3.8 Agricultural Supporting Services

3.8.1 Agricultural Credits

Primary access to agricultral credits is made through the B.A. About 67% of the beneficiaries in the agrarian reform project areas, are rendered financial assistance by the B.A. A branch office of the B.A. is located in Arenoso in which 99% of crop loans and 95% of their total value were destinated for the production of rice in 1983. The conditions of loans by the B.A. are a 6 months term at a 16% interest rate.

The problems associated with the B.A.'s credit service are the lack of financial resources to satisfy the demand and the long period of transactions from approval to payment. The proportion of repayment in both agrarian reform project areas was below 10%. In the light of the fact that most of the farmers depend on the Bank's financial assistance to cultivate crops and that burgeoning grain production constitutes the principal strategy of the Dominican Government, the Bank cannot suspend rendering agricultural credits to the farmers even if they do not repay previous loans and herein exists the bottleneck of the Bank.

In the event that one fails to be approved by the Bank for its credits or that the Bank's credit will not reach his hand in time for the land preparation and for the purchase of inputs, he will appeal his financial need to other lending sources such as middlemen, cooperatives, his relatives or friends, etc. In such cases, the interest rates are as high as 10% a month.

3.8.2 Development and Extension of Rice Production Technology

(1) Development of Rice Production Technology

Centro de Investigaciones Arroceras (CEDIA) is responsible for the development of rice production technology. The CEDIA, belonging to SEA, located in Bonao has six divisions to cover the fields of: (i) Breeding, (ii) Agronomy, (iii) Water Management,

(iv) Pest Control, (v) Soils and Fertilizing, and (vi) Farm Machinery. The branch station of CEDIA is located at El Pozo for experimentation on rice production technology for several years. The research on rice cultivation in organic soils is important to promote agricultural development in the study area. However, very limited research has been conducted by CEDIA.

(2) Extension

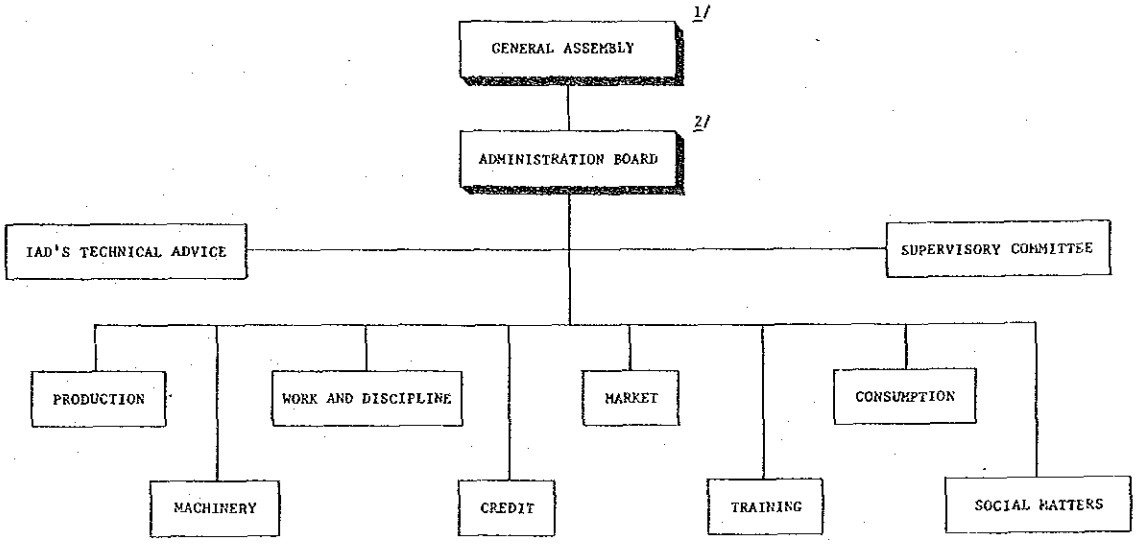
The Bureau of Agricultural Extension belonging to SEA is responsible for agricultural extension services, setting up an Agricultural Extension office in each municipality. Most of the study area is under the jurisdiction of the Arenozo Agricultural Extension Office, where three extension staffers provide services. These staffers however are not rendering their duties adequately because they spend most of their time on other supporting work and have no proper transportation facilities for the services. The supply of inputs for production of rice such as seeds, fertilizers and other chemicals is not taken care of by the Agricultural Extension Office, whereas the seeds and seedlings of other crops than rice are supplied by the extension staff.

The IAD and the B.A. also extend various services for the improvement of farm management through their daily activities regarding administration work for settlers and loans respectively. Such services however are by nature supplementary to the SEA extension services.

3.8.3 Farmers' Organization

With a view to enhancing socio-economic conditions of the beneficiaries, the IAD has undertaken to reinforce the organization of farmers settled in the agrarian reform project area. The target of this promotion is to attain self-management in the course of crop production which comprises the marketing of products, agricultural credit, ownership of machinery, etc. For this purpose, IAD, through the "Plan for the Consolidation of Farmer's Settlements", has

undertaken to organize in each agrarian reform project area as Empresas Campesinas de Reforma Agraria (ECRA) - farmer's enterprises for the agrarian reform. The organization of the ECRA is as illustrated below.



Note: 1/ Executive authority integrated with total associates.
2/ To be integrated by representatives of each committee. The main function is to plan how to carry out the decisions of the General Assembly.

ORGANIZATION OF THE ECRA

Up to date, the ECRA has not been organized in the study area but an organization in the form of an association is found. These associations were organized at the initiative of the governmental institutions. Each association is composed of one president, one secretary and one accountant. They take charge of the daily routines of the association, organization of meetings and contacts with related government institutions assisted by members of committees. In the case of this organization, the members are not working together in the

same farmland to cultivate crops but they are associated so as to jointly receive the agrarian credits and to possess the same agricultural machinery. By forming an association, the access to the credit becomes easier, but if a member of the association fails to reimburse the loan, it should be compensated by the rest of the association.

In the study area over 37.2 percent (41 percent for El Aguacate and 34.5 percent for El Guayabo) of the beneficiaries are organized in associations; there are 8 associations in El Aguacate and 17 in El Guayabo with 200 and 239 members, respectively.

It seems that this form of association has not matured in the study area. One association in El Aguacate could not achieve its production for the year of 1984.

The situation is more complicated in El Guayabo: one association (Nueva Union) includes 13 members without distributed land and another association (Trabajadores Arroceros) is composed of "ocupant's" - illegally settled farmers. Generally speaking, the beneficiaries who are working under better conditions are unlikely to participate in the associations.

3.9 Agrarian Reform

3.9.1 Situation of the Projects

There exists three project areas in the study area: El Aguacate, El Guayabo and Cienaga Vieja and their features are summarized below:

AGRARIAN REFORM AREA

	Distributed Area (ha)	Un-distributed Area	Total Area (ha)	Beneficiary (Family)
El Aguacate	1,940	3,721	5,661	487
Cienega Vieja	484		484	194
El Guayabo	3,019	3,837	6,856	667
Total	5,443	7,558	13,001	1,348

LAND USE OF AGRARIAN REFORM

(Unit: ha)

	El Aguacate	Cienega Vieja	El Guayabo	Total
Distributed area	1,940	484	3,019	5,443
Paddy	1,270	320	1,130	2,720
Cacao, Yautia	270	70	30	370
Pasture	400	94	1,009	1,503
Abandoned land	-	-	850	850

With regard to the Cienega Vieja area which was just established in 1983, the followings have been disclosed during the field work.

- Approximately 480 ha of the land has been distributed to beneficiaries, most of whom live in Arenoso and Villa Riva (outside of the settlement area).

- Neither infrastructure such as roads or irrigation/drainage systems nor IAD's services for the farm management in the distributed lands has been rendered. Furthermore, there is no plan to construct any infrastructural facilities in the relevant area.

- About 25 percent of the distributed land is utilized to grow rice under high rainfall conditions without farm credits from the B.A. The remaining area is left as marsh lands.

The total area developed for paddy field in the said three IAD land settlement project areas amount to about 2,700 ha, of which rice was planted on about 54 percent of that area in 1984. There are two main reasons why a large area of the field was not used for rice cultivation; one is that the irrigation and drainage facilities are not adequately provided in a majority of the area, and the other is that the returns from rice cultivation are not high enough to repay the farm credit which was loaned by the B.A.

3.9.2 Plan for the Consolidation of Farmer's Settlements

Under a Loan Agreement made between the Government of the Dominican Republic and the Inter-American Development Bank in 1973, the IAD has been implementing the "Plan for the Consolidation of Farmer's Settlement" with regard to sample settlement project areas. The Plan aims at an increase in production, elevation of productivity, efficient use of the labor force, increase in farmer's income, and enhancement in the socio-economic situation of the beneficiaries in the IAD's agrarian reform project areas. In order to achieve these targets, the construction of physical (irrigation and drainage systems, rural and in-farm roads), and social (water supply, electrification, living quarters) infrastructure and provisions for assistance services to farmers (technical assistance, extension, credit) have been made by the IAD.

El Aguacate is included in the above-mentioned sample project areas; approximately 8 km of in-farm roads were completed already and, at the present, living quarters for the IAD's technical staff, a crop supply storage warehouse as well as an administrative office are being constructed. In the future, it is anticipated that other projects such as beneficiaries' living quarters, roads, water and electric supply systems will be constructed.

CHAPTER 4: DEVELOPMENT PLAN

CHAPTER 4 : DEVELOPMENT PLAN

4.1 Objectives

In view of aiming at self-sufficiency in basic grains, the Dominican Government has focused much of its attention on efforts to implement agricultural development programs among other economic development policies, especially to encourage an increase in rice output.

Working from understanding, the implementation of the AGLIPO Agricultural Development Program was taken up and, as the first stage of the Program, the construction of irrigation and drainage projects to develop paddy fields covering 7,500 ha of the El Pozo area is being carried out. The Aguacate-Guayabo Agricultural Development Project is thus considered to be the second stage of the said program.

The El Aguacate-El Guayabo area is partially developed for rice production, but the physical infrastructure is not adequately provided. The greater part of the remaining area is covered by lands with peat soils and marsh which are less capable for agricultural use.

The present development plan aims at attaining the following positive economic and social impacts by means of improving and providing an agricultural infrastructure.

- The consolidation of irrigation and drainage systems will make it possible to realize a desirable cropping calendar, and the introduction of superior varieties of rice and innovated technology, will result in an increase in rice production.

- The improvement of the in-farm road network will bring about the mechanization of farm operations together with labor saving and efficient transportation of agricultural supplies and harvested crops.

- The elevation of productivity will result in an increase of net agricultural incomes among farmers as well as creating new settlement opportunities of approximately 1,500 to 2,000 families.

- The implementation of the present development plan is expected to cause various impacts on the isolated zones within the El Guayabo area, which will contribute to the further development of the study area.

Consequently, the development plan for the study area within the AGLIPO Agricultural Development Program, has the objective of developing the agriculture sector in the study area and then to contribute to the socio-economic progress of the Dominican Republic.

4.2 Basic Development Concepts

4.2.1 Basic Considerations

The Development Plan covering the study area of 24,100 ha has been formulated in accordance with the following considerations.

(1) Dominican Counterpart Organizations in Relation to the Development Plan

Alternatives corresponding to the development area and water intake method have been prepared in accordance with an agreement made with the Dominican counterpart organizations.

(2) Agricultural Development in Lands with Peat Soils

A soil survey was carried out as extensively as possible in peat soil lands so as to disclose soil characteristics of these lands. At the same time, specifications to assess the capability of referred lands for agricultural use has been prepared.

(3) Source of Irrigation Water, and Type and Location of Water Intake Facility

Based on the water balance study, available water discharge of the Yuna River was analyzed; with respect to the water intake method, three alternatives consisting of headworks, pumping station and a regulating reservoir were presented and the type and location of these structures have been studied.

(4) Drainage Measures

Investigating the actual drainage system, a drainage scheme has been prepared taking economic returns within a limited development area into account.

(5) Selection of the Development Area

Referring to land capability classification corresponding with paddy field development and consulting with relevant Dominican authorities, a development area has been established.

(6) Integration with the El Pozo Project

In formulating the Development Plan, the comprehensive plan for the El Pozo Project was duly studied so that the implementation of the Plan will not adversely affect the progress and completion of the El Pozo Project.

4.2.2 Development Area

In delineating the development area,physical conditions such as topography, soils, land use, irrigation and drainage system were studied covering the total study area of 24,100 ha and the following two proposals have been presented as a result of consultations with the relevant Dominican authorities.

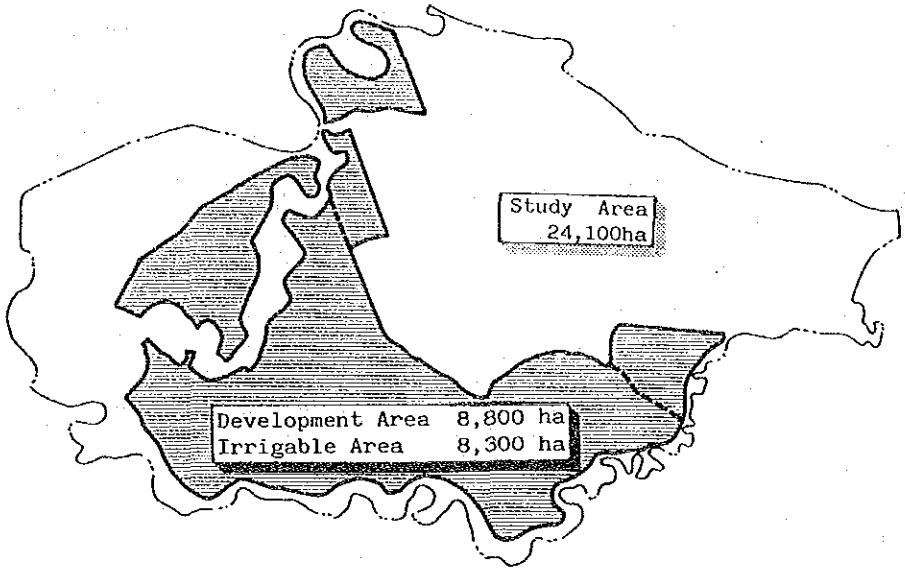
(1) Proposal - A: Development Area - 8,800 ha (Paddy Field: 8,300 ha)

This area has been established deducting the three zones mentioned below from capable lands for paddy field.

1) Natural dyke along the Caño Gran Estero where cash crops such as coconut and cacao are cultivated and residential areas

2) High terrace along the Yuna River in which a supply of irrigation water is technically infeasible due to topographic hazard

3) Small-scale isolated patches



Proposal - A

(2) Proposal - B: Develop]ment Area 7,400 ha (Paddy Field: 7,000 ha)

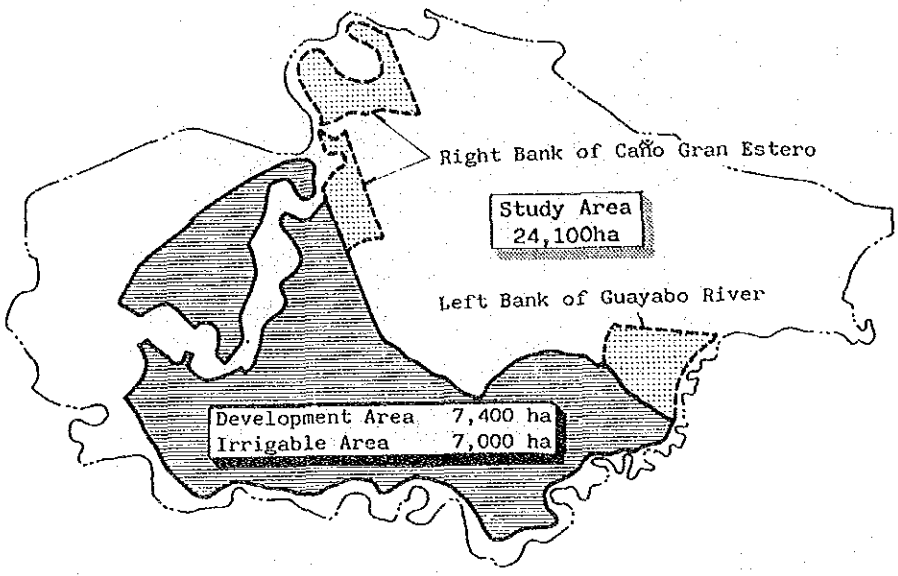
Considering the convenience in establishing irrigation and drainage plans and the economic feasibility for the development of paddy fields, Proposal - B has been established deducting the below-mentioned zones from the development area of Proposal - A.

1) Right Bank of the Caño Gran Estero

The conveyance of water to irrigate this zone from the Yuna River is not viable from a technical viewpoint; in light of this, irrigation water should be pumped up from the Caño Gran Estero, but there remains doubt regarding the higher salinity of this water due to the proximity of the intake point to the coast.

2) Left Bank of the Guayabo River

In addition to a water intake method by construction of pumping station, the topographic inferiority of lower elevation brings poor drainage and forces to seed local variety of rice which produces low productivity.



Proposal - B

4.2.3 Main Intake Facilities

From the viewpoint of availability and quality of water, the principal source for irrigation water has been determined to be the Yuna River. As to intake methods from the Yuna River, proposals to be considered are listed below:

- Regulating reservoir
- Headworks
- Pumping station

(1) Regulation Reservoir

The decision to withdraw the present proposal from consideration as a water intake method is supported by the following technical justifications.

1) The mechanical boring investigation had disclosed the existence of a thick peat soil layer in proposed dam axis, which constitutes a disadvantageous aspect for the construction of a dam on such a foundation.

2) If hydraulic resources are not sufficient enough in the River to supply irrigation water in a drought period however in view of their efficient utilization, the construction of a regulating reservoir is advisable. In the case of the relevant study, as a result of a water balance study on the Yuna River, it has been confirmed that the irrigation water required to supply the development area will surely be gotten from the Yuna River.

3) The topographic condition of the proposed construction site constrains the storage capacity of the reservoir and irrigable area, thus calling for another source of irrigation water. The area irrigable solely by a regulating reservoir is estimated to be approximately 5,400 ha.

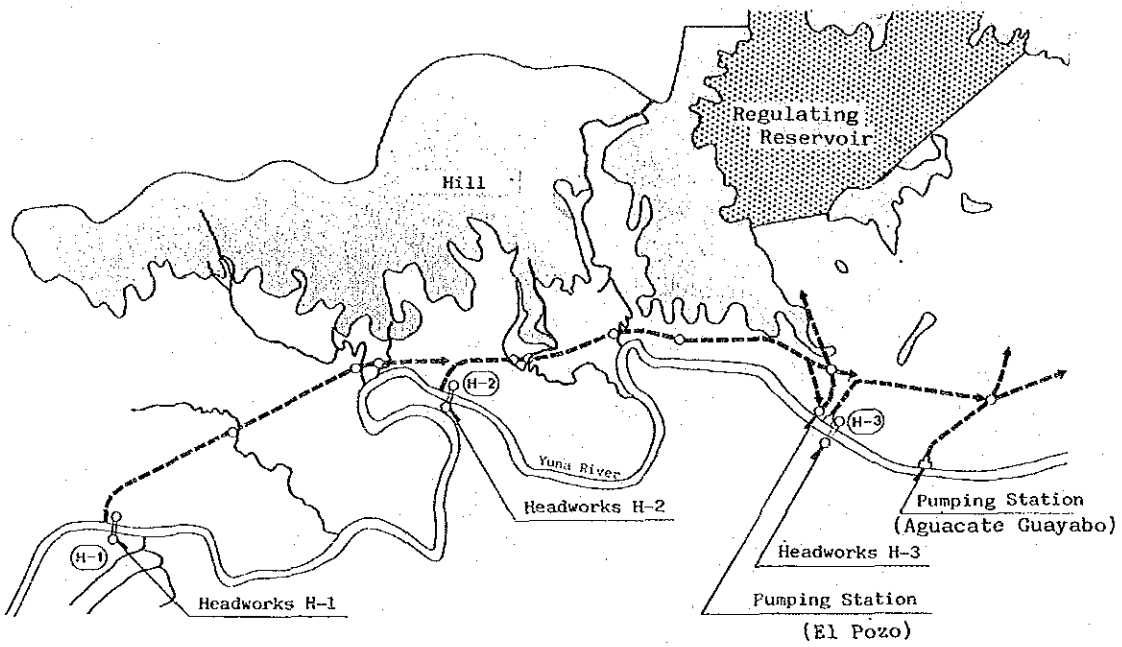
4) This proposal will be completed with the use of some of the facilities of the El Pozo Project which is now under construction. Therefore, a revision in the design and construction works for some facilities of the El Pozo Project is required together with the complicated operation and maintenance for the diversion of the irrigation water.

The detailed study report for this proposal is presented in ANNEX L, Section L.2.1.

(2) Headworks

With respect to the location of the headworks to be installed on the Yuna River, the following three sites are to be proposed:

Villa Riva	:	Upper basin (Proposal H-1)
Chiringo	:	Intermediate basin (Proposal H-2)
Arenoso	:	Lower basin (Proposal H-3)



LOCATION OF HEADWORKS PROPOSAL

At the start of the study, the Proposal H-1 had been excluded from further consideration, because this Proposal is vested with definite disadvantageous aspects in comparison with the other two proposals, i.e.:

- A very long driving canal (6.6 km) has to be constructed
- Siphon works are essential at six points where a driving canal crosses tributaries of the Yuna River.

Consequently, a detailed study to evaluate the economic and technical feasibility was made with respect to Proposals H-2 and H-3. During the course of the detailed study, the study team was requested to study the technical and economic possibility of integrating the water intake scheme of the study with that for the El Pozo Project, thus a detailed study was carried out in line with this requisition. As a result, the detailed study has concluded that Proposal H-3 is superior to Proposal H-2 in the context of every aspect such as construction cost, operation and maintenance method, convenience to implement construction work, integration with the El Pozo Project, etc.

The comparison study between the Proposals H-2 and H-3 is presented in Table 4.2.1 and the detailed study is shown in ANNEX L, Section L.2.2.

(3) Pumping Station

The proposed location of the pumping station is on the left margin of the Yuna River, approximately 440 m upper stream of the existing Aguacate Pumping Station, which has been determined due to: 1) favorable topographic conditions and 2) savings in the length of the driving canal to the diversion works at El Aguacate.

On proposed site for the installation of a Pumping Station, a ground sill will be executed so as to eliminate the erosion of river bed and to secure stable water intake.

(4) Summary

The main water intake facilities to be installed on the Yuna River, the principal source for the irrigation water, have thus been summarized as follows:

Proposal I - Headworks
Proposal II - Pumping Station

Fig. 4.1.1 illustrates the flow chart of the study on the water intake facilities.

