are estimated in Table B.5. The arrangements of facilities of these establishments might be considered to be unchanged since it is so difficult to rearrange these facilities when they are once constructed. Although some minor change of the arrangement may be likely to occur, the present situation as for the general plant layout can be possibly unchanged.

Regarding change of residences in Sabo sub-basin 9 and 12, the number of housing units is likely to increase in the future. However, the probable damage from residences or project benefits are so small, comparing with damage from industrial establishments and/or traffic interruption of the state highway. Taking this situation into consideration, the number of residences is assumed to be the same as under the present conditions.

Value of damageable properties for residence and manufacturing establishment is assumed to increase in accordance with assumptions explained in section 4.1.

4.3.2 Probable future sediment run-off damage

In the same manner applied to the estimation of probable flood damage, project benefits to be mitigated by the implementation of the preventive measures are estimated, based on the simulation of the present sediment run-off damage. Taking the change of damageable properties up to the year 2020, the probable future sediment run-off damages are enumerated in Table B.12, and summarized below for Sabo sub-basin 2, 3, 7 and 10 which are considered to bring about enormous social impact on society.

Probable Sediment Run-off Damage in Future

(Unit: Cr$ million)

Year	Sabo Sub-basin	Return Period 25	50	100
	2	398.9	466.1	513.6
	3	303.3	411.0	538.8
	7	240.9	309.0	420.9
1990	8	38.3	38.9	39.5
	10	37.4	91.0	123.8
	11	145.2	180.7	204.4
	12	200.1	572.9	758.4
	2	536.1	626.3	690.2
	3	407.6	552.3	724.1
	7	323.7	415.3	565.6
2000	8	51.4	52.2	53.0
	10	50.2	122.3	166.4
	11	195.1	242.8	274.7
	12	264.0	760.4	1,006.1
	2	653.5	763.5	841.4
	3	496.9	673.3	882.7
	7	394.6	506.2	689.5
2010	8	62.7	63.6	64.6
	10	61.2	149.1	202.8
	11	237.9	296.0	334.9
	12	320.3	924.0	1,222.4
	2	796.6	930.7	1,025.7
	3	605.7	820.8	1,076.0
	7	481.1	617.1	840.4
2020	8	76.4	77.6	78.8
	10	74.6	181.7	247.2
	11	290.0	360.9	408.2
	12	387.5	1,120.6	1,482.1

TABLES

TABLE B.1 PROBABLE INUNDATION UNDER PRESENT CONDITION IN CUBATÃO RIVER BASIN BY FLOOD RUN-OFF ANALYSIS

Mesh No.	Return Period					
	2	5	10	25	50	100
1	-	-	-	-	0.8	1.4
2	-	-	-	-	0.3	0.9
3	-	-	-	0.3	0.8	1.1
4	-	-	-	0.3	0.7	0.9
5	-	-	-	-	0.4	0.8
6	-	-	-	-	-	0.2
7	-	-	0.3	1.4	1.9	2.2
8	-	-	0.5	0.9	1.3	1.6
9	-	-	-	-	-	0.4
10	-	-	-	-	-	0.7
11	-	-	-	-	-	-
12	-	-	-	-	-	-
13	-	-	-	0.3	0.6	0.9
14	-	-	0.4	1.1	1.4	1.7
15	-	-	-	0.1	-	0.1
16	-	-	-	-	-	0.3
17	-	-	-	0.5	0.9	1.1
18	-	-	-	-	-	-
19	-	-	-	-	-	-
20	-	-	0.3	0.3	0.3	0.3
21	-	-	0.3	0.3	0.3	0.4
22	-	0.1	0.4	0.9	1.2	1.4
23	-	0.2	0.6	1.2	1.5	1.7
24	-	0.8	1.3	1.9	2.3	2.5
25	-	0.9	1.3	1.9	2.2	2.5
26	-	0.4	0.5	0.8	1.0	1.2
27	-	0.3	0.5	0.6	0.6	0.7
28	-	0.2	0.1	0.1	0.1	-
29	-	0.3	0.7	1.0	1.3	1.5
30	-	0.3	0.4	0.5	0.7	0.9
31	-	0.8	1.1	1.6	1.9	2.1
32	-	0.7	1.0	1.5	1.8	2.1
33	-	0.8	1.2	1.8	2.2	2.4
34	-	0.7	1.1	1.7	2.0	2.3
35	-	-	0.3	0.8	1.0	1.2
36	0.8	1.2	1.4	1.4	1.5	1.5
37	-	-	0.4	0.7	0.9	1.1
38	0.3	0.9	1.3	1.6	1.9	2.1
39	0.5	1.4	1.8	2.1	2.4	2.5
40	0.1	0.9	1.3	1.6	1.9	2.1
41	-	0.3	0.6	1.1	1.4	1.6
42	-	-	-	-	-	-
43	-	-	-	-	-	-
44	0.5	1.1	1.5	1.8	2.0	2.2
45	0.1	1.0	1.4	1.7	1.9	2.1
46	-	1.0	1.3	1.7	1.9	2.1
47	0.1	0.8	1.1	1.4	1.6	1.8
48	-	-	-	-	0.1	0.4

Remarks: Simulated by run-off simulation model applying non-uniform flow calculation method.

TABLE B.2 PROBABLE INUNDATION UNDER PRESENT CONDITION IN MOJI RIVER BASIN BY FLOOD RUN-OFF ANALYSIS

Mesh No.	Return Period					
	2	5	10	25	50	100
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	0.4	0.8	0.9	1.0	1.1	1.4
4	0.4	0.7	0.9	1.2	1.4	1.7
5	0.3	1.1	1.4	1.7	1.9	2.2
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	0.5	0.6	0.7	0.6	0.6	0.6
9	0.5	0.7	0.7	0.9	1.1	1.3
10	0.6	1.0	1.2	1.4	1.5	1.7
11	0.5	0.9	1.1	1.3	1.4	1.6
12	-	-	-	-	0.1	0.3
13	0.1	0.5	0.5	0.6	0.6	0.6
14	-	0.3	0.3	0.1	0.3	0.3
15	-	0.5	0.7	0.8	0.8	0.8
16	-	-	-	0.2	0.4	0.6
17	0.5	0.8	1.0	1.2	1.4	1.6
18	0.3	0.7	0.9	1.1	1.2	1.4
19	-	1.0	1.3	1.5	1.6	1.8
20	-	0.3	0.3	0.4	0.4	0.5
21	0.2	0.4	0.6	0.7	0.8	0.8
22	0.1	0.4	0.4	0.5	0.6	0.7
23	0.3	0.6	0.6	0.7	0.7	0.8
24	0.7	1.5	1.8	1.9	1.9	2.0
25	-	-	-	-	-	-
26	-	-	-	-	-	-
27	0.6	0.9	1.0	1.2	1.3	1.4
28	0.8	1.2	1.2	1.3	1.5	1.6
29	0.9	1.3	1.4	1.5	1.6	1.7
30	-	-	-	-	-	-
31	-	-	-	-	-	-
32	-	-	-	-	-	-

Remarks: Simulated by run-off simulation model applying non-uniform flow calculation method.

TABLE B.3 POPULATION AND DAMAGEABLE PROPERTIES IN FLOOD PROTECTION AREAS

Item	River Basin		Total
	Cubatao	Moji	
(1) Population	35,147	1,370	36,517
(2) Building			
1. Residence	8,400	250	8,650
2. Commercial & Services establishment	420	10	430
3. Industrial establishment			
- Major establishment	6	9	15
- Others	90	-	90

Remarks: Number of buldings regarding residence are estimated from the population data compiled by the Cubatao municipality and hearing survey.

Table B.4 PROBABLE INUNDATION WITH RIVER IMPROVEMENT IN MOJI RIVER BASIN BY FLOOD RUN-OFF ANALYSIS

Unit:m

Mesh No.	Return Period					
	2	5	10	25	50	100
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	0.3	0.4	0.5	0.7	0.8	0.8
4	-	0.4	0.5	0.7	0.9	1.0
5	-	0.5	0.6	1.1	1.3	1.5
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	0.5	0.6	0.7	0.7	0.7	0.7
9	0.5	0.7	0.6	0.8	0.9	0.9
10	0.6	0.6	0.7	0.9	1.1	1.2
11	0.4	0.5	0.6	0.8	1.0	1.1
12	-	-	-	-	-	-
13	0.1	0.4	0.4	0.5	0.5	0.6
14	-	0.1	0.1	0.1	0.3	0.3
15	0.1	0.4	0.6	0.5	0.6	0.7
16	-	-	-	-	-	-
17	0.3	0.4	0.5	0.7	0.9	1.0
18	-	0.3	0.4	0.6	0.8	0.9
19	-	-	0.7	1.0	1.2	1.3
20	-	-	0.2	0.3	0.4	0.4
21	-	-	-	0.2	0.4	0.4
22	-	-	-	-	0.3	0.5
23	-	-	-	0.3	0.2	0.3
24	-	0.4	0.5	0.8	1.4	1.4
25	-	-	-	-	-	-
26	-	-	-	-	-	-
27	-	-	-	0.6	0.7	0.7
28	-	-	-	0.8	1.0	1.2
29	-	-	-	0.8	1.0	1.2
30	-	-	-	-	-	-
31	-	-	-	-	-	-
32	-	-	-	-	-	-

Remarks: Simulated by run-off simulation model applying non-uniform flow calculation method.

TABLE B.5 AVERAGE ASSET HOLDINGS OF MANUFACTURING ESTABLISHMENTS BY TYPE OF INDUSTRY IN SÃO PAULO

(Unit: Cr$ million/Establishment)

Industrial Type	1980				1990 *			
	Fixed Assets		Inventory Stock	Total Assets	Fixed Assets		Inventory Stock	Total Assets
	Tangible Assets	Intangible Assete			Tangible Assets	Intangible Assets		
Mining	11.0	-	0.3	11.3	13.7	0.0	0.4	14.2
Non-metal Products	6.7	0.5	1.3	8.4	8.4	0.6	1.6	10.5
Metallurgy	28.5	0.8	7.3	36.4	35.7	1.0	9.2	45.9
Machinery	23.9	0.7	10.0	34.6	29.9	0.8	12.5	43.3
Eletric & Communication Products	23.1	0.5	18.7	42.3	28.9	0.6	23.5	53.0
Vehicle	40.3	0.5	30.1	70.9	50.4	0.6	37.8	88.7
Timber	3.8	0.2	1.3	5.4	4.8	0.3	1.6	6.7
Furniture	3.8	0.1	1.6	5.6	4.8	0.1	2.0	7.0
Paper	39.6	0.6	9.5	49.7	49.6	0.8	11.8	62.2
Rubber	29.8	0.4	10.4	40.6	37.3	0.4	13.1	50.8
Leather	7.8	0.2	0.9	8.9	9.8	0.2	1.1	11.1
Chemistry	97.9	2.8	62.3	163.0	122.7	3.4	78.0	204.0
Medicine	49.2	3.2	42.8	95.2	61.7	4.0	53.6	119.3
Soap and Perfume	21.0	0.2	0.9	30.1	26.3	0.2	11.3	37.8
Plastic Products	15.6	0.3	5.7	21.6	19.6	0.4	7.2	27.1
Textile	17.9	0.4	8.9	27.1	22.4	0.5	11.1	34.0
Clothing	2.9	0.1	1.5	4.6	3.7	0.2	1.9	5.7
Food Products	8.5	0.3	4.0	12.8	10.7	0.3	5.1	16.1
Beverage	23.7	1.0	5.0	29.6	29.7	1.2	6.2	37.0
Tobacco	207.6	0.2	0.3	208.0	259.9	0.2	0.3	260.4
Printing	6.3	0.2	1.8	8.3	7.9	0.3	2.2	10.4
Other Manufacturing	44.7	1.6	8.9	55.2	56.0	2.0	11.2	69.1
Average	16.4	2.1	6.9	25.4	20.6	2.6	8.6	31.8

Source: Censos Industrial, Sao Paulo, 1980: IBGE

Remarks: * Estimated from the price index of May 1990 based on that in 1980.
** Brazilian currency Cruzeiro in 1980 was converted into the current currency Cruzeiro on March 16, 1990 with denomination rate of 1/over one million.

TABLE B.6 ESTIMATION OF ASSET HOLDINGS OF MAJOR INDUSTRIAL ESTABLISHMENTS IN CUBATÃO : 1990

(Unit: Cr$ million)

Establishment	Fixed Assets		Inventory Stock	Total	Damageable Properties		
	Tangible Assets	Intangible Assets			Depreciable Assets	Inventory Stock	Total
ADUBOS TREVO	1301.2	199.8	758.8	2060.0	1296.6	758.5	1473.9
ALBA QUIMICA	304.0	46.7	177.3	528.0	294.3	177.3	471.6
CARBOCLORO	1104.8	169.6	644.3	1918.7	1067.5	644.3	1711.8
CIMENTO SANTA RITA	374.9	73.2	75.3	426.0	369.2	75.3	444.5
ESTIRENO	926.8	142.3	540.5	1609.5	922.9	540.5	1463.4
CIA SANTISTA DE PAPEL	804.2	75.1	191.2	1070.5	576.2	191.2	767.4
COSIPA	9487.7	1917.9	2438.5	13844.1	9092.1	2438.5	11530.6
COPEBRAS	2698.9	414.4	1573.9	4687.2	1856.3	1573.9	3430.2
ELETROPAULO	833.0	167.0	483.7	1483.7	583.0	483.7	1066.7
ENGEBASA	65.1	12.4	13.0	90.5	63.8	13.0	76.8
ENGECLOR	40.8	6.3	23.8	50.9	403.8	23.8	427.6
GESPA	48.1	9.1	9.6	66.8	47.1	9.6	56.7
INDAG	1004.6	154.3	585.9	1744.8	984.0	585.9	1569.9
LIQUID CARBONIC	14.8	2.3	8.7	25.8	13.5	8.7	22.2
LIQUID QUIMICA	26.0	4.0	15.1	45.1	25.5	15.1	40.6
MANAH	616.4	94.5	358.9	848.8	606.9	358.9	965.8
PETROBRAS	9268.1	1423.0	5404.8	16095.7	9080.0	5404.6	14484.6
PETROCOQUE	474.5	72.9	276.7	547.4	471.3	276.7	678.0
RHODIA	103.8	15.9	60.5	180.2	100.1	60.5	160.6
SOLORRICO	26.0	4.0	15.1	45.1	23.1	15.1	38.2
TITANOR	40.8	6.3	23.8	70.9	40.5	23.8	64.3
ULTRAFERTIL	1089.9	167.4	635.6	1892.9	956.2	635.6	1591.8
UNION CARBIDE	1178.9	181.0	687.5	2047.4	1132.4	687.5	1819.9

Remarks: Estimated from the production value in the past, average asset holdings of manufacturing establishments in Sao Paulo in Table B-5, and the price index of May 1990 based on that in 1980.

TABLE B.7 AVERAGE ASSET HOLDINGS OF COMMERCIAL AND SERVICES ESTABLISHMENTS IN SÃO PAULO

(Unit: Cr$ 1,000/Establishment)

Industrial Type	1980				1990 *			
	Fixed Assets		Inventory Stock	Total Assets	Fixed Assets		Inventry Stock	Total Assets
	Tangible Assets	Intangible Assets			Tangible Assets	Intangible Assets		
Commerce								
Retail	574.4	19.8	675.7	1,269.8	719.3	24.7	846.1	1,590.2
Wholesale	3,742.7	593.7	8,639.7	12,976.1	4,686.8	743.5	10,819.0	16,249.3
Services								
Hotel and Catering	439.1	3.9	41.3	484.3	549.9	4.8	51.7	606.5
Maintenance	255.3	2.6	30.4	288.3	319.7	3.2	38.0	361.0
Personal Care	171.7	0.6	79.9	252.2	215.1	0.7	100.0	315.8
Broadcasting	2,970.4	17.0	34.0	3,021.4	3,719.7	21.3	42.5	3,783.6
Other Services	3,610.4	6,528.5	40.5	10,179.5	4,521.1	8,175.3	50.8	12,747.2
Average	873.2	585.0	678.0	2,136.2	1,093.5	732.5	849.0	2,675.1

Source: Censo Commercial, 1984: IBGE
Censo dos Services, 1984: IBGE

Remarks: * Estimated from the price index of May 1990 based on that in 1980.
** Brazilian currency Cruzeiro in 1980 was converted into the current currency Cruzeiro on March 16, 1990 with denomination rate of 1/over one million.

TABLE B.8 FLOOD DAMAGE RATE

Item	Below floor level	More than floor level				
		Less than 0.5m	0.5-0.99m	1.0-1.99m	2.0-2.99m	More than 3.0m
1. Residence*1						
- Building (Housing Unit)	0.030	0.053	0.072	0.109	0.152	0.220
- Household Effects	-	0.086	0.191	0.331	0.499	0.690
2. Industrial and Service Establishment						
- Depreciable Assets	-	0.180	0.314	0.419	0.539	0.632
- Inventory Stock	-	0.127	0.276	0.379	0.479	0.562

Source: Summary of Economic Research on Flood Control, Ministry of Construction, Japan.

