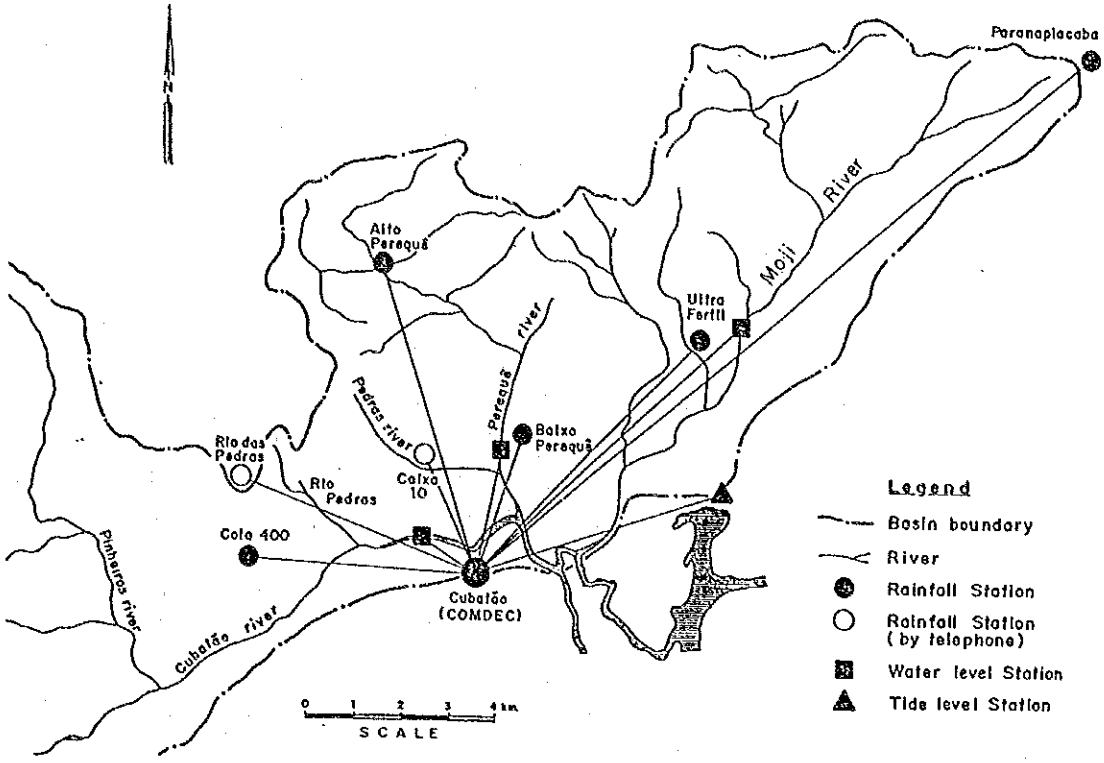
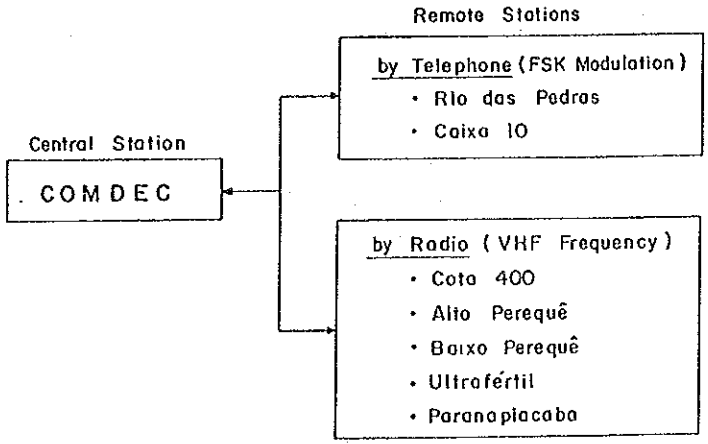




Note:

① Central Station Receives Data and Transmits Orders for Remote Stations.

② Central Station Collects Data From all Remote Stations and Emits a Report Each 30 Minutes.

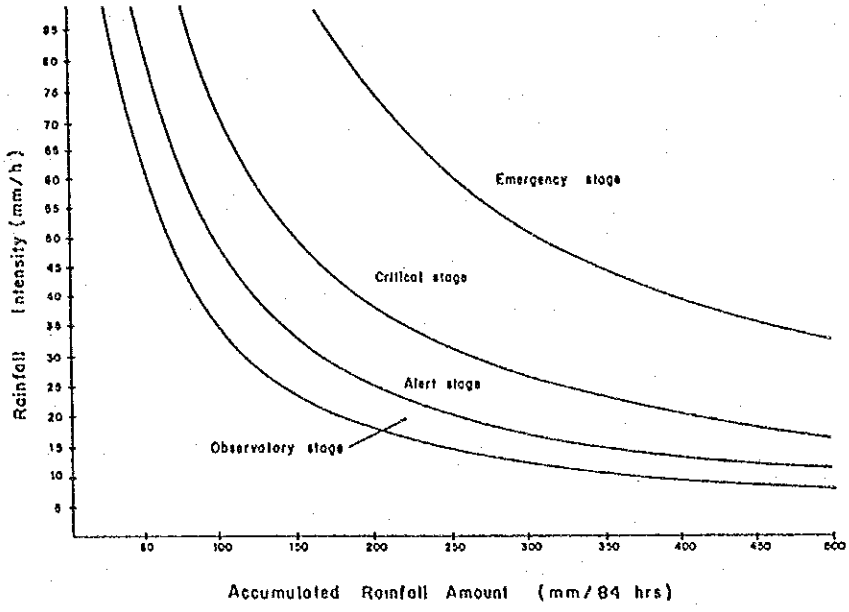
③ Data Collecting System in Remote Stations
Rainfall Depth : Bucket Type
Tide and Water Level : Float Type

Source: DAEE

FIG.C.6
TELEMETERING SYSTEMS OF CUBATAO 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

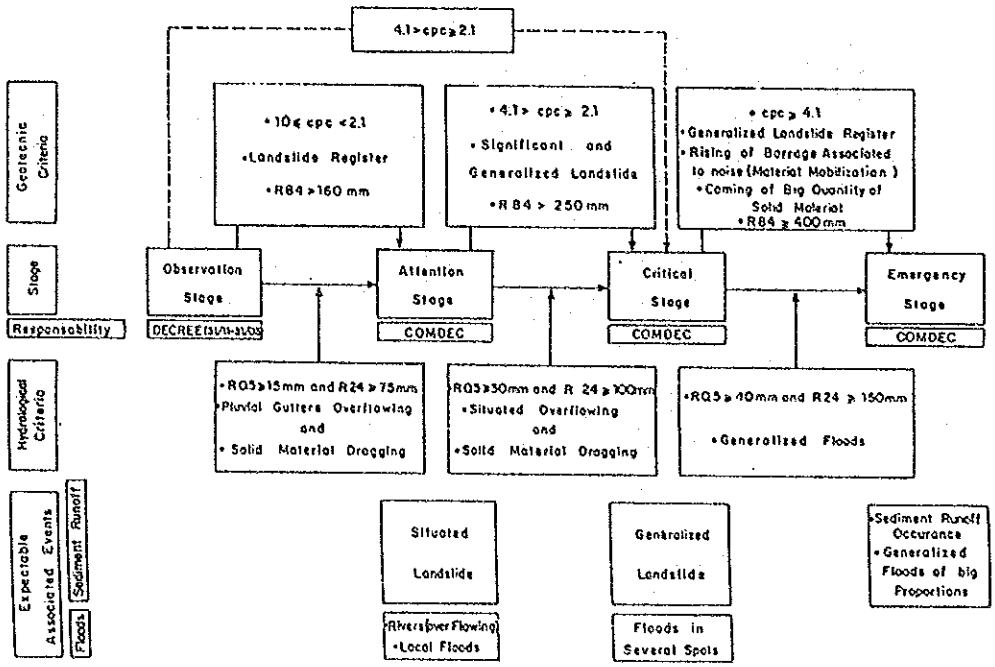
Guide Line Curves of Warning System



Source : Divisão de Operações de Risco (EO) in Cetesb

Action Flow Chart of Civil Defence Plan

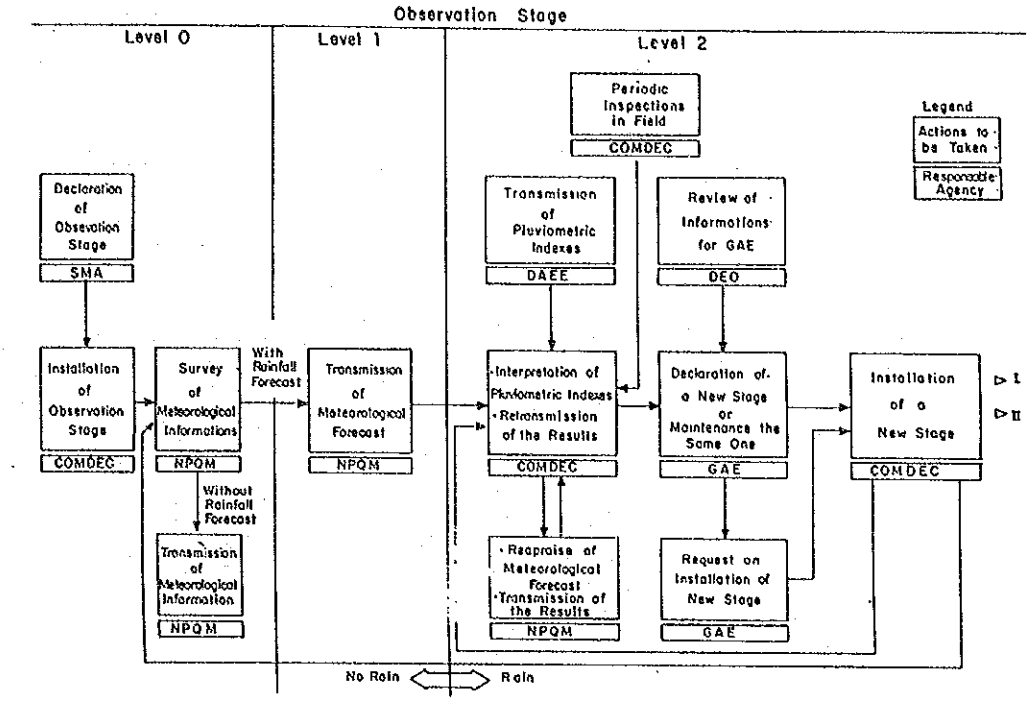
Criteria on Changing Stages

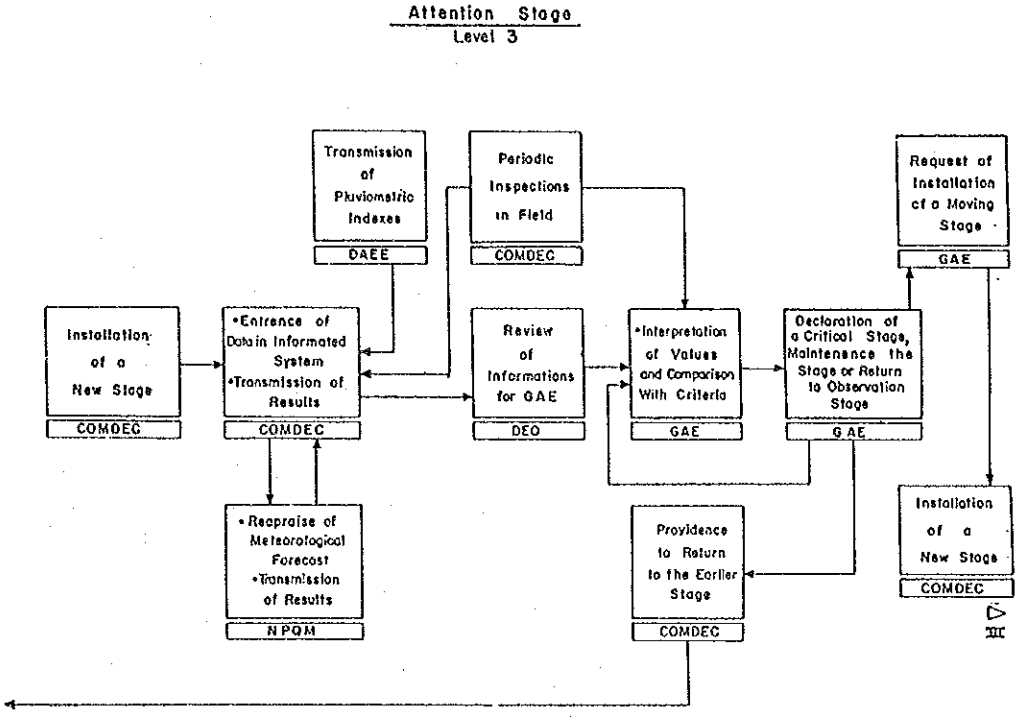


Source: Secretariat of Environment (SMA) and CETESB

FIG.C.7
GUIDE LINES OF WARNING SYSTEMS
OF CUBATAO 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

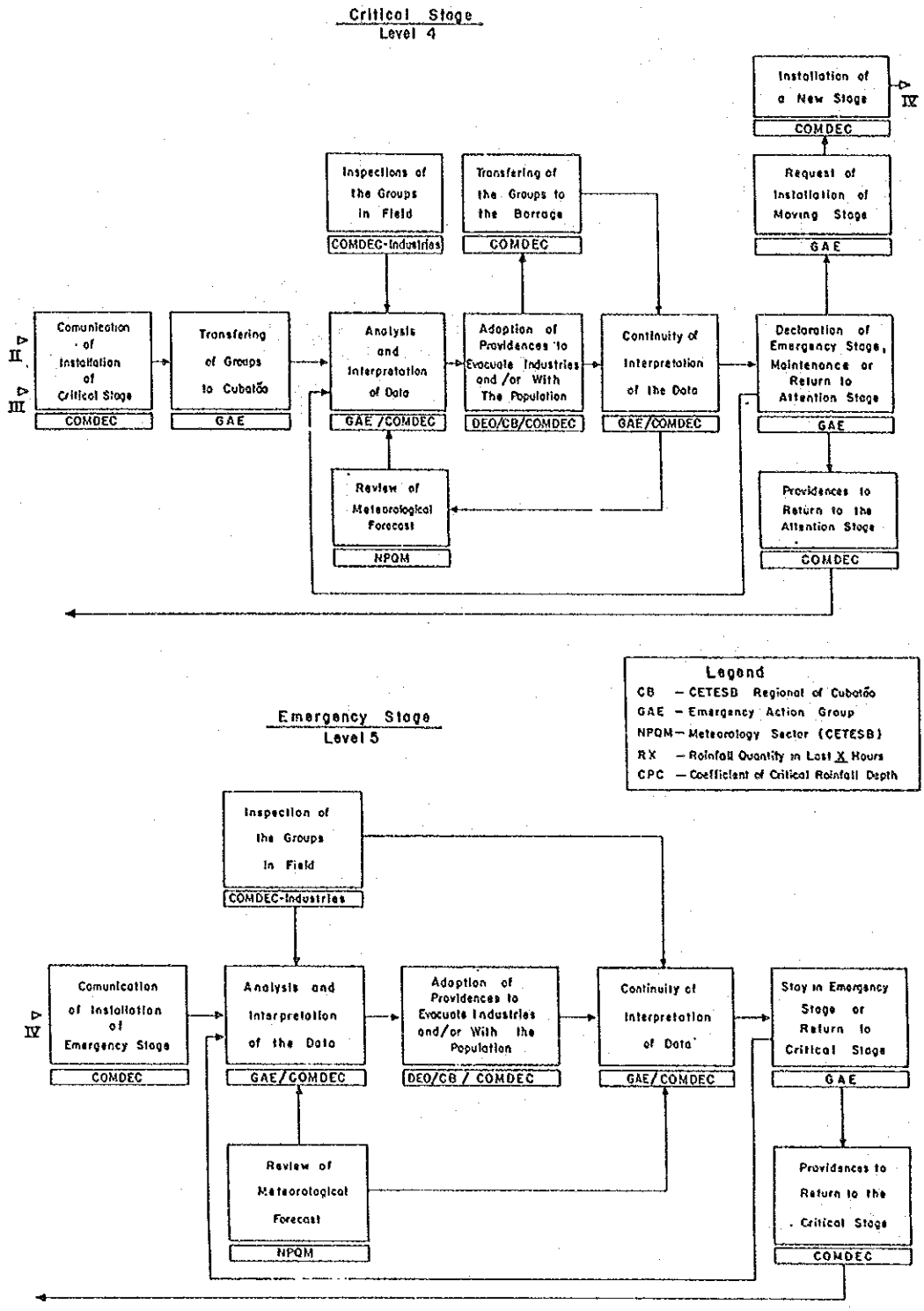




Source: Secretariat of Environment (SMA) and CETESB

FIG.C.8 (1/2)
ACTION FLOW CHART OF CIVIL DEFENSE PLAN

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



Source: Secretariat of Environment (SMA) and CETESB

FIG.C.8 (2/2)
ACTION FLOW CHART OF CIVIL DEFENSE PLAN

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

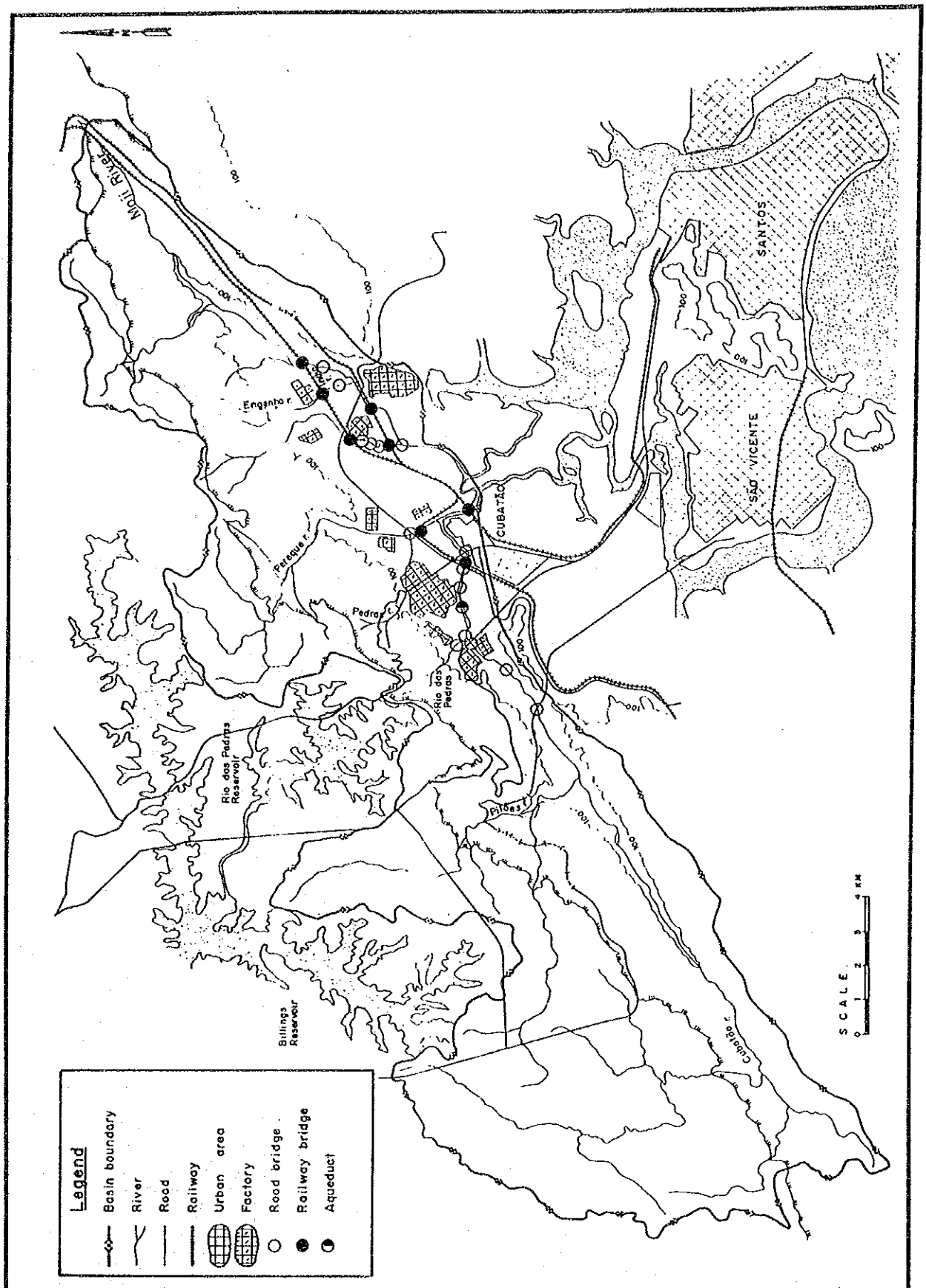


FIG.C.9 (1/2)
MAJOR RELATED FACILITIES

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

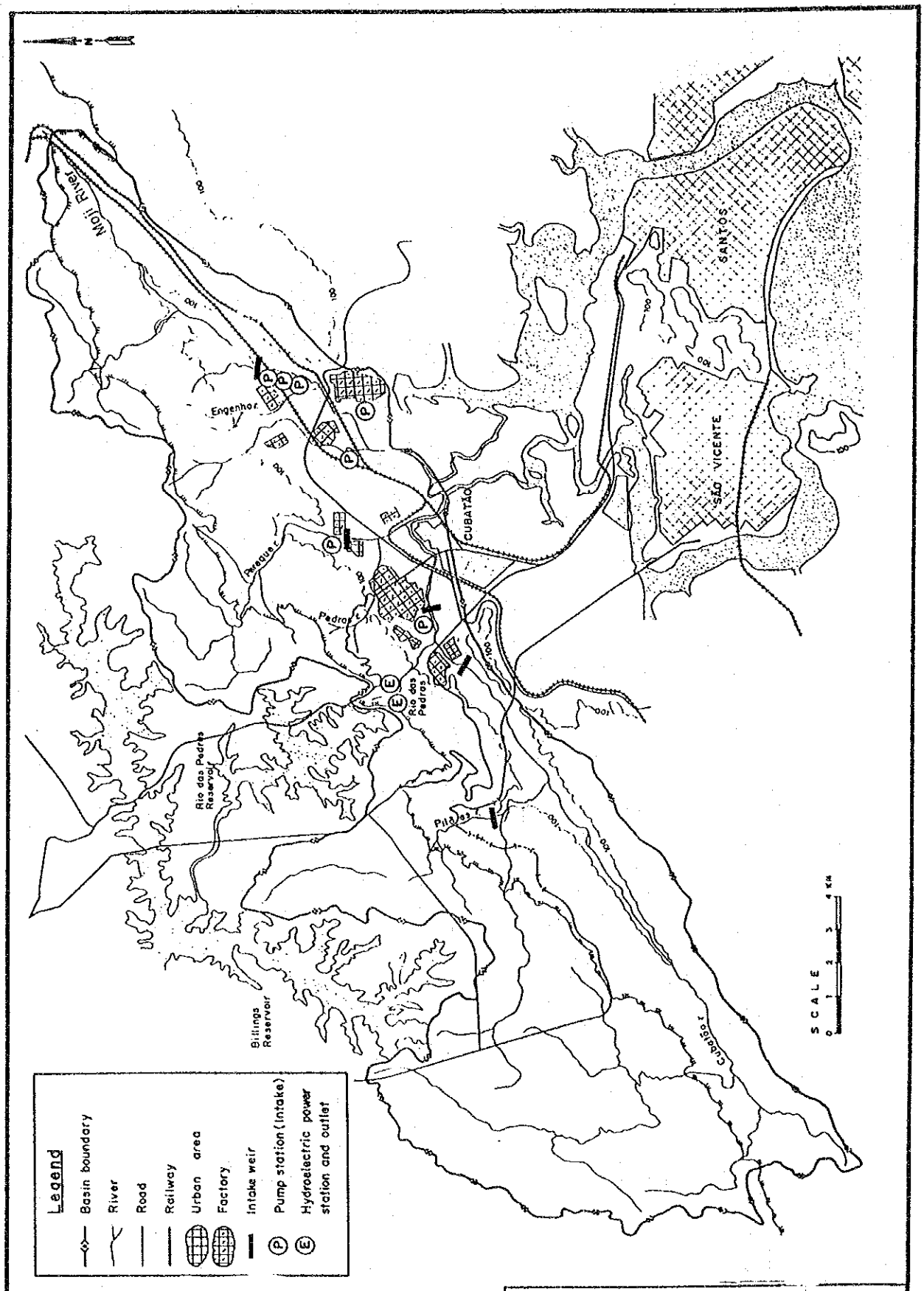
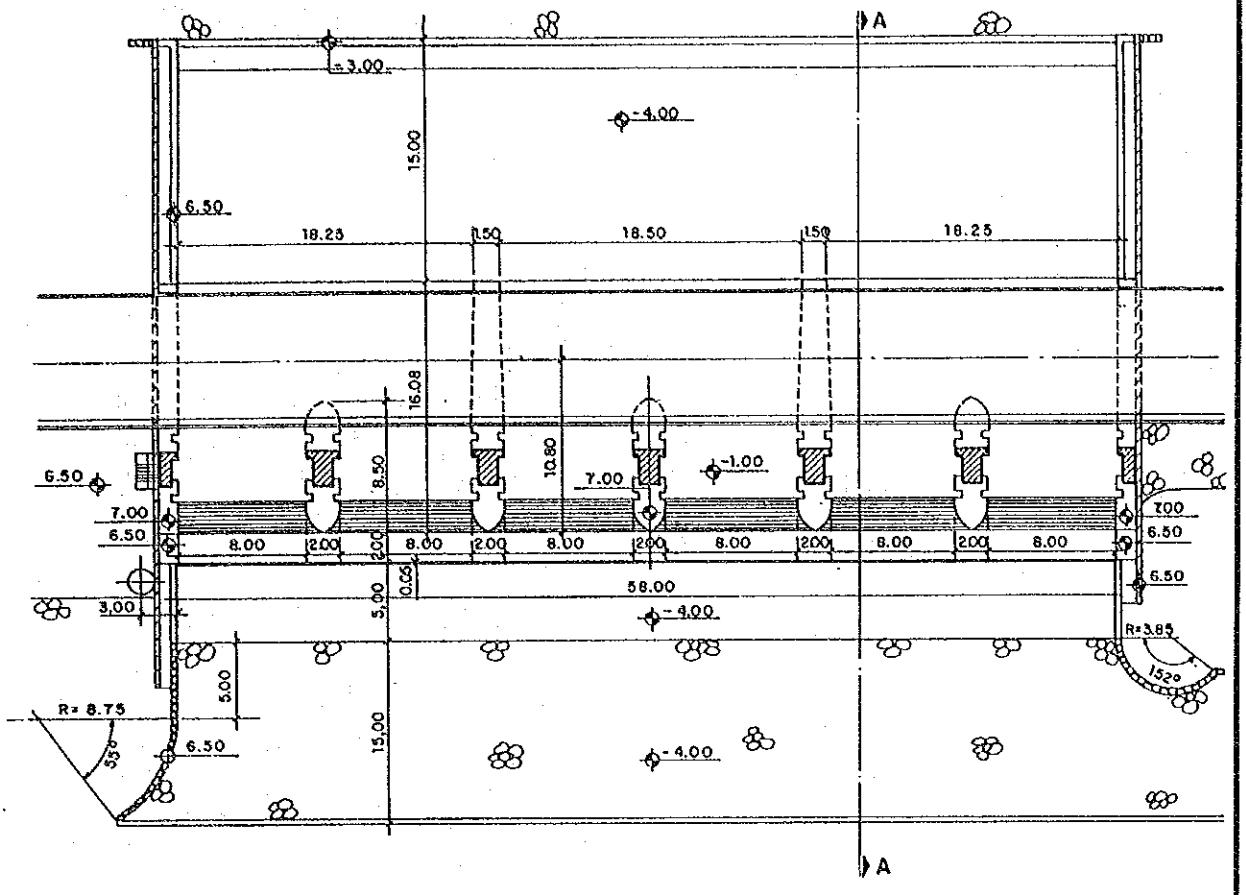
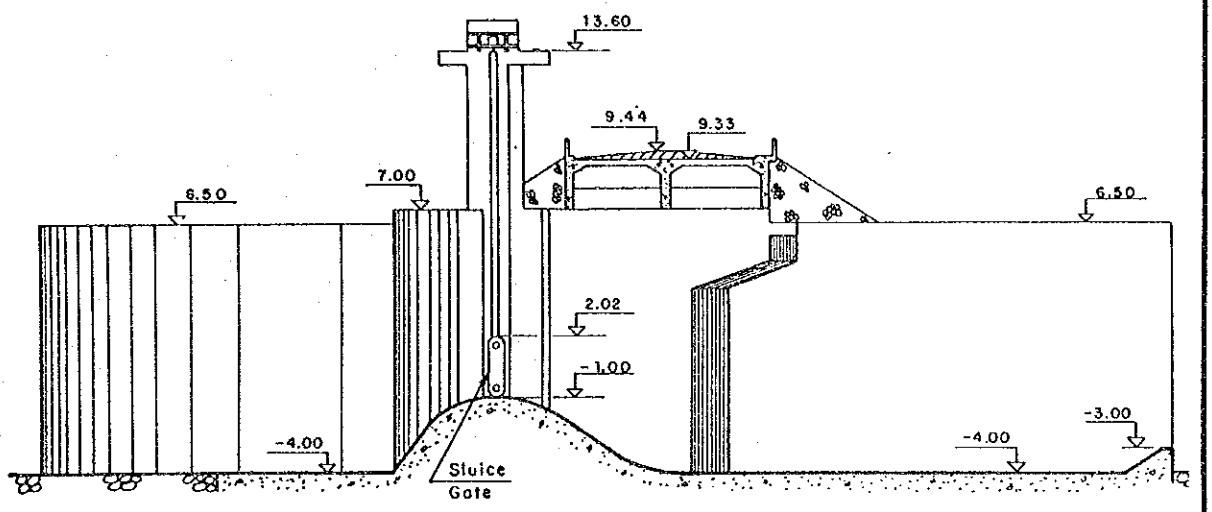


