4. PROSPECTIVE LAND AND WATER RESOURCE DEVELOPMENT

4.1 PROJECT CONCEPTS

The Upper Komering River Basin Development Project, which comprises an irrigation development of about 105,000 ha in net and a hydropower development of some 224 MW in installed capacity in the upper reaches of the Komering river main stem, is formulated to maximize the expected project benefits by means of efficient use of water resources. The main concepts of the project are to:

- increase and stabilize yield and production of rainy season paddy through supply of irrigation water, proper drainage improvement and introduction of improved irrigation farming,
- introduce diversified cropping pattern including the rainy season paddy, dry season paddy and polowijo through provision of year-round irrigation,
- increase agricultural production by opening up new agricultural lands in the areas which have favorable physical conditions for agricultural development,
- promote the levelling up of living standard and more equitable distribution of income of the people, and
- generate hydroelectric power in maximum use of regulated outflow of the existing Lake Ranau and the proposed reservoirs to be created.

Because of no irrigation and drainage facilities in the area except for small drainage canals constructed by farmers themselves, the existing paddy fields often suffer from long-dry spell in the dry season and maldrainage in depressed lands in the rainy season. Therefore, most of the paddy fields are used only for one cropping a year. The intensive agricultural development in the area is constrained by:

- no irrigation system,
- poor drainage conditions,
- poor road network, and
- insufficient agricultural supporting services.

In order to achieve the projected agricultural development in success, the construction of following insfrastructures and further improvement of supporting services are required:

- construction of irrigation network consisting of reservoir, intake structures, main, secondary, tertiary and quaternary canals,
- construction of drainage network which consists of main, secondary, tertiary and quaternary drains,
- construction of road network which includes main, secondary and tertiary roads,
- reclamation of new farm lands,
- operation and maintenance of the irrigation and drainage networks, and
- further improvement of the present agricultural supporting services.

In spite of the promising power market in the urban areas, Palembang, Tanjung Karang and other towns, as well as rural areas, an adequate transmission system and distribution facilities is lack in both South Sumatra province and Lampung province resulting in severe restriction of load growth. The hydropower development in the project area is required to be promoted in due consideration of the comprehensive and long term development program in the South Sumatra region.

4.2 DELINEATION OF PROJECT AREA

4.2.1 Affecting Factors for Delineation of Project Area

In the delineation of the project area, the following factors are taken into consideration.

(1) Land suitability classification

Based on the evaluation of land suitability classification, the areas classified in Grade I, II and III are taken up as the area suitable for agriculture. In this evaluation, the affecting factors for the delineation are erodability of lands, topography, flooding condition, drainability of soils, fertility, soil depth for cropping and degree of soil acidity.

(2) Present land use

The present land use and vegetation of the area are taken into consideration as the important factors for the delineation, because these conditions have large effects on the relative difficulty in making land reclamation for the irrigation development.

(3) Government's policy

The most important factor is the Indonesian Government's development policy. The areas which have been selected for transmigration program, resettlement program of irrigation development program would be given a high priority for the selection of project area.

4.2.2 Area to be Developed

The area to be studied for pre-feasibility is delineated within the upper Komering river basin excluding the Komering-I Irrigation Development Area of 36,700 ha. Following the results of land suitability classification, the gross irrigable areas for the Muncak Kabau, the Lempuing and the Tulangbawang development areas are selected by deducting the non-suitable land (Grade IV) and the area which can not be irrigated due to its high topography as compared with the proposed canal water level.

The gross irrigable areas thus selected are classified as follows:

(Unit: ha)

Grade	Muncak Kabau	Lempuing	Tulangbawang
I	3,100	7,900	-
II	1,800	2,500	600
III	12,000	9,000	79,700
Total	16,900	19,400	80,300

Further by deducting the non-irrigable lands such as village compounds, perennial crop fields, roads, canals, forest to be conserved from the above gross areas, the net irrigable areas are obtained to be 10,700 ha in the Muncak Kabau area, 13,100 ha in the Lempuing area and 44,500 ha in the Tulangbawang area respectively.

4.3 AGRICULTURAL DEVELOPMENT

4.3.1 Proposed Cropping Pattern and Farming Practices

There are two types of farm holding size. One is 2-ha farm predominating in the flat and gently undulating lands in the Muncak Kabau area, the Lempuing area and the Tulangbawang west sub-area. The other is 5-ha farm predominating in the Tulangbawang eastern sub-area, in which transmigrants have settled recently. Based on the above conditions, two fundamental cropping patterns are proposed for the future agricultural development in the project area as follows:

Cropping pattern type I:

This pattern is proposed for the recently transmigrated areas in the Muncak Kabau area, the Lempuing area and in the Tulangbawang west sub-area, where a farm family holds around 2 ha on an average including 0.25 ha of perennial crop field and 0.25 ha of home yard. About 1.50 ha of rainy season paddy and about 1.0 ha of dry season paddy will be cultivated. About 0.5 ha of polowijo and 0.25 ha of perennial cash crops will be grown. The crop intensity will be 2.0 (see Fig. 4.1).

Cropping pattern type II:

This cropping pattern is proposed for the Tulangbawang east sub-area, where transmigrants were settled from 1976/77 to 1979/80. Each transmigrant was given 5.0 ha lands consisting of 4.75 ha of farm lands and 0.25 ha of house yard. The rainy season paddy will be cultivated in 1.5 ha and the dry season paddy will be cultivated in 1.0 ha under this cropping pattern. The perennial cash crops will be grown in 2.0 ha. The crop intensity of this pattern is 1.36 as shown in Fig. 4.2.

In addition to the above, four alternative patterns are conceived in view of crop diversification and water saving, in which more cultivation of polowijo will be introduced than the proposed.

From the viewpoint of photosynthetic efficiency on the increase of yield, the rainy season paddy is proposed to be transplanted from the beginning of December to the end of January, and harvesting period will be from the middle of March to the beginning of May. Dry season paddy is proposed to be transplanted from the end of April to the beginning of June and harvesting period from the end of July to the beginning of September in the proposed cropping pattern Type I. In the proposed cropping pattern Type II, the transplanting period of rainy season paddy is the same as that in the cropping pattern Type I, and harvesting period will be from the middle of March to the beginning of May. The dry season paddy will be transplanted from the middle of May to the beginning of July and harvested from the middle of August to the beginning of October respectively. It is recommended that the high yielding varieties such as IR-36 and IR-38 and improved local varieties like Gehar, Adil and Gata be selected for these cropping patterns from the plant physiological viewpoint.

Polowijo crops such as peanuts, soybeans and maize will be grown during the period from June to October in the proposed cropping pattern Type I and from February to June in the proposed cropping pattern Type II.

The following table shows the cultivation area under each proposed cropping pattern and its crop intensity for the irrigated lands which exclude the perennial crop area because of non-irrigation area.

(Unit: ha)

Item	Type I						Type II	
	Muncak Kabau Area		Lempuing Area		Tulangbawang West Sub-area		Tulangbawang East Sub-area	
	Area/ House	Cultivated Area	Area/ House	Cultivated Area	Area/ House	Cultivated Area	Area/ House	Cultivated Area
Rainy season paddy	1.5	10,700	1.5	13,100	1.5	31,300	1.5	7,200
Dry season paddy	1.0	7,130	1.0	8,730	1.0	20,870	1.0	4,800
Polowijo	0.5	3,570	0.5	4,370	0.5	10,430	1.25	6,000
Total		21,400		26,200		62,600		18,000
Crop intensity		2.0		2.0		2.0		1.36

The details for proposed farming practices for paddy and polowijo are explained in ANNEX-V.

4.3.2 Farm Inputs and Labor Requirements

The required amount of fertilizer per crop per ha would be about 180 kg of urea and 90 kg of triple super phosphate in total for paddy cultivation, and about 30 kg of urea and 40 kg of triple super phosphate in total for polowijo cultivation respectively. Along with proper water management and optimum fertilizer application, the control of pests and diseases through the use of agricultural chemicals is essential under the proper guidance by the extension service stuff. Since large numbers of people directly or indirectly use the canal water for drinking and other purposes, particular attention should be paid to the method of use of chemicals. The labour force needed for the proper farming will mostly be employed from the family labour, but in the peak time of labour requirements like in the transplanting and harvesting times, some hired labours are required. In this connection, the use of draft animals and improved farming tools and equipment is proposed to be introduced.

The labor requirements for the respective crop cultivation are estimated as follows:

Item	Rainy Season Paddy	Dry Season Paddy	Upland Paddy	Maize	Cassave	Peanuts	Soy-beans
Labor requirements							
With project	200	205	-	85	-	90	85
Without project	170	-	137	55	75	65	55

4.3.3 Anticipated Yield and Production

With introduction of improved farming practices as well as proper water management, the crop yield is expected to increase remarkably. The time required to attain the target yield mainly depends on the progress of agricultural support services. The anticipated build-up period after the implementation of the project varies depending on the field conditions. In case of the Muncak Kabau and the Lampuing areas, the crop yield would reach its projected yield in and after seven years, while in case of the Tulangbawang area. Its anticipated yield would be attained within ten years. The anticipated yield and production of respective crops at the full development stage are shown below:

Item	Yield (ton/ha)	Production (10^3 tons)			
		Muncak Kabau Area	Lampuing Area	Tulangbawang West Sub-area	Tulangbawang East Sub-area
Rainy season paddy	4.0	42.8	52.4	125.2	28.8
Dry season paddy	4.5	32.1	39.3	93.9	21.6
Peanuts	1.3	2.3	2.9	6.8	7.8
Soybeans	1.3	2.3	2.9	6.8	-

4.3.4 Marketing and Price Prospects

(1) Marketing

At present, surplus of paddy produced in the project area is mostly marketed through the two channels, i.e. DOLOG/KUD and itinerant grain buyers. The DOLOG/KUD markets the rice and functions for the stabilization of price of rice under the Governmental control. Because of inadequate transportation system, insufficient storage facilities of products and lack of market information, the farmers are often compelled to sell their products, when the prices are low. In order to improve such poor marketing system and to stabilize the prices, particularly for price, the following activities on marketing are to be systematically introduced under the direct control of the agricultural cooperatives;

(a) collection of paddy from farmers in time,

(b) storing of the paddy in the cooperatives' warehouse, as much as possible,

(c) milling of the paddy under the contract with rice millers, and

(d) selling of the milled rice to the BULOG through BUUD/KUD.

Although the rice production in Indonesia as well as the South Sumatra province and the Lampung province is significantly increasing, the high rate of population growth will accelerate the shortage of rice in futures. In forecasting the future demand and supply of rice, various factors such as population growth rate, increase rate of rice consumption per capita, amount of rice consumption at present, amount of final target for rice consumption and rice production increase rate are taken into account.

After implementation of the project, about 300,000 tons of rice will be produced in the project area, and about 260,000 tons will be marketed to the vicinity of the project area, Palembang and Tanjung Karang/Teluk Betung.

(2) Price prospects

(a) Rice

Economic Prices: Economic price of paddy at farm gate is estimated on the basis of the international market price projected by IBRD for the period of 1990 in 1981 constant dollars, taking into account the costs for transportation, processing and others. Table 4.1 shows the rice price at the farm gate to be used for economic evaluation of the project.

Financial Prices: Financial prices of farm products at farm gate are estimated based upon available data on farm gate price collected through farm economy survey and prevailing local market prices of farm products in Martapura and Palembang. The estimated financial prices of farm products are also given in Table 4.1.

(b) Other Crops

Economic prices of soybeans, peanuts and others at farm gate are estimated on the basis of projected international market price forecasted by IBRD as shown in Table 4.1. As for the financial prices of soybeans and peanuts, the economic prices estimated above are taken in the farm budget calculation, because after the full development of the project, considerable amount of these crops would be exported abroad. Financial prices of other crops are estimated based on the present prices prevailing in the local market.

(c) Farm Inputs

Financial prices of farm inputs at farm gate are estimated based on the results of the farm economy survey carried out in 1981 and also referring to the market prices in Martapura. As for the economic prices of farm inputs, the prices are estimated based on the international market prices projected by IBRD for the period of 1990 in 1981 constant dollars as shown in Table 4.1.

4.3.5 Typical Farm Budget

From the farmer's viewpoint, the financial evaluations for the cases of "with project" and "without project" are made for two typical farmers, i.e. 2.0-ha farm holding farmer and 5.0-ha farm holding farmer. Calculation of both income and outgo was made based on the production amount of crops, prices of crops estimated and inputs applied under "with project" and "without project" conditions respectively.

The gross income under "with project" condition will increase remarkably after the full development of the project as compared with the income under "without project" condition. Such high income under "with project" condition is attributed to the production increase of rice and polowijo. The income from livestock is deemed to be insignificant.

Crop production cost under "with project" condition will also increase substantially due to application of proper amount of fertilizers and agrochemicals. Although living expenses of farmer under "without project" condition would increase to some extent from the present basis, those under "with project" condition would substantially increase by approximately two to three times mainly due to raising of food consumption particularly for rice.

The following table shows the comparison of income, outgo and balance (capacity to pay) in both "with project" and "without project" conditions.

(Unit: 10^3 Rp.)

Description	Cropping Pattern							
	Type I						Type II	
	Muncak Kabau Area		Lemping Area		Tulangbawang West Sub-area		Tulangbawang East Sub-area	
	With Project	Without Project	With Project	Without Project	With Project	Without Project	With Project	Without Project
Gross income	1,521	472	1,525	478	1,528	300	2,356	343
Farm outgo	1,132	469	1,021	474	1,085	299	1,309	342
Balance or capacity to pay	389	4	504	4	443	1	1,047	1
(US$)	(622.2)	(5.8)	(805.9)	(6.6)	(708.0)	(1.1)	(1,675.3)	(1.6)

4.3.6 Project Benefit

Irrigation benefit (direct benefit) or incremental benefit of the agricultural development is defined as the difference between the net production value with the project and the net production value without the project. The net production value is defined as the difference between the gross production value and the gross production cost in both "with the project" and "without the project" conditions.

The following table shows a summary of the incremental benefit of each development area at the full development stage.

(Unit: Rp.10^6)

Area	With Project	Without Project	Incremental Benefit
Muncak Kabau area	10,004	867	9,137
Lempuing area	12,248	1,411	10,837
Tulungbawang west area	29,266	97	29,169
Tulungbawang east area	8,222	487	7,735
Total	59,740	2,862	56,878

4.3.7 Transmigration and Resettlement

After implementation of the project, about 39,600 ha of forest and alang-alang areas in the project area; 5,200 ha in the Muncak Kabau area, 5,100 ha in the Lempuing area and 29,300 ha in the Tulangbawang area, will be reclaimed as paddy lands. These areas are considered to be accepted for transmigration of around 3,500 families in the Muncak Kabau area and 3,400 families in the Lempuing area, and resettlement of 19,500 families in the Tulangbawang area.

In order to settle successfully the transmigrants and resettlers, it is proposed to provide the farm lands reclaimed satisfactorily in addition to the subsidy of certain quantities of living accommodation and commodities needed for farming to them.

4.3.8 Agricultural Support Services

In order to attain the expected crop production through the introduction of double cropping a year with irrigation and drainage improvement, it is essential to provide more intensive agricultural support services, in addition to proper operation and maintenance of the project facilities.

For this purpose, further improvement of the present support services will be required, particularly for extension services, agricultural co-operative, credit and research works. In addition, it is recommended to establish the water users' association for proper water management under the guidance of the Project Office.

(1) Research and extension services

The present farming practices in the project area are still primitive and the farmers are not familiar with irrigation farming of which knowledge would become essential for the proposed agricultural development.

In order to ensure the present crop development program and to attain the successful implementation of the farming, a systematic program of adaptation test of agriculture is indispensable. The research works will mainly be conducted in a proposed Provincial Seed Center.

Present Provincial Seed Center located at BK-X in Belitang Proper Area is proposed to be strengthened under the Agricultural Development Center, for which this station will be re-organized to have seven divisions such as Plant Production Division, Soil Conservation & Irrigation Division, Rice Cultivation Division, Seed Multiplication Division, Socio-Economic Division, Publication & Training Division and Administration Division.

Each division chief should be staffed with a competent senior agronomist who has enough knowledge and experiences of paddy cultivation techniques. One PPS specialized in paddy cultivation is preferably appointed to work at Publication and Training Division.

In the project area, each PPL is dealing with about 1,400 farmers with 1,600 ha of cropping field on an average at present. The present agricultural extension service is insufficient for the proper guidance on application of the improved irrigation farming techniques mainly because of shortage of PPL, lack of equipment and materials for extension activities, and shortage of budget. For the successful accomplishment of the services, it is desired to increase the number of PPL and to strengthen their technical knowledge in order to spread evenly the improved farming techniques to the individual farmer. Appropriate command area per one PPL would be about 500 ha of paddy field. Furthermore, some technical testing apparatus and information instruments such as pH meter, soil auger, movie projector, slide projector, motor cycle, etc. are also proposed to be equipped for effective extension services.

Especially in the case of "with project", it will become important to up-grade farmers' knowledge on crop cultivation techniques such as introduction of new high yield varieties, improvement of fertilizer application system and control of insects and diseases and guidance of demonstration farm with Kontak Tani. Group meeting of the voluntary organization, such as rural youth club and farmers activity group, will also be held from time to time with the assistance of the Kontak Tani and PPL.

(2) Seed multiplication and distribution

One seed center exists in the Belitang Proper Area being operated under the control of the Provincial Agricultural Extension Service. Foundation seeds required for this center are provided by CRIA (Central Research Institute of Agriculture), Bogor.

The stock seeds of newly recommended varieties of paddy in the South Sumatra province, such as IR-36 and IR-38, are produced at the Belitang Seed Center, and the stock seeds are distributed to seed stations, seed growers and demonstration farmers for the production of extension seeds. The extension seeds thus produced are supplied to the farmers through BUUD/KUD and seed distributers.

In order to attain the projected target of the agricultural development in the area, a systematic program of adaptation test and selection of crops is essential. In this context, the present Belitang Seed Center should be extended and strengthened in staff, facilities, equipment, field, etc.

(3) Agricultural credit

The most important agricultural credit in Indonesia is the BIMAS/INMAS credit of which operation was commenced in 1965. For the introduction of the BIMAS/INMAS programs, particularly for paddy cultivation, one of the prerequisites is that the technical or semi-technical irrigation system is to be basically provided in the fields to be applied.

There are three kinds of loan for agriculture by the Bank Rakyat Indonesia, i.e. short term, medium term and long term loans. The BIMAS/INMAS credit for paddy production loan is short term loan with 7-month loan term with monthly interest rate of 1%.

One of the important problems encountered in the BIMAS/INMAS program is low repayment of the credit in the project area. The repayment time usually comes immediately after the harvest, when the price of rice is the lowest, and the number of unit BRI in the project area is very limited; only 11 villages or 5% against the total number of villages. For the easy utilization of credit for the farmers, it is recommended that the unit BRI should be established in each village.

(4) Farmers' co-operative

The establishment of village BUUD/KUD was completed for about 12% of total village in the Kabupaten OKU, 7% in the Kabupaten OKI and 3% in the Kabupaten North Lampung respectively. As for the project area, about 11% of villages in the Muncak Kabau area, 7% in the Lempuing area and 3% in the Tulangbawang area have the co-operatives.

Each BUUD/KUD is operated under the guidance and supervision of the District Agricultural Co-operative Union concerned. The major activities of BUUD/KUD are both supply of farm inputs to farmers and purchase of farm

outputs from the members on time. Since the BUUD/KUD plays an important role in providing various services for farmers to achieve the successful implementation of agricultural development, it is desires that the further establishment of BUUD/KUD as well as strengthening of those activities is required.

(5) Water management

For the smooth water management after completion of the irrigation facilities under the project, the following recommendations are desired to be incorporated into the project work.

(a) Present organization of Provincial Public Works should be re-organized by establishing a new Project Office which will cover the operation and maintenance of new canal system in all the project area.

(b) The following regular activities should be carried out:

- collection of the basic data of cultivation such as cropping calendar, planted area, farm practices and yields of crops by each resort in each ten days,

- regular meeting once a ten-day with the watermen (ULu2) working in each Water User's Association in each resort, in which daily problems about operation and maintenance are discussed and solved,

- regular meeting at the Branch Office every three months for discussion about operation and maintenance works,

- regular meeting at Kecamatan level every month by the officers of Irrigation Section (SEKSI), Agricultural Office and other authorities concerned in order to discuss irrigation amount and period, and other periodic topics under the supervision of the Project Office.

(c) Before completion of the construction works of the project, the Water User's Association should be established under the initiation of each village chief, CAMAT and BUPATI with strong guidance of the Project Office and close co-operation of Agricultural Office and the Branch Office of Irrigation Section concerned.

4.4 IRRIGATION AND DRAINAGE DEVELOPMENT

4.4.1 Basic Engineering Considerations

For the project formulation, the following basic considerations and criteria are incorporated in the study.

(1) Water resources

In the study area, there flow six major rivers, i.e. the Komering, Macak, Belitang, Hitam, Pisang and the Tulangbawang of which the upstream is called as the Kanan river. Among them, the Komering river and the Tulangbawang river give an ample perennial flow. Particularly for the utilization of the Tulangbawang river discharge for irrigation purposes, however, pump stations are required because of its low river water stage as compared with the elevation of irrigable lands, whereas the Komering river water stage can cover the elevation up to 80 meters, below which most of the fertile flat lands exist. Following the basic consideration (2) "Gravity irrigation system" mentioned below, only the Komering river is taken as irrigation water resources in this study.

