4.3.4 Anticipated yields and production

(1) Target yield of crops

Present paddy yields in the project area are greatly influenced by factors related to natural conditions including excess water in the wet season, water shortage in dry season and pest and disease attack in both seasons. The present project envisages lifting these farming constraints through irrigation development, drainage development and agronomic means. Accordingly, after completion of the project, the rice yield will be considerably increased through improvement of farming practices and/or the introduction of intensive farming practices, and the anticipated expansion of agricultural support services.

The estimate of future yields of crops has been made on the basis of information from the Department of Agriculture in North Sumatra province as well on yields on well irrigated land in and around the project area.

The anticipated paddy yield for both wet and dry season croppings at the full development stage is assumed as shown in the following table. Unit yield without project conditions is assumed to increase by about 0.4 ton/ha in every land use sub-category from the present level, which is estimated on the basis of the findings in the field survey on paddy farming area in Kabupaten Asahan and the present conditions of physical infrastructures.

Land Use Category		Paddy Yield (ton/ha)		
Present/Without	Future With	Present	Without Project	With Project
Wet Season				
Irrigated paddy I	Irrigated paddy	3.6	4.0	5.5
Irrigated paddy II	Irrigated paddy	3.6	4.0	5.5
Rainfed paddy/HYV	Irrigated paddy	2.4	2.8	5.5
Rainfed paddy/Local	Irrigated paddy	1.1	1.5	5.0
Coconut field	Irrigated paddy	-	-	5.0
Dry Season				
Irrigated paddy I	Irrigated paddy	3.6	4.0	5.5
Irrigated paddy II	Irrigated paddy	2.3	2.8	5.5
Rainfed paddy/HYV	Irrigated paddy	-	-	5.5
Rainfed paddy/Local	Irrigated paddy	-	-	5.0
Coconut field	Irrigated paddy	-	-	5.0

(2) Build-up period of target yield

In order to attain the projected target yields at an earlier stage, it is essential to improve and strengthen the present agricultural supporting services including further expansion of the intensification program in keeping pace with the project implementation. It would take some time to disseminate the proposed farming practices to all farmers, however, progressive farmers in the project area are successively performing intensive irrigated rice farming, which will present strong demonstration effects to other farmers. Similarly, proper operation of irrigation facilities would be one of the most important matters, particularly proper distribution of irrigation water at on-farm level would largely contribute to the time span required to attain the target yield. The earlier establishment of operation and maintenance organization in the irrigated area is prerequisite for the successful irrigation farming. To this effects, comprehensive training of farmers and concerned personnel are envisaged in the present project and the relevant program are proposed in Section 4.6.

Taking the above into consideration, the build-up period is assumed to be 3 years after completion of the implementation works.

(3) Anticipated crop production

The yields and production of paddy in the project area would increase year by year with the proper irrigation as well as with improvements of farmer's farming practices. Based on the crop yields assumed in the previous section, the anticipated crop production and production increment at the full development stage are estimated as shown in Table D-25 and in the following table. The annual production of rice at the full development stage in the project area is estimated at about 109 thousand tons, an increment of about 79 thousand tons from the present level and about 74 thousand tons from the without project conditions.

Anticipated Crop Production in the Project Area

(Unit: dry paddy thousand tons)

Present	Without	With	Incremental Production 1/
30.0	35.0	109.3	74.3

1/: With - without

4.3.5 Marketing

North Sumatra province is the region of shortage of rice at present. The amount of rice imported from other provinces and foreign countries differs from year to year, ranging from 75,700 tons in 1988/89 to 245,500 tons in 1986/87 during the recent four years (Refer to Volume 3, Table 4-1). In addition, the incremental demand for rice in North Sumatra in the future is estimated to expand rapidly as shown in the following table (Details are shown in Table 4-2, Volume 3).

Year	Incremental Demand (1,000 tons of paddy)
1990	294
1995	556
2000	926
2005	1,207
2010	1,487
2015	1,788
2020	2,114

Accordingly, it is considered that the amount of rice to be produced in the project will be marketed in North Sumatra province and will improves self-sufficiency of rice in the province.

Marketing of paddy in the future with project condition will be expected to largely depend on field brokers of paddy. Other marketing channels will be KUD, local rice mills and local market, although the quantity of handling is estimated to be limited.

4.3.6 Crop budget

On the basis of the estimated production cost and gross income, primary profit of paddy per ha is calculated both on future with and without project conditions as shown in Table D-26. In the estimation, it is assumed that under the without condition the production cost will remain constant at the present level as no significant changes in farm inputs is predicted.

4.3.7 Farmer's economy

After implementation of the irrigation and drainage development envisaged, the project will provide the basis for introduction of improved irrigation farming through year round stable irrigation and improvement of land drainability. As a result, a considerable increase of unit yield and cropping intensity will be expected. The paddy yield is anticipated to increase to 5.0 - 5.5 tons per ha. The cropping intensity under with project condition will increase to 200% from present about 120% in the project as a whole.

The farm budget of typical farmers in both with and without project conditions is summarized below and details are shown in Table D-27.

Farm Incomes of Typical Farmers[1/]
- With & Without Project Conditions -

(Unit: Rp.1,000)

	Irrigated Paddy I	Irrigated Paddy II	Rainfed Paddy/HYV	Rainfed Paddy/Local	Coconut[2/] + Ir. Paddy II
Farm size (ha)	1.1	0.8	0.8	1.9	1.1
With Project					
Farm income from paddy farming	2,271	1,652	1,652	3,525	2,157
Other income	448	448	287	665	339
Total income	2,719	2,100	1,939	4,190	2,496
Family expenditure[3/]	960	960	960	960	960
Capacity to pay	1,759	1,140	979	3,230	1,536
Without Project					
Farm income from paddy farming	1,595	551	362	585	1,079
Other income	448	448	287	665	339
Total income	2,043	999	649	1,250	1,418
Family expenditure	803	803	803	803	803
Capacity to pay	1,240	196	-154	447	615
Incremental Income					
Farm income from paddy farming	676	1,101	1,290	2,940	1,078
Capacity to pay	519	944	1,133	2,783	921

1/: Typical farms (owner operator) in each land use category.
2/: Typical farm in the area conversion of coconut field to paddy field planned.
3/: Assumed 1.2 times of the expenditure under without project.

As shown in the table, the expected incremental incomes of typical farmers are Rp. 676, 1,101, 1,290, 2,940 and 1,078 thousand, respectively in cases of irrigated paddy I, irrigated paddy II, rainfed paddy/HYV, rainfed paddy/local and coconut + irrigated paddy II. Accordingly, a considerable to great increase of farm income is expected in all cases encountered in the project area. Similarly, the capacity to pay of typical farmers will increase respectively Rp. 519, 944, 1,133, 2,783 and 921 thousand from the without project conditions.

4.4 Irrigation and Drainage Plan

4.4.1 General

Based on assessment of the development potential of the land and water resources of the project area, development plan for irrigation and drainage has been formulated in line with the development strategy set up in Section 4.1 and 4.3.

The basic planning concept applied for the irrigation and drainage plan are: (a) full use of available water resources for irrigation development without provision of artificial reservoir on the rivers and farm pond, (b) no adverse effects to the downstream users by the proposed irrigation development, (c) introduction of gravity irrigation and drainage systems, (d) full utilization of the existing irrigation and drainage facilities, and (v) harmonization with the existing development plans and proposals prepared by the Government.

4.4.2 Irrigation water requirement and water resource assessment

(1) Irrigation water requirement

The irrigation water requirements have been estimated in accordance with a planning guideline prepared by DGWRD. Consumptive use of water has been estimated on the basis of the modified Penman method proposed by FAO. A percolation rate of 2 mm/day is applied for dry season paddy and 1 mm/day for wet season paddy. The water requirement of land preparation including nursery requirement for paddy is assumed to be 150 mm. The effective rainfall is based on the 5-year low rainfall at Hessa rainfall stations. The overall irrigation efficiency is assumed to be 60%.

The unit diversion irrigation water requirement for paddy is estimated at 1.67 l/sec/ha and details are shown in Table C-8.

(2) Water resource assessment

The water balance study is made to assess the maximum development potential area of the available river run-off of the Silau and Bunut rivers. The water balance assessment is made on the 10-day basis of river run-off of the design year with once in five year probable drought and irrigation water requirement in accordance with the proposed cropping pattern of double cropping of paddy a year. The river maintenance flow to maintain the existing downstream demands is also considered in the balance study.

As a result of the study, the maximum potential development area by conjunctive use of the both river water sources is estimated at about 11,000 ha in net. The inter basin plan that diverts the river water of the Silau to the Bunut river in dry season, will be indispensable for full utilization of the river run-off of the Silau river. According to the water balance study in separate assessment mode, the water resource of the Bunut river only has a development potential of about 500 ha though the Silau river has of about 9,900 ha. The results of the calculation are shown in Table C-10.

The water balance study also shows that the remaining water source of the Silau river could still supply the irrigation water to Tambung Tulang area during the period from October to June where it is adjacent to the Bunut irrigation area in the lower portion.

Basic year for water resource study

According to the irrigation design standard of DGWRD, the basic drought year with once in five years probability is selected based on the estimated discharges. The selection is made by paying attention not only to the minimum drought discharge but to the total discharge from January to August. It is considered that the critical run-off for the irrigation development occurs during rather drought season in the above duration.

As seen in Table B-15, the year of 1977 is selected as the basic year for the study.

River maintenance discharge

The river maintenance discharge is defined as a minimum discharge to maintain the downstream demands and environmental conditions of riverine lives. Since there is no absolute standard for deciding the discharge, the probable drought discharge having 90% reliability is applied to the study. The maintenance discharges estimated based on the 10-day basis discharges for 20 years are tabulated as below.

Site	River	Maintenance discharge (m^3/s)	Study Item
Kisaran bridge	Silau	26.0	Integrated weir and inter-basin plan
P. Janji	Silau	15.7	Inter-basin plan
Highway bridge	Bunut	1.8	Availability of the river flow

Design rainfall of irrigation plan

Hessa rainfall station is selected as the representative station for estimation of the areal rainfall of the project area. The selection criteria applied were as follows:

(i) the station has a long term (more than 20 years) record

(ii) the record is available in series

(iii) average annual and monthly rainfall is similar to that of other stations in the area

(iv) the correlation coefficient between the representative station and other stations is relatively higher than that of others

The monthly rainfall at Hessa station for 20 years is tabulated in Table B-5.

According to the design standard of DGWRD, the design year is selected based on the rainfall having 80% dependability. As seen in Table B-15, the year of 1979 is selected as the design year for the irrigation plan based on the analysis of annual rainfall and total rainfall from January to August.

4.4.3 Proposed irrigation system

(1) Water resource facilities

The following upgrading and rehabilitation works of water resource facilities are planned and the proposed irrigation supply system is illustrated in Fig. 4-2.

(i) Integration of the existing four free intakes on the Silau river into one diversion weir to ensure the stable diversion of river flow in both water level and quantity. A new integrated diversion weir on the Silau river is proposed 600 m downstream from the railway bridge.

(ii) Inter-basin works diverting the surplus river flow of the Silau river to the Bunut river for the conjunctive use of river waters of both the Bunut river and the Silau rivers in the Bunut area. Inter-basin works being composed of intake structure on the river, conveyance channel, and outfall into to the Bunut river.

(iii) Rehabilitation of the existing three weirs of Serbangan, Panca Arga, and Beluru on the Bunut river.

The detailed descriptions of the integrated weir and inter-basin work are given in proceeding sections.

(2) Irrigation canals and related structures

The proposed canal layout is made based on the map of S = 1/5,000 in accordance with the following considerations:

(i) Full utilization of the existing canals and related structures

(ii) The command area of a tertiary irrigation block of about 60 ha (500 m x 1,200 m) on average

(iii) No crossing structure with drainage canals as far as possible

(iv) Delineation of tertiary blocks by administrative boundaries (village boundary) and physical boundaries of the existing canals and roads.

As a result of the above, the project area is divided into about 270 tertiary blocks and six (6) main irrigation systems consisting of two systems in the Silau area and four in the Bunut area. Main features of these systems are presented in Table C-11. The map showing the main and secondary canal layout and irrigation diagram are illustrated in Figs. 4-3 and C-8.

The length of main and secondary canals is estimated at about 170 km long in total, of which about 60 km long is the objective stretch for upgrading and/or rehabilitation works as summarized below and its breakdown is shown in Table C-17.

(Unit: km)

Sub-Area	New Canal	Upgrading/ Rehabilitation	Total
Silau	44.3	42.7	87.0
Bunut	66.0	17.2	83.2
Total	110.3	59.9	170.2

As regards the related structures, various kind of structures of about 340 nos. in total are planned. These consist of turnouts with measuring devices, bridges, culverts, siphons, spillways, etc. as shown in Table C-18.

4.4.4 Drainage plan

(1) Basic plan of drainage

The drainage plan is formulated based on the available topographic maps at 1/50,000 for the external area of the project area and at 1/5,000 for the project command area. The unit drainage water requirement is estimated based on the probable 3-days consecutive rainfall with a return period of once in five years. The drainage requirement of the external drainage areas is also estimated based on the rational formula of DGWRD.

The function of drainage canals is completely separated from the irrigation canal. Taking into account the watershed and existing natural rivers and drains, the project area is divided into 13 drainage sub-blocks as shown in Table C-12. The basic drainage plan of both river systems is mentioned below.

Silau area

The excess water of whole right bank area will be evacuated to the Bandar Jepang canal, which flowing into the downstream of the Silau river. It is noted that the detailed design for improvement of this canal is being executed by the Directorate of River of DGWRD as an additional design work for the lower Asahan flood control project of the Silau river.

As regards the left bank of the river, three main drainage systems are planned; one is the drain to evacuate excess water from the upper part of the left bank project area and the external area of rubber and coconut plantation, the second drainage system is to evacuate the excess water from the areas along both sides of the Serdang river banks, and the third is to evacuate excess water from the lower part of the project area.

Bunut area

The drainage system on the right bank of the Bunut river is broadly divided into four (4) systems.

The most upstream system (Silo Bonto) is planned to evacuate the drainage water mainly from the upstream rubber plantation area. The remaining systems (Tambung Tulang, Air Hitam and Bagan Batak) are planned to evacuate excess water from the paddy fields in the project area. The excess water in these three drains will flow into the Strait of Malacca and these drains run in the swampy area with a ground elevation lower than El. 2 m. The canal dimensions of these drains will be decided taking into account the tidal effects of the canals.

The drainage system on the left bank of the Bunut river are planned to evacuate excess water from the project area to the Bunut river. Taking into consideration that the ground level of the project area is higher than El. 2 m and the river water level during the design flood with return period of once in five years, the excess water from the area could be evacuated after stacking for about one day.

(2) Drainage water requirement

The unit drainage water requirement of the project area is estimated based on the probable 3-days consecutive rainfall with return period of once in five years following the Irrigation Design Standard of DGWRD. According to the selection criteria mentioned below, Sei Belah station is selected among six stations located in and around the project area as the representative rainfall station for the drainage plan:

(i) Long(more than 20 years) and series rainfall record is available

(ii) Station which indicates the maximum probable rainfall of 1-day, 2 consecutive days and 3 consecutive days

The maximum and exceedance probable rainfall of 6 stations are tabulated in Tables B-6 and B-7. The design rainfall is determined at 172 mm for 3 days.

The drainage water requirements of paddy fields and non-paddy fields are estimated separately. Table C-9 shows the estimation method and calculation procedure of the drainage water requirement and the following equations are applied for the estimates.

1) Paddy fields:

$$Qd = 1.62 \times A^{0.92}$$

2) Non-Paddy fields:

$$Qd = 9.58 \times A^{0.92}$$

where, Qd : Drainage requirement (l/ha)
A : Drainage area (ha)

(3) Drainage system

The proposed canal layout is made in accordance with the above drainage plan and the proposed irrigation canal layout. The most important item is full utilization of the existing natural drains and drainage canals. The layout plan of the drainage canals and proposed drainage diagram are shown in Figs. 4-3 and C-9.

As a result of the layout, the main and secondary drains of about 180 km are planned for the project. Of the total, about 80 km of the existing drains could be utilized with re-shaping and expanding their flow capacity. A summary of the drainage canals is tabulated below and a breakdown is given in Table C-19.

(Unit: km)

Area	New Drain	Upgrading/Improving	Total
Silau	32.5	19.0	51.5
Bunut	65.5	63.3	128.8
Total	98.0	82.3	180.3

As regards the related structures, about 160 nos. of various kinds of structures are planned for the project as shown in Table C-20.

4.4.5 Flood control plan

(1) General

The flood control plan of the project is formulated within the frame work of the flood control master plan. Considering the fact that the detailed design works for the flood control of the Silau river were completed in June 1989 by the Directorate of River, DGWRD in accordance with the recommendation made in the feasibility of the urgent flood control project, it is assumed that the flood control works of the Silau river will be executed by the said agency. The main feature of the flood mitigation plan of the lower Asahan river basin and urgent flood control plan of for the Silau and lower Asahan river is summarized below and then the flood prevention plan for the Bunut river is formulated.

(2) Master plan for flood mitigation

Aiming at prevention of the flood damages not only in the existing developrf lands but also in the adjoining lands for future development especially for agriculture development, a master plan for flood mitigation works (long-term flood control plan) for four major rivers of the Bunut, Asahan, Silau and Kualuh was formulated in the Part-I study in 1985. The plan was formulated based on the the design flood level of 30-year return period. As a result of the study on economic viability and degree of the flood damages, first priority for implementation was given to the Silau and Asahan river improvement scheme. The second priority was the Kualuh river and third was the Bunut river.

Following formulation of the overall flood control plan, in the Part-I study the feasibility study on the first priority scheme was conducted as an urgent flood control project taking into consideration the severe flood damages of the stretches. The objective stretch of the study was 62 km long in total and the design flood level was set at 10-

year return period. The proposed urgent flood control plan was composed of the river channel improvement of 57 km in the Asahan and Silau rivers.

(3) Lower Asahan River flood Control Project

Considering the urgency of the flood control proved in the Part-I study, the Government of Indonesia proceeded the detailed design with a financing support of OECF. The design work was commenced in March 1988 and was completed in June 1989.

The project is composed of river channel improvement for the lower reaches of the Asahan mainstream and the Silau river against 10-year flood discharge to prevent flood damages. The main features of the project works are tabulated in Table C-6 and the major work quantities are excavation of 5.8 million m^3, dike embankment of 2.3 million m^3,and parapet wall of 3,100 m, etc. The project cost is estimated at Rp. 107,650 million in total, of which the foreign currency portion is Rp. 72,630 million and local portion is Rp. 35,020 million. The economic feasibility of the project estimated by EIRR is 8.5% at 1989 price level.

