

**THE REPUBLIC OF GUATEMALA
MINISTRY OF AGRICULTURE,
CATTLE AND FOOD RESOURCES**

**FEASIBILITY STUDY
ON THE MONJAS IRRIGATION PROJECT**

FINAL REPORT



**VOLUME I :
MAIN REPORT**

JULY 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Republic of Guatemala, the Japanese Government decided to conduct a survey on the Monjas Irrigation Project and entrusted the survey to the Japan International Cooperation Agency (JICA).

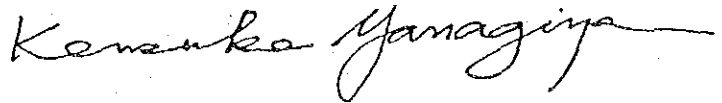
JICA sent to Guatemala a survey team headed by Mr. Saburou Nakanishi, Pacific Consultants International, two times in the period from August, 1987 to January, 1988.

The team exchanged views with the officials concerned of the Government of Guatemala and conducted a field survey (Phase I and II) in the Monjas areas in Jalapa and Jutiapa Departments. After the team returned to Japan, further studies were made and the present report has been prepared.

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

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

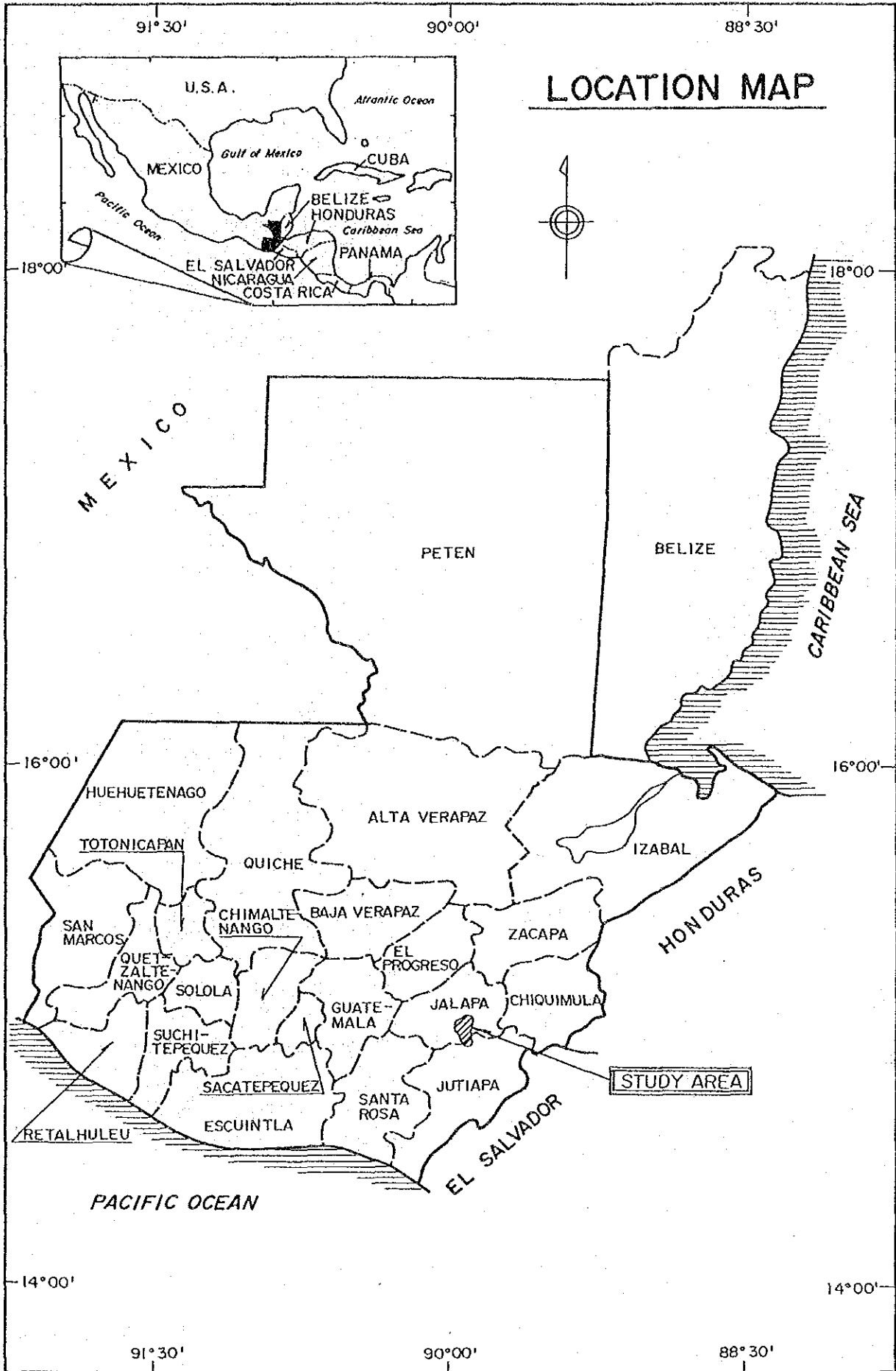
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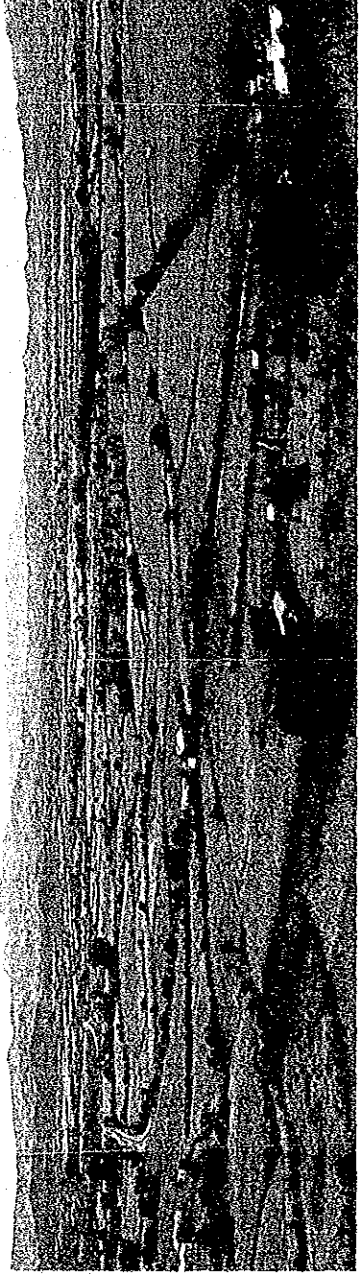
Kensuke Yanagiya