FIG.C.9 (2/2)
MAJOR RELATED FACILITIES

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





Section "A-A"

Source: PETROBRÁS

FIG.C.10
PETROBRAS INTAKE WEIR

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

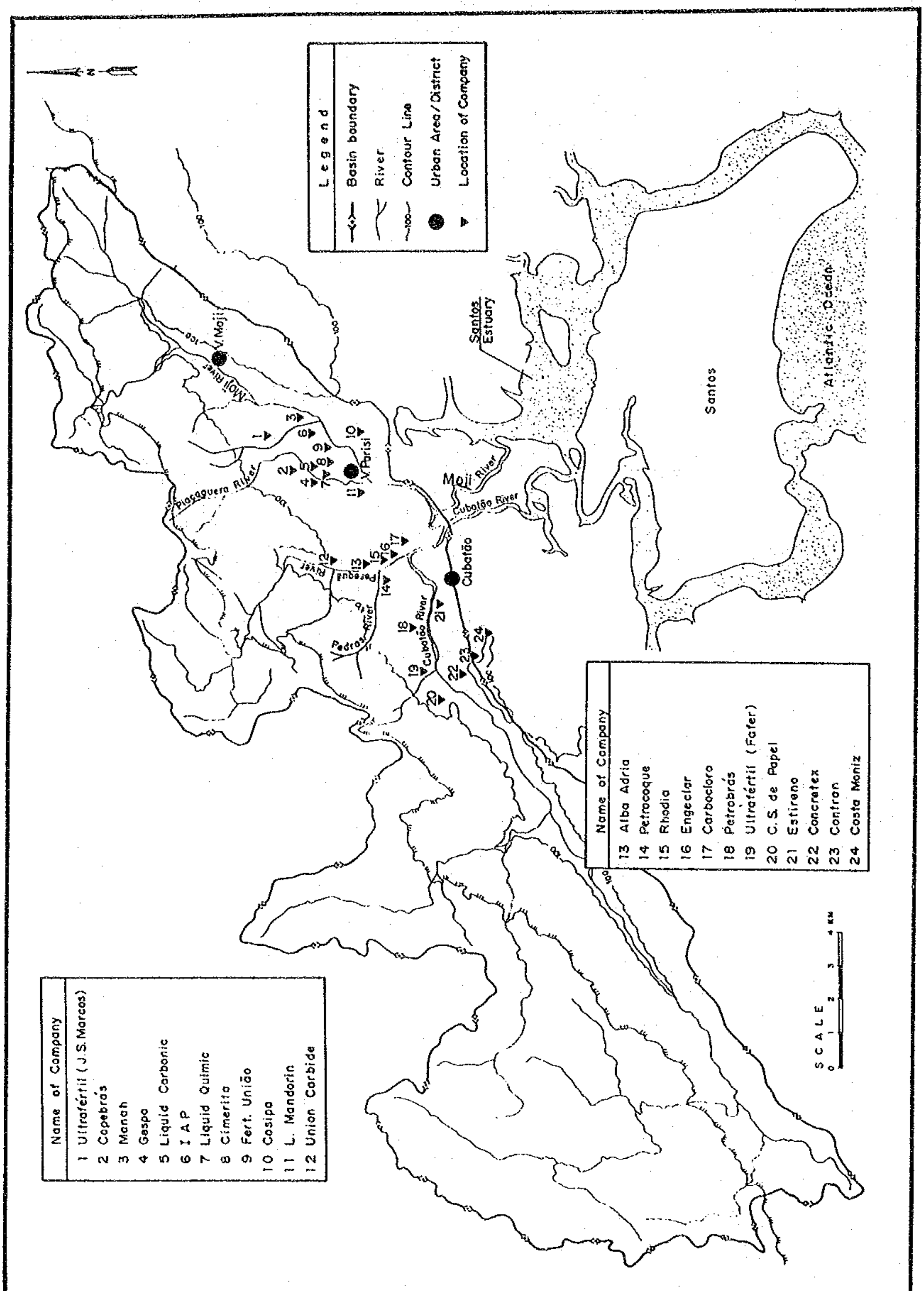
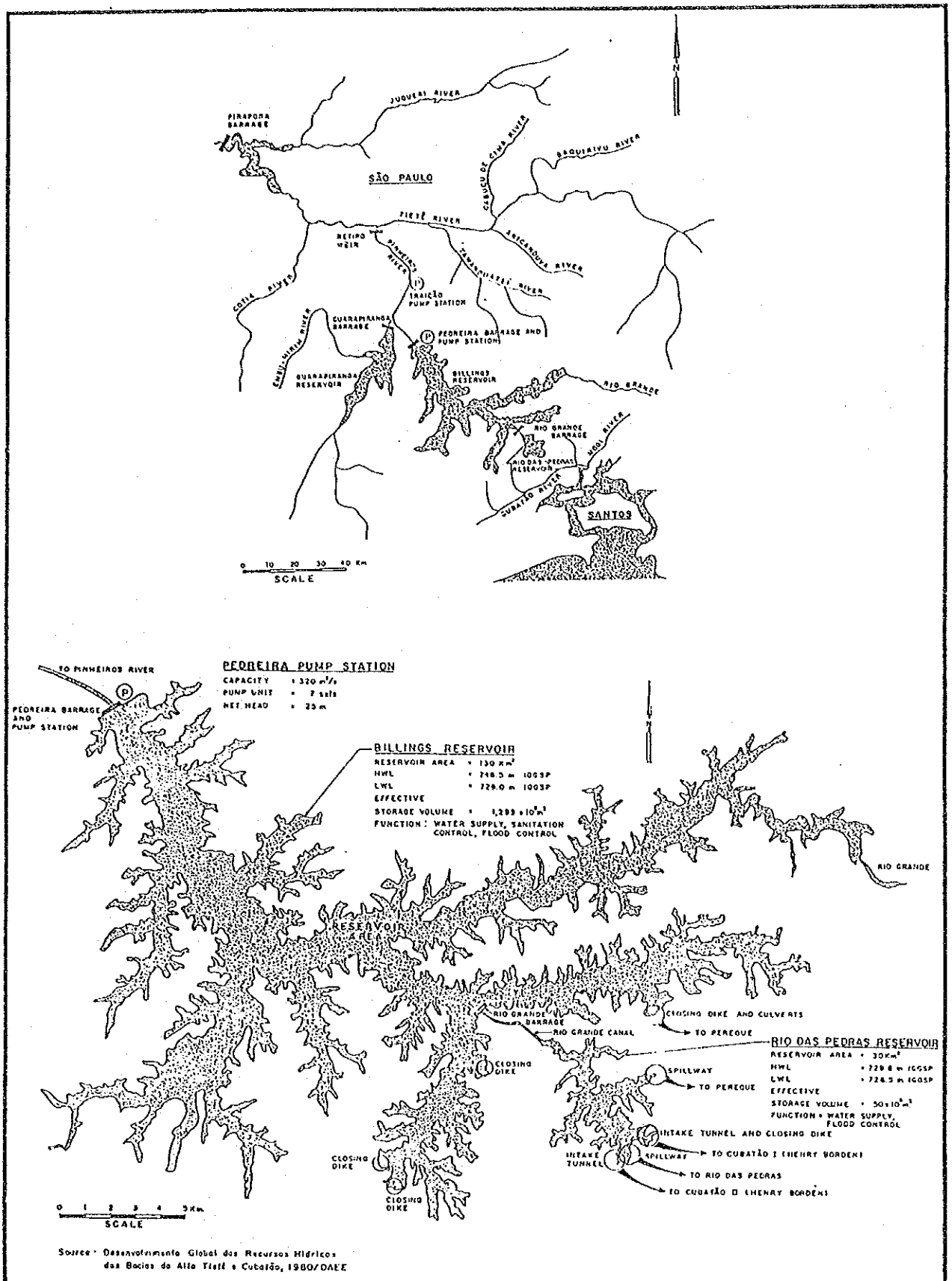


FIG.C.11
LOCATIONS OF MAJOR INDUSTRIAL ESTATE IN THE BASIN

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

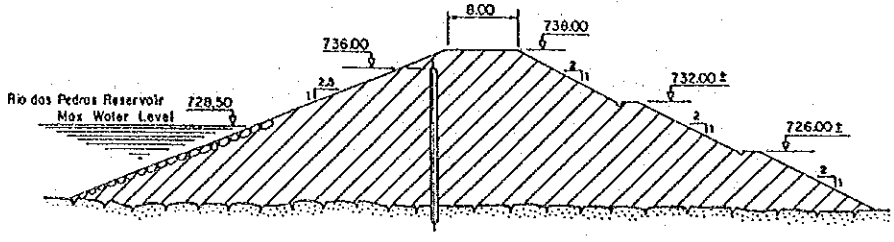


Source : Desenvolvimento Global dos Recursos Hídricos das Bacias do Alto Tietê e Cubatão, 1980/DAEE

FIG.C.12
TIETE RIVER AND BILLINGS RESERVOIR SYSTEM

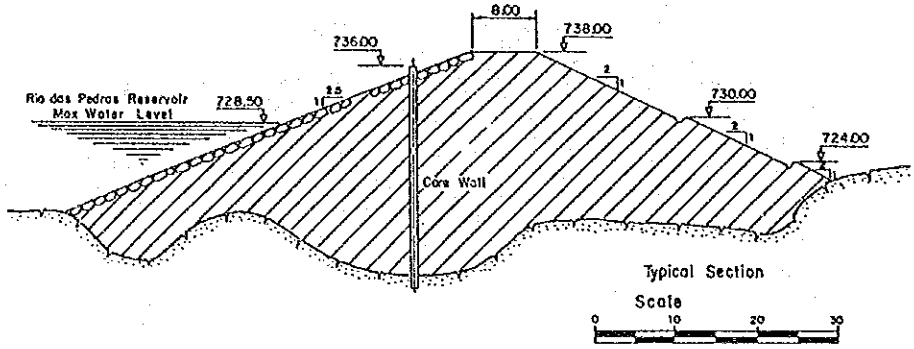
GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO
JAPAN INTERNATIONAL COOPERATION AGENCY

Closing Dike 1 — Closing Dike Near Henry Borden Intake (Cubatao I)



Typical Section

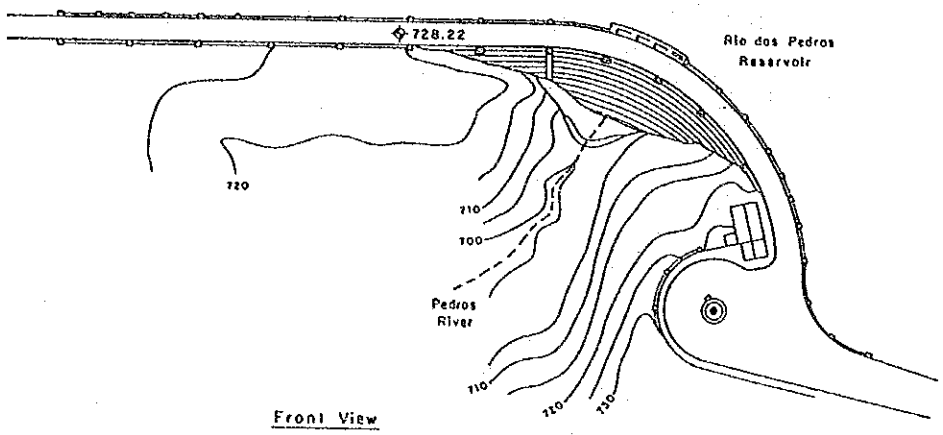
Closing Dike 2



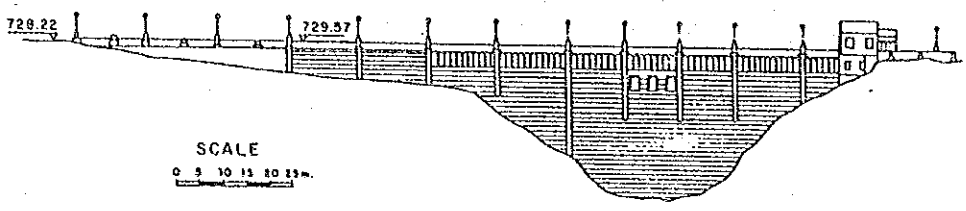
Typical Section

Scale

General Plan of Spillway — Spillway at Uppermost of Rio das Pedras River



Front View

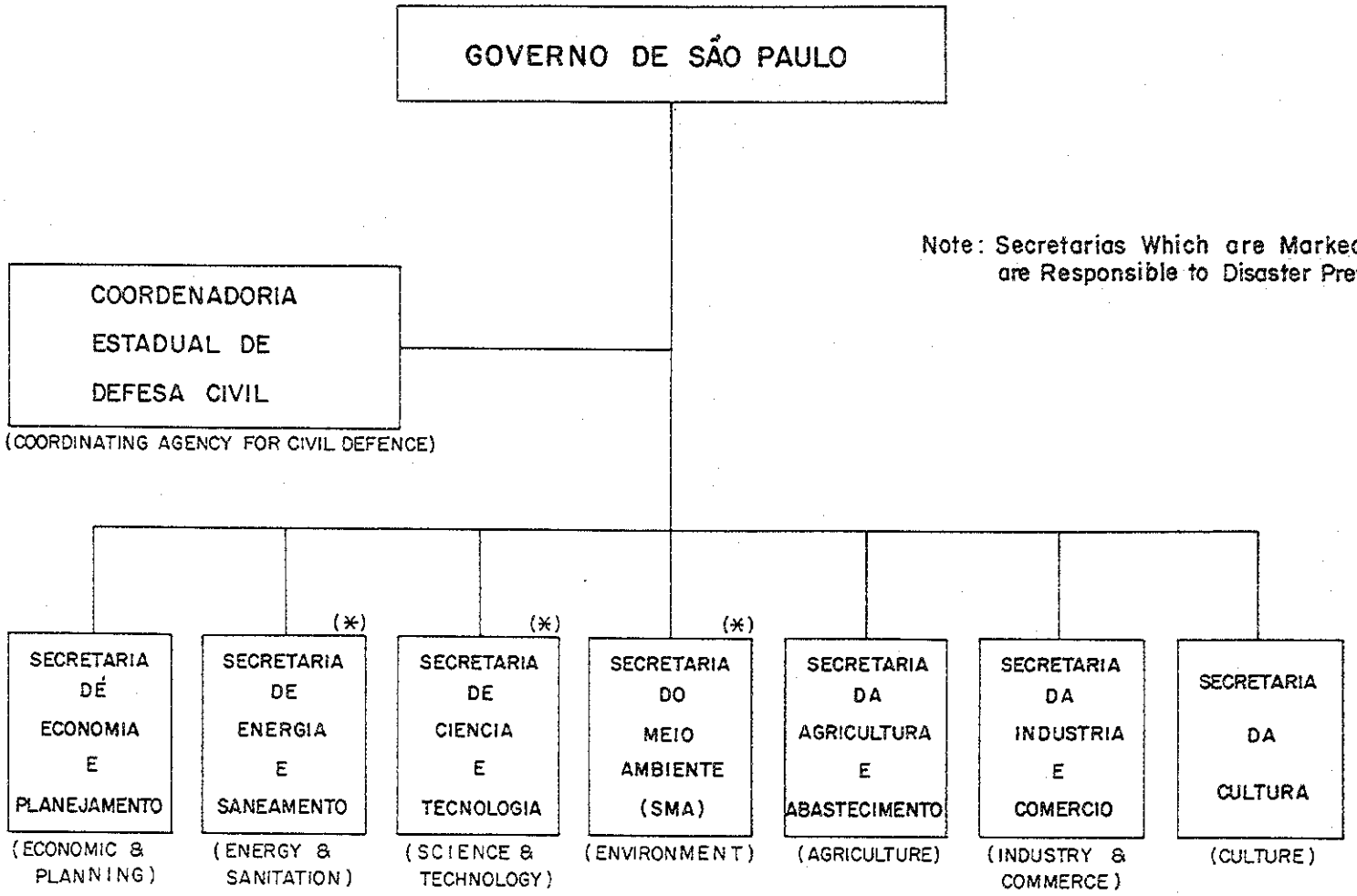


Source - Eletricidade de São Paulo S.A. (ELETROPAULO)

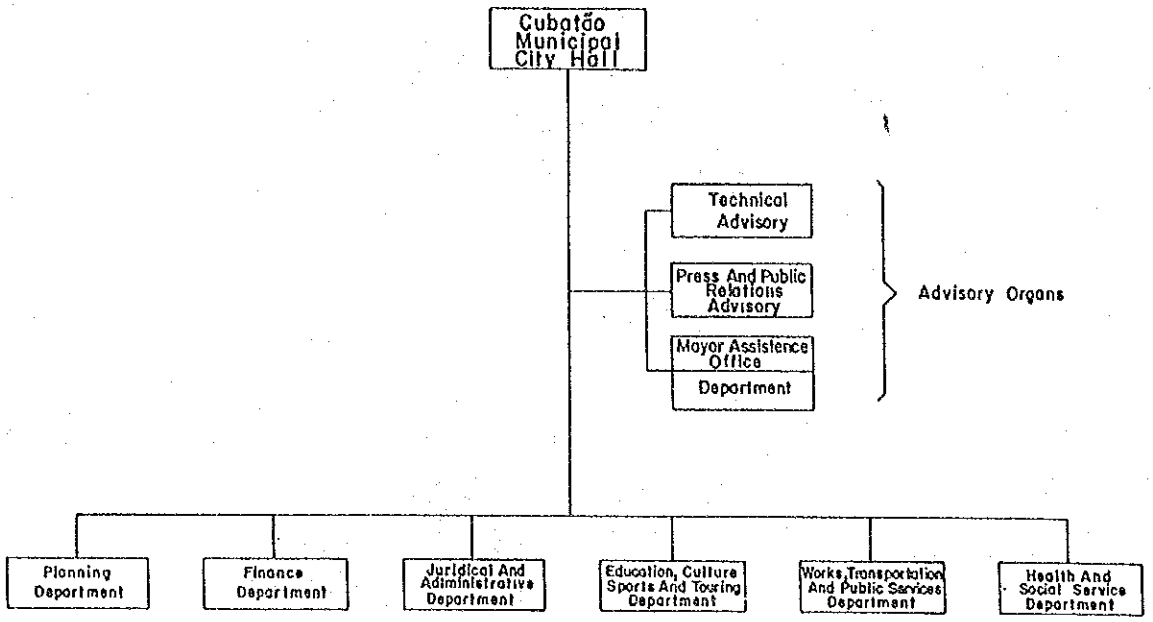
FIG.C.13
CLOSING DIKES AND SPILLWAY ALONG RIM OF BILLINGS RESERVOIR

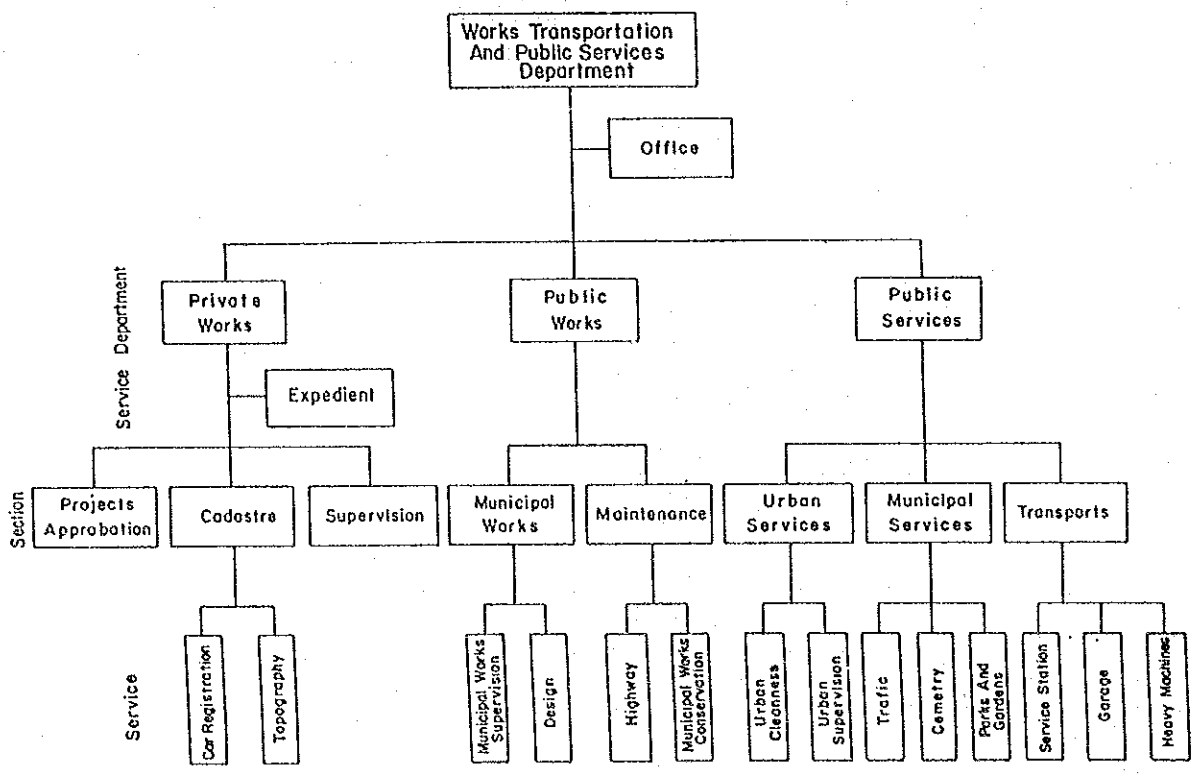
GOVERNMENT OF FEDERATIVE REPUBLIC OF BRAZIL
THE STUDY ON THE DISASTER PREVENTION AND RESTORATION PROJECT IN SERRA DO MAR, CUBATÃO REGION, STATE OF SÃO PAULO
JAPAN INTERNATIONAL COOPERATION AGENCY

