MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF
WATER RESOURCES DEVELOPMENT

INTERIM REPORT

FOR
FEASIBILITY STUDY
ON
RIAM KANAN IRRIGATION PROJECT

SEPTEMBER, 1978

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN

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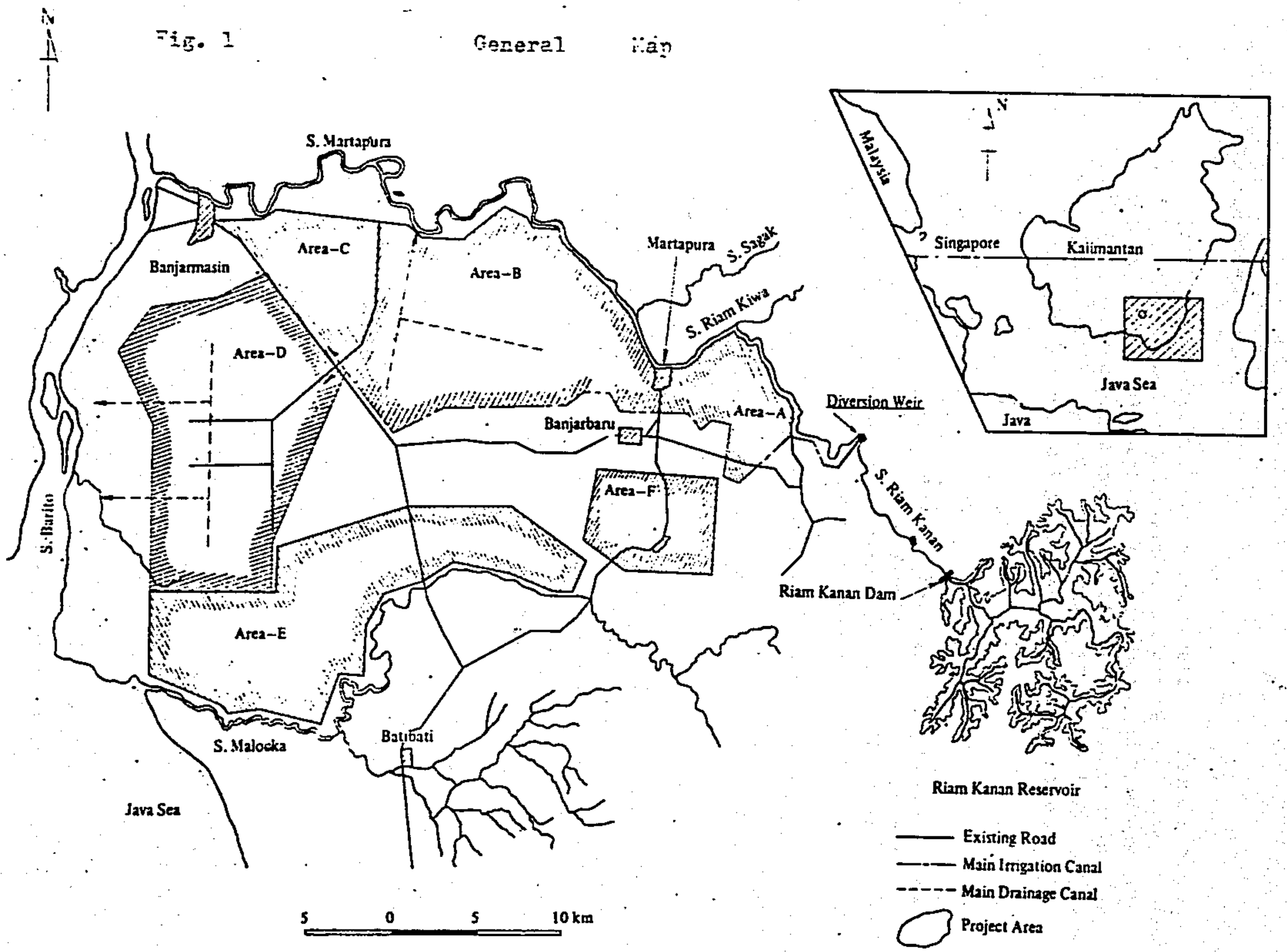
Fig. 1 General Map



SUMMARY

1. Introduction

This interim report presents the results of various studies on the Project based on the field investigation and survey so far made by the Team. Although the results presented here are not completed yet, the preliminary project concept is given for the discussion with the agencies and personnel concerned and for further investigation and survey for the feasibility study.

2. Project History

The Riam Kanan Irrigation Project has been proposed in the Report on the Barito River Basin Development Plan prepared by Overseas Technical Cooperation Agency (OTCA) in March, 1971 as the priority project for agricultural development in the South Kalimantan.

In 1972, the topographic maps on a scale of 1 to 50,000 covering the Barito River Basin in which the project area was included were prepared. In addition, some preparatory works such as soil survey, geological survey, etc. were made by the Government of Indonesia.

In 1977, the preliminary survey team was dispatched from Japan International Cooperation Agency (JICA) mainly to study on the project components and scope of works for the project feasibility study. In the same year, the topographic maps on a scale of 1 to 5,000 covering the project area was prepared under the technical cooperation by JICA.

With these background, the Government of Indonesia requested the Government of Japan the feasibility study on the Project, and the Government of Japan agreed to render the engineering services by the Japanese Expert Team for the feasibility study.

3. Scope of Works

The "Scope of Works" agreed upon between the Government of Indonesia and the Government of Japan is summarized as follows:

(1) Pre-feasibility study on the Riam Kanan Irrigation Project covering about 60,000 hectares in gross,

(2) Feasibility study on the priority areas of the Project covering about 40,000 hectares in gross, and

(3) Training of the Indonesian counterpart personnel.

4. Background

The Government of Indonesia carried out the First Five-Year Development Plan in the period between 1969 and 1974. During the Plan, annual growth rate of rice production reached 3.5 % and the amount of rice produced was 15.4 million tons in 1974.

However, population increased remarkably during the period at the rate of 2.1 % per annum. The domand for foodstuff exceeded the growth of the production of rice, and about one million tons of rice was imported in 1974.

The Second Five-Year Development Plan has been launched in 1974 and aims at the attainment of self-sufficiency in foodstuff. Under the Plan, further increase of food production through introduction of improved irrigation farming is one of the Indonesian Government's strategies.

The area of the Riam Kanan Irrigation Project has favourable natural conditions for further increase of crop production using water available from the Riam Kanan dam now in operation. Therefor, high priority is given to early implementation of this irrigation project.

5. The Project Area

The project area is located in the south-east of Banjarmasin, the capital of the South Kalimantan Province.

The project area is divided into six sub-areas for the study, namely sub-areas A, B, C, D, E and F. Most of the area extends over very flat alluvial plain along the rivers Barito and Martapura.

Soils and Land Classification

Soil survey and land classification study were made in the area covering about 93,000 hectares including the project area and its surrounding areas. The survey and study results indicate that the area is classified into four (4) classes: suitable land for rice cultivation with an area of about 39,000 hectares, moderately suitable land with an area of about 10,000 hectares, marginally suitable land with an area of about 22,000 hectares and unsuitable land with an area of about 22,000 hectares.

Present Irrigation and Drainage System

In the project area, no technical irrigation and drainage system exists at present, except for the canal network, most of which were constructed by the people.

Present Land Use and Land Holding

Out of 93,000 hectares of the study area, about 41,000 hectares are used as paddy field and about 5,000 hectares as plantations, and the remaining 47,000 hectares are infrastructural land and wild land covered with shrub, swamp forest, bush, etc.

About 90 % of total farmers are small farmers with land holding less than two hectares, and about 80 % of total farmers are owner-farmers.

Present Agriculture

Paddy rice is the main crop in this area, and monoculture of paddy rice using flood water in the rainy season is predominant throughout the area. Paddy seeds are sown during the period from early October to late January. During the period, young seedlings are transplanted two to three times according to water conditions in the filed. The paddy is harvested during the period from early May to late October.

No soil preparation such as ploughing, harrowing, puddling, etc. is usually practiced, and the use of chemical fertilizers and agricultural chemicals is still insignificant in this area.

The food crops other than paddy rice such as maize, cassava, sweet poteto, beans, etc. are also grown in small areas and are mostly for home consumption.

The average yileds of stalk paddy are 2.3 tons per hectare for paddy rice and 1.5 tons per hectare for upland rice, respectively. Total annual production of stalk paddy in Kabupaten Banjar in which the project area is included was between 91,000 tons and 127,000 tons.

Agricultural Supporting Services

The extension services in the project area are still limited because of insufficient staffing and equipment. Improvement of the present staffing and equipment is strongly recommended especially for the successful implementation of the Project.

The capacity of the present seed center in the project area is very small. The increase of the seed center in both number and capacity is required.

The paddy field under the BIMAS/INMAS Programs in the project area is very small, because no technical irrigation system exists.

6. The Project

Selection of Areas for Development

Selection of areas proposed for development is made based on the results of the studies on four main factors affecting the selection. They are irrigability, drainability, the present land use and vegetation, and amount of water available for the Project.

The soil and land classification survey reveals the grade of irrigation suitability, say the irrigability. As mentioned before, the area is classified into four classes. Among them, Classes II and III (suitable to moderately suitable lands), and a part of Class IV (marginally suitable land) are taken up for this area selection.

The drainability is studied mainly through the analysis of the present drainage patterns of the area and possible drainage improvement in the future. As a result, the area is classified into four categories: Category 1 (perfect drainable land), Category 2 (favourably drainable land), Category 3 (poorly drainable land) and Category 4 (non-irrigable land). For selecting the area for development, the areas in three categories from 1 to 3 are considered.

The present land use and vegetation of the areas are taken into account mainly for the study on land reclamation which is also one of the factors affecting the area selection.

The amount of water available from the river Riam Kanan depends entirely on the discharge released from the power plants in the dry season, and the discharge from the power plants varies with the power demand. According to information obtained from PLN, the Riam Kanan power station would be operated with 24 to 27 MW at peak, keeping some reserve for the emergency peak power demand, even after the completion of the Riam Kanan 2nd stage project (additional installation of one more 10 MW plant). For the conservative study, the peak demand of 24 MW in and after 1984 is adopted. Load factor is forecasted to be 65 %. With these figures, 42 m^3/sec of discharge from the power plants would be expected as the amount of water available for irrigation in the project area and for the maintenance of the river Martapura. For the maintenance of the Martapura, 8 m^3/sec of mean drought runoff in the Riam Kanan would have to be released from the dam. Therefore, the amount of water available for the Riam Kanan Irrigation Project is estimated at 34 m^3/sec.

In view of land suitability and land use, drainability and irrigability, and available water from the Riam Kanan, the net irrigable area which will be taken up for the Project would be 24,530 hectares in total consisting of 1,870 hectares in the sub-area A, 7,400 hectares in the sub-area B, 3,740 hectares in the sub-area C, and 11,500 hectares in the sub-area D.

The possibility of the economical development of the sub-area E seems very low in view of both irrigation and drainage, though the final decision is subject to further studies on irrigation and drainage methods to be applied to the land with an area of about 2,000 hectares which are being used as paddy field.

The soil survey results indicate that the land in the sub-area F will not be suitable for irrigation farming. In view of the topography in this area, it is rather difficult to arrange a suitable field plot for proper operation of irrigation. In addition, the preliminary study on the selection of pumping stations on the main canal shows that water would be lifted in a few stpes instead of one due to complicated topography. This would require high construction cost. Under these conditions, this area is unsuitable for irrigation development and it is recommended to exclude this area from the Project.

Agricultural Development

The proposed agricultural development in the project area will be the intensified monoculture of paddy rice over the whole project area. Out of 24,530 hectares of net irrigable area, 24,020 hectares will be used for double cropping of paddy using high-yielding varieties and the remaining 510 hectares for single cropping of paddy with the local varieties.

It is tentatively estimated that target yields of paddy with the Project will be 4.0 tons/ha and 4.5 tons/ha for the rainy and the dry season paddy, respectively, using high-yielding varieties. The target yield for the local varieties is provisionally estimated at 1.8 tons/ha.

With these target yields and the proposed irrigation area, annual production at the full development stage is estimated at 205,000 tons in dry unhusked rice.

Irrigation and Drainage Plan

The irrigation water requirements are studied tentatively using the evaporation data for the project study. The peak water requirement is estimated at 1.37 ℓ/sec/ha including washing water for removing water containing humic acid. In addition, the amount of rural water supply to the villages located along the main canal is tentatively estimated at 0.38 m^3/sec, which will be conveyed through the irrigation canals.

The drainage requirements in the project area are estimated using 72-hour design rainfall with 10-year return period. The drainage requirements thus estimated are 7.0 ℓ/sec/ha in the sub-area A, 8.0 ℓ/sec/ha in the sub-area B and 5.9 ℓ/sec/ha in the sub-areas C and D.

The drainage in the project area will be made by gravity, and the low-lying areas and depressions where the pump drainage method should be adopted are excluded from the Project. The drainage by gravity will be made with sluices and/or flap gates at the outfalls using the fluctuation of water level outside the areas due to the tidal influence.

Proposed Project Works

There are two sites topographically suitable for the construction of a diversion weir on the river Riam Kanan. One is located near Sungai Asam (site-A), about 12 km downstream from the Riam Kanan dam, and the other is situated near Mandikapau (site-B), about 1 km upstream from the site-A.

A comparative study is made for six cases with the variation of crest elevation of the diversion weir, El. 9, 10 and 11 m at each site. The comparative study is made, estimating the construction costs of the diversion weir and the main irrigation canal, and the cost for compensation of houses and lands to be submerged by the construction of the weir in each case. As a result, it is concluded at present that the diversion weir with a crest elevation of 10 m at the site-B is the most suitable type of weir. The proposed weir would be concrete weir with a height of about 9 m and a crest length of about 240 m.

The irrigation canal network will consist of the main, secondary, sub-secondary, tertiary canals and field ditch (quaternary canal). The main irrigation canal will run in the hilly area located in the southern part of the project area with a slope ranging from 1/7,000 to 1/8,000. The length of the canal would be 47.5 km. The tertiary canal would be aligned with an interval of about 600 m, and the length would range between 800 m and 1,600 m. The quaternary canal would be provided with an interval of about 400 m. All of the canals would be of unlined type.

The drainage network will include field drain (quaternary drain), tertiary drain, sub-secondary drain, secondary drain and main drain. The construction of three main and nine secondary drains which will be connected with the rivers Barito and Martapura would be required. The control structures to prevent the saline water intrusion would be provided on these drains. In addition, check structures would be provided at each intersection of the drains.

The basic area of 2 hectares would be adopted to make the alignment of the tertiary development. The unit field block for the tertiary development would be, in principle, 200 m x 600 m (12 hectares). Six house holds with 2 hectares of land would be accommodated in one unit field block. One tertiary block would cover 60 to 100 hectares of paddy field, and rotational irrigation would be made within one tertiary block. The tertiary and field drains and farm road would also be provided in the tertiary block.

In addition to the existing highway and earth roads in the project area, three kinds of earth roads would be proposed. One would be constructed along the main canal, and the others would be provided along the secondary and tertiary canals.

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CHAPTER I INTRODUCTION

1.1 AUTHORITY

This interim report is prepared in accordance with the "Scope of Works" for feasibility study on the Riam Kanan Irrigation Project agreed upon between the Government of Indonesia and the Government of Japan. This report presents the result of various studies on the Project based on the field investigation and survey so far made by the Survey Team. Although the study result presented in this report is not completed yet, the preliminary project concept is given in this report for the discussion with the agencies and personnel concerned and for further investigation and survey on the project feasibility.

1.2 PROJECT HISTORY

The Riam Kanan Irrigation Project has been proposed in the Report on the Barito River Basin Development Plan prepared by Overseas Technical Cooperation Agency (OTCA) in March, 1971 as the priority project for agricultural development in the South Kalimantan Province, and very preliminary study on the Project was made under the said Barito River Basin Development Plan.

The Riam Kanan Irrigation Project aims at profitable agricultural development in the area with about 60,000 hectares in gross, using water released from the Riam Kanan Multipurpose Dam which was completed in 1972.

In 1972, the topographic maps on a scale of 1 to 50,000 covering the Barito River Basin in which the project area was included were prepared under the technical cooperation provided by OTCA. In addition, soil survey, geological survey and preparation of some topographic maps related to the Project were made by the Government of Indonesia.

In 1977, the preliminary survey team was dispatched from Japan International Cooperation Agency (JICA), the government agency of Japan, mainly to study on the project components and the scope of works for the feasibility study of the Project. Following this preliminary survey, more detailed topographic maps on a scale of 1 to 5,000 covering the project area were prepared under the technical cooperation provided by JICA.

With these background, the Government of Indonesia requested the Government of Japan the feasibility study on the Project, and the Government of Japan agreed to render the engineering services by Japanese Expert Team for the feasibility study.

The feasibility study by the Team was started from July 2, 1978 upon arrival of the first group of the Team, and it is scheduled to be completed by the middle of March in 1979.

1.3 SCOPE OF WORKS

The summary of the "Scope of Works" agreed upon between the Government of Indonesia and the Government of Japan is as follows:

(1) Pre-feasibility study on the Riam Kanan Irrigation Project covering about 60,000 hectares in gross,

(2) Feasibility study on the priority areas of the Project covering about 40,000 hectares in gross, and

(3) Training of the Indonesian counterpart personnel in the course of survey and study.

In accordance with the above "Scope of Works", the inception report was prepared and submitted to the Government of Indonesia in the beginning of August, 1978. The report presents the Approach to the Project and the detailed Plan of Operation.

The results of the investigation and survey so far made by the Survey Team are presented in this interim report.

The draft of the feasibility report on the Project will be submitted to the Government of Indonesia by the middle of December in 1978.

1.4 PREVIOUS STUDIES

The previous studies on the Project were compiled and incorporated into the following reports:

(1) Survey Report for Development of Barito River Basin by OTCA in 1971.

(2) Preliminary Survey Report on Riam Kanan Irrigation Project by JICA in 1977.

The data, information and the study results presented in these previous study reports are fully used for this feasibility study.

CHAPTER II GENERAL BACKGROUND

The natural conditions of Indonesia are favourable for profitable agricultural development. Approximately 7 % or 14 million hectares are being used as farmland, and about 60 % of population are engaged in agriculture.

The national economy showed a rapid growth during the first Five-Year Development Plan (Pelita I) launched out in 1969. In 1960's, the annual growth rate of GDP was only 2 %, but the growth rate increased to about 7 % per annum during this period. In the final year of the Pelita I (1974), the growth rate was as high as 8.2 %.

The agricultural sector, as a mainstay of the Indonesian economy supporting about 40 % of GDP increased at an annual rate of 4 % during the period of the Pelita I. With the exception of 1972 which was very drought year, rice production during the period from 1970 to 1974 recorded a high average annual growth rate of 3.5 % due to the improved unit yield and increased planted area. The total rice production in 1974 reached the level of 15.4 million tons.

Despite of remarkable increase in rice production, it could not meet the demand during the Pelita I due to the increase in population together with the increase in rice consumption per capita induced by raised living standard. The annual import of rice reached the high level of one million tons in 1974.

Following the Pelita I, the Second Five-Year Development Plan (Pelita II) was started in the 1974/75 fiscal year. This plan has been formulated with the aim of increasing the actual GDP at an average annual growth rate of 7.5 % or an increase of 44 % by the final year of the Plan. In the Plan, high priority has been given to the agricultural sector. It has been planned that the share of the agricultural production in the GDP would come to be 36 % in the final year of the Plan, 1978/79 fiscal year, assuming the production increase at the annual growth rate of 4.6 %.

What has been strongly advocated in this plan as the specific sectorial object is the attainment of self-sufficiency in foodgrain, putting particular emphasis on increase in productivity of rice production. The attainment of rapid growth of the agricultural sector under the Pelita II through introduction of the improved irrigation farming is one of the Indonesian Government's strategies.

In the Plan, priority is also given to the further increase of production of the main food crops, especially rice, and estate crops in the South Kalimantan Province. Particularly in the flat plain, southern part of the Province, the increase of rice production is planned with introduction of improved irrigation farming and creation of new farmland.

Among several development projects already implemented in the Province, the Riam Kanan Multipurpose Dam Project plays an important role in promoting further development of the southern area of the Province. Particularly, the water available from the dam is an important source for introduction of irrigation farming into the area. The Riam Kanan irrigation project area is situated in the southern part of the Province and covers vast flat plain which has high potentiality for further increase of rice production with irrigation using the available water from the Riam Kanan dam and drainage improvement. Following the completion of the Riam Kanan dam project, therefore, high priority is given to early implementation of this irrigation project.

CHAPTER III THE PROJECT AREA

3.1 LOCATION

The South Kalimantan Province is bordered by the East and Central Kalimantan Provinces and the Java Sea. The Province is relatively well developed as compared with other provinces. It has about 37,000 km^2 of geographical area.

The project area is situated in the south-east of Banjarmasin, the capital of the South Kalimantan Province. The total area surveyed for the project study is about 45 km in length and 30 km in width, extending approximately from west to east along the river Martapura. It is bounded by the river Barito, one of the major rivers in Kalimantan, on the west, the Martapura on the north, the river Maluka on the south and Martapura-Batibati road on the east. Administratively, a major part of the project area, more than 90 % in area, belongs to Kabupaten Banjar.

3.2 POPULATION

The population of the project area is estimated at about 650,000 including the population of Banjarmasin city, 318,000. Annual population growth rate in Kabupaten Banjar in recent six years was about 1.8 %. According to the statistics in 1971, about 67 % of the working population in Kabupaten Banjar is involved in agricultural sector.

3.3 NATURAL RESOURCES

3.3.1 Topography

As already studied in the Preliminary Survey Report on the Riam Kanan Irrigation Project prepared in 1977, the project area is divided into six sub-areas A, B, C, D, E and F (see Fig. 1). Most of the project area (sub-areas A, B, C, D and E) extends over very flat alluvial plain along the rivers Barito and Martapura at elevations between 0 m and 2 m. The sub-area F is located in hilly area, the eastern part of the project area, with an elevation ranging from 10 m to 35 m. The land slope of the alluvial flat plain is approximately 1/8,000 or 0.013 %.

In the project area, there are two major rivers affecting the project study, the Barito and the Martapura. The Barito runs through the western part of the project area. The excess water from the sub-areas D and E is drained into this river through many streams and channels. The Martapura, a tributary of the Barito, flows along the northern boundary of the project area, collecting the excess water from the sub-areas A, B and C. The water level of these rivers fluctuates by tidal influence from the Java Sea, which affects drainage improvement in these sub-areas.

3.3.2 Climate

The climate in the project area is characterized by the tropical monsoons. The average annual rainfall is about 2,600 mm in the flat plain and more than 3,000 mm in the mountain area, but varies widely from year to year ranging between 1,200 mm and 3,500 mm. About 70 % of rainfall occurs in the form of intense local storm during the rainy season which lasts from November to April. In the dry season, particularly during the period of three months from July to September, there are often long spells of drought.

The monthly mean temperature is about 26°C with little seasonal variation. However, daily fluctuation shows a wide range of about 8 to 12°C. The annual mean relative humidity is approximately 80 % with a seasonal variation of about 10 %. The annual evaporation is about 1,370 mm. The daily evaporation averages 3.4 mm in the rainy season and 4.1 mm in the dry season.

3.3.3 Geology

Geological reconnaissance was made in the area along the river Riam Kanan extending from the diversion sites to the Riam Kanan dam in order to obtain general information on geology in the area. The detailed geological survey was also made at two diversion sites selected for comparative study. One is located near the village Sungai Asam about 12 km downstream from the Riam Kanan dam (original site), and the other is situated at about 1 km upstream from the Sungai Asam site, near the village Mandikapau.

The general information on geology in the area surveyed is summarized as follows:

Geological sequence	Formation	Age
1	Alluvium (contain terrace deposits)	Quaternary
	～～～ Unconformity ～～～	
2	Quartz sandstone	Tertiary
	～～～ Unconformity, fault ?	
3	Tuffaceous sandstone (acidic)	Upper Cretaceous
	～～～ Unconformity ～～～	
4	Plutonic acidic rocks	Lower Cretaceous
	x x x x x Intrusion x x x x x x x	

- to be continued -

Geological sequence	Formation	Age
	x x x x x Intrusion x x x x x x x	
5	Basic igneous rocks (Peridotite, Pyroxinite)	Lower Cretaceous
	x x x x x Intrusion x x x x x x x	
6	Tuffaceous sandstone	Jurassic
	Unconformity	
7	Crystalline schist	Pre-Mesozoic

Among them, sedimentary formations have a general strike of N 50 - 60°E and distribute north to south with a sequence of 2 - 3 - 6 - 7. The formations dip towards the north. Generally, geological movement is not seen, and there are no remarkable faults, with the exception of fault zone which might be found along the boundary between the Tertiary formation and the Jurassic formation along the Riam Kanan. Drawing No.1 shows the general geology of the area.

Sungai Asam site (site-A)

Geological investigation of this site by core boring (5 holes, about 30 m in total depth) and by digging 11 test pits around the site was made by the Indonesian Government in 1972, and the geological report on the site was prepared. Based on this report, geological conditions of the site was confirmed again by the expert through the field survey.

According to the above report and the confirmation survey at this time, the site comprises quaternary sediments and pyroxinite formation. The thickness of quaternary sediments is 6 to 7 m. Fresh rocks were found in the pyroxinite formation. They are compact and hard enough for constructing concrete weir with a height of approximately 12 m. The field permeability tests showed that the leakage was negligible in fresh rock and the permeability coefficient was of the order 10^{-5} cm/sec in residuum. As a result, the geological investigations show that this site has favourable geological conditions for the foundation of the proposed concrete weir.

Mandikapau site (site-B)

This site consists of quaternary sediments and Jurassic formation. The thickness of quaternary sediments seems to be rather thin, though this should be confirmed later. Jurassic formation is massive and hard for bearing the proposed concrete weir. The geological conditions of this site will be further investigated in detail through test drilling to be carried out soon. From the geological reconnaissance at this time, this site would also have favourable conditions for the foundation of the concrete weir.

After-bay area

After-bay area consists of terrace deposits and mesozoic sediments. Most of the area to be submerged by the creation of after-bay is covered with terrace deposits. According to the design report on the Riam Kanan dam, the permeability coefficient is around the order 10^{-4} cm/sec. Because the area has gentle topography in general, landslide in the after-bay area would not be anticipated.

3.5.4 Soils and Land Classification

The soil survey and sampling, covering approximately 92,800 hectares /1 in gross, were carried out in conformity with the manner mentioned in the Inception Report. Besides, determination of soil acidity as well as degree of a potential soil acidity and soil salinity was made on about 150 samples, which were taken from the representative soil layers and /or horizons, in the laboratory of the Lambung Mangkurat University in Banjarbaru.

Based on the field data and test results in the laboratory further making reference to the previous soil investigation and study study /2 in the project area, semi-detailed soil and land classifications are preliminarily made for the purpose of delineating the potential irrigable area in the project area.

Soils

The soils in the survey area are primarily derived from the clayey to fine loamy alluvium in the recent to quaternary ages and loamy to sandy skeletals in the quaternary to tertiary ages. The clayey to fine loamy alluvium, which generally consists of 35 to 70 % of clayey, 30 to 60 % of silty fractions and very rare sandy particles, is deeply deposited in the most part of the low-lying areas developed widely along the rivers Barito, Martapura and Maluka. Under the seasonal water stagnation, the alluvium

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/1: As mentioned in the Preliminary Survey Report in 1977, the Project covers about 60,000 hectares in gross. For the project study at this time particularly for proper study on the drainage improvement, however, the soil survey was carried out in an area of about 92,800 hectares including the project area and its surrounding areas.

/2: (1) Semi-detailed soil survey covering about 35,750 hectares, a part of the sub-areas D and E, was conducted by the department of Soil Sciences, Faculty of Agriculture, Bogor Agricultural University, 1974.

(2) Semi-detailed soil survey covering about 50,000 hectares, the sub-areas A, B, F and a part of D, was carried out by the Pedologic Section, Bogor Soil Research Institute, 1976.

has been put under the soil formation process of the hydromorphic weathering (gleyzation and mottling) caused by the waterlogging and the seasonal fluctuation of ground water to a certain extent.

The loamy to sandy skeletals originated from the quaternary deposits or directly from the tertiary formation (sandstones) are found in the undulating hills on the east of the survey area. These soil materials have been mainly put under the soil formation process with the oxidization weathering under the tropical humid climate.

Other than the above soil formations, the organic soils (so-called tropical peat) are also developed in the low-lying area where the land is deeply depressed mainly on the foot of the undulating hills.

According to the Soil Taxonomy system defined by the U.S. Department of Agriculture (1972), the soils described in the above are primarily identified as Entisol and Inceptisol in orders at the highest soil category in the soil classification on the alluvium, and Incetisol and Ultisol on the loamy to sandy skeletals, and Histosol on the organic soil formation.

The soils categorized into Entisol are correlated with four soil sub-orders; Psamments, Orthents, Aquents and Fluvents. These four soil sub-orders are, furthermore, classified into five soil groups, seven soil sub-groups at the higher soil category of the soil classification and seven soil families at the lower soil category of the soil classes, as shown in Tables 3-1 and 3-2. according to the soil profile features and soil chemical properties.

The Inceptisols in the survey area are classified into two soil sub-orders; Tropepts and Aquepts. Tropepts are correlated with Dystropepts in the great soil groups, Typic Dystropepts in soil sub-group and further correlated with Loamy skeletal, acid in soil family of Typic Dystropepts. Aquents in soil sub-order are correlated with Tropaquepts and Haplaquepts in the great soil group, and each group is respectively classified into three and two soil sub-groups at the higher soil category in the soil classification as shown in Table 3-1. All of these soils, except for a part of Histic Tropaquepts are correlated with fine clayey to silty clayey and acid family in the lower category. The soil family of a part of Histic Tropaquepts is distinguished from other soil families by coarse sandy texture qualities and dysic (extremely strong acid) in soil acidity regime.

Ultisols in the survey area are correlated with the soils; Ustults in sub-order, Haplustults in great soil group, Typic Haplustults in sub-group at the higher category of the soil classification and sandy to coarse loamy skeletal, acid soil family at the lower category.

The soils in Histosol order are classified into three soil sub-orders; Fibrists, Hemists and Saprist, according to the degree of decomposition of organic materials. Each sub-order of Histosols is correlated with Tropo-great soil group (mainly characterized by warmer iso temperature regime), Terric-soil sub-group (mainly characterized by depth or total thickness of the organic matorials limited by soil layer shallower than 160 cm in the profile) and Dysic soil family, respectively.

The tropical soil profile features and chemical properties in each soil group and association, further environmetal conditions such as topography, vegetation and/or land use, flooding, etc. are summarized in Table 3-3. The development of the soils identified hereinabove is preliminarily illustrated on the semi-detailed soil map on a scale of 1 to 100,000 attached to this report (see Dwg. No.2).

To speak in general, the soils classified into soil families (4), (5) and (7) of Entisols and (9), (10), (13) and (14) of Inceptisols practically have no large differences in their soil characteristics as seen in Table 3-3 , so far as the agricultural soil utilization is concerned. These soils are wet and massive throughout the profile. They are extremely hard under dry condition, while very friable and soft under wet condtion. They have very high moisture holding capacity, while the permeability coefficient is very low ranging between 5.0 x 10^{-5}cm/sec and 5.0 x 10^{-6}cm/sec in percolation speed. The soils are strong to very strong acid with pH values ranging between 5.5 and 4.5 throughout the profile. EC values are mostly less than 1.0 m.mho/cm/25°C (free from the salinity) throughout the profile. Cation exchange capacity ranges between 2[illegible] and 60 m.eq/100 gr of air dry soil and its capacity is saturated by the bases at less than 50 % in which calcium and magnecium are dominant. With some exceptions, saturation degree higher than 50 % is found only on the soils of Typic Fluvaquents and Typic Tropaquepts.

The soils of the soil families (6) and (11) are practically the same as the above soils. These soils are, however, distinguished from the above soils only by the special regimes on soil acidity. Under the natural conditions when the soils are moistured, they show pH values ranging from 4.5 to 5.5 (very strong in acid class), while the soils particularly sub-soils change to extremely acid conditions (pH 3.0 to 3.5) when dry. Their potential acidity shown by pH value is at 2.5 to 3.0.

The soils of the soil families (1), (2) and (12) are the sandy soils which primarily consist of moderately coarse to fine quartz sand with small gravels throughout the profile. Due to very lack of weatherable minerals and clayey fractions, these soils have only a small quantity of plant nutrients and small cation exchange capacity. Regarding the hydro-dinamic feature, the soils have very small water holding capacity, while very rapid percolation speed throughout the profile, even though ground water is shallowly lying in the profile.

The soils of the soil families (3), (8) and (15) generally consist of loamy to sandy skeletals (gravelly particles) throughout the profile. Due to a poor vegetation (alang-alang grass) and undulating topography in the area, almost all of the surface soils (humic epipedon) has been eroded out, and then, organic matters in the soils are only a few percent. Cation exchange capacity ranges between 5 and 10 m.eq., while its base saturation is only 10 % and around. An inherent plant nutrient such as nitrogen, phosphate, potassium, etc. is very poor in these soils. Owing to very coarse texture quality throughout the profile, the soils have low water holding capacity and very rapid percolation speed. A tillability or arability of these soils is low in the light of the soil profile features and physical soil properties.

The soils correlated with the soil families (16), (17) and (18) are primarily the organic materials deeply deposited in the depression. Generally, these soils are strong to very strong acid with pH values ranging between 5.0 and 4.5 throughout the profile under submerged condition, and they show an extremely strong acid reaction with pH values less than 3.5 when dry. A potential soil acidity is estimated at around 2.5 in pH value. No mineral stratification and/or fraction are in the profile, and then, an inherent plant nutrient and effective bases are very rare in these soils.

Land Classification

The land classification for delineation of potential irrigable area is preliminarily made with reference to the land classification system defined by the Bureau of Reclamation, U.S. Department of Interior, 1953 as modified in 1967 especially for the land evaluation on low-lying paddy field and its production.

Of all the sepcifications of land evaluation defined in the above reference, the following soil and physical environments are taken into consideration as the essentials for evaluating the land suitability for irrigation development in the project area.

(1) Soil texture quality (S); limitation by coarse texture with gravels to economic development of paddy field with irrigation facility and/or very fine calyey texture for diversified crops with irrigation.

(2) Effective soil depth (K); limitation due to shallow sand gravel, cobble, plinsite, mud-clay, histic soils and/or impermeable layer.

(3) Soil acidity (A); limitation due to strong acid reaction of soils. Especially, the soils having potential acidity limit to the economic farm operation.

(4) Topography (T); limitation mainly by the unsuitable land elevaltion for economical gravity irrigation, and relief conditions unsuitable for economic drainage improvement and economical field arrangement.

(5) Drainage (D); limitation mainly due to the seasonal flooding for paddy cultivation or very poor internal drainability caused by high ground water table and heavy clay texture for economic farming with diversified crops.

Some other constraints, which will limit future farm operation, such as very hard soil consistence when dry, low inherent soil fertility, prevailing various pest and diseases, etc. are also found in the project area. So far as the objectives of this project are concerned, however, these conditions could be conceptionally excluded from this land classification.

In the light of the profile feature, soil chemical and physical characteristics, all of the low-lying lands, except swamps where the soils are classified into soil families (6) in Sulfic Hydroquents and (16) and (17) in Histosols, are involved in the highly suitable land class (I) for irrigated paddy cultivation. From the drainage engineering point of view, however, this land grade might be down to the suitable (II) to moderately suitable land classes (III) because of rather high capital investment required for flood protection and also rather expensive management cost for surface drainage during the cropping season particularly in the rainy season. The area defined as the soil family (6) where the area is being influenced by deep seasonal flooding and the soils are shallowly bottomed by the mud-clay (potential acid soil) is also classified into arable land. Taking into account the low degree of such limiting factors, the land of soil family (6) is estimated as marginally suitable land class (IV). To satisfactorily reclaim the land in the Histosols, high investment would be required for proper drainage improvement because of the existence of depressions where the flood water is deeply stagnated throughout the year. In addition, high maintenance cost of the facilities and high investment for land levelling would also be required for proper drainage operations because of the Histosols which would gradually decompose year by year, and as a result, the ground surface is depressed irregularly, depending on the degree of decomposition of the organic materials. So far as crop production on the Histosols is concerned, no profitable productions are expected due to the soils having an extremely high content of organic carbon and extremely strong acidity which largely limit to low efficiency on the crop fertilization. With these limiting factors, the area of Histosols is classified into unsuitable land class (V).

The other areas correlating with the soil families (1), (2), (3), (8), (12) and (15) are free from floods and have no large drainage constraints. Because most of the areas have undulating topography, however, it will be rather difficult to make field arrangement suitable for proper operation of irrigation. Besides, the soils having coarse texture with effusive gravels throughout the profile will make the field management on irrigation and farm operations difficult. It is considered that most of the land in these soil areas is unsuitable (V) for economic irrigation development. However, the land in the valley of these areas will be graded into the land classes (III) or (IV) owing to the soil and topography which are specified sufficiently with the requirements of irrigation suitability.

From the above land evaluation, the land in the project area is classified into four suitable land classes for paddy and diversified crops with irrigation as shown in Table 3-4, and the extent area in each class is illustrated on the land classification maps (see Dwgs No.2, No.3 and No.4).

The first class includes the suitable land (II) in which high productivity and profitability can be sufficiently expected from the soil and land. However, there are moderate limitations caused by strong acid soil reaction, poor inherent soil fertility and seasonal floodings. These factors are likely to reduce crop yields and/or to increase recurrent cost for production and conservation of soil and land.

The second class is the moderately suitable land (III). The land of this class is also expected to have higher productivity for the defined paddy and diversified crops, though there are some limitations which may reduce crop yields and call for higher recurrent cost for the production and soil conservation. Rather deep flooding will be the constraint of this land class.

The third is the marginally suitable land (IV). The land of this class is also expected to obtain higher crop yields through proper land use, if the deep water stagnation is reduced by the tidal drainage system. However, improvement of the drainage system would require a large investment. The potential acid soil shallowly underlain is another constraint. If the soils are dried with the heavy drainage system, the present soil reaction would change to extremely strong acid attributed to the oxidiztion process on soils.

The last class is the economically unsuitable land (V) for the defined irrigation development program. Because of the land having very serious limitations such as deep water stagnation and potential acid organic soils in the low-lying area and/or coarse textured soil with gravels, shallow soil depth, rolling topography etc. in the hilly area, the economic development could not be expected with the land in this class, though some possibilities for agricultural development with other specific annual crops and tree crops are recognized.

To repeat in general, all of the lands in the project area have more or less some constraints which would reduce crop yields and require higher cost for crop production and soil conservation particularly for introduction of diversified crops. The project study will be made, taking into account the minimization of these constraints prevailing in the project area.

3.3.5 Hydrology

Rainfall

About twenty rainfall gauging stations have been set and are in operation by the meteorological offices and agricultural offices. Fig. 3-1 shows the location of meteorological and hydrological stations.

Among them, three stations, Banjarmasin (Agricultural office), Ulin (Syamusdin Noor) and Banjarbaru (SPMA), are selected for the study on the irrigation and drainage requirements mainly because of longer observation periods and higher reliability of records as compared with other stations. The available rainfall data are as follows:

Station	Daily records	Monthly records
Banjarmasin	Jan. 1962 - Dec. 1967 Jan. 1969 - Jul. 1978	Jan. 1960 - Jul. 1978
Ulin	Jan. 1960 - Jun. 1978	Jan. 1960 - Jun. 1978
Banjarbaru	Jan. 1960 - Dec. 1976	Jan. 1960 - Dec. 1976

The monthly rainfall records at Banjarbaru, Ulin and Banjarmasin are tabulated in Tables 3-5, 3-6 and 3-7, respectively.

Consecutive three-day probable rainfalls at the three stations are estimated by Gumbel method for the study on the drainage improvement, as shown below.

Return period	Banjarbaru (mm)	Ulin (mm)	Banjarmasin (mm)
5 years	209.4	217.9	187.0
10 years	240.7	259.2	217.6

Streamflows

The river Riam Kanan has a catchment area of 1,285 km^2. It originates from the Meratus mountain in the southeastern part of the South Kalimantan and flows westwards. The river Riam Kiwa has a catchment area of 1,645 km^2 and flows southwestwards from the Meratus mountain. These two rivers join at Astambul and drain into the river Martapura. The river Maluka also originates from the Meratus mountain and flows westwards to the Java Sea. The catchment area is estimated at about 830 km^2.

Nine water level gauging stations are in operation in and around the project area. Among them, four stations, Awangbangkal, Sei Langsat, Sei Tabuk and Liang Anggang, are equipped with automatic water level recorders. Three stations are recording the water levels using staff gauges at Martapura, Astambul and Banyuhirang. One automatic water level recorder has been set in the old harbour on the Martapura. In addition, a new automatic water level recorder has been installed by the Team at Aluh Aluh Besar near the river Barito. The observation period of each station is as follows:

River	Station	Period	Instrument
Riam Kanan	Awangbangkal	Jun. 1975 - Present	Automatic rec.
Riam Kiwa	Sei Langsat	May 1976- Present	- do. -
Martapura	Astambul	Sept. 1976 - Present	Staff gauge
	Martapura	- do. -	- do. -
	Sei Tabuk	Aug. 1978 - Present	Automatic rec.
	Pelabuhan Lawa	Jan. 1959 - Present	- do. -
Aluh Aluh Besar	Aluh Aluh Besar	Aug. 1978 - Present	- do. -
Maluka	Liang Anggang	Jul. 1978 - Present	- do. -
	Banyuhirang	Apr. 1977 - Present	Staff gauge

Runoff discharges were measured at Awangbangkal, Sei Langsat and Banyuhirang. The results of the measurements are given in Table 3-8.

Based on these runoff measurements, rating curves are prepared for the Awangbangkal and Sei Langsat stations. The monthly mean runoff in both the Riam Kanan and the Riam Kiwa is estimated using these rating curves, as shown below (see Figs. 3-2 and 3-3).

Riam Kanan

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.
Runoff (m^3/sec)	104	72	45	35	24	18

Month	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Runoff (m^3/sec)	35	18	19	19	19	37

Riam Kiwa

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.
Runoff (m^3/sec)	83	96	140	95	78	32

Month	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Runoff (m^3/sec)	11	6	3	5	22	64

As for the Maluka, the study on the runoff discharge could not be made at this time because of the lack of data and information on the records of water level and discharge mesurements. The study on this matter will be made later through further collection of data and information.

3.3.6 Water Quality

According to the report on the Riam Kanan dam project, it is concluded that the river water of the Riam Kanan is suitable for both irrigation and domestic purposes. The chemical analysis of water samples to be taken at the proposed diversion site is going to be made soon to confirm their quality for irrigation and domestic use.

The water samples taken at two sites on the Martapura, Sei Bilu pumping station and the Martapura bridge, are now under chemical analysis in the laboratory of the Lambung Mangkurat University in Banjarbaru. The results of the analysis will be presented in the draft of the feasibility report.

Table 3-1 Soil Classification in Higher Categories

Order	Sub-Order	Great Soil Group	Sub-Group
1. Enticols	1. Psamments	1. Quartzipsamments	1. Aquic Quartzipsamments
- do. -	- do. -	- do. -	2. Haplaquodic Quartzipsamments
- do. -	2. Orthents	2. Troporthents	3. Typic Troporthents
- do. -	3. Aquents	3. Fluvaquents	4. Typic Fluvaquents
- do. -	- do. -	- do. -	5. Thapto-Histic Fluvaquents
- do. -	- do. -	4. Hydraquents	6. Sulfic Hydraquents
- do. -	4. Fluvents	5. Tropofluvents	7. Typic Tropofluvents
2. Inceptisols	5. Tropepts	6. Dystropepts	8. Typic Dystropepts
- do. -	6. Aquepts	7. Tropaquepts	9. Aeric Tropaquepts
- do. -	- do. -	- do. -	10. Typic Tropaquepts
- do. -	- do. -	- do. -	11. Histic Tropaquepts
- do. -	- do. -	8. Haplaquepts	12. Aeric Halpaquepts
- do. -	- do. -	- do. -	13. Typic Halpaquepts
3. Ultisols	7. Ustults	9. Haplustults	14. Typic Haplustults
4. Histosols	8. Fibrists	10. Tropofibrists	15. Terric Tropofibrists
- do. -	9. Hemists	11. Tropohemists	16. Terric Tropohemists
- do. -	10. Saprists	12. Troposaprists	17. Terric Troposaprists

Table 3-2 Soil Classification in Lower Categories

Sub-Group	Soil Family
1. Aquic Quartzipsamments	1. Sandy, acid, quartz, Aquic Quartzipsamments
2. Haplaquodic Quartzipsamments	2. Sandy (sandy skeletal to certain extent), acid, quartz, Haplaquodic Quartzipsamments
3. Typic Troporthents	3. Sandy skeletal, acid, Typic Troporthents
4. Typic Fluvaquents	4. Fine clayey, acid, Typic Fluvaquents
5. Thapto-Histic Fluvaquents	5. Fine clayey, dysic, Thapto-Histic Fluvaquents
6. Sulfic Hydraquents	6. Fine to silty clayey, dysic, Sulfic Hydraquents
7. Typic Tropofluvents	7. Fine clayey, acid, Typic Tropofluvents
8. Typic Dystropepts	8. Loamy skeletal, acid, Dystropepts
9. Aeric Tropaquepts	9. Fine to silty clayey, acid Aeric Tropaquepts
10. Typic Tropaquepts	10. Fine to silty clayey, acid, Typic Tropaquepts
11. Histic Tropaquepts	11. Fien to silty calyey, acid, Histic Tropaquepts
12. - do. -	12. Sandy, dysic, Histic Tropaquepts
13. Aeric Haplaquepts	13. Fine clayey, acid, Aeric Haplaquepts
14. Typic Haplaquepts	14. Fine to silty clayey, acid, Typic Haplaquepts
15. Typic Haplustults	15. Sandy to loamy skeletal, acid, Typic Haplustults
16. Terric Tropofibrist	16. Fibric, dysic, Terric Tropofibrist
17. Terric Tropohemists	17. Hemic, dysic, Terric Tropohemists
18. Terric Troposaprists	18. Sapric, dysic, Terric Troposaprists

Table 3-3 Major Characteristics of Soils and Environmental Conditions

Soil Sub-group	Mapping Unit (family No.)	Topography and Relief	Land Use or Vegetation	Seasonal Flood Duration (month)	Seasonal Flood Depth (cm)
1. Aquic Quartzi-psamments	1.	remnant levee & low-terrace; nearly flat	bushes	-	-
2. Haplaquodic Quartzipsamments	2.	low-terrace; nearly flat	bushes	-	-
3. Typic Troporthents	3.	undulating; very gentle sloping	alang-alang	-	-
4. Typic Fluvaquents	4.	recent levee; nearly flat	village-yard	Dec.-Mar.	30
5. Tapto-Histic Fluvaquents	5.	recent levee; nearly flat	paddy field	full-season	50
6. Sulfic Hydraquents	6.	depression; flat	paddy field or galam tree	full-season	100 or more
7. Typic Tropofluvents	7.	flood plain; flat	galam shrub	Nov.-May	50
8. Typic Dystropepts	8.	undulating; gentle slope	alang-alang	-	-
9. Aeric Tropaquepts	9.	flood plain; flat	paddy field	Dec.-Mar.	30
10. Typic Tropaquepts	10.	flood plain; flat	paddy field	Dec.-Apr.	50
11. Histic Tropaquepts	11.	flood plain; flat	galam and swampy forest	Dec.-May	50
- do -	12.	low-terrace; nearly flat	galam and swampy forest	-	-

Note: 1) Mapping unit (family No.) is the soils which classified into the soil family at lower category in the soil classification. The figures are directly referred to the series No. of the soils illustrated in the soil map.

2) Duration of the seasonal flooding is preliminarily defined as the period with water standing.

3) Depth of the seasonal flooding show a maximum depth at the peak flooding.

.... to be continued ....

Soil Sub-group	Mapping Unit (family No.)	Topography and Relief	Land Use or Vegetation	Seasonal Flood	
				Duration (month)	Depth (cm)
12. Aeric Haplaquepts	13.	levee; nearly flat	village-yard and plantation	Dec.-Feb.	30
13. Typic Haplaquepts	14.	old levee; nearly flat	plantation and village-yard	-	-
14. Typic Haplustults	15.	rolling; steep slope	alang-alang	-	-
15. Terric Tropofibrists	16.	depression; -	swampy-forest	full-season	100 or more
16. Terric Tropohemists	17.	depression; -	swampy-forest	full-season	100 or more
17. Terric Troposaprists	18.	flood plain; flat	galam shrub or swampy forest	full-season	50 or more

Note: 1) Mapping unit (family No.) is the soils which classified into the soil family at lower category in the soil classification. The figures are directly referred to the series No. of the soils illustrated in the soil map.