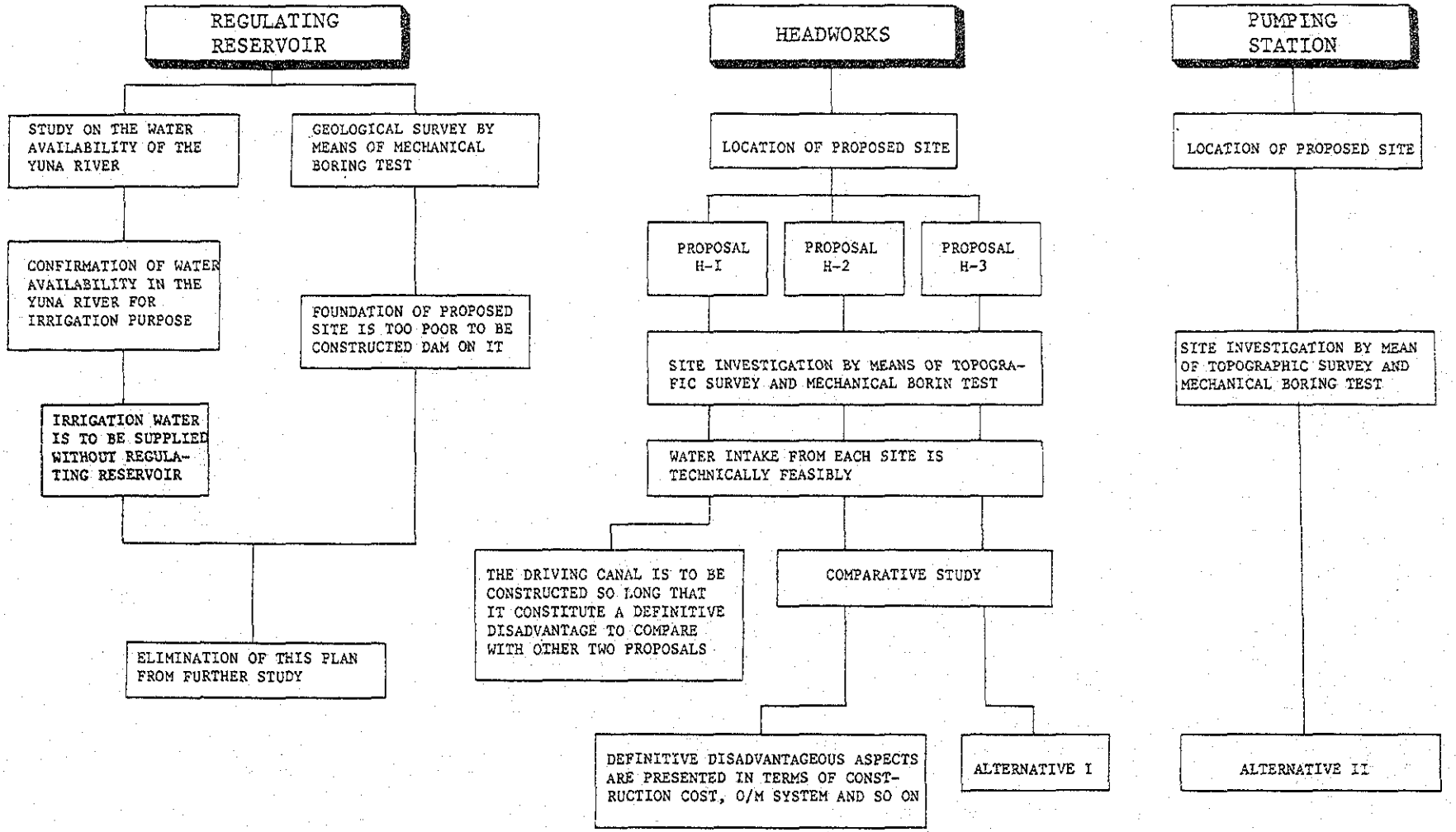


FIG. 4.1.1 FLOW CHART OF THE STUDY ON THE WATER INTAKE FACILITIES

TABLE 4.2.1 COMPARISON OF PROPOSALS H-2 AND H-3

Item	Proposal H-2	Proposal H-3
1. Headworks		
Design Flood Discharge	810 m^3/s	700 m^3/s
Design Flood Water Level	12.6 m	11.4 m
Design Intake Requirement	5.9 + 5.5 = 11.4 m^3/s	5.9 m^3/s
Design Intake Water Level	8.30 m	7.60 m
Design River Bed Level	4.60 m	3.80 m
Design Intake Water Depth	3.70 m	3.80 m
Total Length of Weir	72.50 m	68.50 m
Scouring Sluice Gate	(B) (H) (set)	(B) (H) (set)
	12.500 x 4.037 x 1	12.500 4.107 x 1
Flood Sluice Gate	27.000 x 3.800 x 2	25.000 x 3.900 x 2
Intake Gate	2.500 x 2.000 x 3	2.000 x 2.000 x 2
2. Driving Canal		
Canal Length (Q=11.4 m^3/s)	2,700 m	0 m
" (Q=5.9 m^3/s)	1,300 m	1,300 m
" (Q=5.5 m^3/s)	350 m	0 m
Total	(4,350 m)	(1,300 m)
Siphon	4	0
Diversion Works	1	0
Bridge	3	0
3. Construction Cost	RD$22,320,000	RD$13,257,000
4. Operation and Maintenance	1) Being located far from the El Pozo Pumping Station, an independent organization for operation and maintenance should be established. 2) The driving canal is designed to pass through the inundated plain, so scouring sluice measures to counter flooding should be considered. 3) Complicated operation and maintenance system to divert the El Pozo area should be designed.	1) Owing to the proximity to the El Pozo Pumping Station, an integrated operation and maintenance system can be established. 2) The water intake level at the El Pozo Pumping Station will be elevated, which will benefit the saving in operation cost of pumping facilities.
5. River Protection Measures	Both upper and down streams of the proposed location are meandering, so, protection and water control measures to secure stable river flow should be taken into account.	No protection measures should be considered, because, the river flow in the vicinity of the proposed location is almost straight.

4.2.4 Alternatives to Development Plan

In accordance with the consideration and the detailed study made in the course of the Study, Alternatives to the Development Plan have been presented as summarized below:

Alternatives	Irrigable Area (ha)	Water Intake Facilities	Observations
A-I	8,300	. Headworks on the Yuna River ($Q = 5.9\ m^3/s$) . Pumping Station at Cruce de Rincon ($Q = 0.46\ m^3/s$) . Pumping Station at Rincon Morinillo ($Q = 0.21\ m^3/s$) . Pumping Station at El Guayabo ($Q = 0.41\ m^3/s$)	All lands capable of being developed for paddy field are included. The main water intake facility will be the headworks.
A-II	8,300	. Pumping Station on the Yuna River ($Q = 5.9\ m^3/s$) . Pumping Station at Cruce de Rincon ($Q = 0.46\ m^3/s$) . Pumping Station at Rincon Morinillo ($Q = 0.21\ m^3/s$) . Pumping Station at El Guayabo ($Q = 0.41\ m^3/s$)	All lands capable of being developed for paddy field are included. The main water intake facility will be the pumping station.
B-I	7,000	Headworks on the Yuna River ($Q = 5.9\ m^3/s$)	The main intake facility will be the headworks and area irrigable only by means of the main intake facility is included.
B-II	7,000	Pumping Station on the Yuna River ($Q = 5.9\ m^3/s$)	The main intake facility will be the pumping station and only the area irrigable by means of the main intake facility is included.

4.3 Agricultural Development Plan

The El Aguacate - El Guayabo area, located in the Lower Basin of the Yuna River, is at present being used at a level very much below its potential. This arises in part from the physical constraints of poor drainage associated with topographic inferiority, extensive and deep distribution of peat soils, and lack of irrigation and drainage facilities. Also of major significance are deficiencies in the provision of appropriate support services to the farmers. The development of the area is envisaged with this in mind.

On the basis of present land use, physical conditions (physiography, topography, soils, etc.) actual cropping technique and practice of farmers an agricultural development plan related to the El Aguacate - El Guayabo area has been formulated concentrating on the production of rice which presents higher benefits. The development plan comprises the extension of cultivated area and achievement of double harvests per year by improving irrigation and drainage systems.

4.3.1 Land Use Plan

A land use plan has been prepared taking the area and location of existing paddy fields into account; of the presently used 4,100 ha, those which present no constraints from the viewpoint of availability of irrigation water and land capability will be left as they are, additionally existing grazing lands and marshes will be transformed into paddy fields if they are qualified according to their topography and land capability.

Cacao and coconut plantations play an important role within the study area in terms of producing permanent and cash crops. In this regards, lands allocated to these plantations will be conserved unless they hinder the development of paddy fields.

The uplands extended on the natural levee along the Yuna River will be used as vegetable gardens, and residential and public utilities' lots.

No development will be considered with respect to swampy forests, because: i) vast investments would be required for the development, ii) thick distribution of peat soils incapable for the cultivation of paddy and upland crop fields has been observed, and iii) they are indispensable resources in terms of environmental conservation.

Consequently, a land use plan has been proposed as summarized below:

LAND USE PLAN

	Present	With Project	
		Alternative-A	Alternative-B
EL AGUACATE			
Paddy	2,000	3,500	3,400
Cacao	1,300	900	900
Coconut	-	-	-
Upland	-	-	-
Grazing Land	3,100	1,800	1,800
Swamp	1,200	900	1,000
Swampy Forest	600	600	600
Others 1/	200	700	700
Sub-total	8,400	8,400	8,400
EL GUAYABO			
Paddy	2,100	4,800	3,600
Cacao	400	400	400
Coconut	1,400	1,400	1,400
Upland	500	200	200
Grazing Land	2,700	2,700	3,200
Swamp	3,700	1,100	1,800
Swampy Forest	4,700	4,400	4,400
Others 1/	200	700	700
Sub-total	15,700	15,700	15,700
TOTAL			
Paddy	4,100	8,300	7,000
Cacao	1,700	1,300	1,300
Coconut	1,400	1,400	1,400
Upland	500	200	200
Grazing Land	5,800	4,500	5,000
Swamp	4,900	2,000	2,800
Swampy Forest	5,300	5,000	5,000
Others 1/	400	1,400	1,400
TOTAL	24,100	24,100	24,100

Note: 1/ Others area includes roads, canals, drains, residential areas, etc.

4.3.2 Cropping Pattern

Rice has been selected as the only crop to be developed in the proposed irrigable area and the cropping pattern associated with other crops will be considered when the irrigation and drainage systems have been consolidated and double cropping has been firmly established.

Rice production will be realized in the following manners:

- Double cropping with non-photo-sensitive improved varieties which will be transplanted or direct-seeded into the proposed irrigation area except for the swampy area.

- Single cropping with rice of traditional varieties which will be transplanted and harvested twice a year by means of the ratooning method.

The full development years for the medium and long term targets are set up in the initial six years and proceeding years after the completion of construction. It is planned that the above two types of rice cultivation will be introduced in the project area according to the land class and project development phase as follows:

CROPPING PATTERN OF RICE PRODUCTION

Paddy Field Division	Capability Classification in term of Rice Production	Cropping Program
1R	A1	Double cropping with improved varieties will be introduced to cover the total development area from the initial year after completion of construction.
2R	A2, A3	The double cropping area with improved varieties and single cropping with traditional varieties will cover 50 percent each of the total irrigated area during the medium term target period, while the whole irrigation area will be covered by double cropping with improved varieties throughout the long term target period.
3R	A4 or inferior classes	In the medium term target period, these areas will not be covered by double cropping with improved varieties but by single cropping with traditional varieties. In the long term target period, the entire area will be covered by double cropping with improved varieties.
4R	Land infeasible of drainage improvement	Both medium and long terms target period, single cropping with traditional varieties will be introduced.

4.3.3 Introducing Varieties and Cropping Calendar

The improved varieties for double cropping will be composed of early maturing varieties (ISA 40, Tanioka, etc.) and medium maturing varieties (Juma 57, Juma 58, etc.). Additionally, Mingolo, a traditional variety having a tall height and ratooning ability with wide adaptability to less productive soils, will be used. It is expected that three promising new varieties of early maturing rice will be introduced through variety trial in the project area.

For the purpose of achieving the target production, it is essential that improved varieties should be sown in December or later for the first crop and by the middle of July for the second crop. Between the first and second crops, as much time as possible should be allocated for the maintenance of facilities and protection from continuous infection of pests. Considering the farm labor balance, fifty days of lag period is given in each cropping calendar.

The sowing time in the cropping calendar for the traditional varieties will be established so as to maximize the yield.

Should direct seeding with improved varieties be carried out continously, the growth of weeds and generation of pests will surely be observed. Therefore, a cropping rotation consisted of double cropping with improved varieties (transplanting) and single cropping associated with ratooning method of traditional varieties has been proposed as illustrated in Fig. 4.3.1.

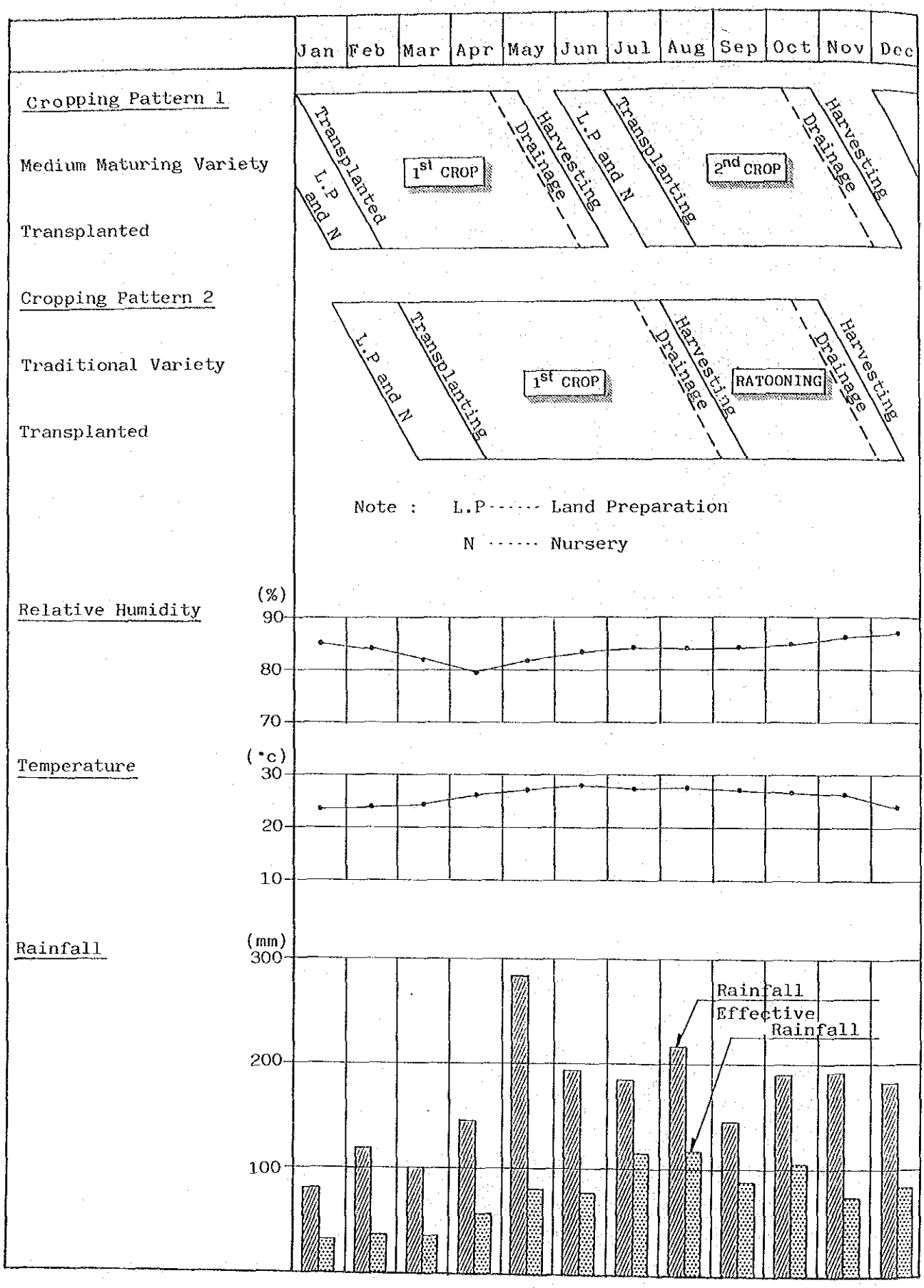


FIG. 4.3.1 CROPPING PATTERN

4.3.4 Proposed Farming Practices

The proposed farming practice, projection of farm inputs requirements, and farming operation plan to correspond to the proposed cropping pattern have been presented as summarized below (refer to ANNEX I for detailed information).

(1) Sowing and Raising Seedlings

Rice seeds have to be selected by using a solution of specific gravity. The selected seeds will have to be disinfected by using disinfectants and then incubated. The seed requirement is 45 kg per ha for the improved varieties, 50 kg per ha for the traditional varieties and 100 kg per ha in case of direct seeding.

Careful water management is very important to raise healthy seedlings. The nursery period is within 30 days after seeding for the improved varieties and 40 days for traditional varieties.

(2) Land Preparation

Plowing is carried out at least 15 days before transplanting or direct-seeding followed by soil breaking. The plowing and soil breaking is done by tractors or power tillers. Puddling and levelling is carried out by animal power.

The land preparation for direct seeding will have to be done by keeping the soil surface as flat as possible.

(3) Transplanting/Direct-seeding

Cross-wise straight row transplanting is made manually with a spacing of 20 cm x 20 cm, which puts the number of hills per m^2 at 25, planting two to four seedlings per hill. The water depth is kept shallow at transplanting time and then careful water control to avoid deep water depth is required to accelerate

vigorous tillering. Especially in case of direct seeding, the standing water depth should be increased in parallel with the growth height of the seedlings.

(4) Fertilizer Application

The total fertilizer requirement for three nutrient elements is estimated at 70-55-28 Kg (N, P_2O_5, K_2O) for the improved varieties. Half of the total amount of nitrogen is applied as top dressing, at about 20 days before heading. The total fertilizer requirement for the cultivation of local varieties with ratooning cultivation is estimated at 68-49-24 Kg. The total amount of nitrogen is divided into three parts.

Fertilizer application to rice in the organic soils should be determined with consideration of soil's maturation after the completion of construction and soil management projects. It may be required to apply some amount of calcium carbonate to improve the organic soils in the A3 or the lower class land area.

(5) Weeding

About five days after transplanting, a pre-emergence type herbicide is applied to the transplanted rice. For effective weeding, it is recommendable to introduce a manual rotary weeder by using a transplanting method of cross-wise straight rows. The direct seeding rices will need to have herbicides applied twice, using pre-emergence and post-emergence type herbicides. One example of a pre-emergence type herbicide is "Buthachlor + 2, 4-D Amine" and that of the post-emergence is "2. 4-D Amine".

(6) Plant Protection

Seed disinfection will be accomplished by such recommendable disinfectants as Benlate. Systematic plant protection has to be used, which consists of not only insecticide application but also cultural control, including selection of resistant varieties to

prevailing insects and diseases, setting of the cropping calendar to minimize infections of insects and diseases, removal of parasitic weeds and crop residues, etc. Considering the life-cycle of insects, it will be required to apply the granular formulation insecticides twice. In view of contact and systemic effects on various kinds of harmful insects will be also be applied during the time that the seedlings are being raised.

(7) Harvesting

Harvesting is carried out by manual in the greater portion of the area and by combine in the rest of the same area. Small type power threshers will be introduced in order to effect efficient threshing operations and also to improve the removable of unfilled grains and impurities. And it is essential to introduce artificial drying to reduce grain moisture content of at least up to 18% at the farmers' level.

(8) Water Management

After the completion of the construction, the shortage and excess water supply will have to be eradicated not only at the main and lateral canal levels but also at the on-farm level. Water should be distributed by group at the on-farm level according to cropping schedule, securing plot-wise water control at each stage of growth.

4.3.5 Production Program

(1) Crop Yield

Base levels of yield for formulating production program have been determined according to the field survey as follows:

1) El Aguacate - El Guayabo Area ..... 2.5 ton/ha
2) Bonao (Juma) ..... 4.5 ton/ha
3) Jarabacoa ..... 5.6 ton/ha

Target yields by variety and land class in full development years have been established in the range of 3.4 - 3.8 tons/ha/cropping in the medium term and 4.0 - 5.0 tons/ha/cropping in the long term each sowing improved varieties; in case of traditional varieties, they have been set up at 2.6 - 3.6 tons/ha/year and at 3.0 - 3.2 tons/ha/year for each term respectively.

These target yields have been established in the following manners:

Long Term:

1R land areas ..... about 90% as high as Jarabacoa's yield
2R land areas ..... about 90% as high as Bonao's yield
3R land areas ..... about 80% as high as 2R land areas

Medium Term:

1R, 2R land areas .... about 80% as high as long term targets

TARGET YIELDS BY LAND CLASS

Land Class	Improved (ton/ha/cropping)		Traditional(ton/ha/year)	
	Medium Term	Long Term	Medium Term	Long Term
1R	3.8	5.0	-	-
2R	3.4	4.0	3.6	-
3R	-	3.2	2.8	-
4R	-	-	2.6	3.0

Note: It is assumed that the classified as A1 is first class land (1R) on which rice is grown after project construction. In the same way, the land of A2 and A3 is the second class (2R) and the land of A4 or the lower classes is third class (3R) land. The lands extending on the left margin of the Guayabo River and the right margin of the Cano Gran Estero are classified as A4 considering the difficulty of improving poor drainage condition in these lands.

(2) Production

Based on the aforesaid cropping patterns and target yields, the total rice production has been estimated as summarized below:

RICE PRODUCTION AND ITS INCREMENT

	Without Project			With Project					
				Medium Term			Long Term		
	Yield (t/ha)	Cultivated Area (ha)	Production (t)	Yield (t/ha)	Cultivated Area (ha)	Production (t)	Yield (t/ha)	Cultivated Area (ha)	Production (t)
Alternative A									
1R				3.8	5,800	22,040	5.0	5,800	29,000
2R	2.5	3,420	8,550	3.4-3.6	3,600	12,480	4.0	4,800	19,200
3R				2.8	1,900	5,320	3.2	3,800	12,160
4R				2.6	1,100	2,860	3.0	1,100	3,300
Total					12,400	42,700		15,500	63.660
Increment					8,980	34,150		12,080	55,110
Alternative B									
1R				3.8	5,800	22,040	5.0	5,800	29,000
2R	2.5	3,050	7,625	3.4-3.6	3,300	11,440	4.0	4,400	17,600
3R				2.8	1,900	5,320	3.0	3,800	12,160
Total					11,000	38,800		14,000	58,760
Increment					7,950	31,175		10,950	51,135

Note: Production is expressed in dried unhulled rice.

4.3.6 Farm Management and Farm Income

(1) No. of Beneficiaries

The projected expansion of the rice fields will be from 2,790 ha to 8,300 ha in Alternative-A and from 2,590 ha to 7,000 ha in Alternative-B. The farm size in terms of rice cultivation area is set at 2.5 ha, considering the prevailing farm size in the new IAD settlement projects, then, the number of total farm after the completion of construction work will increase to 3,320 farms under Alternative-A and 2,800 farms under Alternative-B.

The unemployed people living within the study area and having experience in rice production will be recruited as settlers for the newly developed area.

(2) Farm Mechanization and Labor Balance

1) Farm Mechanization Plan

With the increase of cropping intensity after the completion of the irrigation projects, crop production should be carried out in line with the water management schedule so as to ensure economical water utilization. This is the main reason why farm mechanization will be required in the irrigation project. It is recommendable that mechanization will be introduced partially with a minimum amount of machinery to supplement the use of animal power and manpower. The maximum use will be made with a minimum amount of machinery by applying collective use of machinery among farmers' groups or on a contract-base use of machinery.

Besides four-wheel tractors, power tillers, power threshers and dryers would be introduced according to the proposed farm mechanization plan. The required amount of farm machinery in the proposed mechanization plan includes 53 units of four-wheel tractors 210 units of power tillers, 420 units of power threshers and 210 units of dryers.

The average machinery cost per ha of rice cultivation is estimated at RD$233 as shown in the ANNEX I.

2) Farm Labor Balance

Supposing that 2.0 men of the converted labor force will be available per farm, then there will be a forecasted imbalance between the supply and demand of farm labor on the basis of the average farm size (2.5 ha). This imbalance will be offset by supplying available labor force within the development area (mostly landless farm laborers) and its circumference.

(3) Agricultural Credit

The Dominican Government, via the B.A., has allocated their agricultural credit preferentially to beneficiaries of the agrarian reform and the amount of credit is decided depending on land capability and irrigation water availability. The financial resources of the Bank should be expanded in response to the increase in demand which is envisaged after the completion of the Project. The required amount of credit and interest per hectare has been estimated as summarized below.

REQUIRED AMOUNT OF CREDIT BY LAND CLASS

(Unit: DR$)

Land Division	Medium Term			Long Term		
	Credit	Interest	Total	Credit	Interest	Total
1R	1,488	126	1,614	1,624	138	1,762
2R	1,432	122	1,554	1,559	132	1,691
2R	1,784	152	1,936			
3R	1,432	122	1,554	1,496	127	1,623
4R2/	1,432	122	1,554	1,953	166	2,119

Note: 1/ Term of credit: 6 months, interest rate: 17%/year
2/ Assumed that total lands will be covered by credit without considering the Bank's Guideline.

The total amount of credit will be RD$24,735,500 for the Alternative A and RD$21,963,100 for the Alternative B.

The amount of credit which a farmer receives will be RD$5,262 under the Alternative A and RD$5,565 under the Alternative B; a farmer can be repaid this credit if he attain unit yield of 3.4 t/ha.

(4) Agricultural Income

The net return on rice production per farmer in terms of gross return minus production cost, excluding the family labor cost, is estimated by land class for the medium and long term targets as shown in Table 4.3.1.

The ratio of the estimated net return to the gross income for the improved varieties ranges from 52 percent to 58 percent under the Alternative A, and 54 percent to 60 percent under the B.

The net margin per farmer for the long term target are calculated to be RD$3,486 under the Alternative A and RD$4,446 the under the Alternative B. It is expected that this margin will contribute to the improvement of farm operation and enhancement of farmer's living standard.

The agricultural income according to land capability is presented in ANNEX I.

TABLE 4.3.1 AGRICULTURAL INCOME

	Unit	Without Project	Alternative A		Alternative B	
			Medium Term Target	Long Term Target	Medium Term Target	Long Term Target
Farm Size	ha	2.5	2.5	2.5	2.5	2.5
Cultivated Area	ha	2.5	3.73	4.67	3.93	5.0
Gross Return	RD$	4,423	9,101	13,567	9,809	14,855
1) Production of Rice	t	6.25	12.86	19.17	13.86	20.99
2) Amount	RD$	4,423	9,101	13,567	9,809	14,855
Production Cost	RD$					
1) Seed		270	160	201	169	215
2) Fertilizer and Insecticide		357	1,421	2,120	1,517	2,280
3) Employed labor		280	1,037	1,200	1,057	1,245
4) Machinery		1,000	839	1,079	872	1,135
5) Employed Animal		75	201	229	208	240
6) Water Charge		63	200	200	200	200
7) Miscellaneous		100	160	233	169	250
8) Interest		174	328	427	342	452
Total		2,319	4,346	5,689	4,534	6,017
Net Return on Rice Production	RD$	2,104	4,755	7,878	5,275	8,838
Non-agricultural Return	RD$	2,288	0	0	0	0
Total Net Return of Farmer	RD$	4,392	4,755	7,878	5,275	8,838
Living Cost	RD$	4,392	4,392	4,392	4,392	4,392
Net Margin of Farmer	RD$	0	363	3,486	883	4,446

Note: 1) Both cultivated area and production volume for Alternatives A & B are expressed in weighted average values.
2) Farm gate price of rice is set forth to be RD$707.70.

