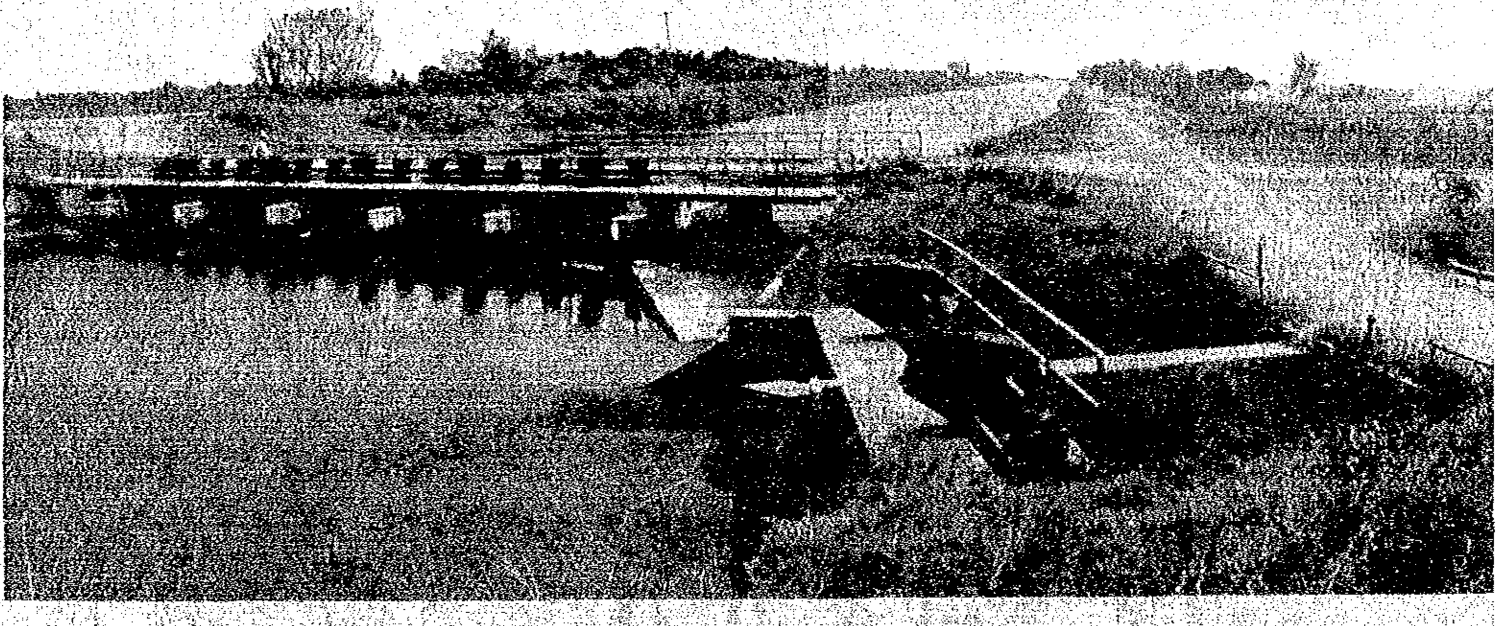
MASTER PLAN STUDY
ON
THE IMPROVEMENT PROJECT OF THE O & M
OF
MAGAT RIVER INTEGRATED IRRIGATION SYSTEM
IN THE
REPUBLIC OF THE PHILIPPINES

ANNEX



JULY, 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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CLIMATE AND HYDROLOGY

A. CLIMATE AND HYDROGY

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1. GENERAL METEOROLOGY

The atmospheric condition in the project area is tropical in nature having high temperature of 23-28°C which is conducive for crop cultivation throughout the year.

An annual rainfall in the service area is about 1,800 mm, of which about 1,100 mm to 1,200 mm is concentrated during the wet season, between June and November, with less rainfall in dry season. The rainfall in wet season, however, fluctuates and could not meet the water requirement for paddy plantation. The rainfall in dry season, in contrast, is absolutely insufficient to cover the water requirement of the paddy.

Typhoon visits two to three times a year mainly during the period from October to November, bringing some damages to paddy plantations.

Climatologic characteristics by season is summarized as follows;

- Annual average temperature varies from 23°C to 28°C with the lowest mean temperature varying in the range from 10°C to 15°C in February.
- Relative humidity varies from 50% to 65% in dry season, and 70% to 80% in wet season.
- Evaporation rate shows 144 and 143 mm/month respectively in dry and wet season.
- Wind speed is moderate in the range of 100 to 150 km/day throughout a year, except the typhoon season.

2. RAINFALL

(1) Rainfall in Service Area

Rainfalls in the service area have been observed at six hydro-met stations for the period of nine years since 1977 up to present. Some data are not considered to be reliable, mainly due to poor maintenance of the observation equipments as well as lack of personnel in charge of observation works. During the course of the study, automatic recording gauges were installed at the sites of Santiago, Nagbacala, Bagong Buhay and Malassin in district I, II, II & III, respectively.

Rainfall record collected from Ilagan, which is located nearby the northeastern corner of the service area, maintains a long-term daily record of rainfall for 26 years from 1961 onwards. Since the hydrological analyses are to be based on the statistical consideration of the long-term historical record, the Ilagan rainfall was employed as a basis mainly for estimating seasonal variation of effective rainfall which could be expected in a standard dry year.

The rainfall in the service area is, in general, well distributed throughout the wet months from July to October, and less distributed in the dry months from November to June. However as seen in Table A-1, seasonal and annual fluctuation of amount of rainfall is remarkable.

Annual rainfall amounts to about 1,800 mm, of which 1,100 to 1,200 mm is concentrated during September to November. Since the area receives insufficient rainfall during the initial stage of wet season paddy cultivation, the wet season cropping accordingly requires supplementary irrigation water. On the other hand, rainfalls in dry season are absolutely insufficient to maintain paddy and upland crop farming, so that dry season cropping requires a large amount of irrigation water to be supplied.

(2) Rainfall in Reservoir Area

Annual average rainfall in the Magat resrvoir watershed is reported at 1,650 mm and 2,290 mm at the damsite and Consuelo station respectively. Tables A-2 and A-3 present monthly rainfall observed at both stations. As is clear from the tables, monthly and annual variation is remarkable resulting in the big fluctuation of the runoffs in the Magat river.

3. RIVER FLOW

Water sources of the MRIIS area are flows of Magat river, Siffu river and return flows of Macanao and Minante Creeks.

(1) Magat River Runoff

Magat river, at the dam site, has a watershed as large as 4,143 sq.km composed of that of three major tributaries of Alimit, Ibulao and Matuno. Annual runoff is 6,550 MCM in average and 3,300 MCM at minimum in 1983. Monthly river flow, as shown in Table A-12, indicates remarkable change in a range of 700 - 1,500 MCM/month in wet season and 50 - 300 MCM/month in dry season. Such river flow may effectively be utilized for dual purposes of irrigation and hydropower generation, only with neat control of water release from the Magat reservoir.

It must be noted that runoff from the Magat river basin depends largely on the storm rainfalls caused by a typhoon during July - September. Arrivals of typhoons are 3.5 times/year on average with much variation by year and month. Frequency of arrivals and their time-interval inevitably influence runoff patterns of the Magat river.

(2) Siffu River Runoff

Siffu river, at Siffuris Diversion dam site, has an watershed of 627 sq.km with 880 MCM of annual average runoff and 290 MCM of annual minimum runoff. Monthly runoff, as shown in Table A-13, indicates remarkable variation as well as in the Magat river.

(3) Daily Runoff

Daily runoff of the said two rivers has been collected or generated for examination of water balance of Magat reservoir. Data collected are those during 1953 - 1985 except three years 1973 - 1975 during which no observation is available. Daily runoff during the short terms of no record has been supplemented and completed in the following manners.

Magat River Runoff

Period	Station (Watershed)	Supplementation
1953 - 57	Oscariz (4,150)	area rate 4,143/4,150
1958 - 61	Damsite (4,143)	by NIA Operation Study
1962 - 64	Oscariz (4,150)	area rate 4,143/4,150
1965 - 67	Bato (1,784)	- do - 4,143/1,784
1968 - 69	Taliktik	- do -
1970 - 72	Damsite (4,143)	by NIA Operation Study
1976 - 78	"	- do -
1979 - 85	"	NIA MRMP Hydrolog. Sec. Data

Siffu River Runoff

Period	Station (Watershed)	Supplementation
1953 - 1956	Munos (686)	area rate 627/686
1957 - 1958	Malig (583)	- do - 627/583
1952 - 1972	Munos (686)	- do - 627/686
1976 - 1979	Magat River (4,143)	- do - 627/4,143 in consideration of areal rainfall ratio
1980 - 1985	Damsite (627)	NIA District III Office

Daily runoffs thus supplemented are adopted for computer data processing in the Magat reservoir water balance simulation.

(4) Return Flow

Return flow from Macanao Creek, the flow of excessive irrigation water from the area along Lateral A-2 canal, is estimated about 5.0 - 10.0 cu.m/s. The flow is used at places along the creek by weir to irrigated downstream area therefrom.

TABLE A-1. MONTHLY RAINFALL OBSERVED AT ILAGAN

* STATION --- ECHAGUE (UNIT: mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1976	-	-	-	-	-	-	-	-	-	-	18.9	36.0	-
1977	29.5	23.0	1.7	5.4	0.2	20.7	9.1	0.6	14.3	17.3	26.5	1.1	149.4
1978	0.5	6.9	10.0	0.0	0.0	5.0	0.3	1.4	8.0	165.6	8.6	5.6	211.9
1979	0.9	2.5	7.9	2.9	0.0	0.0	82.5	136.1	9.4	109.4	54.8	11.6	418.0
1980	2.7	4.8	0.0	0.0	25.0	1.5	-	9.7	4.2	124.2	120.8	17.5	-
1981	8.9	0.5	0.0	0.0	296.8	0.5	5.6	0.0	132.1	1084.3	53.8	169.9	1752.4
1982	53.4	0.0	1.1	0.0	8.9	0.2	16.1	0.0	141.7	43.5	107.8	48.2	420.9
1983	0.4	0.0	7.2	0.0	0.0	-	-	-	12.9	65.5	54.7	14.6	-
1984	12.9	6.0	41.0	243.6	62.9	40.6	0.6	0.0	1.7	379.6	9.1	108.9	906.9
1985	14.6	7.7	19.6	211.2	66.9	299.3	111.9	-	341.9	311.1	115.5	-	-
AVERAGE	13.8	5.7	9.8	51.5	51.2	46.0	32.3	21.1	74.0	255.6	57.0	45.9	643.2

* STATION --- SAGAT (UNIT: mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1977	51.4	27.1	14.7	20.3	151.8	64.7	72.2	374.5	196.7	98.0	216.7	12.2	1300.3
1978	51.4	21.1	14.0	77.9	132.4	273.3	296.2	360.2	337.9	387.7	197.4	90.7	2240.2
1979	0.2	4.6	1.3	43.8	193.5	165.0	208.3	183.6	169.7	77.5	137.2	45.9	1230.6
1980	25.4	20.1	125.2	35.3	132.9	55.8	350.5	115.9	207.6	210.4	200.2	101.2	1580.5
1981	2.3	13.5	0.0	111.5	152.2	295.4	189.0	6.5	218.1	207.4	303.7	11.2	1510.8
1982	7.1	1.0	0.0	292.8	150.5	164.4	37.3	474.7	103.4	3.8	20.9	174.0	1429.9
1983	127.7	0.0	0.0	-	-	-	-	-	73.4	483.9	25.1	9.1	-
1984	0.8	0.0	13.7	271.6	191.5	215.8	-	228.9	83.1	625.7	208.9	26.2	-
1985	1.8	0.0	112.1	9.2	36.9	172.4	5.1	78.3	111.7	105.9	311.1	98.0	1042.5
AVERAGE	29.8	9.7	31.2	107.8	142.7	175.8	165.5	227.8	166.8	244.5	180.1	63.2	1476.4

TABLE A-2. MONTHLY RAINFALL OBSERVED AT MAGAT DAMSITE

* STATION --- BAGONG BUHAY

(UNIT; mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1977	48.2	36.4	3.8	2.5	257.1	93.4	198.9	-	216.2	77.5	161.0	-	-
1978	0.0	12.0	3.3	80.2	145.3	232.8	265.7	223.0	255.0	381.1	187.4	57.1	1842.9
1979	0.0	0.1	8.6	51.2	179.2	91.0	185.9	77.0	134.9	95.3	172.0	-	-
1980	35.4	10.7	43.1	80.8	98.9	47.0	427.7	83.9	211.2	203.1	-	49.1	-
1981	14.9	8.6	0.0	76.7	313.5	140.8	166.7	128.1	203.3	172.3	189.9	33.3	1448.1
1982	15.2	0.0	23.1	152.4	99.3	164.7	81.6	220.6	208.4	43.2	132.9	108.0	1249.4
1983	63.0	0.0	0.0	3.3	131.8	0.0	153.6	164.6	100.8	414.1	77.4	13.1	1121.7
1984	12.7	0.0	7.7	130.2	674.0	180.8	-	335.2	93.4	468.3	40.5	115.6	-
1985	0.0	0.0	98.3	56.1	193.8	407.7	-	354.4	318.4	394.4	180.2	48.2	-
AVERAGE	21.0	7.5	20.9	70.4	232.5	150.9	211.4	198.3	193.5	249.9	142.7	60.6	1415.5

* STATION --- SALVACION

(UNIT; mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1977	-	-	11.7	8.5	220.5	88.2	238.2	371.8	277.1	62.8	171.9	13.6	-
1978	8.0	20.0	67.1	28.0	145.2	266.3	283.2	262.4	272.4	580.1	209.8	73.2	2215.7
1979	3.8	7.9	7.6	184.7	206.5	-	170.4	110.7	110.2	146.4	185.1	68.0	-
1980	9.0	12.5	40.9	13.6	89.4	37.8	476.9	84.6	203.0	268.8	236.2	45.1	1517.8
1981	32.5	9.6	0.0	58.8	166.6	149.4	236.4	159.6	207.8	323.0	196.2	93.7	1633.6
1982	25.8	3.0	25.2	139.5	156.0	80.0	58.4	130.6	193.6	51.2	133.4	96.5	1093.2
1983	51.0	35.6	0.0	-	-	-	-	-	54.8	194.4	22.7	1.6	-
1984	14.4	-	-	-	-	-	-	-	-	-	-	-	-
AVERAGE	20.6	14.8	21.8	72.2	164.0	124.3	243.9	186.6	188.4	232.4	165.0	56.0	1615.1

TABLE A-3. MONTHLY RAINFALL OBSERVED AT CONSUELD

* STATION --- MALASSIN (UNIT : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1977	79.0	12.2	5.1	34.2	454.5	37.3	356.7	272.2	368.2	75.7	193.2	24.9	1913.2
1978	7.1	80.0	1.5	48.3	171.1	58.2	72.2	238.4	101.9	248.3	57.6	90.6	1175.2
1979	0.2	14.8	18.8	69.5	41.0	87.4	60.1	125.4	169.6	160.2	-	152.9	-
1980	19.8	13.8	25.4	11.0	127.9	15.3	341.4	45.6	200.2	200.5	164.8	96.6	1262.3
1981	7.4	19.0	0.0	1.3	-	14.5	117.5	90.3	246.7	228.2	202.0	14.7	-
1982	8.3	0.0	3.7	80.2	195.5	91.0	109.5	212.2	427.3	51.2	201.5	112.6	1493.0
1983	136.9	0.0	0.0	0.0	65.6	223.7	96.0	109.7	140.8	250.9	41.3	34.0	1098.9
1984	17.5	6.1	133.5	236.9	442.9	164.7	-	397.6	3.3	386.7	21.6	76.1	-
1985	7.3	1.3	62.7	79.0	3.1	15.0	74.7	136.5	210.1	82.9	160.0	80.7	913.3
AVERAGE	31.5	16.4	27.9	62.3	187.7	78.6	153.5	180.9	207.6	187.2	130.2	75.9	1309.3

* STATION --- REINA (UNIT : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1976	-	-	-	-	-	213.8	51.5	270.1	260.8	247.2	501.6	165.2	-
1977	122.8	56.8	18.8	71.1	334.0	131.1	214.3	182.3	273.9	45.1	177.7	48.0	1675.9
1978	17.5	53.6	38.7	38.7	129.6	98.8	205.0	459.4	292.5	488.5	269.2	120.7	2212.2
1979	6.6	9.4	12.7	105.6	126.3	144.5	116.9	103.2	149.9	180.3	342.4	62.8	1360.6
1980	19.0	14.3	84.2	9.4	79.1	31.7	454.5	155.3	173.4	327.0	203.8	190.7	1742.4
1981	62.3	15.0	25.1	37.4	94.6	172.1	193.1	169.7	174.8	316.7	586.1	288.3	2135.2
1982	17.5	53.6	38.8	308.6	96.6	38.7	19.0	155.3	259.4	471.6	132.6	135.5	1727.2
AVERAGE	40.9	33.8	36.4	95.1	143.4	118.7	179.2	213.6	226.4	296.6	316.2	144.5	1808.9

* STATION --- SIFFU (DAM SITE (UNIT : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1977	33.6	10.6	53.8	30.8	219.4	31.4	467.5	305.5	458.5	86.0	166.3	9.1	1872.5
1978	27.2	37.8	8.5	47.0	267.9	185.1	185.1	445.7	187.7	437.3	302.0	123.9	2255.2
1979	0.0	0.0	0.0	51.6	351.2	215.5	217.8	114.1	118.3	96.9	143.5	49.7	1358.6
1980	21.6	22.2	54.6	13.5	-	15.7	291.5	70.3	227.0	185.8	206.3	78.0	-
1981	6.8	47.0	0.0	95.6	175.4	389.8	266.7	155.1	168.2	402.0	153.4	0.0	1860.0
1982	6.1	6.4	11.4	126.2	98.9	172.4	11.4	176.8	379.5	5.3	220.0	85.6	1300.0
1983	57.9	0.0	19.6	17.3	195.5	158.3	138.0	129.4	194.7	213.0	53.1	45.0	1221.8
1984	1.5	0.0	6.6	212.3	413.2	144.9	-	425.8	165.3	458.1	18.2	41.5	-
1985	41.5	20.3	-	-	-	-	-	-	-	-	-	-	-
AVERAGE	21.8	16.0	19.3	74.3	245.9	164.1	225.4	227.8	237.4	235.5	157.8	54.1	1644.7

TABLE A-4 (1). MONTHLY RAINFALL OBSERVED AT VARIOUS STATIONS (1)

* STATION --- ECHAGUE (UNIT: mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1976	-	-	-	-	-	-	-	-	-	-	18.9	36.0	-
1977	29.5	23.0	1.7	5.4	0.2	20.7	9.1	0.6	14.3	17.3	26.5	1.1	149.4
1978	0.5	6.9	10.0	0.0	0.0	5.0	0.3	1.4	8.0	165.6	8.6	5.6	211.9
1979	0.9	2.5	7.9	2.9	0.0	0.0	82.5	136.1	9.4	109.4	54.8	11.6	418.0
1980	2.7	4.8	0.0	0.0	25.0	1.5	-	9.7	4.2	124.2	120.8	17.5	-
1981	8.9	0.5	0.0	0.0	296.8	0.5	5.6	0.0	132.1	1084.3	53.8	169.9	1752.4
1982	53.4	0.0	1.1	0.0	8.9	0.2	16.1	0.0	141.7	43.5	107.8	48.2	420.9
1983	0.4	0.0	7.2	0.0	0.0	-	-	-	12.9	65.5	54.7	14.6	-
1984	12.9	6.0	41.0	243.6	62.9	40.6	0.6	0.0	1.7	379.6	9.1	108.9	906.9
1985	14.6	7.7	19.6	211.2	66.9	299.3	111.9	-	341.9	311.1	115.5	-	-
AVERAGE	13.8	5.7	9.8	51.5	51.2	46.0	32.3	21.1	74.0	255.6	57.0	45.9	643.2

* STATION --- SAGAT (UNIT; mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1977	51.4	27.1	14.7	20.3	151.8	64.7	72.2	374.5	196.7	98.0	216.7	12.2	1300.3
1978	51.4	21.1	14.0	77.9	132.4	273.3	296.2	360.2	337.9	387.7	197.4	90.7	2240.2
1979	0.2	4.6	1.3	43.8	193.5	165.0	208.3	183.6	169.7	77.5	137.2	45.9	1230.6
1980	25.4	20.1	125.2	35.3	132.9	55.8	350.5	115.9	207.6	210.4	200.2	101.2	1580.5
1981	2.3	13.5	0.0	111.5	152.2	295.4	189.0	6.5	218.1	207.4	303.7	11.2	1510.8
1982	7.1	1.0	0.0	292.8	150.5	164.4	37.3	474.7	103.4	3.8	20.9	174.0	1429.9
1983	127.7	0.0	0.0	-	-	-	-	-	73.4	483.9	25.1	9.1	-
1984	0.8	0.0	13.7	271.6	191.5	215.8	-	228.9	83.1	625.7	208.9	26.2	-
1985	1.8	0.0	112.1	9.2	36.9	172.4	5.1	78.3	111.7	105.9	311.1	98.0	1042.5
AVERAGE	29.8	9.7	31.2	107.8	142.7	175.8	165.5	227.8	166.8	244.5	180.1	63.2	1476.4

TABLE A-4 (2). MONTHLY RAINFALL OBSERVED AT VARIOUS STATIONS (2)

