表

表　1－1 (1/6) 使用データ一覧表

Study Item	Data Utilized
A. Surveying/Mapping	1. Tophographic Map of the Study Area (Scale: 1:50,000) 2. Tophographic Map of the Study Area (Scale: 1:10,000) 3. Longitudinal Profile of the Achiguate and the Pantaleon Rivers 4. Cross Section of the Achiguate and the Pantaleon Rivers 5. Bench Marks in the Study Area
B. Meteorology/ Hydrology	1. Las Crecidas de los Rios Guacalate y Achiguate en Septiembre de 1969, Publicacion No. 59, Naciones Unidas, San Jose, Costa Rica (1970). 2. Tropical Cyclones of the North Atlantic Ocean, 1971-1980. 3. Atlantic Hurricane Season of 1976, 1977, 1978, 1979, 1980, 1981, 1982, Monthly Weather Review. 4. Monthly Rainfall Record of eight (8) stations in the project area (1961-). 5. Daily Rainfall Record of Main Floods of selected stations in the project area (1961-1982). 6. Hourly Rainfall Record of Sabana Grande (1972-1979), El Chupadero (1974-1981), and El Recuerdo (1972-1980). 7. Monthly Temperature Record of five (5) stations in the project area. 8. Monthly Humidity Record of four (4) stations in the project area. 9. Monthly Evaporation Record of two (2) stations in the project area. 10. Monthly Sunshine Record of one (1) station in the project area.

表　1－1 (2/6) 使用データー覧表

Study Item	Data Utilized
	11. Annual Maximum Discharge of sixteen (16) stations in the South Region since the beginning of observation.
C. River Improvement Plan	1. Resumen de la Ayuda Proporcionada por el CONE (1975) 2. Report on New Road Plan between Escuintla and San Jose. 3. Map of River Basins in Guatemala (Scale: 1:500,000) 4. Aerophotographs (1947, 1954, 1958, 1967, 1983). 5. Drawings of Railway Bridge in Achiguate River (1895, 1969). 6. Drawing of Railway Bridge in Pantaleon River (1895). 7. Drawing of Road Bridge in Achiguate River (1960). 8. Drawing of Road Bridge in Pantaleon River. 9. Sketch Plan of New Road between Escuintla and San Jose.
D. Sediment Control Plan	1. Santiaguito Volcanic Dome, Guatemala (1972). 2. Nuee Ardente from Santiaguito Volcano, April 1973. 3. The 1971 and 1973 eruptions of Fuego Volcano, Guatemala, and some socio-economic considerations for the volcanologist (1973). 4. Studies on volcanic ash from two recent volcanic eruptions in Central America (1973). 5. The October 1974 basaltic tephra from Fuego Volcano (1978).

表 1－1(3/6) 使用データー覧表

Study Item	Data Utilized
	6. Glowing avalanches from the 1974 eruption of Fuego Volcano, Guatemala (1978). 7. Volcanology, Cuatemala/Nicaragua selected materials (1980). 8. Informe de la Investigacion Realizada el 7 de Julio de 1983 en el Municipio de El Palmar (1983). 9. Map of River Basins in Guatemala (Scale: 1:50,000, 1:250,000, 1:500,000). 10. Aerophotographs (1954, 1958, 1964, 1967, 1983). 11. Geological Map and Report (Scale: 1:1,000,000). 12. Data on eruption of the Fuego and the Santa Maria volcanoes.
E. Construction Plan and Cost Estimates	1. Encuesta Basica de Manufacturera de Construccion Mano de Obra y Salalios (Directrato General de Estadistica). 2. Unit costs of labor obtained from CAMINOS. 3. Unit costs of materials obtained from CAMINOS. 4. Prices of machines obtained from agents. 5. Unit costs of machinery obtained from CAMINOS. 6. Memoria 1982 (CAMINOS). 7. Unit costs of land acquisition obtained from the Ministry of Public Finance.
F. Socio-Economy	1. Accidentes de Transito (1979-1980). 2. Anuario Estadistico (1980). 3. Anuario de Comercio Exterior (1976, 1979, 1980).

表　1－1(4/6) 使用データ一覧表

Study Item	Data Utilized
	4. Boletin Estadistico (1975-1980).
	5. II Censo de Agropecuaria (1964).
	6. III Censo de Vivienda (1973).
	7. I Censo Artesanal (1978).
	8. I Censo Artesanal, Tomo V (1978).
	9. III Censo Nacional Agropecuario (1978).
	10. Censos Nacionales (1981).
	11. Breve Monografia de la Republica de Guatemala.
	12. Directorio Nacional de Establecimientos Industriales (1981).
	13. Directorio Nacional de Establecimientos de Atencion Medica.
	14. Estadisticas Agropecuarias Continuas (1975, 1976, 1978-1981).
	15. Excuestas Agricolas de Granos Basicos (1978).
	16. Encuestas Nacionales de Ingresos y Gastos Familiares, Volumen I (1978-1981).
	17. Escuesta Basica de Materiales de Construccion, Mano de Obra y Salarios y Metodogia, para el calculo de los indices respectivos.
	18. Finanzas Municipales (1980-1981).
	19. Interpretacion de las Proyecciones de Poblacion en terminos de demanda de servicios basicos (1950-2000).
	20. Los Indices de Precios al Consumidor para la Republica de Guatemala (1977).
	21. Los Indices de Precios de Materiales de Construccion, Mano de Obra y Salarios, en la Ciudad de Guatemala (1981-1982).

表 1－1(5/6) 使用データ一覧表

Study Item	Data Utilized
	22. Metodologia de los Indices de Precios al Consumidor para la Republica de Guatemala durante el ano 1978.
	23. Metodologia Empleada en la Elaboracion de las Proyecciones de Poblacion Urbana-Rural (1978).
	24. Mapa de Capacidad Productiva de la Tierra 1:500,000 Memoria Explicativa (1980).
	25. Mapa con Ruta y Uso Actual de la Tierra 1:500,000 Memoria Explicativa (1981).
	26. Proyeccion de la Poblacion Urbana y Rural por sexo y grupos de edad (1975-2000).
	27. Quinquenio del Comercio de Guatemala-Centroamerica.
	28. Revision del Indice del Costo de la Construccion de Vivienda en la Ciudad de Guatemala (1925-1979).
G. River Administration	1. Report of "Diario de Sesiones"(1979)
	2. Report of Projecto de Ley de Aguas in Guatemala (1981)
	3. Organization Chart of Government of Guatemala
	4. Organization Chart of related agencies
	5. Thesis of "Analisis Critico de la Legislacion de Aguas en Guatemala (1978)
	6. Water Law of Mexico, Peru, Domicica, and Argentine
	7. Anuario Estadistico (1979)
	8. Boletin Estadistico (1978-1979, primer)
	9. Boletin Estadistico (1978-1979, segundo)
	10. Boletin Estadistico (1979-1980, 1o. y 2o.)

表 1－1 (6/6) 使用データ一覧表

Study Item	Data Utilized
	11. Boletin Estadistico(1980-1981, 1er)
	12. Finanzas Municipales (1980-1981)
	13. Algunas Cifras Acerca de Guatemala (1982)
	14. Codigo Civil
	15. Codigo Municipal y Sus Reformas (3a edicion)
	16. Ley del Organismo Ejectivo
	17. Prontuario de Leyes Tributarias (edicion 1984)
	18. Ley de Expropiacion y Sus Reformas
	19. Codigo de Salud
	20. Ley Forestal
	21. Ley Organica del Prespuesto, Contabilidad y Tesoreria de la Nacion y Sus Reglamentos
	22. Ley de Compras y Contrataciones, Su Reglamento, con Sus Reformas y Disposiciones Conexas
	23. Codigo Penal (con sus reformas)
	24. Codigo de Comercio
	25. Ley de Regimen Petralero de la Nacion
	26. Legislacion Municipal de la Republica de Guatemala

表　2－1　主要農産物　1974/75－1980/81年

Unit;　Thousand Tons

Kind	Productions						
	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81
Coffee	157	139	158	168	170	156	---
Cotton	107	98	134	147	159	148	127
Sugar	405	584	501	431	395	432	488
Sugar Cane	4,624	5,763	6,541	5,224	4,622	5,053	5,985
Maize	757	800	777	906	757	1,058	---
Beans	62	73	70	78	---	---	---
Wheat	45	48	56	60	57	50	50
Beef	58	75	70	70	76	79	---

表 2－2 輸出及び輸入高 1974/75－1980/81年

	Amount (Thousand Quetzales)						Average Annual Growth Rate (%)
	1975	1976	1977	1978	1979	1980	1975 - 1980
A. Export	623,621	760,333	1,160,218	1,111,602	1,217,076	1,472,796	18.8
B. Import	732,368	838,430	1,052,508	1,260,661	1,449,395	1,559,085	16.3
C. Total	1,355,989	1,598,763	2,212,726	2,372,263	2,666,471	3,031,881	17.5
D. Diff.	-108,747	-78,097	107,710	-149,059	-232,319	-86,289	
E. Export of Main Goods							
Coffee	164,154	242,952	525,884	477,435	430,301	469,775	23.4
Cotton	74,061	84,970	152,057	139,116	182,763	166,543	17.6
Sugar	116,792	116,724	92,725	45,753	52,390	75,946	-8.2
Beef	16,967	14,447	27,890	30,772	41,192	26,460	9.3
Banana	16,905	21,545	21,039	21,889	17,918	48,214	23.3
Total of E.	388,879	480,639	819,595	714,965	724,564	786,938	15.1
F. E/A(%)	62.4	63.2	70.6	64.3	59.5	53.4	

表 2－3 国内総生産（GDP） 1971－1980年

	Year										Average Annual Growth Rate (%)
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1971 - 1978
A. At Current Prices											
Total (Million Quetzales)	1,941	2,054	2,521	3,111	3,577	4,292	5,448	6,044	6,891	7,809	16.9
Annual Growth Rate (%)	-	5.8	22.8	23.4	15.0	20.0	26.9	10.9	14.0	13.3	
Per Capita (Quetzales)	346	355	423	506	564	657	809	871	963	1,060	13.2
Annual Growth Rate (%)	-	2.6	19.2	19.6	11.5	16.5	23.1	7.7	10.6	10.1	
B. At 1958 Constant Prices											
Total (Million Quetzales)	1,774	1,870	2,010	2,111	2,134	2,309	2,610	2,691	2,757	2,811	5.2
Annual Growth Rate (%)	-	5.4	7.5	5.0	1.1	8.2	13.0	3.1	2.5	2.0	
Per Capita (Quetzales)	316	323	337	343	337	353	388	388	385	381	2.1
Annual Growth Rate (%)	-	2.2	4.3	1.8	-1.7	4.7	9.9	0.0	-0.8	-1.0	

表　2－4　産業セクター毎のＧＤＰに占める割合　1971－1980年

Unit: %

Industrial Origin	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1. Agriculture	27.7	28.3	27.9	27.9	28.0	27.3	26.3	25.9	25.4	24.9
2. Mining	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.5
3. Manufacturing Industries	16.0	15.7	15.9	15.7	15.1	15.6	16.0	16.2	16.3	16.7
4. Construction	1.5	1.7	1.9	1.7	1.9	3.0	3.2	3.1	3.2	3.2
5. Electricity, Gas, Water Supply	1.2	1.3	1.3	1.3	1.4	1.4	1.6	1.7	1.7	1.7
6. Transportation & Communications	5.6	5.8	6.0	6.4	6.4	6.5	6.5	6.6	6.7	6.9
7. Commercial Services	28.6	28.0	28.1	28.4	27.6	27.9	28.2	28.1	27.5	27.0
8. Financial Services	2.3	2.3	2.5	2.5	2.6	2.6	2.9	3.0	3.4	3.4
9. Housing	6.7	6.4	6.1	5.8	5.9	4.4	4.5	4.5	4.5	4.4
10. Public Administration	4.7	4.8	4.6	4.6	5.0	5.2	4.8	4.8	4.9	5.2
11. Other Services	5.6	5.6	5.6	5.6	6.0	6.0	5.9	5.9	6.1	6.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

表　3－1　各県毎の人口 1950, 1964, 1973, 1981年

Region	Area (km^2)	Population Census (persons)				Average Annual Growth Rate of Population (%)			Population Density Per km^2 in 1981
		1950	1964	1973	1981	1950-1964	1964-1973	1973-1981	
Republic of Guatemala	108,889	2,790,868	4,287,997	5,211,929	6,054,227	3.11	2.19	1.89	56
Departments									
Guatemala	2,126	438,913	810,858	1,127,845	1,311,192	4.48	3.73	1.90	617
El Progreso	1,922	47,874	65,582	73,176	81,188	2.27	1.22	1.31	42
Sacatepequez	465	60,124	80,942	99,710	121,127	2.15	2.34	2.46	260
Chimaltenango	1,979	121,480	163,153	193,557	230,059	2.13	1.23	2.18	116
Escuintla	4,384	123,759	270,267	300,140	334,666	5.74	1.17	1.37	76
Santa Rosa	2,955	109,836	157,040	176,198	194,168	2.59	1.29	1.22	66
Solola	1,061	82,921	107,822	126,884	154,249	1.89	1.83	2.47	145
Totonicapan	1,061	99,354	141,772	166,622	204,419	2.57	1.81	2.59	193
Quetzaltenanago	1,951	184,213	270,916	311,613	366,949	2.79	1.57	2.06	188
Suchitepequez	2,510	124,403	186,634	212,017	237,554	2.94	1.43	1.43	95
Retalhuleu	1,856	66,861	117,562	133,993	150,923	4.11	1.46	1.50	81
San Marcos	3,791	232,591	336,959	388,100	472,326	2.68	1.58	2.49	125
Huehuetenango	7,400	200,101	288,088	368,807	431,343	2.64	2.78	1.98	58
Quiche	8,378	174,911	249,939	300,641	328,175	2.58	2.07	1.10	39
Baja Verapaz	3,124	66,313	96,485	106,909	115,602	2.71	1.15	0.98	37
Alta Verapaz	8,686	189,812	260,498	276,370	322,008	2.29	0.66	1.93	37
Peten	35,854	15,880	26,562	64,503	131,927	3.74	10.36	9.36	4
Izabal	9,038	55,032	116,685	170,864	194,618	5.52	4.33	1.64	22
Zacapa	2,690	69,536	96,554	106,726	115,712	2.37	1.12	1.02	43
Chiquimula	2,376	112,841	149,752	158,146	168,863	2.04	0.61	0.82	71
Jalapa	2,063	75,190	99,153	118,103	136,091	2.00	1.96	1.79	66
Jutiapa	3,219	138,925	194,774	231,005	251,068	2.44	1.91	1.05	78

表　3－2　エスキントラ県に於ける人口，家屋，世帯数　1981年

Administration	Population	Number of Houses	Number of Households	Average Size of Family
Republic of Guatemala	6,054,227	1,259,598	1,151,872	5.26
Department of Escuintla	334,666	70,368	65,751	5.09
Municipality				
Escuintla	75,442	15,110	14,893	5.07
Siquinala	8,646	1,621	1,514	5.71
Masagua	20,369	4,416	4,032	5.05
La Democracia	13,059	2,911	2,595	5.03
San José	23,613	5,329	4,668	5.06
Sub-total	141,129	29,450	27,702	5.09
Santa Lucia	44,422	9,513	8,884	5.00
La Gomera	31,227	7,046	6,342	4.92
Sub-total	75,649	16,559	15,226	4.97
Tiquisate	35,719	7,864	7,378	4.84
Guanagazapa	8,137	1,743	1,555	5.23
Iztapa	6,547	1,462	1,221	5.36
Palin	14,140	2,439	2,839	4.98
San Vicente Pacaya	7,076	1,545	1,403	5.04
Nueva Concepcion	46,269	9,306	8,427	5.49
Sub-total	117,888	24,359	22,823	5.17

表 3－3 年令別，男女別総人口及び労働人口

	Republic of Guatemala				Department of Escuintla				Study Area			
	Over 10 years		Total		Over 10 years		Total		Over 10 years		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Population												
Male	2,024,311	(67.1)/1	3,015,926		118,514	(68.2)/1	173,895		77,952	(68.9)/1	113,080	
Female	2,070,842	(68.2)	3,038,401		108,277	(67.3)	160,771		70,710	(68.2)	103,696	
Total	4,095,153	(67.6)	6,054,227		226,791	(67.8)	334,666		148,662	(68.6)	216,778	
Working Population												
Male	1,449.058	(71.6)/2	1,449,058	(48.0)/3	88,034	(74.3)/2	88,034	(50.6)/3	58,362	(74.9)/2	58,362	(51.6)/3
Female	247,406	(11.9)	247,406	(8.1)	8,250	(7.6)	8,250	(5.1)	5,887	(8.3)	5,887	(5.7)
Total	1,696,464	(41.4)	1,696,464	(28.0)	96,284	(42.5)	96.284	(28.8)	64,249	(43.2)	64,249	(29.6)

/ 1 and / 3: Percentage to the total population by sex group.
/ 2: Percentage to the total population of the same age by sex group.

表　3－4 (1/3) アチグァテ川及びパンタレオン川流域での土砂洪水被害

Date	Cause of Flood	Achiguate River Basin	Pantaleon River Basin
Sep. 5 1969	Hurricane Francelia	Achiguate, Mazate and Gaucalate rivers overflowed.	Flooding along Pantaleon and Taniluya
		Inundation area: 136.8 km^2, 50 dead and 100 injured in Antigua. Guacalate bridges and railway Achiguate, Aceituno bridges were destroyed. Destruction of rialway at Obispo Bridge.	
Sep. 26 1969		Escuintla, 4 dead	
Jul. 27 1970		Ceniza Bridge destroyed.	
Sep. 29-31 1970		Achiguate and Guacalate rivers overflowed. Escuintla, agriculture and cattle damage.	
Sep. 9 1971		Road to San Jose was cut off by water from Achiguate river.	
----- Eruption of Fuego Volcano on Sep. 14, 1971 -----			
Sep. 24 1971	Hurricane Olivia	Inhabitants evacuated, Siquinala	Flood and debris flow along Pantaleon and Taniluya rivers.
			CA-2 bridge was destroyed .
Oct. 10 1971			Railway bridge was washed out.
Aug. 3 1972		Escuintla, houses were damaged by flood from Mazate river.	

表 3－4 (2/3) アチグァテ川及びパンタレオン川流域での土砂洪水被害

Date	Cause of Flood	Achiguate River Basin	Pantaleon River Basin
Oct. 10 1972		Escuintla, Plantation was inundated by flood from Obispo river.	
Jun. 26 1973			Railway bridge was destroyed. Right bank of CA-2 road bridges was scoured.
Aug. 21 1973		Escuintla, Plantation damaged by flod from Obispo river.	
Sep. 21 1974	Hurricane Fifi	Traffic to San Jose, interrupted.	Inundation Area: 13.3 km^2, Blance and Petaya bridges were destroyed.
Jul. 1 1976		Traffic to San Jose interrupted by flood from Achiguate river.	
Sep. 17 1977		-- Ditto -- Cultivated land along Achiguate river was inundated.	
Sep. 6 1978		Sinquinala, big damages caused by flood from Mazate river.	
Sep. 12 1978		-- Ditto --	
Oct. 11 1978		Road to San Jose was cut off by flood from Achiguate river.	
Aug. 31 1979		-- Ditto -- Cultivated land along Achiguate river was inundated.	

表　3－4 (3/3) アチグァテ川及びパンタレオン川流域での土砂洪水被害

Date	Cause of Flood	Achiguate River Basin	Pantaleon River Basin
Sep. 3 1979		Road to San Jose was cut off by flood from from Achiguate river.	
Sep.10 1979			Railway bridge was partially destroyed. Some casualities due to flood.
Sep. 21 1979		Mazate bridge was partially destroyed.	
Sep. 12 1982	Hurricane Paul	Inundation area was almost same scale as that in 1969.	

SOURCE : "El Imparcial" and Report of CAMINOS

NOTE : Road bridge and railway bridge have been repeatedly reconstructed after destruction by flood.

Reconstruction data are as follows:

Achiguate River	CA-2 road bridge	: 1964 and 1970
	Railway bridge	: 1970
Pantaleon River	CA-2 road bridge	: 1964 and 1973
	Railway bridge	: 1972 and 1979

表　3－5　エスキントラ県の主要道路に於ける日平均交通量　1978－1982年

Station	Road	Traffic Volume 1978	1979	1980	1981	1982	Average Annual Increase Rate (%) 1978-1982
200/1	CA-2	3,706	4,469	4,548	4,558	4,318	7.09
207	CA-2	5,577	5,141	4,739	5,340	5,187	-1.83
208	CA-2	3,311	4,137	3,641	3,338	3,653	2.49
	Feeder of						
0205	CA-2	1,786	1,934	1,466	1,233	1,146	-11.51
0206	"	1,441	1,403	1,622	1,184	1,155	-5.69
0207	"	1,282	1,920	1,332	1,214	1,261	-0.41
0208	"	1,194	1,115	1,199	1,088	1,311	2.36
0209	"	1,553	1,435	1,187	953	1,068	-9.81
0904	CA-9	3,432	3,449	2,944	3,185	--	-2.46
0905	"	1,689	1,723	1,521	1,398	1,678	-0.16
0906	"	839	1,118	1,296	1,280	1,479	15.23
0907	"	691	1,037	1,031	1,322	1,298	17.07

/1 : Station 200 is situated at 78 km from the Municipality of Guatemala.

表　3－6　グアテマラ国及びエスキントラ県の土地利用

Land Use	Area			
	Republic of Guatemala (km^2)	(%)	Department of Escuintla (km^2)	(%)
1. Cultivated	11,715	10.8	2,307	52.6
2. Cultivated and Pasture	14,951	13.7	163	3.7
3. Pasture	13,338	12.2	1,323	30.2
Sub-total	40,004	36.7	3,793	86.5
4. Forestry	43,226	39.7	63	1.4
5. Waste	24,091	22.1	472	10.8
6. Lake and Swamp	1,274	1.2	---	---
7. Sand and Rock	294	0.3	56	1.3
Sub-total	68,885	63.3	591	13.5
TOTAL	108,889	100	4,384	100

表　3－7　調査対象地域内の土地利用

Land Use	Area					
	Total		Achiguate River Basin		Pantaleon River Basin	
	(ha)	(%)	(ha)	(%)	(ha)	(%)
1. Town	1,641	1.3	1,364	1.3	277	1.3
2. Coffee and Cacao	2,262	1.7	2,009	1.8	253	1.2
3. Orchard	1,031	0.8	587	0.5	444	2.1
4. Sugar Cane	16,744	12.9	12,138	11.2	4,606	21.3
5. Palm	31	0.0	31	0.0	40	0.0
6. Banana	1,029	0.8	943	0.9	86	0.4
7. Cotton	3,932	3.0	3,102	2.9	830	3.9
8. Maize	8,571	6.6	6,879	6.3	1,692	7.8
9. Sesame	189	0.1	96	0.1	93	0.4
10. Pasture	53,448	41.1	44,821	41.3	8,627	39.9
Sub-Total (2-10)	88,878	68.3	71,970	66.3	16,908	78.3
11. Road & Railway	3,636	2.8	2,897	2.7	739	3.4
12. Forestry	29,005	22.3	26,236	24.1	2,769	12.8
13. Waste	3,831	2.9	3,474	3.2	357	1.6
14. Lake, Swamp & River	4,142	3.2	3,853	3.3	559	2.6
15. Salina	151	0.1	151	0.1	---	---
16. Sand & Rock	557	0.4	289	0.3	268	1.3
Sub-Total (12-16)	37,686	28.9	33,733	31.0	3,953	18.3
TOTAL	130,200	100	108,600	100.0	21,600	100.0

表　3－8　調査対象地域内での他のプロジェクト

Project	Location	Execution Body	Cost (10^3 Quetzales)	Period of Construction (year)
Highway Construction	Escuintla-San Jose	CAMINOS	16,675	1984 and 1985
Railway Rehabilitation	Sta. Maria-San Jose	FEGUA	6,900	1985
New Port Construction	San Jose	UNECPA	296,100	from 1980 to 1986

表 3－9 月平均降雨量

Code	Name of Station	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Remarks
5.8.2	San José FEGUA	0 (0)	0 (0)	4.7 (1)	28.1 (2)	79.1 (6)	236.4 (13)	155.3 (10)	156.7 (10)	240.4 (12)	137.8 (8)	57.6 (2)	5.7 (1)	1101.8 (60)	1960-79
5.6.5	Sta. María FEGUA	3.6 (1)	3.9 (1)	18.7 (1)	79.5 (5)	231.1 (12)	386.5 (17)	285.0 (15)	328.6 (17)	444.0 (18)	317.4 (17)	106.6 (6)	19.9 (1)	2224.0 (109)	1960-79
5.10.5	Santa Lucía FEGUA	11.2 (1)	11.5 (1)	34.0 (3)	133.4 (7)	316.7 (14)	484.0 (20)	357.1 (17)	404.3 (18)	567.6 (19)	471.9 (19)	154.1 (7)	23.0 (1)	2968.8 (125)	1960-79
5.1.2	Escuintla FEGUA	3.7 (2)	9.9 (1)	24.4 (2)	100.3 (7)	324.4 (14)	565.9 (19)	284.2 (15)	334.9 (16)	571.3 (21)	340.4 (15)	125.5 (5)	9.6 (1)	2694.5 (111)	1960-79
5.1.4	Ceylan	21.8 (2)	28.4 (3)	76.0 (5)	204.1 (11)	605.8 (21)	767.0 (26)	484.2 (21)	583.4 (23)	797.5 (28)	576.3 (24)	180.2 (8)	41.5 (4)	4366.2 (172)	1960-79
5.10.3	Los Tarros	29.0 (3)	34.2 (3)	80.0 (5)	235.8 (10)	517.1 (17)	736.9 (22)	614.0 (20)	650.5 (21)	865.9 (24)	749.0 (22)	256.5 (10)	55.0 (2)	4824.4 (156)	1960-79
16.1.1	Antigua E.E.	2.4 (1)	0 (1)	6.3 (1)	17.7 (2)	103.1 (6)	225.7 (15)	154.0 (11)	143.2 (13)	202.7 (15)	91.3 (8)	16.0 (2)	1.4 (1)	963.8 (73)	1960-79
3.5.2	El Recuerdo	9.3 (4)	6.6 (2)	11.3 (2)	46.5 (6)	128.9 (14)	275.0 (22)	190.2 (19)	204.6 (18)	329.7 (23)	122.3 (16)	34.9 (9)	9.3 (4)	1368.6 (141)	1968-79

Note: Figures in Perentheses are mean rainfall days in the month.

