REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

FEASIBILITY STUDY
ON
THE BILA IRRIGATION PROJECT

EXECUTIVE SUMMARY REPORT

JUNE 1982

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN

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PREFACE

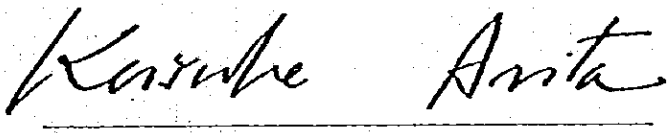
In response to the request of the Government of the Republic of Indonesia, the Government of Japan decided to conduct a feasibility study on the Bila Irrigation Development Project and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Indonesia a survey team headed by Mr. Masashi Shono from June 15 to December 6, 1981.

The team exchanged views with the officials concerned of the Government of Indonesia and conducted a field survey in the project area. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Indonesia for their close cooperation extended to the team.

June, 1982



Keisuke ARITA
President
Japan International Cooperation Agency,
Tokyo, Japan

Mr. Keisuke ARITA
President,
Japan International Cooperation Agency,
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

We are pleased to submit the feasibility report on the Bila Irrigation Project in the Central South Sulawesi, the Republic of Indonesia, in accordance with the terms of reference issued by your Agency. In the report, we fully incorporated the advices and suggestions offered by the Advisory Committee of your Agency as well as the comments raised by the Indonesian Authorities concerned.

The project is basically formulated with the principal aim of the increase of agricultural production and the improvement of farmer's living standards in the Bila area of 9,800 hectares through exploitation of irrigation water from the Bila and the Kalola rivers.

The increase in the agricultural production would substantially contribute to the attainment of the national goal on a series of the 5-year development plans as well as regional economy in the Central South Sulawesi. The economic internal rate of return of the proposed project is estimated to be 15.3 percent and the project is verified to be economically feasible. In view of the importance and need of the project in the regional economy, we would recommend that the project should be soon implemented along the conclusion presented in this report.

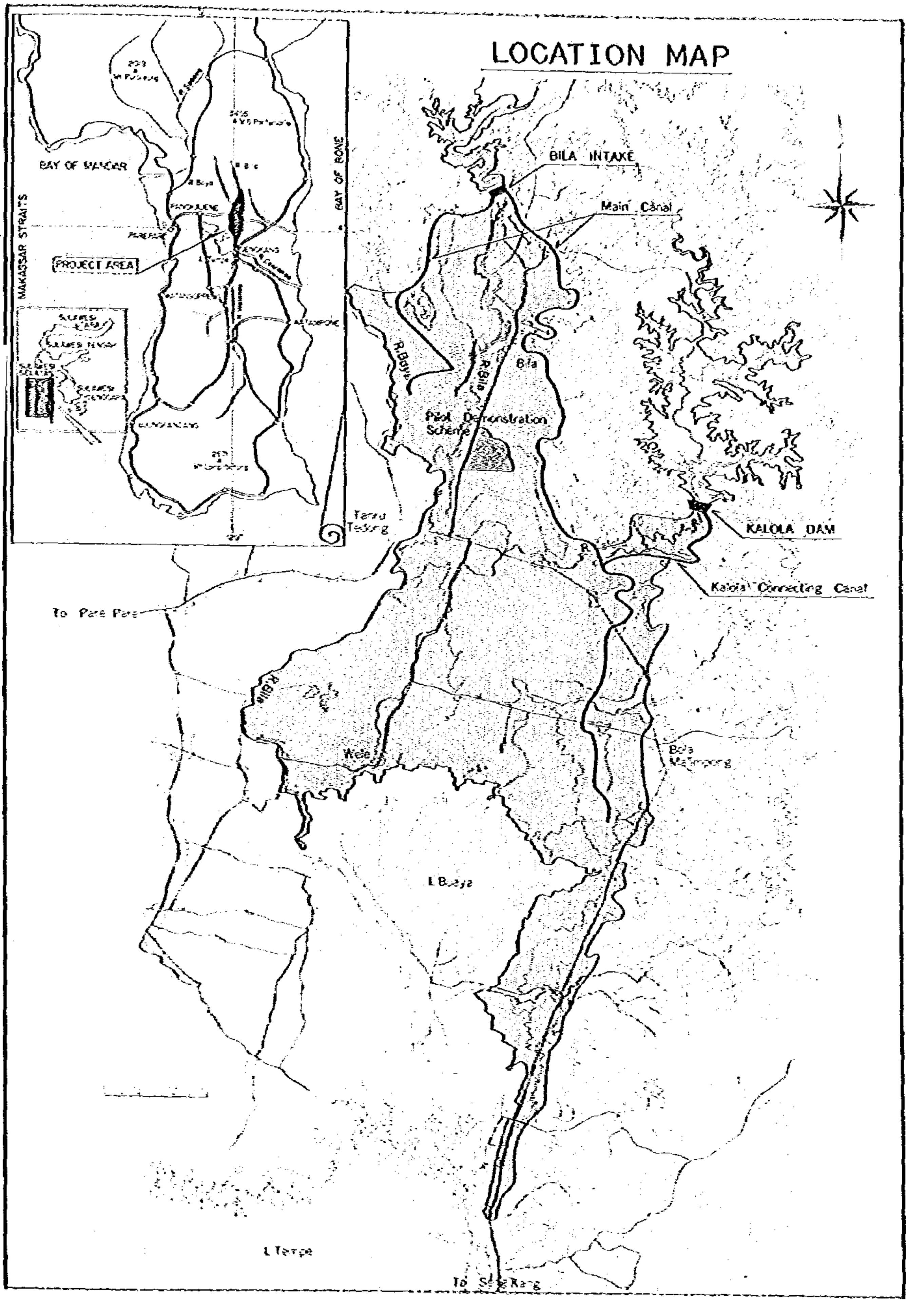
In submitting this report, we wish to express our sincere appreciation and gratitude to the personnel concerned of your Agency, the Embassy of Japan in Indonesia and the Authorities concerned of the Government of Indonesia for the courtesies and cooperation extended us during our field surveys and studies.

Very truly yours,

M. Shono

Masashi SHONO
Leader of the Survey Team for
the Bila Irrigation Project

LOCATION MAP



Principal Features of the Project

Location	:	Kabupaten Sidrap & Wajo, South Sulawesi
Project Area	:	9,800 ha
Water Sources	:	Bila & Kalola rivers
Project Facilities	:	- Bila intake weir - Kalola dam - Irrigation canals Main canal ; 46.1 km Secondary canal; 98.3 km - Drainage canal ; 86.5 km - Farm roads ; 172.5 km - Tertiary system ; 9,800 ha
Project Cost	:	F.C. Rp. 32,926 million L.C. Rp. 34,897 million Total Rp. 67,823 million
Construction Period:		5.5 years from late 1984 excluding 1.5 years for detailed design
Annual O/M Cost	:	Rp. 345 million
Annual Benefits	:	Rp. 9,552 million
Internal Rate of Return (IRR)	:	15.3%

FEASIBILITY STUDY
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I. INTRODUCTION

1.1 This report presents the results of survey and study for the feasibility study on the Bila Irrigation Project commanding a net irrigation area 9,800 ha in the South Sulawesi Province. The general layout of the Project is presented in Fig. 1.

1.2 The Government of Indonesia has laid great emphasis on substantial increases in food production to attain self-sufficiency of foodstuff and the high economic growth together with the achievement of national stability and equalization of social justice. Following the national development policy, South Sulawesi Province, one of the surplus rice producing provinces, has launched the development plan with the high priority to the increase in foodstuff, especially of rice, through the expansion of irrigation area and improvement of its efficiency.

1.3 The Government forcussed on the comprehensive regional development in the Central South Sulawesi area in early 1970s. To realize the development concept, the Government requested the Government of Japan to extend technical assistance for formulation of the master plan for comprehensive development in this region. In response to the request, the Japan International Cooperation Agency (hereinafter referred to JICA) commenced to offer the technical assistance for this region since 1973, which resulted in hydrological data accumulation and aerial topographic mapping.

1.4 The master plan for the Central South Sulawesi water resources development project was formulated in March 1980 in line with the above technical cooperation programme by JICA. In the master plan, nine (9) viable projects consisting of irrigation, flood control, inland fisheries and hydropower projects were embodied for the regional economic development and the increase in public welfare of local inhabitants in the Central South Sulawesi. Among the above projects, the Bila Irrigation Project was given the first priority for implementation from technical and socio-economic viewpoints.

1.5 The Government has commenced the study and investigation for the Bila Irrigation Project since 1975 in response to the strong request on the early implementation of the project from the local inhabitants, and prepared the detailed designs for main irrigation facilities such as intake structure, main and secondary irrigation canals commanding an irrigation area of 9,288 ha.

1.6 In accordance with the conclusion of the master plan study, the Government decided to promote the Bila Irrigation Project into realization as the initial step of the development in the region, and requested again the Government of Japan to extend the technical assistance for the feasibility study on the project in early 1981.

1.7 Based on the scope of works for feasibility study on the Bila Irrigation Project agreed upon between the Government of Indonesia and the Government of Japan in February 1981, the feasibility study on the project was carried out by JICA from June 1981 to May 1982.

II. GENERAL BACKGROUND

2.1 Indonesia having a territory of about 2 million km^2 with more than 14,000 islands is an agricultural country blessed with favourable natural conditions for agriculture. Population in Indonesia is about 148 million in 1980 with density of 77 persons per km^2. About 18 million ha or 9% equivalence of the land are being used for agriculture and about 70% of the total working population are engaged in agricultural sector including fishery and forestry. About 30% of Gross Domestic Product (GDP) in Indonesia comes from the agricultural sector.

