Table M-11 Monthly & Annual Rainfall Observed at the Hacienda Luisita in mm.

1968		1969		1970		1971		1972	
D(1)=	12.7	D(1)=	0.0	D(1)=	6.1	D(1)=	2.3	D(1)=	21.1
D(2)=	1.5	D(2)=	1.0	D(2)=	0.0	D(2)=	0.3	D(2)=	0.3
D(3)=	9.9	D(3)=	0.5	D(3)=	5.9	D(3)=	19.5	D(3)=	47.2
D(4)=	33.3	D(4)=	2.3	D(4)=	105.7	D(4)=	28.3	D(4)=	229.2
D(5)=	243.2	D(5)=	209.3	D(5)=	65.6	D(5)=	250.5	D(5)=	162.6
D(6)=	223.9	D(6)=	100.0	D(6)=	319.6	D(6)=	267.3	D(6)=	290.9
D(7)=	255.4	D(7)=	319.0	D(7)=	217.8	D(7)=	243.1	D(7)=	1589.2
D(8)=	637.9	D(8)=	305.0	D(8)=	582.8	D(8)=	81.4	D(8)=	723.4
D(9)=	283.2	D(9)=	251.0	D(9)=	401.4	D(9)=	365.0	D(9)=	313.6
D(10)=	45.1	D(10)=	199.0	D(10)=	154.8	D(10)=	335.3	D(10)=	15.5
D(11)=	32.5	D(11)=	51.4	D(11)=	38.0	D(11)=	180.2	D(11)=	44.7
D(12)=	0.0	D(12)=	19.0	D(12)=	28.9	D(12)=	106.5	D(12)=	18.3
SUM X=	1778.6	SUM X=	1457.5	SUM X=	1926.6	SUM X=	1879.7	SUM X=	3456.

1973		1974		1975		1976		1977	
D(1)=	0.8	D(1)=	10.5	D(1)=	21.8	D(1)=	22.9	D(1)=	23.4
D(2)=	1.0	D(2)=	7.2	D(2)=	1.3	D(2)=	9.6	D(2)=	0.0
D(3)=	1.8	D(3)=	3.8	D(3)=	11.8	D(3)=	1.0	D(3)=	15.0
D(4)=	59.0	D(4)=	196.3	D(4)=	11.4	D(4)=	55.4	D(4)=	10.9
D(5)=	130.0	D(5)=	87.9	D(5)=	244.0	D(5)=	784.6	D(5)=	151.5
D(6)=	131.1	D(6)=	115.7	D(6)=	138.7	D(6)=	720.1	D(6)=	215.0
D(7)=	142.9	D(7)=	276.2	D(7)=	219.2	D(7)=	146.6	D(7)=	425.8
D(8)=	260.8	D(8)=	716.9	D(8)=	259.8	D(8)=	274.4	D(8)=	297.2
D(9)=	81.6	D(9)=	259.0	D(9)=	268.0	D(9)=	493.1	D(9)=	328.1
D(10)=	397.9	D(10)=	323.2	D(10)=	254.4	D(10)=	13.3	D(10)=	2.2
D(11)=	85.2	D(11)=	198.4	D(11)=	10.7	D(11)=	1.3	D(11)=	240.4
D(12)=	0.3	D(12)=	46.8	D(12)=	71.8	D(12)=	4.4	D(12)=	0.0
SUM X=	1292.4	SUM X=	2241.9	SUM X=	1512.9	SUM X=	2526.7	SUM X=	1709.5

1978		1979		1980		1981		1982	
D(1)=	3.0	D(1)=	14.0	D(1)=	0.0	D(1)=	1.6	D(1)=	0.0
D(2)=	1.8	D(2)=	0.3	D(2)=	0.0	D(2)=	0.0	D(2)=	0.0
D(3)=	0.8	D(3)=	0.0	D(3)=	16.0	D(3)=	15.5	D(3)=	62.8
D(4)=	20.8	D(4)=	94.8	D(4)=	2.3	D(4)=	1.3	D(4)=	49.5
D(5)=	121.1	D(5)=	150.8	D(5)=	132.6	D(5)=	130.1	D(5)=	58.9
D(6)=	170.9	D(6)=	101.4	D(6)=	25.9	D(6)=	366.2	D(6)=	224.2
D(7)=	347.3	D(7)=	268.0	D(7)=	464.2	D(7)=	413.7	D(7)=	413.5
D(8)=	616.8	D(8)=	498.9	D(8)=	250.2	D(8)=	340.4	D(8)=	244.7
D(9)=	308.7	D(9)=	234.5	D(9)=	425.8	D(9)=	180.9	D(9)=	366.5
D(10)=	379.6	D(10)=	40.8	D(10)=	178.8	D(10)=	136.1	D(10)=	97.9
D(11)=	31.6	D(11)=	77.5	D(11)=	239.7	D(11)=	62.4	D(11)=	36.6
D(12)=	40.7	D(12)=	27.4	D(12)=	13.3	D(12)=	17.2	D(12)=	4.9
SUM X=	2042.3	SUM X=	1508.4	SUM X=	1748.8	SUM X=	1665.4	SUM X=	1559.5

1983		1984		1985		1986		1987	
D(1)=	54.6	D(1)=	29.4	D(1)=	0.0	D(1)=	22.1	D(1)=	6.6
D(2)=	1.1	D(2)=	20.3	D(2)=	3.6	D(2)=	25.8	D(2)=	0.0
D(3)=	1.8	D(3)=	35.0	D(3)=	4.4	D(3)=	27.7	D(3)=	0.0
D(4)=	7.9	D(4)=	94.7	D(4)=	96.9	D(4)=	2.0	D(4)=	25.2
D(5)=	95.4	D(5)=	256.3	D(5)=	71.3	D(5)=	136.5	D(5)=	163.6
D(6)=	78.2	D(6)=	344.5	D(6)=	625.8	D(6)=	200.7	D(6)=	223.7
D(7)=	265.7	D(7)=	239.6	D(7)=	244.8	D(7)=	499.4	D(7)=	182.1
D(8)=	432.5	D(8)=	504.2	D(8)=	308.7	D(8)=	369.5	D(8)=	417.2
D(9)=	137.7	D(9)=	244.6	D(9)=	275.0	D(9)=	300.9	D(9)=	228.9
D(10)=	248.7	D(10)=	433.8	D(10)=	186.9	D(10)=	253.6	D(10)=	186.4
D(11)=	24.1	D(11)=	5.6	D(11)=	43.5	D(11)=	138.2	D(11)=	38.6
D(12)=	0.0	D(12)=	0.3	D(12)=	21.2	D(12)=	25.6	D(12)=	25.4
SUM X=	1347.7	SUM X=	2208.3	SUM X=	1881.3	SUM X=	2082.	SUM X=	1417.7

Note: D(1): January,D(2):February,D(3):March,D(4):April,D(5):May, ...D(12):December.
Sum X : Annual Rainfall.

Table M-12 Monthly rainfall Hacienda Luisita

Monthly	Rainfall in the Period					
	Mean	S.D.	SKEW	11th order T=2 50%	7th order T=3.1 68%	5th order T=5.5 82%
n=21	mm	mm		mm	mm	mm
Jan.	12.5	13.6	1.41	9.4	2.3	0.8
Feb.	4.4	7.6	1.76	1.0	0.3	0
Mar.	13.3	17.1	1.55	5.9	1.8	0.5
Apr.	56.4	62.6	1.46	33.3	11.4	7.9
May	185.1	151.4	3.01	150.8	130.0	95.4
Jun	242.3	169.3	1.48	215.0	138.7	115.7
Jul.	358.8	299.3	3.40	268.0	243.1	219.2
Aug.	402.5	173.8	0.41	340.4	297.2	260.8
Sep.	295.1	100.5	-0.01	283.2	251.0	234.5
Oct.	189.3	132.2	0.26	178.8	106.4	45.1
Nov.	82.1	80.8	1.27	44.7	36.6	31.6
Dec.	22.5	26.7	1.72	18.3	4.4	0.3
Annual n=20	1,858.2	496.0	1.68	1,778.6	1,559.5	1,508.4

Note : T means the retern period, Percentage means the dependability

Table M- 13 10-day (decade) Rainfall and Effective Rainfall for Paddy Cultivation at the Hacienda Luisita (27° N,120° 38'E) (1)

unit : mm

		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	n	Mean
Jan	1		0	0	5.6	0.3	1.3	0.8	0	0	22.9	22.6	0	0.8	0	1.6	0	44.2	29.4	0	0	6.6	5.6	21	6.7
	2		0	0	0.5	0	0	0	0	3.3	0	0	3.0	0	0	0	9.9	0	0	0	0	0.8	21	0.8	
	3		12.7	0	0	2	19.8	0	10.5	18.5	0	0.8	0	13.2	0	0	0	0.5	0	0	22.1	0	3.0	21	4.9
	T		12.7	0	6.1	2.3	21.1	0.8	10.5	21.8	22.9	23.4	3.0	14.0	0	1.6	0	54.6	29.4	0	22.1	6.6	9.4	21	12.5
Feb.	1		1.5	1.0	0	0.3	0	1.0	3.6	0	1.5	0	0.3	0	0	0	0	0	20.3	3.6	23.3	0	0	21	2.7
	2		0	0	0	0	0.3	0	0	1.3	0	0	0	0.3	0	0	0	0.8	0	0	0	0	17.5	21	1.0
	3		0	0	0	0	0	0	3.6	0	8.1	0	1.5	0	0	0	0	0.3	0	0	2.5	0	0	21	0.8
	T		1.5	1.0	0	0.3	0.3	1.0	7.2	1.3	9.6	0	1.8	0.3	0	0	0	1.1	20.3	3.6	25.8	0	17.5	21	4.4
Mar.	1		9.9	0	0	0	0.3	0	3.8	0	0	11.7	0	0	0	0	0	0.5	5.1	0	0	0	0	21	1.5
	2		0	0.5	0	5.3	20.3	0	0	0	1.0	0	0	0	0	15.5	0	1.3	29.9	0	0	0	0	21	3.5
	3		0	0	5.9	14.2	26.6	1.8	0	11.8	0	3.3	0	0	16.0	0	62.8	0	0	4.4	27.7	0	0	21	8.3
	T		9.9	0.5	5.9	19.5	47.2	1.8	3.8	11.8	1.0	15.0	0	0	16.0	15.5	62.8	1.8	35.0	4.4	27.7	0	0	21	13.3
Apr.	1		0	2.0	5.1	0	33.8	0	0	8.2	55.4	0	0	0.3	0	0	32.3	3.3	15.7	17.3	2.0	4.6	53.7	21	11.1
	2		0	0.3	0	1.3	5.6	8.9	27.5	0	0	0	5.3	94.5	1.3	1.3	5.0	0	17.1	23.7	0	20.6	3.6	21	10.3
	3		33.3	0	100.6	27.0	189.8	50.1	168.8	3.3	0	10.9	15.5	0	1.0	0	12.2	4.6	62.1	55.9	0	0	0.3	21	35.0
	T		33.3	2.3	105.7	28.3	229.2	59.0	196.3	11.4	55.4	10.9	20.8	94.8	2.3	1.3	49.5	7.9	94.7	96.9	2.0	25.2	57.6	21	56.4

Table M- 13 10-day (decade) Rainfall and Effective Rainfall for Paddy Cultivation at the Hacienda Luisita (27° N,120° 38'E) (2)

unit : mm

			1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	n	Mean
May	1			59.8	45.2	4.8	97.8	15.6	57.0	46.3	21.6	31.3	0	0	0	0.8	0	7.4	0	95.1	18.3	55.4	63.8	61.2	21	32.4
				41.2	36.1	0	77.6	8.2	42.7	36.0	14.6	23.8	0	0	0	0	0	3.7	0	72.3	9.4	40.9	51.0	46.6		24.0
	2			58.6	106.4	59.5	90.4	110.1	45.0	1.3	23.4	78.9	39.5	1.8	101.8	29.3	75.7	7.6	50.7	82.7	0.3	18.3	60.6	30.6	21	51.1
				43.4	80.2	45.5	67.0	87.0	35.0	0	15.4	62.5	27.6	0	81.4	22.6	56.2	6.1	36.6	55.8	0	10.2	45.0	23.2		38.1
	3			124.8	57.6	1.3	62.3	36.9	28.0	40.3	199.0	674.2	112.0	119.3	49.0	102.5	54.4	43.9	44.7	78.5	52.7	62.8	39.2	150.0	20	73.0
				94.1	45.3	0	49.2	23.2	17.3	22.3	153.0	240.0	84.6	93.8	35.0	80.0	40.2	34.7	33.1	62.2	42.1	41.2	13.8	112.8	21	62.8
	T			243.2	209.3	65.6	250.5	162.6	130.0	87.9	244.0	784.6	151.5	121.1	150.8	132.6	130.1	58.9	95.4	256.3	71.3	136.5	163.6	241.8	21	185.1
Jun.	1	1		142.5	24.5	146.1	50.6	153.9	71.5	19.8	25.8	30.0	36.3	48.3	46.2	0.8	124.0	41.2	51.1	70.1	33.5	71.1	16.9	114.4	21	62.8
				111.4	14.0	113.9	32.3	115.6	55.5	4.9	16.9	23.4	29.0	35.4	35.9	0	97.5	32.2	40.2	53.7	20.3	53.4	9.5	84.1		46.6
	2	1		37.8	62.3	138.9	117.9	27.7	52.7	44.7	38.1	140.3	109.3	51.5	4.9	7.1	178.5	109.8	5.6	118.7	65.2	104.2	123.7	16.3	21	74.1
				24.1	44.5	106.5	91.0	21.7	30.6	23.4	21.2	106.6	84.6	35.6	0	5.3	133.6	77.4	0	87.2	46.7	78.7	95.7	6.1		53.4
	3	3		43.6	13.2	34.6	98.8	109.3	6.9	51.2	74.8	549.7	69.4	71.1	50.3	18.0	63.7	73.2	21.5	155.7	527.1	25.4	83.1	73.2	19	59.8
				30.4	6.1	24.0	65.8	82.1	4.1	33.8	55.9	240.0	51.4	52.1	36.6	5.3	51.0	50.8	14.8	121.5	240.0	16.2	56.2	55.3	21	61.6
	T			223.9	100.0	319.6	267.3	290.9	131.1	115.7	138.7	720.1	215.0	170.9	101.4	25.9	366.2	224.2	78.2	344.5	625.8	200.7	223.7	203.9	21	242.3
Jul.	1	4		65.2	29.6	53.6	92.0	466.5	19.6	26.7	24.9	28.7	125.5	125.9	65.3	124.8	156.1	146.2	30.9	103.8	152.3	310.2	61.1	102.4	20	92.2
				46.5	9.8	40.9	59.0	240.0	8.2	20.3	12.8	19.3	90.9	97.8	44.4	94.7	115.3	114.9	22.7	78.2	119.4	162.4	46.1	78.9	21	72.5
	2	Σ15 6		48.0	104.5	61.8	105.6	569.1	66.8	129.6	19.1	18.6	97.8	126.7	77.2	126.8	149.1	148.6	180.2	17.6	65.3	81.0	55.3	93.8	20	88.7
				31.9	82.6	44.0	82.2	240.0	48.8	96.7	8.2	10.8	72.2	95.7	52.8	100.8	111.4	112.2	143.1	13.0	50.6	57.7	39.2	71.4	21	74.5
	3	5		142.2	184.9	102.4	45.5	613.6	56.5	119.9	175.4	99.3	202.5	94.7	125.5	212.6	108.5	118.7	54.6	118.2	26.4	108.2	65.7	166.8	20	116.4
				109.7	143.7	68.6	34.3	240.0	33.9	78.4	129.9	70.9	162.0	67.4	95.1	167.0	100.8	88.0	41.8	90.6	18.1	83.9	43.4	123.7	21	94.8
	T			255.4	319.0	217.8	243.1	1,589.2	142.9	276.2	219.2	146.6	425.8	347.3	268.0	464.2	413.7	413.5	265.7	239.6	244.0	499.4	182.1	363.0	21	358.8

Table M- 13 10-day (decade) Rainfall and Effective Rainfall for Paddy Cultivation at the Hacienda Luisita (27° N,120° 38'E) (3)

unit : mm

		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	n	Mean
Aug	1	73.0	159.8	235.7	124.7	64.5	326.8	38.7	113.6	108.2	164.8	108.0	127.2	185.2	15.5	93.1	121.8	79.4	128.0	88.9	51.8	38.9			116.6
		58.4	123.3	187.5	95.5	47.4	240.0	29.0	89.8	79.0	111.6	85.1	96.3	138.1	5.7	72.6	90.8	58.8	93.3	64.8	35.0	29.4		21	87.2
	2	179.3	71.6	42.2	172.2	14.0	242.3	80.4	538.7	80.3	32.4	97.6	201.8	280.9	139.2	197.1	40.2	306.8	125.3	176.2	55.1	323.4		20	142.9
		139.4	53.2	27.3	127.4	6.1	185.5	61.5	240.0	58.6	13.4	76.8	156.4	146.5	106.2	154.8	25.7	240.0	96.6	133.9	34.0	132.9		21	105.5
	3	77.9	406.5	27.1	285.9	2.9	154.3	141.7	64.6	72.2	77.2	91.6	287.8	32.8	95.5	50.2	82.7	46.3	250.9	43.6	262.6	54.9		20	110.2
		56.9	237.9	17.8	83.5	0	115.1	110.1	47.4	55.4	56.9	68.3	214.4	25.8	67.6	36.8	58.1	33.5	182.4	28.1	208.6	37.8		21	83.0
	T	330.2	637.9	305.0	582.8	81.4	723.4	260.8	716.9	259.8	274.4	297.2	616.8	498.9	250.2	340.4	244.7	432.5	504.2	308.7	369.5	417.2		21	402.5
Sep	1	165.4	56.1	103.6	167.7	95.6	168.8	17.7	119.4	70.9	164.9	131.8	88.9	39.6	126.0	44.0	163.3	34.8	132.5	169.7	171.3	83.1		21	110.2
		111.9	39.0	75.4	127.0	71.9	128.0	10.0	92.5	50.0	130.6	102.4	68.0	26.0	95.0	32.6	124.2	24.8	101.8	129.8	133.4	54.9			82.3
	2	90.3	108.4	84.4	140.7	146.8	47.8	35.9	55.7	92.2	233.4	102.3	100.1	182.8	201.8	18.0	53.6	10.4	74.8	21.9	84.1	121.6		21	95.6
		66.4	79.8	64.4	85.1	89.8	29.9	20.2	41.4	72.6	181.8	93.9	77.6	141.4	158.8	10.8	39.0	7.9	57.0	9.1	67.3	118.8			72.0
	3	194.8	118.7	63.0	93.0	122.6	97.0	28.0	83.9	104.9	94.8	94.0	119.7	12.1	98.0	118.9	149.6	92.5	37.3	83.4	45.5	24.2		21	89.3
		155.8	85.8	41.4	69.1	94.6	68.2	19.5	64.5	81.3	75.2	73.5	89.8	7.3	73.4	88.2	116.2	66.8	27.6	60.7	31.7	17.7			67.1
	T	450.5	283.2	251.0	401.4	365.0	313.6	81.6	259.0	268.0	493.1	328.1	308.7	234.5	425.8	180.9	366.5	137.7	244.6	275.0	300.9	228.9		21	295.1
Oct.	1	76.2	6.1	77.4	18.5	215.3	15.5	131.5	54.9	6.9	6.9	0.3	171.1	31.9	20.8	34.5	19.0	167.2	78.5	2.0	160.9	59.2		21	64.5
		60.3	4.2	56.6	9.8	170.4	10.2	103.4	41.5	0	0	0	131.6	25.5	12.8	26.8	9.0	130.6	55.4	0	117.8	46.6			48.2
	2	66.0	39.0	121.1	89.4	112.3	0	266.4	156.2	148.1	0.3	0.3	45.9	6.9	42.4	6.1	76.6	35.3	20.2	157.4	88.4	39.4		21	72.3
		47.9	27.9	96.2	65.0	89.8	0	110.9	123.5	109.5	0	0	33.5	5.5	32.0	0	52.2	23.5	13.2	89.6	67.3	31.3			48.5
	3	29.4	0	0.5	46.9	7.7	0	0	112.1	99.4	6.1	1.6	162.6	2.0	115.5	95.5	2.3	46.2	335.1	27.5	4.3	7.8		21.	52.5
		21.9	0	0	31.0	0	0	0	88.2	71.8	0	0	128.2	0	79.3	64.0	0	29.3	227.2	16.5	0	0			36.1
	T	171.6	45.1	199.0	154.8	335.3	15.5	397.9	323.2	254.4	13.3	2.2	379.6	40.8	178.8	136.1	97.9	248.7	433.8	186.9	253.6	106.4		21	189.2

Table M- 13 10-day (decade) Rainfall and Effective Rainfall for Paddy Cultivation at the Hacienda Luisita (27° N,120° 38'E) (4)

unit : mm

		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	n	Mean
Nov.	1	93.9	0	0	11.5	15.0	44.7	2.5	95.5	9.9	0	0	4.1	35.0	214.3	1.3	23.9	24.1	3.8	1.0	69.6	0		21	31.0
	2	0	0	19.1	16.8	36.3	0	6.1	34.0	0	1.3	290.4	19.1	39.2	25.4	18.2	12.7	0	0	15.8	68.6	20.3		21	27.3
	3	0	32.5	32.3	9.7	128.9	0	76.6	68.9	0.8	0	0	8.4	3.3	0	42.9	0	0	1.8	26.7	0	18.3		21	21.5
	T	93.9	32.5	51.4	38.0	180.2	44.7	85.2	198.4	10.7	1.3	240.4	31.6	77.5	239.7	62.4	36.6	24.1	5.6	43.5	138.2	38.6		21	81.1
Dec.	1	0	0	9.1	5.1	20.8	14.0	0.3	12.0	6.6	3.1	0	1.8	0	1.8	0	0.5	0	0	20.4	2.5	0.3		21	4.7
	2	1.3	0	9.9	23.8	1.8	4.3	0	33.5	37.9	0	0	12.2	0	11.5	0	1.3	0	0	0	0	0		21	6.5
	3	0	0	0	0	83.9	0	0	1.3	27.3	1.3	0	26.7	27.4	0	17.2	3.1	0	0.3	0.8	23.1	25.1		21	11.3
	T	1.3	0	19.0	28.9	106.5	18.3	0.3	46.8	71.8	4.4	0	40.7	27.4	13.3	17.2	4.9	0	0.3	21.2	25.6	25.4		21	22.5
Annual T		1,778.6		1,926.6		3,456.0		2,241.9		2,526.7		2,042.3		1,748.8		1,559.5		2,208.3		2,002.0				21	1,858.2
			1,457.5		1,879.7		1,292.4		1,512.9		1,709.5		1,508.4		1,665.4		1,347.7		1,881.3		1,417.7				

Note 1. For May thru October, the upper line value is of 10-day rainfall and the lower line is of the effective rainfall.
2. For the other month, the line value is of 10-day rainfall.

Table M-14 Analysis on 10-day (Decade) rainfall, effective rainfall and designed effective rainfall
on paddy field (Hacienda Luisita)

Items		Rainfall in the Period						Effective Rainfall in the Period for Paddy							
		Mean	S.D.	SKEW	11th order T=2 50%	7th order T=3.1 68%	5th order T=5.5 82%	Mean	S.D.	SKEW	11th order T=2 50%	7th order T=3.1 68%	5th order T=5.5 82%	Designed Effective Rainfall mm	
n=20 Vegetation		mm	mm		mm	mm	mm	mm	mm		mm	mm	mm	Land Preparation	Crop
Apr.	1	11.1	17.6	1.56	2.0	0	0	-	-	-	-	-	-	-	-
	2	10.3	21.1	3.15	1.3	0	0	-	-	-	-	-	-	-	-
	3	35.0	55.1	1.79	10.9	0.3	0	-	-	-	-	-	-	-	-
May	1	32.4	31.2	0.58	4.8	21.6	0	24.0	25.2	0.64	14.6	0	0	22	0
	2	51.1	35.7	0.11	50.7	29.3	18.3	38.1	27.1	0.19	36.6	22.8	10.2	30	23
	3	73.0	47.7	1.03	57.6	44.7	40.3	62.8	55.1	1.73	42.1	34.7	23.2	45	35
Jun.	1	62.8	46.2	0.80	48.3	33.5	25.8	46.6	36.8	0.76	35.4	23.4	16.9	34	24
	2	74.1	51.7	0.26	62.3	38.1	27.7	53.4	41.0	0.28	44.5	23.4	21.2	39	24
	3	59.8	37.2	0.69	69.4	43.6	25.4	61.6	65.5	1.91	51.0	30.4	16.2	44	31
Jul.	1	92.2	69.4	1.46	92.0	53.6	29.6	72.5	56.7	1.17	59.0	40.9	20.3	54	41
	2	88.7	46.1	0.11	93.8	65.3	55.3	74.5	52.4	1.39	71.4	48.8	39.2	66	49
	3	116.4	52.5	0.19	118.2	99.3	65.7	94.8	53.2	0.89	88.0	68.6	43.4	100	69
Aug.	1	116.5	71.3	1.24	108.2	79.4	64.5	87.2	53.9	1.14	85.1	58.8	47.4	80	59
	2	142.9	94.7	0.44	139.2	80.3	55.1	105.5	69.4	0.35	106.2	58.6	34.0	81	59
	3	110.2	88.0	1.00	77.9	54.9	46.3	83.0	69.7	1.09	56.9	37.8	33.5	55	38
Sep.	1	110.2	51.8	-0.28	119.4	83.1	56.1	82.3	40.7	-0.26	92.5	54.9	39.0	84	55
	2	95.6	60.0	0.64	90.3	55.7	47.8	72.0	48.1	0.63	67.3	41.4	29.9	56	42
	3	89.3	43.8	0.18	94.0	83.4	45.5	67.1	35.0	0.36	69.1	60.7	31.7	84	61
Oct.	1	64.5	66.2	0.93	34.5	18.5	6.9	48.2	52.3	0.94	26.8	9.8	4.2	19	10
	2	72.3	68.7	1.10	45.9	35.3	6.9	48.5	41.2	0.38	33.5	23.5	5.5	36	24
	3	52.5	79.2	2.16	7.8	2.3	1.6	36.1	57.7	1.96	0	0	0	0	0
Nov.	1	31.0	51.7	2.33	9.9	1.3	0	-	-	-	-	-	-	-	-
	2	27.3	51.8	3.45	16.8	1.3	0	-	-	-	-	-	-	-	-
	3	21.5	33.7	1.86	3.3	0	0	-	-	-	-	-	-	-	-

Note : T means the retern period, Percentage means the dependability

Table M-15 Evaporation Analysis on Pan Evaporation observed at the Hacienda Luisita Station (1967-1983) in mm

(1) Obseved Data

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1967	154.0	196.0	247.0	232.5	250.0	121.5	147.5	107.5	127.5	147.5	132.0	174.0	2,037.0
1968	159.4	171.5	240.9	241.2	157.1	131.0	114.2	85.1	99.8	156.2	159.5	152.7	1,868.6
1969	159.7	176.8	233.6	246.0	197.3	150.8	116.0	123.9	94.0	120.9	128.0	152.5	1,899.5
1970	151.6	167.8	218.5	208.0	204.7	120.0	111.0	76.9	111.4	111.6	115.7	121.4	1,718.6
1971	155.6	174.5	216.7	224.7	159.7	134.2	115.7	140.7	106.5	145.5	119.2	117.6	1,810.6
1972	128.8	151.0	194.7	195.6	169.3	141.5	69.9	79.8	128.9	145.2	141.6	135.7	1,682.0
1973	160.9	161.8	222.6	247.4	187.1	142.6	130.8	95.2	121.1	127.6	129.5	141.6	1,868.2
1974	156.6	168.0	209.0	220.3	166.6	128.5	155.2	87.2	115.5	96.3	116.6	118.2	1,738.0
1975	138.0	158.3	216.1	236.3	182.1	128.8	119.7	95.2	109.9	98.8	141.7	128.8	1,753.7
1976	162.1	174.9	227.0	214.8	119.0	106.0	127.2	92.7	64.8	118.0	152.7	135.8	1,695.0
1977	126.4	167.4	193.9	208.1	167.6	121.7	84.5	95.5	66.5	149.6	124.1	169.7	1,675.0
1978	162.4	159.2	205.2	212.0	178.3	100.1	83.6	55.3	72.0	78.9	122.8	156.2	1,586.0
1979	137.3	141.0	189.9	193.4	139.5	120.8	94.1	101.3	111.3	104.4	116.0	127.7	1,576.7
1980	132.5	154.5	184.2	210.4	170.7	161.0	108.3	87.7	118.7	101.5	110.9	113.7	1,654.1
1981	140.3	165.9	213.8	243.4	178.2	86.6	105.8	76.2	118.7	112.3	109.9	129.8	1,680.9
1982	150.8	154.6	198.3	196.6	169.2	110.9	78.2	73.2	76.2	113.8	131.2	117.3	1,543.3
1983	122.0	133.0	184.6	220.5	191.2	168.0	129.0	88.3	111.2	87.2	119.3	161.9	1,716.2

(2) Statistic Parameter

Mean	147.0	163.3	211.5	219.1	175.7	127.9	111.2	91.9	103.2	118.5	127.7	138.5	1,735.5
S.D.	13.8	14.6	19.1	21.2	28.1	21.1	22.9	19.7	21.0	23.4	14.2	19.4	128.0
SKEW.	-0.462	-0.022	0.211	-0.524	0.581	0.069	-0.004	0.735	-0.726	0.129	0.802	0.420	0.637
Daily Mean mm/day	4.7	5.8	6.8	7.3	5.7	4.3	3.6	2.9	3.4	3.8	4.3	4.5	4.8