According to the Feasibility Study on the Komering-I Irrigation Development Project made by JICA in 1981, the irrigation water for the Komering-I development area was planned to be diverted from the Komering river at Perjaya. In order to deliver water from the intake site to the Komering-I area, the Perjaya Headworks and Headreach, North Main Canal and South Main Canal will be constructed. Furthermore, based on the results of the alternative study on the intake system for the proposed development areas in Section 4.4.2 hereof, the irrigation water for the Muncak Kabau area will directly be diverted from the Komering river. As for the Lempuing and Tulangbawang areas, the irrigation water will be supplied from the end

point of Komering-I North Main Canal and from the 18-km point of Komering-I South Main Canal respectively.

(2) Gravity irrigation system

Judging from the fact that the pump irrigation is less familiar in Indonesia, the gravity irrigation system is cotemplated in the whole development areas.

(3) Irrigation water requirements

In planning of irrigation project, a full knowledge of irrigation water requirements of crop from time of seeding until harvest is needed. It is also necessary to know the total amount of water required in each season in order to make a water balance study in the basin. Peak water requirement by crop must be known to determine the design capacity of irrigation system.

Since field measurement relating to estimation of water requirements is not carried out fully in this study period, the study is made mainly depending on the field measurement results collected by JICA for the Komering-I Irrigation Development Project in 1981. The empirical and theoretical formulas developed in the past by various experts were also used in this study.

The irrigation water requirements are calculated for each proposed cropping pattern for the past 18 years using the daily balance method between the rainfall and consumptive use of water, and the calculated results are used for the determination of canal design discharge. In the determination the effective rainfall with a 80% probability of exceedence of the drought year is used.

Canal conveyance and operation efficiencies are estimated to be 85% and 60%, which makes combined efficiency of 51%. The peak water requirements for each cropping pattern and the diversion requirements for each development area are shown below (for the details, vide ANNEX-VI).

(a) Peak water requirements for each cropping pattern:

- for cropping pattern-I ; 1.28 lit/sec/ha
- for cropping pattern-II ; 0.71 lit/sec/ha
- for 1.0 ha area of the Komering-I area; 1.45 lit/sec/ha
- for Lebak area ; 0.99 lit/sec/ha

(b) Diversion water requirements:

- for Muncak Kabau area ; 13.7 m^3/sec
- for Lempuing area ; 16.8 m^3/sec
- for Tulangbawang area ; 48.8 m^3/sec
- for total area including Komering-I, Lempuing and Tulangbawang areas ; 115.9 m^3/sec

The water requirements to be used for the water balance study in the Upper Komering river basin will also be calculated for 18 years using the daily balance method. The detailed calculations and results for the above requirements are presented in ANNEX-VI.

(4) Drainage water requirement

For the design of suitable drainage improvement plan within a feasible range, the study is made to estimate the drainage requirements for the areas where the drainage improvement could be practiced economically by gravity. The study is made taking into account the various factors such as topographic conditions, present drainage conditions, soils, groundwater tables, etc., which vary from area to area.

The proposed drainage requirement is estimated for 3-day consecutive rainfall with a 10-year return period. Thus, the design drainage requirement is estimated to be 7.5 lit/sec/ha for all the development areas (for the details, vide ANNEX-VI).

4.4.2 Alternative Study on Intake System for Belitang Proper and Muncak Kabau Development Areas

In the Feasibility Study on the Komering-I Irrigation Development Project, the economic comparison on the integration of intake for the Belitang Proper Area into the intake system of the Komering-I project was made, because the large amount of sediment loads from the Komering river is deposited at the upper reaches of the Belitang Irrigation Canal, resulting in very less discharge in the headreach. In addition, stoplogs provided at BK-I check cum turnout commanding 1,300 ha of elevated land bottleneck the flow capacity of the headreach. As the result of economic comparison, it was proposed to construct the headreach of the Komering-I project at its own capacity only inclusive of irrigation water for 1,300 ha of BK-I commanding area.

The economic comparison on the integration of intake of the Muncak Kabau area into the Komering-I system was also made in the feasibility study. The result of study showed that water intake through its own intake structure to be constructed near Muncak Kabau would be economical, though certain O&M costs for desilting are required annually.

As mentioned briefly in the above feasibility study report, both economic comparisons mentioned above were made without considering the possibilities of micro-hydropower development. From the rough studies based on the available topographic maps and the proposed plan of Komering-I project, it is expected to generate about 800 kW at Kurungan Nyawa and about 600 kW at Muncak Kabau harnessing the head to be created between the proposed canal water level in the Komering-I system and the proposed intake water levels of the said development areas, if the integrated intake systems are applied to both Belitang Proper Area and Muncak Kabau area.

Moreover, both economic comparisons mentioned above were made for the provision of free intakes only without construction of diversion weirs on the Komering river in the case of individual intake from the Komering river. However, the study on the watershed management (ANNEX-IX) shows that the annual total sediment loads in the Komering river would amount to $4.6 \times 10^6 m^3$, which correspond to 1,068 m^3/km^2/year. After completion of

the dams in the upper reaches of the Komering river, most of the sediment discharge will be checked by the dams, and there will be less supply of sediment loads to the downstream. This will cause the degradation of the Komering river bed in the downstreams, and result in the lowering of river water levels at Kurungan Nyawa and Muncak Kabau. These phenomena will adversely affect the free intake practices at those intake sites. Although a further study is required on the above subject, it may be concluded that the construction of diversion weirs is required for both Kurungan Nyawa and Muncak Kabau sites to keep the design intake water levels.

Taking into account the above alternation of the conditions for the economic comparison, a comparative study for each area is made between the following cases.

(1) Alternative Cases for Belitang Proper Area

Case - 1: Water supply to the high elevated area from the Komering-I system

According to the results of the field investigation and hydraulic analysis of the headreach, the present Belitang Irrigation Canal can convey the water required in the whole Belitang Proper Area, if the hydraulic gradient of the headreach is improved by lowering of the water level at BK-I. Therefore, the following plan is conceived with respect of the irrigation system capacity of Komering-I Project and the improvement of the unfavourable hydraulic conditions of the Proper area:

- The irrigation water for the elevated area about 1,300 ha commanded by BK-I is supplied from the Komering-I system.
- Regulating stoplogs provided at BK-I, which are the main cause to reduce the hydraulic gradient in the headreach, are removed.
- Sediment problem in the headreach remains. Annual sediment loads are estimated to be 104,000 m^3 based on the design discharge of 25 m^3/sec.
- Overflow-type diversion weir is constructed immediately downstream of the intake structure to maintain the design water level.

Case - 2: Diversion of the whole water required in the Proper area from the Komering-I system

The North Main Canal of the Komering-I system crosses over the Belitang Irrigation Canal with an adequate water level to supply water to the Belitang Proper area. The irrigation water for the Proper area can be diverted from the Komering-I system when the Perjaya headworks and headreach and the North Main Canal of the Komering-I system are constructed at the capacity inclusive of the irrigation water to the Proper area. Consequently, the adequate irrigation water for the whole Proper area will be secured, and the expensive O&M costs for the desilting of the Belitang Irrigation Canal will become needless. Moreover, the micro-hydropower generation in the order of 800 kW can be conceived at the inlet point from the Komering-I system harnessing the water head difference of about 5 m between the Belitang Irrigation Canal and the Komering North Main Canal, and this benefit can be counted in the comparative study.

(2) Alternative Cases for Muncak Kabau Area

Case - 1: Water intake through own intake near Muncak Kabau

The relating costs to the comparison are the construction costs of an intake structure, a diversion weir, a settling basin and a main canal concerned, and the annual cost for O&M of the related facilities and dredging.

Case - 2: Diversion of water from the Komering-I system

The relating costs to the comparison are the allocated construction costs of the headworks, the headreach and the North Main Canal of the Komering-I irrigation system, the construction cost of the connecting channel and the annual cost for O&M for the related facilities. The costs of facilities required for the micro-hydropower generation in the order of 600 kW and its benefit are also counted in the comparative study.

The results of the economic comparison for both areas show that the diversion method of the irrigation water required in the area from the Komering-I system (Case-2) is less attractive as compared with the direct diversion method of the irrigation water through its own intake structure (Case-1), even if the benefit of the micro-hydropower scheme is counted in the comparison. The result of economic comparison will further be justified, if the electric supply from the hydropower schemes contemplated in the upper reaches of the Komering river is considered for the rural electrification instead of the said micro-hydropower stations, because the upper Komering hydropower schemes can be developed more economically than the micro-hydropower schemes. Therefore, the direct diversion system through its own intake structure is taken up as the proposed intake system for each area (for the details, vide ANNEX-VI).

4.4.3 Development Areas and Their Development Plans

Through the reconnaissance and study made this time as well as the feasibility study made by JICA in 1981, four development areas mentioned below are taken up as priority areas. The followings are brief descriptions of present and future development plans of the respective development areas. Fig. 4.3 shows schematic water distribution system to each development area.

(1) Komering-I area

(a) Present and natural conditions

The Komering-I area has 50,600 ha in gross (36,700 ha in net) and extends to the northeast direction sandwiching the Belitang Proper Area. The boundaries between the project area and the Proper Area are the Macak river in the North and the Belitang river in the south. The area is topographically bisected by the Pisang river, i.e. 45,800 ha (gross) of the Central area and 4,800 ha (gross) of the Prisang area.

The general topography of the project area is characterized by the flat alluvial plains and the undulating peneplains.

The alluvial flat plains lie mainly along the right bank of the Komering river over 30 km towards downstream reach from Perjaya. The undulating peneplains occupy around 60% of the total area. Ground elevations of the irrigable area range from 25 to 80 meters in the Central area and 25 to 60 meters in the Pisang area.

In this area, particularly in the southwestern half of the Central area, the land settlement by transmigrants was firstly commenced in 1937 and continued up to 1941, and most of the areas are cultivated with paddy and/or upland crops. As for the north-eastern half of the Central area, approximately one-third of the area has been opened up since 1953. The Pisang area was firstly transmigrated by spontaneous migrants in 1940's mainly along the Umpu river. According to the reconnaissance and aerial photo map taken in September 1979, around 16% of the area has been reclaimed for agricultural use. At present, this area is being opened up at high speed by spontaneous migrants.

From the viewpoint of the project development sequence, the project area is divided into two sub-areas, i.e. Sub-Area-I and Sub-Area-II. The Sub-Area-I, 18,500 ha, extends over the western half of the Central Area, and the Sub-Area-II of 18,200 ha occupies the eastern half of the Central area and the whole Pisang area.

(b) Development plan

The irrigation water for the Komering-I area will be diverted from the Komering river by means of headworks at Perjaya. The irrigation water thus diverted will be carried for about 8 km through the headreach, then bifurcated to the North Main Canal and the South Main Canal.

The North Main Canal of 50 km will be constructed for the irrigation of the Sub-Area-I of 18,500 ha, which includes around 3,300 ha of the command area of the headreach. This canal will cross the existing Belitang Irrigation Canal at 4-km point of the canal. This canal is designed for the discharge of about

22 m^3/sec at its head including 1.9 m^3/sec for 1,300 ha in the Proper Area. When the Lempuing area is developed and the Lempuing Main Canal is extended from the end of the North Main Canal, the above design discharge will be increased up to about 39 m^3/sec. The South Main Canal will run for about 71 km to irrigate the Sub-Area-II of 18,200 ha. On its way, the water will be diverted to the Pisang Main Canal at 13-km point. The design discharge at the head of the canal is about 24 m^3/sec which include the irrigation water for the Pisang area (4 m^3/sec). When the implementation of the Tulangbawang area is realized, this canal will also branch off the Tulangbawang Main Canal at its 18-km point. For this, the flow capacity of the South Main Canal will be increased up to about 72 m^3/sec. The Pisang Main Canal branched off from the South Main Canal runs for about 14 km for the irrigation of 2,900 ha in the Pisang area. The design capacity of the Komering-I system including the capacity for the Lempuing and Tulangbawang areas is shown in PLATE NO. 5.

The drainage water from the irrigated lands will be evacuated to the Belitang and the Macak rivers through the tertiary and secondary drains linking the respective irrigation service units.

The total area to be reclaimed for paddy fields are about 27,700 ha in gross. The land clearing and levelling are required in about 16,300 ha and 23,400 ha respectively.

(2) Muncak Kabau area

(a) Present and natural conditions

This area, 16,900 ha in gross (10,700 ha in net), extends to the northeast direction along the right bank of the Komering river as shown in the PLATE No.1.

The general topography of this development area is characterized by the flat alluvial plains and the undulating hilly lands. The alluvial flat plains lie mainly along the right bank of the Komering river over 30 km towards downstream reach from the

intake site. The undulating hilly lands occupy more than 60% of the total area. Ground elevations of the irrigable area range from 30 to 60 meters.

In this area, around 43% of the gross irrigable area has been opened up for the agricultural use: around 2,900 ha is utilized for deep water paddy cultivation and 2,100 ha for the cultivation of upland crops.

(b) Development plan

The irrigation water will directly be diverted from the Komering river through the free intake structure (refer to PLATE NO. 6). The 37-km long East Main Canal will be constructed to lead irrigation water of about 14 m^3/sec to the irrigable area and branch off the 11-km long West Main Canal at its 5-km point. The design discharge of the main canal is shown in PLATE NO. 4. A overflow-type weir will be constructed at the immediately downstream of the free intake structure against the possible lowering of river water level at the intake structure due to degradation of the river bed.

The drainage water from the irrigated lands will be evacuated into the Komering river through the natural rivers and the drainage canals linking the irrigation service units. Particularly in the areas subject to stagnant water carried by the annual flood from the Komering river, drainage structures equipped with flap gates together with protective perimeter bunds will be provided around such areas.

As mentioned in the above, around 43% of the gross area has been opened up for the agricultural use, and accordingly the land reclamation cost particularly for land clearing would be nominal.

(3) Lempuing Area

(a) Present and natural conditions

The development area extends over a gross area of about 19,400 ha extending along the left bank of the Macak and the Lempuing rivers; from the Betung-Petanggan road up to the swamp area extending along the Lempuing river as shown in the PLATE No.2. The net irrigable area is about 13,100 ha.

Topographically this development area is deemed to be the extension of the Komering-I and the Belitang Proper areas, and has a flat topography. Ground elevations of the irrigable area range from 20 meters in the riparian area to 50 meters in the area along the proposed main canal. Many small streams draining into the Macak and Lempuing rivers dissect the area into small patches.

This area was firstly settled by transmigrants in 1972 in the southern parts of the area. According to the reconnaissance and the said aerial photo, about 52% of the gross area has been opened up for paddy and upland crop cultivations, and about 48% of the area is still covered with secondary forest and grass lands.

(b) Development plan

According to the geographical location of the Komering river and the irrigation area selected, irrigation water for the Lempuing area has to be served through the irrigation system of the Komering-I project. The expansion works of joint portions to be implemented under the Komering-I project will be made at the development stage of the Lempuing area (for the details, vide ANNEX-VI).

Irrigation water of about 17 m^3/sec in maximum is supplied from the Komering-I North Main Canal to this area. The water thus supplied will be distributed over the area by the Lempuing Main

Canal which will directly be led from the end point of the Komering North Main Canal and run for about 41 km along the ridge between the Macak and Curnai rivers.

The excess water in the area will be drained into the Macak river or the Lempuing river directly from the drainage canals to be provided newly or via natural streams, most of which will be used as secondary drains. The flood protection dike will be constructed along the lower reaches of the Lempuing river.

As mentioned in the above, since about 52% of the gross area has been opened up for the agricultural use and moreover the area has less undulation, the land reclamation cost would be nominal.

(4) Tulangbawang area

(a) Present and natural conditions

The Tulangbawang development area covers a gross area of about 80,300 ha extending along the left bank of the Kanan and the Tulangbawang rivers between the confluence of the Umpu river with the Pisang river and Menggala as shown in the PLATE No.3.

Out of the total gross area, around 18,000 ha are occupied by forest to be reserved (3,000 ha) and the lands to be selected for perennial crop cultivation (15,000 ha). After deducting these areas as well as the non-irrigable lands such as village compounds, roads and canals (17,800 ha) from the gross area, about 44,500 ha are selected as a net irrigable area.

Most of this area is undulating topography, and there exist small scale of alluvial flood plains which are formed by narrow but clearly defined levee and narrow strip covered by forest behind the levee. Ground elevations of the irrigable area range from 20 to 60 meters. Many small streams run in the north-south direction and dissect the area into small patches. This requires more costly canal construction.

The land settlement by transmigrants was firstly commenced in the northern area of Menggala in 1977 and about 4,800 families have settled by 1979/80. About 14,200 ha of the land have been reclaimed and mostly cultivated with upland crops. Other than this area, small patches of lands mainly along the Tulangbawang river are only cultivated by spontaneous transmigrants.

The Lampung Provincial Government has decided not to receive any transmigrants, and instead, to promote the settlement program. According to the resettlement program, about 35,000 families are scheduled to be resettled to the Kabupaten North Lampung. In the western area of the Tulangbawang area, the resettlement program is being promoted.

(b) Development plan

Irrigation water of about 49 m^3/sec in maximum is diverted from 18-km point of the Komering-I South Main Canal to the Tulangbawang Main Canal. According to the results of comparative study made in the Feasibility Study of the Komering-I project prepared by JICA in 1981, the expansion works of the joint portion to be implemented under the Komering-I project will be carried out at the development stage of the Tulangbawang area. The main canal with a total length of about 91 km will be constructed almost in the west-east direction crossing the many north-south streams which increase the canal construction costs, because many numbers of crossing structures such as syphons, aqueducts and cross-drains would be required at the crossing points.

As mentioned in the above, during the rainy season from October to May, the flood plain areas suffer from inundation. The construction of flood protection bunds with drainage outlet structures may be needed in some area. The north-south streams will fully be used as drainage canals.

Most of this area, as mentioned above, is still covered with forest and has undulating topography. This adverse present condition increases the land reclamation cost.

4.5 MUNICIPAL WATER SUPPLY

No pipe-served population exists in the Komering river basin at present except for Palembang where the water is supplied from the main stream of the Musi river. The population in Kayuagung and its vicinity located at the lower reaches of the Komering river is estimated at about 51,000 in 1980. The people often suffer from the stagnant water from their living during the lowest river flow season. The total population in 1990 and 2000 is estimated to be about 66,000 and about 85,000 respectively applying 2.6% of annual increase rate in the past 10 years.

According to the water supply plan of Palembang, the water required in 1979 and 1995 is estimated at 160 lit/day and 170 lit/day per capita respectively. Meanwhile, the lowest flow of the Komering at Kayuagung was recorded at about 9 m^3/sec which correspond to about 20% of total flow of the Komering river, in November 1977 at Cempaka; about 40 km upstream of Kayuagung, and the remainder flowed out to the Ogan river. The quantity of water required for the people in and around Kayuagung is only about 10% of the above lowest flow even if pipe-served water supply system is provided. The minimum flow of the Komering river at Kayuagung for maintaining acceptable quality for people is unknown so far. The river flow phenomenon of the Komering should be surveyed and then grasped in more detail. Based on the results of above survey, the maintenance flow to the lowest reach of the Komering river is proposed to be determined. In this context, the comprehensive river improvement study of the Komering river as well as the Ogan river is essential.

4.6 STORAGE DEVELOPMENT

4.6.1 Objectives

The primary objective of the proposed storage development is to balance water demand and supply in the Komering river basin by constructing dams in the upper valley. Another objective is hydropower generation that requires augmentation of low flow to sustain firm continuous power output.

4.6.2 Water Demand and Supply Balance

Required river flow at the proposed Perjaya headworks was investigated taking into account the irrigation water requirements in the existing and proposed irrigation area including 76,000 ha of Lebak area. The river maintenance flow in the Komering river below the proposed Perjaya headworks would be 25 m^3/sec. The required river flow was estimated to range between 2 x 10^9 m^3/year and 4 x 10^9 m^3/year, and on an average 2.9 x 10^9 m^3/year corresponding to 46% of the average annual river flow of 6.5 x 10^9 m^3. If no storage dam is constructed above the Perjaya headworks, water deficit will occur every year. It will be highest in June. A comparison of the required river flow and run-off record showed that 400 x 10^6 m^3 of storage reservoir would be necessary for a safe supply.

4.6.3 Storage Development Plan

The proposed dams between the Lake Ranau and the Perjaya headworks are the Ranau, Komering No. 1, Komering No. 2 and Muaradua dams.

Taking into account the geological, topographic and environmental conditions, the active storage capacity of seemingly the best scale was estimated to be 200 x 10^6 m^3 for the Ranau dam, 120 x 10^6 m^3 for the Komering No. 1 dam, 4 x 10^6 m^3 for the Komering No. 2 dam and 150 x 10^6 m^3 for the Muaradua dam.

A reservoir operation study is carried out assuming the hydrological condition in the 18 years from 1963 to 1980. The primary target is to regulate the river flow in order to sustain the required river flow at the proposed Perjaya headworks.

The results of the study showed that the required river flow at the Perjaya headworks can be attained all the time except that some deficit would occur under the hydrological condition in 1963, 1964, 1972 and 1976 in 18 years. The firm discharge for power generation is estimated to be 15 m^3/sec for the Ranau dam, 30 m^3/sec at the Komering No.1 dam, 32 m^3/sec for the Komering No. 2 dam and 60 m^3/sec for the Muaradua dam.