* STATION --- BAGONG BUHAY (UNIT: mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1977	48.2	36.4	3.8	2.5	257.1	93.4	198.9	-	216.2	77.5	161.0	-	-
1978	0.0	12.0	3.3	80.2	145.3	232.8	265.7	223.0	255.0	381.1	187.4	57.1	1842.9
1979	0.0	0.1	8.6	51.2	179.2	91.0	185.9	77.0	134.9	95.3	172.0	-	-
1980	35.4	10.7	43.1	80.8	98.9	47.0	427.7	83.9	211.2	203.1	-	49.1	-
1981	14.9	8.6	0.0	76.7	313.5	140.8	166.7	128.1	203.3	172.3	189.9	33.3	1448.1
1982	15.2	0.0	23.1	152.4	99.3	164.7	81.6	220.6	208.4	43.2	132.9	108.0	1249.4
1983	63.0	0.0	0.0	3.3	131.8	0.0	153.6	164.6	100.8	414.1	77.4	13.1	1121.7
1984	12.7	0.0	7.7	130.2	674.0	180.8	-	335.2	93.4	468.3	40.5	115.6	-
1985	0.0	0.0	98.3	56.1	193.8	407.7	-	354.4	318.4	394.4	180.2	48.2	-
AVERAGE	21.0	7.5	20.9	70.4	232.5	150.9	211.4	198.3	193.5	249.9	142.7	60.6	1415.5

* STATION --- SALVACION (UNIT; mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1977	-	-	11.7	8.5	220.5	88.2	238.2	371.8	277.1	62.8	171.9	13.6	-
1978	8.0	20.0	67.1	28.0	145.2	266.3	283.2	262.4	272.4	580.1	209.8	73.2	2215.7
1979	3.8	7.9	7.6	184.7	206.5	-	170.4	110.7	110.2	146.4	185.1	68.0	-
1980	9.0	12.5	40.9	13.6	89.4	37.8	476.9	84.6	203.0	268.8	236.2	45.1	1517.8
1981	32.5	9.6	0.0	58.8	166.6	149.4	236.4	159.6	207.8	323.0	196.2	93.7	1633.6
1982	25.8	3.0	25.2	139.5	156.0	80.0	58.4	130.6	193.6	51.2	133.4	96.5	1093.2
1983	51.0	35.6	0.0	-	-	-	-	-	54.8	194.4	22.7	1.6	-
1984	14.4	-	-	-	-	-	-	-	-	-	-	-	-
AVERAGE	20.6	14.8	21.8	72.2	164.0	124.3	243.9	186.6	188.4	232.4	165.0	56.0	1615.1

TABLE A-4 (3). MONTHLY RAINFALL OBSERVED AT VARIOUS STATIONS (3)

* STATION --- MALASSIN (UNIT : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1977	79.0	12.2	5.1	34.2	454.5	37.3	356.7	272.2	368.2	75.7	193.2	24.9	1913.2
1978	7.1	80.0	1.5	48.3	171.1	58.2	72.2	238.4	101.9	248.3	57.6	90.6	1175.2
1979	0.2	14.8	18.8	69.5	41.0	87.4	60.1	125.4	169.6	160.2	-	152.9	-
1980	19.8	13.8	25.4	11.0	127.9	15.3	341.4	45.6	200.2	200.5	164.8	96.6	1262.3
1981	7.4	19.0	0.0	1.3	-	14.5	117.5	90.3	246.7	228.2	202.0	14.7	-
1982	8.3	0.0	3.7	80.2	195.5	91.0	109.5	212.2	427.3	51.2	201.5	112.6	1493.0
1983	136.9	0.0	0.0	0.0	65.6	223.7	96.0	109.7	140.8	250.9	41.3	34.0	1098.9
1984	17.5	6.1	133.5	236.9	442.9	164.7	-	397.6	3.3	386.7	21.6	76.1	-
1985	7.3	1.3	62.7	79.0	3.1	15.0	74.7	136.5	210.1	82.9	160.0	80.7	913.3
AVERAGE	31.5	16.4	27.9	62.3	187.7	78.6	153.5	180.9	207.6	187.2	130.2	75.9	1309.3

* STATION --- REINA (UNIT : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1976	-	-	-	-	-	213.8	51.5	270.1	260.8	247.2	501.6	165.2	-
1977	122.8	56.8	18.8	71.1	334.0	131.1	214.3	182.3	273.9	45.1	177.7	48.0	1675.9
1978	17.5	53.6	38.7	38.7	129.6	98.8	205.0	459.4	292.5	488.5	269.2	120.7	2212.2
1979	6.6	9.4	12.7	105.6	126.3	144.5	116.9	103.2	149.9	180.3	342.4	62.8	1360.6
1980	19.0	14.3	84.2	9.4	79.1	31.7	454.5	155.3	173.4	327.0	203.8	190.7	1742.4
1981	62.3	15.0	25.1	37.4	94.6	172.1	193.1	169.7	174.8	316.7	586.1	288.3	2135.2
1982	17.5	53.6	38.8	308.6	96.6	38.7	19.0	155.3	259.4	471.6	132.6	135.5	1727.2
AVERAGE	40.9	33.8	36.4	95.1	143.4	118.7	179.2	213.6	226.4	296.6	316.2	144.5	1808.9

* STATION --- SIFFU DAM SITE (UNIT : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1977	33.6	10.6	53.8	30.8	219.4	31.4	467.5	305.5	458.5	86.0	166.3	9.1	1872.5
1978	27.2	37.8	8.5	47.0	267.9	185.1	185.1	445.7	187.7	437.3	302.0	123.9	2255.2
1979	0.0	0.0	0.0	51.6	351.2	215.5	217.8	114.1	118.3	96.9	143.5	49.7	1358.6
1980	21.6	22.2	54.6	13.5	-	15.7	291.5	70.3	227.0	185.8	206.3	78.0	-
1981	6.8	47.0	0.0	95.6	175.4	389.8	266.7	155.1	168.2	402.0	153.4	0.0	1860.0
1982	6.1	6.4	11.4	126.2	98.9	172.4	11.4	176.8	379.5	5.3	220.0	85.6	1300.0
1983	57.9	0.0	19.6	17.3	195.5	158.3	138.0	129.4	194.7	213.0	53.1	45.0	1221.8
1984	1.5	0.0	6.6	212.3	413.2	144.9	-	425.8	165.3	458.1	18.2	41.5	-
1985	41.5	20.3	-	-	-	-	-	-	-	-	-	-	-
AVERAGE	21.8	16.0	19.3	74.3	245.9	164.1	225.4	227.8	237.4	235.5	157.8	54.1	1644.7

TABLE A-5. RAINFALL RECORDED BY JICA RAIN-GAUGES

(UNIT : MM)

		BAGONG BUHAY	LAT.D	SALVASION	MALASSIN	ILAGAN
1986.MAR.	6-12			(4.5)	(11.4)	24.9
	13-19			47.6	80.2	26.6
	20-26			4.4	17.1	4.8
	27- 2			3.9	0.0	6.9
JUNE	3- 9			131.2	27.0	77.4
	10-16			1.5	44.2	0.0
	17-23			1.5	16.4	7.4
	24-30			15.0	35.4	0.4
JULY	1- 7			138.5	157.6	11.3
	8-14			21.3	15.3	270.5
	15-21			59.1	40.0	32.4
	22-28	0.0	3.0	1.9	1.6	1.3
	29- 4	118.0	61.5	213.5	205.5	345.5
AUG.	5-11	54.5	25.5	51.0	39.5	35.8
	12-18	65.8	(7.5)	56.5	76.5	92.9
	19-25	15.6	(56.6)	15.5	0.0	64.7
	26- 1	17.0	(2.9)	0.0	84.5	0.0
SEP.	2- 8	162.5	(3.0)	20.6	96.5	31.5
	9-15	90.3	5.2	0.0	67.5	5.9
	16-22	44.5	45.0	4.0	42.5	34.2
	23-29	36.0	92.0	12.4	3.5	1.6
	30- 6		(40.0)	82.4	31.8	55.8
OCT.	7-13		117.2	114.6	113.8	72.1
	14-20		29.5	30.5	26.2	54.9
	21-27		107.0	139.0	131.4	88.1
	28- 3		64.9	(43.0)	(87.6)	(142.1)
TOTAL (JULY22-NOV.3)			(660.8)	(784.9)	(1008.4)	(1026.4)

NOTE: ( ) INDICATES INCOMPLETE OBSERVATION.

TABLE A-6. MONTHLY MEAN MINIMUM TEMPERATURE

STATION: ILAGAN, ISABELA

UNIT: C°

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
1966	21.5	21.3	21.4	22.0	23.1	23.4	23.0	23.1	22.4	21.4	21.9	20.1
1967	18.6	17.7	19.1	20.8	22.3	-	21.8	22.9	22.7	21.9	19.1	18.9
1968	18.2	17.7	19.1	20.5	22.4	22.3	22.6	22.1	22.2	19.8	-	16.6
1969	-	14.6	18.1	21.4	22.6	21.5	21.7	21.3	21.1	19.7	17.5	17.1
1970	16.7	15.3	18.1	19.5	20.2	20.2	19.9	19.0	18.7	18.1	17.1	16.4
1971	12.9	14.5	14.3	18.4	22.2	22.5	22.2	21.7	21.5	20.9	19.6	19.2
1972	18.3	11.4	17.6	20.6	22.0	22.1	22.8	20.8	20.2	18.9	17.9	17.3
1973	16.4	15.7	15.9	19.2	21.0	22.0	21.3	20.4	20.4	20.8	19.1	17.1
1974	15.3	16.3	16.3	18.2	19.5	20.1	19.5	19.7	18.3	18.5	18.0	16.3
1975	15.6	15.1	16.7	18.3	20.2	19.0	15.4	15.2	14.3	14.4	15.3	10.9
1976	9.2	10.1	10.5	17.6	24.1	21.6	23.3	21.4	18.8	20.3	19.1	19.8
1977	19.6	17.2	17.4	19.4	20.1	19.3	18.8	18.8	17.9	20.2	18.7	15.9
1978	15.0	15.4	21.9	22.2	21.6	20.2	19.0	18.0	18.0	17.6	18.7	17.5
1979	12.3	14.9	15.7	18.1	17.4	17.4	17.5	17.3	16.4	15.6	15.7	14.4
1980	15.7	13.8	14.1	15.8	21.7	24.3	22.9	23.7	22.8	22.8	22.1	20.5
1981	18.4	19.4	20.1	23.0	23.8	23.8	23.8	24.1	23.2	23.2	21.8	19.3
1982	17.8	20.2	20.1	23.3	23.7	24.4	23.9	22.8	23.1	21.1	20.8	19.8
1983	18.9	17.4	19.4	21.6	23.6	23.3	23.1	22.8	21.7	22.3	20.7	17.6
1984	18.6	17.6	19.8	22.2	22.8	23.6	21.2	23.8	23.0	22.7	22.1	20.2
1985	17.9	20.4	20.9	22.9	-	-	-	-	-	-	-	-
MEAN	16.7	16.3	17.8	20.3	21.8	21.7	21.2	21.0	20.4	20.0	19.2	18.6

TABLE A-7. MONTHLY MEAN TEMPERATURE

STATION: ILAGAN, ISABELA

UNIT: C°

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
1966	26.3	27.7	28.1	29.8	28.5	29.7	28.5	29.0	22.4	27.4	26.0	24.6
1967	23.3	23.2	25.5	28.0	29.6	-	28.8	27.5	28.4	26.2	24.7	23.1
1968	23.3	24.1	26.6	27.6	29.5	29.1	29.0	28.1	28.2	26.5	-	23.6
1969	-	22.2	26.4	28.6	30.7	28.4	28.3	28.4	27.9	26.5	23.4	22.0
1970	22.2	23.1	26.4	27.8	28.7	28.5	28.1	26.6	25.8	24.6	23.2	22.9
1971	20.4	21.4	22.9	26.8	28.5	28.3	27.8	28.8	27.7	25.9	24.3	23.3
1972	23.5	21.7	24.1	27.5	29.3	29.0	28.7	27.5	27.2	26.9	25.1	23.8
1973	23.9	24.3	25.1	28.6	30.0	29.6	28.0	27.3	27.2	26.4	24.7	22.4
1974	21.2	23.3	24.5	27.8	27.8	27.5	28.2	27.2	26.1	25.5	24.0	22.7
1975	21.9	23.0	25.3	26.7	28.5	26.1	23.1	24.6	24.6	23.7	22.1	19.3
1976	17.8	19.8	21.7	26.7	29.4	28.3	29.1	28.1	24.6	26.3	24.2	23.9
1977	24.5	22.4	25.1	27.8	27.1	26.9	26.0	26.6	25.3	25.9	23.8	22.1
1978	21.6	21.9	27.7	28.3	28.1	25.5	26.0	24.6	24.9	24.4	24.1	24.9
1979	24.9	25.2	-	-	-	-	-	-	-	-	-	23.3
1980	25.4	25.6	23.8	25.9	29.1	30.3	29.1	29.7	28.4	28.4	29.1	24.2
1981	27.4	25.2	27.0	30.1	30.6	30.1	29.4	30.0	29.1	27.7	26.0	23.2
1982	24.1	25.6	27.0	28.8	29.5	30.4	30.1	28.8	28.8	27.5	26.9	25.4
1983	23.8	24.9	27.1	29.1	-	-	-	29.9	-	27.9	25.4	23.5
1984	24.4	25.2	26.8	28.9	29.4	29.4	26.6	29.0	28.9	26.8	26.0	23.5
1985	22.3	26.0	26.5	28.1	-	-	-	-	-	-	-	-
MEAN	23.3	23.8	25.7	28.0	29.1	28.6	27.9	27.9	26.8	26.4	24.8	23.2

TABLE A-8. MONTHLY MEAN MAXIMUM TEMPERATURE

STATION: ILAGAN, ISABELA UNIT: C°

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
1966	31.0	34.1	34.7	37.5	33.9	36.0	33.9	34.9	34.3	33.4	30.1	29.1
1967	27.9	28.7	32.0	35.1	36.9	-	35.7	32.1	34.1	30.9	30.3	27.4
1968	28.4	30.4	34.1	34.7	36.6	35.9	35.4	33.1	34.2	32.3	-	30.7
1969	-	29.6	34.6	25.8	38.8	35.3	35.2	35.6	34.6	33.3	29.2	26.9
1970	27.8	30.8	34.7	36.1	37.2	36.8	36.4	34.3	32.8	31.2	29.3	29.4
1971	28.0	28.3	31.5	35.2	34.8	34.1	33.5	35.8	33.9	31.0	29.0	27.4
1972	28.8	32.1	30.7	34.5	36.6	35.9	34.7	34.3	34.2	34.9	32.3	30.4
1973	31.5	33.0	34.3	38.1	28.9	37.2	34.7	34.3	34.1	32.1	30.3	27.8
1974	27.1	30.4	32.7	37.5	36.0	35.0	36.9	34.7	33.9	32.5	30.0	29.1
1975	28.3	30.9	33.9	35.1	36.9	33.2	30.9	34.1	34.9	33.1	28.9	27.7
1976	26.4	29.6	32.5	35.8	34.7	35.0	34.9	34.9	30.5	32.4	29.1	27.9
1977	29.4	27.5	32.7	26.3	34.1	34.6	33.3	34.5	32.7	31.6	28.9	28.2
1978	28.2	28.4	34.0	34.5	34.3	31.4	33.0	31.3	31.7	31.1	29.6	32.3
1979	37.6	35.3	-	-	-	-	-	-	-	-	-	32.3
1980	35.4	32.3	33.6	35.9	36.4	36.4	35.2	35.7	33.9	33.9	30.4	27.8
1981	36.4	30.9	33.9	37.1	37.4	36.4	35.1	35.9	34.8	32.3	30.2	27.1
1982	30.3	30.9	33.8	34.3	35.3	36.4	36.2	34.8	34.6	34.0	33.2	31.1
1983	28.6	32.4	34.7	36.6	-	-	-	37.2	-	34.1	30.2	29.4
1984	30.2	32.8	33.9	35.7	36.0	35.2	31.9	34.2	34.8	30.8	29.9	26.8
1985	26.8	31.5	32.1	33.2	-	-	-	-	-	-	-	-
MEAN	29.9	31.0	33.3	34.7	35.6	35.3	34.5	34.5	33.8	32.5	30.1	28.9

TABLE A-9. MONTHLY MEAN RELATIVE HUMIDITY

STATION: ECHAGUE, ISABELA UNIT: %

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
1976	-	-	-	-	-	-	-	-	-	-	80	92
1977	76	87	82	52	58	45	66	59	66	88	75	67
1978	70	86	81	50	48	61	66	70	67	89	76	76
1979	63	57	45	58	51	85	81	61	66	89	83	75
1980	71	74	78	46	52	60	-	62	65	67	90	77
1981	71	57	45	50	58	62	64	-	64	70	79	73
1982	68	61	56	64	71	69	74	73	79	83	86	90
1983	82	66	64	82	52	-	-	-	59	72	77	76
1984	68	62	53	61	-	82	59	60	-	73	70	72
1985	-	-	-	-	-	-	-	-	-	-	-	-
MEAN	71	69	63	58	56	66	68	64	67	79	80	78

TABLE A-10. MONTHLY MEAN CLOUDINESS

STATION: ILAGAN, ISABELA (LAT. 17°08' LONG. 121°53') UNIT: DECIMAL

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
1968	-	2	1	-	-	-	3	5	5	5	-	6
1969	-	3	2	1	2	1	4	4	5	5	6	6
1970	6	4	3	1	1	2	4	5	6	8	9	8
1971	6	6	7	5	6	5	8	5	8	9	10	8
1972	9	6	6	6	4	4	7	8	8	7	7	8
1973	7	6	5	2	3	5	6	9	6	7	9	9
1974	9	8	6	3	6	8	5	9	8	8	9	9
1975	8	5	5	4	4	7	7	9	6	8	8	8
1976	10	7	6	4	7	7	7	7	8	7	9	8
1977	9	8	5	3	4	6	7	7	7	7	9	5
1978	7	6	3	4	5	5	5	7	7	9	9	6
1979	-	-	-	-	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-
1983	-	-	-	-	-	-	-	-	-	-	-	-
1984	-	-	-	-	-	-	-	-	-	-	-	-
1985	-	-	-	-	-	-	-	-	-	-	-	-
MEAN	8	6	4	3	4	5	6	7	8	7	9	7

TABLE A-11. MONTHLY MEAN WIND SPEED

STATION: ECHAGUE, ISABELA UNIT: KM/DAY

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
1976	-	-	-	-	-	-	-	-	-	-	222	133
1977	178	89	89	133	89	89	178	178	222	89	178	133
1978	178	89	133	178	133	89	133	178	133	133	178	133
1979	133	222	178	-	133	133	133	178	133	133	222	178
1980	133	44	133	178	267	133	-	89	178	133	89	178
1981	133	133	178	178	133	133	133	133	133	133	222	178
1982	178	133	89	89	44	44	133	89	89	89	89	133
1983	133	133	178	222	178	178	133	133	89	133	267	89
1984	89	133	133	89	44	89	89	133	133	44	89	44
1985	89	133	133	89	44	89	89	133	133	44	89	89
MEAN	138	188	148	156	123	118	122	128	133	113	160	129

TABLE A-12. MAGAT RIVER MONTHLY RUNOFF AT DAM

*** MAGAT RIVER MONTHLY RUNOFF AT DAM ***

UNIT - MCM/MON.

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT	OCT.	NOV.	DEC.	ANNUAL
1953	326.4	222.2	141.8	253.4	572.5	1241.1	907.0	1150.4	933.4	845.5	721.4	1059.5	8374.6
1954	342.4	135.2	195.3	199.1	107.0	134.5	270.2	401.3	584.3	497.6	861.0	286.3	4014.2
1955	500.4	183.6	115.0	108.6	227.4	191.4	318.4	449.4	705.9	714.4	1013.6	457.5	4985.6
1956	227.4	137.9	155.1	930.8	497.6	201.7	572.5	484.3	393.6	615.4	1507.4	992.6	6716.3
1957	305.0	147.4	505.6	354.2	125.8	367.2	334.4	508.3	1303.2	912.4	677.4	227.4	5768.3
1958	157.8	84.6	117.7	142.2	173.9	362.0	222.0	896.3	1280.0	1142.4	493.9	240.8	5313.6
1959	131.1	111.1	1006.0	188.8	286.3	142.2	128.4	243.5	377.5	350.5	692.9	272.9	3931.2
1960	214.0	654.0	267.5	243.1	200.7	343.9	441.4	800.0	998.0	941.8	254.7	206.1	5565.2
1961	123.1	70.1	149.8	147.4	240.8	359.4	963.2	874.9	809.3	762.5	375.0	131.1	5006.6
1962	203.4	205.4	291.6	250.8	203.4	385.2	1046.1	872.2	773.1	618.1	840.4	436.1	6125.8
1963	251.5	415.5	203.4	124.0	96.3	530.1	864.1	1546.4	928.2	382.6	284.4	489.6	6116.1
1964	235.4	215.5	179.3	93.0	256.9	377.5	917.6	1305.6	967.1	1685.5	1639.3	882.9	8755.6
1965	321.1	372.1	187.3	462.8	385.2	411.1	639.4	610.0	830.0	607.4	475.8	334.4	5636.6
1966	283.6	159.4	272.9	263.0	1359.1	532.6	465.5	452.1	545.6	420.1	806.7	757.1	6317.7
1967	398.6	171.5	37.4	188.8	216.7	385.2	711.7	1166.5	1993.5	1741.7	1303.2	524.4	8839.2
1968	444.1	278.1	232.8	227.5	347.8	605.1	642.1	1348.4	1437.6	717.0	279.2	224.7	6784.4
1969	184.6	111.1	72.3	116.4	152.5	287.0	698.3	695.6	558.4	893.6	426.7	417.4	4613.9
1970	532.4	224.6	165.9	196.5	294.3	659.3	334.4	778.6	1272.1	2279.5	2546.9	1003.3	10287.8
1971	500.4	425.2	481.6	268.9	543.1	708.5	1570.5	746.4	1473.8	2785.2	1494.6	1530.4	12528.6
1972	1032.7	456.5	323.8	493.9	781.3	560.0	2071.0	1367.0	991.0	281.0	346.0	104.0	8808.2
1976	519.1	215.1	240.6	126.8	2222.0	1311.9	1248.7	802.2	1095.1	957.5	286.4	340.4	9365.8
1977	348.4	205.8	135.8	110.8	284.0	345.2	597.9	684.5	949.9	521.9	621.8	294.4	5100.4
1978	108.7	62.6	50.6	119.2	181.9	284.1	501.4	1300.6	1709.0	2280.0	1068.3	739.5	8405.9
1979	207.7	106.5	81.5	85.7	217.4	530.0	586.2	506.7	710.6	1034.9	511.3	351.3	4929.8
1980	201.7	129.8	143.2	106.3	226.2	186.1	930.6	647.9	816.1	946.3	2313.6	592.3	7240.1
1981	228.7	199.8	95.6	128.0	228.7	418.9	1586.4	696.5	456.2	811.3	1316.1	487.5	6653.7
1982	204.2	142.2	74.1	294.2	353.8	491.3	399.4	506.5	660.7	378.6	136.2	394.8	4036.0
1983	412.2	215.8	127.0	41.8	63.5	67.9	149.7	380.1	330.0	928.1	397.6	163.4	3277.1
1984	157.5	105.5	250.9	381.3	896.9	453.2	610.8	945.6	637.2	1022.5	700.6	296.2	6458.1
1985	118.9	62.8	94.6	312.4	298.5	497.3	628.4	640.5	1347.4	1303.6	709.5	387.8	6401.7
TOTAL	9222.5	6226.9	6395.9	6959.6	12041.5	13370.8	21357.6	23808.2	27867.7	29378.8	25101.8	14626.1	196358.1
MEAN	307.4	207.6	213.2	232.0	401.4	445.7	711.9	793.6	928.9	979.3	836.7	487.5	6545.3

TABLE A-13. SIFFU RIVER MONTHLY RUNOFF AT DAM

*** SIFFU RIVER MONTHLY RUNOFF AT DAM ***

UNIT - MCM/MON.