FIG.C.14
ORGANIZATION CHART OF
SÃO PAULO STATE



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





Source: Cubatão Municipal office

FIG.C.15
ORGANIZATION CHART OF
CUBATÃO CITY HALL

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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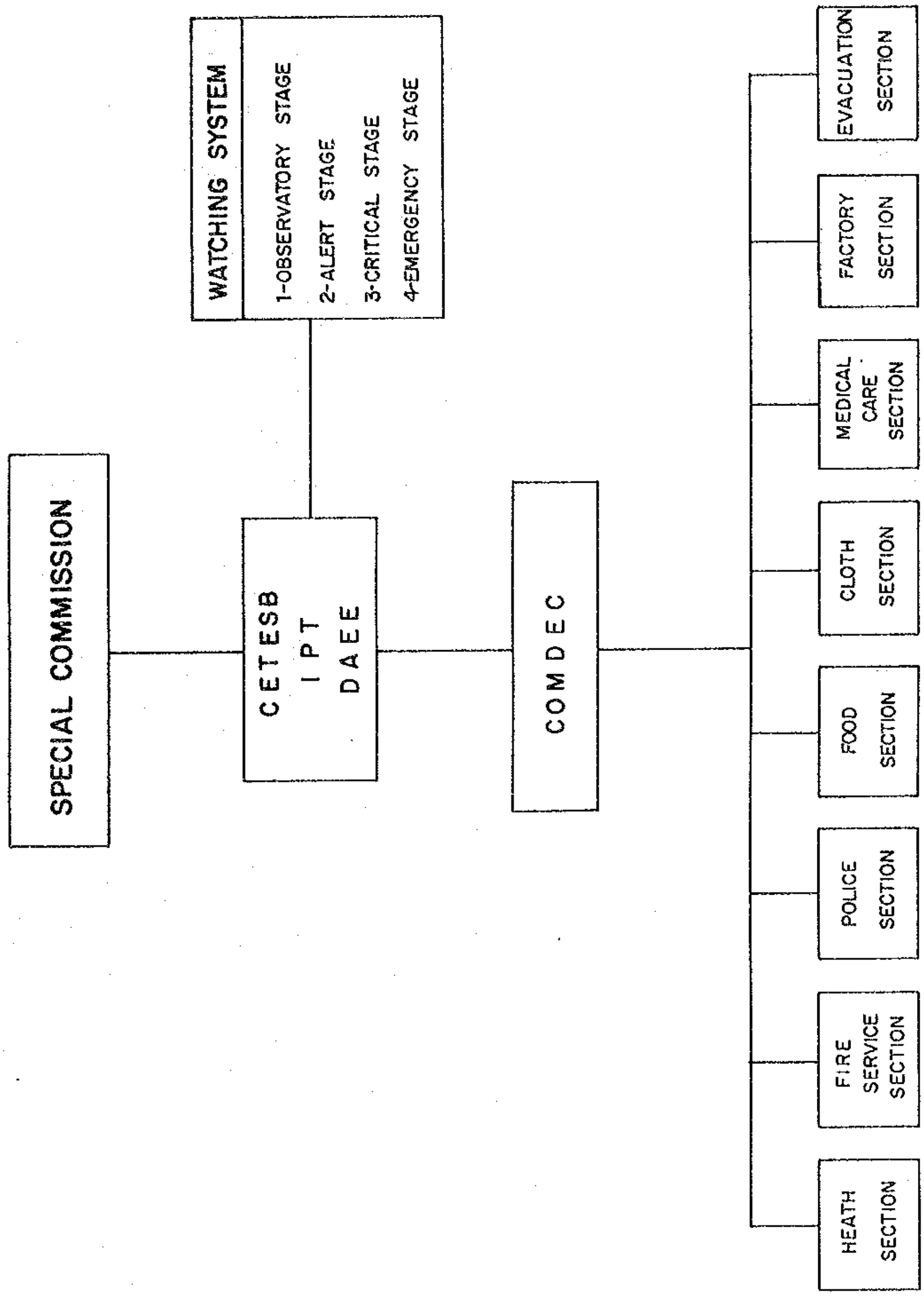


Source : Cubatão Municipal Civil Defence Commission (Comdec)

FIG.C.16
ORGANIZATION CHART OF
COMDEC IN CUBATÃO

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 D

TOPOGRAPHIC SURVEY

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

This ANNEX-D presents the results of the topographic survey carried out by the study team for the master plan from the beginning of December 1989 to the end of February 1990. Topographic mapping was carried out for the feasibility study from the end of July through the beginning of September.

The objectives of the topographic survey were as follows:

(1) Collection of available data such as aerial photographs and topographic maps;

(2) Photogrammetric mapping on a scale of 1:5,000, with contour intervals of 1m in the plain and 5m in the mountain area;

(3) Cross sectional survey of about 53km in total length, 220 sections, from the estuary of the Cubatão and the Moji Rivers to their upper reaches;

(4) Topographic mapping on a scale of 1:500, with contour intervals of 1 m;

From the above survey works, the photogrammetric mapping and cross sectional survey were undertaken by a Brazilian local contractor under supervision of the study team. The survey area is shown in Fig D.1.

2. DATA COLLECTION AND REVIEW

The existing topographic maps and aerial photographs were collected from IBGE and other agencies concerned.

The list of the collected topographic maps and aerial photographs are shown in Tables D.1 and D.2, respectively.

The existing cross sectional survey data was obtained from DAEE. This data was significant for the determination for the cross sectional survey lines. The list of the collected data are shown in Table D.3. The index map of the collected topographic maps is shown on Fig. D.2.

3. PHOTOGRAMMETRIC MAPPING AND CROSS SECTIONAL SURVEY

3.1 Photogrammetric Mapping

3.1.1 Aerial photographs

The existing aerial photographs, on a scale of 1:10,000, shot by ELETROPAULO in 1987 and on a scale of 1:35,000 shot by the government of São Paulo state in 1980, were used for the photogrammetric mapping as original aerial photographs. The mapping area of 100km2 shown on Fig D.3 was determined from the viewpoints of the sediment run-off and flood prevention studies.

3.1.2 Ground control survey

Ground control surveys were done using the following standard.

- Vertical: Imbituba, Santa Catarina;
- Horizontal: SAD-69 (South American data in 1969)
- Projection: Universal Transverse Mercator (UTM)

The coordinates of the ground control points surveyed are listed in Table D.4.

The horizontal control survey was carried out by traverse survey method and these control points were marked by concrete pegs for later continuous field works. On the other hand, the vertical control survey was made by direct leveling from national bench marks.

The following equipment was used for the ground control survey:

- Distance measure: Geodimeter (Swedish), CMW (American)
- Angle measure: Theodolite T-2 (Swiss)
- Leveling : Auto-Level NA-2 (West German)

3.1.3 Field classification

Prior to the execution of field classification, a deliberation was held with staff members regarding the map symbols and the application rules. The data gathered by the field classification was

edited on to the enlarged aerial photographs with water-resistant ink.

3.1.4 Aerial triangulation

The aerial triangulation based on the ground control survey was executed for topographic mapping on a scale of 1:5,000. As for the method of aerial triangulation, the independent analytical method, PAT-M-43, which was developed by Prof. Ackerman of Stuttgart University, West Germany, was applied.

The following equipment was used for the aerial triangulation:

Point transfer device	: PUG-4 (Swiss)
Observation	: Autograph A-10 (Swiss)
Recorder	: EK-22 (Swiss)
Computer	: VAX 11/730 (American)

3.1.5 Restitution

The mapping was carried out based on the aerial triangulation. The topographic features were plotted using Autograph A-10 (Swiss) and Stereo plotter A-8 (Swiss).

3.1.6 Scribing

The topographic map manuscript on a scale of 1:5,000 was produced by scribing. Scribing was carried out by establishing direct continuity to scribing sheets.

3.2 Cross Sectional Survey

3.2.1 Field work

Cross sectional surveys were carried out along the Cubatão, the Moji, the Perequê and the Piaçaguera Rivers and their tributaries.

The intervals of the cross sections were basically about 200-300m. The temporary bench marks (hereinafter referred to as T.B.M) were driven in both banks of each river. The coordinates of T.B.M were

obtained by the traverse survey. The deep water area was surveyed by sounding.

The following equipment was used for the cross sectional survey.

- Distance measure: Geodimeter (Swedish),
- Angle measure : Transit T-1A (Swiss),
- Leveling : Auto-Level NA-2 (West German),
- Sounding : Echo sounder RAYTHEON (American)

3.2.2 Indoor work

The scales of the cross sections were as follows:

1) Plain area: Horizontal 1:500 - 1:1,000, Vertical 1:200
2) Mountain area: Horizontal 1:500, Vertical 1:500.

Longitudinal profiles were prepared based on the cross sectional survey results. The scales of profiles were as follows:

1) The Cubatão and Moji rivers:

Horizontal: 1:20,000 ; Vertical: 1:200

2) The Perequê, Piaçaguera rivers and other tributaries:

Horizontal: 1:10,000 ; Vertical: 1:200

3.3 Delivered Materials

3.3.1 Photogrammetric mapping

(1) Topographic map, original (polyester base)	1 set
(2) Topographic map, copy (polyester base)	1 set
(3) Description of ground control points and bench marks	1 set
(4) Field notes and calculation data of ground control survey	1 set
(5) Calculation data of aerial triangulation survey	1 set

3.3.2 Cross sectional survey

(1) Drawing of cross sections (polyester base)	1 set
(2) Drawing of profiles (polyester base)	1 set
(3) Field notes	1 set

4. TOPOGRAPHIC MAPPING ON THE SABO DAMSITE IN THE FEASIBILITY STUDY

4.1 Topographic Mapping

4.1.1 Field work

In order to prepare the topographic maps for the sabo dam structure sites in the feasibility study.

The topographic survey was carried out for the total extent of 110,000 m^2, based on the ground control points established in the master plan.

The accuracy and the contents of the topographic maps were executed as follows;

1) Map scale : 1:500
2) Contour interval : 1.0 m
3) Accuracy
   - Plarimetry : within 0.7 mm on the map
   - Height : within 1/2 of contour interval

The following equipment was used;

1) Distance measure : Geodimeter (Swedish)
2) Angle measure : Theodolite T-2 (Swiss)
3) Leveling : Anto-Level NA-2 (West German)

Location of the sabo dam structure sites is shown in Fig.D.3, Fig.D.4 and Fig.D.5.

The coordinates of the ground control points are listed in Table D.5.

4.1.2 Indoor work

The topographic map manuscripts for the sabo dam sites were drawn on a polyester base by the scribing method.

Scribing was carried out by establishing direct continuity to scribing sheets.

The topographic maps were prepared as follows;

Sheet No.	Dam Site No.	Area
1	2-1	18,000 m^2
2	3-1	9,000 m^2
3	7-1, 7-3, 7-4	8,000 m^2
4	8-1	12,000 m^2
5	10-1	13,000 m^2
6	11-1	28,000 m^2
7	12-1	14,000 m^2
Total		110,000 m^2

4.2 Delivered Materials

1) Topographic maps, original : 7 pcs
2) Topographic maps, copy : 7 pcs
3) Field notes calculated data : 1 set

TABLES

TABLE D.1 COLLECTED TOPOGRAPHIC MAPS

Name of Map	Scale	Contour Interval (m)	Mapping Year	Number of Sheets	Related Agencies
National Base Map	1:50,000	20	1984	2	IBGE
Sao Paulo Metropolitan Base Map	1:25,000	5 or 10	1974	5	EMPLASA
-do-	1:10,000	5	1987	7	EMPLASA.IGC
Sao Paulo State Map	1:10,000	5 or 10	1987	16	EMPLASA.IGC
Cubatao City Planning Map	1: 2,000	1	1990	1	Cubatao City

TABLE D.2 COLLECTED AERIAL PHOTOGRAPHS

Date of Shooting		Scale	Kind of Photo	Number of Photographs	Related Agency
Year	Month				
1962		1:25,000	Monochrome	44	
1972		1:40,000	-do-		
1977	June/July	1:40,000	-do-	29	
1980/81	March/May	1:35,000	-do-	29	
1985		1:25,000	False Color	32	CETESB
1987	June/August	1:10,000		106	
1989	April	1:25,000	False Color	38	CETESB

TABLE D.3 COLLECTED RIVER CROSS SECTIONS

River	Total Length of Survey (Km)	Intervals (m)	Production Scale		Number of Sections
			Horizontal	Vertical	
Cubatao	0.5	60-90	1:1,000	1:1000	7
Mogi	4.0	50-150	1:1,000	1:1000	64
Pereque	1.4	30-100	1: 200	1: 200	23
Piacaguera	0.8	60-100	1: 100	1: 100	12

Source:DAEE

TABLE D.4 COORDINATES OF GROUND CONTROL POINTS (1/3)

(MAIN TRAVERSING SURVEY)

CODE NO.	EAST	NORTH	EL. (m)
B0	356480.32	7358229.1	5.19
BA01=M	355066.29	7358847.51	19.38
BA02	355719.87	7359915.41	6.86
BA03	356741.01	7361355.92	22.97
BA04	357025.98	7361677.24	23.15
BA05	358134.18	7361992.47	4.57
BA06=M	357978.51	7361295.82	4.77
BA60	359607.78	7362713.18	7.12
BA61	360828.88	7363766.87	11.61
BA62	361054.66	7363851.22	17.59
BA63	361079.41	7364257.92	13.11
BA64	361190.12	7364326.44	14.06
BA65	361187.53	7364490.85	15.1
BA200	359146.58	7346861.06	1.43
BA201	353935.6	7356426.69	5.97
BA202	351202.3	7353170.41	55.71
BA500=M	353470.47	7357351.49	12.15
BA501	352323.74	7358344.49	18.19
BA502	352951.18	7357941.97	25.6
BA503=M	350654.67	7356227.84	29.96
BA504=M	349928.03	7355645.15	13.83
BA505	350025.04	7356049.86	66.34
BA506	348519.04	7354857.15	21.07
BA506A	348951.32	7354860.75	17.25
BA507	348238.6	7354537.03	23.63
BA508	347748.89	7354421.17	25.76

Note ; EL. means elevation

TABLE D.4 COORDINATES OF GROUND CONTROL POINTS (2/3)

(SECUNDARY TRAVERSING SURVEY)

CODE NO.	EAST	NORTH	EL. (m)
V01	357003.66	7358257.24	1.48
V02	357051.48	7357958.04	0.88
V03	356463.98	7358001.57	1.65
V04	356355.53	7358129.14	5.46
V05	356022.78	7358960.1	2.76
V6	355323.66	7358483.01	3.89
V7	355269.9	7358335.9	2.6
V8	354383.94	7358332.85	6.5
V9	354093.24	7358423.16	7.32
V10	353792.46	7358392.74	6.84
V11	353564.64	7358313.84	7.18
V12	353032.89	7358073.22	6.54
V13	352873.55	7358180.29	6.36
V14	352725.08	7358262.8	8.93
V15	352479.34	7358110.94	4.36
V16	352241.61	7357823.96	5.85
V17	352089.52	7357693.64	5.57
V18	351663.28	7356868.03	5.61
V19	351506.76	7356778.05	5.57
V20	351419.71	7356553.32	5.61
V21	351089.09	7356494.48	6.62
V22	350983.62	7356161.99	6.39
V23	350741.81	7356060.19	5.78
V24	350420.74	7355983.12	9.43
V25	350369.22	7355966.66	12.08
V26	350076.39	7355765.59	12.7
V27	349909.44	7356636.96	13.75
V28	349799.94	7355589.03	14.44
V29	349737.18	7355508.96	15.21
V30	349594.23	7355408.26	17.17
V31	349506.48	7355331.88	16.54
V32	349432.36	7355269.17	17.27
V33	349319.07	7355202.53	17.6
V34	349281.3	7355247.44	13.68
V35	349175.4	7355118.03	14.05
V36	348951.35	7354860.67	17.11
V37	348859.8	7354849.78	18.3
V38	348512.35	7354849.13	20.13
V39	348450.26	7354776.9	20.45
V40	348185.86	7354510.74	22.57
V41	348093.68	7354528.6	23.01
V42	347838.31	7354440.22	24.77
V43	347665.61	7354353.54	26.87
V44	347479.43	7354187.16	28.82
V45	347327.89	7353902.3	31.25
V46	347367.97	7353712.95	35.1

Note ; EL. means elevation

CODE NO.	EAST	NORTH	EL. (m)
V47	347174.1	7353644.51	36.07
V48	347102.6	7353600.47	36.78
V49	346874.5	7353640.44	39.48
V50	346760.1	7353626.45	40.67
V51	346524.8	7353380.64	42.77
V101	355983.1	7359253.68	3.45
V102	355924.7	7359361.64	2.77
V103	355717.2	7359669.12	5.75
V104	355644.8	7359846.96	7.18
V105	355660.1	7359992.39	5.69
V106	355663.0	7360144.25	5.57
V107	355669.7	7360307.84	5.82
V108	355662.9	7360547.41	6.73
V109	355660.0	7360795.1	7.95
V110	355644.6	7361403.07	6.07
V111	355767.2	7361871.69	11.42
V112	355799.9	7361973.9	15.32
V113	355854.8	7362146.43	20.39
V114	355909.9	7362324.84	26.05
V115	355976.4	7362456.18	26.77
V116	355799.0	7362535.01	32.44
V117	355734.4	7362512.76	33.54
V118	355582.6	7362527.2	44.03
V119	355468.3	7362589.63	48.07
V202	358230.0	7361173.98	2.37
V203	358285.3	7361431.85	3.75
V204	358252.7	7361696.98	3.5
V205=H	358416.3	7361895.95	3.92
V206	358557.9	7362004.51	3.68
V207	358654.1	7362088.57	4.05
V208	358743.3	7362138.85	4.62
V209	358674.1	7362771.4	17.2
V210	359050.9	7363014.71	16.05
V211	358976.6	7363164.65	18.72
V212	358786	7363290.07	17.26
V213	358606.4	7363339.23	22.4
V214	358432.2	7363368.82	28.89
V301	353743.8	7358492.33	6.46
V302	353630.9	7358667.24	7.38
V303	353592.2	7358757.56	7.7
V304	353444.9	7358835.48	5.6
V305	353183.2	7358851.92	7.01
V306	352985.4	7358876.39	11.9
V307	352874.8	7358822.17	8.94
V308	352776.9	7358949.19	21.51
V309	352667.5	7359058.01	27.52
V310	352600.7	7359219.49	54.38
V311	352608.0	7359371.74	64.37
V312	352656.2	7359409.07	67.95
V313	352690.0	7359465.86	78.72
V314	352687.5	7359504.63	83.6

TABLE D.4 COORDINATES OF GROUND CONTROL POINTS (3/3)

(SECUNDARY TRAVERSING SURVEY)

CODE NO.	EAST	NORTH	EL. (m)
V315	352687.42	7359577.14	93.05
V400	359262.81	7360984.84	5.78
V401	359302.24	7360722.83	2.4
V402	359008.75	7360643.66	2.49
V403	358231.43	7360239.02	6.06
V404	358243.39	7359225.08	1.81
V405	357794.66	7358527.82	4.01
V406	357285.06	7358309.62	1.4
V407	356962.19	7358471.88	1.14
V408	356806.6	7358392	1.43
V401A	353374.2	7359379.8	15.15
V402A	353249.26	7359414.59	18.31
V403A	353189.15	7359493.87	23.6
V404A	353136.11	7359490.58	29.85
V405A	353077.26	7359475.27	33.8
V406A	353037.26	7359440.27	41.39
V407A	353005.75	7359462.04	46.32
V408A	352978.94	7359500.56	44.88
V409	352939.83	7359509.56	49.39
V410	352909.84	7359532.65	56.84
V411	352898.61	7359566.06	61.89
V412	352917.2	7359563.91	74.8
V413	352805.53	7359709.46	111.09
V500	360428.89	7362604.55	6.67
V501	360368.21	7363209.61	8.83
V502	360280.73	7363337.9	11.21
V503	361048.09	7363841.04	17.71
V504	362094.74	7364244.67	12.94
V505	361155.73	7364315.42	13.79
V506	361194.87	7364499.92	14.89
V507	361619.86	7365097.34	19.29
V508	362018.02	7365729.2	29.66
V509	362160.69	7365791.2	29.23
V510	362062.75	7365734.56	29.07
V511	362032.45	7365919.62	33.86
V600	348498.42	7354897.11	22.38
V601	348355.06	7355113.24	26.69
V602	348249.84	7355137.34	29.39
V603	348029.13	7355397.33	35.76
V604	348017.06	7355641.68	40.01
V605	348060.85	7355869.66	45.12
V606	348139.29	7356039.38	55.64
V607	347944.71	7356035.85	56.6
V608	347712.19	7356129.43	64
V700	352593.82	7358389.24	10.31
V701	352331.88	7358669.47	10.34
V702	351962.38	7358755.55	16.26
V703	351850.65	7358883.85	36.46
V704	351839.13	7358922.41	35.53
V705	351774.52	7358996.65	44.64
V706	351764.96	7359036.25	47.29
V707	351652.38	7359121.43	76.08
V800	359816.62	7361568.6	3.43
V801	359807.73	7361831.88	4
V802	359632.96	7362747.53	7.64
V803	359460.95	7362690.16	7.76
V804	359064.75	7363136.37	17.99
V805	358619.66	7364200.69	102.91
V806	358587.36	7364259.6	107.97
V807	358615.58	7364347.88	118.35
V808	358690.16	7364401.17	132.99
V809	358720.81	7364511.96	154.32
V810	358697.23	7364548.62	166.95
V900	355536.11	7359923.95	7.25
V901	355325.45	7359905.51	6.56
V902	355127.99	7360013.17	6.95
V903	353943.98	7359992.33	42.31
V904	353761.43	7359974.96	37.19
V905	353711.33	7360081.9	43.51
V906	353651.43	7360134.49	48.31
V907	353547.65	7360158.57	58.28
V908	353537.85	7360217.46	61.97
V909	353452.89	7360169.79	66.9
V910	353396.93	7360164.78	71.66
V911	353271.9	7360135.83	84.7
V912	353221.76	7360159.93	87.34
V913	353155.45	7360258.01	100.3
V914	353163.42	7360319.86	110.56
V915	353112.41	7360320.52	111.06
N2	352373.18	7354332.26	0.47
N5	359917.75	7361521.82	3.14
N6	358935.69	7363035.08	30.02
M1	352404.77	7358129.81	6.71
M2	352494.03	7358163.87	11.04
M3	352223.78	7358212.87	12.22
M4	352148.5	7358221.19	14.28
M5	352099.58	7358273.83	16.35
M6	351787.95	7358363.33	48.96
M7	351622.19	7358281.31	59.71
M8	351571.26	7358181.14	68.41
M9	351282.55	7358263.66	111.72
E1	360403.5	7363797.66	26.28
E2	360619.91	7364587.84	50.28
E3	360379.56	7364839.04	39.52
E4	360251.02	7365122.91	149.35
E5	360401.72	7365249.5	124.04
E10	358359.4	7363369.31	33.18
E11	358010.17	7363733.44	58.98
E12	357918.39	7363771.46	90.83
E13	357926.15	7363835.27	111.6
E14	357914.81	7363942.09	121
E15	357866.74	7364026.2	131.86
J1	359113.14	7361036.27	4.93
J2	359244.47	7361120.66	4.94
J3	359327.92	7361151.8	5.01
J4	359481.26	7361246.99	4.96
J5	359652.91	7361340.06	4.29
J6	359817.23	7361426.27	5.11
J7	359990.83	7361535.9	4.73
J8	360221.96	7361689.37	5.66
J9	360214.51	7361765.8	3.44
J10	360098.47	7361784.1	2.59
J11	360185.25	7361951.96	3.85
J12	360190	7361909.13	2.52
J13	360256.92	7361986.08	2.23
J14	360307.26	7362094.98	4.36
J15	360321.8	7362268.85	4.24
J16	360309.63	7362322.32	7.7
L01	364176.71	7353045.04	6.67
L10	358293.08	7363314.07	30.89
L11	358161.98	7363130.57	30.95
L12	357924.96	7363191.26	37.62
L13	357884.38	7363153.47	40.33
L14	357844.11	7363160.66	46.81
L15	357799.2	7363221.64	54.54
L16	357754.49	7363239.75	61.51
L17	357746.41	7363283.03	65.08
L18	357708.47	7363310.72	70.32
L19	357646.78	7363320.58	78.87
L20	357597.54	7363330.33	84.01
L21	357570.66	7363355.01	89.18
L22	357487.85	7363359.84	103.41
L23	357464.34	7363401.12	14.57

Note ; EL. means elevation

TABLE D.5 COORDINATES OF GRAND CONTROL POINTS

AREA 2-1

CODE No.	EAST	NORTH	ELEVATION (m)
BA-01	358029.199	7363434.938	76.22
BA-02	358292.772	7363565.822	51.59
AUX 01	358140.123	7363554.259	43.72
AUX 02	358092.039	7363609.404	50.26
AUX 03	358020.217	7363714.339	57.82

AREA 3-1

CODE No.	EAST	NORTH	ELEVATION (m)
BA-01	358151.839	7363124.725	30.92
BA-02	357946.562	7363206.523	36.92
BA-03	357884.835	7363145.603	48.55
BA-04	357816.607	7363180.238	48.20
BA-05	357774.408	7363222.199	65.39

