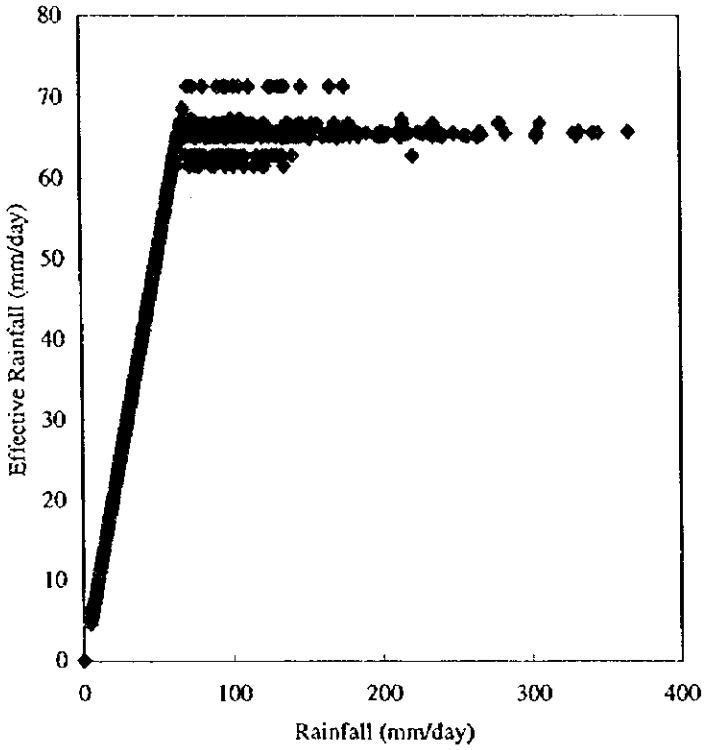
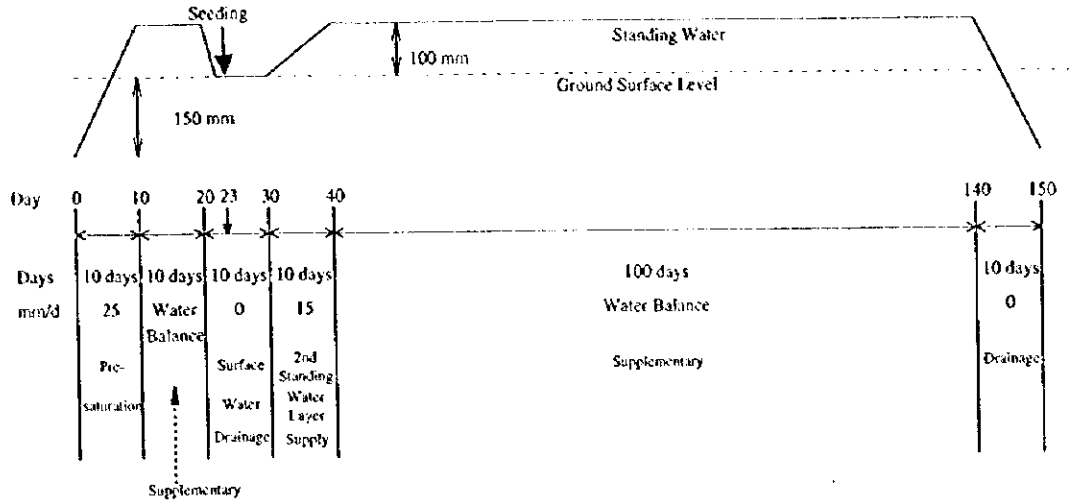


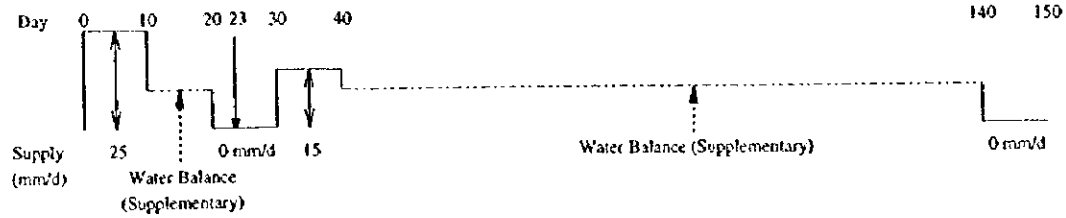
Fig. I-17 10days Effective Rainfall

Pulau Pinang Scheme,
Sungai Muda Sub-Scheme, Block M1

(1) Water Level in the Paddy



(2) Daily Water Supply



(3) Crop Coefficient

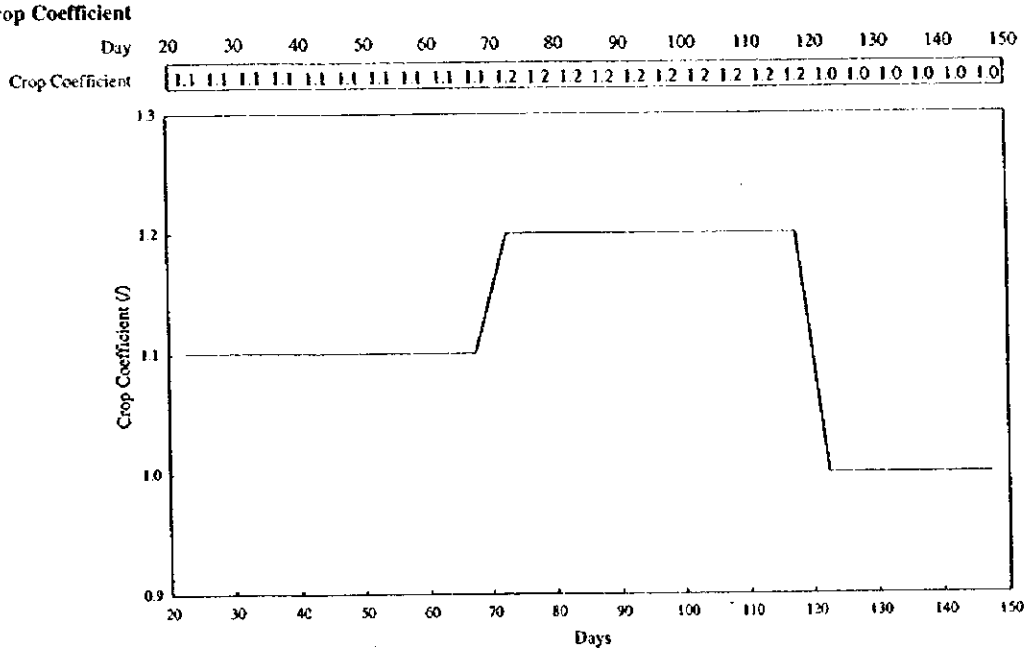
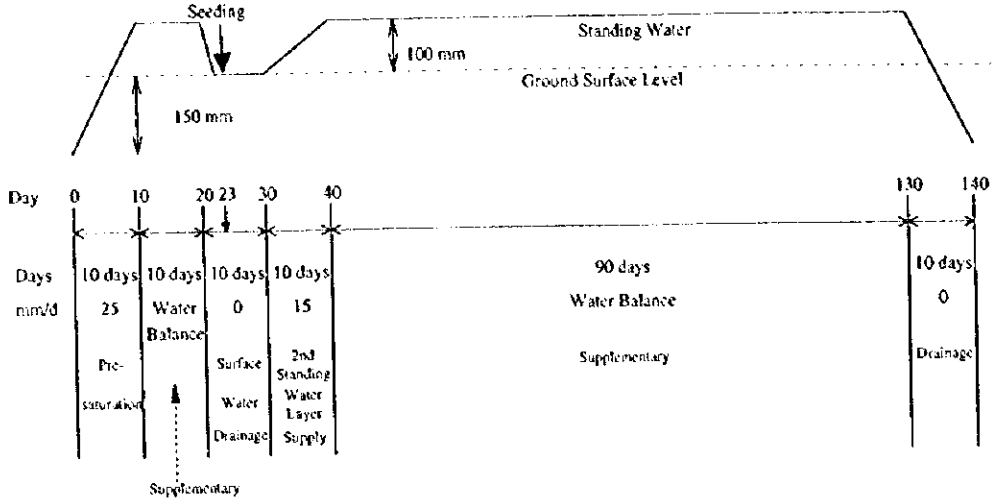
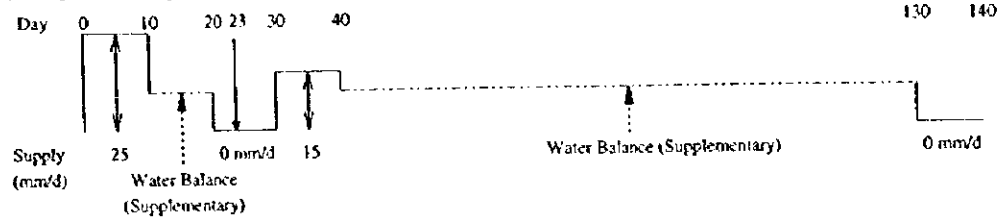


Fig. I-18 Irrigation Supply Pattern Used for Water Balance Study (10 Days Basis) (Wet Direct Seeding Method <Growth Period 130 Days>)

(1) Water Level in the Paddy



(2) Daily Water Supply



(3) Crop Coefficient

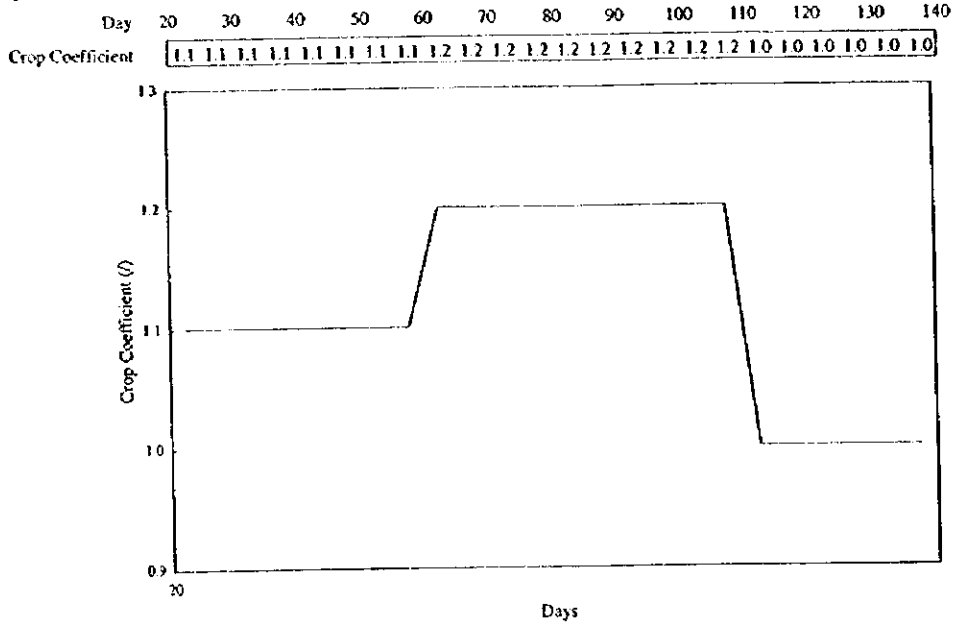
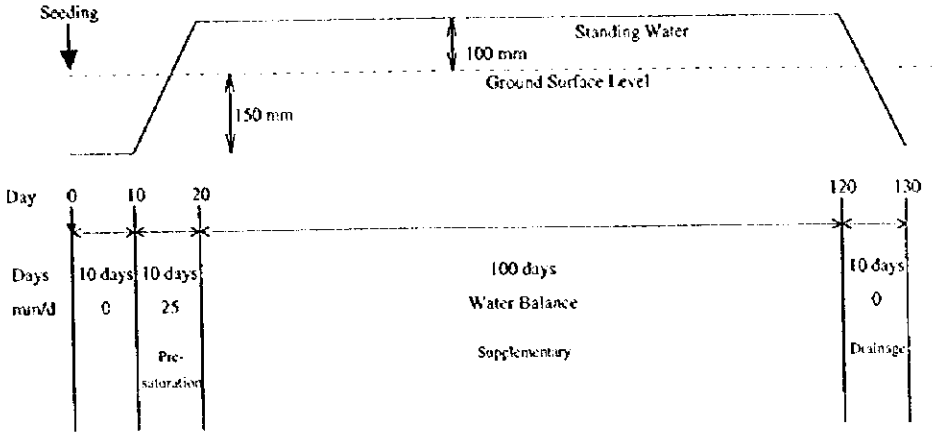
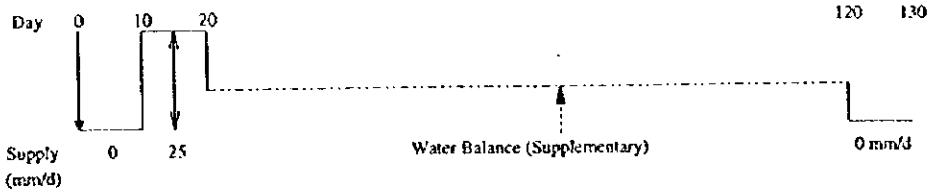


Fig. I-19 Irrigation Supply Pattern Used for Water Balance Study (10 Days Basis) (Wet Direct Seeding Method <Growth Period 120 Days>)

(1) Water Level in the Paddy



(2) Daily Water Supply



(3) Crop Coefficient

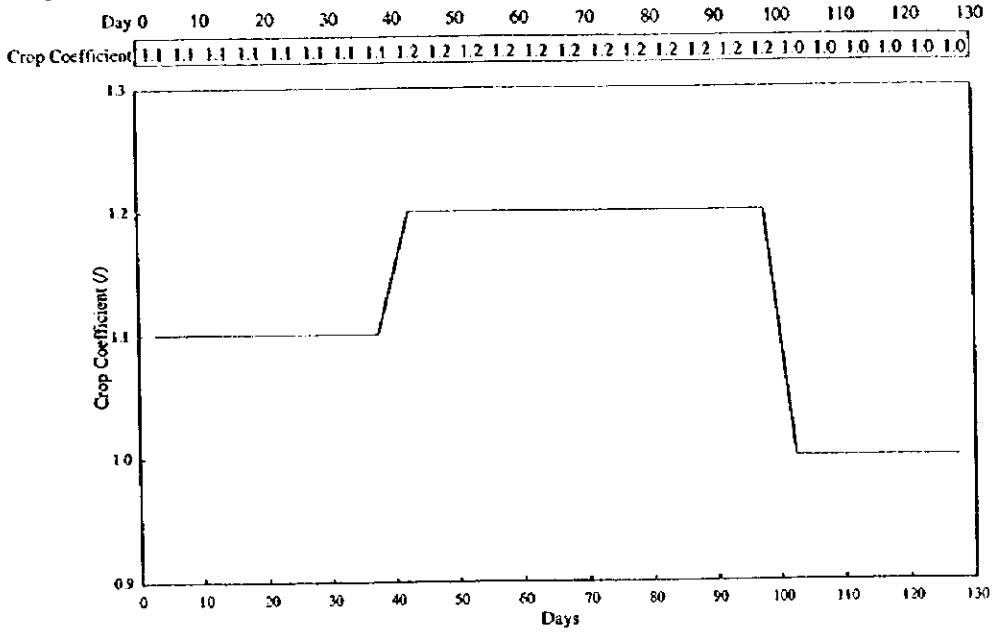
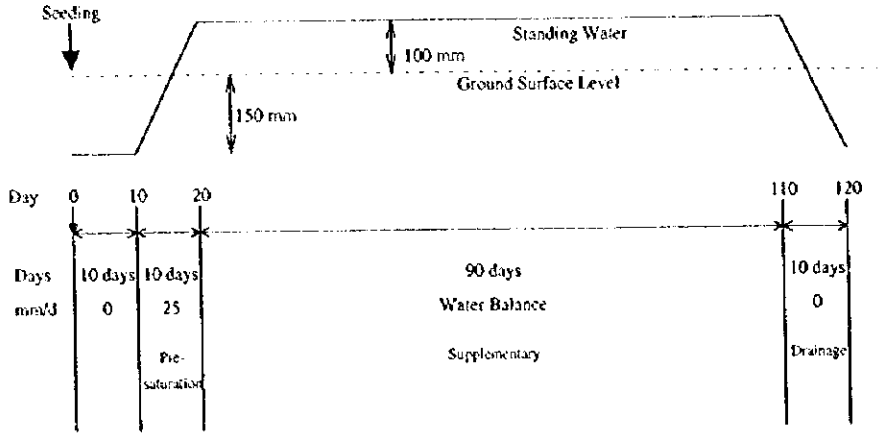
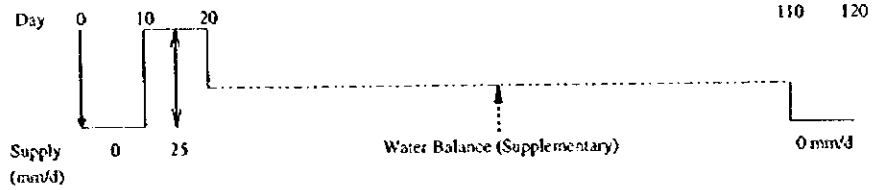


Fig. I-20 Irrigation Supply Pattern Used for Water Balance Study (10 Days Basis) (Dry Direct Seeding Method <Growth Period 130 Days>)

(1) Water Level in the Paddy



(2) Daily Water Supply



(3) Crop Coefficient

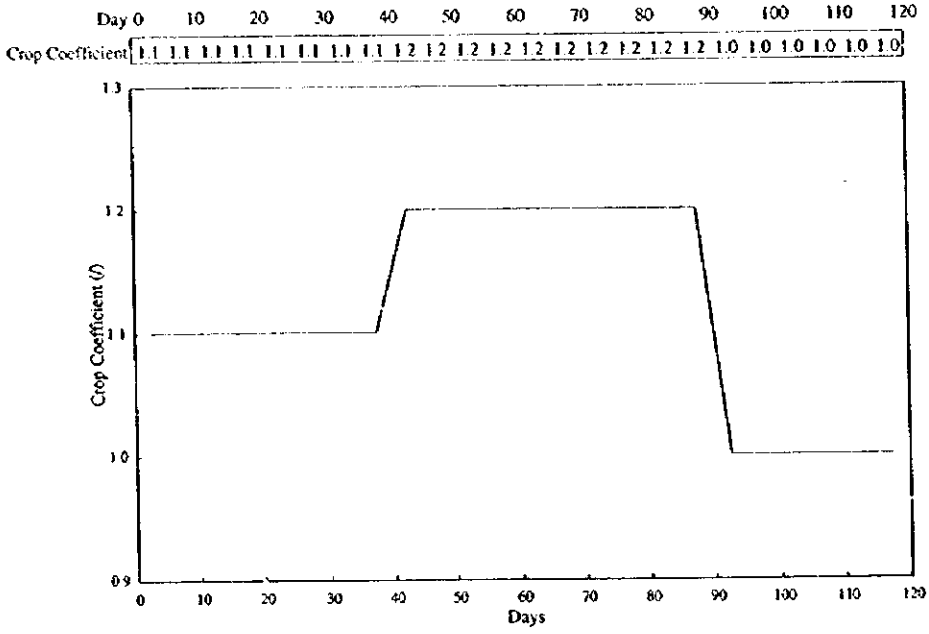
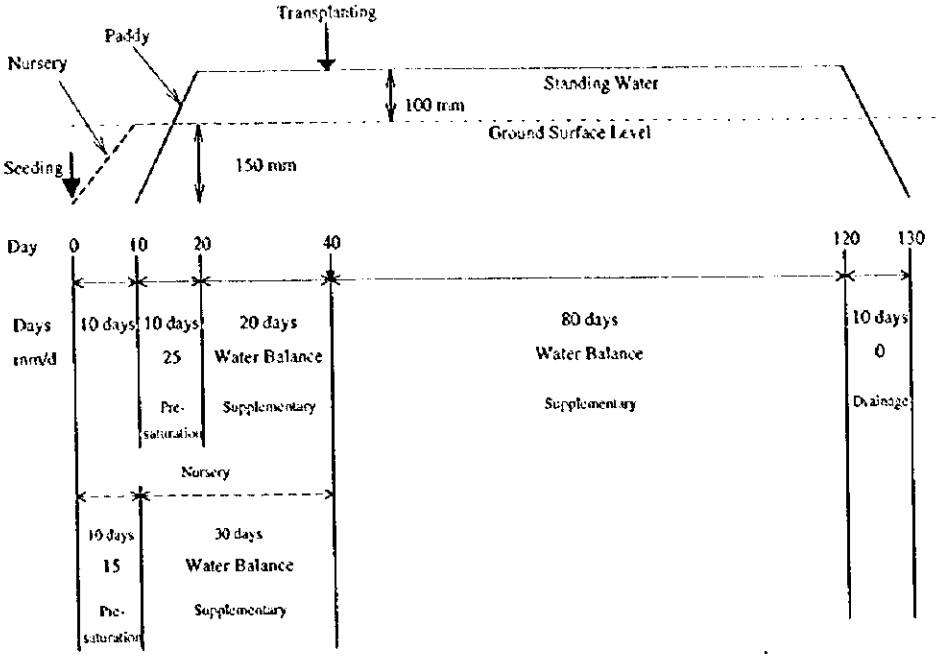
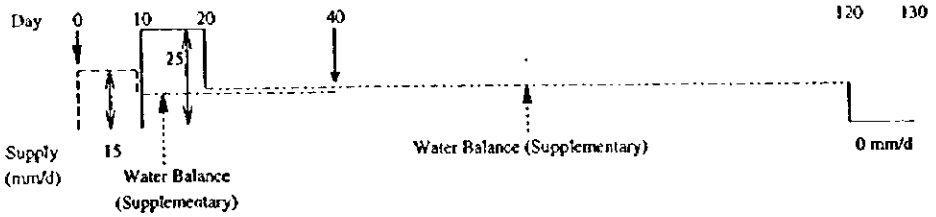


Fig. I-21 Irrigation Supply Pattern Used for Water Balance Study (10 Days Basis) (Dry Direct Seeding Method <Growth Period 120 Days>)

(1) Water Level in the Paddy



(2) Daily Water Supply



(3) Crop Coefficient

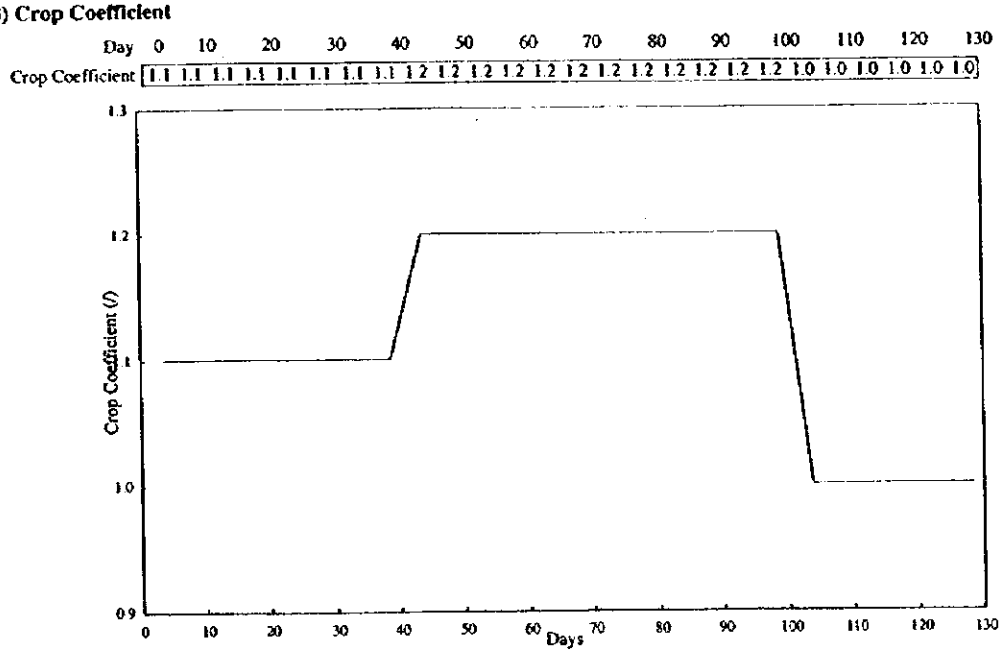


Fig. I-22 Irrigation Supply Pattern Used for Water Balance Study (10 Days Basis) (Transplanting Method)

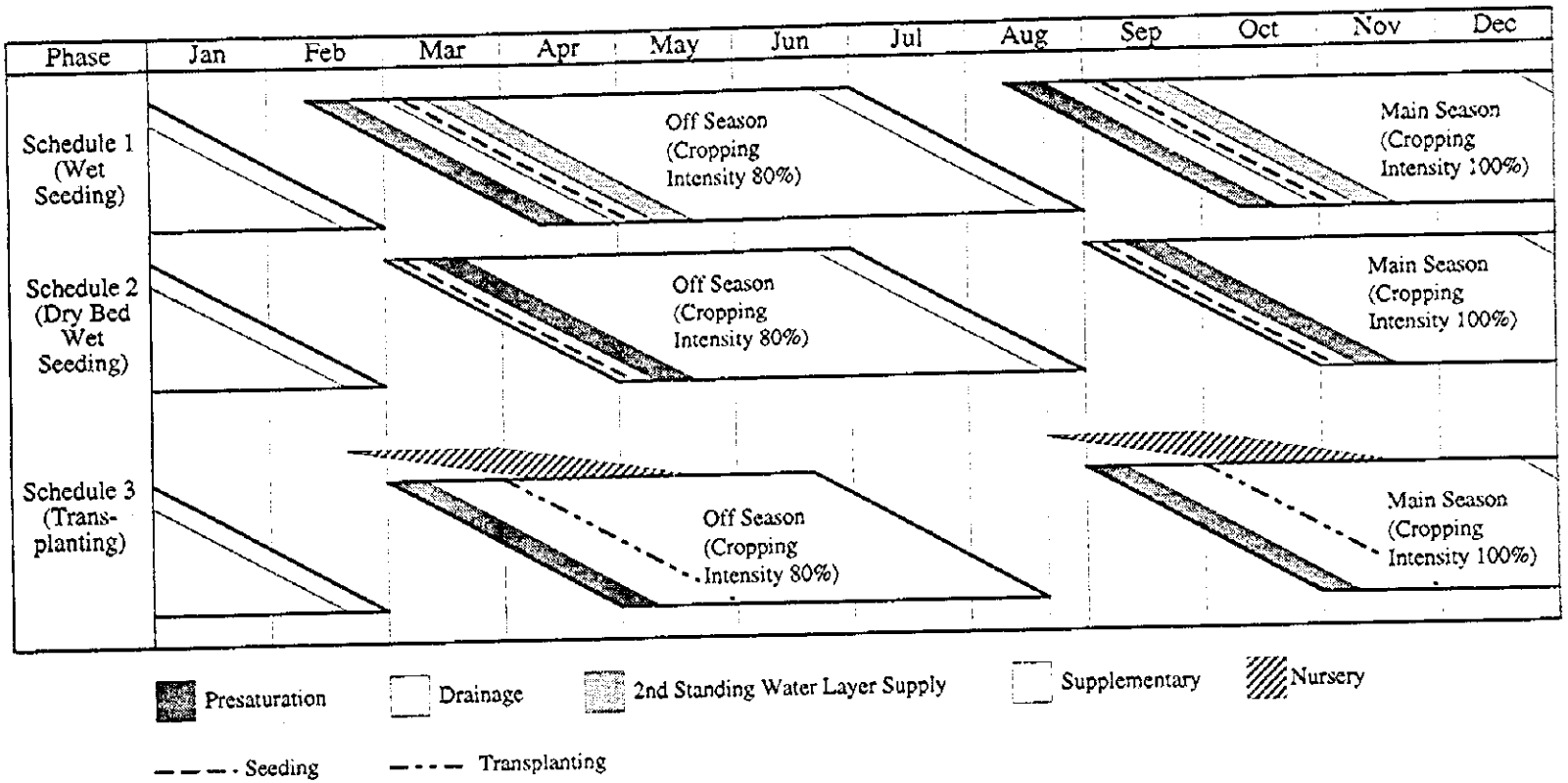


Fig. I-23 Present Cropping Schedule Used for Water Balance Study (10 Days Basis) (Kerian-Compartment A-F)