4.7 HYDROPOWER DEVELOPMENT

4.7.1 Objective

The objective of the proposed hydropower development is to maintain appropriate share of hydropower in balancing power demand and supply in the South Sumatra and Lampung provinces.

4.7.2 Hydropower Development Plan

The slope of the Komering river is steep of 1/100 between the Lake Ranau and Komering No. 2 dam site. The Ranau, Komering No. 1 and Komering No. 2 power stations are proposed for the cascade development of this stretch. These power stations are of dam and waterway type. The upper two stations are planned as peak load power stations, but the Komering No. 2 power station is a base load power station. A base load power station is also proposed at the Muaradua dam site.

The installed capacity is preliminarily proposed to be 83.7 MW for the Ranau power station, 108 MW for the Komering No. 1 power station, 35.7 MW for the Komering No. 2 power station and 23.8 MW for the Muaradua power station.

A location map and river profile of the proposed dams and power stations are shown in Fig. 4.4 and the principal feature of these facilities are as shown in Table 4.2.

5. WATERSHED MANAGEMENT

5.1 GENERAL CONDITIONS OF THE UPPER KOMERING WATERSHED

The upper Komering river basin; study area, extends over the south-west corner of the South Sumatra province and partly in the northern part of the Lampung province having about 4,260 km^2 at Martapura. The surface elevation of the basin ranges from EL. 2,180 m (Mt. Pesagi) in the Barisan Mountains to EL. 80 m at Martapura. Forest covers around 60% of the basin, particularly in the mountainous region, and shifting cultivation and plantation areas cover the remaining area. Geologically the lands are composed of pleistocene formations of soft tuffaceous sandstone, sandy conglomerate and siltstone, and are dissected extensively by gullies and rivulets. The alluvial plains lie mainly along the lower reaches of the upper Komering river.

The main stream of the Komering river originates from the Lake Ranau with a surface of about 127 km^2 and the elevation of about 542 m above mean sea level, and flows in torrents in north west direction until it joins with the Baru river. At the confluence, the river changes its course towards northeast and flows down through steep and narrow gorge dividing the Barisan Mountains. At Muaradua it joins with the Saka river and travels through hilly area collecting the water from other tributaries towards almost north-east up to Martapura.

Shifting cultivation in association with the uncontrolled and irresponsible fire is causing destructive havoc to the extent of creating a foreseeable ecological disaster in the Komering watershed. Soil erosion is largely accelerated by the above shifting culture with fire particularly in the steep mountainous region, and considerable sediment loads are transported from the upper basin resulting in raising of river bed in the downstream reaches of the Komering river. Recognizing this serious conditions of the watershed, the Government of Indonesia has put a great emphasis on "Penyelamatan Hutan, Tanah dan Air" (forest, soil and water conservation).

There are five rivers connecting the Komering river to the Organ river between Cempaka and Kayuagung. These five rivers are the Randu, the Arisan, the Jambu, the Sigonang and the Anyar from upstream to downstream. According to the discharge data measured by the provincial P3SA, South Sumatra, about 75% of river flow of the Komering flows into these five rivers. Recently, Kayuagung city and its surroundings have suffered from the stagnant flow of the Komering river in the dry season, which has sometimes resulted in an epidemic. It is considered that the above facts are mainly due to raise of the river bed resulted from the considerable deposits of sediment and a large diversion of water from the Komering river to the Organ river as mentioned above. Another problem observed along the lower reaches of the Komering river is bank erosion caused by changes in meandering mode of the river, for which the gravel digging by local people for the use of construction work affects the erosion to some extent.

5.2 FACTOR INFLUENCING EROSION AND SEDIMENT TRANSPORT

5.2.1 Vegetation

Generally well vegetated lands are less influenced by erosion due to the following actions of vegetation:

(1) to relieve the energy,

(2) to reduce the velocity of surface flow,

(3) to increase the percolation rate of soil resulting in the reduction of surface flow, and

(4) to increase the shearing strength of soil and to keep the clod of soil strong due to development of root network.

According to the vegetation map provided by BAPPEDA of the South Sumatra province, and the aerial photographs taken by JICA in 1979, the vegetation in the upper Komering river basin is broadly classified into three groups; virgin forest, secondary forest including plantation, and cultivation area including alang-alang. The virgin forest, about 1,720 km^2, is mainly located in high altitude of the basin. The secondary forest and coffee or rubber plantation, about 1,830 km^2, is mainly situated in hilly area along the upper Komering river. Around 710 km^2 of the cultivation area including alang-alang extend along the lower reach of the upper Komering river (for details, vide ANNEX-IX).

5.2.2 Topography

The general topography of the upper Komering river basin can be explained as follows:

(1) hilly area with elevation of 80 m - 120 m and land slope of 0° - 10° between Martapura and Muaradua;

(2) volcanic plain with elevation of 120 m - 540 m and land slope of 10° - 20° between Muaradua and Ranau; and

(3) the Barisan Mountains with an elevation of 540 m - 2,750 m and land slope of more than 20°.

The following table shows the area extents for respective land slopes.

Range of Land Slope	Area (km^2)	Ratio (%)
0° - 10°	600	14.1
10° - 20°	1,380	32.4
20° - 30°	1,630	38.2
more than 30°	520	12.2
Lake Ranau	130	3.1
Total	4,260	100

Generally, the area with a steeper slope tends to suffer from more erosion, but in the upper Komering basin, the area with a steeper slope than 30° is mostly covered with virgin forest, and had less erodability. Rather, the area with a slope of 10° - 20° tends to be eroded, because this area is covered with very erosive materials such as the Ranau tuffs and weathered granite, and moreover, the area has once artificially devastated.

Another notable topography of the basin is presented by the development of V or U - shaped valleys along the Komering tributaries. In these valleys, the vertical (gully) erosion is still occurring to great extent, and this erosion is deemed to be one of the main causes for the big amount of sediment loads in the Komering river.

5.2.3 Geology

Geologically the upper Komering river basin mainly consists of Pleistocene formations underlied by the Tertiary sedimentary rocks and the Pre-tertiary igneous rocks, and further classified into following four geological groups:

(1) Young volcanic products,

(2) Ranau tuffs,

(3) Upper Palembang formation, and

(4) Granite.

The young volcanic products occupy the Barisan Mountains, both banks of the Baru river, left bank of the Selabung river and the upper basin of Saka river. This formation is not so erosive. The Ranau tuffs are mainly distributed along the right bank of the Selabung and the Komering rivers, where the land slopes range from 10° to 20°. These tuffs, especially the acid volcanic ash, are very erosive. The Upper Palembang formation is observed in the patches along the upper reaches of the Saka river. The area of this formation is not so erosive. Granite is mainly observed in the patches on both banks of the Komering river near Muaradua. The granite has been weathered and become erosive.

5.2.4 Rainfall

The rainfall intensity is one of the most important influencing factor of soil erosion. Whole upper Komering river basin is included in 100 - 120 mm/hr zone, and it can be said that this high intensity of rainfall influences the watershed erosion to great extent.

5.2.5 Danger Area for Erosion

Erosion is a phenomenon as a result of compound action of the foregoing factors. No decisive technique has been established yet regarding the judgement of an erosion danger zone. However, past examples empirically indicate that under which conditions the erosion is liable to occur. It is possible to determine to some extent where such danger exists by combining these conditions.

In this study, the danger zones are estimated by giving marks to the foregoing factors in accordance with their danger degrees and by combining these marks (for details, refer to ANNEX-IX). As the results, it may be concluded that about 43% of the watershed and V or U-shaped valleys along the Komering tributaries would be under the serious conditions against possible erosion as shown in Fig. 5.1.

5.3 ESTIMATION OF SEDIMENT LOADS

In the study area of the upper Komering river basin, suspended load sampling at the Martapura water level gauging station and their analyses had been undertaken by P3SA of the South Sumatra province for the period from September 1980 to March 1981 for 6 times. In addition to the above measurements of the suspended sediment loads, the sampling and grain size analysis were carried out on the bed loads of the Komering river collected at Martapura.

The results of the suspended load measurements show a relation between the river discharge and sediment discharge as shown by the following equation:

$$Q = 1{,}658 \times 10^{-4} \cdot Q^{1.252}$$

where, q ; sediment discharge of suspended load (m^3/sec)

Q ; river discharge (m^3/sec)

Using the above equation, the annual amount of suspended load is calculated to be 4.1×10^6 m^3 for the average year. Assuming that the amount of the bed load is 10% of the suspended load, the annual total sediment loads are estimated to be 4.55×10^6 m^3, which correspond to 1,068 m^3/km^2/year. This estimated result is compared with the estimated result of 880 m^3/km^2/year in the FAO/UNDP report/1 and 1,030 m^3/km^2/year estimated using the modified Einstain Method. The above-estimated result is further compared with the annual total sediment loads estimated for the Way Seputih and the Way Sekampung, 1,000 - 1,300 m^3/km^2/year/2, and for the Way Rarem, 750 m^3/km^2/year/3. As the result, the erosion rate of 1,000 m^3/km^2/year seems reasonable and applicable to the study of reservoir operation.

5.4 PROBLEMS AND NEEDS RELATED TO WATERSHED MANAGEMENT

For the proper watershed management in the upper Komering river basin, the following three things can be pointed out as the basic problems.

(a) About 57% of the basin has once artificially been devastated for the agricultural use, i.e. shifting cultivation, plantation or logging for the production of wood, and the forest has lost its function for soil and water conservation.

/1 : Belitang Extension Area Agricultural Development Project, Annex - IV, FAO/UNDP, 1974.

/2 : Feasibility Study on the Way Seputih and the Way Sekampung Basins, Volume 4, Ministry of Overseas Development, London, 1978.

/3 : Feasibility Study on the Way Rarem Irrigarion Project, JICA, 1975.

(b) At present, the Provincial Forestry Services Office administers 99,000 ha of the forest area, which corresponds to 23% of the total river basin area, which is far below the area required for the proper watershed management.

(c) Valley peak erosion in the valley erosion process can be witnessed with volcanic plateaus in the watershed, primarily causing production of soil.

Understanding the above basic problems, the following countermeasures are proposed for the rehabilitation of the forest function for the soil and water conservations.

(1) For the forest lands below EL. 500 m; These lands occupy around 55% of the total river basin area. Most of the lands have flat topography, and are used for the shifting cultivation. For this area, shifting cultivation should be allowed only in the area with a land slope of less than 10°, where less soil erosion is observed, and rehabilitation of forest should be made in the area with a land slope of more than 10° through reforestation. In parallel with the reforestation, land reclamation works should be made in the downstream area to resettle the farmers who live in the area to be reforested.

(2) For the forest lands between EL. 500 m to EL. 1,000 m; All the area should be designated to be the hydrological protection forest, and clear cutting should not be allowed but selective cutting.

(3) For the forest lands above EL. 1,000 m; All the area should be designated to be the hydrological protection forest, and felling should not be allowed in this forest area.

(4) For the vertical erosion in the Komering tributaries; The vertical (gully) erosion in the upper reaches of the Komering tributaries should be checked by constructing the Sabo dam (check dam against the vertical erosion) on the tributaries.

(5) For the erosion along the roads; Along the farm raods or access roads should be provided the properly design gutters and turfing on the side slopes to protect the gully erosion along the roads.

5.5 ENVIRONMENTAL CONSEQUENCES OF THE PROJECT

5.5.1 Impacts of the Ranau Regulating Dam Construction

In order to utilize the large water body of the Lake Ranau efficiently for irrigation and hydropower generation, the present outflow pattern of the lake will be regulated by constructing a regulating dam. With this regulation, the water surface of the lake will fluctuate between the high water level of EL. 542.3 m and the low water level of EL. 540.8 m, while the present water surface fluctuation is in the range from EL. 542.3 m to EL. 541.5 m. The future water surface fluctuation will give some affects mentioned below (for details, vide ANNEX-IX).

(1) Land slide

Geologically the western and the southwestern parts of the lake consist of hard and well compacted Tertiary vocanic products, and there might be very rare possibility of land slide even if the lake water level fluctuate widely. The southern part of the lake is bordered by a steep footslope of Seminung volcano consisting mainly of andestic lavas, and the possibility of land slide in this area might also be small. On the other hand, the northern and eastern parts of the lake seem to have some possibility of land slide because of the distribution of soft-mad-loose pyroclastic sediments of the Ranau tuff and high terrace-scarp-like slopes in the shoreline.

(2) Retrogressive erosion in the streams flowing into the lake

More than 40 streams flow into the lake. After start of the operation of the regulating dam, some retrogressive erosions may occur on the stream beds due to more steep hydraulic gradient in the stream caused by lowering the water level of the lake.

(3) Change of inhabitation conditions for fish

The following four principal environmental conditions are required for inhabitation of fish:

- water temperature is maintained at an appropriate level;
- dissolved oxygen is available;
- feed is available; and
- places for reproduction and spawning are avilable.

Among these, all the conditions except the last one will not change much and will not give much problems to fishery after start of the operation of the regulating dam. However, there will be some effects on regeneration and spawning of fish, because the hydrophyte zones of the lake, which are important for fish to spawn and for fries to grow, but will sometimes dry up due to the fluctuation of the water surface of the lake. When the fish resource quantity decreases after the completion of the dam, some countermeasures such as stocking fries in the river by artificial hatching will become necessary.

(4) Other affects

Other than the above-mentioned affects, the lowering of the water surface of the lake will bring about the some problems on existing facilities along the lake shore, particularly for the landing stages for boats. For this, the extension of the landing stages or replacement with the floating-type stages will be required. The lowering of the water level of the lake will also bring down the groundwater table in the paddy fields around the lake. This phenomenon will increase the vertical percolation in the paddy fields, and some paddy fields may dry up in the dry season. In order to solve this problem, the construction of tirol-type weirs on the nearby streams is proposed to divert irrigation water to these paddy fields.

5.5.2 Impacts of Dam Construction

The construction of the Komering No.1, the Komering No.2 and the Muaradua dams will bring about the following affects to the reservoir areas or the downstream of the Komering river.

(1) Inundation of area and houses

Due to creation of reservoirs, about 210 houses and 550 ha of cultivated area will be inundated.

(2) Flood control

In the design of the dam spillways, any function of flood control is not given to the reservoirs, but the flood peak would be cut to some extent due to raise of reservoir water level by the flow depth over the spillway crest.

(3) Increase of potential fish production

After creation of the reservoirs, the potential fish production in the area will be increased to great extent. The most productive reservoir is likely to be that with a large surface area in relation to depth. In this view, the Muaradua reservoir will be the most productive one.

(4) Improvement of transportation and introduction of tourism

The access roads to be provided for the dam construction, particularly from Teluk Agung to the Komering No.1 dam and from Karang Pendeta to the Komering No.2 dam will fully be used for the transportation of coffee to be harvested in the area and the local traffic. The creation of reservoir will also induce a significant increase of recreational opportunities to the region.

(5) Biological impacts of the reservoirs

The area to be inundated by the reservoir mainly consists of the cultivated lands and the tropical rain forests, but this area is relatively small as compared with its total catchment area. Therefore, the creation of reservoir will not seriously affect the vegetation and wildlife in the region.

(6) Degradation of the Komering river

After completion of the dams in the upper reaches of the Komering, most of the sediment discharge will be checked by the dams, and there will be less supply of sediment loads to the downstream. This would cause the river bed variation from upstream downward. In order to assess the bed variation along the lower reaches, particularly for the reaches from Muaradua to Muncak Kabau, the calculation is made using the empirical formulas. The results of the assessment are as follows:

	Degraded Depth for 20 years
- at Kurungan Nyawa	1.7 m
- at Muncak Kabau	1.0 m

5.5.3 Impacts of Irrigated Agricultural Development

(1) Impacts of fertilizer and chemical use

After completion of the irrigation project, the intensive farming will be practiced, and more fertilizer and agricultural chemicals will be used without considering the environmental problems which give adverse effects on wildlife and human. These problems are mainly associated with the persistence of pesticides. In order to minimize the environmental problems, guidance to farmers for proper use of fertilizer and chemicals is essential from start of the project.

(2) Impacts on water-borne diseases

After completion of the project, a plenty of water will be led from the Komering river to the project area, and the development of road network will increase a human exchange between the urban areas and the project area. This change of circumstances will create more chances for spreading and propagation of water-borne diseases, such as malaria, schistomiasis, dengue fever, cholera, typhoid fever, filariasis, etc. For this, a long term improvement in hygine and sanitation should be required for the prevention and control of these diseases.

(3) Change of soil productivity

The soil forming process for upland soils will be changed remarkably after start of irrigation. Gleization will predominate over the project area, and metallic elements in soils such as iron, aluminium and manganese will become soluble. These compounds are translocated to and accumulated in subsoils. Excess iron frequently causes plant physiological problems, especially Akagare Type-I. Besides, leaching of bases from rooting zones degrades soil fertility by the repeated irrigation and drainage. In order to keep a soil productivity high, appropriate farming practices such as fertilization, deep tillage in a certain interval and liming are needed.

5.5.4 Socio-economic Impacts

In addition to the direct benefits stipulated in the economic evaluation, favorable but intangible socio-economic impacts are expected from the implementation of the project.

(1) Foreign exchange saving

Under the project implementation, rice production will increase to about 480,000 tons per annum from the present production of 60,000 tons. Out of this increased production, it is expected that the marketable rice would be about 420,000 tons after deducting the local consumption. This surplus would reduce the annual amount of imported rice, resulting in the saving of foreign exchange amounting to around US$156 million equivalent.

(2) Increase of employment opportunity to local people

Employment opportunity to the local people will be increased by the project implementation, and a favorable impact will be given to the national economy. Furthermore, the employee will be able to gain more experience, technical know-how, skillfulness in the various working fields. These accumulations would be applied to the future development in the South Sumatra province.

(3) Improvement of local transportation

The local transportation will be improved much by the construction of the operation and maintenance roads along the irrigation canals. The expanded road system will not only enhance the economic activity in and around the project area but also contribute to inter-regional accessibility and communication.

5.6 FUTURE SURVEYS AND STUDIES

For the further study on the watershed management in the upper Komering river basin, the following surveys and studies should be started immediately:

(1) Aerial photo shooting over the total basin area on a scale of 1: 20,000 (preferably color photos),

(2) Preparation of topographic map on a scale of 1 : 20,000 with 5-m contour lines,

(3) Establishment of experimental area with 1,000 - 2,000 ha for the observation of actual patterns of surface flow and soil erosion,

(4) Detailed survey on the actual situation of the shifting culture in the basin,

(5) Water quality analysis and measurement of sediment loads at the proposed dams and headworks sites,

(6) Continuous observation on the change of the Komering river bed in its lower reaches,

(7) Survey on species and population of fish and wildlife in the Komering river basin including the Lake Ranau, and

(8) Survey on annual fish production and income in the Komering river basin.

6. PROJECT ORGANIZATION AND MANAGEMENT

6.1 PROJECT COODINATION COMMITTEE

In order to ensure an adequate control of development work and to maintain a close coordination between the South Sumatra province and the Lampung province, and also between the various technical and administrative departments involved in the project management, it is proposed to organize the Upper Komering River Basin Development Coordination Committee (UKDC) on both national and provincial levels as shown in Fig. 6.1.

The National UKDC will be chaired by the Minister of Public Works, and the members of the committee consist of the officials selected from the Ministries of Agriculture, Mines and Energy, Trade and Cooperative, Labor and Transmigration, Internal Affairs and Finance, and the representatives of the related public organizations such as BAPPENAS, BRI and PLN. The main roles of the committee are coordination of two provinces, establishment of the project basic policy, appointment of key staffs of the project and recommendation of the project budget. Each Ministry concerned is responsible for the preparation of annual budget of the project which will be examined and recommended by the National UKDC.

The Provincial UKDC will be chaired by either the Governor of South Sumatra or Lampung, and its members will comprise the Chiefs of the Provincial Public Works, Agriculture, Mines and Energy, Trade and Cooperative, Labor and Transmigration, Internal Affairs, BRI and the PLN Region-IV. The Secretariate of UKDC to be established under the Governor will formulate the budget bill. After the approval of UKDC meeting, the budget will be submitted to the National Government and the Provincial Government.

6.2 PROJECT OFFICE

6.2.1 Organization

The Upper Komering River Basin Development Project (UKDP) Office will be established under the Provincial UKDC. This office will cover all the irrigation development schemes and the hydropower development

schemes in the basin including the existing Belitang Proper Area. The UKDP Office will have four working divisions, i.e. Irrigation Division, Agricultural Division, Electrical Division and Administrative Division.

For the smooth execution of construction work and operation and maintenance of the project, nine sub-offices will be established in the respective irrigation development areas and the power station sites. All the irrigation development sub-offices such as Tulangbawang, Lempuing, Muncak Kabau, Komering-I and Belitang Proper sub-offices will have three departments; Irrigation Department, Agricultural Department and Administrative Department, supported by ten Sections. As for the hydropower development sub-offices such as Komering No. 1, Komering No. 2 and Muaradua sub-offices, the respective sub-offices will consist of Electrical Department and Administrative Department which will have four Sections respectively as shown in Fig. 6.1.

