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**KEMENTERIAN PERTANIAN MALAYSIA**

**UPGRADING OF IRRIGATION SCHEMES  
IN  
BALIK PULAU AND SEBERANG PERAI  
PULAU PINANG**

**INCEPTION REPORT**

**MARCH 1981**

**BINNIE DAN RAKAN (M)**

**KUALA LUMPUR**  
in association with

**HUNTING TECHNICAL SERVICES LTD.**  
UNITED KINGDOM

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BINNIE DAN RAKAN (MALAYSIA)

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31st March 1981

Tuan,

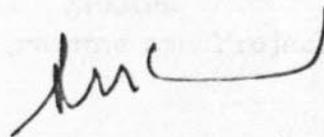
Upgrading of irrigation schemes in Balik Pulau  
and Seberang Perai, Pulau Pinang

We have pleasure in submitting herewith our Inception Report for the above study. As requested by the Technical Committee the Report contains separate sections on Balik Pulau and Seberang Perai, although the majority of the contents are common to both areas. For this reason the suggestion to produce two separate reports was not adopted.

The contents list and details of proposed sample areas were tabled at the Technical Committee meeting held on 16th March 1981. After that date we proceeded to finalise the report; in the period since we have not received any further comments or instructions from the Committee.

Yang benar,  
BINNIE DAN RAKAN (MALAYSIA)

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Abbreviations used in this report

DID	Drainage and Irrigation Department
DOA	Department of Agriculture
FMP	Fourth Malaysia Plan
FOA	Farmers' Organisation Authority
MARDI	Malaysian Agricultural Research and Development Institute
MMS	Malaysian Meteorological Service
MOA	Ministry of Agriculture
NEP	New Economic Policy
SEPU	State Economic Planning Unit
TMP	Third Malaysia Plan
TOR	Terms of Reference
Sg.	Sungai
Kg.	Kampung
in.	inches
ch.	chains
mi.	miles
m	metres
ac	acres
ha	hectares
m-m	man-months

## LIST OF CONVERSION UNITS

Throughout this report the fps (foot, pound, second) system of weights and measures has been used.

Abbreviations used are listed below together with equivalent units in the metric system.

MS	=	Malaysian dollar (ringgit)
1 inch (in)	=	25.4 millimetres (mm)
1 foot (ft)	=	0.305 metre (m)
1 mile	=	1.6 kilometre (km)
1 square foot (sq ft)	=	0.093 square metre (m <sup>2</sup> )
1 acre	=	0.405 hectare (ha)
1 square mile (sq mile)	=	2.59 square kilometres (km <sup>2</sup> ) or 259 ha
1 ton	=	1.016 tonne
1 chain = 66 ft	=	20.1m
1 gantang = 5.6 lb	=	2.5 kg
100 gantang/acre	=	0.63 tonnes/ha



# 1. THE NEED FOR THE STUDY

## 1.1 The study area

1.1.1 The study area consists of mainly agricultural lands in all the three districts of Seberang Perai and in the South-West district of Penang Island. In the Butterworth-Bukit Mertajam area and in the southern half of Penang Island, the study area is dominated by urban and industrial development.

1.1.2 Figure 1 shows the location of the irrigation and drainage schemes to be studied and their relation to these urban and industrial centres and the road system.

## 1.2 Urban and industrial development

1.2.1 The need for upgrading existing irrigation and drainage schemes becomes apparent when the existing and proposed development of the State of Penang is considered. Based on the 1980 census and growth since that time, the population of the state is nearly one million.<sup>1</sup> Outside Kuala Lumpur conurbation, with a forecast population of 1.35 million,<sup>2</sup> this represents the biggest concentration of population in Malaysia and reflects the growing industrial importance of the area.

1.2.2 The state's potential for attracting new industries, particularly in the fields of electronic component assembly and light engineering generally, has been enhanced by the development of the international airport at Bayan Lepas, some 10 miles south of Georgetown. Because of the facilities and infrastructure already available in development terms, the island has been likened to Hong Kong and Singapore with the added advantage that at present industrial labour is cheaper; industries that automatically looked to Hong Kong and Singapore as a good manufacturing base are now looking increasingly to Penang.

---

<sup>1, 2</sup> A list of references is included at the end of the report.

### 1.3 Future development

1.3.1 The development of the state is being given a further boost by the construction of a toll bridge linking the island with the mainland and by the construction of a motorway running southwards to Kuala Lumpur and Johor and northwards to Alor Setar. Such a road system will mean that Penang will be within 4 to 5 hours driving time from the capital.

1.3.2 The west side of the island and the town of Balik Pulau will also become more accessible and subject to increased development pressure when the more direct mountain road, at present under construction between the town and the east coast road network, is completed. Already the labour force in the Balik Pulau area is being attracted to work in the new industrial estates near the international airport, and further disruption of agriculture could occur when the new township of Pondok Upih, planned to be sited near Balik Pulau, is established.

1.3.3 On the mainland, too, the development impetus that the new motorway and bridge will give is being recognised by the proposals for a new conurbation between Butterworth and Bukit Mertajam.

### 1.4 The effects on agriculture

1.4.1 The above descriptions of improved road communication (augmenting the already excellent links by sea and air) and the enlargement of urban communities mean that special attention must be given to agricultural development, to raise farm incomes to match the general prosperity of the area; it is the purpose of this study to ascertain if sufficient such agricultural improvements are possible.

## 2. THE OBJECTIVES

### 2.1 The Terms of Reference

2.1.1 The terms of reference state that the principal objective of the study is "to formulate and implement proposals for the upgrading of irrigation, drainage and access facilities for each of the irrigation schemes in the project area, with the aim of raising efficiency, improving farm and water management and providing the necessary pre-conditions for increased productivity and farm incomes". This objective was subsequently extended to give special consideration, in the Balik Pulau area, to the effects of competing demands for land, water and labour from urban and industrial development. In addition a review of tree crop areas from the drainage aspect was added, together with increased survey input to permit the rapid completion of design work after the feasibility stage.

#### Balik Pulau area

2.1.2 The objective for this area is to derive an agricultural plan suitable for an area where rice growing is in serious decline, partly due to water shortage, but mainly for social and economic reasons. Priority is to be given to hydrological study of the Sg. Burung catchment to determine the consequences to irrigation of urban development upstream of the irrigated areas. To assist in the study an updating of the Ministry of Agriculture's 1979 Socio-economic survey<sup>3</sup> is to be carried out (the 1979 survey sampled 88 farmers, of whom 70 were growing padi at that time). Special consideration is to be given to the whole of Balik Pulau, whose nominal padi growing acreage is only 8% of that in the whole project. We know that there is a strong desire by the Ministry of Agriculture to preserve an agricultural area on Pulau Pinang, presumably this must be achieved through voluntary means, by developing an agricultural community which is contented and prosperous.

## Seberang Perai

2.1.3

The objective for the great majority of the project area is as given in 2.1.1. Special cases however occur when farmland is close to the urban development centres. Priority is to be given to the area of the Sg. Kulim scheme, about 9,000 acres, because it is the worst affected by urban development and its side effects. Here it is necessary not only to improve the agricultural, irrigation and drainage technology, but also to reclaim abandoned areas and raise the income and interests of the farmers through innovations and supplementary activities (see 2.2.3). In the area as a whole it is apparent from inspection, and after discussions with Federal and State officials, that earnings in agriculture must be raised to compete with those in industry if farmers, particularly padi farmers, are to survive and if padi land is not to be abandoned and/or sold to speculators. Measures to be investigated include enlarging of holdings, mechanisation, formation of production co-operatives, and supplementary activities such as livestock, horticulture.

2.1.4

The full text of the terms of reference is reproduced in Appendix A; in addition to covering the main objective of improving farmers income, the terms cover all aspects expected from an integrated agricultural development study of the project areas.

2.2

## The New Economic Policy

2.2.1

Although it is not referred to as such in the Terms of Reference (TOR), we are very well aware that any measure proposed in the study must be in line with the important principles of the New Economic Policy (NEP). We have read the chapters of the Mid-Term Review of the Third Malaysia Plan (TMP)<sup>4</sup> which outline the principles of the NEP, and progress reach with it up to December 1978. We await with interest the text of the Fourth Malaysia Plan (FMP), recently announced in Kuala Lumpur, to see if there are any new aspects or changes of emphasis in the Policy.

2.2.2

Eradication of poverty is the first principle of the NEP and a matter which is obviously of primary importance for social and humanitarian reasons. It is likewise important for the maintenance of a flourishing agricultural sector that poverty amongst farmers should be eliminated. The present project forms one of those devoted to in-situ development, namely the improvement of existing agricultural areas through introduction of more efficient farming and irrigation practices, and through crop diversification. The field crops of padi farmers will not normally be 'diversified' but the potential for high return and high nutrition supplementary activities such as orchid culture, aquaculture (fish pond), poultry and other livestock production, is to be pursued and implemented.

2.2.3

The second principal of the NEP - restructuring society - will be furthered through the agricultural improvements mentioned above, leading to improved relative standards of living among the farming community. Mechanisation of agriculture with the need for a body of skilled operators and mechanical maintenance centres, will directly help to bridge the gap between two of the principal sectors of the community. The national policy of providing job opportunities in industry for those from traditional farming areas appears to be working very well already in Penang State, and the most difficult challenge of the Integrated Agricultural Development Project is to retain the interest and commitment of a sufficient number of men and women to continue farming with the best possible technological help.

### 3. THE PRESENT SITUATION

#### 3.1 Balik Pulau

3.1.1 Balik Pulau town is the centre for the South-West (SW) administrative district of Penang Island. The area covered by the Integrated Agricultural Development Project is less than that of the SW District, being limited to the coastal flat lands from Kg. Pantai Acheh in the north to Sg. Pulau Betong in the south, together with the hill catchments of the streams which flow into that area. According to the Market Potential Study<sup>5</sup> the project area is 21,600 acres or about 30% of the area of Penang Island. There are two irrigation schemes in the area:

- Sg. Burung 1,296 acres

- Sg. Pinang 1,486 acres

together with an area at Pantai Acheh which has been reclaimed but not yet developed in any way (except for placing fill at a proposed housing development). In this context, and in Ministry of Agriculture usage, 'reclaim' means to construct a shoreline or off-shore bund (embankment) and a minimum of landward drainage works only. Much of the reclaimed land is still mangrove swamp.

3.1.2 The Sg. Burung scheme has a severe shortage of water for padi cultivation and only some 145 acres (11%) have recently been double-cropped. For a variety of reasons a substantial amount of the remaining area is not cultivated at all. There is a tendency to ascribe these situations as being due to lack of water and/or drainage but the replies in the Socio-Economic Survey<sup>3</sup> on reasons for not double-cropping indicate different reasons in 51% of cases. The proportion of padi holdings giving only a single crop in the Balik Pulau schemes taken together is 85% of the survey sample as compared with only 7% in Seberang Perai North and Central Districts. (Figures extracted from the Socio-Economic Survey will be reviewed by us later, since sampling density by districts is not proportional to cultivated areas, and changes may well have occurred since the survey was made in 1979).

- 3.1.3 The Sg. Burung catchment includes Balik Pulau town and the sites of major housing development to the south and west of it. The township of Pondok Upih has a certain defined area but it is clear that private development will add greatly to this. Urban development over a large part of the Sg. Burung catchment, though not the hill areas, will reduce the baseflow (dry weather flow) in the stream because run-off from an urban area has higher peaks and steeper recession curves than is the case when covered by vegetation. This effect will inevitably reduce the water available for irrigation and may also though not necessarily, affect water quality seriously.
- 3.1.4 The housing developments mentioned are needed to meet the strong demands from Penang's industrial workforce a large number of whom work in the expanding centres in the south-east of the island. The development is in phase with the construction of a new road crossing the hills between Relau and Balik Pulau which appears to be nearly completed.
- 3.1.5 Well paid jobs in housing and road construction as well as in the industrial areas have had their inevitable effect on the farm work-force, which is understood to be seriously depleted. We are informed that Sg. Burung is an area where indefinite continuation of rice growing is unlikely, and high income crops are likely to be the right choice. However we shall make calculations to find out what acreage could in principle continue to receive enough water for double-cropping of padi.
- 3.1.6 The Sg. Pinang irrigation scheme enjoys a larger upland catchment for its water source than the Sg. Burung and one which, in its lower reaches, is not at present threatened by urban development. It is not clear however how similar conflicts of land use will be avoided indefinitely. No double-cropping of rice in the Sg. Pinang area is reported. This could be due to water shortage on account of abstractions from Sg. Pinang by the Penang Water Authority.

3.1.7 The newly reclaimed areas form a strip between 75 m and 730 m wide in front of much of the project area. A similar strip fronting the Sg. Burung area is scheduled for reclamation in the Fourth Malaysia Plan. The first requisite for these areas is good drainage and the ability to discharge flood run-off quickly to leach the presently saline soil. It has been suggested that coconut plantations could be developed on the marine soil. Fish-ponds and use of the land for poultry and livestock by the present sea-fishing communities are other possibilities.

3.1.8 The reclaimed areas are:

- Pantai Acheh	300 acres
- Fronting Sg. Pinang	430 acres
- Fronting Sg. Burung (future)	350 acres
	1080 acres
Total	1080 acres

3.2 Seberang Perai

3.2.1 The Integrated Agricultural Development Project covers the whole of Seberang Perai on the mainland. The catchments of the rivers and streams essential to the project extend into the neighbouring states of Kedah, to the north and east, and Perak, to the south.

3.2.2 The present study covers 15 irrigation schemes in the Seberang Perai area, with a total area of about 35,000 acres of padi, and includes tree crop areas of 100,700 acres. About half of this latter area consists of 'drainage areas' which are maintained by the DID.

- Mengkuang Mak Sulong (SPS)	60 "
- Sg. Dart (SPS)	50 "
	110 "
Sub-total	110 "
Total irrigation area	35,214 acres

\* The Aims scheme has river diversion structures and an irrigation system, so it is not truly 'rainfed'.

3.2.3 The irrigation schemes to be studied are:

(a) Seberang Perai Utara (SPU):

- Sg. Muda	17,580	acres
- Pinang Tunggal	3,697	"
- Jarak	1,950	"
- Tasek Gelugor	547	"
- Jarak Tengah	260	"
	<hr/>	
Sub-total	24,034	"
	<hr/>	

(b) Seberang Perai Tengah (SPT):

- Sg. Kulim	9,052	acres
- Juru	602	"
- Macang Bubok	335	"
- Renjau	50	"
- Kuala Tasek	45	"
	<hr/>	
Sub-total	10,084	"
	<hr/>	

(c) Seberang Perai Selatan (SPS):

- Tasek Junjong	482	acres
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(d) 'Rainfed' areas:

- Alma (SPT) *	240	acres
- Cherok Tok Kun (SPT)	263	"
- Mengkuang Mak Sulong (SPT)	60	"
- Sg. Duri (SPS)	50	"
	<hr/>	
Sub-total	613	"
	<hr/>	

Total irrigation area 35,214 acres

\* The Alma scheme has river diversion structures and an irrigation system, so it is not truly 'rainfed'.

3.2.4 The drainage areas to be studied, which are maintained by the DID are:

- Bukit Minyak/Bukit Tengah	8,629	acres	
- Bukit Tambun	10,564	"	
- Nibong Tebal	13,547	"	
- Tasek Gelugor	2,426	"	
- Sg. Udang/Tanjung Berembang	1,030	"	
- Sg. Chenaham/Sg. Udang Kecil	290	"	
- Benteng Kg. Melayu	420	"	
	<hr/>		
	Total	36,906	"
		<hr/>	

In addition there is an area of 32,800 acres, not presently maintained by the DID, for which drainage requirements are to be considered.

3.2.5 The main influence on agriculture in Seberang Perai, and particularly the padi production, is the rapidly expanding urban and industrial development in Butterworth and Perai and on Penang Island, and to a lesser extent in the smaller towns such as Bukit Mertajam and Tasek Gelugor. Inevitably with such expansion there is a great demand for land in the neighbourhood of these areas for industry and throughout Seberang Perai for housing development. As in Balik Pulau the well-paid, cleaner, jobs in the industrial area have attracted many of the farm work force. Although the farm labour shortage is most acute in the areas nearest to Butterworth and Perai, the effect is significant on all schemes.

3.2.6 The other major constraints on agriculture in Seberang Perai are the water resources. The main source for much of the irrigation supply is the Sg. Muda which forms the northern boundary of the state. Both the Sg. Muda and the Pinang Tunggal schemes are supplied solely from this river, and the Tasek Gelugor, the Jarak and

the Sg. Kulim schemes have their own, apparently inadequate, supplies augmented from the Muda via a transfer system utilising Sg. Kereh and a series of pumping stations and canals. This transfer scheme is presently being uprated. The remaining schemes to the south utilise a number of small streams and rivers which generally are insufficient to ensure an adequate supply during the off-season for double-cropping. Close consideration will be given to the most efficient use of these resources and to the conflicting demands for water for industry and domestic supply within the project area and from upstream users, such as the irrigation schemes fed from the Sg. Muda in Kedah.

3.2.7 Some 34,000 acres out of the total irrigable area of 35,214 acres (including the 'rainfed' areas) is designated as 'double-cropped' in the TOR. However in recent years the pressure on land, which has caused speculative buying and abandonment of padi areas in anticipation of industrial and urban development, and on labour and water resources have led to areas being left uncultivated. This allows uncontrolled increase in pests, such as brown hopper and rats which are reported as being a major problem in areas of the Sg. Muda and the Sg. Kulim schemes, affecting neighbouring crops and further reducing yields and incomes. Figures supplied by the DID indicate that, for the 1979-80 main and dry seasons, only about 26,300 acres were cultivated and of this area double-cropping was achieved on only about 87% (23,000 acres).

3.2.8 As can be expected this reduction in cultivated land is most marked in areas nearest the urban centres, with less than half the Sg. Kulim scheme being cropped (4,255 acres) and significant areas in the southern part of the Sg. Muda and Jarak schemes being left idle. Conversely areas in the north furthest from competing job markets and nearest to the main water source, the Sg. Muda, have the most efficient land use and the highest yields. Thus Pinang Tunggal is virtually 100% double-cropped with average yields of 3.1 tonnes/ha (500 gantangs per acre). This scheme appears the most efficiently

run with farmers keeping to the scheduled cropping seasons, and the canals and drains in relatively well-maintained condition. In the eastern block of this scheme there is considerable area, probably in excess of 100 acres, being cropped with a variety of vegetables and other crops such as long beans, okra and chillies.

- 3.2.9 The Sg. Muda scheme is the largest scheme in the State, lying along the coast between the Sg. Muda and the Sg. Perai. The lowest areas are subject to drainage problems, and tidal gates are installed on all drain outfalls. Work has recently been carried out in Mukim 5 to improve tertiary canal systems and is continuing on improvements to the drainage works.
- 3.2.10 Work is also continuing on major drainage improvements in the drainage basin of the Sg. Kereh and the Sg. Korok within which lie the schemes of Tasek Gelugor and Jarak. These rivers also act as part of the transfer system between the Sg. Muda and the Sg. Kulim schemes. As noted, the capacity of this is being increased with additional pumping capacity in the several pumping station, enlargements to the link canals, and a new gated river control structure on the Sg. Kereh to serve the uprated pumping station serving the Jarak scheme and linking with the Sg. Kulim by a canal via the Sg. Jarak.
- 3.2.11 Although not of direct influence on the irrigation works a major gated barrage is under construction on the Sg. Perai (of which the Sg. Kulim, the Sg. Jarak and the Sg. Kereh are tributaries). This will prevent saline intrusion upstream of Permatang Pauh and will improve the drainage of the swamps north of the Sg. Kulim scheme. We understand that these areas are to be reclaimed and consideration will be given to their agricultural potential.
- 3.2.12 Considerable expenditure has over recent years been put into improving the main canal system of the Sg. Kulim scheme and further work on the drainage system is planned. However the increasing abandonment of padi areas has nullified the immediate

## ATTAINING THE OBJECTIVES

effects of these improvements. We understand that funds have been made available and work is soon to start on the rehabilitation of these abandoned areas.