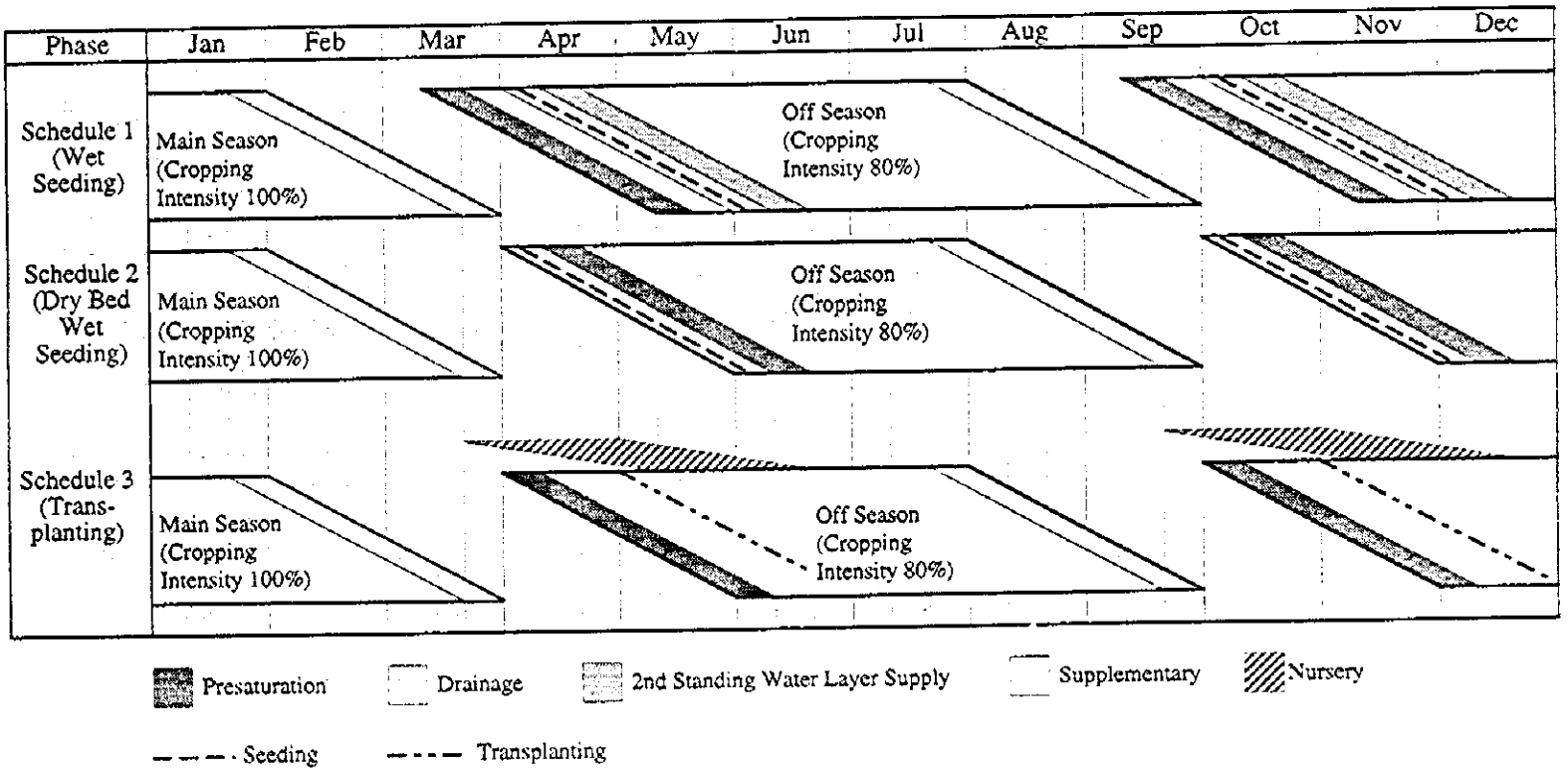


Fig. I-24 Present Cropping Schedule Used for Water Balance Study (10 Days Basis) (Kerian-Compartment G,H)

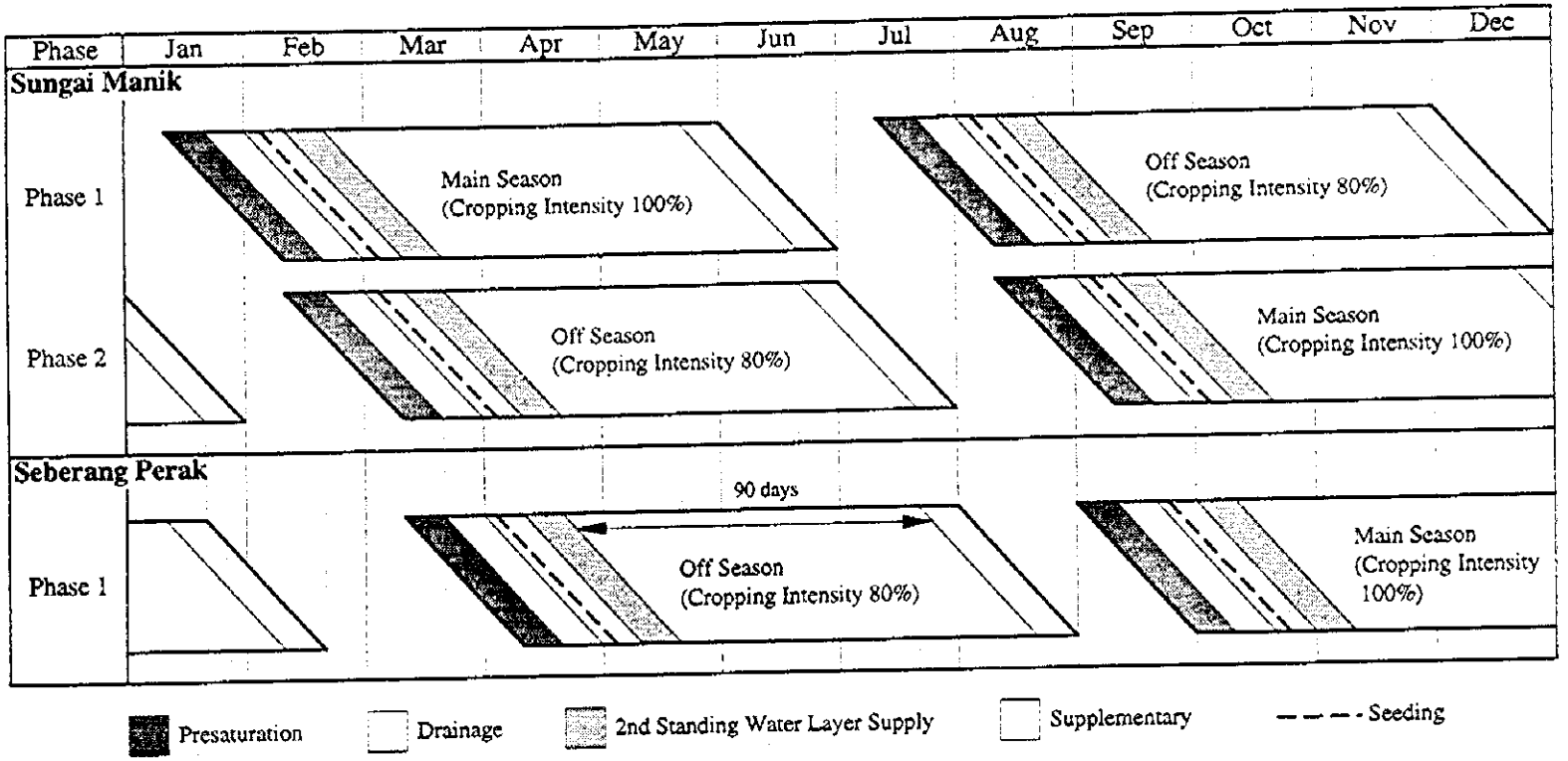


Fig. I-25 Present Cropping Schedule Used for Water Balance Study (10 Days Basis) (Sungai Manik, Seberang Perak)

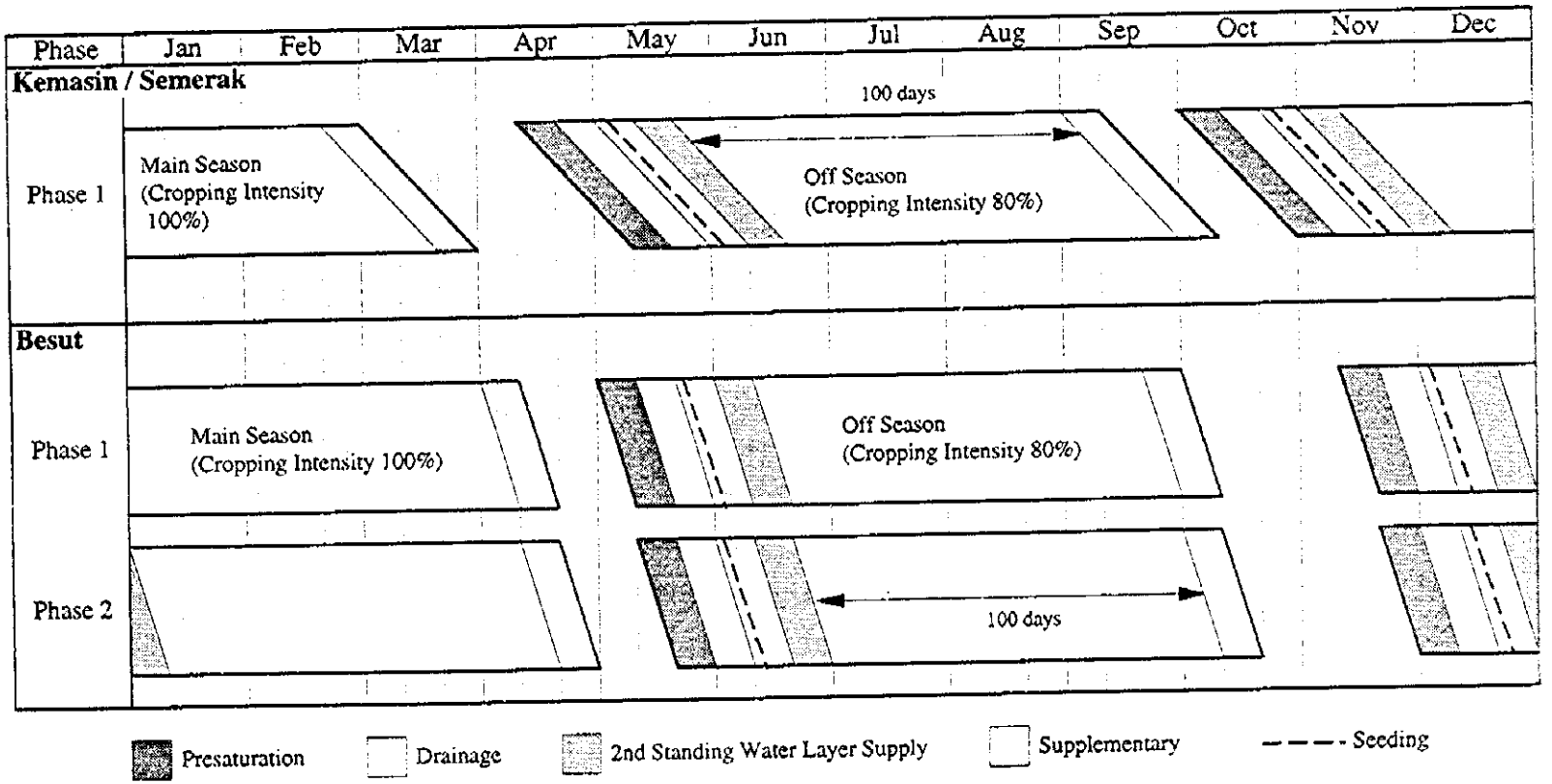


Fig. I-26 Present Cropping Schedule Used for Water Balance Study (10 Days Basis) (Kemasin / Semerak, Besut)

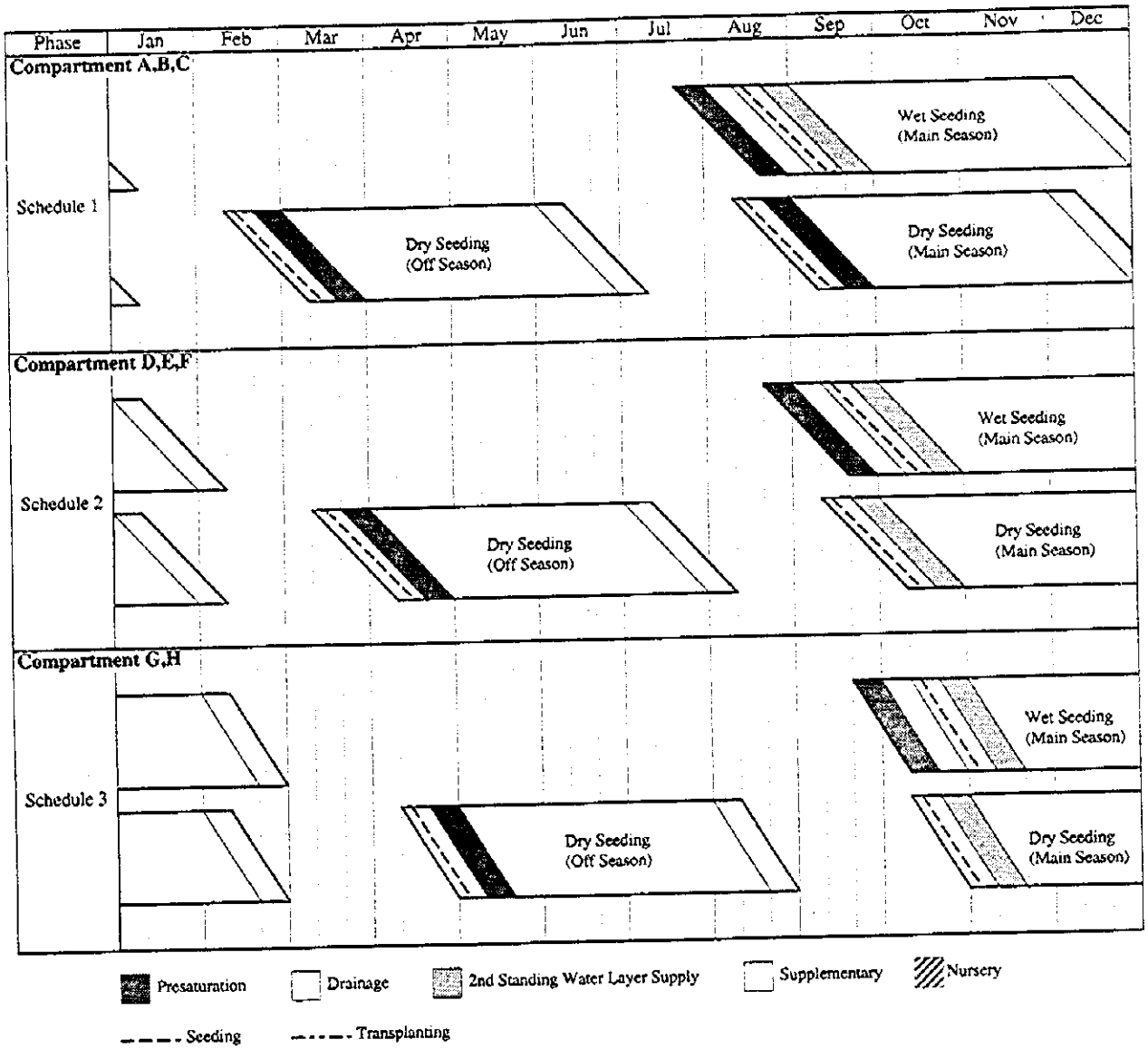


Fig. I-27 Proposed Cropping Schedule Used for Water Balance Study (10 Days Basis) (Kerian)

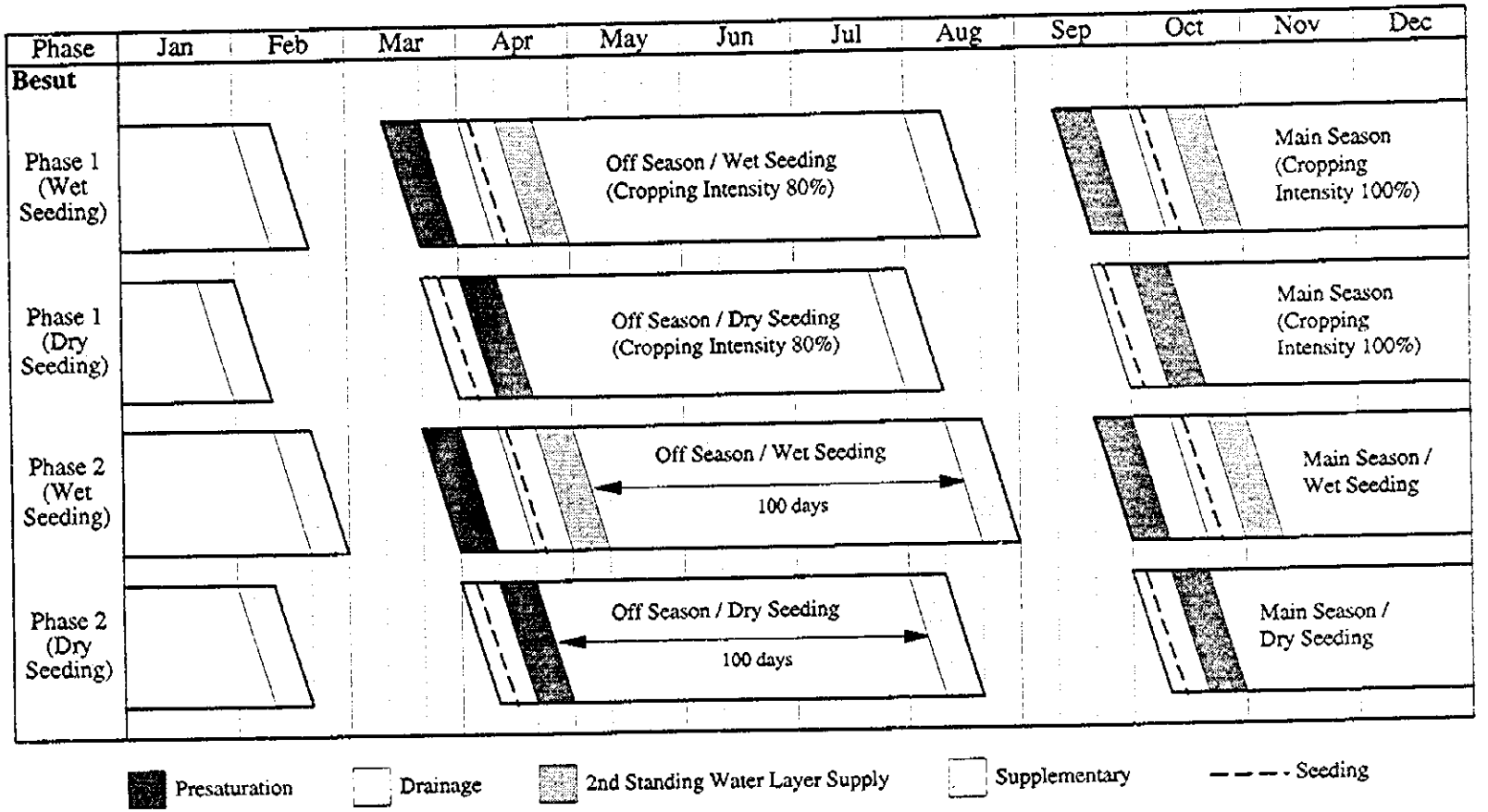


Fig. I-28 Proposed Cropping Schedule Used for Water Balance Study (10 Days Basis) (Besut)