2.2 Indonesia is one of the largest rice producing countries with 26 million tons of paddy production in 1979 marking the third rank of paddy production in the world. Indonesia, however, still imports about 1.9 million tons of rice in 1979 indicating the highest rice import country, because of rapid population increase and raising of per capita rice consumption.

2.3 Following to the successful implementation of the First and the Second Five-year National Development Plans (PELITA I and II), the Third Five-year National Development Plan launched in 1979/80 puts also stress on the higher economic growth together with more equitable distribution of welfare. As to the water resources development sector of PELITA III, the increase of the food production especially for rice is raised as one of the top priority in the national development policy.

2.4 The Central South Sulawesi region is graced with favourable natural conditions for rice production. The region still remains as a representative rice granary of the country. The surplus rice produced in the region has been supplied to the surrounding rice shortage areas and adjacent isles. Present agricultural land in the region is about 344,000 ha of which 47% or 160,000 ha are used for paddy cultivation. More than 75% of paddy fields, however, is still under rainfed condition.

2.5 The Bila Irrigation Project area, located in the northern part of the Central South Sulawesi region, is mostly covered with rainfed paddy fields. Paddy cultivation is restricted in the wet season and paddy yields are unstable and low. More than 78% of working population in the area are engaged in agriculture. Seasonal outmigrations to the well developed surrounding areas are accelerated due to low employment opportunity during the dry season and low farm incomes.

2.6 Under these circumstances, the Bila Irrigation Project would much contribute to the raising of the living standard and public welfare of the inhabitants. The Project would also increase the paddy production in the area and would contribute to the saving of foreign exchange for import of rice.

III. THE PROJECT AREA

3.1 The Project area is located in the central part of South Sulawesi Province, about 210 km northeast along the national road from Ujung Pandang, the capital of the Province. It is bounded by Lake Tempe on the south and the Bila and Boya rivers on the west. The northern and eastern boundaries are skirted along the foot of hilly ranges. The study area relevant to the Project covers 20,000 ha in gross.

3.2 Population in the study area is estimated at about 83,900 as of 1980. The average population growth rate is about 1.2% per annum for the recent ten years from 1971 to 1980. The total working population is estimated at about 34,300, out of which 26,800 are engaged in agriculture. The total number of household is about 15,400, within which the farm household total about 11,600. It accounts for about 75% of the total number of household.

3.3 The Project area is roughly triangular in shape, bounded by the Bila and Boya rivers, Lake Buaya and hilly ranges. The Bila river originating in Mt. Tallu in the northern mountainous zone runs in from the north to discharge into Lake Buaya and Lake Tempe. The Kalola river running in from the east joins the Bila river in the central part of the Project area. Northern part of the Project area extends over a slightly undulating alluvial plain with the average gradient of about 1.0% toward the Bila and Kalola rivers. Its altitudes range from 35 m to 15 m. Southern part lies on an alluvial flat plain with little undulation sloping gently toward Lake Buaya. The average topographic gradient of about 0.1% prevails in the plain with the altitudes of 15 m to 10 m.

3.4 The recent alluvial flat plain is covered mainly by very soft clayey or silty deposits. The surrounding gentle hills are underlain by Tertiary Pliocene molasse deposits composed of alternation of week to moderately cemented sedimentary rocks of siltstone, sandstone and conglomerate. Geological investigation on the Bila intake and Kalola dam sites reveals the favourable geological conditions of the foundation for the hydraulic structures to be constructed. Sand and gravels for concrete aggregates are obtained from the riverbeds of the Bila and Boya.

3.5 The soils in the study area are classified into five soil units, consisting of Eutric Fluvisols, Eutric Gleysols, Eutric Regosols, Plinthic Acrisols and Ferric Acrisols as shown in Fig. 2. Eutric Fluvisols and Eutric Gleysols are suitable for irrigated paddy cultivation in view of their general characteristics of flat topography, deep surface soils, heavy texture and easy availability of water. They account for 13,700 ha. Most of the existing paddy fields are developed on these soil units. Eutric Regosols, Plinthic Acrisols and Ferric Acrisols are not suitable for irrigated paddy cultivation. They account for 6,300 ha.

3.6 Climate in the Project area is characterized by two distinctive seasons, wet and dry. The cease and onset of these seasons, however, widely vary year by year. About 65% of the annual rainfall of 1,500 mm to 2,000 mm is concentrated from March thru July in the wet season, while the remaining 35% is distributed over 7 months of dry season. The consecutive droughts of more than 30 days are almost annually observed during the period from August to October. Such unstable and uneven distribution of rainfall frequently hampers rice production under the rainfed condition.

3.7 The Bila river system has a catchment area of 1,368 km^2 in total at its river mouth, of which the catchment area of the Kalola river covers 167 km^2. Annual rainfall in the river basin reaches to 2,000 mm to 2,500 mm. The average annual runoff of the Bila river is about 18 m^3/sec at Bila having a catchment area of 379 km^2, which corresponds to the annual runoff depth of 1,506 mm. The maximum monthly runoff of 31.4 m^3/sec in May and the minimum monthly runoff of 9.4 m^3/sec in January are observed. The average annual runoff of the Kalola river is estimated at 4.7 m^3/sec at the proposed damsite having a catchment area of 122 km^2, which corresponds to 1,230 mm per annum. The mean monthly runoff reaches its maximum in June of about 10.7 m^3/sec and the minimum, occurs in January at about 1.0 m^3/sec.

3.8 The existing irrigation systems are limitedly provided in the Project area. Six small irrigation systems are developed; one semi-technical irrigation system of 500 ha and five non-technical irrigation systems covering 700 ha. The water sources of them are the small streams originating in the eastern hill ranges. They have permanent intake structures constructed with wet stone masonry. The irrigation systems, however, are poorly provided with distribution canals and related structures, and less effectively operated. No exclusive drainage facilities are developed in the Project area.

3.9 A national road leading from Ujung Pandang runs in from the west and passes by the southeast boundary of the Project area. It functions as a trunk road in and around the Project area. Provincial roads branch off from the above trunk road. The full spans of those roads are asphalt-paved and all-weathered. Although a number of unpaved rural roads are networked in the Project area, they are mostly unpassable in the wet season.

3.10 Paddy fields are predominantly developed to the possible maximum extent. Most of paddy fields are under the rainfed condition. The present land use in the study area is as shown in Fig. 3 and summarized below:

Land category	Area (ha)	Proportion (%)
Paddy field	13,700	68.5
Unland field	700	3.5
Orchard	1,260	6.3
Forest/grass land	3,800	19.0
Villages/others	540	2.7
Total	20,000	100

3.11 The average farm holding size in the study area is 1.54 ha, out of which paddy fields account for 1.29 ha. Farmers with small holding sizes less than 0.5 ha accounts for about 42% of the total number of farmers.

3.12 Four types of cropping pattern are practiced in the study area. They consist of (1) paddy-fallow, (2) paddy-paddy & polowijo, (3) paddy-polowijo and (4) paddy-polowijo-polowijo. The pattern (1) is predominant, accounting for about 73% of the paddy fields. The rice cultivation in the study area is concentrated in the wet season and is very limited in the dry season. The polowijo crops are generally planted in the dry season after harvesting of wet season paddy. The crop yields and production largely fluctuate year by year due to wide variation of annual rainfall and unexpected damages caused by floods, insects and diseases. The average unit yield and production of crops under the present condition are estimated for five years from 1976 to 1980 as follows:

Crops	Harvested area (ha)	Unit yield (tons/ha)	Production (tons)
Wet season paddy	10,800	2.97 (Dried paddy)	32,000
Dry season paddy	730	2.84 (Dried paddy)	2,000
Polowijo crops	3,500	0.73	2,550

3.13 The paddy cultivation is carried out by labour intensive form throughout farming practices. All the family member contribute their labour to rice farming. Animal power such as oxen and buffaloes is extensively used for paddy field preparation and the use of agricultural machines is not common. The high yielding varieties have been widely spread over the Project area. The fertilizers and agro-chemical are also widely used. Farming practices of polowijo is primitive. Neither fertilizers nor improved varieties are used.

3.14 Surplus of paddy produced in the Project area is mostly marketed through two channels, KUD/DOLOG and grain brokers. The KUD/DOLOG market the rice for stabilization of price of rice under the Government control. The following table shows the farm gate prices of major farm products in the Project area in 1980:

Crops	Price (Rp./kg)
Dry paddy	90
Maize	66
Groundnuts	400
Greenbeans	217
Soybeans	212

IV. PROJECT FORMULATION

4.1 Different approaches to the development of the Bila Irrigation Project have been made; (1) the Master Plan for the Central South Sulawesi Water Resources Development by JICA (referred to the Master Plan) and (2) the detailed design by the Directorate of Irrigation, the Directorate General of Water Resources Development (referred to the DOI Plan). They have concluded the different development plans. Those plans have been formulated with the irrigation areas of 10,500 ha and 9,288 ha for the Master Plan and the DOI Plan respectively with the different intake sites on the Bila river.