3.2.13

The smaller schemes to the south are in varying condition. That at CheroK Tok Kun suffers from its proximity to Bukit Mertajam and a severe water shortage and appears to be largely abandoned. Machang Bubok, Tasek Junjong and Kuala Tasek also suffer from water shortages but generally only some small isolated patches of padi have been abandoned. The Alma scheme has the additional problem of pollution from factory effluent discharged upstream. Juru was a rainfed, controlled-drainage scheme but has recently had a canal system constructed with irrigation supplies pumped from the Sg. Junjong Mati. However in the dry season there is adequate water for only about 50% of the area to be cultivated. There are also drainage problems remaining.

#### 4. ATTAINING THE OBJECTIVES

##### 4.1 Broad Strategy

4.1.1 The broad strategy to meet the principal objectives of improved farmer's incomes depends on an assessment of the land and water resources of the project area and of its irrigation and drainage needs, with a study of the agricultural alternatives in the context of labour shortages, and analysis of the economic and social benefits from improved engineering and agricultural services. Although the tasks and strategies in Balik Pulau and Seberang Perai will differ, as explained in other chapters, it is the aim to describe general methods in this chapter, and it therefore applies equally to both parts of the project.

##### 4.2 Meetings and briefing

4.2.1 The first step in this strategy has been to seek the guidance of Federal and State officials on the lessons that have already been learnt and how Government sees the development problems; such guidance will continue to be essential for the study.

4.2.2 Having obtained the opinions of Federal and State officials and inspected the whole project area, subsequent steps will be to study each resource and the economic and social possibilities in detail, and then to co-ordinate the whole into a development plan for the project areas.

4.2.3 Discussions on the project and connected technical matters have been held among others, with:

Encik Wan Abu Bakar bin Wan Abd. Rahman	Director, SEPU, Penang
Encik Othman bin Ismail	Deputy Director, SEPU, Penang
Ir. S. Kandiah	State Director, DID, Penang
Encik Zainal Rashid	Deputy State Director, DOA, Penang
Encik Fong Chek Sam	Director, State Town and Country Planning Department.

4.3.3

Datuk Mohd Feisol bin  
Hj. Hassan ) President, Seberang Perai  
Municipal Council

Encik Mohd Esa bin Shariff ) MOA, Kuala Lumpur

Encik Hiu Kim Loi ) DID Kuala Lumpur

Dr. Supard Amin ) )  
Encik Tay Chan Yong ) ) MARDI, Bumbong Lima,  
Penang.

4.3.4

Dr. I.F.T. Wong ) )  
Dr. Lau Wai Ming ) ) Soils and Analytical Services  
Branch, Dept. of Agriculture.

In addition numerous officials of the DOA and of the DID have helped us, in the field and in their offices, by explaining matters relating to particular areas of the project.

4.3.5

#### 4.3 Water resources and crop water requirements

##### Sources of data

4.3.1

The following government departments were visited in Kuala Lumpur, Penang and Seberang Perai to obtain information relevant to the study:

4.3.6

- DID, Headquarters, Kuala Lumpur
- Malaysian Meteorological Service, Kuala Lumpur
- Division of Environment, Kuala Lumpur
- DID, Georgetown and Bukit Mertajam
- Chemistry Department, Georgetown
- MARDI, Bumbong Lima, Seberang Perai
- Penang Water Authority

4.3.2

A list of streamflow and rainfall records obtained from the DID are shown in bar chart form on Table 4.3.1 and Table 4.3.2. Some records listed are from adjacent river basins. Climatological records obtained from the MMS are shown in bar chart form on Table 4.3.3. These records will be evaluated and used for yield calculations.

4.3.3 Where point rainfall and local streamflow and evaporation records are lacking, regional hydrological data in the form of isohyets, isopleths and evaporation lines are available from DID Hydrological Procedures and Water Resources Publication. The DID also produces procedures for estimating low flows and presaturation of padi fields.

4.3.4 Several reports on various aspect of water management and usage in and around the study area are available. These reports will form the basic reference for the study area. Duplication work will be avoided so that more time can be spent on field investigation.

4.3.5 The Division of Environment provided some chemical analysis records of Sg. Juru and Sg. Kelang Ubi. Chemical water quality data of Sg. Muda and Sg. Kulim are available from DID Water Quality Publications.

Fieldwork

4.3.6 Additional hydrological data were obtained from fieldwork carried out recently. The following fieldwork have been carried out:-

- General site visits to the study area to identify the various river systems serving the padi schemes in Balik Pulau and Seberang Perai.

- River discharge measurements and water sampling of the following rivers:-

(i)	Sg. Burong	)	Sg. Burong Padi Scheme
(ii)	Sg. Kongs	)	
(iii)	Sg. Kelang Ubi	)	Alma Padi Scheme
(iv)	Sg. Perangin	)	Renjau Padi Scheme
(v)	Sg. Junjong	)	Junjong Padi Scheme
(vi)	Sg. Kulim	)	Kulim Padi Scheme
(vii)	Sg. Jarak	)	Jarak Padi Scheme

Table 4.3.4 gives the results of the discharge measurements.



4.3.7

- The following fieldwork has been planned:-
- Continue river discharge measurements and water sampling of the above mentioned streams and other river systems.

4.3.10

- Carry out flow discharge measurements on main irrigation canals to determine abstraction totals and provide if possible, a rating curve for the irrigation canals. Canal losses will also be determined whenever possible.

- Carry out salinity measurements where necessary.

4.3.11

- Prepare an inventory of existing water users in each river basin.

#### Approach to the assessment of water resources

4.3.8

All the irrigation schemes are supplied with water from either pumping stations or headworks. Therefore the availability of water to the padi schemes is dependent mainly on the run-of-river yield and the efficiency of the distribution channels. There are some padi schemes like the Sg. Jarak and Sg. Kulim that receive 'transfer' water from the Sg. Muda basin. Two prospective padi schemes potentially suitable for such 'transfers' are Sg. Juru and Sg. Burong.

4.3.9

The normal DID design criterion of water requirement for padi is a 1 in 5 year return period (80 per cent probability of exceedence). This criterion has been adopted in this study. The methods used for run-of-river yield assessment are:-

- Direct assessment, that is using available long term daily flow records.

- Indirect assessment, using DID Hydrological Procedure No. 12.

The following fieldwork has been planned:-

- Continue river discharge measurements and water sampling of the above mentioned streams and other river systems.

- Carry out flow discharge measurements on main irrigation canals to determine abstraction totals and provide if possible, a rating curve for the irrigation canals. Canal losses will also be determined whenever possible.

- Carry out salinity measurements where necessary.

- Prepare an inventory of existing water users in each river basin.

Approach to the assessment of water resources

All the irrigation schemes are supplied with water from either pumping stations or headworks. Therefore the availability of water to the paddy schemes is dependent mainly on the run-off of river yield and the efficiency of the distribution channels. There are some paddy schemes like the Sg. Jarak and Sg. Kofin that receive 'transfer' water from the Sg. Muda basin. Two prospective paddy schemes potentially suitable for such 'transfer' are Sg. Jera and Sg. Hutong.

The normal DID design criterion of water requirement for paddy is a 1 in 5 year return period (80 per cent probability of exceedence). This criterion has been adopted in this study. The methods used for can-of-river yield assessment are:-

- Direct assessment, that is using available long term daily flow records.
- Indirect assessment, using DID Hydrological Procedures

- 4.3.10 - Transposition of run-of-river yield from results of direct assessment method by percentage of average daily flow. (ADF)

#### Crop water requirement

- 4.3.10 Consumptive use requirements will be estimated using published Meteorological Department data on daily open-water evaporation from Class A pans. Data from representative stations will be used to determine any likely variation between the various schemes within the project. Open-water values will be adjusted to the reference crop evapo-transpiration using suitable pan coefficients.
- 4.3.11 Crop factors, to convert the reference crop values to the consumptive use of the particular crop at its various growth stages, will be taken from published values with emphasis on any local data.
- 4.3.12 Maximum water demands for rice occur during pre-saturation of the fields. This requirement will be estimated in accordance with the DID 'Information Paper No. 2' and with regard to local practices regarding period of saturation and to soil types.

#### Flood assessment

- 4.3.13 Floods in the padi area are caused generally by heavy direct rainfall on padi schemes with poor drainage or by river overflowing its banks. There are available data on severe floods in the study area. These will be analysed and collated. Padi schemes subject to flooding will be identified and the causes of the flooding highlighted. Flood damage to padi schemes will also be studied.

#### Hydrometeorological stations

- 4.3.14 Hydrological and meteorological stations will be visited and the method of data collection assessed, if there is need for improvement, recommendations will be made.

## Groundwater assessment

- 4.3.15 Initial assessment of groundwater potential in the study area will be based on available information obtained from Kedah Perlis Water Resources Management study report, hydrogeological maps produced by geological survey, aerial photographs and any additional data obtainable from the Geological Survey, Ipoh.
- 4.3.16 This will be followed by fieldwork at the various padi schemes to carry out investigation of shallow hand dug wells and evaluate some of the wells performance. This will provide an idea of groundwater recharge and the water quality of hand-dug wells.
- 4.3.17 A general assessment of the groundwater will also be carried out by the water balance method taking into consideration the lithology of the area under study.
- 4.3.18 Results obtained from these initial appraisals will form the basis of recommending a full hydrogeological investigation which could take place during Phase II. This would involve:-
- Resistivity survey of selected area to determine the lithology and to select borehole sites.
  - Sinking of test and observation boreholes to confirm lithology and identify potential aquifers and their characteristics such as yield and water quality. If results are favourable, production boreholes can then be considered.
- 4.3.19 The possible use of groundwater supplies as an intermittent supplementary source for irrigation is an important option for study. This seems likely to be a promising line of study for smaller schemes, especially those with polluted surfaces supplies, such as Alma, Juru, Sg. Burong and rainfed areas.

#### 4.4 Studies on Soils and Agriculture

4.4.1 The major task is to examine and re-think the whole process of padi cultivation in the four large schemes in Seberang Perai. These schemes cover over 12,000 ha (30,000 ac) and form 85% of the total irrigated area on the mainland. The existing situation in these and the smaller schemes is summarised below, and in section 3.2. Current practice in the Pinang Tunggal scheme may be of value in other areas, since this scheme appears to have fewer problems than elsewhere.

4.4.2 The Balik Pulau situation is very different because of water shortage and the small areas involved; it is described in sections 3.1 and 5.

4.4.3 The State's total planted padi acreage (main and off-season) fluctuates from year to year and is estimated to be circa 30,000 ha (74,100 ac) annually. Padi is the most important agricultural crop next to rubber. The industry constitutes the livelihood of more than 23,000 padi farming families. Of the physical area of the total padi land of 17,000 ha the DOA Pulau Pinang reported that an estimated 3,600 ha or 21% have been abandoned and classified as "tanah rang", \* with yet more areas expected to come under "tanah rang" in the immediate future.

4.4.4 Some of the reasons for abandonment given in interviews with farmers and Government officials are listed below:-

- (a) Shortage of farm labour as a result of rapid urban and industrial development;
- (b) Repeated damage by rats resulting in the abandonment of more fields with each succeeding cropping season;
- (c) Deficiencies in irrigation infrastructures
- (d) Staggered planting which provide an uninterrupted supply of food to rats;

\* Padi lands uncultivated for 4 consecutive seasons of double-cropping or 2 consecutive years of single cropping.

(e) Absentee landlords;

(f) Land speculations.

4.4.5

For rice cultivation to be economical and giving a fair return to a farmer for his investment and labour, it has been estimated that holdings of around 2.4 ha (6 ac) fully double-cropped are required. The present level of income based on the average farm holding of 0.72 ha (1.79 ac)<sup>3</sup> offers little incentive for farmers to continue growing rice. Job opportunities in the urban and industrial sectors provide assured monthly incomes which are too attractive to resist and lands are thus abandoned in favour of off-farm jobs.

4.4.6

The average yield of padi in the State during the last 3 years, as compared with yield in the Muda Irrigation Scheme (Kedah), are given below: (DID, Pulau Pinang, and Padi Production Survey, DOA 1978).

	<u>Main season</u>		<u>Off season</u>	
	tonnes/ha	gantang/ac	tonnes/ha	gantang/ac
P. Pinang	2.55	406	2.96	472
Muda	3.42	544	4.23	672

In term of production efficiency using the potentials of Sri Malaysia 2 and Sekencang (MR7) as benchmarks, the State's padi production efficiency is only 44%. There is therefore ample scope for improvement which can be achieved through better cultural and agronomic practices, better irrigation and drainage, use of selected high yielding varieties (HYV), simultaneous and organised planting, better control of pest and diseases and more effective extension.

4.4.7

The most serious problems the State is faced with is the problem of "tanah rang" which has now reached a stage where the individual farmer's efforts to rehabilitate his field will be futile. Rehabilitation requires co-ordinated efforts on a massive scale quite beyond the capacity of individual farmers. Our suggestions for dealing with this are given in section 6.3.

## Work Programme

- 4.4.8 Field work began in March. Each of the 18 Scheme areas listed will be visited and studied in detail to assess the present situation. Farmers will be interviewed to assess their level of technology and skill, to ascertain the type of agricultural support services available to them, to find out the constraints to higher farm production and the problems relating to farm mechanisation, to find out their preference and acceptability of crops other than padi, and their ability to grow these crops successfully.
- 4.4.9 Based on the findings and discussion with other team members a suitable cropping calendar will be formulated for each of the broad groups.
- (a) Double Cropping of Padi
  - (b) Main Season Padi and Off Season upland Crops.
- 4.4.10 The inputs in the three specialist subjects - rural sociology, horticulture and farm mechanisation - will be co-ordinated with the Agronomist's work and will provide important data leading to the recommendations of cropping calendars and supplementary activities. Officials of various Government departments and agencies will be interviewed to obtain basic data for the study, and information in regard to their role and functions and the type of supporting service available to farmers in the Scheme areas.
- 4.4.11 In the tree crop areas we will study the proposals by other agencies for intensification and diversification and assess the changes in the drainage criteria which may be necessary for the new crops. The flooding tolerance of cocoa, for example, may well be less than that for which drainage schemes were designed.

### Soils - Present Situation

- 4.4.12 Soils data at the reconnaissance level is available for the bulk of the schemes in Seberang Perai and Balik Pulau, and for the

4.4.12 Balik Pulau area a semi-detailed soils survey has been carried out. However it is necessary to re-examine the soils of all the schemes under study through on-the-ground field checking. All existing records and relevant literature have been carefully surveyed. During the inception study visit, the following unusual conditions were noted.

- (i) In the Penaga area, soft spongy top soils with low soil bearing pressures. Improved drainage is urgently necessary.
- (ii) Part of the Sungai Burung scheme might include peaty surface soils with high organic matter. A close examination of the properties of soils here will be carried out.
- (iii) Along the coastal edge of the Pantai Acheh area reclamation of a coastal strip under mangrove has been started. It is strongly possible that this area consists of potentially acid sulphate soils.

#### Soils - Work Programme

4.4.13 Field work will commence in April, with the examination of the soils in all the schemes under study so as to identify and characterise the major soils in each of them.

An essential requirement to the formulation of possible cropping patterns will be the identification of the main textural type for each individual scheme.

4.4.14 The alluvial soils which comprise the study area are likely to resemble the soils in the Kedah-Perlis area. Results from fertilizer trials and demonstration plots in that area will be studied, and extrapolated where applicable. We are also fortunate to have in the Project area the MARDI (Rice Research Branch) situated at Bumbong Lima, where numerous trials have been conducted; the results of these where applicable would be utilised in the formulation of agronomic practices.

4.4.15

After the initial field visits soil sampling and analysis will be undertaken. It is essential that certain physical and chemical properties of the soil are evaluated. The padi schemes are partly composed of fairly small schemes. It is envisaged that a sampling intensity of 1 sample per 50 acres for the smaller schemes, an intensity of 1 sample per 100 acres for the intermediate schemes and 1 sample per 250 acres for the large schemes be used for the following analyses:-

- (1) mechanical composition (clay, silt and sand fractionation)
- (2) pH and CEC
- (3) total N, P and K.

Each sample site will be sampled at the following depth intervals:-

- (a) 0" - 6"
- (b) 6" - 12"
- (c) 12" - 24"

In addition to the above, field auger examinations will be carried out to determine and verify soil characteristics of representative soils spatially dispersed for each scheme.

4.4.16

For the tree crop areas field examination will be extensively carried out but sampling intensities will be of a much lower magnitude.

4.4.17

In order to determine the likely presence of pyrite in coastal soils urgent priority in the assessment of such areas is a chemical examination of soil fractions for pH changes by the moist incubation technique.

4.4.18

In addition to the soil physical-chemical analyses planned for the study area as a whole, some insitu field measurements of redox potentials will be attempted in the areas of soft spongy soils ((i) of 4.4.12 above).

4.4.19

After the field visits, soil auger evaluation, soil collection, soil analysis, the information obtained will be checked further with available maps and aerial photographs where relevant to delineate problem areas and main textural types for each scheme. The chemical analysis will be confined to the 0"-6" fractions. All soil samples collected from the three depth intervals will be routinely examined for texture, colour and structural features.

4.4.20

After the main characteristics of the soils have been determined, some deep percolation loss studies will be carried out on soils having a clay +  $\frac{1}{2}$  silt index of less than 40. The percolation losses will be carried out under puddled conditions.

4.5.2

The DID has provided recultivated photo-mosaics at 2 ch to 1 in for all the project irrigated (padir) areas except those in Bukit Pulau and south of the Bukit Lengah drainage area. Most of the Cherok Tok Kap rainfed area lies outside this limit, together with the whole of the Jura, Macang Bubek, Pénjar, Kuala Tasek and Tasek Junjung schemes and the Bukit and the Sg. Durai rainfed areas. All of these are to the south of the area covered. Cadastral (land ownership) film overlays to the mosaic have also been supplied.

4.5.3

The DID State offices have in their possession original tracings of scheme layouts at 8 ch scale generally, and prints of these are being supplied to us as quickly as routine work load in those offices permits. No difficulty is anticipated in obtaining all such layout plans, and engineering drawings when and where needed for our study, though it has not yet been possible to check the completeness of the drawings of every scheme. We have received excellent co-operation in this matter from the DID offices in Georgetown and Bukit Mertajam.

4.5.4

For general study of the project area 1:25,000 topographic maps are available; some of the 1:10,000 topographic maps have recently been supplied also, and the contours are expected shortly.

#### 4.5 Topographic survey

4.5.1 The Addendum to the TOR enlarged the survey task on pages 5 and 6 of the original TOR with a request to survey the irrigation areas for planning and detailed design. As a result the approved staffing list includes one surveyor and five survey technicians. The task set is to produce maps at 8 chains scale (1:6, 336), and to perform sufficient additional survey for detailed design of the sample areas (sections 5 and 6) and for feasibility study of upgrading works in the rest of the irrigation areas.

#### Available data

4.5.2 The DID has provided rectified photo-mosaics at 8 ch to 1 in for all the project irrigated (padi) areas except those in Balik Pulau and south of the Bukit Tengah drainage area. Most of the Cherok Tok Kun rainfed area lies outside this limit, together with the whole of the Juru, Macang Bubok, Renjau, Kuala Tasek and Tasek Junjong schemes and the Alma and the Sg. Duri rainfed areas. All of those are to the south of the area covered. Cadastral (land ownership) film overlays to the mosaics have also been supplied.

4.5.3 The DID State offices have in their possession original tracings of scheme layouts at 8 ch scale generally, and prints of these are being supplied to us as quickly as routine work load in those offices permits. No difficulty is anticipated in obtaining all such layout plans, and engineering drawings when and where needed for our study, though it has not yet been possible to check the completeness of the drawings of every scheme. We have received excellent co-operation in this matter from the DID offices in Georgetown and Bukit Mertajam.

4.5.4 For general study of the project area 1 in to 1 mi topographic maps are available; some of the 1:25, 000 topographic maps have recently been supplied also, and the remainder are expected shortly.

## Plan of work

4.5.5 Survey in the priority area in Seberang Perai - the Sg. Kulim scheme - started on 6th March 1981 with two surveyors establishing a horizontal and vertical control network. As from 17th March this work will lead into a detailed survey of the selected Kulim scheme sample area. Within the next few weeks three (possibly four) additional surveyors will start work to supplement the two who started on 6th March.