4.4 Irrigation Plan

4.4.1 Source for Irrigation Water

The Yuna River was selected as the principal source to supply the development area with irrigation water after a comparison study on the quality and volume of water with other possible sources. As mentioned in Section (2) of 3.2.2, the available discharge from the Yuna River is estimated to be 11.7 m^3/s, which is sufficient enough to irrigate the proposed development area of 8,300 ha, though one part of the development area will be irrigated by water to be obtained from other sources. The table below indicates the sources for irrigation water of the Project and the maximum gross water requirements.

SOURCE FOR IRRIGATION WATER

Sources	Design Intake Requirement (m^3/s)	Irrigable Area (ha)	Water Intake Sites	Observation
Yuna River	5.90	7,000	Arenoso	Alternatives A, B
Caño Gran Estero	0.46	550	Cruce de Rincon	Alternative A
Caño Gran Estero	0.21	250	Rincon Molinillo	Alternative A
Guayabo River	0.41	500	El Guayabo	Alternative A
Total	6.98	8,300		

Details of this study are presented ANNEX J.1.

4.4.2 Irrigation Water Requirement

(1) Net Irrigation Requirement

The net irrigation requirement has been calculated using climatic data, because data on actual field irrigation consumption are not available with respect to the study area. The Penman Method was applied for this calculation and climate data were collected at

the Barraquito Station which is located adjacent to the study area and provided more reliable data. Criteria applied for this purpose are mentioned below:

1) Design rainfall frequency ..... 5 years return period

2) Crop coefficients

Period of Growth	Crop Coefficient
1st month	1.1
2nd month	1.1
Mid-season	1.05
Last 4 weeks	0.95

3) Water requirements for land preparation and nursery ..... 100 mm

4) Deep percolation ..... 0.5 mm/day

5) Irrigation efficiency

Conveyance efficiency ..... Ec = 0.9
Field canal efficiency ..... Eb = 0.8
Field application efficiency ..... Ea = 0.8
Irrigation efficency = Ec x Eb x Ea = 0.58

The computation of net irrigation requirements is summarized in Tables 4.4.1 - 4.4.3 in which maximum requirements are indicated as follows:

Medium maturing varieties transplanted twice a year ..... 1.028 l/s/ha (April)

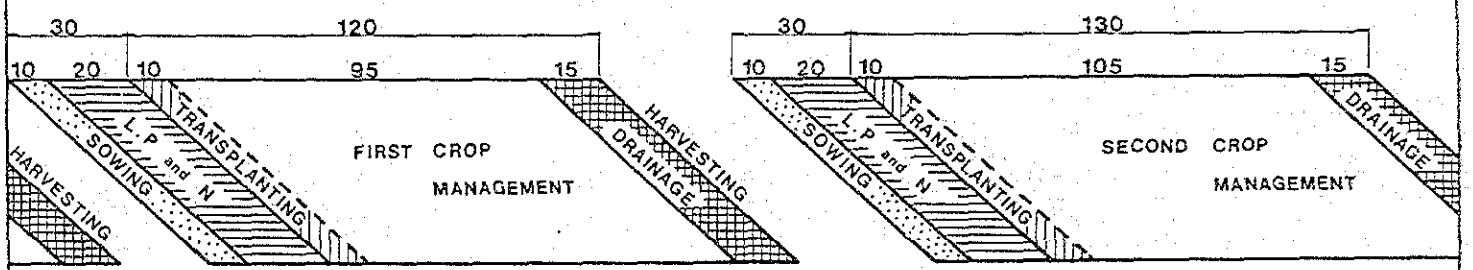
Traditional varieties transplanted and ratooned ..... 0.999 l/s/ha (September)

For detailed study results, refer to ANNEX J.2.

TABLE 4.4.1 CALCULATION OF REFERENCE CROP EVAPOTRANSPIRATION

	JUN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Reference
(1) T mean °c	23.5	23.8	24.6	25.6	26.5	27.4	27.2	27.2	27.1	26.7	25.5	23.7	
(2) RH mean %	85.1	83.8	81.7	79.3	81.9	83.1	83.6	84.2	84.3	84.6	86.0	86.3	
(3) ea mbar	29.0	29.5	30.9	32.8	34.7	36.5	36.1	36.1	35.9	35.1	32.7	29.3	
(4) ed=(2)x(3) mbar	24.7	24.7	25.2	26.0	28.4	30.3	30.2	30.4	30.3	29.7	28.1	25.3	
(5) ea-ed mbar	4.3	4.8	5.7	6.8	6.3	6.2	5.9	5.7	5.6	5.4	4.6	4.0	
(6) Wind U km/day	130	138	147	164	147	138	130	104	112	104	104	104	
(7) $f(u)=0.27(1+\frac{U}{100})$	0.62	0.64	0.67	0.71	0.67	0.64	0.62	0.55	0.57	0.55	0.55	0.55	
(8) Weighting factor (1-W)	0.27	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.24	0.24	0.25	0.27	
(9) Weighting factor (W)	0.73	0.73	0.74	0.75	0.76	0.76	0.76	0.76	0.76	0.76	0.75	0.73	
(10) Ra mm/day	11.2	12.7	14.4	15.6	16.3	16.4	16.3	15.9	14.8	13.3	11.6	10.7	
(11) n/N Ratio	0.60	0.64	0.64	0.62	0.57	0.58	0.58	0.58	0.59	0.59	0.59	0.59	
(12) (0.25+0.5n/N)	0.55	0.57	0.57	0.56	0.54	0.54	0.54	0.54	0.55	0.55	0.55	0.55	
(13) Rs=(12)x(10) mm/day	6.2	7.2	8.2	8.7	8.8	8.9	8.8	8.6	8.1	7.3	6.4	5.9	
(14) Rns=(1-:)x(13) mm/day	4.7	5.4	6.2	6.5	6.6	6.7	6.6	6.5	6.1	5.5	4.8	4.4	
(15) f(T)	15.3	15.4	15.6	15.8	16.0	16.2	16.1	16.1	16.1	16.0	15.8	15.3	
(16) f(ed)	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.12	0.12	0.12	
(17) f(n/N)	0.64	0.68	0.68	0.66	0.62	0.62	0.62	0.62	0.63	0.63	0.63	0.63	
(18) Rnl=(15)x(16)x(17)	1.2	1.3	1.3	1.3	1.2	1.1	1.1	1.1	1.1	1.2	1.2	1.2	
(19) Rn=(14)-(18)	3.5	4.1	4.9	5.2	5.4	5.6	5.5	5.4	5.0	4.3	3.6	3.2	
(20) Adjustment factor (C)	1.05	1.07	1.08	1.13	1.14	1.14	1.14	1.12	1.08	1.07	1.05	1.05	
(21) (9)x(19)	2.56	2.99	3.63	3.90	4.10	4.26	4.18	4.10	3.80	3.27	2.70	2.34	
(22) (8)x(7)x(5)	0.72	0.83	0.99	1.21	1.01	0.55	0.88	0.75	0.77	0.71	0.63	0.59	
(23) (21)+(22)	3.28	3.82	4.62	5.11	5.11	5.21	5.06	4.85	4.57	3.98	3.33	2.93	
(24) ETo=(20)x(23) mm/day	3.4	4.1	5.0	5.8	5.8	5.9	5.8	5.4	4.9	4.3	3.5	3.1	
(25) For Project F	1.10	1.12	1.13	1.15	1.15	1.15	1.15	1.15	1.13	1.12	1.11	1.10	
(26) ETo mm/day	3.7	4.6	5.7	6.7	6.7	6.8	6.7	6.2	5.5	4.8	3.9	3.4	
(27) ETo mm/month	114.7	128.8	176.7	201.0	207.7	204.0	207.7	192.0	165.0	148.8	117.0	105.4	
* ETo of El Pozo mm/month	112	129	177	192	198	192	198	192	171	146	117	109	

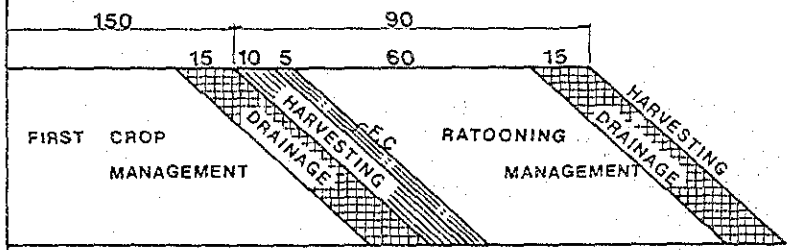
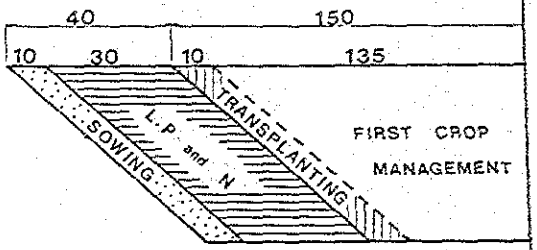
TABLE 4.4.2 CALCULATION OF UNIT WATER REQUIREMENT - IMPROVED VARIETY

	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
(1) Cropping Pattern												
(2) ET_o (mm/month)	204.0	207.7	192.2	165.0	148.8	117.0	105.4	114.7	128.8	176.7	201.0	207.7
(3) Crop Coefficiency	1.00	1.10	1.10	1.10	1.05	0.95	1.10	1.10	1.10	1.10	1.05	0.95
(4) C.W.R (mm/month)	204.0	228.5	211.4	181.5	156.2	111.2	115.9	126.2	141.7	194.4	212.0	197.3
(5) Area Factor of C.W.R	0.074	0.318	0.884	1.000	0.895	0.340	0.009	0.318	0.871	1.000	0.992	0.590
(6) Weighted C.W.R (mm/month)	15.1	72.7	186.9	181.5	139.8	37.8	1.0	40.1	123.4	194.4	210.3	116.4
(7) Area Factor of L.P and N	0.200	0.620	0.180	-	-	-	0.200	0.620	0.180	-	-	-
(8) Water Requirement L.P and N (mm/month)	20.0	62.0	18.0	-	-	-	20.0	62.0	18.0	-	-	-
(9) Field Water Requirement (mm/month)	35.1	134.7	204.9	181.5	139.8	37.8	21.0	102.1	141.4	194.4	210.3	116.4
(10) Effective Rainfall (mm/month)	74.3	113.0	114.8	85.0	102.1	67.7	39.0	32.4	37.6	37.3	57.0	77.0
(11) Area Factor of Effective Rainfall	0.207	0.718	1.000	1.000	0.895	0.340	0.138	0.718	1.000	1.000	0.992	0.590
(12) Weighted Effective Rainfall (mm/month)	15.4	81.1	114.8	85.0	91.4	23.0	5.4	23.3	37.6	37.3	56.5	45.4
(13) Net Irrigation Requirement (mm/month)	19.7	53.6	90.1	96.5	48.4	14.8	15.6	78.8	103.8	157.1	153.8	71.0
(14) Irrigation Efficiency	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
(15) Irrigation Requirement (mm/month)	34.0	92.4	155.3	166.4	83.4	25.5	26.9	135.9	179.0	270.9	265.2	122.4
(16) " (mm/day)	5.469	4.152	5.011	5.546	3.006	2.502	6.287	6.104	6.392	8.737	8.883	6.693
(17) " (l/s/ha)	0.633	0.481	0.580	0.642	0.348	0.290	0.728	0.706	0.740	1.011	1.028	0.775

Note ; C.W.R : Crop Water Requirement
L.P : Land Preparation
N : Nursery
F.C : Flooding for Cultivation Water

Note : (4) = (2) x (3) (9) = (6) + (8) (15) = (13)/(14)
(6) = (4) x (5) (12) = (10) x (11) (16) = (15)/(Days of Month x (11))
(8) = 100.0 x (7) (13) = (9) - (12) (17) = (16)/8.64

TABLE 4.4.3 CALCULATION OF UNIT WATER REQUIREMENT - TRADITIONAL VARIETY

	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
(1) Cropping Pattern												
Note ; C.W.R : Crop Water Requirement L.P : Land Preparation N : Nursery F.C : Flooding for Cultivation Water												
(2) ET_o (mm/month)	204.0	207.7	192.2	165.0	148.8	117.0	105.4	114.7	128.8	176.7	201.0	207.7
(3) Crop Coefficiency	1.05	1.00	1.00	1.10	1.05	0.95	0.95	1.10	1.10	1.10	1.10	1.10
(4) Crop Water Requirement (mm/month)	214.2	207.7	192.2	181.5	156.2	111.2	100.1	126.2	141.7	194.4	221.1	228.5
(5) Area Factor of C.W.R	1.000	0.895	0.445	0.661	0.884	0.320	0.000	0.002	0.010	0.315	0.880	1.000
(6) Weighted C.W.R (mm/month)	214.2	185.9	85.5	120.0	138.1	35.6	0.0	0.3	1.4	61.2	194.6	228.5
(7) Area Factor of L.P and N	-	-	-	-	-	-	-	0.001	0.299	0.580	0.120	-
(8) Water Requirement L.P and N (mm/month)	-	-	-	-	-	-	-	0.1	29.9	58.0	12.0	-
(9) Area Factor of F.C	-	-	0.410	0.582	0.008	-	-	-	-	-	-	-
(10) Flooding for Cultivation Water (mm/month)	-	-	41.0	58.2	0.8	-	-	-	-	-	-	-
(11) Field Water Requirement (mm/month)	214.2	185.9	126.5	178.2	138.9	35.6	0.0	0.4	30.4	119.2	206.6	228.5
(12) Effective Rainfall (mm/month)	74.3	113.0	114.8	85.0	102.1	67.7	39.0	32.4	37.6	37.3	57.0	77.0
(13) Area Factor of Effective Rainfall	1.000	0.895	0.511	0.758	0.885	0.320	0.000	0.003	0.330	0.876	1.000	1.000
(14) Weighted Effective Rainfall (mm/month)	74.3	101.1	58.7	64.4	90.4	21.7	0.0	0.1	12.4	32.7	57.0	77.0
(15) Net Irrigation Requirement (mm/month)	139.9	84.8	67.8	113.8	48.5	13.9	-	0.3	18.0	86.5	149.6	151.5
(16) Irrigation Efficiency	0.58	0.58	0.58	0.58	0.58	0.58	-	0.58	0.58	0.58	0.58	0.58
(17) Irrigation Requirement (mm/month)	241.2	146.2	116.9	196.2	83.6	24.0	-	0.5	31.0	149.1	257.9	261.2
(18) " (mm/day)	8.040	5.270	7.379	8.628	3.048	2.496	-	5.376	3.359	5.492	8.598	8.426
(19) " (l/s/ha)	0.931	0.610	0.854	0.999	0.353	0.289	0.0	0.622	0.389	0.636	0.995	0.975

Note : (4) = (2) x (3) (10) = 100 x (9) (15) = (11) - (14) (19) = (18)/8.64
(6) = (4) x (5) (11) = (6) + (8) + (10) (17) = (15)/(16)
(8) = 100 x (7) (14) = (12) x (13) (18) = (17)/(Days of Month x (13))

(2) Return Flow

For the purpose of an efficient utilization of water resources, the use of return flow will be considered.

Given the net irrigation requirement is 1.00, irrigation water requirement at the intake point will be calculated as follows:

Net Irrigation Requirement	:	1.00
Conveyance Loss	:	0.16
Field Canal Loss	:	0.28
Field Application Loss	:	0.28
Irrigation Water Requirements	:	1.72

Available water for return flow will be calculated adding field canal loss to field application loss, and if 60% of this volume is to be utilized repeatedly, the return flow will be calculated as follows:

$$\text{Return Flow} = (\text{Field Canal Loss} + \text{Field Application Loss}) \times 0.6 = (0.28 + 0.28) \times 0.6 = 0.34$$

If return flow is to be used in the adjacent fields located in the lower catchment, the irrigation requirements to the adjacent fields are calculated by subtracting conveyance loss from total irrigation requirement (I.R.):

$$\text{I.R.} = 1.72 - 0.16 = 1.56$$

Therefore, the project efficiency will become: $0.34 \div 1.56 = 0.22$, which indicates that if water is taken to irrigate 100 ha of field, another 22 ha of land can be irrigated by using return flow.

(3) Design Intake Requirement

Taking return flow into account, the design intake requirement is computed with regard to each intake facility as follows:

DESIGN INTAKE REQUIREMENT

Intake Facility	Irrigable Area (ha)	Design Intake Requirement (m^3/s)	Intake Sites
Headworks (Pumping Station) on the Yuna River	7,000	5.90	Arenoso
No. 1 Pumping Station	550	0.46	Cruce de Rincon
No. 2 Pumping Station	250	0.21	Rincon Molinillo
No. 3 Pumping Station	500	0.41	El Guayabo

Details are as per ANNEX J.4.

4.4.3 Irrigation Canal

(1) Main Irrigation Canal

Based on the division of irrigation area together with topographic conditions, etc., the main irrigation canal has been delineated as shown in Fig. 4.4.1. Furthermore, an irrigation network proposal is illustrated in Fig. 4.4.3.

In relation to the cross-section of the main irrigation canals, concrete lining structure (TYPE A) has been proposed for canals with a design discharge of more than 0.4 m^3/s and masonary lining structure (TYPE B) for those of less than 0.4 m^3/s. Length, discharge and gradient of each canal are presented in Table 4.4.4 and their cross-sectional plans are illustrated in following figures.

Detailed hydraulic calculations are included in ANNEX J.5 - J.7.

(2) Secondary Irrigation Canals

Secondary irrigation canals will be earthen structure and their cross sections are proposed so as to meet with water discharge as summarized below. The cross-sectional plan is illustrated in Fig. 4.4.3.

SUMMARY OF SECONDARY IRRIGATION CANALS

Type of Canal	Water Discharge (m^3/s)	Width of Canal Bed (m)	Height of Canal (m)	Length (m)	
				Alternative A	Alternative B
A	0.11	0.60	0.60	102,700	86,100
B	0.06	0.50	0.50	112,100	90,900
C	0.03	0.40	0.40	27,800	23,900
TOTAL				242,600	200,900
Density of Canal				29.2 m/ha	28.7 m/ha

Details are as per ANNEX J.7.

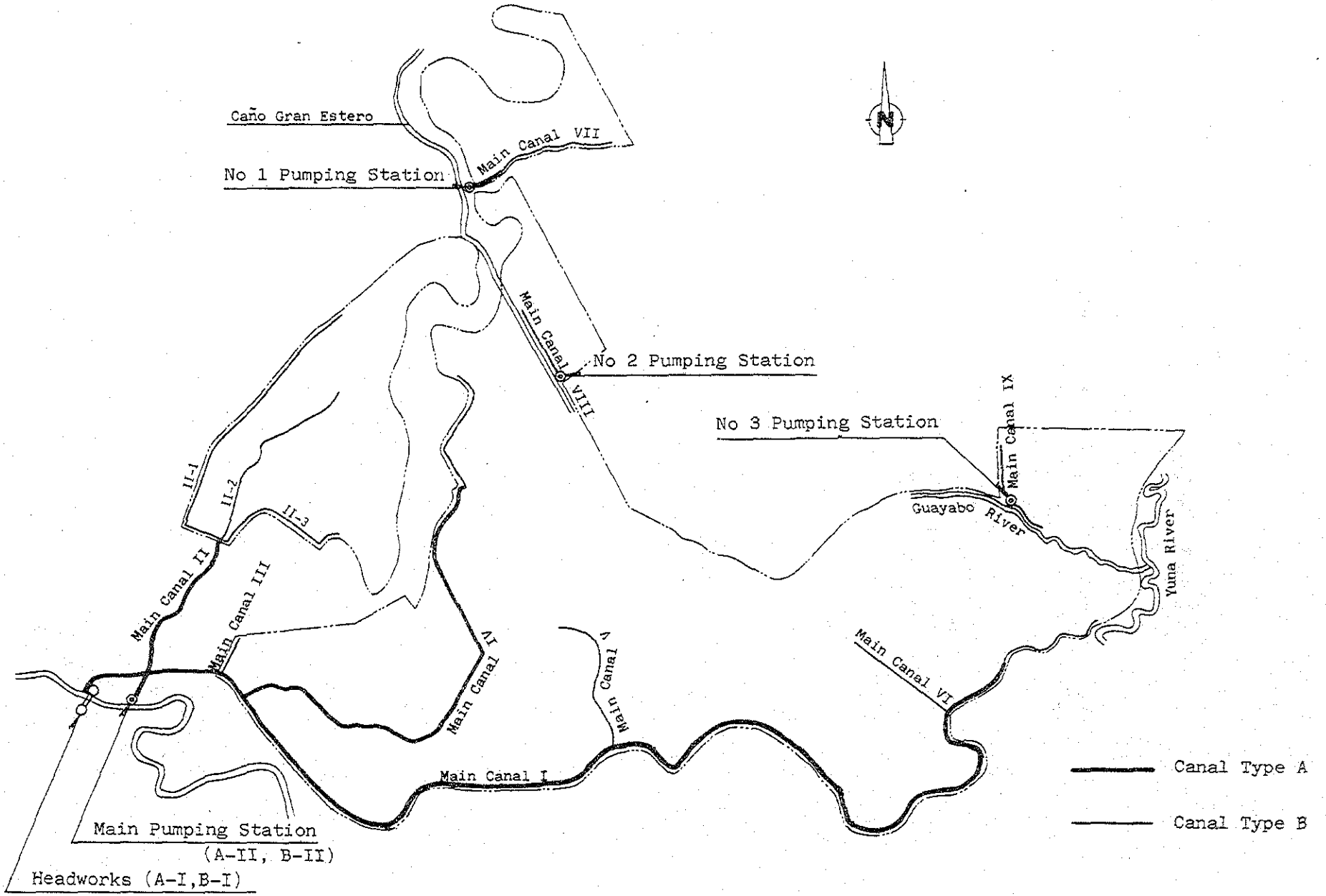


FIG. 4.4.1 PLAN OF MAIN IRRIGATION CANAL

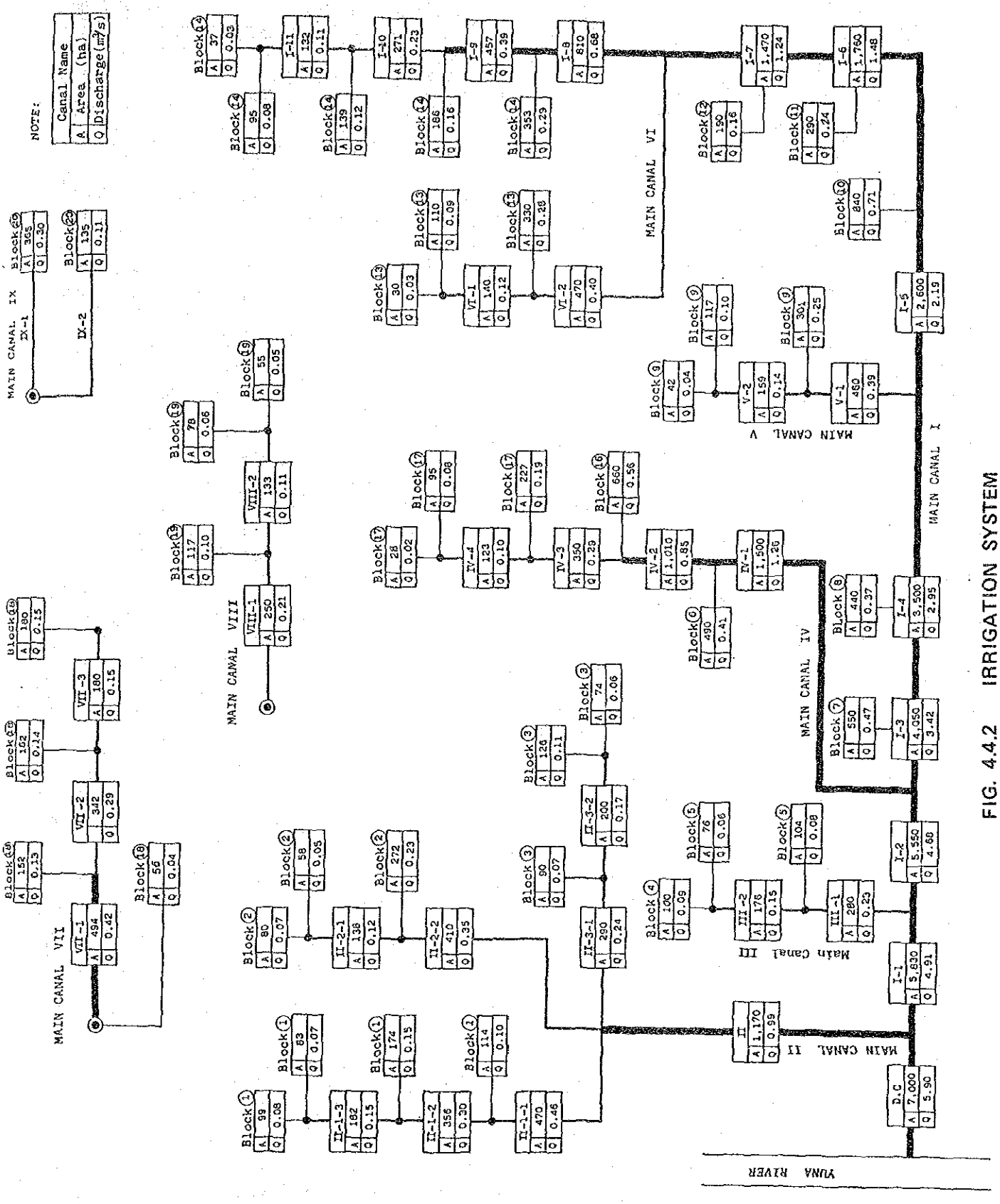
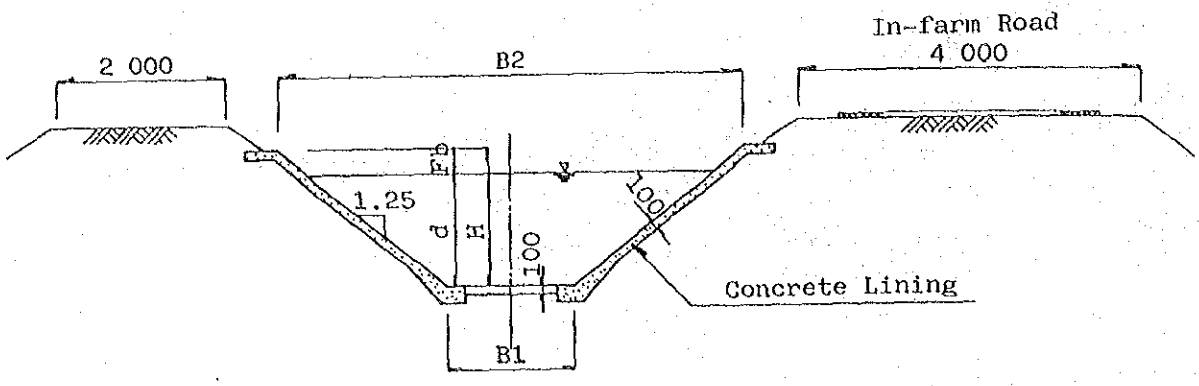
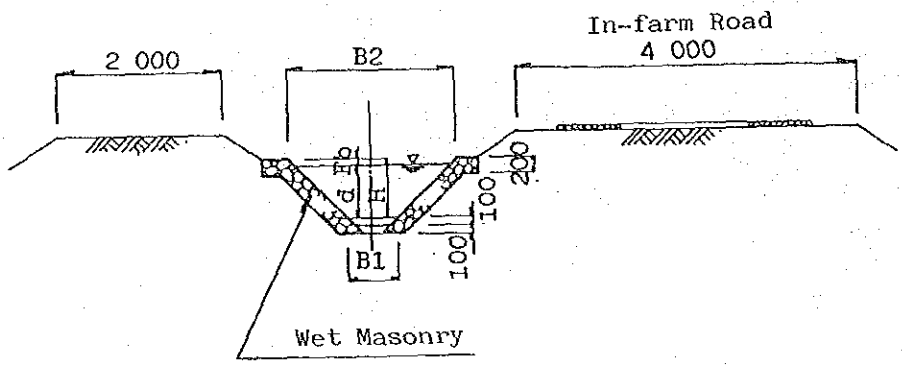


