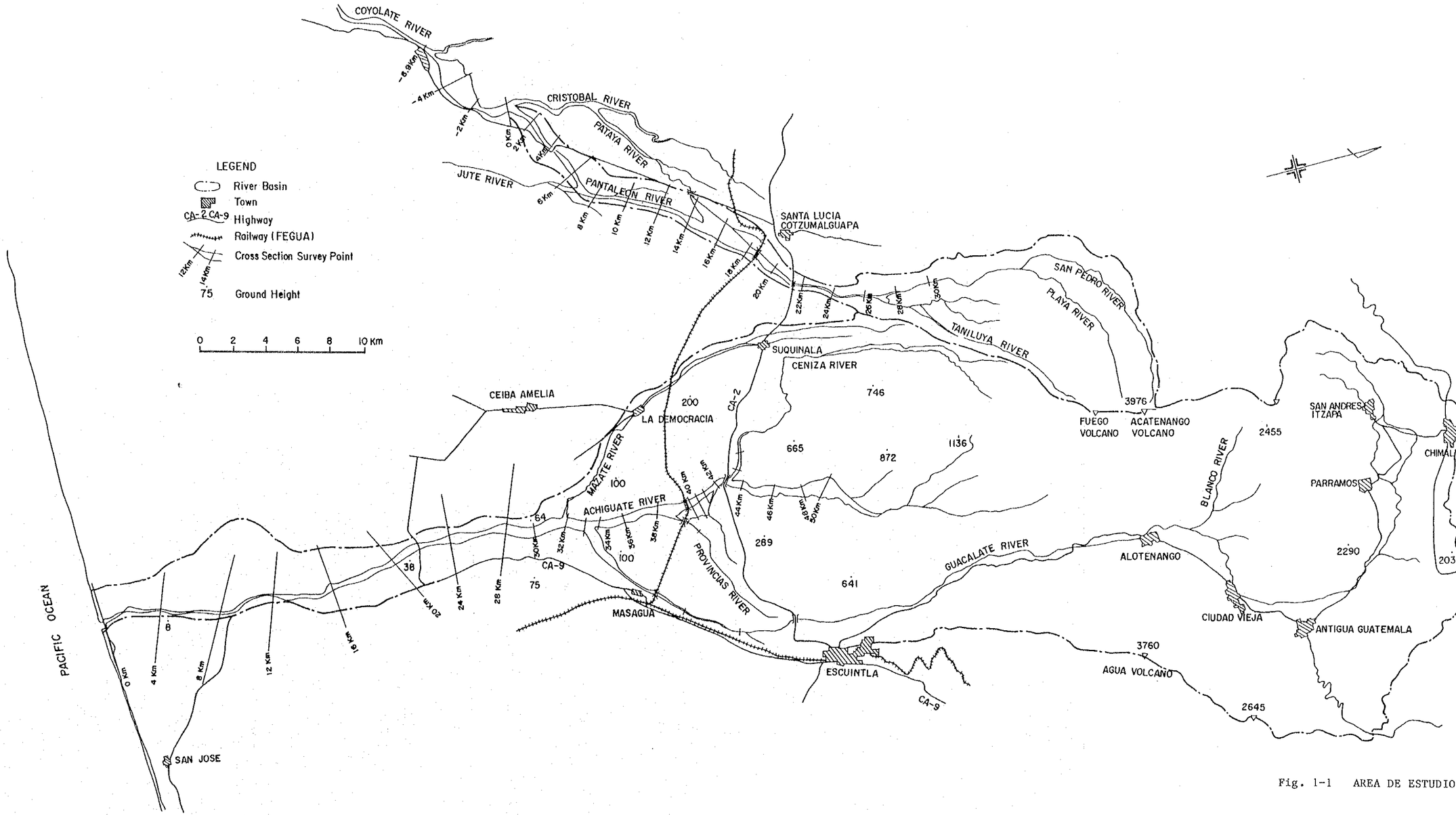


Fig. 1-1 AREA DE ESTUDIO

F

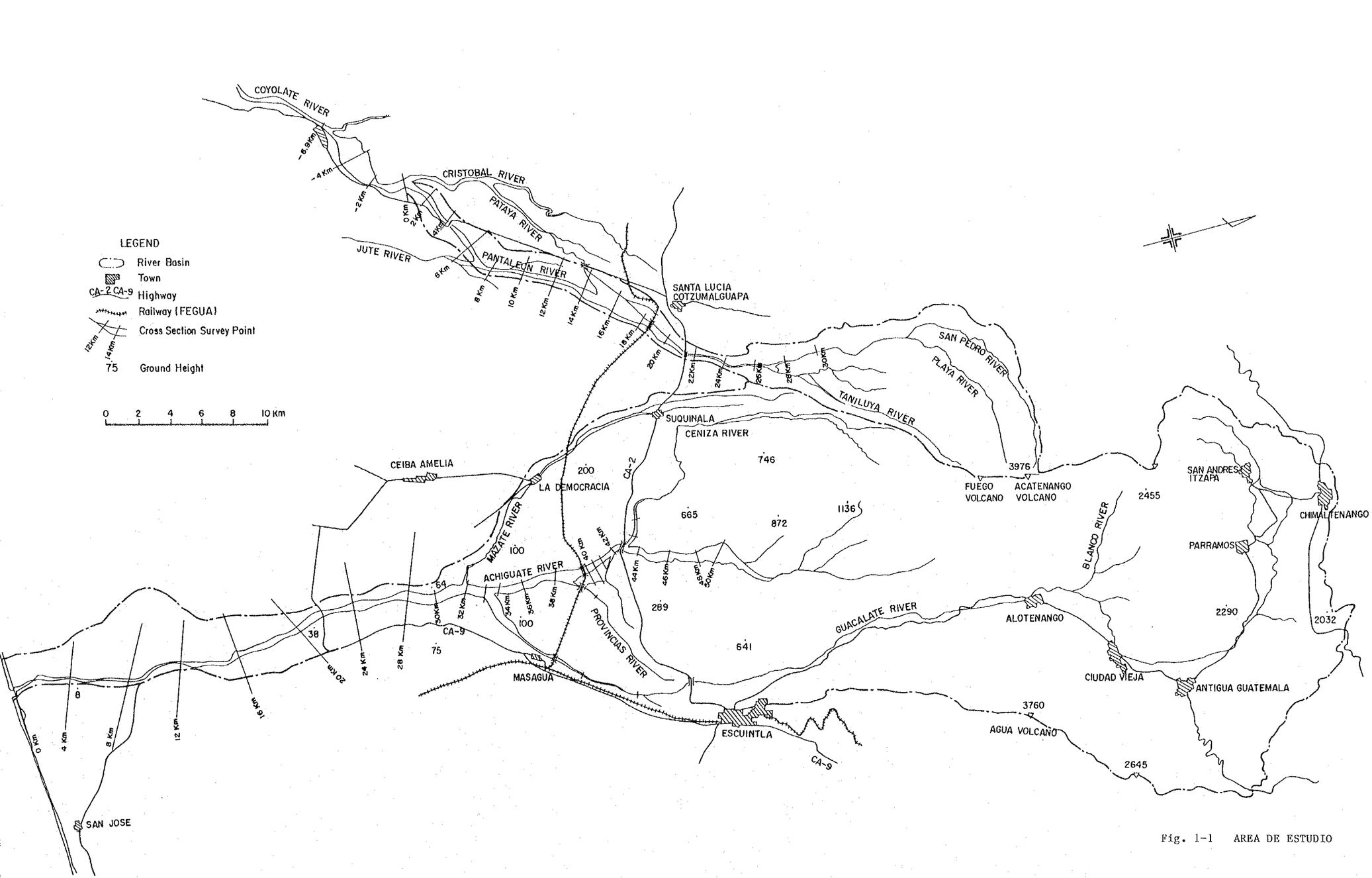


Fig. 1-1 AREA DE ESTUDIO

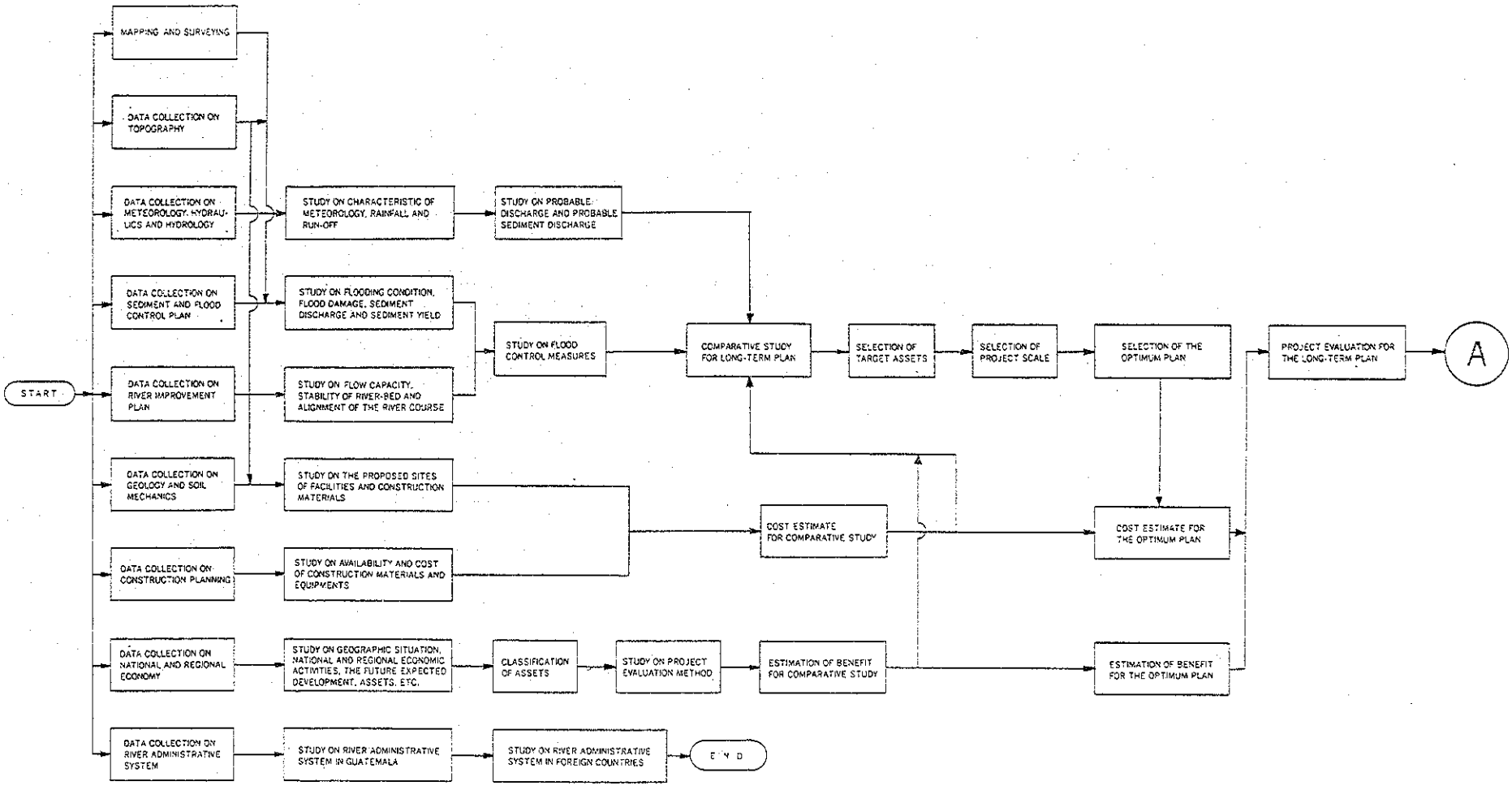


Fig. 1-2 (1/2) PROCESO DE ESTUDIO
(PLAN A LARGO PLAZO)

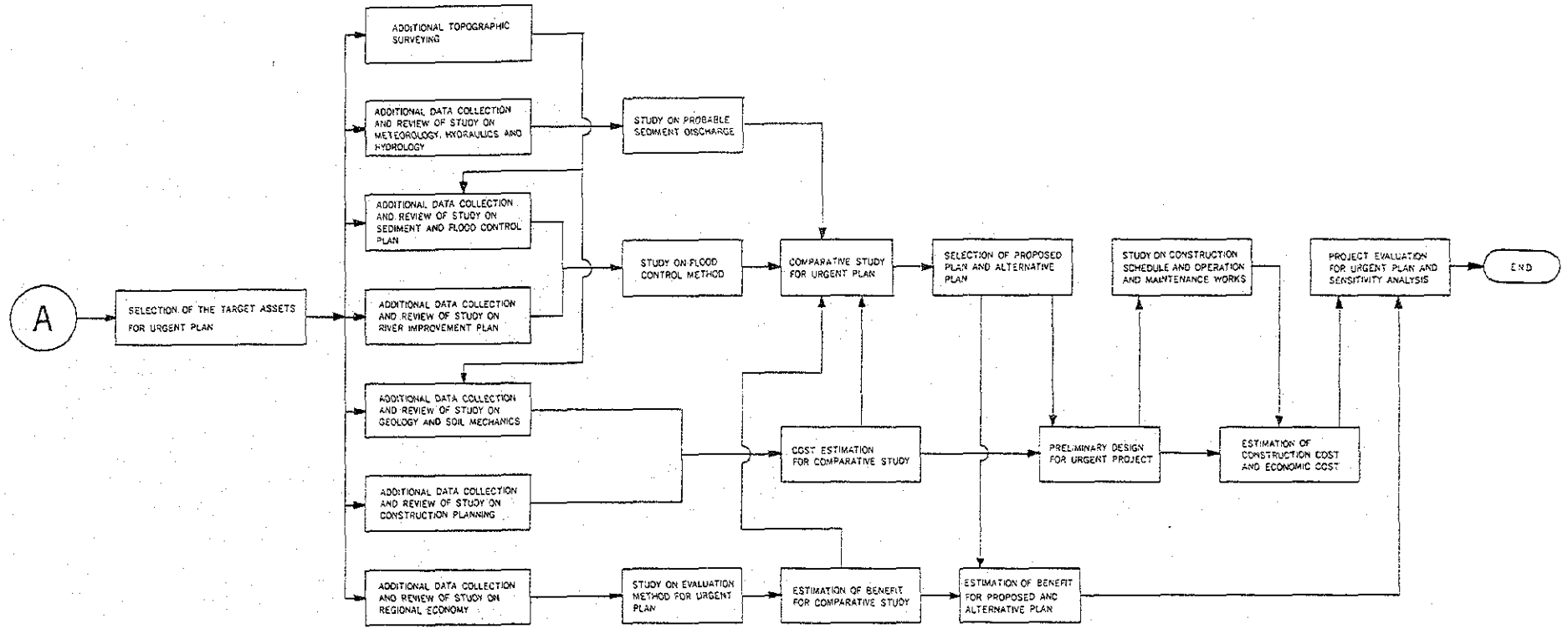


Fig. 1-2 (2/2) PROCESO DE ESTUDIO
(PLAN URGENTE)

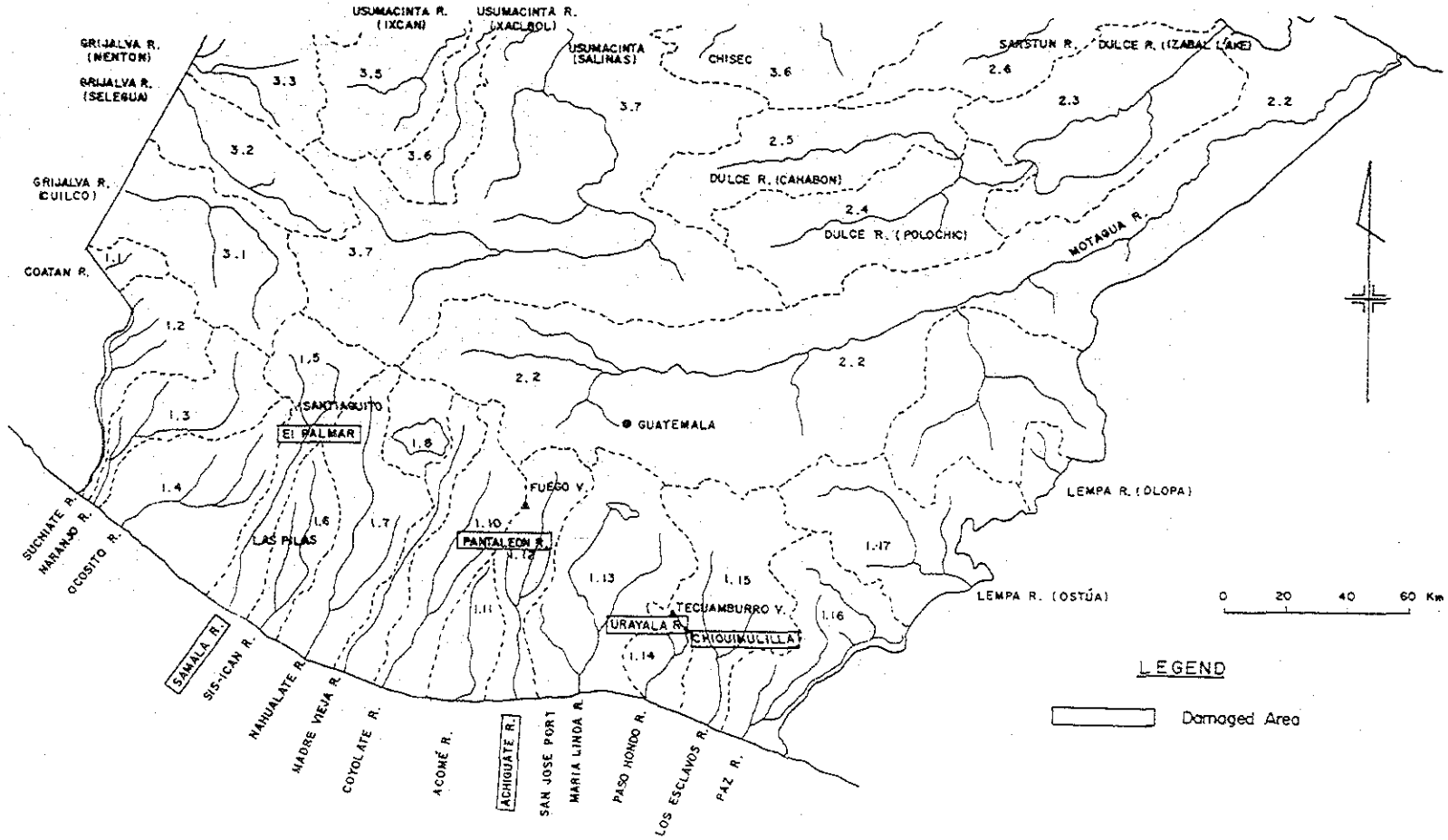
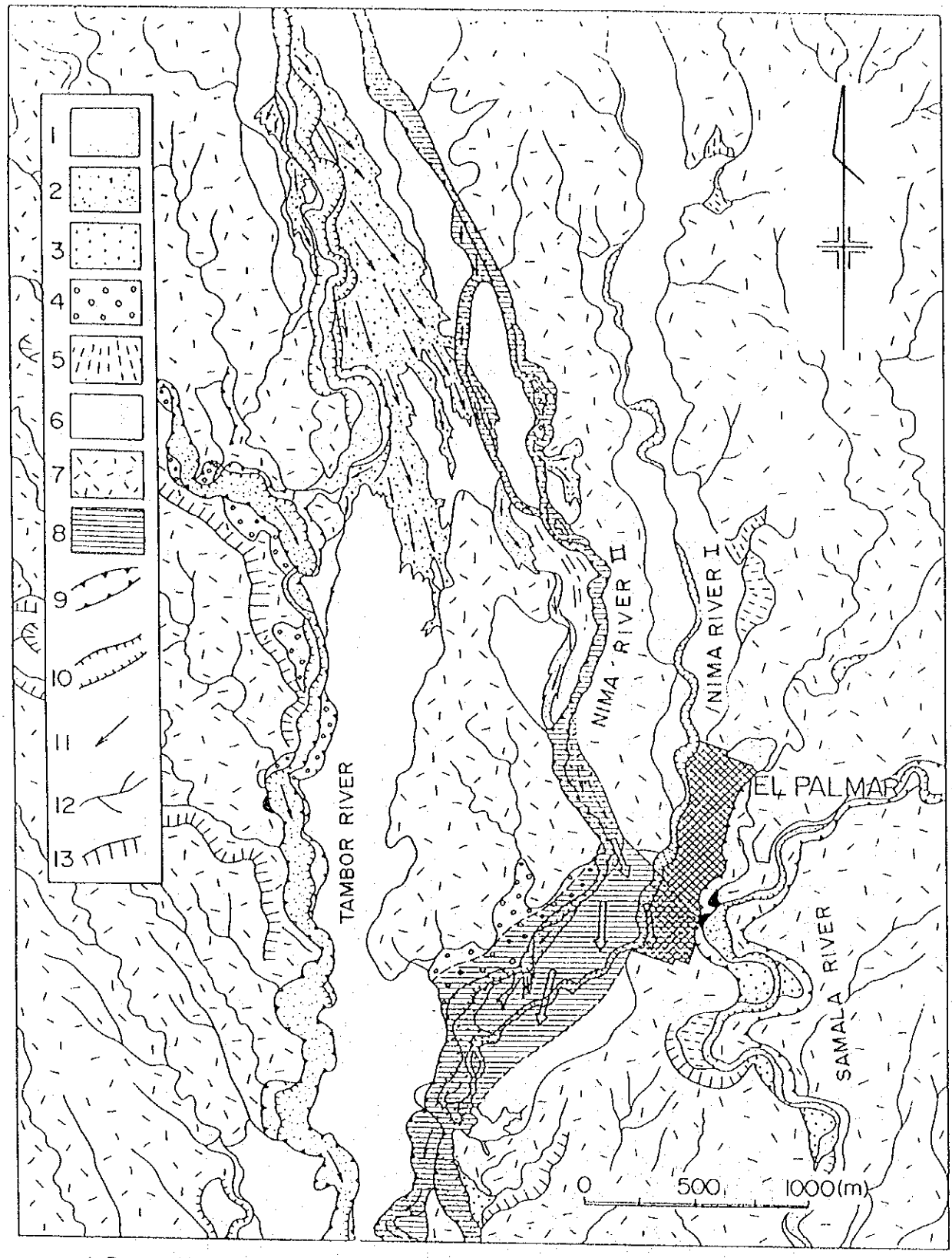


Fig. 2-1 UBICACION DE LAS AREAS DAÑADAS EN GUATEMALA



1: Recent riverbed
2: Recent debris flow deposits
3: Lower terrace
4: Middle terrace
5: Talus
6: Volcanic fan
7: Mountain slope
8: Debris flow deposits in June – July, 1983
9: Gully (deep)
10: Gully (shallow)
11: Direction of debris flow
12: Stream
13: Cliff

Fig. 2-2 AREA DAÑADA DE EL PALMAR Y CONDICION GEOMORFOLOGICA

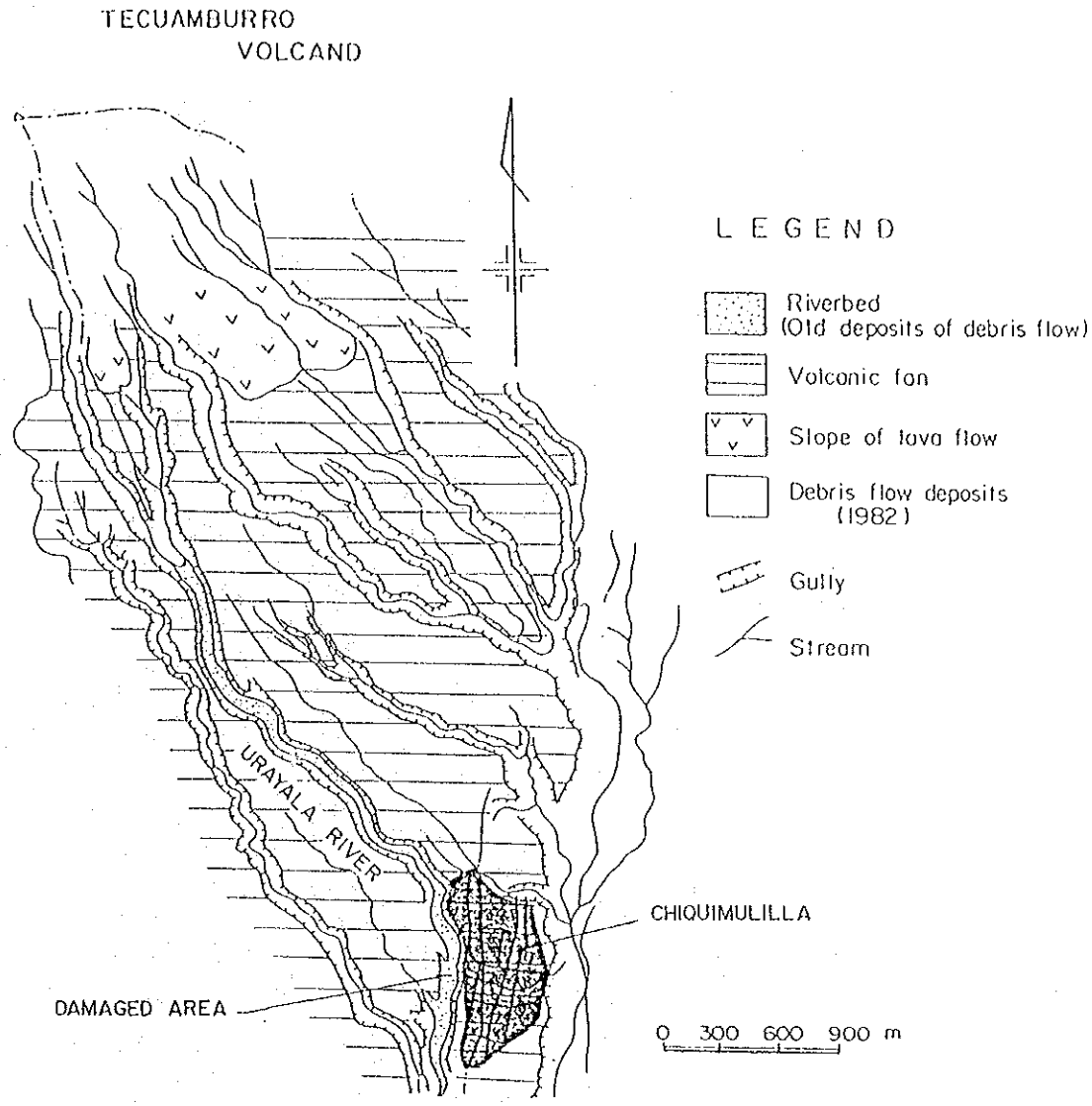


Fig. 2-3 AREA DAÑADA DE CHIQUIMULILLA Y CONDICION GEOMORFOLOGICA

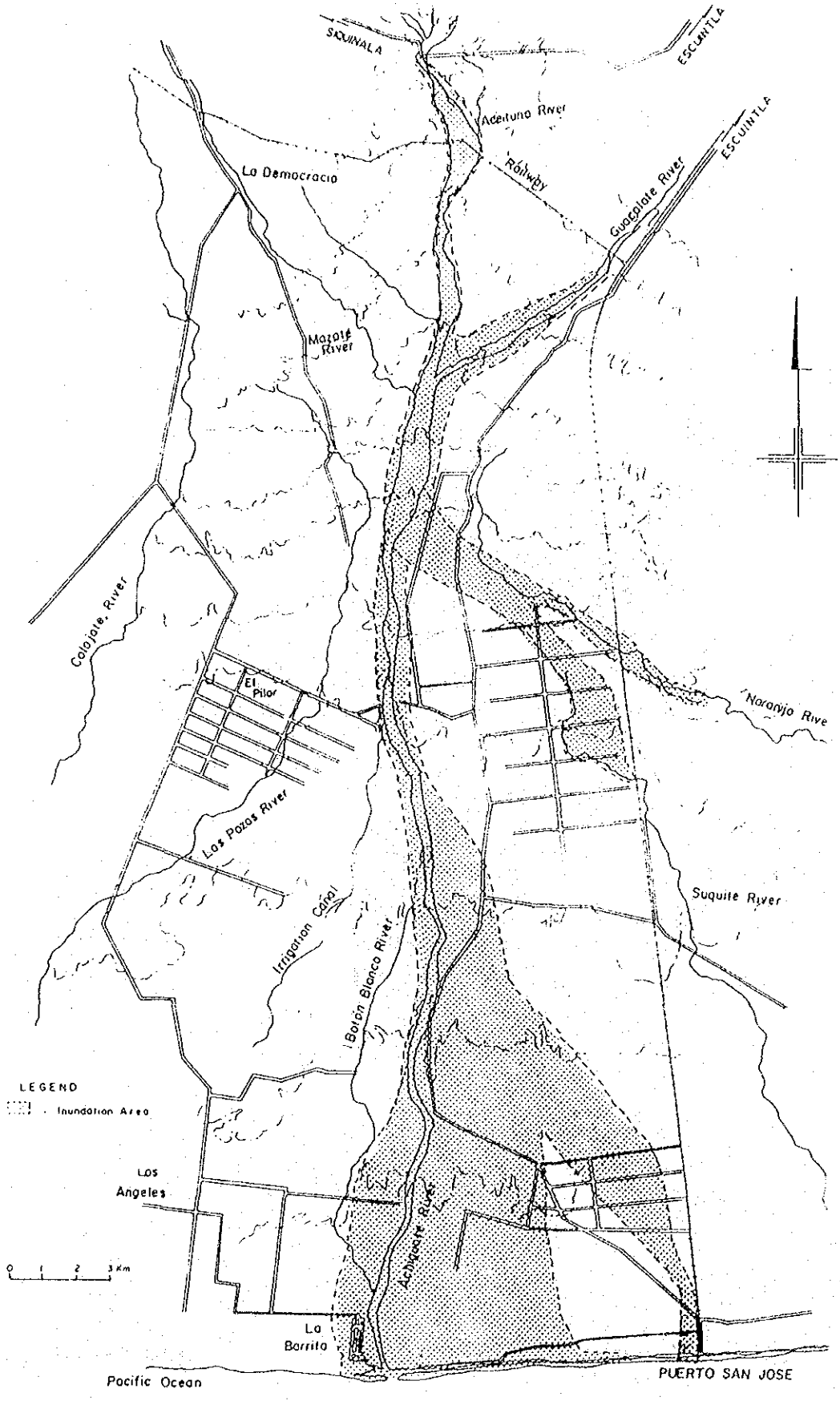


Fig. 3-1 (1/2) MAPA DE INUNDACION DE LA CRECIDA EN SEPTIEMBRE 1969 (RIO ACHIGUATE)