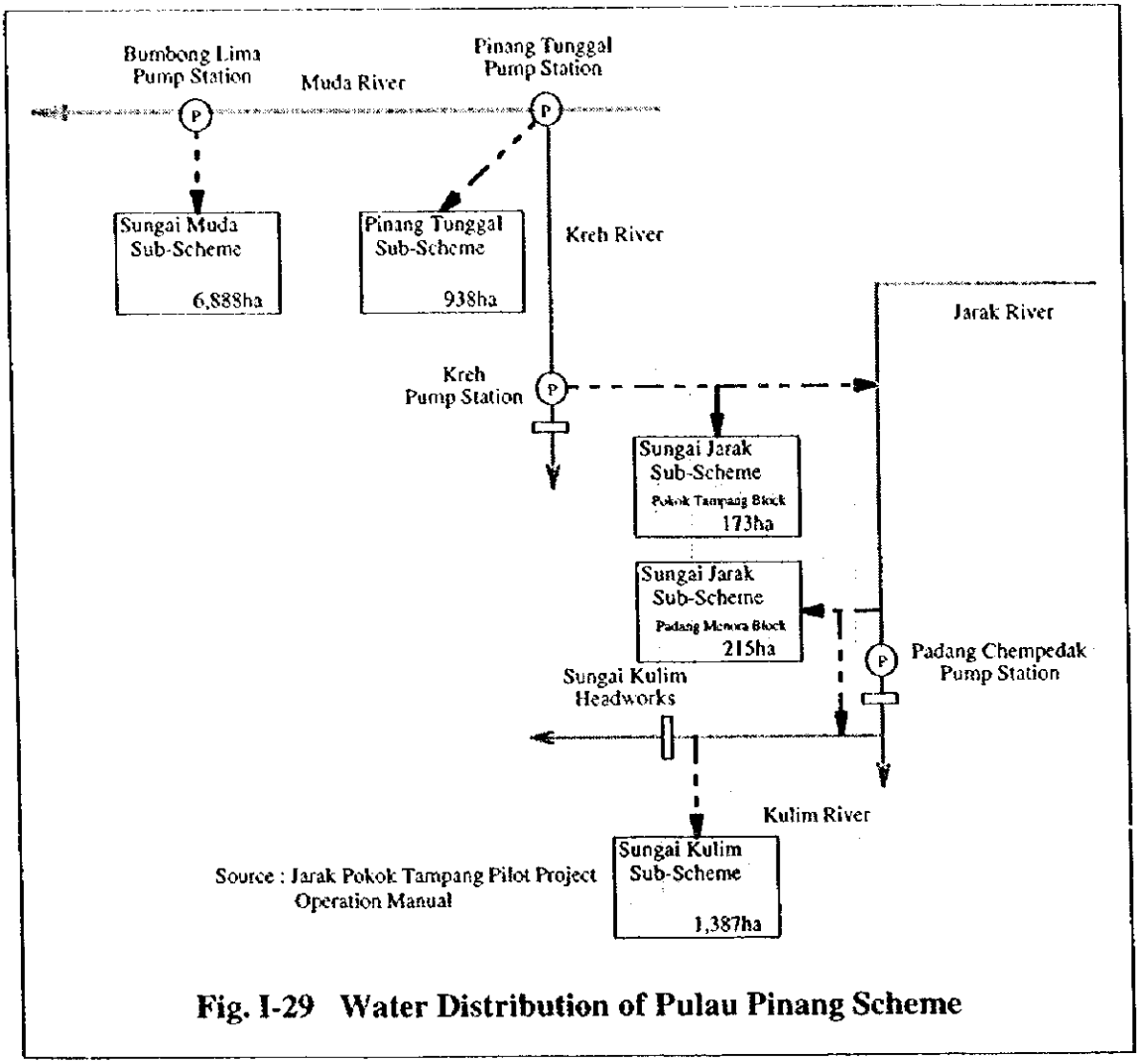


Fig. I-29 Water Distribution of Pulau Pinang Scheme

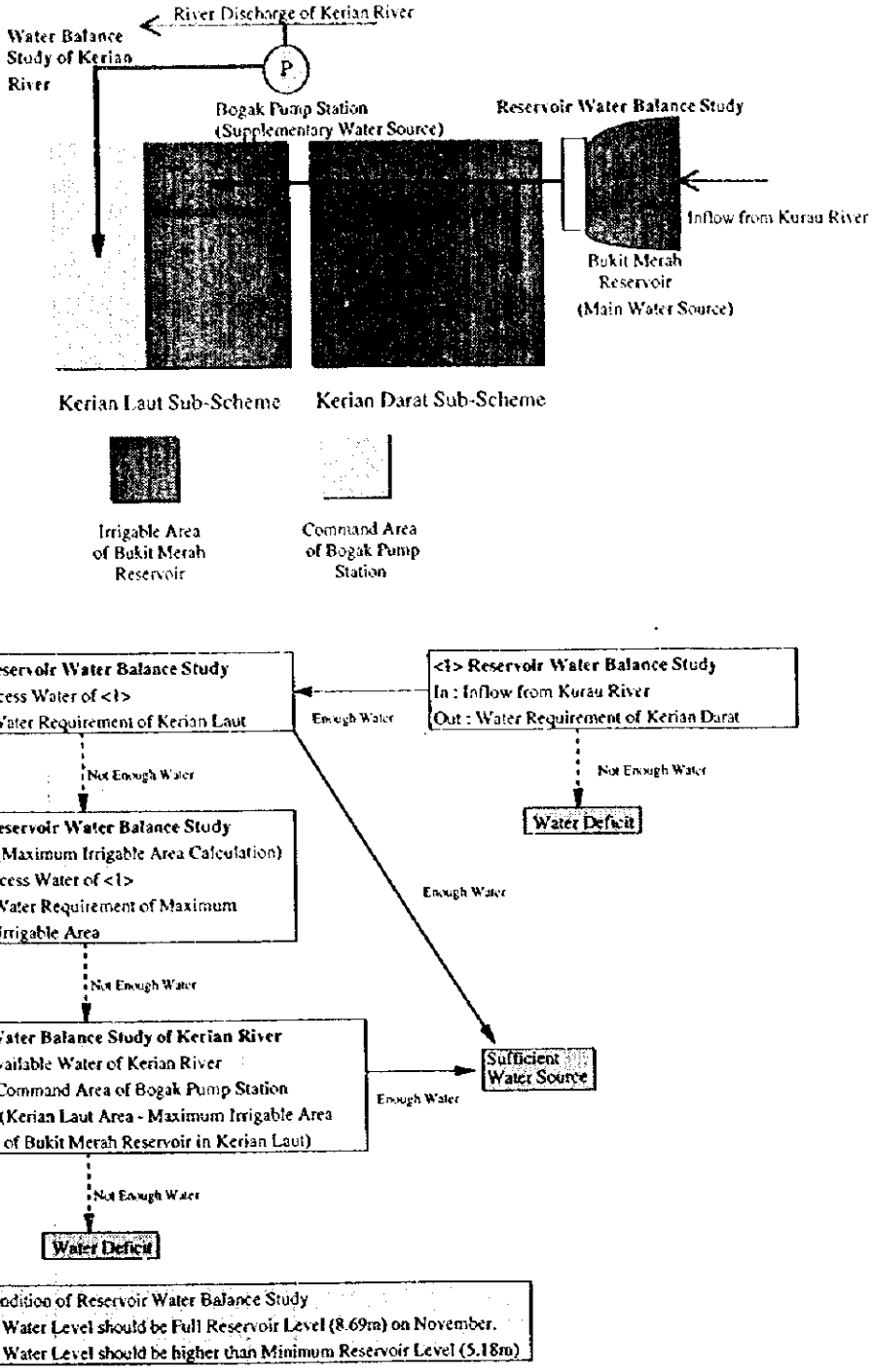


Fig. I-30 Water Balance Model of Kerian Scheme

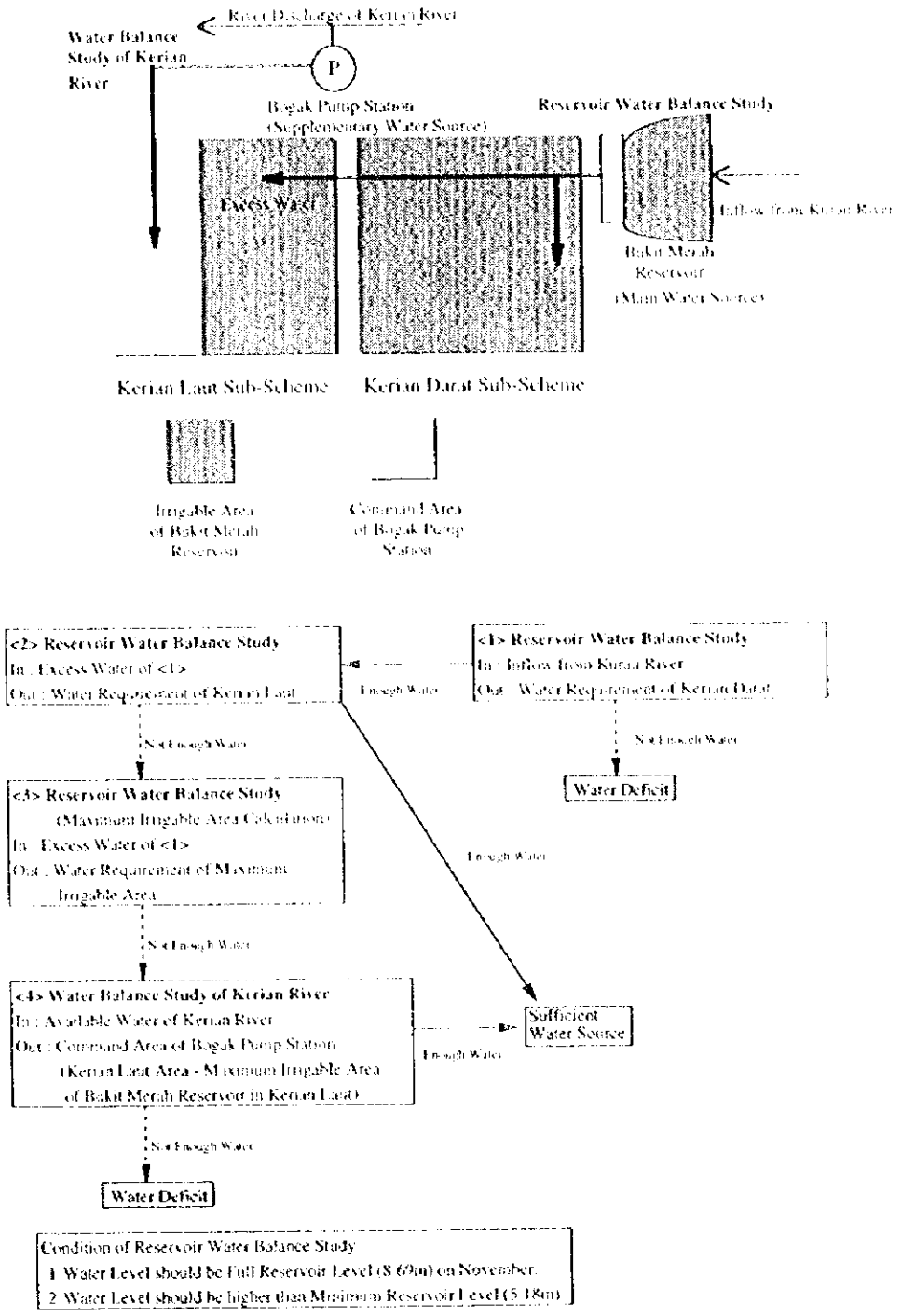
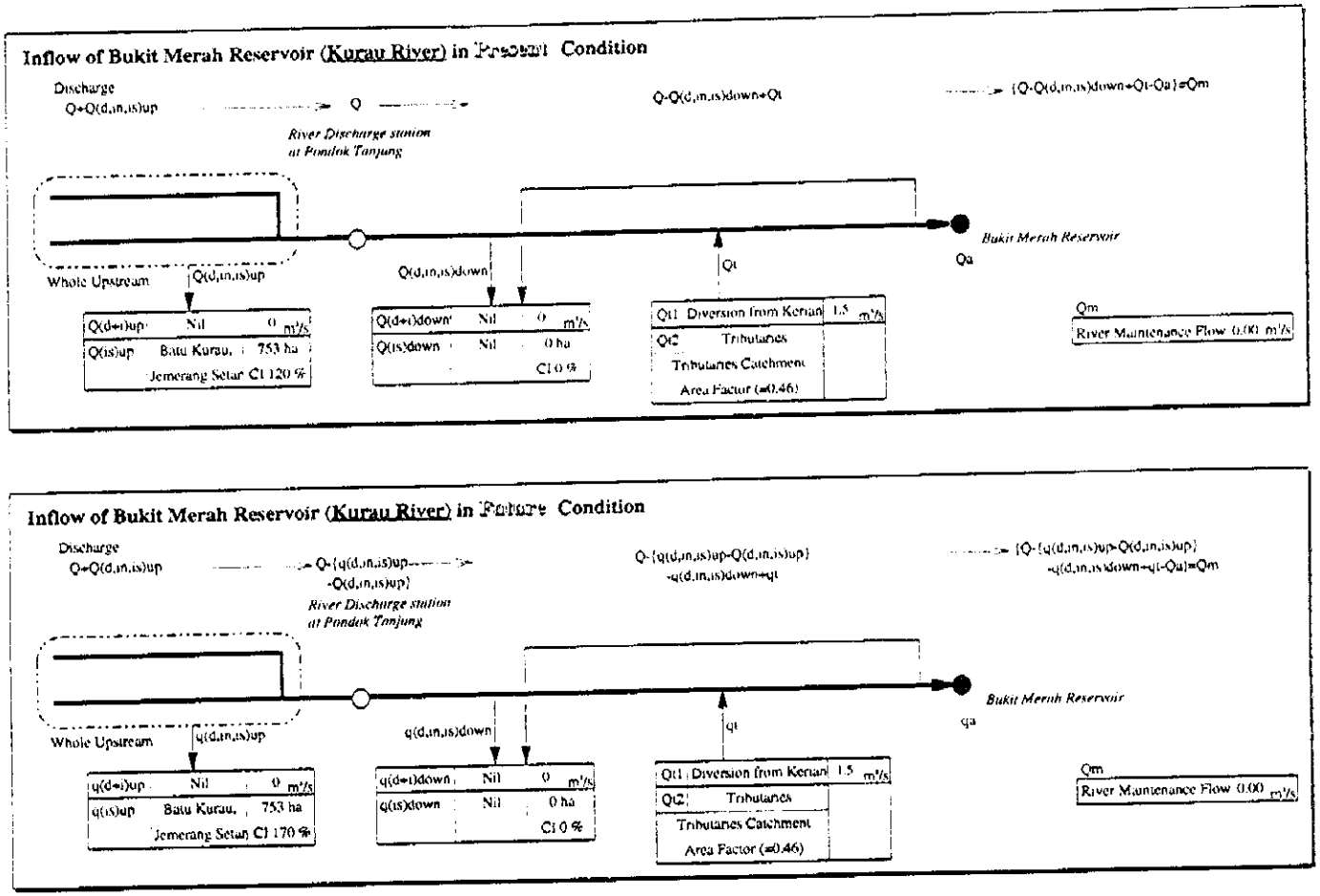
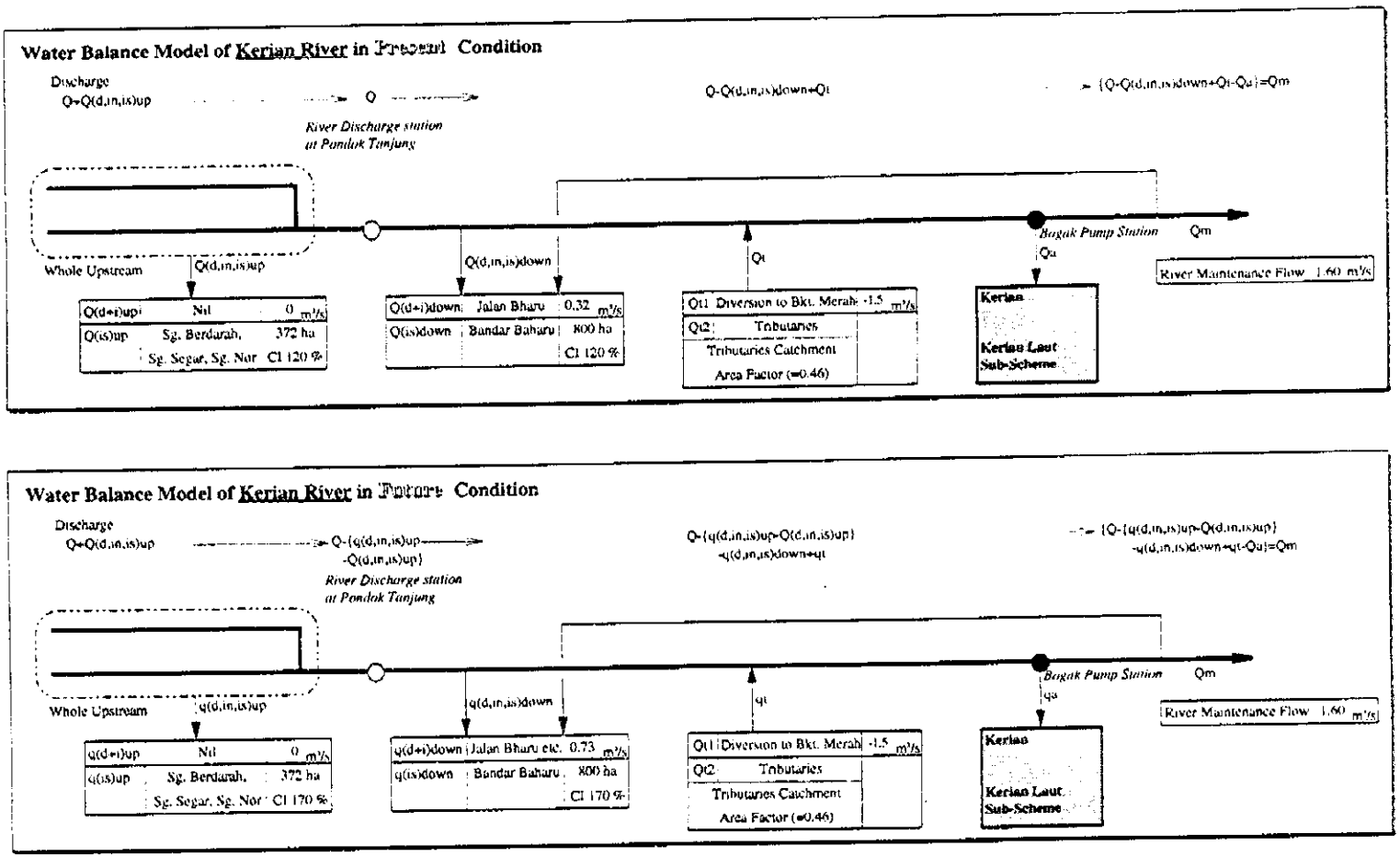


Fig. I-30 Water Balance Model of Kerian Scheme



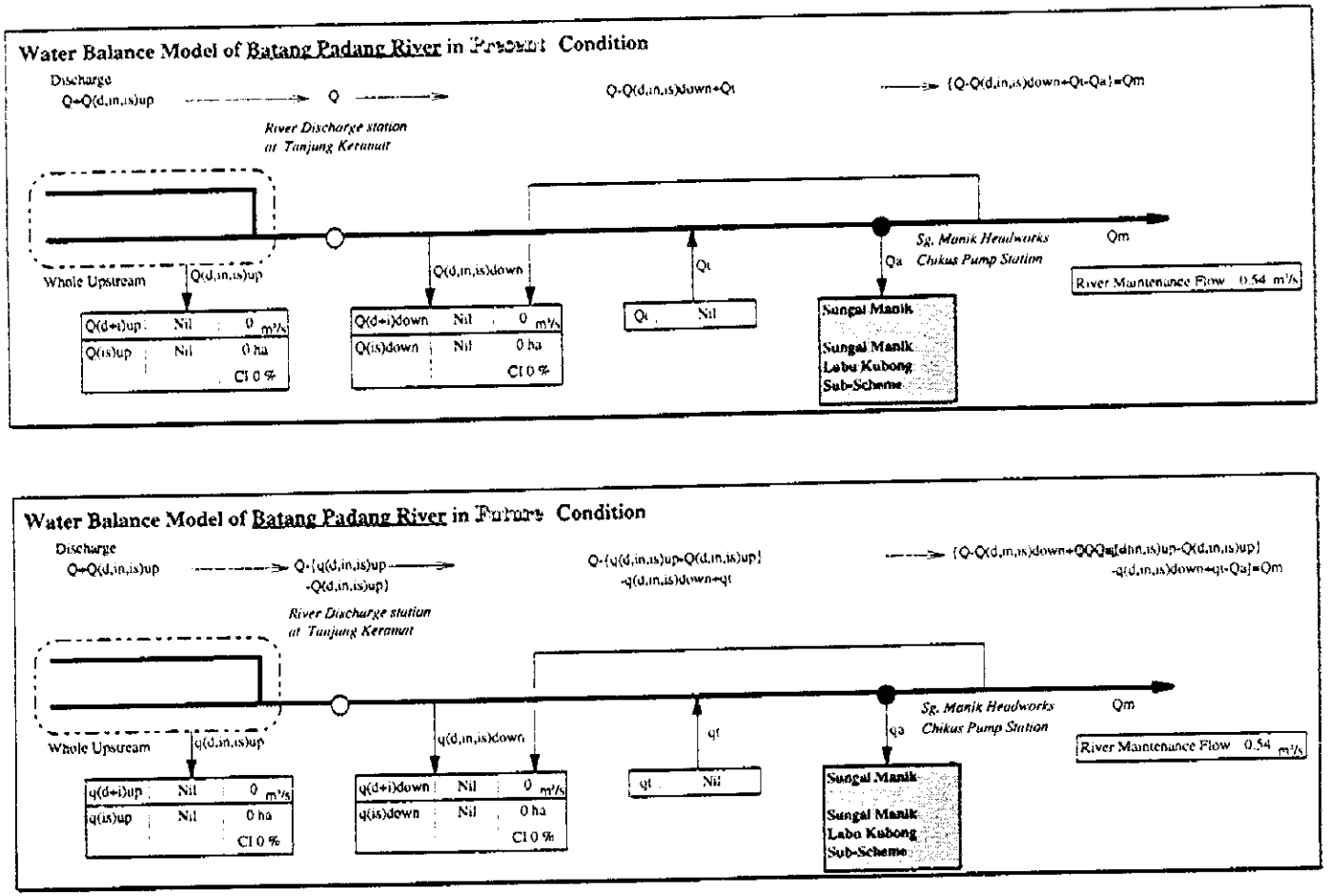
Note
- Q(d) : Domestic Water
- Q(in) : Industrial Water
- Q(is) : Irrigation Water for Secondary Granary Areas
- Qm : River Maintenance Flow
- Qt : Inflow from Major Tributaries (between Discharge Station and Intake Point of the Study Area)
- Qa : Available Water for Study Area (Main Granary Area)
- Q : Present Measured Discharge at River Discharge Station
- q : Discharge or Water Demand in Future Condition
- Qup : Water Taken from Upstream of River Discharge Station
- Qdown : Water Taken from Downstream of River Discharge Station

Fig. I-31 Water Balance Model (Inflow of Bukit Merah Reservoir) of Kurau River



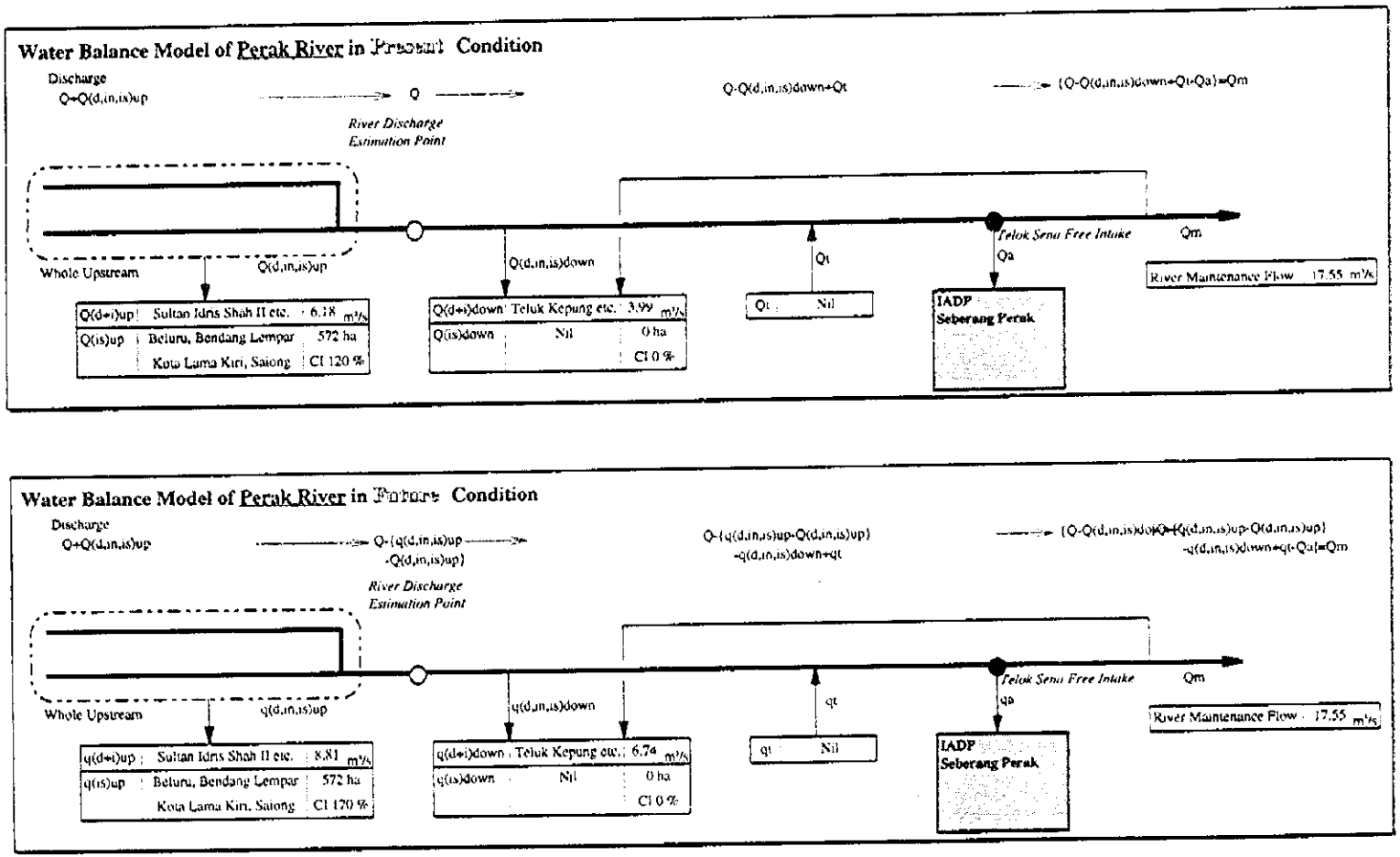
Note
- Q(d) : Domestic Water
- Q(in) : Industrial Water
- Q(is) : Irrigation Water for Secondary Granary Areas
- Qm : River Maintenance Flow
- Qt : Inflow from Major Tributaries (between Discharge Station and Intake Point of the Study Area)
- Qu : Available Water for Study Area (Main Granary Area)
- Q : Present Measured Discharge at River Discharge Station
- q : Discharge or Water Demand in Future Condition
- Qup : Water Taken from Upstream of River Discharge Station
- Qdown : Water Taken from Downstream of River Discharge Station

Fig. I-32 Water Balance Model of Kerian River



Note
- Q(d) : Domestic Water
- Q(in) : Industrial Water
- Q(is) : Irrigation Water for Secondary Granary Areas
- Qm : River Maintenance Flow
- Qt : Inflow from Major Tributaries (between Discharge Station and Intake Point of the Study Area)
- Qa : Available Water for Study Area (Main Granary Area)
- Q : Present Measured Discharge at River Discharge Station
- q : Discharge or Water Demand in Future Condition
- Qup : Water Taken from Upstream of River Discharge Station
- Qdown : Water Taken from Downstream of River Discharge Station

Fig. I-33 Water Balance Model of Batang Padang River



Note
- Q(d) : Domestic Water
- Q(in) : Industrial Water
- Q(is) : Irrigation Water for Secondary Granary Areas
- Qm : River Maintenance Flow
- Qt : Inflow from Major Tributaries (between Discharge Station and Intake Point of the Study Area)
- Qa : Available Water for Study Area (Main Granary Area)
- Q : Present Measured Discharge at River Discharge Station
- Q : Discharge or Water Demand in Present Condition
- q : Discharge or Water Demand in Future Condition
- Qup : Water Taken from Upstream of River Discharge Station
- Qdown : Water Taken from Downstream of River Discharge Station

Fig. I-34 Water Balance Model of Perak River

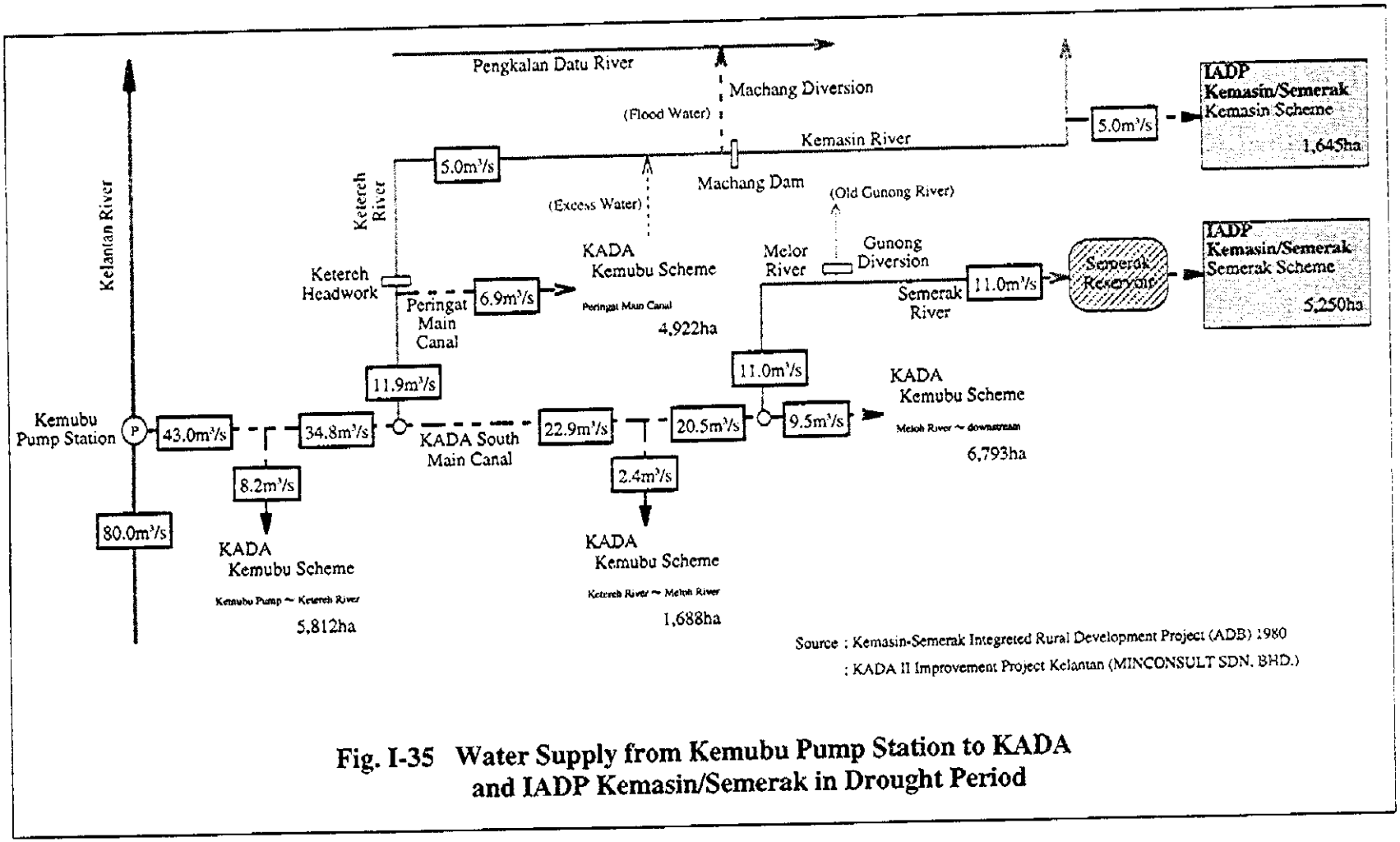
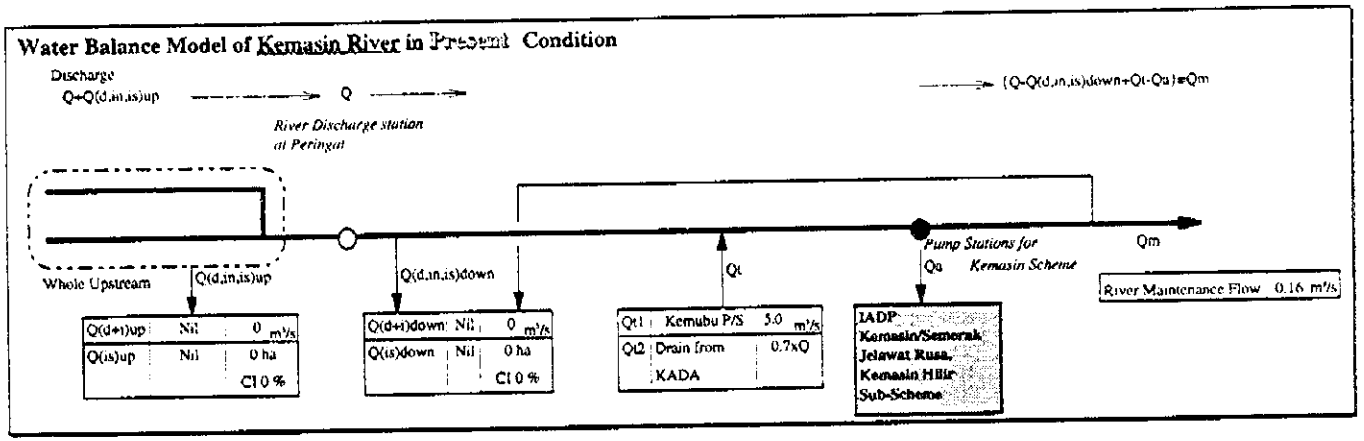
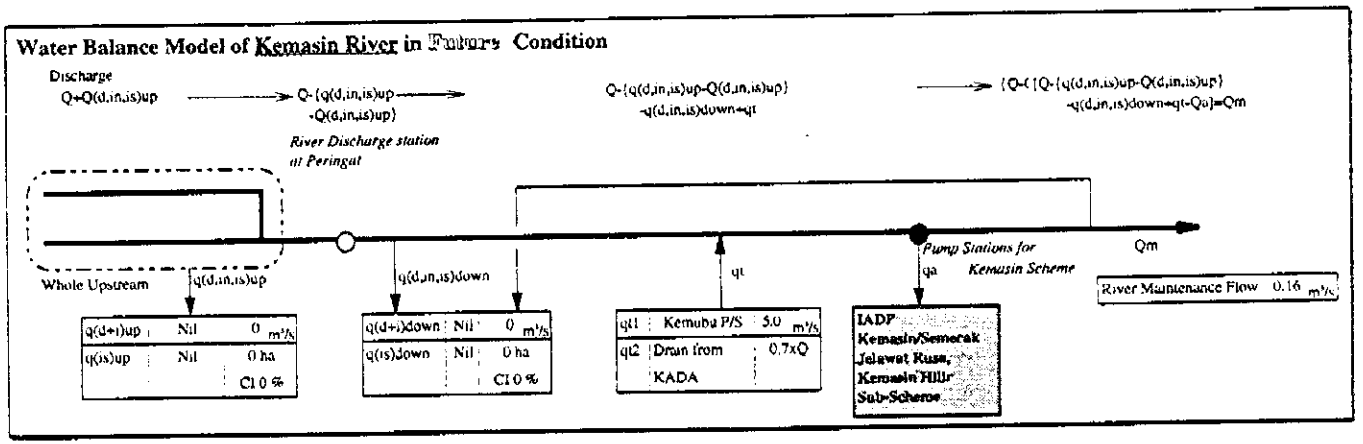