4.2 In selecting the area for irrigation development, the following four (4) principal factors are taken into consideration; (1) land use, (2) soil condition, (3) irrigability, and (4) drainability. The study area is classified, by superimposing the study results of those factors. The possible maximum area for irrigation development under the project will be 11,200 ha of the existing paddy field in the alluvial plain, which corresponds to about 10,000 ha of future irrigated paddy fields in net, as shown below:

Land category	Extent of area (ha)
I. Potential area for development	
- Well drained paddy field	5,900
- Moderately well drained paddy field	5,300
	11,200
II. Exclusion from potential development area	
- Elevated paddy field	1,600
- Poor drained paddy field	900
- Upland, orchard and village area	2,500
- Forest	900
- Grassland	2,900
	8,800
Total	20,000

4.3 The irrigation water requirement was studied based on the empirical prediction method. The puddling water requirement is estimated at 220 mm and percolation loss is measured in the field and estimated at 2 mm/day in the dry and wet seasons. Effective rainfall is estimated by applying the daily water balance method using the daily rainfall data at Tanru Tedong from 1973 to 1981. Conveyance and application losses are set at 20% respectively, which result in the total irrigation efficiency of 64%. The unit design diversion water requirement is estimated on 10-day basis with the dependability level of four out of five years. The design value is estimated at 1.65 ℓ/sec/ha.

4.4 The water balance study between the Bila river discharges and the irrigation water requirements conducted by use of the accumulated hydrological data indicates that the Bila river flows fall short to irrigate the potential area of 10,000 ha. The maximum irrigation area with dependability level of four out of five years would be 4,600 ha and 2,600 ha in the rainy season and dry season cropping respectively.

4.5 In accordance with the above findings and the present agricultural conditions so far revealed, the Master Plan and DOI Plan were reviewed and updated. The results indicate that the envisaged irrigation areas would not sufficiently served with the Bila river natural flow and the economic aspects of both plans lie in the lows of 8.9% and 10.3% of the Master Plan and the DOI Plan respectively.

4.6 In order to improve the low economic feasibility of either of the existing two plans, the alternative reservoir plans are conceived on the Bila river and the Kalola river in view of hydrology, topography and geology; (1) construction of a dam on the Bila river and (2) construction of a dam on the Kalola river which supplements the diversion water of the Bila river. The comparison concludes that the construction of the reservoir on the Kalola river is much economical.

4.7 With reference to the conclusion that the incorporation of the Kalola reservoir is the most economical way to improve the existing plans, the following three alternative cases are established;

Case-1 (Proposed Plan)	:	This case aims to serve the greater part of the possible maximum irrigable land, 9,800 ha, of which the irrigation system is based on the built-up DOI design of the intake and canals inclusive of an additional canal starting from the Kalola dam for commanding the southern elevated area.
Case-2 (Alternative-I)	:	This case aims to serve the possible maximum irrigable area 10,000 ha with the irrigation system based on the Master Plan study, and incorporating the Kalola dam.
Case-3 (Alternative-II)	:	This case aims to serve the irrigable area 8,500 ha with the irrigation system agreed with the built-up DOI design of the intake and canals, and incorporating the Kalola dam.

With the elaborate technical and economical comparison Case-1 is selected as the optimal development plan of the Project in view of:

- highest economic efficiency indicating the internal rate of return of 15.3%,
- commanding the greater part of the possible maximum irrigable land of 9,800 ha, i.e., the large number of beneficiary and the large amount of production to be ensured,
- available design of major irrigation facilities to promote the early implementation.

V. THE PROJECT

5.1 The agricultural development plan in the Project area which covers 9,800 ha of land in net is formulated with the main concepts of:

- stabilization and improvement of paddy cultivation in the wet season,
- expansion of planted area for dry season paddy and maximization of total production of paddy,
- increase of irrigation area up to the possible maximum area in conformity with government policy for equalization as well as for the maximum total benefits,
- improvement of drainage condition to ensure the stabilization of high yield production of paddy under irrigated condition,
- improvement of farm road network to make the agricultural activities more active, and
- effective operation of existing agricultural institution, especially in the field of agricultural extension services.

5.2 With the Project, all the area proposed for the Project will be turned into fully irrigated areas, and the land use is expected to become more intensive with the introduction of irrigation farming. The present condition of land use will change with the Project as follows:

Description	Without project condition (ha)	With project condition (ha)
Gross project area	10,900	10,900
Paddy fields	10,300	9,800
Irrigation drainage farm road facilities and field borders	600	1,100
Net irrigation area	-	9,800
Harvesting area	9,490	9,800

5.3 For the proposed cropping pattern in the Project area, double cropping of paddy as shown in Fig. 4 is recommended on the basis of comparison of five (5) alternative cropping patterns consisting of paddy and polowijo in view of profitability, labour requirement and water requirement. In order to maximize the crop production, early matured high yielding varieties are introduced in the area. The proposed farming for paddy rice cultivation will be practiced basically by manual operations with small farming equipment.

5.4 The annual production at the full development stage of the Project will be about 98,000 tons of dried paddy, and the increment of rice production will be about 68,100 tons of dried paddy as follows:

Condition	Harvest area (ha)	Unit yield (tons/ha)	Production (tons)
Without project			
Paddy	10,080	2.96	29,870
Wet season	9,490	2.97	28,190
Dry season	590	2.84	1,680
Polowijo	2,720	0.73	1,990
With project			
Paddy	19,600	5.00	98,000
Wet season	9,800	5.00	49,000
Dry season	9,800	5.00	49,000
Polowijo	-	-	-

5.5 The economic farm gate price of dried paddy is estimated to be Rp.200,000/ton on the basis of the projected international market price forecasted by IBRD in the long term range for the period of 1981 to 1990. With the project, the net crop production value will amount to Rp.1,401,000 per ha per annum at the full development stage.

Description	Wet season paddy	Dry season paddy	Annual total
Unit yield (tons/ha)	5.00	5.00	10.00
Production cost (Rp./ha)	294,500	304,700	599,200
Gross production value (Rp./ha)	1,000,000	1,000,000	2,000,000
Net production value (Rp./ha)	705,500	695,300	1,400,800

5.6 The central features of the proposed Project is to supply irrigation water of 12.71 m^3/sec to the Project area of 9,800 ha from the Bila river with the supplemental water of the Kalola reservoir. The facilities required for the Project include an intake weir on the Bila river, a dam on the Kalola river, main and secondary irrigation canals, drainage canals, farm roads, their related structures and tertiary systems. The Bila intake will be constructed on the meanders of the Bila river approximately 8 km upstream of the junction with the Boya river. The Kalola dam will be constructed on a gorge of the Kalola river approximately 10 km upstream of the junction of the Bila river.

5.7 The main features of the proposed project works are summarized in the following table. The general layout of the Project is as shown in Fig. 1. The irrigation diagram showing commanding areas and canal capacities is as presented in Fig. 5.

(1) Bila Intake

Diversion weir

- Type of weir	Cascade type (wet stone masonry)
- Crest elevation	EL. 30.3 m
- Max. diversion discharge	12.71 m^3 sec
- Design flood discharge	1,200 m^3 sec (100-year flood)
- Total width	70.0 m (inside from both bank walls)
- Crest length of weir	47.5 m
- Width of scoring sluice	7.0 m (left side), 3.5 m (right side)

- Width of intake	8.5 m (left side), 1.3 m (right side)
- Height of weir	8.65 m (upstream), 9.85 m (downstream)
- Bridge	Total width 5.1 m and length 70.0 m

Closure embankment

- Type of embankment	Homogeneous
- Crest elevation	EL. 36.15 m
- Crest width	5.0 m
- Max. height	12.65 m
- Crest length	60 m

(2) Kalola Dam and Reservoir

General

- Catchment area	122 km^2
- Reservoir surface area at F.W.L	12 km^2
- Storage capacity	
Total storage	43 x $10^6 m^3$
Effective storage	37 x $10^6 m^3$
Dead water volume	6 x $10^6 m^3$
- Water level	
Flood water level	EL. 39.5 m
Normal high water level	EL. 36.0 m
Low water level	EL. 30.0 m

Dam

- Type	Rockfill dam having central impervious earth core
- Crest elevation	EL. 42.5 m
- Dam height	30.5 m
- Crest length	230 m

Spillway

- Type	Non-gated side channel overflow weir
- Design discharge	800 m^3/sec (1000-year flood)

- Crest elevation	EL. 36.0 m
- Crest length	57.0 m
Diversion tunnel	
- Type	Pressured tunnel
- Design diversion discharge	485 m^3/sec (20-year flood)
- Diameter x tunnel Nos.	6.0 m x 2 Nos.
Intake	
- Design discharge	12.01 m^3/sec
- Intake gate	Sluice gate (1.8 m wide x 1.8 m high x 2 Nos.)

(3) Irrigation Canals

Main and connecting canals	
- Canal length	46.1 km
- Related structure	109 Nos.
Secondary and sub-secondary canals	
- Canal length	98.3 km
- Related structure	123 Nos.

(4) Drainage Canals

Major drains	
- Canal length	86.5 km
- Related structure	151 Nos.

(5) Farm Roads

- Construction road	28.0 km
- Main inspection road	46.1 km
- Secondary inspection road	98.3 km

(6) Tertiary System

- Tertiary irrigation canal	224 km
- Sub-tertiary irrigation canal	70 km
- Quaternary irrigation canal	686 km
- Tertiary drain	294 km
- Tertiary inspection road	294 km

5.8 The construction cost of the Project is estimated at Rp.67,823 million equivalent, comprising Rp.32,926 million of local currency and Rp.34,897 million equivalent of foreign currency on the basis of current market price levels in 1981. The summary of the construction cost is given in Table 1. The foreign currency portion will cover: (1) construction materials of reinforcing steel bars, structural steel, metal works and cement, (2) depreciation cost of construction machinery and equipment and (3) expenses and fees of engineering services by foreign consultnats. The above cost includes the physical contingency of 15% to the direct cost. The price contingency of 7% per annum for the foreign currency portion and 10% for the local currency portion is included in the estimate.