(3) Probability of Exceedance (Weible)

50%	151.6	165.9	213.8	220.3	170.7	128.5	114.2	88.3	111.2	113.8	124.1	135.7	1,716.2
33%	156.6	168.0	218.5	232.5	182.1	134.2	119.7	95.2	115.5	127.6	131.2	152.5	1,753.7
17%	160.9	174.9	233.6	243.4	197.3	150.8	130.8	107.5	121.1	147.5	141.7	161.9	1,868.6

(4) Designed Pan Evaporation

Monthly mm	155	168	217	231	183	135	121	93	117	127	132	152	1,831
Daily mm/day	5.0	6.0	7.0	7.7	5.9	4.5	4.0	3.0	3.9	4.1	4.4	4.9	5.0

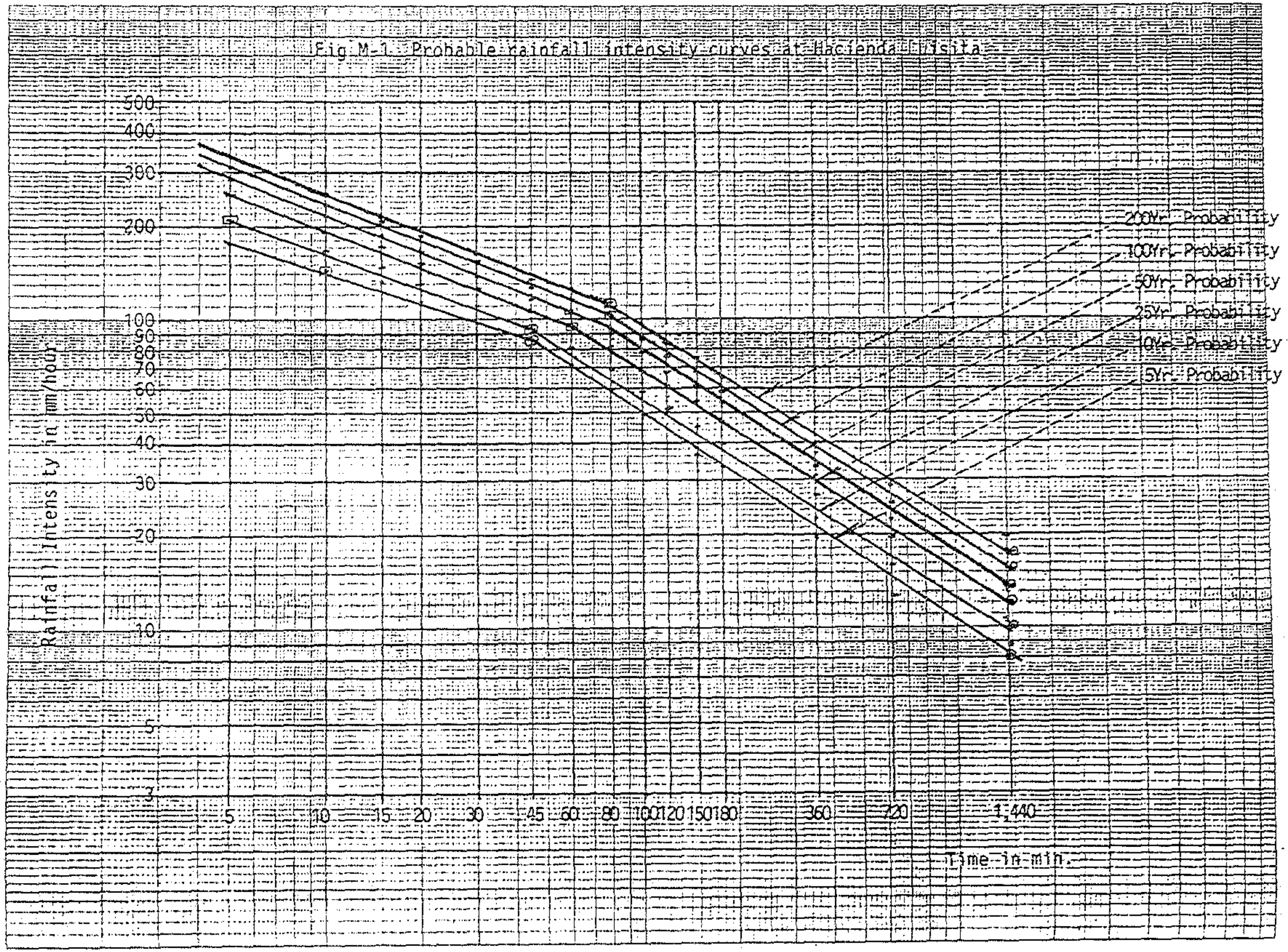

Fig M-1 Probable rainfall intensity curves at Hacienda Luisita

Technical Data :

2. Runoff Analysis

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The water resources for the irrigation plan are four tributaries of the Bulsa River ; Mangillog, Bulelatin, Pangasan and Balnges. Since discharge of these rivers has not been observed, the runoff was estimated as follows :

(1) Basic data

The catchment area and vegetation of each reservoir are as follows :

	Reservoir	Catchment Area (km^2)	Vegetation
1.	Mangillog	8.1	Paddy field about 50%, forestry about 50%
2.	Bulelatin	2.0	Paddy field about 20%, forestry about 80%
3.	Pangasan	12.9	Mostly forestry
4.	Balnges	27.9	Mostly forestry

Hydrological data are as follows :

	Data	Name of Station	Kind	Data Collection Period
1.	Rainfall	Hacienda Luisita	Daily rainfall	1968 - 1988
2.	Runoff	Bulsa River, Villa Aglipay	Daily discharge	1975 - 1984
3.	Evaporation	Hacienda Luisita	Monthly evaporation	1958 - 1983

Fig. H-1 shows the locations of the Stations.

(2) Selection of the analytical method

Two methods are available for analysis: a tank model method and a statistical method. The tank model method is an analytical method in which the non-linearity of the runoff for the rainfall is analogous to the runoff from the tank. On the other hand, the statistical method is to represent the relationship between the rainfall and runoff by means of a single or multiple regression method. In general, a single regression method is used to simplify the calculation.

Though the rainfall-runoff relationship as established by the statistical method can be applied to the analytical period with high reliability, if this relationship is to be applied to periods other than the analytical one, careful consideration to the following points is required.

i. Necessity of using large number of data in relation to the reliability required,

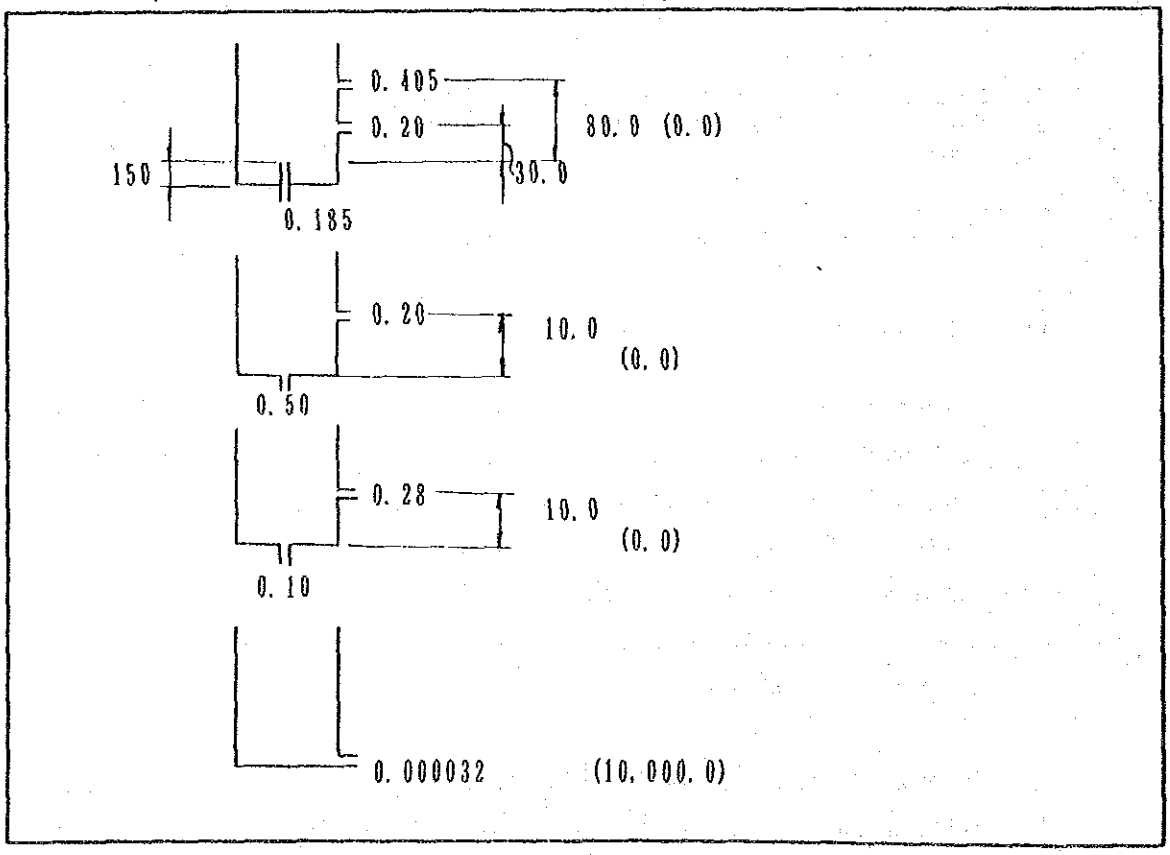
ii. Necessity of understanding whether data used are from the average, drought or plentiful rainfall year.

The tank model method is superior to the statistical method because the runoff characteristic in each year can be represented by one model regardless of the average, drought or plentiful rainfall year (though due attention should be paid on above points). Consequently, the tank model method was chosen for this analysis.

(3) Analytical result

Using the above basic data, the tank model could be identified as follows:

(Tank model of the Bulsa River, Villa Aglipay station)



Note: Figures in parentheses show the initial storage level.

The observed and calculated hydrographs are shown in Fig. H-2, which show relatively well agreement for both low and high level portions. The correlation coefficients between calculated and observed discharges are shown below, which have proved high correlation. The observed and calculated discharges are compared in Table H-1.

Correlation Coefficients (%)

Year	Daily	Half-decade
1975	73	84
1976	84	96
1977	64	49
1978	77	87
1979	82	86
1980	67	73
1981	57	71
1982	43	61
1983	71	82
1984	41	58

(4) Water resources

i. Pangasan and Balnges River

Since the vegetation of the basins of these rivers is nearly similar to that of the Bulsa River Basin, the runoff was estimated by multiplying the calculated runoff by the basin area ratio.

ii. Mangillog River

About 50% of the basin is paddy field, which is substantially different from that of the Bulsa River. The field surveys performed during the dry season also showed almost no base runoff. The water resources were estimated by subtracting the base flow from discharges obtained by multiplying the calculated runoff by the basin area ratio.

iii. Bulelatin River

Same as the Mangillog River, this river is located on the left bank of the Bulsa River. Since spring water was found at several points in the upstream area by the field surveys, the base flow was taken into account. Accordingly, the water resources were estimated by multiplying the calculated runoff by the basin area ratio.

On the basis of the above , the annual average water resources at the damsites were calculated below :

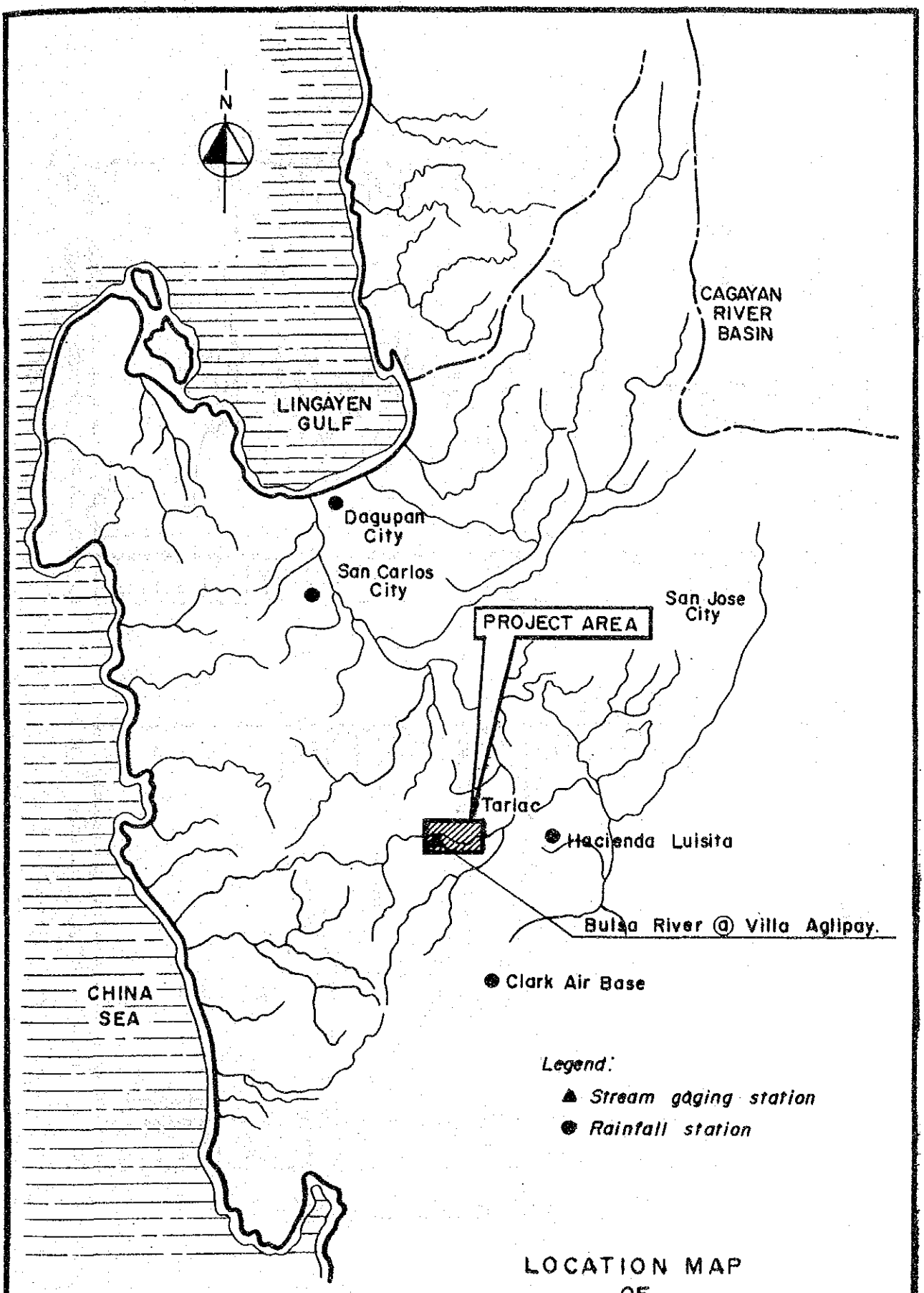
Table H-2

Annual Average Water Resources

Name of Reservoir	Drainage Area (km^2)	Water Resource (MCM)	
1. Mangillog	8.1	14.0	(1,728 mm)
2. Bulelatin	2.0	3.6	(1,800 mm)
3. Pangasan	12.9	23.3	(1,806 mm)
4. Balnges	27.9	50.4	(1,806 mm)
Total	50.9	91.3	

Note: 1) The calculation period is from 1968 to 1987.
2) Figures in parentheses are mean annual runoff in mm.

The distribution map of mean annual runoff (mm) on the Agno River Basin is indicated on Fig. H-3. This map was prepared by the former National Water Resources Council (NWRC). Mean annual runoff around the Project Area has been estimated at 1,700 mm to 1,800 mm based on the map. These figures correspond to the calculated water resources shown in Table H-2.



