FIGURES

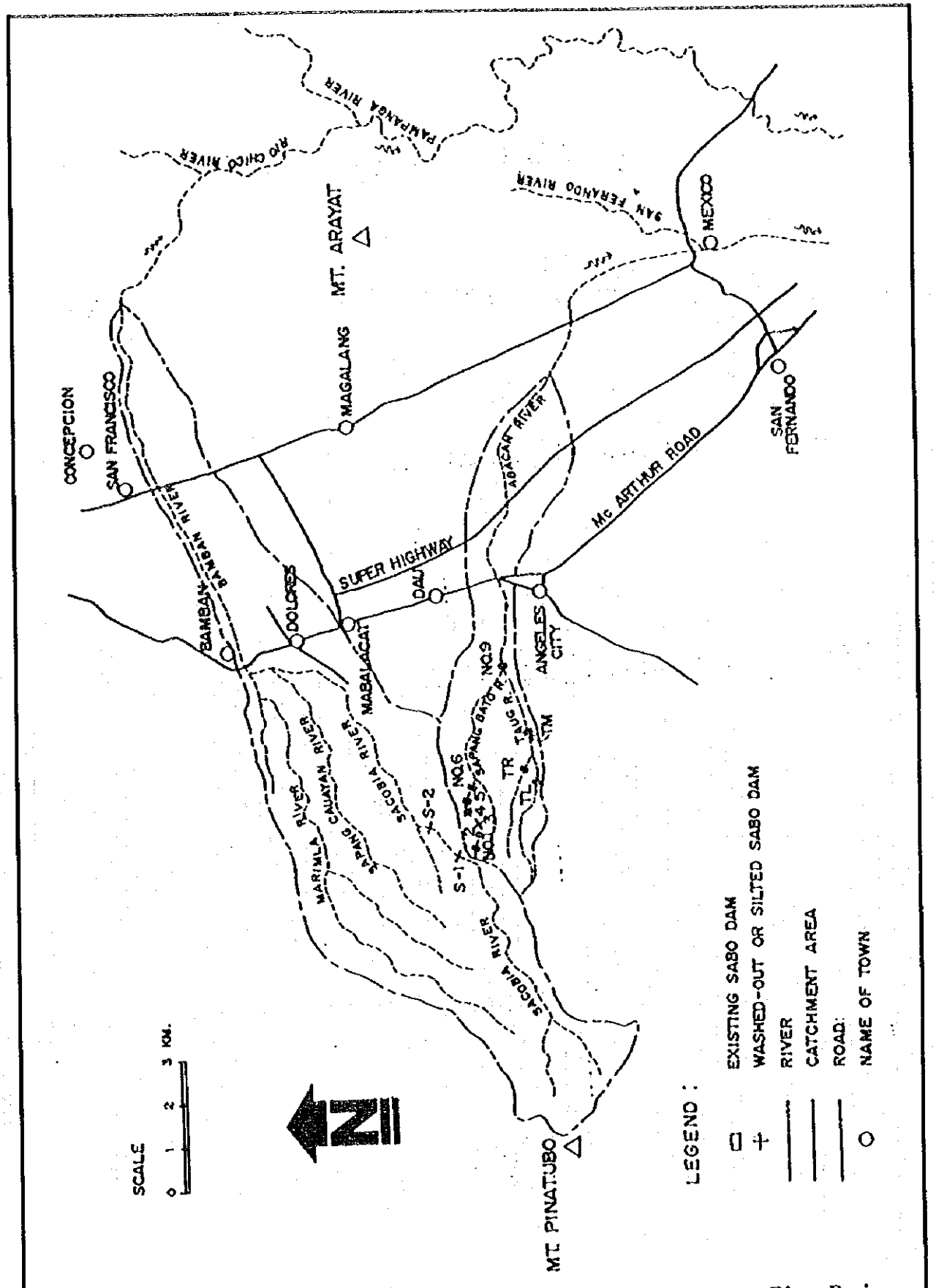
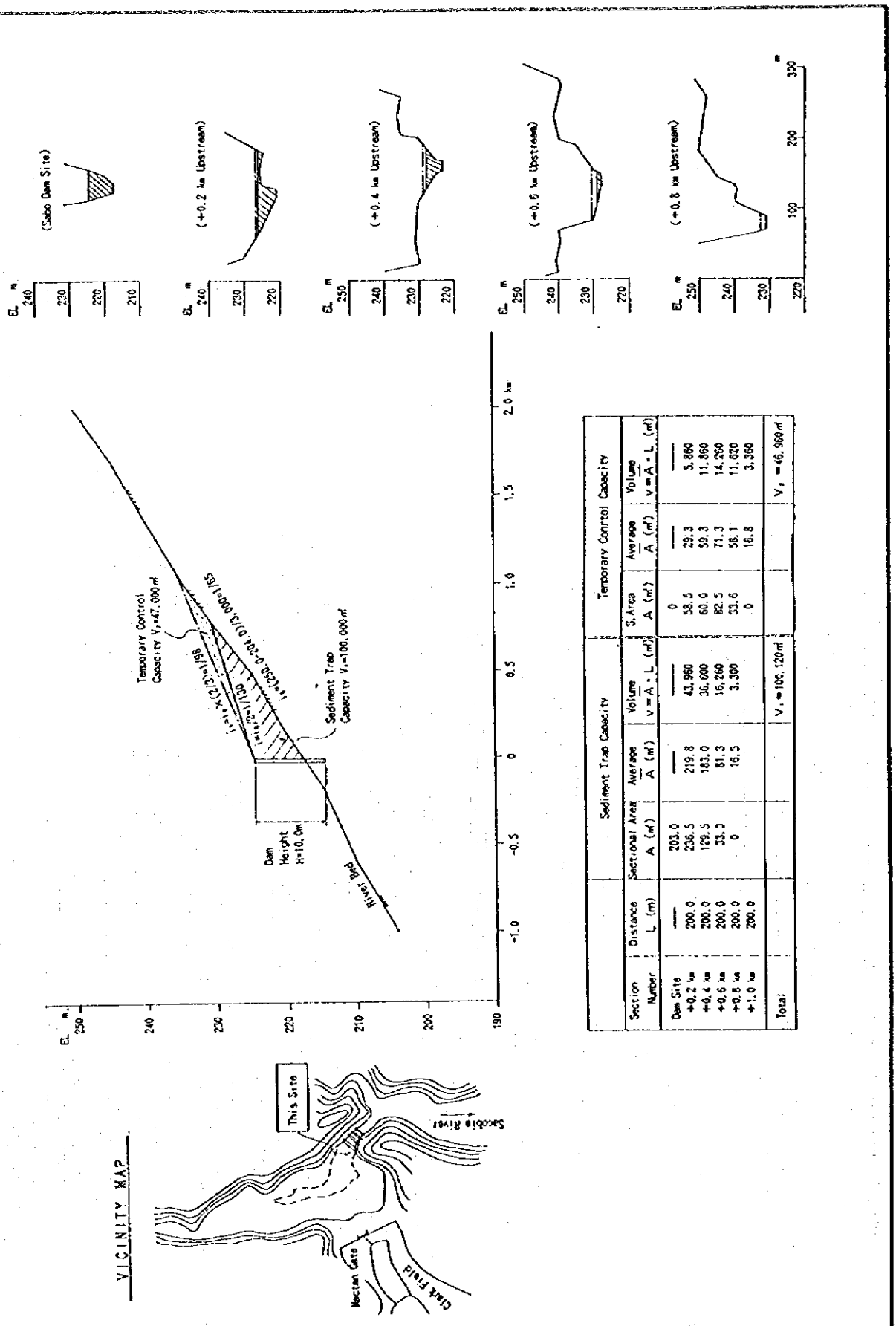


Figure H.1 Location of Sabo Dam in the Sacobia-Bamban and Abacan River Basin

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



Section Number	Distance L (m)	Sediment Trap Capacity: Sectional Area A (㎡)	Sediment Trap Capacity: Average A (㎡)	Sediment Trap Capacity: Volume v = Ā · L (㎥)	Temporary Control Capacity: S.Area A (㎡)	Temporary Control Capacity: Average Ā (㎡)	Temporary Control Capacity: Volume v = Ā · L (㎥)
Dam Site	——	203.0	——	——	0	——	——
+0.2 ka	200.0	236.5	219.8	43,960	58.5	29.3	5,860
+0.4 ka	200.0	129.5	183.0	36,600	60.0	59.3	11,860
+0.6 ka	200.0	33.0	81.3	16,260	82.5	71.3	14,260
+0.8 ka	200.0	0	16.5	3,300	33.6	58.1	11,620
+1.0 ka	200.0				0	16.8	3,350
Total				V₂ =100,120㎥			V₁ =46,960㎥

Figure II.2 Estimation of Sediment Retention Capacity of Mactan Sabo Dam

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

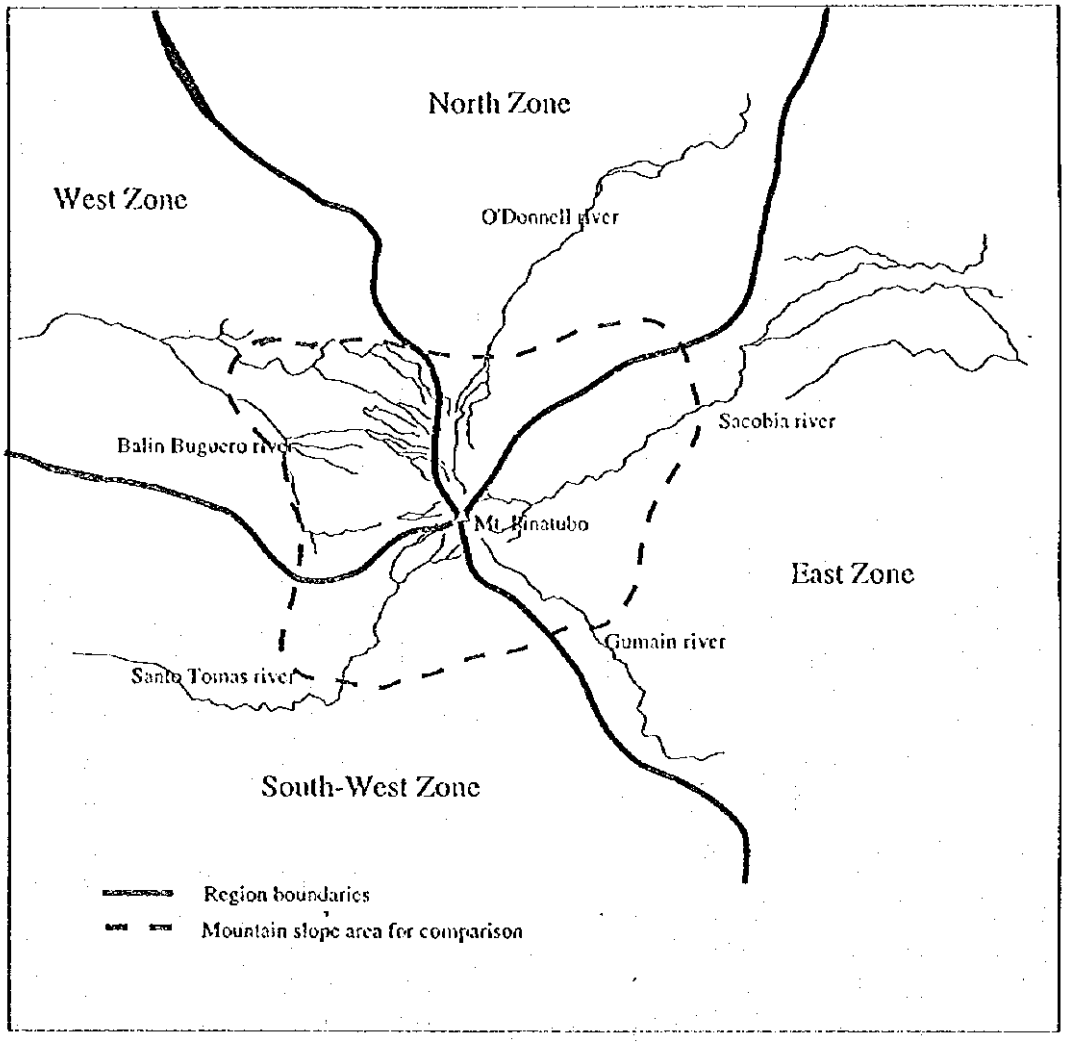
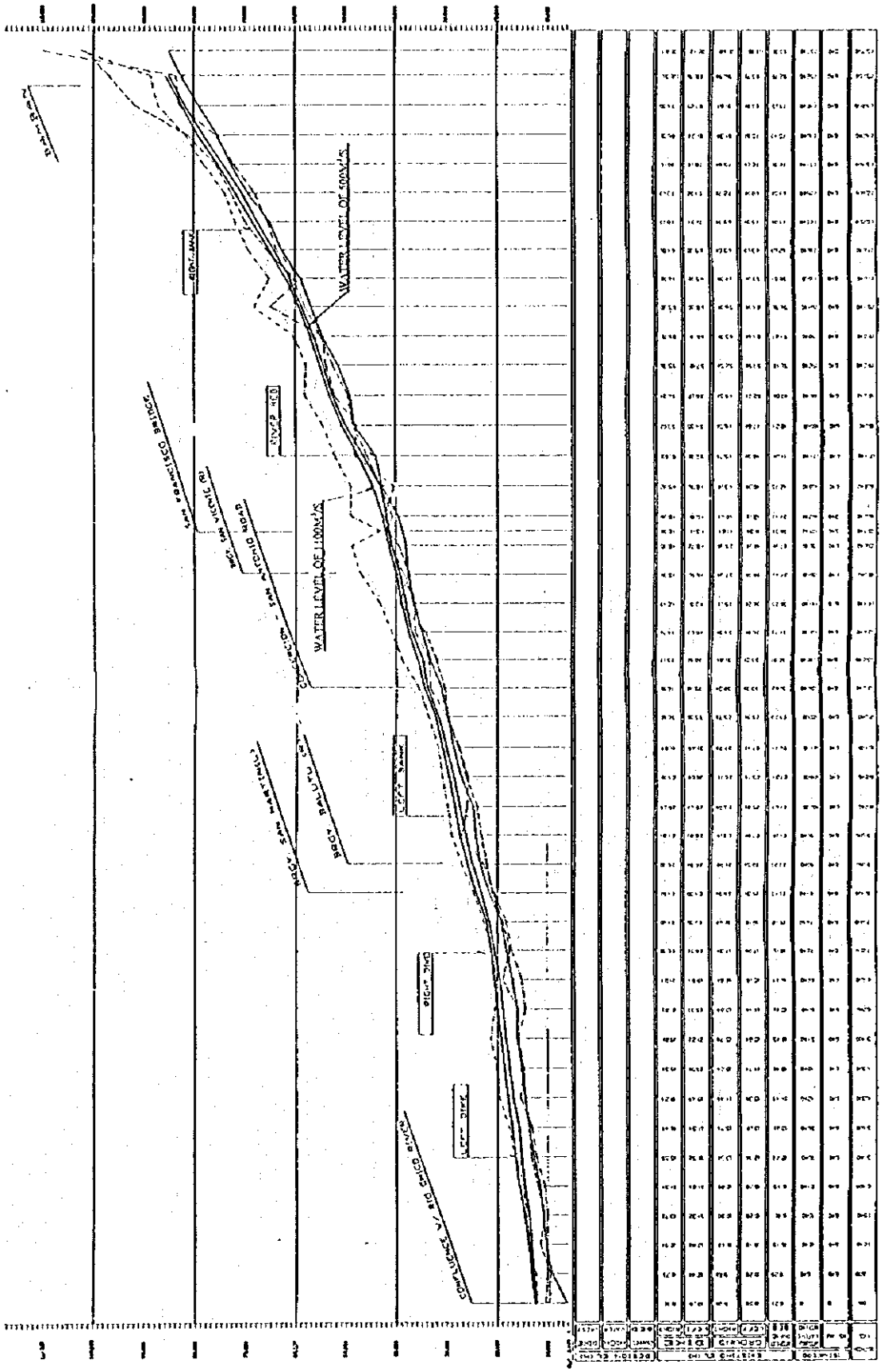


Figure II.3

Subdivided Area for Revegetation Analysis

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure H.4 Present Longitudinal Profile of Bamban River

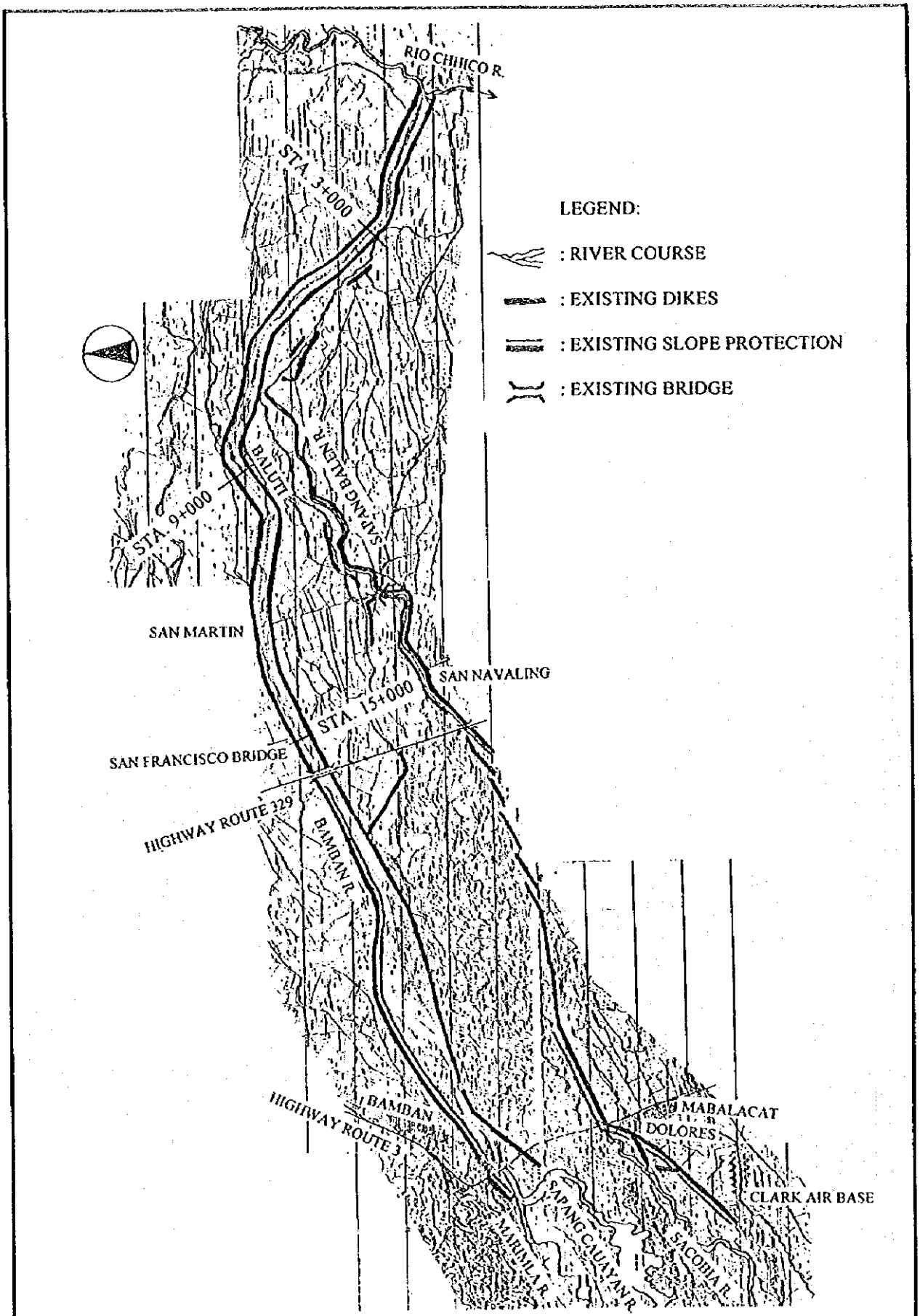


Figure H.5

Existing Structures in Sacobia-Bamban River System

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

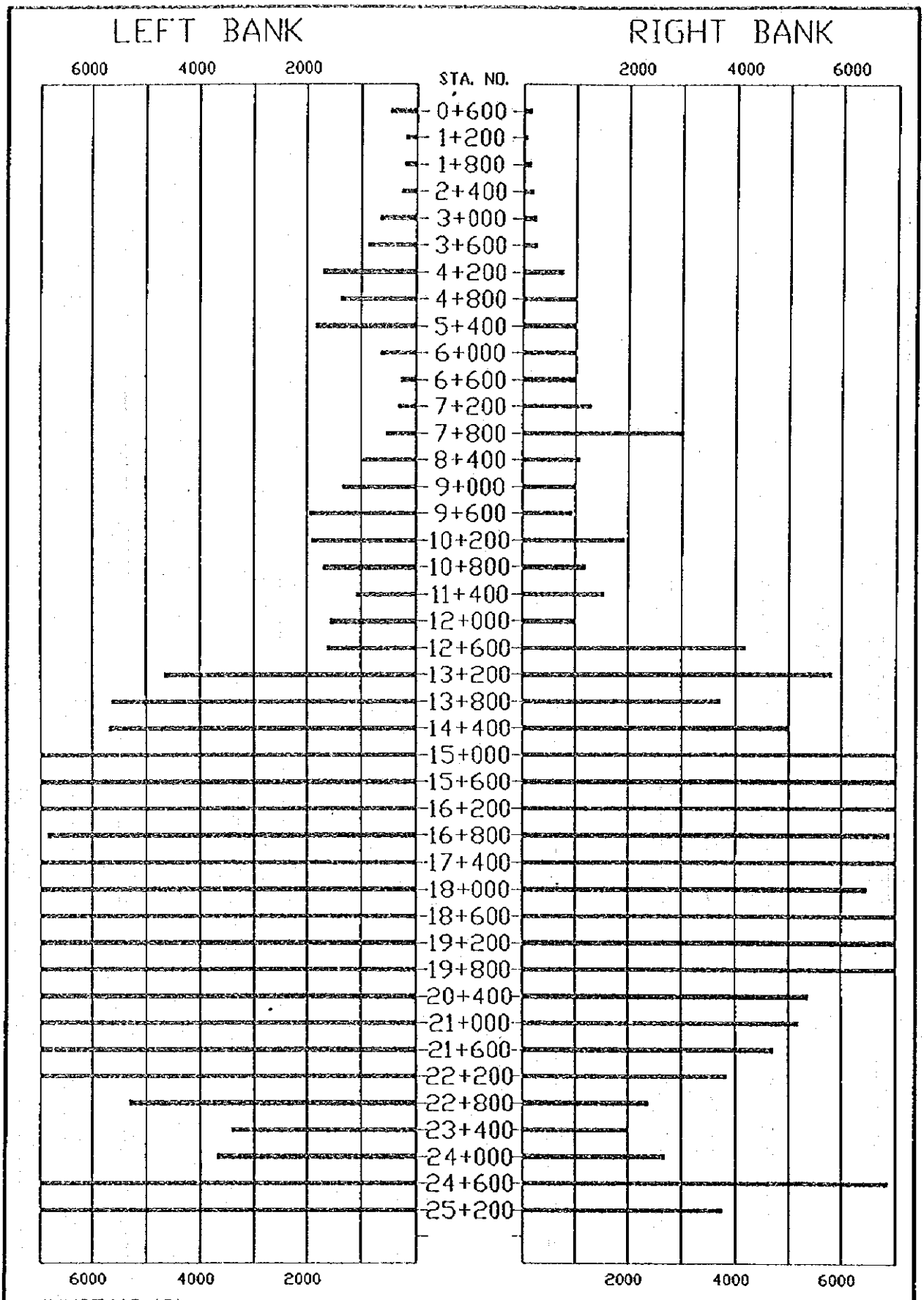


Figure H.6

Present Flow Capacity of Bamban River

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

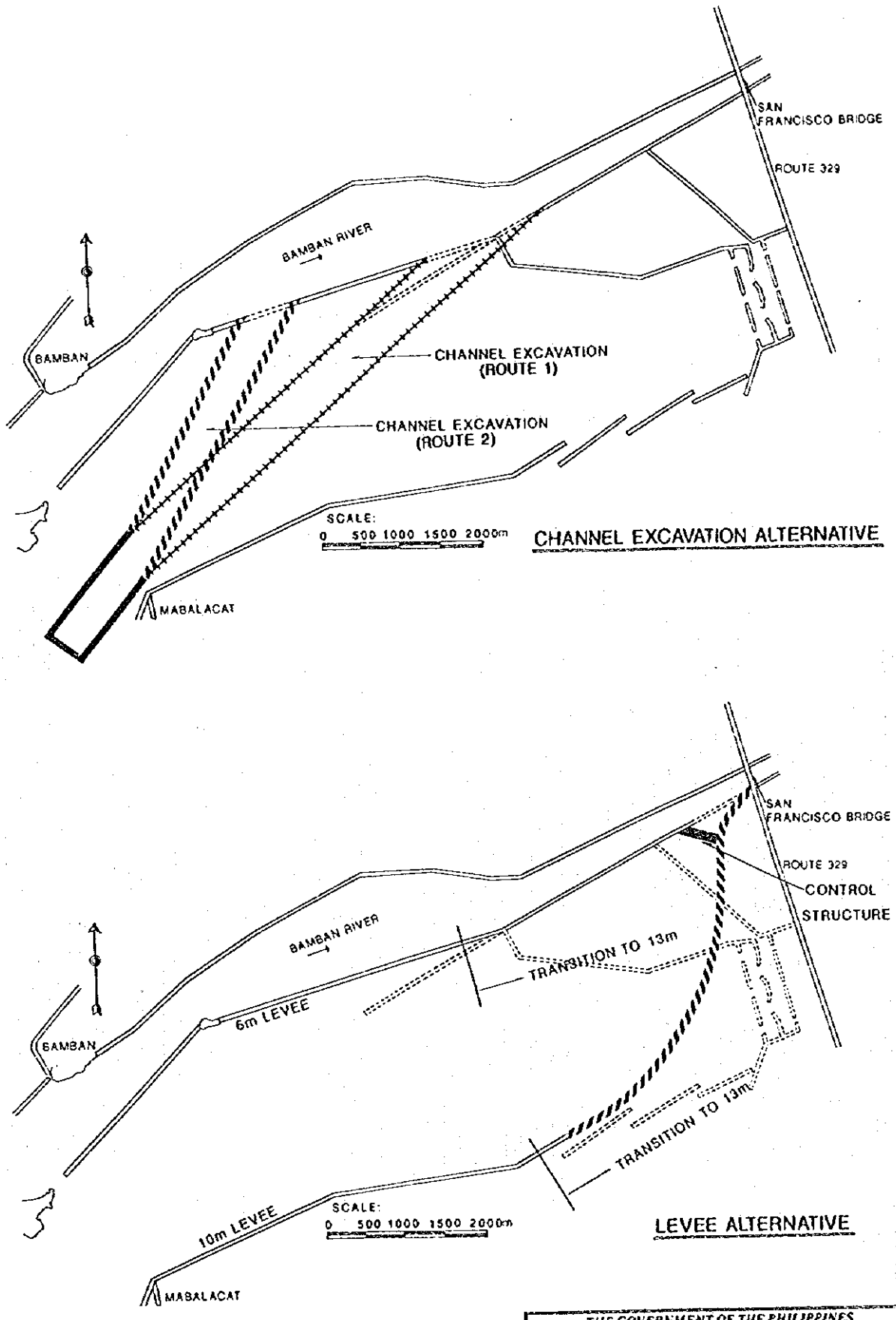


Figure H.7 Layout of USACE's Alternatives

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

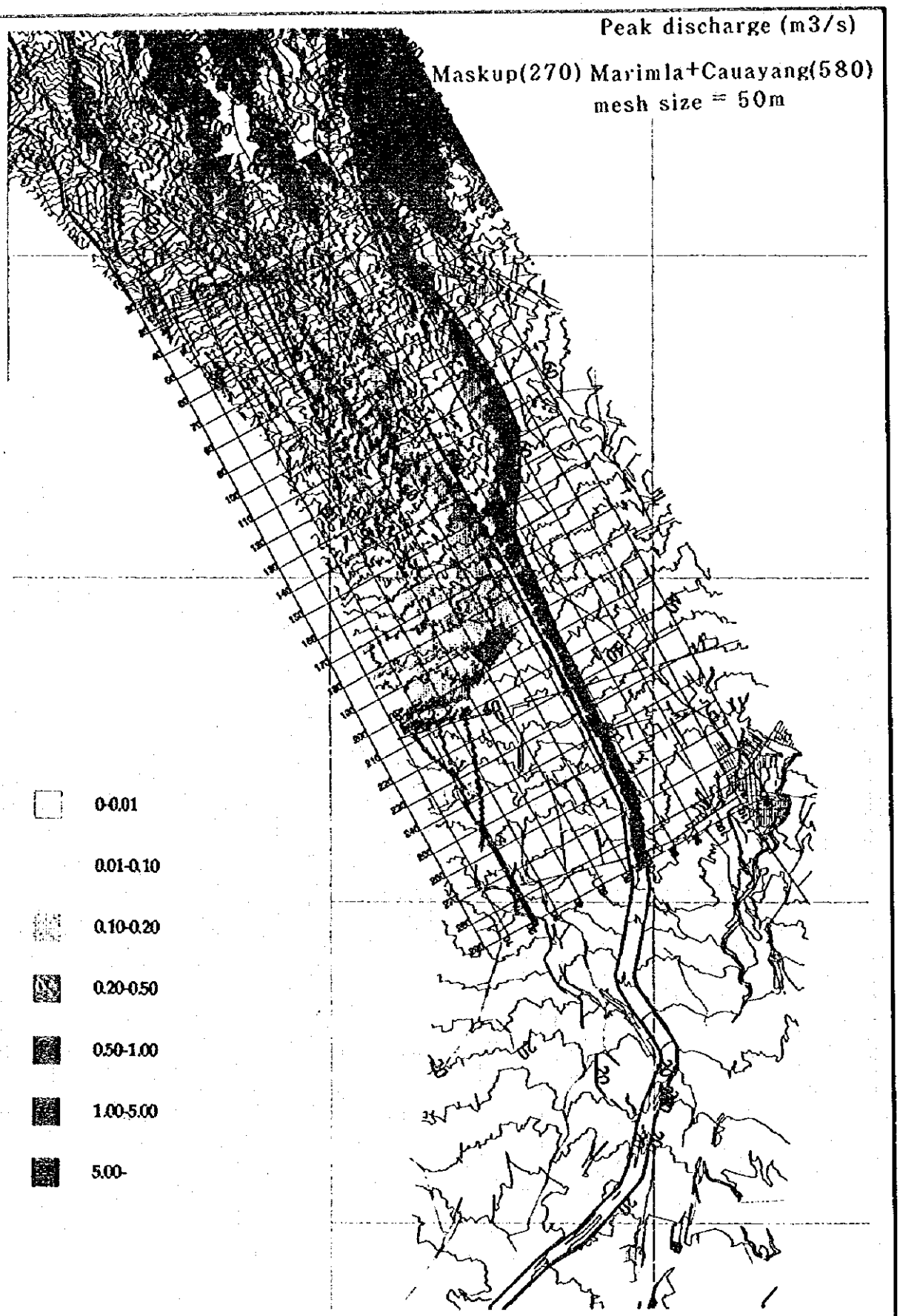
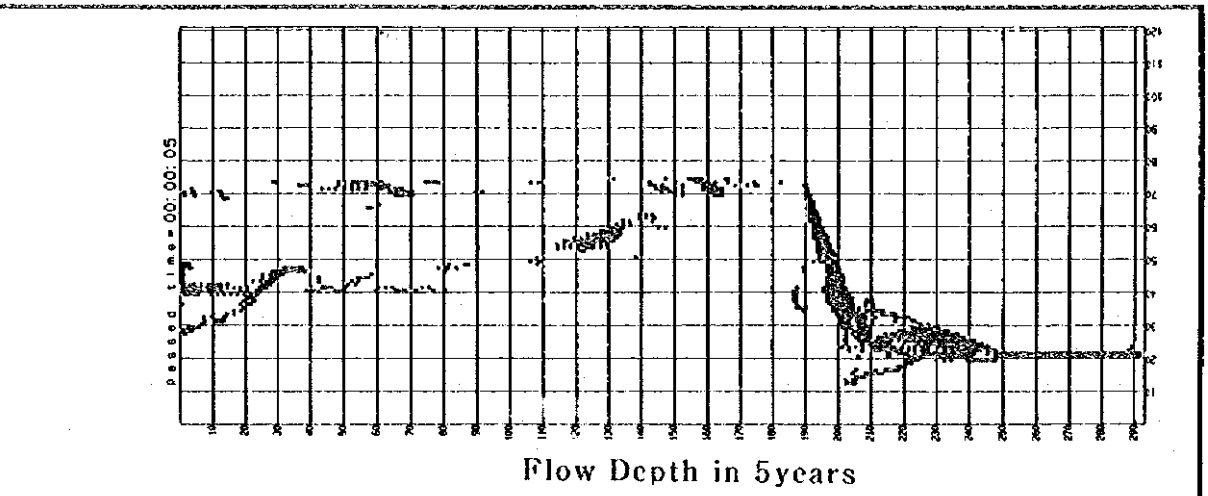


Figure H.8

Flood Control Effect of Sand Pocket Structures

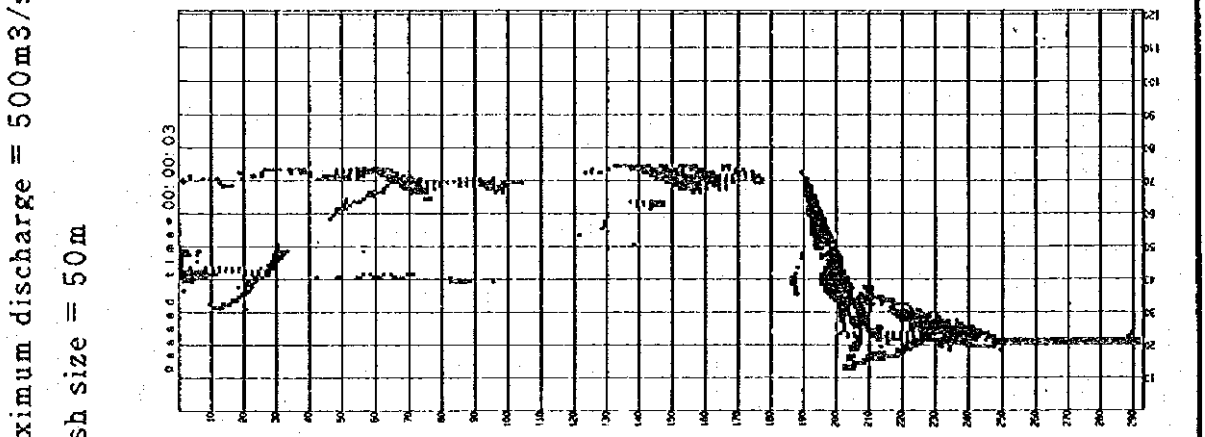
THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