President

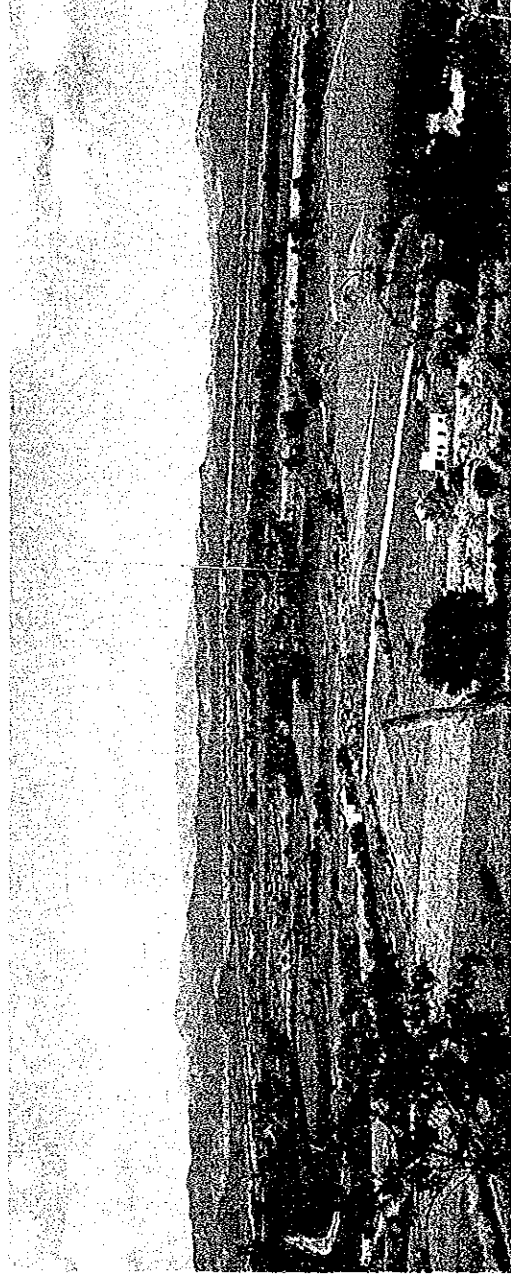
Japan International Cooperation Agency



Distant View from the Hoyo Lake
Vista Distante de la Laguna del Hoyo



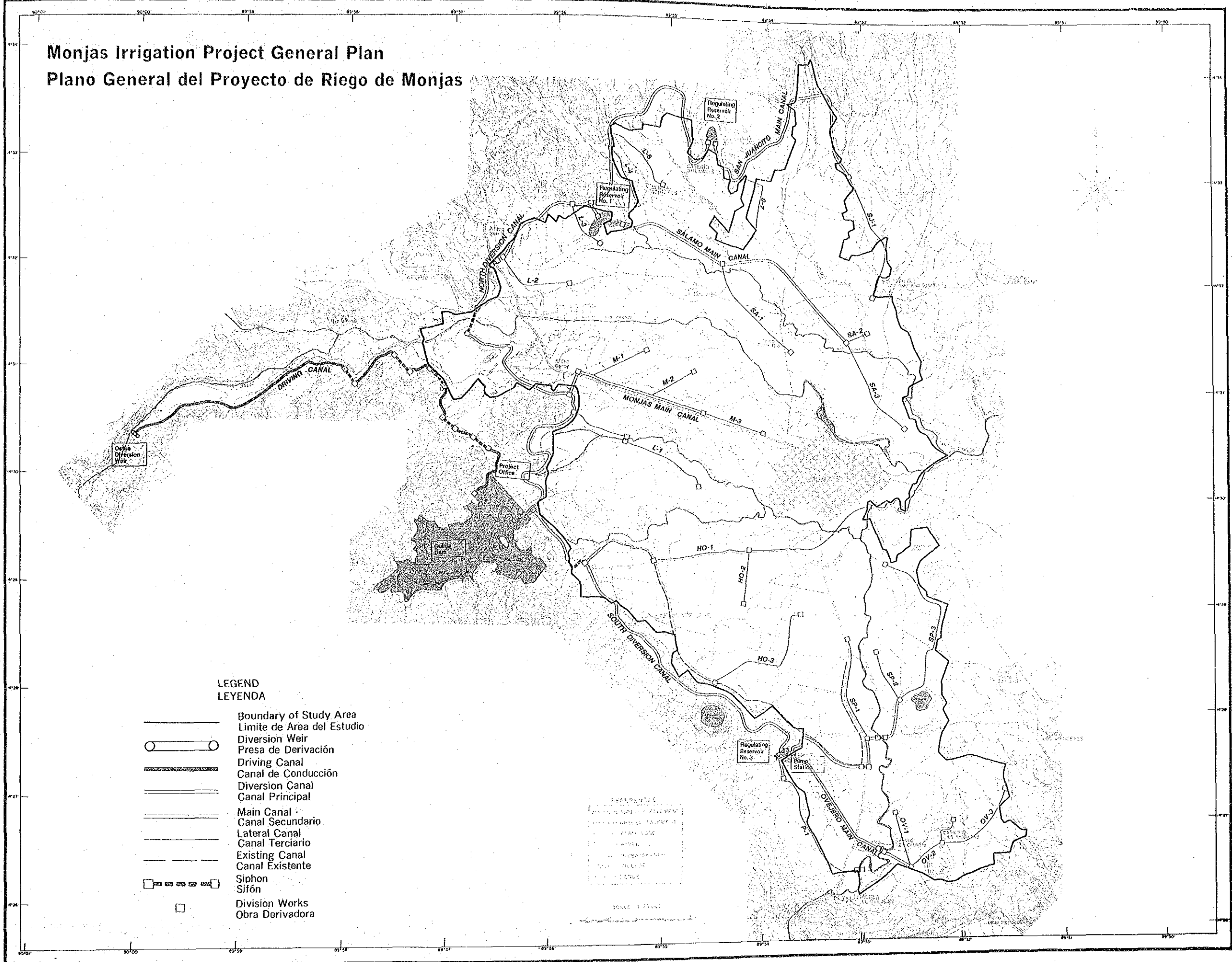
Wet Season (August, 1987)
Epoca Lluviosa (Agosto, 1987)