(4) Flood control plan for the Bunut river

Since the present river flow capacity is much less than the design flood discharge, and the existing flood dike along the river is inadequate provision level as clearly identified in Part-I study, the flood control work for the Bunut river is planned as one of the the project works in the framework of the long term plan formulated in the Part-I study.

While the long-term plan was formulated based on the design flood discharge of 30-year return period, the design flood discharge for the project is set at 10-year return period in correspond to the urgent flood control project for the Silau river. The flood distribution plan as well as the discharge capacity of the existing river channel are shown in Fig. C-10.

The objective stretch of the Bunut including a part of the stretch of the Kiri river is planned for about 34 km long taking into consideration the discharge capacity of the existing river channel and design flood discharge. The proposed work are composed mainly of construction of flood dikes and river bed dredging.

4.4.6 Road network plan

Since no inspection road exists along the existing canals, inspection roads along the full length of the proposed canals are to be constructed newly under the project. The total length of proposed roads, including connection roads with provincial and Kabupaten roads, is estimated at about 350 km long as shown in Table C-21 and Fig.C-6.

Taking into account the less accessibility of the Bunut area to the Provincial roads, a main trunk road 10 km long between Meranti and Pasar XI/Air Joman is proposed. The road is planned to be 5 m wide in total with asphalt pavement.

The pavement conditions of inspection roads along the canals are; macadam/general pavement for the main and secondary irrigation canals and main drainage canals, and earth roads with a minimum embankment height of 50 cm along secondary drainage canals.

4.4.7 Operation and maintenance plan

(1) General

The operation of irrigation facilities and maintenance of the project facilities (O&M) is one of the most important and vital factors of the project.

The operation and maintenance works including daily water management of irrigation water to secure the scheduled delivery to each paddy field from the river diversion sites, and periodic maintenance of the project facilities such as irrigation and drainage

canals, and the road network will be one of the most important management activities.

An operation and maintenance office is to be established for the purpose in Kisaran under jurisdiction of provincial irrigation service of North Sumatra, because the failure of the irrigation water supply will cause serious or vital damages to agricultural activities. The organization of the O&M office is described in Section 6.2.

(2) Operation works

The water management will be undertaken by both operation section of the O&M office and the ditch tenders belonging to the farmers' water users' associations. The former will be responsible for operation of the major irrigation facilities down to turnout at the head of tertiary irrigation canal, while the latter will be responsible for operation and water management within respective tertiary blocks.

Special attention should be paid to operation of the river intakes especially to the Silau integrated weir, which should be so operated as to take river water in accordance with the scheduled intake plan and current river flow conditions of the Bunut river. In order to achieve an effective and equitable distribution of the irrigation water to the whole command area of the project, discharges of the river flow and canals will be measured and recorded.

The main activities of the operation works are itemized as below:

(i) To collect information and data on river discharges of the both Silau and Bunut rivers, and water demands for irrigation and the downstream maintenance flows.

(ii) To prepare the water supply schedule to respective irrigation blocks.

(iii) To operate and control gates of the diversion facilities of the rivers and main and secondary irrigation canals so as to

secure the scheduled delivery of irrigation water to tertiary canals.

(iv) To advise the farmers water users' association (P3A) and farmers in the field level water management, which will actually be made by the ditch tenders under direction of P3A.

(3) Maintenance works

The maintenance works are boardly divided into the routine maintenance work and emergency repair.

The routine maintenance work will include regular care-taking such as silt and weed clearance in the canals and sand desilting basin at the river diversion works, minor periodical repair of canal banks, road surface, etc. In addition, periodic inspection of the river conditions at the weirs is required for ensuring the stable intake of water. Those works will be carried out according to the annual repairing and maintenance program to be prepared by the O&M office.

The emergency repair is the works for the damages such as failure or breakage of the canals, dikes or structures. The flexible treatment and cure is required.

The main tasks are summarized as below:

(i) To prepare the program for the maintenance, repair and improvement of the facilities.

(ii) To design the repair works needed and to estimate their cost.

(iii) To execute the repairing and maintenance works by using the equipment and materials owned.

(iv) To call tenders for major repairing works and supervise the contractor(s).

(v) To execute periodical and routine maintenance of the project facilities.

(4) O&M equipment

To assure the effective execution of the O&M works, several O&M equipment are required such as earth work heavy construction equipment, operation cars, communication system, meteo-hydrological equipment, etc. for the O&M office. The items and required numbers of the proposed equipment is tabulated in Table C-13.

4.4.8 Proposed project works

(1) General

The main project works proposed are (a) construction of an inter-basin diversion canal between the Silau and the Bunut of about 8 km, (b) construction of the Silau integrated weir on the Silau river, (c) construction of a connection canal from the integrated headworks to the existing free intake points, (d) rehabilitation and upgrading of existing irrigation and drainage canals and related facilities of about 180 km, (e) extension of irrigation and drainage canals of 210 km, (f) construction of farm road network of 350 km, (g) on-farm development for 9,500 ha, (h) reclamation of new farm land of 670 ha from coconut fields in the Silau area, (i) construction of a flood protection dike along the Bunut river of 34 km long, and (j) procurement of O&M equipment. The construction of agro-business quarter is also proposed for enhancement of the agricultural activities by farmers.

The basic design of the irrigation and drainage facilities is made based on the detailed topographic map on a scale of 1:5,000 and national map on a scale of 1:50,000. The supplemental topographic surveys of alternative route for the inter-basin diversion canals and external drains in the lower Bunut area are also employed for the design. The geo-technical data and information for the proposed Silau integrated weir are taken from the investigation results of the lower Asahan river flood control project by DGWRD.

The principal features of the proposed project works are summarized in Table 4-2.

(2) Integrated diversion weir on the Silau river

(i) General

The integrated diversion weir is planned in connection with the inter-basin plan from the Silau to the Bunut river as well as improvement of malfunctioned existing free intakes on the Silau river. The main purpose of the weir is to ensure the stable irrigation water supply in both quantity and water level, to the areas located on the both sides of the bank of the Silau river after diverting the water to the Bunut area.

As a result of the studies, the movable type weir (rubber tube weir) located at about 300 m downstream reach from the existing Si Umbut-Umbut free intake site, equivalent to 600 m downstream reach from the railway bridge, is selected for the project.

The principal features of the proposed Silau integrated weir and its related facilities are illustrated in Figs. 4-4, C-12 and C-13. The related facilities are composed of (a) scouring sluices on both banks of the weir to secure the intake condition of intake structures located on both bank sides, (b) intake structures for right and left bank of the Silau irrigation system and for the inter-basin canal to the Bunut area, (c) sand settling basin and discharge measuring device located just downstream reach from the intake gates, and (iv) side overflow type spillway to prevent the excess inflow to the main canal during flood season.

(ii) Related river conditions and works

The Silau river having the catchment area of 1,180 km^2 and 124 km long is one of the tributaries of the Asahan river. The planform of the low-flow channel is rather meandered. The longitudinal slope of the river near the Si Umbut-Umbut free intake site ranges from 1/1,200 - 1/1,400. The present bankful capacity is estimated at 600 m^3/sec in the stretch near Kisaran city and about 150 m^3/sec only in the stretch downstream Kisaran city. Due mainly to the less flow capacity of the river in the stretch downstream Kisaran city, the flood damages occur on the both sides of the bank of the river every year.

The probable peak flood discharge with return period of 10 and 30 years at Kisaran are estimated at 600 m^3/sec and 950 m^3/sec, respectively. The flood frequency of the river is illustrated in Fig. C-14. The detailed design work for the urgent flood control plan was completed in June 1989. The design discharge of the urgent plan is taken 10-year probable peak flood discharge of 600 m^3/sec. The objective stretch of the design is about 20 km from the confluence of the Asahan to the Si Umbut-Umbut free intake.

According to the study on the sediment carrying capacity at Kisaran in the Part-I study, the sediment load of 420,000 m^3 has been carried by the river flow from the upstream catchment area annually .

The results of the geo-technical investigations along the Silau river for the detailed design of the flood control works by the Directorate of River, indicated that the bearing capacity expressed in N-value is rather weak ranging from 4 to 12. Since the foundation soil layer is composed of soft clay and loose fine sand, the permeability coefficient is ranging from $3x10^{-4}$ to $9x10^{-5}$. Volume 3 gives the detailed information of the foundation condition at the weir site.

(iii) Selection of diversion site

The site selection is made based on the available topographic map of 1/5,000 and the field reconnaissance by referring to the results of the detailed design for the urgent flood control. The criteria for selection of the integrated weir site are considered as follow:

i) The site is to be located as near as possible to the project area to avoid the high construction cost of conveyance canal from intake site to the project area.

ii) The site is to be located at the stable planform stretch in the river to avoid the problems caused by meandering. The straight stretch within the river improvement section is preferable.

iii) The site upstream the railway bridge is not preferable for minimizing the compensation work to the existing facilities, especially the railway and houses along the river.

Based on the above criteria, the site is selected at about 600 m downstream reach from the railway bridge as shown on Fig. 4-4. It is considered that no other alternative site exists to satisfying the above condition.

(iv) Type selection of diversion structure

The type selection of the diversion structure is made through studies on three types, namely (a) free intake, (b) fixed weir type and (c) barrage type. As a result of the following basic requirement of the structure, the barrage type movable weir is selected as the suitable one.

Taking into account the river characteristics and circumstances of the river, the basic requirements for the diversion structure are to be considered as below:

i) Stable intake of irrigation water in both quantity and water level during dry season

ii) No backwater effect to the Kisaran city to avoid the artificial flood caused by the structure

iii) No aggradation of river bed which will cause the reduction of river flow capacity

Major results obtained in the three types are as follows:

Free intake type

As seen in the Fig. C-5, the stable water intake is hardly possible by referring to the existing Si Umbut-Umbut free intake condition. Assuming that the intake water level of El. 14.5 m is desirable intake water level to maximize the command area, the free intake is to be located at 5 km upstream of the selected site (near Bypass bridge). It is not realistic to locate the structure considering that there exists Kisaran city between the selected site and upstream site.

Fixed weir type

The main constraints of this type are the backwater effect to the Kisaran city and reduction of flow capacity caused by aggradation of river bed.

The calculation result for 600 m^3/sec of 10-year return period flood in the case of no aggradation condition tells that the flood water level raises more than the ground level of the bank in Kisaran city due to the backwater effect of the fixed type weir as shown in Fig. C-11.

On the other hand, the river flow capacity is reduced to 50 m^3/sec from 600 m^3/sec at the critical section of S103

when the aggradation of river bed reached up the crest elevation of the weir. Assuming that the aggregated river bed slope would be at 1/2,400, the sediment deposit capacity of the river channel by the crest elevation of El. 14.5 m is estimated at about one million m^3. Taking into account the quantity of the river bed material inflow of 420,000 m^3/year at Kisaran, the aggradation of river bed will reach the crest elevation of the fixed weir within a few years.

Considering the above, the river channel is to be maintained by periodical dredging as well as new dike construction along the river in Kisaran city. As a result, the fixed type weir is not recommendable for the project.

Movable type weir

Taking into consideration of the river characteristics mentioned above, movable type weir is the most suitable type of weir. This type of weir clears all of the requirement for the weir. No backwater effect to the upstream channel and no aggradation by sediment loads will be caused by movable type weir though some systematic and technical maintenance and operation procedures are required for O&M works.

Selection of the movable weir type is made through comparative study on (a) girder type roller gate, (b) flap gate, and (c) rubber tube weir. Table C-14 shows the comparison items covering boardly (a) structural features, (b) operation, (c) maintenance, (d) durability, (e) related foundation works, and (f) construction cost, etc.

(a) Structural features

In the case of a roller type gate, the piers and foundation slab need greater strength owing to far

heavier weight of the gate leaf compared to others. In the case of a flap gate and the rubber gate, neither slot nor sheet works are needed. In its stead, installation of the conduits is required through the bottom and the piers to deliver the air or oil-pressure. Because of the lighter weight, the requirement for the supporting strength is not so much.

(b) Operation

The power requirement is biggest in the case of a roller gate, while it is rather small in case of a flap gate and rubber tube weir. From the viewpoint of the delicacy and reliability of the operation, the roller type seems to be superior in respect that it enables minute operation by adjusting the opening height of the gate. Partial opening of the gate is impossible in case of the flap gate and the rubber gate.

(c) Maintenance

Periodical derusting and painting is required for the steel gate such as the roller and the flap gates. In case of the rubber gate, no such periodical maintenance works are required for the main body.

(d) Durability

It is said that the durability or the useful life is almost the same to all the cases spanning over 30 years if the maintenance works are well done.

(e) Related foundation work

Roller types gate needs the foundation be reinforced by means of the piling. The number of the piles, of which depth is assumed at about 10 m, is about 80 piles owing to its heavier weight and. It is considered that

the flap and rubber tube gate does not need the piling works due to rather small weight.

(f) Construction cost

Including the cost for the related civil and foundation works, the construction cost for each type of the gates is estimated as below:

- Roller gate Rp.9,700 million (1.00)
- Flap gate Rp.7,880 million (0.81)
- Rubber tube weir Rp.6,115 million (0.63)

Based on the above comparative studies, it is concluded that the most suitable type is the rubber tube weir followed by the flap type and the roller gate type in the descendent order.

(3) Inter-basin works from the Silau river to the Bunut river

The inter-basin work to utilize the available surplus river flow of the Silau river is one of the most important key works of the project.

Two alternative plans are studied. Alternative-I is composed of side-spillway type free intake at Prapat Janji, about 20 km upstream from Kisaran city,, inter-basin diversion channel from the Silau river to Bunut river (7 km long), and river improvement work of the Bunut river (about 16 km long) to convey the diverted discharge of about 8 m^3/sec as shown in Fig. C-15. Profile of the diversion channel is shown in Fig. C-16.

Alternative-II is composed of intake facility at the integrated weir on the Silau river, with inter-basin diversion channel of about 8 km from the intake to the just upstream site of the Serbangan weir on the Bunut river as shown in Fig. C-15. Profile of the diversion channel is shown in Fig. 16.

Comparative study is made for the above two alternative plans from view points of river hydraulics as well as hydraulic design of intake, operation and maintenance, and construction cost. The summary of the comparative study is tabulated in Table C-15. It is noted that the Silau integrated weir is required in both alternative plans.

As a result of the comparative study, the plan of Alternative-II is selected for the project.

(4) Rehabilitation of existing weirs on the Bunut river

The rehabilitation plan of three existing weirs of Serbangan, Panca Arga and Buluru is made putting emphasis on the flood flow capacity of the weir and on the deterioration degree of the structural condition. The principal features of the existing conditions and rehabilitation plans for these three weirs are presented in Table C-16 and Figs. C-17 to C-19. No rehabilitation plan for the Serani weir is proposed since the present condition of the weir and intake is sufficient enough for the proposed project.

The Serbangan weir is semi-permanent type weir with wooden stop-log constructed in 1943. Since the present flow capacity of the weir is estimated at 80 m^3/sec, the present capacity of the weir has adequate flow capacity against the design flood discharge having 30-year return period of 80 m^3/sec. It is planned to install the diversion gates of the weir, manually operated steel roller gates of 6 nos, without widening of the weir width. The construction of new intake structures on the both banks is also planned to intake the irrigation water for the areas.

The Panca Arga weir is the fixed weir constructed in 1974. The flow capacity of the present weir is estimated at only 12 m^3/sec, while the design flood discharge of the weir is 70 m^3/sec. It is planned to widen the weir width to 25 m from 9 m at present. The construction of new intake structure on the right bank is planned to intake the irrigation water for the areas.

The Buluru weir is the gabion mattress weir constructed in 1983. The flow capacity of the present weir is estimated at only 21 m^3/sec, while the design flood discharge of the weir is 60 m^3/sec. The main constraints of the weir is the leakage of of the weir. Considering that the command area of the weir in the proposed plan is only about 150 ha, the rehabilitation plan is formulated as simple work as placing the concrete facing work for upstream the present gabion mattress and construction of dike upstream the weir.

(5) Rehabilitation and extension of irrigation and drainage systems

The basic concepts for the canal layout are (a) to utilize the existing canals and roads as much as possible for realizing the economical construction, and (b) to extend down the secondary canals to lower reach commanding 1 or 2 tertiary units to ensure water distribution. Fig. 4C-4-3 shows overall irrigation and drainage systems.

Total length of the proposed main and secondary irrigation canals is 170 km long and drainage canals is 180 km, of which the objective stretch of the rehabilitation works is 60 km for the irrigation canals and 82 km for the drainage canals.

Based on the results of the inventory survey in the area and required capacity and function for the proposed canals and related structures, the rehabilitation works of the existing canals are classified into the following two types :

Type I rehabilitation : Re-shaping or minor maintenance works for the existing canals and structures which have enough flow capacity and in good or fair condition.

Type II rehabilitation. : Flow area expansion or re-banking works for the canals and structures except mentioned above.

Details of the rehabilitation works and new construction canals and structures are tabulated in Tables C-17 and C-19. Longitudinal profiles of main irrigation and drainage canals, and the related structures on the canals are presented in Figs. C-20 to C-29. It is noted that the main drainage canals in lower Bunut area are proposed to be largely expanded to have enough flow capacity.

Tide gates are planned at each mouth to the sea of the external drains in the lower Bunut area to avoid enlarging the blackish water area, where malaria mosquitos lay their eggs, due to the excess salt water intrusion by the improvement of the drainage condition. Principal features of tide gates are illustrated in Fig. C-30.

(6) Construction of farm road network

The inspection roads along the full stretch of proposed canals and connection road with provincial and Kabupaten roads are planned to be constructed newly under the project. The total length of proposed road, including the inspection and connection roads is estimated at 350 km long.

Following to the design standard of DGWRD, the width of roads along the main and secondary canals and connection roads are planned to be 5.0 m in total with 4.0 m effective width.

The road pavement is planned to be made by asphalt or macadam for connection roads connecting the project area with existing provincial roads, and by macadam for canal inspection roads along main and secondary canals except secondary drainage canals to execute the operation and maintenance works of the project facilities as well as improvement of internal transportation. Earth paved canal is planned for the inspection roads along secondary drainage canals.

The proposed road network and main dimensions of the proposed roads are shown in Fig. C-6 and Table C-21.

(7) Flood protection work of the Bunut river

Referring to the long-term flood control plan formulated in Part-I study, the flood prevention work for the Bunut river is proposed based on the design flood discharge of 10-year return period as already shown in Fig. C-10. The objective stretch of 34 km is extended over from the Bunut highway bridge to the road bridge on the Kiri river as shown Fig. 4-5.