Remarks: *1 In areas with slope of less than 1/1,000.

TABLE B.9 PROBABLE FLOOD DAMAGE UNDER PRESENT CONDITION

(1) CUBATAO RIVER BASIN

(Unit : Cr$ million)

ITEM	RETURN PERIOD					
	2	5	10	25	50	100
DIRECT DAMAGES						
Damageable Properties						
(1) Residence						
- House	15.9	20.3	27.0	49.0	72.4	86.0
- Household effects	13.6	22.1	33.3	62.1	95.8	114.8
Sub-total (1)	29.5	42.4	60.3	111.1	168.2	200.8
(2) Commercial & Services						
- Depreciable assets	2.2	3.8	5.6	8.2	12.5	16.6
- Inventry stocks	1.8	3.6	5.5	8.1	12.1	16.0
Sub-total (2)	4.0	7.4	11.1	16.3	24.6	32.6
(3) Industry						
1) Major Industries						
- Depreciable assets	6.7	14.5	22.1	29.7	45.9	48.6
- Inventry stocks	3.4	6.8	8.4	16.0	27.9	30.9
Sub-total (3)	10.1	21.3	30.5	45.7	73.8	79.5
2) Other Industries						
- Depreciable assets	4.9	8.5	11.8	22.1	33.7	40.4
- Inventry stocks	2.8	5.3	7.5	14.1	21.2	25.2
Sub-total (4)	7.7	13.8	19.3	36.2	54.9	65.6
Sub-total (3)+(4)	17.8	35.1	49.8	81.9	128.7	145.1
Total (5)	51.3	84.9	121.2	209.2	321.5	378.5
Infrastructure (25 % of 5)	12.8	21.2	30.3	52.3	80.4	94.6
Total (6)	64.1	106.1	151.5	261.6	401.9	473.1
INDIRECT DAMAGES (10% of 6)	6.4	10.6	15.1	26.2	40.2	47.3
Grand Total	70.5	116.7	166.6	287.7	442.1	520.4

(2) MOJI RIVER BASIN

(Unit : Cr$ million)

ITEM	RETURN PERIOD					
	2	5	10	25	50	100
DIRECT DAMAGES						
Damageable Properties						
(1) Residence						
- House	1.4	1.9	2.3	1.9	3.0	3.0
- Household effects	1.4	2.1	2.7	3.5	3.8	5.3
Sub-total (1)	2.8	4.0	5.0	5.4	6.8	8.3
(2) Commercial & Services						
- Depreciable assets	0.8	1.2	1.5	1.7	1.9	2.5
- Inventry stocks	0.7	1.2	1.5	1.7	1.8	2.5
Sub-total (2)	1.5	2.4	2.9	3.4	3.7	5.0
(3) Industry						
Major Industries						
- Depreciable assets	30.4	42.4	66.3	76.6	84.5	94.0
- Inventry stocks	10.9	23.9	35.6	39.4	50.4	56.1
Sub-total (3)	41.3	66.3	101.9	116.0	134.9	150.1
Total (4)	45.6	72.7	109.8	124.8	145.4	163.4
Infrastructure (15 % of 5)	6.8	10.9	16.5	18.7	21.8	24.5
Total (6)	52.4	83.6	126.2	143.5	167.2	187.9
INDIRECT DAMAGES (10% of 6)	5.2	8.4	12.6	14.4	16.7	18.8
Grand Total	57.6	92.0	138.9	157.9	183.9	206.7

TABLE B.10 PROBABLE FLOOD DAMAGE WITH RIVER IMPROVEMENT IN MOJI RIVER BASIN

(Unit : Cr$ million)

ITEM	RETURN PERIOD					
	2	5	10	25	50	100
DIRECT DAMAGES						
Damageable Properties						
(1) Residence						
- House	0.5	0.6	0.8	0.6	1.0	1.0
- Household effects	0.5	0.7	0.9	1.2	1.3	1.8
Sub-total (1)	1.0	1.3	1.7	1.8	2.3	2.8
(2) Commercial & Services						
- Depreciable assets	0.2	0.3	0.3	0.4	0.4	0.5
- Inventry stocks	0.1	0.2	0.3	0.3	0.4	0.5
Sub-total (2)	0.3	0.5	0.6	0.7	0.8	1.0
(3) Industry						
Major Industries						
- Depreciable assets	36.3	50.1	65.8	71.8	76.0	81.2
- Inventry stocks	13.0	28.2	35.4	37.0	45.3	48.5
Sub-total (3)	49.3	78.3	101.2	108.8	121.3	129.7
Total (4)	50.6	80.2	103.4	111.3	124.4	133.5
Infrastructure (15 % of 5)	7.6	12.0	15.5	16.7	18.7	20.0
Total (6)	58.2	92.2	119.0	128.0	143.0	153.5
INDIRECT DAMAGES (10% of 6)	5.8	9.1	11.9	12.8	14.4	15.4
Grand Total	64.0	101.3	130.9	140.8	157.4	168.9

TABLE B.11 DESIGN SEDIMENT RUN-OFF DISCHARGE

No.	Sabo Sub-basin Area (sq.km)	Return Period 5 Discharge (cu.m)	5 Area (sq.m)	25 Discharge (cu.m)	25 Area (sq.m)	50 Discharge (cu.m)	50 Area (sq.m)	100 Discharge (cu.m)	100 Area (sq.m)	Target Properties
1	2.39	-		-		-		(155,500)		ULTRAFERTIL
2	3.79	77,600	120,500	124,200	170,000	142,900	196,000	159,400	251,000	COPEBRAS
3	1.29	56,400	43,750	87,100	107,750	99,000	145,000	109,400	199,000	COPEBRAS
4	8.42	72,900	41,500	119,800	52,000	139,900	59,500	158,700	65,750	-
5	0.90	19,100	36,250	30,200	82,000	34,600	101,500	38,700	130,000	-
6	1.73	38,400	36,000	62,100	97,500	71,600	160,000	80,100	198,500	UNION CARBIDE
7	2.64	83,000	64,750	130,500	186,750	149,800	241,000	166,600	303,500	PETROBRAS
8	0.41	7,500	11,750	11,800	27,500	13,600	44,000	15,200	67,000	PETROBRAS
9	0.17	13,700	16,000	21,800	24,500	24,900	35,500	27,700	55,500	Residence
10	1.26	18,700	12,750	29,400	23,750	33,700	35,250	37,700	37,500	ELETROPAULO
11	0.62	13,000	16,250	20,400	28,500	23,400	42,500	26,100	57,000	ELETROPAULO
12	1.11	24,500	34,000	37,300	66,500	42,500	78,000	46,800	115,500	Residence/SP-150

Source: Estimated from the study results by the study team and part agency.

TABLE B.12 PROBABLE SEDIMENT RUN-OFF DAMAGE UNDER PRESENT CONDITION (1/4)

(1) SABO BASIN-02

(Unit : Cr$ million)

ITEM	RETURN PERIOD 5	25	50	100
DIRECT DAMAGES				
Damageable Properties				
Residence	0.0	0.0	0.0	0.0
Industry	35.8	234.9	275.0	302.5
Sub-total (A)	35.8	234.9	275.0	302.5
Restoration Activity	19.4	31.1	35.7	39.9
Sub-total (B)	55.2	266.0	310.7	342.4
Infrastructure (0 % of A)	0.0	0.0	0.0	0.0
Total (C)	55.2	266.0	310.7	342.4
INDIRECT DAMAGES (50% of C)	27.6	133.0	155.4	171.2
Grand total	82.8	398.9	466.1	513.6

(2) SABO BASIN-03

(Unit : Cr$ million)

ITEM	RETURN PERIOD 5	25	50	100
DIRECT DAMAGES				
Damageable Properties				
Residence	0.0	0.0	0.0	0.0
Industry	0.0	180.4	249.2	332.0
Sub-total (A)	0.0	180.4	249.2	332.0
Restoration Activity	14.1	21.8	24.8	27.2
Sub-total (B)	14.1	202.2	274.0	359.2
Infrastructure (0 % of A)	0.0	0.0	0.0	0.0
Total (C)	14.1	202.2	274.0	359.2
INDIRECT DAMAGES (50% of C)	7.1	101.1	137.0	179.6
Grand total	21.2	303.3	411.0	538.8

(3) SABO BASIN-04

(Unit : Cr$ million)

ITEM	RETURN PERIOD 5	25	50	100
DIRECT DAMAGES				
Damageable Properties				
Residence	0.0	0.0	0.0	0.0
Industry	0.0	0.0	0.0	0.0
Sub-total (A)	0.0	0.0	0.0	0.0
Restoration Activity	24.8	40.9	47.7	54.2
Sub-total (B)	24.8	40.9	47.7	54.2
Infrastructure (0 % of A)	0.0	0.0	0.0	0.0
Total (C)	24.8	40.9	47.7	54.2
INDIRECT DAMAGES (10 % of C)	2.5	4.1	4.8	5.4
Grand total	27.3	45.0	52.5	59.6

TABLE B.12 PROBABLE SEDIMENT RUN-OFF DAMAGE UNDER PRESENT CONDITION (2/4)

(4) SABO BASIN-05

(Unit : Cr$ million)

ITEM	RETURN PERIOD			
	5	25	50	100
DIRECT DAMAGES				
Damageable Properties				
Residence	0.0	0.0	0.0	0.0
Industry	0.0	0.0	0.0	0.0
Sub-total (A)	0.0	0.0	0.0	0.0
Restoration Activity	6.5	10.4	11.9	13.3
Sub-total (B)	6.5	10.4	11.9	13.3
Infrastructure (0 % of A)	0.0	0.0	0.0	0.0
Total (C)	6.5	10.4	11.9	13.3
INDIRECT DAMAGES (10 % of C)	0.7	1.0	1.2	1.3
Grand total	7.2	11.4	13.1	14.6

(5) SABO BASIN-06

(Unit : Cr$ million)

ITEM	RETURN PERIOD			
	5	25	50	100
DIRECT DAMAGES				
Damageable Properties				
Residence	0.0	0.0	0.0	0.0
Industry	0.0	0.0	0.0	0.0
Sub-total (A)	0.0	0.0	0.0	0.0
Restoration Activity	13.1	21.2	24.5	68.8
Sub-total (B)	13.1	21.2	24.5	68.8
Infrastructure (0 % of A)	0.0	0.0	0.0	0.0
Total (C)	13.1	21.2	24.5	68.8
INDIRECT DAMAGES (10 % of C)	1.3	2.1	2.4	6.9
Grand total	14.4	23.3	26.9	75.7

(6) SABO BASIN-07

(Unit : Cr$ million)

ITEM	RETURN PERIOD			
	5	25	50	100
DIRECT DAMAGES				
Damageable Properties				
Residence	0.0	0.0	0.0	0.0
Industry	64.0	128.0	168.5	238.9
Sub-total (A)	64.0	128.0	168.5	238.9
Restoration Activity	20.8	32.6	37.5	41.7
Sub-total (B)	84.8	160.6	206.0	280.6
Infrastructure (0 % of A)	0.0	0.0	0.0	0.0
Total (C)	84.8	160.6	206.0	280.6
INDIRECT DAMAGES (10% of C)	42.4	80.3	103.0	140.3
Grand total	127.2	240.9	309.0	420.9

TABLE B.12 PROBABLE SEDIMENT RUN-OFF DAMAGE UNDER PRESENT CONDITION (3/4)

(7) SABO BASIN-08

(Unit : Cr$ million)

ITEM	RETURN PERIOD			
	5	25	50	100
DIRECT DAMAGES				
Damageable Properties				
Residence	0.0	0.0	0.0	0.0
Industry	28.3	33.8	45.0	56.3
Sub-total (A)	28.3	33.8	45.0	56.3
Restoration Activity	1.9	3.0	3.4	3.8
Sub-total (B)	30.2	36.8	48.4	60.1
Infrastructure (0 % of A)	0.0	0.0	0.0	0.0
Total (C)	30.2	36.8	48.4	60.1
INDIRECT DAMAGES (50% of C)	15.1	18.4	24.2	30.0
Grand total	45.4	55.1	72.6	90.1

(8) SABO BASIN-09

(Unit : Cr$ million)

ITEM	RETURN PERIOD			
	5	25	50	100
DIRECT DAMAGES				
Damageable Properties				
Residence	4.3	42.0	56.2	94.0
Industry	0.0	0.0	0.0	0.0
Sub-total (A)	4.3	42.0	56.2	94.0
Restoration Activity	5.1	8.3	9.3	10.4
Sub-total (B)	9.4	50.3	65.5	104.4
Infrastructure (0 % of A)	0.0	0.0	0.0	0.0
Total (C)	9.4	50.3	65.5	104.4
INDIRECT DAMAGES (10 % of C)	0.9	5.0	6.6	10.4
Grand total	10.3	55.3	72.1	114.8

(9) SABO BASIN-10

(Unit : Cr$ million)

ITEM	RETURN PERIOD			
	5	25	50	100
DIRECT DAMAGES				
Damageable Properties				
Residence	0.0	0.0	0.0	0.0
Industry	0.0	11.3	37.1	49.5
Sub-total (A)	0.0	11.3	37.1	49.5
Restoration Activity	4.7	7.4	8.4	12.4
Sub-total (B)	4.7	18.7	45.5	61.9
Infrastructure (0 % of A)	0.0	0.0	0.0	0.0
Total (C)	4.7	18.7	45.5	61.9
INDIRECT DAMAGES (100% of C)	4.7	18.7	45.5	61.9
Grand total	9.4	37.4	91.0	123.8

TABLE B.12 PROBABLE SEDIMENT RUN-OFF DAMAGE UNDER PRESENT CONDITION (4/4)

(10) SABO BASIN-11

(Unit : Cr$ million)

ITEM	RETURN PERIOD			
	5	25	50	100
DIRECT DAMAGES				
Damageable Properties				
Residence	0.0	0.0	0.0	0.0
Industry	45.0	67.5	84.5	95.7
Sub-total (A)	45.0	67.5	84.5	95.7
Restoration Activity	3.3	5.1	5.9	6.5
Sub-total (B)	48.3	72.6	90.4	102.2
Infrastructure (0 % of A)	0.0	0.0	0.0	0.0
Total (C)	48.3	72.6	90.4	102.2
INDIRECT DAMAGES (100% of C)	48.3	72.6	90.4	102.2
Grand total	96.6	145.2	180.7	204.4

(11) SABO BASIN-12

(Unit : Cr$ million)

ITEM	RETURN PERIOD			
	5	25	50	100
DIRECT DAMAGES				
Damageable Properties				
Residence	6.4	23.9	46.1	63.6
Industry	0.5	3.6	7.2	8.1
Sub-total (A)	6.9	27.5	53.3	71.7
Restoration Activity	7.5	14.3	19.4	21.6
Sub-total (B)	14.4	41.8	72.7	93.3
Traffic Interruption	29.4	91.6	309.2	412.3
Total (C)	43.8	133.4	381.9	505.6
INDIRECT DAMAGES (50% of C)	21.9	66.7	191.0	252.8
Grand total	65.8	200.1	572.9	758.4

TABLE B.13 PROBABLE FLOOD DAMAGE UP TO YEAR 2020

(1) CUBATAO RIVER BASIN

(Unit : Cr$ million)

YEAR	RETURN PERIOD					
	2	5	10	25	50	100
1990	70.5	116.7	166.7	287.8	442.1	520.4
1991	72.2	119.6	170.7	294.7	452.8	533.0
1992	73.9	122.5	174.9	301.9	463.8	545.9
1993	75.6	125.5	179.2	309.2	475.0	559.1
1994	77.4	128.6	183.6	316.7	486.6	572.7
1995	79.3	131.8	188.2	324.4	498.5	586.6
1996	81.1	135.0	192.8	332.3	510.6	600.9
1997	83.1	138.4	197.6	340.3	523.1	615.5
1998	85.1	141.8	202.5	348.6	535.9	630.5
1999	87.1	145.3	207.5	357.1	549.0	645.9
2000	89.2	148.9	212.6	365.9	562.5	661.6
2001	90.8	151.7	216.6	372.6	572.9	673.9
2002	92.5	154.5	220.6	379.5	583.5	686.3
2003	94.2	157.4	224.7	386.5	594.3	699.0
2004	95.9	160.3	228.9	393.7	605.3	712.0
2005	97.7	163.3	233.1	401.0	616.5	725.1
2006	99.5	166.3	237.5	408.4	627.9	738.5
2007	101.3	169.4	241.9	415.9	639.5	752.2
2008	103.1	172.6	246.4	423.6	651.4	766.1
2009	105.0	175.8	251.0	431.5	663.5	780.3
2010	107.0	179.0	255.6	439.5	675.7	794.8
2011	107.9	180.9	258.4	443.9	682.7	802.8
2012	108.9	182.9	261.2	448.4	689.7	810.9
2013	110.0	184.9	264.0	453.0	696.9	819.3
2014	111.0	186.9	266.9	457.7	704.2	827.7
2015	112.1	189.0	269.9	462.5	711.7	836.4
2016	113.2	191.1	272.9	467.4	719.3	845.3
2017	114.3	193.3	276.0	472.3	727.1	854.3
2018	115.4	195.5	279.2	477.4	735.0	863.5
2019	116.5	197.7	282.4	482.6	743.1	872.8
2020	117.7	200.0	285.7	487.9	751.4	882.4