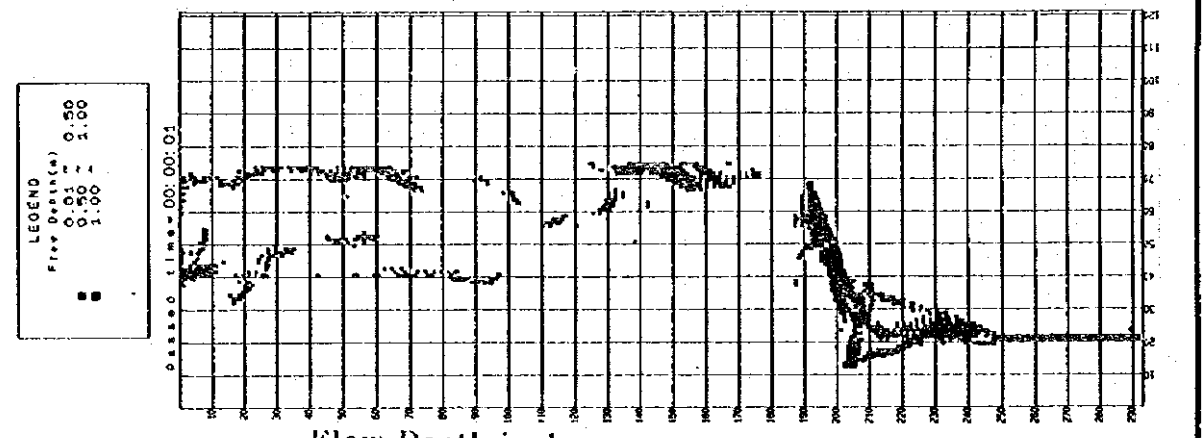
Flow Depth in 5years

Maximum discharge = 500m3/s

mesh size = 50m



Flow Depth in 3 years



Flow Depth in 1 year

Figure H.9

Maximum Flow Depth in Sand Pocket Structures for Short Duration

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

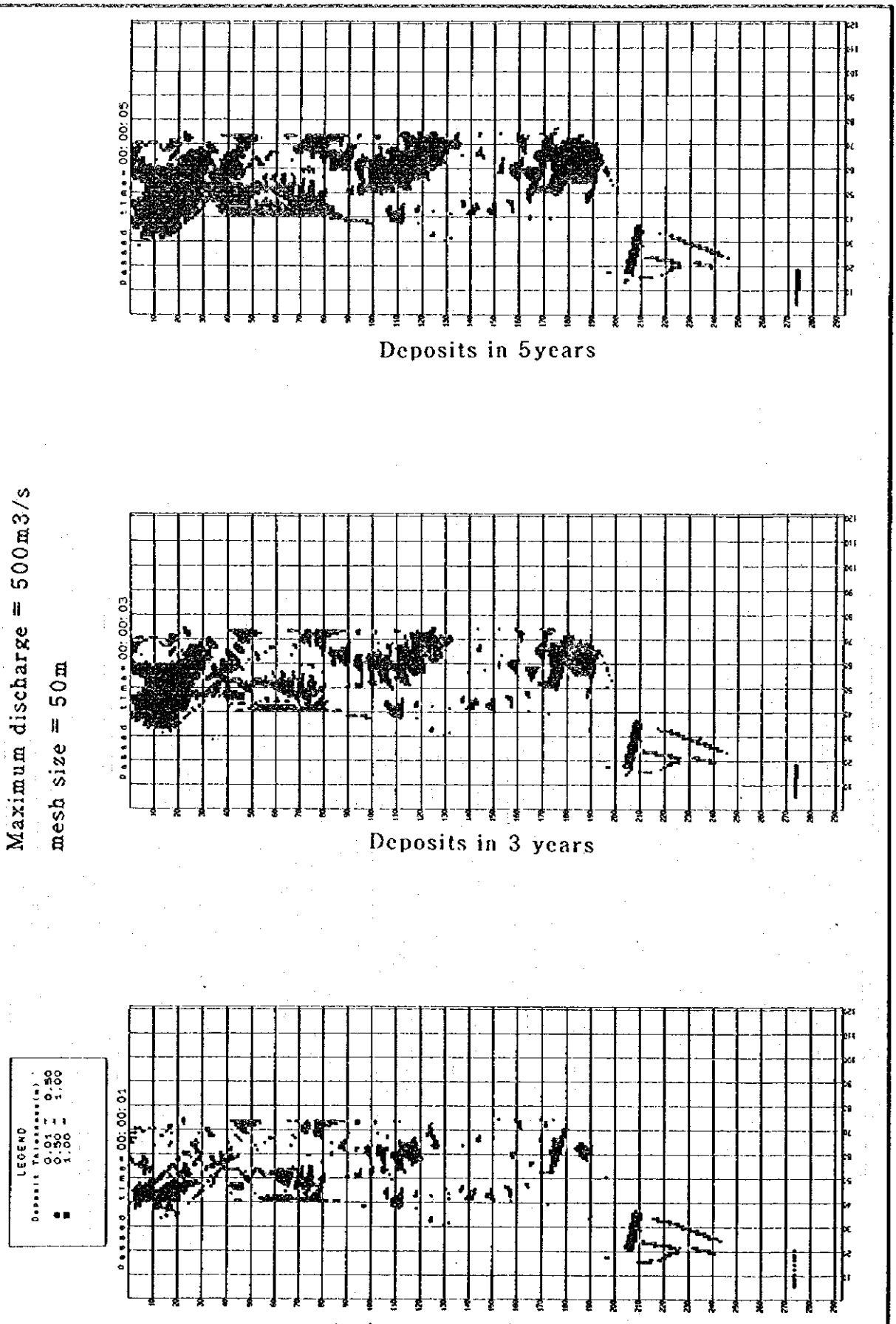


Figure H.10

Maximum Deposit Depth in Sand Pocket Structures for Short Duration

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

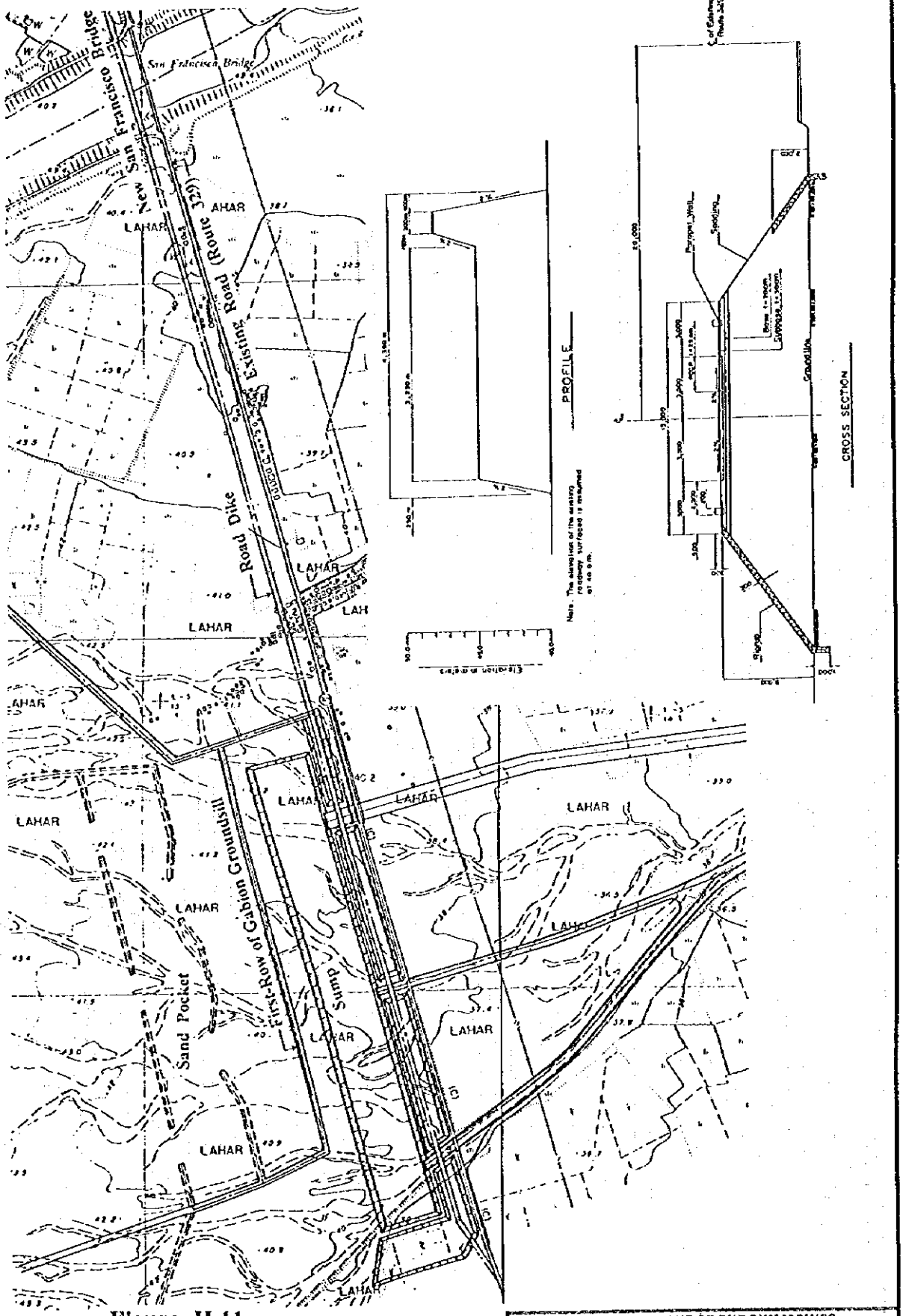


Figure H.11
Preliminary Plan of Road Dike of Route 329 Highway

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

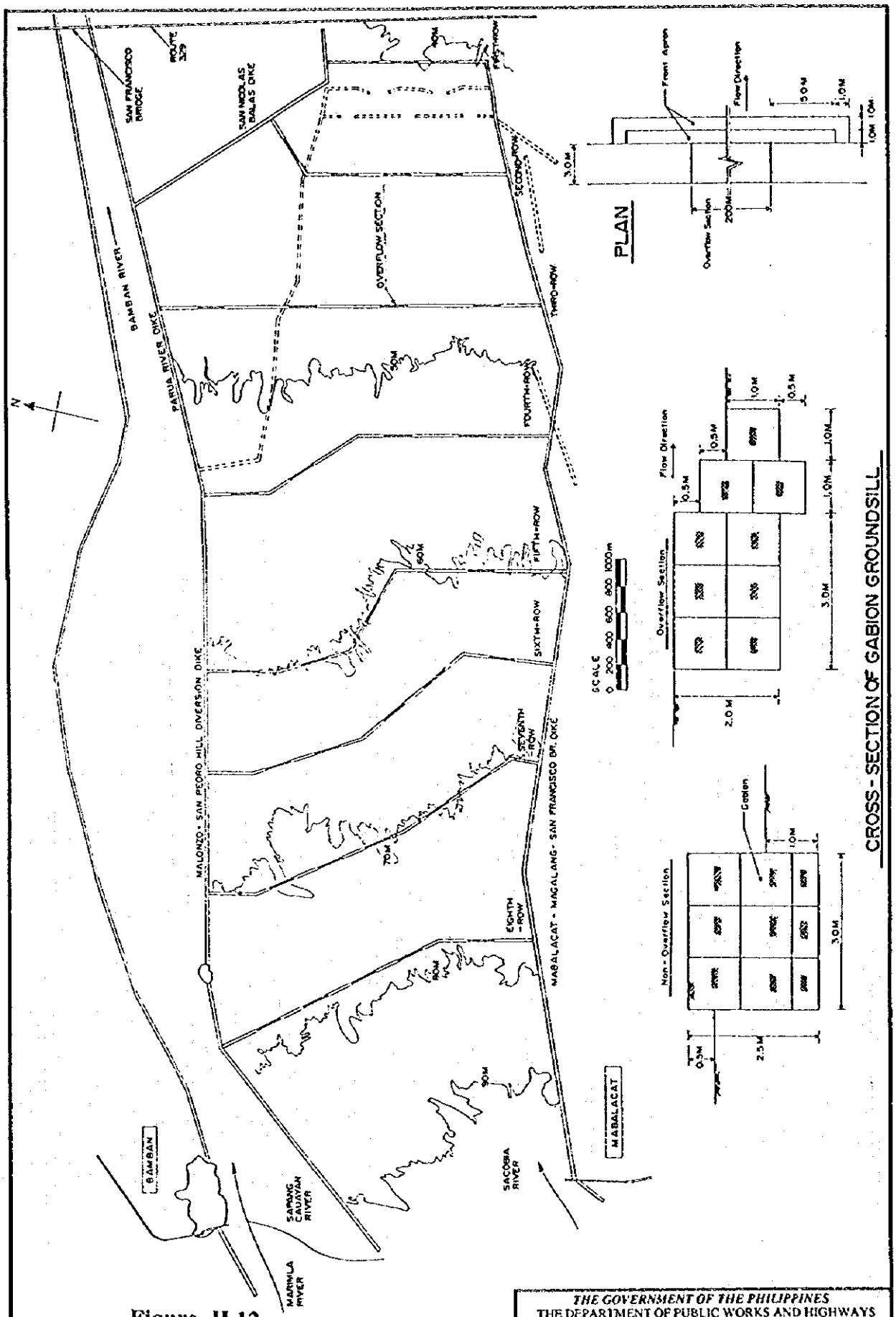


Figure II.12
Preliminary Plan of Lateral Dike System of Sand Pocket

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

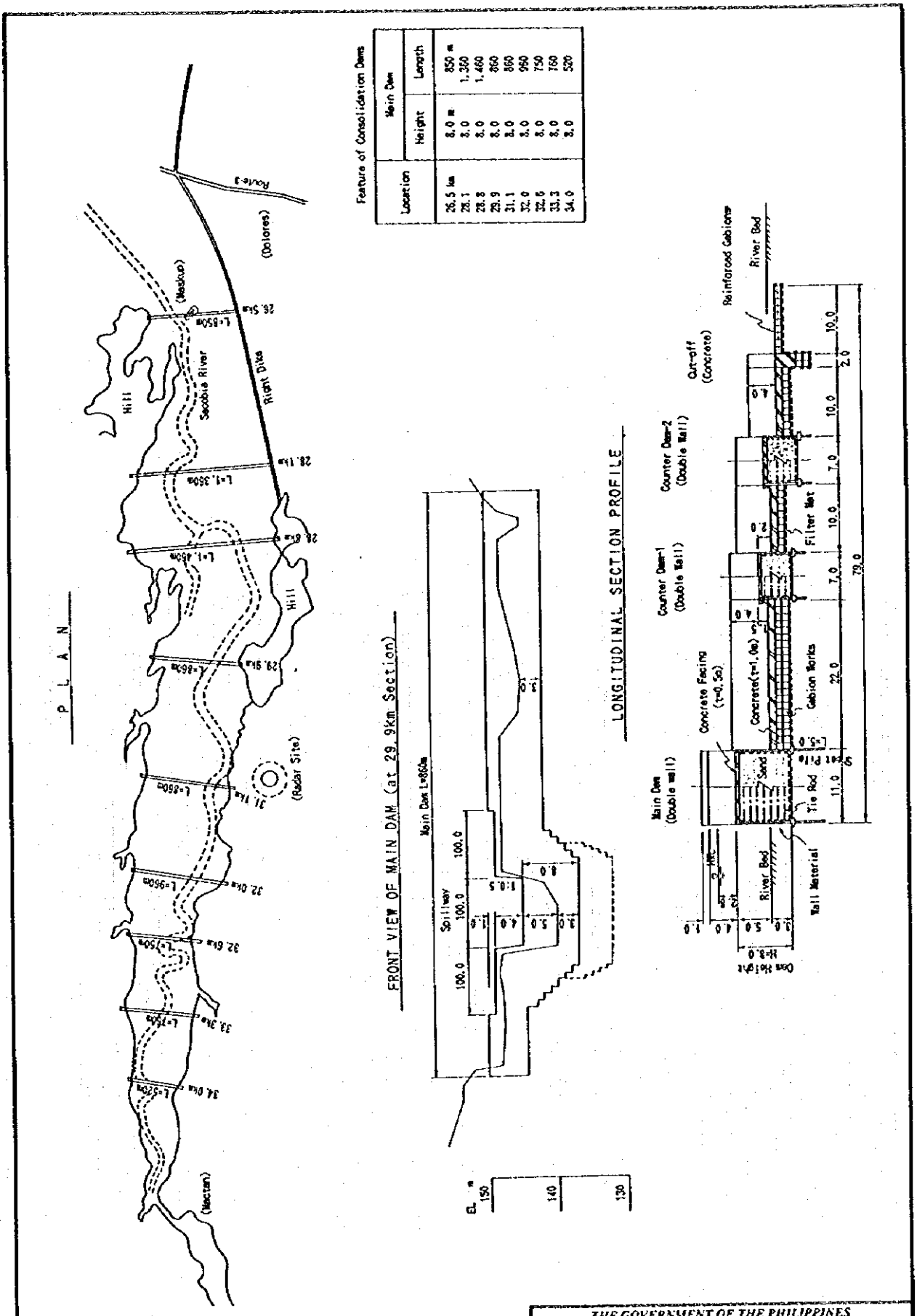
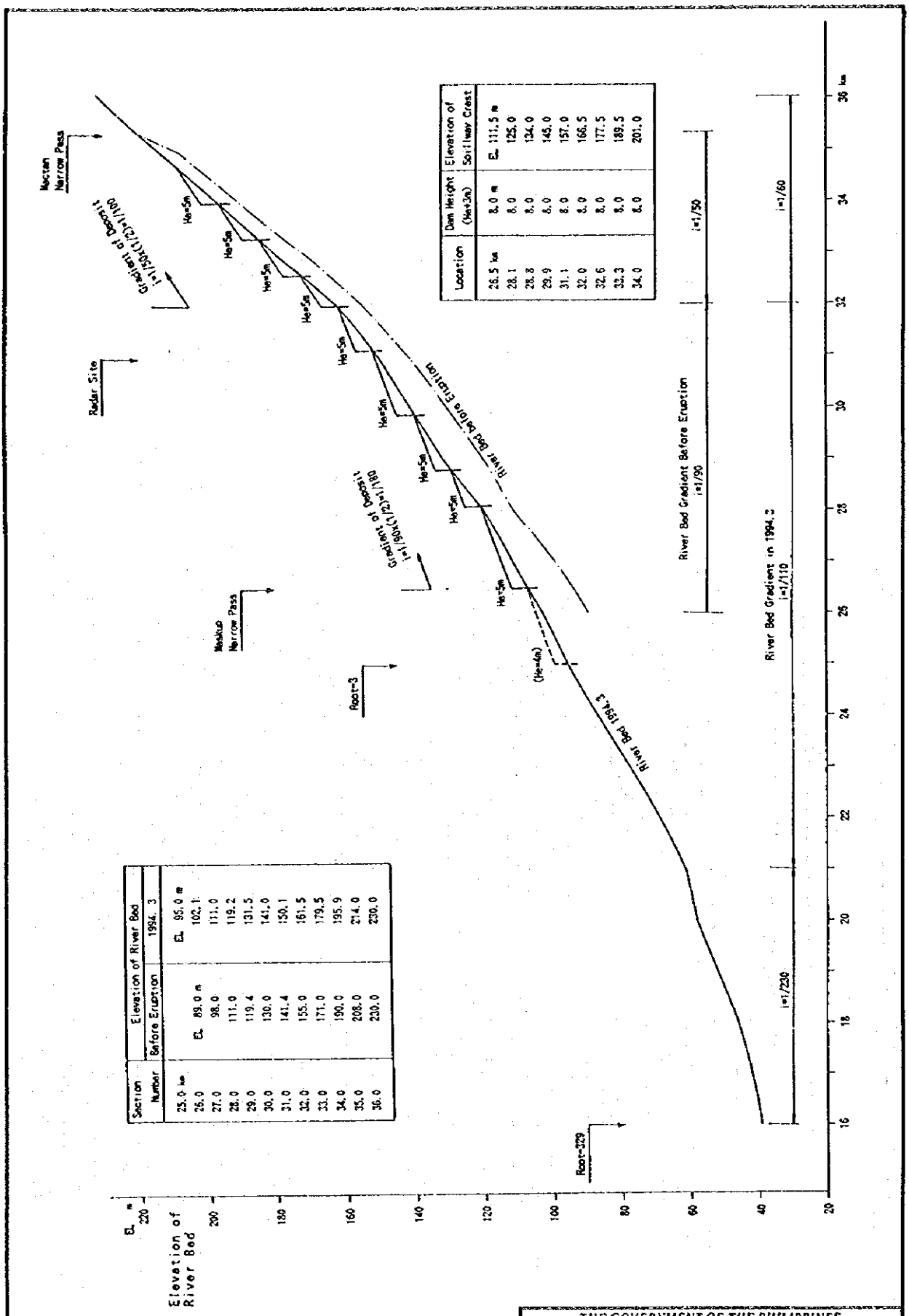


Figure II.13 Preliminary Plan of Series of Consolidation Dams

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



Section Number	Elevation of River Bed	
	Before Eruption	1994. 3
25.0 km		EL. 95.0 m
26.0	EL. 89.0 m	102.1
27.0	98.0	111.0
28.0	111.0	119.2
29.0	119.4	131.5
30.0	130.0	141.0
31.0	141.4	150.1
32.0	155.0	161.5
33.0	171.0	179.5
34.0	190.0	195.9
35.0	208.0	214.0
36.0	230.0	230.0

Location	Dam Height (He=3m)	Elevation of Spillway Crest
26.5 km	8.0 m	EL. 111.5 m
28.1	8.0	125.0
28.8	8.0	134.0
29.9	8.0	145.0
31.1	8.0	157.0
32.0	8.0	166.5
32.6	8.0	177.5
32.3	8.0	189.5
34.0	8.0	201.0

Figure II.14 Longitudinal Profile of Series of Consolidation Dams

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

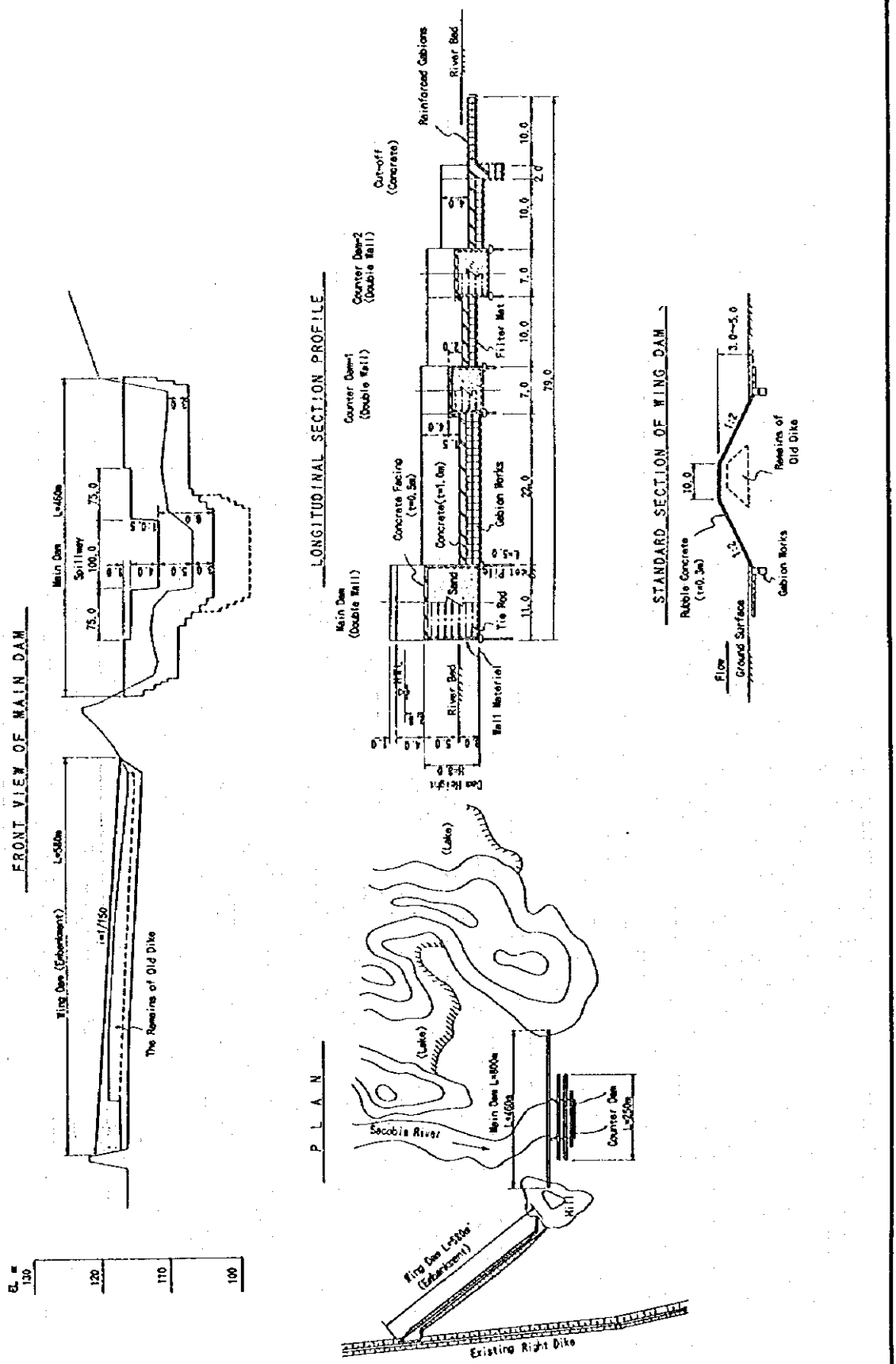


Figure H.15 Preliminary Plan of Maskup Consolidation Dam

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

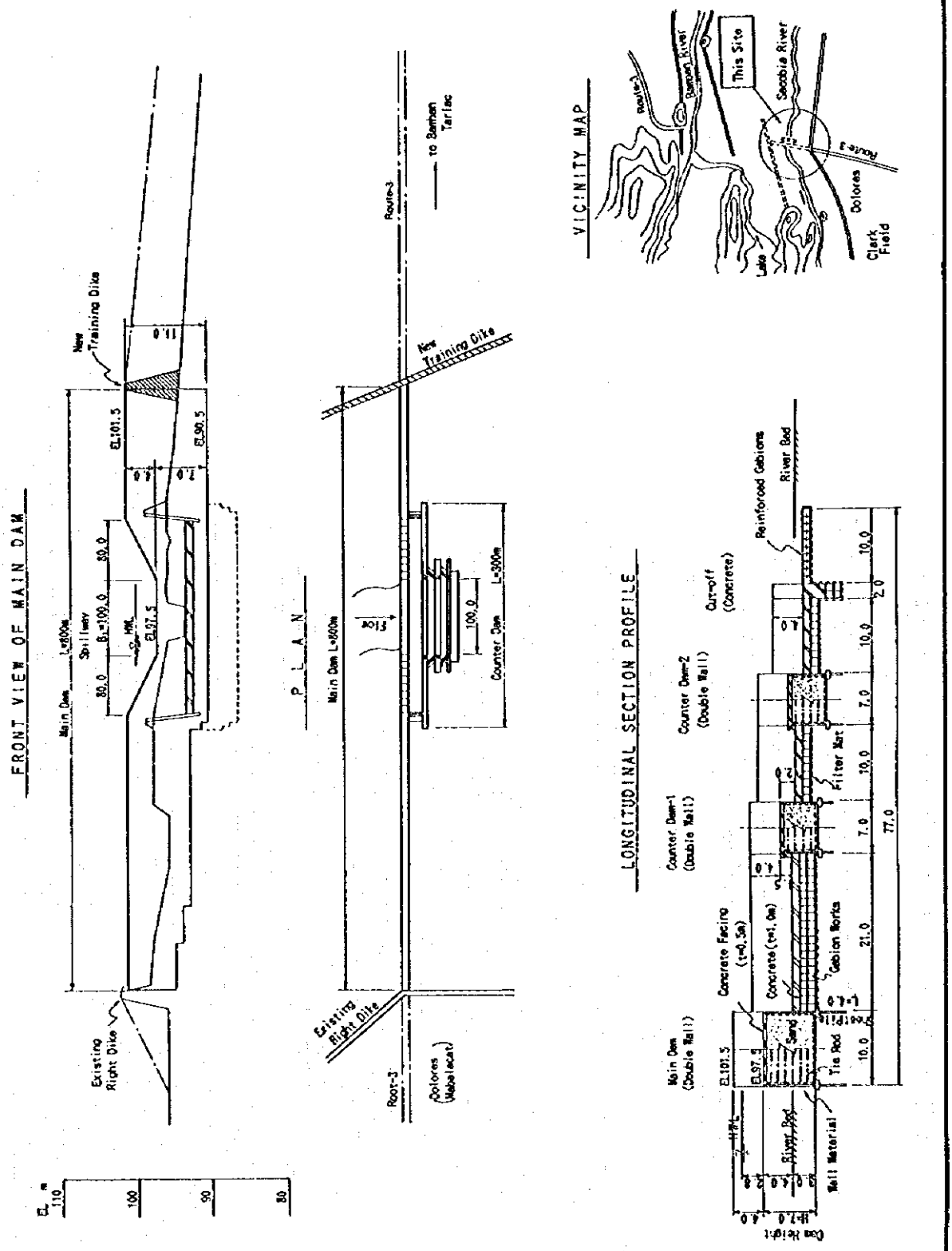


Figure H.16 Preliminary Plan of Dolores Consolidation Dam

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

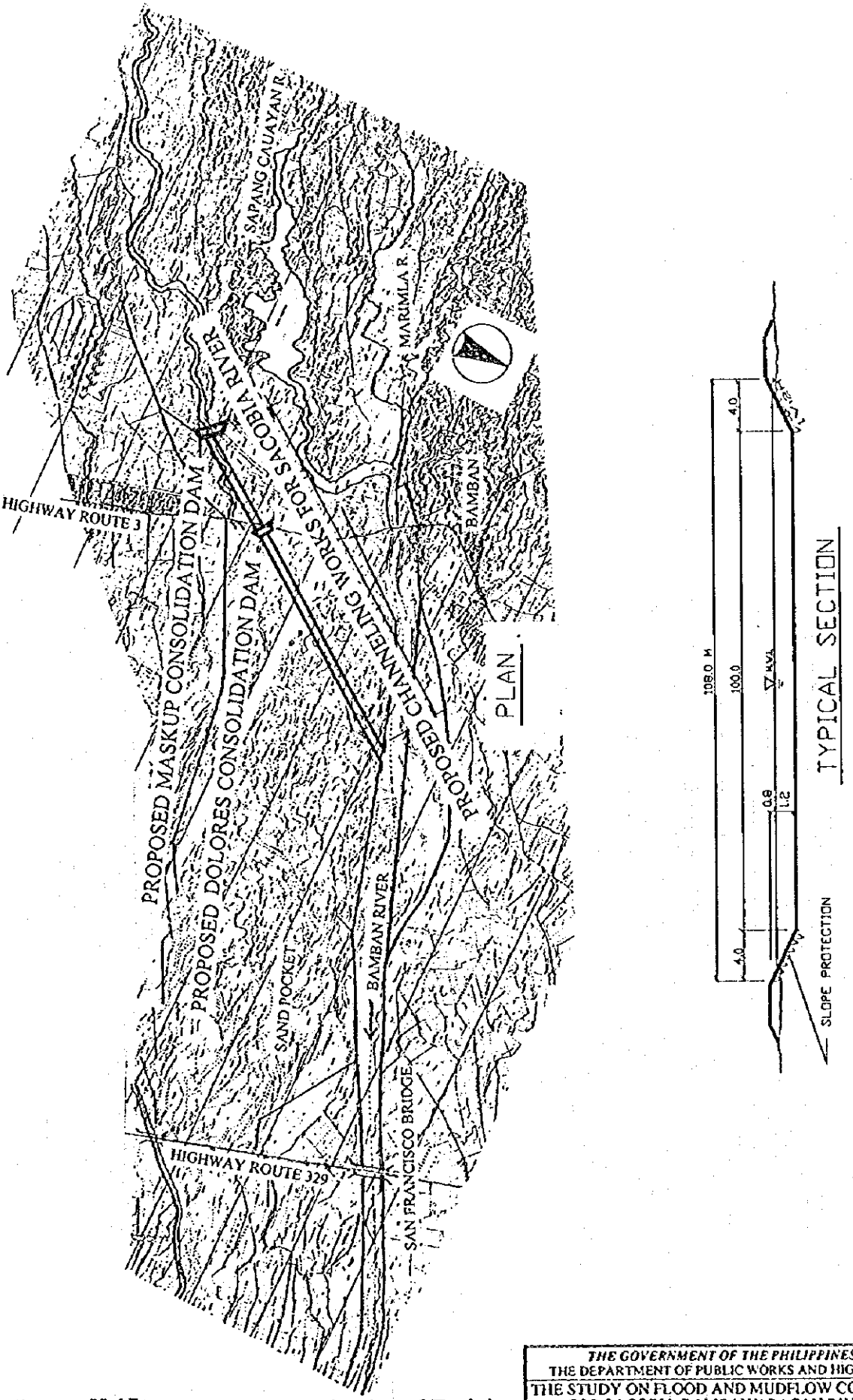
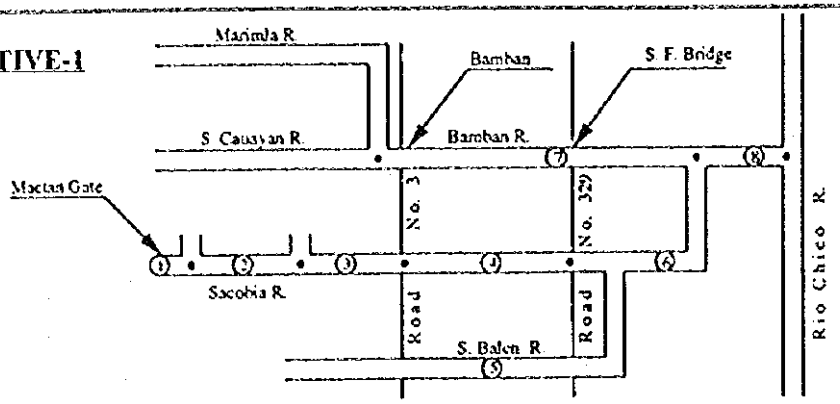


Figure II.17 **Typical Cross Section of Training Works of Sacobia River**

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

FOR ALTERNATIVE-1

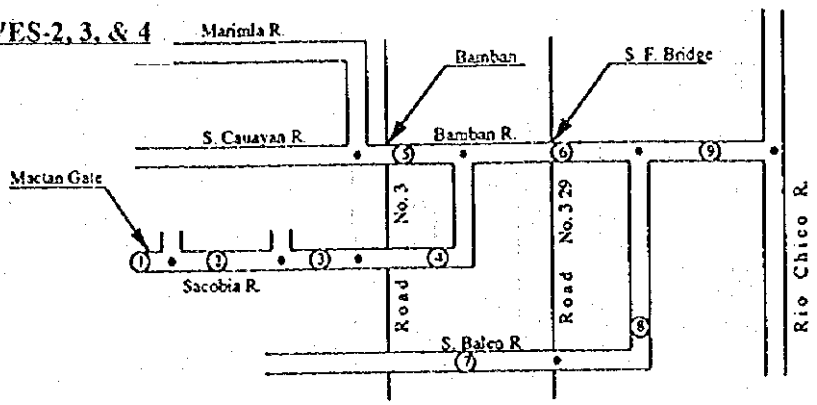


Probable Peak Discharge Distribution

CASE 1-2 Unit :m3/s

	Return Period					
Reach	100	50	20	10	5	2
No.1	180	160	135	115	85	60
No.2	250	220	180	155	115	85
No.3	370	330	270	230	170	125
No.4	520	440	380	320	240	175
No.5	200	170	145	125	90	70
No.6	850	730	610	510	380	280
No.7	760	640	520	430	320	230
No.8	1570	1320	1060	900	660	490

FOR ALTERNATIVES-2, 3, & 4



Probable Peak Discharge Distribution

CASE 2-2 Unit :m3/s

	Return Period					
Reach	100	50	20	10	5	2
No.1	180	160	135	115	85	60
No.2	250	220	180	155	115	85
No.3	370	330	270	230	170	125
No.4	470	410	340	290	210	160
No.5	800	690	580	490	360	270
No.6	1240	1070	890	750	560	410
No.7	200	170	145	125	90	70
No.8	440	380	310	260	195	140
No.9	1610	1360	1110	940	690	510