表 3－10 月平均気温

(Unit: °C)

Code	Name of Station	Item	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
5.8.5	Puerto San José P.H.C	Max.	31.5	32.2	32.8	33.4	31.6	30.7	31.8	31.5	30.6	31.3	31.7	31.9	31.6
		Ave.	25.7	26.2	27.5	28.3	28.3	27.3	27.9	27.5	26.4	26.8	27.0	26.4	27.0
		Min.	18.4	18.5	20.6	22.2	23.5	22.5	22.5	22.7	22.8	22.6	21.9	19.5	21.6
5.1.17	El Chupadero P.H.C.	Max.	33.9	34.8	34.7	33.6	33.0	32.1	33.0	32.7	32.0	32.6	33.0	33.5	33.2
		Ave.	25.8	25.6	26.5	26.1	26.3	25.8	25.9	25.9	25.3	25.6	26.0	25.9	25.9
		Min.	20.0	20.2	21.2	21.5	21.4	21.7	21.5	21.2	21.0	21.0	20.8	19.6	20.9
5.10.8	Camantulul	Max.	32.1	33.1	33.7	33.5	32.0	31.0	31.0	31.6	30.8	30.8	31.3	31.7	31.8
		Ave.	24.1	25.5	25.6	26.0	25.7	25.3	25.5	25.0	24.8	24.7	24.8	24.2	28.0
		Min.	16.0	16.1	17.5	18.8	20.2	20.0	19.7	19.2	19.6	18.7	18.2	16.5	18.5
5.1.9	San Andrés /1 Osuna	Max.	27.4	28.3	28.0	28.2	27.4	26.6	26.4	27.7	26.3	26.5	26.9	27.3	27.2
		Ave.	24.3	24.8	24.8	24.8	24.6	24.0	23.9	24.0	23.7	23.8	24.1	24.2	24.2
		Min.	21.3	21.4	21.3	21.5	21.8	21.5	21.4	21.4	21.2	21.2	21.3	21.1	21.4
3.5.2	El Recuerdo	Max.	20.7	21.0	22.0	21.8	22.4	20.5	21.1	20.7	20.3	20.9	21.2	21.8	21.2
		Ave.	13.4	13.6	14.8	15.4	16.5	15.7	15.8	15.6	15.3	15.5	14.8	14.2	15.0
		Min.	6.2	6.2	7.7	9.0	10.7	10.9	10.5	10.6	10.4	10.1	8.4	6.7	8.9

/1 : This station is located at the skirts of Fuego Volcano in Ceniza River Basin (760 m. MSL)

表 3－11 月平均湿度

(Unit: %)

Code	Name of Station	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
5.1.14	Sabana Grande	69.00	67.27	72.55	75.64	85.45	86.91	82.55	82.73	79.64	85.73	76.36	70.91	77.90
5.1.17	El Chupadero	70.44	65.44	66.22	69.44	77.78	81.89	79.33	78.78	80.44	81.33	76.22	67.89	74.60
5.8.5	San Jose Aero-puerto	75.38	71.50	73.88	73.88	80.00	82.38	80.88	82.38	84.88	83.88	79.25	75.00	78.52
5.10.8	Camantului	76.17	73.50	73.58	75.08	83.42	85.50	84.33	84.67	85.92	86.67	81.67	78.83	80.78

表 3－12 月平均蒸発散量

(Unit: mm/day)

Code	Name of Station	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
5.1.14	Sabana Grande	4.7	4.8	3.9	3.4	2.4	2.7	3.1	2.8	2.1	2.9	4.1	4.2	1244.9 /1
5.10.8	Camantului	4.7	5.4	5.4	4.9	4.2	3.9	4.0	4.2	3.8	3.5	4.0	4.1	1583.1 /1

/1 : Unit mm/year

表 3-13 火山活動とその影響

Year	Period	Intensity	Lava flow *	Explosion of a lava dome or a spire	Lahar or nuees ardentes	Ash (normal Explosion)	Solfatara fields vaporous	Other activities	Remarks	Damages caused by volcanic activities	Year & Period	Precipitation	Sedimentation or flood damage
1921~1927 1932	 21-22 Jun	 ◎	* Ash flows are easily termed "lava flow" by inhabitants. For this reason, current reports and possibly historical accounts may be misleading		○ (not avalanches)	○	○		· Ashes fell as far as Salvador and Honduras In Guatemala City, 138 Kg tephra fell on 1m² during one hour. The top (50~60m?) of the volcano was destroyed, and a new crater, deeply breached in NE direction, was formed. Hot avalanches came down		1927 27 June 1927 29 July 1932 30 Aug 1932 10 Sep 1932 14 Oct 1933 11 July 1933 14 Sep 1933 22 Sep 1933 25 Sep 1933 28 Sep 1934 8 June 1936 19 June 1936 3 Oct		· Damages cause by the storm serious. railway destoloyed in San Jose, in flooded. · Numerous damage in La Escuintla, due to a violent cyclon. · damages due to rains in the road to Esquintla · Yepocapa and this sufferes heavy damages. · San Jose is flooded. Guacalate river overflowed. · Strong hurricane raged over the city San Jose · San Jose flooded due to hevy rain · Guacalate river overflowed. · San Jose abondoned by its inhabitants. · Escuintla were panicked by a very strong cyclon · San Jose flooded · San Jose flooded · San Jose flooded again
1944 1947 1949 1953 1954 1955 1957	end of the year ? Nov 11 Apr 9 Sept July	◎	○ ○	○ (Lava dome) ○ (Spin)		○ (black Scoria) ○	○		· From 1932 till 1944 observations are failing · S.S.W top slopes are covered with black scoria. Crater, breached in NE direction, was filled with fresh lava up to about 20m. New lava had flown throw the deep noch of 1932 in NE direction reaching downwards halfway the mountain in slope		1949 4 Oct 1949 14 Oct 1950 7 Oct 1953 21 Sep 1953 30 Sep		· Flood of San Jose. · San Jose was destroyed · San Jose port flooded by torrential rains, damaged to the road. · San Jose port flooded due to the torrential rains. · San Jose port flooded.
1962 · · 1963 1966 1967	3, 6 Aug Oct 3 Nov 28,30 Sept 7 Feb 20 Apr 1 May 12,13 Aug 22,24 Apr	◎ ◎ ◎	○		○○ (Lahar)	○○ (Ash flows)		○ (Mud flows)	· Central crater explosive activity and lahar · Strong explosive activty, central crater lava. Ash clowd estimated to 12,000 m. · Explosive activity central crater, mud flows, lava, SE flank · Explosive activity central crater. · Ash eruption largest since 1932, lava flow · Ash clouwd estimated to 12,000 m. · Ash eruption		1968 11 Sep 1968 18 Oct 1968 19 Oct 1969 5 Sep 1969 26 Sep		· San Jose flooded due to the rivermouth closing Water level reached over 1 meter. · San Jose port flooded. 5,000 inhabitants evcuated. · 6000 inhabitants evacuated from San Jose. House almost submerged. This flood is due to overflow of Achiguate river. · Hurricane most heavily hits Escuintla. · 4 dead by flood situation were worse in Escuintla San Jose is flooded and has been evacuated.
1971 1973 1974 1975 	14 Sept 22 Feb 23 Feb 23 March (With a quiet interval from 3 to March) 10 Oct 14 Oct 17-19 Oct 25 Oct – 4 Dec 28 May 23 July – 4 Aug 18 Sep and continuing 11-21 Oct	◎ ◎			○ (nuees ardentes)	○ (Basaltic ash, scoria ash flows) ○ (steam mission) ○ (ash fall, ash flows, black Scoria) ○ (ash fall, ash flows) ○ (ash fall, ash flows) ○ (ash fall and gas) ○ (ash fall and gas) ○ (ash fall, ash flow?) ○ (ash fall, ash flow?) ○ (ash fall) ○ (ash fall)			· The 1971 event was the largest by far of all the recent Fuego activity. All observers agree that this was the most spectacular eruption of Fuego in memory (at least 70 years) The eruption consisted of large Vulcanian type eruption and of nuees ardentes which flowed down various gulleys on the flanks of the cone. The most notable flows occured in Barrancos Honda, Las Lajas, and Ceniza. Eruption cloud reached over 10000m in height. · Privailing winds deposited a 1cm layer of ash more than 160 km to the west. Up to 5cm size scoria was transported 8km to the west, where the town of Yepocapa was covered with 30cm of ash. · The 1973 eruption was much less than violent and produced only a fraction of the ash volume of the 1971 eruption. · There was continuous steam emission but no explosive activity similar to the 1971 eruption. · Acatenango which is a twin of the Fuego volcano started gentle, tiny ash eruption on Nov.12. 1972, the first since 1927. Ash continued to rise in the crater, but never developed into an actual explosive eruption. · On this day, there were strong steam emissions from Fuego, and ligth ash fall and ash flows started the following day. In summerly, Fuego erupted ash from Feb 23 to March 2, and had renewed ash fall on March 22. and 23, for a total of 10 days of ash eruption. · Expect for a brief shower of 1cm scoria fallen on the SE slope of the cone, most of the materials was fine sand to dust in size. The 1cm isopach extended to about 10km southly from the crater · The eruption began at 4 a.m. with small eruption of ash fall and ash flows · A period of intense activity began at 2 a.m. and contined to 7 p.m. A thick ash cloud rose over 7500m above the summit, and numerous hot ash flows cascaded down the slopes of the volcanic cone. · A renewed eruption lasted from 9:45 p.m. 17 Oct. to 12 p.m. 18 Oct. The smallest of the major period of activity occured 19 Oct. and lasted for an undetermined length of time · In the afternoon and evening, Fuego was once again in violent activity for at lest 4~6 hours. Gas cloud rose 3 or more kilometers above the summit, and this episodes concluded the eruptions period of intensive activity. This activity was characterised by the emission of gas and ash in a cloud reaching to 1000~2,000m over the summit. · Sine 25 Oct, the gas and ash cloud have not exceeded 1,500m in height, from 4 Dec. through 12 Dec. 12, the plume from the crater rose only a few hundred meter at most and contained almost no ash. · Small ash eruptions, possible ash flow · Sporadic very small ash eruptions, possible ash flows 24 July. · Increasing vapur emission followed by small airfall ash eruption · Larter airfall eruptions ash failing at Antigua	About 20% of the roofs in Yepocapa were collapsed, including many of public buildings. Volume of ash produced this 1971 eruptions estimated to about 62×10⁶m³ Winds at the time of the eruption carried the ash in a westerly direction. Acording to Dr Samuel Bonis who prepared the isopach map of the ash thickness, 185×10⁶m³ of ash was produced by the 4 major eruptive episodes, about 3 times the calculated volume of the 1971 eruption.	1970 30 July 31 July 1971 9 Sep 1971 25 Sep 1971 15 Oct 1971 21 Oct 1972 3 Aug 1972 10 Oct 1973 21 Aug 1974 21 Sep 1975 29 Sep 1975 11 Sep 1976 1 July		· Achiguate and Guacalate rivers over flowed. · Achiguate and Guacalate river damaged and lost the agricultural land. · Achiguate river and affluents overflowed in the road to San Jose in the 46-100km. · Several river overflowed due to eruption of the Fuego Volcano. The bridge over the Pantaleon river bridge falls interrupting the road. Siquinala is evacuated. · One dead, several wounded and destroyed houses due to overflowing of Guacalate and Achiguate rive in Masagua Escuintla. Siquinala suffered from the overflowing of the Obispo river. · A Bailey bridge and two other were destroyed by the Pantaleon river which overflowed again due to heavy rains. The railway brige over the Pantaleon river was destroyed. · In La Democracia in Escuintla, the Mazate river overflowed flooding houses and lots Mazate river overflowed flooding La Democracia. · Obispo river in Democracia overflowed due to heavy sedimentation. · The water level in San Jose rose two meters cutting all comunication was with Esquintla. · San Jose port flooded due to overflowing of the Achiguate and Guacalate river The Barrio Cerritos (a neighbourhood) of San Jose is completely flooded. Traffic interrupted in the 78, 100 km due to the overflowing of Achiguate river. · Achiguate river overflowed in the 78, 79, 33 and 34 km of the road to the San Jose port road.
1977 1978 1979	3 Mar 19 Apr 11 Sep and continuing Jun 23 Jun 10 Feb					○ (ash fall, ash fall) ○ (ash fall) ○ (ash fall)			· Small ash eruption · Small ash eruption · Weak airfall eruptions · Light eruption · Intense activity · Intense activity		1977 17 Sep 1978 8 Sep 12 Sep 11 Oct 1979 [illegible] Sep [illegible] Sep		· Achiguate and Guacalate rivers overflowed · At Siquinala, big damages when the river Mazate overflowed · Mazate river overflowed · Road to San Jose with half way between 80 and 90 km due to the out flood of Achiguate River · Achiguate River flooded and road to San Jose interrupted damaged the agricultural crops. · The road to San Jose flooded in several kms by the Achiguate river
1980	11 Jun 3 Feb								· Weak eruption · Weak eruption		1982 20 Jul 1983 10 Sep		· Strong rains accompanied of hurricane winds occuring last night at Escuintla letting down trees and leaving 5 houses without ceiling · Achiguate river flooded again. Over 5,000 inhabitants evacuated

表　4－1　確率流出土砂量

Return Period	Achiguate River				Pantaleon River			
	Probable Discharge	Probable Sediment Discharge	Allowable Sediment Discharge /1	Exceeding Sediment Volume /1	Probable Discharge	Probable Sediment Discharge	Allowable Sediment Discharge /1	Exceeding Sediment Volume /1
	$x10^6 m^3$/flood	$x10^3 m^3$/flood	$x10^3 m^3$/flood	$x10^3 m^3$/flood	$x10^6 m^3$/flood	$x10^3 m^3$/ flood	$x10^3 m^3$/flood	$x10^3 m^3$/flood
50	24.6	2,200	100 50	2,100 2,150	22.9	3,440	410 320	3,030 3,120
30	22.3	1,940	90 50	1,850 1,890	20.8	3,100	370 290	2,730 2,810
20	20.5	1,740	80 40	1,660 1,700	19.1	2,790	340 270	2,450 2,520
10	17.3	1,420	70 40	1,350 1,380	16.3	2,300	290 230	2,010 2,070
5	14.1	1,110	60 30	1,050 1,080	13.3	1,820	240 190	1,580 1,630

/ 1 :　Upper line:　Entire river course improvement

Lower line:　Partial improvement

表　4－2　確率洪水流量

Unit: m^3/s

Return Period	Achiguate		Pantaleon
	Control Point I CA=205.1 km^2	Control Point II CA=956.2 km^2	Control Point CA=150.0 km^2
50	1310 (6.39)	1860 (1.95)	1220 (8.13)
30	1190 (5.80)	1670 (1.75)	1110 (7.40)
20	1090 (5.31)	1520 (1.59)	1020 (6.80)
10	920 (4.49)	1250 (1.31)	870 (5.80)
5	750 (3.66)	970 (1.01)	710 (4.73)
2	480 (2.34)	550 (0.56)	470 (3.13)

NOTE: Figures in Parentheses show the specific discharge;
Unit: $m^3/sec/km^2$

表　4－3 (1/2) 洪水氾濫水位（アチグァテ川流域）

(Unit: m)

Section	Extent of Inundation Water	Return Period 50 year	30 year	20 year	10 year	5 year	2 year
Road Bridge		Not Washed away /1					
(From 42km) to 34km	400	1.56 (1.48)	1.43 (1.35)	1.36 (1.28)	1.19 (1.14)	1.01 (0.69)	0.66 (0.62)
Railway Bridge		Washed away					
28km left (over flowed)	200	0.8	0.75	0.69	0.60	0.51	0.37
28km	400	1.6	1.5	1.4	1.2	1.0	0.65
(From 26km) to 20km	200	0.6	0.55	0.5	0.4	0.35	0.25
16km	2500	0.5	0.48	0.45	0.4	0.35	0.22
12km	400	0.42	0.40	0.37	0.33	0.29	0.19
8km	5500	0.34	0.32	0.29	0.27	0.23	0.16
4km	7000	0.25	0.23	0.22	0.20	0.18	0.13
0km	7000	0.25	0.23	0.22	0.20	0.18	0.13

/ 1: During the flood, the bridge falls into dangerous condition of collapse by the sediment discharge, so that transportation is interrupted, which considered flood damage.

/ 2: Figures in parentheses show the water stage under the condition of sediment deposition for urgent plan.

表 4－3 (2/2) 洪水氾濫水位（パンタレオン川流域）

(Unit: m)

Section	Extent of Inundation Water	Return Period					
		50 year	30 year	20 year	10 year	5 year	2 year
Road Bridge		Not washed away					
Railway Bridge		Washed away					
(From 20km) to 16 km	200	1.16 (0.58)	0.98 (0.45)	0.88 (0.33)	0.60 (1.16)	0.32 (0.0)	0 (0.0) / 2
16km Right (1)	1000	0.32	0.29	0.27	0.23	0.18	0.07
16km Right (2)	500	0.70	0.65	0.60	0.50	0.40	0.22
Pataya Road Bridge		Washed away			Not washed away		
(From 14km) to 8km		No damage					
6km Left	500	0.51	0.48	0.46	0.42	0.36	0.25
(from 6 km) to 0km	500	0.52	0.52	0.82	0.52	0.52	0.52

/ 1: During flood time, the bridge falls into dangerous condition of collapse due to the sediment discharge so that transportation is interrupted which is considered as flood damage.

/ 2: Figures in parentheses show water stage under the condition of sediment deposition for urgent plan.

表　4－4　国際融資機関の利子率

Agency	Interest Rate
Inter-American Development Bank (BID)	1% - 2%
International Development Agency (AID)	2% - 3%
Central American Economic Integration Bank (BCIE)	6%
International Bank for Reconstruction and Development (IBRD)	9%
Venezuelan Investment Fund (FIV)	8.25%
Central American Economic Investment Bank (BCIE)	8.75%
Average	
(1) Average of International Agencies	5%
(2) Average of Local Financing Agencies	8%
(3) Average of (1) and (2)	6.5%

表 5－1 部分河川改修案（ケースII）経済比較

(1) River	(2) Asset to be Protected	(3) No.	(4) Method	(5) Required work	(6) Total Construction Cost $x10^3$ US$	(7) Annual Benefit $x10^3$ US$	(7)/(6)
Achiguate River	CA-2 road Bridge & railway bridge	I-1	River channel improvement (I)	River Course (43km - 42.8km) (41.7km - 38km)	6,050	1,280	0.21
		I-2	River channel improvement (II)	River course (43km - 42.8km) (40.4km - 38.0km) Training levee (41.7km - 40.4km)	6,140	1,280	0.21
		I-3	Heightening of railway bridge	River course (43km - 42.8km) Bridge reconstruction, Raising of approach, Railway embankment (4,000m)	11,300	1,160	0.10
	Urban area of Finca La Trinidad	II-1	River channel improvement	River course (31.5km - 25.5km)	8,350	1,030	0.12
		II-2	Raising of CA-9 road	Road raising (H=1.25m,L=2,500)	2,560	880	0.34
		II-3	Ring Levee	Embankment/ revetment (H=1.75,L=4,000m)	2,150	170	0.08
	Urban area of La Barrita	III-1	River channel improvement & training levee	River course (8km - 0km) Training levee (9km - 8km)	22,400	760	0.03
		III-2	Ring levee	Embankment/ revetment (H=1.45m,L=5,000m)	2,220	240	0.11
Pantaleon River	CA-2 road bridge & railway bridge	IV-1	River channel improvement (I)	River course (21.4km - 21.35 km) (20.5km - 18 km)	5,460	670	0.12
		IV-2	River channel improvement (II)	River course (21.4km - 21.35km) (18.3km - 18 km) Training levee (20.5km - 18.3 km)	8,180	670	0.08

表 5－2 長期計画最適案建設費

Works Item	Unit	Quantity			Cost (x 10^3)		
		Achiguate River	Pantaleon River	Total	F.C. (US$)	L.C. (Q.)	Total (US$)
1.Sediment Control Dam							
Excavation	m^3	103,000	202,000	305,000	824	519	1,343
Back-filling	m^3	9,400	14,300	23,700	74	89	163
Main Dam	m^3	78,000	126,000	204,000	7,175	6,895	14,070
Sub Dam	m^3	10,000	11,000	21,000	743	878	1,621
Apron and Side Walls	m	69	140	209	651	579	1,230
Saddle Dam	m	170	-------	170	174	107	281
Sub-total of 1.					9,641	9,067	18,708
2.River Improvement							
Excavation	m^3	1,140,000	240,000	1,380,000	3,174	1,932	5,106
Embankment	m^3	160,000	-------	160,000	1,488	944	2,432
Sodding	m^2	79,000	7,000	86,000	-------	147	147
Drainage Ditch	m	12,000	-------	12,000	588	684	1,272
Revetment(1:0.5)	m	4,600	4,600	9,200	947	1,008	1,955
Groundsill	Unit	15	45	60	1,383	1,256	2,639
Check Groundsill	Unit	2	2	4	171	202	373
Ring Levee	m	5,000	-------	5,000	510	424	934
Drainage Facility	L/S	1	-------	1	490	130	620
Sub-total of 2.					8,751	6,727	15,478
Sub-total of 1. and 2.					18,392	15,794	34,186
3.Preparation Cost (10% of total of 1. and 2.)	L/S				1,839	1,579	3,418
4.Land Acquisition Cost							
Dam Construction	ha	4	-------	4	-------	3	3
River Improvement	ha	24	-------	24	-------	17	17
5.Engineering Services	L/S				5,526	1,374	6,900
6.Administration Cost	L/S				216	448	664
Sub-total of 1. to 6.					25,973	19,215	45,188
7.Physical Contingency (10% of total of 1. to 6.)	L/S				2,597	1,922	4,519
Grand Total of 1. to 7.					28,570	21,137	49,707

表 5－3 長期計画最適案年度別事業費

Unit:
Total : US$ x 10^3
F.C : US$ x 10^3
L.C : Q x 10^3

Item	Total	F.C	L.C	1st.		2nd.		3rd.		4th.		5th.		6th.		7th.	
				F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	F.C	F.C	L.C
1.Sediment Control Dam	18,708	9,641	9,067	-----	-----	-----	-----	1,153	1,042	2,702	2,532	2,639	2,494	1,957	1,847	1,190	1,152
2.River Improvement	15,478	8,751	6,727	-----	-----	-----	-----	-----	-----	1,166	900	2,184	1,827	2,573	1,872	2,328	2,128
Sub total of 1. and 2.	34,186	18,392	15,794	-----	-----	-----	-----	1,153	1,042	3,868	3,432	4,823	4,321	4,530	3,719	4,018	3,280
3.Preparation Cost (10% of total of 1. and 2.)	3,418	1,839	1,579	-----	-----	-----	-----	115	104	387	343	482	432	453	372	402	328
4.Compensation	20	-----	20	-----	-----	-----	20	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Sub total of 1. to 4.	37,624	20,231	17,393	-----	-----	-----	20	1,268	1,146	4,255	3,775	5,305	4,753	4,983	4,091	4,420	3,608
5.Engineering Services	6,900	5,526	1,374	1,111	305	740	204	795	173	720	173	720	173	720	173	720	173
6.Administration Cost	664	216	448	113	53	75	35	28	72	-----	72	-----	72	-----	72	-----	72
Sub total of 1. to 6.	45,188	25,973	19,215	1,224	358	815	259	2,091	1,391	4,975	4,020	6,025	4,998	5,703	4,336	5,140	3,853
7.Physical Contingency (10% of total of 1. to 6.)	4,519	2,597	1,922	122	36	81	26	209	139	498	402	603	500	570	434	514	285
Total of 1. to 7.	49,707	28,570	21,137	1,346	394	896	285	2,300	1,530	5,473	4,422	6,628	5,498	6,273	4,770	5,654	4,238
8.Price Contingency F.C (6 %) L.C (6 %)	13,492	7,611	5,881	-----	-----	54	17	284	189	1,045	845	1,740	1,443	2,122	1,613	2,366	1,774
9.Grand total of 1. to 8.	63,199	36,181	27,018	1,346	394	950	302	2,584	1,719	6,518	5,267	8,368	6,941	8,395	6,383	8,020	6,012

表　6－1　河川改修方法の経済比較

River	Case No.	Principal River Improvement Method	Return Period (year)	Construction Cost (x 10^3 US$)		
				River Improvement	Sediment Control Dam	Total
Achiguate River	A-E-5	Channel excavation	5	4,980	4,880	9,860
	A-E-10	- do. -	10	5,390	5,330	10,720
	A-E-30	- do. -	30	5,810	6,130	11,940
	A-T-5	Channel excavation and construction of training levee	5	3,470	4,880	8,350
	A-T-10	- do. -	10	3,770	5,330	9,100
	A-T-10′	- do. -	10 (30)	4,110	5,330	9,440
	A-T-30	- do. -	30	5,820	6,130	11,950
Pantaleon River	P-E-5	Channel excavation	5	2,360	2,630	4,990
	P-E-10	- do. -	10	2,490	3,000	5,490
	P-E-10′	- do. -	10 (30)	2,700	3,000	5,700
	P-E-30	- do. -	30	4,580	5,590	10,170
	P-T-5	Construction of training levee	5	3,890	2,630	6,520
	P-T-10	- do. -	10	4,310	3,000	7,310
	P-T-30	- do. -	30	7,930	5,590	13,520

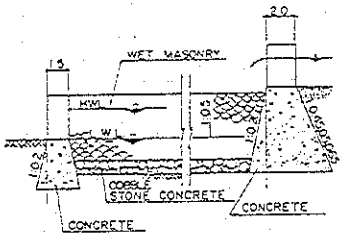
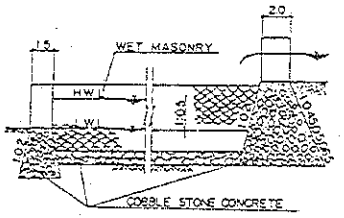
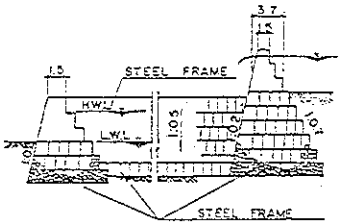
表　6－2　計画規模毎の経済比較

Unit: x 10^3US$

Study Case	Construction Cost		Annual O M R Cost/1	Annual Benefit /1					EIRR
	Base Cost	Economic Cost		Railway Bridge/2	Road Bridge/3	Traffic /4	Houses /5	Total	(%)
A-T-5 & P-E-5	13,340	11,340	260	360	100	680	110	1,250	6.0
A-T-10 & P-E-10	14,590	12,410	260	420	110	800	130	1,460	7.0
A-T-10´& P-E-10´	15,140	12,870	260	420	110	800	130	1,460	7.0
A-T-30 & P-E-30	22,110	18,790	260	470	130	880	150	1,630	5.0

/1 : Economic Cost
/2 : Loss of National railway bridge
/3 : Partial damage to CA-2 road bridge
/4 : Interruption of Traffic
/5 : Damage to houses, house-hold effects and agricultural crops.

表 6－3 砂防ダム構造型式の経済比較

Item	Dam Type		
	Concrete	Cobble Stone Concrete	Steel Flame
Section of Dam (Unit ; m)			
Base Construction Cost ($\times 10^3$ US$) A－1 Dam	2,900	2,500	4,900
C－1 Dam	2,500	2,200	4,400
P－2 Dam	3,000	2,600	5,300
Total	8,400	7,300	14,600

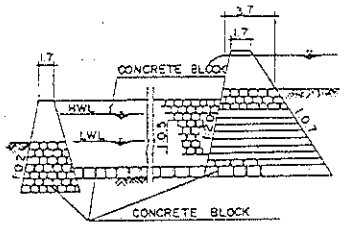
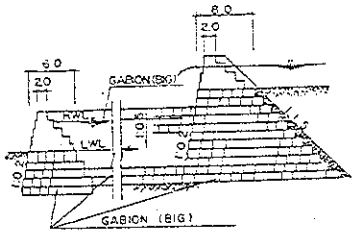
Item	Dam Type	
	Concrete Block	Gabion Mattress
Section of Dam (Unit; m)		
Base Construction Cost ($\times 10^3$ US$) A－1 Dam	3,700	3,300
C－1 Dam	3,100	2,900
P－2 Dam	3,900	3,700
Total	10,700	9,900

表 6－4 砂防ダム構造基本諸元

Plan	River	Dam Name	Dam Site	Main Dam: Effective Height	Main Dam: Dam Height (m) Overflow Section	Main Dam: Dam Height (m) Non-overflow Section (max.)	Main Dam: Gradient of Upstream Slope	Main Dam: Crest Length (m)	Overflow Section: Design Discharge (m^3/sec)	Overflow Section: Bottom Width (m)	Overflow Section: Water Depth (m)	Sub Dam: Dam height (m) Overflow Section	Sub Dam: Dam height (m) Non-overflow Section	Apron: Length (m)	Apron: Thickness (m)	Side Well: Height (m)
Proposed	Achiguate	A-1	A	6.5	7.0	10.4	1:0.50	409	1,250	180	2.4	4.0	7.4	24	1.0	5.1
		C-1	D	4.5	6.0	9.1	1:0.45	425	1,250	220	2.1	3.5	6.6	21	1.0	4.6
	Pantaleon	P-2	F	9.0	11.0	14.6	1:0.65	392	1,250	160	2.6	4.5	8.1	29	1.3	5.8
Alternative	Achiguate	A-1	A	5.0	5.0	9.0	1:1.0	404	1,250	180	2.4	---	---	12	2.0	---
		A-1'	B	3.5	4.0	8.0	1:1.0	401	1,200	180	2.3	---	---	12	2.0	---
		A-2	C	5.0	5.0	10.0	1:1.0	101	1,050	70	3.9	---	---	12	2.0	---
		C-1	D	4.5	5.0	8.0	1:1.0	424	1,250	220	2.1	---	---	12	2.0	---
	Pantaleon	P-2	F	5.0	5.0	9.0	1:1.0	276	1,250	160	2.6	---	---	12	2.0	---
		P-2'	G	4.0	4.0	8.0	1:1.0	308	1,100	120	2.8	---	---	12	2.0	---
		P-3	H	5.0	5.0	9.0	1:1.0	167	1,100	120	2.8	---	---	12	2.0	---
		P-4	I	5.0	5.0	9.0	1:1.0	170	1,100	120	2.8	---	---	12	2.0	---
		P-5	J	5.0	5.0	9.0	1:1.0	158	1,100	120	2.8	---	---	12	2.0	---

表 6－5 河川構造物型式の経済比較

Purpose	Structure	Durability	Type	Description	Cost (US$) Construction	Replacement	Total
Bank Protection	Revetment	Permanent	R 1	Concrete retaining wall (n=1: 0.5) with foot protection of gabion mattresses	470 /m	0 /m	470/m
			R 2	Concrete block (n=1:0.5) with foot protection of gabion mattresses	480	0	480
			R 3	Wet masonry (n=1:0.5) with foot-protection of gabion mattresses	290	0	290
		Semi Permanent	R 4	Gabion cylinder (n=1:1.5)	210	420 /1	630
	Groyne	Permanent	G 1	Non-permeable concrete groyne (@ 20m)	410	0	410
			G 2	Non-permeable wet masonry groyne (@ 20m)	530	0	530
		Semi Permanent	G 3	Permeable foot protection groyne of wooden piles (@ 20m)	110	220 /1	330
			G 4	Permeable foot protection groyne of cribs (@ 20m)	67	133 /1	200
Riverbed Stabilization	Groundsill	Permanent	GS 1	Concrete type with concrete sub groundsill and concrete apron	120 x10^3/Unit	0x10^3/Unit	120 x10^3/Unit
			GS 2	Concrete type with apron of gabion mattresses	74	0	74
		Semi Permanent	GS 3	Concrete block type	46	92 /1	138
			GS 4	Gabion mattress type	29	58 /1	87

/1. Replacement will be carried out twice a project life (30 years), because these structures have a life of 10 years.