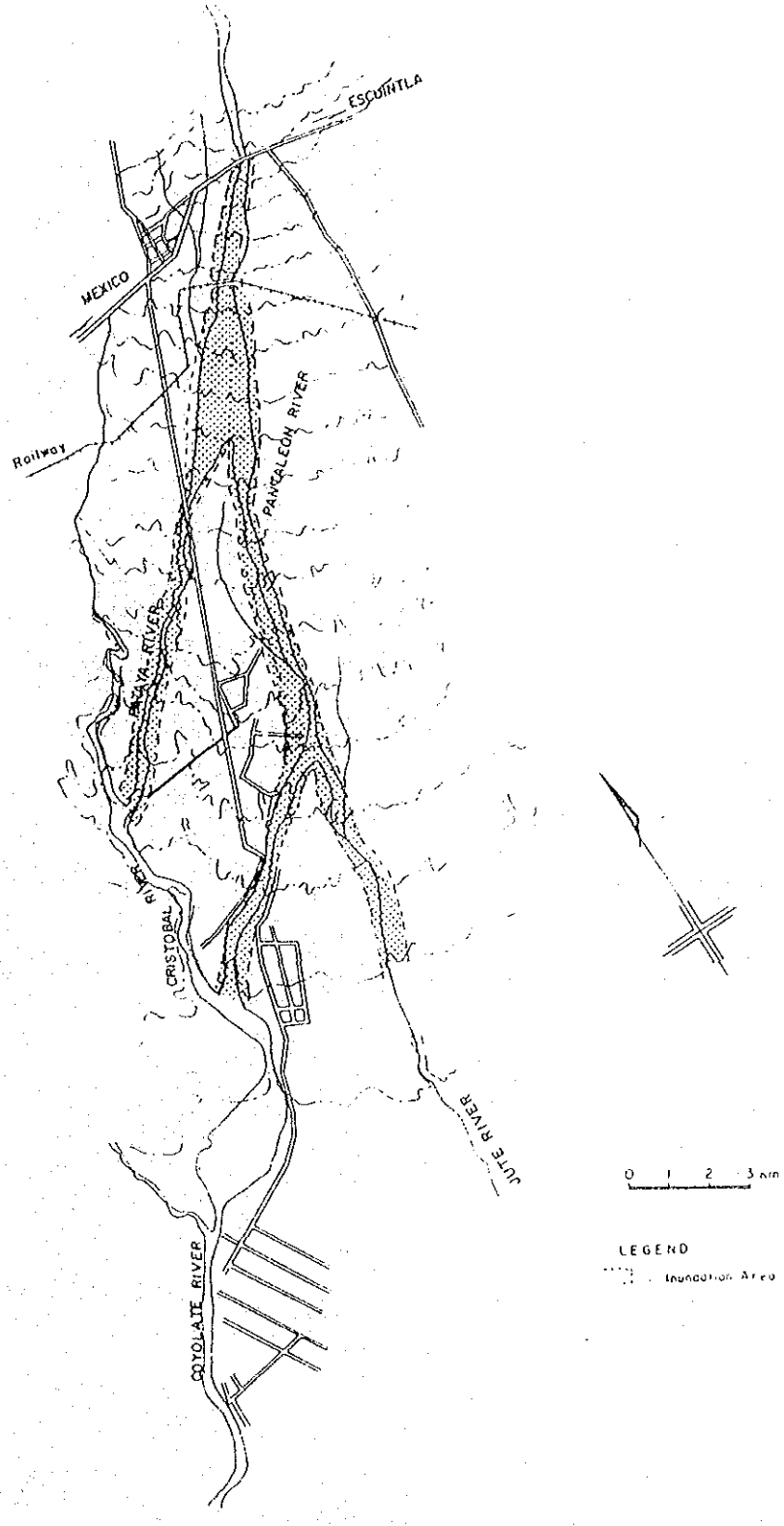


Fig. 3-1 (2/2) MAPA DE INUNDACION DE LA CRECIDA EN SEPTIEMBRE 1969
(RIO PANTALEON)

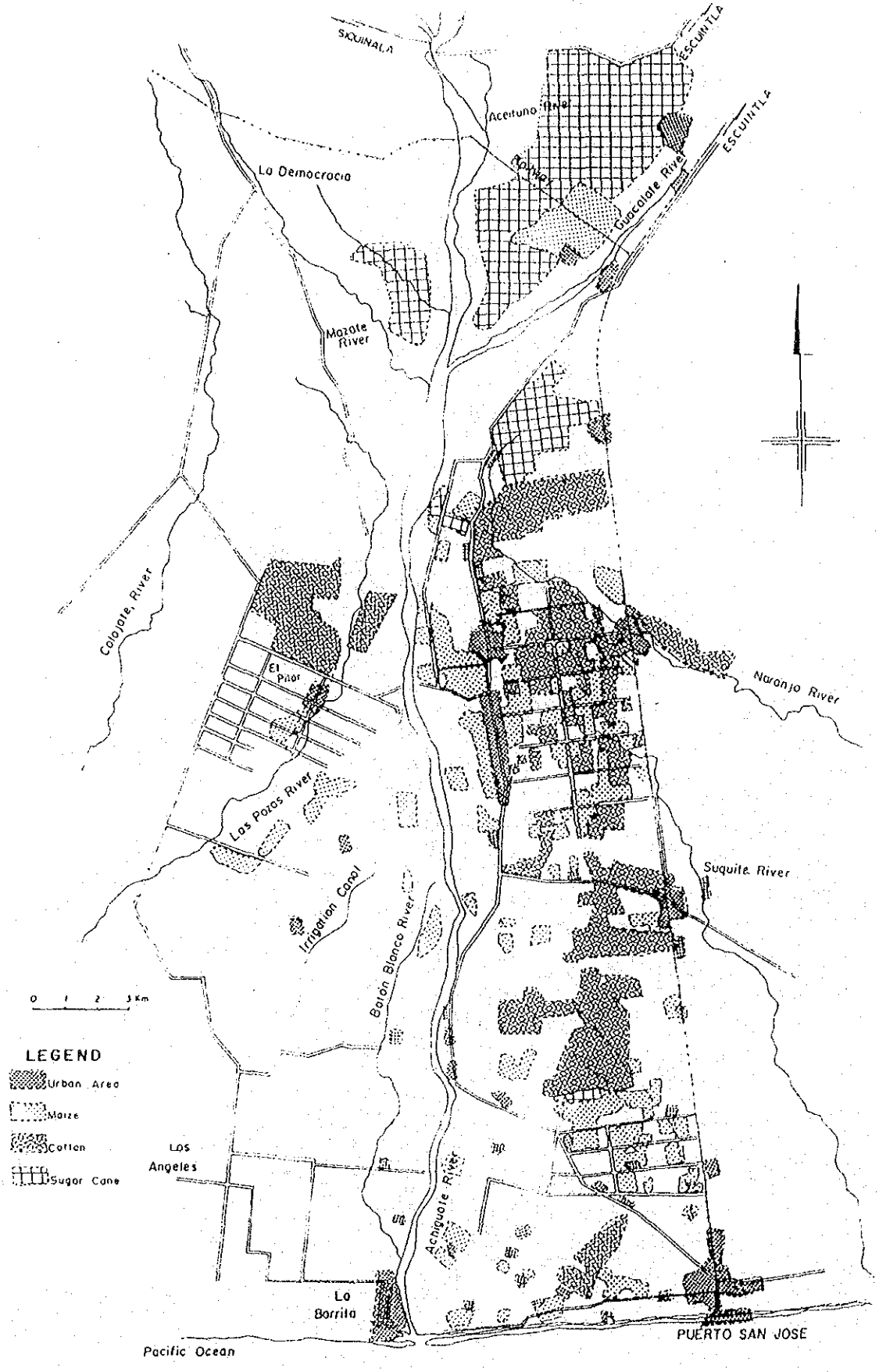


Fig. 3-2 (1/2) MAPA DEL USO DE SUELO (CUENCA DEL RIO ACHIGUATE)

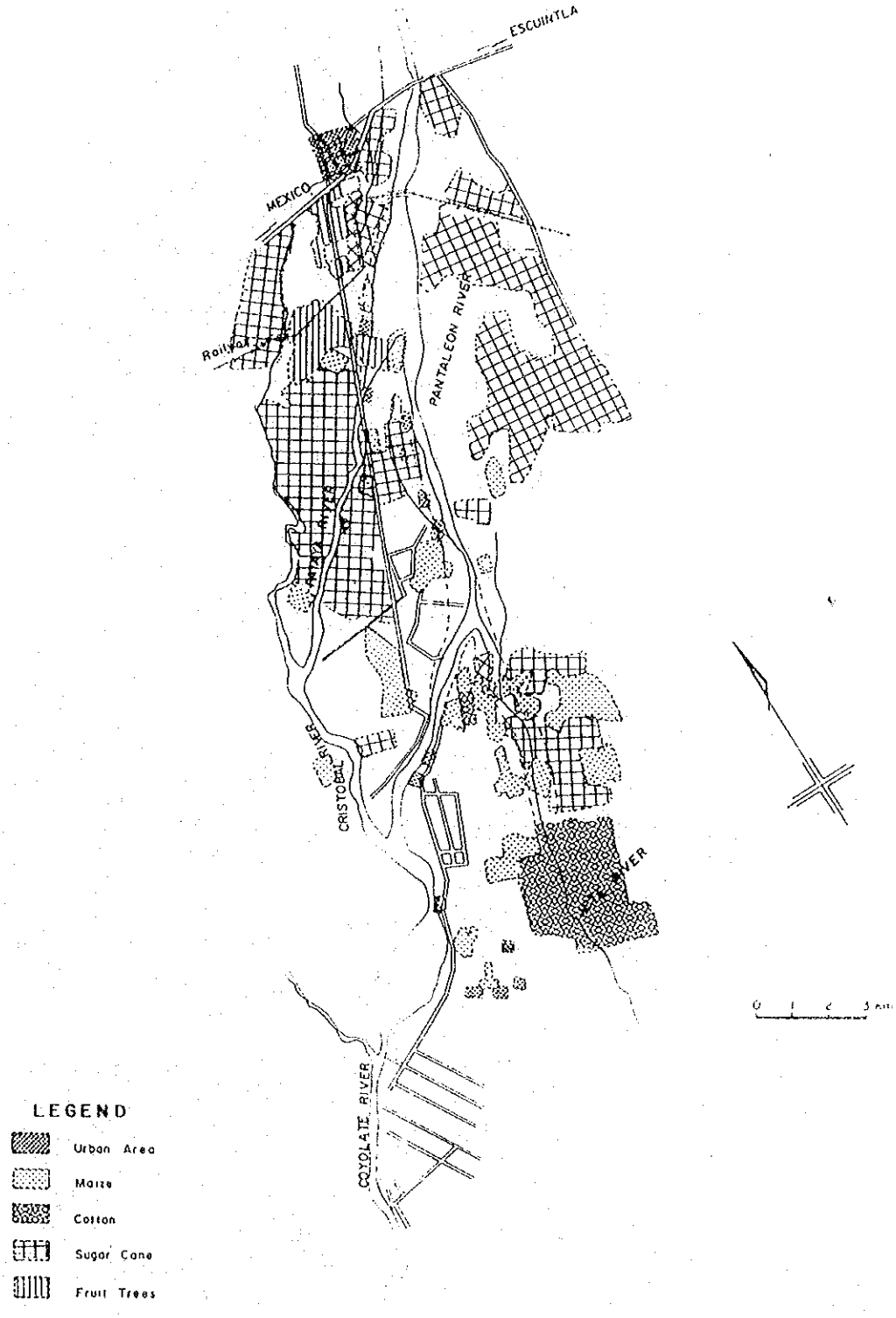


Fig. 3-2 (2/2) MAPA DEL USO DE SUELO (CUENCA DEL RIO PANTALEON)

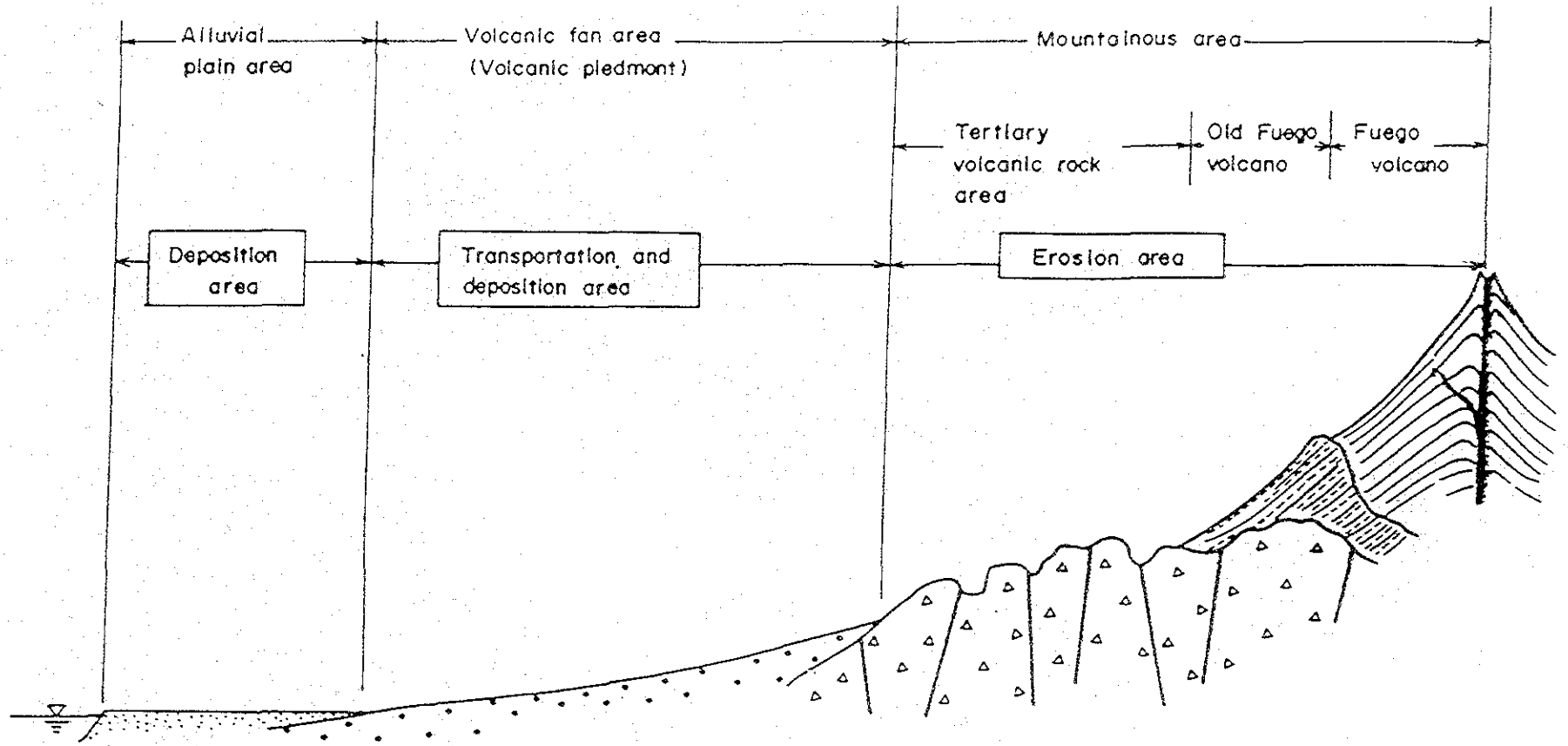


Fig. 3-3 DIVISION GEOMORFOLOGICA DEL AREA DE ESTUDIO

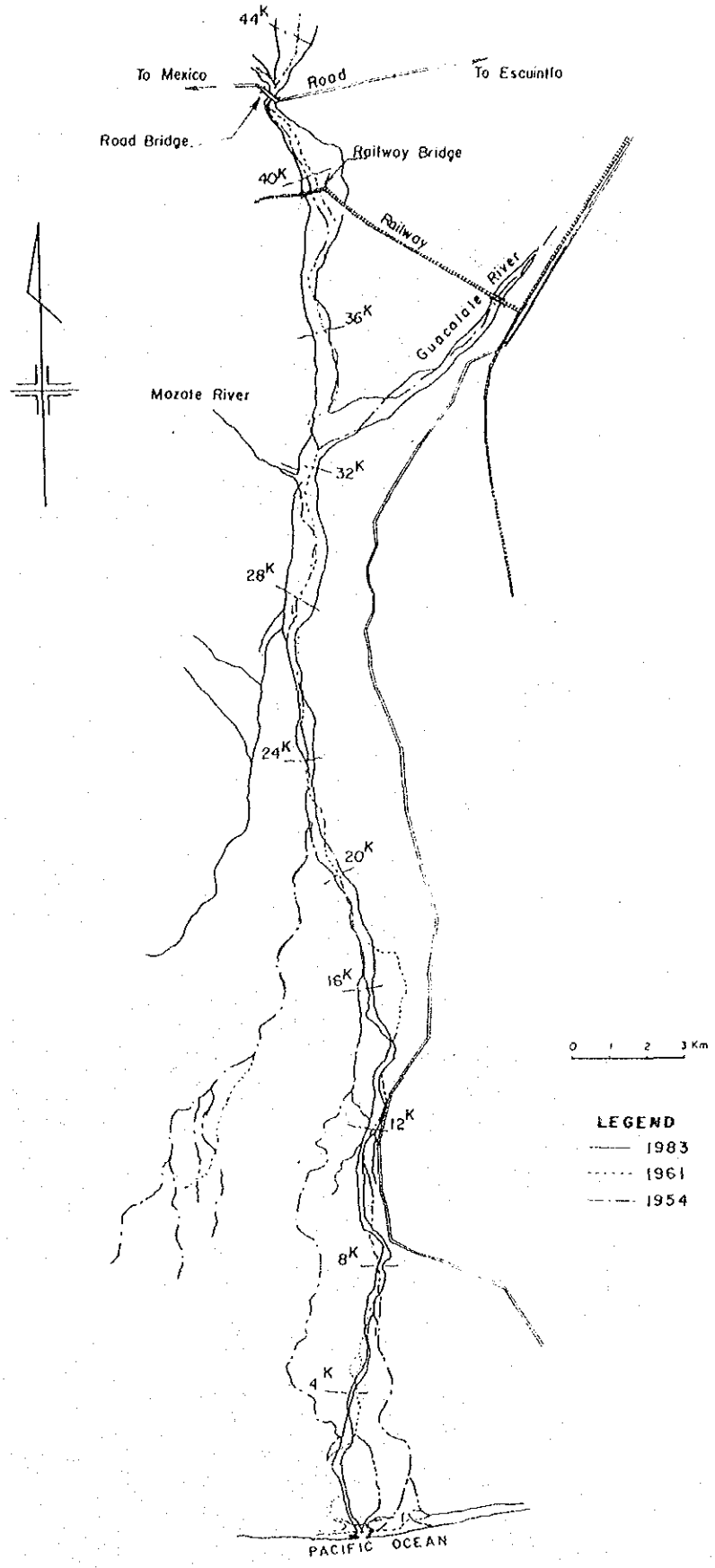


Fig. 3-4 (1/2) TRANSICION DEL CAUCE DEL RIO (RIO ACHIGUATE)

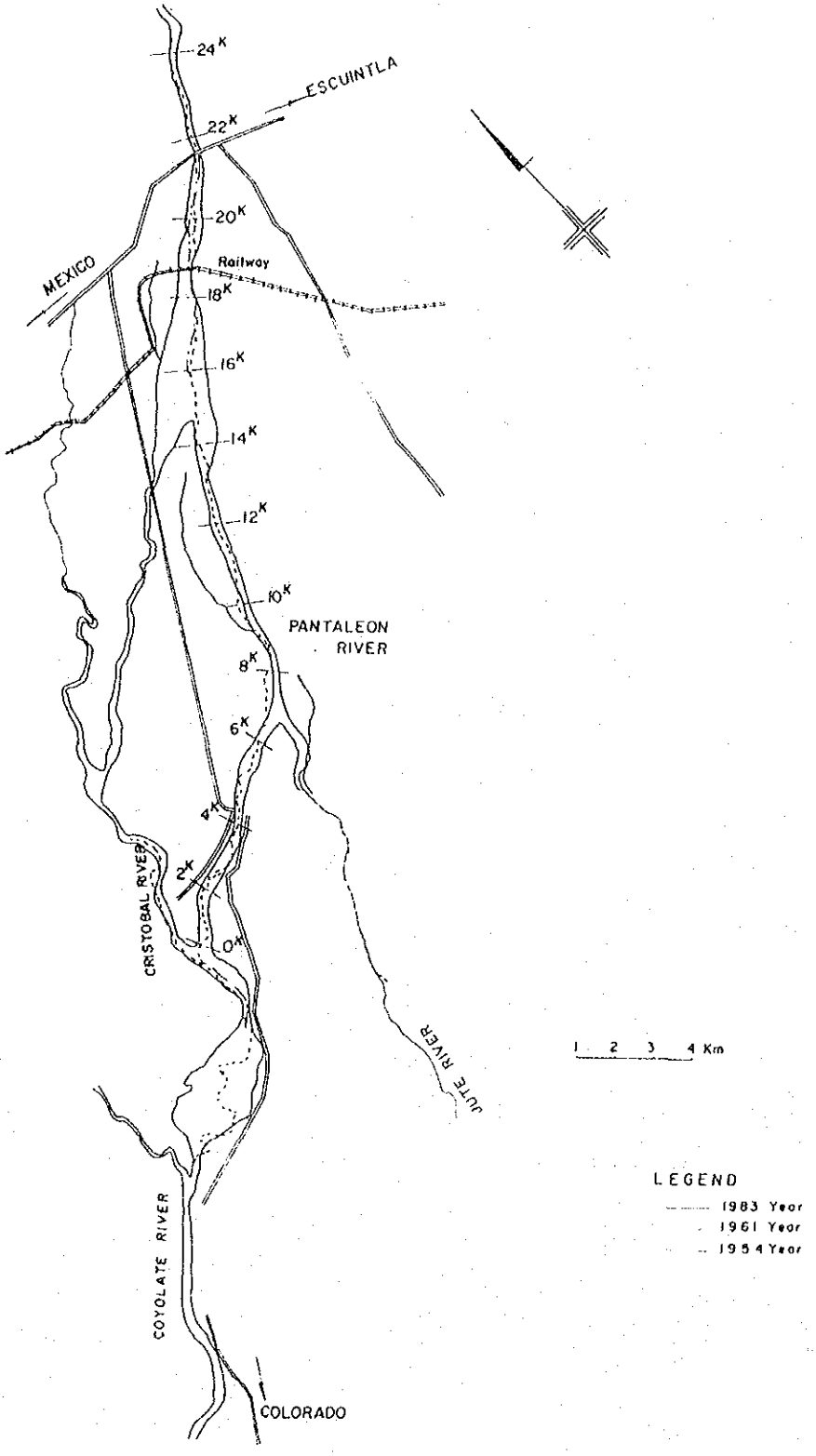


Fig. 3-4 (2/2) TRANSICION DEL CAUCE DEL RIO (RIO PANTALEON)