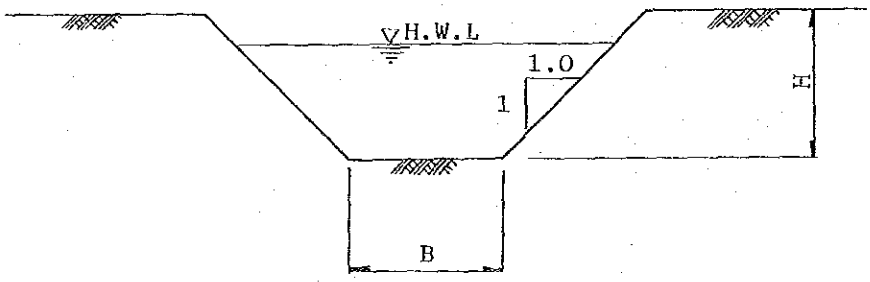
FIG. 4.4.2 IRRIGATION SYSTEM



Main Irrigation Canal Type-A



Main Irrigation Canal Type-B



Secondary Irrigation Canal

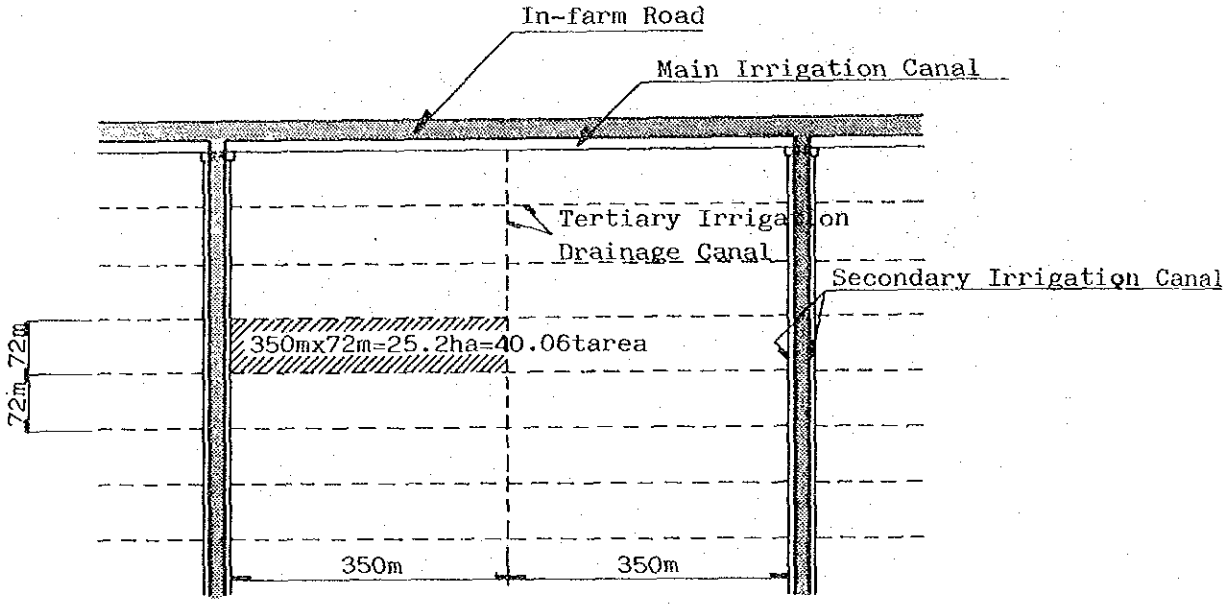
FIG. 4.4.3 CROSS-SECTIONS OF IRRIGATION CANALS

TABLE 4.4.4 LIST OF MAIN IRRIGATION CANALS

Name of Canal	Discharge Q (m³/s)	Gradient	Canal Length (m)			
			Alternative A-I	Alternative A-II	Alternative B-I	Alternative B-II
Driving Canal	5.90	1/6000	1,250m	700m	1,250m	700m
Main Canal I	4.91 ~ 0.11	1/6000	22,900	22,900	22,900	22,900
〃 II	0.99 ~ 0.12	1/600 ~1/1200	14,200	14,200	14,200	14,200
〃 III	0.23 ~ 0.15	1/3000	2,450	2,450	2,450	2,450
〃 IV	1.26 ~ 0.10	1/2000~1/3000	11,100	11,100	11,100	11,100
〃 V	0.36 ~ 0.14	1/1500	2,650	2,650	2,650	2,650
〃 VI	0.40 ~ 0.12	1/1500	2,000	2,000	2,000	2,000
〃 VII	0.42 ~ 0.15	1/6000	2,850	2,850	—	—
〃 VIII	0.21 ~ 0.11	1/6000	1,450	1,450	—	—
〃 IX	0.30 ~ 0.11	1/6000	1,800	1,800	—	—
Total			62,650m	62,100m	56,550m	56,000m
Density of Canal			7.5m/ha	7.5m/ha	8.1m/ha	8.1m/ha

4.4.4 Farmland Plan

In accordance with the IAD's land settlement policy, the standard farmland size has been proposed to be 40 tareas (2.5 ha), and an in-farm road is laid out along one side of each piece farmland. The dimensions of one parcel of farmland thus will be: 350m-long by 72m-wide (see figure below).



FARMLAND PLAN

4.4.5 Rural and In-farm Road Plan

Actually the following three rural roads exist within the study area.

Route	Length (km)
Cruce de Rincon - Aguacate Pumping Station	11.8
Cruce de Ponton - Cruce Las Cabirmas	12.8
Arenoso - La Mata	30.3

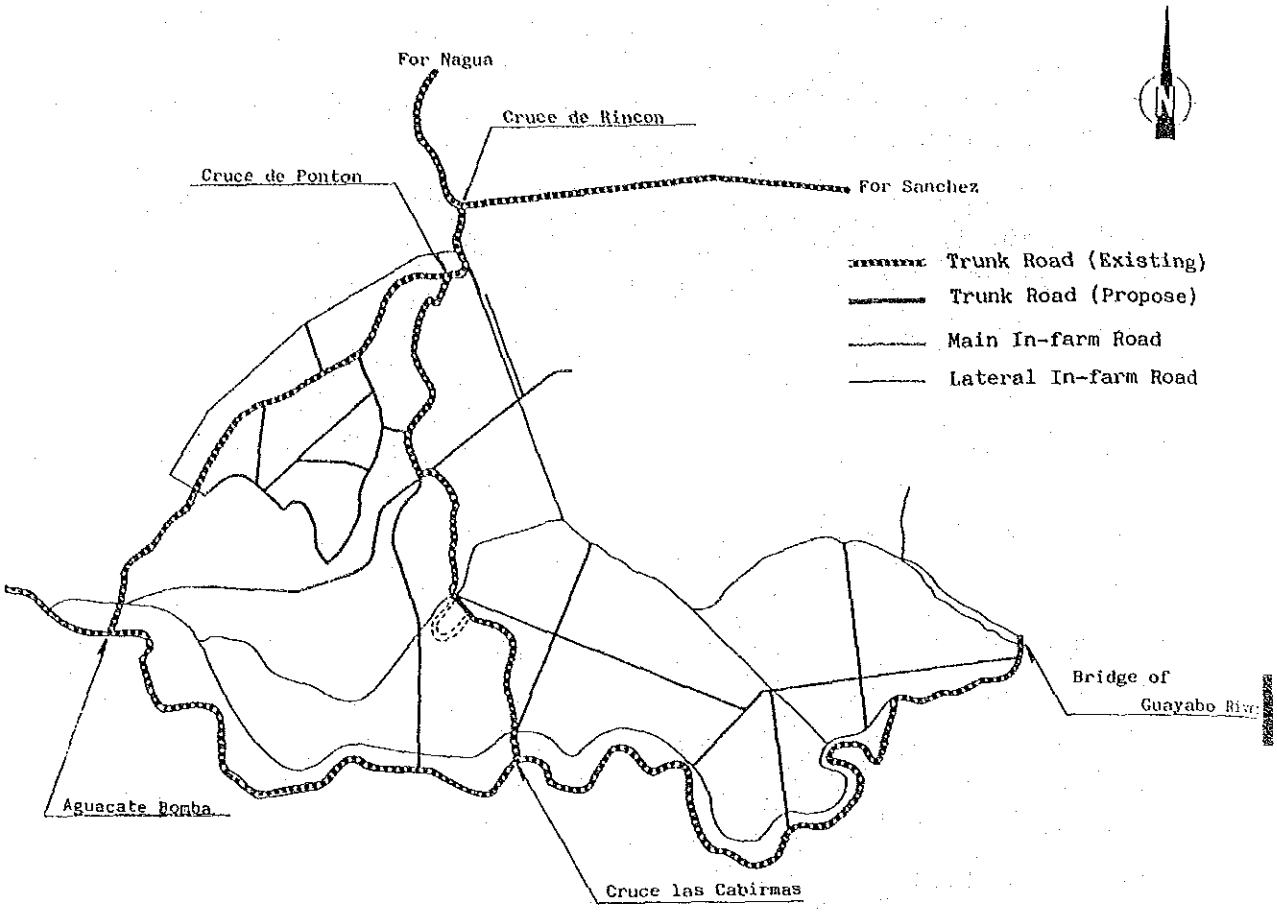
In the road network plan, the existing road will be left as they are except for such improvement works as cutting-off of a meandering part of the Cruce de Ponton - Cruce Las Cabrimas Route. A road network has been proposed connecting in-farm roads with rural roads (see Fig. 4.4.4). The length of this proposed road network is summarized in the table below.

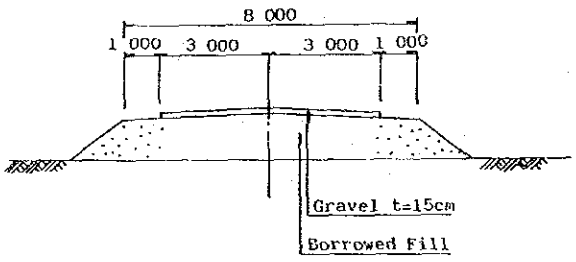
ROAD NETWORK PLAN

(Unit: m)

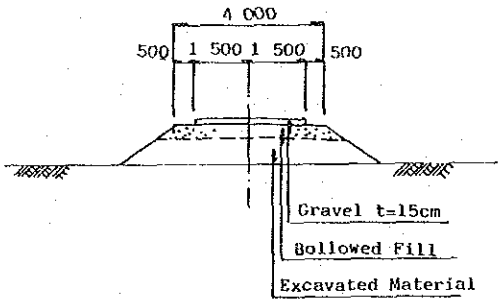
	Width	Alternatives			
		A-I	A-II	B-I	B-II
Trunk Rural Road	8.0	700	700	700	700
Trunk In-farm Road	6.0	46,700	46,700	43,900	43,900
Lateral In-Farm Road I	4.0	67,850	67,300	58,650	58,100
Lateral In-farm Road II	4.0	97,300	97,300	79,050	79,050
Total		212,550	212,000	182,300	181,750
Density of Road		25.6 m/ha	25.5 m/ha	26.0 m/ha	26.0 m/ha

Detailed study is presented in Annex J.8.

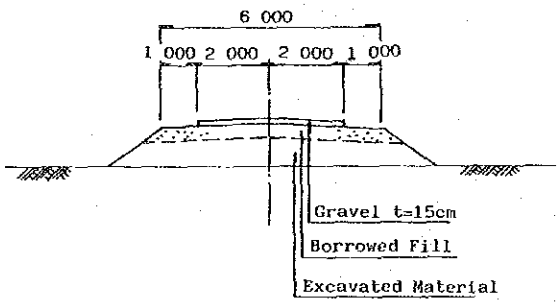




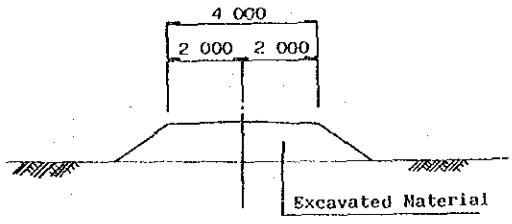
TRUNK ROAD



LATERAL IN-FARM ROAD I



MAIN IN-FARM ROAD



LATERAL IN-FARM ROAD II

FIG. 4.4.4 ROAD NETWORK

4.5 Drainage Plan

4.5.1 Basic Consideration

A topographic survey during the field work has revealed that the study area is covered by low and moist land with an elevation of less than 10 m above sea level. This topographic characteristic of the area has resulted in the formation of permanently inundated lands or frequently inundated lands even in the event of small flooding. Thus, the inadequate drainage of lands has constituted the principal constraint on the productive capacity of the study area. In view of these circumstances, an effective and economically viable drainage plan has been established in correspondence with the following basic considerations.

(1) The main drainage system will consist of the Caño Gran Estero and the Guayabo River and surplus water will be drained through these systems.

(2) The outlet of the Caño Gran Estero, which is presently closed due to the accumulation of soil, will be improved by constructing training levee. At the same time, with regard to the Guayabo River, the installation of a watergate at its confluence with the Yuna River has been proposed so as to protect against the invasion of flow from the Yuna River.

(3) The existing drains and rivers will be utilized as far as possible.

(4) A drainage network will include drains along each side of the farmland.

4.5.2 Design Criteria

The design criteria employed in establishing the drainage plan are as listed below:

Design drainage discharge	:	Flooding for 5 years' return period
Design daily rainfall	:	141.6 mm/day
Runoff ratio	:	0.4
Design outer water level		
Escocesa Bay	:	+ 0.40 m
Confluence of the Guayabo River and the Yuna River	:	+ 0.90 m

4.5.3 Drainage Canal

(1) Drainage System

The drainage system within the development area will consist of the Caño Gran Estero and the Guayabo River and water will be drained through these rivers (see Fig. 4.5.1).

(2) Design Drainage Discharge

The rational formula was applied for the establishment of design drainage discharge.

$$Q = \frac{1}{3.6} . f . r . A$$

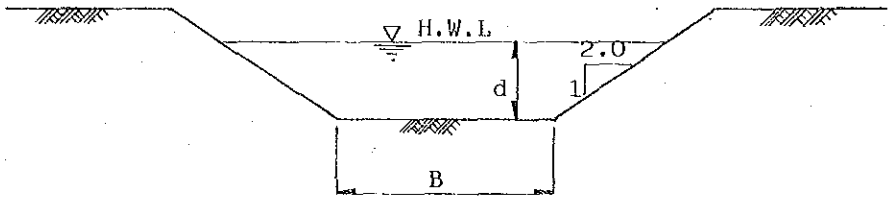
where, Q : peak discharge (m^3/s)
f : runoff coefficient
r : average rainfall intensity for the duration of flooding (mm/hr)
A : area to be drained (km^2)

The maximum peak discharges for each main drain are as computed below:

Main Drainage Canal I	:	$Q = 73.9\ m^3/s$
Main Drainage Canal II	:	$Q = 15.9\ m^3/s$
Main Drainage Canal III	:	$Q = 17.8\ m^3/s$
Main Drainage Canal IV	:	$Q = 8.9\ m^3/s$

(3) Cross-section of Drainage Canal

The Manning formula was employed for establishing the design criteria for the cross section of the drainage canal. The standard cross-section is as illustrated below.



CROSS-SECTION OF DRAINAGE CANAL

Design criteria of the main drainage canals are summarized in the following table.

DESIGN CRITERIA OF MAIN DRAINAGE CANAL

Main Drainage Canals	Maximum Peak Discharge Q (m^3/s)	Gradient of Canal I	Bottom Width B (m)	Depth of Flow d (m)	Cross-sectional Area of Flow A (m^2)	Velocity of Flow V (m/s)
I	73.9	1/15,000	45.00	3.40	176.1	0.41
II	15.9	1/6,000	15.00	2.00	38.0	0.44
III	17.8	1/15,000	20.00	2.50	62.5	0.32
IV	8.9	1/20,000	15.00	2.00	38.0	0.24

Standard cross-sections for the upper stream portion of the main drainage canals and secondary ones together with their hydraulic calculations are presented in ANNEX K.

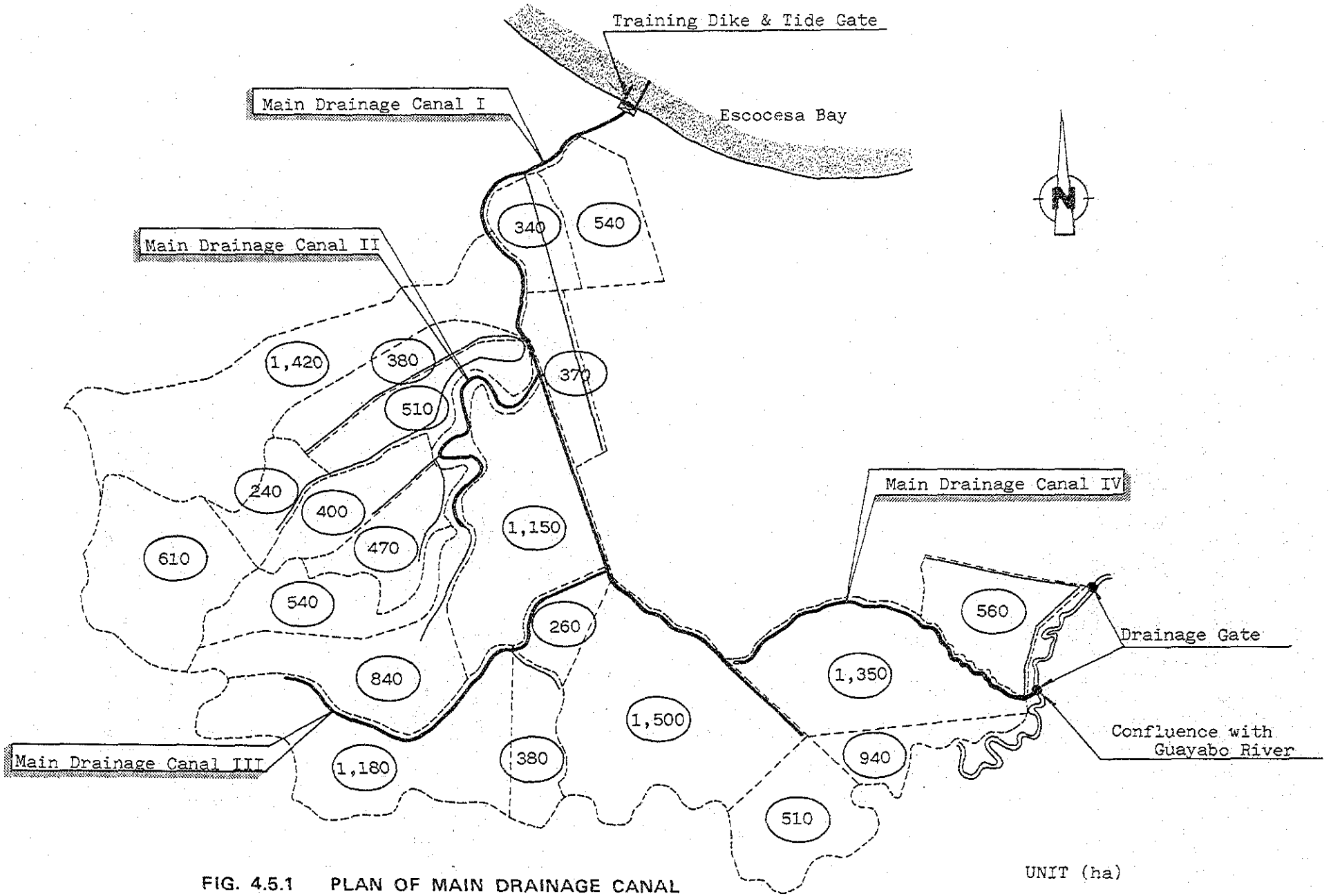


FIG. 4.5.1 PLAN OF MAIN DRAINAGE CANAL

4.5.4 Drainage Facilities

(1) Tide Gate

The Caño Gran Estero, for which improvement is planned so as to attain effective drainage, contains water of high salinity (500 ppm - 1,500 ppm) stagnated between its outlet and Cruce de Rincon; this water presents a constraint on being used as irrigation water for rice production.

It is expected that the salt wedge will be extended with the realization of the improvement work at the river-mouth of the Caño Gran Estero. The invasion of the salt wedge will be alleviated by constructing a tide gate as has been proposed in Alternatives A-I and A-II which comprise the diversion of irrigation water from the Caño Gran Estero. In case of Alternatives B-I & B-II a tide gate would not be designed in view of the fact that the Caño Gran Estero is not considered as a source of irrigation water. The outline of the tide gate is shown in 4.6.4.

(2) Training Dike

The closing of an outlet caused by the formation of a sandbank is frequently observed in the Caño Gran Estero like other tributaries draining to Escocesa Bay. The construction of a training dike has thus been proposed to prevent the formation of sandbank. The design of training dike has been made so that it might extend from shoreline to the fractured zone (see 4.6.5 for reference of the facility).

(3) Drainage Gate

The Guayabo River is one of confluents of the Yuna River and, at high tide in Sanchez Bay, the flow of the latter is directed to the upstream of the former. Furtheremore, this situation may occur in case of flooding of the Yuna River. Due to these circumstance, the installation of a drainage gate at the confluence has been proposed so as to prevent the Guayabo River from being invaded by the flow of the Yuna River.

4.6 Facilities Plan

4.6.1 Outline of Facilities

The major facilities to be constructed in this project are irrigation and drainage facilities and road networks.

(1) Irrigation Facilities

Major irrigation facilities are as follows;

Intake facilities	:	Headworks on the Yuna River (Alternatives A-I & B-I)
	:	Pumping Station on the Yuna River (Alternatives A-II & B-II)
	:	Sub-pumping stations (Alternatives A-I & A-II)
Irrigation canals	:	Main and secondary canals
Related structures	:	Diversion works, Check gates etc.