表 6－6 緊急計画最適案建設費

Work Item	Unit	Quantity			Cost (x 10^3)		
		Achiguate River	Pantaleon River	Total	F.C (US$)	L.C (Q.)	Total (US$)
1. Sediment Control Dam					(2,500)	(2,538)	(5,038)
Excavation	m^3	56,800	51,200	108,000	292	184	476
Embankment and Back-filling	m^3	28,700	5,400	34,100	106	126	232
Concrete Works	m^3	25,200	16,100	41,300	1,776	1,446	3,222
Bounlder Works for Main and Sub Dams	m^3	7,600	4,500	12,100	100	64	164
Boulder Works for Apron	m^3	5,300	3,700	9,000	62	40	102
Form Works	m^2	20,100	9,200	29,300	0	557	557
Wet Masonry Works for Side Walls	m^2	520	390	910	14	29	43
Saddle Dam Works	m	150	0	150	150	92	242
2. River Improvement					(2,893)	(2,344)	(5,237)
Excavation of River Channel	m^3	552,000	163,000	715,000	1,645	1,001	2,646
Excavation and Back-filling of Trench	m^3	21,600	36,100	57,700	138	87	225
Wet Masonry Works (Type A)	m^2	8,020	0	8,020	56	144	200
Wet Masonry Works (Type B)	m^2	0	10,200	10,200	112	255	367
Base Concrete Works for Wet Masonry (Type A)	m	1,630	0	1,630	26	34	60
Base Concrete Works for Wet Masonry (Type B)	m	0	2,280	2,280	55	66	121
Gabion Mattress Works for Wet Masonry	m^3	2,450	3,420	5,870	194	23	217
Foot-protection Groyne works (Crib)	Unit	68	0	68	24	38	62
Concrete and Form Works for Grondsill	m^3	2,760	6,600	9,360	384	665	1,049
Gabion Mattress Works for Groundsill	m^3	2,100	5,760	7,860	259	31	290
Sub-total of 1. and 2.					(5,393)	(4,882)	(10,275)
3. Preparation Works (10% of Total of 1. and 2.)	L/S	------	------	------	539	488	1,027
4. Engineering Services	L/S	------	------	------	2,100	400	2,500
5. Land Acquisition	ha	4	0	4	0	3	3
6. Administration Cost	L/S	------	------	------	0	414	414
7. Physical Contingency (10% of Total of 1. to 6.)	L/S	------	------	------	803	619	1,422
Sub-total of 1. to 7.					(8,835)	(6,806)	(15,641)
8. Price Contingency (6% for F/C and L/C)	L/S	------	------	------	2,677	2,140	4,817
Grand Total					11,512	8,946	20,458

表 6－7 緊急計画最適案年度別事業費

Unit; x 10^3 US$

Item	1986		1987		1988		1989		1990		Total		
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	Grand
1.Sediment Control Dam	-----	-----	-----	-----	1,250	1,269	1,000	1,015	250	254	2,500	2,538	5,038
2.River Improvement	-----	-----	-----	-----	-----	-----	2,170	1,758	723	586	2,893	2,344	5,237
3.Preparation Works	-----	-----	250	254	289	234	-----	-----	-----	-----	539	488	1,027
4.Engineering Services	740	118	198	19	475	113	502	113	185	37	2,100	400	2,500
5.Land Acquisition	-----	-----	0	3	-----	-----	-----	-----	-----	-----	0	3	3
6.Administration Cost	0	83	0	83	0	83	0	83	0	82	0	414	414
7.Physical Contingency (10% of Total of 1. to 6.)	74	20	45	36	201	170	367	297	116	96	803	619	1,422
Sub-total of 1. to 7.	(814)	(221)	(493)	(395)	(2,215)	(1,869)	(4,039)	(3,266)	(1,274)	(1,055)	(8,835)	(6,806)	(15,641)
8.Price Contingency (6% for F/C and L/C)	101	27	94	75	583	492	1,365	1,104	534	442	2,677	2,140	4,817
Total	915	248	587	470	2,798	2,361	5,404	4,370	1,808	1,497	11,512	8,946	20,458

表 6－8 緊急計画代替案建設費

Work Item	Unit	Quantity			Cost (x 10^3)		
		Achiguate River	Pantaleon River	Total	F.C (US$)	L.C (Q.)	Total (US$)
1. Sediment Control Dam					(3,137)	(4,760)	(7,897)
Excavation	m^3	29,400	34,200	63,600	172	108	280
Back-filling	m^3	5,600	6,600	12,200	38	45	83
Gabion Mattress Works	m^3	103,000	92,000	195,000	2,730	4,485	7,215
Boulder Works	m^3	2,600	3,100	5,700	47	30	77
Saddle Dam Works	m	150	0	150	150	92	242
2. River Improvement					(1,777)	(1,511)	(3,288)
Excavation of River Channel	m^3	505,000	146,000	651,000	1,497	911	2,408
Gabion Cylinder Works	m^3	4,960	5,980	10,940	98	284	382
Foot-protection Groyne Works (Crib)	Unit	68	0	68	17	45	62
Gabion Mattress Works for Groundsill	m^3	3,150	8,640	11,790	165	271	436
Sub-total of 1. and 2.					(4,914)	(6,271)	(11,185)
3. Preparation Works (10% of Total of 1. and 2.)	L/S	------	------	------	491	627	1,118
4. Engineering Services	L/S	------	------	------	2,100	400	2,500
5. Land Acquisition	ha	4	0	4	0	3	3
6. Administration Cost	L/S	------	------	------	0	444	444
7. Physical Contingency (10% of Total of 1. to 6.)	L/S	------	------	------	751	775	1,526
Sub-total of 1. to 7.					(8,256)	(8,520)	(16,776)
8. Price Contingency (6% for F/C and L/C)	L/S	------	------	------	2,435	2,597	5,032
Grand Total					10,691	11,117	21,808

表 6－9 緊急計画代替案年度別事業費

Unit; x 10^3 US$

Item	1986		1987		1988		1989		1990		Total		
	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	Grand
1.Sediment Control Dam	-----	-----	-----	-----	1,568	2,380	1,255	1,904	314	476	3,137	4,760	7,897
2.River Improvement	-----	-----	-----	-----	-----	-----	1,333	1,133	444	378	1,777	1,511	3,288
3.Preparation Works	-----	-----	313	476	178	151	-----	-----	-----	-----	491	627	1,118
4.Engineering Services	740	118	198	19	475	113	502	113	185	37	2,100	400	2,500
5.Land Acquisition	-----	-----	0	3	-----	-----	-----	-----	-----	-----	0	3	3
6.Administration Cost	0	89	0	89	0	89	0	89	0	88	0	444	444
7.Physical Contingency (10% of Total of 1. to 6.)	74	21	51	59	222	273	310	324	94	98	751	775	1,526
Sub-total of 1. to 7.	(814)	(228)	(562)	(646)	(2,443)	(3,006)	(3,400)	(3,563)	(1,037)	(1,077)	(8,256)	(8,520)	(16,776)
8.Price Contingency (6% for F/C and L/C)	101	28	107	123	643	791	1,149	1,204	435	451	2,435	2,597	5,032
Total	915	256	669	769	3,086	3,797	4,549	4,767	1,472	1,528	10,691	11,117	21,808

表　7－1　潜在外貨交換率　1976－1980年

Unit:　Million Quetzales

Item	Year				
	1976	1977	1978	1979	1980
Import(CIF)					
Amount(I)	838.4	1,052.5	1,260.7	1,449.4	1,559.1
Duty(di)	48.5	77.1	82.5	83.3	81.5
I + di	886.9	1,129.6	1,343.2	1,532.7	1,640.6
Export(FOB)					
Amount(E)	760.3	1,160.2	1,111.6	1,217.1	1,472.8
Duty(de)	49.1	151.6	158.4	129.2	146.9
E - de	711.2	1,008.6	953.2	1,087.9	1,325.9
I + E	1,598.7	2,212.7	2,372.3	2,666.5	3,031.9
I+di+E-de	1,598.1	2,138.2	2,296.4	2,620.6	2,966.5
SER	1.00	0.97	0.97	0.98	0.98

Note:　SER = I+E/I+di+E-de

表　7－2　エスキントラ県での主要農産物の単位面積当り収穫量及び価格

Crops	Unit Yield (kg/ha)	Unit Price (Q/kg)
Sugar	8,000	0.350
Pasture (Q/ha) /1	225	
Maize	850	0.240
Cotton	1,700	1.200
Banana	60,000	0.200
Orchard /2	60,000	0.200
Coffee	550	3.200
Upland crops /3	25,000	0.300

/1 : estimated on the basis of the production of beef and milk

/2 : orange and other tree fruits

/3 : vegetables, beans, etc., except sugar cane and maize

表 7－3 冠水被害率

(a) Excluding Sediment Accumulation of Earth and Sand

Assets	Inundation Depth (m)							
	0.01 to 0.25	0.25 to 0.49	0.50 to 0.74	0.75 to 0.99	1.00 to 1.24	1.25 to 1.49	1.50 to 1.99	2.00 to 2.99
1. General Assets								
House	0.078	0.151	0.192	0.26	0.258	0.292	0.341	0.439
Household Effects	0.050	0.115	0.167	0.215	0.262	0.307	0.373	0.499
2. Agricultural Crop								
Sugar Cane	0.05	0.60	0.70	0.75	0.80	0.85	0.90	1.00
Pasture	0.35	0.50	0.60	0.65	0.70	0.75	0.80	0.90
Maize	0.45	0.60	0.70	0.75	0.80	0.85	0.90	1.00
Cotton	0.40	0.60	0.70	0.80	0.90	1.00	1.00	1.00
Banana	0.10	0.25	0.40	0.50	0.60	0.70	0.80	1.00
Orchard /1	0.05	0.10	0.15	0.20	0.25	0.30	0.40	0.50
Coffee	0.20	0.40	0.50	0.60	0.70	0.80	1.00	1.00
Upland Crops /2	0.55	0.70	0.80	0.85	0.90	0.95	1.00	1.00

(b) Including Sediment Accumulation of Earth and Sand

Assets	Inundation Depth (m)							
	0.01 to 0.25	0.25 to 0.49	0.50 to 0.74	0.75 to 0.99	1.00 to 1.24	1.25 to 1.49	1.50 to 1.99	2.00 to 2.99
1. General Assets								
House	0.117	0.227	0.288	0.339	0.387	0.438	0.512	0.659
Household Effects	0.075	0.173	0.250	0.322	0.393	0.460	0.560	0.749
2. Agricultural Crops								
Sugar Cane	0.65	0.90	1.00	1.00	1.00	1.00	1.00	1.00
Pasture	0.50	0.75	0.90	1.00	1.00	1.00	1.00	1.00
Maize	0.65	0.90	1.00	1.00	1.00	1.00	1.00	1.00
Cotton	0.60	0.90	1.00	1.00	1.00	1.00	1.00	1.00
Banana	0.15	0.40	0.60	0.75	0.90	1.00	1.00	1.00
Orchard /1	0.10	0.15	0.25	0.30	0.40	0.45	0.60	0.75
Coffee	0.30	0.60	0.75	0.90	1.00	1.00	1.00	1.00
Upland Crops /2	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00

/1 : orange and other tree fruits
/2 : vegetables, beans, etc., except sugar cane and maize

表　7－4　年度別経済費用，便益及びＥＩＲＲ（長期計画最適案）

Unit: US$10^3

Year	Economic Cost		Economic Benefit
	Construction Cost	OMR Cost /1	
1	1,683		
2	1,139		
3	3,608		
4	9,252	100	696
5	11,326	200	1,391
6	10,349	300	2,087
7	9,276	400	2,782
8		500	3,478
9		500	3,478
10		500	3,478
'		'	'
'		'	'
'		'	'
'		'	'
'		'	'
'		'	'
37		500	3,478
Total	46,633	16,000	111,296

EIRR = 5.1%

/1 : Operation, maintenance and replacement cost

表　7－5　年度別経済費用，便益及びＥＩＲＲ（緊急計画最適案）

Unit: US$10^3

Year	Economic Cost		Economic Benefit
	Construction Cost	OMR Cost /1	
1986	1,003		
1987	830		
1988	3,812	52	293
1989	6,830	104	586
1990	2,175	208	1,172
1991		260	1,465
1992		260	1,465
1993		260	1,465
'		'	'
'		'	'
'		'	'
'		'	'
'		'	'
'		'	'
'		'	'
'		'	'
2020		260	1,465
Total	14,650	8,164	46,001

EIRR = 7.3%

/1 : Operation, maintenance and replacement cost

表　7－6　年度別経済費用，便益及びＥＩＲＲ（緊急計画代替案）

Unit: US$10^3

Year	Economic Cost		Economic Benefit
	Construction Cost	OMR Cost /1	
1986	1,009		
1987	1,114		
1988	5,012	108	293
1989	6,445	216	586
1990	1,957	432	1,172
1991		540	1,465
1992		540	1,465
1993		540	1,465
'		'	'
'		'	'
'		'	'
'		'	'
'		'	'
'		'	'
'		'	'
'		'	'
2020		540	1,465
Total	15,537	16,956	46,001

EIRR = 4.4%

/1 : Operation, maintenance and replacement cost

表 8－1 グアテマラ国国家予算

Unit: $x10^3$ Quezales

Governmental Agencies	1981 Budget	%	1982 Budget	%	1983 Budget	%
Judicial	8,246	0.6	8,291	0.6	8,291	0.6
Office of the President	155,148	10.6	131,919	8.8	82,789	7.1
Foreign Affairs	9,820	0.7	10,518	0.7	10,312	0.7
Interior	42,998	2.9	47,058	3.2	49,261	3.7
National Defense	78,981	5.4	86,727	5.9	142,524	0.8
Public Finance	393,101	26.7	403,612	27.2	362,411	27.6
Education	156,213	10.7	156,735	10.6	162,884	12.4
Public Health and Social Assistance	120,784	8.2	139,450	9.4	101,037	7.7
Labor and Social Security	4,457	0.3	3,373	0.2	3,301	0.3
Economics	9,301	0.6	11,676	0.8	5,205	0.4
Agriculture	71,896	4.9	72,031	4.9	77,305	5.9
Communication and Public Works	409,853	28.0	405,026	27.3	294,334	22.4
Public	1,136	0.1	1,303	0.1	944	0.1
Accounting Office	3,765	0.3	3,712	0.3	3,655	0.3
T o t a l	1,465,699	100	1,481,431	100	1,304,253	100

Note: The Ministry of Energy and Mines was established in 1983, and its budget was included in that for the Office of the President.

Source: Presupuesto de Ingresos y Egresos del Estado. Dec. 1982, Fiscal 1983, Ministerio de Finanzas Publicas

表 8－2 グアテマラ国経済セクター毎の予算配分

Fiscal Year: 1983
Unit: x10^3 Quetzals

Sector	Budget	%
General Administration and Services	57,452	4.4
Defense and Internal Security	128,590	9.8
Finance	259,216	19.7
Urban Housing Development	14,493	1.1
Mineral and Hydrocarbon	5,010	0.4
Agriculture	68,138	5.2
Industry and Commercial	11,083	0.8
Tourism	2,651	0.2
Transportation	141,468	10.8
Communication	8,623	0.7
Energy	132,042	10.0
Health and Social Assistance	105,084	8.0
Labor and Social Security	220,893	16.8
Science and Cultural Education	159,510	12.1
T o t a l	1,314,253	100.0

Source : Presupuesto de Ingresos y Egresos del Estado. Dec. 1982
Fiscal 1983, Ministerio de Finanzas Publicas

表　8－3 (1/3) グアテマラ国の水管理関連組織の役割

Ministry	Agency	Activities for Water Management
Communication, Transportation and Public Works	General Direction of Roads (CAMINOS)	- Flood prevention and restoration works of roads and road bridges - Dredging of Chiquimulilla Canal maintain normal navigation - Surveying works of the river channel in the vicinity of road bridges
	General Direction of Public Works (DGOP)	- Planning and design of water supply system for urban areas - Planning and design of sewege system for urban areas
	National Institute of Seismology, Volcanology, Meteorology and Hydrology (INSIVUMEH)	- Hydrological study - Observation of rainfall and water stage - Operation and maintenance of its facilities
	National Project of XAYA-PIXCAYA (XAYA-PIXCAYA)	- Design and construction of service water supply system for the Municipality of Guatemala which takes in water from Xaya and Pixcaya rivers
	National Institute of Electricity (INDE)	- Design, construction, operation maintenance and management of hydro-power generation facilities - Observation of rainfall and water stage related to hydro-power generation

表　8－3 (2/3) グアテマラ国の水管理関連組織の役割

Ministry	Agency	Activities for Water Management
Communication, Transportation and Public Works	National Railway of Guatemala (FEGUA)	- Flood prevention and restoration works for railway and its bridges - Surveying works of the river channel in the vicinity of railway bridges - Observation of rainfall related to railway operation
Agriculture, Livestock and Nutrition	General Direction of Agricultural Services (DIGESA)	- Design, construction, operation and maintenance of irrigation and drainage facilities - Flood prevention and restoration works of these facilities
	National Institute of Forest (INAFOR)	- Conservation and fostering of national forest in the river basin - Environmental conservation and maintenance of ecological balance in the river basin
National Defense	Military Geographic Institute (IGM)	- Topographical survey and mapping - Geological survey - Lnad use survey
	National Emergency Committee (CONE)	- Research on areas vulnerable to disasters - Warning against disaters and direction of evacuation - Rescue activities for victims

表　8－3 (3/3) グアテマラ国の水管理関連組織の役割

Ministry	Agency	Activities for Water Management
Public Health and Social Assistance	Executor Unit of Rural Aqueduct Program (UNEPAR)	- Design and construction of the supply facilities for villages with a population of about 500 or more
	General Direction of Health Services (DGSS)	- Design and construction of water supply facilities for communities with a population of about 500 or less - Analysis and conservation of quality of service water, river and lake water
Interior	National Institute of Municipal Development (INFOM)	- Design and construction of water supply facilities and sewege facilities in the central areas of Municipalities (except Guatemala and Mixco)
(Guatemala Municipality)	Municipal Water Enterprise (EMPAGUA)	- Construction of water supply and sewage facilities designated by DGOP in Guatemala Municipality (except the XAYA-PIXCAYA project area) - Operation and maintenance for all the water supply and sewage facilities constructed in Guatemala Municipality - Observation of water levels

表 8－4 グアテマラ国の水管理に係わる主要な法律

Name of the Law	Year of Enactment
Regulation for Registry, Matriculation and Inscription of Vessels, Ships and Craft	1932
Organic Law of INFOM	1957
Municipal Code	1957
Law on Foundation of INDE	1959
Law of Agrarian Transformation	1962
Civil Code	1963
Regulation for the Rural Operation System of Domestic Water	1967
General Regulations of CONE	1969
Water Conduction Act	1972
Regulation of Irrigation	1972
National Harbor Commission	1972
Organic Law of INAFOR	1974
Forestry Law	1974
Regulation of INSIVUMEH	1974
Code of Health	1979
Regulation of the Ministry of Agriculture Livestock and Nutrition	1982

表　8－5 (1/2) 日本国の水管理に係わる各省の機能とその役割

Ministry	Functions and Responsibilities
MINISTRY OF CONSTRUCTION	- Formulation of Riparian Projects - Water control activities including flood control, riparian restoration works, etc. - Adjustment and approval of water utilization programs - Formulation and implementation of water resources development - Observation of water-level, discharge and precipitation - Conservation of water quality - Prevention of damages due to debris and sharply sloped terrain
PRIME MINISTER'S OFFICE Subordinate Agencies: - Hokkaido Development Agency - Environmental Agency - Okinawa Development Agency - National Land Agency	- Investigation and formulation of development plans palns in Hokkaido and Okinawa - Formulation of policies and long-term plans for water resources development as well as disaster prevention - Conservation of water quality and wild life - Ecological preservation
MINISTRY OF HEALTH AND WELFARE	- Assurance of purity of water supplied through water works - Conservation of water quality

表　8－5 (2/2)　日本国の水管理に係わる各省の機能とその役割

Ministry	Functions and Responsibilities
MINISTRY OF AGRICULTURE, FORESTRY AND FISHERY	- Development and use of irrigation water
Subordinate Agencies: - Food Agency - Forestry Agency - Fishery Agency	- Flood control in minor river basins - Development of fisheries
MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY	- Hydro-electric power - Assurance of industrial water
Subordinate Agency: - Agency of Natural Reserches and Energy	- Regulation of drainage water (water quality conservation)
MINISTRY OF TRANSPORT	- Observation of rainfall and weather forecasting
Subordinate Agency: - Meterological Agency	- Announcement of flood warnings

表　8－6 (1/2) 建設省河川局内組織の機能とその役割

Division	Functions and Responsibilities
General Affairs	- Coordination within the River Bureau
Water Administration	- Drafting of laws and ordinances in connection with river administration - Issurance of water use permits - Administrative supervision of river and seacoasts
Planning	- Comprehensive planning for river and seacoast projects - Coordination of water resources development projects - Water quality and environmental problems - International affairs
River Improvement	- Investigation into planning, implementation of construction and maintenance as well as management of river channels
Urban Rivers	- Investigation into planning and implementation of construction as well as management of urban rivers
Development	- Investigation into planning, construction and management of multipurpose dams - Enforcement of the Water Resources Development Public Corporation Act - Technical judgements regarding permission of water usage - Structural regulations for dams - Water resources development and natural environmental conservation

表　8－6 (2/2) 建設省河川局内組織の機能とその役割

Division	Functions and Responsibilities
Seacoast	- Investigation into planning and execution of coastal conservation projects - Improrvement and maintenance of seacoast
Disaster Prevension	- Estimation of expenditure on natural disaster rehabilitation projects for public utility facilities - Natural disaster prevention planning, natural disaster precautions, natural disaster emergency countermeasures and natural disaster rehabilitation
Sabo	- Coordination in the Sabo Department - Investigation into planning and implementation as well as direction and supervesion of the Sabo works - Maintenance and management of Sabo facilities
Slope Conservation	- Investigation into planning and implementation for landslide prevention works, coal slagheap collapse prevention works - Maintenance of facilities mentioned above

表　8－7 (1/2) 米国の水管理に係わる主要機関とその役割

Agency	Major Responsibilities
U.S. Water Resources Council	- Coordination/administration river planning
	- Grants to states for planning
	- Coordination river basin commissions
U.S. Department of Defense	
Corps of Engineers	- Navigation
	- Hydroelectric power generation
	- Municipal/industrial water supply
	- Water quality
	- Recreation
U.S. Department of the Interior	
Bureau of Reclamation	- Hydroelectric power generation
	- Municipal and industrial water supply
	- Irrigation
	- Floodplain management/navigation
	- Water quality
	- Recreation
Geological Survey	- Floodplain management
	- Water quality and quantity records
Heritage, Conservation and Recreation Service	- Preservation of cultural and historical values
Fish and Wildlife Service	- Fish and wildlife habitant values

表　8－7 (2/2) 米国の水管理に係わる主要機関とその役割

Agency	Major Responsibilities
U.S. Water Resources Council	- Coordination/administration river
U.S. Department of Agriculture	
Soil Conservation Service	- Floodplain management
	- Irrigation
	- Water quality
	- Recreation
U.S. Department of Energy	- Hydroelectric power generation
U.S. Depatment Protection Agency	- Water quality
	- Foodplain management
	- Financing/budgeting (grants)
Tennessee Valley Authority	- Navigation
	- Hydroelectric power generation
	- Municipal and industrial water supply
	- Floodplain management
	- Water quality
	- Recreation

表　8－8 (1/2) 英国の水管理機関の役割

Agency	Functions and Responsibilities
Department of the Environment Water Authority	- Overall responsibility of water administration in England and Wales - Water administration in connection with land use plan; improvement of urban environments; conservation of non-urban areas; recreational use of waters; water pollution control; urban housing plan; construction of new towns - City water-works - Conservation of water sources - River-water pollution control - Recreational use of waters
Ministry of Agriculture, Fisheries and Food Water Authority	- Fisheries promotion and control - Inland water elimination - Drainage works from inland and coastal areas and responsibility on water related to fisheries in England and Wales
National Water Counsil	- Negotiation on working conditions of fishery workers - Labor information services on behalf of water agencies and waterworks companies - Education and training of the fishery workers - Technical assistance to water agencies - Inspection and test of waterworks fittings

表　8－8 (2/2) 英国の水管理機関の役割

Agency	Functions and Responsibilities
Water Space Amenity Commission	- Maintenance of water space amenities and agreeable environments in England - Combination of national water space and recreational activities
Water Data Unit	- Information-exchange among various water agencies and the Central Government
Water Research Center	- Research on water pollution along rivers, on the seacoast and estuaries - Research on sewarage water disposal and waste disposal - Studies on water resources, city water treatment, city water and sewarage conveyance, and health-related water quality problems - Technical assistance on the field

表　8－9　日本の水管理に関する主要な法律

Name of the Law	Year of Enactment/Revision
River Law	1894, 1964
Sabo Act	1897
Flood Fighting Association Act	1908
Act on Reclamation of Public Water Surface Area	1921
Flood Fighting Act	1948
Act on Financial Aid for Relief Projects of Public Utilities	1951
Seacoast Act	1956
Specified Multipurpose Dam Act	1957
Sewerage Act	1958
Landslide Prevention Act	1958
Basic Act on Counter Measures Against Natural Disasters	1961
Act on Anti-erosion and Anti-flood Special Measures	1960
Flood Control Special Accounting Act	1960
Water Resources Development Promotion Act	1961
Water Resources Development Public Corporation Act	1961
Act on Financial Aid for Relief from Severe Natural Disasters	1961
Act on Disasters Prevention due to Collapse of Steep Slope Land	1969
Basic Act for Environment Pollution Control	1970
Water Pollution Control Act	1970
Act on Special Measures for the Reservoir Area Development	1973