AREA 7-1, 7-3, 7-4

CODE No.	EAST	NORTH	ELEVATION (m)
S 02	353274.870	7360131.939	87.25
S 03	353274.996	7360151.648	88.64
S 05	353275.210	7360186.217	104.73
S 01	353274.734	7360113.268	103.26
S 06	353284.702	7360189.081	101.24
S 11	353392.003	7360203.345	94.72
BA-08	353395.152	7360181.145	80.78
V-910	353396.931	7360164.784	71.66
S 11A	353387.257	7360204.147	96.71
S 12	353411.625	7360206.296	89.58
S 06	353529.056	7360216.295	61.07
BA-05	353471.283	7360181.731	66.27
BA-06	353449.918	7360168.840	67.46
BA-07	353427.364	7360160.409	67.97
BA-08	353395.152	7360181.145	80.78
BA-15	353319.018	7360143.670	77.93
BA-09	353292.721	7360276.029	86.60
BA-10	353295.970	7360305.085	92.56
BA-11	353294.105	7360331.756	98.73
BA-12	353272.978	7360344.533	99.77
BA-13	353247.296	7360351.744	103.00
BA-14	353237.444	7360378.213	109.39
BA-16	353181.006	7360227.632	94.66
BA-17	353159.353	7360241.043	99.18
BA-18	353159.052	7360267.211	101.88
BA-19	353165.625	7360287.036	102.81
BA-20	353158.236	7360307.311	104.46
BA-21	353144.528	7360323.714	107.58
BA-22	353124.125	7360318.412	109.35
BA-23	353104.632	7360329.113	112.43
S 01	353576.283	7360130.568	53.21
S 07	353519.679	7360235.771	66.07
PE-1-10R	353530.677	7360194.288	62.76
BA-01	353551.422	7360262.296	71.18
BA-02	353553.061	7360317.059	83.32
BA-03	353543.164	7360334.455	87.79
BA-04	353539.473	7360354.754	100.62

AREA 8-1

CODE No.	EAST	NORTH	ELEVATION (m)
BA-01	353008.997	7359458.057	47.09
BA-02	352993.456	7359486.390	44.28
AUX 1	353032.573	7359443.699	42.75
AUX 2	352957.753	7359427.166	52.09
AUX 3	353044.524	7359513.058	57.10
BA-03	352979.838	7359509.581	44.83
BA-04	352959.797	7359525.972	48.96
V 409	352939.832	7359509.560	49.39
AUX 4	352920.053	7359524.950	52.00
BA-05	352880.017	7359587.440	64.81
BA-06	352860.807	7359604.565	67.22
BA-07	352853.146	7359628.095	71.19
BA-08	352826.420	7359673.028	74.94

AREA 10-1

CODE No.	EAST	NORTH	ELEVATION (m)
BA-01	351818.979	7358948.105	39.12
E 01	351854.805	7358897.926	33.73
E 02	351842.049	7358915.794	35.52
E 03	351830.542	7358931.875	35.69
E 04	351807.147	7358964.737	41.37
E 05	351795.448	7358981.145	42.45
E 06	351783.443	7358997.981	43.64

AREA 11-1

CODE No.	EAST	NORTH	ELEVATION (m)
EST 12	351738.460	7358774.848	121.92
BA-01	351527.075	7358698.208	150.89
EST 01	351552.193	7358657.825	135.18
EST 08	351670.719	7358732.290	95.79
EST 04	351602.979	7358689.731	119.89
BA-02	351647.832	7358744.406	102.99
BA-03	351611.966	7358762.392	110.75
BA-04	351580.253	7358785.582	116.90
BA-05	351636.268	7358796.825	111.76
BA-06	351668.242	7358775.674	106.49
BA-07	351723.053	7358710.641	92.71
BA-08	351735.425	7358674.282	87.06
EST 07	351653.784	7358721.650	106.11
BA-10	351683.433	7358680.384	91.46
BA-11	351792.148	7358641.123	76.88
BA-12	351806.160	7358579.150	65.29
BA-16	351828.035	7358540.476	63.68
BA-15	351764.571	7358545.603	72.36
BA-14	351732.841	7358596.050	82.26
BA-13	351686.826	7358631.708	87.10

AREA 12-1

CODE No.	EAST	NORTH	ELEVATION (m)
BA-01	351291.995	7358150.934	118.49
BA-02	351200.819	7358171.414	127.01
BA-07	351364.240	7358302.502	95.46
BA-03	351273.357	7358323.861	139.31
BA-04	351241.711	7358208.373	114.79
BA-05	351225.193	7358252.545	110.74
BA-06	351292.911	7358216.316	100.25
BA-08	351183.798	7358289.024	114.70
BA-09	351140.475	7358229.761	122.42
BA-10	351083.115	7358382.772	138.75
BA-11	351146.203	7358257.037	120.08
BA-12	351120.371	7358214.696	126.37
BA-14	351036.538	7358250.601	138.68
BA-13	351090.735	7358204.325	134.06

FIGURES

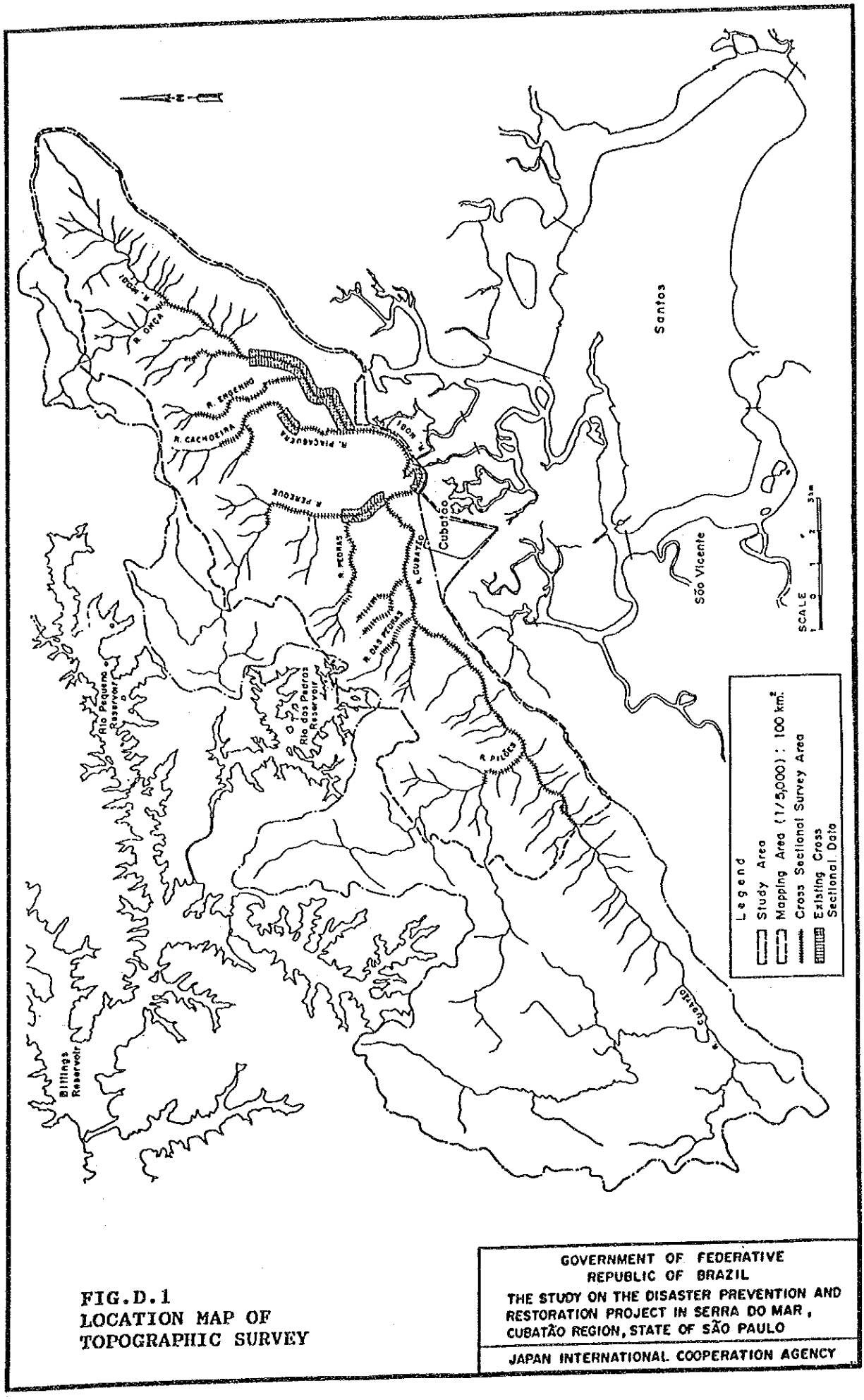


FIG.D.1
LOCATION MAP OF
TOPOGRAPHIC SURVEY

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

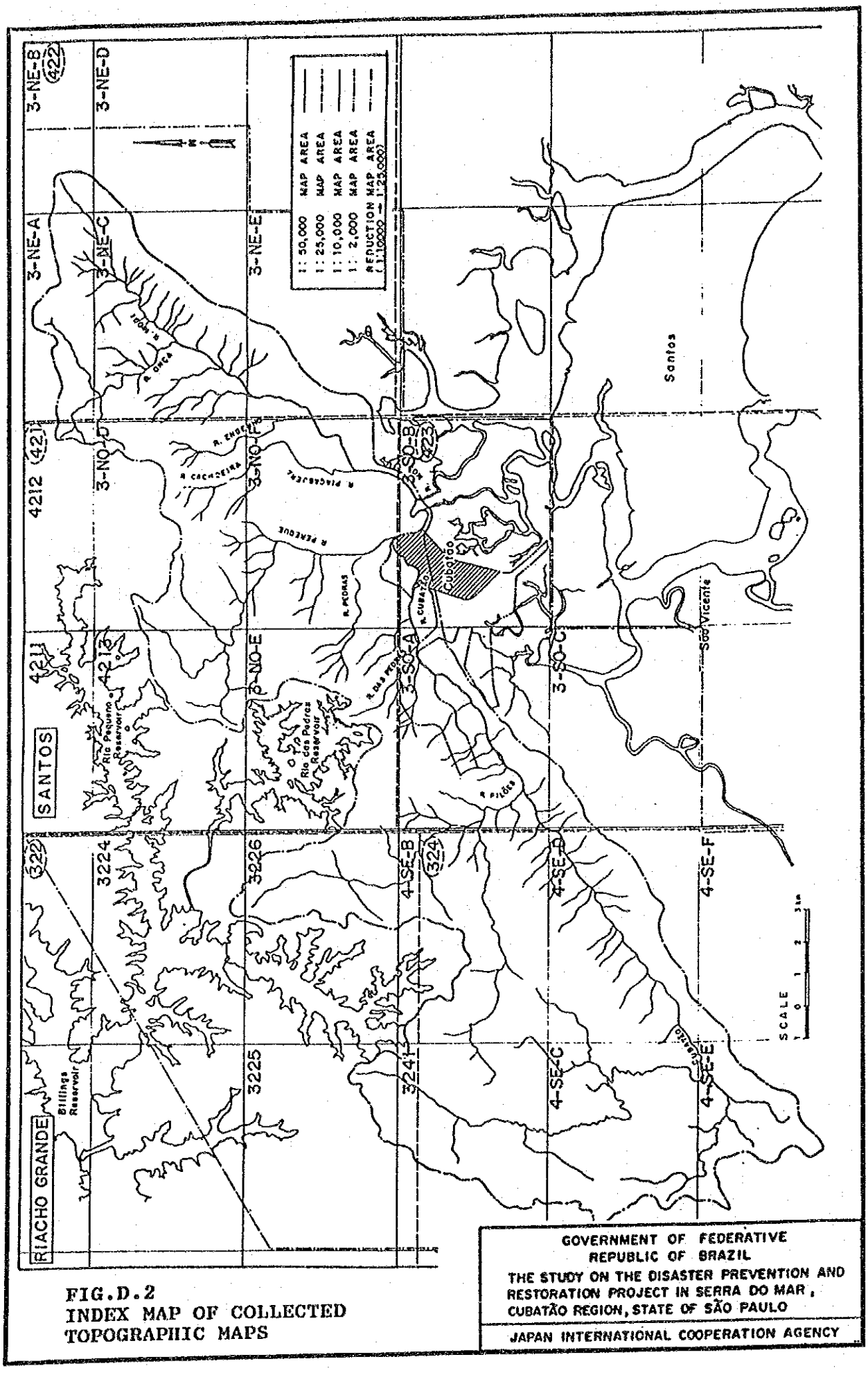


FIG.D.2
INDEX MAP OF COLLECTED
TOPOGRAPHIC MAPS

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

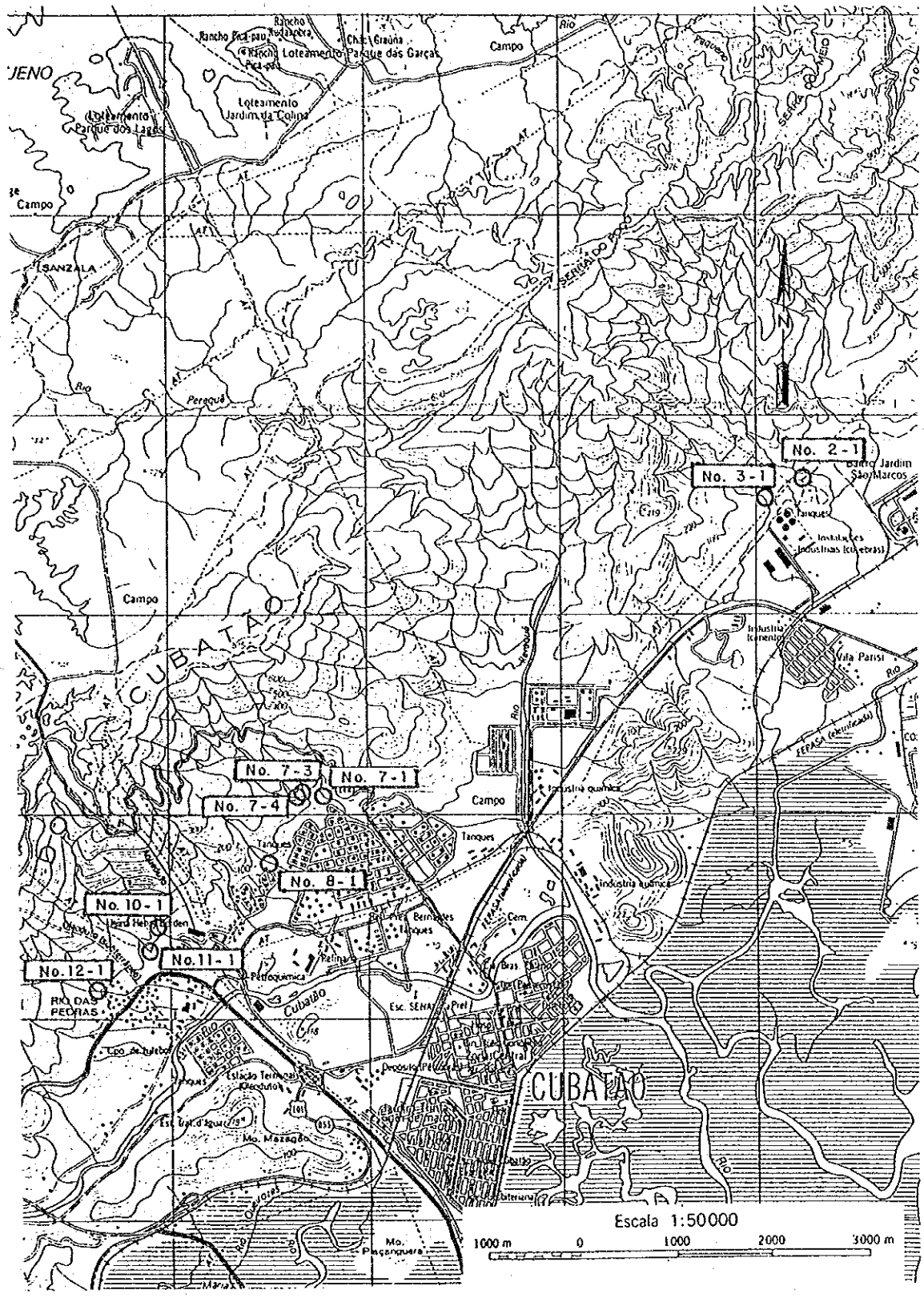
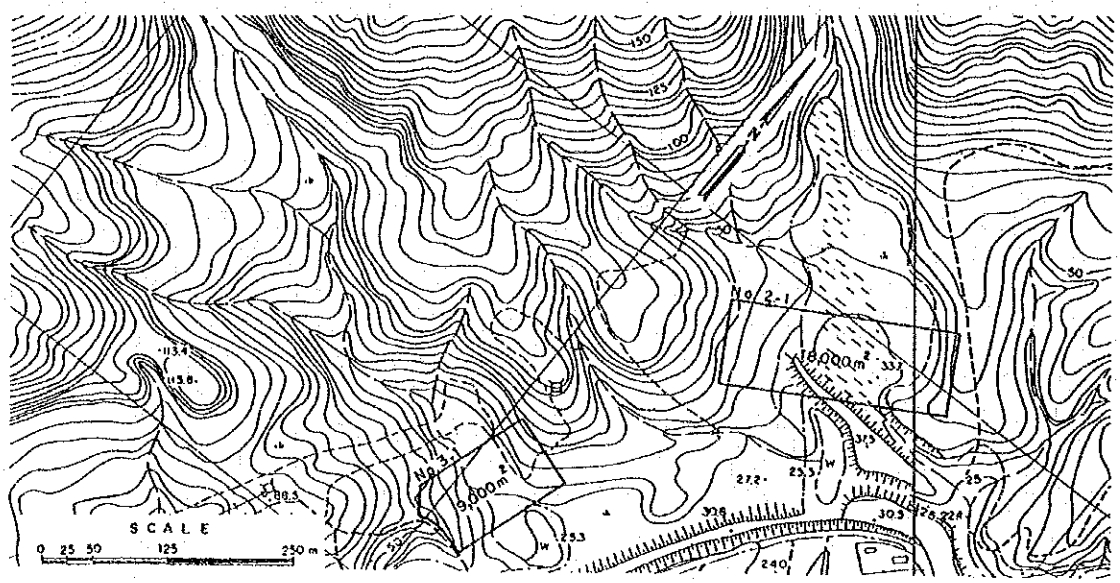


FIG. D.3
LOCATION MAP OF SURVEY AREA

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



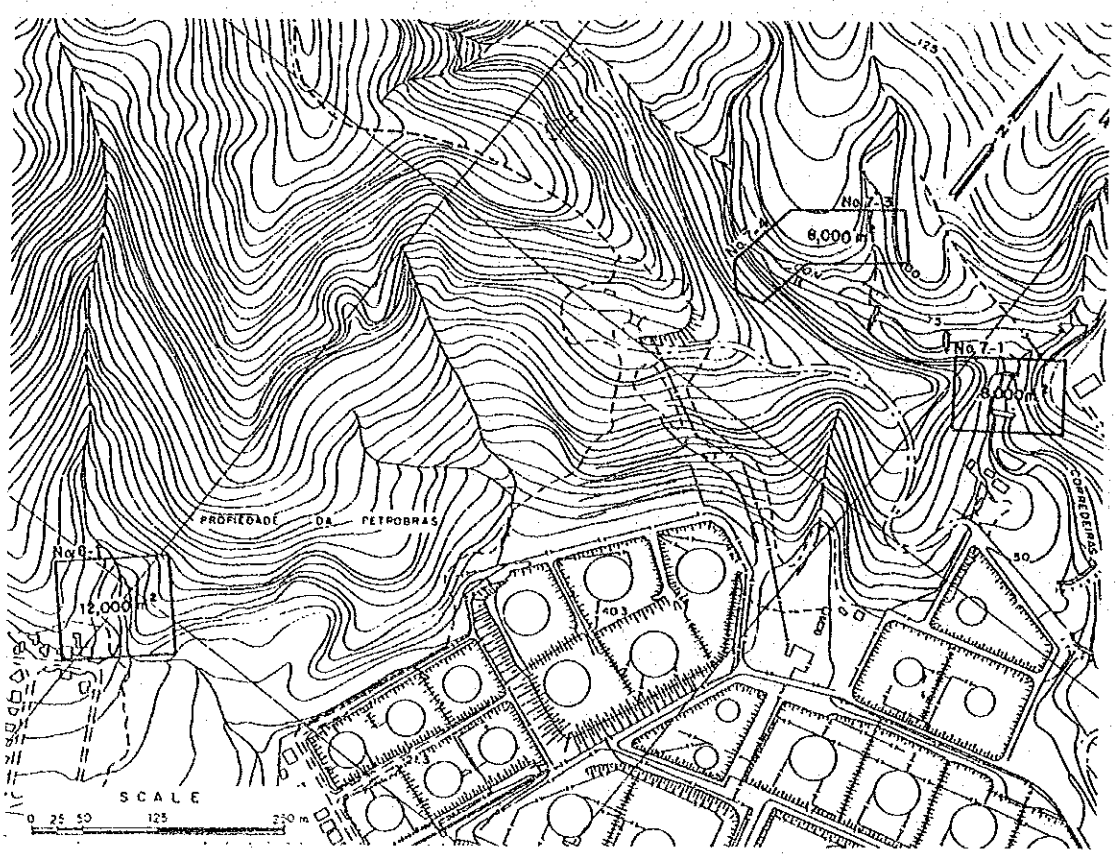


FIG. D.4
TOPOGRAPHIC SURVEY AREA(1)

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

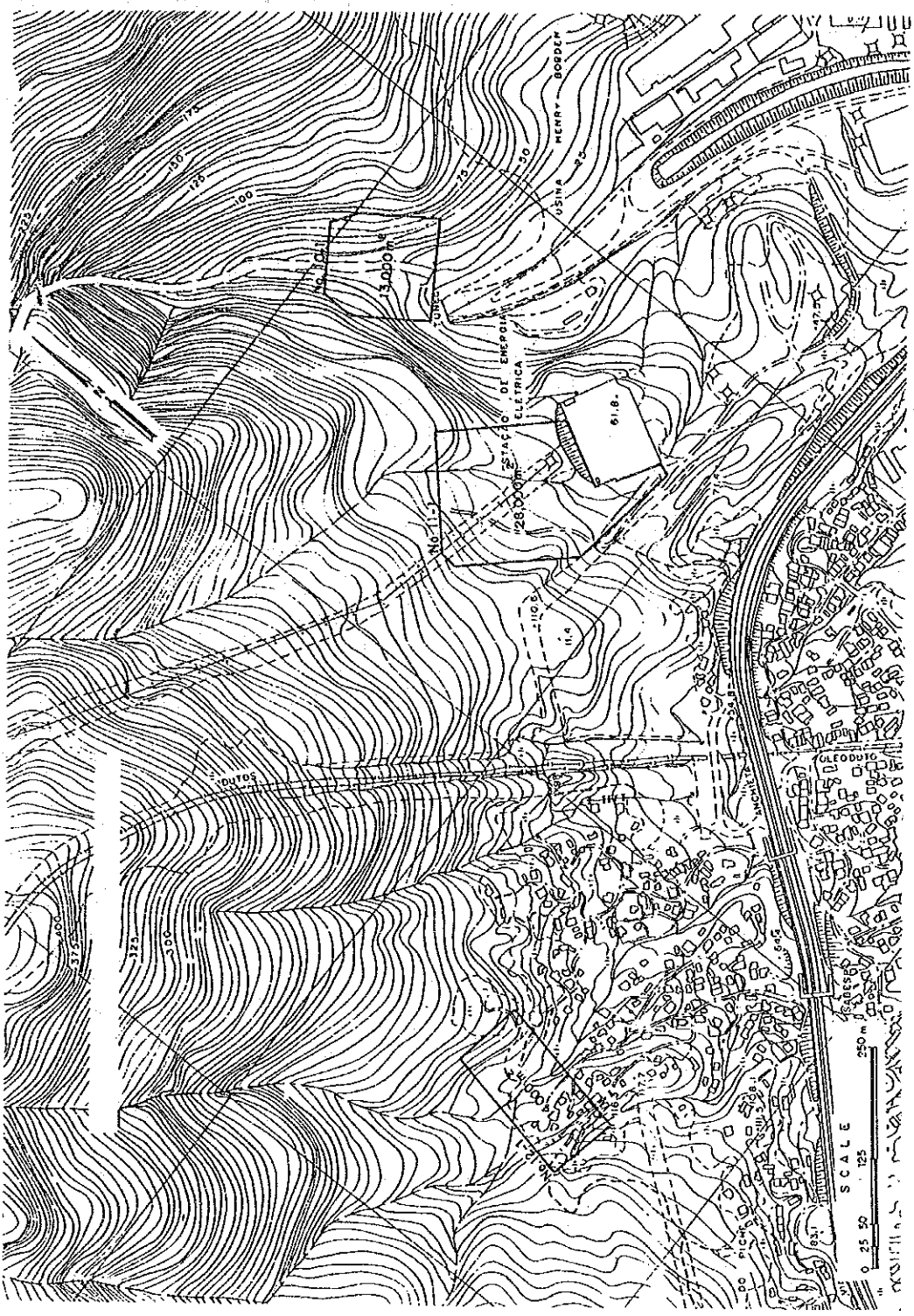


FIG. D.5
TOPOGRAPHIC SURVEY AREA(2)

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 E

GEOLOGICAL INVESTIGATION

ANNEX E GEOLOGICAL INVESTIGATION

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1. INTRODUCTION

This ANNEX-E presents the results of the geological and geomorphological investigations carried out from the middle of November 1989 to the end of October 1990 in the study area.

The purposes of the study are:

(1) to clarify the geomorphological and geological conditions in the study area by data analysis, drilling and field geological survey.

(2) to evaluate the geological conditions of sabo damsites and river improvement facilities for the feasibility study.

The data available to the study were obtained from and prepared by IPT and the study team.

2. GEOMORPHOLOGICAL AND GEOLOGICAL CONDITIONS

2.1 General

The study area is situated in the south-east of Serra do Mar in the Cubatão region about 60 kilometers south-east of São Paulo.

Serra do Mar extends long in parallel to the coast line and it forms articulately the boundary between Brazilian plateau and the alluvial plain.

Many residences are studded along Via Anchieta on the gentle slopes of Serra do Mar and the urban area and many factories are concentrated on the alluvial plain.

In general, the area may be divided into three(3) zones, plateau (EL. 700-800m), mountain slope and alluvial plain.

The Brazilian plateau is characterized by its undulated relief and highly weathered and alterated rocks similar to residual soil.

The mountain slope area, almost natural forest except for scar of slope failures, is characterized by gentle slope and steep slope at a gradient of 30^{o}-40^{o} on an average.