6.2.2 Duties and Tasks

The UKDP Office will have the following broad duties and tasks:

(1) Irrigation aspects

- survey, planning and design of all the irrigation and drainage facilities and the maintenance works,
- construction supervision for all the construction activities down to tertiary systems,
- assistance to farmers in construction of quaternary systems and the maintenance works,
- estimation of water requirements and preparation of water supply schedule based on the cropping schedule obtained from the water users' associations,
- supply of information of water supply management to the Sub-office,

- periodical and routine inspection of irrigation and drainage facilities,
- preparation of the program for routine and periodical maintenance and emergency repair,
- tender for repair works and supervision of the works,
- assistance and advice to water users' association in maintenance works of tertiary canals down to terminal facilities,
- management of workshop and O&M equipment,
- preparation of operation schedule of O&M equipment, and
- repair and maintenance of metal works of the project facilities.

(2) Agricultural Aspects

- agricultural practices and demonstration of proposed cropping pattern and inputs,
- guidance to farmers in plant protection,
- farmer training in all the farming practices,
- extension staff training,
- preparation of sample crop census,
- applied agricultural research,
- assistance and guidance to farmers in credit organization,
- arrangement of farm inputs,
- construction of village storages,

- marketing organization and supervision, and

- establishment and management of village cooperatives including training aspects.

(3) Hydropower aspects

- survey, planning and design of all the hydropower generating and supplying facilities and the maintenance works,

- construction supervision for all the construction activities,

- operation and maintenance for smooth power supply,

- planning and programming of annual maintenance schedule,

- analysis and measurement associated to operation and maintenance of power system,

- maintenance of powerhouse and building, etc.,

- survey of cause of failure and trouble, and study for preventive measures,

- maintenance of equipment, accessories, spare parts, etc.,

- miscellaneous works related to the operation and maintenance works, and

- planning and implementation of technical and safety training to the staff.

(4) Administrative aspects

- establishment of administration and financial policies,

- general and financial administration,

- personnel management,

- coordination of Divisions,
- project recording,
- budgeting and budget control,
- treasury and payments,
- contract administration,
- administration of project stores,
- book keeping,
- internal audit,
- annual accounts,
- preparation of financial statements,
- secretariate management, and
- management of legal aspects.

7. COST ESTIMATE

7.1 CONSTRUCTION COST

7.1.1 Conditions of Cost Estimate

The construction cost is estimated based on the following conditions:

(1) The exchange rate used in the estimate is US$1 = Rp.625 = ¥220.

(2) All the construction of the project works are to be carried out on the contract basis using contractor's own machinery.

(3) All the unit rates for civil work items are estimated using the current prices prevailing in the South Sumatra and the Lampung provinces as of August 1981. On the other hand, the mechanical and electrical works are estimated based on the international market prices as of August 1981.

(4) Taxes on the construction materials, machinery and equipment to be imported from abroad are exempted from the estimate of construction cost.

(5) Cost of forest cleaning is not included in the construction cost.

(6) The physical contingencies of 15% of direct cost for the irrigation schemes and 20% for the dam and power schemes are included in the construction cost.

(7) The associated costs to be financed by the Government, such as the costs for the establishment of Project offices and improvement of the social infrastructures will not be included in the construction cost.

7.1.2 Estimate

The total construction costs are estimated to be US$1,187.88 million, which comprise US$198.25 million for the dams, US$686.3 million for the irrigation and drainage systems in all the development areas and US$303.33 million for the hydropower schemes. The summary of the cost estimate is as shown in Table 7.1 (for the details, vide ANNEX-X).

7.2 ANNUAL OPERATION AND MAINTENANCE COSTS

The annual operation and maintenance costs include the salaries of project administrative and water control staffs, the materials and labor costs for repair and maintenance of project facilities, the costs for operation, repair and maintenance of O & M equipment, and the running costs of project facilities. The estimated costs are US$11.99 million per annum in total as shown in Table 7.2 (for details, vide ANNEX-X).

7.3 REPLACEMENT COSTS

Some of the facilities, especially mechanical and electrical works have a shorter useful life than the civil works, and require replacement at certain times within the project useful life. The replacement costs and the useful lives of these facilities are listed in Table 7.3.

8. PROJECT EVALUATION

8.1 GENERAL

The economic feasibility of the project is evaluated in terms of the economic internal rate of return (EIRR) for both irrigation development areas and hydropower schemes. For the evaluation, the following basic assumptions are established:

(1) The construction period for each development area and the hydropower scheme are as shown in Fig. 9.1.

(2) Only direct benefit is counted in the evaluation and any indirect or intangible benefits are not taken into account.

(3) The economic prices estimated on the basis of the international market prices projected by IBRD for the period of 1990 in 1981 constant dollars are used in the evaluation.

(4) The exchange rate of Indonesian Rupiah to US Dollar is taken as Rp. 625 = US$1.

(5) The economic useful life of the project is taken as 50 years for the dams, irrigation facilities and other civil works and 35 years for the hydropower generating plants.

8.2 ECONOMIC COST

The economic cost for the implementation of the project includes the costs for (1) preparatory works, (2) construction of project facilities, (3) procurement of O&M equipment (first procurement only), (4) administration expenses, (5) engineering services and (6) physical contingency of 15% for the irrigation schemes and 20% for the dam and hydropower schemes. In addition to the above costs, the construction cost for the on-farm development works and the cost for forest clearing, both of which are estimated using the opportunity cost for labor, are counted in the economic cost.

This project will involve construction of joint facilities which will serve for each development area and power schemes. The project costs estimated in the Chapter 6 are those before allocation. For the assessment of the economic feasibility of each development area and the hydropower scheme, the joint costs involved are allocated to the development areas and the hydropower schemes concerned. The joint facilities are:

(1) Ranau Regulating Dam : to all the irrigation development areas and the Ranau hydropower scheme,

(2) Komering No. 1 Dam : to all the irrigation development areas and the Komering No. 1 hydropower scheme,

(3) Muaradua Dam : to all the irrigation development areas and the Muaradua hydropower scheme,

(4) Perjaya Headworks : to all the irrigation development areas except the Muncak Kabau area.

The allocation of the joint costs are firstly made between the irrigation development areas and the hydropower schemes using the "separable costs - remaining benefits method". Then, the total costs thus allocated to the irrigation development area are re-allocated to each irrigation development area taking the ratio of the annual amount of the water demands in the respective irrigation areas. The economic cost of the Perjaya headworks is allocated to each development area also taking the ratio of the annual amount of the water demands in the respective development areas. Table 8.1 shows the economic cost for each irrigation scheme and hydropower scheme after allocation of the joint costs (for details, vide ANNEX-XI).

The annual disbursement of the economic cost for each development area and hydropower scheme is summarized as follows:

(Unit: 10^6 US$)

	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	Total
(1) Irrigation Development Areas								
- Komering - I	14.90	24.80	37.20	54.50	54.50	37.20	24.78	247.88
- Muncak Kabau	7.60	11.40	22.90	22.90	11.37	-	-	76.17
- Lempuing	10.10	15.10	30.30	30.30	15.08	-	-	100.88
- Tulangbawang	18.30	36.60	54.80	73.10	73.10	73.10	36.52	365.52
Sub-total								790.45
(2) Hydropower Schemes								
- Ranau	10.10	15.20	30.40	30.40	15.13	-	-	101.23
- Komering No. 1	12.90	19.30	38.60	38.60	19.38	-	-	128.78
- Komering No. 2	9.60	14.50	28.90	28.90	14.56	-	-	96.46
- Muaradua	7.10	10.70	21.40	21.40	10.81	-	-	71.41
Sub-total								397.88
Total								1,188.33

In addition to the above economic construction cost, the O & M costs and the replacement costs estimated in Chapter 6 are counted in the economic cost.

8.3 PROJECT BENEFITS

The agricultural benefit through the project was estimated for the cases of "with project" and "without project" in Section 4.3.6 hereof to know the net incremental benefit in the full operation stage of the project. The benefit for each development area is summarized as follows:

Total Incremental Benefits
in Full Development Stage

Irrigation Development Area	Area	Net Incremental Benefit
	(ha)	(10^3 US$)
- Komering - I	36,700	45,300
- Muncak Kabau	10,700	14,600
- Lempuing	13,100	17,300
- Tulangbawang	44,500	59,000
Total	105,000	136,200

As for the hydropower schemes, the sum of kW value and kWh value is taken as the annual benefit.

Power Station	Installed Capacity	Annual Benefit
	(kW)	(10^3 US$)
- Ranau	80,700	20,060
- Komering No. 1	114,300	43,480
- Komering No. 2	20,900	16,820
- Muaradua	7,700	10,390
Total	223,600	90,750

8.4 EVALUATION

For the calculation of EIRR, the cost and benefit streams are firstly prepared. Then, the EIRR is obtained graphically for each irrigation development area and hydropower scheme (Fig. 8.1). The following table shows the EIRR for each irrigation development area and hydropower scheme as well as the EIRR for the whole project.

Economic Internal Rate of Return

	EIRR
(1) Irrigation Development Areas	
- Komering - I	15.1 %
- Muncak Kabau	14.3 %
- Lempuing	13.1 %
- Tulangbawang	11.9 %
- Overall	13.3 %
(2) Hydropower Schemes	
- Ranau	14.4 %
- Komering No. 1	23.7 %
- Komering No. 2	13.4 %
- Muaradua	10.5 %
- Overall	16.8 %
(3) Whole Project Case	14.6 %

9. PRIORITY OF DEVELOPMENT AND IMPLEMENTATION SCHEDULE

9.1 GENERAL

For the assessment of the sequence of the development priority of the project, the project work is divided into the following development units considering the irrigation water supply system in the area, socio- and agro-economic groups:

(1) Irrigation development areas

(a) Komering-I area (36,700 ha)
(b) Muncak Kabau area (10,700 ha)
(c) Lempuing area (13,100 ha)
(d) Tulangbawang area (44,500 ha)

(2) Hydropower development schemes

(a) Ranau (83,700 kW)
(b) Komering No. 1 (108,000 kW)
(c) Komering No. 2 (35,700 kW)
(d) Muaradua (23,800 kW)

In the assessment of the development sequence particularly for the irrigation development, the following factors are taken into consideration:

(a) Economic feasibility in terms of the economic internal rate of return;

(b) Development effect on equalization of social and public welfare;

(c) Existing conditions of infrastructures required for early implementation and smooth operation of the project; and

(d) Influence of the implementation to the adjacent area.

Among the above, the economic viability is the most decisive factor for the assessment of the development sequence.

The Government's policy for the development sequence is the most important factor in the assessment. In this study, however, the assessment is made only from the economical and technical viewpoints without considering the Government's policy, because the policy was not available to the study team in the field survey period.

9.2 ASSESSMENT OF PRIORITY

9.2.1 Irrigation Development

Following the above-mentioned factors, the assessment for each area and scheme is made as follows:

(1) Komering-I area

More than 60% of the total area have been developed and cultivated with paddy, upland crops and perennial crops. This situation requires less cost for its implementation. The economic feasibility is the highest among the development areas. In this area, the road network is well developed as compared with the other areas. Moreover, the trunk road linking Martapura to Palembang and the main canal road of the Belitang proper area, both of which are asphalt-paved, run through this development area, and provide a good access for the implementation. In order to lessen the economic gap between this area and the surrounding area, i.e. the Belitang proper area, the early implementation is awaited. The farmers in the area are acquainted with the irrigation farming to some extents due to the influence from the Belitang proper area, and the earlier attainment of the projected benefit will be expected than in the other development areas. The feasibility study on this area has been completed by JICA in 1981.

(2) Muncak Kabau area

This area can independently be irrigated with its own canal system without waiting for the completion of joint facilities, such as the Perjaya head works and the headreach. Out of the total area, around 50% of the area is still covered with forest or alang-alang. This increases

the land reclamation cost, but the construction cost for the irrigation facilities per hectare is low, because the development area is closely located to the water source as compared with the other areas. The economic feasibility is the second highest. At present, the Government's transmigration program is going on, and a rapid development is expected in this area. There runs the trunk road linking Martapura to Palembang through the project area, which will provide a good access for the implementation.

(3) Lempuing area

Topographically this development area is deemed to be the extension of the Komering-I area and the Belitang proper area, and has a flat topography. More than 55% of the area has been opened up by transmigrants. In spite of this favorable situation in the area, the economic feasibility is inferior to the Muncak Kabau area, because the area is located away from the water source, and requires high construction cost for a long main canal and large amounts of the allocated costs for the joint facilities. The access from the trunk road or from the main canal road of the Belitang proper area to this area is less developed. In order to fill the economic gap between this area and the Belitang proper area, the intensive farming should be promoted through the provision of irrigation facilities.

(4) Tulangbawang area

Around 75% of the area is still covered with forest or along-along, and many small streams run in the north-south direction. These two factors require more investment for the implementation. Furthermore, a large amount of allocated costs and construction costs of main canal will be burdened on this area because of its remote location from the water source. The internal rate of return is the lowest among the development areas, but it is still in the economical range. A part of the area has been settled by transmigrants since 1977, and the resettlement program is going on in the western half of the area. A rapid agricultural development in this area is expected in near future. This area was given a high priority in the resettlement program. The access road to this area and the road network in this area are less developed.

9.2.2 Hydropower Development

The assessment of development priority for the hydropower schemes is also made mainly from the viewpoint of economic viability, and the first priority is given to the Komering No. 1 scheme followed by the Ranau, the Komering No. 2 and the Muaradua schemes. However, the first priority is given to the Ranau scheme in this study considering the following matters;

(a) Since the investment cost of the Ranau scheme is less than that of the Komering No. 1, the Ranau scheme can be taken up more easily than the Komering No. 1 scheme from the financial viewpoint.

(b) The meteo-hydrological data are available at the Ranau dam site for about 10 years, while no data are available at the other dam sites. This means that more detailed study can be started soon for the Ranau scheme, which results in the earlier implementation.

9.3 PROJECT IMPLEMENTATION SCHEDULE

Based on the results of the assessment mentioned in the preceding section, the following development sequence is proposed.

(1) Irrigation Development

Stage - I ; Komering-I area including the construction of perjaya headworks.

Stage - II ; Muncak Kabau area.

Stage - III ; Lempuing area.

Stage - IV ; Tulangbawang area.

(2) Hydropower Development

Stage - I ; Ranau power scheme.

Stage - II ; Komering No. 1 power scheme.

Stage - III ; Komering No. 2 power scheme.

Stage - IV ; Muaradua power scheme.

The implementation schedule including the feasibility study and the detailed design of the respective development units are tentatively illustrated in Fig. 9.1.

TABLES

Table 1.1 LIST OF PRE-FEASIBILITY TEAM

A. Advisory Committee

1)	K. Naito	Chairman of the Committee Ministry of Agriculture, Forestry and Fisheries
2)	H. Itoh	Senior Irrigation Engineer, Ministry of Agriculture, Forestry and Fisheries
3)	Y. Baba	Senior River Planner, Ministry of Construction
4)	I. Yamamoto	Senior Hydropower Engineer, Ministry of International Trade and Industry
5)	T. Okazaki	Senior Agronomist, Ministry of Agriculture, Forestry and Fisheries
6)	Y. Ogawa	Senior Agro-Economist, Ministry of Agriculture, Forestry and Fisheries
7)	F. Hoshi	Senior Project Economist, Overseas Economic Cooperation Fund

B. Study Team

1)	Shinichi Yano	Team Leader
2)	Toshihiro Tomita	Deputy Team Leader/ Irrigation Planning Engineer
3)	Hiromichi Sekine	Irrigation Design Engineer
4)	Isamu Aizawa	Watershed Management Engineer
5)	Seiichi Nakao	Hydro-Power Planning Engineer
6)	Yoshiki Tomiyama	Electric Engineer
7)	Masafumi Watanabe	Hydrologist
8)	Isao Suzuki	Geologist
9)	Toshiyasu Matsuoka	Soil Mechanical Engineer
10)	Ikuo Koshino	Agronomist/Agro-Economist
11)	Masayuki Koyama	Pedologist
12)	Shigeyoshi Hanada	Topographic Surveyor/Design Engineer
13)	Chikanori Kubota	Topographic Surveyor/Design Engineer

C. Advisory Members of GOI

1)	Ir. H. Hasbullah Bandarnata	South Sumatera Province
2)	Ir. Sigit Rahardjo	Lampung Province
3)	Ir. Hasan Nuh	South Sumatera Province
4)	Ir. Agusnardi	Lampung Province

D. Counterpart Personnels

1)	Ir. Sukarno Wahab (Chief Counterpart)	Water Resources Development Planning Engineer
2)	Suratno Hp. BIE	Irrigation Planning Engineer
3)	Yusuf Marzuki	Irrigation Planning Engineer
4)	Ir. Alimin Hanafiah	Irrigation Design Engineer
5)	Ir. Sjafarizal	Watershed Management Engineer
6)	Fadil Somad	Hydropower Planning Engineer
7)	Ir. Hendriyanto	Electrical Engineer
8)	E. Praptodi Mulyo BSC	Hydrologist
9)	Sujaswadi BIE	Hydrologist (Lampung)
10)	Abdussalim	Assistant Hydrologist
11)	Ir. Syarbini Husin Alam	Geologist
12)	Ir. Abu Amat HAK	Geologist
13)	Kertalegawa	Soil Mechanic Engineer
14)	Ir. Armand Sulun	Agronomist
15)	Suwarto BSC	Agronomist (Lampung)
16)	Musatafa Kemal BSC	Assistant Agronomist
17)	Ir. Buchori Rachman MSC	Agro-Economist
18)	Maryanah Hamzah	Agro-Economist
19)	Sri Bisowarno BSC	Pedologist
20)	Ibrahim Istar	Topographic Surveyor/Design Engineer
21)	Sumadi	Topographic Surveyor/Design Engineer

Table 3.1 ACREAGE AND PROPORTIONAL EXTENT OF EACH SOIL MAPPING

A. THE MUNCAK KABAU AREA

Soil Mapping Unit	Associated Soil	Land Form	Soil Survey Area ha	%
Yellowish Brown Podzolic Soils		Peneplain	29,800	75.2
Brown Podzolic Soils		Peneplain	1,300	3.3
Brown Hydromorphic Soils	Brown Alluvial Soils	Natural levee	600	1.5
Low Humic Gley Soils	Brown Hydromorphic Soils	Inland valley Alluvial plain	3,800	9.6
Humic Gley Soils	Organic Soils	Depression	4,100	10.4
Total			39,600	100.0

B. THE LEMPUING AREA

Soil Mapping Unit	Associated Soil	Land Form	Soil Survey Area ha	%
Yellowish Brown Podzolic Soils	-	Peneplain	2,400	8.1
Reddish Brown Podzolic Soils	-	Peneplain	10,400	35.1
Grayish Yellow Brown Alluvial Soils	Brown Hydromorphic Soils	Natural levee River terrace	1,700	5.8
Low Humic Gley Soils	Brown Hydromorphic Soils Humic Gley Soils	Alluvial plain Inland valley	8,700	29.4
Humic Gley Soils	Organic Soils	Depression	6,400	21.6
Total			29,600	100.0

C. THE TULANGBAWANG AREA

Soil Mapping Unit	Associated Soil	Land Form	Soil Survey Area ha	%
Orange Podzolic Soils	Yellowish Brown Podzolic Soils Brown Podzolic Soils Brown Hydromorphic Soils	Peneplain	140,500	89.7
Gray Hydromorphic Soils	Organic Soils Humic Gley Soils	Depression	16,100	10.3
Total			156,600	100.0

Table 3.2 ACREAGE AND PROPORTIONAL EXTENT OF EACH SUITABILITY UNIT

A. THE MUNCAK KABAU AREA

Grade	Suitability Class	Suitability Sub-class		Survey Area	
		Paddy	Polowijo	ha	%
I.	Highly suitable	S1	S2w	3,400	8.6
II.	Moderately suitable	S2t	S1	600	1.5
		S2i	S3wi	1,200	3.0
III.	Marginally suitable	S3tf	S2tef	31,100	78.6
		S3wif	N1wif	1,700	4.3
IV.	Currently non-suitable	N1wi	N1wio	1,600	4.0
	Total			39,600	100.0

B. THE LEMPUING AREA

Grade	Suitability Class	Suitability Sub-class		Survey Area	
		Paddy	Polowijo	ha	%
I.	Highly suitable	S1	S2w	7,900	26.8
II.	Moderately suitable	S2t	S1	1,700	5.7
		S2i	S3wi	800	2.7
III.	Marginally suitable	S3tf	S2tef	12,800	43.2
		S3wif	N1io	800	2.7
IV.	Currently non-suitable	N1wi	N1wio	5,600	18.9
	Total			29,600	100.0

C. THE TULANGBAWANG AREA

Grade	Suitability Class	Suitability Sub-class		Survey Area	
		Paddy	Polowijo	ha	%
II.	Moderately suitable	S2i	S3wi	900	0.6
III.	Marginally suitable	S3tf	S2tef	130,600	83.4
		S3tf	S3tef	9,900	6.3
IV	Currently non-suitable	N1wi	N1wio	15,200	9.7
	Total			156,600	100.0

Note: Following abbreviated symbol letters indicate the limiting factor.

t:	topography	e:	erosion
w:	drainability	i:	inundation
o:	acidity	f:	fertility

Table 3.3 SUMMARY TABLE OF CLIMATOLOGICAL DATA

Monthly Rainfall (mm)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
BK-IX	346	243	313	276	200	96	94	96	122	210	294	338	2,628
BK-0	334	275	399	298	247	141	113	111	122	222	258	402	2,922
Martapura	353	291	333	292	214	124	108	150	126	202	259	376	2,829
Muaradua	225	204	270	275	239	114	147	149	127	206	263	305	2,523
Banding Agung	235	213	211	237	182	106	132	111	176	180	224	241	2,247
Menggala	288	308	355	193	147	117	106	70	128	179	220	352	2,461

Monthly Temperature (°C)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Mean
Belitang	26.3	26.9	27.3	27.8	27.8	27.7	27.5	27.6	27.5	27.8	27.6	26.9	27.4
Banding Agung	23.2	23.6	24.1	24.4	24.0	24.2	23.9	23.0	23.9	24.0	24.1	23.9	23.9
Menggala	27.1	27.2	27.4	27.8	28.0	27.0	26.4	26.9	27.4	27.4	27.6	27.7	27.3

Monthly Relative Humidity (%)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Mean
Belitang	83	82	82	83	82	80	78	77	77	78	80	83	81
Banding Agung	83	83	83	81	82	83	82	83	83	81	81	83	82
Menggala	78	77	72	80	86	80	79	74	72	71	74	74	76

(to be continued)

Monthly Sunshine Duration (hr)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Average
Belitang	4.0	4.0	5.0	5.6	6.2	5.8	5.5	5.9	5.2	5.0	4.9	4.1	5.2

Monthly Solar Radiation (cal/cm^2)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Average
Belitang	363.5	385.2	425.7	428.4	404.1	382.5	366.3	406.8	396.0	412.2	404.1	396.0	397.6
Menggala	459.1	456.5	483.2	484.5	470.7	441.9	416.2	445.9	458.8	462.6	455.1	464.3	458.2

Monthly Wind Velocity (km/ha)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Average
Belitang	3.7	3.5	3.2	2.5	2.4	2.3	3.0	3.2	3.2	2.8	2.6	3.2	3.0
Banding Agung	3.1	2.6	4.4	4.6	4.5	4.2	5.6	4.5	4.8	5.1	5.5	4.2	4.4
Menggala	2.4	2.6	2.5	2.2	2.5	2.6	3.1	3.0	3.4	2.6	2.4	2.6	2.7

Monthly Evaporation (mm/day)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Average
Belitang	4.3	4.4	5.0	4.9	4.6	4.2	4.3	4.8	4.8	4.8	4.6	4.5	4.6
Banding Agung	4.8	4.6	4.4	4.0	4.9	5.2	5.8	5.4	4.8	4.9	4.8	4.8	4.9
Menggala	5.8	5.4	6.7	5.3	4.9	4.3	3.9	4.2	4.1	5.7	5.2	5.6	5.1

Table 4.1 ECONOMIC AND FINANCIAL PRICES

(Unit: Rp./kg or lit.)