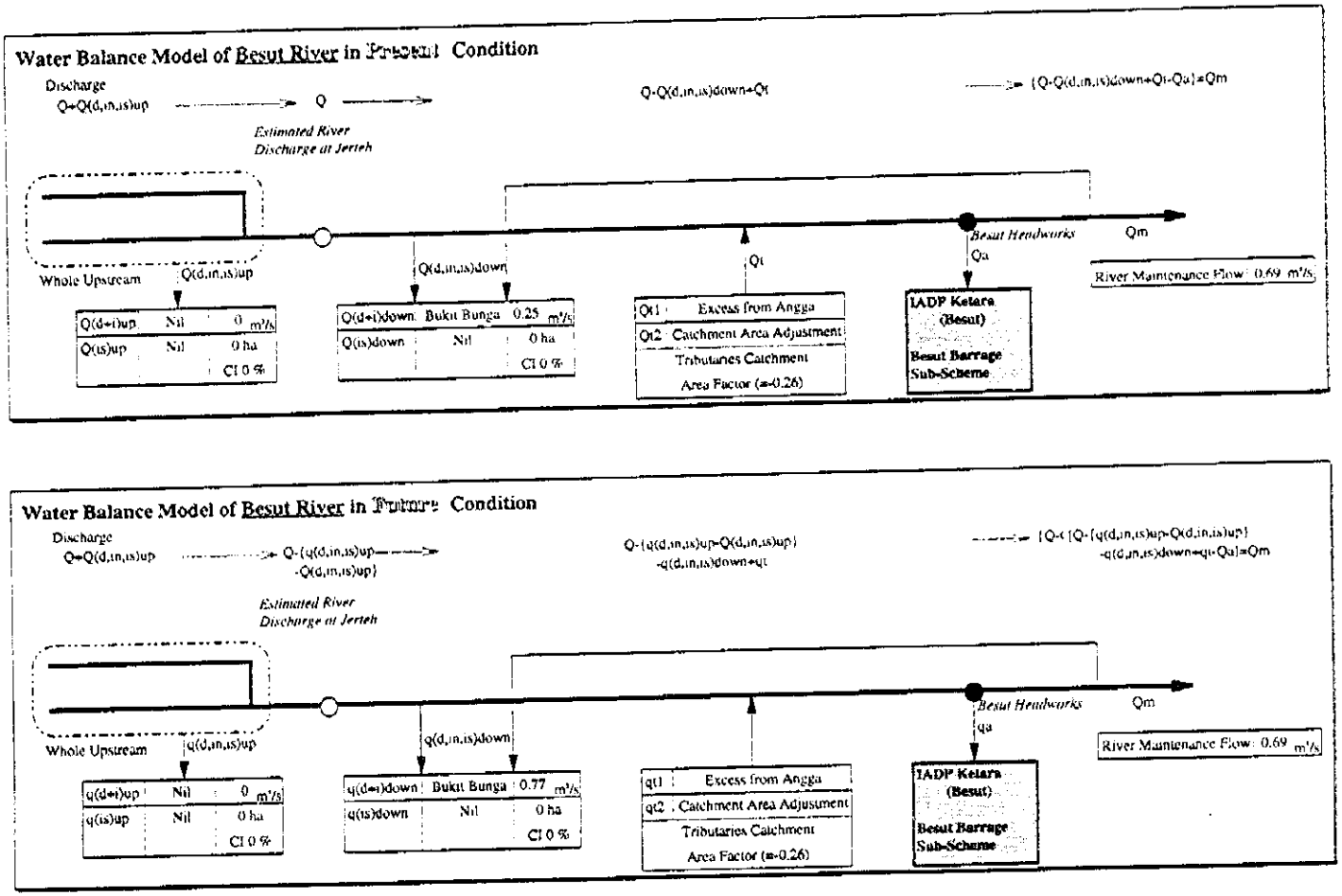
Fig. I-35 Water Supply from Kemubu Pump Station to KADA and IADP Kemasin/Semerak in Drought Period





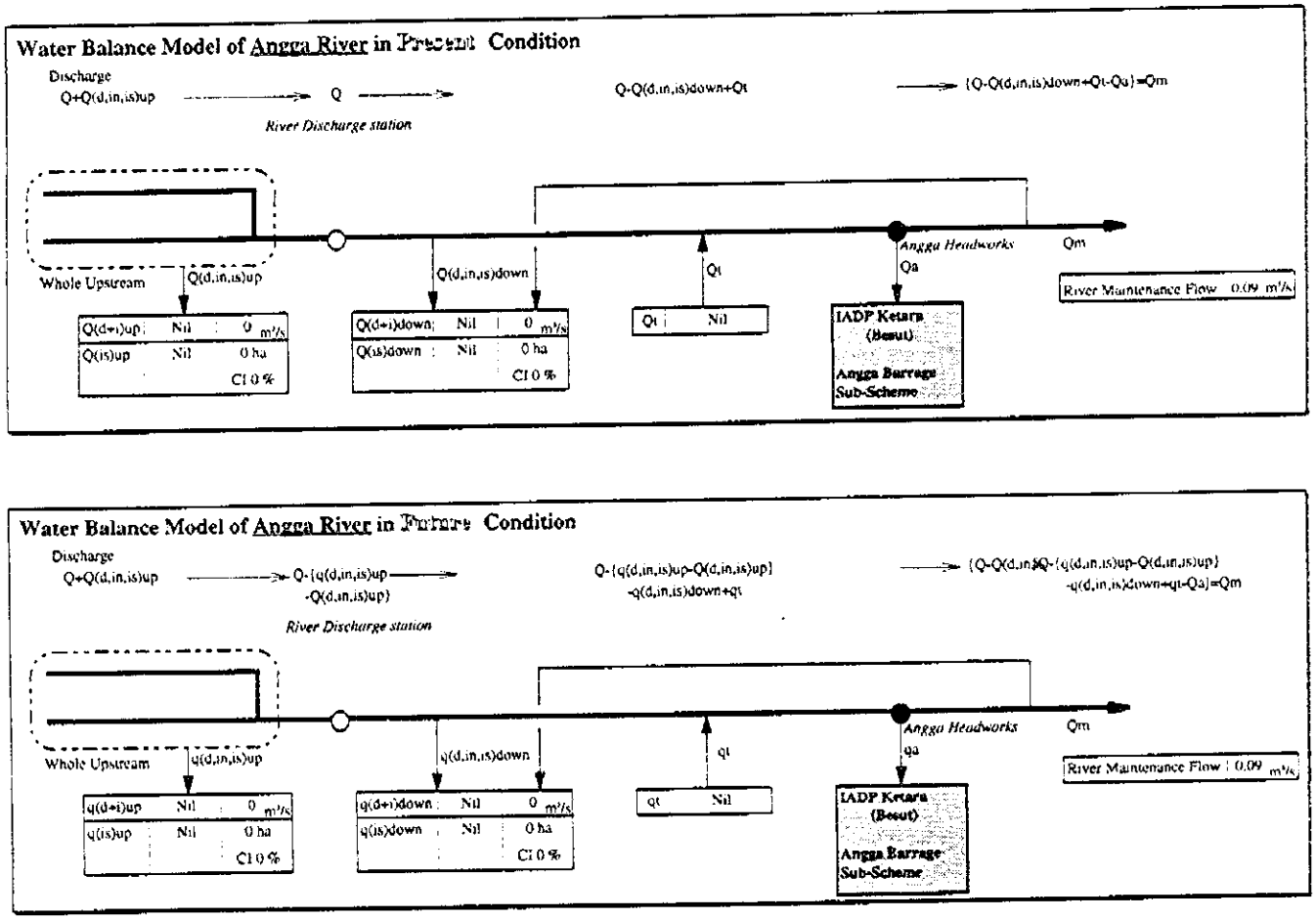
Note
- Q(d) : Domestic Water
- Q(in) : Industrial Water
- Q(is) : Irrigation Water for Secondary Granary Areas
- Qm : River Maintenance Flow
- Qt : Inflow from Major Tributaries (between Discharge Station and Intake Point of the Study Area)
- Qa : Available Water for Study Area (Main Granary Area)
- Q : Present Measured Discharge at River Discharge Station
- q : Discharge or Water Demand in Future Condition
- Qup : Water Taken from Upstream of River Discharge Station
- Qdown : Water Taken from Downstream of River Discharge Station

Fig. I-36 Water Balance Model of Kemasin River



Note
- Q(d) : Domestic Water
- Q(in) : Industrial Water
- Q(is) : Irrigation Water for Secondary Granary Areas
- Qm : River Maintenance Flow
- Qt : Inflow from Major Tributaries (between Discharge Station and Intake Point of the Study Area)
- Qa : Available Water for Study Area (Main Granary Area)
- Q : Present Measured Discharge at River Discharge Station
- Q : Discharge or Water Demand in Present Condition
- q : Discharge or Water Demand in Future Condition
- Qup : Water Taken from Upstream of River Discharge Station
- Qdown : Water Taken from Downstream of River Discharge Station

Fig. I-37 Water Balance Model of Besut River



Note
- Q(d) : Domestic Water
- Q(in) : Industrial Water
- Q(is) : Irrigation Water for Secondary Granary Areas
- Qm : River Maintenance Flow
- Qt : Inflow from Major Tributaries (between Discharge Station and Intake Point of the Study Area)
- Qa : Available Water for Study Area (Main Granary Area)
- Q : Present Measured Discharge at River Discharge Station
- q : Discharge or Water Demand in Future Condition
- Qup : Water Taken from Upstream of River Discharge Station
- Qdown : Water Taken from Downstream of River Discharge Station

Fig. I-38 Water Balance Model of Angga River

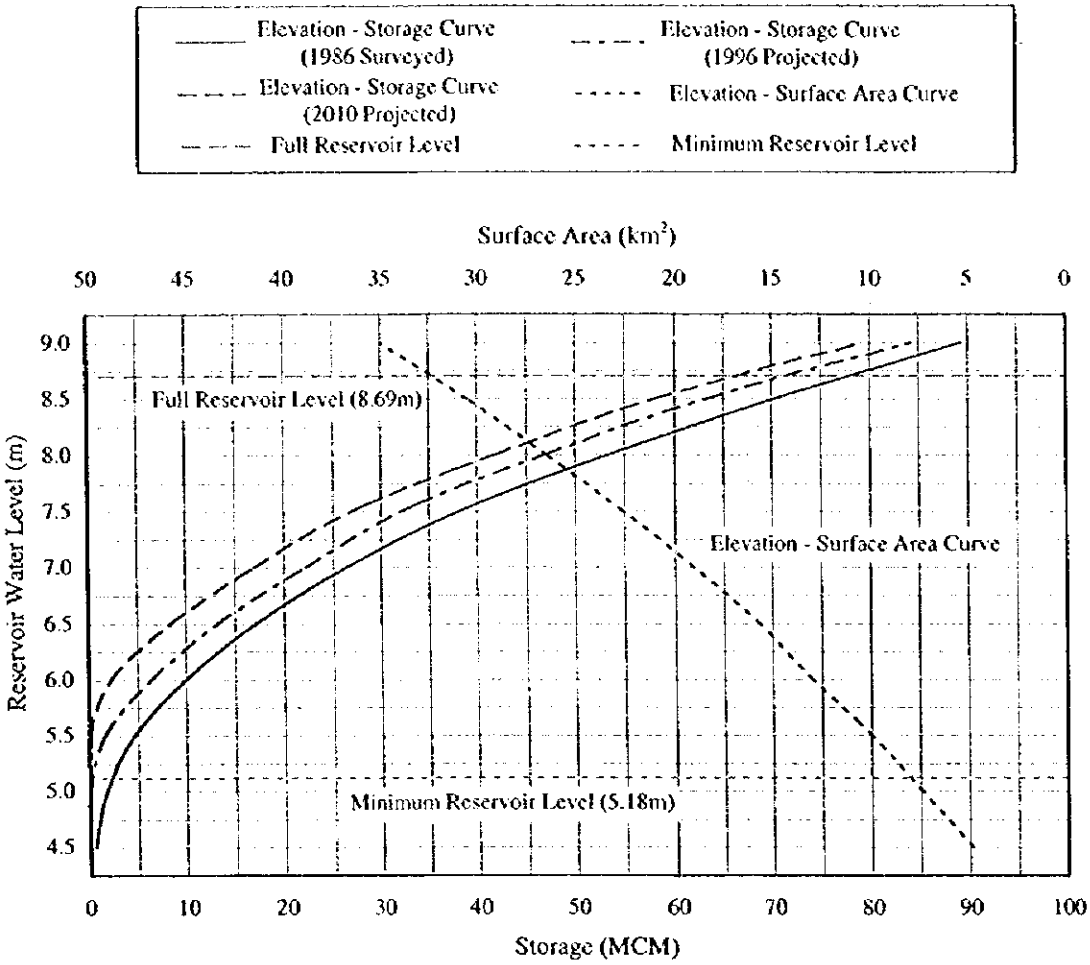


Fig. I-39 Elevation - Storage - Surface Area Curve of Bukit Merah Reservoir

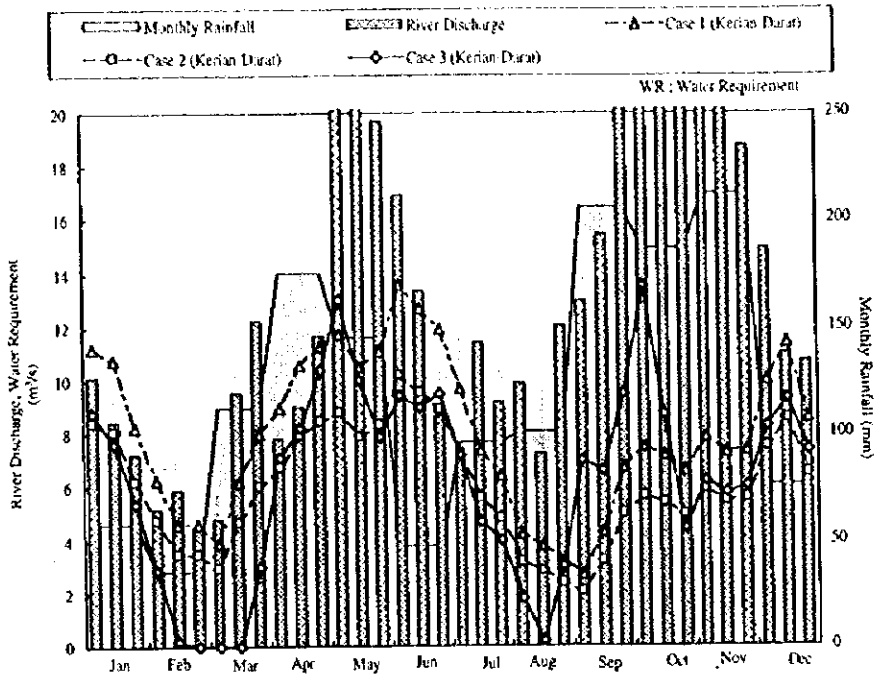


Fig I-40 Relationship between Monthly Rainfall, River Discharge(Kurau River) and Water Requirement(Kerian Darat) (1/5 Probability Drought Year)

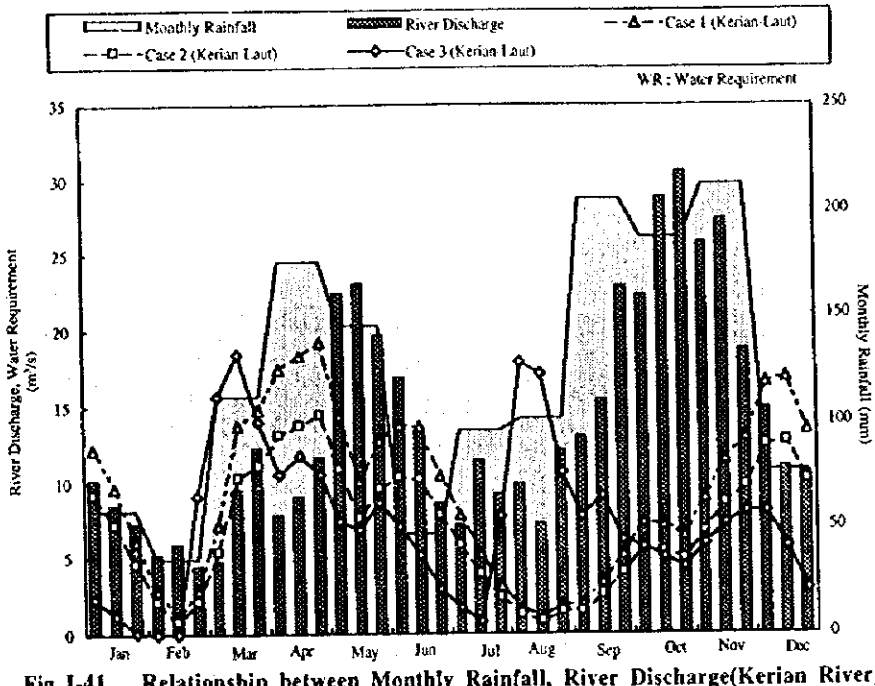


Fig I-41 Relationship between Monthly Rainfall, River Discharge(Kerian River) and Water Requirement(Kerian Laut) (1/5 Probability Drought Year)

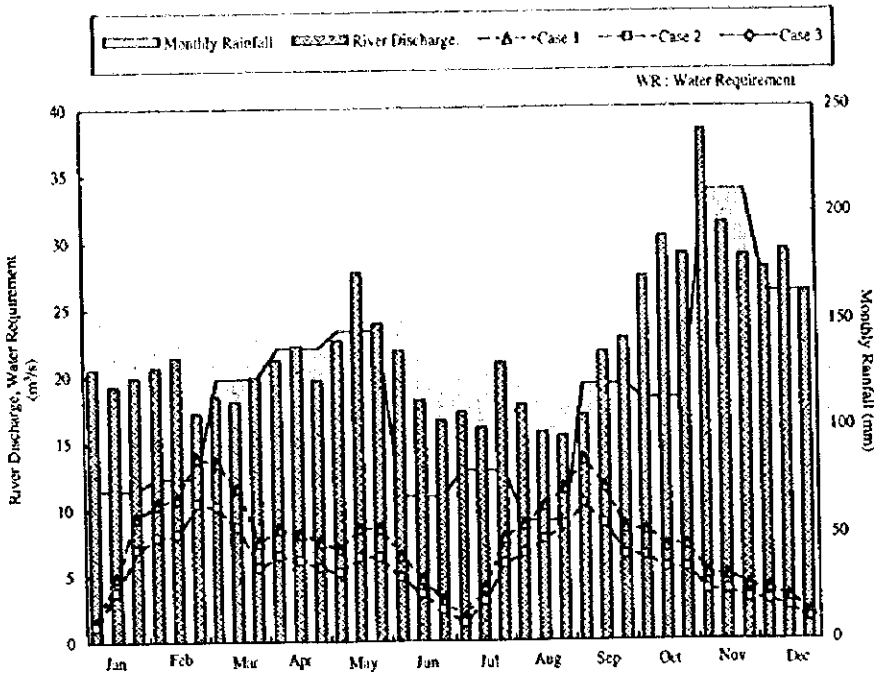


Fig I-42 Relationship between Monthly Rainfall, River Discharge and Water Requirement (Batang Padang River System) (1/5 Probability Drought Year)

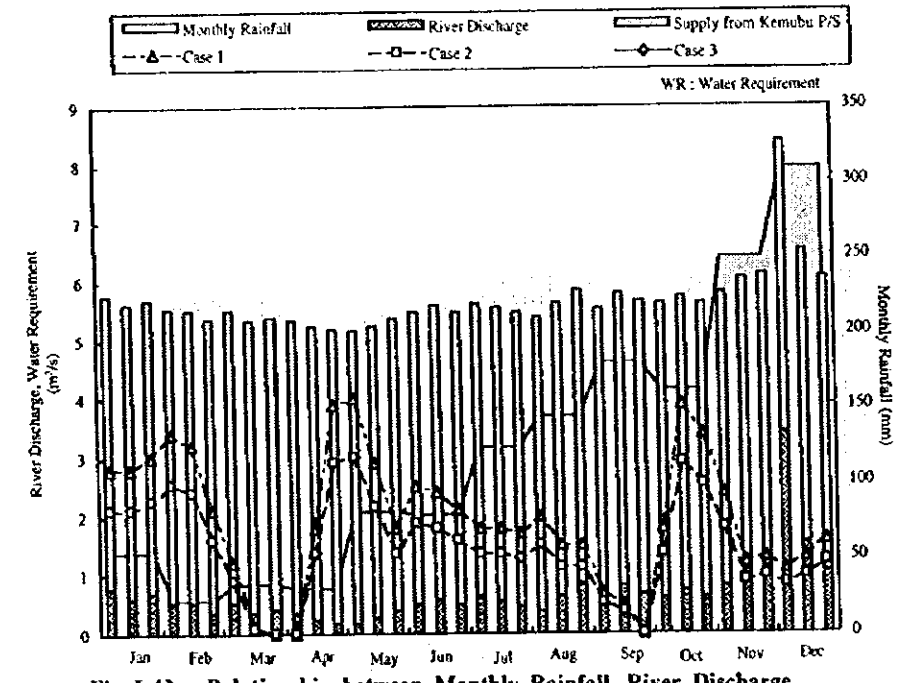


Fig I-43 Relationship between Monthly Rainfall, River Discharge and Water Requirement (Kemasia River System) (1/5 Probability Drought Year)

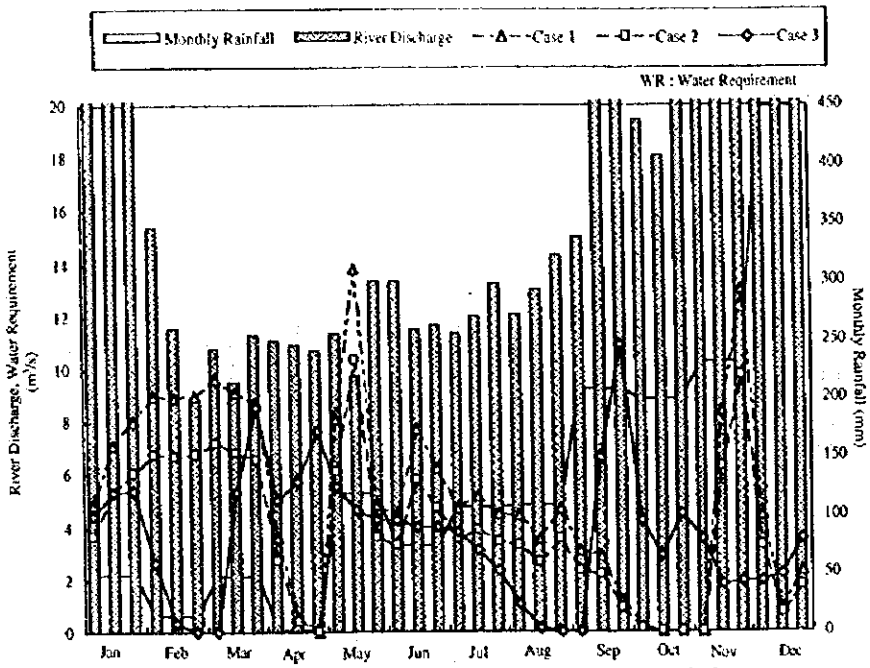


Fig I-44 Relationship between Monthly Rainfall, River Discharge and Water Requirement (Besut River System) (1/5 Probability Drought Year)