表　8－10　米国の水管理に関する主要な法律

Name of the Law	Year of Enactment/Revision
River and Harbor Act	1899
Reclamation Act	1902
Flood Control At	1917, 1928, 1936, 1955, 1960
Tennessee Valley Authority Act	1933
Soil Conservation Act	1936
Reclamation Project Act	1939
Watershed Protection and Flood Prevention Act	1954
Water Resources Planning Act	1965
National Flood Insurance Act	1968
National Environmental Policy Act	1970
Federal Water Pollution Control Act	1972
Disaster Relief Act	1972
Flood Disaster Prevention Act	1973
Water Resources Development Act	1974
Clean Water Act	1977

表　8－11　英国の水管理に関する主要な法律

Name of the Law	Year of Enactment/Revision
Water Works Clauses Act	1847, 1863
Public Health Act	1875, 1936
Water Act	1945, 1973
River Pollution Prevention Act	1876, 1951
Land Drainage Act	1930, 1961
River Board Act	1963
Control of Pollution Act	1974

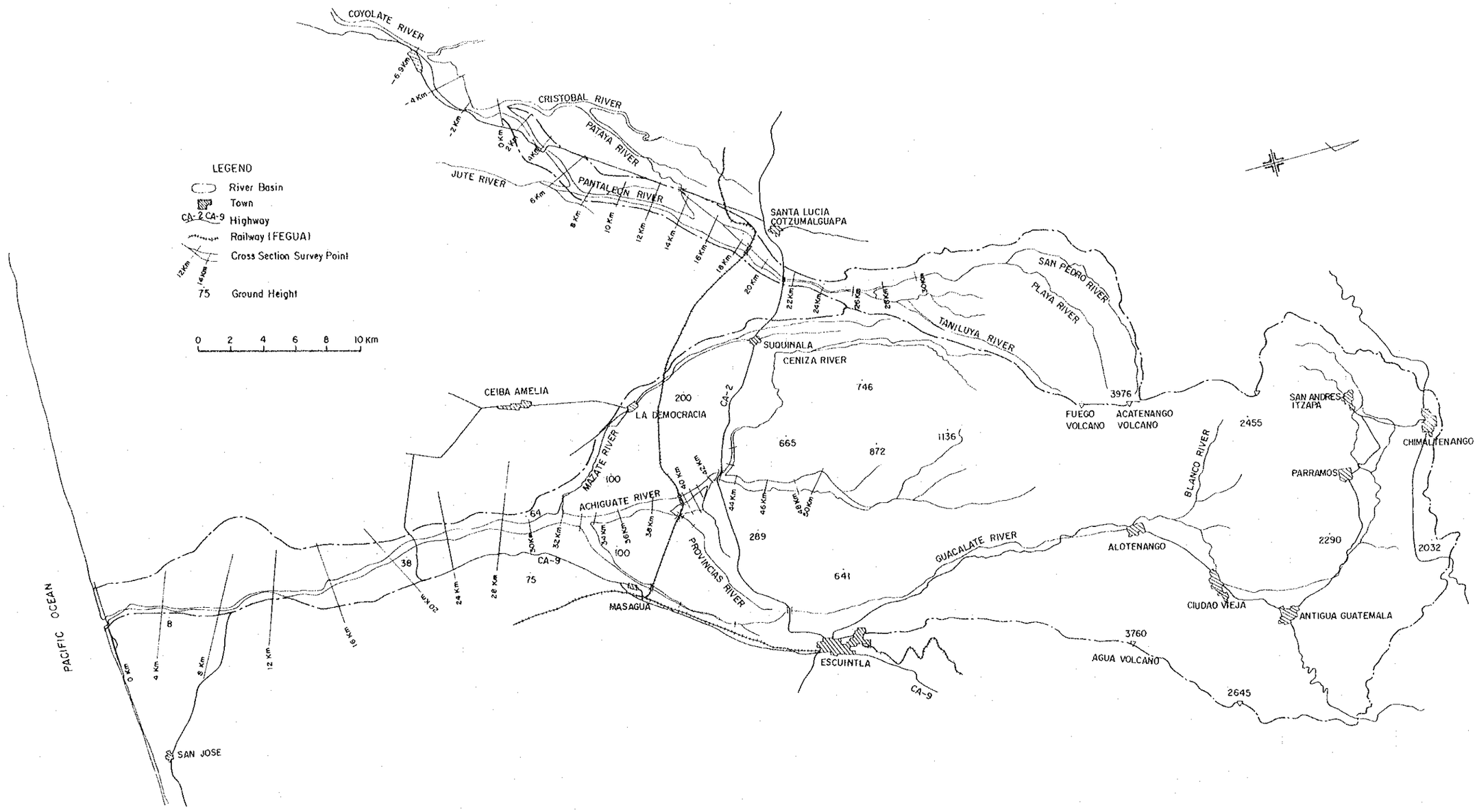

LEGEND
River Basin
Town
CA-2 CA-9 Highway
Railway (FEGUA)
Cross Section Survey Point
75 Ground Height
0 2 4 6 8 10 Km
COYOLATE RIVER
CRISTOBAL RIVER
PATAYA RIVER
JUTE RIVER
PANTALEON RIVER
SANTA LUCIA COTZUMALGUAPA
SAN PEDRO RIVER
PLAYA RIVER
TANILUYA RIVER
SUQUINALA
CENIZA RIVER
CEIBA AMELIA
LA DEMOCRACIA
MAZATE RIVER
ACHIGUATE RIVER
CA-2
CA-9
PROVINCIAS RIVER
MASAGUA
ESCUINTLA
PACIFIC OCEAN
SAN JOSE
FUEGO VOLCANO
ACATENANGO VOLCANO
BLANCO RIVER
GUACALATE RIVER
ALOTENANGO
CIUDAD VIEJA
ANTIGUA GUATEMALA
AGUA VOLCANO
SAN ANDRES ITZAPA
PARRAMOS
CHIMALTENANGO
200
746
3976
665
872
1136
2455
100
64
38
75
289
641
2290
2032
3760
2645

図　1－1　調査対象地域

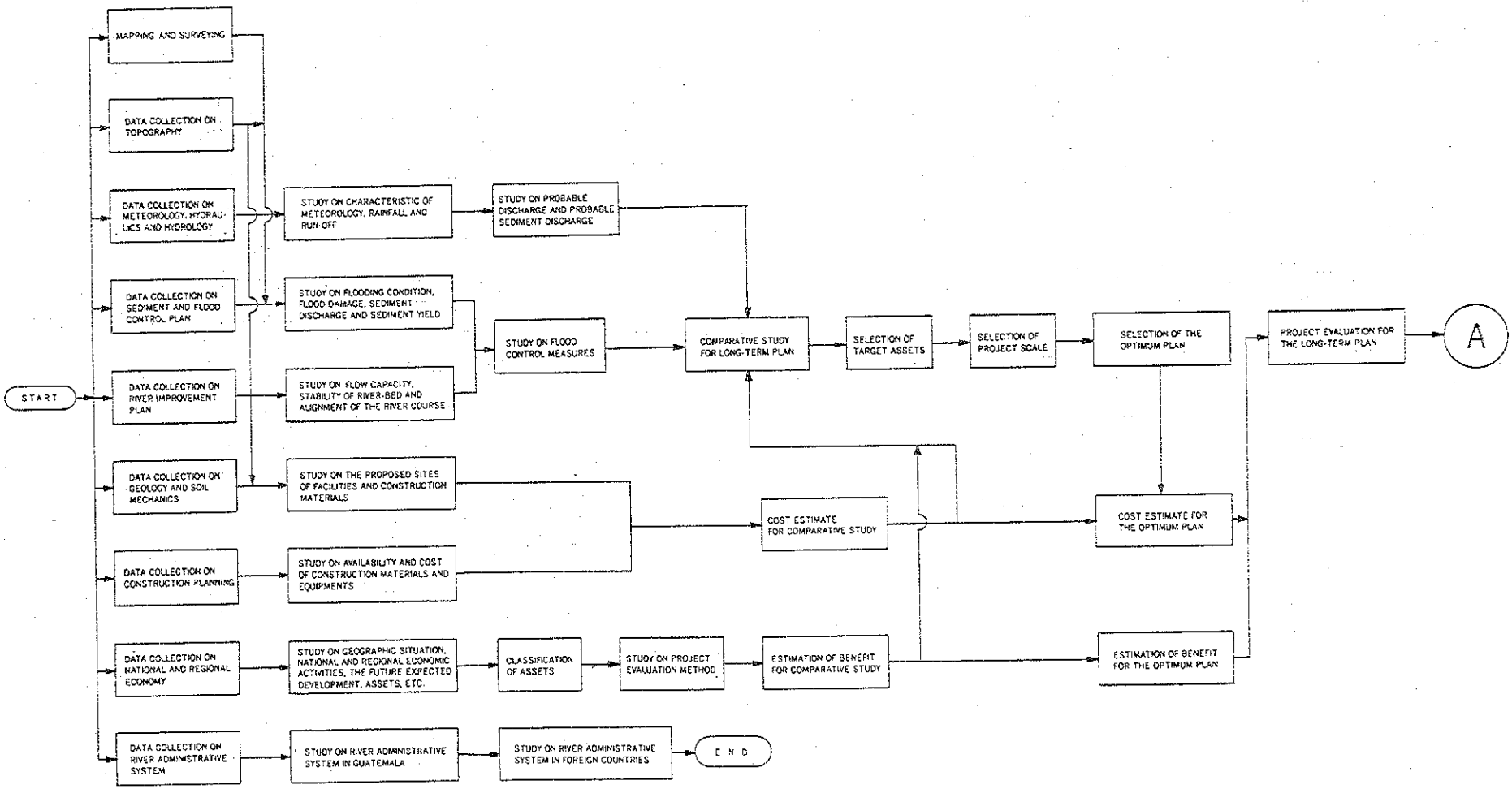


図　1－2(1/2) 調査の手順（長期計画）

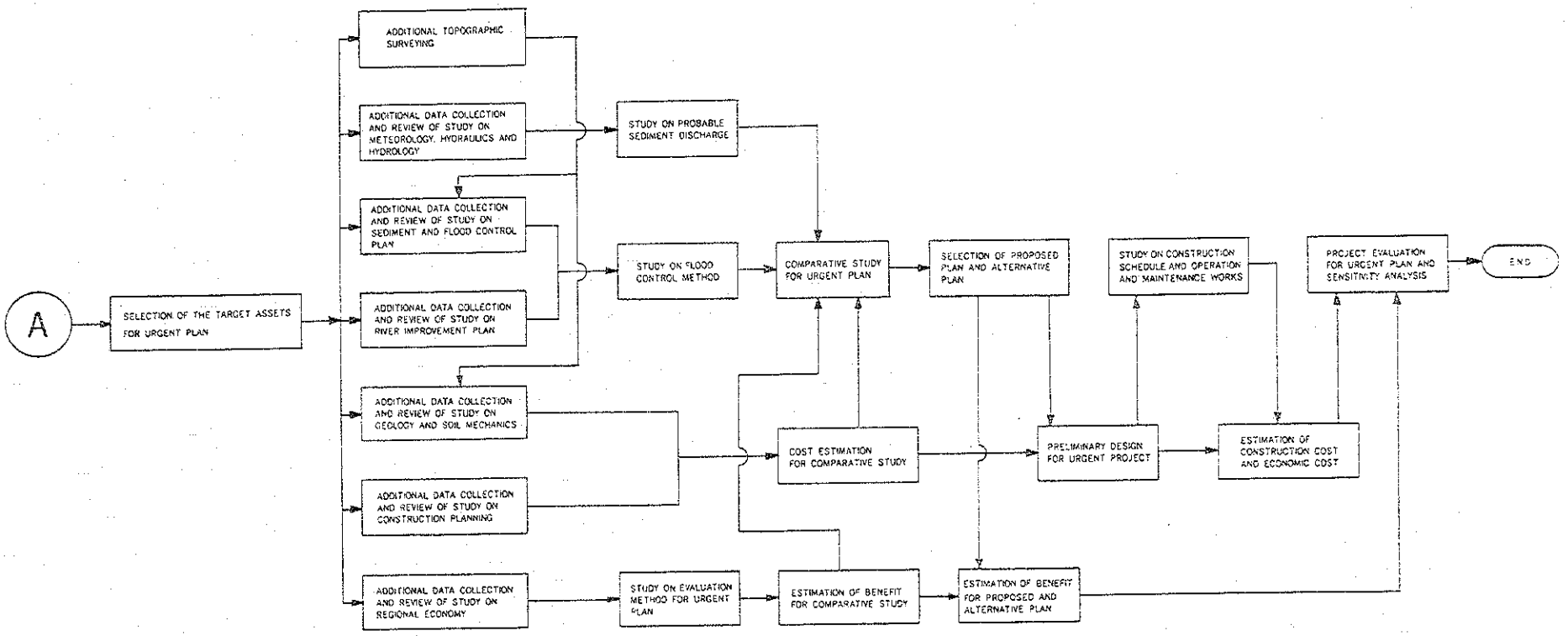


図　1－2 (2/2) 調査の手順（緊急計画）

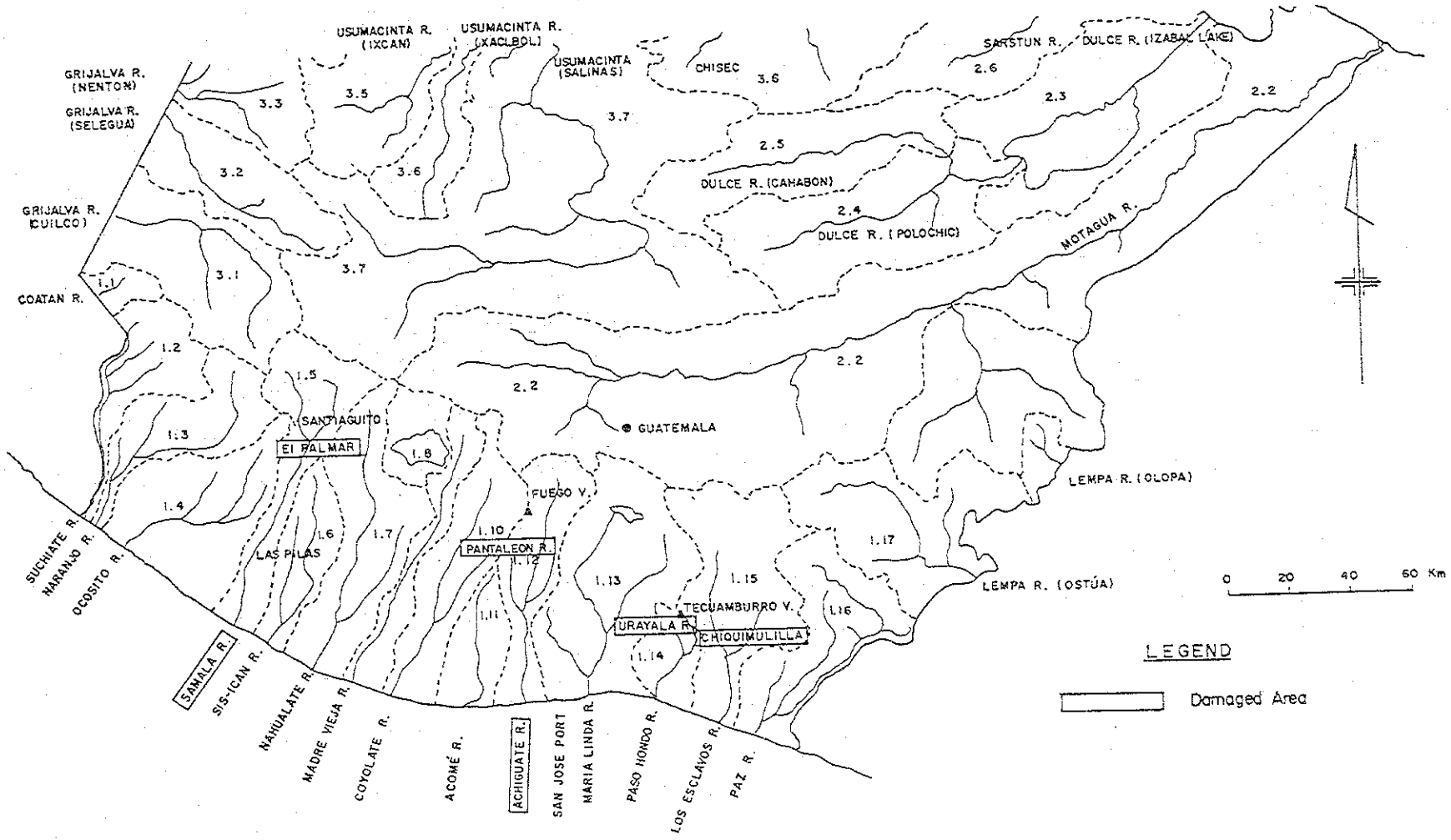
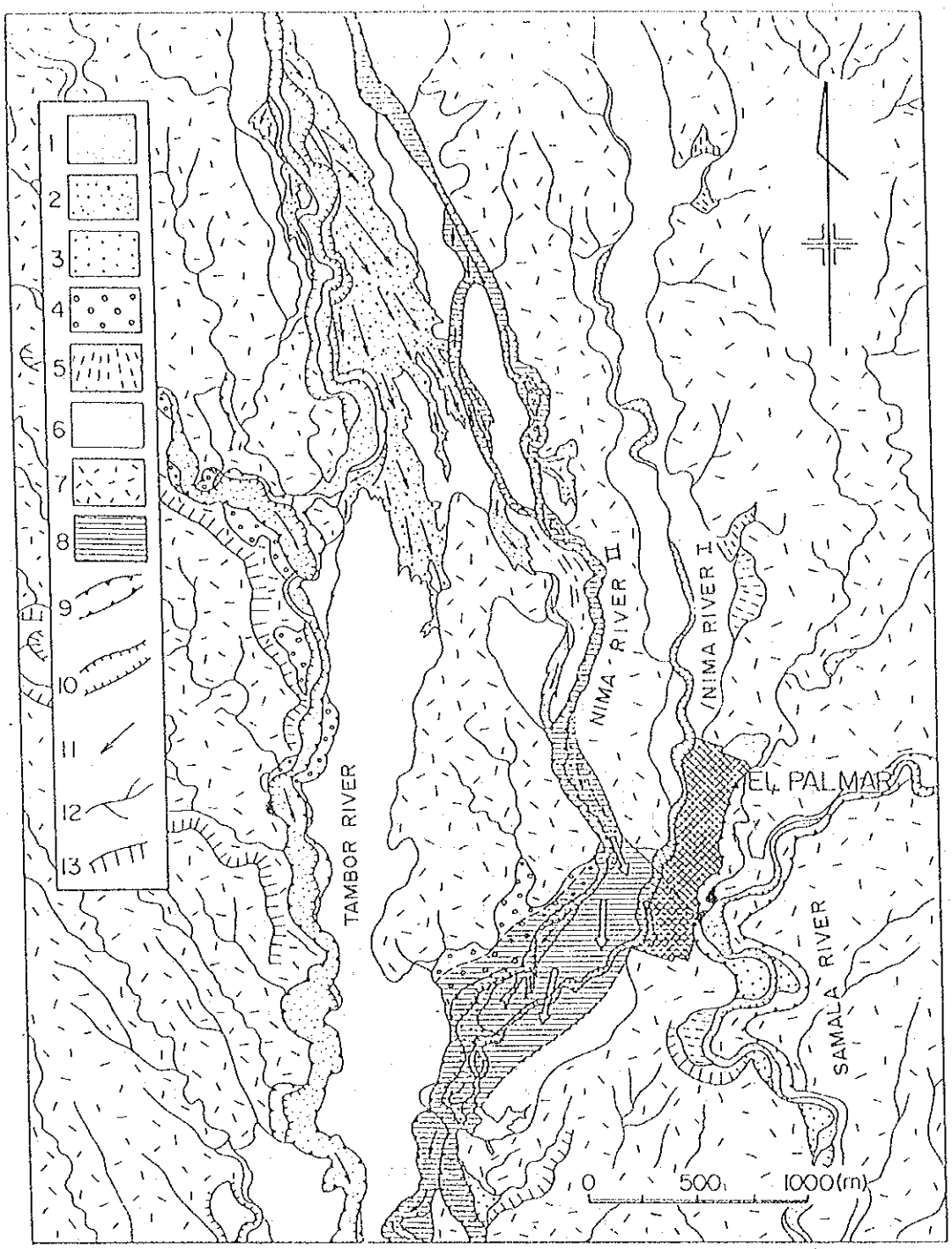