The plain area where the fluvial deposits spread widely from the confluence of the Cubatão and the Moji Rivers. The Cubatão River flows from the south-west and the Moji River from the north-east and they finally empty into the Atlantic ocean.

The area is underlain chiefly by a complex of Precambrian metamorphic rocks, intruded by granitic rocks of early Proterozoic, which is covered by unconsolidated deposits of Cenozoic on gentle slopes and plains. The regional geology is shown in Fig. E.1.

2.2 Regional Geomorphology and Geology

2.2.1 Geomorphology

The study area, south-east of São Paulo city, is situated in between $23^{o}45'$ and $24^{o}00'$ (of south latitude and between $46^{o}20'$ and $46^{o}40'$ of west longitude) and its total area is about 250 km^2.

The north-west study area is characterized by ranging mountain, 1500 km long along the Atlantic coast, and the Brazilian plateau at a average altitude of around 800m.

On the other hand, the south-east study area comprises mountain slope area at a gradient of 20-40^{o} and the plain area at an altitude of 0-20m, spreading over the estuary of the Cubatão and the Moji Rivers.

The mountain slope area, reflecting geological conditions, can be divided into two(2) areas, that are gentle slope area underlain by schist and steep slope area by migmatite.

Steep slopes covered with forest have been suffered from slope failures since mid-1970s because of vegetation degradation by air

pollution.

Dissected fans of Pleistocene can be identified at the foot of the mountain slopes and the lower portions of them are overlain by alluvial deposits.

Most largest heavy industrial area in South America and Cubatão City are located on the above-mentioned dissected fans in the plain area consist of mangrove swampy deposits and river deposits.

The drainage network, slope gradient and lineaments were analyzed by using the topographic maps and the aerial photographs of 1987 on the scale of 1:10,000 in order to reveal the geomorphological conditions in the study area. The analysis results of geomorphological conditions can be summarized as follows:

(1) Drainage network

The map of the drainage systems illustrating the river and valley courses is shown in Fig. E.2.

The drainage systems are divided into two(2) patterns, the cross stripe pattern that is in the plateau area on the north-west mountain slopes, and the branch pattern that is in the mountain slope area and in the plain area on the south-east mountain side.

(2) Slope gradient and slope configuration

The map of slope gradient and slope configuration, as shown in Fig. E.3 and Fig. E.4, respectively can be expected to provide the basic information because they present occurrence possibility and dimensions of slope failures in the study area.

Geomorphological features, such as rectilinear slopes overlain by talus deposits, may be defined by three(3) categories according to slope gradients clarified.

(3) Lineaments

From interpretation of the aerial photographs of 1987, the directions of photo lineaments are divided into two(2) types (cf. Fig.E.2). One type is in the direction of NE-SW parallel to the Moji and the Cubatão Rivers and another type is in the direction of NW-SE cross over the former. These lineaments may be considered to suggest the existence of faults and the direction of geological structure.

2.2.2 Geology

The regional geology of consisting mainly of Precambrian rocks is shown in Fig. E.1. Precambrian rocks can be classified into two(2) geological categories, namely, "Açungui group" and "Coastal Complex", and widely distributed around the study area.

"Açungui group" is regarded belong to the Proterozoic and divided into two(2) complexes of "EMBU Complex" and "PILAR Complex". "Açungui" group is composed mainly various schists including quartzite and migmatite.

"Coastal Complex" is regarded as of the Archaeozoic and is occupied largely by migmatite.

In the area, several faults extend from north-east to south-west with steep dip can be found in these complexies, in generally. In the valley of the Cubatão and the Moji Rivers, the tectonic lines and faults run parallel with the mountains.

Unconsolidated deposits are widely distributed on Precambrian rocks along the rivers on the plateau area, in the gentle mountain slopes and in the plain area. They are regarded as of the Horocene in Quarternary. The deposits along rivers in the plateau area predominant fluvial deposits, and in the gentle mountain slopes, they comprise mainly collovial deposits. On the other hand, the deposits in the plain area are composed of fluvial, lagoonal and coastal deposits.

2.3 Geology in The Study Area

The geology in the study area is shown in Fig. E.5 and Fig. E.6 to be composed mainly of crystalline shist in the superior Proterozoic; "Açungui group" and migmatite with gneiss in the Archaeozoic; "Coustal Complex". Small scale granite intrusion, being generally considered to be of early Proterozoic, is sporadically distributed.

As mentioned before, the study area may be divided into three(3) zones, plateau (E.L. 700-800m), mountain slope and alluvial plain. The geology in these area is summarized as follows.

2.3.1 Plateau area

The area has relatively gentle slopes inclined towards São Paulo city and it is covered mainly with laterite, which is highly weathered residual soil rich in secondary oxides of iron, aluminum and etc. The migmatite with schist (Açungui group) is highly weathered and alterated with thicknesses of from several meters to approximately 20 m under the subtropical weathering conditions. The laterite ground is easily eroded by rain and thereby, guillies are easily formed.

In the area, the fresh rocks of "Açungui group" are not observable except for steep cliffs along roads and deep valleys.

2.3.2 Mountain slope area

The mountain slope area is formed largely of migmatite but includes gneiss and schist belonging to "Açungui group" and "Coastal Complex". They are relatively hard rocks with developed joints. The distinguished joints strike N 60^{O}E-EW and dip 60^{O}-80^{O}N and the mountain slope is considerally steep. There are also gently slopes covered with collovial deposits along the foot of the mountain slope.

2.3.3 Plain area

The alluvial plain develops in the lower areas of the Cubatão and

the Moji Rivers in the study area.

The schmatic geological profile in the alluvial plain is shown in Fig. E.7. The sedimentation process of the plain area may be summarized as follows.

The main cause of sedimentation of the coastal plain is related to the sea-level changes (eustatic movements) during the Quaternary. The sedimentary deposits are classified into two(2) different types of sediments.

The first type (the sediments of Pleistocene) is clayey in its lower parts and sandy at its upper. After the deposition of the sediment of Pleistocene, they were eroded deeply by the action of the ancient rivers with sea-level changes.

The second one (the sediments of Horocene) consists of sandy clay or sand of fluvial-lagoonal origin. They are generally deposited where the sediments of Pleistocene had been eroded.

In the present alluvial plain, as mentioned above, the lagoonal deposits are widely, distributed on the sediments of Pleistocene composed of sand and clay, after words, the fluvial deposits, and composed chiefly of gravel, sand and clay, are lain on the lagoonal deposits along the reach of the rivers.

3. GEOTECHNICAL INVESTIGATION IN THE MASTER PLAN

3.1 Drilling

The main purpose of the geological investigations by drilling is to clarify the geological conditions such as the distribution of strata and foundation conditions in the study area. Five (5) drillings together with the standard penetration tests (hereinafter referred to as S.P.T) with a total depth of 50m, 10m each, were conducted by a local contractor between the beginning of February and the middle of March, 1990 under the supervision of the study team. The location of the

drillings is shown in Fig.E.8.

3.1.1 Description

(1) Item and quantities

Items and quantities of the drilling are shown in Table E.1 and coordinates of the drilling points in Table E.2, respectively.

(2) Investigation methods

The investigations were executed by using the following equipment listed below.

Kind of equipment	Description
Drilling machine	Sondeq - SS.31 (Agrale engine)
Pump	Sondeq - SB.75 (-do-)
Drilling rod (NX)	i= 50.8mm, ϕ=60.3mm
Casing (NX)	ϕ= 88.9mm

Diamond bits were used in rock formation and tungsten carbide bits in soil formation.

S.P.T were made in each drill hole every one (1) meter in accordance with ASTM Standard.

3.1.2 Geological condition of drilling sites

All the drilling sites except for No.2 were located in the present major river courses of the Cubatão , the Pilões, the Perequê and the Moji Rivers. Drilling site No.2 is in the alluvial plain near the confluence of the Cubatão and the Perequê Rivers. The drilling logs are shown in Fig.E.9.

3.2 Landslide Observation

Large scale landslides (hereinafter referred to as landslides), characterized by their deep slip surfaces and slow movement compared with the slope failures, may be found sporadically in the study area.

Three(3) major landslides, as shown in Fig.E.10, have been investigated and some countermeasures have been performed under instruction of IPT.

In the course of discussions between IPT and the study team, it was decided that 2 sets of extensometer should be installed at "Setor 8 - Dutos" by the study team in close collaboration with IPT staff, as shown in Fig.E.10, because of the many important facilities such as pipelines of ammonia, gas and oil, and electric transmission towers which are located in this landslide area.

The observation to analyze the movement of the landslide were carried out by the study team from early in July, 1990 to late in August, 1990.

The results of the analysis may be summarized as follows:

(1) Extensometer A

Extensometer A is installed at an altitude of 50 m and across an existing tension crack of the landslide. No movement has yet been observed.

(2) Extensometer B

Extensometer B is installed at an altitude of 95 m, 450 m inside the mountain area from the pipe line along the highway and also across an existing tension crack. Since observations began, slightly movement of landslide has been observed during rainfall.

As the landslide is expected to move in the rainy season or during heavy rain, continuous observation by extensometers should be continued.

3.3 Geotechnical Consideration

3.3.1 Geological features

(1) Rocks

Migmatite, hard and massive, is exposed with gneissic structure and partially granitic phase. Shists, namely mica schist and quartz schist, are massive if fresh, but is susceptible to weathering compared with migmatite. In general, migmatite easily forms steep slopes but shist gentle slopes.

The weathering occurred in the mountain slopes can be classified into four(4) categories as illustrated Fig.E.11.

Fresh rock zone

Fresh rock can be mainly found along the rapids in upstream reaches. It is hard, fresh and massive.

Weathered rock zone

Weathered rock zone is characterized by weathering and alteration of contact surface along open joints. Due to its weathering, massive rock body become separated rock.

Highly weathered rock zone

Highly weathered rock is remarkably soft due to highly weathering, especially shist. Although the texture of the rock can be recognized, almost all the constituents except quartz are altered more or less.

Latelite zone (highly weathered residual soil zone

Latelite is distributed in common on the gentle slopes with a thickness of 5 to 20 m or more. Under the biological and the chemical actions, latelite easily is produced by intensive weathering.

(2) Colluvial deposits

Colluvial deposits including talus deposits and cliff debris are distributed at the foot of the steep slopes and the gentle slopes. They are loose and incoherent deposits with angular and sub-angular breccia.

The thickness of them depend on their locations but can be estimated to be several meters.

(3) Fluvial deposits/river bed deposits

According to the result of the investigations, fluvial deposits and river bed deposits are composed mainly of loose gravel, sand and silt with the total thickness of about 4-5 meters. But in the river basin near the alluvial plain in Cosipa and at the drilling site of No.2 (see Fig. E.8), river bed deposits compose of loose sand, silt and clay with organic matters.

(4) Lagoonal deposits

Lagoonal deposits are composed mainly of very loose sand, silt and clay with organic matters, and are widely distributed in the alluvial plain.

According to the result of the geological investigations carried out by IPT around Cosipa, their average thickness is more than several meters.

The lagoonal deposits overlain by the sediments of Pleistocene composed mainly of sand and clay.

3.3.2 Foundation Conditions

(1) Sabo dams

A total of thirty-two(32) sabo dams in twelve(12) basins were planned in the study area as a result of the sediment run-off disaster prevention study (see ANNEX H).

Table E.3 gives the characteristics of geographic and geological features of each dam site.

Foundation condition on the proposed sabo dams with heights of 8-14 m are evaluated as follows:

- With regard to bearing capacity, slightly weathered and fresh rock are judged to be adequate for the dam foundation because of their hard and massive conditions. However, unconsolidated deposits and highly weathered rock will require excavation. In the case of thick unconsolidated deposits, cut-slope stability should be considered.

(2) Groundsill and channel works

Groundsills are planned in sub-basins 4 and 12. Foundation condition is commented as follows:

- River deposits which consist mainly of sand and gravel may be judged to be suitable for the proposed groundsills foundation due to low height of the proposed structures.

- No geotechnical points have been found up till now.

(3) Floodway

Floodway including the diversion tunnel and open channels, etc is planned in the flood disaster prevention plan. The geological

considerations on the floodway can be pointed out as follows:

- As a result of the geological field survey by the study team, migmatite, schist and talus deposits are distributed. Of these, highly weathered rocks and talus deposits of both portals of the proposed tunnel are considered to have some geological problems related to the tunnel construction method. Careful excavation will be needed in these portions.

- With regard to the open channel down stream of the tunnel outlet, the excavation slope stability of the lagoonal deposits must be considered due to its poor shearing resistance.

(4) Embankment and excavation for the river channel improvement

The river channel improvements are planned in the middle to lower reaches of the Cubatão River and in the lower reaches of the Moji River (see ANNEX. I).

The Cubatão River

The excavation slope gradient for the widening improvement is recommended to be similar to the present slope gradient of the river on account of its stability.

Materials to be excavated from the present banks and riverbed are considered to be suitable and available embankment materials.

The Moji River

The proposed river channel improvement will be carried out mainly by excavating bank materials overlying lagoonal deposits. In the case of excavation reaching the lagoonal deposits, excavation slope stability will have to be considered.

The present bank materials, when excavated for river channel improvement are judged to be suitable and available embankment

materials.

4. GEOTECHNICAL INVESTIGATION IN THE FEASIBILITY STUDY

4.1 Field Geological Survey

Field geological survey at nine(9) sabo-damsites in seven(7) subbasins of the priority project was carried out by using the topographic maps on a scale of 1 to 500 from the middle of September 1990 to the beginning of October 1990 by the study team.

Geological maps and geological cross sections were prepared through the field geological survey as shown in Figs.H-12 to H-20.

As for the channel improvement of the Moji river basin of the priority project, only the data analysis on the geological reports collected from IPT was made without any additional field geological survey such as drilling.

4.2 Geotechnical Conditions

4.2.1 Sabo dam

(1) Geotechnical classification

The layers distributed each sabo damsites can be classified taking account into mechanical properties as shown in Table E.4. Allowable bearing capacity, cohesion and internal friction angle can be estimated on the basis of representative values used in Japan.

(2) Foundation condition

Foundation condition of nine(9) sabo dams with a maximum dam height of less than 15 m are summarized as follows:

- With regard to bearing capacity, fresh rock (Rf) including slightly weathered rock is judged to be adequate for the dam foundation because of its hard and massive conditions. However, river deposits (Rd), talus deposit (Tl) and highly weathered rock (Rw) like saprolite soil (laterite) are required to be excavated due to their poor bearing capacity.

  Old talus deposit (Tl-o) and terrace deposit (Te) except for their upper loose portion are basically suitable for dam foundation.

  Above mentioned foundation condition is summarized below.

Stream	Allowable bearing capacity (tf/m2)	Evaluation of dam foundation
River deposit (Rd)	30- 70 (30)	in need of excavation
Talus deposit (Tl)	-	- do -
Terrace deposit (Te)	70-110 (70)	adequate except for loose portion
Talus deposit (Tl-o) (old)	70-110 (70)	- do -
Weathered rock (Rw)	70-110 (70)	adequate except for weathered rock
Fresh rock (Rf)	70-160 (120)	adequate

- Regardingly cut slope stability and groundwater treatment, no serious problem can be found.

(3) Concrete aggregate

Sand and gravel distributed in the upper reaches of the Moji

river are judged to be available to concrete aggregate for sabo dams.

4.2.2 Groundsill and channel works

Two(2) groundsill and six(6) channel works of 2,980 m in total are planned in the priority project. No geotechnical points is considered.

4.2.3 Channel improvement

(1) Foundation condition

According to the IPT's reports which describe the geological investigation results on the highway between Vila Parisi and Cosipa, new channel construction area consists mainly of land-ground bank materials underlain by the lagoonal deposits.

Land-ground bank materials, 2 m in average thickness, show their N value of 2 to 5. Lagoonal deposits ranging in thickness from 10 to 20 m comprise mainly organic clay and fine sand with N value of zero (0) or less than one(1). Their thickness depend on the location where base rock's contour shaped by the sea-level change action.

(2) Excavation

Since the maximum depth of the excavation is planned to be around 4 m, land-ground bank materials and lagoonal deposits must be excavated. In this case, the excavation slope stability of the lagoonal deposits must be very important point to be considered.

Adequate gradient of the excavation slope is considered to be 1 (vertical) to 1.5 (horizontal) each step slope but 1 to 2.0 in total in the case of excavation depth of less than 5 m.

Geological investigation such as drilling together with standard penetration test and soil tests must be conducted prior to detailed design.

(3) Embankment

Sliding and subsidence of embankment foundation, lagoonal deposits are pointed out because of their soft foundation. Physical and mechanical properties of lagoonal deposits such as cohesion, internal friction angle and coefficient of consolidation, etc must be revealed in furthermore evaluation.

As for embankment materials, land-grounding bank materials distributed in the proposed new channel area are considered to be available. In the case of lagoonal deposits, they are not adequate for embankment material because of very soft clay with organic matter. Effective treatment are required, if possible.

4.2.4 Railway bridge and road bridge

Rebuilt of railway bridge and road bridge are planned in line with the channel improvement works. Piling will be recommended as these foundation method because of very soft foundation. The length of the Piles are considered to be 10 to 30 m in view of its geological condition. Drilling will be needed to reveal the geological conditions.

LIST OF REFERENCES AND DATA COLLECTED

No.	TITLE	ISSUED ON	ISSUED BY
E01	MAPA GEOLÓGICO DO ESTADO DE SÃO PAULO VOL. I		IPT
E02	MAPA GEOLÓGICO DO ESTADO DE SÃO PAULO VOL. II		IPT
E03	SONDAGENS À PERCUSSÃO DE N 01 A 30 PARA O PROJETO EXECUTIVO DE DUPLICAÇÃO DA RODOVIA SP-55, CUBATÃO-GUARUJÁ, NO TRECHO ENTRE A VIA ANCHIETA E O TREVO DA ULTRAFÉRTIL	1980	IPT
E04	ESTUDOS GEOTÉCNICOS, ANTEPROJETO GEOTÉCNICO E RECOMENDAÇÕES PARA O PROJETO EXECUTIVO DOS CORTES E OBRAS DE ESTABILIZAÇÃO DE TALUDES DA RODOVIA SP-55, PIAÇAGUERA-GUARUJÁ (1 TRECHO) VOL I	1980	IPT
E05	ESTUDOS GEOTÉCNICOS, ANTEPROJETO GEOTÉCNICO E RECOMENDAÇÕES PARA O PROJETO EXECUTIVO DOS CORTES E OBRAS DE ESTABILIZAÇÃO DE TALUDES DA RODOVIA SP-55, PIAÇAGUERA-GUARUJÁ (1 TRECHO) VOL II	1980	IPT
E06	ESTUDOS GEOLÓGICOS, ANTEPROJETO GEOTÉCNICO E RECOMENDAÇÕES PARA O PROJETO EXECUTIVO DOS CORTES E OBRAS DE ESTABILIZAÇÃO DE TALUDES DA RODOVIA SP-55, PIAÇAGUERA-GUARUJÁ (1 TRECHO) VOL III	1980	IPT
E07	ESTUDOS GEOLÓGICOS-GEOTÉCNICOS E ORIENTAÇÃO PARA O PROJETO DOS ATERROS DA DUPLICAÇÃO DA RODOVIA SP-55, CUBATÃO-GUARUJÁ, ENTRE A VIA ANCHIETA E O TREVO DA ULTRAFÉRTIL (1 TRECHO) VOLUME I	1980	IPT

(to be continued)

(Continuation)

E08	ESTUDOS GEOLÒGICOS-GEOTÈCNICOS E ORIENTAÇÃO PARA O PROJETO DOS ATERROS DA DUPLICAÇÃO DA RODOVIA SP-55, CUBATÃO-GUARUJÀ, ENTRE A VIA ANCHIETA E O TREVO DA ULTRAFÈRTIL (1 TRECHO) VOLUME II	1980	IPT
E09	ESTUDOS GEOLÒGICOS-GEOTÈCNICOS E ORIENTAÇÃO PARA O PROJETO DOS ATERROS DA DUPLICAÇÃO DA RODOVIA SP-55, CUBATÃO-GUARUJÀ, ENTRE A VIA ANCHIETA E O TREVO DA ULTRAFÈRTIL (1 TRECHO) VOLUME III	1980	IPT
E10	ENSAIOS GEOTÈCNICOS DE CAMPO PARA ELABORAÇÃO DO PROJETO EXECUTIVO DE DUPLICAÇÃO DA RODOVIA SP-55, CUBATÃO-GUARUJÀ, NO TRECHO ENTRE A VIA ANCHIETA E O TREVO DA ULTRAFÈRTIL, EM CUBATÃO - SÃO PAULO	1980	IPT
E11	SONDAGENS DE SIMPLES RECONHECIMENTO EXECUTADAS NO TRECHO ENTRE A COSIPA E O TERMINAL DA ULTRAFÈRTIL, VISANDO AO PROJETO EXECUTIVO DA DUPLICAÇÃO DA RODOVIA SP-55, CUBATÃO-GUARUJÀ	1980	IPT
E12	ESTUDOS GEOLÒGICO-GEOTÈCNICOS E PROJETO GEOTÈCNICO DAS FUNDAÇÕES DA PONTES SOBRE O CANAL DE BERTIOGA DA RODOVIA SP-55, PIAÇAGUERA-GUARUJÀ (2 TRECHO) VOL II	1982	IPT
E13	ESTUDOS GEOLÒGICO-GEOTÈCNICOS PARA CARACTERIZAÇÃO E QUANTIFICAÇÃO DE MATERIAIS DE EMPRÈSTIMO TERROSOS E GRANULARES PARA EXECUÇÃO DE ATERROS E PAVIMENTO DA RODOVIA SP-55, PIAÇAGUERA-GUARUJÀ (TRECHO ULTRAFÈRTIL-GUARUJÀ)	1982	IPT

TABLES

TABLE E.1 WORK QUANTITIES OF DRILLING

Drilling No.	Drilling Depth (m)	S.P.T. (Nos.)
1	10.0	10
2	10.0	10
3	10.0	10
4	10.0	6
5	10.0	6
Total	50.0	42

Note ; S.P.T. : Standard Penetration Test

TABLE E.2 COORDINATES OF DRILLING POINTS

Drilling No.	Coordinates	
	X	Y
1	7,364.100	361.225
2	7,359.350	355.450
3	7,355.600	349.750
4	7,355.350	348.050
5	7,362.400	355.950

TABLE E.3 GEOGRAPHICAL AND GEOLOGICAL FEATURES OF SABO DAM POINTS

Basin No.	Sabo Dam No.	Riverbed Elevation (m)	Dam Height from Riverbed (m)	Thickness of Fluvial Deposits in Riverbed (m)	Dam Height (m)	Geographical Features			Geological Features			
						Riverbed	Right Bank	Left Bank	Base Rock	Unconsolidated Deposits - Highly Weathered Rock		
										Riverbed	Right Bank	Left Bank
1	1-1	95.0	10.0	1.0	12.0	very narrow	slightly steep	slightly steep	migmatite	very thin	none	very thin
2	2-1	33.0	7.0	5.0	13.0	very wide	very gentle	gentle	schist	thick	thick	thick
	2-2	47.0	10.0	3.0	14.0	wide	slightly steep	gentle	schist	thick	none	slightly thick
	2-3	101.0	10.0	0.0	11.0	narrow	slightly steep	slightly steep	schist	none	none	none
3	3-1	29.0	10.0	3.0	14.0	wide	gentle	gentle	schist	very thick	thick	very thick
	3-2	44.0	10.0	2.0	13.0	slightly narrow	gentle	slightly steep	schist	thick	slightly thick	very thick
4	4-1	25.0	7.0	5.0	14.0	wide	gentle	gentle	schist	thick	thick	thick
	4-2	43.0	10.0	2.0	13.0	wide	steep	slightly gentle	schist	thick	very thin	thick
5	5-1	36.0	10.0	3.0	14.0	wide	gentle	gentle	schist	thin	slightly thin	slightly thick
	5-2	60.0	5.0	2.0	8.0	wide	gentle	gentle	schist	slightly thick	slightly thick	slightly thick
6	6-1	34.0	10.0	2.0	13.0	slightly narrow	gentle	gentle	schist	slightly thick	slightly thick	slightly thin
	6-2	63.0	10.0	1.0	12.0	slightly wide	gentle	very slightly	schist	-thin	thick	none
	6-3	105.0	10.0	2.0	13.0	narrow	gentle steep	gentle	migmatite	slightly thick	none	thick
7	7-1	57.0	10.0	1.0	12.0	narrow	slightly gentle	gentle	migmatite	thin	very thin	none
	7-2	72.0	10.0	3.0	14.0	wide	slightly gentle	steep	migmatite	thick	thick	thin
	7-3	84.0	10.0	1.0	14.0	narrow	gentle	slightly steep	migmatite	slightly thick	thick	thick
	7-4	81.0	10.0	1.0	12.0	narrow	steep	slightly steep	migmatite	thin	none	none
	7-5	110.0	10.0	1.0	12.0	slightly narrow	gentle steep	gentle steep	migmatite	thin	thin	thin
	7-6	114.0	6.0	1.0	8.0	narrow	very gentle	very gentle	migmatite	thin	slightly thin	slightly thin
8	8-1	44.0	7.0	3.0	14.0	wide	slightly steep	slightly steep	schist	very thick	slightly thick	thick
	8-2	65.0	10.0	1.0	12.0	narrow	steep	steep	schist	thin	thin	thick
9	9-1	57.0	10.0	1.0	12.0	slightly narrow	gentle	gentle	schist	thick	thin	thick
	9-2	86.0	10.0	2.0	13.0	narrow	slightly gentle	slightly gentle	migmatite	slightly thick	thick	thick
	9-3	135.0	10.0	0.0	11.0	narrow	steep	steep	migmatite	none	slightly thin	none
10	10-1	42.0	8.0	0.0	10.0	wide	steep	steep	migmatite	none	none	none
	10-2	61.0	10.0	1.0	12.0	slightly wide	gentle	gentle	migmatite	thin	thin	none
11	11-1	88.0	10.0	3.0	14.0	wide	slightly gentle	slightly gentle	migmatite	thick	thick	thick
	11-2	170.0	10.0	2.0	13.0	narrow	gentle	gentle	migmatite	slightly thick	thick	thick
	11-3	250.0	10.0	1.0	12.0	narrow	slightly steep	slightly steep	migmatite	thin	none	thin
12	12-1	105.0	9.0	3.0	14.0	wide	gentle	gentle	migmatite	thick	thick	thick
	12-2	129.0	10.0	1.0	12.0	wide	gentle	gentle	schist	thin	none thin	none
	12-3	141.0	10.0	3.0	14.0	slightly wide	slightly wide	gentle	schist	thick	thick	thick

TABLE E.4 GEOTECHNICAL CLASSIFICATION

Stratum	Symbol	Description	*1 Mechanical properties		
			Allowable bearing capacity(tf/m2)	Cohesion(tf/m2)	Internal friction angle(o)
River deposit	Rd	Sand and gravel with thin layers of silt and clay. loose.	30 -70 (30)	0	35
Talus deposit	Tl	Cleyer soil with sub-anglar graver. loose.			
Terrace deposit	Te	sand and gravel with rounded cobble or boulder	70 -110 (70)	5	35
Talus deposit (old)	Tl-O	Clayer soil with sub-anglar gravel. moderately firm.	70 -110 (70)	10	25
Saprolite Soil Highly weathered rock	Rw	Saprolite soil(laterite) with average N values of 10 - 20. highly weathered rock.	70 -110 (70)	10	25
Fresh rock	Rf	Slightly weatered rock or fresh rock, massive and hard.	70 -160 (120)	60	35

*1; Mechanical properties can be proposed on the basis of representative values of mechanical properties in Japan.
*2; Number in parentheses shows proposed value.