2) Duration of the seasonal flooding is preliminarily defined as the period with water standing.

3) Depth of the seasonal flooding show a maximum depth at the peak flooding.

Mapping Unit	Ground Water Fluctuation (cm)	Soil Depth (cm)	Soil Texture	Specific Horizon	Salinity
1.	0 to 50	0 to 5	LS/ SG	–	free
2.	10 to 50	0 to 10	LS/ SG	spodic	free
3.	–	30 to 50	L/ LG	–	free
4.	10 to 50	100 to 150	SiC/ C	canbic	free
5.	0	30 to 50	SiC/ peat	histic	free
6.	0	30 to 50	C / C	sulfic or dysic	free
7.	0 to 20	100 to 150	C / C	gleyic	free
8.	–	10 to 20	fL / LG	cambic	free
9.	20 to 50	150 or more	SiC/ C	gleyic	free
10.	0 to 30	100 to 150	SiC/ C	gleyic	free
11.	10 to 50	100 to 150	humic C/ SiC	histic	free
12.	5 to 30	30 to 50	humic S/ S	histic	free
13.	10 to 60	150 or more	SiC/ C	gleyic	free
14.	30 to 70	150 or more	C / SiC	cambic	free
15.	–	5 to 25	LG/ LG	cambic	free
16.	–	100 to 150	peat	fibric	free
17.	–	100 to 150	peat	hemic	free
18.	–	50 to 100	peat	sapric	free

Mapping Unit	Acidity (pH: H_2O) (field)	(air-dry)	(potential)	C.E.C. (m.e)	Base Saturation Degree (%)	Soil Evaluation
1.	4.5 to 5.5	4.5 to 5.0	-	2 to 7	5 to 20	non-arable
2.	4.0 to 5.0	3.5 to 4.0	-	1 to 6	5 to 15	non-arable
3.	4.5 to 5.5	4.5 to 5.0	-	3 to 10	10 to 20	conditionally arable
4.	4.5 to 5.5	4.0 to 4.5	-	30 to 50	40 to 60	arable
5.	4.5 to 5.0	3.5 to 4.5	3.0 to 3.5	25 to 45	30 to 45	conditionally arable
6.	4.0 to 4.5	3.0 to 4.0	2.5 to 3.5	50 to 60	10 to 20	conditionally arable
7.	4.0 to 5.0	3.5 to 4.0	3.0 to 3.5	30 to 50	30 to 50	arable
8.	4.5 to 6.0	4.5 to 5.0	-	10 to 25	5 to 10	conditionally arable.
9.	4.5 to 5.5	4.5 to 5.0	-	30 to 60	35 to 60	arable
10.	4.0 to 4.5	4.0 to 4.5	-	30 to 60	40 to 60	arable
11.	4.0 to 4.5	3.5 to 4.0	3.0 to 3.5	5 to 10	5 to 10	arable
12.	4.0 to 4.5	3.5 to 4.0	3.0 to 3.5	5 to 15	5 to 10	arable
13.	4.5 to 6.0	4.5 to 5.0	-	25 to 35	30 to 50	arable
14.	4.5 to 5.5	4.0 to 5.0	-	30 to 50	35 to 50	arable
15.	4.0 to 5.0	4.0 to 4.5	-	10 to 20	5 to 10	conditionally arable
16.	4.0 to 4.5	3.5 to 4.0	2.0 to 2.5	100 to 150	few	currently non-arable
17.	3.5 to 4.5	3.0 to 4.0	2.0 to 2.5	150 to 170	few	currently non-arable
18.	3.5 to 4.5	3.0 to 3.5	2.0 to 2.5	50 to 65	few	conditionally arable

Table 3-4 Land Classification

Land Suitability for Irrigated Paddy Rice Cultivation

Lnad class		Definition	Area (ha)	%
Class	1	No land satisfied in the project area	-	-
Class	2	Suitable for the objectives	38,700	41.7
Class	3	Moderately suitable for the objectives	10,400	11.2
Class	4	Marginally suitable for the objectives	22,040	23.7
Class	5	Unsuitable for the objectives	21,640	23.4
		Total	92,780	100.0

Land Suitability for Diversified Crops (Polowijo) with Irrigation

Land class		Definition	Area (ha)	%
Class	1	No land satified in the project area	-	-
Class	2	Suitable for the objectives	1,200	1.3
Class	3	Moderately suitable for the objectives	1,150	1.2
Class	4	Marginally suitable for the objectives	42,040	45.3
Class	5	Unsuitable for the objectives	48,390	52.2
		Total	92,780	100.0

Note: The specification of land classification is referred to the land classification system defined by the Bureau of Reclamation U.S. Department of Interior, 1953, modified in 1967, especially for the land evaluation on lowland paddy field and its production (Lam Nam Oon Project, Thailand).

Table 3-5 Monthly Rainfall Records at Banjarbaru

Station : Banjarbaru (S.P.K.A.) Unit : mm

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1960	351	438	296	155	346	99	189	64	135	80.5	362	186	2,701.5
1961	437	201	278	154	202	195	37	23	29	23	314	216	2,109.0
1962	530	412	273	259	229	155	113	90	98	208	529	215	[illegible]
1963	447	284	322	90	178	18	26	49	-	59	195	251	1,919.0
1964	410	249	193	155	187	128	334	69	213	182	406	122	2,648.0
1965	295	377	327	82	159	154	40	8	23	105	[illegible]	565	[illegible]
1966	549	454	349	294	96	127	57	80	54	272	264	543	3,139.0
1967	314	522	351	245	231	122	115	70	130	108	55	234	2,500.0
1968	712	209	408	321	158	244	230	136	197	186	411	286	3,498.0
1969	321	377	529	263	280	110	58	23	58	65	273	541	2,898.0
1870	505	483	880	441	452	399	111	88	140	27	145	601	4,272.0
1971	392	222	265	165	123	90	74	69	151	107	228	209	2,095.0
1972	184	128	120	258	125	37	18	4	-	6	135	361	1,378.0
1973	314	238	519	443	184	123	92	68	191	103	320	411	2,883.0
1974	155	308	20	72.1	86.0	151.7	134.6	143.3	166.5	300	273	157.5	1,962.6
1975	219	155.5	421	290	145	155	204	89	279	189	407	540	3,093.5
1976	591	343	277	94	103	110	-	51	3	307	542	388	2,809.0
Mean	395.6	317.7	342.3	219.7	193.2	142.2	117.7	66.1	124.5	137.0	290	342.7	2,659.2

Table 3-

Monthly Rainfall Records at Ulin

Station : Syamsudin Noor

Unit : mm

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1960	335.8	524.0	312.3	192.0	345.7	234.8	320.6	80.5	132.8	82.1	173.5	269.8	3,011.6
1961	485.4	317.0	243.5	294.5	235.7	127.6	52.5	6.1	40.9	47.3	272.5	182.9	2,305.9
1962	538.0	461.0	269.3	302.0	189.4	165.1	141.6	98.2	73.0	187.8	281.2	273.5	2,986.1
1963	508.0	339.0	448.0	57.0	117.0	7.0	47.0	60.0	28.0	34.0	174.0	226.0	2,045.0
1964	408.5	232.1	180.1	227.0	137.1	137.3	199.6	140.6	220.0	280.1	443.1	248.8	2,855.2
1965	227.4	355.4	279.0	79.4	174.4	125.8	6.0	11.0	10.5	81.8	107.6	373.6	1,831.9
1966	454.0	417.0	352.9	201.1	168.5	90.6	78.7	130.5	40.6	128.1	243.3	444.7	2,750.0
1967	558.1	536.4	268.9	283.0	105.3	83.1	44.0	10.9	71.0	116.9	114.2	247.4	2,439.2
1968	532.0	204.0	236.6	218.2	93.4	216.5	205.1	117.0	150.0	181.0	192.0	283.8	2,413.1
1969	186.0	128.0	325.0	152.0	170.0	66.0	19.0	36.0	9.0	85.0	190.0	455.0	1,821.0
1970	492.0	-	459.0	137.0	292.0	135.0	205.0	110.0	170.0	81.0	195.0	572.0	2,392.0
1971	431.0	213.0	255.0	115.0	96.0	36.0	152.0	165.6	345.0	155.0	321.0	338.0	2,622.6
1972	322.0	259.0	255.7	270.0	98.0	36.0	22.0	18.0	-	33.0	180.0	227.2	1,720.9
1973	324.9	331.8	494.9	231.6	293.0	110.0	100.3	115.6	190.0	249.0	211.3	311.4	2,963.8
1974	125.8	504.4	337.0	216.5	163.0	104.0	228.1	68.9	178.4	241.4	278.3	340.4	2,786.2
1975	383.0	161.2	469.1	227.3	59.3	131.0	170.0	167.2	158.0	287.0	463.0	400.0	3,075.1
1976	421.0	396.1	218.8	131.6	97.5	155.7	107.7	82.8	32.0	262.3	401.0	422.5	2,729.0
1977	399.4	417.7	376.6	462.2	158.2	239.0	35.9	125.9	27.9	60.4	256.7	412.3	2,972.2
Mean	396.2	341.4	321.2	211.7	166.3	122.3	118.6	85.8	110.4	144.1	249.9	335.0	2,602.9

Table 3-7 Monthly Rainfall Records at Banjarmasin

Station : Banjarmasin

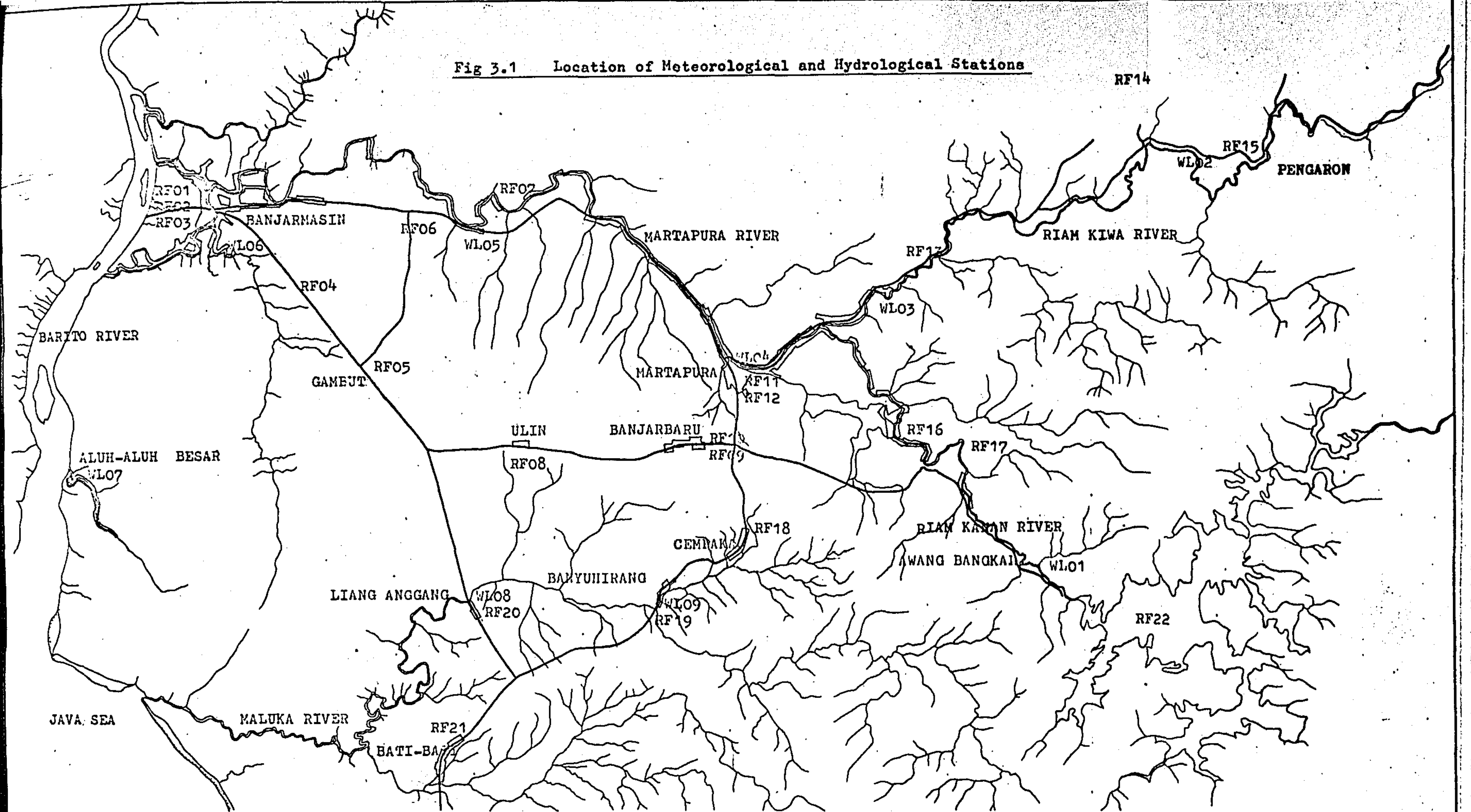
Unit : mm

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1960	488	497	289	419	273	139	210	15	241	18	338	421	3,348
1961	482	431	284	297	163	115	130	10	63	33	179	215	2,408
1962	529	535	397	332	144	151	161	69	145	263	437	344	3,507
1963	533	780	747	84	110	51	65	101	1	-	325	335	3,132
1964	331	377	358	383	176	85	80	93	139	338	265	200	2,825
1965	319	248	327	174	137	69	-	2	39	38	105	383	1,841
1966	400	373	270	233	128	60	62	96	68	152	234	430	2,506
1967	273	400	192	80	141	34	45	47	52	97	58	151	1,570
1968	222	203	286	444	81	90	65	15	52	78	133	239	1,908
1969	94	147	354	120	75	9	11	12	-	49	76	282	1,229
1970	321	320	253	212	178	65	167	122	130	136	167	526	2,597
1971	116	x	244	166	107	35	44	152	225	171	357	224	1,841
1972	367	264	223	67	85	32	4	24	-	60	208	238	1,572
1973	520	309	595	192	164	88	114	180	260	78	266	996	3,262
1974	179	461	281	145	161	70	53	83	212	154	197	175	2,171
1975	347	255	220	104	99	43	108	269	262	250	292	335	2,584
1976	312	365	383	210	20	132	39	2	31	387	311	441	2,533
1977	312	316	376	163	13	137	17	46	15	26	203	382	2,016
Mean	341.7	369.5	332.2	212.5	125.6	78.1	80.9	74.3	120.9	136.9	230.9	350.9	2,454.4

Table 3-8 Discharge Measurement on Riam Kanan, Riam Kiwa and Maluka Rivers

River	Station	Date	Gauge reading (m)	Discharge (m^3/ sec)
Riam Kanan	Awang Bangkal	2 October, 1977	0.38	16.70
		14 November, 1977	0.435	21.60
		25 March, 1978	1.05	70.10
		8 August, 1978	0.91	37.10
		11 September, 1978	0.59	25.61
Riam Kiwa	Sei Langsat	15 February, 1976	1.425	50.69
		15 February, 1976	1.41	47.145
		19 October, 1976	0.308	4.07
		3 March, 1977	3.305	115.50
		13 August, 1977	0.605	11.30
		10 September, 1977	0.32	4.61
		28 September, 1977	0.445	7.36
		14 November, 1977	0.13	2.18
		28 February, 1978	1.66	45.10
		17 June, 1978	1.16	28.19
		8 August, 1978	0.95	20.60
		10 September, 1978	0.73	14.608
		12 September, 1978	0.68	12.17
Maluka	Banyuhirang	14 September, 1978	1.49	10.50

Fig 3.1 Location of Meteorological and Hydrological Stations



Rainfall Gauging Station

RF01 Banjarmasin, Diperta
RF02 Banjarmasin, P4S (Automatic)
RF03 Banjarmasin, PU
RF04 Kertak Hanyar
RF05 Gambut
RF06 Sei Tabuk, PU (Automatic)
RF07 Sei Tabuk, Diperta
RF08 Ulin, Syamsudin Noor (Automatic)
RF09 Banjarbaru, LMG (Automatic)
RF10 Banjarbaru, SPMA
RF11 Martapura, PU
RF12 Martapura, Diperta
RF13 Danau Salak
RF14 Simpang Empat
RF15 Pengaron (Automatic)
RF16 Karang Intan
RF17 Sei Asam
RF18 Cempaka
RF19 Banyuhirang
RF20 Liang Anggang
RF21 Bati-Bati
RF22 Kalaan Riam Kanan (Automatic)

Water Level Gauging Station

WL01 Awang Bangkal (Automatic)
WL02 Sei Langsat (Automatic)
WL03 Astambul
WL04 Martapura
WL05 Sei Tabuk (Automatic)
WL06 Pelabuhan Lama (Automatic)
WL07 Aluh-Aluh Besar (Automatic)
WL08 Liang Anggang (Automatic)
WL09 Banyuhirang

Fig. 2.[illegible] Rating Curve at Awang Bangkal on Riam Kanan River

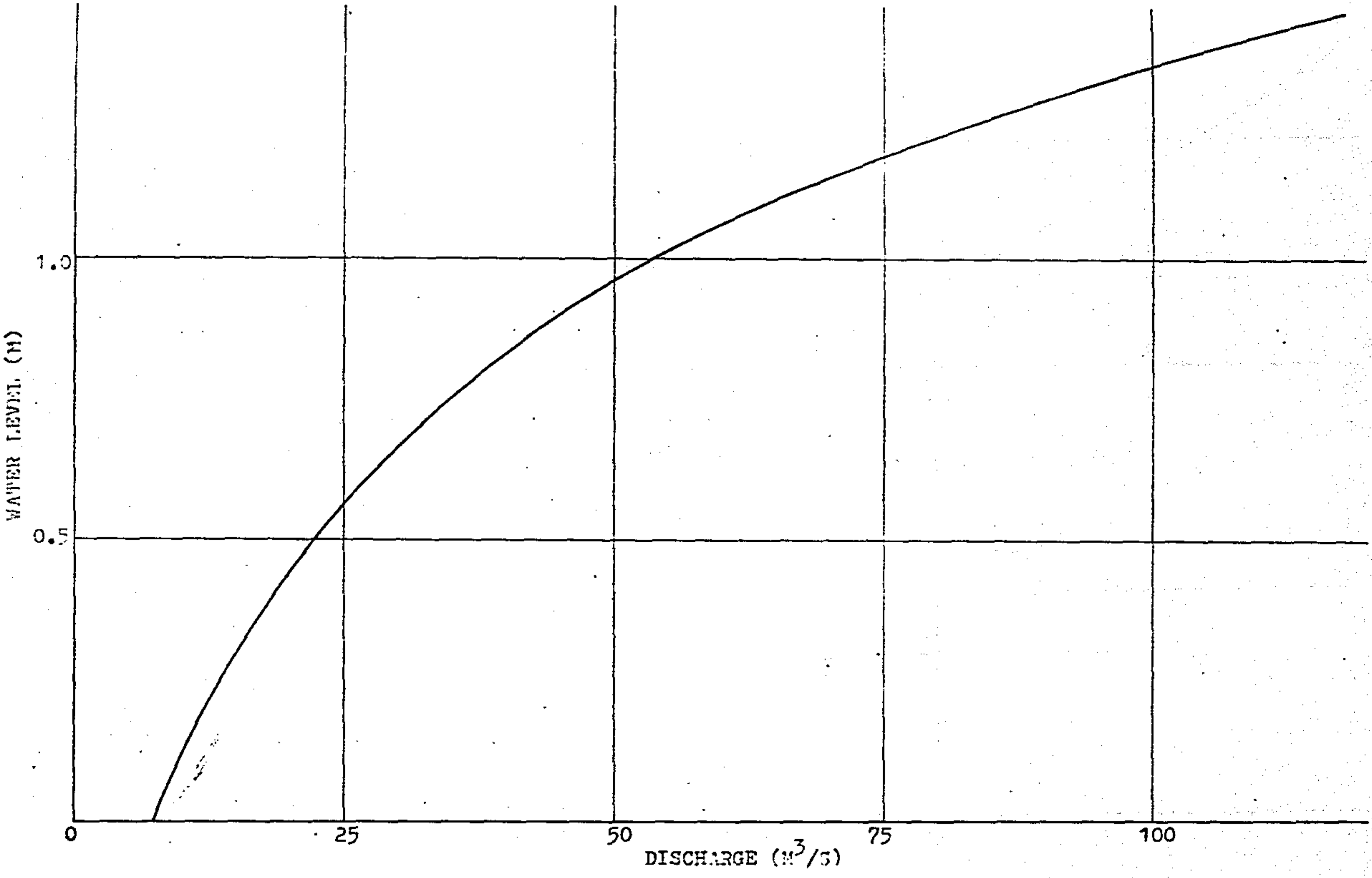
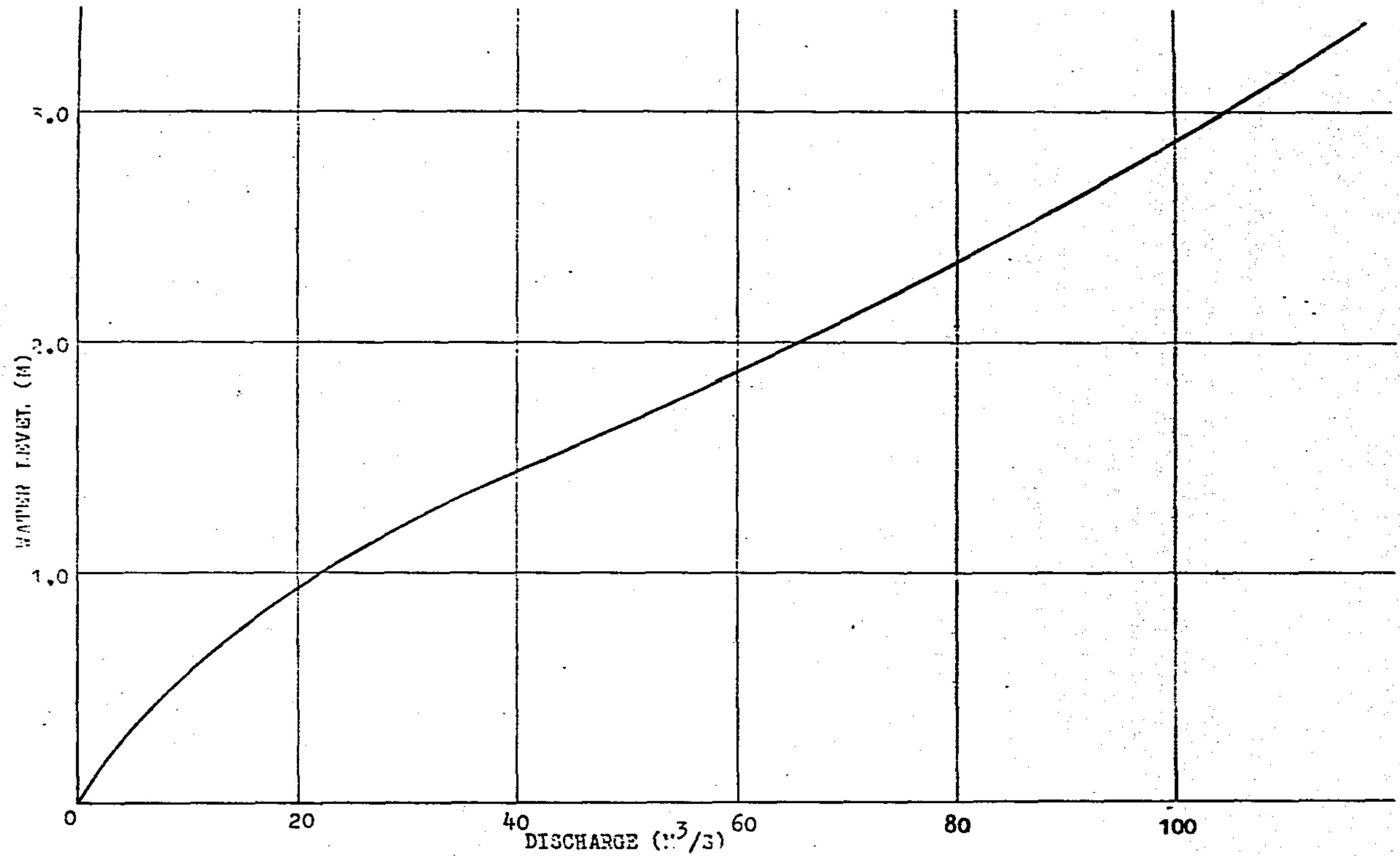


Fig 3.[illegible] Rating Curve at Sei Langsat on Riam Kiwa River



3.4 INFRASTRUCTURES

3.4.1 The Riam Kanan Dam Project

The construction of the Riam Kanan Multipurpose Dam Project was started in 1963 and completed in 1972 with the financial assistance of the Japanese Government. The hydropower plant with an installed capacity of 20 MW was put into commercial operation in 1973. Since then, the power supply conditions in Banjarmasin, Banjarbaru, Martapura and some rural areas which are located in the project area has been much improved. The power demand, which was 7 MW in 1974, increased to 12 MW at present. PLN (National Electric Supply Corporation) forecasts that the future power demand will be 24 to 27 MW at peak in and after 1984.

With this power demand forecast, PLN is making necessary preparatory works to install one more 10 MW power plant together with the increase of the capacity of transmission line and extension of distribution lines in the rural areas as well as in the cities by the year of 1982 (the Riam Kanan 2nd Stage Project). With the completion of the 2nd stage project, the discharge from the power station will increase. More detailed study on this matter is made in Sub-chapter 4.1 of this report.

The main features of this multipurpose dam project is summarized in Table 3-9.

3.4.2 Present Irrigation and Drainage System

In the project area, no technical irrigation and drainage system exists at present, except for the canal network, most of which were constructed by the people without any technical advice from the government offices, as mentioned below.

Sub-area A

There is one polder which was constructed in the late nineteenth century. It is connected with the river Riam Kanan through two chennels with check gates. The area inside the embankment being 1,550 hectares is irrigated from and drained to the river, depending on the water levels in the polder and of the river.

There are no other notable structures in the remaining areas. The paddy fields are being rainfed, except for the limited areas along the small river which runs from south to north in the sub-area A. In these areas, irrigation is being practiced using the small river water through the ditchs excavated by the local people.

Sub-area B

There is another old polder covering an area of 1,920 hectares in the eastern part of the sub-area B. The water level in the polder is regulated through a check gate located near the river Martapura.

Water for the present paddy fields along the Martapura is controlled through several artificially made channels which, running from south to north, are connected with the river. Some of them are equipped with sluice gates and stoplogs. Depending on the water levels between the fields and the river, then, either irrigation or drainage is practiced.

It is noted that there is a fairly large drain, which was constructed in the 1940's. It is parallel to and joins the river Martapura passing through the lowest part of the sub-area B. A part of this drain may be used as one of the main drains in this sub-area with its rehabilitation under the Project. Most of the paddy fields in this sub-area is relieved from the floods from swamp areas situated on the south.

Sub-area C

There is nothing to report, except for a small channel along the highway and a few damming-up structures on the natural small rivers. The purpose of these is not only for irrigation but also securing water for living.

Sub-area D

There are many man-made channels on the eastern half of the sub-area. These are directed to the natural rivers and streams connecting to the river Barito. They are mostly used for both irrigation and drainage using tidal fluctuation, and also for traffic by small boats. There are some check structures with stoplogs on these channels. The maintenance of these channels is poor, and no systematic control of these canal network is actually practiced.

Sub-area E

In the western part of this sub-area, there are man-made channels which are used for irrigation, drainage and traffic purposes. The present conditions of these channels are quite the same as those in the sub-area D. The eastern half of the area is the swamp area in which no irrigation system exists.

There are two swampy land reclamation projects under construction on the right bank of the Maluka river basin. One is located at about 10 km upstream from the estuary of the Maluka and the other, 27 km. The service area of the former is about 1,600 hectares and the latter, 700 hectares. Both of them aim at reclamation by excavating drains at an interval of 300 m.

Sub-area F

There is no irrigation and drainage system in this sub-area.

3.4.3 Transportation and Communication

The existing road network centers in Banjarmasin. The national highway linking Banjarmasin with Banjarbaru, Martapura and other major towns runs west to east approximately in the middle part of the project area. This highway is well maintained, and widening of the road width from the present 9 m to 12 m of this highway is now under construction. In the rural areas, particularly in the sub-areas B, C, D and E, transportation by vehicles is limited because of poor road network in both number and condition. In such rural areas, however, most of the existing streams and channels are used for transporting farm products and other consumable goods using small boats.

Civil airport in Ulin is providing services for transportation of passengers and goods to the major cities not only in Kalimantan but also in other islands.

The dredging operations on the estuary of the river Barito have made possible the navigation of freights of the 7,000 to 8,000 deadweight ton class to go up the river to the newly completed port of Trisakti in Banjarmasin.

The international and national communication services by telephone and telegram are available in Banjarmasin. However, communication between Banjarmasin and other major cities in the project area is still limited.

3.4.4 Municipal Water Supply

The municipal water supply facility is available only in Banjarmasin. The present supply capacity is 275 ℓ/sec. The city water is supplied from the Martapura by two pumping stations. One is located at Sei Bilu near the estuary of the Martapura, and the other is at Sei Tabuk, about 20 km upstream from the Sei Bilu pumping station. The Sei Bilu station is mainly used for the water supply services. The concentration of Chlorine Cl^- is measured every hour at the Sei Bilu station in the dry season. When the measured value of Chlorine exceeds 200 ppm, the Sei Tabuk station is operated instead of the Sei Bilu station.

The river Martapura is affected by tide. According to the data on Chlorine concentration measured at the Sei Bilu station, the saline water intrusion is observed according to the season. However, the saline water intrusion was not observed at the Sei Tabuk station even before the completion of the Riam Kanan dam, with the exception of the year of 1972 which was very drought year and in which the Riam Kanan dam started to store the water.

The first pumping station for the city water supply was constructed in Banjarmasin in 1945 and operated throughout the year, except for the period during which the saline water intrusion was observed. When the river water was affected by the saline water, the city water was taken at the Sei Tabuk site and supplied to the people. In 1970, the Sei Tabuk pumping station was constructed to supply clean water to Banjarmasin. Mainly because of high operation cost for the Sei Tabuk station, however, the Sei Bilu pumping station was constructed in 1973. Since then, this station is in operation as mentioned above.

According to the data on Chlorine concentration of the water measured at the Sei Bilu station, the river water of the Martapura is affected by the saline water coming through the river Barito for 3 to 6 months according to the years. The maximum value of Chlorine concentration of about 7,000 ppm was observed in October, 1977. Some data on Chlorine concentration measured at the Sei Tabuk station in 1972 are also available. According to the data, the river water at the Sei Tabuk station is not affected by the saline water since 1945, except the year of 1972 in which high value of 3,940 ppm was recorded.

For further study on this matter, the investigation on the saline water intrusion was carried out through measurement of the electric conductivity of the river water of the Martapura at flood tide. The vertical and longitudinal variation of the electric conductivity of the river water ranged between 200 and 400 μmho/cm in the reach from the Sei Bilu station to the Sei Tabuk station. Even at the estuary of the Martapura, the electric conductivity was less than 400μmho/cm. This means that there is no saline water intrusion into the Martapura in this year. It seems that these facts are due to large runoff in both the Brito and the Martapura.

The river water released from the Riam Kanan power station will be diverted to the project area for irrigation use by constructing a diversion weir on the Riam Kanan. It will not be allowed, however, that all amount of such river water available from the dam be used for the project use only. This means that some amount of water should be released to the downstream reaches of the Martapura, particularly for navigation and for protecting the Martapura from the saline water intrusion and water pollution.

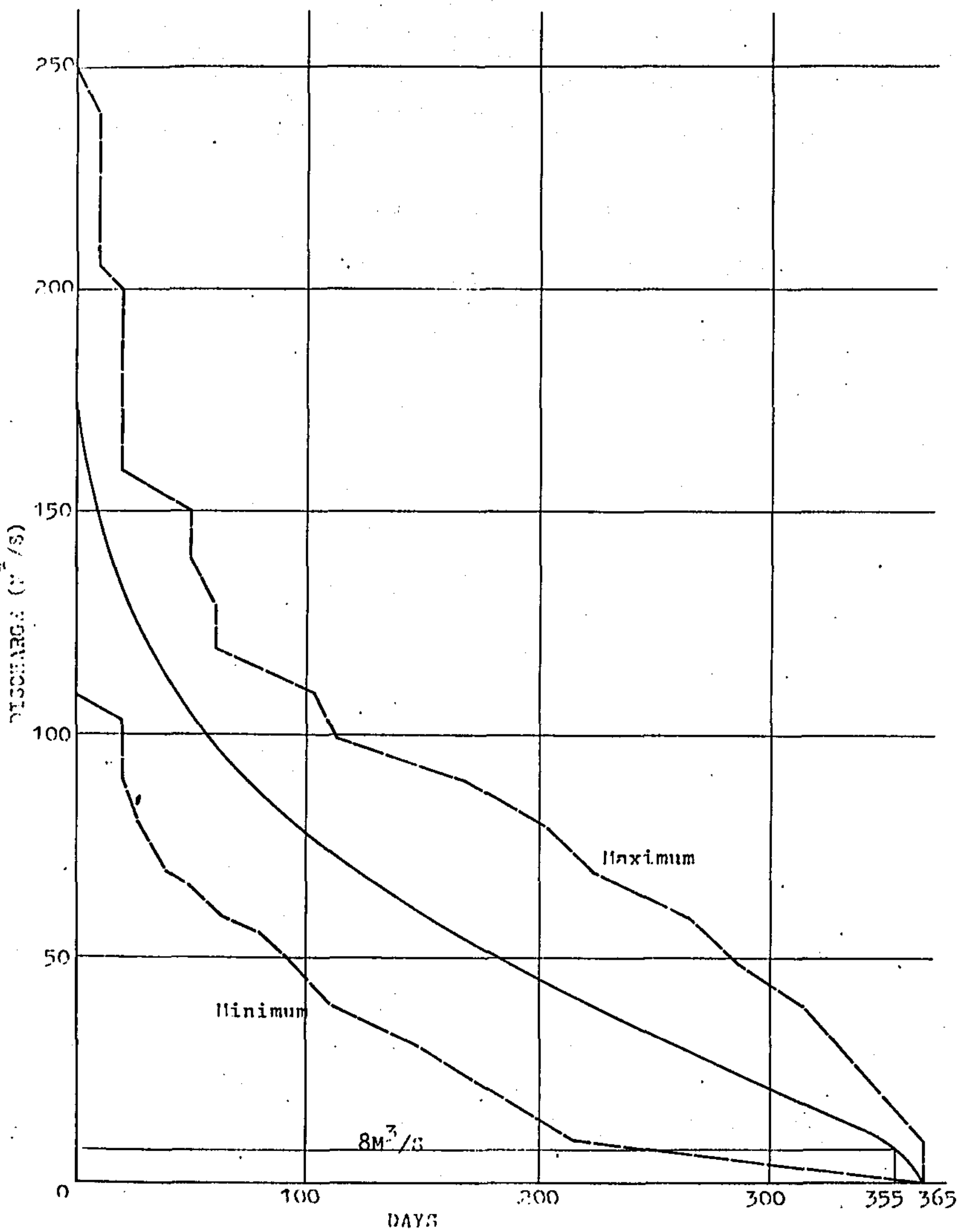
For the study on this matter, the discharge duration curve at the Riam Kanan dam site is prepared as shown in Fig. 3-4. From this figure, the drought runoff which is the mean value of 12 years' drought runoff is estimated at 8 m^3/sec.

According to the data and information from the City Waterworks Bureau mentioned before, the river water of the Martapura at the Sei Tabuk station is not affected by the saline water intrusion, except for the year of 1972. It is considered from these that the Sei Tabuk station could be used for the city water supply services without saline water problem, when a constant release of 8 m^3/sec of water to the downstream reach is secured at the diversion weir, though the further study on this matter should be made based on the more reliable data and information.

Table 3-9 Main Features of the Riam Kanan Multipurpose Dam Project

1.	RESERVOIR		
	Catchment area		1,043 km^2
	Total storage capacity		1,200,000,000 m^3
	Submergible area		92 km^2
	High water level		
	Low water level		
	Flood water level		
2.	DIVERSION		
	Coffer dam, type		Earthfill
	Coffer dam, height		28 m
	Coffer dam, volume		210,000 m^3
	Diversion tunnel, length		332 m
	Diversion tunnel, discharge		340 m^3/sec
3.	MAIN DAM		
	Type		Homogeneous earthfill
	Height		57 m
	Volume		670,000 m^3
	Crest elevation		
4.	SPILLWAY		
	Service spillway		Morning-glory-tunnel type Discharge capacity 500 m^3/sec
	Emergency spillway		Open channel type Discharge capacity 230 m^3/sec
5.	POWER GENERATION		
	Gross head, maximum		49.5 m
	Gross head, minimum		41.5 m
	Rated head		39.8 m
	Discharge, maximum		87 m^3/sec
	Installed capacity	initial	20,000 kW
		final	30,000 kW
	Average annual output		155,600,000 kWh
	Turbine, type		Francis, vertical shaft
	Generator, type		Semi umbrella
6.	70 kV TRANSMISSION LINE		
	Circuit	initial	Single
		final	Double
	Conductor		ACSR 120 mm^2
	Length		52 km
	Tower		92 numbers of double circuit type, steel tower

Fig 3.4 Discharge Duration Curve at Riam Kanan Damsite



3.5 LAND USE AND AGRICULTURAL PRODUCTION

3.5.1 Land Holding and Land Tenure System

Kalimantan is classified into "Less Crowded Area" in accordance with Land Reform Law proclaimed in 1960, and land ownership is limited to 15 to 20 hectares per owner according to the provinces in Kalimantan. Upper limit of land ownership for a transmigrant is 3 hectares (2 ha at the time of transmigration plus 1 ha to be purchased later).

Table 3-10 shows the number and area of the farms by size of holding in the South Kalimantan Province. As seen in this table, land holding of about 90 % of total farmers is less than 2 hectares, and small farmers with land holding less than one hectare occupy about 70 % of the farmers.

Table 3-11 gives the present situation on land holding in Kecamatan Kertak hanyar in the project area. This table also indicates that most of the farmers are classified into small farmers who own less than 2 hectares of land.

No data on land tenure system are available at present. According to the data available from some villages in the above Kecamatan, however, it is estimated that about 82 % of the farmers are owner-farmer, 2 % tenant and 16 % owner-farmer + tenant. According to information obtained from the rural extension office in Kecamatan Aluh Aluh, in addition, it is assumed that owner-farmers are about 75 % of the farmers, tenant 5 % and owner-farmer + tenant 15 %.

3.5.2 Present Land Use

The present land use survey is also carried out in the area which includes the project area (60,000 ha) and its surrounding areas to obtain as much data and information as possible for the various project studies. The area surveyed is about 93,000 hectares.

In spite of the present constraints, approximately 45,300 hectares or about 50 % of the total survey area have been used as agricultural land long since. Most of the agricultural land is in low-lying flood plain. The agriculture in the survey area is characterized by a large share of paddy rice cultivation. Paddy field is about 40,500 hectares or about 90 % of the total agricultural land, and most of the remaining agricultural land is used as small scale plantations of rubber and coconut.

The paddy field has been developed with the canal network constructed by the people without any technical advice from the government offices. The canal network is used not only for both irrigation and drainage purposes but also for navigation for transporting farm products and other consumable commodities using small boats. The existing canals have no structures for water control, except for few check structures. Seasonal flooding is generally seen in the whole paddy field. On the contrary, no sufficient irrigation water is available in the dry season. The prevailing paddy cultivation is therefore practiced only in the rainy season using the stagnant water in the paddy field.

Out of 4,800 hectares of plantation area in total (5.2 % of total survey area), rubber plantation occupies about 2,500 hectares and coconut plantation, 2,300 hectares. Rubber plantation exists mainly in the old river levees or hilly land where the land is free from the seasonal flooding, while coconut plantation is in the low-lying flood plain or the recent levees along the rivers Barito, Martapura and Maluka. The peak time of the productivity of these plantations is nearly over, and their productivity tends toward decreasing.

The land primarily categorized as the infrastructural land including the village yard, homestead, airport, roads, canals, rivers, etc. is estimated at about 7,400 hectares or about 8 % of total survey area.

The remaining area of some 40,100 hectares are wild land at present. According to the present vegetation and topographical environment, the wild land is broadly classified into five land types; (1) Alang-alang grass land in the hilly area, (2) Galam shrub in the low-lying flood plain, (3) Bushes in the old sand levees or sand terrace on the foot of the hills, (4) Swampy forest in the low-lying areas and (5) Swampy grass area in the low-lying flood plain. The area of each land type is (1) 9,800 hectares, (2) 4,200 hectares, (3) 6,400 hectares, (4) 18,900 hectares and (5) 800 hectares, respectively.

The alang-alang grass land (sub-area F) is being developed gradually with transmigration settlement, and small scale clove plantations and farmland for cultivation of upland crops mainly for home consumption by transmigrants are settled in a small area. However, most of the land is not suitable for profitable agricultural development because of very shallow and gravelly or stony soils.

The land covered with Galam shrub extends over the low-lying flood plain along the river Martapura (sub-areas A and B). The land is very densely covered with young Galam trees which might be at the tertiary or the fouth vegetation stage. Because of light flooding with a shallow water depth even in the dry season and fine clayey alluvium deeply deposited in this area, it would be possible to reclaim this shrub land for the increase of agricultural productivity in the project area.

The land being covered by bushes under vegetation of fern extends mainly on the foot of the hills (sub-areas B and E). Due to medium to fine size of quartz sand skeletal deeply deposited, all the lands in this category are not suitable for agricultural use. These lands are used as borrow area for producing sand for the construction use.

The swampy forest extends in the sub-areas B and E. The northern half of the sub-area B is covered by the secondary forest developed on the deep peat soils. Because of such physical environments as deep water stagnation and the soils having an extremely strong acidity, the land covered with the swampy forest is not suitable for agricultural use as mentioned in the previous sub-section 3.3.4. The southern half of the sub-area E is covered mainly by tertiary Galam trees. Although the land is at present deeply inundated throughout the year, it could be developed for agricultural use with proper drainage improvement, but such development for agricultural use particularly for paddy cultivation would be limited to small area from the soil and agronomic viewpoint.

The swampy grass land is developed in a narrow area along the river Maluka and small streams in the project area. Among the grasses being grown, rushes are harvested in a small area for handicraft of mat. The main constraint to the agricultural development is a deep water stagnation throughout the year. If such a water stagnation could be improved economically, it would be possible to utilize this land for paddy cultivation.

The present land use in the survey area is shown in Table 3-12 and illustrated in the land use map (see Dwg. No.5).

3.5.3 Present Cropping Patterns and Farming Practices

The field survey of the present cropping patterns and farming practices is also made in the area, about 93,000 hectares in total, including the project area and its surrounding areas for the same reason as mentioned before.

Paddy rice is the main crop in the area, and monoculture of paddy rice using the flood water in the rainy season is predominant throughout the survey area.

Generally, the water depth of flooding in the paddy field gradually increases from November and reaches to the maximum of about 50 to 70 cm between the end of January and mid-February. Afterwards, the stagnant water gradually decreases its depth and reaches to the minimum water depth of about 15 to 20 cm during the period from March to April. Under these flooding conditions, the following paddy cultivation is practiced as a whole in the survey area.

It is noted in the present paddy cultivation that two-time transplanting or three-time transplanting of seedlings is traditionally practiced at the nursery stage, and so-called "Ani-ani" (harvest of matured panicles only) is the common practice for the harvesting. It is considered that these farming practices would be suited to the paddy cultivation in this area under the present field condition and from the plant physiological characteristics of the prevailing varieties such as high shattering, uneven maturing and high plant height.

Paddy seeds at a rate of 5 to 10 kg per hectare are sown in the nursery bed during the months from October for early planting to January for late planting, according to the availability of water necessary for plant growth. Young seedlings are grown for 30 to 40 days in the nursery bed and transplanted to the field where sufficient water is available, with a plant space of 30 x 30 cm approximately. These seedlings are re-transplanted to more wide area after making tiller-separation, so as to expand the planted area over the total holding. When the time at which the depth of stagnant water reaches the maximum is over and the water depth decreases to the favourable level for plant growth (approximately 30 cm), the final transplanting to the main field is carried out around the end of February which is the eariest one and in May that is the latest one. After growing for 7 to 10 months, the paddy is harvested during the period from May to October.

Early transplanting of the paddy is generally common in most part of the sub-areas C, D and E. It seems that the seasonal flooding is controlled to a certain extent by the existing canal network, though the land is deeply submerged at the peak flood time. While, late transplanting is practiced mostly in the sub-area B and a part of the D. It may be caused by the deep water stagnation for rather long time. Recently, the varieties with a short growing period such as Perita I/1, I/2 and C4-63 have been introduced in these areas, but they are still at the trial stage.

In the back-swamp extending along the river Barito, the paddy rice is also cultivated with early transplanting because of sufficient water available throughout the season and high plant height which would have a tolerance to deep water stagnation.

In the depressions of the polders in the sub-areas A and B, the paddy rice is cultivated only in the dry season from April to October because of deep flooding during the rainy season.

The present cropping pattern of paddy cultivation in the survey area is illustrated in Fig. 3-5. Under this cropping pattern, local varieties such as Lemo, Bayar and some other varieties of the Siam series are cultivated in most of the area. Among them, Lemo and Bayar varieties have high photo-sensitivity, while the Siam series has rather weak photo-sensitivity, as shown in Table 3-13. Generally, farmers grow 3 to 4 varieties in their farm during one crop season in order to control the peak labor requirements particularly for harvesting.

All the works for farming are operated by labors, not using any animal and mechanical powers. Seasonal labors are employed to supplement a shortage of family labor at the peak time such as land preparation, transplanting, harvesting and processing of products. The labor requirements for each work are summarized in Table 3-14.

No soil preparation, i.e. ploughing, harrowing, puddling, etc., is usually practiced in this area. The filed preparation being practiced by the farmers is only to return straw of paddy rice and grasses to their farm as primitive manuring. During the vegetative stage from the final transplanting to harvest of panicles, little attention is paid by the farmers only to weed control and cleaning of the field ridges. The use of chemical fertilizers and agricultural chemicals is still insignificant in this area. Water ponded by the field redges is drained out to the canals by cutting the field redges when almost all of the panicles are headed successfully. Generally, harvesting is practiced twice or three times even for one variety because of uneven maturing of panicles. Threshing and processing of products are also made by hand with small farming instruments such as winnower, etc.

The food crops other than paddy rice such as maize, cassava, sweet poteto, beans, groundnut, etc. are also grown in small areas and are mostly for home consumption. In the paddy field, no diversified crops (so-called polowijo) are introduced at present, even if there are time enough for their cultivation and sufficient soil moisture during the dry season.

As for the industrial crops, rubber and coconut are dominant in this area. However, their share in the rural economy is not so significant. Recently, clove plantations have been developed in the hilly area (sub-area F), but most of them are limited to small area. Coffee and pepper are also grown in house yard mainly for home consumption.

3.5.4 Crop Yield and Production

Table 3-15 shows the cultivated area and production of paddy rice, the main crop in the project area, in Kabupaten Banjar for recent ten years from 1968 to 1977. From this table, the average unit yield of stalk paddy is estimated at 2.3 tons per hectare for paddy rice and at 1.5 tons per hectare for upland rice, respectively. This average unit yield is still lower than the average unit yield of 3.1 tons per hectare in the whole Indonesia.

Total annual production of stalk paddy was between 91,000 tons and 127,000 tons, and upland rice was between 4,000 tons and 12,000 tons.

3.5.5 Marketing and Processing Facilities

Farm Inputs

Market flow of farm inputs in the South Kalimantan Province is illustrated in Fig. 3-6. The capacity of the existing storages for the marketing of farm inputs in the Province is as follows:

	Location	Capacity (ton)
(1)	Banjarmasin	2,000
(2)	Kandangan	100
(3)	Barabai	500
(4)	Banjar (in the project area)	5,500 (under planning)

The farmers under the BIMAS Program can purchase necessary farm inputs such as fertilizers, chemicals, etc. through BUUD/KUD. The farmers other than the BIMAS farmer have to buy such farm inputs from private companies. The prices of farm inputs for the BIMAS farmer are subsidized by the Government. In the Province, the farm inputs used for one crop of paddy cultivation under the BIMAS Program were about 30 tons of Urea, 60 tons of T.S.P. and 600 liters of insecticides.

Marketing of Rice

The share of rice production occupies more than 90 % of total agricultural production in the project area. Fig. 3-7 shows the present market flow of rice. The farmer can sell his paddy to BUUD/KUD or middleman or both as he likes. The share of marketing of paddy by BUUD/KUD is very limited mainly due to the shortage of BUUD/KUD offices in the project area.