4.5.6 The main problems lies not in the survey itself but in the correct selection of sample areas at very early stage of the study to avoid loss of time for field survey work. Sample areas ought probably to include the two priority (and problem) areas of the Sg. Burung and the Sg. Kulim; however ideally their agricultural, soils and socio-economic needs should be studied before the survey, since the latter implies a decision to modify and improve the irrigation and drainage systems. Since the greatest uncertainty about such a decision is attached to the Sg. Burung, the detailed survey there will not be started until the other studies are more advanced.

4.5.7 The outline programme therefore will be to survey the sample areas at the Sg. Kulim, the Sg. Muda, Alma and possibly Juru and the Sg. Burung in detail, and to carry out such other check surveys for feasibility level study as necessary. The latter are likely to include local surveys for any new major structures and longitudinal profiles of proposed new or reconditioned canals sufficient for outline hydraulic design. If time permits then detailed area surveys of scheme outside the sample areas will be started.

## Method of working

4.5.8 A fully checked control network of levels, tied to Government survey benchmarks, will be taken from each scheme headworks to the sample area or scheme supply area, with loops to surround and intersect the areas as necessary. Horizontal control will be less

4.5.8 rigorous because it is assumed the photo-mosaics form an accurate plan for calculation of areas and shapes of the irrigated land. EDM (Electronic distance measuring) instruments will however be used to check all principal canal distances so as to compute gradients, quantities, etc. It is furthermore assumed that the original DID plans are essentially accurate and do not have to be checked, except where specific changes may have been made after the drawings were prepared, and except for the effects of settlement, scour and sedimentation.

4.5.9

After the control surveys are made the detailed survey will proceed with a view to new mapping at 8 ch scale. With the aid of aerial mosaics the surveys should proceed quite quickly, since the field bunds will form an irregular grid which will enable surveyors to identify themselves anywhere in the field and to avoid the need for extensive horizontal measurement. Spot levels will be taken using the mosaics, with tachymetry when necessary, to obtain levels on representative padi terraces or at 100 m to 150 m intervals in open areas.

4.5.10

After improved drainage and irrigation canal layouts have been selected by the design engineers then longitudinal profiles will be surveyed in the field for detailed design. It seems unlikely that cross-sections will be needed for minor channels, though they will of course be made where remodelling of any existing canal is involved.

4.5.11

The new maps will be at 8 ch to 1 in scale in order to utilise the existing data and cadastral framework. Levels will be measured in metres and horizontal field measurements will also be metric. (This must be a known current practice since a leading Georgetown equipment supplier sells scales measuring metres at a ratio of 1 : 6, 336). All profiles and cross-sections will be plotted to metric scales.

## 4.6 Irrigation and drainage systems

### Present situation

4.6.1 As has been mentioned in 4.5.2 above, the State DID appears to possess extensive record drawings of the schemes under their control, and to date no gaps in the coverage have been observed. Should there be any such gaps we have been told that prints could be made from the microfilm records kept at the DID Headquarters.

4.6.2 The DID is at present engaged in a number of construction tasks within the project area, many of which were initiated during the Third Malaysia Plan and are now nearing completion. We have seen details of seven such schemes, of which the most important is that for the Prai Barrage and drainage works, costing nearly \$15 million. The next largest scheme costs about \$2 million. The work on several of the schemes apparently overlaps our proposed sample areas within the Sg. Kulim and the Sg. Muda schemes, but in these cases the DID works were over 90% complete at the end of the TMP. We understand this information is provisional, since it is extracted from the draft FMP document which has not necessary been approved.

### Plan of work

4.6.3 The proper distribution and application of water is essential in order to obtain high crop yields and to ensure that the extent of the irrigated area is as large as possible. The aspects which will receive particular attention include:

- Present distribution of water from the rivers to the pumps and/or main canals, including legal and physical restraints, and the consequent delivery per unit area under command of each canal.
- Losses from stream beds and canals to deep percolation and in evapotranspiration, recoveries of such losses and ingress of sea water to streams, canals or fields.

- Effectiveness of intake, diversion, and turnout structures, in abstracting, measuring, sharing out and delivering water to the fields; in many cases such structures are absent at the tertiary and field level.
- To consider whether, in areas of shortage, a revision of the cropping pattern and/or controlled staggering of planting dates could reduce peak demands and deficits.

4.6.4                    Measurements with current meters, flumes and/or notches may be necessary for these studies.

4.6.5                    At field level attention will be given to the methods of abstraction from the canal and application to the field with particular reference to:

- Uniformity of application
- Possibility of rotation of supplies
- Amount applied compared with crop needs
- Losses to deep percolation
- Through-flow or return flows
- Recovery and reuse of percolation and through-flows
- Effectiveness of drainage of excess water from the fields.

4.6.6                    These factors are likely to vary from one area to another, but we hope to arrive at realistic figures for the present overall efficiency of each scheme and for the improvements which may be possible.

## Drainage

- 4.6.7 Drainage design in irrigated rice schemes is as basic to their successful operation as the irrigation system; both aspects will be assessed and designed together, and the preceding sub-sections cover our approach to drainage works in this category.
- 4.6.8 In addition the Addendum to the Terms of Reference requires a study of the drainage of tree crop areas estimated to cover 100,700 acres. This study is limited in scope, and does not include agricultural and economics aspects as does the principal task relating to irrigated areas. We will inspect all the drainage areas, in wet weather if possible, and report on their efficiency and the need for improvements. This work will be critically dependent on the advice and operating experience of the DID officers and the plantation smallholders/managers, since it is not intended to mount a comprehensive observation and monitoring programme. We understand that the reference to "Government intention" in sect (i)(b) refers to a recently completed report of the Working Group on Land Use. We shall study and act on this report as soon as it is made available.
- 4.6.9 During our preliminary inspection visit in November 1979 it was noticed that flooding of plantations was occurring in several tree crop (drainage) areas. This situation will be studied further in the 1981 April-June wet season.
- 4.6.10 During Phase I of the project it will not be practicable to carry out topographic survey in the tree crop areas, and the majority of the engineering input must be concentrated on the irrigation schemes. We will however study the engineering needs of the drainage areas and report on their feasibility and cost.

## Design criteria and standards

4.6.11

We shall adopt DID standards and criteria wherever practicable after reviewing them in the light of our experience. If any important changes seem desirable we will discuss and agree them with DID engineers. It may be that the use of metric units is not yet widespread within the Department, and in that case our experience of work within countries which have never used the Imperial (British) system may be beneficial.

4.6.12

We understand that the DID has a flexible approach to the standard for field irrigation and drainage networks proper to each particular case. We should nevertheless wish to establish guiding standards for this Project with as few variations between one scheme and another as practicable. It is believed the DID Manual (1973) is out-of-date in some respects, and that a new departmental design guide is circulating in draft. If the Department wishes us to work with this draft then we should appreciate receiving a copy as soon as possible.

4.7

### Improved access

4.7.1

The pattern of main and secondary roads in the Project area is very good, and extends to all towns and larger villages. The TOR require the formulation of proposals to upgrade the access facilities, (page 5, 2rd para) and we take this to mean access from the road system into the rice growing areas. In particular we have noticed the absence of roads, or even unsurfaced tracks, wide enough for vehicles beside most of the main canals. Roads on the banks of main and secondary canals are essential for easy inspection and maintenance by the DID.

4.7.2

The absence of roads to their fields for the farmers is obviously a serious handicap to their effective work, and renders the use of most machinery impracticable. For example there appears to be a block of land in the Sungai Kulim command 4 km by 4 km, that is 1600 ha (nearly 4000 acres) which is not crossed by any roads

at all. We will record the existing situation and develop criteria for farm road densities, to be applied in all irrigation schemes in due course. It may be that new canal bridges and siphon crossings will have to be provided. Canal banks will have to be widened to take these roads, since the presumption is that all access roads will follow canals or drains. Strips of land will have to be acquired for the new roads.

#### 4.8 Mechanisation

4.8.1 Mechanisation of farming operations to a very considerable extent is certain to be an important factor in improving the output per farm worker and raising his income and his self-respect. The levels of mechanisation desirable and the economic benefit available from different machines will be studied by our Farm Mechanical Specialist and Agricultural Economists. Mechanisation is one of the fields in which the Farmers' Organisation Authority (FOA) is active, and we shall consult closely with their representatives. The Working Group for the Project on Farm Production Services on Padi and Other Crops<sup>7</sup> has also gone into tractor requirements in some detail.

4.8.2 Mechanisation will require changes in agricultural practice which will not be easy for many farmers, and may be impossible to make for some of the older men. This point will be followed up in our agronomic and socio-economic studies. The subject of course is closely related to the feasibility of co-operative farming in one form or another; machines may be owned by a Co-operative, and they cannot generally be efficiently used unless the particular field operation is carried out at one time in an area very much larger than the average farmer's land-holding. Ways and means of effecting this without fundamental land reform have been studied by the FOA, whose Director General has described systems such as "Landlord-in-trust"<sup>6</sup>.

#### 4.9 Social and Economic Studies

4.9.1 From the social surveys already made in the area - Balik Pulau and Seberang Perai, a comprehensive set of data is already available. The number of families involved, the size of their land holdings, pattern of cultivation, soil, marketing network and governmental infra-structure, from irrigation to extension services, area readily available from the reports. What seems to be lacking is the information on the target population themselves. A socio-cultural profile of the farmers in the scheme should be ascertained, for the successful development of the area will rest not only on the solving of technological and infra-structural problems, but also on the human factor involved. The question simply put is whether the farmers would respond positively to the projected development, especially when in this particular area the agricultural sector has to compete with the industrial buildup which is close by. Not only is farm labour short at the present, but the attraction to the industrial sector must also affect the established farmers. There are two socio-cultural factors that need looking into:-

- (i) the attitude of the farmers towards agriculture: that is to say, even with the attraction towards the industrial sector, would the farmers be ready to remain on their lands if their lots could be improved through the proposed project;
- (ii) the perception, understanding and expectation of the farmers with regard to the project proposals - mechanisation, enlarged farm units and so on.

No formal social surveys are being planned in respect of these factors, but it is necessary to gather the above information from the field. It is proposed therefore to conduct random field surveys, consisting mainly of interviews with the farmers in some of the schemes, in April 1981.

4.9.2 In addition the Ministry's socio-economic survey<sup>3</sup> will be updated in the Balik Pulau area by a check survey appropriate to the level of input allowed for this study.

4.9.3 An assessment of the existing status of the institutions responsible for the supply of agricultural inputs will be made by the Agronomist and the Economist, including the availability of supplies and sources of fertilisers, chemicals and farm equipment, with particular reference to facilities for mechanisation. Attention will also be given to the availability of credit, the provision of appropriate methods of collecting, grading and paying for produce from the farm within an effective marketing system, and the impact which current pricing policies have upon the promotion of better cultivation practices and improved cropping patterns. For the above work we shall make full use of the Working Group Reports (especially that for Farm Production Services on Padi and Other Crops<sup>7</sup>).

4.9.4 The study of cooperatives is not specifically mentioned in the Terms of Reference. However as this study is concerned with a project which is aimed at a specific target poverty group, the question of farmer organisations or co-operatives, and the extent to which they can contribute to enhancing the efficiency of water and farm management practices will be given close consideration. There were already 8 Farmers Co-operatives in Pulau Pinang with a membership of 7184<sup>6</sup> as at December 1977. These must be considered as a potential nucleus for the development for production co-operatives.

4.9.5 Economic studies have to cover a very wide field, with a large variety of cropping patterns envisaged and a relatively small input (see 7.1). "Cropping patterns" to be assessed will include double crop padi, single crop padi with subsidiary crops, fruit trees and other tree crops. In addition the use of part of a farmer's land for supplementary activities like horticulture, livestock, poultry and aquaculture must be assessed. In this work we shall depend heavily on the studies already carried out by Government Working Groups and Consultants (listed in Appendix C). Some of the Working Group

reports are not yet available, but we assume that all of them will be supplied to us before the arrival of the Agricultural Economists in June.

4.9.6

Prices of farm produce will be derived on a farm-gate basis, for use in the enterprise and farm budgets. Where necessary, distinctions will be made between financial (i. e. market) and economic (the real value to the national economy) prices. Costs and returns will be calculated for each crop and each form of livestock production on a unit basis, per acre and per head. The costs included will be the direct inputs (e.g. seed, fertilisers, farm chemicals) and, if relevant hire of machinery.

4.9.7

On the basis of the agronomic studies, water requirements and availability, labour requirements and availability, social considerations and the relative profitability of the various possible crop and livestock enterprises, a number of cropping patterns and production systems will be formulated. These will be designed to cover the range of conditions encountered on all the irrigation schemes. From these farm budgets returns to land, labour and water will be calculated, and the best cropping patterns will be selected. For each group of schemes, the selected pattern of crop and livestock production will form the basis for the estimation of project benefits.

4.9.8

As requested in the Terms of Reference, we will undertake economic analyses of the proposed development. This will be done for the large schemes individually, but for schemes of less than 500 ha the scale of project may be too small to justify the time required for a full conventional analysis and a grouping system will be proposed. For each project, we will then draw up the year-by-year stream of costs and benefits at constant 1980 prices. Net present values at different discount rates, and internal rates of return, will then be calculated.

4.9.9 The main financial analyses will concern the projects' impact on farm incomes and the financial implications for DID operation of the schemes. Farm incomes 'with project' and 'without project' will be calculated, in order to assess the amount by which farmers' incomes will be raised.

#### 4.10 Development Programme and Project Management

4.10.1 The last two items of the detailed scope of work, to be found on page 7 of the TOR, refer to preparation of proposals for project management, project operation and maintenance and data collection, in the first item, and of a detailed construction programme in the second item. For the first case we shall study the existing systems of drainage and irrigation management and study implementation methods used by both the DID and the DOA. It seems likely that the problems to be encountered in implementing new agricultural practices, and the use of larger farming units, will outweigh those in the engineering field, and will in consequence control the time-table. The only exception to this might be the time needed for land acquisition for new canals, drains and roads.

4.10.2 Management of the Project is being studied, we understand, by one of the Working Groups. We would hope that they will favour a simplification of the present institutional arrangements which involve a large number of bodies in the day-to-day running of the project areas. The possibility of a multi-disciplinary government body to cover engineering, agriculture and market support operations may be one solution. The FOA, representing the farmers, would not have a role in such a body.

4.10.3 At the interim report stage we shall need guidance from our Steering or Technical Committee on a number of matters affecting the final recommendations for these subjects. They include:-

- degree to which engineering improvements should be phased in with agricultural and land tenure changes (by itself engineering likely to be faster);

- size of construction contracts;
- rate of engineering development( sums available each year);
- apportioning of implementation responsibility between State and Federal or specially appointed authorities;
- validity of, and timing for, our assumptions about land tenure,operating co-operatives, reconditioning idle land, etc.( to be set out in interim report).

4.10.4

Preparation of an engineering programme, including construction phasing and man-power requirements, will follow from our feasibility study recommendations. Schemes could be ranked in order of economic attractiveness, but we suspect that priorities may be more affected by social needs and hope that the great majority of the works necessary could be phased within the FMP period.

TABIE 4.3.1

STREAMFLOW STATION RECORD  
KELDAH

Station Name	Grid Reference Station No.	Catchment area sq.mile.	1945 to 1946	1947 to 1948	1949 to 1950	1951 to 1952	1953 to 1954	1955 to 1956	1957 to 1958	1959 to 1960	1961 to 1962	1963 to 1964	1965 to 1966	1967 to 1968	1969 to 1970	1971 to 1972	1973 to 1974	1975 to 1976	1977 to 1978	1979 to 1980
Sg. Muda @ Naini Cableway	QY 506485 6007415	470																		
Sg. Muda @ Jeniang Cableway	QY 340203 5806414	660																		
Sg. Muda @ Batu Pekaka	D 32931 5506413	1290																		(Station closed in 1973)
Sg. Muda @ Victoria Estate	D 271854 2412	1550																		(Station closed in 1973)
Sg. Sedim @ Nerbau Pulas	D 349897 5506416	170																		(Station closed in 1973)
Sg. Karangan @ Titi Karangan	D 328643 5506417	32																		(Station closed in 1973)
Sg. Kulim @ Ara Kuda	D 199738 5405421	50																		(Station closed in 1973)

Source: JPT

TABLE 4.3.2  
Sheet 1 of 2

RAINFALL STATION RECORD  
PENANG/PROVINCE WELLESLEY

Station Name	Station No.	Grid Reference	1933 to 1935	1936 to 1939	1942 to 1944	1945 to 1947	1948 to 1950	1951 to 1953	1954 to 1956	1957 to 1959	1960 to 1962	1963 to 1965	1966 to 1968	1969 to 1971	1972 to 1974	1975 to 1977	1978 to 1980
Sg. Acheh Area	5104052	QX722698															
Bukit Panchor Reservoir	5105051	QX831713															
Bayan Lepas Met. Station	5202021	QX539867															
Simpang Ampat	5204048	QX768852															
Batu Kawan Estate	5204049	QX716819															
Sg. Bakap	5205050	QX795784															
Sg. Pinang Main Canal	5302001	QX472972															
Bagan Ayer Itam Gate	5302002	QX460929															
Bukit Berapit Reservoir	5304045	QX788952															
Permatang Rawa	5304046	QX748935															
Cherok To' Kun	5304047	QX785932															
Agricultural Station, Ayer Itam	5402011	QX553979															
Butterworth Met. Station	5403042	QX669048															
Malakoff Estate	5404041	QX754076															
Sg. Kulim Headworks	5404043	QS770015															
Bukit Merah	5404044	QX715993															
Permatang Bendahari	5503031	QS655178															
Permatang Binjai	5503034	QS674093															
Pinang Tunggal	5505033	QS801151															

TABLE 4.3.2  
Sheet 2 of 2

RAINFALL STATION RECORD  
KEDAH

Station Name	Station No.	Grid Reference	1906 to 1910	1911 to 1915	1916 to 1920	1921 to 1925	1926 to 1930	1931 to 1935	1936 to 1940	1941 to 1945	1946 to 1950	1951 to 1955	1956 to 1960	1961 to 1965	1966 to 1970	1971 to 1975	1976 to 1980
Kulim Hospital	5305091	QX857943															
Bukit Besar, Kulim	5305092	QX857907															
Bagan Sena Estate	5406081	QS984041															
Kelong Bahru, Kulim	5406083	QS909009															
Dublin Estate	5407080	QY054978															
Merbau Pulas	5506078	QS946162															
Bukit Karangan Estate	5506082	QS931124															
27th Mile, Baling Road	5507076	QT018092															
Pelam Estate	5507079	QT055096															
Lubok Segintah Estate	5600677	QS958246															
Pulai	5608074	QT236260															
Baling Hospital	5609072	QT257286															
Baling Reservoir	5609073	QT262278															
KG. Terabak	5708071	QT230365															
KG. Gajah Puteh	5806065	QY362292															
Jeniang	5806066	QS942435															
Sik	5807067	QT068444															
62nd Mile, Baling Road	5808069	QT232526															
KG. Lubok Badak	5808070	QT232460															
Nami	6007063	QT090702															

Source: JPT

METEOROLOGICAL STATION RECORD  
 BUMBONG LIMA (STATION NO. 5504332)

Climatic Parameters	1972 to 1973	1974 to 1975	1976 to 1977	1978 to 1980
Rainfall				
Temperature				
Humidity				
Evaporation				
Wind				

Source: MMS

PENANG IRRIGATION

SUMMARY OF DISCHARGE MEASUREMENTS

River	Date	Velocity ft/sec	Area ft <sup>2</sup>	Discharge cfs
Sg. Burong d/s of Balik Pulau Rd. Bridge	6/3/81	0.38	13.61	5.23
Sg. Kongsu d/s of Sg. Pinang Rd. Bridge	6/3/81	0.83	10.51	8.77
Sg. Kilang Kain Upstream of Alma	7/3/81	0.41	2.13	0.87
Sg. Kelang Ubi Upstream of Alma	7/3/81	0.60	2.53	1.53
Sg. Perangin d/s of Rd. Bridge	7/3/81	0.87	11.02	9.60
Sg. Junjong u/s of Rd. Bridge	7/3/81	0.68	8.82	5.99
Sg. Kulim @ Lunas u/s of wooden Bridge	8/3/81	3.19	53.58	170.96
Sg. Jarak d/s of Rd. Bridge	8/3/81	3.48	13.19	45.85

## 5. DEVELOPMENT AND STRATEGIES IN BALIK PULAU

### 5.1 General

5.1.1 Special consideration for the Balik Pulau area is an essential part of the whole study. Clause 1.3 of the Addendum to the TOR requires the Consultants "take cognizance of the development (non-agricultural) in Balik Pulau area as well as in the island of Penang". Furthermore we were formally asked at a meeting of the Technical Committee to give priority to the Sungai Burung area. It was later explained that this priority implies "deeper than average" rather than "faster than average" study, and that in particular the aspect needing priority study is the effect of development of housing and a new township in the Sungai Burung catchment. In view of the importance of this area to state development it has also been selected for one of the sample areas of the study.