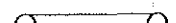









Dry Season (December, 1987)
Epoca Seca (Diciembre, 1987)

Monjas Irrigation Project General Plan

Plano General del Proyecto de Riego de Monjas



-  Boundary of Study Area
Limite de Area del Estudio
-  Diversion Weir
Presa de Derivación
-  Driving Canal
Canal de Conducción
-  Diversion Canal
Canal Principal
-  Main Canal
Canal Secundario
-  Lateral Canal
Canal Terciario
-  Existing Canal
Canal Existente
-  Siphon
Sifón
-  Division Works
Obra Derivadora

ESCALA 1:50,000

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

1. Introduction

This Report describes and explains results of the Feasibility Study on the Monjas Irrigation Project in the Republic of Guatemala.

The Report consists of the Main Report in Volume I and the Appendix in Volume II.

2. Background of the Study

2.1 Agricultural sector is the basic economical activity of Guatemala. The Government of Guatemala grants high priority to the agricultural sector in line with Five-year National Development Plan (1987 - 1991). The Government promotes irrigation agriculture in particular as one of the significant agricultural development program.

The Monjas Irrigation Project is given the highest priority as a part of the irrigation agriculture program and was requested by the Government of Guatemala in 1985 to the Government of Japan to conduct a feasibility study.

In compliance with the request, the Government of Japan despatched a pre-study team to Guatemala in advance of the feasibility study on February, 1987 and concluded the Scope of Work (S/W) through the discussion between the pre-study team and the Government of Guatemala.

As a result, the Feasibility Study (the Study) was started in August, 1987.

2.2 The objectives of the Study is to form the water resource development plan which is pertinent in technique, in economic, in financial, and in social aspects in order to promote the agricultural development in Monjas area, Jalapa Department, located in the south-east of Guatemala.

3. Brief Description of the Study Area

3.1 The Study area is Monjas area situated about 150 km east south-east of the capital. The area is located in the direction of south-east of central high land and surrounded by mountains with their height ranging from 1,200 m to 1,500 m. The whole area of the basin is about 9,000 ha and the Study area is about 7,100 ha of the whole area.

3.2 Ostua River flows from west to east on the north side of the center of the basin, and joins branches Guirila, Mojarritas, Juan Cano, etc. before flowing out of the east end of the basin. The discharge of water in these tributaries decrease extreamly in the dry season and some of them even dry up.

3.3 The climate varies from the wet season (from May to October) to the dry season (from November to April) through the year.

Annual precipitation is about 1,000 mm and 95% of the total depends on the wet season.

Annual average temperature is 22°C and its monthly variation is small.

3.4 Volcanic rocks form mountains surrounding the basin and its basement of the basin. Covering the basement rock, pyroclastic materials and sediments are underbedded to compose the basin.

3.5 Vertisol suitable for agriculture and high fertility is widely distributed in the Study area. Inceptisol and Alfisol are also found.

In view of land classification Class I to Class III accounts for most of agricultural land. The Study area is regarded as suitable for agriculture.

3.6 Agricultural land in the area is 5,350 ha which covers 75% of the total Study area consisting of 4,350 ha of upland field and 1,000 ha of pasture.

3.7 Agricultural products in the wet season are mainly maize, and kidney beans, moreover tomatoes and tobacco are also partly cultivated. However, no cultivation is found except the irrigation area partly practiced during the dry season.

At present, Hoyo Lake Irrigation Project (irrigation area is about 350 ha), groundwater irrigation (460 ha), surface water irrigation (90 ha) are put into practice and vegetables such as broccoli, tomatoes and onions are cultivated.