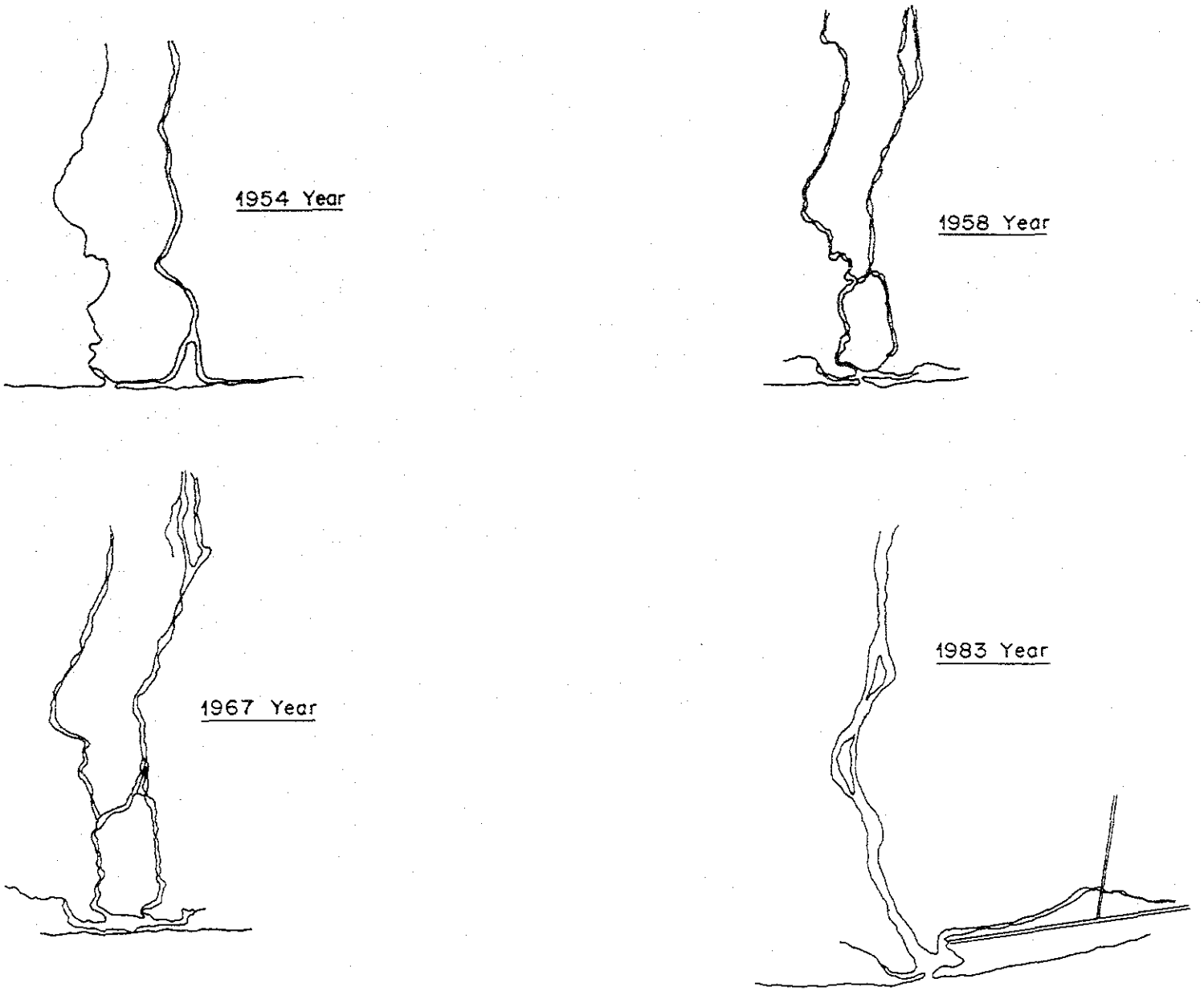


Fig. 3-5 TRNASICION DE LA DESEMBOCADURA DEL RIO ACHIGUATE

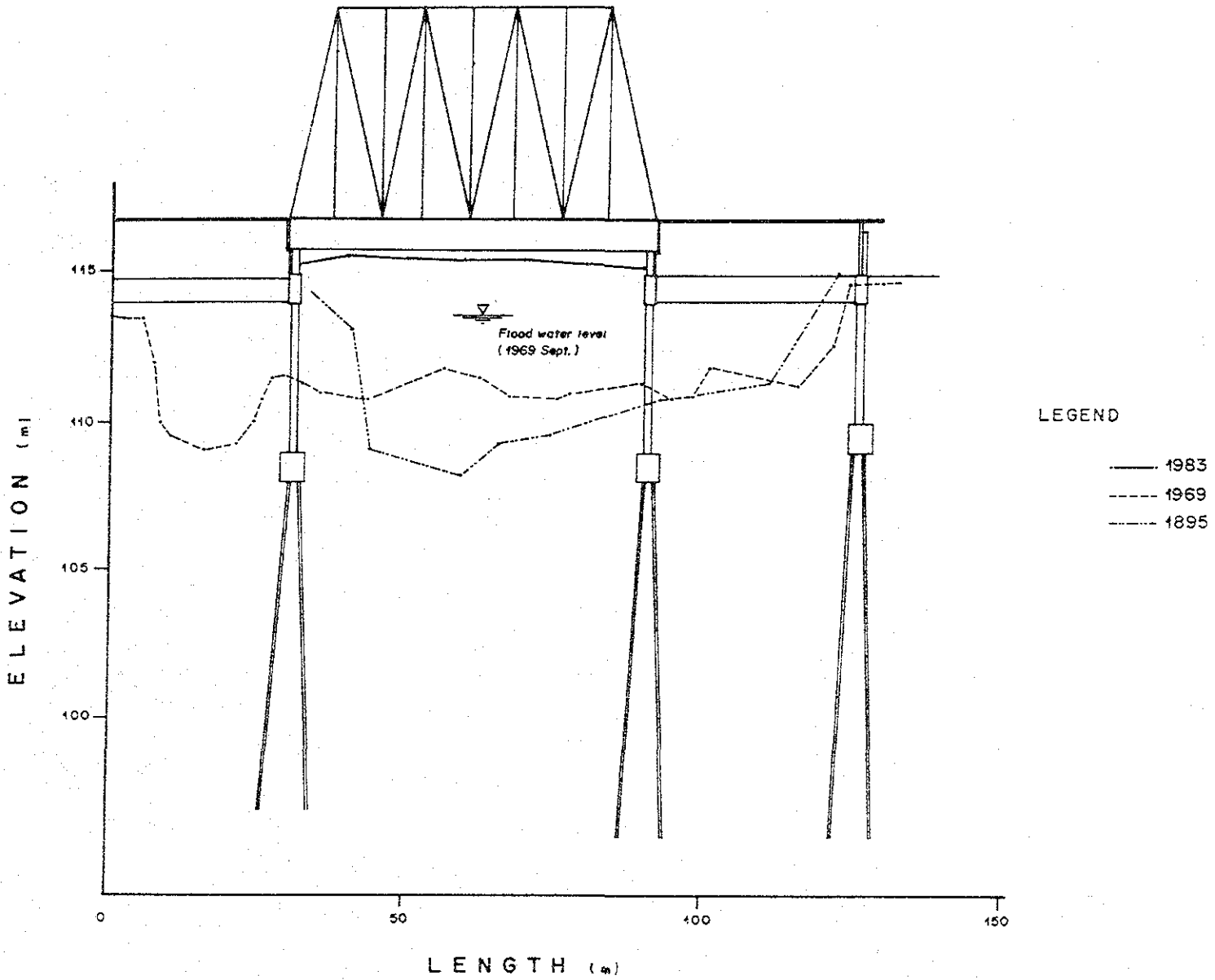


Fig. 3-6 TRANSICION DE LA SECCION TRANSVERSAL EN EL PUENTE DE FERROCARRIL DEL RIO ACHIGUATE

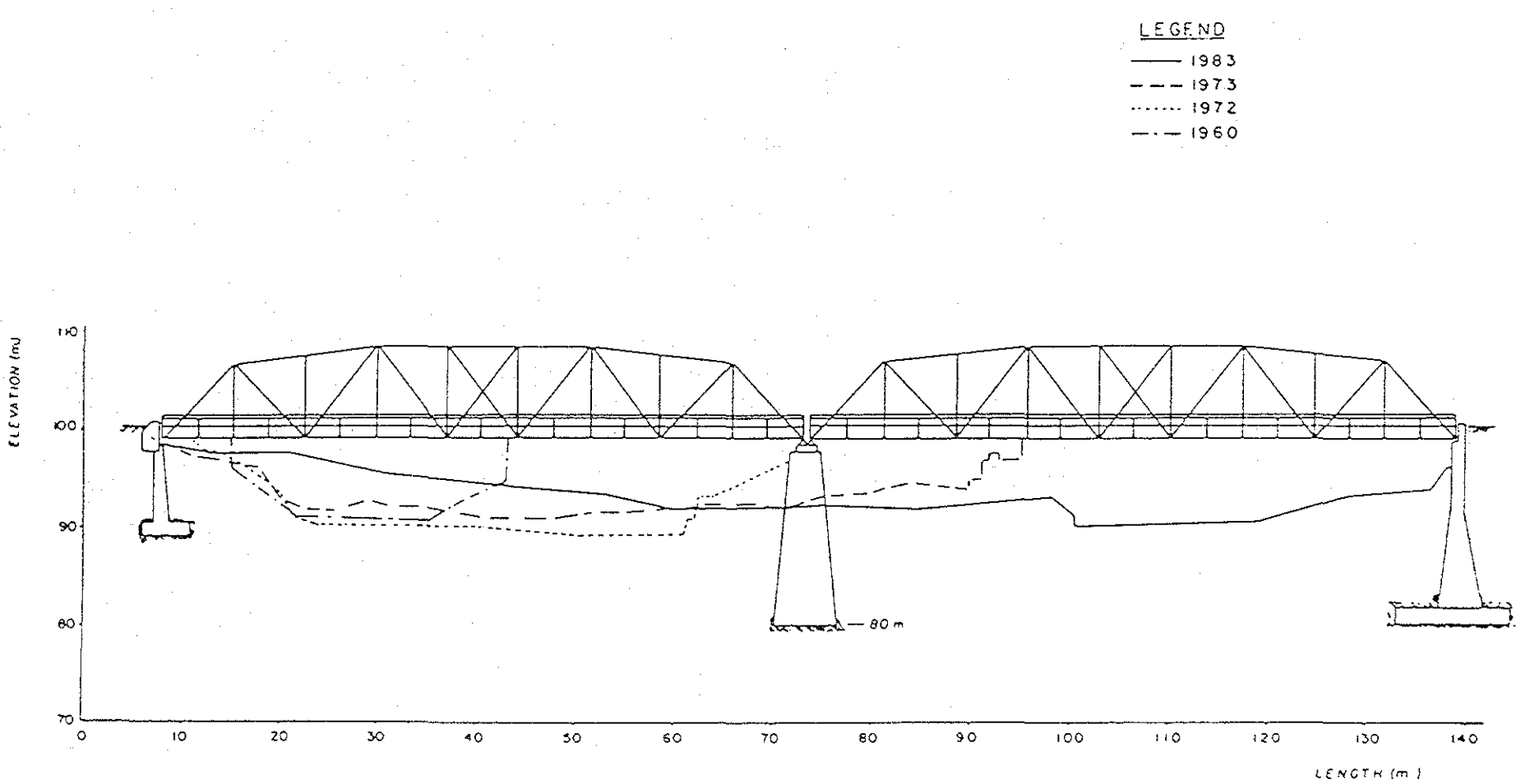


Fig. 3-7 TRANSICION DE LA SECCION TRNASVERSAL EN EL PUENTE DEL FERROCARRIL DEL RIO PANTALEON

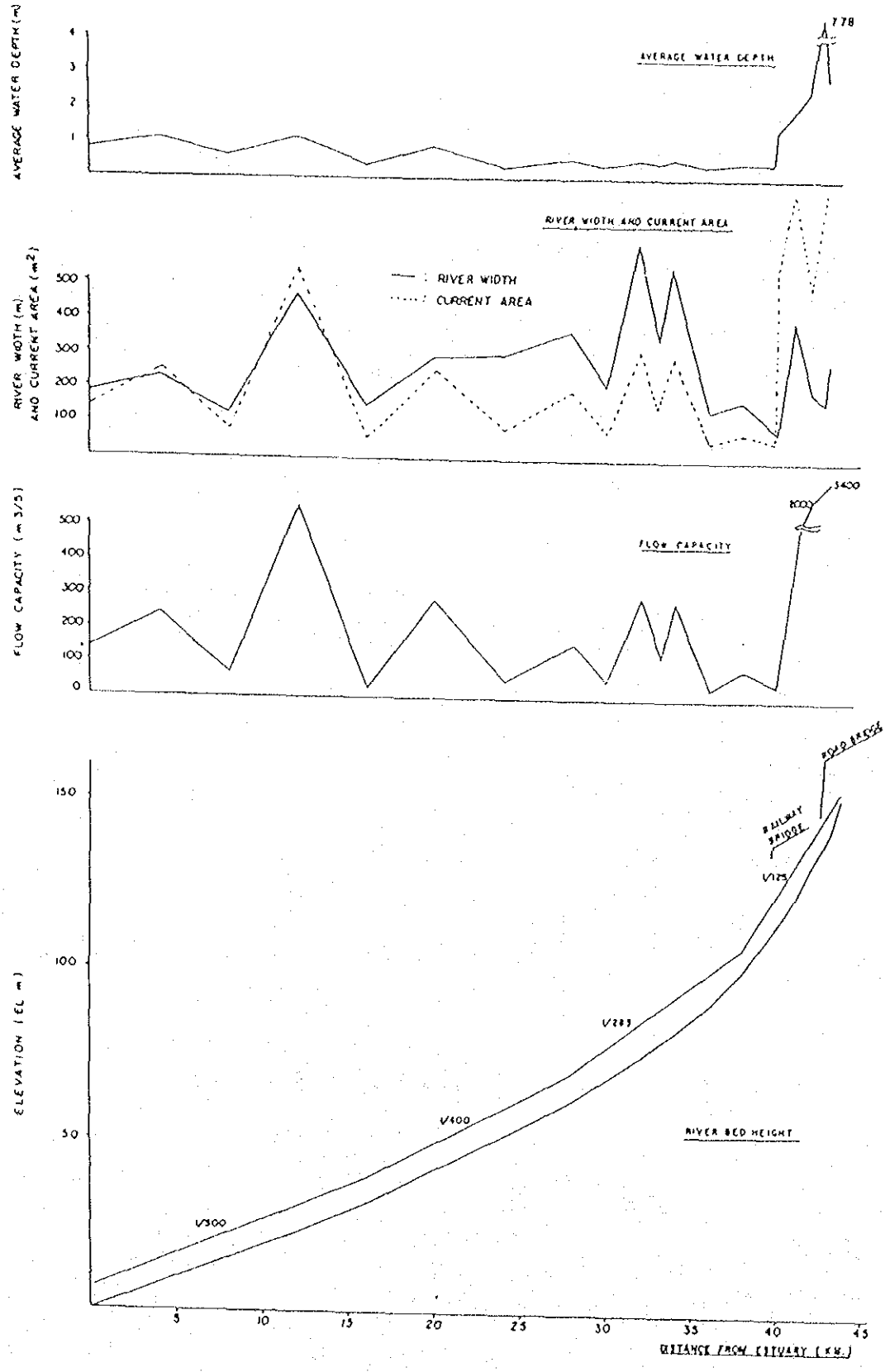


Fig. 3-8(1/2) CARACTERISTICAS DEL RIO (RIO ACHIGUATE)

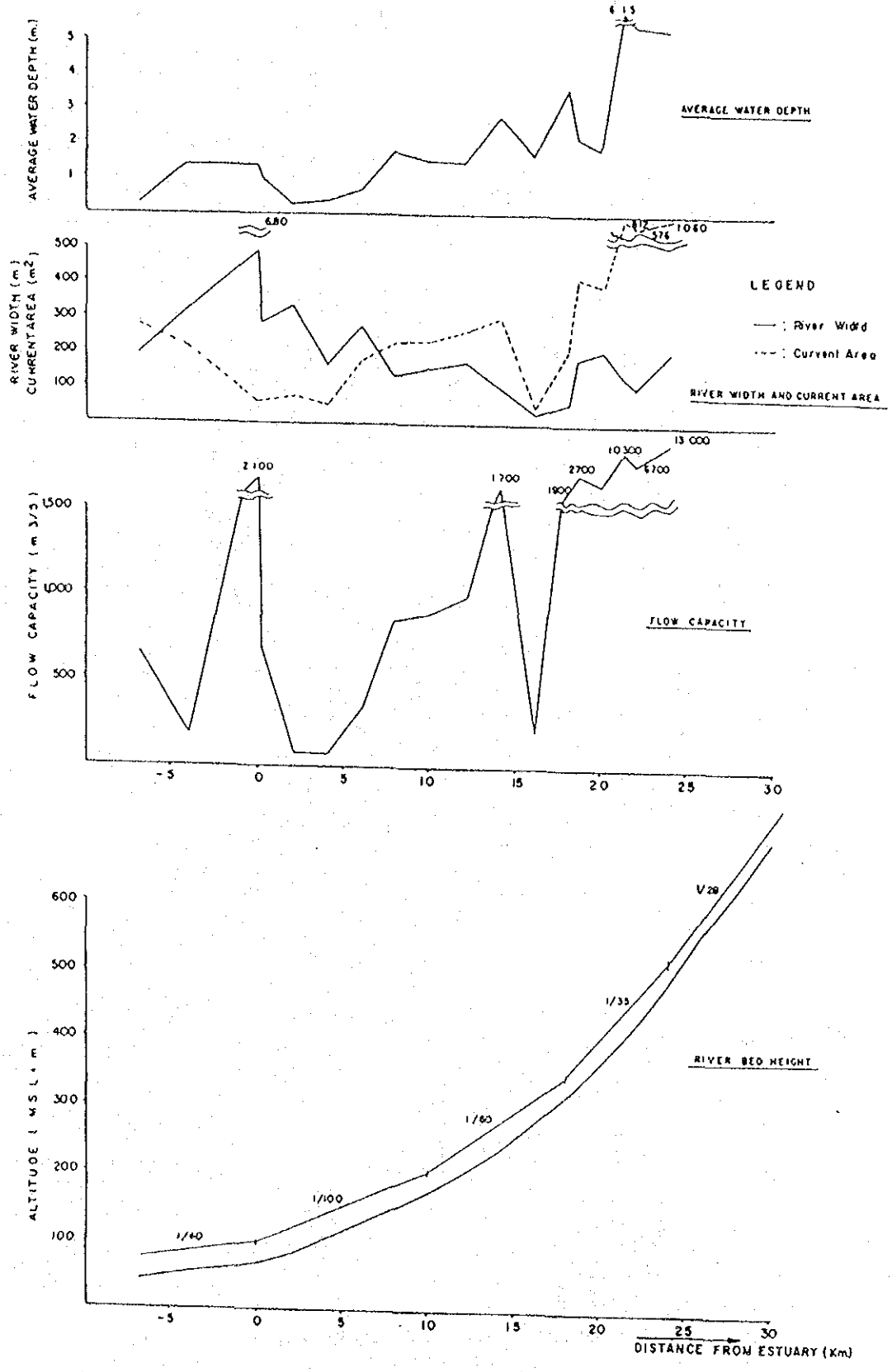


Fig. 3-8 (2/2) CARACTERISTICAS DEL RIO (RIO PANTALEON)

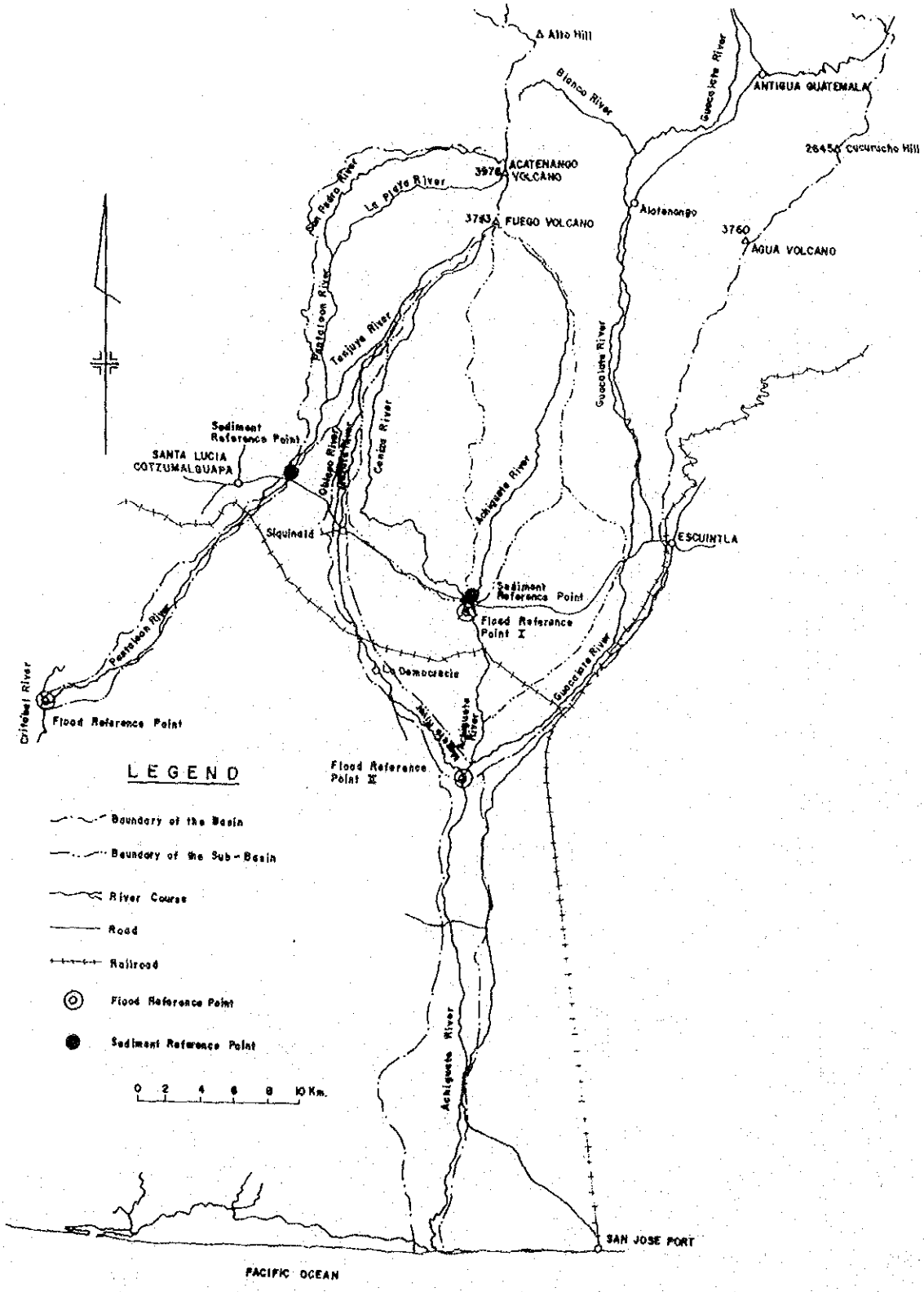


Fig. 4-1 UBICACION DE PUNTOS DE REFERENCIA

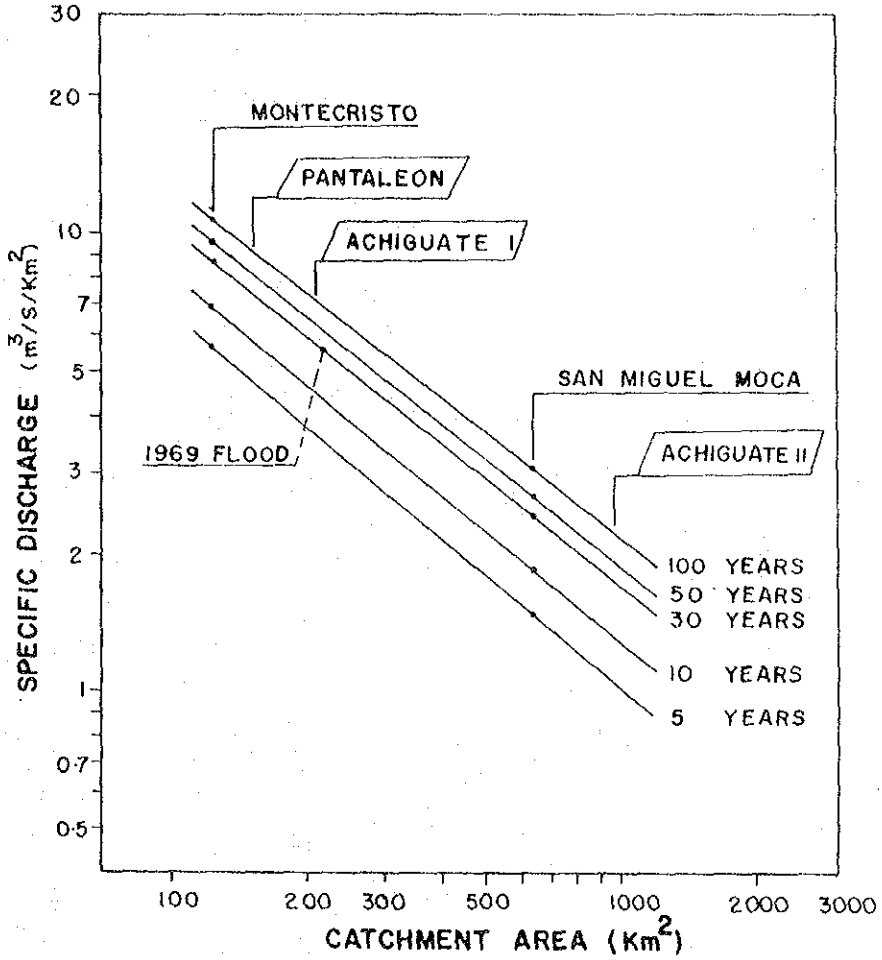


Fig. 4-2 DESCARGA ESPECIFICA

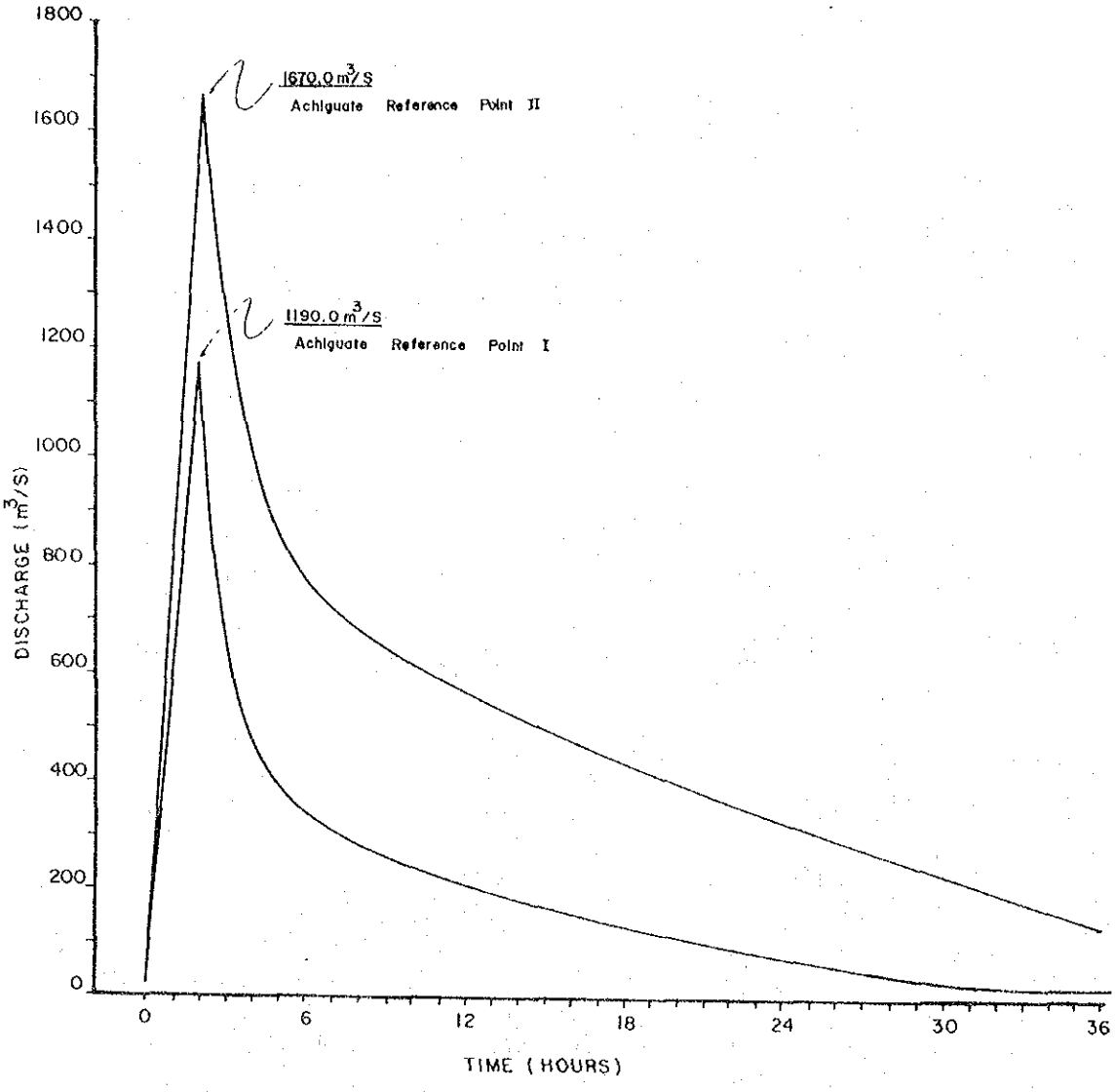


Fig. 4-3 (1/2) MODELO DE HIDROGRAMA (RIO ACHIGUATE)

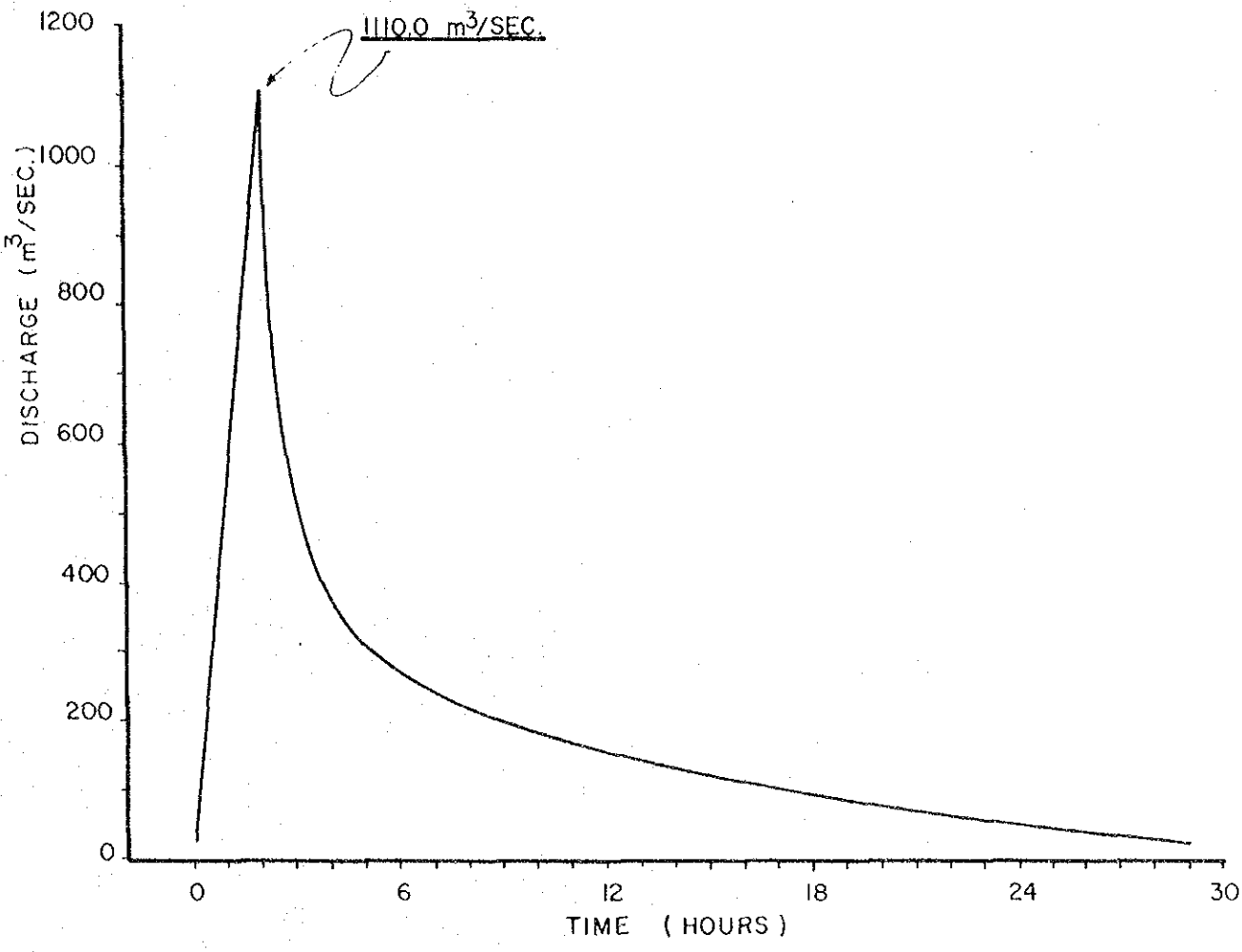
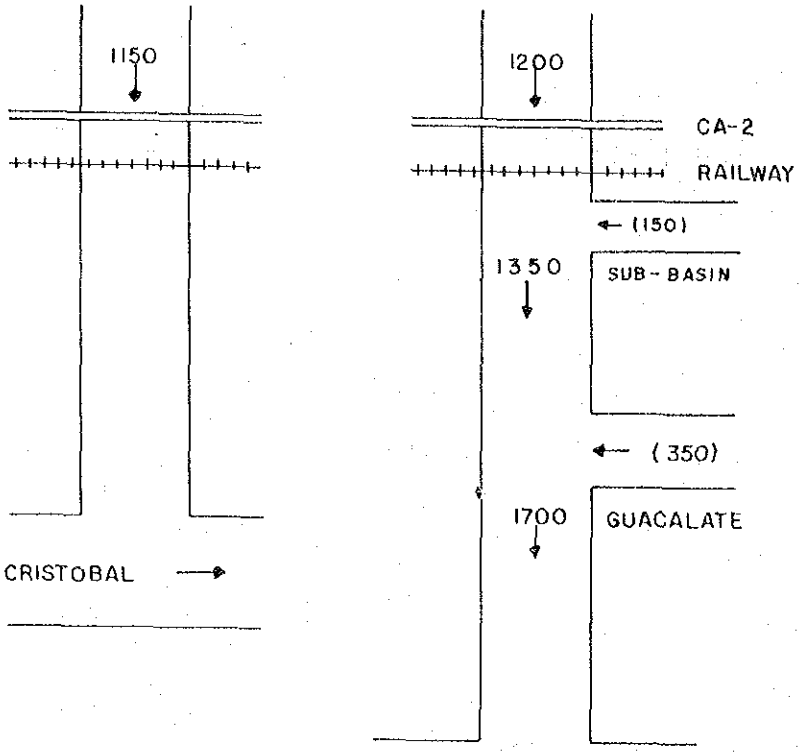


Fig. 4-3 (2/2) MODELO DE HIDROGRAMA (RIO PANTALEON)

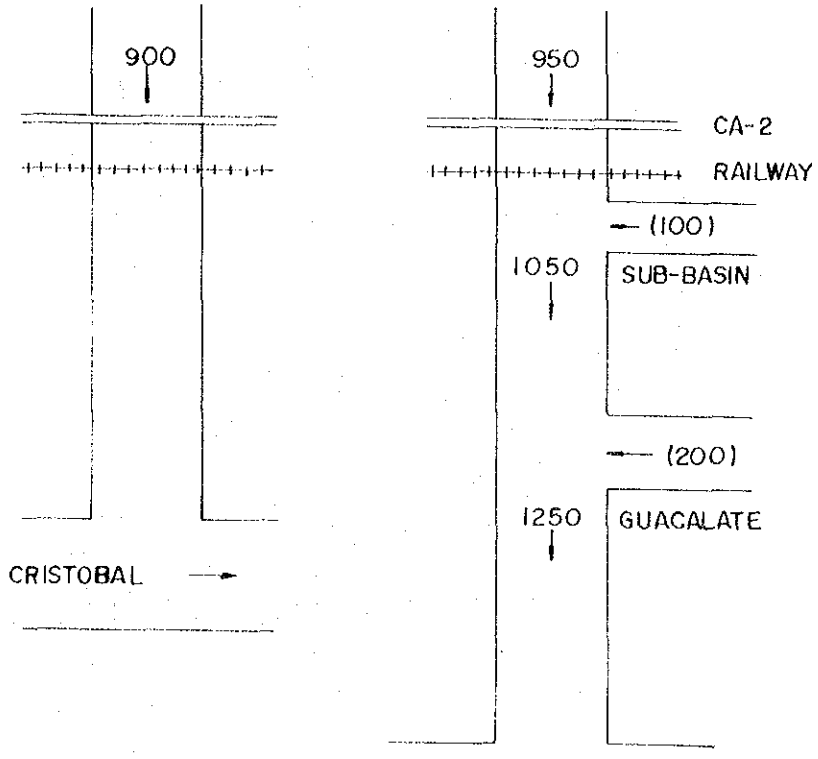


NOTE

Unit : m^3/sec

Figures in parentheses show the discharge added by the tributary at the peak flow time of the main river