### 5.2 Sample areas

5.2.1 Sample areas as defined in the TOR (page 5, top) are those in which detailed survey takes place during the feasibility stage. The objectives are:

- (a) to provide up-to-date mapping which can be used for feasibility studies of irrigation and drainage requirements, and
- (b) to enable an early start to be made to detailed design, as and when Phase II of the upgrading project is implemented.

To meet objective (a) some of the sample areas must be representative of the project as a whole, in order to provide typical outline design and cost data. It is however not thought suitable to limit sample areas to this category, in view of the particular importance attached to areas like Balik Pulau. A sample area has been selected in the Sungai Burung scheme which covers 243 ha (601 ac) or 46% of the whole scheme. This area is at the northern end of the scheme, and it includes a portion of the 140 ha which are double-cropped. As mentioned in 4.5.3 above it may not be appropriate to survey in detail areas which

ultimately may be recommended for non-irrigated crops, except as needed to plan drainage and aquaculture earthworks. The boundaries of the Burung sample area will later be revised if necessary to meet this requirement. Selection of this area for detailed survey means that its engineering design for drainage and irrigation will be well advanced by the end of Stage I of the present study. It should therefore be possible to implement any necessary improvements as one of the first tasks in the following stage.

5.2.2 The priority attached to study of the Sungai Burung catchment will be extended to cover all streams discharging through or at the side of the scheme boundaries. Although the principal intake is on the stream from which the scheme is named, the yields of several others will be closely examined, including:

Sungai Korok

Sungai Khongsi

Sungai Pulau Betong

### 5.3 Development Opportunities

5.3.1 Balik Pulau forms an easily defined natural area and hydrological unit. It is to be hoped that it can be planned for development, both of agriculture and to absorb an increasing population, without the two aims becoming antagonistic. In the field of water resources the needs of municipal and industrial supply must be given priority for a defined growth of abstractions with time, but the present and future needs of irrigation should also be determined and agreed upon.

5.3.2 What is at present not clear is how to estimate the rate of growth of urban development in the private sector. This is not subject to Government control and yet, without reliable estimates, forecasts of future water availability, calculations of economic benefit from agricultural schemes and hence planning of most forms of agricultural renewal become difficult and uncertain.

- 5.3.3 We have been given data on proposals for development within the defined boundaries of the new township at Pondok Upih, and must make estimates for the areas likely to be taken by private development. We shall endeavour to derive upper and lower limits for the rate of areal growth of urban development of all types, and for this we shall depend heavily on the knowledge of the area available in Government planning departments and the Pulau Pinang Municipality.
- 5.3.4 We shall investigate the likelihood of deriving additional water supplies by means of impounded storage, ground water and the re-use of drainage water. Re-use of water possibly could be carried a stage further if the means, and funds, are available for segregating and treating urban waste water.
- 5.3.5 Agricultural development proposals are handicapped by the reported shortage of water, which is generally expected to grow worse on account of the urban development mentioned above. However we believe there are ways to mitigate the effects of this.
- 5.3.6 It is clear that, even more than in Seberang Perai, any new farming opportunities to be developed must be those which will compete, both in job interest and cash returns, with alternative work in industry. Furthermore, and unlike Seberang Perai, there is not the same scope for large scale reorganisation of padi cultivation through a heavy mechanisation programme. There is however a serious shortage of agricultural labour and this suggests study of low-labour options such as tree crops and aquaculture. Our updating of the socio-economic survey in Balik Pulau will be designed to gauge the farmers interest in options of this sort.
- 5.3.7 The Working Group Report for Farm Production Services on Padi and Other Crops<sup>7</sup> discusses proposals made by the Land Use Working Group which we have not yet seen. They give three main alternatives:-

- (a) Conversion of padi areas to dry land crops, especially coconut;
- (b) "Conversion" of padi areas for double cropping;
- (c) Continued single cropping of padi with alternative cash crops in the off-season.

5.3.8

There seem likely to be difficulties with alternative (a) on account of acid sulphate soils. The growth to fruit bearing of new trees would take several years, with consequent difficulty in retaining farmers and providing them with cash income in the interim. Alternative (b) is a restoration of the original situation, but this must be considered an impracticable aim in the circumstances due to water shortages. Only 27% of the Sg. Burung scheme and none of the Sg. Pinang scheme are currently double cropped.

5.3.9

Alternative (c) above was recommended by the Padi Working Group, and our first task is to study the water resources of both schemes to find out whether, in the light of urban development, there is still sufficient water for main season padi over the majority of the area. The overall cropping intensity in the last main season was only 527 ha (47%) due primarily to the large proportion of abandoned land in Sg. Burung. In spite of this low figure there remains 140 ha (12%) in Sg. Burung which is double cropped effectively and which should be preserved in this cropping pattern (5.3.11).

5.3.10

It seems likely that there will be scope for mixed farming in both the Sg. Pinang and Sg. Burung areas as mentioned in sections 5.3.12 onward. Given the conditions of labour shortage and land abandonment, means must be sought to enlarge land holdings or the area worked per head of farming population. Existing land holdings in Balik Pulau are even smaller than in Seberang Perai. A special

case occurs within the coastal strips, where there is a significant population of fishermen who also keep livestock. There may be scope for enlarging the livestock areas and working them in conjunction with fish ponds and possibly tree crops. Excavation for fish ponds in newly reclaimed areas could be used as fill to increase the dry soil depth for tree crops.

#### Sg. Burung Scheme

5.3.11 Sungai Burung Scheme - This Scheme area covers 525 ha (1296 ac) of which 140 ha are annually double-cropped with padi. Irrigation facilities are good and the padi farmers keen. The area should probably remain as double-cropping padi land, as farmers have supplementary sources of income from fishing and off-farm jobs in the public and private sectors. Members of the farm households also work in factories.

5.3.12 The remaining 385 ha (950 ac) of padi land are nominally under single cropping but have been abandoned, some as early as 1974. The average farm plot size is only 0.65 ha (1.61 ac). Due to limitations of farm size and lack of opportunity to double-crop, interest in padi farming changed in favour of other off-farm jobs which can guarantee a more assured form of income. If it is accepted that padi farming, as governed by the limitations mentioned above, can no longer offer the operator a reasonable income, then a more intensive farming enterprise should be found. There is a distinct possibility for the introduction of an integrated type of farming based on a combination of aquaculture, poultry and ducks, market garden and horticultural crops with emphasis on orchids/cut flowers. Even crocodile farming may be considered. Soil and water quality investigations will have to be carried out before specific recommendations can be made.

5.3.13

DEVELOPMENT

The State Government of Pulau Pinang should take

cognizance of the vast potential of the export markets for orchids. There is already the training facility at Relau Agric. Station, which can also act as a centre for multiplication and distribution of planting materials. Sungai Burung is a possible commercial production area by virtue of its proximity to the Bayan Lepas International Airport.

6.1

6.1.1

of the Sungai Burung area in the year 1971, which is grouped with schemes in Perak. Certain details of the study are excluded, but study on the feasibility of the project is limited to scope, as explained in the Introduction. A further study in Kedah and Perlis is mentioned in para 5.2 under Appendix B.

6.2

Sample areas

6.2.1

Some of the sample areas were selected for the convenience of those readers who are interested in the study. Sample areas are listed in the Table on page 11. A more detailed survey was made during the study stage. The objectives are:

- (a) to provide up-to-date mapping, which can be used for feasibility studies of irrigation and drainage systems, and
- (b) to enable an early start to be made on detailed design and when Phase II of the irrigation project is implemented.

To meet objective (a) some of the sample areas must be representative of the project as a whole, in order to provide typical outline design and cost data. It is however not thought advisable to limit sample areas to one category, in view of the particular importance attached to areas like the Sungai Burung scheme. Selection of a sample area of course implies that the area will lead to the irrigation and drainage infrastructure improvement programme. Sample areas have provisionally been selected as given overhead. They are also shown on the relevant schematic plans in Appendix B.

## 6. DEVELOPMENT OPPORTUNITIES AND STRATEGIES IN SEBERANG PERAI

### 6.1 General

6.1.1 The study is concerned with all irrigated and drained land in Seberang Perai which is covered by DID schemes, with the exception of the Sungai Acheh scheme in the south of the state which is grouped with schemes in Perak. Certain drainage scheme areas also are excluded, but study of the drainage schemes will, in any event, be limited in scope, as explained in 4.6.8. Details of the schemes under study in Seberang Perai are given in section 3.2 and in Appendix B.

### 6.2 Sample areas

6.2.1 (Some of the comments made in 5.2 are repeated here for convenience of those readers not concerned with Balik Pulau). Sample areas as defined in the TOR (page 5, top) are those in which detailed survey takes place during feasibility stage. The objectives are:

- (a) to provide up-to-date mapping which can be used for feasibility studies of irrigation and drainage requirements, and
- (b) to enable an early start to be made to detailed design as and when Phase II of the upgrading project is implemented.

To meet objective (a) some of the sample areas must be representative of the project as a whole, in order to provide typical outline design and cost data. It is however not thought suitable to limit sample areas to this category, in view of the particular importance attached to areas like the Sungai Kulim scheme. Selection of a sample area of course implies that the area will lead in the irrigation and drainage infrastructure improvement programme. Sample areas have provisionally been selected as given overleaf. They are also shown on the relevant scheme plans in Appendix B.

Proposed area:-	Approx area hectares (acres)
1. Sungai Muda Scheme:	
Area in Mukims 4 and 5 supplied from taliayer Ageh; bounded by Sungai Tembus on the northern side and by Sungai Lahar Endin on the south.	890 (2200)
2. Sungai Kulim Scheme:	
Area in north west corner in Mukim 2 (north of Permatang Pauh) supplied from taliayer No. 1, including the small area of pumped supply in Peng. Tambang.	425 (1050)
3. Juru Scheme:	
Entire area	240 (600)
4. Alma Scheme:	
Entire area	97 (240)
Total	1,652 (4,090)

6.2.2 Area 1, the part of Sungai Muda scheme, forms a complete irrigation unit, in the form of a strip from West to East, supplied from the Muda main canal on its eastern boundary and ending on the sea coast. The portion nearest the sea is subject to the problem of spongy badly drained soils mentioned in 4.4.12. Area 2, in the Sungai Kulim scheme, is north of the road from Butterworth, through Permatang Pauh, eastward. Its northern boundary is the Seberang Perai river/swamp area, which is due to be improved with the construction of the Perai barrage a short distance downstream. The

North-West corner of the area is crossed by the proposed North-South motorway, and we trust the exact alignment can be supplied to us to permit irrigation and drainage design to conform. Area 1, and to a lesser extent Area 2, are representative of the Project as a whole.

- 6.2.3 Area 3, Juru scheme, is known to have water supply problems, and there is doubt as to how much of its total area could be supplied with water for double padi cropping. Because of this, its status as a sample area is provisional, and no topographic survey will be done until more consideration has been given to the difficulties of water supply. Area 4, Alma scheme, is listed as a "rainfed" area, and the only sample area in this category. However since it now possesses a canal and gated diversion structures use of the term "rainfed" is apparently no longer correct. The Alma scheme source, the Sungai Kelang Ubi, is polluted by the effluent from three factories upstream. We shall investigate the possibilities of dry season supplies from ground water for this area.

### 6.3 Development Opportunities

- 6.3.1 The irrigation and drainage systems in the larger schemes viz. Sg. Muda and Kulim Irrigation Schemes were good in early years when draught buffaloes were used for land preparation and harvesting was done manually. However the labour is no longer available to farm properly in this way. The essential task is to improve padi yields with reduced labour input and, where necessary, to remedy shortcomings from the causes listed earlier (4.4.4), especially those due to inadequate drainage and irrigation infrastructure.

- 6.3.2 As explained in 4.4.6 the yields of padi are at present very low, and a large improvement of over 100% should be possible when new agricultural techniques are combined with improved irrigation and access, and the present negative effects caused by abandoned land, increased pests and uncontrolled planting are eliminated.

- 6.3.3 Re-organisation of the present very small land holdings by some form of larger grouping also appears essential, so that machinery may be used effectively and the quantity of manual labour reduced. We envisage that the present systems may have to be redesigned to allow for block planting of 100-200 ha (250-500 ac). Internal roads with lay-byes will be needed for quick and easy access into each of the blocks, for transport of inputs and padi in and out of each of the blocks.
- 6.3.4 One can foresee also the need for simultaneous planting of large blocks with a single variety to overcome uneven ripening when several varieties are grown and to facilitate large scale combine harvesting. The economy of scale of operation will lend itself to lower cost of production and increase of yield with fewer incidences of damage by rats and other insect pests.
- 6.3.5 The problem of abandoned padi lands in the State, and in Seberang Perai particularly, may in fact compel the adoption of a new approach to padi farming. In view of labour shortage due to rapid urban and industrial development, the emphasis will be on large scale operation of padi farm with heavy reliance on mechanisation. Mini estate type of farming has been suggested. How the farmers who now own small size lands can be organised into pooling all their resources into a mini estate unit will require careful study.
- 6.3.6 Where there is found to be a real shortage of water we will carefully study means of reducing losses and investigate the prospects for re-use of drainage water, by pumping if necessary.
- 6.3.7 A number of useful suggestions for improving the effectiveness of the padi farmers are made in the Working Group on Farm Production Services<sup>7</sup>. Among those not mentioned above are:
- (a) Demonstrations on rice cultural and varietal techniques.
  - (b) Demonstrations on control of pests and diseases.

- (c) Padi seed renewal scheme.
- (d) Expanded credit facilities both for agricultural inputs and farm machinery.

The above services would be co-ordinated either by the DOA or by a new special body operating the Project (4.10.2) .

6.3.8 The scope for introduction of alternative crops in the main padi areas appears small, but there may be opportunities in the rainfed schemes when water supplies will not sustain a second rice crop. The prospects for growing non-perishable food crops such as soya, maize and ground nuts will be investigated.

6.3.9 Scope may also exist for the introduction of a cash crop in addition to two crops of padi, but this will only be followed up if it appears there is real interest among the farmers.

6.3.10 In addition to orthodox cropping patterns for the area we shall study the opportunities for introduction of supplementary on-farm activities such as livestock, poultry production, to such degree as is practicable.

#### Sg. Kulim Scheme - Priority Area

6.3.11 Sungai Kulim Irrigation Scheme - This scheme covers an area of 3,663 ha (9052 ac), all of which have facilities for double-cropping. Yield of padi can be raised from its present average of 2.65 tonnes/ha (422 gantangs/acre) to 3.77 tonnes/ha (600 gantangs/acre), with improved agronomic practices, better seeds, better pest and disease control measures, and better designed irrigation and drainage facilities.

6.3.12 Since this scheme area is large, it should be divided into irrigation blocks to facilitate better water management. As far as possible, new designs will ensure that farmers do not depend too much on one another for irrigation water or drainage. We shall also

study staggering of field operations such as land preparation, transplanting and harvesting so as to minimize peak demands for water, labour and farm machinery.

6.3.13

According to the DOA report, 2180 ha or 59% of the padi land in Seberang Perai Tengah are now abandoned. By far the largest block of abandoned land lies along the main trunk road between Prai/Butterworth and Bukit Mertajam. We shall require guidance from the Government as to exactly which areas are to be rehabilitated before starting to cost scheme improvements and assess economic benefits.

7.1.2

- Project objectives
- Team, support & resources
- Team, other disciplines
- Conditions, objectives

7.1.3

The large collection is the... information for the study, and that... for gaining... necessary in the... considered... the... and the... of... with the... process and...

## 7. PROGRAMME FOR THE STUDIES

### 7.1 Staff Inputs

7.1.1 The study team was mobilised on 16th February 1981, when the team leader and two assistant drainage and irrigation engineers started work in the Kuala Lumpur office of Binnie dan Rakan. This team moved to Penang on 22nd. February and attended an introductory meeting with the Technical Committee on 23rd February. The Irrigation/Water engineer arrived on 2nd March. The programme for staff deployment is given on Figure 7.1 .

7.1.2 Inputs of all professional staff, as agreed for the contract, differ from those put forward for Phase I in our Proposal of services dated December 1979, as follows:

	1979 Proposal (m - m)	Contract (m - m)
Project direction	10	1½
Team, engineers/hydrologist	45½	34½
Team, other disciplines*	32	11
Consultants/specialists	20	4
Total	<u>107½</u>	<u>51</u>

7.1.3 The large reduction in the totals no doubt reflects the Government view that the Project area is well provided with background information for the study, and that time which would be required for gaining information, preparing statistics and so on is not necessary in the present situation. Furthermore the other studies commissioned independently by the Government, such as those by six Working Groups and the Market Potential Survey of July 1980, cover much of the ground which the non-engineering specialists originally proposed had expected to be engaged in.

\* Surveyors excluded

7.1.4 It follows from the foregoing that, as a general rule, the team will accept the data provided by Government or their consultants in matters of agricultural economics, socio-economics and specialist farming activities, subject only to general review and occasional checks.

7.1.5 The engineering situation is somewhat different, because there have not been comparable engineering studies of the area. However the reduction of engineering input is only a fraction of that occurring in other fields of study.

## 7.2 Work Programme

### Mobilisation

7.2.1 Six members of the resident team of ten have been engaged full time on the study since early March, in addition to the Surveyor and two survey technicians. The Soil Scientist will start early in April, and the Hydro-geologist will start later in the month, so that 8 of the 10 team members will be engaged full time before the end of April. In addition the Rural Sociologist and Farm Mechanical Specialist will start work in April. Due to the short nature of their inputs the two Agricultural Economists will not start work until June 1981.

7.2.2 The programme of work is shown in Figure 7.2. The programme of work in matters of agriculture, agricultural soils and agricultural economics is constrained to some extent by the availability of, and very short intermittent inputs allowed for, the specialists in these fields. A number of these specialists hold university appointments and are seconded to the team on a part-time basis.

7.2.3 Field work on agricultural soils will start in April, as explained in 4.4.13, with examination of soils in all the project schemes and their identification and characterisation. The Agronomist has

already started a comprehensive programme of examination of every scheme with questioning of representative farmers and the local DOA and FOA officials. This work will continue through the month of April. Preliminary recommendations for measures to improve padi yields and for supplementary farming activities will be worked up in April and May for inclusion in the Interim Report.

7.2.4 Survey work will continue, with the objective of completing all the sample area mapping as early as possible. The work in the Kulim and Alma areas should be completed before the end of April. Surveyors will continue with their other tasks thereafter (4.5.7).

7.2.5 Engineering studies, following the present review and inspection stage, will focus on several matters in the stages leading up to the Interim Report. These include: detailed analyses of the irrigation and drainage systems, and their shortcomings, in the sample areas; development of standard design criteria for upgrading works; establishment of unit cost data for feasibility study of construction alternatives; inspection and assessment of performance of DID drainage schemes.

7.2.6 Preliminary agricultural recommendations and engineering options put forward in the Interim Report ought to be agreed or decided by the Steering/Technical Committees in good time to permit full use of the July-August period by the Economists and Engineers in preparation of schemes with their economic and financial analysis for the Final Report.

### 7.3 Logistics Office

7.3.1 Since no suitable office accommodation was available at the start of the Project, the Government decided to recondition premises located above the Magistrate's Court in Butterworth.