3.8 Maize and kidney beans, except those used for self-consumption, are purchased by broker and distributed to domestic markets. While most broccoli, tomatoes, onions, and tobacco are exported mainly to the U.S.A. and El Salvador through exporters, wholesale buyers, and tobacco companies, respectively.

3.9 Broccoli and tobacco are cultivated on the contract basis. Technical assistance has been provided for those vegetables producers by exporters, wholesale buyers, etc. However, technical assistance for the other kind of products is not enough.

3.10 Topographical, climatical, and soil condition in the Study area is suitable for agriculture. However, cropping in the dry season is not practiced due to the shortage of irrigation water. Consequently, few job opportunities and low land use ratio during the dry season restrict the raising of living standard and vitalization of regional economy.

4. The Project

4.1 Objectives and Basic Policy of the Project

In order to solve the irrigation water shortage problem which limits the amount of the agricultural production during the dry season, water resources development and introduction of irrigation facilities are planned.

The project aims to establish agricultural development plan which will enable to practice the whole-year-cultivation, thus increasing the amount of agricultural products.

4.2 Basic Development Concept

4.2.1 Water Resources

As water resources, surface water gained in the wet season in a dam and groundwater are considered.

1) Dam

The storage capacities necessary for irrigation area ranging from 4,000 ha to 4,800 ha are between about 31 MCM and 38 MCM.

Considering conditions mentioned above, five dam sites were studied and compared. As a consequence, Guirila dam site was selected due to larger capacity and lower dam height than other sites. However, in order to secure effective storage, surface water of the Ostua River should be diverted through driving canal.

2) Groundwater

After studying the productivity of the wells, Mojarritas and San Pedro sector are found feasible for groundwater development area.

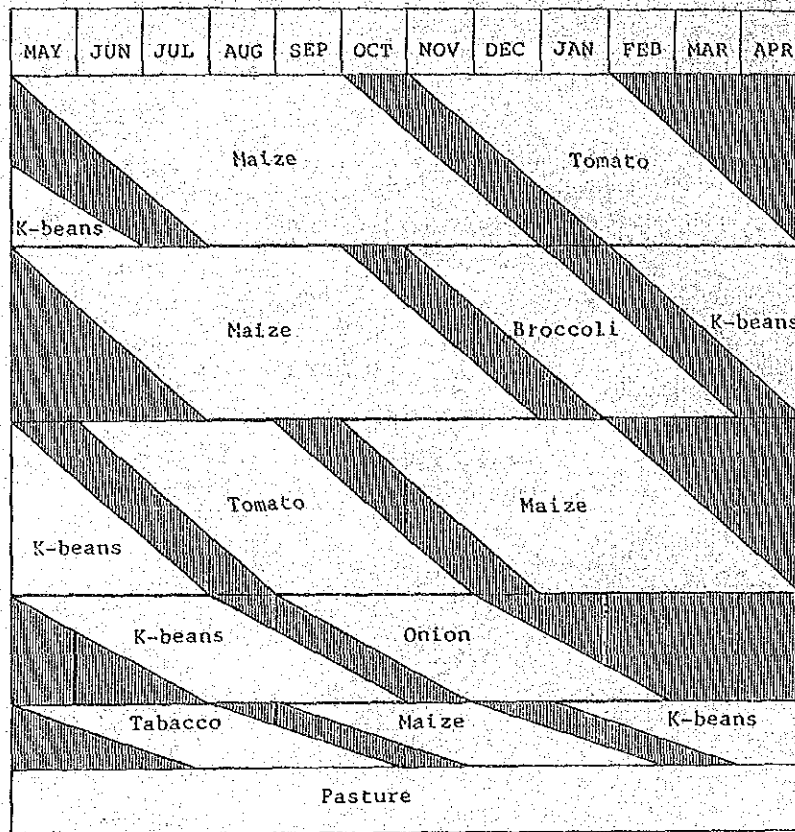
4.2.2 Benefited Area

Benefited area is 4,800 ha which consist of 4,350 ha of existing upland field including existing irrigation area and 450 ha of converted field from pasture.

4.2.3 Cropping Pattern

The cropping pattern for agricultural production plan is suitable for the extention of upland field area, increasing cropping ratio, and production of high profitable crops and also considers maintain of fertility of soil, avoiding damage given by continuous cropping, and rotation cropping pattern for required labor.

Main crops are maize, kidney beans, tobacco and tomatoes in the wet season and maize, kidney beans, tomatoes, broccoli and onion in the dry season.



4.2.4 Study for Optimum Plan

The basic conditions of the plan before studying the optimum plan is set as follows.

- Irrigation covers as wide as possible, including the present irrigation area, on condition that necessary water resource is ensured.
- A reservoir, the main facility, should preferably be formed as low as possible in height in consideration of topography, geology, etc.
- Cost and expenses are borne to local beneficiaries, as a rule, maintenance expenses necessary for the management of the project is limited a minimum.
- Facilities of Hoyo Lake irrigation project, etc. are effectively utilized.
- Groundwater development is simultaneously studies.

To determine an optimum plan, the following three alternatives are studies which have different conditions of irrigation area, different kinds of water resources, etc.

Case 1:

Independent Guirila dam, irrigation area 4,800 ha

Case 2:

Independent Guirila dam, irrigation area 4,350 ha

Case 3:

Guirila dam and groundwater wells, irrigation area 4,800 ha

As a result of comparison of alternatives in view of technical and economical aspects, Case 1 is determined as the optimum plan due to following reasons.