Fig. 5-1 (1/2) DISTRIBUCION DE DESCARGA DE DISEÑO (30 años)



NOTE

Unit : m^3/sec

Figures in parentheses show the discharge added by the tributary at the peak flow time of the main river

Fig. 5-1 (2/2) DISTRIBUCION DE DESCARGA DE DISEÑO (10 años)

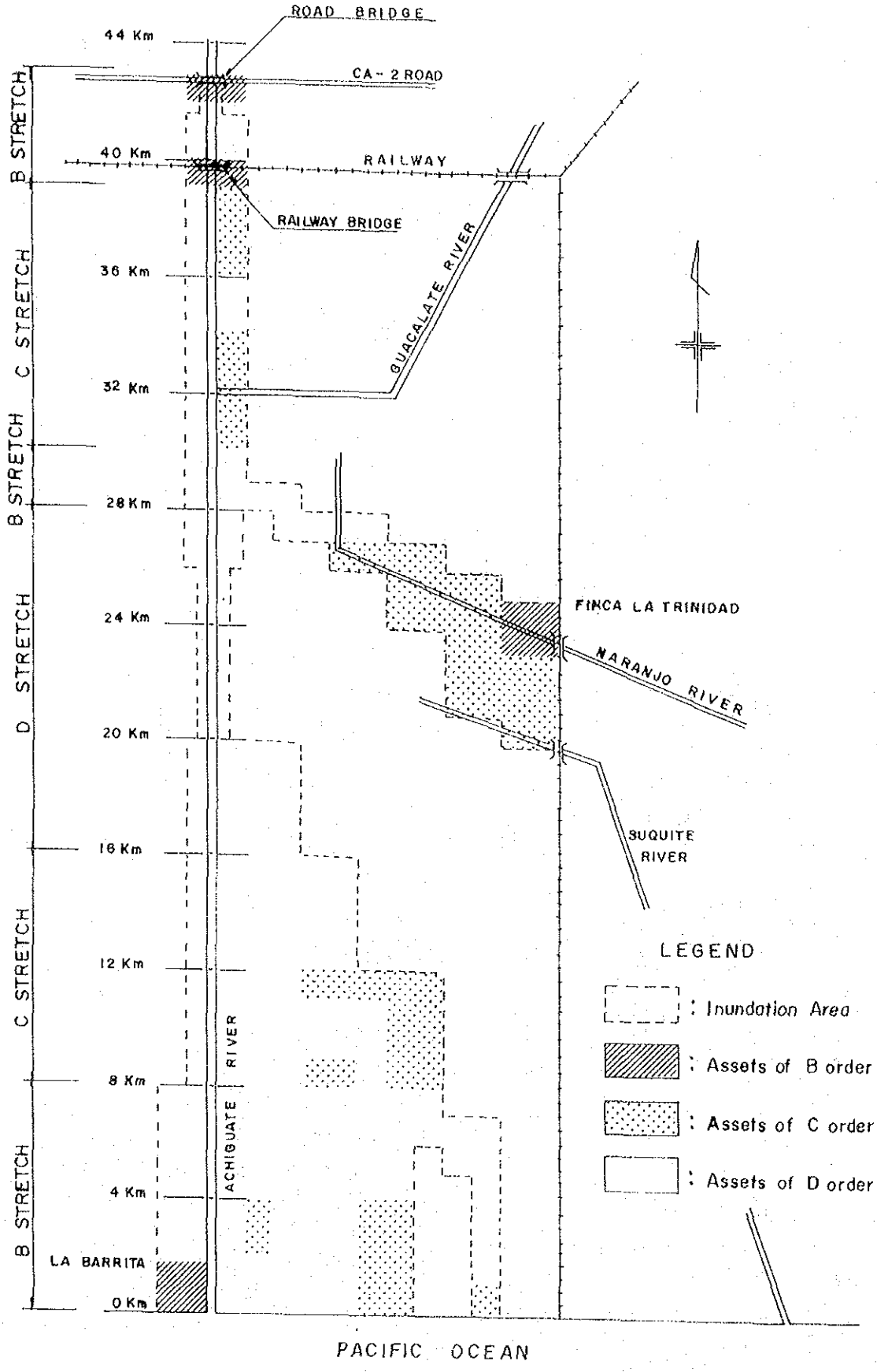


Fig. 5-2 (1/2) CLASIFICACION DE LOS BIENES (RIO ACHIGUATE)

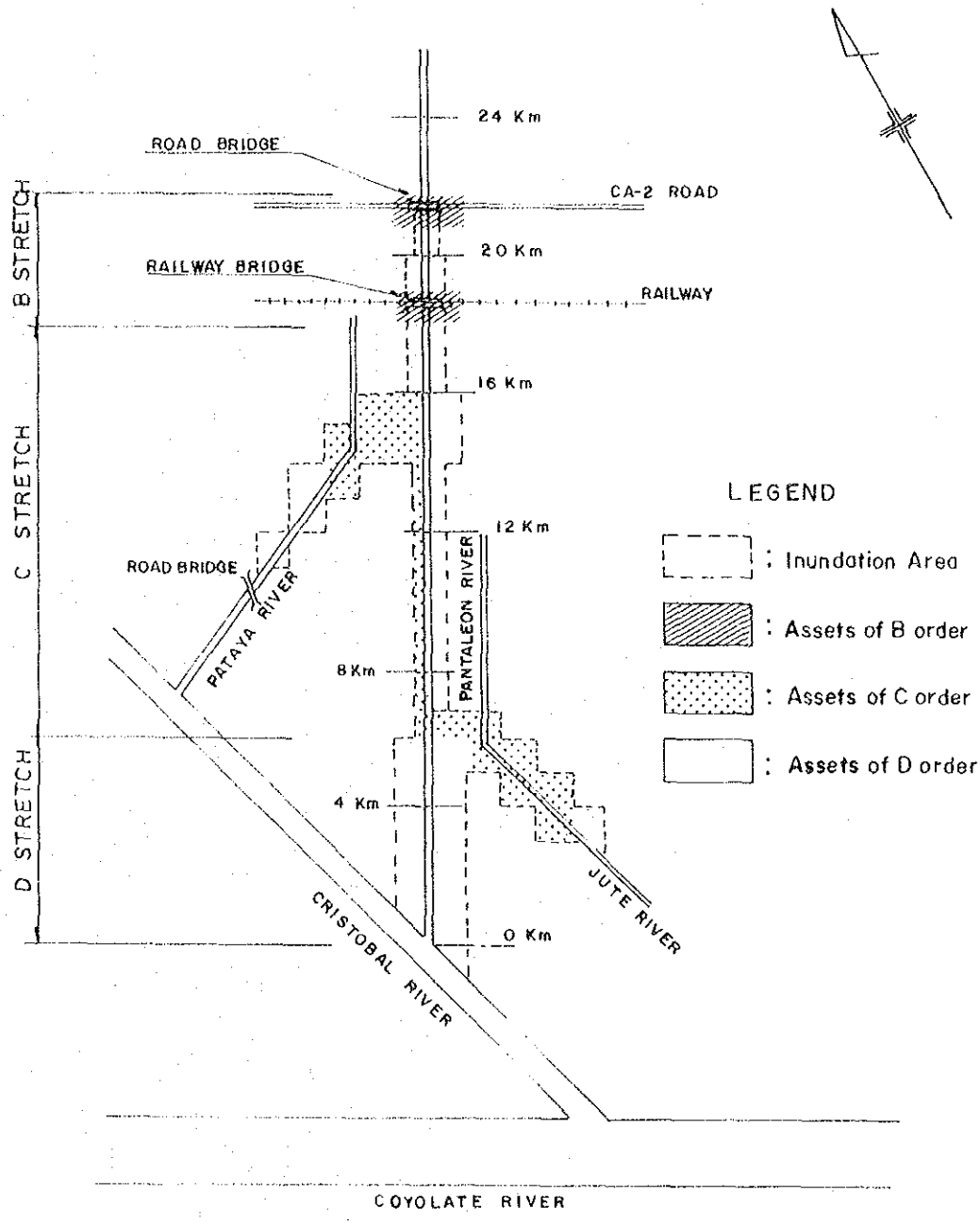
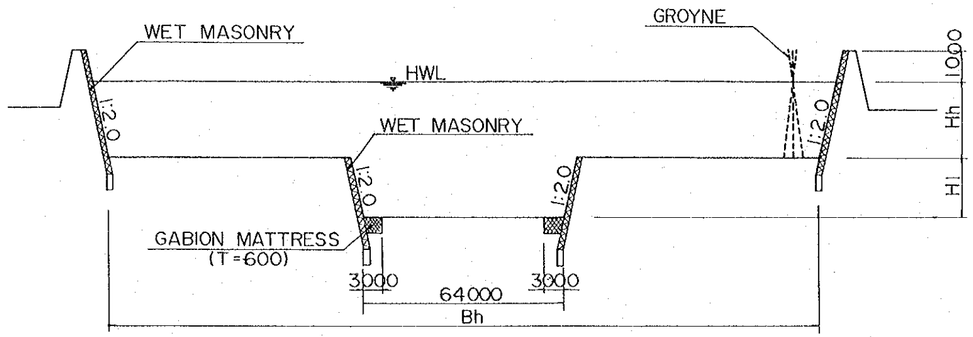
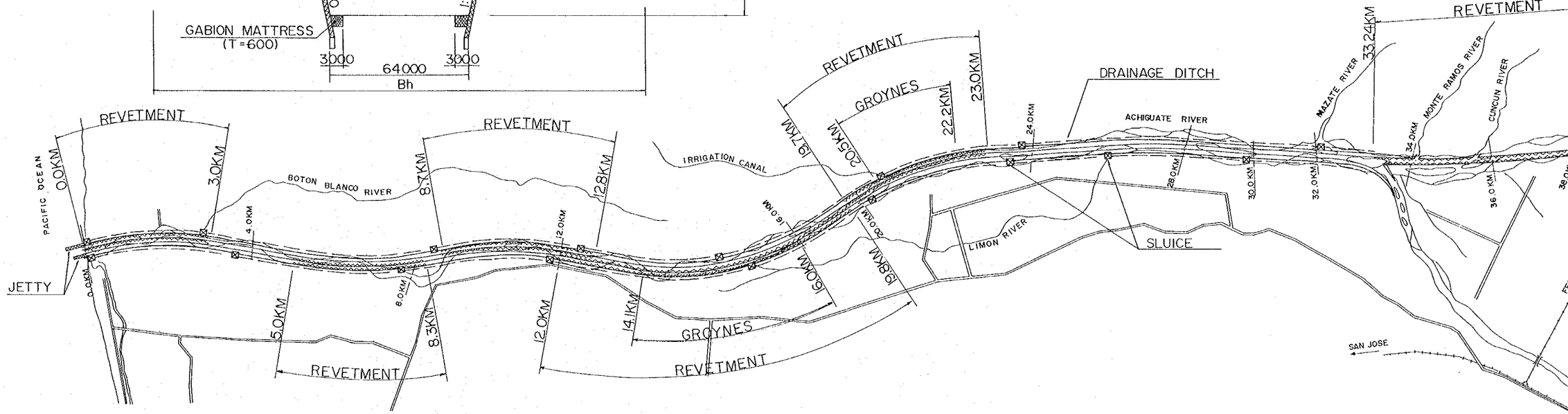


Fig. 5-2 (2/2) CLASIFICACION DE LOS BIENES (RIO PANTALEON)

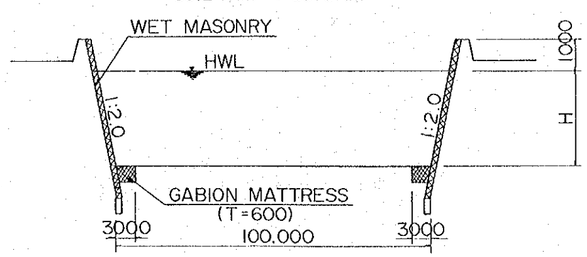
0.0KM ~ 33.24KM



STRECH	Hl	Hh	Bh
0.0KM~16.0 KM	2500	2000	226000
16.0KM~27.0 KM	2350	1850	225400
27.0KM~33.24KM	2150	1700	225000

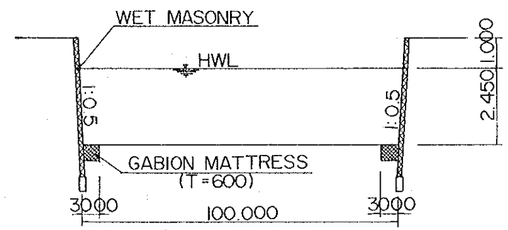


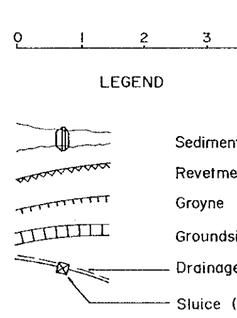
33.24KM ~ 39.6KM



STRECH	H
33.24KM~38.0KM	3250
38.0 KM~39.6KM	2750

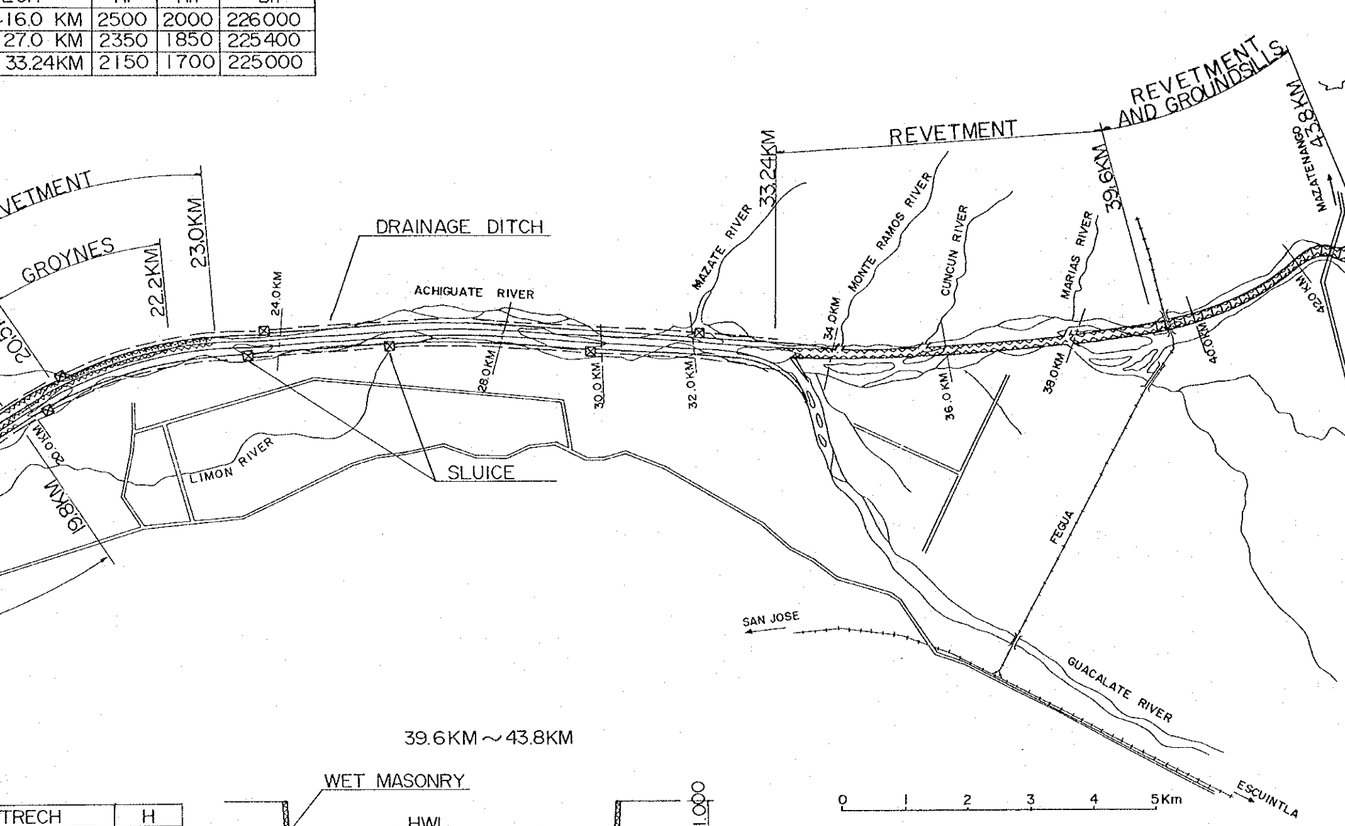
39.6KM ~ 43.8KM





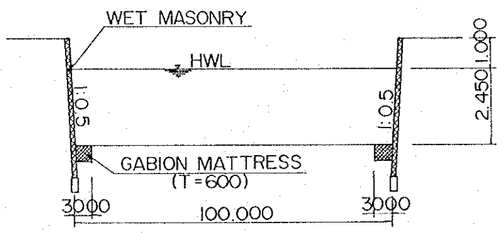
F

ECH	HI	Hh	Bh
-16.0 KM	2500	2000	226000
27.0 KM	2350	1850	225400
33.24KM	2150	1700	225000



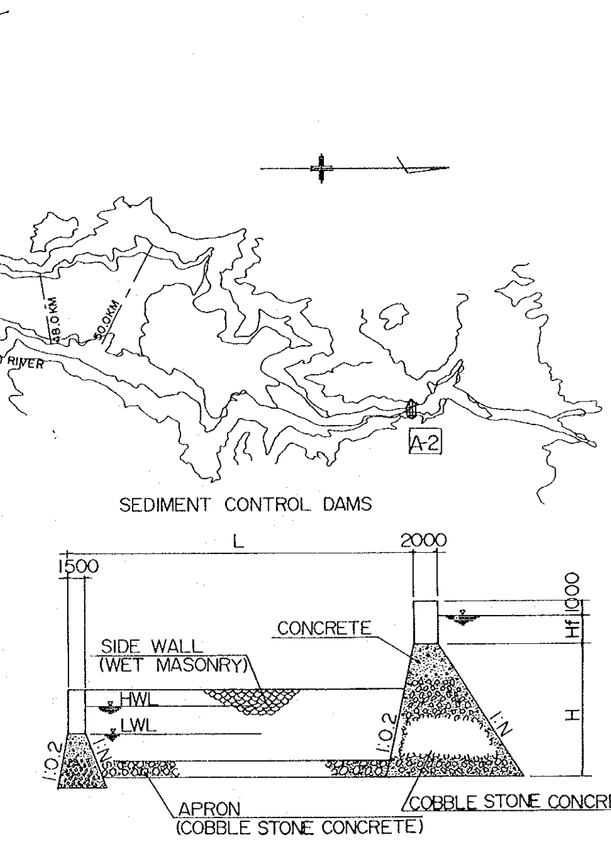
TRECH	H
KM~38.0KM	3250
KM~39.6KM	2750

39.6KM ~ 43.8KM



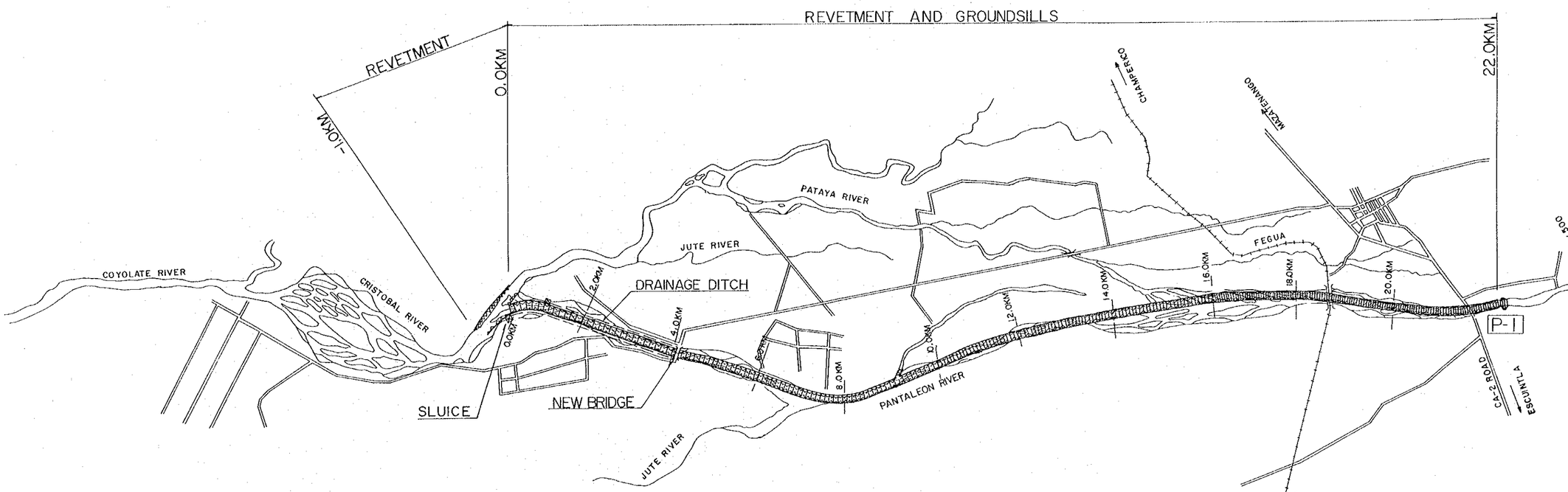
LEGEND

- Sediment Control Dam
- Revetment
- Groyne
- Groundsill (30 Places)
- Drainage Ditch
- Sluice (17 Places)

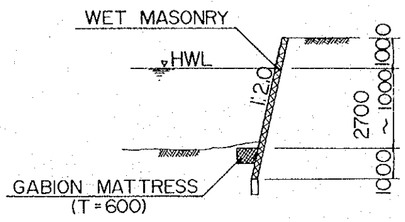


DAM	N	$H_{(m)}$	$Hf_{(m)}$	$L_{(m)}$	Ns	CREST LENGTH (m)	DAM VOLUME (m^3)
A-1	0.6	8.5	2.4	29	0.3	460	26,500
A-2	1.2	20.0	2.1	35	0.3	135	25,200
C-1	0.6	8.5	2.1	29	0.2	455	23,200

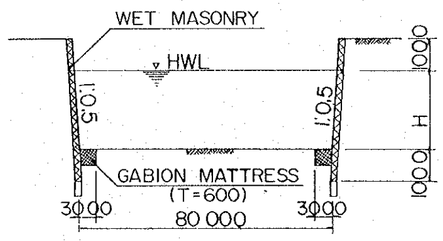
Fig. 5-3 (1/2) PLAN COMPRENSIVO (RIO ACHIGUATE)



-1.0KM ~ 0.0KM

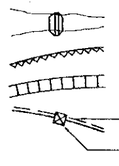


0.0KM ~ 22.0KM



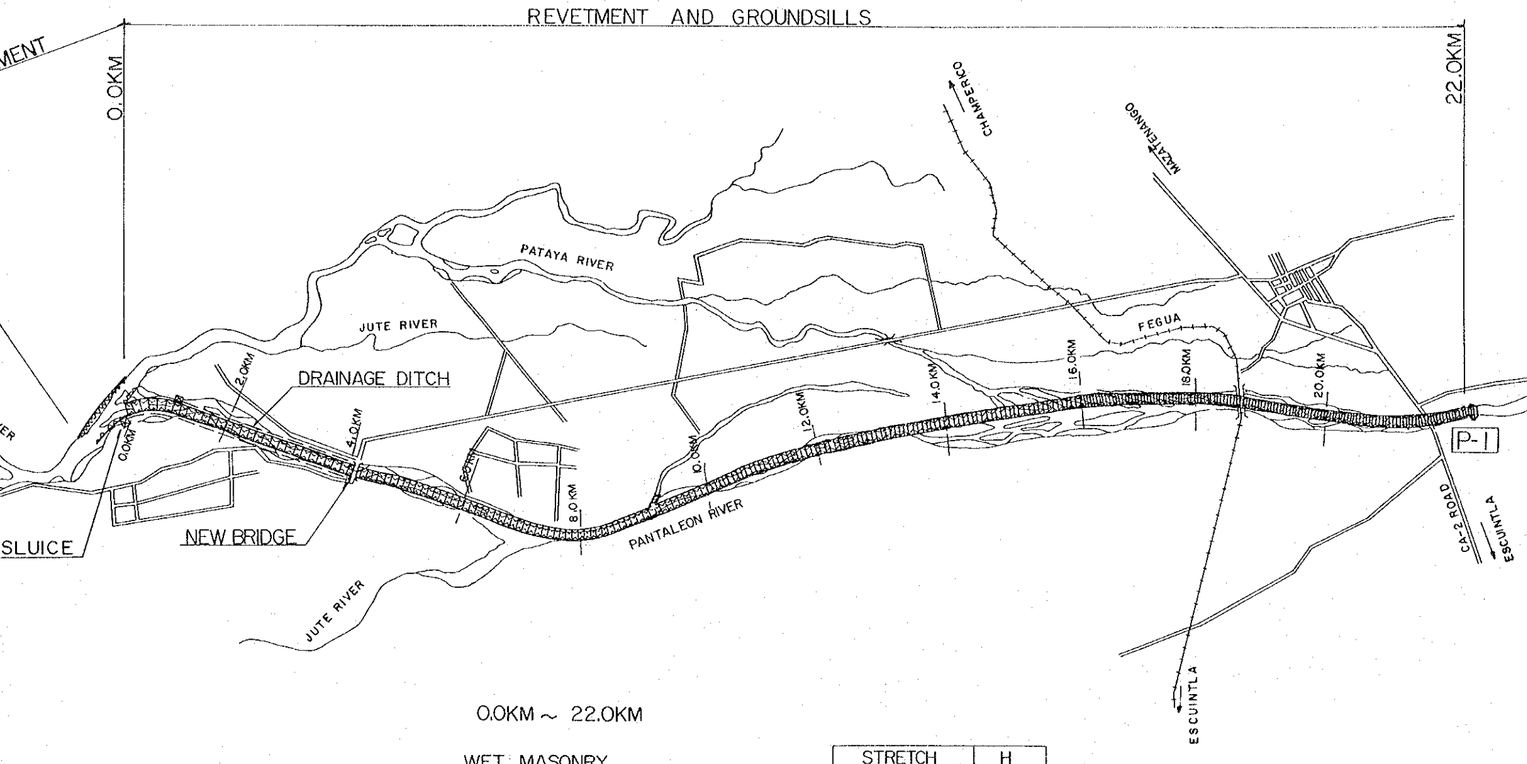
STRETCH	H
0.0KM~4.0KM	2 700
4.0KM~6.0KM	2 600
6.0KM~10.0KM	2 500
10.0KM~12.0KM	2 350
12.0KM~14.0KM	2 250
14.0KM~16.0KM	2 200
16.0KM~18.3KM	2 050
18.3KM~22.0KM	2 000

LEGEND

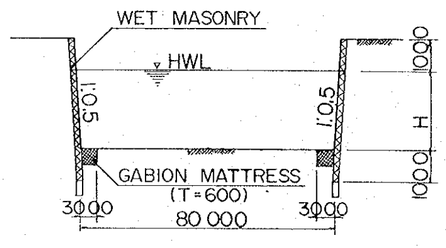


Sediment Control Dam
Revetment (Wet Masonry)
Groundsill (293 Places)
Drainage Ditch
Sluice (2 Places)

F



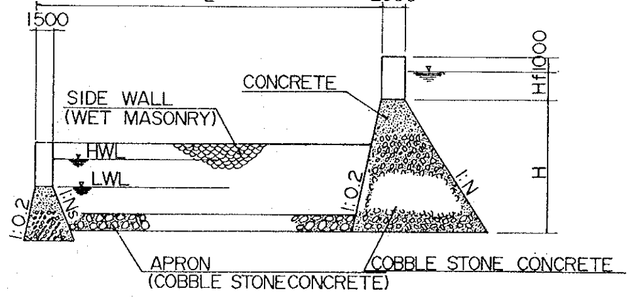
0.0KM ~ 22.0KM



STRETCH	H
0.0KM~4.0KM	2.700
4.0KM~6.0KM	2.600
6.0KM~10.0KM	2.500
10.0KM~12.0KM	2.350
12.0KM~14.0KM	2.250
14.0KM~16.0KM	2.200
16.0KM~18.3KM	2.050
18.3KM~22.0KM	2.000

LEGEND

- Sediment Control Dam
- Revetment (Wet Masonry)
- Groundsill (293 Places)
- Drainage Ditch
- Sluice (2 Places)



DAM	N	H (m)	Hf (m)	L (m)	Ns	CREST LENGTH (m)	DAM VOLUME (m³)
P-1	0.5	6.5	2.6	20	0.4	210	4,400
P-2	0.65	11.0	2.6	29	0.4	392	20,600
P-3	0.90	13.0	2.8	30	0.4	155	19,600
P-4	0.65	10.5	2.8	29	0.4	190	15,400
P-5	1.30	20.0	2.8	35	0.4	230	47,400

Fig. 5-3 (2/2) PLAN COMPRENSIVO (RIO PANTALEON)

