Fig. 2.1 GENERAL LAYOUT OF UPRIIS

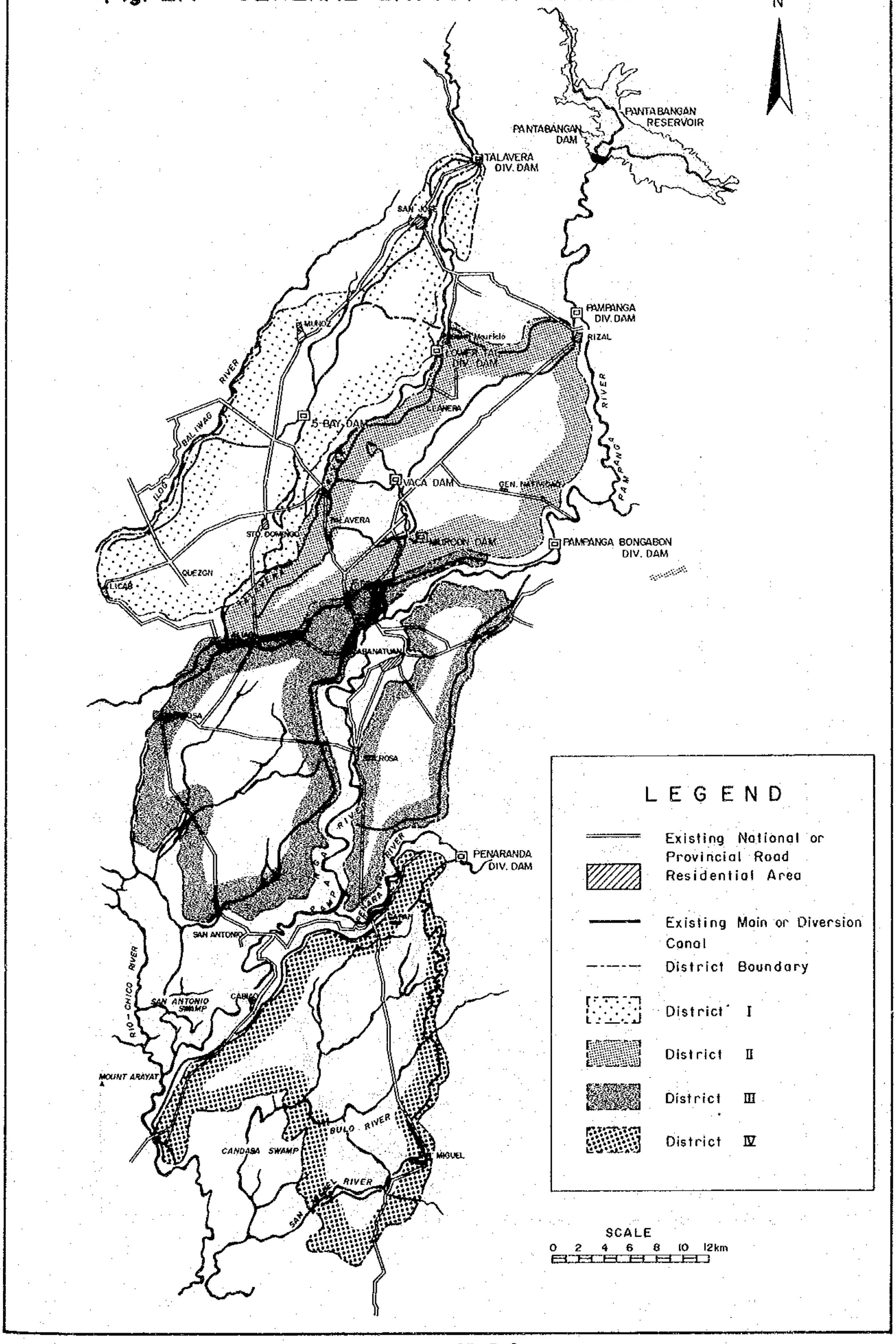


Fig. 2.2 GENERAL LAYOUT OF DISTRICT I

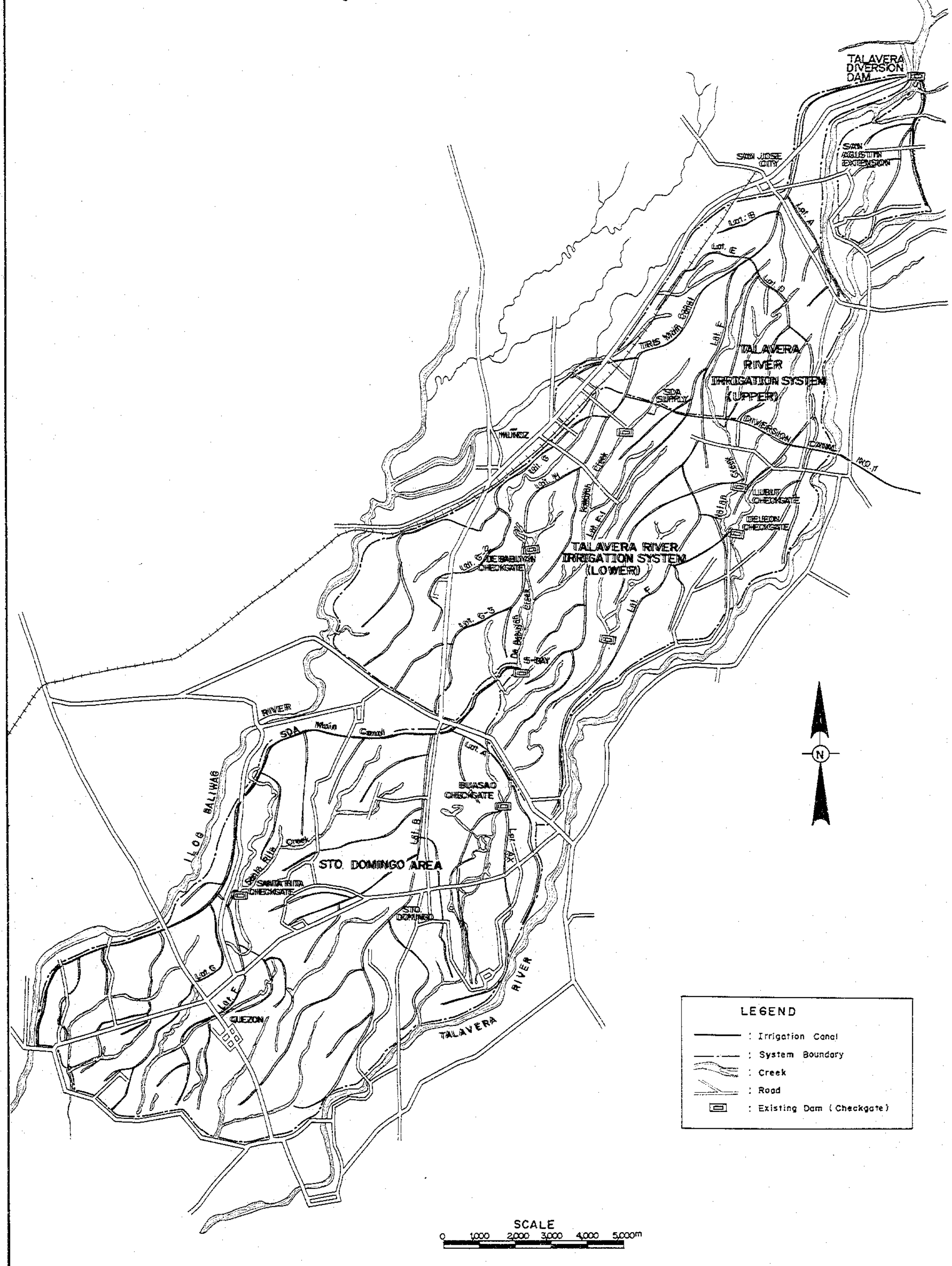


Fig. 2.3 GENERAL LAYOUT OF DISTRICT II

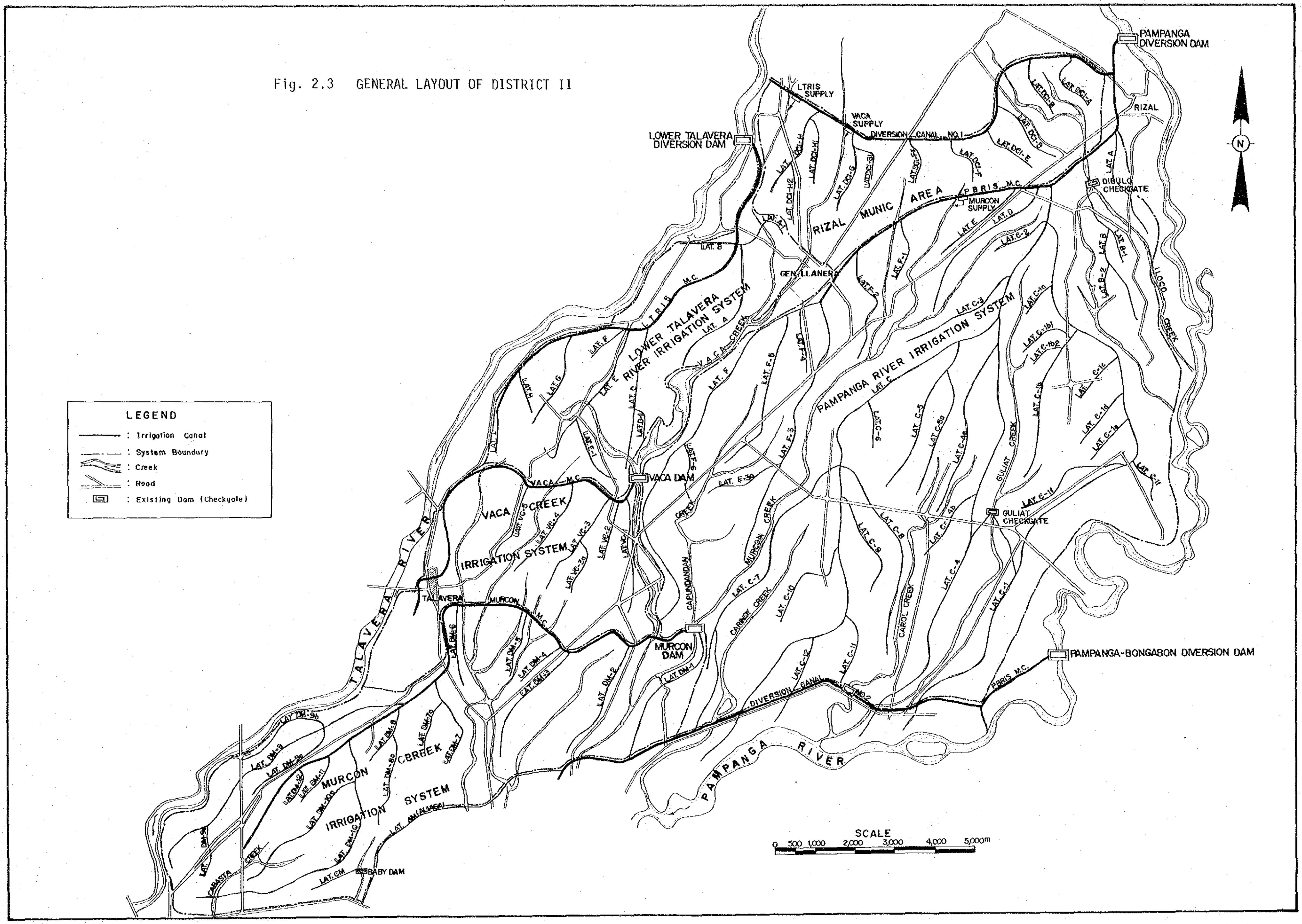


Fig. 2.4 GENERAL LAYOUT OF DISTRICT III

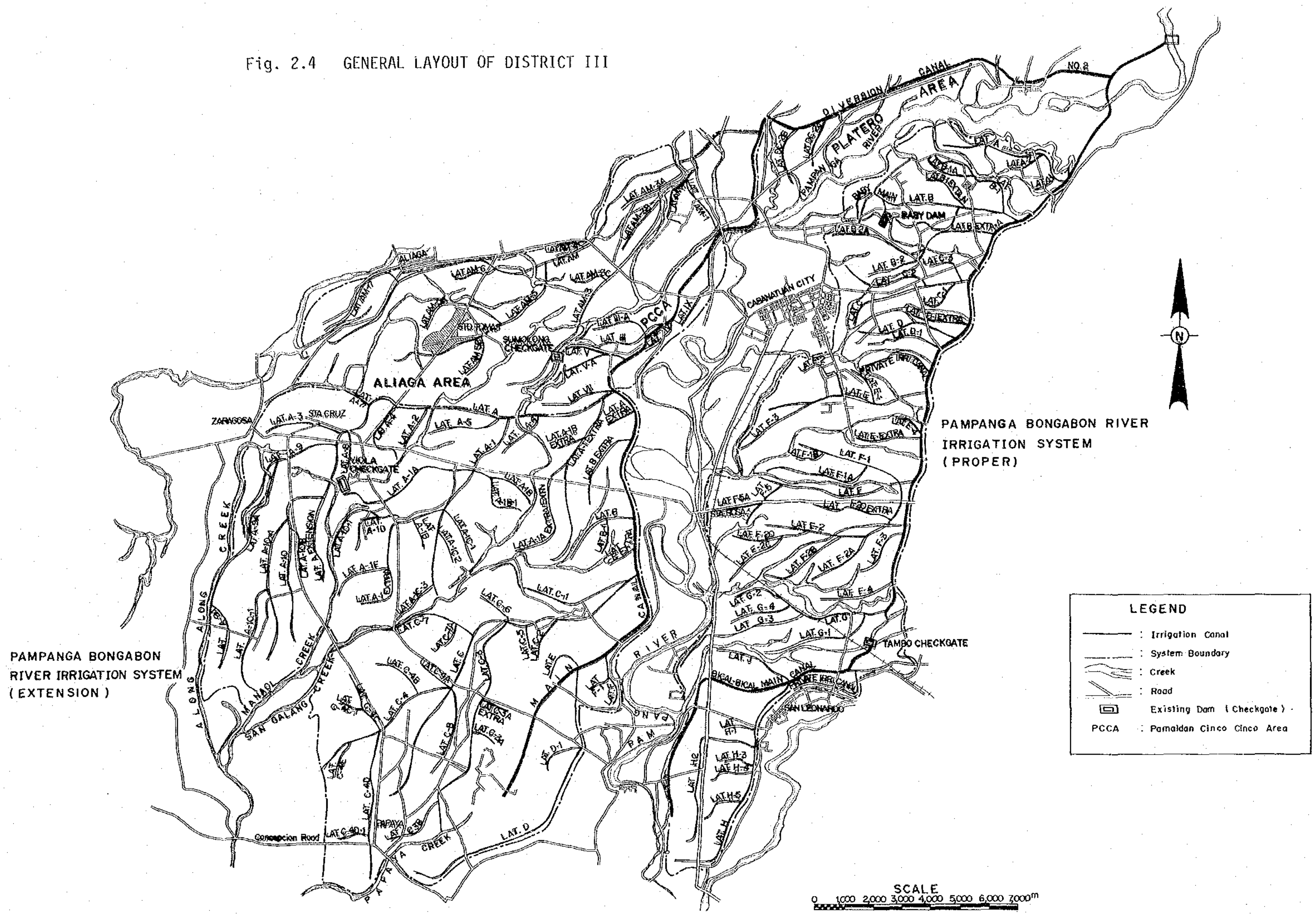


Fig. 2.5 GENERAL LAYOUT OF DISTRICT IV

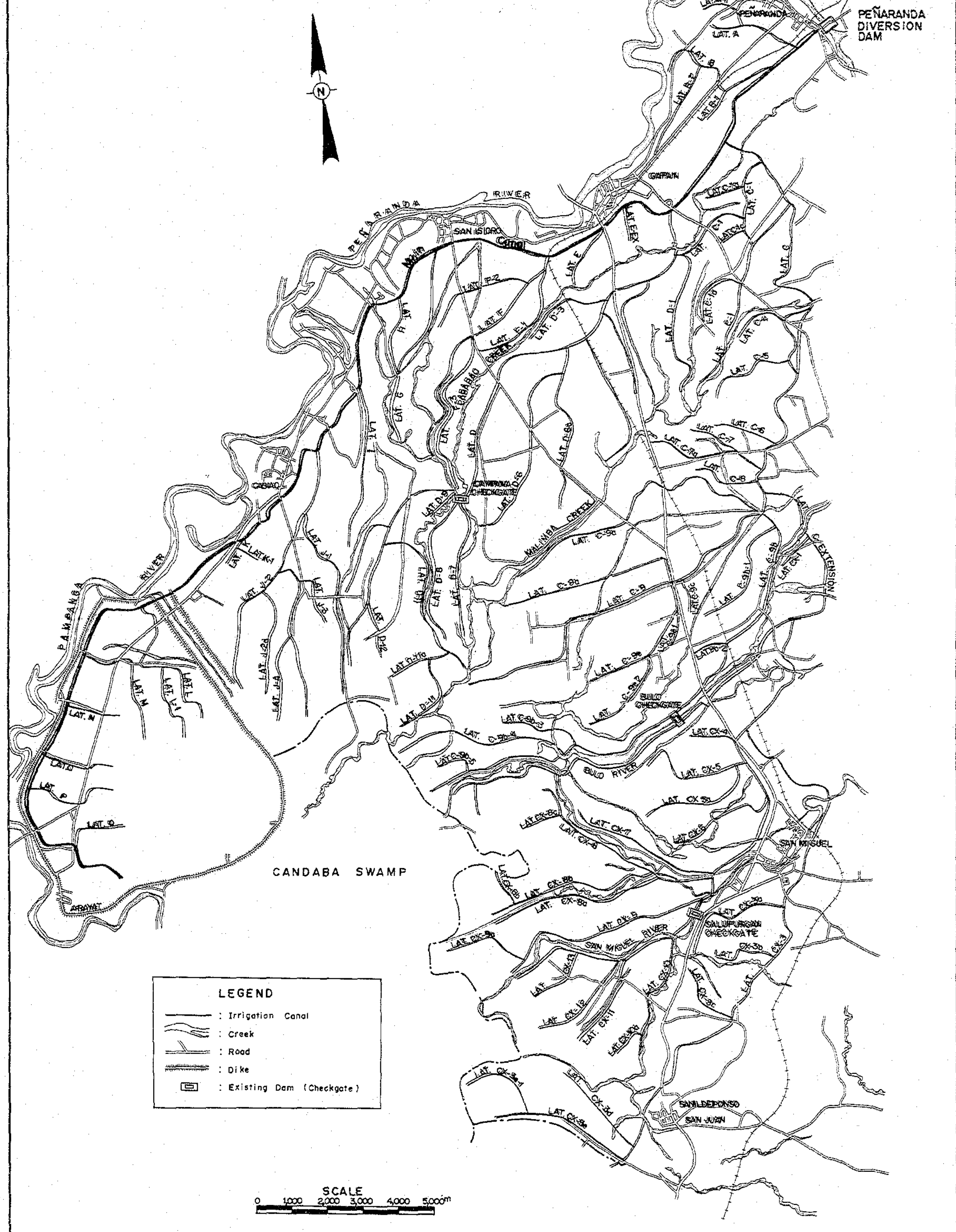


Fig. 2.6 IRRIGATION NETWORKS

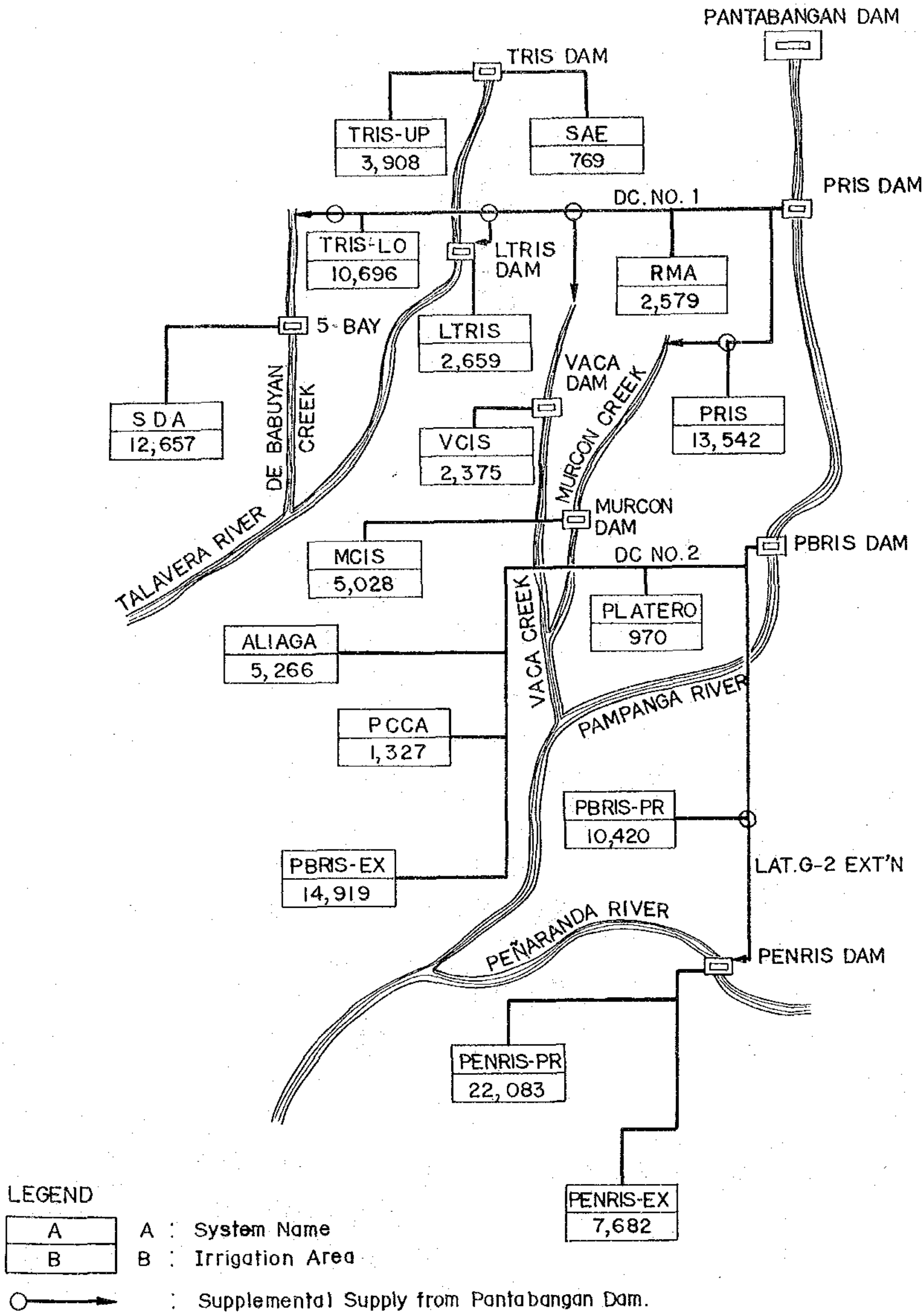
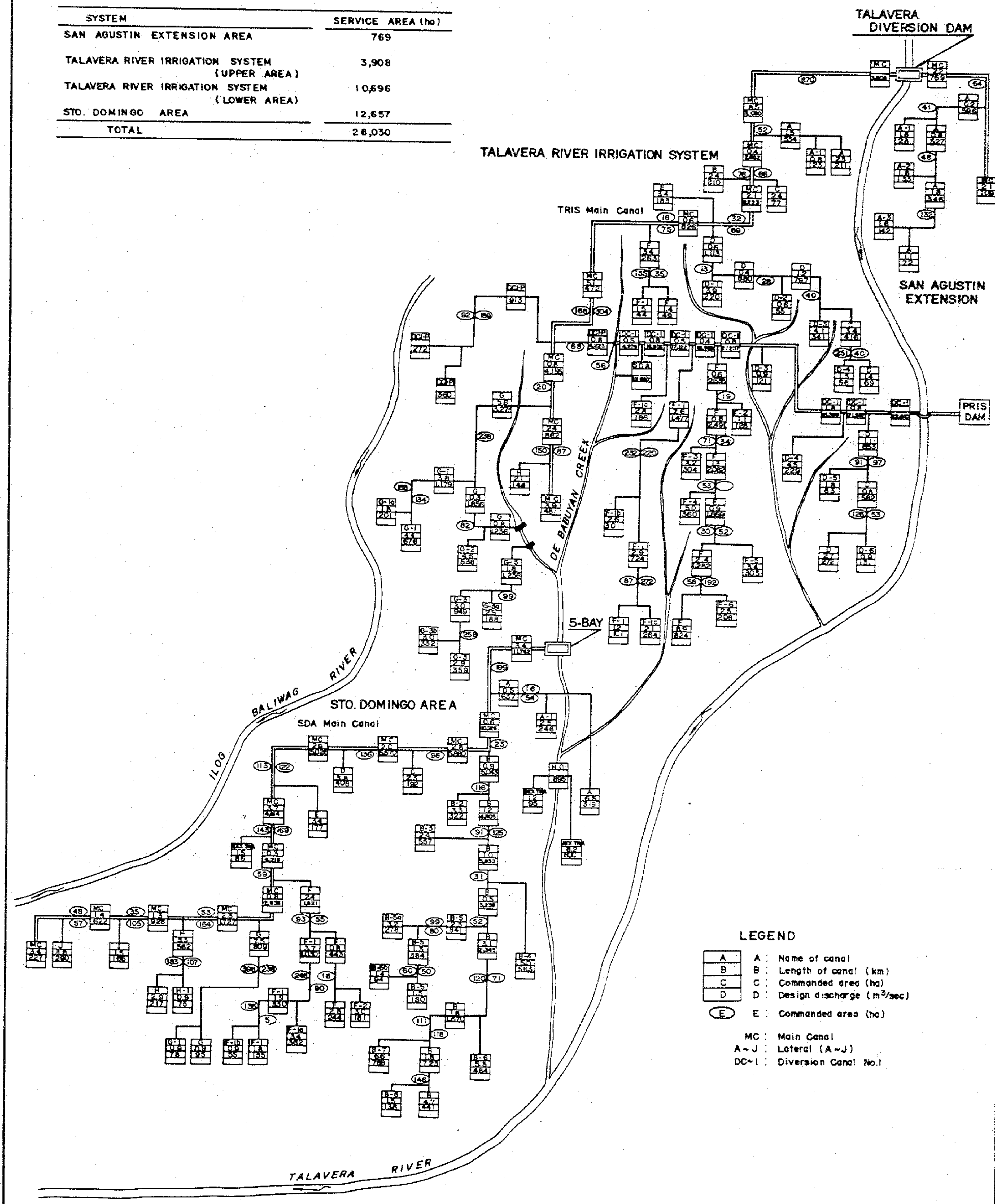