- A large irrigation area of 4,800 ha is covered, including pasture to be converted into upland field.
- A net reservoir storage of 37.7 MCM (live capacity of reservoir 39.6 MCM) is ensured by water introduced into the Guirila River from the Ostua River.
- Water resource construction cost by dam per ha is lower than Case 2.
- Operation and maintenance is easy and least expensive.
- The canal constructed by the Hoyo Lake irrigation project is effectively utilized.
- Case 3 (depending its water source partly on groundwater) is costly for its operation and maintenance, thus resulting in poor profitability.

4.3 Development Plan

4.3.1 Land Use Plan

The area to be irrigated is the existing upland field and a part of pasture to be converted into upland field, and covers a total area of 4,800 ha.

Existing upland field.	4,350 ha
Pasture to be converted	450 ha
Total	4,800 ha

4.3.2 Irrigation Plan

Irrigation plan for benefited area of 4,800 ha is established based on the cropping pattern. Annual water requirement and maximum water requirement are 49.3 MCM and 3.28 m³/s, respectively. Irrigation methods are furrow (80%) and sprinkler (20%) irrigation.

Average water requirement for each irrigation operation is 33 mm and irrigation interval is 7 days.

Irrigation system is structured by South and North Diversion Canal. The benefited irrigation area is divided into 10 blocks. Three regulating reservoirs are planned to be built at the end of diversion canals. Unit water requirement for main and lateral canals range from 0.87 to 1.43 l/sec/ha.

4.3.3 Reservoir Plan

The scale of reservoir of Guirila dam are as follows:

Gross capacity of reservoir	40.9 MCM
Live capacity of reservoir	39.6 MCM
Design flood discharge	461 m ³ /s
Reservoir area in FWL	2.05 km ²
Usable water depth	39.5 m
Crown elevation	1,044.0 m

4.4 Agricultural Development Plan

4.4.1 Agricultural Production Plan

The total cropping area is doubled which corresponds to 11,250 ha as compared with the present and annual average cropping ratio increases to 234%, especially increases significantly in the dry season.

The production of crops increase about 2 to 8 times as big as the present production especially vegetables. Annual required labor is doubled which corresponds to 1.179 million, consequently job opportunities increase remarkably. Gross production value and net production value multiply about 3.1 and 5.4 times corresponding to Q 42.391 and 19.773 million, respectively.

4.4.2 Agricultural Management Plan

Gross agricultural profit, agricultural income, farm household income, and farm household economic surplus by each scale of farm are increased as follows:

	<u>Without Project</u>	<u>With Project</u>
Gross agricultural profit	1	1.7 - 2.5
Agricultural income	1	2.7 - 4.9
Farm household income	1	2.6 - 4.9
Farm household economic surplus	1	5.6 - 7.2

4.4.3 Marketing and Agricultural Supporting System

For the increase of agricultural production, improvement of marketing system is desired. Effective supports by authority concerning such as experiment and study of vegetables, technical guidance, agricultural finance, development of farmer's organization, and etc. will contribute to enhance the effect of the development.

4.5 Facilities Plan

Reservoir, diversion weir, canals are planned as irrigation facilities.

Reservoir:

Guirila dam consists of main and saddle dam. Height and Length of main dam are 49 m and 1,072 m, respectively and dam volume is 2.63 MCM. 31 m of dam height is proposed for the saddle dam.

Diversion Weir:

The type of diversion weir is fixed type. Intake water level and amount are 1,059.1 m and 4.0 m³/s, respectively.

Canals:

Driving canal from the diversion weir to Guirila dam about 9.5 km in length is planned.

Irrigation canal system consists of diversion canals, main canals, lateral canals, and tertiary canals.

Three regulating reservoirs are proposed at the end of diversion canals.

The project implementation period is estimated 78 months in total which is subdivided by 18 months of detailed design period including pre-engineering and by 60 months of construction period.

4.6 Project Cost

The total project cost including price escalation is estimated Q 117.125 consisting of Q 46.161 million as local currency and Q 70.963 million as foreign currency.

The local and foreign currencies of the project cost excluding price escalation are Q 28.398 million (32%) and Q 58.981 million (68%), respectively.