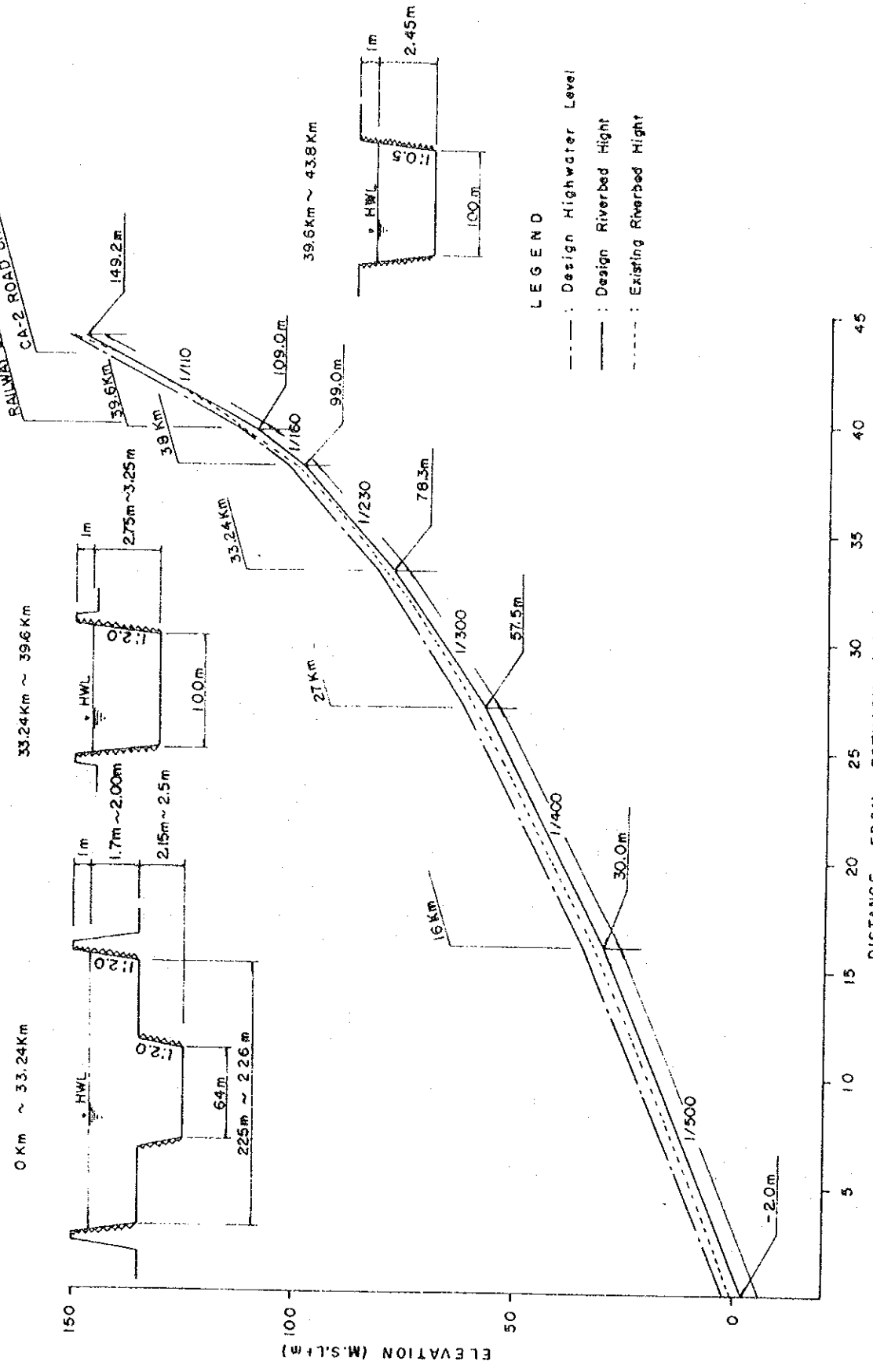


Fig. 5-4 (1/2) PERFIL LONGITUDINAL (RIO ACHIGUATE)

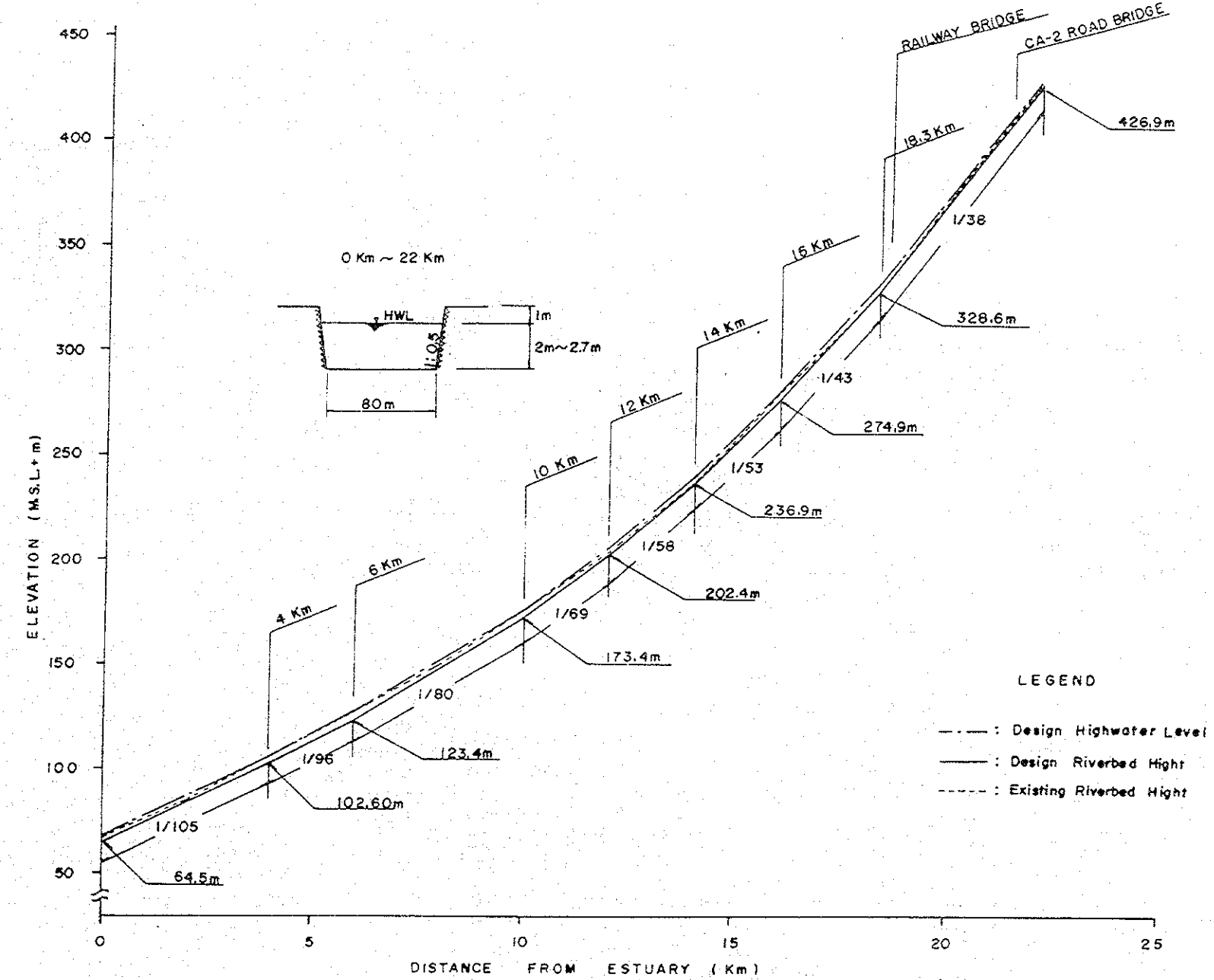


Fig. 5-4 (2/2) PERFIL LONGITUDINAL (RIO PANTALEON)

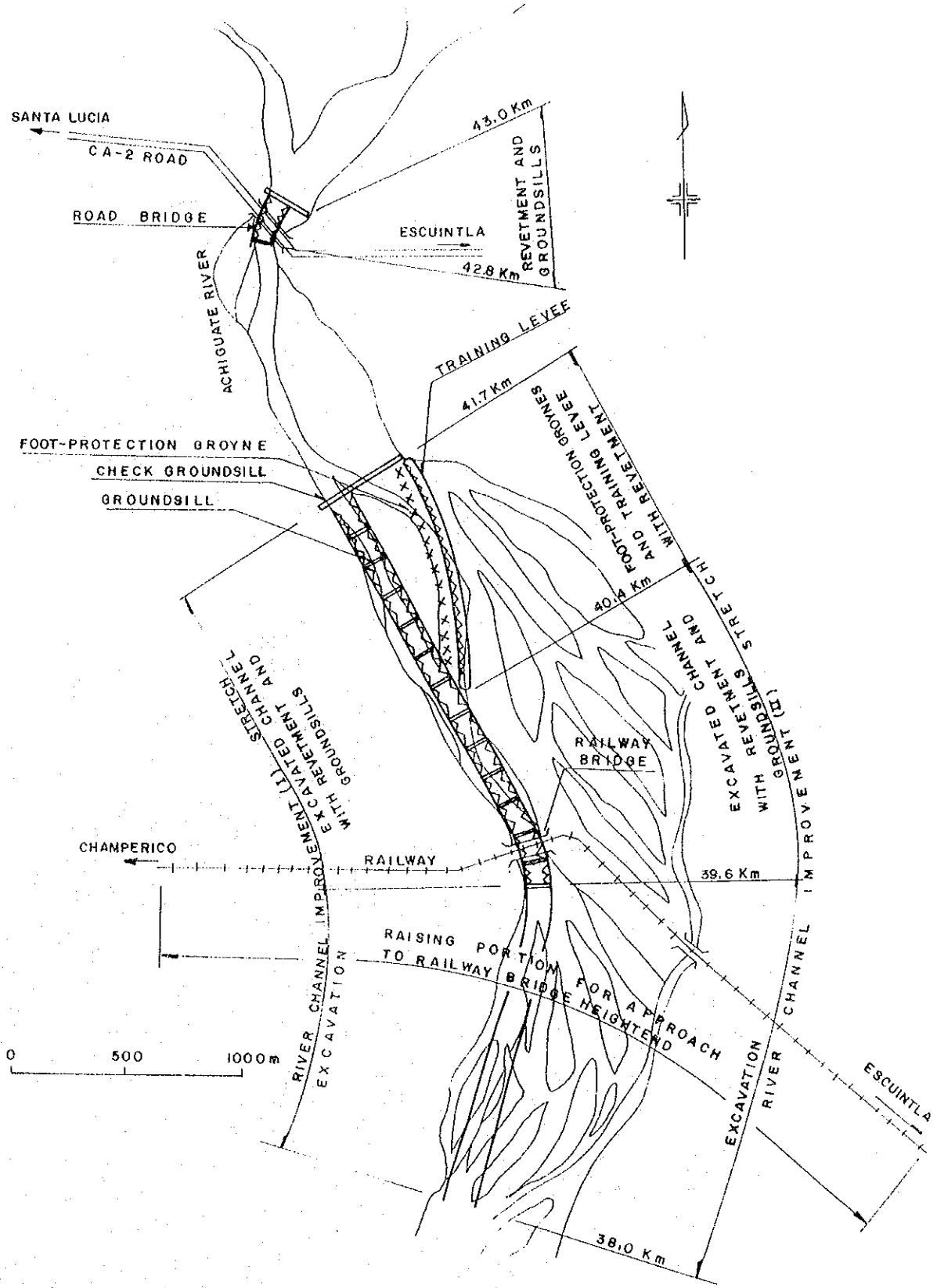


Fig. 5-5 (1/4) UBICACION DE OBRAS ALTERNATIVAS (RIO ACHIGUATE, PROTECCION DE LOS PUENTES)

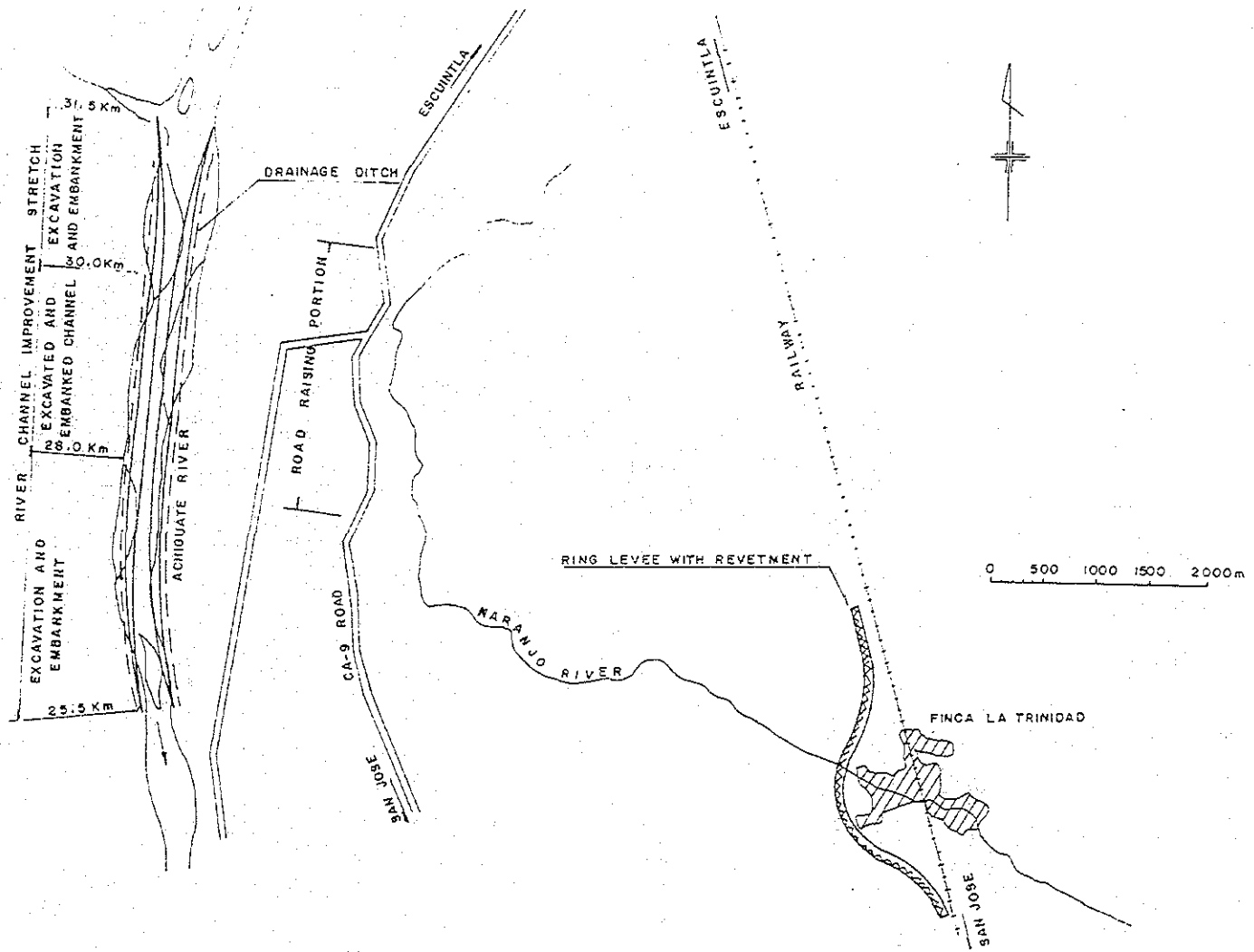


Fig. 5-5 (2/4) UBICACION DE OBRAS ALTERNATIVAS (RIO ACHIGUATE, PROTECCION DE LA FINCA LA TRINIDAD)

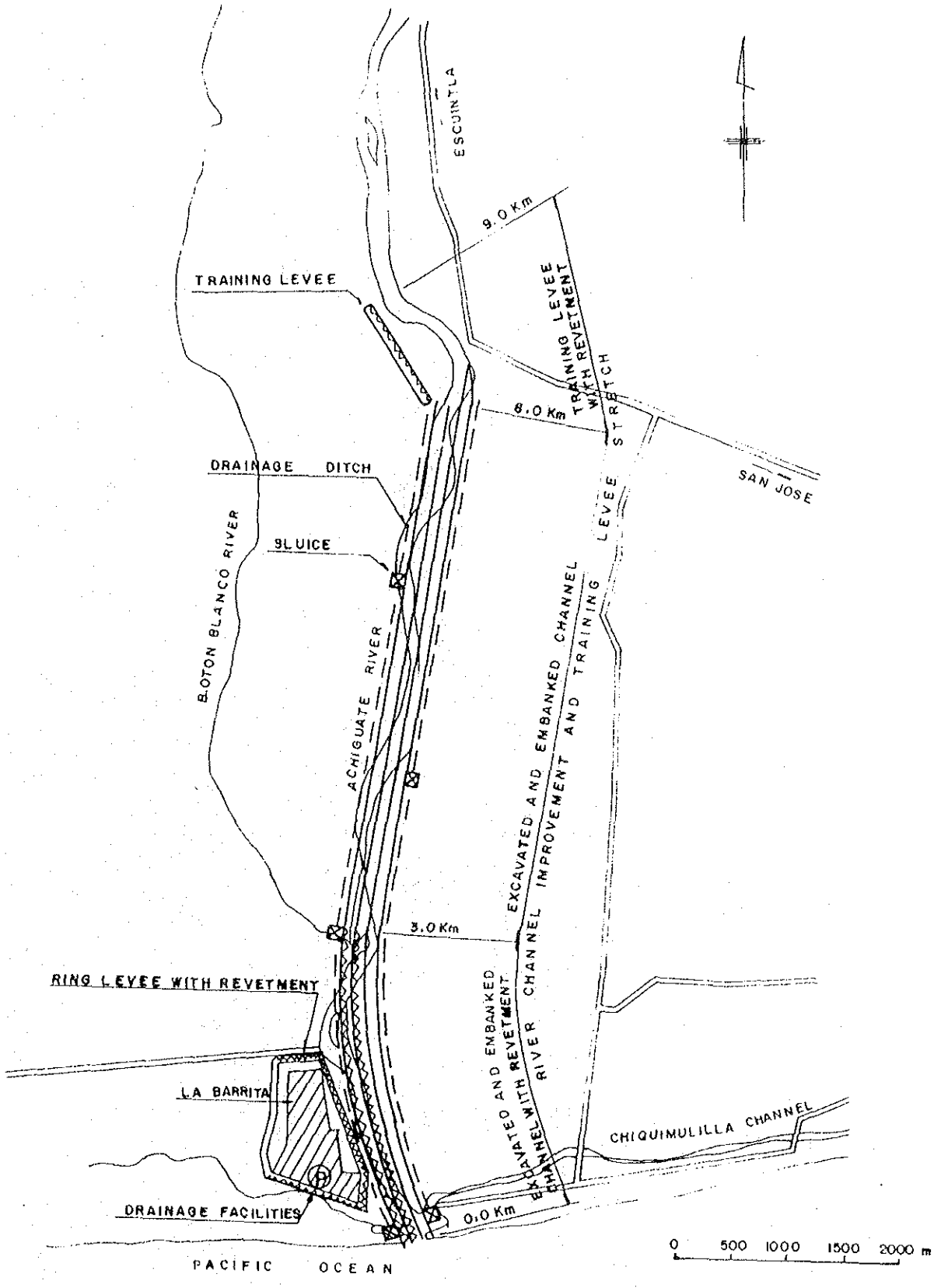


Fig. 5-5 (3/4) UBICACION DE OBRAS ALTERNATIVAS (RIO ACHIGUATE, PROTECCION DE LA BARRITA)

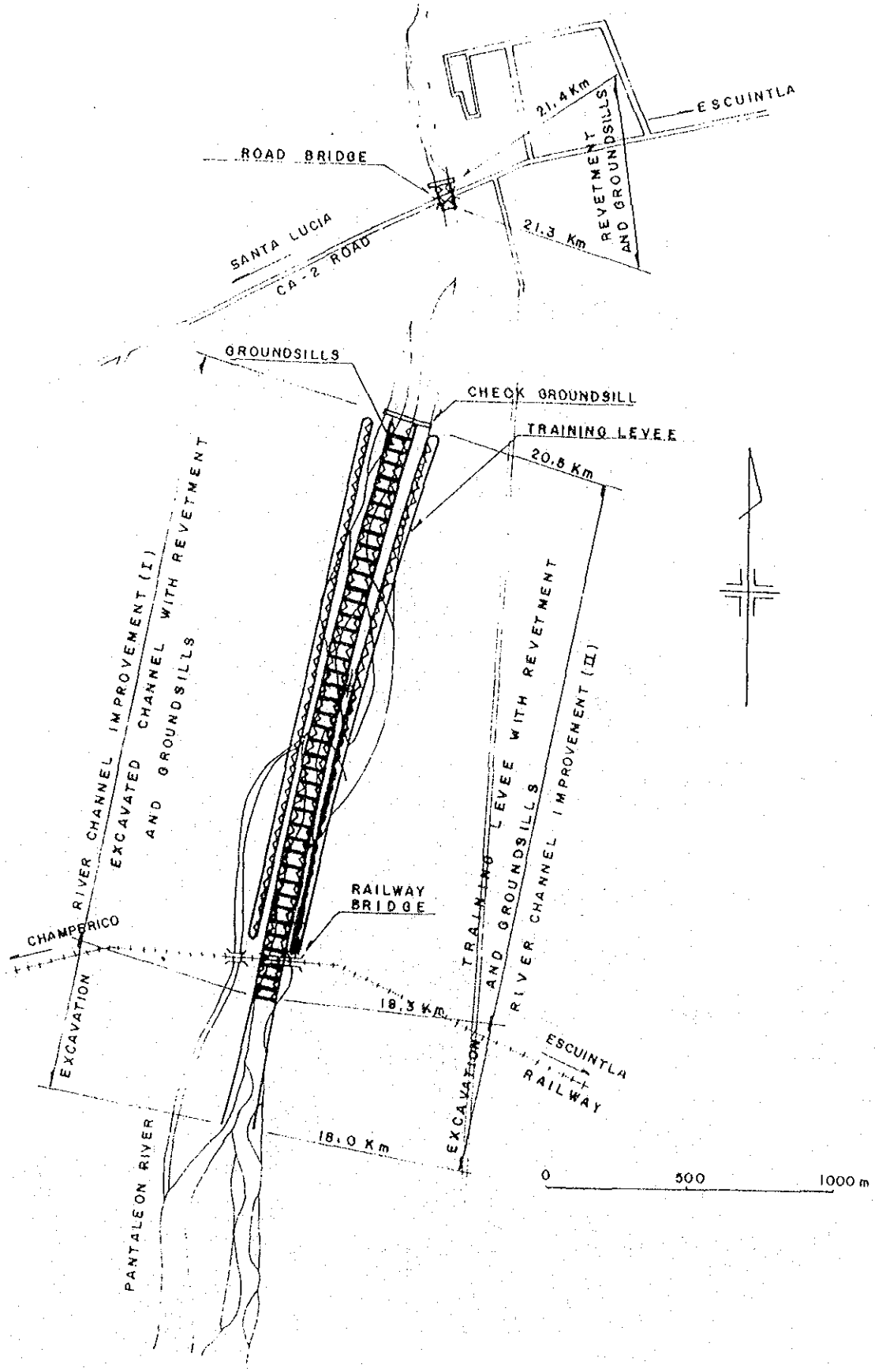
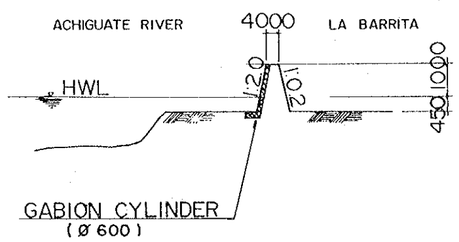


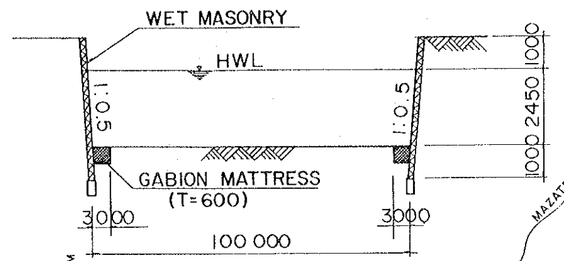
Fig. 5-5 (4/4) UBICACION DE OBRAS ALTERNATIVAS (RIO PANTALEON, PROTECCION DE LOS PUENTES)

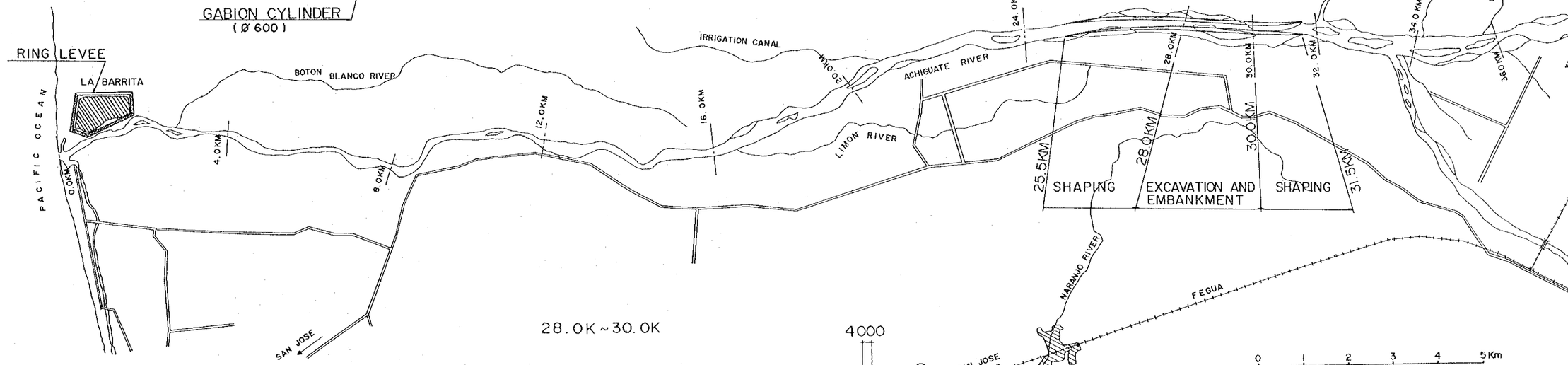
RING LEVEE



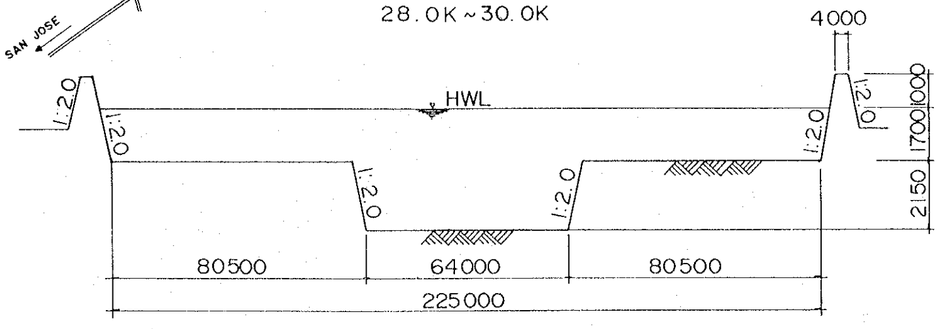
GABION CYLINDER
(Ø 600)