Fig. 2.7(1) IRRIGATION DIAGRAM - DISTRICT I

SYSTEM	SERVICE AREA (ha)
SAN AGUSTIN EXTENSION AREA	769
TALAVERA RIVER IRRIGATION SYSTEM (UPPER AREA)	3,908
TALAVERA RIVER IRRIGATION SYSTEM (LOWER AREA)	10,696
STO. DOMINGO AREA	12,657
TOTAL	28,030



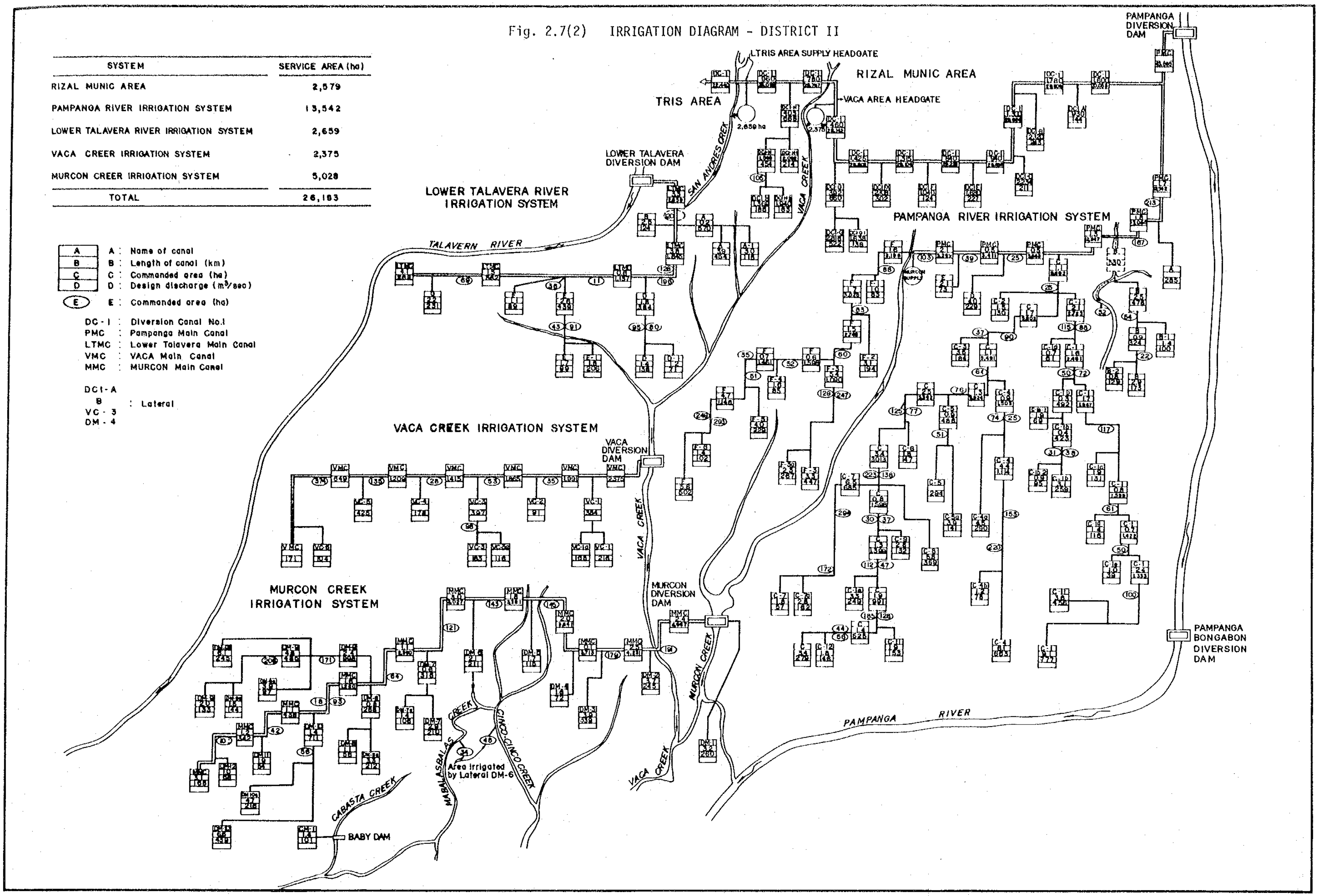
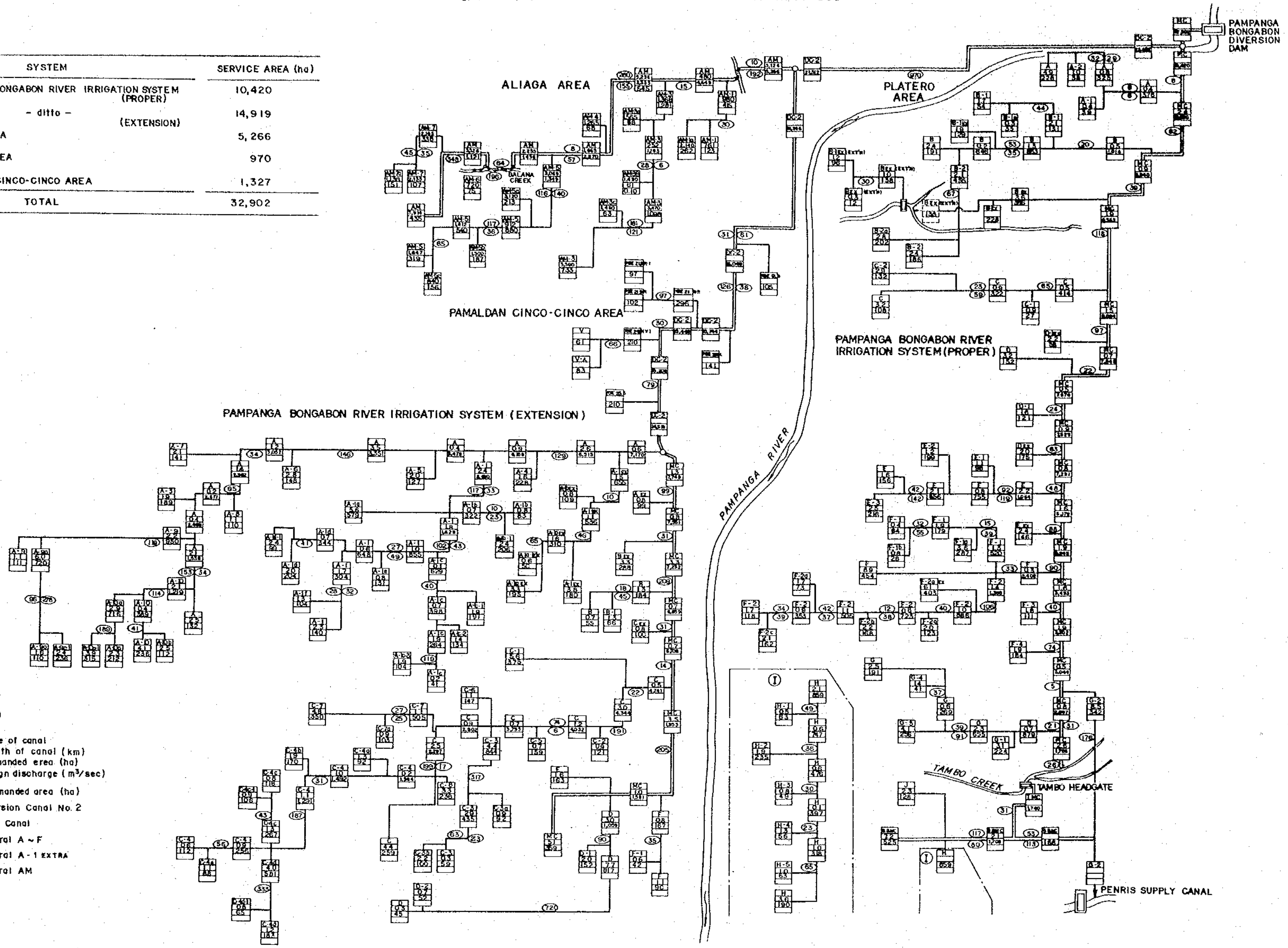


Fig. 2.7(2) IRRIGATION DIAGRAM - DISTRICT II

Fig. 2.7(3) IRRIGATION DIAGRAM - DISTRICT III

SYSTEM	SERVICE AREA (ha)
1. PAMPANGA BONGABON RIVER IRRIGATION SYSTEM (PROPER)	10,420
2. - ditto - (EXTENSION)	14,919
3. ALIAGA AREA	5,266
4. PLATERO AREA	970
5. PAMALDAN CINCO-CINCO AREA	1,327
TOTAL	32,902



LEGEND

A	A : Name of canal
B	B : Length of canal (km)
C	C : Commanded area (ha)
D	D : Design discharge (m³/sec)
(E)	E : Commanded area (ha)
DC - 2	: Diversion Canal No. 2
MC	: Main Canal
A ~ F	: Lateral A ~ F
A - 1EX	: Lateral A - 1 EXTRA
AM	: Lateral AM

Fig. 2.7(4) IRRIGATION DIAGRAM - DISTRICT IV

SYSTEM		SERVICE AREA (ha)
PENARANDA RIVER IRRIGATION SYSTEM	(PROPER)	22,083
- ditto -	(EXTENSION)	7,682
TOTAL		29,765

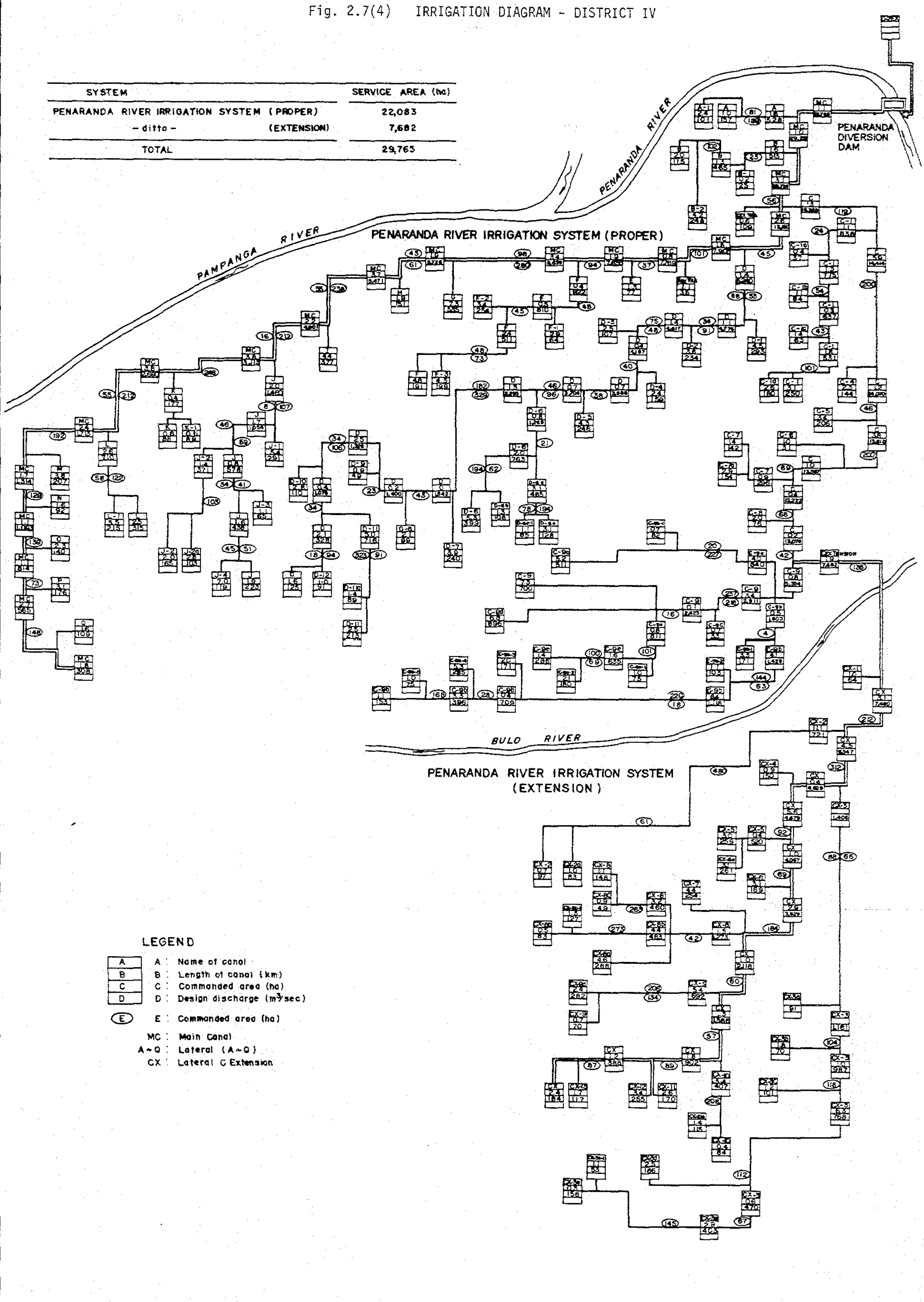


Fig. 2.8 CONSTRAINTS IN IRRIGATION FACILITIES

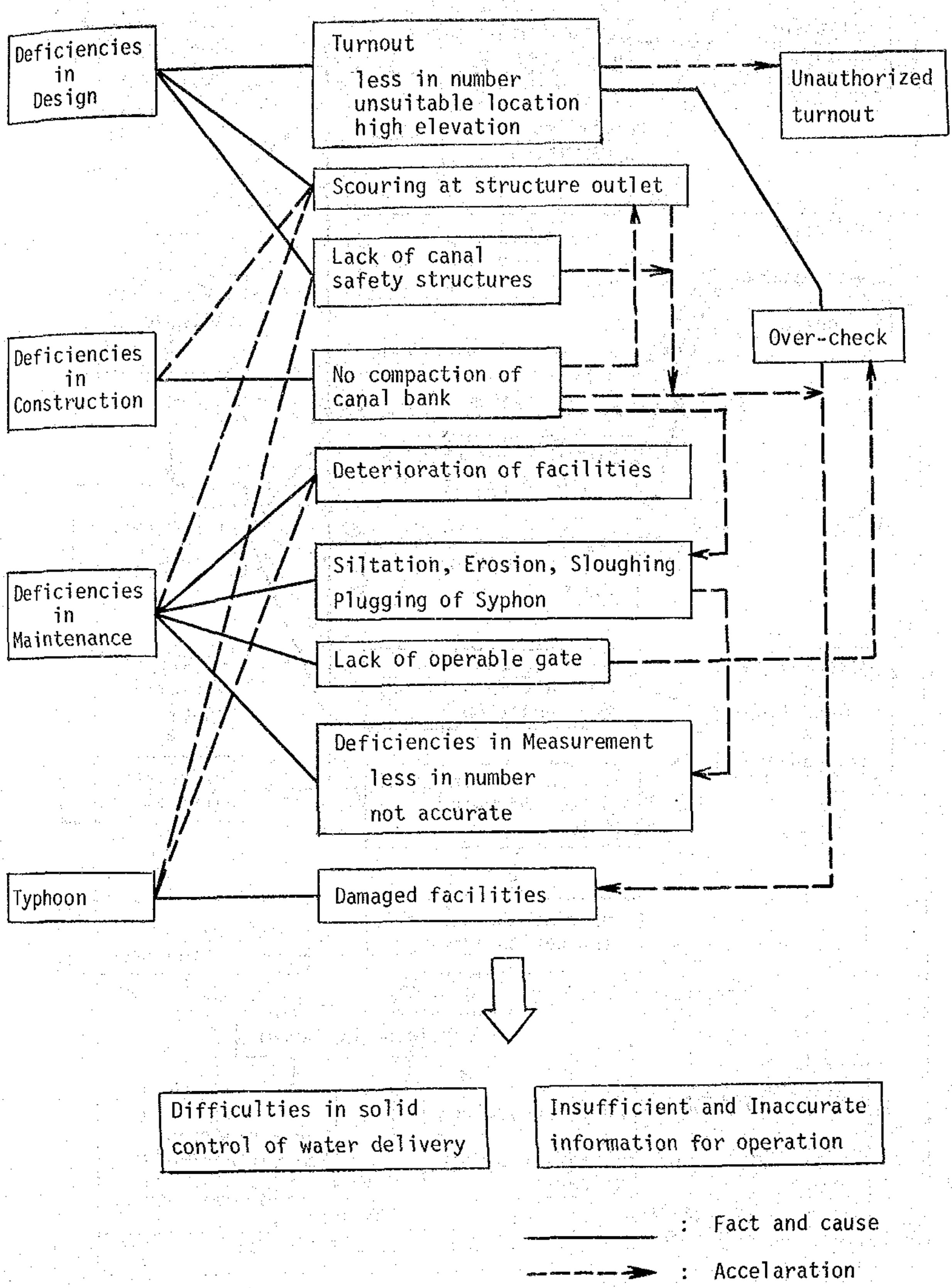


Fig. 2.9 CONSTRAINTS IN WATER MANAGEMENT AND CONTROL

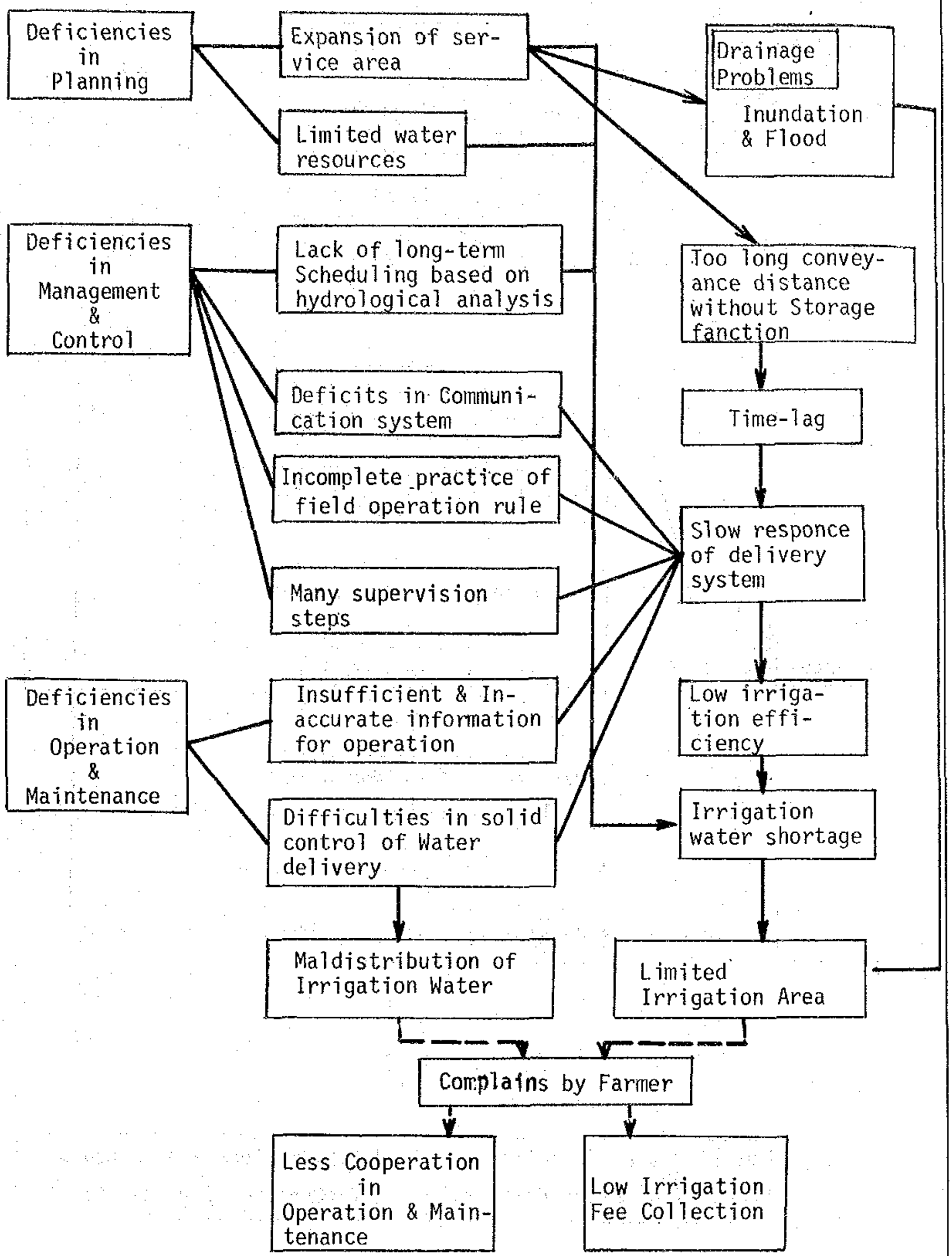
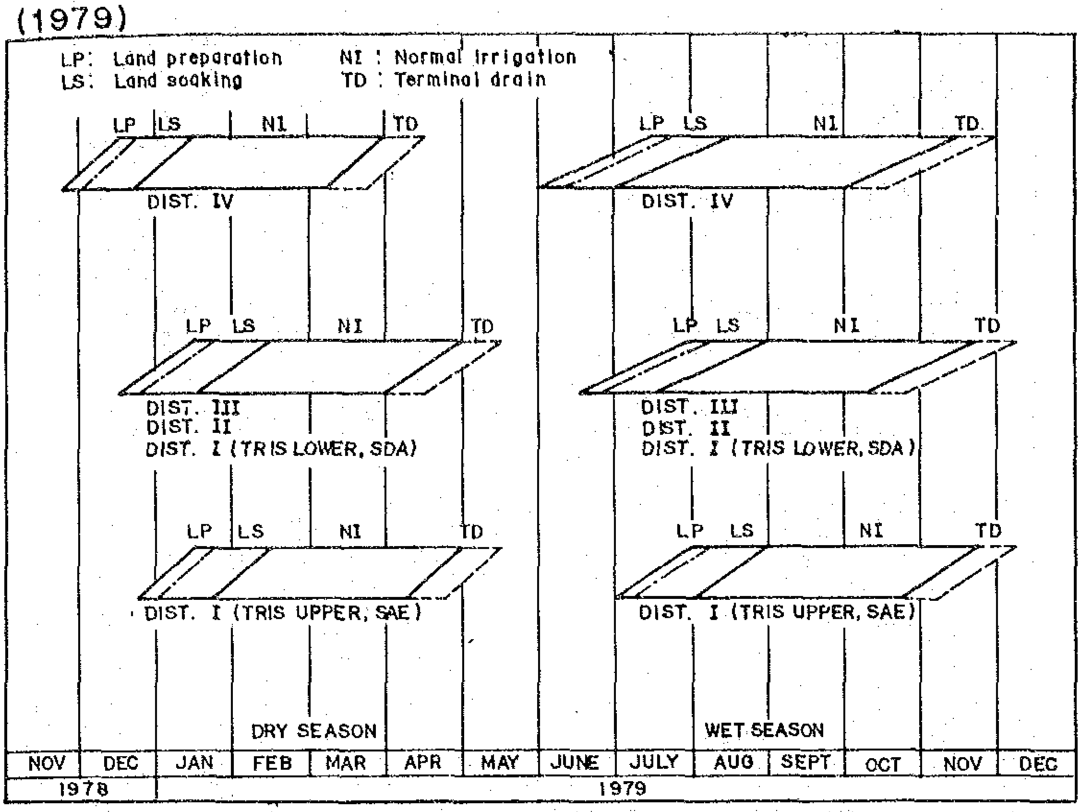