5. Project Implementation, Operation and Maintenance Plan

5.1 Project Implementation Organization

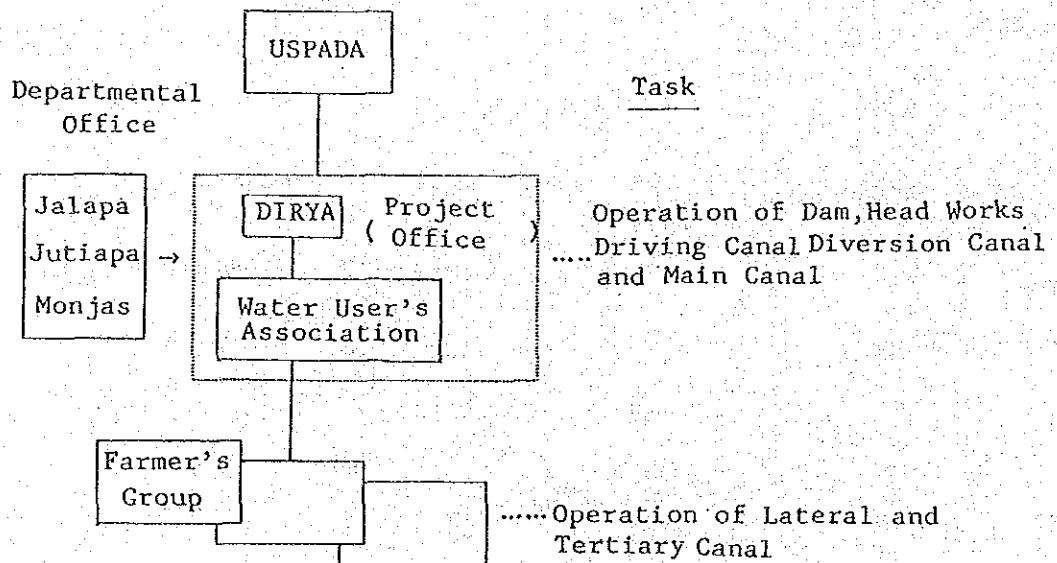
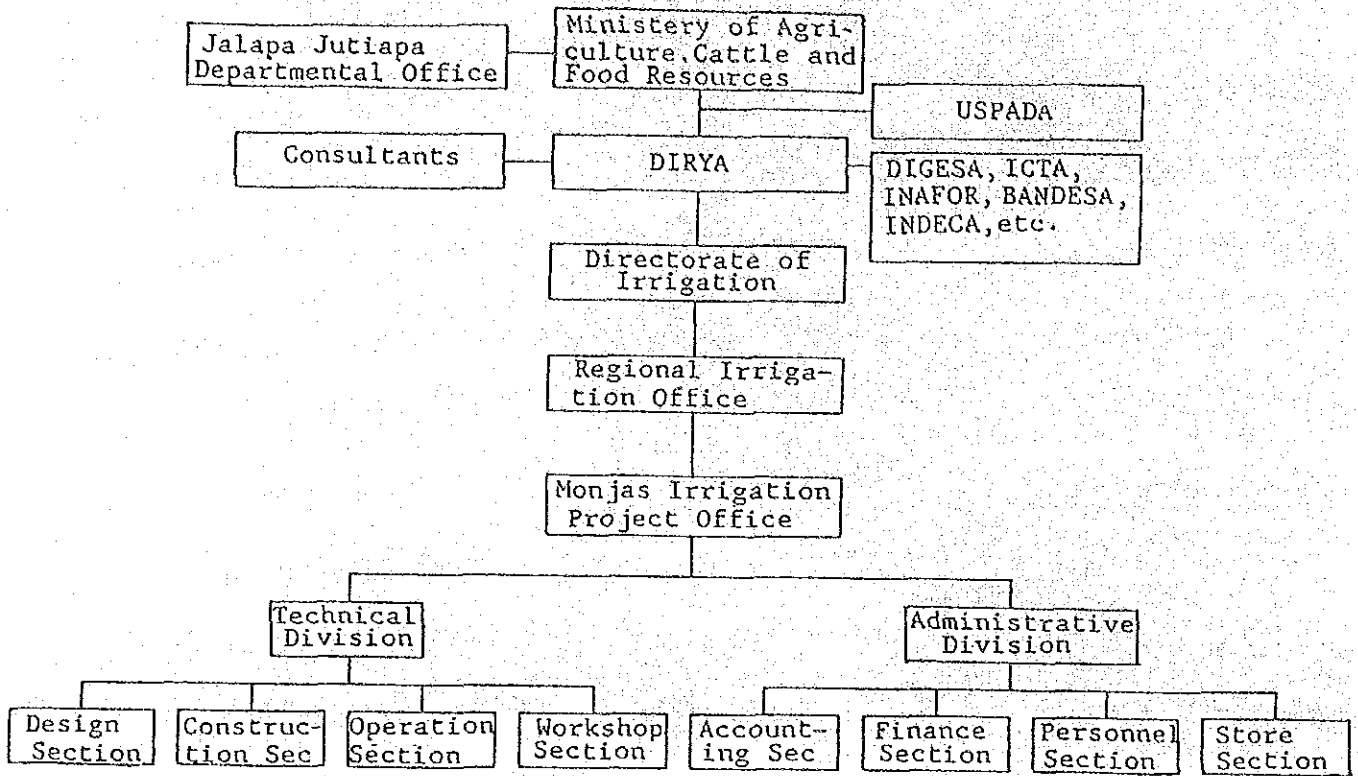
DIRYA plays the leading role in organizing an executing agency. DIRYA is expected to keep close interrelation with local government such as Jalapa and Jutiapa Departments and authorities concerned for the smooth implementation of construction works.

5.2 Operation and Maintenance Plan

In accordance with the government policy for the operation and maintenance, O & M organization is established mainly composed of beneficiaries. However, DIRYA will give instruction and support the O & M organization and also will operate directly the key facilities such as reservoir, diversion weir, diversion and main canals. Lateral and tertiary canals will be operated and maintained by beneficiaries.

5.3 Technical Services of Consultants

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 detailed design, tender evaluation, and supervisory services during the construction works term such as technical control, process control, and safety control.



6. Evaluation of the Project

6.1 The project life of the development plan is 60 years including the detailed design and construction period.

6.2 The quantifiable project benefit is increase of agricultural production. Annual project benefit at the time of accomplishment of the proposed production is estimated approximately Q 20 million.

6.3 EIRR of the project is 18.5% and at 12% of discount rate, ENVP is Q 44.78 million at price for 1987. Benefit-Cost ratio (B/C) is 1.72 at the same discount rate.

It is judged that implementation of the project is economically validated.

6.4 As a result of sensitivity analysis for cost and benefit, it was judged that a change of construction period has stronger influence on economy of the project than a change in project cost and benefit.

6.5 Considering the proportion of Governmental Subsidy for the project cost is 40% FIRR of the project is 16.2% and at 12% of discount rates, FNPV is Q 21.19 million at price of 1987. Benefit-Cost ratio (B/C) at said discount rate is 1.43.