Figure H.18 Probable Peak Discharge of Sacobia-Bamban River System

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

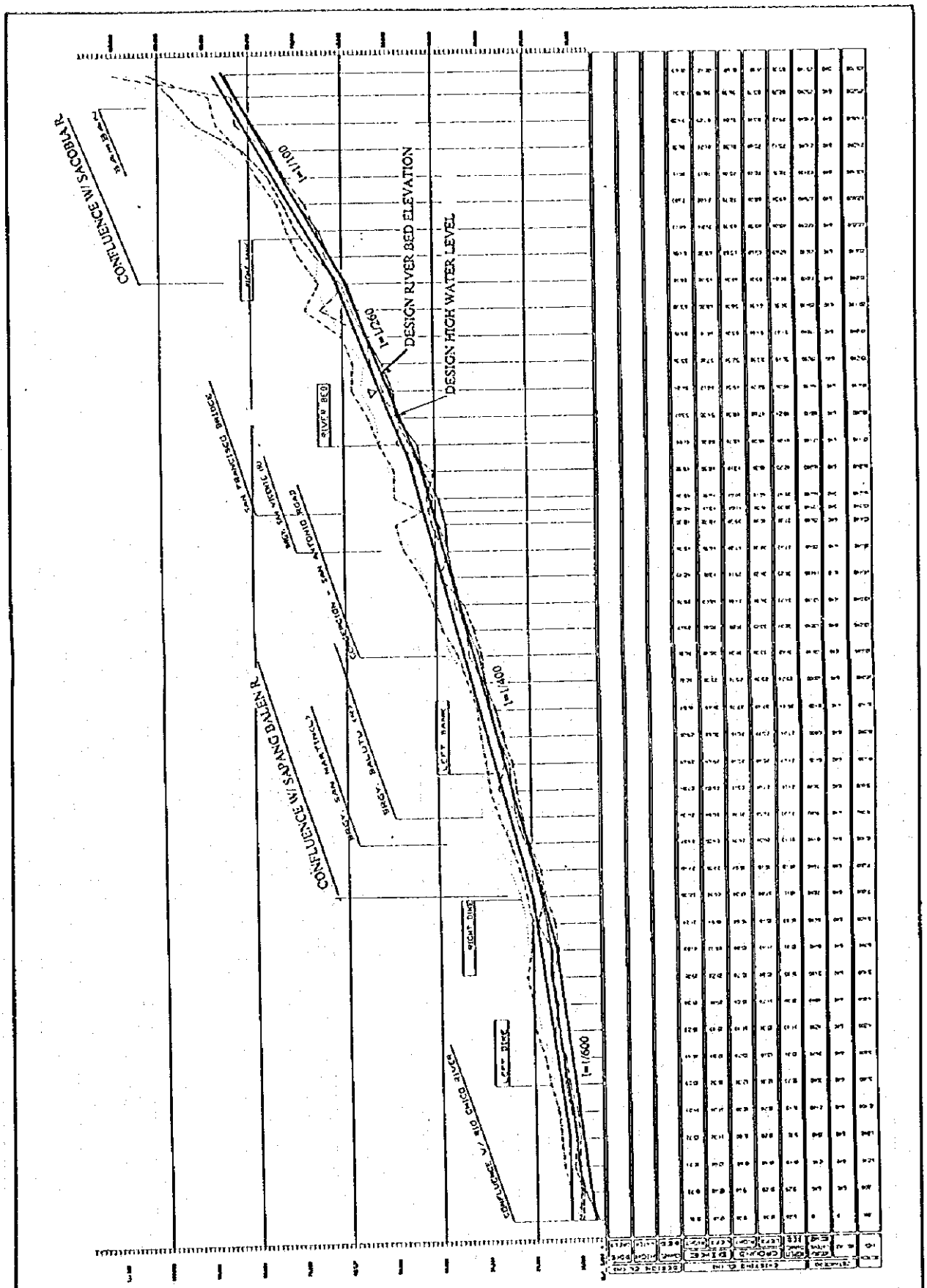


Figure H.19

Proposed Longitudinal Profile of Bamban River

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

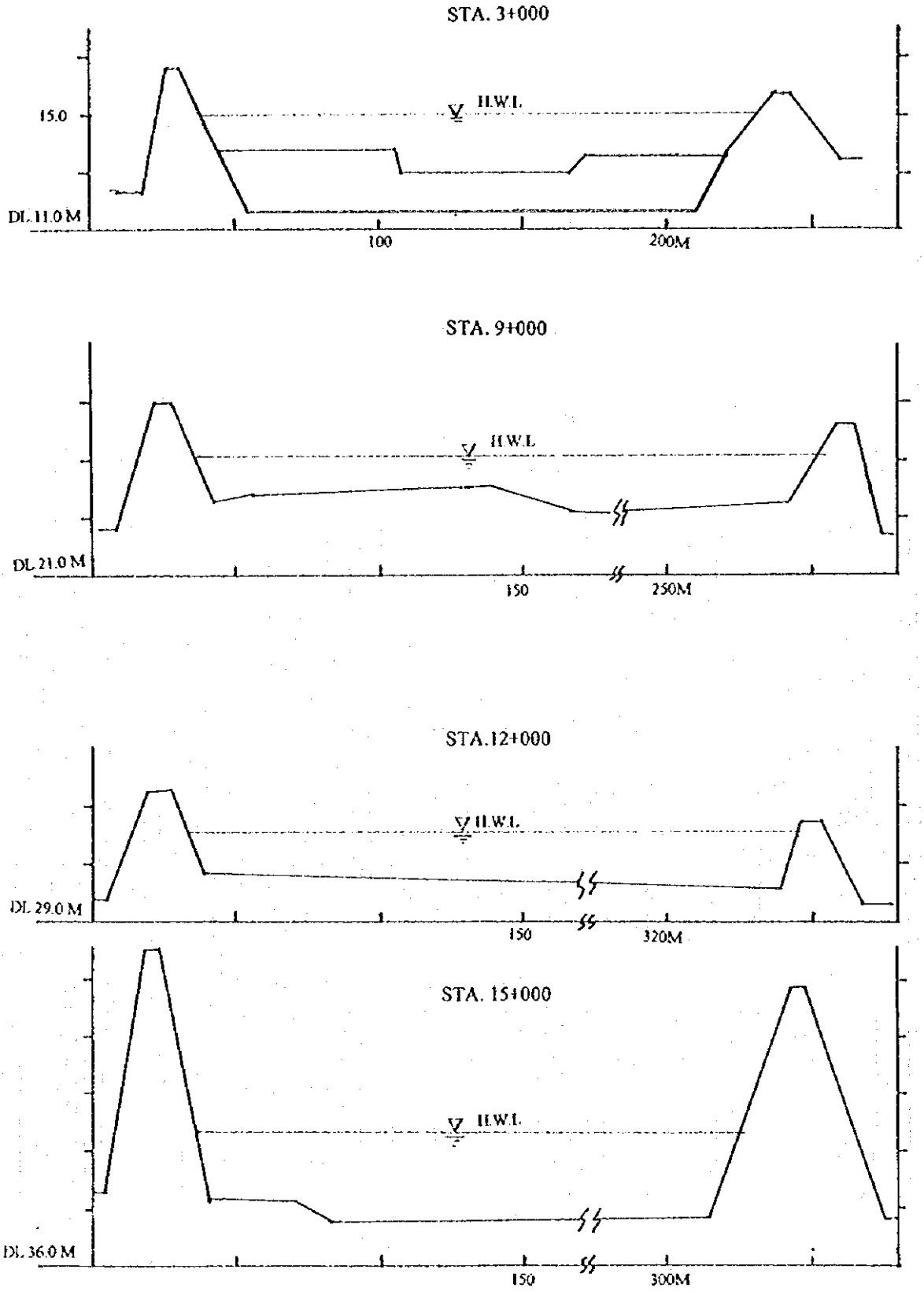


Figure H.20 **Proposed Typical Cross Section of Bamban River**

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

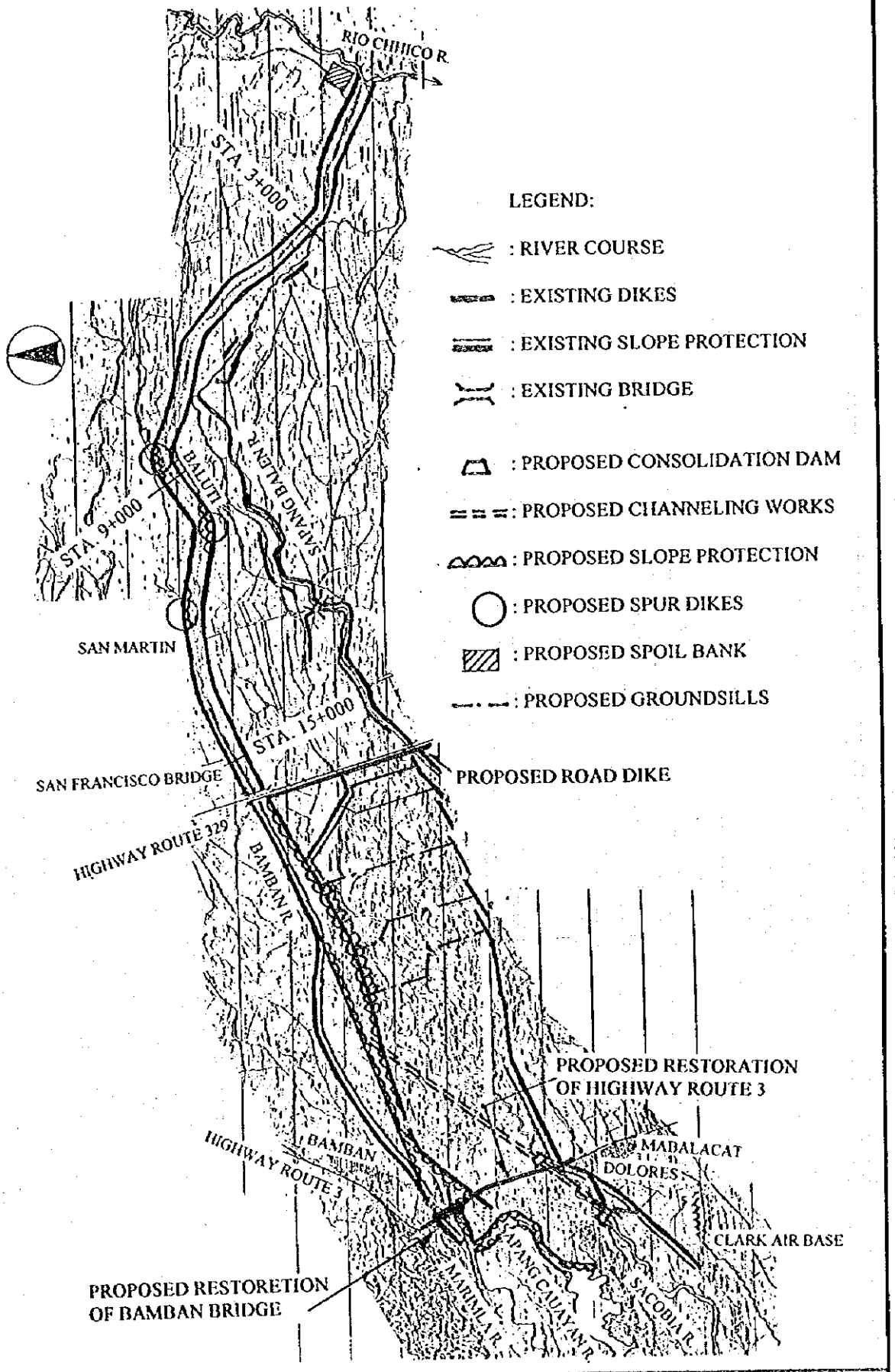
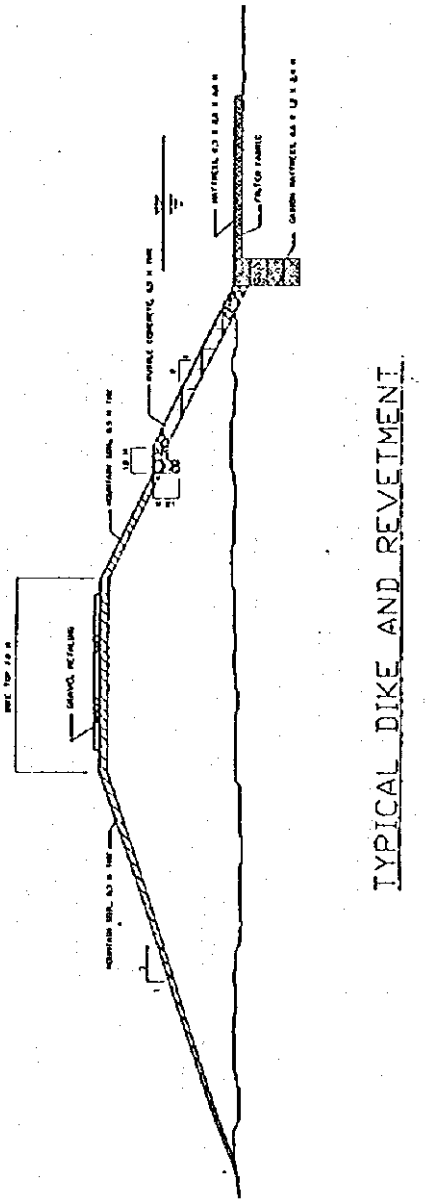
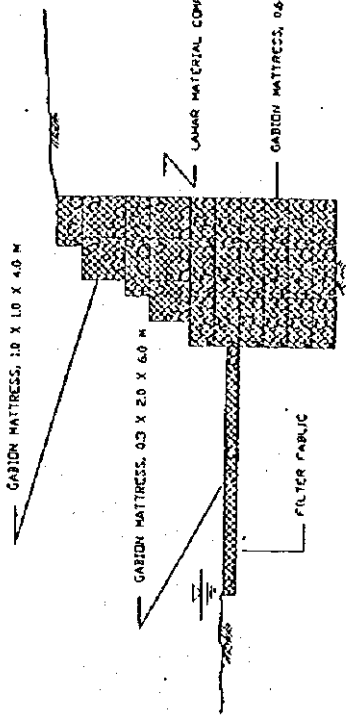


Figure II.21 Proposed Structural Arrangement of Sacobia-Bamban River

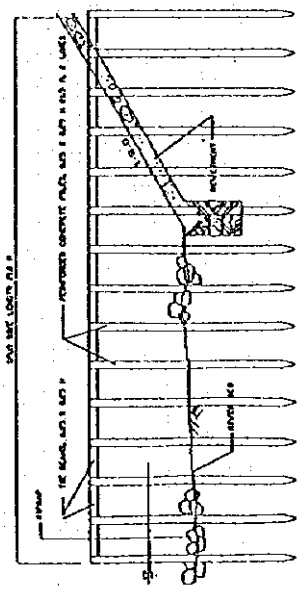
THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



TYPICAL DIKE AND REVETMENT



RETAINING WALL (S. CAUAYAN RIVER)

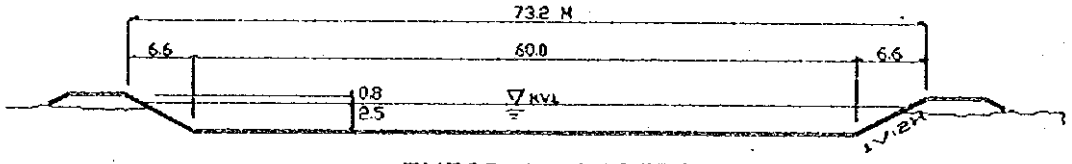


TYPICAL PILE SPUR DIKE

Figure H.22 **Preliminary Design of Proposed Structures**

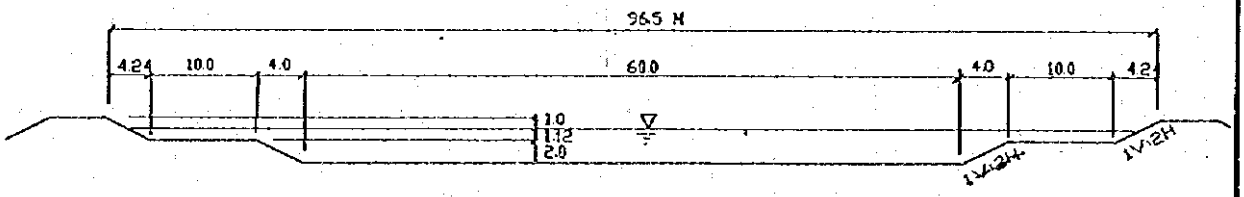
THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

(1) SAPANG BALEN RIVER IMPROVEMENT (5-YEAR RETURN PERIOD)



TYPICAL SECTION

(2) SAPANG BALEN RIVER IMPROVEMENT (20-YEAR RETURN PERIOD)