Fig. 2.10(1) SCHEDULED CROPPING PATTERN



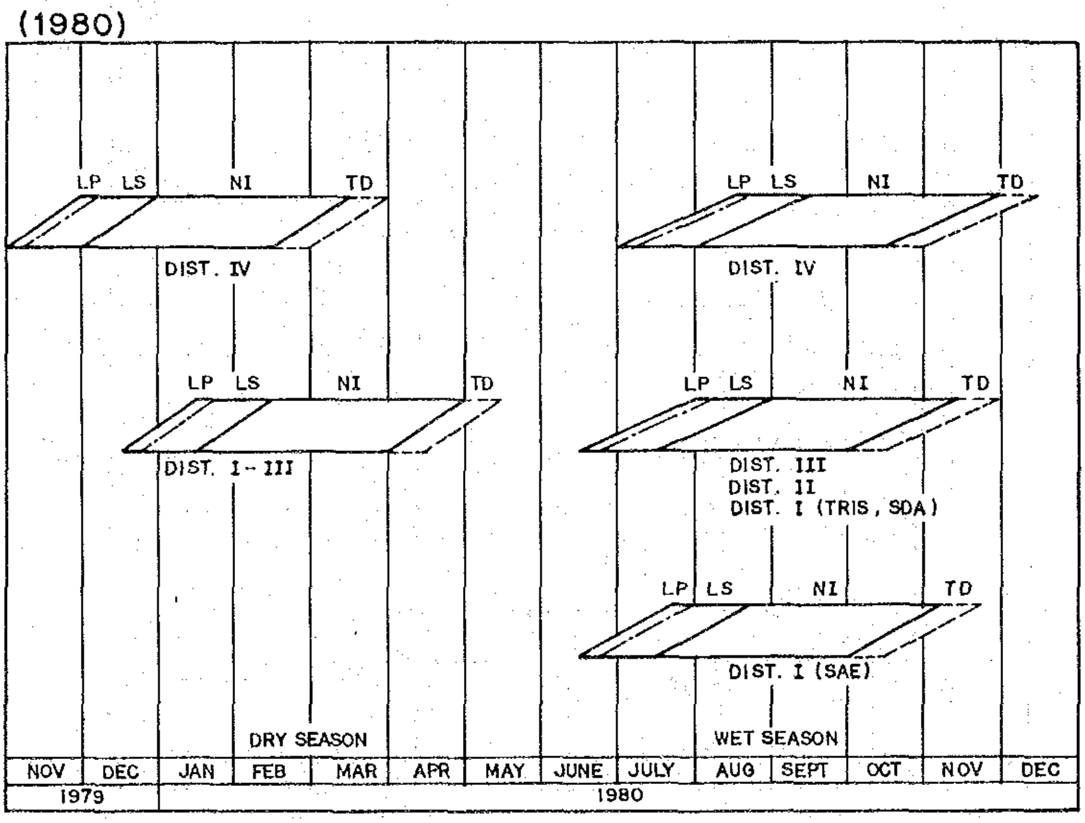
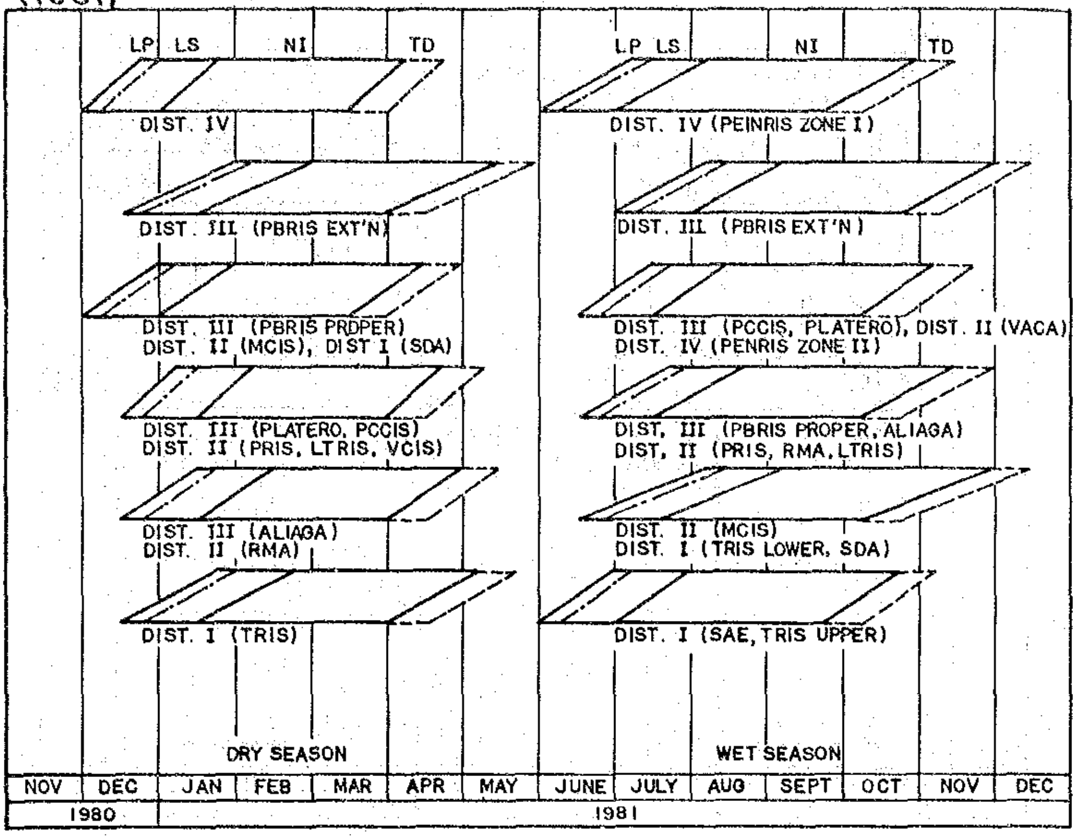


Fig. 2.10(2) SCHEDULED CROPPING PATTERN

(1981)



(1982)

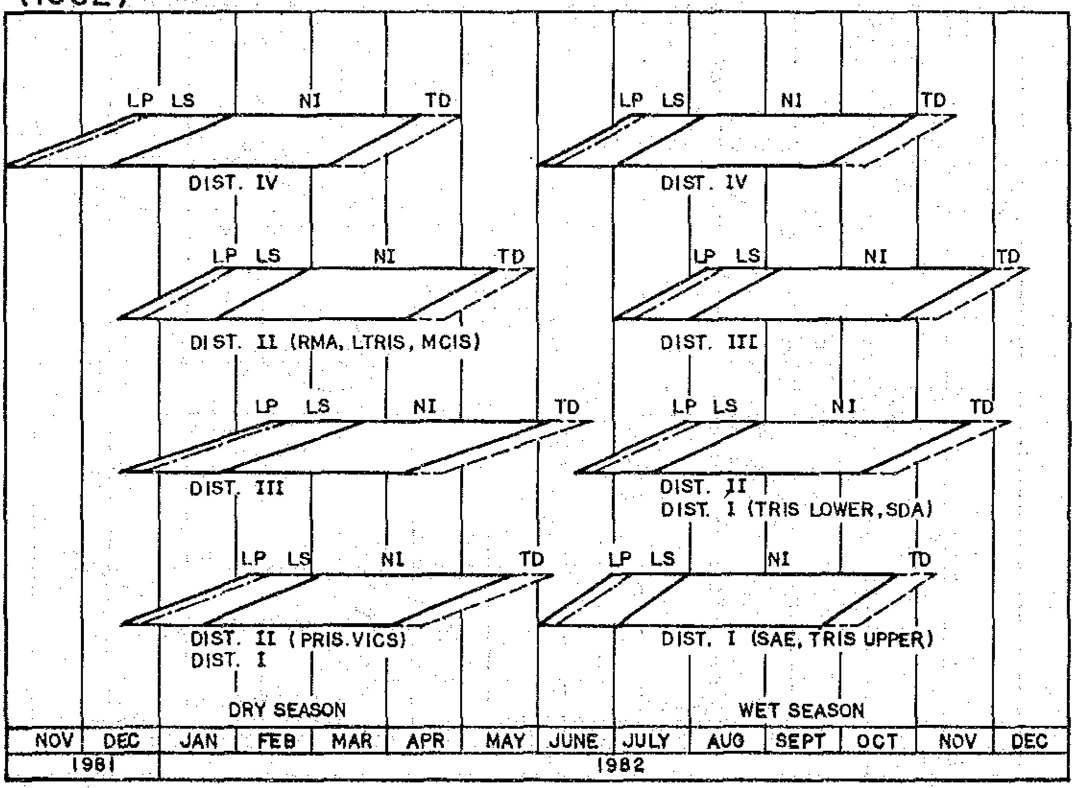


Fig. 2.11(1) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM
1979 DRY SEASON

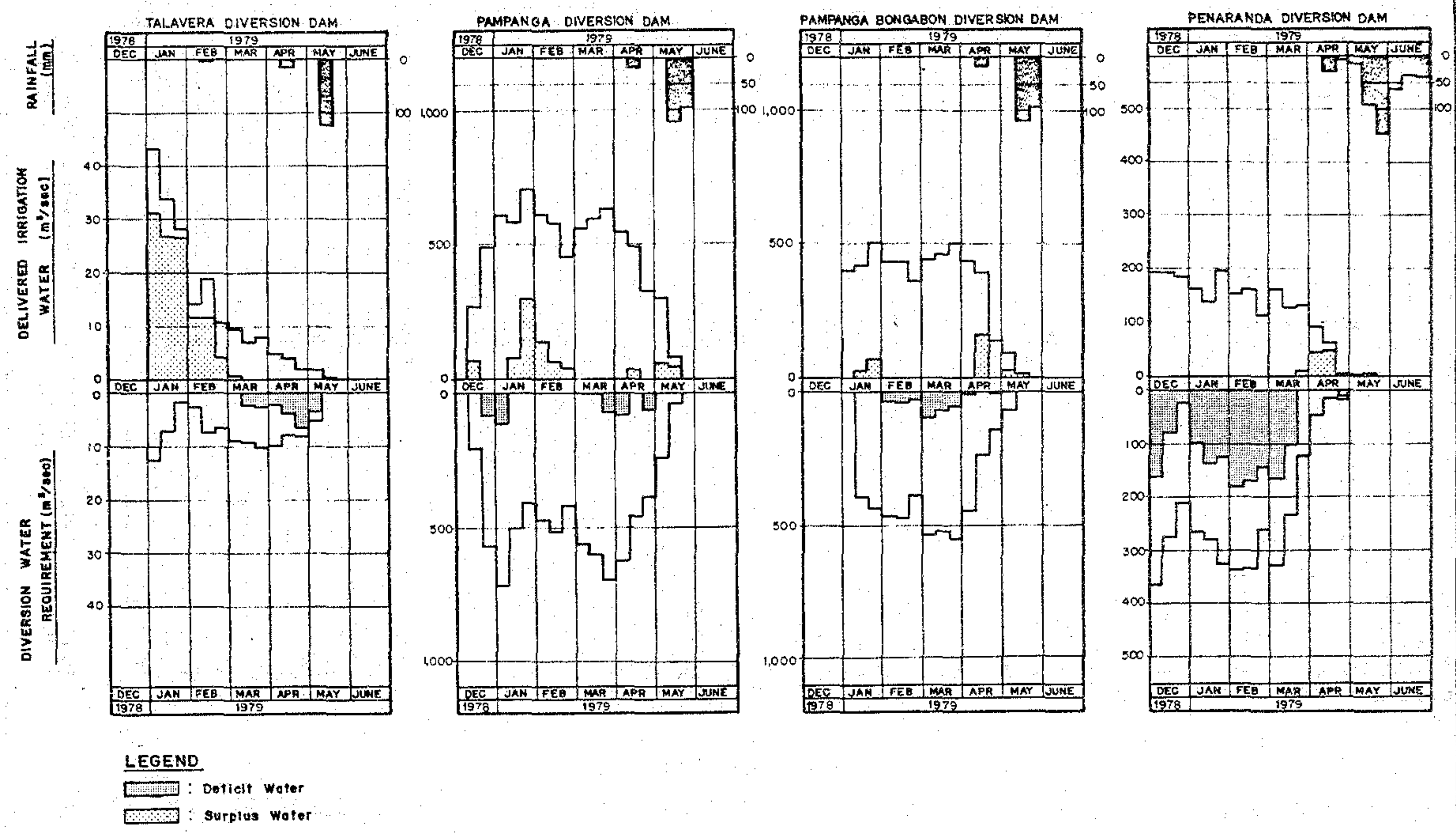


Fig. 2.11(2) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM
1979 DRY SEASON

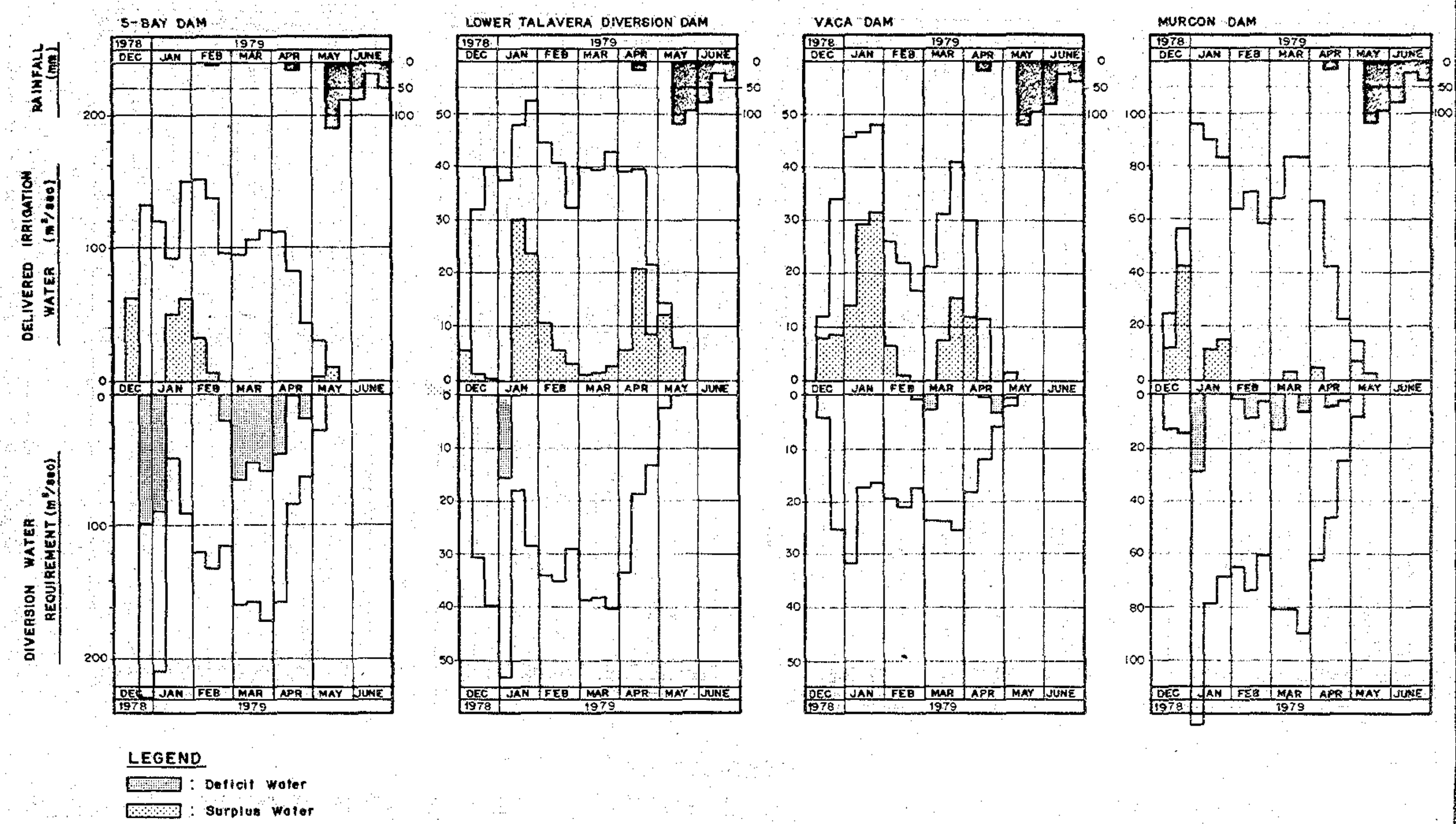


Fig. 2.11(3) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM
1979 WET SEASON

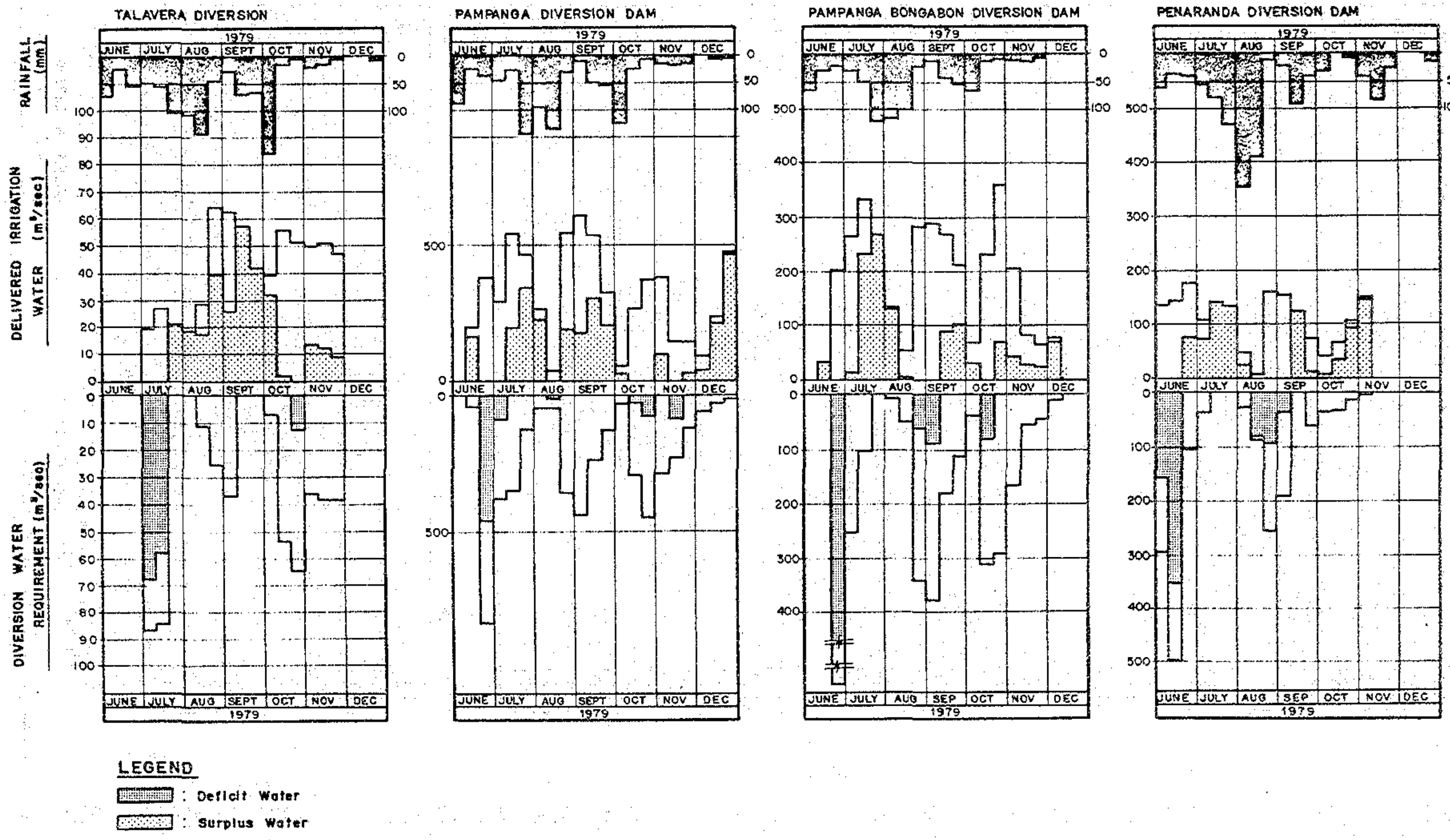


Fig. 2.11(4) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM

1979 WET SEASON

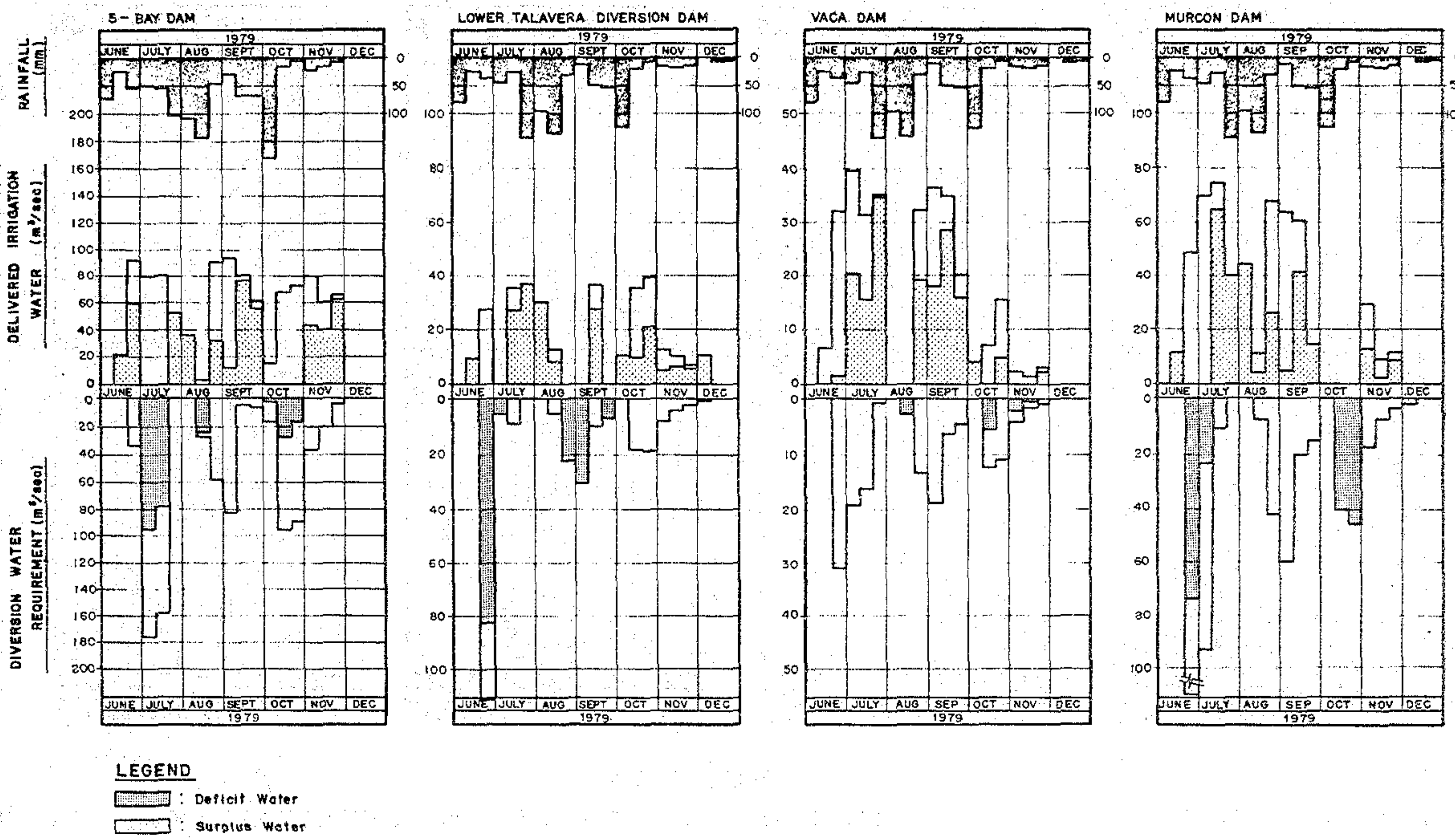


Fig. 2.11(5) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM 1980 DRY SEASON