(2) MOJI RIVER BASIN

(Unit : Cr$ million)

YEAR	RETURN PERIOD					
	2	5	10	25	50	100
1990	57.6	92.0	138.9	157.9	183.9	206.7
1991	59.3	94.7	143.0	162.5	189.3	212.7
1992	61.1	97.5	147.2	167.3	194.9	219.0
1993	62.8	100.4	151.5	172.3	200.7	225.5
1994	64.7	103.3	156.0	177.4	206.6	232.1
1995	66.6	106.4	160.6	182.6	212.7	238.9
1996	68.5	109.5	165.4	188.0	219.0	246.0
1997	70.6	112.7	170.2	193.5	225.4	253.2
1998	72.6	116.0	175.3	199.3	232.1	260.7
1999	74.8	119.4	180.4	205.2	238.9	268.4
2000	77.0	123.0	185.8	211.2	246.0	276.3
2001	78.5	125.4	189.5	215.4	250.9	281.8
2002	80.0	127.9	193.2	219.7	255.9	287.4
2003	81.6	130.4	197.1	224.1	260.9	293.1
2004	83.2	133.0	201.0	228.5	266.1	298.9
2005	84.9	135.7	205.0	233.1	271.4	304.8
2006	86.6	138.3	209.1	237.7	276.8	310.9
2007	88.3	141.1	213.2	242.4	282.3	317.1
2008	90.0	143.9	217.5	247.3	287.9	323.4
2009	91.8	146.7	221.8	252.2	293.7	329.8
2010	93.7	149.7	226.2	257.2	299.5	336.4
2011	95.5	152.6	230.7	262.3	305.4	343.0
2012	97.4	155.6	235.2	267.5	311.5	349.8
2013	99.3	158.7	239.9	272.8	317.6	356.7
2014	101.3	161.8	244.6	278.2	323.9	363.8
2015	103.3	165.0	249.5	283.7	330.3	371.0
2016	105.3	168.3	254.4	289.3	336.9	378.3
2017	107.4	171.6	259.5	295.0	343.5	385.8
2018	109.5	175.0	264.6	300.9	350.3	393.4
2019	111.7	178.5	269.9	306.9	357.3	401.2
2020	113.9	182.0	275.2	312.9	364.4	409.1

TABLE B.14 PROBABLE FLOOD DAMAGE WITH RIVER IMPROVEMENT IN MOJI RIVER BASIN UP TO YEAR 2020

(Unit : Cr$ million)

YEAR	RETURN PERIOD					
	2	5	10	25	50	100
1990	64.0	101.3	130.9	140.8	157.4	168.9
1991	65.9	104.3	134.8	145.0	162.1	173.9
1992	67.9	107.5	138.9	149.3	166.9	179.1
1993	69.9	110.7	143.0	153.8	171.9	184.4
1994	72.0	114.0	147.3	158.4	177.0	189.9
1995	74.1	117.4	151.7	163.1	182.3	195.6
1996	76.3	120.9	156.2	167.9	187.7	201.4
1997	78.6	124.5	160.8	173.0	193.3	207.4
1998	81.0	128.2	165.6	178.1	199.0	213.6
1999	83.4	132.0	170.6	183.4	205.0	219.9
2000	85.8	135.9	175.7	188.9	211.1	226.5
2001	87.6	138.7	179.2	192.7	215.3	231.0
2002	89.3	141.4	182.7	196.5	219.6	235.6
2003	91.1	144.3	186.4	200.4	224.0	240.3
2004	92.9	147.1	190.1	204.4	228.4	245.1
2005	94.8	150.1	193.9	208.5	233.0	250.0
2006	96.7	153.1	197.8	212.7	237.7	255.0
2007	98.6	156.1	201.7	216.9	242.4	260.0
2008	100.5	159.2	205.7	221.3	247.2	265.2
2009	102.6	162.4	209.9	225.7	252.2	270.5
2010	104.6	165.7	214.0	230.2	257.2	275.9
2011	106.7	169.0	218.3	234.8	262.3	281.4
2012	108.8	172.3	222.7	239.4	267.5	287.0
2013	111.0	175.8	227.1	244.2	272.9	292.7
2014	113.2	179.3	231.6	249.1	278.3	298.6
2015	115.4	182.8	236.2	254.0	283.8	304.5
2016	117.7	186.5	240.9	259.1	289.5	310.6
2017	120.1	190.2	245.7	264.3	295.3	316.7
2018	122.5	194.0	250.6	269.5	301.2	323.1
2019	124.9	197.8	255.6	274.9	307.2	329.5
2020	127.4	201.8	260.7	280.4	313.3	336.0

TABLE B.15 PROBABLE SEDIMENT RUN-OFF DAMAGE UP TO YEAR 2020 (1/6)

(1) SABO BASIN-02

(Unit : Cr$ million)

YEAR	RETURN PERIOD			
	5	25	50	100
1990	82.8	398.9	466.1	513.6
1991	85.3	410.9	480.0	529.0
1992	87.8	423.2	494.4	544.9
1993	90.5	435.9	509.3	561.2
1994	93.2	449.0	524.5	578.1
1995	96.0	462.5	540.3	595.4
1996	98.9	476.3	556.5	613.3
1997	101.8	490.6	573.2	631.7
1998	104.9	505.3	590.4	650.6
1999	108.0	520.5	608.1	670.1
2000	111.3	536.1	626.3	690.2
2001	113.5	546.8	638.9	704.0
2002	115.8	557.8	651.6	718.1
2003	118.1	568.9	664.7	732.5
2004	120.4	580.3	678.0	747.1
2005	122.9	591.9	691.5	762.1
2006	125.3	603.8	705.4	777.3
2007	127.8	615.8	719.5	792.9
2008	130.4	628.2	733.8	808.7
2009	133.0	640.7	748.5	824.9
2010	135.6	653.5	763.5	841.4
2011	138.4	666.6	778.8	858.2
2012	141.1	679.9	794.3	875.4
2013	143.9	693.5	810.2	892.9
2014	146.8	707.4	826.4	910.8
2015	149.8	721.5	843.0	929.0
2016	152.8	736.0	859.8	947.5
2017	155.8	750.7	877.0	966.5
2018	158.9	765.7	894.6	985.8
2019	162.1	781.0	912.4	1,005.5
2020	165.4	796.6	930.7	1,025.7

(2) SABO BASIN-03

(Unit : Cr$ million)

YEAR	RETURN PERIOD			
	5	25	50	100
1990	21.2	303.3	411.0	538.8
1991	21.8	312.4	423.3	555.0
1992	22.4	321.8	436.0	571.6
1993	23.1	331.4	449.1	588.8
1994	23.8	341.4	462.6	606.4
1995	24.5	351.6	476.5	624.6
1996	25.3	362.2	490.8	643.4
1997	26.0	373.0	505.5	662.7
1998	26.8	384.2	520.6	682.5
1999	27.6	395.7	536.3	703.0
2000	28.4	407.6	552.3	724.1
2001	29.0	415.8	563.4	738.6
2002	29.6	424.1	574.7	753.4
2003	30.2	432.6	586.2	768.4
2004	30.8	441.2	597.9	783.8
2005	31.4	450.0	609.8	799.5
2006	32.0	459.0	622.0	815.5
2007	32.7	468.2	634.5	831.8
2008	33.3	477.6	647.2	848.4
2009	34.0	487.1	660.1	865.4
2010	34.6	496.9	673.3	882.7
2011	35.3	506.8	686.8	900.3
2012	36.0	516.9	700.5	918.3
2013	36.8	527.3	714.5	936.7
2014	37.5	537.8	728.8	955.4
2015	38.3	548.6	743.4	974.5
2016	39.0	559.6	758.3	994.0
2017	39.8	570.8	773.4	1,013.9
2018	40.6	582.2	788.9	1,034.2
2019	41.4	593.8	804.7	1,054.9
2020	42.2	605.7	820.8	1,076.0

TABLE B.15 PROBABLE SEDIMENT RUN-OFF DAMAGE UP TO YEAR 2020 (2/6)

(3) SABO BASIN-04

(Unit : Cr$ million)

YEAR	RETURN PERIOD			
	5	25	50	100
1990	27.3	45.0	52.5	59.6
1991	28.1	46.4	54.1	61.3
1992	29.0	47.7	55.7	63.2
1993	29.8	49.2	57.4	65.1
1994	30.7	50.6	59.1	67.0
1995	31.6	52.2	60.9	69.0
1996	32.6	53.7	62.7	71.1
1997	33.6	55.3	64.6	73.2
1998	34.6	57.0	66.5	75.4
1999	35.6	58.7	68.5	77.7
2000	36.7	60.5	70.6	80.0
2001	37.4	61.7	72.0	81.6
2002	38.2	62.9	73.4	83.3
2003	38.9	64.2	74.9	84.9
2004	39.7	65.5	76.4	86.6
2005	40.5	66.8	77.9	88.4
2006	41.3	68.1	79.5	90.1
2007	42.1	69.5	81.0	91.9
2008	43.0	70.9	82.7	93.8
2009	43.8	72.3	84.3	95.6
2010	44.7	73.7	86.0	97.6
2011	45.6	75.2	87.7	99.5
2012	46.5	76.7	89.5	101.5
2013	47.5	78.2	91.3	103.5
2014	48.4	79.8	93.1	105.6
2015	49.4	81.4	95.0	107.7
2016	50.4	83.0	96.9	109.9
2017	51.4	84.7	98.8	112.1
2018	52.4	86.4	100.8	114.3
2019	53.4	88.1	102.8	116.6
2020	54.5	89.9	104.8	118.9

(4) SABO BASIN-05

(Unit : Cr$ million)

YEAR	RETURN PERIOD			
	5	25	50	100
1990	7.2	11.4	13.1	14.6
1991	7.4	11.7	13.4	15.0
1992	7.6	12.1	13.8	15.4
1993	7.9	12.5	14.3	15.9
1994	8.1	12.8	14.7	16.4
1995	8.3	13.2	15.1	16.9
1996	8.6	13.6	15.6	17.4
1997	8.9	14.0	16.0	17.9
1998	9.1	14.4	16.5	18.4
1999	9.4	14.9	17.0	19.0
2000	9.7	15.3	17.5	19.6
2001	9.9	15.6	17.9	19.9
2002	10.1	15.9	18.2	20.3
2003	10.3	16.3	18.6	20.8
2004	10.5	16.6	19.0	21.2
2005	10.7	16.9	19.4	21.6
2006	10.9	17.3	19.8	22.0
2007	11.1	17.6	20.1	22.5
2008	11.3	18.0	20.5	22.9
2009	11.6	18.3	21.0	23.4
2010	11.8	18.7	21.4	23.8
2011	12.0	19.0	21.8	24.3
2012	12.3	19.4	22.2	24.8
2013	12.5	19.8	22.7	25.3
2014	12.8	20.2	23.1	25.8
2015	13.0	20.6	23.6	26.3
2016	13.3	21.0	24.1	26.8
2017	13.5	21.5	24.6	27.4
2018	13.8	21.9	25.0	27.9
2019	14.1	22.3	25.5	28.5
2020	14.4	22.8	26.1	29.1

TABLE B.15 PROBABLE SEDIMENT RUN-OFF DAMAGE UP TO YEAR 2020 (3/6)

(5) SABO BASIN-06

(Unit : Cr$ million)

YEAR	RETURN PERIOD 5	25	50	100
1990	14.4	23.3	26.9	75.5
1991	14.8	23.9	27.7	77.7
1992	15.3	24.7	28.5	80.0
1993	15.7	25.4	29.3	82.4
1994	16.2	26.2	30.2	84.9
1995	16.7	27.0	31.1	87.5
1996	17.2	27.8	32.1	90.1
1997	17.7	28.6	33.0	92.8
1998	18.2	29.5	34.0	95.6
1999	18.8	30.3	35.0	98.4
2000	19.4	31.2	36.1	101.4
2001	19.7	31.9	36.8	103.4
2002	20.1	32.5	37.5	105.5
2003	20.5	33.2	38.3	107.6
2004	20.9	33.8	39.1	109.8
2005	21.4	34.5	39.8	112.0
2006	21.8	35.2	40.6	114.2
2007	22.2	35.9	41.4	116.5
2008	22.7	36.6	42.3	118.8
2009	23.1	37.3	43.1	121.2
2010	23.6	38.1	44.0	123.6
2011	24.1	38.9	44.9	126.1
2012	24.5	39.6	45.8	128.6
2013	25.0	40.4	46.7	131.2
2014	25.5	41.2	47.6	133.8
2015	26.0	42.1	48.6	136.5
2016	26.6	42.9	49.5	139.2
2017	27.1	43.8	50.5	142.0
2018	27.6	44.6	51.5	144.8
2019	28.2	45.5	52.6	147.7
2020	28.8	46.4	53.6	150.7

(6) SABO BASIN-07

(Unit : Cr$ million)

YEAR	RETURN PERIOD 5	25	50	100
1990	127.2	240.9	309.0	420.9
1991	131.0	248.1	318.3	433.5
1992	134.9	255.6	327.8	446.5
1993	139.0	263.2	337.7	459.9
1994	143.2	271.1	347.8	473.7
1995	147.5	279.3	358.2	487.9
1996	151.9	287.6	369.0	502.5
1997	156.4	296.3	380.0	517.6
1998	161.1	305.2	391.5	533.1
1999	166.0	314.3	403.2	549.1
2000	170.9	323.7	415.3	565.6
2001	174.4	330.2	423.6	576.9
2002	177.9	336.8	432.1	588.4
2003	181.4	343.6	440.7	600.2
2004	185.0	350.4	449.5	612.2
2005	188.7	357.4	458.5	624.5
2006	192.5	364.6	467.7	637.0
2007	196.4	371.9	477.0	649.7
2008	200.3	379.3	486.6	662.7
2009	204.3	386.9	496.3	675.9
2010	208.4	394.6	506.2	689.5
2011	212.6	402.5	516.4	703.2
2012	216.8	410.6	526.7	717.3
2013	221.1	418.8	537.2	731.7
2014	225.6	427.2	548.0	746.3
2015	230.1	435.7	558.9	761.2
2016	234.7	444.4	570.1	776.4
2017	239.4	453.3	581.5	792.0
2018	244.2	462.4	593.1	807.8
2019	249.0	471.6	605.0	824.0
2020	254.0	481.1	617.1	840.4

TABLE B.15 PROBABLE SEDIMENT RUN-OFF DAMAGE UP TO YEAR 2020 (4/6)

(7) SABO BASIN-08

(Unit : Cr$ million)

YEAR	RETUEN PERIOD			
	5	25	50	100
1990	45.4	55.1	72.6	90.1
1991	46.7	56.8	74.8	92.8
1992	48.1	58.5	77.0	95.6
1993	49.6	60.2	79.3	98.4
1994	51.1	62.0	81.7	101.4
1995	52.6	63.9	84.2	104.4
1996	54.2	65.8	86.7	107.6
1997	55.8	67.8	89.3	110.8
1998	57.5	69.8	92.0	114.1
1999	59.2	71.9	94.7	117.5
2000	61.0	74.1	97.6	121.1
2001	62.2	75.6	99.5	123.5
2002	63.4	77.1	101.5	125.9
2003	64.7	78.6	103.5	128.5
2004	66.0	80.2	105.6	131.0
2005	67.3	81.8	107.7	133.7
2006	68.7	83.4	109.9	136.3
2007	70.0	85.1	112.1	139.1
2008	71.4	86.8	114.3	141.8
2009	72.9	88.5	116.6	144.7
2010	74.3	90.3	118.9	147.6
2011	75.8	92.1	121.3	150.5
2012	77.3	94.0	123.7	153.5
2013	78.9	95.8	126.2	156.6
2014	80.5	97.8	128.7	159.7
2015	82.1	99.7	131.3	162.9
2016	83.7	101.7	133.9	166.2
2017	85.4	103.7	136.6	169.5
2018	87.1	105.8	139.4	172.9
2019	88.8	107.9	142.1	176.4
2020	90.6	110.1	145.0	179.9

(8) SABO BASIN-09

(Unit : Cr$ million)