図　2－1　グアテマラに於ける土砂洪水被災地域



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

図　2－2　エルパルマールに於ける被災地域とその地勢条件

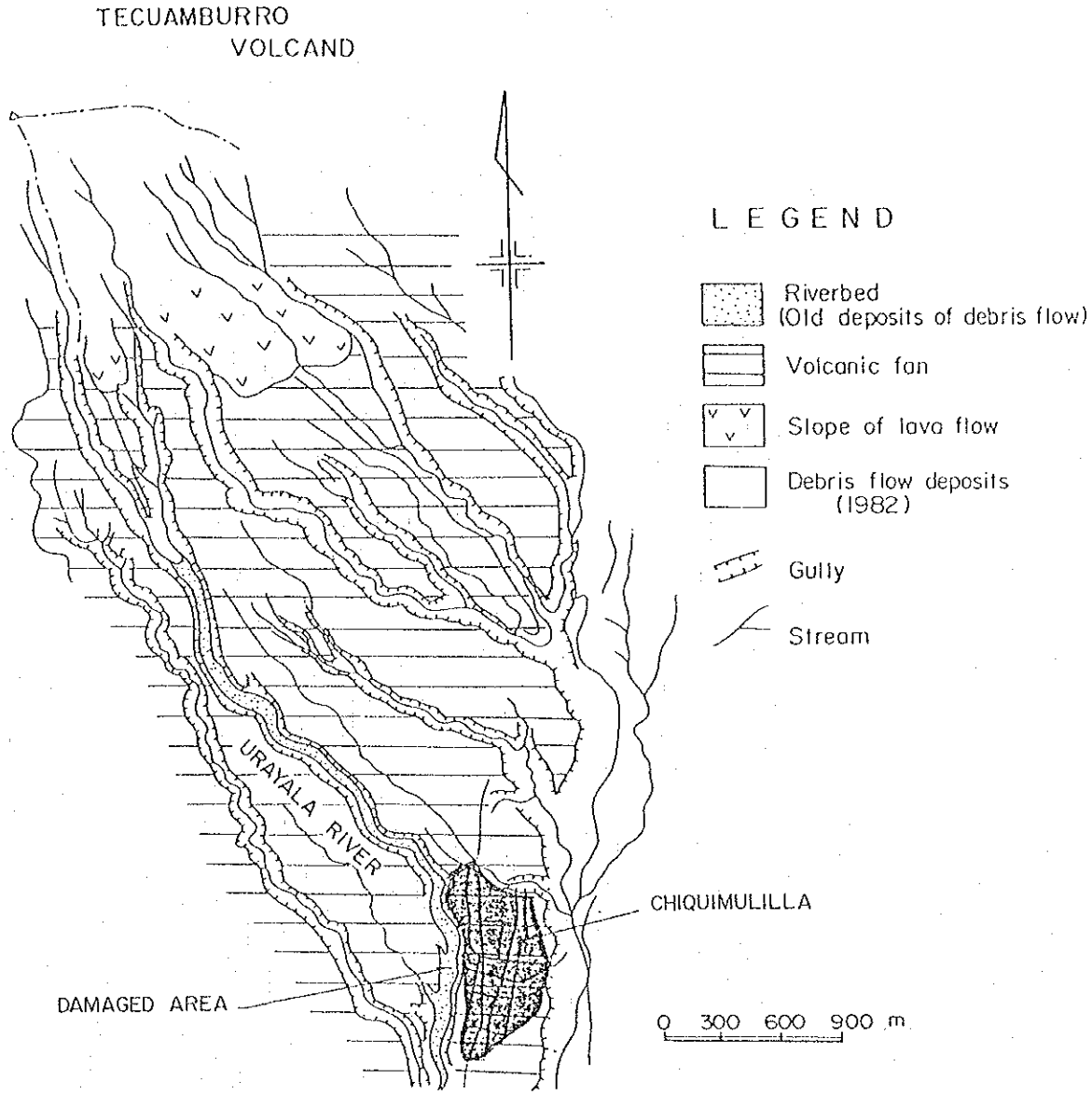


図　2－3　チキムリャに於ける被災地域とその地勢条件

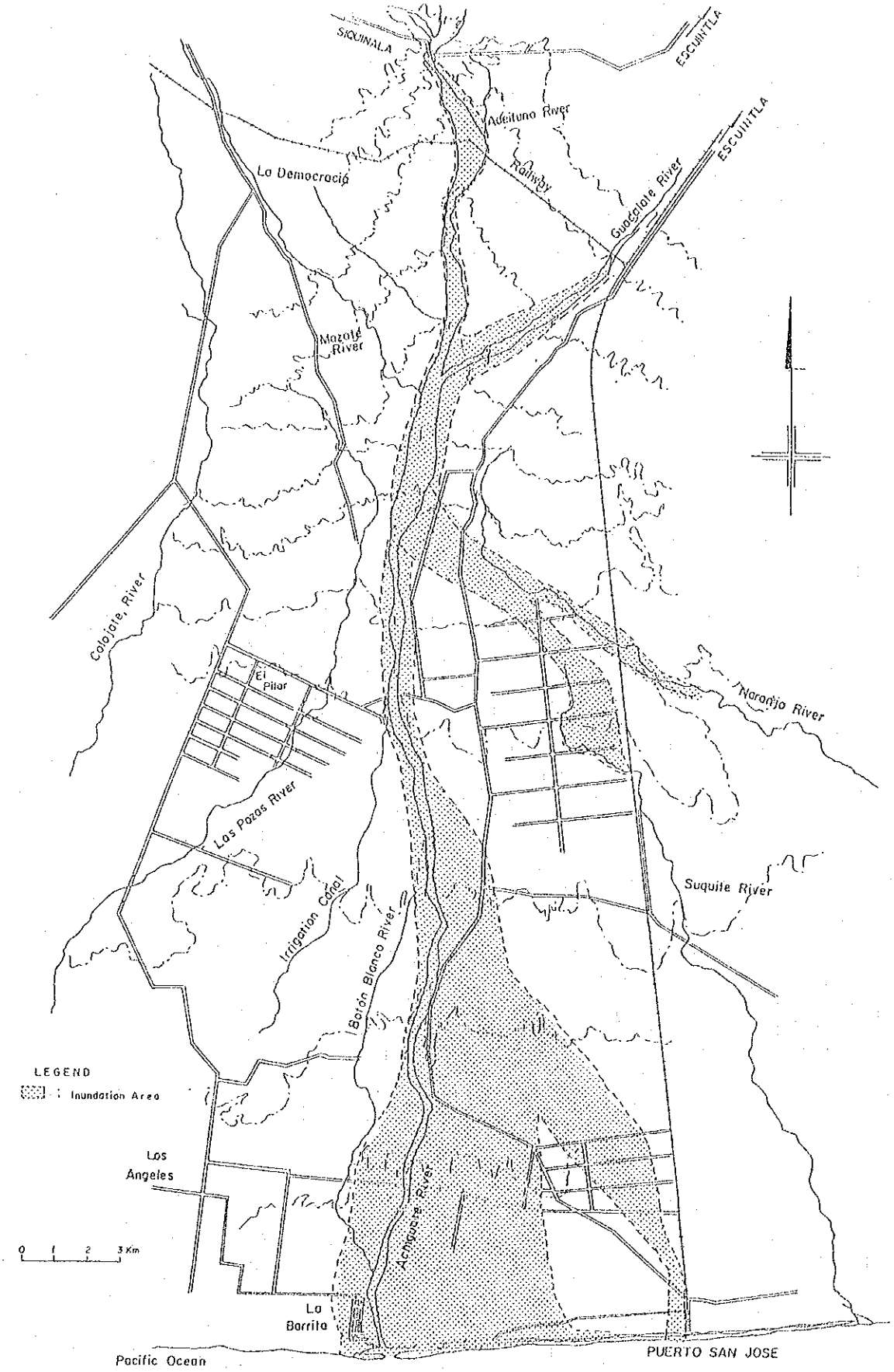


図　3－1 (1/2) 1969年9月の洪水氾濫地域図（アチグァテ川）

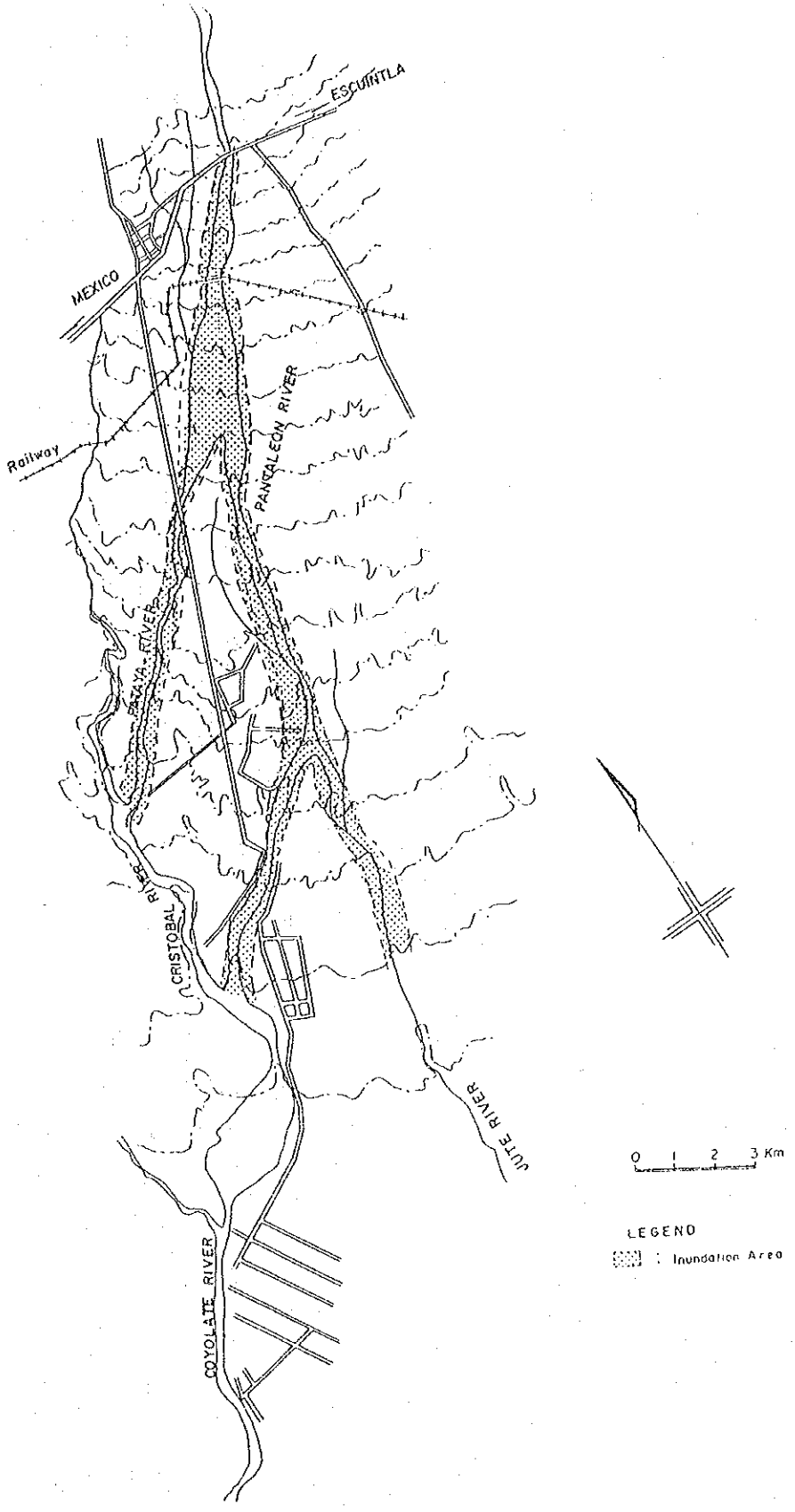


図　3－1 (2/2)　1969年９月の洪水氾濫地域図（パンタレオン川）

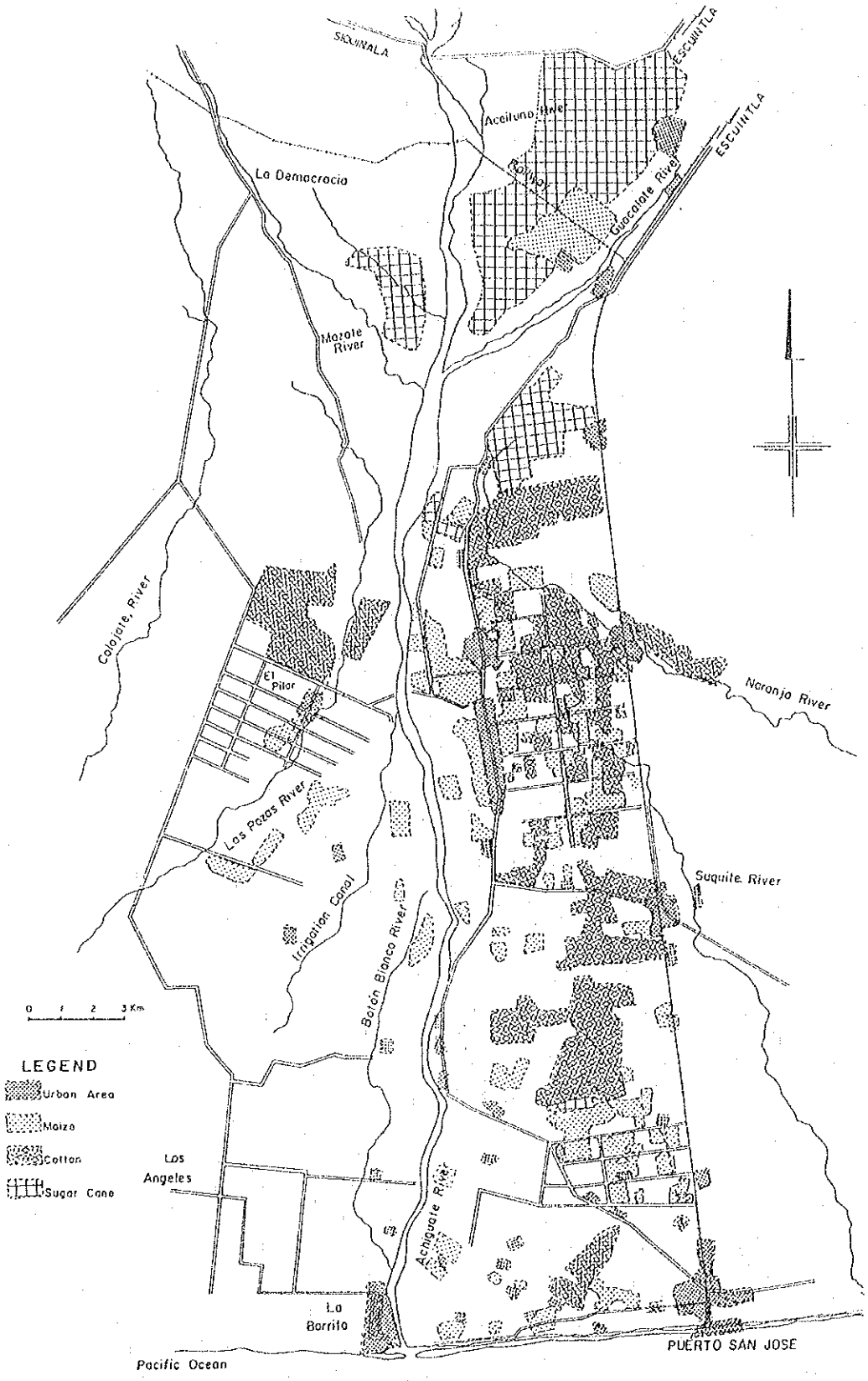


図　3－2(1/2) 土地利用図（アチグァテ川流域）

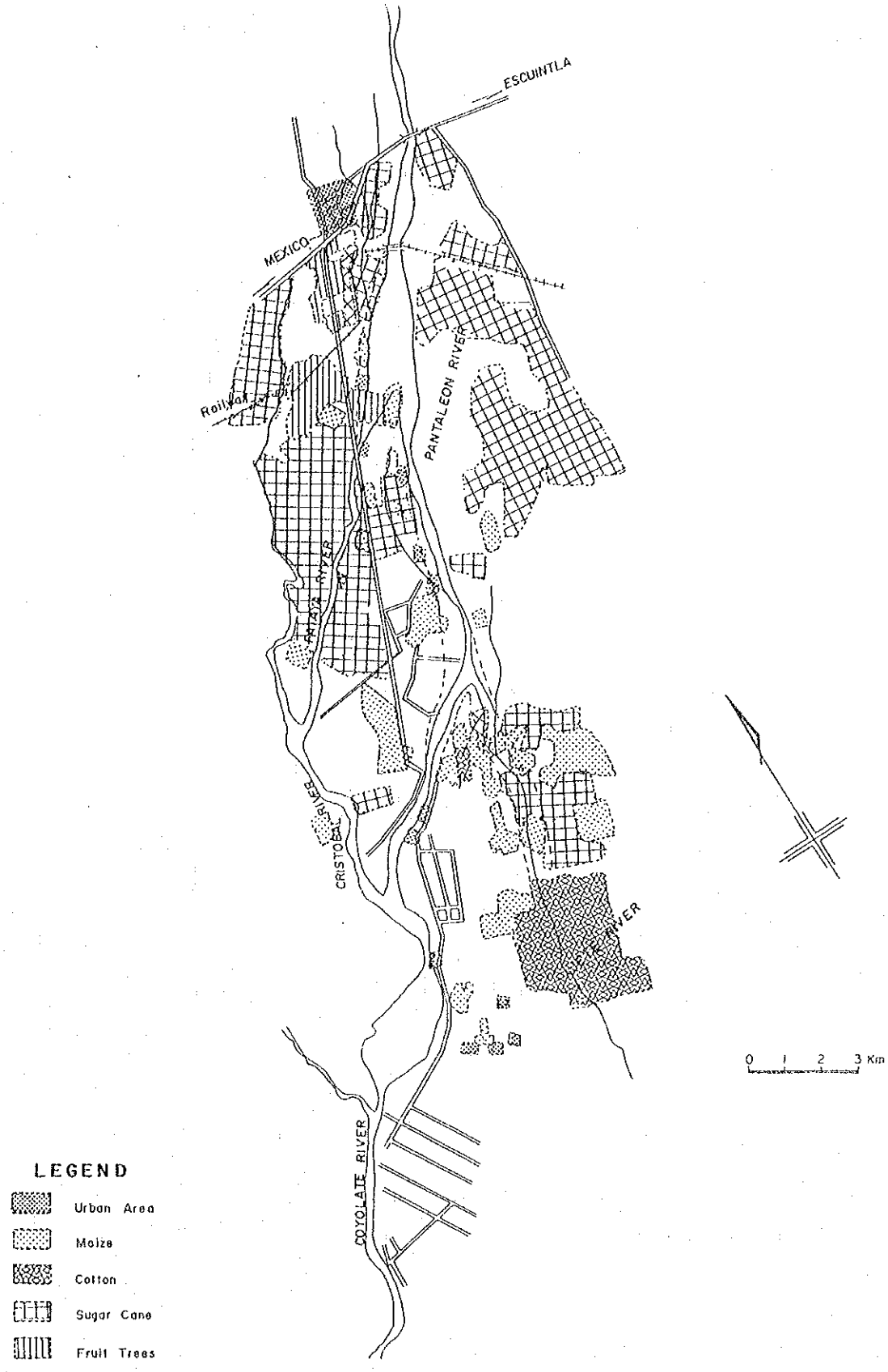


図　3－2 (2/2) 土地利用図（パンタレオン川流域）

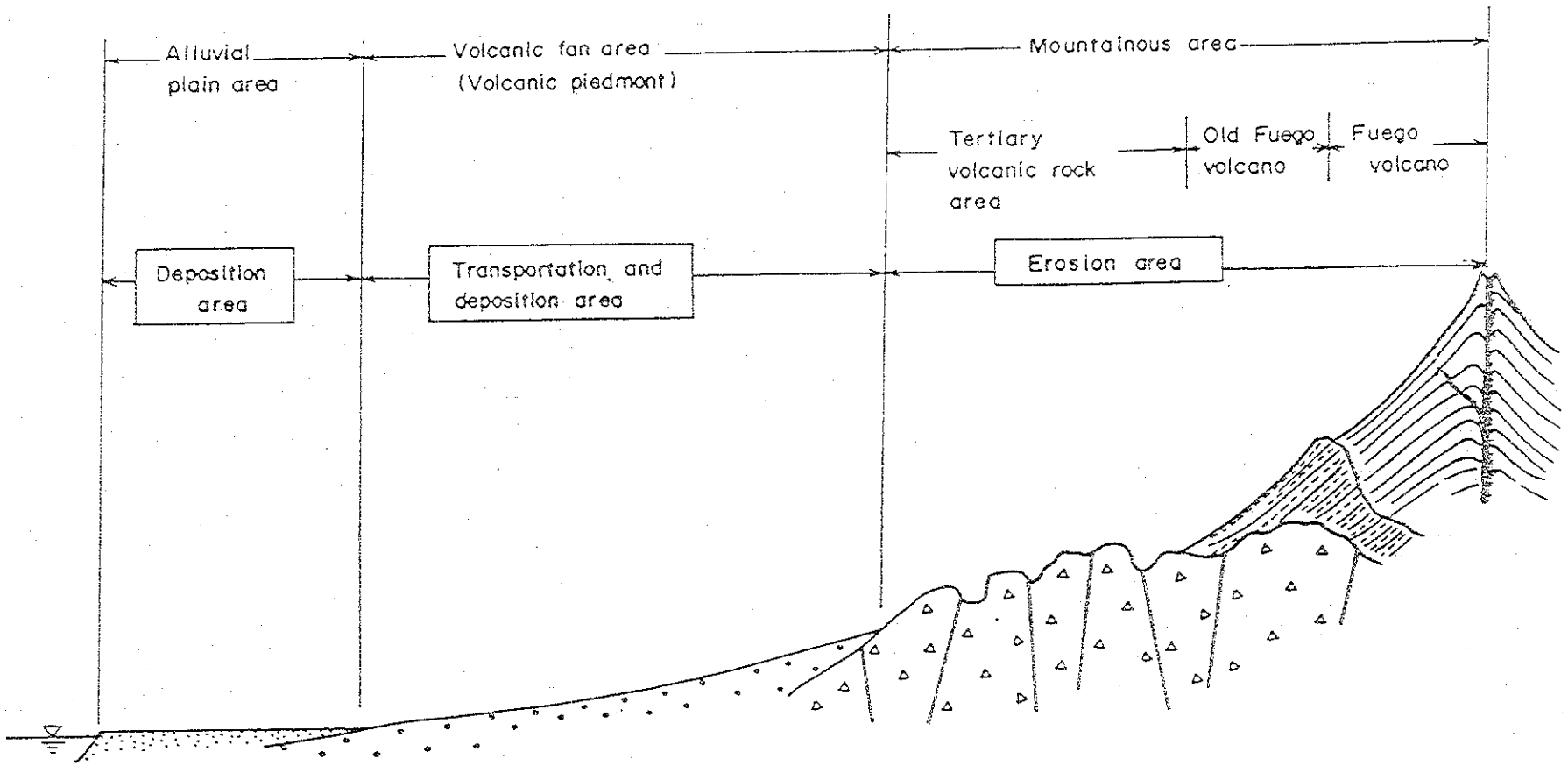


図　3－3　調査対象地域の地勢分類概念図

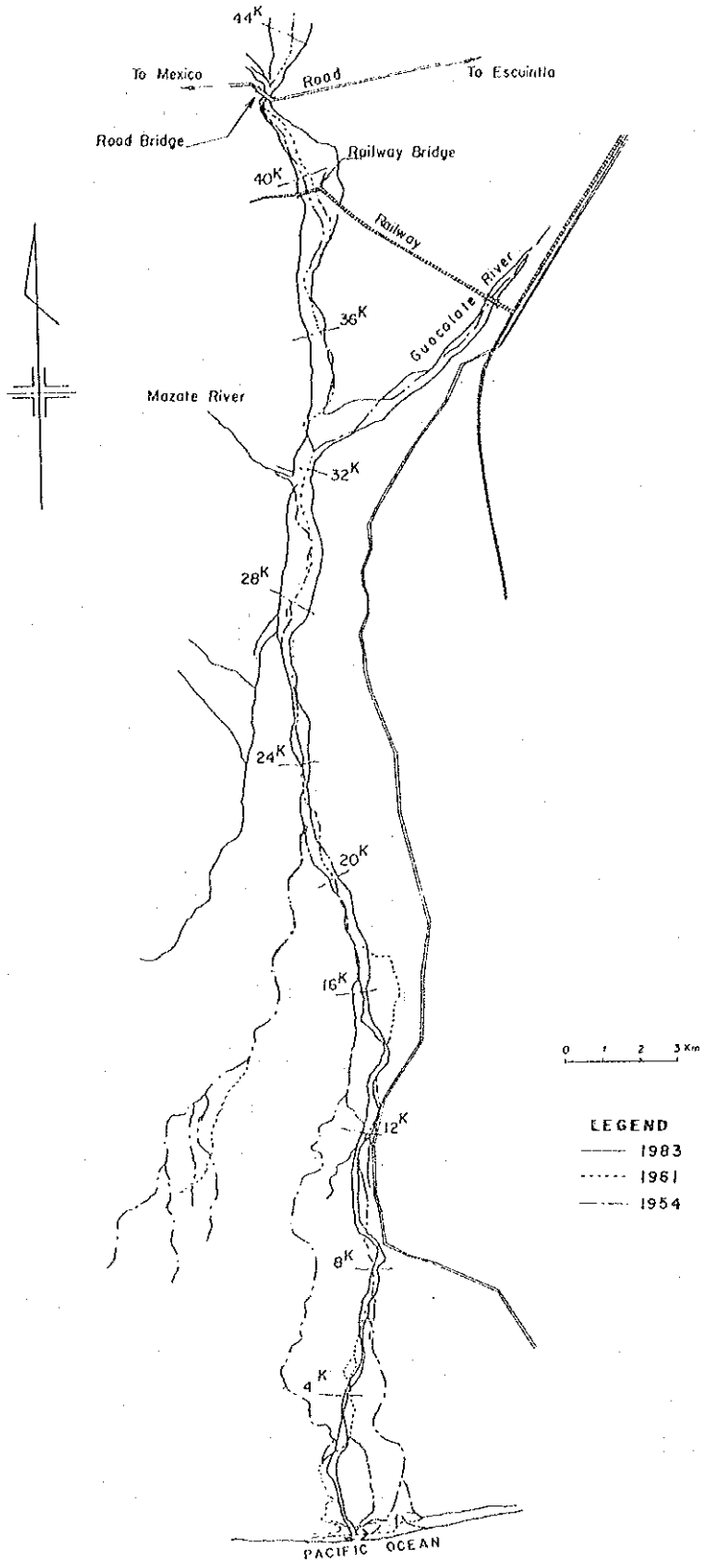


図　3－4 (1/2) 河道の変遷（アチグァテ川）

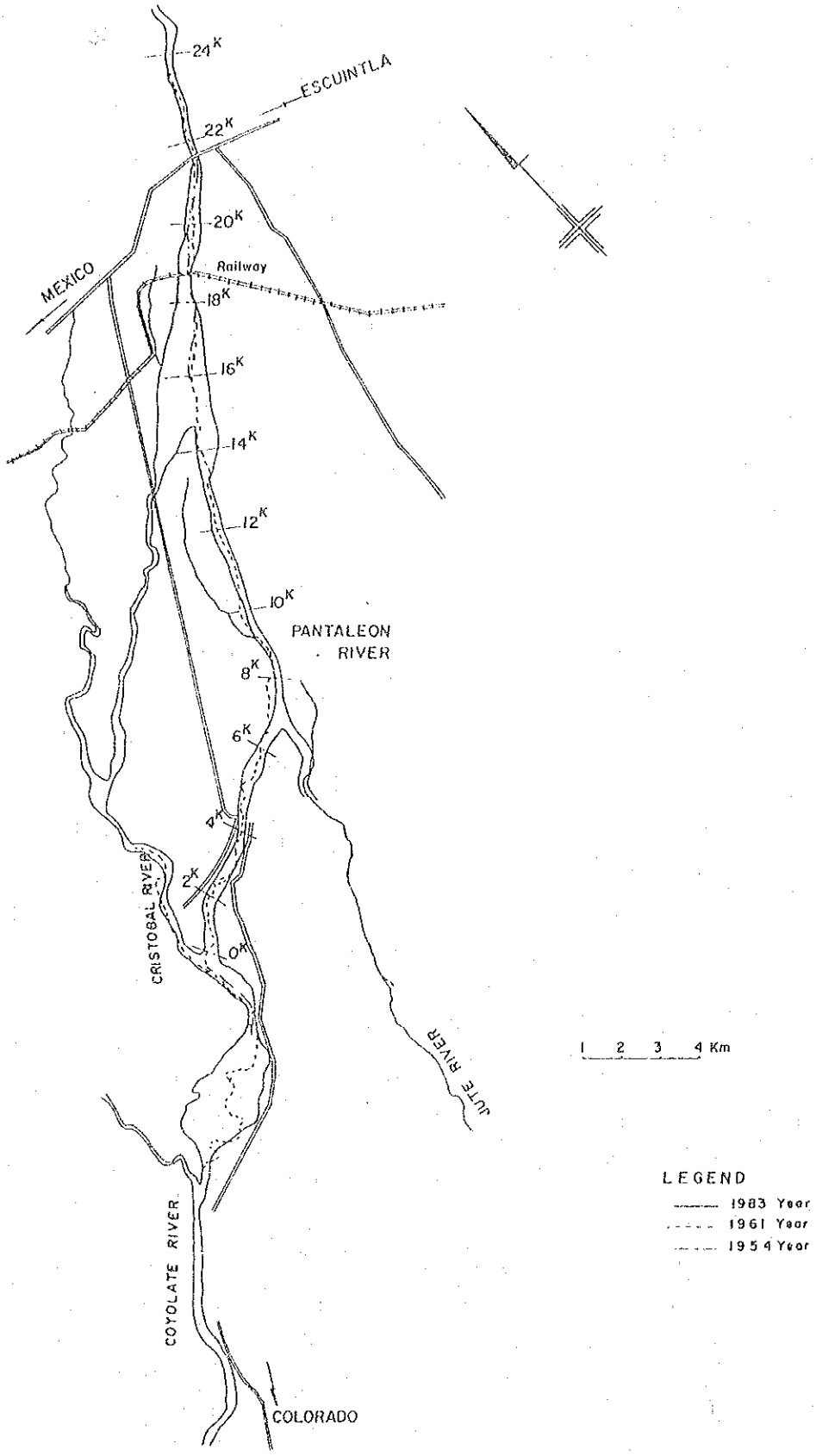
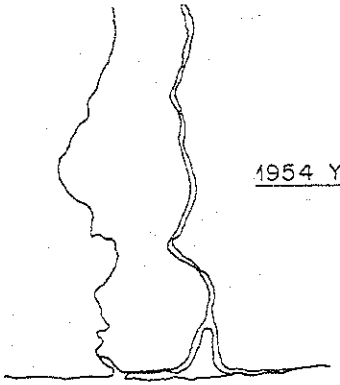
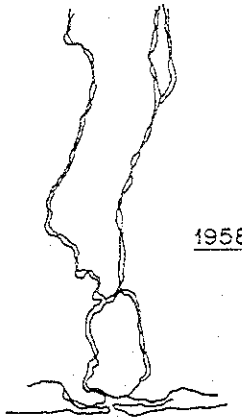
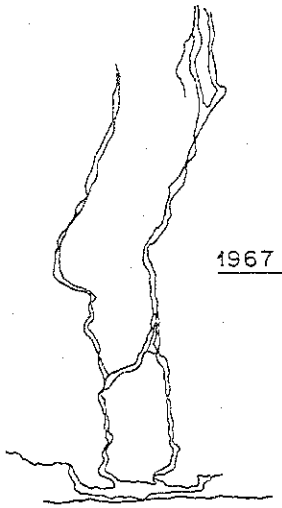