Item	Financial Price	Economic Price	Remarks
Farm Products			
Rice	200	290	
Paddy	115	200	Dry paddy
Peanuts	370	370	
Soybeans	230	230	
Maize	100	80	
Cassava	25	10	
Farm Inputs			
Paddy seed	150	300	
Urea	80	260	
TSP	80	220	
Insecticide	1,200	6,500	
Rodenticide	2,500	2,300	
Labor (light)	600	700	1 person/day
(heavy)	800	1,000	1 person/day

Table 4.2 PRINCIPAL FEATURES OF PROPOSED DAMS AND POWER STATIONS

		Ranau	Komering No.1	Komering No.2	Muaradua
Dam & Reservoir					
Catchment area	(km^2)	508	1,056	1,165	2,866
Annual inflow	($10^6 m^3$)	580	1,441	1,612	4,285
HWL	(EL.m)	542.3	420	252.5	140.0
Drawdown	(m)	1.6	25.0	11.5	7.5
Active storage	($10^6 m^3$)	200	120	4	150
Dam type		Concrete gravity	Rockfill	Concrete gravity	Earthfill
Dam height	(m)	15	85	65	30
Dam volume	($10^3 m^3$)	8	2,000	200	1,800
Power Station					
Type		Dam & Waterway	Dam & Waterway	Dam & Waterway	Dam
Power house		Underground	Underground	Underground	Surface
Max. discharge	(m^3/s)	90	90	64	180
Rated head	(m)	112	144	67	16
TWL	(EL.m)	415.0	252.5	180.0	120.0
Installed Capacity	(MW)	83.7	108.0	35.7	23.8
Annual energy output	(GWh)	151	474	230	149
Construction Cost at 1981 Constant Price Level					
Dam	($\$10^6$)	2.62	64.61	41.43	43.45
Power station	($\$10^6$)	79.57	139.74	77.18	95.66
Engineering & Administration	($\$10^6$)	8.22	13.97	7.72	9.56
Physical Contingency	($\$10^6$)	12.33	20.96	11.58	14.35
Total	($\$10^6$)	102.74	174.67	96.48	119.57

Table 7.1 SUMMARY OF CONSTRUCTION COST

(Unit: 10^3 US$)

Item	Construction Cost
1. DAMS	
- Ranau regulating dam	3,280
- Komering No. 1 dam	83,760
- Komering No. 2 dam	51,840
- Muaradua dam	59,370
Sub-total	198,250
2. IRRIGATION SCHEMES	
- Perjaya weir	15,500
- Komering-I scheme	202,800
- Muncak Kabau Scheme	63,900
- Lempuing Scheme	85,100
- Tulangbawang Scheme	313,000
Sub-total	686,300
3. POWER SCHEMES	
- Ranau power scheme	99,470
- Komering No. 1 power scheme	93,910
- Komering No. 2 power scheme	44,690
- Muaradua power scheme	65,260
Sub-total	303,330
TOTAL	1,187,880

Table 7.2 ANNUAL OPERATION AND MAINTENANCE COSTS

(Unit: 10^3 US$)

Item	Annual O&M Costs
1. DAM	950
- Ranau Regulating Dam	20
- Komering No. 1 Dam	400
- Komering No. 2 Dam	260
- Muaradua Dam	270
2. IRRIGATION DEVELOPMENT SCHEMES	3,420
- Komering-I	1,170
- Muncak Kabau	420
- Lempuing	410
- Tulangbawang	1,420
3. HYDROPOWER SCHEMES	7,620
- Ranau Scheme	2,500
- Komering No. 1 Scheme	2,360
- Komering No. 2 Scheme	1,130
- Muaradua Scheme	1,630
TOTAL	11,990

Table 7.3 REPLACEMENT COST AND USEFUL LIFE OF FACILITIES

(Unit: 10^3 US$)

Item	Useful Life (year)	Komering -I Area	Muncak Kabau Area	Lempuing Area	Tulang-bawang Area
A. IRRIGATION DEVELOPMENT SCHEMES					
1. Gates	25	10,220	2,980	3,650	12,400
2. Electrical Facilities	20	450	130	160	550
3. O&M Equipment	10	4,990	1,620	1,780	6,050

		Ranau Power Scheme	Komering No. 1 Power Scheme	Komering No. 2 Power Scheme	Muaradua Power Scheme
B. DAM - GATES	50	210	4,140	3,830	8,880
C. POWER STATION					
1. Gates	50	1,300	1,870	1,550	3,390
2. Generating Equipment	40	15,550	19,800	14,870	20,140
3. Transmission Line	35	800	700	600	100

Table 8.1 SUMMARY OF ALLOCATED ECONOMIC COSTS

(Unit: 10^3 US$)

Proposed Works	Before Allocation	After Allocation
1. DAM	190,170	-
- Ranau Regulating Dam	3,270	-
- Komering No. 1 Dam	80,760	-
- Komering No. 2 Dam	51,770	-
- Muaradua Dam	54,370	-
2. AGRICULTURAL DEVELOPMENT AREA	694,830	790,450
- Perjaya Weir	15,500	-
- Komering-I Area	205,070	247,880
- Muncak Kabau Area	65,670	76,170
- Lempuing Area	86,150	100,880
- Tulangbawang Area	322,440	365,520
3. HYDROPOWER SCHEMES	309,940	397,880
- Ranau Power Scheme	99,470	101,230
- Komering No. 1 Scheme	93,910	128,780
- Komering No. 2 Scheme	44,690	96,460
- Muradua Scheme	65,260	71,410
TOTAL	1,188,330	1,188,330

FIGURES

Fig. 1.1 ACTIVITIES OF THE PRE-FEASIBILITY STUDY TEAM

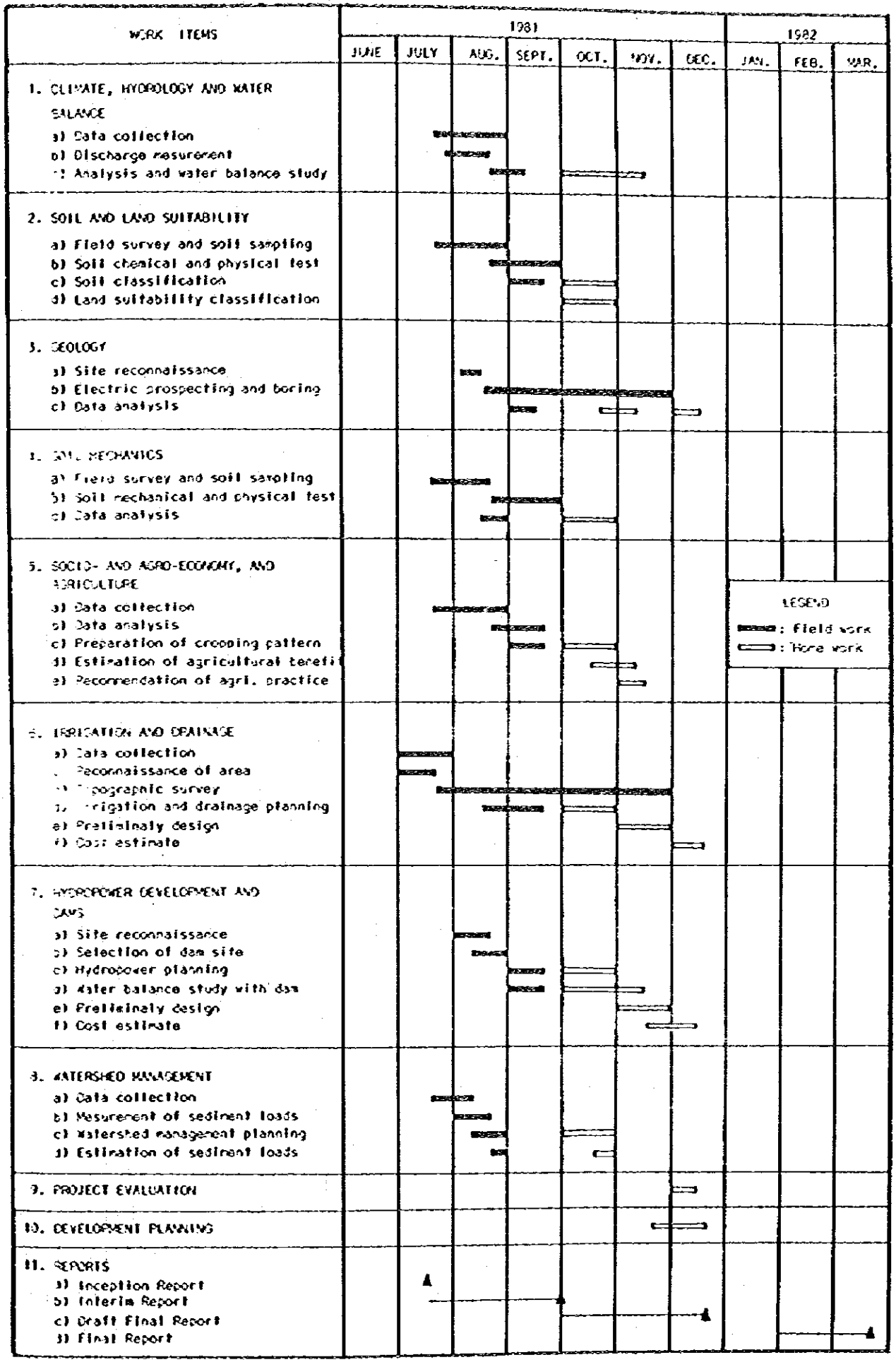


Fig. 3.1 PRESENT CROPPING PATTERN TYPE I (MUNCAK KABAU AREA)

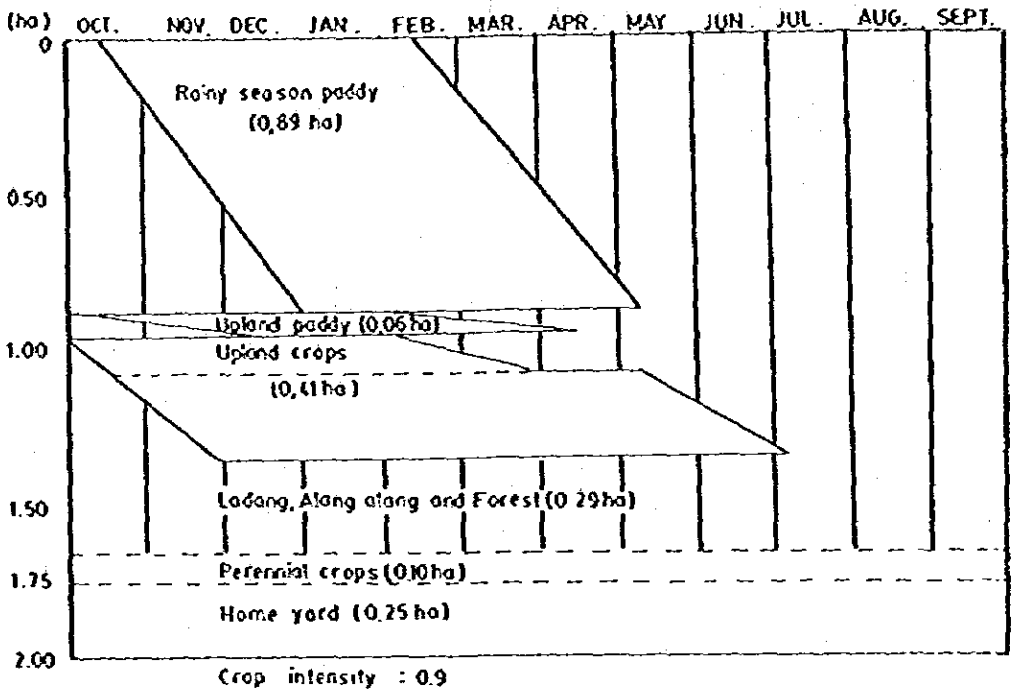


Fig. 3.2 PRESENT CROPPING PATTERN TYPE II (LEMPUING AREA)

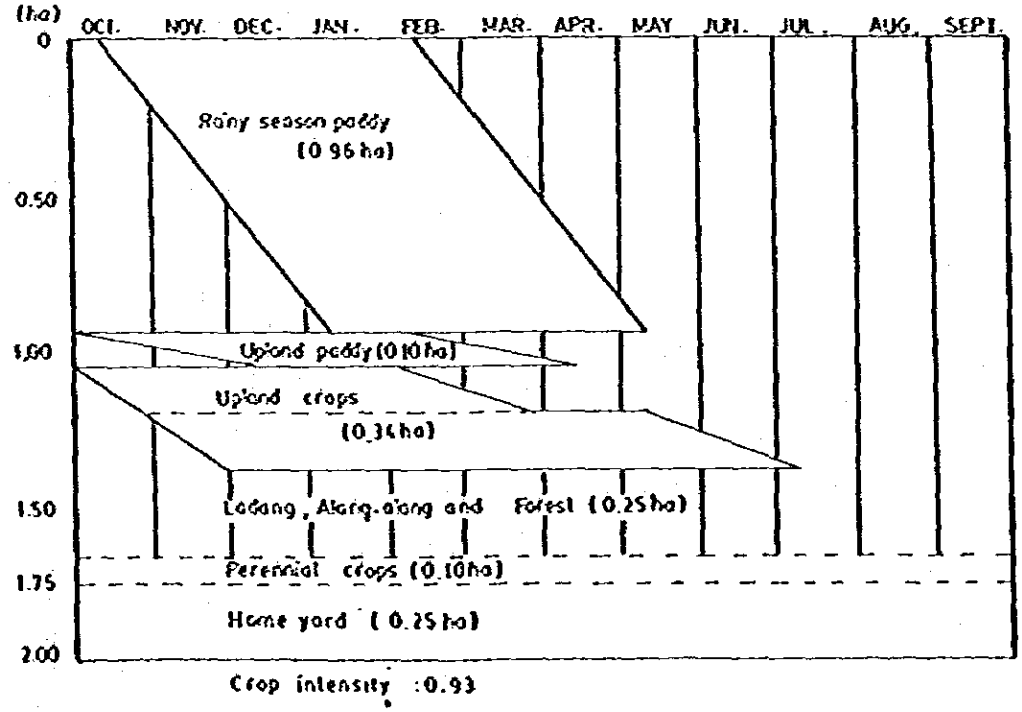


Fig. 3.3 PRESENT CROPPING PATTERN TYPE III (TULANGBAWANG WEST SUB-AREA)

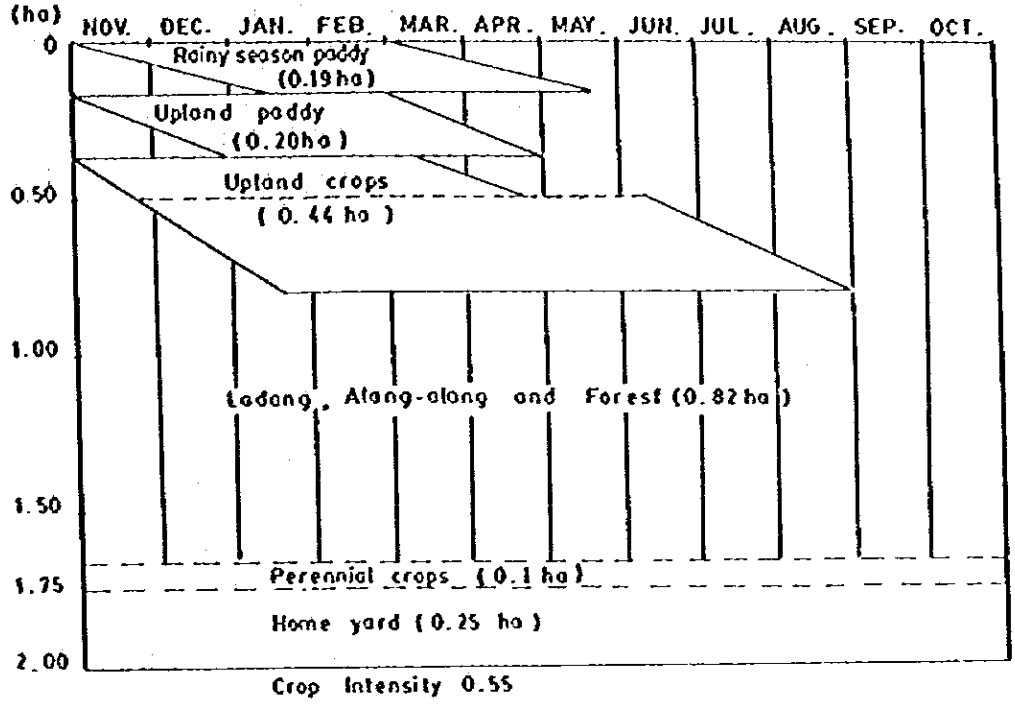
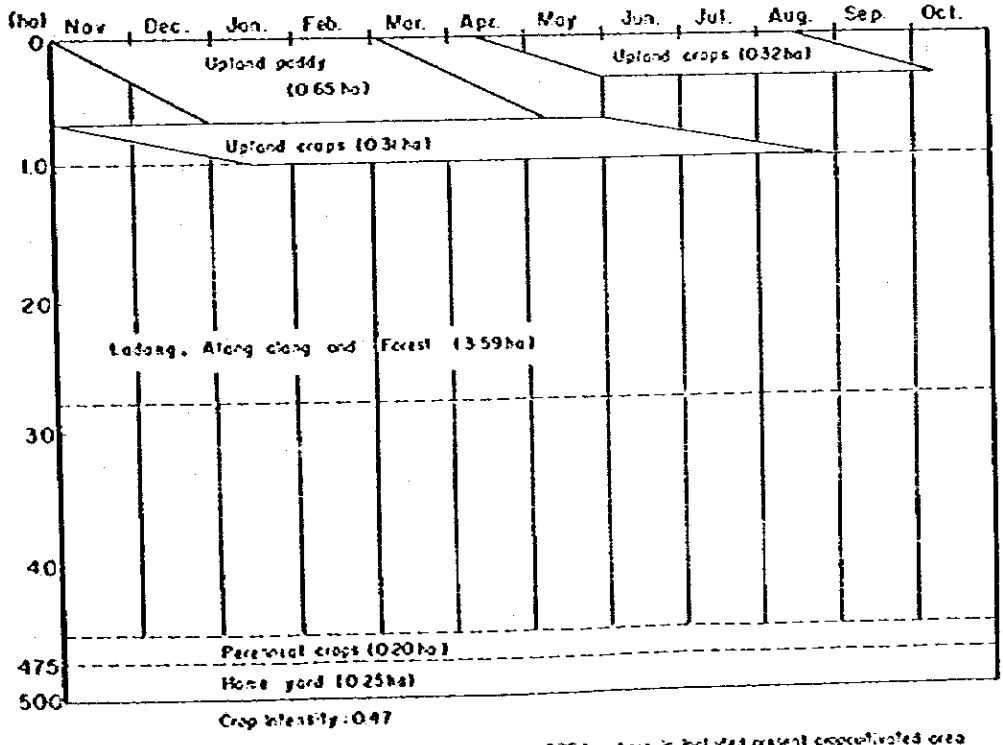
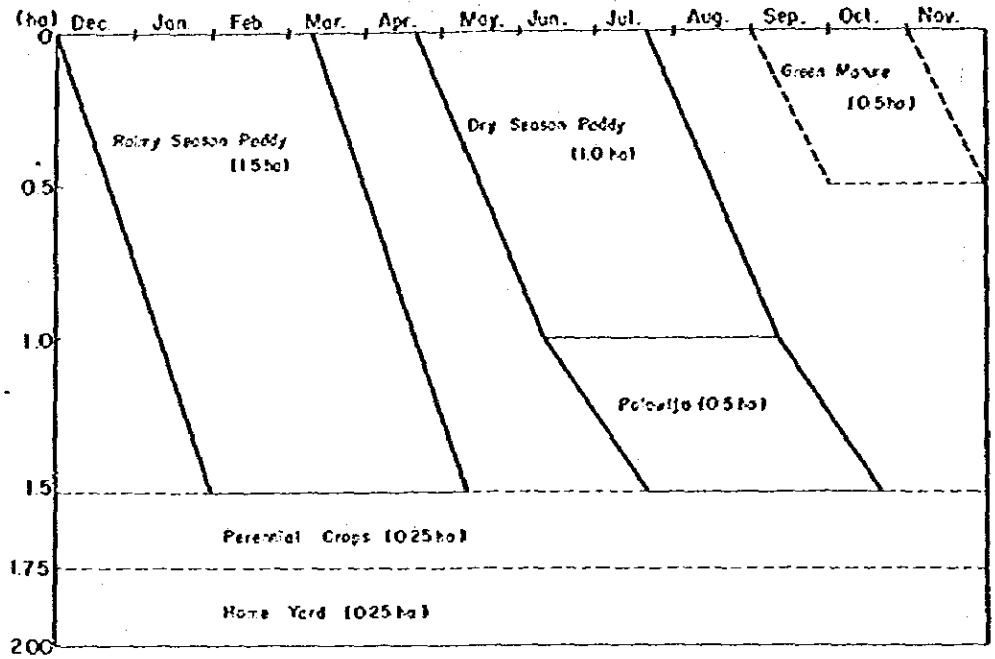