LOCATION MAP
OF
HYDRO-MET STATION

Fig. H-1

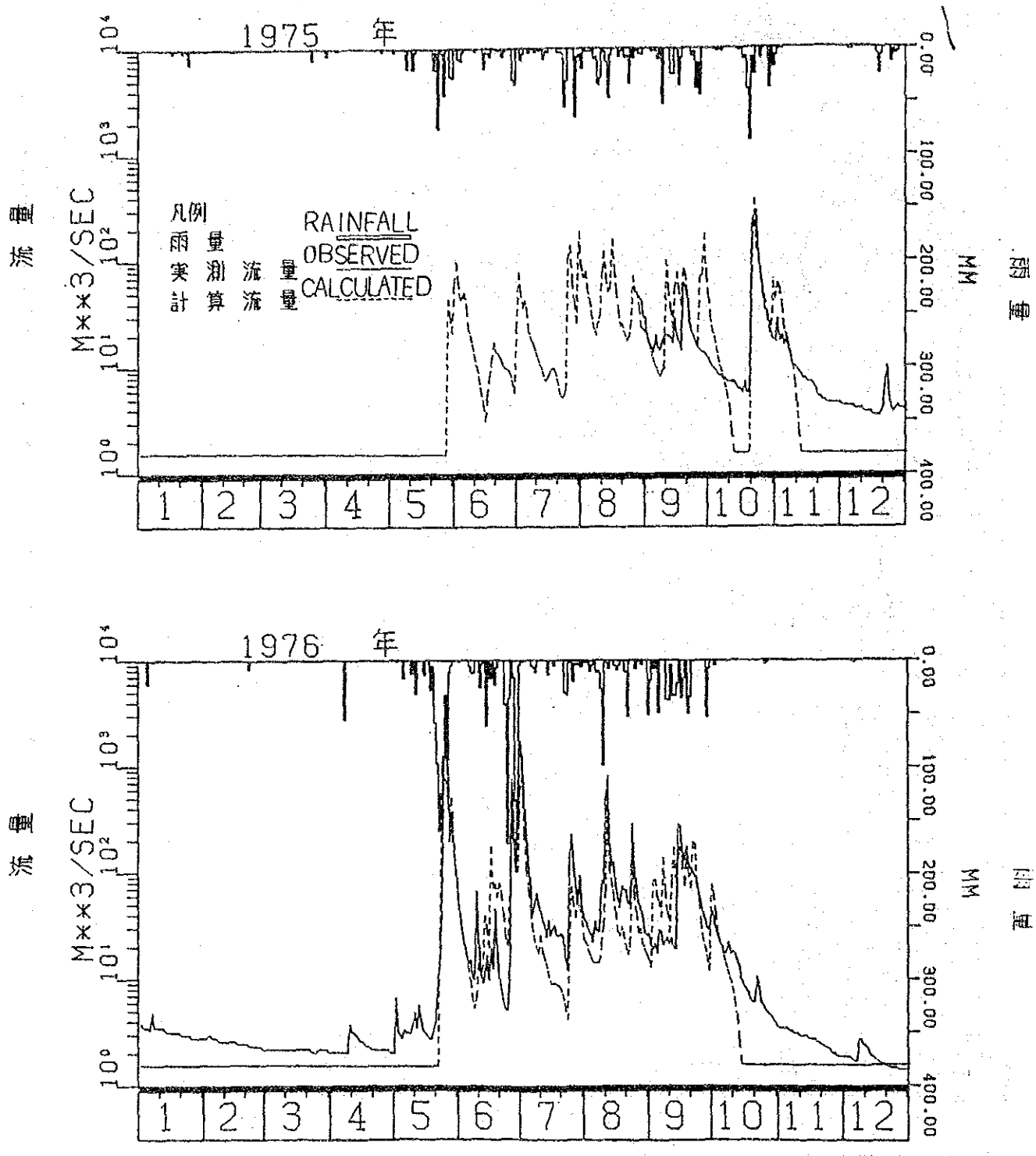


Fig. H -2 (1) Forecast Hydrographs

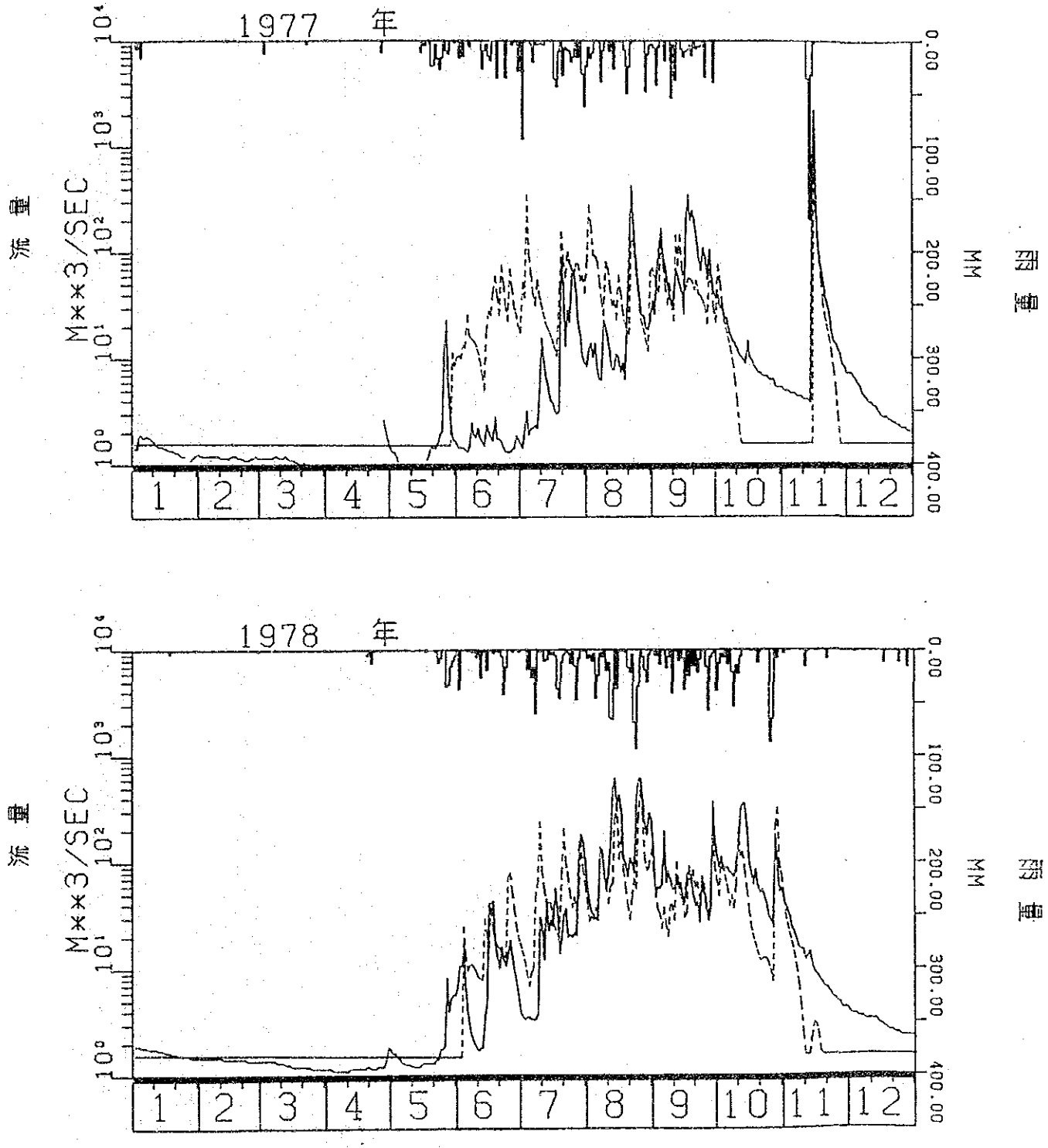


Fig. H -2 (2) Forecast Hydrographs

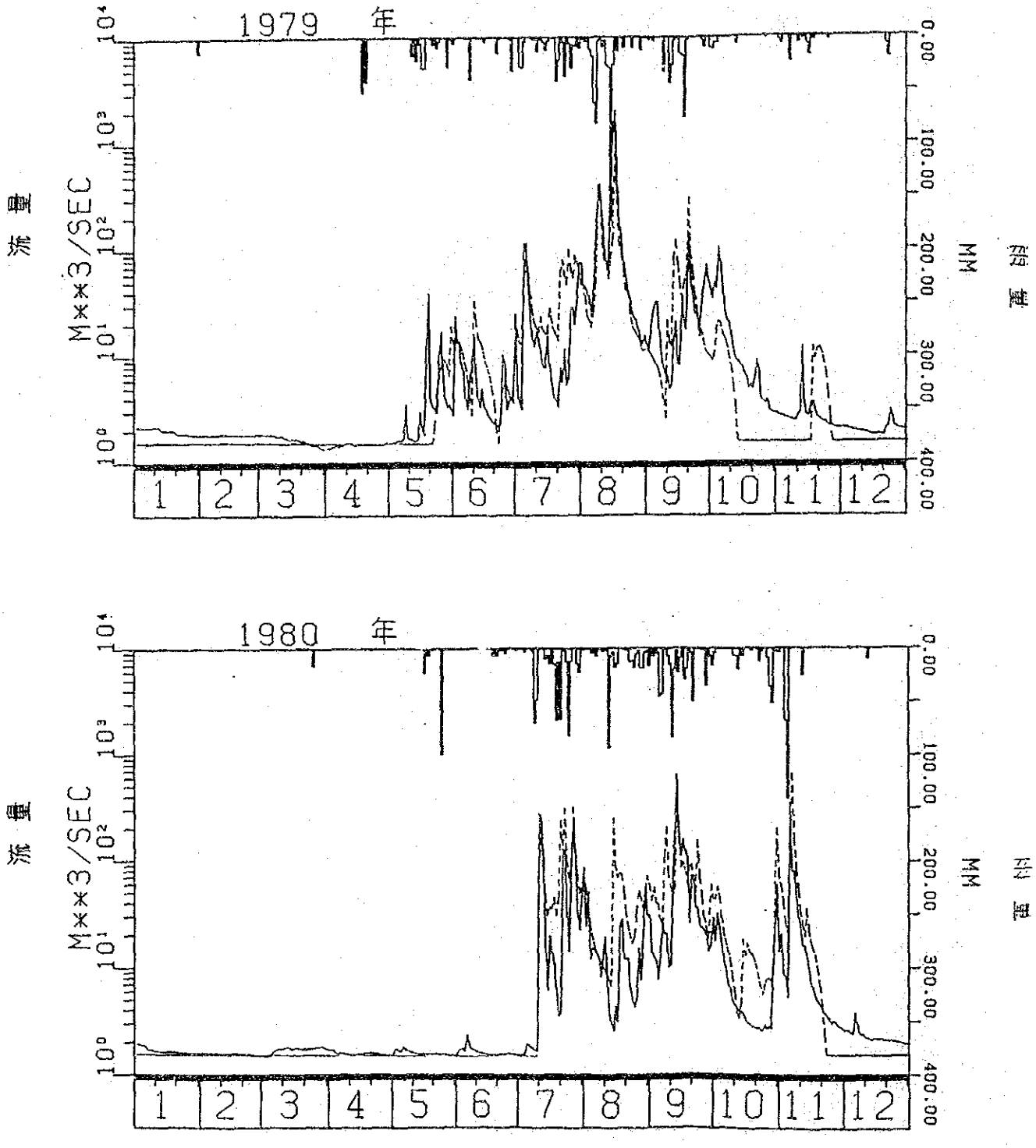


Fig. H -2 (3) Forecast Hydrographs

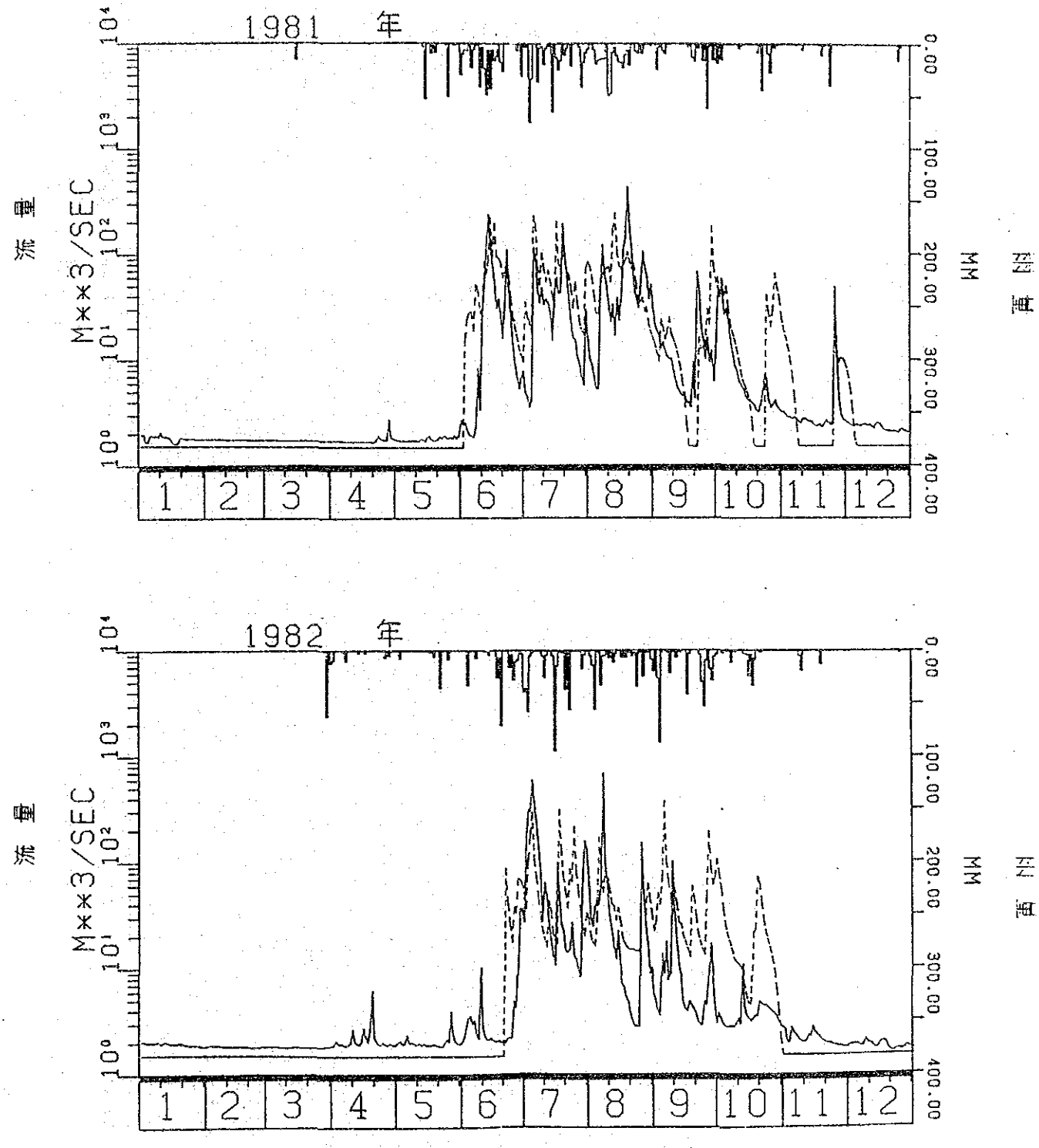


Fig. H -2 (4) Forecast Hydrographs

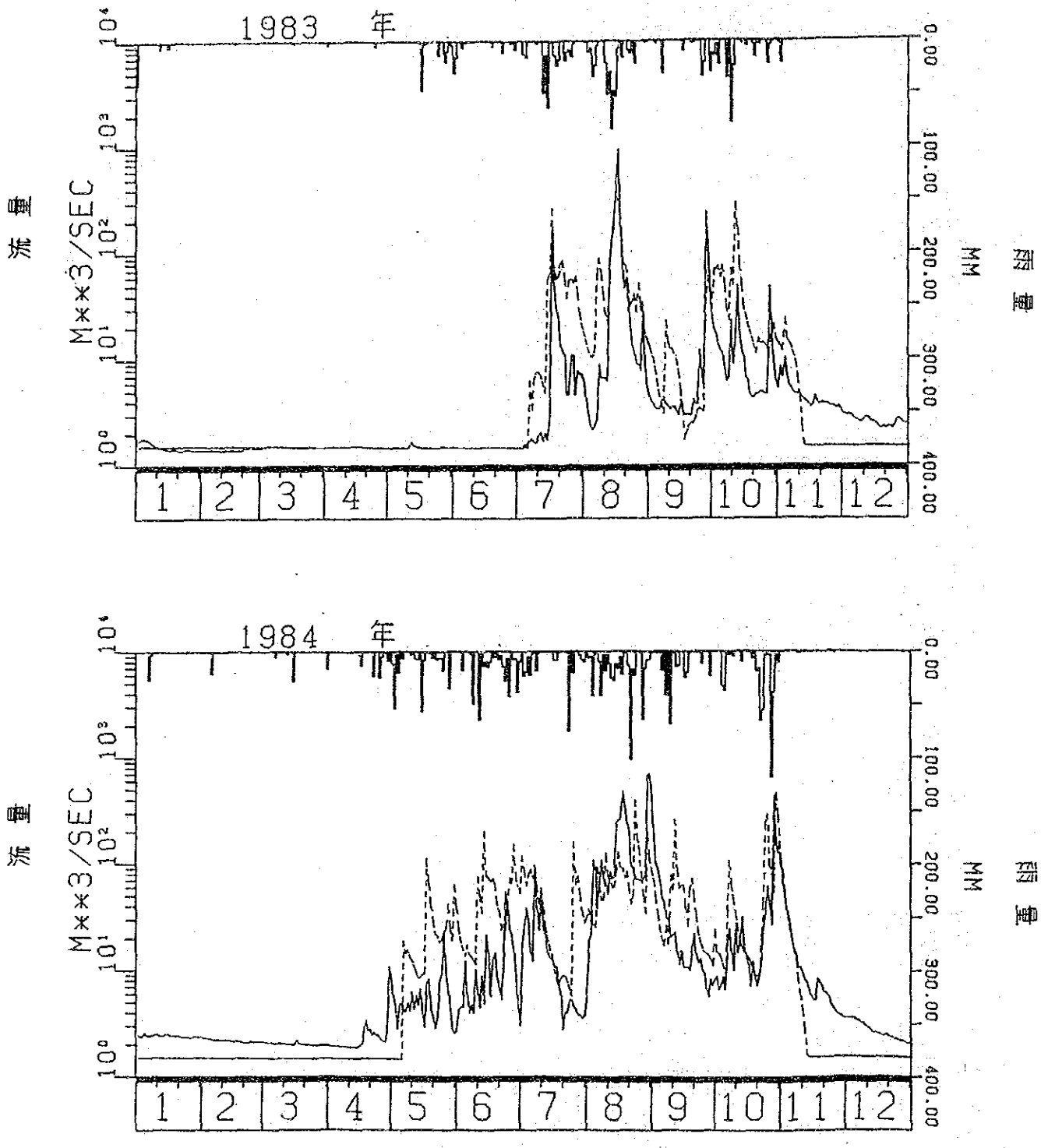


Fig. H -2 (5) Forecast Hydrographs

Fig. II-3

Map of Mean Annual Runoff (mm) : Scale 1:500,000 ,Source,
Agno River Basin : National Water Resources Council

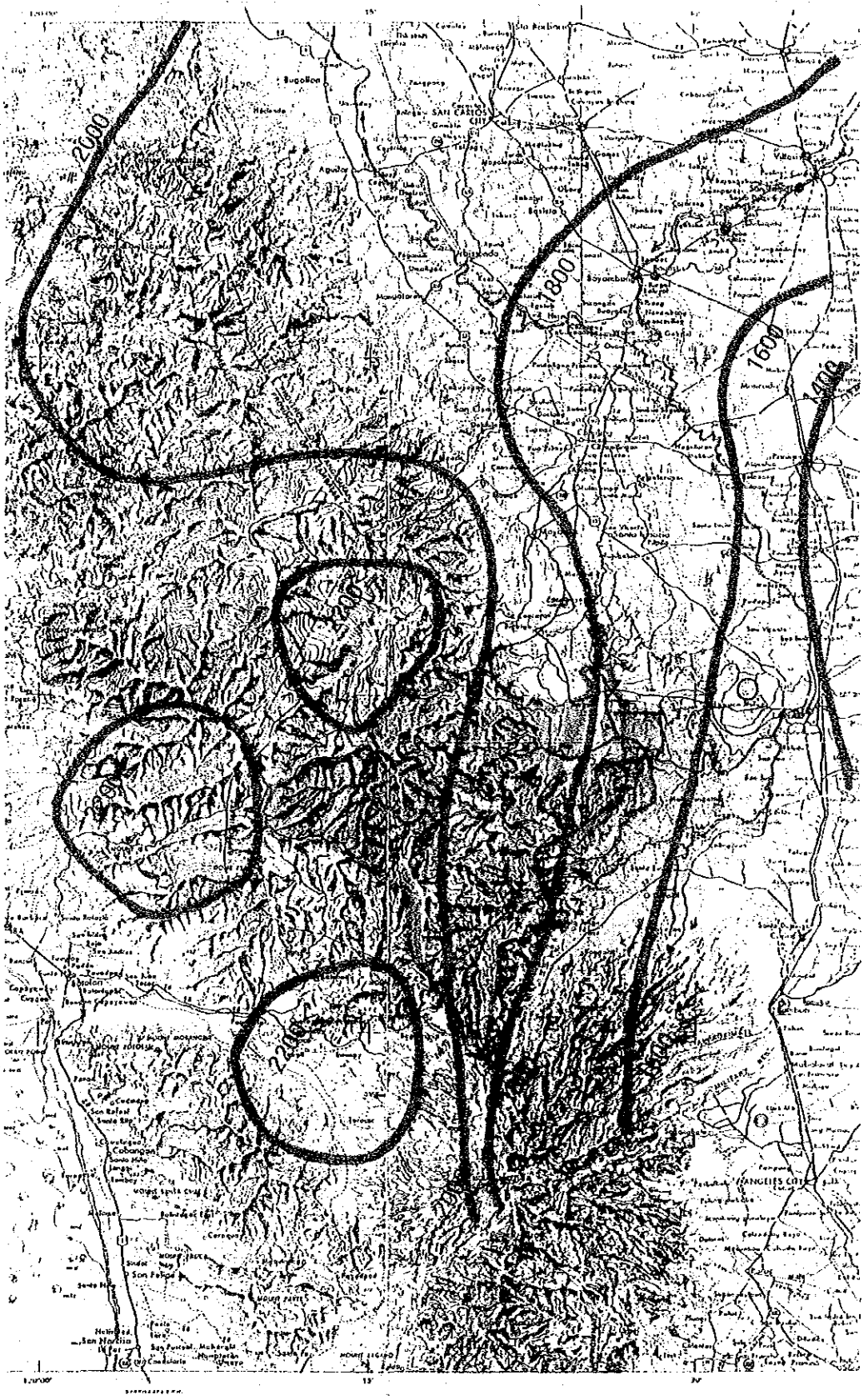


Table H-1 Comparison of Measured and Computed Runoff

Bulsa River @ Villa Aglipay

(Catchment Area 405 km^2)

Year	Adjusted Annual Rainfall[1)] (mm)	Observed Annual Rainfall (mm)	Computed Annual Runoff (m^3/s)	Observed Annual Runoff (m^3/s)	Runoff Coefficients of Computed Runoff (%)	Runoff Coefficients of Observed Runoff (%)
1976	3,537.1	2,526.5	13,042.625	18,877.310	78.664	113.855
1977	2,392.5	1,708.9	7,844.876	8,484.270	69.952	75.654
1978	2,859.6	2,042.6	10,050.340	14,228.370	74.977	106.146
1979	2,111.8	1,508.4	6,314.645	9,178.210	63.792	92.720
1980	2,448.3	1,748.8	8,491.262	5,648.210	73.988	49.216
1981	2,331.6	1,665.4	7,678.521	5,541.760	70.257	50.706
1982	2,183.3	1,559.5	6,802.152	5,686.430	66.465	55.563
1983	1,777.3	1,269.5	5,805.523	4,165.994	69.685	50.006
1984	3,091.9	2,208.5	10,412.945	9,395.032	71.470	64.824
Mean	2,525.9	1,804.2	8,493.654	9,022.843	71.7	76.2

1) Adjustment factor of +5% per +100 meters in elevation difference between rainfall station and average elevation of a watershed was assumed.

Technical Data :

3. Reservoir Operation Study

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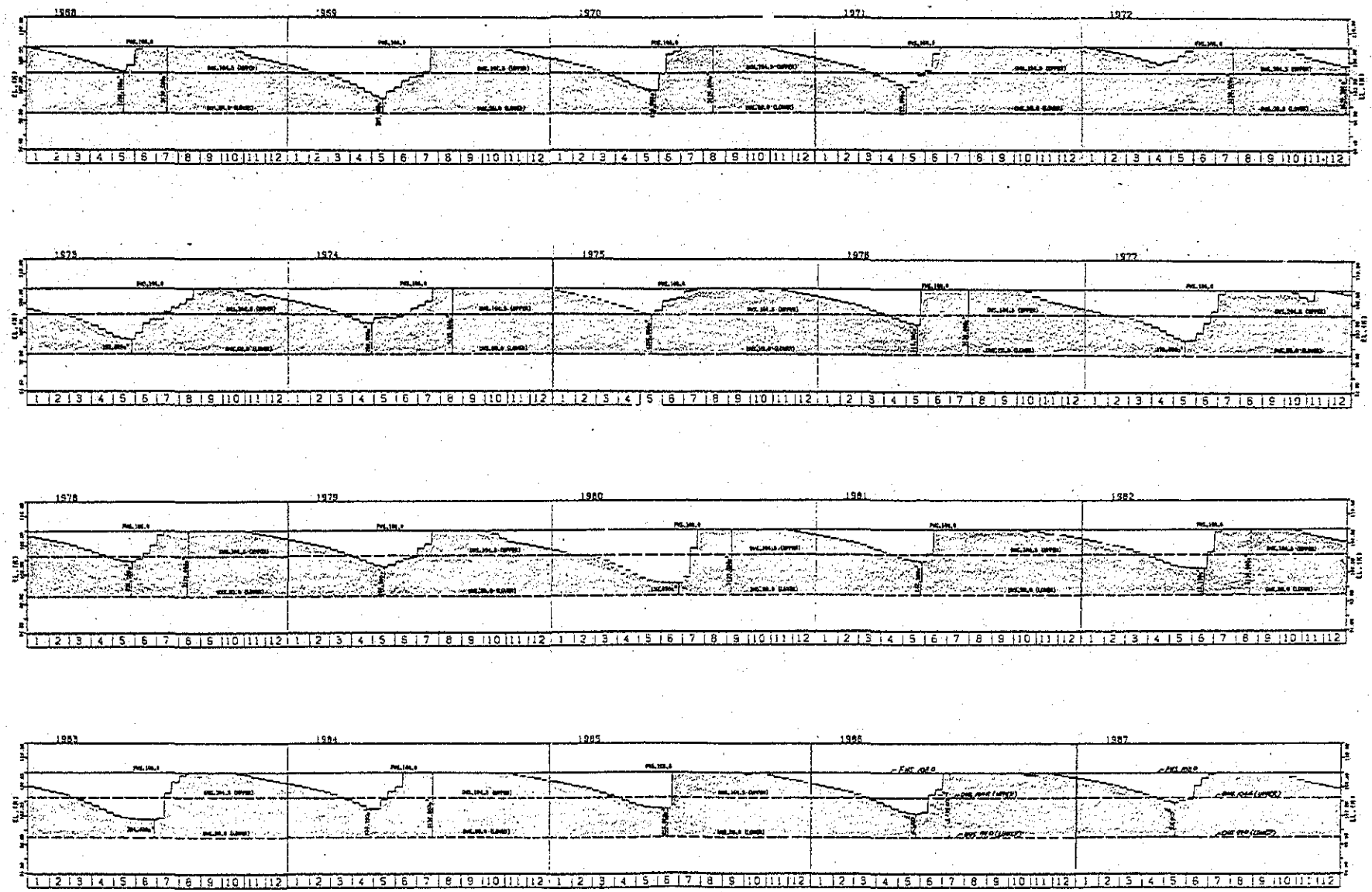

Fig. R-1　水位変動図（マンギログ貯水池）：
Operation Curve of Mangilog Reservoir

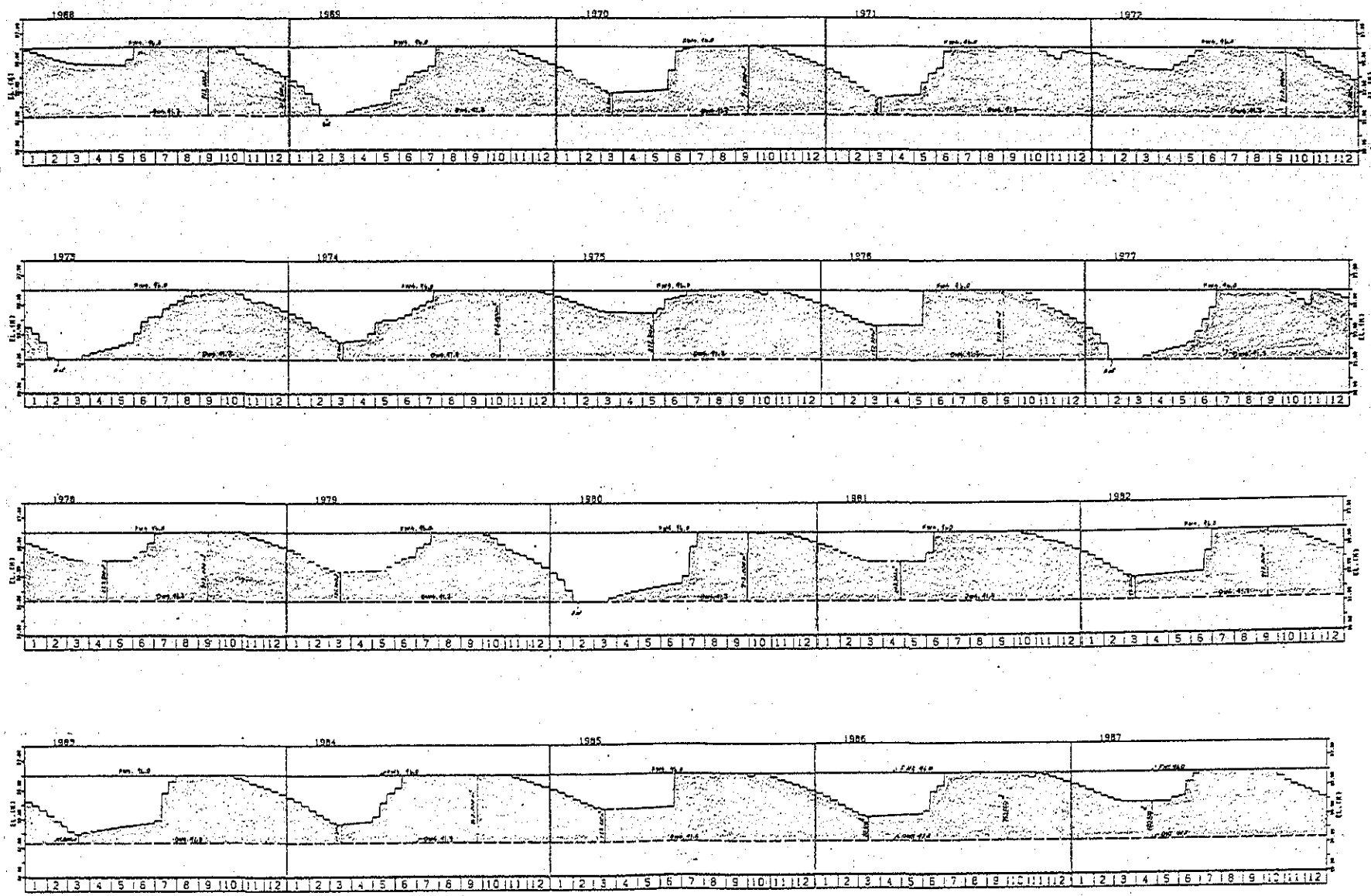

Fig. R-2　水位変動図（ブレラティン貯水池）：
Operation Curve of Bulelatin Reservoir

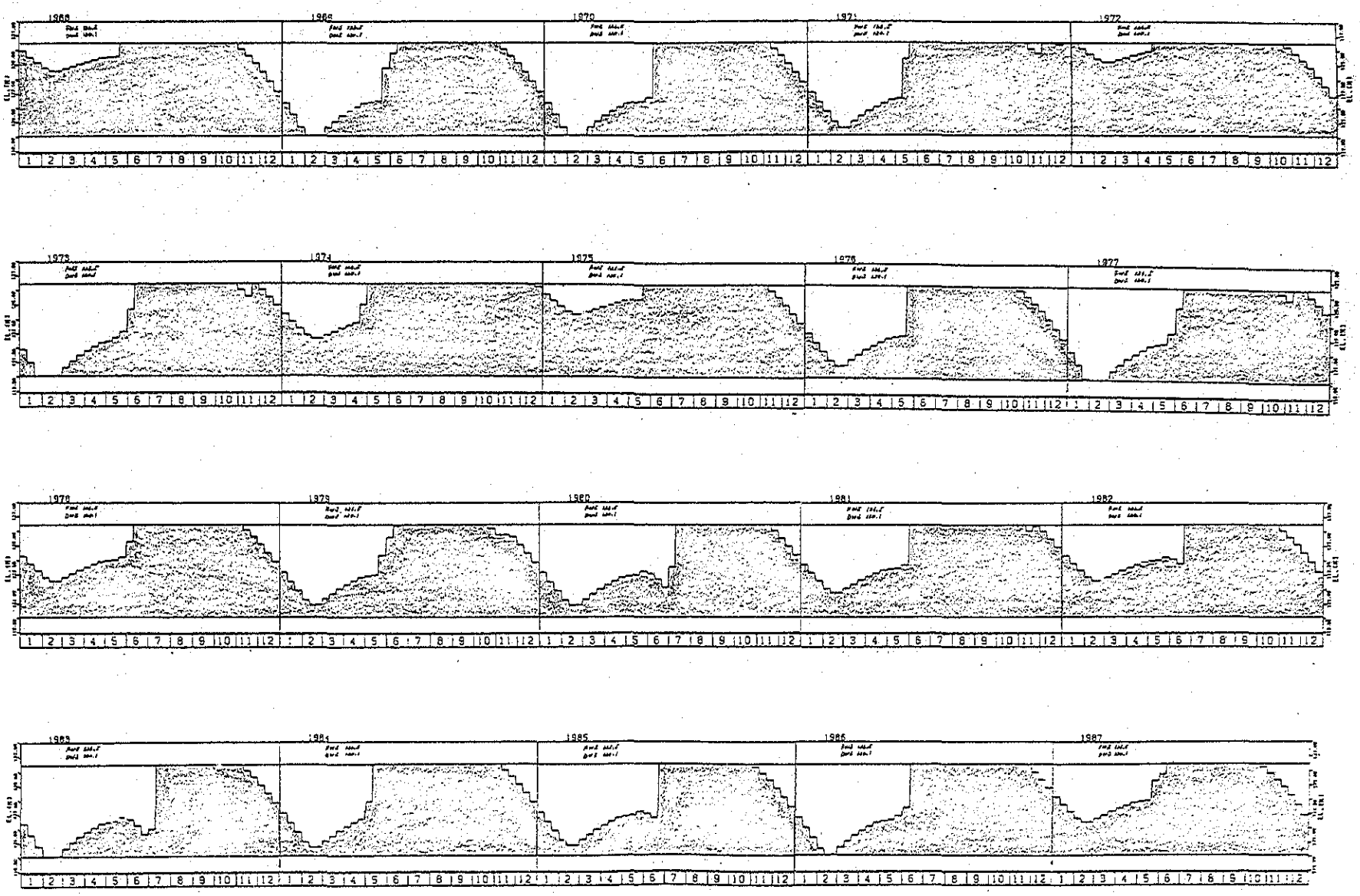

Fig. R-3　水位変動図（パンガサン貯水池）：
Operation Curve of Pangasan Reservoir

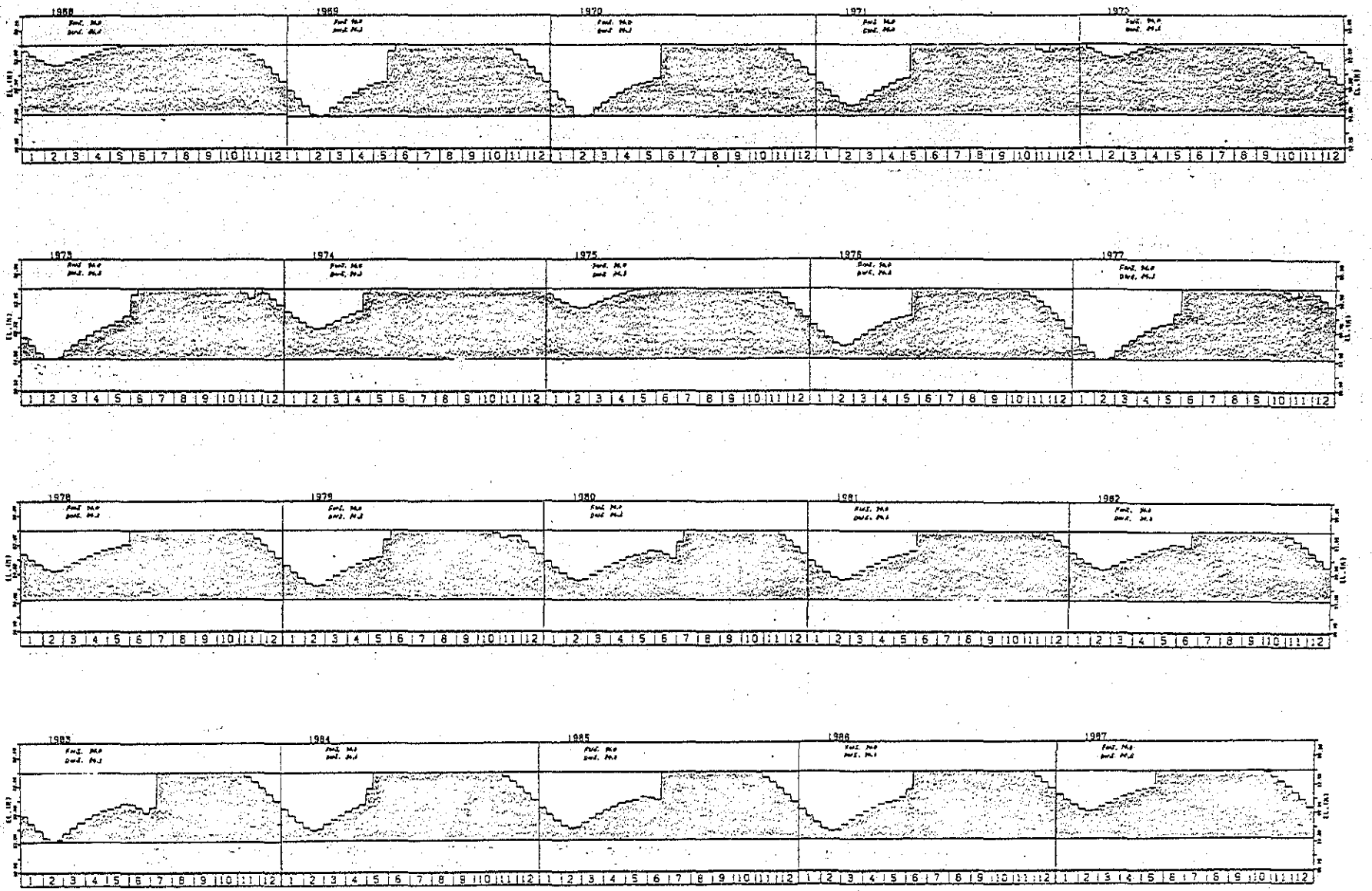

Fig. R-4　水位変動図（バルンゲス貯水池）：
Operation Curve of Balages Reservoir

Table R-1 Summary of Reservoir Operation Study

Mangillog Reservoir (Case 1)
(Irrigable Area Rice-360ha, Corn-360ha)

Year	Total Inflow (MCM)	Total[1] Demand (MCM)		Total Loss (MCM)	Storage End-Year (MCM)	Total Spillage (MCM)	Total[2] Shortage (MCM)	Percent[3] Shortage (%)
1968	13.38	3.26	1.33	0.60	1.34	10.06	0	0
1969	9.92	3.25	1.33	0.47	1.81	5.63	1.22	37.6
1970	14.55	3.25	1.33	0.51	1.81	10.26	0.79	24.2
1971	13.12	3.25	1.33	0.53	2.75	7.86	0.79	24.2
1972	30.68	3.26	1.33	0.59	1.29	27.01	0.05	1.5
1973	8.27	3.25	1.33	0.45	1.79	4.00	1.27	39.0
1974	17.14	3.25	1.33	0.52	2.82	11.81	0.80	24.6
1975	10.03	3.25	1.33	0.55	2.12	5.61	0	0
1976	21.59	3.26	1.33	0.53	1.29	17.86	0.57	17.4
1977	12.61	3.25	1.33	0.49	2.45	7.65	1.27	39.0
1978	16.42	3.25	1.33	0.51	2.02	11.96	0.20	6.2
1979	9.97	3.25	1.33	0.47	1.29	6.31	0.65	20.0
1980	13.73	3.26	1.33	0.46	2.36	8.88	1.28	39.3
1981	12.33	3.25	1.33	0.53	1.97	7.88	0.28	8.5
1982	10.81	3.25	1.33	0.48	1.66	6.71	0.64	19.6
1983	9.17	3.25	1.33	0.45	1.85	4.87	0.92	28.4
1984	17.05	3.26	1.33	0.54	2.11	12.41	0.76	23.4
1985	14.19	3.25	1.33	0.50	1.85	9.88	0.50	15.4
1986	15.16	3.25	1.33	0.50	2.41	10.26	0.75	23.0
1987	9.77	3.25	1.33	0.50	1.43	5.91	0.24	7.3
Total	279.89	65.05	26.60	10.18	38.42	192.82	12.98	398.6
Mean	13.99	3.25	1.33	0.51	1.92	9.64	0.65	19.9

1. Year of Max. Shortage : 1980
   Max. Shortage : 1.28 MCM
   Max. Shortage Percent : 39.3%
2. No. of Years Shortage : 18
   Yearly Reliability : 10.0%
3. No. of Months Shortage: 47
   Monthly Reliability : 80.4%

1 Left Value = Demand for Area Commanded by Upper Intake.
Right Value = by Lower Intake

2 The shortage has arose on the upper intake only.

3 This percentage has been caluclated using the demand on the upper intake.

Table R-2 Summary of Reservoir Operation Study

Mangillog Reservoir (Case 2)
(Irrigable Area Rice-360ha, Corn-232.5ha)