図　3－4 (2/2) 河道の変遷（パンタレオン川）







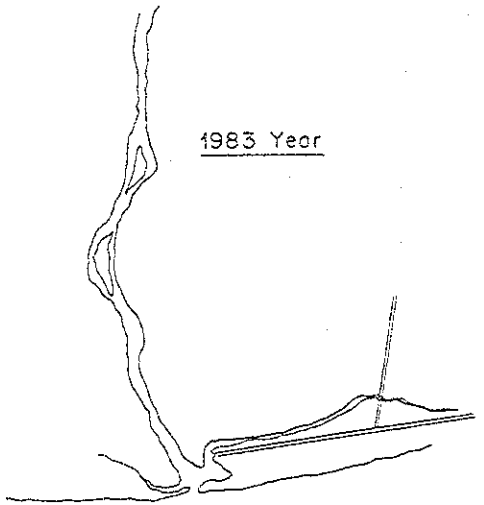


図　3－5　アチグァテ川河口部の変遷

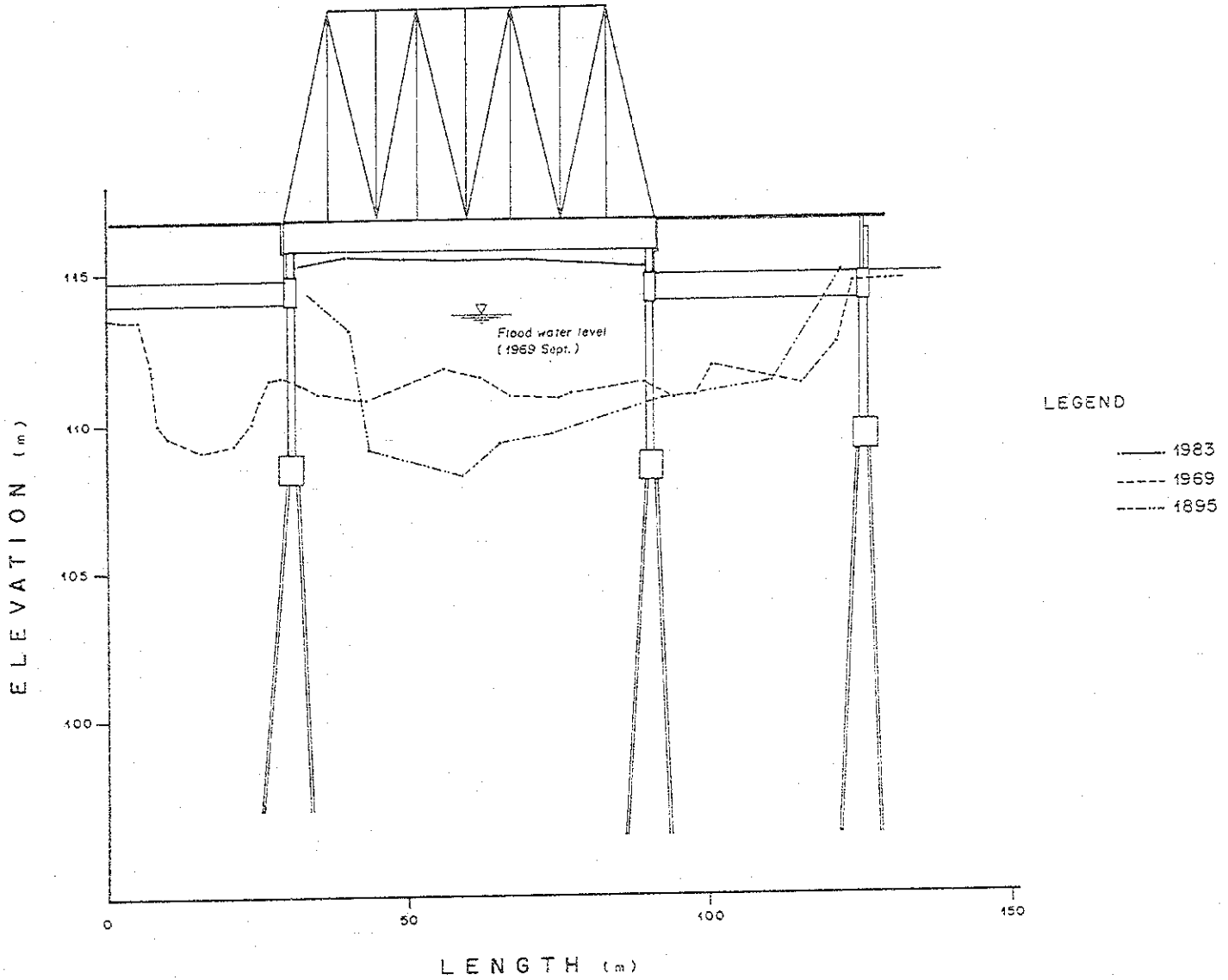


図　3－6　アチグァテ川鉄道橋での河道横断形の変遷

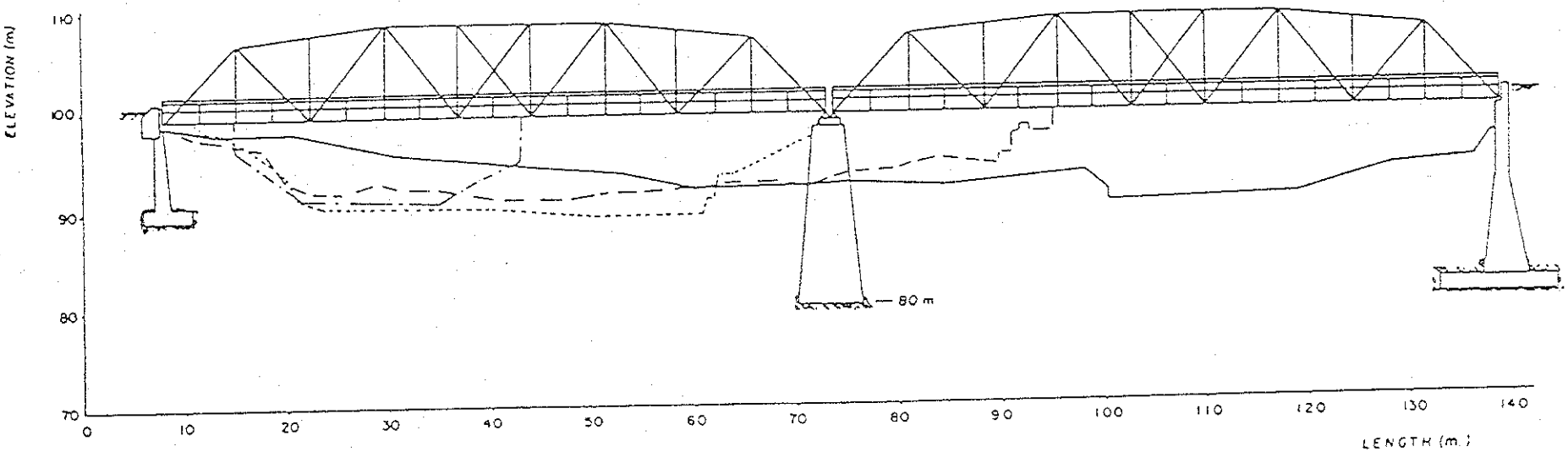


図　3－7　パンタレオン川道路橋での河道横断形の変遷

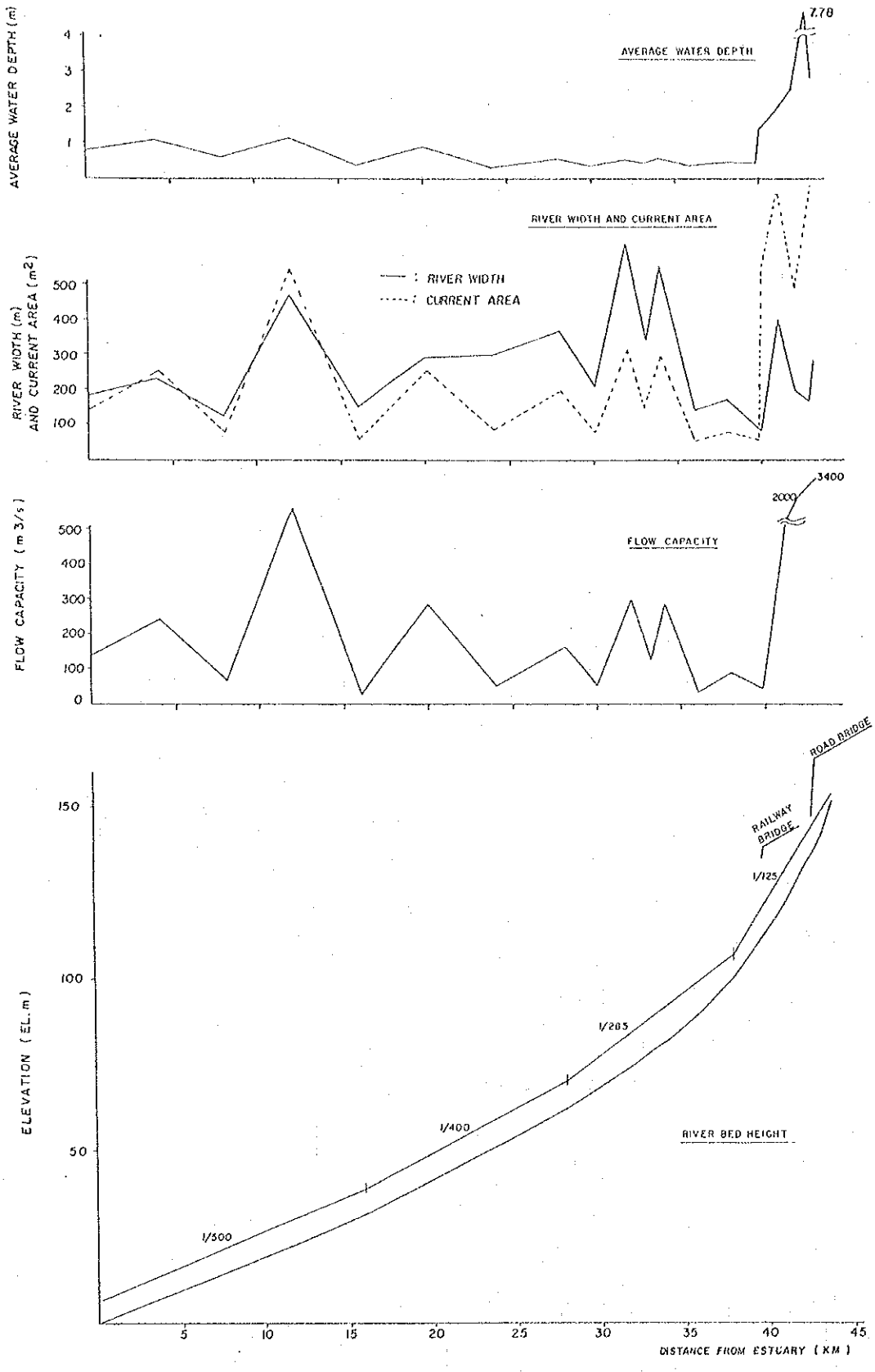


図　3－8 (1/2) 現況河川疎通能力（アチグァテ川）

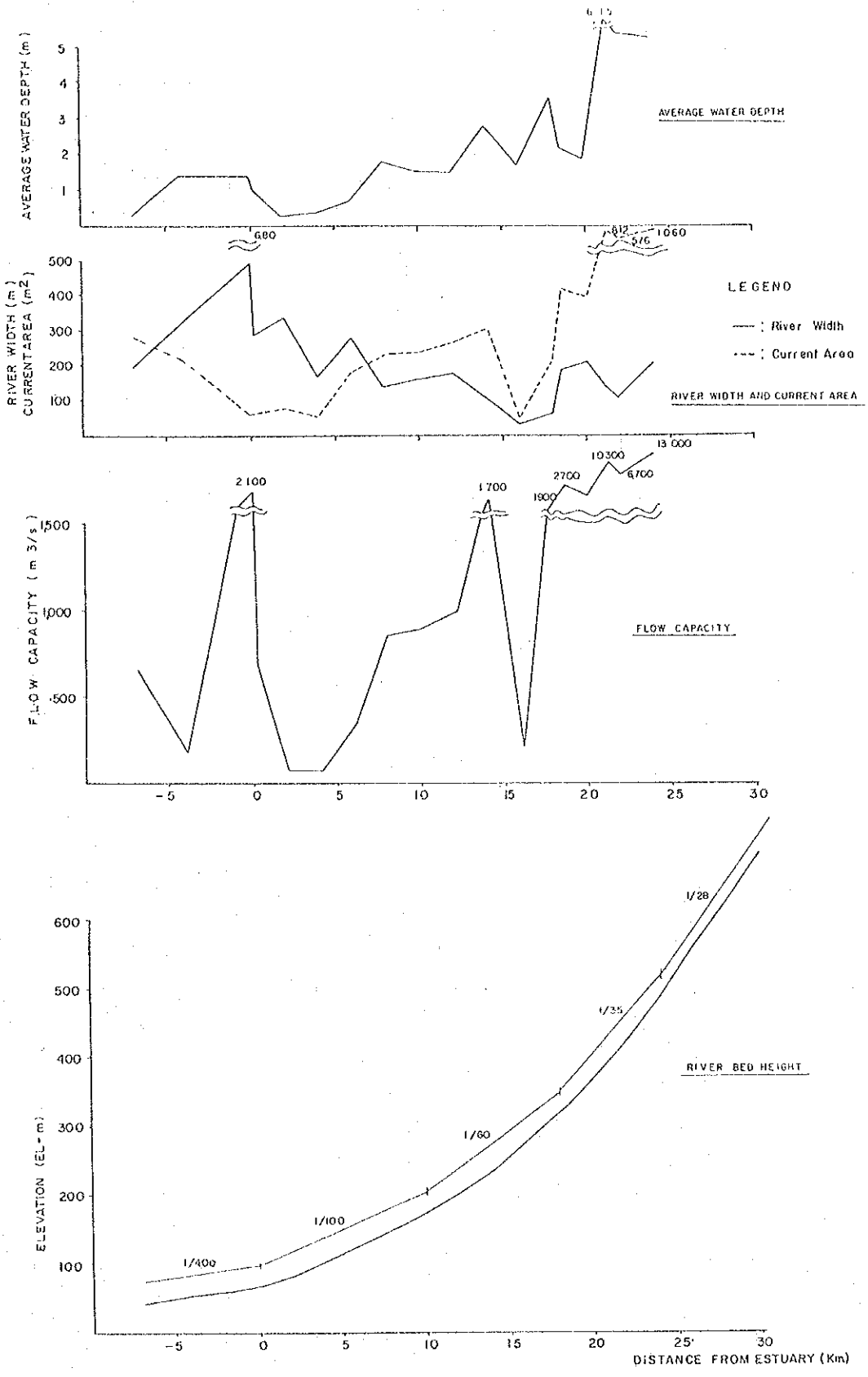


図　3－8 (2/2) 現況河川疎通能力（パンタレオン川）

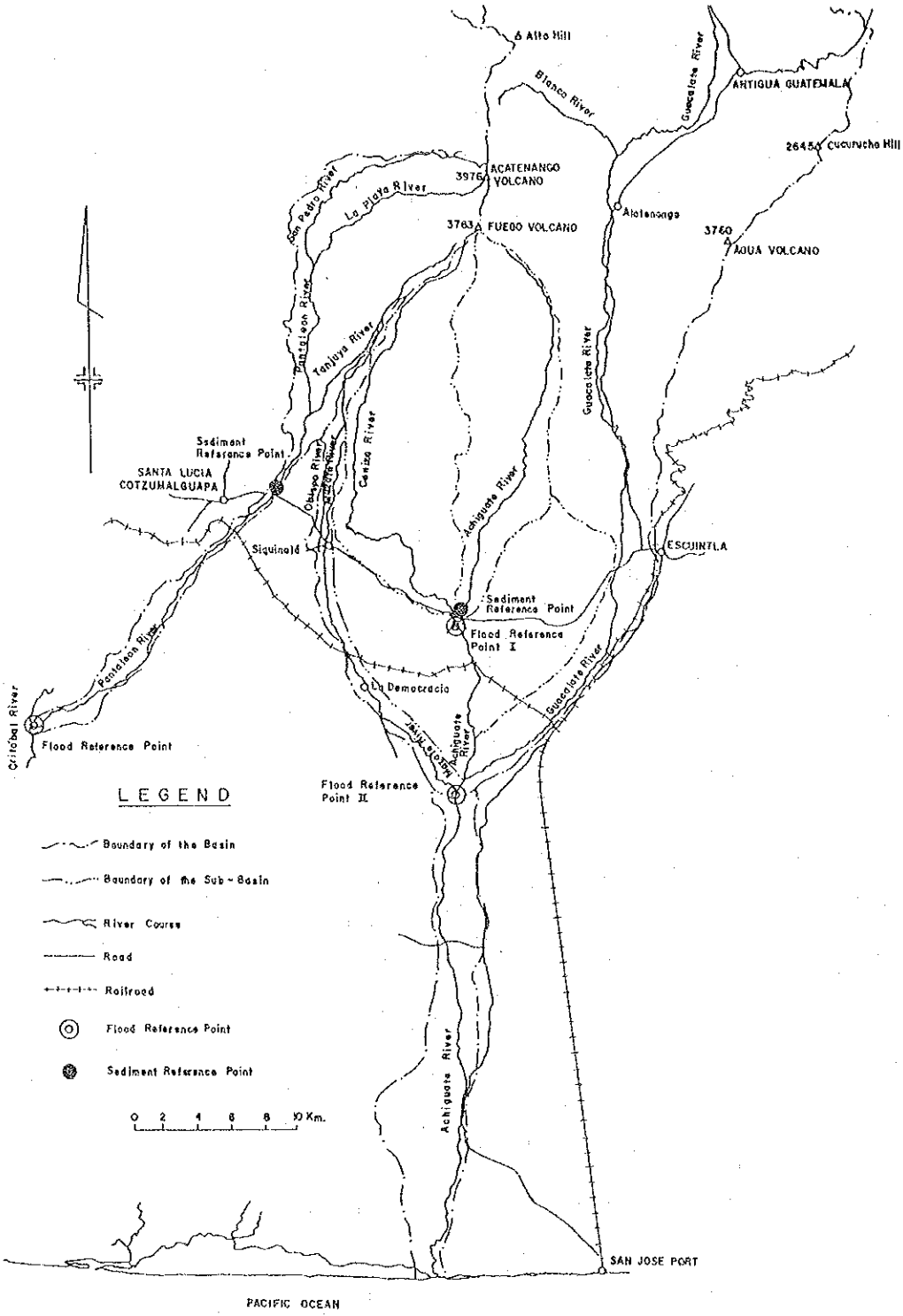


図　4－1　計画基準点位置図

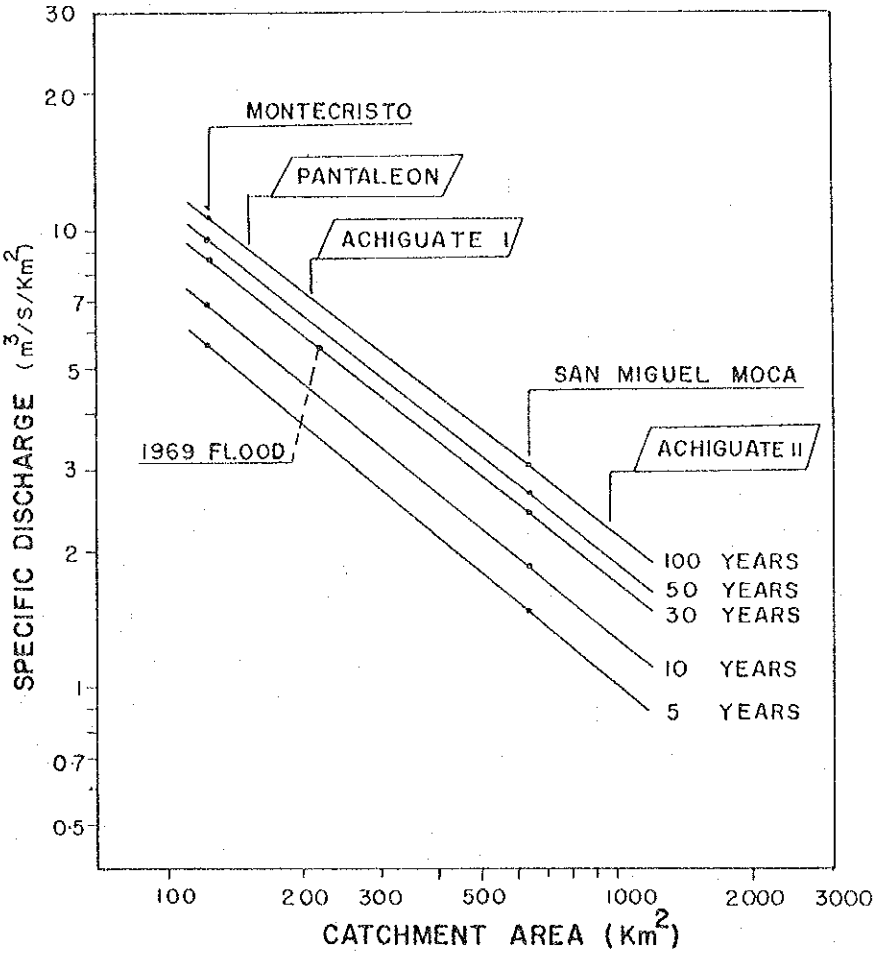

30
20
10
7
5
3
2
1
0·7
0·5
SPECIFIC DISCHARGE ($m^3/s/Km^2$)
MONTECRISTO
PANTALEON
ACHIGUATE I
SAN MIGUEL MOCA
ACHIGUATE II
1969 FLOOD
100 YEARS
50 YEARS
30 YEARS
10 YEARS
5 YEARS
100
200
300
500
1000
2000
3000
CATCHMENT AREA (Km^2)

図　4－2　比流量図

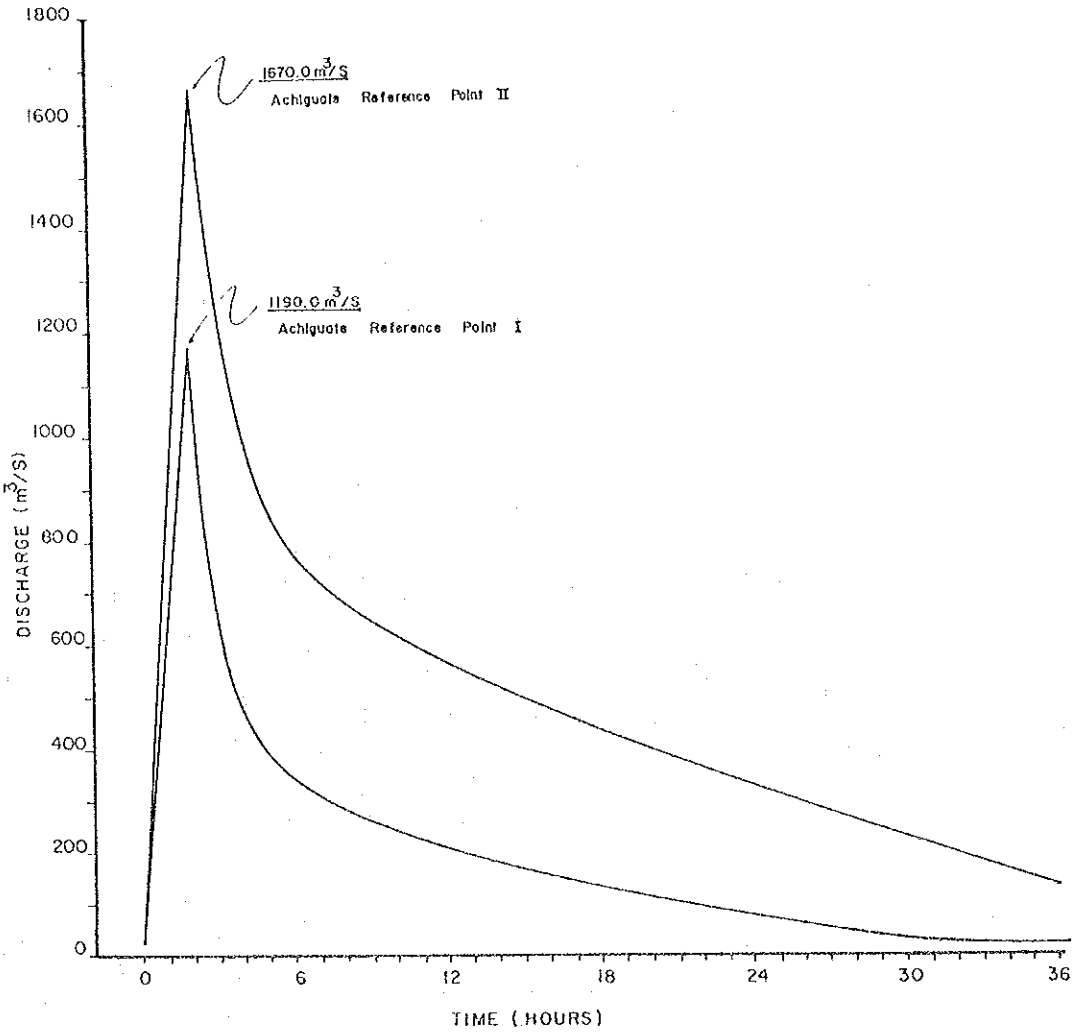


図　4－3 (1/2) モデル洪水波形（アチグァテ川）

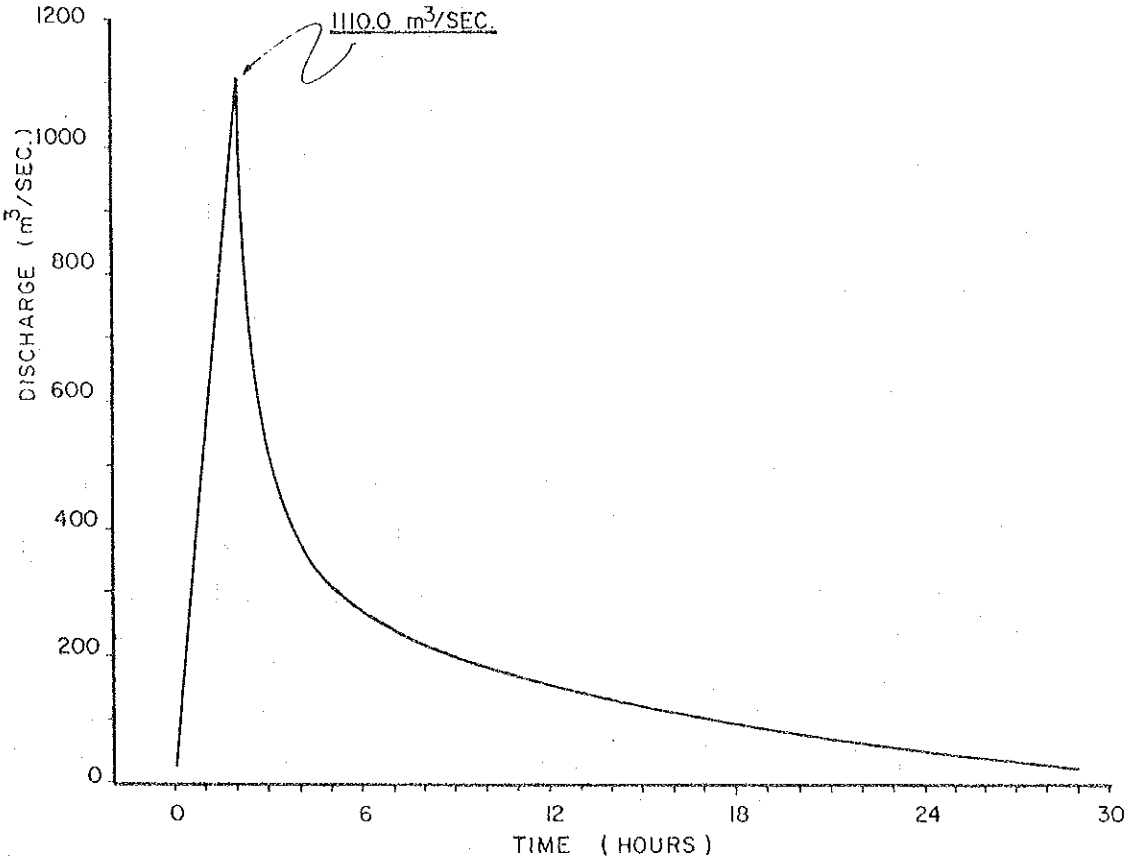
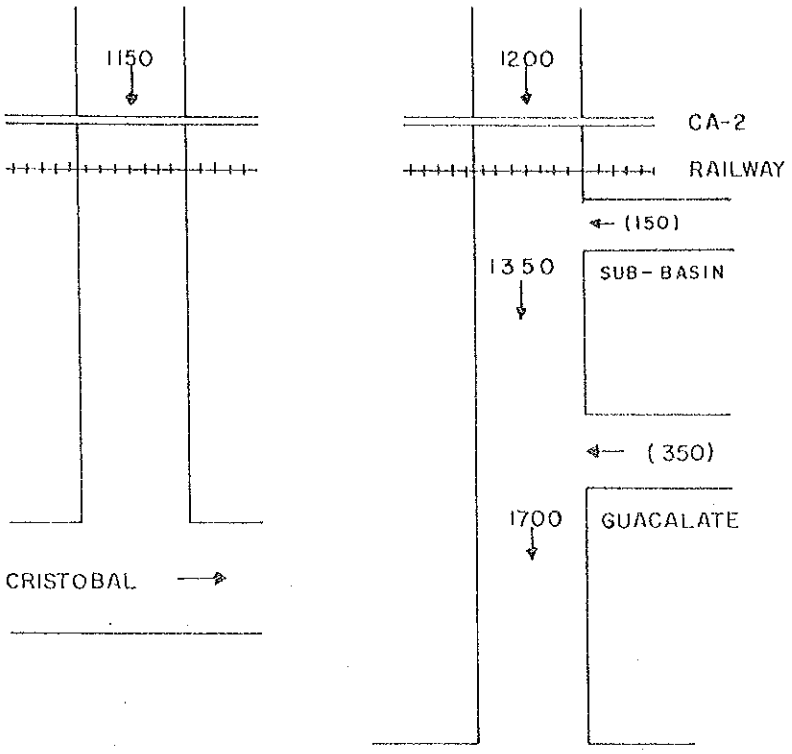


図　4－3 (2/2) モデル洪水波形（パンタレオン川）

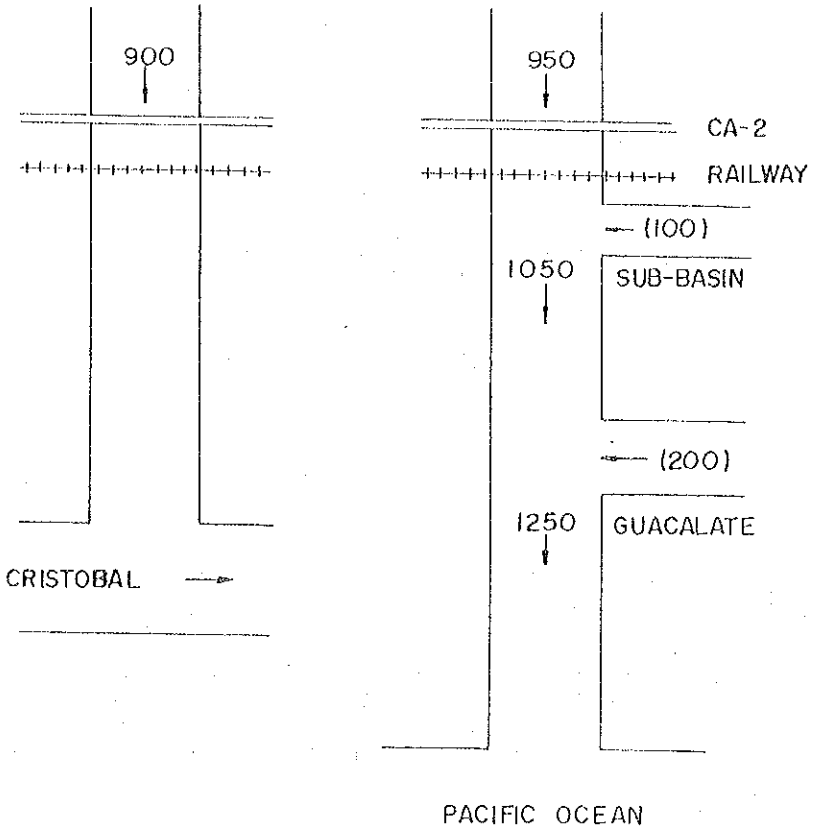


NOTE

Unit : m^3/sec

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

図　5－1 (1/2) 計画洪水流量配分図 (30年確率)