(2) Drainage Facilities

Major drainage facilities are as follows;

Drainage canals	:	Main, secondary and tertiary canals
Related structures	:	Training dike
	:	Tide gate (Alternatives A-I & B-I)
	:	Drainage gate
	:	Outlet

(3) Road

Road facilities are as follows;

Road	:	Trunk road
	:	Main in-farm road
	:	Lateral in-farm road
Related structures	:	Bridges, Culverts

Summary of facilities for each alternative is shown in the Table 4.6.1 and details are described in ANNEX L.1.

TABLE 4.6.1 SUMMARY OF FACILITIES

Facilities		Alternative A-I	Alternative A-II	Alternative B-I	Alternative B-II	Remarks
Irrigation Facilities	Main Intake Facilities	Headworks on Yuna River Type: Floating type Height of gate: 3.8 m Length of headworks: 68.5 m Intake rate: 5.9 m^3/s	Pumping station on Yuna River Type: Vertical mixed flow Diameter & Nos.: ϕ900 mm x 3 units Actual pump head: 4.3 m Pumping up capacity: 5.9 m^3/s	Headworks in Yuna River Type: Floating type Height of gate: 3.8 m Length of headworks: 68.5 m Intake rate: 5.9 m^3/s	Pumping Station on Yuna River Type: Vertical mixed flow Diameter & Nos.: ϕ900 mm x 3 units Actual pump head: 4.3 m Pumping up capacity: 5.9 m^3/s	
	Sub-Intake Facilities	No. 1 Pumping station Q = 0.46 m^3/s No. 2 Pumping station Q = 0.21 m^3/s No. 3 Pumping station Q = 0.41 m^3/s	Same as left	None	None	Pump type: Inclined mixed flow
	Irrigation Canals	Main canal: 62,650 m Type A 35,450 Type B 27,200 Secondary canal 242,600 m Total 305,250 m	Main canal: 62,100 m Type-A 34,900 Type B 27,200 Secondary canal 242,600 m Total 304,700 m	Main canal 56,550 m Type A 34,200 Type B 22,350 Secondary canal 200,900 m Total 257,450 m	Main canal 56,000 m Type A 33,650 Type B 22,350 Secondary canal 200,900 m Total 256,900 m	Type A: Concrete lined Type B: Wet masonry
	Diversion Works Check Gates	95 units 30 units	95 units 30 units	80 units 25 units	80 units 25 units	
Drainage Facilities	Drainage Canals	Main canal 44,300 m Secondary canal 31,300 m Tertiary canal 114,700 m Total 190,300 m	Same as left	Main canal 44,330 m Secondary canal 22,400 m Tertiary canal 99,900 m Total 166,600 m	Same as left	
	Tide Gate Training Dike Drainage Gate Outlet	1 units 320 m 2 units 21 units	1 unit 320 m 2 units 21 units	None 320 m 2 units 21 units	None 320 m 2 units 21 units	
Road	Road	Trunk road 700 m Main in-farm road 46,700 m Lateral in-farm road 165,150 m Total 212,550 m	Trunk road 700 m Main in-farm road 46,700 m Lateral in-farm road 164,600 m Total 212,000 m	Trunk road 700 m Main in-farm road 43,900 m Lateral in-farm road 137,700 m Total 182,300 m	Trunk road 700 m Main in-farm road 43,900 m Lateral in-farm road 137,150 m Total 181,750 m	
	Bridges Culverts	9 units 32 units	9 units 32 units	8 units 29 units	8 units 29 units	

4.6.2 Headworks

(1) General

Headworks on the Yuna River has been planned as a main intake facility for Alternatives A-I and B-I. As the area covered by the intake rate of headworks is same in two alternatives, the location and the scale of facilities are identical. Besides the headworks, Alternative A-I requires small scale pumping stations as sub-intake facilities.

(2) Basic Consideration

Basic consideration for planning of headworks is as follows;

1) As no significant river improvement works are made for the Yuna River, the free board of natural banks are not sufficient to contain flood waters and, thus, inundations are often seen.

   This project plan is concerned only with agricultual development and does not include a flood control scheme. It is believed that flood damage should not be accelerated by the construction of the headworks. Principally, a fixed weir will not be employed within the cross section of the river flow. Aiming to maintain the existing river cross-section, a movable weir is planned for this Project.

2) In the case of movable weir, safety management for gate operation is the most important aspect, therefore counter-measures in the event of an emergency are definitely required.

(3) Location

As the result of a comparison study, the location of Arenoso was selected as the construction site in light of the lower construction costs, easier maintenance and superior operation as compared to the Chiringo location. The detailed analysis is described in ANNEX L.2.2.

(4) Feature of Headworks

Type	:	Floating type
Design flood discharge	:	700 m^3/S
Design flood water level	:	EL 11.40 m
Design water requirement	:	5.90 m^3/S
Design water intake level	:	EL 7.60 m
Design river bed	:	EL 3.80 m
Design water depth	:	3.80 m
Length of headworks	:	68.50 m
Scouring sluice	:	B 12.50 m x H 4.107 m x 1 set
Flood sluice	:	B 25.00 m x H 3.90 m x 2 sets
Intake	:	B 2.00 m x H 2.00 m x 2 sets
Elevation of emergency floodway	:	EL. 7.70 m
Bottom width of emergency floodway	:	52.00 m

The general plan of the headworks is shown in the FIGs. 4.6.1 and 4.6.2 and detailed analysis is described in ANNEX L.2 and L.3.

(5) Countermeasures in an Emergency

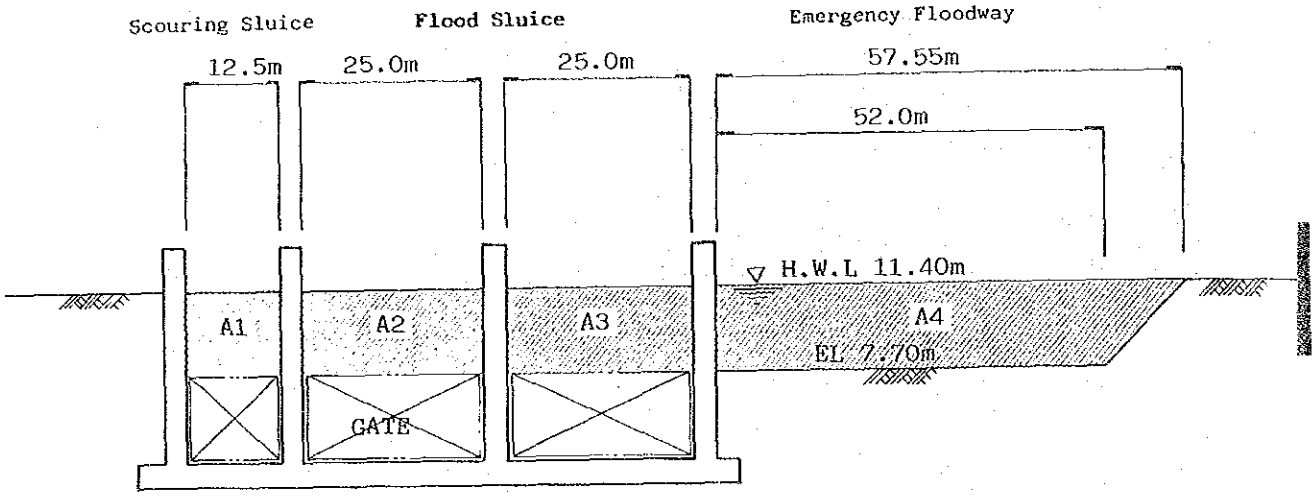
In order to achieve the proper functioning of the gates, adequate operation and maintenance should be established. The following countermeasures should be taken into consideration in the event of inadequate functioning of the gates.

- Countermeasure 1: Supplemental power suply source will be considered.

- Countermeasure 2: Manual operation system will be established.

- Countermeasure 3: Installation of an emergency floodway.

An emergency floodway will be considered as to handle the inflow of flood water in case a flood sluice gate should not be opened. The section of this floodway will be kept not smaller than actual flow area (430 m^2).



$A1 + A2 + A3 + A4 = 434\ m^2 \quad 430\ m^2$

The detailed analysis is described in ANNEX L.3.7.

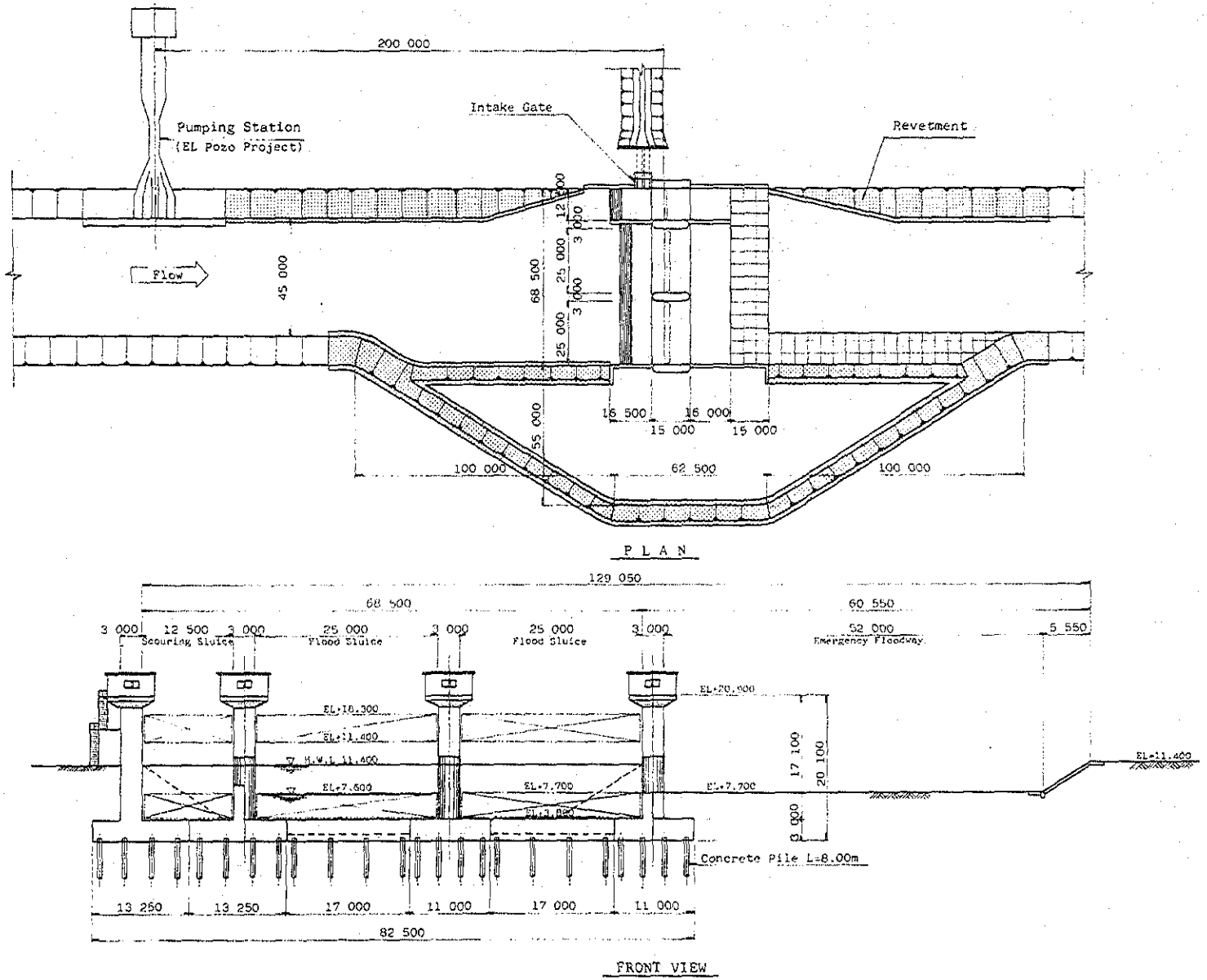


FIG. 4.6.1 GENERAL PLAN OF HEADWORKS (1/2)

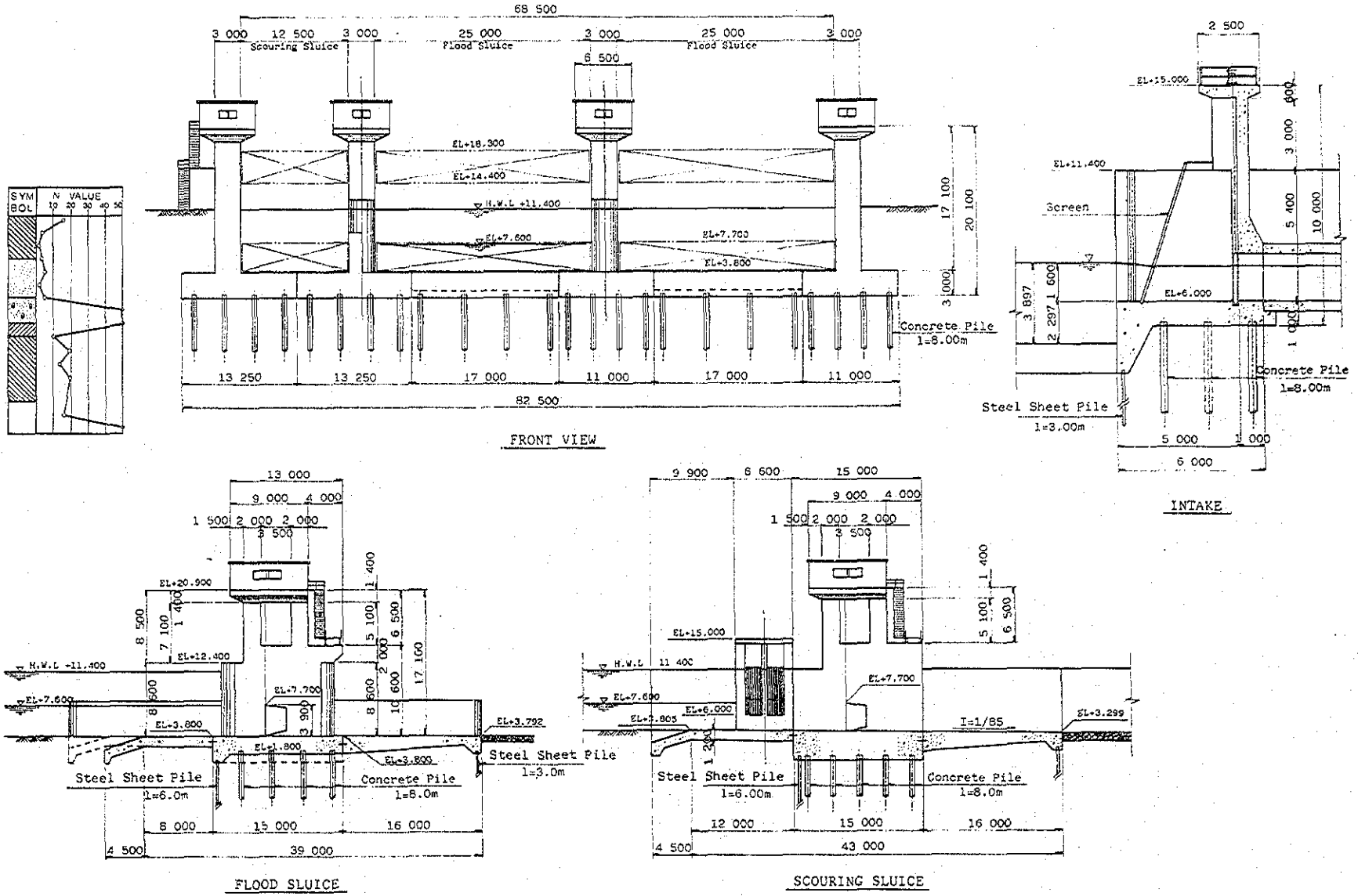


FIG. 4.6.2 GENERAL PLAN OF HEADWORKS (2/2)

4.6.3 Pumping Station

(1) General

A pumping station on the Yuna River has been proposed as a main intake facility for Alternatives A-II and B-II. Besides the main pumping station, three sub-pumping stations are required for Alternative A-II.

(2) Main Pumping Station

1) Location

As a result of a location analysis for the main pumping station, the construction site has been planned 400 m upstream from the existing Aguacate pumping station. The major reasons are as follows;

- The river flow as well as the course is stable at this site.
- The rock foundation is found to be more shallow, which places this site at an advantage in the context of the foundation improvement works.
- The existing road passing beside this site can be used as an access road for the construction works.
- Houses are not concentrated.
- The distance from the terminal of the main irrigation canal is comparatively short and thus advantageous from hydraulic and economic points of view.

2) Design Criteria

- Pumping up capacity : 5.90 m^3/S
- Intake water surface : 3.70 m
- Discharge water surface : 8.00 m
- Actual head : 4.30 m
- Total loss of suction & discharge head : 0.60 m
- Total head : 4.90 m

3) Specifications of Pumps

Three (3) pump units have been planned as a result of consideration of discharge regulation, risk factors, pump house space and equipment costs. The vertical mixed flow type is employed due to available discharge regulation and advantageous pumping efficiency.

- Discharge capacity per unit: 118 m^3/min

$$\left(\frac{5.90\ m^3/s \times 60\ min}{3\ units}\right)$$

- Pump diameter : 900 mm
- Rotation : 424 r.p.m.
- Motor output

An electric motor is employed due to the ease operation and maintenance. Required output is as follows;

$$S = \frac{0.163 \times Q \times H \times (1 + \alpha)}{\eta P}$$

where:

S : Motor output (Kw)

Q : Discharge capacity (118 m^3/min)

H : Total head (4.9 m)

ηP: Pump efficiency = 80%

α : Allowance = 20%

$$S = \frac{0.163 \times 118 \times 4.9 \times (1 + 0.2)}{0.8} = 142 \text{ KW}$$

Thus, a 145 KW electric motor with 16 poles will be employed.

4) Structure of Pumping Station

For easy operation and maintenance and protection against flood damage, a double deck structure with upper positioned equipment will be proposed. The structure is shown in Fig. 4.6.3.

5) Measures for Stable Intake

The ground sill will be constructed on the river bed at the intake sites on the Yuna River to ensure the stable intake of the pumps.

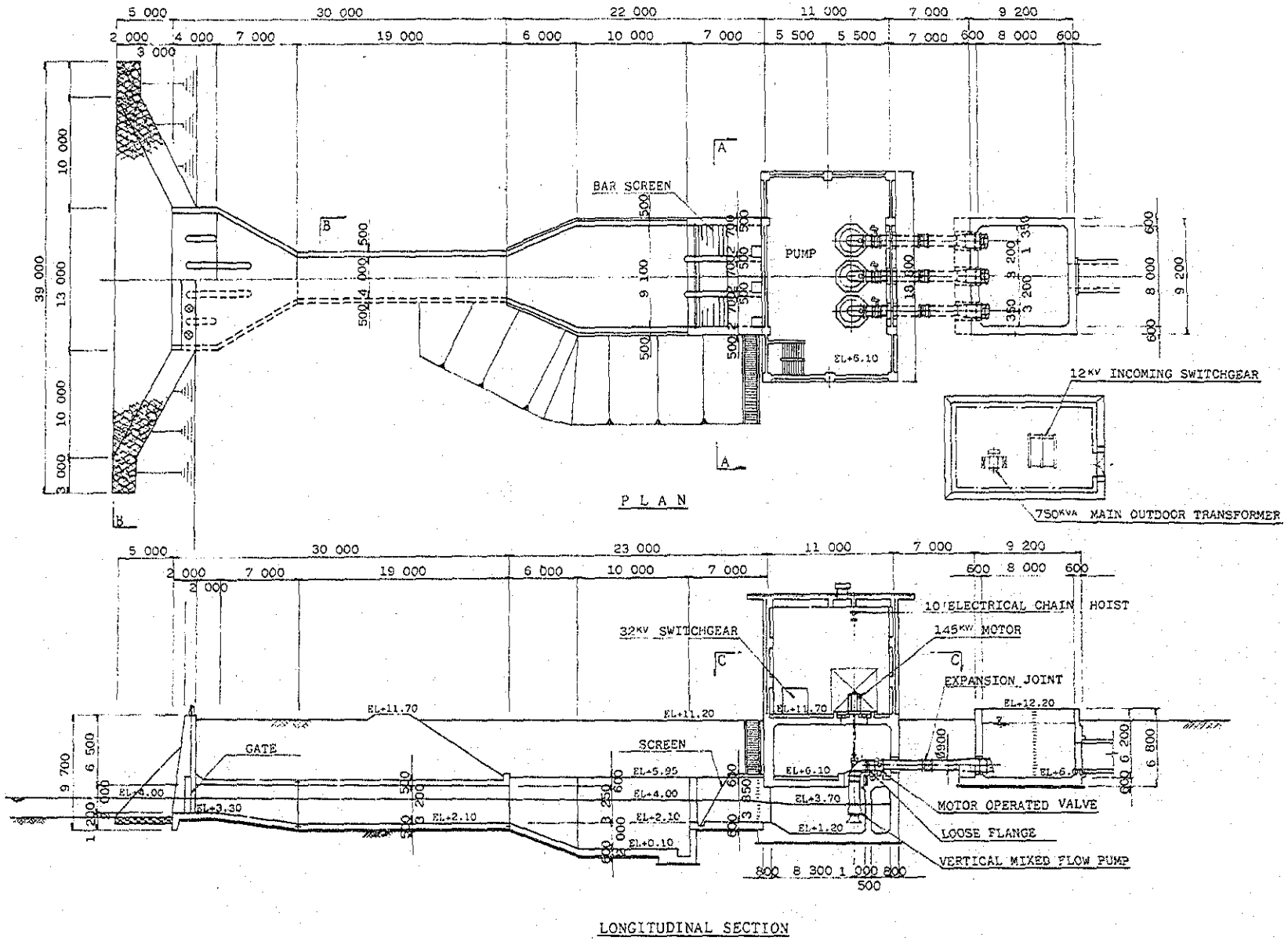


FIG. 4.6.3 GENERAL PLAN OF MAIN PUMPING STATION

(3) Sub Pumping Station

Location and design criteria of sub pumping stations are as follows:

	No. 1 Pumping Station	No. 2 Pumping Station	No. 3 Pumping Station
Location	Cruce de Rincon	Rincon Molinillo	Guayabo
Pumping up capacity	0.46 m^3/s	0.21 m^3/s	0.41 m^3/s
Type of pump	Inclined mixed flow pump	Inclined mixed flow pump	Inclined mixed flow pump
Diameter & Nos.	ϕ350 mm x 2 units	ϕ350 mm x 1 unit	ϕ350 mm x 2 units
Discharge capacity	13.8 m^3/min	12.6 m^3/min	12.3 m^3/min
Total Head	5.5 m	4.8 m	3.1 m

4.6.4 Tide Gate

(1) General

For the prevention of salt water intrusion, a tide gate has been planned at the outlet of the Cano Gran Estero.

(2) Cross-section

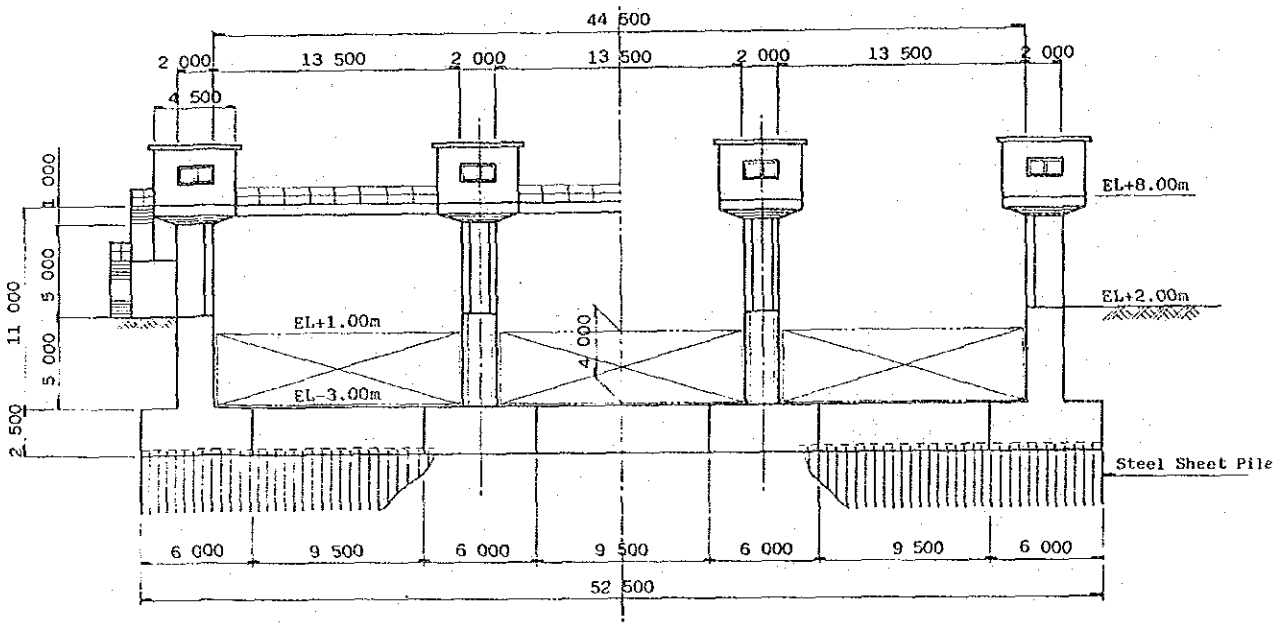
The cross section of the tide gate shall comply with that of the Cano Gran Estero. In consideration of the continuous operation of gate, three spans have been proposed. Accordingly, the dimensions of gate are;

13.50 m width x 4.00 m height x 3 units

The elevation of gate has been designed.as follows;

Highest high water level (H.H.W.L.)	+ 0.70 m
Allowance	0.30 m
Elevation of gate	+ 1.00 m

The detailed analysis is described in ANNEX L.5.