Fig. 3.4 PRESENT CROPPING PATTERN TYPE IV (TULANGBAWANG EAST SUB-AREA)



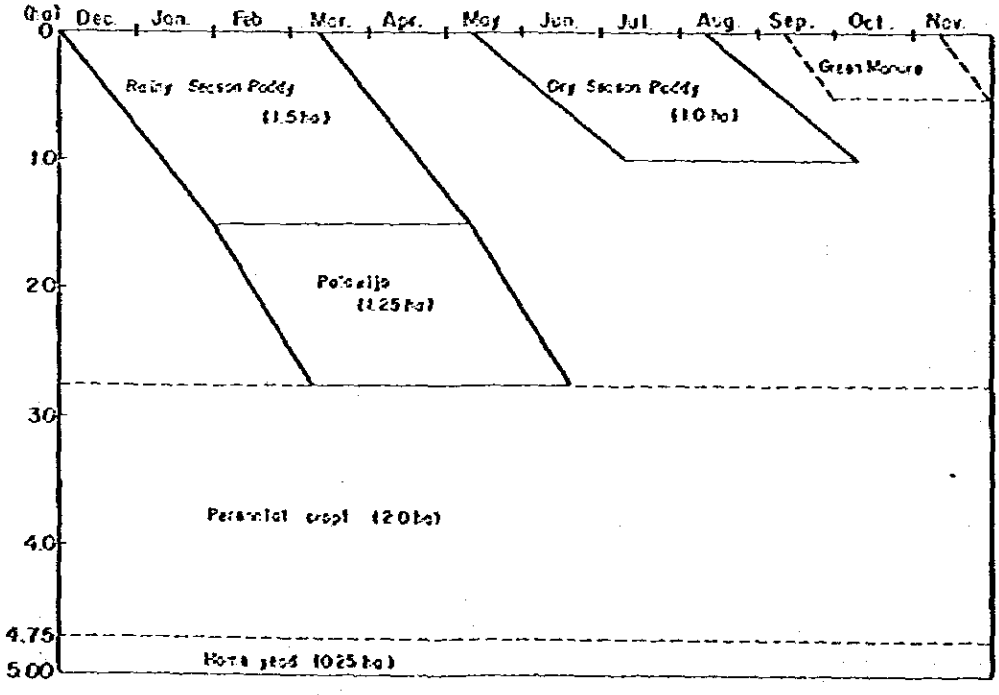
Note : Crop intensity is estimated based upon the farm land of 2.75 ha where is included present cropcultivated area and fallow land, etc. except perennial crops

Fig. 4.1 PROPOSED CROPPING PATTERN TYPE I (MUNCAK KABAU, LEMPUING AND TULANGBAWANG WEST SUB-AREA)



Crop Intensity = 2.0 (Except 0.5 ha of Green Manure and 0.25 ha of perennial crops)

Fig. 4.2 PROPOSED CROPPING PATTERN TYPE II (TULANGBAWANG EAST SUB-AREA)



Crop intensity = 1.36 (Except 2.0 ha of perennial crops and 0.5 ha of green manure)

Fig. 4.3 WATER DISTRIBUTION SYSTEM IN THE UPPER KOMERING RIVER BASIN

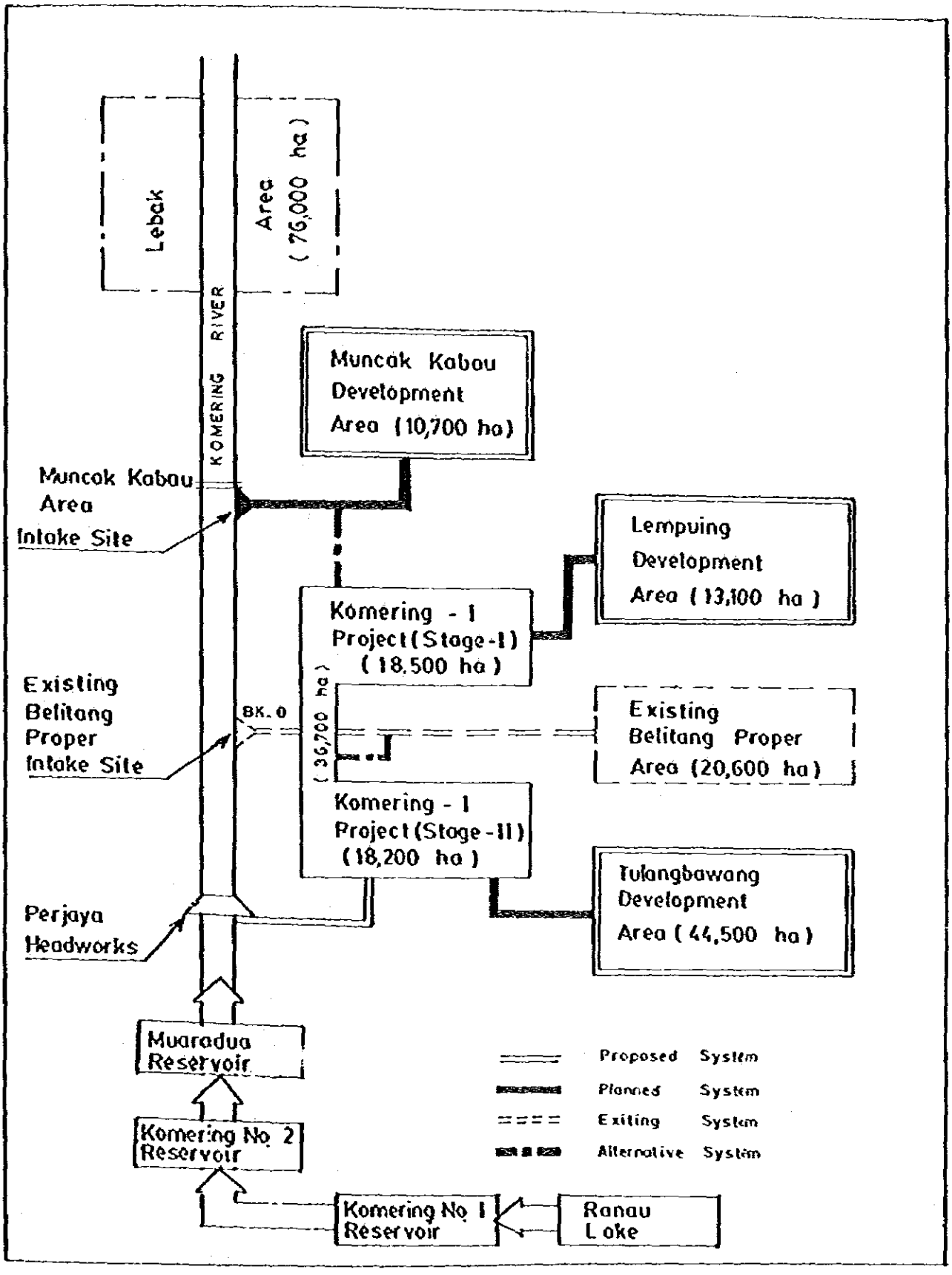


Fig. 4.4 KOMERING HYDROPOWER DEVELOPMENT SCHEME

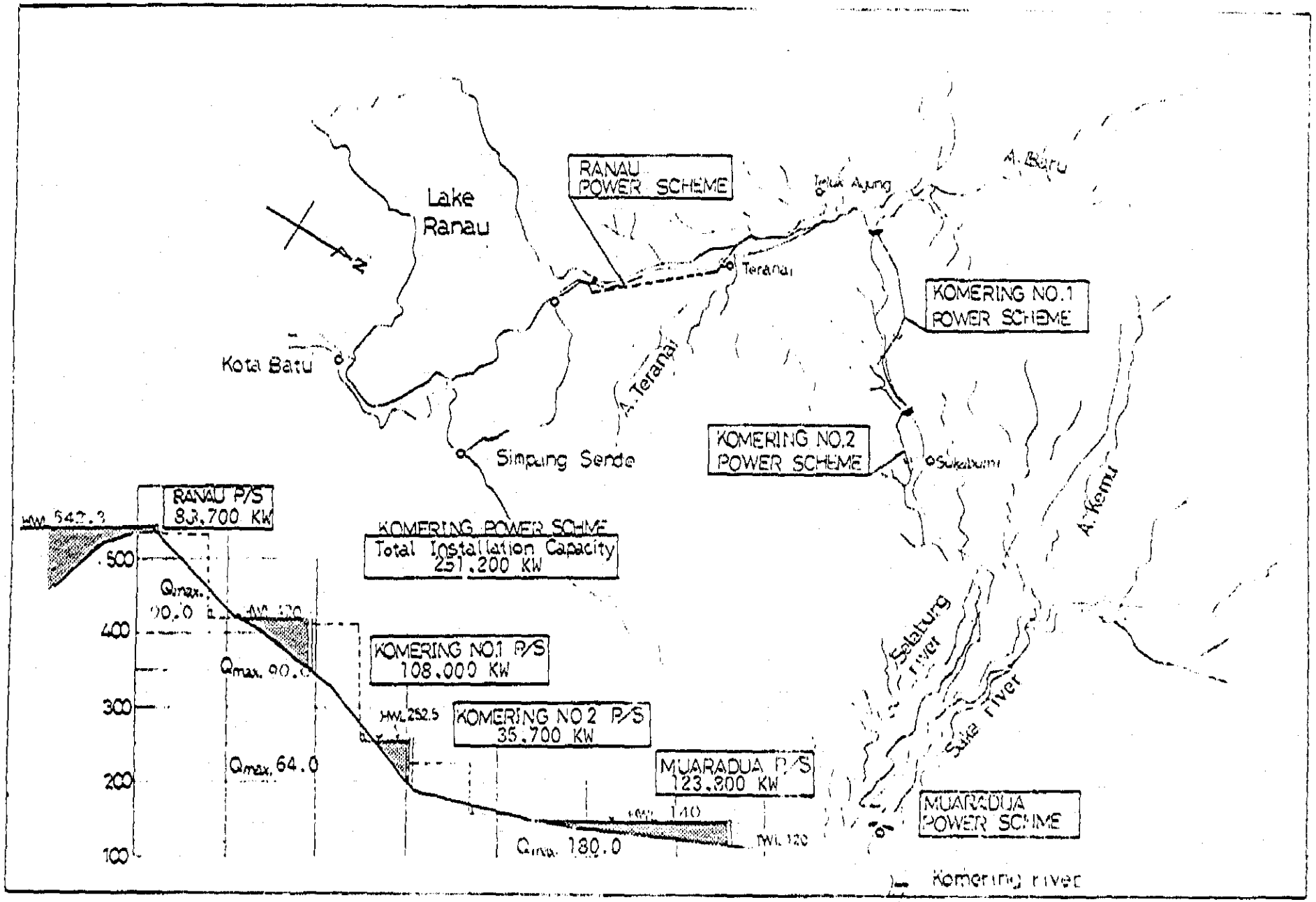


Fig. 5.1 SUSPECTED AREA FOR EROSION

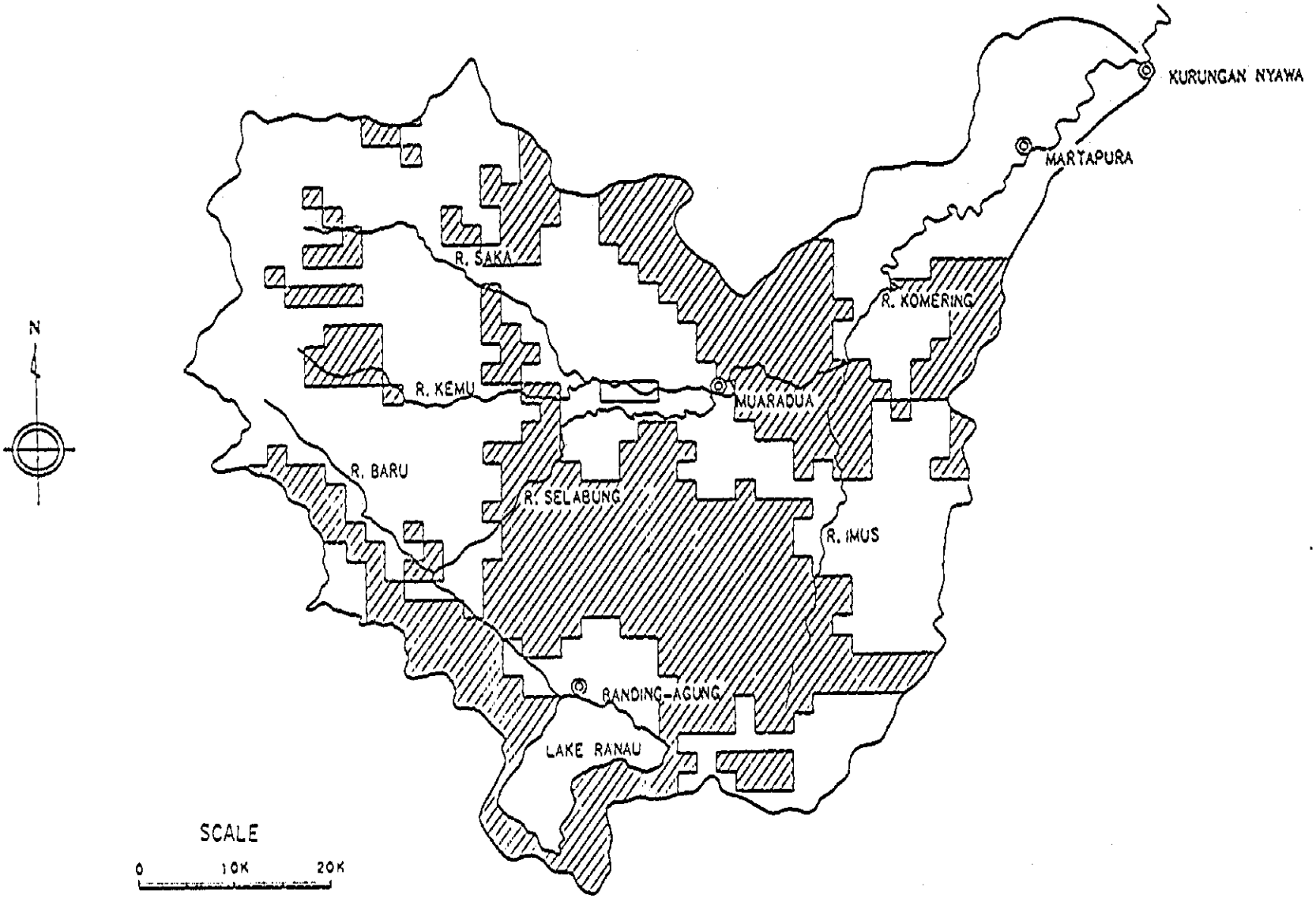


Fig. 6.1 ORGANIZATION CHART FOR THE UPPER KOMERING RIVER BASIN DEVEROPMENT PROJECT

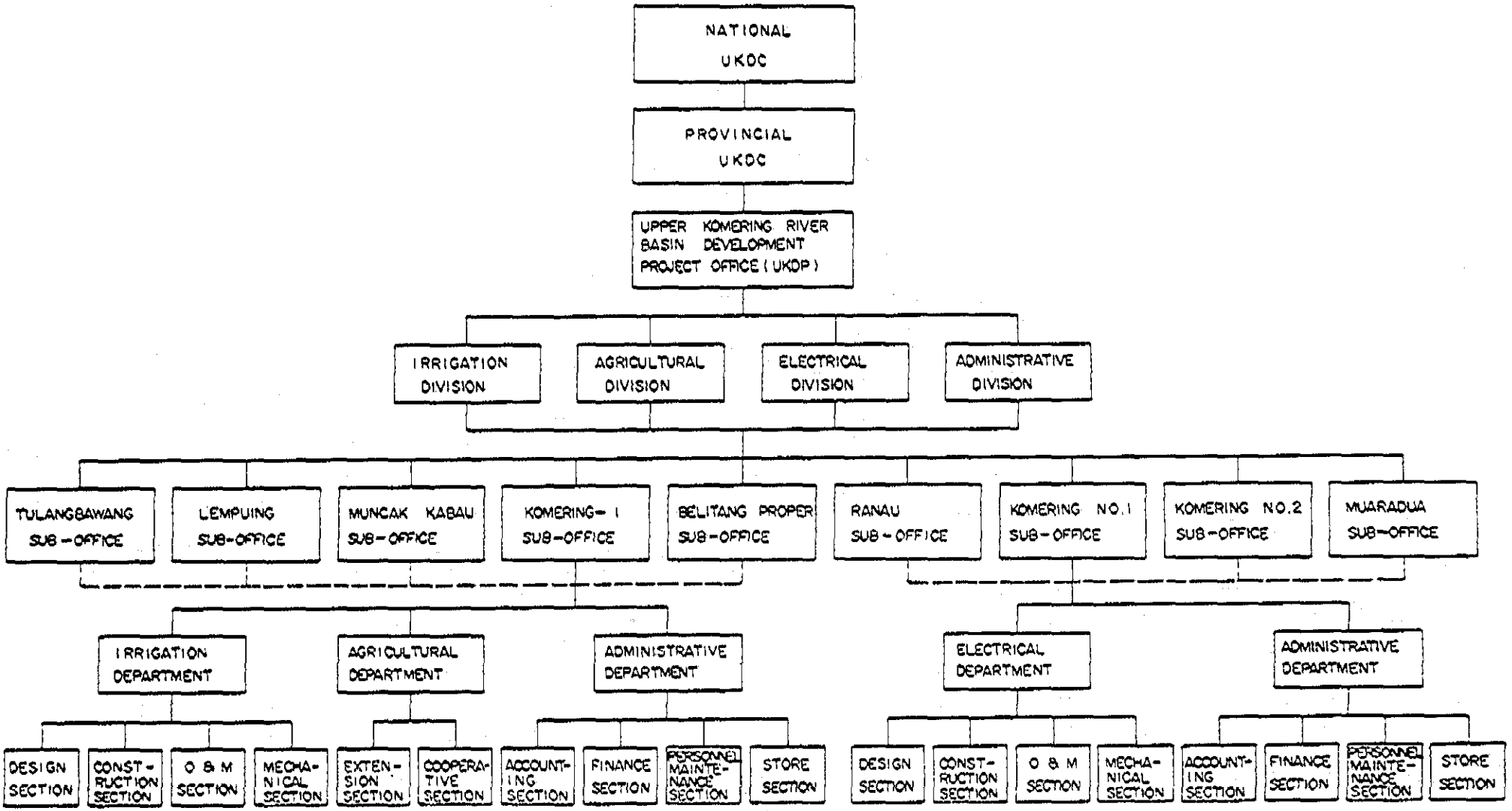
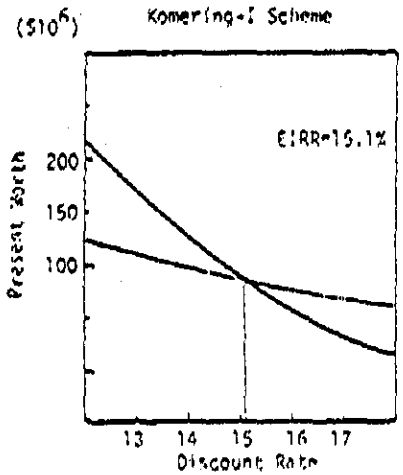
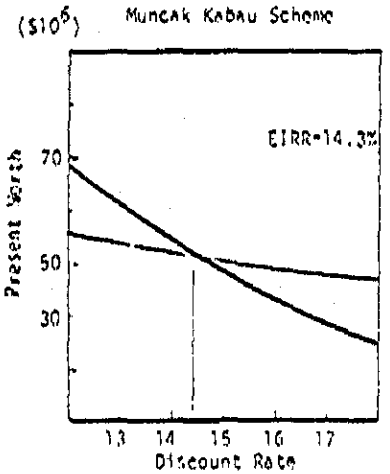
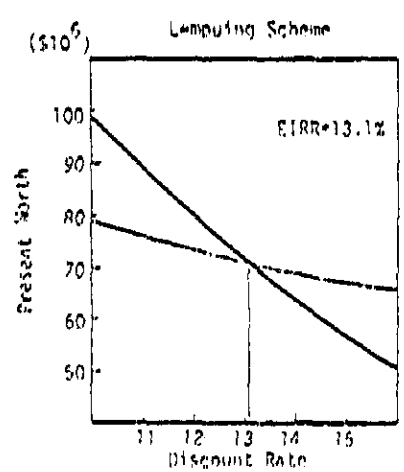