DOLOG (Depot Logistik) purchases paddy from BUUD/KUD for stabilizing the price of rice at a floor price and sell it when the market price goes up above the ceiling price. However, the operations of DOLOG are still limited to the supply to the military and government employees due to inadequate organization, insufficient staffing and storing capacity. Most of paddy and rice are handled by middlemen and private companies. This means that the farmers often sell their farm products at unreasonable prices. It is estimated from the present paddy production and rice consumption in Kabupaten Banjar that about 36,000 tons of rice are marketed through DOLOG, private companies and middlemen in Banjarmasin and other major cities in the project area.

Processing Facilities

The main processing facility for farm products in the project area is rice mill. The number and the capacity of the existing rice mills in Kabupaten Banjar are given in Table 3-16. Small scale rice mills with a milling capacity of 1 to 2 tons per hour occupy about 66 % of total mills in number. Total milling capacity in the project area is estimated at about 145 tons per hour. The present facilities for processing paddy are insufficient in both number and capacity.

3.5.6 Farm Economy

Although more detailed survey of farm economy is going to be carried out for the feasibility study, very preliminary survey was made through interview with some farmers to obtain some data and information on the present conditions of the farm economy. Table 3-17 shows the result of this survey for a typical owner-farmer with a land holding of about one hectare.

As shown in this table, annual gross income and outgo are estimated at Rp. 229,300 and Rp. 227,400, respectively. The balance or capacity to pay is Rp. 1,900 or US$ 4.6. About 70 % of the gross income come from the farm products, of which income from paddy rice cultivation occupies about 99 %. It is assumed from these figures that most of the farmers in the project area are depending on the monoculture of paddy rice using the local varieties. It is noted, in addition, that most of the farmers do not raise large animals such as cattle and buffalo that are useful for farming.

Table 3-10 **Number and Area of Farms by Size of Holding in South Kalimantan Province**

Size of Holding	No.of farm	%	Area (ha)	%
0.10	3,280	1.3	192	-
0.10 - 0.20	21,456	8.3	3,475	1.3
0.20 - 0.30	24,690	9.6	6,376	2.4
0.30 - 0.40	28,138	10.9	9,496	3.5
0.40 - 0.50	23,142	9.0	10,348	3.8
0.50 - 0.60	22,968	8.9	12,810	4.8
0.60 - 0.75	26,394	10.2	17,698	6.6
0.75 - 1.00	28,525	11.1	24,719	9.2
1.00 - 2.00	52,052	20.2	71,145	26.4
2.00 - 3.00	16,004	6.2	38,167	14.2
3.00 - 4.00	4,633	1.8	15,698	5.8
4.00 - 5.00	2,119	0.8	9,187	3.4
More than 5.00	4,423	1.7	50,232	18.6
Total	257,824	100.0	269,540	100.0
Average			1.04	

Data Source : Agriculture census in 1973 Central Bureau of Statistics, Jakarta.

Table 3-11 **Number and Area of Farms by Size of Holding in Kecamatan Kertak hanyar**

Size of Holding	No. of farm	%	Area (ha)	%
<0.10	0	0	0	0
0.1 - 0.20	17	1.9	2.9	0.3
0.20- 0.30	89	10.0	25.0	3.0
0.30- 0.40	22	2.5	8.2	1.0
0.40- 0.50	98	11.0	43.2	5.1
0.50- 0.60	135	15.1	77.6	9.2
0.60- 0.75	89	10.0	67.1	7.9
0.75- 1.00	159	17.8	127.2	15.0
1.00- 2.00	221	24.7	307.5	36.3
2.00- 3.00	44	4.9	110.6	13.1
3.00- 4.00	12	1.3	41.8	4.9
4.00- 5.00	5	0.8	23.3	2.7
More than 5.00	2	-	13.0	1.5
Total	893	100.0	847.4	100.0
Average			0.95	

Data Source : Kecamatan Kertak hanyar office, 1977.

Table 3-12 **Present Land Use in the Project Area**

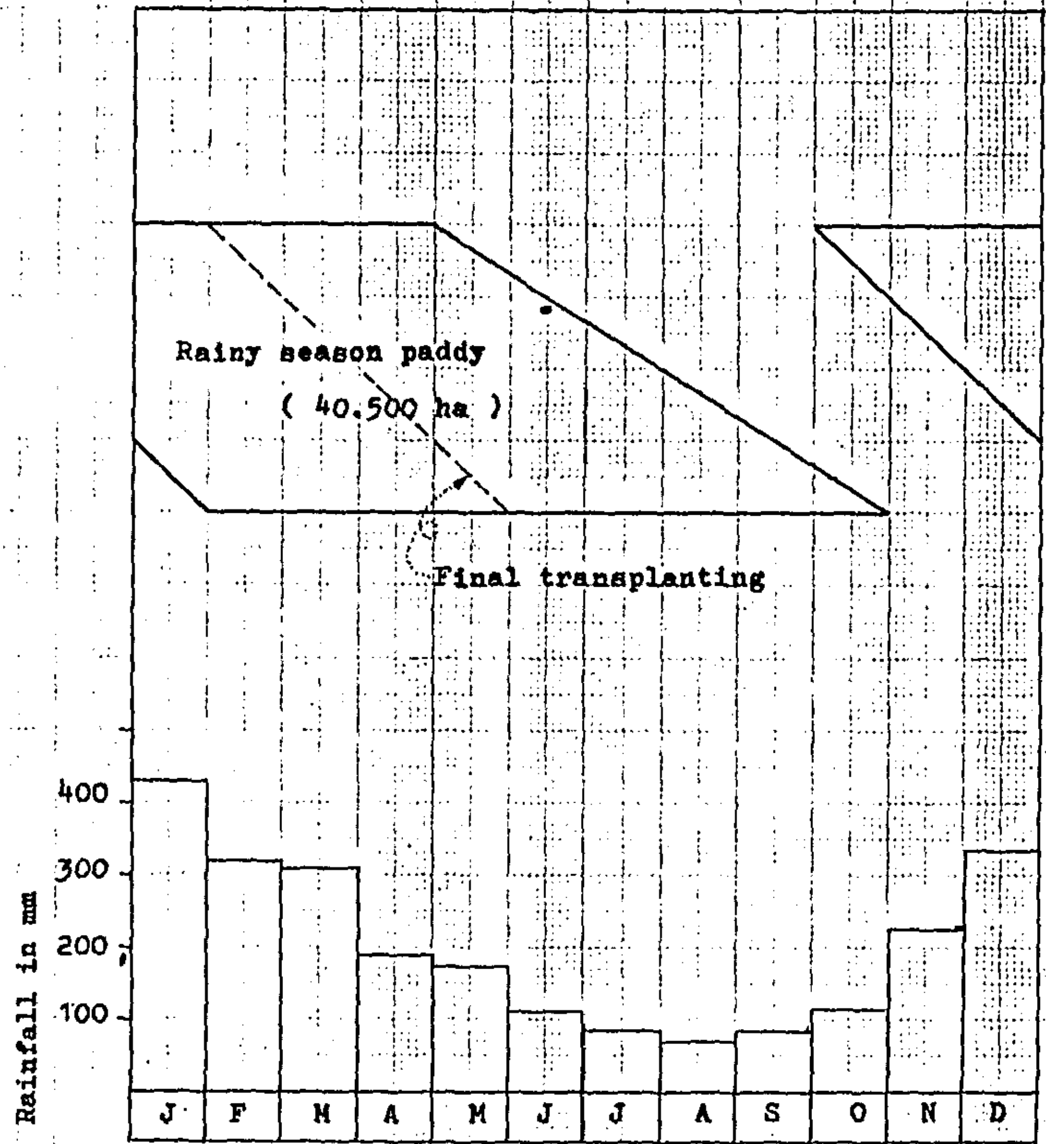
Description	Area (ha)
1. Agricultural Land	
Paddy	40,500
Plantation /1	4,800
2. Non-Agricultural Land	
Alang alang area /2	9,800
Shrub	4,200
Bush	6,400
Swamp forest	18,900
Swamp grass area	800
Others /3	7,400
3. Total	92,800

/1: This includes rubber and coconut plantations.

/2: The alang alang area includes the small scale clove plantations being under development and upland crop field for cassava, maize, etc. mainly for home consumption.

/3: Others primarily defined as infrastructural land including village yard, roads, channels, rivers, etc.

Fig. 3-5 **Present Cropping Pattern of Paddy**



Note: 1) In the sub-areas A and B, the dry season paddy is grown in small area.

2) Rainfall shown in this table is the average value for 10 years at Banjarmasin station.

Table 3-13 List of the Main Varieties in the Project Area

Variety	Growing duration (days)	Plant height (cm)
Lemo	255	155
Bayar putih	287	195
Bayar kuning	265	175
Bayar raden rata	255	150
Bayar raden jawa	265	160
Siam ganal	270	165
Siam panangah	270	160
Siam serai	270	150
Kencana	235	155
Randah padang	230	150
Pandak	240	150
Karang dukuh	245	150
Simon	235	165
Pelita I/1	135~145	130
C_4- 63	125~130	125

Data source : Agricultural Extension Services,
Kabupaten Banjar.

Table 3-14 Farm Input Requirements per Hectare for Present Paddy Cultivation

Item	Requirements
1. **Labor**	
Preparation of seedlings	8 man-day
Field preparation	35 man-day
Transplanting	35 man-day
Weeding	20 man-day
Harvesting	35 man-day
Threshing, drying & transportation	15 man-day
T o t a l	148 man-day
2. **Seeds, Fertilizers & Chemicals**	
Seeds	10 kg
Fertilizers	-
Insecticides	-
Fungicide	-
Rodenticide	-
3. **Miscellaneous**	
Bags, mats, tools, etc.	About 10 % of total production cost.

Table 3-15 **Planted Area, Damaged Area, Harvested Area and Production of Paddy in Kabupaten Banjar**

Description		1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
		Year									
1. Lowland Paddy											
Planted area	(ha)	41,700	42,400	41,900	43,300	43,700	49,000	50,100	50,300	51,700	50,200
Damaged area	(ha)	700	900	2,600	2,500	5,000	3,400	800	300	3,800	700
Harvested area	(ha)	41,000	41,500	39,300	40,800	38,700	45,600	49,300	50,000	47,800	49,500
Production	(ton)	67,500	102,400	124,100	77,000	97,000	91,300	126,500	121,500	108,300	108,800
Unit yield	(ton/ha)	1.6	2.5	3.2	1.9	2.5	2.0	2.6	2.4	2.3	2.2
2. Upland Paddy											
Planted area	(ha)	7,800	8,900	8,700	8,100	5,300	6,900	3,600	2,500	3,400	3,800
Damaged area	(ha)	400	900	700	300	400	200	100	100	100	100
Harvested area	(ha)	7,400	8,000	8,000	7,800	4,900	6,700	3,500	2,400	3,300	3,700
Production	(ton)	10,400	12,000	8,700	10,900	7,300	9,600	4,700	4,000	5,800	6,200
Unit yield	(ton/ha)	1.4	1.5	1.1	1.4	1.5	1.4	1.3	1.7	1.8	1.7
3. Total											
Planted area	(ha)	49,500	51,300	50,600	51,400	49,000	55,900	53,700	52,800	55,100	54,000
Damaged area	(ha)	1,100	1,800	3,300	2,800	5,400	3,600	900	400	3,900	800
Harvested area	(ha)	48,400	49,500	47,300	48,600	43,600	52,300	52,800	52,400	51,100	53,200
Production	(ton)	77,900	114,400	132,800	87,900	104,300	100,900	131,200	125,500	114,100	115,000
Unit yield	(ton/ha)	1.6	2.3	2.8	1.8	2.4	1.9	2.5	2.4	2.2	2.2

Data source: Monografi Daerah 1976, Dinas Pertanian Rakyat South Kalimant. 1977 and Laporan Tahunan 1973, Dinas Pertanian Rakyat Kabupaten Banjar.

Fig. 3-6 **Marketing Flow of Farm Inputs in South Kalimantan**

Location	Organization	Price: Seed (Rp/Kg)	Fertilizers (Rp/Kg): Urea	T.S.P	D.A.P	Kcl	Chemicals (Rp/L): Diazinen	Sumithion	Sevin
Jakarta	Center of P.T. Tawison ↓		70	70	90	70	900	900	900
Province (Banjarmasin)	Branch of P.T. Tawison ↓ (also → INMAS farmers, → Other farmers)		70	70	90	70	900	900	900
Kabupaten/ Kecamatan	BUUD/KUD ↓	150	70	70	90	70	900	900	900
Desa	BIMAS farmers, INMAS farmers, Other farmers	150	70	70	90	70	900	900	900

∠1 : Farmers can get seeds from Balai Benih Seed center in Kecamatan Sungai Tabuk, Kabupaten Banjar.

Data Source: P.T. Tawison in Banjarmasin.

Fig. 3-7 Market Flow of Rice

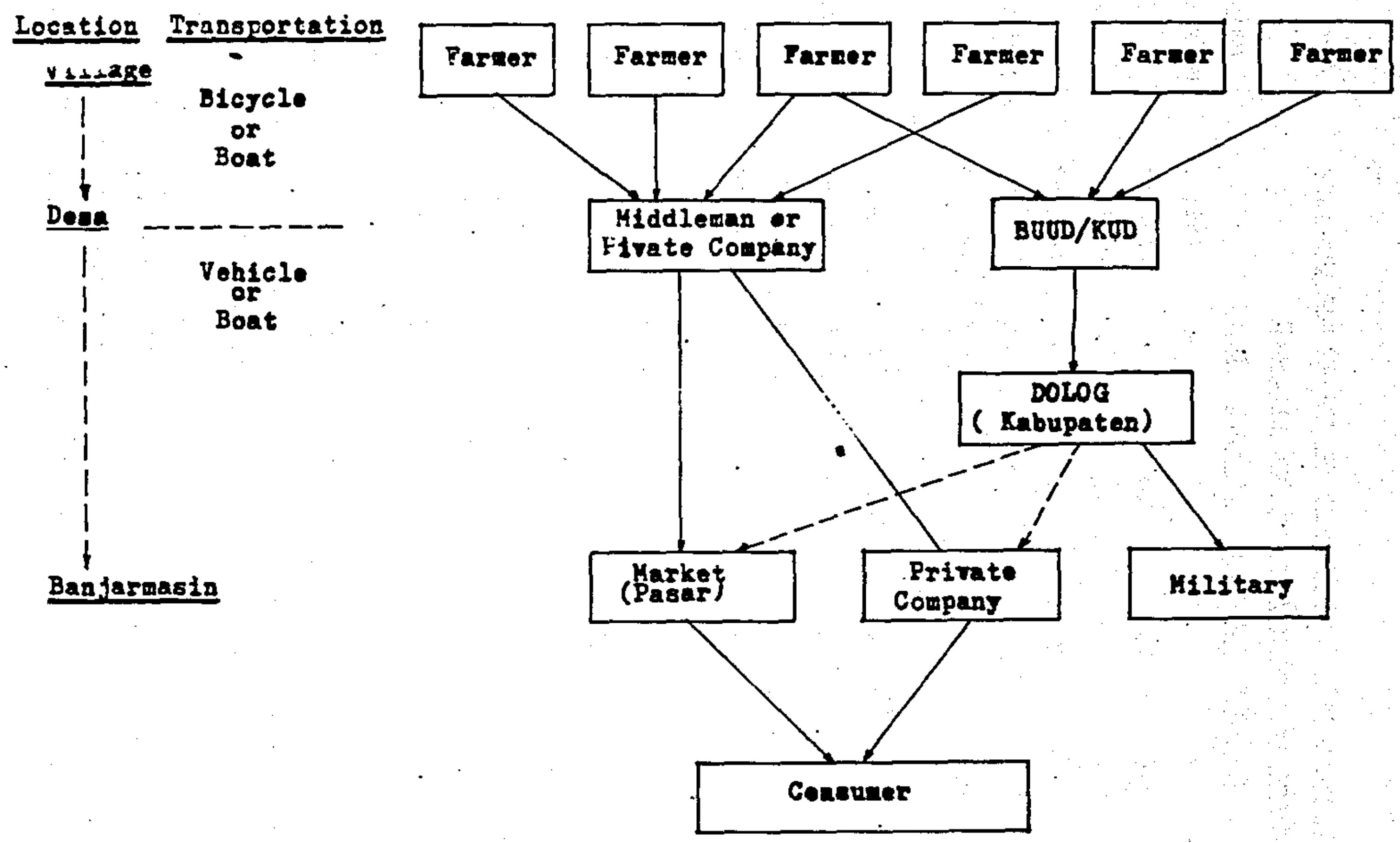


Table 3-16 Capacity and Number of Rice Mills in Kabupaten Banjar

Kecamatan		Capacity and Number (capacity: ton/hr)					
		≤1.0	1.0~2.0	2.0~3.0	3.0~4.0	4.0≤	Total
Sungai Tabuk	Number	-	4	2	1	-	7
	Capacity	-	6.3	4.5	3.5	-	14.3
Gambut	Number	-	15	2	-	-	17
	Capacity	-	23.7	5.0	-	-	28.7
Kertak Hanyar	Number	2	14	4	1	-	21
	Capacity	1.4	28.1	9.6	3.5	-	42.6
Alun Alun besar	Number	2	1	-	-	-	3
	Capacity	0.7	1.05	-	-	-	1.75
Martapura	Number	2	12	2	2	1	19
	Capacity	1.4	14.9	4.6	8	8	36.9
Banjar Baru	Number	-	1	-	-	-	1
	Capacity	-	1.03	-	-	-	1.03
Astambul	Number	8	9	2	-	-	19
	Capacity	4.45	9.1	4.2	-	-	17.75
Karang Intan	Number	-	2	-	-	-	2
	Capacity	-	2.8	-	-	-	2.8
Sub-total	Number	14	58	12	4	1	89
	Capacity	7.95	86.98	27.9	15.0	8	145.83
Kab. Banjar	Number	14	60	12	4	1	91
	Capacity	7.95	90.73	27.9	15.0	8	149.58

Note : 1) The capacity shown in this table is the input capacity.

2) Besides, 95 rice mills exist in Kabupateh Banjar for which no data on milling capacity are available.

3) Number of rice mills in this table includes the mills owned by private companies.

Data Source:Monografi Pertanian Kabupaten Banjar, 1976.

Table 3-17 **Present Annual Budget on Typical Owner-Farmer (Tentative)**

Farm size : 1 ha

Family size : 5 persons

Description	Amount (Rp.)
1. Gross Income	
Farm income	
Paddy	145,250
Upland crops	1,400
Livestock income (poultry)*	19,000
Miscellaneous	63,650
Total	229,300
2. Outgo	
Farming expenses	
Seeds	1,500
Miscellaneous	150
Livestock expenses	1,900
IPEDA tax	2,000
Interests, etc.	500
Family living expenses	221,350
Total	227,400
3. Balance or Capacity to Pay	Rp.1,900 or US$ 4.6

3.6 AGRICULTURAL SUPPORT SERVICES

3.6.1 Agricultural Extension Services

In connection with the re-organization of the Central Government carried out in August, 1974, the organization for agricultural extension services in Indonesia has been much improved through establishment of an Agency for agricultural education, training and extension in the Ministry of Agriculture. At the same time, the Agricultural Development Center (ADC) has been established at the provincial level. The main functions of the ADC are as follows:

(1) Extension of new and improved farming techniques derived from the research works,

(2) Preparation and determination of the main activities necessary for extension services,

(3) Training of the representative farmers (key farmers), and

(4) Preparation of programs including necessary texts for the training.

In 1975, the Rural Extension Center (REC) was opened, and the main activities of this center are summarized below.

(1) Preparation of programs for extension services for the farmers,

(2) Public relations necessary for extension services,

(3) Services for improvement of farm management,

(4) Guidance for optimum use of farm inputs, and

(5) Guidance for optimum farm mechanization.

The organization for agricultural extension services in the South Kalimantan Province is shown in Fig. 3-8, and Table 3-18 shows the present situation on the REC, extension workers and equipment for the services. The area and the farm family served by each center range widely from area to area; as for the area between 10,000 and 30,000 hectares, and as to the farm family between 2,000 and 4,000 families. As seen in Table 3-18, motorcycle is the main equipment for smooth activities by the center, but visual aid equipment are still not sufficient.

The present situation on the REC, extension workers and equipment in Kabupaten Banjar is given in Table 3-19.

As seen in this table, Kabupaten Banjar is served by four extension centers. The centers have PPM (Extension supervisor) and PPL (Field extesnion worker). There is a wide range of staffing among the centers.

The organization of the Aluh-Aluh rural extension center is shown in Fig. 3-9 as an example. Under this organization, a PPL is giving necessary guidance to 16 key farmers in each village in his service area, and a key farmer transfers new and improved farming techniques which he has learned to a group consisting of 16 to 20 farmers. This is a common flow in extension services. In addition, each key farmer operates a demonstration farm covering some hectares in his village for effective transfer of technical knowledge to his member farmers.

In addition to the guidance to 16 key farmers as the main work, PPL is serving for the control of pests and diseases, guidance to the farmers under BIMAS/INMAS Programs, meeting and discussions with the agencies and personnel concerned, and so on. Under these conditions, it would be difficult to expect higher efficiency in his extension services unless further improvement of the present staffing and equipment has been made. Particularly, such an improvement in the project area is essential for successful implementation of the Project.

3.6.2 Research Works

The agricultural research works in the South Kalimantan Province are conducted by the Branch of the Central Research Institute Bogor in Banjarmasin and seven sub-stations of the Branch located in seven Kabupaten, as illustrated in Fig. 3-10.

The Branch consists of six departments including general affairs, and the main activities are as follows:

(1) Plant breeding tests,

(2) Fertilizer tests for both local and high-yielding varieties,

(3) Tests for control of pests and diseases,

(4) Experiments on plant physiology, and

(5) Socio-economic survey.

Those main activities are mostly concentrated on paddy rice.

The main research works being carried out at the seven sub-stations are the application tests of local varieties suitable for each Kabupaten area, and some field tests for introduction of polowijo such as variety test, fertilizer tests, etc. are also conducted.

In the project area, there is an experimental farm at Handil Manarap in the sub-area C. In this farm, indirect tidal swampy paddy rice is mainly tested in about 20 hectares of paddy field. Some high-yielding varieties such as IR-26, IR-28 and IR-36 are also tested at small experimental plots.

This experimental farm is equipped with an office, a storage and paddy drying yard (concrete pavement) and has a simple meteorological station. This farm has a plan to expand his research activities in the test fields of seed breeding, fertilizer response, weed control, etc. However, the progress on these testing works is still very low, because the staffing, buildings and testing equipment and apparatus are still not sufficient. As this farm is located approximately in the center of the project area, which would be favourable for extension of improved irrigation farming over the project area, it may be necessary to study on the possibility of expanding and strengthening this farm as the pilot demonstration farm under the Project.

3.6.3 Seed Multiplication and Supply

The present organization for seed multiplication and distribution in the South Kalimantan Province is illustrated in Fig. 3-11.

Foundation seeds are supplied from LP_3 (Central Research Institute, Bogor) to the Balai Benih seed center through the agricultural extension service sections in the Province and Kabupaten Banjar. After multiplication at the center, the seeds are distributed to the farmer in response to his request through BUUD/KUD. In this province, however, the services in this field is very limited. Further efforts are strongly required for distributing the improved seeds smoothly and in as wide area as possible, because the activities of BUUD/KUD in this field are not managed properly.

In the project area, there is a seed center located at Sei Tabuk in Kecamatan Sungai Tabuk, the northern part of the project area. It covers about 10 hectares of paddy field, of which about 2 hectares are actually used for seed multiplication. The seeds of IR-26, IR-28, IR-36 and B4-62C are multiplicated. The supply capacity of this seed center in the future is estimated at about 5,000 kg for about 200 hectares, which is very far from the seed requirements to be anticipated after completion of the Project. Therefore, the increase of seed center with proper stationing of the centers over the project area should be studied.

In addition, consideration will have to be given to utilization of the existing demonstration farms being operated by the key farmers (9 farms with total area of about 40 ha in Kabupaten Banjar) for the purpose of seed multiplication particularly in the beiginning of the project operation.

3.6.4 Agricultural Cooperatives and Credits

Agricultural Cooperatives

The existing agricultural cooperatives in Kabupaten Banjar is shown in Table 3-20. As seen in this table, the number of the cooperatives already established is quite insufficient as compared with that of the villages.

For profitable farm management, BUUD/KUD plays an important role in supplying necessary farm inputs, buying farm products from the farmers and providing farm credits. Much effort by the Government is required for further increase of BUUD/KUD unit.

KIOS is supplying farm inputs and small farming equipment, and buying farm products from the farmers under the control of BUUD/KUD.

BRI is managing credit business, including repayment, for the farmers in accordance with BIMAS Program.

RMU is managing rice mill units as the sub-ordinance office of BUUD/KUD.

The present activities of these cooperatives are still not sufficient mainly because of the shortage of well-trained managing staff and budget.

Agricultural Credits

BIMAS Package Program in the South Kalimantan Province is summarized in Table 3-21. The unit amount of the credit for the Program in the 1976/77 fiscal year was about Rp.26,000/ha for paddy and Rp.38,000/ha for polowijo (mostly for beans). When local varieties of paddy rice are planted under the BIMAS Program (called as BIMAS Biasa), fertilizers are mostly not used.

The past records on the area served by the BIMAS and INMAS Programs in both the Province and Kabupaten Banjar are given in Tables 3-22 and 3-23. The total area served by the Programs was about 44,000 hectares in the whole Province and about 3,400 hectares in Kabupaten Banjar in the 1977/78 fiscal year, respectively. The area under the Programs in Kabupaten Banjar in which most part of the project area is included is only 8 % of total paddy area. The construction of technical irrigation system is the basis for introduction of the BIMAS Program.

Tables 3-24 and 3-25 show the records on total amount of credit given for the farmers and its repayment in both the Province and Kabupaten Banjar. The unit amount averages about Rp. 20,200/ha. As seen in these tables, recovery rate of the credit was very low, ranging between 30 % and 10 %.

Fig. 3-8 Organization for Agricultural Extension Service In South Kalimantan Province

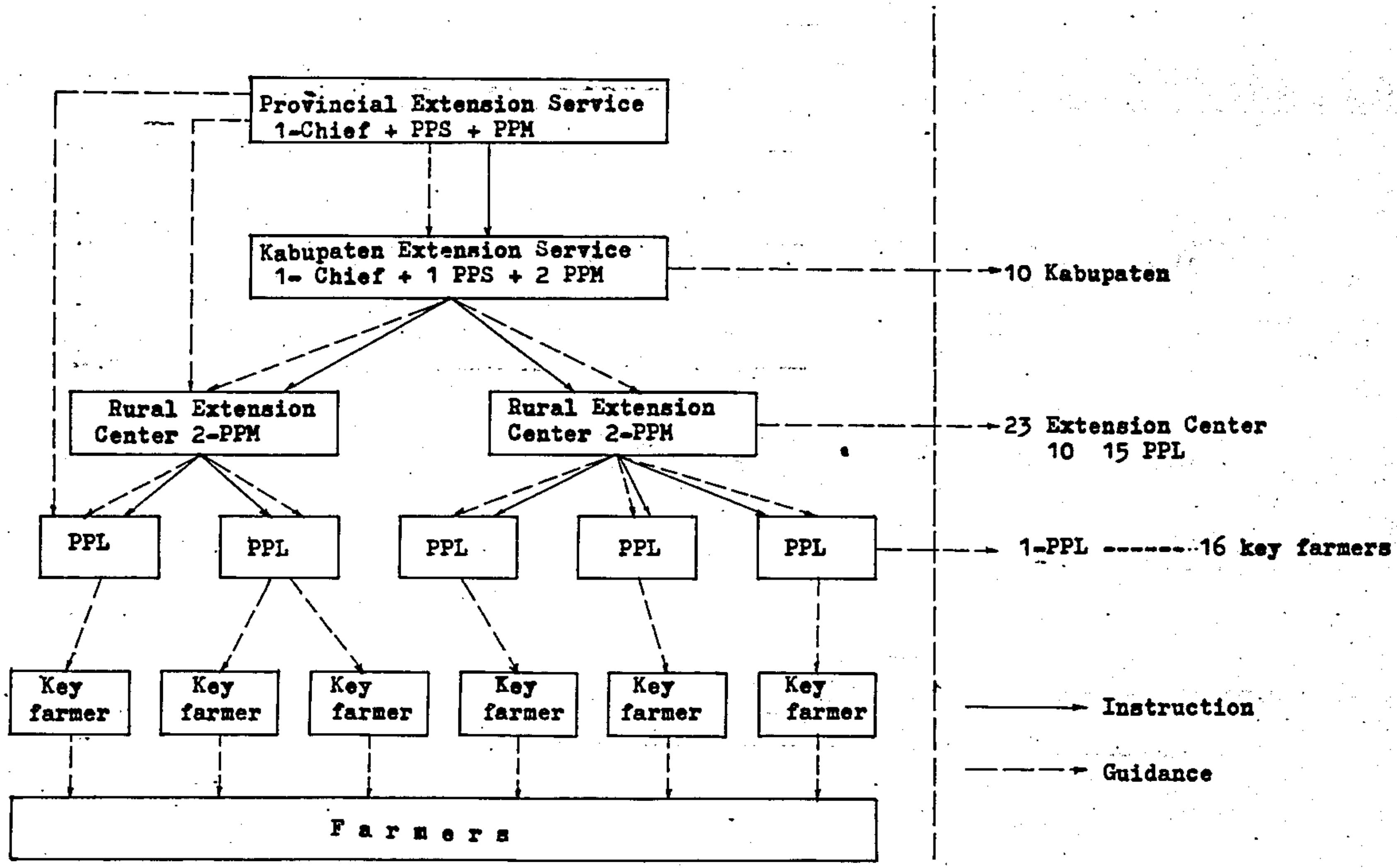


Table 3-18

Present Staffing and Equipment for Extension Services in South Kalimantan

Kabupaten	No. of Extension center	No. of PPS	No.of PPM	No. of PPL	Equipment for Extension activities Auto/Jeep	Motor-cycle	Slide Projector	Film Projector
Banjarbaru (Province)	-	5	8	-	8	8	2	2
Tabalong	2	-	7	21	2	14	- -	- -
Hulu Sungai Utara	3	1	9	26	2	18	- -	- -
Hulu Sungai Tengah	3	1	9	21	2	18	-	- -
Hulu Sungai Selatan	3	-	9	23	2	16	-	-
Tapin	2	1	9	18	2	15	- -	- -
Banjar	4	-	8	27	2	21	- -	- -
Tanah Laut	2	1	6	24	2	15	-	-
Barito Kuala	2	1	7	18	-	4	-	- -
Kota Baru	2	1	5	6	2	11	- -	- -
Banjarmasin	-	-	-	3	-	1	- -	- -
Total	23	11	77	187	24	141	- -	- -

Data source: Agricultural Department in South Kalimantan

Table 3-19 **Present Staffing and Equipment of Rural Extension Centers (REC) in Kabupaten Banjar**

REC	Kecamatan	Staffing: PPS	Staffing: PPM	Staffing: PPL	Equipment: Jeep	Equipment: Motor-cycle	Service area per PPL (ha)	No. of farmer per PPL (person)
Gambut	Gambut			6			988	528
	Kertak hanyar			3			2,267	1,166
	Sungai Tabuk			3			2,752	1,570
	Banjarbaru			2			2,245	7,327
	Kota Madya Banjarmasin /1			1			-	-
	Sub-total		2	15		5	2,063	2,648
Astambul	Astambul			5			1,042	632
	Karang Intan			2			7,034	2,129
	Martapura			1			13,949	9,393
	Sub-total		2	8		6	7,341	4,051
Simpang empat	Pengaron /1			1			-	-
	Simpang empat /1			1			-	-
	Sungai Kinang /1			-			-	-
	Sub-total		2	2		5	-	-
Aluh Aluh	Aluh Aluh besar		2	2		3	2,390	857
	Total	1	8	27	-	19	3,931	2,512

/1 : Located outside the project area.

Note: PPS (Subject matter specialist)
PPM (Extension supervisor)
PPL (Field extension worker)

Fig. 3-9 **Organization for Aluh Aluh Rural Extension Center**

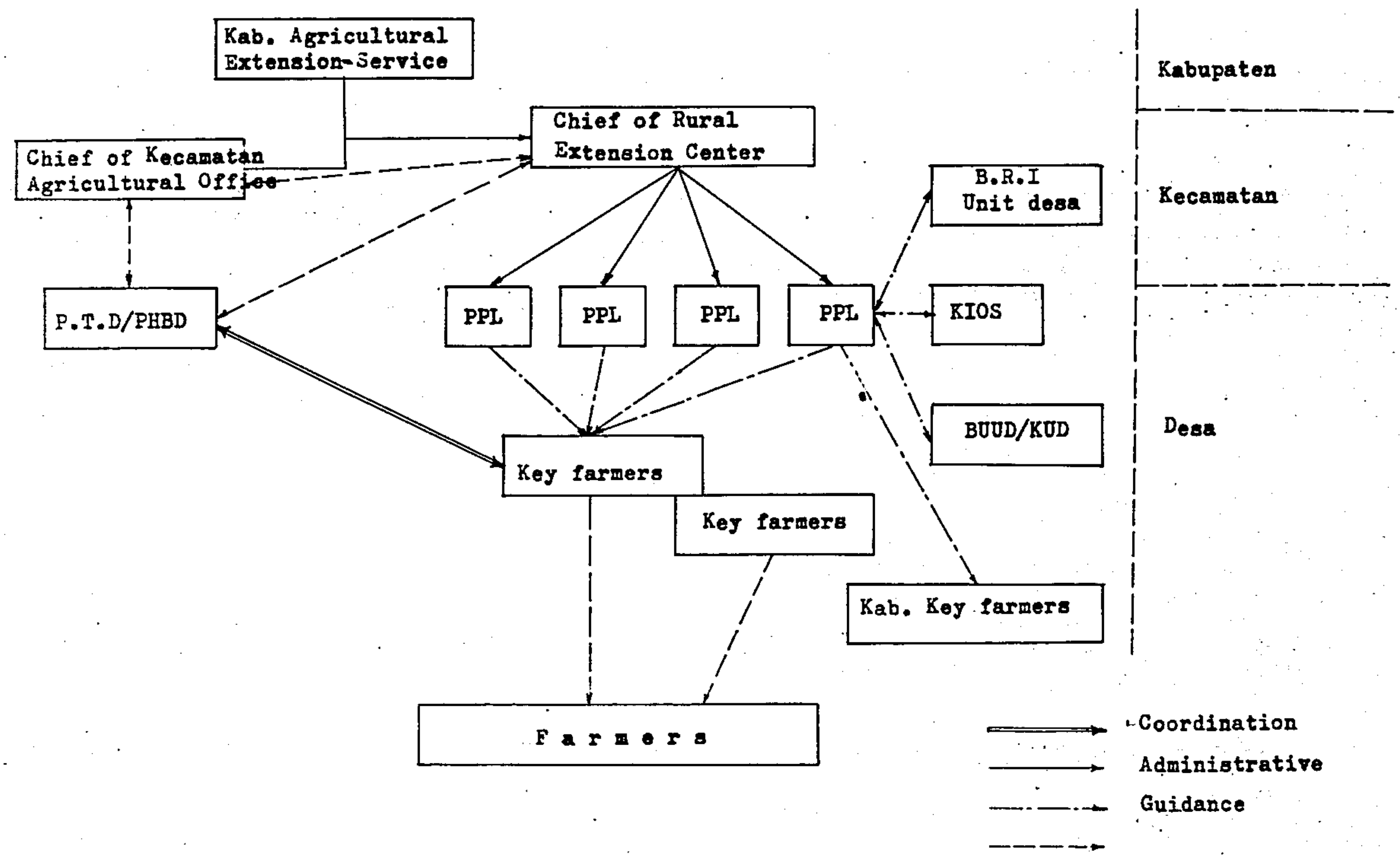
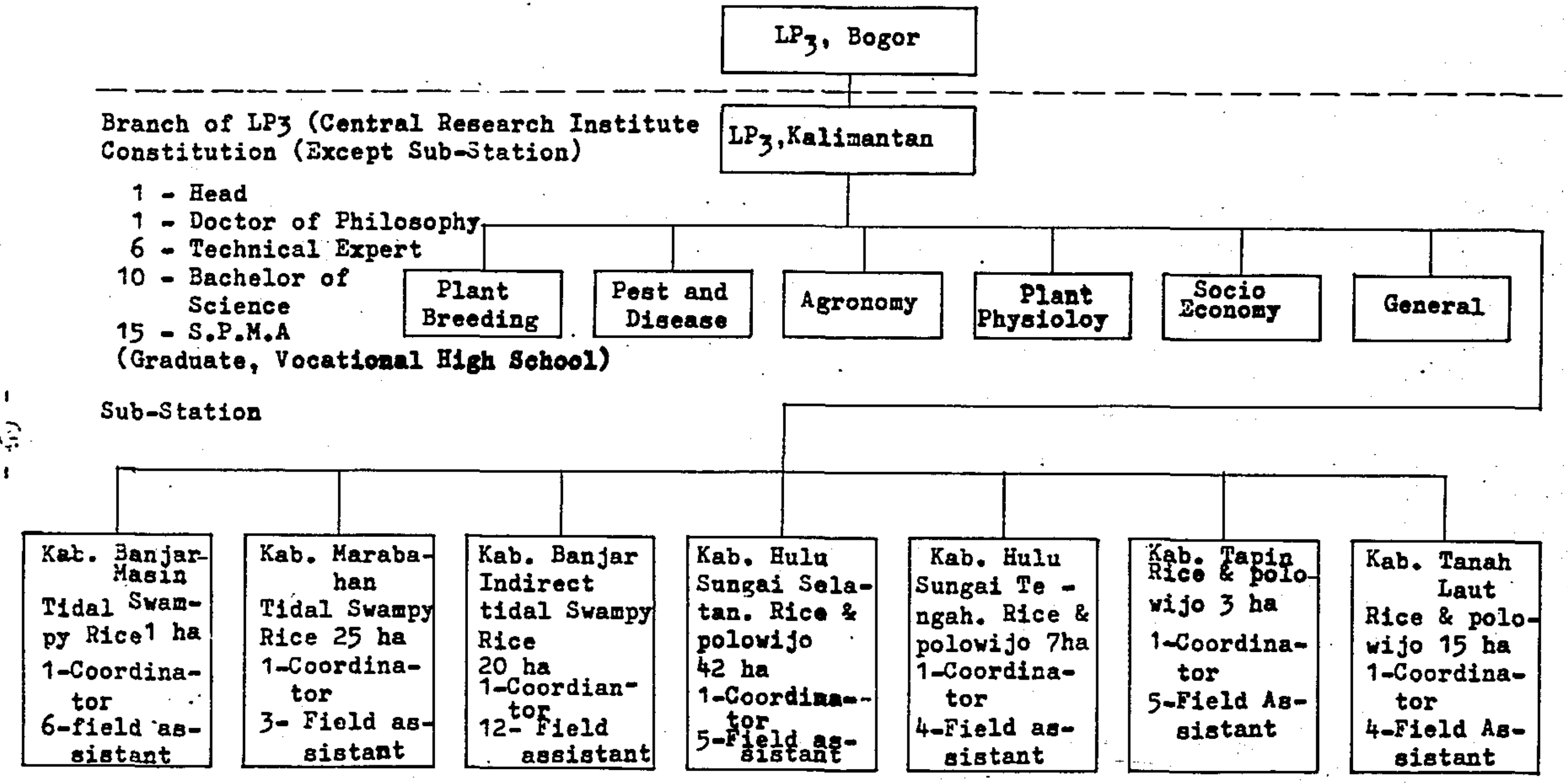


Fig. 3-10 Organization of Central Research Institute for Agriculture, Kalimantan



Note: Object crops; Rice, Maize, Sorgham, pulses (Ground nuts, Soybean)
Mang bean, Cowpea)
Tuber crops (Cassava, Sweet potato, etc.)

Fig. 3-11 **Organization of Seed Multiplication and Distribution**

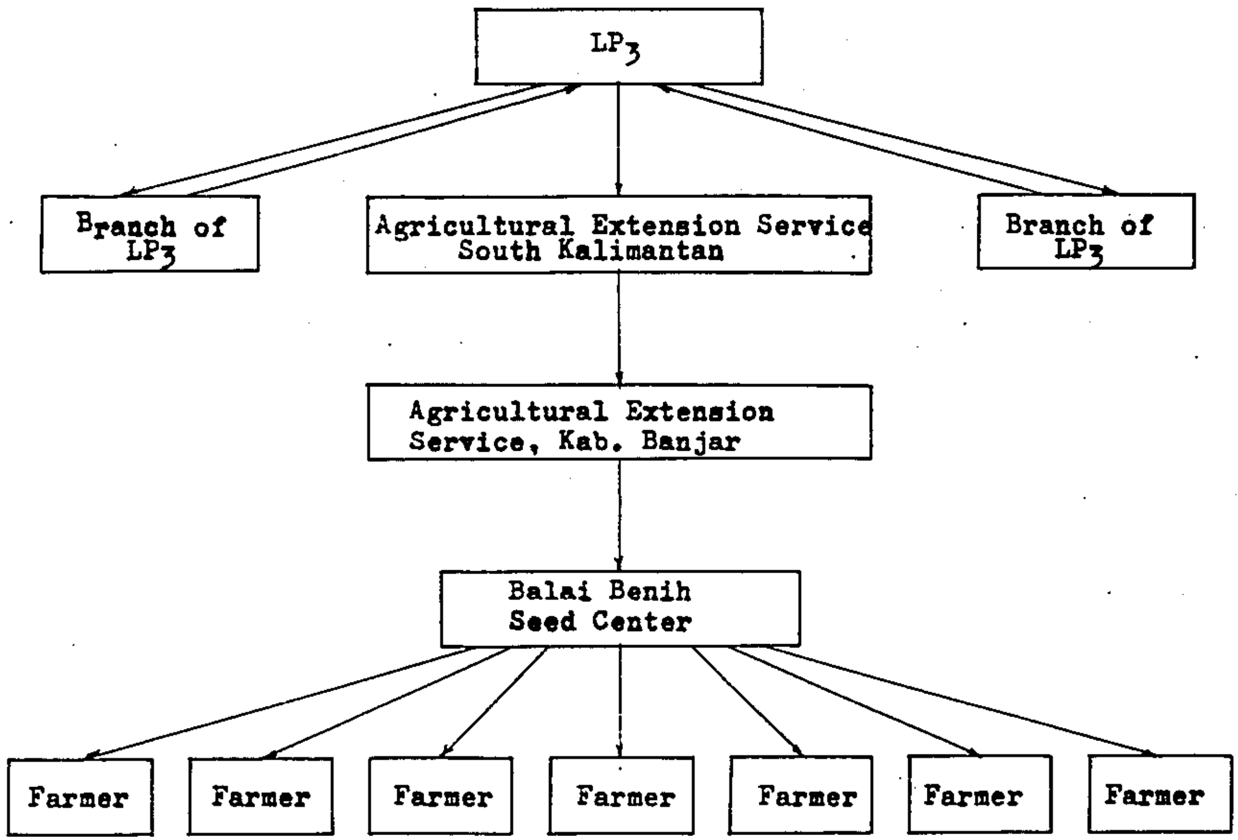


Table 3-20 Number of Cooperatives in Kabupaten Banjar

Kecamatan	Desa	BUUD/KUD	KIOS	B.R.I./1 (Unit Desa)	R.M.U./2
Sungai Tabuk	14	4	4	11	1
Gambut	9	3	3	3	2
Kertak hanyar	12	5	5	1	1
Aluh Aluh Besar	16	3	3	3	1
Martapura	27	-	-	1	-
Banjarbaru	12	1	1	1	-
Astambul	24	2	2	3	-
Karang Intan	26	1	-	-	-
Sub-total	140	19	18	23	5
Whole Kabupaten Banjar	177	21	20	24	5

/1 : Bank Rakyat Indonesia

/2 : Rice mill unit in Kecamatan involved in the Project

Data source : Agricultural office in Kabupaten Banjar

Table 5-21 Unit Amount for BIMAS Package Program in 1976/77

BIMAS Paddy		Quantity	Amount (Rp.)
1.	Urea	105 kg	7,350
2.	T.S.P.	70 kg	4,900
3.	Insecticides	3 liters	2,700
4.	Zink phosphide	200 g	460
5.	Sprayer		2,000
6.	Seeds		3,750
7.			5,000
	Total		26,160/ha

BIMAS Polowijo (Peanuts)		Quantity	Amount (Rp.)
1.	Urea	50 kg	3,500
2.	T.S.P.	100 kg	7,000
3.	Insecticides	1 liter	900
4.	Seed	120 kg	24,000
5.	Sprayer		1,000
6.			2,000
	Total		38,400/ha

Data source: Laporan Tahunan 1977/78, Propinsi Dati, Kalimantan Selatan

Table 3-22 Area under BIMAS and INMAS Programs in South Kalimantan

Cropping season	BIMAS		INMAS		Total	
	Target (ha)	Actual progress (ha)	Target (ha)	Actual progress (ha)	Target (ha)	Actual progress (ha)
1973	2,200	203	8,250	4,304	10,450	4,507
1973/74	30,000	19,643	55,000	14,638	85,000	34,281
1974	5,000	293	6,000	907	11,000	1,200
1974/75	30,000	9,991	43,000	40,200	73,000	50,191
1975	5,000	5,056	7,500	10,357	12,500	15,413
1975/76	35,000	8,244	50,000	29,725	85,000	37,969
1976	5,000	4,584	8,000	21,000	13,000	25,584
1976/77	20,150	12,187	114,500	35,836	140,400	42,641
1977	5,000	4,193	22,500	11,475	27,500	15,668
1977/78	16,640	5,778	34,900	38,671	51,540	44,449
1978*	5,000	3,520	20,000	12,155	25,000	15,675

* shows the progress as of August in 1978.
Data source: 1) Year books for 1973, 1974, 1975, 1976 and 1977
2) Data from Department of Agriculture in South Kalimantan Province.

Table 3-23 Area under BIMAS and INMAS Programs in Kabupaten Banjar

Cropping season	BIMAS		INMAS		Total	
	Target (ha)	Actual progress (ha)	Target (ha)	Actual progress (ha)	Target (ha)	Actual progress (ha)
1974/75	2,500	753	2,500	500	5,000	1,253
1975	*	*	500	240	500	240
1975/76	2,500	318	2,500	1,000	5,000	1,318
1976	400	550	250	2,000	650	2,550
1976/77	3,350	2,653	4,600	5,250	7,950	7,903
1977	500	425	1,000	2,800	1,500	3,225
1977/78	2,640	1,684	10,600	1,729	13,240	3,413
1978**	500	255	1,750	70	2,250	325

* : No data are available.
** shows the progress as of August in 1978.
Data source: 1) Year books for 1975, 1976 and 1977.
2) Data from Department of Agriculture in South Kalimantan Province.

Table 3-24 Credit and Repayment of BIMAS Program in South Kalimantan

Cropping season	Credit (Rp. 1,000)	Repayment (Rp. 1,000)	Repayment percentage (%)	Outstanding (Rp. 1,000)
1973	12,002	4,534	37.8	7,468
1973/74	411,407	75,942	18.5	335,465
1974	*	*	-	-
1974/75	192,493	22,799	11.8	169,694
1975	77,263	*	-	-
1975/76	211,052	15,634	7.4	195,418
1976	59,181	19,217	32.5	39,964
1976/77	240,613	27,966	11.6	212,647
1977	62,742	6,930	11.0	55,812
1977/78	170,974	11,202	6.6	159,772
1978	82,267	4,053	4.9	78,214

* : Data are not available.
Data source: 1) Year books
2) Data from the Department of Agriculture in South Kalimantan Province.

Table 3-25 Credit and Repayment of BIMAS Program in Kabupaten Banjar

Cropping season	Credit (Rp. 1,000)	Repayment (Rp. 1,000)	Repayment percentage (%)	Outstanding (Rp. 1,000)
1974/75	13,017	1,252	9.6	11,765
1975	*	*	-	-
1975/76	8,123	616	7.6	7,512
1976	6,916	2,185	31.6	4,731
1976/77,	45,770	4,531	9.9	41,239
1977	5,678	274	4.8	5,404
1977/78	36,891	56	0.2	36,835
1978	5,077	0	0	5,077

* : No data are available.
Data source: 1) Year books
2) Data from the Department of Agriculture in the South Kalimantan Province

CHAPTER IV THE PROJECT

4.1 SELECTION OF AREAS FOR DEVELOPMENT

A variety of complex and interrelated land data have been collected and analyzed in selecting the area for the Project. Systematic appraisal for the soils and topography in terms of irrigation and drainage conditions is briefed in this section, which aims at the delineation of the first priority area as a part of the comprehensive development of plan of the Riam Kanan Irrigation Project.