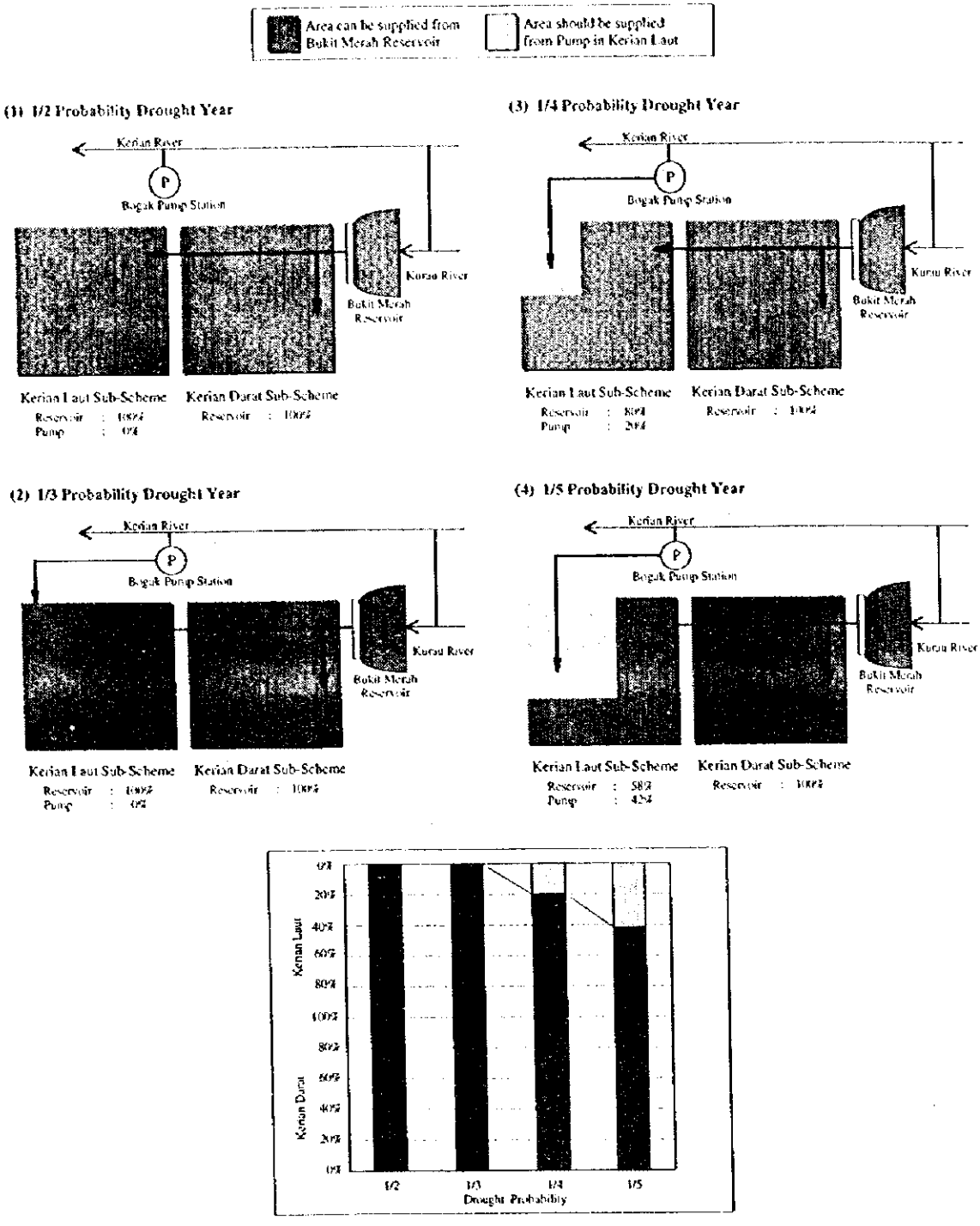


Fig. I-45 Command Area Distribution in Kerian Scheme (in Present Condition : Case 1)

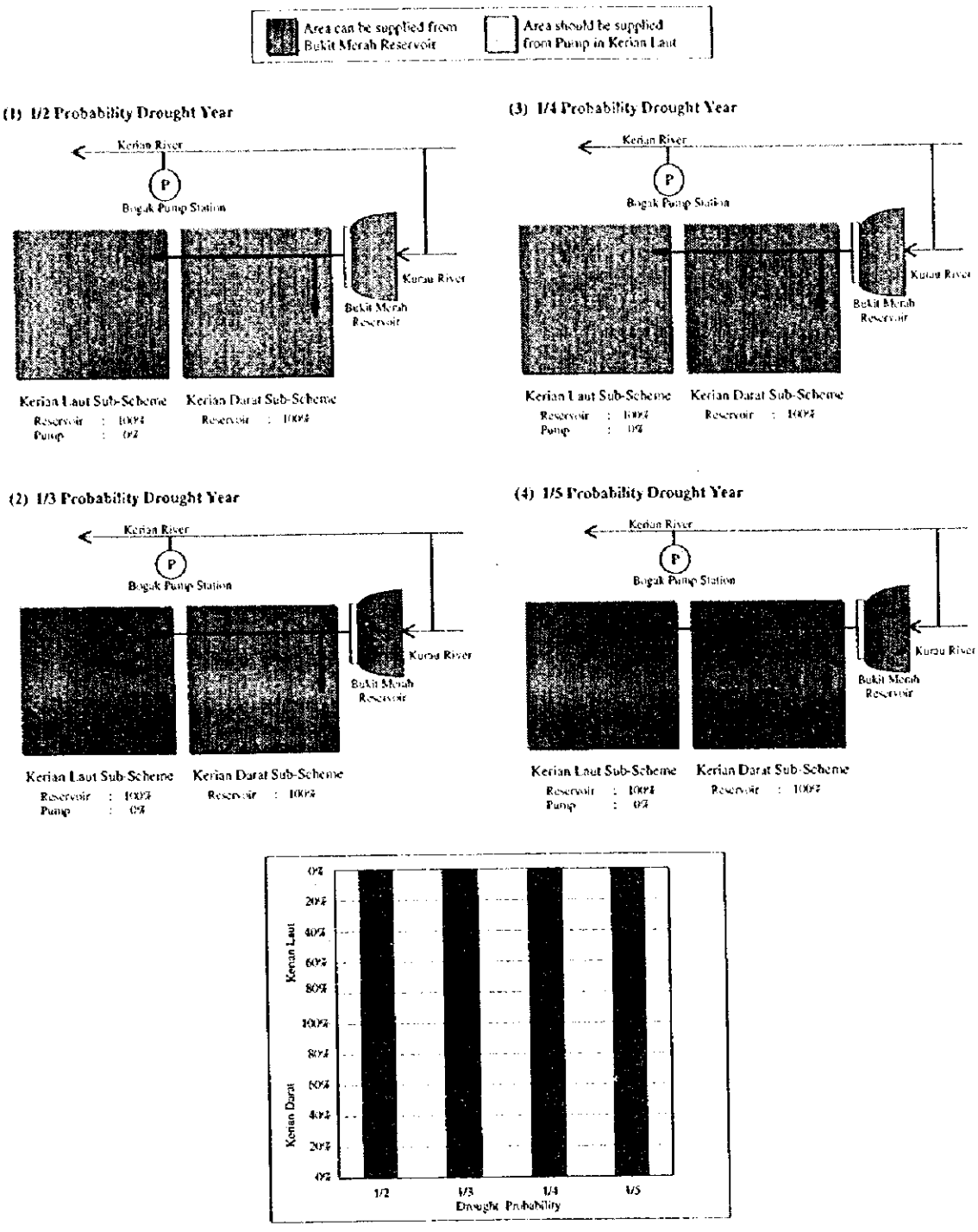


Fig. I-46 Command Area Distribution in Kerian Scheme (in Present Condition : Case 2)

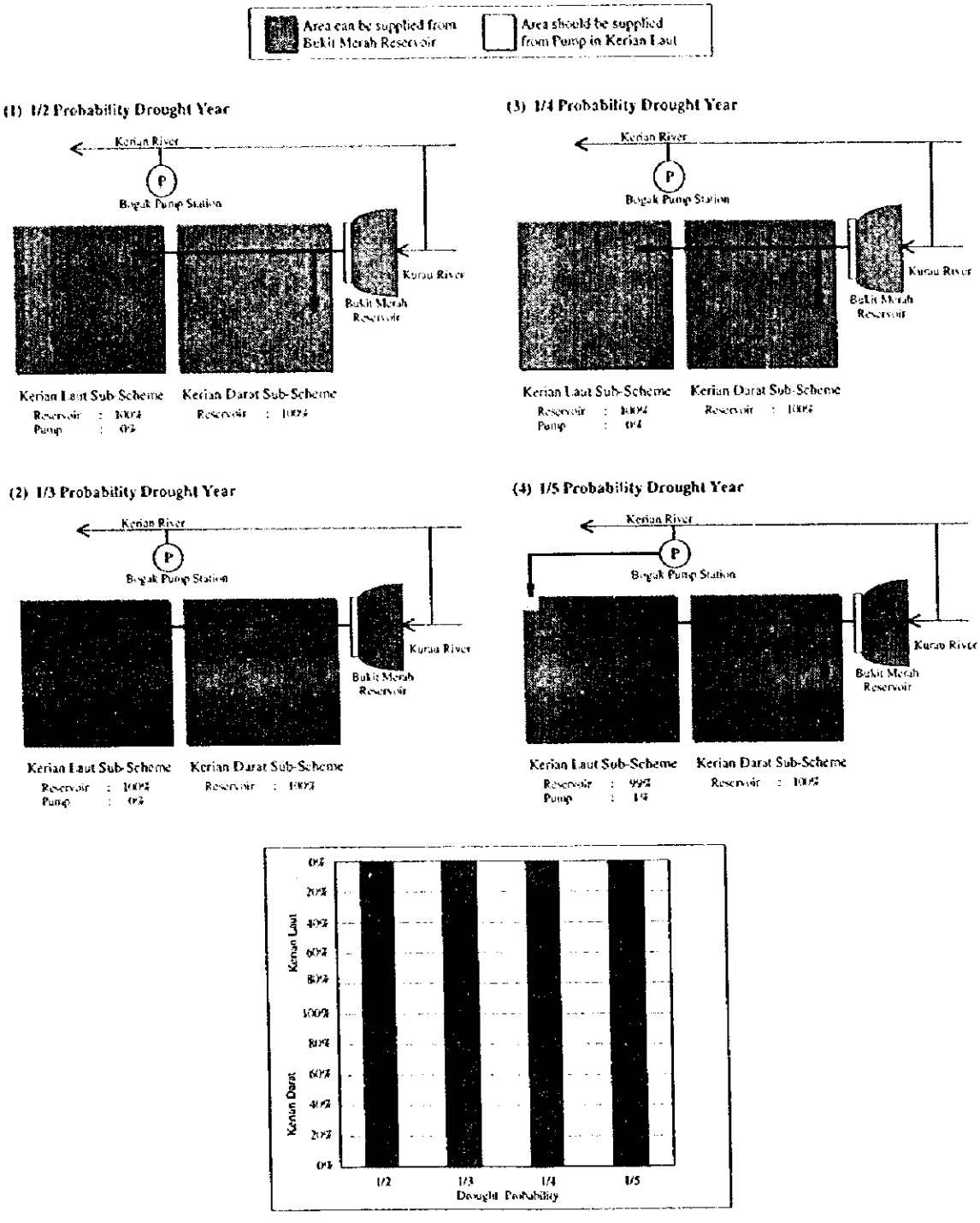


Fig. I-47 Command Area Distribution in Kerian Scheme (in Present Condition : Case 3)

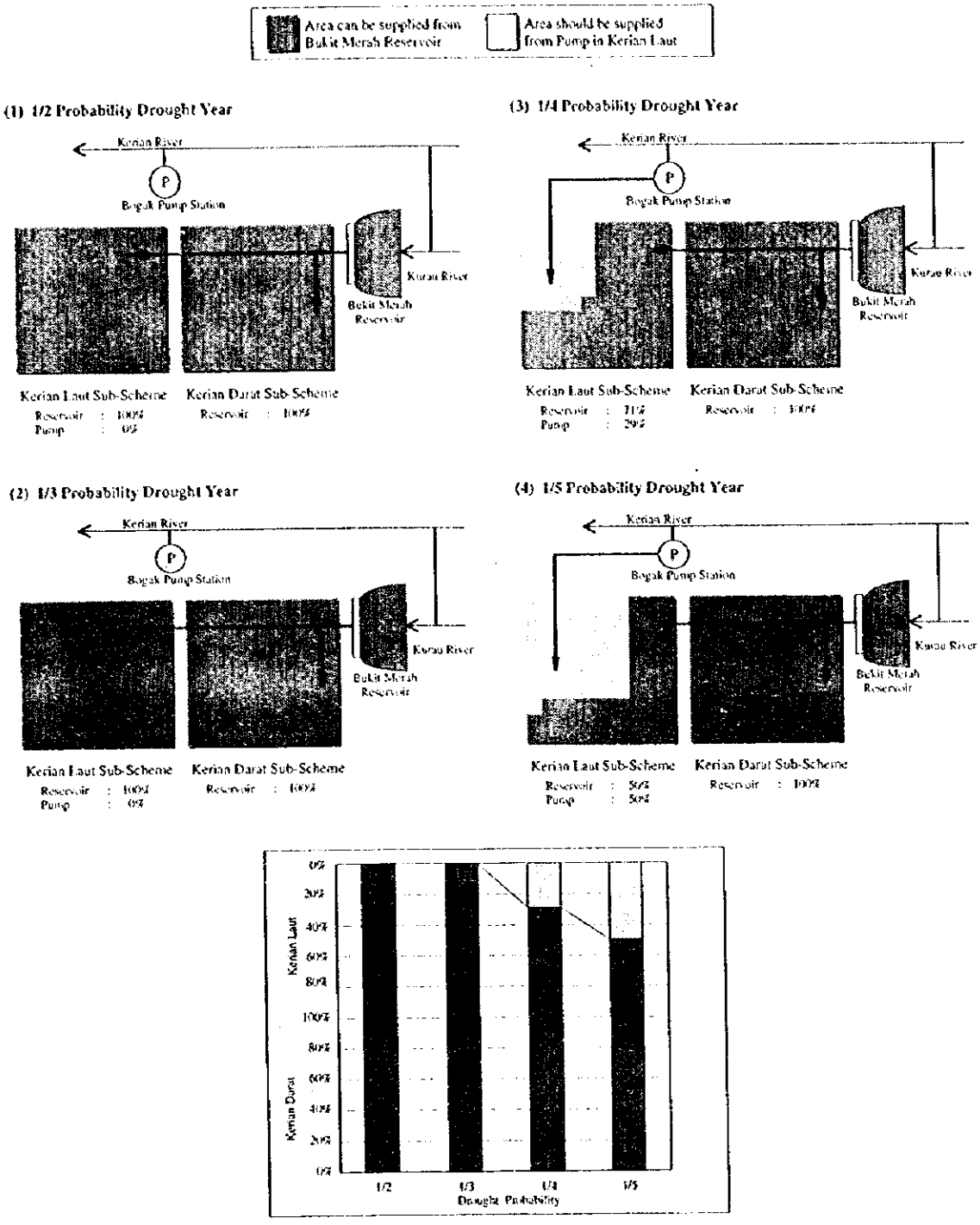


Fig. I-48 Command Area Distribution in Kerian Scheme (in Future Condition : Case 1)

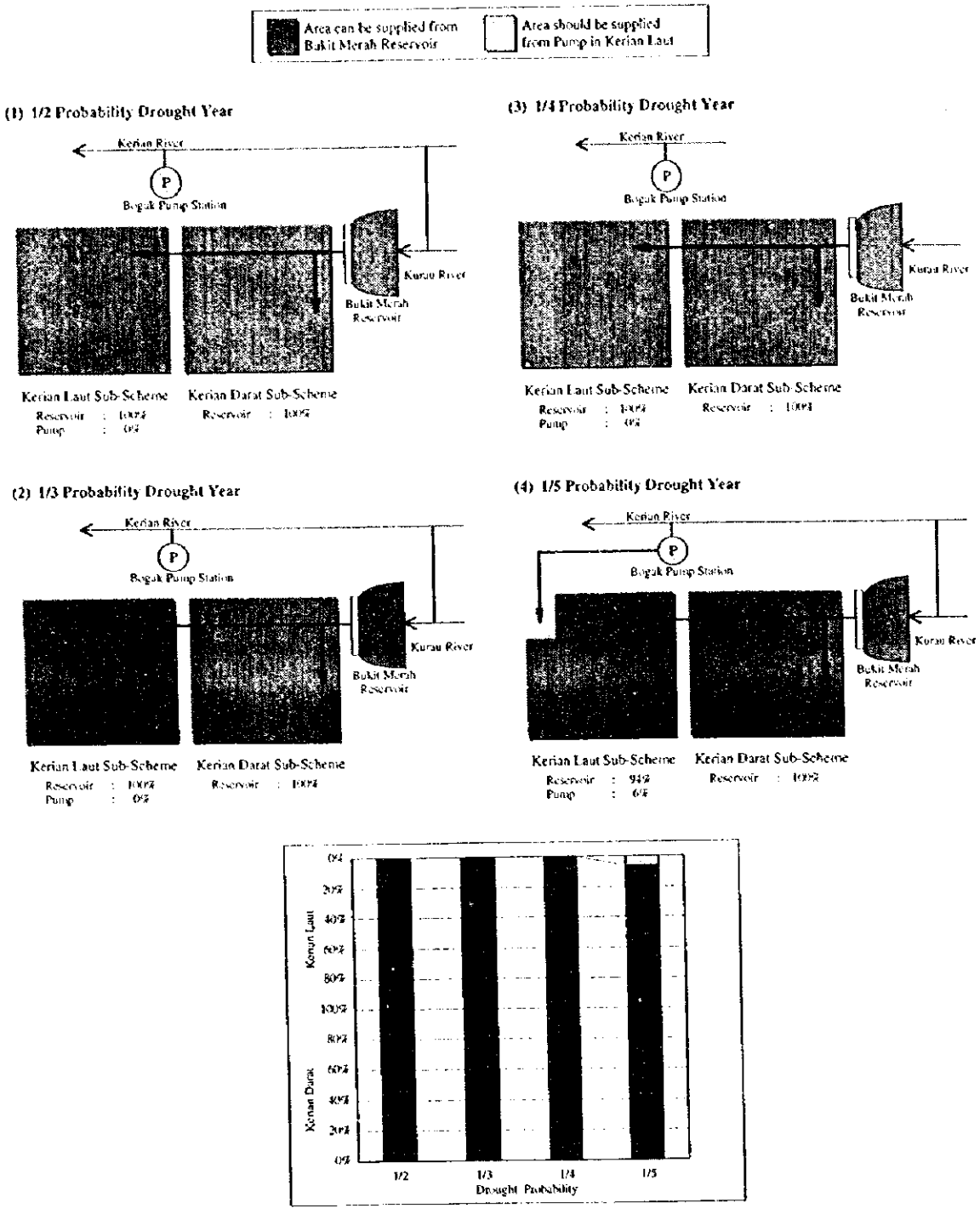


Fig. I-49 Command Area Distribution in Kerian Scheme (in Future Condition : Case 2)

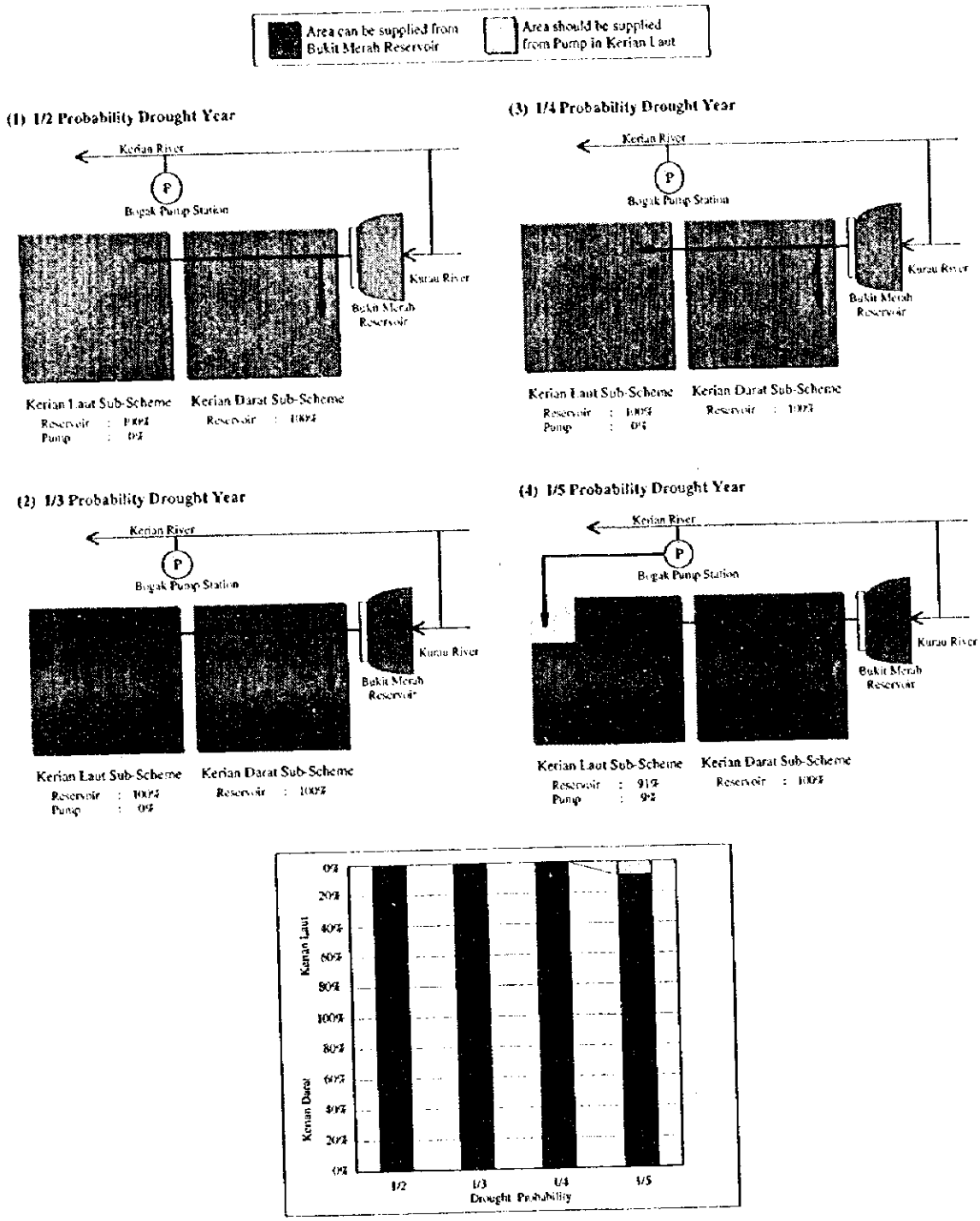


Fig. I-50 Command Area Distribution in Kerian Scheme (in Future Condition : Case 3)

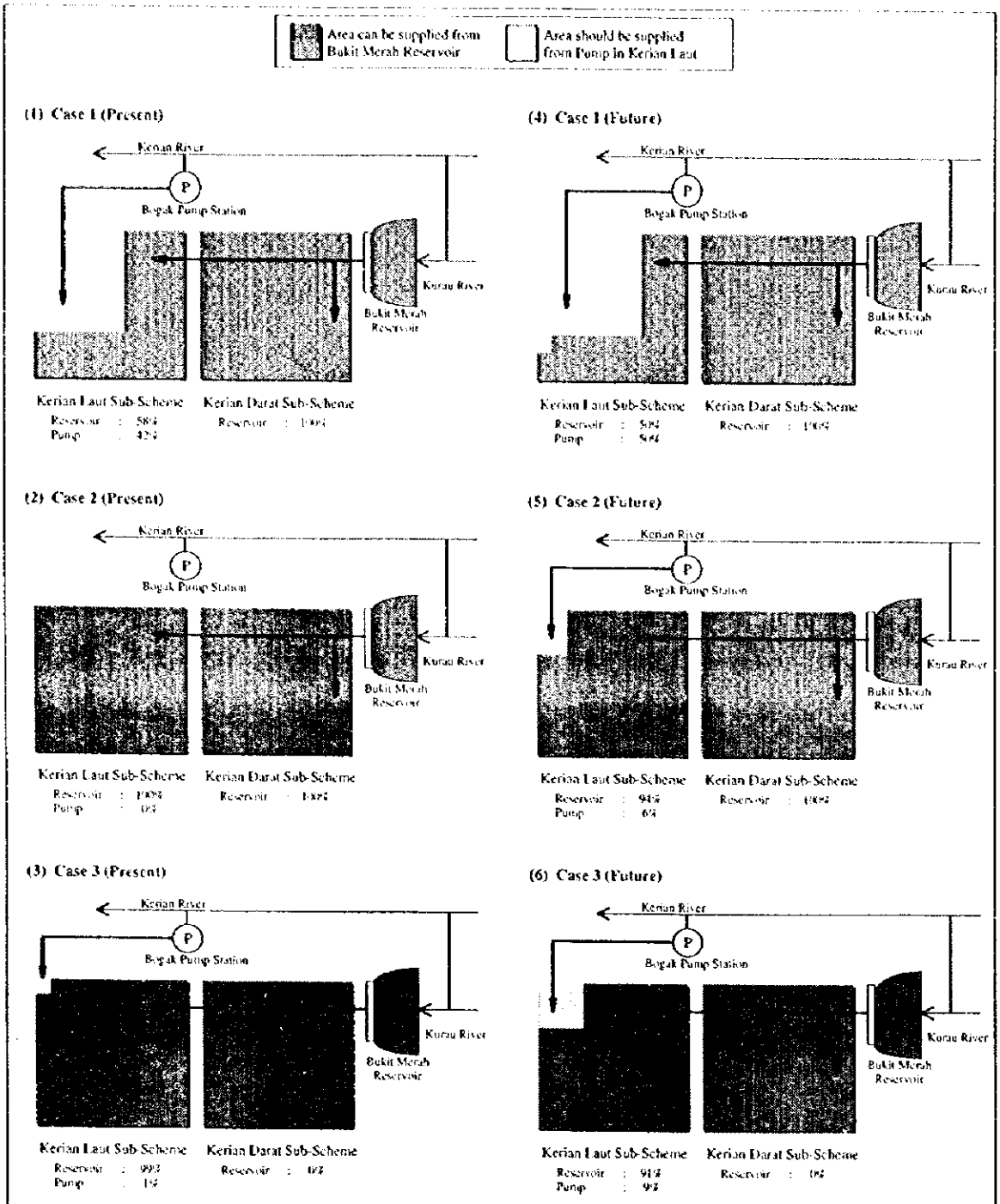


Fig. I-51 Command Area Distribution in Kerian Scheme (1/5 Probability Drought Year)

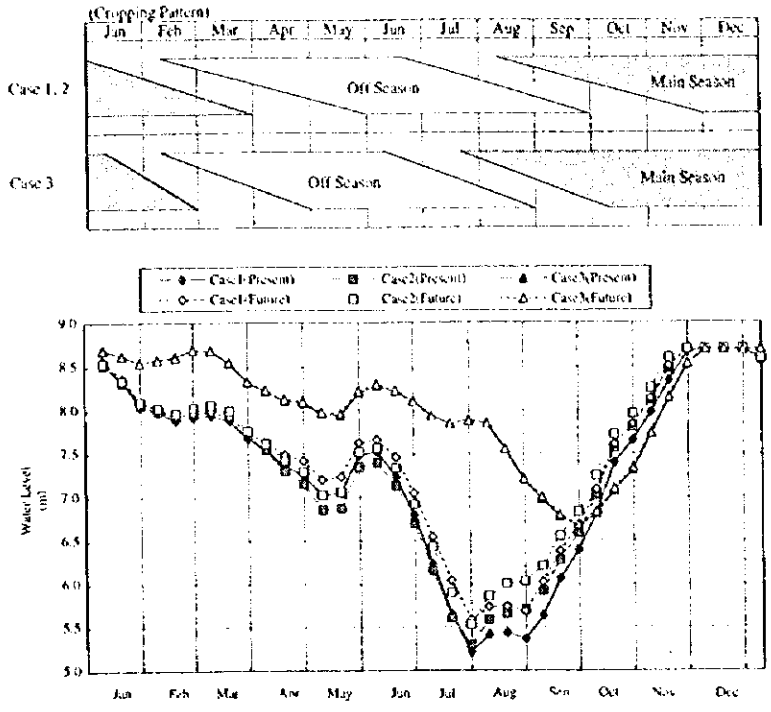


Fig. I-52 10-Days Basis Transition of Bukit Merah Reservoir Water Level (1/5 Probability Drought Year)