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT	OCT.	NOV.	DEC.	ANNUAL
1953	49.2	32.3	28.8	44.8	115.3	112.9	44.0	156.1	189.0	166.1	96.8	196.8	1232.1
1954	44.5	22.2	30.4	30.9	10.5	20.9	54.6	57.7	120.5	131.1	102.5	54.5	680.3
1955	64.4	20.7	15.0	16.2	14.2	27.8	66.7	101.1	93.8	79.1	228.3	80.4	807.6
1956	21.6	18.2	28.3	64.4	41.0	24.5	111.2	127.8	159.8	121.2	92.3	61.2	871.3
1957	48.6	20.1	33.7	19.4	13.8	51.8	43.4	55.8	137.1	124.7	136.1	31.4	715.9
1958	33.5	19.9	20.9	10.1	31.1	90.3	52.0	178.0	229.8	58.9	68.9	24.1	817.5
1959	16.4	19.0	52.9	18.3	59.1	36.1	46.5	95.1	163.6	84.2	171.8	159.4	922.4
1960	76.0	153.9	40.9	39.8	24.6	35.0	38.6	64.0	183.2	150.3	33.6	28.2	868.0
1961	23.7	22.6	35.1	38.3	71.9	39.1	112.3	155.0	86.9	122.9	125.4	13.5	846.8
1962	22.6	21.7	27.0	28.3	30.3	121.6	75.8	153.2	67.3	74.2	77.5	72.2	771.6
1963	27.8	52.5	23.7	23.8	24.5	91.1	121.1	136.7	190.0	25.1	23.4	65.7	805.4
1964	21.4	21.4	21.9	29.5	125.4	139.8	136.7	218.8	170.5	166.1	271.9	137.2	1460.6
1965	46.0	37.6	27.2	63.5	37.4	95.5	117.9	104.1	149.8	56.2	40.9	36.5	812.4
1966	26.6	23.2	22.6	31.5	136.1	92.2	98.1	154.5	59.3	35.5	209.8	131.8	1021.1
1967	64.7	23.5	27.8	27.5	19.8	83.1	95.9	155.1	183.4	145.2	109.9	41.2	977.2
1968	25.1	21.9	21.3	26.7	32.5	133.5	66.2	119.6	103.7	50.0	31.2	22.8	654.5
1969	22.6	12.4	22.1	31.0	38.9	73.4	137.3	30.6	73.0	95.3	72.5	72.7	681.7
1970	77.5	27.8	20.0	24.1	39.2	100.0	44.2	121.0	212.0	418.0	485.3	165.5	1734.7
1971	72.5	60.0	69.2	34.0	79.0	107.5	270.0	114.0	251.4	520.5	256.3	265.0	2099.3
1972	165.9	65.5	43.0	70.0	119.8	82.5	372.0	230.0	158.0	37.0	47.7	22.5	1413.9
1976	63.6	26.4	29.5	15.5	272.4	160.8	153.1	98.3	134.2	117.4	35.1	41.7	1148.1
1977	43.8	25.9	17.1	13.9	35.7	43.4	75.1	86.0	119.3	65.6	78.1	37.0	640.7
1978	13.3	7.7	6.2	14.6	22.3	34.8	61.5	159.4	209.5	279.5	131.0	90.7	1030.4
1979	29.5	15.2	11.6	12.2	30.9	75.4	83.4	72.1	101.1	147.2	72.7	50.0	701.3
1980	41.4	20.8	11.6	5.3	16.0	11.9	96.6	62.7	66.6	53.1	43.4	36.2	465.6
1981	24.8	16.8	8.9	5.6	17.9	103.8	99.8	146.3	104.8	118.4	131.3	72.1	850.5
1982	28.1	15.0	9.7	15.8	53.6	45.2	39.3	45.2	42.6	29.5	46.0	56.6	426.6
1983	48.9	19.5	10.4	8.8	8.1	9.2	13.0	40.0	23.0	43.4	38.5	26.2	289.1
1984	17.7	11.1	17.6	8.0	26.1	42.3	54.2	64.5	35.8	41.7	36.2	43.0	398.3
1985	16.1	8.2	7.4	12.4	26.5	43.5	44.5	51.0	44.1	54.9	52.5	39.8	400.9
TOTAL	1277.8	863.0	741.5	784.4	1573.8	2128.8	2825.1	3353.6	3863.2	3612.2	3346.8	2175.9	26545.8
MEAN	42.6	28.8	24.7	26.1	52.5	71.0	94.2	111.8	128.8	120.4	111.6	72.5	884.9

FIGURE A-1. HISTORICAL RAIN AND METEOROLOGICAL RECORD

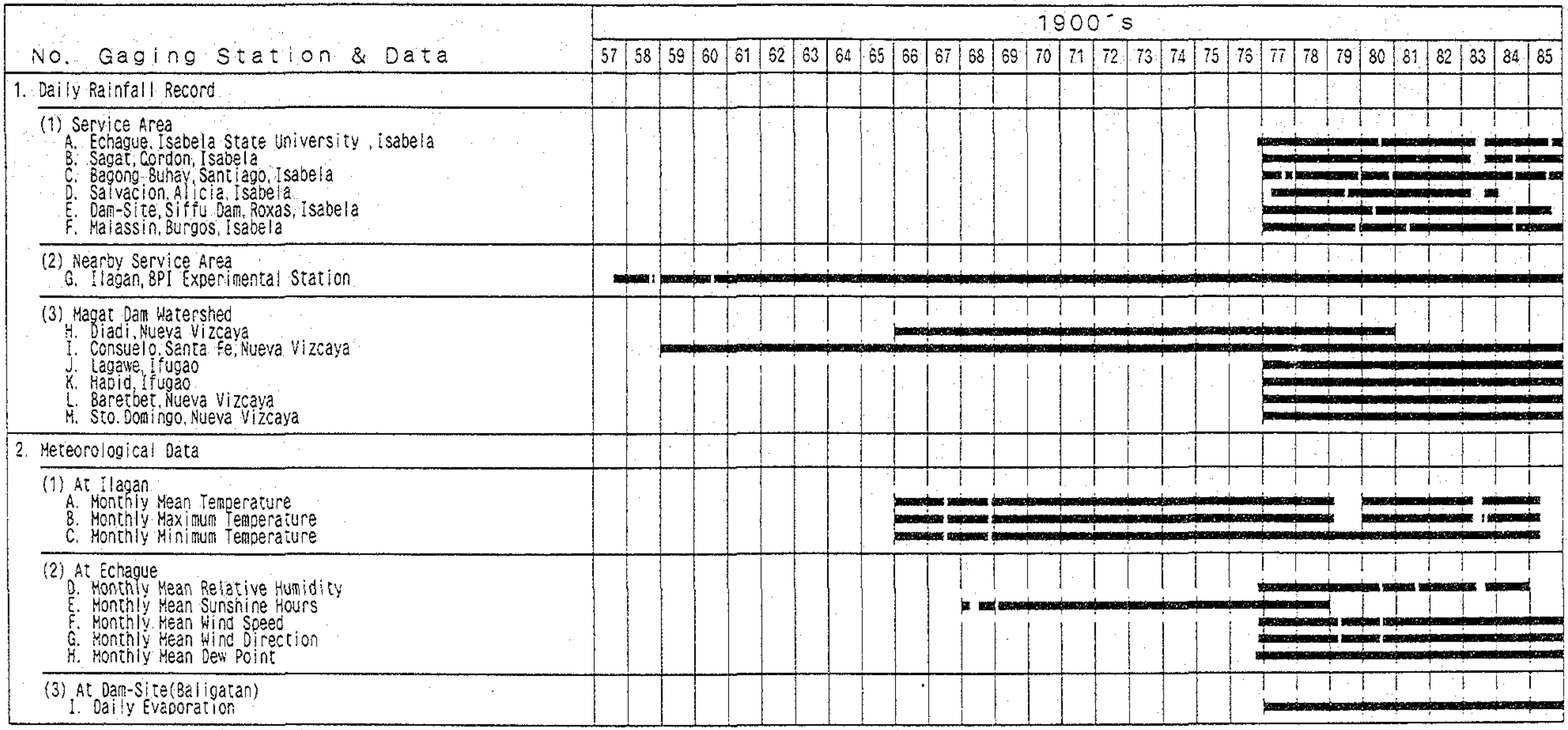
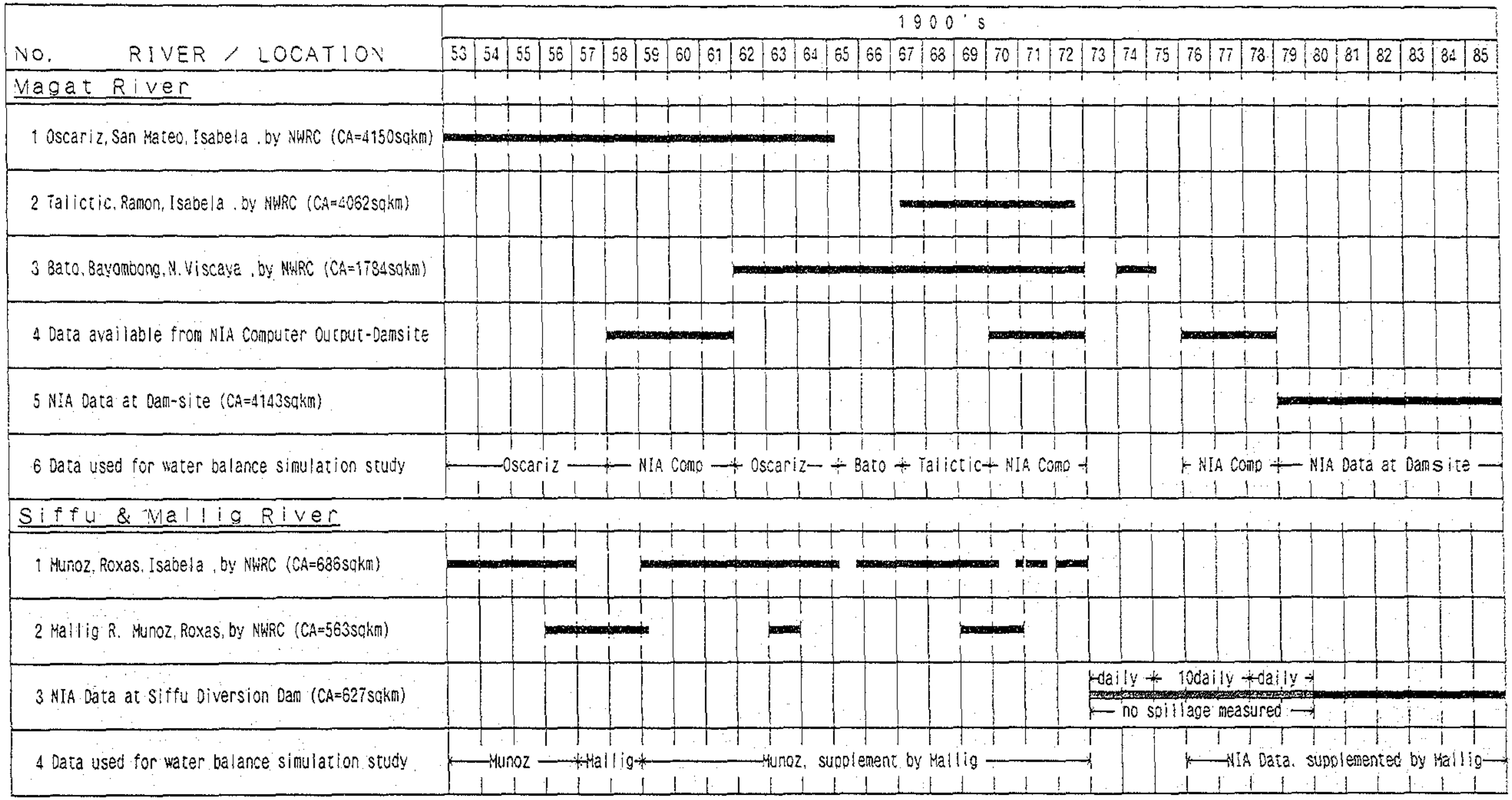


FIGURE A-2. HISTORICAL STREAMFLOW RECORD



ANNEX B

SOILS AND LAND USE

B. SOILS AND LAND USE

1. PRESENT LAND USE

The area distribution of land use in the Project area measured on the topographic maps scaled at 1:25,000 (see O/M Drawing No.6) is as follows;

Paddy Field	:	92,700 ha
Upland Field	:	21,600
Grassland, Woodland	:	22,000
Residential Area	:	5,600
Road, River Course	:	6,400
Canal, Creek	:	3,900
Others	:	12,600
Total		164,800 ha

The Project area except for the southern part of the area is occupied mostly by paddy field and covered with an irrigation system. The upland fields are found on the flood plains along the Magat river and mostly used for corn and beans production. the rolling and undulating areas are mainly used for grassland and woodland.

Some parts of a gently undulating area have been used for paddy fields and they are now being developed for paddy fields. Most paddy soils of the service area have heavy and very firm sub-soils. Their internal drainage is very poor and external drainage is also poor in the main flat land of the service area. Therefore, it is not easy to convert paddy fields into diversified crop lands and to obtain considerable income.

2. SOILS

2.1. Geomorphology and Surface Deposit

The Project area consists of i) flood plains, ii) alluvial terraces, iii) natural levees, and iv) residual or colluvial terraces from the viewpoint of geomorphology. i) and ii) comprises about 90 percent of the service area, iii) and iv) are not extensive and less than 10 percent.

Flood plains occur in the adjacent area to the Cagayan river and its tributaries. They are two to four kilometers in width and range in elevation from about 40 - 50 m above sea level. Soils on flood plains are mainly medium to coarse textured, and have been used for diversified crop production. They comprise less than ten percent of the Project area. The alluvial terraces, located a few meters above the flood plains, comprise above 80 percent of the service area. Most of them are irrigated and developed into paddy fields.

Three defined terrace levels can be observed throughout the service area and are as follows:

- Recent Alluvial Terraces (50 - 60 m elevation above sea level)
- Intermediate Alluvial Terraces (60 - 80 m elevation above sea level)
- Old Alluvial Terraces (80 - 120 m elevation above sea level)

Natural levees can be seen running parallel with the Magat river. Residual or colluvial terraces are located along the south and west fringes of the Project area. These terraces and natural levees comprise an insignificant part of the total area.

2.2. Soils

The soil maps, descriptions of soils and land classification of the Project area have been provided in the "Soil Survey of Isabela Province, Soil Report 38" published in 1969 by the Bureau of Soils, "the Magat River Project Feasibility Report, Vol.3" prepared by NIA, USBR in 1975, "the Detailed Soil Maps of Several Municipalities" made by Bureau of Soils and "the Soil Map" made by ADD of MRIIS.

JICA Study Team has carried out a soil survey including the soil profile examination of 110 points and the laboratory analysis of soil samples taken from representative profiles in order to confirm the soil characteristics in the service area. The results of the soil survey have been summarized in the O/M Drawing No.47, 48.

The soil characteristics of the four Districts are summarized as follows.

Soils of District-I

The southern half part of the District is mainly occupied by Cauayan Series and the northern half part mostly by Bago Series. However, Qungua Series, Tagulod Series and Bontog Series are found near Santiago, and Faraon Series and Rugao Series can be observed in the southern part of the district. But these five soil series are not very extensive.

Cauayan soils are found mostly on rolling or undulating terraces. The steeper or rougher portions are covered with grasses and trees, and used for pasture and woodland. They are unsuitable for cultivation, while the less sloping portions are used for paddy fields. These soils are fine textured with some mottles and difficult to till when dry. The external drainage is excessive while internal drainage is very poor. They have a low moisture retainabity, because of their shallow surface soils and very compact subsoils. Soils of this series appear to be somewhat more acid in reaction and less fertile than most of the other soils. The erosion will tend to be sever with the absence of vegetative cover.

As above-mentioned, Cauayan soils are poor for diversified crop production. Some of them have been developed into paddy fields. But the present yield of rice is rather low. It would be further increased with adequate fertilizer and lime application as well as the addition of organic matter.

The grasslands occupied by the Cauayan soils are planned to be developed into paddy fields. Not a few soils occurring in the southeastern part of the district have coalesced iron-manganese nodules, gravelly layer or bed rock within 20 to 30 m below surface. It is necessary to examine the soil profile status before land development.

Bago sandy loam is found in a rather extensive area between Santiago and Ramon. Because of their coarse textured surface soil, this soil is deficient in plant nutrients as well as low in holding capacity of fertilizer nutrients. These characteristics of this soils should be considered in the fertilizer application. At the lateral and sublateral canals in the area occurring Bago sandy loam, many sediments of sand and silt are found caused by side slope erosion of the canals. It is necessary to maintain the canals in good condition in this area.

Bago sandy clay loam extensively occupies the northern part of the district. The surface soil is medium textured and slightly acid in reaction. As it has no serious deficiency for paddy soil, present yield of paddy rice may increase up to considerable higher level with the adequate management of irrigation water and improvement of fertilizer application.

The soils of Rugao Series occur on rolling lands in the south-western part of the District, but not extensively. These soils are developed from limestone and usually tend to be deficient in potassium. The lands are mostly covered with grasses and trees, and not cultivated much. The desirable uses to these soils are for pasture and woodland. Where crop cultivation may be possible, the erosion control measures should be taken.

Soils of District-II

Most of the dual class land in the service area occupies the low terrace on the right side of the Magat river. The main soils found in this dual class land are San Manuel Series and Sta. Rita Series. The clay contents of these soils are not so much as that of Cauayan soils or Bago soils occurring extensively in the central part of the service area. The sand and gravel layers underlie at a depth of two to three meters in most part of this dual class land. Besides, there are several old river courses in this area. They are playing a role of the natural outlets for the drainage of this area. For above reasons, the drainage of this area is rather well and in dry season soils dry up to subsoil to some extent when not irrigated. Consequently, the moderately strong soil structures are developed in subsoils. These soil structures increase permeability of paddy soils.

From the viewpoint of soil fertility, Sta. Rita soils are near neutral in reaction and rich in plant nutrients. They are highly valued for paddy rice production and for diversified crop production. The yield of paddy rice in this area is the highest in the service area, because of good conditions of the soils and the irrigation water supply.

The Cauayan soils are located on undulating land to the east of Alicia. These soils are rather strongly acid in reaction and deficient in plant nutrients. They are recommended to be improved by adequate soil management practices, such as liming, applying of organic matter and adequate fertilizer application. The Cauayan soils often have concretionary layer of iron-manganese nodules or bed rock within 20 to 50 cm below surface. So the detailed examination of soils is necessary for developing land into paddy fields.

Soils of District-III

The Bigaa Series are extensive and found in the central flat part of the District with a slope not over one percent. The whole profiles of these soils are very finely textured. These soils are poorly drained and difficult to till when dry. They are slightly acid in reaction and productive for paddy rice cultivation but not for diversified crops. Considering the fertility of Bigaa soils, a higher yield of paddy rice will be expected under adequate water management and improvement of fertilizer application.

The lands irrigated by pumping in the District are on Old Alluvial Terraces. The soils found on them are strongly acid in reaction and deficient in plant nutrients. The subsoil of these soils are very finely textured and very firm. The internal drainage is very poor while the surface drainage is excessive for undulating or rolling topography. So these soils can not be valued highly for diversified crop production. In paddy rice cultivation, they need applications of lime and organic matter for soil improvement.

Good fertilizer applications after these practices will bring increment in the yields of paddy rice. There are often coalesced iron-manganese nodules in shallow depth below the soil surface. It is advisable to conduct a detailed soil survey prior to land development for paddy field in this area.