4.1.1 Considerations affecting Selection

The land classification survey reveales the grade of irrigation suitability. Typical characteristics of the natural soil bodies involved are: soil texture quality, effective soil depth, soil acidity, topography and drainage.

Micro and macro topography are evaluated with respect to degree and direction, land capability and land development requirements. Irrigability in relation to location and topography is the main point in this context.

The drainability of the area as a whole has been considered in relation to the drainage characteristics of topography, and river and sea water fluctuations. For this, data were collected and analyzed regarding:

1) drainage patterns of the area and subdivision of the area into sub-areas of different hydrologic characteristics, 2) position and fluctuation of inundation water level, 3) ground countours and main direction of water flow, 4) identification of barries and runoff characteristics and, 5) natural drainage of the area and eventual inflow from the surrounding areas.

Last but not least, the present land use and vegetation of the area have been taken into account, since these conditions have large effects on the relative difficulty in making reclamation for irrigation farming.

The preliminary delineation of the project area is made based on the above four conditions as well as the predictions of future alternations such as sea water intrusion which might increase due to the completion of the Project. The areas which satisfy these factors are described hereinafter.

4.1.2 Preliminary Delineation of the Project Area

In determining the location of the main irrigation canal, there are two major factors in this project. One is the existence of the Riam Kanan dam, and the other is the soil conditions along the canal. The both restricts the location and elevation of diversion weir and the main canal. The diversion weir should be designed so as not to disturb dam operations due to the backwater caused by damming up the river water level of the Riam Kanan, and the main irrigation canal should be aligned avoiding the swamp areas in which the soil conditions for the construction of the canal are obviously bad.

These two restrictions confine the water level at the main canal head between El. 9.00 m and El. 13.00 m. Within this range the economic comparative study is made in combination of diversion weir and the main canal. The study result indicates that the optimum water level will be El. 10.00 m at the canal head. The location of the canal route is then inevitably settled. The selection of the area for the Project is made within the areas which are effectively irrigable with this main irrigation canal.

Sub-area A

The total gross area of this sub-area is 3,660 hectares.

According to the soil survey results, the area is graded into three classes, the suitable land (Class II) with an area of 2,600 hectares, the marginally suitable land (Class IV) with an area of 400 hectares and the economically unsuitable land (Class V) with and area of 660 hectares.

The present land use survey results explain that Class II consists of small- productive rubber plantations with an area of 2,300 hectares and paddy field with an area of 300 hectares. Class IV consists of dry season paddy field, and Class V is wasted gravel soil land covered with alang-alang grass.

The studies on the drainability indicate that the area is classified into three, the perfect drainable land (Category 1) with an area of 2,960 hectares, the favourably drainable land (Category 2) with an area of 300 hectares and poorly drainable land in the rainy season (Category 3) with an area of 400 hectares.

The investigation on the irrigability reveals that the water could be distributed to the land with an area of 1,870 hectares by gravity through the proposed main canal.

The systematic appraisal conducted as an integrated study with the above four disciplines results in the selection of lands with an area of 1,800 hectares suitable for double cropping of paddy. In this context, it would be suggested to shift the present small productive rubber plantations into paddy field. Since the land in Class IV with an area of 400 hectares which is inundated in the rainy season is located in the central part of this sub-area, it will also be included in the Project to make comprehensive drainage system in the area. The area will be used for single cropping of paddy. The land in Class V, 660 hectares and technically non-irrigable land, 800 hectares, will be excluded from the Project.

The total irrigable land in the sub-area A would be 2,200 hectares in gross.

Sub-area B

The total gross area of this sub-area is 18,380 hectares.

According to the land classification survey results, the area is graded into four classes, the suitable land (Class II) with an area of 7,800 hectares, the moderately suitable land (Class III) with an area of 1,380 hectares, the marginally suitable land (Class IV) with an area of 2,900 hectares and the economically unsuitable land (Class V) with an area of 6,300 hectares.

The present land use survey results indicate that Class II consists of paddy field and small extent of shrub with an area of 7,700 hectares and small productive rubber plantation with an area of 100 hectares. The vegetation of Class III which is wasted at present could be developed as paddy field, provided that the drainage improvement would be made properly. Classes IV and V consist of wasted swamp bush and wasted hilly land with alang-alang grass, respectively.

The studies on the drainability indicate that the area is classified into four, the perfect drainable land (Category 1) with an area of 7,730 hectares, the favourably drainable land (Category 2) with an area of 4,800 hectares, the poorly drainable land (Category 3) with an area of 800 hectares and the non-irrigable land (Category 4) with an area of 5,050 hectares.

The investigation on the irrigability reveals that a part of the area which is locally elevated could not be irrigated by gravity. The extent is estimated to be 480 hectares. Other than this elevated land, it is expected that the irrigation water could be distributed to the entire area without any difficulty.

An integration is made among the above four conditions in selecting the area for the Project. The land which is classified into Class II with an area of 7,800 hectares is taken up as the first priority area, because it falls into either Category 1 or 2 in terms of the drainability. In this context, it would also be suggested to shift the present small productive rubber plantation into paddy field. Class III consisting of shrub which covers 900 hectares of land would be included in the project area, because the land falls mostly into Category 2 (about 200 hectares in Category 3) in view of drainage conditions. The lands classified into Classes IV and V will be excluded from the Project due to poor soil conditions, low irrigability and drainability.

Then, total gross irrigable land in the sub-area B would be 8,700 hectares including 200 hectares of land for single cropping of paddy.

Sub-area C

The total gross area of the sub-area C is 5,320 hectares. Since the coconut plantations occupy 920 hectares of land, the area envisaged for the Project will be 4,400 hectares in gross.

According to the land classification survey, the area is graded into two classes, the suitable land (Class II) with an area of 4,000 hectares and the moderately suitable land (Class III) with an area of 400 hectares.

The present land use survey results indicate that Class II consists of paddy field with an area of 3,900 hectares and small productive rubber plantation with an area of 100 hectares, and Class III consists of paddy field only.

The studies on the drainability shows that the area is classified into two, the perfect drainable land (Categiry 1) with an area of 1,690 hectares and the favourably drainable land (Category 2) with an area of 2,710 hectares (excluding the area for coconut plantations).

From the proposed location of the main canal, the entire area could be irrigated by gravity.

It is concluded, therefore, that the whole area excluding the coconut plantations will be included in the Project, including the present rubber plantation wich would be shifted into paddy field.

The total irrigable land in this sub-area would be 4,400 hectares.

Sub-area D

The total gross area of the sub-area D is 24,540 hectares.

The land clssification studies show that the area is graded into three classes, the suitable land (Class II) with an area of 13,600 hectares, the moderately suitable land (Class III) with an area of 3,220 hectares and the marginally suitable land (Class IV) with an area of 7,720 hectares.

The present land use survey results explain that Classes II and III consist of paddy field exclusively. Whilst Class III, which is located in the western swampy area, consists of paddy field with coconut trees.

From the viewpoint of the drainability, the area is classified into three, the perfect drainable land (Category 1) covering 4,930 hectares of land, the favourably drainable land (Category 2) with an area of 11,890 hectares and the poorly drainable land in the rainy season (Category 3) with an area of 7,720 hectares.

The entire area, except for the elevated river shore belt along the river Barito, could be irrigated by gravity with the proposed irrigation canal.

With these studies, the land, which classified into Classes II and III with an area of 16,820 hectares, is included in Category 1 or 2 in terms of the drainability. Therefore, this land will be taken up for the Project with the irrigation and drainage improvement. While the land which classified into Class IV submerges during the rainy season without any drastic measures such as construction of large scale polder with chech devices. Moreover, the land in Class IV in land use study are shallowly bottomed by the mud-clay (potential acid soil). The fact would result in very acidic soils once the soils are dried by the drainage works. Therefore, it would be suggested that Class IV should be left as it is excluding from the Project.

The total irrigable land in this sub-area would be 16,820 hectares.

4.1.3 Available Amount of Water for the Project

The source of irrigation water for the Project will be the rivers Riam Kanan and Maluka. The river water of the Riam Kanan will be used mainly for irrigation farming in the sub-areas A, B, C, and D. The sub-area E would be served by the Maluka from the topographic point of view.

The amount of water available from the Riam Kanan depends entirely on the discharge released from the power plants in the dry season, and the discharge from the power plants varies with the power demand. This section deals with the estimation of water available for the Project after the completion of the Project, based on the available hydrological data and the forecast of power demand in the future. According to information obtained from PLN, the Riam Kanan power station would be operated with 24 to 27 MW at peak, keeping some reserve for the emergency peak power demand, even after the completion of the Riam Kanan 2nd stage project. Load factor at that time (ratio of average output to peak output) is forecasted to be about 65 % from the present load factor, about 60 to 62 %. The peak demand of 24 MW in and after 1984 is adopted to estimate the amount of water available for the Riam Kanan irrigation project from the power station for the conservative calculation. With these forecasted power demand and load factor, the average output is estimated at 15.6 MW, 24 MW x 0.65 = 15.6 MW. This is the basis for estimating the discharge to be released through the power plants.

An output of hydropower depends entirely upon the static head, a difference in height between the water level in the reservoir and the tail race of the dam. Various amounts of discharges enough to generate 15.6 MW of electric power are considered with the variation of the static head. According to the study on the irrigation water requirements made in Sub-chapter 4.3 of this report, the peak water requirement would occur in mid-August. The proposed reservoir operation program for the Riam Kanan dam /1 shows that the water level in the reservoir in August will range between 60.707 m and 58.70 m in elevation. The design high water level in the reservoir, say 60.707 m in elevation, is used for conservative estimation of the amount of water available for the Project.

The relationship among the discharge, static head and generating output may be expressed by the following equations:

$$P = 9.8 \times \eta \times He \times Q \quad \text{.......... Equation (1)}$$

$$He = 0.94 \times (WLR - WLTR) \quad \text{......... Equation (2)}$$

where,
- P : Generating output, 15,600 kW
- η : Efficiency of turbin generator, 0.86
- He : Effective head in meter
- Q : Discharge in m^3/sec.
- WLR : Water level in reservoir, 60.707 m
- WLTR : Water level in tail race in meter

The relationship between Q and WLTR may be expressed as follows:

$$WLTR = 60.707 - \frac{1,969}{Q} \quad \text{..... Equation (3)}$$

/1 : Regulation for Operation of the Riam Kanan Dam, the Riam Kanan Project prepared in June, 1972.

The rating curve showing the relationship between the water level in the tail race and the discharges is shown in Fig. 4-1. The required values of the discharges and gross static head under the above conditions is indicated at the intersection point of the two curves, the rating curve at the tail race and the curve derived from the above equation (3). As a result, 42 m^3/sec of discharge would be expected as the amount of water available for irrigation and maintenance of the river Martapura.

Fig. 4-2 shows the mass curve of runoff at the Riam Kanan dam site for the full period of 12 years from June 1965 to May 1977. The high reliability of releasing 42 m^3/sec of discharge from the power plants will be confirmed by this mass curve, except for 40 m^3/sec in 1972 which was very drought year.

As described in the previous section 3.4.4, mean drought runoff, 8 m^3/sec, as the minimum discharge for the maintenance of the river Martapura would have to be released from the dam. Therefore, the amount of water available for the Riam Kanan Irrigation Project is estimated at 34 m^3/sec.

4.1.4 Areas to be Developed under the Project

The previous discussions made clear the areas which could be developed and the amount of water for the Project. Table 4-1 summarizes the results of the discussions so far made. In view of land suitability and land use, drainability and irrigability, the land with a total area of 32,120 hectares consisting of 2,200 hectares in the sub-area A, 8,700 hectares in the sub-area B, 4,400 hectares in the sub-area C and 16,820 hectares in the sub-area D in gross are taken up.

Since the above gross area includes the non-irrigable lands such as village compounds, coconut plantations, roads, canals, dikes, etc., the net irrigable area is assumed to be 85 % of the total gross area. The net area which could be developed under the Project become 27,310 hectares.

Applying the unit peak diversion requirement of 1.37 ℓ/sec/ha, the total diversion water requirement amounts to 37.41 m^3/sec. As the available water from the river Riam Kanan is restricted to 34 m^3/sec including the rural water supply of 0.4 m^3/sec, there would be a shortage of 3.81 m^3/sec for irrigating the whole potential areas and for the rural water supply. The southernmost land with an area of 2,780 hectares in the sub-area D will be excluded from the Project.

The areas which will be taken up for the Project will be 24,530 hectares in total consisting of 1,870 hectares in the sub-area A, 7,400 hectares in the sub-area B, 3,740 hectares in the sub-area C and 11,520 hectares in the sub-area D in not.

4.1.5 Potentiality for Development of Sub-areas E and F

Sub-area E

The total gross area which could be taken up for the sub-area E is 16,100 hectares.

According to the land classification survey, the area is graded into four classes, the suitable land (Class II) with an area of 5,000 hectares, the moderately suitable land (Class III) with an area of 4,300 hectares, the marginally suitable land (Class IV) with an area of 6,000 hectares and the economically unsuitable land (Class V) with an area of 800 hectares. These would indicate that the land with an area of 9,300 hectares could be developed provided irrigation and drainage could be practiced properly.

The present land use survey results explain that Class II consists of paddy field. Class III includes paddy field and waste land with shrub. Class IV consists mainly of waste land with shrub and grass underlain by the potential acid soil, and Class V consists of sand levees.

The preliminary studies show that the drainability is very poor on the whole, except partially for the areas which are used as paddy field at present. The poor drainability is thought to be the fact that the slope of the river Maluka is very gentle and that the tidal fluctuation exerts an effect on the water level up to the fairly upper reaches of the river. This suggests that the improvement of the river by training to increase the capacity would need a large scale measures to prevent sea water intrusion.

As regrads the available water, the discharge in the dry season is provisionally estimated to be 3 m^3/sec. This limits the area as small as 2,000 hectares, which could be taken up for development. Moreover, it is found by the preliminary investigation that there are no favourable locations for dam construction because of very flat topography of both banks of the Maluka througout the whole stretch.

The possibility of the economical development of the sub-area E seems very low in view of both irrigation and drainage, though the final decision is subject to further studies on irrigation and drainage methods to be applied to the land with an area of 2,000 hectares.

Sub-area F

The soils in this area are characterized by loamy to sandy skeletals (gravelly particles) throughout the profile. Due to poor vegetation (alang-alang grass) and rolling topography in the area, almost all the surface soils (humic epipedon) have been eroded out, and then, organic matters in the soils are only a few percent. An inherent plant nutrient is very poor in these soils. Due to very coarse texture quality throughout the profile, the soils have low water holding capacity and very big percolation rate. The tillability or arability of these soils is low, in the light of the soil profile features and physical soil properties.

In view of the topography in the most area, it is rather difficult to arrange a suitable field plot for proper operation of irrigation. Besides, the soil having coarse texture with effusive gravels throughout the profile hardly limits the field management of irrigation and farm operation. It is considered that the most land in this area are economically unsuitable for irrigation development.

The preliminary studies on the selection of pumping stations on the main canal made it clear that the water would have to be lifted in a few steps instead of one due to complicated topography for lifting water. This would incur high construction cost and difficult operations.

As the above discussions manifestly indicate that this area is unsuitable for irrigation development, it is recommended to exclude this area from the Project.

Fig. 4-1 **Relationship Between Expected Discharge and Gross Head**

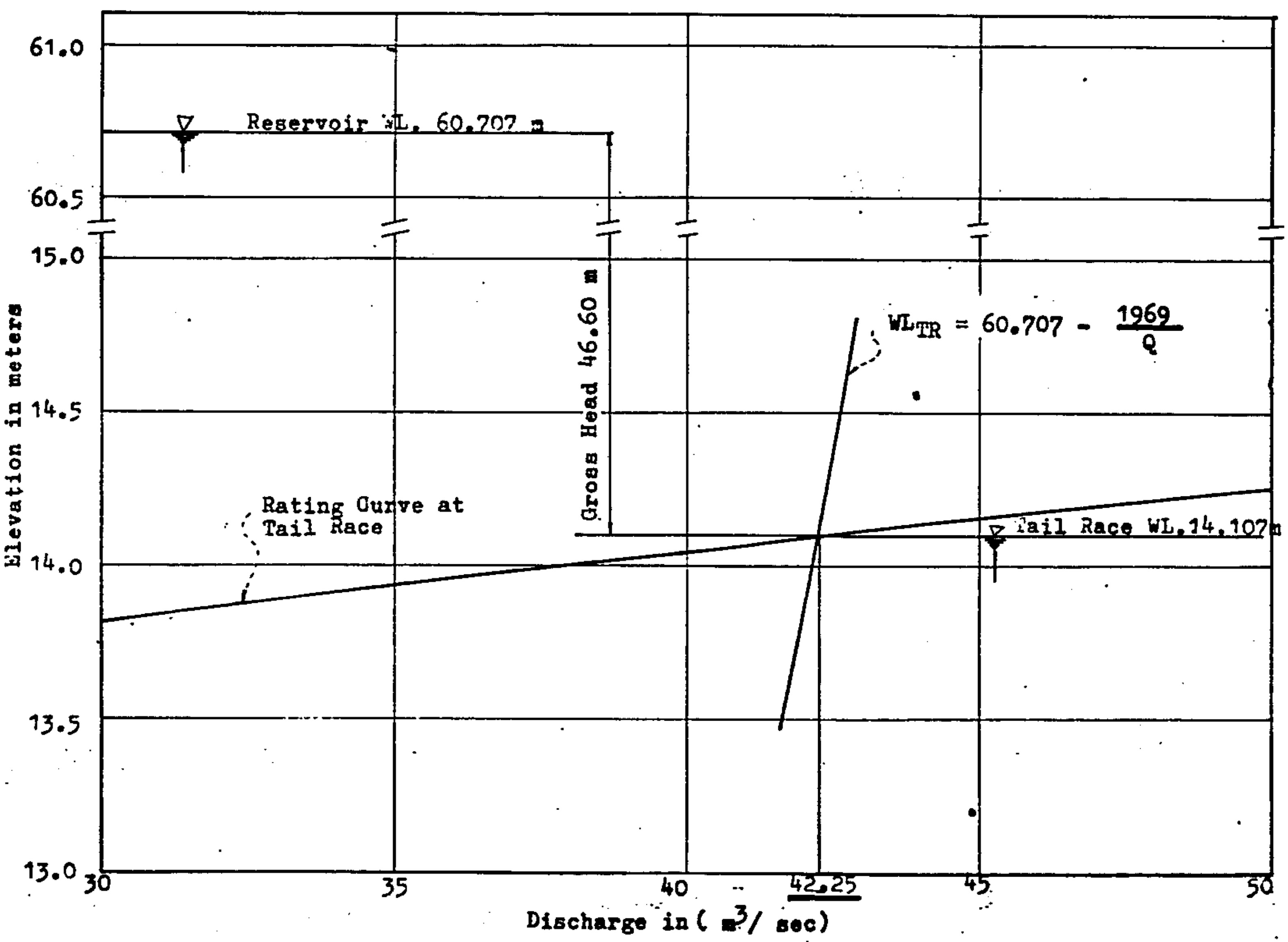


Fig. 4-2 **Mass Curve by 10 - days Mean Run-off at Riam Kanan Dam**

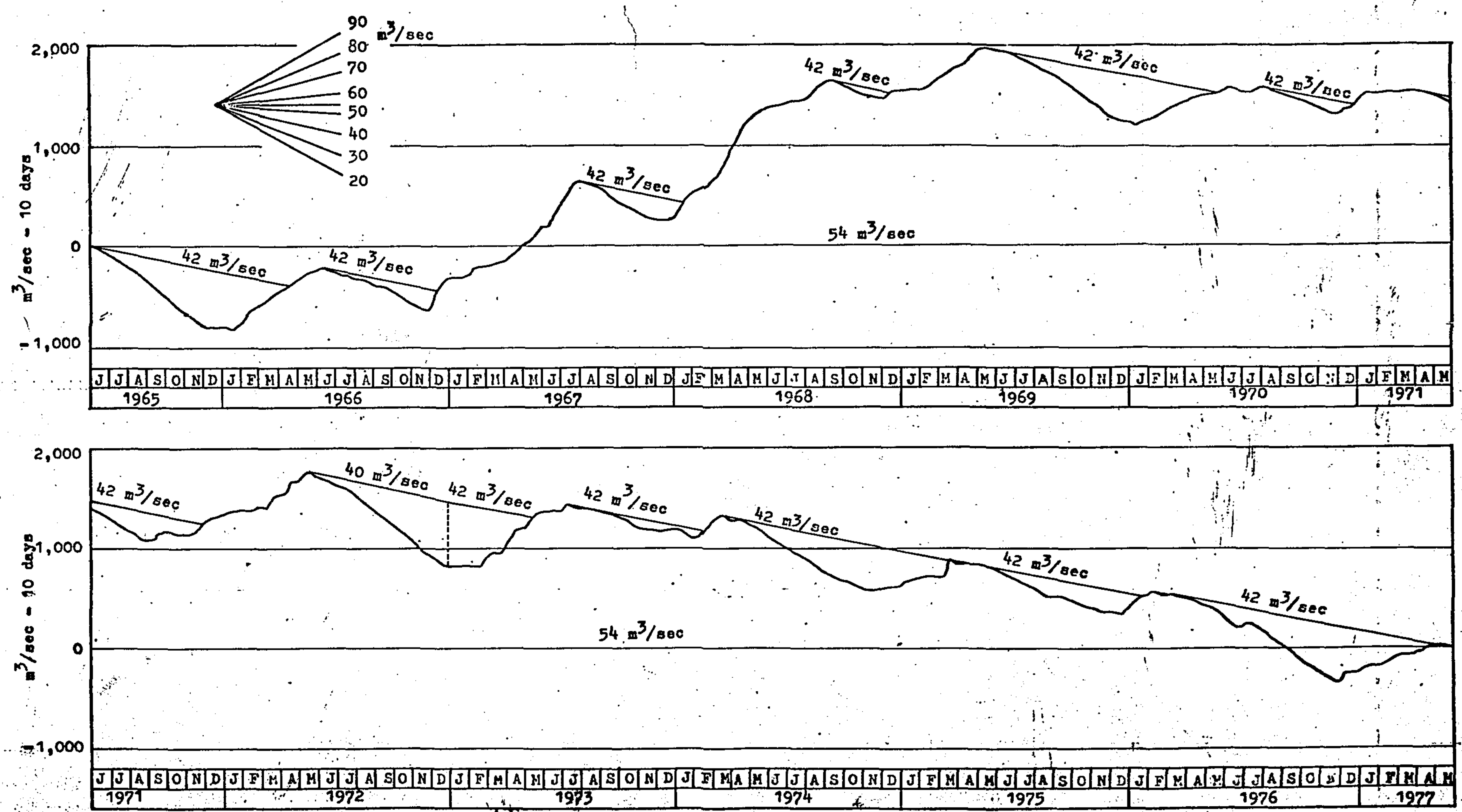


Table 4-1 **Preliminary Delineation of the Project**

		Sub-area A (ha)	Sub-area B (ha)	Sub-area C (ha)	Sub-area D (ha)	Total area (ha)
A	Land suitability class					
A-1.	Area to be taken up for the Project (Gross area)					
	Class II	2,600	7,800	4,000	13,600	28,000
	Class III	-	1,380	400	3,220	5,000
	Class IV	400	-	-	-	400
	Sub-total	3,000	9,180	4,400	16,820	33,400
A-2	Area to be excluded from the Project (Gross area)					
	Class IV	-	2,900	-	7,720	10,620
	Class V	660	6,300	-	-	6,960
	Sub-total	660	9,200	-	7,720	17,580
	Total	3,660	18,380	4,400	24,540	50,980
B.	Drainability class					
B-1.	Area to be taken up for the Project (Gross area)					
	Category 1	2,300	3,580	1,690	4,930	12,500
	Category 2	300	4,800	2,710	11,890	19,700
	Category 3	400	800	-	-	1,200
	Sub-total	3,000	9,180	4,400	16,820	33,400
B-2	Area to be excluded from the Project (Gross area)					
	Category 1	660	4,150	-	-	4,810
	Category 3	-	-	-	7,720	7,720
	Category 4	-	5,050	-	-	5,050
	Sub-total	660	9,200	-	7,720	17,580
	Total	3,660	18,380	4,400	24,540	50,980
C.	Technically irrigable area (Gross area)	2,200	8,700	4,400	16,820	32,120
D.	Area to be developed					
D-1	Double cropping of paddy (Gross area)	1,800	8,500	4,400	16,820	30,920
D-2	Single cropping of paddy (Gross area)	400	200	-	-	1,200
	Total	2,200	8,700	4,400	16,820	32,120
E.	Net irrigable area	1,870	7,400	3,740	14,300	27,310
F.	Maximum available water (m^3/sec)	(2.56)	(10.14)	(5.12)	(15.78)	(33.60)
G.	Delineation of the area (Net area)	1,870	7,400	3,740	11,520	24,530
G-1	Double cropping of paddy	1,530	7,230	3,740	11,520	24,020
G-2	Single cropping of paddy	340	170	-	-	510

4.2 AGRICULTURAL DEVELOPMENT

4.2.1 Proposed Land Use and Cropping Pattern

The proposed land use and cropping pattern in the project area are formulated based on the following basic concept:

(1) Economize the capital investment for elimination or improvement of the present agricultural constraints.

(2) Utilize the available irrigation water as effectively as possible to expect higher project benefits.

(3) Increase production of staple food crops by means of crop intensification so as to contribute to the Government policy for self-sufficiency in food.

(4) Level up the living standard of the farmers through the increase of farm products.

With the integration made among the above four basic concepts, paddy rice cultivation under the condition with the Project will play an important role in the future agricultural development in the project area. The crop diversification and/or intensification using polowijo crops are also one of the Government policies for profitable agricultural development. However, it would be rather difficult to introduce polowijo into the project area from the current farm economics and the field environmental situations.

The proposed land use and crop production program are worked out with the intensified monoculture of paddy rice over the whole project area.

Proposed Land Use

Based on the preliminary delineation of the proposed irrigation area and the field conditions to be improved under the Project, the future land use is prepared under two conditions: (1) double cropping of paddy using high-yielding varieties in both the perfect and favourably drainable areas and (2) single cropping of paddy with local varieties in the poorly drainable area. As seen in Table 4-1, each land use would be 24,020 hectares and 510 hectares in net, respectively. A breakdown of the future land use in each sub-area is summarized in Tables 4-2 and 4-3. As shown in Table 4-3, about 4,200 hectares of land covered with Galam shrub and 1,200 hectares of rubber plantations could be developed for agricultural use under the Project mainly because of favourable soil conditions.

As for the sub-area E, the basic land use and crop production pattern proposed for other sub-areas would be applicable, particularly for the existing paddy field, when the land is properly drained and irrigated. In case of the wild land which widely lies in the middle reaches of the river Maluka, however, there would be difficulties in developing the land for profitable agricultural development because of the existence of acid soils, low elevation of the land, etc. as mentioned in the previous section. In order to realize profitable farming through reclamation of the land, careful study should be made for the proposed land use. In this connection, it is recommeded to arrange a systematic monitoring of the drainage effect and re-characterization of soils particularly for soil acidity caused by oxidization of mud-clay through the small reclamation projects now under construction.

As mentioned before, the land in the sub-area F is not suitable for irrigation farming mainly because of undulating topography and coarse textured gravelly and stony soils. The land in this area could be used only for rainfed farming with vegetables, legums and/or perennial crops such as clove, fruit trees, etc. which are being grown in small areas.

Cropping Pattern

Cropping pattern of paddy cultivation under the Project is studied taking into account the field environment such as climate, drainage, irrigation, agronomic characteristcs of paddy varieties and available labor forces in both unit farm family and the total project area.

Climate in the project area characterized by warm and humid conditions is favourable for paddy cultivation. As mentioned before, double cropping of paddy will be practiced in the perfect and favourably drainable lands with proper drainage improvement. In this case, attention should be paid to the fact that high rainfall and relatively long rain days in the wet season will largely restrict smooth operations of harvesting and processing of paddy. Favourable harvesting will be limited to the period from the end of the rainy season to the end of the dry season. With this view, double cropping of paddy a year with the first harvest at the end of the rainy season and the second harvest at the end of the dry season will be practically the most applicable pattern to the project area. This pattern will also be acceptable from the agronomic point of view.

In order to maximize the potential productivity and profitability of the proposed pattern, high-yielding varieties are primarily introduced as much as possible instead of local varieties. The high-yielding varieties with growing period of 110 to 120 days and the varieties specified for 130 to 140 days growing will be adopted for the dry season cropping and the wet season cropping, respectively. These varieties will be selected among the improved varieties such as B-series, IR-series, etc.

For the poorly drainable land, the local varieties, which have a weak or less photo-sensitivity, relatively short maturation period of about 150 days, tall plant height and resistance against deep inundation, are adopted for one cropping of paddy cultivation. The local varieties suitable for the above requirements will be selected from the superior being widely accepted in Indonesia.

In the proposed cropping pattern, it is estimated that the duration of transplanting including sowing will be about two months mainly because of limited labor force of the unit farm family and full manual operations. The sowing of the rainy season paddy will be practiced during the period from mid-November to mid-January, and harvesting between early April and late May. The dry season paddy will be sown from mid-May to mid-July and harvested between mid-September and mid November. The proposed cropping pattern is illustrated in Fig. 4-3.

In order to introduce these new cropping patterns into the project area successfully, it is inevitable to provide strong agricultural supporting services, including training of both the extension workers and the farmers, by all government agencies concerned. In this connection, it is recommended to establish a pilot demonstration farm in the project area for which the study will be made.

4.2.2 Farming Practices and Farm Inputs

In order to expect possible higher return per hectare with irrigation and drainage improvement, improved farming practices should be introduced into the project area. The proposed farming practices and farm inputs to be applied are studied to find the most practical way which would be acceptable for the farmers, taking into account the following: (1) the soil and land to be improved by the Project, (2) land holding size including tenant and cultivation right, (3) availability of labor force in and around the project area, (4) familiality with modern farming and (5) farmers' intension.

Proposed Farming Practices

According to the analysis of farm population and the size of unit farm family in the project area, the labor force in the unit farm family would be sufficient for growing high-yielding varieties by manual operations, excpet for some shortage at transplanting and harvesting times. It is planned, therefore, that farming will be practiced fully by manual operation with small farming equipment and instruments such as rotary weeder, knapsack type mist-duster, treadal thresher, winnower, etc.

It is essential for profitable farming that soil preparation, fertilization, plant protection, weeding and water management should be practiced properly. Among the above practices, plant protection by chemical application is of importance, because the entire project area is now infected by pests and diseases mainly of plant hoppers, stem borers, leaf-blight, etc.

Some modification will also be required for transplanting and harvesting. They are one-time transplanting with young seedling and harvesting by cutting all the straws using sickles. Particularly, the proposed harvesting method is one of the most practical countermeasures for saving the labor requirements and also for protecting the plant from the infection of pests and diseases.

Farm Inputs

Based on the field survey results of the BIMAS/INMAS programs in the Hulu Sungai Tengah Irrigation Project and the interim result of soil chemical analysis, it is tentatively estimated that combination treatment of about 90 to 120 kg/ha of nitrogen, 60 kg/ha of phosphate and 35 to 40 kg/ha of potash would be required for both the wet and dry season croppings.

As for the plant protection, intensive application of insecticides will be required for control of plant hoppers, stem borers, etc. Considering the life-cycle of these insects, three to four ℓ/ha of insecticides would be required for 3 to 4 times application during one cropping.

The damage of the plant caused by diseases is not so serious as compared with that due to the insects, since most of the farmers are using the local varieties which have a tolerance to the diseases. When the high-yielding varieties are introduced, however, it will be necessary to apply about 2 ℓ/ha of fungicides to control the diseases for each crop season.

In selecting suitable insecticides and fungicides, chemical toxicity which directly or indirectly affects the human being should be taken into consideration.

The seed requirement is estimated at 25 kg/ha in accordance with the BIMAS program.

The farm inputs and farming equipment required for one hectare operation is summarized in Table 4-4.

4.2.3 Anticipated Crop Yield and Production

The crop research and crop cultivation trial in the Barito river basin are being carried out by the Branch of the Central Research Institute for Agriculture in Banjarmasin from 1961 up to the present. However, the results obtained through these activities are still not enough to make the feasibility study of the Project.

In the project area, technical demonstration of paddy cultivation using high-yielding varieties of IR-26, IR-32 and IR-36 was made at eight locations (32 ha in total) by the leading farmers under the direct guidance of the rural extension offices in 1977. In this demonstration program, paddy was grown under the rain-fed condition with four times plant protection but without any fertilization. According to the production records of this program, average unit yield of each variety is estimated at about 4 tons/ha in dry unhusked rice.

In the area served by the Hulu Sungai Tengah Irrigation Project, average unit yields of high-yielding varieties were 4.25 tons/ha in the technical irrigation area, 5.45 tons/ha in the semi-technical irrigation area and 4.55 tons/ha in the non-technical irrigation area, respectively, under the BIMAS program.

From these figures, it is tentatively estimated that target yields will be 4.0 tons/ha and 4.5 tons/ha for the rainy and the dry season paddy, respectively, using high-yielding varieties. Regarding the local varieties to be grown in the poorly drainable area, the target yield is provisionally estimated at 1.8 tons/ha.

With these target yields and the proposed irrigation area, annual production at the full development stage is estimated at about 205,000 tons in dry unhusked rice. The incremental production which is attributed to the Project is about 168,000 tons per annum or 4.5 times of the present production (see Table 4-5).

Further study on the prospective paddy yields will be carried out, making reference to the production records to be obtained from the large scale irrigation projects in Indonesia.

Marketing Prospect

As mentioned before, the demand and supply of rice in Indonesia is still not balanced mainly due to the increase in population together with the increase in rice consumption per capita by the raised living standard, and it is reported that the annual import of rice reached about one million and a half tons in 1976.

As seen in the following Table 4-6 the production and consumption of paddy in the whole Kalimantan (central, east, west and south provinces) in recent six years are generally balance with a small surplus.

Table 4-6 Paddy Production and Consumption in Kalimantan

Year	Population (1,000)	Production (1,000 t)	Consumption (1,000 t)	Balance (1,000 t)	Per capita (kg/year)	Converted to rice (kg/year)
1971	5,190	825.3	829.4	- 4.1	159.8	83.1
1972	5,335	888.1	849.0	39.1	159.1	82.7
1973	5,481	954.2	867.2	87.0	158.2	82.3
1974	5,625	1,013.1	994.6	18.5	176.8	91.9
1975	5,773	1,003.1	1,021.3	- 18.2	176.9	92.0
1976	5,925	1,070.9	1,022.5	48.4	172.6	89.7

Data source: BAPPEDA in the South Kalimantan

The preliminary study on future prospect of the demand - supply condition of paddy in Kalimantan is made and illustrated in Fig. 4-4. Assuming that the annual growth rate of population is 2.65 % (data from statistic office) and that the annual growth rate of rice consumption is 1.5 %, the estimated paddy production will not catch up with the demand in and after 1980.

It is estimated that the South Kalimantan Province has 100,000 to 200,000 tons of surplus paddy (50,000 to 100,000 tons of rice) every year since 1970, and such surplus paddy is exported to other provines in Kalaimantan. The total paddy production in the South Kalimantan occupies 60 to 65 % of total production in Kalimantan. In 1977, about 110,000 tons of paddy were exported from the South Kalimantan to other provinces.

As mentioned before, total quantity of paddy marketed in Kabupaten Banjar is about 70,000 tons which correspond to about 64 % of the above 110,000 tons of paddy exported. It may be said from this that Kabupaten Banjar is the largest rice producing area in the South Kalimantan. With the completion of the Project, furthermore, further increase of rice will be expected in this Kabupaten, which will contribute largely to the improvement of the demand-supply condition of rice in the future in Kalimantan.

Table 4-2 Prospective Land Use

Land category	Land use	Extent Area Without Project (ha)	Extent Area With Project (ha)
1. Paddy field			
a) Irrigated & well drained	Double cropping of paddy /1	0	24,020
b) Irrigated & fairly well drained	Double cropping of paddy /2	0	0
c) Not irrigated & poorly drained	Single cropping of paddy /3	21,400	510
Sub-total		21,400	24,530
2. Plantation	Rubber production	2,500	1,300 /4
3. Infrastructural land /5		2,060	4,330
4. Wild land	Galam shrub	4,200	0 /6
	Swampy forest	4,950	4,950
	Bushes	740	740
Sub-total		9,890	5,690
Total		35,850	35,850

/1 : High-yielding varieties are grown in both the rainy and dry seasons.

/2 : High-yielding varieties are grown in the dry season, but in the rainy season local varieties are grown.

/3 : Only local varieties are grown.

/4 : The exsiting rubber plantations are shifted into the land category 1-a).

/5 : This includes the village yard, rivers canals, roads, etc.

/6 : The land covered with Galam shrub is shifted into the land category 1-a).

Table 4-5

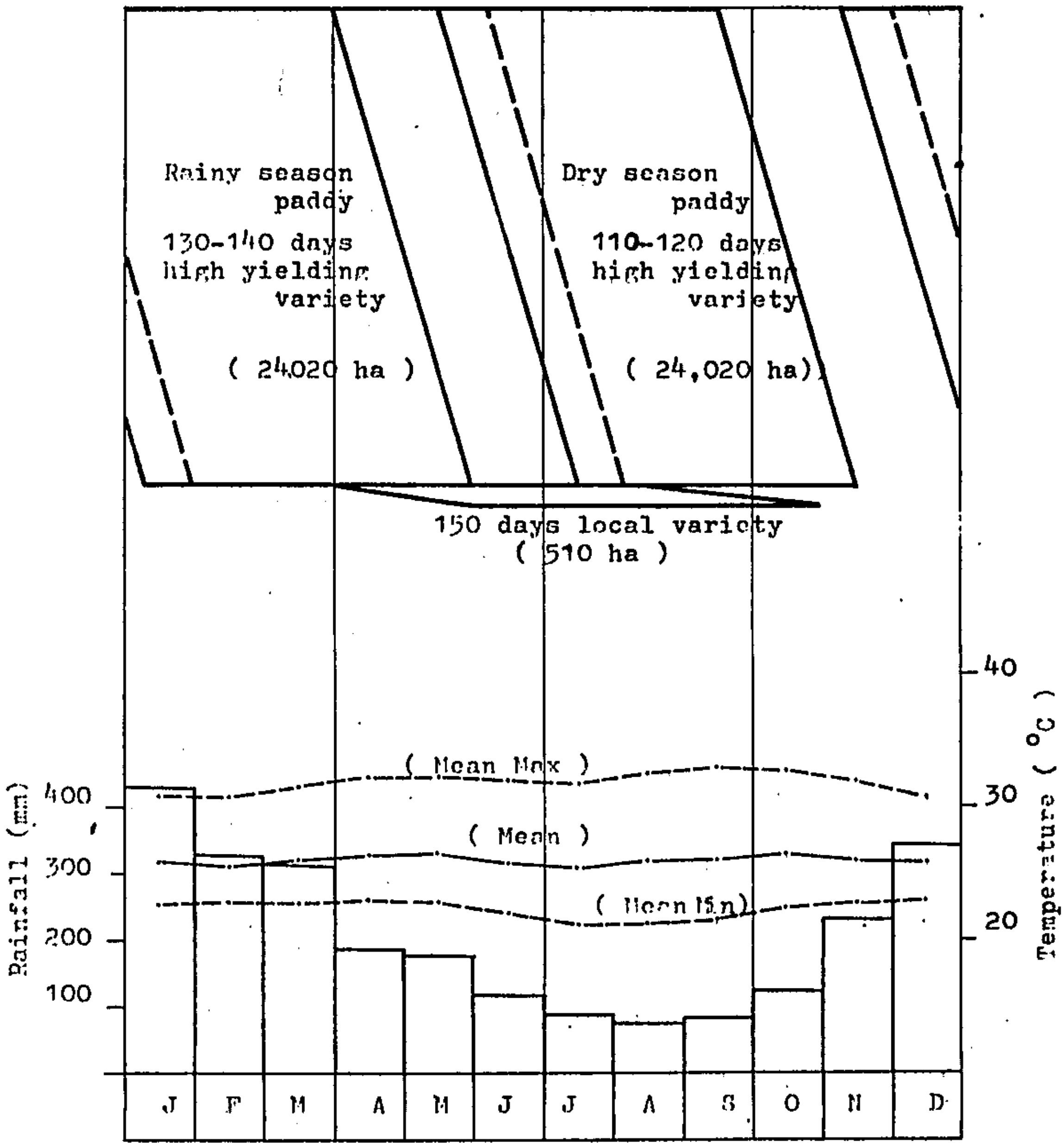
Prospective Land Use in Each Sub-area

(paddy cultivation with and without the project)

(Unit: Ha)

Field Condition	Sub-area A	Sub-area B	Sub-area C	Sub-area D	Total
I. With The Project					
a. Irrigated & well drained	1,530	7,230	3,740	11,520	24,020
b. Irrigated & rather well drained	340	170	0	0	510
Total	1,870	7,400	3,740	11,520	24,530
II. Without The Project					
Non-irrigated & poor drained	1,200	4,100	3,900	12,200	21,400

Fig. 4-3 Proposed Cropping Pattern



Note; Rainfall is the average value for ten years at Banjarmasin.
Temperature is the average value for four years at Banjarbaru.

Table 4-4 Requirement of Labour, Input and Equipment for Paddy Cultivation per Ha with Project

Items	Requirement
1. Labour	
Raising of seedling	30 man-day
Field preparation	50 "
Transplanting	50 "
Weeding	55 "
Fertilizing & Spraying	24 "
Water management	7 "
Harvesting	30 "
Threshing, drying & transportations	15 "
Sub-total	261 man-day
2. Seed, Fertilizer & Chemicals	
Seed	25 kg
Fertilizer, Urea	250 kg
T.S.P	100 kg
KCL	60 kg
Insecticide	4 lit.
Fungicide	2 lit.
Rodenticide	200 g
3. Equipment	
Rotary weeder	2 sets
Treadal thresher	1 "
Winnower	1 "
Knap-sac type mist-duster	20 hrs.

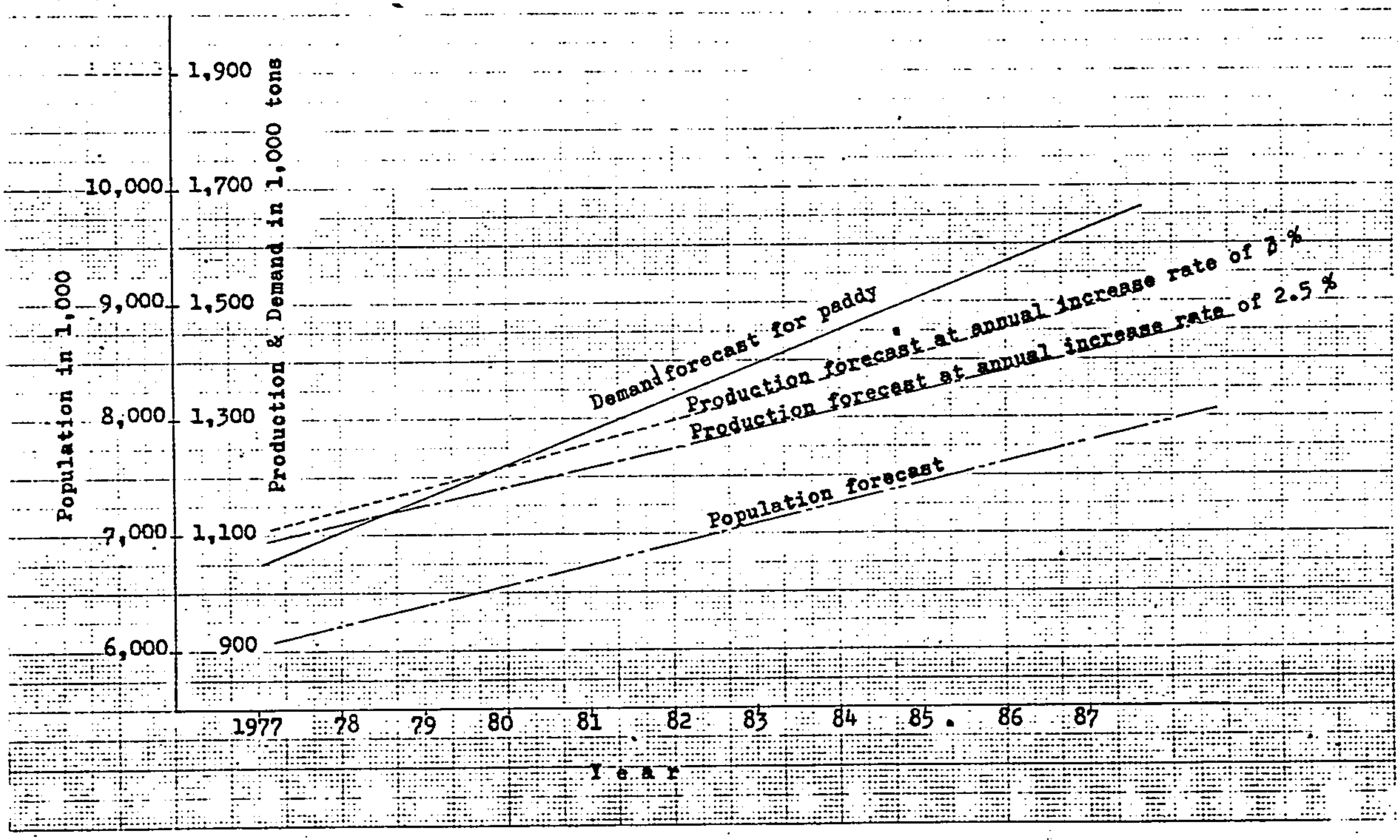
Table 4-5

Annual Cropping Area and Production
With or Without the Project

	Rainy season crop			Dry season crop			Total	
	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Production (ton)
A. With Project	24,020	4.0/1	96,080	24,020	4.5/1	108,090	48,040	204,170
	0	-	0	510	1.8/2	920	510	920
Sub-total	24,020	-	96,080	24,530	-	109,010	48,550	205,090
B. Without Project	21,400	1.75	37,500	0	-	0	21,400	37,500
C. Increment (A-B)	2,620	-	58,580	24,530	-	109,010	27,150	167,590

/1: Improved high yielding varieties
/2: Local varieties

Fig. 4-4 Paady Production and Demand Prospects in Kalimantan



4.3 IRRIGATION AND DRAINAGE PLAN

4.3.1 Water Requirements for Irrigation and Rural Water Supply

Field measurement of crop consumptive use of water is being carried out from the middle of August at the experimental farm in the sub-station of Bogor Agricultural Research Institute located in the sub-area C. As the data available from this measurement are still not sufficient, howevere, the study on water requirements is made tentatively using the evaporation data for the project study at this time.

Evaporation

After processing the meteorological records available at Banjarbaru for the period of 1975 to 1977, a set of potential evaporation is prepared using the Penmam method. A comparison between the calculated potential evapotranspiration and the evaporation from the class A pan located at the same station is made for the cross checking. The result indicates that the former is less than the latter by about 10 %. This reason is thought to be the fact that the sunshine hour recorded is somewhat shorter than expected. Therefore, it seems practical at present to use the value of evaporation from the class A pan in connection with the crop coefficient. As the pan evaporation is measured for only three years, it is impossible to assess the probable value statistically. In view of giving some allowance, the highest mean values of the three years, among which there are small differences, are adopted.

Crop Coefficient

Six sets of measurement tanks were installed to obtain the various records at different stages between the transplanting and yellow ripening. Pan-evaporation and rainfall are being observed simultaneously to corelate with the evapotranspiration. It is noted, however, that the measurements so far made are insufficient to work out the crop coefficient during the whole growing stages.

Instead of adopting the crop coefficient obtained in the project area, those derived from the experimental results at the trial farms conducted by FAO staff near Palembang city are provisionally used, since the comparative study reveals that the difference between the both sides are within the range of 15 %. The variances of the coefficient to the growing stages are shown below. Modifications of the figures will be made after the completion of the observation in the project area.

Crop Coefficient of Paddy

Percentage of growing stage	10	20	30	40	50	60	70	80	90	100
Crop coefficient	0.75	0.76	0.90	1.13	1.27	1.36	1.35	1.27	1.03	0.47

Puddling Water Requirements

The quantity of water required for puddling works is theoretically assessed by soil depth to be saturated and soil porosity. However, both vary relatively from place to place. Provisionally, the puddling water requirement is estimated by using the following formula and assumptions:

$$PW = DS + WS$$

where,

PW : Puddling water requirement
DS : Water depth above soil surface after puddling in mm
WS : Difference in soil moisture before and after puddling water needed for saturation of soil in mm

a) Water depth on soil surface after puddling is 45 mm.

b) Porosity rate is assumed to be 50 % on both surface soil with depth of 20 cm and sub-soil with depth of 10 cm.

c) Vapour phase in soils after the puddling is assumed to be 5 %.

d) Soil moisture before irrigation is 20 % in volume.