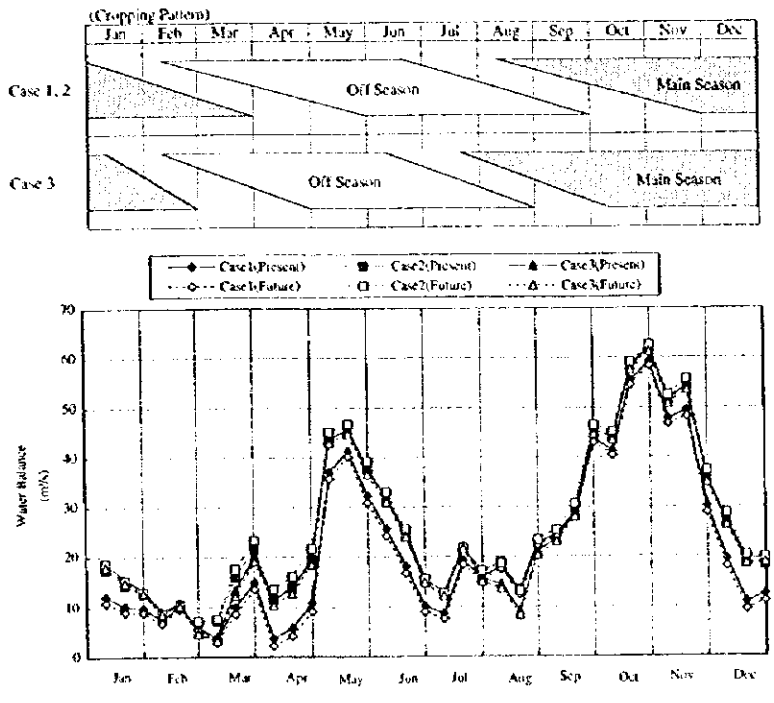


Fig. I-53 10-Days Basis Water Balance of Kerian River (1/5 Probability Drought Year)

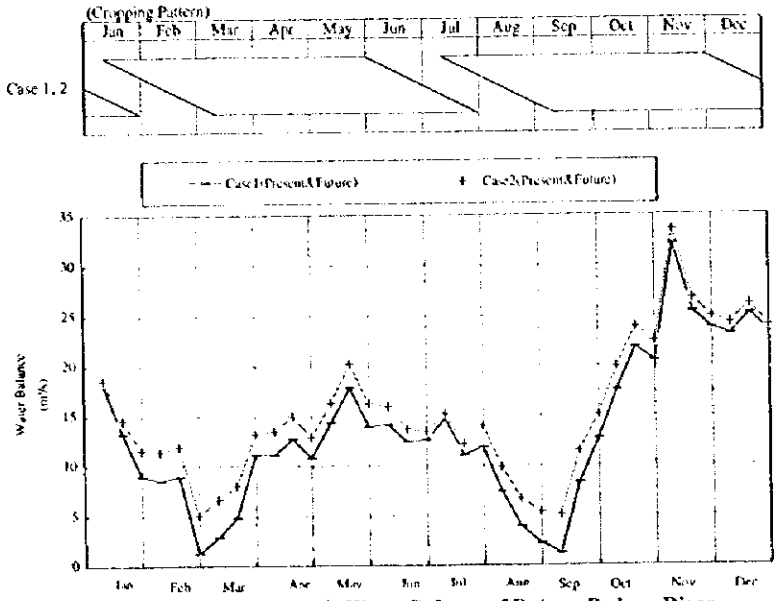


Fig. I-54 10-Days Basis Water Balance of Batang Padang River (1/5 Probability Drought Year)

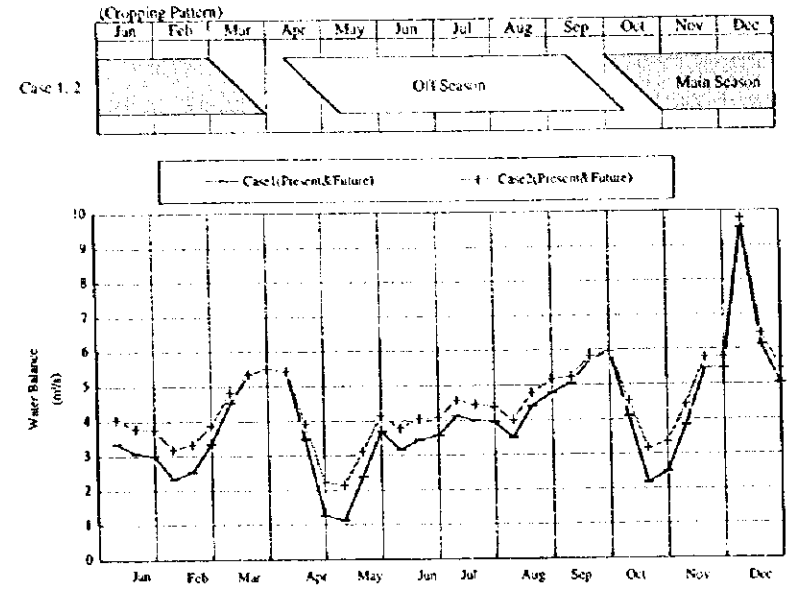


Fig. I-55 10-Days Basis Water Balance of Kemasin River (1/5 Probability Drought Year)

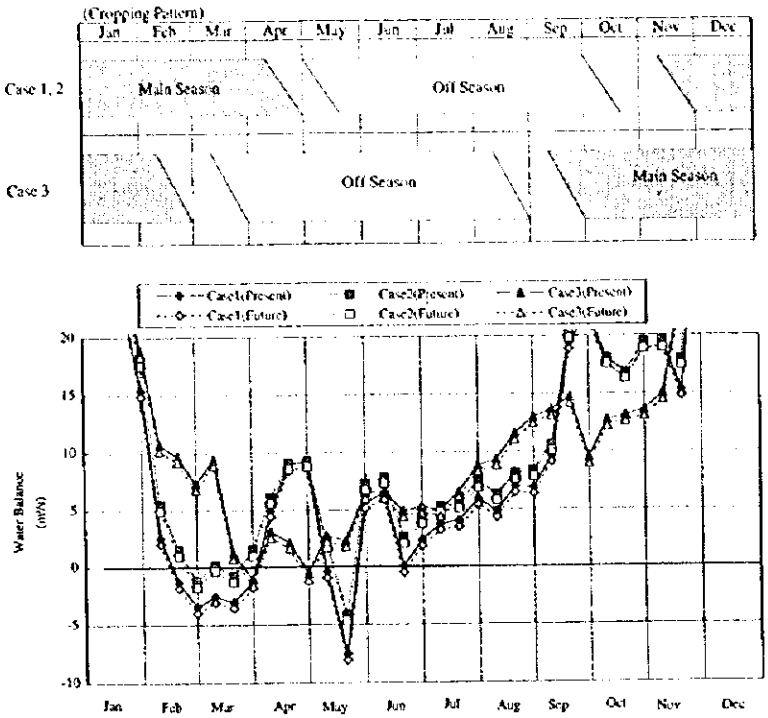


Fig. I-56 10-Days Basis Water Balance of Besut River (1/5 Probability Drought Year)

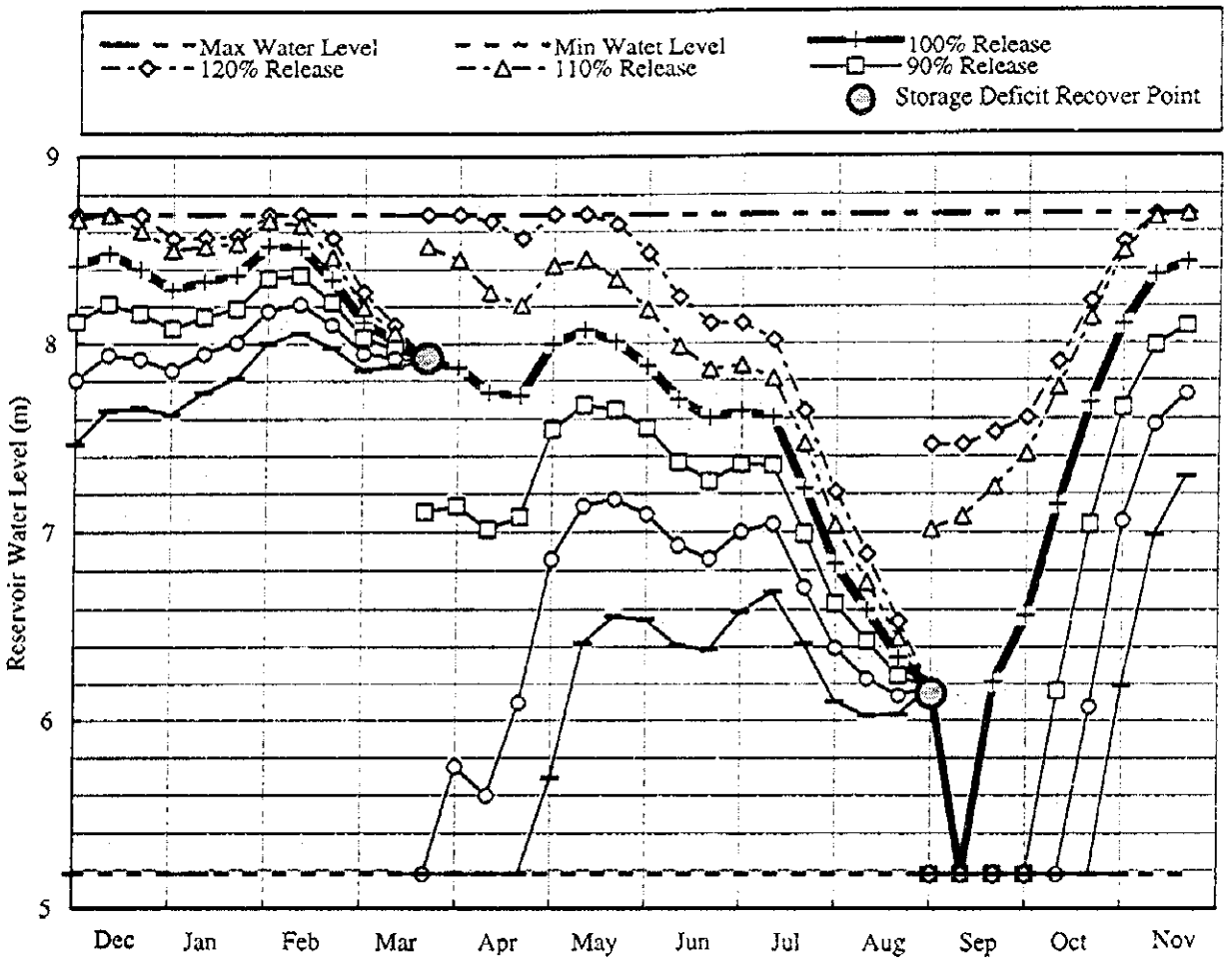


Table I-57 Sample "Drought - Required Reservoir Storage Curve" of Bukit Merah Reservoir (in Future Condition : Case 3)

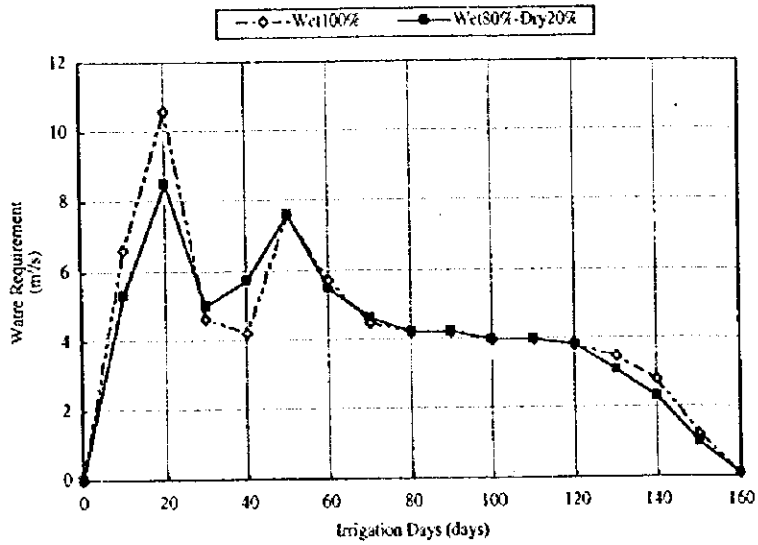


Fig. I-58 Comparison of Water Requirement (Besut Scheme)
1/5 Probability Drought Year
(Wet Seeding 100% vs Wet 80% - Dry 20%)

ANNEX-II

IRRIGATION AND DRAINAGE

ANNEX - II

IRRIGATION AND DARINAGE

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II. IRRIGATION AND DRAINAGE

1. INTRODUCTION

This Annex details the present conditions and the rehabilitation and improvement plan of the irrigation and drainage facilities in order to accomplish the modernized irrigation water management system in the granary schemes, namely IADP Pulau Pinang Scheme, IADP Kerian/Sungai Manik Scheme, IADP Seberang Perak Scheme, IADP Kemasin/Semerak Scheme and IADP Ketara (Besut) Scheme.

Chapter 2 shows the present conditions of the irrigation and drainage facilities and Chapter 3 explains modernization plan of those system infrastructures in the five granaries, throughout the master plan study and feasibility study.

2. PRESENT CONDITIONS OF FIVE GRANARIES

2.1 General

Field works in the study were conducted in two phases, namely Phase-I study from March to May, 1997 and Phase-II study from September to December, 1997. Site investigations as well as data collection were carried out in those periods. In addition, following surveys were performed under the sub-let contract basis :

Phase-I

(i) Canal route survey in the five granary areas including longitudinal and cross section survey (around 50 km in total)

(ii) Survey for present conditions of irrigation and drainage system in the five granary areas including preparation of general layout and inventory survey of existing structures (around 1,000 nos. in total)

Phase-II

(i) Canal route survey in Kerian, Besut and Pulau Pinang Schemes including longitudinal and cross section survey (63 km in total)

(ii) Topographic survey on paddy fields in Kerian, Besut and Pulau Pinang Schemes (about 20 ha each)

(iii) Geotechnical investigations at Angga Barrage site

Based on the results of those surveys, present conditions as well as problems and constraints to agricultural development in the respective granary scheme are explained below.

2.2 IADP Pulau Pinang Scheme

2.2.1 Irrigation System

The IADP Pulau Pinang Scheme, which covers 9,832 ha of paddy area in total, consists of five(5) sub-schemes, namely Sungai Muda (6,888 ha), Sungai Kulim (1,387 ha), Pinang Tunggal (938 ha), Sungai Jarak (388 ha) and Sungai Burung (231 ha) sub-schemes. Out of five sub-schemes, Sungai Burung sub-scheme is located in the Pinang Island and the remaining are situated in the Peninsular Malaysia.

The sub-schemes are divided into several irrigation blocks, which are 6 blocks (Block M1 - M6) in Sungai Muda sub-scheme, 2 blocks (Block P1A and P2) in Pinang Tunggal sub-scheme and 4 blocks (Block K1B, K2B, K3 and K4) in Sungai Kulim sub-scheme and 2 blocks (Pokok Tampang and Padang Menora) in Sungai Jarak sub-scheme. It is noted that Block P1B in Pinang Tunggal sub-scheme and Blocks K1A, K2A, K5 and K6 in Sungai Kulim sub-scheme are excluded from the granary area due to area conversion for industrial, residential purposes, etc .

The irrigation water for Sungai Muda sub-scheme and Pinang Tunggal sub-scheme is taken from Muda river through Bumbong Lima pump station and Pinang Tunggal pump station, respectively. A part of water pumped up at Pinang Tunggal pump station flows into Kreh river, a tributary of Jarak river and is reused as irrigation water for a part of Sungai Jarak sub-scheme, namely Pokok Tampang Block, through the Kreh pump station. A headworks at Jarak river also supplies water to Pokok Tampang Block. Another block in Sungai Jarak sub-scheme, Padang Menora Block is covered with a Padang Cempedak pump station at Jarak river. Sungai Kulim sub-scheme is supplied irrigation water from Sungai Kulim Headworks on Kulim river. In Sungai Burung sub-scheme, water for irrigation is mainly supplied from a headworks at Sungai Burung and supplementary irrigation water is diverted at a headworks at Titi Teras river especially in the dry season. Those pump stations and headworks are well operated presently.

Water sources and intake method as well as irrigation area and designed intake discharge for each sub-scheme are summarized below :

Name of Sub-Scheme	Water Source	Remarks	Irrigation Area
Sungai Muda	Muda river	Pumping	6,888 ha
Pinang Tunggal	Muda river	Pumping	938 ha
Sungai Jarak	Jarak river	Gravity + Pump	388 ha
Sungai Kulim	Kulim river	Gravity	1,387 ha
Sungai Burung	Titi Teras and Burung rivers	Gravity	231 ha

Note : The above irrigation area is defined as granary.

In order to increase intake water volume, Bumbong Lima pump station is under improved by DID, providing 8 new pumps. It is scheduled to be completed in January 1998.

Most of main and secondary canals in the scheme are unlined with trapezoidal sections and some erosion and weed are found in those canals. The tertiary canals except those in KIB block of Kulim sub-scheme consist of concrete lined trapezoidal or U shape block sections. Canal density in the scheme is about 39 m/ha in average. Constant head orifice offtakes which measure and divert the irrigation water from the main canal into the secondary canals and from the secondary canal to the tertiary canals are provided. Farm offtake with a 150 mm dia. is installed to supply water to every farm plot of about 3 ha. Water distribution within each farm plot is by means of overflow or quaternary canal. Those structures are relatively in well conditions. Designed field water requirement for presaturation period is 2.60 l/sec/ha and for normal supply is 1.30 l/sec/ha.

2.2.2 Drainage System

Main, secondary and tertiary drainage channels are provided to drain away the standing water in the paddy field and excess water to prevent crop damage and yield reduction due to inundation of the fields, to reclaim swampy waterlogged areas for paddy cultivation and to lower the ground water table to improve the bearing capacity for farm machinery. Some of existing rivers are used for main and secondary drainage system. Density of drainage channels in the scheme is 36 m/ha in average.

Drainage control structures are installed at the end of the tertiary drains in order to control the water level in the paddy fields and to serve as drainage crossing for farm machinery. Drainage outlets of 300 mm dia. are provided in each farm plot to drain excess water from the field to the tertiary drains. There are no serious drainage problems in the scheme.

2.2.3 Farm Road

Farm road with 5 m width and 230 mm laterite surfacing, and with 4 m width and 150 mm laterite surfacing are provided along one side of the main, secondary and tertiary canals, respectively. Density of farm road in the scheme is about 35 m/ha. Earth ramps are also provided to enable heavy machinery to go onto the farm land. Some of farm roads are used not only for farming but also for living transportation and commercial purposes, however, in bumpy conditions.

General map and features as well as present conditions of the scheme are shown in Fig. II-1 and Table II-1, respectively. Irrigation water distribution diagram and drainage diagram are given in Fig. II-2 and Fig. II-3, and irrigation canal and drains as well as their related structures in the scheme are listed in Table II-2 and Table II-3, respectively.

2.3 IADP Kerian / Sungai Manik Scheme

Total commanding area of IADP Kerian / Sungai Manik Scheme is 29,878 ha, which consists of 23,560 ha of Kerian Scheme and 6,318 ha of Sungai Manik Scheme.

2.3.1 Kerian Scheme

(1) Irrigation System

The Kerian Scheme is divided into 2 sub-schemes, namely Kerian Laut sub-scheme (13,726 ha) and Kerian Darat sub-scheme (9,834 ha) and further those sub-schemes comprise of 8 compartments, designated as A to H. Out of 8 compartments, 4 compartments, E to H in Kerian Darat sub-scheme are supplied water from the Bukit Merah Reservoir while the remaining 4 compartments, A to D in Kerian Laut get their supply from the reservoir supplemented by Samagagan river, a tributary of Kerian river through the Bogak Pumping Station as summarized below. Twenty one (21) movable pumps and one fixed booster pump provide water from the drains supplementary in drought season.

Name of Sub-Scheme	Water Source	Intake Method	Irrigation Area
Kerian Laut	Bukit Merah/Kerian River	Gravity + Pump	13,726ha
Kerian Darat	Bukit Merah Reservoir	Gravity	9,834 ha

Main canal Terusan Besar, which is diverted from Bukit Merah Reservoir, conveys water to compartments A to F. Main canals Terusan Alor Pongsu, Terusan Tg. Piandang and Terusan Serong are branched from Terusan Besar through diversion structures and supply water to compartment E, C & B and A, respectively. Compartments G and H are provided water from Bukit Merah Reservoir through main canal Terusan Serinsing. Secondary canals are branched from the main canals through constant head orifice offtake, and supply water to tertiary canals or directly to the fields. Every farm plots are provided water through farm offtakes installed on secondary and tertiary canals and water distribution within each farm plot is by means of overflow or quaternary canal. Both main and secondary canals are unlined trapezoidal sections and tertiary canals are either earth, concrete lined or glass reinforced polyester. Average density of irrigation canal for the scheme is about 31 m/ha. At upper reach of Terusan Besar, canal seepage is remarkable, and several gated structures such as offtakes and checks have been damaged. Designed field water requirement for presaturation period is 2.30 l/sec/ha and that for normal supply is 1.16 l/sec/ha.

(2) Drainage System

The scheme has a network of secondary and tertiary drains. The ultimate drainage is provided by Kurau and Kerian rivers, and major drainage outlets are flowing directly into the Strait of Malacca through tidal gates. Bund protection dikes were constructed to reduce flooding and provide protection from the influence of sea water in the coastal areas of the

scheme. The drainage density in the scheme is approximately 44 m/ha. There are some drainage problem areas especially in compartments A, B and C due to their topography and less maintenance of tertiary drains.

(3) Farm Road

Farm roads surfaced with laterite are provided on the bund of main, secondary and tertiary canals, and average density of the roads is 29 m/ha . Effective width of the road along main and secondary canals is 3.0 m to 4.0 m, however, that along tertiary canals is insufficient for traveling of farm machinery. Moreover, surface of roads is in muddy conditions during rain.

General map and features as well as present conditions of the scheme are shown in Fig. II-4 and Table II-4, respectively. Irrigation water distribution diagram and drainage diagram are given in Fig. II-5 and Fig. II-6, and irrigation canal and drains as well as their related structures in the scheme are listed in Table II-5 and Table II-6, respectively.

2.3.2 Sungai Manik Scheme

(1) Irrigation System

The Sungai Manik Scheme with 6,318 ha of the total irrigation area consists of 2 sub-schemes, Sungai Manik sub-scheme (3,602 ha) in the southern part and Labu Kubong sub-scheme (2,716 ha) in the northern part. Those sub-schemes are divided into 5 irrigation blocks in the Sungai Manik sub-scheme, namely Block 1A, 1B, 2, 3A and 3B, and 4 blocks in the Labu Kubong sub-scheme comprising of Block 4A, 4B, 5A and 5B.

Irrigation water for the scheme is supplied from Batang Padang river, a tributary of Perak river, mainly through a diversion headworks (Sungai Manik Headworks) and a pumping station (Chikus Pumping Station) supplementary supplies water to Block 3A.

Name of Sub-Scheme	Water Source	Intake Method	Irrigation Area
Sungai Manik	Batang Padang River	Gravity + Pump	3,602 ha
Labu Kubong	Batang Padang River	Gravity	2,716 ha

The Sungai Manik Headworks is gated weir type and diverts water to Right and Left Main Canals through an intake structure. Right Main Canal conveys water to the Labu Kubong sub-scheme and Left Main Canal covers irrigation for the Sungai Manik sub-scheme. A weir located at the downstream of Left Main Canal is provided as a bifurcation structure feeding Secondary Canals 5 and 3A. The Chikus Pumping Station is located at the downstream of the Sungai Manik Headworks below the confluence of Chikus river and Batang Padang river, and the pumping water is supplied to Block 3A through Secondary Canal 3B. Most of main and secondary canals in the scheme are unlined trapezoidal sections. Tertiary canals in Labu

Kubong sub-scheme are almost concrete lined, however, those in Sungai Manik sub-scheme are still earth lined. Sediment and erosion are found in those earth canals.

Several gate leaves for the diversion offtakes as well as for check structures are made by wooden plates and water leakage is found from the gates due to their deterioration. Moreover, irregular pipes on some farm offtakes were installed by farmer themselves. Those result in difficulty of proper water distribution in the scheme. Field water requirement for presaturation period is 2.80 l/sec/ha and that for normal supply is 1.40 l/sec/ha.

(2) Drainage System

Practically all the tertiary drains are located beside tertiary irrigation canals. Water from tertiary drains is collected along secondary drains, which eventually flows into main drain and into the Perak river through 3 tidal gates. Drainage control structures are provided along the drains and rivers to maintain a certain height of water level so as to reduce the seepage loss from paddy fields, and drainage pipe is put at the boundary of every 2 farm lots to drain away water from paddy field. Density of drains in the scheme is about 38 m/ha.

(3) Farm Road

Public roads paved with asphalt is utilized for access to the farm lands. Farm roads are provided on the bund of main, secondary and tertiary canals surfaced with laterite. The width of laterite pavement are 3 m along the main and secondary canals and 1.8 m along the tertiary canals. It is insufficient for mechanized farming.

General map and features as well as present conditions of the scheme are shown in Fig. II-7 and Table II-7, respectively. Irrigation water distribution diagram and drainage diagram are given in Fig. II-8 and Fig. II-9, and irrigation canal and drains as well as their related structures in the scheme are listed in Table II-8 and Table II-9, respectively.

2.4 IADP Seberang Perak Scheme

2.4.1 Irrigation System

The IADP Seberang Perak Scheme covers 8,708 ha of paddy land which consists of 4,343 ha of Right Branch Canal sub-scheme and 4,365 ha of Left Branch Canal sub-scheme. The Right Branch Canal sub-scheme is divided into 3 blocks, namely Block E, F and G and the Left Branch Canal sub-scheme comprises of 4 blocks, Block A, B, C and D. A free intake structure at Telok Sena diverts water from Perak river to the scheme area.

