

**CHAPTER 5 PROJECT IMPLEMENTATION PLAN,  
OPERATION AND MAINTENANCE PLAN**



## CHAPTER 5 PROJECT IMPLEMENTATION PLAN, AND OPERATION AND MAINTENANCE PLAN

### 5.1 Project Implementation Plan

#### 5.1.1 Project Implementation System

In the light of implementation and smooth management of the project, organizations responsible for the design work plan and supervision must be centralized.

The core of the construction work is civil works relevant to irrigation, therefore DIRYA\* serves as the organization in charge. In implementing the project, the present organization of DIRYA should be utilized to a maximum and further strengthened.

In view of the project oriented to agricultural development, DIRYA is expected to keep close interrelation with DIGESA, DIGESEPE, ICTA, INAFOR, BANDESA, INDECA, etc., which are organization under Ministry of Agriculture, Cattle and Food Resources. In addition, the local government of Jalapa and Jutiapa Departments should give proper guidance to farmers to cope with project since the dam and irrigation facilities are constructed mainly in existing upland field.

Fig. 5.1.1-1 shows the organization of authorities in charge of implementation of the project.

\* DIRYA may be uprated to a general bureau in 1988.

#### 5.1.2 Project Implementation Method

This project consists of various types of civil works for the dam, regulating reservoir, diversion weir, canal, road, etc.

Generally, this type of construction work is kept under the direct control and management of the government or is contracted with contractor(s) who assumes the responsibility of construction.

This project is the large-scale dam irrigation project that DIRYA executes for the first time.

The direct management work method requires that DIRYA promotes procurement of construction machines, upbringing of dam engineers, an increase in engineers, etc. In the light of implementation of the work in earlier days, DIRYA is presumed to encounter difficulties in satisfying the above requirement. Therefore, the work should be started earlier by means of the contract basis. Practically, candidate contractors are invited to an open tender, screened by prequalification, and listed as bidders. In the open bid, a successful tenderer is nominated.

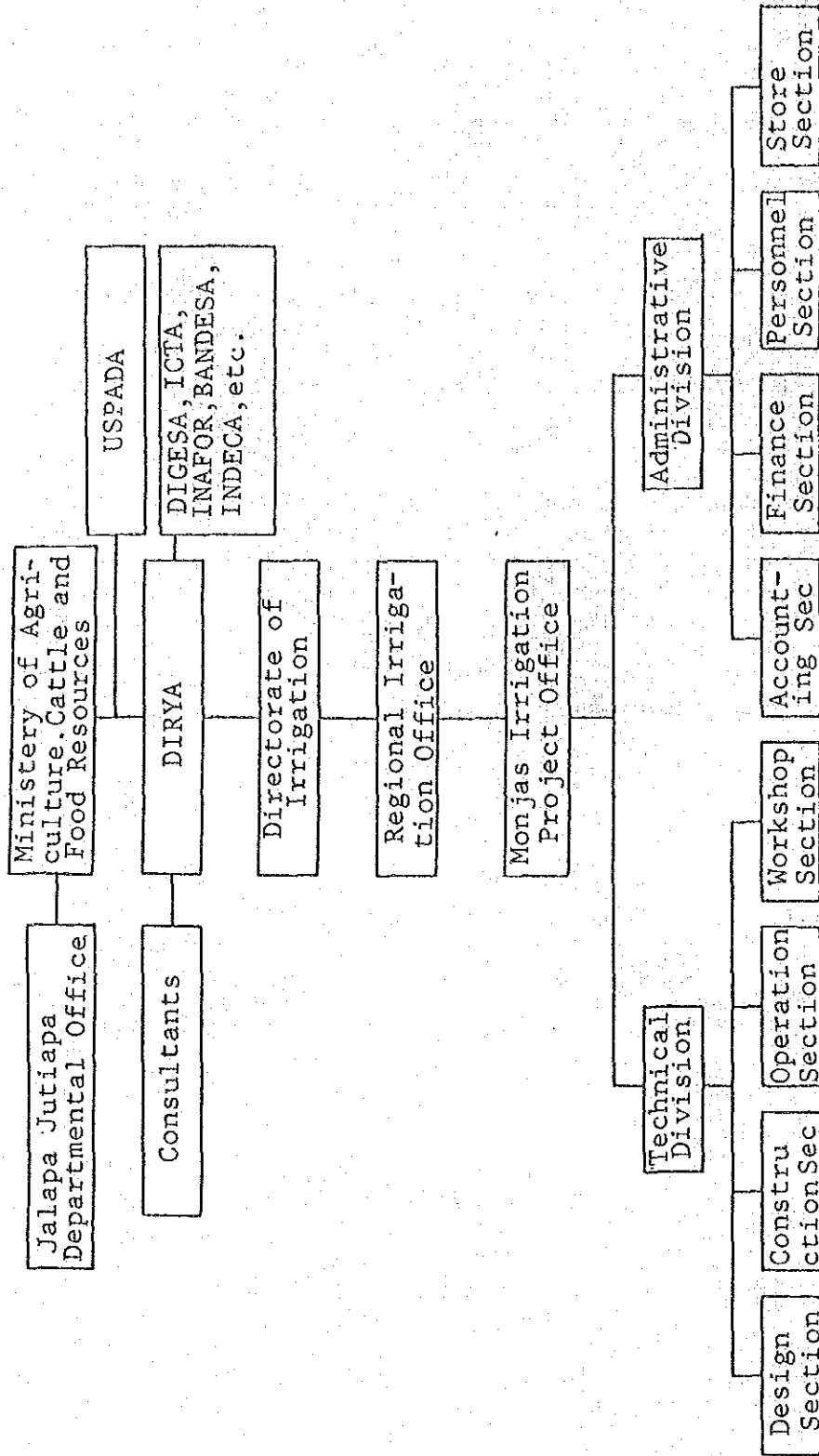


Fig. 5.1.1-1 Organization for Project Implementation

### 5.1.3 Project Implementation Plan

The project implementation program is roughly divided into pre-engineering, detail design, tender, and construction work. In the pre-engineering period, things to be carried out are preparation of topographic map of the project area, the plan survey of main structure points, canal route survey, boring survey of the dam site and diversion weir site, embankment material test, etc. all of which are necessary for detail design and kept under technical control of consultant. Pre-engineering is scheduled to start in April, 1989 for 6 months in preparation for detail design.

Detail design is started on completion of the pre-engineering. Detail design includes documents necessary for a tender, such as the general specification, special specification, technical specification, drawings, estimation of quantity and cost, work plan, and work program. Detail design is scheduled to start in October, 1989 for 12 months.

On completion of detail design, candidate contractors are invited by publications and qualified in prequalification. Qualified candidate contractors are registered in the short list and approved as tenderers. Selection of tenderers is immediately followed by the international tender, and the contract is awarded to a successful tenderer. Prequalification and selection of tenderers are scheduled to start in October 1990 and continue for 6 months.

Land acquisition and compensation are started on completion of topographic maps and ended by 1990, because land must be obtained prior to the start of the construction work.

Civil works are started after a 6-month preparatory period that starts on completion of the tender. The scheduled construction term is 51 months, including the preparatory period.

Consultants provide technical services through the period of the pre-engineering, detail design, tender, and construction term, and are expected to be on duty for 78 months, including the settlement of services that remain at completion of the whole work.

Fig. 5.1.3-1 shows the project implementation schedule and the outlined schedule of civil works.

## 5.2 Operation and Maintenance Plan

### 5.2.1 Operation and Maintenance Policy

The project area of 4,800 ha extends widely in the Monjas basin, and irrigation facilities are dispersedly constructed.

In order to operate these facilities properly, advanced and unified operation and maintenance organization should be established.

MONJAS IRRIGATION PROJECT IMPLEMENTATION SCHEDULE

Description	1987	1988	1989	1990	1991	1992	1993	1994	1995	Remarks
Feasibility Study	██████████									
Pre-Engineering			██████████							
Detailed Design			██████████							
Tendering			██████████							
Construction						██████████	██████████	██████████	██████████	
1 Land Acquisition and Compensation			██████████							
2 Project Facilities						██████████				
3 Project Administration						██████████	██████████	██████████	██████████	
4 Consulting Services						██████████	██████████	██████████	██████████	
5 Civil Works										
5.1 Preparatory Works						██████████				
5.2 Dam										
(a) Diversion Tunnel						██████████	██████████	██████████	██████████	
(b) Foundation Treatment										
(c) Dam Body										
(d) Spillway										
(e) Intake Facilities										
(f) Maintenance Road										
5.3 Regulating Reservoir										
5.4 Diversion System										
(a) Diversion Dam										
(b) Driving Canal										
5.5 Canal Network Syst										
(a) Diversion Canal										
(b) Main Canal										
(c) Lateral Canal										
(d) Tertiary Canal										
5.6 Land Reclamation										

Fig. 5.1.3-1 Project Implementation Schedule

As a policy, the Government has decided that operation and maintenance of irrigation project should be practiced, as a rule, by benefitted farmers themselves, consequently, operation and maintenance organization for the Monjas project established with farmers association and DIRYA. DIRYA will give instruction and support the organization for the project, and also, will directly operate the key facilities such as dam, diversion weir, diversion canal, etc.

Operation and maintenance organization for the project is shown as follows;