Then, the puddling water requirement is calculated as follows:

$$PW = 45 + 300 \times (0.5 - 0.05) - 20 \times 300 = 120 \text{ mm}$$

Percolation Rate

Three sets of cylinders were installed in the said sub-station of the Institute for the measurements of percolation only. The results of the measurements show very small values even in the driest season. Therefore, the percolation rate is assumed to be 1 mm/day in the dry season and 0.5 mm/day in the wet season.

Horizontal percolation through pond in terraced land supplies water to the lower adjacent fields. Since this water is not lost, such percolation need not be considered in the overall irrigation requirements.

Washing Water

The percolation rate suitable for paddy field is commonly reported to be the range between 2 to 3 mm/day and 80 mm/day. According to the experiments in the project area, however, percolation rate is about 1 mm/day even in the driest season. In order to remove the water containing humic acid coming from the tropical soils, it seems essential to supply another 2 mm/day of fresh water in addition to the percolation water (1 mm/day in the dry season and 0,5 mm/day in the wet season).

Effective Rainfall

Effective rainfall in the project area is estimated by applying the daily water depth balance method, using the following assumption:

a) Rainfall less than 5 mm/day is ineffective.

b) The excess beyond 50 mm/day is ineffective.

c) 90 % to the total of each 10-day rainfall through the above procedures is effective.

Daily rainfall data used are for the period of 18 years at Banjarbaru station. The results of the calculation with the recurrence interval of once five drought years are shown in Table 4-7. Item D.

Farm Requirements

The farm requirements or net irrigation water requirements are obtained by using the following formula:

$$FR = CU + PL + WW + PW - ER$$

where,
FR : Farm requirements
CU : Consumptive use of water
PL : Percolation loss
WW : Washing water
PW : Puddling water
ER : Effective rainfall

Item H in Table 4-7 shows the results of calculation of the farm requirements.

Gross Irrigation Requirements

Certain losses are unavoidable for conveying water and supplying it to the farm. The gross irrigation water requirements are obtained by dividing the farm irrigation requirements by the conveyance and operation efficiency. The most of irrigation canals over the project area are planned as unlined and, thus, they incur rather high conveyance losses are tentatively estimated at 20 % and operation losses at 15 %, resulting in 68 % of total efficiency. Item I in Table 4-7 shows seasonal gross irrigation water requirements in terms of mm/day. The maximum 10-day water requirement is 11.8 mm/day which are translated as 1.37 ℓ/sec/ha.

Rural Water Supply

The total population in the project area is about 330,000, excluding Banjarmasin city where the municipal water supply facility is available. Provided that per-capita consumption of water is 100 ℓ/day, total consumption will be 0.38 m^3/sec, which corresponds to about 1.1 % to the maximum total water requirement. In the design of the capacity of the main canal, this amount will be taken into consideration.

4.3.2 Drainage Improvement Plan

Present Conditions of Floods and Drains

It is noted that each of the sub-areas is separated in terms of drainage conditions either by the lay of the land or roads. There is no incoming and outgoing of water among the sub-areas. Therefore, the water balance studies for each sub-area could be made independently.

The preliminary survey results indicate that the lands could be divided into four categories in view of flood conditions as stated below.

Category 1 : Areas which are free from the seasonal floodings, including the areas poorly drained due to micro-relief condition.

Category 2 : Areas which suffer from the seasonal floodings from the beginning of December to the end of March. The maximum water standing is assumed to be 30 cm.

Category 3 : Areas which suffer from the seasonal floodings from early November to the end of May. The maximum water standing is assumed to be 50 cm.

Category 4 : Areas which are submerged throughout the year. The maximum water standing is assumed to be more than 100 cm (mid-February) and the minimum, 30 cm (beginning of September) on an average.

The map showing the present flooding status is presented in Drawing No.6, which indicates that there exists a considerable extent of areas suffering from inundation annually.

In order to estimate the present outflow conditions for each sub-area, a water balance study among rainfall, evapotranspiration, percolation and the amount of submergence is made using the present available data. For sub-areas A and B, the mean monthly records at Banjarbaru, and for the sub-areas C and D, at Banjarmasin were used. Evapotranspiration from the land surface is tentatively assumed to be as high as 80 % of class A pan evaporation since the whole areas are more or less submerged or very wet condition throughout the year. Percolation is regarded to be practically zero.

Sub-area A

The sub-area A is divided into two, north (sub-area A_1) and south (sub-area A_2) in view of drainage, since it is separated by a road running from east to west and no incoming and outgoing of water between the two sub-areas are observed.

Each of the catchment areas is classified as follows:

Sub-area	Total catchment area (ha)	Category 1 (ha)	Category 2 (ha)	Category 3 (ha)	Category 4 (ha)
Sub-area A_1	1,550	80	420	580	470
Sub-area A_2	6,550	-	-	1,030	5,520
Total	8,100	80	420	1,610	5,990

The sub-area A_1 is characterized by a polder surrounding almost the whole area. There is no inflow from the outside areas except for the Riam Kanan river, from which inflow is checked by the gates at the outlet. Since the area is fairly low and flat, there is a remarkable retarding effect within the area. The water balance study reveals that the pattern of discharge would be flatter than that of rainfall and, hence, there would be a lag of time of peak discharge from that of rainfall. The volume of water to be stored in this sub-area is estimated to be 4.9 million m^3.

The features of the sub-area A_2 could be characterized by steep slope and relatively large catchment basin behind it. Since there is not so large area to be inundated, the runoff pattern of the area would be consistent with rainfall pattern. Rain water is collected to a few numbers of small rivers, which join a fairly large channel connecting the Riam Kanan with the Martapura river.

Sub-area B

It is noted that the vast extent of the area is occupied by peat which is submerged throughout the year. As the adjacent land, which is also low and flat, is subject to attack of floods, a very large area suffers from seasonal submergence. These areas other than the peat area are being used as paddy field depending on the degree of submergence.

The area is classified based on the depth and duration of inundation as follows:

Total catchment area (ha)	Category 1 (ha)	Category 2 (ha)	Category 3 (ha)	Category 4 (ha)
22,010	3,680	4,230	7,020	7,080

The above table indicates that about 7,000 hectares of land are submerged from early November, and additional 4,200 hectares from the beginning of December. Thetotal areas to be submerged are, therefore, 18,300 hectares including the area perenially submerged. The volume of storage water would be as big as 82 million m^3 in the middle of February.

Fig. 4-5 shows the rough relationship among the storage volume (submerged depth is converted to the depth to the total catchment area), rainfall and outflow in mm to the total catchment area. There is remarkable time lag between the rainfall pattern and outflow pattern. The peak discharge would take place in the middle of February whereas the biggest rainfall in January. The highest average discharge is estimated at 25 m^3/sec through the existing drains.

Sub-area C

Since the sub-area C is enclosed by roads and the river Martapura, there is no water coming from and going to the adjacent areas. Despite the fact that the area is low and flat, drainage is made naturally fairly well through the existing three small rivers. The area submerged before December and after April is small. Most of the area are used as paddy field.

The area is classified in view of drainage condition as follows:

Total catchemet area (ha)	Category 1 (ha)	Category 2 (ha)	Category 3 (ha)	Category 4 (ha)
7,790	70	7,270	450	-

Sub-area D

The area is characterized by the tidal effect from the river Barito. Since the western one-quater of the area is flat and lower than the high tide except for only the river side belt, the area is more or less submerged throughout the year. Three-fourths of the eastern area, which are little bit elevated and free from the tidal effect, are well developed as paddy field, because the area is flooded only from December to March with shallow water depth.

The area is classified based on the depth and duration of inundation as follows:

Total catchment area (ha)	Category 1 (ha)	Category 2 (ha)	Category 3 (ha)	Category 4 (ha)
28,570	3,380	16,500	2,870	5,820

Present Drainage System

Before making the future drainage plan in the project area, the watershed map is prepared based on the 1/5,000 maps with contour interval of 1 m as shown in Fig. 4-6 . The map indicates that the sub-areas B and D have fairly large ctachment basin, whereas the sub-areas A and C, small.

Based on the above map, the present drainage system is schematically presented as shown in Fig. 4-7 . The figures in the chart shows the catchment area of each of the existing rivers and drains. The possibility of using these rivers and drains in the future plan will be discussed in the subsequent sections in relation to the water level of the rivers to be drained.

Drainage Requirements

It is essential to maintain soil moisture in an adequate condition where the irrigation farming is practiced. If, on the other hand, the areas where drainage could not be made within a feasible range, those areas would have to be abandoned. This subsection deals with the drainage requirements for the areas where the drainage is practiced economically.

The drainage requirements in the project area are estimated on the basis of the following assumptions and procedures:

(1) Rainfall data covering 17 years from1960 to 1976 at Banjarbaru, 18 years from 1960 to 1977 at Syamsudin Noor

and 15 years from 1962 to 1977, except for 1968, at Banjarmasin are used. The data of each station are applied to the following sub-areas:

Sub-area	Data
A	at Banjarbaru
B	at Syamsudin Noor
C	at Banjarmasin
D	at Banjarmasin

(2) Design rainfall is estimated at 240.7 mm of 72-hour rainfall at Banjarbaru, 259.2 mm at Syamsudin Noor and 217.6 mm at Banjarmasin during the wet season paddy from December to March taking 10-year return period. Three days (72 hours) maximum in each year at the above three stations are tabulated in Table 4-8 . The probable rainfall is thus estimated as shown below.

Return period	Rainfall in mm Banjarbaru	Syamsudin Noor	Banjarmasin
5 years	209.4	217.9	187.0
10 years	240.7	259.2	217.6

(3) Relationship between rainfall and runoff distribution is assumed as follows:

Relationship between accumulated rainfall and total runoff in lowland

Accumulated rainfall (mm)	10	10-30	30-50	50-100	100-300
Runoff coefficient (f)	0	0.1	0.3	0.5	0.8

Relationship between runoff distributions

Rainfall (mm)	1st day (%)	2nd day (%)	3rd day (%)	4th day (%)
Less than 30	100			
30 - 50	70	30		
50 - 100	60	30	10	
More than 100	50	30	15	5

(4) Based on the above assumptions, the drainage requirements are estimated as shown on the following page.

Design Drainage Requirement in Sub-area A

Design rainfall (mm)	Accumulated rainfall (mm)	f	Runoff (mm) 1st day	2nd day	3rd day	4th day	5th day
110.7	110.7	0.8	44.3	26.6	13.3	4.4	-
69.8	180.5	0.8	-	33.5	16.8	5.6	-
60.2	240.7	0.8	-	-	28.9	14.4	4.8
Total			44.3	60.1	59.0	24.4	4.8
	(ℓ/sec/ha)		5.2	7.0	6.9	2.9	0.6

Design Drainage Requirement in Sub-area B

Design rainfall (mm)	Accumulated rainfall (mm)	f	Runoff (mm) 1st day	2nd day	3rd day	4th day	5th day
83.1	83.1	0.5	26.4	13.2	4.5	-	-
75.2	163.3	0.8	-	36.1	18.0	6.0	-
95.9	259.2	0.8	-	-	46.0	23.0	7.7
Total			26.4	49.3	68.5	29.0	7.7
	(ℓ/sec/ha)		3.1	5.7	8.0	3.4	0.9

Design Drainage Requirement in Sub-area C and D

Design rainfall (mm)	Accumulated rainfall (mm)	f	Runoff (mm) 1st day	2nd day	3rd day	4th day	5th day
89.2	89.2	0.5	26.8	13.4	4.5	-	-
65.3	154.5	0.8	-	31.3	15.7	5.2	-
63.1	217.6	0.8	-	-	30.3	15.1	5.0
Total			26.8	44.7	50.5	20.3	5.0
	(ℓ/sec/ha)		3.1	5.2	5.9	2.4	0.6

The drainage requirements, accordingly, are estimated at 7.0 ℓ/sec/ha in the sub-area A, 8.0 ℓ/sec/ha in the sub-area B and 5.9 ℓ/sec/ha in the sub-areas C and D, which are used for the design capacity of the drainage system in the project area.

Basic Plan for Drain

The method of drainage is classified into three types: (1) gravity drainage, (2) pump drainage, and (3) a combination of gravity and pump.

When the water level in the area is higher than the water level outside for most of the time, the method (1) is adopted with sluice gate or flap gate in the outfalls which is closed when the outside stage is higher than inside.

In very low-lying areas, where water can not be drained by gravity, the method (2) is adopted and is also used for lowering the groundwater table in the field. When the reclaimed land from the low-lying area is lower than the sea level or flood stage in the river during a certain period of time and the land has not enough storage capacity to keep the inside water level lower than the level required by only gravity drainage, the method (3) is adopted to achieve better drainage.

It is useally very common in planning the reclamation of a low-lying area to make investigation of the methods of drainage and ratio of gravity to pump drainage with relation to the benefits produced. Taking into account the higher operating costs of pump drainage than gravity, the provisional selection of the project area in view of the drainage condition will be made in the subsequent section, provided that the areas for irrigation farming are to be secured by gravity only. If other restrictions such as soil conditions and amount of available water permit, selection of additional areas, where pump drainage method should be adopted, would be made with a comparison between the investment cost and benefits.

Outside Water Level (water level along the rivers Martapura and the Barito)

There are three gauging stations along the Martapura and one the Barito river estuary. Fig. 4-8 shows the location of them, i.e. Banjarmasin (station X), Sungai Tabuk (station Y), Martapura (station Z) and Barito (station U). Out of the above stations, stations X and Z have made observation for a fairly long period (about two years), whereas stations Y and U were newly established. In analyzing the water level fluctuations, the data available at stations X and Z are mostly used. The data available at station Y are so limited, they are used only for correlation with those at stations X and Z. No data at station U are available at present.

It is stated in the previous section that the design discharge due to flood is estimated on the basis of the probable heavy rainfall which occurs once ten years. If the same probability is employed for the estimation of the water level on the rivers, the overall probability would become too small. Practically, therefore, the normal highest water level which takes place during the heavy rainy season is adopted as the provisional design high water level.

First of all, the tidal effect on the upmost stream in the project area, station Z, is examined. The regular daily fluctuation of the water level at station X indicates that the water level outside, the river Martapura, is under the effect of tide.

Fig. 4-9 shows maximum, minimum and average water levels in each month using the data available from September, 1976 to July, 1978 at station Z. Since the data available are only two years, the highest value that took place in March, 1977 and the lowest value that was recorded in September, 1977 are employed tentatively. The fluctuation of the water level due to runoff is estimated at 2.6 m, because the average elevation of the former is El. 2.3 m and the latter, El. -0.3.

The same analysis is made for the data available at station X as shown in Fig. 4-10 , which reveals that the daily maximum water level varies from El. 0.02 m (September, 1977) to El. 0.58 m (January, 1978). Therefore, the fluctuation of the water level due to runoff is estimated at 0.56 m.

As the data at station Y are too short to make the same procedure with the above, the proportional allotment is made based on the distance. Since the distance along the river course from station X to station Y and from station Y to station Z is 25.25 km and 24.55 km, respectively, the following calculation would be valid.

$$\frac{2.60 \text{ m} - 0.56 \text{ m}}{25.25 \text{ km} + 24.55 \text{ km}} \times 25.25 \text{ km} \doteq 1.03 \text{ m}$$

There are no available data to estimate the seasonal fluctuation in the Barito at station U so far. The data available at station X are provisionally used, taking into account the smaller seasonal variation due to runoff, which is assumed to be 0.44 m (the average difference of water level between the rainy season and the dry season at station X).

Table 4-9 shows the daily variation of the water level at stations X and Z in January, 1978. The table indicates that average fluctuations due to tidal effect are 1.41 m at station X and 0.15 m at station Z.

As the data on the daily fluctuations at station Y are not available in the flood season, the simultaneous observation among stations X, Y and Z is made in September, 1978 as shown in Fig. 4-11. The figure indicates that the daily fluctuation at station X was 1.64 m, whereas 1.36 m at station Y. Provided that this ratio is applicable in the flood season, the daily fluctuation at station Y due to tidal effect would be:

$$\frac{1.36 \text{ m}}{1.64 \text{ m}} \times 1.41 \text{ m} = 1.17 \text{ m}$$

It is necessary to standardize the tidal cycle to decide the drainage canal capacity. For this, data recorded at station X in January, 1979 are used. Fig. 4- 12 shows the monthly mean tidal cycle in the said month. The upper diagram illustrates the relationship between the time and the water level. The lower diagram illustrates the duration of time between the two same water levels from the ebb tide to the flood tide.

Superimposed in the diagram at station X is the same diagram at station Y. The latter is modified from the former assuming that the ratio of amplitude is 1.41 m to 1.17 m.

The standardiztion of tidal range is made as shown in Fig. 4-13 and 4-14 for stations X and Y, respectively, using the information obtained from Fig. 4-12

Since there are no data available at station U, the data obtained at station X are used. The tidal effect at station U is considered to be more or less the same with those at station X in the dry season. In this context, the monthly mean tidal cycle from August to October, 1977 is averaged. Through the same procedure as stated in Fig. 4-12 , the standardization of tidal range is made as shown in Fig. 4-15.

The longitudinal profile of the water level along the Martapura, taking into account the effects of flood and tide, is worked out provisionally as shown in Fig. 4-16 as the summary of discussions in this section. Based on this figure, the classification of the area in terms of drainability will be made in the following section:

Drainability

The foregoing sections showed that the drainability of the project area would be affected by both flood and tide. In view of the location, the drainage condition of the sub-area A depends mostly on the runoff from the upper stretch, that of the sub-area B depends on both runoff and tide, and that of the sub-areas C, D and E depends mostly on tide.

The drainability is classified into the following four categories:

Category 1 : Good. The ground level is higher than the water level outside throughout the year. No measures are needed in the outfalls.

Category 2 : Favourable. The submergence more than 30 cm does not last more than 24 hours. Sluice or flap gates are required in the outfalls.

Category 3 : Poor. In the rainy season, the submergence more than 30 cm lasts more than 24 hours. But in the dry season, the submergence more than 30 cm does not last with sluice or flap gates in the outfalls.

Category 4 : Bad. No gravity drainage can be made throughout the year.

In the previous sections, which deal with the present flood conditions, the discussion is made based on the total catchment area. However, in this section, the classification of the land will be made based on the areas which are effectively irrigable through the main irrigation canal, as the alignment of it has already been settled by the economical comparative studies.

Sub-area A

The sub-area A would be divided into two areas, sub-area A_1 and sub-area A_2, since the area is separated in terms of drainage by a road running from east to west as stated in the previous section. The drainability of part of the sub-area A_1 is poor due to depression in the central area. Whilst, the drainability of the most of the sub-area A_2 is very good.

Each of the sub-areas is classified as follows:

	Total area (ha)	Category 1 (ha)	Category 2 (ha)	Category 3 (ha)	Category 4 (ha)
Sub-area A_1	1,550	900	250	400	-
Sub-area A_2	2,110	2,060	50	-	-
Total area	3,660	2,960	300	400	-

The above table shows that drainability of about 400 hectares which are located in the central part of the sub-area A is poor, and no perfect drainage could be expected during the heavy rainy season by gravity from January to March. The submerging depth ranges from 30 cm to 60 cm depending on the ground elevation. This indicates that the rainy season paddy (improved variety) could not be introduced. However, it is recommeded that this area would be included in the project area, because it is located in the center of the sub-area A_1. The alignment of drains would be made to save this area in the dry season.

Sub-area B

The sub-area B would be divided into four areas in view of the location and the alignment of drains to be planned. The sub-area B_1 is the small area located between the Martapura and the road which connects Banjarmasin and Martapura cities rinning along the river Martapura. The sub-area B_2 is located along the Martapura road. The area is composed of present paddy fields and shrub lands. The sub-area B_3 which is located in the central part consists of swamp land of peat with trees and grasses. The sub-area B_4 is high land, which is located in the south and consists of plantation of rubber and wild land of alan-alang.

Each of the areas is classified in view of drainability as follows:

	Total area (ha)	Category 1 (ha)	Category 2 (ha)	Category 3 (ha)	Category 4 (ha)
Sub-area B_1	810	200	-	610	-
Sub-area B_2	8,370	3,380	4,800	190	-
Sub-area B_3	5,050	-	-	-	5,050
Sub-area B_4	4,150	4,150	-	-	-
Total area	18,380	7,730	4,800	800	5,050

The above table indicates that the sub-area B_3 with 5,050 hectares could not be drained. Therefore, the area is to be excluded from the Project in view of low drainability. Drainability of 800 hectares in the sub-area B_1 and B_2 is poor, and no perfect drainage could be expected by gravity during the heavy rainy season from January to March. The submerging depth varies between 30 cm to 60 cm depending on the ground elevation. This indicates that the rainy season paddy (improved variety) could not be introduced. But, it is proposed to include in the project area as these depressions scattered within the present paddy field which could be drained well. Since the remaining areas of 12,530 hectares could be favourably drained, these areas could be selected as the irrigable area, provided thatthe other conditions such as soils, land use, topography, etc. permit.

<u>Sub-area C</u>

The sub-area C would be divided into two areas in terms of the present land use. The majority of the area belongs to the sub-area C_1 which is well developed as paddy field. The sub-area C_2 which is located near Banjarmasin consists of coconut plantation.

Each of the areas is calssified in view of drainability as follows:

	Total area (ha)	Category 1 (ha)	Category 2 (ha)	Category 3 (ha)	Category 4 (ha)
Sub-area C_1	4,400	1,690	2,710	-	-
Sub-area C_2	920	-	920	-	-
Total area	5,320	1,690	3,630	-	-

The foregoing table indicates that the drainability of the whole area of the sub-area C is favourable. Double cropping of paddy rice can be expected throughout the area, since the submergence more than 30 cm in depth does not last more than 24 hours even in the heaviest rainy season with sluice or flap gates in the outfalls.

Sub-area D

The sub-area D could be divided into four areas based on drainage system. The sub-area D_1 is located on the north-east of the area and is encircled by roads. The direction of drain is toward the river Martapura. The sub-area D_2 occupies the north-west of the area and is bounded by a road on the east and the south. The direction of flow is toward the river Barito. The sub-area D_3 is situated in the south of the area and is separated from the sub-areas D_1 and D_2 by a road located at high land. The sub-area D_4 is located on the east of the area and is separated from the sub-areas D_1 and D_3.

Each of the areas is classified in view of drainability as follows:

	Total area (ha)	Category 1 (ha)	Category 2 (ha)	Category 3 (ha)	Category 4 (ha)
Sub-area D_1	4,990	1,860	2,640	490	-
Sub-area D_2	10,660	-	3,430	7,230	-
Sub-area D_3	7,120	1,300	5,820	-	-
Sub-area D_4	1,770	1,770	-	-	-
Total area	24,540	4,930	11,890	7,720	-

The above table indicates that the drainability of the area of 7,720 hectares situated along the Barito is very poor. Of course it is not impossible to make drainage even in the rainy season, since the tidal fluctuation is more than 1.8 m. For this, however, a fairly large scale polder would be necessary to protect the tidal effect. The final decision whether or not to include these areas in the Project is subject to other restrictions such as soils, amount of water available, etc.

Table 4-7 10-DAY IRRIGATION WATER REQUIREMENTS FOR IMPROVED VARIETIES

Description	Nov.		Dec.			Jan.			Feb.			Mar.			Apr.			May			June			
Schematic cropping pattern	Nursery Stage					135 - 140 - day varieti, IR - 26, IR - 34, etc.								Ripening Stage							Nursery Stage			
A. Consumptive water requirements																								
(1) Crop coefficient, k_c			0.75	0.76	0.85	1.06	1.20	1.31	1.37	1.33	1.23	0.98	0.47									0.75	0.77	0.87
				0.75	0.76	0.85	1.06	1.20	1.31	1.37	1.33	1.23	0.98	0.47									0.75	0.77
					0.75	0.76	0.85	1.06	1.20	1.31	1.37	1.33	1.23	0.98	0.47									0.75
						0.75	0.76	0.85	1.06	1.20	1.31	1.37	1.33	1.23	0.98	0.47								
							0.75	0.76	0.85	1.06	1.20	1.31	1.37	1.33	1.23	0.98	0.47							
								0.75	0.76	0.85	1.06	1.20	1.31	1.37	1.33	1.23	0.98	0.47						
(2) Average, k_c			0.75	0.76	0.79	[illegible]	[illegible]	[illegible]	1.09	[illegible]	1.25	1.24	[illegible]	1.08	1.00	0.89	0.73	0.47				0.75	0.76	0.83
(3) Pan evaporation			3.5	3.5	3.5	3.7	3.7	3.7	3.5	3.5	3.5	4.2	4.2	4.2	4.1	4.1	4.1	3.9				3.8	[illegible]	[illegible]
(4) Consumptive water requirement, mm/day			2.6	2.7	2.8	3.2	3.4	3.7	3.8	4.2	4.4	5.2	4.7	4.5	4.1	3.6	3.0	1.8				[illegible]	[illegible]	[illegible]
B. Percolation, mm/day			0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5				[illegible]	[illegible]	[illegible]
C. Washing water, mm/day			2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0				[illegible]	[illegible]	[illegible]
D. Effective rainfall, mm/day			5.9	6.9	[illegible]	8.9	7.6	7.5	6.9	6.6	5.4	6.0	7.3	7.4	4.9	3.8	4.6	4.2				3.7	[illegible]	[illegible]
E. (A)+(B)+(C)-(D), mm/day			-	-	-	-	-	-	-	0.1	1.5	1.7	-	-	1.7	[illegible]	[illegible]	[illegible]				1.2	[illegible]	[illegible]
F. Crop intensity to total area			1/6	2/6	3/6	4/6	5/6	1	1	1	1	1	1	5/6	4/6	3/6	2/6	1/6				1/6	2/6	3/6
G. Puddling water, 120 mm		2.0	2.0	2.0	2.0	2.0	2.0	-	-	-	-	-	-	-	-	-	-	-			2.0	[illegible]	[illegible]	[illegible]
H. Net irrigation requirement (E)×(F)+(G), mm/day		2.0	2.0	2.0	2.0	2.0	2.0	-	-	0.1	1.5	1.7	-	-	1.1	1.2	[illegible]	[illegible]			2.0	[illegible]	[illegible]	[illegible]
I. Irrigation water requirement(H) / E*, mm/day		2.9	2.9	2.9	2.9	2.9	2.9	-	-	0.1	2.2	2.5	-	-	1.6	1.8	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]

*Note : E = Irrigation efficiency, 68%

10-DAY IRRIGATION WATER REQUIREMENTS FOR IMPROVED VARIETIES

...ge

135 - 1?0 - day varieti, IR - 26, IR - 34, etc. — Ripening Stage

Nursery Stage — 120 - day variety IR - 30, IR28, etc. — Ripening Stage

	Jan.			Feb.			Mar.			Apr.			May			June			July			Aug.			Sept.			Oct.			Nov.		
[illegible]	1.06	1.20	1.31	1.37	1.33	1.23	0.98	0.47									0.75	0.77	0.97	1.18	1.32	1.37	1.29	1.06	0.47								
[illegible]	0.85	1.06	1.20	1.31	1.37	1.33	1.23	0.98	0.47									[illegible]	0.77	0.97	1.18	1.32	1.37	1.29	1.06	0.47							
[illegible]	0.76	0.85	1.06	1.20	1.31	1.37	1.33	1.23	0.98	0.47									0.75	0.77	0.97	1.18	1.32	1.37	1.29	1.06	0.47						
	0.75	0.76	0.85	1.06	1.20	1.31	1.37	1.33	1.23	0.98	0.47									0.75	0.77	0.97	1.18	1.32	1.37	1.29	1.06	0.47					
		0.75	0.76	0.85	1.06	1.20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]									0.75	0.77	0.97	1.18	1.32	1.37	1.29	1.06	0.47				
			0.75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.47									0.75	0.77	0.97	1.18	1.32	1.37	1.29	1.06	0.47			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.73	0.47				0.75	0.76	0.83	0.92	1.00	1.06	1.15	1.20	1.12	1.10	1.05	0.94	0.77	0.47			
[illegible]	3.7	3.7	3.7	3.5	3.5	3.5	4.2	[illegible]	[illegible]	4.1	[illegible]	[illegible]	3.9				[illegible]	[illegible]	4.5	4.5	4.5	5.1	5.1	5.1	5.5	5.5	5.5	5.4	5.4	5.4			
[illegible]	[illegible]	3.4	3.7	3.8	4.2	[illegible]	[illegible]	[illegible]	4.5	4.1	3.6	3.0	1.8				[illegible]	[illegible]	[illegible]	4.1	4.5	5.4	5.9	6.1	6.2	6.1	5.8	5.1	4.2	2.5			
[illegible]	0.5	0.5	0.5	0.5	0.5	[illegible]	0.5	[illegible]	0.5	0.5	0.5	0.5	[illegible]				[illegible]	[illegible]	[illegible]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0			
[illegible]	2.0	2.0	2.0	2.0	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0			
[illegible]	8.9	7.6	7.5	6.9	6.6	5.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]	2.8	2.7	1.1	0.9	2.0	2.6	2.7	2.9	3.2	1.9	3.4			
	–	–	–	–	0.1	[illegible]	1.7	–	–	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]	[illegible]	4.3	4.8	7.3	8.0	7.1	6.6	6.4	5.9	4.9	5.3	2.1			
[illegible]	4/6	5/6	1	1	1	1	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				1/6	2/6	[illegible]	4/6	5/6	1	1	1	1	5/6	4/6	3/6	2/6	1/6			
[illegible]	2.0	2.0	–	–	–	–	–	–	–	–	–		–			2.0	[illegible]	[illegible]	[illegible]	2.0	2.0	–	–	–	–	–	–	–	–	–			
[illegible]	2.0	2.0	–	–	0.1	1.5	1.7	–	–	[illegible]	[illegible]	[illegible]	[illegible]			2.0	[illegible]	[illegible]	[illegible]	4.9	6.0	7.3	8.0	7.1	6.6	5.3	3.9	2.5	1.8	0.4			
[illegible]	2.9	[illegible]	–	–	0.1	2.2	2.5	–	–	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	7.2	8.8	10.7	11.8	10.4	9.7	7.8	5.7	3.7	2.6	0.6			

Fig. 4-5 Relationship among Rainfall minus Evapotranspiration, Submergence and Runoff in Sub-area B

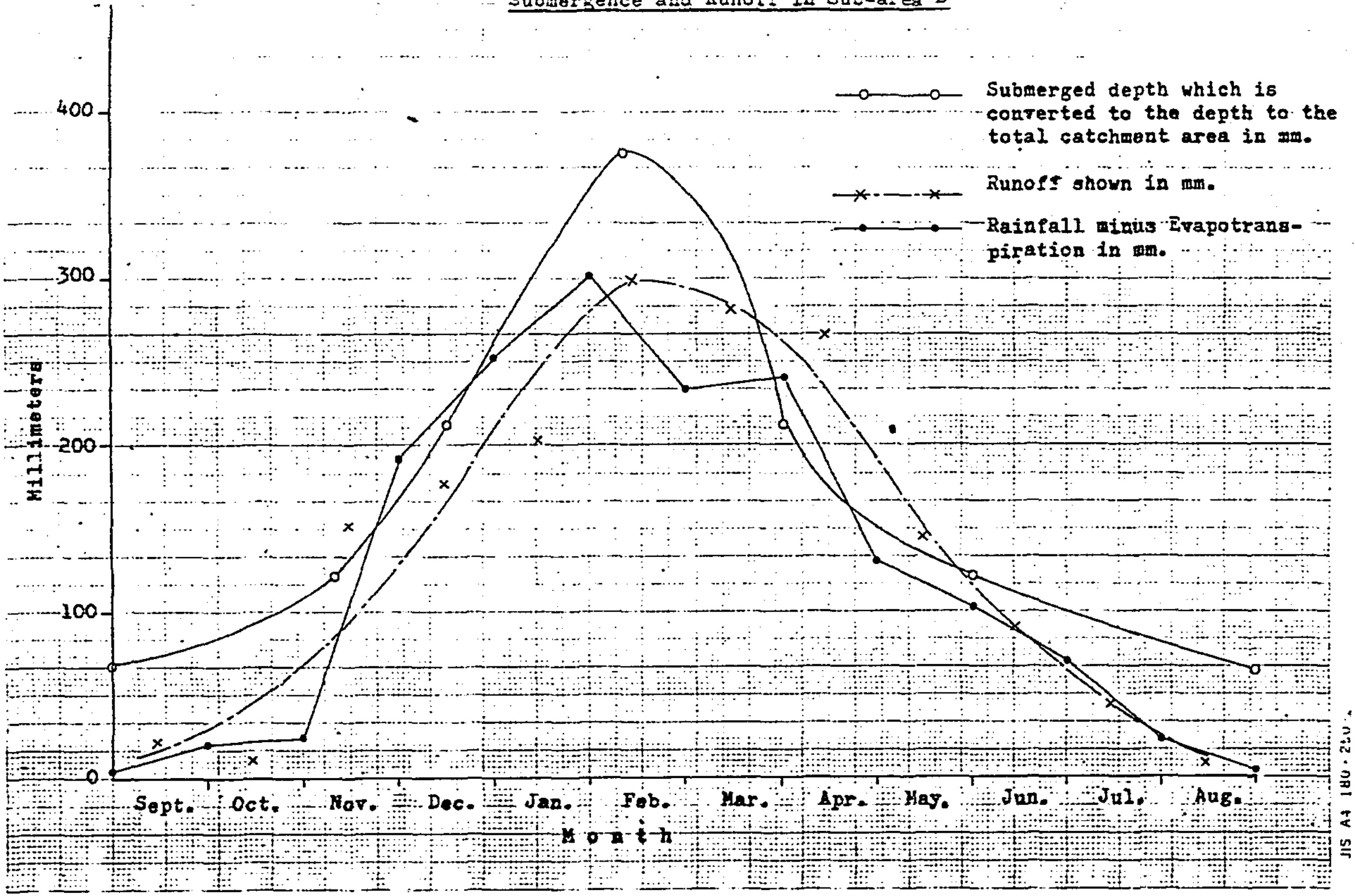


FIG. 4-6 WATERSHED MAP (SHOWN IN HA)

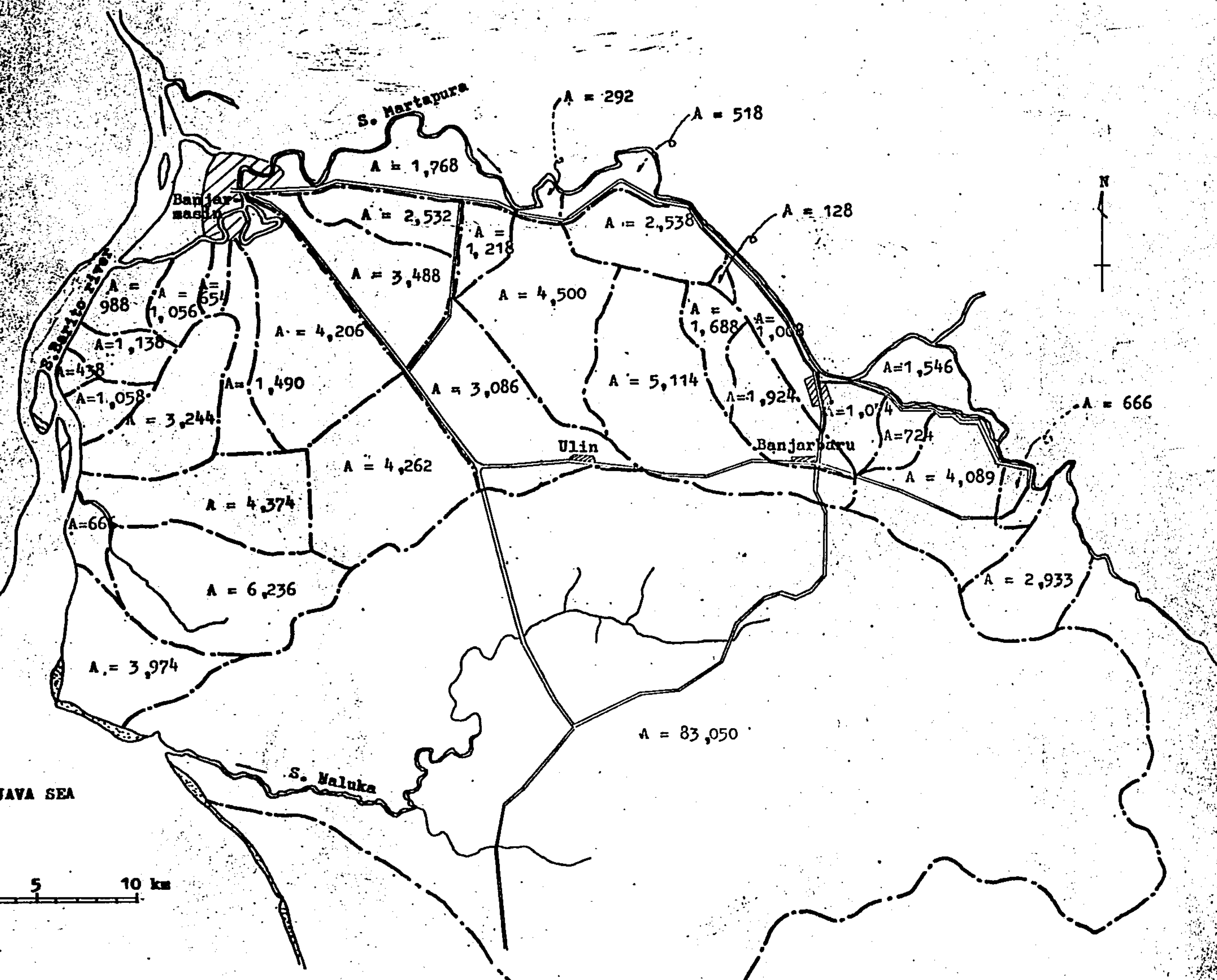


FIG. 4-7 PRESENT DRAINAGE SYSTEM

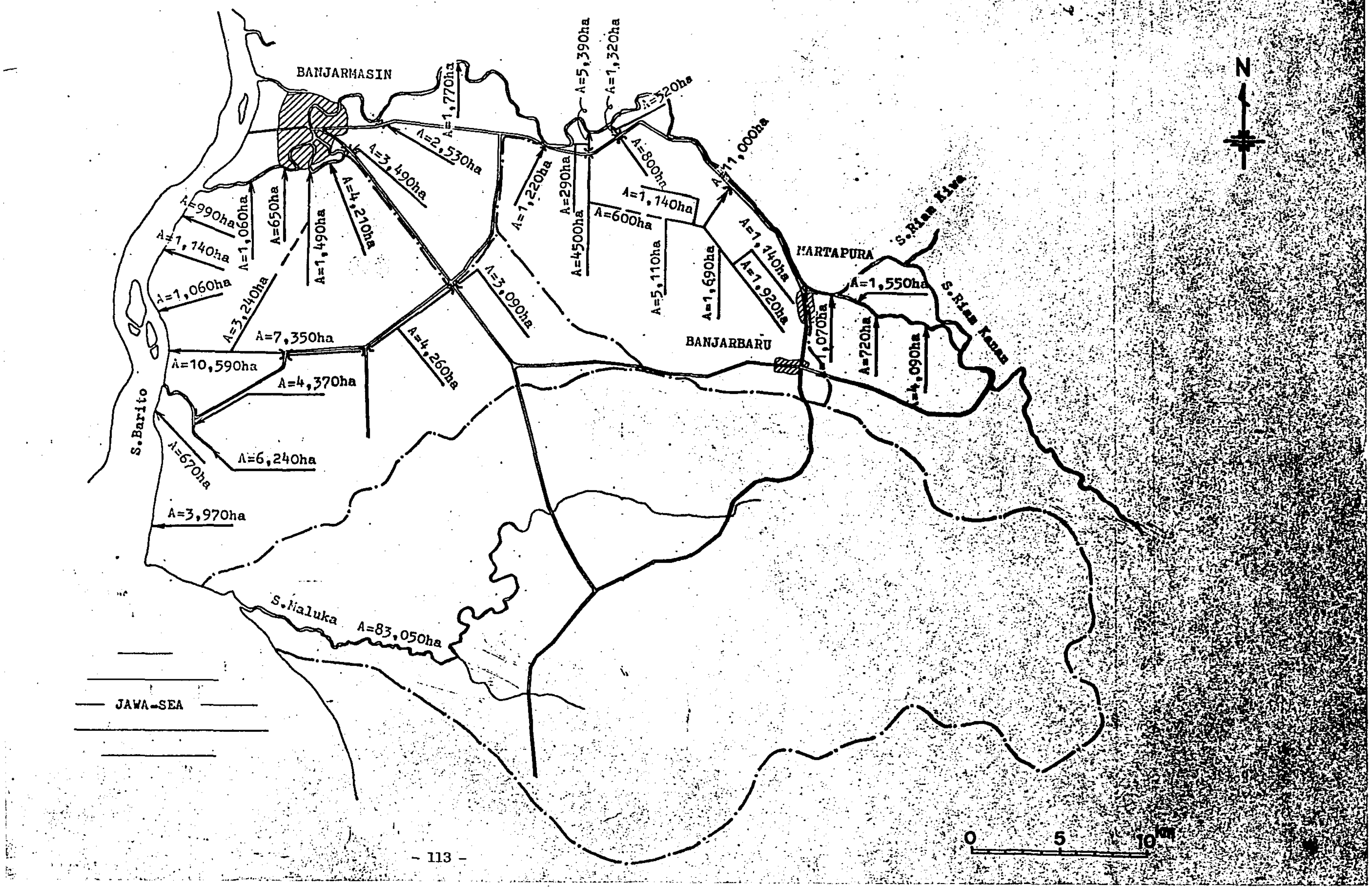


Table 4-8 Three days maximum rainfall (mm)

Year	Banjarbaru				Syamsudin Noor				Banjarmasin			
	1st Day	2nd Day	3rd Day	Total	1st Day	2nd Day	3rd Day	Total	1st Day	2nd Day	3rd Day	Total
1960	36	78	0	114	46	60	53.5	159.5	-	-	-	-
1961	74	77	24	175	56	80	14.1	150.1	-	-	-	-
1962	137	22	35	194	44	18	51	113	39	117	25	181
1963	2	163	10	175	72	12	158	242	127	135	8	270
1964	2	130	40	172	75	46.2	12	133.2	106	17	23	146
1965	44	0	88	132	63	28	45	136	78	26	26	130
1966	53	0	104	157	30	34.2	85	149.2	100	5	15	120
1967	118	0	31	149	26	14	297.5	337.5	68	1	63	132
1968	112	27	144	283	19	137	7	163	-	-	-	-
1969	110	0	68	178	75	16	36	127	101	0	37	138
1970	77	30	73	180	25	78	87	190	35	48	25	108
1971	148	26	20	194	128	95	32	255	-	-	-	-
1972	87	0	5	92	56	10	43	109	52	14	30	96
1973	35	92	19	146	64	5.2	72	141.2	2	3	175	180
1974	38	58	12	108	85.3	15.9	17	118.2	17	7	100	124
1975	142	71	12	225	19	68	44	131	34	85	19	138
1976	95	44	25	164	50	53	6	109	51	90	10	151
1977	-	-	-	-	52	69.4	32.1	153.5	23	60	30	113
	(46%)	(29%)	(25%)	(100%)	(34%)	(29%)	(37%)	(100%)	(41%)	(30%)	(29%)	(100%)

Fig 4-8 GENERAL MAP SHOWING THE LOCATION OF GAUGING STATIONS

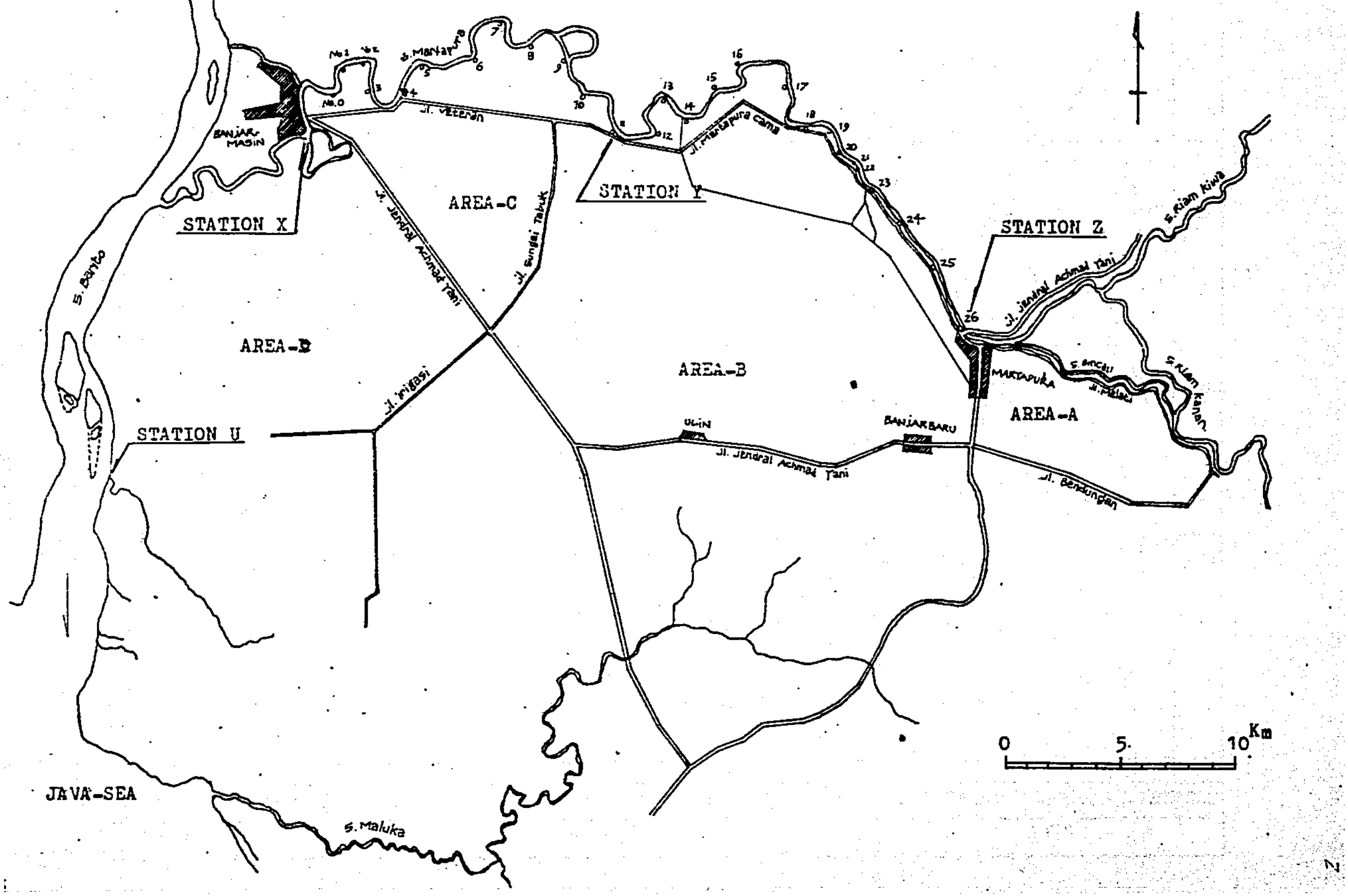


Fig. 4-9 WATER LEVEL IN THE MARTAPURA RIVER
(LOCATION: MARTAPURA, STATION Z)