Soils of District-IV

The Bago Series and Cauayan Series occupy the flat area along the west of the highway between Cauayan and Alicia. These soils have very finely textured and very firm subsoils. Their internal drainage is very poor and they do not have enough outlets of surface water. Excessive irrigation water from higher lands discharges into the depression of the flat area and brings inundation problem. The inundation is severer during and after heavy rains. This periodic inundation impedes adequate cultivation practices in rice crop production and reduce the yields of rice. It is necessary to construct a drainage facility in this area. These soils, having coarsely textured surface soils, are usually deficient in potassium. It is recommendable to consider this characteristics in fertilizer applications.

The area under pumping irrigation is located on the undulating land adjacent to the east of the highway. Cauayan Series occupying this land have very finely textured and very firm subsoils. Their surface soils are medium to somewhat coarsely textured and moderately acid in reaction. They are not so inherently fertile as most of the other soils.

Present land use of this area is pasture and paddy field. They will respond to soil improvement and rather suitable for grazing or paddy rice cultivation. Some parts of the diversified crop lands adjacent to the Cagayan river and the Magat river are classified as 2R-class or 3R-class land in the "MRMP Feasibility Report". Soils of these lands are usually medium to coarsely textured and well drained, and productive for diversified crops. However, they are somewhat excessively drained for paddy fields and require large amount of irrigation water. For these reasons, it is advisable to continue to use these land for diversified crops production.

3. LAND CLASSIFICATION

In MRMP Feasibility Study has conducted the land classification and prepared the map at the scale of 1:100,000 (see the O/M Drawing No.49). The said classification covers various results of the studies on the land productivity, irrigation water requirements, topography, drainage conditions, etc. in giving the grading of the land by 1 to 3 for upland cropping, 1 - 3 for paddy cropping and other as dual land.

The results of classification are as follows;

- Arable rice land : class 1R to class 3R
- Arable diversified crops land: class 1 to class 3
- Arable dual class land : class 1R(2) and 2R(3)

The details of land classification are shown in the attached "Processed Drawings".

The hectare distribution of land classes is as follows:

Land Class	MARP Feasibility Report Area (ha)	MRIIS Service Area (ha)
- Rice Land		
1R	59,910	53,900
2R	31,930	25,400
3R	20,920	10,800
Sub-total	112,760	90,100
- Diversified Crop Land		
1R	310	-
2R	4,430	-
3R	5,630	-
Sub-total	10,370	-
- Dual Class Land	10,750	7,300
Total	133,880	97,400

The class 1R lands and the class 2R lands are located mostly in the main part of the District II, III, IV and the northern part of the District I. Most of class 3R lands are found or rolling and undulating terraces such as in the southern part of the District I, and the pumping irrigation areas of the District III and IV.

The undeveloped class 3R lands are now being developed and mostly located in above mentioned areas. The soils of these lands frequently have shallow effective soil layer. It is necessary to examine the soil profile status for land development.

The class 3R land requires considerable investments to prepare the land for irrigation, or results in low yield of rice or high production cost, because of their topographic and/or soil deficiencies. Most of the dual class lands occupy the recent alluvial terrace on the right side of the Magat river. This land would be well suited for rice production and for diversified crops production with subsurface drainage.

A few areas among present diversified crop lands on flood plains had been classified into rice land class 2R or 3R in the MRMP Feasibility Report. Some of them are being planned to be converted into rice lands. However, these lands are quite suitable for diversified crop cultivation. Farmers are obtaining as much income from corn cultivation as from rice production.

Furthermore, the soils of these areas are sandy or loamy textured. They would require much irrigation water for paddy rice cultivation. Therefore, it is not recommendable to convert these lands into paddy fields.

ANNEX C

IRRIGATION AND DRAINAGE

C. IRRIGATION AND DRAINAGE

LIST OF TABLES

LIST OF FIGURES

1. CLASSIFICATION OF PROJECTED SERVICE AREA

1.1. Projected Service Area

According to "The Magat River Project Feasibility Study Report" prepared by NIA and USBR in 1975, the projected Service Area was about 102,000 ha, however, in the course of the project implementation, MRIIS O/M Office examined its Service Area in year 1982 - 1983, and finalized to be about 97,400 ha based on the parcellary map and proposed as irrigable area covered by the irrigation system, which was divided into four Districts.

The projected service areas in each District are as follows:

District I	:	24,054 ha
District II	:	24,468
District III	:	24,793
District IV	:	24,087
Total		97,402 ha

The service area of District I is located at the south-west part of the Project area in a hilly area in topography with a relative high elevation. It is served by the main canals of the South High, South Low and a part of Lateral C and Oscaring main canal. The area was developed under Stages Ib and III, thus, considered to be the newest area as compared with the other Districts in the Project area, and there exist about 4,330 ha of undeveloped area in the district.

The service area of District II is located near the Magat damsite and along the Magat river, and considered to be the center of the four Districts. The area is served by the Maris main canal, and mostly developed under Stage Ia.

The service area along the bank of the Magat river consists of medium to light textured soils with high permeability, requiring much irrigation water compared with the other service areas.

The service area of District III lies between the Magat and Siffu rivers. Irrigation water is served by the Siffu North and South main canals. Western and northern parts of the area are developed under Stages Ia and Ib, and irrigated by gravity irrigation systems. On the other hand, a hilly area located on eastern part of the area is developed under Stage III and irrigated by the pump irrigation systems. In this hilly area, undeveloped area is found at present as same as in District I.

The service area of District IV is located at the downstream of District II and receives the irrigation water from the Maris main canal which also serves District II at the upstream area. The service area shows flat topography but always suffers from shortage of water during dry season because the area can take irrigation water only after passing through District II, and also suffers from inundation problem during wet season due to excess water from District II. Upstream area of the district is developed under Stage III, while downstream area of the district is developed under Stage Ib and Stage III, which includes the pump irrigation area at the eastern part of it with a hilly topography.

1.2. Present Irrigation Area

Present irrigation area during wet season in 1986 is about 71,000 ha or 73 percent of the projected area which is classified as follows on district basis. Details are shown in O/M Drawings No.8.

District	Projected Service Area (ha)	Irrigation Area (ha)	Percent (ha)
I	24,054	17,874	73.5
II	24,468	20,708	84.6
III	24,793	17,403	70.2
IV	24,087	15,077	60.8
Total	97,402	71,062	73.0

According to the 1986 MRIIS annual reports, some portions of the projected Service Areas are not irrigated for the following reasons:

Unirrigated Area in Service Area

(unit: ha)

Item	District I	District II	District III	District IV	Total
Undeveloped	4,330	1,080	2,940	4,870	13,220
Lack of On-Farm Facility	310	1,270	2,660	2,460	6,700
High Elevation	-	370	860	-	1,230
Drainage Problem	130	300	540	830	1,800
Financial	970	470	-	610	2,050
Others	440	270	390	240	1,340
Total	6,180	3,760	7,390	9,010	26,340

As is seen in the above table, many lands remain undeveloped area in District I and IV, and the development of these areas is a very essential and important subject to be solved, in order to raise the project economy.

The subsequent deals with the detail explanation of unirrigated areas by District-wise.

(1) Undeveloped Area

District I; The undeveloped area of 4,330 ha in 1986 is mostly scattered along the South High and Oscariz main canals. Division I-12, I-6, I-10, I-11 and I-12 have many undeveloped area of 500 to 850 ha, as shown in O/M Drawings No.8.

District II; The undeveloped area is 1,080 ha in 1986 and mainly located at Division I-12 and I-13 along the Oscariz canal and Division II-27 and II-29 in the Lateral "H Extention and "J" of the Maris main canal. These areas lie on undulated hilly area, which is rather difficult to develop by farmer's own manpower.

District III; The undeveloped area of 2,940 ha in 1986 is mostly concentrated in Divisions I-7, I-9, I-10 and I-12, in which the service area is newly developed by pump irrigation. The delay of land development in these Divisions is caused by insufficient irrigation water due to defect of pump and high operation cost of pump as well as by difficulty of land development made by farmers due to undulated topography.

District IV; Many Divisions comprise the undeveloped area of 200 to 500 ha and its total reaches 4,870 ha in 1986. District IV has an area with many problems caused by insufficient irrigation water in dry season and innundation in wet season due to improper irrigation facilities and poor water management in the Maris canal system.

In addition, the land development in the service area covered with the Cauayan East Extension canal and pumping No.1 station is considerably delayed because of the similar reasons as mentioned in District III.

(2) Lack of On-Farm Facility

District I; Since the undeveloped area of 4,330 ha to be converted to the paddy field is still remained, a big scale of the on-farm facility works will be required in parallel with the land development works in future.

The service area without on-farm facilities is mainly scattered in all Divisions along the South High main canal presenting the area of 30 to 100 ha in each Division.

Since the service area in District I is located generally in the undulated hilly area, the construction and maintenance of the on-farm facilities require a particular care.

District II; The service area lacking on-farm facility in District II is mainly found in the Division I-2, I-12, I-13 and I-29. Since the service area in Division I-2 is located on the flood problem area of the Magat river, the on-farm facility is damaged by flood and not repaired yet. The on-farm facilities in the other Division are constructed mainly at the hilly area and some of them are broken due to improper facilities and maintenance.

District III; A large area of 2,660 ha is remained in District III as the lack of on-farm facility area. These areas are mainly located along the North Division main canal and the lateral canal served by the pumping station of No.2 and No.3, and presents a hilly topography with steep slope. Some lateral canals are not properly designed and constructed by NIA to provide the on-farm facilities and many on-farm facilities constructed by the farmer's institution are not well functioning.

District IV; District IV has also a large area of 2,460 ha in the lack of on-farm facility area with the similar reasons as mentioned in the above Division. These areas are found in many places in all Division, especially in Divisions I-9, I-12, I-19, I-23 and I-24 which are newly developed.

Since the service area in District IV is generally suffered from shortage of water in dry season and innundation damage in wet season, farmers cannot accelerate the on-farm facility construction. In addition, some completed on-farm facilities have been damaged by innundation in wet season.

(3) Other Unirrigated Area

Unirrigated areas due to other reasons such as the high elevation, drainage problem, financial problem as shown below was about 8,260 ha in 1985 and reduced to 6,420 ha in 1986.

(a) High Elevation Area

High elevation area cannot get irrigation water due to higher elevation than the water level in lateral canal. This land was about 1,400 ha in 1985 and mostly found in the hilly area, especially in the pumping area of District III. In order to irrigate such higher land, new lateral or sub-lateral shall be provided by the MRIIS O/M Office.

(b) Drainage Problem Area

Unirrigated area due to drainage problem was 1,490 ha in 1985 and increases to 1,800 ha in 1986. This area is mainly located at the District III and IV and requires drainage canal works. The MRIIS O/M and District O/M Offices shall make a plan for drainage systems in the problem area and carry out the construction of drainage canal under the O/M Improvement Project.

(c) Financial Problem Area

Unirrigated area due to financial problem was 2,130 ha in 1985 and 2,050 ha in 1986. Since low income farmers have no fund to engage in farming activity as procuring seed, fertilizer, equipment etc., the MRIIS O/M Office shall research these farmer conditions and will request the rural bank so as to lend agricultural fund with low interest and long period.

It is also desirable to exempt irrigation fee collection from the low income farmers during one to two years until the farmers become in self-sustaining conditions.

1.3. Classification of Projected Service Area

The projected Service Area of about 97,400 ha is divided into four Districts for the purpose of operation and maintenance of the whole irrigation systems. Furthermore, this Service Area can be subdivided into seven areas as shown below, from a viewpoint of canal networks.

The present irrigation systems are shown in Figure C-1 and their details are shown in the O/M Drawings No.23-No.26.

MARIS Main Canal System

About 53,900 ha of irrigation area located on the central part of the service area is covered by the Maris main canal connected with the right side intake facilities of the Maris diversion dam. This area has an advantage to utilize easily irrigation water for its location.

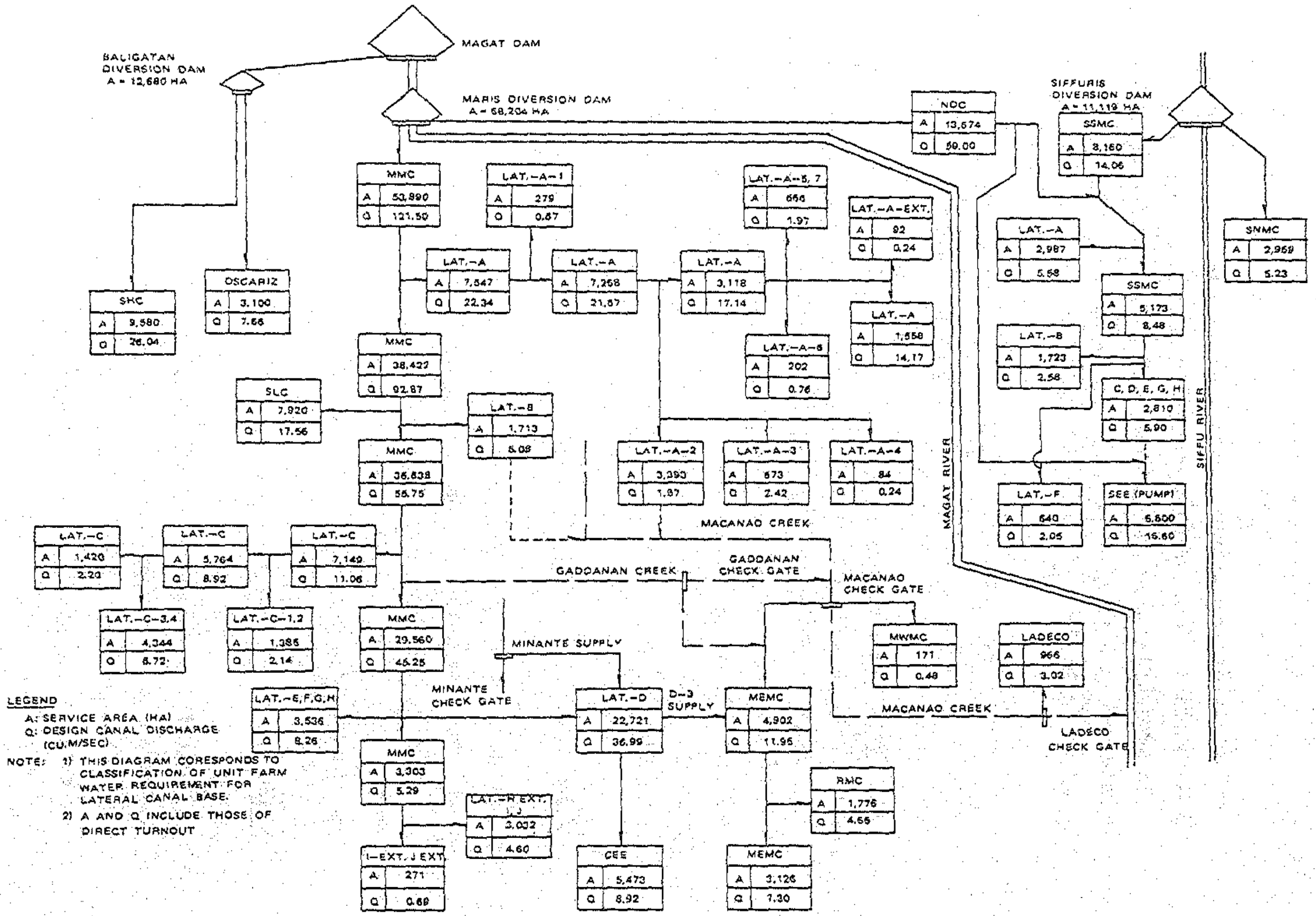
South High and Oscariz Main Canal Systems

About 12,700 ha of land, which is irrigated by the South High and Oscariz main canals connecting with the Baligatan diversion dam are situated in the hilly topography at the south and south-western part of the service area. This area has a large undeveloped area as it is a newly developed area.

South Low Main Canal System

South Low main canal system branching off the Maris main canal covers an area of about 7,900 ha, and is suffering from a periodical water shortage at the lower reaches, because of a very long canal distance with a gentle slope of canal.

FIGURE C-1. SUMMARY OF FLOW DIAGRAM OF PRESENT IRRIGATION SYSTEM



North Diversion Main Canal System

The area of about 13,600 ha located on the left side of the Magat river is irrigated by the North Diversion main canal connecting with the left side intake facilities of the Maris diversion dam. The lower parts of this area are also irrigated by the Siffu South main canal. This system includes pump irrigation areas of about 6,600 ha at the lower parts of this system. However, large undeveloped areas are also found at the lower reaches.

Siffu South Main Canal System

The area of about 8,200 ha located on the left side of the Siffu river is covered by the Siffu South main canal connecting with the left side intake facilities of the Siffuris diversion dam. Irrigation water for this area will be supplied from the North diversion main canal, when the river runoff discharges of the Siffu river are scarce to meet the required irrigation demand in both areas of the Siffu North and South irrigation areas during dry season.

Siffu North Main Canal System

The area of about 3,000 ha located on the left side bank of the Siffu river is irrigated by the Siffu North main canal connecting with the Siffuris diversion dam. This area takes priority of getting runoff discharges of the Siffu river as water sources compared with that for Siffu South main canal system, so that no water shortage is found in this area even in dry season.

Macanao and Ladeco Check Gate Systems

A part of supplied irrigation water to the Laterals A and B in the Maris main canal system is drained to the existing Macanao and Gaddanan creeks and these surplus drainage discharges are utilized for irrigation as supplemental water source (return flow). Small intake weirs such as Macanao, Ladeco, Minante and Gaddanan check gates are provided in the creek to divert the return flow, and to irrigate about 6,000 ha in the lower reaches.

2. IRRIGATION WATER REQUIREMENT

2.1. Unit Irrigation Requirement at On-Farm Level

Unit irrigation requirement at on-farm level so called farm water requirement (crop water requirement) refers to the amount of water to be supplied to the farm to satisfy the percolation, field evaporation and evapotranspiration, since these are the basis of distributing irrigation water on the area.

The values of farm water requirement at different stages of crop growing are presently computed based on the researches[1/] conducted by MRIIS O/M Office within the Service Area. In the Study, these values and procedure for the estimation were reviewed and proved to be basically adequate for the application to estimate farm water requirement. The formula used in estimating these values is summarized as follows;

$$LSWR = \frac{Sn + F}{7} + Ef + P$$

$$LPWR = Ef + P$$
$$VSWR = Et + P$$
$$RSWR = Et + P$$

where;

LSWR = Land Soaking Water Requirement
LPWR = Land Preparation Water Requirement
VSWR = Vegetative Stage Water Requirement
RSWR = Reproductive Stage Water Requirement
Sn = Saturation Requirement
Ef = Field Evaporation
P = Percolation
Et = Evapotranspiration
F = Flooding (65 mm)

1/ Source: "Operation and Maintenance Manual for the Magat River Integrated Irrigation System" Prepared by MRIIS Office in June, 1985.

Saturation Requirement

Soil saturation is the amount of water used to fill pore spaces in the soil after a considerable length of the fallow period. Saturation requirement was computed by using the established rate of moisture depletion for every soil type and were tabulated into simplified form readily available for irrigation personnel in estimating their land soaking irrigation requirement.

Accordingly, saturation requirement has been computed by using the following equation;

$$Sn = \frac{(Sc - Mc) \times As \times Ds}{100}$$

Where;

Sn = Saturation requirement
Sc = Saturation capacity
36% for rice class land
49% for dual class land
Mc = Moisture content
As = Apparent specific gravity
1.7 for rice class land
1.35 for dual class land
Ds = Depth of root zone of rice (30 cm)

Saturation requirement of the different laterals within the Service Area is tabulated as shown below based on the above equation:

Saturation Requirement of Laterals

(unit: mm)

Month	Lat. A	Lat. B	South[2/] Zone	East[3/] Zone	Division III
Jan.	50	77	48	37	37
Feb.	113	97	61	58	58
Mar.	128	97	68	68	68
Apr.	130	93	75	71	71
May	80	89	58	54	20
Jun.	69	77	31	34	26
Jul.	60	65	17	20	30
Aug.	46	61	14	14	32
Sep.	39	35	33	5	5
Oct.	0[1/]	0	0	0	0
Nov.	0	0	0	0	0
Dec.	0	0	0	0	0

Note: 1/: Saturated
2/: South Zone - South area of Maris main canal, (SLC, C, C-Extra, E, E-Extra, F, G, H, I-Extra, J-Extra)
3/: East Zone - North-East area of Maris main canal (Lat. D, H-Extra, I.J)

Field Evaporation and Evapotranspiration

According to the study on the relationship between pan-evaporation (Ep) and field evaporation (Ef), evapotranspiration (Et), which has been conducted by MRIIS Office, the values of Ef and Et can be estimated as shown below by using the model equation expressing Ef and Et as a function of Ep.

Field Evaporation and Evapotranspiration based on Evaporation

(unit: mm/day)

Month	Ep	Ef	Et Vegetative Stage	Et Reproductive Stage
Jan.	3.6	2.6	4.0	4.2
Feb.	4.4	3.2	4.6	5.0
Mar.	5.3	3.8	5.4	5.8
Apr.	6.3	4.5	6.2	6.8
May	6.1	4.4	6.0	6.6
Jun.	5.8	4.2	5.8	6.3
Jul.	5.8	4.2	5.8	6.3
Aug.	5.5	4.0	5.6	6.0
Sep.	4.4	3.2	4.6	5.0
Oct.	4.7	3.4	4.9	5.3
Nov.	4.0	2.9	4.3	4.6
Dec.	3.3	2.4	3.7	4.9

Note: Model equations are expressed as follows:
$Ef = 0.72\ Ep - 0.004$
$Et = 0.83\ Ep + 0.99$ (during vegetative stage)
$Et = 0.94\ Ep + 0.85$ (during reproductive stage)

Percolation Rate

In the determination of irrigation water, one of the most important parameters is percolation rate of the soil - downward movement of water into soil profile which varies greatly with soil type, groundwater depth and drainability of the area.