5.9 On the basis of the Project costs and benefits the internal rate of return of the Project was calculated. In the calculation, economic project benefit was estimated for only the direct benefit derived from the crop production with the irrigation development. The calculation is made based on 50 years of the Project life starting from 1983 which will be a starting year of the Project implementation, and assuming that attainment of the Project target is primarily 5 years after start of the cropping. The net Project benefit amounts to Rp.9,552 million per annum at the full development stage as shown in Table 2. The economic cost is estimated at Rp.35,178 million consisting of Rp.20,670 million of foreign currency component and Rp.14,508 million of local currency component. The operation and maintenance cost will be about Rp.345 million per annum. The result of economic evaluation indicates that the Project is quite feasible with the internal rate of return of 15.3% as shown in Table 3.

5.10 With completion of the Project, the net reserve or capacity to pay of the average size farmers will increase from Rp.1,190 to Rp.302,810 per annum. The Project would much contribute to the raise of living standard of the farmers. Further the Project will create incentives to the regional development. The substantial payment capacity will enable them to pay some charges for irrigation water. The financial viability of the Project is evaluated with respect of farm economy. The farmer would have to pay some of the project annual cost as the water charge. It will be about Rp.35,200 per ha from the increased payment capacity, which corresponds to the project annual operation and maintenance cost or about 15% of the payment capacity of the farmer. The Government would have to subsidize a certain proportion of the project annual cost.

5.11 With the completion of the Project, the following socio-economic impacts are expected:

- Saving of foreign exchange for import of rice
- Demonstration effects of modern irrigation practices
- Increase of employment opportunity
- Improvement of quality of farm products and increase of marketability
- Improvement of rural environment

VI. PROJECT IMPLEMENTATION SCHEDULE

6.1 The construction works of the Project are broadly divided into the main civil works and the tertiary development works. The main civil works consist of the Bila intake, Kalola dam, main and secondary canals, major drains, construction roads. The tertiary development works include all the facilities below the tertiary outlets such as tertiary irrigation canals, tertiary drains, farm roads, farm ditches and their related structures. The main civil works will be executed by foreign or local civil work contractors selected through international competitive bidding, and the tertiary canals drains and roads, by local contractors. The quaternary canal networks will be constructed by farmers themselves under the guidance of the local government.

6.2 Construction works will be executed by both equipment and manpower. Construction equipment will be used intensively in construction of the main civil works, while the tertiary development works will be carried out by manpower with minor construction equipment.

6.3 The Project will be implemented in the following three stages:

(1) Review of the existing design and detailed design of the main project facilities

(2) Construction of the main project facilities, and

(3) Detailed design and construction of tertiary development works

6.4 To smoothly implement the Project, the consultant engineers will have to be engaged for the assistance and guidance to the Project staff during the design stage and construction stage.

6.5 The Project implementation schedule is shown in Fig. 6. It includes the Project preparatory works and the construction works. The Project preparatory works will last 22 months including the time necessary for survey and mapping works, review of the existing design and the detailed design works, mobilization, and construction of offices and quarters. The construction works will last 68 months for the main civil works and tertiary development works.

6.6 The project preparatory works consist of topographic mapping, detailed design, construction of office and quarters, land acquisition. Topographic maps on a scale of 1:5,000 with a contour interval of 0.5 m will have to be prepared for the Project area of 20,000 ha. Mapping will be started on March 1983. The review and improvement of the existing design of the canals and Bila intake structure will be started on March, 1983. The design of the Bila intake structure will be completed by the end of October, 1983, and the design of the canals, by the end of February, 1984. The design of Kalola dam will be started in the late 1983 and be completed by the end of August, 1984. The Project office and quarters will be completed prior to the major construction works. This will be started from the beginning of 1984 and completed by the end of 1984. The land acquisition for the Project facilities will be completed at least one year prior to the construction works.

6.7 The Bila intake structure consists of various components such as an intake weir, intake, bridge, coupure channel, closure embankment, etc. The intake weir will be constructed by means of coupure channle. The time required for construction of the intake will be 57 months from the start of the preparatory works. The construction of the weir will be carried out in the excavated site on the coupure channel in the dry condition. Since the weir consisting of mainly wet stone masonry will be constructed by labour force, the time required for completing the masonry works will be 3 years. The masonry works will be started on the beginning of March, 1985 and completed by the end of February, 1988. After completing the intake weir, the excavation of coupure channel will be started and completed by the end of December, 1989. Earthfilling of the closure embankment will be carried out by use of excavated material from the coupure channel, so that the embankment will be conducted in parallel with the construction of the coupure channel. In those works the machinery works will mainly be employed.

6.8 Time required for completing the Kalola dam will be about 56 month from the start of the preparatory works. The preparatory works consisting a coffer dam and pressure diversion tunnel will be started on the beginning of May, 1985, and completed by the end of October, 1986. Following to the completion of the diversion works, the main dam construction will be started on the November, 1986, and it will be completed by the end of December, 1989. The concrete work of the spillway will be executed in parallel with the embankment work of the main dam, starting on the May, 1987 and completing by the end of May, 1989. The construction of intake and installation of gates will be executed in 7 months completing by the end of June, 1989.

6.9 The construction of main irrigation canal including main inspection road will be carried out for 40 months from January, 1985 through April, 1988. In parallel with construction of the main irrigation canal, the secondary irrigation canals will be constructed in 25 months, starting from June, 1987. The construction of the irrigation canal will be executed from the upper reaches to the lower reaches. In the rainy season, the earthworks will be suspended and a main effort will be paid to the construction of related structures. The excavated materials from the canals will be used for embankment of canals and inspection roads.

6.10 The construction road for access of constructing the Project facilities will be started on January, 1985, in parallel with the main canal construction. The inspection roads will also use for access during the construction. The lack of embankment material of canals and inspection roads will be obtained from excavation in drainage canals. The mamor drainage canals will be executed for the period from January, 1987 to the end of February, 1990. The pavement of the inspection roads and construction roads will be made at the final stages of respective construction periods. The construction roads will be transferred as the village link roads.

6.11 The detailed design of the tertiary development will be started from September, 1984 based on the aerial photo maps and field survey. The construction will be executed by stagewise. The construction will be started on October, 1984 from the upper part of the Project area, and be completed by the end of February, 1990.

6.12 The Directorate General of Water Resources Development, the Ministry of Public Works would be the executing body for the Bila Irrigation Project. The Directorate General would be responsible for both the engineering works and the construction works of the Project, and it would coordinate all activities of the relevant government agencies and regional administrative organizations in connection with the Project execution. The Directorate of Irrigation under the Directorate General of Water Resources Development would have the direct responsibility for the Project execution. The Provincial Office of Public Work, South Sulawesi, would coordinate the construction of the Project at the provincial level on behalf of the Directorate of Irrigation.

6.13 To smoothly execute the Project, a project office for the Bila Irrigation Project would be established in the Provincial Office of Public Works, South Sulawesi. The Project Office would operate all the field works such as additional survey and investigation, settlement of field quarters, land acquisition, the detailed design and construction supervision. The Project Office would consist of one head office and four branch offices. It is proposed to establish the head office at Sengkang. The branch offices would be established at Bila, Tanru Tedong, Kalola and Bola Malimpong in keeping pace with the progress of the project construction works. The organization for the project execution is proposed as shown in Fig. 7.

6.14 The annual fund requirements for the project construction works are set out as shown in Table 4 based on the proposed implementation schedule of the Project.

VII. RECOMMENDATIONS

7.1 The feasibility study made herewith on the Bila Irrigation Project concluded that the Project would be technically sound and economically feasible. The Project area surrounded with the existing irrigation areas has been left behind for irrigation development and the inhabitants in the Project area have waited for long time the early realization of the Project. With such background, it is strongly recommended that the Project should be implemented as early as possible.

7.2 The feasibility investigation and study for the Project were carried out based on the following topographic maps to have been made available before the commencement of the field works:

(1) 1:5,000 scale with 1.0 m contour intervals covering major part of the Project area prepared on the ground survey basis by DOI in 1976.

(2) 1:25,000 scale with 5.0 m or 10.0 m contour intervals covering the whole project area prepared with aerial photo mapping by JICA in 1978.

For the successful implementation of the Project, especially of the tertiary irrigation development and the major Project facilities, supplemental topo-survey and preparation of maps in acceptable scale are required in the detailed design works of the Project.

(1) Topographic maps of 1:5,000 scale with 0.5 m contour intervals for tertiary development and cadastral survey covering the entire project area of 20,000 ha,

(2) Topographic maps of 1:500 scale with 0.25 m contour intervals at Bila intake and Kalola dam sites covering about 50 ha and 70 ha respectively, and

(3) Longitudinal profile survey of the Kalola river from the proposed Kalola damsite for about 3 km downstream reaches.

7.3 Hydrological analysis of the Kalola dam was carried out based on the estimated discharges from the short-period observation data of the Kalola river discharge and the run-off characteristics of the other rivers. In view of vital importance of the observed discharge data on the Kalola river, the hydrological network in the Kalola river basin has to be urgently established. Further reliable data on meteo-hydrological observation are limited in and around the Project area. The present networks of meteo-hydrological observation would have to be improved and strengthened.

7.4 For making sediment study on the proposed Kalola reservoir, periodical measurement of sediment transport of the river at the Kalola dam site is essential.