Year	Total Inflow (MCM)	Total[1] Demand (MCM)		Total Loss (MCM)	Storage End-Year (MCM)	Total Spillage (MCM)	Total[2] Shortage (MCM)	Percent[3] Shortage (%)
1968	13.38	2.14	1.33	0.65	1.82	10.65	0	0
1969	9.92	2.13	1.33	0.49	2.29	5.68	0.17	8.1
1970	14.55	2.13	1.33	0.56	2.29	10.53	0	0
1971	13.12	2.13	1.33	0.58	3.13	8.23	0	0
1972	30.68	2.14	1.33	0.68	1.71	27.95	0	0
1973	8.27	2.13	1.33	0.47	2.27	4.04	0.26	12.2
1974	17.14	2.13	1.33	0.57	3.09	12.29	0	0
1975	10.03	2.13	1.33	0.65	2.57	6.45	0	0
1976	21.59	2.14	1.33	0.60	1.71	18.38	0	0
1977	12.61	2.13	1.33	0.51	2.84	7.78	0.26	12.4
1978	16.42	2.13	1.33	0.61	2.50	12.69	0	0
1979	9.97	2.13	1.33	0.54	1.70	6.76	0	0
1980	13.73	2.14	1.33	0.48	2.75	9.01	0.28	13.0
1981	12.33	2.13	1.33	0.61	2.45	8.55	0	0
1982	10.81	2.13	1.33	0.56	2.14	7.11	0	0
1983	9.17	2.13	1.33	0.50	2.33	5.03	0.02	0.8
1984	17.05	2.14	1.33	0.59	2.56	12.75	0	0
1985	14.19	2.13	1.33	0.58	2.33	10.39	0	0
1986	15.16	2.13	1.33	0.56	2.80	10.66	0	0
1987	9.77	2.13	1.33	0.60	1.91	6.60	0	0
Total	279.89	42.65	26.60	11.39	47.19	201.53	0.99	46.5
Mean	13.99	2.13	1.33	0.57	2.36	10.08	0.05	2.3

1. Year of Max. Shortage : 1980
   Max. Shortage : 0.28 MCM
   Max. Shortage Percent : 13.0%
2. No. of Years Shortage : 5
   Yearly Reliability : 75.0%
3. No. of Months Shortage: 9
   Monthly Reliability : 96.3%

1 Left Value = Demand for Area Commanded by Upper Intake.
Right Value = by Lower Intake

2 The shortage has arose on the upper intake only.

3 This percentage has been caluclated using the demand on the upper intake.

Table R-3 Summary of Reservoir Operation Study

Bulelatin Reservoir (Case 1)
(Irrigable Area Rice-120ha, Corn-120ha)

Year	Total Inflow (MCM)	Total Demand (MCM)	Total Loss (MCM)	Storage End-Year (MCM)	Total Spillage (MCM)	Total Shortage (MCM)	Percent Shortage (%)
1968	3.54	1.53	0.23	0.01	2.50	0.01	0.8
1969	2.68	1.53	0.15	0.15	1.42	0.55	36.0
1970	3.82	1.53	0.16	0.13	2.58	0.42	27.1
1971	3.47	1.53	0.17	0.36	1.98	0.44	28.9
1972	7.81	1.53	0.19	0.01	6.65	0.22	14.4
1973	2.28	1.53	0.14	0.12	1.05	0.55	35.9
1974	4.46	1.53	0.17	0.45	2.88	0.44	28.9
1975	2.71	1.53	0.18	0.25	1.34	0.14	9.1
1976	5.56	1.53	0.17	0.01	4.47	0.37	24.3
1977	3.35	1.53	0.16	0.37	1.85	0.55	35.8
1978	4.29	1.53	0.17	0.20	2.96	0.21	13.7
1979	2.69	1.53	0.14	0.01	1.65	0.42	27.7
1980	3.62	1.53	0.15	0.32	2.19	0.55	36.3
1981	3.28	1.53	0.17	0.15	2.00	0.26	16.8
1982	2.90	1.53	0.15	0.09	1.71	0.42	27.2
1983	2.50	1.53	0.14	0.14	1.26	0.47	31.0
1984	4.44	1.53	0.18	0.26	3.05	0.44	28.6
1985	3.74	1.53	0.16	0.16	2.46	0.32	20.6
1986	3.98	1.53	0.16	0.30	2.56	0.40	26.4
1987	2.65	1.53	0.16	0.03	1.50	0.28	18.1
Total	73.77	30.60	3.30	3.52	48.06	7.46	487.6
Mean	3.69	1.53	0.17	0.18	2.40	0.37	24.4

1. Year of Max. Shortage : 1980
   Max. Shortage : 0.55 MCM
   Max. Shortage Percent : 36.3%
2. No. of Years Shortage : 20
   Yearly Reliability : 0%
3. No. of Months Shortage: 56
   Monthly Reliability : 76.7%

Table R-4 Summary of Reservoir Operation Study

Bulelatin Reservoir (Case 2)
(Irrigable Area Rice-120ha, Corn-60ha)

Year	Total Inflow (MCM)	Total Demand (MCM)	Total Loss (MCM)	Storage End-Year (MCM)	Total Spillage (MCM)	Total Shortage (MCM)	Percent Shortage (%)
1968	3.54	1.01	0.30	0.22	2.74	0	0
1969	2.68	1.00	0.17	0.38	1.42	0.06	6.0
1970	3.82	1.00	0.22	0.35	2.63	0	0
1971	3.47	1.00	0.22	0.58	2.02	0	0
1972	7.81	1.01	0.28	0.20	6.90	0	0
1973	2.28	1.00	0.16	0.34	1.05	0.08	8.0
1974	4.46	1.00	0.22	0.64	2.95	0	0
1975	2.71	1.00	0.29	0.47	1.59	0	0
1976	5.56	1.01	0.24	0.19	4.60	0	0
1977	3.35	1.00	0.17	0.55	1.89	0.08	8.0
1978	4.29	1.00	0.27	0.43	3.15	0	0
1979	2.69	1.00	0.21	0.17	1.74	0	0
1980	3.62	1.01	0.16	0.53	2.21	0.10	10.2
1981	3.28	1.00	0.26	0.37	2.17	0	0
1982	2.90	1.00	0.20	0.31	1.76	0	0
1983	2.50	1.00	0.17	0.36	1.27	0	0
1984	4.44	1.01	0.23	0.47	3.10	0	0
1985	3.74	1.00	0.24	0.39	2.58	0	0
1986	3.98	1.00	0.22	0.52	2.62	0	0
1987	2.65	1.00	0.25	0.25	1.66	0	0
Total	73.77	20.05	4.48	7.72	50.05	0.32	32.2
Mean	3.69	1.00	0.22	0.39	2.50	0.02	1.6

1. Year of Max. Shortage : 1980
   Max. Shortage : 0.10 MCM
   Max. Shortage Percent : 10.2%
2. No. of Years Shortage : 4
   Yearly Reliability : 80.0%
3. No. of Months Shortage : 8
   Monthly Reliability : 96.7%

Table R-5 Summary of Reservoir Operation Study

Pangasan Reservoir
(Irrigable Area Rice-200ha, Corn-200ha)

Year	Total Inflow (MCM)	Total Demand (MCM)	Total Loss (MCM)	Storage End-Year (MCM)	Total Spillage (MCM)	Total Shortage (MCM)	Percent Shortage (%)
1968	22.81	2.11	0.24	0.45	21.13	0	0
1969	17.29	2.11	0.18	0.44	15.07	0.06	3.0
1970	24.66	2.11	0.18	0.55	22.33	0.07	3.2
1971	22.37	2.11	0.20	1.12	19.50	0	0
1972	50.36	2.11	0.25	0.39	48.73	0	0
1973	14.68	2.11	0.18	0.78	12.11	0.11	5.0
1974	28.80	2.11	0.23	1.07	26.17	0	0
1975	17.49	2.11	0.24	0.56	15.65	0	0
1976	35.89	2.11	0.19	0.40	33.75	0	0
1977	21.59	2.11	0.18	0.76	19.03	0.10	4.5
1978	27.66	2.11	0.22	0.57	25.53	0	0
1979	17.38	2.11	0.19	0.57	15.09	0	0
1980	23.37	2.11	0.18	0.66	20.98	0	0
1981	21.13	2.11	0.21	0.77	18.71	0	0
1982	18.72	2.11	0.21	0.45	16.72	0	0
1983	16.10	2.11	0.17	0.55	13.77	0.05	2.4
1984	28.66	2.11	0.20	0.56	26.34	0	0
1985	24.10	2.11	0.19	0.51	21.87	0	0
1986	25.65	2.11	0.18	0.74	23.12	0	0
1987	17.06	2.11	0.21	0.40	15.09	0	0
Total	475.77	42.20	4.03	12.30	430.69	0.39	18.1
Mean	23.79	2.11	0.20	0.62	21.53	0.02	0.9

1. Year of Max. Shortage : 1973
   Max. Shortage : 0.11 MCM
   Max. Shortage Percent : 5.0%
2. No. of Years Shortage : 5
   Yearly Reliability : 75.0%
3. No. of Months Shortage : 6
   Monthly Reliability : 97.5%

Table R-6 Summary of Reservoir Operation Study

Balunges Reservoir
(Irrigable Area Rice-350ha, Corn-350ha)

Year	Total Inflow (MCM)	Total Demand (MCM)	Total Loss (MCM)	Storage End-Year (MCM)	Total Spillage (MCM)	Total Shortage (MCM)	Percent Shortage (%)
1968	49.32	3.69	0.25	0.77	46.43	0	0
1969	37.39	3.69	0.19	0.76	33.54	0.02	0.6
1970	53.33	3.69	0.19	0.92	49.30	0.03	0.9
1971	48.39	3.69	0.21	1.82	43.59	0	0
1972	108.90	3.69	0.26	0.70	106.10	0	0
1973	31.75	3.69	0.20	1.30	27.34	0.07	1.9
1974	62.28	3.69	0.24	1.82	57.83	0	0
1975	37.82	3.69	0.25	0.95	34.75	0	0
1976	77.63	3.69	0.21	0.71	73.97	0	0
1977	46.69	3.69	0.20	1.26	42.30	0.05	1.3
1978	59.82	3.69	0.23	0.97	56.19	0	0
1979	37.59	3.69	0.21	1.08	33.59	0	0
1980	50.55	3.69	0.21	1.10	46.61	0	0
1981	45.70	3.69	0.22	1.33	41.57	0	0
1982	40.49	3.69	0.23	0.78	37.12	0	0
1983	34.82	3.69	0.19	0.94	30.78	0	0
1984	61.98	3.69	0.21	0.95	58.06	0	0
1985	52.13	3.69	0.21	0.90	48.29	0	0
1986	55.47	3.69	0.21	1.26	51.21	0	0
1987	36.91	3.69	0.23	0.72	33.53	0	0
Total	930.95	73.80	4.35	20.09	952.10	0.17	4.7
Mean	46.55	3.69	0.22	1.00	47.61	0.009	0.2

1. Year of Max. Shortage : 1973
   Max. Shortage : 0.07 MCM
   Max. Shortage Percent : 1.9%
2. No. of Years Shortage : 4
   Yearly Reliability : 80.0%
3. No. of Months Shortage : 4
   Monthly Reliability : 98.3%

Technical Data :

4. Dam and Reservoir

LIST OF FIGURES

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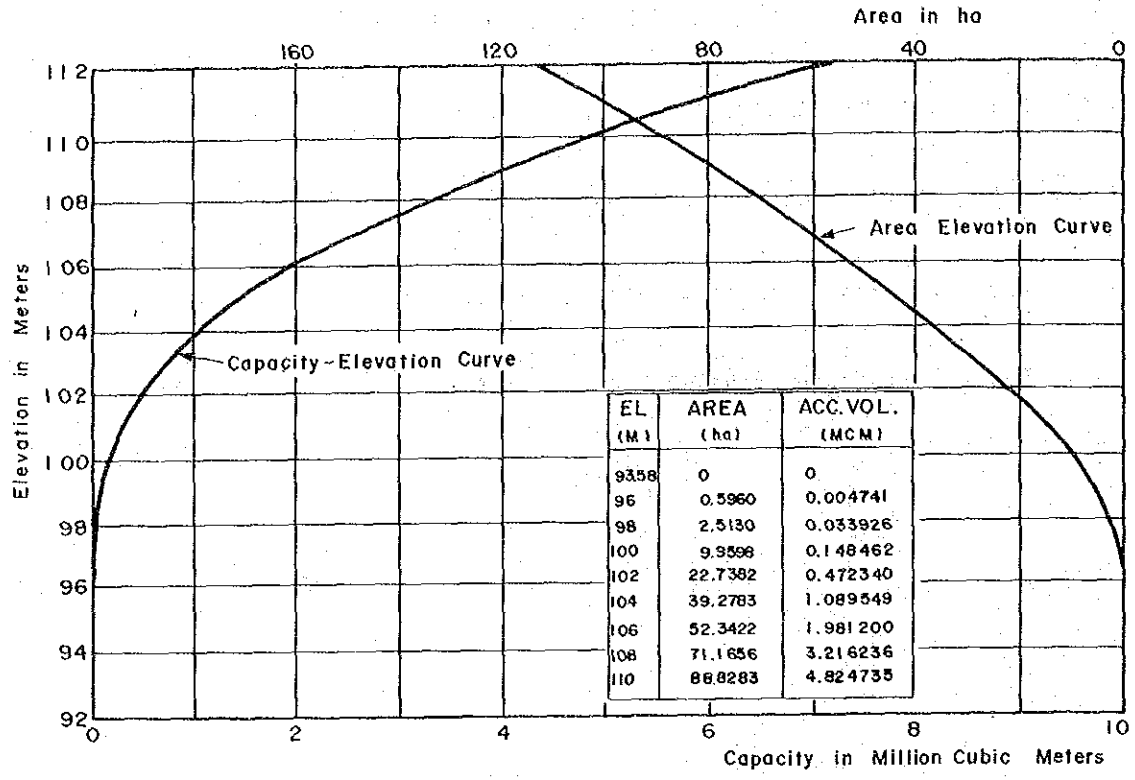

EL (M)	AREA (ha)	ACC.VOL. (MCM)
9358	0	0
96	0.5960	0.004741
98	2.5130	0.033926
100	9.3598	0.148462
102	22.7382	0.472340
104	39.2783	1.089549
106	52.3422	1.981200
108	71.1656	3.216236
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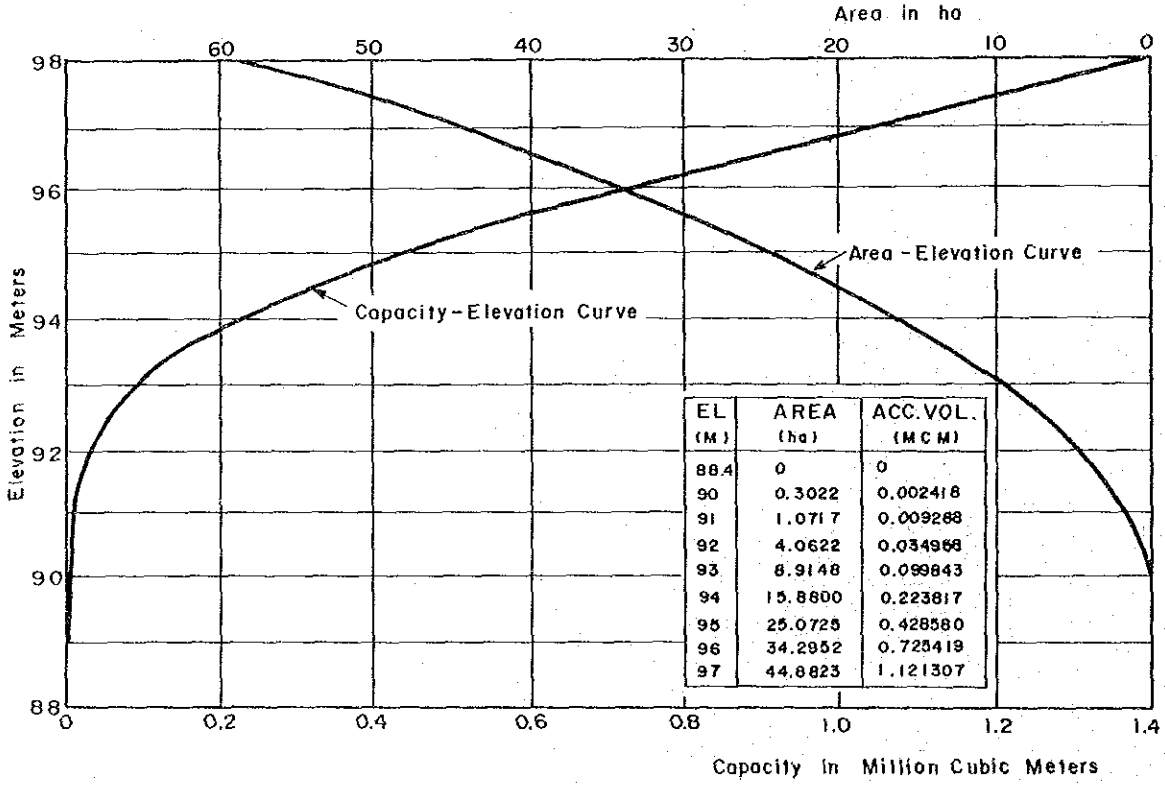
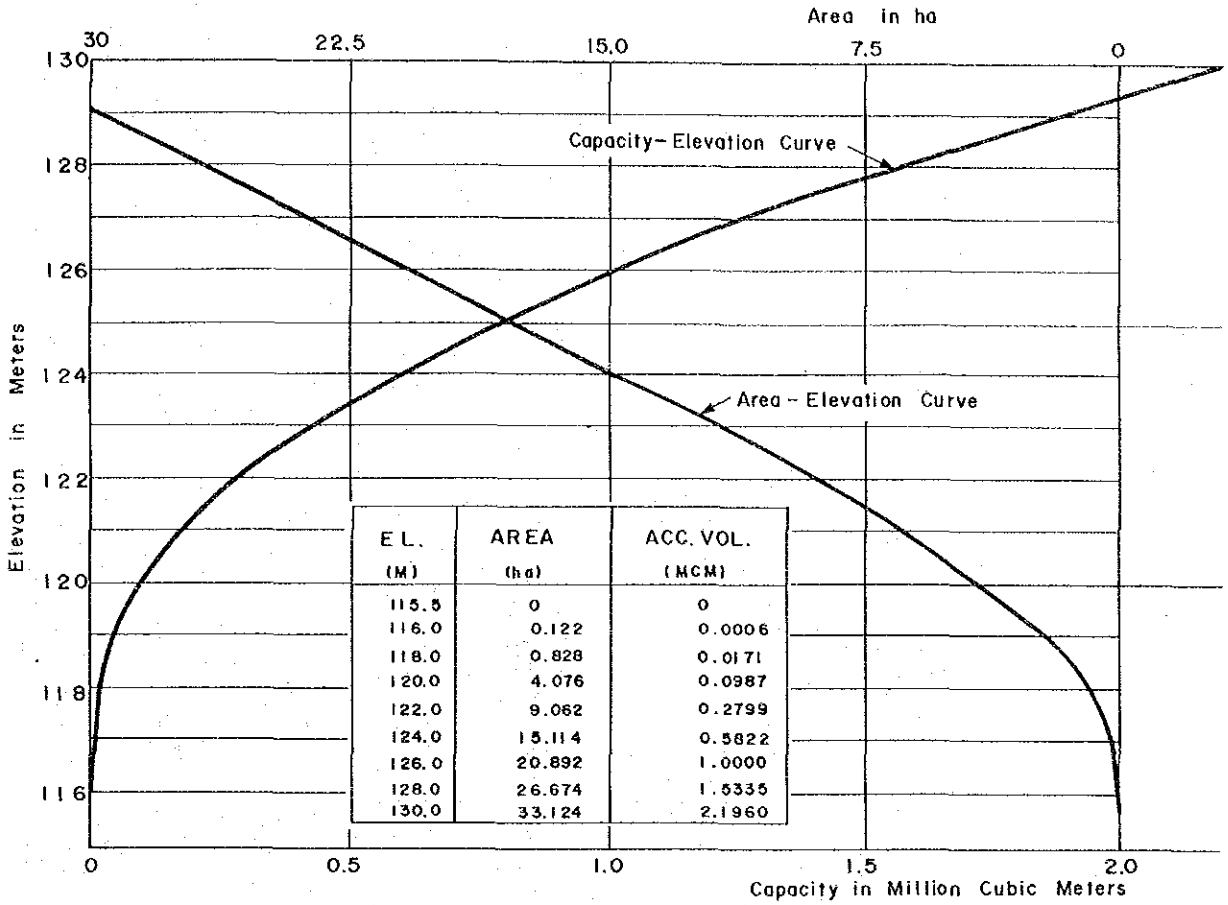
Fig. D-1 AREA-CAPACITY-ELEVATION CURVE
MANGILLOG RESERVOIR



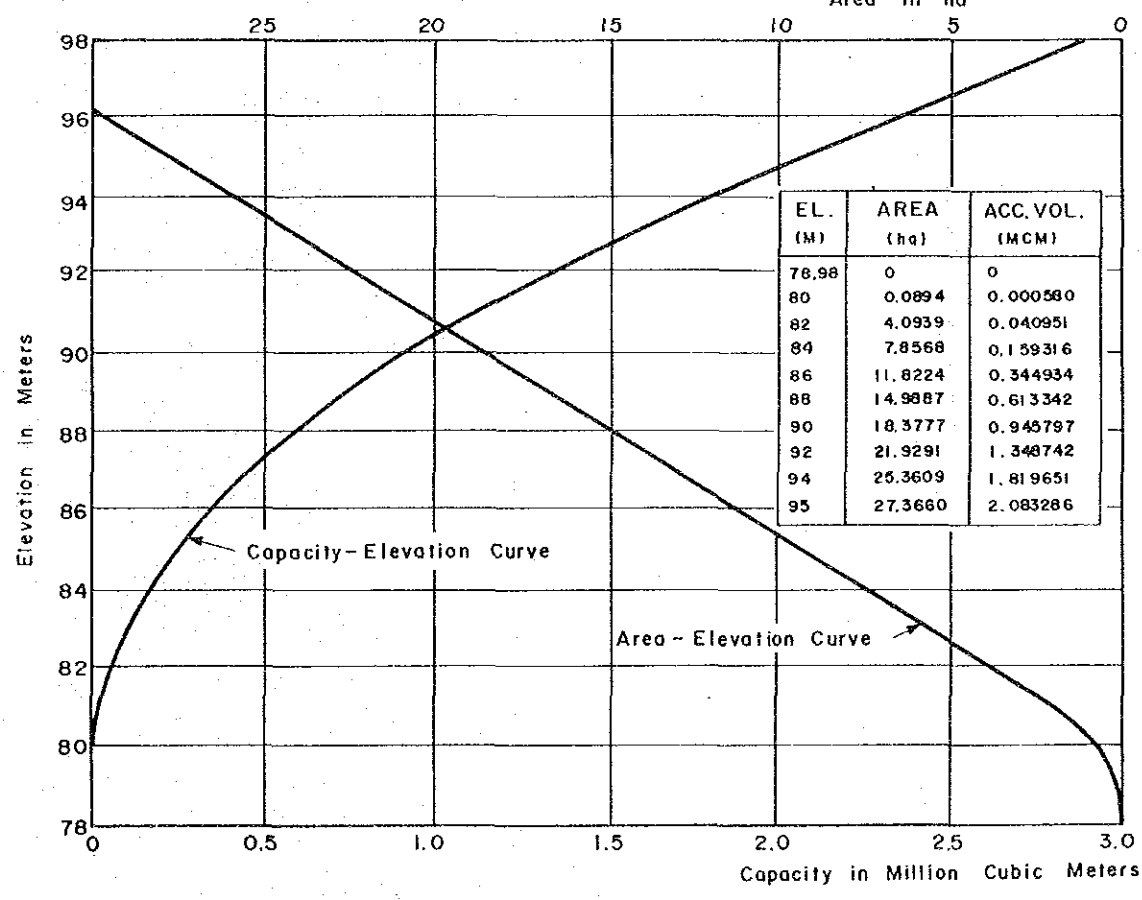
EL (M)	AREA (ha)	ACC.VOL. (MCM)
88.4	0	0
90	0.3022	0.002418
91	1.0717	0.009268
92	4.0622	0.034968
93	8.9148	0.099843
94	15.8600	0.223817
95	25.0725	0.428580
96	34.2952	0.725419
97	44.8823	1.121307

Fig. D-2 AREA-CAPACITY-ELEVATION CURVE
BULELATIN RESERVOIR



EL. (M)	AREA (ha)	ACC. VOL. (MCM)
115.5	0	0
116.0	0.122	0.0006
118.0	0.828	0.0171
120.0	4.076	0.0987
122.0	9.062	0.2799
124.0	15.114	0.5822
126.0	20.892	1.0000
128.0	26.674	1.5335
130.0	33.124	2.1960

Fig. D-3 AREA - CAPACITY - ELEVATION CURVE
PANGASAN RESERVOIR



EL. (M)	AREA (ha)	ACC. VOL. (MCM)
78.98	0	0
80	0.0894	0.000580
82	4.0939	0.040951
84	7.8568	0.159316
86	11.8224	0.344934
88	14.9887	0.613342
90	18.3777	0.945797
92	21.9291	1.348742
94	25.3609	1.819651
95	27.3660	2.083286

Fig. D-4 AREA - CAPACITY - ELEVATION CURVE
BALNGES RESERVOIR

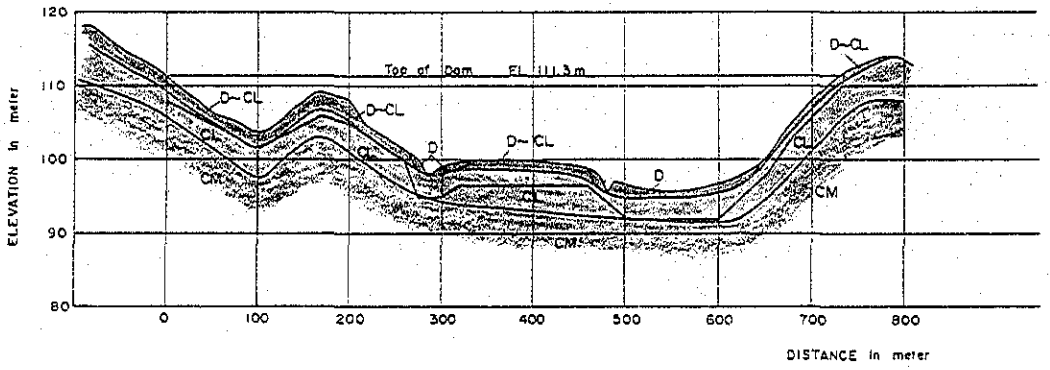


FIG. D-5 CLASSIFICATION OF MANGILLOG DAM BASEMENT ROCK

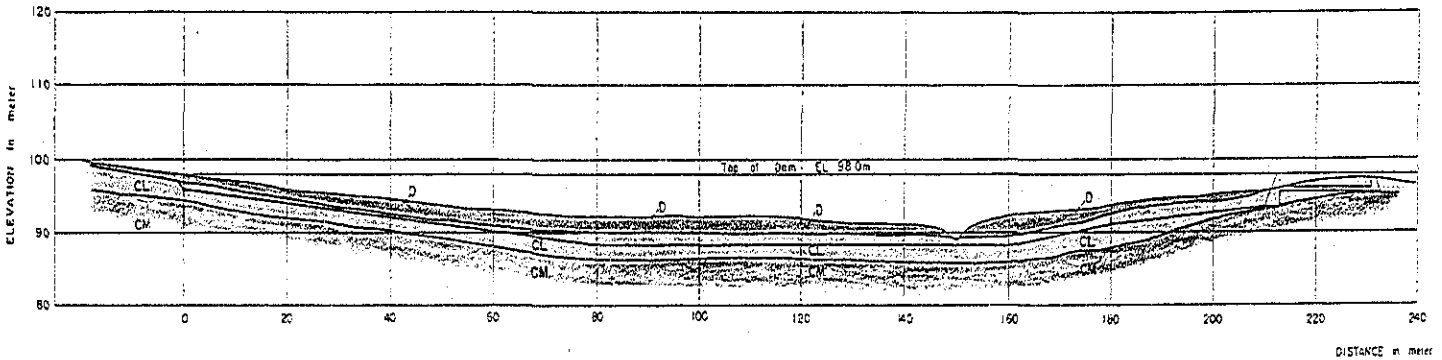


FIG. D-6 CLASSIFICATION OF BULELATIN DAM BASEMENT ROCK

LEGEND

(See page D -11)

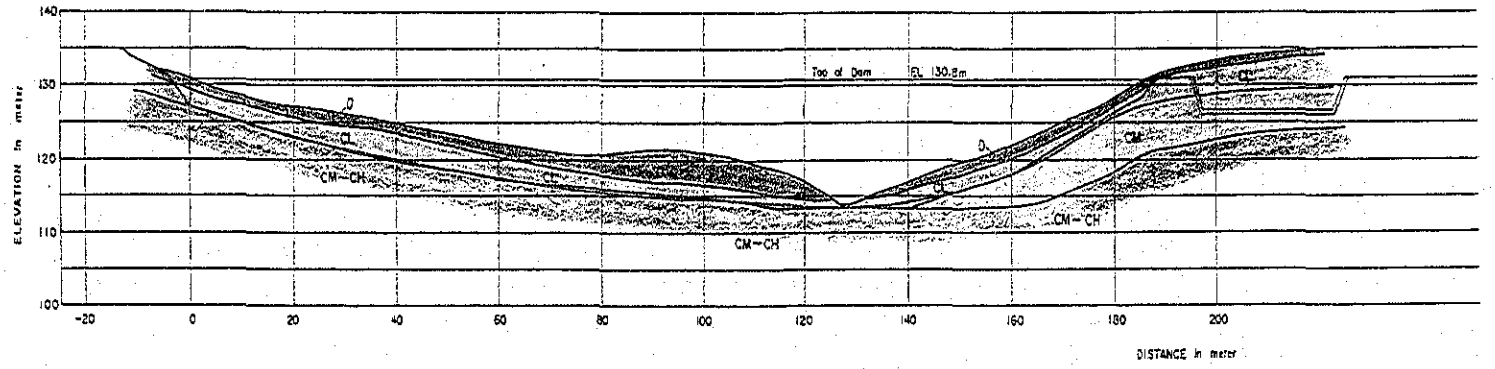


FIG. D-7 CLASSIFICATION OF PANGASAN DAM BASEMENT ROCK

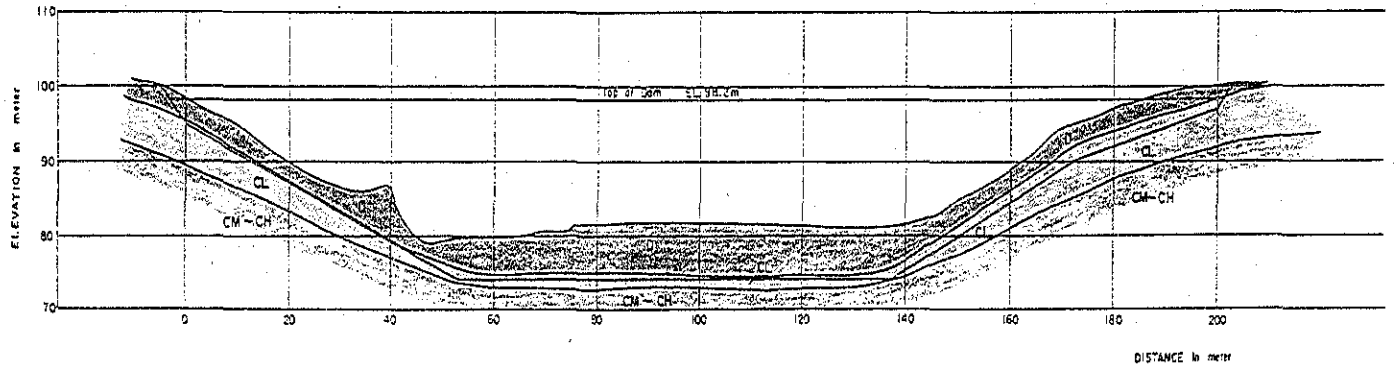


FIG. D-8 CLASSIFICATION OF BALNGES DAM BASEMENT ROCK

LEGEND

(See page D -11)

Legend for Fig. D-5 to Fig. D-8

Classification criteria for rock foundation of dam (by Tanaka)

Category	Characteristics
A	Very fresh rock, no weathering nor alteration observed in rock-formation minerals and particles. Fissures and joints are well closed and no weathering is observed on the planes. thereof. Sound of hammering is metallic.
B	Very hard rock, well closed with no opened (even 1 mm) fissures or joints, and well closed. However, partial and slight weathering and alteration are observed. Sound of hammering is metallic.
C_H	Relatively hard rock, though rock-forming minerals and particles except quarts are weathered. Generally chemically compounded with limonite, etc. Cohesive strength at joints and fissures is slightly reduced. Rock fragments are flaked at joints by strong hit with hammer, and clayey material may be observed on the stripped face. Sound of hammering is slightly dull.
C_M	Rock, rock-forming minerals and particles except quartz are slightly softened by weathering. Cohesive strength at joints and fissures is slightly reduced. Rock fragments are flaked at joints by normal hit with hammer, and clayey material may be observed at the stripped face. Sound of hammering is slightly dull.
C_L	Rock, rock-forming minerals and particles are softened. Cohesive strength at joints and fissures are reduced. Rock fragment are flaked at joints by light hit with hammer, and clayey material is observed at stripped face. Sound of hammering is dull.
D	Rock, rock-forming minerals and particles are remarkably softened by weathering. Cohesive strength at joints and fissures is almost completely lost. Rock is easily destroyed by slight hit with hammer, and clayey material is observed at stripped face. Sound of hammering is very dull.