The percolation rates of the different areas to be served with irrigation water within the Service Area have been quantified by the MRIIS O/M Office as shown below;

Percolation Rate

(unit: mm/day)

Laterals/Sub-Laterals	Percolation Rate	Laterals/Sub-Laterals	Percolation Rate
Division-I			
C	2.0	B	10.1
C-1	2.6	B-1	10.1
C-2	2.6	D, H-Extra, I	2.6
C-3		and J	
C-4	1.8	CEE	2.2
	1.8	RMC	2.2
E series, F, G		Mac. East	2.6
and H	2.6	Mac. West	10.1
SLC	2.1		
SHC	2.2		
Division-II		Division-III	
A	11.2	NMC	5.2
A-1	12.0	SMC	2.5
A-2	9.0	A	6.4
A-3	16.0	A-1, A-Extra	6.0
A-4	9.0	B	6.0
A-5	7.0	C, D, E, F, G & H	2.5
A-5 Extra	29.0	NDC	2.7
A-6	4.0		
A-7	7.0		

As shown in the above table, percolation rates in the Laterals "A" and "B" which belong to dual class land are comparatively large, so that the Study Team installed the measuring devices of percolation rate at four sites in those areas to check the rates for the periods of three months from June 1986 to August 1986 during the wet season. As the results, it was proved that an average percolation rate in the dual class land varies in the ranges of 11 mm/day to 15 mm/day, although further long term observation will be needed.

Unit irrigation water requirement at on-farm level thus estimated by the above mentioned procedures is tabulated in Table C-1.

TABLE C-1 UNIT WATER REQUIREMENT AT ON-FARM LEVEL IN EACH GROWING STAGE (1)

(unit : mm/day)

Main/Lateral Canal	Service Area (ha)	Farming Stage	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Lat C.	1,420	LS	20.7	23.2	24.8	26.5	24.0	19.9	17.9	17.3	15.9	14.7	14.2	13.7
		LP	4.6	5.2	5.8	6.5	6.4	6.2	6.2	6.0	5.2	5.4	4.9	4.4
		VS	6.0	6.6	7.5	8.2	8.0	7.8	7.8	7.6	6.6	6.9	6.3	5.7
		RS	6.2	7.0	7.8	8.8	8.6	8.3	8.3	8.0	7.0	7.3	6.6	6.0
Lat. C-1 & C-2	1,385	LS	21.3	23.8	25.4	27.1	24.6	20.5	18.5	17.9	16.5	15.3	14.8	14.3
		LP	5.2	5.8	6.4	7.1	7.0	6.8	6.8	6.6	5.8	6.0	5.5	5.0
		VS	6.6	7.2	8.0	8.8	8.6	8.4	8.4	8.2	7.2	7.5	6.9	6.3
		RS	6.8	7.6	8.4	9.2	9.2	8.9	8.9	8.6	7.6	7.9	7.2	6.6
Lat. C-3 & C-4	4,344	LS	20.5	20.8	24.6	26.3	23.8	19.7	17.7	17.1	15.7	14.5	14.0	13.5
		LP	4.4	5.0	5.6	6.3	6.2	6.0	6.0	5.8	5.0	5.2	4.7	4.2
		VS	5.8	6.4	7.2	8.0	7.8	7.6	7.6	7.4	6.4	6.7	6.1	5.5
		RS	6.0	6.8	7.6	8.4	8.4	8.1	8.1	7.8	6.8	7.1	6.4	5.8
Lat. E.F.G.H.	3,536	LS	21.3	23.8	25.4	27.1	24.6	20.5	18.5	17.9	16.5	15.3	14.8	14.3
		LF	5.2	5.8	6.4	7.1	7.0	6.8	6.8	6.6	5.8	6.0	5.5	5.5
		VS	6.6	7.2	8.0	8.8	8.6	8.4	8.4	8.2	7.2	7.5	6.9	6.3
		RS	6.8	7.6	8.4	9.2	9.2	8.9	8.9	8.6	7.6	7.9	7.2	6.6
South Low Canal (SLC)	7,920	LS	20.8	23.3	24.9	26.6	24.1	20.0	18.0	17.4	16.0	14.8	14.3	13.8
		LP	4.7	5.3	5.9	6.6	6.5	6.3	6.3	6.1	5.3	5.5	5.0	4.5
		VS	6.1	6.7	7.6	8.3	8.1	7.9	7.9	7.7	6.7	7.0	6.4	5.8
		RS	6.3	7.1	7.9	8.9	8.7	8.4	8.4	8.1	7.1	7.4	6.7	6.1
South High Canal (SHC) & Oscariz	12,680	LS	20.9	23.4	25.0	26.7	24.2	20.1	18.1	17.5	16.1	14.9	14.4	13.9
		LP	4.8	5.4	6.0	6.7	6.6	6.4	6.4	6.2	5.4	6.5	5.1	4.6
		VS	6.2	6.8	7.7	8.4	8.2	8.0	8.0	7.8	6.8	7.1	6.5	5.9
		RS	6.4	7.2	8.0	9.0	8.8	8.5	8.5	8.2	7.2	7.5	6.8	6.2

TABLE C-1 UNIT WATER REQUIREMENT AT ON-FARM LEVEL IN EACH GROWING STAGE (2)

(unit : mm/day)

Main/Lateral Canal	Service Area (ha)	Farming Stage	Month											
			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Lat. A.	1,558	LS	30.2	39.8	42.6	43.6	36.3	34.5	33.2	31.1	29.7	25.9	23.4	22.9
		LP	13.8	14.4	15.0	15.7	15.6	15.4	15.4	15.2	14.4	14.6	14.1	13.6
		VS	15.2	15.8	16.6	17.4	17.2	17.0	17.0	16.8	15.8	16.1	15.5	14.0
		RS	15.4	16.2	17.0	18.0	17.8	17.5	17.5	17.2	16.2	16.5	15.8	15.2
A-1	279	LS	31.0	40.6	43.4	44.4	37.1	35.3	34.1	31.8	30.5	24.7	24.2	23.7
		LP	14.6	15.2	15.8	16.5	16.4	16.2	16.2	16.0	15.2	15.4	14.9	14.4
		VS	16.0	16.6	17.4	18.2	18.0	17.8	17.6	17.6	16.6	16.9	16.3	15.7
		RS	16.2	17.0	17.8	18.8	18.6	18.3	18.3	18.0	17.0	17.3	16.6	16.0
A-2 & A-4	4,077	LS	28.0	37.6	40.4	41.4	34.1	32.3	31.0	28.8	27.5	21.7	21.2	20.7
		LP	11.6	12.2	12.8	13.5	13.4	13.2	13.2	13.0	12.2	12.4	11.9	11.4
		VS	13.0	13.6	14.4	15.2	15.0	14.8	14.8	14.6	13.6	13.9	13.3	12.7
		RS	13.2	14.0	14.8	15.8	15.6	15.3	15.3	15.0	14.0	14.3	13.6	13.0
A-3	673	LS	35.0	44.6	47.4	48.4	41.1	39.3	38.0	35.8	34.5	28.7	28.2	27.7
		LP	18.0	19.2	19.8	20.5	20.4	20.2	20.2	20.0	19.2	19.4	19.4	18.4
		VS	20.0	20.6	21.4	22.2	22.0	21.8	21.8	21.6	20.6	20.9	20.3	19.7
		RS	20.2	21.0	21.8	22.8	22.6	22.3	22.3	22.0	21.0	21.3	20.6	20.0
A-5 & A-7	666	LS	26.0	35.6	38.4	39.4	32.1	30.3	29.0	26.9	25.5	19.7	19.2	18.7
		LP	9.6	10.2	10.8	11.5	11.4	11.2	11.2	11.0	10.2	10.4	9.9	9.4
		VS	11.0	11.6	12.4	13.2	13.0	12.8	12.8	12.6	11.6	11.9	11.3	10.7
		RS	11.2	12.0	12.8	13.8	13.6	13.3	13.3	13.0	12.0	12.3	11.6	11.0
A-5 Extra	92	LS	48.0	57.6	60.4	61.4	54.1	52.3	51.0	48.9	47.5	41.7	41.2	40.7
		LP	31.6	32.2	32.8	33.5	33.4	33.2	33.2	33.0	32.2	32.4	31.9	31.4
		VS	33.0	33.6	34.4	35.2	35.0	34.8	34.8	34.6	33.6	33.9	33.3	32.7
		RS	33.2	34.0	34.8	35.8	35.6	35.3	35.3	35.0	34.0	34.3	33.6	33.0
A-6	202	LS	23.0	32.6	35.4	36.4	29.1	27.3	26.0	23.9	22.5	16.7	16.2	15.0
		LP	6.6	7.2	7.8	8.5	8.4	8.2	8.2	8.0	7.2	7.4	6.9	6.4
		VS	8.0	8.6	9.4	10.2	10.0	9.8	9.8	9.6	8.6	8.9	8.3	7.7
		RS	8.2	9.0	9.8	10.8	10.6	10.3	10.3	10.0	9.0	9.3	8.6	8.0

TABLE C-1 UNIT WATER REQUIREMENT AT ON-FARM LEVEL IN EACH GROWING STAGE (3)

(unit : mm/day)

Main/Lateral Canal	Service Area (ha)	Farming Stage	Month Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Lat. B.	1,713	LS	33.0	36.4	37.0	37.2	36.5	34.6	32.9	32.1	27.6	22.8	22.3	21.8
		LP	12.7	13.3	13.9	14.6	14.5	14.3	14.3	14.1	13.3	13.5	13.0	12.5
		VS	14.1	14.7	15.5	16.3	16.1	15.9	15.9	15.7	14.7	15.0	14.4	13.8
		RS	14.3	15.1	15.9	16.9	16.7	16.4	16.4	16.1	15.1	15.4	14.7	14.1
Lat. D. H-Extra I and J	20,280	LS	19.8	23.4	25.4	26.5	24.0	20.9	18.9	17.9	15.8	15.3	14.8	14.3
		LP	5.2	5.8	6.4	7.1	7.0	6.8	6.8	6.6	5.8	6.0	5.5	5.0
		VS	6.6	7.2	8.0	8.8	8.6	8.4	8.4	8.2	7.2	7.5	6.9	6.3
		RS	6.8	7.6	8.4	9.2	9.2	8.9	8.9	8.6	7.6	7.9	7.2	6.6
Lat. I-Extra, J-Extra	271	LS	21.3	23.8	25.4	27.1	24.6	20.5	18.5	17.9	16.5	15.3	14.8	14.3
		LF	5.2	5.8	6.4	7.1	7.0	6.8	6.8	6.6	5.8	6.0	5.5	5.5
		VS	6.6	7.2	8.0	8.8	8.6	8.4	8.4	8.6	7.6	7.9	7.2	6.6
		RS	6.8	7.6	8.4	9.2	9.2	8.9	8.9	8.6	7.6	7.9	7.2	6.6
CEE & RMC	7,249	LS	19.4	23.0	25.0	26.1	23.6	20.5	18.5	17.5	15.4	14.9	14.4	13.9
		LP	4.8	5.4	6.0	6.7	6.6	6.4	6.4	6.2	5.4	5.6	5.1	4.6
		VS	6.2	6.8	7.7	8.4	8.2	8.0	8.0	7.8	6.8	7.1	6.5	5.9
		RS	6.4	7.2	8.0	9.0	8.8	8.5	8.2	7.2	7.2	7.5	6.8	6.2
Mac. East	3,126	LS	19.8	23.4	25.4	26.5	24.0	20.9	18.9	17.9	15.8	15.3	14.8	14.3
		LF	5.2	5.8	6.4	7.1	7.0	6.8	6.8	6.6	5.8	6.0	5.5	5.0
		VS	6.6	7.2	8.0	8.8	8.6	8.4	8.4	8.2	7.2	7.5	6.9	6.3
		RS	6.8	7.6	8.4	9.2	9.2	8.9	8.9	8.6	7.6	7.9	7.2	6.6
Mac. West Ladeco	1,138	LS	33.0	36.4	37.0	37.2	36.5	34.6	32.9	32.1	27.6	22.8	22.3	21.8
		LP	12.7	13.3	13.9	14.6	14.5	14.3	14.3	14.1	13.3	13.5	13.0	12.5
		VS	14.1	14.7	15.5	16.3	16.1	15.9	15.9	15.7	14.7	15.0	14.4	13.8
		RS	14.3	15.1	15.9	16.9	16.7	16.4	16.4	16.1	15.1	15.4	14.7	14.1

TABLE C-1 UNIT WATER REQUIREMENT AT ON-FARM LEVEL IN EACH GROWING STAGE (4)

(unit : mm/day)

Main/Lateral Canal	Service Area (ha)	Farming Stage	Month											
			Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
		LS	23.6	27.2	29.2	30.3	22.9	23.6	24.2	24.3	19.6	19.1	18.6	18.1
Siffu-South		LP	9.0	9.6	10.2	10.9	10.8	10.6	10.6	10.4	9.6	9.8	9.3	8.6
Lat. A.	2,987	VS	10.4	11.0	11.9	12.6	12.4	12.2	12.2	12.0	11.0	11.3	10.7	10.1
		RS	10.6	11.4	12.2	13.2	13.0	12.7	12.7	12.4	11.4	11.7	11.0	10.4
Lat. B.		LS	23.2	26.8	28.8	29.9	22.5	23.2	23.8	23.9	19.2	18.7	18.2	17.7
	1,723	LP	8.6	9.2	9.8	10.5	10.4	10.2	10.2	10.0	9.2	9.4	8.9	8.4
		VS	10.0	10.6	11.5	12.2	12.0	11.8	11.8	11.6	10.6	10.9	10.3	9.7
		RS	10.2	11.0	11.8	12.8	12.6	12.3	12.3	12.0	11.0	11.3	10.6	10.0
Lat. C.D.E.		LS	19.7	23.3	25.3	26.4	19.0	19.7	20.3	20.4	15.7	15.2	14.7	14.2
F.G.H.		LP	5.1	5.7	6.3	7.0	6.9	6.7	6.7	6.5	5.7	5.9	5.4	4.9
	3,450	VS	6.5	7.1	7.9	8.7	8.5	8.5	8.3	8.1	7.1	7.4	6.8	6.2
		RS	6.7	7.5	8.3	9.1	8.1	8.8	8.8	8.5	7.5	7.8	7.1	6.5
Siffu-North		LS	19.7	23.3	25.3	26.4	19.0	19.7	20.3	20.4	15.7	15.2	14.7	14.2
NMC	2,959	LP	5.1	5.7	6.3	7.0	6.9	6.7	6.7	6.5	5.7	5.9	5.4	4.9
		VS	6.5	7.1	7.9	8.7	8.5	8.3	8.3	8.1	7.1	7.4	6.8	6.2
		RS	6.7	7.5	8.3	9.1	9.1	8.8	8.8	8.5	7.5	7.8	7.1	6.5
NDC		LS	19.9	23.5	25.5	26.2	19.2	19.9	20.5	20.6	15.9	15.4	14.9	14.4
	13,674	LP	5.3	5.9	6.5	7.2	7.1	6.9	6.9	6.7	5.9	6.1	5.6	5.1
		VS	6.7	7.3	8.1	8.9	8.7	8.5	8.5	8.3	7.3	7.6	7.0	6.4
		RS	6.9	7.7	8.5	9.3	9.3	9.0	9.0	8.7	7.7	8.0	7.3	6.7

2.2. Unit Diversion Water Requirement on Main and Lateral Canal Basis

Diversion water requirement can be calculated by taking into account the effective rainfall and water losses in addition to the farm water requirement.

Effective Rainfall

According to the criteria for estimating an effective rainfall, which is mentioned in the Operation and Maintenance Manual, an effective rainfall has been estimated at 409 mm for the dry season paddy and 518 mm for the wet season paddy, respectively. However, total average rainfall during the above-mentioned cultivation seasons, is 557 mm for the dry season and 714 mm for the wet season, according to the rainfall data observed at the Ilagan station. When rainfalls is compared between observed one and estimated effective one during dry season, the effective rainfall of 409 mm is deemed to be too large. Therefore, the concept for estimating an effective rainfall was reviewed in the Study.

The following describes the proposed criteria for estimating an effective rainfall.

i) Effective rainfall for paddy cultivation will be estimated on the daily basis in paddy fields which is considered as a small storage taking into account rainfall, evapotranspiration, percolation, water depth on paddy field and irrigation water supply.

ii) Estimation of effective rainfall will be made on the basis of the following conditions:

- Ilagan observation record (1961 - 1985) are selected as representative rainfall.

- Effective rainfall will be counted throughout the crop growing periods for both seasons.

- Initial water depth on paddy field is assumed to be 50 mm.

- Daily water balance in field will be made in considering evapotranspiration, rainfall and percolation, and when water depth at paddy field drops to less than 20 mm, irrigation water is to be supplied up to the depth of 50 mm.

- In case much rainfall will be obtained in the paddy field, such rainfall will be stored in the field at the maximum depth of 80 mm, and rain water more than 80 mm will be drained to the lower plot or terminal drainage canal as there is no effective use for crops.

iii) Based on the above-mentioned criteria, the calculation of effective rainfall was made for a period of 25 years for two groups of different percolation rates, that is, those for rice class land and dual class land, and their average values are estimated at 2.7 mm/day for rice land and 10.1 mm/day for the dual class land.

The design effective rainfall with a return period of about six years with an extremely dry year is determined. The following table indicates an estimated effective rainfall for two group areas.

Estimated Effective Rainfall

(unit: mm)

Farming	Rice Class Land	Dual Class Land
Dry Season Paddy (Nov. - Apr.)	122.7	268.6
Wet Season Paddy (May - Oct.)	456.7	559.5
Total	579.4	828.1

Note: Details are shown in Table C-2.

TABLE C-2 ESTIMATED EFFECTIVE RAINFALL

(unit : mm)

Month.	Rainfall	Effective Rainfall	
		Dual Class Land	Rice Class Land
Jan.	62.7	27.9	27.9
Feb.	29.1	13.3	13.6
Mar.	38.2	2.8	6.7
Apr.	55.0	2.7	1.0
May	136.0	66.0	23.4
Jun.	160.8	195.1	89.1
Jul.	166.0	77.9	73.1
Aug.	195.8	173.3	169.0
Sep.	188.8	31.4	77.7
Oct.	297.5	15.8	24.4
Nov.	315.3	167.8	41.2
Dec.	150.3	54.1	32.3
Total	1,805.1	828.1	579.4

Irrigation Efficiency

Overall irrigation efficiency (1 - loss) is usually divided into two parts: the efficiency of water use below the farm turnout and the efficiency of water use in the conveyance system between the source of water supply and the farm turnout. Furthermore, from the aspects of water losses encountered in the operation of irrigation system, the water losses are subdivided into three stages: i) farm waste at on-farm level, ii) conveyance losses in lateral and sub-lateral canals, and iii) system operation losses in main and lateral canals.

The proposed overall irrigation efficiency adopted in the Project is 54 percent for the dry season paddy and 48 percent for the wet season paddy on average, as shown below;

Irrigation Efficiency	Dry Season Paddy (%)	Wet Season Paddy (%)
Farm Irrigation Efficiency	80	70
Conveyance Efficiency (average)	80	80
System Operation Efficiency	85	85
Overall Efficiency	54.4	47.6

Conveyance efficiency for each lateral applied to the Project has been decided by MRIIS Office as shown below, based on the actual discharge observation, and these efficiencies are considered to be appropriate at the prevailing farming practices, water management and physical conditions of canals.

Conveyance Efficiency (C.E)

(unit: %)

Lateral/ Sub-Lateral	C.E.	Lateral/ Sub-Lateral	C.E.	Lateral/ Sub-Lateral	C.E.
Division-I				Division-II	
C	80	A-5	80	SIFFU-SMC	76
C-1	95	A-5 Extra	91	A	86
C-2	88	A-6	94	A-Extra	85
C-3	70	A-7	88	B	67
C-4	70	B	80	C	84
E	88	B-1	80	D	76
E-1	80	D	84	E	70
E-2	82	D-1	89	E-Extra	88
E-3	83	D-2	88	F	61
F	81	D-3	83	G	83
G	90	D-4	83	H	94
H	86	H-Extra	76	SIFFU-NMC	76
SLC	80	I	86	A	80
SHC	80	I-Extra	79	B	85
		J	79	NDC	76
		J-Extra	81		
Division-II		CEE	80		
A	74	RMC	80		
A-1	94	MAC-East	80		
A-2	76	MAC-West	80		
A-3	72				
A-4	92				

Unit diversion water requirement for lateral canal basis exclusive effective rainfall is shown in the O/M Drawings No.10.

2.3. Irrigation Water Requirement

(1) Cropping Pattern

Present cropping pattern proposed in the Service Area is presented with 18 types by the irrigation systems, but there exists a lag time of farming activities ranging about four months between up and down stream areas, due to several interrelated factors such as water allocation, available labour force, farmers' financial reason, warehouse capacity etc., which limits the cropping calendar to certain time period (see O/M Drawings No.11).

This lag time for farming activities in the Service Area causes a difficulty in adequate water management and operation and maintenance of the project facilities. MRIIS O/M Office makes efforts to standardize the typical cropping pattern planned in the Operation and Maintenance Manual.

(2) Irrigation Water Requirement

Present irrigation water requirement for the both wet and dry seasons is tabulated in Table C-3 based on the available three years data from 1984 to 1986.