TYPICAL SECTION

Figure H.23 River Improvement Plan of Sapang Balen River

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

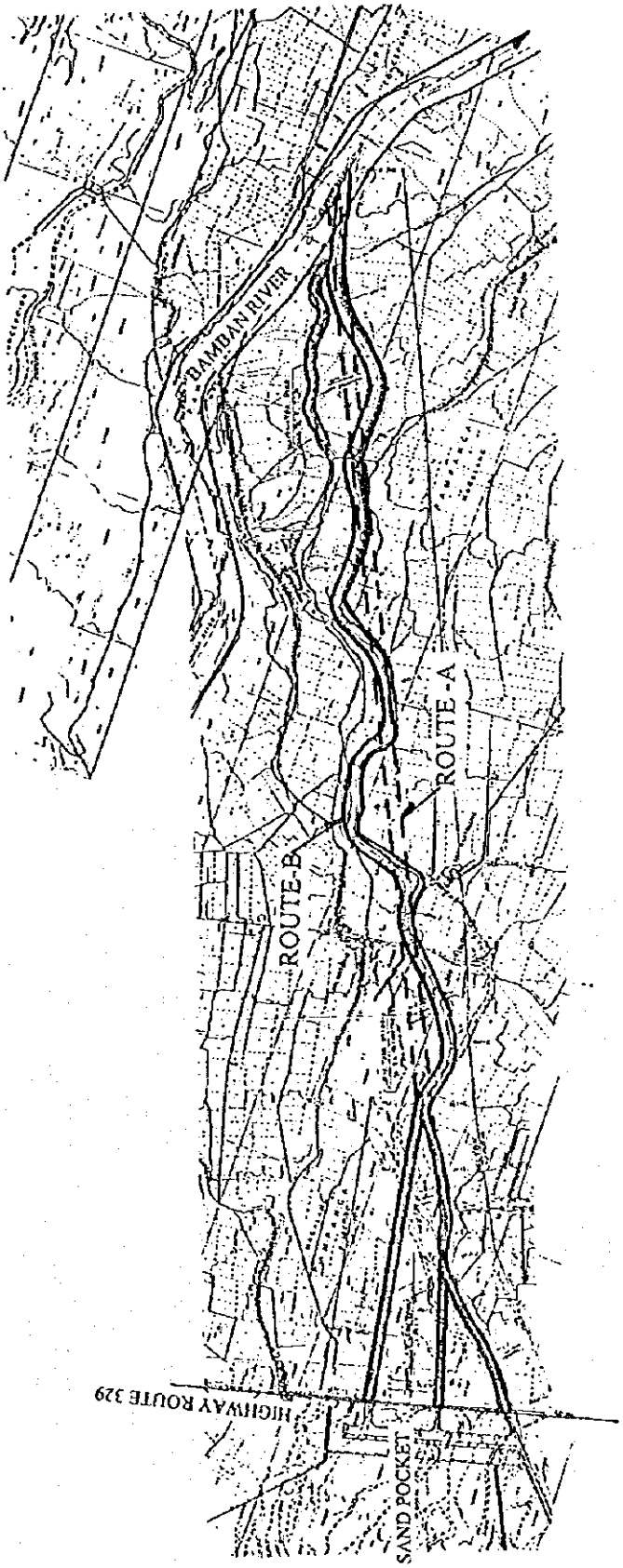


Figure H.24 Channel Alignment Alternatives of Sapang Balen River Improvement

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

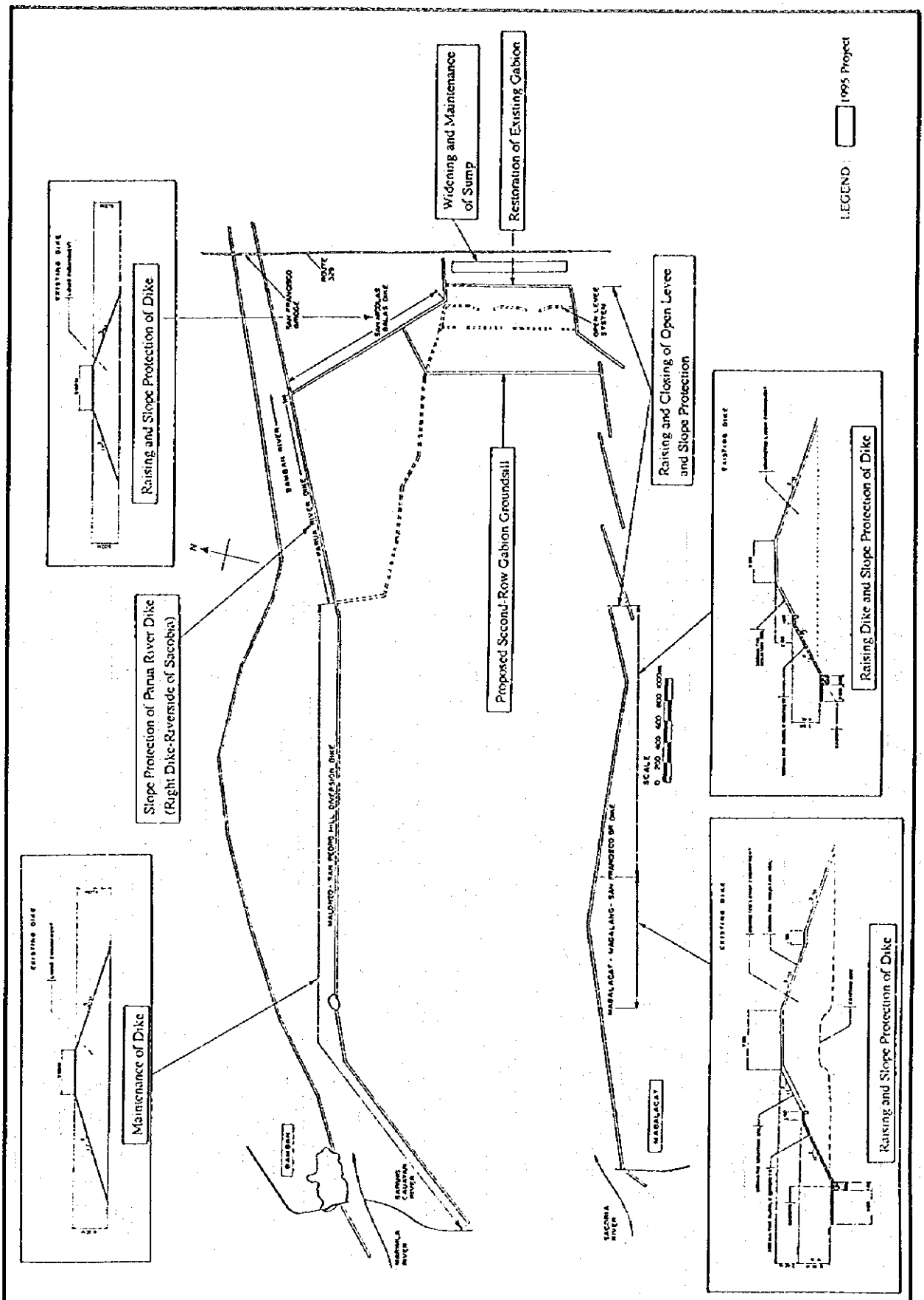


Figure II.25
Existing Dike System and 1995 Project in Sand Pocket Area

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

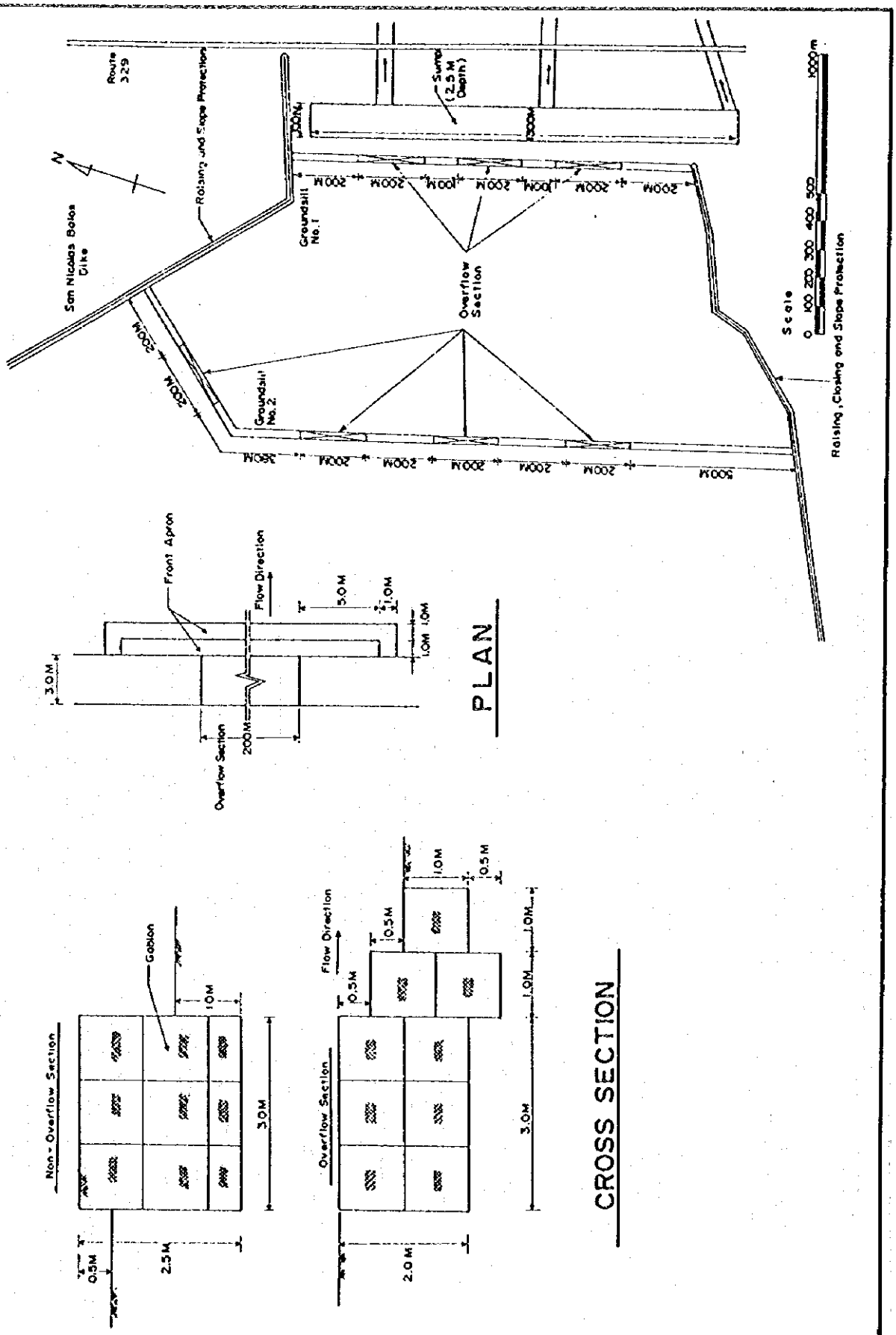


Figure H.26 Proposed Two-Rows of Gabion Groundsill for 1995 Project

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

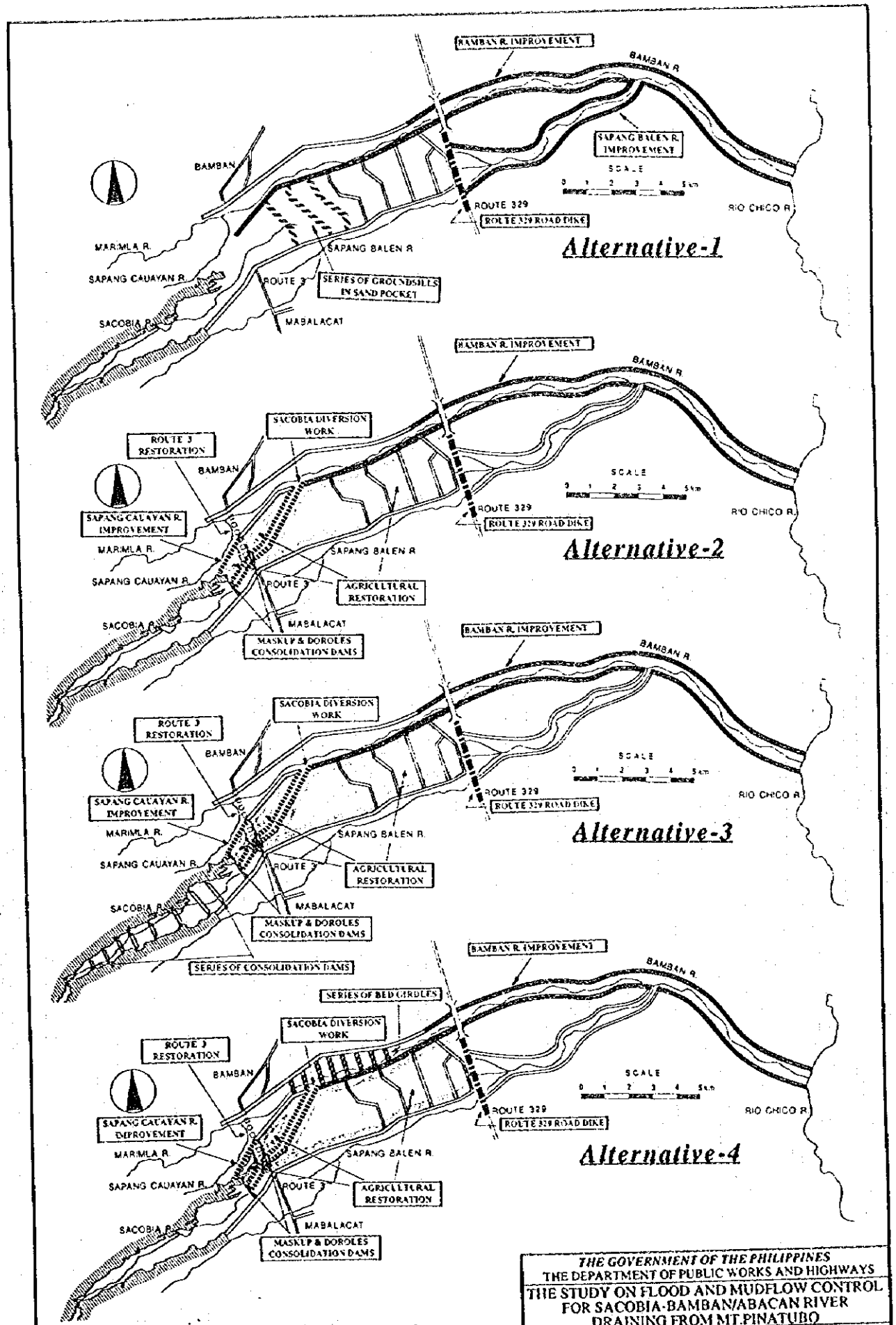


Figure H.27 Schematic Plan of Alternatives

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

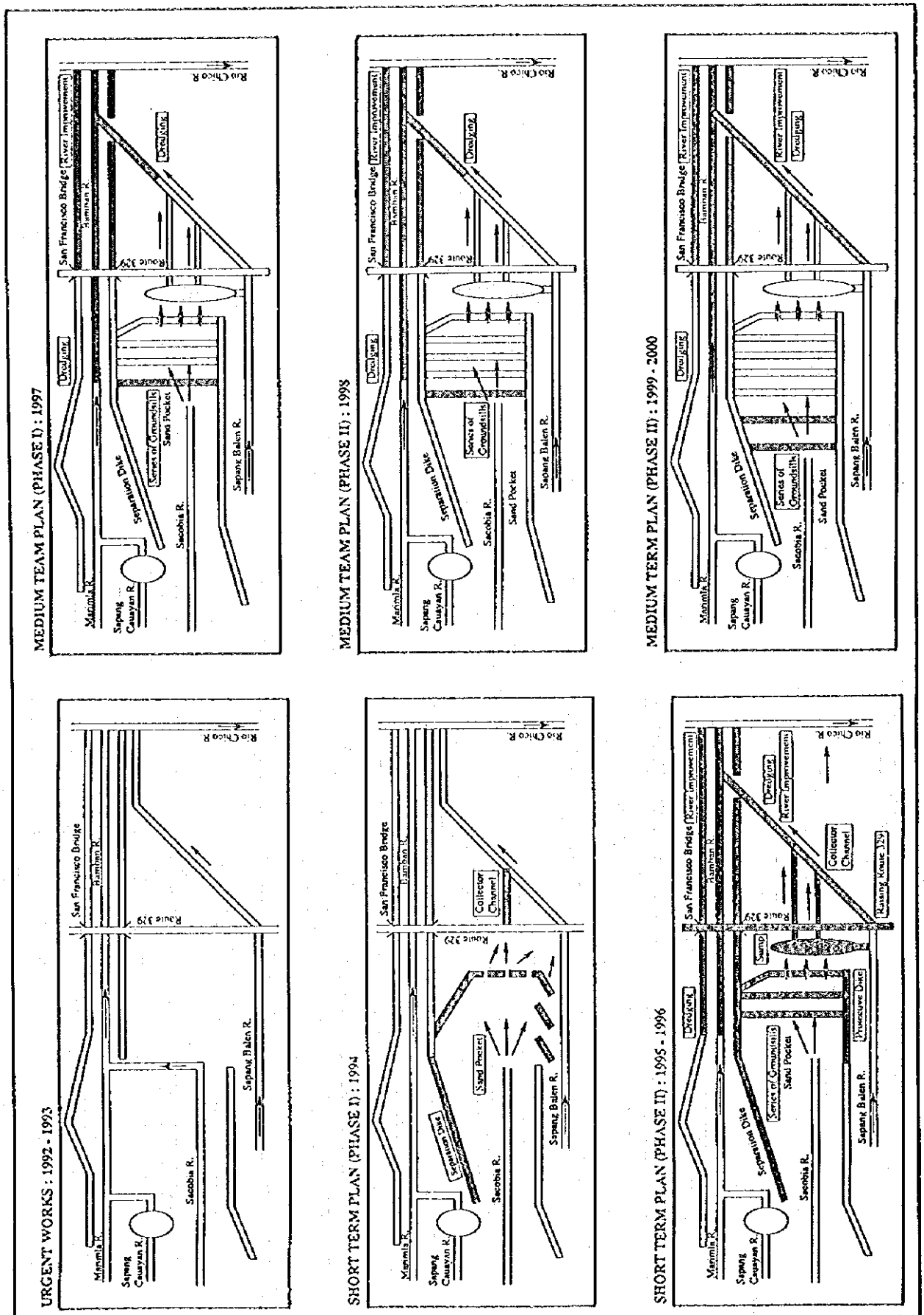


Figure H.28 Schematic Diagram of Alternative-1

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

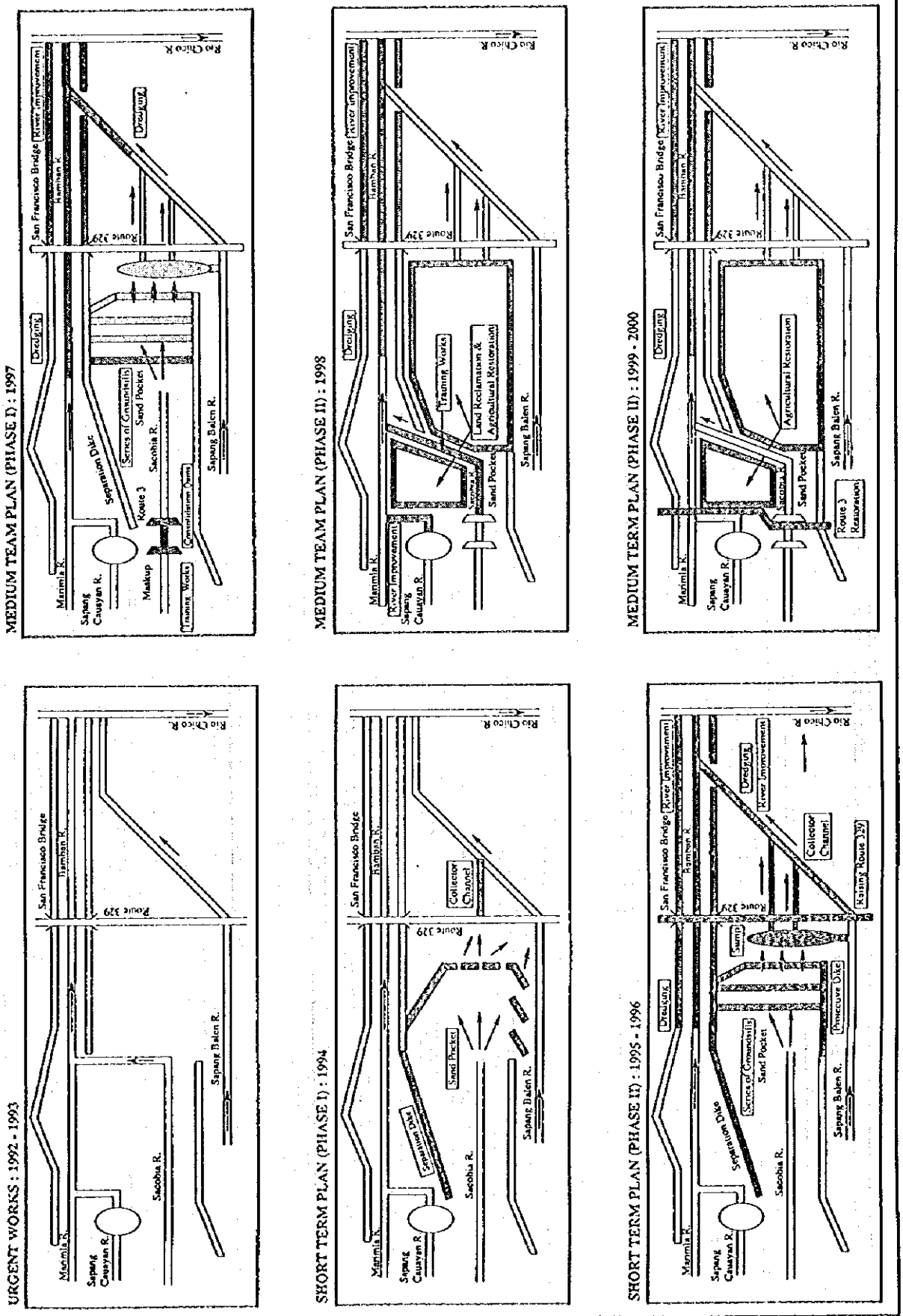


Figure H.29 Schematic Diagram of Alternative-2

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

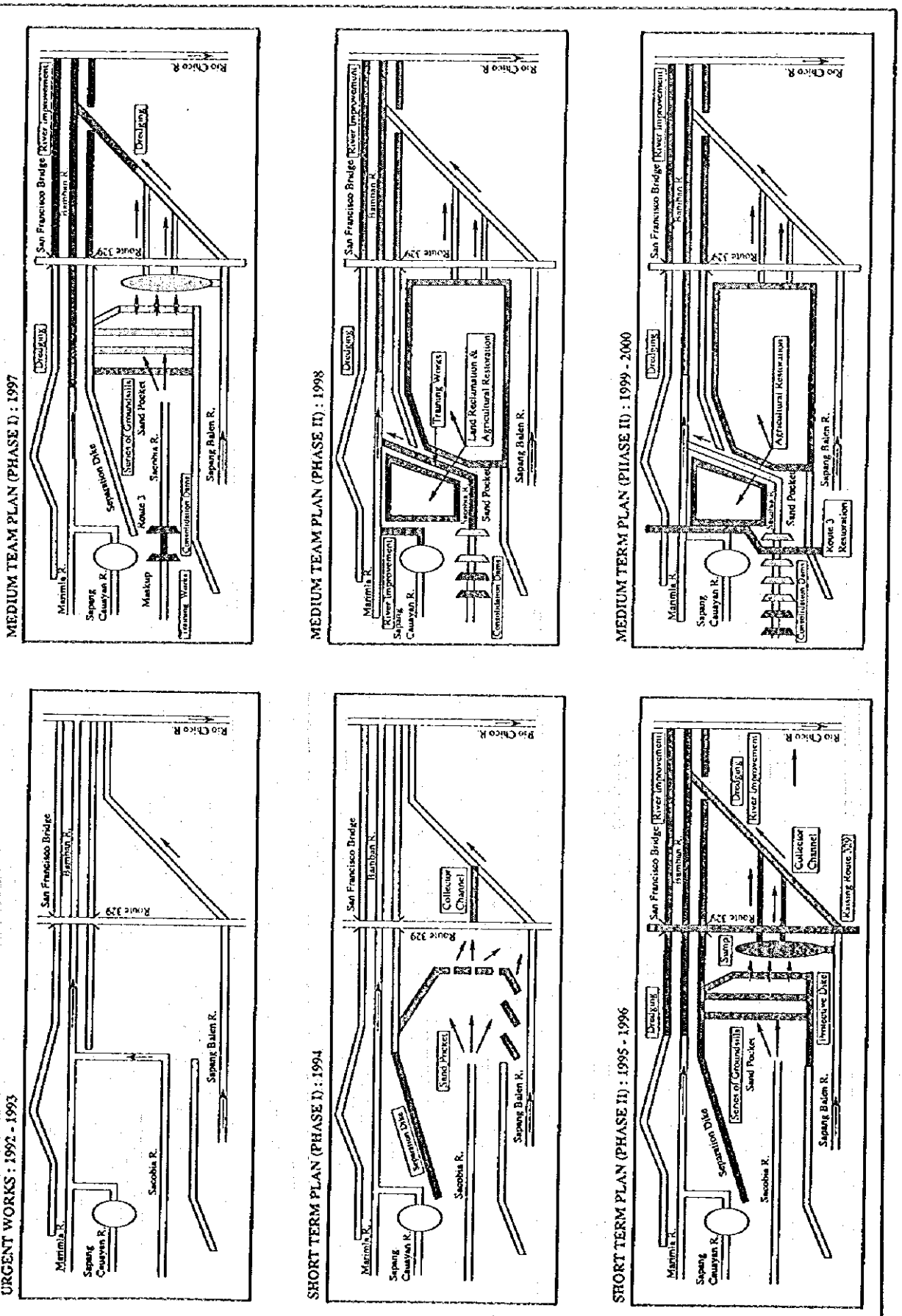


Figure H.30 Schematic Diagram of Alternative-3

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

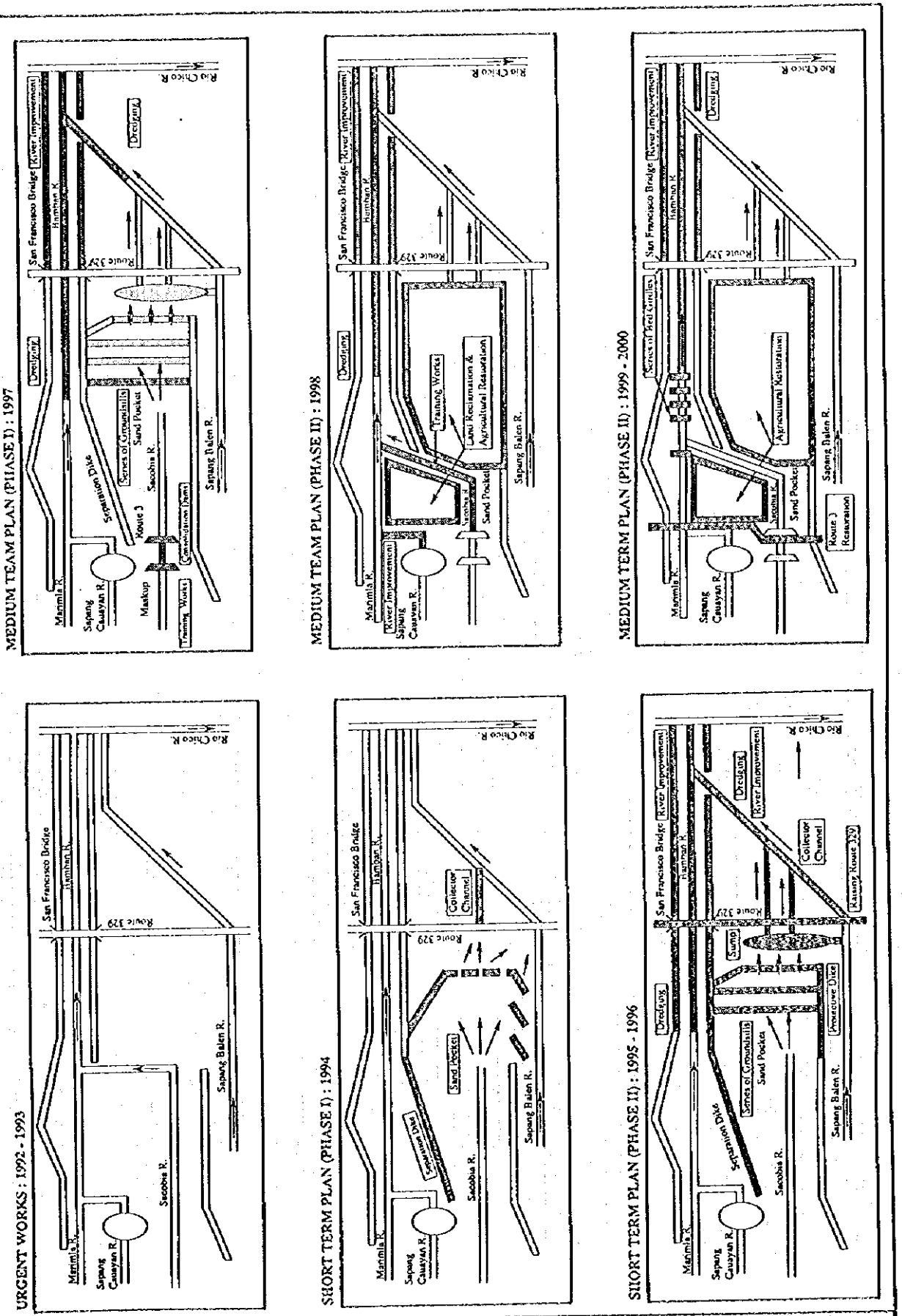
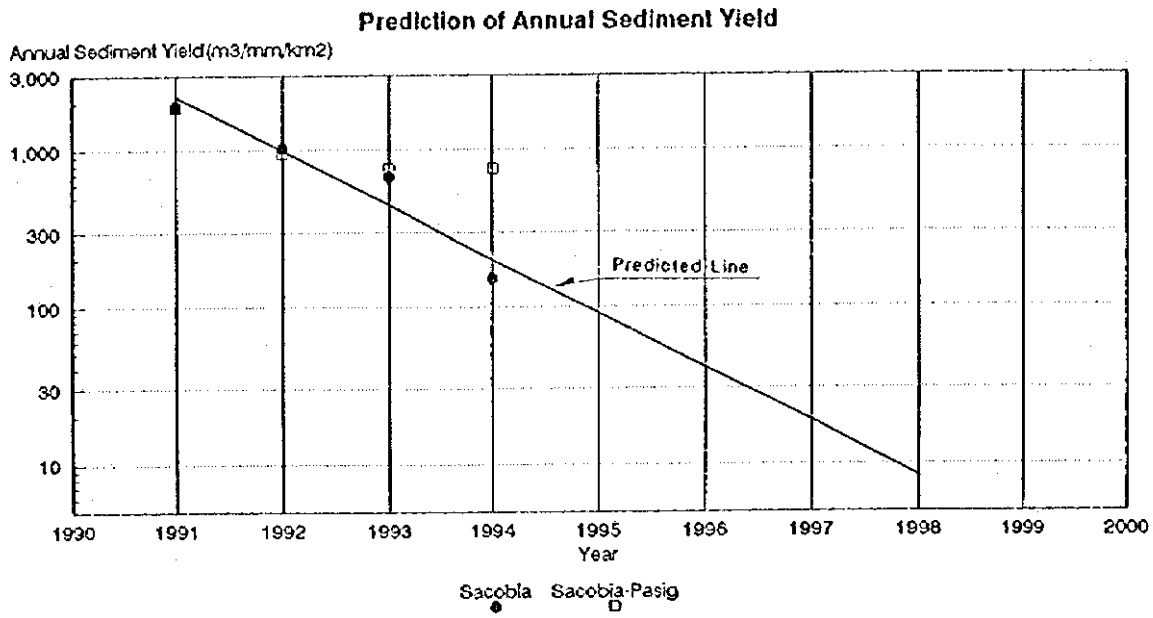


Figure H.31 Schematic Diagram of Alternative-4

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



Volume of Source Material, Lahar Deposition, Rainfall and Catchment Area

Year	Volume of Pyroclastic Flow Deposits (10^6 m^3)			Volume of Lahar Deposits (10^6 m^3)				Annual Rainfall (mm)	Catchment Area of Headwaters (km^2)			Normalized Sediment Yields (m^3/mm/km^2)		
	Sacobia-Abacan	Pasig	Total	Sacobia	Abacan	Pasig	Total		Sacobia	Pasig	Total	Sacobia	Pasig	Total
1991	968	430	1,398	150	50	50	250	2,250	35.3	24.5	59.8	1,889	907	1,858
1992	-	-	-	80	0	40	120	2,000	38.8	24.2	63.0	1,031	826	952
1993	688	340	1,028	65	0	55	120	2,500	38.8	24.2	63.0	670	909	762
1994	303	605	908	8	0	130	138	2,900	18.0	45.0	63.0	153	996	755

Note 1) Volume of pyroclastic flow deposits and lahar deposits is obtained by combination of PHIVOLCS-USGS & DPWH data and the results of the Study.

2) Annual rainfall from 1991 to 1993 is refered to PHIVOLCS-USGS data, the value of 1994 is refered to PHIVOLCS observation data at Upper-Sacobia gauge.

Prediction of Sediment Yield from P.F.D in Sacobia River

Year	Volume of Sediment Yield (10^6m^3)	Accumulated Volume (10^6m^3)
1995	4.1 (8.9)	4.1 (8.9)
1996	1.8 (4.0)	5.9 (12.9)
1997	0.9 (1.8)	6.8 (14.7)
1998	0.4 (0.9)	7.2 (15.6)
1999	0.4 (0.9)	7.6 (16.5)
2000	0.4 (0.9)	8.0 (17.4)

Note Values in the parentheses show the case of recapturing the headwaters by the Sacobia River.

Figure II.32

Prediction of Annual Sediment Yield from Pyroclastic Flow Deposits

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

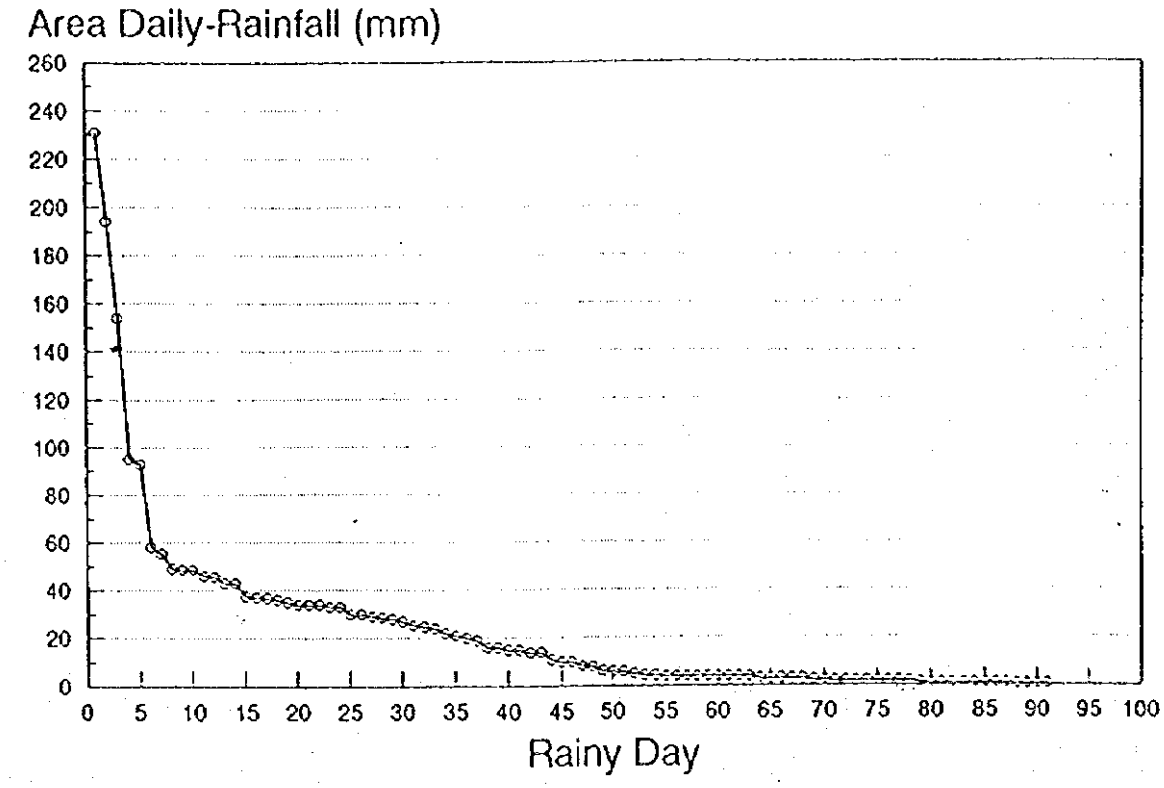


Figure H.33 Area Daily Rainfall of Average Year in Sacobia-Bamban River Basin

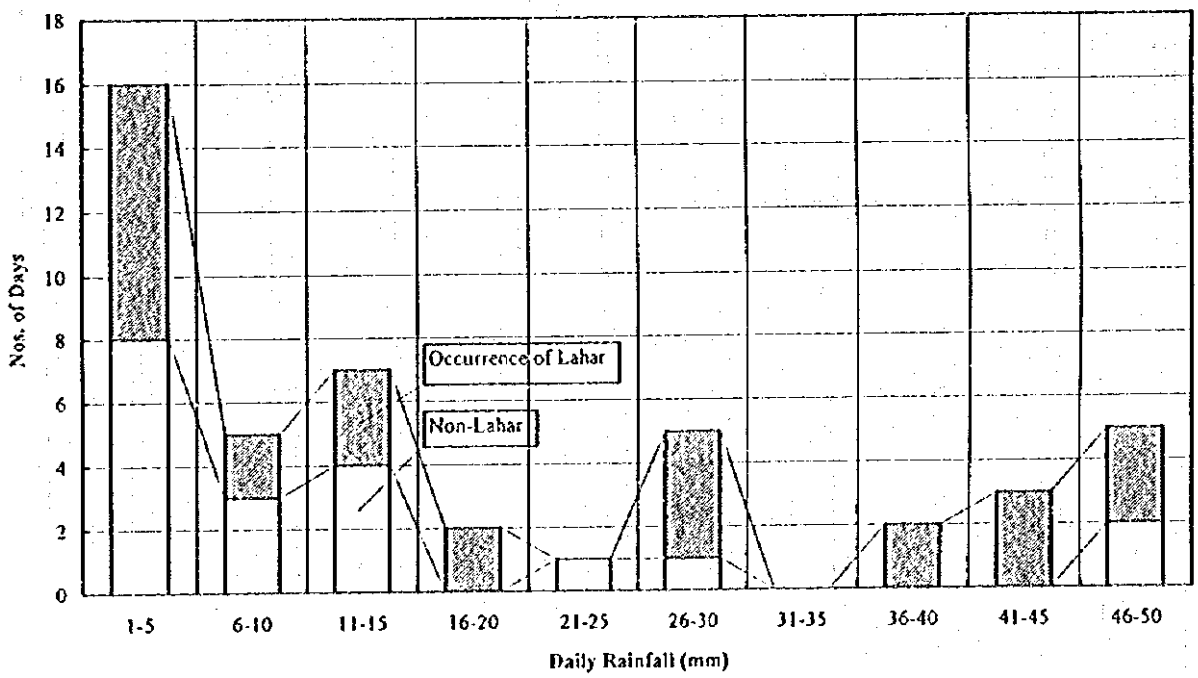


Figure H.34 Relation between Daily Rainfall at Upper-Sacobia Gauge and Lahar Events at Mactan Watch Point in 1994

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

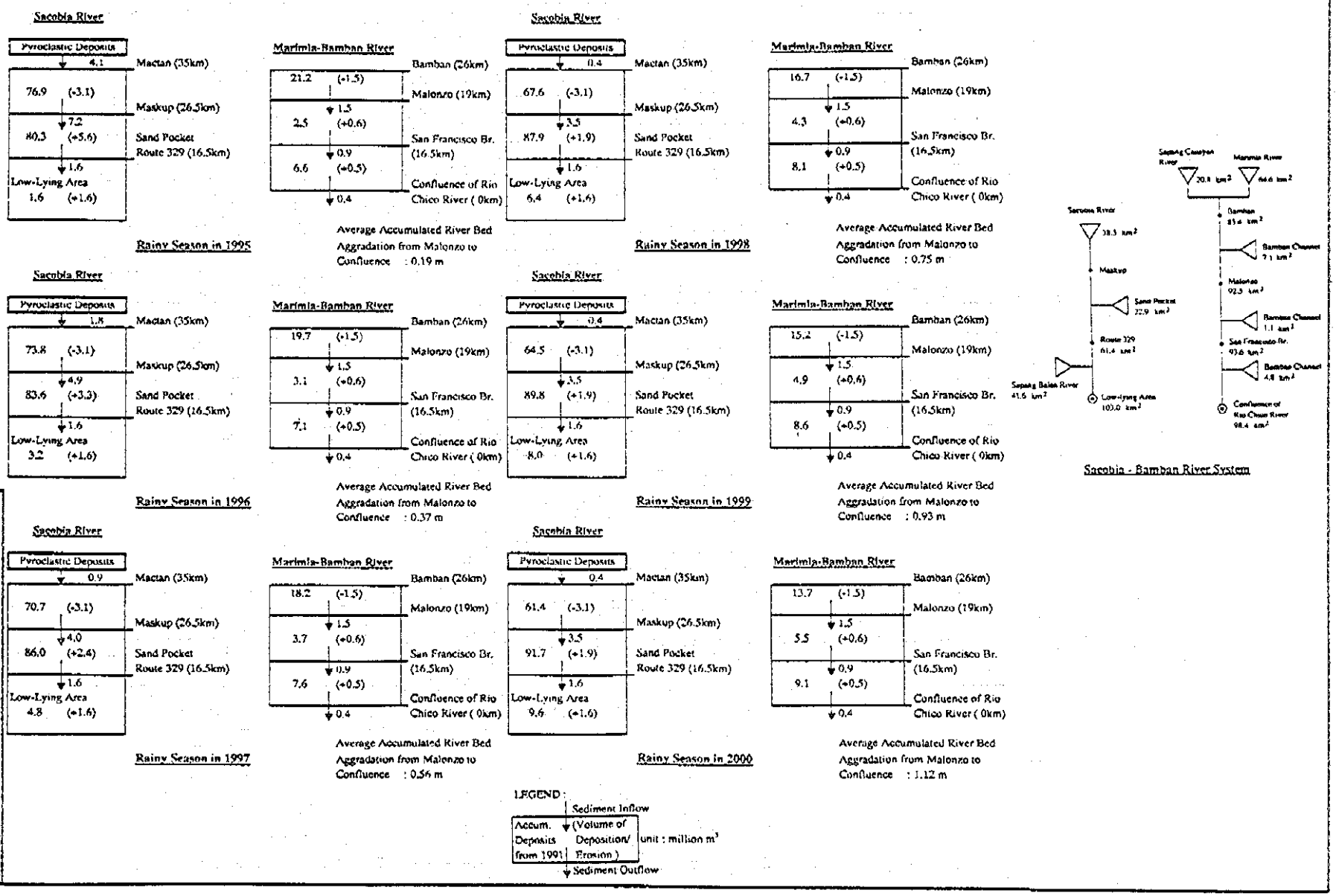


Figure II.35 Sediment Balance Prediction under Present Conditions, 1995-2000

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL
FOR SACOBIA-BAMBAN/ABACAN RIVER
DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

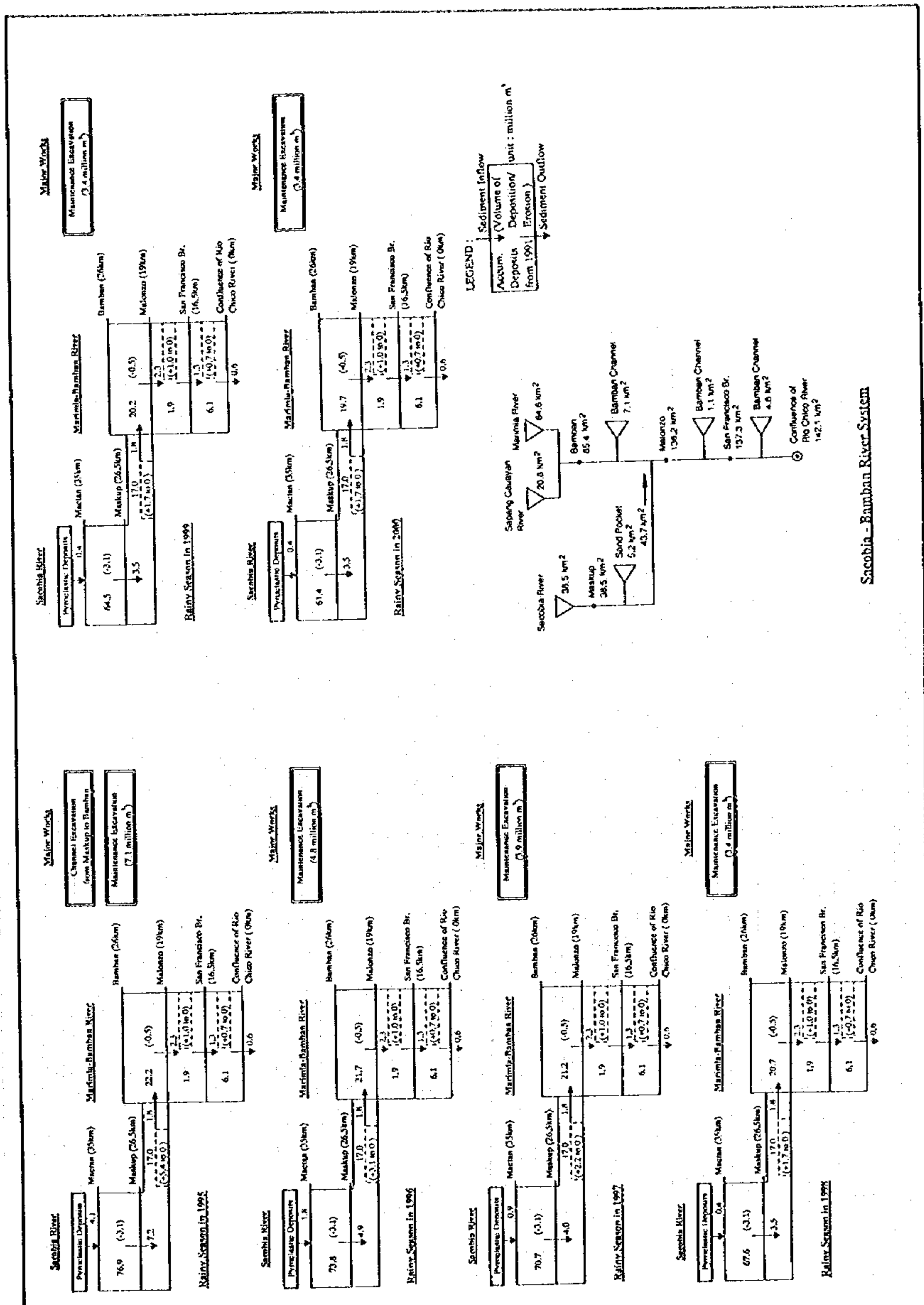


Figure H.36

Sediment Balance Prediction on Diversion and Dredging Alternative (Case 1), 1995-2000

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

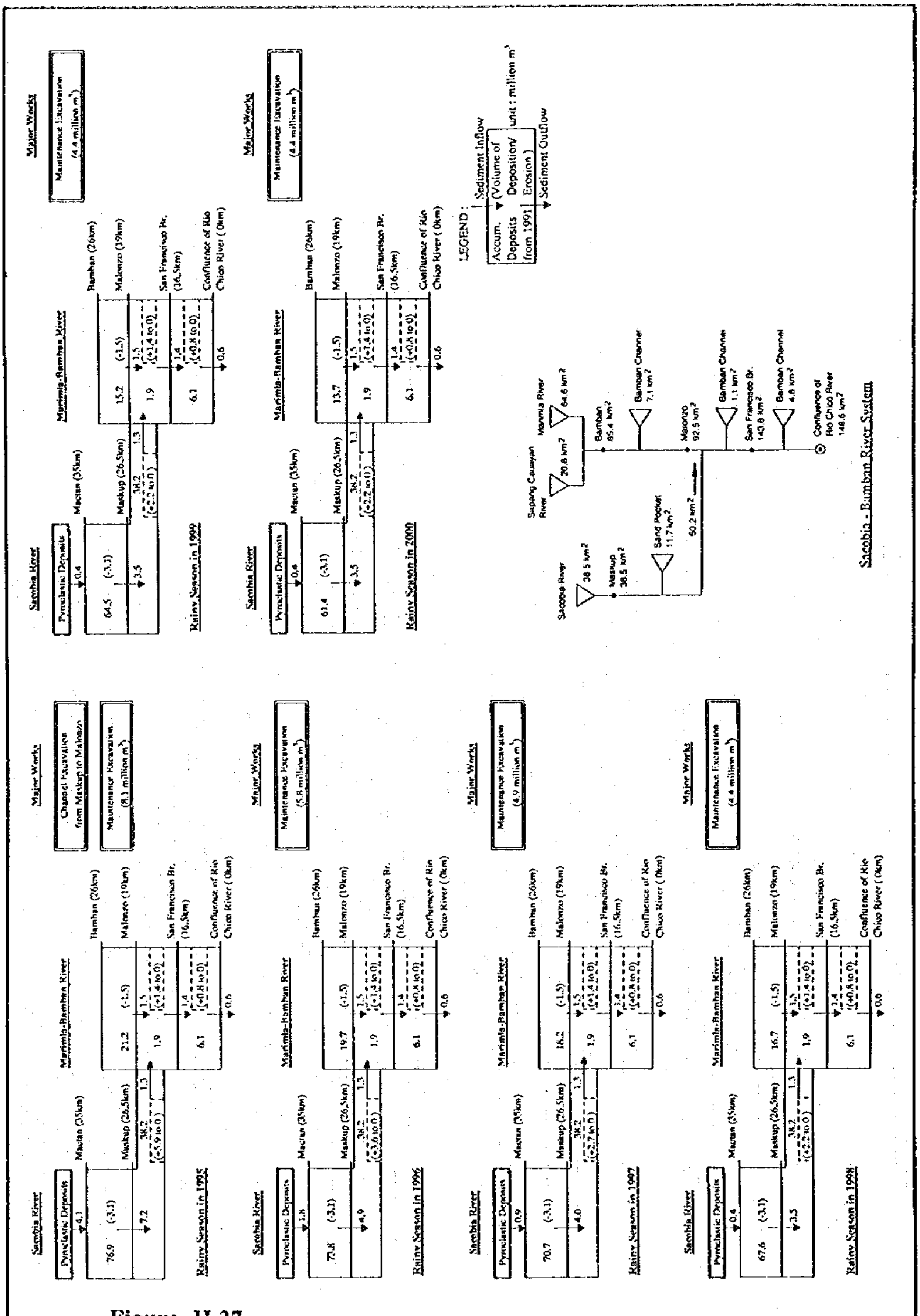


Figure H.37

Sediment Balance Prediction on Diversion and Dredging Alternative (Case 2), 1995-2000

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

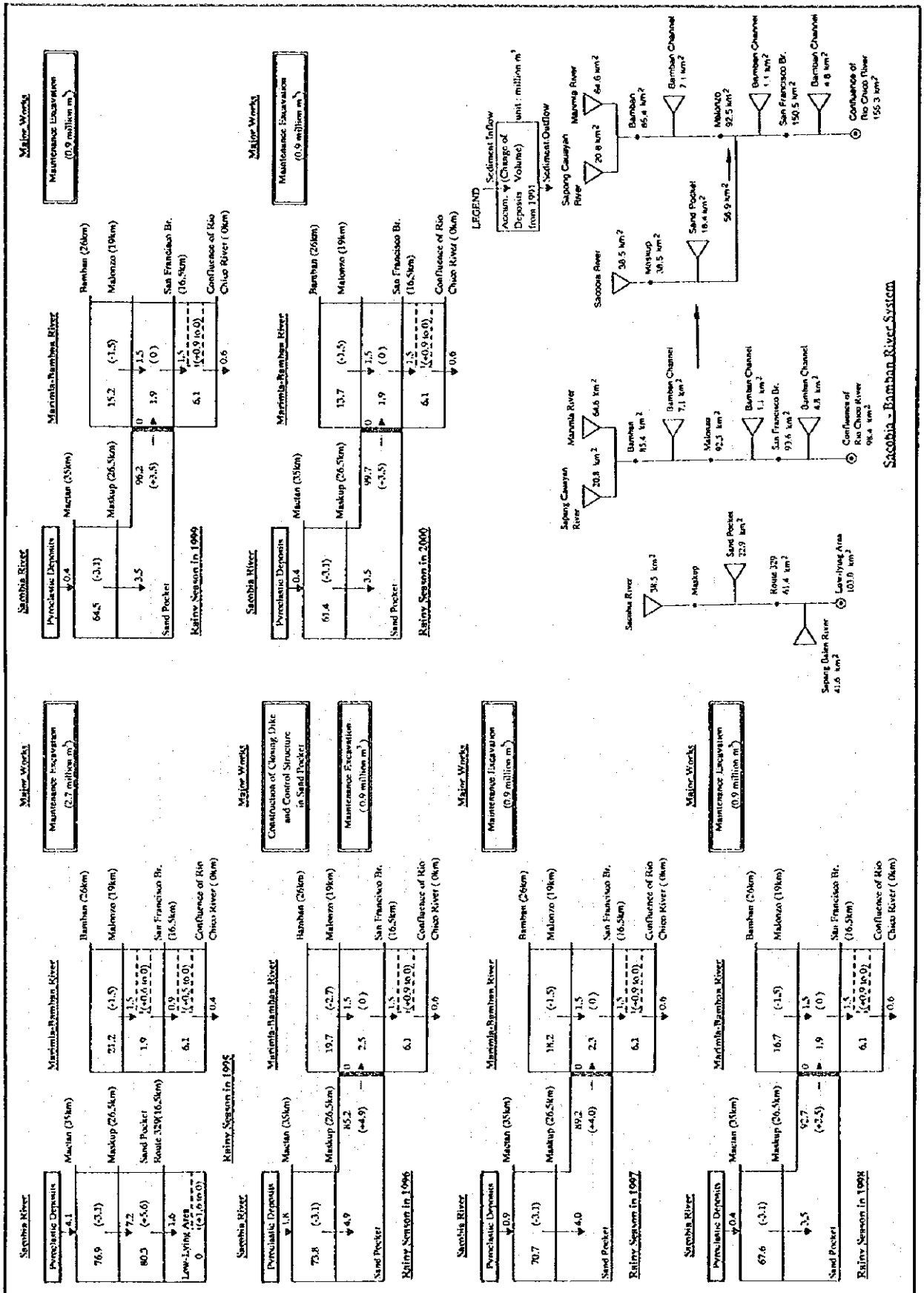


Figure H.38

Sediment Balance Prediction on Permanent Sand Pocket with Control Structure Alternative, 1995-2000