YEAR	RETURN PERIOD			
	5	25	50	100
1990	10.3	55.3	72.1	114.8
1991	10.5	56.4	73.5	117.0
1992	10.8	57.6	75.0	119.4
1993	11.0	58.8	76.6	121.8
1994	11.3	60.0	78.2	124.2
1995	11.6	61.2	79.8	126.7
1996	11.9	62.5	81.4	129.2
1997	12.2	63.8	83.1	131.8
1998	12.5	65.1	84.8	134.5
1999	12.8	66.5	86.5	137.2
2000	13.1	67.9	88.3	139.9
2001	13.3	69.0	89.8	142.4
2002	13.6	70.2	91.4	144.8
2003	13.8	71.5	93.0	147.3
2004	14.1	72.7	94.6	149.9
2005	14.4	74.0	96.2	152.5
2006	14.6	75.3	97.9	155.1
2007	14.9	76.6	99.6	157.8
2008	15.2	77.9	101.4	160.5
2009	15.5	79.3	103.1	163.3
2010	15.7	80.7	104.9	166.1
2011	16.0	82.0	106.6	168.7
2012	16.3	83.3	108.3	171.3
2013	16.6	84.6	110.0	174.0
2014	16.9	85.9	111.7	176.7
2015	17.2	87.3	113.4	179.4
2016	17.5	88.7	115.2	182.2
2017	17.8	90.1	117.0	185.0
2018	18.1	91.5	118.9	187.9
2019	18.4	93.0	120.8	190.8
2020	18.8	94.4	122.7	193.8

TABLE B.15 PROBABLE SEDIMENT RUN-OFF DAMAGE UP TO YEAR 2020 (5/6)

(9) SABO BASIN-10

(Unit : Cr$ million)

YEAR	RETURN PERIOD			
	5	25	50	100
1990	9.4	37.4	91.0	123.8
1991	9.7	38.5	93.7	127.5
1992	10.0	39.6	96.5	131.3
1993	10.3	40.8	99.4	135.3
1994	10.6	42.0	102.4	139.3
1995	10.9	43.3	105.5	143.5
1996	11.2	44.6	108.7	147.8
1997	11.6	45.9	111.9	152.3
1998	11.9	47.3	115.3	156.8
1999	12.3	48.7	118.7	161.5
2000	12.6	50.2	122.3	166.4
2001	12.9	51.2	124.7	169.7
2002	13.1	52.2	127.2	173.1
2003	13.4	53.3	129.8	176.6
2004	13.7	54.3	132.4	180.1
2005	13.9	55.4	135.0	183.7
2006	14.2	56.5	137.7	187.4
2007	14.5	57.7	140.5	191.1
2008	14.8	58.8	143.3	194.9
2009	15.1	60.0	146.2	198.8
2010	15.4	61.2	149.1	202.8
2011	15.7	62.4	152.1	206.9
2012	16.0	63.7	155.1	211.0
2013	16.3	65.0	158.2	215.2
2014	16.7	66.2	161.4	219.5
2015	17.0	67.6	164.6	223.9
2016	17.3	68.9	167.9	228.4
2017	17.7	70.3	171.2	233.0
2018	18.0	71.7	174.7	237.6
2019	18.4	73.1	178.2	242.4
2020	18.8	74.6	181.7	247.2

(10) SABO BASIN-11

(Unit : Cr$ million)

YEAR	RETURN PERIOD			
	5	25	50	100
1990	96.6	145.2	180.7	204.4
1991	99.5	149.6	186.1	210.5
1992	102.5	154.0	191.7	216.8
1993	105.6	158.7	197.5	223.4
1994	108.7	163.4	203.4	230.1
1995	112.0	168.3	209.5	237.0
1996	115.3	173.4	215.8	244.1
1997	118.8	178.6	222.2	251.4
1998	122.4	183.9	228.9	258.9
1999	126.0	189.5	235.8	266.7
2000	129.8	195.1	242.8	274.7
2001	132.4	199.0	247.7	280.2
2002	135.1	203.0	252.7	285.8
2003	137.8	207.1	257.7	291.5
2004	140.5	211.2	262.9	297.3
2005	143.3	215.4	268.1	303.3
2006	146.2	219.8	273.5	309.4
2007	149.1	224.2	279.0	315.5
2008	152.1	228.6	284.5	321.9
2009	155.1	233.2	290.2	328.3
2010	158.3	237.9	296.0	334.9
2011	161.4	242.6	301.9	341.6
2012	164.6	247.5	308.0	348.4
2013	167.9	252.4	314.1	355.3
2014	171.3	257.5	320.4	362.5
2015	174.7	262.6	326.8	369.7
2016	178.2	267.9	333.4	377.1
2017	181.8	273.2	340.0	384.6
2018	185.4	278.7	346.8	392.3
2019	189.1	284.3	353.8	400.2
2020	192.9	290.0	360.9	408.2

TABLE B.15 PROBABLE SEDIMENT RUN-OFF DAMAGE UP TO YEAR 2020 (6/6)

(11) SABO BASIN-12

(Unit : Cr$ million)

YEAR	RETURN PERIOD			
	5	25	50	100
1990	65.8	200.1	572.9	758.4
1991	67.6	205.7	589.3	780.1
1992	69.6	211.5	606.2	802.4
1993	71.5	217.4	623.6	825.4
1994	73.6	223.5	641.5	849.0
1995	75.7	229.8	659.9	873.4
1996	77.8	236.3	678.9	898.4
1997	80.0	242.9	698.4	924.2
1998	82.3	249.8	718.5	950.7
1999	84.7	256.8	739.1	978.0
2000	87.1	264.0	760.4	1,006.1
2001	88.8	269.2	775.4	1,025.9
2002	90.5	274.5	790.6	1,046.1
2003	92.3	279.8	806.2	1,066.6
2004	94.1	285.3	822.0	1,087.6
2005	96.0	290.8	838.2	1,109.0
2006	97.8	296.5	854.7	1,130.8
2007	99.8	302.3	871.5	1,153.0
2008	101.7	308.2	888.7	1,175.7
2009	103.7	314.2	906.2	1,198.8
2010	105.7	320.3	924.0	1,222.4
2011	107.8	326.5	942.0	1,246.2
2012	109.9	332.8	960.3	1,270.4
2013	112.0	339.2	979.0	1,295.1
2014	114.2	345.7	998.1	1,320.3
2015	116.4	352.3	1,017.5	1,346.0
2016	118.6	359.1	1,037.3	1,372.2
2017	120.9	366.0	1,057.5	1,398.9
2018	123.3	373.0	1,078.1	1,426.1
2019	125.7	380.2	1,099.2	1,453.8
2020	128.1	387.5	1,120.6	1,482.1

FIGURES

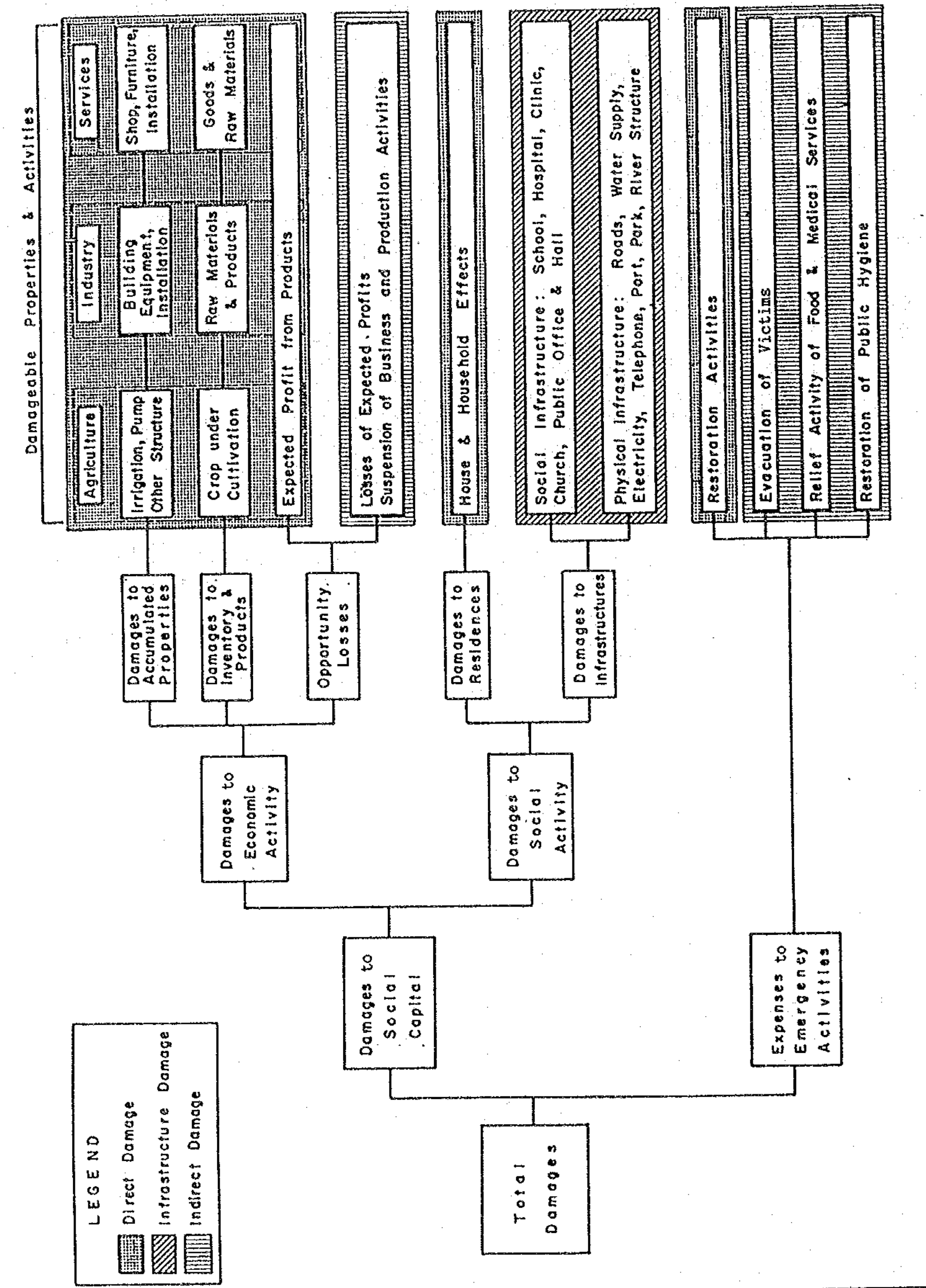


FIG.B.1
STRUCTURE OF DISASTER DAMAGE

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

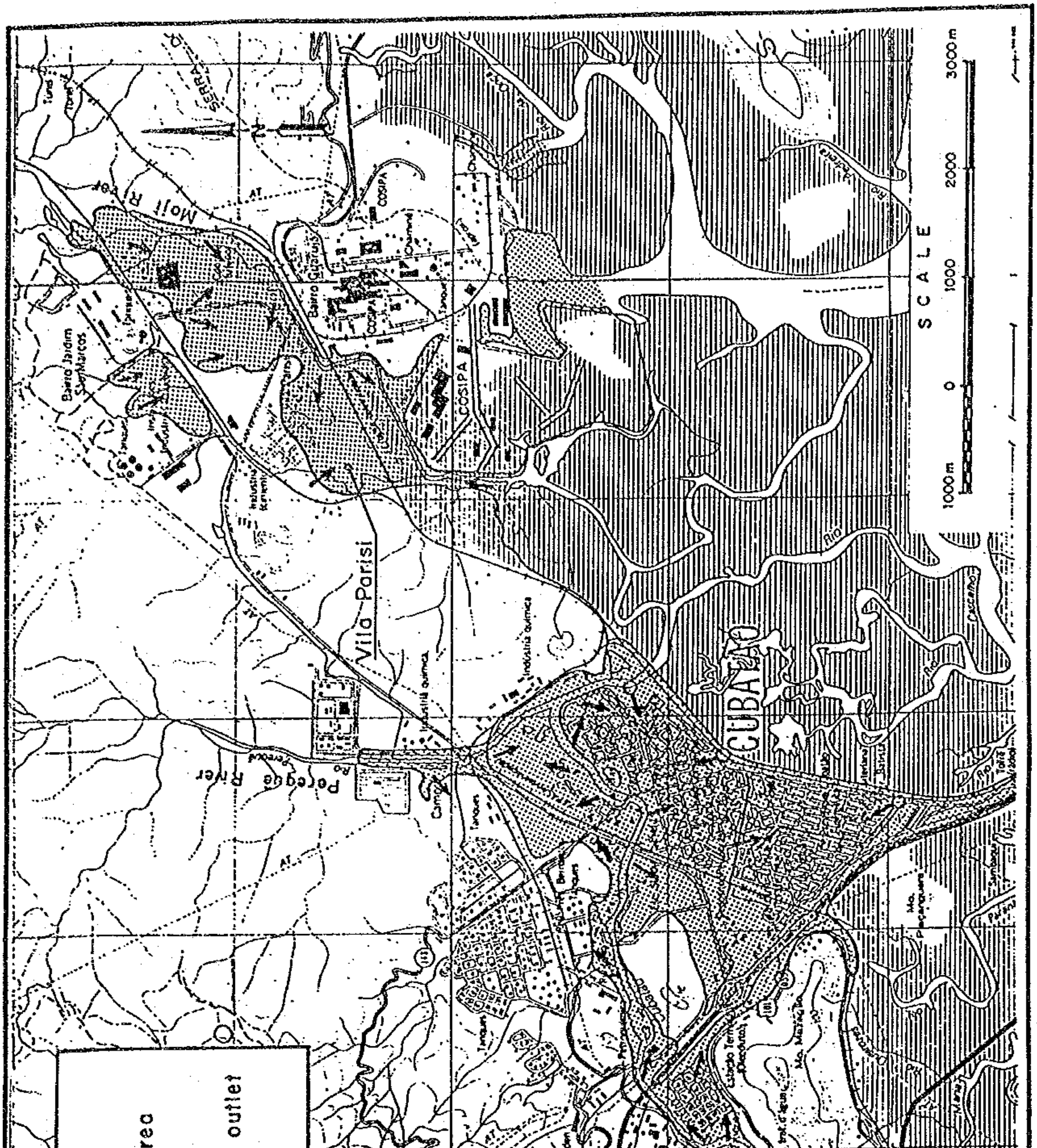
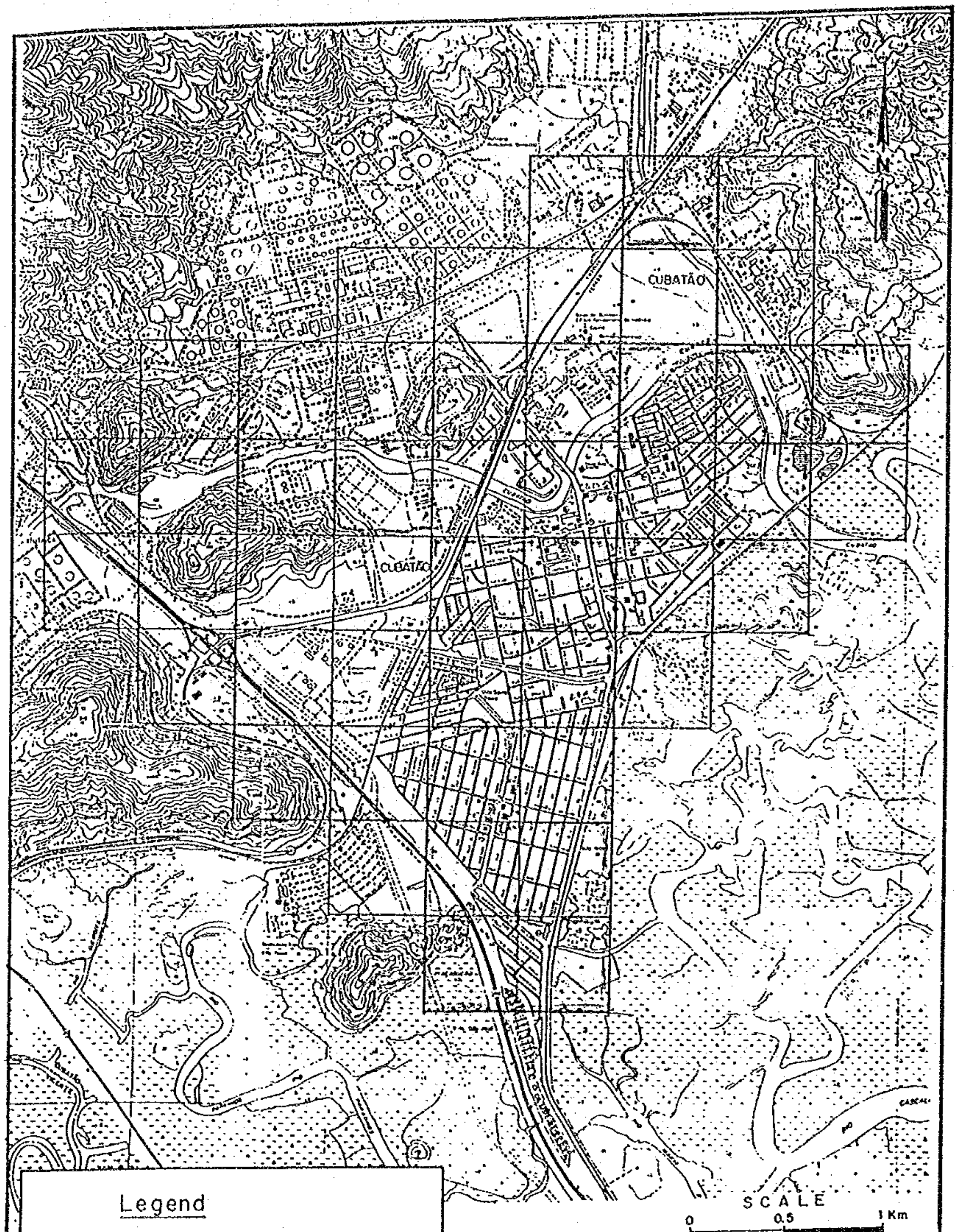