2.4. Re-Use of Irrigation Water

The downstream areas of Laterals "A" and "B" covered by the Maris main canal are irrigated by the return flow of irrigation water (re-use of irrigation water) supplied to those areas. In order to divert the return flow, intake weirs are provided in the existing creeks such as Macanao, Ladeco, Minante and Gaddanan creeks.

During the Phase II survey period, discharge measurements of inflow and outflow at the selected sample area of about 2,830 ha located on downstream area of Laterals "A-2" and "B" (see Figure C-2) were conducted to analyze an available amount of return flow. The following table indicates the results of observation.

Discharge Measurement for Return Flow

Item	Discharge Observation		
	June 24	July 1	July 14
Total Inflow (cu.m/s)	24.7	21.3	17.9
Total Outflow (cu.m/s)	23.9	20.6	15.2
Outflow Ratio (%)	97	97	85

As is seen in the above figures, an average outflow ratio is estimated at a high percentage of 93 percent. In the Project, the ratio of return flow was decided at 45 percent on the assumption that 50 percent of total outflow discharge could be utilized for return flow in the above mentioned systems.

Furthermore, Study Team analyzed the amount of wasted irrigation water in the selected creeks located in the lower area of District IV during the periods of June to October, 1986. As the results, it was found out that about 680 mm of irrigation water equivalent to about 20 to 30 percent of supplied water is wasted to the creeks during the wet season paddy cultivation, as shown in Table C-4.

TABLE C-3 PRESENT IRRIGATION SUPPLY FOR MAJOR CANAL SYSTEM

Item	Wet Season 1/			Dry Season 2/			Total		
	Area (ha)	Demand (MCM)	Demand/ha (mm/ha)	Area (ha)	Demand (MCM)	Demand/ha (mm/ha)	Area (ha)	Demand (MCM)	Demand/hr (mm/ha)
A. 1984 (May 1984 - Apr. 1985)									
1. Baligatan Diversion Dam	9,990	90.5	906	8,060	99.1	1,230	18,050	189.6	2,101
2. Maris Diversion	36,700	1,045.4	2,849	48,240	1,051.2	2,179	84,940	2,096.6	4,937
3. Siffuris Diversion Dam	16,100	305.3	1,896	16,580	341.9	2,062	32,680	647.2	4,961
Total	62,790	1,441.2	2,295	72,880	1,492.2	2,047	135,670	2,933.4	4,324
B. 1985 (May 1985 - Apr. 1986)									
1. Baligatan Diversion Dam	7,260	141.7	1,952	9,570	171.7	1,794	16,830	313.4	3,724
2. Maris Diversion Dam	46,700	1,223.1	2,619	43,340	1,146.6	2,646	90,040	2,369.7	5,264
3. Siffuris Diversion Dam	15,180	400.3	2,637	14,500	386.0	2,662	29,680	786.3	5,299
Total	69,140	1,765.1	2,553	67,410	1,704.3	2,528	136,550	3,469.4	5,082

Note: 1/ Wet Season: May to October
2/ Dry Season: November to April
Data source: MRIIS O/M Office

TABLE C-4 ESTIMATION OF WASTED WATER AMOUNT

(Period: June 3, 1986 to October 6, 1986)

Description	Unit	Marabulig Creek	Minante Creek	Nungnungan Creek	Burgos Creek	Paddad Creek	Total Average
Drainage Area	sq.km	39.2	34.4	25.9	13.1	60.5	173.1
Rainfall 1/ (Jun.-Sep.'86)	mm	826	826	826	826	826	826
Total Run-off in Creek 2/	MCM	26.6	26.9	24.1	14.1	44.3	136.0
Estimated Run-off by Rainfall 3/	MCM	10.1	8.7	6.7	3.3	15.5	44.3
Wasted Water from Excess Irrigation	MCM	16.5	18.2	17.4	10.8	28.8	91.7
Irrigated Area in Wet Season '86	ha	3,000	2,500	2,500	1,000	3,900	12,900
Wasted Water Depth	mm/crop season 4/	523	693	663	1,029	703	676

Note: 1/ Salvation Rainfall Station, Alicia

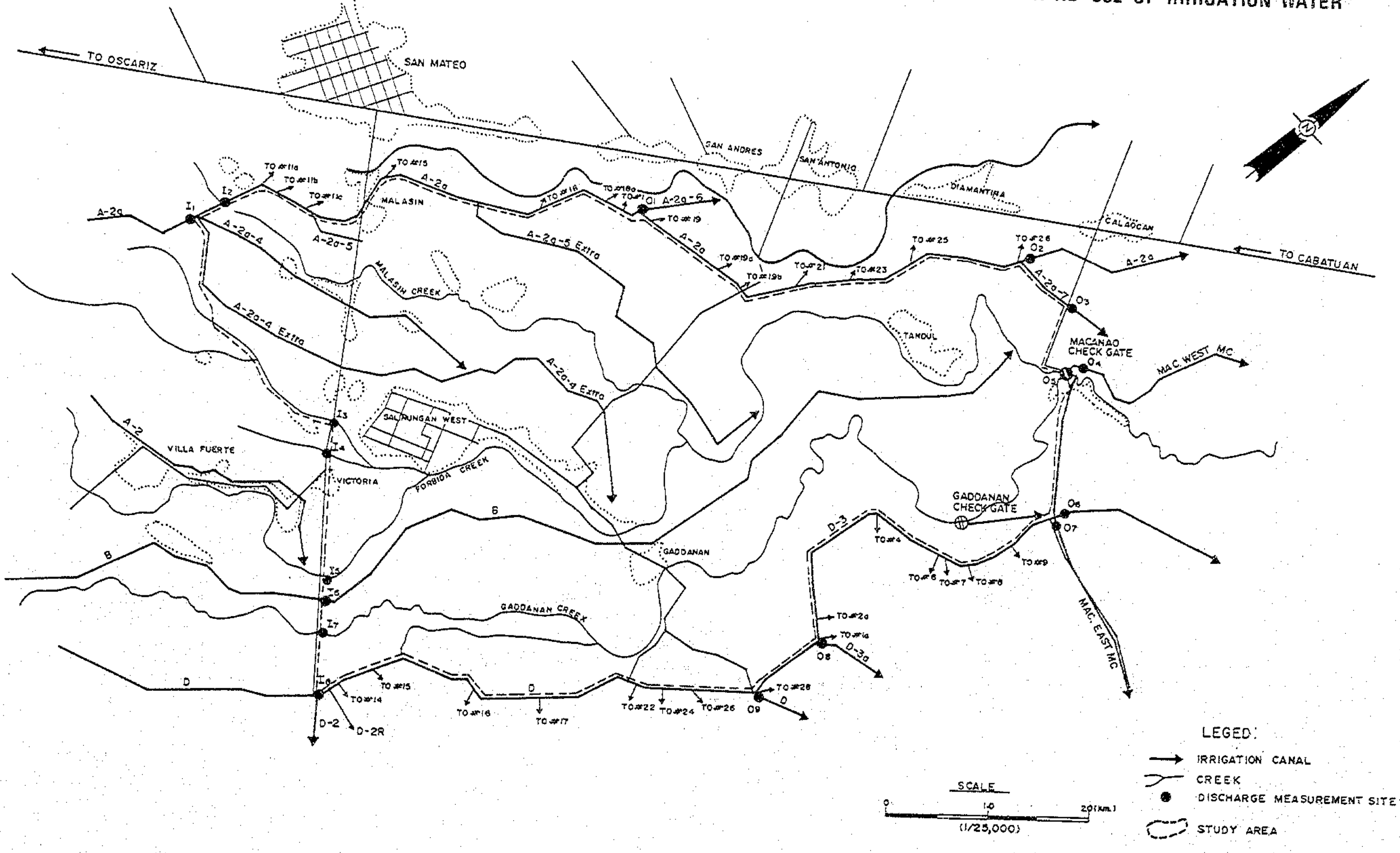
2/ Converted value from observed water depth in creek

3/ Total of estimated weekly run-off, of which run-off coefficients to weekly rainfall magnitude are as follows:

Weekly Rainfall (mm)	Run-off Coefficient (%)	Weekly Rainfall (mm)	Run-off Coefficient (%)
0-10	0	41- 60	20
11-20	5	61-100	30
21-40	10	101-	40

4/ 120 days

FIGURE C-2. DISCHARGE MEASUREMENT FOR RE-USE OF IRRIGATION WATER



3. IMPROVEMENT OF IRRIGATION AND DRAINAGE SYSTEMS

3.1. Proposed Irrigation Water Requirement and Water Distribution

(1) Proposed Cropping Pattern

An appropriate combination of cropping schedules in time and space anywhere in the Service Area was examined to obtain the most suitable distribution of reservoir water, so as to expect the optimum use of storage for the dual purposes of irrigation and power generation.

Starting from the prototype cropping schedule given in the existing MRIIS O/M Manual, and making a comparison between seasonal water requirement for power generation projected by NPC and irrigation demand, a combination of cropping patterns were proposed in consideration of the followings;

- To expect efficient utilization of the Siffu river runoff especially in wet season, cropping schedule for the Siffu service area for both the wet and dry crops should be shifted about 30 to 40 days afterward.

- Cropping schedule for the service area of the Baligatan diversion dam should also be recommendable to be shifted afterwards in order to expect higher yield of generated outputs by use of irrigation release while the reservoir keeps relatively elevated water levels, and to reduce the burden for the reservoir by means of utilizing wet season discharge as much as possible.

- The North Diversion main canal service area, involving the Siffu East Extension area, should also be the subject for shifting its cropping schedule. Especially for service areas of the Siffu East Extension where irrigation water is supplied by pumping up, it may inevitably be advantageous to be planted during such period that much effective rainfalls are expected on the field and that electric charge are relatively cheap.

Figure C-3 presents the prototype and alternative cropping schedules while the proposed pattern thus obtained is given in Figure C-4.

(2) Total irrigation Water Requirement

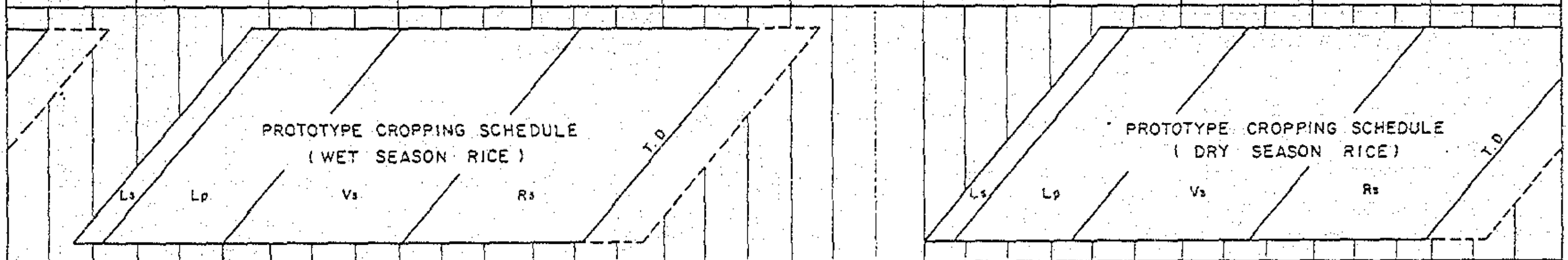
The total water demand corresponding to a relative drought year for the projected Service Area of about 97,400 ha was estimated on the daily basis in case of paddy cultivation for both dry and wet seasons, and estimated water requirement is summarized as shown below by each water resource such as the Baligatan diversion dam, Maris diversion dam and Siffuris diversion dam. In the above estimation of water requirement, an effective rainfall was counted.

Total Water Requirement by Water Resources

(unit: MCM)

Month	Baligatan Diversion Dam	Maris Diversion Dam	Siffuris Diversion Dam	Total
Jan.	37.6	287.2	35.5	360.3
Feb.	45.2	279.6	41.4	366.2
Mar.	52.0	164.6	43.3	259.9
Apr.	16.4	130.7	14.3	161.4
May	14.4	283.0	13.5	310.9
Jun.	48.6	221.1	38.6	308.3
Jul.	46.2	346.5	43.8	436.5
Aug.	23.6	182.7	21.3	227.6
Sep.	22.7	86.8	19.3	128.8
Oct.	11.5	66.4	12.5	90.4
Nov.	4.6	122.1	8.8	135.5
Dec.	34.2	216.2	30.5	280.9
Total	357.0	2,386.9	322.8	3,066.7

FIGURE C-3. PROTOTYPE AND ALTERNATIVE CROPPING SCHEDULE

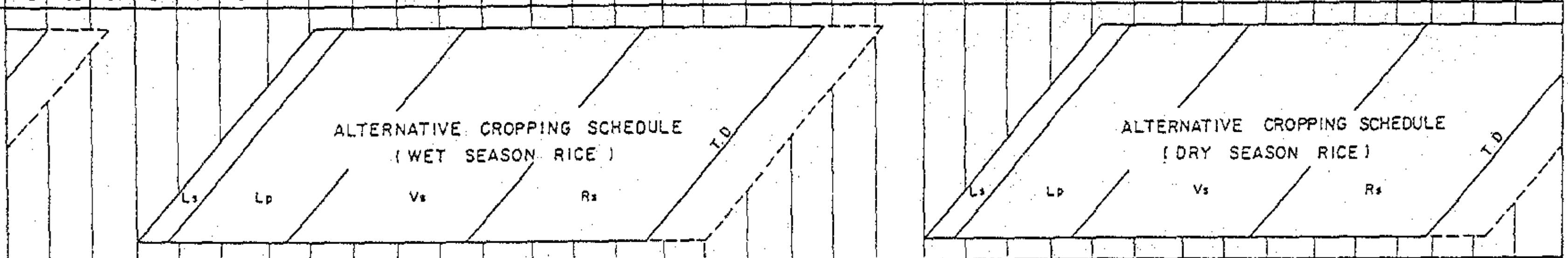


AREAL RATE (Prototype), April – September

	APR			MAY			JUNE			JULY			AUG			SEP		
Ls		5/168	11/140	1/6	1/6	23/154	3/280											
Lp			8/105	13/42	23/42	28/42	73/120	8/21	1/7	1/840								
Vs						11/84	8/21	13/21	6/7	379/420	2/3	5/12	1/6	1/210				
Rs	5/42									27/280	1/3	7/12	5/6	193/210	19/28	3/7	4/21	3/280
TOTAL	5/42	5/168	13/84	10/21	5/7	125/132	1/1	1/1	1/1	1/1	1/1	1/1	1/1	97/105	19/28	3/7	4/21	3/280

AREAL RATE (Prototype), October – March

	OCT			NOV			DEC			JAN			FEB			MAR		
Ls				13/120	1/6	1/6	1/6	11/120										
Lp				3/280	4/21	3/7	107/168	559/840	43/84	11/42	3/70							
Vs							5/168	5/21	41/84	31/42	197/210	65/84	11/21	2/7	7/96			
Rs											2/105	19/84	10/21	5/7	311/336	6/7	13/21	31/84
TOTAL				5/42	5/14	25/42	5/6	209/210	1/1	1/1	1/1	1/1	1/1	1/1	671/672	6/7	13/21	31/84



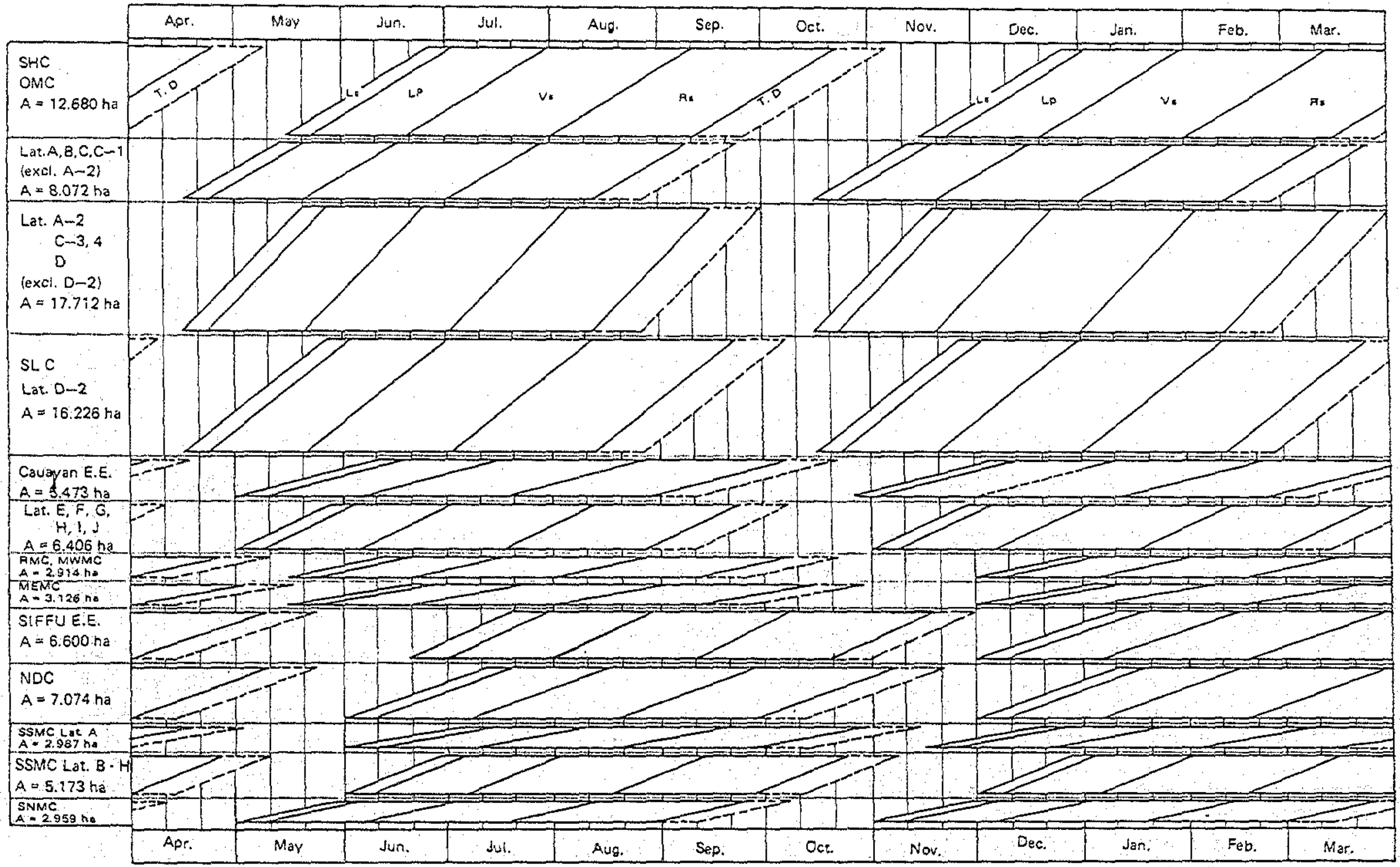
AREAL RATE (Alternative), April – September

	APR			MAY			JUNE			JULY			AUG			SEP		
Ls				13/120	1/6	1/6	1/6	3/40										
Lp				3/280	4/21	37/84	68/105	139/210	1/2	11/42	3/70							
Vs							3/70	11/42	1/2	31/42	197/210	65/84	11/21	2/7	7/132			
Rs	5/42										2/105	19/84	10/21	5/7	859/924	11/14	23/42	13/42
TOTAL	5/42			5/42	5/14	17/28	6/7	839/840	1/1	1/1	1/1	1/1	1/1	1/1	227/231	11/14	23/42	13/42

AREAL RATE (Alternative), October – March

	OCT			NOV			DEC			JAN			FEB			MAR		
Ls				13/120	1/6	1/6	1/8	11/120										
Lp				3/280	4/21	3/7	107/168	559/840	43/84	11/42	3/70							
Vs							5/168	5/21	41/84	31/42	197/210	65/84	11/21	2/7	7/96			
Rs	8/105										2/105	19/84	10/21	5/7	311/336	6/7	13/21	31/84
TOTAL	8/105			5/42	5/14	25/42	5/6	209/210	1/1	1/1	1/1	1/1	1/1	1/1	671/672	6/7	13/21	31/84

FIGURE C-4. PROPOSED CROPPING SCHEDULE



Irrigation water requirement was estimated by using fundamental factors such as evapotranspiration, percolation, effective rainfall and water losses, which were discussed in the previous paragraph of "Irrigation Water Requirement". However, further studies on these factors will be needed in future, in order to make the estimation of water requirement more accurate.

Diversion water requirements, as computed on the basis of the proposed cropping schedule and irrigation diagram, are compiled in Table C-5, Table C-6 and O/M Drawings No.13.