Name of Sub-Scheme	Water Source	Intake Method	Irrigation Area
Left Branch Canal	Perak River	Free intake	4,365 ha
Right Branch Canal	Perak River	Free intake	4,343 ha

A main canal conveys water from Telok Sena Intake to a bifurcation located at about 8 km downstream of the intake. The bifurcation structure regulates and controls the amount of discharge into the right branch canal and left branch canal. It seems difficult to operate both intake and bifurcation gates properly because of their manual moving, so that water surface in main canal and upper reaches of branch canals often rises up to top of canal bank. The main and secondary canals have unlined trapezoidal sections except the secondary canals lined by concrete in the Right Branch Canal sub-scheme. Tertiary canals in the Right Branch Canal sub-scheme consist of concrete-lined trapezoidal or block sections and the remaining are still unlined. Canal density in the scheme is about 36 m/ha.

Canal structures on main and branch canals are relatively well maintained, but those on secondary and tertiary canals in Left Branch sub-scheme require to be improved. Designed field water requirement for presaturation period is 2.40 l/sec/ha and that for normal supply is 1.20 l/sec/ha.

2.4.2 Drainage System

Water in the paddy fields is collected in tertiary drains and flows into Perak river or its tributaries through main and secondary drains. Drainage water flow to the rivers is controlled by 9 numbers of drainage gate structures (tidal gates) to prevent saline intrusion into the paddy fields. Every tertiary drains have a drainage control structure at their ending in order to regulate the water level in the paddy fields and to serve as drainage crossing for farm machinery. Block H is included in drainage system of the scheme, in which area oil palms are planted as shown in Fig. II-10. Density of drains in the scheme is 43 m/ha.

2.4.3 Farm Road

Public roads along the main and branch canals paved by asphalt with about 7m width are used for access to the intake and bifurcation structures sites, for operation and maintenance of the main and branch canals and for approach to the farm lands. Farm roads with 3.65 m width and laterite surfacing are provided along one side of the secondary canals or secondary drains, however, those are in bumpy conditions.

General map and features as well as present conditions of the scheme are shown in Fig. II-10 and Table II-10, respectively. Irrigation water distribution diagram and drainage diagram are given in Fig. II-11 and Fig. II-12, and irrigation canal and drains as well as their related structures in the scheme are listed in Table II-11 and Table II-12, respectively.

2.5 IADP Kemasin/Semerak Scheme

2.5.1 Irrigation System

The Kemasin/Semerak Scheme, which covers 6,895 ha of paddy land in total, comprises of eight sub-schemes, namely Kemasin Hilir (261 ha), Jelawat Rusa (1,384 ha), Semerak Hilir (1,000 ha), Semerak Hulu (174 ha), Semerak Selatan (1,100 ha), Semerak Barat (115 ha), Sungai Yong-Gaal (2,260 ha) and Jeram-Rasan (601 ha) sub-schemes. Two phase-wise execution has been adopted for the development of the scheme and the phase-I works, consisting of Kemasin Hilir and Jelawat Rusa sub-schemes in Kemasin area have been completed. The execution of phase-II works for the remaining sub-schemes in Semerak area, however, are awaiting for the completion of flood mitigation works in the Semerak area which is under executed by DID, because the design review of those sub-schemes shall be referred the results of the said flood mitigation works.

The Kumbu Pumping Station in KADA Scheme shall supply 16.0 m3/sec of water to Kemasin Semerak Scheme, which consist 5.0 m3/sec for Kemasin area through Kemasin river and 11.0 m3/sec for Semerak area through Semerak river. However, the regulation is not strictly followed due to incomplete sub-schemes mentioned above. The Kemasin river is a water source for both Kemasin Hilir and Jelawat Rusa sub-schemes. Present water supply to the sub-schemes is summarized below:

Name of Sub-Scheme	Water Source	Intake Method	Irrigation Area
Kemasin Hilir	Kemasin River	Pumping	261 ha
Jelawat Rusa	Kemasin River	Pumping	1,384 ha
Semerak Hilir	- no planting presently -		1,000 ha
Semerak Hulu	- no planting presently -		174 ha
Semerak Selatan	- no planting presently -		1,100 ha
Semerak Barat	- irrigated by movable pump -		115 ha
Sungai Yong-Gaal	- single cropping by old facilities -		2,260 ha
Jeram-Rasau	- cropping by rainfed -		601 ha

The Kemasin Hilir sub-scheme consists of 5 blocks, Block A, B, C, D and E and all blocks are supplied water from Kemasin river by pumping up. The Jelawat Rusa sub-scheme, comprising of 5 blocks, Block A0, B0, B1, C0 and C1, is also irrigated by pumping water from Jelawat river, a tributary of Kemasin river. Water supplied to Block B0 and C0 are again pumped up by booster pumps to irrigate Block B1 and C1.

Water conveyed by main canal is diverted to secondary, tertiary and quaternary canals through farm offtakes and adjustable weirs and farm offtakes on those canals supply water to every service units. Weir regulator and adjustable weir are used as regulating structures. Canal and structures in two sub-schemes are relatively well conditions. Designed field water requirement of 2.06 l/sec/ha is adopted for presaturation period of the scheme.

2.5.2 Drainage System

Excess water within a service unit is drained by quaternary drains flowing into tertiary drains which have their outfalls at the secondary drains. The main drains collect the outflow from the secondary drains and discharge off at the drainage outlets to the rivers. A tidal gate structure on Kemasin river is operated to avoid tidal influence to the main drain. Density of drains in Kemasin Hilir and Jelawat Rusa sub-schemes is 35 m/ha.

2.5.3 Farm Road

Farm roads are provided along the canals and drains to facilitate maintenance and operation of the scheme and farming activities. Those roads are mainly surfaced by gravel with 3.0 m width. Quaternary farm roads are also built across paddy land.

General map and features as well as present conditions of the scheme are shown in Fig. II-13 and Table II-13, respectively. Irrigation water distribution diagram and drainage diagram are given in Fig. II-14 and Fig. II-15, and irrigation canal and drains as well as their related structures in the scheme are listed in Table II-14 and Table II-15, respectively.

2.6 IADP Ketara (Besut) Scheme

2.6.1 Irrigation System

The IADP Ketara (Besut) Scheme consists of 2 sub-schemes, namely Angga Barrage sub-scheme and Besut Barrage sub-scheme and the total commanding area of the scheme is 5,164 ha. Those sub-schemes are further divided into 4 compartments, which are 1 compartment in the Angga Sub-Scheme (Compartment 2) and 3 compartments in the Besut Sub-Scheme (Compartment 1, 3 and 4). There are two main water sources to the scheme consisting of Angga river and Besut river. In drought season, water in drains are utilized as supplemental sources, which is pumped up to irrigation canals by six (6) recycling pumps.

Name of Sub-Scheme	Water Source	Intake Method	Irrigation Area
Angga	Angga River	Gravity	1,147 ha
Besut	Besut River	Gravity	4,017 ha

Note : The above irrigation area is defined as granary.

The Angga sub-scheme and the Besut sub-scheme are supplied water from Angga river and Besut river through two(2) barrages, namely Angga Barrage and Besut Barrage, respectively. The Angga Barrage consists of two radial gated weirs and two sluice gates for intake, however, it is difficult to operate those gates properly due to their superannuating. The Besut Barrage comprises of four gated weirs (motor driving roller gates) and three slide gates (motor moving) for intake portion. Much water leakage from the weir gates is found.

The main canals conveys water to downstream and the water is diverted to secondary and tertiary canals through offtake structures. About 70 % of Besut main canal and secondary canals have been lined with concrete. Tertiary canals, of which length about 117 km, are almost lined with concrete or glass reinforced polyester. Irrigation facilities in the scheme including structures are rather deteriorated because of their long term use. Design field water requirement of the scheme is 2.33 l/sec/ha for presaturation period.

2.6.2 Drainage System

The drainage system of the scheme are about 177 km of main and secondary drains and 44 km of tertiary drains. Existing rivers which are flowing in the scheme are fully utilized as main drains. Density of drains in the scheme is about 35 m/ha. Due to sedimentation in the drains, poor drainage fields are found in the downstream area.

2.6.3 Farm Road

Farm roads are mainly provided along the main, secondary and tertiary canals with about 241 km in total length. Those are paved by asphalt (57 km), crashed stone (39 km) and laterite (118 km) and remaining (27 km) is still non-paved. Width of main and secondary farm roads is sufficient for mechanical farming, however, that of tertiary farm road is considerably narrow.

General map and features as well as present conditions of the scheme are shown in Fig. II-15 and Table II-16, respectively. Irrigation water distribution diagram and drainage diagram are given in Fig. II-16 and Fig. II-17, and irrigation canal and drains as well as their related structures in the scheme are listed in Table II-17 and Table II-18, respectively.

2.7 Problems and Constraints in the Granary Areas

Based on the present conditions described in the previous chapter, problems and constraints to the agricultural development in the view point of irrigation and drainage fields are pointed out as follows :

(a) Pulau Pinang Scheme

(i) Competition of river water use among irrigation, industry and domestic supply
(ii) Existence of abandon area from paddy cultivation
(iii) Sedimentation and weeds in the main canal
(iv) Bumpy conditions of farm road surface and insufficient road width along tertiary canals

(b) Kerian Scheme

(i) Huge weed in Bukit Merah Reservoir resulting in reduction of storage capacity

(ii) Seepage from main canal Terusan Besar

(iii) Insufficient numbers of regulating structures

(iv) Damage of gated structures such as offtakes and check structure

(v) Existence of drainage problem areas in Block A, B and C

(vi) Muddy conditions of farm road surface and insufficient road width along tertiary canals

(c) Sungai Manik Scheme

(i) Sedimentation at just downstream of the headwork

(ii) Insufficient farm offtake resulted in bank cut for taking water and use of bigger pipes for offtake installed by farmers

(iii) Erosion of unlined tertiary canals

(iv) Less land consolidation in Sungai Manik sub-scheme

(v) Existence of damaged facilities due to less maintenance

(vi) Insufficient width of farm roads and crossing structures

(d) Seberang Perak Scheme

(i) Huge sedimentation in main canal

(ii) Difficulty of proper operation of intake and bifurcation gates because of their manual moving

(iv) Existence of damaged facilities due to less maintenance

(v) Less land consolidation in Block A

(vi) Less control of farm offtake in Block A

(e) Kemasin/Semerak Scheme

(i) Delay of irrigation development of Phase II areas due to under execution of Flood Mitigation Project in Semerak area

(ii) Less land consolidation

(f) Ketara (Besut) Scheme

(i) Water leakage and damage of lifting wires of Besut barrage gates

(ii) No operation of Angga intake gates

(iii) Huge sedimentation in the canal at downstream of Angga barrage

(iv) Decrepitude of facilities

3. MODERNIZATION PLAN OF SYSTEM INFRASTRUCTURE

3.1 General

Irrigation and drainage facilities including on-farm facilities in the five(5) granary schemes have been constructed except for Kemasin-Semerak Scheme. Based on the water balance study in the existing irrigation water sources, it is found that the water sources for irrigation are much sufficient only in Sungai Manik and Seberang Perak Schemes. However, it is difficult to extend paddy area in those two schemes, because most of areas possible to be extended are located at lower coastal area and affected by fluctuation of the sea water level. Available irrigation water for the remaining four(4) schemes is quite limited and there is no possibility to develop new water sources for those schemes in a short term. Accordingly, a basic concept of development plan in the irrigation and drainage field will be mainly put on the rehabilitation and improvement of the existing facilities (system infrastructures) such as canals, roads and related structures. Irrigation plan for the respective schemes aims to supply water to the farm land with adequate quantity of water required for crops timely and effectively as well as to distribute the water with the less conveyance and operation losses through improvement of irrigation water supply system. The direct objective of drainage is to improve crop growing condition and working condition for farming by draining excess water on the ground surface and in the soil. Road plan is to be established to keep proper road density and width for mechanized farming and marketing. Since the operation and maintenance works of tertiary system will be transferred from DID to the farmer's groups, the improvement plans for system infrastructures will be considered from the viewpoint of easiness and cost-saving for the said works.

In order to realize the modernized irrigation water management system in the granaries, improvement plans for the system infrastructures in the respective schemes are formulated taking into account the following points, which are picked out from the present problems and constraints to the agricultural development in the each granary scheme as explained in Chapter 2:

(1) IADP Pulau Pinang Scheme : Labour-saving in farming and water management

(2) IADP Kerian / Sungai Manik Scheme

- Kerian Scheme : Saving irrigation water and drainage improvement for introducing mechanized farming and direct seeding in drainage problem area
- Sungai Manik Scheme : Upgrading of facilities for optimum operation

(3) IADP Seberang Perak Scheme : Upgrading of facilities for optimum operation

(4) IADP Kemasin-Semerak Scheme : Acceleration of flood mitigation project and rehabilitation of damaged facilities

(5) IADP Ketara (Besut) Scheme : Securing water source at headworks, saving irrigation water and rehabilitation of superannuated structures

3.2 Proposed Concept of the Modernization Plan on System Infrastructure

Improvement plan of the irrigation and drainage system, which consists of provision of new facilities and rehabilitation/upgrading of the existing facilities, is established in relation to the proposed water management system including the telemetry/telecontrol system and the proposed farming practices.

Provision of control and monitoring points on the canal system and rainfall station in the representative locations of the granary areas are proposed for proper operation of water distribution as well as for effective use of available water. At the control points, which will be mainly the headworks, main pump station and major diversion points of canals, water level gauges and remote control gates will be installed in order to regulate the intake and diversion discharges timely. Monitoring points will be provided at several locations of canals for checking discharge whether the canal operation is proper or not. Adequate operation will be instructed to the site based on the actual discharge of canal which will be observed by water level gauge installed at each monitoring point. These control points, monitoring points and rainfall stations will be linked to telemetry/telecontrol system. Observed data at points/stations will be transferred to the central station of the scheme through the telemetry system, and daily water balance as well as water distribution will be calculated by computer system in the central station.

For the purpose that modern mechanized farming shall be introduced to the granary areas in order to solve labour shortage for farming and realize intensive agriculture, the existing infrastructures such as irrigation and drainage facilities and farm roads will be rehabilitated and/or upgraded. In formulating the rehabilitation and upgrading plan of irrigation and drainage facilities, securing sufficient capacity and reducing water loss of the facilities, preserving required water level in the canals and saving O&M cost shall be also taken into consideration. For the improvement plan of farm roads, it shall be considered that the farm roads be used not only for farming but also other purpose such as living transportation, communication and commerce.

The expected benefits from these programs are :

- Effective use of available water
- Optimum, equal and accurate water distribution
- Easy operation and maintenance
- Forwarding mechanized farming

3.3 Proposed Modernization Plan of System Infrastructure

3.3.1 Master Plan for Five Granary Schemes

(1) IADP Pulau Pinang Scheme

Since industrialization is being remarkably developed around this scheme, shortage of labour for farming is one of the major constraints for agricultural activity in the scheme. Further, effective use of water sources, such as Muda, Kulim and Jarak rivers, is also essential for agricultural and industrial activities and domestic water supply. Accordingly, the following measures will be recommended for improvement of the scheme :

Labor-saving : Introducing mechanized farming and telemetry and telecontrol system for water management

Establishment of optimum water distribution system : Effective use of water source for agriculture, industry and domestic supply through the optimum irrigation operation by the telemetry and telecontrol system

In taking consideration of the above items and based on the results of the inventory survey of existing structures, and longitudinal and cross section surveys of existing canals, following improvement plans for system infrastructures in the scheme are formulated in order of the priority :

(a) Rehabilitation and improvement of system infrastructures

- Concrete lining for main and secondary canals including removal of sediment in the canals
- Provision of regulating structures and rehabilitation of damaged structures
- Desilting of tertiary drains
- Pavement and widening of farm roads

(b) Provision of water management facilities (to be connected with telemetry and telecontrol system)

- Installation of water level gauges at major pump stations, headworks, and major diversion points on main and secondary canals (Control and monitoring points)
- Installation of four (4) rainfall stations at representative points of the scheme
- Installation of remote control facilities for major gates and pumps

Proposed control and monitoring points, which are classified into key, second and third points, as well as proposed rainfall stations are as follows :

Control Point

1. Key control point

(i) Sg. Muda Sub-scheme

- Bumbung Lima Pump Station	: Regulate pump up water
- Offtake point to TA. B	: Regulate water distribution to TA. B and control Kawasan M1 and M2
- Offtake point to TA. C	: Regulate water distribution to TA . C and control Kawasan M3
- Offtake point to TA. G	: Regulate water distribution to TA . G and control Kawasan M4 &M5
- Offtake point to TA. H	: Regulate water distribution to TA . H and control Kawasan M6

(ii) Pinang Tunggal Sub-scheme

- Pinang Tunggal Pump Station	: Regulate pump up water

(iii) Sg. Kulim Sub-scheme

- Kulim Headworks	: Regulate intake water

2. Second control point

(i) Sg. Muda Sub-scheme

- Offtake point to TA. CA	: Regulate water distribution to TA. CA and control Kawasan M3
- Offtake point to TA. D	: Regulate water distribution to TA. D and control Kawasan M4
- Offtake point to TA. E	: Regulate water distribution to TA . E and control Kawasan M4 & M5

(ii) Sg. Kulim Sub-scheme

- Offtake point to TA. I	: Regulate water distribution to TA. I and control Kawasan K3 and K4

Monitoring Point

1. Key monitoring point

(i) Sg. Muda Sub-scheme

- Lower reach of offtake for TA. A on main canal
- Lower reach of offtake for TA. F on main canal

(ii) Pinang Tunggal Sub-scheme

- Beginning of TA PS

(iii) Sg. Kulim Sub-scheme

- Lower reach of offtake for TA. 2 on main canal

(iv) Sg. Jarak Sub-scheme

- Sg. Jarak Headworks
- Padang Cempedak Pump Station
- Sg. Kreh Headworks
- Kreh Pump Station

2. Second monitoring point

(i) Sg. Muda Sub-scheme

- Lower reach of offtake for TA. A 9L on TA. A
- Beginning of TA. A3
- Beginning of TA. B2
- Lower reach of offtake for TA. C 7L on TA. C
- Beginning of TA. F1
- Lower reach of offtake for TA. F 8R on TA. F
- Lower reach of offtake for TA. H 2R on TA. H
- Lower reach of offtake for TA. H3 3R on TA. H3

3. Third monitoring point

(i) Sg. Muda Sub-scheme

- Beginning of TA. A1
- Lower reach of offtake for TA. A3-4R on TA. A3
- Beginning of TA. B1
- Beginning of TA. C1
- Beginning of TA. C2
- Beginning of TA. C4
- Lower reach of offtake for TA. F1 on TA. F
- Beginning of TA. F3
- Beginning of TA. F1A
- Beginning of TA. H1
- Beginning of TA. H2

(ii) Pinang Tunggal Sub-scheme

- Lower reach of offtake for TA. PS-2R on TA. PS

(iii) Sg. Kulim Sub-scheme

- Upper reach of offtake for 1-2R on TA. 1

Rainfall Station

- Station R 5503034	: for Sg. Muda Sub-scheme
- P. Tunggal pump station	: for Pinang Tunggal Sub-scheme
- Padang.Cempedak pump station	: for Sg. Jarak Sub-scheme
- Offtake for TA.2	: for Sg. Kulim Sub-scheme

(2) IADP Kerian / Sungai Manik Scheme

(a) Kerian Scheme

In Kerian scheme, drainage improvement especially in Compartment A, B and C will be executed as first priority works, in order to introduce direct seeding and large scale mechanized farming. Water saving is also essential in the scheme due to the large command area and water distribution following irrigation schedule has to be performed taking advantage of storage capacity of Bukit Merah Reservoir. The reservoir is infested with a local variety of aquatic weed, which must be removed periodically so that storage capacity of the reservoir will be maintained.

Following improvement plans for system infrastructures in Kerian Scheme are summarized in order of the priority :

(i) Rehabilitation and improvement of system infrastructures

- Construction of new drains and desilting of existing drains
- Construction of bund
- Provision and rehabilitation of drainage gates
- Concrete lining for main and secondary canals including removal of sediment in the canals
- Provision of regulating structures and rehabilitation of damaged structures
- Pavement and widening of farm roads

(ii) Provision of water management facilities (to be connected with telemetry and telecontrol system)

- Installation of water level gauges at Bukit Merah Reservoir, Bogak Pump Station and major diversion points on main and secondary canals (Control and monitoring points)
- Installation of four (4) rainfall stations at representative points of the scheme
- Installation of remote control facilities for major gates and pumps

Proposed control and monitoring points, which are classified into key, second and third points, as well as proposed rainfall stations are as follows :

Control Point

1. Key control point

- Intake at Bukit Merah Reservoir	: Regulate intake discharge to Terusan Besar & Terusan Selinsingn and control Compartment G & H
- Offtake point to Terusan Alor Pongsu	: Regulate water distribution to Terusan Alor Pongsu and control Compartment D, E & F
- Offtake point to Terusan Tg.Piandang	: Regulate water distribution to Terusan Tg. Piandang and control Compartment B & C
- Offtake point to TA. 218	: Regulate water distribution to TA 218 and control Compartment A
- Bogak Pump Station	: Regulate pump up water

2. Second control point

- Offtake point to TA. Kolam 1167
- Offtake point to TA. 74
- Offtake point to TA. 136

Monitoring Point

1. Key monitoring point

- Lower reach of offtake for TA. Haji Ali on Terusan Besar
- Lower reach of offtake for TA. 804 KI, KN on Terusan Besar
- Lower reach of offtake for TA. Sg. Dungan 1088 on Terusan Besar
- Lower reach of offtake for TA. 303 on Terusan T. Serong
- Lower reach of offtake for TA. 195 on Terusan Serinsing
- Upper reach of offtake for TA. 1B on Terusan Serinsing
- Lower reach of offtake for TA. Alor Pongsu 3 on Terusan Alor Pongsu

2. Second monitoring point

- Beginning of TA. 315
- Beginning of TA. 1B
- Beginning of TA. 539 Ki
- Beginning of TA. Alor Pongsu 3
- Beginning of TA. Panchor 2/1
- Beginning of TA. 310 A
- Beginning of TA 303
- Beginning of TA. Air Hitam

3. Third monitoring point

- Beginning of TA Tebok Panchor-A
- Beginning of TA Ali Kalang 2
- Beginning of TA Hj. Aman 2/1
- Beginning of TA Haji Ali
- Lower reach of offtake for TA. Ismail 2/1
- Lower reach of offtake for TA. 1088 KN-B
- Beginning of TA 16
- Beginning of TA 206
- Beginning of TA Sg. Tongkan
- Beginning of Sg. Udang
- Beginning of TA 375
- Beginning of TA 539
- Beginning of TA 564 Kn

Rainfall Station

- Station Jalan Baru	: for Compartment A, B and C
- Station Alor Pancor	: for Compartment D, E and F
- Station FCD Simpang Empat	: for Compartment G
- Bukit Merah	: for Compartment H

Operation and maintenance manual containing the method and frequency of weeding of aquatic weed in the reservoir should be prepared for preservation of the storage capacity of the reservoir.

(b) Sungai Manik Scheme

There is sufficient water available for irrigation in the area, however, operation and maintenance of the system is not adequately performed. Silting at the downstream of intake structures, erosion of tertiary canal banks and damaged related structures are observed and subsequently, water distribution is not accurately done. Especially in Sungai Manik sub-scheme, tertiary canals are earthen and land consolidation is not sufficiently executed. Operation and maintenance of tertiary canals and downwards is planned to be handed over to

farmers in future. Therefore, concrete lining over tertiary canals should be introduced for easy operation and maintenance as well as cost reduction. In this scheme, upgrading of the existing facilities will be given high priority. Since drainage problem in the downstream area is found in the rainy season, improvement of drainage facilities is also to be executed.

Based on the results of site reconnaissance, inventory survey and canal route survey, rehabilitation and improvement plans of system infrastructures in this scheme are summarized below, in order of the priority :

(i) Rehabilitation and improvement of system infrastructures

- Construction of settling basin at downstream of intake structure
- Concrete lining for main and secondary canals including removal of sediment in the canals
- Provision of regulating structures and road crossing structures, and rehabilitation of damaged structures
- Desilting of main drains
- Pavement and widening of farm roads

(ii) Provision of water management facilities (to be connected with telemetry and telecontrol system)

- Installation of water level gauges at intake, Rambai diversion weir and major diversion points on main and secondary canals (Control and monitoring points)
- Installation of two (2) rainfall stations at representative points of the scheme
- Installation of remote control facilities for major gates

Proposed control and monitoring points, which are classified into key, second and third points, as well as proposed rainfall stations are as follows :

Control Point

1. Key control point

- Intake at Headworks	: Regulate intake discharge to Sungai Manil sub-scheme and Labu Kubong sub-scheme (both beginning of left & right main canals)
- Downstream of diversion weir on left main canal	: Regulate water distribution to TA No.5 and control Block 1A, 1B, 2 and 3B

- Offtake point to TA No.2 : Regulate water distribution to TA No.2 and control Block 1A
- Offtake point to TA. No.4 : Regulate water distribution to TA No.4 and control Block 4A and 4B
- Offtake point to TA. No.7 : Regulate water distribution to TA No.7 and control Block 5A and 5B

Monitoring Point

1. Key monitoring point

- Cikus Pump Station
- Lower reach of offtake for TA. 6-6L on TA. No.6

2. Second monitoring point

- Lower reach of offtake for TA. 1-8R on TA. No.1
- Lower reach of offtake for TA. 7-4R on TA. No.7

3. Third monitoring point

- Lower reach of offtake for TA. 2-4R on TA. No.2
- Lower reach of offtake for TA. 5-5R on TA. No.5
- Lower reach of offtake for TA. 3A-3R on TA. No.3A
- Lower reach of offtake for TA. 6-3R on TA. No.6
- Lower reach of offtake for TA. 6-8R on TA. No.6
- Lower reach of offtake for TA. 7-2R on TA. No.7

Rainfall Station

- Existing station R 4010138 : for Sungai Manik sub-scheme
- Offtake point to TA. 7-4R : for Labu Kubong sub-scheme

(3) IADP Seberang Perak Scheme

For intake of water from Perak river, gate control is manually done, however, the operation does not correspond to the change of water level and irrigation schedule, so occasionally, main canal conveys more than designed volume of water and the water level comes up close to the top of canal embankment. Judging from the results of canal longitudinal and cross sectional survey, silting and erosion are found seriously in main canals. As regards paddy fields, land consolidation is not fully achieved, which is conspicuous particularly in Block A and water diversion is not performed as scheduled, either.