UPGRADING OF IRRIGATION SCHEMES - BALIK PULAU AND SEBERANG PERAI, PULAU PINANG

PHASE I

Post	Project direction	Name	1981	Feb 1	Mar 2	Apr 3	May 4	Jun 5	Jul 6	Aug 7	Sep 8	Oct 9	Nov 10	Man months
1. Project Director		Syed Muhammad Shahabudin/ A.P. Goudy/Hooi Kah Hung		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0½
Technical Director Drainage/Irrigation		W.M. Clark		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0½
Technical Directors Agriculture/Soils/ Economics		I.L.A. Ysselmuiden/ J. Joyce		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0½
Project Team														
2. T.L./Irrigation Engineer		A.K. Macdonald		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	7½
3. Agronomist		Lee Sin Fook		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	4
4. Soil Scientist		K.T. Joseph		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	3
5. Hydro-geologist		S. Puri		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2
6. Hydrologist		Yap Teong Seng		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	5
7. Irrigation/Water Resident Engineer		P.B. Clark		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	7
8. Asst. D & I Engineer		Loh Kit Mun		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	6
9. Asst. D & I Engineer		Hoh Hock Koon		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	6
10. Agricultural Economist		T.M. Boyd		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2
11. Agricultural Economist		Dr. Ahmad Mahdzan Ayob		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2
Consultants & Specialists														
12. Rural Sociologist		Prof. Muhamad Taib		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2
13. Horticultural Specialist		Dr. Mohd Ali		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1
14. Farm Mechanical Specialist		B. Potheary		-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1
														51

Key: Intermittent - - - - - Full-time -----

STAFF DEPLOYMENT CHART

Figure 7.1

UPGRADING OF IRRIGATION SCHEMES IN  
BALIK PULAU AND SEBERANG PERAI, PULAU PINANG

Months	1981									
	1 F	2 M	3 A	4 M	5 J	6 J	7 A	8 S	9 O	10 N
<u>General</u>										
1	Mobilisation									
2	Review literature and inspect areas									
<u>Hydrology</u>										
3	Obtain and collate records									
4	Establish new measurements									
5	Water available for project									
6	Groundwater resources									
7	Water quality									
8	Infiltration, evaporation, rainfall									
9	Crop water and canal requirements									
<u>Agriculture</u>										
10	Evaluate existing practice									
11	Soil survey, land use/classification									
12	Padi improvements									
13	Mechanisation									
14	Balik Pulau options									
15	Rain-fed schemes options									
16	Horticulture									
17	Poultry, fish ponds									
18	Drainage needs									
<u>Engineering</u>										
19	Evaluate existing irrigation									
20	Evaluate existing drainage									
21	Sample areas									
22	Main networks; structures									
23	Other irrigation schemes									
24	Drainage schemes									
25	Access roads									
26	Cost analysis									
<u>Survey</u>										
27	Establish co-ordinates and levels									
28	Main canals, drains									
29	Sample areas									
<u>Social and Economics Studies</u>										
30	Evaluate existing situation									
31	Labour and farm services									
32	Economic analysis									
<u>Reports</u>										
33	Inception									
34	Interim									
35	Final									

WORK PLAN  
Figure 7.2

Instructions were given to the JKR around 24th February to start this work. It involves reconstruction of partition walls, ceiling and flooring as well as complete re-wiring and provision of air-conditioning. As at 25th March the work was well advanced but no date for moving in could be given.

7.3.2 Temporary office space has kindly been made available in Georgetown by the State Economic Planning Unit. There are two rooms with desk space for four people, including clerical staff. This was only adequate for a very short time, as total staff exceeded four after 5th March. Since then we have had up to six professional and three clerical staff, with the result that the Agronomist and Hydrologist and other visitors have worked from their hotels. There is also a complete lack of shelf or other storage space, so that office efficiency is seriously handicapped. Housing for the team, and the greatest proportion of the study area, are in Seberang Perai, so that appreciable time is lost in crossing to Penang Island to the temporary office. It is not possible to engage any survey draftsmen, since there is neither equipment nor space for them.

7.3.3 As a result of the lack of typewriters and other office facilities, this report has been typed and printed at our head office in Kuala Lumpur.

7.3.4 We are confidently looking forward to moving to our permanent office in Butterworth early in April, but if there should be any delay with this move, the work done under this contract would be very seriously affected.

#### Transport

7.3.5 Two saloon cars are being used by the study team as at 25th March, and a third vehicle will be available shortly. At present this is adequate for the needs of the professional team, including specialists, though not for the surveyor and his assistants. Two further cars are currently used by the three surveyors and their 12 labourers. With the onset of monsoon weather at a later date

it may be that a jeep or similar vehicle will be needed for access in certain cases, particularly in the drainage areas. If this turns out to be the case we trust that the DID or Dept. of Iowa Agriculture will be able from time to time to loan a suitable vehicle as extra requirement.

2. Upgrading of Living Conditions and Planning and Development Study 1977, by Department of Planning, 1979.
3. Socio-economic Survey of South Dakota, February 1978, by NCSA, 1979 (available in Library of Congress).
4. Agriculture Outlook for the United States, May 1977, 1980.
5. Market Potential Study for DIDP, October 1978, prepared by SRI, Inc., and APAC, Inc.
6. Final Report, Planning and Development Study, January 1978, Michigan, Fairbanks Corporation on the State of MI.
7. A. H. James Corp. 1978.
8. Working Group for the South Dakota Agricultural Food Integrated Agricultural Development Program, South Dakota State University, Services to Food and other Crops.

## References

1. Verbal communication from Penang State Director of Town and Country Planning. (the 1980 Census population was 911,000).
2. Updating of Klang Valley Regional Planning and Development Study 1973, by Shankland Cox Partnership, 1980.
3. Socio-economic survey of Balik Pulau/Seberang Perai MOA, 1979 (tabulation of answers to questionnaires).
4. Mid-term Review of the Third Malaysia Plan 1976-1980.
5. Market Potential Study by MIDF Industrial Consultants Sdn. Bhd. and ANDZEC Limited.  
  
Final Report, Summary and Recommendations, Volume 1.
6. Malaysia, Farmers' Cooperatives on the Move - by A. H. Ahmad Sarji, 1978.
7. Working Group (of the Balik Pulau/Seberang Perai Integrated Agricultural Development Project) on Farm Production Services on Padi and Other Crops.

APPENDIX 'A'

TERMS OF REFERENCE

## TERMS OF REFERENCE

### Upgrading of Irrigation Schemes in Balik Pulau and Seberang Perai, Pulau Pinang

#### 1. Introduction

1.1 Seberang Perai has about 34,590 acres of land under padi cultivation. Of this total, about 34,000 acres are double cropped leaving about 590 acres under single cropping. Balik Pulau has about 2,782 acres of land under padi of which about 500 acres are double cropped.

1.2 The existing irrigation facilities in the Seberang Perai and Balik Pulau areas were completed some 25 years ago. The existing facilities therefore fall short of the present day standard of irrigation system, designed for optimum water management and maximum productivity. It was reported that the farmers lost one crop in three years as a result of inadequate irrigation facilities and poor farm management. There is a proposal to re-evaluate the performance of the existing facilities with a view for upgrading of the system. It is envisaged that this will include improvements to the irrigation, drainage and access facilities as well as the strengthening of agricultural supporting services. These measures will contribute to increase crop productivity and farm incomes and hence are in line with the Government's policy of poverty eradication, which is particularly acute among the padi cultivators in many parts of the country.

1.3 The Government of Malaysia has therefore decided to engage the services of consultants to carry out feasibility study, detailed design and construction supervision of all engineering works necessary for the upgrading of the 11 existing irrigation

schemes in the Seberang Perai area, the four rainfed areas of Alma, Sg. Duri, Mengkuang Mak Sulong and Cherok Tok Kun and the Balik Pulau area (as listed in 3.3).

## 2. Objective

The principal objectives of the project would be to formulate and implement proposals for the upgrading of irrigation, drainage and access facilities for each of the irrigation schemes, in the project area with the aim of raising efficiency, improving farm and water management and providing the necessary pre-conditions for increased productivity and farm incomes.

## 3. Background

3.1 Irrigated agriculture, especially padi cultivation, places the heaviest overall demand on the surface water resources. This demand has grown as a result of the steady increase in the irrigated area and the policy of increasing the acreage of double cropped padi. Optimising the use of water is now essential if water is not to become the main constraint of further agricultural development. In the case of padi cultivation, optimisation of water use can be achieved by improved water management techniques made possible by the provision of more intensive reticulation system and in field structures.

3.2 Padi cultivators are one of the major poverty group identified in the Third Malaysia Plan as in need of selective treatment. The project is thus directly aimed at a specific target poverty group and will assist the Government in its effort to eradicate rural poverty. Based on an average holding size of 2 - 3 acres, the project can benefit about 14,000 farm families.

3.3 The project area consists of 11 irrigation schemes in the Seberang Perai area, covering a total acreage of 34,590 acres of padi, four rainfed areas of Alma, Sg. Duri, Mengkuang Mak Sulong and Cherok Tok Kun totalling 613 acres and the Balik Pulau area, (2,782 acres under padi).

(A) (a) Seberang Perai Utara

(i) Sungai Muda Irrigation Scheme	17,580 acres
(ii) Pinang Tunggal Irrigation Scheme	3,697 "
(iii) Jarak Irrigation Scheme	1,950 "
(iv) Tasek Glugor Irrigation Scheme	547 "
(v) Jarak Tengah Irrigation Scheme	260 "
Sub-Total	<u>24,034 acres</u>

(b) Seberang Perai Tengah

(i) Sungai Kulim Irrigation Scheme	9,052 acres
(ii) Juru Irrigation Scheme	602 "
(iii) Macang Bubok Irrigation Scheme	335 "
(iv) Renjau Irrigation Scheme	50 "
(v) Kuala Tasek Irrigation Scheme	45 "
Sub-Total	<u>10,084 acres</u>

(c) Seberang Perak Selatan

(i) Tasek Junjung Irrigation Scheme	<u>482 acres</u>
Total	<u>34,600 acres</u>

(B) Provision of irrigation to the four rainfed padi areas.

(i) Alma	240 acres
(ii) Cherok Tok Kun	263 acres
(iii) Mengkuang Mak Sulong	60 acres
(iv) Sungai Duri	50 acres
Total	<u>613 acres</u>

(C) Provision of drainage and/or irrigation facilities to

(i) Pantai Acheh 500 acres, for the cultivation of suitable crop(s) to be recommended by the consultants.

(ii) Sungai Burung 1,296 acres.

(iii) Sungai Pinang 1,486 acres.

Total 3,282 acres

Grand Total 38,495 acres.

#### 4. Scope of Work

It is intended that the project shall be undertaken in two phases. Phase I will cover all study and investigations up to feasibility stage. Phase II will involve the detailed design and implementation of the schemes. The consultant's approach to the Study shall be in consonance with local institutional and engineering standards. In view of the labour shortage problem in the project area, the engineering system shall be of the type that minimizes labour requirements during actual operations. During the course of Study, the consultant shall take into account the results of the socio-economic survey undertaken by the Ministry of Agriculture which had been carried out in the project area in the middle of 1979.

##### Phase I : Feasibility Study

- Review and evaluate the engineering, agricultural and economic aspects of each scheme to determine the present technical and economic viability in the light of changes since the scheme was originally planned and implemented.

- Carry out detailed survey of suitably chosen sample areas and other necessary site investigations, where necessary for each of the schemes.
- Formulate proposals for upgrading of irrigation, drainage and access facilities.
- Prepare a feasibility report for each scheme including cost benefit analysis.
- Prepare a schedule of implementation of proposed work.

If proposed development is found feasible and after approval by the Government, the consultants shall proceed to phase II as follows.

Phase II: Detailed design and Construction Supervision

- Preparation of detailed designs and plan for each scheme including tender documents.
- Calling of tender, evaluation and recommendation of award of tender.
- Contract administration and construction supervision.

The scope of work during the two phases includes, but not necessarily restricted to the following:

Phase I : Feasibility Study

- (i) Review the rainfall, runoff, streamflow, evaporation and other hydro-meteorological data for each scheme and collect

- additional data where necessary.
- (ii) Review available survey and topographical data and arrange for collection of additional data/information where necessary.
  - (iii) Review all soil and land classification data and standardise on agreed system.
  - (iv) Assess the availability of surface water resources and where necessary, conduct investigations for ground water and propose a system for conjunctive use of surface and ground water resources.
  - (v) Determine the suitability of surface water and/or ground water for agricultural use.
  - (vi) Collate and review all existing literatures/reports on each irrigation scheme.
  - (vii) Examine existing infrastructural layout to assess irrigation and drainage requirements and efficiencies and prepare proposals for upgrading of the schemes.
  - (viii) Examine existing padi varieties, yields and crop water requirements and propose changes where necessary to improve production.
  - (ix) Examine the potential for providing irrigation supply to neighbouring potential paddy areas.

- (x) To look into the possibility of having double crops plus some other cash crops.
- (xi) Taking into consideration the labour shortage problem, examine the need for mechanization of agricultural activities and to recommend suitable choice of agricultural machines where needed.
- (xii) Carry out financial, social and economic appraisal of proposed upgrading of the irrigation schemes.
- (xiii) Prepare proposals for project management during construction as well as operation and maintenance stage and propose a system of data collection where necessary for the monitoring of the overall project.
- (xiv) Draw up detailed programme for the construction of proposed engineering works, covering phasing of implementation, manpower requirements and coordination activities.

Phase II: Detailed Design and Construction Supervision

- (i) Prepare land acquisition plans for the purpose of acquiring the necessary reserves for proposed canals, drains and any other works.
- (ii) Prepare detail engineering designs and plans

for schemes approved by the Government on the basis of the feasibility report, together with tender documents.

(iii) Assist the Drainage and Irrigation Department in calling tender, processing and awarding of contract.

(iv) Carry out contract administration and supervision of construction.

## 5. Duration of Project

5.1 Phase I of the Project shall be of 9 months duration and shall commence within two weeks after signing of the contract. Phase II is estimated to be completed in 48 months.

Phase I : Review and evaluation 3 - 4 months.  
Preliminary proposals and cost estimate:  
5 - 6 months.

Phase II : Detailed planning and design and preparation of tender documents; 6 months.  
Implementation 42 months.

## 6. Reports

The consultants shall prepare and submit the following reports in English.

Phase I :

(i) An Inception Report (50 copies) containing a detailed statement of the Consultant's proposed study, procedures and work schedule, to be submitted within 1 month of the starting date;

(ii) Interim Report (50 copies)

giving a summary of the work performed during the reporting period and any preliminary findings and redommendations; to be submitted within 4 months after the starting date;

(iii) A Draft Final Report (100 copies)

summarizing all work performed in the study and the findings and recommendations of the consultants, including maps, plans and diagrams, to be submitted not later than 7 months after the starting date;

(iv) A Final Report (100 copies)

incorporating all revisions deemed appropriate by the consultants after considering comments by the Government on the Draft Final Report.

Phase II :

(i) Preliminary design and land acquisition plans within 4 months. (25 copies)

(ii) Final Design complete with Tender Table Documents and Specification shall be submitted within another 2 months. (50 sets)

(iii) Progress Reports shall be submitted quarterly throughout the duration of construction.

- (iv) Completion Report summarizing the details of design and construction works including an operation manual with sufficient details and guidelines for the operation and maintenance of the completed works.

## 7. Supervision of the Project

A steering committee chaired by the Ministry of Agriculture will be formed, to include representatives of the Treasury, Malaysian Agricultural Research and Development Institute, Implementation and Coordination Unit, Economic Planning Unit, Drainage and Irrigation Department (Federal and State), State Economic Planning Unit and the Department of Agriculture (Federal and State), and Farmer's Organisation Authority for the overall monitoring and guidance of the project. A technical Sub-Committee responsible for day-to-day management of the Project will be formed and the consultants will be required to maintain close liason with this Sub-Committee, the State Economic Planning Unit and other relevant Government agencies.

The successful consultant will be required to set up an office in Seberang Perai.

## 8. Consultant's Qualification

The consultant should have considerable experience in feasibility study, detailed design and project management for works of similar nature and under similar social and environmental conditions. The consultant's staff assigned

to the project should, at least comprise of the following key personnels.

- (i) Irrigation Engineer
- (ii) Hydrologist/Water Resources Engineer
- (iii) Agronomist
- (iv) Construction Engineer
- (v) Project Economist.

9. Data Availability

All existing relevant records, data, plans, reports and relevant literature will be made available on request to the consultant. The consultants are required to indicate any shortfall in the availability of information required for the project and to discuss their additional requirements with the relevant Government agencies. The consultant shall be responsible for the collection of any additional data, where necessary.

29.10.79

/ao.

The works involved include the following:

Addendum to Terms of Reference  
Phase 1: Upgrading of Irrigation Schemes,  
in Balik Pulau and Seberang Prai,  
Pulau Pinang

(a) Consultants are hereby informed that the Terms of Reference for the above project are to be extended.

1. Additional Scope of Work

1.1 Topographical Survey

Consultants would be requested to provide the necessary manpower and equipment to carry out detailed topographical survey for the irrigation areas of the project for planning and detailed design. Topographical survey of sample areas, as referred to in paragraph 1 of page 5 of original Terms of Reference will form part of the above survey requirement and should be scheduled to take place early so that information could be obtained in time to facilitate the feasibility study under Phase 1 of the project assignment.

1.2 Extension to include the tree crop areas

Project assignment should cover the tree crop areas estimated at 100,694 acres of which some 43,200 acres are drainage areas maintained by DID. The land use projection for the tree crops are:

	<u>acres.</u>
rubber -	51,287
coconut -	35,826
oil palm -	3,205
other tree crop - (cloves, nutmegs, fruit trees and cocoa)	10,376

The works involved include the following:

Phase I: Feasibility Study

- (i) In respect of drainage areas maintained by DID.
  - (a) To review and evaluate existing drainage schemes and to identify shortfalls, problems and areas for improvement of the drainage schemes. The drainage schemes included are:

<u>Name</u>	<u>Acres</u>
Bukit Minyak/Bukit Tengah	8,629
Bukit Tambun	10,564
Nibong Tebal	13,547
Tasak Glugor	2,426
Sungai Udang/Tanjung Berembang	1,030
Sungai Chenaham/Sg. Udang Kecil	290
Benteng Kampong Melayu	420

- (b) To propose necessary drainage improvement works taking into consideration Government intention for agricultural intensification and crop diversification in the areas.
- (ii) To examine the need and to propose appropriate drainage works, where necessary for 32,800 acres of land outside DID schemes to permit agricultural improvement.

Phase II: Detailed design and construction supervision

If proposed drainage improvement, works are found feasible and after approval by the Government, the Consultants shall proceed to Phase II as follows:

- Carrying out necessary survey and field investigation.
- Preparation of detailed designs and plans including tender documents.
- Calling of tender, evaluation and recommendation of award of tender.
- Contract administration and construction supervision.

### 1.3 Special Consideration to the whole Balik Pulau area

The Consultants' proposal for the Pantai Aceh, Sg. Eorong and Sg. Pinang areas should take cognizance of the development in Balik Pulau area as well in the island of Penang. There is also limited water supply for agriculture due to competing demand by industry and urban household. There should be a socio-economic study to assess income patterns in the Balik Pulau area. The feasibility study should therefore be broadened to assess the best way to raise the income of the farmers and the general population, not only through improved agriculture but also through other measures such as broiler production, horticulture, fish and livestock production etc.

### 2. Report Submission

In view of the considerable differences in the nature and characteristics of the project areas in Seberang Prai and those of the Penang island, the Consultants should therefore submit reports separately for the two areas, to facilitate assessment and follow up action by the Government.

### 3. Consultants' Qualification

The consultant's team for the project should include an experienced engineering surveyor to undertake the detailed topographical survey and other survey work as required under the Terms of Reference and its addendum. An agricultural economist should also be included as one of the key personnel of the project team.

## MODIFICATION TO THE TERMS OF REFERENCE

As detailed at meeting of the Technical Committee on 16th March 1981. The changes are underlined.

Page 7; Item 4(x) to read :-

- (x) To look into the possibility of having double crops plus some other cash crops, or single padi crop plus off season other crop, or conversion of area to other crop or alternative usage.