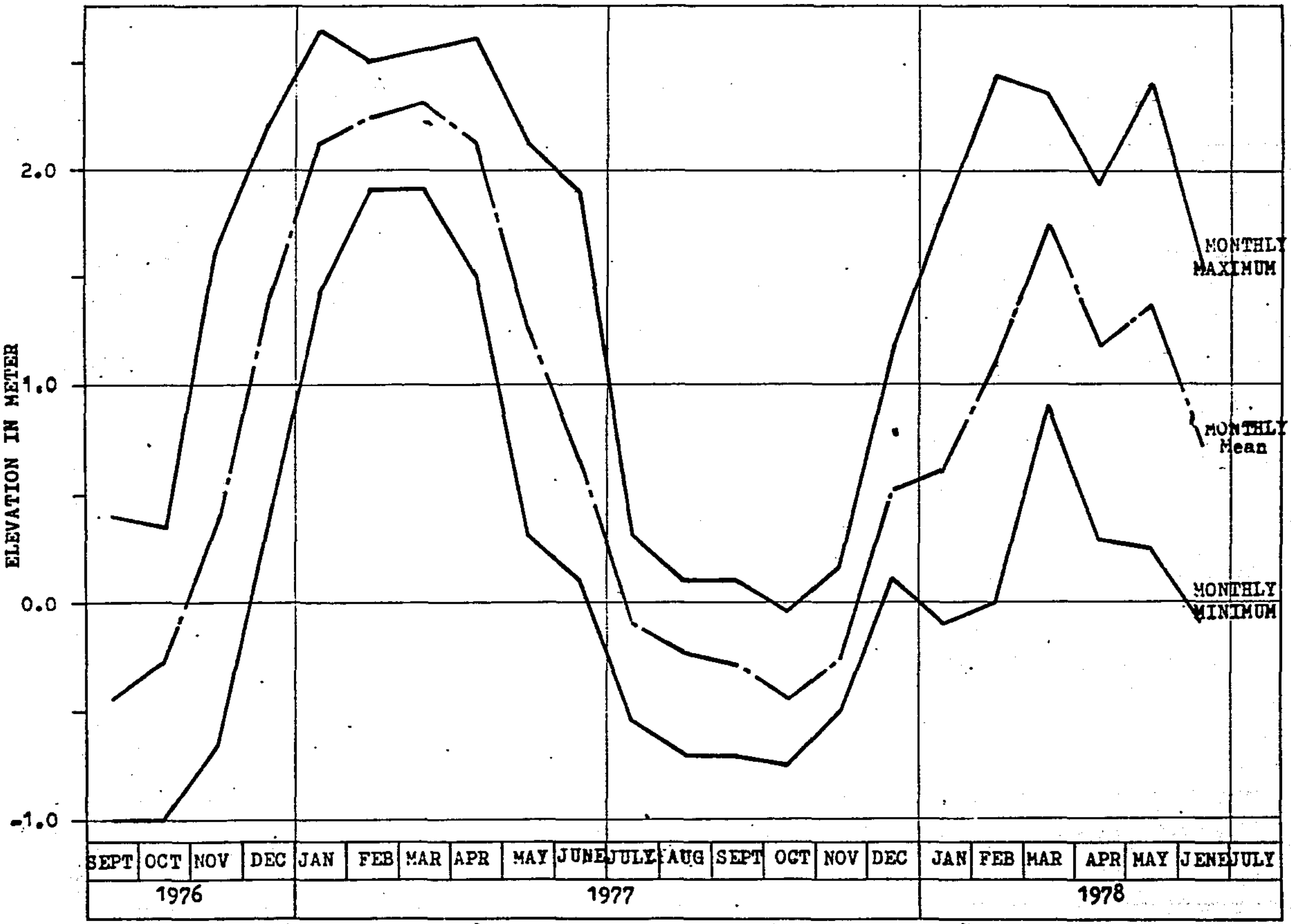


FIG. 4-10 WATER LEVEL IN THE MARTAPURA RIVER
(LOCATION: BANJARMASIN, STATION X)

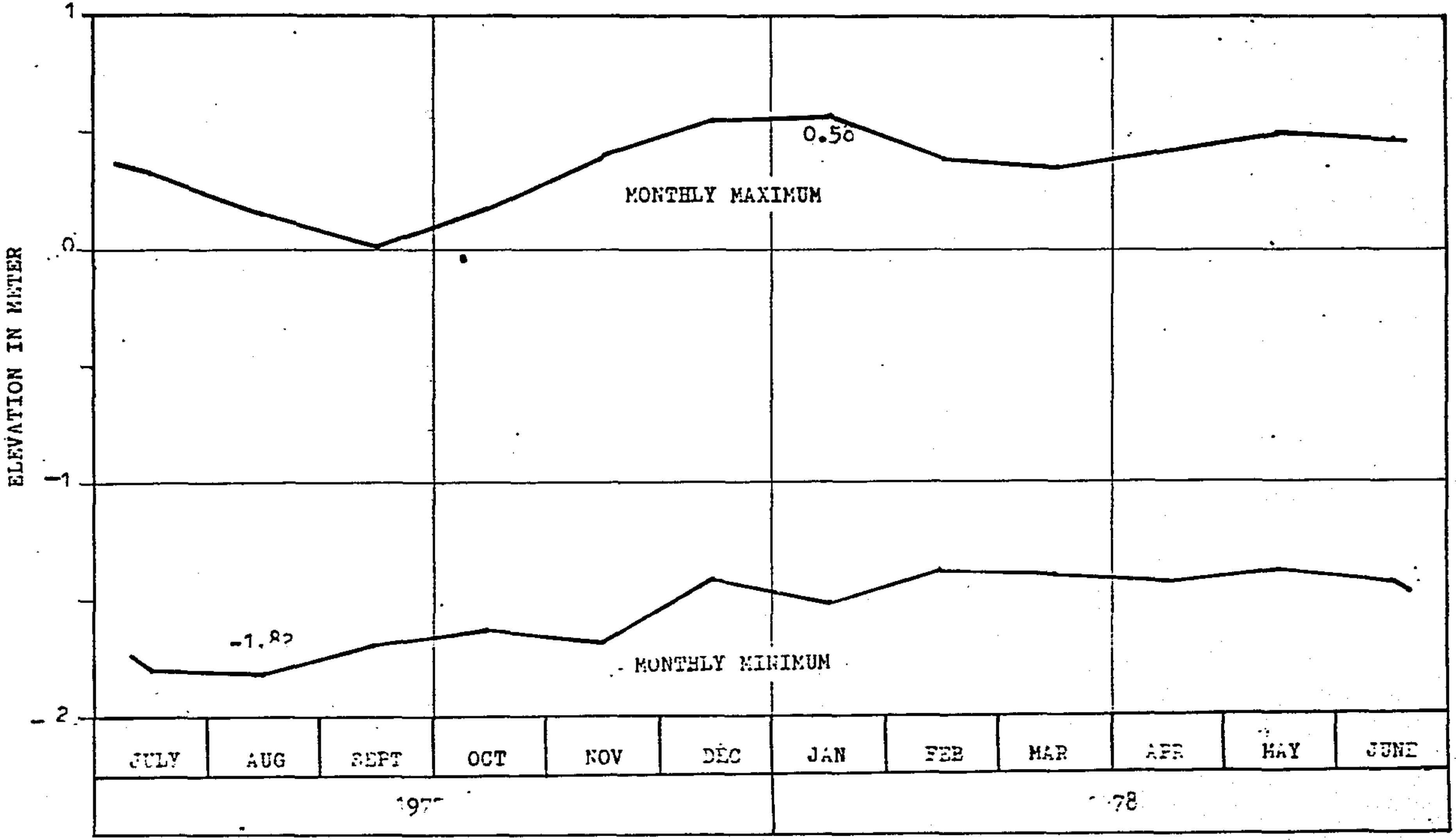


Table 4-9 Daily Variation of Water Level at Stations X and Z in January, 1978

Day	Martapura (Station Z)	Banjarmsin (Station Y)
1	0.05	1.34
2	0.05	1.19
3	0.05	1.25
4	0.05	1.23
5	0.10	1.47
6	0.40	1.53
7	0.10	1.26
8	0.25	1.74
9	0.20	1.91
10	0.10	1.76
11	0.20	1.84
12	0.10	1.67
13	0.20	1.64
14	0.15	1.45
15	0.20	1.29
16	0.15	1.21
17	0.10	1.27
18	0.20	1.37
19	0.30	1.32
20	0.10	1.43
21	0.10	1.40
22	0.35	1.50
23	0.10	1.60
24	0.05	1.50
25	0.30	1.46
26	0.10	1.51
27	0.05	1.48
28	0.10	1.34
29	0.10	1.24
30	0.10	0.89
31	0.15	0.95
Total :	4.550	43.840
Average :	0.147	1.414

FIG. 4-11 RELATIONSHIP OF WATER LEVEL FLUCTUATIONS AMONG MARTAPURA, SUNGAITABUK AND BANJARMASIN

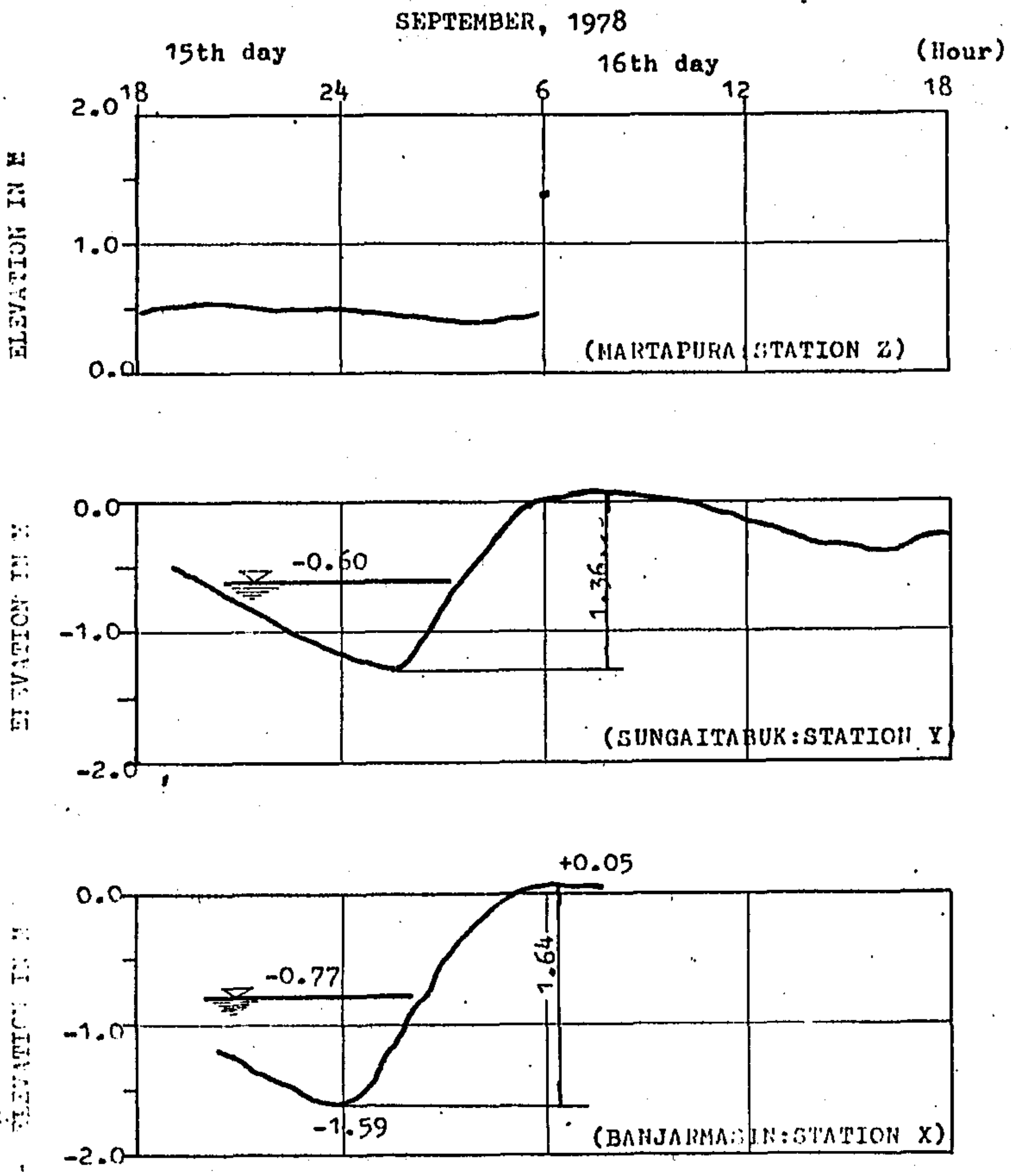
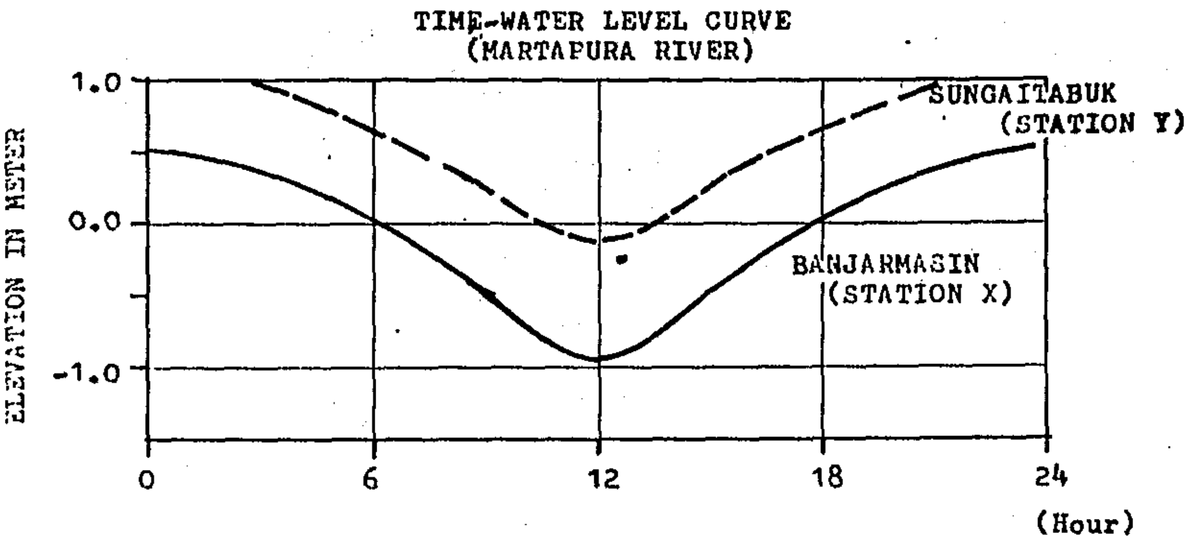


FIG. 4-12 MEAN DAILY TIDAL CYCLE (JANUARY, 1978)



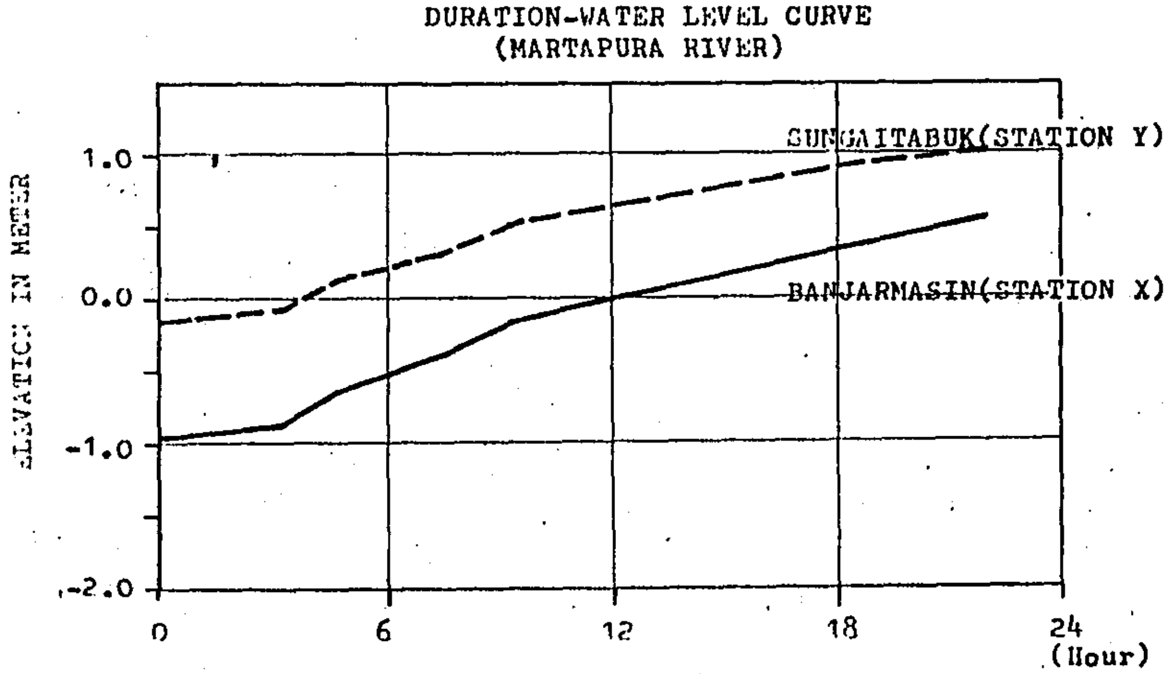


FIG. 4-13 STANDARDIZED TIDAL RANGE AT BANJARMASIN (STATION X)
(MARTAPURA RIVER)

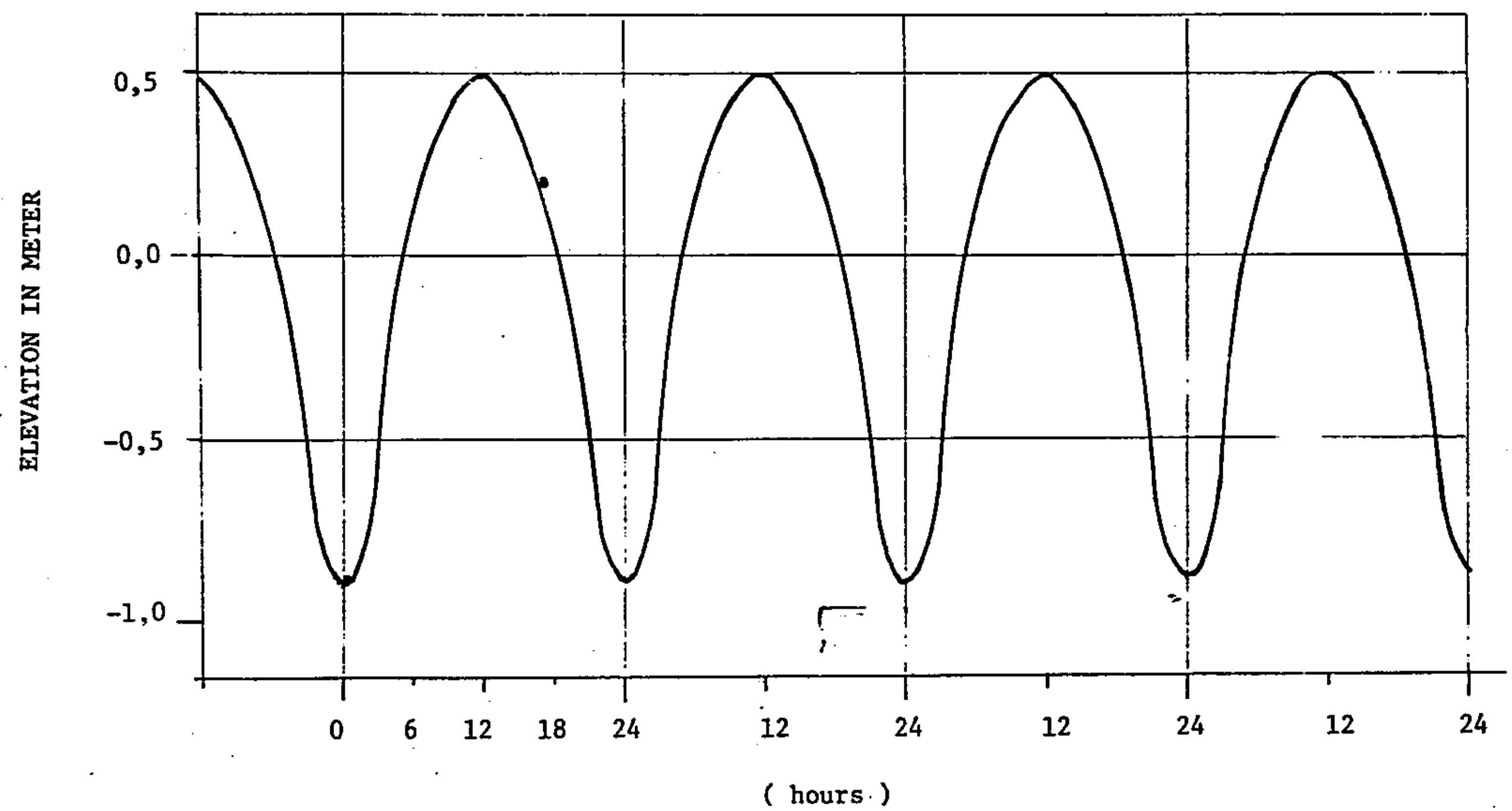


FIG. 4-14 - STANDARDIZED TIDAL RANGE AT SUNGAI TABUK (STATION Y)
(MARTAPURA RIVER)

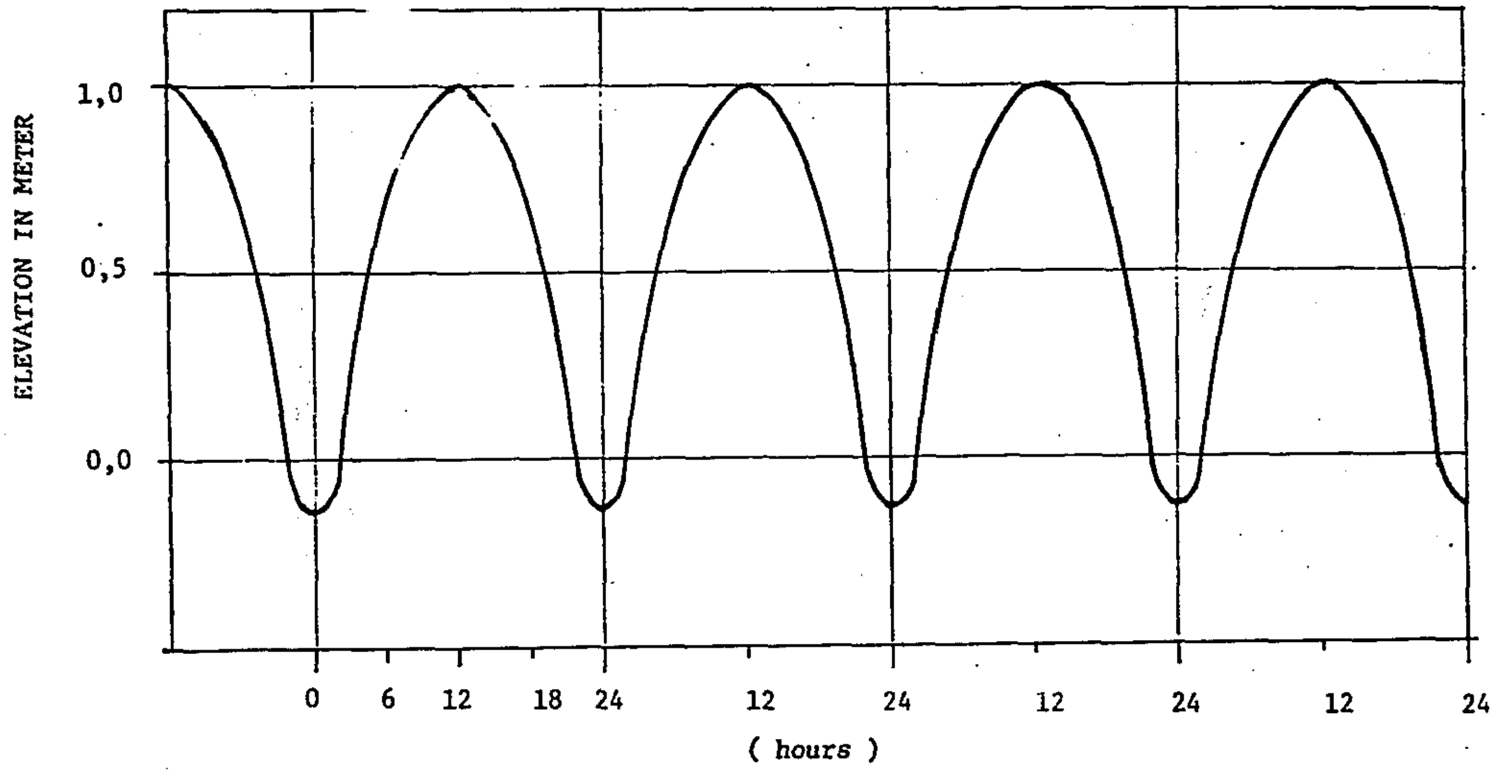


FIG. 4-15 STANDARDIZED TIDAL RANGE AT BARITO (STATION U)

(BARITO RIVER)

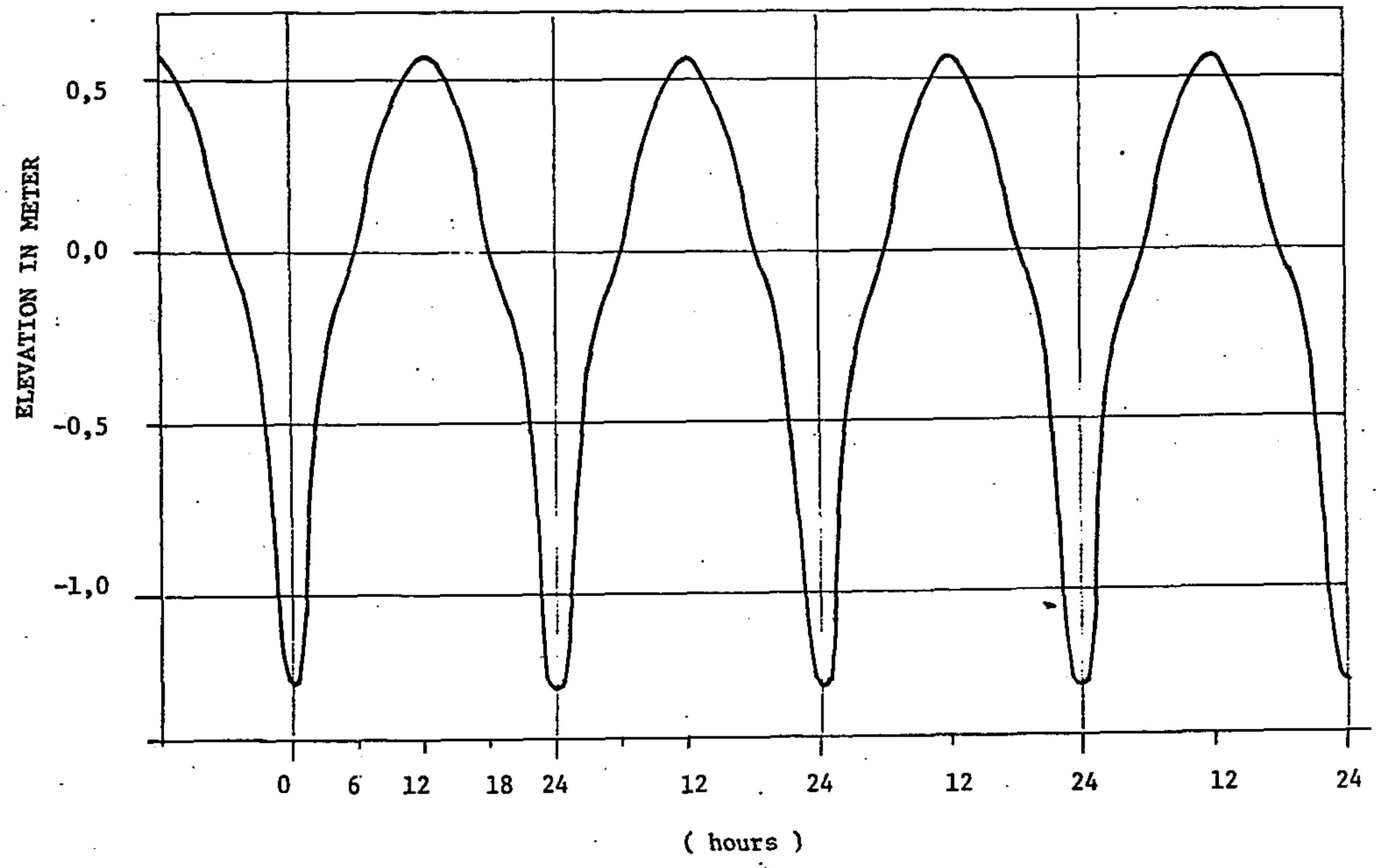
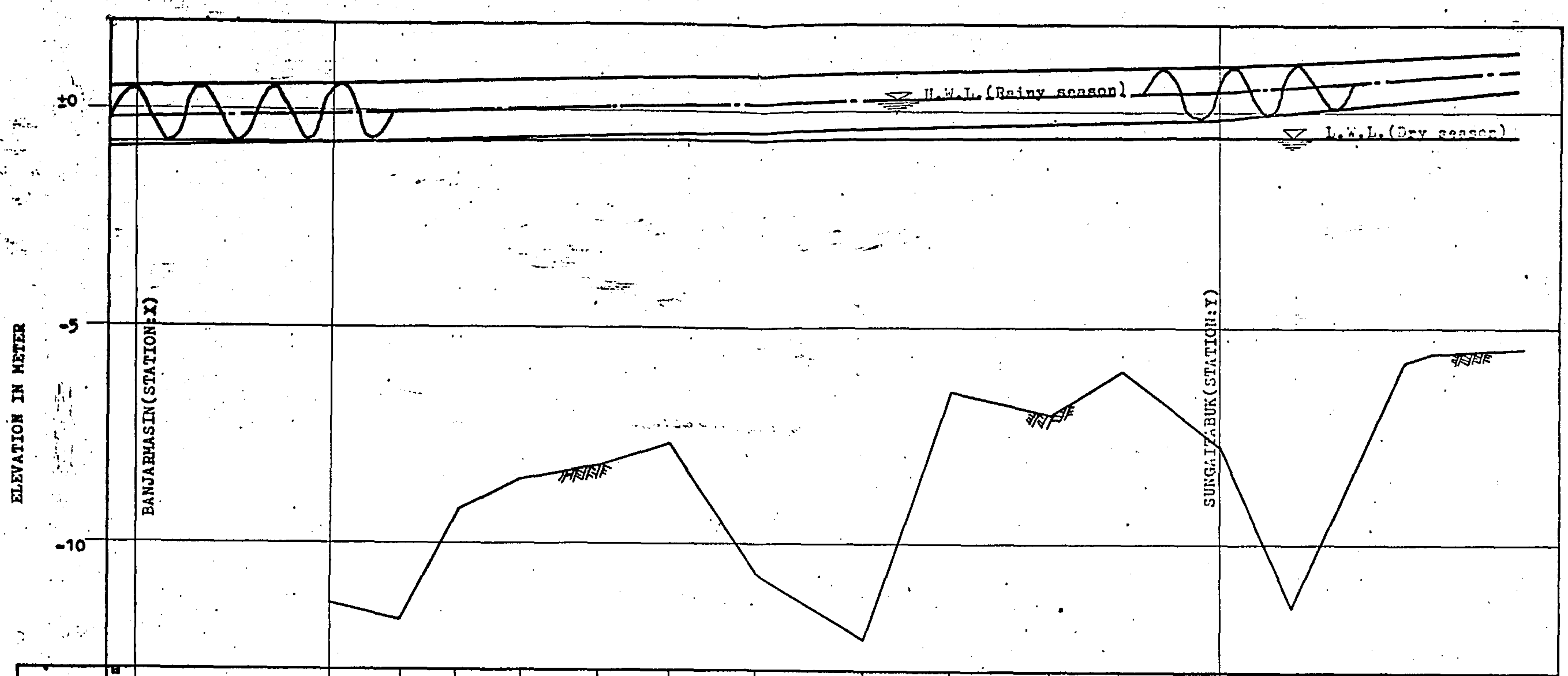
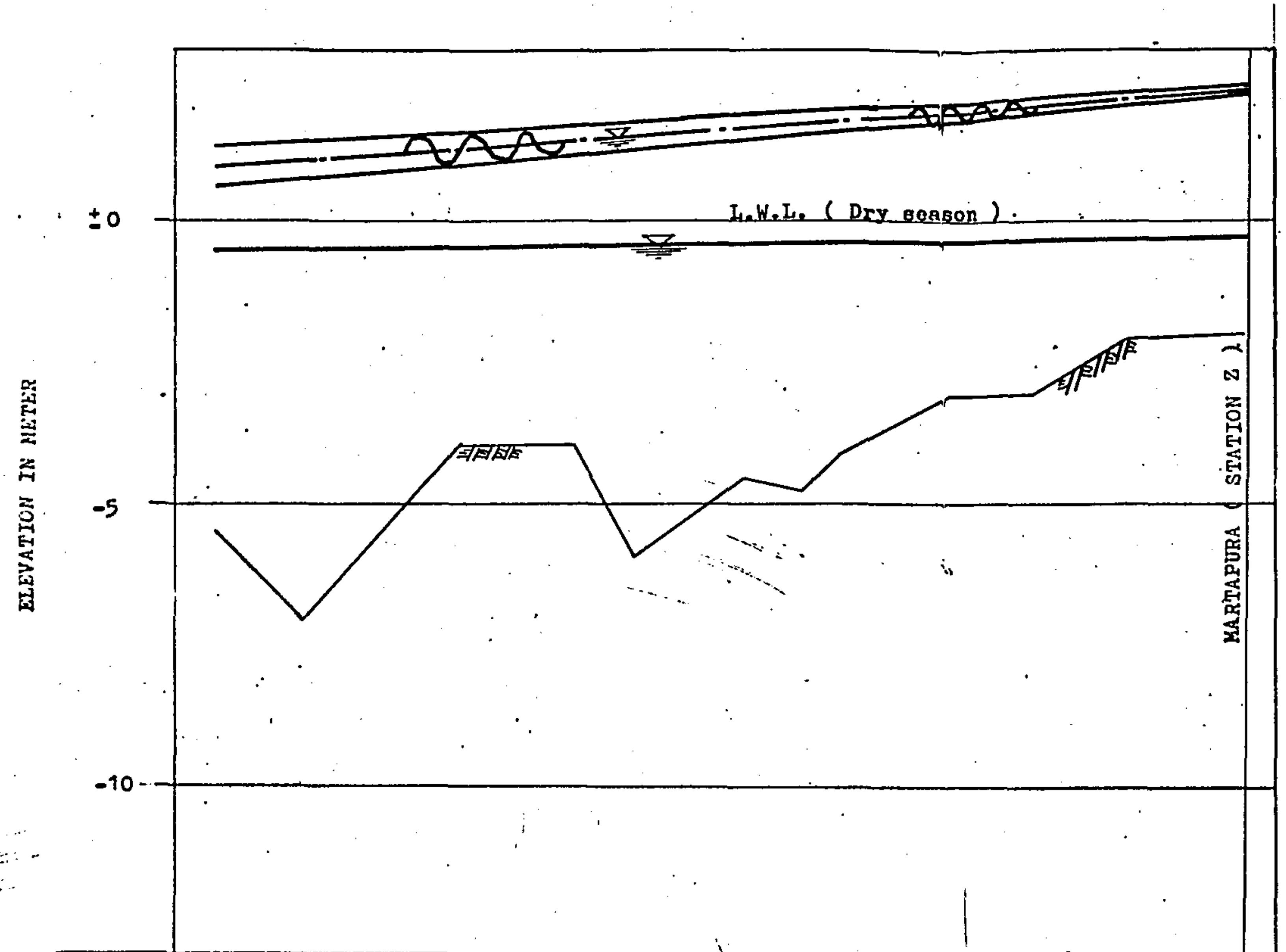


FIG. 4-16 LONGITUDINAL PROFILE OF WATER LEVEL ALONG THE MARTAPURA RIVER



Station NO.	Reduced Dist. (Km)	Average of H.W.L. (EL m)	Amplitude of H.W.L. (EL m)
Port (W.L.R)	0.00	-0.17	1.41
No. 0	4.40	-0.07	1.37
No. 1	6.00	-0.03	1.35
No. 2	7.75	0.01	1.34
No. 3	9.25	0.05	1.32
No. 4	11.05	0.09	1.30
No. 5	12.65	0.13	1.29
No. 6	14.65	0.18	1.27
No. 7	17.15	0.24	1.25
No. 8	19.10	0.28	1.23
No. 9	21.35	0.34	1.21
No. 10	23.00	0.38	1.19
No. 11	25.25	0.43	1.17
No. 12	26.85	0.55	1.10
No. 13	29.30	0.74	1.00
No. 14	29.95	0.79	0.97
No. 15	31.95	0.94	0.89

LONGITUDINAL PROFILE OF WATER LEVEL ALONG THE MARTAPURA RIVER



Station No	Reduced Dist. (Km)	Average H.W.L. (EL m)	Amplitu. H.W.L. (m)
15	31.95	0.94	0.89
16	33.55	1.06	0.83
17	36.10	1.26	0.72
18	38.10	1.41	0.64
19	39.16	1.49	0.59
20	41.00	1.63	0.52
21	42.10	1.71	0.47
22	42.77	1.77	0.44
23	44.66	1.91	0.36
24	46.13	2.02	0.30
25	47.83	2.15	0.23
26	49.80	2.30	0.15

4.4 PROPOSED PROJECT WORKS

4.4.1 Topographic Survey and Maps

As mentioned before, the topographic survey was carried out for preparation of the topographic maps necessary for the project study under the technical cooperation by the Japanese Government. The maps thus prepared are as follows:

(1) Topographic maps on a scale of 1 to 50,000 with contour interval of 25 m, covering the Barito river basin in which the whole project area is included.

(2) Topographic maps on a scale of 1 to 5,000 with contour intervals of 1 m in the flat plain and 2 m in the hilly area, covering the after-bay area on the Riam Kanan, the sub-areas A, B, C and a part of the sub-area D.

For the sub-areas E and F, the topographic survey by levelling was carried out to prepare the preliminary topographic maps on a scale of 1 to 20,000 based on the available photo mosaic (un-controlled) for the pre-feasibility study of these two sub-areas. The preparation of the map is on the way.

For preparation of these maps, detailed observation of tide was made at Takisung, about 60 km south from Banjarmasin, in 1972. Based on the result of analysis of the tide records thus obtained, new benchmark network, namely Takisung pile system (T.P. system), has been established in the Barito river basin. The above topographic maps are all prepared using this T.P. system.

On the other hand, there is another benchmark network established in 1953, namely Banjarmasin pile system (B.P. system), in the South Kalimantan . The existing structures, including the Riam Kanan dam, were constructed using this B.P. system.

The difference in elevation between these two systems was checked in connection with the field works for preparation of the 1/5,000 topo-maps in 1977. As a result, it is cleared that zero point elevation of T.P. system is 0.676 meter lower than that of B.P. system.

In connection with this feasibility study, the elevations related to the Riam Kanan dam such as water level in the reservoir, tail race level, etc. were checked by the Team using T.P. system. As a result, the original elevations shown in the as-built drawings of the dam and related structures and the new elevations checked using T.P. system at this time are as shown in the following page.

Location	Original elevation (m)	New elevation from T.P. system (m)
1. Crest of dam	66.000	66.707
2. Water level in reservoir		
F.W.L.	63.000	63.707
H.W.L.	60.000	60.707
L.W.L.	52.000	52.707
3. Water level of tail race		
F.W.L.	18.900	19.607
Max. W.L.	14.100	14.807

4.4.2 Diversion Weir

Selection of Site

A diversion weir has been proposed to be constructed at Sungai Asam, about 12 km downstream from the Riam Kanan dam, in the previous study reports. It was planned to adopt the Copure method for the construction of the diversion weir.

Detailed field reconnaissance of the proposed weir site was carried out for this study based on the detailed topographic maps on a scale of 1 to 5,000. As a result, another suitable site from the topographic point of view was found near the village Mandikapau, about 1 km upstream from the Sungai Asam site.

Further field reconnaissance was made in both upstream area of Mandikapau and downstream area of Sungai Asam for the alternative sites which might be found. In the downstream area of Sungai Asam, the elevation of both banks of the Riam Kanan is too low to construct the diversion weir suitable for this irrigation project. Under such topographic condition, a large scale diversion weir with a long crest will be required, which will call for high construction cost as compared with those at Sungai Asam and Mandikapau.

If the diversion weir is constructed in the upstream area of Mandikapau, the main irrigation canal will cross the manifold hilly area. Due to the increase of canal length and earthwok volume, the construction cost of the main irrigation canal would be high.

For the above two main reasons, the suitable weir sites are not considered in both upstream and downstream areas, except for the two sites already selected at Sungai Asam and Mandikapau. The sites are shown in Drawing No. 9.

Therefore, either Sungai Asam site (site-A) or Mandikapau site (site-B) is finally proposed for the Project. The comparative study on these two sites is made to determine the final weir site and the most suitable type of weir from both technical and economic points of view as presented below.

Topographic and Geological Investigations on Weir Sites

The plan table surveying and check levelling were carried out for the two sites. As for the site-A, the topographic map on a scale of 1 to 2,000 was prepared by the Indonesian Government based on B.P. benchmark system. This map was reviewed and revised by supplementary topographic survey carried out at this time using T.P. benchmark system. For the site-B, the topographic map on a scale of 1 to 1,000 was prepared by the Team using T.P. system.

Geological investigation of the site-A by core boring and test pits was made by the Indonesian Government in 1972. As described in the previous section 3.3.3 in this report, this site has favourable geological conditions for the foundation of the proposed concrete weir. From the geological reconnaissance, the site-B would also have favourable conditions for bearing the proposed concrete weir. The further detailed geological investigation by test drilling will be made to confirm the geological conditions of this site.

Hydrological Analysis of the Weir Sites

The discharges of the river Riam Kanan is completely controlled by the Riam Kanan dam. Hydrological conditions at the proposed weir sites depends entirly on the operation of the dam, power generation and flood control.

Small reservoir to be created by constructing the diversion weir will have a function as after-bay for regulating the daily variation of discharges released through power plants in order to obtain the stable irrigation water and to release some amount of water for the maintenance of the river Martapura. Hydrological values of the proposed diversion weir should be determined so that power generation should not be affected by the backwater caused by the construction of the weir.

The rating curve at the proposed weir sites is estimated using the Manning's formula with cross-checking by hydraulic calculation of non-uniform flow between Mali Mali, about 9 km downstream from the weir sites, and the Riam Kanan dam site, based on the following investigation and available data:

(1) River cross sectional survey at the proposed weir sites.

(2) The past flood traces obtained through interview with the people, especially for the floods in 1937 and 1961 estimated at more than 1,000 m^3/sec and 800 m^3/sec at Mali Mali, respectively.

(3) Available rating curves at three gauging stations on the Riam Kanan, Mali Mali, Awangbankal and Riam Kanan dam site.

(4) The reports on the Riam Kanan dam project and operation manual of the dam.

The estimated rating curve at the proposed weir sites is shown in Fig. 4-17

According to the design report /1 on the Riam Kanan dam, the peak flood discharge is 1,950 m^3/sec which is defined as 1.44 times the 100 year-flood peak. The regulated peak discharge from the dam is 500 m^3/sec in case of this flood.

The 100 year-flood peak at the Riam Kanan dam site is estimated at 1,400 m^3/sec, and the regulated peak discharge in this case is 420 m^3/sec as shown in Fig. 4-18

As mentioned before, the proposed diversion weir at the site-A would be concrete weir with embankment of about 800 m in length as shown in Drawing No.9. On the other hand, the diversion weir at the site-B would be concrete weir without embankment as shown in Drawing No.11. The maximum design flood discharge to be applied to each site will be as follows:

	site-A (m^3/sec)	site-B (m^3/sec)
Regulated discharge from dam	500	420
Flood from the remaining catchment area /2	150	110
Total	650	530

/1: Report on the design of emergency spillway for the Riam Kanan Project, Jan. 1971.

/2: 80 km^2 between the weir site and the Riam Kanan dam site.

The ordinary discharge at the proposed weir sites is considered to be the discharge from the power station plus discharge from the remaining catchment area. According to the design report on the Riam Kanan dam, maximum discharge from the power station is 87 m^3/sec and average daily discharge is 44 m^3/sec at the final stage. The discharge from the remaining catchment area is expected to be 4 m^3/sec. Therefore, ordinary and ordinary maximum discharges at the weir sites will be 48 m^3/sec and 91 m^3/sec, respectively.

Hydraulic calculation of the backwater from the proposed weir sites to the Riam Kanan dam is made in case of the design flood and the ordinary maximum discharge. The results of the calculation are shown in Fig. 4-19 and 4-20.

When the flood water level at the design flood time is 13 m in elevation at the weir sites, the water level in the tail race of the Riam Kanan dam would exceed the design flood water level, 19.607 m in elevation. If the water level of the ordinary maximum discharge is higher than 12 m in elevation at the weir sites, the water level in the tail race would exceed the design ordinary maximum water level, say 14.807 m in elevation.

Consequently, the crest elevation of the diversion weir should be determined so that the water level in the upstream of the weir does not exceed 13 m in elevation at the maximum design flood time and 12 m in elevation at the time of ordinary maximum discharge.

Regulating Capacity

As described in the previous section 4.1.4, the expected average discharge from the Riam Kanan dam is estimated at 42 m^3/sec. The maximum discharge from the dam is estimated at some 65.6 m^3/sec with 24 MW of peak power generation. The duration of this peak power generation would be 5 hours, making reference to the present actual operation pattern in Surabaya. With these figures, the regulating capacity required for the diversion weir is calculated as follows:

$$V = (65.6\ m^3/sec - 42\ m^3/sec) \times 5\ hours \times 3,600\ sec = 425,000\ m^3$$

Based on the topographic maps on a scale of 1 to 5,000, storage volume curves at both site-A and site-B were prepared as shown in Fig. 4-21

The fluctuation range of the water level in the after-bay necessary to regulate 425,000 m^3 and the water levels at the head of the main irrigation canal are tabulated on the following page and are shown in Fig. 4-21 in three cases of crest elevation of 11, 10 and 9 m in elevation at both site-A and site-B.

Crest elevation	Fluctuation range of water level (m)		Water levels at the head of canal (El.)	
	Site A	Site B	Site A	Site B
11	0.13	0.15	10.87	10.85
10	0.17	0.20	9.83	9.80
9	0.24	0.27	8.76	8.73

According to the report on the Riam Kanan Dam Project/1, annual sedimentation in the Riam Kanan reservoir was estimated at 86 m^3/year/km^2, based on the results of observation at Awangbangkal. With this figure, the 100 year life sedimentation in the after-bay from the remaining catchment area, about 80 km^2, is estimated as follows:

$$86\ m^3/year/km^2 \times 80\ km^2 \times 100\ year = 700{,}000\ m^3 < 2{,}700{,}000\ m^3 *$$

* Gross storage capacity in case of El. 9 m of crest elevation at the site-B.

Accordingly, total sedimentation would not exceed the capacity of the after-bay.

Determination of Diversion Weir Site and Crest Elevation

As mentioned before, the crest elevation of the diversion weir should be determined so that the water level in the upstream of the weir does not exceed 12 m in elevation at the time of ordinary maximum discharge. Considering the overflow water depth on the crest of the weir, the maximum crest elevation of the weir is determined to be 11 m. The minimum crest elevation of the weir required for the supply of irrigation water keeping suitable head is to be 9 m. Even with this variation of the crest elevations between 11 m and 9 m, there will be no variation of irrigated land to be served by the weir. The higher crest elevation would call for the higher costs for the construction of the weir and compensation for houses and lands to be submerged by the construction of the weir. Since the proposed main irrigation canal will be aligned avoiding the swamp area in principal, the canal route will be selected so as to pass through the elevated land as far as possible. This means that the lower crest elevation would require the higher construction cost of the canal due to the increase of excavation work.

In order to determine the most suitable weir site and its crest elevation, the comparative study is made, estimating the costs of

/1: Preliminary Report on the Riam Kanan Project, July in 1962.

the following items:

- Costs for concrete works and earth works for the construction of the weir
- Costs for earth works for the main irrigation canal
- Compensation costs for houses and lands to be submerged

The comparison of these costs is made for the following six cases:

Crest elevation (m)	Site A	Site B
9	Case A-1	Case B-1
10	Case A-2	Case B-2
11	Case A-3	Case B-3

The main features of the weir such as dimensions of the weir, hydrological values, etc. in the above six cases are shown in Table 4-10. The work quantities, costs of weir, main canal and compensation are shown in Tables 4-11, 4-12 and 4-13 , respectively. The unit costs used for this cost comparison are estimated, making reference to those for the similar irrigation projects completed and/or under construction in both the South Kalimantan and Java, and based on the survey results of the compensation.

The total costs of each case are summarized below.

Item	Site - A			Site - B		
	Case A-1	Case A-2	Case A-3	Case B-1	Case B-2	Case B-3
Weir	2,520	2,830	3,800	1,360	1,420	1,570
Main irrigation canal	9,260	8,960	8,670	9,650	9,340	9,050
Compensation	253	383	532	235	405	568
Total	12,033	12,173	13,002	11,245	11,165	11,188

* All costs in the above are shown in 1,000 US$.

From this cost comparison, the total costs in each case at the site-B are all lower than those at the site-A, and the case B-2 shows the lowest total cost. At the site-A, the total cost in the case A-1 is the lowest. It is concluded at present that the case B-2 is taken up as the most suitable type of weir for the following studies.

The preliminary design of the weir in the cases A-1 and B-2 are shown in Drawings No.9, No.10 and No.11, respectively.