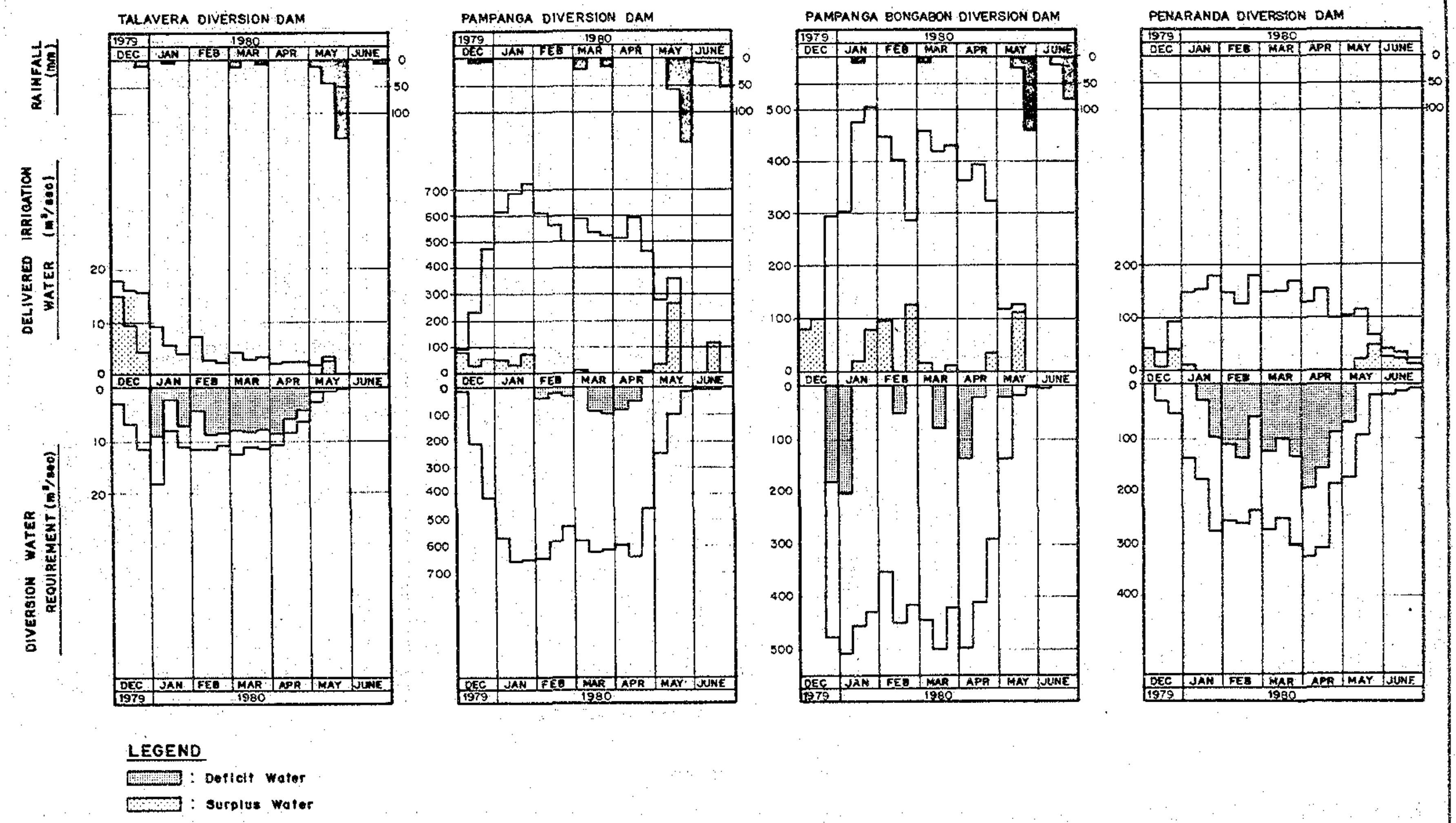


Fig. 2.11(6) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM
1980 DRY SEASON

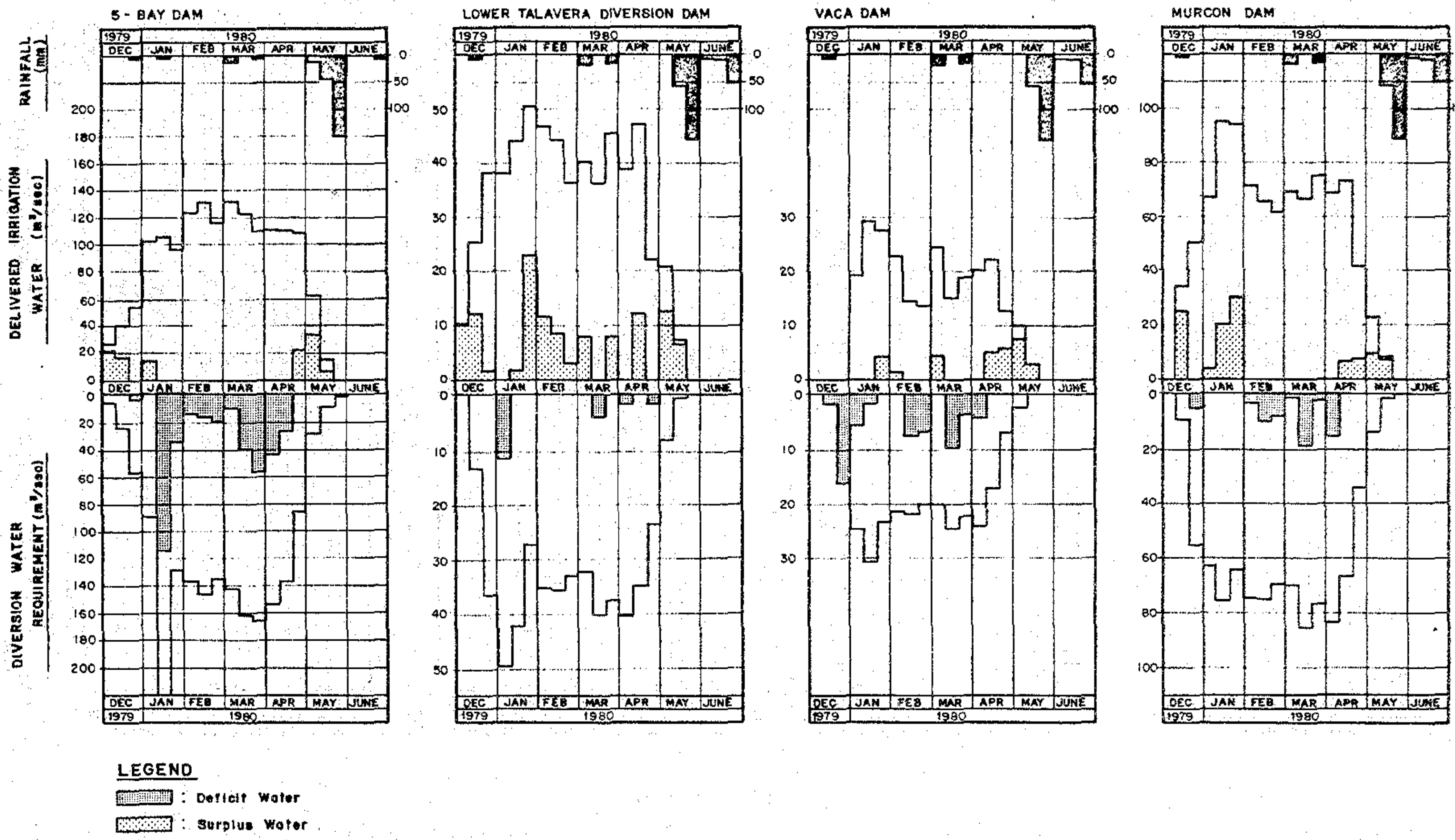


Fig. 2.11(7) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM 1980 WET SEASON

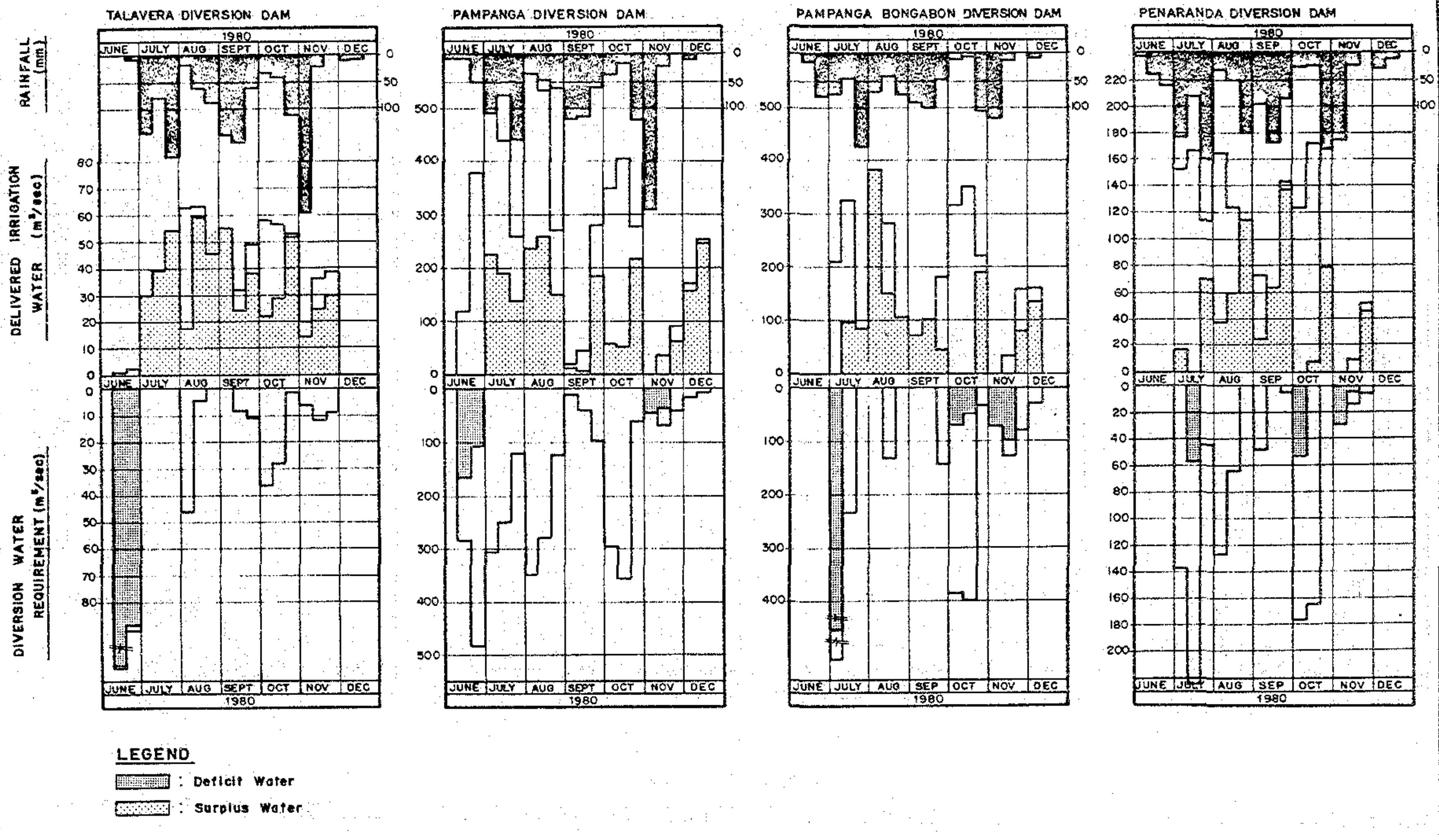


Fig. 2.11(8) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM
1980 WET SEASON

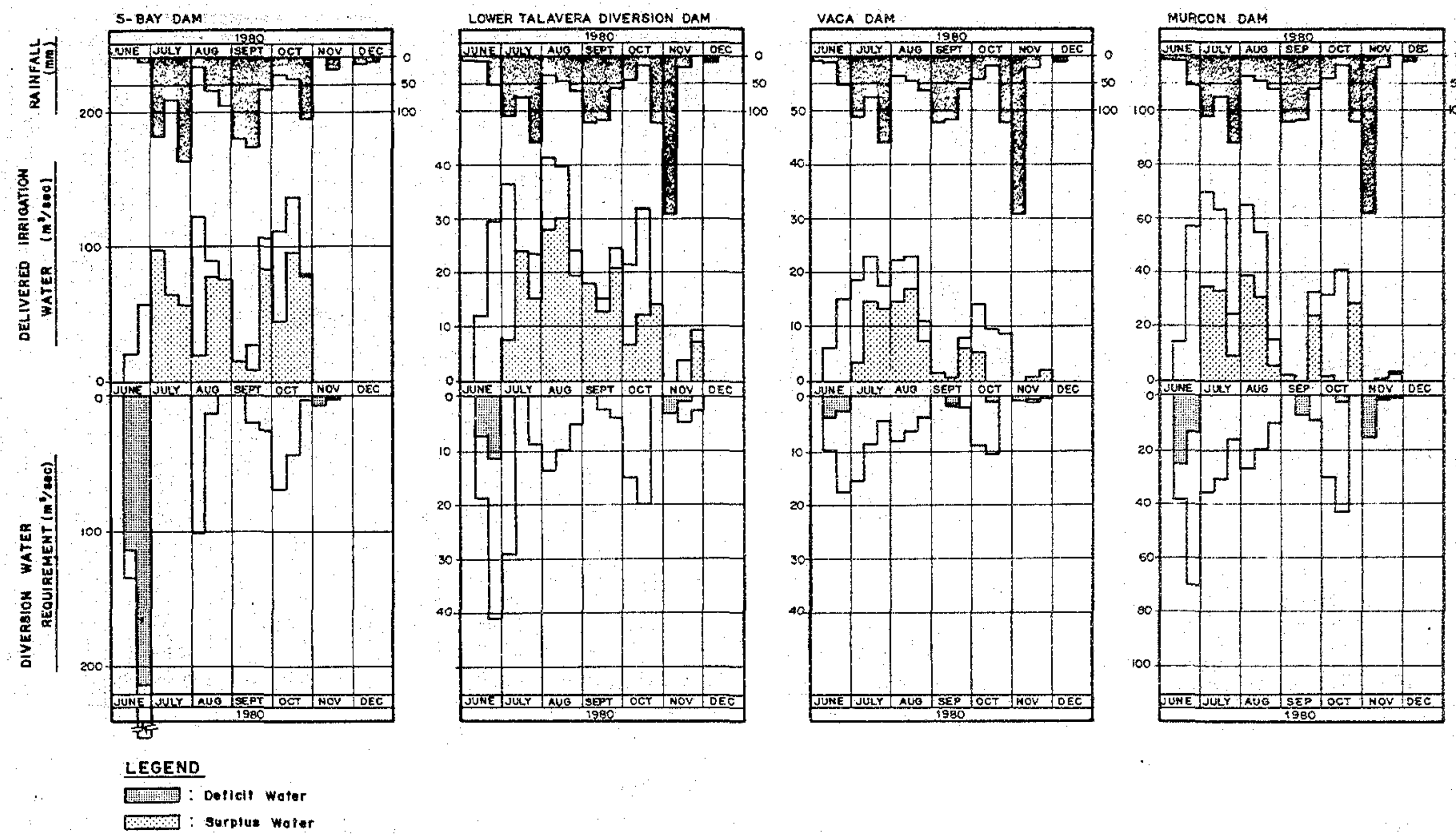


Fig. 2.11(9) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM 1981 DRY SEASON

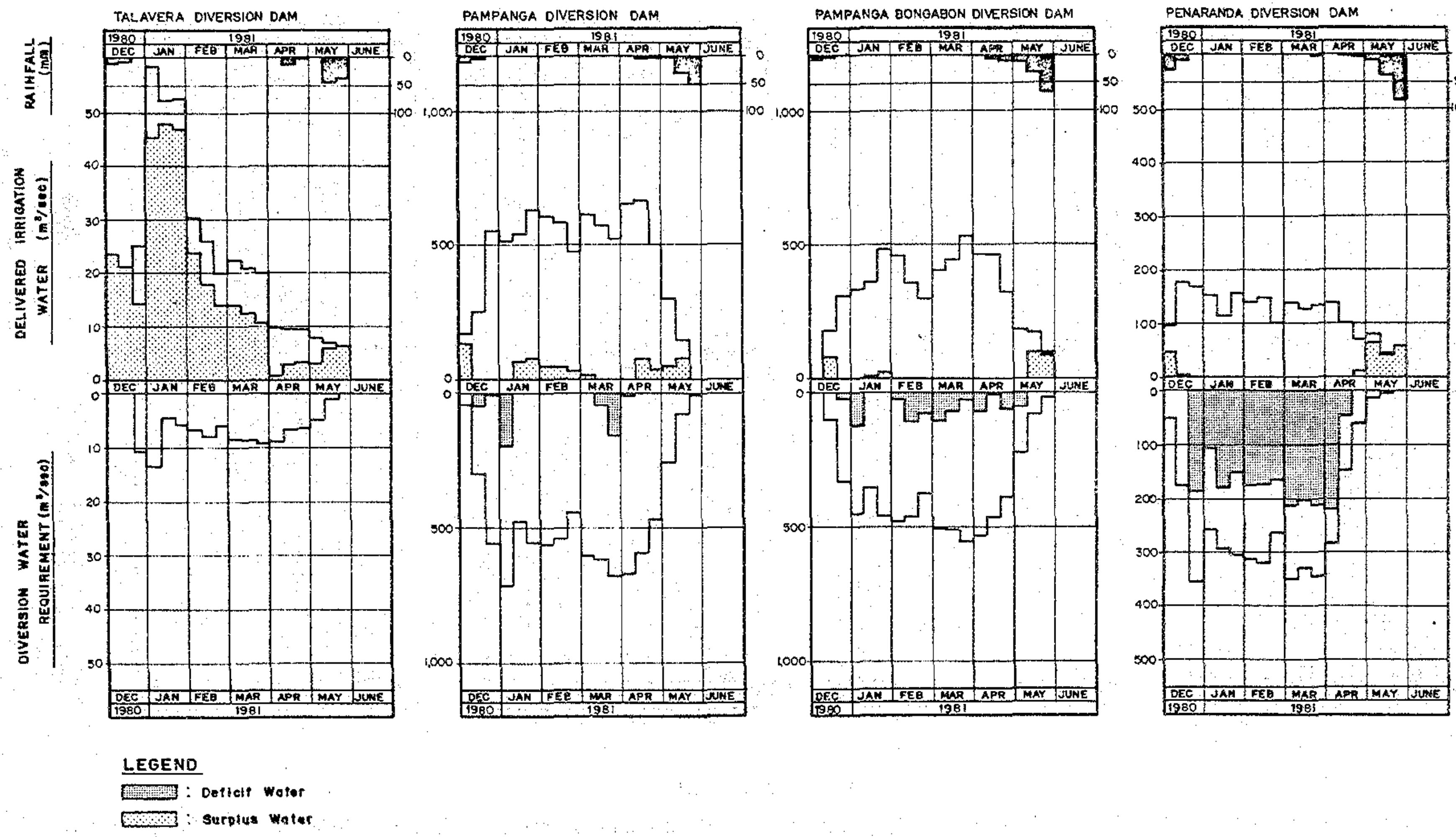


Fig. 2.11(10) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM

1981 DRY SEASON

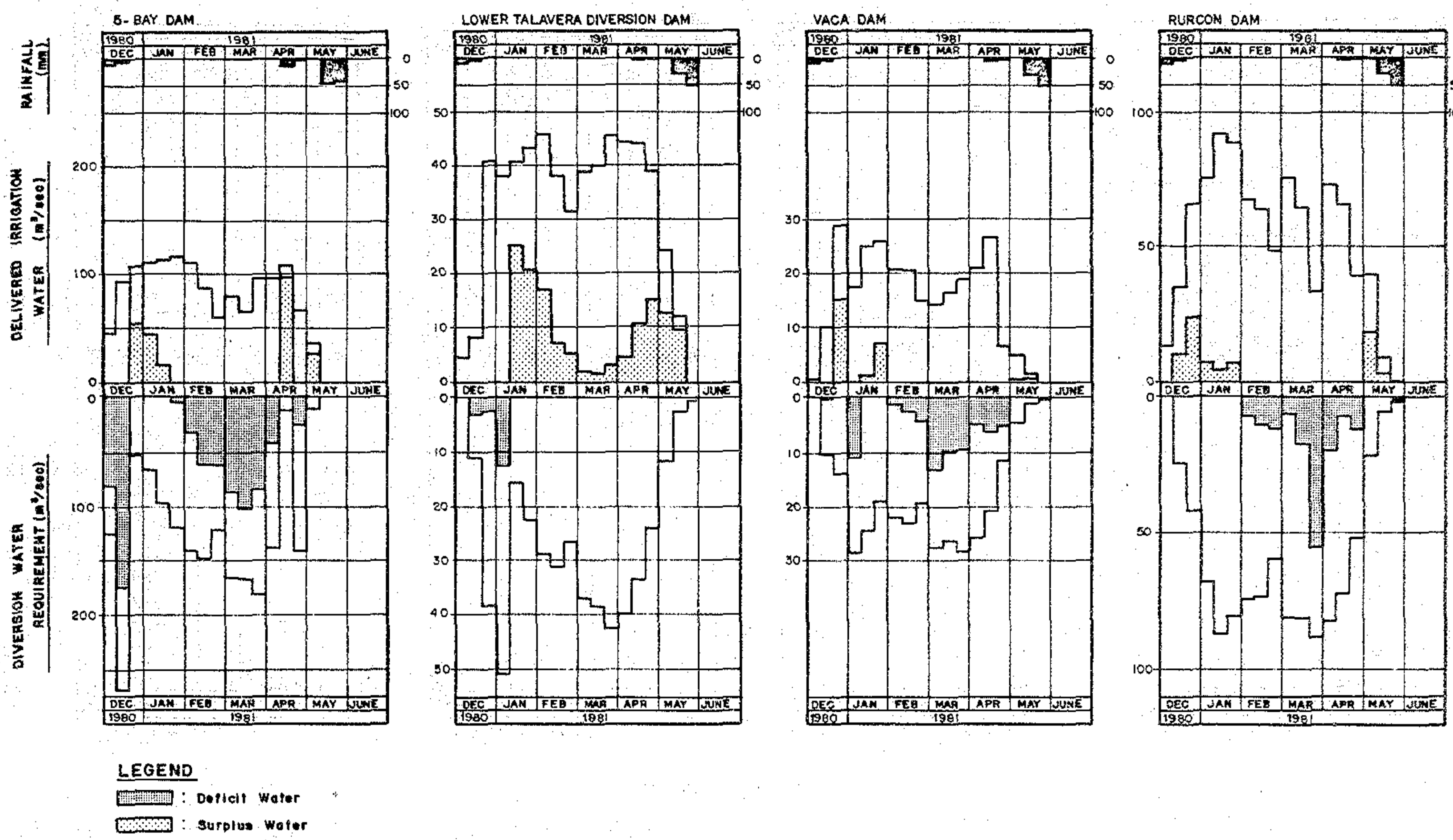


Fig. 2.11(11) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM
1981 WET SEASON