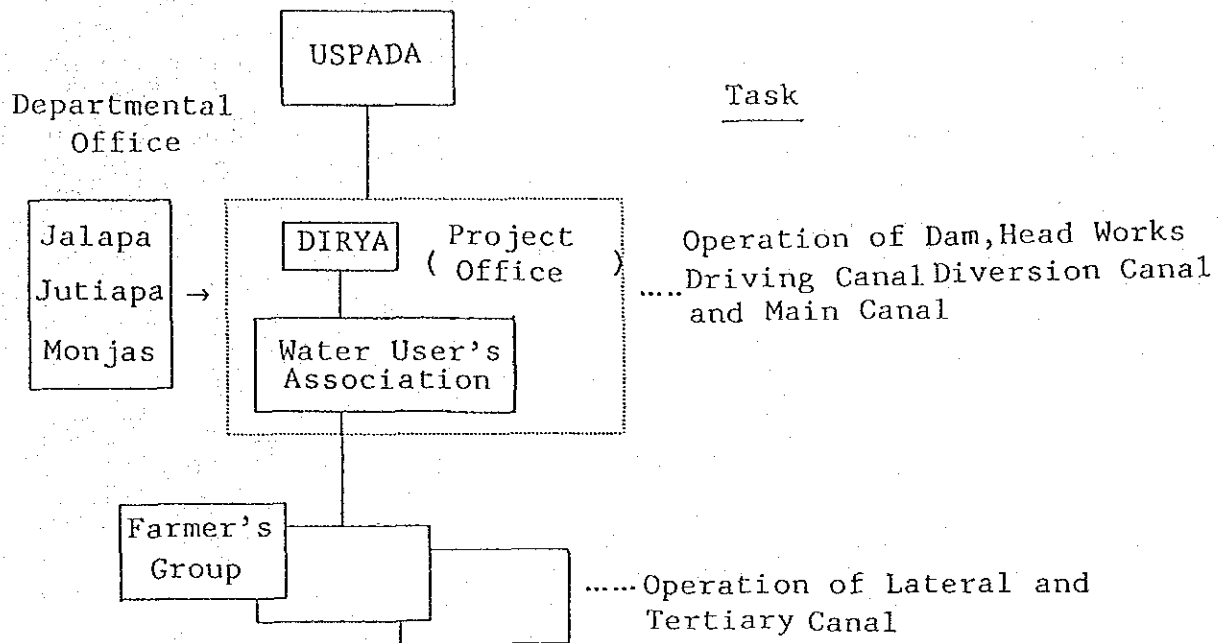


Fig. 5.2.1-1 Operation and Maintenance Organization

### 5.2.2 Operation and Maintenance System

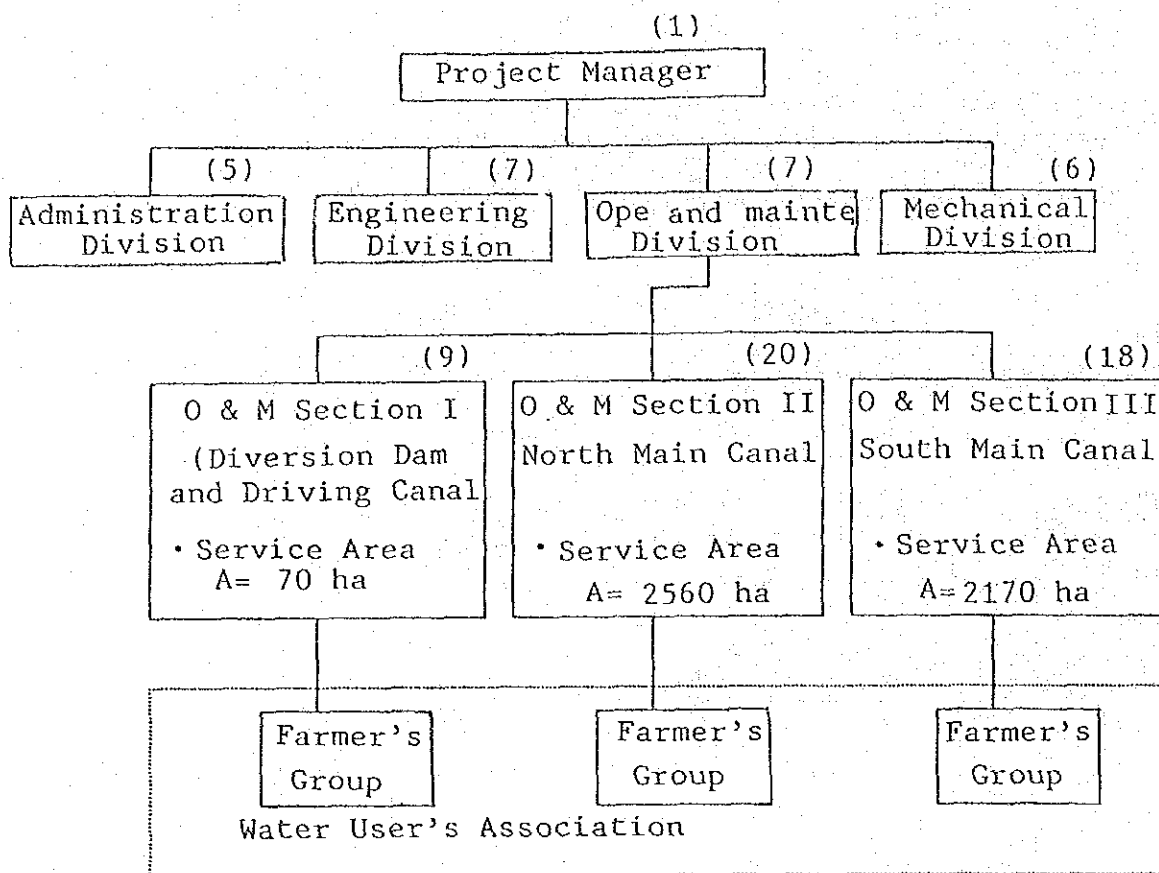
In order to carry out the operation of project facilities, the operation and maintenance office for the Monjas Irrigation Project will be established. The operation and maintenance office headed by project manager is divided into 4 divisions; Administration, Engineering, Operation and Maintenance and Mechanical divisions. The office assumes the operation of project facilities.

Staffing is constituted of 73 personnels in total including mainly Hoyo irrigation project staff.

The main task of staff is summarized as below:

- to decide the irrigable area and its water requirement,
- to collect the information required for operation and water charge,
- to process the data and information to make water distribution plan,
- to operate the dam facilities,
- to execute and practice water distribution, and
- to give guidance and orientation to the water user's association.

Operation and maintenance organization and staffing are shown in Fig. 5.2.2-1.



( ) Number of Personnel

Fig. 5.2.2-1 Organization for Operation and Maintenance Office

### 5.2.3 Operation and Maintenance Cost

The annual operation and maintenance cost for the project would amount to about Q 664,734 and Q 138 per hectare.

Annual O & M Cost	
Items	Amount (Q)
Salary and Wage	479,050
Equipment	94,127
Material and Supplies	18,700
Administration and General Expenditure	71,857
<u>Total</u>	<u>663,734</u>
per ha	138



### 5.3 Consulting Services

Consultants provide technical services on the contract basis with the project implementation organization. Consulting services consist of all services for the period of the pre-engineering and detail design, qualification of tender, and supervisory services during the construction work term such as technique control, process control, and safety control. The consultant team consists of engineers and experts who have wide knowledge and long experience in the sector of the plan, design, facilities, hydrology, geology, civil engineering, agriculture, etc. They serve to ensure top-quality work progressed in smooth process while keeping close contact with the project implementation organization and the contractor. In addition, consultants transfer techniques to government staff of the project implementation organization through their services. In particular, consultants should place emphasis on work quality control, agricultural village development, and irrigation water control, and execute them including training.

The man-month schedule of consulting services requires 458 man-month. The contents of such man-month is as follows: 80 man-month for foreign consultant and 24 for local consultant during pre-engineering and detailed design, and 177 man-month for foreign consultant and 120 man-month for local consultant during construction period.



## **CHAPTER 6 EVALUATION OF THE PROJECT**



## CHAPTER 6 EVALUATION OF THE PROJECT

### 6.1 Economic Evaluation Policy

The evaluation method to assess the development plan for validity of project implementation includes economic evaluation, financial evaluation, and socio-economic evaluation (effect). Emphasis is placed on economic evaluation since the main object of this development plan is agricultural development plan, and public profitability is emphasized. Financial evaluation is oriented to the investment and disbursement plan and farm household economic analysis. The basic policy of evaluation conforms to the evaluation method and criteria established by the international organization.

Benefit and cost for evaluation are calculated in local currency, with reference made to actual market price in October, 1987, and the applicable foreign exchange rate is US \$ 1.00 = Q 2.50. Agricultural product price is farm-gate price, and the price of construction work material is price on delivery at site.

The project life is 60 years, including the detailed design period and construction work period.

### 6.2 Project Benefit

#### 6.2.1 Calculation of Benefit

The benefit of the project refers to a difference of net profit between with project and without project. The project benefit consists of quantifiable benefit, i.e. an increase in agricultural production and unquantifiable benefit such as acquisition of foreign exchange, stabilized food supply, and creation of employment opportunities. Directly quantifiable benefit is subjected to economical and financial evaluation while unquantifiable benefit is integratedly evaluated for socio-economic impact.

#### 6.2.2 Agricultural Production Benefit

Agricultural production benefit is derived from expansion of upland field, an increase in cropping rate and an increase in unit yield which results from introduction of fertilizer, agricultural chemicals, high-output seeds, labor, etc.

#### 6.2.3 Annual Variation of Benefit Accrual

The gestation period before maturing of production depends on 2 constituents.

- Secular change in irrigation area which occurs in the process of construction work and in accordance with the maturity of irrigation control.
- Secular change in yield in the course to the maturity of production techniques.

About 25% of the projected area becomes irrigable in the 6th and 7th years of the construction work period (Table A.6.2-1). The plan estimates that both irrigation area and yield attain the targeted benefit 3 years after completion of construction work. Annual project benefit at the moment of completion of proposed production is about Q 20 million.

Table 6.2.3-1 Rate of Benefit Attainment in Gestation Period  
(unit : %)

Year	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Irrigation area	0	0	0	0	0	25	25	100	100	100
Yield	-	-	-	-	-	80	80	80	90	100
Rate of combined attainment	0	0	0	0	0	20	20	80	90	100

### 6.3 Economic Evaluation

#### 6.3.1 Evaluation Criteria

Economic evaluation is to evaluate economical effect of the project on the basis of economic benefit and economic cost as computed at economic price in the light of national economy.

Evaluation uses 3 interrelated indexes : economic internal rate of return (EIRR), economic net present value (ENPV), and benefit - cost ratio (B/C). Project benefit and cost are discounted by the opportunity cost of capital through project life. The term ENPV is a difference between accumulated benefit and accumulated cost, and B/C is the ratio of the former to the latter. Term EIRR means a discount rate by which accumulated benefit is equalized to accumulated cost.

The criteria to economically validate implementation of the project are that ENPV is positive, or B/C is more than 1, or EIRR exceeds opportunity cost of capital.

The opportunity cost of capital (discount rate) is social marginal productivity of capital input in the project, and the discount rate in agriculture sector is 12%.

#### 6.3.2 Prices Conversion

Economic price corresponds to shadow price. To obtain shadow price, market price is subtracted by transfer items other than real resources used for the project, and the difference obtained is multiplied by the conversion factor to correct distortion of the market price.

The price of import construction material and export agricultural products is economically estimated in local currency using the rate of shadow foreign exchange. The inter-bank foreign exchange rate (also called parallel rate) is substantially higher than the official rate.

Originally, the parallel rate is not equal to the shadow foreign exchange rate, but has influence on formation of trade commodity price as taxes and subsidies have. Therefore, this plan applies the mean inter-bank exchange rate from September to October in 1987, US \$ 1.00 = Q 2.70 (Banco of Guatemala) as the shadow exchange rate to convert international price (border price) into price in local currency. The conversion factor is 1.08.

Tobacco, tomatoes, bloccoli, and onions are export agricultural products and as such they are all trade goods; farm-gate price is converted on the basis of FOB price, which is international price. However, exports and imports of maize and kidney beans are extremely small, and therefore maize and kidney beans are included in non-trade goods (Table A.6.3-1 and 2).

As to the price of import agricultural production material, which is trade goods, the conversion factor 0.72 is applied to fertilizer and agricultural chemicals considering the import duty, freight, domestic distribution expenses, etc.

Conversion factor 0.77 is applied to shadow wages of the skilled laborer considering rate of unemployment in construction sector. Opportunity cost of the unskilled laborer close to market price because unemployed laborers is likely to get jobs in other region; conversion factor 0.90 is applied (Informe de Proyecto Guatemala Segundo Programa de Riego y Drenaje, BID, 1987).

Opportunity cost of land purchase and compensation are regarded as 0.

#### (1) Benefit calculation

Transfer items to be subtracted are as follows.

- Rent occupied in direct production cost
- Water charge occupied in direct production cost
- Facilities depreciation expenses (50%) in administrative expenses, indirect production cost
- Agriculture finance interest occupied in indirect production cost

Shadow price is applied as follows

- Farm-gate price of export agricultural products
  - Tobacco : Q 4,930/t
  - Tomato : Q 350/t
  - Bloccoli: Q 560/t
  - Onion : Q 460/t
- Fertilizer and agricultural chemicals in direct production cost, conversion factor 0.72
- Labor wage in direct production cost, conversion factor 0.90

## (2) Cost calculation

Transfer items to be subtracted are as follows.