Front View of Tide Gate

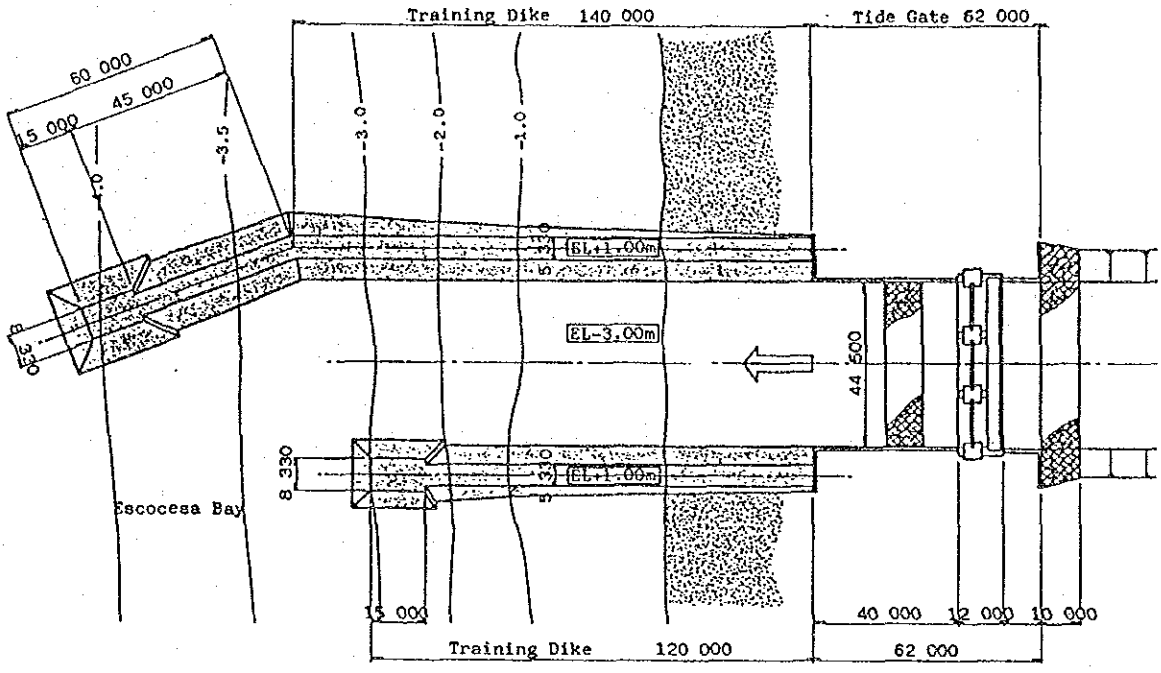
4.6.5 Training Dike

(1) General

In view of the mitigating accumulation of sand at the outlet of the Caño Gran Estero, the construction of a training dike has been considered at the newly opened river-month.

(2) Location of Head for Training Dike

Drift sand is frequently observed within the breaker zone, therefore, the head of training dike should be located on the offshore side from the point in which more frequent breaker a depth is observed. It is proposed that the head of a training dike be located at depth of 4 m.



(3) Structure

From a technical and economic viewpoint, concrete blocks designed for breakwater will be used as materials for the training dike. The weight of each block will be around 6 tons.

Detailed analysis is described in ANNEX L.6.

CHAPTER 5: IMPLEMENTATION PLAN OF THE PROJECT

CHAPTER 5: IMPLEMENTATION PLAN OF THE PROJECT

5.1 Construction Schedule

The construction period for all alternatives i.e., A-I, A-II, B-I and B-II is set at four years, taking account of total amount of construction, similar scale of previous projects in the neighboring area and similar kinds of construction works.

Construction period of each civil works are arranged so as to generate the economic benefits of the Project as early as possible by relaxing the water shortage in the existing paddy field. Also important are considerations regarding the quantity and disposition of the proposed construction equipment and coordination among each item of civil works.

The proposed construction schedule of each alternative is shown in Fig. 5.1.1.

5.1.1 Preparatory Works

Preparatory works will be conducted in one and a half years, of which one year is for detailed design and preparation of tender documents and a half year for tendering and its evaluation. Topographic survey of an intake structure and other major structures, route survey of the irrigation and drainage canals and road networks, and a geological investigation of the said structures are included in the scope of detailed design.

5.1.2 Construction of Irrigation Structures

Construction of irrigation structures will begin at the earliest stage of the whole construction period and will be completed within two and a half years so that the water shortage in the existing paddy field may be relaxed and hence the project benefits can be generated as early as possible.

Excavated materials will be used for the embankment of the main and lateral roads, if they are qualified for this purpose. Meanwhile disqualified ones will be used as dressing soil for the neighboring paddy fields.

5.1.3 Construction of Drainage Structures

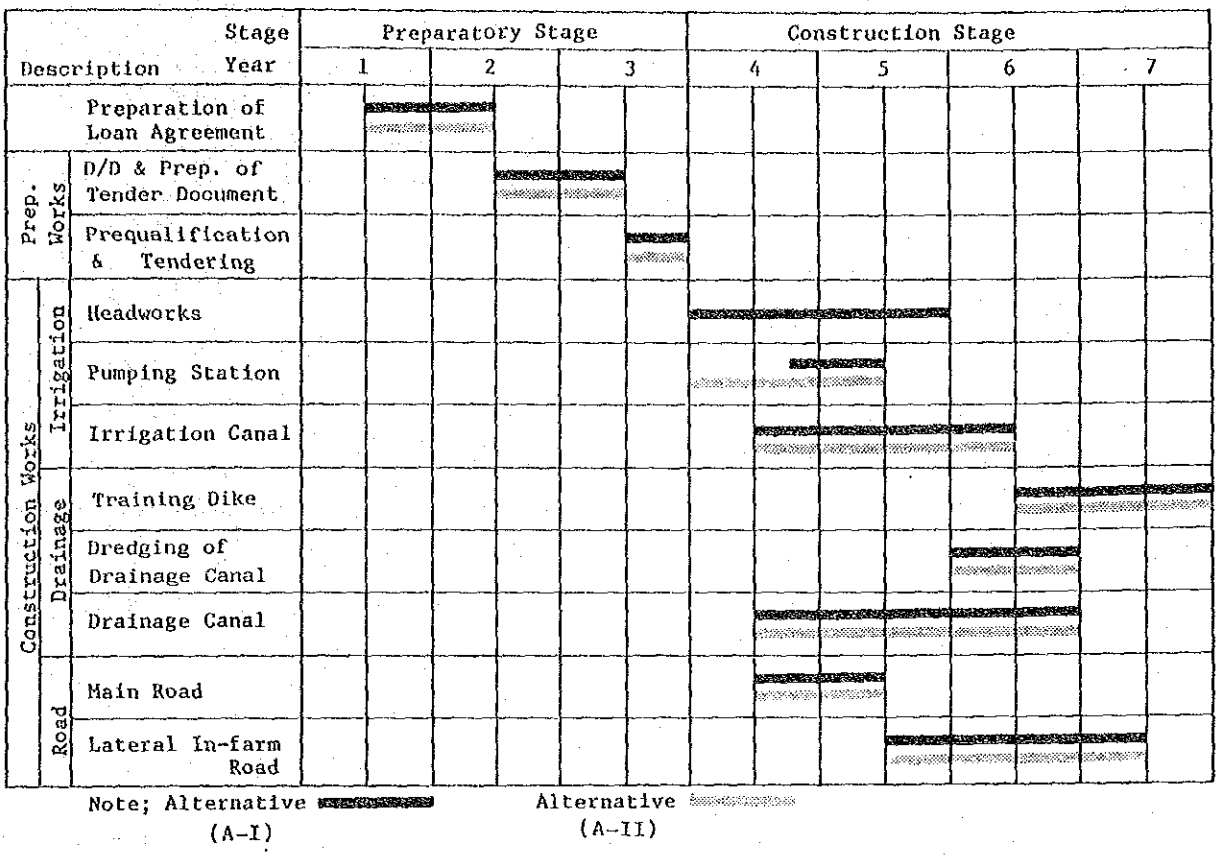
Construction of drainage structures will be carried out in the latter half of the construction period of the project, that is two and a half years following construction of the irrigation facilities. However, since most of the lateral drainage canals are located very closely to the lateral irrigation canals, construction of both canals will be undertaken at the same time.

Rehabilitation of the existing drainage canals and excavation of some parts of the river will be carried out by a pump dredger(400 HP portable type). The training dike adjacent to the tide gate will also be constructed by the pump dredger. Therefore, the river dredging must be completed before starting construction on the training dike. Excavated materials will be utilized as dressing soil for the neighboring paddy field. Under Alternative A, temporary materials such as sheet pile will be allocated for the construction of both intake structures and a tide gate.

5.1.4 Road Network

The rural and access roads are schedule to be completed within one and a half year after the commencement of construction works so that they can be used as temporary roads for construction work. The construction of lateral in-farm roads will be carried out coincidently with that of lateral irrigation and drainge canals. Embankment material will be selected out of excavated materials from irrigation and drainage canals. The deficient embankment materials will be supplied from borrow-pit.

ALTERNATIVE A



ALTERNATIVE B

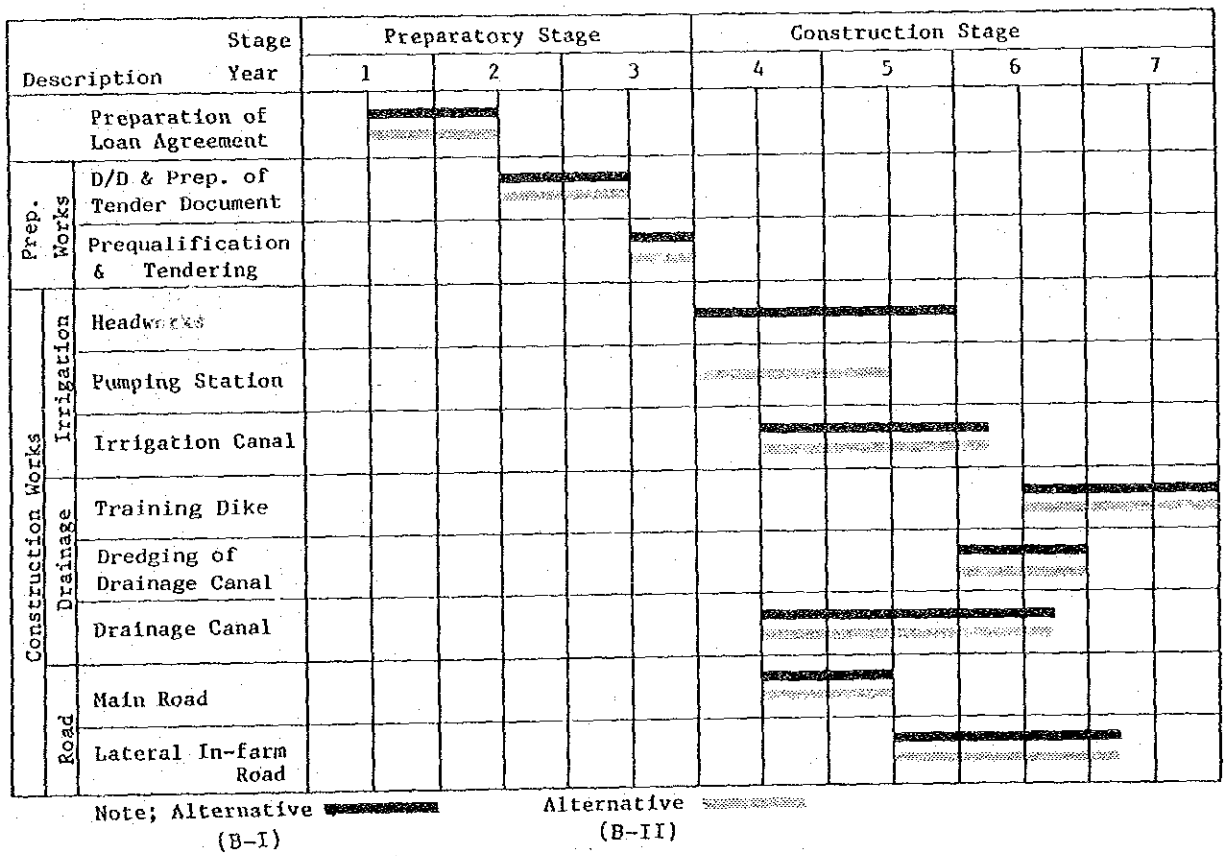


FIG. 5.1.1 THE IMPLEMENTATION SCHEDULE FOR THE PROJECT

5.2 Project Costs

5.2.1 Basic Parameters in Estimation of Project Costs

For the estimation of Project costs the following parameters have been used.

(1) Equipment Cost

Construction of the project facilities will be executed under a contract basis. Equipments necessary for the construction will be provided by the contractor. Therefore, the depreciation cost of equipments constitutes the equipment cost.

(2) Basic Unit Price

Basic unit prices such as wages, materials and equipment applied for project costs estimation was employed current prices prevailing in the Dominican Republic.

(3) Unit Cost

The unit cost of construction items is divided into foreign currency and local currency portions. The foreign currency portion is calculated on the basis of CIF to Santo Domingo as of 1985 and local currency portion is based on the market prices in the country at the time.

(4) Exchange Rate

An exchange rate of US$1.00 = RD$3.12 as of 1985 is used.

(5) Contingency

The contingency for the project costs is classified into physical and price escalation contingencies. Physical contingency is estimated at 15% of the direct and indirect costs and price

escalation contingency is estimated based on the assumption of price escalation rate being at 3.0% p.a. for the foreign currency portion and at 13% p.a. for the local currency portion.

5.2.2 Project Costs and Operation and Maintenance Costs

(1) Project Costs

Project costs for each alternative are estimated according with the construction implementation schedule. The estimated costs of each alternative are summarized as follows:

SUMMARY OF PROJECT COSTS

(Unit: RD$1,000)

Alternatives	F/C	L/C	Total
A - I	98,052	90,542	188,594
A - II	94,331	85,147	179,478
B - I	69,220	64,440	133,660
B - II	66,214	61,137	127,351

(2) Operation and Maintenance Costs

Based on the proposed operation and maintenance plan, annual operation and maintenance costs are estimated as presented below.

OPERATION AND MAINTENANCE COSTS

(Unit: RD$ 1,000)

Alternatives	Electric Charge	O/M Cost	Total
A - I	105	1,905	2,010
A - II	648	2,288	2,936
B - I	1	1,260	1,261
B - II	584	1,659	2,243

(3) Annual Disbursement Schedule of the Project Costs

In compliance with the implementation schedule of the Project, annual disbursement of the Project costs is as follows:

(Unit: RD$1,000)

	A - I			A - II		
	F/C	L/C	Total	F/C	L/C	Total
1987	2,391	499	2,890	2,391	499	2,890
1988	4,694	1,122	5,816	4,694	1,079	5,773
1989	10,983	8,436	19,419	15,304	8,660	23,964
1990	27,842	25,021	52,863	20,095	19,830	39,925
1991	33,517	36,116	69,633	33,209	35,745	68,954
1992	18,625	19,348	37,973	18,638	19,334	37,972
Total	98,052	90,542	188,594	94,331	85,147	179,478

	B - I			B - II		
	F/C	L/C	Total	F/C	L/C	Total
1987	2,391	499	2,890	2,391	499	2,890
1988	4,694	1,024	5,718	4,694	984	5,678
1989	7,937	5,473	13,410	11,303	6,128	17,431
1990	20,594	18,617	39,211	14,317	14,806	29,123
1991	24,103	27,828	51,931	24,011	27,711	51,722
1992	9,501	10,999	20,500	9,498	11,009	20,507
Total	69,220	64,440	133,660	66,214	61,137	127,351

Note: F/C = Foreign currency portion
L/C = Local currency portion

TABLE 5.2.1 PROJECT COST

(R0$ 1,000)

	A - I			A - II			B - I			B - II		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
1 Construction Cost												
1.1 Preparatory Work	775	235	1,010	775	235	1,010	775	235	1,010	775	235	1,010
1.2 Headworks	10,127	3,130	13,257	-	-	-	10,127	3,130	13,257	-	-	-
1.3 Pumping Station	-	-	-	7,712	1,810	9,522	-	-	-	7,712	1,810	9,522
1.4 Sub Pumping Station	2,417	651	3,068	2,417	651	3,068	-	-	-	-	-	-
1.5 Irrigation Canal	11,013	13,219	24,232	10,587	12,108	22,695	7,020	9,377	16,397	6,883	9,198	16,081
1.5.1 Driving Canal	(358)	(1,485)	(1,843)	(211)	(289)	(500)	(316)	(424)	(740)	(179)	(245)	(424)
1.5.2 Main Irrigation Canal	(6,896)	(9,277)	(16,173)	(6,896)	(9,277)	(16,173)	(4,388)	(7,338)	(11,726)	(4,388)	(7,338)	(11,726)
1.5.3 Secondary Irrigation Canal	(1,265)	(1,658)	(2,923)	(1,265)	(1,658)	(2,923)	(780)	(1,030)	(1,810)	(780)	(1,030)	(1,810)
1.5.4 Related Structures	(2,494)	(799)	(3,293)	(2,215)	(884)	(3,099)	(1,536)	(585)	(2,121)	(1,536)	(585)	(2,121)
1.6 Drainage Canal	14,776	9,371	24,147	14,776	9,371	24,147	10,993	6,940	17,933	10,993	6,940	17,933
1.6.1 Main Drainage Canal	(12,116)	(6,622)	(18,738)	(12,116)	(6,622)	(18,738)	(9,481)	(5,361)	(14,842)	(9,481)	(5,361)	(14,842)
1.6.2 Secondary Drainage Canal	(1,625)	(1,272)	(2,897)	(1,625)	(1,272)	(2,897)	(865)	(688)	(1,533)	(865)	(688)	(1,553)
1.6.3 Tertiary Drainage Canal	(591)	(869)	(1,460)	(591)	(869)	(1,460)	(387)	(628)	(1,015)	(387)	(628)	(1,015)
1.6.4 Outlet of Drainage Canal	(444)	(608)	(1,052)	(444)	(608)	(1,052)	(260)	(263)	(523)	(260)	(263)	(523)
1.7 Tide Gate	6,879	2,258	9,137	6,879	2,258	9,137	-	-	-	-	-	-
1.8 Training Dike	4,345	3,653	7,998	4,345	3,653	7,998	4,345	3,653	7,998	4,345	3,653	7,998
1.9 Outlet Gate	1,287	530	1,817	1,287	530	1,817	805	292	1,097	805	292	1,097
1.10 Road Work	3,560	4,212	7,772	3,560	4,212	7,772	2,495	2,802	5,297	2,495	2,802	5,297
1.10.1 Trunk Road	(51)	(40)	(91)	(51)	(40)	(91)	(47)	(36)	(83)	(47)	(36)	(83)
1.10.2 Main In-farm Road	(1,107)	(903)	(2,010)	(1,107)	(903)	(2,010)	(800)	(648)	(1,448)	(800)	(648)	(1,448)
1.10.3 Lateral In-farm Road	(142)	(67)	(209)	(142)	(67)	(209)	(90)	(42)	(132)	(90)	(42)	(132)
1.10.4 Bridge	(2,186)	(3,014)	(5,200)	(2,186)	(3,014)	(5,200)	(1,498)	(1,920)	(3,418)	(1,498)	(1,920)	(3,418)
1.10.5 Crossing Structure	(74)	(188)	(262)	(74)	(188)	(262)	(60)	(156)	(216)	(60)	(156)	(216)
Sub-Total	55,179	37,259	92,438	52,338	34,828	87,166	36,560	26,429	62,989	34,008	24,930	58,938
2 Indirect Cost	17,465	2,303	19,768	17,615	2,218	19,833	15,374	1,934	17,308	15,374	1,910	17,284
2.1 O/M equipment	(4,159)	(20)	(4,179)	(4,159)	(20)	(4,179)	(3,459)	(20)	(3,479)	(3,459)	(20)	(3,479)
2.2 Engineering & Administration Cost	(13,306)	(2,283)	(15,589)	(13,456)	(2,198)	(15,654)	(11,915)	(1,914)	(13,829)	(11,915)	(1,890)	(13,805)
Sub-Total	72,644	39,562	112,206	69,953	37,046	106,999	51,934	28,363	80,297	49,382	26,840	76,222
3 Physical Contingency	10,897	5,937	16,834	10,494	5,558	16,052	7,777	4,246	12,023	7,398	4,020	11,418
Total (1 -3)	83,541	45,499	129,040	80,447	42,604	123,051	59,711	32,609	92,320	56,780	30,860	87,640
4 Price Contingency	14,511	45,043	59,554	13,884	42,543	56,427	9,509	31,831	41,340	9,434	30,277	39,711
Ground Total	98,052	90,542	188,594	94,331	85,147	179,478	69,220	64,440	133,660	66,214	61,137	127,351

5.3 Executing Agency and Organization for O & M

5.3.1 Executing Agency

Implementation of the Project will be programed in two stages, namely construction and settlement of the farmers.

(1) Construction

Considering the administration system in the government organization of the Dominican Republic and evaluating the experience in execution of similar type of projects, INDRHI is qualified to be the executing agency of the project because major components of the Project are irrigation and drainage facilities.

INDRHI has sufficient experience and is competent in carrying out detailed design, construction, and O & M of the irrigation and drainage facilities.

The previous executing mode of projects similar to this in the Dominican Republic shows that most of large scale projects were carried out on a contract basis with the exception of some small scale projects which were on a force account basis. Therefore, it is considered that a contract basis will be appropriate for the construction of this Project.

Therefore, at the implementation of the Project, it is recommended that INDRHI undertakes: 1) the employment of engineering consultant to carry out the detailed design including topographic survey and geological investigation, preparation of tender documents, tender evaluation and construction supervision, 2) the construction of the project facilities by selected qualified contractor, and 3) the undertaking of the O & M of the project facilities in collaboration with organizations concerned with farmers' settlement.

The greater portion of the Project area corresponds to IAD's settlement lands. After completion of the irrigation and drainage facilities, reallocation of farm lands for actually settled farmers along with the introduction of new settlers will be needed. Accordingly, it is necessary that IAD may participate in the implementation of the Project.

(2) Settlement Plan

Following to the progress of the construction, new settlers will be introduced and farmers who have settled already will be resettled immediately after completion of the construction works. Establishment of land consolidation together with irrigation and drainage canal systems, and the distribution of farm land among settlers in line with a general replotting plan will be required. IAD will be in charge of establishing a replotting plan and its execution.

5.3.2 Project Implementation

(1) Budgetary Allocation

The Project costs except for the amount that the government of the Dominican Republic can appropriate as local currency portion will be financed by a foreign monetary institution.

(2) Contractor

A contractor will be employed through formal international competitive tendering.

(3) Project Management Office

The Project management office for project implementation and for the construction supervision will be set up; the branch office of INDRHI located in Nagua or the project office of the El Pozo Project may be used for this purpose. However, these offices are considerably far from the Project area and have insufficient

space, therefore a new project management office is recommended to be established in Arenoso, which is located in central portion of the Project area. This project management office should be also used as the O/M office after completion of construction.

(4) Engineering Services

In the Dominican Republic, engineering services such as detailed design, preparation of tender documents, tender evaluation and construction supervision are carried out in most cases of similar projects by consulting firms employed by the Government. In line with this, a qualified consulting firm should be employed to perform the engineering services for this Project.

5.3.3 Organization of O & M

In order to maintain better functioning of the facilities during their life span, the facilities should be managed with appropriate operation and maintenance methods. For this purpose, an organization in charge of operation and maintenance should be established for this Project.

Operation and maintenance for mechanical works such as a headworks, a tide gate, and a diversion weir etc., as well as maintenance of civil works such as canals and roads, and water management of the Project are required.

(1) O & M for Mechanical Works

While the gates of diversion works are manually operated, gates to be installed in the headworks and the tide gate are electric-motor-driven. Accordingly, an electrical engineer and a mechanical engineer together with operators will be required for O & M of these gates.

The location of the headworks is planned at the site about 200 m downstream of the pumping station of the El Pozo Project. Therefore, it is preferable to carry out operation and maintenance of these two facilities under the responsibility of the same organization.