The main works are composed of the construction of flood protection dike of 34 km, river bed excavation/dredging for enlargement of low flow channel of 28 km and construction of three bridges. Longitudinal profile and typical cross section of the proposed flood dike and channel are presented in Fig. C-32 and C-33, respectively.

It is noted that the flood control works for the Silau river is not included in the project works. The flood control works of the river will be implemented as the river control project by the Directorate of River of DGWRD. It is expected that the construction works will be commenced in middle of 1990/91.

(8) Construction of on-farm facilities

It is concluded in the field investigation in the project area that the existing paddy fields of 8,840 ha out of the total project area of 10,300 ha has been left unprovided with on-farm facilities. Construction of on-farm facilities such as tertiary / quaternary irrigation and drainage canals, inspection/farm roads and their related structures are planned for acceleration of agricultural development.

Two sample areas are selected for the basic plan formulation and cost estimate of the work. One sample tertiary block is selected among lowlying areas where average farm plot size is 0.8 ha (Type I). The other sample is selected among relatively high land area where average farm plot size is 0.4 ha and plot shape is relatively irregular (Type II).

By referring to the design standard of DGWRD, the canal layout and facility design are made based on the following concepts.

1) No land consolidation is made, no change is given for existing farm plot layout and ditches.

2) A quaternary canal reaches 12 or less farm plot

3) Over-bund irrigation or drainage within 5 plots is permitted.

Fig. C-31 shows the layouts of canals and facilities for Type I and II, and dimension of canals and facilities. For the estimate of the construction cost, it is assumed that Type I is representative for irrigation areas of Panca Arga, Meranti, Buluru and Silau Kiri and Type II is for Serbangan and Silau Kanan areas.

(9) Land reclamation of coconuts fields to paddy field

According to the farmer's intention for shifting land use from coconut fields to paddy fields, the land reclamation work of 670 ha in net are planned. The coconuts fields are scattered in the left and right banks of the Silau rivers and density of the coconuts trees is estimated at about 110 nos./ha. The farm plot size is planned to be 0.3 ha taking into account the average coconut land holding size per farmer of 0.5 - 0.6 ha ranging from 0.3 ha to 1.5 ha. The on-farm facilities are also planned to be provided for the land reclamation areas.

(10) Construction of agri-business quarter

To facilitate farmers' joint activities on daily farm operation and post harvest and marketing activities, an agri-business quarter is planned to be constructed at the density of one quarter per about 150 ha. The total number of the quarter is 70 and one quarter has an area of 0.2 ha with meeting room, conventional field deposit for farm input and output, and sun-drying concrete yard. In the future, the quarter will have functions of rice processing including rice mill unit and garage for farm machinery by farmer group.

4.5 Basic Approach for Organizational Development

4.5.1 Summary of problems of farmer's organization

Main problems of the existing farmer's organizations in the project area are summarized as follows;

(i) Low participant rate of member farmers: mainly because majority of the farmers do not give an attention to KUD with respect to consciousness on cooperative activities. Low efficiency of facility operation is caused by shortage of competent technical and managing workers and also resulted in being far from scale merit under the severe competition with private agri-business enterprises.

(ii) Ineffective water management of P3A because of insufficient irrigation facilities and maintenance works together with shortage of competent workers.

(iii) Shortage of self-determination for joint activities of farmer groups especially joint utilization of farm machinery, and post-harvest and marketing activities.

4.5.2 Basic approach for development

In order to promote cooperating activities among farmers and to realize effective farmer's organizations, there are two countermeasures to be carried out. One is improvement of infrastructure such as road net-work, irrigation and drainage system and on-farm development, etc. The other is improvement of socio-economic infrastructure such as traditional tenant system, traditional farm operation system, and farm product marketing system, etc., together with innovation of farmers consciousness.

Improvement of physical infrastructure will be mainly undertaken by the government authorities concerned. Improvement of socio-economic infrastructure will be implemented step by step and spot by

spot by farmers themselves with growing their consciousness on cooperating activities.

Development of individual farmer's consciousness and better experiences on cooperating activities among farmers in daily small scale activities is the prerequisite for realization of large scale effective farmer's organization. Therefore, an effort in the project should initially be concentrated to the farmer groups and P3As for their development. After that, development activities will be expanded to promote KUD when the majority of the farmers will become to pay keen attention to KUD.

4.5.3 Proposed improvement

(1) Reorganization of P3A

The present P3A should be adjusted to reorganize so that one P3A union covers new irrigation blocks with about 200 ha on an average. The estimated number of P3A will amount to about 50 in the whole project area. The necessary staff for these P3As are 100 of Ulu-ulu and 400 of Ili-ili in total.

(2) Adjustment of farmer group

Together with reorganization of P3A, present farmer groups should be adjusted to cover new one secondary irrigation block by one farmer group or farmer group union to make homogenized farming condition of all member farmers to facilitate farmers joint activities on daily farm operation and post harvest and marketing activities. The farmers in the present paddy area should be newly organized as farmer groups. The total farmer groups in the project area is estimated at 50.

(3) Construction of agri-business quarter

An agri-business quarter with about 0.2 ha should be constructed at the field at the density of one quarter per 150 ha. Number of quarter in the project area accounts for about 70 in total. These quarters are

planned to have meeting rooms, conventional field depot for farm input and output and sundrying concrete yard in the project. In the future these quarters will have function in rice processing center including rice mill units and garage of farm machinery by farmer groups.

4.6 Training Program

(1) General

In order to keep the facilities of irrigation and drainage system on the functional condition, quality improvement of O&M staff and farmers in the system is one of the most important factors. All the farmers in the systems are requested to have such attitude to pay attention always to the facilities of irrigation and drainage system whether they are on the functional condition. Aiming to develop such attitude of farmers, training program on O&M is planned for government O&M staff and farmers such as chairman of P3A, water master (Ulu-ulu) and ditch tender (Ili-ili).

In addition, is is essential to improve quality of the field extension workers (PPL) concerned who should advise the farmer any proper action on O&M of irrigation facilities together with improved agricultural technique at his regular visit.

(2) Objectives

The objectives of O&M training programs are defined as follows:

For government O & M staff

(i) to understand his duty and responsibility of the job.

(ii) to be able to undertake meteo-hydrological measurements.

(iii) to be able to instruct operation and maintenance technique and skill of each in the system to the farmers.

(iv) to be able to find out any abnormal condition which may lead to severe damage.

(v) to be able to judge the proper counter measures to damaged condition of facilities.

(vi) to be able to make effective plan on water distribution including irrigation rotation.

(vii) to be able to make better coordination between P3A and to make quick action.

For farmers

(i) to make such attitude always to pay attention to keeping the functional condition of facilities.

(ii) to gain proper technique and skill for operation and maintenance of irrigation and drainage facilities on tertiary and quaternary level.

(iii) to understand the system management and responsibility of P3A and each members.

(iv) to be able to lead the members to co-operate on O&M activities.

(v) to be able to manage the finance of P3A union.

For field extension workers (PPL)

(i) to understand the system management and responsibility of government O&M staff, P3A and member farmers.

(ii) to be able to make effective farm operation plan in relation with water distribution plan.

(ii) to be able to advise P3A and members properly on O & M of irrigation facilities.

(3) Training methods

The training methods to be used in the programs would include (a) lectures and field practice, (b) workshop and (c) field visit. The lectures and field inspection will be made based on the training modules and materials prepared by the consultants in consultation with the professional members of DPU central office. O&M staff, DPU professionals and consultants will have discussion on specific technical and managerial problems on the improved method of working and better procedures. Field visit will be made to the advanced area such as Ular River Irrigation System.

(4) Training modules and materials

The training materials to be used will include (a) trainer's handbook, (b) training modules, (c) trainer/trainee note and practical exercises.

(5) Trainers and trainees

Trainers to be engaged in the training of O&M staff, field extension workers and farmers will be consultants.

The number of trainers and trainees in O&M staff's training, extension worker's training and farmer's training are summarized as follows :

Item	Government Staffs		Farmers		
	O&M Staff	Extension Workers	Chairman of P3A	Water Master	Ditch Tender
Trainee	38	20	50	100	400
Trainer	2	3	3	3	8

(6) Training curriculum and program

The training curriculum for the O&M staff, the farmers and extension workers is made to expand their knowledge, understanding and practical ability. The outline of the curriculum is shown in Table D-28 for O&M staff, Table D-29 for extension workers, Table D-30 for chairman of P3A and Table D-31 for Ulu-ulu and Ili-ili.

The training programs will be undertaken during the implementation period (1993/94). The training period for respective program will be two weeks for O&M staff and extension workers and one week for farmers, respectively.

These trainings will be carried out at the meeting room of Bupati office and village offices or Rural Extension Center concerned.

5. COST ESTIMATE

5.1 Condition for Cost Estimate

Construction costs for the proposed project works are estimated on the basis of the following conditions:

(i) All the civil works of the project will be executed on the contract basis. Contractors will be selected through international competitive bidding.

(ii) The physical contingency is assumed to be 15% of the direct construction cost.

(iii) Exchange rate used for the estimate is US$1.00 = Rp.1,770 as of late 1989.

(iv) Annual escalation rate is taken at 3% for the foreign currency component and 10% for the local currency component.

The construction cost is estimated for the foreign currency component and local currency component in accordance with the origin of material.

The currency for cost estimate is expressed in Indonesian Rupiah (Rp.) for local currency component and in the United States dollar (US$) for foreign currency component, respectively. Total construction cost is expressed in Indonesian Rupiah (Rp.).

The local and the foreign currency components include the following items respectively;

Local currency component

- Labour cost
- Cost of local materials such as cement, aggregate, reinforcement bars, P.O.L

- Project administration expenses
- Local portion of engineering service
- Local mechanic and spare parts cost for repair of plant and equipment

Foreign currency component

- Cost of plant and equipment
- Cost of imported materials such as slide gate, metal form, concrete admixture
- Cost of foreign portion of local materials such as cement, reinforcement bars, P.O.L
- Cost of engineering service for consultant

5.2 Project Cost

5.2.1 General

The project cost is composed of (a) engineering cost for the detailed design of the project facilities, (b) land acquisition and compensation cost, (c) direct construction cost of civil works, (d) tax on civil works, (e) procurement cost of O&M equipment, (f) administration expenses, (g) engineering service cost for the construction management, (h) cost for the training program for the government staff and farmers, and (i) physical and price contingencies.

The total construction cost is estimated at Rp. 157,300 million of which the foreign currency portion is US$ 56,520 thousand and the local currency portion is Rp. 57,270 million respectively, as shown in Table 5-1.

5.2.2 Direct construction cost

The direct construction cost is estimated based on the calculated work quantities of the proposed project works and unit prices of the works. The unit prices are described based on those for similar works

quoted in recent engineer's estimates such as for the "Detailed Design of Lower Asahan River Basin Flood Control Project", by DGWRD in 1989, Bah Bolon Irrigation Project in 1989, and Ular Irrigation Project in 1989. The wages and material costs, and unit prices for main items used in the cost estimate are shown in Tables C-22 and C-23, respectively.

The direct construction cost excluding the price contingency is estimated at Rp.100,426 million (equivalent to US$ 5,500 per ha). The breakdown of direct construction costs of proposed project are shown in Table C-24.

5.2.3 Procurement cost of O&M equipment

The maintenance equipment consist of (a) heavy construction equipment and transportation vehicles for maintenance works, (b) operation equipment of ordinary vehicles, communication system and equipment and tools and (c) meteo-hydrological equipment for the daily water management monitoring. Local currency cost is required for inland transportation of these machinery and equipment.

The estimated cost is summarized as below and broken down in Table C-25.

Item	F/C (US$ 1,000)	L/C (Rp. million)	Total (Rp. million)
Maintenance equipment	595,860	48,530	1,103,200
Operation equipment	201,610	15,560	372,400
Meteo-hydro equipment	19,950	1,880	37,200
Total	817,420	65,970	1,512,800

5.2.4 Other costs

The detailed design and engineering services cost is estimated at 7% and 10% of the direct construction cost of the project facilities.

Land acquisition cost is estimated based on the acquisition cost applied for the cost estimate of the detailed design for the lower Asahan river flood control project.

Administration expense consists of the direct administration cost at the construction site and compensation cost for the crops and minor items affected by the execution of the construction works. The cost is estimated at 3% of the direct construction cost of the project facilities.

The training program cost is composed of direct cost for training material, perdiem of the trainees, and some administration cost.

5.2.5 Fund requirement

According to the construction time schedule mentioned in Section 6.1, the construction cost is assumed to be disbursed as shown in Table C-26. The total fund requirement for the project for seven years is estimated at Rp. 157,311 million consisting of US$56,520 thousand for foreign currency component and Rp. 57,270 million for the local currency component.

5.3 Operarion, Maintenence and Replacement Costs

(1) Operarion and maintenence (O&M) cost

The operation and maintenance (O&M) costs will consist of salaries of O&M staff, cost of maintaining the project facilities, materials and labour costs for repair works, and running costs of project facilities. The annual O&M costs have been assumed at Rp. 1,000 million, 1.0% of the direct construction cost (Rp. 97,000 /ha/year).

(2) Replacement cost

The economic durable years of the civil work facilities under the suitable maintenance works are assumed as follows:

Description	Economic life (year)
Diversion gate	30
Small gates on canal related facilities	20
Drainage gates	30
O&M equipment	20

The replacement cost for diversion gate, small gates and O&M equipment required during the project life is estimated to be Rp. 12,066 million in total.

6. PROJECT IMPLEMENTATION

6.1 Implementation Program

6.1.1 General

The actual construction work of the irrigation project is scheduled to be implemented from middle of 1992/93 after detailed design and pre-construction arrangement for the construction works. On the other hand, the lower Asahan river flood control project, the detailed design for the project was completed in June 1989, is expected to be executed from 1990/91 after budgetary arrangement by Directorate of River of DGWRD. It is scheduled that the actual construction works of the flood control project for the Silau river stretch will be commenced in 1991/92 and completed in 1994/95 as shown in Fig. 6.1.

There will exist two national level projects in the early 1990's in the project area. From technical point of view, these two projects shall be implemented in parallel to avoid the waste of the compensation work for the existing free intakes on the Silau river by the flood control project, and to construct the irrigation canals economically along the flood protection dikes.

It is expected that the coordination committee for the implementation for the two projects will be established between executing agencies of flood control works and irrigation development to make a harmonious and effective implementation of these projects.

6.1.2 Time schedule for pre-construction arrangement

The budgetary arrangement of the detailed design work is required urgently to realize the targeted increase of the rice production which was formulated in the master plan for the agricultural development in the lower Asahan area. The arrangement is to be started in the beginning of 1990/91 and the detailed design works for

1.5 years will start from middle of 1990/91. The detailed design will include the review of the in-depth study and preparation of the tender documents. In the middle of the 1991/92, the implementation program (I/P) will be prepared for the budgetary arrangement of the construction works.

The pre-construction program broadly consists of loan arrangement, selection of consultant, and selection of contractor. The program will start with the loan arrangement which will require about eight months. Immediately after conclusion of the loan agreement, the selection of consultant will be started. Based on the procurement guideline of bank(s) for a large scale construction, the pre-qualification, tendering, tender evaluation, approval from bank and contractual events will be required for the selection of qualified contractor through the international competitive bidding. The selection of the qualified contractor will be commenced from the beginning of 1992/93 in parallel with the selection of consultant.

6.1.3 Construction time schedule

The total construction period of the Project is scheduled to be about 4.5 years from the contract signing.

In parallel with the mobilization for the construction work, the construction of Silau integrated weir will be commenced immediately from the dry season in middle of 1992/93.

The rehabilitation and construction of the irrigation and drainage facilities, flood protection dike along the Bunut river, and on-farm works in the Silau and Bunut areas will be started from the beginning of 1993/94 giving the required period of the field survey for the detailed on-farm design.

The construction of the inter-basin diversion canal will be started from the middle of the 1993/94 to meet the completion time of the Silau integrated weir.

By the end of seventh year from the start of budgetary arrangement for the detailed design, all the construction work will be completed.

The construction time schedule of the project as well as the flood control project is shown in Fig. 6.1.

6.2 Organization and Management

6.2.1 Construction stage

The Directorate General of Water Resources Development (DGWRD), the Ministry of Public Works, will be the executing agency for the implementation of the project, coordinating all the activities of the all governmental agencies and regional administrative organization in connection with the project implementation.

The Directorate of Irrigation will have a direct responsibility for the construction and supervision of the project works. The office of Public Works of North Sumatra will jointly be responsible for the implementation at the provincial level.

For smooth and proper execution of the construction in the field, it is proposed to establish the project office in Kisaran. The proposed organization structure of the project office is shown in Fig. 6.2.

6.2.2 Operation and maintenance stage

(1) Organization

For the operation and maintenance of the project facilities, it is proposed to establish the Project O&M office under the jurisdiction of the provincial irrigation service of North Sumatra. The office will be organized by three sections, namely (a) operation section, (b) maintenance section, and (c) administration section. It is presumed that the field level water management will be entrusted to the farmers;

water users associations with technical assistance and guidance of the office.

The operation section will be in charge of operation of the river diversion weirs and irrigation canals down to the turnout at the heads of tertiary irrigation canals. The main functions of the section will include:

(i) To collect information and data on river discharges of the both Silau and Bunut rivers, and water demands for irrigation and the downstream maintenance flows.

(ii) To prepare the water supply schedule to respective irrigation blocks.

(iii) To operate and control gates of the diversion facilities of the rivers and main and secondary irrigation canals so as to secure the scheduled delivery of irrigation water to tertiary canals.

(iv) To advice water user's, association (P3A) and farmers in the field level water management, which will actually be made by the ditch tenders under direction of P3A.

The maintenance section will be responsible for maintenance and repair of the project facilities including the river diversion weirs, irrigation and drainage canals, farm roads, and flood dike along the Bunut river. The equipment and materials for the maintenance and repair works of the facilities will be kept by the section. The main tasks of the section will be:

(i) To prepare the program for the maintenance, repair and improvement of the facilities.

(ii) To design the repair works needed and to estimate their cost.

(iii) To execute the repairing and maintenance works by using the equipment and materials owned.

(iv) To call tenders for major repairing works and supervise the contractor(s).

(v) To execute periodical and routine maintenance of the project facilities.

The proposed organization chart for the O&M office is presented in Fig. 6.3.

7. PROJECT EVALUATION

7.1 General

The flood control master plan in the lower Asahan river basin was formulated and the most urgent flood control project was selected in September 1985. The objective rivers for the urgent flood control project are (a) the Asahan river, (b) the Silau river and (c) the Lebah river. The detailed design for these flood control projects was performed by DGWRD with a financial assistance from OECF, Japan, as the "LOWER ASAHAN RIVER FLOOD CONTROL PROJECT" and completed in June 1989.