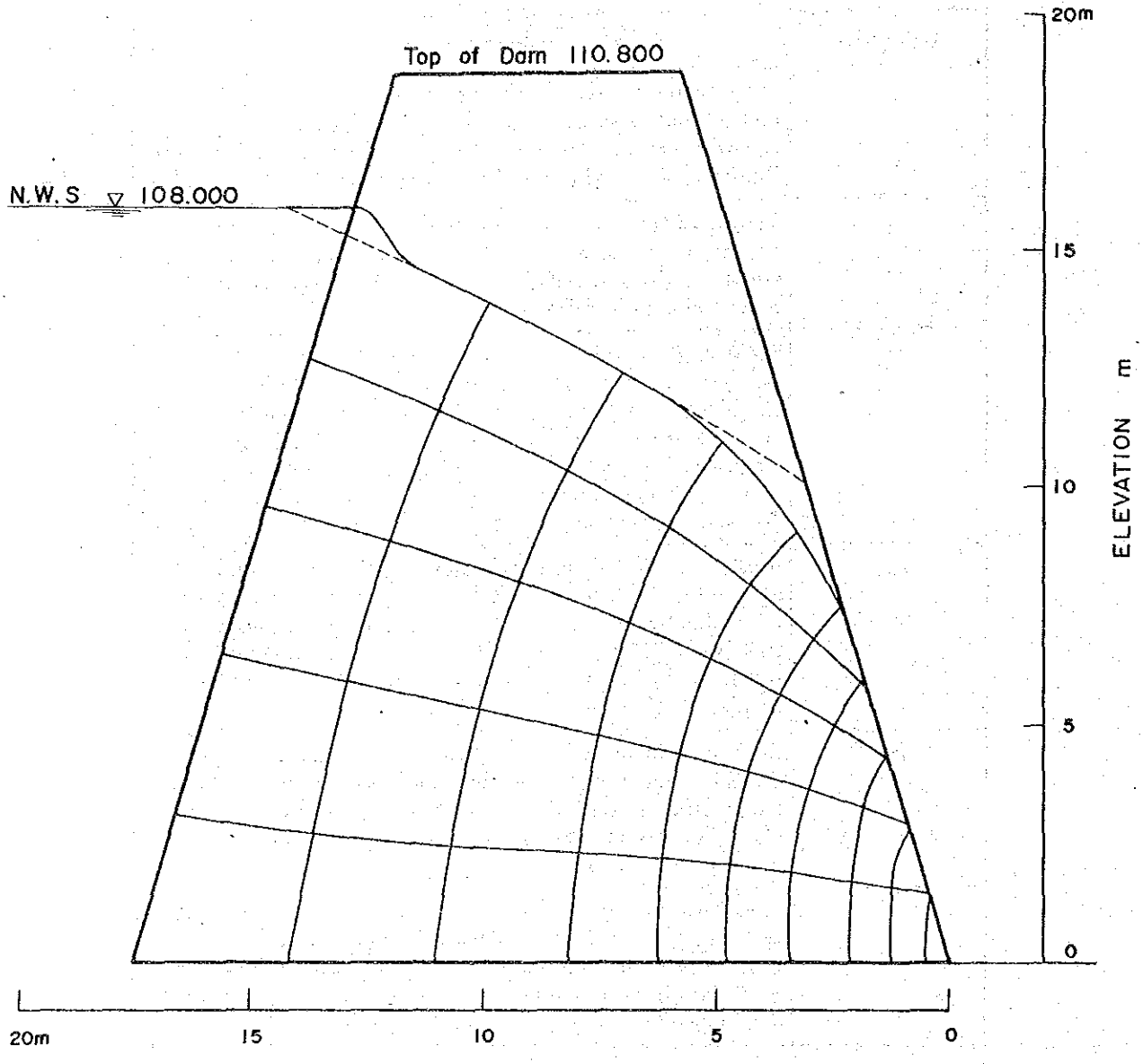


FIG. D-9 STREAM LINE IN IMPERVIOUS ZONE

MANGILLOG DAM

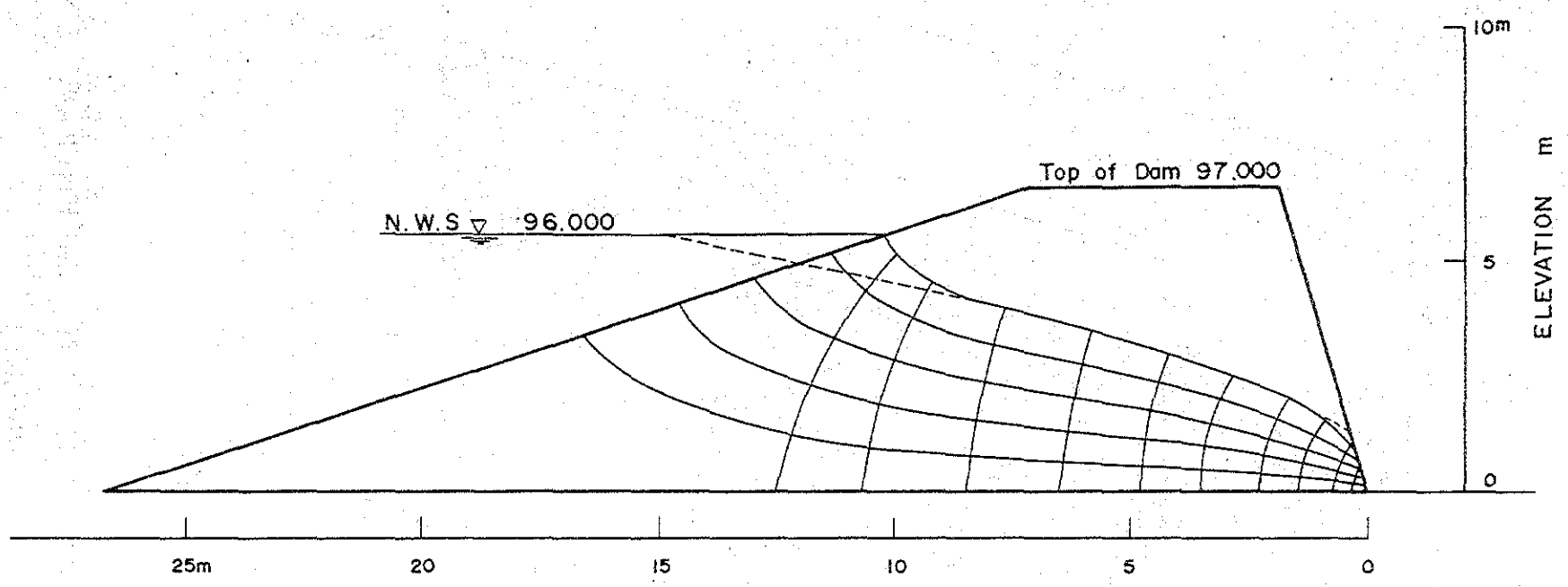


FIG. D-10 STREAM LINE IN IMPERVIOUS ZONE
BULELATION DAM

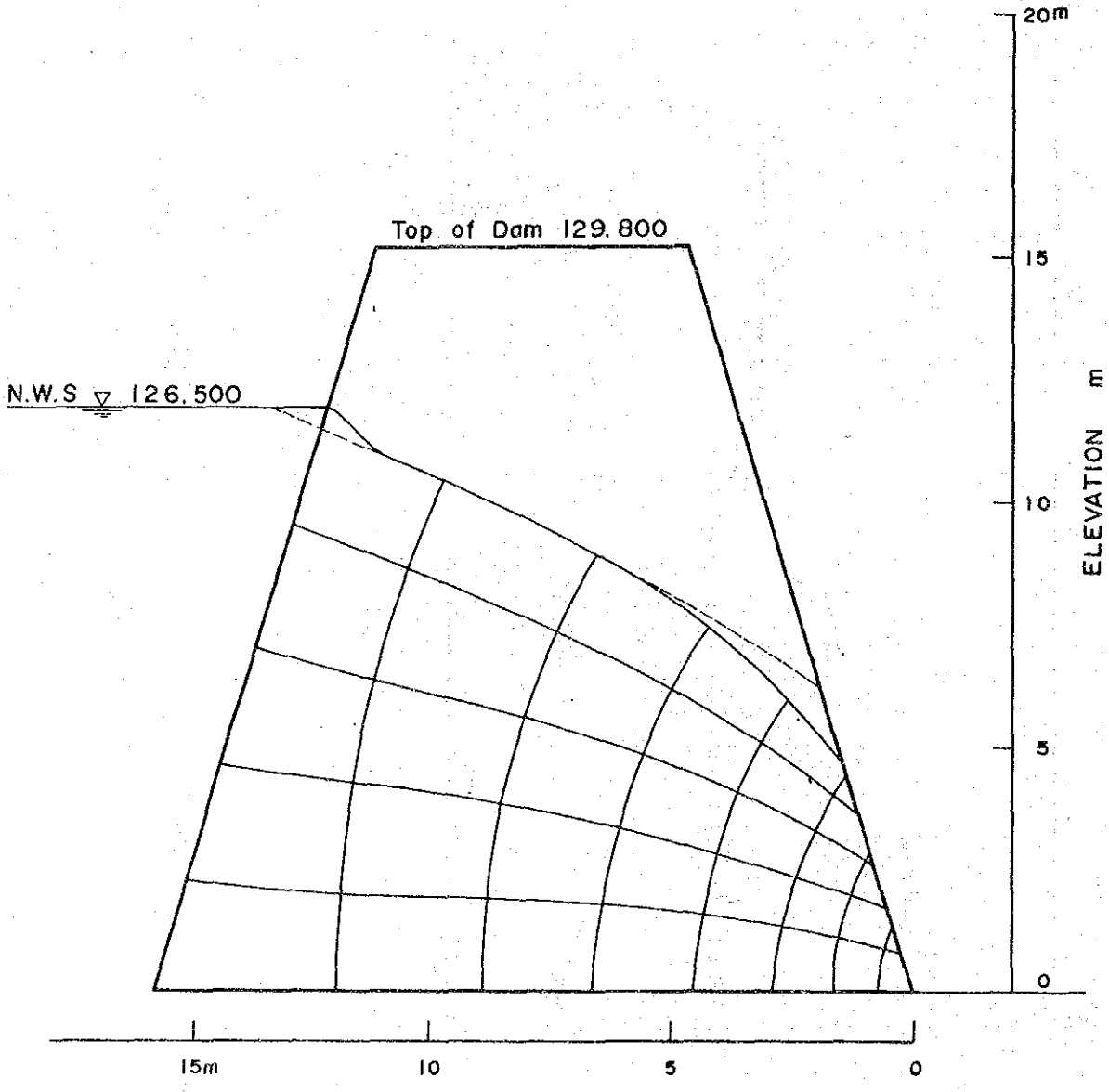


FIG. D-11 STREAM LINE IN IMPERVIOUS ZONE
PANGASAN

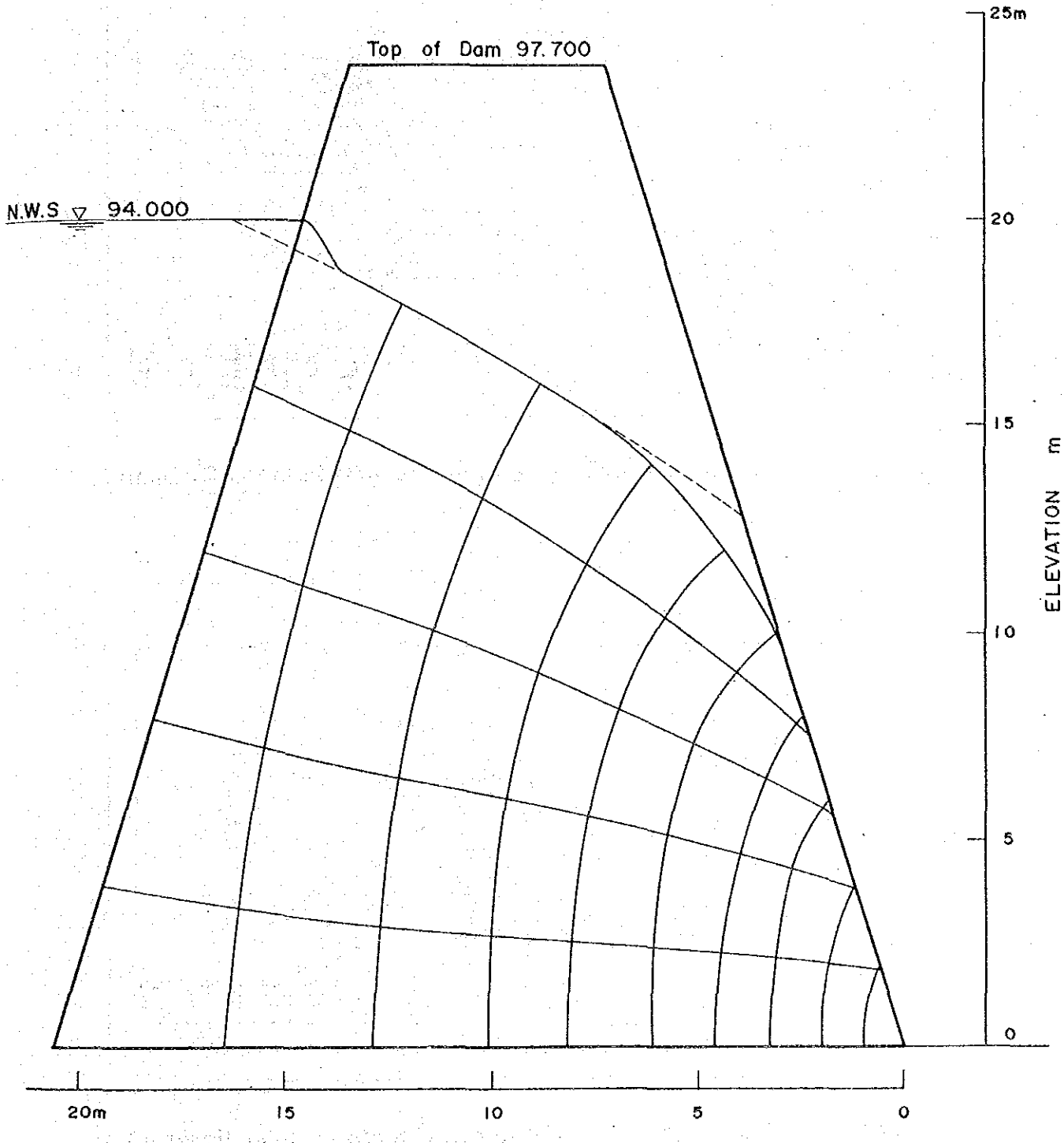


FIG. D-12 STREAM LINE IN IMPERVIOUS ZONE
BALNGES DAM

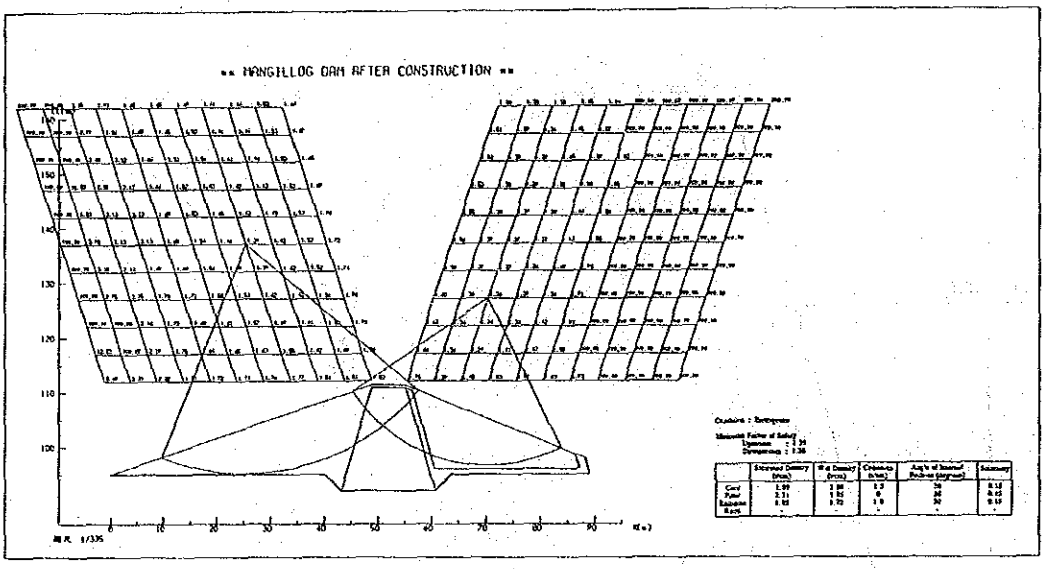


Fig. D-13 Factor of Safety by Slip Circle Method (Mangillog Dam)

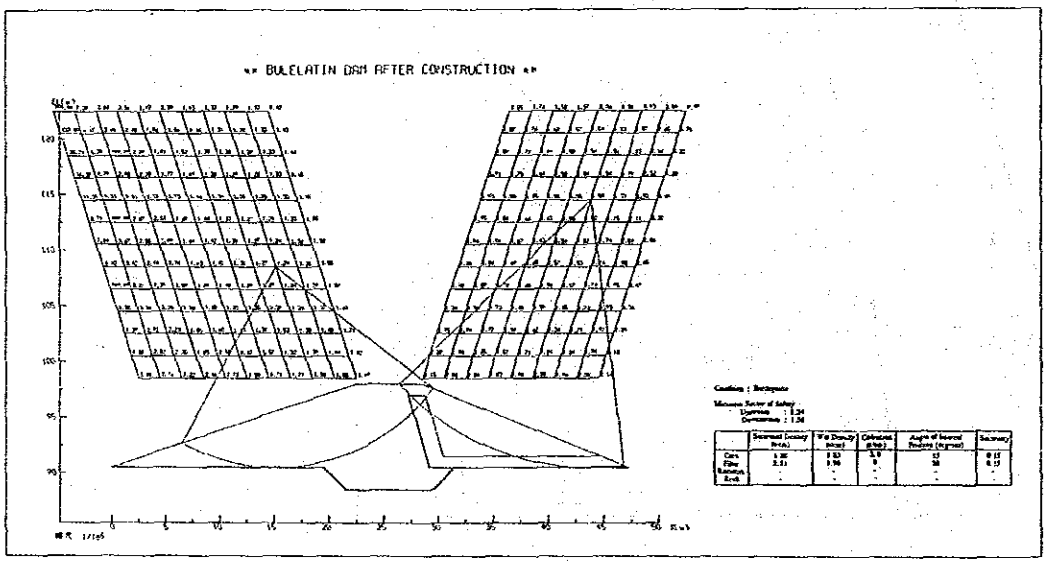


Fig. D-14 Factor of Safety by Slip Circle Method (Bulelatin Dam)

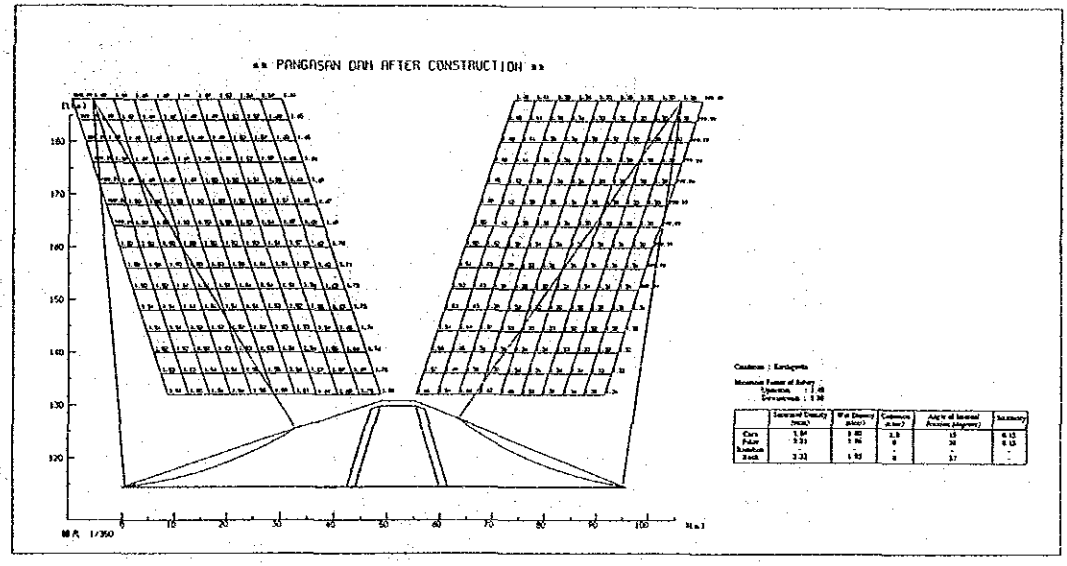


Fig. D-15 Factor of Safety by Slip Circle Method(Pangasan Dam)

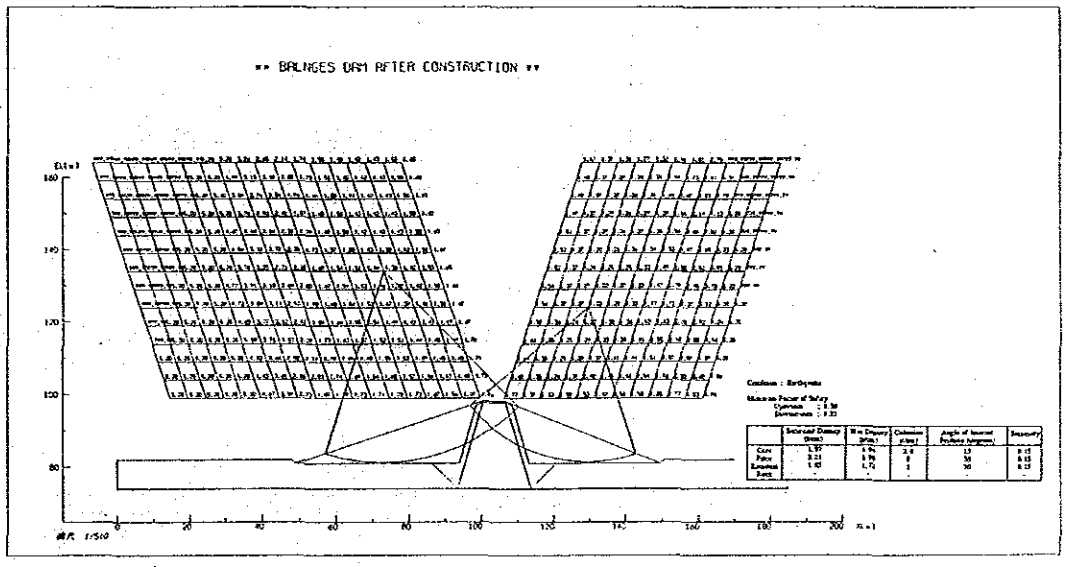


Fig. D-16 Factor of Safety by Slip Circle Method(Balnges Dam)

Table D-1　土質試験結果

Results of Soil Tests

マンギログダム

Mangillog Dam

番号 No.	比重 Specific Gravity	液性限界 Liquid Limit (%)	塑性指数 Plasticity Index	自然含水比 Natural Moisture Content (%)	最適含水比 Optimum Moisture Content (%)	最大乾燥密度 Max. Dry Density (t/㎥)	備考 Remarks
TP－1	2.74	56	24	28	27.5	1.40	Random Fill
TP－2	2.82	64	40	29－39	29.2	1.49	
TP－3	2.68	53	28	20	28.5	1.42	Random Fill
TP－4	2.82	65	42	38－50	31.5	1.44	
TP－5	2.68	56	36	36－37	21.0	1.55	
AH－1		54	33	33－29			
AH－2		41	23	26－15			
AH－3				27			
AH－4		52	26	42－24			
AH－5		51	28	42－37			
AH－6		54	31	35－37			
TP－35	2.65	78	53	26	27.9	1.50	F/S c=3t/㎡, ϕ=20°

Table D-1　土質試験結果
Results of Soil Tests

ブレラチンダム
Bulelatin Dam

番号 No.	比重 Specific Gravity	液性限界 Liquid Limit (%)	塑性指数 Plasticity Index	自然含水比 Natural Moisture Content (%)	最適含水比 Optimum Moisture Content (%)	最大乾燥密度 Max. Dry Density (t/㎥)	備考 Remarks
TP－1	2.83	46	25	30－32	26.0	1.55	
TP－2	2.67	63	44	35	21.1	1.59	
TP－3	2.67	56	32	39－41	21.2	1.48	
AH－1		54	35	28			
AH－2		47	26	31－34			
AH－3		46	27	24－31			
TP－18	2.63	48	32	28	24.0	1.54	F/S c=3.2t/㎡, ϕ=16°

Table D-1　土質試験結果
Results of Soil Tests

パンガサンダム
Pangasan Dam

番号 No.	比重 Specific Gravity	液性限界 Liquid Limit (%)	塑性指数 Plasticity Index	自然含水比 Natural Moisture Content (%)	最適含水比 Optimum Moisture Content (%)	最大乾燥密度 Max. Dry Density (t/㎥)	備考 Remarks
TP－1	2.68	52	28	35－41	25.0	1.53	
TP－2	2.80	34	15	25－26	20.1	1.64	
TP－3	2.67	51	28	23－44	28.1	1.37	
TP－4	2.77	73	45	36	33.5	1.32	
AH－1				19			
AH－2		53	29	30－43			
AH－3		55	33	35－29			
AH－4							
AH－5		53	36	28－25			
TP－10	2.64	72	46	25	29.6	1.40	F/S c=1.6t/㎡, φ=20°