- Value added tax (7%) imposed on construction material cost included in local currency of project cost
- Price contingency of project cost
- Facility depreciation expenses of operation and maintenance cost
- Value added tax (7%) on expenses other than personnel expenses of operation and maintenance cost

Shadow price is applied as follows.

- Land purchase and compensation cost occupied in project cost, conversion factor 0
- Wage of skilled laborer occupied in construction work cost, conversion factor 0.77
- Wage of unskilled laborer occupied in construction work cost, conversion factor 0.90
- Foreign exchange rate, conversion factor 1.08

### 6.3.3 Economic Internal Rate of Return, Economic Net Present Value and Benefit-Cost Ratio

The period of evaluation is to be 60 years in agreement with the dam having long economical service life. Therefore, replacement costs are gusted for some machine and equipment with shorter service life, which require at each end of economical service life. These machines and equipment of final project year have small residual values, which are not taken into account.

Table 6.3.1-1 shows a flow of the project cost, operation and maintenance cost, replacement cost, and project benefit, which are converted to economical price.

Where EIRR of the project is 18.51% and at discount rate of 12%, ENPV is Q 44,783,000 at price for 1987, B/C is 1.72 at the same discount rate.

Evaluation has proven that EIRR exceeds the opportunity cost of capital in agriculture sector 12%, ENPV is positive, and B/C exceeds 1. It is judged that implementation of the project is economically validated.

### 6.3.4 Sensitivity Analysis

Sensitivity analysis is made under the conditions : 1 project cost is increased by 10%, 2 project benefit is decreased by 10%, and 3 the construction period delays for a year.



Table 6.3.3-1 Cash Flow of Economic Cost and Benefit

(1,000 Q)

YEAR IN ORDER	C O S T				PRESENT VALUE			
	CONST. COST	O/M COST	REPLACE MENT	TOTAL	BENEFIT	DISCOUNT RATE	COST	BENEFIT
1	2390.0	0.0	0.0	2390.0	0.0	1.0000	2390.0	0.0
2	3672.0	0.0	0.0	3672.0	0.0	.8438	3098.5	0.0
3	8206.0	0.0	0.0	8206.0	0.0	.7120	5842.9	0.0
4	21467.0	0.0	0.0	21467.0	0.0	.5008	12897.9	0.0
5	29068.0	0.0	0.0	29068.0	0.0	.5070	14737.1	0.0
6	17553.0	141.0	0.0	17694.0	4994.0	.4278	7569.6	2136.5
7	7520.0	141.0	0.0	7661.0	4994.0	.3610	2765.5	1802.8
8	0.0	564.0	0.0	564.0	19977.0	.3046	171.8	6085.2
9	0.0	564.0	0.0	564.0	22474.0	.2570	145.0	5776.6
10	0.0	564.0	0.0	564.0	24972.0	.2169	122.3	5416.2
11	0.0	564.0	0.0	564.0	24972.0	.1830	103.2	4570.3
12	0.0	564.0	0.0	564.0	24972.0	.1544	87.1	3856.5
13	0.0	564.0	0.0	564.0	24972.0	.1303	73.5	3254.2
14	0.0	564.0	0.0	564.0	24972.0	.1100	62.0	2745.9
15	0.0	564.0	0.0	564.0	24972.0	.0928	52.3	2317.1
16	0.0	564.0	0.0	564.0	24972.0	.0783	44.2	1955.2
17	0.0	564.0	841.0	1405.0	24972.0	.0661	92.8	1649.8
18	0.0	564.0	0.0	564.0	24972.0	.0557	31.4	1392.2
19	0.0	564.0	0.0	564.0	24972.0	.0470	26.5	1174.7
20	0.0	564.0	0.0	564.0	24972.0	.0397	22.4	991.3
21	0.0	564.0	0.0	564.0	24972.0	.0335	18.9	836.4
22	0.0	564.0	0.0	564.0	24972.0	.0283	15.9	705.8
23	0.0	564.0	0.0	564.0	24972.0	.0238	13.5	595.6
24	0.0	564.0	0.0	564.0	24972.0	.0201	11.4	502.6
25	0.0	564.0	0.0	564.0	24972.0	.0170	9.6	424.1
26	0.0	564.0	0.0	564.0	24972.0	.0143	8.1	357.8
27	0.0	564.0	1190.0	1754.0	24972.0	.0121	21.2	301.9
28	0.0	564.0	0.0	564.0	24972.0	.0102	5.8	254.8
29	0.0	564.0	0.0	564.0	24972.0	.0086	4.9	215.0
30	0.0	564.0	0.0	564.0	24972.0	.0073	4.1	181.4
31	0.0	564.0	0.0	564.0	24972.0	.0061	3.5	153.1
32	0.0	564.0	0.0	564.0	24972.0	.0052	2.9	129.2
33	0.0	564.0	0.0	564.0	24972.0	.0044	2.5	109.0
34	0.0	564.0	0.0	564.0	24972.0	.0037	2.1	92.0
35	0.0	564.0	0.0	564.0	24972.0	.0031	1.8	77.6
36	0.0	564.0	0.0	564.0	24972.0	.0026	1.5	65.5
37	0.0	564.0	841.0	1405.0	24972.0	.0022	3.1	55.3
38	0.0	564.0	0.0	564.0	24972.0	.0019	1.1	46.6
39	0.0	564.0	0.0	564.0	24972.0	.0016	.9	39.3
40	0.0	564.0	0.0	564.0	24972.0	.0013	.7	33.2
41	0.0	564.0	0.0	564.0	24972.0	.0011	.6	28.0
42	0.0	564.0	0.0	564.0	24972.0	.0009	.5	23.6
43	0.0	564.0	0.0	564.0	24972.0	.0008	.5	19.9
44	0.0	564.0	0.0	564.0	24972.0	.0007	.4	16.8
45	0.0	564.0	0.0	564.0	24972.0	.0006	.3	14.2
46	0.0	564.0	0.0	564.0	24972.0	.0005	.3	12.0
47	0.0	564.0	1190.0	1754.0	24972.0	.0004	.7	10.1
48	0.0	564.0	0.0	564.0	24972.0	.0003	.2	8.5
49	0.0	564.0	0.0	564.0	24972.0	.0003	.2	7.2
50	0.0	564.0	0.0	564.0	24972.0	.0002	.1	6.1
51	0.0	564.0	0.0	564.0	24972.0	.0002	.1	5.1
52	0.0	564.0	0.0	564.0	24972.0	.0002	.1	4.3
53	0.0	564.0	0.0	564.0	24972.0	.0001	.1	3.7
54	0.0	564.0	0.0	564.0	24972.0	.0001	.1	3.1
55	0.0	564.0	0.0	564.0	24972.0	.0001	.1	2.6
56	0.0	564.0	0.0	564.0	24972.0	.0001	0.0	2.2
57	0.0	564.0	841.0	1405.0	24972.0	.0001	.1	1.9
58	0.0	564.0	0.0	564.0	24972.0	.0001	0.0	1.6
59	0.0	564.0	0.0	564.0	24972.0	.0001	0.0	1.3
60	0.0	564.0	0.0	564.0	24972.0	0.0000	0.0	1.1
	89876.0	30174.0	4903.0	124953.0	1326011.0		50473.7	50473.9

B / C = 1.00000360391

B - C = .181902558696

E I R R = 18.5089

Table 6.3.4-1 Sensitivity Analysis

Item	EIRR(%)	ENPV(10 <sup>3</sup> Q)	B/C
Base	18.5	44,783	1.72
Project cost increased by 10%	17.2	38,535	1.56
Project benefit decreased by 10%	17.1	34,057	1.55
Construction delayed for a year	16.5	33,263	1.53

An increase in project cost is attributable to rise of construction material cost and wages, and an increase in work volume, a decrease in project benefit to an increase in production cost, a reduction in yield, and a fall farm-gate price of agricultural product and, a delay of the construction period to a delay in occurrence of benefit.

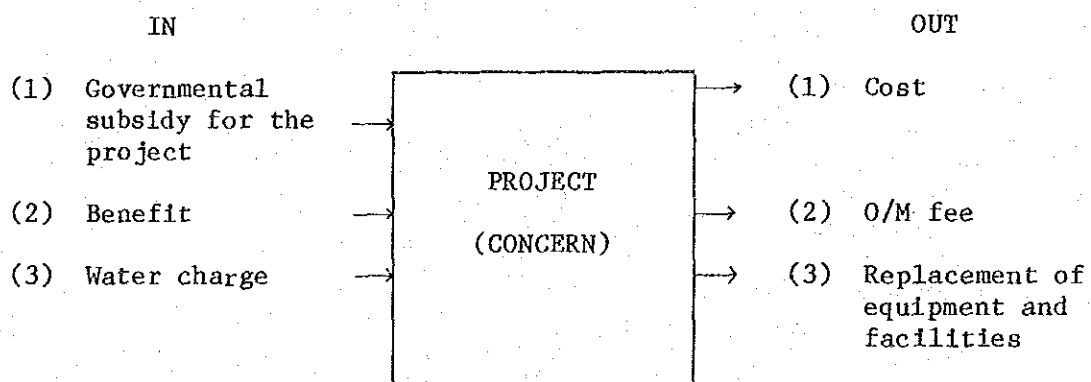
Sensitivity analysis has proven that a change in the construction period has stronger influence on economy of the project than a change in project cost and project benefit (Fig. 6.3.4-1).

#### 6.4 Financial Evaluation

Financial evaluation is to evaluate soundness of financial state of the project from the viewpoint of the project implementation organization and beneficiary, based on financial benefit and financial expenses as calculated at financial price (actual market price).

##### 6.4.1 Financial Internal Rate of Return, Financial Net Present Value, and Benefit-Cost Rate

Cash flow of the financial evaluation is illustrated as below:



As illustrated above, the governmental subsidy for the project is considered income of the concern.