The Silau-Bunut rehabilitation irrigation project was formulated within the framework of the lower Asahan river flood control project. The Silau-Bunut rehabilitation irrigation project was planned under the assumption that the flood control project of the Silau river is completed. As mentioned in the Chapter 5, project cost for the Silau-Bunut rehabilitation irrigation project does not contain the construction cost for the flood control works of the Silau river. An overall project evaluation for the Silau-Bunut rehabilitation irrigation project, however, was done taking account of not only irrigation but also flood control sectors.

The project evaluation is to make an assessment of the project feasibility in view of economic, financial and socio-economic aspect. The economic feasibility analysis is first evaluated by calculating the internal rate of return. Sensitivity analysis is also made in order to elucidate the economic viability of the project against the changes in the benefit and the project cost. The financial evaluation is carried out by analyzing the effect of the project on the farm economy for typical type of the farmers and by preparing the repayment schedule of the project capital cost. The socio-economic impacts from the implementation of the project are also briefly studied.

7.2 Economic Evaluation

7.2.1 Basic assumptions

The economic evaluation for the project is made by adopting the following basic assumptions:

(i) The economic useful life of the project is 50 year.

(ii) All prices are expressed in constant 1989 prices.

(iii) The exchange rate of US$ 1.00 = Rp.1,770.

(iv) The construction period is 7 years including 2.5 years for detailed design, implementation program, budget arrangement and pre-construction arrangement.

7.2.2 Economic factors

Tariff and trade restrictions introduce a distortion in the price relationship between trade goods and non-trade goods. In order to evaluate the project costs and benefits with respect to world market prices, a standard conversion factor (0.8) is applied to the price of non-trade goods and services.

The transfer payments such as contract tax, subsidy and interest are considered as a domestic monetary movement without direct productivity. These transfer payments are, therefore, excluded from the project cost in the economic analysis.

The economic prices of tradable agricultural outputs (paddy) and farm inputs (urea, triple super phosphate and potassium chloride) are estimated on the basis of IBRD projections of world market prices for 1995. The economic price of coconuts is applied to the present farm gate prices. Economic prices of tradable agricultural outputs and inputs are shown in Tables D-32 and D-33.

Farm labor and unskilled labor are priced by applying labor shadow price factor of 0.6.

7.2.3 Economic benefit

It is expected that benefits accrued from the project consist of irrigation benefit, flood control benefit and negative benefit.

(1) Irrigation benefit

Irrigation benefit to be expected is defined as the difference of primary profit from crops between future with project and without project conditions. The primary profit for crop per ha is calculated both on future with and without project condition as shown in Table D-26. Applying the primary profit per crop to cropped area, total primary profits accrued from agricultural production for the irrigation project area are estimated both on without and with project conditions. Based on this result, irrigation benefit is calculated. The irrigation benefit will be expected to increase year by year and reach the full benefit in and after three years after the completion of the project as follows;

First year	60 % of the full benefit
Second year	80 % of the full benefit
Third year	100 % of the full benefit

The area-wise development of the Silau-Bunut rehabilitation irrigation project is carried out during the period of four years as follows;

(Unit: ha)

Year	Development Area	Accumulated Area
1994/95	3,390	3,390
1995/96	2,760	6,150
1996/97	2,750	8,900
1997/98	1,400	10,300

As a result, irrigation benefit will be born from the year of 1994/95 and reach its maximum at 1999/2000. Annual irrigation benefit at full development stage is estimated at Rp. 15,597 million as shown in Table 7.1.

(2) Flood control benefit

The flood control benefit is expressed as flood damage reduction by the implementation of the flood control project for the Silau and Bunut rivers. The objective flood is the 10-year probable flood for both rivers.

The flood damage consists of direct flood damage, indirect flood damage and intangible flood damage. The direct flood damage comprises damages to houses, agricultural crops and public facilities. The indirect flood damage includes loss of normal profit and earning to capital management and labour, interruption of transportation and other public services, unusual expenditures and others. The intangible flood damage is loss of human life, impairment of public health due to outbreak of contagious diseases and adverse effect on the national economy resulting from temporary closure of major transportation arteries.

Direct damage to public facilities is estimated by applying 30% to the direct damages to houses and agricultural crops. The indirect benefit is estimated by applying 10% to the direct flood damages.

The annual probable flood damage is estimated by summing up the potential flood damages which are obtained by multiplying the amount of flood damage due to flood with selected return period by the probability of floods as Table 7-2. Details are shown in Table D-34. Based on the result of flood damage study, the annual flood damage reduction is estimated at Rp. 7,969 million consisting of Rp. 1,489 million for the Bunut river and Rp. 6,480 million for the Silau river.

(3) Negative benefit

Negative benefit is the loss of benefit which is expected to accrue on the cultivated land to be acquired for the construction of irrigation and drainage canals and levees for flood control. The total agricultural area to be acquired is 1,445 ha comprising 160 ha of irrigated paddy field land, 910 ha of rainfed paddy field and 375 ha of coconut land. Total negative benefit expected annually is estimated at Rp. 639 million as shown in Table 7-3. The negative benefit will arise from 1991/92 when the cultivated land is partly purchased for the construction of the levees and irrigation and drainage facilities, and will attain its maximum level in 1996/97.

7.2.4 Economic cost

(1) Economic project cost

The economic project cost is estimated based on the financial cost of the construction taking account of transfer payment, shadow price for unskilled laborers and standard conversion factor for non-tradable goods. The economic project cost is estimated to be Rp. 148,431 million as shown in Table 7-4.

(2) Economic operation and maintenance cost

The economic annual operation and maintenance cost at the full development stage is estimated at Rp. 5.7 million.

7.2.5 Economic evaluation

The economic internal rate of return is calculated on the basis of the cost and benefit flow as shown in Table 7-5. The economic internal rate of return of the project is 13.2%. A sensitivity analysis is carried out to evaluate the soundness of the project against possible adverse change in the future in the following factors; (a) cost overrun by 10% and (b) reduction of irrigation benefit by 10% due to unexpected decrease in forecasted price. The results are presented below.

Base	:		13.2%
Case 1	:	cost overrun	12.0%
Case 2	:	reduction of irrigation benefit	12.4%
Case 3	:	combined effect of case 1 and case 2	11.3%

From the above results, the project could be justified economically with internal rate of return of 13.2%. The sensitivity analysis indicates that an economic viability of the project is rather insensitive to the possible adverse changes.

7.3 Financial Analysis

Financial analysis of the project is made by the analysis of the typical farm budgets and the assessment for repayment of the project construction cost.

7.3.1 Farm budget analysis

In order to evaluate the project feasibility from farmer's household economy, typical farm budgets are prepared for the future with and without project conditions as shown in Table D-27.

Upon completion of the project, the project will provide bases for introduction of improved irrigation farming through a year round irrigation. As a result, increase of unit yield of paddy and cropping intensity will be much expected. So farm income is expected to increase considerably. On the other hand, substantial increase on farm income will not be expected in the future without project condition. As a result, net reserve or capacity to pay will also increase as follows;

(Rp. 1,000)

Description	Typical farmers		
	Irrigated land (HYV) (1.1 ha)	Rainfed (HYV) (0.8 ha)	Rainfed (Local) (1.9 ha)
With project condition	1,759	979	3,230
Without project condition	1,240	-154	447
Increase	519	1,133	2,783

These net reserves will offer incentive to the farmers in the project area.

7.3.2 Repayment

Fund requirement for construction of the project is estimated as shown in Chapter 5. The estimated fund requirement is Rp. 157,311 million consisting of foreign currency portion of Rp. 100,040 million equivalent and local currency portion of Rp. 57,271 million. Based on the estimated fund requirement, cash flow statement is prepared under an assumption of the following conditions.

(i) 80% of fund requirement is financed by the international organization with loan service fee of 2.5% per annum and repayment period of 30 years including a grace period of 10 years.

(ii) Remaining local currency is financed by the budget allocation of the Government with no interest and no repayment.

The cash statement is shown in Table 7-6.

The project will bring about a great improvement in farm budget and give an incentive to the farmers in the project area. The project would be justified from the farmer's viewpoint. Since no financial revenue is expected from the project, the Government should subsidize

about Rp. 8 - 10 billion per annum comprising loan repayment, loan service fee and O&M cost during the repayment of 30 years.

8 ENVIRONMENTAL ASSESSMENT

8.1 General

In addition to the direct benefits assessed in the economic evaluation, various positive or negative environmetal and socio-economic impacts are expected from the implementation of the project.

An environmental and socio-economic assessment is made for the impacts of the project during the stages of (a) pre-construction stage, (b) construction stage and (c) operation and maintenance stage. Based on the analysis of present conditions, physical changes accrued from the construction of the project work and so on, it is predicted that there are main seventeen environmental impacts as follows:

(A) Pre-construction Stage

1) speculation in land

(B) Construction Stage

2) loss of agricultural land
3) social conflict of land acquisition
4) loss of agricultural crop production
5) traffic jam, accident and damage against the existing roads
6) noise and air pollution
7) soil erosion
8) increase of turbidity in river water and unstable supply of bathing and washing water for local people
9) social conflict between people in the project area and from the outside area
10) cultural innovation
11) increase of job opportunity

(C) Operation and Maintenance Stage

11) increase of job opportunity
12) change of land use and increase of rice production and foreign exchanges savings

13) increase in farmer's income and raising of living standard
14) betterment of marketing
15) betterment of sanitation
16) betterment and easiness of communication
17) impacts by use of agricultural chemicals

8.2 Environmental Assessment

The description of the environmental impacts and their assessment is given below.

8.2.1 Pre-construction stage

Speculation in land: In the project, it will become necessary to acquire the land of about 1,400 ha for the construction of irrigation and drainage canals, dikes and related structures. It is predicted that investors from the outside of the project area speculate in land buying for profit. To minimize such negative impacts, it is proposed that a specific regulation against selling and purchasing land within the project area should be enacted. And the regulation will be put in force only for the period of project implementation stage.

8.2.2 Construction stage

Loss of agricultural land: It is estimated that 1,070 ha of paddy field and 375 ha of coconut field are lost due to construction of project facilities. These lands should be compensated by the project.

Social conflict of land acquisition: It is predicted that problems of acquisition and compensation for the land occur because of a small farmhold size of the beneficiaries in the project area. To minimize such negative impacts, detailed design of the project facilities should be done so as to minimize area for compensation. In addition the project execution organization should institute a

coordination committee with the local governments such as village chieves, Camats, Bupatis and the authorities concerned through which better understanding for the project by the farmers in the project area should be realized.

Loss of agricultural crop production: A construction of the improvement and rehabilitation of the existing irrigation systems is planned to be carried out during the dry season. It is predicted that some loss of agricultural crop production in the dry season will be brought about due breaking cropping by the construction. An appropriate construction schedule and methods such as half-closure diversion methods should be applied to for minimizing the loss.

Traffic jam, accident and damage against existing roads: A lot of the heavy equipment such as heavy truck, dump truck, bulldozer, backhoe, etc. are planned to be utilized for the construction of the project facilities. Traffic jam, traffic accidents and damage against the existing roads will be considered. Compensation cost for the roads to be damaged is budgeted in the project cost.

Noise and air pollution: During the construction period, problems on noise and air pollution accrued from the construction may occur, but small.

Soil erosion: Since good soil materials are not found in the project area, borrow pit sites is to be at the undulating elevated lands located in the north of the project area. A great deal of soil materials will be excavated at the sites and sheet soil erosion is considered. Erosion control measures such as terrace structures, vegetative coverage, etc, will be needed for prevention against soil erosion.

Increase of turbidity in river water and unstable supply of bathing and washing water for local people: The excavation and dredging of the river channel of the Silau and Bunut rivers will affect turbidity of river water and increase it. This fact may give a

negative impact against living organisms such as fishes especially cultured in the cages, plankton, etc. A unstable water supply to the people in the downstream, which will be accrued from the construction of the integrated diversion weir in the Silau river, is planned to be minimized through an application of half-closure diversion method.

Social conflict between people in the project area and from outside: Labor requirement of the unskilled laborers is estimated at 4.2 million man-days during the construction period. So considerable portion of such laborers will be dependent on the laborers from the outside of the project area. Under such situation social conflict may occur between the laborers in terms of competition of seeking jobs and their different behaviour. A settlement of project workers should be placed in the particular location to prevent such problems.

Cultural innovation: Skilled workers necessary for the project may be from the outside of the project area. These people will give technical knowledge and cultural innovation to the local people through the project work.

Increase of job opportunity: It is estimated that the project will generate employment opportunities totalling about 4.2 million man-days of unskilled labors during the construction period.

8.2.3 Operation and maintenance stage

Increase of job opportunity: In addition the project creates a demand for farm labor requirement accrued from increased farming activities due to intensive use of the land. The incremental farm labor requirement is estimated at 1.6 million man-days annually. The ratio of labor absorbed in farming activities to total available labor force will be expected to increase from 30% at present condition to about 60% in the project condition. Furthermore the increase of rice production under

project condition will generate an additional employment opportunity of rice millers and merchants.

Change of land use and increase of rice production: At the full development stage, present land use pattern having 9,630 ha of the existing paddy field and 670 ha of coconut field will change into all the irrigated paddy field. It is expected that incremental paddy production of about 74,000 tons will be generated. These incremental product will play an important role in self-sufficiency in rice in North Sumatra province. The incremental production will bring in total annual foreign exchange savings of about Rp. 22.2 billion equivalent.

Increase in farmer's income and raising of living standard: Farmer's income will be expected to improve considerably due to production increase of rice. Their incomes will become about twice the present level or more, which will provide motivation in improvement of living standards of farmers as well as of the regional economy.

Betterment of marketing: The project will provide about 350 km of roads including connection road with provincial and Kabupaten roads. Under such situation easy transportation of farm inputs and outputs is realized. Reduction of their marketing costs is also expected.

Betterment of sanitation: The conditions of the drainage and flooding in the project area are much improved by the construction of about 230 km of the drainage canals and river channel improvement. By these improvements, malaria, filariasis and various kinds of skin diseases will be expected to be significantly reduced.

Betterment and easiness of communication: Through improvement of road network in the project area, easy and better communication among communities will be realized.

Use of agricultural chemicals: After the implementation of the projects, improved irrigation farming practices will be followed by the farmers. At the full development stage, total amount of chemicals is forecasted to become 2.3 times of that of the present use,which results from not increase of dosage/ha but expansion of cropping area. At present the chemicals used in the project area is low in toxicity. The selection and practice of these chemicals have been carefully made and guided by Department of Agriculture. It is recommended for the project office to monitor kind of chemicals and their amounts.

It is concluded from the above that the negative impacts to be predicted would not be serious to the local people in the project area.

Tables

Table 3-1 SOIL AND LAND CLASSIFICATION OF THE PROJECT AREA

Soil Unit / subunit		Land System	Potential Land Suitability Classes 1/		Distribution		Classification by USDA system
			Paddy	Upland crops	Area (ha)	Proportion (%)	
Partly ripened poorly drained low land soils	Fine textured, deep, poorly drained	Tidal flat above storm level	S2	S3	1,650	11.5	Tropaquepts
Partly ripened very poorly drained low land soils	Fine textured, deep, very poorly drained	Tidal flat above storm level	S2	S3	2,310	16.2	Hydraquepts
	Sapric, fine textured, deep, very poorly drained		S3	S3	320	2.2	
Medium textured alluvial soils	Coarse to medium textured, moderate to deep, moderately drained	Alluvial plains	S2	S2	1,230	8.6	Tropaquents
	Medium textured, deep, poorly drained		S2	S2	480	3.4	
Flat volcanic tuff soils	Fine to medium textured, deep, poorly drained	Flat plains and fans of Toba tuff	S1	S2	750	5.2	Tropaquepts/ Dystropepts
	Fine to medium textured, deep, moderately drained		S2	S2	370	2.6	
	Medium textured, moderate moderately drained		S2	S2	5,430	38.0	
Coarse textured volcanic tuff soils	Coarse textured, shallow, well drained	Flat plains and fans of Toba tuff	S3	S3	1,240	8.7	Dystrandepts
Moderately deep organic soils	Sapric, very poorly drained, moderate depth 0.5-1 m	Tidal flat above storm level, peat deposit	S3	S3	360	2.5	Troposaprists
River and riverbed			NR	NR	160	1.1	
Total					14,300	100.0	

Note:
1/: S1 - Suitable, S2 - Moderately suitable, S3 - Marginally suitable
N - Not suitable, NR - Not relevant for classification

Table 3-2 PRESENT IRRIGATION CONDITIONS

(unit : ha in gross)

Sub-area	Irrigated Sawah				Rainfed sawah	Total sawah	Other land	Total
	I	II	III	Total				
I Silau river system								
1.1 PU manage area								
1) Si Umbut umbut	0	0	360	360	220	580	420	1,000
2) Binjai Serbangan	0	0	100	100	40	140	70	210
3) Tasik Malaya	0	0	320	320	480	800	440	1,240
4) Kapias Batu VIII	0	0	200	200	150	350	20	370
5) Sei Silau	400	440	0	840	100	940	400	1,340
6) Bandar Saleh	180	0	0	180	0	180	20	200
7) Si Jambi	460	0	0	460	100	560	150	710
Sub-total 1.1	1,040	440	980	2,460	1,090	3,550	1,520	5,070
1.2 Non-PU area	0	0	0	0	400	400	500	900
Total of Silau	1,040	440	980	2,460	1,490	3,950	2,020	5,970
II Bunut river system								
2.1 PU manage area								
1) Sei Serani	110	0	0	110	0	110	20	130
2) Serbangan	450	580	640	1,670	180	1,850	520	2,370
3) Panca Arga	40	70	0	110	600	710	150	860
4) Silo Bonto	0	0	0	0	610	610	210	820
5) Desa Gaja	0	0	0	0	280	280	50	330
6) Sei Beluru	0	130	0	130	0	130	30	160
Sub-total 2.1	600	780	640	2,020	1,670	3,690	980	4,670
2.2 Non-PU area	0	240	110	350	2,710	3,060	600	3,660
Total of Bunut	600	1,020	750	2,370	4,380	6,750	1,580	8,330
Total	1,640	1,460	1,730	4,830	5,870	10,700	3,600	14,300

Note: 1) Irrigated sawah (paddy field)
Grade I : Irrigated throughout year.
Grade II : Irrigated during rainy season (Sept - Jan).
Grade III : Irrigated but only in flood season (Oct - Dec).

2) Area of irrigated sawah is estimated based on i) the result of field survey conducted by the Team and ii) detailed topographic map of S = 1/5,000.