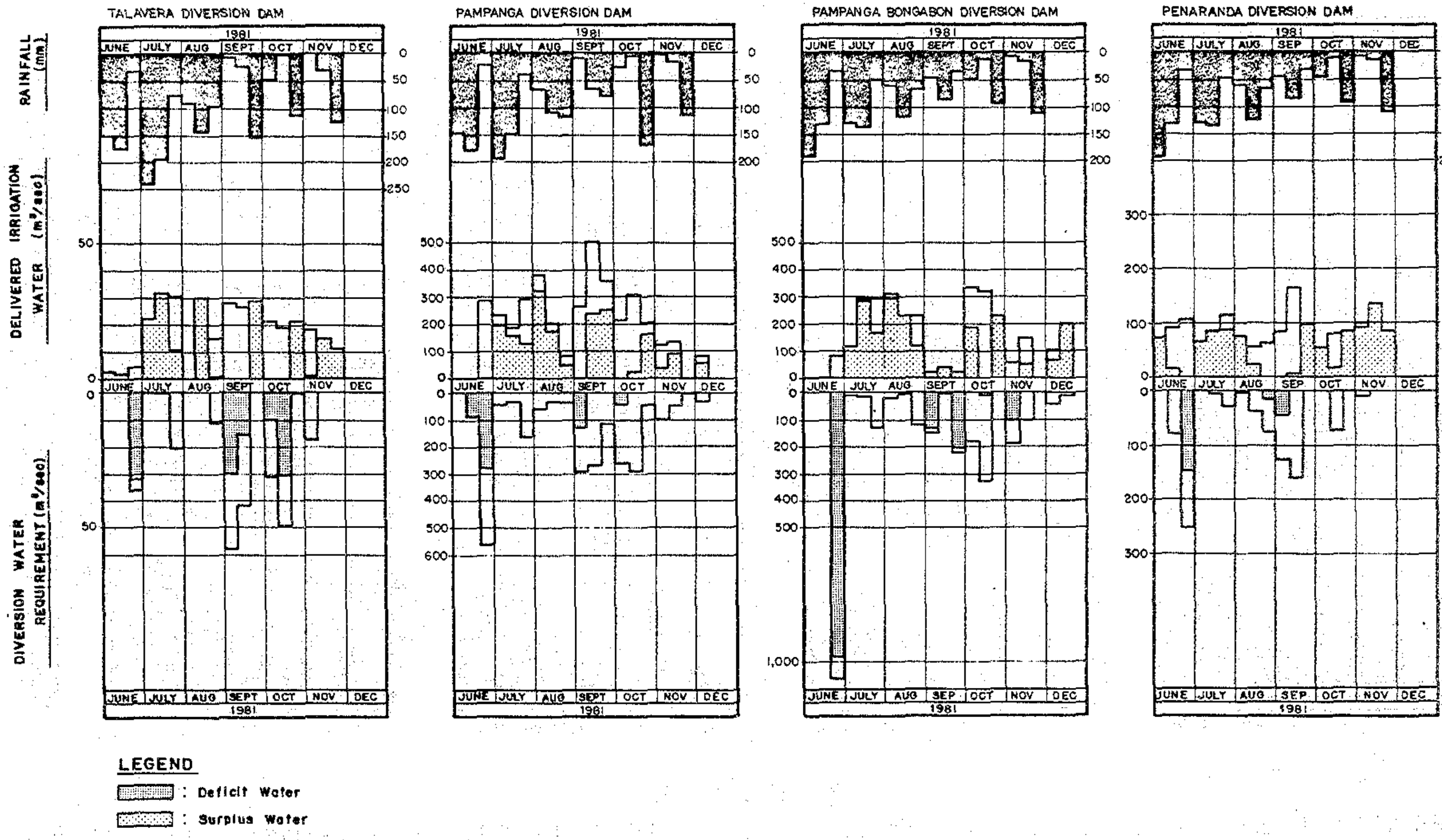


Fig. 2.11(12) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM 1981 WET SEASON

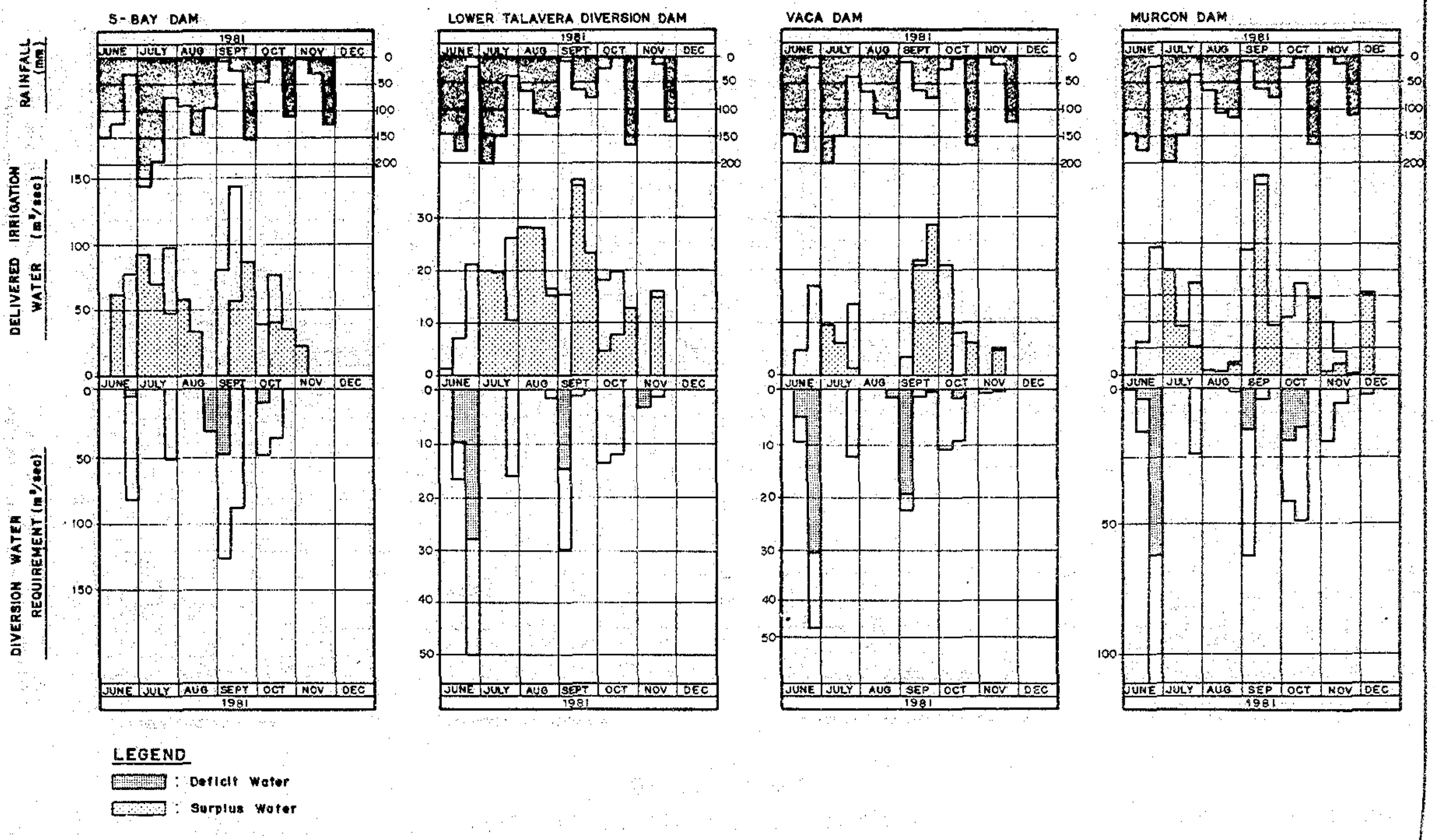


Fig. 2.11(13) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM 1982 DRY SEASON

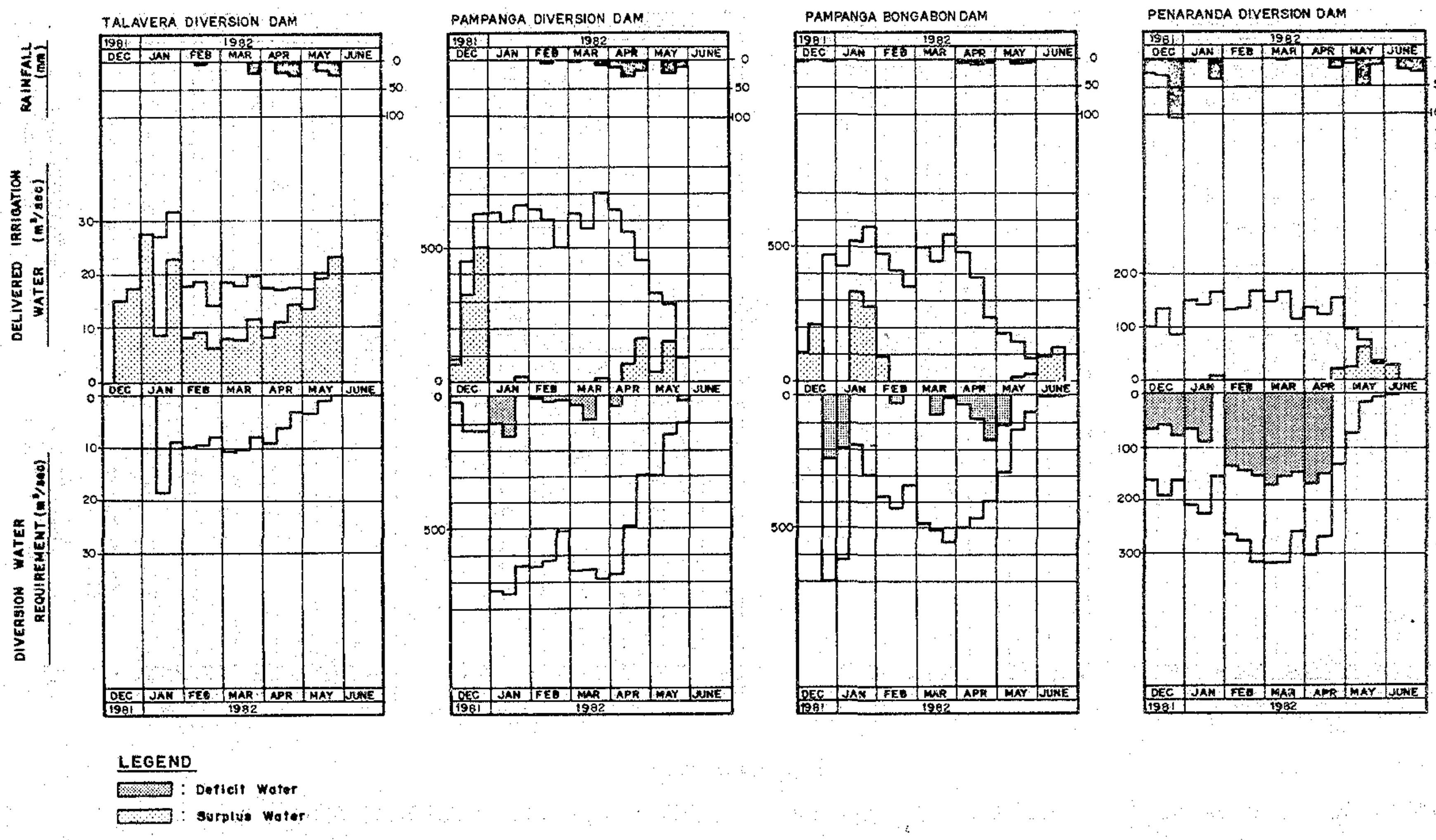


Fig. 2.11(14) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM
1982 DRY SEASON

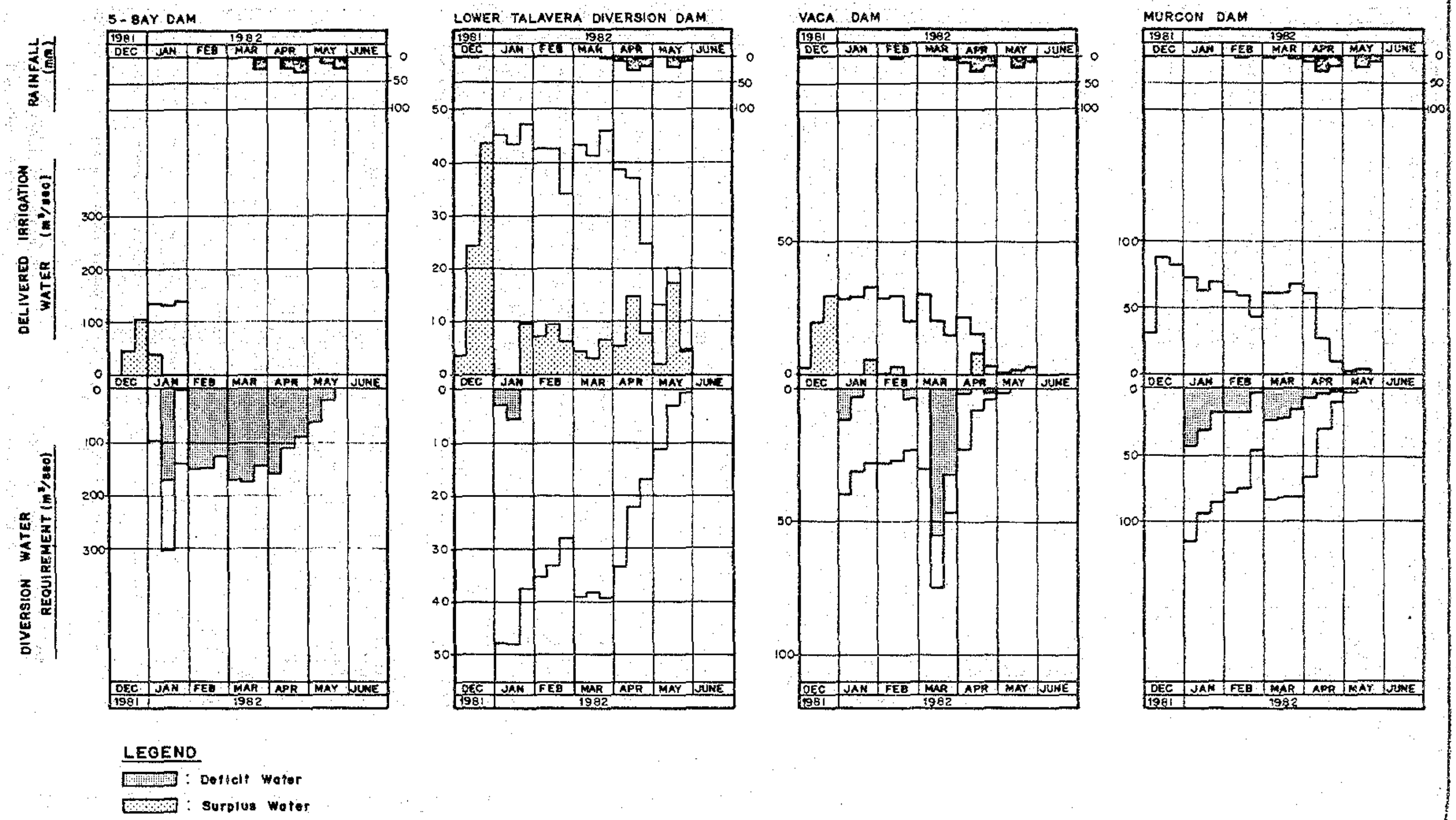


Fig. 2.11(15) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM 1982 WET SEASON

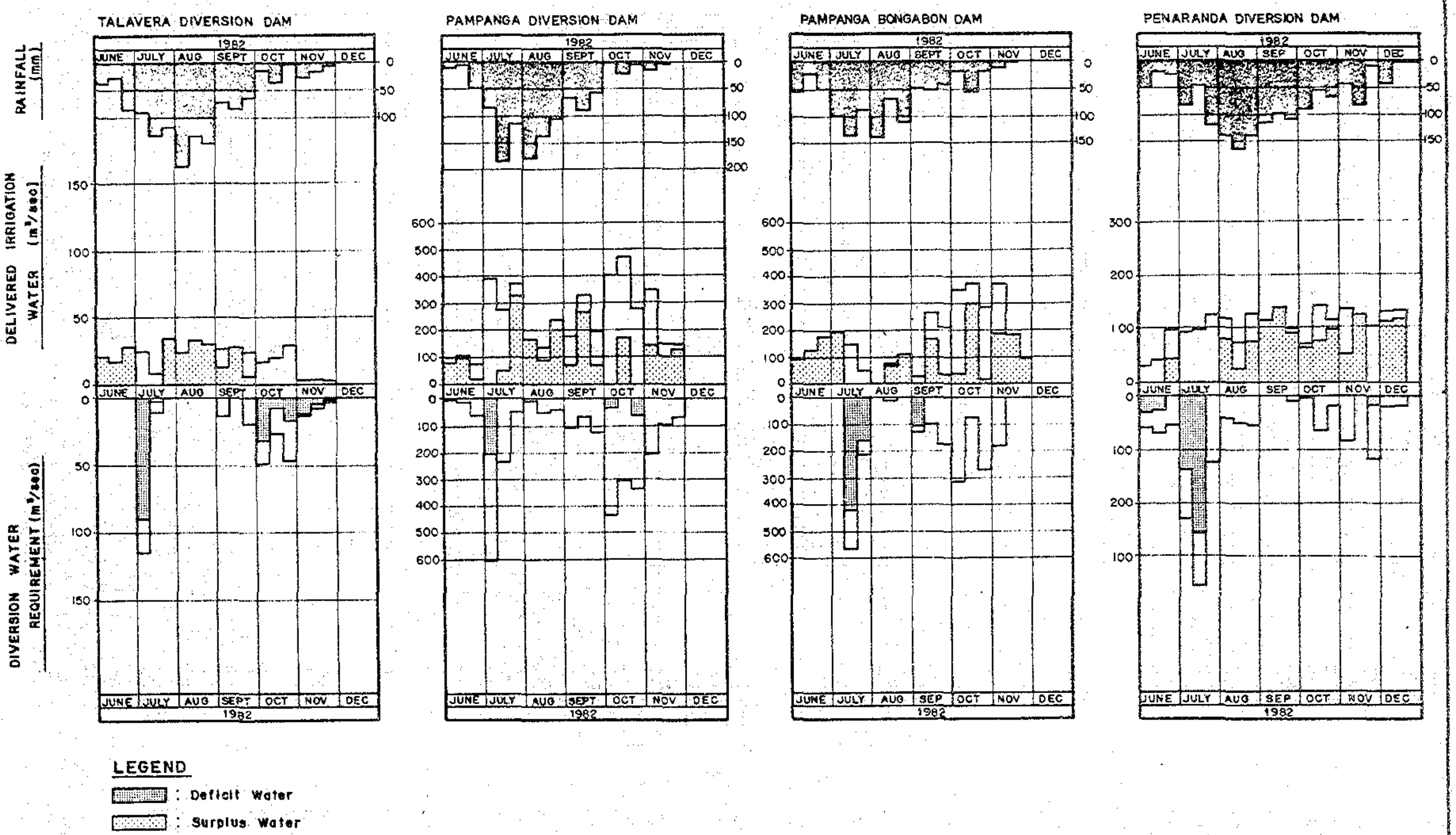


Fig. 2.11(16) DELIVERED IRRIGATION WATER AND CALCULATED DIVERSION WATER REQUIREMENT AT THE MAJOR DIVERSION DAM 1982 WET SEASON