NOTE

Unit : m^3/sec

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

図　5－1 (2/2) 計画洪水流量配分図 (10年確率)

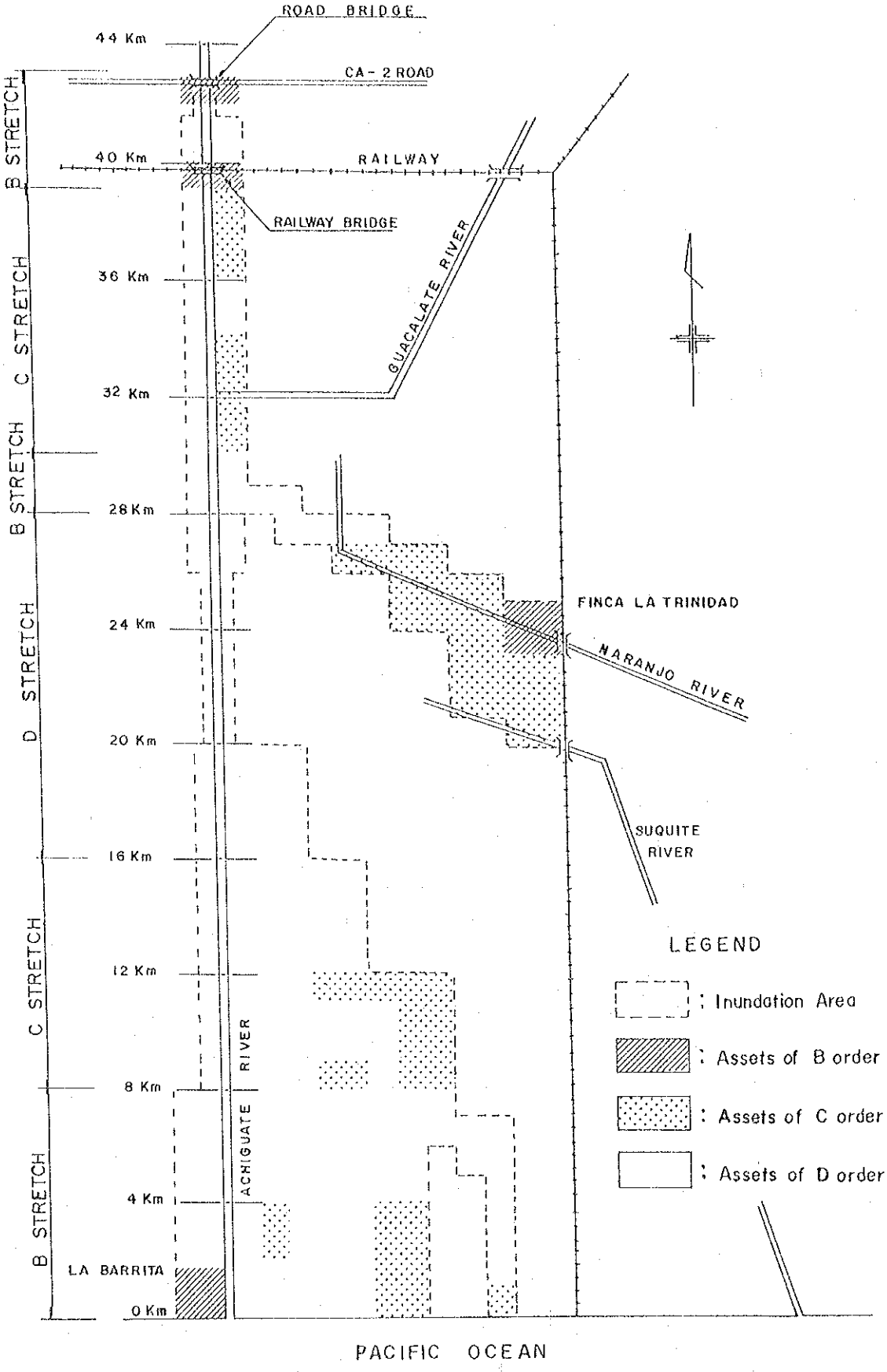


図　5－2 (1/2) 流域資産分類図（アチグァテ川流域）

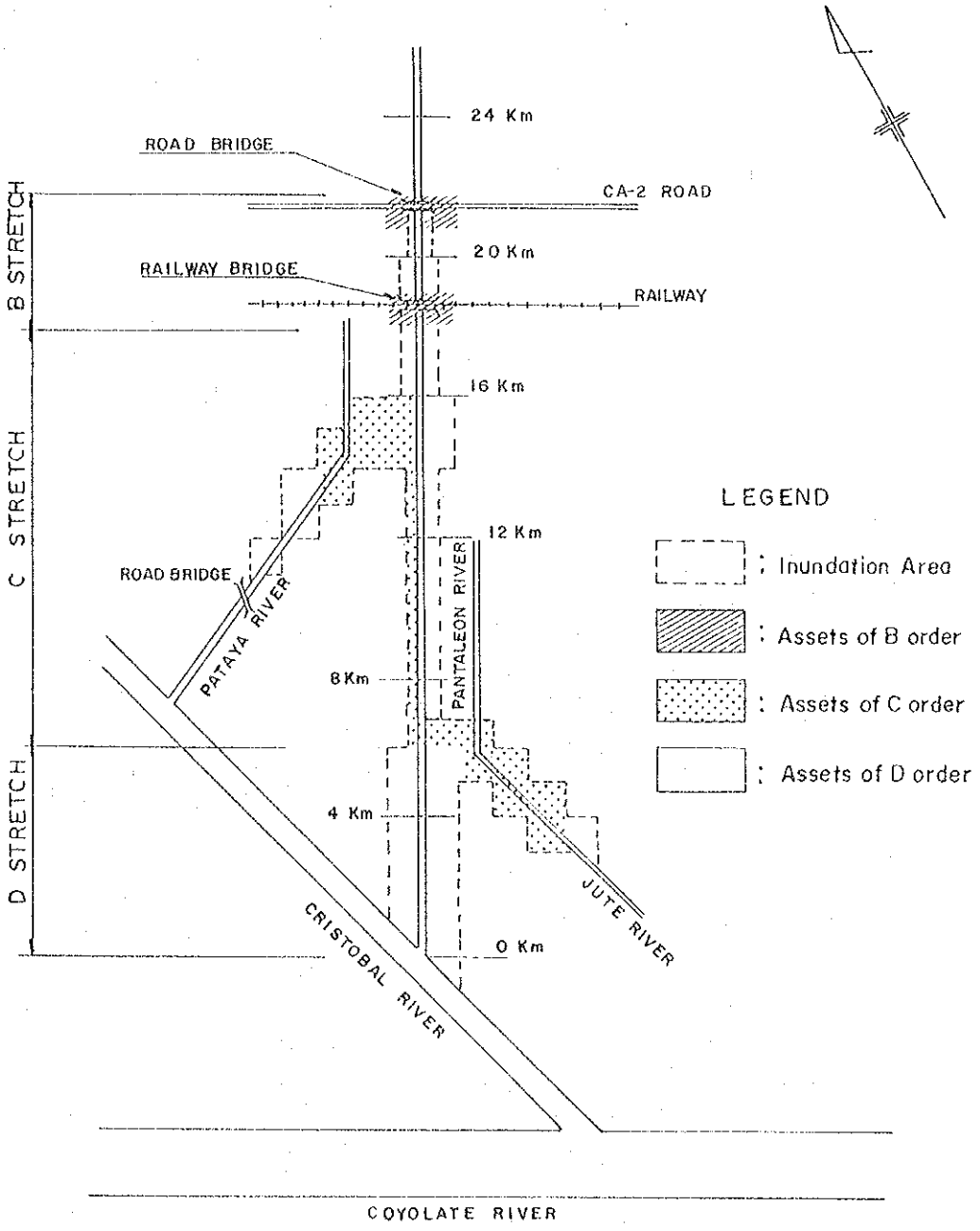
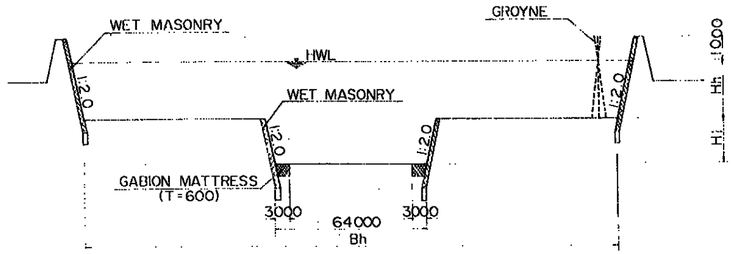
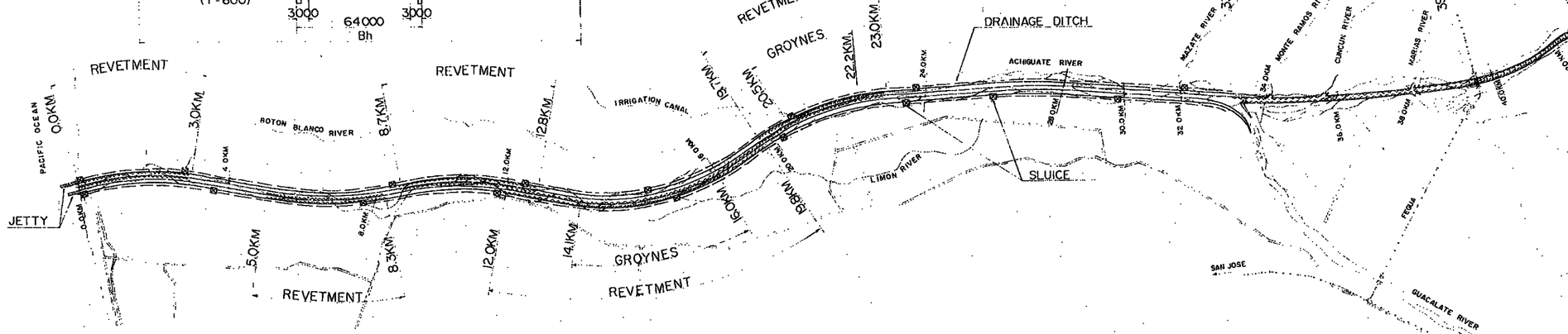


図　5－2 (2/2) 流域資産分類図（パンタレオン川流域）

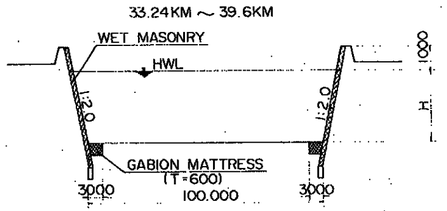
0.0KM ~ 33.24 KM



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

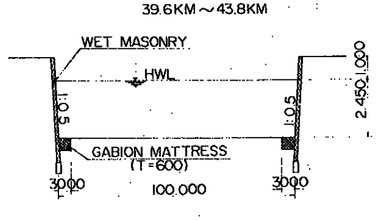


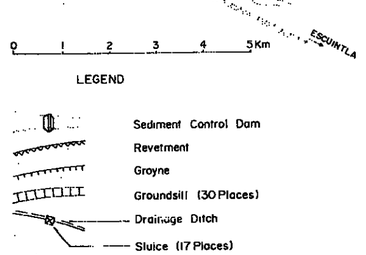
33.24KM ~ 39.6KM

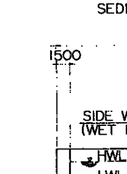


STRECH	H
33.24KM~38.0KM	3250
38.0 KM~39.6KM	2750

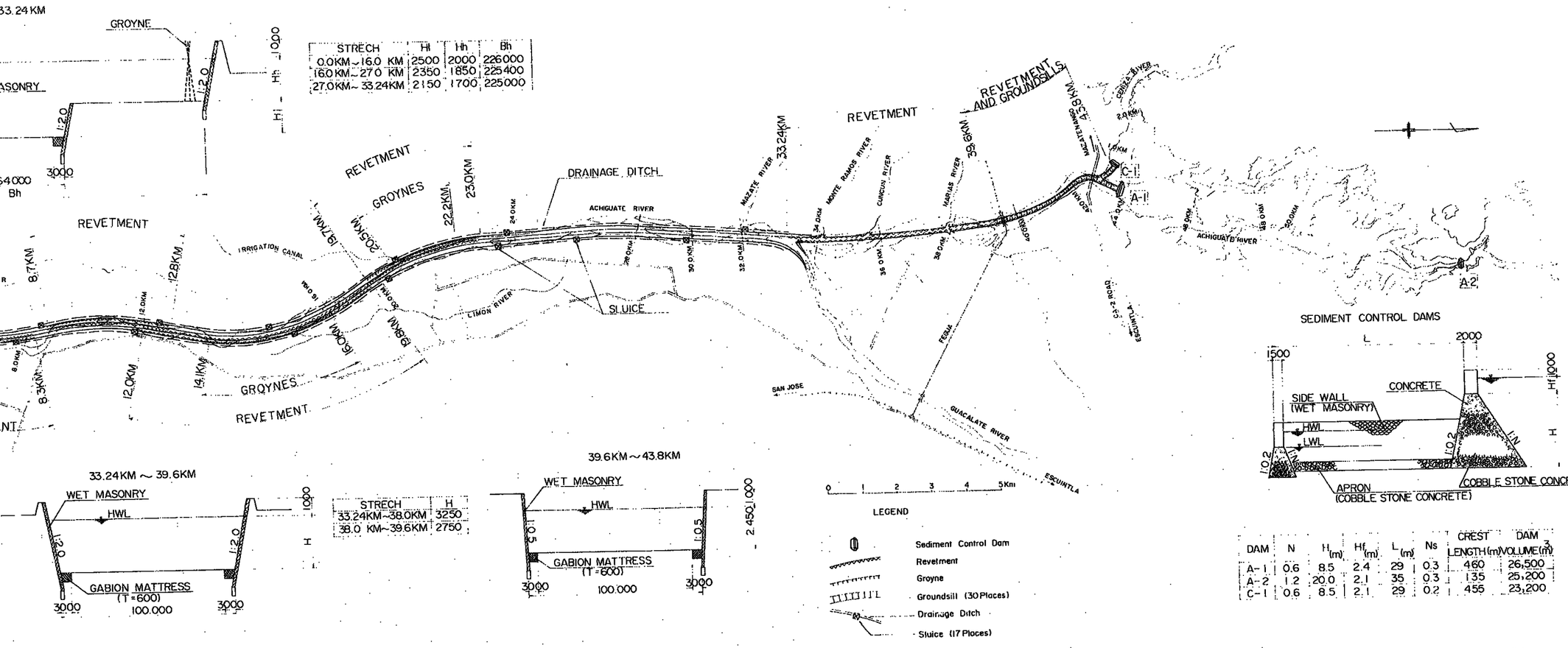
39.6KM ~ 43.8KM





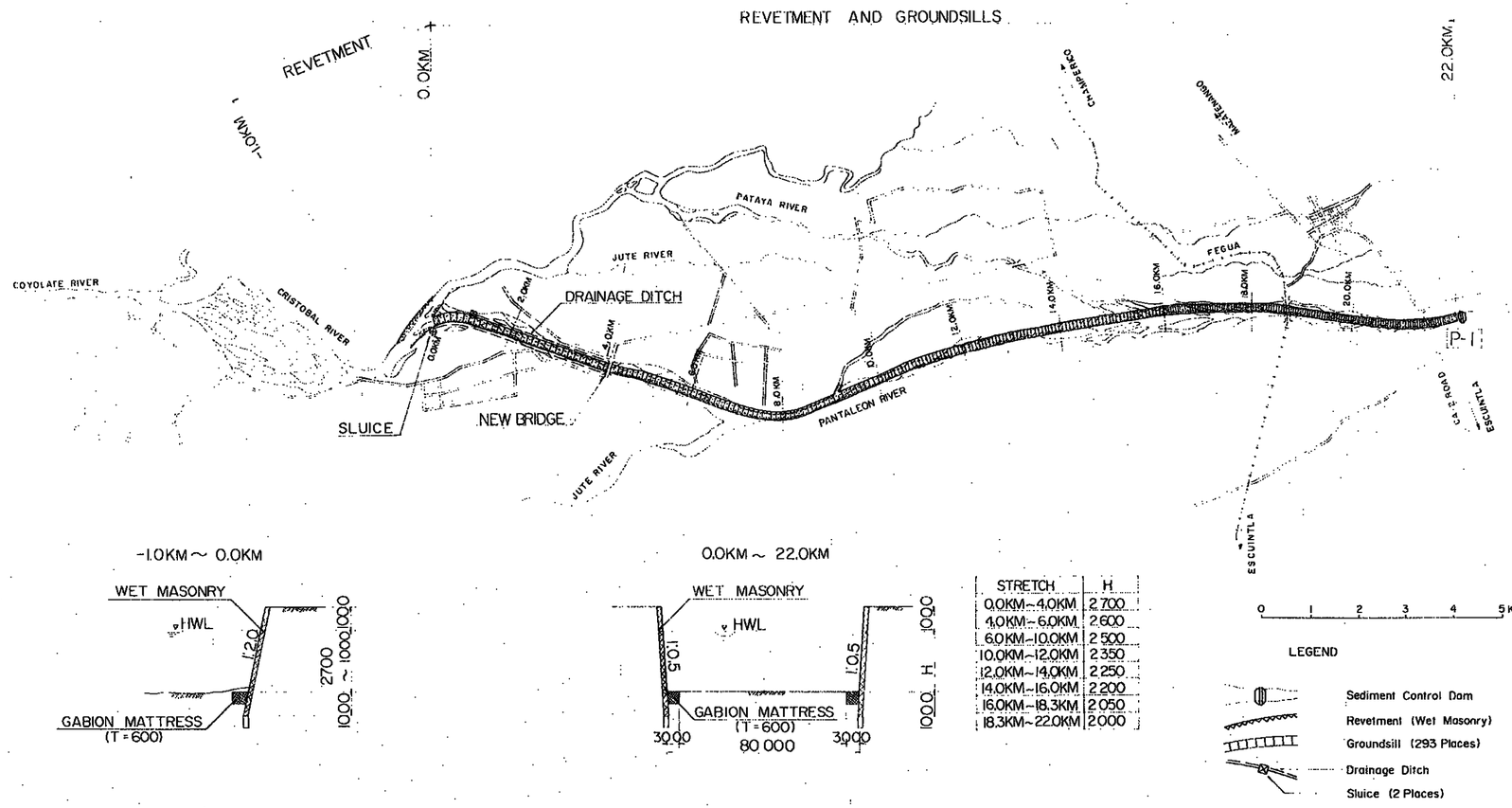


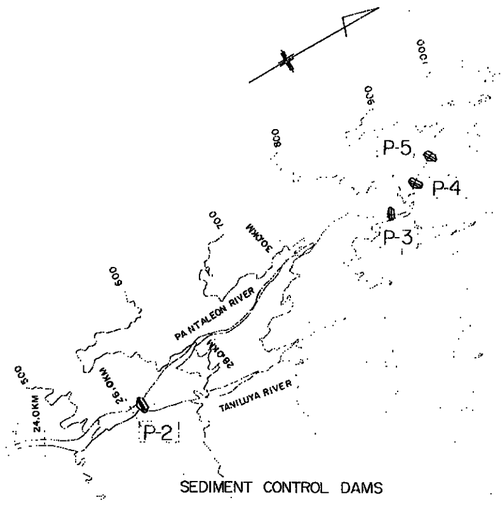
DAM	N	H
A-1	0.6	8.
A-2	1.2	20.
C-1	0.6	8.



DAM	N	$H_{(m)}$	$Hf_{(m)}$	$L_{(m)}$	Ns	CREST LENGTH(m)	DAM VOLUME(m³)
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

図　5－3 (1/2)　全川改修案平面図
（アチグァテ川）





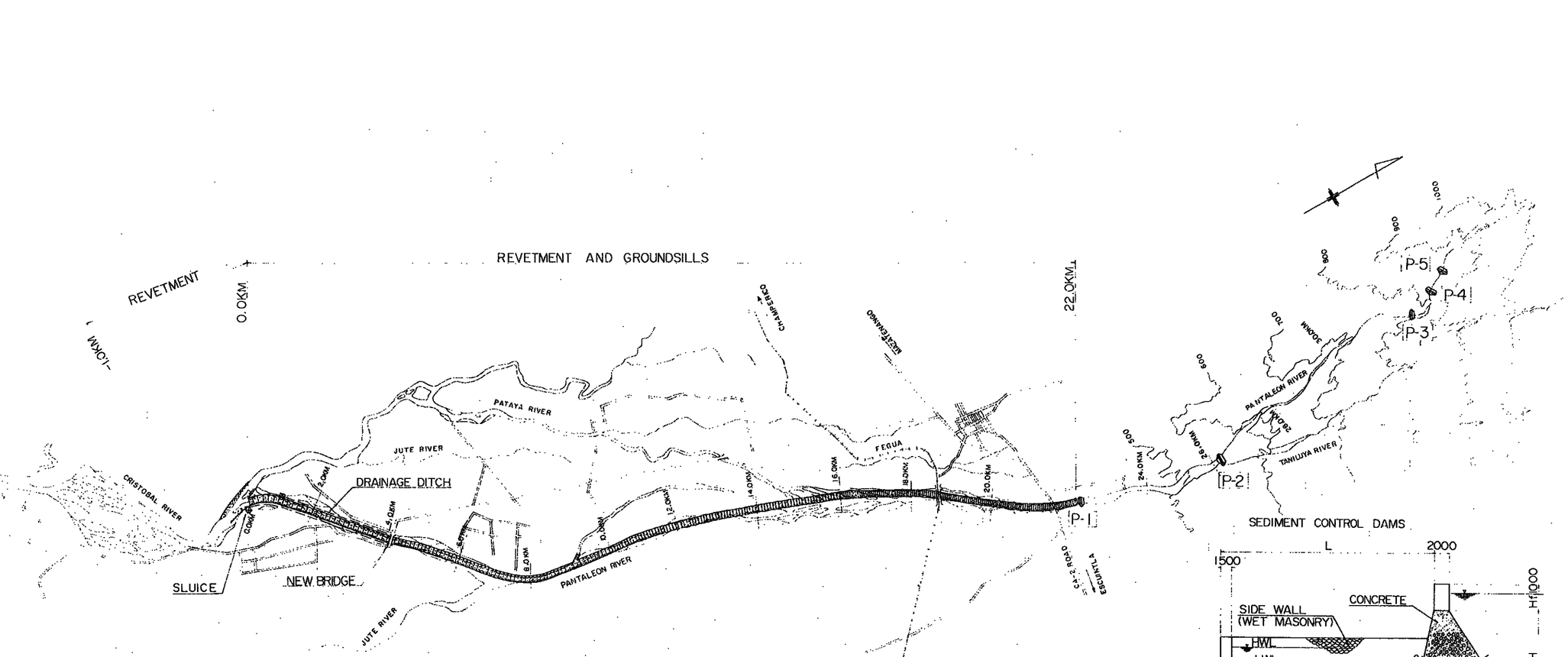
-1.0KM ~ 0.0KM

0.0KM ~ 22.0KM

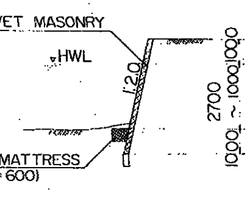
STRETCH	H
0.0KM~4.0KM	2.700
4.0KM~6.0KM	2.600
6.0KM~10.0KM	2.500
10.0KM~12.0KM	2.350
12.0KM~14.0KM	2.250
14.0KM~16.0KM	2.200
16.0KM~18.3KM	2.050
18.3KM~22.0KM	2.000

DAM	N	H (m)	Hf (m)	L (m)	Ns	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

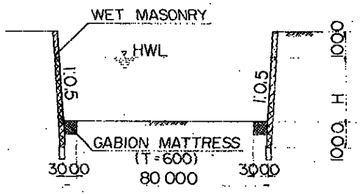
図 5－3 (2/2) 全川改修案平面
(パンタレオン



-1.0KM ~ 0.0KM



0.0KM ~ 22.0KM



STRETCH	H
0.0KM~4.0KM	2 700
4.0KM~6.0KM	2600
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	2000

DAM	N	H_m (m)	Hf (m)	L (m)	Ns	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

図 5－3 (2/2) 金川改修案平面図
(パンタレオン川)