FIG.B.2
LOCATION MAP OF FLOOD PROTECTION AREA

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO
JAPAN INTERNATIONAL COOPERATION AGENCY



Legend

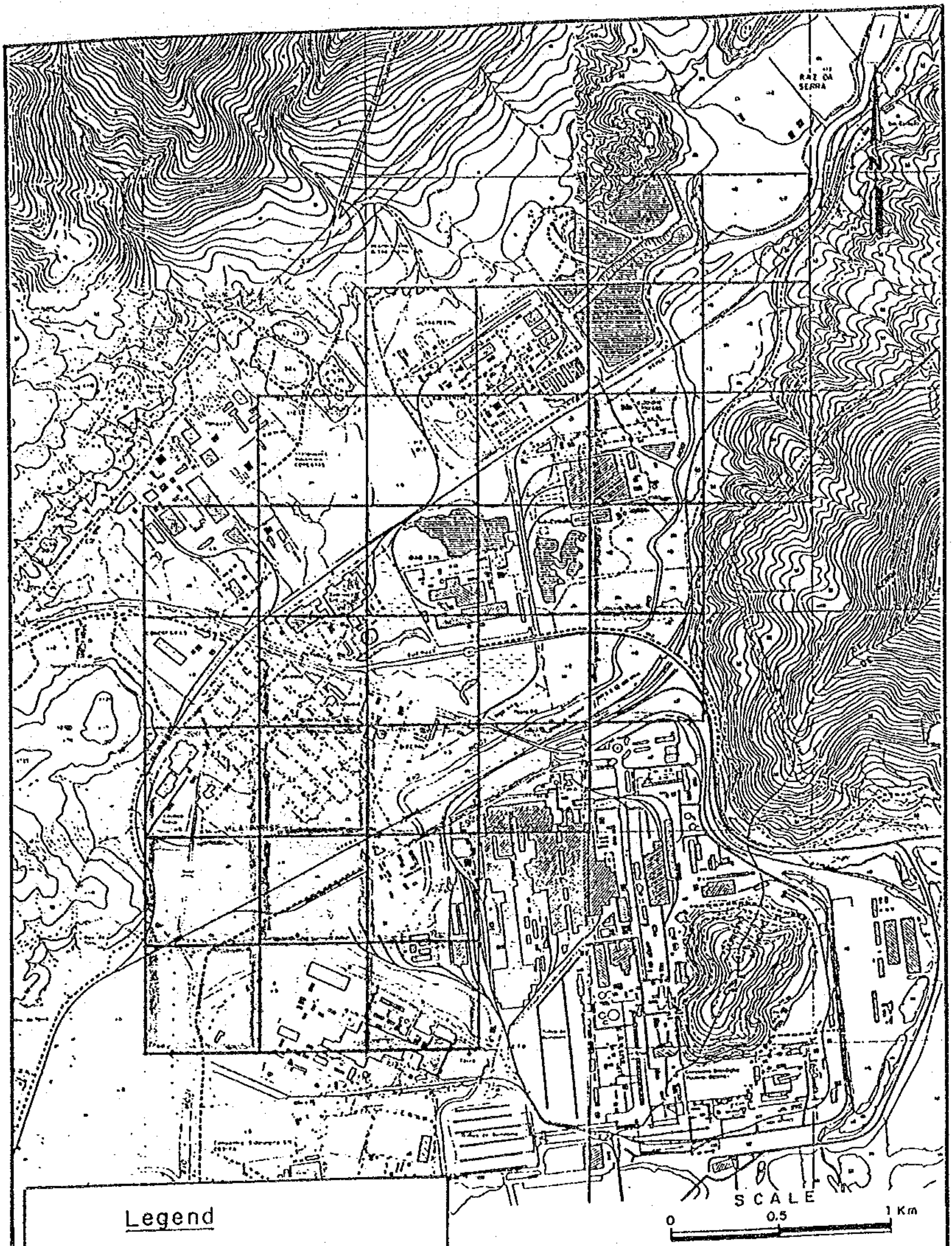
	Not Inundated
	0.0 < Water Depth < 0.5m
	0.5 < Water Depth < 1.0m
	1.0 < Water Depth < 2.0m
	2.0 < Water Depth < 3.0m

FIG.B.3
INUNDATION MAP DUE TO
50-YEAR PROBABLE FLOOD
IN CUBATÃO RIVER BASIN

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY



Legend

[ ]	Not Inundated
[ ]	0.0 < Water Depth < 0.5 m
[ ]	0.5 < Water Depth < 1.0 m
[ ]	1.0 < Water Depth < 2.0 m
[ ]	2.0 < Water Depth < 3.0 m

FIG.B.4
INUNDATION MAP DUE TO
50-YEAR PROBABLE FLOOD
IN MOJI RIVER BASIN

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

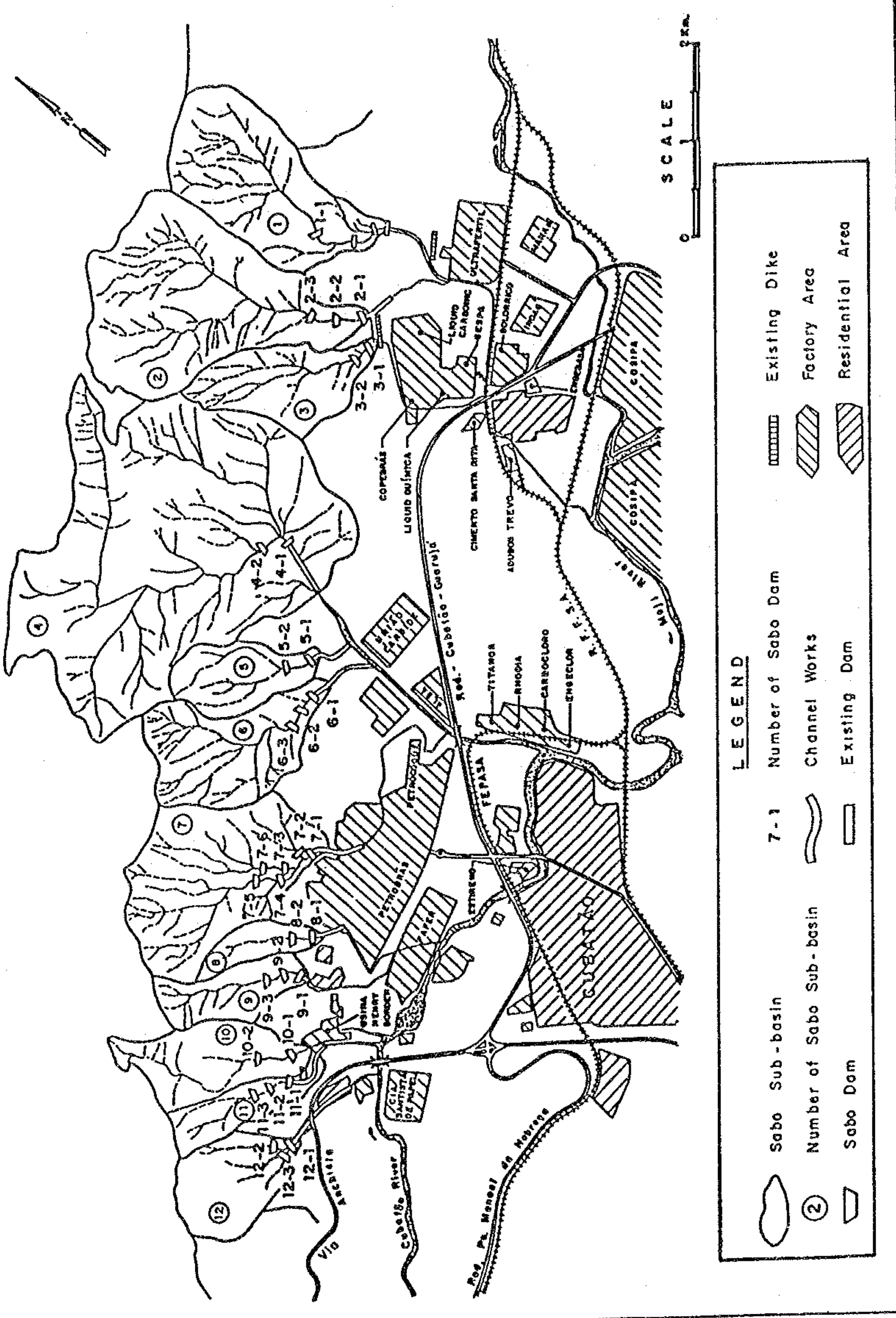


FIG.B.5
GENERAL LAYOUT OF
SABO SUB-BASINS

GOVERNMENT OF FEDERATIVE
REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND
RESTORATION PROJECT IN SERRA DO MAR,
CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

ANNEX C

EXISTING DISASTER PREVENTION MEASURES

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1. INTRODUCTION

This ANNEX-C presents the study results on the existing structural measures and non-structural measures for disaster prevention and activities for disaster prevention in the objective basins of the Cubatão and Moji rivers. These measures consist of structures for sediment runoff and flood control, non-structural measures and related facilities in and around the objective basins.

The study was carried out dividing into 2 stage of about 4.5 months from Nov.15,1989 to Mar.27,1990 and 3 months from June 11, 1990 to Sept. 8, 1990 in São Paulo.

The study purpose of ANNEX-C is 1) to grasp the existing structural and non-structural measures for disaster prevention, 2) to assess the related facilities in and around objective basins and 3) to identify the authorities concerned with disaster prevention works in order to obtain basic information for carrying out the formulation of a master plan on disaster prevention in the basin and a feasibility study on a priority project selected from the scheme of the formulated master plan.

2. EXISTING STRUCTURES AND NON-STRUCTURAL MEASURES FOR DISASTER PREVENTION

2.1 General

The basin has been suffering from debris and mud flows and floods due to heavy rainfalls and deterioration of vegetation in Serra do Cubatão, especially in the Moji river basin. Serious disasters occurred in 1968, 1971, 1976,1985 and 1988. Of these, it is said that the disaster of 1971 was the most serious one for flooding and the disaster in 1985, for debris and mud flows.

Cubatão city is being developed as urban area and an indispensable industrial zone in the state of São Paulo as well in Brazil. The major rivers contribute to drainage as well as water resources for municipal and industrial uses.

In order to protect the urban area and industrial estates from recurrent disasters, some measures have already been realized. Such existing measures for disaster prevention include both of structural and nonstructural ones.

The existing measures for the disaster prevention are explained below.

2.2 Existing Structures for Disaster Prevention

2.2.1 Structures for sediment runoff

Major structures for sediment runoff and mud flows exist in the valley reaches of the Pedras and Pereque in the Cubatão river system and of the Cachoeira, Engenho(Indio) and Moji in the Moji river system. Such areas are divided into 9 sectors.

The boundaries of the 9 sectors are presented in Fig.C.1 and are described below.

Sector 1 : Upper Moji river (Moji)
Sector 2 : Engenho river (Ultrafertil)
Sector 3 : Cachoeira river (Copebras)
Sector 4 : Upper Pereque river (Pereque)
Sector 5 : Pedras river (Refinaria)
Sector 6 : Left tributary of Cubatão river (Eletropaulo)
Sector 7 : Left bank of lower Cubatão river (Carbocloro)
Sector 8 : Upper Piaçaguera river (Dutos)
Sector 9 : Left bank of upper Moji river (Morrão)

The existing structures are concentrated especially in sectors 1,2,3,4 and 5. Such structures are mainly cross dams across valleys (so called "sabo dams") consisting of gabion and riprap stones and of earth walls. The purpose of these structures is to trap the sediment runoff and mud flows and to protect the tanks in the industrial estates by earth walls.

The main facilities in the respective sectors are presented in Figs.C.2 and C.3, and are summarized below.

Sector 1 (Moji)

- Riprap cross dam : 4 sets

Sector 2 (Ultrafertil)

- Gabion dam : 3 sets (see Data Book)

Sector 3 (Copebras)

- Rock and earth dam : 2 sets (see Data Book)
- Concrete block dam : 1 set
- Riprap cross dam : 1 set

Sector 4 (Pereque)

- Riprap cross dam : 4 sets
- Earth wall : 700 m

Sector 5 (Refinaria)

- Gabion dam : 9 sets(see Data Book)
- Concrete wall : 200 m
- Slope protection works : ls

Sector 6 (Eletropaulo)

- Concrete wall : ls

Sector 7 (Carbocloro)

- Protection wall : ls

Sector 8 (Dutos)

- Protection wall : 1s

2.2.2 Structures for flood control

In addition to the above structures, some measures for flood control have been provided. These are of flood dikes and drainage culverts. The main flood control structures are presented in Fig.C.4 and explained below.

(1) Cubatão River System

The middle and lower reaches of the Cubatão river were improved after the destructive disaster in 1971. In these works, the said reaches were channelized for a about 2.5 km from the railway bridge at the river mouth. The major structures in the Cubatão river system are as follows.

(A) Improved channel of the middle and lower Cubatão

- Improved channel length : 2.5 km
- Channel top width : 100- 70 m
- Channel depth : 6-7 m
- Channel section : trapezoidal section

(B) Flood dike with slope protection on right bank of Cubatão river

- Length : 2.0 km
- Dike height : 0.8 m
- Dike crown width : 1.0 m
- Slope gradient : 1/1.5 to 1/2
- Slope protection : dry stone masonry

(C) Cut-off channel of middle and lower Cubatão river

- Location : around bridge of Caminho do Mar and upstream of river mouth
- Length : 200 m each

(D) Adjustment of confluence of Pereque river

- Length : 500 m

(E) Concrete wall on right bank of Cubatão by Petrobras

- Location : Petrobras on right bank of Cubatão
- Length : about 400 m

(F) Drainage culvert

- Cubatão river
- Pereque river

(2) Moji River System

The main structures in the Moji river system are channelization of the Indio river and drainage culverts. The main structures are explained below.

(A) Improved channel and culverts in Indio

- Improved channel length : 250 m
- Channel top width : 10 m
- Channel depth : 3-4 m
- Channel section : trapezoidal section
- Culvert length : 27 m
- Nos. of culvert : 2 nos.
- Section of culvert : 2.5 m high and 6 m wide

(B) Drainage culverts

- Moji main river
- Piaçaguera river
- Engenho river

2.3 Existing Non-structural Measures

The existing non-structural measures were taken up and have been realized under a program of the Special Commission for Restoring the Serra do Mar in the Cubatão Region which will be explained in chapter 4 of this ANNEX.

The following are the main existing non-structural measures in the Cubatão river basin.

- Relocation of resident areas
- Civil defense plan
- Air pollution control
- Experimental planting

The various measures are described in the following.

<u>Relocation of resident areas</u>

The residential houses in the dangerous areas for flooding, debris and mud flows and air pollution are to be removed into the other areas. Such houses are estimated at about 4,800 houses. The nominated locations to be removed are given in Fig.C.5. Out of the above, about 1,200 houses in the Villa Parisi area and 500 houses in the Cotas and Morro do Piche area have been removed already.

Relocation of residential houses has been considered by the authorities concerned of Cubatão city, Companhia de Saneamento Ambiental(CETESB), Instituto de Pesquisas Tecnologicas do Estado São Paulo(IPT) and NUDEC.

According to the relocation plan, the progress in relocation as of Jan. 1990 is as follows.

Progress of Relocation of Houses

Area	House to be Relocated (nos.)	Relocated Already (nos.)	Remaining (nos.)
Villa Parisi	1948	1184	764
M. Piche	164	152	12
P. Miranda	1175	205	970
Cotas 95/100	475	134	323
Cotas 200	945	44	901
Cotas 400	117	0	117
Cotas 500	3	0	3
Total	4809	1719	3090

The detailed inventory survey of residential houses in the danger areas has been presently conducted by Cubatão City, CETESB and IPT.

Civil defense plan

The objective of this plan is to protect residents from disasters and to eliminate situations where accidents with products or stocks could cause dangerous harm to people.