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

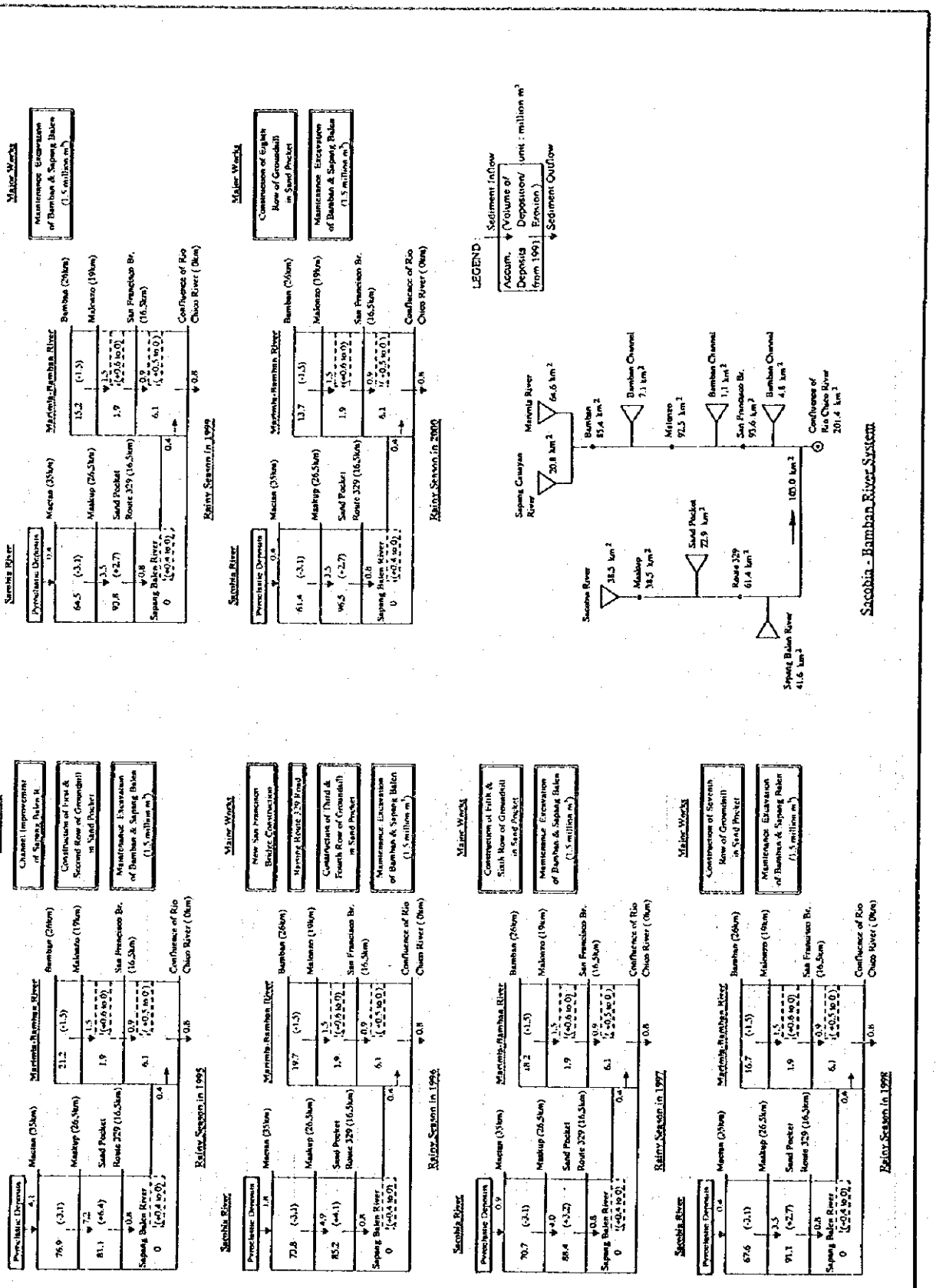


Figure H.39

Sediment Balance Prediction on Permanent Use of Sand Pocket Alternative, 1995-2000

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

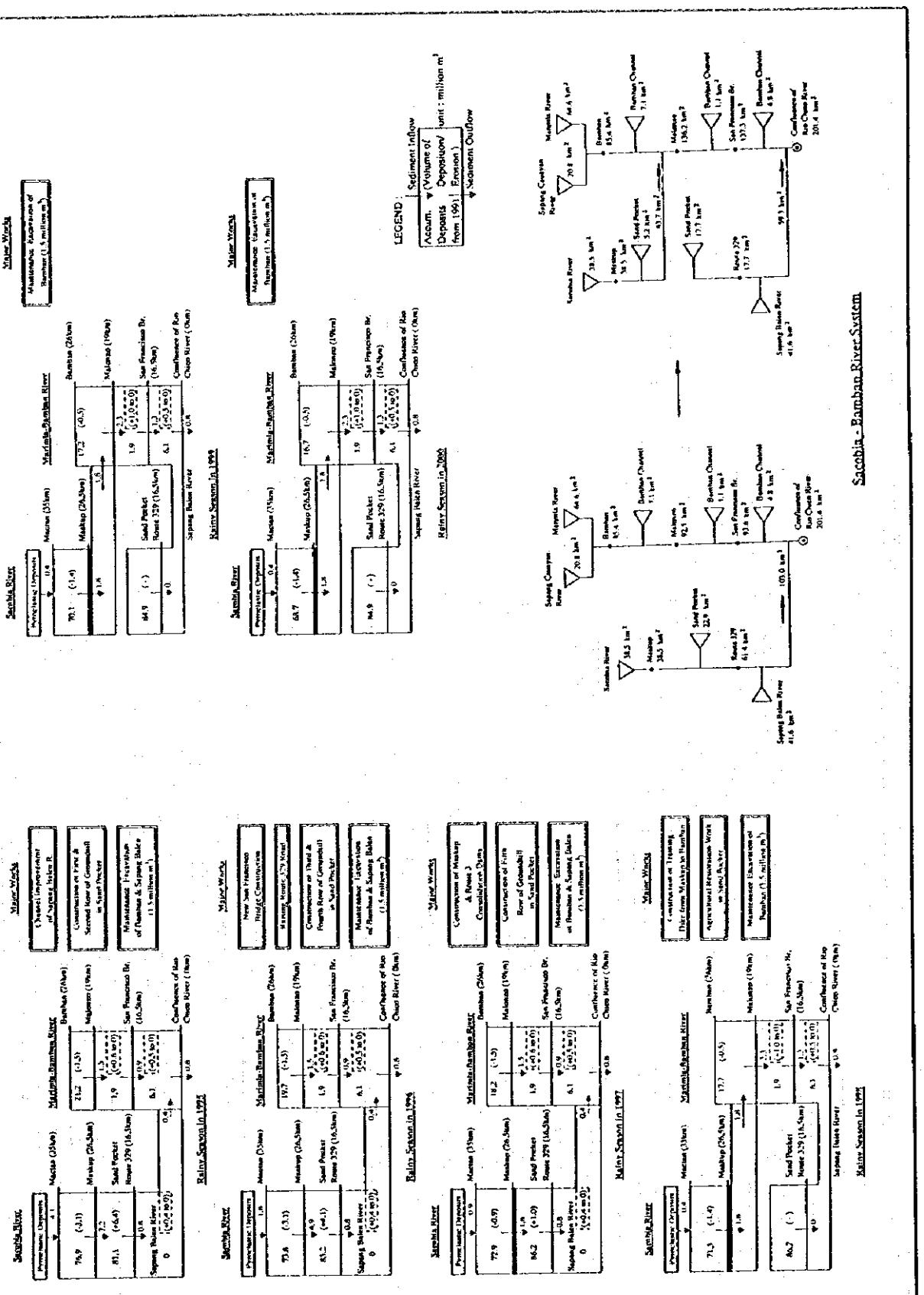


Figure H.40

Sediment Balance Prediction on Alternative Composed of Provisional Use of Sand Pocket, and Maskup and Route 3 Consolidation Dams, 1995-2000

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

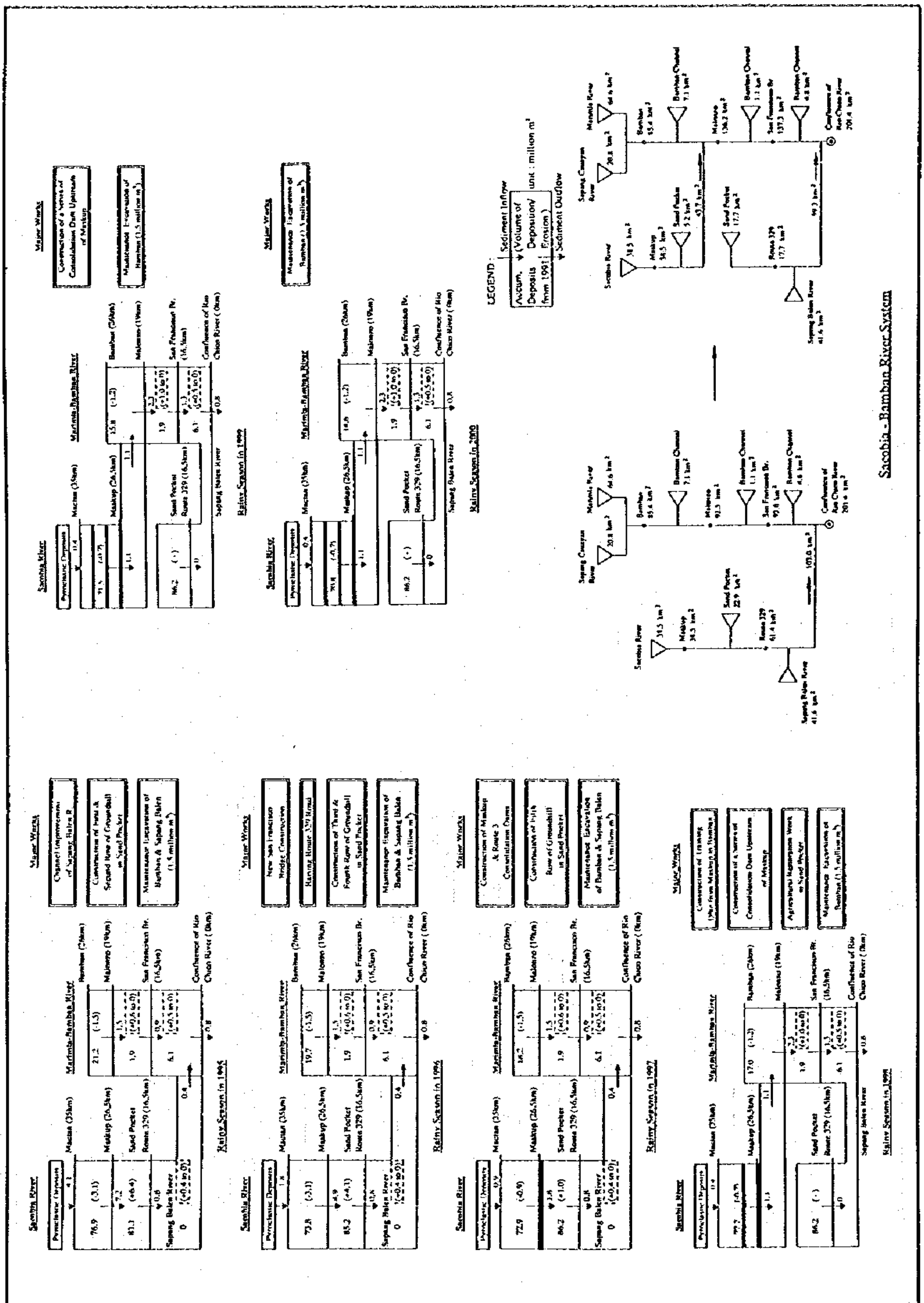


Figure H.41

Sediment Balance Prediction on Alternative Composed of Provisional Use of Sand Pocket and Series of Consolidation Dams from Maskup to Mactan, 1995-2000

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO

JAPAN INTERNATIONAL COOPERATION AGENCY

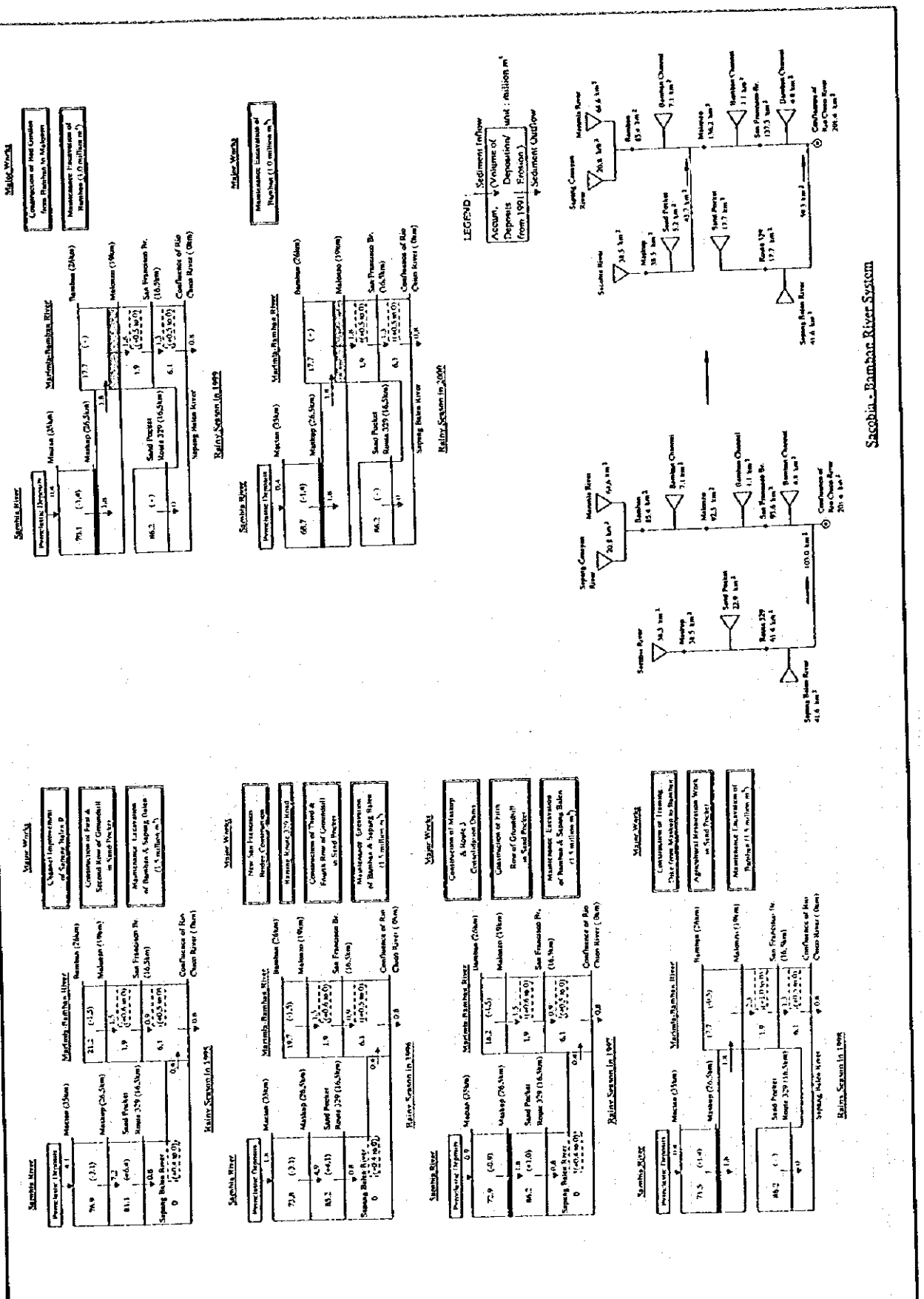


Figure II.42

Sediment Balance Prediction on Alternative Composed of Provisional Use of Sand Pocket, Maskup and Route 3 Consolidation Dams, and Upper-Bamban Bed Girdles, 1995-2000

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

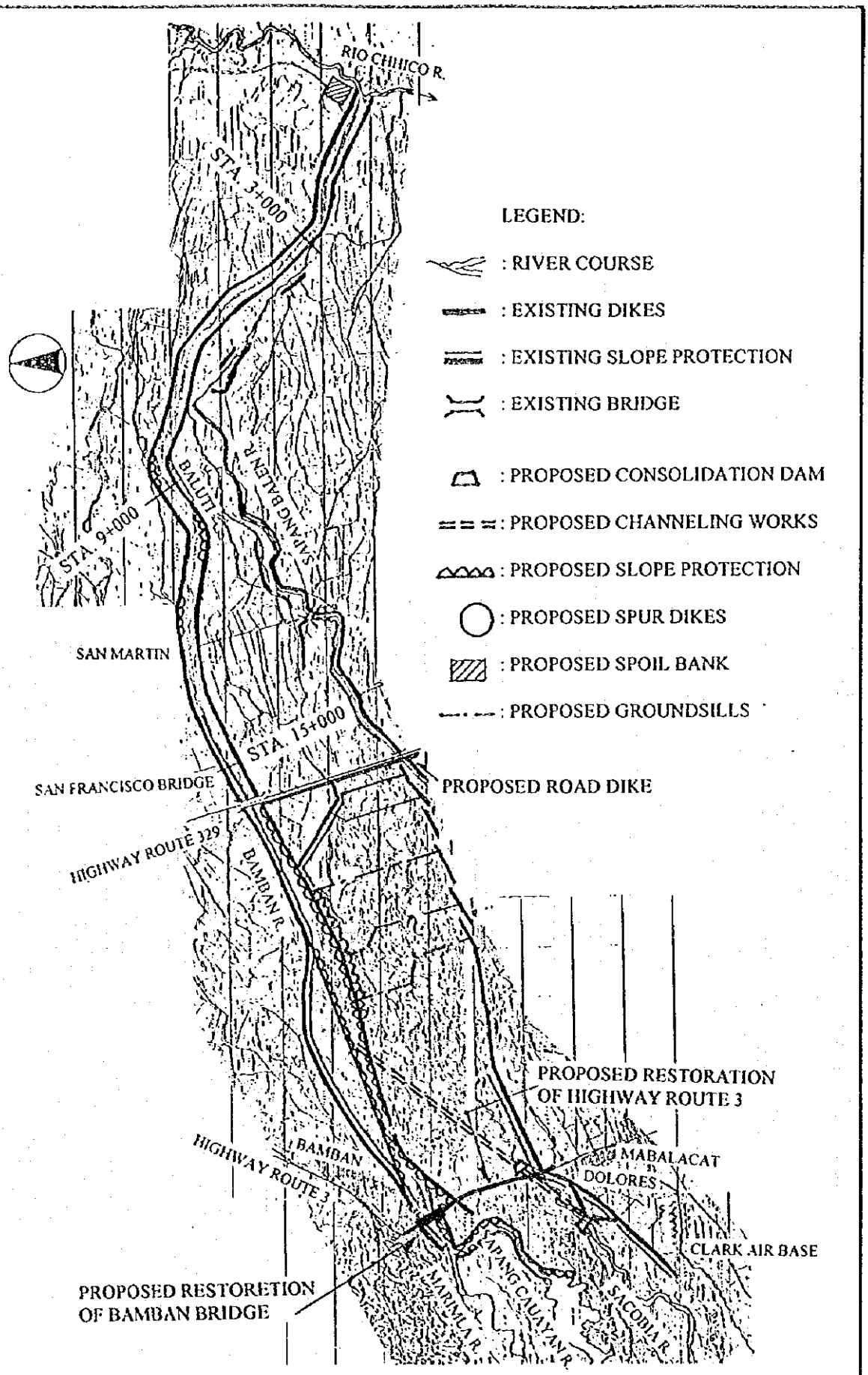


Figure H.43
Project Plan of Sacobia-Bamban River System

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

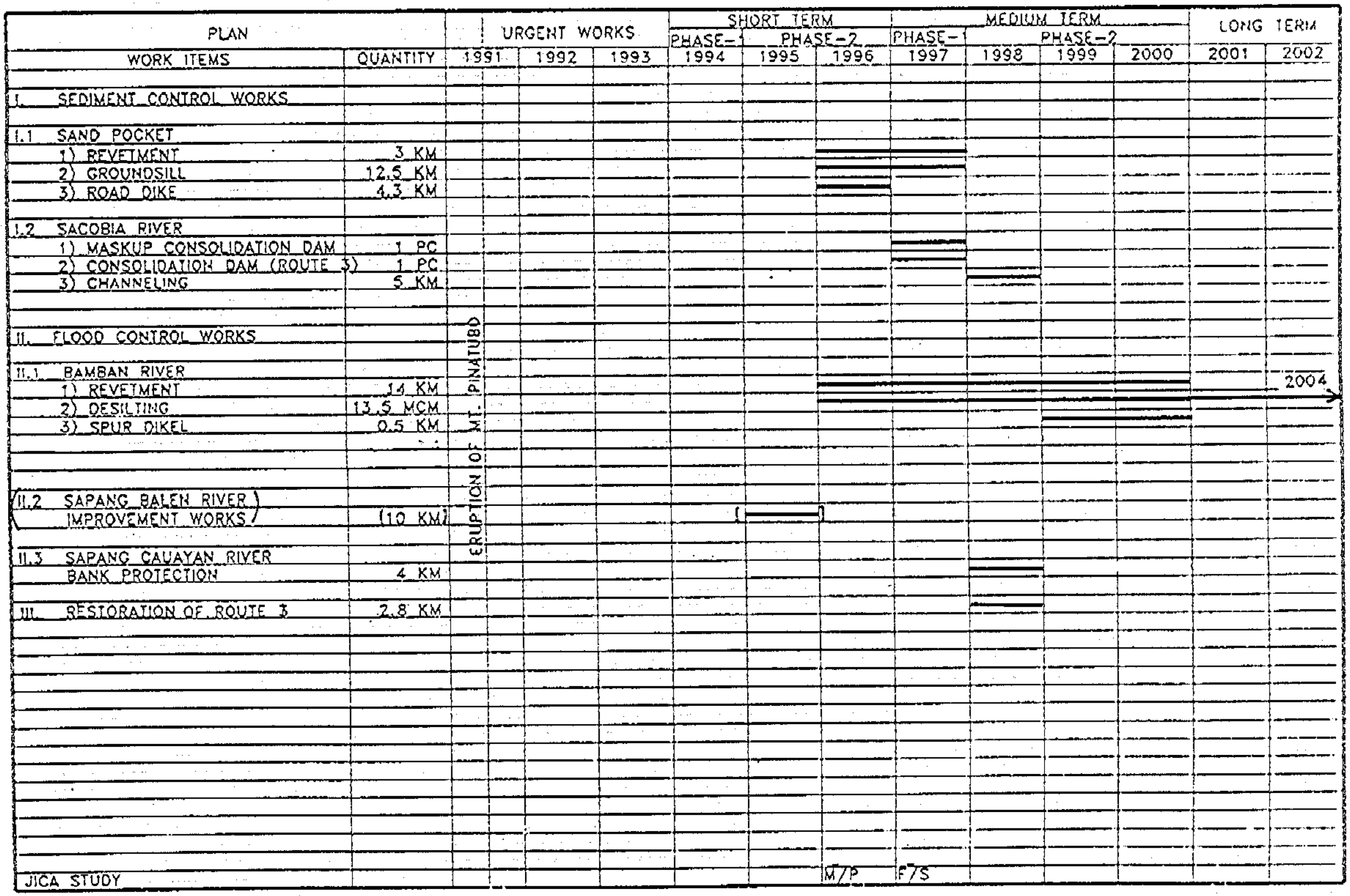


Figure H.44
Construction Schedule of Sacobia- Bamban River System

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

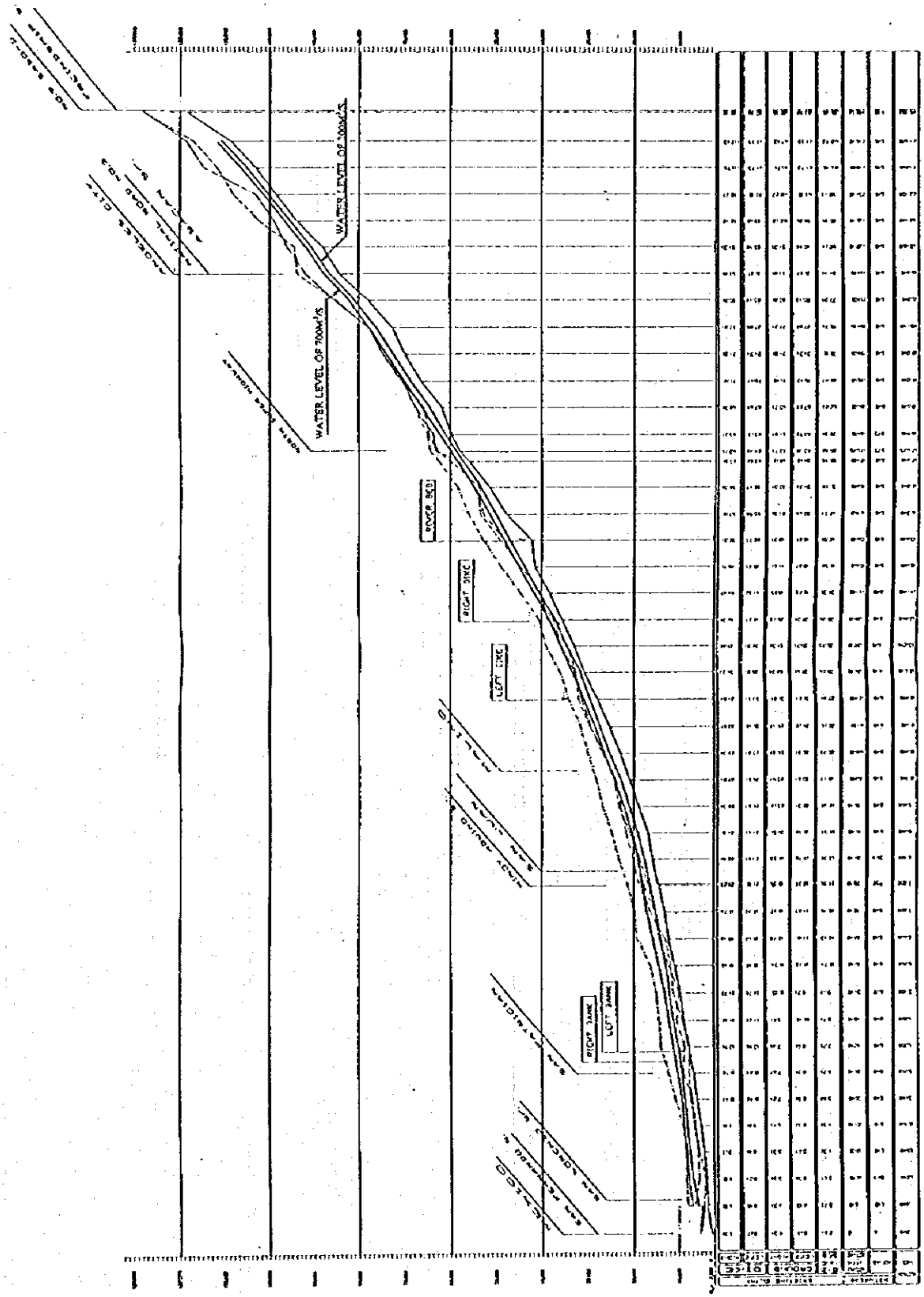


Figure II.45 Present Longitudinal Profile of Lower Abacan River

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

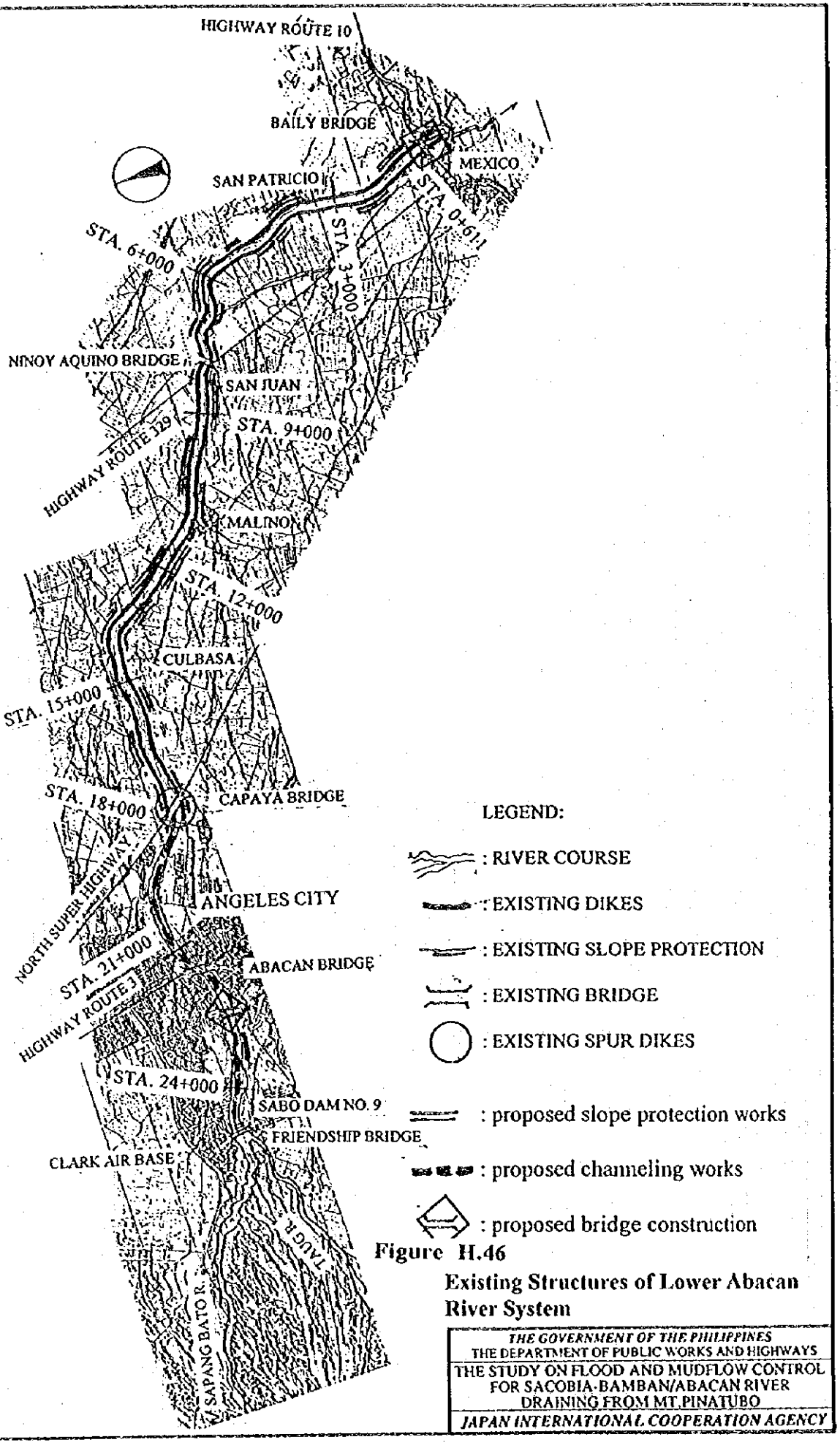


Figure H.46

Existing Structures of Lower Abacan River System

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT. PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

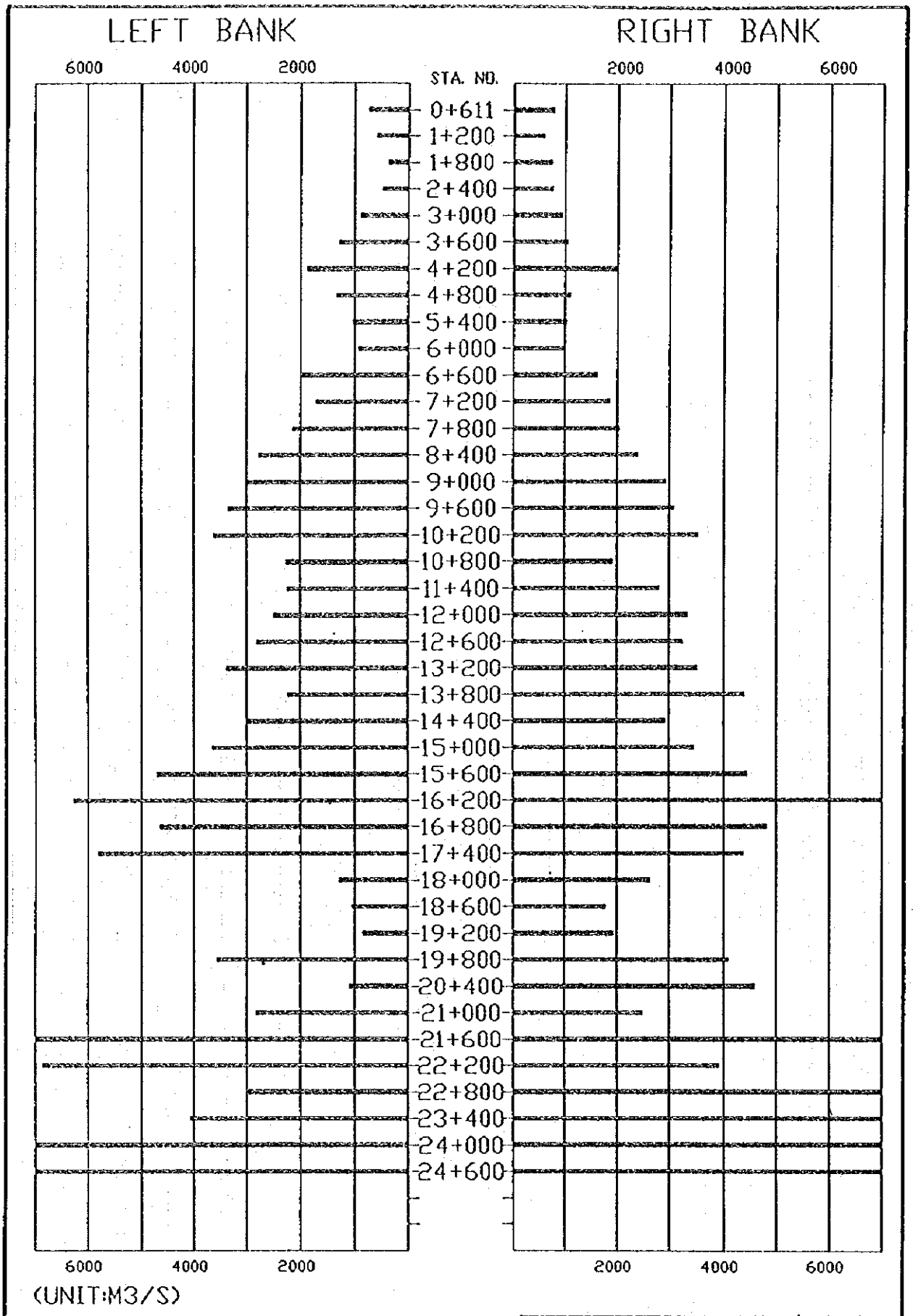


Figure II.47

Present Flow Capacity of Lower Abacan River

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

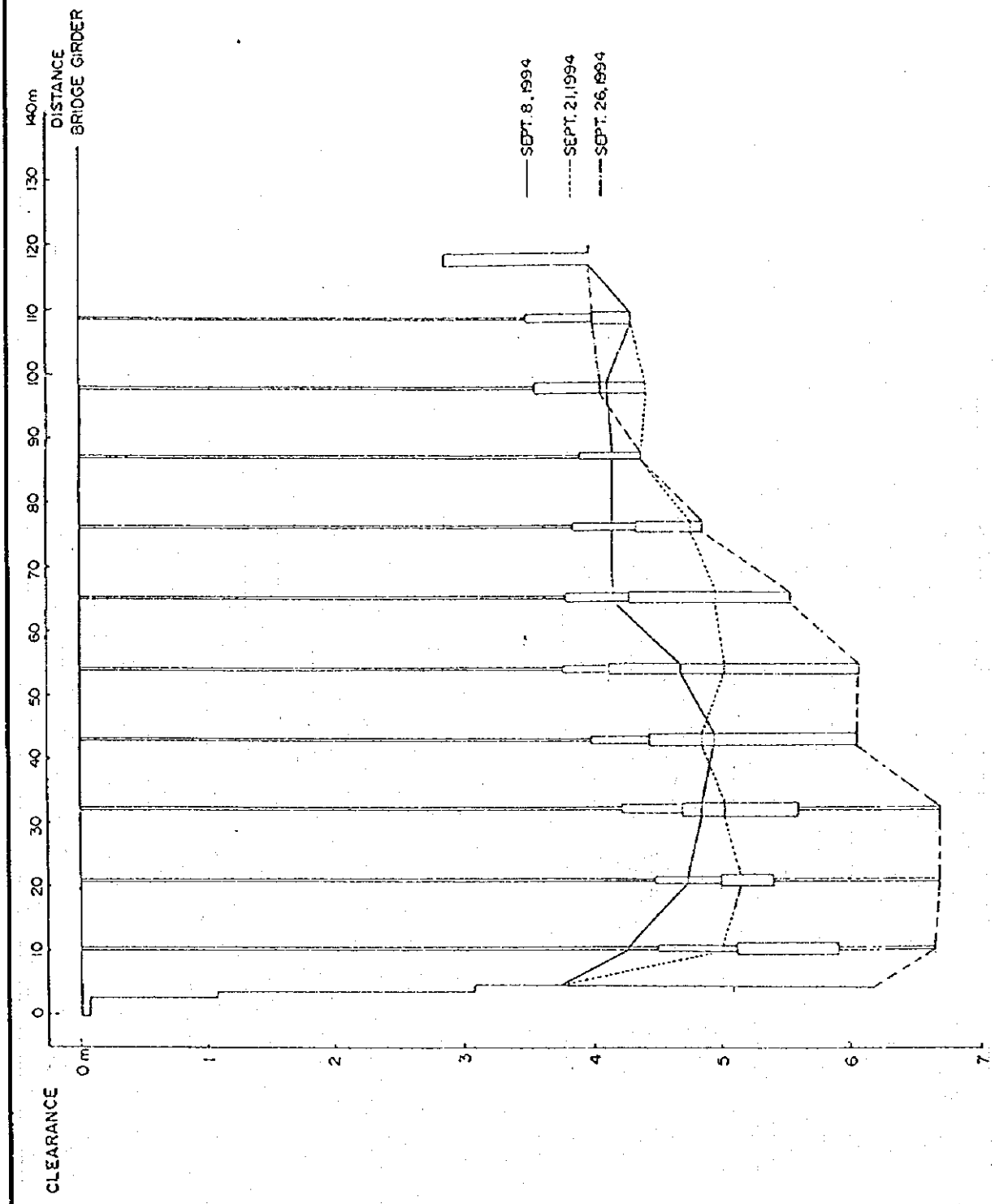
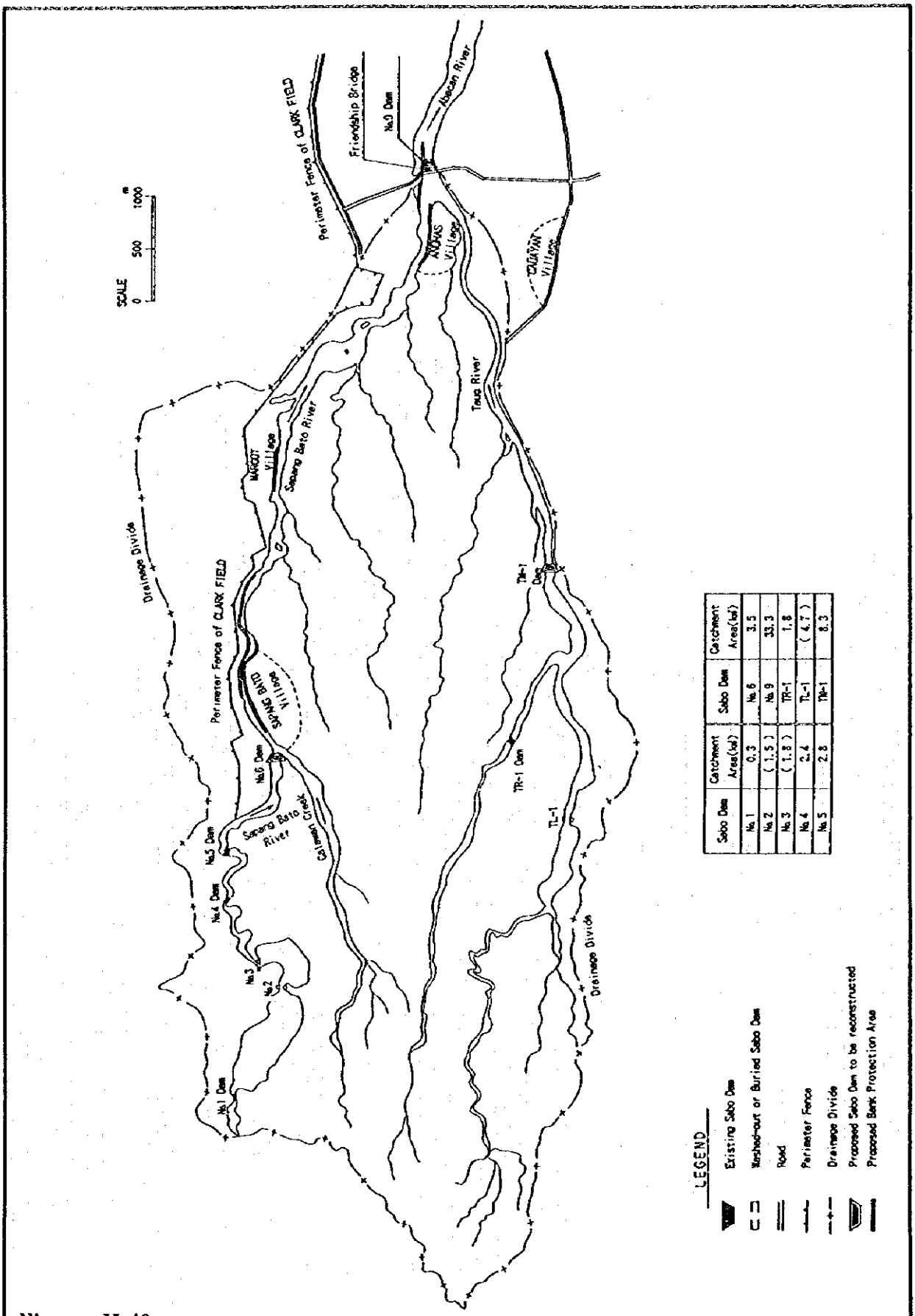