39.6 K ~ 41.7K
42.8 K ~ 43.0K



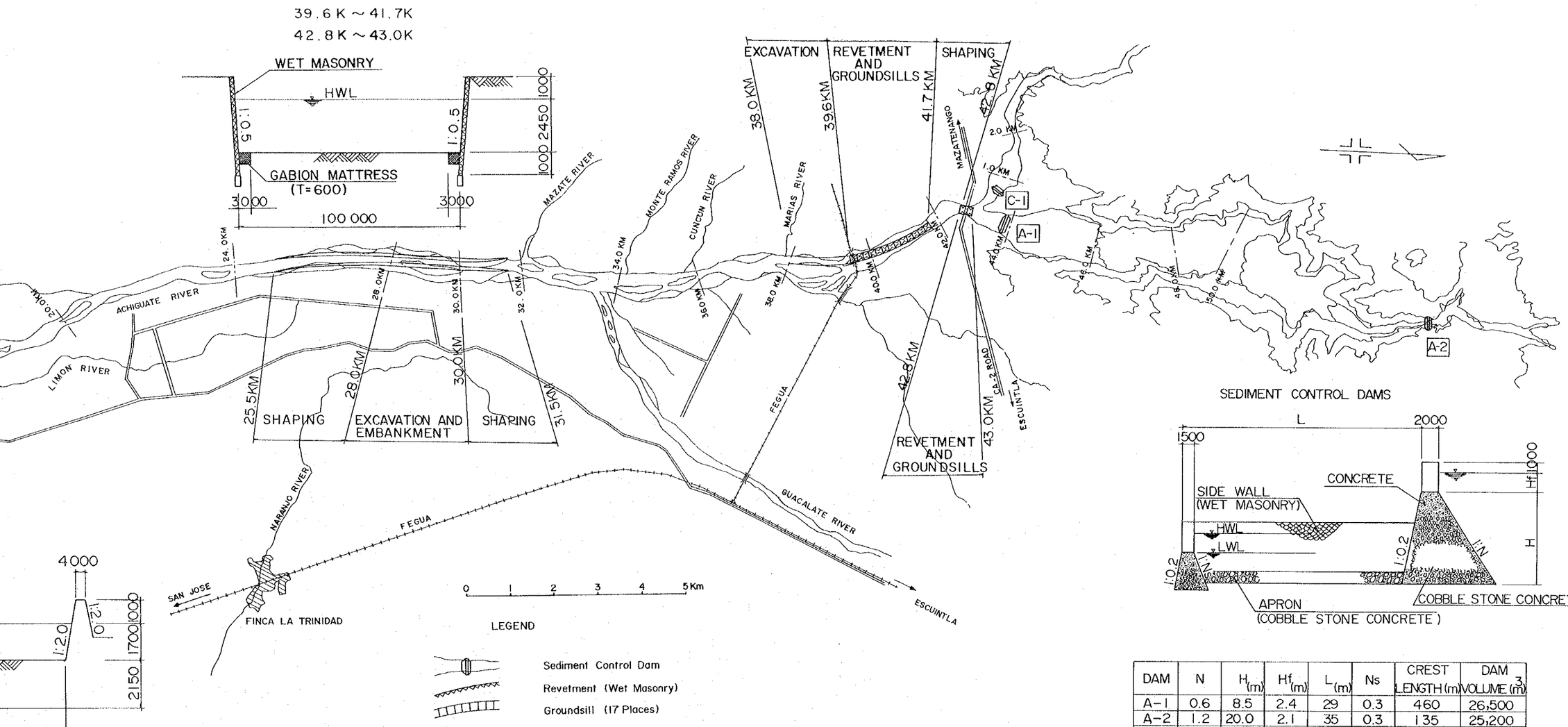


28.0K ~ 30.0K



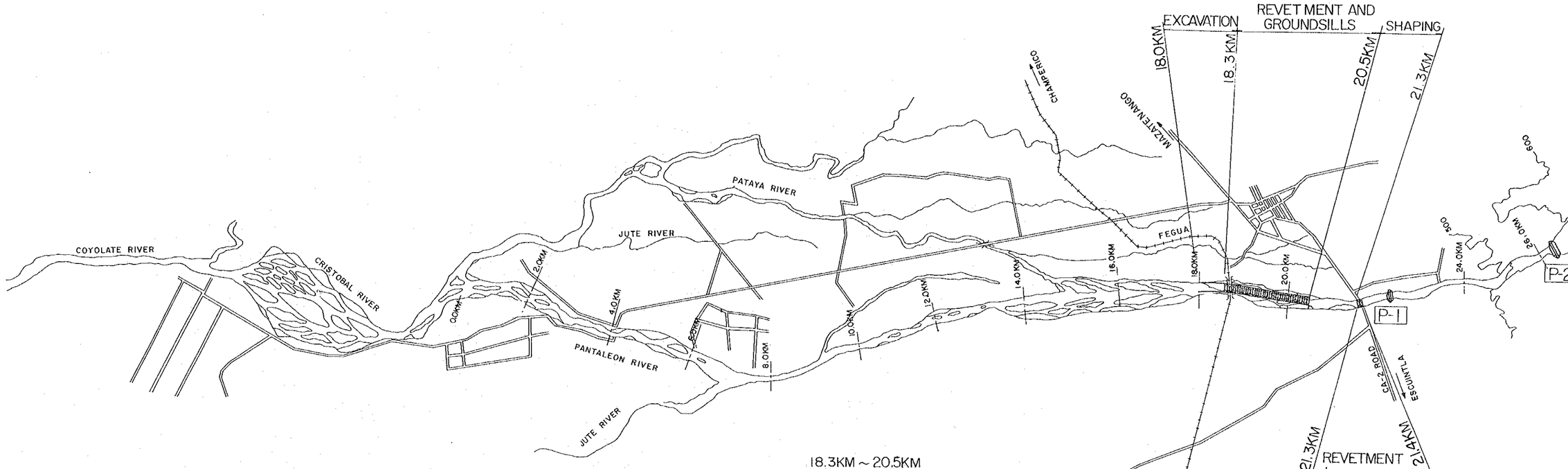
LEGEND

Sediment Control Dam
Revetment (Wet Masonry)
Groundsill (17 Places)



DAM	N	H (m)	Hf (m)	L (m)	Ns	CREST LENGTH (m)	DAM VOLUME (m^3)
A-1	0.6	8.5	2.4	29	0.3	460	26,500
A-2	1.2	20.0	2.1	35	0.3	135	25,200
C-1	0.6	8.5	2.1	29	0.2	455	23,200

Fig. 5-6 (1/2) PLAN PROPUESTO
(RIO ACHIGUATE)



0 1 2 3 4 5Km

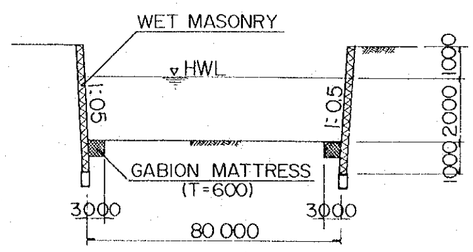
LEGEND

Sediment Control Dam

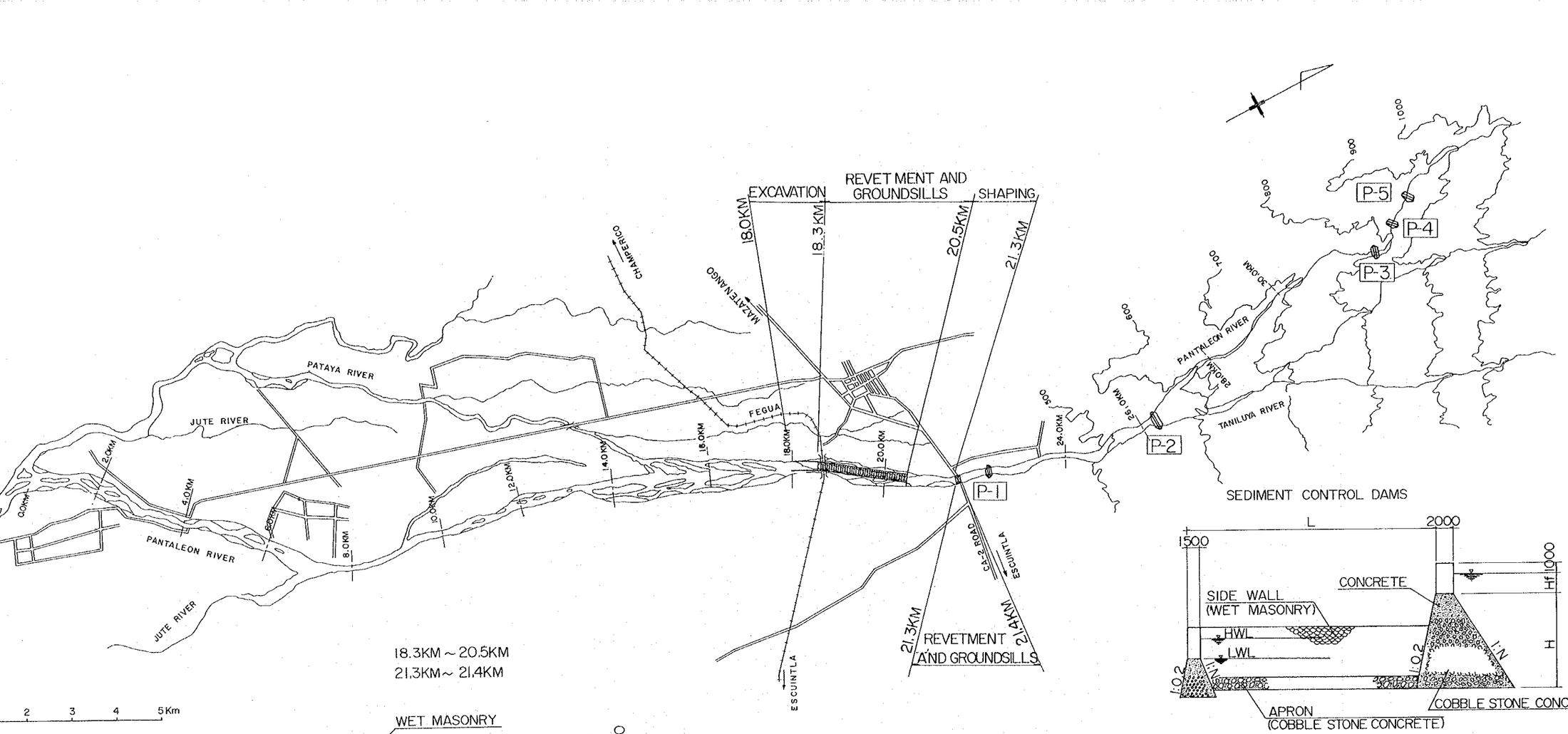
Revetment (Wet Masonry)

Groundsill (47 Places)

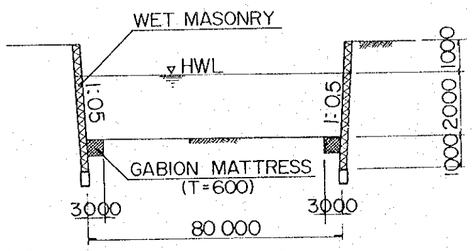
18.3KM ~ 20.5KM
21.3KM ~ 21.4KM



DAM
P-1
P-2
P-3
P-4
P-5



18.3KM ~ 20.5KM
21.3KM ~ 21.4KM



SEDIMENT CONTROL DAMS

DAM	N	$H_{(m)}$	$Hf_{(m)}$	$L_{(m)}$	$Ns_{(m)}$	CREST LENGTH (m)	DAM VOLUME (m^3)
P-1	0.5	6.5	2.6	20	0.4	210	4,400
P-2	0.65	11.0	2.6	29	0.4	392	20,600
P-3	0.90	13.0	2.8	30	0.4	155	19,600
P-4	0.65	10.5	2.8	29	0.4	190	15,400
P-5	1.30	20.0	2.8	35	0.4	230	47,400

Fig. 5-6 (2/2) PLAN PROPUESTO (RIO PANTALEON)

WORK STAGE			WORK VOLUME
DETAILED DESIGN			1 L/S
SEDIMENT CONTROL DAM	ACHIGUATE	PREPARATION	1 L/S
		EXCAVATION	103 000 m^3
		MAIN DAM	78 000 m^3
		SUB DAM	10 000 m^3
	PANTALEON	PREPARATION	1 L/S
		EXCAVATION	202 000 m^3
		MAIN DAM	126 000 m^3
		SUB DAM	11 000 m^3
RIVER IMPROVEMENT	ACHIGUATE	PREPARATION	1 L/S
		EXCAVATION	1 140 000 m^3
		EMBANKMENT	160 000 m^3
		REVETMENT	4 600 m
		GROUNDSILL	17 Units
		DRAINAGE FACILITIES (RING LEVEE)	1 L/S
	PANTALEON	PREPARATION	1 L/S
		EXCAVATION	240 000 m^3
		REVETMENT	4 600 m
		GROUNDSILL	47 Units

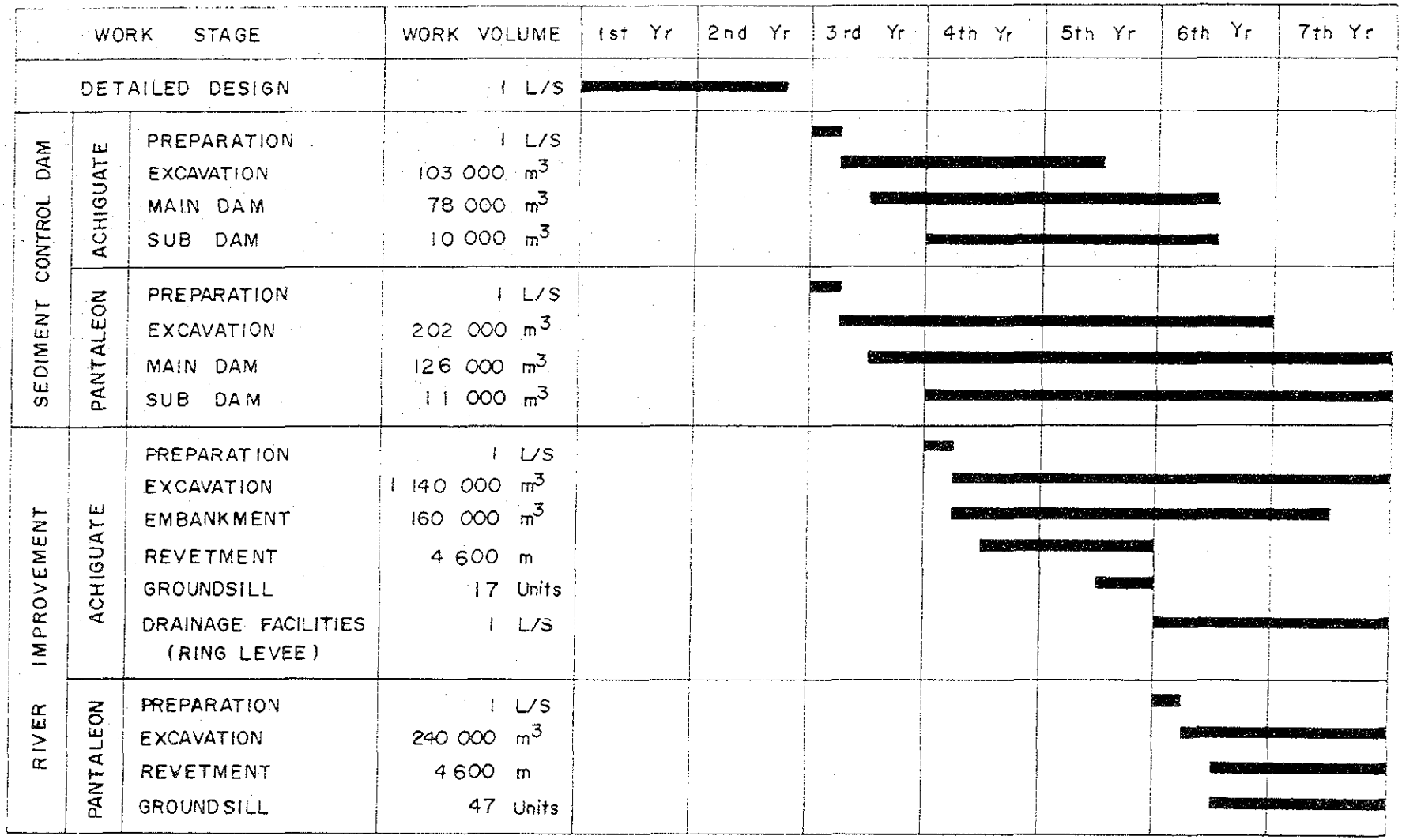
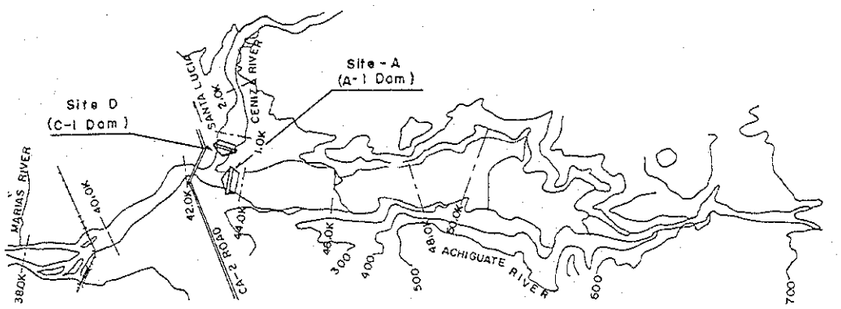
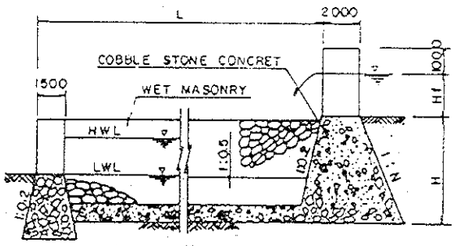
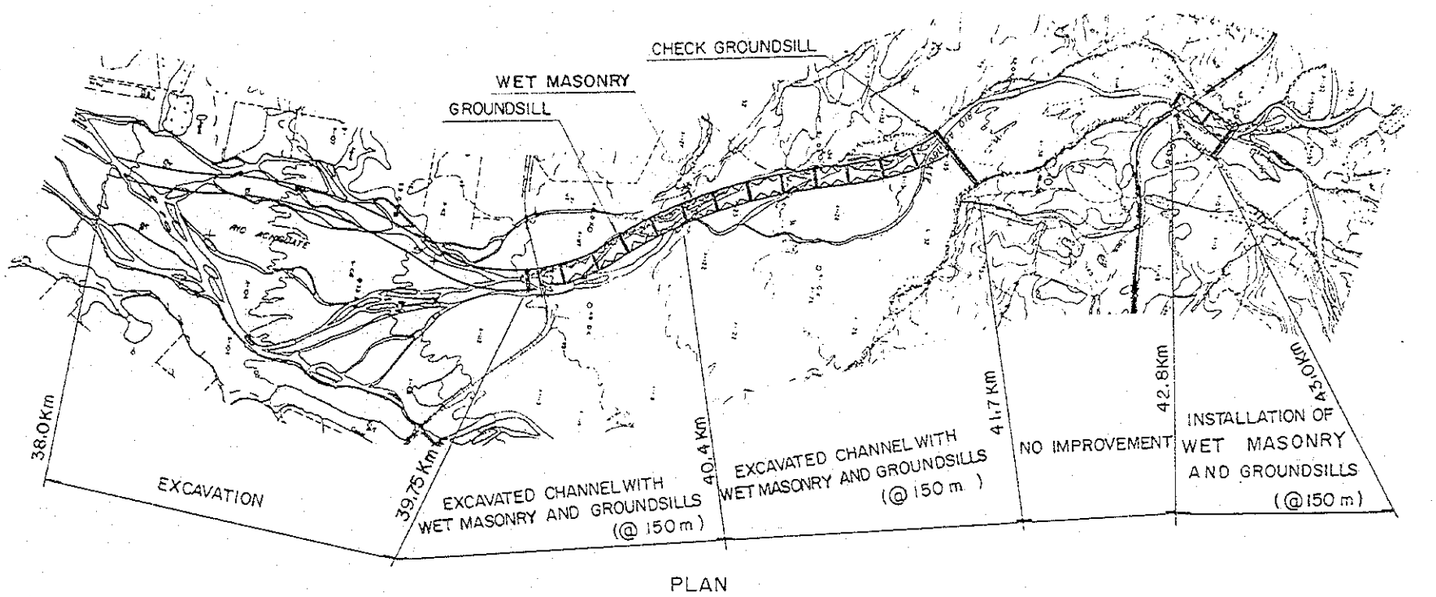


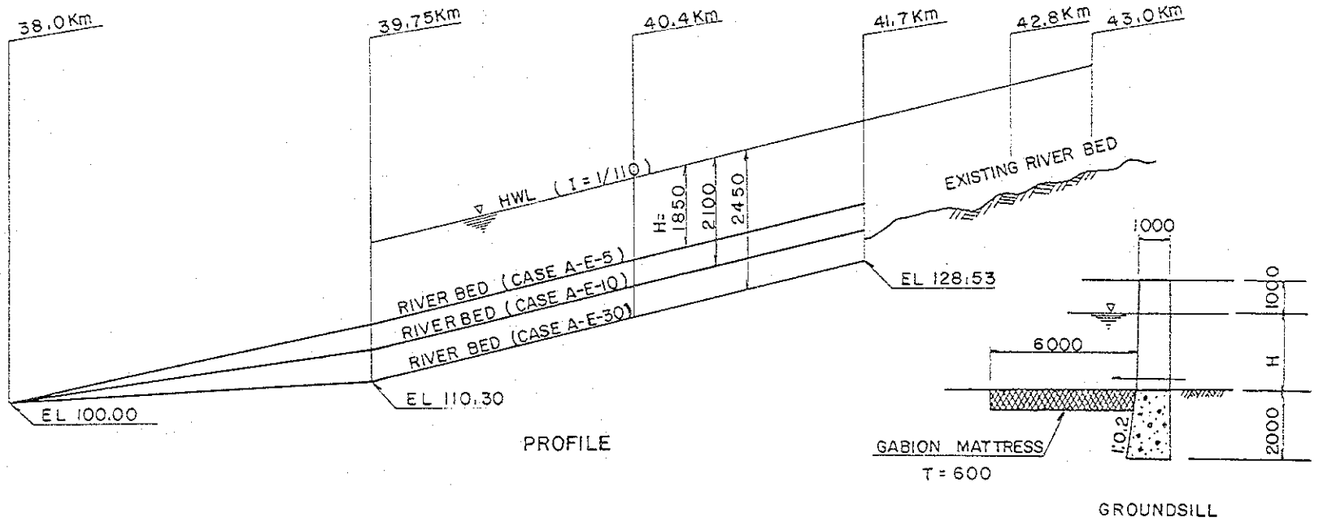
Fig. 5-7 CALENDARIO DE CONSTRUCCION

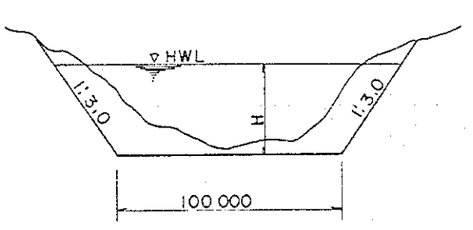




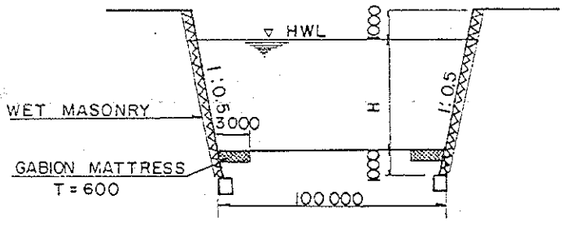
DAM	CASE	H(m)	1 : N	Hf(m)	L(m)
A - 1	A-E-5	6.5	0.5	2.4	24.0
	A-E-10	7.0	0.5	2.4	24.0
	A-E-30	7.5	0.55	2.4	24.0
C - 1	A-E-5	5.5	0.4	2.1	21.0
	A-E-10	6.0	0.45	2.1	21.0
	A-E-30	7.5	0.5	2.1	21.0



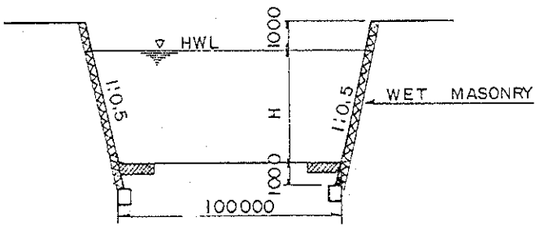




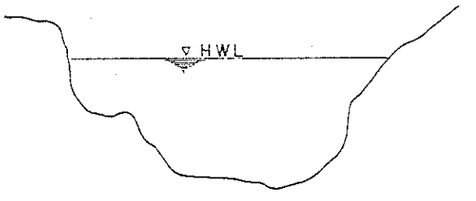
38.0Km ~ 39.75Km



39.75Km ~ 40.4Km



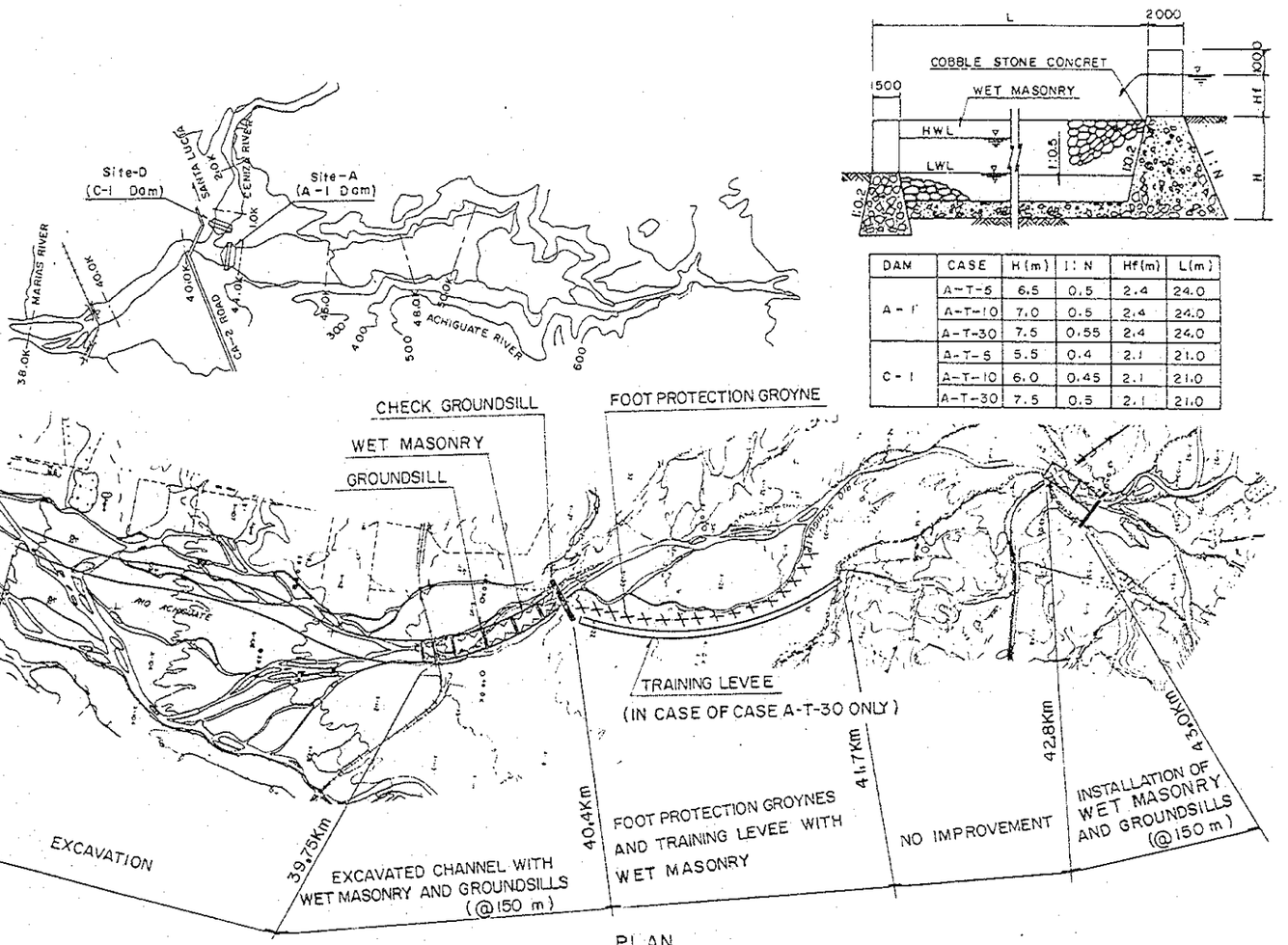
40.4Km ~ 41.7Km



41.7Km ~ 43.0Km

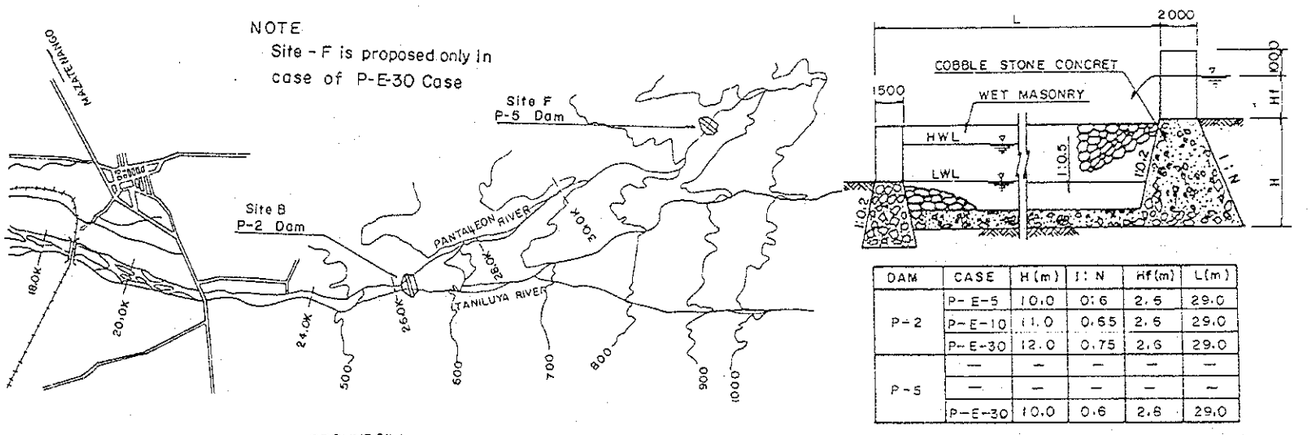
CROSS - SECTION

Fig. 6-1 (1/4) ASPECTOS GENERALES DE PLANES COMPARATIVOS (A-E)

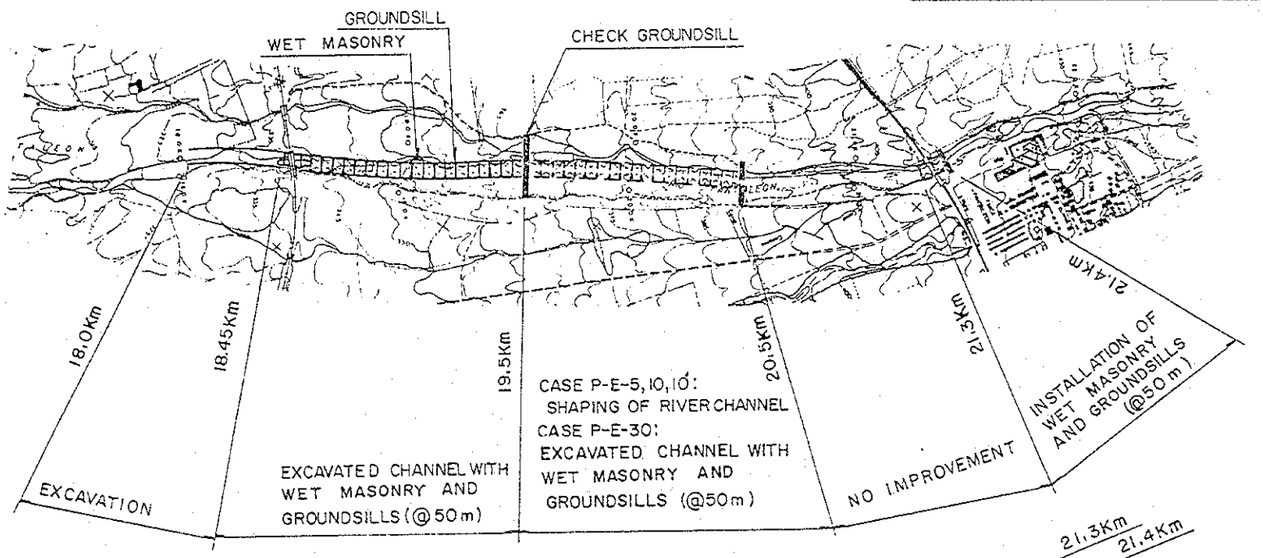


DAM	CASE	H(m)	I : N	Hf(m)	L(m)
A - I	A-T-5	6.5	0.5	2.4	24.0
	A-T-10	7.0	0.5	2.4	24.0
	A-T-30	7.5	0.55	2.4	24.0
C - I	A-T-5	5.5	0.4	2.1	21.0
	A-T-10	6.0	0.45	2.1	21.0
	A-T-30	7.5	0.5	2.1	21.0

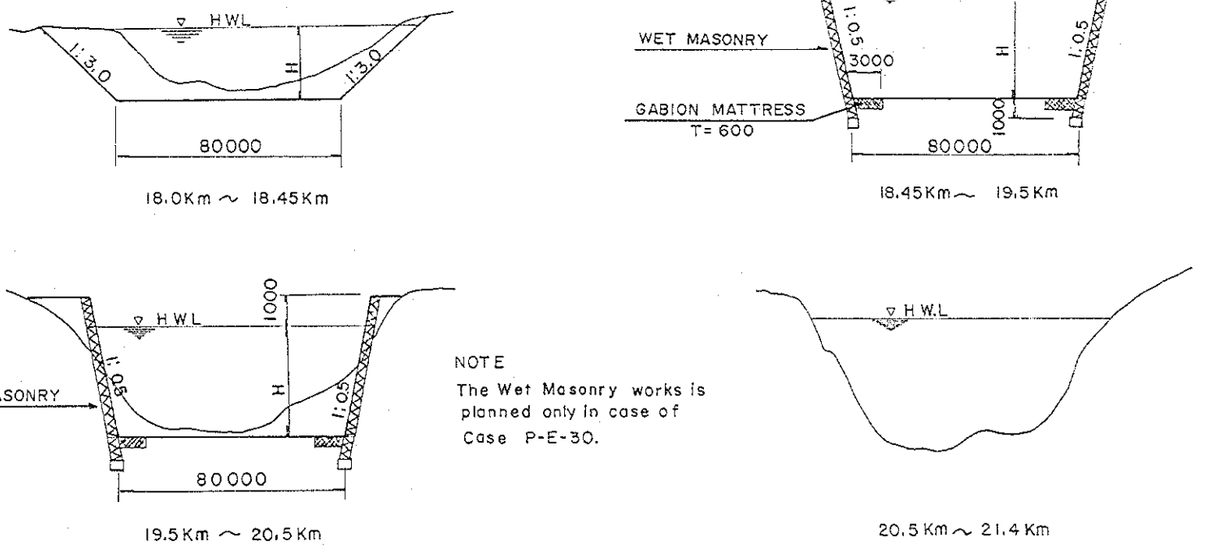
Fig. 6-1 (2/4) ASPECTOS GENERALES DE PLANES COMPARATIVOS (A-T)



DAM	CASE	H(m)	1:N	Hf(m)	L(m)
P-2	P-E-5	10.0	0.6	2.5	29.0
	P-E-10	11.0	0.65	2.6	29.0
	P-E-30	12.0	0.75	2.6	29.0
P-5	—	—	—	—	—
	—	—	—	—	—
	P-E-30	10.0	0.6	2.8	29.0



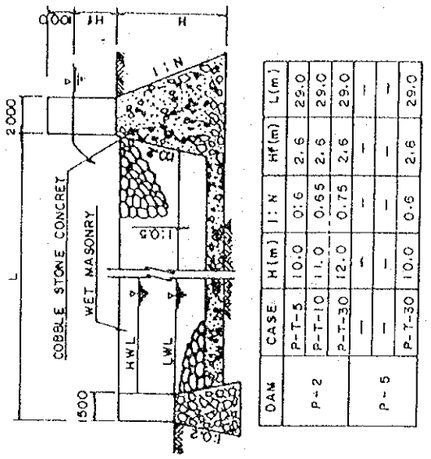
NOTE
In case of Case P-E-10', Case P-E-30 is applied to 18.0 $K^{m}_{\sim}$ 19.5 K^{m} and 21.3 $K^{m}_{\sim}$ 21.4 K^{m} and Case P-E-10 is applied to 19.5 $K^{m}_{\sim}$ 20.5 Km.