Table 3-3 SUMMARY OF EXISTING IRRIGATION AND DRAINAGE FACILITIES

Sub-area	Year of construction	Irrigation canal	Drainage canal **	Total (km)	Related structures (nos.) Irrigation	Drainage
I Silau river system						
1.1 PU manage area						
1) Si Umbut umbut *	1969/70	8.79	9.20	17.99	24	0
2) Binjai Serbangan *	1977/78	4.80	0.00	4.80	5	0
3) Tasik Malaya *	1973/74	7.43	5.43	12.86	13	0
4) Kapias Batu VIII *	1975/76	12.50	0.00	12.50	10	0
5) Sei Silau	1973/74	13.29	12.60	25.89	36	12
6) Bandar Saleh	1975/76	1.41	3.60	5.01	6	0
7) Si Jambi	1975/76	5.06	13.50	18.56	13	0
Sub-total 1.1		53.28	44.33	97.61	107	12
1.2 Non-PU area		0.00	0.00	0.00	0	0
Total of Silau		53.28	44.33	97.61	107	12
II Bunut river system						
2.1 PU manage area						
1) Sei Serani	1982/83	4.06	0.00	4.06	9	0
2) Serbangan	1969 (1945)	15.16	13.00	28.16	49	12
3) Panca Arga	1977/78	4.85	6.00	10.85	13	2
4) Silo Bonto	1969	0.00	13.90	13.90	0	1
5) Desa Gaja	1969	0.00	3.20	3.20	0	1
6) Sei Beluru	1982/83	4.00	0.90	4.90	11	1
7) Others		0.00	18.80	18.80	0	2
Sub-total 2.1		28.07	55.80	83.87	82	19
2.2 Non-PU area		2.86	0.00	0.00	8	0
Total of Bunut		30.93	55.80	83.87	90	19
Total		84.21	100.13	181.48	197	31

Source Inventory survey results made by the team in Oct - Nov, 1989.

Note : - *; Managed by irrigation service section of Kabupaten Asahan.

- **; Canals made by plantation company and farmers are contained.
- Related structures include diversion weir and intake structure on the rivers.
- Others; Drainage canals adjacent to the project area, these drains will be utilized as external drain of the Project.
- Non jeepable inspection rood along canal exits.
- On-farm facilities exist in Serbangan area of 496 ha and in Sijambi area of 485 ha.

Table 3-4 PRESENT LAND USE IN THE PROJECT AREA

(Unit: ha in gross)

Land Use Category/Subcategory	Irrigation Area		Total (%)
	Silau	Bunut	
Paddy Field			
Irrigated Paddy Field I	1,040	600	1,640 (11.5)
Irrigated Paddy Field II	440	1,020	1,460 (10.2)
Rainfed Paddy Field/HYV	1,590	2,290	3,880 (27.1)
Rainfed Paddy Field/Local	930	2,790	3,720 (26.0)
Subtotal	4,000	6,700	10,700 (74.8)
Coconut Field	1,290	860	2,150 (15.0)
Upland Field	150	90	240 (1.7)
Housing Yard 1/	360	450	810 (5.7)
Others 2/	90	310	400 (2.8)
Whole Project Area	5,890	8,410	14,300 (100.0)

1/: Composed of village area and housing yard.
2/: Others include swampy grass land, shrub land, rubber estate.

Table 4-1 LAND USE PLAN

(unit : ha)

Present land use	Land Use Plan						
	Paddy field (net)		Coconut field	Up-land field	Housing yard	Others	Total
	Irrigated	Rainfed					
1. Paddy field	9,630	-	-	-	-	1,070 *	10,700
(1) Irrigated **	(1,480)	-	(-)	(-)	(-)		(1,640)
(2) Rainfed	(8,150)	-	(-)	(-)	(-)		(9,060)
2. Coconut field	670	-	1,400	-	-	80 *	2,150
3. Upland field	-	-	-	240	-	-	240
4. Housing yard	-	-	-	-	810	-	810
5. Others	-	-	-	-	-	400	400
Total	10,300	0	1,400	240	810	1,550	14,300

Note :
1) Coconuts field of 750 ha is converted into irrigated paddy field.
2) * ; Land used for additional canals and roads.
3) ** ; Irrigated paddy field which is irrigated throughout year (Grade I condition) only.

Table 4-2 PRINCIPAL FEATURES OF THE PROPOSD PROJECT WORKS

Item	Description
1. Location	Noth-east of Kisaran, 150 km from Medan, North Sumatra Province
2. Water resources	Conjunctive use of Silau and Bunut river flows
3. Project Command Area	
1) Gross area	14,300 ha
2) Net irrigation area	10,300 ha
4. Agricultural Development Plan	
1) Cropping pattern	Double crop of paddy per year
2) Cropping intensity	200%
3) Annual incremental paddy production	74,000 ton/year
5. Proposed Project Work	
1) Water resource facilities	
(i) Construction of Silau integrated weir	Rubber tube type movable weir on the Silau river
(ii) Construction of inter-basin diversion canal	Diversion canal from the Silau to the Bunut river (L= 8.3 km)
(iii) Rehabilitation of existing weirs on Bunut river	3 weirs of Serbangan, Panca Arga and Buluru
2) Rehabilitation and construction of irrigaiton canals	49 canals of 170 km in total (Rehabilitation : 60 km, New construction ; 110 km)
3) Rehabilitation and construction of drainage canals	48 canals of 180 km in total (Rehabilitation : 82 km, New construction ; 98 km)
4) Construction of farm road network	354 km in total(New roads)
5) Construction of Bunut flood dike	Construction of earth dike and dredging of river bed for 34 km
6) Construction of on-farm facilities	9,510 ha (area of 790 ha has been developed)
7) Land reclamation	670 ha from coconuts field to paddy fields in Silau system
8) Construction of agri-business quarter	70 sites (each has drying yard and building in 2,000 sq-m land)
9) Procurement of O&M equipment	Operation vehicles, maintenance equipment, etc.
10) Training program for O&M staff and farmers	Nos. of trainees : Government staff ; 58 , Farmers ; 550
6. Project Cost *	
1) Construction cost (Rp. million)	100,426 (US$ 5,500/ha)
2) Other costs (Rp. million)	31,635
3) Total (Rp. million)	132,061
7. Project Fund Requirement	
1) Foreign currency portion (US$ 1,000)	56,520
2) Local currency portion (Rp. million)	57,271
3) Total cost (Rp. million)	157,311
8. Implementation Program	
1) Implementation period	
(i) Detailed design and pre-construction management	2.5 years
(ii) Construction period	4.5 years
(iii) Total period	7 years
2) Execution agency	DGWRD, DPU (Project office will be established)
9. Economic Evaluation **	
1) Economic capital costs (Rp. million)	148,432
2) Annual economic benefit (Rp. million)	22,898
3) E-IRR (%)	13.20%
4) Benefit-Cost (B/C) ratio (at 12 % discount rate)	1.10
5) Benefit minus Cost (B-C) ratio (at 12 % discount rate)	Rp. 9,580 million

1. Conversion rate : US$ 1.0 = Rp. 1,770
2. Price escalation ratio : Foreign currency ; 3% / year, Local currency ; 8 % /year

*: The cost does not include a price contingency

**: The economic evaluation is made based on the costs and benefits of the Project and Silau flood control works by DGWRD

Table 5-1 SUMMARY OF PROJECT COST

	Item	Foreign Currency (US $1,000)	Local currency (Rp. million)	Total (Rp. million)	Remarks
I	DETAILED DESIGN	2,418	1,834	6,113	(7 % of Item III-1 & 2)
II	LAND ACQUISITION				
	1 Silau Area	0	950	950	
	(0) Bunut Area	0	1,550	1,550	
	Total for Item II	0	2,500	2,500	
III	CONSTRUCTION COST				
	1 Direct Cost for Irrigation Development				
	(1) Silau River System (4,250 ha)				
	1) General items	1,082	850	2,766	(9%)
	2) Silau integrated weir	2,959	1,125	6,363	(20%)
	3) Irrigation canal system	3,509	2,302	8,513	(27%)
	4) Drainage canal system	1,081	895	2,809	(9%)
	5) Farm road network	1,463	1,100	3,689	(12%)
	6) On-farm development	1,811	2,151	5,356	(17%)
	7) Agri. business quarter	644	413	1,552	(5%)
	Sub-total (1)	12,549	8,836	31,047	(100%)
	(2) Bunut River System (6,050 ha)				
	1) General items	1,839	1,578	4,834	(12%)
	2) Rehabilitation of weirs	634	406	1,528	(4%)
	4) Inter-basin canal	791	816	2,216	(5%)
	5) Irrigation canal system	3,170	2,045	7,656	(18%)
	6) Drainage canal system	4,067	3,591	10,790	(26%)
	7) Farm road network	1,912	1,445	4,829	(12%)
	8) On-farm development	2,636	3,080	7,745	(18%)
	9) Agri. business quarter	965	619	2,328	(6%)
	Sub-total (2)	16,015	13,579 0	41,926	(100%)
	Total for Item III-1	**28,564**	**22,415 0**	**72,973**	**US $ 4,003 /ha**
	2 Direct Cost for Bunut Flood Dikes	5,975	3,779	14,354	US $ 787 /ha
	Total for Items III-1 & 2	**34,539**	**26,194 0**	**87,327**	**US $ 4,790 /ha**
	3 Contingency				
	(1) Physical Contingency	5,181	3,929	13,099	(15 % of Item III-1)
	(2) Price Contingency	6,139	14,384	25,250	(F/C : 3 % /year) (L/C : 8 % /year)
	Total for Item III-2	11,320	18,313 0	38,349	
	4 Total for Items III-1, 2 & 3	**45,859**	**44,507 0**	**125,676**	
	5 Tax on Civil Works (VAT)	3,972	3,012	10,043	(10 % of Item III-3)
	Total for Item III	**49,830**	**47,520 0**	**135,719**	
IV	O&M EQUIPMENT	817	66	1,513	
V	ENGINEERING SERVICE	3,454	2,619	8,733	(10 % of Items III-1 & 2)
VI	ADMINISTRATION COST	0	2,620	2,620	(3 % of Items III-1 & 2)
VII	TRAINING PROGRAM	0	113	113	
	GRAND TOTAL	**56,520**	**57,271**	**157,311**	

(Conversion rate : US $ 1.0 = Rp. 1,770)

Table 7-1 IRRIGATION BENEFIT AT FULL STAGE DEVELOPMENT

(Unit: Rp. million)

	Present Land Use Category						
	Irrigated I	Irrigated II		Rainfed/HYV	Rainfed/Local	Coconut	Total
	Wet/Dry	Wet	Dry	Wet	Wet		Primary Profit
Without Project							
Cropping season							
Cropped area(ha)	2,960	1,310	460	3,490	3,350	670	
Profit/ha	0.744	0.74	0.460	0.429	0.194	0.330	
Total profit	2,202.2	974.6	211.6	1,497.2	649.9	221.1	5,756.6
With Project							
Cropped area(ha)	2,960	2,620		6,980	6,700	1,340	
Profit/ha	1.092	1,092		1.092	0.950	0.950	
Total profit	3,232.3	2,861.0		7,622.2	6,365.0	1,273.0	21,353.5
Irrigation Benefit	1,030.1	1,674.8		6,125.0	5,715.1	1,051.9	15,596.9
Irrigation Benefit/Ha	0.7	1.278		1.8	1.7	1.6	1.5

Table 7-2 ANNUAL PROBABLE FLOOD DAMAGE FOR SILAU AND BUNUT RIVERS

Annual flood damage for the Bunut river

Return Period	Annual Exceedance	dP	Damage (Rp. M)	Average Damage (aD) (Rp.M)	dP*aD (Rp. M)	Annual Flood Damage (Rp.M)
1.01	0.99	0	0	0	0	0
2	0.5	0.49	1,667	834	409	409
5	0.2	0.3	3,169	2,420	726	1,135
10	0.1	0.1	3,921	3,546	355	1,489
15	0.0667	0.0333	4,672	4,297	143	1,632
30	0.0333	0.0334	6,863	5,768	193	1,825
100	0.01	0.0233	9,173	8,019	187	2,012

Annual flood damage for the Silau river

Return Period	Annual Exceedance	dP	Damage (Rp. M)	Average Damage (aD) (Rp.M)	dP*aD (Rp. M)	Annual Flood Damage (Rp.M)
1.33	0.752	0	0	0	0	0
2	0.5	0.252	11,632	5,816	1,466	1,466
5	0.2	0.3	12,846	12,239	3,672	5,138
10	0.1	0.1	13,994	13,420	1,342	6,480
15	0.0667	0.0333	21,292	17,643	582	7,062
30	0.0333	0.0334	25,391	23,342	794	7,856
100	0.01	0.0233	31,916	28,654	659	8,515

Annual flood damage for the Bunut and Silau rivers

Return Period	Annual Exceedance	dP	Damage (Rp. M)	Average Damage (aD) (Rp.M)	dP*aD (Rp. M)	Annual Flood Damage (Rp.M)
1.33	0.752	0	0	0	0	0
2	0.5	0.252	13,299	6,659	1,875	1,875
5	0.2	0.3	16,015	14,659	4,398	6,273
10	0.1	0.1	17,915	16,966	1,697	7,970
15	0.0667	0.0333	25,964	21,940	725	8,695
30	0.0333	0.0334	32,254	29,110	987	9,682
100	0.01	0.0233	41,089	36,673	846	10,528

Table 7-3 NEGATIVE BENEFIT

Land Categories	Area ha	Primary Profit Rp.million/ha	Amount Rp.million
Irrigated Paddy Field			
wet season	160	0.744	119
dry season	160	0.744	119
Rainfed Paddy Field Growing High Yielding Variety			
wet season	431	0.429	185
Rainfed Paddy Field Growing Local Variety			
wet season	479	0.194	93
Coconut Field	375	0.330	123
Total			639

Table 7-4 ECONOMIC PROJECT COST

	Item	Local Currency (Rp. million)	Foreign Currency (US $1,000)	Total (Rp. million)
I	Detailed Design (7 % of Item III-1)	1,254	2,418	5,533
II	Land Acquisition			
	1) Silau area	760	0	760
	2) Bunut area	1,168	0	1,168
	Total of Item II	1,928	0	1,928
III	Construction Cost			
	1 Direct Cost			
	1) Silau River System	6,075	12,549	28,286
	2) Bunut River System	11,836	21,990	50,758
	Total of Item III-1	17,911	34,538	79,044
	2 Physical Contingency (15 % of Item III-1)	2,687	5,181	11,857
	Total of Item III	20,598	39,719	90,901
IV	Procurement of O&M Equip.	53	1,706	3,073
V	Engineering Service (10 % of total cost of Item III -1)	2,230	3,454	8,343
VI	Administration Cost (3 % of total cost of Item III-1)	2,112	0	2,112
VII	Training Program	90	0	90
VIII	Silau Flood Dike	10,262	15,886	38,380
	TOTAL	38,527	63,183	150,361

Note: Conversio rate : US $ 1.0 = Rp. 1,770

Table 7-5 ECONOMIC CASH FLOW

(Unit:Rp.million)

No.	Year	Costs				Benefits				
		Irrigation	Flood (Silau)	OMR	Total	Irrigation	Flood	Negative (Irri,)	Negative (Flood)	Total
1	1990	1,087	2,419		3,506					0
2	1991	4,446	5,652		10,098				-32	-32
3	1992	12,808	11,305		24,113				-65	-65
4	1993	26,037	11,305		37,342		3,240	-187	-97	2,956
5	1994	25,197	9,421	430	35,048	3,079	4,536	-339	-97	7,179
6	1995	25,947		800	26,747	6,613	7,671	-491	-97	13,696
7	1996	12,808		1,040	13,848	10,973	7,969	-568	-97	18,277
8	1997			1,170	1,170	13,914	7,969	-568	-97	21,218
9	1998			1,170	1,170	15,170	7,969	-568	-97	22,474
10	1999			1,170	1,170	15,594	7,969	-568	-97	22,898
11	2000			1,170	1,170	15,594	7,969	-568	-97	22,898
12	2001			1,170	1,170	15,594	7,969	-568	-97	22,898
13	2002			1,170	1,170	15,594	7,969	-568	-97	22,898
14	2003			1,170	1,170	15,594	7,969	-568	-97	22,898
15	2004			1,170	1,170	15,594	7,969	-568	-97	22,898
16	2005			1,170	1,170	15,594	7,969	-568	-97	22,898
17	2006			1,170	1,170	15,594	7,969	-568	-97	22,898
18	2007			1,170	1,170	15,594	7,969	-568	-97	22,898
19	2008			1,170	1,170	15,594	7,969	-568	-97	22,898
20	2009			1,170	1,170	15,594	7,969	-568	-97	22,898
21	2010			1,170	1,170	15,594	7,969	-568	-97	22,898
22	2011			1,170	1,170	15,594	7,969	-568	-97	22,898
23	2012			1,170	1,170	15,594	7,969	-568	-97	22,898
24	2013			1,170	1,170	15,594	7,969	-568	-97	22,898
25	2014			1,170	1,170	15,594	7,969	-568	-97	22,898
26	2015			1,952	1,952	15,594	7,969	-568	-97	22,898
27	2016			1,952	1,952	15,594	7,969	-568	-97	22,898
28	2017			1,561	1,561	15,594	7,969	-568	-97	22,898
29	2018			1,170	1,170	15,594	7,969	-568	-97	22,898
30	2019			1,170	1,170	15,594	7,969	-568	-97	22,898
31	2020			1,170	1,170	15,594	7,969	-568	-97	22,898
32	2021			1,170	1,170	15,594	7,969	-568	-97	22,898
33	2022			1,170	1,170	15,594	7,969	-568	-97	22,898
34	2023			1,170	1,170	15,594	7,969	-568	-97	22,898
35	2024			5,159	5,159	15,594	7,969	-568	-97	22,898
36	2025			1,170	1,170	15,594	7,969	-568	-97	22,898
37	2026			1,170	1,170	15,594	7,969	-568	-97	22,898
38	2027			1,170	1,170	15,594	7,969	-568	-97	22,898
39	2028			1,170	1,170	15,594	7,969	-568	-97	22,898
40	2029			1,170	1,170	15,594	7,969	-568	-97	22,898
41	2030			1,170	1,170	15,594	7,969	-568	-97	22,898
42	2031			1,170	1,170	15,594	7,969	-568	-97	22,898
43	2032			1,170	1,170	15,594	7,969	-568	-97	22,898
44	2033			1,170	1,170	15,594	7,969	-568	-97	22,898
45	2034			1,170	1,170	15,594	7,969	-568	-97	22,898
46	2035			1,170	1,170	15,594	7,969	-568	-97	22,898
47	2036			1,952	1,952	15,594	7,969	-568	-97	22,898
48	2037			1,952	1,952	15,594	7,969	-568	-97	22,898
49	2038			1,561	1,561	15,594	7,969	-568	-97	22,898
50	2039			1,170	1,170	15,594	7,969	-568	-97	22,898