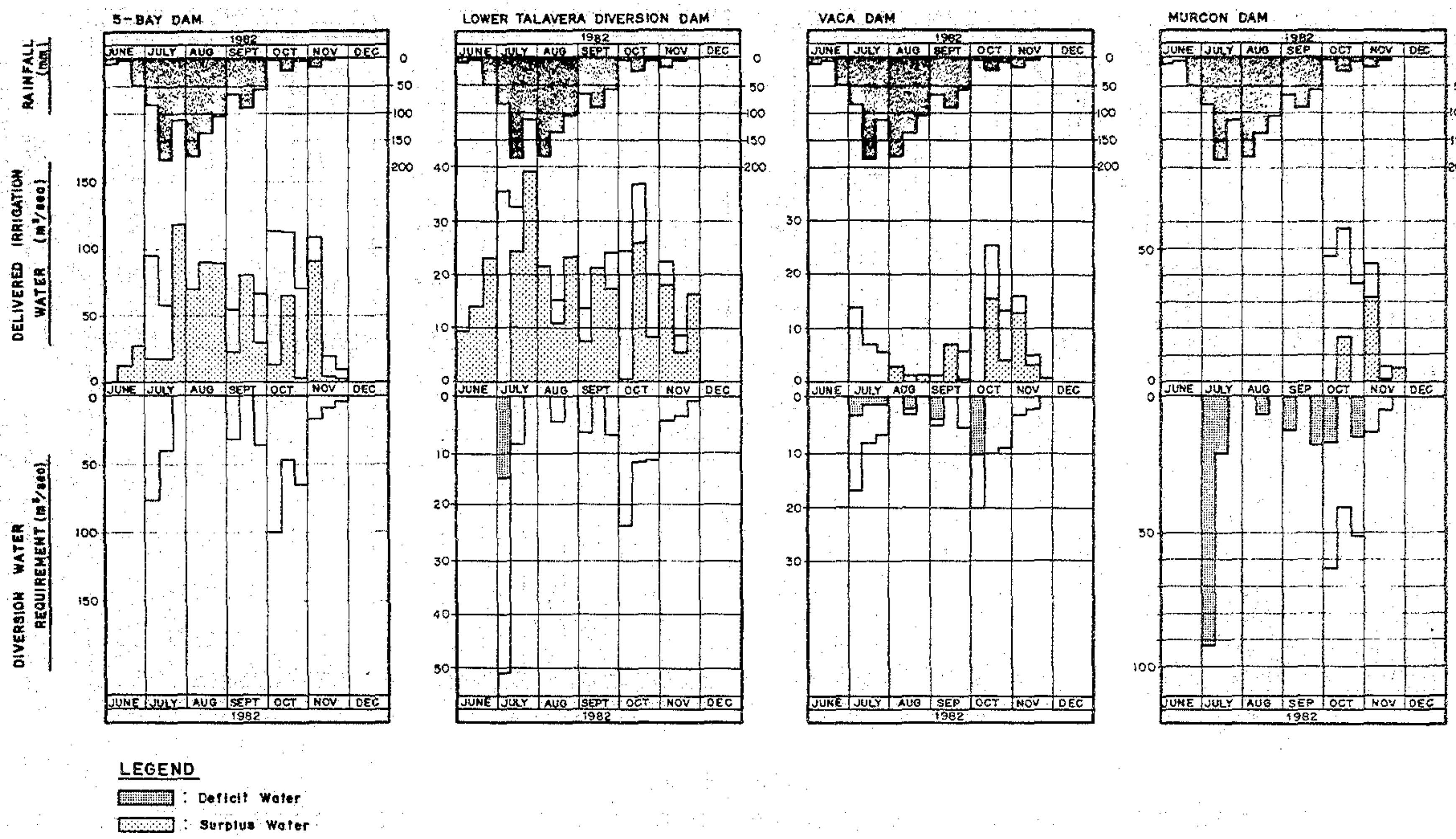
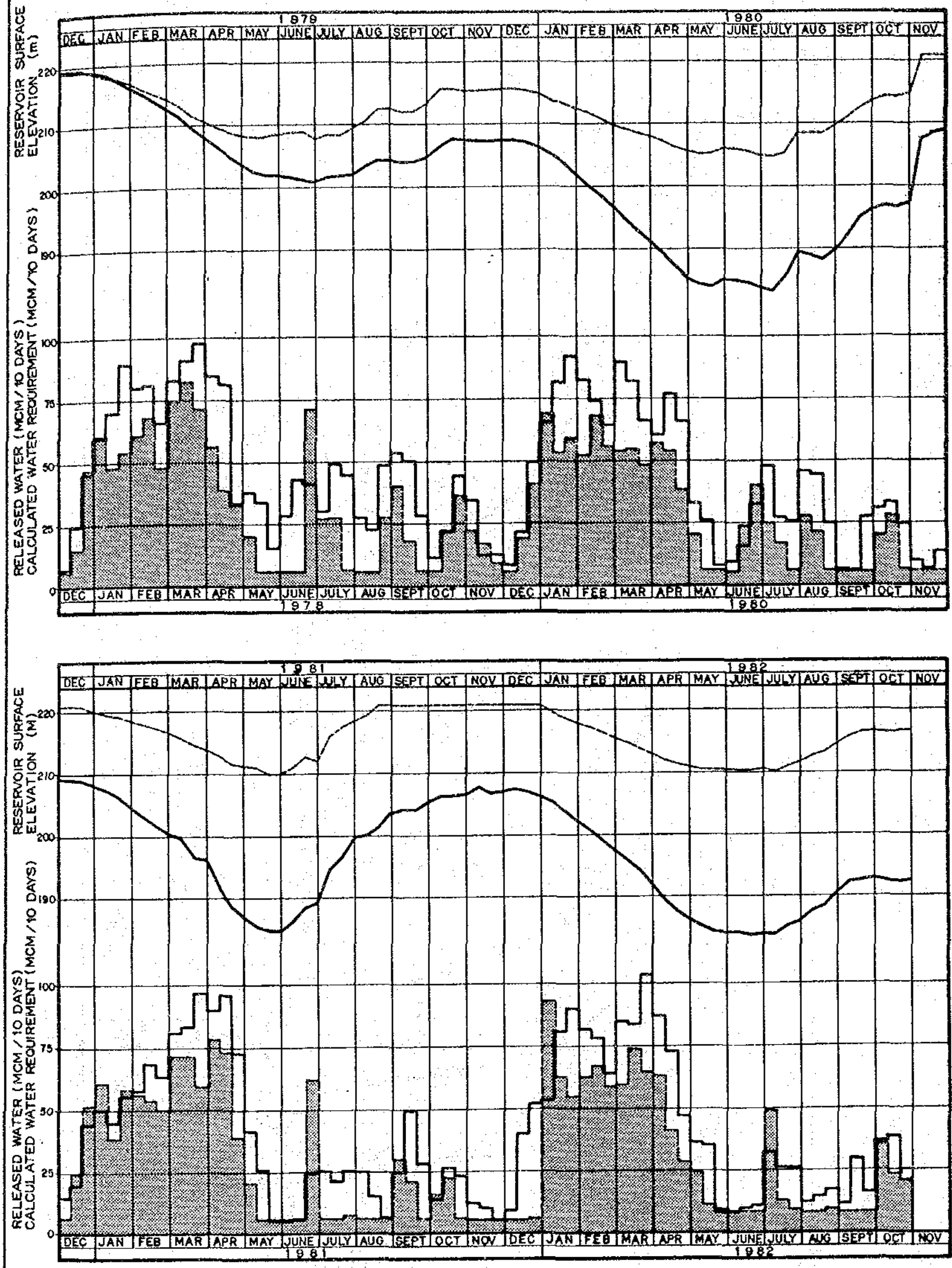


Fig. 2.12 WATER BALANCE AT PANTABANGAN DAM



LEGEND

: RELEASED WATER

: CALCULATED WATER REQUIREMENT

: RECORDED RESERVOIR SURFACE ELEVATION

: RESERVOIR SURFACE ELEVATION BASED ON CALCULATED WATER REQUIREMENT

Fig. 2.13 RESULTS OF FIELD MEASUREMENT AND TIME-LAG SIMULATION (PEÑRIS LATERAL C9-a)

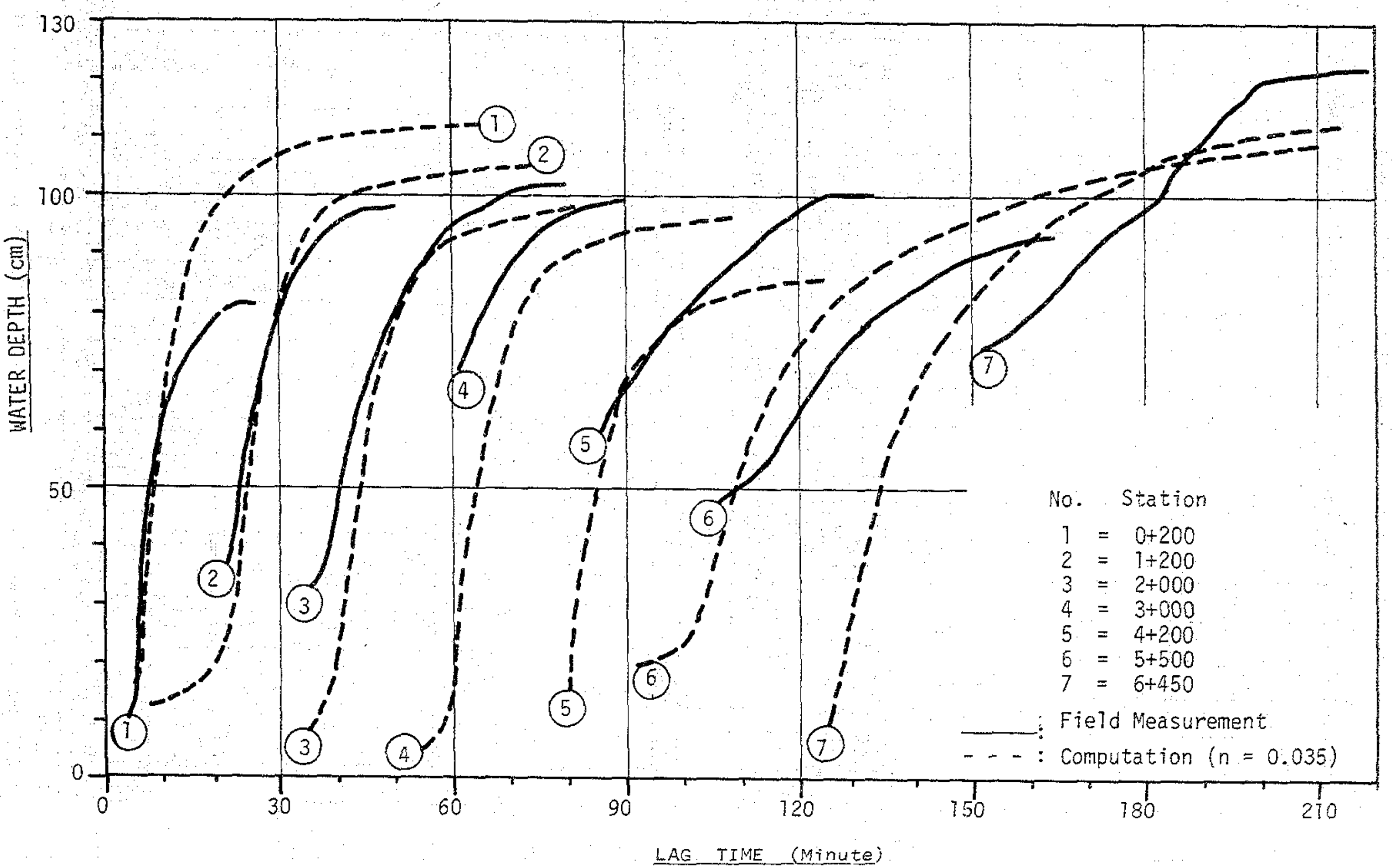


Fig. 2.14 RESULT OF THE TIME LAG SIMULATION

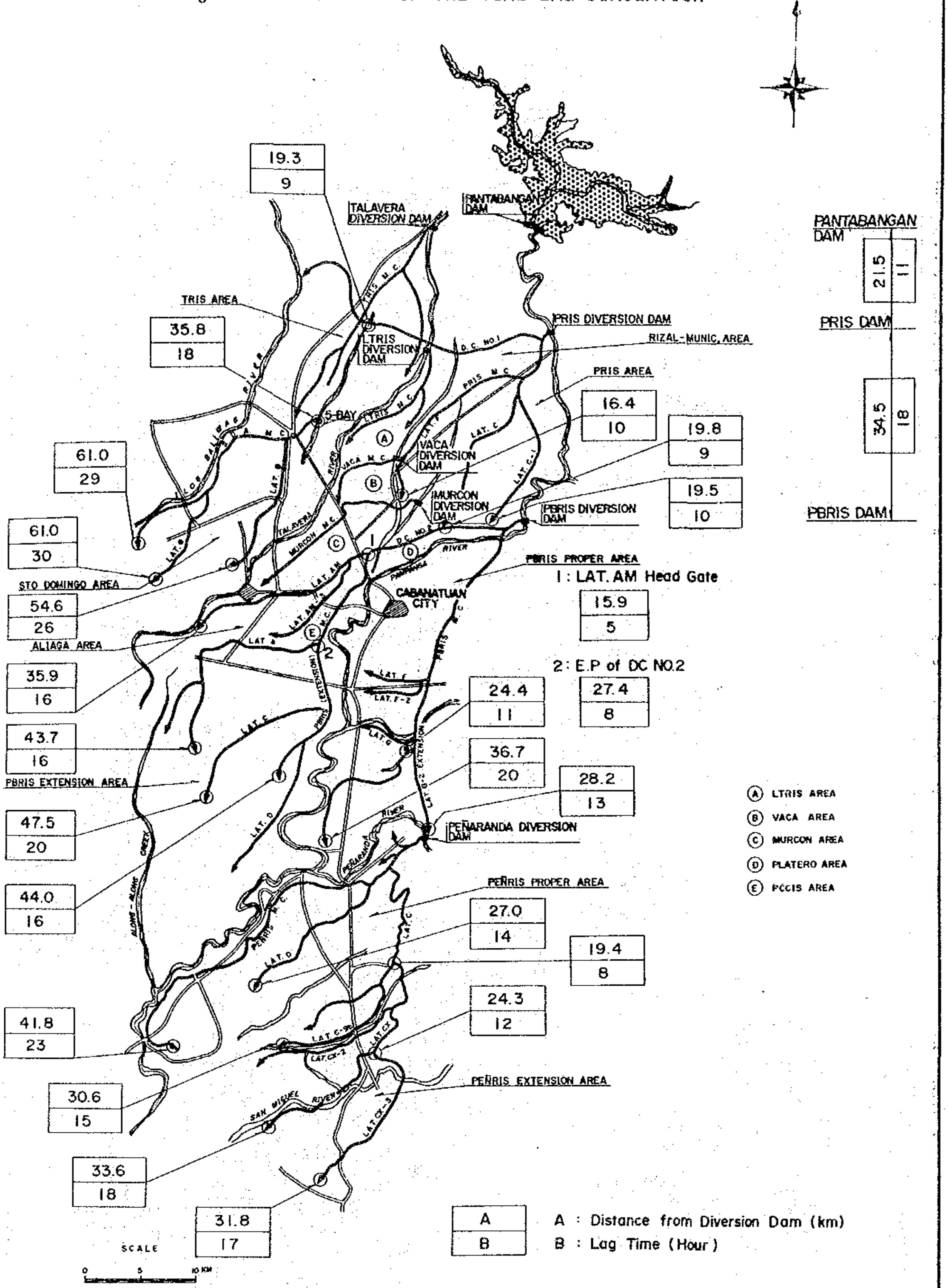


Fig. 2.15 IRRIGATION DIAGRAM INCLUDING RE-USE POINTS

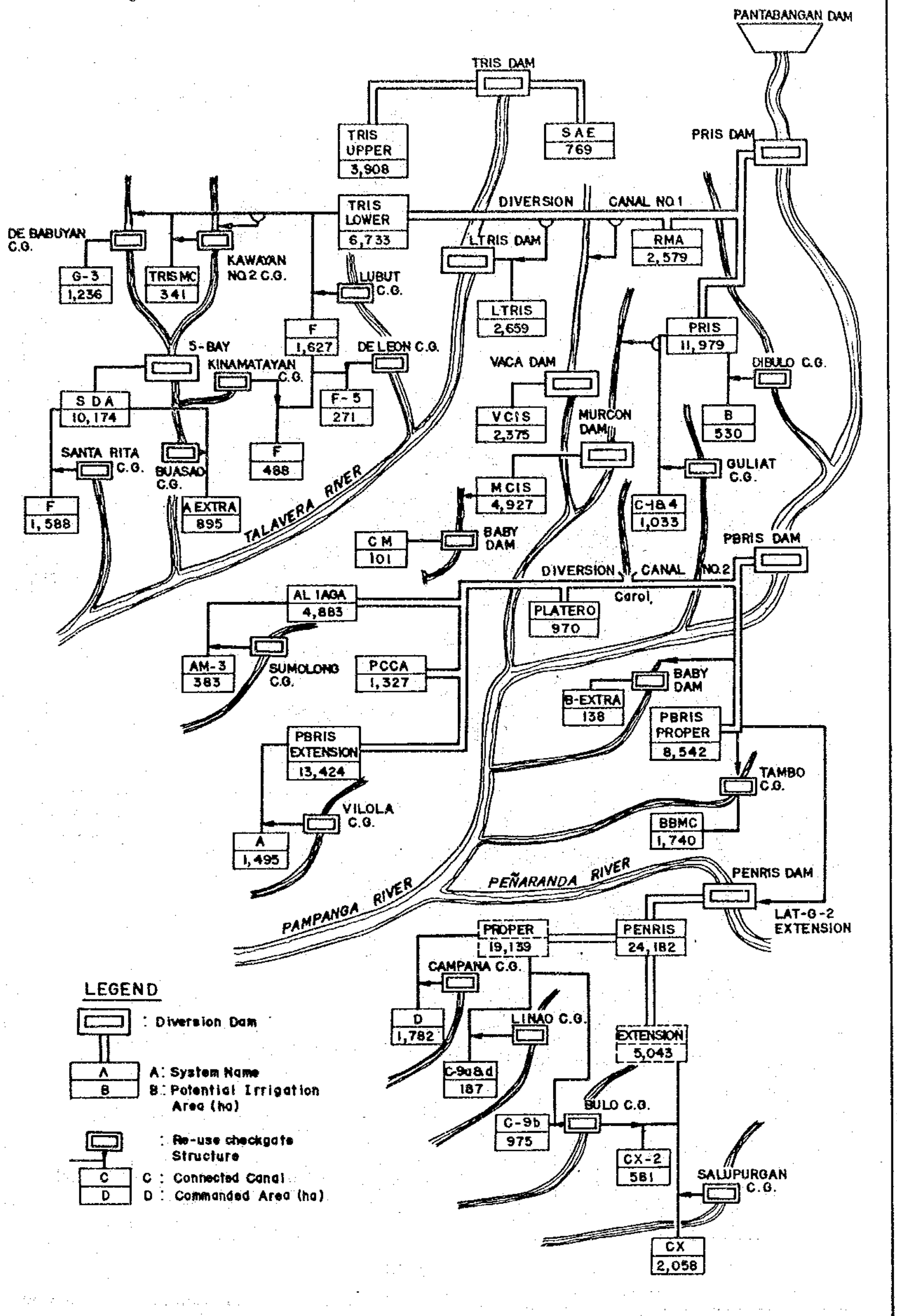


Fig. 2.16(1) IRRIGATION DIAGRAM INCLUDING RE-USE POINTS FOR EACH SYSTEM - DISTRICT I

SYSTEM	SERVICE AREA (ha)
SAN AGUSTIN EXTENSION AREA	769
TALAVERA RIVER IRRIGATION SYSTEM (UPPER AREA)	3,908
TALAVERA RIVER IRRIGATION SYSTEM (LOWER AREA)	9,783
STO. DOMINGO AREA	12,252
TOTAL	26,712

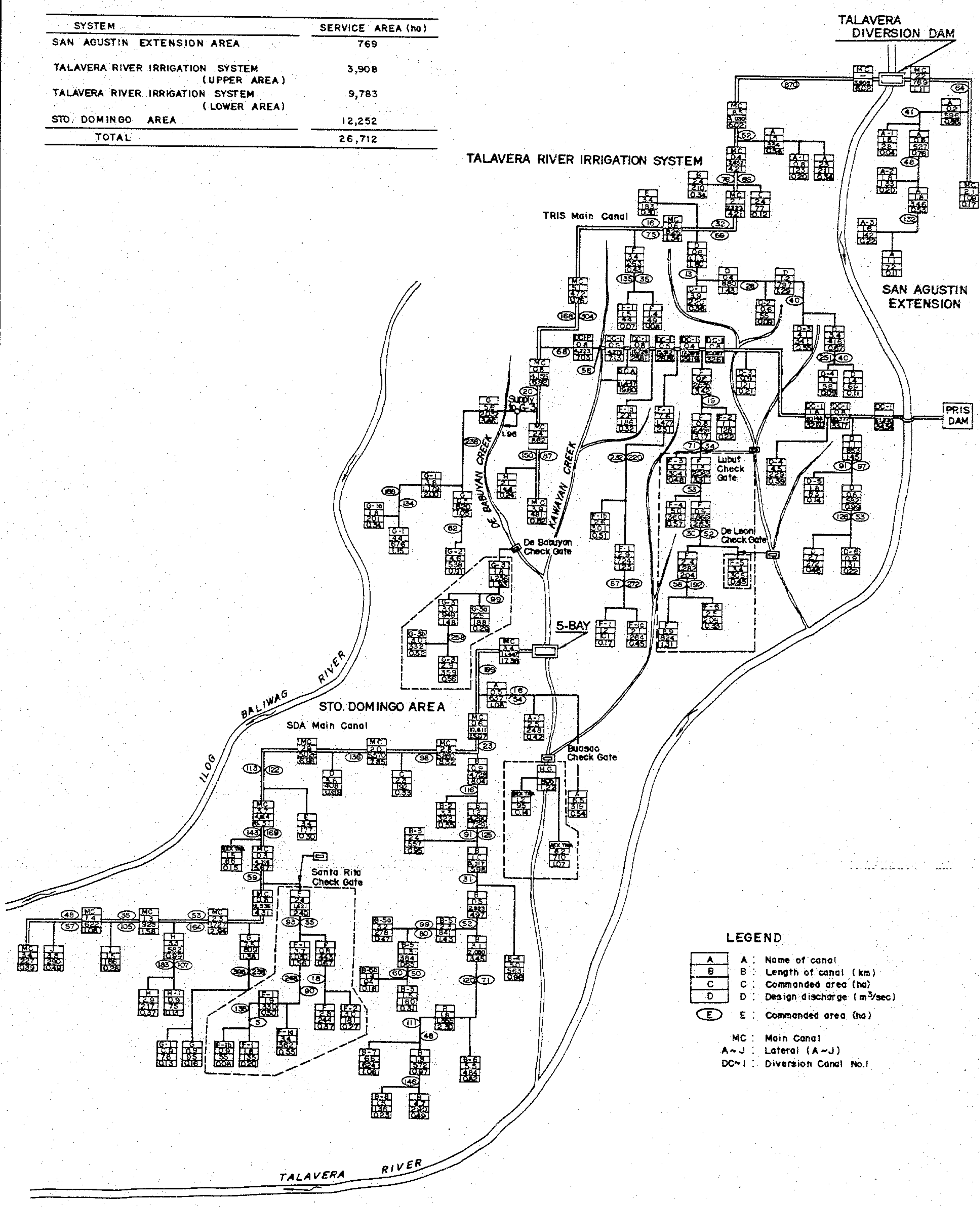


Fig. 2.16(2) IRRIGATION DIAGRAM INCLUDING RE-USE POINTS FOR EACH SYSTEM - DISTRICT II

SYSTEM	SERVICE AREA (ha)
RIZAL MUNIC AREA	2,579
PAMPANGA RIVER IRRIGATION SYSTEM	13,542
LOWER TALAVERA RIVER IRRIGATION SYSTEM	2,659
VACA CREER IRRIGATION SYSTEM	2,375
MURCON CREER IRRIGATION SYSTEM	5,028
TOTAL	26,183

A : Name of canal
B : Length of canal (km)
C : Commanded area (ha)
D : Design discharge (m^3/sec)
E : Commanded area (ha)

DC-I : Diversion Canal No.I
PMC : Pampanga Main Canal
LTMC : Lower Talavera Main Canal
VMC : VACA Main Canal
MMC : MURCON Main Canal