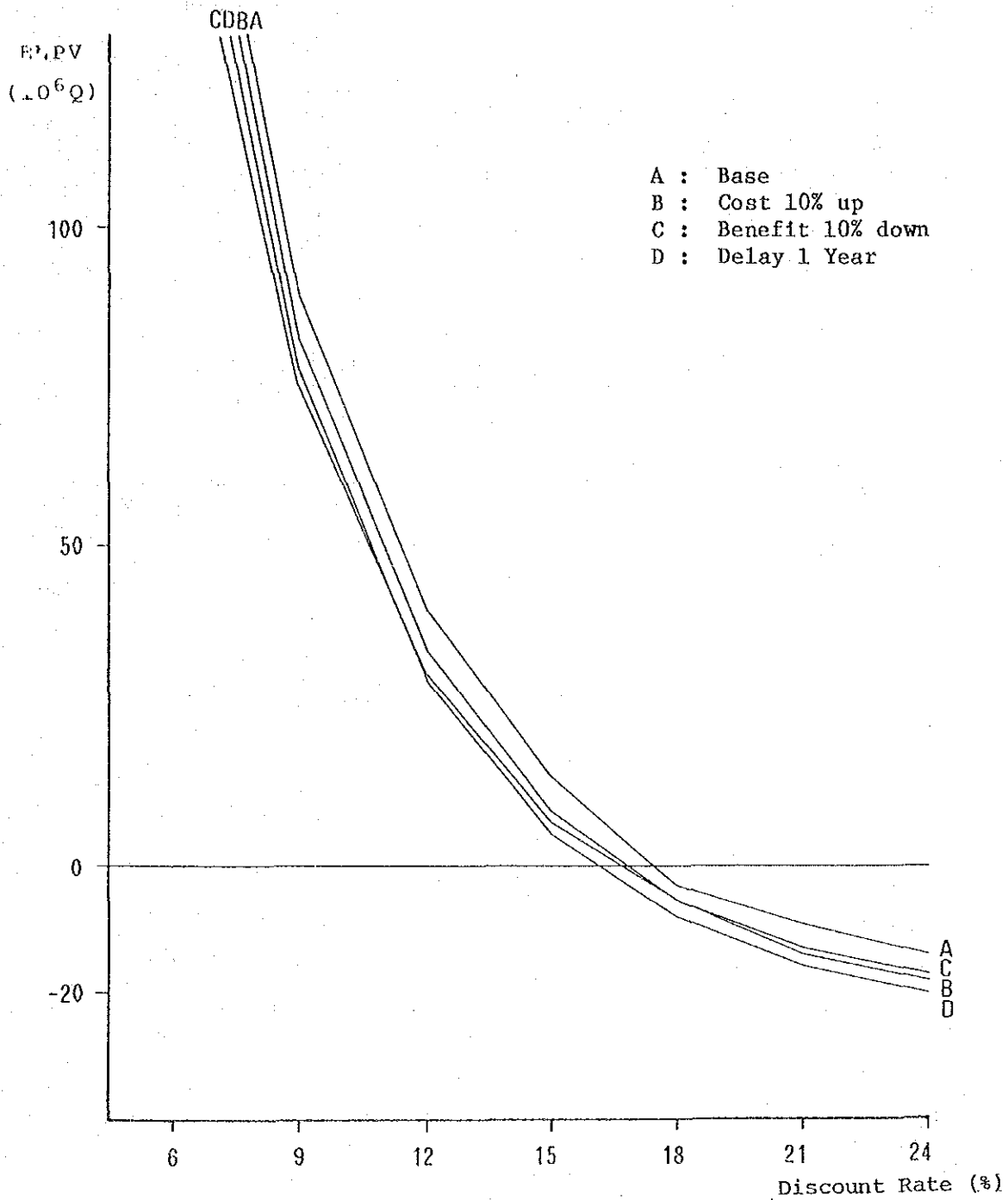


Fig. 6.3.4-1 Economic Sensitivity

Discount Rate (%)	(Unit: $10^3 Q$ )						
	6	9	12	15	18	21	24
Base	202,430	95,957	44,783	17,492	1,919	-7,329	-12,918
Cost 10% up	194,435	88,957	38,535	11,853	-3,207	-12,017	-17,225
Benefit 10% down	174,191	79,361	34,057	10,104	-3,400	-11,284	-15,933
Delay 1 Year	185,689	82,112	33,263	7,850	-6,195	-14,193	-18,753

Therefore, the financial evaluation was examined in the following 4 cases.

- (1) The Subsidy of Government for the Project Cost 0%
- (2) The Subsidy of Government for the Project Cost 20%
- (3) The Subsidy of Government for the Project Cost 40%
- (4) The Subsidy of Government for the Project Cost 60%

Results are tabulated in the following Table 6.4.1-1.

Cash flow of these four cases are shown in Tables 6.4.1-2 - 6.4.1-5.

Table 6.4.1-1 Government's Project Cost Share and Financial Internal Rate of Return

	Proportion of Subsidy of Government for the Project Cost (%)	Concern's Share for the Project Cost (%)	FIRR	At Discount Rate of 12%	
				B/C	ENPV (10 <sup>3</sup> Q)
(1)	0	100	10.7	0.880	-9,680
(2)	20	80	12.9	1.089	5,753
(3)	40	60	16.2	1.428	21,188
(4)	60	40	21.8	2.076	36,623

#### Condition of analysis

- Subsidy will not be repaid to the Government.
- Interest of the project cost will be borne by Government.

As results of financial analysis it was judged that when the project (concern) bears 100% of the project cost, the discount rate is 10.7% which is below the opportunity cost of capital in agricultural sector 12%, ENPV is negative, and B/C is below 1. However, 20% of the project cost as subsidy make the project sound financial aspect, discount rate higher than the opportunity cost, FNPV positive, and B/C exceeds 1.

Considering that subsidy of the Government is 40% of the Project Cost (Acuerdo Gubernativo Numero Ministerio de Agricultura y Ministerio de Finanzas Publicas 11-80), the project is judged to be quite sound financially.

In addition sensitivity analysis in financial aspect for 4 cases stated previously are also carried out under the same condition of economic evaluation. Financial Internal Rate of Return by case are as follow (Table 6.4.1-6).

Table 6.4.1-2 Cash Flow of Financial Cost of Benefit  
(Government's Share of Project Cost 0%)

(1,000 Q)

YEAR IN ORDER	C O S T				PRESENT VALUE			
	CONST. COST	O/M COST	REPLACE MENT	TOTAL	BENEFIT	DISCOUNT RATE	COST	BENEFIT
1	2382.0	0.0	0.0	2382.0	0.0	1.0000	2382.0	0.0
2	4814.0	0.0	0.0	4814.0	0.0	.9031	4347.3	0.0
3	9535.0	0.0	0.0	9535.0	0.0	.8155	7775.9	0.0
4	27233.0	0.0	0.0	27233.0	0.0	.7365	20056.0	0.0
5	38626.0	0.0	0.0	38626.0	0.0	.6651	25688.8	0.0
6	24109.0	166.0	0.0	24275.0	3291.0	.6006	14579.4	1976.6
7	10425.0	166.0	0.0	10591.0	3291.0	.5424	5744.3	1784.9
8	0.0	664.0	0.0	664.0	13162.0	.4898	325.2	6446.7
9	0.0	664.0	0.0	664.0	14808.0	.4423	293.7	6549.8
10	0.0	664.0	0.0	664.0	16453.0	.3994	265.2	6571.9
11	0.0	664.0	0.0	664.0	16453.0	.3607	239.5	5934.8
12	0.0	664.0	0.0	664.0	16453.0	.3257	216.3	5359.5
13	0.0	664.0	0.0	664.0	16453.0	.2942	195.3	4839.9
14	0.0	664.0	0.0	664.0	16453.0	.2656	176.4	4370.7
15	0.0	664.0	0.0	664.0	16453.0	.2399	159.3	3947.0
16	0.0	664.0	0.0	664.0	16453.0	.2166	143.8	3564.4
17	0.0	664.0	779.0	1443.0	16453.0	.1956	282.3	3218.9
18	0.0	664.0	0.0	664.0	16453.0	.1767	117.3	2906.8
19	0.0	664.0	0.0	664.0	16453.0	.1595	105.9	2625.0
20	0.0	664.0	0.0	664.0	16453.0	.1441	95.7	2370.6
21	0.0	664.0	0.0	664.0	16453.0	.1301	86.4	2140.8
22	0.0	664.0	0.0	664.0	16453.0	.1175	78.0	1933.2
23	0.0	664.0	0.0	664.0	16453.0	.1061	70.5	1745.8
24	0.0	664.0	0.0	664.0	16453.0	.0958	63.6	1576.6
25	0.0	664.0	0.0	664.0	16453.0	.0865	57.5	1423.7
26	0.0	664.0	0.0	664.0	16453.0	.0781	51.9	1285.7
27	0.0	664.0	1102.0	1766.0	16453.0	.0706	124.6	1161.1
28	0.0	664.0	0.0	664.0	16453.0	.0637	42.3	1048.5
29	0.0	664.0	0.0	664.0	16453.0	.0576	38.2	946.9
30	0.0	664.0	0.0	664.0	16453.0	.0520	34.5	855.1
31	0.0	664.0	0.0	664.0	16453.0	.0469	31.2	772.2
32	0.0	664.0	0.0	664.0	16453.0	.0424	28.1	697.3
33	0.0	664.0	0.0	664.0	16453.0	.0383	25.4	629.7
34	0.0	664.0	0.0	664.0	16453.0	.0346	23.0	568.7
35	0.0	664.0	0.0	664.0	16453.0	.0312	20.7	513.6
36	0.0	664.0	0.0	664.0	16453.0	.0282	18.7	463.8
37	0.0	664.0	779.0	1443.0	16453.0	.0255	36.7	418.8
38	0.0	664.0	0.0	664.0	16453.0	.0230	15.3	378.2
39	0.0	664.0	0.0	664.0	16453.0	.0209	13.8	341.6
40	0.0	664.0	0.0	664.0	16453.0	.0187	12.4	308.4
41	0.0	664.0	0.0	664.0	16453.0	.0169	11.2	278.5
42	0.0	664.0	0.0	664.0	16453.0	.0153	10.2	251.5
43	0.0	664.0	0.0	664.0	16453.0	.0138	9.2	227.2
44	0.0	664.0	0.0	664.0	16453.0	.0125	8.3	205.1
45	0.0	664.0	0.0	664.0	16453.0	.0113	7.5	185.2
46	0.0	664.0	0.0	664.0	16453.0	.0102	6.8	167.3
47	0.0	664.0	1102.0	1766.0	16453.0	.0092	16.2	151.1
48	0.0	664.0	0.0	664.0	16453.0	.0083	5.5	136.4
49	0.0	664.0	0.0	664.0	16453.0	.0075	5.0	123.2
50	0.0	664.0	0.0	664.0	16453.0	.0068	4.5	111.3
51	0.0	664.0	0.0	664.0	16453.0	.0061	4.1	100.5
52	0.0	664.0	0.0	664.0	16453.0	.0055	3.7	90.7
53	0.0	664.0	0.0	664.0	16453.0	.0050	3.3	81.9
54	0.0	664.0	0.0	664.0	16453.0	.0045	3.0	74.0
55	0.0	664.0	0.0	664.0	16453.0	.0041	2.7	66.8
56	0.0	664.0	0.0	664.0	16453.0	.0037	2.4	60.3
57	0.0	664.0	779.0	1443.0	16453.0	.0033	4.8	54.5
58	0.0	664.0	0.0	664.0	16453.0	.0030	2.0	49.2
59	0.0	664.0	0.0	664.0	16453.0	.0027	1.8	44.4
60	0.0	664.0	0.0	664.0	16453.0	.0024	1.6	40.1
	117124.0	35524.0	4541.0	157189.0	873655.0		84176.2	84176.6

B / C = 1.00000484257

B - C = .407629101173

F I R R = 10.73475

Table 6.4.1-3 Cash Flow of Financial Cost of Benefit  
(Government's Share of Project Cost 20%)

(1,000 Q)