Page 7; Item 4(xi) to read:-

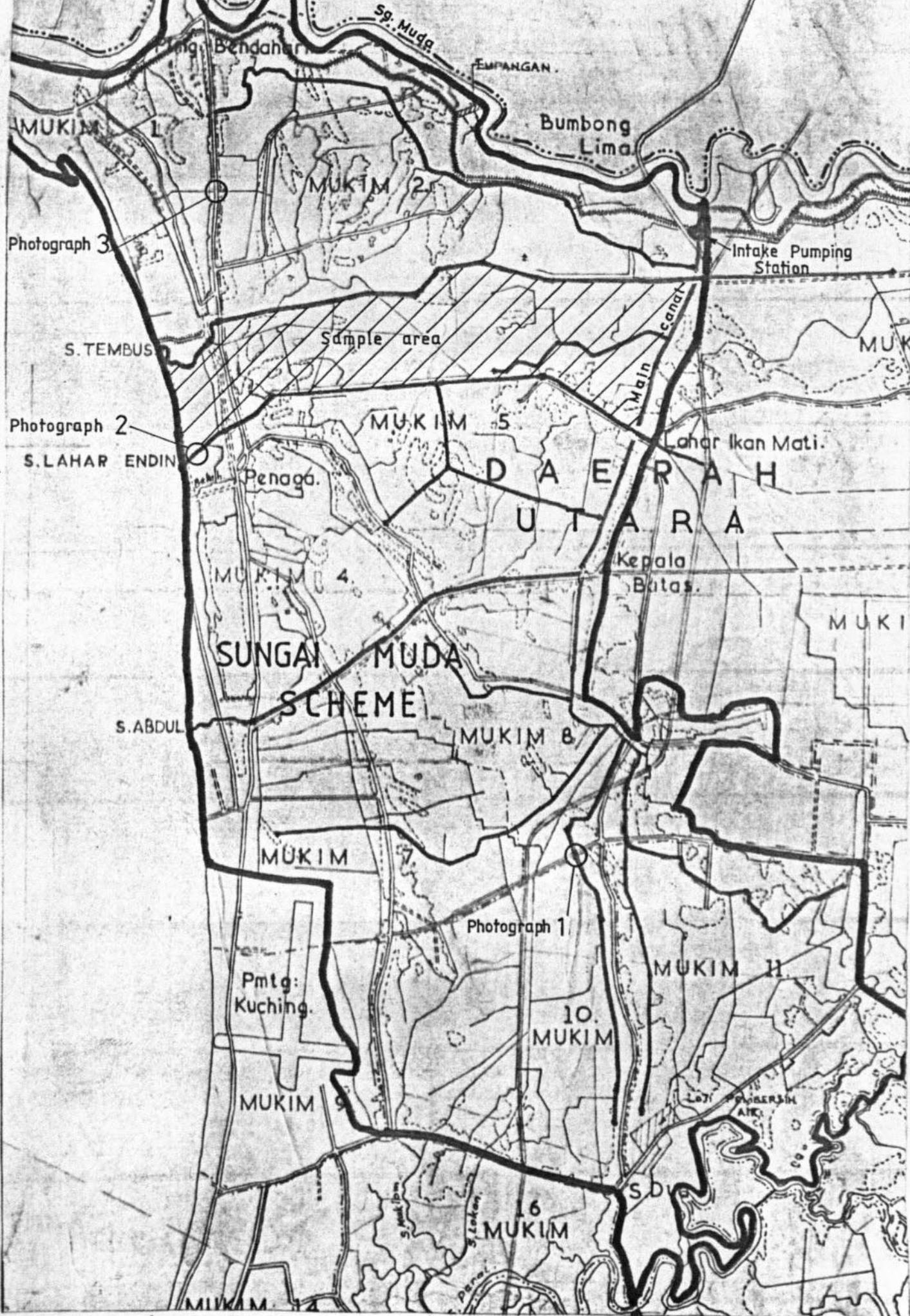
- (xi) Taking into consideration the labour shortage problem and soil condition, examine the need for mechanization of agricultural activities and to recommend suitable choice of agricultural machines in view of future development.



DETAILS OF EXISTING SCHEMES

The following pages record brief details of most of the existing irrigation schemes. Only the three small schemes - Sg. Duri (50 acres); Kuala Tasek (45 acres) and Mengkuang (60 acres) - are not included. The data is based on brief field visits and preliminary discussions with government officials. Figures quoted have not yet been checked or confirmed. In particular, values of cropped areas and yields have shown minor inconsistencies between those given by different departments and these have not yet been reconciled. In some instances data has not been readily available or has not yet been collected. The absence of figures does not indicate zero values.

# SUNGAI MUDA SCHEME





1. Sg. Muda Scheme : Branch canal



2. Sg. Muda Scheme: Tidal gates on Sg. Lahar Endin



3. Sg. Muda Scheme : Low-lying, coastal area with drainage problems.

SCHEME : A(i) SUNGAI MUDA

Irrigable area : 7,115 ha (17, 580 acres)

A. 1. Source : Sg. Muda

2. Location of intake (map reference) : 272, 200E; 615, 500N

3. Type of intake : Pumped intake; river levels controlled only by gated tidal barrage approx. 2.5 km downstream.

4. Nominal intake capacity : 3 No.  $2.8 \text{ m}^3/\text{s}$  (100 cusecs) + 1 No.  $5.7 \text{ m}^3/\text{s}$  (200 cusecs) electric powered pumps; total :  $14.2 \text{ m}^3/\text{s}$  (500 cusecs).

5. Canal and drainage systems : Primary network of main and secondary canals extensive and relatively well maintained. Lack of field canals. Primary drainage but lack of drains within tertiary blocks. Drain outlets with tidal gates.

6. Access : Good primary access but lack of farm roads into irrigation areas.

B. Present cropping patterns (based on figures for 1979 off-season. 1979-80 main season).

1. Main season : Area cultivated : 6,617 ha (16,350 acres)

93% of irrigable area.

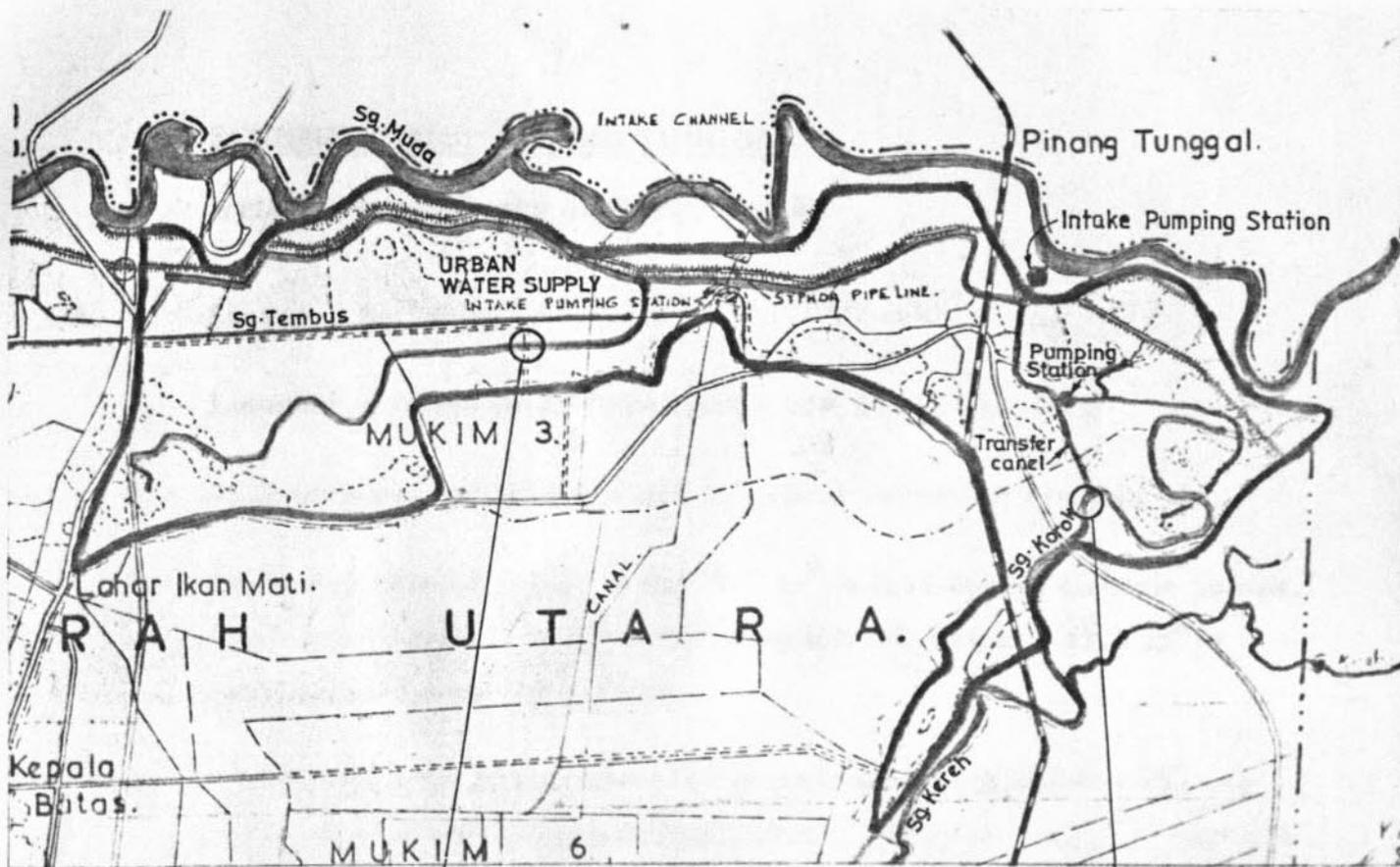
Average yield : 3.27 tonnes/ha (520 gantangs/acre)

2. Off season : Area cultivated : 4,980 ha (12,305 acres)

70% of irrigable area.

Average yield : 2.83 tonnes/ha (450 gantangs/acre)

C. Comments : Basic irrigation and drainage systems in fair condition but drainage problems in low-lying coastal areas. Apparently adequate water but land in southern blocks being abandoned with increasing problems of pests. Labour shortage in southern areas particularly.



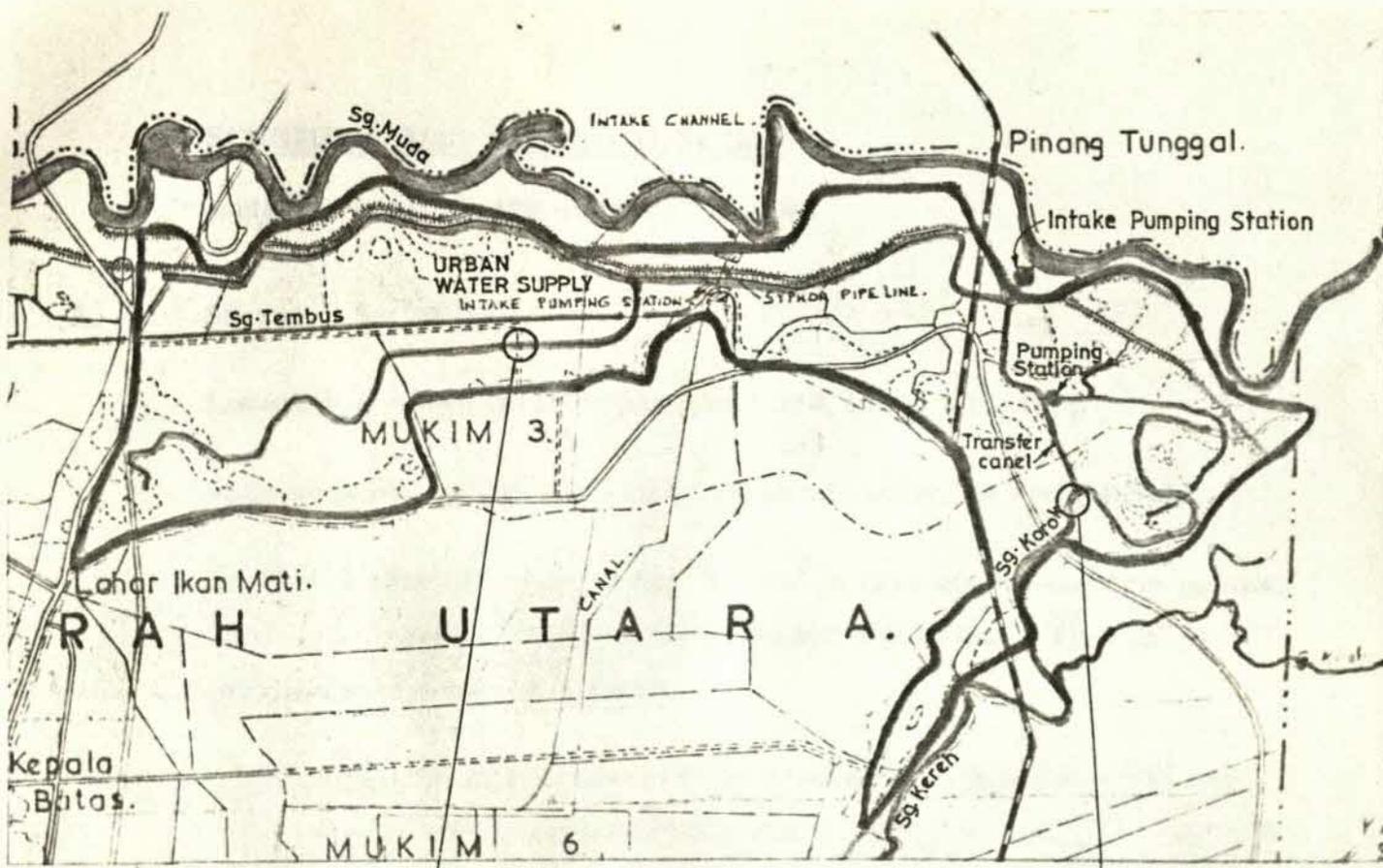
PINANG TUNGGAL SCHEME



Inverted syphon on southern branch canal



Sg. Korok immediately d/s of exit of transfer canal. River badly choked with weeds. Note small pumping station for vegetable farmer.



PINANG TUNGGAL SCHEME



Inverted syphon on southern branch canal



Sg. Korok immediately d/s of exit of transfer canal. River badly choked with weeds. Note small pumping station for vegetable farmer.

SCHEME : A(ii) PINANG TUNGGAL

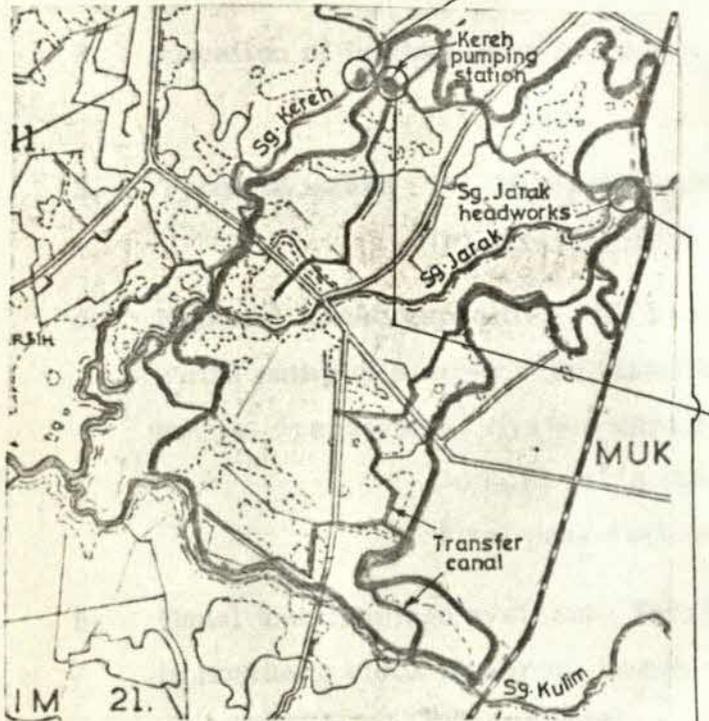
Irrigable area : 1,496 ha (3,697 acres)

- A. 1. Source : Sg. Muda
2. Location of intake (map reference) : 280,100 E; 615,400N
3. Type of intake : Pumped intake ; no local control of river levels.
4. Nominal intake capacity : 2 No.  $3.8 \text{ m}^3/\text{s}$  (135 cusec) electric pumps. Third pump of similar sized installed but full output -  $11.5 \text{ m}^3/\text{s}$  (405 cusec) not yet operational.
5. Canal and drainage systems : Well maintained system of main and secondary canals but lack of field canals. Primary drainage but lack of field drains. Areas outside flood protection bund liable to flooding from Sg. Muda and therefore classed as 'rainfed'.
6. Access : Primary access good but insufficient farm roads.
- B. Present cropping patterns (based on figures for 1979 off-season. 1979-80 main season)
1. Main season : Area cultivated: 1,451 ha (3,585 acres)  
97% of irrigable area.  
Average yield : 3.77 tonnes/ha (599 gantangs/acre)
2. Off-season: Area cultivated: 1,466 ha (3,623 acres)  
98% of irrigable area.  
Average yield: 3.02 tonnes/ha (480 gantangs/acre)
- C. Comments : Main irrigation and drainage systems in good order but lack of field canals causes some problems with supply to fields distant from canal off-takes. Adequate water supplies. Area in eastern block, probably in excess of 40 ha, being used for vegetables, frequently supplied by farmers' own pumps drawing from S. Korok.

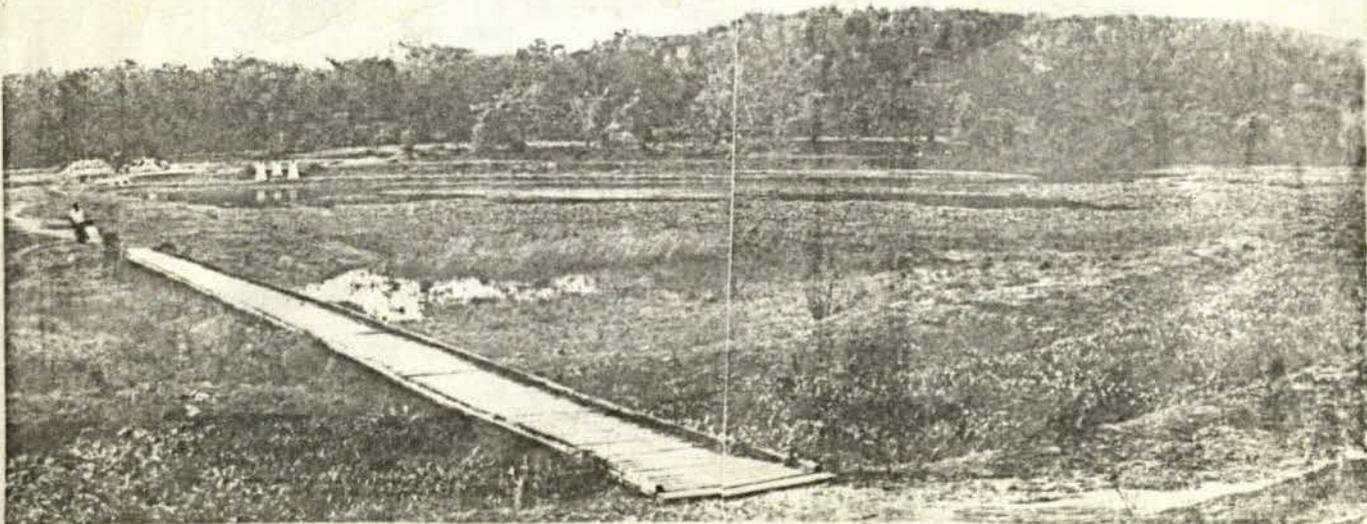
# JARAK SCHEME



New radial-gate control structure at Sg. Kereh headworks.