Figure H.48 River Bed Scouring at Friendship Bridge during Collapse of No.9 Sabo Dam

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



Sabo Dam	Catchment Area(sq)	Sabo Dam	Catchment Area(sq)
No.1	0.3	No.6	3.5
No.2	(1.5)	No.9	33.3
No.3	(1.8)	TR-1	1.8
No.4	2.4	TL-1	(4.7)
No.5	2.8	TR-1	8.3

Figure H.49

Location of Sabo Dams and Proposed Works in Medium Term Plan for Abacan River

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

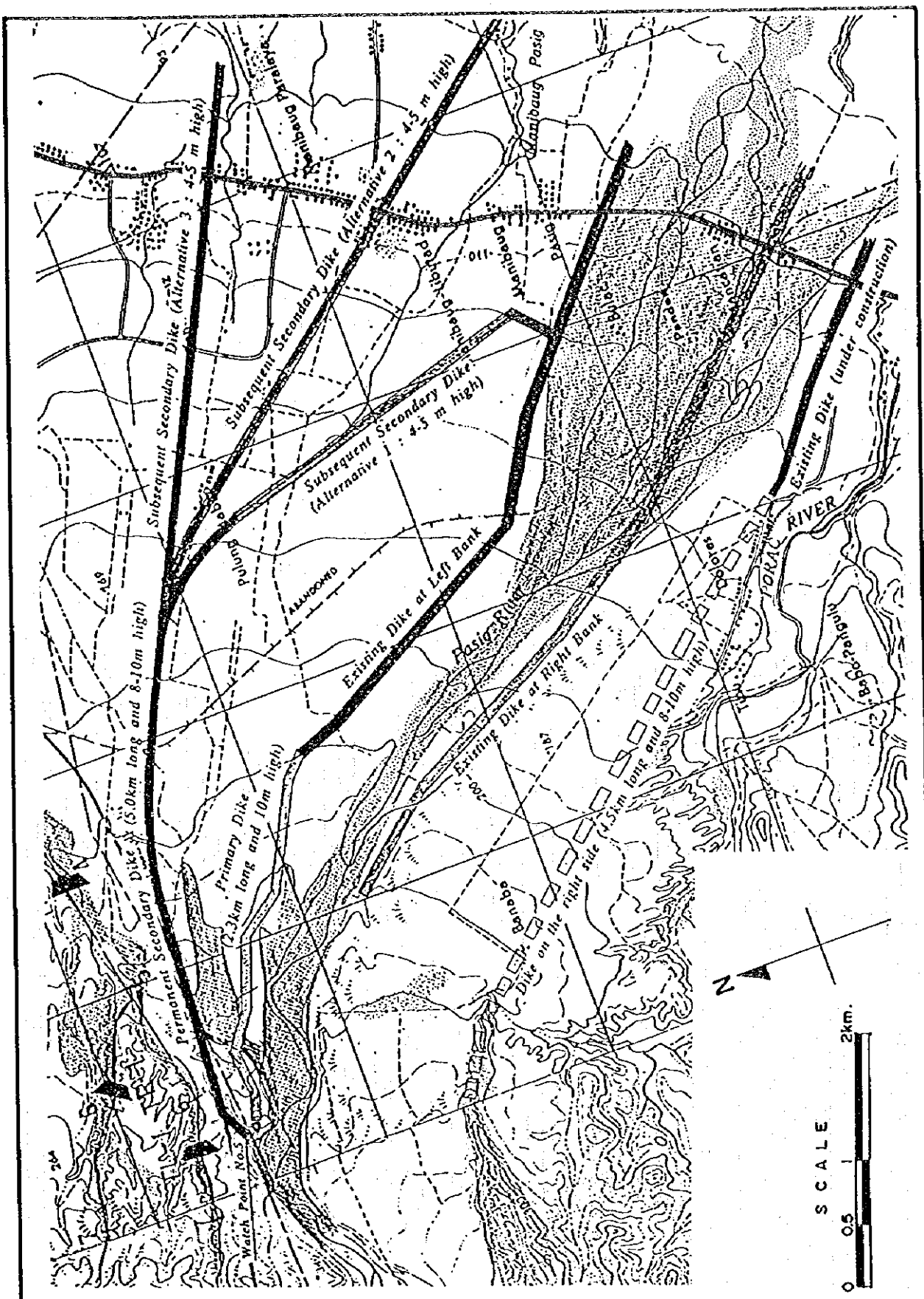


Figure H.50 Proposed Protective Dike System in Pasig River

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

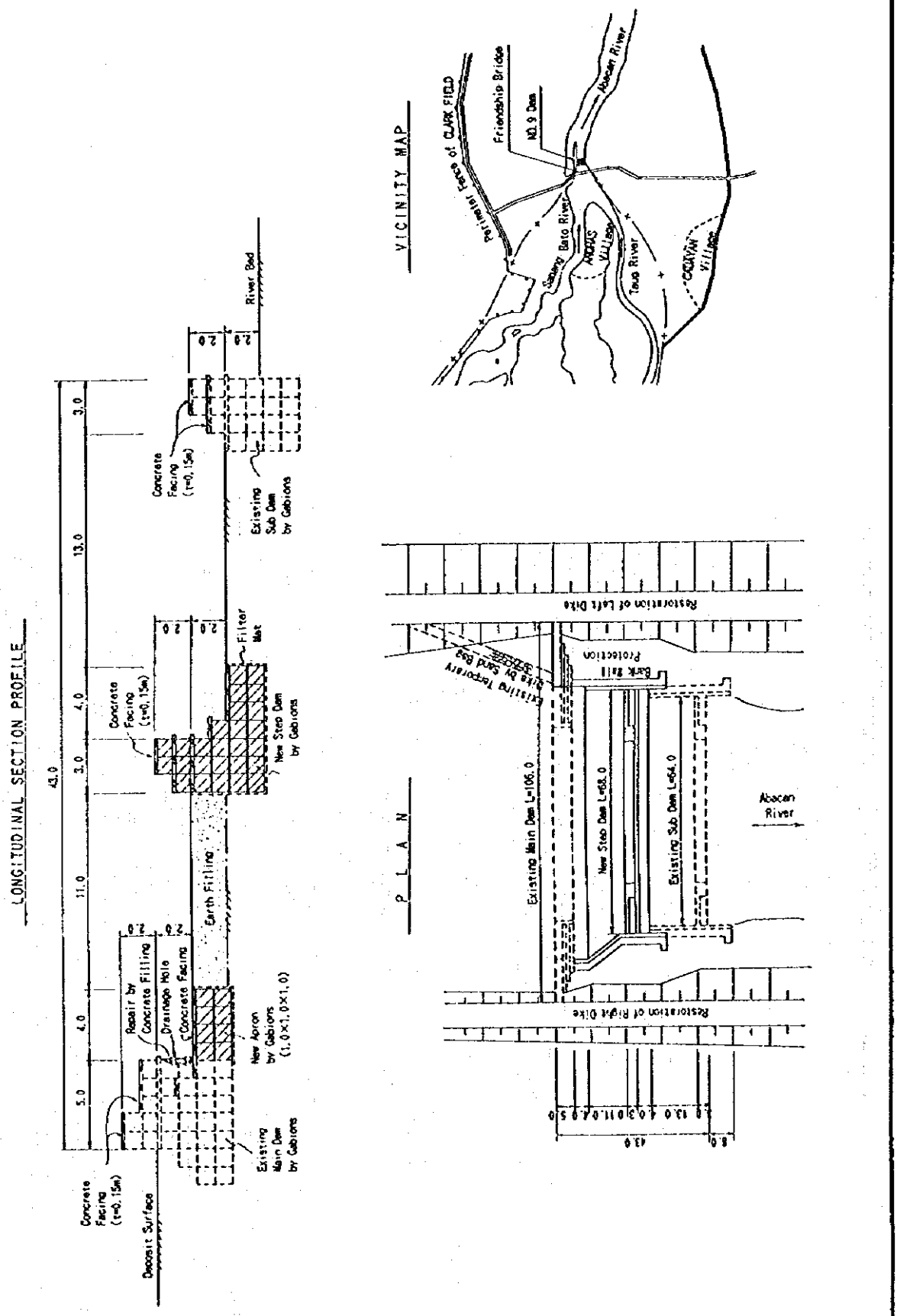
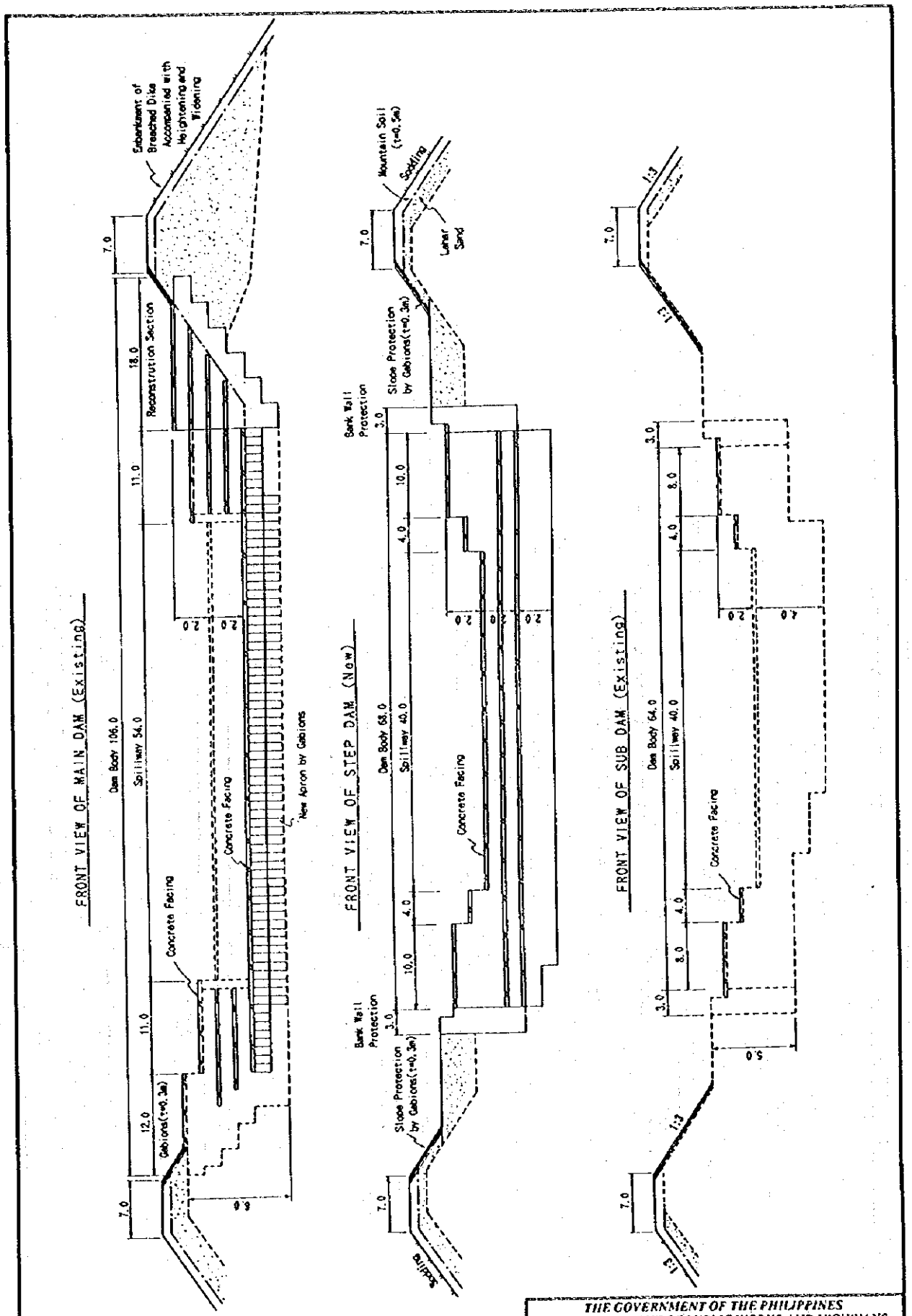


Figure II.51

Rehabilitation Plan of No.9 Sabo Dam (1/2)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

Figure H.51
Rehabilitation Plan of No.9 Sabo Dam (2/2)

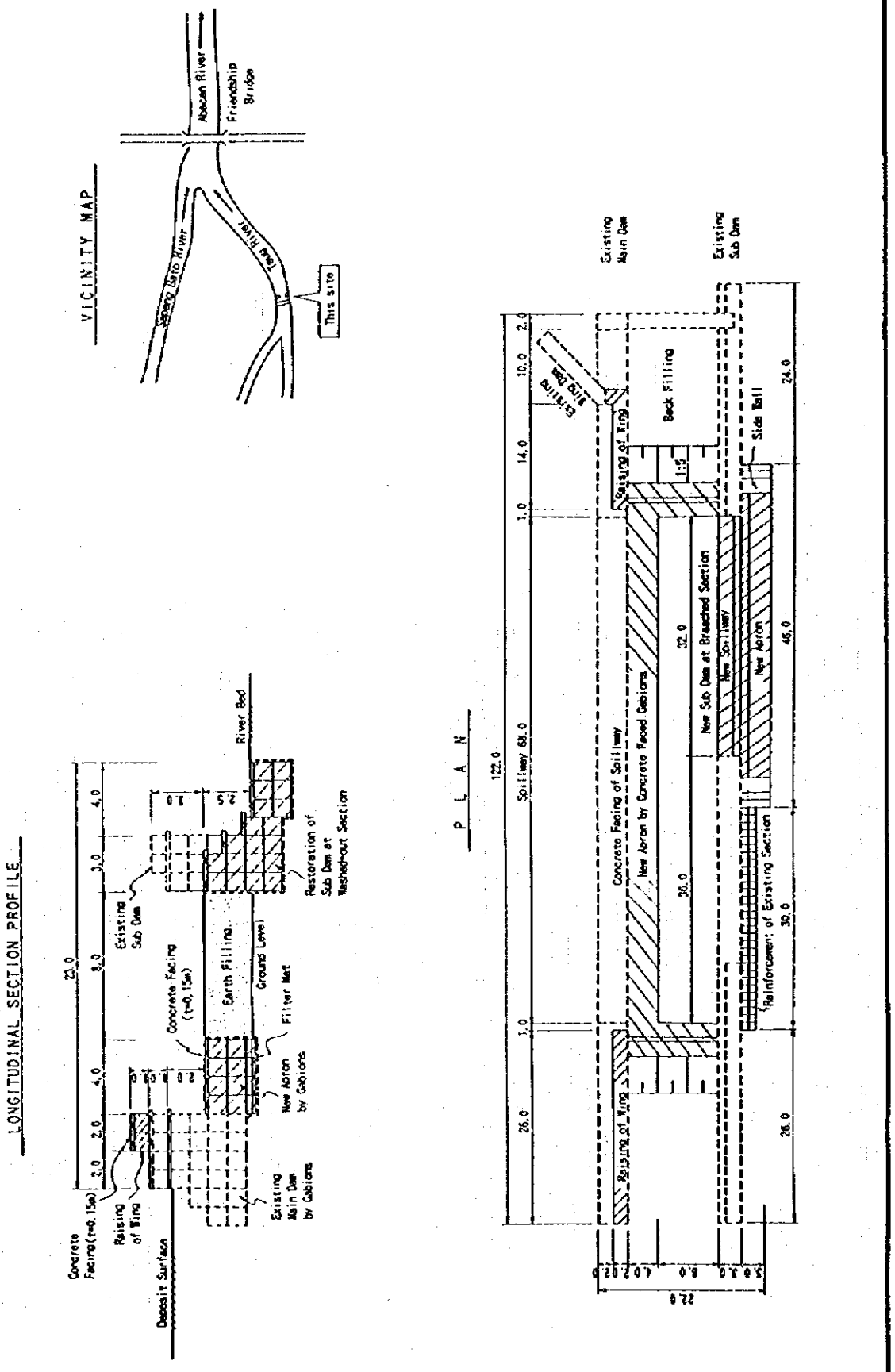


Figure H.52

Rehabilitation Plan of TM-1 Sabo Dam (1/2)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT. PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

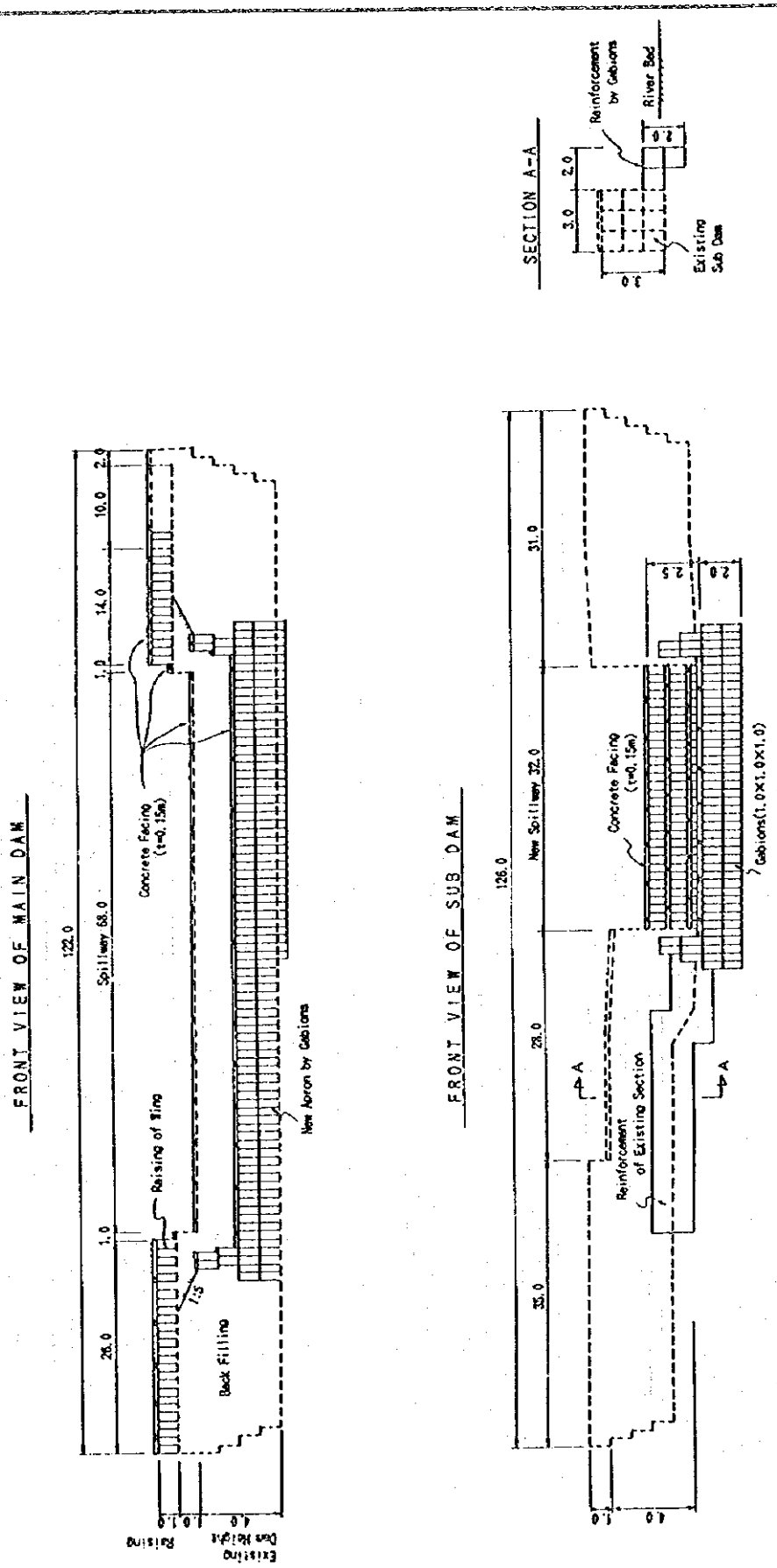


Figure H.52

Rehabilitation Plan of TM-1 Sabo Dam (2/2)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

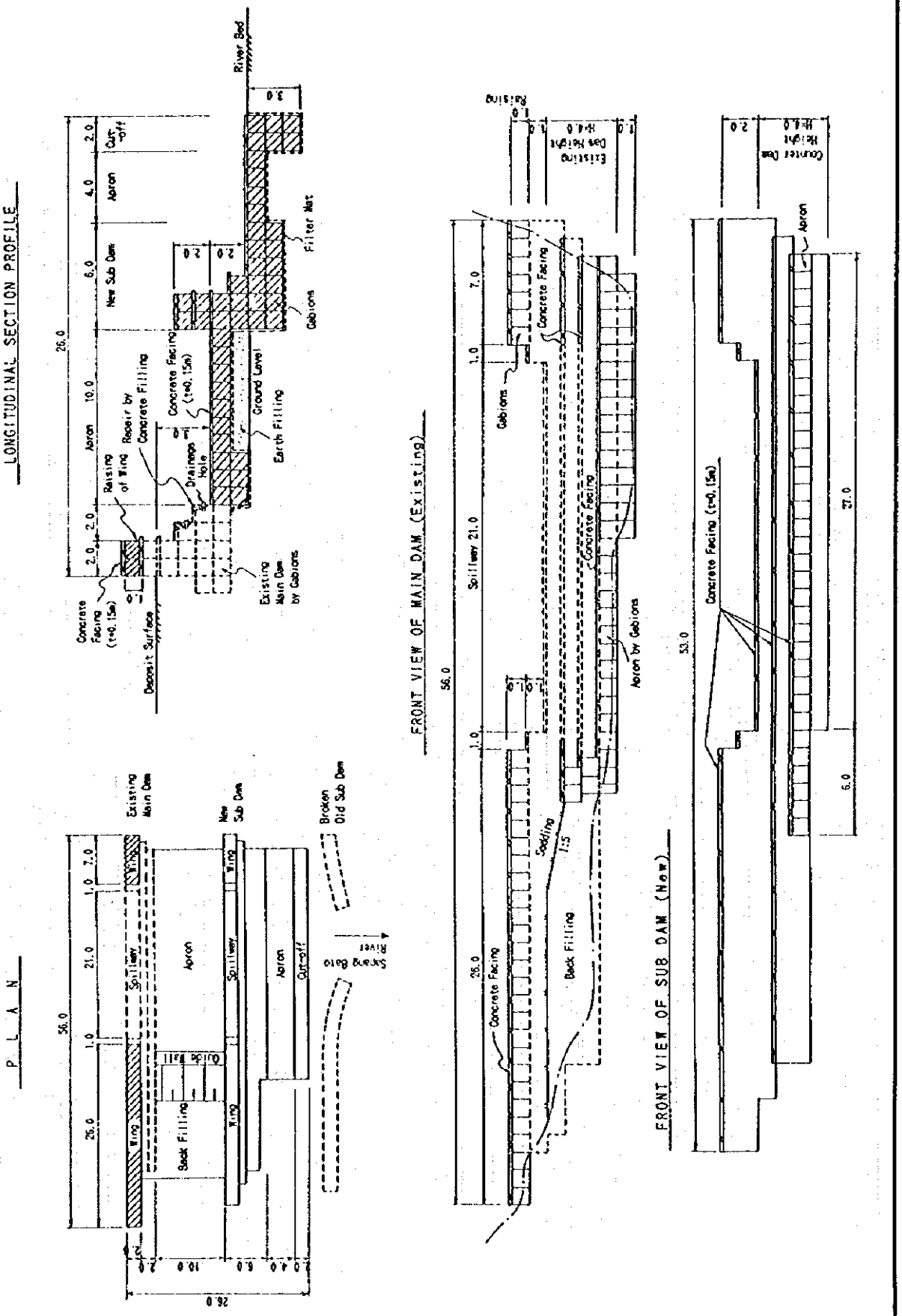


Figure II.53

Rehabilitation Plan of No.6 Sabo Dam

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

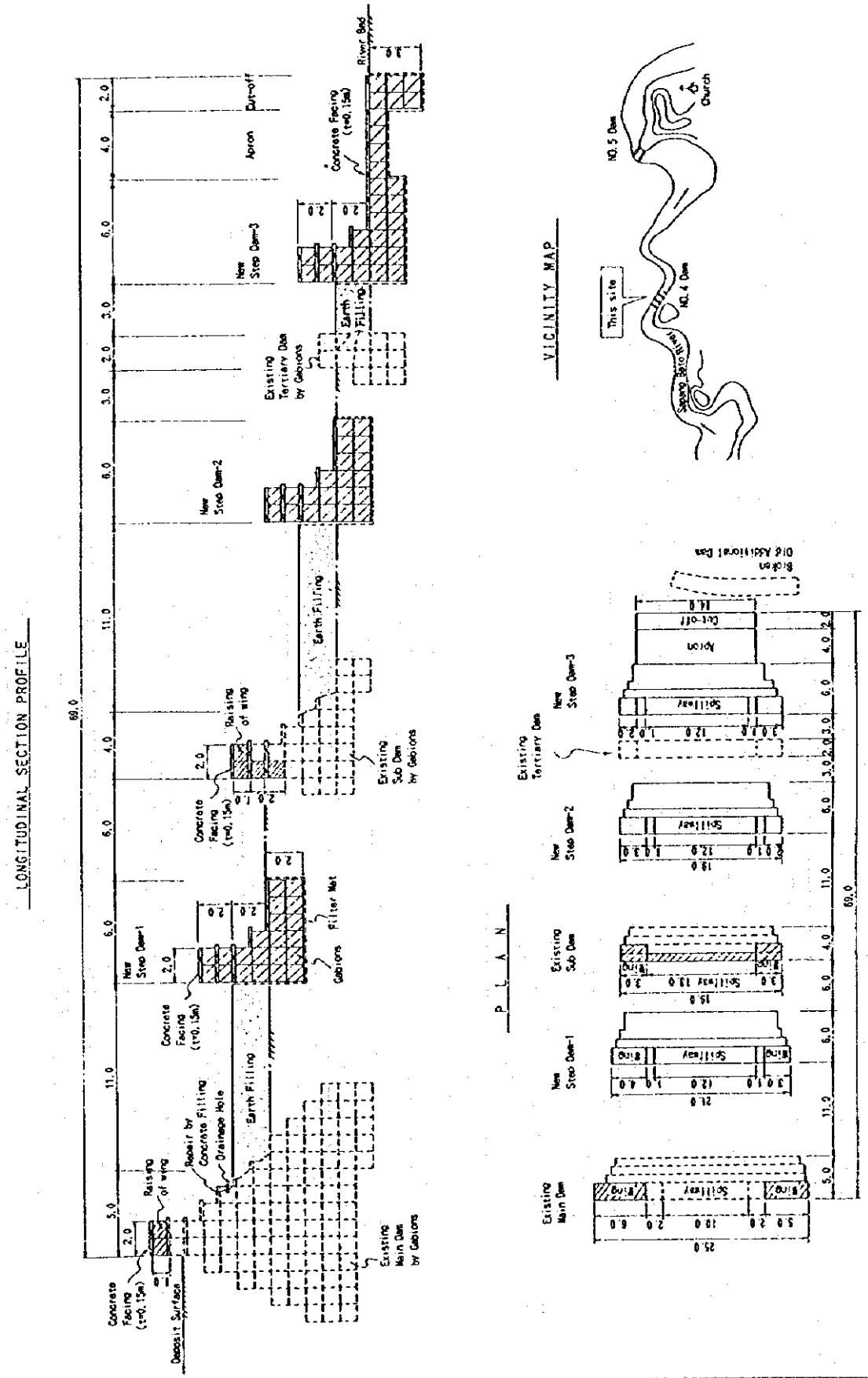


Figure H.54

Rehabilitation Plan of No.4 Sabo Dam (1/2)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

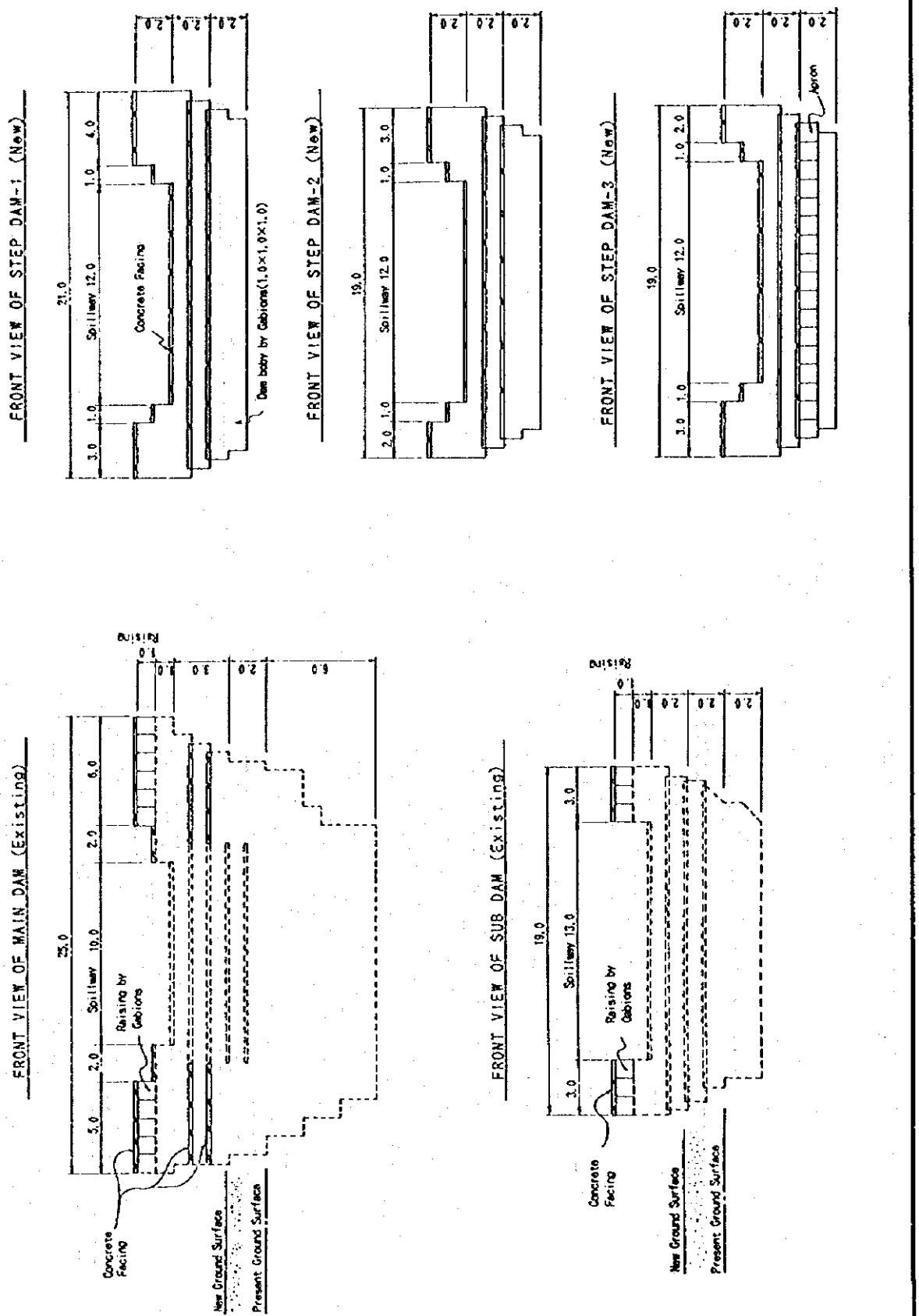
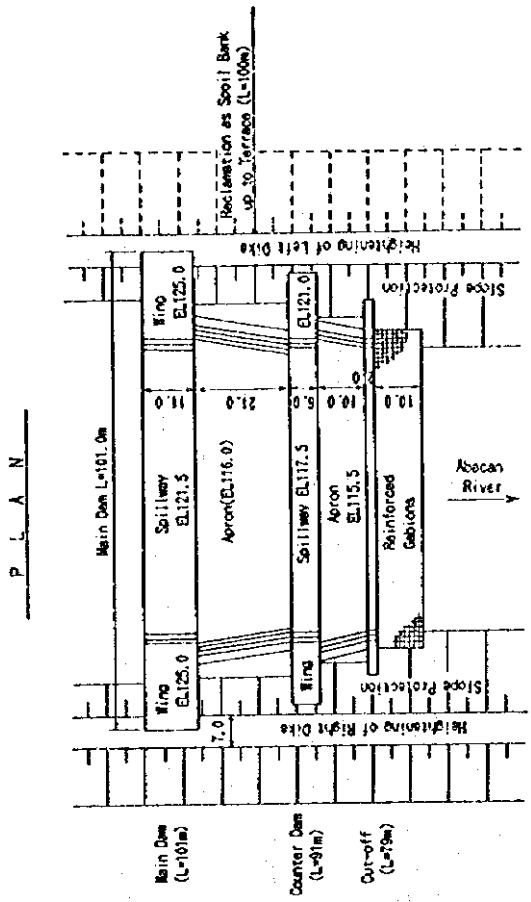