Table 7-6 FINANCIAL CASH FLOW STATEMENT

(Unit : Rp. Million)

Year	Year in Order	Cash Outflow						Cash Inflow						
		Project Cost	O &M Cost	Peplacement Cost	Loan Interest	Loan Repayment	Total Outflow(A)	Foreign Loan	Government Budget	Government Subsidy	Water Charge	Total Inflow(B)	Balance (B)-(A)	Accumulated Loan
1990	1	3,723	0	0	25	0	3,748	1,013	2,710	25	0	3,748	0	1,013
1991	2	5,110	0	0	131	0	5,241	4,231	879	131	0	5,241	0	5,244
1992	3	16,890	0	0	468	0	17,358	13,477	3,413	468	0	17,358	0	18,720
1993	4	35,691	0	0	1,196	0	36,887	29,118	6,573	1,196	0	36,887	0	47,839
1994	5	36,354	329	0	1,937	0	38,620	29,631	6,723	2,266	0	38,620	0	77,470
1995	6	38,975	597	0	2,732	0	42,304	31,799	7,176	3,329	0	42,304	0	109,269
1996	7	20,568	864	0	3,146	0	24,578	16,576	3,992	4,010	0	24,578	0	125,844
1997	8	0	1,000	0	3,146	0	4,146	0	0	4,146	0	4,146	0	125,844
1998	9	0	1,000	0	3,146	0	4,146	0	0	4,146	0	4,146	0	125,844
1999	10	0	1,000	0	3,146	0	4,146	0	0	4,146	0	4,146	0	125,844
2000	11	0	1,000	0	2,989	6,292	10,281	0	0	10,281	0	10,281	0	119,552
2001	12	0	1,000	0	2,832	6,292	10,124	0	0	10,124	0	10,124	0	113,260
2002	13	0	1,000	0	2,674	6,292	9,966	0	0	9,966	0	9,966	0	106,968
2003	14	0	1,000	0	2,517	6,292	9,809	0	0	9,809	0	9,809	0	100,676
2004	15	0	1,000	0	2,360	6,292	9,652	0	0	9,652	0	9,652	0	94,384
2005	16	0	1,000	0	2,202	6,292	9,495	0	0	9,495	0	9,495	0	88,092
2006	17	0	1,000	0	2,045	6,292	9,337	0	0	9,337	0	9,337	0	81,800
2007	18	0	1,000	0	1,888	6,292	9,180	0	0	9,180	0	9,180	0	75,508
2008	19	0	1,000	0	1,730	6,292	9,023	0	0	9,023	0	9,023	0	69,216
2009	20	0	1,000	0	1,573	6,292	8,865	0	0	8,865	0	8,865	0	62,924
2010	21	0	1,000	0	1,416	6,292	8,708	0	0	8,708	0	8,708	0	56,632
2011	22	0	1,000	0	1,259	6,292	8,551	0	0	8,551	0	8,551	0	50,340
2012	23	0	1,000	0	1,101	6,292	8,393	0	0	8,393	0	8,393	0	44,048
2013	24	0	1,000	0	944	6,292	8,236	0	0	8,236	0	8,236	0	37,756
2014	25	0	1,000	0	787	6,292	8,079	0	0	8,079	0	8,079	0	31,464
2015	26	0	1,000	702	629	6,292	8,624	0	0	8,624	0	8,624	0	25,172
2016	27	0	1,000	702	472	6,292	8,466	0	0	8,466	0	8,466	0	18,880
2017	28	0	1,000	603	315	6,292	8,210	0	0	8,210	0	8,210	0	12,588
2018	29	0	1,000	0	157	6,292	7,450	0	0	7,450	0	7,450	0	6,296
2019	30	0	1,000	0	0	6,292	7,292	0	0	7,292	0	7,292	0	0
										0		0		
Total		157,311	24,790	2,007	48,962	125,844	358,914	125,844	31,467	201,603	0	358,914	0	

Remarks:
Foreign Loan: Annual interest of 2.5% for repayment period of 30 years including 10-year grace period.

Figures

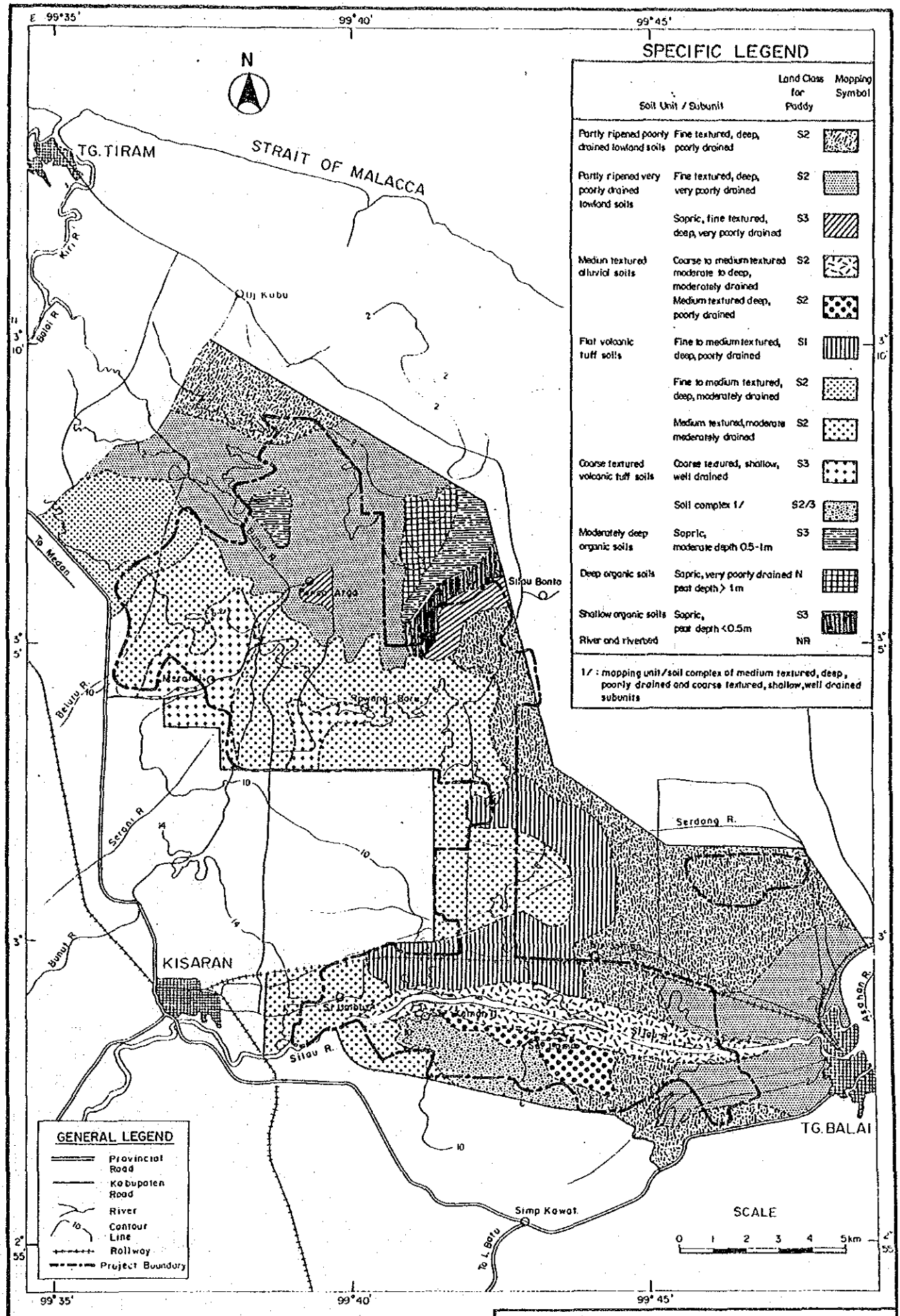

Fig. 3 - 1 SOIL MAP

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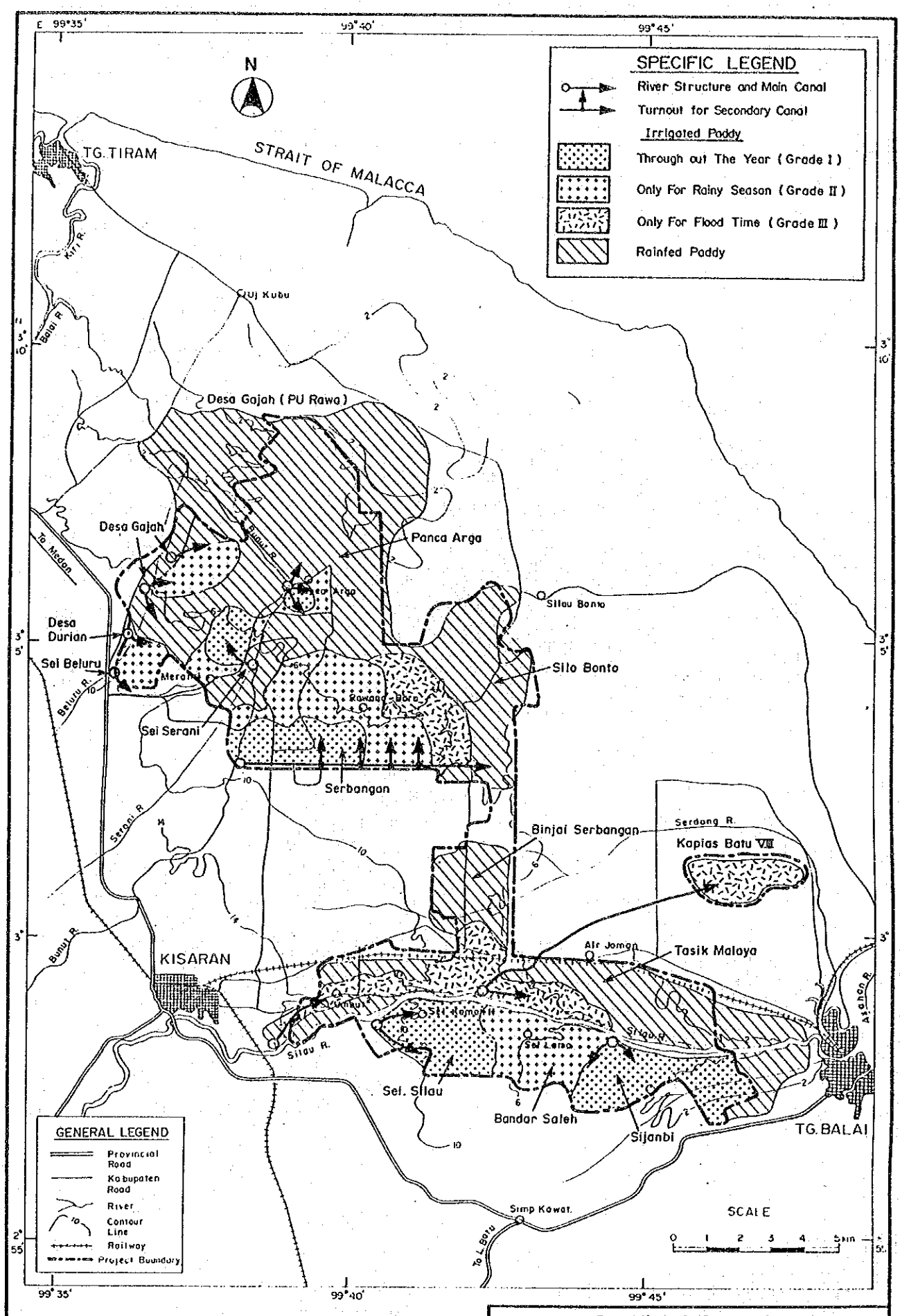

Fig. 3 - 2 PRESENT IRRIGATION CONDITION

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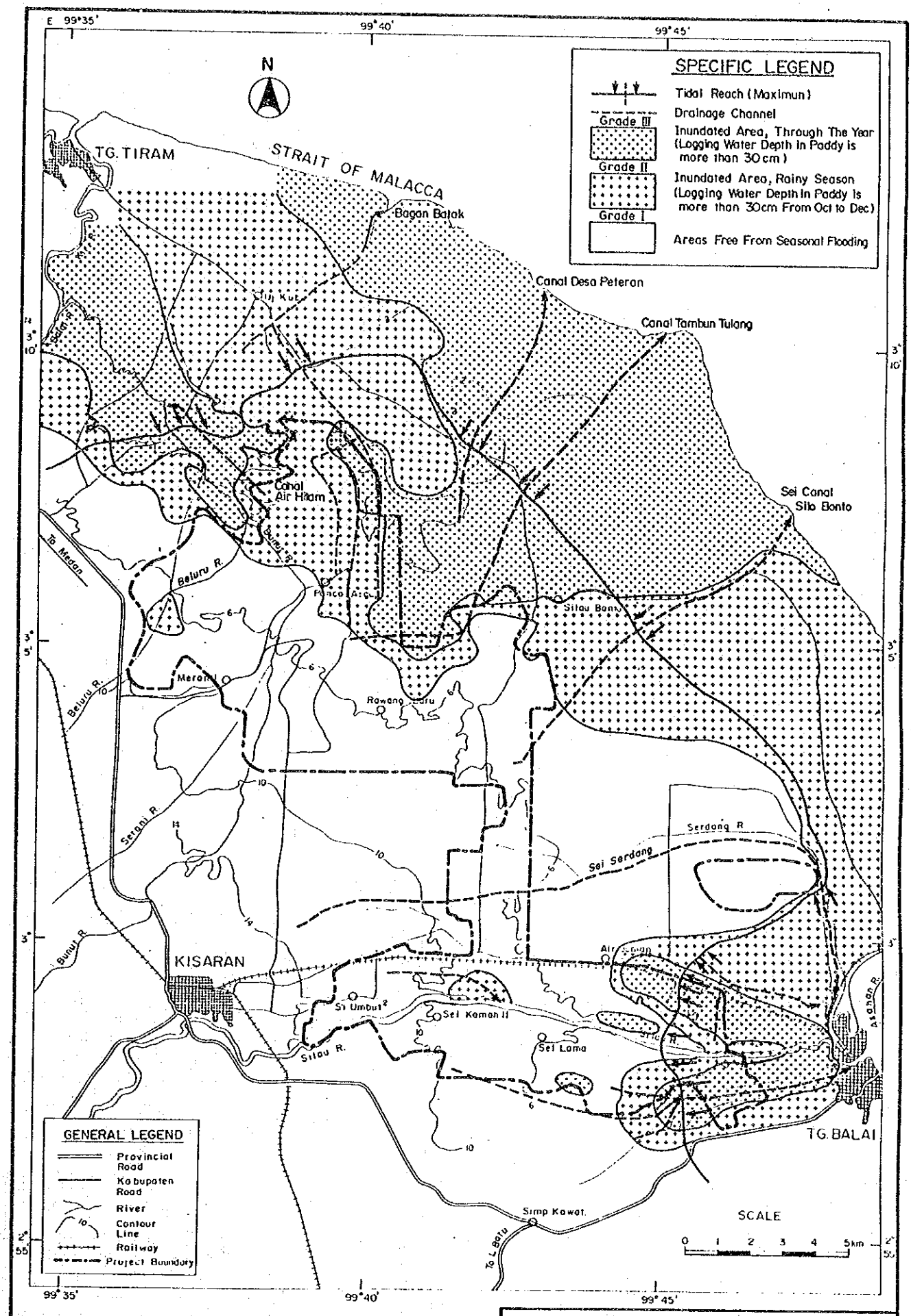

Fig. 3 - 3 PRESENT DRAINAGE CONDITION

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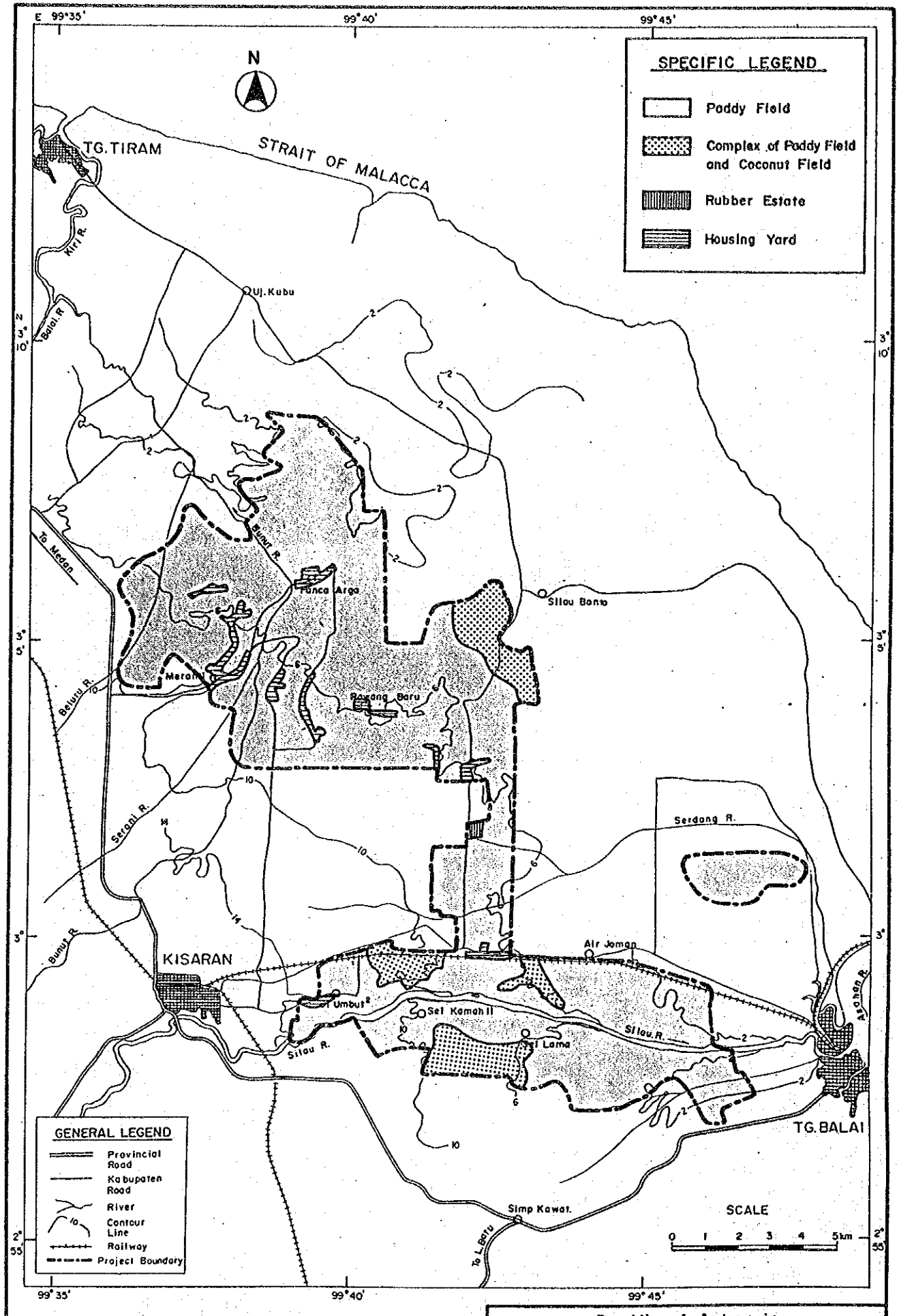