DCI-A, B, VC-3, DM-4 : Lateral

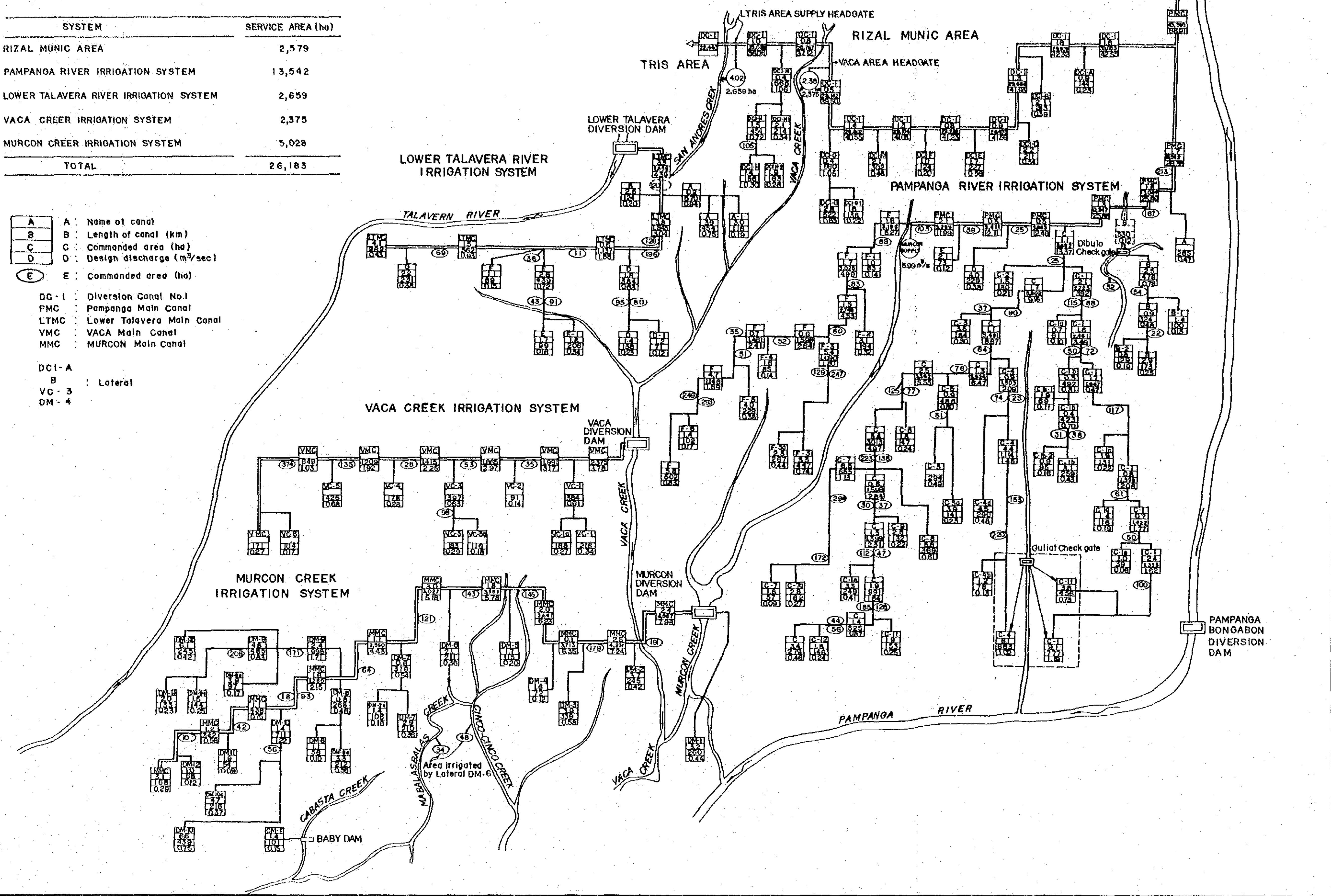
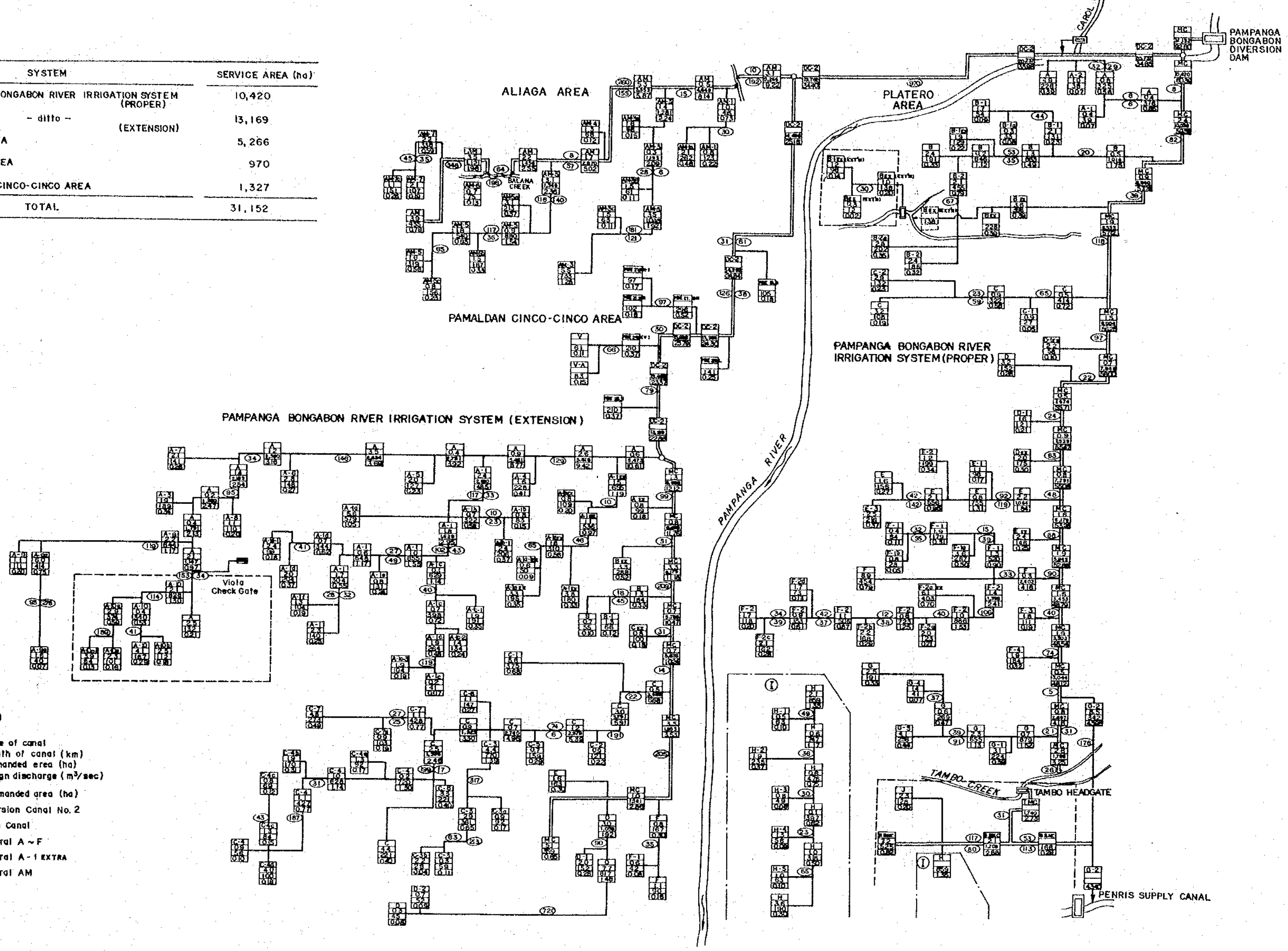


Fig. 2.16(3) IRRIGATION DIAGRAM INCLUDING RE-USE POINTS FOR EACH SYSTEM - DISTRICT III

SYSTEM	SERVICE AREA (ha)
1. PAMPANGA BONGABON RIVER IRRIGATION SYSTEM (PROPER)	10,420
2. - ditto - (EXTENSION)	13,169
3. ALIAGA AREA	5,266
4. PLATERO AREA	970
5. PAMALDAN CINCO-CINCO AREA	1,327
TOTAL	31,152

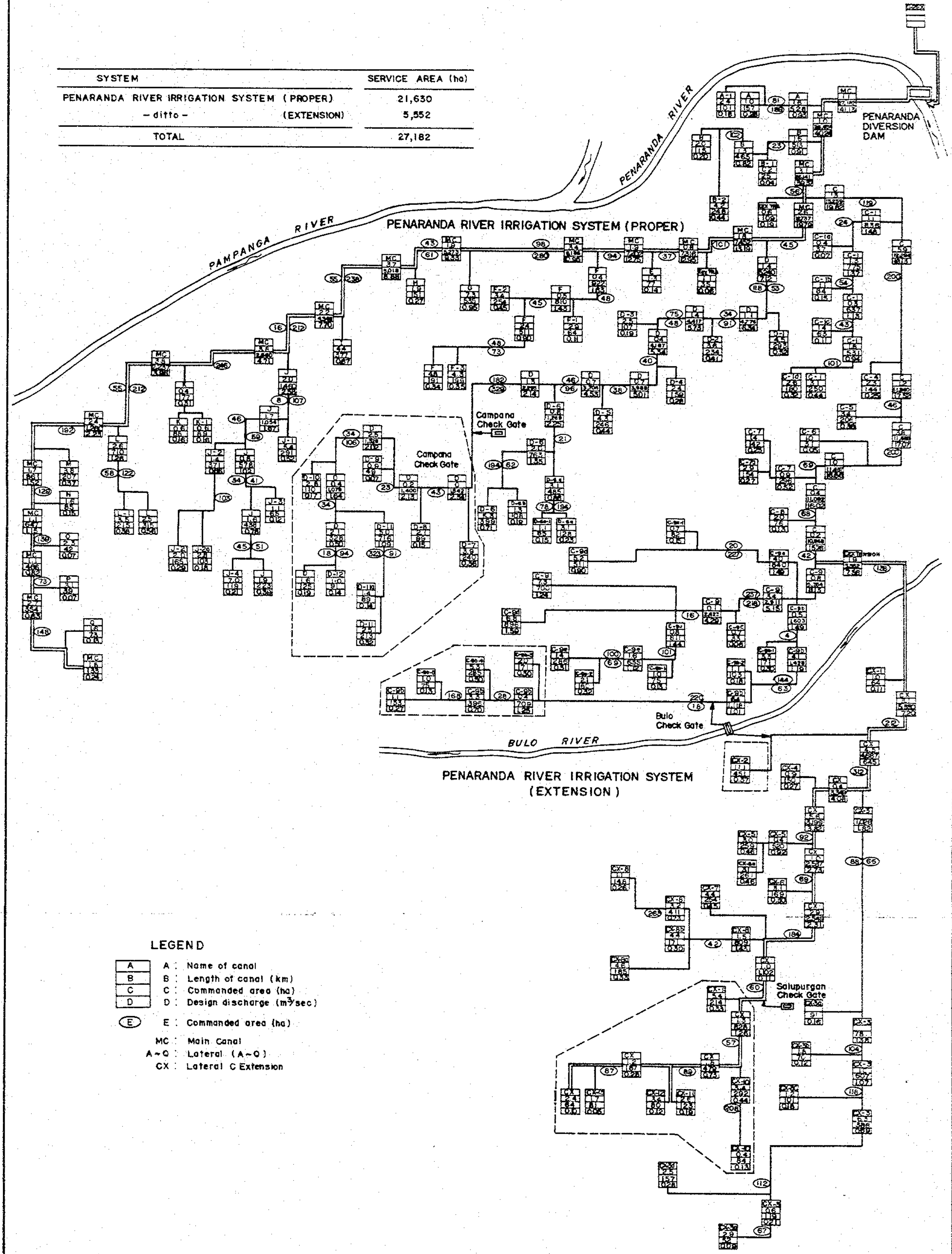


LEGEND

- A : Name of canal
- B : Length of canal (km)
- C : Commanded area (ha)
- D : Design discharge (m³/sec)
- (E) E : Commanded area (ha)
- DC - 2 : Diversion Canal No. 2
- MC : Main Canal
- A ~ F : Lateral A ~ F
- A - 1ex : Lateral A-1 EXTRA
- AM : Lateral AM

Fig. 2.16(4) IRRIGATION DIAGRAM INCLUDING RE-USE POINTS FOR EACH SYSTEM - DISTRICT IV

SYSTEM	SERVICE AREA (ha)
PENARANDA RIVER IRRIGATION SYSTEM (PROPER)	21,630
- ditto - (EXTENSION)	5,552
TOTAL	27,182



Reference 2.1 IRRIGATION WATER REQUIREMENT DETERMINATION (WCCC PROCEDURE)

The preparation of a composite cropping and the weekly irrigation requirement is done using the following steps:

1. Land Soaking Irrigation Requirement (LSIR) - the amount of irrigation water needed to saturate the soil prior to the initial breaking.

$$LSIR = \frac{\frac{Sn}{t} + 0.88\ PET + P - Re}{Eff} \quad \frac{A}{8.64}$$

where, LSIR: liters per second

Sn: soil saturation requirement, 145 mm for dry seaon and 165 for wet season (will substantially reduce when rainfall occurs at this stage)

t: number of days to saturate soil (it takes 7 days for an average farmer in UPRIIS)

PET: potential evapotranspiration, mm/day (Table 1)

P: percolation rate, mm/day (Table 2)

0.88: conversion value to equate PET to Ev

Eff: farm efficiency, 80% for dry season and 75% for wet season

Re: effective rainfall, mm/day (refer to the Determination of Effective Rainfall)

A: program area, ha

8.64: conversion constant, mm/day to lit/sec/ha

2. Land Preparation Irrigation Requirement (LPIR) - the amount of water needed immediately after land soaking has been satisfied. This requirement is only that needed to replace the losses due to evaporation and percolation.

$$LPIR = \frac{(0.88\ PET + P - Re)}{(Eff)} \quad \frac{A}{8.64}$$

where, LPIR: liters per second

3. Farm Crop Irrigation Requirement (FCIR) - the amount of water needed by the crop from the time it is planted/transplanted up to two weeks before harvesting.

$$FCIR = \frac{(Kc\ PET + P - Re)}{(Eff)} \quad \frac{A}{8.64}$$

where, FCIR: liters per second

Kc: rice crop growth stage coefficient (Table 3)

4. Farm Irrigation Requirement (FIR) - the summation of land soaking, land preparation and farm crop irrigation requirements. This is the amount of irrigation water releases at the beginning point of water delivery which in the case of UPRIIS is the gated turnout.

$$FIR = LSIR + LPIR + FCIR$$

where, FIR: liters per second

5. Irrigation Diversion Requirement (IDR) - defined as the farm irrigation requirement plus the consideration for conveyance losses in the distribution system until it is delivered to the farm less any return flows entering the system.

$$IDR = \frac{FIR + CL - QR}{1,000}$$

where, IDR: cubic meters per second

CL: conveyance loss expressed in percent farm irrigation requirement (Table 4)

QR: return flows or re-use entering the system/area

1,000: conversion constant from lit/sec/to cm

6. Reservoir Diversion Demand (RDD) - refers to irrigation diversion requirement less available local flow and return flow plus river channel losses.

$$RDD = IDR + RCL - LF$$

where, RDD: cubic meters per second

LF: local flows/return flows

RCL: river channel loss from Masiway re-regulation dam to PRIS and PBRIS dam

Table 1 POTENTIAL EVAPOTRANSPIRATION

(Unit: mm/day)

Month	PET
January	5.08
February	6.19
March	6.74
April	7.30
May	6.88
June	5.97
July	5.28
August	5.11
September	5.19
October	5.40
November	4.97
December	5.00

Table 2 PERCOLATION RATES (DISTRICT LEVEL)

(Unit: mm/day)

District	Dry	Wet
I	2.05	1.65
II	1.81	1.41
III	2.04	1.65
IV	2.04	1.65

Table 3 CROP GROWTH STAGE COEFFICIENT, Kc

Crop Growth Stage	Coefficient
Nursery	0.90
Tillering	0.95
Booting	1.05
Heading	1.12
Flowering	1.03
Ripening	0.96

Table 4 AVERAGE CONVEYANCE LOSSES AT MAJOR FLOW POINTS IN UPRP SERVICE AREA

From	To	Average Conveyance Loss, % FIR
TRIS Dam	San Agustin Ext'n	6.30
TRIS Dam	TRIS Upper	13.13
Hadial Gate #3	TRIS Lower	19.10
5-Bay Check Gate	Sto. Domingo Area	18.67
Radial Gate #3	SDA Supply Head Gate	8.93
Diversion Canal #1 Head Gate	Radial Gate #3	17.10
Diversion Canal #1 Head Gate	Rizal-Munic Area	13.44
Diversion Canal #1 Head Gate	VCIS Supply Head Gate	14.49
VCIS Dam	VCIS Area	13.13
Diversion Canal #1 Head Gate	LTRIS Supply Head Gate @DC-1	16.97
LTRIS Dam	LTRIS Area	18.08
PRIS M.C. Head Gate	PRIS Area	17.28
PRIS M.C. Head Gate	MCIS Supply Head Gate @PRIS Main Canal	11.42
MCIS Dam	MCIS Area	22.35
PBRIS M.C.	PBRIS Proper (Z-1 & 2)	16.20
PBRIS M.C.	PBRIS Proper (Z-2 & 4)	26.97
Diversion Canal #2 Head Gate	Plater Area	14.45
Diversion Canal #2 Head Gate	Lat. AM Head Gate @DC-2	23.33
Lateral AM Head Gate	Aliaga Area	17.27
Lat. AM Head Gate	PCCIS	9.26
Lat. AM Head Gate	Lat. A Junction (PBRIS Ext. @DC-2)	16.95
Lat. A Junction (PBRIS Ext. @DC-2)	PBRIS Ext. (North Abbot)	26.97
Lat. A Junction (PBRIS Ext. @DC-2)	PBRIS Ext. (South Abbot)	27.75

Reference 2.2 DETERMINATION OF EFFECTIVE RAINFALL

The method employed in the determination of effective rainfall still uses the Thiessen Polygon average but the maximum paddy spillway height is considered with 50 mm limit (mean at all stages of crop growth). Actual effective rainfall cannot exceed the consumptive use of crop (CWR), however, it can be carried over into the following days. Any amount of rainfall that overflows into the paddy spillway is termed as ineffective. With this concept therefore, it could be expressed by the following equations:

Test for Overflow:

$$PWLf = PWLi - CWR_{ave} + Ra$$

where, PWLf: final paddy water level after the day's rainfall considered, mm

PWLi: initial paddy water level, mm. This parameter covers the carry over or the amount of rainfall previously trapped in the paddy prior to the occurrence of rain day considered.

CWR_{ave}: weighted average crop water requirement, mm/day (refer to the determination of average crop water requirement)

Ra: actual depth of rainfall for the day considered, mm

Using the above formula, an overflow will occur if the computed PWLf exceeds the 50 mm limit of paddy spillway height. The amount of effective rainfall is then determined by:

Without Overflow:

$$RE = Ra$$

With Overflow:

$$RE = PSH - PWLi - CWR_{ave}$$

where, RE: effective rainfall

PSH: paddy spillway height (assumed = 50 mm)

Reference 2.3 UNSTEADY FLOW SIMULATION

1. Hydraulic Model

Unsteady flow is expressed by the following differential equations taking flow velocity and depth as variables:

(Equation of motion)

$$\frac{\eta}{g}\left(\frac{\partial V}{\partial t}\right) + \frac{\alpha}{g}\cdot\frac{\partial}{\partial x}\left(\frac{V^2}{2}\right) + I + \frac{\partial H}{\partial x} + \frac{n^2 V}{R^{4/3}} \times V = 0 \quad \cdots\cdots\cdots\cdots (1)$$

(Equation of continuation)

$$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} - q = 0 \quad \cdots\cdots\cdots\cdots (2)$$

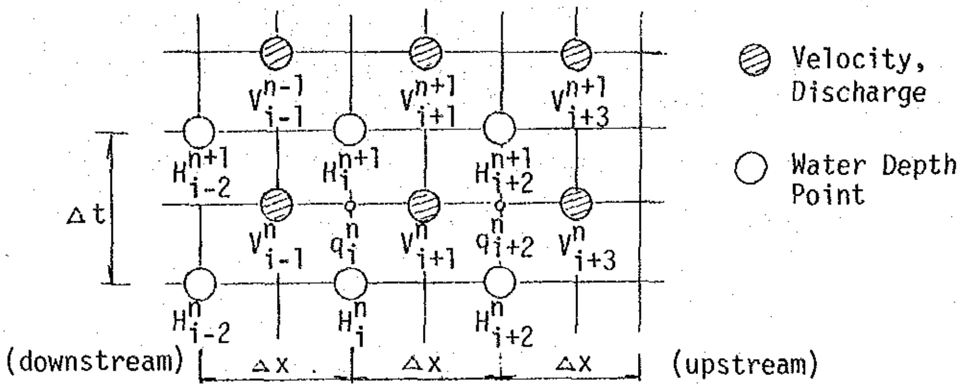
where,
- V: velocity
- H: depth
- R: hydraulic radius
- n: roughness coefficient
- I: canal gradient
- A: flow area
- Q: discharge
- q: side inflow (outflow) discharge
- η,α: energy coefficient ($\fallingdotseq$ 1.0)
- W: water surface width

Assuming $R = A/W$ and $\eta = \alpha = 1.0$, equation (1) is expressed by the following equation (3):

$$\frac{1}{g}\left(\frac{\partial V}{\partial t}\right) + \frac{1}{g}\cdot\frac{\partial}{\partial x}\left(\frac{V^2}{2}\right) + I + \frac{\partial H}{\partial x} + \frac{n^2 |V|}{H^{4/3}} \times V = 0 \quad \cdots\cdots\cdots\cdots (3)$$

where,
- x: distance (m) (positive to upstream)
- t: time (sec)
- H: depth of water (m)
- V: velocity (m/sec)
- Q: discharge (m^3/sec)
- A: flow area (m^2)
- q: inflow/outflow (m^3/sec/m)
- I: canal gradient

Taking differential grid as follows:



H_i^n: depth at time of t = n xΔt at point i

H_i^{n+1}: depth at time of t = (n+1) xΔt at point i

V_{i+1}^n: velocity at time of t = n xΔt at point i+1

Then the equation of continuation will be expressed by the following:

$$\frac{\partial A}{\partial t} = W \times \frac{\partial H}{\partial t} = W \times \frac{H_i^{n+1} - H_i^n}{\Delta t}$$

$$\frac{\partial Q}{\partial x} = \frac{Q_{i+1}^n - Q_{i-1}^n}{\Delta x}$$

$$W \times \frac{H_i^{n+1} - H_i^n}{\Delta t} + \frac{Q_{i+1}^n - Q_{i-1}^n}{\Delta x} - q_i^n = 0 \quad \dots\dots\dots\dots\dots\dots \quad (4)$$

where, W: water surface width

$$W = \frac{1}{6}(6 \times W_i^n + W_{i+2}^n + W_{i-2}^n)$$

$$Q_{i+1}^n = V_{i+1}^n \times \frac{H_{i+2}^n + H_i^n}{2}$$

$$Q_{i-1}^n = V_{i-1}^n \times \frac{H_i^n - H_{i-2}^n}{2}$$

Then, solving equation (4) by H_i^{n+1},

$$H_i^{n+1} = H_i^n - \frac{\Delta t}{W}\left(\frac{Q_{i+1}^n - Q_{i-1}^n}{\Delta x} - q_i^n\right) \quad \text{......................... (5)}$$

Therefore, the depth of water at point i at time of (n+1) xΔt is obtained by the items at time of n xΔt.