Kereh Pumping Station



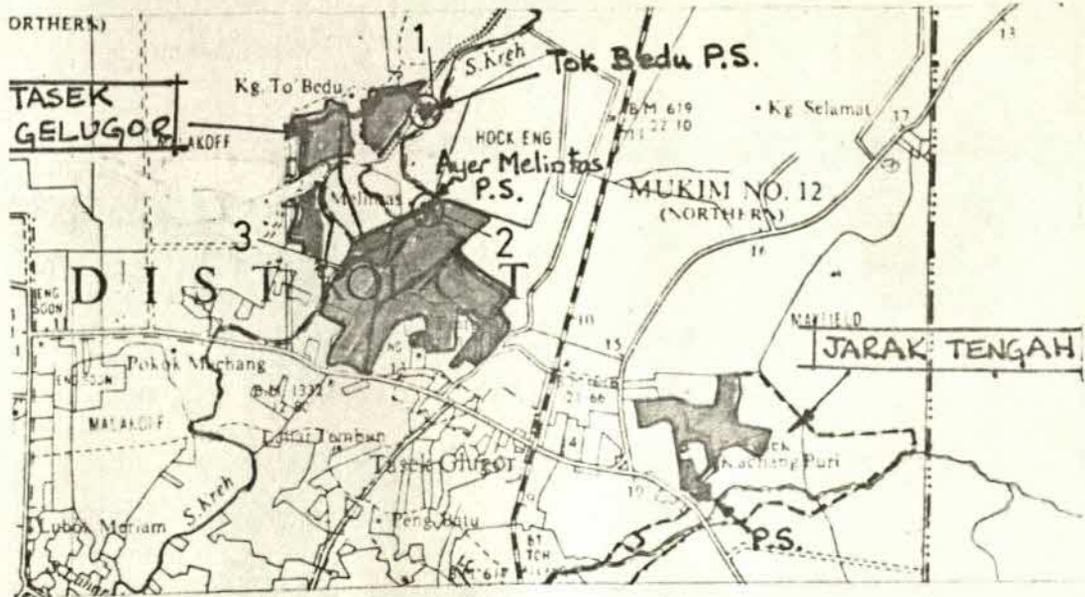
Upstream view of Sg. Jarak headworks. River control structure at left with exit structure of transfer canal from Sg. Kereh immediately to right. Weed choked entrance to Jarak transfer canal in foreground.

SCHEME : A(iii) JARAK

Irrigable area : 789 ha (1,950 acres)

- A. 1. Source : (a) Sg. Kereh, augmented by pumped supply transferred from Sg. Muda.  
(b) Sg. Jarak.  
(c) Part of scheme fed from Ayer Melintas P.S. (Tasek Gelugor).
2. Location of intakes (map reference) : (a) 276,500 E; 606,400 N  
(b) 278,700 E; 605,400 N
3. Types of intake : (a) Pumped intake with gated, river-control structure  
(b) Gravity intake with gated, river-control structure
4. Nominal intake capacities : (a) 2 No.  $2 \text{ m}^3/\text{s}$  (70 cusec) electric pumps. Third pump of similar size installed but full capacity  $6 \text{ m}^3/\text{s}$  (210 cusec) not yet operational. System part of Sg. Muda to Sg. Kulim transfer.  
(b)  $4.25 \text{ m}^3/\text{s}$  (150 cusec). Also part of transfer scheme.  
Total peak requirement for Jarak =  $1.7 \text{ m}^3/\text{s}$  (60 cusec).
5. Canal and drainage systems : Primary system reasonably well maintained in northern block (fed from Kereh to Jarak canal). Considerable weed growth in Jarak/Kulim canal.
6. Access : Area fragmented and access varies. New road being constructed to Sg. Jarak headworks.
- B. Present cropping patterns (based on figures for 1979 off-season, 1979-80 main season).
1. Main season : Area cultivated : 710 ha (1,755 acres) - 90% of irrigable area  
Average yield : 2.01 tonnes/ha (320 gantangs/acre).
2. Off-season : Area cultivated : 671 ha (1,657 acres) - 85% of irrigable area  
Average yield : 2.20 tonnes/ha (350 gantangs/acre).
- C. Comments : Block south of Padang Manora appears abandoned, apparently due to labour shortage but possibly also with drainage problems. Work presently being carried out on uprating of transfer system and on drainage and flood control works on Sg. Kereh including an additional gated structure at the pumped intake.

# TASEK GELUGOR AND JARAK TENGAH SCHEME



1. Tok Bedu Pumping Station  
(downstream view)



2. Ayer Melintas Pumping Station  
(Upstream view)



3. Concrete distribution canal and distribution box

SCHEME : A(iv) TASEK GELUGOR

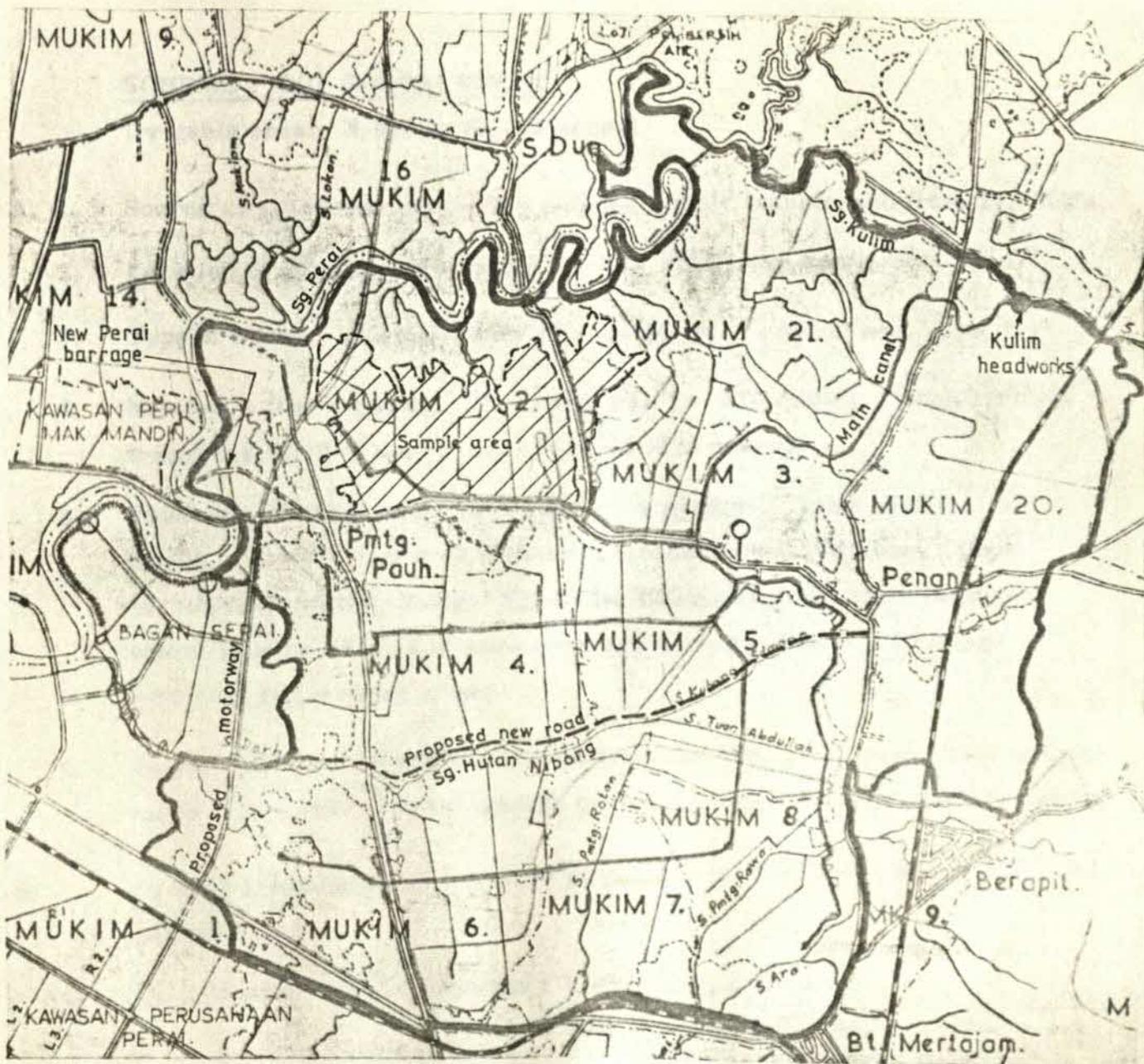
Irrigable area : 221 ha (547 acres)

- A. 1. Source : Sg. Kereh augmented by pumped supply transferred from Sg. Muda.
2. Location of intakes (map reference):
- (a) Ayer Melintas : 278, 000E; 608, 700N
  - (b) Tok Bedor : 277, 600E; 609, 200N
3. Type of intake : Both diesel powered pumped intakes without river-control structures.
4. Nominal intake capacities : Ayer Melintas P.S. - 2 No.  $0.21 \text{ m}^3/\text{s}$  pumps :  
total  $0.42 \text{ m}^3/\text{s}$  (15 cusec)  
Tok Bedor P.S. - 2 No.  $0.07 \text{ m}^3/\text{s}$  pumps:  
total  $0.14 \text{ m}^3/\text{s}$  (5 cusec)
5. Canal and drainage systems : Generally canals appear in good condition and well maintained. Some minor canals concrete lined and distribution boxes constructed. Relatively high intensity of canals, but lack of field drainage systems. Canals extend into northern part of Jarak scheme.
6. Access : Fairly good.
- B. Present cropping patterns (based on figures for 1979 off-season, 1979-80 main season)
- 1. Main season : Area cultivated : 210 ha (520 acres)  
95 % of irrigable area  
Average yield : 2.2 tonnes/ha (350 gantangs/acre)
  - 2. Off-season : Area cultivated : 214 ha (530 acres)  
97% of irrigable area  
Average yield : 2.2 tonnes/ha (350 gantangs/acre)
- C. Comments : Systems in generally good condition with adequate water supplies. Some minor drainage problems. Yields have been dropping over the last two years - possibly due to pests which are reported as being a serious problem.

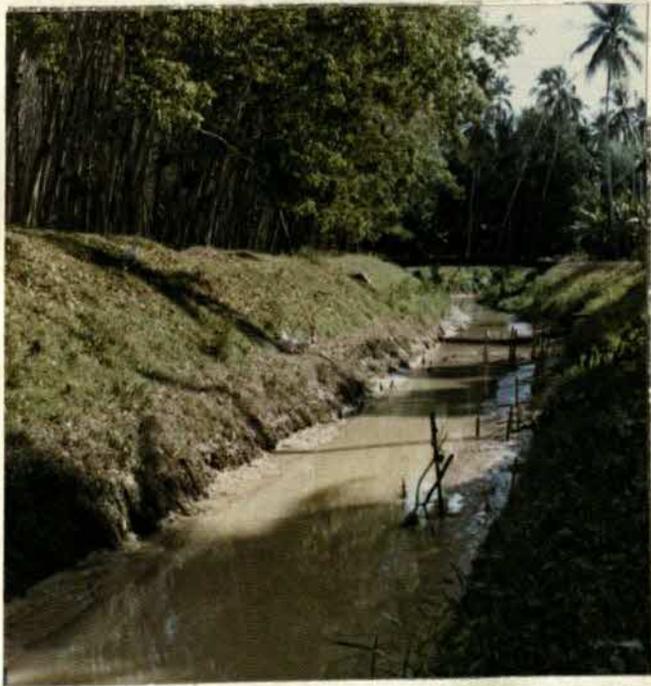
SCHEME : A(v) JARAK TENGAH

Irrigable area : 105 ha (260 acres)

- A. 1. Source : Sg. Jarak.
2. Location of intake (map reference) : 280, 600E; 606, 400N
3. Type of intake : Pumped intake from canal offtaking from Sg. Jarak.  
No river control structure.
4. Nominal intake capacity : Not known.
5. Canal and drainage systems : Part of area presently subject to flooding from Sg. Jarak and only part of system in use. Canals in moderate condition.
6. Access : Inadequate for vehicles.
- B. Present cropping patterns (based on figures for 1979 off-season, 1979-80 main season).
1. Main season : Area cultivated : 40 ha (100 acres)  
38% of irrigable area  
Average yield : 2.2 tonnes/ha (350 gantang/acre)
2. Off-season : Area cultivated : 49 ha (120 acres)  
47% of irrigable area  
Average yield : 2.2 tonnes/ha (350 gantang/acre)
- C. Comments : Flooding of area serious problem. Flood bank protects part of scheme but drainage within protected area difficult. River levels controlled by gated headworks on Sg. Jarak scheme approx. 2 km downstream and flood alleviation measures must take into account operation of these gates.



### SUNGAI KULIM SCHEME



Main canal during maintenance period



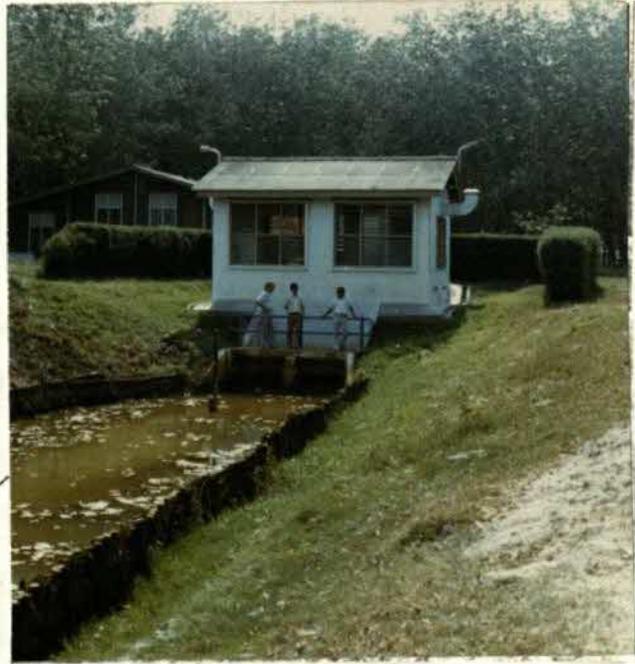
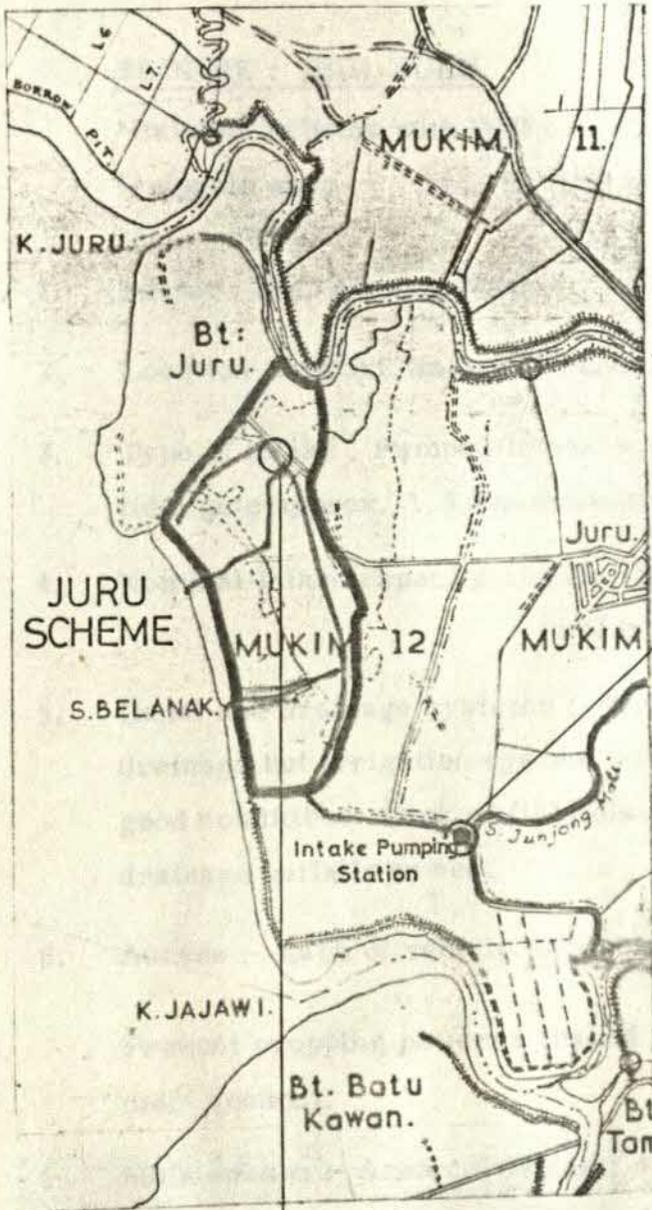
Sungai Kulim headworks

SCHEME : B(i) SUNGAI KULIM

Irrigable area : 3,663 ha (9,052 acres)

- A. 1. Source : Sg. Kulim augmented by pumped supply transferred from Sg. Muda.
2. Location of intake (map reference) : 276,800E; 601,600N.
3. Type of intake : Gravity intake with gated river control structure.
4. Nominal intake capacity : Presently  $5 \text{ m}^3/\text{s}$  (175 cusec). When uprated transfer system in operation;  $6.4 \text{ m}^3/\text{s}$  (225 cusecs).
5. Canal and drainage systems : Extensive system of main distribution canals, recently improved with one secondary concrete lined. Lack of field distribution canals. Sg. Hutan Nibong is main drain through centre of area but lack of secondary and tertiary drains. Drainage problems in low-lying areas.
6. Access : Main road system around area but very poor access into irrigated areas. New road planned through centre of area beside Sg. Hutan Nibong.
- B. Present cropping patterns (based on figures for 1979 off-season, 1979-80 main season)
1. Main season : Area cultivated : 1,365 ha (3,372 acres)  
37% of irrigable area  
Average yield : 3.14 tonnes/ha (500 gantangs/acre)
2. Off-season : Area cultivated : 1,722 ha (4,255 acres)  
47% of irrigable area  
Average yield : 2.83 tonnes/ha (450 gantangs/acre)
- C. Comments : Labour shortages and pressures on land from urban development have led to large areas being abandoned with consequent increase in pests particularly rats. Distribution and command problems to fields distant from canal system in some areas. Drainage problems in low lying areas. Water shortages but uprated transfer system from Sg. Muda not yet in operation.