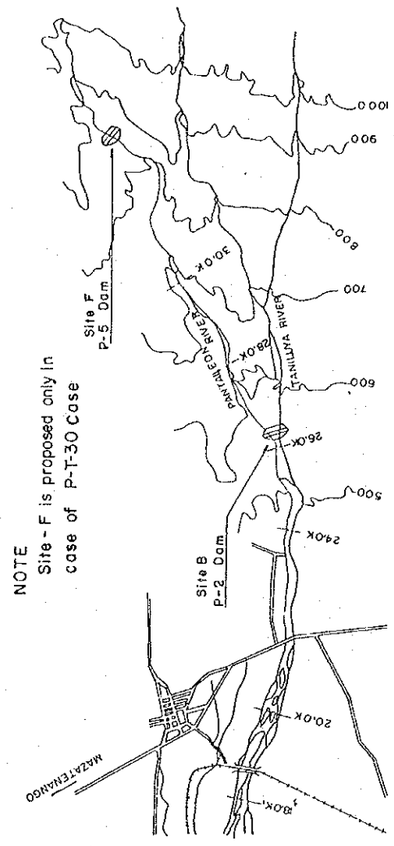
NOTE
The Wet Masonry works is planned only in case of Case P-E-30.

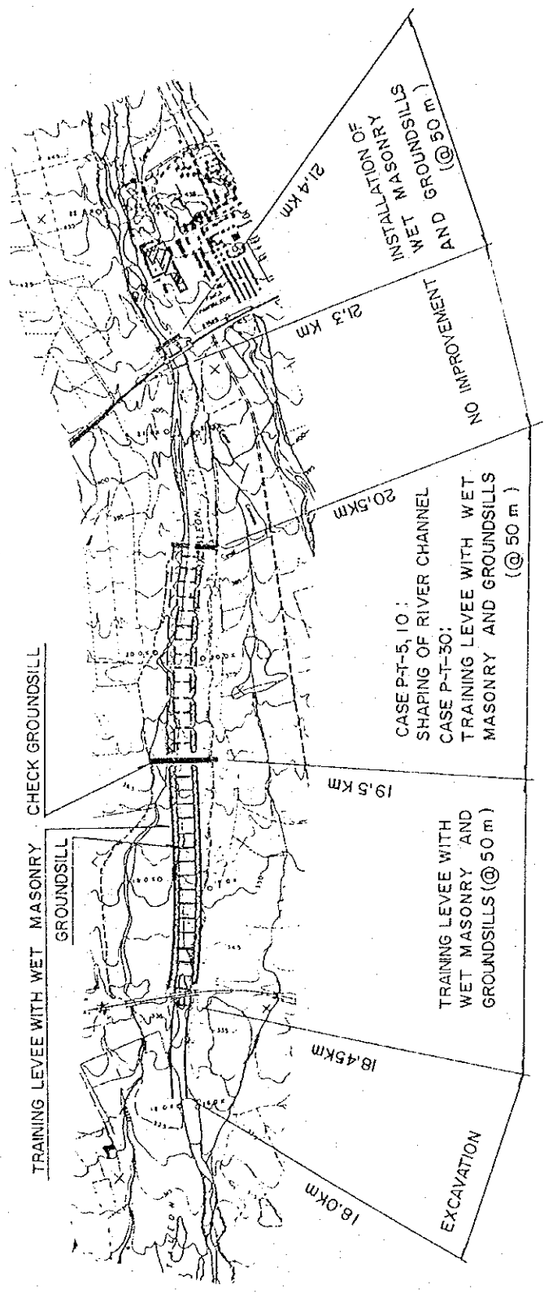
CROSS - SECTION

Fig. 6-1 (3/4) ASPECTOS GENERALES DE PLANES COMPARATIVOS (P-E)

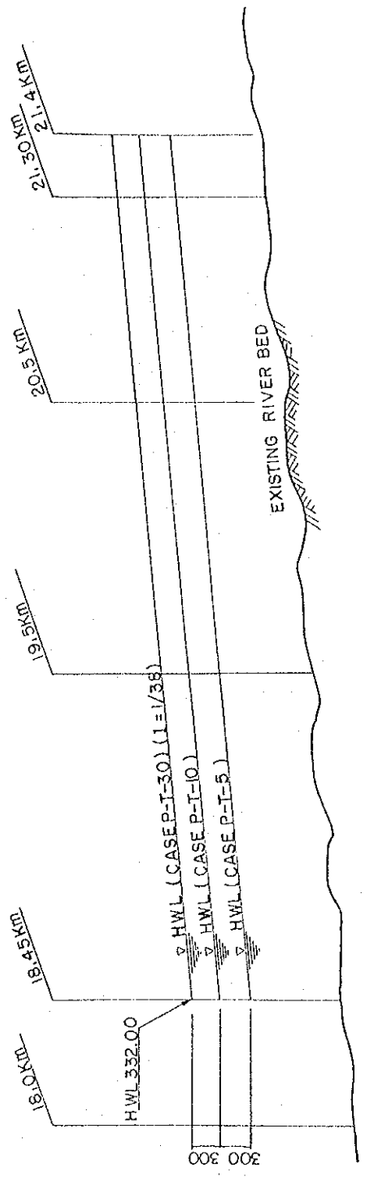


DAM	CASE	H(m)	1: N	Hf(m)	L(m)
P-2	P-T-5	10.0	0:6	2.6	29.0
	P-T-10	11.0	0.65	2.6	29.0
	P-T-30	12.0	0.75	2.6	29.0
P-5	—	—	—	—	—
	—	—	—	—	—
	P-T-30	10.0	0.6	2.6	29.0

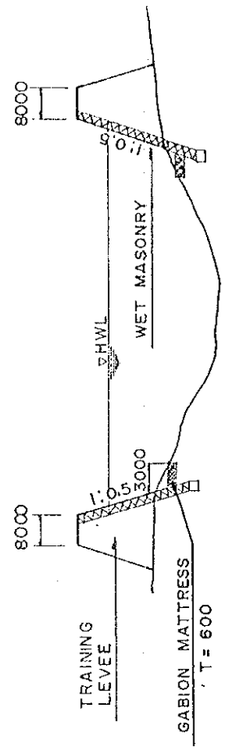




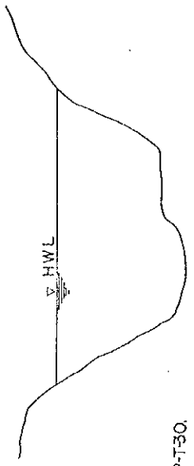
PLAN



PROFILE

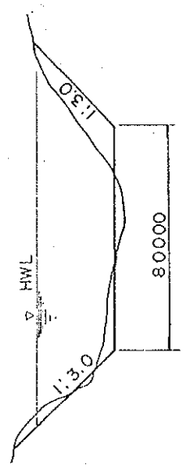


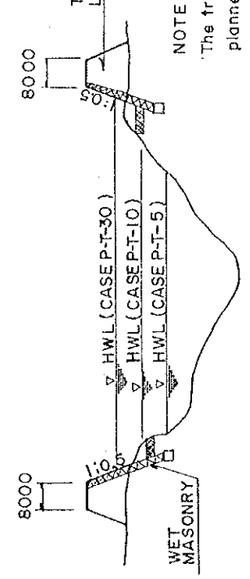
18.45Km ~ 19.5Km



20.5Km ~ 21.40Km

CROSS — SECTION





19.5Km ~ 20.5Km

Fig. 6-1 (4/4) ASPECTOS GENERALES DE PLANES COMPARATIVOS (P-T)

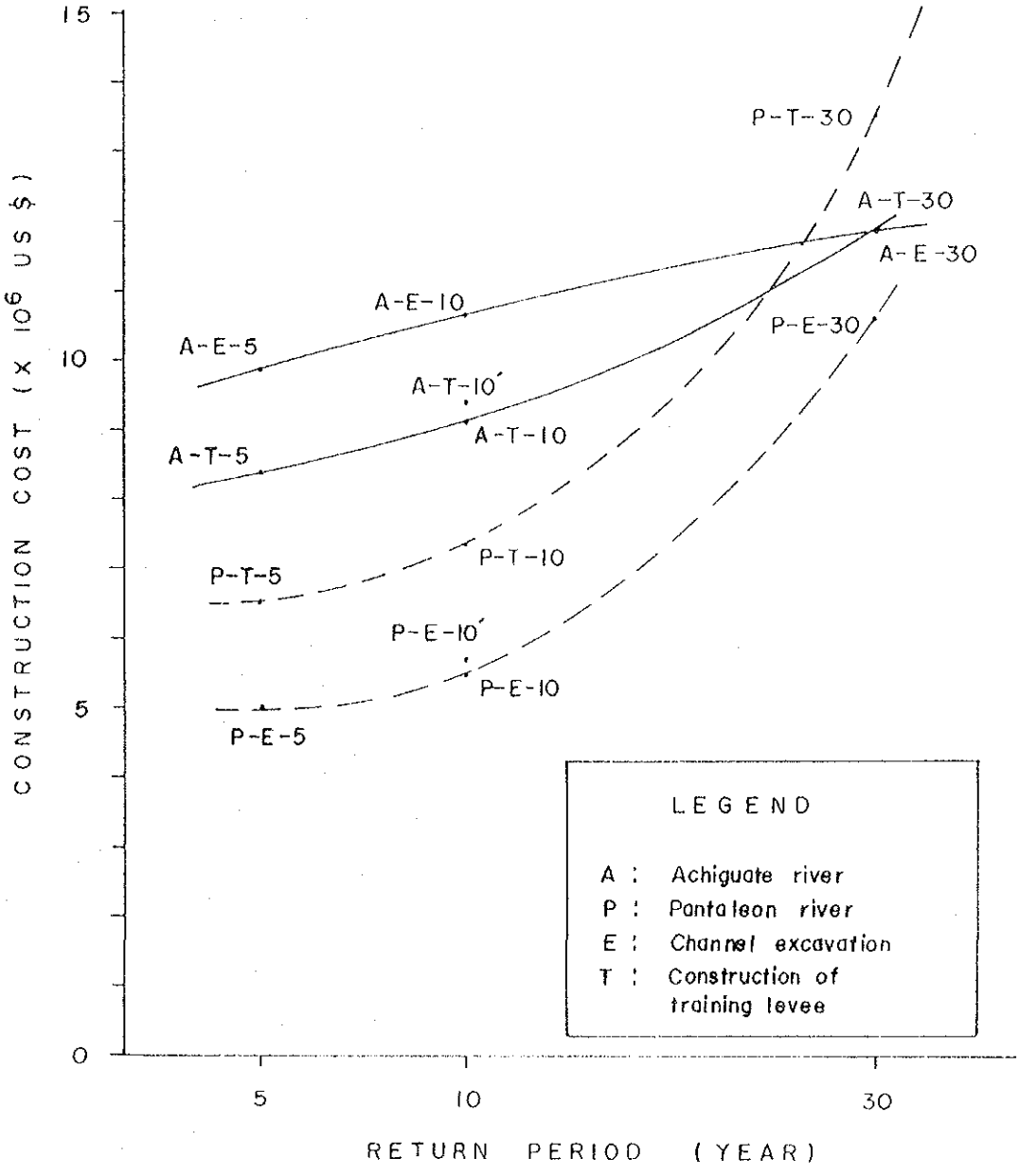


Fig. 6-2 COMPARACION DE COSTOS PARA METODOS DEL MEJORAMIENTO DEL CAUCE

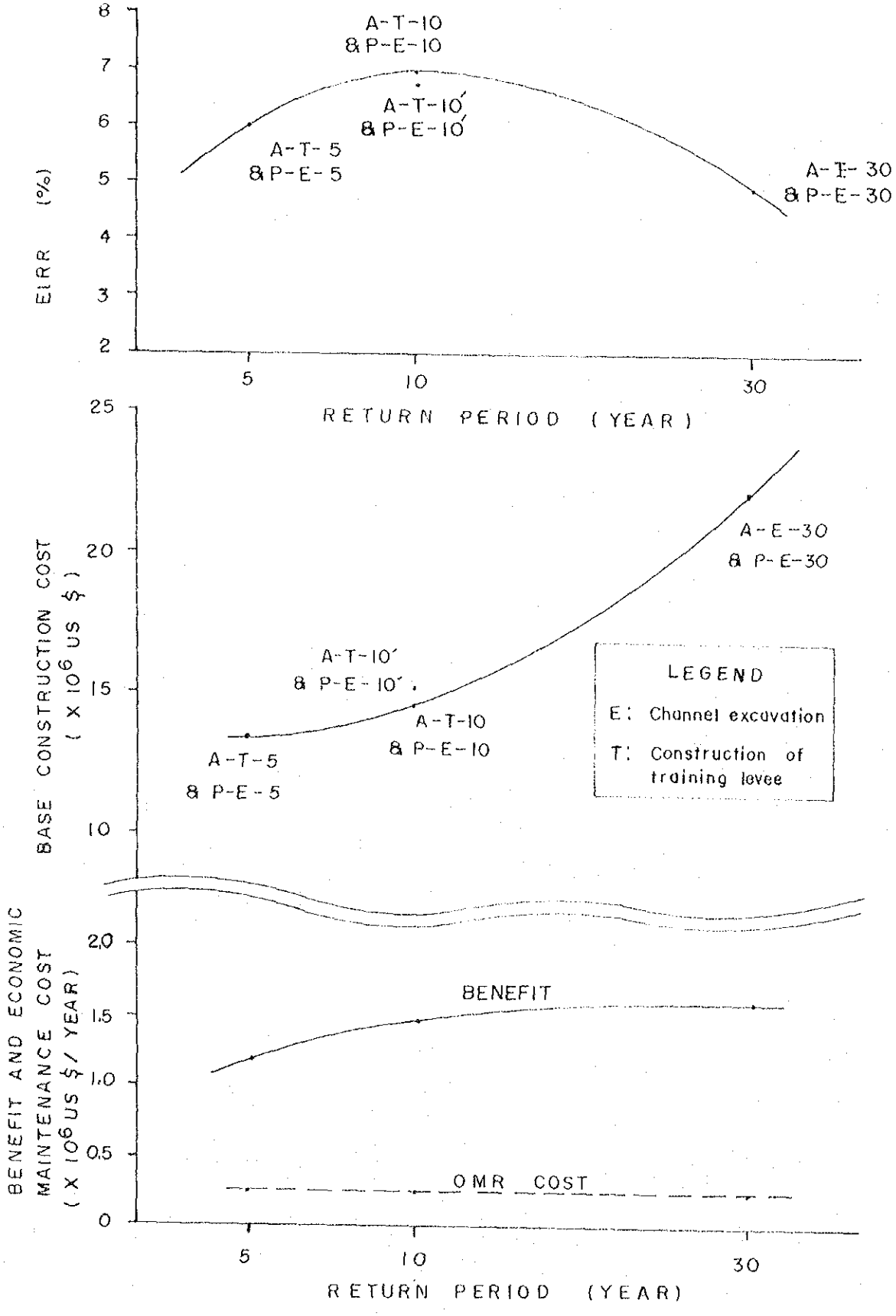


Fig. 6-3 COMPARACION ECONOMICA PARA ESCALAS DEL PROYECTO

Name of River	1930'S									1940'S										1950'S										1960'S										1970'S										1980'S					Numbers Occurence	Frecuency
	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84		
Suchiate			0	0		0															0										0																									5	10 Year
Naranjo																					0										0																									2	25 Year
Ocosito																																														0			0		0					3	18 Year
Samala			0	0		0								0								0	0							0				0													0		0		0	0			12	5 Year
Sis- Ican			0					0																																										0					3	18 Year
Nahualate																																				0													0					2	25 Year
Madre Vieja																																				0																			1	50 Year
Coyolate			0																																	0					0		0	0				0			0				7	8 Year
Acome																																																			0			1	50 Year
Achiguate		0	0	0																	0	0		0												0	0				0	0	0	0	0		0	0	0	0		0				18	3 Year
Maria Linda																															0					0	0					0							0					6	9 Year
Paso Hondo																																																			0			1	50 Year
Los Esclavos																0															0																					0			3	18 Year
Paz																																																			0			1	50 Year
Motagua	0		0	0		0																0										0	0	0										0		0							10	5 Year

Fig. 6-4 FRECUENCIAS DE DAÑOS POR INUNDACIONES EN GUATEMALA

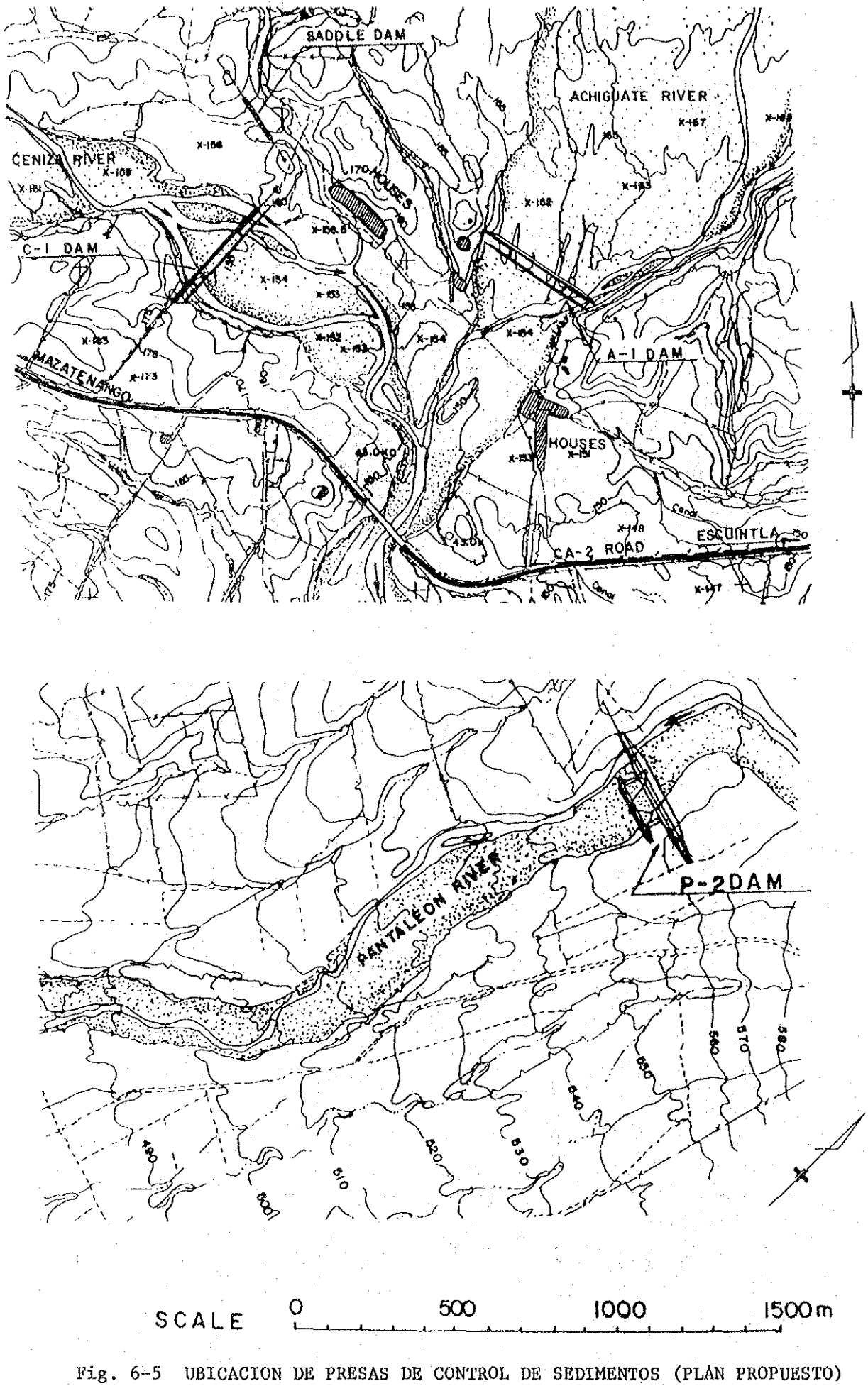


Fig. 6-5 UBICACION DE PRESAS DE CONTROL DE SEDIMENTOS (PLAN PROPUESTO)

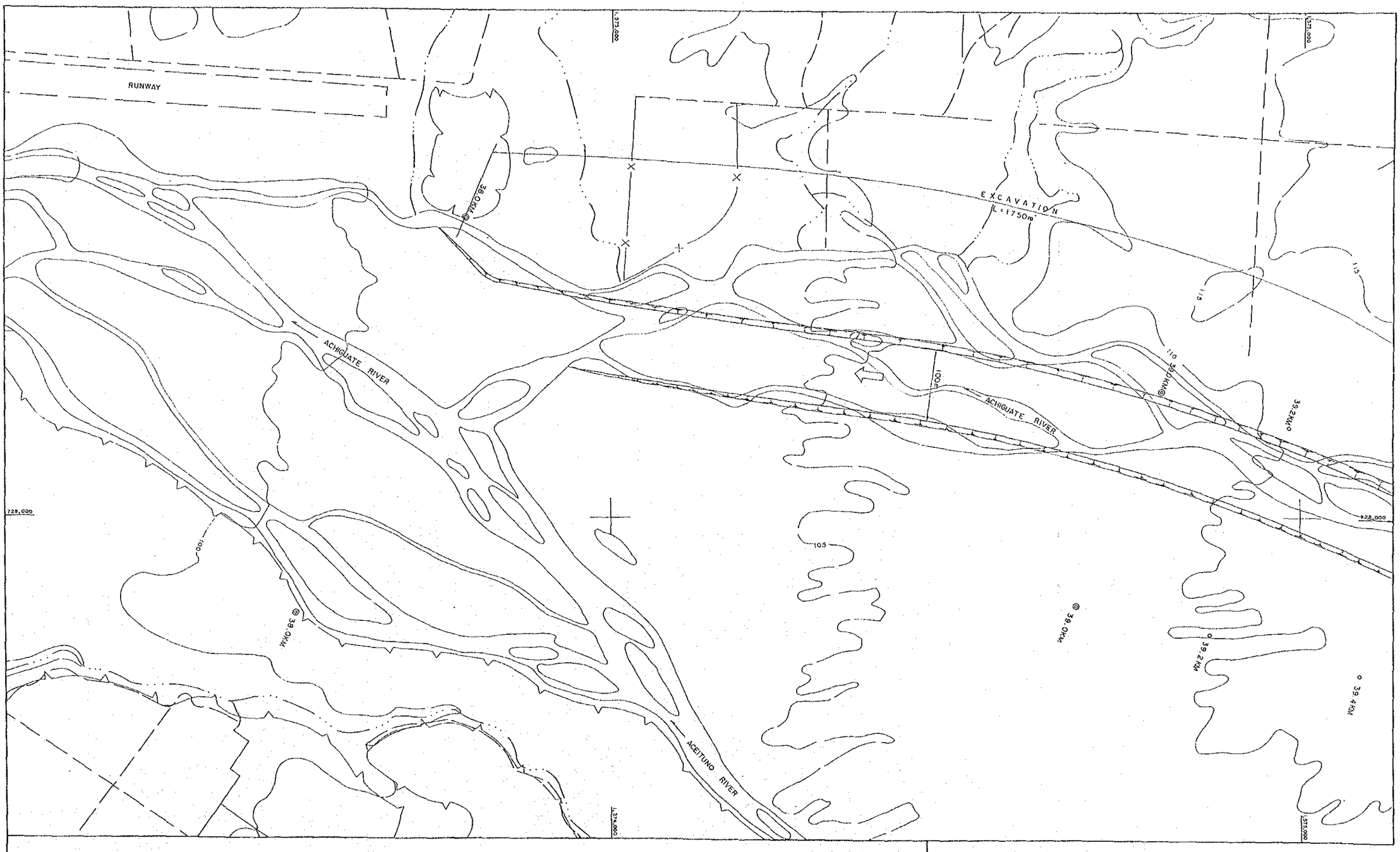


Fig. 6-6 (1/6) PLAN DE MEJORAMIENTO DEL CAUCE (PLAN PROPUESTO) (RIO ACHIGUATE)

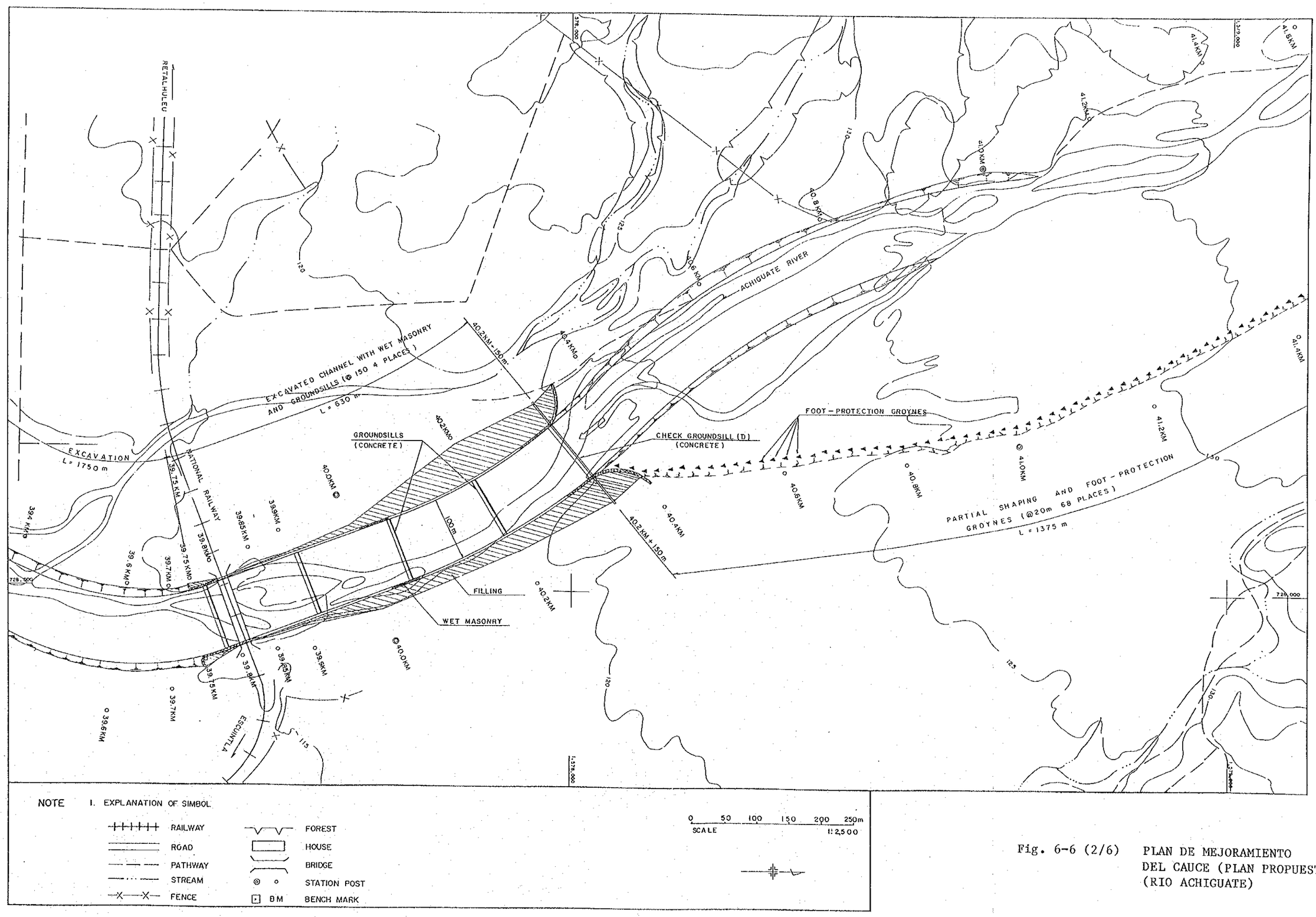


Fig. 6-6 (2/6) PLAN DE MEJORAMIENTO DEL CAUCE (PLAN PROPUESTO) (RIO ACHIGUATE)