As for the equation of motion, it is solved as follows:

$$\frac{\partial V}{\partial t} = \frac{V_{i+1}^{n+1} - V_{i+1}^n}{\Delta t}$$

$$\frac{\partial H}{\partial x} = \frac{H_{i+2}^{n+1} - H_i^{n+1}}{\Delta x}$$

$$\frac{\partial V^2}{\partial x} = \frac{(V_{i+3}^n)^2 - (V_{i-1}^n)^2}{2 \cdot \Delta x}$$

$$I = \frac{Z_{i+2} - Z_i}{\Delta x} \qquad \text{where, Z: canal bed elevation}$$

$$V = \frac{V_{i+1}^n + V_{i+1}^{n+1}}{2}$$

$$H = \frac{H_{i+2}^{n+1} + H_i^{n+1}}{2}$$

$$|V| = |V_{i+1}^n|$$

Then the equation (3) will be;

$$\frac{1}{g}\,\frac{V_{i+1}^{n+1} - V_{i+1}^n}{\Delta t} + \frac{1}{2g}\,\frac{(V_{i+3}^n)^2 - (V_{i-1}^n)^2}{2 \cdot \Delta x} + \frac{Z_{i+2} - Z_i}{\Delta x} + \frac{H_{i+2}^{n+1} - H_i^{n+1}}{\Delta x}$$

$$+ \frac{n^2 |V_{i+1}^n|}{\left(\dfrac{H_{i+2}^{n+1} + H_i^{n+1}}{2}\right)^{4/3}} \times \frac{V_{i+1}^n + V_{i+1}^{n+1}}{2} = 0$$

Solving by V^{n+1}_{i+1};

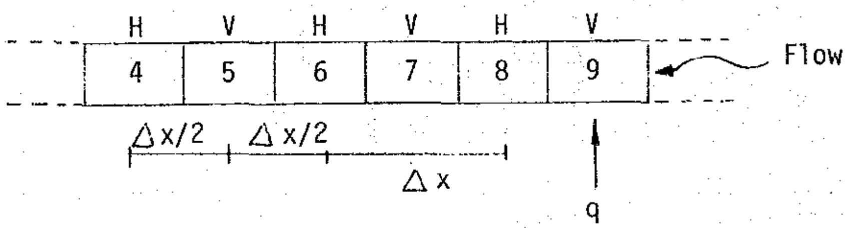
$$V^{n+1}_{i+1} = \frac{\dfrac{V^n_{i+1}}{g \cdot \Delta t} - V^n_{i+1} \times F - M}{\left(\dfrac{1}{g \cdot \Delta t} + F\right)}$$

where, $$F = \frac{1}{2} \times \frac{n^2 \left| V^n_{i+1} \right|}{\left(\dfrac{H^{n+1}_{i+2} + H^{n+1}_i}{2} \right)^{4/3}}$$

$$M = \frac{1}{2g} \frac{(V^n_{i+3})^2 - (V^n_{i+1})^2}{2 \cdot \Delta x} + \frac{Z_{i+2} - Z_i}{\Delta x} + \frac{H^{n+1}_{i+2} - H^{n+1}_i}{\Delta x}$$

Therefore, the velocity at point (i+1) at time of (n+1) xΔt (V^{n+1}_{i+1}) is obtained from the value V^n and H^{n+1}.

Giving initial depth and velocity, the successive values of depth and velocity will be calculated by Δt and Δx steps. The hydraulic model will be formulated by the following blocks, assuming odd number block as a velocity calculation point and even number block as a depth calculation point.

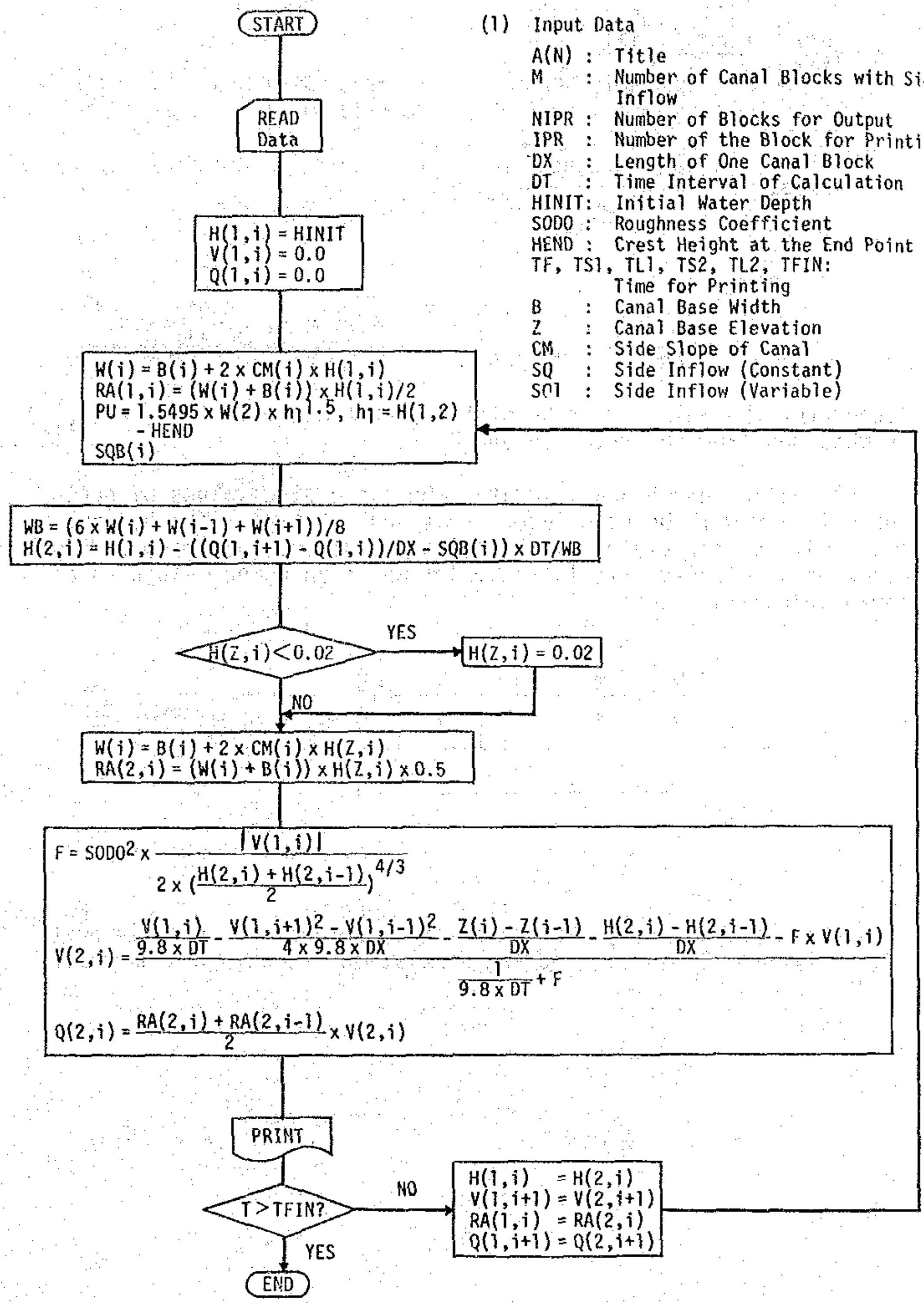


Flow chart for unsteady flow calculation program is shown in next page. Program lists of time-lag simulation are attached hereafter.

FLOW CHART FOR UNSTEADY FLOW CALCULATION PROGRAM

(1) Input Data

- A(N) : Title
- M : Number of Canal Blocks with Side Inflow
- NIPR : Number of Blocks for Output
- IPR : Number of the Block for Printing
- DX : Length of One Canal Block
- DT : Time Interval of Calculation
- HINIT: Initial Water Depth
- SODO : Roughness Coefficient
- HEND : Crest Height at the End Point
- TF, TS1, TL1, TS2, TL2, TFIN: Time for Printing
- B : Canal Base Width
- Z : Canal Base Elevation
- CM : Side Slope of Canal
- SQ : Side Inflow (Constant)
- SQ1 : Side Inflow (Variable)



```
C     UNSTEADY FLOW - UPRIIS
      DIMENSION B(42),Z(42),W(42),CM(42),H(2,42),V(3,43),RA(2,42),
     +Q(3,43),WL(2,42),SQ(42),A(20),SQB(42),IS(20),IT(20),SQ1(42,10),
     +TSQ(42,10),IPR(42),WLP(42),VP(42),RAP(42),QP(42),SQBP(42)
      READ(5,1030)(A(N),N=1,20)
      WRITE(6,1030) (A(N),N=1,20)
      WRITE(6,1010)
      READ(5,1005) (A(N),N=1,20),M,MB,NIPR
      WRITE(6,1005) (A(N),N=1,20),M,MB,NIPR
      WRITE(6,1010)
      READ(5,1005) (A(N),N=1,20),(IPR(I),I=1,NIPR)
      WRITE(6,1005) (A(N),N=1,20),(IPR(I),I=1,NIPR)
      WRITE(6,1010)
      READ(5,1000) (A(N),N=1,20),DX,DT,HINIT,SODO,HEND
      WRITE(6,1000) (A(N),N=1,20),DX,DT,HINIT,SODO,HEND
      WRITE(6,1010)
      READ(5,1000) (A(N),N=1,20),TF,TS1,TL1,TS2,TL2,TFIN
      WRITE(6,1000) (A(N),N=1,20),TF,TS1,TL1,TS2,TL2,TFIN
      WRITE(6,1010)
      READ(5,1000)  (A(N),N=1,20),(B(I),I=2,M)
      WRITE(6,1000) (A(N),N=1,20),(B(I),I=2,M)
      WRITE(6,1010)
      READ(5,1000)  (A(N),N=1,20),(Z(I),I=2,M)
      WRITE(6,1000) (A(N),N=1,20),(Z(I),I=2,M)
      WRITE(6,1010)
      READ(5,1000)  (A(N),N=1,20),(CM(I),I=2,M)
      WRITE(6,1000) (A(N),N=1,20),(CM(I),I=2,M)
      WRITE(6,1010)
      READ(5,1000)  (A(N),N=1,20),(SQ(I),I=2,M)
      WRITE(6,1000) (A(N),N=1,20),(SQ(I),I=2,M)
      WRITE(6,1010)
      IF(MB.EQ.0) GO TO 10
      READ(5,1005)  (A(N),N=1,20),((IS(I),IT(I)),I=1,MB)
      WRITE(6,1005) (A(N),N=1,20),((IS(I),IT(I)),I=1,MB)
      WRITE(6,1010)
      DO 20 I=1,MB
      INU=IS(I)/2
      ITU=IT(I)
      READ(5,1000)  (A(N),N=1,20),((SQ1(INU,IJ),TSQ(INU,IJ)),IJ=1,ITU)
   20 WRITE(6,1000) (A(N),N=1,20),((SQ1(INU,IJ),TSQ(INU,IJ)),IJ=1,ITU)
   10 WRITE(6,1035)
C     INITIAL CONDITIONS
      NPAGE=1
      WRITE(6,1090) NPAGE
      N=1
      NN=2
      JJ=1
      TS=TS1
      DO 100 I=1,M
      H(1,I)=HINIT
      V(1,I)=0.0
  100 Q(1,I)=0.0
      H(1,1)=HEND
      DO 110 I=2,M
      W(I)=B(I)+2*CM(I)*H(1,I)
  110 RA(1,I)=(W(I)+B(I))*H(1,I)*0.5
      DO 120 I=3,M
  120 Q(1,I)=(RA(1,I)+RA(1,I-1))*V(1,I)*0.5
  200 DTIME=DT*(NN-1)/3600
      IF(HEND.GE.H(1,2)) GO TO 130
      H1=H(1,2)-HEND
      PU=1.5495*W(2)*(H1**1.5)
      GO TO 140
  130 PU=0.0
  140 DO 150 I=2,M
  150 SQB(I)= 0.0
      IF(MB.EQ.0) GO TO 160
      DO 170 I=1,MB
      ITU=IT(I)
      INU=IS(I)/2
      CALL HOKAN(SQ1,TSQ,DTIME,ITU,INU,SSQ,INDER)
      IF(INDER.EQ.0)  GO TO 510
  170 SQB(INU)=SSQ
  160 DO 180 I=2,M
      SQB(I)=SQB(I)+SQ(I)
      IF(I.EQ.M) GO TO 180
      IF(ABS(SQB(I)).GT.ABS(Q(1,I+1))) SQB(I)=Q(1,I+1)
  180 SQB(I)=SQB(I)/DX
      SQB(2)=SQB(2)-PU/DX
      Q(1,2)=0.0
C     CALCULATION OF WATER LEVEL
      MM=M-1
      DO 210 I=3,MM
      WB=(6*W(I)+W(I-1)+W(I+1))/8
     .H(2,I)=H(1,I)-((Q(1,I+1)-Q(1,I))/DX-SQB(I))*DT/WB
  210 IF(H(2,I).LT.0.02) H(2,I)=0.02
      WB=(3*W(2)+W(3))/4
      H(2,2)=H(1,2)-((Q(1,3)-Q(1,2))/DX-SQB(2))*DT/WB
      IF(H(2,2).LT.0.02) H(2,2)=0.0
      WB=(3*W(M)+W(M-1))/4
      H(2,M)=H(1,M)+(Q(1,M)/DX+SQB(M))*DT/WB
      IF(H(2,M).LT.0.02) H(2,M)=0.02
      DO 220 I=2,M
      W(I)=B(I)+2*CM(I)*H(2,I)
  220 RA(2,I)=(W(I)+B(I))*H(2,I)*0.5
C     CALCULATION OF VELOSITY
      V(1,2)=V(1,3)
      V(1,M+1)=V(1,M)
      DO 230 I=3,M
      F=SODO*SODO*ABS(V(1,I))*0.5/(((H(2,I)+H(2,I-1))*0.5)**(4/3))
      V(2,I)
     +      =(V(1,I)/(9.8*DT)-(V(1,I+1)**2-V(1,I-1)**2)/(4*9.8*DX)
```

PROGRAM LIST OF TIME-LAG SIMULATION (2/3)

```
     +-(Z(I)-Z(I-1))/DX-(H(2,I)-H(2,I-1))/DX-F*V(1,I))/(1/(9.8*DT)+F)
      Q(2,I)=(RA(2,I)+RA(2,I-1))*0.5*V(2,I)
  230 CONTINUE
      V(2,M+1)=V(2,M)
      Q(2,M+1)=Q(2,M)
      V(2,2)=V(2,3)
      Q(2,2)=Q(2,3)
C     PRINT OUT
      TOUT=DT*NN
      DTIME=TOUT/3600
      NN=NN+1
      T=(TF+TS*(JJ-1))*60
      IF(T.NE.TOUT) GO TO 450
      JJ=JJ+1
      MTH=DTIME
      MTM=(DTIME-MTH)*60
      MTS=TOUT-MTH*3600-MTM*60
      IF(MTS.EQ.60) MTM=MTM+1
      IF(MTS.EQ.60) MTS=0
      IF(MTM.EQ.60) MTH=MTH+1
      IF(MTM.EQ.60) MTM=0
      NJ=8
      IF(NIPR.GE.29) NJ=3
      IF(NIPR.GE.15) NJ=4
      IF(N.NE.NJ) GO TO 390
      NPAGE=NPAGE+1
      WRITE(6,1035)
      WRITE(6,1090) NPAGE
      N=1
  390 WRITE(6,1100) MTH,MTM,MTS
      N=N+1
      DO 400 I=1,NIPR
      NIU=IPR(I)/2
      V(3,NIU)=(V(2,NIU)+V(2,NIU+1))*(-0.5)
      Q(3,NIU)=V(3,NIU)*RA(2,NIU)
      WL(2,NIU)=Z(NIU)+H(2,NIU)
  400 CONTINUE
      Q(3,M)=V(2,M)*RA(2,M)*(-1.0)
      SQBP(M)=SQB(M)*DX
      IF(Q(3,M).GT.SQBP(M)) Q(3,M)=SQBP(M)
      DO 430 I=1,NIPR
      IP=IPR(I)/2
      WLP(I)=WL(2,IP)
      VP(I)=V(3,IP)
      RAP(I)=RA(2,IP)
      QP(I)=Q(3,IP)
      SQBP(I)=SQB(IP)*DX
  430 CONTINUE
      NX=NIPR
      IF(NIPR.GT.14) NX=NIPR-14
      IF(NIPR.GT.28) NX=NIPR-28
      IF(NIPR.LE.14) GO TO 410
      IF(NIPR.LE.28) GO TO 420
      CALL PROUT(IPR,WLP,VP,RAP,QP,SQBP,1,14,14)
      CALL PROUT(IPR,WLP,VP,RAP,QP,SQBP,15,28,14)
      CALL PROUT(IPR,WLP,VP,RAP,QP,SQBP,29,NIPR,NX)
      GO TO 440
  410 CALL PROUT(IPR,WLP,VP,RAP,QP,SQBP,1,NIPR,NX)
      GO TO 440
  420 CALL PROUT(IRP,WLP,VP,RAP,QP,SQBP,1,14,14)
      CALL PROUT(IPR,WLP,VP,RAP,QP,SQBP,15,NIPR,NX)
  440 TE=T/60
      IF(TE.EQ.TFIN) GO TO 500
      IF(TE.EQ.TL2) GO TO 480
      IF(TE.NE.TL1) GO TO 450
      TF=TL1
      TS=TS2
      JJ=2
      GO TO 450
  480 TF=TL2
      TS=TS1
      JJ=2
  450 DO 470 I=2,M
      H(1,I)=H(2,I)
      V(1,I+1)=V(2,I+1)
      RA(1,I)=RA(2,I)
      Q(1,I+1)=Q(2,I+1)
  470 CONTINUE
      GO TO 200
  510 WRITE(6,1080) INDER
  500 WRITE(6,1035)
 1000 FORMAT (20A4/(8F10.4))
 1005 FORMAT(20A4/(8I10))
 1010 FORMAT(///)
 1030 FORMAT(20A4)
 1035 FORMAT(1H1)
 1080 FORMAT(1H0,7X,14HERROR OF HOKAN,5X,I1)
 1090 FORMAT(102X,4HPAGE,I4)
 1100 FORMAT(1H0,6X,4HTIME,3(I3,1X))
      STOP
      END
      SUBROUTINE HOKAN(SQ1,TSQ,DTIME,ITU,INU,SSQ,INDER)
      DIMENSION  SQ1(42,10),TSQ(42,10)
      INDER=1
      I=1
   10 IF(DTIME.LT.TSQ(INU,I+1)) GO TO 20
      I=I+1
      IF(I.GT.ITU) GO TO 30
      GO TO 10
   20 SSQ=(DTIME-TSQ(INU,I))/(TSQ(INU,I+1)-TSQ(INU,I))
      SSQ=SSQ*(SQ1(INU,I+1)-SQ1(INU,I))+SQ1(INU,I)
      GO TO 40
   30 INDER=0
   40 RETURN
      END
```

```
      SUBROUTINE PROUT(IPR,WLP,VP,RAP,QP,SQBP,K1,K2,N)
      DIMENSION IPR(42),WLP(42),VP(42),RAP(42),QP(42),SQBP(42)
      IF(N.EQ.1) GO TO 10
      IF(N.EQ.2) GO TO 12
      IF(N.EQ.3) GO TO 13
      IF(N.EQ.4) GO TO 14
      IF(N.EQ.5) GO TO 15
      IF(N.EQ.6) GO TO 16
      IF(N.EQ.7) GO TO 17
      IF(N.EQ.8) GO TO 18
      IF(N.EQ.9) GO TO 19
      IF(N.EQ.10) GO TO 20
      IF(N.EQ.11) GO TO 21
      IF(N.EQ.12) GO TO 22
      IF(N.EQ.13) GO TO 23
      IF(N.EQ.14) GO TO 24
   10 WRITE(6,1010) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
   12 WRITE(6,1012) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
   13 WRITE(6,1013) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
   14 WRITE(6,1014) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
   15 WRITE(6,1015) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
   16 WRITE(6,1016) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
   17 WRITE(6,1017) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
   18 WRITE(6,1018) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
   19 WRITE(6,1019) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
   20 WRITE(6,1020) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
   21 WRITE(6,1021) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
   22 WRITE(6,1022) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
   23 WRITE(6,1023) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
   24 WRITE(6,1024) (IPR(I),I=K1,K2),(WLP(I),I=K1,K2),(VP(I),I=K1,K2),
     +(RAP(I),I=K1,K2),(QP(I),I=K1,K2),(SQBP(I),I=K1,K2)
      GO TO 30
 1010 FORMAT(1H,2HNO,3X,1I8/1H ,2H H,3X,1F8.3/1H ,2H V,3X,1F8.3/
     +1H ,2H A,3X,1F8.3/1H ,2H Q,3X,1F8.3/1H ,2HSQ,3X,1F8.3/)
 1012 FORMAT(1H,2HNO,3X,2I8/1H ,2H H,3X,2F8.3/1H ,2H V,3X,2F8.3/
     +1H ,2H A,3X,2F8.3/1H ,2H Q,3X,2F8.3/1H ,2HSQ,3X,2F8.3/)
 1013 FORMAT(1H,2HNO,3X,3I8/1H ,2H H,3X,3F8.3/1H ,2H V,3X,3F8.3/
     +1H ,2H A,3X,3F8.3/1H ,2H Q,3X,3F8.3/1H ,2HSQ,3X,3F8.3/)
 1014 FORMAT(1H ,2HNO,3X,4I8/1H ,2H H,3X,4F8.3/1H ,2H V,3X,4F8.3/
     +1H ,2H A,3X,4F8.3/1H ,2H Q,3X,4F8.3/1H ,2HSQ,3X,4F8.3/)
 1015 FORMAT(1H ,2HNO,3X,5I8/1H ,2H H,3X,5F8.3/1H ,2H V,3X,5F8.3/
     +1H ,2H A,3X,5F8.3/1H ,2H Q,3X,5F8.3/1H ,2HSQ,3X,5F8.3/)
 1016 FORMAT(1H ,2HNO,3X,6I8/1H ,2H H,3X,6F8.3/1H ,2H V,3X,6F8.3/
     +1H ,2H A,3X,6F8.3/1H ,2H Q,3X,6F8.3/1H ,2HSQ,3X,6F8.3/)
 1017 FORMAT(1H ,2HNO,3X,7I8/1H ,2H H,3X,7F8.3/1H ,2H V,3X,7F8.3/
     +1H ,2H A,3X,7F8.3/1H ,2H Q,3X,7F8.3/1H ,2HSQ,3X,7F8.3/)
 1018 FORMAT(1H ,2HNO,3X,8I8/1H ,2H H,3X,8F8.3/1H ,2H V,3X,8F8.3/
     +1H ,2H A,3X,8F8.3/1H ,2H Q,3X,8F8.3/1H ,2HSQ,3X,8F8.3/)
 1019 FORMAT(1H ,2HNO,3X,9I8/1H ,2H H,3X,9F8.3/1H ,2H V,3X,9F8.3/
     +1H ,2H A,3X,9F8.3/1H ,2H Q,3X,9F8.3/1H ,2HSQ,3X,9F8.3/)
 1020 FORMAT(1H ,2HNO,3X,10I8/1H ,2H H,3X,10F8.3/1H ,2H V,3X,10F8.3/
     +1H ,2H A,3X,10F8.3/1H ,2H Q,3X,10F8.3/1H ,2HSQ,3X,10F8.3/)
 1021 FORMAT(1H ,2HNO,3X,11I8/1H ,2H H,3X,11F8.3/1H ,2H V,3X,11F8.3/
     +1H ,2H A,3X,11F8.3/1H ,2H Q,3X,11F8.3/1H ,2HSQ,3X,11F8.3/)
 1022 FORMAT(1H ,2HNO,3X,12I8/1H ,2H H,3X,12F8.3/1H ,2H V,3X,12F8.3/
     +1H ,2H A,3X,12F8.3/1H ,2H Q,3X,12F8.3/1H ,2HSQ,3X,12F8.3/)
 1023 FORMAT(1H ,2HNO,3X,13I8/1H ,2H H,3X,13F8.3/1H ,2H V,3X,13F8.3/
     +1H ,2H A,3X,13F8.3/1H ,2H Q,3X,13F8.3/1H ,2HSQ,3X,13F8.3/)
 1024 FORMAT(1H ,2HNO,3X,14I8/1H ,2H H,3X,14F8.3/1H ,2H V,3X,14F8.3/
     +1H ,2H A,3X,14F8.3/1H ,2H Q,3X,14F8.3/1H ,2HSQ,3X,14F8.3/)
   30 RETURN
      END
```