As same as the case in Sungai Manik scheme, there is ample water available in this Scheme. Consequently, taking into above points into consideration, emphasis of rehabilitation

and improvement plan will be laid on upgrading of facilities, which are summarized in order of the priority :

(a) Rehabilitation and improvement of system infrastructures

- Removal of sediment and reshaping of main canal
- Concrete lining for secondary and tertiary canals
- Provision of regulating structures and spillway, and rehabilitation of damaged structures
- Desilting of main drains
- Construction of new farm roads and widening of existing farm roads along tertiary canals

(b) Provision of water management facilities (to be connected with telemetry and telecontrol system)

- Motorization of intake and bifurcation gates
- Installation of water level gauges at intake, bifurcation and major diversion points on main and secondary canals (Control and monitoring points)
- Installation of two (2) rainfall stations at representative points of the scheme
- Installation of remote control facilities for major gates

Proposed control and monitoring points, which are classified into key, second and third points, as well as proposed rainfall stations are as follows :

Control Point

1. Key control point

- Teluk Sena Intake	: Regulate intake discharge
- Bifurcation	: Regulate water distribution to Left and Right Branch Canals (both beginning of branch canals)
- Offtake point to Branch canal L1on Right Branch Canal	: Regulate water distribution to Branch canal L1 and control Block E and F
- Offtake point to Branch canal R4 on Right Branch Canal	: Regulate water distribution to Branch canal R4 and control Block G

2. Second control point

- Offtake point to secondary canal S3L

on Left branch canal	: Regulate water distribution to secondary canal S3L and control Block A
- Offtake point to secondary canal R7 on Right branch canal	: Regulate water distribution to secondary canal R7
- Offtake point to secondary canal R4b3 on branch canal R4	: Regulate water distribution to secondary canal R4b3

Monitoring Point

1. Key monitoring point

- Lower reach of offtake for secondary canal S4L on Left Branch canal
- Lower reach of offtake for secondary canal S5L on Left Branch canal
- Lower reach of offtake for branch canal R4 on Right Branch canal
- Lower reach of offtake for secondary canal L1b2 on branch canal L1b

2. Second monitoring point

- Lower reach of offtake for T1SL on Left branch canal
- Lower reach of offtake for T5S3L on secondary canal S3L
- Lower reach of offtake for L1b4 on branch canal L1b
- Lower reach of offtake for secondary canal R7 on Right branch canal
- Lower reach of offtake for secondary canal R4b1 on branch canal R4

3. Third monitoring point

- Beginning of Secondary canal S1L
- Beginning of Secondary canal S2L
- Beginning of Secondary canal S4L
- Beginning of Secondary canal L1c
- Beginning of Secondary canal L1b1
- Beginning of Secondary canal L2
- Beginning of Secondary canal L1b3
- Beginning of Secondary canal L3
- Beginning of Secondary canal L1b5
- Beginning of Secondary canal L1b6
- Beginning of Secondary canal L1b7
- Beginning of Secondary canal L1a
- Beginning of Secondary canal L1d
- Beginning of Secondary canal L5
- Beginning of Secondary canal R7
- Beginning of Secondary canal L6

- Beginning of Secondary canal R8
- Beginning of Secondary canal L7

Rainfall Station

- Lower reach of offtake for secondary canal S4L on Left Branch canal : for Left branch canal sub-scheme
- Lower reach of offtake for branch canal R4 on Right Branch canal : for Right branch canal sub-scheme

(4) IADP Kemasin-Semerak Scheme

As for this Scheme, in Semerak area, flood mitigation project is under progress and six(6) sub-schemes (Semerak Hilir, Semerak Hulu, Semerak Selatan, Semerak Barat, Sungai Yong-Gaal and Jeram Rasau) are scheduled to be implemented after the flood mitigation project is completed. Kemubu Pumping Station, located in adjacent KADA area, is to supply 35 % (16 m^3/sec) of its intake water to Kemasin-Semarak, however, since the sub-schemes are yet to be operated, the distribution from the pump station is not commenced as planned. Water distribution plan in this area should be decided based on the design review of the six sub-schemes taking into consideration of the two completed sub-schemes (Kemasin Hilir and Jelawat Rusa) and KADA area as well. Facilities in the two completed schemes are relatively well operated and maintained, however, reconsideration shall be necessary based on the results of the review of water distribution plan.

Consequently, in the Study, the following rehabilitation and improvement plans for system infrastructures are formulated as regards two on-going projects, namely Kemasin Hilir and Jelawat Rusa.

(a) Rehabilitation and improvement of system infrastructures

- Rehabilitation of damaged structures
- Desilting of main drains
- Widening of existing farm roads along tertiary canals

(b) Provision of water management facilities (to be connected with telemetry and telecontrol system)

- Installation of water level gauges at major pump stations (Control and monitoring points)
- Installation of two (2) rainfall stations at representative points of the scheme

Proposed control and monitoring points, which are classified into key, second and third points, as well as proposed rainfall stations are as follows :

Monitoring Point

1. Key monitoring point

- Pump station for Jerawat Rusa sub-scheme Block A0
- Pump station for Jerawat Rusa sub-scheme Block B0
- Pump station for Jerawat Rusa sub-scheme Block C0

2. Second monitoring point

- Booster pump station for Jelawat Rusa sub-scheme Block B1
- Booster pump station for Jelawat Rusa sub-scheme Block C1
- Pump station for Kemasin Hilir sub-scheme Block A
- Pump station for Kemasin Hilir sub-scheme Block B
- Pump station for Kemasin Hilir sub-scheme Block C
- Pump station for Kemasin Hilir sub-scheme Block D
- Pump station for Kemasin Hilir sub-scheme Block E

Rainfall Station

- Pump station for Jerawat Rusa sub-scheme Block C0
  : for Jerawat Rusa sub-scheme

- Existing rainfall station R 6024074 : for Kemasin Hilir sub-scheme

(5) IADP Ketara (Besut) Scheme

According to the results of water balance study, it is judged that water shortage of this scheme is serious and effective water intake and water saving are given the highest priority. Intake structures in this scheme are Angga and Besut Barrages. The former is considerably deteriorated and substantially out of operation and the latter is troubled with seepage through old gates. Therefore, rehabilitation of the both barrages should be given the first priority. For water saving, operational loss and loss from structures themselves have to be controlled as much as possible. In order to achieve this purpose, introduction of telemetry and telecontrol system will be utilized to enable appropriate gate operation to evade unnecessary water distribution. In addition, water loss should be controlled through introduction of concrete lining on canals. As a matter of fact, secondary and tertiary canals in this scheme are concrete lined to significant extent, so, the lining plan will be centered around main canal lining taking into consideration the ease of operation and maintenance in the future. There are many small size farm plots in the area and so, plot readjustment should be considered for mechanized farming.

Rehabilitation and improvement of system infrastructures in this scheme are summarized as follows:

(a) Rehabilitation and improvement of system infrastructures

- Replacement of Angga Barrage
- Repair of Besut Barrage gates
- Concrete lining for main, secondary and tertiary canals
- Heightening of lining
- Provision of regulating structures and rehabilitation of damaged structures
- Desilting of main drains and provision of drainage controls
- Pavement of farm roads along main canals and widening of existing farm roads along tertiary canals

(b) Provision of water management facilities (to be connected with telemetry and telecontrol system)

- Installation of water level gauges at Besut and Angga barrages and major diversion points on main and secondary canals (Control and monitoring points)
- Installation of three (3) rainfall stations at representative points of the scheme
- Installation of remote control facilities for major gates

Proposed control and monitoring points, which are classified into key, second and third points, as well as proposed rainfall stations are as follows :

Control Point

1. Key control point

- Intake at Besut Barrage	: Regulate intake discharge to Besut main canal and control Compartment 1
- Offtake point G on Besut main canal	: Regulate water distribution to H and control Compartment 3 & 4
- Intake at Angga Barrage	: Regulate intake discharge to Angga main canal and control Compartment 2

2. Second control point

- Offtake point E on Besut main canal	: Regulate water distribution to TA. Telaga Nibong and control Compartment 3 &4
- Offtake point M on Besut main canal	: Regulate water distribution to M-M1 and control Compartment 3

Monitoring Point

1. Key monitoring point

- Lower reach of offtake point E on Besut main canal
- Lower reach of offtake point M on Besut main canal
- Offtake point O on Besut main canal
- Upper reach of offtake point R on Angga main canal

2. Second monitoring point

- Beginning of TA. Lubuk Lawah (point B on Besut main canal)
- Upper reach of offtake point E on Besut main canal
- Lower reach of offtake point N on Besut main canal
- Lower reach of offtake point H on Besut main canal
- Lower reach of offtake point S on Angga main canal

3. Third monitoring point

- Beginning of TA. Lubuk Agu
- Beginning of TA. Gong Kulim
- Beginning of TA. Kubang Depu
- Beginning of TA. Lulau Ribu
- Beginning of TA. TG. Gelai
- Beginning of TA. FC1/FG
- Beginning of TA. HH1
- Beginning of TA. IJ
- Beginning of TA. M1a
- Beginning of TA. M1b
- Beginning of TA. NN1
- Beginning of TA. PP1
- Beginning of TA. QQ1
- Beginning of TA. Q2a
- Beginning of TA. Q2b
- Beginning of TA. Padang Baloh
- Beginning of TA. Awek
- Beginning of TA. RR1
- Beginning of TA. SS1

Rainfall Station

- Besut Barrage : for Compartment 1
- Point O of Besut main canal : for Compartment 3 and 4
- Point R of Angga main canal : for Compartment 2

Rehabilitation and improvement plans for system infrastructures in five(5) granary areas in mater plan level are given in Table II-19. General plans of telemetry and telecontrol system are shown in Fig. II-18 to Fig. II-23.

(6) Implementation Schedule

The works for modernization of water management system in the granary areas are formulated in the maintenance of hard and soft sides. The former consists of rehabilitation / improvement of system infrastructures and in-field infrastructures and establishment of water management / monitoring facilities, and the latter comprises of training of water users' group. In order to achieve the target yield of 5.5 ton/ha in 2010 in the National Agricultural Policy, it is scheduled that the works are to be commenced from 1999 and completed in 2006. In Kemasin / Semerak scheme, it is essential to complete on-going Flood Mitigation Project as early as possible and to start the modernization works. The implementation schedule for system infrastructure improvement as well as other works mentioned above in the five granary schemes is shown in Fig. II-24.

3.3.2 Feasibility Study for Selected Three Schemes

(1) Kerian Scheme

(a) Irrigation Facilities

Through the water balance study, it is confirmed that required irrigation water can be supplied by Bukit Merah Reservoir and Bogak Pump Station. However, due to the difficulty to secure the required water level at several diversion points, water shortage is sometimes found in the downstream areas. Accordingly, it is proposed to provide regulating structures with a monitoring function connecting with telemetry system for proper water distribution. The existing diversion structures are relatively in well conditions, however, replacement of gates is required at a part of damaged portions. Further, concrete lining is to be introduced to main and secondary canals in order to reduce canal losses because it does not leave much space for available irrigation water in the scheme. Rehabilitation and improvement plans for irrigation facilities in the scheme are summarized below and shown in Table II-20.

(i) Concrete lining : Main canals 62 km, secondary canals 40 km including removal of sediment in the canals

(ii) Provision of regulating structures : On main canal 7 nos., on secondary canal 8 nos.

(iii) Rehabilitation of damaged structures : Replacement of diversion gates 16 nos., replacement of gate spindle 2 nos.

(b) Drainage Facilities

Improvement of drainage facilities in Compartment A, B and C is the most important measures in the scheme, which aims to increase baring capacity of the fields for direct seeding

and large scale mechanized farming. Moreover, drainage improvement in Compartment D is also essential, where organic soil exists.

DID has a drainage improvement plan for about 4,500 ha mainly in Compartment B and C as Drainage Polder Project, consisting following items :

- Construction of bund
- Construction of additional drainage gates
- Desilting of existing drains
- Provision of additional drainage pipe
- Construction of new drains
- Provision of drainage pump

Pilot project covering 330 ha has been commenced in June 1997 and is to be completed in March 1998. Based on the plan of the drainage polder project, improvement plans for drainage facilities in Kerian scheme are given below and presented in Table II-20.

(i) Rehabilitation and construction of drainage gates
: Tidal gate 2 nos., drainage control structures 120 nos.

(ii) Desilting of drains : 580 km

(iii) Construction of bund : 153 km

(iv) Construction of additional drains
: 17 km

(v) Provision of drainage pump : 10 nos.

(vi) Others : Drainage pipes etc.

(c) Farm Roads

Alignment of farm roads in the scheme are relatively well and those are being utilized not only for farming but also for other purposes such as living transportation, communication and commerce. Farm roads along main and secondary canals have sufficient width for traveling of vehicle and farm machinery, however, those surfaces are in dumpy conditions in the rainy season. Road width along several tertiary canals is insufficient for farm machinery traveling, which is about 1.0 m. Accordingly, pavement of road surfaces along main canals and widening of tertiary roads are proposed in taking consideration of large scale mechanized farming and future growth of the region. Improvement plans of farm road in the scheme are summarized below :

(i) Pavement : Asphalt pavement along main canals 40 km

(ii) Widening : 100 km along tertiary canals

(d) Water Management Facilities

Since it does not leave much space for available irrigation water in the scheme, advantage of storage capacity of Bukit Merah Reservoir should be maintained avoiding to take excess water as well as reducing canal losses mentioned above. It is proposed to introduce a central management system for adequate intake and proper water distribution, providing control and monitoring points at major intake and diversion structures together with rainfall stations at the representative locations of the scheme. Those points are classified into key points, second points and third points depending on their importance.

(i) Key Control Point

The Kerian scheme consists of eight (8) compartments and same irrigation schedule is applied within the respective compartment. Therefore, five (5) key control points are proposed at Bukit Merah Reservoir, Bogak Pump Station and three (3) diversion points in order to regulate intake water and diversion water to the compartments. Water level gauges, remote control gates and remote control panels for pumps are installed at those points.

(ii) Second Control Points

Other than key control points, three (3) second control points are planned at the diversion structures, of which inadequate operation gives much affects to proper water distribution in the scheme. At those points, water level gauges and remote control gates are also provided.

(iii) Key Monitoring Points

Seven (7) key monitoring points are established on main canals with an interval of about 1,000 ha command, in order to confirm whether the water distribution is proper or not. These points are installed on regulating structures (check gate) provided through improvement works of irrigation facilities. Water level gauges are equipped at the points to check canal discharge as well as supply water level.

(iv) Second Monitoring Points

Eight (8) second monitoring points are proposed at beginning of secondary canals commanding more than 500 ha, to inspect distributed discharge by water level gauges.

(v) Third Monitoring Points

8 compartments are comprised of 28 irrigation service blocks in the scheme Thirteen (13) third monitoring points are added to the above key and second points in order to check water distribution to those irrigation service blocks.

Table II-21 shows locations and required works for provision of those control and monitoring points.

(e) Rainfall Stations

Effective use of rainfall to irrigation as well as avoiding excess water supply is essential for saving water from the water sources. For this purpose, rainfall stations are provided at the representative locations of the scheme in order to calculate daily water requirement and to execute proper operation of water distribution through the control and monitoring points mentioned above. Since Kerian scheme has a large scale of irrigation area (about 24,000 ha), pattern of rainfall is different in region by region. In taking consideration of this and irrigation schedule of each compartment, following four (4) rainfall stations are proposed for water management in the scheme. Those are existing stations, however, the installment are to be replaced due to their superannuating.

- Station Jalan Bahru : for Compartment A,B and C
- Station Alor Pancor : for Compartment D, E and F
- Station FCD Simpang Empat : for Compartment G
- Station Bukit Merah : for Compartment H

The control points, monitoring points and rainfall stations are to be connected with telemetry and telecontrol system for the central management as presented in Fig. II-25.

(2) Besut Scheme

(a) Irrigation Facilities

Existing irrigation facilities in the scheme have been in superannuated conditions, and proper water distribution is being disturbed by leakage of water from Besut Barrage gates, difficulty of operation of Angga intake gates, damage of canal diversion gates, insufficient canal height, etc. Further, it seems difficult to achieve the target crop intensity under the available water from Besut and Angga Barrage estimated in the water balance study. Accordingly, the recovery of effective water intake from both barrages is put on the highest priority works in the scheme. In addition, rehabilitation and improvement of irrigation facilities as well as provision of water management facilities are also to be executed for reducing canal losses and adequate water distribution. Those plans are summarized below and given in Table II-22.

(i) Replacement of Angga Barrage

Due to long time use of about 50 years and manual operation type of Angga barrage gates, operation of both intake and barrage gates can not be done properly and

renewal of Angga Barrage is proposed. In taking consideration of seasonal fluctuation of water level in Angga river, which sometimes reaches up to 6 times of gate height in October to December, and smooth flow of the flood, same type as the present barrage is planned for the replacement. Dimensions of gates are shown below : (refer to Fig. II-26)

- Barrage gates : Radial gate 2 nos., width 7.6m and height 1.2 m each
- Intake gate : Sluice gate 2 nos., width 1.3 m and height 1.0 m each

Those gates are to be connected with telemetry and telecontrol system for the central management.

(ii) Rehabilitation of Besut Barrage Gates

In order to maintain required intake water level, settlement of water leakage from Besut Barrage gates is urgently required. DID has two improvement programs of the barrage, which are a repair plan of barrage gates as a short term measure and a renewal plan of the barrage as long term programs called "Besut Barrage Improvement Plan". However, details of the latter have not been published yet because the final plan is under examination. Since present condition downward intake is unchanged in both plans, repair of barrage gates shown below is adopted in this study.

- Barrage gate : Roller gate 4 nos., width 12.32 m and height 2.95 m each

3 intake gates, which are electric moving slide type with 1.93 m width and 2.49 m height, are in well conditions. These gates are modified for telecontrol operation in provision of the water management system.

(iii) Rehabilitation and Improvement of Irrigation Facilities

Since available water for irrigation in the scheme is rather limited, it is essential to save canal losses and distribute water effectively. Concrete lining, reshaping of canal, repair of damaged diversion gates, provision of regulating structures, etc. are proposed for these measures as shown below and the details are given in Table II-22.

- Concrete lining : Main canals 4.4 km, secondary canals 16.9 km, tertiary canals 3.0 km
- Heightening of lining : Main canals 8.8 km, secondary canals 2.8 km
- Provision of regulating structures : On main canal 5 nos., on secondary canal 1 no.
- Rehabilitation of damaged structures : 74 nos.

(b) Drainage Facilities

Condition of drainage facilities in the scheme is relatively well, however, a part of downstream area is flooded in October to December. Accordingly, following improvement works are planned :

(i) Desilting of main drains : 16 km
(ii) Construction of drainage control : 15 nos.

(c) Farm Roads

Asphalt pavement for un-paved portions of farm road along main canals, and widening and laterite pavement along tertiary canals are proposed. Up to 2.5 m widening is planned in taking consideration of mechanized farming. Details are shown in Table II-22.

(i) Pavement along main canal : Asphalt pavement 8 km
(ii) Widening and laterite pavement along tertiary canals : 27 km

(d) Water Management Facilities

In addition to the improvement of irrigation facilities mentioned in the above (a), proper operation of diversion gates as well as even water distribution is important in Besut scheme. For this purpose, central water management system is introduced providing control and monitoring points at intake and major diversion structures, and rainfall station at representative locations in the scheme. Those points are classified into key point, second point and third point.

(i) Key Control Point

The Besut scheme consists of four (4) compartments and those are irrigated in two phases (phase-I for Compartment 1, 4 and a half of Compartment 2 and phase-II for Compartment 3 and remainder of Compartment 2). Therefore, three (3) key control points are proposed at Besut and Angga intakes and one (1) diversion point in order to regulate intake water and diversion water to the compartments. Water level gauges and remote control gates are installed at those points.

(ii) Second Control Points

Two (2) second control points are provided at the diversion structures to get more proper water distribution in the scheme. At those points, water level gauges and remote control gates are also provided.

(iii) Key Monitoring Points

Monitoring points are established at the diversion points E, M, O on Besut main canal and point W on Angga main canal, of which mis-operation gives much affects to the proper water distribution in the respective compartment. These points are installed on regulating structures (check gate) provided through improvement works of irrigation facilities. Water level gauges are equipped at the points to check whether diversion gate operations are adequate or not.

(iv) Second Monitoring Points

Five (5) second monitoring points equipped water level gauges are proposed in order to get more accurate water distribution within the compartments.

(v) Third Monitoring Points

4 compartments are comprised of 30 irrigation groups (Kumplan Pertani). Nineteen (19) third monitoring points are added to the above key and second points in order to check water distribution to those irrigation groups.

Table II-23 shows locations and required works for provision of those control and monitoring points.

(e) Rainfall Stations

Effective use of rainfall to the irrigation, following three (3) rainfall stations are provided at the representative locations of the scheme in order to calculate daily water requirement and to execute proper operation of water distribution through the control and monitoring points mentioned above.

- Besut Barrage : for Compartment 1
- Point O of Besut main canal : for Compartment 3 and 4
- Point R of Angga main canal : for Compartment 2

The control points, monitoring points and rainfall stations are to be connected with telemetry and telecontrol system for the central management as presented in Fig. II-27.

Drainage water is utilized for irrigation in the scheme by six (6) recycle pump stations as shown in Table II-24. Effective use of those pumps through the central water management is essential to hold water shortage to a minimum.

(3) Pulau Pinang Scheme

(a) Irrigation Facilities

Major subjects in the scheme are labour-saving for water management and farming and proper distribution of water sources such as Muda river, Kulim river and Jarak river for agriculture, industry and domestic supply. Provision of concrete lining and water management facilities are proposed as the measures. There are insufficient structures in Sungai Jarak sub-scheme which result in low yield. Additional structures such as regulating structures are provided to this sub-scheme. Rehabilitation and improvement plans for irrigation facilities in Pulau Pinang Scheme are summarized below and given in Table II-25.

(i) Concrete lining : Main canals 35 km, secondary canals 79 km including removal of sediment in the canals

(ii) Provision of regulating structures : On main canal 6 nos., on secondary canal 12 nos.

(iii) Rehabilitation of damaged structures : Replacement of diversion gates 2 nos.

(b) Drainage Facilities

Condition of drainage facilities in the scheme is relatively well, however, following desilting works are planned in tertiary drains

(i) Desilting of tertiary drains : 40 km

(c) Farm Roads

One of the major subjects in the scheme is improvement of farm roads, which makes large scale mechanized farming possible. Since the area in / around the scheme is well developed, the farm roads are utilized not only for farming but also for commerce and living transportation. Accordingly, farm roads along main canals are proposed to be paved by asphalt. Farm roads along tertiary canals, which have narrow width for mechanized farming, widening up to 2.5 m is planned. Improvement plans of farm roads in the scheme are shown below and the details are presented in Table II-25.

(i) Pavement along main canal : Asphalt pavement 11 km

(ii) Widening along tertiary canals : 100 km

(d) Water Management Facilities

For effective use of water sources to agriculture, industry and living supply, it is essential to grasp required irrigation water immediately and to avoid excess water intake. For

this purpose, central water management system is introduced providing control and monitoring points at intake and major diversion structures, and rainfall station at representative locations in the scheme. Those points are classified into key point, second point and third point. Since irrigation schedule is established in the sub-schemes individually, those points are planned in the respective sub-scheme.

(i) Key Control Point

- Sungai Muda sub-scheme is divided into six (6) blocks and irrigation schedule in the sub-scheme is set up in the respective blocks. Accordingly, five (5) key control points are proposed to regulate intake water at Bumbong Lima Pump Station and diversion water to the each block.
- In Pinang Tunggal sub-scheme, a key control point is provided to regulate intake water at Pinang Tunggal Pump Station because total irrigation area in the sub-scheme is rather small (less than 1,000 ha).
- Sungai Kulim sub-scheme is also established a key control point at Kulim Headworks in order to manage the whole area.
- Since command area of 388 ha in Sungai Jarak sub-scheme is quite small, water management in the sub-scheme is executed by monitoring point.

Water level gauges, remote control gates and remote control panels for pumps are installed at those points.

(ii) Second Control Points

- In Sungai Muda sub-scheme, three (3) second control points other than above key control points are provided at the diversion structures, of which mis-operation gives much affects to the proper water distribution in the sub-scheme.
- In Sungai Kulim sub-scheme, a second control point is established in order to regulate Block K3 and K4.

At those points, water level gauges and remote control gates are also provided.

(iii) Key Monitoring Points

- In Sungai Muda sub-scheme, two (2) key monitoring points are installed at downstream of diversion structures on main canal, where key control points are not planned. Those confirm whether discharge and water distribution on main canal are proper or not.
- In Pinang Tunggal sub-scheme, a key monitoring point are set up at the point diverted from TA. PB to TA. PS.

- In Sungai Kulim sub-scheme, a key monitoring point is provided at the lower reaches of the point which isn't being controlled in the key control point mentioned above.
- In Sungai Jarak sub-scheme, where key control points are not provided, four (4) key monitoring points are installed at Sungai Jarak and Sungai Kreh headworks and Padang Cempedak and Kreh pump stations.

Water level gauges are equipped at the points to check canal discharge.

(iv) Second Monitoring Points

- Second monitoring points are proposed to be provided on secondary canals in Sungai Muda sub-scheme in taking consideration of its large scale command. Respective block in the sub-scheme mentioned above (i) is irrigated by three stages, so eight (8) second monitoring points are installed at the points to check water distribution for those blocks as well as at beginning of secondary canals covering about 500 ha command. Water level gauges are equipped at those points.

(v) Third Monitoring Points

- In Sungai Muda sub-scheme, eleven (11) third monitoring points are installed at the points diverting water from secondary canals to tertiary canals, which are not being controlled in the key and second points mentioned above.
- In Pinang Tunggal sub-scheme, a third monitoring point is provided at middle reaches of main canal TA. PS.
- In Sungai Kulim sub-scheme, a third monitoring point is installed at boundary point of block K2A and K2B on secondary canal, which covers block K2.

Table II-26 shows locations and required works for provision of those control and monitoring points.

(e) Rainfall Stations

Following four (4) rainfall stations are provided at the representative locations in the each sub-scheme in order to calculate daily water requirement and to execute proper water distribution through the control and monitoring points mentioned above. Existing station is utilized for Sungai Muda sub-scheme, however, the installment are to be replaced due to their superannuating.

- Station R 5503034 : for Sg. Muda sub-scheme
- P. Tunggal Pump Station : for Pinang Tunggal sub-scheme
- Padang Cempedak Pump Station

: for Sungai Jarak sub-scheme

- Offtake point for TA. 2 : for Sungai Kulim sub-scheme

The control points, monitoring points and rainfall stations are to be connected with telemetry and telecontrol system for the central management as presented in Fig. II-28.

(4) Implementation Schedule

A degree of execution priority of rehabilitation and improvement of system infrastructure in the scheme is put in order of (i) drainage facilities, (ii) irrigation facilities, (iii) farm road and (iv) water management facilities in Kerian, (i) replacement of Angga Barrage, (ii) Repair of Besut Barrage gates, (iii) irrigation facilities, (iv) drainage facilities, (v) farm road and (vi) water management facilities in Besut and (i) irrigation facilities, (ii) drainage facilities, (iii) farm road and (iv) water management facilities in Pulau Pinang. However, taking into consideration of the achievement of the target of the National Agricultural Policy in 2010, the works for modernization of water management system in those schemes such as improvement of system infrastructure and in-field infrastructure and establishment of water management / monitoring system will be commenced from 1999 and completed in 2006. Training of water users' group, which will be put the management of tertiary system, will be executed in parallel with the above works. Implementation schedule for Kerian, Besut and Pulau Pinang Schemes in feasibility study level, which include improvement of system infrastructure and in-field infrastructure and establishment of water management / monitoring system as well as training of water users' group, are shown in Fig. II-29, Fig. II-30 and Fig. II-31, respectively.

The proposed modernization plans of system infrastructures in the selected three schemes comprising of general plan, typical lining sections and canal related structures are given in Fig. II-32 to Fig. II-43.