7.5 Numbers of geological and soil mechanical investigation were conducted at the intake and dam sites and along the canal routes during the study period. Besides, the geological and soil mechanical information on the proposed Bila intake site and the proposed main canal route has been made available through the investigation conducted by DOI in 1976 and 1978. Prior to the implementation of the Project, however, in order to confirm more detailed geological conditions at the Bila intake and Kalola dam sites and to examine the technical characteristics of construction materials, the following investigation is needed:

(1) Drilling, standard penetration test and permeability test

- Bila intake site with total depth of 100 m for five (5) numbers of holes, and
- Kalola dam site with total depth of 100 m for four (4) number of holes

(2) Soil mechanical and construction material test

- Bila intake site for embankment materials for closure embankment, and
- Kalola dam site for embankment materials of core, filter and rock zones

7.6 The Bila river and the Kalola river are main water sources of the Project. The total watershed of these rivers is about 500 km^2, out of which only about 56% of the area is covered with forest and has been gradually depleted by unrestricted shifting cultivation and over-grazing of domestic animals. Such being the situation, it is strongly recommended that reforestation work should be promoted for conservation of land and water resources. The reforestation work should be carried out under close coordination with "Pembinaan Reboisasi dan Penghijauan Daerah Aliran Sungai".

7.7 In order to facilitate the early realization of modern irrigation farming, the present institutions for guidance services both for operation and maintenance of irrigation facilities and for irrigation rice farming have to be strengthened through the increase of staff and budget allocation. The staffs to be in charge of the Project operation and maintenance works should be given the practical guiding experience on the similar activities to the operation and maintenance. With this in view, it is highly recommended that a pilot demonstration scheme should be established within the Project area prior to the commencement of the main construction works.

7.8 The present capacity of rice mills will not be sufficient for processing the increased crop production at the full development stage of the Project. Moreover, most of the existing milling facilities are of one-pass system simultaneously carrying out two processes of husking and whitening, which produce much broken rice. The increase and improvement of these facilities would be needed, together with improvement of drying practices for attainment of better marketability.

7.9 Improvement of farm road networks is prerequisite of the introduction of irrigation farming into the Project area. Concurrently with construction of the irrigation facilities, the selected village roads should be improved with the Project works to provide the construction access. After completion of the project construction works, they would be used as the village link roads.

THE BILA IRRIGATION PROJECT

Table 1 Summary of Construction Cost

(Unit: 10^6 Rp.)

Item	Total	Foreign Currency	Local Currency
1. Preparatory Works	1,718	698	1,020
2. Bila Intake	2,665	1,774	891
3. Kalola Dam	7,656	5,456	2,200
4. Irrigation Canals and Roads			
- Irrigation canals and inspection roads	8,208	4,574	3,634
- Drainage canals	1,343	1,063	280
- Construction road	780	491	289
5. Tertiary Development	4,485	444	4,041
6. Office and Quarters	640	-	640
Sub-total	27,495	14,500	12,995
7. Land Acquisition	2,370	-	2,370
8. O & M Equipment	992	942	50
9. Administration Expenses	612	-	612
10. Engineering Services	4,889	4,529	360
11. Physical Contingency	5,454	2,996	2,458
Sub-total	14,317	8,467	5,850
Total	41,812	22,967	18,845
12. Price Contingency	26,011	11,930	14,081
GRAND TOTAL	67,823	34,897	32,926

Table 2 Irrigation Benefit

	Description		Without Project	With Project	Increment
1.	Project Area	(ha)	10,900	9,800	-1,100
2.	Planted/Harvested Area	(ha)			
	Wet season paddy		9,490	9,800	310
	Dry season paddy		590	9,800	9,210
	Polowijo crops		2,720	-	-2,720
3.	Gross Production Value	(10^6 Rp.)	6,518	19,600	13,082
	Wet season paddy		5,637	9,800	4,163
	Dry season paddy		335	9,800	9,465
	Polowijo crops		546	-	-546
4.	Total Production Cost	(10^6 Rp.)	2,499	5,872	3,373
	Wet season paddy		2,131	2,886	755
	Dry season paddy		121	2,986	2,865
	Polowijo crops		247	-	-247
5.	Net Production Value	(10^6 Rp.)	4,019	13,728	9,709
	Wet season paddy		3,506	6,914	3,408
	Dry season paddy		214	6,814	6,600
	Polowijo crops		299	-	-299
6.	Production Loss Value	(10^6 Rp.)	157	-	-157
	Wet season paddy		136	-	-136
	Dry season paddy		8	-	-8
	Polowijo crops		13	-	-13
7.	Annual Incremental Benefits	(10^6 Rp.)	4,176	13,728	9,552 (US$1,560/ha)

Table 3 Annual Costs and Benefit Flow

(Unit: 10^6 pp.)

Year	Year in Order	Cost			Benefit
		Capital	Replacement	O & M	
1983	1	1,320	0	0	0
1984	2	2,255	0	0	0
1985	3	3,600	0	0	0
1986	4	4,004	0	0	0
1987	5	6,700	0	0	0
1988	6	9,419	0	0	0
1989	7	6,252	0	168	752
1990	8	1,628	0	345	2,536
1991	9	0	0	345	4,478
1992	10	0	0	345	6,421
1993	11	0	0	345	8,362
1994	12	0	0	345	9,552
1995	13	0	0	345	9,552
1996	14	0	0	345	9,552
1997	15	0	0	345	9,552
1998	16	0	445	345	9,552
1999	17	0	445	345	9,552
2000	18	0	0	345	9,552
2001	19	0	0	345	9,552
2002	20	0	0	345	9,552
2003	21	0	0	345	9,552
2004	22	0	0	345	9,552
2005	23	0	0	345	9,552
2006	24	0	0	345	9,552
2007	25	0	0	345	9,552
2008	26	0	445	345	9,552
2009	27	0	445	345	9,552
2010	28	0	0	345	9,552
2011	29	0	0	345	9,552
2012	30	0	43	345	9,552
2013	31	0	55	345	9,552
2014	32	0	962	345	9,552
2015	33	0	0	345	9,552
2016	34	0	0	345	9,552
2017	35	0	0	345	9,552
2018	36	0	445	345	9,552
2019	37	0	445	345	9,552
2020	38	0	0	345	9,552
2021	39	0	0	345	9,552
2022	40	0	0	345	9,552
2023	41	0	0	345	9,552
2024	42	0	0	345	9,552
2025	43	0	0	345	9,552
2026	44	0	0	345	9,552
2027	45	0	0	345	9,552
2028	46	0	445	345	9,552
2029	47	0	445	345	9,552
2030	48	0	0	345	9,552
2031	49	0	0	345	9,552
2032	50	0	0	345	9,552

Present Worth

Interest (%)	Cost	Benefit
4	35,778	136,858
6	30,758	87,954
8	27,038	59,272
10	24,120	41,540
12	21,738	30,058
14	19,738	22,324
16	18,026	16,937
18	16,533	13,080
20	15,235	10,253

IRR: 15.3%

Table 4 Annual Disbursement Schedule

(Unit: 10^6Rp.)

Description	Total		1983		1984		1985		1986		1987		1988		1989		1990	
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC
1. Preparatory Work	698	1,020	-	-	349	510	349	510	-	-	-	-	-	-	-	-	-	-
2. Bila Intake	1,774	891	-	-	-	-	155	216	183	254	183	254	1,245	162	8	5	-	-
3. Kalola Dam	5,456	2,200	-	-	-	-	208	76	878	303	728	222	1,540	519	1,412	565	690	515
4. Canals & Roads																		
(1) Canals & inspection roads	4,574	3,634	-	-	-	-	597	453	595	453	1,320	1,048	1,442	1,170	622	510	-	-
(2) Drainage canals	1,063	280	-	-	-	-	-	-	-	-	340	90	340	90	340	89	43	11
(3) Construction roads	491	289	-	-	-	-	167	98	162	96	162	95	-	-	-	-	-	-
5. Tertiary System	444	4,041	-	-	-	-	-	-	31	283	129	1,172	129	1,172	129	1,172	26	242
6. Office and Quarters	-	640	-	-	-	640	-	-	-	-	-	-	-	-	-	-	-	-
Sub-total	14,500	12,995	-	-	349	1,150	1,474	1,353	1,849	1,389	2,862	2,881	4,696	3,113	2,511	2,341	759	768
7. Land Acquisition	-	2,370	-	570	-	1,300	-	500	-	-	-	-	-	-	-	-	-	-
8. O & M Equipment	942	50	-	-	-	-	-	-	-	-	-	-	471	25	471	25	-	-
9. Administration Expenses	-	612	-	46	-	68	-	88	-	101	-	101	-	101	-	97	-	10
10. Engineering Service	4,529	360	1,155	74	564	48	519	44	489	41	580	49	640	54	549	47	33	3
11. Physical Contingency	2,996	2,458	173	103	137	385	299	298	351	230	516	455	871	494	530	376	119	117
Sub-total	8,467	5,850	1,328	793	701	1,801	818	930	840	372	1,096	605	1,982	674	1,550	545	152	130
Total	22,967	18,845	1,328	793	1,050	2,951	2,292	2,283	2,689	1,761	3,958	3,486	6,678	3,787	4,061	2,886	911	898
12. Price Contingency	11,930	14,081	192	167	236	977	712	1,060	1,082	1,075	1,982	2,690	4,045	3,593	2,917	3,300	764	1,219
GRAND TOTAL	34,897	32,926	1,520	960	1,286	3,928	3,004	3,343	3,771	2,836	5,940	6,176	10,723	7,380	6,978	6,186	1,675	2,117

Remarks: /1; Engineering service of item 10 includes the expenses required for the detailed design.