Table D-1　土質試験結果
Results of Soil Tests

バルンゲスダム
Bainges Dam

番号 No.	比重 Specific Gravity	液性限界 Liquid Limit (%)	塑性指数 Plasticity Index	自然含水比 Natural Moisture Content (%)	最適含水比 Optimum Moisture Content (%)	最大乾燥密度 Max. Dry Density (t/㎥)	備考 Remarks
TP－1	2.67	40	19	25－29	15.6	1.67	
TP－2	2.65	42	22	32－28	20.4	1.45	
TP－3	2.69	31	15	18－23	15.4	1.76	
TP－4	2.69	28	12	24－25	19.3	1.66	
AH－1		38	21	21－19			
AH－2		44	25	24－27			
AH－3		40	20	14－20			
AH－4		34	15	23－31			
TP－32	2.64	38	21	19	18.6	1.63	F/S c=3.2t/㎡, ϕ=17°

Table D-1　土質試験結果
Results of Soil Tests

砂礫材料
Sand and Gravel Materials

番号 No.	粗骨材 Coarse Aggregate 比重 Specific Gravity	粗骨材 Coarse Aggregate 吸水率 Water Absorption (%)	細骨材 Fine Aggregate 比重 Specific Gravity	細骨材 Fine Aggregate 吸水率 Water Absorption (%)	合成比重 Compound Specific Gravity
SGTP－1	2.77	1.4	2.69	3.1	2.75
SGTP－2	2.73	1.6	2.69	2.9	2.72
SGTP－3	2.71	1.6	2.65	3.6	2.70
ATP－1	2.75	1.3	2.70	0.5	2.74
ATP－2	2.73	1.6	2.68	0.8	2.71

Table D-2　堤体材料設計値：
Design Values of Materials

マンギログダム Mangillog Dam	不透水材料 Impermeable Materials	ランダム材料 Random Fill	フィルター材料 Filter Materials
比重 Specific Gravity	2.7	2.68	2.7
含水比 (%) Moisture Content	33.0	27.5	1.5
乾燥密度 (t/㎥) Dry Density	1.42	1.35	1.93
湿潤密度 (t/㎥) Wet Density	1.89	1.72	1.96
飽和密度 (t/㎥) Saturated Density	1.89	1.85	2.21
粘着力 (t/㎡) Cohesion	1.5	1.0	0
内部摩擦角 (deg) Internal Friction Angle	20	30	38
透水係数 (cm/sec) Coefficient of Permeability	1×10^{-5}	1×10^{-4}	1×10^{-3}

ブレラチンダム Bulelatin Dam	不透水材料 Impermeable Materials	フィルター材料 Filter Materials
比重 Specific Gravity	2.67	2.7
含水比 (%) Moisture Content	30.0	1.5
乾燥密度 (t/㎥) Dry Density	1.41	1.93
湿潤密度 (t/㎥) Wet Density	1.83	1.96
飽和密度 (t/㎥) Saturated Density	1.88	2.21
粘着力 (t/㎡) Cohesion	2.0	0
内部摩擦角 (deg) Internal Friction Angle	15	38
透水係数 (cm/sec) Coefficient of Permeability	1×10^{-5}	1×10^{-3}

Table D-2　堤体材料設計値：
Design Values of Materials

パンガサンダム Pangasan Dam	不透水材料 Impermeable Materials	ロック材料 Rock Materials	フィルター材料 Filter Materials
比重 Specific Gravity	2.7	2.70	2.7
含水比 (%) Moisture Content	35.0	2.0	1.5
乾燥密度 (t/㎥) Dry Density	1.33	1.93	1.93
湿潤密度 (t/㎥) Wet Density	1.80	1.95	1.96
飽和密度 (t/㎥) Saturated Density	1.84	2.22	2.21
粘着力 (t/㎡) Cohesion	1.0	0	0
内部摩擦角 (deg) Internal Friction Angle	15	37	38
透水係数 (cm/sec) Coefficient of Permeability	1×10^{-5}	1×10^{-3}	1×10^{-3}

バルンゲスダム Balnges Dam	不透水材料 Impermeable Materials	ランダム材料 Random Fill	フィルター材料 Filter Materials
比重 Specific Gravity	2.65	2.68	2.7
含水比 (%) Moisture Content	25.0	27.5	1.5
乾燥密度 (t/㎥) Dry Density	1.55	1.35	1.93
湿潤密度 (t/㎥) Wet Density	1.94	1.72	1.96
飽和密度 (t/㎥) Saturated Density	1.97	1.85	2.21
粘着力 (t/㎡) Cohesion	2.0	1.0	0
内部摩擦角 (deg) Internal Friction Angle	15	30	38
透水係数 (cm/sec) Coefficient of Permeability	1×10^{-5}	1×10^{-4}	1×10^{-3}

取 水 施 設 諸 元 表

Salient Features of Intake Facilities

Table D-3

Dam	(導入口最高) Min. Water Surface (m)	(水路水面最高) N.W.S. at Impact Box (m)	(流 量) Design Capacity (m³/sec)	(管 径) Conduit Diameter (mm)	(バルブ径) Outlet Valve Diameter (mm)	(底樋延長) Conduit Length (m)	(取水部ゲート数) Intake Gate Number
Mangillog (Upper)	104.5	104.0	0.51	1,000	600	68.5	1
Mangillog (Lower)	99.0	98.0	0.21	1,000	400	123.5	2
Bulelatin	91.3	91.0	0.20	1,000	500	68.0	2
Pangasan	120.1	118.0	0.40	1,000	500	98.0	1
Balnges	84.3	83.0	0.70	1,000	600	115.0	1

合理式による設計洪水量の推定

Table D−4 Estimation of Design Flood for Spillway by Rational Formula

Nawe of Dam	Watershed Area	△H	△L	△S	Tp	I_{200}	fp	$QD=\frac{A \cdot fp \cdot 1200}{3600} \times 10^3$
	㎢	m	m		min	mm/hr		㎥/s
Mangiliog	8.1	80	3,750	0.021	210	58.2	0.60	79
Bulelatin	2.0	30	2,000	0.015	200	60.5	0.55	18
Pangasan	12.9	240	3,400	0.071	200	60.5	0.85	184
Balnges	27.9	450	18,000	0.021	360	41.2	0.80	255

Note 1. △H is the difference of the elevation between the reservoir and the highest in the watershed.

2. △L is the longest flow distance from the remotest area in the watershed.

3. △S is the mean slope △H／△L.

4. Tp is the concentration time of a flood to the reservoir, in min.

5. I_{200} is the design rainfall intensity for Tp with a return period of 200 year at the Hacienda Luisita PAGASA station. [I=Exp(7.4903−0.6408×LnT) in mm/hr.]

6. fp is the peak run off coefficient for infiltration and site storage in the catchment area (affected by geology, topography, soil condition and vegetation)

7. Qp is the estimated design flood by the rational formula.

Technical Data :

5. Project Evaluation

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Table E-1 Summary of Production

	Cropping Area (ha)			Production (ton)		
	Present	Future		Present	Future	
		W/O	W/		W/O	W/
Wet Season						
Irrigated Paddy	-	-	1,030	-	-	4,635
Rainfed Paddy	1,030	1,030	-	2,060	2,472	-
Dry Season						
Irrigated Corn	-	-	842.5	-	-	3,370
Total	1,030	1,030	1,872.5	2,060	2,472	8,005
Paddy Rice	1,030	1,030	1,030	2,060	2,472	4,635
Corn	0	0	842.5	0	0	3,370
Crop Intensity (%)	100	100	182	-	-	-

Table E-2 Economic Analysis of Net Value of Production

		Area	Yield	Farm Gate Price	Gross Value of Production	Production Cost	Net Value of of Production	Net Return from Project Area
		(ha)	(ton/ha)	(₱/ton)		(₱/ton)		(₱ Thousand)
Wet Season								
Rainfed Rice	$\overline{W}$	1,030	2.4	3,410	8,185	2,755	5,430	5,592.90
Irrigated Rice	W	1,030	4.5	3,410	15,345	4,285	11,060	11,391.80
Dry Season								
Irrigated Corn	W	842.5	4.0	3,975	15,900	4,915	10,985	9,254.86
Total								
	$\overline{W}$	1,030						5,592.90
	W	1,872.5						20,646.66

	$\overline{W}$	(₱ Thousand)	W
Total Net Value of Production Before Costing of Labor	5,592.90		20,646.66
Less Imputed Cost of Labor	964.08		2,320.05
Total Net value of Production	4,628.82		18,326.61
Net Incremental Value of Production at full development 1)		13,697.79	

W = With Project
$\overline{W}$ = Without Project
1) Less value of annual production foregone estimated at ₱ 121 thousand/year= Net incremental benefit would be ₱ 13,577/year

Table E-3

Rice Crop Budget

Item	Present				Future Without Project				Future with Project	
	Rainfed		Irrigated		Rainfed		Irrigated		Irrigated	
	WS	DS	WS	DS	WS	DS	WS	DS	WS	DS
Yield (ton/ha)	2.0	-	2.5	2.3	2.4	-	3.0	3.0	4.5	4.5
Farm Gate Price (₱/ton)	3,400	-	3,400	3,400	2,840	-	2,840	2,840	2,840	2,840
Gross Value of Production (₱/ha)	6,800	-	8,500	7,820	6,815	-	8,520	8,520	12,780	12,780
Production Costs Excluding Labor (₱/ha)	1,905	-	2,130	2,065	2,540	-	2,825	2,825	3,950	4,270
Net Value of Production Excluding Labor (₱/ha)	4,895	-	6,370	5,755	4,275	-	5,695	5,695	8,830	8,510
Labor Requirements (man-days/ha)	72	-	79	83	78	-	86	86	110	110

Corn Crop Badget

Item	Present		Future Without Project		Future with Project	
	Rainfed		Rainfed		Irrigated	
	WS	DS	WS	DS	WS	DS
Yield (ton/ha)	-	1.0	-	1.3	-	4.0
Farm Gate Price (₱/ton)	-	3,400	-	3,325	-	3,325
Gross Value of Production (₱/ha)	-	3,400	-	4,320	-	13,300
Production Costs Excluding Labor (₱/ha)	-	1,650	-	2,110	-	4,595
Net Value of Production Excluding Labor (₱/ha)	-	1,750	-	2,210	-	8,705
Labor Requirements (man-days/ha)	-	64	-	69	-	95

Table E-4 Farm Budget (1.5 ha)

		Present Rainfed	Future with Project Irrigated
1.	Cropped Area (ha)	1.5	2.73
2.	Total Production (m.t.)	3.0	11.67
3.	Gross Value of Production (₱)	10,200	35,529
4.	Production Cost (Excluding Labor (₱))	2,855	11,577
5.	Cost of Hired Labor (60%)[1]	1,295	3,382
6.	Net Value of Production (₱) (Before Water Charges)	6,050	20,570
7.	Water Charges (₱)[2]	-	1,210
8.	Net Value of Production (₱) (After Water Charges)	6,050	19,360
9.	Annual Lease Payment for Land (₱)[3]	2,110	7,606
10.	Net Farm Income (₱)		
	10.1 Full Owner	6,050	19,360
	10.2 Lessee	3,940	11,754
11.	Farm Labor Requirement (man-days)	72	282

1) Based on the average wage rate of ₱20/day; 60% of labor are assumed hired.
2) Based on irrigation fee rates of 2.5 cavans (125kg) and 2.1 cavans (105kg) per hectare for wet and dry seasons, respectively.
3) Based on the rate under agricultural leasehold system which is 25% of the value of harvest after deducting the costs of seeds, harvesting and threshing.

Note: 1. cropping intensity = Present Rainfed - 100%; with project - 182%.
2. cropping pattern for with project - Rice in wet season and corn in dry season.

Table E-5 Estimated Traffic Volume of Bridge

Item	Transportation Volume	Vehicle Type	Traffic Volume (units/year)
1. Transportation for agriculture			
1.1 Products (Rice)	4,050 tons/year [1)]	4-ton truck (50%)	507
		14-ton truck (50%)	145
1.2 Products (Corn)	2,200 tons/year [1)]	4-ton truck	550
1.3 Materials (10% of the above total)		4-ton truck	120
Sub-Total			1,322
2. Transportation for non-agriculture			
2.1 Persons and living supplies		Jeepny	50,722 [2)]
Total			52,044

Note: 1) Products of rice from Pangasan and Balnges irrigation area and existing irrigation area of Lubigan. Products of corn from Pangasan and Balnges irrigation area.

2) Projection for ten years after was made as follows on the basis of assumption that one person of every households crosses the bridge while using a jeepny to go and return from the outside everyday.

570 households x 1.02^{10} x 1 x 2 x 365/10 (persons/unit) = 50,722 units/year

Technical Data :

6. Soil Series and Land Classification

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1. Soil Series and Land Classification

(1) Identified Soil Series in the Project Area

There are two soil series that were established in the project area. These are San Manuel soil series and Tarlac soil series. The San Manuel soil series have three soil types, such as: SmA SiCl, SmAFSCL and SmASL. Tarlac soil series on the other hand is represented by four mapping units like TcACL, TcBCL, TcCL and TcDCL. Hectarage summary of these soil series and types are shown in Table A-1 of this appendix. (See Fig. A-1 to Fig. A-3)

i) San Manuel Series (Sm)

San Manuel series is a member of the fine loamy, deep and well drained soil. It is a recent alluvial soil transported by water from high grounds and mountain ranges. The surface soil is grayish brown to pale brown, loose and friable silty clay loam to sandy loam. The subsoil is light yellowish brown to yellowish brown, fine sandy loam to silty clay loam. The solum thickness ranges from 80 to 100 centimeters. Relief is level to nearly level. Drainage condition is fair to good. This soil series covers 294.5 hectarage or 25 per cent of the total project area.

ii) Tarlac Series (Tc)

This soil series is a member of the fine loamy deep, poorly drained, residual soil derived from tuffaceous sandstone. The A horizon, 30 to 60 centimeters is dark gray gritty clay loam. The B horizon, 55 to 110 centimeters is brownish gray to grayish brown chalky tuff or tuffaceous sandstone. Relief is rolling to hilly with small intervening flat areas. Surface drainage is generally good to excessive but internal drainage is poor. This soil series occupies 856.5 hectares of 73 per cent of the project area.

(2) Chemical Properties

Results on the study conducted by the Bureau of Soils, Manila, the following laboratory analysis by soil series is shown in Table A-2. Based on the results, pH is slightly acidic with value ranging from 6.03 to 6.18. The pH requirement

Table A-1 Hectarage Tabulation of Soil Series/Type by Dam

Name	Soil Series	Area (ha)	Per Cent (%)
Bulelatin Dam	TcA	60.5	44.2
	TcB	73.5	53.6
	Hydrosol	3.0	2.2
	Total	137.0	100.0
Balnges Dam	TcA	60.5	15.0
	TcB	65.0	16.0
	TcC	10.0	2.5
	SmA	254.5	64.0
	Hydrosol	10.0	2.5
	Total	400.0	100.0
Mangillog Dam	TcA	176.0	44.0
	TcB	154.0	38.5
	TcDCL	27.0	6.8
	SmA	40.0	10.0
	Hydrosol	3.0	0.7
	Total	400.0	100.0
Pangasan Dam	TcA	70.5	30.6
	TcB	71.5	31.1
	TcC	68.0	29.6
	TcD	20.0	8.7
	Total	230.0	100.0
	Total	1,167.0	

for rice is between 6.0 to 7.0 which is slightly acidic to neutral. On the other hand, the general NPK recommendation of the project area for rice production during wet and dry season is about 60-30-30 and 80-30-30 kilograms per hectare, respectively. For diversified crop like corn, the recommended rate is about 80-60-45 kilograms per hectare.

Table A-2 Chemical Properties

Particular	San Manuel	Tarlac Series
pH	6.03	6.18
OM (%)	0.76	2.05
CEC	20.87	50.97
BSP	66.67	82.13
Available P (ppm)	5.25	8.77
Exchangeable K (ml/100 g)	0.10	0.25
General fertility	Low	High

(3) Description of Land Classes in the Project Area

i) Arable Land Classes

A total of 1,030.0 hectares or 88 per cent of the project area were classified as arable land as shown in Table A-3. (See Fig. A-1 to A-3)

a. Class 1R

This land class consists of about 346.0 hectares or 30 per cent of the project area. Topography is nearly level to slightly sloping with slope ranging from 0.0 to 3.0 per cent. Class 1R consists of highly productive land having low development cost and no limitation on topography, soils and drainage.

The soil varies from clay loam to clay under laid by tuffaceous sandstone. Surface soil color is grayish brown to dark gray, while sub-soil is gray to dark gray.

b. Class 2R

This class consists of good quality land lower than class 1R in potential productivity for lowland rice production. Due to its moderate topographic limitation, this area is downgraded to class 2Rt.

There are 342.5 hectare of land under this class. It represents 29 per cent of the total project area.

c. Class 3R

This class consists of fair quality land lower than class 2R in productivity for lowland rice production due to its severe topographic limitation, this is are downgraded to class 3Rt.

There are 74.0 hectares of land classified under this class, or equivalent to 6 per cent of the total project areas.

d. Dual Class Land (1R-2d)

This land has potentials for both rice and diversified crop production. The land has a friable surface soil having texture of fine sandy loam, silty clay loam and clay loam throughout the root zone. Subsoil have good permeability and drainage condition. However, for diversified crop of restricted trainability should be provided with facilities to drain excess water at the root zone.

This class of land is highly suitable for irrigated rice during the wet season and diversified crop in the dry season with adequate irrigation supply. Class 1R-2d covers a total area of 267.5 hectares or 23 per cent of the project area.

ii) Non-Arable Land

These are the lands which are not suitable for irrigation development due to severe restriction on soils, topography and drainage. It includes the residential areas (Class M), rivers and hilly areas (Class 6).

A total of 137.0 hectares were classified and mapped and represents 12 per cent of the project area.

2. Farm Economic Survey

A farm economic survey was carried out to collect data and information relating to the present economic situation of farmers in the Project area. These data and information provide the present condition of farmers for formulating the development plan as well as basic data for project benefit monitoring and evaluation.

For the purpose, items investigated in the survey included family structure and composition, land tenure and holding, irrigation condition, crop and livestock production, extension services, agricultural credit, farmer's organization and farmer's intention toward the development.

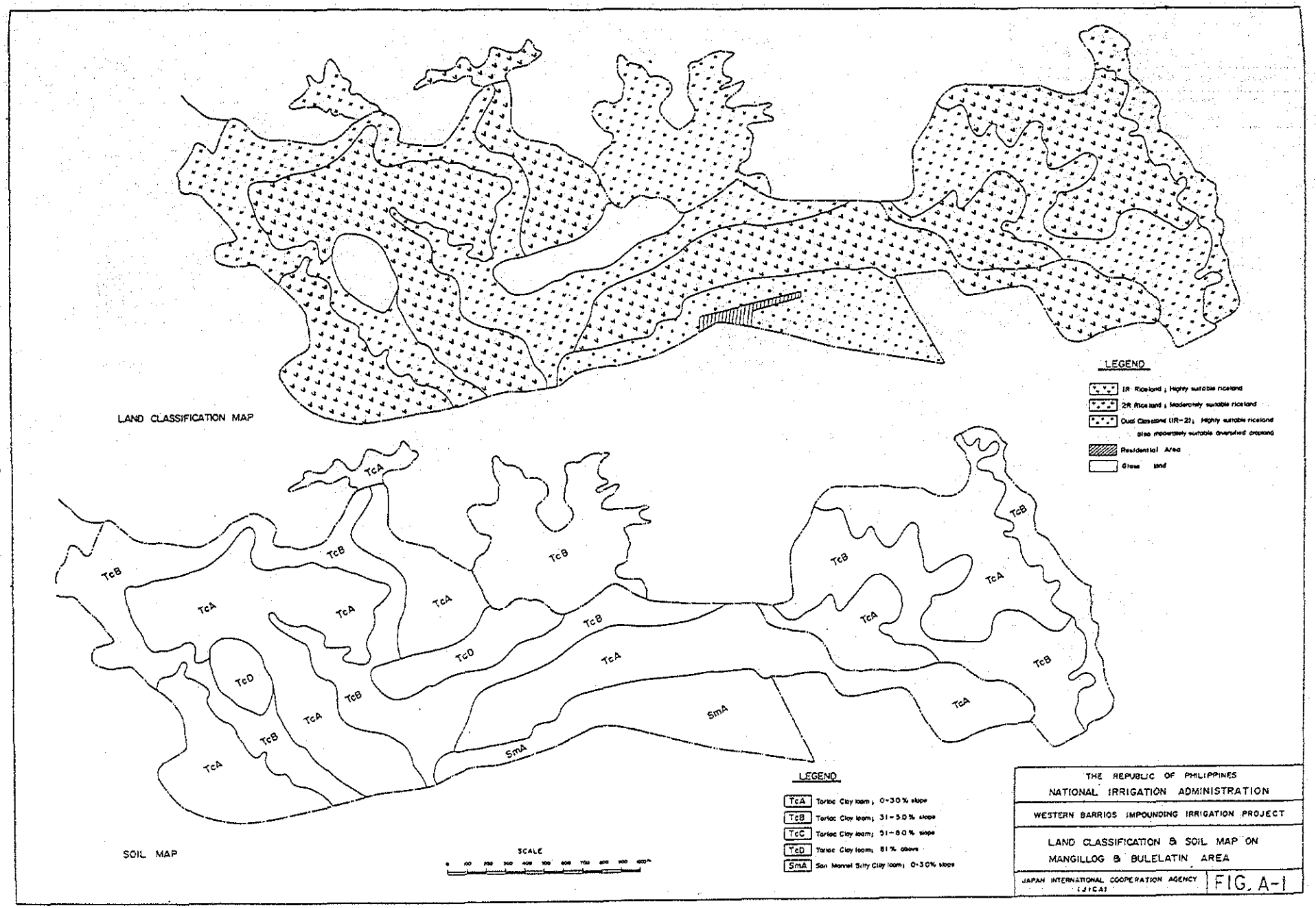
Random sampling was adopted in this survey. There are about 2,000 farm households in the barangays related to the Project area. In total, 120 farmers were interviewed by counterparts. The sampled farmers were about 6 % of all the farm households in the barangays.

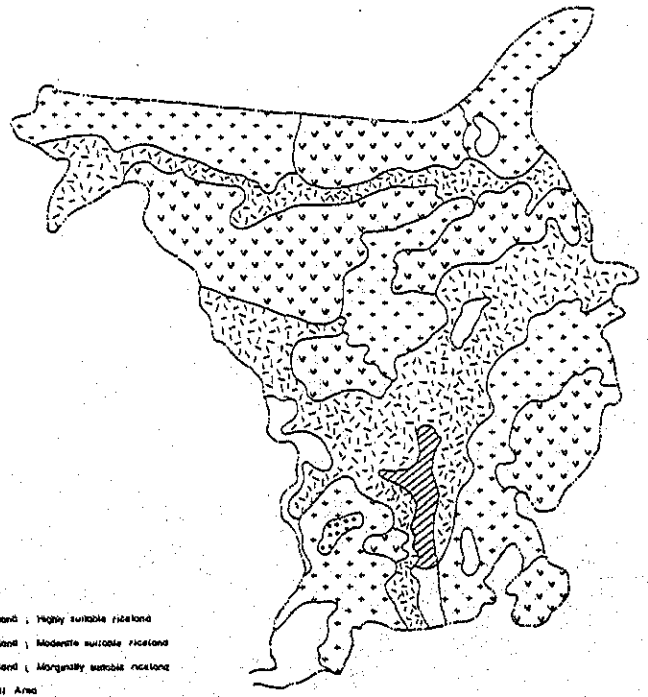
Table A-3 Hectarage Tabulation of Land Classes/Land Use by Dam

Name of Dam	Land Classes	Land Use [1]						Row	M	6	Total
		Pr	PrIp	Cn	L	Gl	Total				
Bulelatin Dam	1R	54.0	-	-	-	-	54.0	6.5			
	2R	66.0	-	-	-	-	66.0	7.5			
	Total	120.0	-	-	-	-	120.0	14.0	-	3.0	17.0
Balnges Dam	1R	49.5	4.5	-	-	-	54.0	6.5			
	2R	40.5	-	-	-	18.0	58.5	6.5			
	3R	-	-	-	-	9.0	9.0	1.0			
	1R-2d	26.0	22.5	9.0	171.0	-	228.5	26.0			
	Total	116.0	27.0	9.0	171.0	27.0	350.0	40.0	-	10.0	50.0
Mangillog Dam	1R	171.0	-	-	-	-	171.0	5.0			
	2R	150.0	-	-	-	-	150.0	4.0			
	1R-2d	5.5	-	-	33.5	-	39.0	1.0			
	Total	326.5	-	-	33.5	-	360.0	10.0	-	30.0	40.0
Pangasan Dam	1R	66.0	1.0	-	-	-	67.0	3.5			
	2R	49.5	1.0	-	-	17.5	68.0	3.5			
	3R	11.0	-	-	-	54.0	65.0	3.0			
	Total	136.5	2.0	-	-	71.5	200.0	10.0	4.5	15.5	30.0
Total		689.0	29.0	9.0	204.5	98.5	1,030.0	74.0	4.5	58.5	137.0

1) Land Use

Pr	(Paddy rice rainfed)	Gl	(Grassland)
PrIp	(Paddy rice pump irrig)	M	(Residential)
Cn	(Corn, pump irrigated)	6	(Hilly areas)
L	(Diversified unirrigated)	ROW	(Right-of-Way)

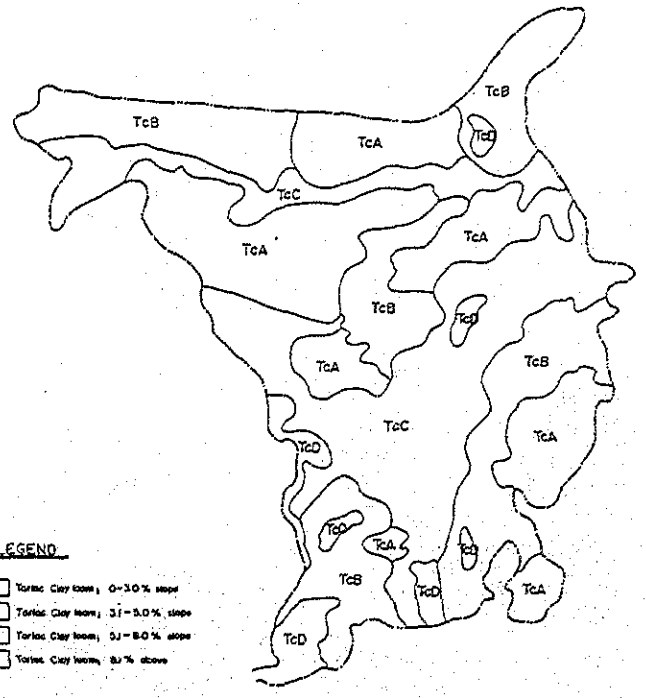

LAND CLASSIFICATION MAP
LEGEND
IR Riceland ; Highly suitable riceland
2R Riceland ; Moderately suitable riceland
Dual Cropping (IR-2); Highly suitable riceland
also moderately suitable diversified cropland
Residential Area
Grass land
SOIL MAP
TcA
TcB
TcC
TcD
SmA
SCALE
LEGEND
TcA Tarlac Clay loam ; 0-3.0 % slope
TcB Tarlac Clay loam; 3.1-5.0 % slope
TcC Tarlac Clay loam; 5.1-8.0 % slope
TcD Tarlac Clay loam; 8.1 % above
SmA San Manuel Silty Clay loam; 0-3.0% slope
THE REPUBLIC OF PHILIPPINES
NATIONAL IRRIGATION ADMINISTRATION
WESTERN BARRIOS IMPOUNDING IRRIGATION PROJECT
LAND CLASSIFICATION & SOIL MAP ON
MANGILLOG & BULELATIN AREA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
FIG. A-1



LEGEND

- 1R Rice land ; Highly suitable riceland
- 2R Rice land ; Moderate suitable riceland
- 3R Rice land ; Marginally suitable riceland
- Residential Area
- High Ground ; Not to be served by the project

LAND CLASSIFICATION MAP



LEGEND

- TcA Tarlac Clay loam ; 0~3.0 % slope
- TcB Tarlac Clay loam ; 3.1~5.0 % slope
- TcC Tarlac Clay loam ; 5.1~8.0 % slope
- TcD Tarlac Clay loam ; 8.1 % above