4.4.3 Irrigation and Drainage Canal Systems

Definition of Canals

- Main canal is defined as the trunk canal which conveys water from the diversion weir to the entrance of the sub-areas.
- Secondary canal is defined as the canal which is diverted from the main canal to distribute water to each sub-area.
- Sub-secondary canal is defined as the canal which is diverted from the secondary canal to distribute water to each sub-divided sub-area.
- Tertiary canal is defined as the canal which is diverted from either the secondary canal or the sub-secondary canal to distribute water to each farm block with an interval of 600 m, and the length ranging from 800 m to 1,600 m.
- Field ditch (quaternary canal) is defined as the ditch which is diverted from the tertiary canal to each field patch with an interval of 400 m and a length of 600 m.

Definition of Drains

- Field drain (quaternary drain) is defined as the drain which corresponds with the field ditch (quaternary canal). The interval and the length are 400 m and 600 m, respectively.
- Tertiary drain is defined as the drain which collects water from the field drains and corresponds with the tertiary canal with an interval of 600 m. The length of the tertiary drain ranges from 800 m to 1,600 m.
- Sub-secondary drain is defined as the drain which collects water from the tertiary drains and corresponds with the sub-secondary canal.
- Secondary drain is defined as the drain which collects water from the sub-secondary drains.
- Main drain is defined as the drain which collects water from the secondary drains.

Main Canal

As stated in the previous sections, there are two restrictions, the existence of the Riam Kanan dam and the poor soil condition along the proposed main canal in determining the location and elevation of the intake weir and the main canal. Taking into account these, the water level at the head has been decided to be EL. 10.0 meters.

Drawing No.7 shows the alignment of the main canal, which would be proposed to be located at the lowest possible elevation to minimize the excavation works within the limits of favourable soil conditions or avoiding the swamp area. Due to the low elevation of the water level at the head and the undulating topography along the main canal route, the volume of soil excavation would be inevitably large.

The amount of water to be conveyed through the main canal would vary between 34 m^3/sec and 22 m^3/sec from the head to the end. The slope of the canal would range from 1/7,000 to 1/8,000. The verocity of flow would be between 0.4 m/sec and 0.5 m/sec, which would be favourable for unlined canal.

The length of the main canal would be 47.5 km from the head to the end (branching point of canals for Sub-area C and D). The type of the canal would be proposed to be unlined so far as the topographic and soil conditions permit. If the future investigation on these conditions would indicate the necessity for some measures, the lined canal with concrete would be proposed.

Two highway bridge, a few local road bridges, several checks with gates, diversion works and cross drains would be the principal structures on the main canal.

Secondary Alignments

The secondary alignments of canals and drains are referred to in Drawing No.7.

Alignments in Sub-area A

As stated in the previous section, sub-area A is subdiveded into two, the north (sub-area A_1) and the south (Sub-area A_2) in view of drainage, because it is separated by a road running from East to West and there are no incoming and outgoing of water between the two areas.

Sub-area A_1 is characterized by a polder surrounding the whole area, a depression in the center and a natural channel connecting the Riam Kanan river with the Martapura river a little to the west of the area. Since the water standing in the center would have to be drained, a secondary drain would be aligned to pass through the center of the area connecting with the Martapura river. The existing channel would be used as another secondary drain by improving its course and capacity.

In order to irrigate both banks of the former secondary drain, this would be placed between the two secondary canals. The area separated by the latter drain would be irrigated by extending one of the secondary canals to west.

Sub-area A_2 is characterized by its relatively steep slope and unduration topography. There are five natural depressions running from South to North. Five sub-secondary drains would be arranged in these depressions by connecting with the Riam Kanan river.

In order to irrigate the separated areas by the above drains, four sub-secondary canals would be needed. Each of the sub-secondary canal would be located between each of the sub-secondary drains.

Alignments in Sub-area B

Sub-area B is characterized by the vast extent of the unsuitable land located on the southern half of the area. The land consists of wasted swamp bush submerged throughout the year and wasted hilly area with alang-alang. As the land on the northern half which is used as paddy field at present is also low and flat, a very large area suffers from seasonal flooding.

In order to develop the suitable area on the northern half, it seems essential to protect the area from floods which come from the southern half. In this context, it would be proposed to provide this area with a main drain which would separate the two contrasted areas running from east to west and connecting with the Martapura river. The function of the main drain would be then to undertake all of the floods from the southern half.

The suitable land in the northern half is characterized by a shallow depression extending from east to west. It is expected that the rain water within this area would be collected to this depression. To drain this water, another main drain would be proposed to be located at the center of the area which would run from east to west and be drained to the Martapura river.

The said alignment of the main drains would separate the suitable land into two, one of which is located between the two main drains and the other, between the main drain and the Martapura river. In this context, two secondary canals would inevitably be necessary. One would be proposed to be located along the former main drain to irrigate the southern half and the other along the Martapura river to irrigate the northern half. The third secondary canal would be required to irrigate the southwestern part of the area.

The micro relief in the irrigable area would necessitate to arrange sub-secondary drains. Eight numbers of sub-secondary drain which runs from south to north and six numbers of the sub-secondary drain which runs from north to south would be proposed to be connected with the latter main drain. In order to irrigate the sub-divided areas by this drain, 13 numbers of sub-secondary canals would be needed.

Alignments in Sub-area C

Since sub-area C is enclosed by roads, there is no water coming from the adjacent areas. (In the description of the present condition of this area, the area facing to the Martapura river is included in the topic, but at the stage of delineation this area is excluded.) Despite the fact that the area is low and flat, drainage is made naturally fairly well through the existing two small rivers connecting the Martapura river.

There would be no competition to use these rivers as secondary drains by improving their capacity because these are located at the lowest parts of the area. Since these drains separate the area into three, three secondary canals would inevitably be necessary to irrigate each subdiveded area.

Alignments in Sub-area D

Sub-area D could be divided into three areas in view of the future drainage system. Sub-area D_1 is located on the northeast of the area and is encircled by roads. The direction of drain is toward the Martapura river. Sub-area D_2 occupies the northwest of the area and is bounded by roads on the east and the south. The direction of flow is toward the Barito river. Sub-area D_3 is situated in the south of the area and is separated from sub-area D_1 and D_2 by a road located at higher land.

As there are two small rivers draining into the Martapura river in sub-area D_1, these would be used as secondary drains by improving thier courses. Since these two secondary drains and another subsecondary drain divided the area into three parts, three secondary canals would be inevitably necessary to be constructed. The micro relief in this subarea would necessitate to arrange sub-secondary drains. The number would be six excluding the one stated above. To correspond with these subdivided areas, the same number of the sub-secondary canal would be needed.

For the development of sub-area D_2, two numbers of artifcially made secondary drain would be required toward the Barito river, because there are no notable existing drains at present. Irrigation water necessary for thus subdivided four areas would be fed by the same number of either secondary or sub-secondary canals.

In sub-area D_3, one main drain would be proposed to be located along the road which separates the area from sub-area D_1 and D_2.

This would collect all of the waters from the upper reaches. For the remaining areas, two secondary drains would be needed. The areas thus subdivided into three would be favourably irrigated by two secondary canals. According to the micro relief, four sub-secondary drains and five sub-secondary canals would be aligned.

4.4.4 Tertiary Development

General

This subsection deals with the basic consideration of the alignment of the tertiary and downwards. Fig. 4-22 is referred to in this context.

The preliminary survey on the present farmers' status indicate that the average land holding is about 1 hectare per house hold with the range between 0.5 hectare and 2.0 hectares (more than 80 %), and the area of one field patch is smaller than 2 hectares. The basic area of 2 hectare, which satisfy these two conditions, is adopted to make the alignment of the tertiary development.

Shape and Size of Field Block

The shape and the size of the field block are planned to minimize the construction costs within the permissible limits of various conditions. Therefore, (a) the length of the longer side of the field block is planned to become equal to the permissible length of the quaternary canal, that is, 600 m, (b) the length of the shorter side of the field block is determined to be 200 m taking into account the distance from the quaternary canals and minimum allowable drainage condition of each field patch, (c) the size of the field block would become, in principle, 200 m x 600 m (12 hectares)

Provided that the average land holding would be 2 hectares, it is expected that six house holds would be accomodated in one farm block.

Irrigation Canals

Since the topography of the Project area is almost flat or very gentle in slope, it is suggested, in principle, to separate the canals for irrigation and drainage completly in order to make the perfect control of the water in the fields.

The alignment of the canal networks would be necessarily settled according to the shape and size of the field block. The distance between the turnouts on the sub-secondary canals would be 600 meters and the distance between the adjacent two tertiary canals, which are diverted from the said turnouts and aligned in parallel each other, would be 600 m. Therefore, the length of each quaternary canal would be 600 m with an interval of 200 m.

The type of tertiary canals and downwards is planned to be of earth in order to minimize the construction costs. The cross sections of the tertiary canals are designed to convey the peak discharge provided that the irrigation for one block lasts for 5 days. The design capacity of the quaternary canals are designed to be the same throughout the whole line.

Drainage Canals

The arrangements of drains would be decided according to the shape and size of the field block, and the alignment of the canal networks. The length of the quaternary drains would become 600 m and the interval between the two, 200 m. Therefore, the quaternary drains join the tertiary drain, which is aligned to make the right angle with them, in every 600 m.

The drainability of the Project area is fairly poor on the whole. The depth of the groundwater table from the surface is assumed to be less than 1 m even in the non-irrigated period. During the irrigation period, it is expected that the groundwater would rise and be connected with the submerged water in saturated cindition.

For this kind of fields, it is preferable for canals to have the capacity to drain the groundwater. However, as stated previously, in view of the high water surface elevation of the outside and construction costs, it is proposed to design the canals to have the capacity to drain the surface water only.

Farm Roads

The government intends to introduce farming machinery to the Project area in future. It is, therefore, proposed to construct the farm roads in a minimum density or at least along the tertiary canals. The width and height are to be 3.5 m and 0.3 m, respectively.

4.4.5 Road Network

In the Project area, there is one trunk road paved with asphalt which connects Banjarmasin with the Riam Kanan dam. Other than this, there are a few earth roads. One is located along the Martapura river, which links sub-areas A, B and C with Banjarmasin. Two local roads connect sub-area D with Banjarmasin.

For the Project, three kinds of earth roads would be proposed.

One would be constructed along the main canal. This would be of laterite paved type with 5.0 meters in width and 0.5 meter in height. The other would be made along the secondary canal. This would also be of laterite paved type with 4.0 meters in width and 0.3 meter in height. The third is aligned along the tertiary canal (See sub-section 4.4.4). No pavement would be made in this type.

The road network other than the above is shown in Drawing No. 7. These would be proposed to connect the highway with the main canal, the main canal and a sub-ares, a local road and a secondary canal, a secondary canal and a secondary canal, etc. The type would be depend on the roads which would be linked each other.

Fig. 4.17 Rating Curve at Weir Site

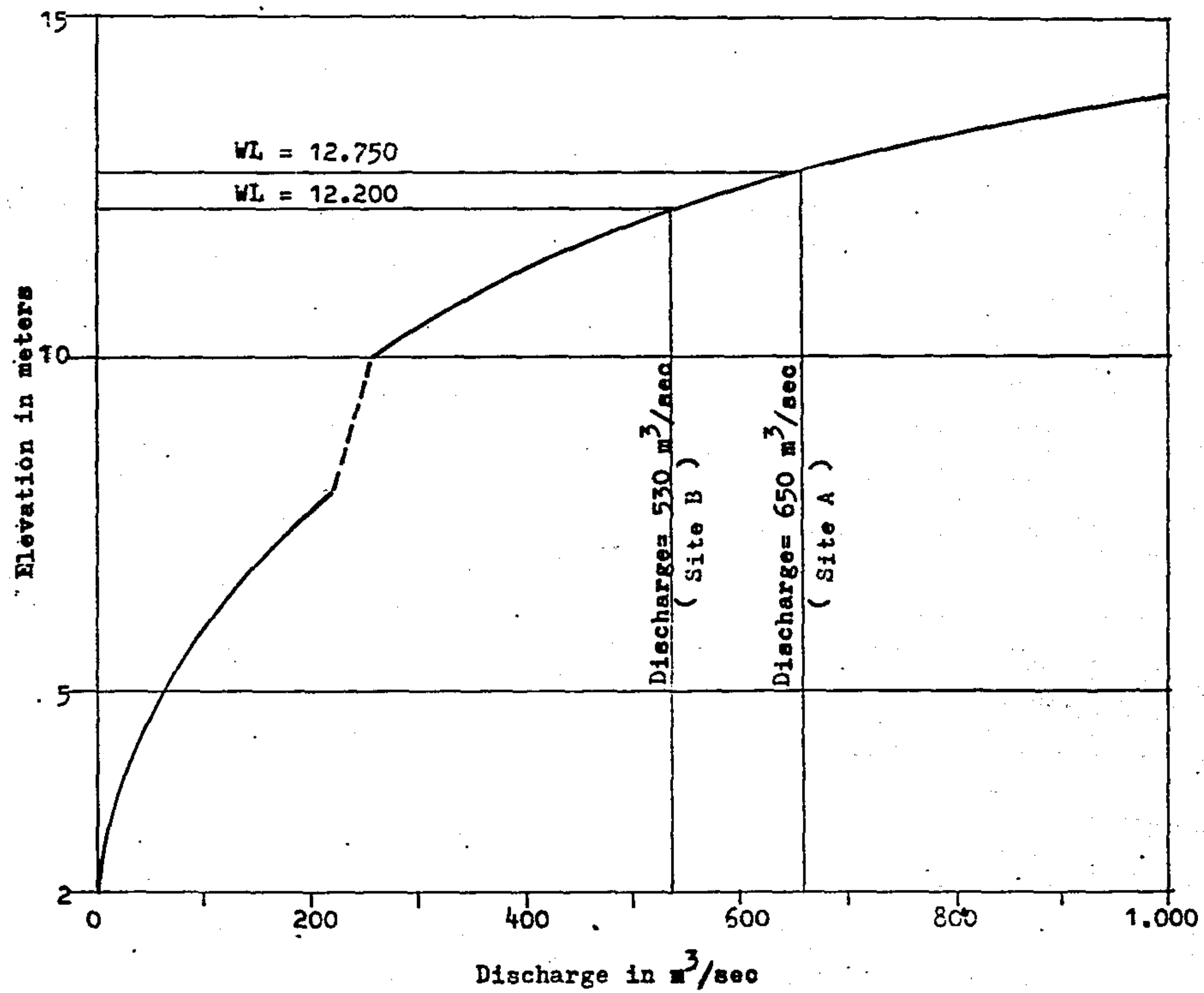


Fig. 4-18 Regulated Flow and Reservoir Water Level

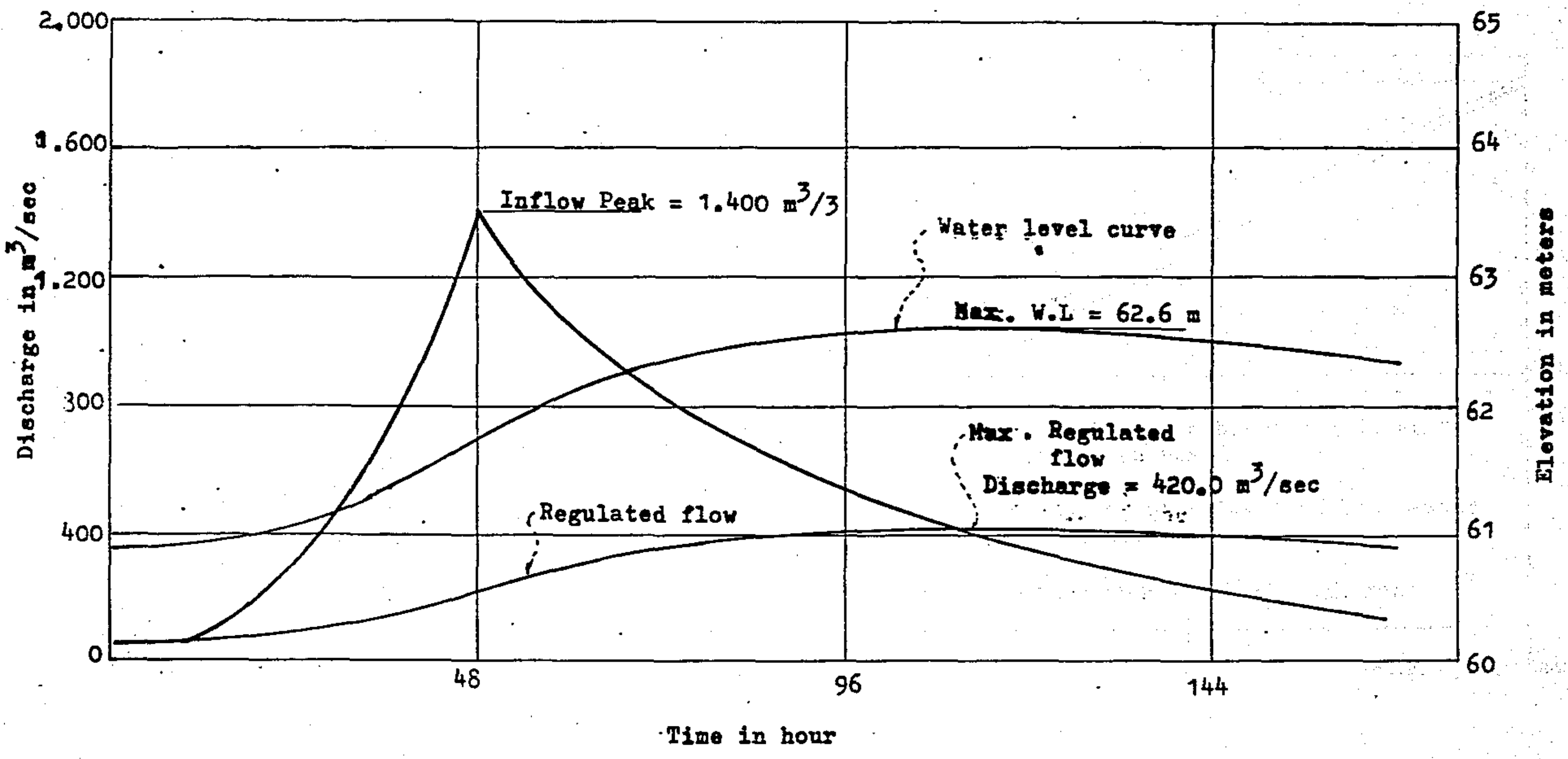


Fig. 4-10 **Back Water Curve**

(Discharge = 500 m^3/ sec /1)

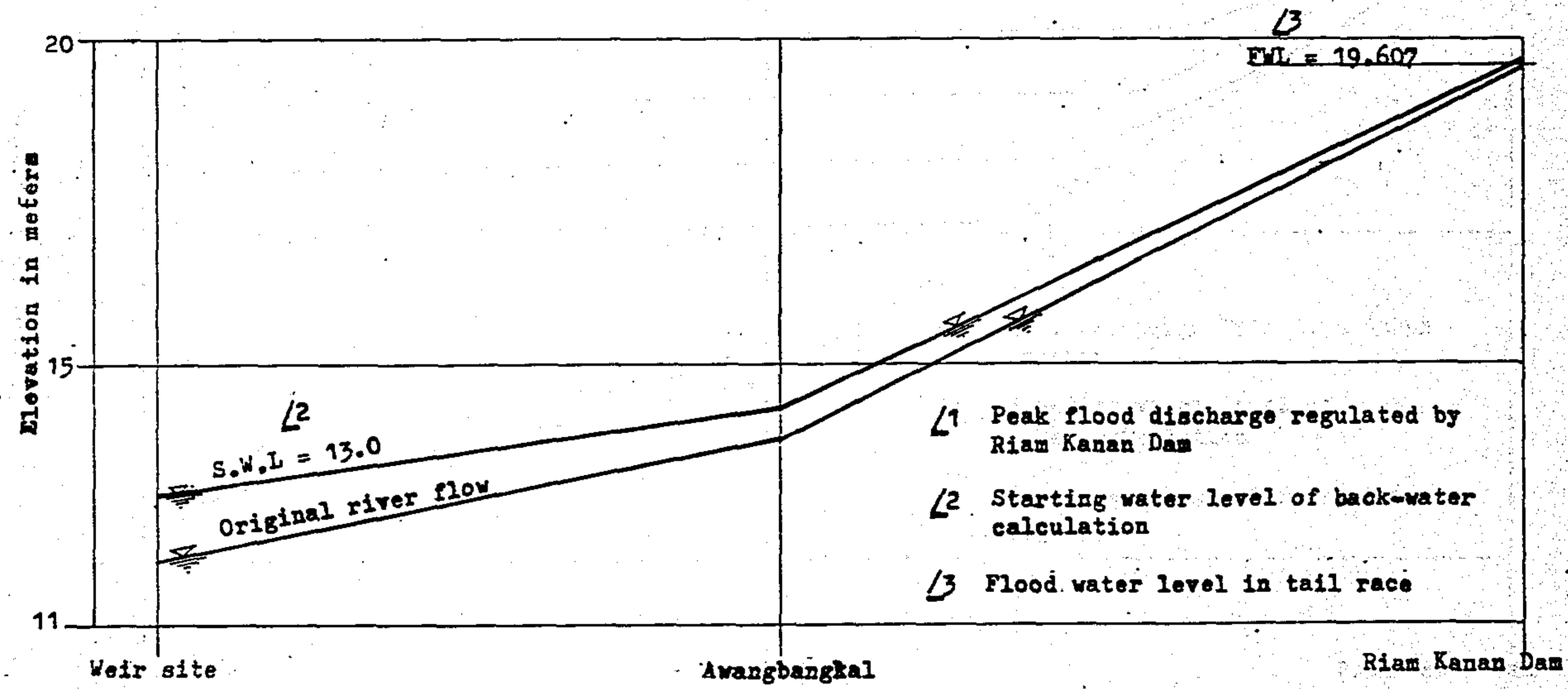


Fig. 4-20 Back Water Curve

(Discharge 87 m^3/sec ∠1)

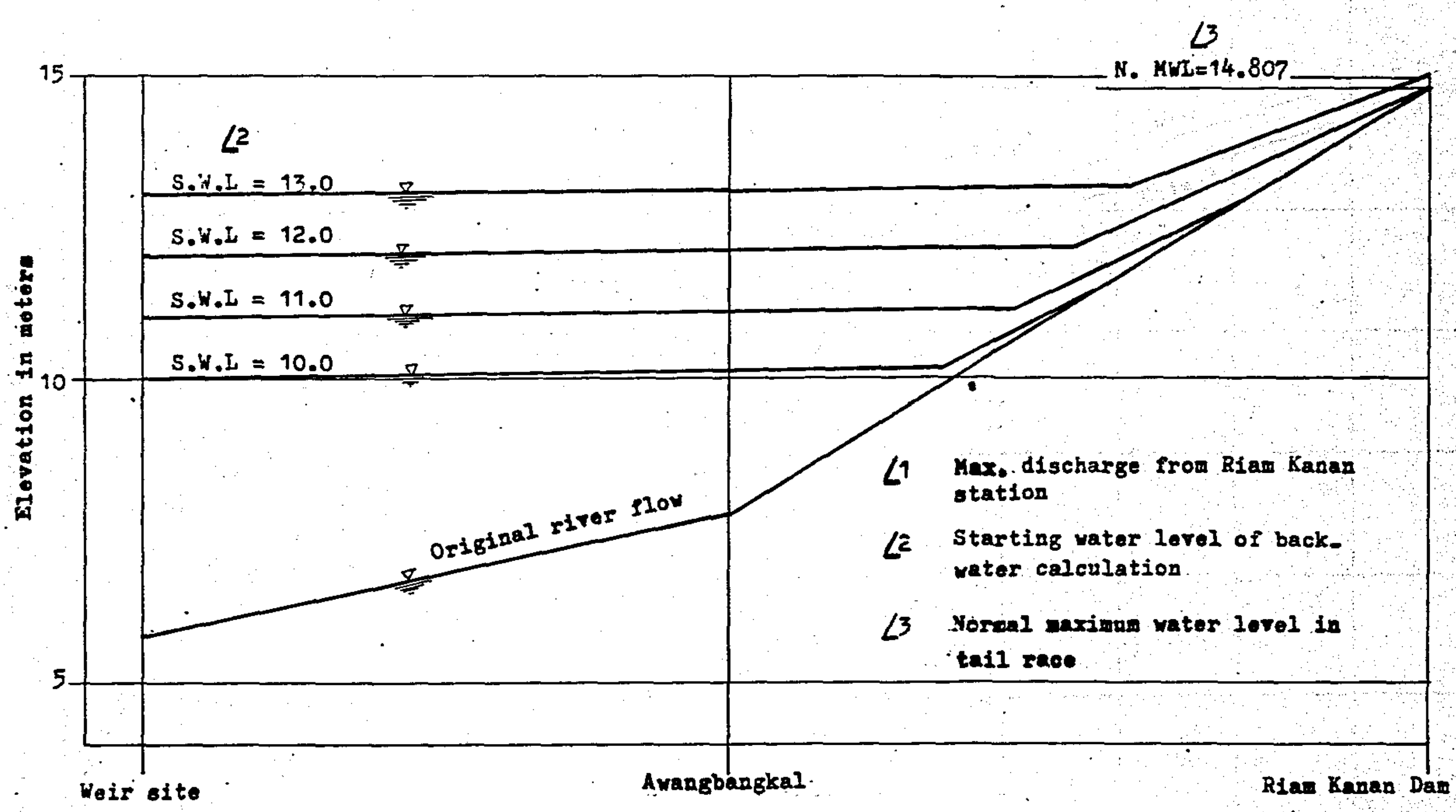


Fig. 4-21 **Storage Volume Curve**

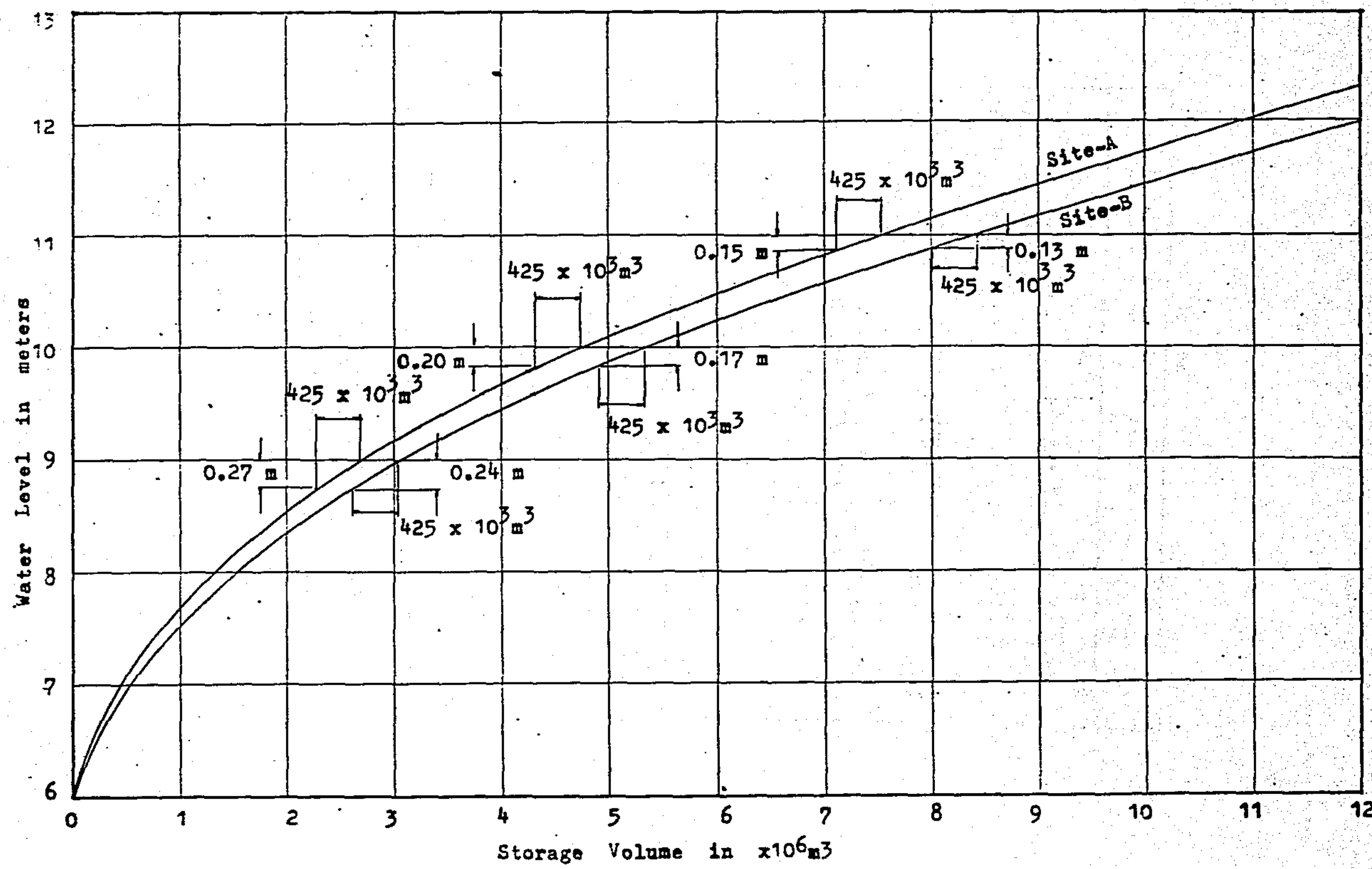


Table 4-10 **Comparison of Design Values between Site-A and Site-B**

Unit: Meters

CASE		Site-A A - 1	Site-A A - 2	Site-A A - 3	Site-B [1] B - 1		B - 2		B - 3	
Crest Elevation of Weir		EL. 9.0	10.0	11.0	9.0	10.0 (Flood W)	10.0	11.0 (Flood W)	11.0	12.0 (Flood W)
Emergency Flood Water Discharge Q = 650 m^3/sec Water Level in Downstream WL. 12.75 m	Allowable water level in upstream	WL. 13.0	13.0	13.0	13.0		13.0		13.0	
	Maximum overflow water depth	4.0	3.0	2.0	4.0	3.0	3.0	2.0	2.0	1.0
	Water depth in downstream from crest of weir	3.75	2.75	1.75	3.75	2.75	2.75	1.75	1.75	0.75
	Minimum width of weir	64	100	180	64	-	100	-	180	-
					Actual width 240		Actual width 240		Actual width 240	
Maximum ordinary Discharge Q = 91 m^3/sec	Allowable water level in upstream	WL. 12.0	12.0	12.0	12.0		12.0		12.0	
	Maximum overflow water depth	3.0	2.0	1.0	3.0	2.0	2.0	1.0	1.0	-
	Minimum width of weir	9.3	19.0	60.0	9.3 -	- 19.0	19.0 -	- 60.0	60.0 -	- -
Actual width of weir		70	110	200	60	180	80	160	140	100
					Total width 240		Total width 240		Total width 240	
Actual overflow water depth	Emergency flood water discharge	3.9	2.9	1.9	3.8	2.8	2.85	1.85	2.0	1.0
	Maximum ordinary water discharge	0.93	0.7	0.47	1.0	-	0.85	-	0.6	-
Actual water level in upstream	Emergency flood water discharge	WL. 12.9	12.9	12.9	12.8		12.85		13.0	
	Maximum ordinary water discharge	WL. 9.93	10.7	11.47	10.0		10.85		11.60	

[1] The weir at Site-B consists of two parts of crest for overflow of normal discharge and overflow of flood discharge.

Table 4-11 Quantities and Costs of Diversion Weir

Description	Unit	Work Quantities						Costs (1,000 US$)					
		Site -A			Site -B			Site -A			Site -B		
		A-1	A-2	A-3	B-1	B-2	B-3	A-1	A-2	A-3	B-1	B-2	B-3
WEIR													
Concrete Type-A	m^3	3,100	5,300	11,000	15,000	16,000	18,000	186	318	648	900	960	1,020
Concrete Type-B	m^3	2,500	2,500	2,500	800	800	1,000	200	200	200	64	64	80
Reinforcement bar	ton	200	200	200	50	50	60	140	140	140	35	35	42
Concrete form	m^2	5,300	5,800	7,300	7,300	7,500	8,000	50	56	70	72	74	79
Rock Riprap	m^3	1,200	1,600	2,500	3,000	2,800	3,000	5	8	12	16	14	16
Rock Excavation	m^3	14,800	22,600	39,300	6,000	6,000	6,000	68	104	180	28	28	28
Excavation	m^3	282,100	354,300	654,300	15,200	15,200	15,200	516	649	1,195	28	28	28
(Sub-Total)								(1,165)	(1,475)	(2,445)	(1,143)	(1,203)	(1,353)
DIKE													
Excavation	m^3	100,000	100,000	100,000	-	-	-	183	183	183	-	-	-
Embankment	m^3	426,000	426,000	426,000	-	-	-	1,172	1,172	1,172	-	-	-
(Sub-Total)								(1,355)	(1,355)	(1,355)			
COFFERING													
Concrete Type-B	m^3	-	-	-	900	900	900	-	-	-	72	72	72
Reinforcement bar	ton	-	-	-	55	55	55	-	-	-	39	39	39
Concrete form	m^2	-	-	-	700	700	700	-	-	-	7	7	7
Embankment	m^3	-	-	-	36,000	36,000	36,000	-	-	-	99	99	99
(Sub-Total)											(217)	(217)	(217)
Total								2,520	2,830	3,800	1,360	1,420	1,570

Table 4-12 Work Quantities and Costs of Main Irrigation Canal

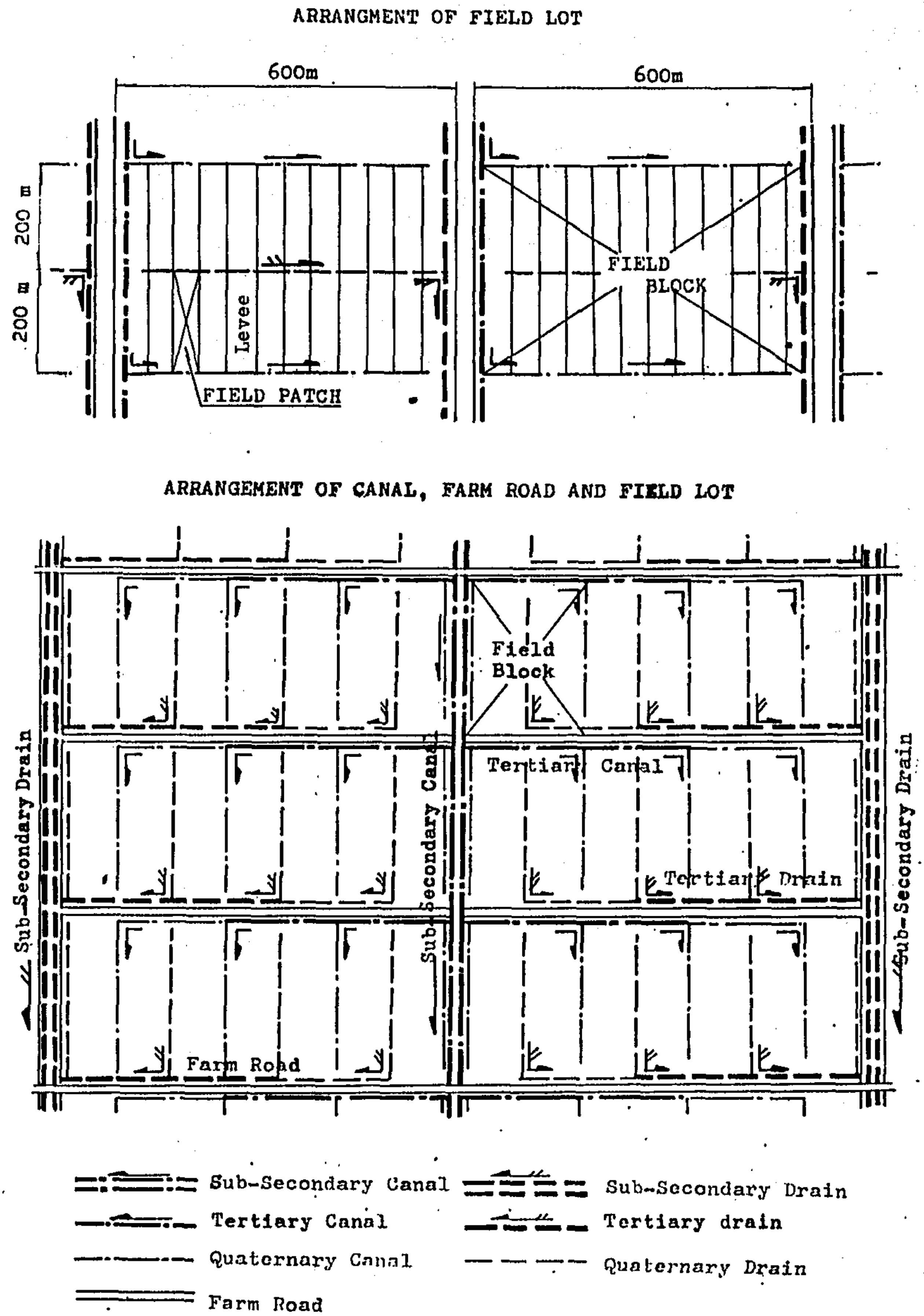
Description	Unit	Work Quantities						Costs (1,000 US$)					
		Site-A			Site-B			Site-A			Site-B		
		A-1	A-2	A-3	B-1	B-2	B-3	A-1	A-2	A-3	B-1	B-2	B-3
(length)	Km	42	42	45	42	42	45	-	-	-	-	-	-
Excavation	10^3m^3	3,440	3,140	2,860	3,580	3,260	2,980	6,880	6,280	5,720	7,160	6,520	5,960
Excavation (Rock)	10^3m^3	81	74	67	84	77	70	370	340	310	390	360	330
Embankment	10^3m^3	670	780	880	700	860	920	2,010	2,340	2,640	2,100	2,460	2,760
Total		4,191	3,994	3,807	4,364	4,197	3,970	9,260	8,960	8,670	9,650	9,340	9,050

Table 4-13 Compensation Costs

Description	Unit	Compensational Area						Compensation Costs (1,000 US$)					
		Site-A			Site-B			Site-A			Site-B		
		A-1	A-2	A-3	B-1	B-2	B-3	A-1	A-2	A-3	B-1	B-2	B-3
Paddy field	ha	11	14	17	11	14	18	14	17	21	14	17	22
Upland crop-field	ha	2	2	2	2	2	2	2	2	2	2	2	2
Waste land	ha	78	80	105	77	92	108	16	16	22	16	19	22
Plantation	ha	96	120	148	94	124	155	58	72	89	57	75	93
House	10^3m^3	20	34	49	18	36	53	159	270	390	143	286	421
Sub-total								(249)	(377)	(524)	(232)	(399)	(560)
Adm. charge (1.5% x Sub-total)								4	6	8	3	6	8
Total								253	383	532	235	405	568

Note: Areas sub-merged by the 2-years probable flood.

FIG. 4-22 TERTIARY DEVELOPMENT



CHAPTER V *FURTHER INVESTIGATION AND STUDIES*

5.1 TOPOGRAPHIC SURVEY

It is noted that the works have made good progress for the major works, such as plan table survey of the proposed intake weir sites, the route survey of the main irrigation canal and the spot levelling survey in the sub-area F. Since these works are expected to be completed by the 5th of October, one of the surveyors of the Team is going to leave for Japan on time.

The remaining works which include the plan table survey for major structure sites and the cross sectional survey of the existing canals will be made by the counterpart personnel under the supervision of the topographic surveyor cum design engineer of the Team.

5.2 INVESTIGATION AND STUDIES FOR IRRIGATION PLANNING

The water requirements provisionally estimated in this report will be modified based on the field measurements on actual crop consumptive use of water which are being made.

The preliminary alignments of the intake weir and of the irrigation canal network have been completed based on the topographical surveys, geological investigations, data and information so far collected and detailed field reconnaissance. Further investigations will be made to confirm and to justify the results stated in this report.. The decision of the irrigation area will be subject to the finalization of the canal network. The preliminary design of canals will follow.

The inflow to the Riam Kanan reservoir was estimated by analysing the past operation records of the power station. Based on this estimated inflow and power generation programme in the future, the firm discharge from the station was also predicted. The additional studies which follow will be focused on the amount of compensation discharge to the lower reaches of the river Martapura in relation to the sea water intrusion.

5.3 INVESTIGATION AND STUDIES FOR DRAINAGE PLANNING

Based on the study results of meteo-hydrology, tidal influence and field survey on flooding conditions, the planning of drainage improvement together with estimation of drainage requirements has been made. The alignment of drain network has also settled corresponding with the canal network.

The following investigation will be concentrated on the confirmation and the justification of the results stated in this report. The studies to be made are estimation of flood hydrograph from design rainfall, decision for the capacity of drainage channels and sluices, and preliminary design of main and secondary drains.

5.4 METEO-HYDROLOGICAL INVESTIGATION

For the study on the amount of available water sources for the project and suitable irrigation and drainage network, meteo-hydrological data were collected and studied as given in this report.

In addition to the above, the following investigation and studies are expected to be made including: runoff analysis on the rivers Riam Kanan, Riam Kiwa and Maluka, salinity intrusion measurement and analysis along the river Martapura, and water quality analysis for major rivers.

5.5 GEOLOGICAL AND SOIL MECHANICAL INVESTIGATION

As presented in this report, the investigation which have already finished are: collection of data and information on geology and soil mechanics in and around the project area, detailed field reconnaissance at the proposed intake weir sites based on the existing geological data, and cone penetration test at the representative sites.

The items which are under study are: geological investigation by test drilling at the alternative intake weir site, soil mechanical investigation by test pits and standard penetration test at several kilometers interval along the route of the main irrigation canal, and soil mechanical test of the representative soil samples of materials to be used for foundation and embankment.

5.6 INVESTIGATION FOR CONSTRUCTION MATERIALS

Field survey of the main construction materials such as cement, concrete aggregate, embankment materials, etc. is being made with their total available quantities and transportation to the jobsite.

Market survey of current unit prices of the construction materials, equipment and labour prevailing in the project area will be made in the near future.

5.7 SOIL AND LAND CLASSIFICATION

Semi-detailed soil and land classifications, covering about 93,000 ha in gross, have been successfully completed in conformity with the U.S. Soil Taxonomy system and the U.S.B.R. classification standard as modified in 1969, based upon the cross checking of the previous soil studies and the results of additional field investigation and studies.

From the viewpoint of soil-crop response, all of the soils in the project area is very strong acid and very low in fertility. It is notable that the soils are deficient in phosphate, potassium and other effective bases. . Thus, discussion will be concentrated mainly on the above point and will clarify an economic range of soil modification by means of chemical fertilizing and proper soil conservation system. In this context, lime requirement, water requirement for leaching the active acid, absorption rate of phosphate, etc. will be carefully studied with the typical soils in the project area.

In addition, water sampling and its chemical analyses will be made in the existing major drainage canal, in order to clarify the degree of water pollusion to be caused by the brackish water and/or acid water influence.

5.8 AGRICULTURAL STUDIES

The agricultural development plan has been preliminarily formurated with the monoculture of paddy rice over the whole the project area, taking into consideration the Government policy for the agricultural development and the field environments so far studied.

Further investigation and studies will be made to confirm and to justify the above plan. In order to estimate the target yields and to forecast the built-up period required for the full development of the project, carefull study will be made, making referrence to the tertiary development and the production records in the coastal land in both Java and Sumatra, and also some data from Malaysia where the field conditions are quite similar to those in the project area.

5.9 AGRO-ECONOMIC SURVEY AND STUDIES

Further investigation and study on the following will be carried out for the feasibility study.

(1) Land holding and land tenure system

Data on land holding and land tenure system are not available in both the Province and Kabupaten offices. According to information so far obtained, however, some data on this matter would be available in Kecamatan and/or Desa offices. The confirmation and collection will be carried out soon, and further study will be made for the preparation of the draft teport.

(2) Farm economy

Further data collection for more detailed study on farm economy for some typical farms is going to be carried out through door-to-door inspection of about 60 farmers selected at random in the project area. Based on the data thus collected, farm budgets on the typical farms both with and without the project will be made for the project evaluation.

(3) Evaluation on the project

Evaluation on the project will be made from both economic and financial viewpoints.

The economic feasibility of the project is evaluated by calculating the Internal Rate of Return . Sensitivity analysis is also made with respect to changes in the economic construction cost, price of rice and build-up period of the irrigation benefit.

Financial evaluation will be made by analyzing typical farm budget and by repayment analysis.

In addition, socio-economic impacts of the project are briefly assessed in consideration of the effect of the project on the regional development.

These works related to the project evaluation will be made using the exchange rate of Rp. 415 / US$ 1 and on the assumption that the project life for the economic evaluation is 50 years.

5.10 PRELIMINARY DESIGN AND CONSTRUCTION PLAN

Based on the field survey and various studies so far made, and additional investigation and studies to be made as stated above, the preliminary design of the irrigation and drainage network including their related structures will be carried out. For proper design of the main project facilities such as intake weir, large control gates, etc., comparative study will be carried out for determination of the most suitable type and size of those facilities.

Based on the preliminary design thus made, the provisional construction plan will be prepared.

5.11 COST ESTIMATE

The cost estimate of the Project will be made based on the unit prices of the construction materials, labor and equipment estimated from the market survey and from the similar irrigation projects completed and/or under construction in Indonesia. The cost estimate will be made in both domestic and foreign currencies.

5.12 ORGANIZATION AND MANAGEMENT OF THE PROJECT

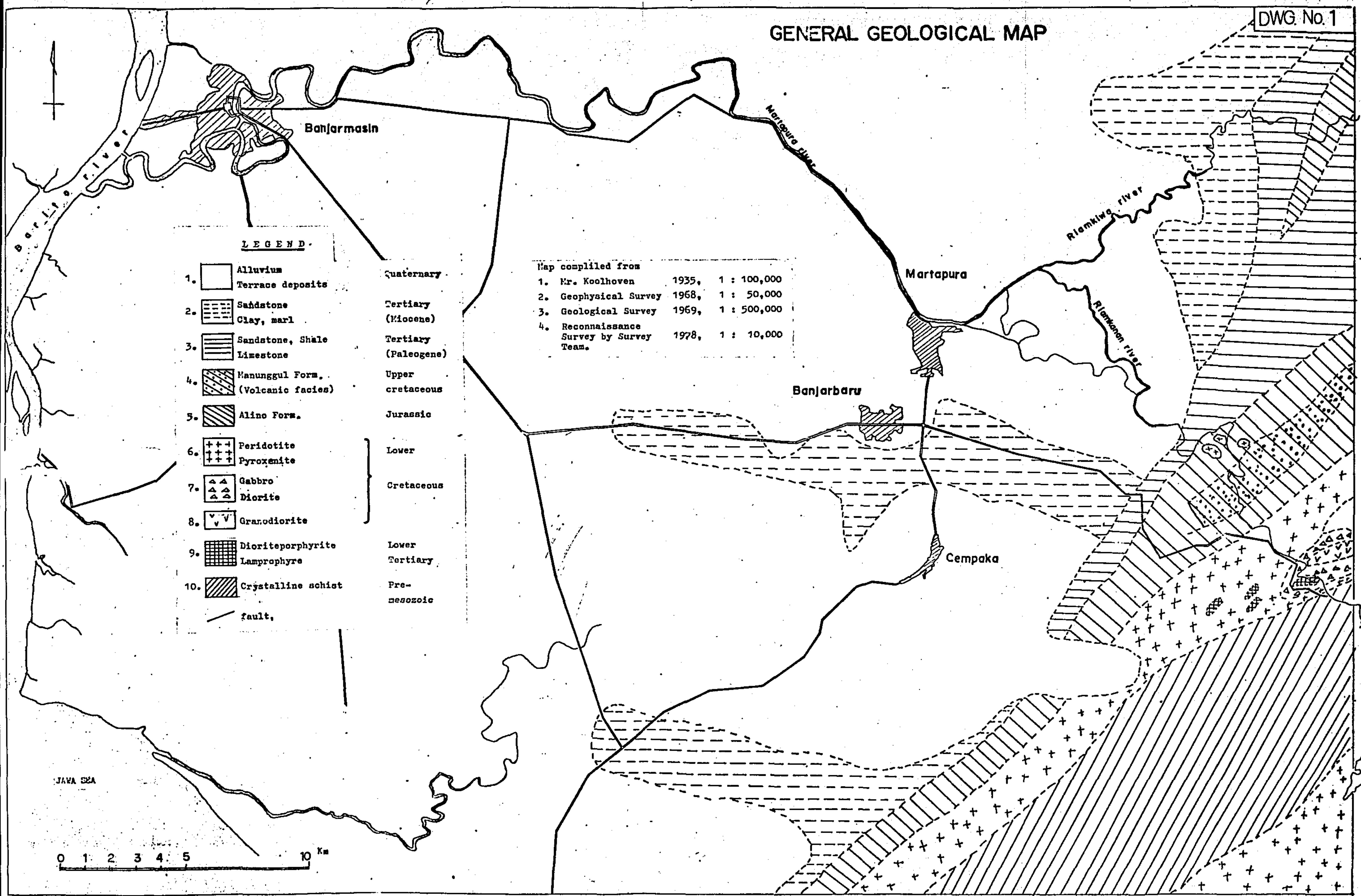
The proposed organization for project execution, O & M of the project and farmer's cooperative will be studied carefully, taking into account the current and future government policies for promoting agricultural development in the South Kalimantan Province.