YEAR IN ORDER	C O S T				PRESENT VALUE			
	CONST. COST	O/M COST	REPLACE MENT	TOTAL	BENEFIT	DISCOUNT RATE	COST	BENEFIT
1	1905.6	0.0	0.0	1905.6	0.0	1.0000	1905.6	0.0
2	3851.2	0.0	0.0	3851.2	0.0	.8857	3411.1	0.0
3	7628.0	0.0	0.0	7628.0	0.0	.7845	5984.2	0.0
4	21786.4	0.0	0.0	21786.4	0.0	.6949	15138.3	0.0
5	30900.8	0.0	0.0	30900.8	0.0	.6154	19017.8	0.0
6	19287.2	166.0	0.0	19453.2	3291.0	.5451	10604.2	1794.0
7	8340.0	166.0	0.0	8506.0	3291.0	.4828	4106.9	1589.0
8	0.0	664.0	0.0	664.0	13162.0	.4276	284.0	5626.7
9	0.0	664.0	0.0	664.0	14809.0	.3788	251.5	5608.9
10	0.0	664.0	0.0	664.0	16453.0	.3355	222.8	5519.8
11	0.0	664.0	0.0	664.0	16453.0	.2972	197.3	4889.0
12	0.0	664.0	0.0	664.0	16453.0	.2632	174.8	4330.3
13	0.0	664.0	0.0	664.0	16453.0	.2331	154.8	3835.4
14	0.0	664.0	0.0	664.0	16453.0	.2065	137.1	3397.1
15	0.0	664.0	0.0	664.0	16453.0	.1829	121.4	3008.9
16	0.0	664.0	0.0	664.0	16453.0	.1620	107.6	2665.1
17	0.0	664.0	779.0	1443.0	16453.0	.1435	207.0	2360.5
18	0.0	664.0	0.0	664.0	16453.0	.1271	84.4	2090.8
19	0.0	664.0	0.0	664.0	16453.0	.1126	74.7	1851.8
20	0.0	664.0	0.0	664.0	16453.0	.0997	66.2	1640.2
21	0.0	664.0	0.0	664.0	16453.0	.0883	58.6	1452.8
22	0.0	664.0	0.0	664.0	16453.0	.0782	51.9	1286.8
23	0.0	664.0	0.0	664.0	16453.0	.0693	46.0	1139.7
24	0.0	664.0	0.0	664.0	16453.0	.0614	40.7	1009.5
25	0.0	664.0	0.0	664.0	16453.0	.0543	36.1	894.1
26	0.0	664.0	0.0	664.0	16453.0	.0481	32.0	791.9
27	0.0	664.0	1102.0	1766.0	16453.0	.0426	75.3	701.4
28	0.0	664.0	0.0	664.0	16453.0	.0378	25.1	621.3
29	0.0	664.0	0.0	664.0	16453.0	.0334	22.2	550.3
30	0.0	664.0	0.0	664.0	16453.0	.0296	19.7	487.4
31	0.0	664.0	0.0	664.0	16453.0	.0262	17.4	431.7
32	0.0	664.0	0.0	664.0	16453.0	.0232	15.4	382.4
33	0.0	664.0	0.0	664.0	16453.0	.0206	13.7	338.7
34	0.0	664.0	0.0	664.0	16453.0	.0182	12.1	300.0
35	0.0	664.0	0.0	664.0	16453.0	.0161	10.7	265.7
36	0.0	664.0	0.0	664.0	16453.0	.0143	9.5	235.3
37	0.0	664.0	779.0	1443.0	16453.0	.0127	18.3	208.4
38	0.0	664.0	0.0	664.0	16453.0	.0112	7.5	184.6
39	0.0	664.0	0.0	664.0	16453.0	.0099	6.6	163.5
40	0.0	664.0	0.0	664.0	16453.0	.0088	5.8	144.8
41	0.0	664.0	0.0	664.0	16453.0	.0078	5.2	128.3
42	0.0	664.0	0.0	664.0	16453.0	.0069	4.6	113.6
43	0.0	664.0	0.0	664.0	16453.0	.0061	4.1	100.6
44	0.0	664.0	0.0	664.0	16453.0	.0054	3.6	89.1
45	0.0	664.0	0.0	664.0	16453.0	.0048	3.2	78.9
46	0.0	664.0	0.0	664.0	16453.0	.0043	2.8	69.9
47	0.0	664.0	1102.0	1766.0	16453.0	.0038	6.6	61.9
48	0.0	664.0	0.0	664.0	16453.0	.0033	2.2	54.9
49	0.0	664.0	0.0	664.0	16453.0	.0030	2.0	48.6
50	0.0	664.0	0.0	664.0	16453.0	.0026	1.7	43.0
51	0.0	664.0	0.0	664.0	16453.0	.0023	1.5	38.1
52	0.0	664.0	0.0	664.0	16453.0	.0021	1.4	33.8
53	0.0	664.0	0.0	664.0	16453.0	.0018	1.2	29.9
54	0.0	664.0	0.0	664.0	16453.0	.0016	1.1	26.5
55	0.0	664.0	0.0	664.0	16453.0	.0014	.9	23.5
56	0.0	664.0	0.0	664.0	16453.0	.0013	.8	20.8
57	0.0	664.0	779.0	1443.0	16453.0	.0011	1.6	18.4
58	0.0	664.0	0.0	664.0	16453.0	.0010	.7	16.3
59	0.0	664.0	0.0	664.0	16453.0	.0009	.6	14.4
60	0.0	664.0	0.0	664.0	16453.0	.0008	.5	12.8
	93699.2	35524.0	4541.0	133764.2	873655.0		62822.5	62823.0

B / C = 1.00000785223

B - C = .493297067769

F I R R = 12.9022

Table 6.4.1-4 Cash Flow of Financial Cost of Benefit  
(Government's Share of Project Cost 40%)

(1,000 Q)

YEAR IN ORDER	C O S T				PRESENT VALUE			
	CONST. COST	O/M COST	REPLACE MENT	TOTAL	BENEFIT	DISCOUNT RATE	CDST	BENEFIT
1	1429.2	0.0	0.0	1429.2	0.0	1.0000	1429.2	0.0
2	2888.4	0.0	0.0	2888.4	0.0	.8607	2486.2	0.0
3	5721.0	0.0	0.0	5721.0	0.0	.7409	4238.5	0.0
4	16339.8	0.0	0.0	16339.8	0.0	.6377	10419.8	0.0
5	23175.6	0.0	0.0	23175.6	0.0	.5489	12720.8	0.0
6	14465.4	165.0	0.0	14631.4	3291.0	.4725	6912.6	1554.8
7	6255.0	165.0	0.0	6421.0	3291.0	.4067	2611.1	1338.3
8	0.0	664.0	0.0	664.0	13162.0	.3500	232.4	4607.0
9	0.0	664.0	0.0	664.0	14808.0	.3013	200.0	4461.4
10	0.0	664.0	0.0	664.0	16453.0	.2593	172.2	4266.6
11	0.0	664.0	0.0	664.0	16453.0	.2232	148.2	3672.5
12	0.0	664.0	0.0	664.0	16453.0	.1921	127.6	3161.0
13	0.0	664.0	0.0	664.0	16453.0	.1654	109.8	2720.8
14	0.0	664.0	0.0	664.0	16453.0	.1423	94.5	2341.9
15	0.0	664.0	0.0	664.0	16453.0	.1225	81.4	2015.8
16	0.0	664.0	0.0	664.0	16453.0	.1055	70.0	1735.1
17	0.0	664.0	779.0	1443.0	16453.0	.0908	131.0	1493.4
18	0.0	664.0	0.0	664.0	16453.0	.0781	51.9	1285.5
19	0.0	664.0	0.0	664.0	16453.0	.0672	44.7	1106.4
20	0.0	664.0	0.0	664.0	16453.0	.0579	38.4	952.4
21	0.0	664.0	0.0	664.0	16453.0	.0498	33.1	819.7
22	0.0	664.0	0.0	664.0	16453.0	.0429	28.5	705.6
23	0.0	664.0	0.0	664.0	16453.0	.0369	24.5	607.3
24	0.0	664.0	0.0	664.0	16453.0	.0318	21.1	522.7
25	0.0	664.0	0.0	664.0	16453.0	.0273	18.2	449.9
26	0.0	664.0	0.0	664.0	16453.0	.0235	15.6	387.3
27	0.0	664.0	1102.0	1766.0	16453.0	.0203	35.8	333.3
28	0.0	664.0	0.0	664.0	16453.0	.0174	11.6	286.9
29	0.0	664.0	0.0	664.0	16453.0	.0150	10.0	247.0
30	0.0	664.0	0.0	664.0	16453.0	.0129	8.6	212.6
31	0.0	664.0	0.0	664.0	16453.0	.0111	7.4	183.0
32	0.0	664.0	0.0	664.0	16453.0	.0096	6.4	157.5
33	0.0	664.0	0.0	664.0	16453.0	.0082	5.5	135.6
34	0.0	664.0	0.0	664.0	16453.0	.0071	4.7	116.7
35	0.0	664.0	0.0	664.0	16453.0	.0061	4.1	100.4
36	0.0	664.0	0.0	664.0	16453.0	.0053	3.5	86.4
37	0.0	664.0	779.0	1443.0	16453.0	.0045	6.5	74.4
38	0.0	664.0	0.0	664.0	16453.0	.0039	2.6	64.0
39	0.0	664.0	0.0	664.0	16453.0	.0034	2.2	55.1
40	0.0	664.0	0.0	664.0	16453.0	.0029	1.9	47.4
41	0.0	664.0	0.0	664.0	16453.0	.0025	1.6	40.8
42	0.0	664.0	0.0	664.0	16453.0	.0021	1.4	35.2
43	0.0	664.0	0.0	664.0	16453.0	.0018	1.2	30.3
44	0.0	664.0	0.0	664.0	16453.0	.0016	1.1	26.0
45	0.0	664.0	0.0	664.0	16453.0	.0014	.9	22.4
46	0.0	664.0	0.0	664.0	16453.0	.0012	.8	19.3
47	0.0	664.0	1102.0	1766.0	16453.0	.0010	1.8	16.6
48	0.0	664.0	0.0	664.0	16453.0	.0009	.6	14.3
49	0.0	664.0	0.0	664.0	16453.0	.0007	.5	12.3
50	0.0	664.0	0.0	664.0	16453.0	.0006	.4	10.6
51	0.0	664.0	0.0	664.0	16453.0	.0006	.4	9.1
52	0.0	664.0	0.0	664.0	16453.0	.0005	.3	7.8
53	0.0	664.0	0.0	664.0	16453.0	.0004	.3	6.8
54	0.0	664.0	0.0	664.0	16453.0	.0004	.2	5.8
55	0.0	664.0	0.0	664.0	16453.0	.0003	.2	5.0
56	0.0	664.0	0.0	664.0	16453.0	.0003	.2	4.3
57	0.0	664.0	779.0	1443.0	16453.0	.0002	.3	3.7
58	0.0	664.0	0.0	664.0	16453.0	.0002	.1	3.2
59	0.0	664.0	0.0	664.0	16453.0	.0002	.1	2.7
60	0.0	664.0	0.0	664.0	16453.0	.0001	.1	2.4
	70274.4	35524.0	4541.0	110339.4	873655.0		42584.5	42584.5

B / C = 1.00000155069

B - C = .0660352846317

-160-

F I R R = 16.1793

Table 6.4.1-5 Cash Flow of Financial Cost of Benefit  
(Government's Share of Project Cost 60%)

(1,000 Q)