Figure II.54

Rehabilitation Plan of No.4 Sabo Dam (2/2)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



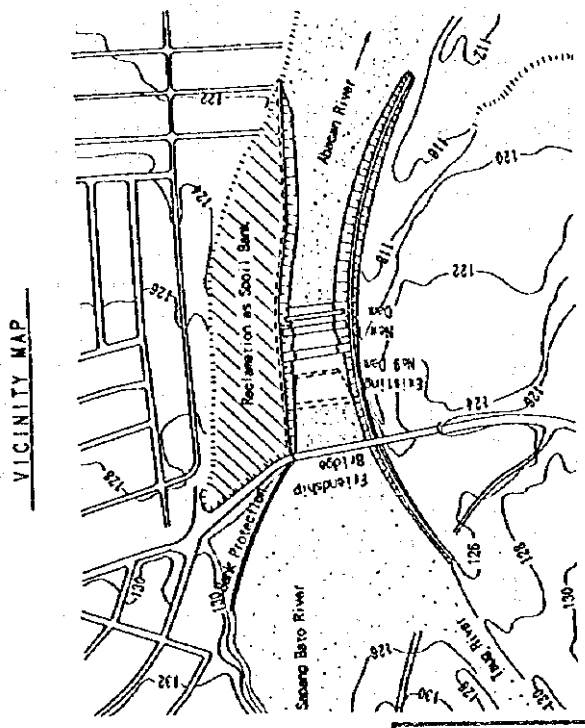


Figure H.55

Preliminary Plan of No.9 Sabo Dam (1/2)

THE GOVERNMENT OF THE PHILIPPINES
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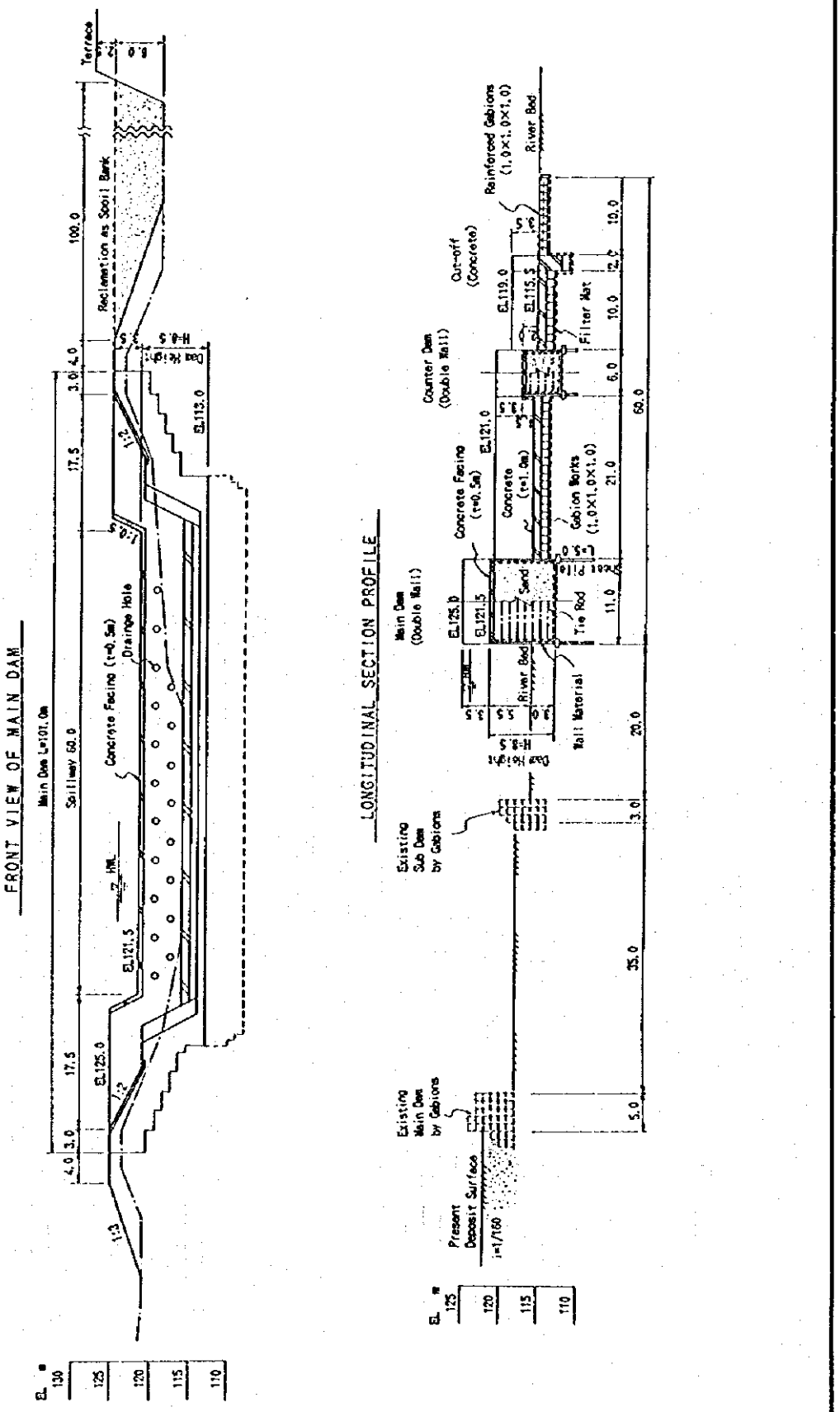

Figure II.55

Preliminary Plan of No.9 Sabo Dam (2/2)

THE GOVERNMENT OF THE PHILIPPINES
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THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

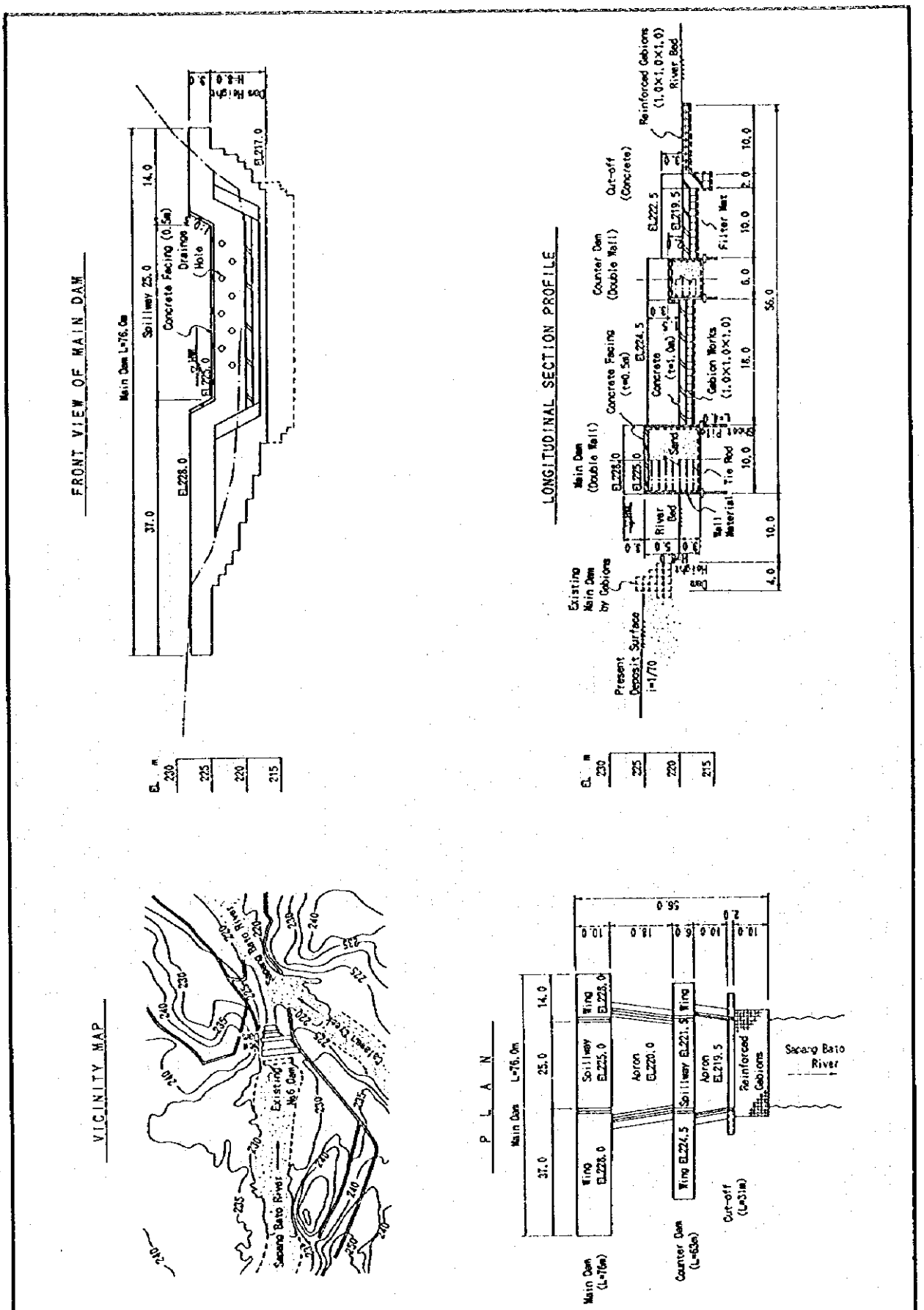

Figure 11.56 Preliminary Plan of No.6 Sabo Dam

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
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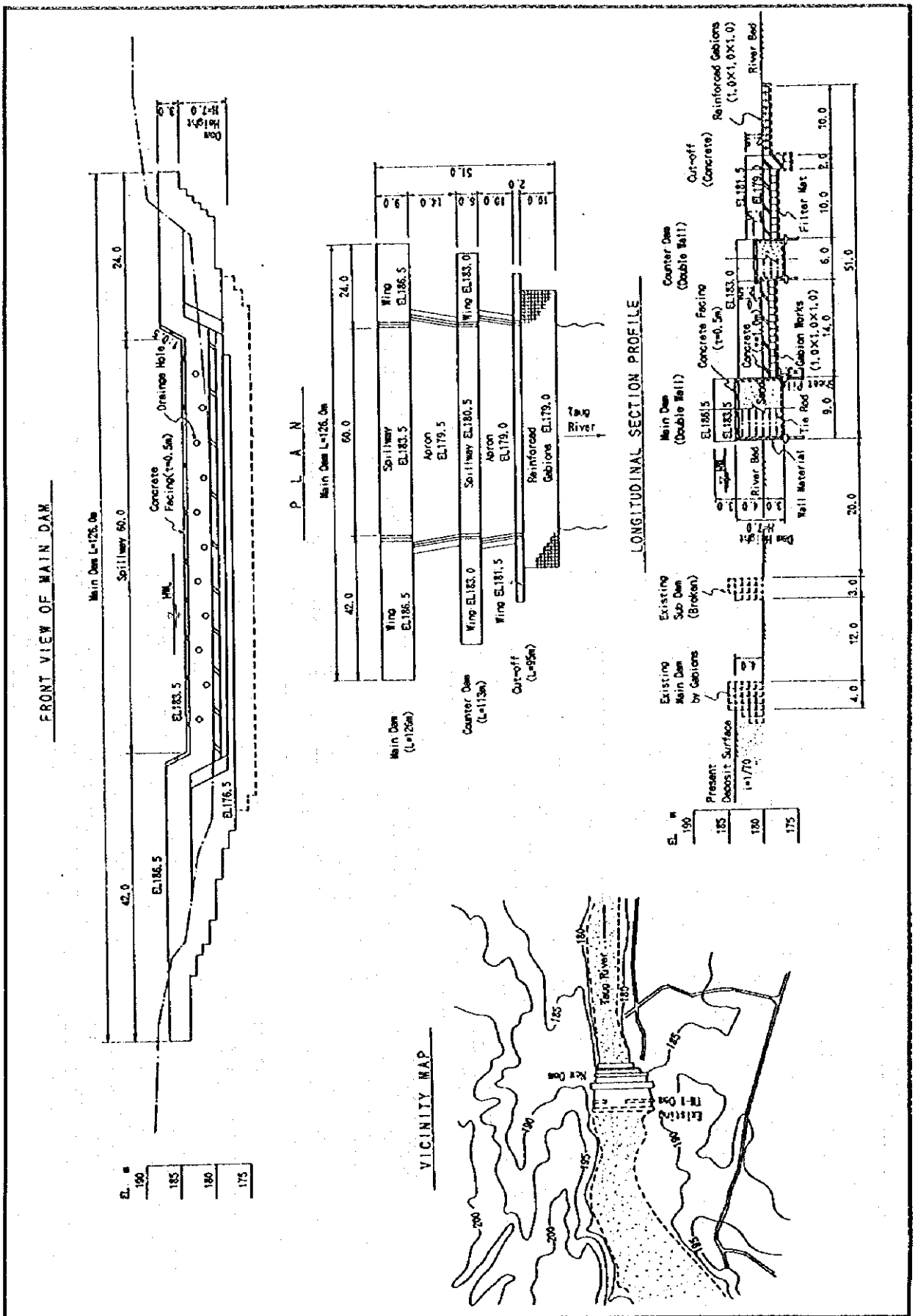

Figure II.57 Preliminary Plan of TM-1 Sabo Dam

THE GOVERNMENT OF THE PHILIPPINES
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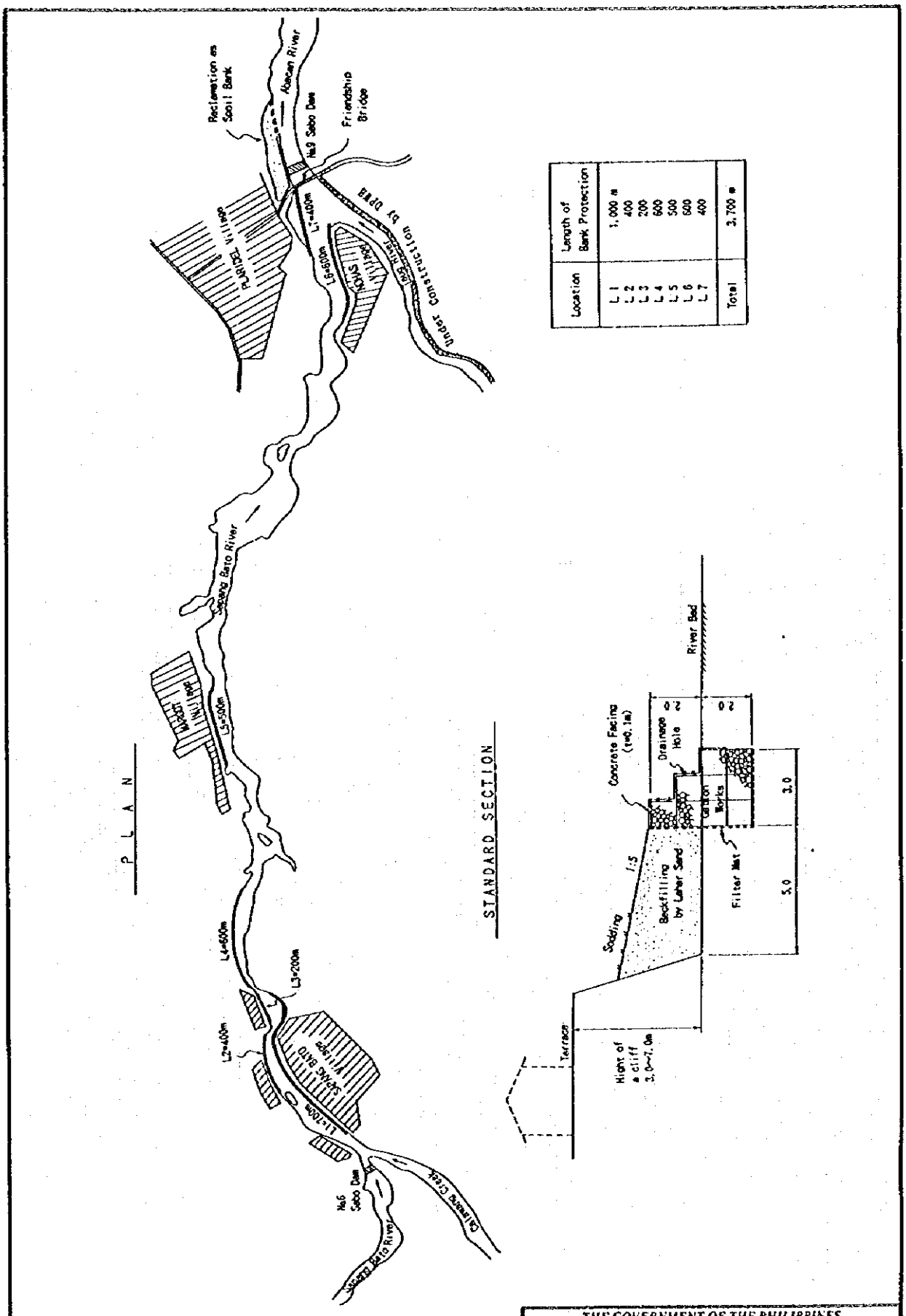

Figure II.58 Preliminary Plan of Bank Protection Works

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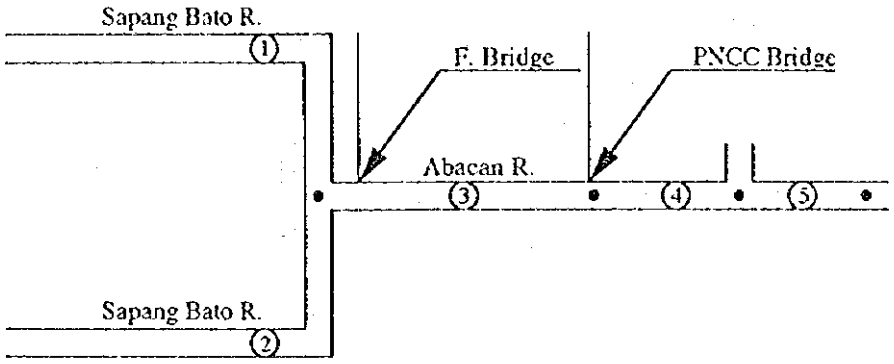
ABACAN RIVER



Probable Peak Discharge Distribution

ABACAN RIVER Unit :m3/s

	Return Period					
Reach	100	50	20	10	5	2
No.1	150	130	120	100	80	60
No.2	200	170	150	130	100	80
No.3	490	430	370	310	240	180
No.4	590	510	440	380	290	230
No.5	710	620	520	450	350	270

Figure H.59 Probable Peak Discharge of Abacan River System

THE GOVERNMENT OF THE PHILIPPINES
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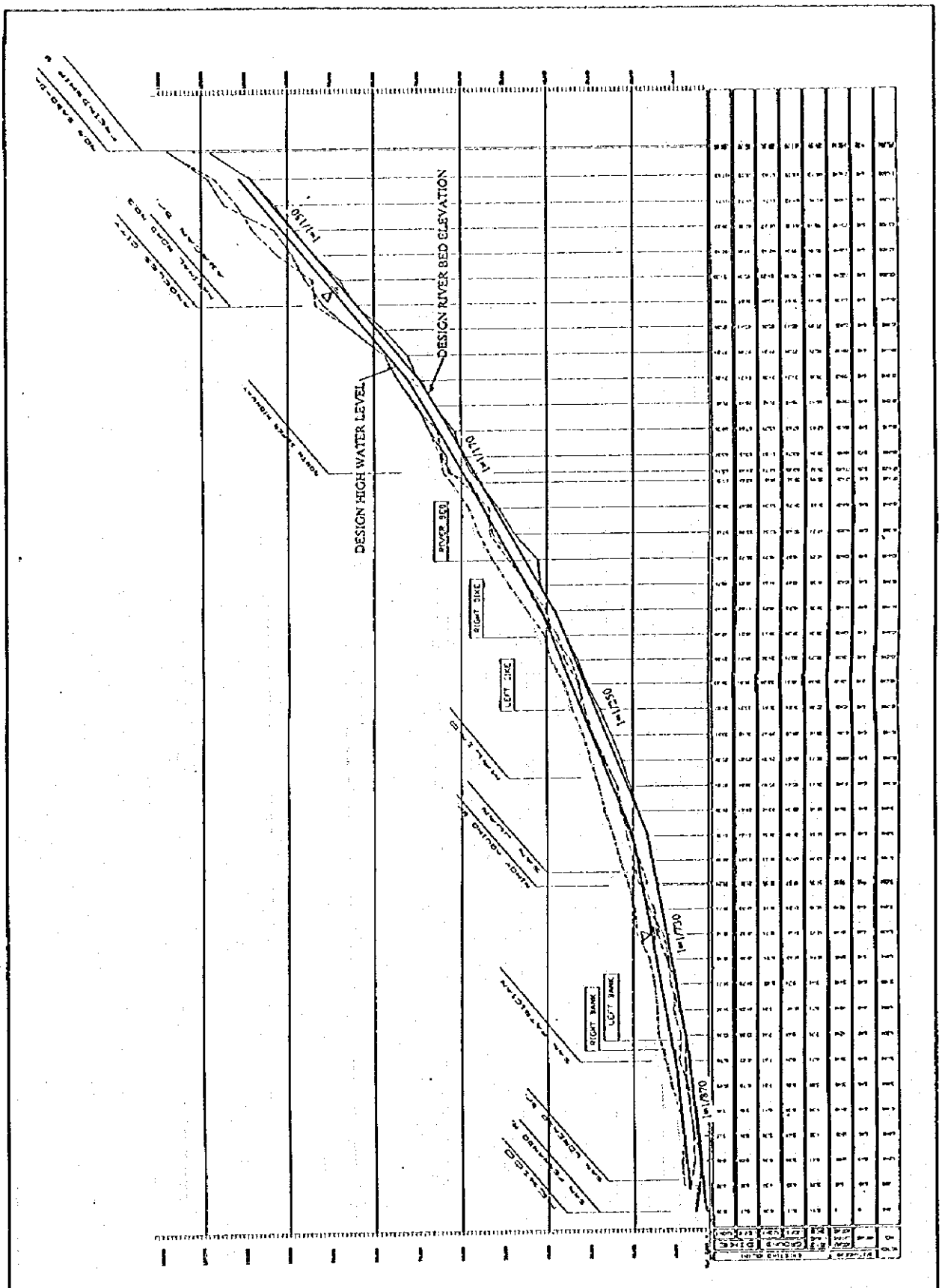

Figure H.60 Proposed Longitudinal Profile of Lower Abacan River

THE GOVERNMENT OF THE PHILIPPINES
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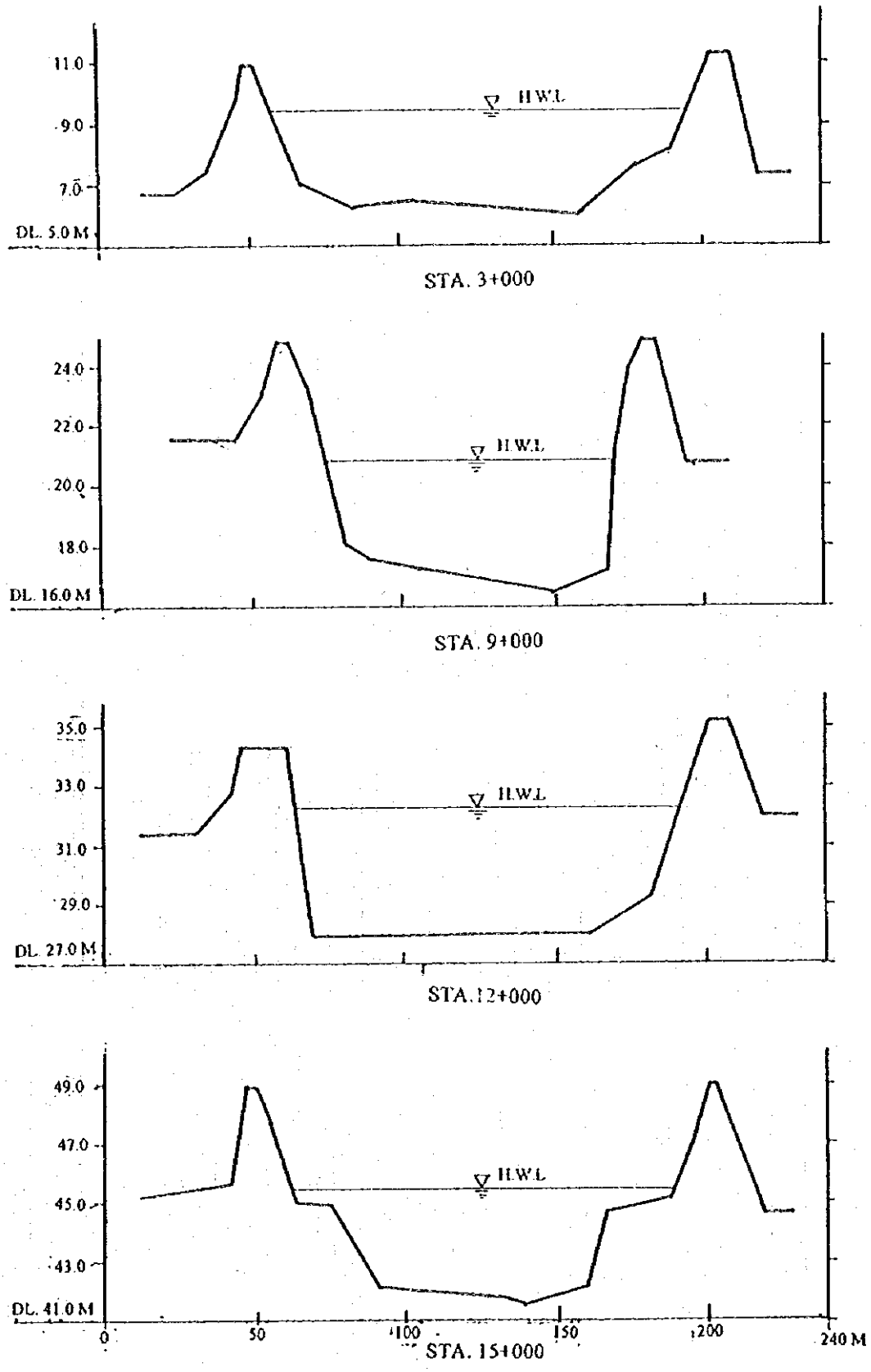

Figure H.61 Typical Cross Section of Abacan River

THE GOVERNMENT OF THE PHILIPPINES
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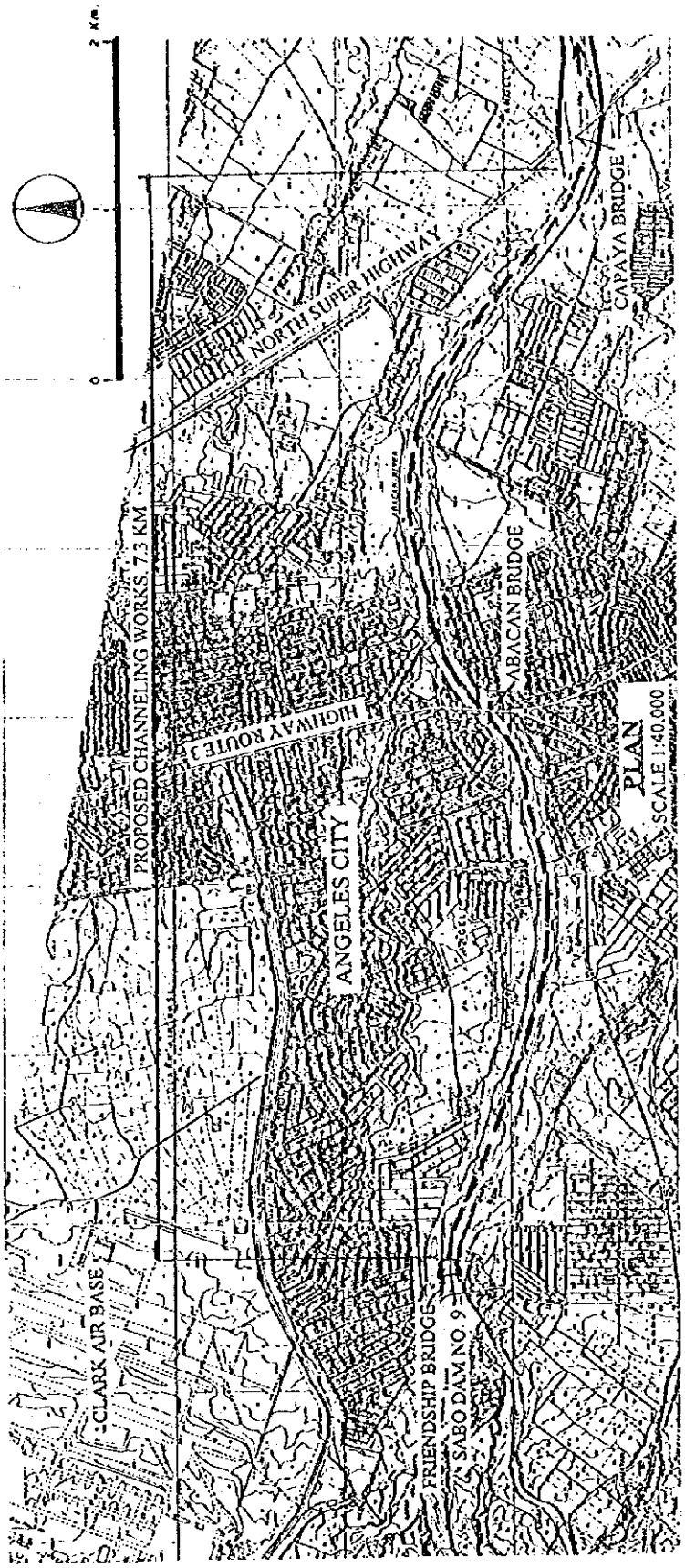

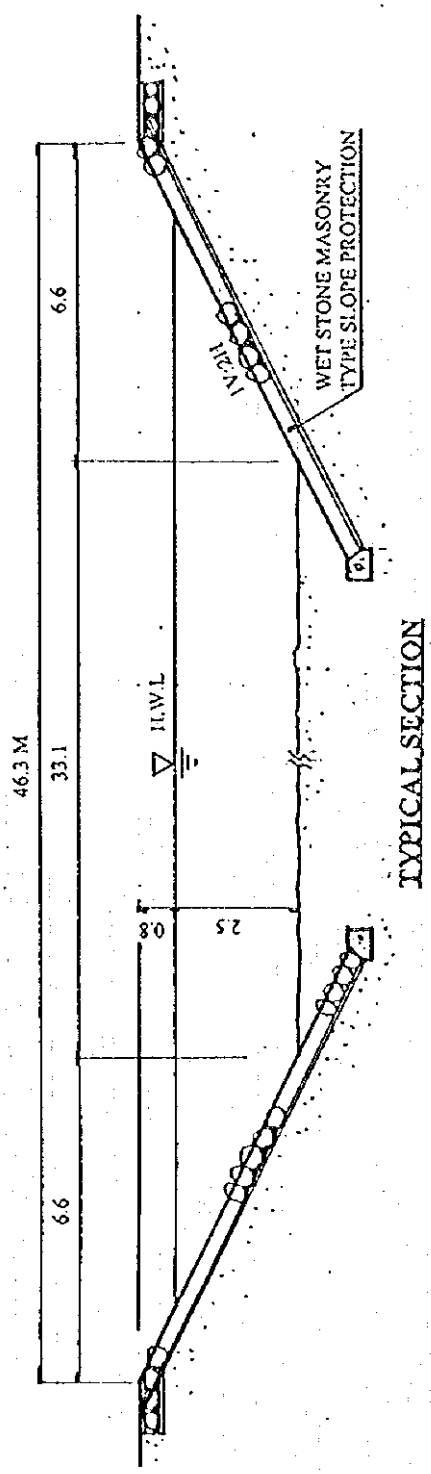

Figure H.62 Proposed Channeling in Angeles City Urban Reach

THE GOVERNMENT OF THE PHILIPPINES
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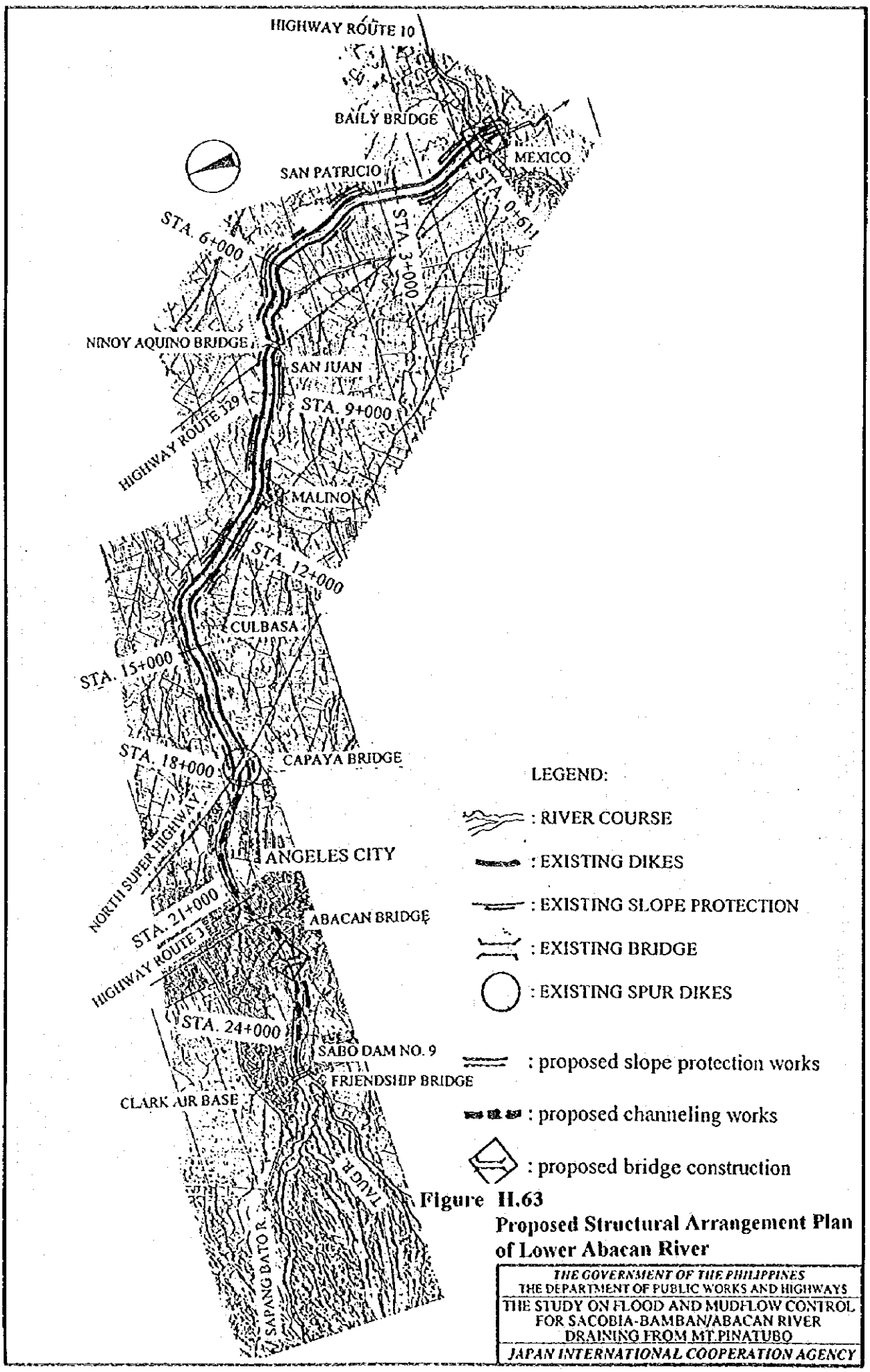