Fig. 3-4 PRESENT LAND USE IN THE PROJECT AREA

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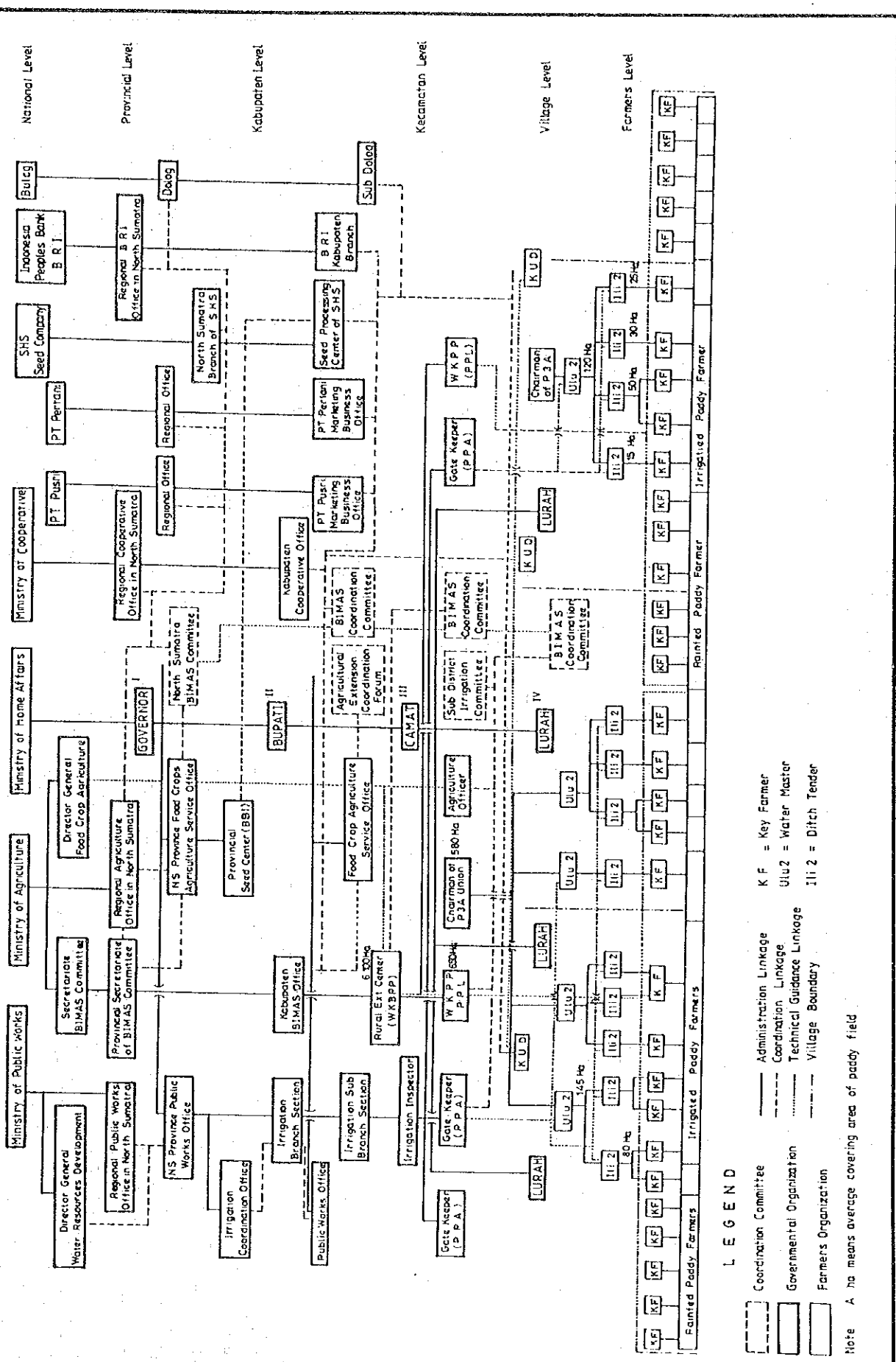

Fig. 3-5 OVERALL ORGANIZATIONAL STRUCTURE ON AGRICULTURAL DEVELOPMENT

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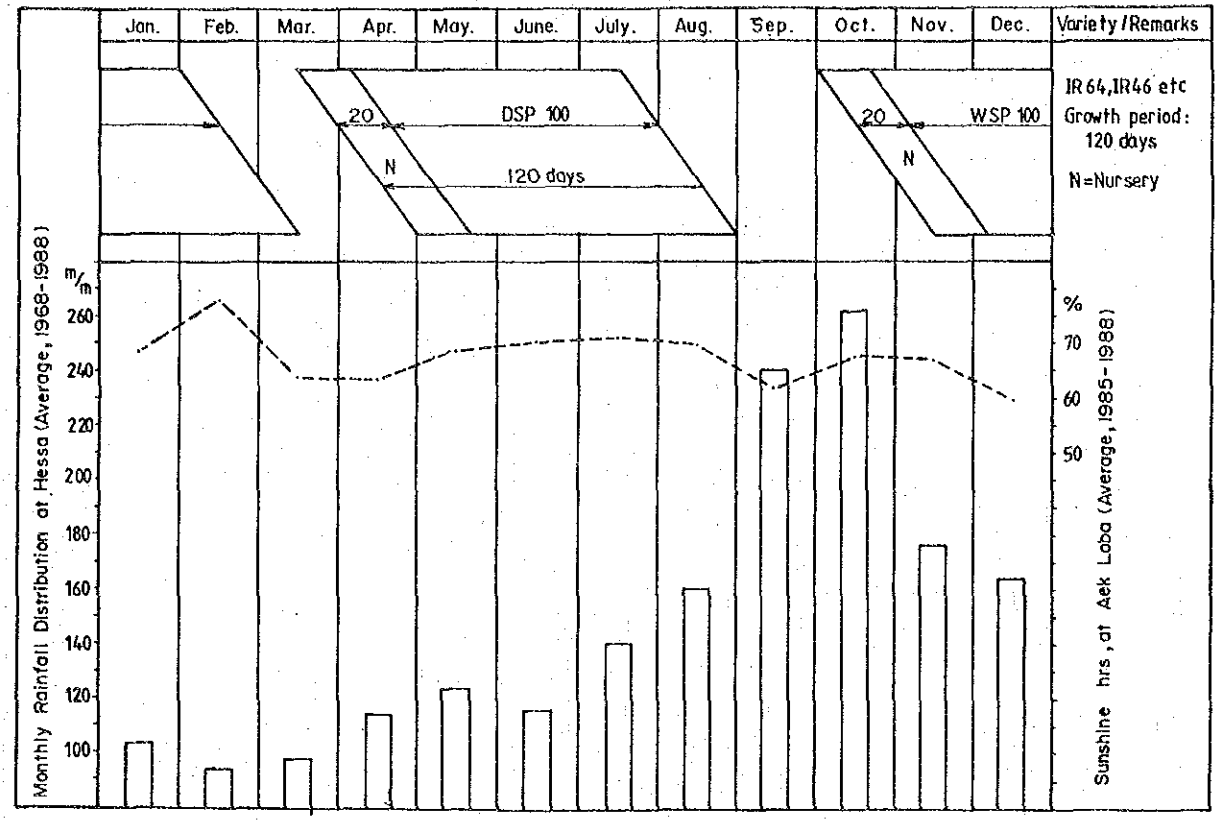

Fig. 4-1 PROPOSED CROPPING PATTERN
(DOUBLE CROPPING OF PADDY)

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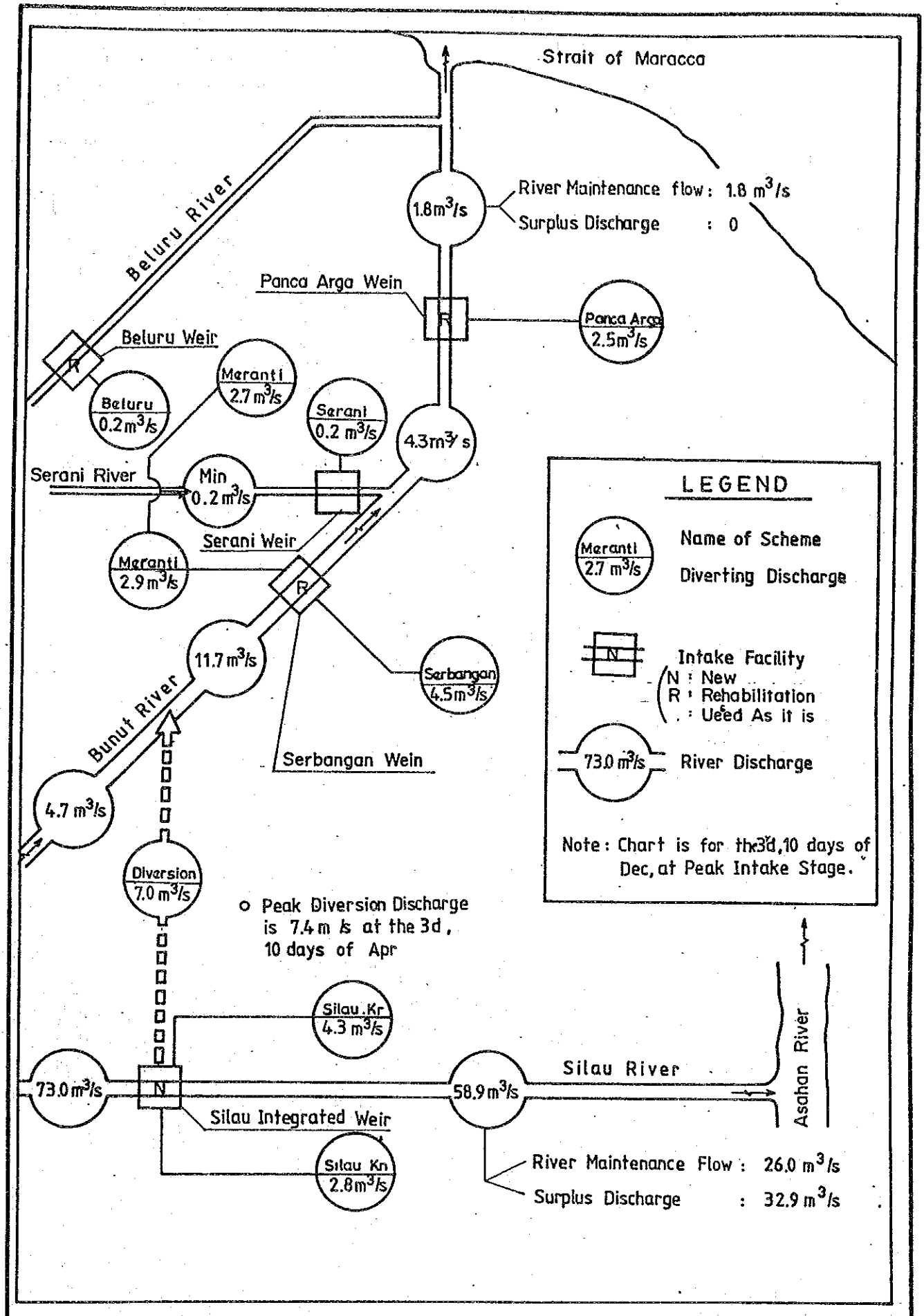

Fig. 4-2 IRRIGATION SYSTEM CHART

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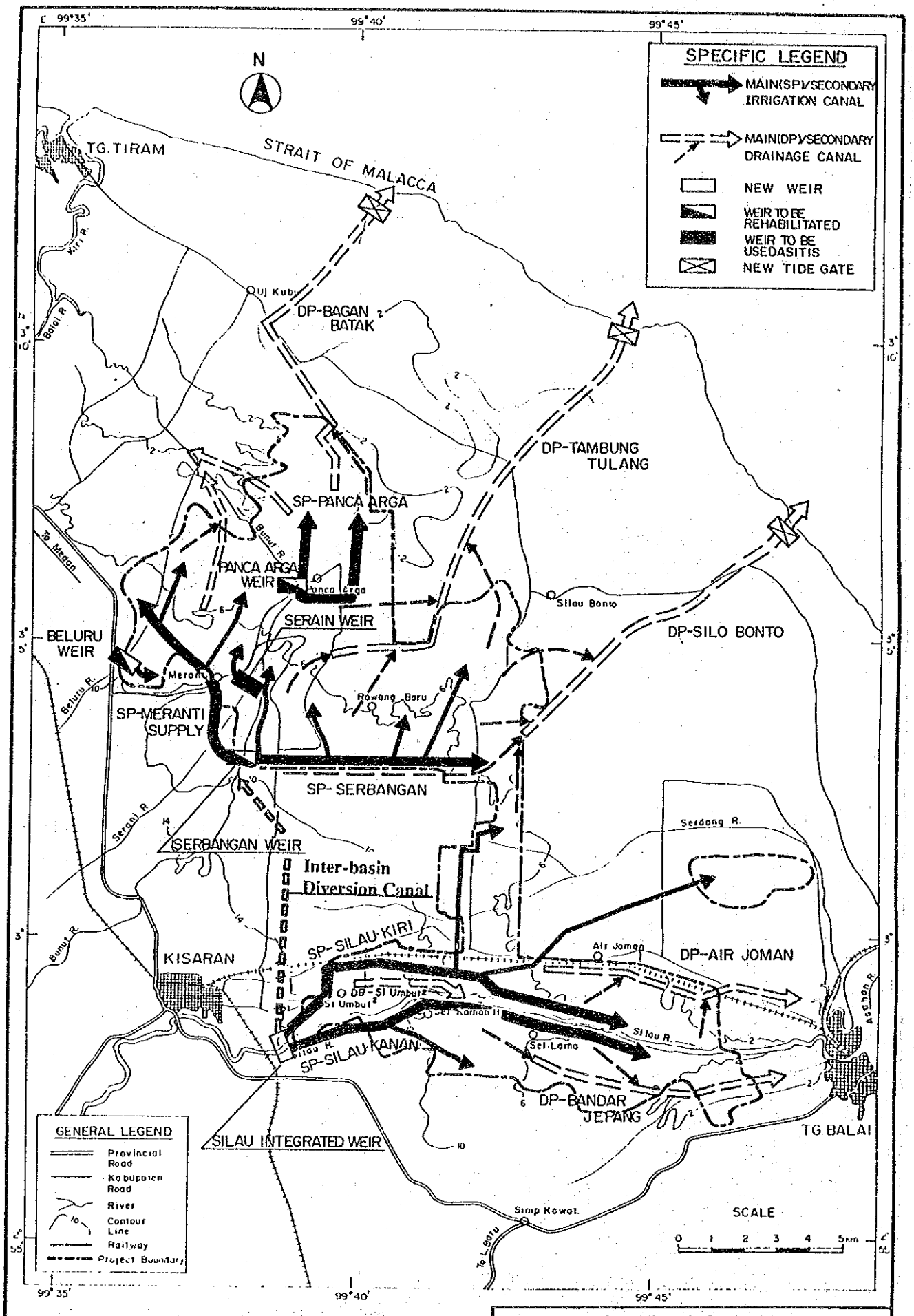

Fig. 4-3 PROPOSED IRRIGATION AND DRAINAGE SYSTEMS

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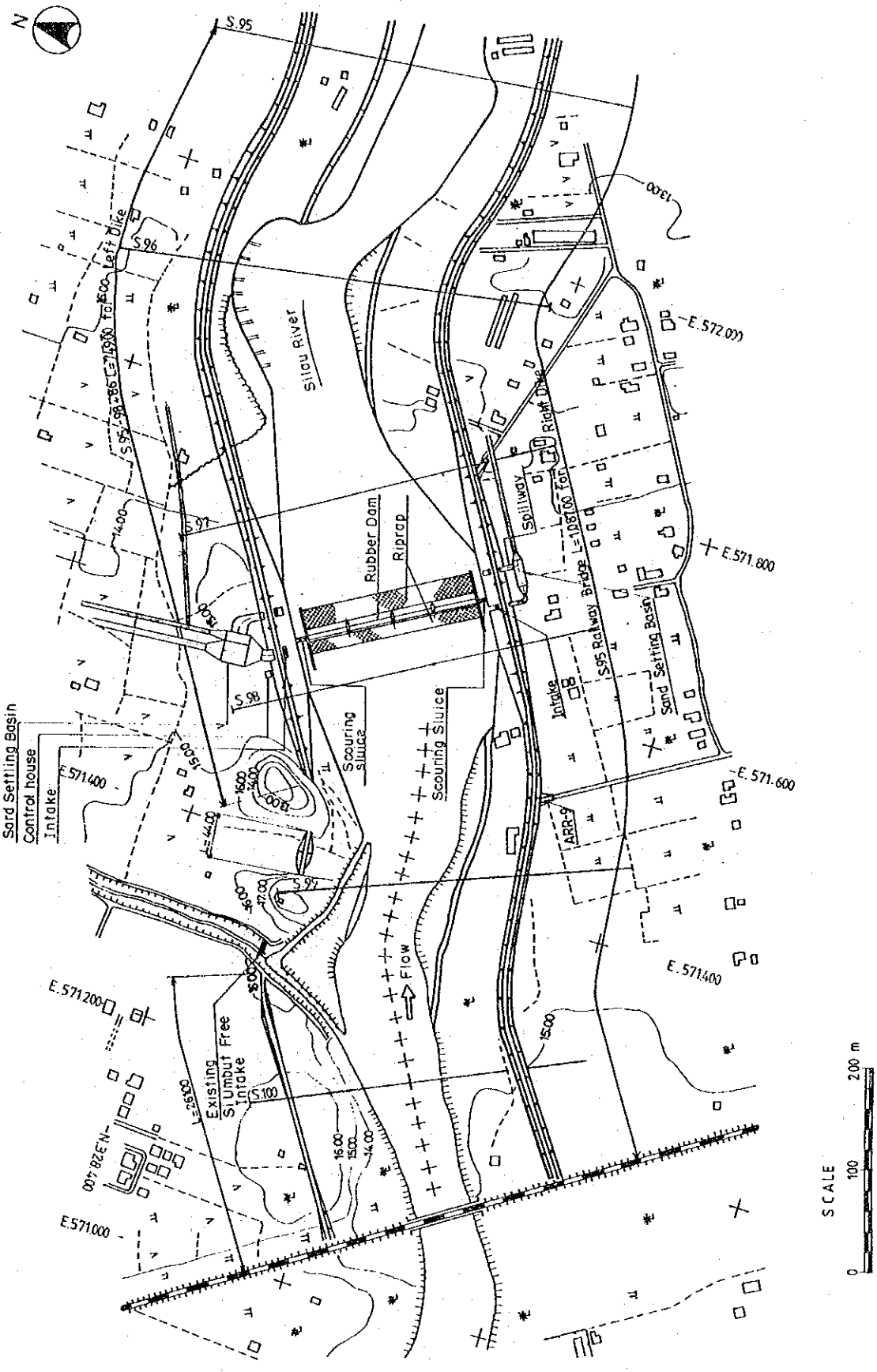