FIGURES

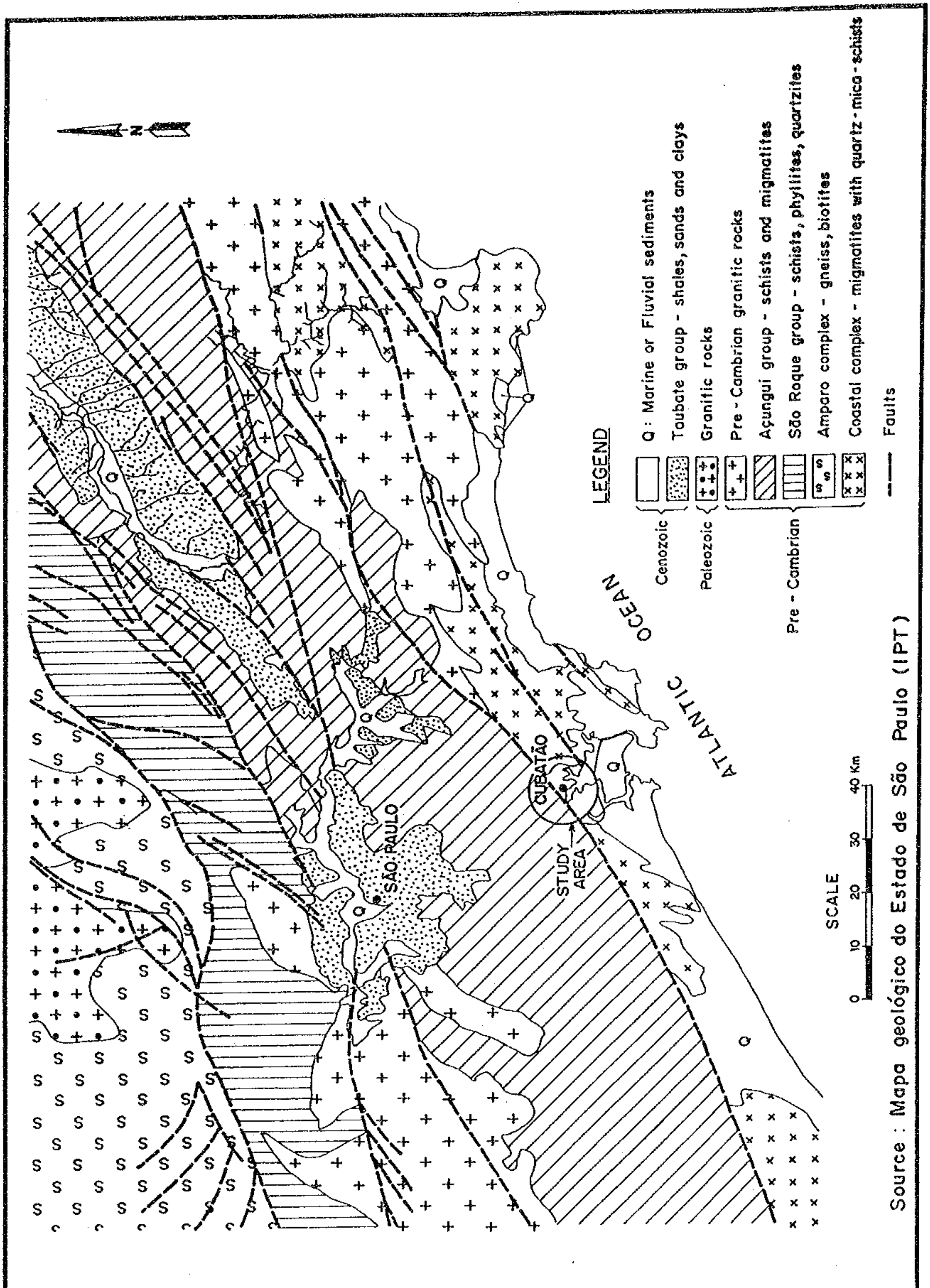


FIG.E.1
REGIONAL GEOLOGICAL MAP

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

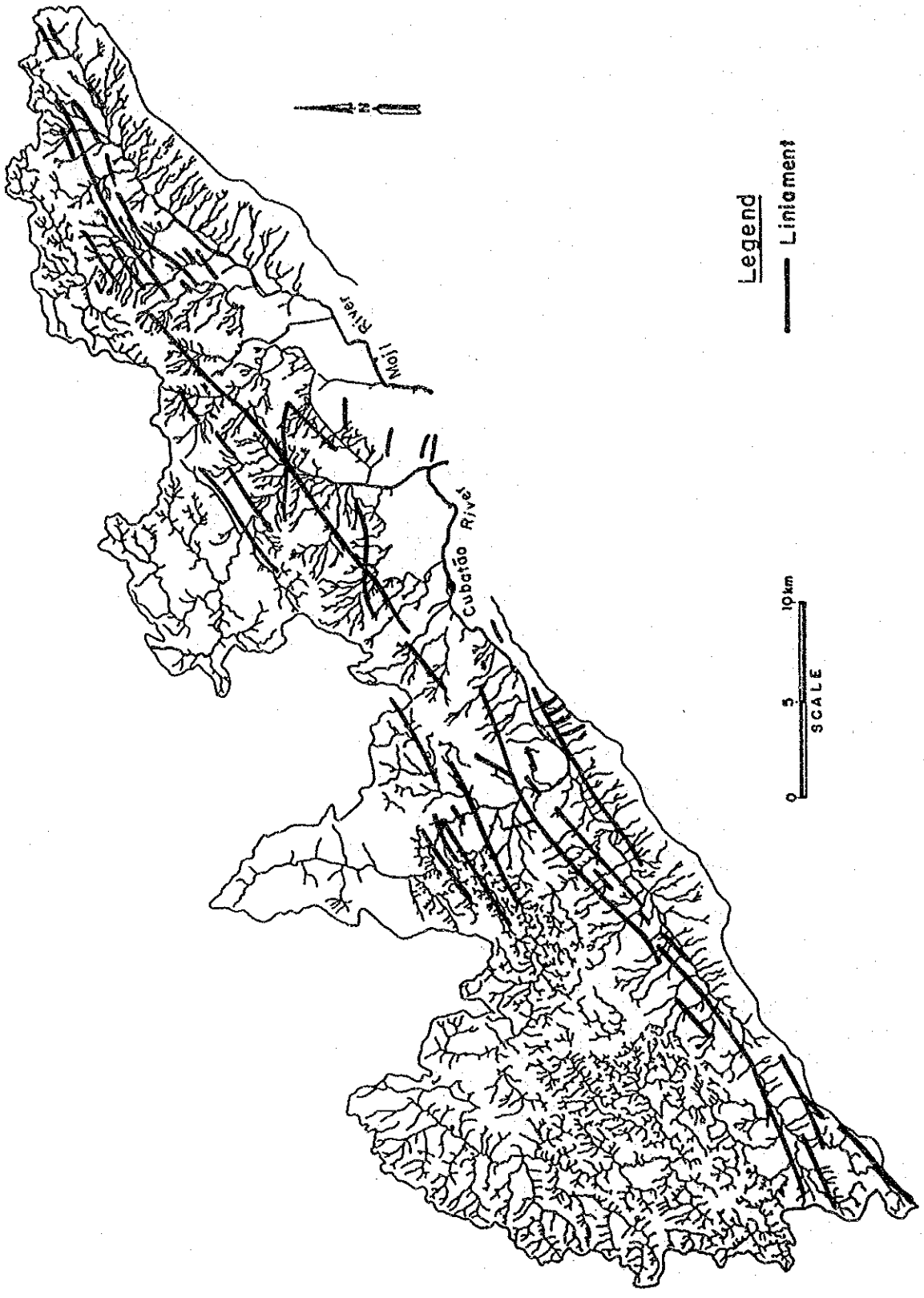


FIG.E.2
MAP OF DRAINAGE NETWORK

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

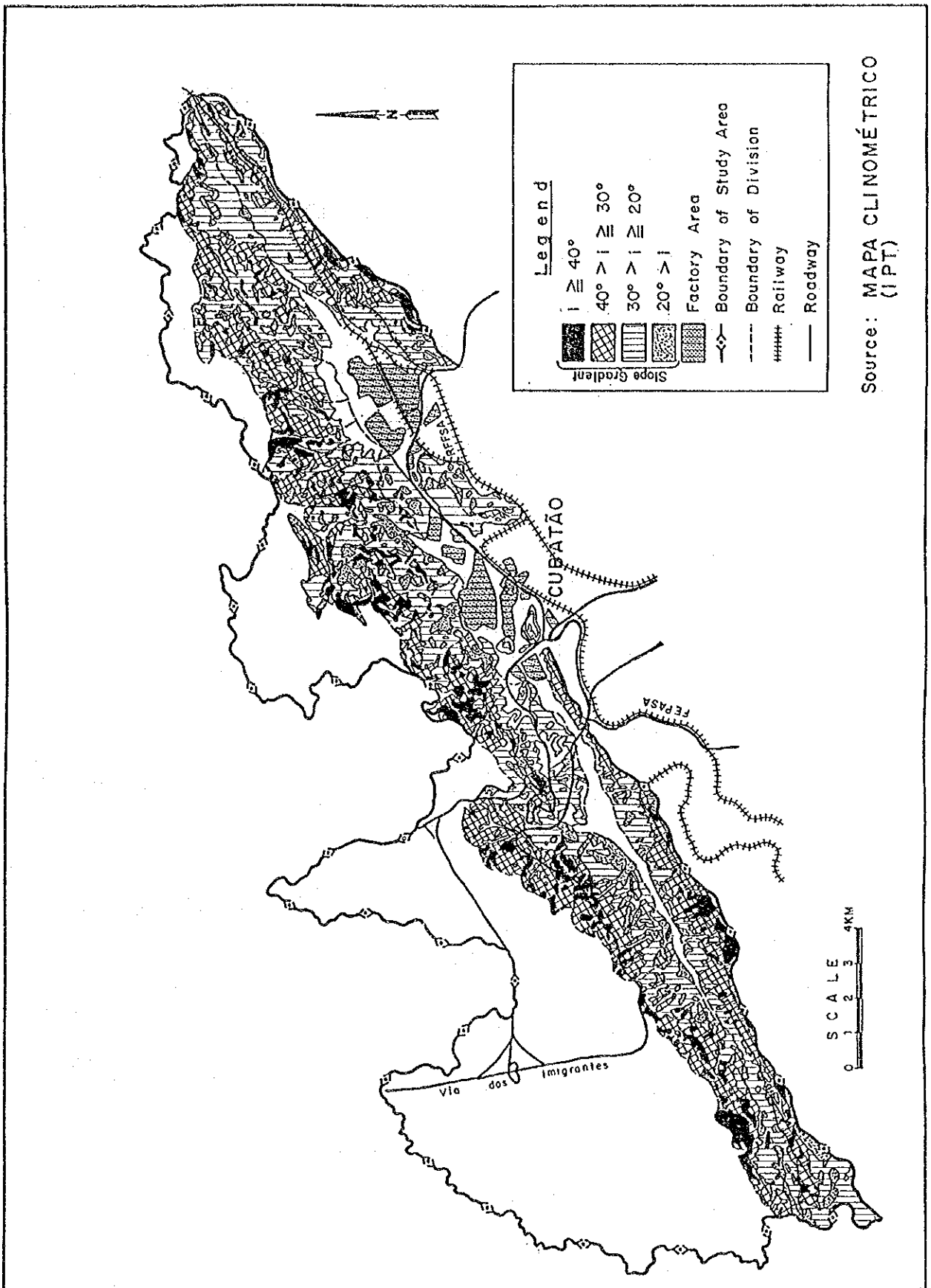


FIG.E.3
MAP OF SLOPE GRADIENT

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

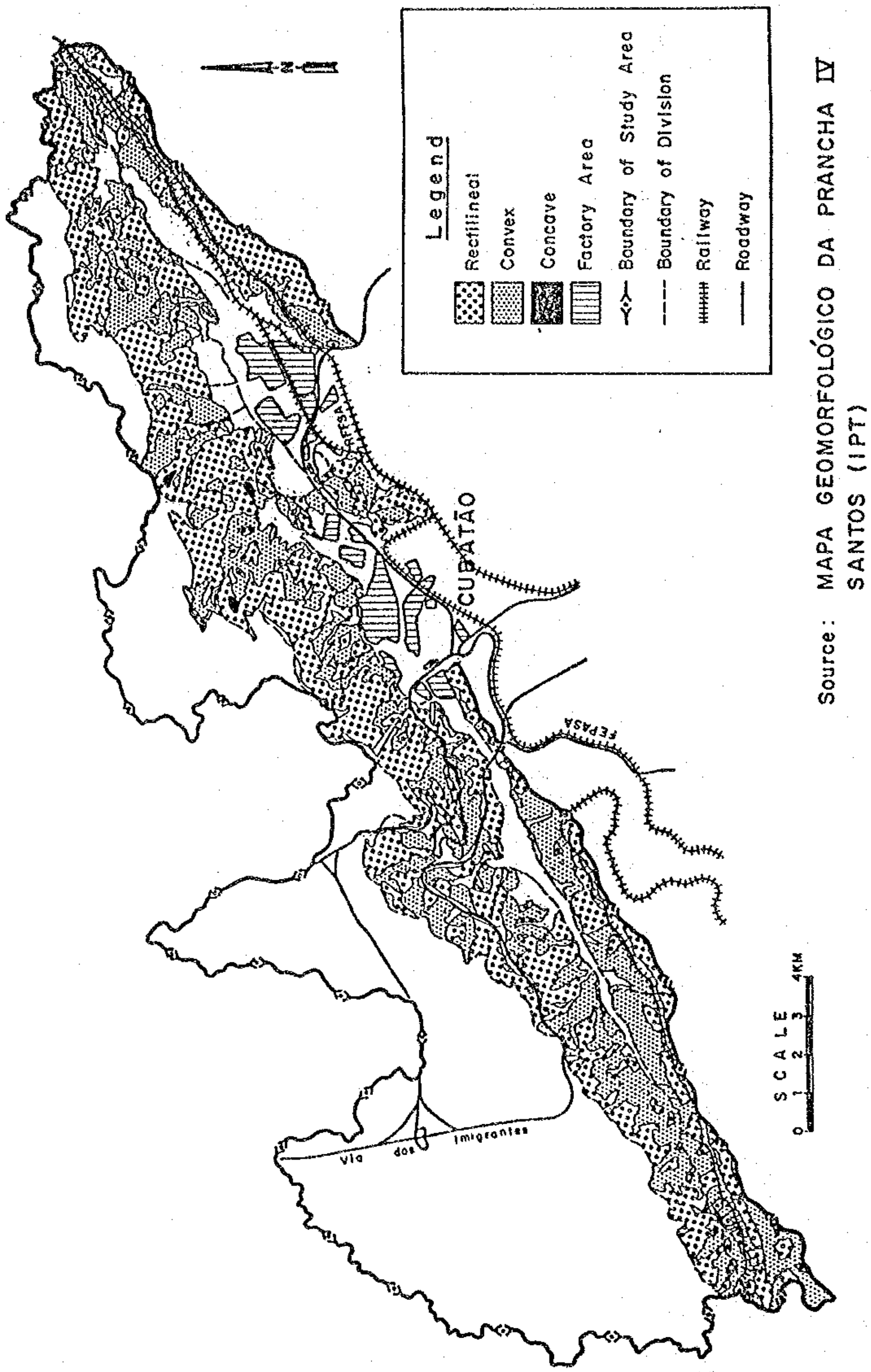
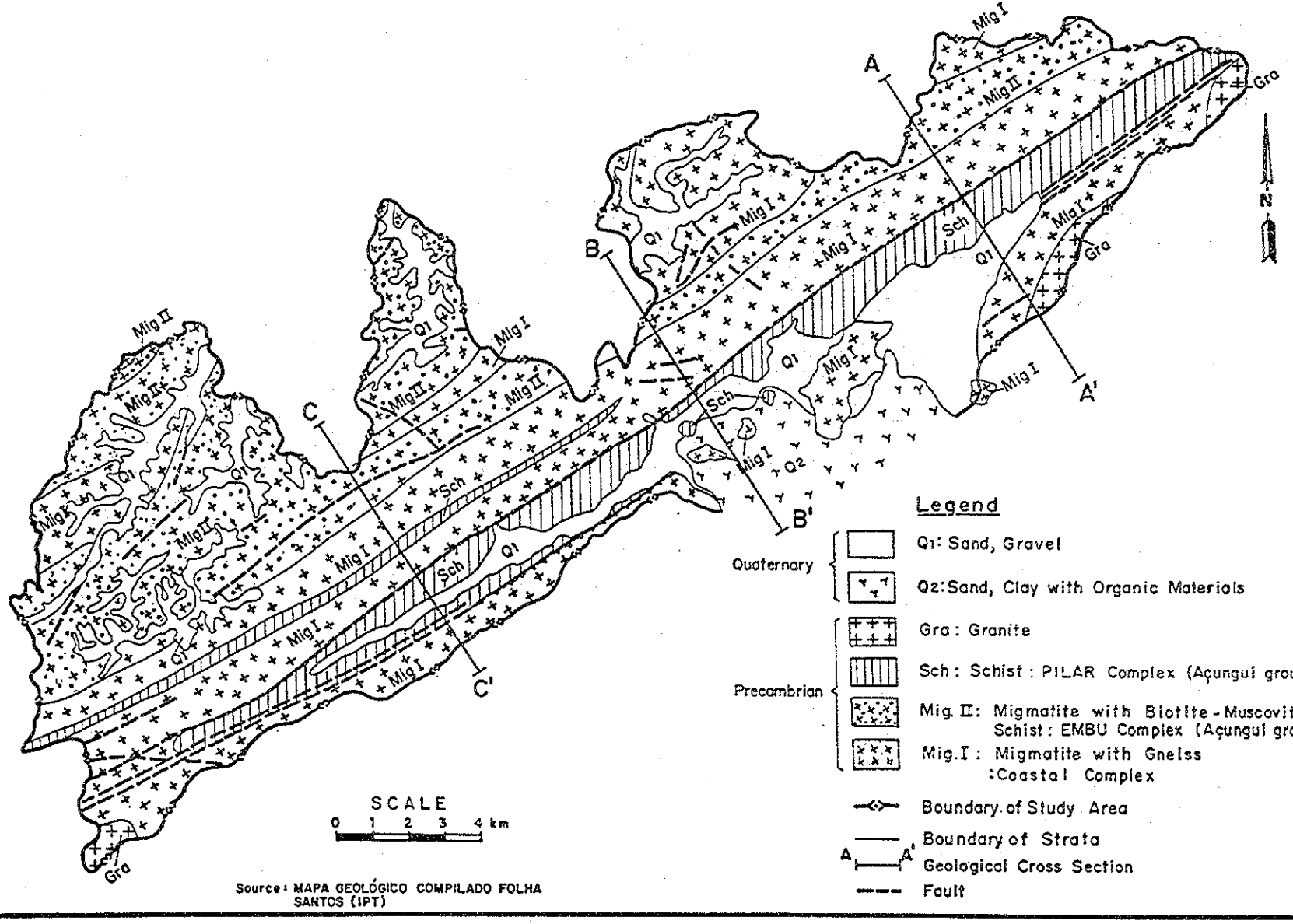


FIG.E.4
MAP OF SLOPE CONFIGURATION

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. E. 5
GEOLOGICAL MAP OF THE
STUDY 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