(3) Water Duty in Irrigation System

(a) Water Duty at Main and Lateral Basis

Water duty at main and lateral basis was estimated from the results of estimation of diversion water requirements mentioned above. The estimated water duty at major main and lateral canals is shown in O/M Drawings No.14. The subsequent shows the maximum water duty during the cropping season at diversion dam sites:

Baligatan irrigation system	:	1.71 lit/sec/ha
Maris irrigation system	:	1.77 lit/sec/ha
Siffuris irrigation system	:	1.51 lit/sec/ha

(b) Water Duty at On-farm Basis

Unit area of irrigation at on-farm level so called rotational area is 30 - 45 ha on average. Distribution of irrigation water at on-farm level will be discussed in two stages of paddy cultivation as mentioned below;

Land Soaking and Preparation Stages

According to the proposed cropping pattern, land soaking and preparation periods extend from the middle of October to the middle

TABLE C-5 PROPOSED DIVERSION WATER REQUIREMENT FOR MAJOR CANAL SYSTEM

Canal System	Area (ha)	Wet Season		Dry Season		Total	
		Demand (MCM)	Demand/ha (mm/ha)	Demand (MCM)	Demand/ha (mm/ha)	Demand (MCM)	Demand/ha (mm/ha)
1. Baligatan Diversion Dam							
South High Canal	9,580	126.2	1,317	144.3	1,506	270.5	2,824
Oscariz Canal	3,100	40.8	1,316	45.7	1,474	86.5	2,790
Sub-total	12,680	167.0	1,317	190.0	1,498	357.0	2,815
2. Maris Diversion Dam							
Maris Main Canal	53,889	935.8	1,736	832.4	1,545	1,768.2	3,281
Macanao	6,040	99.0	1,639	110.5	1,829	209.5	3,469
Siffu East Extension	6,600	84.2	1,276	112.7	1,708	196.9	2,983
Sub-total	66,529	1,119.0	1,682	1,055.6	1,587	2,174.6	3,269
3. Siffuris Diversion Dam							
North Diversion Canal	7,074	91.0	1,286	121.4	1,716	212.4	3,002
Siffu North Canal	2,959	43.2	1,460	41.9	1,416	85.1	2,876
Siffu South Canal	8,160	105.7	1,295	132.0	1,618	237.7	2,913
Sub-total	18,193	239.9	1,319	295.3	1,623	535.2	2,942
T o t a l	97,402	1,525.9	1,567	1,540.9	1,582	3,066.8	3,149

Note: 1. Effective rainfall is counted in the above irrigation demand.
Water requirement covered by North Diversion cand is included in the group of Siffuris Diversion dam.

2. Above figures are obtained by dividing the estimated diversion water requirement at lateral base by system operation efficiency of 85 percent.

TABLE C-6. DIVERSION WATER REQUIREMENT BY LATERAL (WITH EFFECTIVE RAINFALL) (1)

(PAGE....1)
(UNIT = MCM)

PERIOD	BALIGATAN D.D. S.H.C 9580HA	BALIGATAN D.D. O.M.C 3100HA	BALIGATAN D.D. TOTAL 12680HA	LATERAL.A (MARIS) A-1 279HA	A-2 3993HA	A-3 673HA	A-4 84HA	A-5 579HA	A-5EX 92HA	A-6 202HA	A-7 87HA	LAT.A 1558HA	TOTAL 7547HA	LAT.B 1713HA	S.L.C 7920HA
JAN *F	7.652	2.476	10.128	0.491	8.679	1.545	0.151	1.198	0.167	0.355	0.164	3.483	16.233	3.545	7.218
*M	7.903	2.557	10.460	0.493	8.719	1.553	0.152	1.204	0.168	0.357	0.164	3.502	16.312	3.561	7.283
*L	9.262	2.997	12.259	0.545	9.636	1.718	0.168	1.330	0.186	0.395	0.182	3.873	18.032	3.934	8.086
*T	24.817*	8.030*	32.847*	1.529*	27.033*	4.816*	0.472*	3.732*	0.521*	1.107*	0.509*	10.857*	50.577*	11.041*	22.587*
FEB *F	10.250	3.317	13.567	0.542	9.585	1.710	0.167	1.326	0.185	0.393	0.180	3.850	17.938	3.922	8.886
*M	10.388	3.361	13.749	0.464	8.481	1.462	0.143	1.134	0.158	0.336	0.154	3.293	15.626	3.355	8.120
*L	8.410	2.721	11.131	0.232	4.823	0.733	0.072	0.568	0.079	0.168	0.077	1.650	8.403	1.681	4.952
*T	29.047*	9.399*	38.447*	1.239*	22.889*	3.904*	0.381*	3.028*	0.423*	0.897*	0.412*	8.793*	41.966*	8.958*	21.958*
MAR *F	12.043	3.897	15.940	0.127	3.870	0.397	0.039	0.308	0.043	0.092	0.042	0.897	5.814	0.910	4.986
*M	11.635	3.765	15.400	0.001	0.953	0.003	0.000	0.003	0.000	0.001	0.000	0.007	0.969	0.008	2.493
*L	9.719	3.145	12.865	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.343
*T	33.398*	10.807*	44.205*	0.128*	4.822*	0.401*	0.039*	0.310*	0.043*	0.092*	0.042*	0.905*	6.783*	0.918*	7.821*
APR *F	6.740	2.181	8.921	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*M	3.370	1.091	4.461	0.078	1.099	0.245	0.024	0.189	0.026	0.056	0.026	0.550	2.293	0.560	1.122
*L	0.421	0.136	0.558	0.492	7.855	1.552	0.152	1.201	0.168	0.356	0.164	3.493	15.432	3.552	3.713
*T	10.531*	3.408*	13.939*	0.570*	8.954*	1.796*	0.175*	1.390*	0.194*	0.413*	0.190*	4.043*	17.725*	4.112*	4.835*
MAY *F	0.0	0.0	0.0	0.585	8.431	1.846	0.180	1.428	0.200	0.424	0.195	4.156	17.444	4.224	7.519
*M	1.158	0.375	1.532	0.643	11.062	2.031	0.198	1.570	0.219	0.466	0.215	4.569	20.974	4.646	9.425
*L	8.104	2.622	10.727	0.571	11.450	1.804	0.176	1.395	0.195	0.414	0.191	4.058	20.254	4.127	12.319
*T	9.262*	2.997*	12.259*	1.800*	30.943*	5.681*	0.555*	4.393*	0.614*	1.303*	0.601*	12.783*	58.671*	12.997*	29.263*
JUN *F	8.346	2.701	11.047	0.357	6.244	1.123	0.110	0.870	0.121	0.258	0.119	2.525	11.727	2.573	4.625
*M	10.478	3.391	13.868	0.380	6.589	1.196	0.117	0.926	0.129	0.275	0.127	2.690	12.429	2.740	4.956
*L	12.380	4.006	16.386	0.386	6.872	1.215	0.118	0.940	0.131	0.279	0.129	2.733	12.804	2.782	5.494
*T	31.204*	10.097*	41.301*	1.122*	19.706*	3.535*	0.344*	2.736*	0.382*	0.813*	0.374*	7.948*	36.960*	8.095*	15.075*
JUL *F	9.046	2.927	11.973	0.572	10.083	1.801	0.176	1.398	0.195	0.414	0.191	4.060	18.890	4.136	8.555
*M	9.471	3.065	12.536	0.580	10.191	1.826	0.178	1.416	0.198	0.420	0.193	4.112	19.113	4.188	8.736
*L	11.170	3.614	14.784	0.647	11.336	2.037	0.199	1.578	0.220	0.468	0.216	4.584	21.282	4.667	9.817
*T	29.687*	9.607*	39.294*	1.798*	31.610*	5.664*	0.553*	4.391*	0.613*	1.302*	0.599*	12.756*	59.285*	12.992*	27.108*
AUG *F	4.714	1.525	6.239	0.453	7.855	1.430	0.139	1.106	0.155	0.328	0.151	3.217	14.835	3.271	5.030
*M	4.872	1.576	6.448	0.401	7.147	1.267	0.123	0.979	0.137	0.291	0.134	2.850	13.329	2.897	4.738
*L	5.541	1.793	7.334	0.249	5.315	0.787	0.077	0.608	0.085	0.180	0.083	1.769	9.154	1.799	3.831
*T	15.127*	4.895*	20.021*	1.104*	20.317*	3.484*	0.339*	2.693*	0.378*	0.799*	0.368*	7.836*	37.318*	7.967*	13.599*
SEP *F	5.617	1.817	7.434	0.091	3.383	0.287	0.028	0.222	0.031	0.066	0.030	0.646	4.785	0.657	3.988
*M	5.173	1.674	6.847	0.0	0.554	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.554	0.0	1.773
*L	3.807	1.232	5.040	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.100
*T	14.597*	4.724*	19.321*	0.091*	3.937*	0.287*	0.028*	0.222*	0.031*	0.066*	0.030*	0.646*	5.339*	0.657*	5.861*
OCT *F	5.002	1.619	6.620	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*M	2.223	0.719	2.942	0.037	0.524	0.116	0.011	0.090	0.013	0.027	0.012	0.261	1.089	0.266	0.556
*L	0.137	0.044	0.182	0.290	4.132	0.912	0.089	0.707	0.099	0.210	0.097	2.056	8.592	2.092	4.035
*T	7.362*	2.382*	9.745*	0.327*	4.656*	1.028*	0.100*	0.797*	0.111*	0.237*	0.109*	2.316*	9.681*	2.358*	4.591*
NOV *F	0.0	0.0	0.0	0.260	3.954	0.817	0.080	0.632	0.088	0.188	0.086	1.841	7.945	1.869	3.821
*M	0.640	0.207	0.848	0.277	5.241	0.871	0.085	0.673	0.094	0.201	0.092	1.966	9.501	1.990	4.735
*L	2.284	0.739	3.023	0.242	5.022	0.762	0.075	0.588	0.082	0.175	0.080	1.720	8.747	1.740	5.609
*T	2.924*	0.946*	3.870*	0.779*	14.216*	2.450*	0.240*	1.892*	0.265*	0.564*	0.259*	5.527*	26.193*	5.599*	14.165*
DEC *F	5.457	1.766	7.223	0.416	7.294	1.313	0.128	1.016	0.142	0.301	0.139	2.952	13.701	3.007	5.101
*M	7.034	2.276	9.310	0.432	7.541	1.365	0.133	1.055	0.147	0.313	0.144	3.067	14.197	3.123	5.354
*L	9.455	3.059	12.514	0.480	8.519	1.516	0.148	1.172	0.164	0.347	0.160	3.406	15.912	3.468	6.322
*T	21.945*	7.101*	29.047*	1.328*	23.354*	4.194*	0.409*	3.244*	0.453*	0.961*	0.444*	9.424*	43.809*	9.597*	16.776*
ANNUAL	229.901	74.394	304.294	11.815	212.437	37.240	3.635	28.828	4.028	8.554	3.937	83.834	394.307	85.290	183.638

TABLE C-6. DIVERSION WATER REQUIREMENT BY LATERAL (WITH EFFECTIVE RAINFALL) (2)

(PAGE....2)
(UNIT = MCM)

PERIOD	LATERAL.C (MARIS) C-1 427HA	C-2 958HA	C-3,4 4344HA	LAT.C 1420HA	TOTAL 7149HA	LATERAL.D (MARIS) D-1 3089HA	D-2 8306HA	D-3,4 3517HA	LAT.D 2769HA	C.E.E 5473HA	TOTAL 23154HA	LATERAL.E (MARIS) E-1 694HA	E-2,3 214HA	LAT.E 1754HA	TOTAL 2662HA
JAN *F	0.327	0.792	4.525	1.297	6.941	2.524	6.852	3.086	2.403	4.372	19.236	0.629	0.188	1.437	2.254
*M	0.331	0.804	4.568	1.315	7.017	2.555	6.920	3.121	2.423	4.515	19.534	0.630	0.189	1.441	2.261
*L	0.368	0.897	5.075	1.465	7.805	2.845	7.691	3.473	2.689	5.291	21.990	0.702	0.210	1.606	2.518
*T	1.025*	2.494*	14.168*	4.076*	21.763*	7.924*	21.463*	9.681*	7.515*	14.178*	60.760*	1.960*	0.587*	4.485*	7.032*
FEB *F	0.406	0.985	5.585	1.607	8.583	3.119	8.468	3.824	2.963	5.856	24.230	0.768	0.231	1.773	2.772
*M	0.347	0.843	4.945	1.375	7.510	2.761	7.736	3.386	2.623	5.934	22.441	0.779	0.235	1.802	2.815
*L	0.174	0.422	2.812	0.689	4.097	1.570	4.717	1.925	1.492	4.804	14.509	0.622	0.187	1.439	2.249
*T	0.927*	2.250*	13.343*	3.671*	20.190*	7.450*	20.922*	9.135*	7.078*	16.594*	61.180*	2.169*	0.653*	5.014*	7.836*
MAR *F	0.102	0.248	2.440	0.402	3.192	1.368	4.750	1.670	1.297	6.880	15.966	0.716	0.215	1.643	2.574
*M	0.001	0.002	0.601	0.003	0.607	0.337	2.375	0.411	0.319	6.647	10.089	0.391	0.117	0.896	1.404
*L	0.0	0.0	0.0	0.0	0.0	0.0	0.327	0.0	0.0	5.553	5.879	0.080	0.024	0.183	0.287
*T	0.103*	0.250*	3.040*	0.406*	3.799*	1.705*	7.452*	2.082*	1.617*	19.080*	31.935*	1.186*	0.356*	2.722*	4.265*
APR *F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.850	3.850	0.0	0.0	0.0	0.0
*M	0.076	0.185	0.844	0.302	1.408	0.473	1.070	0.576	0.449	1.925	4.493	0.0	0.0	0.0	0.0
*L	0.468	1.135	5.850	1.849	9.302	3.275	3.542	3.993	3.108	0.241	14.159	0.0	0.0	0.0	0.0
*T	0.545*	1.320*	6.694*	2.151*	10.710*	3.747*	4.612*	4.569*	3.556*	6.016*	22.502*	0.0 *	0.0 *	0.0 *	0.0 *
MAY *F	0.487	1.178	5.530	1.923	9.118	3.099	7.185	3.778	2.941	2.420	19.422	0.454	0.137	1.043	1.633
*M	0.487	1.179	6.903	1.926	10.494	3.869	9.013	4.715	3.673	4.833	26.104	0.900	0.271	2.068	3.238
*L	0.384	0.928	6.506	1.516	9.335	3.649	11.787	4.444	3.466	7.072	30.418	1.265	0.381	2.905	4.552
*T	1.358*	3.284*	18.939*	5.366*	28.947*	10.617*	27.985*	12.937*	10.080*	14.325*	75.944*	2.619*	0.788*	6.016*	9.424*
JUN *F	0.170	0.415	2.529	0.673	3.786	1.421	4.461	1.737	1.355	5.565	14.539	0.481	0.144	1.110	1.734
*M	0.205	0.500	2.936	0.811	4.452	1.643	4.777	2.006	1.574	5.231	15.231	0.497	0.150	1.148	1.796
*L	0.214	0.521	3.270	0.847	4.852	1.824	5.290	2.227	1.753	4.610	15.704	0.568	0.171	1.311	2.050
*T	0.589*	1.436*	8.735*	2.331*	13.090*	4.888*	14.528*	5.971*	4.681*	15.406*	45.474*	1.546*	0.465*	3.569*	5.580*
JUL *F	0.395	0.954	5.415	1.553	8.318	3.017	8.169	3.682	2.875	5.502	23.244	0.742	0.223	1.709	2.675
*M	0.406	0.981	5.532	1.601	8.520	3.085	8.325	3.768	2.943	5.853	23.973	0.745	0.224	1.716	2.686
*L	0.458	1.109	6.222	1.816	9.605	3.473	9.335	4.245	3.316	6.620	26.988	0.840	0.253	1.935	3.028
*T	1.260*	3.044*	17.169*	4.970*	26.443*	9.575*	25.828*	11.695*	9.133*	17.975*	74.206*	2.328*	0.701*	5.360*	8.388*
AUG *F	0.251	0.613	3.289	0.994	5.147	1.835	4.784	2.240	1.740	2.828	13.427	0.358	0.109	0.829	1.296
*M	0.222	0.543	3.001	0.880	4.646	1.673	4.505	2.043	1.587	2.918	12.727	0.371	0.113	0.862	1.345
*L	0.138	0.337	2.232	0.547	3.253	1.244	3.643	1.519	1.180	3.249	10.836	0.397	0.121	0.923	1.441
*T	0.611*	1.492*	8.522*	2.421*	13.046*	4.752*	12.932*	5.802*	4.507*	8.996*	36.989*	1.126*	0.342*	2.614*	4.082*
SEP *F	0.070	0.170	1.982	0.277	2.498	1.107	3.783	1.356	1.053	3.753	11.052	0.492	0.148	1.131	1.772
*M	0.0	0.0	0.324	0.0	0.324	0.181	1.681	0.222	0.172	2.615	4.872	0.233	0.070	0.536	0.839
*L	0.0	0.0	0.0	0.0	0.0	0.0	0.095	0.0	0.0	1.478	1.573	0.021	0.006	0.048	0.075
*T	0.070*	0.170*	2.306*	0.277*	2.823*	1.288*	5.559*	1.578*	1.225*	7.846*	17.496*	0.746*	0.224*	1.715*	2.685*
OCT *F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.591	0.591	0.0	0.0	0.0	0.0
*M	0.038	0.091	0.417	0.148	0.694	0.234	0.530	0.284	0.221	0.0	1.269	0.0	0.0	0.0	0.0
*L	0.272	0.659	3.027	1.075	5.033	1.695	3.849	2.065	1.607	0.0	9.216	0.0	0.0	0.0	0.0
*T	0.310*	0.750*	3.444*	1.224*	5.727*	1.928*	4.379*	2.349*	1.829*	0.591*	11.076*	0.0 *	0.0 *	0.0 *	0.0 *
NOV *F	0.240	0.579	2.785	0.945	4.549	1.564	3.648	1.902	1.479	0.0	8.593	0.236	0.071	0.540	0.846
*M	0.218	0.526	3.416	0.855	5.014	1.923	4.521	2.337	1.814	0.366	10.961	0.469	0.141	1.075	1.685
*L	0.164	0.397	2.807	0.642	4.010	1.586	5.349	1.925	1.490	1.305	11.655	0.604	0.182	1.388	2.175
*T	0.622*	1.502*	9.008*	2.442*	13.574*	5.074*	13.519*	6.164*	4.783*	1.671*	31.209*	1.309*	0.395*	3.003*	4.706*
DEC *F	0.234	0.563	3.166	0.922	4.884	1.777	4.852	2.159	1.676	3.118	13.583	0.465	0.141	1.070	1.676
*M	0.259	0.622	3.455	1.018	5.355	1.938	5.095	2.350	1.826	4.018	15.228	0.459	0.139	1.053	1.651
*L	0.292	0.701	4.064	1.147	6.204	2.277	6.019	2.759	2.146	5.401	18.603	0.564	0.171	1.290	2.025
*T	0.785*	1.886*	10.685*	3.087*	16.443*	5.992*	15.967*	7.268*	5.648*	12.537*	47.413*	1.489*	0.451*	3.413*	5.352*
ANNUAL	8.204	19.878	116.052	32.421	176.554	64.941	175.146	79.231	61.652	135.215	516.183	16.478	4.962	37.911	59.352

TABLE C-6. DIVERSION WATER REQUIREMENT BY LATERAL (WITH EFFECTIVE RAINFALL) (3)

(PAGE....3)
(UNIT = MCM)