Fig. 4 - 4
PROPOSED SILAU INTEGRATED WEIR
(1/2)

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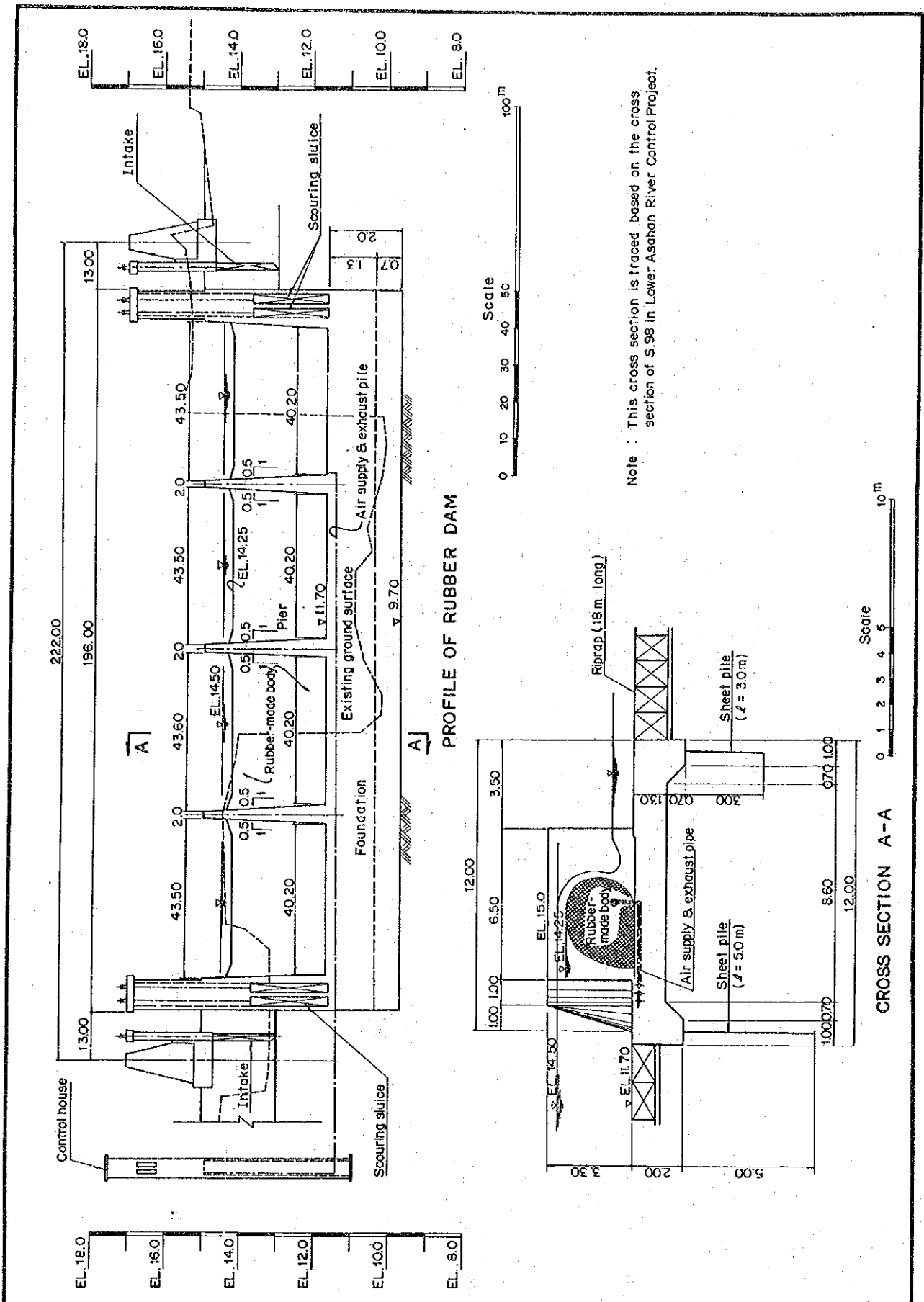

Fig. 4-4 PROPOSED SILAU INTEGRATED WEIR (2/2)

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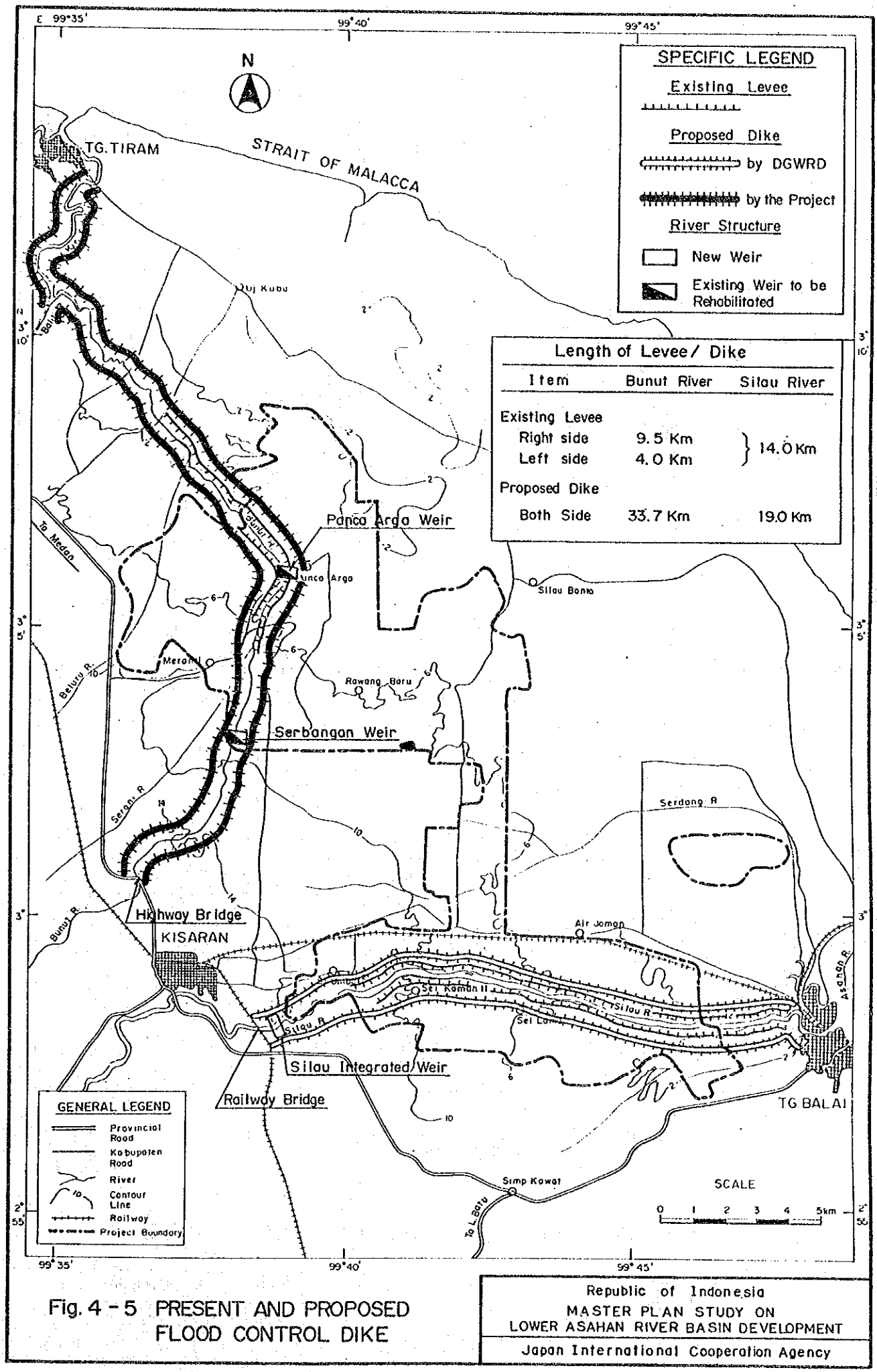

Fig. 4 - 5 PRESENT AND PROPOSED FLOOD CONTROL DIKE

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Description	Unit	Q'ty	Year in order 1	2	3	4	5	6	7	8
1. Detailed Design										
(1) Budget Arrangement										
(2) D/D work										
2. Construction Works										
(1) Implementation Program										
(2) Budget Arrangement										
(3) Pre-construction Arrange.										
1) Tendering										
2) Preparatory works										
3) Land acquisition										
(4) Construction Works										
1) Silau river system	ha	4,250								
- Integrated weir	no	1								
- Canal networks	km	139								
- On-farm works	ha	3,860	*(Area of 390 ha has already been developed)*			(1,200)	(1,330)	(1,330)		
- Land reclamation	ha	670								
2) Bunut river system	ha	6,050								
- Inter-basin canal	km	8.3								
- Rehabilitation of weirs	no	3								
- Canal networks	km	212								
- On-farm works	ha	5,650	*(Area of 400 ha has already been developed)*			(1,400)	(1,430)	(1,420)	(1,400)	
- Flood dike	km	35								
(5) Construction of Silau Dike by Directorate of River, DGWRD										
3. Training of Government Staff and Farmers										
4. O&M Works										
5. Development Area under the Project	ha									
(1) Silau River Sytem							1,590	1,330	1,330	
(2) Bunut River System							1,800	1,430	1,420	1,400
Total							3,390	2,760	2,750	1,400
(Accumulated area)							(3,390)	(6,150)	(8,900)	(10,300)

Note *Project Work*

Implemented under Lower Asahan River Flood Control Project, Directorate of River, DGWRD, DPU.

Fig. 6-1 IMPLEMENTATION TIME SCHEDULE OF THE PROJECT

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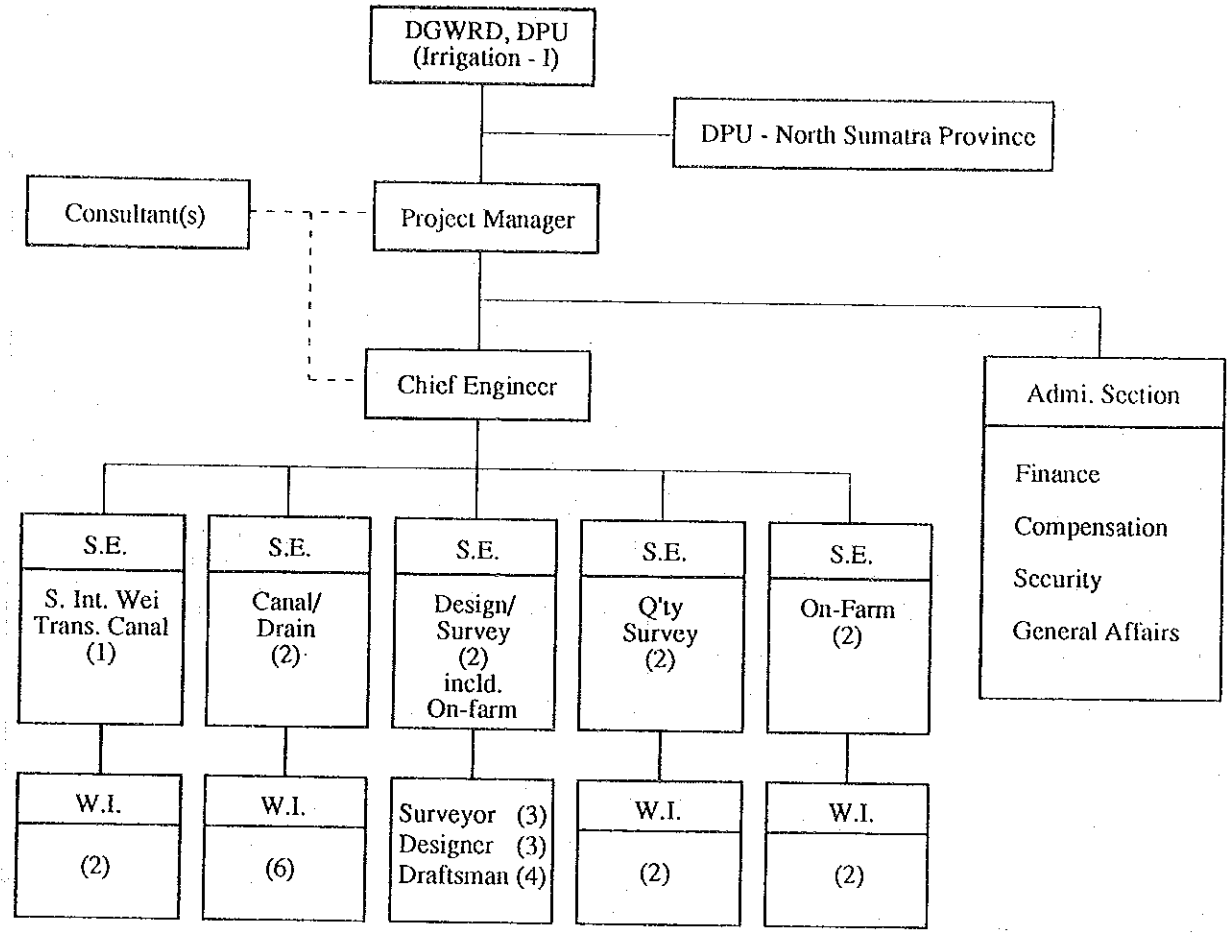

S.E. : Site Engineer
W.I. : Work Inspector

Fig. 6-2 PROPOSED ORGANIZATION OF PROJECT OFFICE FOR CONSTRUCTION

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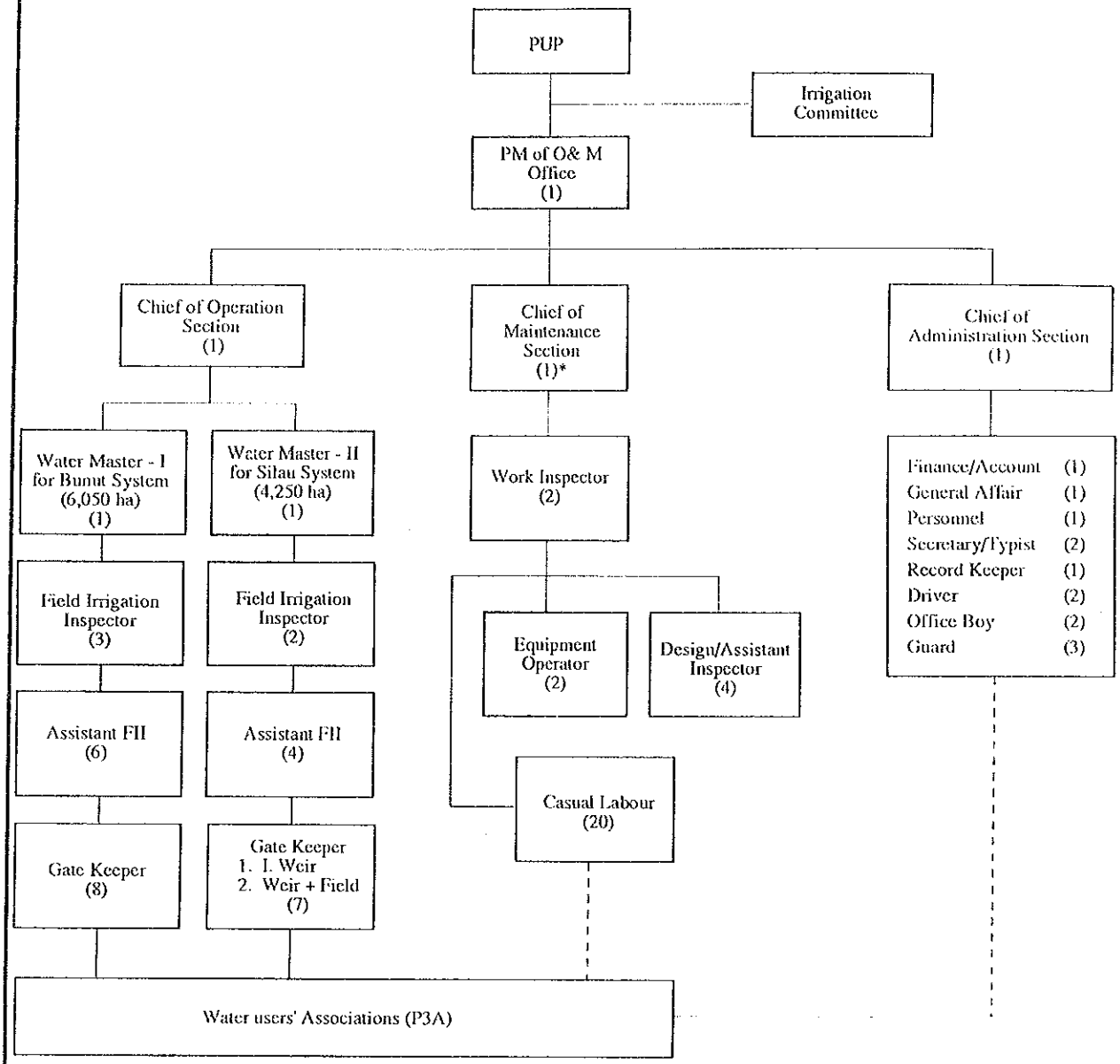

PUP : DPU, North Sumatera Province
PM : Project Manager of the Office
FII : Field Irrigation Inspector
* : Repair and periodical maintenance of O&M equipment will be subject to local workshop in Medan

Fig. 6-3 PROPOSED ORGANIZATION OF PROJECT O&M OFFICE

Republic of Indonesia
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LOWER ASAHAN RIVER BASIN DEVELOPMENT
Japan International Cooperation Agency