The plan consists of an evacuation plan and a management plan under a radio system. During the rainy season, the basin is kept a close watch by radio system as shown in Fig.C.6 (telemetering system) which is administrated at CETESB and Cubatão city in close cooperation with IPT and Departamento de Aguas e Energia Eletrica (DAEE).

Based on information on the total rainfall depth and rainfall intensity in the questioned area obtained from the radio system, a warning is announced and some action is taken up according to the following warning system (guide line).

The warning is announced based on guide lines prepared mainly by Divisão de Operações de Risco (DEO) in CETESB as shown in Fig.C.7. According to this guide lines, the stepwise warning consists of the following 4 steps.

- Step 1 : Observatory stage
- Step 2 : Alert stage
- Step 3 : Critical stage
- Step 4 : Emergency stage

The details of action flow chart are given in Fig.C.8. In emergency stage, evacuation of people starts and stocks of dangerous materials for industrial use are started to reduce.

Cubatão Municipal Civil Defense Commission (COMDEC) is responsible for the above action in Cubatão city, in close cooperation with IPT, DAEE, CETESB and other agencies.

Environmental pollution control plan

According to CETESB, it is reported that there are 320 sources of pollution in the 23 industrial complexes of Cubatão city. The pollutant sources are divided into the three categories of air(230), water(44) and soil(46).

CETESB is responsible for this pollution control. Under the leadership of CETESB, the various factories prepare the control program for each source and the programs are implemented. According to CETESB, it is reported that 90 to 95 % of the target in the plan was performed as of 1984.

Experimental Planting

Instituto de Botanica (IBT) first studied the following to restore the vegetation in Serra do Mar especially in the Cubatão region.

- Endemic tree species which are strong and/or durable against air pollution
- Mechanism of plant succession of natural forest and acceleration of succession process

As the result of the above, it was proved that about 25 kinds of trees are strong and/or durable against air pollution.

Experimental planting was then made of selected seeds of the trees strong against air pollution. Experimental planting has recently been made for the areas of the Pereque and Moji rivers from the air by helicopter from Feb. to April 1989. Such planting has been done by CETESB in cooperation with IPT, IBT and Instituto Florestal (IF).

3. RELATED FACILITIES

There are many facilities in the objective rivers of the Cubatão, Pereque, Moji and their tributaries. They include intake weirs, intake pump stations, outlets of hydroelectric power stations, bridges and so on. Such facilities related to the objective rivers are presented in Fig.C.9 and are explained below.

3.1 Facilities in Cubatão River System

(1) Intake Weir and Pump Station by Petrobras and Ultrafertil

The weir is located about 3.2 km upstream from the railway bridge near the river mouth. The weir is an intake facility designed to act as a barrier against the intrusion of sea water. The pump station is used as to intake water for industrial purpose. The weir is shown in Fig.C.10 and with the pump station are administrated by Petrobras and Ultrafertil. The main features are outlined below.

- Design discharge : 1300 m3/s (1/1000 return period)
- Weir type : sluice gate
- Weir dimensions : 8 m * 6 lanes

- Sill elevation : -1 m IGGSP
- Gate height : 3 m
- HWL : 6.5 m IGGSP
- LWL : 1.7 m IGGSP
- Nos. of pump plant by Petrobras
  - for cooling : 5 units(5 m3/s)
  - for fire : 3 units(4 m3/s)
- Nos. of pump plant by Ultrafertil
  - for cooling : 3 units(1.8 m3/s)

2) Henry Borden Hydroelectric Power Station

The hydroelectric power station of Henry Borden consists of the two plants of Cubatão I and Cubatão II. Cubatão II is an underground. The operation of these plants was initiated in 1926 at Cubatão I and in 1956 at Cubatão II,respectively. The station have been administered and operated by Eletricidade de São Paulo S.A. (Eletropaulo) and the electricity has been supplied to São Paulo and Santos areas.

The water required for power generation is provided from the Rio das Pedras reservoir through intake facilities and tunnels. The total of generation capacity is 880 MW consisting of 460 MW in Cubatão I and of 420 MW in Cubatão II.

An outline of the facilities is as follows.

Cubatão I

- Inlets
  - Tunnel B : 4 m (diameter) * 500 m (long) * 2 nos.
  - Tunnel C : 5.1 m (diameter) * 500 m (long) * 1 no
- Penstocks : 1.4 m (diameter) * 1,600 m (long) * 8 nos.
- Capacity of penstocks : 90 m3/s
- Power capacity : 460 MW
- No. of generators : 8 units

Cubatão II

- Inlet tunnel
  Penstocks : 3.25 m (diameter) * 1500 m (long) * 6 nos.
- Capacity of penstocks : 70 m3/s
- Power capacity : 420 MW
- No. of generators : 6 units

(3) SABESP Intake Dam and Treatment Plant

This intake dam is located upstream of the Anchieta road bridge. The dam and its treatment facilities are administrated by Sabesp in Secretaria da Energia e Saneamento. This system covers the municipalities of Cubatão, Santos, São Vicente and adjacent areas. The main features are as follows.

- Type of intake dam : fixed dam 7.9 m wide * 7 lanes
- Intake water level : about 4.7 m IGGSP
- Intake pipe : 1200 mm diameter * 1000 m
- Intake amount : 3.5-3.8 m3/s
- Pump for treatment plant : main 5 sets additional 4 sets
- Service population : about 1 million

(4) Union Carbide Intake Dam

This dam is located on the middle reach of the Pereque river. Union Carbide company mainly intakes water from this dam. Type of dam is fixed one having an approximate width of 40 m.

In addition to the above, there are the two small intake facilities in the lower Piloes and in the pedras river in Caixa 10. The intake volumes are 600 l/s(Piloes) and 60 l/s (Caixa 10), respectively.

(5) Other Intake Facilities

In addition to the above, there are some pumped intake facilities in the Cubatão and Pereque river system. These are listed in Table C.1.

(6) Bridge

There are 8 bridges over the Cubatão and 4 bridges over the Pereque(see Table C.2). There are also water and oil supply bridges over located at 2 sites of the middle Cubatão river in Petrobras industrial estate at two sites.

3.2 Facilities in Moji River System

(1) Pump Station and Sedimentation Basin for Intake by COSIPA

There is a pump station and intake canal, which also functions as a sedimentation basin, in the lower Moji river at the Cosipa industrial estate. Such facilities are administrated by Cosipa. The pump plant and intake capacity are as follows:

- Nos. of pump plant : 4 sets
- Intake amount : 5.5 - 7.0 m3/s

Since the flow of water in the Moji river is very low in the dry season and to avoid sea water intrusion into the sedimentation basin, water is supplied by Eletropaulo through the Cubatão river channel and the Moji river. For this reason, the Eletropaulo and Cosipa companies concluded an agreement on water supply. According to this agreement, a minimum discharge of 60 m3/s is to be supplied to Cosipa.

(2) Intake Dam at São Marcos

There is an intake weir for pump stations on the Moji river just upstream of the railway bridge. The dam is a fixed weir having a total width of 50 m and approximate direct height of 2 m. From this dam, Ultrafertil and Copebras are taking water by means of pump stations.

(3) Other Intake Facilities

Intake facilities for industrial use have been installed in the Moji river system, as shown in Table C.1.

(4) Bridges

There are 7 bridges in the Moji and 4 bridges in the lower Piaçaguera river(see Table C.2).

3.3 Major Industrial Estates

In the river basin of the Cubatão, Pereque, Piaçaguera and Moji, there are the 23 major industrial companies, and about 30 industrial estates. Most of the industrial estates are located on the fluvial plain formed by the Cubatão, Moji and their tributaries.

The locations of the main estates are presented in Fig.C.11. The main industrial estates are listed below:

Major Factories in Cubatão City

Name of Factory	Starting Date of Operation
1. Cia. Santista de Papel	01/05/32
2. Cia. Siderurgica de Paulista (COSIPA)	/ /54
3. Petroleo Brasileiro S.A. (RPBC/PETROBRAS)	01/23/55
4. Cia. Petroquimica Brasileira(COPEBRAS)	05/20/55
5. Cia. Brasileira de Estireno	10/21/57
6. Alba Quimica Ind e Com Ltda	10/23/57
7. Union Carbide da Brasil	04/01/58
8. Ultrafertil S.A. Ind e Com. de Fert FAFER	04/16/58
9. Carbocloro S.A. Ind. Quimica	04/12/64
10. Cimento Santa Rita S.A.	12/01/68
11. Engeclor Industria Quimica S.A.	04/16/69
12. Ultrafertil S.A.Ind e Com de Fert S.MARCOS (ULTRAFERTIL)	07/03/69
13. Terminal Maritimo da Ultrafertil	/ /70
14. Liquid Carbonic Industrias S.A.	04/10/70
15. Concretex S.A.	/ /72
16. Liquid Quimica S.A.	09/01/72
17. Solorrico S.A. Industria e Comercio	09/01/72
18. Petrobras Distribuidora S.A. Basan	10/01/72
19. Indag S.A. Industria de Fertilizantes	03/08/73
20. Engębasa Mecanica e Usinagem S.A.	03/09/73
21. Manah S.A.	03/07/74
22. Rhodia S.A.	11/01/74
23. Hidromar Produtos Quimicos	11/13/74
24. Petroleo Brasileiro S.A. (TEDEP)	11/19/74
25. Adubos Trevo S.A.	06/01/75
26. Concrebras S.A. Engenharia de Concreto	06/20/75
27. Titanor Industria e Comercio de Maquinas e Metais	01/07/76
28. Gespa gesso Paulista Ltda	08/07/76
29. Petrocoque S.A. Industria e Comercio	08/16/83

3.4 Billings Reservoir

(1) Tiete River

The Tiete river runs through the urban area of São Paulo city and is the one of the tributaries of the Parana river. The river system of the Tiete is shown in Fig.C.12. The total catchment area of the Tiete is about 5,720 km2 at the Pirapora barrage.

The main tributaries of the Tiete are the Juqueri on the right bank and the Citica, Pinheiros and Tamanduatei rivers on the left bank. As seen in Fig.C.12, the Tiete river and its tributaries are highly developed for water utilization and flood control. In the upper reaches of the main tributaries, there are many reservoirs. They function as reservoirs for municipal water, hydroelectric generation and others purposes.

The Pinheiros river, the left tributary of the Tiete, is the most important one in this system. The Pinheiros river with a total length of 25 km has two large-scale reservoirs, the Guarapiranga and the Billings. The Retiro weir is located at the confluence of the Pinheiros river with the Tiete river.

The Billings reservoir system has a connection with the Cubatão river basin, especially with the Cubatão and Pereque rivers, through the water supply to Henry Borden (hydroelectric power station) and emergency release of highflows into the Cubatão and Pereque rivers when the water level in the Rio das Pedras exceeds the high water level of 728.5 m IGGSP.

(2) Billings Reservoir

1) Reservoir System

The Billings reservoir was created by construction of the Rio Grande barrage and Grande canal in around 1940s. The total catchment area of the reservoir is around 560 km2. The reservoir is largely consists of into the two reservoirs Billings and Rio das Pedras. The reservoir area of approximately 160 km2 is divided into the 130 km2 of the Billings and 30 km2 in the Rio das Pedras. The Rio das Pedras reservoir is connected with the Billings reservoir by the Rio Grande regulation barrage(summit control) and Rio Grande canal. The reservoir system is presented in Fig.C.12.

The purposes of the two reservoirs are 1) to supply water for hydroelectric generation , 2)to control water quality as sanitary control and 3) to impound flood waters in the Tiete and Pinheiros rivers. In order to intake water and impound flood waters, the two pump stations of Traição and Pedreira were constructed on the Pinheiros river.

The reservoir is administrated and controlled by Eletricidade de São Paulo(Eletropaulo) in accordance with a central control system.

After completion of the reservoir system, it is reported that about 23 km2 formerly subject to periodic floodings, was newly created for residential and industrial zones. Thus, the reservoir system has contributed much to the region.

The main facilities related to the Billings reservoir are also given in Fig.C.12.

(A) Retiro Weir

- Weir length : 140 m
- HWL : 16 m IGGSP

(B) Traição Pump Station

- Pump capacity : 280 m3/s
- Units of pump plant : 4 sets
- Head (Net) : 5.5 m

(C) Pedreira Pump station (dual purpose operation)

- Pump capacity : 320 m3/s
- Units of pump plant : 7 sets
- Head (Net) : 25 m

(D) Billings Reservoir

- Reservoir area : 130 Km2
- Rio Grande barrage
  - Crest elevation : 750 m IGGSP
  - Barrage length : 1500 m
  - Height : 25 m
- HWL : 746.5
- LWL : 728.0
- Effective storage volume : 1299*10E6 m3
- Completion year : 1937

(E) Regulation Barrage and Rio Grande Canal

- Barrage length : 173 m
- Barrage height : 35 m
- Gate : 3 nos.
- Capacity of gates : 210 m3/s
- Canal length :
- Completion : 1926

(F) Rio das Pedras Reservoir

- Reservoir area : 30 Km2
- Crest elevation of barrage : 729.58 m IGGSP
- HWL : 728.5 m IGGSP
- LWL : 726.5 m IGGSP
- Effective storage volume : 50*10E6 m3

2) Major Facilities Related to the Cubatão River System

The Cubatão river basin borders on the Billings reservoir system catchment throughout closing dikes with and without outlet facilities such as culvert or spillways. The locations of closing dikes and other facilities are given in Fig.C.12. Among such are the upper ends of Pereque and Rio das Pedras rivers which are connected by culverts and spillways with the Rio das Pedras reservoir.

The closing dikes and regulation facilities in the above are principally as follows:

(A) Closing Dike at upper end of Cubatão (Cubatão do Cima)

- Dike length	:	300 m
- Dike height	:	17 m
- Dike crown width	:	10 m
- Top elevation	:	750 m IGGSP

(B) Closing Dike and Culvert at upper end of Pereque (Pequeno Pereque)

- Dike length	:	50 m
- Dike height	:	15 m
- Dike crown width	:	13 m
- Top elevation	:	750 m IGGSP
- Culvert	:	4 m wide * 9 m high * 4
- Culvert capacity	:	75 m3/s

(C) Intake of Henry Borden (Cubatão I)

- Intake tunnel B	:	4.0 m dia * 1
- Intake tunnel C	:	5.1 m dia * 1

(D) Closing Dike 1 of Henry Borden Intake (Cubatão I) (see Fig.C.13)

- Dike length	:	62 m
- Dike height	:	19 m
- Dike crown width	:	8 m
- Top elevation	:	738 m IGGSP

(E) Closing Dike 2 of Henry Borden Intake (Cubatão I) (see Fig.C.13)

- Dike length : 115 m
- Dike height : 25 m
- Dike crown width : 8 m
- Top elevation : 738 m IGGSP

(F) Intake of Henry Borden (Cubatão II)

- Intake tunnel : 3.25 m dia * 1

(G) Spillway at upper end of Rio Das Pedras (see Fig.C.13)

- Dike length : 173 m
- Dike height : 35 m
- Dike crown width : 6 m
- Top elevation : 728.5 m IGGSP
- Spillways : 1.98 m * 1.98 m * 3 nos.
- Max. discharge capacity : 80 m3/s at max. operation level of 727.6 m IGGSP

(H) Culvert at upper end of Pereque (Pedras Pequenas)

- Culvert dimension : 7.46 m wide * 9.34 m high
- Top elevation of culvert : 729.2 m IGGSP
- Max. water level : 728.5 m IGGSP

4. DISASTER PREVENTION ACTIVITIES

4.1 General

The industrial development of Cubatão city was initiated in the early 1950s. Since its inception, Cubatão city has been actively developed into residential and industrial zones.

However, both the industrial and the residential zone have been suffered from recurrent disasters such as sediment runoff and mud flows and flooding due to heavy rainfall in the region.

In the course of development, these disasters have become more frequent due to air pollution from the chimneys in the industrial estates which has been killing the natural protective forest.

The Cubatão and Moji river basins region experienced disasters in 1968, Feb. 1971, Jan. 1976, Jan. 1985 and Dec. 1988. Of these recurrent disasters, the Feb. 1971 and the Jan. 1985 floods were very destructive.

In order to mitigate or minimize the damage of such disasters, various disaster prevention measures have been taken by the authorities concerned. In this ANNEX, the disaster prevention activities are explained with emphasis on the authorities concerned, and the special program for disaster prevention.

4.2 Authorities Concerned with Disaster Prevention

4.2.1 Organization of state government for disaster prevention

The state government of São Paulo consists of the seven ministries, as shown in Fig.C.14.

The following three ministries are responsible for disaster prevention in the region of Serra do Mar. They are the Secretaria da Meio Ambiente(SMA), the Secretaria da Energia e Saneamento(Energy and Sanitation), and the Secretaria da Ciencia e Tecnologia(Science and Technology).

In June 1985 immediately after the destructive disaster in Feb. 1985, the state government established a Special Commission including various government administrative organizations for Restoring Serra do Mar in the Cubatão region(Special Commission).