SOIL MAP

SCALE

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000m

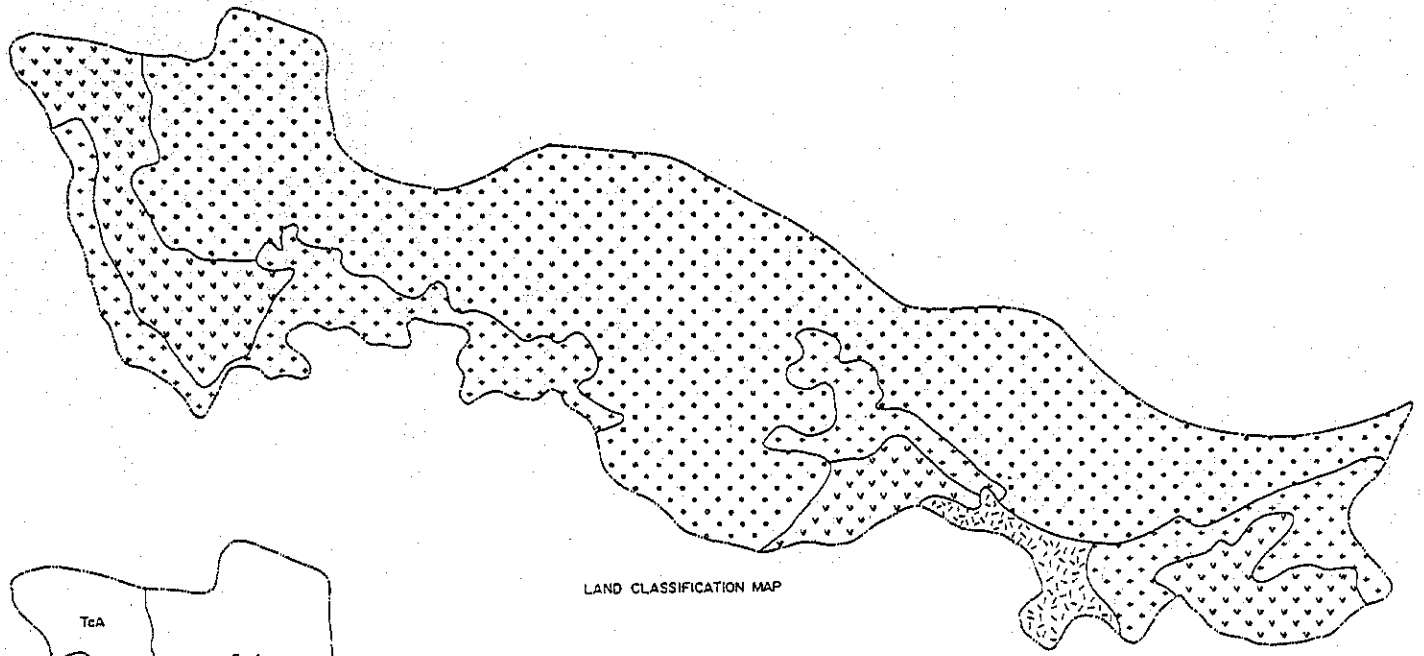
THE REPUBLIC OF PHILIPPINES
NATIONAL IRRIGATION ADMINISTRATION

WESTERN BARRIOS IMPOUNDING IRRIGATION PROJECT

LAND CLASSIFICATION & SOIL MAP ON PANGASAN AREA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

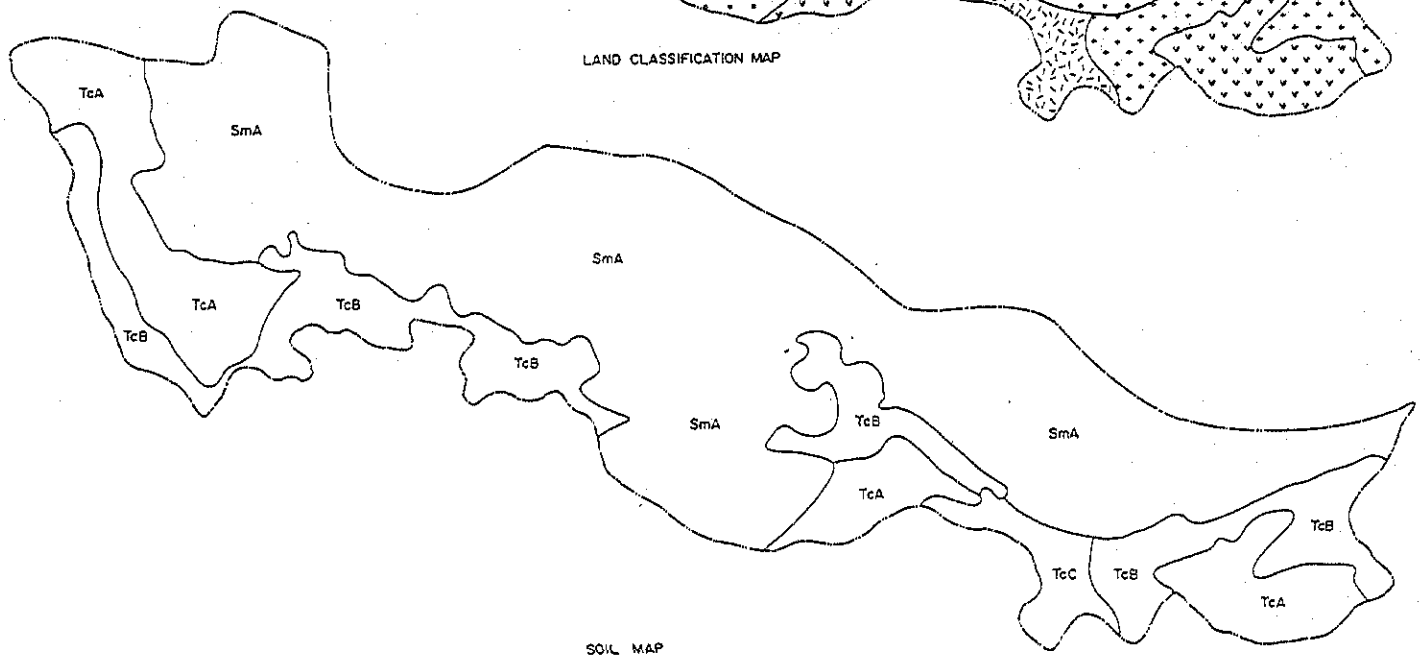
FIG. A-2



LAND CLASSIFICATION MAP

LEGEND

- 1R Riceland ; Highly suitable riceland
- 2R Riceland ; Moderately suitable riceland
- Dual Classland (1R-2); Highly suitable riceland also moderately suitable diversified cropland



SOIL MAP

LEGEND

- TcA Tarlac Clay loam ; 0-3.0% slope
- TcB Tarlac Clay loam ; 3.1-8.0% slope
- TcC Tarlac Clay loam ; 8.1-18.0% slope
- SmA San Manuel Silty Clay loam ; 0-3.0% slope

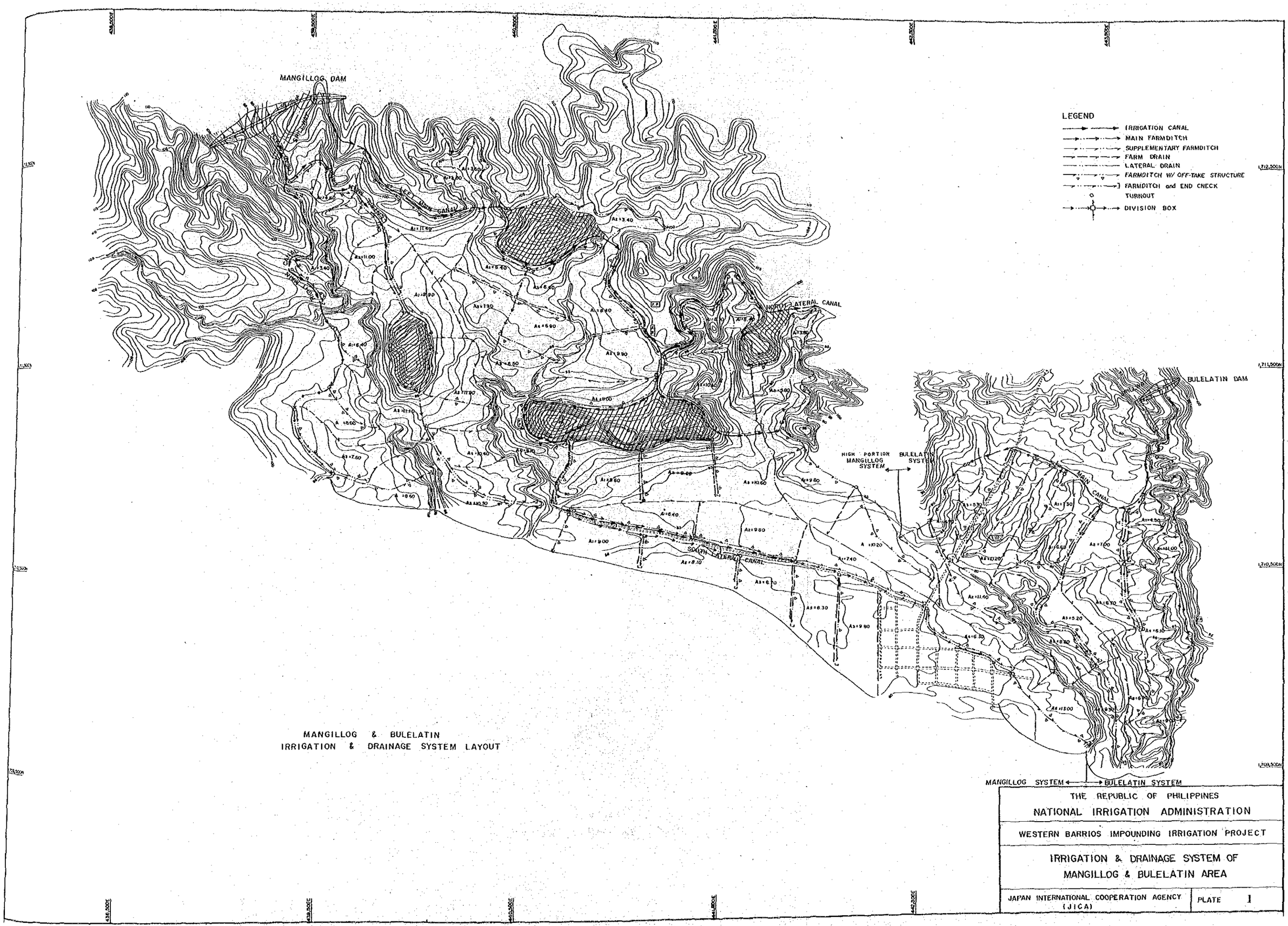
SCALE

0 100 200 300 400 500 600 700 800 900 1000 m

THE REPUBLIC OF PHILIPPINES
NATIONAL IRRIGATION ADMINISTRATION
WESTERN BARRIOS IMPOUNDING IRRIGATION PROJECT
LAND CLASSIFICATION & SOIL MAP ON BALNGES AREA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
FIG. A-3

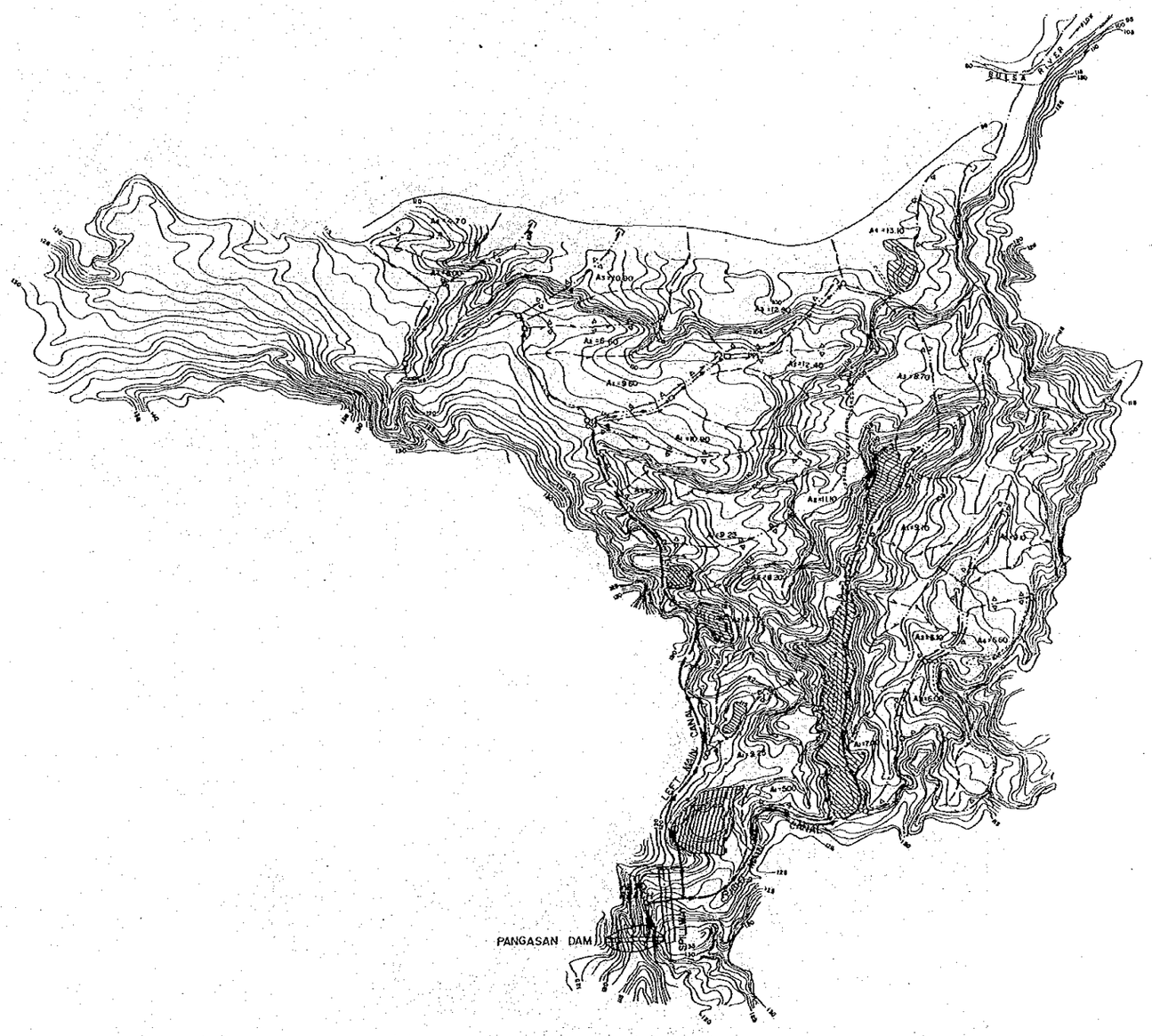
Plates

LIST OF PLATES



MANGILLOG & BULELATIN
IRRIGATION & DRAINAGE SYSTEM LAYOUT

THE REPUBLIC OF PHILIPPINES
NATIONAL IRRIGATION ADMINISTRATION
WESTERN BARRIOS IMPOUNDING IRRIGATION PROJECT
IRRIGATION & DRAINAGE SYSTEM OF MANGILLOG & BULELATIN AREA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
PLATE 1



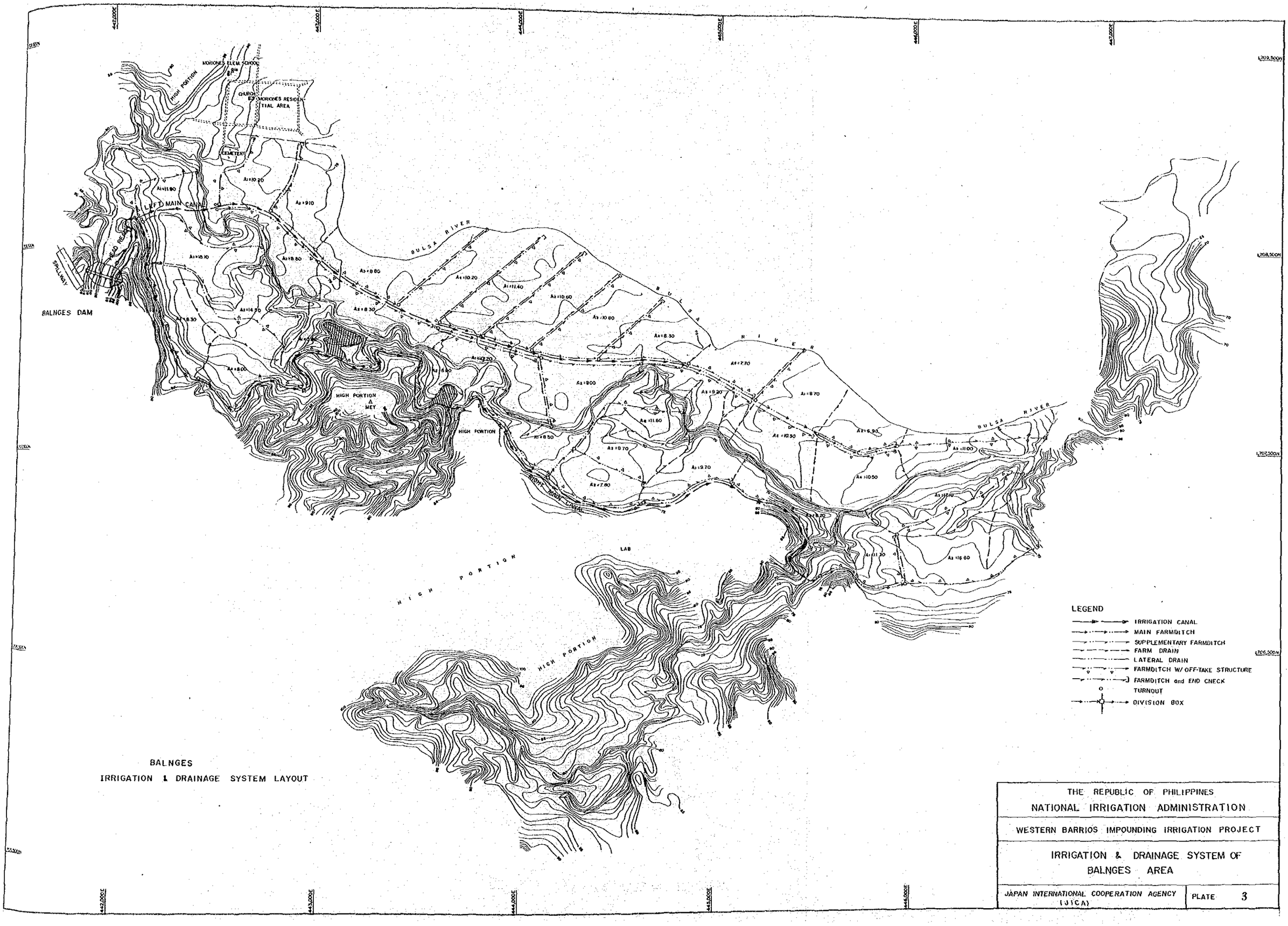
PANGASAN

IRRIGATION & DRAINAGE SYSTEM LAYOUT

LEGEND

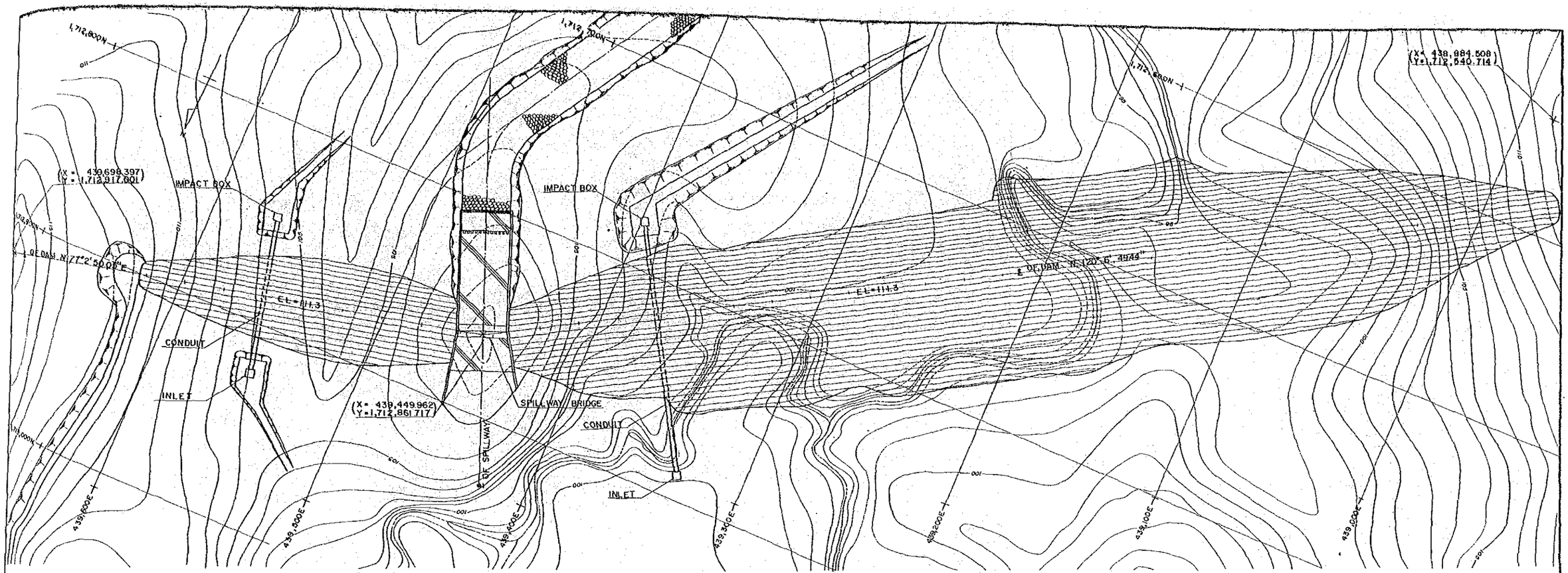
- IRRIGATION CANAL
- MAIN FARMDITCH
- SUPPLEMENTARY FARMDITCH
- FARM DRAIN
- LATERAL DRAIN
- FARMDITCH W/ OFFTAKE STRUCTURE
- FARMDITCH and END CHECK
- TURNOUT
- DIVISION BOX

THE REPUBLIC OF PHILIPPINES	
NATIONAL IRRIGATION ADMINISTRATION	
WESTERN BARRIOS IMPOUNDING IRRIGATION PROJECT	
IRRIGATION & DRAINAGE SYSTEM OF PANGASAN AREA	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	PLATE 2

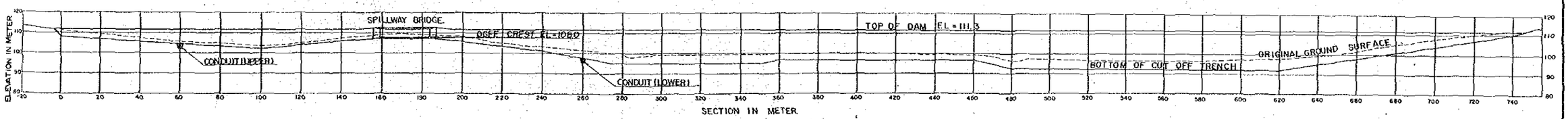


BALNGES
IRRIGATION & DRAINAGE SYSTEM LAYOUT

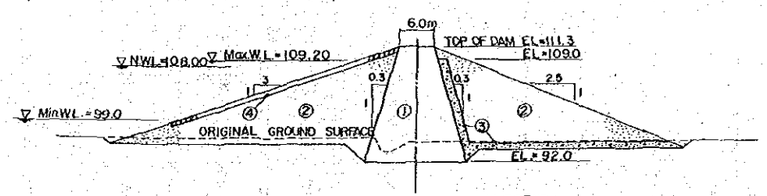
THE REPUBLIC OF PHILIPPINES
NATIONAL IRRIGATION ADMINISTRATION
WESTERN BARRIOS IMPOUNDING IRRIGATION PROJECT
IRRIGATION & DRAINAGE SYSTEM OF BALNGES AREA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
PLATE 3



PLAN OF DAM



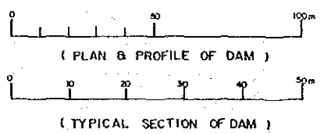
PROFILE ON ℄ OF DAM



LEGEND

①	Impervious core	(Clayey soil)
②	Random fill	(Clayey soil & Weathered rock)
③	Drain	(Sand & Gravel)
④	Riprop	(Cobble)

TYPICAL SECTION OF DAM

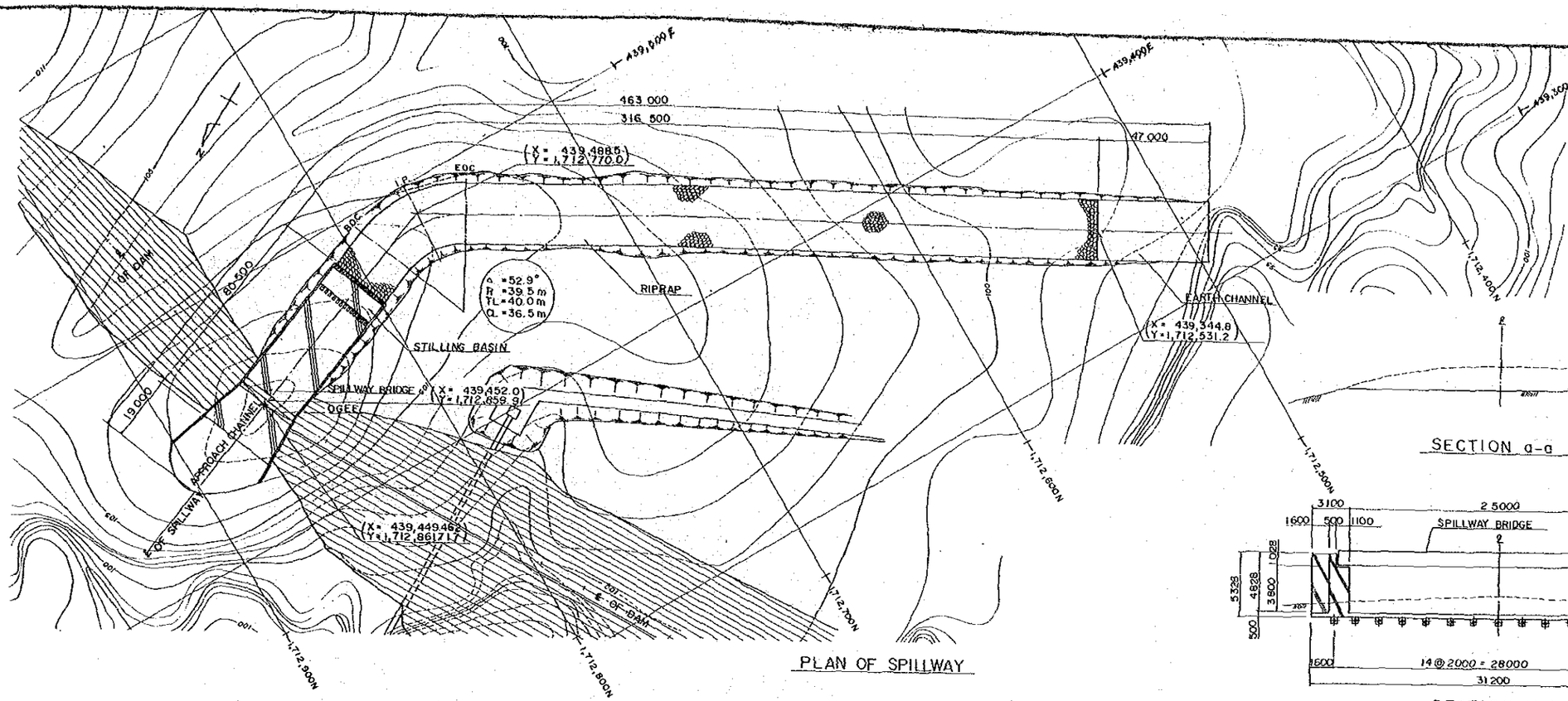


THE REPUBLIC OF PHILIPPINES
NATIONAL IRRIGATION ADMINISTRATION

WESTERN BARRIOS IMPOUNDING IRRIGATION PROJECT

MANGILLOG DAM
PLAN, PROFILE AND TYPICAL SECTION OF DAM

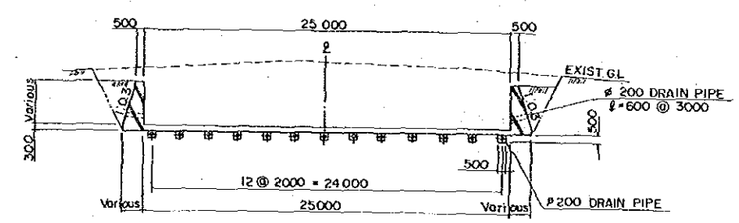
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) | PLATE 4