YEAR IN ORDER	C O S T				P R E S E N T V A L U E			
	CONST. COST	O/M COST	REPLACE MENT	TOTAL	BENEFIT	DISCOUNT RATE	COST	BENEFIT
1	952.8	0.0	0.0	952.8	0.0	1.0000	952.8	0.0
2	1925.6	0.0	0.0	1925.6	0.0	.8207	1580.3	0.0
3	3814.0	0.0	0.0	3814.0	0.0	.6736	2568.9	0.0
4	10893.2	0.0	0.0	10893.2	0.0	.5528	6021.6	0.0
5	15450.4	0.0	0.0	15450.4	0.0	.4537	7009.5	0.0
6	9643.6	166.0	0.0	9809.6	3291.0	.3723	3652.4	1225.4
7	4170.0	166.0	0.0	4336.0	3291.0	.3056	1325.0	1005.7
8	0.0	664.0	0.0	664.0	13162.0	.2508	166.5	3300.9
9	0.0	664.0	0.0	664.0	14908.0	.2058	136.7	3047.8
10	0.0	664.0	0.0	664.0	16453.0	.1689	112.2	2779.2
11	0.0	664.0	0.0	664.0	16453.0	.1386	92.1	2280.9
12	0.0	664.0	0.0	664.0	16453.0	.1138	75.5	1872.0
13	0.0	664.0	0.0	664.0	16453.0	.0934	62.0	1536.3
14	0.0	664.0	0.0	664.0	16453.0	.0766	50.9	1260.9
15	0.0	664.0	0.0	664.0	16453.0	.0629	41.8	1034.8
16	0.0	664.0	0.0	664.0	16453.0	.0516	34.3	849.3
17	0.0	664.0	779.0	1443.0	16453.0	.0424	61.1	697.0
18	0.0	664.0	0.0	664.0	16453.0	.0348	23.1	572.0
19	0.0	664.0	0.0	664.0	16453.0	.0285	18.9	469.5
20	0.0	664.0	0.0	664.0	16453.0	.0234	15.5	385.3
21	0.0	664.0	0.0	664.0	16453.0	.0192	12.8	316.2
22	0.0	664.0	0.0	664.0	16453.0	.0158	10.5	259.5
23	0.0	664.0	0.0	664.0	16453.0	.0129	8.6	213.0
24	0.0	664.0	0.0	664.0	16453.0	.0106	7.1	174.8
25	0.0	664.0	0.0	664.0	16453.0	.0087	5.8	143.5
26	0.0	664.0	0.0	664.0	16453.0	.0072	4.8	117.7
27	0.0	664.0	1102.0	1766.0	16453.0	.0059	10.4	96.6
28	0.0	664.0	0.0	664.0	16453.0	.0048	3.2	79.3
29	0.0	664.0	0.0	664.0	16453.0	.0040	2.6	65.1
30	0.0	664.0	0.0	664.0	16453.0	.0032	2.2	53.4
31	0.0	664.0	0.0	664.0	16453.0	.0027	1.8	43.8
32	0.0	664.0	0.0	664.0	16453.0	.0022	1.5	36.0
33	0.0	664.0	0.0	664.0	16453.0	.0018	1.2	29.5
34	0.0	664.0	0.0	664.0	16453.0	.0015	1.0	24.2
35	0.0	664.0	0.0	664.0	16453.0	.0012	.8	19.9
36	0.0	664.0	0.0	664.0	16453.0	.0010	.7	16.3
37	0.0	664.0	779.0	1443.0	16453.0	.0009	1.2	13.4
38	0.0	664.0	0.0	664.0	16453.0	.0007	.4	11.0
39	0.0	664.0	0.0	664.0	16453.0	.0005	.4	9.0
40	0.0	664.0	0.0	664.0	16453.0	.0005	.3	7.4
41	0.0	664.0	0.0	664.0	16453.0	.0004	.2	6.1
42	0.0	664.0	0.0	664.0	16453.0	.0003	.2	5.0
43	0.0	664.0	0.0	664.0	16453.0	.0002	.2	4.1
44	0.0	664.0	0.0	664.0	16453.0	.0002	.1	3.4
45	0.0	664.0	0.0	664.0	16453.0	.0002	.1	2.8
46	0.0	664.0	0.0	664.0	16453.0	.0001	.1	2.3
47	0.0	664.0	1102.0	1766.0	16453.0	.0001	.2	1.9
48	0.0	664.0	0.0	664.0	16453.0	.0001	.1	1.5
49	0.0	664.0	0.0	664.0	16453.0	.0001	.1	1.3
50	0.0	664.0	0.0	664.0	16453.0	.0001	0.0	1.0
51	0.0	664.0	0.0	664.0	16453.0	.0001	0.0	.8
52	0.0	664.0	0.0	664.0	16453.0	0.0000	0.0	.7
53	0.0	664.0	0.0	664.0	16453.0	0.0000	0.0	.6
54	0.0	664.0	0.0	664.0	16453.0	0.0000	0.0	.5
55	0.0	664.0	0.0	664.0	16453.0	0.0000	0.0	.4
56	0.0	664.0	0.0	664.0	16453.0	0.0000	0.0	.3
57	0.0	664.0	779.0	1443.0	16453.0	0.0000	0.0	.3
58	0.0	664.0	0.0	664.0	16453.0	0.0000	0.0	.2
59	0.0	664.0	0.0	664.0	16453.0	0.0000	0.0	.2
60	0.0	664.0	0.0	664.0	16453.0	0.0000	0.0	.1
	46849.6	35524.0	4541.0	86914.6	873655.0		24079.6	24079.8

B / C = 1.00000858424

B - C = .206705329019

-161-

F I R R = 21.8466



Table 6.4.1-6 Government's Project Cost Share and Financial Sensitivity Analysis

	Proportion of Subsidy of Government for the Project Cost (%)	Concern's Share for the Project Cost (%)	FIRR (%)		
			Price Cost Increased by 10%	Project Benefit Decreased by 10%	Construction delay for a year
(1)	0	100	9.85	9.77	9.86
(2)	20	80	11.89	11.79	11.73
(3)	40	60	14.97	14.85	14.49
(4)	60	40	20.33	20.17	19.11

Sensitivity analysis has proven that a change in the construction period has stronger influence on finance of the project than a change in project cost and project benefit.

#### 6.4.2 Investment and Repayment

Table 6.4.2-1 shows the necessary annual disbursement of project cost (including the price escalation) in foreign currency and in local currency.

The plan attempts to introduce external fund from international finance organization to cover expenses mainly paid in foreign currency for the purpose of implementation of the project. Expenses paid in local currency are budgeted in the frame of the public investment account at the responsibility of the Government. Table 6.4.2-1 shows an example of investment and repayment for the project. Financial conditions of the foreign fund are annual interest rate of 3%, term of redemption of 30 years, and grace period of 10 years.

In the 11th project year the sum of capital reimbursed according to the straight line method, and interest comes to a maximum, about Q 5,680,000. In the 5th project year the sum of the reimbursed interest of the foreign fund and domestic investment comes to a maximum, about Q 18,000,000. This amount accounts for, about 0.43% of the national budget in 1987 (price in 1993), and about 9.8% of the budget of Ministry of Agriculture, Cattle and Food Resources. Repayment of beneficiaries' share, i.e. 60% of the project cost, will be started after 2 years of the completion of Construction Annual repayment of beneficiaries, Q 1,756,860 for 40 years Q 1,405,488 for 50 years, under condition of equivalence payment condition, will be revenue of the Government.

Table 6.4.2-1 Program of Investment and Repayment  
(Repayment Period 40 Years) (1,000 Q)

No.	Year	1 Foreign Loan	2 Govern. Finance	3 Total Inflow	4 Accumula. F.C Loan	5 Amort.	6 Inter. 3 %	2+5+6 Total	7 Farmer's Repayment	8 Total Balance
1	1989	2271.0	111.0	2382.0	2271.0	0.0	68.1	179.1	0.0	179.1
2	1990	3509.0	1305.0	4814.0	5780.0	0.0	173.4	1478.4	0.0	1478.4
3	1991	6408.0	3127.0	9535.0	12188.0	0.0	365.6	3492.6	0.0	3492.6
4	1992	15281.0	11952.0	27233.0	27469.0	0.0	824.1	12776.1	0.0	12776.1
5	1993	21983.0	16643.0	38626.0	49452.0	0.0	1483.6	18126.6	0.0	18126.6
6	1994	14490.0	9619.0	24109.0	63942.0	0.0	1919.3	11537.3	0.0	11537.3
7	1995	7021.0	3404.0	10425.0	70963.0	0.0	2128.9	5532.9	0.0	5532.9
8	1996	0.0	0.0	0.0	70963.0	0.0	2128.9	2128.9	0.0	2128.9
9	1997	0.0	0.0	0.0	70963.0	0.0	2128.9	2128.9	0.0	2128.9
10	1998	0.0	0.0	0.0	70963.0	0.0	2128.9	2128.9	1756.9	372.0
11	1999	0.0	0.0	0.0	70963.0	3548.2	2128.9	5677.0	1756.9	3920.2
12	2000	0.0	0.0	0.0	67414.9	3548.2	2022.4	5570.6	1756.9	3813.7
13	2001	0.0	0.0	0.0	63866.7	3548.2	1916.0	5464.2	1756.9	3707.3
14	2002	0.0	0.0	0.0	60318.6	3548.2	1809.6	5357.7	1756.9	3600.8
15	2003	0.0	0.0	0.0	56770.4	3548.2	1703.1	5251.3	1756.9	3494.4
16	2004	0.0	0.0	0.0	53222.3	3548.2	1596.7	5144.8	1756.9	3388.0
17	2005	0.0	0.0	0.0	49674.1	3548.2	1490.2	5038.4	1756.9	3281.5
18	2006	0.0	0.0	0.0	46125.9	3548.2	1383.8	4931.9	1756.9	3175.1
19	2007	0.0	0.0	0.0	42577.8	3548.2	1277.3	4825.5	1756.9	3068.6
20	2008	0.0	0.0	0.0	39029.6	3548.2	1170.9	4719.0	1756.9	2962.2
21	2009	0.0	0.0	0.0	35481.5	3548.2	1064.4	4612.6	1756.9	2855.7
22	2010	0.0	0.0	0.0	31933.3	3548.2	958.0	4506.2	1756.9	2749.3
23	2011	0.0	0.0	0.0	28385.2	3548.2	851.6	4399.7	1756.9	2642.8
24	2012	0.0	0.0	0.0	24837.0	3548.2	745.1	4293.3	1756.9	2536.4
25	2013	0.0	0.0	0.0	21288.9	3548.2	638.7	4186.8	1756.9	2430.0
26	2014	0.0	0.0	0.0	17740.7	3548.2	532.2	4080.4	1756.9	2323.5
27	2015	0.0	0.0	0.0	14192.5	3548.2	425.8	3973.9	1756.9	2217.1
28	2016	0.0	0.0	0.0	10644.4	3548.2	319.3	3867.5	1756.9	2110.6
29	2017	0.0	0.0	0.0	7096.3	3548.2	212.9	3761.0	1756.9	2004.2
30	2018	0.0	0.0	0.0	3548.1	3548.2	106.4	3654.6	1756.9	1897.7
31	2019	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
32	2020	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
33	2021	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
34	2022	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
35	2023	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
36	2024	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
37	2025	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
38	2026	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
39	2027	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
40	2028	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
41	2029	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
42	2030	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
43	2031	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
44	2032	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
45	2033	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
46	2034	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
47	2035	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
48	2036	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
49	2037	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1756.9	-1756.9
50	2038	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	-0.0
51	2039	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	-0.0
52	2040	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	-0.0
53	2041	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	-0.0
54	2042	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	-0.0
55	2043	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	-0.0
56	2044	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	-0.0
57	2045	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	-0.0
58	2046	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	-0.0
59	2047	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	-0.0
60	2048	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	-0.0
		70963.0	46161.0	117124.0		70963.0	35702.0	152826.0	70274.4	82551.6