6.6 As a result of the analysis of investment and repayment, utilizing of foreign fund with practical condition for foreign currency investment is within a range sufficiently payable by the Government.

6.7 5,000 people of 735 families will receive benefit directly by the implementation of the project. Should farm bear 60% of total construction cost, comparing with farm economic surplus increased, farmer's allotment will not be burden for farm.

6.8 Implementation of the project will contribute to socio-economic impact such as national development plan, acquisition of foreign exchange, stable supply of food, increase in employment opportunity, improvement of living standard, promotion of marketing and processing of agricultural products, correction of differences among areas, utilization of sight-seeing resource, and economic stimulation.

7. Conclusion

Implementation of the project is judged as valid technically as a result of economical and financial evaluation. In addition, socio-economic impact evaluated from unquantifiable benefit is also judged as sufficiently expectable.

8. Recommendation

8.1 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 plan area as a result of implementation of the present development plan.

8.2 Further Survey Required

Prior to the implementation of the project following survey should be carried out.

- Topographic Survey: Study area, canal route, vicinity of dam site, major structure points
- Geological Survey: Dam foundation survey (Boring geophysical exploration, etc.) and material tests.
- Embankment Material Survey: Material survey (Borrow area of random and previous material) and material test.

8.3 Civil Works

- Before the construction, land which is occupied by dam construction should be acquired through full discussion with owners.
- Diversion tunnel should be carried out in advance in order to avoid suspending the Hoyo Lake irrigation project during the period of civil works.
- It is proposed that farmers living in site should be given priority in employment of laborers for the work.

8.4 Management of Project and Operation and Maintenance Organization

- 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.
- The operation and maintenance organization should preferably include department concerned in the agricultural extension system for the purpose of increasing development effect.
- 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 canal and tertiary canal.

8.5 Agriculture Promotion

The following promotion are necessary for higher development effect.

- Technical guidance systems and research systems for agriculture and cattle breeding should be re-organized to a unified system so that technical guidance is given synthetically and continuously.
- Expansion of cropping rate requires finance for farmers. DIRYA is requested to respond to demand of farmers for finance in close cooperation with BANDESA, etc.
- Farmers' organization should positively brought up because efficient management of the marketing system is necessary with an increase in production.

8.6 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 for this project.

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Summary and conclusion
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Abbreviations and Measures

1. Abbreviation

BANDESA	:	National Agricultural Development Bank
BID	:	Inter-American Development Bank
BIRF	:	International Bank for Reconstruction and Development
CAMINOS	:	General Direction of Roads
CEPAL	:	Economic Commission for Latin America
DIGESA	:	General Direction of Agricultural Services
DIGESEPE	:	General Direction of Livestock Services
DIRYA	:	Technical Direction of Irrigation and Drainage
EC	:	Electric Conductivity
EIRR	:	Economic Internal Rate of Return
ENPV	:	Economic Net Present Value
FADES	:	Foundation for Analysis and Development of Central America
FAO	:	Food and Agricultural Organization
FIRR	:	Financial Internal Rate of Return
IMF	:	International Monetary Fund
FNPV	:	Financial Net Present Value
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
ICTA	:	Institute of Agricultural Science and Technology
IGM	:	Military Geographic Institute
INAFOR	:	National Institute of Forestry
INDECA	:	National Institute of Agricultural Commercialization
INE	:	National Institute of Statistics
INTA	:	National Institute of Agrarian Transformation
INSIVUMEH	:	National Institute of Seismology, Volcanology, Meteorology and Hydrology
INDE	:	National Institute of Electrification
IRR	:	Internal Rate of Return
JICA	:	Japan International Cooperation Agency
MAGA	:	Ministry of Agriculture, Cattle and Food Resources
MCC	:	Caribbean Common Market
CACM	:	Central American Common Market
MCTOP	:	Ministry of Communication, Transport and Public Works
NPV	:	Net Present Value

OEA : Organization of American States
 ODECA : Organization of Central American States
 pH : Hydrogen Ion Concentration
 SAR : Sodium Absorption Ratio
 SEGEPLAN : General Secretary of Planning
 USA : United States of America
 USAC : San Carlos National University
 USPADA : Department of Agriculture, Livestock and Food Planning

2. Length

mm = millimeter
 cm = centimeter
 m = meter
 km = kilometer
 yd = yard = 0.9144 m
 vara = 0.835906 m
 pie = 0.3048 m
 pulgada = 0.0254 m
 milla = 1.609344 km

3. Area, Volume and Weight

cm² = square centimeter
 m² = square meter
 km² = square kilometer = 10⁶ m²
 ha = hectare = 10⁴ m²
 l = liter = 1,000 cm³
 G = galon = 3.75 l
 m³ = cubic meter
 g = gram
 kg = kilogram
 MCM = million cubic meter
 t = ton = 1,000 kg
 lb = pound = 453.6 g
 Mz = manzana = 0.7 ha
 qq = quintal = 100 lb = 45.36 kg

4. Derived Measures

m/s, m/sec	=	meter per second
m ³ /s, m ³ /sec	=	cubic meter per second
t/ha, ton/ha	=	ton per hectare
m ³ /km ²	=	cubic meter per square kilometer
mm/day	=	millimeter per day
m ³ /km ² /year	=	cubic meter per square kilometer per year
l/s, l/sec	=	liter per second
qq/mz	=	quintal per manzana
Q/qq	=	quetzales per quintal
Q/kg	=	quetzales per kilogram