/2; Price contingency of item 12 is calculated from the standpoint 1981 based on the annual increase rates of 7% and 10% for the foreign currency and local currency portions respectively.

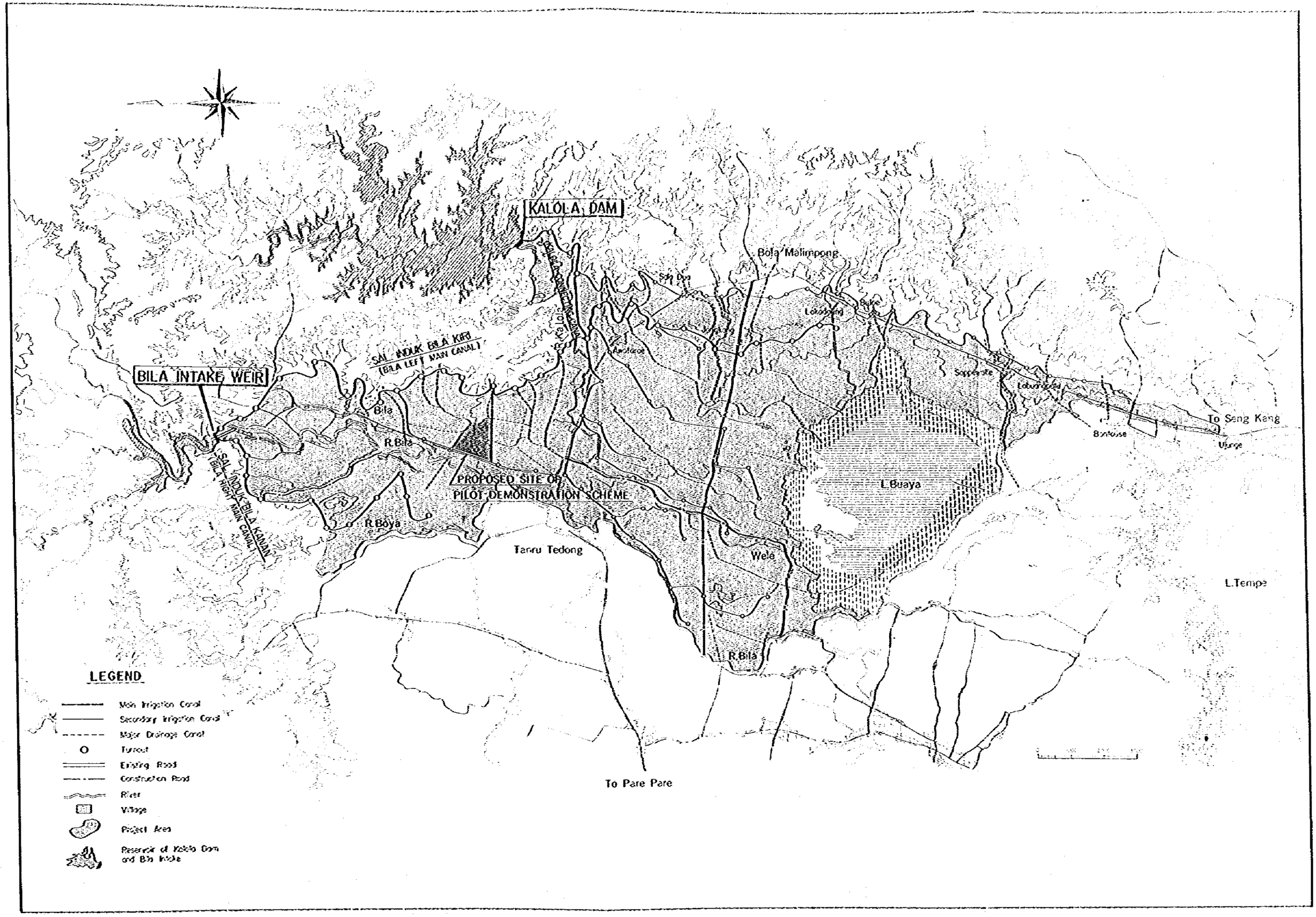
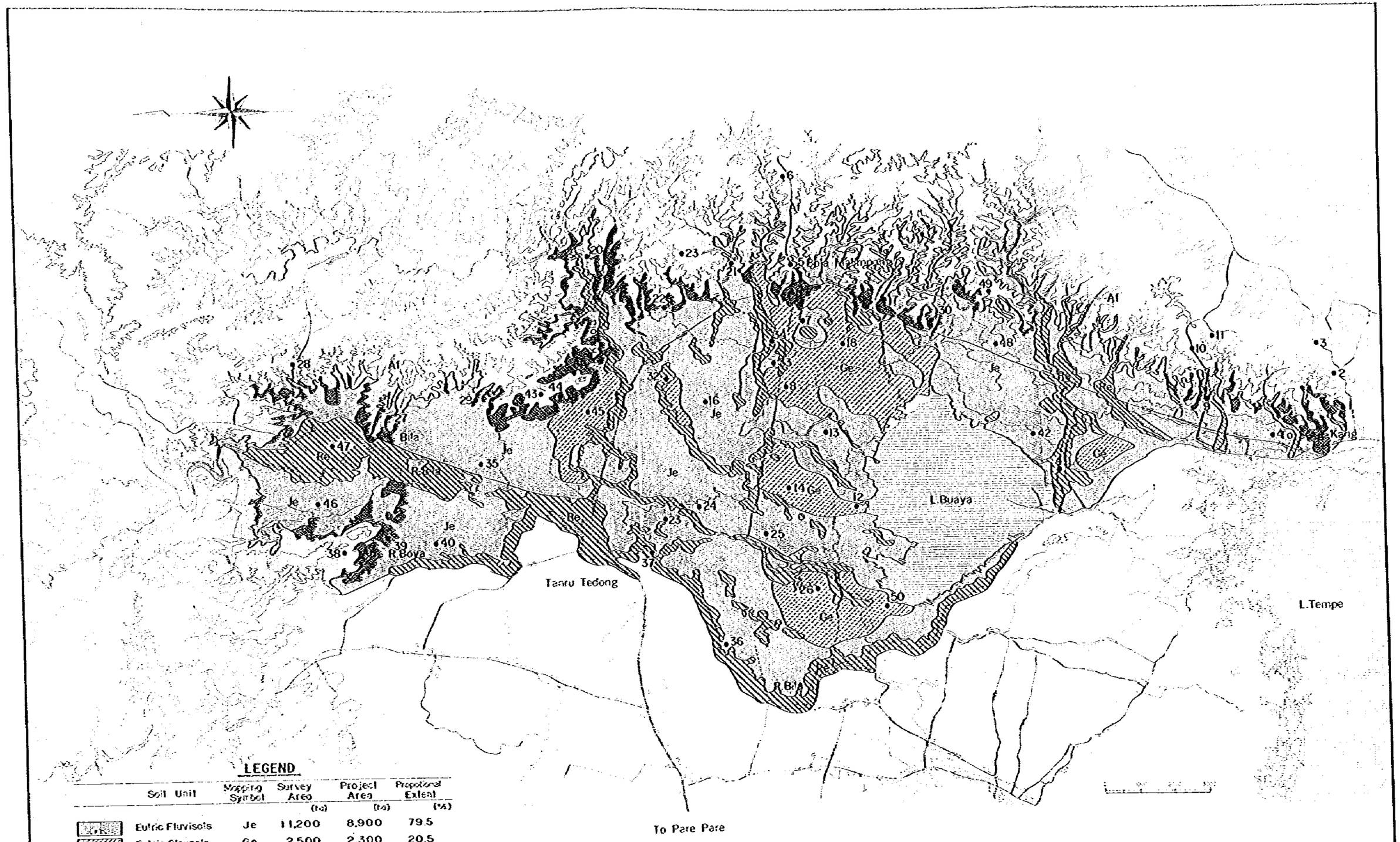