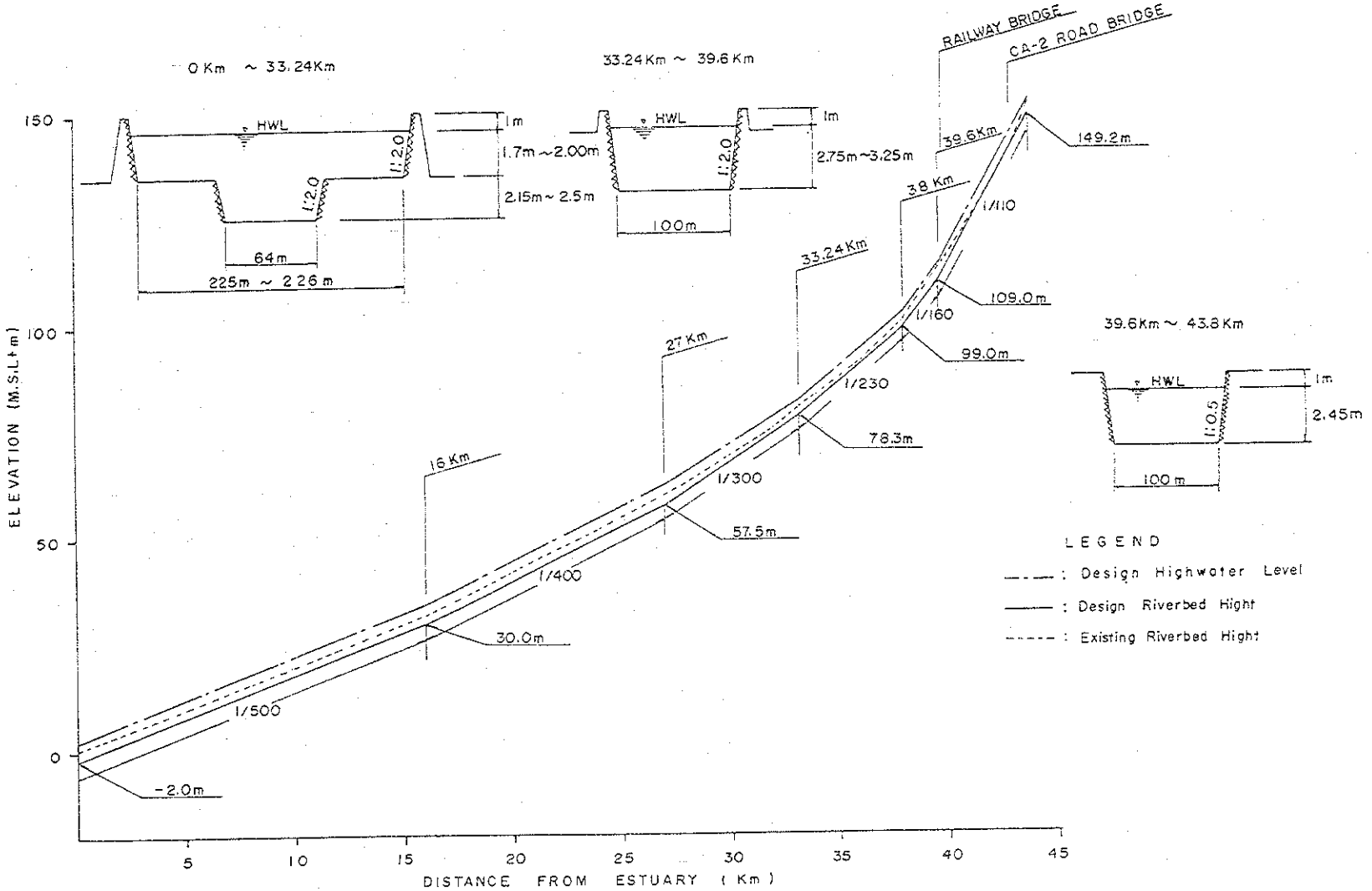


図　5－4 (1/2) 全川改修案縦断図（アチグァテ川）

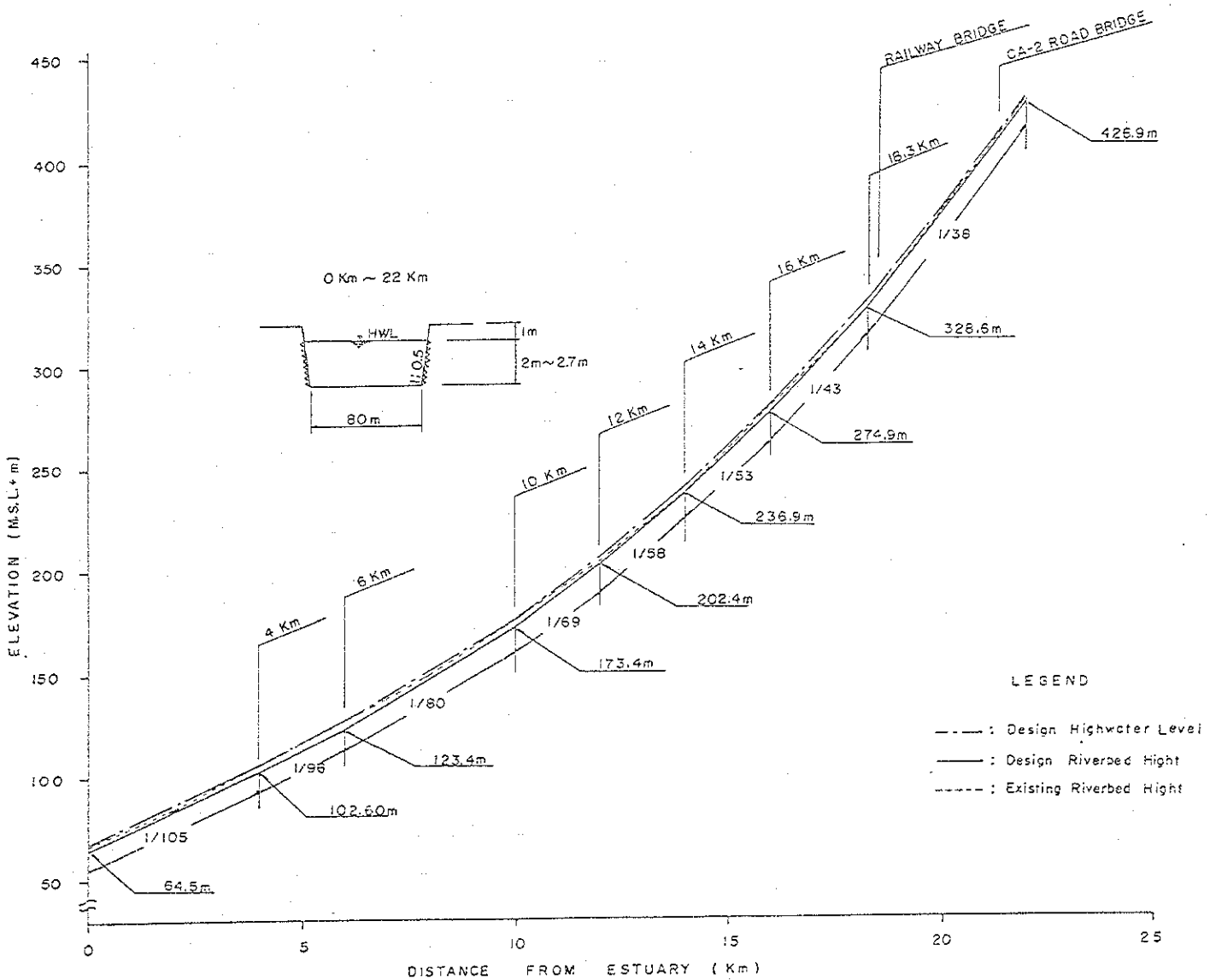


図　5－4 (2/2) 全川改修案縦断図（パンタレオン川）

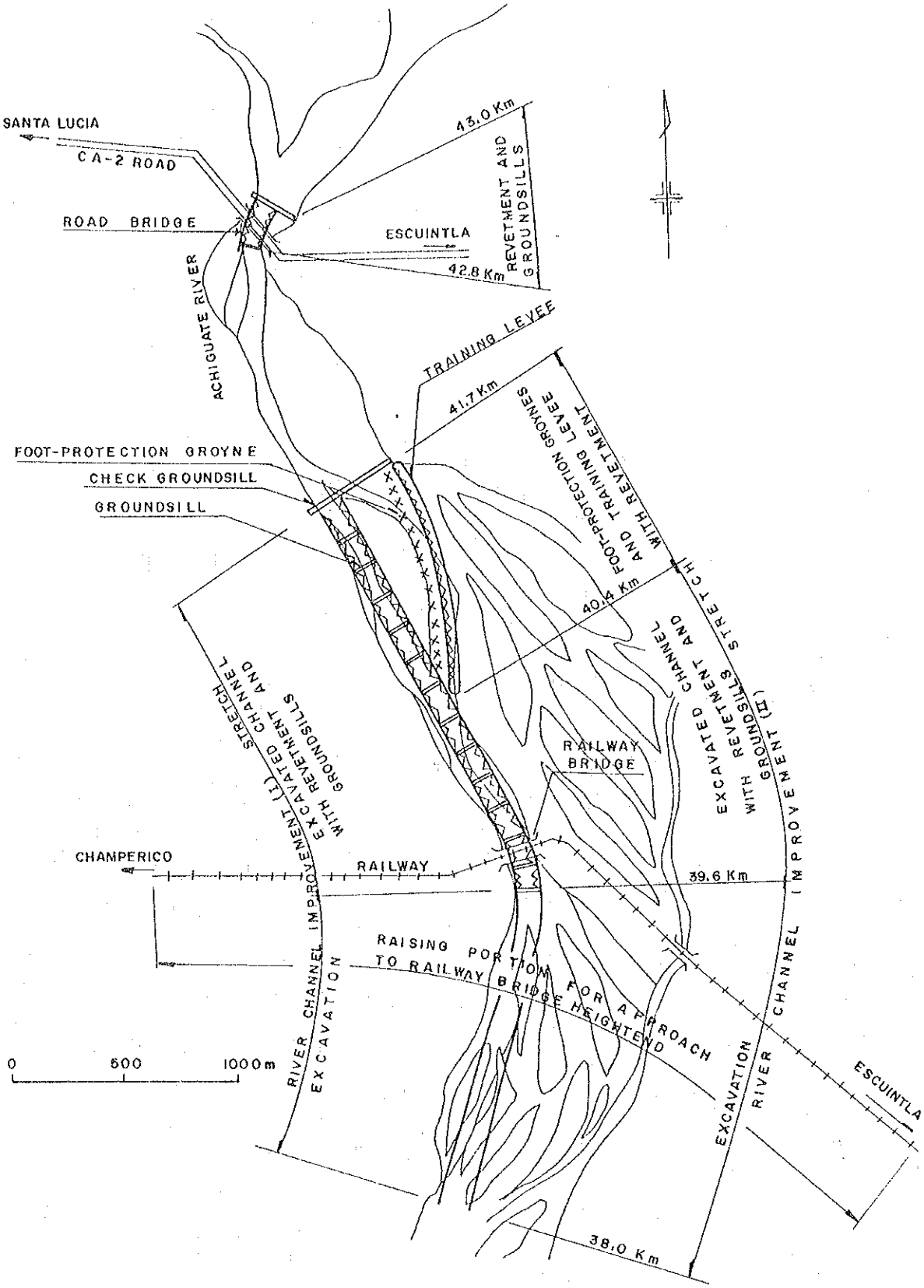


図　5－5 (1/4) 部分河川改修案（ケースII）比較検討図
（アチグァテ川：橋梁防御）

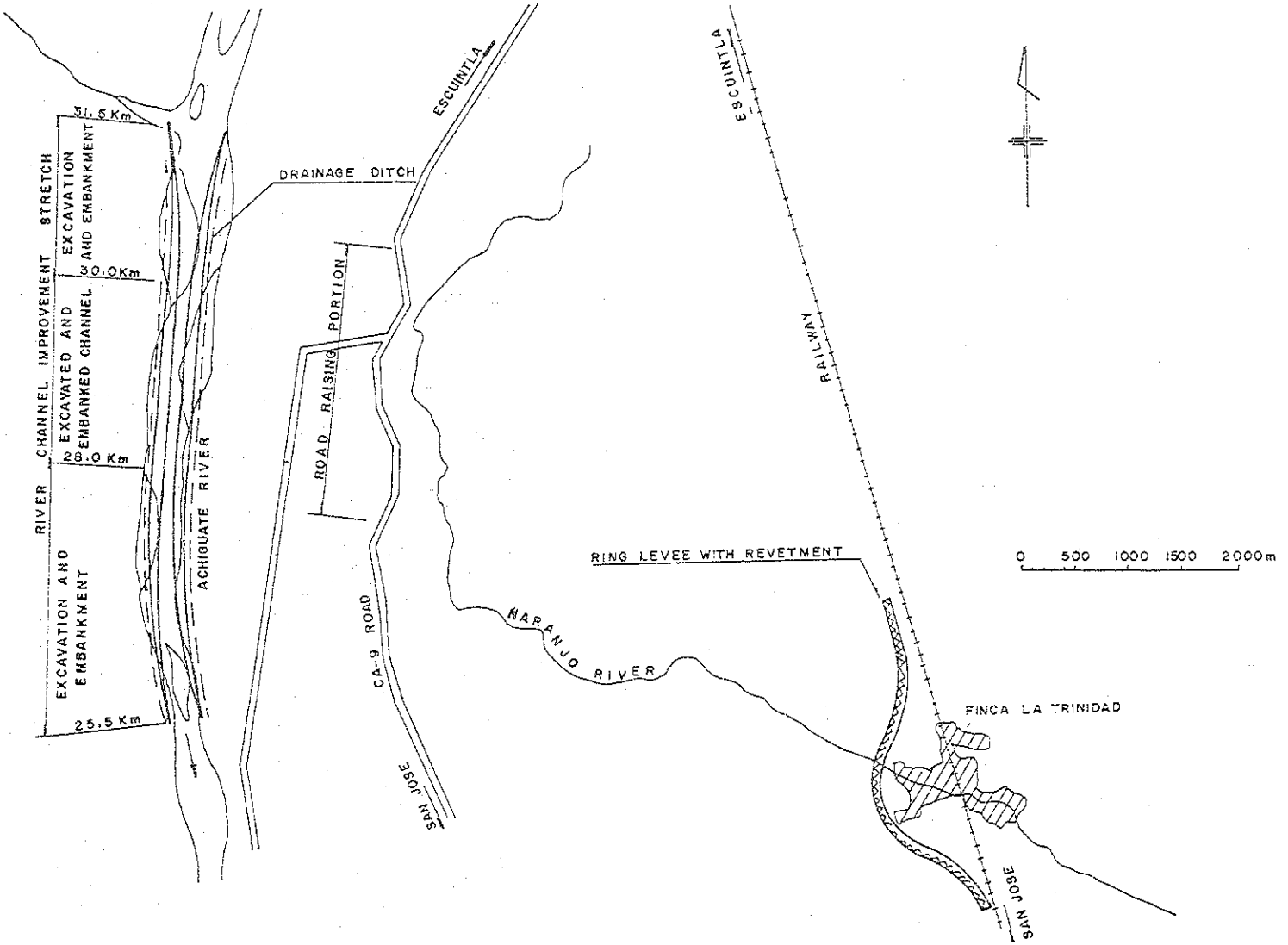


図　5－5 (2/4) 部分河川改修案（ケースⅡ）比較検討図
(アチグァテ川：フィンカラトリニダッド防御)

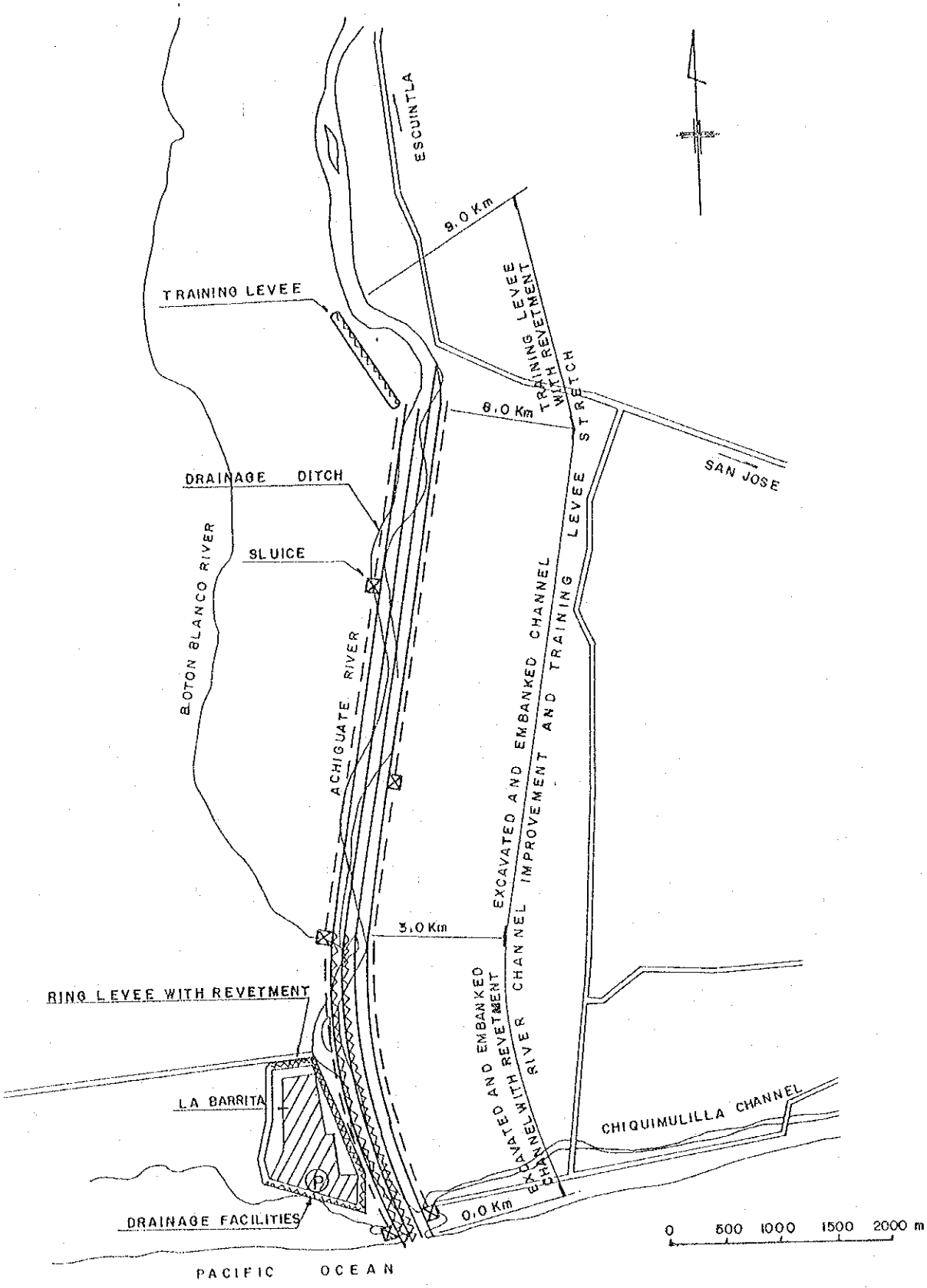


図　5－5(3/4) 部分河川改修案（ケースⅡ）比較検討図
(アチグァテ川：フィンカラバリタ防御)

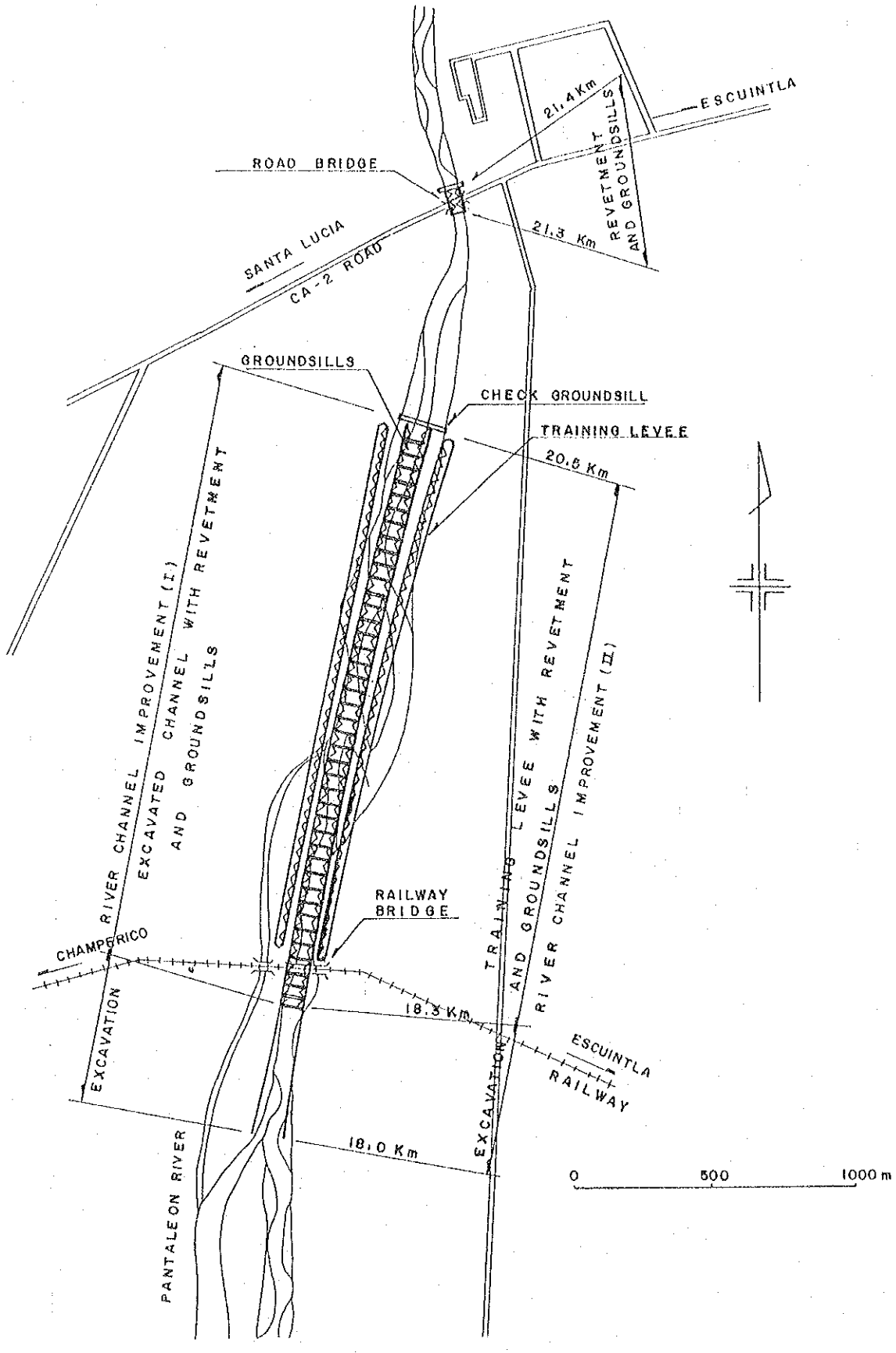
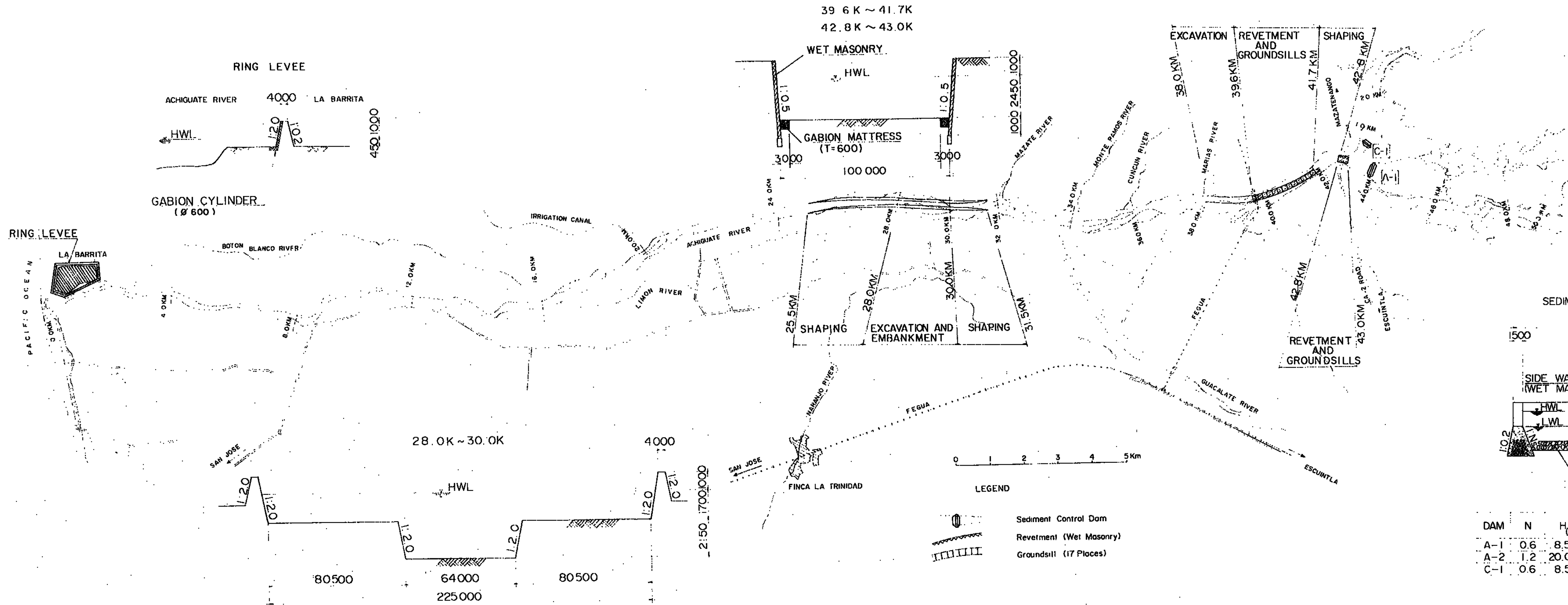
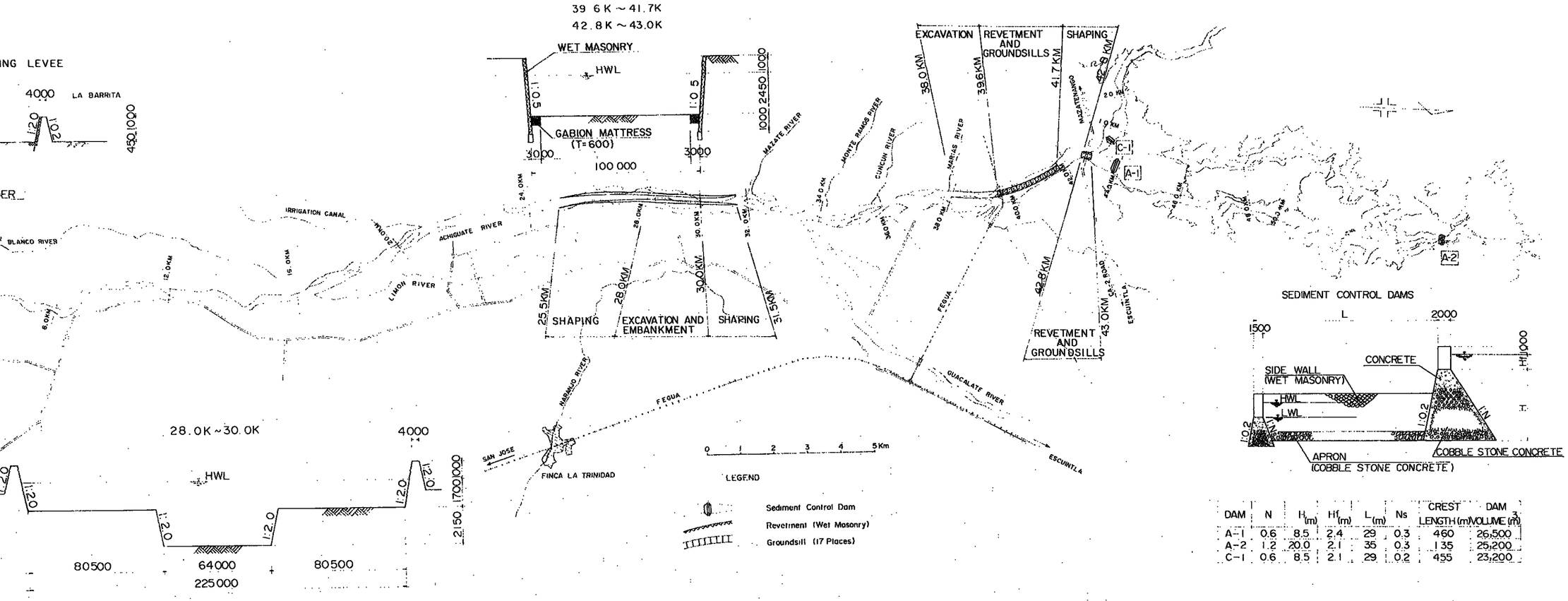


図　5－5 (4/4) 部分河川改修案（ケースII）比較検討図
(パンタレオン川：橋梁防御)



RING LEVEE
ACHIGUATE RIVER
4000
LA BARRITA
HWL
1:2.0
1:0.2
450 1000
GABION CYLINDER (Ø 600)
RING LEVEE
LA BARRITA
PACIFIC OCEAN
BOTON BLANCO RIVER
IRRIGATION CANAL
ACHIGUATE RIVER
LIMON RIVER
39.6K ~ 41.7K
42.8K ~ 43.0K
WET MASONRY
HWL
1:0.5
GABION MATTRESS (T=600)
3000
100 000
1000 2450 1000
SHAPING
EXCAVATION AND EMBANKMENT
25.5KM
28.0KM
30.0KM
31.5KM
MAZATE RIVER
MONTE RAMOS RIVER
CUNCUN RIVER
MARIAS RIVER
MAZATENANGO
EXCAVATION
REVETMENT AND GROUNDSILLS
38.0KM
39.6KM
41.7KM
42.8KM
43.0KM
C-1
A-1
REVETMENT AND GROUNDSILLS
ESCUINTLA
FEGUA
GUACALATE RIVER
NARANJO RIVER
FINCA LA TRINIDAD
SAN JOSE
28.0K ~ 30.0K
4000
HWL
1:2.0
80500
64000
225000
2150 1700 1000
0 1 2 3 4 5Km
LEGEND
Sediment Control Dam
Revetment (Wet Masonry)
Groundsill (17 Places)
SIDE WA
HWL
LWL
1500
DAM N H
A-1 0.6 8.5
A-2 1.2 20.0
C-1 0.6 8.5



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

図　5－6 (1/2)　長期計画最適案平面図
（アチグァテ川）