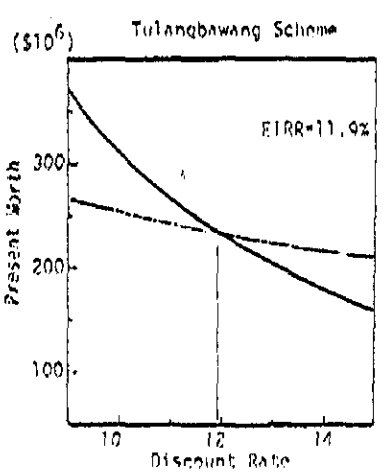
Fig. 8.1 RESULTS OF ECONOMIC EVALUATION

Agricultural Development Schemes

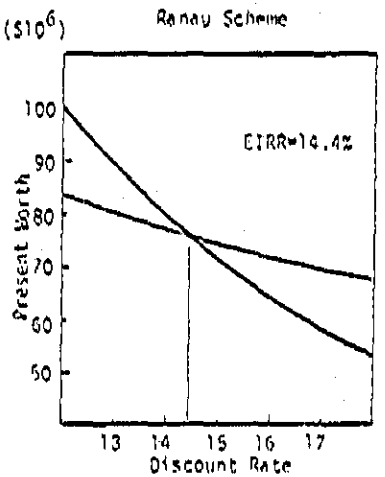


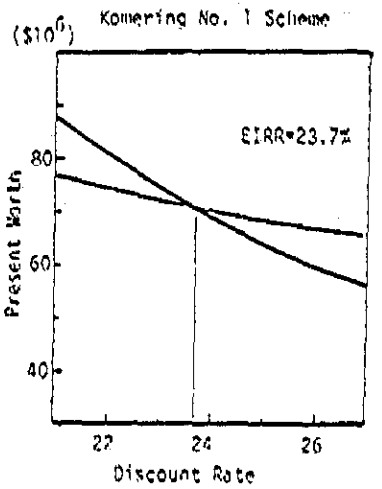


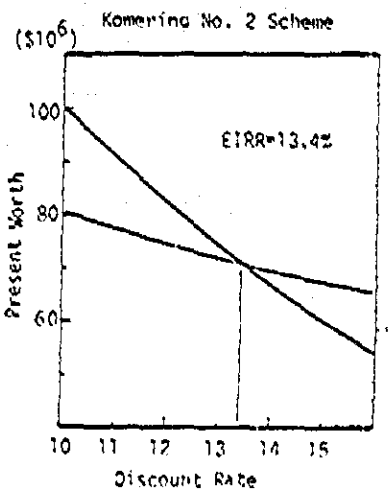


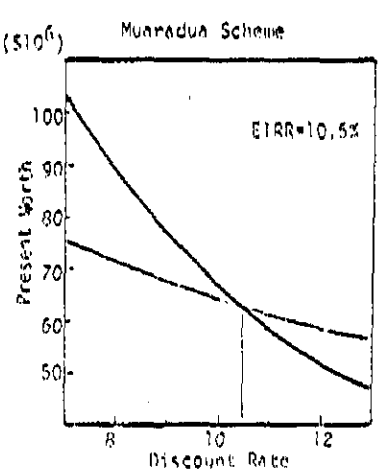


Hydro-power Development Schemes



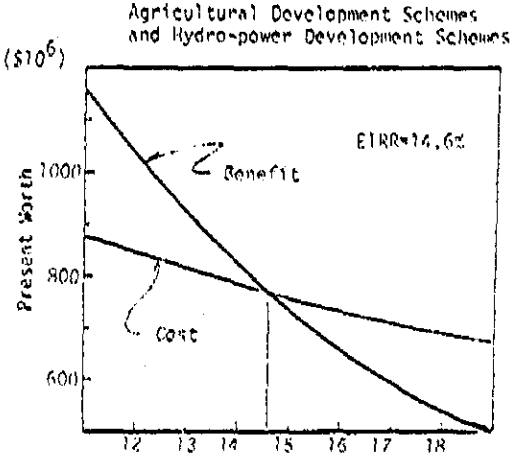






Whole Project

Agricultural Development Schemes and Hydro-power Development Schemes

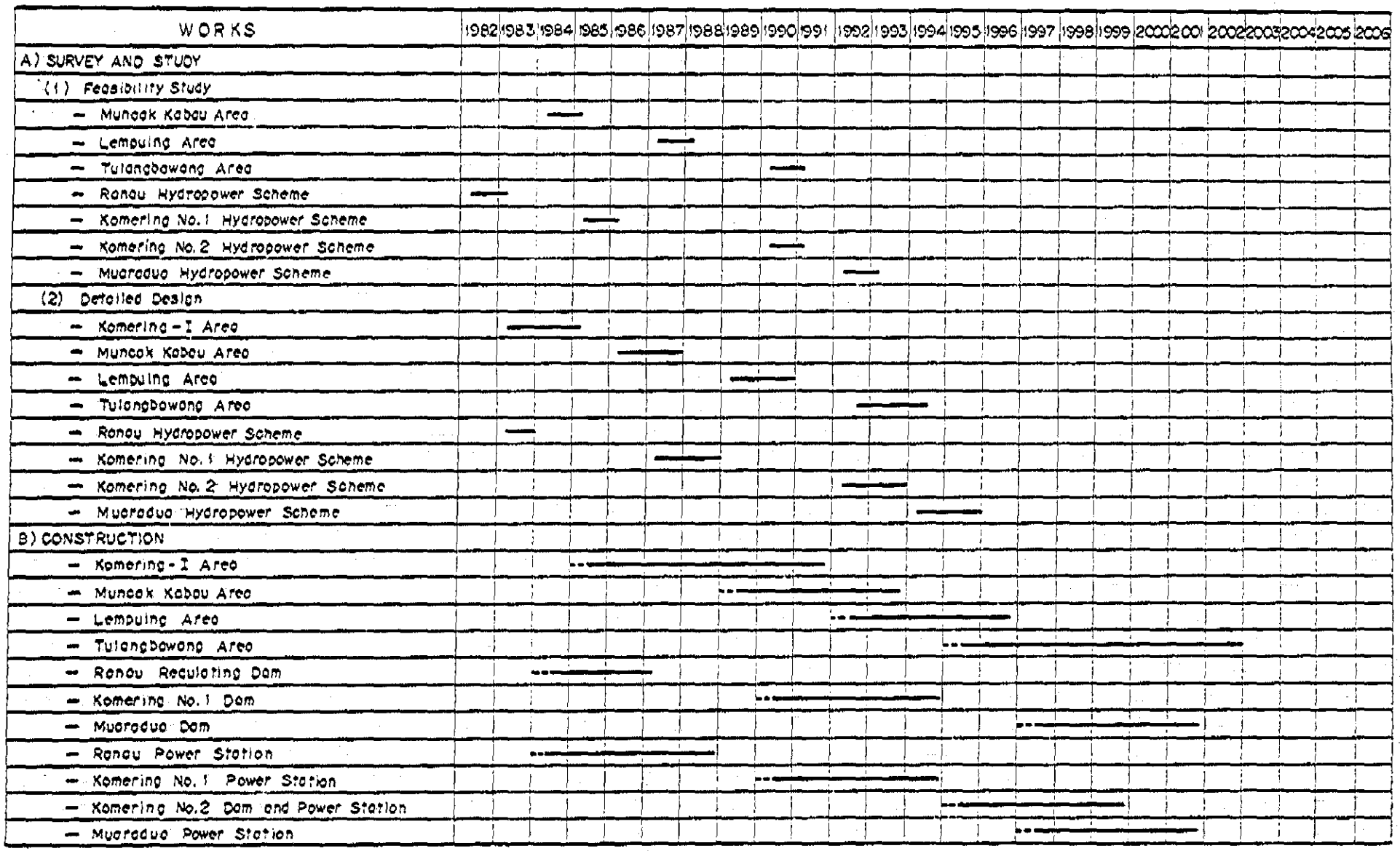


Remarks:

Cost

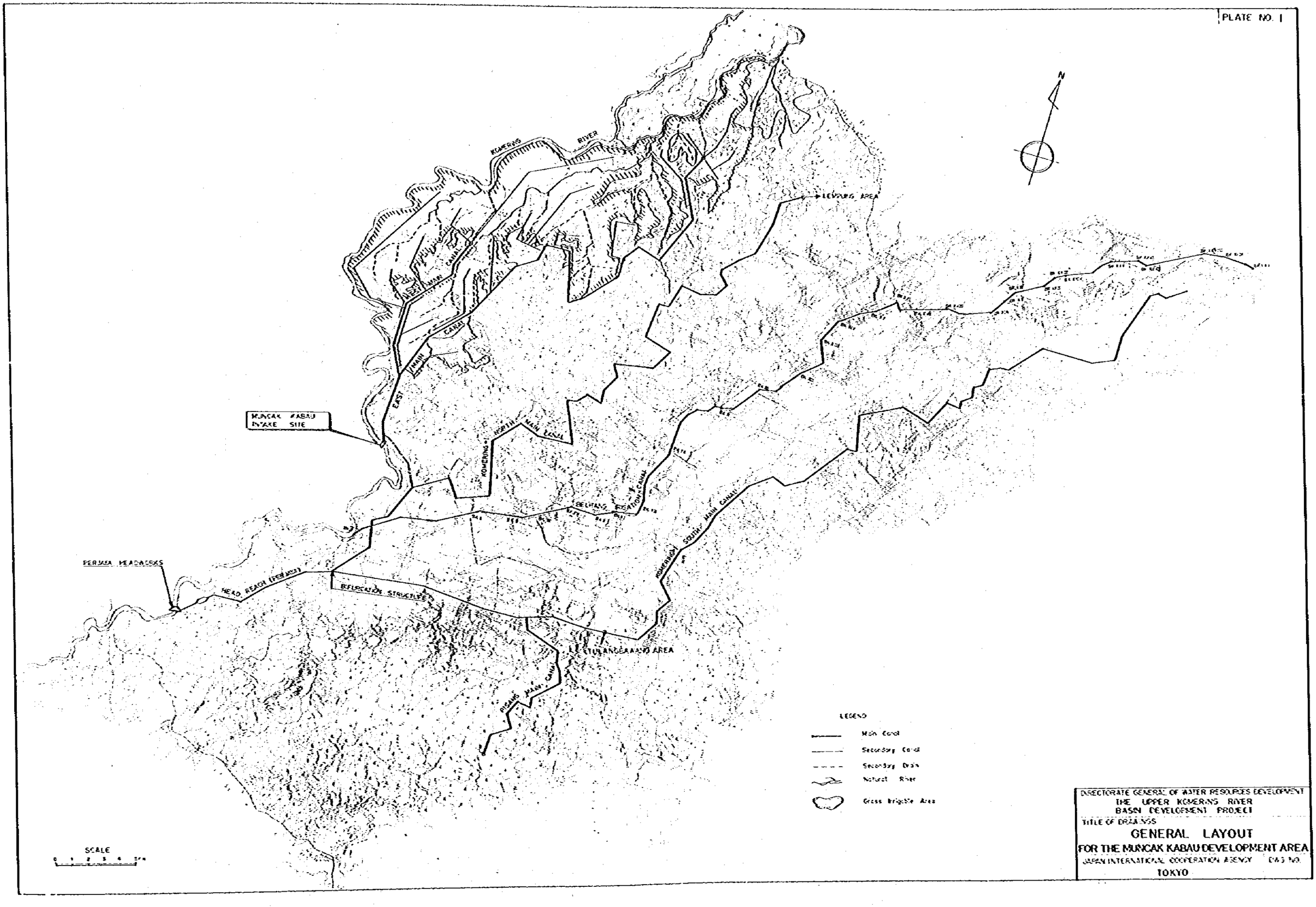
Benefit

Fig. 9.1 PROJECT IMPLEMENTATION SCHEDULE



PLATES

PLATE NO. 1



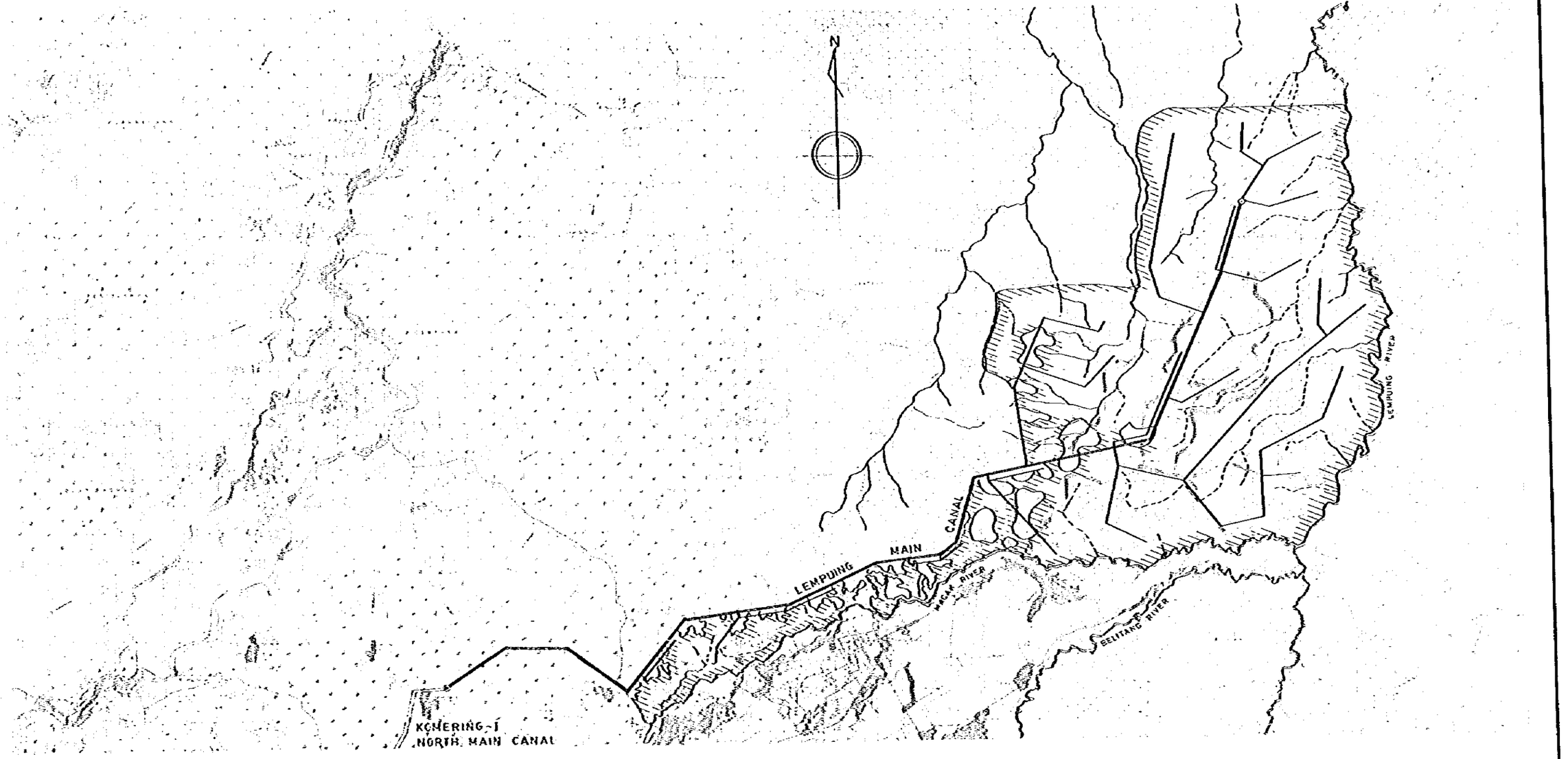
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
THE UPPER KOMERING RIVER
BASIN DEVELOPMENT PROJECT

TITLE OF DRAWING

GENERAL LAYOUT
FOR THE MUNCAK KABAU DEVELOPMENT AREA

JAPAN INTERNATIONAL COOPERATION AGENCY DRG NO.
TOKYO

PLATE NO. 2



SCALE

0 1 2 3 4 5Km

LEGEND

- Main Canal
- Secondary Canal
- Secondary Drain
- Natural River
- Gross Irrigable Area