As for the gate of the diversion works, O & M for the Aguacate-Guayabo Project should be carried out independently from that for the El Pozo Project, because the location of respective works is too far.

Regarding equipments necessary for O & M, a motor boat and a pumping dredger, for the headworks and tide gates, respectively are required.

(2) O & M for Canals and Roads

One of the duties of the new O & M organization is to maintain the main and lateral irrigation and drainage canals and the main and lateral in-farm roads. Some construction machinery should be provided in order to complete this task.

(3) Water Management Plan

Distribution of irrigation water to the Project area will be determined taking the actual cropping pattern and weather conditions into account. To achieve this, participation by the SEA and IAD will be required to establish an irrigation water management plan and its operation.

The officers and engineers who will be in charge of the irrigation water management plan for the Project must at times negotiate with the concerned officers of other irrigation schemes for which the discharge of the Yuna River is or will be utilized. Therefore, a coordinating committee composed of representatives from all concerned government agencies and water management officers of all irrigation schemes which take water for irrigation and other purposes from the Yuna River will be required.

(4) Supporting Activities

Since the marketing system and price of rice are important aspects, some appropriate advice from INESPRE is expected.

The CEDIA located in Bonao and its branch station in El Pozo play an important role regarding the rice cultivation technique. It is thus desirable that these CEDIA offices give instructions to the concerned farmers, and IAD and SEA participate and dispatch some farm management experts to the O & M office of the Project.

In view of the foregoing, it is recommended that the organization for the O & M of the Project should be established being mainly composed of INDRHI and other concerned agencies such as IAD and SEA. A proposed organization chart is shown in Fig. 5.3.1.

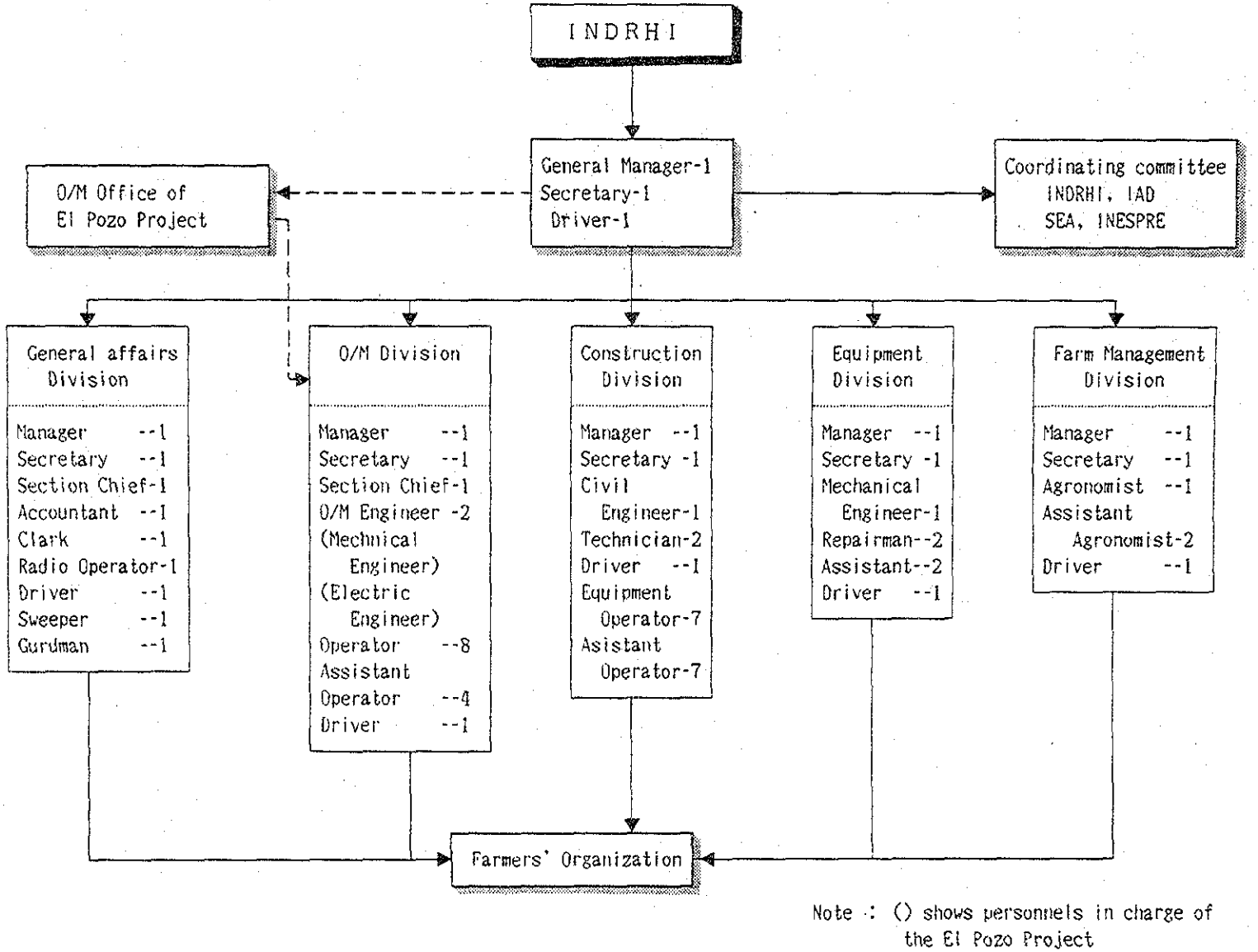


FIG. 5.3.1 O & M ORGANIZATION CHART OF AGUACATE-GUAYABO PROJECT

5.4 Agricultural Supporting Organization

5.4.1 Agricultural Extension Organization

After completion of the construction works including irrigation and drainage facilities and roads, high yield and high quality varieties of rice will be introduced resulting in a stabilization of the farmers' economy. In order to attain a high yield, high level farming techniques and extension services such as water management corresponding to growing stages of paddy, efficient introduction of farm mechanization and suitable cropping pattern etc. are indispensable.

Presently, SEA is conducting extension of rice cultivating technique on national and regional basis, while IAD is taking charge of the same in its settlement area.

The research and investigation of rice cultivation technique are mainly carried out by the CEDIA in Bonao; fortunately its experimental station is located at El Pozo and, consequently, it is recommended that this station may become the core for the development and extension of rice cultivation in and around the Project area.

5.4.2 Credit for Agriculture

As for the agriculture credit system, B.A. is at present financing credit for crop production and procurement of agricultural equipments. However, most of farmers who do not have enough money for their crop production miss very often the most favorable time for cultivation due to the delay of credit associated with the complicated application and time consuming procedures necessary to obtain it. Since it is considered that number of farmer to be settled in this area will increase and the cultivated area will be dramatically expanded after completion of the Project, the increase in financing resources for agricultural, the simplification of loan procedure, and the establishment of vicarious agency are envisaged.

5.4.3 Farmers' Association

Presently, farmers' association is organized within the study area, but it is expected that this organization should be enhanced and consolidated with the participation of new settlers. Furthermore, this organization is required to be managed in close relation and due coordination with the Project O/M Agency. The followings are examples of key function which farmers' assocation involves.

(1) Water Management

In order to simplify operation of water management, it is desirable to divide the farm land into blocks according to the lateral irrigation canal system.

(2) Cooperation in Farming

Cooperation in cultivation and procurement of farm machinery means that farm machines can be used efficiently and production cost can be saved.

(3) Farm Management

Agricultural productivity and farmers' consciousness of a common society will be raised by means of conducting farming activities such as the procurement of agricultural inputs, instruction and extension of farming techniques and a credit system in cooperation with other farmers.

(4) O & M

Major facilities of irrigation and drainage system will be operated and maintained by the O & M office of the Project, while it is necessary that the terminal facilities be operated and maintained through cooperation of the farmers.

CHAPTER 6: PROJECT EVALUATION

CHAPTER 6: PROJECT EVALUATION

The objective of this chapter is to select the most appropriate development plan for the Project from among the four alternatives described in Chapter 4, which combine the development area with the intake facilities of the irrigation water.

6.1 Economic Evaluation

The following parameters are employed in the economic evaluation of the Project.

(1) The term of evaluation is set up as 50 years after commencement of the Project. This term is coincident with land reclamation life which has longest durable period among components of the Project. The replacement cost in the project life is calculated assuming that equipments and machinery required for O & M are replaced in the course of its life.

(2) The Dominican peso is used for economic evaluation. The exchange rate of US$1.00 = RD$3.12 as actual rate of 1985 is used as shadow price.

(3) The costs of transfer items concerned to project cost and O & M cost (price escalation, contingency, interest of the loan, depreciation cost, tax, subsidy, etc.) are excluded.

(4) The economic labor cost concerned to project cost and O & M cost is applied at actual wage, consequently, the shadow price for labor cost is not used.

(5) Land acquisition and compensation costs are excluded assuming that the opportunity costs for these items is zero.

(6) Costs for electricity, water supply, and communication are expressed as financial cost since no economic cost is considered for them.

(7) The rice price (paddy at farm-gate) as economic price is used at RD$840/ton, which is calculated adding freight and insurance charges to Santo Domingo to international trade price in the U.S. (Financial price: RD$707.70/ton of sustaining price in 1985 by INESPRE)

(8) As economic price for inputs which is included in the production cost, market price is used although the inputs are sold to settlers lower than market price in the IAD's settlement area under the Governmental policy. The farm labor wage of RD$8.00/day and preparation cost of RD$400.00/ha, the IAD's official rate, are used as economic prices.

6.1.1 Project Benefits

The project benefits are evaluated with incremental value which represent the difference between the with project estimates and the without project estimates. The benefits are calculated by deducting the production cost from the value of production.

The benefits obtained by means of rice production will be increased as a result of increase in yield which is expected through the diffusion of the new farming system and the extension of harvest area to be brought by the introduction of double cropping.

The total increased benefits in each target term is as follows:

(Unit: RD$)

Alternatives	Medium Term	Long Term
A-I, II	28,686,000	46,292,000
B-I, II	26,187,000	42,953,000

6.1.2 Project and Operation and Maintenance Costs

(1) Project Costs

Project costs involve construction, procurement of equipments for operation and maintenance, engineering services and administration costs. The annual disbursement schedule of the project costs is as follows:

SUMMARY OF PROJECT COSTS DISBURSEMENT

(Unit: RD$1,000)

Year	A - I	A - II	B - I	B - II
1987	2,645	2,645	2,645	2,645
1988	5,073	5,043	5,005	4,977
1989	14,930	18,905	10,407	13,799
1990	37,607	28,105	28,308	20,391
1991	45,419	44,983	33,553	33,420
1992	23,366	23,370	12,402	12,408
Total	129,040	123,051	92,320	87,640

(2) Operation and Maintenance Costs and Replacement Cost

Annual operation and maintenance costs and replacement costs in the project life are summarized below.

ANNUAL OPERATION AND MAINTENANCE COST

(Unit: RD$1,000)

Alternatives	Running Cost	Cost of O & M Facilities	Total
A-I	105	1,905	2,010
A-II	648	2,288	2,936
B-I	1	1,260	1,261
B-II	584	1,659	2,243

REPLACEMENT COST

(Unit: RD$1,000)

Equipment	Life (Year)	Alternatives A-I	A-II	B-I	B-II
O & M Equipment	8	3,479	3,479	3,479	3,479
Pump (Small Scale)	20	2,004	2,004	-	-
Pump (Main)	20	-	4,548	-	4,548
Gate (Small Scale)	30	1,421	1,421	1,253	1,253
Motor for Large Scale Gate	20	3,095	1,343	2,005	253
Total Replacement Cost		30,724	36,494	22,658	29,969

Note: Above costs represent those for each time of replacement.

6.1.3 Economic Internal Rate of Return and Benefit-Cost Ratio

The economic evaluation for the Project has been made on the assumption that the project life is 50 years. The economic internal rates of return (EIRR) of each Alternative are calculated based on the benefits and the costs as mentioned above, and the results are as obtained below.

On the other hand, the benefit-cost ratio (B/C) at 10% discount rate and the net present value (NPV) of each alternative are also included in the following table.

EIRR, B/C AND NPV OF THE PROJECT

Alternatives	EIRR	At 10% Discount Rate B/C	NPV (RD$1,000)
A-I	10.7%	1.03	7,006
A-II	10.5%	1.02	5,388
B-I	13.5%	1.18	30,428
B-II	13.3%	1.16	27,654

As a result, Alternatives B-I and B-II are highly rated in a terms of the EIRR. And, Alternative B-I is superior to the Alternative B-II because of high value with respect to NPV and the low costs in O & M and replacement of equipments. Hence, a higher priority has been given to the Alternative B-I.

6.1.4 Sensitivity Analysis

Sensitivity analysis of Alternatives A-I and B-I as represented among the 4 alternatives is made in the event of a variation in project costs and rice price or yield.

SENSITIVITY ANALYSIS

Variation	Alternative A-I	Alternative B-I
(i) Project cost increased by 10%	9.9%	12.6%
(ii) Rice price or yield reduced by 10%:	8.7%	11.3%
(iii) Project cost increased by 10% and rice price or yield reduced by 10%:	8.0%	10.5%

It is clear that the economic evaluation of the Project is affected more severely by a decrease in the rice price or yield than an increase in the project cost.

6.2 Financial Evaluation

Financial evaluation is carried out on Alternatives A-I and B-I to which the high priority among the Alternatives A and B is given in terms of the economic evaluation.

6.2.1 Project Costs

The project costs including physical and price escalation contingencies consist of foreign and local currencies. Annual disbursement of the project costs is proposed as follows:

Alternative A-I

(Unit: RD$1,000)

Year	Project Cost	F/C	L/C
1987	2,890	2,391	499
1988	5,816	4,694	1,122
1989	19,419	10,983	8,436
1990	52,863	27,842	25,021
1991	69,633	33,517	36,116
1992	37,973	18,625	19,348
Total	188,594	98,052	90,542

Alternative B-I

(Unit: RD$1,000)

Year	Project Cost	F/C	L/C
1987	2,890	2,391	499
1988	5,718	4,694	1,024
1989	13,410	7,937	5,473
1990	39,211	20,594	18,617
1991	51,931	24,103	27,828
1992	20,500	9,501	10,999
Total	133,660	69,220	64,440

The foreign currency portion of the project costs will be procured by the international banking institution and the local currency one will be covered under the responsibility of the of the Dominican Republic.

6.2.2 Amortization of Foreign Currency

The amortization schedule of foreign currency loan is set under the following conditions:

Annual interest rate:		5%
Grace period	:	7 years
Loan period	:	25 years (Semi-annual repayment with per-capita rate of the principal)

The maximum amount of foreign currency repayment including interest payment will reach RD$10,064,000 in the Alternative A-I and RD$7,105,000 in the Alternative B-I.

Amortization schedule is shown in Tables 6.2.1 (1) and 6.2.1 (2).

6.2.3 Surplus of Agricultural Household Economy

The agricultural gross income is calculated based on the estimated paddy yield and the financial price of rice sustained by the INESPRE in 1985. Production costs are also expressed in financial price. Family labor cost is excluded from the production cost.

Farm income is defined as the balance between the gross agricultural income and production costs, and does not include non-agricultural income. A surplus of agricultural household income is obtained by deducting the living cost from the farm income.

The annual surplus of the agricultural household economy in the Project is as follows:

SURPLUS OF AGRICULTURAL HOUSEHOLD ECONOMY

(Unit: RD$)

	Medium Term		Long Term	
	Per Household (Mean)	Total Amount	Per Household (Mean)	Total Amount
Alternative A	363	1,205,160	3,486	11,573,520
Alternative B	883	2,472,400	4,446	12,448,800

The annual surplus of agricultural household economy at the time of attaining high yield (long term) can bear the O & M cost and most of invested capital for the Project.

6.2.4 Water Charge

Operation and maintenance cost is borne by the beneficiaries as water charge is included in the production costs. According to the cost calculated based on the operation and maintenance plan, the amount to be borne per ha, is estimated at RD$130 in Alternative A-I and at RD$90 in Alternative B-I.

Though the water charge of RD$80/ha has been calculated as a component of the production cost, it is considered that the beneficiaries will be able to bear the estimated water charge in the target period of the long term except in the 4R area.

6.2.5 Comparison between Amortization and Surplus of Agricultural Household Economy

The proportion of the amount of amortization (the foreign currency) against the surplus of agricultural household economy is as follow:

RATIO OF AGRICULTURAL HOUSEHOLD ECONOMY SURPLUS TO AMORTIZATION AMOUNT

Alternatives	Year of Max. Repayment	Ratio	Year attained to Long Term Target	Ratio
A-I	7th year	673%	13th year	39%
B-I	7th year	203%	13th year	26%

In other words, in the case of Alternative B-I, the ratio of amortization amount will be less than 26% against the surplus of the agricultural household economy after the 13th year from commencement of the Project when the target yield is attained, though the ratio will reach between 139% and 203% at maximum amortization period between the 7th year and the 12th year after commencement of the Project.

Examining the ability to bear a burden to repay the foreign loan in the Alternative B-I, it is predicted that the foreign currency portion of the Project will be compensated by the benefits of beneficiaries if the amount corresponding to 26% of the surplus of agricultural household economy appropriates to the repayment of foreign loan by way of increase of water charge and/or taxation for the right of cultivation.

Besides, if a part of the local corrency portion will be borrowed with the same condition as the foreign loan, in this case, the amortization seems to be within the limits of its financial capability considering the whole project life.

Note: Though the payment of interest in grace period for the foreign currency is covered by the responsibility of the government on the repayment plan, it also consists in the limit of possibility to a burden for the settlers.

6.3 Social Evaluation

The completion of the Project is expected to produce such positive effects as the increase in agricultural productivity, the increase in the number of settler, the creation of job opportunity, which are described more detailed as below.

- Through the efficient agricultural productivity brought about by the consolidation of arable land and the introduction of double cropping of paddy fields, the increase of rice production that can be achieved over current levels are 55,000 tons in Alternative A and 51,000 tons in Alternative B.

- The number of settlers in the Project area will reach 3,320 in Alternative A and at 2,800 in Alternative B; assuming 4.9 person for each family, the population in Alternative A will 16,000 and in Alternative B, 14,000, which corresponds to approximately 4% of the total population in the 3 provinces (Duarte, Maria Trinidad Sanchez and Semana) constituting the project area and approximately to 23% of the rural population in the same.

- Since intensive farming i.e., double cropping will absorb the labor force of farmer's family and especially in the months of June, July, December and January in which overlap of seeding and harvesting will demand an increase in the labor force, employment opportunity could be provided for the unemployed people in neighboring areas.

On the other hand, as the secondary impacts, a considerable enhancement in the living standard of the whole area can be anticipated based on the considerable increase in income as a consequence of the increase of agricultural productivity and improvement of roads to be constructed.

Further increase of the facilities needed for the commercialization, rice mill plant, etc. will be expected, and other industries which process by-products such as straw, and rice bran, and livestock breeding will be developed.

According to development of social infrastructure, the allied industries will be also prospected.

Therefore, the stabilization of the project will improve the public welfare of the farmers. Both Alternatives A and B are feasible with respect to the social evaluation.

6.4 Comprehensive Evaluation

The purpose of the Project is to develop and convert the swampy area, which is currently wasted due to poor natural conditions, into arable land to be capable of the double cropping of the paddy rice can be possible as the second stage of the AGLIPO Agricultural Development Project. Therefore, the completion of the Project will contribute to not only to the development of the national economy also to giving stimulative effect for the development of the surrounding area which is presently considered to be under developed.

Total production of the rice atributable to the project area will be more than 60,000 tons which is equivalent to 12% of the total national production of 500,000 ton. Therefore, the Project will also contribute toward the attainment of food self-sufficiency and improving balance of payments. The Aguacate-Guayabo area will become a granary of the Dominican Republic in near future together with the El Pozo area, which is located adjacent to the Project with agricultural development project currently under way, and the Limon del Yuna area which is situated in the neighboring area across the Yuna River.

The project area is presently one of the less developed area with notable trend of emigration in the Dominican Republic. The project area under such conditions will be converted to an economically developed area by increasing the agricultural production and bringing about an expansion of the agro-industries. Such economic conditions will invite new investment to the industries which might be established in close connection with Sanchez Port.

After completion of the Project, it is considered that the farm management in the project area will be diversified to the various cropping patterns from the original cropping pattern of only paddy cultivation. This will occur due to the versatile food demand necessary to meet to the population growth and the dissemination of modern farming technology. In addition, the project area will become the food production center to supply the agricultural products to the neighboring resort area.

Of four alternatives, proposed Alternative-A and Alternative-B cover different areas; Alternative-A is featured by a high project cost and low benefits due to the inclusion of a vast area of swampy land which is almost impossible to be improved even by a better drainage canal system. On the other hand, Alternatives I & II are having different intake methods represented by headworks and pumping station; the plan of headworks through which water is derived from the river by gravity is more advantageous than that of the pumping equipment because the O&M cost is quite low which surpasses the high initial construction cost.

Therefore, after economic and financial evaluation have been made, it is concluded that the Alternative B-I is an optimum plan for the implementation of the Project.

TABLE 6.2.1(1) AMORTIZATION SCHEDULE OF FOREIGN LOAN (A-1)

Unit: RD$1,000

Year in Order	Foreign Loan	Accumulated Foreign Loan	Interest Payment	Capital Payment	Total Payment
1	2,391	2,391	120		120
2	4,694	7,085	354		354
3	10,983	18,068	904		904
4	27,842	45,910	2,296		2,296
5	33,517	79,427	3,972		3,972
6	18,625	98,052	4,903		4,903
7		98,052	4,903	5,161	10,064
8		92,891	4,645	5,161	9,806
9		87,730	4,387	5,161	9,548
10		82,569	4,129	5,161	9,290
11		77,408	3,870	5,161	9,031
12		72,247	3,612	5,161	8,773
13		67,086	3,354	5,161	8,515
14		61,925	3,096	5,161	8,257
15		56,764	2,838	5,161	7,999
16		51,603	2,580	5,161	7,741
17		46,442	2,322	5,161	7,483
18		41,281	2,064	5,161	7,225
19		36,120	1,806	5,161	6,967
20		30,959	1,548	5,161	6,709
21		25,798	1,290	5,161	6,451
22		20,637	1,032	5,161	6,193
23		15,476	774	5,161	5,935
24		10,515	526	5,161	5,687
25		5,154	258	5,154	5,419
26	-	0	0	0	0

TABLE 6.2.1(2) AMORTIZATION SCHEDULE OF FOREIGN LOAN (B-1)

Unit: RD$1,000

Year in Order	Foreign Loan	Accumulated Foreign Loan	Interest Payment	Capital Payment	Total Payment
1	2,391	2,391	120		120
2	4,694	7,085	354		354
3	7,937	15,022	751		751
4	20,594	35,616	1,781		1,781
5	24,103	59,719	2,986		2,986
6	9,501	69,220	3,461		3,461
7		69,220	3,461	3,644	7,105
8		65,576	3,279	3,644	6,923
9		61,932	3,097	3,644	6,741
10		58,288	2,914	3,644	6,558
11		54,644	2,732	3,644	6,376
12		51,000	2,550	3,644	6,194
13		47,356	2,368	3,644	6,012
14		43,712	2,186	3,644	5,830
15		40,068	2,003	3,644	5,647
16		36,424	1,821	3,644	5,465
17		32,780	1,639	3,644	5,283
18		29,136	1,457	3,644	5,101
19		25,492	1,275	3,644	4,919
20		21,848	1,092	3,644	4,736
21		18,204	910	3,644	4,554
22		14,560	728	3,644	4,372
23		10,916	546	3,644	4,190
24		7,272	364	3,644	4,008
25		3,628	181	3,628	3,825
26	-	0	0	0	0

CHAPTER 7: CONCLUSION

CHAPTER 7 : CONCLUSION

7.1 Conclusion

Four Alternatives have been formulated for the Aguacate-Guayabo Agricultural Development Project, of which the Alternative B-I with a develpment area of 7,000 ha and irrigation water intake by means of headworks has been seleced as an optimum development plan. The implementation of the Aguacate-Guayabo Agricultural Development Project is justified in economic, financial technical and social aspects. With the implementation of the Project (Alternative B-I), it is expected that the following impacts will be ascertained.

7.1.1 Project in General

Of the total study area (24,100 ha), the Project comprises a development area of 7,400 ha, of which 7,000 ha of paddy field will be benefitted by the supply of irrigation water and improvement of the poor drainage system. The Project aims at an increase of rice production, which may be expected to contribute to the elevation of gross regional productivity and auto-sufficiency in foodstuff in the Dominican Republic.

7.1.2 Land Use

In addition to currently developed paddy field of 3,300 ha, the inclusion of a total of 3,700 ha of undeveloped land such as grazing fields, swamps, for paddy field development has been proposed after having evaluated their capability for rice production. As a result, total paddy field area will cover 7,000 ha. In such paddy fields, annual double cropping is technically viable, therefore, the harvested area will be increased from 3,050 ha to 14,000 ha.

7.1.3 Agricultural Production

The prevailing unstable rice production which is carried out depending upon natural conditions will be reformed to a stable one which will be attained by improving irrigation and drainage systems as well as by realizing double cropping with high-yield varieties. With regard to rice production two target terms - medium term (six years after completion of construction works) and long term (from the 7th year on) - have been established; target productions for each term are 38,800 ton for the medium term and 58,760 ton for the long term.