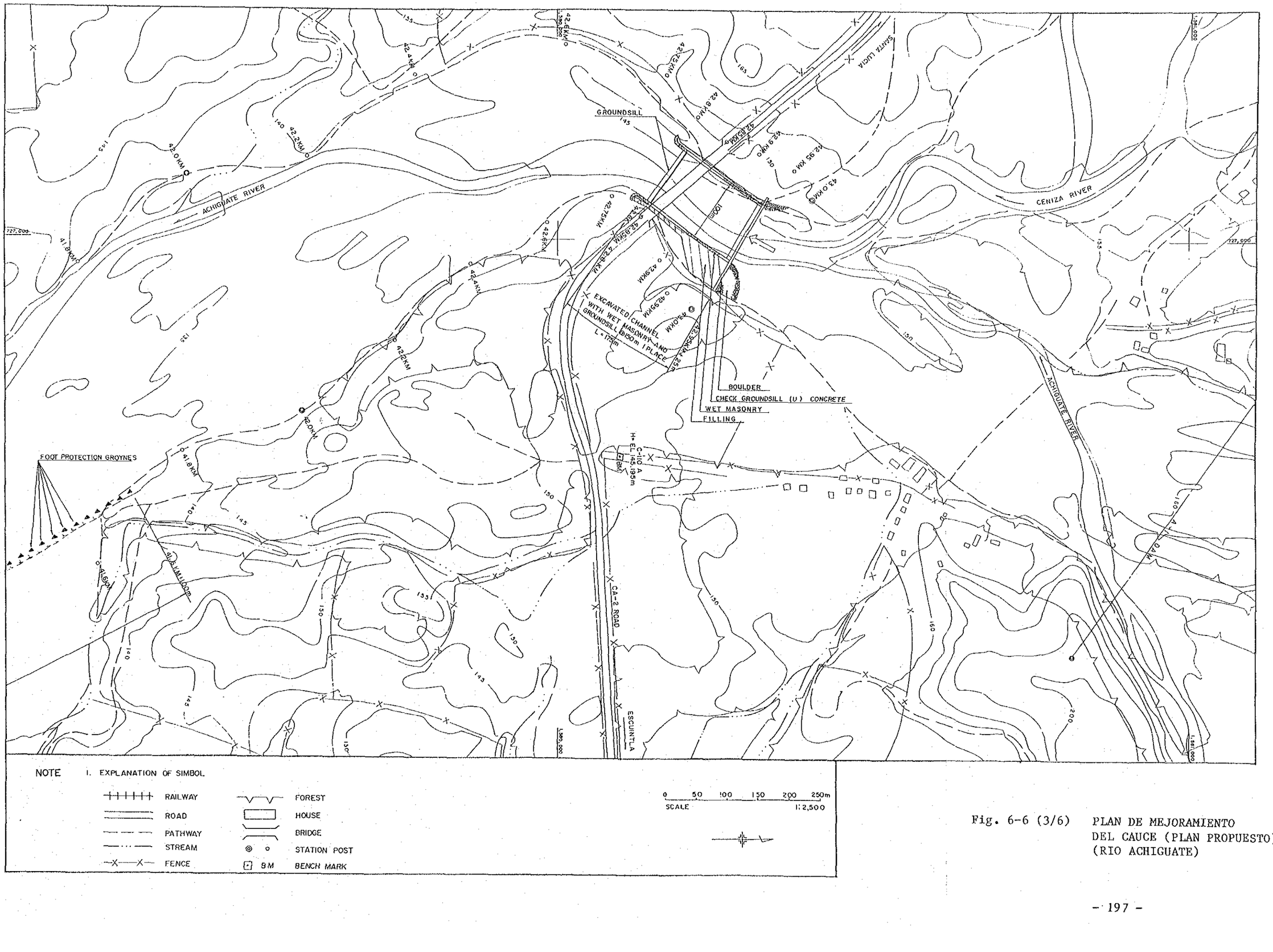


Fig. 6-6 (3/6) PLAN DE MEJORAMIENTO DEL CAUCE (PLAN PROPUESTO) (RIO ACHIGUATE)

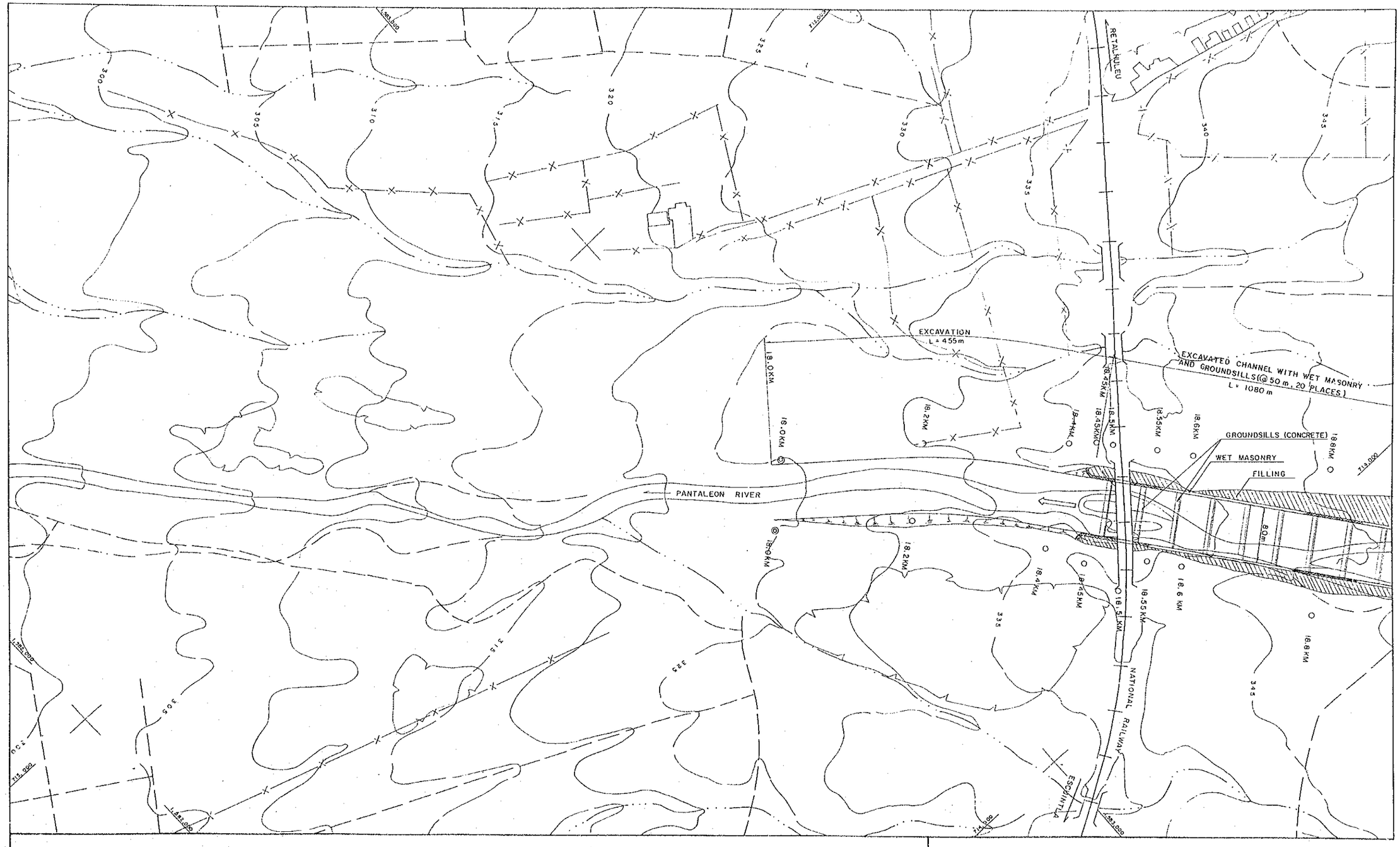


Fig. 6-6 (4/6) PLAN DE MEJORAMIENTO DEL CAUCE (PLAN PROPUESTO) (RIO PANTALEON)

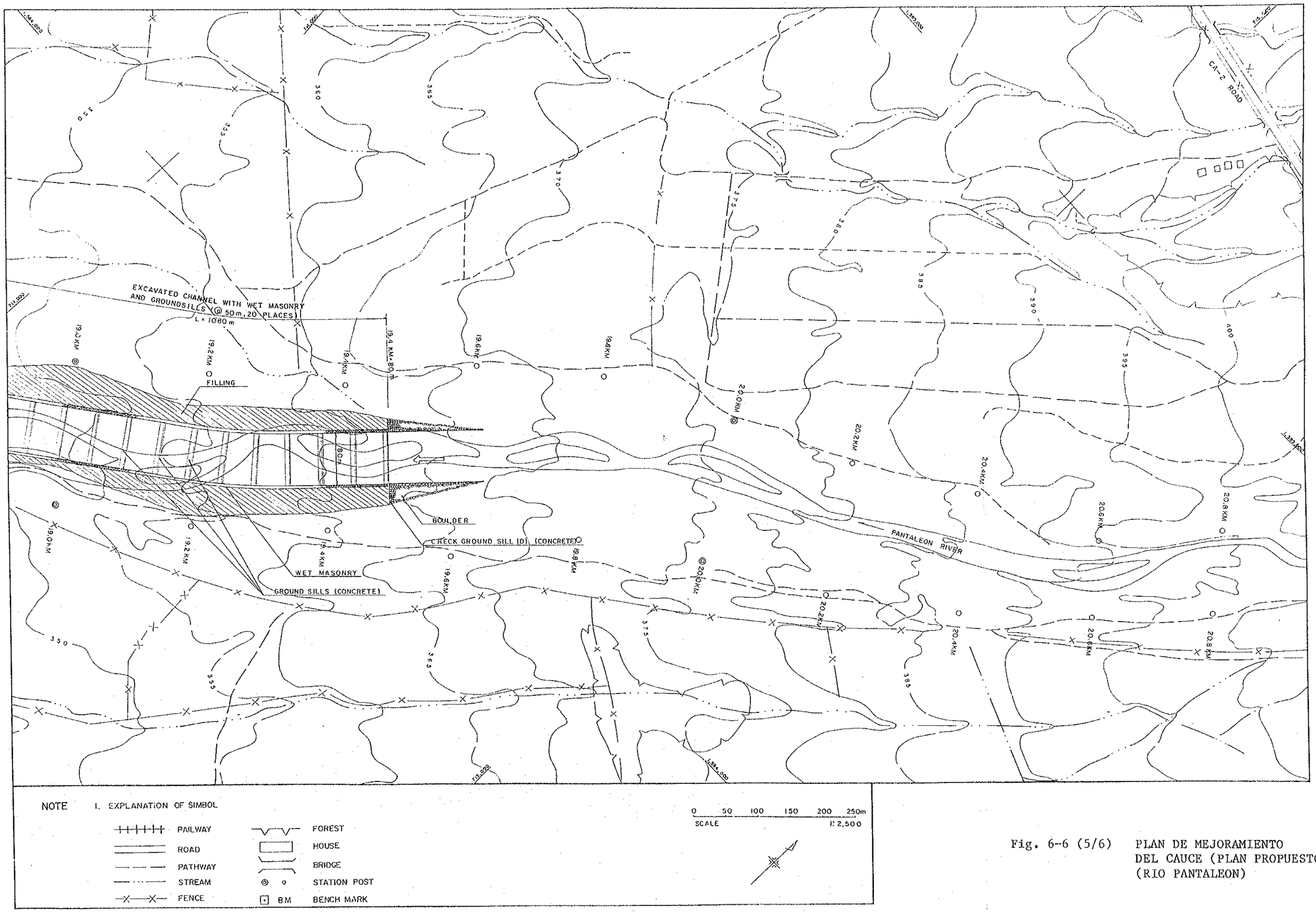


Fig. 6-6 (5/6) PLAN DE MEJORAMIENTO DEL CAUCE (PLAN PROPUESTO) (RIO PANTALEON)

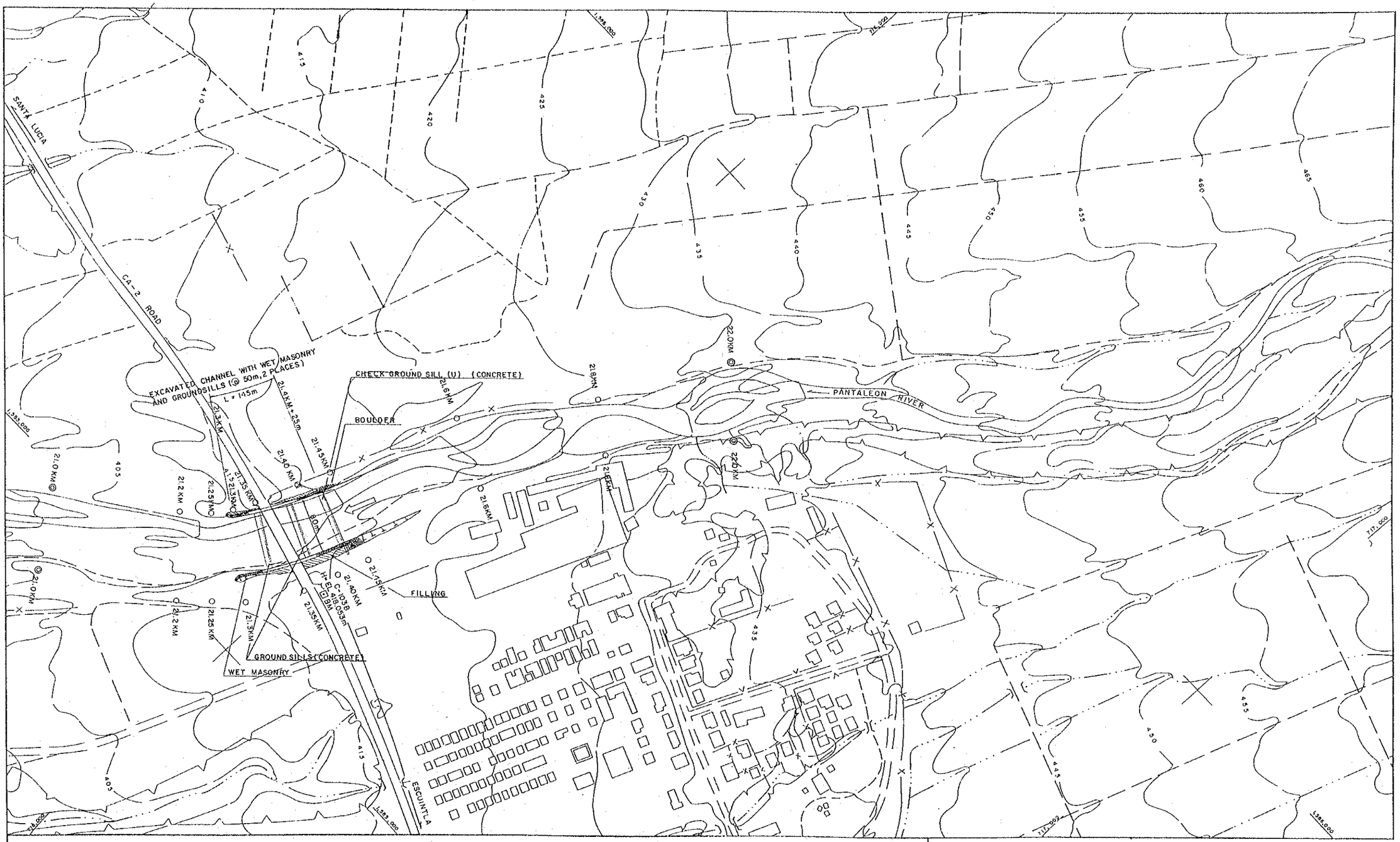
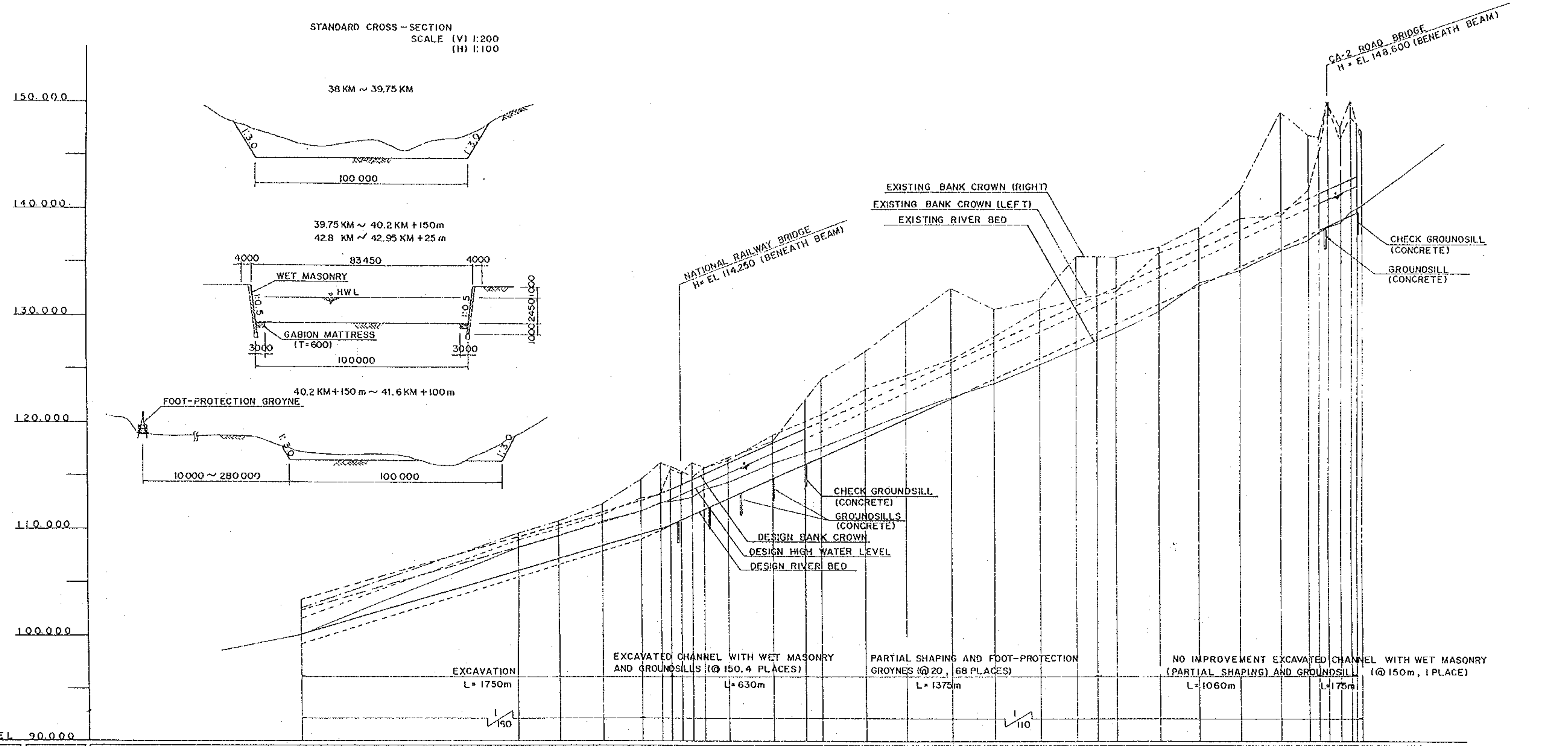


Fig. 6-6 (6/6) PLAN DE MEJORAMIENTO DEL CAUCE (PLAN PROPUESTO) (RIO PANTALEON)



STATION No. (KM)	DISTANCE (m)	ACCUMULATIVE DISTANCE (m)	DESIGN ELEVATION EL (m): BANK CROWN	DESIGN ELEVATION EL (m): HIGH WATER LEVEL	DESIGN ELEVATION EL (m): RIVER BED
38.0	0	38000	(103.25)	(102.25)	100.00 (99.00)
39.0	1025	39025	(109.16)	(108.16)	106.03 (105.41)
39.2	195	39220	(110.38)	(109.38)	107.18 (106.63)
39.4	205	39425	(111.66)	(110.66)	108.39 (107.91)
39.6	180	39605	(112.75)	(111.75)	109.45 (109.00)
39.7	95	39700	(113.31)	(112.31)	110.01 (109.86)
39.75	50	39750	113.75	112.75	110.30
39.8	50	39800	114.20	113.20	110.75
39.85	55	39855	114.70	113.70	111.25
39.9	55	39910	115.20	114.20	111.75
40.0	110	40020	116.20	115.20	112.75
40.2	210	40230	118.11	117.11	114.66
	150	40380	119.57	118.57	116.03
40.4	75	40455	120.16	119.16	116.71
40.6	205	40660	(122.02)	(121.02)	118.57
40.8	195	40855	(123.80)	(122.80)	(120.35)
41.0	215	41070	(125.75)	(124.75)	122.30
41.2	200	41270	(127.57)	(126.57)	124.12
41.4	215	41485	(129.52)	(128.52)	(126.07)
41.6	170	41655	(131.07)	(130.07)	(127.62)
	100	41755			
41.8	95	41850	(132.84)	(131.84)	(129.39)
42.0	205	42055	(134.70)	(133.70)	(131.25)
42.2	185	42240	(136.39)	(135.39)	(132.94)
42.4	195	42435	(138.16)	(137.16)	(134.71)
42.6	195	42630	(139.93)	(138.93)	(136.48)
42.75	135	42765	(141.16)	(140.16)	(137.71)
42.8	50	42815	141.61	140.61	138.16
42.85	40	42855	141.98	140.98	138.53
42.9	60	42915	142.52	141.52	139.07
42.95	50	42965	142.98	141.98	139.53
	25	42990	143.20	142.20	139.75
43.0	25	43015			(139.98)

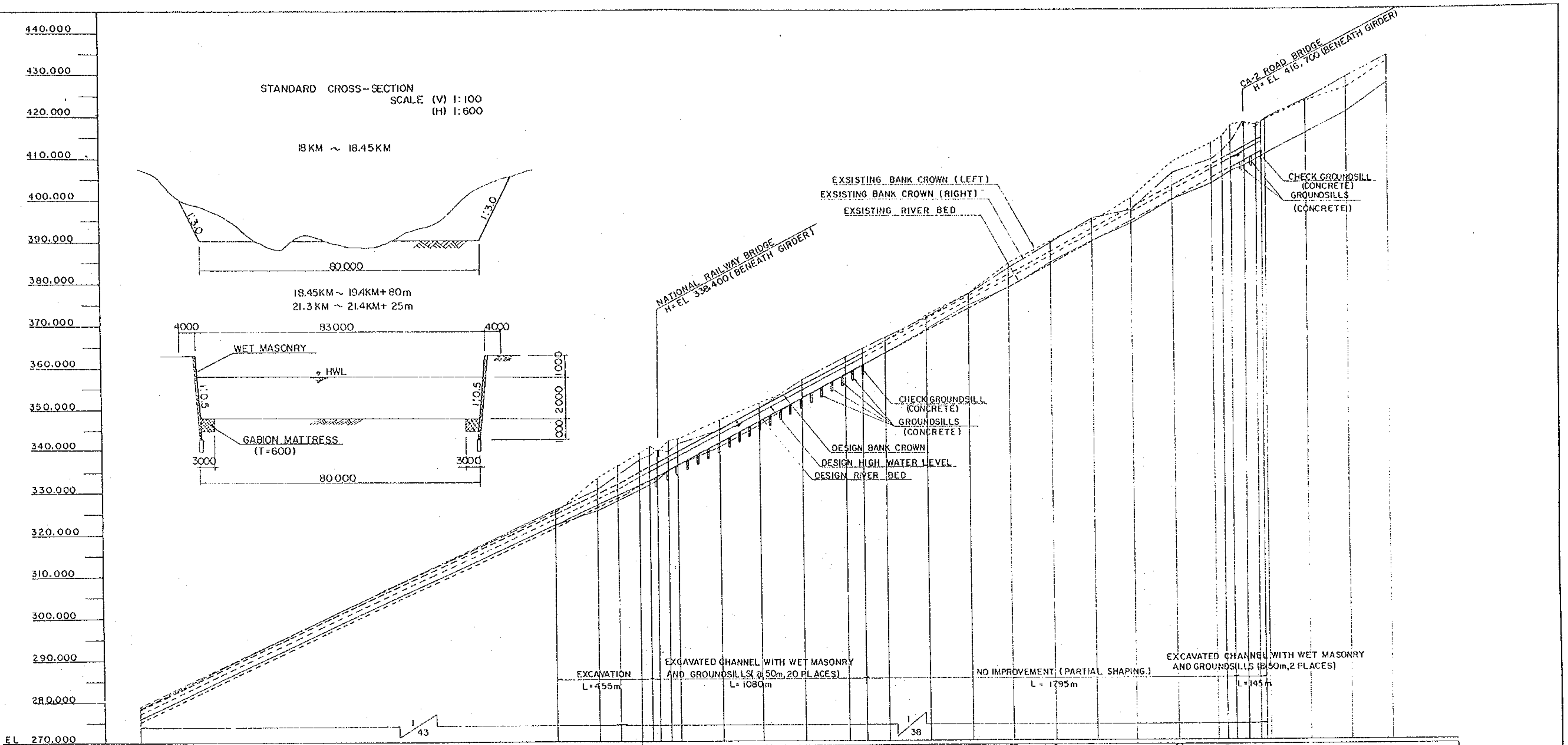
NOTE

1. The real lines and broken lines in the drawing and also the figures outside ( ) and inside ( ) in the columns are applied to the urgent plan and the comprehensive long-term plan, respectively.

VERTICAL
0 5 10 15 20m
SCALE 1:200

HORIZONTAL
0 200 400 600 800 1000m
SCALE 1:10,000
0 20 40 60 80 100m
SCALE 1:100

Fig. 6-7 (1/2) PERFIL DE DISEÑO DEL CAUCE
(PLAN PROPUESTO)
(RIO ACHIGUATE)



STATION No. (KM)	DISTANCE (m)	ACCUMULATIVE DISTANCE (m)	DESIGN ELEVATION EL (m): BANK CROWN	DESIGN ELEVATION EL (m): HIGH WATER LEVEL	DESIGN ELEVATION EL (m): RIVER BED
16.0	0	16000	(278.08)	(277.08)	(274.88)
18.0	2010	18010	(324.67)	(323.67)	322.00 (321.62)
18.2	200	18210	(329.33)	(328.33)	326.65 (326.28)
	100	18310	(331.97)	(330.97)	328.92 (328.60)
18.4	105	18415	(334.36)	(333.36)	331.68 (331.36)
18.45	50	18465	336.00	335.00	333.00
18.5	35	18500	336.92	335.92	333.92
18.55	55	18555	338.37	337.37	335.37
18.6	50	18605	339.68	338.68	336.68
18.8	200	18805	344.95	343.95	341.95
19.0	195	19000	350.08	349.08	347.08
19.2	205	19205	355.47	354.47	352.47
19.4	210	19415	361.00	360.00	358.00
	80	19495	363.11	362.11	360.11
19.6	115	19610	(366.13)	(365.13)	(363.13)
19.8	205	19815	(371.53)	(370.53)	(368.53)
20.0	205	20020	(376.92)	(375.92)	(373.92)
20.2	195	20215	(382.05)	(381.05)	(379.05)
20.4	205	20420	(387.45)	(386.45)	(384.45)
20.6	200	20620	(392.71)	(391.71)	(389.71)
20.8	190	20810	(397.71)	(396.71)	(394.71)
21.0	200	21010	(402.97)	(401.97)	(399.97)
21.2	190	21200	(407.97)	(406.97)	(404.97)
21.25	50	21250	(409.29)	(408.29)	(406.29)
21.3	40	21290	410.34	409.34	407.34
21.35	60	21350	411.92	410.92	408.92
21.4	60	21410	413.50	412.50	410.50
	25	21435	414.16	413.16	411.16
21.45	25	21460			
21.6	195	21655			
21.8	195	21850			
22.0	195	22045			

NOTE

1. The real lines and broken lines in the drawing and also the figures outside ( ) and inside ( ) in the columns are applied to the urgent plan and the comprehensive long-term plan, respectively.

VERTICAL
0 10 20 30 40 50m
SCALE 1:500
0 2 4 6 8 10m
SCALE 1:100
HORIZONTAL
0 200 400 600 800 1000m
SCALE 1:10,000
0 10 20 30 40 50 60m
SCALE 1:600

Fig. 6-7 (2/2) PERFIL DE DISEÑO DEL CAUCE
(PLAN PROPUESTO)
(RIO PANTALEON)