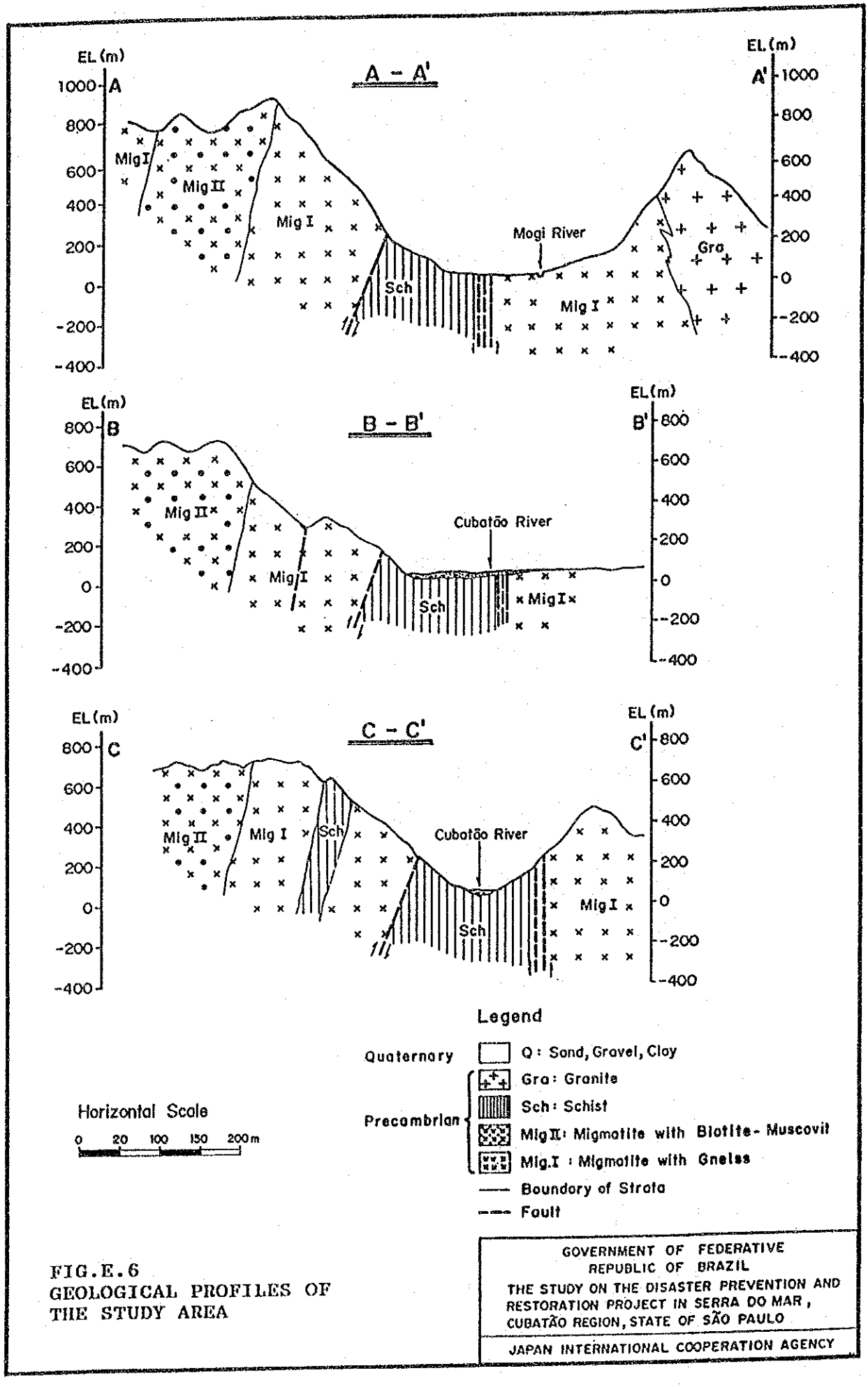


FIG.E.6
GEOLOGICAL PROFILES OF
THE STUDY AREA

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

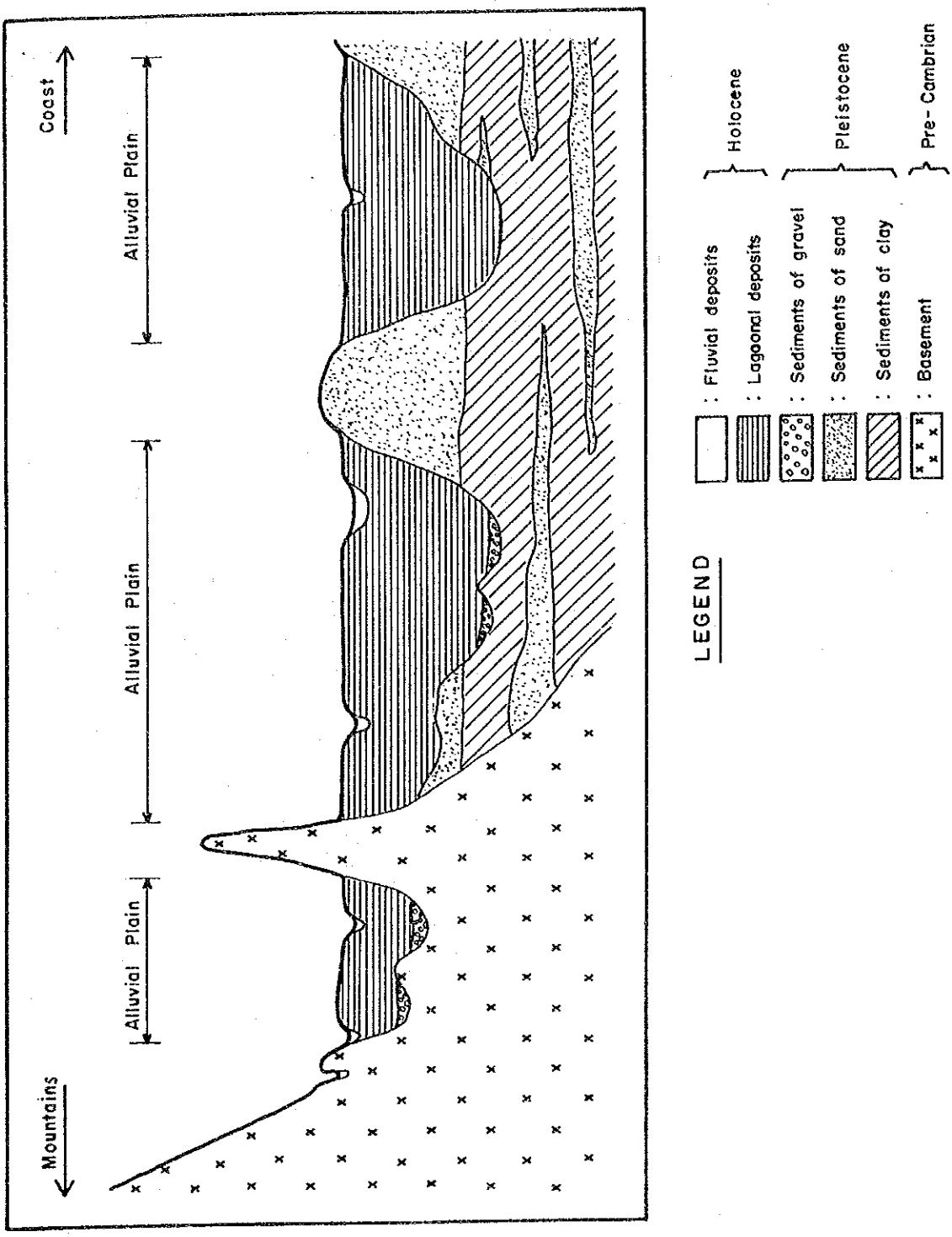


FIG.E.7
SCHEMATIC GEOLOGICAL PROFILE
IN THE ALLUVIAL PLAIN

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

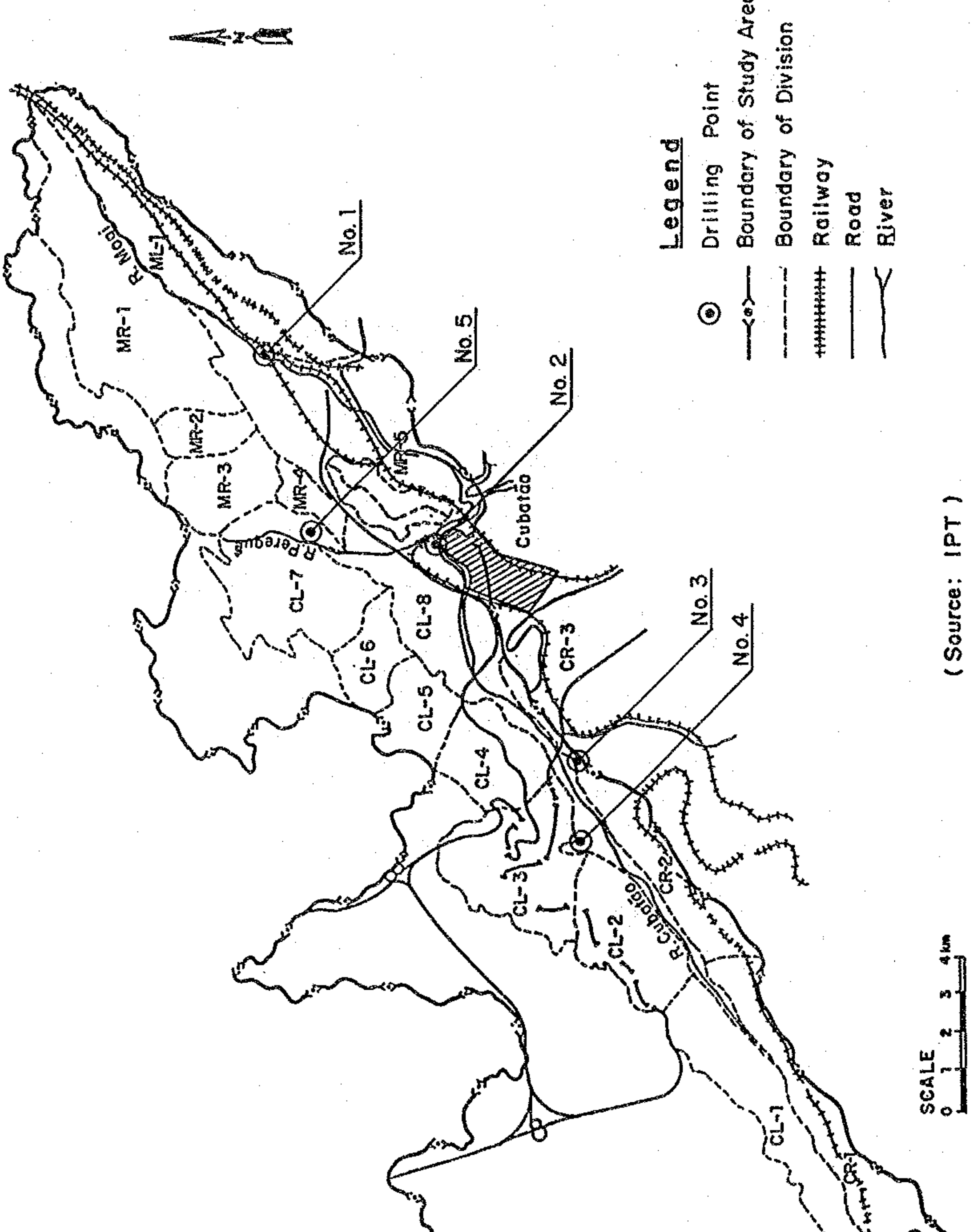


FIG.E.8
LOCATION MAP OF
GEOLOGICAL INVESTIGATIONS

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

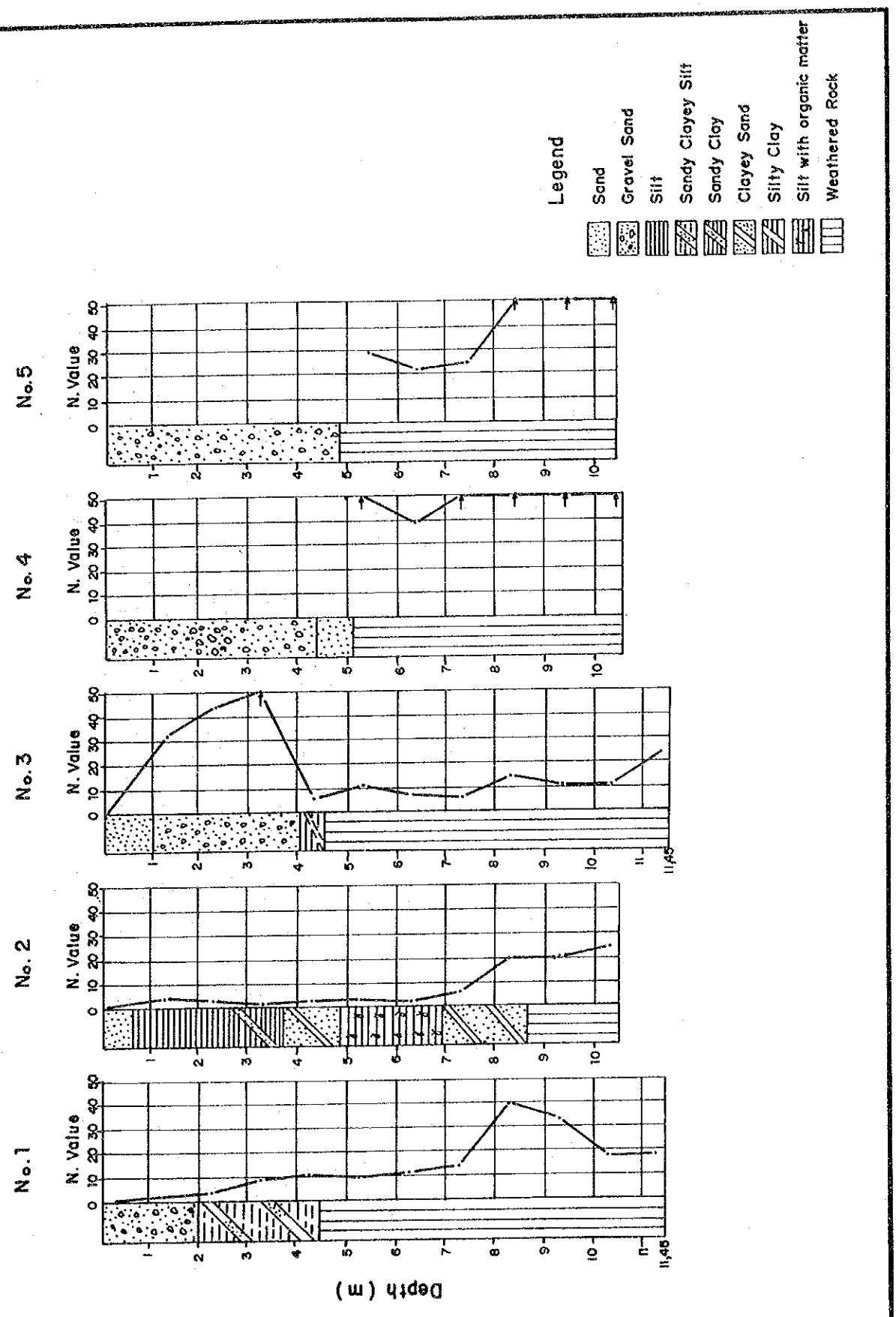


FIG.E.9
DRILLING LOGS

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

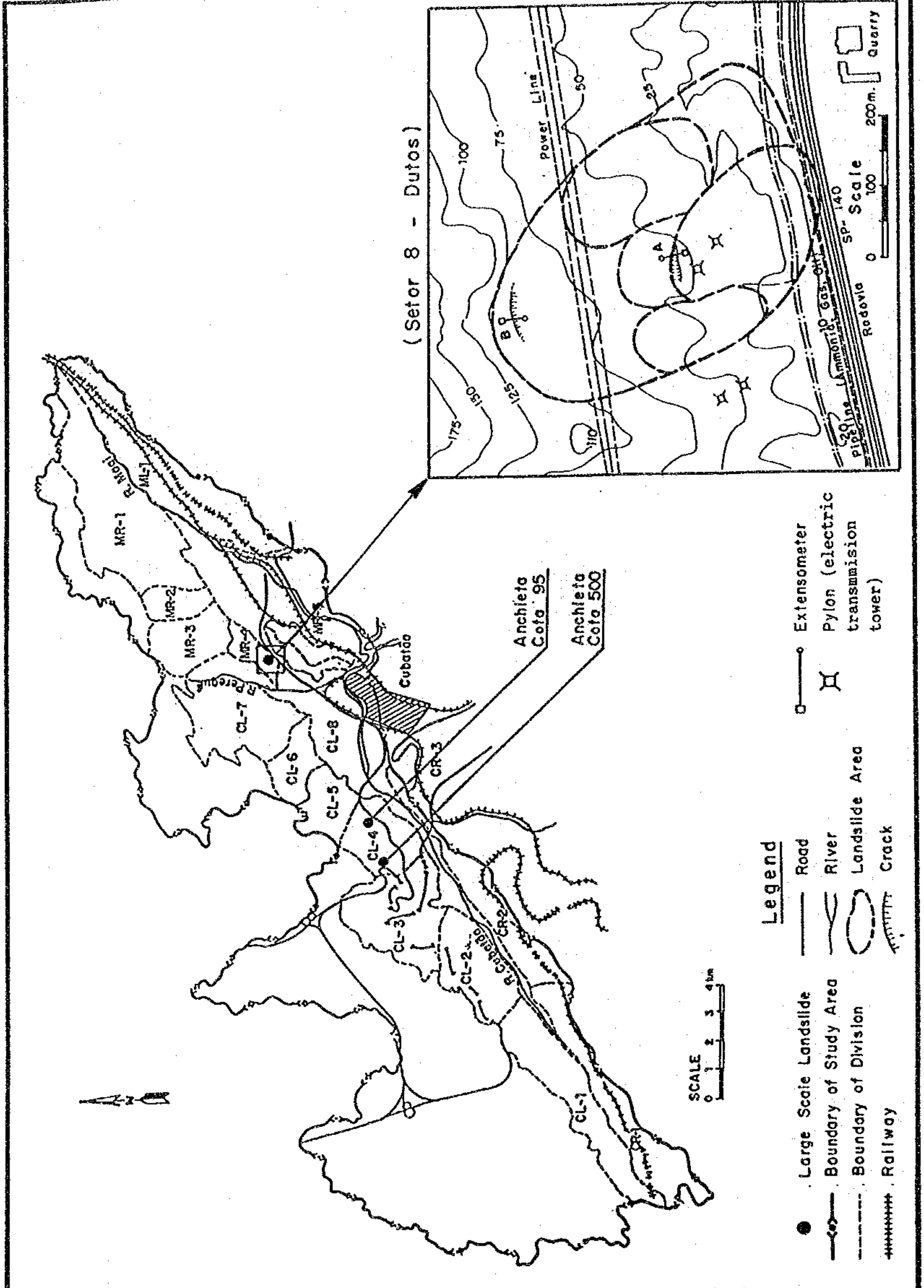


FIG.E.10
LOCATION MAP OF LARGE SCALE LANDSLIDES AND EXTENSOMETERS

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

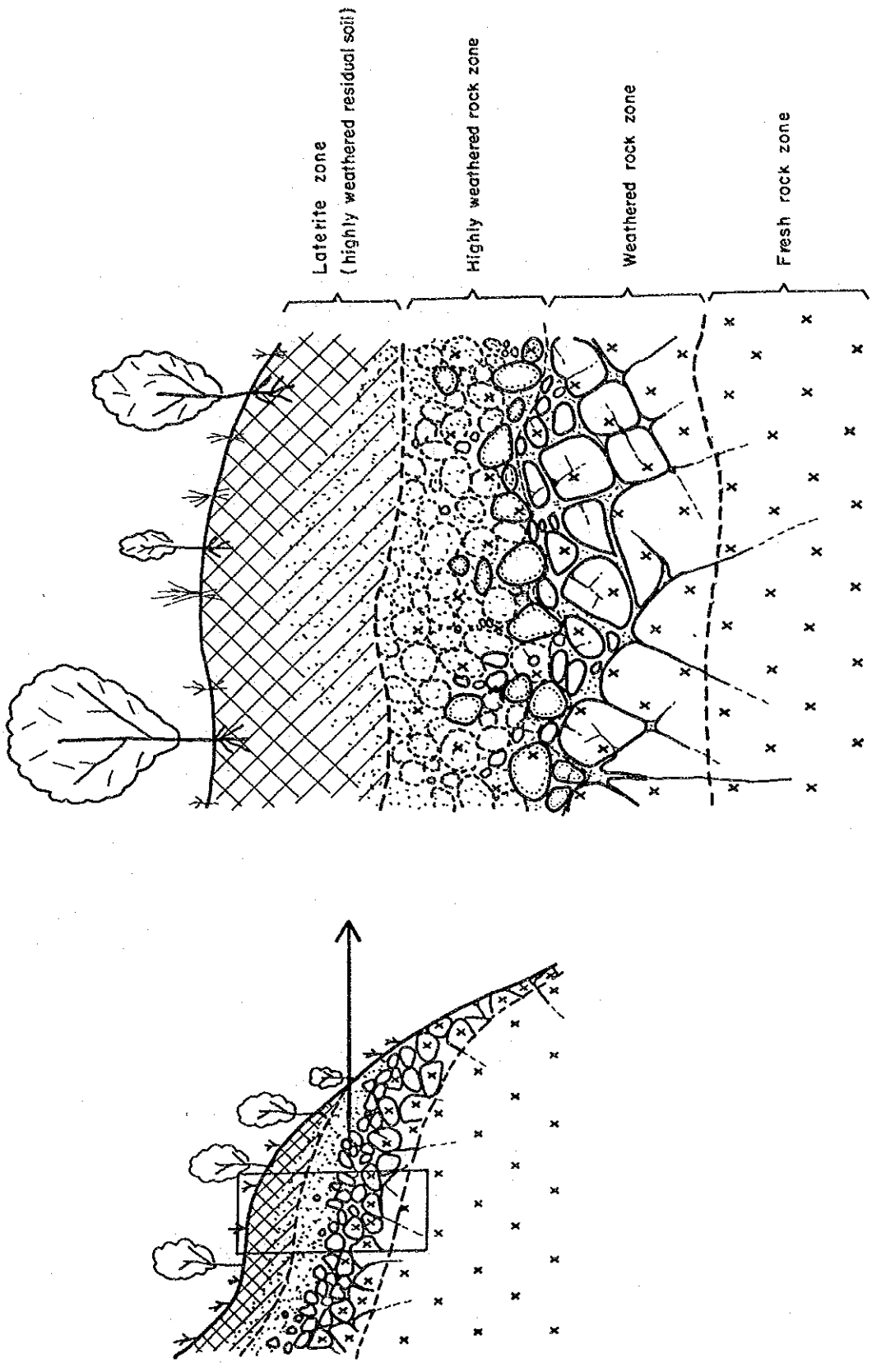


FIG.E.11
SCHEMATIC WEATHERING PROFILE
IN THE STUDY AREA

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

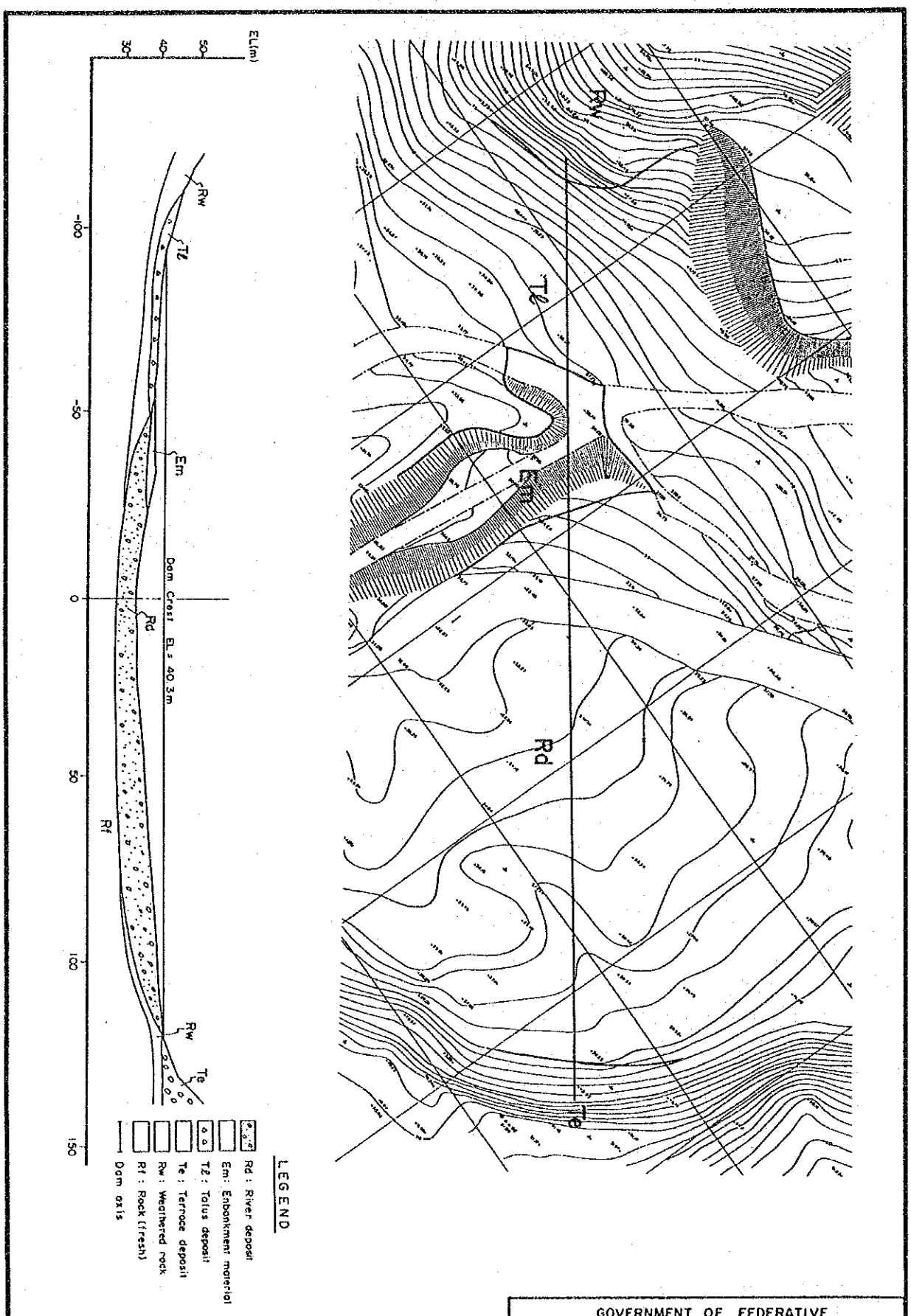
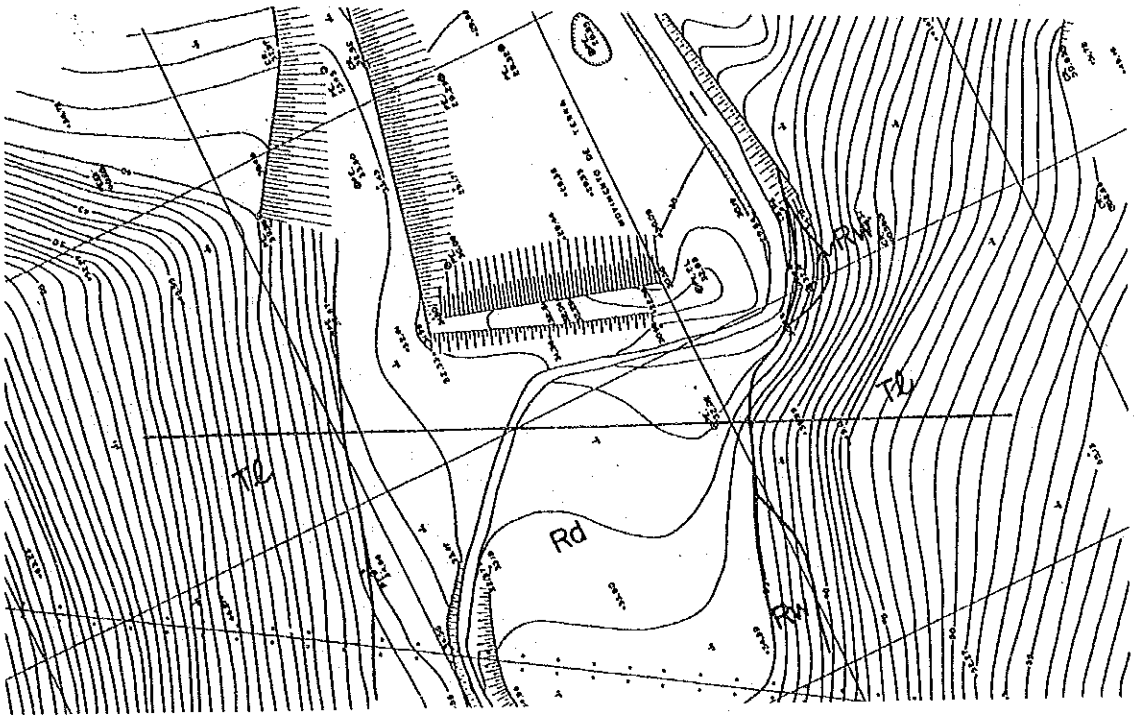
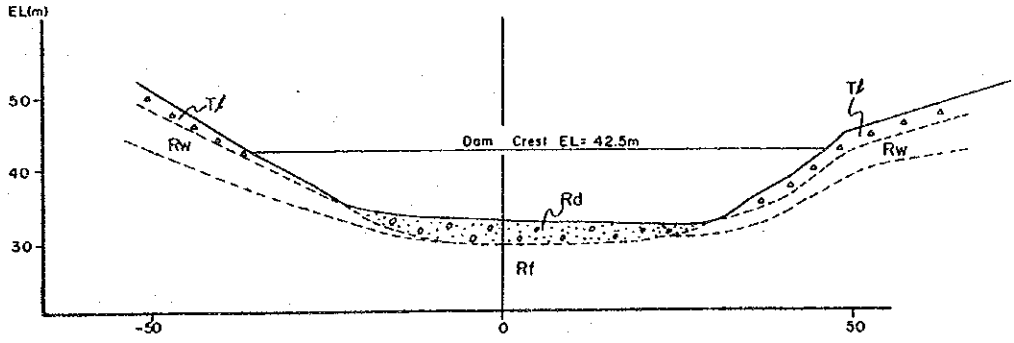


FIG.E.12
GEOLOGICAL CONDITIONS OF SABO DAMSITES IN PRIORITY PROJECT (DAMSITE 2-1)