Accordingly, disaster prevention activities are presently controlled by the Special Commission, in close cooperation with the SMA, Secretaria da Energia e Saneamento and the Secretaria da Ciencia e Tecnologia.

The Special Commission consists of the 17 authorities including 6 special authorities. The duties of the Special Commission are 1)to prepare a program for restoring the Serra do Mar in the Cubatão region and 2)to supervise implementation of the plan. The detailed program is explained in the following section of 4.3. The member of the Special Commission are as follows.

Members

Agency	Responsible for
Secretaria da Meio Ambiente	: Environment
Secretaria da Energia e Saneamento	: Energy and Sanitation
Secretaria da Ciencia e Tecnologia	: Science and Technology
Secretaria da Economia e Planejamento	: Economic Planing
Secretaria da Agricultura e Abastecimento	: Agriculture
Coordenadoria Estadual de Defesa Civil (CODEC)	: Coordination of Civil Defense
Companhia de Tecnologia de Saneamento Ambiental (CETESB)	: Air Pollution Control
Departamento de Aguas e Energia Eletrica (DAEE)	: Water and Energy
Instituto de Pesquisas Tecnologicas do Estado de São Paulo S.A (IPT)	: Institute of Research and Technology
Instituto de Botanica (IBT)	: Vegetation
Prefeitura Municipal de Cubatão (PMC)	

Special Members

Agency	Responsible for
Desenvolvimento Rodoviario S.A.	: Roads and highways
Rede Ferroviaria Federal S.A.	: Railways
Instituto de Pesquisas Espaciais	
Eletricidade de São Paulo (Eletropaulo)	: Energy and electric
Conselho Municipal de Defesa do Meio Ambiente de Cubatão	
Conselho Municipal de Meio Ambiente de Santos	

Among the above members, CETESB, DAEE, IPT, and IBt are directly responsible for their respective fields in disaster prevention in Serra do Mar in the Cubatão region,under the leadership of the Secretaria de Meio Ambiente.

4.2.2 Authorities concerned with disaster prevention in cubatão region

Activities for disaster prevention in Cubatão region (Cubatão river basin) are actually proceeded in by the 6 authorities of Secretaria de Meio Ambiente(SMA), CETESB, IBt, DAEE, IPT and Cubatão Municipal Civil Defense Commission(COMDEC). The main duties of each authority are as follows.

(1) Secretaria de Meio Ambiente (SMA)

SMA is the competent ministry with regard to restoring Serra do Mar in the Cubatão region and is responsible for all over coordination of the other authorities.

(2) Companhia de Tecnologia de Saneamento Ambiente (CETESB)

CETESB is a public cooperation which belongs to the Secretaria de Meio Ambiente and is responsible for pollution control and environmental technical development. The Departamento de Pesquisa de Tecnologia Ambiental in CETESB is directly responsible for disaster prevention in view of its environmental aspects.

(3) Instituto de Botanica (IBt)

IBt also belongs to SMA and is responsible for research and survey on natural vegetation. In the restoration of Serra do Mar in Cubatão region, IBt has been taken part in the experimental planting.

(4) Departamento de Aguas e Energia Eletrica (DAEE)

DAEE is directly controlled by the Secretaria da Energia e Saneamento. DAEE is responsible for hydrological and hydraulic survey, and planning, design and construction of water resources, sanitation and flood control facilities.

With regard to disaster prevention in Serra do Cubatão region, the following sections are concerned and disaster prevention works have been made mainly by those.

Section		Responsible for
Diretoria da Bacia do Alto Tiete e Baixada Santista (BAT)	:	Investigation and planning on water development, flood control and erosion control in upper Tiete and Baixada Santista
Centro Tecnologico de Hidraulica (CTH)	:	Hydraulic laboratory
Diretoria de Engenharia (DEN)	:	Design and construction of hydraulic structures

(5) Instituto de Pesquisas Tecnologia do Estado de São Paulo S.A. (IPT)

IPT is the state institute for technical research, and has composed 11 divisions. Of those, the divisions of civil construction and geology are responsible for disaster prevention in the Cubatão region. The civil construction division is further divided into the three sectors of Structures, Concrete and Geotechnics. The geotechnic sector has been closely involved in the disaster prevention in the region in studies of its geotechnical aspects study and in providing technical assistance.

(6) Cubatão Municipal Civil Defense Commission (COMDEC)

Cubatão Municipal Civil Defense Commission (COMDEC) in Cubatão city,is organized under the Cubatão City Council as shown in Fig.C.15. The main purpose of COMDEC is to carry out the civil defense plan of Cubatão city. As shown in Fig.C.16, COMDEC is controlled by the Special Commission in close cooperation with CETESB, IPT and DAEE.

During the rainy season from November to March, COMDEC operates 24 hours a day.

COMDEC works from on rainfall information received every 30 minutes from the telemetering system and based on the forecasting guidelines explained in section 2.3 of this ANNEX-C. During the observation stage in the rainy season, the Cubatão basin is patrolled by two cars. The total staff of COMDEC is about 20 persons.

4.3 Outline of Restoration Program for Serra do Mar in Cubatão Region by Special Commission

The Cubatão river basin has been seriously damaged by mud slides and floods which have occurred over an extensive area, especially in the Moji river basin in Feb. 1985.

Confronted with this destructive disaster, the state of São Paulo set up the Special Commission by, Decrees No. 23,457 of June 11, 1985, and 23,711 of June 26, 1985 to restore Serra do Mar in Cubatão region.

The Special Commission accordingly conducted surveys, studies and researches with two objectives: 1)to develop a program of immediate measures(urgent plan) to avoid or minimize the damage due to future mud flows and floods, and to protect industrial estates and local residents from disaster in critical areas, and 2)to restore the vegetation of the mountains through a long-term plan.

The program was thus divided between immediate action and a long-term plan.

The program of immediate action was concentrated on:

- Environmental pollution control
- Relocation of residential houses in the critical areas
- Flood control
- Civil defense plan
- Reforestation of Serra do Cubatão
- Study on slope stabilization and its countermeasures

The various components are further outlined below.

(1) Environmental Pollution Control

Purpose

In 1983, CETESB prepared an environmental pollution control plan with the following purposes.

- To achieve appropriate environmental conditions by using effective control measures against the major pollution sources.
- To establish a forecasting system for environmental pollution (public hazard)
- To institute an ordinance on land use and operation in industrial estates.

Program

- Environmental control plan
- Technical assistance for regulation activities
- Environmental education and participation of civil

CETESB is mainly responsible for executing the environmental pollution control program.

(2) Relocation of Residential Houses

The following three areas of Vila Parisi, Jd. São Marcos and Piaçaguera were nominated as the dangerous ones by the Commission. The plan is to relocate houses in these areas into others. Accordingly, the purpose of this plan is to relocate the above houses and to provide alternative residential areas. The program is divided into the four stages. It is proposed that the houses be relocated as follows.

- First stage : 336 houses
- Second stage : 646 houses
- Third stage : 1000 houses
- Fourth stage : others

Cubatão city(PMC) is mainly responsible for the above program.

(3) Flood Control

Purpose

The purpose is to protect the Moji river basin from flood and mud flows and to establish system for utilization of the river networks and O and M of rivers in the Cubatão and Moji basin. This countermeasure is an urgent one. Finally, this program will cover the whole basin of the Cubatão and Moji rivers in a macro drainage plan.

Program

The program consists of the following.

- Flood and drainage control in Moji river
- Flood and drainage control in Pereque
- Flood and drainage control in Piaçaguera
- Flood and drainage control in Cubatão
- Establishment of flood forecasting system
- Hydrological study in the whole basins
- Construction of urgent works(dredging)

DAEE is mainly responsible for the above program.

(4) Civil Defense Plan

The purpose of this plan is to protect residents and industrial estates from disasters and to eliminate situations where accidents to products or stocks could cause dangerous harm to people.

Program

The program consists of the followings.

- Data collection of pollutant sources
- Inventory survey on products and stocks in industrial companies
- Review of urgent plan
- Computerization of various data (Data bank)
- Introduction of communication system

- Inventory survey on infrastructure
- Establishment of network systems for meteorology and hydrology
- Establishment of evacuation system

The above program is mainly the responsibility of CETESB and Cubatão city.

(5) Reforestation of Serra do Cubatão

Purpose

The purpose is to get the basic data on vegetation in order to facilitate restoration of Serra do Mar in Cubatão region. The program is to be proceeded in close cooperation by IBt, CETESB and IPT.

Program

The reforestation program consists of the following components.

- Study on influence of environmental pollution on ecology
- Study on kinds of trees hardy to environmental pollution
- Study on degradation of soil
- Monitoring of air quality
- Experimental planting
- Preparation of vegetation distribution map including locations of landslides

(6) Slope Stabilization and Countermeasures

Purpose

This program aims to study the mechanisms of land slides and the relationship between mountain slope and vegetation in order to restore the rich vegetation of Serra do Mar in Cubatão region. The study is being made mainly by IPT.

Program

The program is divided into the two stages of short-term and long-term. The short-term one is to study basic matters and the long-term one is to undertake stabilization works as well as planting.

The program is as follows.

- Establishment of criteria on reforestation in Serra do Mar in Cubatão region
- Determination of concepts for urgent slope stabilization works
- Study on the mechanism of land slides
- Study on the influence of reforestation on river systems

Further, the program finally aims to restore Serra do Mar in the Cubatão region. At present, some measures are being taken up towards the final target of restoring the vegetation of Serra do Mar in Cubatão region. These measures are mainly air pollution control and experimental planting. Such measures will be to continue to create strong and stabilized mountain slopes covered by rich vegetation to prevent future disasters.

5. CONSIDERATION ON EVACUATION PLAN

In order to eliminate or mitigate damage which will be brought by unexpected disaster, an evacuation and management plan has been provided by governmental agency.

The existing evacuation and management plan (civil defense plan) has been well developed as shown in Figs.C.7 and C.8. With due consideration of the existing plan, the following matter could be said for the further stages.

(1) Periodical adjustment of warning curves

The criteria curves on warning as shown in Fig.C.7 could be improved in order to raise its reliability by collecting further data of the relationships among rainfalls, land collapse, sediment runoff, flood runoff and so on.

(2) Flow of general information

Exact and prompt information is desirable to transmit to inhabitants and companies time to time. It seems that information has been eccentrically distributed to governmental sides.

(3) Judgment system

The existing judgment system has been set up accurately and carefully, but, items to be judged are so much and complicated. Consequently, this matter could be made judgment complicated. Therefore, it is recommended to simplify judgment items for prompt judgment. In future, judgment itself should be transfered to COMDEC.

(4) Campaign for enlightenment and training

Campaign for enlightenment and training must be carried out to smoothly and effectively proceed actual evacuate activity.

Campaign will be mainly made for inhabitants and companies in view of enlightenment and preparedness for disasters.

Also demonstration of evacuation is periodically needed participating governmental side, companies and inhabitants.

(5) Others

For effective carrying out of the warning and evacuation systems, the following will also be helpful materials.

- Preparation of hazard map or risk map and its announcement.
- Confirmation of stored food, cloth, medicine and so on for refugee.

TABLES

TABLE C.1 LIST OF COMPANIES WHICH INTAKE WATER FROM CUBATÃO AND MOJI RIVERS

River/Company	Intake Volume (m3/S)	Outlet Volume (m3/S)
Cubatao River		
- Cia Santista de Papel	0.08	0.08
- Carbocloro S/A Inds. Quim.	0.32	0.33
- Petroleo Brasileiro S/A	6.80	3.34
- Petrobras Quimica S/A-Petroquisa	1.80	1.81
- Cia Brasileira de Estireno	0.90	0.90
- Sabesp	3.50-3.80	
- Subtotal	13.40-13.70	
Pereque River		
- Cimento Santa Rita S/A	(0.01)	0.01
- Petrobras	0.14	
- Alba Adria S/A Inds. Reunidas Ind. e Com.	0.03	0.01
- Union Carbide do Brasil S/A	0.11	0.05
- Subtotal	0.29	
Moji River		
- Cosipa	5.50-7.00	
- Iap S/A Ind. de Fertilizantes	0.10	
- Manah S/A Com. e Ind.	0.06	
- Ultrafertil S/A Ind. e Com. de Fertilizantes	0.26	
- Cia Petroquimica Bras.	0.20	
- Bayer do Brasil Inds. Quim. S/A	0.40	0.26
- Subtotal	6.52-8.02	
Piacaguera River		
- Ultrafertil S/A Ind. e Com. de Fertilizantes	0.07	0.07
- Cia Petroquimica Brasileira	0.54	
- Fertilizanters Uniao S/A	0.003	0.003
- Subtotal	0.613	
Cor do Indio		
- Ultrafertil S/A Ind. e Com. de Fertilizantes	0.06	
- Iap S/A Ind. de Fertilizantes	(0.10)	0.10
- Subtotal	0.17	
Grand Total	20.983-22.783	

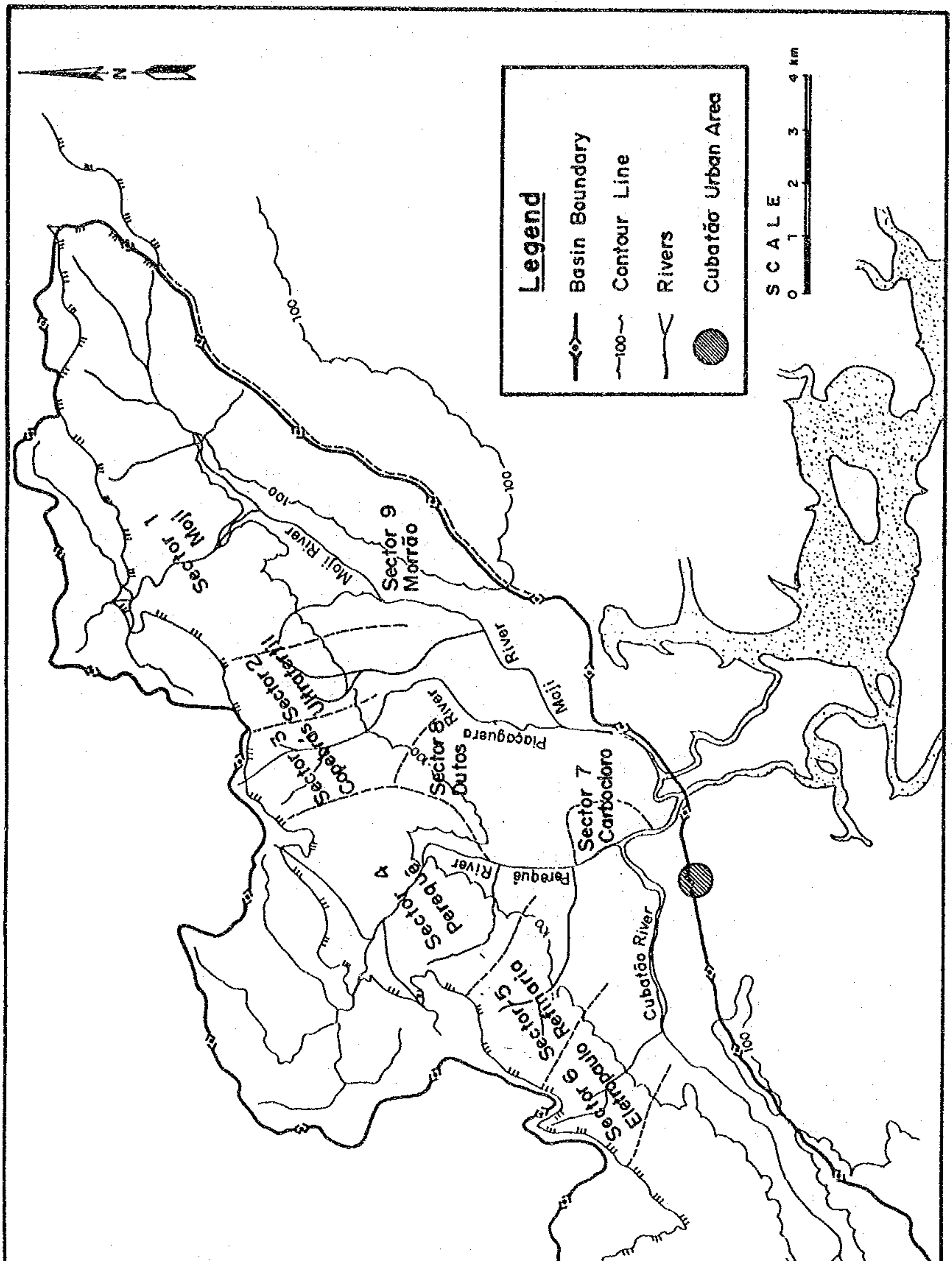
Note: ( ) is estimated based on the outlet volume

TABLE C.2 DIMENSIONS OF MAJOR BRIDGES

Location (Distance from confluence. Km)	Purpose	Dimension		
		Width (m)	Length (m)	Elevation Girder (m, IGGSP)
Cubatao River *1				
0.670	Railway	20.0	100	4.65
2.755	Road	25.0	150	5.00
3.340	Railway			
3.375	Road	24.0	110	6.51
3.775	Road	8.4	58	7.00
5.575	Road	5.7	81	4.50
5.740	Road	20.0	60	6.28
7.230	Road			
Pereque River				
0.815	Railway	6.7	70	4.50
0.950	Road	8.5	55	4.50
1.000	Railway			
1.015	Road	8.5	55	4.50
Moji River *1				
3.435	Road	11.0	115	4.58
4.855	Road	9.5	40	4.60
4.985	Railway	9.5	69	3.70
5.655	Road Flyover	11.0	300	7.35
6.400	Road Flyover			
6.425	Road			
6.815	Railway	5.15	67	5.40
Piasaguera River				
0.31	Railway	10.5	40	1.90
0.63	Road	5.0	20	1.95
1.42	Road	5.6	12	2.60
1.76	Road	46.5	5	2.15

Note; Distance in *1 is from confluence of cubatao and Moji rivers.