Annual Interest Rate : 3 %  
Loan Period : 30 Years  
Grace Period : 10 Years

Table 6.4.2-1 Program of Investment and Repayment  
(Repayment Period 50 Years)

(1,000 Q)

No.	Year	1 Foreign Loan	2 Govern. Finance	3 Total Inflow	4 Accumula. F.C Loan	5 Amort.	6 Inter. 3 %	2+5+6 Total	7 Farmer's Repayment	8 Total Balance
1	1989	2271.0	111.0	2382.0	2271.0	0.0	68.1	179.1	0.0	179.1
2	1990	3509.0	1305.0	4814.0	5780.0	0.0	173.4	1478.4	0.0	1478.4
3	1991	5408.0	3127.0	9535.0	12188.0	0.0	365.6	3492.6	0.0	3492.6
4	1992	15281.0	11952.0	27233.0	27469.0	0.0	824.1	12776.1	0.0	12776.1
5	1993	21983.0	16643.0	38626.0	49452.0	0.0	1483.6	18126.6	0.0	18126.6
6	1994	14490.0	9619.0	24109.0	63942.0	0.0	1918.3	11537.3	0.0	11537.3
7	1995	7021.0	3404.0	10425.0	70963.0	0.0	2128.9	5532.9	0.0	5532.9
8	1996	0.0	0.0	0.0	70963.0	0.0	2128.9	2128.9	0.0	2128.9
9	1997	0.0	0.0	0.0	70963.0	0.0	2128.9	2128.9	0.0	2128.9
10	1998	0.0	0.0	0.0	70963.0	0.0	2128.9	2128.9	1405.5	723.4
11	1999	0.0	0.0	0.0	70963.0	3548.2	2128.9	5677.0	1405.5	4271.6
12	2000	0.0	0.0	0.0	67414.9	3548.2	2022.4	5570.6	1405.5	4165.1
13	2001	0.0	0.0	0.0	63866.7	3548.2	1916.0	5464.2	1405.5	4058.7
14	2002	0.0	0.0	0.0	60318.6	3548.2	1809.6	5357.7	1405.5	3952.2
15	2003	0.0	0.0	0.0	56770.4	3548.2	1703.1	5251.3	1405.5	3845.8
16	2004	0.0	0.0	0.0	53222.3	3548.2	1596.7	5144.8	1405.5	3739.3
17	2005	0.0	0.0	0.0	49674.1	3548.2	1490.2	5038.4	1405.5	3632.9
18	2006	0.0	0.0	0.0	46125.9	3548.2	1383.8	4931.9	1405.5	3526.4
19	2007	0.0	0.0	0.0	42577.8	3548.2	1277.3	4825.5	1405.5	3420.0
20	2008	0.0	0.0	0.0	39029.6	3548.2	1170.9	4719.0	1405.5	3313.6
21	2009	0.0	0.0	0.0	35481.5	3548.2	1064.4	4612.6	1405.5	3207.1
22	2010	0.0	0.0	0.0	31933.3	3548.2	958.0	4506.2	1405.5	3100.7
23	2011	0.0	0.0	0.0	28385.2	3548.2	851.6	4399.7	1405.5	2994.2
24	2012	0.0	0.0	0.0	24837.0	3548.2	745.1	4293.3	1405.5	2887.8
25	2013	0.0	0.0	0.0	21288.9	3548.2	638.7	4186.8	1405.5	2781.3
26	2014	0.0	0.0	0.0	17740.7	3548.2	532.2	4080.4	1405.5	2674.9
27	2015	0.0	0.0	0.0	14192.6	3548.2	425.8	3973.9	1405.5	2568.4
28	2016	0.0	0.0	0.0	10644.4	3548.2	319.3	3867.5	1405.5	2462.0
29	2017	0.0	0.0	0.0	7096.3	3548.2	212.9	3761.0	1405.5	2355.6
30	2018	0.0	0.0	0.0	3548.1	3548.2	106.4	3654.6	1405.5	2249.1
31	2019	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
32	2020	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
33	2021	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
34	2022	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
35	2023	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
36	2024	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
37	2025	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
38	2026	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
39	2027	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
40	2028	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
41	2029	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
42	2030	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
43	2031	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
44	2032	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
45	2033	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
46	2034	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
47	2035	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
48	2036	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
49	2037	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
50	2038	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
51	2039	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
52	2040	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
53	2041	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
54	2042	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
55	2043	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
56	2044	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
57	2045	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
58	2046	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
59	2047	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	1405.5	-1405.5
60	2048	0.0	0.0	0.0	-0.0	0.0	-0.0	-0.0	0.0	-0.0
		70963.0	46161.0	117124.0		70963.0	35702.0	152826.0	70274.4	82551.6

Annual Interest Rate : 3 %  
Loan Period : 30 Years  
Grace Period : 10 Years

### 6.4.3 Farmer's Economic Analysis

Direct beneficiaries are 735 families and about 5,000 personnels through the implementation of project. As for farmer's economic surplus by management scale increases by 5.6 - 7.5 times in comparison with without project, therefore living standard is expected to be evaluated.

After the project is implemented, the sub-families, families, and multi-families have annual farmers economic surplus of Q 6,655, Q 62,123, and Q 199,398, respectively. Such surplus is increased by 5.6 - 7.2 times the surplus without the project is implemented (Table 4.4.2-6).

Where 60% of the project cost is borne to beneficiaries (Acuerdo Gubernativo Numero Ministerio de Agricultura y Ministerio de Finanzas Publicas 11-80), a burden charge is Q 14,641/ha. If this burden charge is paid under the conditions of no interest, reimbursement of 40 years or 50 years, the annual reimbursement is Q 366/ha or Q 293/ha, respectively. Table 6.4.3-1 shows a burden charge for each scale of farmers. This charge is sufficiently payable by each farmer considering an increase in farmer's economic surplus.

Table 6.4.3-1 Annual Burden Charge of Beneficiaries

(Unit: Q)

	Cultivated land (ha)	Farmer's economic surplus	40-year reimbursement	50-year reimbursement
Sub-families	2.3	6,655	842	674
Families	15.4	62,123	5,636	4,512
Multi-families	66,6	199,398	24,376	19,514

### 6.5 Socio-economic Evaluation

As stated before, this development plan brings about direct, quantifiable benefit as well as the secondary or indirect unquantifiable benefit, which is important in reviewing validity of implementation of the project.

#### (1) Contribution to national development plan

Implementation of the project contributes to national development in ensuring accomplishment of many objectives of the agricultural irrigation development plan, which is one of important tasks in the national development plan.

(2) Acquisition of foreign exchange

The plan increases production of vegetables, most of which are exported. Assuming that 80% of production volume of the vegetable are exported, a annual foreign exchange income of about US \$ 6 million is acquired (Table A.6.5-1). In view of external debt, an increase in export agricultural products contributes to guatemalan economy in acquiring foreign exchange and improving balance of payment.

(3) Stable supply of food

Productions of maize and kidney beans, which are basic major crops, increase by 1.9 times and 5.9 times, respectively. An increase in production keeps pace with growing demand as a result of an increase in population contributes to improve of self-supply rate.

(4) Increase in employment opportunity

Construction work employs about 259,000 man/day of the skilled laborer and 274,000 man/day of the unskilled laborer in total over a period of 5 years (Table A.6.5-2). In addition, agricultural production requires an increase in agricultural laborers of about 677,000 man/day. In particular, an employment opportunity is markedly increased in the dry season.

Implementation of the project absorbs excess labor in and around the project area, reduces unemployed laborers, and improves the living standard of employed laborers, thus contributes to stabilization of civil living in the project area.

(5) Improvement of living standard

As evidently proven by financial evaluation, farmer's economic surplus is increased to a great extent by implementation of the project, even if part of project cost is borne to farmers. A rapid increase in funds in farmer's economy by far exceeds cost of improving living environments.

(6) Promotion of marketing and processing of agricultural products

Increased production of agricultural products stimulates the marketing system, and opens a door to improvement of the system. In addition, processing of agricultural products such as tomatoes ensures increased values added. Stable supply of raw materials effectively utilizes existing processing facilities that would otherwise be left in poor utilization efficiency, thereby contributing to promotion of the agricultural product processing sector.

(7) Correction of differences among areas

Construction of the maintenance road of the canal not only serves to operation and maintenance of the canal but reduces economical differences among areas by stimulating distribution of goods among areas.

(8) Utilization of sight-seeing resource

Presence of the reservoir changes the scene of the area to a great extent. Monjas area has a relatively monotonous scene and few sight-seeing facilities. The reservoir, dam, etc. have a large potential as a sight-seeing resource.

(9) Economical stimulation

As stated, implementation of the project increases the income of the local farmer and improves the living standard to a great extent. Improved income further increases purchase power of the local farmer and vitalizes local commercial activities. Increased purchase power and vigorous commercial activities are expected to combinedly promote local industries.

In this way, implementation of the project will bring about significant repercussive effect to Jalapa Department and Jutiapa Department, and finally to economy of the Republic, not limited to Monjas area.

## 6.6 Overall Evaluation

Implementation of the project allows prediction that the living standard of local inhabitants in and around the project area is greatly improved, which results from an increase in agricultural production, acquisition of foreign exchange, stable supply of food, creation of employment opportunities, expansion of income, etc. All these merits are attained mainly by expansion of cultivated land, and an increase in cropping rate and unit yield owing to the project. Implementation of the project is highly evaluated that serves to stabilization of civil living and welfare in Monjas area, gives an intense impact to production activities, and contributes to national economy.

Thus, implementation of this project is judged as valid with the result of economical evaluation and financial evaluation as computed from quantifiable benefit. In addition, socio-economic impact evaluated from unquantifiable benefit is also judged as sufficiently expectable.

## **CHAPTER 7 RECOMMENDATION**





## CHAPTER 7 RECOMMENDATION

### 7.1 Early Implementation of Project

It is recommended to implement the project early in consideration of socio-economical effect to the Republic of Guatemala and the project area as a result of implementation of the present development plan.

### 7.2 Civil Works

The following concepts are taken into account to implement civil works smoothly.

- (1) Before the opening of construction, land to be used for the project facilities should be acquired through full discussion with owners.
- (2) Diversion tunnel should be carried out in advance in order to avoid suspending the Hoyo Lake irrigation project during the period of civil works.
- (3) It is proposed that farmer's living in site should be given priority in employment of laborers for the work.

### 7.3 Operation and Maintenance Organization

- (1) For the purpose of efficient management of the project, operation and maintenance of facilities should be emphasized, operation and maintenance should be established that is composed of relevant institutes headed by DIRYA and of beneficiaries.
- (2) The operation and maintenance organization should preferably include a department involved in the agricultural extension system for the purpose of increasing development effect.
- (3) DIRYA is responsible for operation and maintenance of main facilities such as dam, regulating reservoir, and main canal. However, beneficiaries should be responsible for the lateral canals and tertiary canals.

### 7.4 Agriculture Promotion Measures

The following promotion measures are necessary to obtain higher development effect.