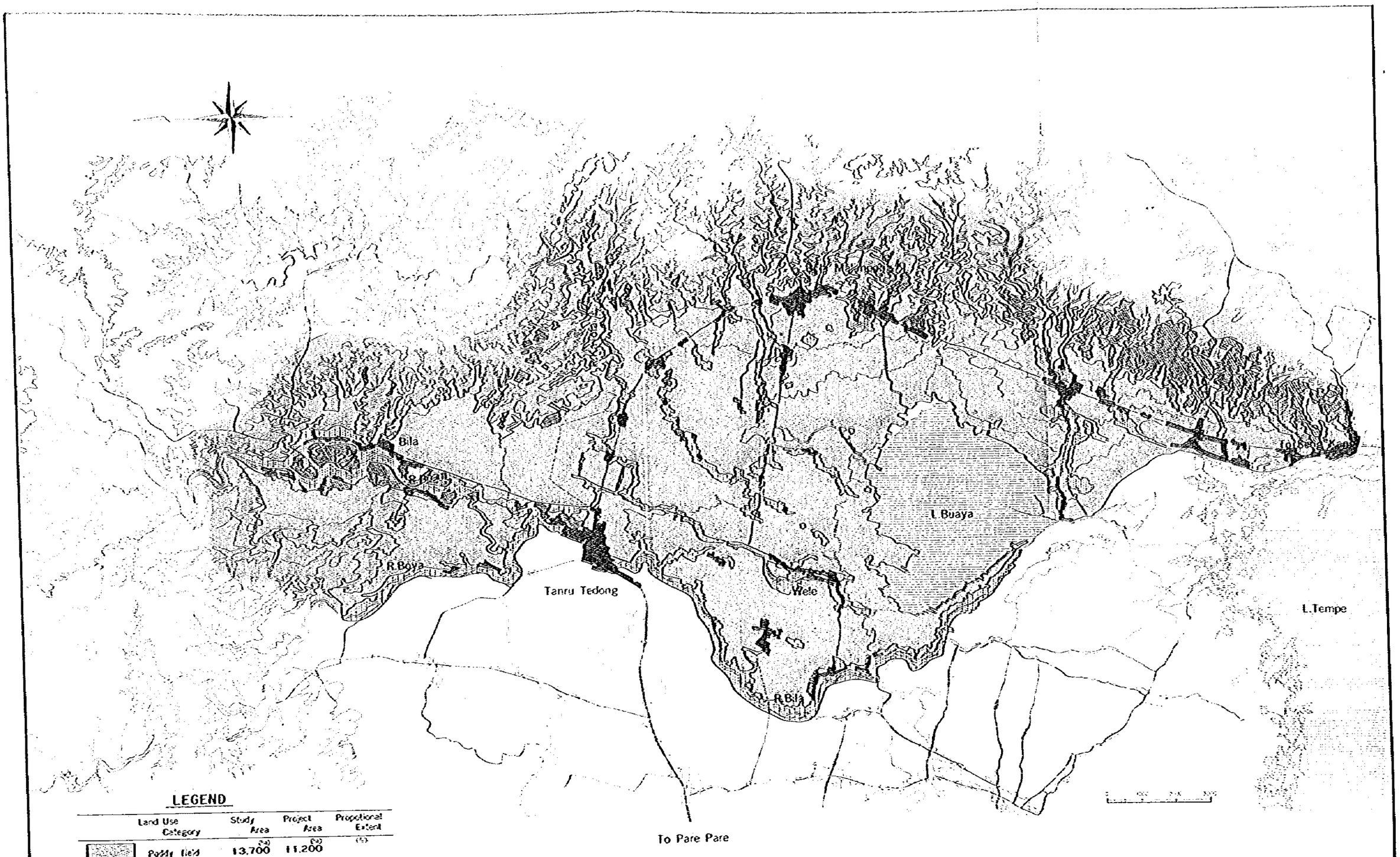
Fig. 1 GENERAL LAYOUT OF THE BILA IRRIGATION PROJECT



LEGEND

	Soil Unit	Mapping Symbol	Survey Area (ha)	Project Area (ha)	Proportional Extent (%)
	Eutric Fluvisols	Je	11,200	8,900	79.5
	Eutric Gleysols	Ge	2,500	2,300	20.5
	Eutric Regosols	Re	2,500	—	—
	Plinthic Acrisols	Ap	900	—	—
	Ferric Acrisols	Al	2,900	—	—
Total			20,000	11,200	100.0

Fig. 2 SOIL MAP OF THE STUDY AREA



LEGEND

Land Use Category	Study Area	Project Area	Proportional Extent
	(ha)	(ha)	(%)
Paddy field	13,700	11,200	
Upland field	700		
Orchard	1,260		
Forest / Gross land	3,800		
Villages / Others	540		
Total	20,000	11,200	100.0