7.1.4 Irrigation Plan

All irrigation water will be diverted from the Yuna River by constructing headworks and conveyed to the development area through irrigation canals and diversion works. The maximum intake volume from the Yuna River has been estimated to be 5.90 m^3/s.

7.1.5 Drainage Plan

The current poor drainage system of the study area will be improved with the installation of a training dike at the outlet of the Cano Gran Estero and a gate at the confluence of the Yuna River and the Guayabo River. Drainage canals and other ancillary works are also included.

7.1.6 Project Implementation Period

The project implementation period consists of the preparatory stage (2.5 year) which includes loan procedure, detailed design and preparation of tender documents and the construction stage (4 years).

7.1.7 Project Costs

The direct construction costs are estimated to be at RD$62,989 thousand. The total project costs comprising direct construction cost, indirect cost, physical contingency [(construction cost +

indirect cost) x 15%] and price contingency will be RD$133,660 thousand. Additionally, RD$1,261 thousand will be incurred yearly for the operation and maintenance of structures.

7.1.8 Project Evaluation

Benefits expected from the implementaion of the Project are estimated to be RD$21,478 thousand, expressed in economic price. The total project costs consist of construction costs (RD$92,320 thousand) and operation and maintenance, and replacement costs. The economic internal rate of return (EIRR) is calculated at 13.5%. The benefit-cost ratio and the net present value with discount rate at 10% are 1.18 and RD$30,428 thousand, respectively.

Sensitivity analyses are made in respect to the variation of construction cost and rice price as follows:

Factors of Sensitivity Analysis	IRR (%)
I. 10% increase in construction cost	12.6
II. 10% decrease in rice price or productivity	11.3
III. 10% increase in construction cost and 10% decrease in rice price or productivity	10.5

It is disclosed that the EIRR is more strongly influenced by the variation of rice price than that of construction cost.

The total project costs (RD$133,660 thousand) may be divided into two components: foreign currency portion (RD$69,220 thousand) and local currency portion (RD$64,440 thousand). The foreign currency portion will be procured by a loan from foreign banking institutions and the local currency portion will be borne by the Dominican Government. In case of the loan from foreign banking institutions, the interest rate is set forth at 5% per annum for the 25 year amortization period.

If the repayment of loan will be made semi-annually and per capita basis of the principal with 7 years' grace period, the maximum annual amount of amortization including the payment of interest will be RD$7,105 thousand.

After completion of construction works, approximately 59 thousand ton of rice will be produced in paddy fields covering 7,000 ha, and the number of farms will increase to 2,800 (the population: 14,000). Taking advantage of the opportunities of Project implementation, agricultural related industry will be invited and job opportunities in and around the Project area will be increased.

With the elevation of agricultural productivity and the provision of such infrastructures as roads and electric lines, the living standard of the people will be enhanced and the public welfare be improved.

The Project is placed at the second stage of the AGLIPO Area Integrated Project; after completion of infrastructure works both for El Pozo and Aguacate-Guayabo, it is expected that these undeveloped region will be converted to a granary and as a result, a core area for the industrial development of the north-east region of the Dominican Republic.

7.2 Development of Peat Swamps

7.2.1 Constraints on Development

Generally speaking, peat swamps in tropical zone have high lure for development, because they are distributed near coastal zones extensively and flatly. Nevertheless, for the agricultural development of peat soils, following physical constraints should be relaxed.

(1) Difficulty to Identify Properties and Distribution of Peat Soils

Being distributed in swamps without any appropriate access, it is difficult to take samples of peat soils for property analysis and identify their distribution. If a development plan should be implemented without any accurate information on land conditions, revision of design works will be accompanied in the course of the project implementation. Furthermore, considerable costs will be incurred for the study of peat soils.

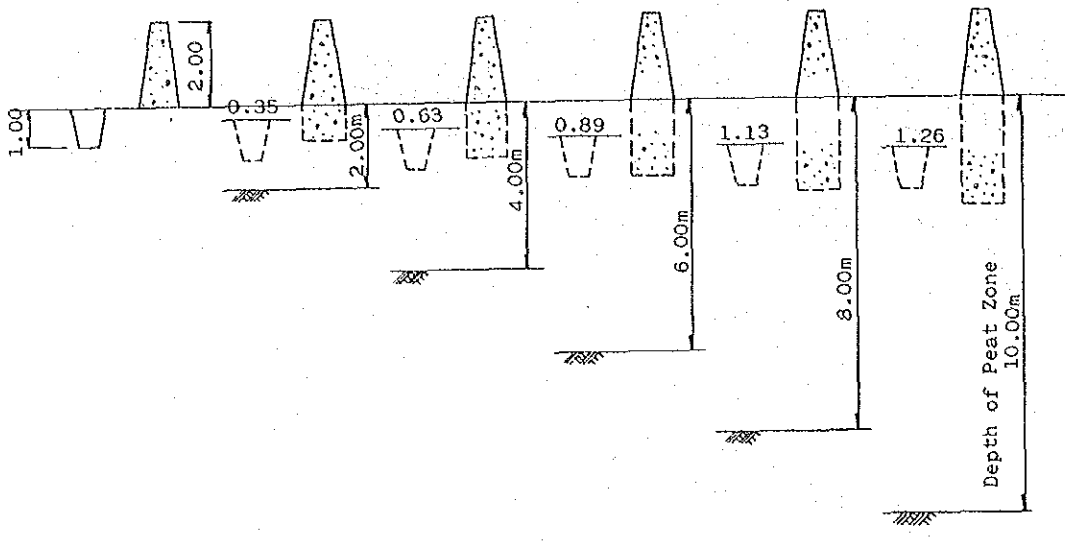
(2) Notable Settlement of Land by Drainage and Embankment Works

The development of peat swamps is always associated with the drying up and contraction of soils which are caused in the course of draining water and by the compaction of soils due to embankment works. This phenomenon is observed only at the initial stage of development and ceases within a period fluctuating from a few months to a couple of years.

The amount of soil settlement depends on the property of the peat, but is normally affected by the thickness of layer. An example of setelement observed in Jamaica is presented below.

Land settlement to be caused by the exhustion of peat which takes place in the course of decomposition of acidification related to drainage improvement presents a more serious problem. In such case, it is reported that land settlement will last permanently;

according to the survey carried out in Florida, U.S.A., the rate of settlement varies in the range of 0.025 - 0.05 m per annum. No appropriate measures to counter the settlement caused by decomposition of acidification have yet been provided.



(3) Small Bulk Density and Bearing Capacity

Peat soils are characterized by small bulk density and bearing capacity, which constitutes a constraint on using it as banking material or as sub-base for structures. No structure can be installed on land with peat unless improvement works are carried out.

(4) Lack of Nourishment

High acid soils need to be improved by the application of lime, and soils with low contents of P, Cu, Si, Mg, etc., need to have fertilizers applied if they are to be used for crop production.

(5) Environmental Aspect

Peat is distributed in humid forests and swamps which are precious resources in terms of environmental conservation. For this reason, thorough consideration should be made regarding development of peat swamps.

7.2.2 Agricultural Development Opportunities

In accordance with the result of the Study and examples of other similar projects carried out in tropical zones, the following considerations have been made on the agricultural development of peat swamps.

(1) Phased Development

- The layer of peat extended over El Guayabo is thick and, if it must be used for crop production, soil dressing, construction of a ring levee and/or pumping drainage will be substantial. In this context, the development of peat swamps requires vast investment followed by longer period of implementation, thus a phased development will be recommended.

- The improvement of drainage system temporarily contributes to the elevation of land productivity, but it also causes the land settlement; as a result, drainage conditions become worse and land inundation lasts longer than before. These phenomena are observed on the right bank of the Guayabo River, where farmers had evacuated their lands due to the deterioration of cropping conditions. Consequently, it is advised that the development of peat swamps should be carried out keeping pace with the implementation of flood control projects on the Yuna River.

- With the implementation of Aguacate-Guayabo Agricultural Development Project, necessary information on the development of peat swamps will be compiled and the access to the peat swamps will be facilitated.

(2) The lands settlement to be caused by the decomposition and acidification will be mitigated by maintaining groundwater table at a higher level; for this purpose, double cropping of rice will be recommended.

(3) The soil survey carried out in the course of the Study has disclosed that the application of phosphric acid and potassium is essential for attaining higher productivity of rice cultivation. Besides, a lack of zinc related to the organic metabolism is anticipated. Acid soil with low pH value should be improved by the application of lime.

(4) Apart from being costly and troublesome for stumping and land reclamation, the development of forest swamps should be well taken care of from an environmental viewpoint.

(5) Land preparation by large-scale machinery is not technically viable in peat swamps, so it is recommended that a unit parcel of a farmland be set forth at less than 0.5 ha.

(6) The suggestion will be made that a pilot farm be established in the development area which has similar physical conditions with peat swamps, and research and investigation on cropping cultivation in peat soil lands be conducted there.

(7) The introduction of inland fisheries, like shrimp culture being conducted in Sanchez, yautia production and animal husbandry is suggested in peat swamps.

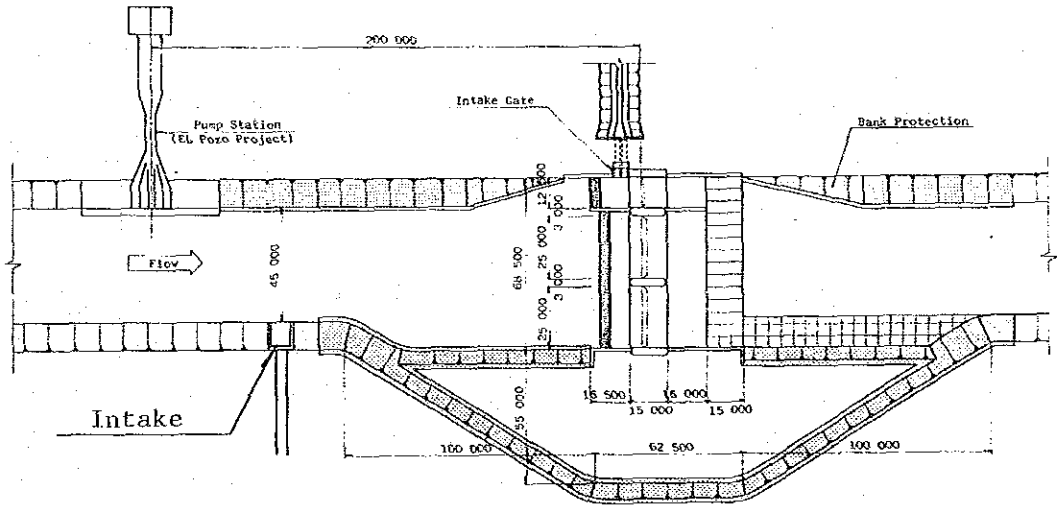
(8) It is advisable that a soil study on a more detailed level be carried out so as to evaluate more precisely the land capability in peat swamps and contribute to the feasibility study of the next phase.

(9) The construction of access roads within peat swamps requires vast investment, therefore, alternative plans for access such as canal transportaton should be considered.

7.3 Supply of Irrigation Water to Limon del Yuna by means of Installation of Intake Works to the Right Bank of Headworks of the Yuna River

7.3.1 Development Opportunity

From technical point of view, it is possible to supply by gravity one portion of Limon del Yuna area with irrigation water by installing intake works to the headworks which is to be constructed for the purpose of deviating irrigation water of the Yuna River to the Aguacate-Guayabo area (see the figure below).



PROPOSAL FOR SUPPLY OF IRRIGATION WATER BY GRAVITY

If only irrigation by gravity is taken into account, the topographic inferiority of the area will permit to develop no more than 900 ha of lands located along the Caño Barraquito which runs in prallel with the Yuna River and flow into the Barracote River; meanwhile, those lands along the Yuna River are extended so high that the irrigation water cannot reach by gravity (see Fig. 7.3.1).

Given same conditions as the irrigation plan of the Aguacate-Guayabo area, the design intake rate is calculated as follows:

$$Q = \frac{1.028 \times 900}{1.22 \times 1,000} = 0.76 \text{ m}^3/\text{s}$$

The available discharge at the headworks site of the Yuna River was obtained as 11.7 m^3/s for the return period of drought of 1:5 year; of this volume, the irrigation requirements to the Aguacate-Guayabo (5.9 m^3/s) should be deducted and then the balance of 5.8 m^3/s is available for the Limon del Yuna area. Consequently, there is no question in terms of irrigation water availability. The required distances to convey the irrigation water (0.76 m^3/s) will be approximately 5.4 km for the driving canal and 10 km for the main irrigation canal, respectively.

7.3.2 Development Constraints

(1) Irrigable Area

Unlike the Aguacate-Guayabo area, due to high land elevation the irrigable area by means of headworks at the Yuna River is limited to only about 900 ha at Limon del Yuna. Judging by soil conditions there are many capable lands for agricultural production along the Yuna River and irrigation water to be supplied to these lands should not be made by gravity but by pumping up together with the installation of diversion works at the terminal of the driving canal.

(2) Siphon Works at the Payabo River

Siphon works should be considered for the conveyance of irrigation water to Limon del Yuna area, because the driving canal crosses the Payabo River. The installation of a siphon is associated with larger hydraulic loss in the course of water conveyance and countermeasures against sand sedimentation in the pipe should be taken.

(3) Integrated Water Resource Development Project at Limon del Yuna

Apart from the Yuna River, there are such sources for irrigation water to be supplied to Limon del Yuna as the Payabo River, springs in the Los Haitises, etc. In this regard, it is recommended that, first of all, an integrated agricultural and water resources development including the utilization of the headworks in the Yuna River should be formulated to cover the total area of Limon del Yuna and afterwards detailed irrigation plan with respect to intake method from the right bank of the headworks should be designed according with the demand of the area in question.

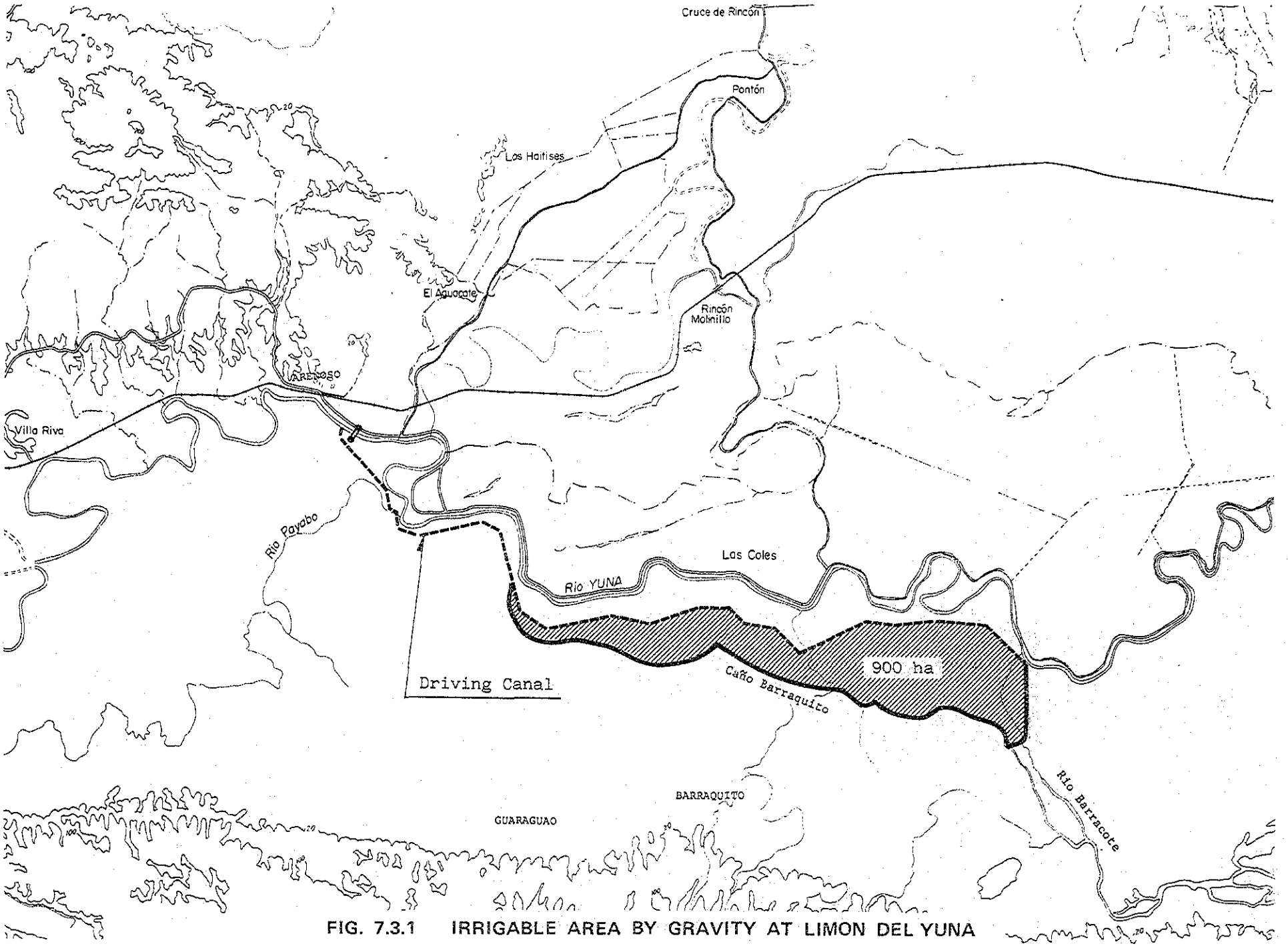


FIG. 7.3.1 IRRIGABLE AREA BY GRAVITY AT LIMON DEL YUNA

APPENDICES

APPENDIX-1: MEMBER LIST OF DOMINICAN PERSONNELS CONCERNED

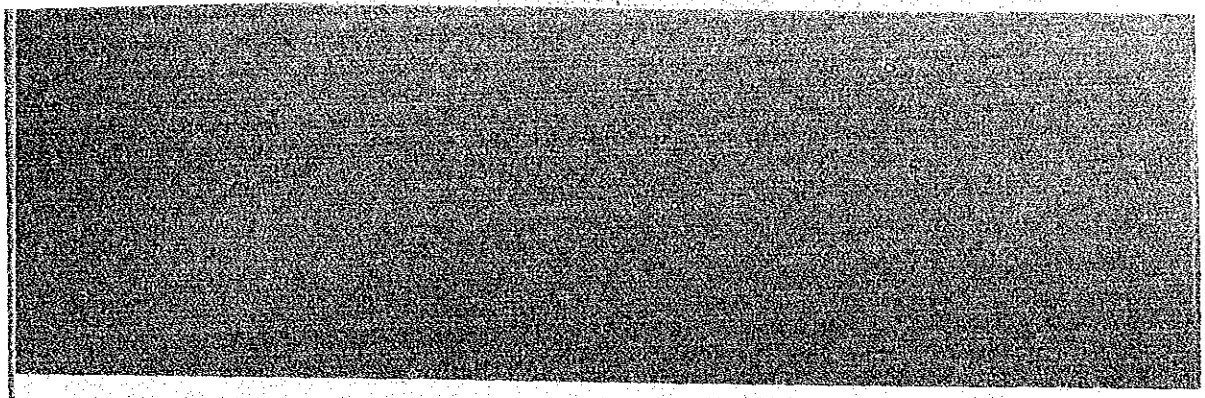
	Name	Position
(IAD)	Mr. Carlos Guillen Tatis	General Director
	Mr. Jose Antonio Fabelo Molino	General Sub-director
	Mr. Juan Davis pérez	Administrative Sub-director
	Mr. H. Guerro	Manager of Planning Dept.
	Mr. Victor Alifonso	Chief of Plans and Projects Section
	Mr. Cosme Damián Ramírez	Counterpart, Agro-economy and Crops
	Mr. Diómedes Moreta	Counterpart, Soils
	Mr. Ocutavio Vargas	Counterpart, Soils
	Mr. Luiz Perez	Counterpart, Topographic Survey
(INDRHI)	Mr. Alexis Espinal Tactuk	Executive Director
	Mr. Erasmo de Jesus de Leon Meteo	Executive Sub-director
	Mr. E. Almonte	Consultant of INDRHI
	Mr. Isidoro Pazos	Advisor, Executive Directorate
	Mr. Teresa Dauhajre	Manager of Planning Dept.
	Mr. Gilberto Reynoso	Manager of Irrigation Dept.
	Mr. Fredy Recio	Manager of Project Dept.
	Mr. Jose Francisco Febrillet	Manager of Hydrology Div.
	Mr. Leonel Duarte	Coordinator for the AGLIPO Project (EL POZO)
	Mr. Lucas de Castro	Deputy Manager of Planning Dept.
	Mr. Jesus M. Pichardo	Manager of Operation Dept.
	Mr. Hector Iniguez	Coordinator for the Aguacate-Guyabo Study
	Mr. F. de León	Counterpart, Cost Estimation
	Mr. Silvio López	Counterpart, Irrigation and Drainage
	Mr. Juan Sarmiento	Counterpart, Hydrology
	Mr. José Rafael Guzmán	Counterpart, Topographic Survey
	Mr. José Rafael Ortiz	Counterpart, Geology
	Mr. R. Lewis	Counterpart, Agronomy

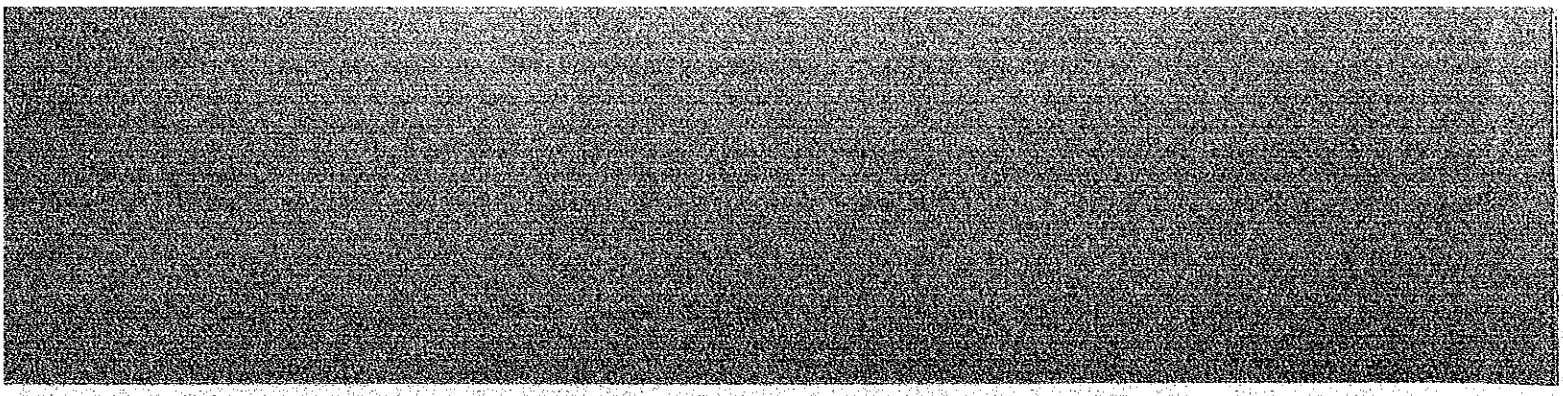
APPENDIX-2: MEMBER LIST OF ADVISORY COMMITTEE

Field in Charge	Name	Position
Chairman	Mr. Masahiro SUZUKI	Director, Land Improvement Engineering Service Center, Tokai Agricultural Administration Office, Ministry of Agriculture, Forestry and Fisheries (M.A.F.F.)
Rural Planning	Mr. Takeshi HASHIMOTO	Director, Planning Department, Hokuriku Agricultural Administration Office, M.A.F.F.
Irrigation/ Drainage	Mr. Norifumi TAKAMURA	Deputy Manager, Project Planning Division, Planning Department, Agricultural Structure Improvement Bureau, M.A.F.F.
Crops/Soils	Mr. Noriaki SHIOJIRI	Chief, Resources Division, Planning Department, Kinki Agricultural Administration Office, M.A.F.F.
Economic Appraisal	Mr. Hisao TANIMOTO	Deputy Manager, Third Technical Appraisal Division, Economic Research and Technical Appraisal Department, the Overseas Economic Cooperation Fund of Japan (OECF)

APPENDIX-3: FEASIBILITY STUDY TEAM MEMBER LIST

Field in Charge	Name
Team Leader	Mr. Satoru Kido
Hydrology	Mr. Minoru Yahata
Irrigation/Drainage	Mr. Shinichiro Matsumoto
Soil	Mr. Yasuo Takijima
Geology	Mr. Sakae Takada
Cropping/Farm Practice	Mr. Yasunori Hasegawa
Facilities/Cost Estimate	Mr. Takahisa Isozuka
Economic Evaluation	Mr. Yoshihiro Uchida
Topographic Survey/Land Use	Mr. Masayuki Honjo
Topographic Survey	Mr. Seiichiro Nishiyama
Rural Planning/Economic Survey	Mr. Tamio Ota





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