PERIOD		LAT.F 555HA	LAT.G 137HA	LAT.H 182HA	L.HEX 801HA	LAT.I 1084HA	LAT.J 714HA	L.IEX 75HA	L.JEX 196HA	MACANAO EAST M.C R.M.C 1776HA	MACANAO EAST M.C MEMC 3126HA	MACANAO EAST M.C TOTAL 4902HA	MACANAO WEST M.C LADECO 967HA	MACANAO WEST M.C MWMC 171HA	MACANAO WEST M.C TOTAL 1138HA	NORTH S.F.E 6600HA
JAN	*F	0.498	0.110	0.154	0.760	0.916	0.653	0.069	0.176	1.372	3.215	4.587	1.877	0.332	2.209	6.870
	*M	0.499	0.110	0.154	0.762	0.919	0.655	0.069	0.176	1.378	2.356	3.735	1.870	0.331	2.201	6.415
	*L	0.554	0.122	0.171	0.848	1.020	0.729	0.077	0.196	1.674	2.803	4.478	2.143	0.379	2.522	6.136
	*T	1.551*	0.342*	0.479*	2.370*	2.855*	2.036*	0.214*	0.548*	4.425*	8.375*	12.799*	5.890*	1.042*	6.932*	19.421*
FEB	*F	0.609	0.135	0.188	0.934	1.117	0.802	0.084	0.215	1.887	3.260	5.147	2.147	0.380	2.526	7.047
	*M	0.618	0.137	0.190	0.947	1.132	0.814	0.085	0.218	1.892	3.330	5.222	2.150	0.380	2.530	7.381
	*L	0.494	0.110	0.152	0.757	0.905	0.650	0.068	0.174	1.538	2.702	4.240	1.733	0.306	2.039	6.009
	*T	1.721*	0.382*	0.530*	2.638*	3.154*	2.266*	0.238*	0.608*	5.316*	9.292*	14.609*	6.029*	1.066*	7.096*	20.436*
MAR	*F	0.565	0.126	0.174	0.870	1.038	0.746	0.078	0.200	2.185	3.824	6.009	2.309	0.408	2.717	8.464
	*M	0.308	0.068	0.095	0.475	0.566	0.407	0.043	0.109	2.220	3.878	6.099	2.328	0.412	2.740	8.573
	*L	0.063	0.014	0.019	0.097	0.116	0.083	0.009	0.022	2.432	4.284	6.716	2.547	0.450	2.998	9.512
	*T	0.936*	0.208*	0.289*	1.441*	1.719*	1.237*	0.130*	0.331*	6.836*	11.987*	18.824*	7.185*	1.271*	8.456*	26.548*
APR	*F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.968	3.652	5.620	1.911	0.338	2.249	8.411
	*M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.031	2.347	3.378	1.001	0.177	1.178	6.008
	*L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.169	1.043	1.212	0.164	0.029	0.193	3.605
	*T	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	3.167*	7.042*	10.210*	3.076*	0.544*	3.620*	18.024*
MAY	*F	0.359	0.080	0.111	0.552	0.660	0.473	0.050	0.127	0.0	0.066	0.066	0.0	0.0	0.0	1.188
	*M	0.711	0.158	0.220	1.094	1.309	0.939	0.099	0.251	0.321	0.452	0.774	0.273	0.048	0.321	0.0
	*L	0.999	0.222	0.309	1.539	1.840	1.321	0.139	0.353	2.247	3.168	5.415	1.992	0.352	2.345	0.0
	*T	2.069*	0.460*	0.640*	3.185*	3.810*	2.732*	0.287*	0.731*	2.569*	3.686*	6.254*	2.265*	0.401*	2.666*	1.188*
JUN	*F	0.379	0.084	0.117	0.586	0.698	0.502	0.053	0.134	2.194	3.171	5.365	2.041	0.361	2.402	2.738
	*M	0.393	0.087	0.121	0.607	0.723	0.520	0.055	0.139	2.072	3.944	6.016	2.054	0.363	2.417	5.542
	*L	0.450	0.100	0.139	0.694	0.827	0.595	0.063	0.159	1.597	3.298	4.895	1.663	0.294	1.957	7.362
	*T	1.222*	0.271*	0.377*	1.887*	2.247*	1.617*	0.170*	0.431*	5.863*	10.413*	16.276*	5.758*	1.018*	6.776*	15.642*
JUL	*F	0.584	0.130	0.180	0.905	1.075	0.776	0.081	0.206	1.686	2.892	4.578	2.163	0.382	2.545	7.919
	*M	0.587	0.131	0.181	0.909	1.080	0.779	0.082	0.207	1.858	3.147	5.005	2.257	0.399	2.656	8.227
	*L	0.663	0.147	0.205	1.023	1.220	0.878	0.092	0.234	2.093	3.693	5.786	2.509	0.444	2.953	8.097
	*T	1.834*	0.408*	0.567*	2.837*	3.375*	2.433*	0.256*	0.648*	5.637*	9.732*	15.370*	6.928*	1.225*	8.154*	24.243*
AUG	*F	0.285	0.063	0.088	0.439	0.522	0.375	0.039	0.101	0.881	1.543	2.425	1.608	0.284	1.892	3.127
	*M	0.297	0.065	0.091	0.456	0.542	0.388	0.041	0.105	0.925	1.605	2.530	1.632	0.289	1.920	3.573
	*L	0.318	0.070	0.097	0.488	0.580	0.415	0.044	0.112	1.066	1.837	2.903	1.821	0.322	2.143	4.128
	*T	0.899*	0.197*	0.276*	1.383*	1.644*	1.178*	0.124*	0.318*	2.873*	4.985*	7.858*	5.061*	0.895*	5.955*	10.828*
SEP	*F	0.390	0.087	0.121	0.596	0.718	0.515	0.054	0.138	1.120	1.886	3.006	1.771	0.313	2.084	3.495
	*M	0.185	0.041	0.057	0.283	0.340	0.244	0.026	0.065	0.958	1.672	2.630	1.515	0.268	1.783	3.617
	*L	0.016	0.004	0.005	0.025	0.030	0.022	0.002	0.006	0.560	1.134	1.694	0.886	0.157	1.042	3.693
	*T	0.592*	0.131*	0.183*	0.904*	1.089*	0.780*	0.082*	0.209*	2.638*	4.692*	7.330*	4.172*	0.738*	4.910*	10.805*
OCT	*F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.360	1.299	1.658	0.381	0.067	0.448	4.662
	*M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.213	0.213	0.0	0.0	0.0	3.291
	*L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.036
	*T	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.360*	1.511*	1.871*	0.381*	0.067*	0.448*	9.990*
NOV	*F	0.186	0.041	0.057	0.286	0.341	0.245	0.026	0.066	0.0	0.0	0.0	0.0	0.0	0.0	0.673
	*M	0.371	0.082	0.114	0.570	0.682	0.489	0.051	0.131	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	*L	0.480	0.106	0.148	0.735	0.881	0.630	0.066	0.169	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	*T	1.037*	0.230*	0.320*	1.591*	1.904*	1.364*	0.143*	0.366*	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.673*
DEC	*F	0.367	0.082	0.113	0.567	0.673	0.485	0.051	0.129	0.650	0.919	1.568	0.555	0.098	0.653	1.712
	*M	0.362	0.081	0.111	0.560	0.664	0.479	0.050	0.128	1.344	1.904	3.247	1.331	0.235	1.566	3.557
	*L	0.446	0.099	0.137	0.687	0.815	0.587	0.062	0.158	1.960	2.870	4.830	2.167	0.383	2.550	5.371
	*T	1.175*	0.263*	0.361*	1.815*	2.152*	1.551*	0.163*	0.415*	3.954*	5.692*	9.645*	4.053*	0.717*	4.770*	10.641*
ANNUAL		13.035	2.894	4.021	20.051	23.948	17.195	1.806	4.604	43.637	77.408	121.046	50.798	8.983	59.780	168.439

TABLE C-6. DIVERSION WATER REQUIREMENT BY LATERAL (WITH EFFECTIVE RAINFALL) (4)

(PAGE....4)
(UNIT = MCM)

PERIOD	DIVERSION-C N.D.C 7074HA	TOTAL 13674HA	SIFFU-SOUTH-MAIN-CANAL LAT.A 2987HA	LAT.B 1723HA	LAT.C 480HA	LAT.D 1071HA	LAT.E 333HA	LAT.F 640HA	LAT.G 693HA	LAT.H 233HA	TOTAL 8160HA	SIFFU-NORTH-MAIN-CANAL LAT.A 880HA	LAT.B 226HA	N.M.C 1853HA	TOTAL 2959HA
JAN *F	7.364	14.234	2.193	1.582	0.352	0.869	0.293	0.649	0.515	0.153	6.606	0.797	0.193	1.758	2.748
*M	6.876	13.291	2.370	1.590	0.354	0.875	0.295	0.652	0.517	0.154	6.807	0.799	0.193	1.763	2.756
*L	6.577	12.713	2.768	1.933	0.431	1.066	0.358	0.793	0.629	0.186	8.164	0.890	0.215	1.961	3.065
*T	20.816*	40.237*	7.331*	5.104*	1.137*	2.811*	0.946*	2.094*	1.661*	0.493*	21.577*	2.486*	0.601*	5.482*	8.569*
FEB *F	7.553	14.599	2.990	2.188	0.485	1.202	0.406	0.895	0.712	0.211	9.090	0.973	0.236	2.161	3.371
*M	7.911	15.292	3.034	2.194	0.487	1.206	0.407	0.898	0.714	0.212	9.152	0.988	0.240	2.192	3.419
*L	6.440	12.449	2.459	1.785	0.396	0.979	0.330	0.729	0.581	0.172	7.432	0.789	0.192	1.751	2.731
*T	21.904*	42.340*	8.483*	6.167*	1.367*	3.387*	1.143*	2.523*	2.007*	0.595*	25.673*	2.750*	0.668*	6.104*	9.521*
MAR *F	9.072	17.536	3.523	2.540	0.563	1.388	0.469	1.035	0.823	0.245	10.586	0.908	0.219	2.013	3.140
*M	9.188	17.761	3.354	2.584	0.571	1.412	0.477	1.054	0.836	0.249	10.538	0.495	0.120	1.098	1.713
*L	10.195	19.706	2.611	2.831	0.625	1.547	0.522	1.154	0.916	0.273	10.480	0.101	0.024	0.224	0.350
*T	28.455*	55.003*	9.488*	7.955*	1.760*	4.348*	1.467*	3.243*	2.575*	0.767*	31.604*	1.504*	0.363*	3.335*	5.203*
APR *F	9.015	17.426	1.534	2.278	0.507	1.249	0.421	0.929	0.741	0.219	7.877	0.0	0.0	0.0	0.0
*M	6.439	12.447	0.378	1.193	0.266	0.654	0.220	0.487	0.388	0.115	3.700	0.0	0.0	0.0	0.0
*L	3.864	7.468	0.0	0.195	0.043	0.107	0.036	0.080	0.064	0.019	0.544	0.0	0.0	0.0	0.0
*T	19.318*	37.342*	1.911*	3.666*	0.816*	2.011*	0.677*	1.495*	1.193*	0.352*	12.121*	0.0 *	0.0 *	0.0 *	0.0 *
MAY *F	1.273	2.461	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.575	0.139	1.276	1.991
*M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.141	0.276	2.531	3.949
*L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.605	0.388	3.560	5.552
*T	1.273*	2.461*	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	3.321*	0.803*	7.367*	11.491*
JUN *F	2.935	5.673	1.303	1.193	0.265	0.653	0.220	0.487	0.387	0.115	4.623	0.609	0.148	1.356	2.113
*M	5.940	11.483	2.630	2.391	0.531	1.309	0.442	0.975	0.775	0.230	9.284	0.631	0.153	1.405	2.188
*L	7.890	15.252	3.486	3.100	0.689	1.698	0.573	1.264	1.004	0.299	12.113	0.720	0.174	1.605	2.500
*T	16.765*	32.407*	7.419*	6.684*	1.485*	3.661*	1.236*	2.726*	2.165*	0.644*	26.020*	1.961*	0.474*	4.366*	6.801*
JUL *F	8.488	16.407	3.393	1.998	0.446	1.093	0.370	0.817	0.652	0.194	8.963	0.941	0.228	2.093	3.262
*M	8.818	17.045	2.715	1.954	0.436	1.069	0.361	0.798	0.637	0.189	8.160	0.945	0.229	2.102	3.276
*L	8.678	16.775	3.212	2.395	0.532	1.309	0.443	0.976	0.780	0.231	9.879	1.065	0.258	2.367	3.690
*T	25.985*	50.228*	9.321*	6.348*	1.415*	3.471*	1.173*	2.592*	2.069*	0.614*	27.003*	2.951*	0.715*	6.562*	10.228*
AUG *F	3.351	6.478	1.301	1.008	0.223	0.553	0.186	0.407	0.322	0.096	4.097	0.454	0.111	1.015	1.580
*M	3.829	7.402	1.398	1.016	0.225	0.557	0.188	0.411	0.325	0.097	4.216	0.470	0.115	1.054	1.640
*L	4.424	8.552	1.587	1.164	0.259	0.638	0.215	0.473	0.374	0.112	4.821	0.504	0.123	1.129	1.756
*T	11.605*	22.433*	4.286*	3.188*	0.707*	1.749*	0.589*	1.291*	1.020*	0.305*	13.134*	1.428*	0.349*	3.199*	4.976*
SEP *F	3.746	7.240	1.394	1.029	0.231	0.568	0.191	0.419	0.334	0.099	4.265	0.624	0.151	1.380	2.155
*M	3.877	7.494	1.445	1.069	0.240	0.591	0.198	0.436	0.347	0.102	4.428	0.296	0.072	0.654	1.021
*L	3.959	7.652	1.452	1.055	0.237	0.583	0.195	0.430	0.342	0.101	4.394	0.026	0.006	0.058	0.091
*T	11.581*	22.386*	4.291*	3.153*	0.708*	1.742*	0.585*	1.285*	1.022*	0.302*	13.088*	0.946*	0.229*	2.091*	3.267*
OCT *F	4.997	9.660	2.011	1.542	0.344	0.846	0.286	0.632	0.500	0.150	6.310	0.0	0.0	0.0	0.0
*M	3.527	6.819	1.266	0.771	0.172	0.423	0.143	0.316	0.250	0.075	3.416	0.0	0.0	0.0	0.0
*L	2.183	4.219	0.532	0.106	0.024	0.058	0.020	0.043	0.034	0.010	0.828	0.0	0.0	0.0	0.0
*T	10.707*	20.697*	3.809*	2.419*	0.539*	1.327*	0.448*	0.991*	0.785*	0.235*	10.553*	0.0 *	0.0 *	0.0 *	0.0 *
NOV *F	0.722	-1.395	0.004	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.004	0.299	0.072	0.661	1.032
*M	0.0	0.0	0.222	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.222	0.594	0.144	1.318	2.056
*L	0.0	0.0	1.589	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.589	0.766	0.185	1.701	2.653
*T	0.722*	1.395*	1.815*	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	1.815*	1.659*	0.401*	3.680*	5.741*
DEC *F	1.835	3.548	1.862	0.753	0.167	0.413	0.139	0.307	0.244	0.073	3.959	0.590	0.142	1.313	2.045
*M	3.813	7.370	2.393	1.558	0.346	0.853	0.288	0.636	0.506	0.150	6.730	0.582	0.140	1.296	2.018
*L	5.757	11.129	2.422	2.275	0.505	1.243	0.419	0.928	0.738	0.219	8.749	0.716	0.172	1.590	2.478
*T	11.405*	22.046*	6.677*	4.586*	1.018*	2.509*	0.846*	1.872*	1.488*	0.442*	19.438*	1.887*	0.455*	4.199*	6.541*
ANNUAL	180.536	348.975	64.831	49.270	10.951	27.015	9.111	20.113	15.985	4.749	202.026	20.895	5.058	46.385	72.338

TABLE C-6. DIVERSION WATER REQUIREMENT BY LATERAL (WITH EFFECTIVE RAINFALL) (5)

(PAGE.....5)
(UNIT = MCM)

PERIOD	MARIS MAIN CANAL (53889HA)	MACANAO EAST+WEST (6040HA)	<RETURN FL> LAT.A-2,4,B (5790HA)	NORTH DIVERSION (7074HA)	SIFFU EAST EXTENSION (6600HA)	SOUTH HIGH CANAL (9580HA)	OSCARIZ MAIN CANAL (3100HA)	NORTH MAIN CANAL (2959HA)	SOUTH MAIN CANAL (8160HA)
	<---MARIS DIVERSION DAM				--->	<-BALIGATAN DIVERSION->		<---SIFFU DIVERSION--->	
JAN *F	58.762	6.796	< 12.376>	7.364	6.870	7.652	2.476	2.748	6.606
*M	59.311	5.935	< 12.432>	6.876	6.415	7.903	2.557	2.756	6.807
*L	66.081	7.000	< 13.738>	6.577	6.136	9.262	2.997	3.065	8.164
*T	184.155*	19.731*	< 38.546>*	20.816*	19.421*	24.817*	8.030*	8.569*	21.577*
FEB *F	70.415	7.673	< 13.674>	7.553	7.047	10.250	3.317	3.371	9.090
*M	64.009	7.752	< 11.979>	7.911	7.381	10.388	3.361	3.419	9.152
*L	39.199	6.279	< 6.575>	6.440	6.009	8.410	2.721	2.731	7.432
*T	173.623*	21.704*	< 32.228>*	21.904*	20.436*	29.047*	9.399*	9.521*	25.673*
MAR *F	37.239	8.727	< 4.819>	9.072	8.464	12.043	3.897	3.140	10.586
*M	17.641	8.839	< 0.961>	9.188	8.573	11.635	3.765	1.713	10.538
*L	6.931	9.714	< 0.0 >	10.195	9.512	9.719	3.145	0.350	10.480
*T	61.811*	27.279*	< 5.780>*	28.455*	26.548*	33.398*	10.807*	5.203*	31.604*
APR *F	3.850	7.869	< 0.0 >	9.015	8.411	6.740	2.181	0.0	7.877
*M	9.875	4.556	< 1.682>	6.439	6.008	3.370	1.091	0.0	3.700
*L	46.157	1.405	< 11.558>	3.864	3.605	0.421	0.136	0.0	0.544
*T	59.883*	13.830*	< 13.241>*	19.318*	18.024*	10.531*	3.408*	0.0 *	12.121*
MAY *F	61.772	0.066	< 12.835>	1.273	1.188	0.0	0.0	1.991	0.0
*M	79.662	1.094	< 15.906>	0.0	0.0	1.158	0.375	3.949	0.0
*L	87.725	7.760	< 15.753>	0.0	0.0	8.104	2.622	5.552	0.0
*T	229.159*	8.920*	< 44.494>*	1.273*	1.188*	9.262*	2.997*	11.491*	0.0 *
JUN *F	41.537	7.767	< 8.927>	2.935	2.738	8.346	2.701	2.113	4.623
*M	44.249	8.433	< 9.446>	5.940	5.542	10.478	3.391	2.188	9.284
*L	46.712	6.852	< 9.773>	7.890	7.362	12.380	4.006	2.500	12.113
*T	132.498*	23.052*	< 28.146>*	16.765*	15.642*	31.204*	10.097*	6.801*	26.020*
JUL *F	69.755	7.123	< 14.395>	8.488	7.919	9.046	2.927	3.262	8.963
*M	71.172	7.661	< 14.558>	8.818	8.227	9.471	3.065	3.276	8.160
*L	79.850	8.739	< 16.201>	8.678	8.097	11.170	3.614	3.690	9.879
*T	220.776*	23.523*	< 45.154>*	25.985*	24.243*	29.687*	9.607*	10.228*	27.003*
AUG *F	44.915	4.317	< 11.265>	3.351	3.127	4.714	1.525	1.580	4.097
*M	41.665	4.450	< 10.167>	3.829	3.573	4.872	1.576	1.640	4.216
*L	32.438	5.046	< 7.191>	4.424	4.128	5.541	1.793	1.756	4.821
*T	119.018*	13.813*	< 28.623>*	11.605*	10.828*	15.127*	4.895*	4.976*	13.134*
SEP *F	27.371	5.090	< 4.068>	3.746	3.495	5.617	1.817	2.155	4.265
*M	9.603	4.413	< 0.554>	3.877	3.617	5.173	1.674	1.021	4.428
*L	1.857	2.737	< 0.0 >	3.959	3.693	3.807	1.232	0.091	4.394
*T	38.831*	12.240*	< 4.622>*	11.581*	10.805*	14.597*	4.724*	3.267*	13.088*
OCT *F	0.591	2.106	< 0.0 >	4.997	4.662	5.002	1.619	0.0	6.310
*M	3.873	0.213	< 0.800>	3.527	3.291	2.223	0.719	0.0	3.416
*L	28.969	0.0	< 6.314>	2.183	2.036	0.137	0.044	0.0	0.828
*T	33.433*	2.319*	< 7.114>*	10.707*	9.990*	7.362*	2.382*	0.0 *	10.553*
NOV *F	28.871	0.0	< 5.902>	0.722	0.673	0.0	0.0	1.032	0.004
*M	36.378	0.0	< 7.316>	0.0	0.0	0.640	0.207	2.056	0.222
*L	37.153	0.0	< 6.836>	0.0	0.0	2.284	0.739	2.653	1.589
*T	102.402*	0.0 *	< 20.055>*	0.722*	0.673*	2.924*	0.946*	5.741*	1.815*
DEC *F	44.419	2.221	< 10.429>	1.835	1.712	5.457	1.766	2.045	3.959
*M	47.343	4.814	< 10.796>	3.813	3.557	7.034	2.276	2.018	6.730
*L	55.524	7.380	< 12.134>	5.757	5.371	9.455	3.059	2.478	8.749
*T	147.286*	14.415*	< 33.359>*	11.405*	10.641*	21.945*	7.101*	6.541*	19.438*
ANNUAL	1502.873	180.826	<301.362>	180.536	168.439	229.901	74.394	72.338	202.026

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of February for dry season paddy and from the middle of April to the end of July for wet season paddy. Water supply during these periods is planned with rotation irrigation of seven days by rotation unit having an average area of six to nine hectares. According to NIA O/M Manual, the maximum unit water duty during these periods is 3.2 lit/sec/ha to 4.0 lit/sec/ha for rice class land and 6.4 lit/sec/ha to 8.0 lit/sec/ha for dual class land.

Normal Crop Growth Stage

The crop growth stage of a paddy extends from the end of November to the beginning of May for dry season paddy and from the end of May to the beginning of November for wet season paddy. Irrigation water supply during these periods is planned to be simultaneous irrigation. The maximum unit water duty during these periods is 0.8 lit/sec/ha to 1.8 lit/sec/ha for rice class land and 1.6 lit/sec/ha to 4.0 lit/sec/ha for dual class land based on the above mentioned O/M Manual.

3.2. Improvement of Irrigation Systems

Main and lateral irrigation systems to irrigate the projected Service Area of about 97,400 ha have already been constructed (See O/M Drawings No.23 - No.26). These irrigation systems may not be altered in the Project, although partial improvement of a canal sections will be planned by widening cross sectional areas to meet the designed canal discharge.

However, lower reaches of Laterals "A" and "B" (Macanao and Ladeco areas) in the Maris main canal system are supplied irrigation water depending upon return flow from the upstream areas, by constructing the intake facilities in the creeks. But due to the checking up of water flow by those weirs, several thousand hectares of paddy fields around the check gates are inundated even in dry season. These inundations conditions are remarkable around the Minante and Macanao systems.

Under the conditions, present irrigation canal systems for both areas, Minante and Macanao, will be required to be altered, as shown below:

<u>Minante System</u>

Due to the utilization of return flow of only 0.2 cu.m/sec for Lateral D-4, the Minante weir checks up the flow of about 1.5 m. In this reason, about 2,000 ha of paddy field is affected as poor drainage area.

If it is possible to remove the Minante weir, the drainage problem of those affected areas will be improved. The supply water of 0.2 cu.m/sec from the Minante weir is less than 10 percent of the designed discharge of Lateral D-4. The additional requirement can be supplied from Lateral D by minor improvement of Lateral D-4 (see Figure C-5).

On the other hand, due to accumulation of sediment materials in the canal and extension of the canal, the area of about 880 ha (680 ha irrigated by Lateral D-4 and 200 ha by Lateral D-4a) are affected as water shortage areas. Necessary improvement of those canals should be taken in the Project.

<u>Macanao System</u>

The water source of the Macanao East main canal is mainly diverted from the Macanao weir (9.95 cu.m/sec) and supplementary supplied by the Gaddanan weir through the Gaddanan supply canal (2.0 cu.m/sec). As the water source of Gaddanan and Macanao is the same, if the Macanao intake can supply all the requirements, the Gaddanan supply will not be necessary.

Due to the checking up of water flow of about 1.2 m by the Gaddanan weir, the upstream area along the Gaddanan creek is