Fig. 3 PRESENT LAND USE MAP OF THE STUDY AREA

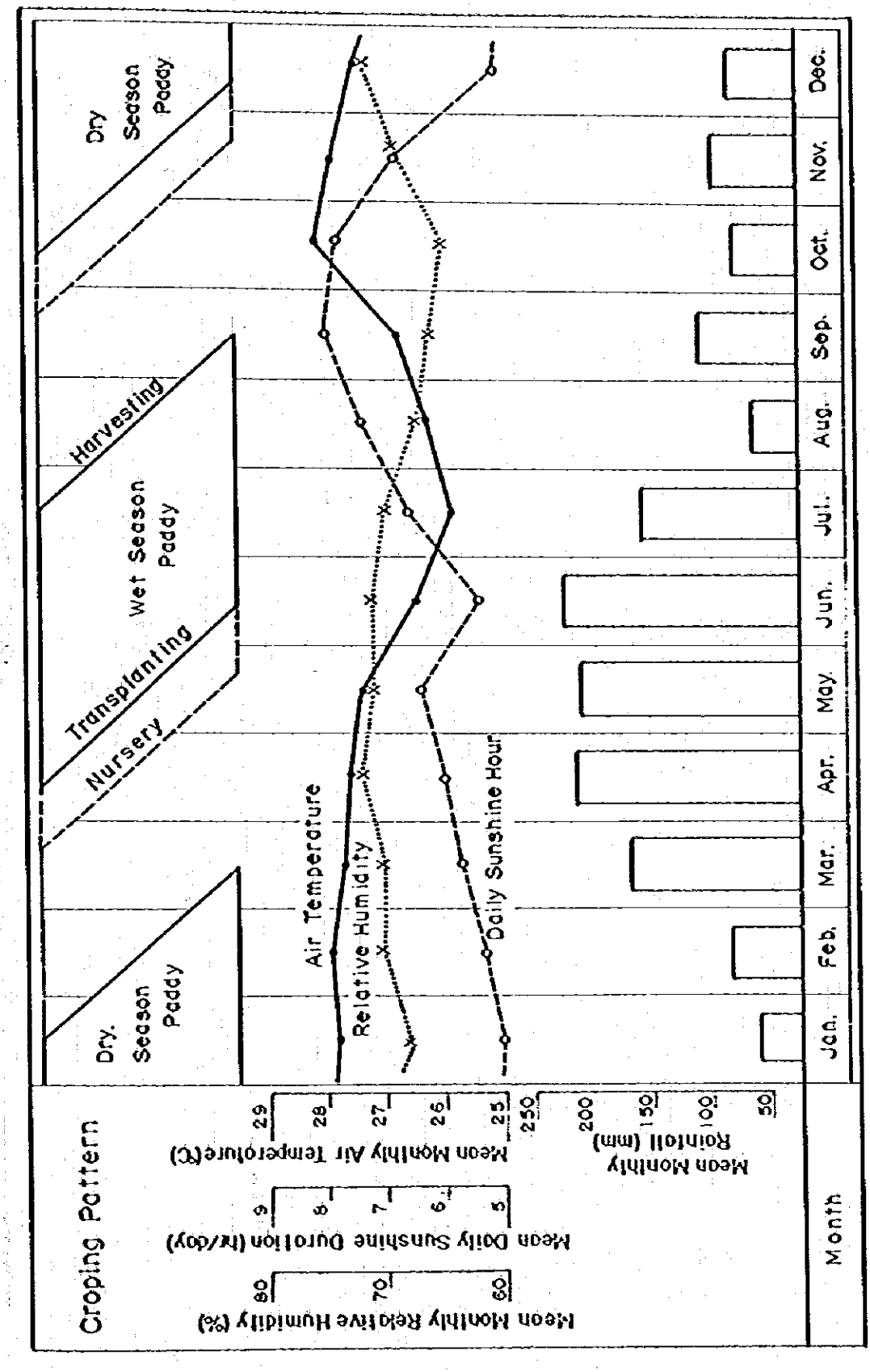


Fig. 4 PROPOSED CROPPING PATTERN

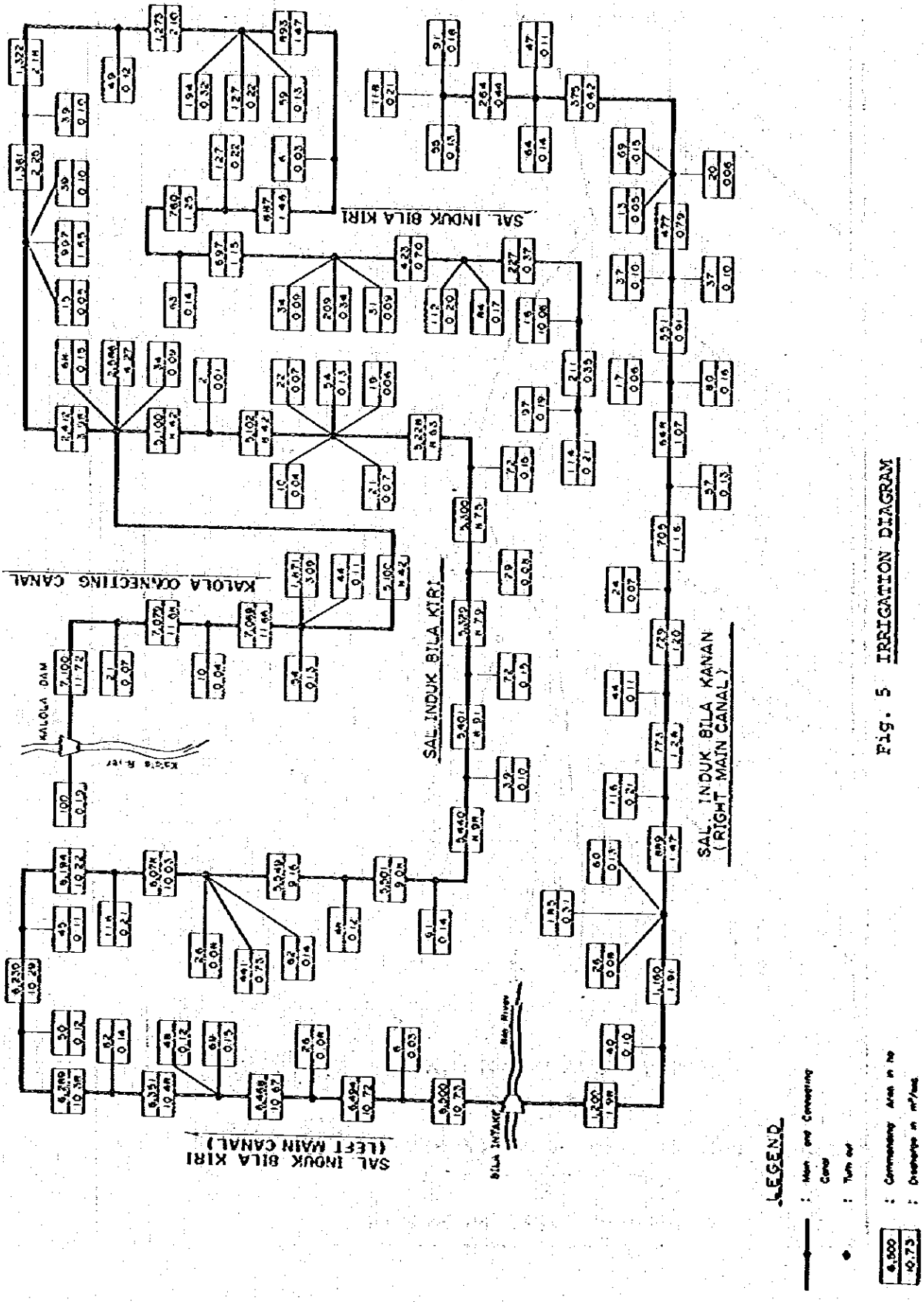


Fig. 5 IRRIGATION DIAGRAM

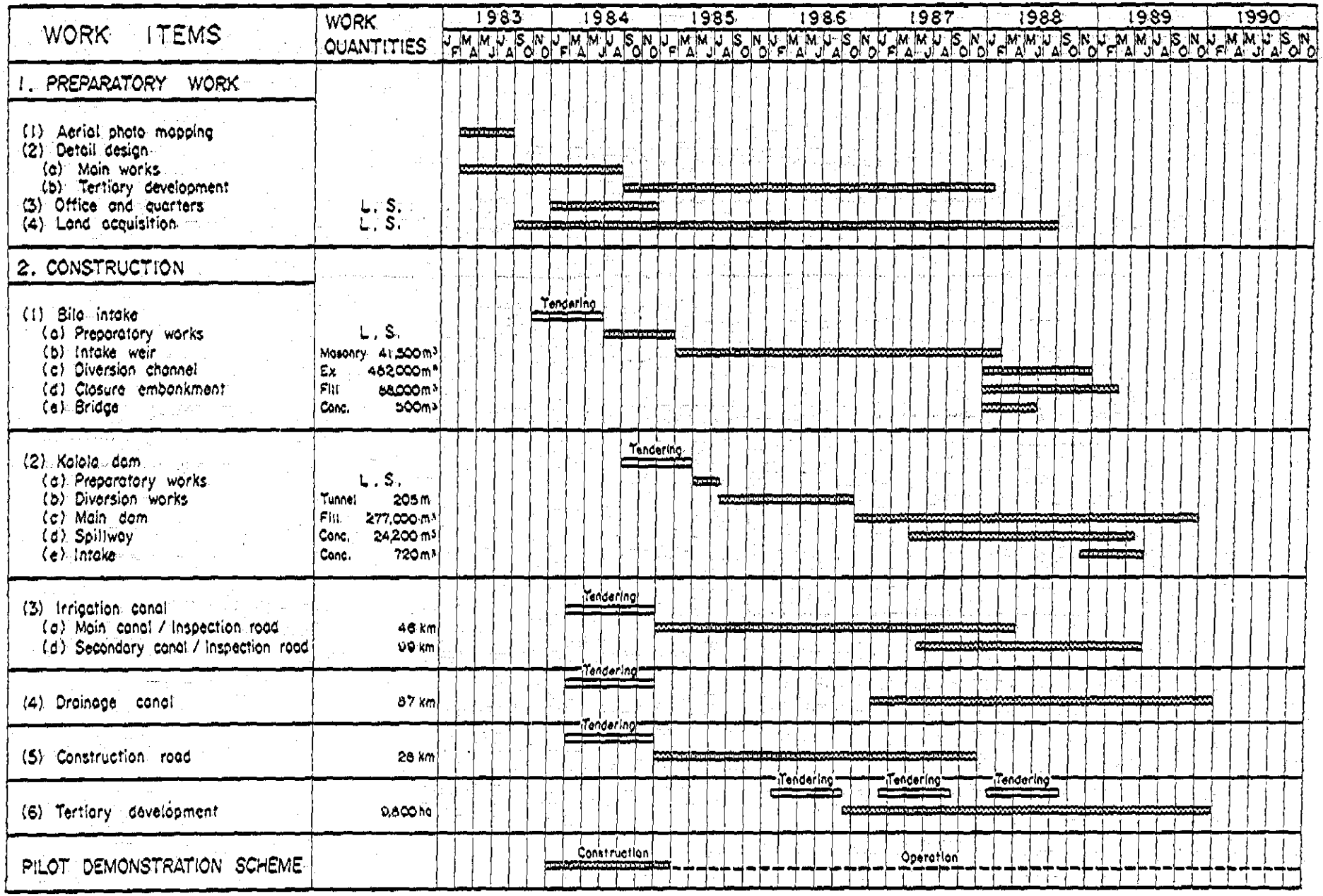


Fig. 6 PROJECT IMPLEMENTATION SCHEDULE

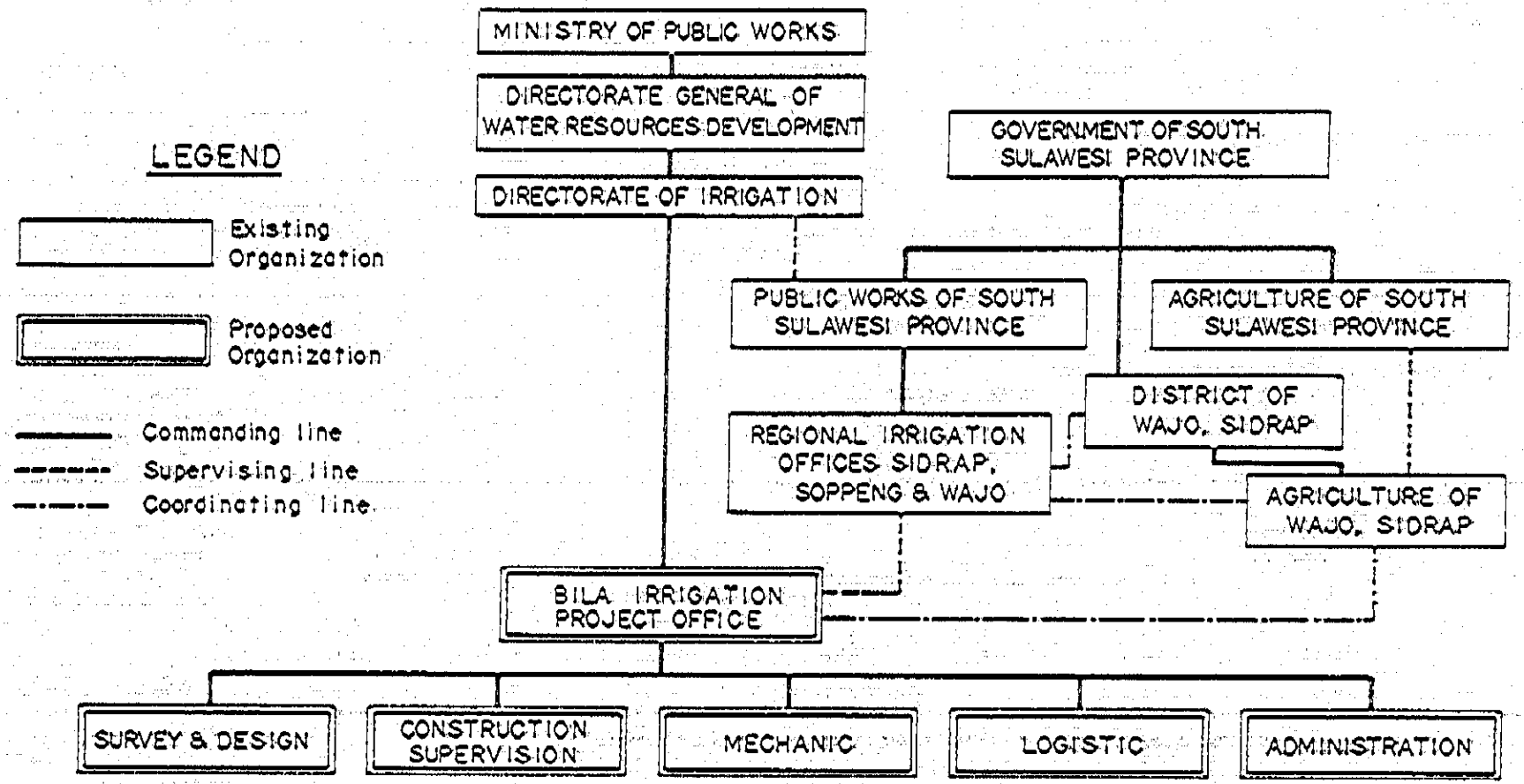


Fig. 7 ORGANIZATION OF PROJECT EXECUTION

JICA