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



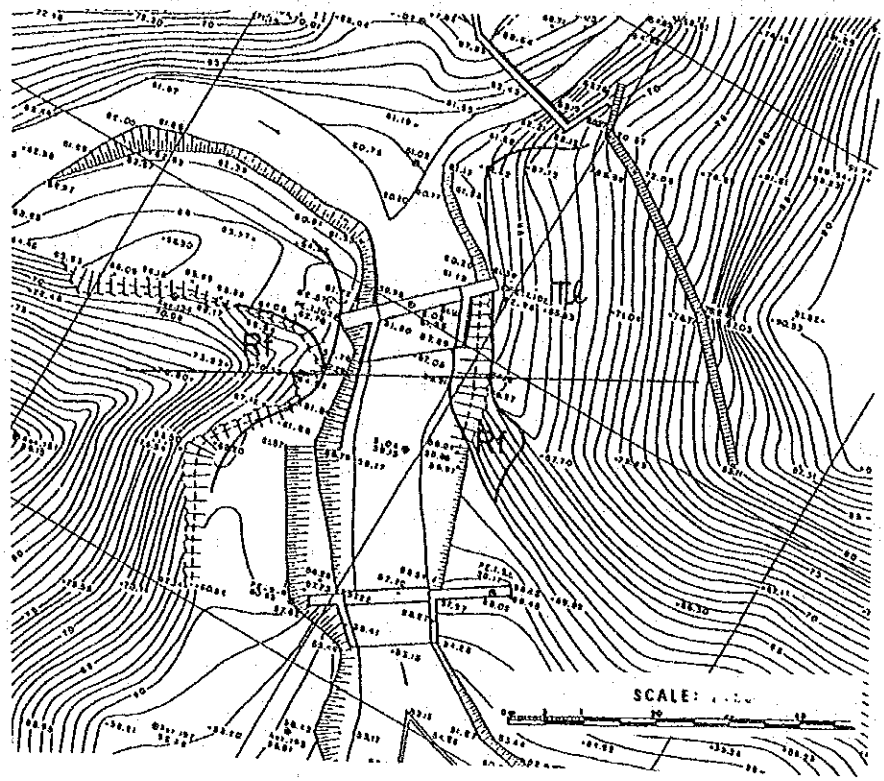


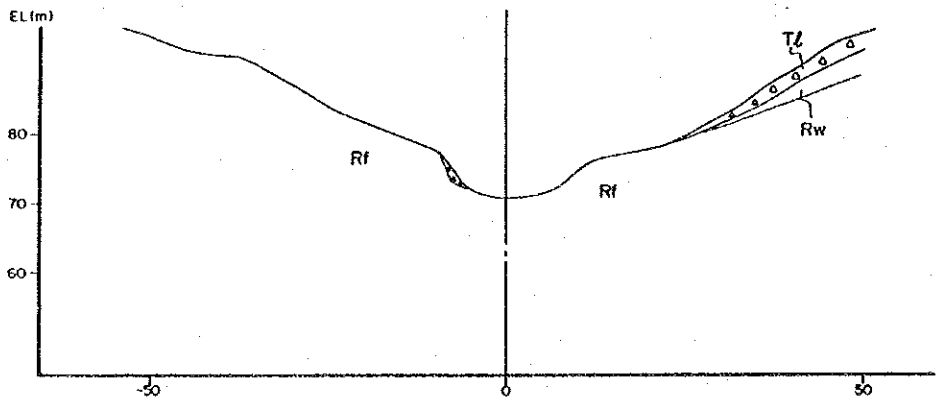
LEGEND

- Rd : River deposit
- Tℓ : Talus deposit
- Rw: Weathered rock
- Rf : Rock (fresh)
- Dam axis

FIG.E.13
GEOLOGICAL CONDITIONS OF SABO DAMSITES IN PRIORITY PROJECT (DAMSITE 3-1)

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



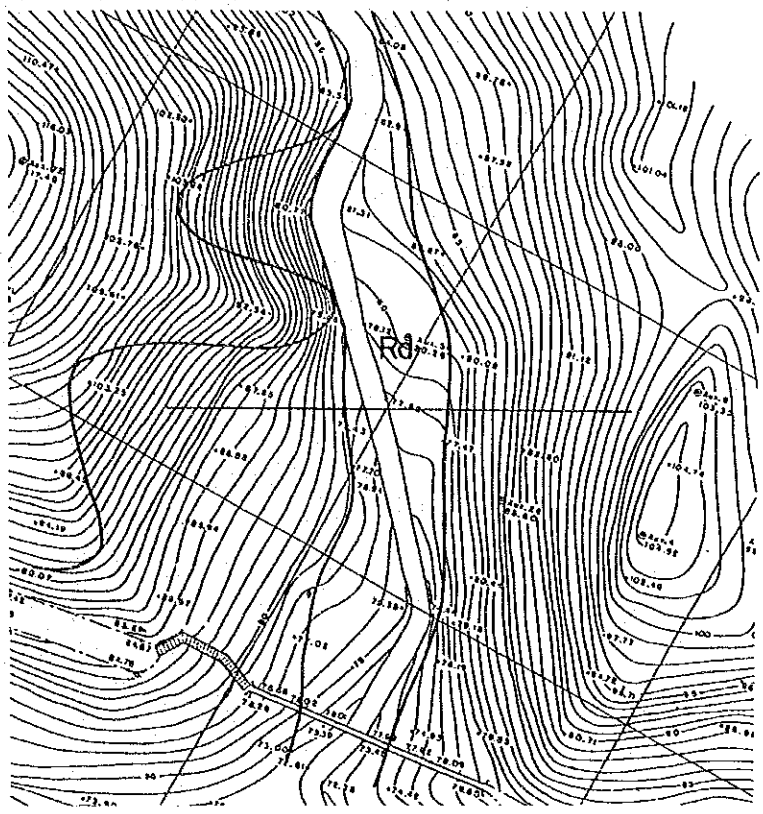


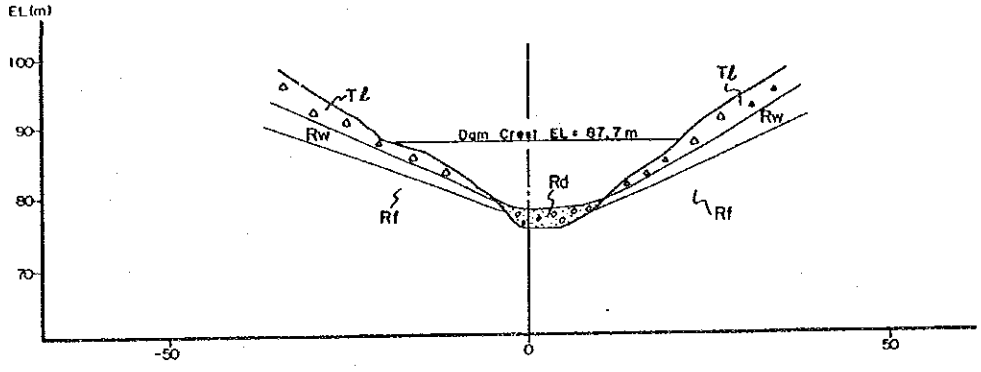
LEGEND

- Rd : River deposit
- Tℓ : Talus deposit
- Te : Terrace deposit
- Rw: Weathered rock
- Rf : Rock (fresh)
- Dam axis

FIG.E.14
GEOLOGICAL CONDITIONS OF SABO DAMSITES IN PRIORITY PROJECT (DAMSITE 7-1)

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





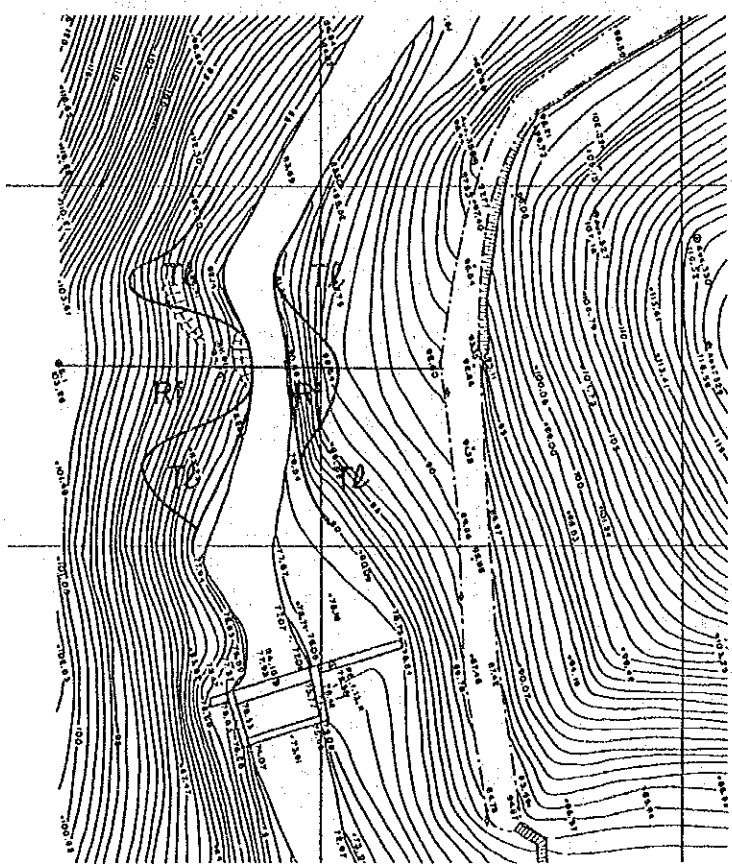
LEGEND

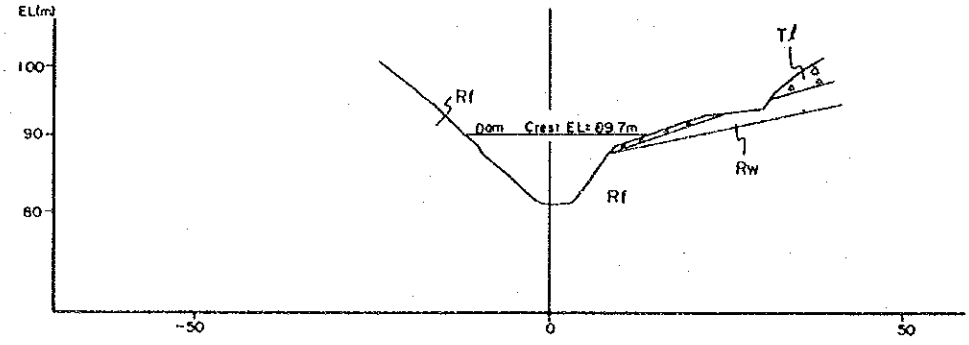
- Rd : River deposit
- Tℓ : Talus deposit
- Rw: Weathered rock
- Rf : Rock (fresh)
- Dam axis

FIG.E.15
GEOLOGICAL CONDITIONS OF SABO DAMSITES IN PRIORITY PROJECT (DAMSITE 7-3)

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



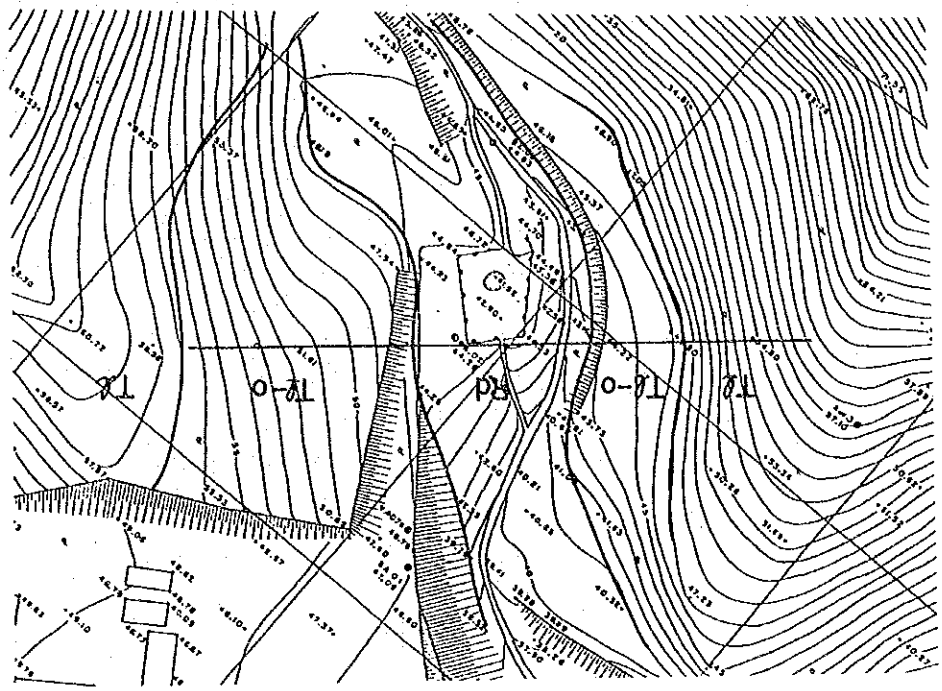


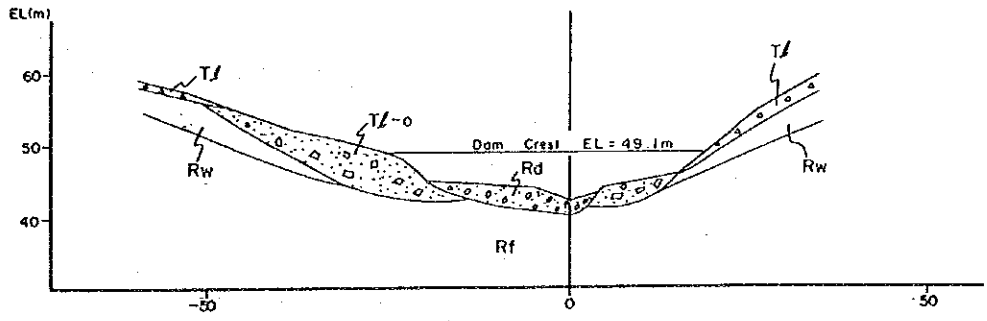
LEGEND

- Tℓ : Talus deposit
- Rw : Weathered rock
- Rf : Rock (fresh)
- Dam axis

FIG.E.16
GEOLOGICAL CONDITIONS OF SABO DAMSITES IN PRIORITY PROJECT (DAMSITE 7-4)

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



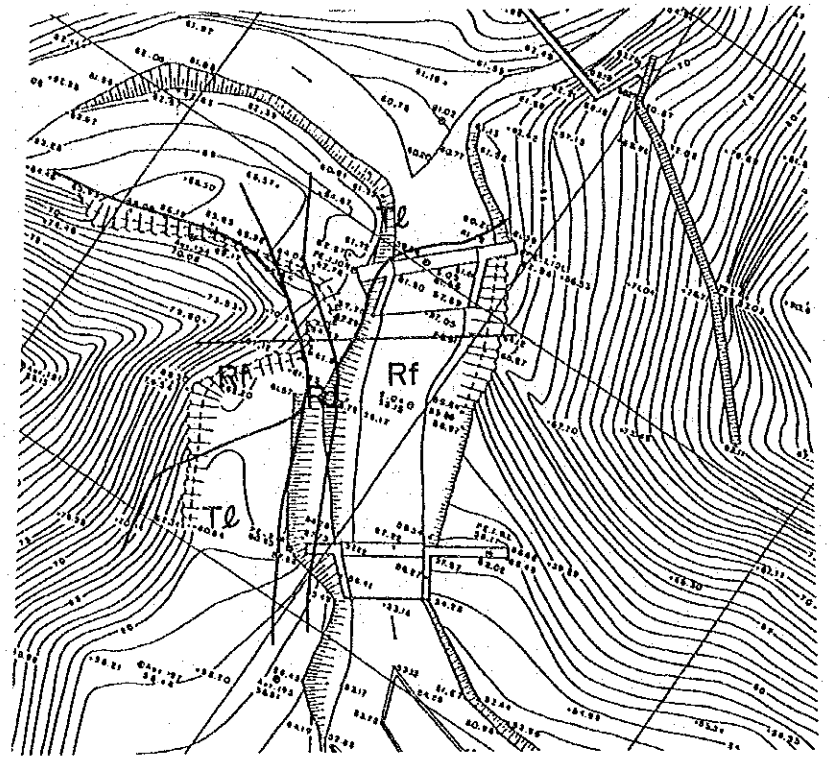


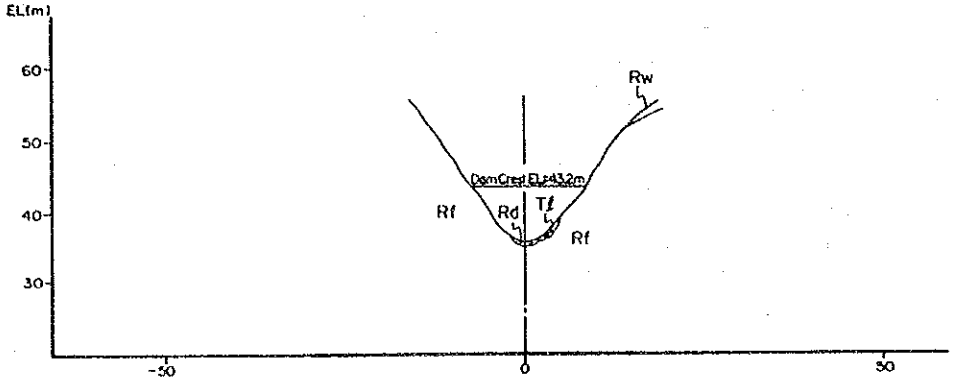
LEGEND

- Rd : River deposit
- Tl : Talus deposit
- Tlo: Talus deposit (old)
- Rw: Weathered rock
- Rf : Rock (fresh)
- Dam axis

FIG.E.17
GEOLOGICAL CONDITIONS OF SABO DAMSITES IN PRIORITY PROJECT (DAMSITE 8-1)

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



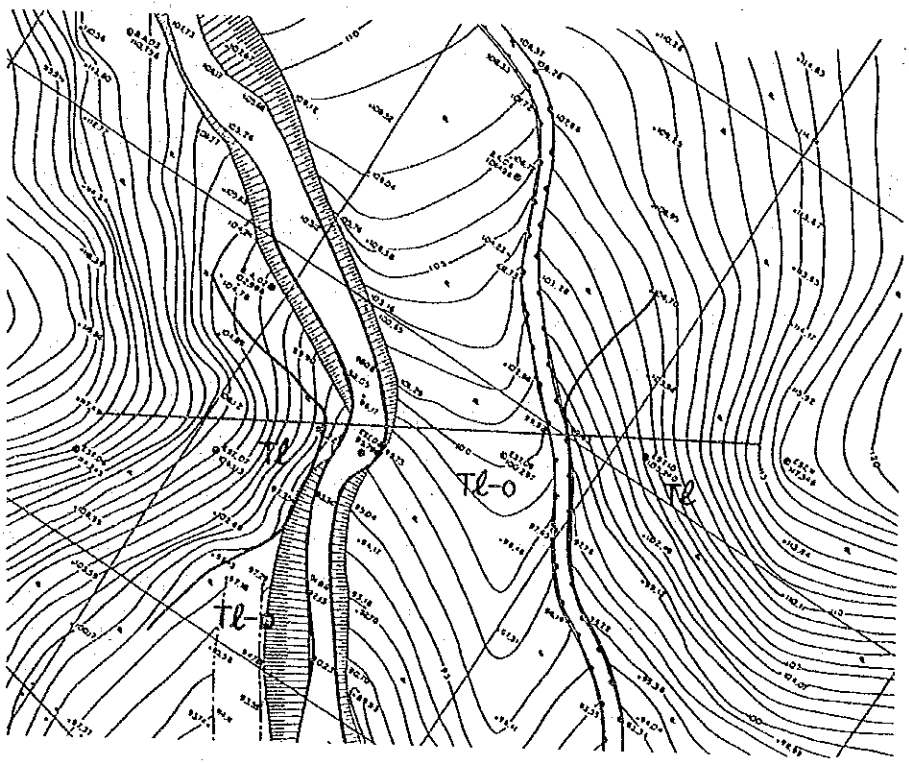


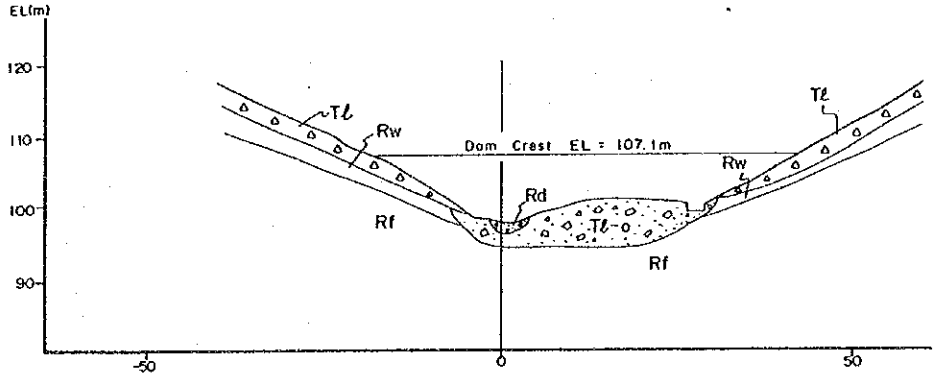
LEGEND

- Rd : River deposit
- Tℓ : Talus deposit
- Rw : Weathered rock
- Rf : Rock (fresh)
- Dam axis

FIG.E.18
GEOLOGICAL CONDITIONS OF SABO DAMSITES IN PRIORITY PROJECT (DAMSITE 10-1)

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



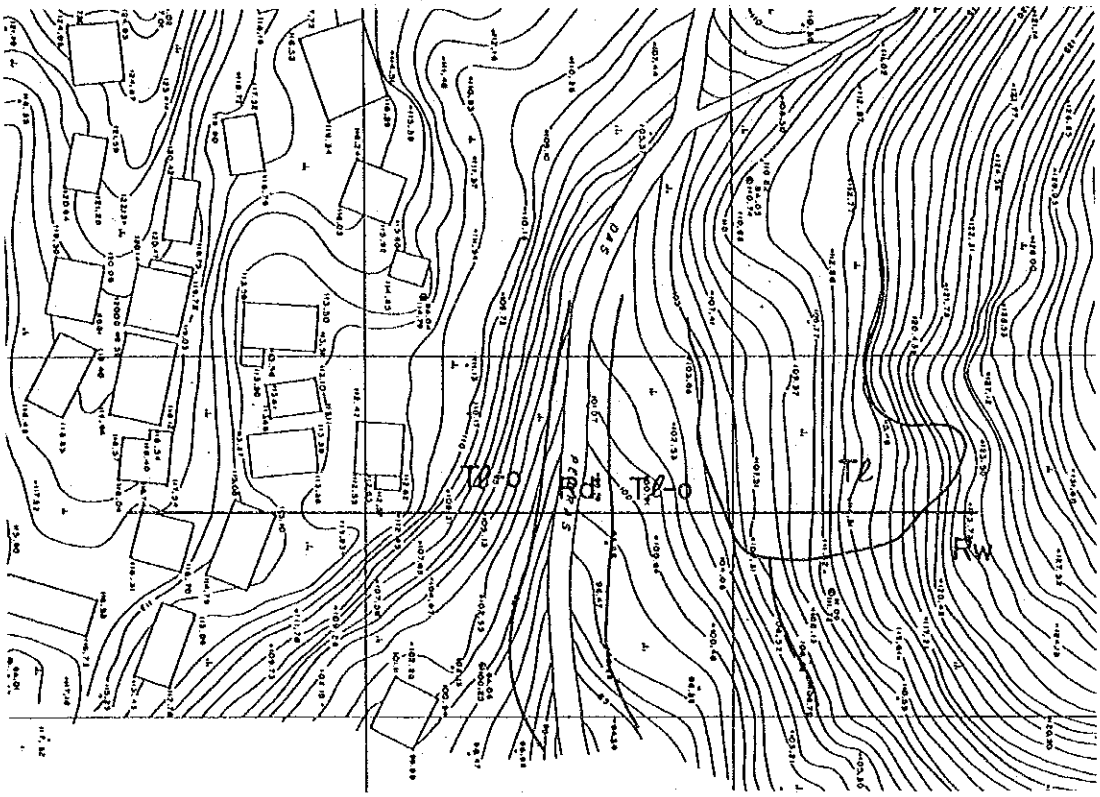


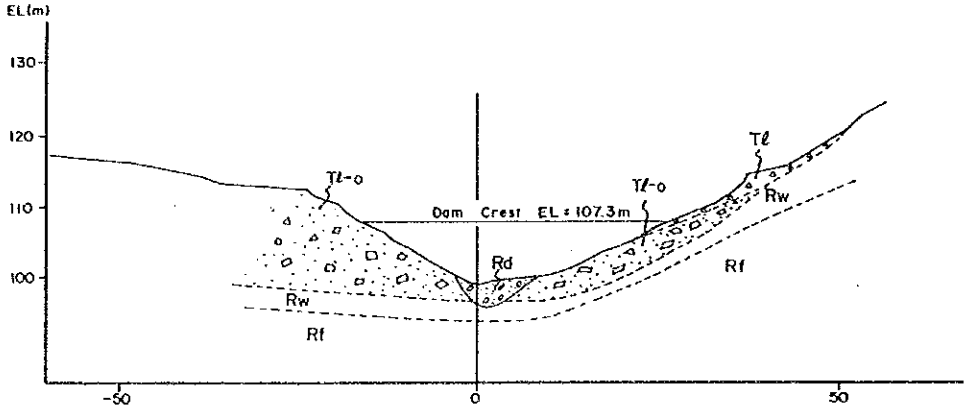
LEGEND

- Rd : River deposit
- Tℓ : Talus deposit
- Tℓo: Talus deposit (old)
- Rw : Weathered rock
- Rf : Rock (fresh)
- Dam axis

FIG.E.19
GEOLOGICAL CONDITIONS OF SABO DAMSITES IN PRIORITY PROJECT (DAMSITE 11-1)

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

- Rd : River deposit
- Tℓ : Talus deposit
- Tℓ-o: Talus deposit (old)
- Rw : Weathered rock
- Rf : Rock (Without weathering)
- Dam axis

FIG.E.20
GEOLOGICAL CONDITIONS OF SABO DAMSITES IN PRIORITY PROJECT (DAMSITE 12-1)

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 F

HYDROLOGY

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