In addition, study on the proposed operation and maintenance program of the Project and the estimate of O & M cost will be made based on the proposed project organization and the farmer's cooperative.

5.13 PREFEASIBILITY STUDIES

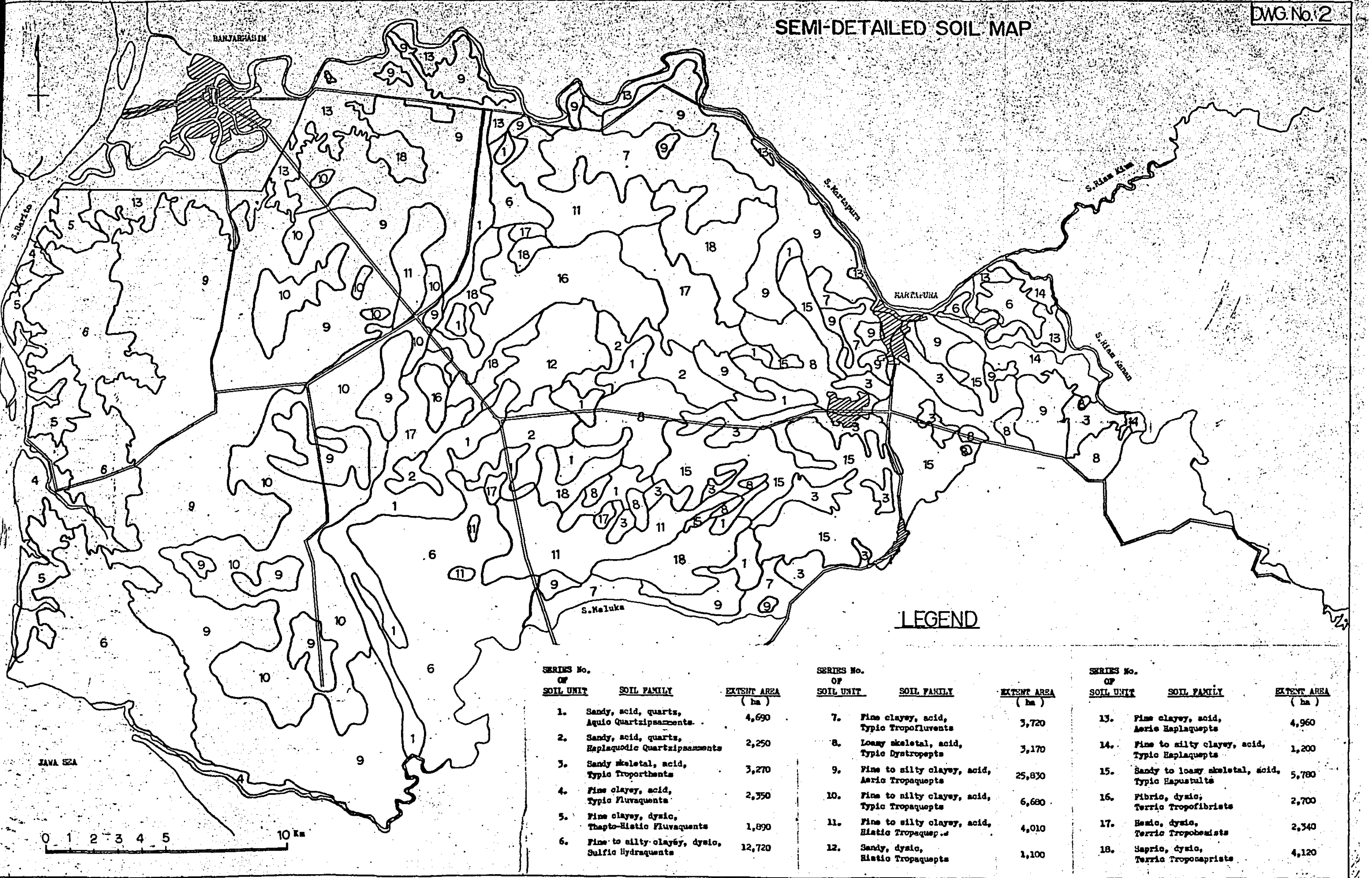
As regards the prefeasibility study for sub-area E, the plan of operation which is given in the Inception Report is still valid.

It is recommended at this stage that sub-area F is to be excluded from the Project.


DWG. No. 1
GENERAL GEOLOGICAL MAP
Banjarmasin
Barito river
Martapura river
Martapura
Riamkiwa river
Riamkanan river
Banjarbaru
Cempaka
JAVA SEA
LEGEND
1. Alluvium Terrace deposits — Quaternary
2. Sandstone Clay, marl — Tertiary (Miocene)
3. Sandstone, Shale Limestone — Tertiary (Paleogene)
4. Manunggul Form. (Volcanic facies) — Upper cretaceous
5. Alino Form. — Jurassic
6. Peridotite Pyroxenite — Lower Cretaceous
7. Gabbro Diorite — Lower Cretaceous
8. Granodiorite — Lower Cretaceous
9. Dioriteporphyrite Lamprophyre — Lower Tertiary
10. Crystalline schist — Pre-mesozoic
fault,
Map compliled from
1. Mr. Koolhoven 1935, 1 : 100,000
2. Geophysical Survey 1968, 1 : 50,000
3. Geological Survey 1969, 1 : 500,000
4. Reconnaissance Survey by Survey Team. 1978, 1 : 10,000
0 1 2 3 4 5 10 Km

DWG. No. 2

SEMI-DETAILED SOIL MAP

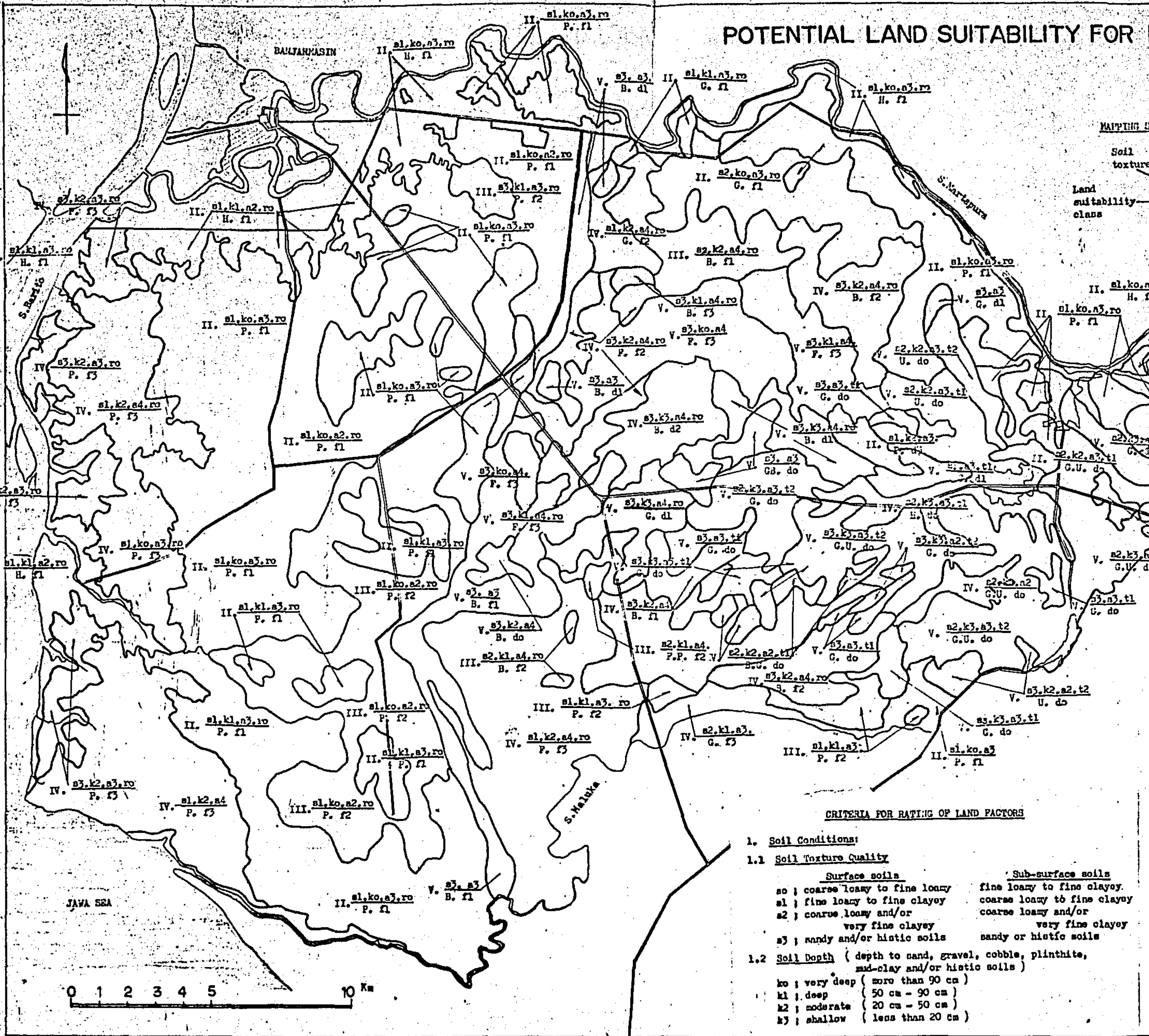


LEGEND

SERIES No. OF SOIL UNIT	SOIL FAMILY	EXTENT AREA (ha)
1.	Sandy, acid, quartz, Aquic Quartzipsamments	4,690
2.	Sandy, acid, quartz, Haplaquodic Quartzipsamments	2,250
3.	Sandy skeletal, acid, Typic Troporthents	3,270
4.	Fine clayey, acid, Typic Fluvaquents	2,350
5.	Fine clayey, dysic, Thapto-Histic Fluvaquents	1,890
6.	Fine to silty clayey, dysic, Sulfic Hydraquents	12,720
7.	Fine clayey, acid, Typic Tropofluvents	3,720
8.	Loamy skeletal, acid, Typic Dystropepts	3,170
9.	Fine to silty clayey, acid, Aeric Tropaquepts	25,830
10.	Fine to silty clayey, acid, Typic Tropaquepts	6,680
11.	Fine to silty clayey, acid, Histic Tropaquep.s	4,010
12.	Sandy, dysic, Histic Tropaquepts	1,100
13.	Fine clayey, acid, Aeric Haplaquepts	4,960
14.	Fine to silty clayey, acid, Typic Haplaquepts	1,200
15.	Sandy to loamy skeletal, acid, Typic Hapustults	5,780
16.	Fibric, dysic, Terric Tropofibrists	2,700
17.	Hemic, dysic, Terric Tropohemists	2,340
18.	Sapric, dysic, Terric Troposaprists	4,120

DWG No. 3

POTENTIAL LAND SUITABILITY FOR IRRIGATED PADDY



MAPPING SYMBOL

Land suitability class — II. $\frac{\text{s1.k2.a3.ro}}{\text{B. f2}}$ (Soil texture, Soil depth, Soil acidity, Topography / Land use, Drainage conditions)

LAND SUITABILITY CLASSIFICATION

LAND CLASS	DEFINITION	EXTENT AREA (ha)
Class 1.	No land satisfied in the project area	-
Class 2.	Suitable for irrigated paddy rice cultivation	38,700
Class 3.	Moderately suitable for irrigated paddy rice cultivation	10,400
Class 4.	Marginally suitable for irrigated paddy rice cultivation	22,040
Class 5.	Unsuitable for paddy rice cultivation	21,640
	Total	92,780

CRITERIA FOR RATING OF LAND FACTORS

1. Soil Conditions:

1.1 Soil Texture Quality

	Surface soils	Sub-surface soils
so ;	coarse loamy to fine loamy	fine loamy to fine clayey.
s1 ;	fine loamy to fine clayey	coarse loamy to fine clayey
s2 ;	coarse loamy and/or very fine clayey	coarse loamy and/or very fine clayey
s3 ;	sandy and/or histic soils	sandy or histic soils

1.2 Soil Depth (depth to sand, gravel, cobble, plinthite, mud-clay and/or histic soils)

- ko ; very deep (more than 90 cm)
- k1 ; deep (50 cm - 90 cm)
- k2 ; moderate (20 cm - 50 cm)
- k3 ; shallow (less than 20 cm)

1.3 Soil Acidity (pH ; H_2O)

- ao ; slightly acid to neutral (6.1 - 7.3)
- a1 ; moderately strong acid (5.6 - 6.0)
- a2 ; strong acid (5.1 - 5.5)
- a3 ; very strong acid (4.6 - 5.0)
- a4 ; extremely strong acid (less than 4.5)

2. Topographic Conditions

2.1 Relief

- ro ; flat to nearly flat land
- r1 ; gently sloped land
- r2 ; undulating land
- r3 ; rolling land

2.2 Slope

- to ; 0 to 2 %
- t1 ; 2 to 5 %
- t2 ; 5 to 8 %
- t3 ; 8 to 15 %

3. Drainage Conditions

3.1 Drainage Class

- do ; well drained
- d1 ; moderately well drained
- d2 ; somewhat poorly drained
- d3 ; poorly drained
- d4 ; very poorly drained

3.2 Seasonal Flooding

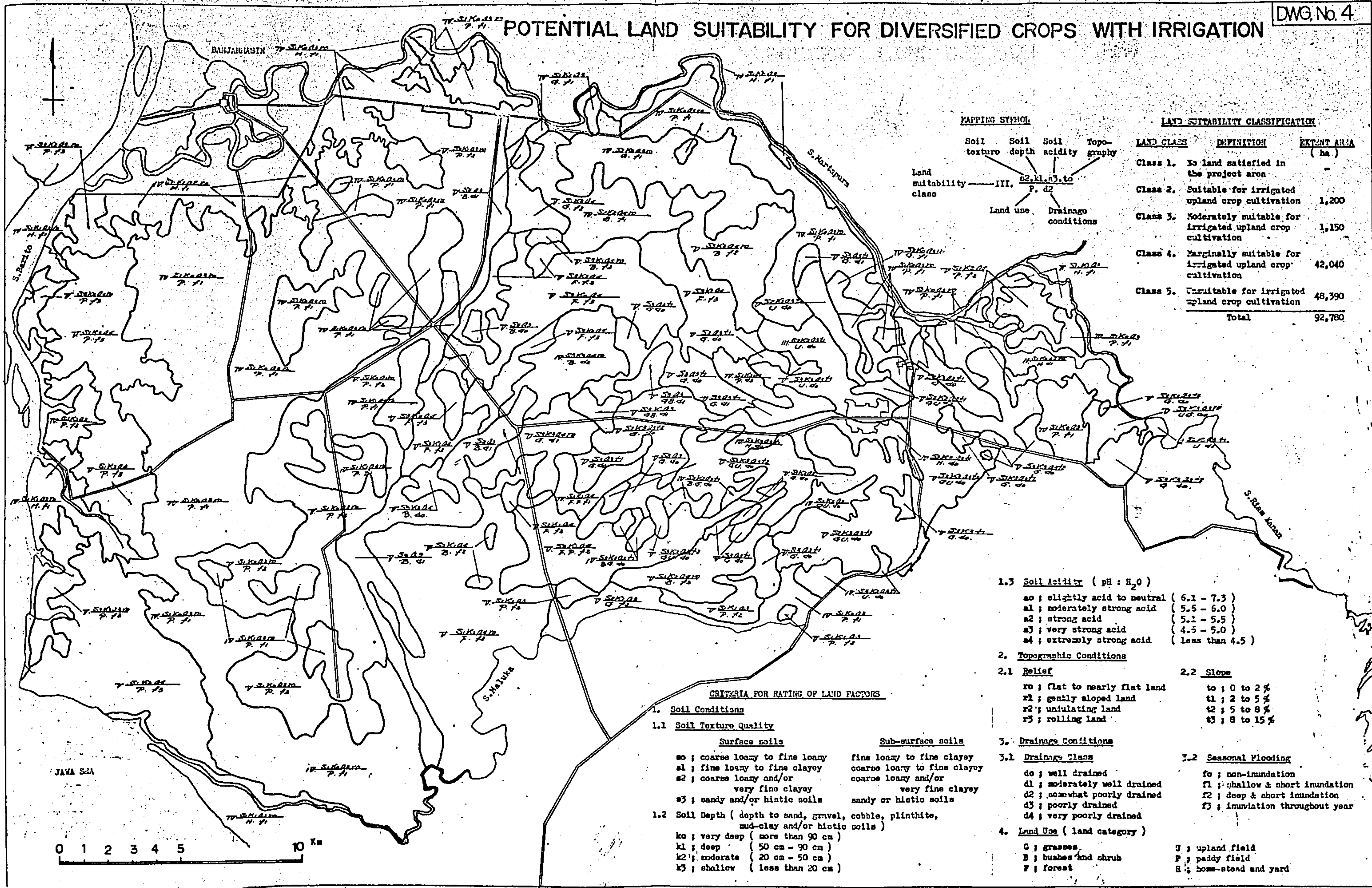
- fo ; non-inundation
- f1 ; shallow & short inundation
- f2 ; deep & short inundation
- f3 ; inundation throughout year

4. Land Use (land category)

- G ; grasses
- B ; bushes and shrub
- F ; forest
- U ; upland field
- P ; paddy field
- H ; home-stead and yard

DWG. No. 4

POTENTIAL LAND SUITABILITY FOR DIVERSIFIED CROPS WITH IRRIGATION



MAPPING SYMBOL

Soil texture — Soil depth — Soil acidity — Topography

Land suitability class —— III. $\frac{s2.k1.a3.to}{P.\ d2}$

Land use — Drainage conditions

LAND SUITABILITY CLASSIFICATION

LAND CLASS	DEFINITION	EXTENT AREA (ha)
Class 1.	No land satisfied in the project area	-
Class 2.	Suitable for irrigated upland crop cultivation	1,200
Class 3.	Moderately suitable for irrigated upland crop cultivation	1,150
Class 4.	Marginally suitable for irrigated upland crop cultivation	42,040
Class 5.	Unsuitable for irrigated upland crop cultivation	48,390
	Total	92,780

CRITERIA FOR RATING OF LAND FACTORS

1. Soil Conditions

1.1 Soil Texture Quality

	Surface soils	Sub-surface soils
so ;	coarse loamy to fine loamy	fine loamy to fine clayey
s1 ;	fine loamy to fine clayey	coarse loamy to fine clayey
s2 ;	coarse loamy and/or very fine clayey	coarse loamy and/or very fine clayey
s3 ;	sandy and/or histic soils	sandy or histic soils

1.2 Soil Depth (depth to sand, gravel, cobble, plinthite, mud-clay and/or histic soils)

ko ; very deep (more than 90 cm)
k1 ; deep (50 cm - 90 cm)
k2 ; moderate (20 cm - 50 cm)
k3 ; shallow (less than 20 cm)

1.3 Soil Acidity (pH : H_2O)

ao ; slightly acid to neutral (6.1 - 7.3)
a1 ; moderately strong acid (5.5 - 6.0)
a2 ; strong acid (5.1 - 5.5)
a3 ; very strong acid (4.5 - 5.0)
a4 ; extremely strong acid (less than 4.5)

2. Topographic Conditions

2.1 Relief

ro ; flat to nearly flat land
r1 ; gently sloped land
r2 ; undulating land
r3 ; rolling land

2.2 Slope

to ; 0 to 2 %
t1 ; 2 to 5 %
t2 ; 5 to 8 %
t3 ; 8 to 15 %

3. Drainage Conditions

3.1 Drainage Class

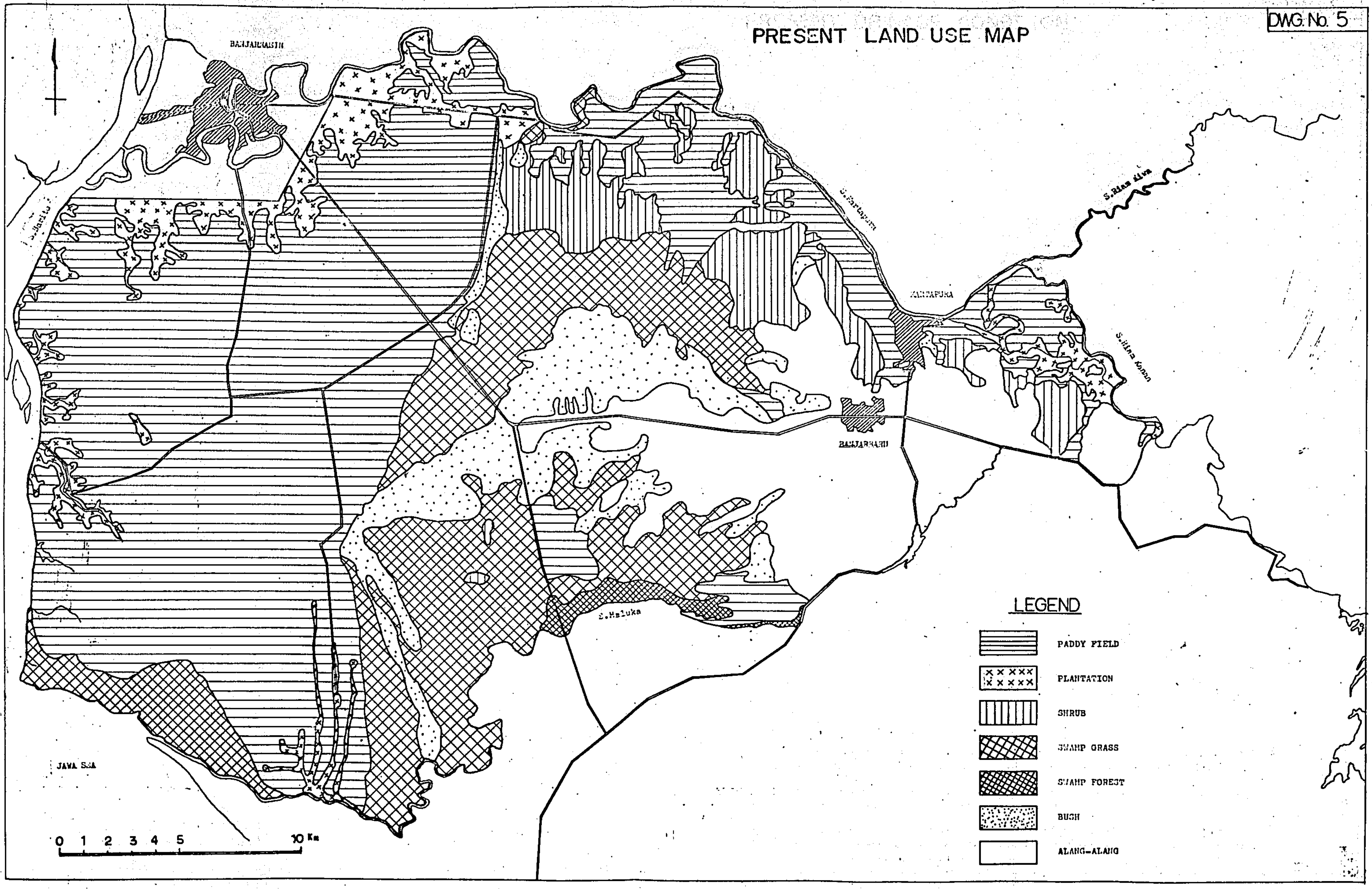
do ; well drained
d1 ; moderately well drained
d2 ; somewhat poorly drained
d3 ; poorly drained
d4 ; very poorly drained

3.2 Seasonal Flooding

fo ; non-inundation
f1 ; shallow & short inundation
f2 ; deep & short inundation
f3 ; inundation throughout year

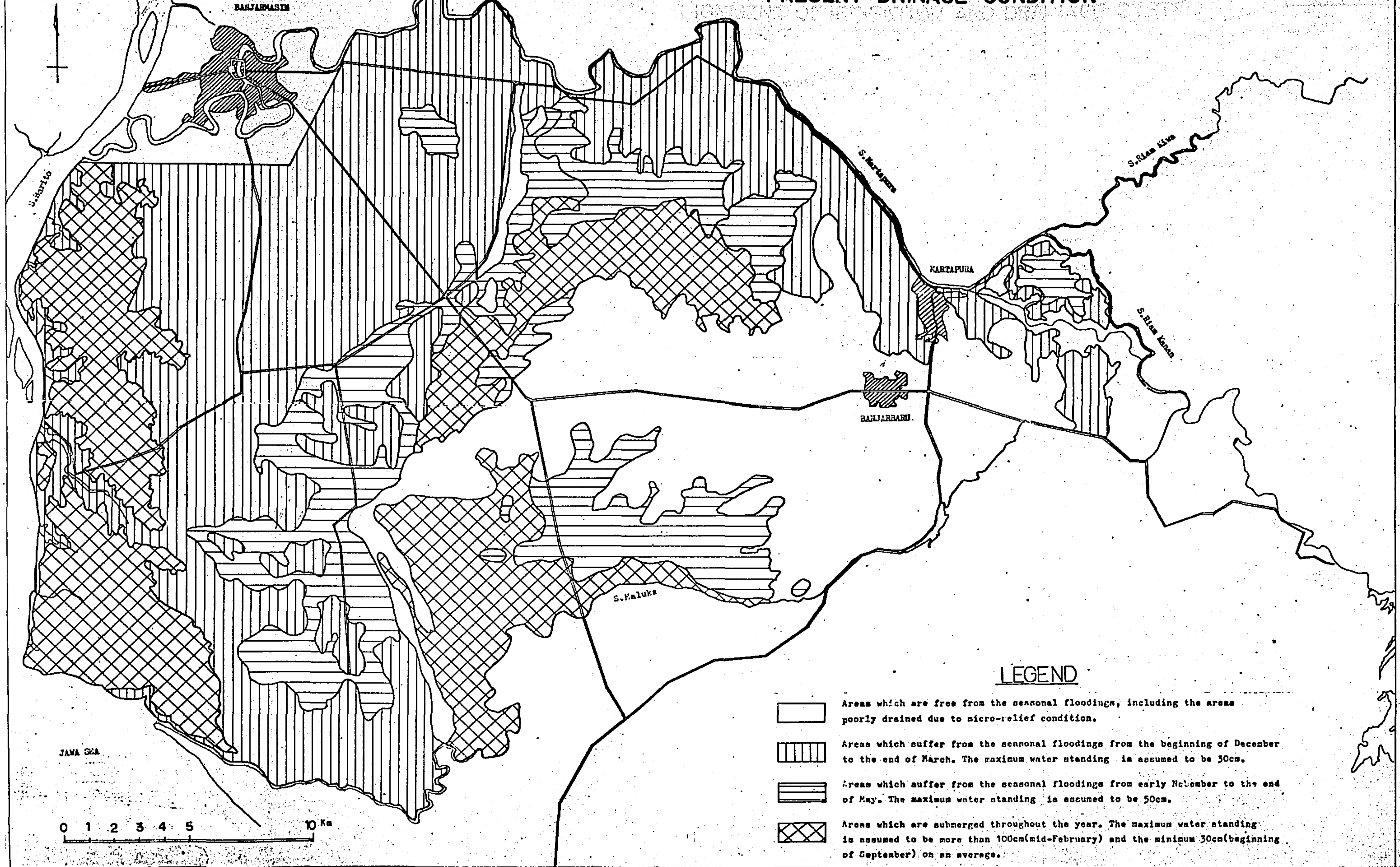
4. Land Use (land category)

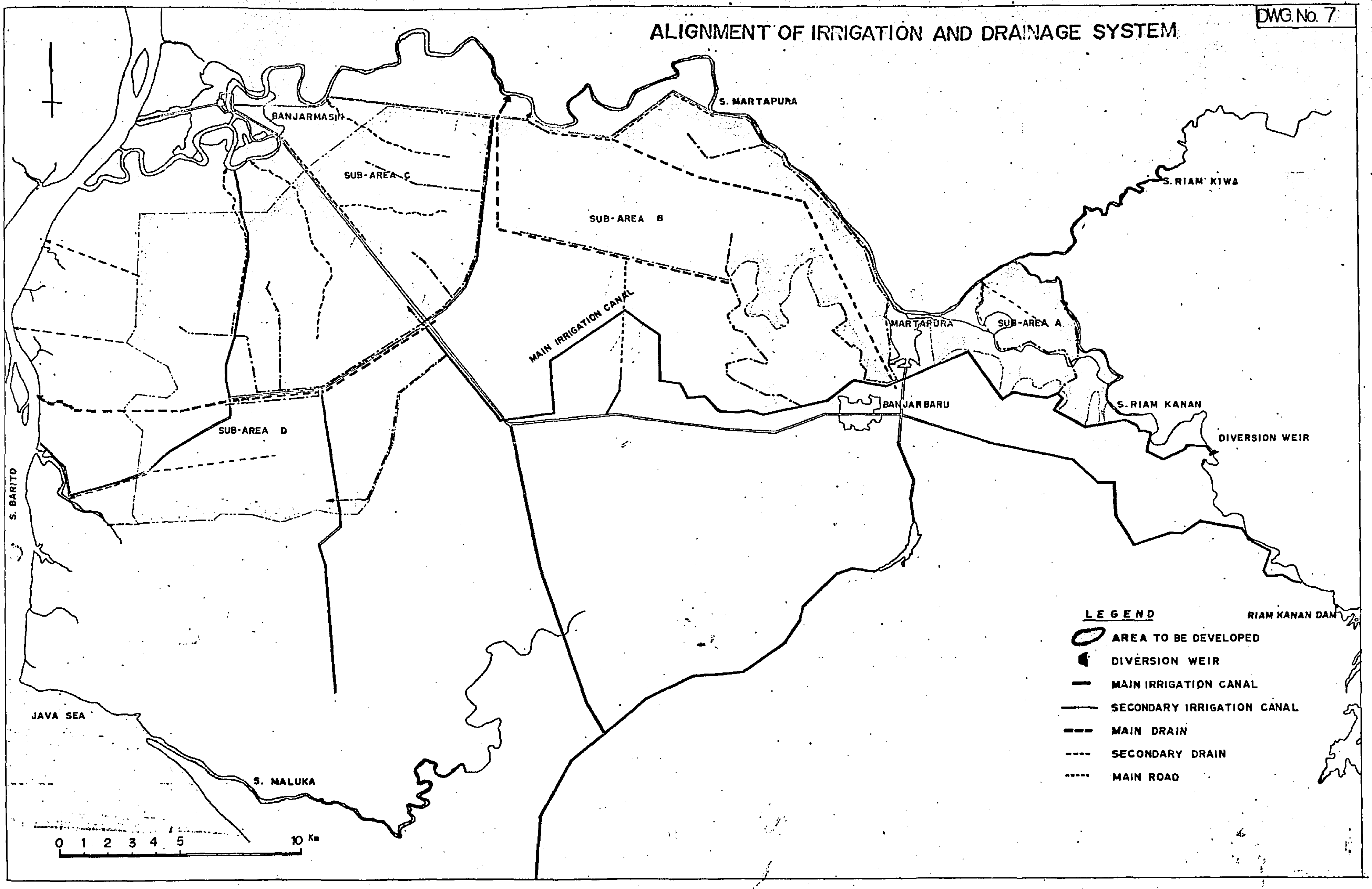
G ; grasses
B ; bushes and shrub
F ; forest
U ; upland field
P ; paddy field
H ; home-stead and yard

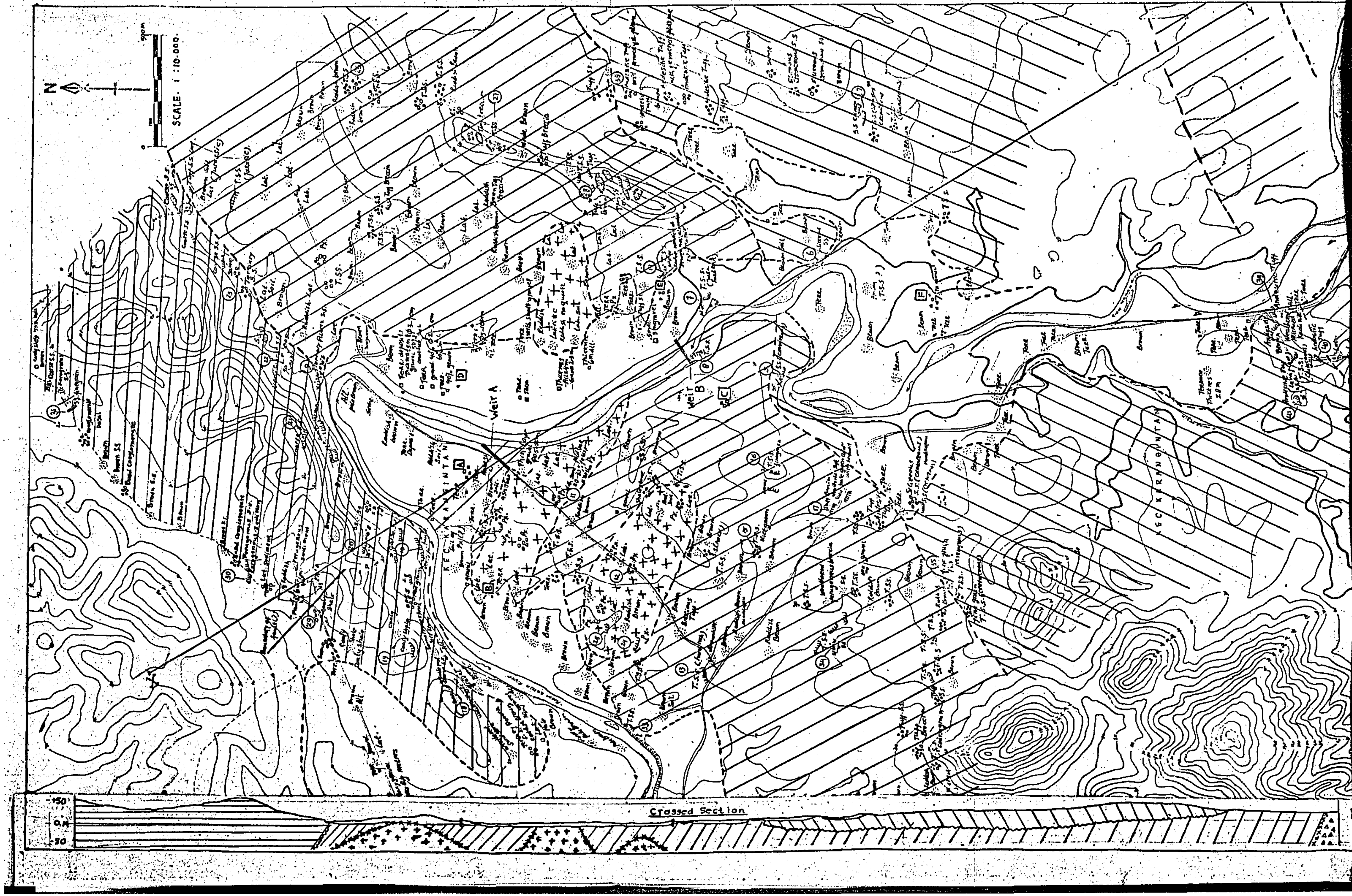

DWG. No. 5
PRESENT LAND USE MAP
LEGEND
PADDY FIELD
PLANTATION
SHRUB
SWAMP GRASS
SWAMP FOREST
BUSH
ALANG-ALANG
0 1 2 3 4 5 10 Km
S.Maluka

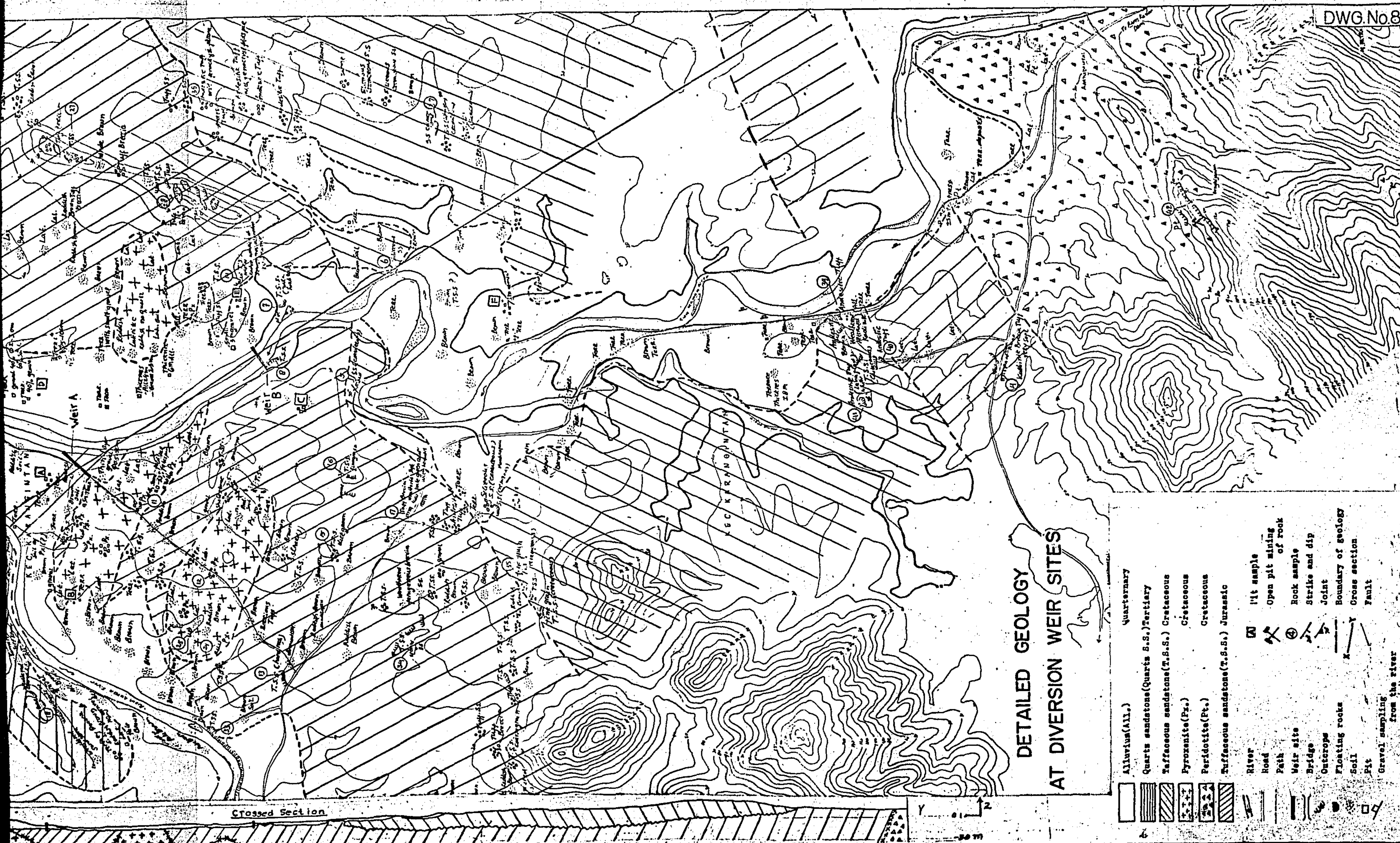
DWG. No. 6

PRESENT DRINAGE CONDITION



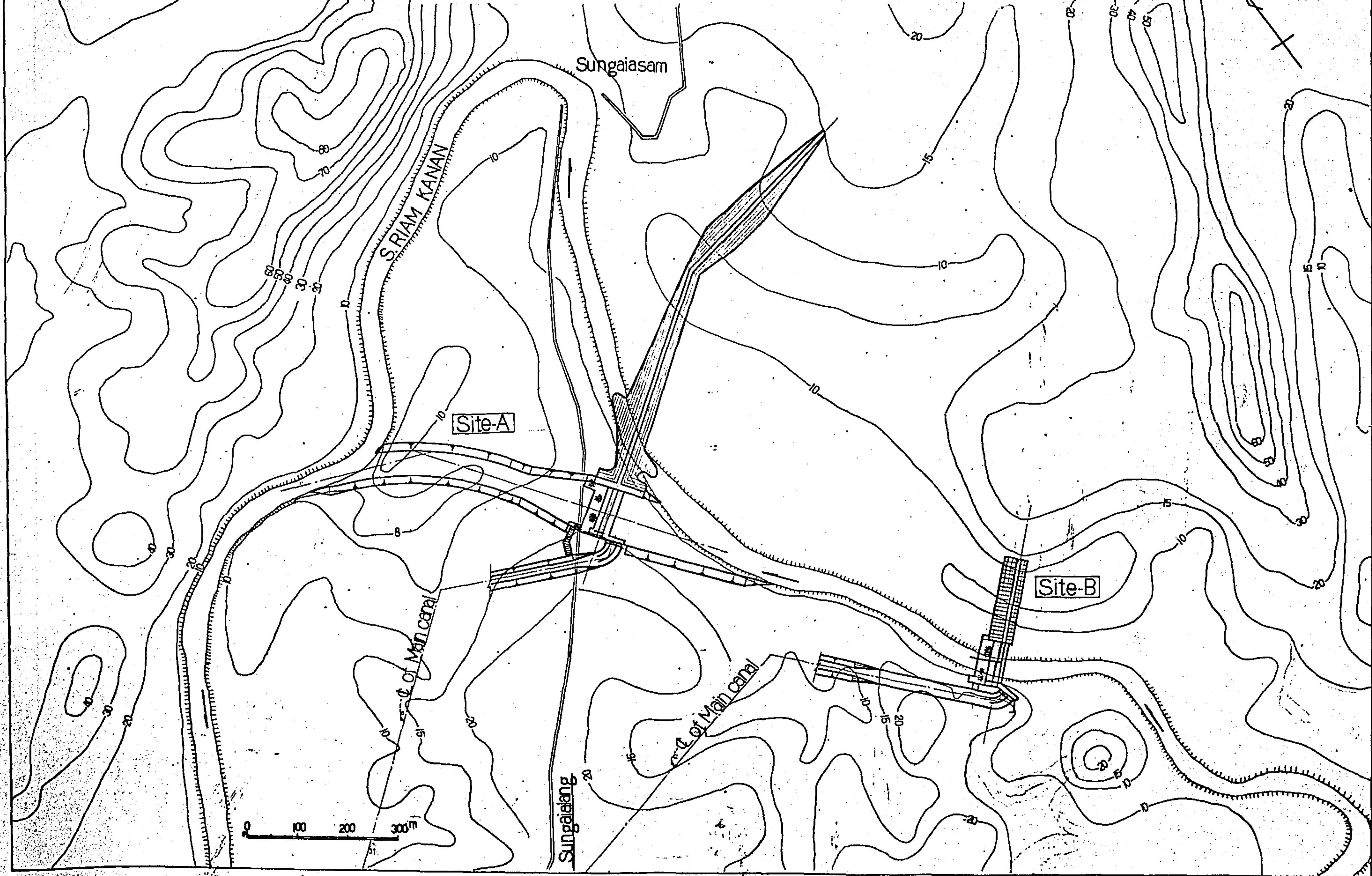

DWG. No. 7
ALIGNMENT OF IRRIGATION AND DRAINAGE SYSTEM
S. MARTAPURA
BANJARMASIN
SUB-AREA C
SUB-AREA B
S. RIAM KIWA
MARTAPURA
SUB-AREA A
MAIN IRRIGATION CANAL
BANJARBARU
S. RIAM KANAN
DIVERSION WEIR
SUB-AREA D
S. BARITO
LEGEND
AREA TO BE DEVELOPED
DIVERSION WEIR
MAIN IRRIGATION CANAL
SECONDARY IRRIGATION CANAL
MAIN DRAIN
SECONDARY DRAIN
MAIN ROAD
RIAM KANAN DAM
JAVA SEA
S. MALUKA
0 1 2 3 4 5 10 Km


N
SCALE 1 : 10,000
Weir A
Weir B
Crossed Section
150
50



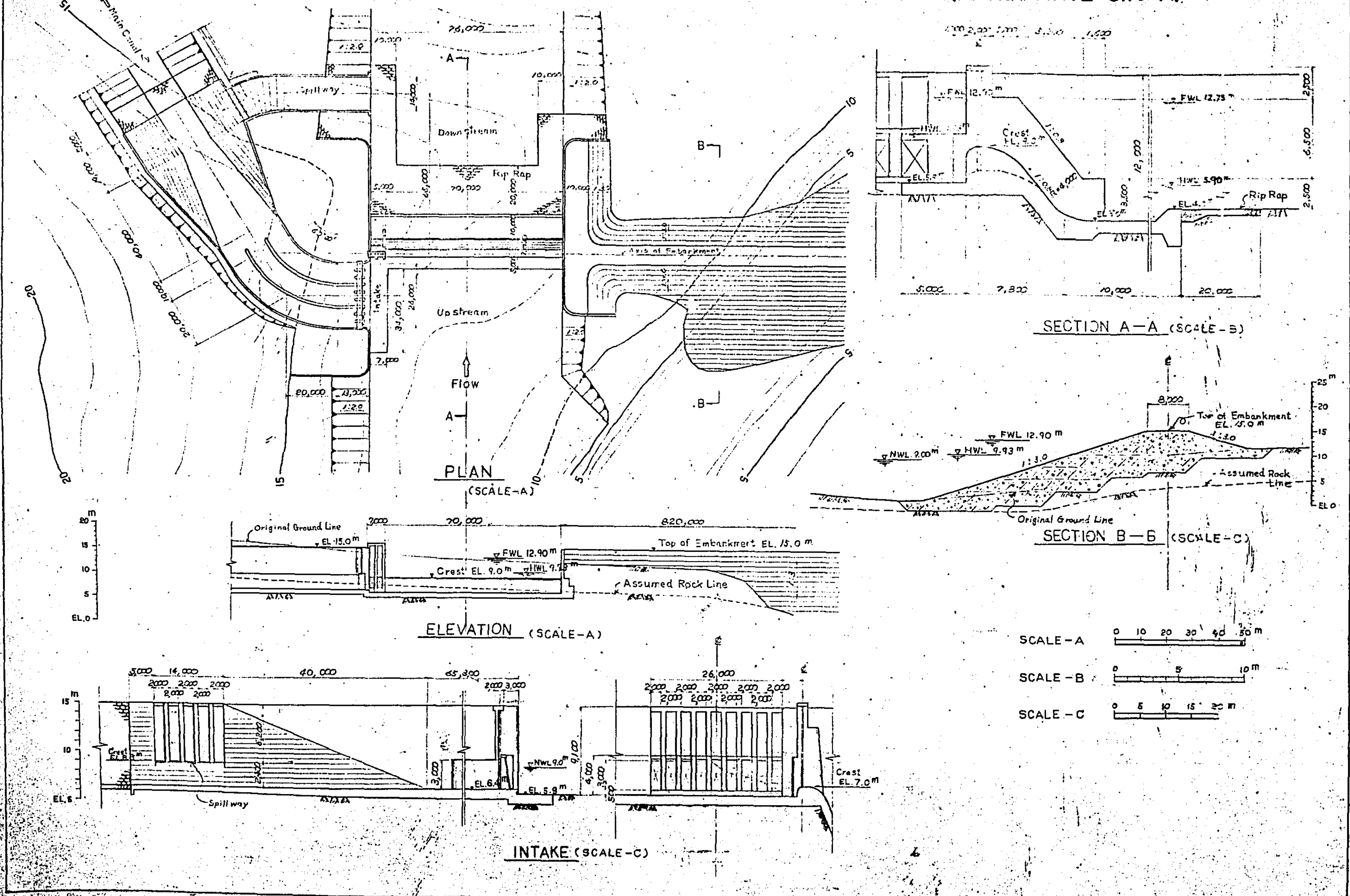
DWG.No.8
DETAILED GEOLOGY
AT DIVERSION WEIR SITES
Alluvium(All.) Quaternary
Quartz sandstone(Quartz S.S.) Tertiary
Tuffaceous sandstone(T.S.S.) Cretaceous
Pyroxenite(Px.) Cretaceous
Peridotite(Pt.) Cretaceous
Tuffaceous sandstone(T.S.S.) Jurassic
River
Road
Path
Weir site
Bridge
Outcrops
Floating rocks
Soil
Pit
Gravel sampling from the river
Pit sample
Open pit mining of rock
Rock sample
Strike and dip
Joint
Boundary of geology
Cross section
Fault
Weir A
Weir B
Crossed Section

GENERAL LAYOUT OF DIVERSION WEIRS(Sites-A,B)



LAYOUT OF DIVERSION WEIR (ALTERNATIVE Site-A)

DWG No 10



DWG No 11

LAYOUT OF DIVERSION WEIR (ALTERNATIVE Site-B)