Figure H.63
Proposed Structural Arrangement Plan of Lower Abacan River

THE GOVERNMENT OF THE PHILIPPINES
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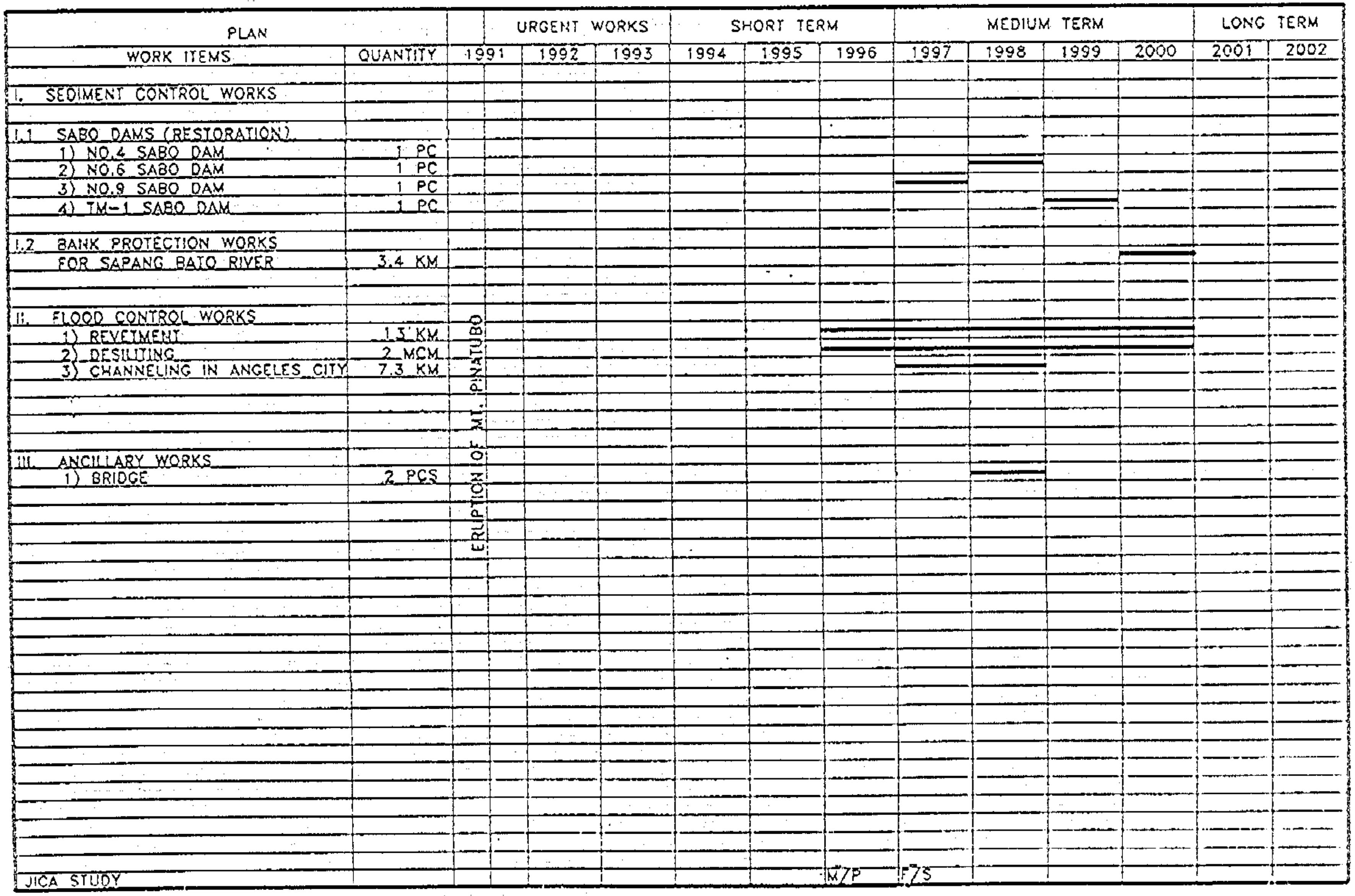

Figure H.64

Construction Schedule of Abacan River System

THE GOVERNMENT OF THE PHILIPPINES
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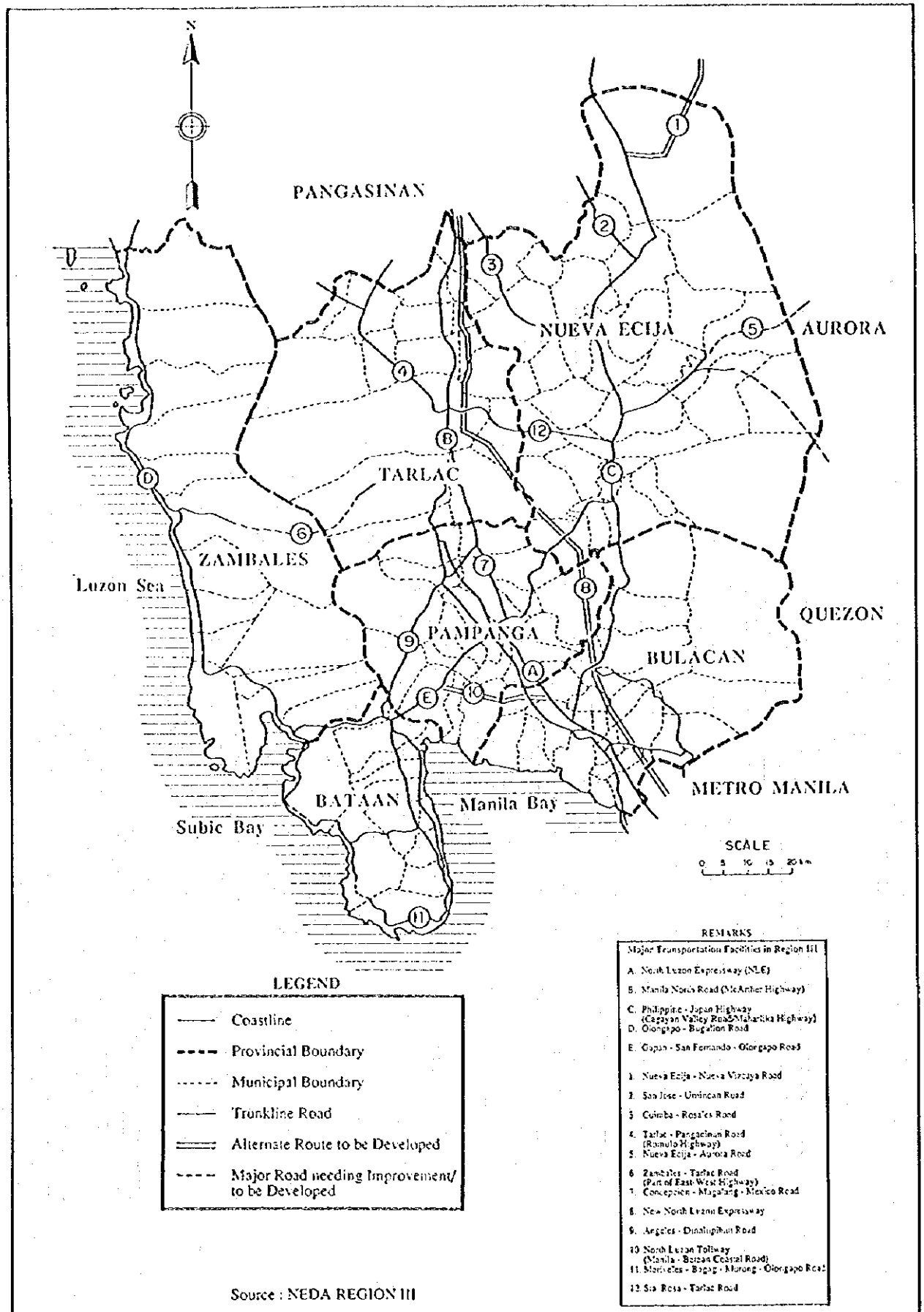

Source : NEDA REGION III

Figure H.65 Road Network Plan

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
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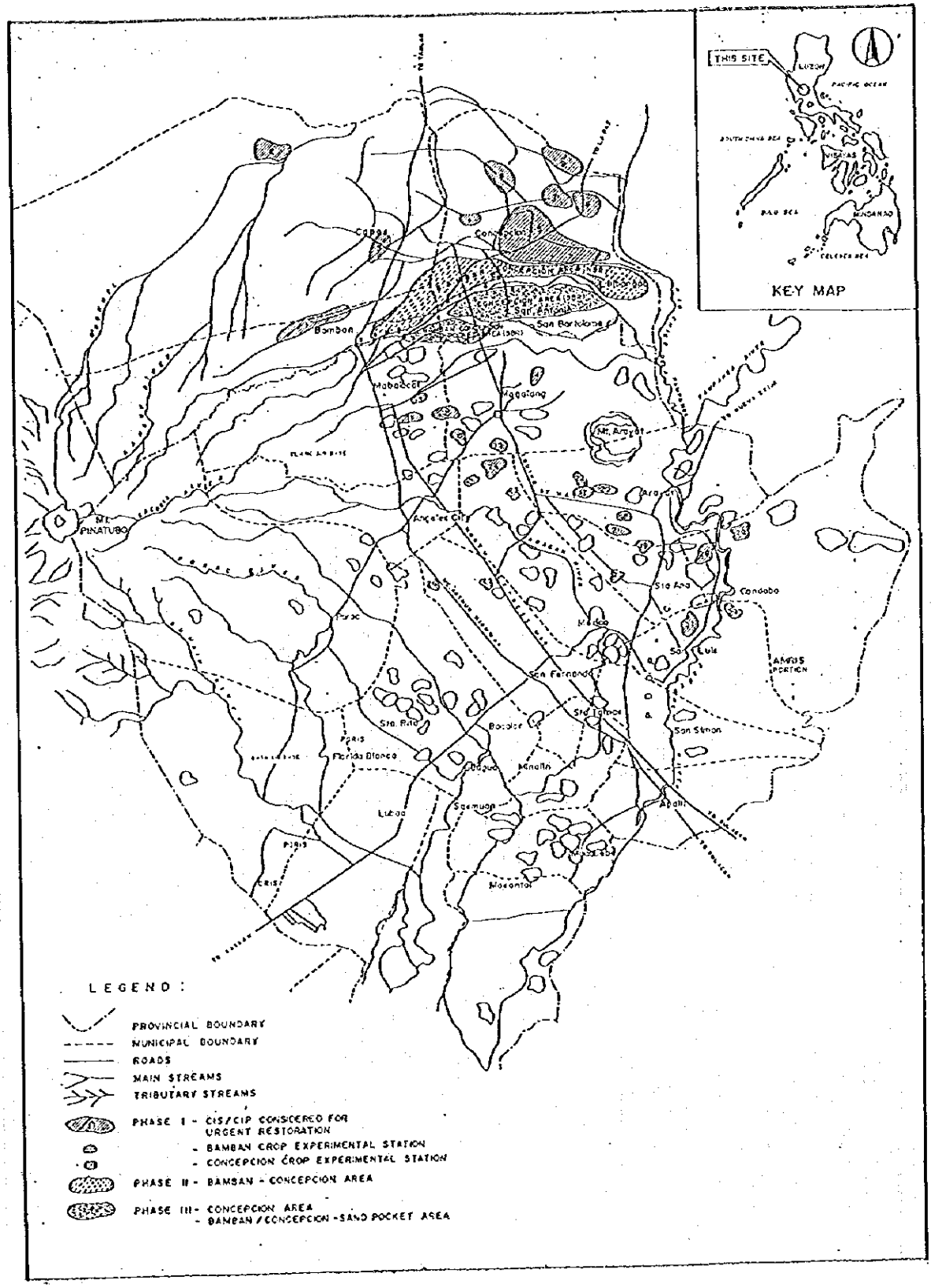

Figure H.66

Location Map of Priority Schemes for Irrigation Development

THE GOVERNMENT OF THE PHILIPPINES
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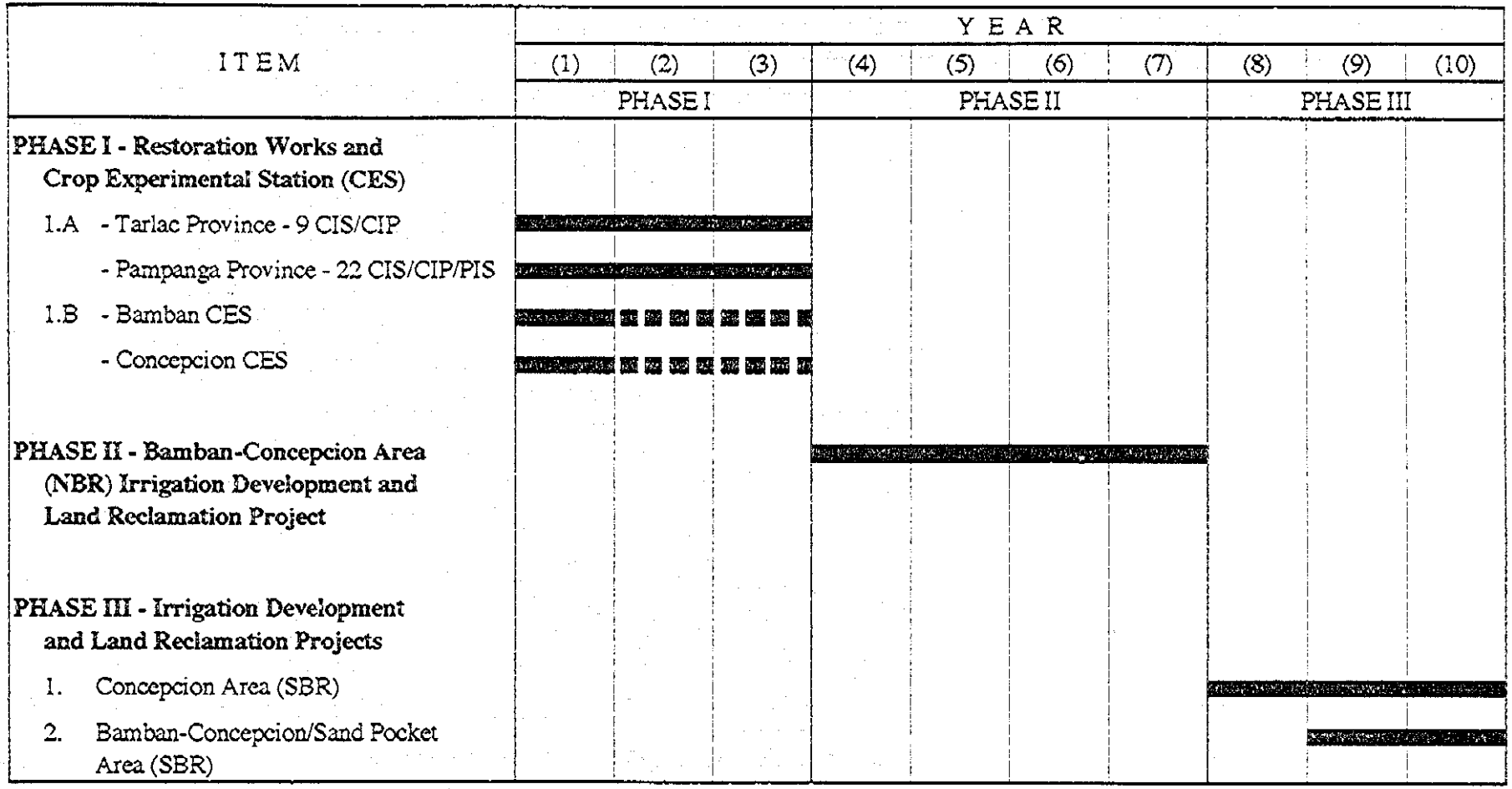
Figure H.67 Preliminary Proposed Implementation Schedule



Note:
NBR - North of Bamban River
SBR - South of Bamban River

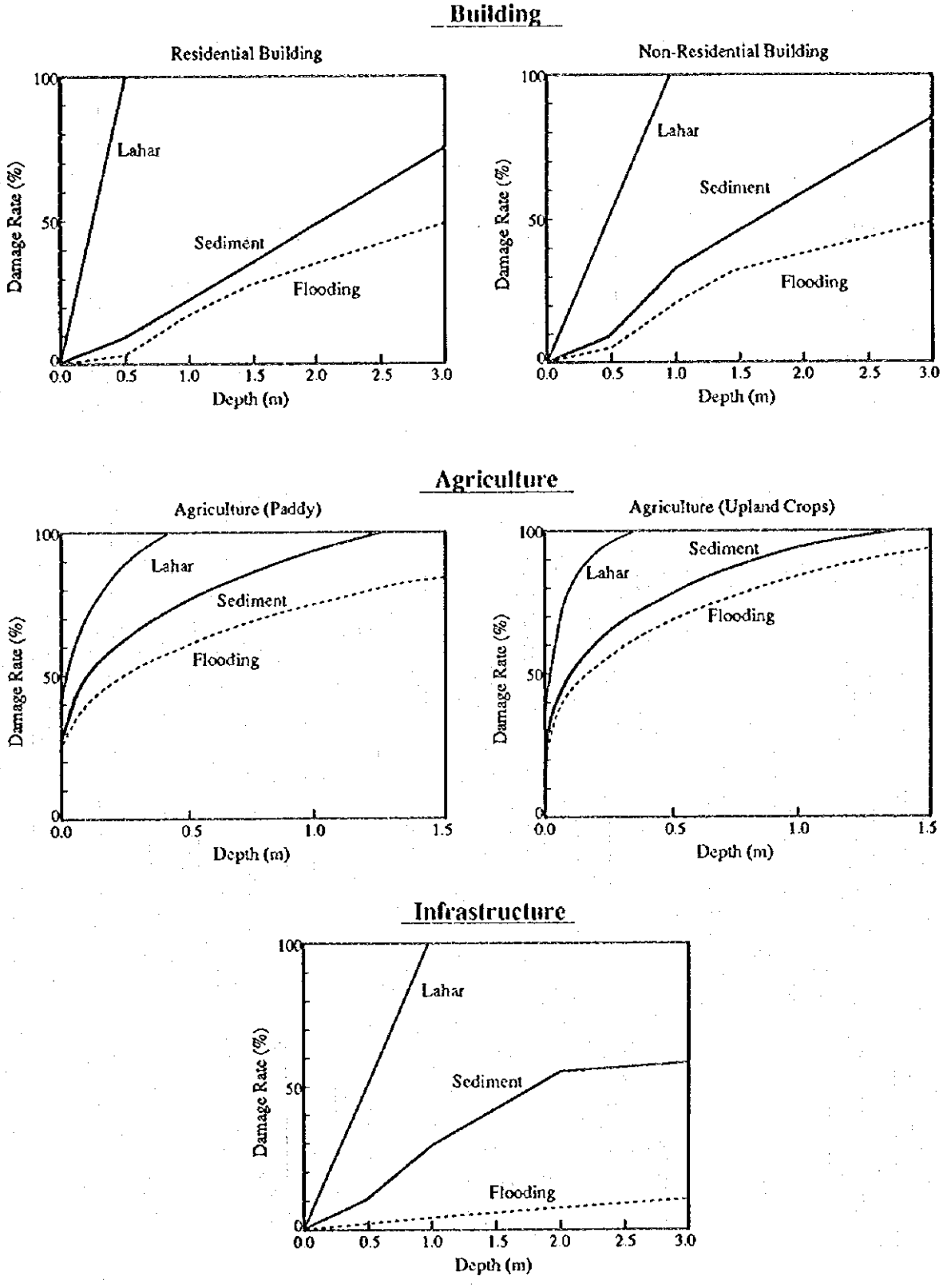


Figure II.68 Damage Curves for Properties

THE GOVERNMENT OF THE PHILIPPINES THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT. PINATUBO
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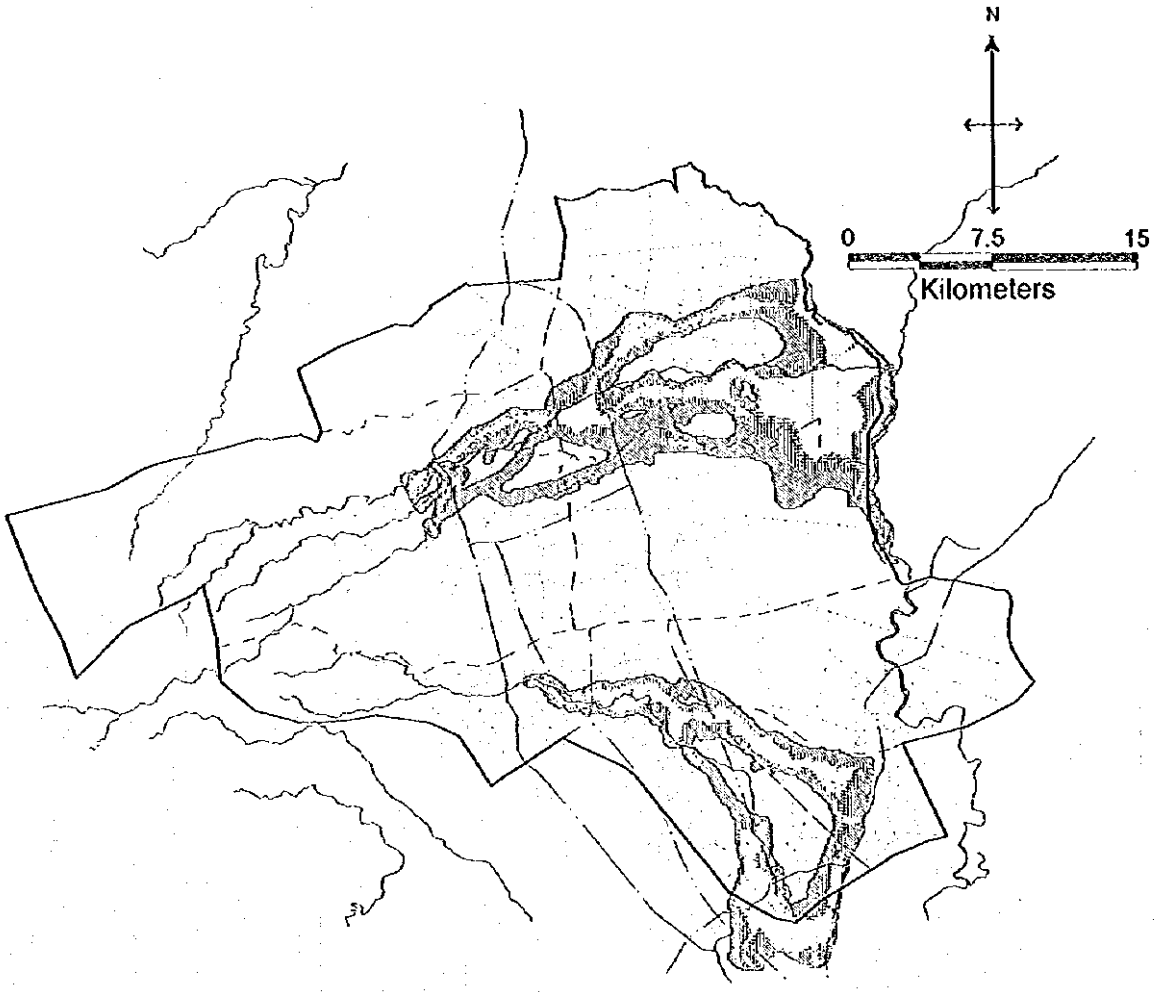

AREA (in Sq. Km)

Years	Sacobia - Bamban Rivers	Abacan River
2	42.02	29.42
5	44.11	30.64
10	48.13	32.63
20	59.37	38.69
50	77.46	48.52
100	142.35	76.78

Flooding Area (2 years)
Flooding Area (5 years)
Flooding Area (10 years)
Flooding Area (20 years)
Flooding Area (50 years)
Flooding Area (100 years)

Figure H.69 Probable Inundation Area by Return Period

THE GOVERNMENT OF THE PHILIPPINES
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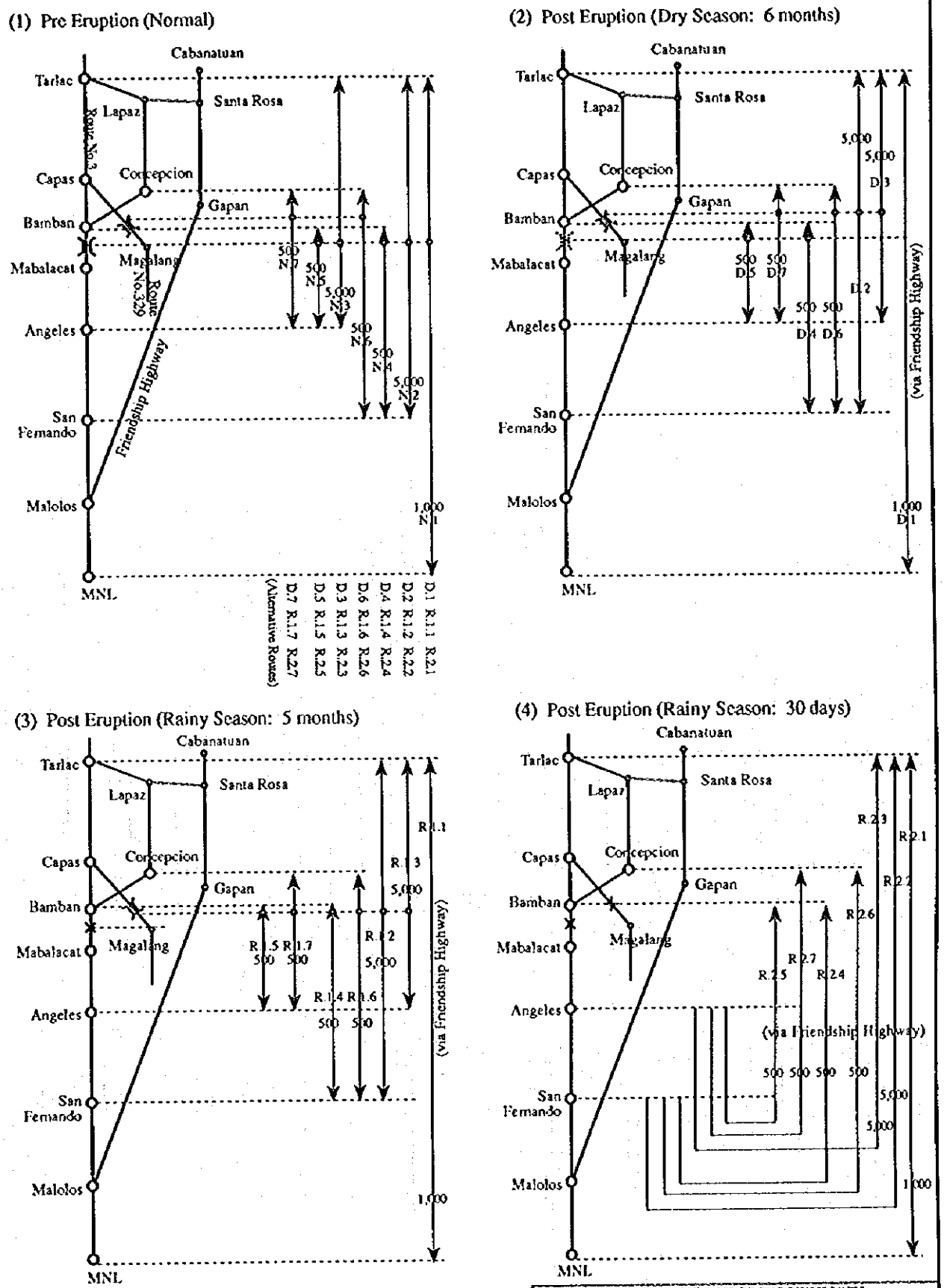

Figure H.70 Schematics of Detour Alternative Routes and Number of Vehicles

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
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JAPAN INTERNATIONAL COOPERATION AGENCY

APPENDIX J

ROAD NETWORK DEVELOPMENT

APPENDIX J

ROAD NETWORK DEVELOPMENT

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J.1 INTRODUCTION

1.1 TRANSPORT TARGETS IN CENTRAL LUZON

The Medium-Term Philippines Development Plan (1993 - 98) has established goals and objectives, policies and strategy, and priorities for the transportation sector to support the agro-industrialization thrust of the nation. The goals emphasize strengthening inter-regional and urban-rural linkages for all-weather flow of agro-industrial commodities as well as safe, efficient and responsive transport service.

Under these general policies, the Medium Term Plan for Central Luzon has set the following targets;

1) rehabilitation and reconstruction of 397 km of road infrastructures damaged during the Mt. Pinatubo calamity

2) development of the required access to and from identified priority investment areas, economic/production zones, and permanent resettlement sites

3) improvement and maintenance of four major trunk lines and their connecting laterals as well as the development of alternative roads for the trunk lines

4) pavement of 156 km of national roads to attain 90% paved surfacing

5) improving all the bridges along national roads into more permanent structures

1.2 TRAFFIC FLOW

The Sacobia-Bamban river basin constitutes a strategic point for the transportation connecting the Northern Luzon and the Metro Manila. The present traffic in the Central Luzon is estimated as shown in Figure J.1. Two main arteries can be observed running northwards from Metro Manila through the Region: one is the Manila North Road (Route 3 or Mac-Arthur Highway) and North Luzon Expressway which join together at Mabalacat and run further northwards through Bamban, Capas and Tarlac; another is the Philippine Friendship Highway running from Bulacan northwards through Sta.Rosa.

According to a spot traffic survey conducted by the JICA/DPWH in August 1994 at the San Francisco bridge on the Route No.329 (Ninoy Aquino Byway), the total traffic was counted at about 8,000 vehicles in the daytime of 12 hours and 13,000 for 24 hours. The survey was also conducted in July 1995 as well as the data collection of traffic volume data in the North Luzon Expressway. The results show that 13,000 vehicles for 24 hours pass the San Francisco Bridge and 8,000 vehicles pass through North Luzon Expressway of which about 60 % vehicles comes from Metro Manila.

Judging from the above data, most of the traffic that has passed over the Bamban Bridge when it was passable seems to take the route crossing the San Francisco Bridge on the Route No.329. The importance of the San Francisco Bridge is accordingly increasing until the Route 3 is restored. However, the clearance of the San Francisco Bridge is reduced from 90 cm in June 1995 to 72 cm in October 1995. The DPWH commenced the construction works for new San Francisco Bridge in October 1995 under the ADB fund.

During the dry season, some trucks and buses cross the Bamban River running in the shallow river water. According to the traffic survey of DPWH in November 1994, about 3,000 vehicles crossed the shallow Bamban River. During the rainy season, access roads to the San Francisco Bridge become inundated when a typhoon hits the area. In such cases, no vehicles can cross the Bamban River and all the vehicles going northwards are forced to detour through the Friendship Highway.

J.2 EXTENSION OF NORTH LUZON EXPRESSWAY

2.1 GENERAL

The Project is introduced in the "Integrated Plan for the Mt.Pinatubo-Affected Areas" (MPC,1994). It aims to improve the capacity of the existing North Luzon Expressway and to provide a direct access route to Clark Special Economic Zone and the provinces of Tarlac and Pangasinan.

The Base Conversion and Development Authority (BCDA) designates the Clark Special Economic Zone as the future site for a premier international airport. Recently, the President agreed on the parallel development of the Clark International Airport and the new international terminal building at the Ninoy Aquino International Airport (NAIA).

In the Central Luzon Regional Development Study (JICA, 1995) also gives the priority of the extension of North Luzon Expressway acrossing the Sacobia-Bamban River including a direct access to Clark.

2.2 ROUTE SELECTION

This Project is organized into four (4) segments; these area, (i) Segment-1: Balintawak to Tabang (25 km), (ii) Segment-2: Burol to Sta. Ines (55 km), (iii) Segment-3: Dau to Bamban (10 km) and (iv) Segment-4 : Bamban to Rosales (82 km).

Among the segments, the segment-3 would traverse directly in the Study Area. An alternative route between Dau and Bamban is, therefore, delineated preliminarily taking into account the future development plan of Clark Special Economic Zone as shown in Figure J.2. and Table J.1.

1) Alternative-1 : Extension from Dau through Clark Special Economic Zone

   An alternative route given the priority of accessibility to Clark International Airport. The expressway bifurcates at Dau to Clark and extends to north to Tarlac. The alternative involves the construction of a 400-m bridge across the Sacobia River and a 300-m bridge across the Bamban River.

2) Alternative-2 : Extension of Existing North Luzon Expressway

   An alternative route given the priority of present alignment of the North Luzon Expressway. The expressway extends to north to Tarlac. The alternative also involves the construction of a 300-m bridge across the Sacobia River and a 300-m bridge across the Bamban River. The interchange is planned at Dau for the access to the Clark.

3) Alternative-3 : Extension from Dau to North

An alternative route given the priority of shortest alignment between Dau and Tarlac. The expressway bifurcates at Dau and extends to north to Tarlac. The alternative also involves the construction of a 800-m bridge across the Bamban River. The interchange is also planned at Dau for the access to the Clark.

Table J.1. shows that the construction cost of Alternative-1 is estimated at two times that of Alternative-2.

J.3 RECONSTRUCTION OF FRIENDSHIP BRIDGE

3.1 GENERAL

Friendship Bridge located at the confluence between Taug and Sapangbato rivers was constructed in 1968. Immediately after the eruption of Mt.Pinatubo in 1991, the left approach to Friendship Bridge had badly eroded by lahar. However, the piers and girders of the bridge still remained at original position. The DPWH then embanked lahar material at left approach road to the bridge and sabo dam No.9 was constructed to protect the foundation of the bridge in 1992. However, the left bank dike of sabo dam No.9 was washed out in spite of continuous rehabilitation works by the DPWH in 1995, so that the surface of sediment deposits in the storage of sabo dam No.9 forms rather steep gradient and the piers were exposed above the surface of sediment deposits.

3.2 SELECTION OF BRIDGE LOCATION

In this Study, the existing Friendship Bridge is planned to be protected by the permanet structure, reconstruction plan of Sabo Dam No.9. But the existing bridge is shaken and made a noise by the heavy traffic at the site for incomplete construction of transverse stress, besides, is kept the insufficient span length for the Japanese Structural Standard. Therefore, the selection of bridge location is studied preliminarily taking into account the future development plan of Friendship Bridge as shown in Figure J.3. and Table J.2.

1) Alternative-1 : Access route to the area between Sapng Bato River and Taug River

An alternative route given the priority of accessibility from the Clark Air Base to the area between the Sapang Bato River and the Taug River, and of keeping the new bridge in safety from the malinfluence of two direction turbulent flow of the Sapang Bato River and the Taug River. But the construction cost is the highest and additional land acquisition is the largest.

2) Alternative-2 : Shifted route to the upstream side of the existing Friendship Bridge

An alternative route given the priority of avoiding the existing Friendship Bridge and the shortest bridge across the Abacan River. But it is difficult to avoid the malinfluence of two direction turbulent flow of the Sapang Bato River and the Taug River.

3) Alternative-3 : Reconstruction at the same location of the existing Friendship Bridge

An alternative route given the priority of lowest cost and minimum additional land acquisition. But it is difficult to avoid the malinfluence of two direction turbulent flow of the Sapang Bato River and the Taug River and the existing Friendship Bridge will be disturbed the construction works of the new bridge.

Table J.2. shows that the construction cost of Alternative-1 is estimated at two times that of Alternative-3 approximately.