- (1) Technical guidance systems and research systems for agriculture and livestock breeding should be re-organized into a unified system so that technical guidance will be given integrately and continuously.
- (2) Expansion of cropping rate requires finance for the farmers. The Ministry of Agriculture, livestock and food resources is requested to respond to demand of farmers for finance in close cooperation with BANDESA, etc.

- (3) Farmers' organization should positively be brought up because efficient management of the marketing system is necessary with an increase in production.

#### 7.5 Continuance of Observation

Meteorological and hydrological observations not only provide important data in the course of the project but significantly contribute to similar projects. Observation should be continued by use of gauging meters, etc. provided in this plan.

#### 7.6 Pre-engineering

To avoid a major change in design during construction and performing the work plan on schedule data necessary for detailed design, estimation of construction cost, and establishment of construction schedule is collected during the pre-engineering.

Moreover, it is necessary to perform the following surveys such as topographical survey, embankment material survey and test boring at site of diversion weir on responsibility of the Government except boring at dam site and geophysical exploration.

##### (1) Topographical survey

The purpose of topographical survey is to collect basic data for selection and design of the dam site, dam foundation, spillway, intake works, canals, etc. and for geological survey. Therefore, the following surveys are required.

##### 1) Aerial survey

- Topographical map of the catchment area: scale 1/25,000
- Topographical map of the project area : scale 1/2,000

##### 2) Topographical map of dam site and surrounding area

- Topographical map of main dam and saddle dam sites:
- Scale 1/500, contour 1 to 2 m
- Longitudinal sections of main dam and saddle dam points: scale 1/500
- Cross Sections of main dam and saddle dam sites: scale 1/500
- Longitudinal section of reservoir and river: scale 1/500
- Topographical map of quarry: scale 1/500
- Topographical map of reservoir: scale 1/2,000

##### 3) Topographical map of canal route and main structure site

- Plan of route: scale 1/500
- Longitudinal sections of route: scale 1/500
- Cross section of route: scale 1/100
- Plan of main structure site: scale 1/200

#### 4) Scope of survey at dam site

Scope within a horizontal distance of about 100 m from the outside of the dam (at the elevation of the dam crest) and within about 100 m from the end of the upstream and downstream of the dam.

### (2) Geological survey

#### Dam Site

The purposes of geological survey at the dam site are as enumerated below.

- To grasp distribution condition of unconsolidated deposits at dam foundation
- To grasp the bearing capacity as dam foundation
- To determine basic lines to excavate foundation of dam body and ancillary structures, and
- To grasp the method and scope of foundation treatment

#### 1) Scope of survey

- Main dam site and saddle dam site including ancillary structure sites
- Overall area of reservoir

#### 2) Survey item

The survey is subdivided into the areal survey, core boring, geophysical exploration, etc.

The survey location map is shown in Fig. 7.6-1.

#### - Areal survey

The purpose of the areal survey is to prepare a detailed geological map by checking the existing geological map on the basis of the topographical map of the Study area and reservoir.

#### - Core boring

The following table shows the location of boring and number of bores.

Boring No.	Location	Boring depth	Remarks
MB-1 to MB-6	Left abutment on main dam axis	300 m	50 m/bore x 6
MB-7 to MB-11	Left abutment on main dam axis	350 m	70 m/bore x 5
MB-12 to MB-17	River bed on main dam axis	420 m	70 m/bore x 6
MB-18 to MB-19	Right abutment on main dam axis	140 m	70 m/bore x x
Sub-total		1210 m	
SB-1	Spillway center; inlet	40 m	
SB-2	Intersection of spillway with dam axis	50 m	
SB-3	Spillway center; rapids	20 m	
SB-4	Spillway center; still water pond	20 m	
Sub-total		130 m	

Boring No.	Location	Boring depth	Remarks
TB-1	Diversion foundation	20 m	
TB-2	Tunnel inlet	20 m	
TB-3	Tunnel curve center	50 m	
TB-4	Intersection of tunnel with dam axis	70 m	
TB-5	Tunnel exit	30 m	
Sub-total		190 m	
SDB-1 to SDB-2	Left abutment on saddle dam axis	100 m	
SDB-3 to SDB-5	River bed on saddle dam axis	150 m	
SDB-6 to SDB-8	Left abutment on saddle dam axis	150 m	
Sub-total		400 m	
Grand-total		1930 m	

Note: \* In the boring shaft the sand and gravel layer is subjected to the standard penetration test and the rock to the in-bore loading test.

\* The permeability test is carried out at intervals of 5.0 m.

\* Groundwater table is measured.

\* Typical boring cores are subjected to the rock test.

- Geophysical exploration

The geophysical exploration is carried at the following locations.

Route line	Location	Length
A-A survey line	On main dam axis	1400 m
B-B survey line	River bed; right angle to dam axis	750 m
C-C survey line	Tunnel center; upstream	450 m
D-D survey line	Tunnel center; downstream	700 m
E-E survey line	Spillway center	550 m
F-F survey line	On saddle dam axis	600 m
Total		4450 m

Diversion weir site

The purposes of geological survey at the diversion weir site are shown below.

- To grasp structure and properties of foundation
- To grasp bearing strength of foundation
- To ascertain condition of river bed deposits
- To grasp groundwater table and flow condition

1) Scope of survey

The intake weir, apron, sand sluiceway, and settling basin are included.

2) Survey item

The survey conforms to the geological survey at the dam point.

The following table shows the location of boring and number of bores.

Boring No.	Location	Boring depth	Remarks
1	Intake weir center line	60 m	30 m/bore x 2
2	Apron downstream end	30 m	30 m/bore x 1
3	Upstream and downstream of sand sluiceway	60 m	30 m/bore x 2
4	Settlement basin extension line	30 m	30 m/bore x 1
Total		180 m	

Note: \* In the boring shaft the sand and gravel layer is subjected to the standard penetration test and the rock to the in-bore loaded test.

\* The groundwater table is measured.

\* Typical boring cores are subjected to the physical test.

(3) Embankment material survey and test

Embankment materials should be subjected to survey and test to sufficient accuracy to grasp deposits and physical properties.

1) Material survey

a. Soil borrow area

About 50 test pits are bored to a depth of 5 m on a 50 m grid.

b. Random and pervious materials

- About 20 test pits are bored to a depth of 5 m on a 100 m grid and about 20 boring cores are made to a depth of 15 m.

- About 5 tranches are excavated to a depth of 5 m and in a length of 50 m.

- Seismic prospecting is conducted to a total length of 3 km to ascertain the thickness of the weathered layer.

2) Material test

a. Impervious material and random material

Test item	Test standard	Impermeable material	Random material
<b>a) Physical test</b>			
Moisture content test	ASTM D2216-71	50 Sample	20 Sample
Specific gravity test	ASTM D854-58	50	20
Mechanical analysis	ASTM D422-63	50	20
Liquid limit test	ASTM D423-63	50	20
Plastic limit test	ASTM D424-59	50	20
Shrinkage limit test	ASTM D427-61	50	20
<b>b) Mechanical test</b>			
Compaction test	ASTM D698-78	10 Sample	5 Sample
Permeability test	ASTM D2434-68	10	5
Consolidation test	ASTM D2435-80	10	5
Triaxial compression test (U-U)	ASTM D2850-70	10	5
Triaxial compression test (C-U)	-	10	5

b. Pervious material

About 10 samples of the pervious material are taken at a outcrop and subjected to the following tests.

- Specific gravity and moisture content test; ASTM C97-47
- Stability test; ASTM C88-76
- Abrasion test; US Bureau of Reclamations Designation 21
- Unconfined compression test; ASTM D2938-79

Fig. 7.6-1 Location Map of Boring and Geophysical Exploration

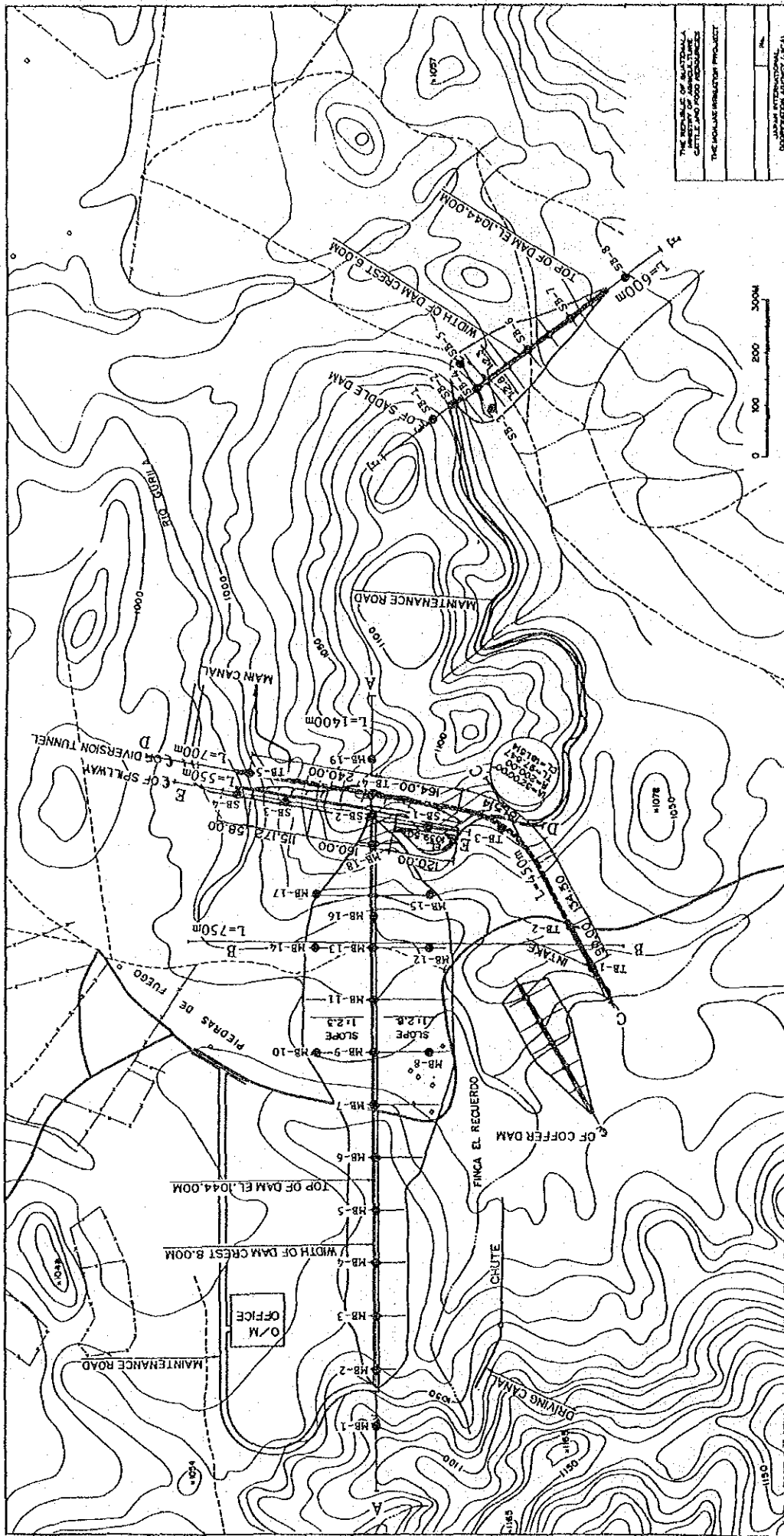


Fig. 7.6-1 Location Map of Boring and Geophysical Exploration





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