# JURU SCHEME



Sg. Junjong Mati Pumping Station



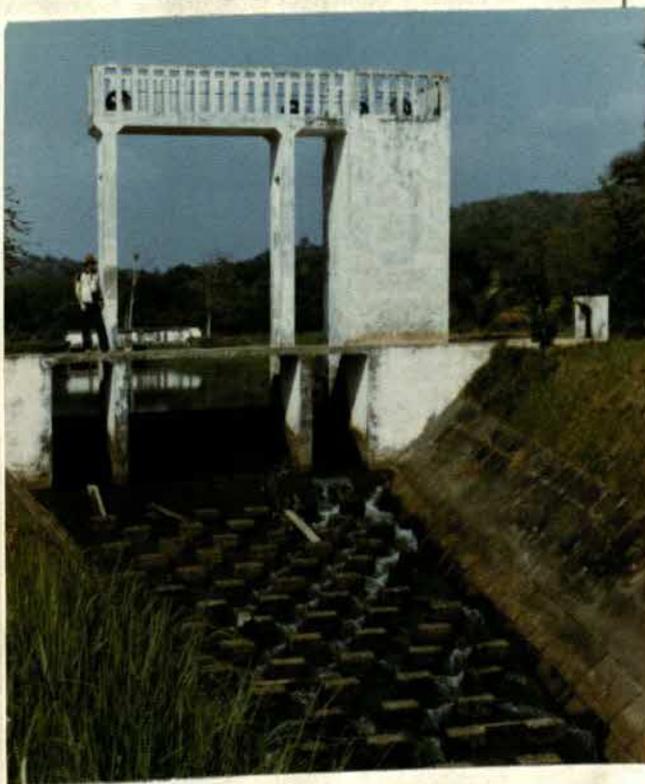
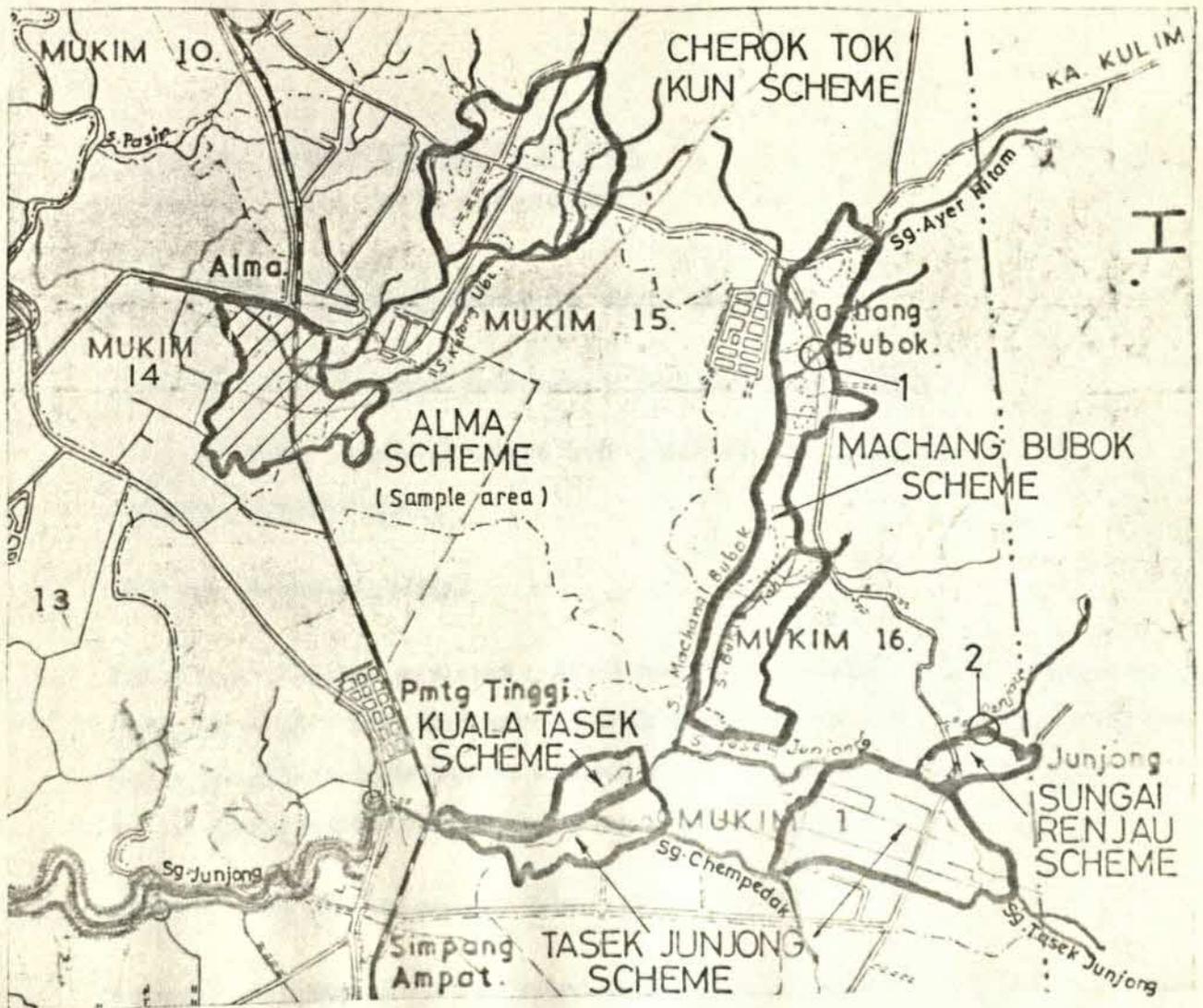
Main canal

SCHEME : B(ii) JURU

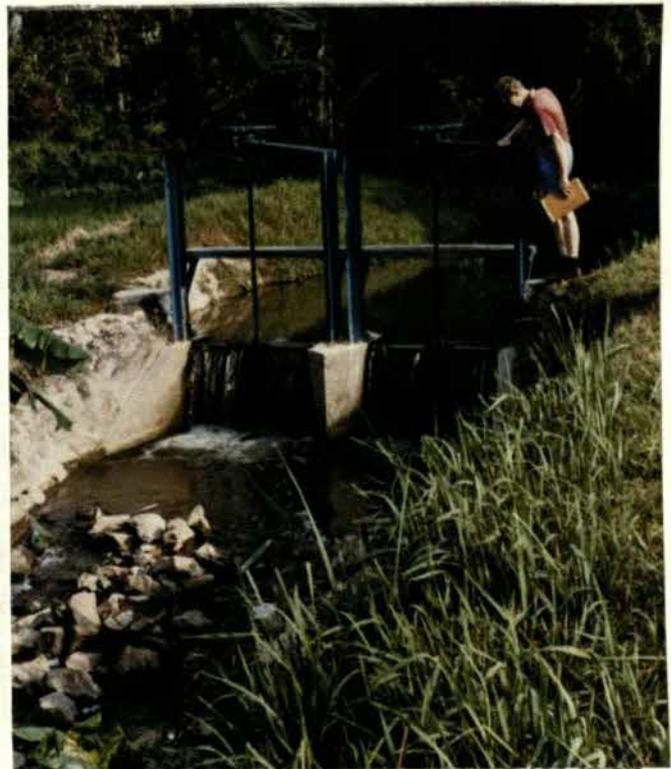
'Rainfed' scheme with DID supply

Irrigable area : 244 ha (602 acres)

- A.
1. Source : Sg. Junjong Mati.
  2. Location of intake (map reference): 272, 900E; 586, 900N.
  3. Type of intake : Pumped intake without river control structure but with tidal gate approx. 1.5 km downstream.
  4. Nominal intake capacity : 2 No. pumps  $0.42 \text{ m}^3/\text{s}$  (15 cusec)  
total  $0.85 \text{ m}^3/\text{s}$  (30 cusec).
  5. Canal and drainage systems : Irrigation originally by controlled drainage but irrigation system built recently. Canals maintained in good condition. Lack of field distribution canals. Tidal gates on drainage outfalls to sea.
  6. Access : Lack of vehicle access into irrigated areas.
- B.
- Present cropping patterns (based on figures for 1979 off-season, 1979-80 main season).
1. Main season : Area cultivated : 40 ha (100 acres)  
17% of irrigable area  
Average yield : 1.57 tonnes/ha (250 gantangs/acre)
  2. Off-season : Area cultivated : 61 ha (150 acres)  
25% of irrigable area  
Average yield : 1.57 tonnes/ha (250 gantangs/acre)
- C.
- Comments : Inadequate water for double cropping - hence 'rainfed' status. Some distribution and command problems to areas distant from the supply canals. Drainage problems in lowest areas but potential acid-sulphate soils.



1. Machang Bubok headworks



2. Sg. Renjau : Control gate at headworks

SCHEME : B(iii) MACHANG BUBOK

Irrigable area : 136 ha (335 acres)

- A. 1. Source : Sg. Machang Bubok/Sg. Ayer Merah.
2. Location of intake (map reference): 280, 800E; 590, 300 N
3. Type of intake : Gravity intake with gated river control structure.  
Offtakes on both banks.
4. Nominal intake capacity : -
5. Canal and drainage systems : Well maintained canal system. Shape of irrigated area - long and narrow with main canal down one side - enables fairly good field distribution without many tertiary and field canals. Sg. Machang Bubok along other long side of area acts as main drain.
6. Access : No vehicle access into irrigation areas.
- B. 1. Present cropping patterns (based on figures for 1979 off-season, 1979-80 main season)
1. Main season : Area cultivated : - ha ( - acres)  
- % of irrigable area
- Off-season : Area cultivated : - ha ( - acres)  
Average yield : - tonnes/ha ( - gantangs/acre)
2. Off-season : Area cultivated : 113 ha (280 acres)  
84% of irrigable area  
Average yield : 1.89 tonnes/ha (300 gantangs/acre)
- C. Comments : Scheme appears to operate fairly well although some isolated areas north of the main block have been abandoned. Possible supply difficulties to these areas which may have been supplied from stream tributaries of the main river. Small area of vegetable cultivation in MARDI research station including one field under sprinkler irrigation.

SCHEME : B(iv) SUNGAI RENJAU

Irrigable area : 20 ha (50 acres).

- A. 1. Source : (a) Sg. Tasek Junjong; (b) Sg. Chempedak
- A. 1. Source : Sg. Perangin (Sg. Renjau)
2. Location of intake (map reference) :
2. Location of intake (map reference) : 282, 300E; 586, 900N
3. Type of intake : Gravity intake with gated river control structure.
4. Nominal intake capacity: -
5. Canal and drainage systems : Small area supplied from a single canal which is in need of maintenance. Sg. Perangin acts as drain.
6. Access : No vehicle access into irrigation areas except for main road through centre of scheme.
- B. Present cropping patterns (based on figures for 1979 off-season, 1979-80 main season).
1. Main season : Area cultivated : 20 ha(50 acres)  
100% of irrigable area  
Average yield : 2.20 tonnes/ha (350 gantangs/acre)
2. Off-season : Area cultivated : 20 ha (50 acres)  
100% of irrigable area  
Average yield : 2.51 tonnes/ha (400 gantangs/acre)
- C. Comments : Small scheme adjacent to Tasek Junjong. No reported water shortages.

SCHEME : C(i) TASEK JUNJONG

Irrigable area : 195 ha (482 acres).

- A. 1. Source : (a) Sg. Tasek Junjong; (b) Sg. Chempedak
2. Location of intake (map reference) :  
(a) 282,900E; 585,400N  
(b) 279,500E; 585,800N
3. Type of intake : Both gravity intakes with gated river-control structures.
4. Nominal intake capacity: -
5. Canal and drainage systems : Two separate blocks with own supplies. Eastern block, south of Kg. Tasek Junjong, has canal system in fair condition with tertiary/field canals, and some drainage channels leading back to Sg. Tasek Junjong. Western block, south of Kg. Kuala Tasek on left bank of Sg. Junjong, has well maintained canals but no drainage channels. Sg. Junjong is deeply incised and acts as the main drain.
6. Access : No vehicle access into either area.
- B. Present cropping patterns (based on figures for 1979 off-season, 1979-80 main season)
1. Main season : Area cultivated : 184 ha (454 acres)  
94% of irrigable area  
Average yield : 1.89 tonnes/ha (300 gantangs/acre)
2. Off-season : Area cultivated: - ha ( - acres)  
- % of irrigable area  
Average yield : - tonnes/ha ( - gantangs/acre)
- C. Comments : Both systems appear to work reasonably well. Some water shortages are reported in the western block, but water said to be adequate for double cropping in eastern block. Some problems with distribution to furthest areas. Pests, particularly rats, are reported. A small area of vegetable cultivation is being developed upstream of the eastern headworks with own pumped supply.

SCHEME : ALMA

"Rainfed" scheme

Irrigable area : 97 ha (240 acres)

- A. 1. Source (a) Sg. Kelang Ubi; (b) Sg. Kelang Kain
  2. Location of intake (map reference)
    - (a) 276,200E; 589,900N
    - (b) 276,000E; 590,300N
  3. Type of intakes : Gravity intakes with gated river control structures
  4. Nominal intake capacity : -
  5. Canal and drainage systems : Canals in fairly well maintained condition, but lack of tertiary/field distribution channels. No separate drainage system.
  6. Access : Access to headworks but no vehicle access into irrigated areas.
- B. Comments : 'Rainfed' scheme with water shortages. Serious problem of pollution from factories upstream. No available figures on yields but farmers report values as low as 1 tonne/ha (160 gantangs/acre) probably due to the pollution effects.

SCHEME : CHEROK TOK KUN

'Rainfed' scheme

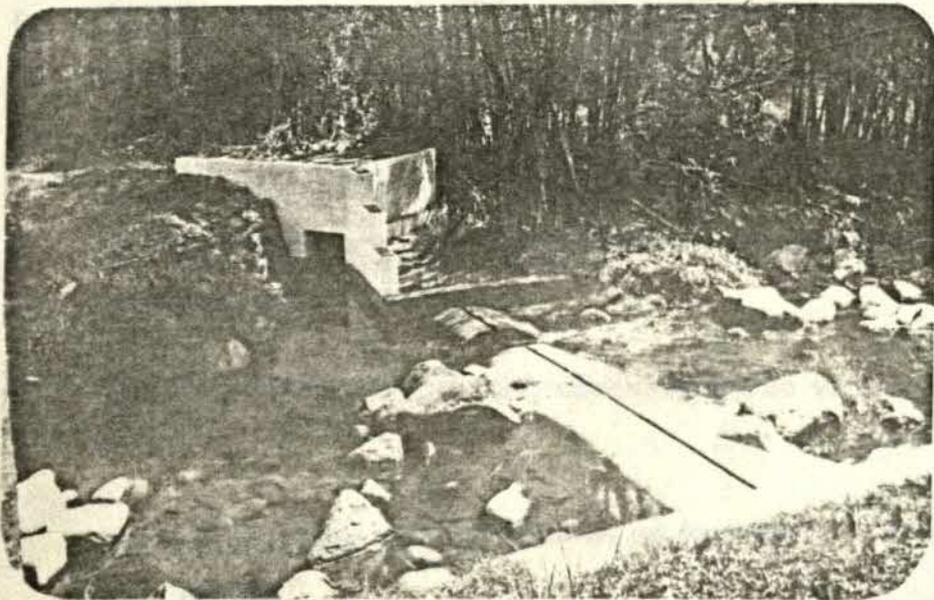
Irrigable area : 106 ha (263 acres)

- A.
1. Source : Several minor streams with run-off from Bukit Mertajam.
  2. Type of intakes : Temporary stone bunds to divert flow to gravity intake.
  3. Nominal intake capacity : -
  4. Canal and drainage systems : Simple systems in poor state of repair. In some cases direct stream diversion into the fields. No drains.
  5. Access : No vehicle access into irrigation areas.
- B.
- Comments : The area is almost entirely abandoned. A few farmers have attempted a crop but most of this has failed from shortage of water. Some fish ponds have been established upstream which has further reduced any available supply. Pressures on labour and land from urban development are also serious constraints.

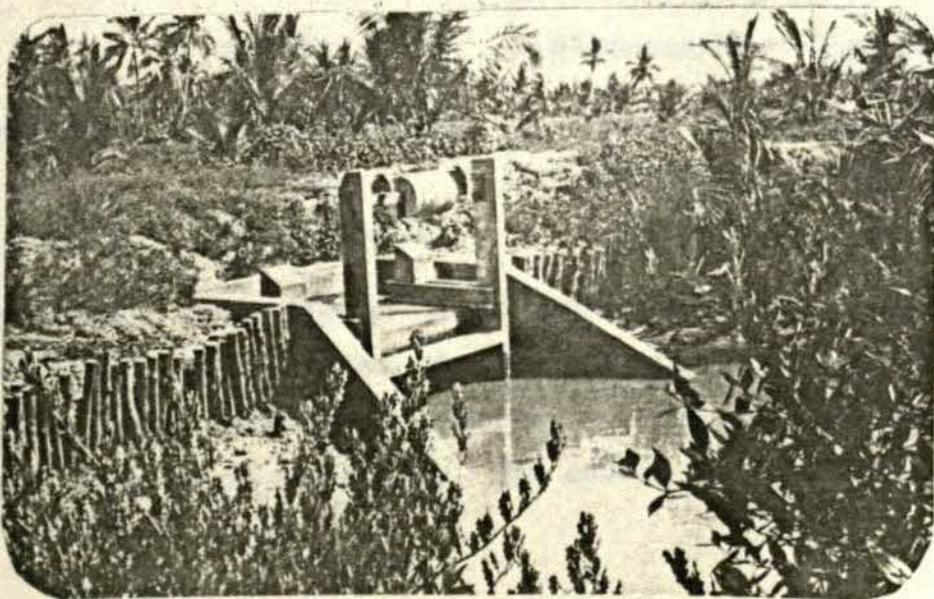




1. Pantai Aceh - reclaimed land



2. Sg. Pinang Headworks



3. Sg. Pinang Tidal gate

## SCHEME : SUNGAI BURONG

Irrigable area : 525 ha (1,296 acres)

- A.
1. Source : Sg. Burong with supplementary supplies from Sg. Ayer Hitam and Sg. Betong.
  2. Location of Sg. Burong intake (map reference) : 247,600E; 591,700N.
  3. Type of intake : Gravity with gated river control structure.
  4. Nominal intake capacity : -
  5. Canal and drainage systems : Upper areas supply by canal system except for small area upstream of main headworks supplied by pumped supply from Sg. Ayer Hitam. Lower coastal areas mainly irrigated by controlled drainage system. Canals in moderate condition with weed growth removal required. Controlled drainage system in poor state requiring rehabilitation.
  6. Access : Main road access adequate but no vehicle access to irrigated areas.
- B.
- Present cropping patterns (based on figures for 1979 off-season, 1979-80 main season)
1. Main season : Area cultivated : 104 ha (256 acres)  
20 % of irrigable area  
Average yield : 2.83 tonnes/ha (450 gantangs/acre)
  2. Off-season : Area cultivated : - ha ( - acres)  
- % of irrigable area.  
Average yield : - tonnes/ha ( - gantangs/acre)
- C.
- Comments : Some area presently double cropped but most of lower area below road abandoned. Insufficient water for double cropping throughout and severe labour shortage. Development in catchment may affect water supply and quality. The coastal strip has been reclaimed.

SCHEME : SUNGAI PINANG

Irrigable area : 601 ha (1,486 acres)

- A. 1. Source : Sg. Pinang
2. Location of intake (map reference) : 247,600E; 597,800N
3. Type of intake : Gravity intake with concrete weir as river control structure.
4. Nominal intake capacity: -
5. Canal and drainage systems : Upper areas with irrigation supplies, lower areas with controlled drainage irrigation. Canals in moderate condition. Some drains require maintenance.
6. Access : No vehicle access into irrigation areas.
- B. Present cropping patterns (based on figures for 1979 off-season, 1979-80 main season).
1. Main season : Area cultivated : 423 ha (1,044 acres)  
70% of irrigable area  
Average yield : 2.52 tonnes/ha (400 gantangs/acre)
2. Off-season : Area cultivated : - ha ( - acres)  
- % of irrigable area  
Average yield : - tonnes/ha ( - gantangs/acre)
- C. Comments : Water shortages are experienced particularly during the off-season Sg. Pinang also acts as source for urban water supply and the abstraction may increase as urbanisation expands in Balik Pulau. Drainage problems in low lying areas but potentially acid-sulphate soils if drained. The coastal strip has been reclaimed.

APPENDIX 'C'

LIST OF REPORTS

HELD BY THE TEAM

LIST OF REPORTS HELD BY THE TEAM

Working Groups of the Balik Pulau/Seberang Perai Integrated  
Agricultural Development Project

1. Draft Report of the Working Group on Farm Production Service on Padi and Other Crops.
2. Report of the Working Group on Farm Production Service on Rubber and Coconut.
3. Draft Final Report Working Sub-Committee on Fisheries and Livestock.

Market Potential Study by MIDF Industrial Consultants Sdn. Bhd. and  
ANDZEC Limited.

Final Report, Summary and Recommendations. Volume: 1

Integrated Agricultural Development Project Balik Pulau/Seberang Perai  
Final Report Volume 11.

Study of Aquaculture Development by Equasian Sdn. Bhd., Wan Mohamed  
and Khoo Sdn. Bhd. and KPM Khidmat Sdn. Bhd.

Draft Final Report. Figures and Tables.

Draft Final Report. Volume: 1 The Concept Plan.

Other Reports

1. Pinang Tunggal Pumping Scheme.
2. Socio Economic Survey by the Ministry of Agriculture. 1979.
3. A report on Padi and Padi-Field Fish Production in Krian, Perak.
4. Drainage and Irrigation Division, Integrated Farm Water Management.
5. Proceedings of the National Seminar on Water Management and Control At Farm Level.
6. Guide to Fertilizer, Malaysia.
7. Presaturation of Padi Fields.

8. Hydrological Design of Agricultural, Drainage Systems.
9. Hydrological Aspects of Agricultural Planning and Irrigation Design.
10. Agriculture, Second Malaysian Plan 1971 - 1975, Midterm Review for Second Malaysia Plan, Third Malaysia Plan 1976 - 1980. (small booklet)
11. Third Malaysia Plan 1976 - 1980.
12. Mid-Term Review of the Third Malaysia Plan 1976 - 1980.
13. Kementerian Pertanian, Ministry of Agriculture, Rumusan Perangkaan, Statistical Digest, Semenanjung Malaysia. Peninsular Malaysia. 1977.
14. Farmers' Co-operatives - Institution for small farmers in Malaysia.
15. Malaysia, Farmers' Cooperatives on The Move .... by A. H. Ahmad Sarji, 1978.
16. Drainage & Irrigation Department. Extracts from Triennial Reports:
  - 1961 - 1963
  - 1964 - 1966
  - 1967 - 1969
  - 1970 - 1972
  - 1973
17. Reconnaissance Soil Survey of Penang and Province Wellesley, by Soo Swee Weng and K. Selvadurai.
18. Kedah-Perlis Water Resources Management Study, by Yusoff Ibrahim Sehu Sdn. and Renardet Engineering. Final report, January 1981 (6 volumes, on loan only).

Reports and studies by and for the Muda Area Development Authority (MADA) will be obtained or borrowed at Alor Setar in the immediate future.