FIGURES



Source : Measures for Restoring the Serra do Mar by Special Comission and CETESB.

FIG.C.1
SECTORIAL DIVISION OF PROTECTION WORKS BY SPECIAL COMMISSION

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

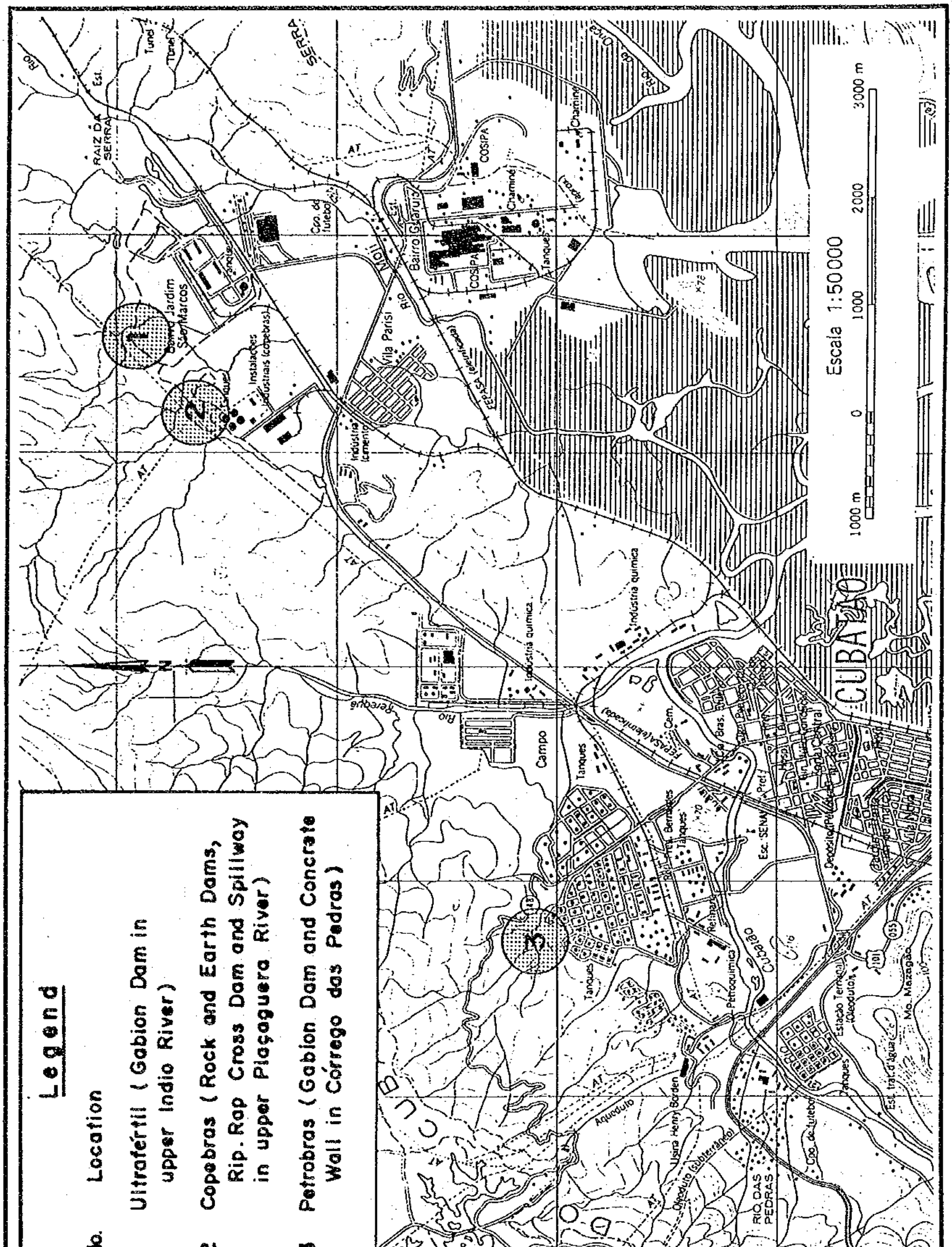


FIG.C.2
LOCATIONS OF MAJOR SEDIMENT TRAPPING STRUCTURES

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

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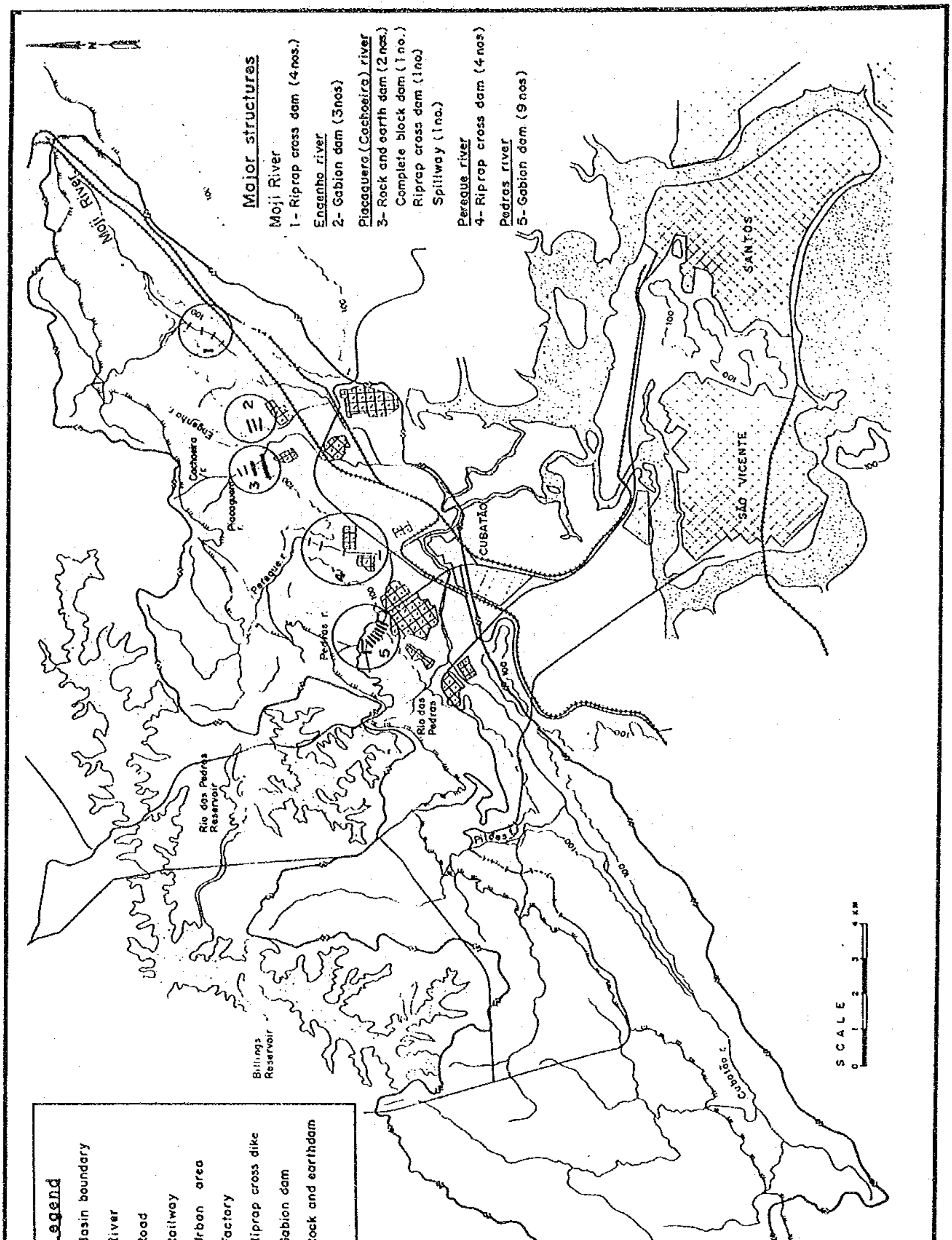

FIG.C.3
LOCATIONS OF STRUCTURES FOR SEDIMENT RUN-OFF

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

JAPAN INTERNATIONAL COOPERATION AGENCY

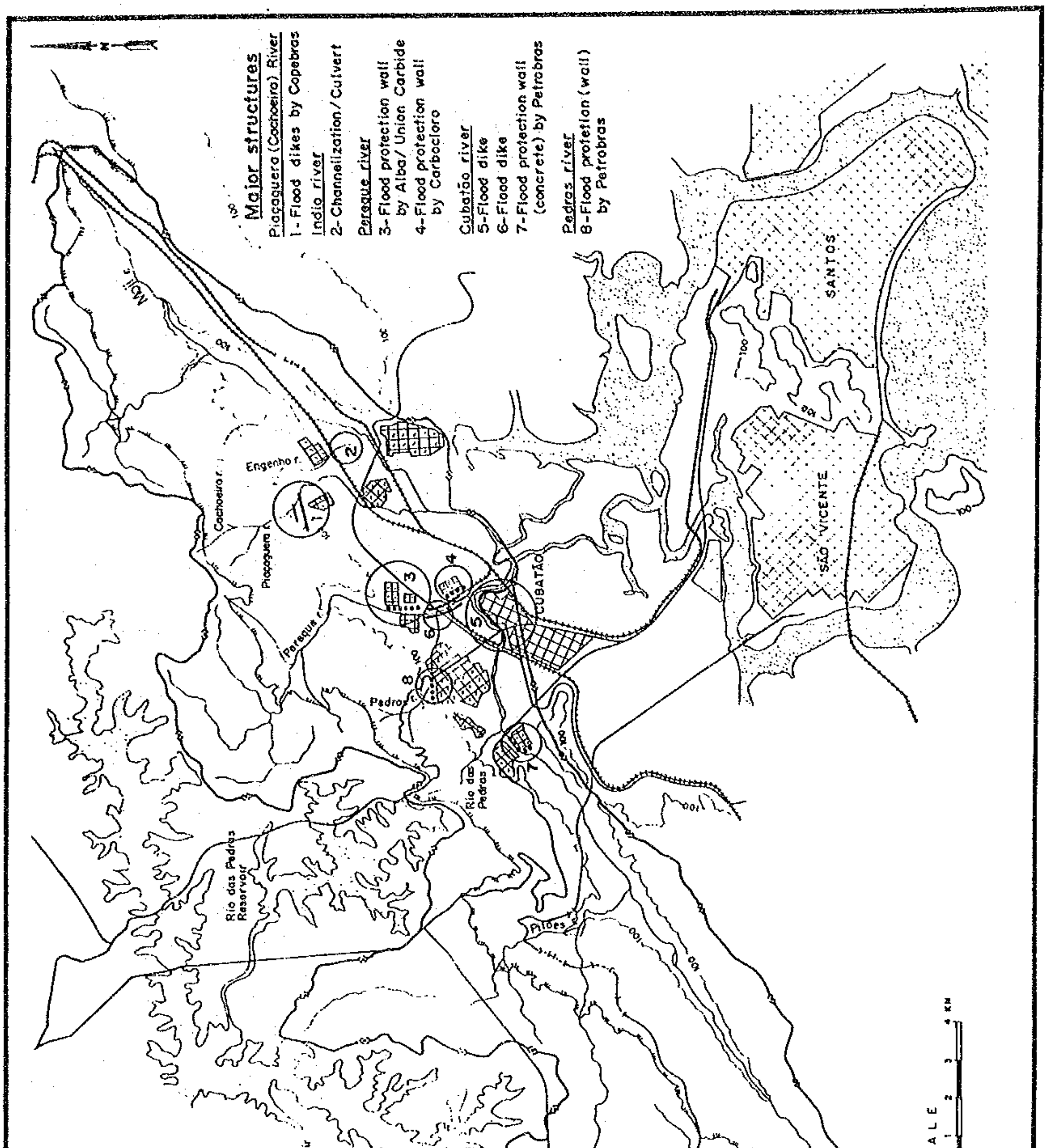

FIG.C.4
LOCATIONS OF STRUCTURES FOR FLOOD CONTROL

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

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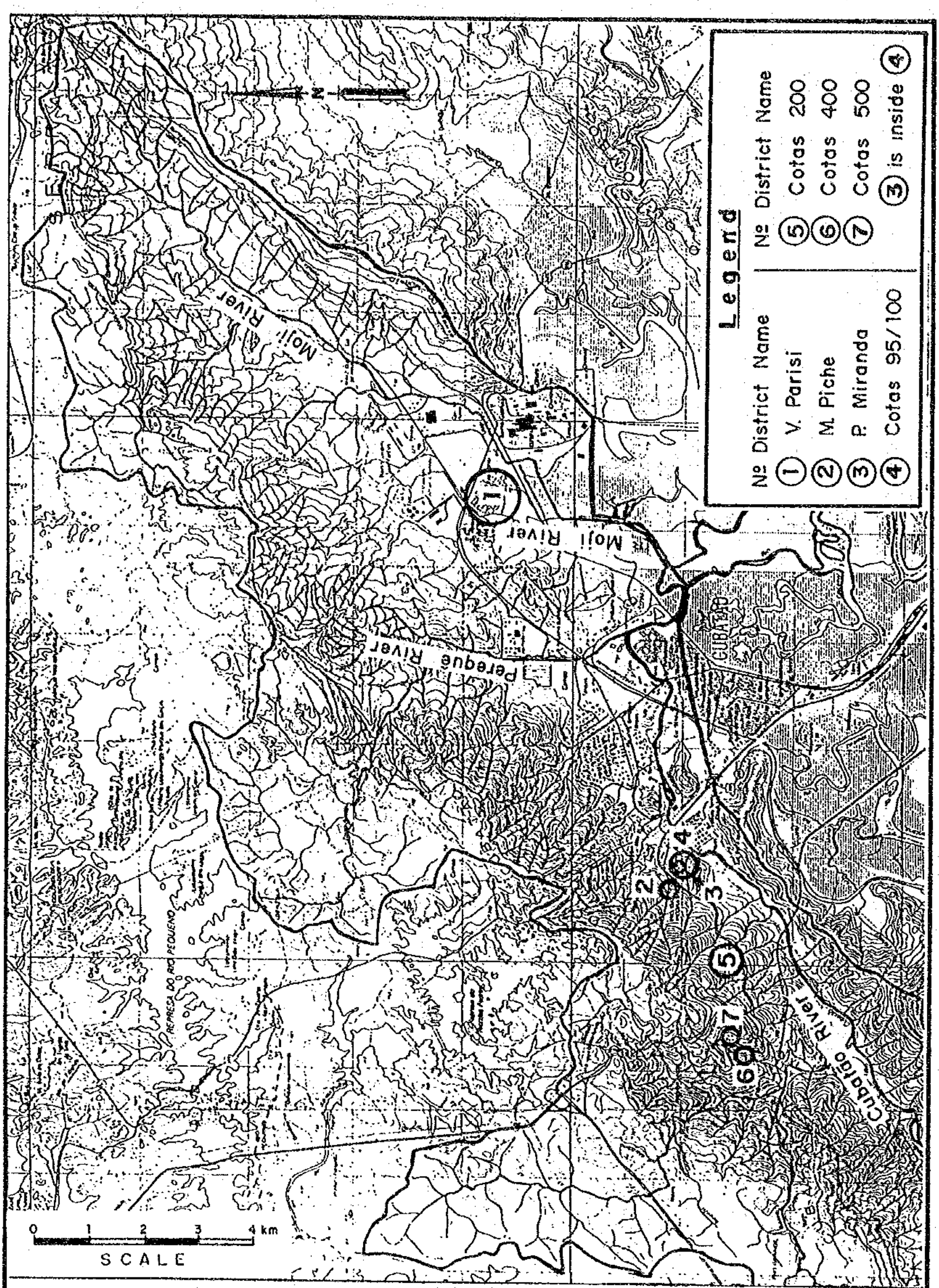

Source : Cubatão Municipal City Hall / IPT

FIG.C.5
RESIDENT AREAS TO BE RELOCATED

GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL

THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO

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