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
THE UPPER KONERING RIVER BASIN DEVELOPMENT PROJECT

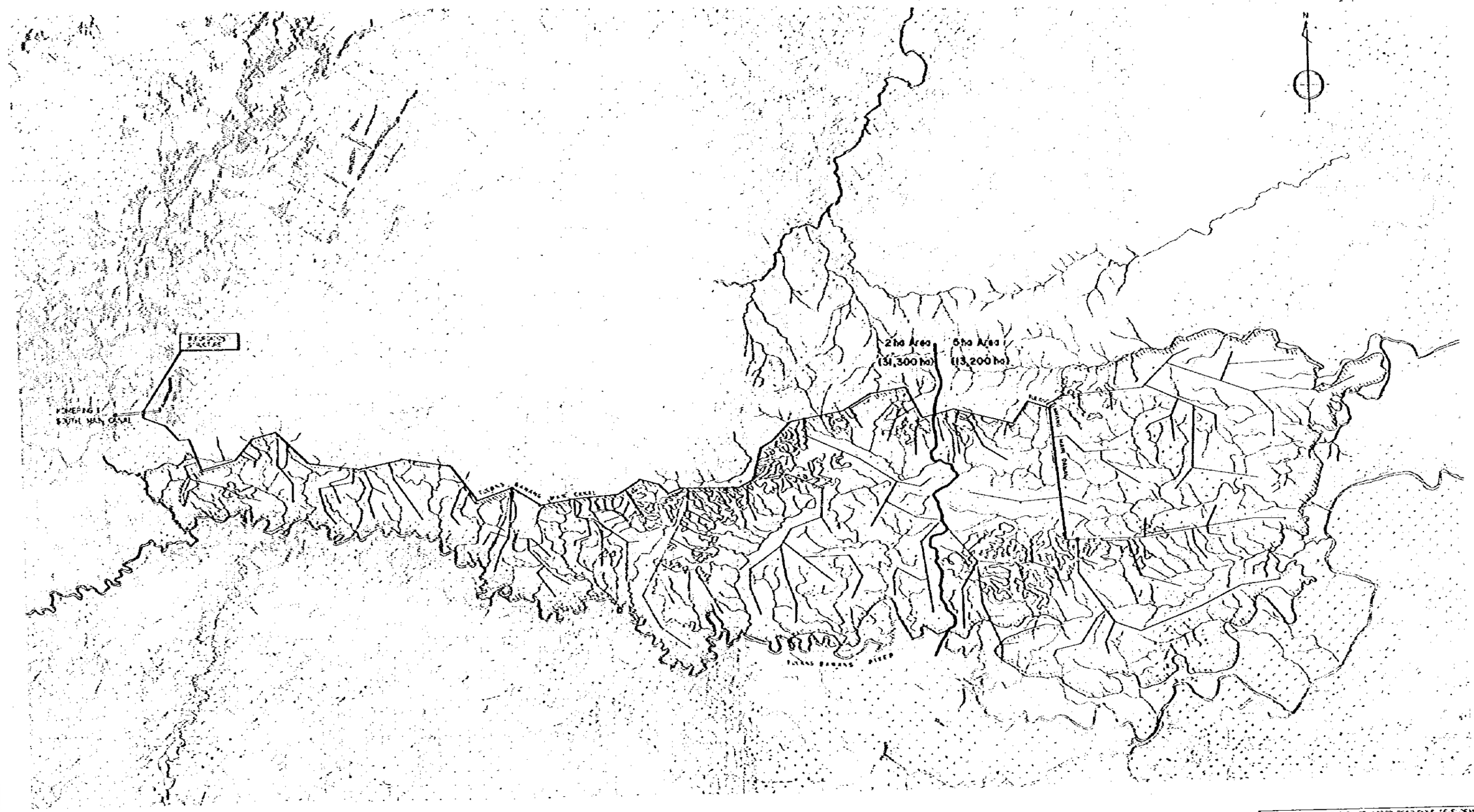
TITLE OF DRAWING

GENERAL LAYOUT FOR THE LEMPUNG DEVELOPMENT AREA

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO

DWG NO

PLATE NO 3



DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
THE UPPER KOMERING RIVER BASIN DEVELOPMENT PROJECT

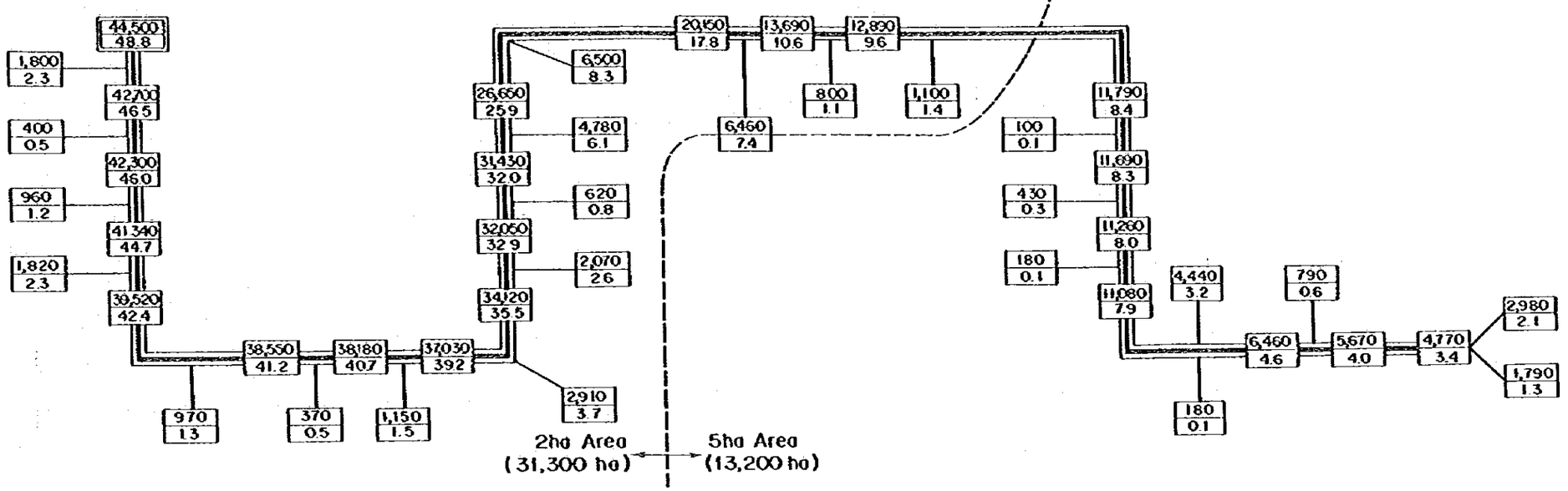
TITLE OF DRAWING

GENERAL LAYOUT FOR THE TULANGBAWANG DEVELOPMENT AREA

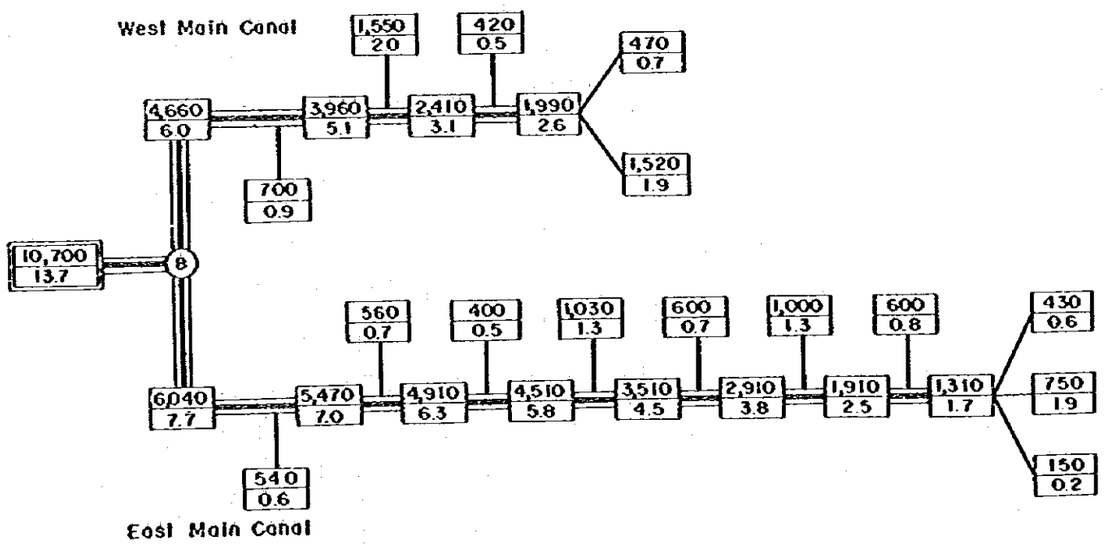
JAPAN INTERNATIONAL COOPERATION AGENCY	DWG NO
TOKYO	

PLATE NO. 4

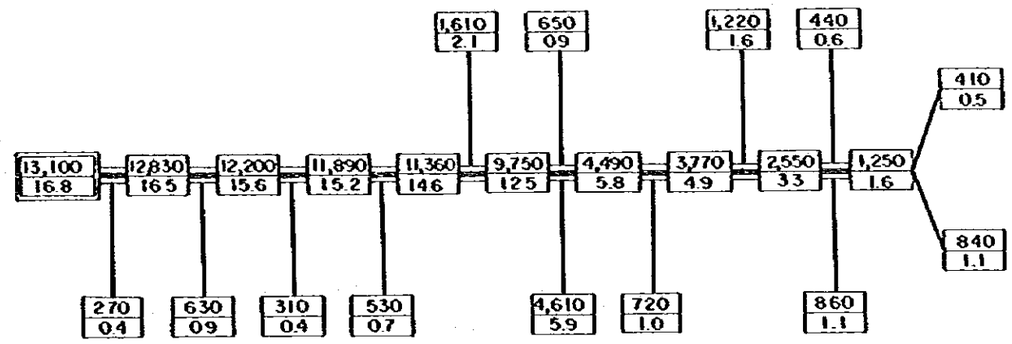
3. TULUNGBAWANG AREA



1. MUNCAK KABAU AREA



2. LEMPUING AREA



LEGEND

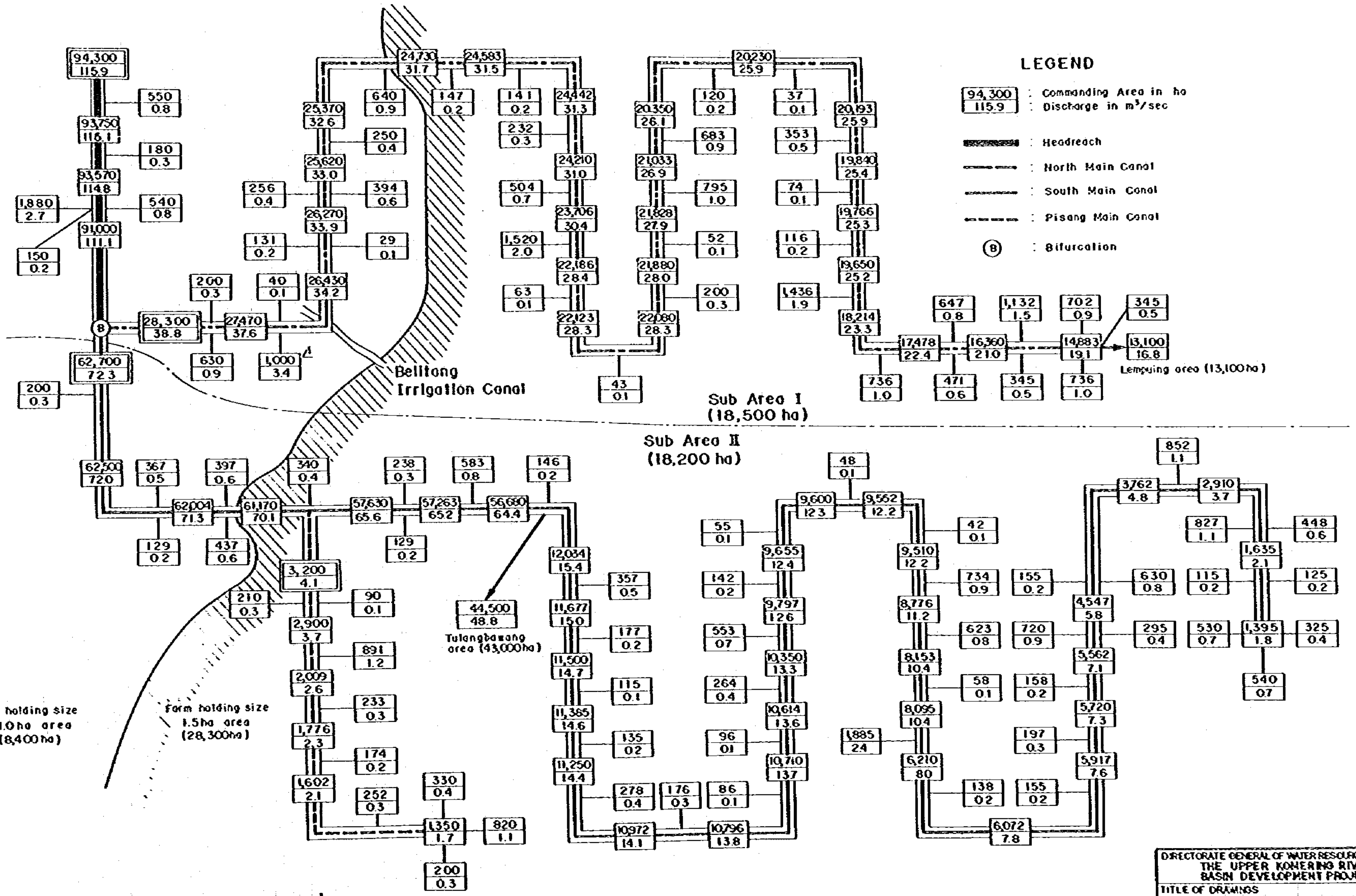
- 44,500 / 3.3 : Commanding Area in ha / Discharge in m³/sec
- ——— : Main Canal
- (8) : Bifurcation

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
THE UPPER KOMERING RIVER BASIN DEVELOPMENT PROJECT

TITLE OF DRAWINGS
IRRIGATION DIAGRAM FOR THE DEVELOPMENT AREAS

JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO | DWG. NO.

PLATE NO. 5



Note ; ⚠ : Including the water requirement of 1.9 m³/sec for BK-1 area (1,300 ha) in Belitang Proper area.

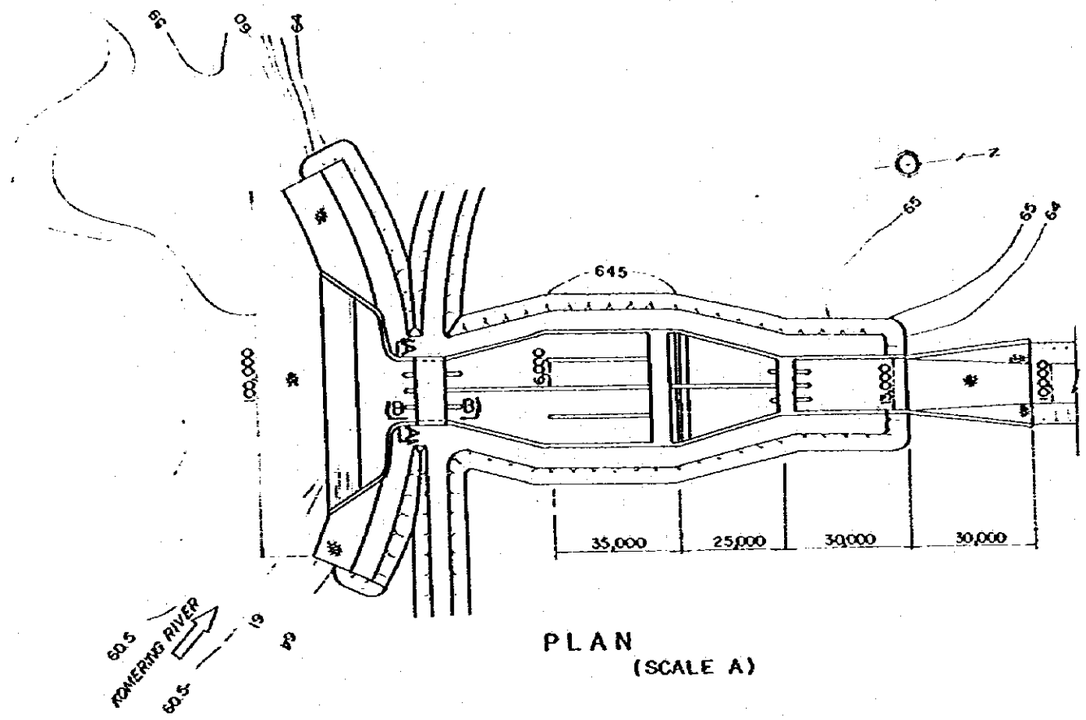
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
THE UPPER KOMERING RIVER BASIN DEVELOPMENT PROJECT

TITLE OF DRAWINGS

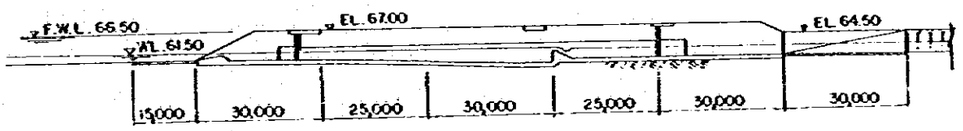
IRRIGATION DIAGRAM FOR THE KOMERING-I AREA

JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO | DWG. NO.

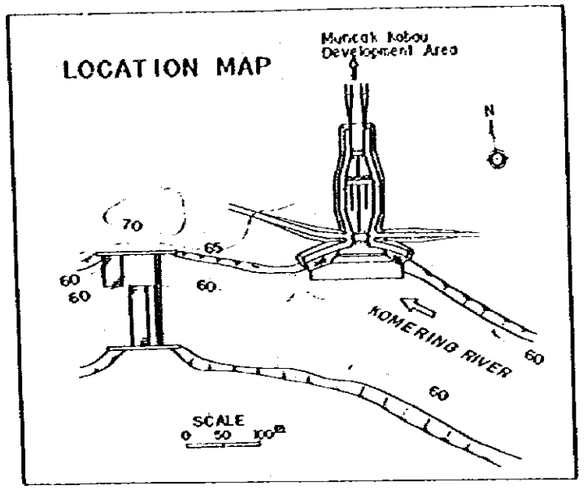
PLATE NO. 6



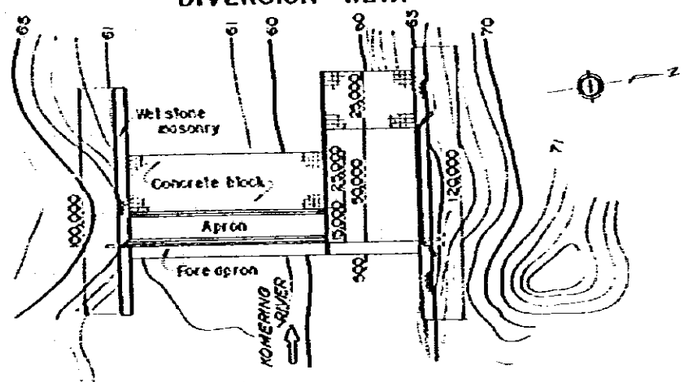
PLAN
(SCALE A)



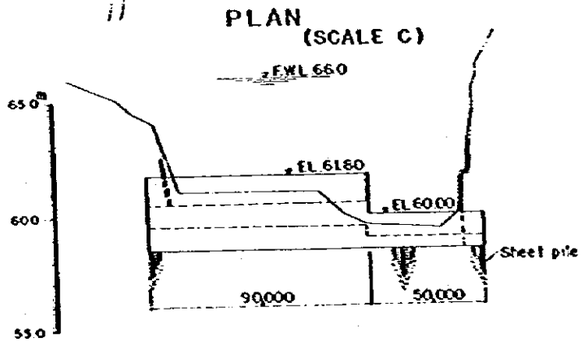
PROFILE
(SCALE A)



DIVERSION WEIR



PLAN
(SCALE C)

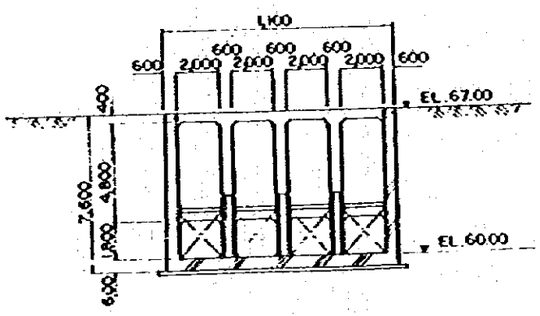


PROFILE
(SCALE C)

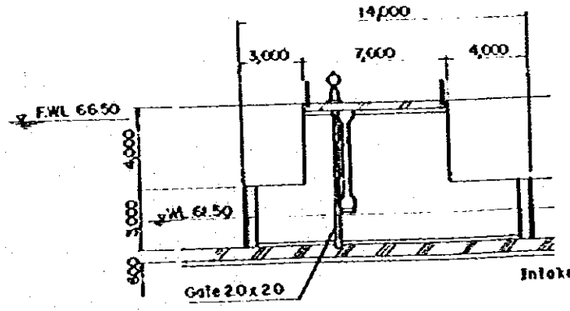
SCALE A
0 50m

SCALE B
0 5 10m

SCALE C
0 50m



SECTION A-A
(SCALE B)



Intake water level : 61.50m

SECTION B-B
(SCALE B)

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
THE UPPER KOMERING RIVER
BASIN DEVELOPMENT PROJECT

TITLE OF DRAWINGS
GENERAL FEATURE OF INTAKE STRUCTURE
FOR THE MUNCAK KABAU AREA

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO

DWG. NO.

APPENDIX

SCOPE OF WORKS

1. Objectives

The objectives of the study will be:

(1) to make comprehensive study on water resources development of the whole project area, prior to the feasibility study and the pre-feasibility study mentioned below.

(2) to make the feasibility study on irrigation development covering a net area of about 19,500 ha.

(3) to make the pre-feasibility study on the remaining area of about 61,500 ha to be irrigated, and on hydropower development of the upper reach of the Komering river basin in connection with point (1) and (2), and

(4) to undertake the training of the Indonesian counterparts in the course of the survey and study, both in-country and in Japan.

2. Survey and Study

The survey and study to be undertaken by the survey team will comprise the following:

(1) to review data and information collected during the study on water resources development, the formulated plans and their implementation program and to make supplementary study for improvement of them, if necessary.

(2) to take aerial photographs 1:20,000 over an area of 81,000 ha to be irrigated and over the catchment area of the upper reach of the Komering river.

(3) to prepare the topographic maps with 1:5,000 for the feasibility study area.

(4) to carry out the field investigation and survey including the following items:

(a) meteorological & hydrological survey including sediment load analysis of the riverflow, test on river water quality and etc.

(b) topographic survey for major structure sites and check survey of the elevations along the main canal alignments for the F/S scheme.

(c) geological investigation for structure foundation at the sites of regulating dam, headworks and main canal by means of surface exploration and core drilling for the F/S scheme.

(d) semi-detailed soil and land use survey including soil sampling and chemical analysis for the F/S scheme.

(e) irrigation and drainage survey

(f) agro-economic survey

(g) land reclamation survey

(h) agriculture survey including measurement of consumptive use by crop

(i) regional economic and institutional survey including power demand

(j) construction material and cost survey

(k) environmental assessment, and

(l) others, if necessary.

(5) to establish the definite irrigation, drainage and road system and to prepare the pre-design of the systems for the F/S scheme.

(6) to prepare the pre-F/S of the hydro-electric power in the upper Komering river basin.

(7) to make economic study and justification of the Project including cost and benefit estimates.

(8) to prepare an implementation schedule of the Project.

3. Work Schedule

In order to attain the on-the-job training and transfer of knowledge and technical know-how to Indonesian counterparts, the planning and design works will be carried out in Indonesia as much as possible.

The time span required for the survey, study and preparation of reports will be thirty (30) months. The field survey will be carried out mainly in two dry seasons on three irrigation development areas delineated in view of efficient irrigation water supply system, namely Pracak, Muncak Kabau and Tulangbawang areas.

The agro-photographic mapping including field survey will be proceeded in conformity with the schedule of the irrigation and hydropower development planning to provide the necessary maps in time.

4. Report

The following reports will be prepared and submitted to the Government in accordance with the Scope of Works set forth in Section 2 in the manner as specified hereunder.

(1) Inception Report in thirty (30) copies in English within one month after the commencement of the works.

(2) Interim Report in thirty (30) copies in English at the end of field works.

(3) Reports on the F/S Scheme

(a) Draft Feasibility Report in thirty (30) copies in English will be submitted up to the end of December, 1980.

(b) Feasibility Report in fifty (50) copies in English up to the end of March, 1981.

(4) Reports on the pre-F/S scheme

(a) Draft Pre-Feasibility Report in thirty (30) copies in English will be submitted up to the end of December, 1981.

(b) Pre-Feasibility Reports in fifty (50) copies in English up to the end of March, 1982.

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