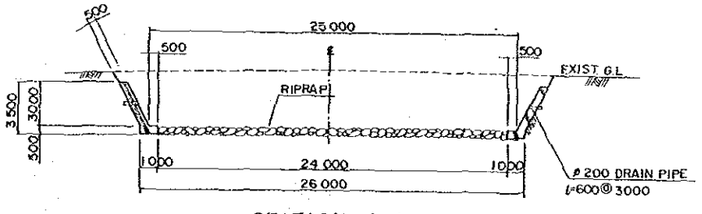
PLAN OF SPILLWAY

SECTION a-a

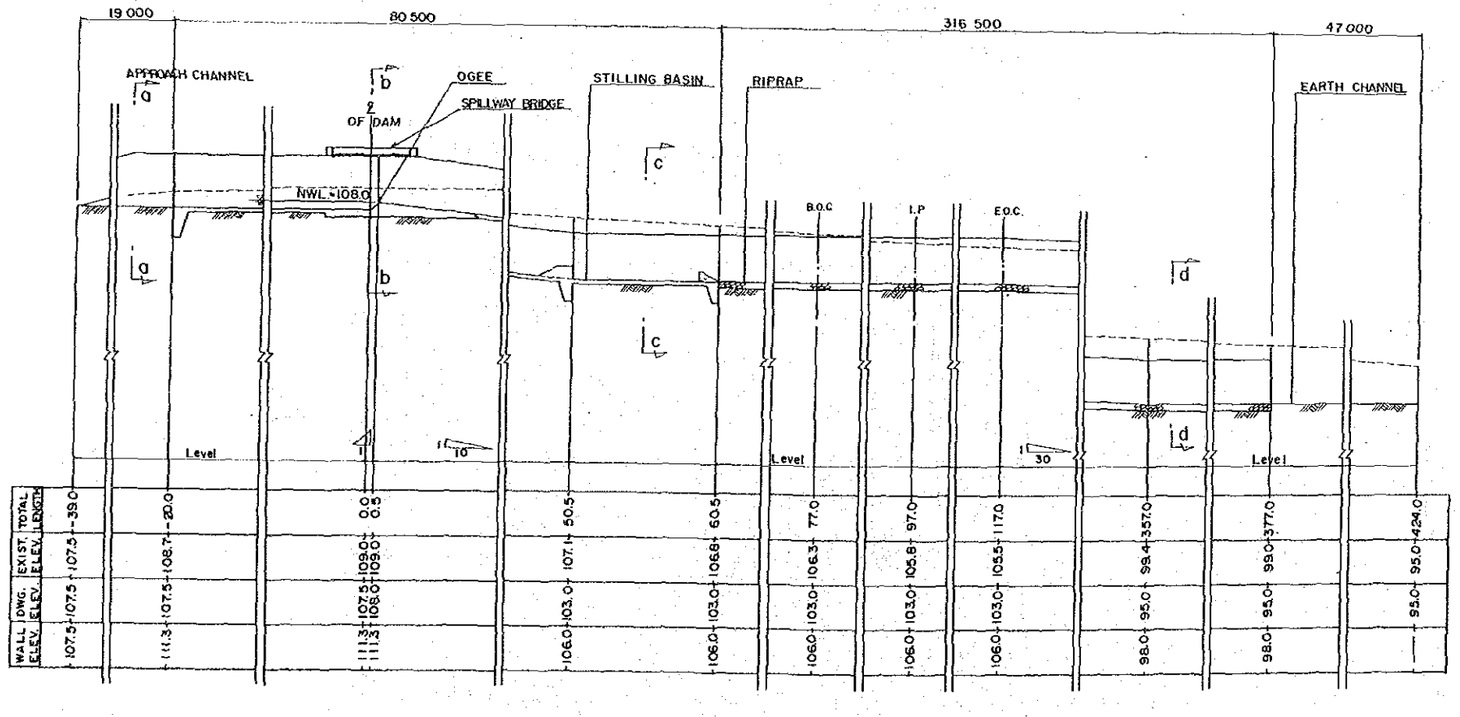
SECTION b-b



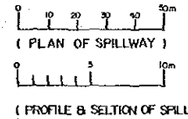
SECTION c-c



SECTION d-d



PROFILE ON ℄ OF SPILLWAY



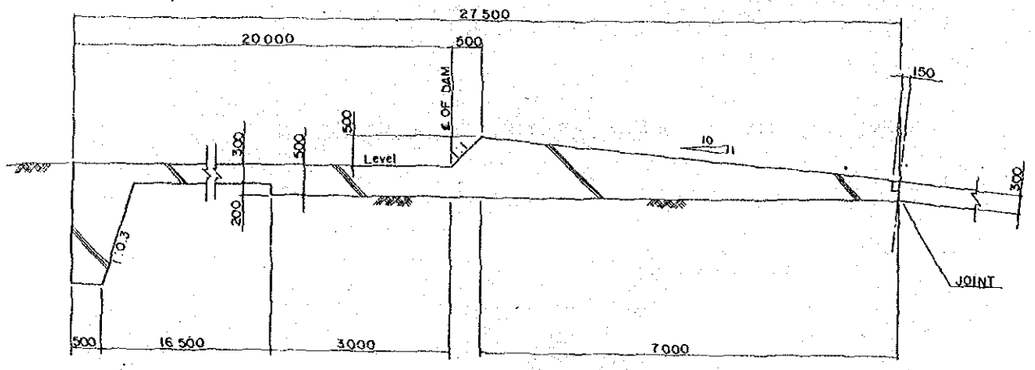
THE REPUBLIC OF PHILIPPINES
NATIONAL IRRIGATION ADMINISTRATION

WESTERN BARRIOS IMPOUNDING IRRIGATION PROJECT

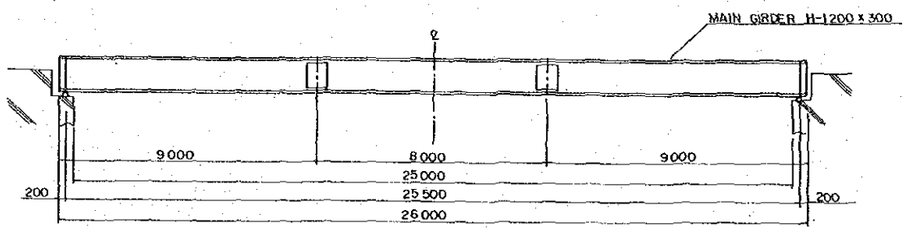
MANGILLOG DAM
PLAN, PROFILE AND SECTION OF SPILLWAY

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

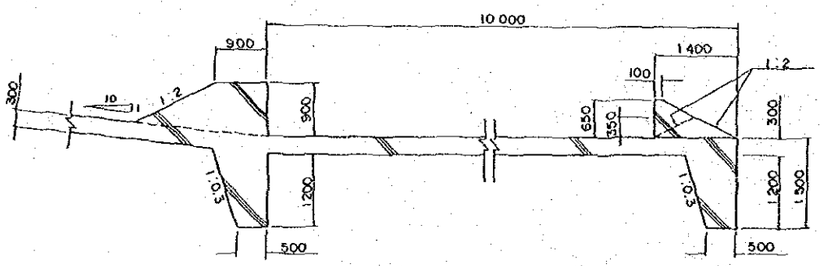
PLATE 5



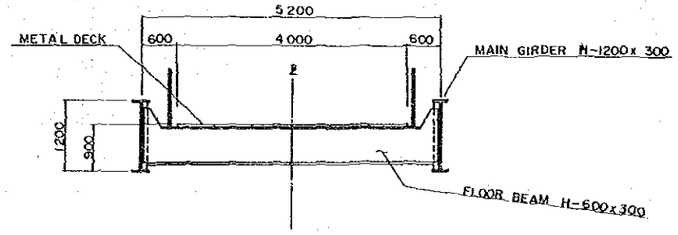
SECTION OF OGEE



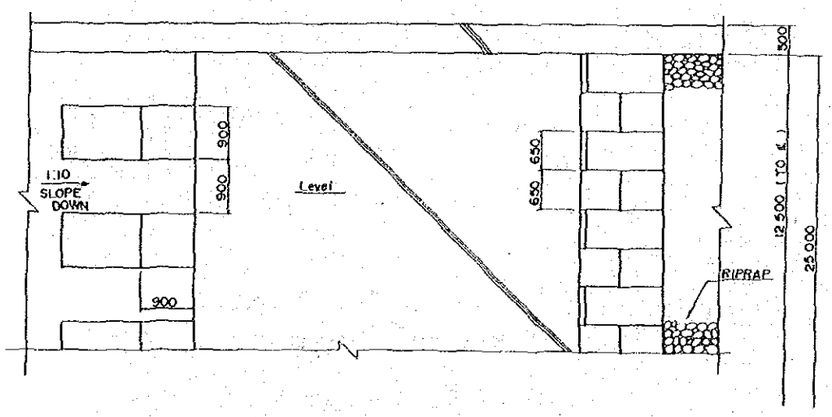
ELEVATION OF SPILLWAY BRIDGE



SECTION OF STILLING BASIN



CROSS SECTION OF SPILLWAY BRIDGE

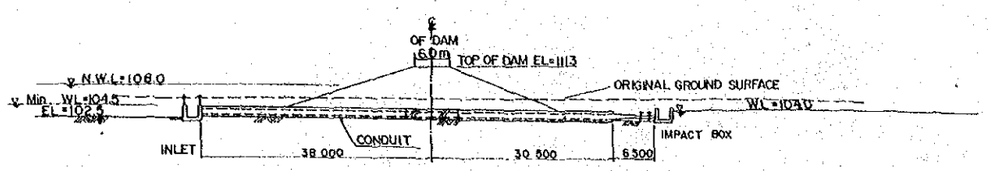


PLAN OF STILLING BASIN

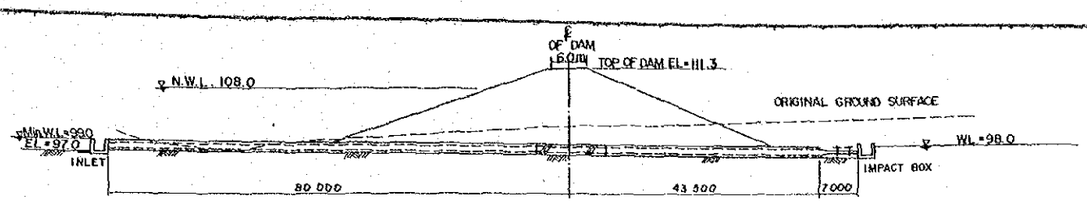
0 5m
(OGEE & STILLING BASIN)

0 5 10m
(SPILLWAY BRIDGE)

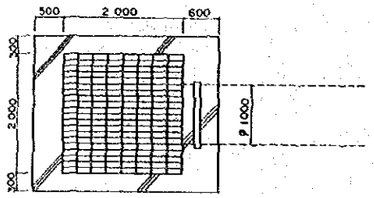
THE REPUBLIC OF PHILIPPINES
NATIONAL IRRIGATION ADMINISTRATION
WESTERN BARRIOS IMPOUNDING IRRIGATION PROJECT
MANGILLOG DAM
DETAIL OF SPILLWAY
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
PLATE 6



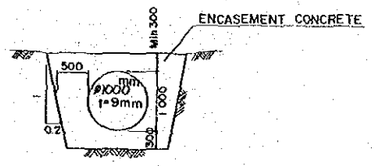
PROFILE ON ℄ OF OUTLET WORKS CONDUIT (UPPER)



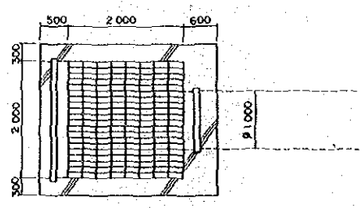
PROFILE ON ℄ OF OUTLET WORKS CONDUIT (LOWER)



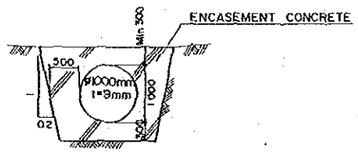
PLAN OF INLET



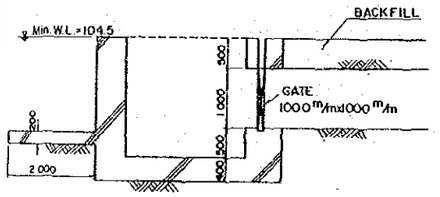
SECTION OF CONDUIT IN CORE TRENCH



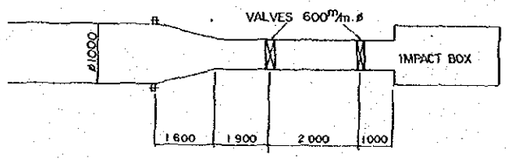
PLAN OF INLET



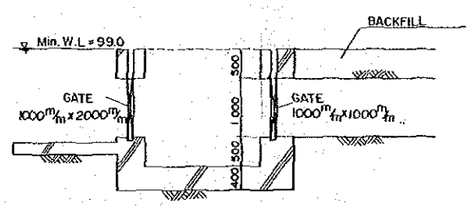
SECTION OF CONDUIT IN CORE TRENCH



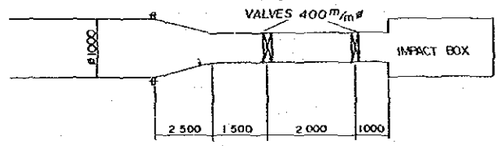
SECTION OF INLET



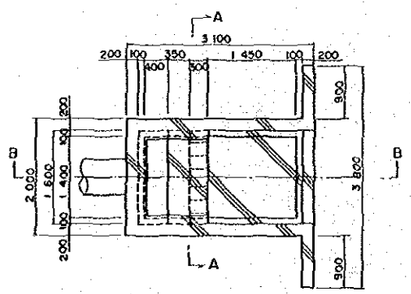
VALVES OF OUTLET



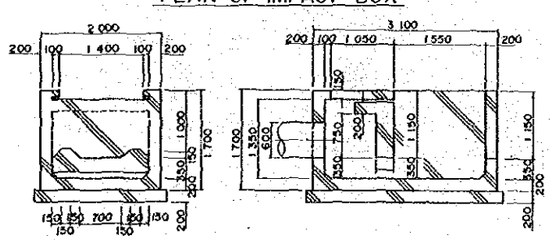
SECTION OF INLET



VALVES OF OUTLET

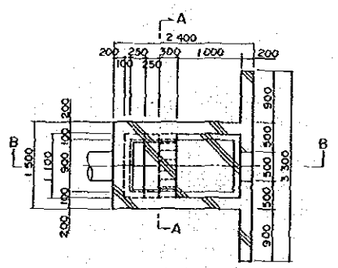


PLAN OF IMPACT BOX

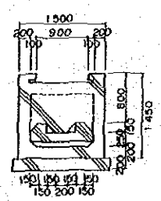


SECTION A-A

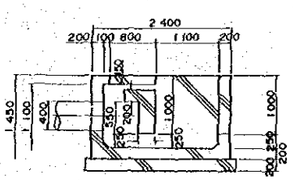
SECTION B-B



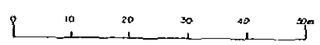
PLAN OF IMPACT BOX



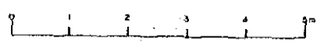
SECTION A-A



SECTION B-B

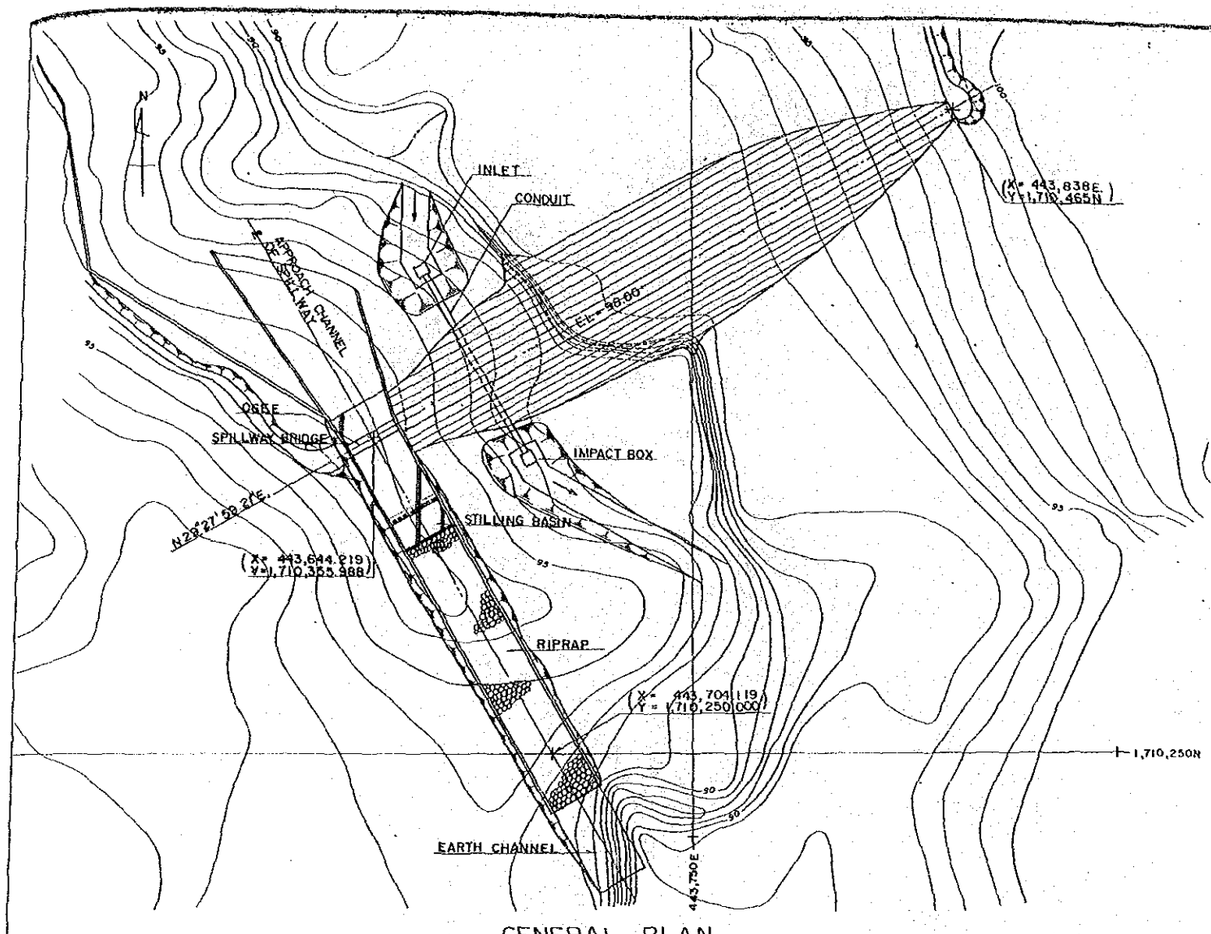


(PROFILE OF OUTLET)

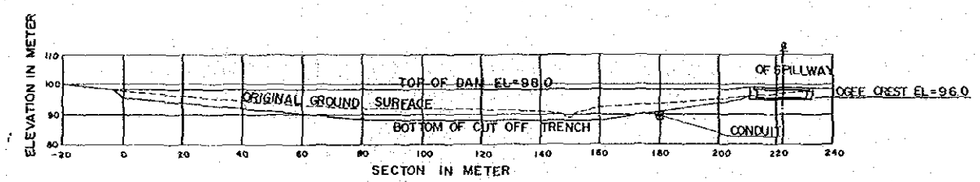


(DETAIL OF OUTLET)

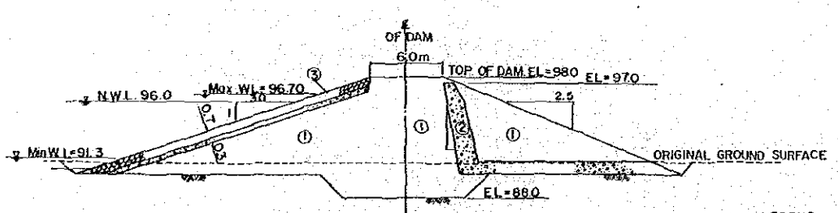
THE REPUBLIC OF PHILIPPINES
NATIONAL IRRIGATION ADMINISTRATION
WESTERN BARRIOS IMPOUNDING IRRIGATION PROJECT
MANGILLOG DAM
DETAIL OF OUTLET WORKS
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
PLATE 7



GENERAL PLAN



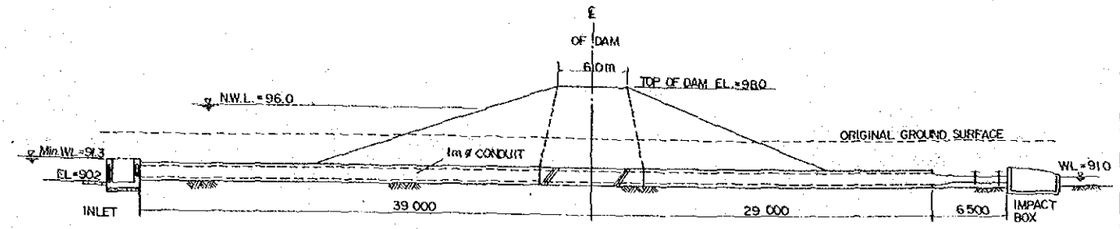
PROFILE ON ℄ OF DAM



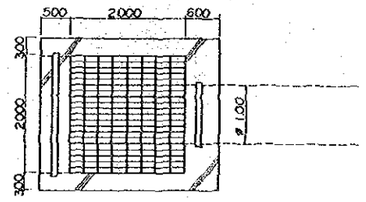
TYPICAL SECTION OF DAM

LEGEND

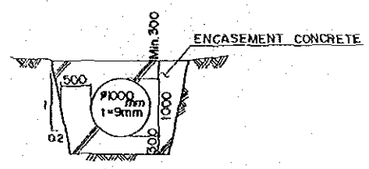
① Impervious Soil (Clayey Soil)
② Drain (Sand & Gravel)
③ Riprap (Cobble)



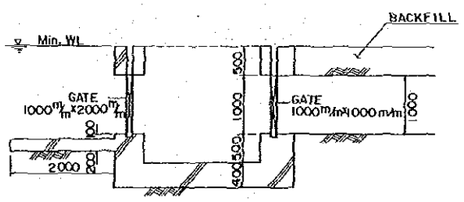
PROFILE ON ℄ OF OUTLET WORKS CONDUIT



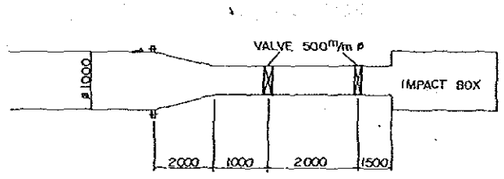
PLAN OF INLET



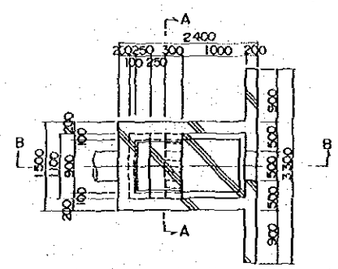
SECTION OF CONDUIT IN CORE TRENCH



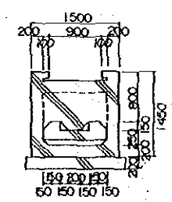
SECTION OF INLET



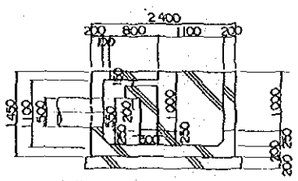
VALVES OF OUTLET



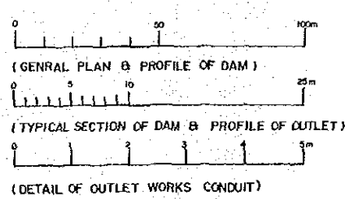
PLAN OF IMPACT BOX



SECTION A-A



SECTION B-B



THE REPUBLIC OF PHILIPPINES

NATIONAL IRRIGATION ADMINISTRATION

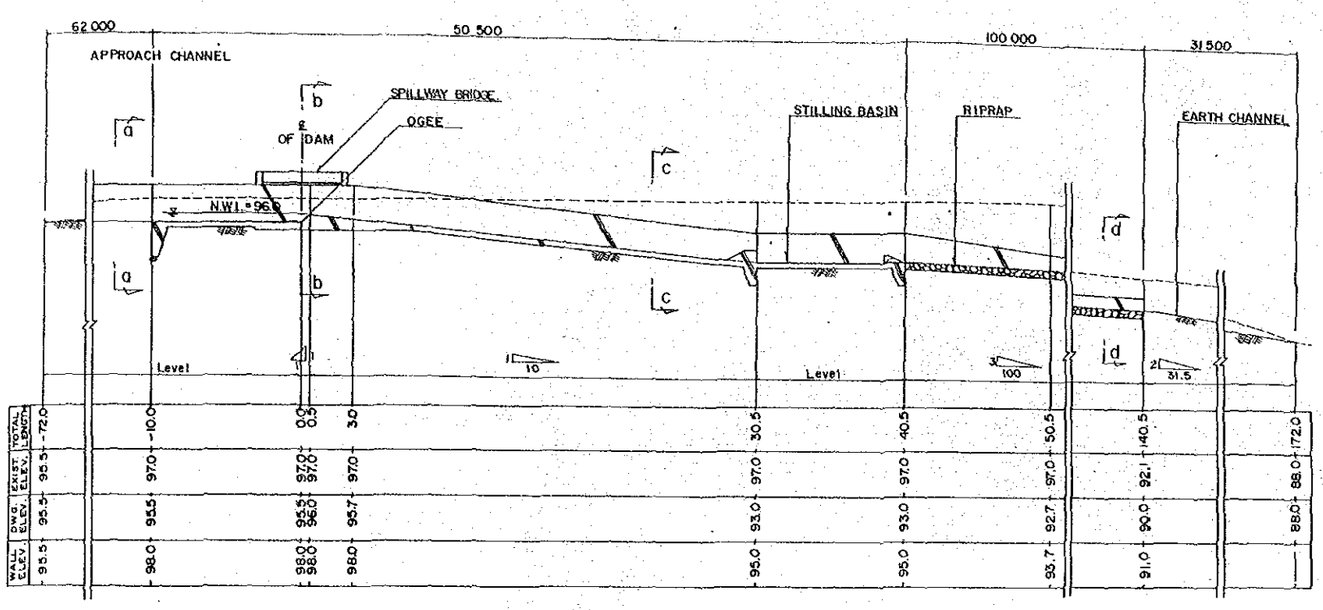
WESTERN BARRIOS IMPOUNDING IRRIGATION PROJECT

BULELATIN DAM

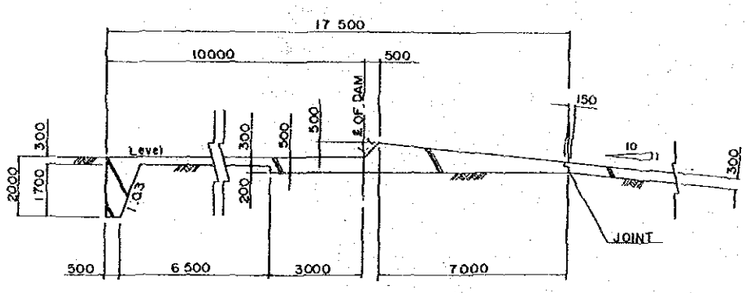
GENERAL PLAN, PROFILE AND TYPICAL SECTION OF DAM, PROFILE AND DETAIL OF OUTLET WORKS

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

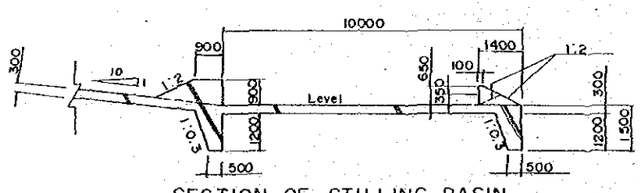
PLATE 8



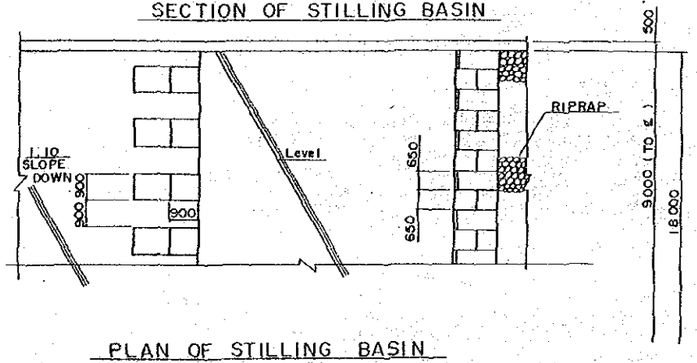
PROFILE ON ℄ OF SPILLWAY



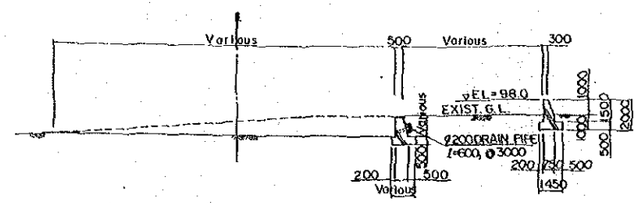
SECTION OF OGEE



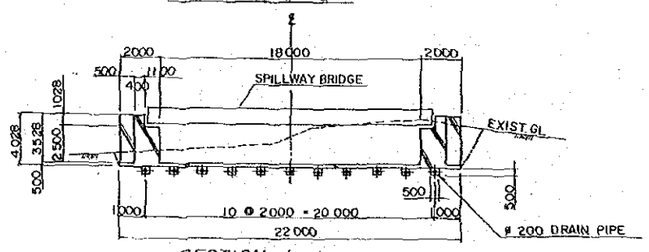
SECTION OF STILLING BASIN



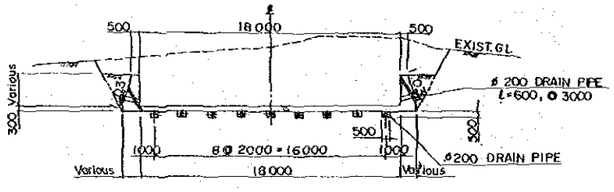
PLAN OF STILLING BASIN



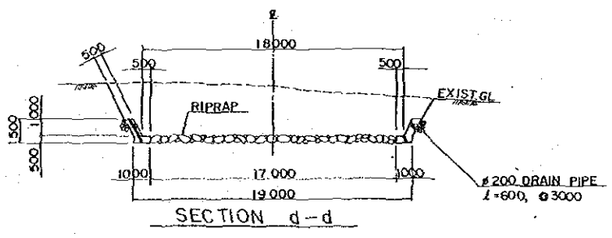
SECTION a – a



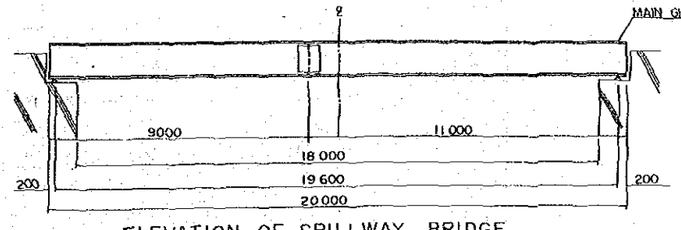
SECTION b – b



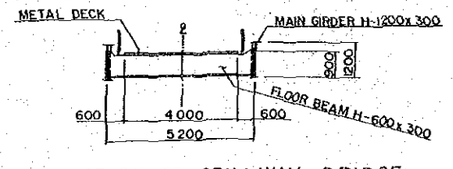
SECTION c – c



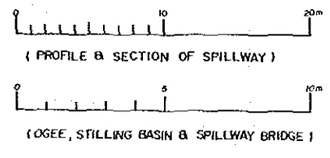
SECTION d – d



ELEVATION OF SPILLWAY BRIDGE



CROSS SECTION OF SPILLWAY BRIDGE



THE REPUBLIC OF PHILIPPINES	
NATIONAL IRRIGATION ADMINISTRATION	
WESTERN BARRIOS IMPOUNDING IRRIGATION PROJECT	
BULELATIN DAM	
DETAIL OF SPILLWAY	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	PLATE 9