5. Electric Measures

KW	=	kilowatt
KV	=	kilovolt
KWH	=	kilowatt-hour
GWH	=	gigawatt-hour

6. Currency

US \$	=	United States Dollar
Q	=	Guatemalan Quetzal
¥	=	Japanese Yen

7. Temperature, Height, etc.

°C	=	degrees in centigrade
A.S.L.	=	above sea level
DL	=	datum line
EL, GL	=	elevation
%	=	percent
No.	=	number
Nos.	=	numbers
HP	=	horsepower

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CHAPTER 1 INTRODUCTION

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1.1 Background of the Study

In Guatemala, agricultural sector accounts for about 25% of the gross domestic product (GDP) and employs about 56% of population engaged in economical activities. In addition, primary and secondary agricultural products account for about 70% of total exports amount. High dependence of domestic economy on the agriculture sector means that the trend of agriculture production has significant influence on economy and society of Guatemala.

However, the agricultural production index has reduced year by year. In particular, since 1983, the food production index per capita has been lower than the level from 1974 to 1976.

To cope with reduction in agriculture production, the Government of Guatemala grants high priority to the agricultural sector in Five-year National Development Plan (1987-1991). In particular, Ministry of Agriculture, Cattle, and Food Resources promotes irrigation agriculture as one of the significant program of agricultural development.

Although the irrigated cultivated land has only a limited share in the whole cultivated land in Guatemala, the irrigated land has registered significant growth; 38,000 ha between 1961 and 1965, 68,000 ha in 1980, and 74,000 ha in 1983.

The Government of Guatemala has intention to accomplish the following targets through expansion of irrigation land and improvement of the irrigation system.

- Improvement of living level of local inhabitants by an increase in diversification of agricultural products.
- Elimination of unemployment problem due to the increase of employment opportunities.
- Revitalization of local economy through introduction of agricultural product processing industry, etc.
- Acquisition of foreign currency by export of agricultural products and processed agricultural products.
- Improvement in food situations by increased production of agricultural products for domestic consumption.

The Government of Guatemala is promoting "Monjas Irrigation Project" as a part of the irrigation land expansion program. For the Project, DIRYA performed a survey in 1960s, and a pre-feasibility study was conducted by technical assistance granted by Italy.

In September 1985, the Government of Guatemala requested the Government of Japan to conduct a Feasibility Study (the Study) for the Project. In compliance with the request, the Government of Japan despatched a pre-study team to Guatemala in advance of the Study in February 1987,

and concluded the Scope of Work (S/W) of the Study through a discussion between the pre-study team and the Government of Guatemala.

As a result, the Study was started in August, 1987.

1.2 Objectives of the Study

In response to the request of the Government of Guatemala as stated above, the objectives of the Study is to review the technical, economical, and social validity of the "Monjas Irrigation Project" in order to promote development of agriculture in Monjas area, Jalapa Department.

The Government of Guatemala has a great interest in the Study and expects results of following points from the Study.

- Establishment of economical irrigation system and review of operation and maintenance system,
- Improvement of productivity of existing crops and introduction of new crops, and
- Review of agricultural organization and marketing of agricultural products.

CHAPTER 2 SOCIO-ECONOMIC BACKGROUND

CHAPTER 2 SOCIO-ECONOMIC BACKGROUND

2.1 National Land and Population

2.1.1 Location, Area, Topography and Climate

The Republic of Guatemala (hereinafter referred to as Republic) is situated in lat. 13°45' - 13°49'N and long. 88°13' - 92°14'W. The Republic borders on the Mexico in the north and west, and on Honduras and El Salvador in the southwest, facing the Atlantic Ocean in the south, and Caribbean Sea and Belize in the east. The Republic covers the area of about 109,000 km², extending about 440 km from north to south and about 420 km from east to west. Topographically, the land is roughly classified into the central highland, south coastal low land, and northern low land.

The central highland is a mountain zone formed by the Sierra Madre mountain range, etc. which runs almost from east to west in the south of the national land; the basin in the mountain is favored with moderately warm or cool tropical highland climate, with the wet season (from May to October) discriminated from the dry season (from November to April). Comfort for living attracts most of the whole population concentrates to this mountain basin. The south coastal low land is situated on the Atlantic Ocean, having tropical savanna climate. The north low land is a plane forest zone, and has humid tropical rainy forestal climate or savanna climate under which extended in the zone most under-developed of Guatemala.

2.1.2 The Political and Regional Administration

Political system of Guatemala is the constitutional republican form. In 1986, Guatemala was released to civil administration, a new constitution established, and present President Cerezo was elected. As to foreign relation, the Republic is positively consolidating conjunction with western free countries including the U.S.A. as well as Central and South American countries.

In terms of local administration, the Republic is divided into 22 Departments (Departamento), which are composed of 1

2.1.3 Population

The Republic has a population of about 8.041 millions, 37.5% of which is urban population. The population density in nation average is 75 persons/km². The rate of population increase in recent years is about 2.8%. It is estimated that population will exceed 10 millions in 1995, reach 12.22 millions in 2000, and exceed 20 millions in 2025.

Approximately 42% of indigenous, 52% of white and mixed blood are racial formation of the Republic (INE, 1987).

Both rate of natality and mortality tend to reduce in recent years, and registered 4.27% and 1.05% in average between 1980 and 1985, respectively. The expected life at birth is extended year by year, and has reached 59.0 ages on the average between 1980 and 1985. Number of childbirths has reduced year by year, and is 6.1 in average, making Guatemala one of the most prolific countries of Central and South American countries.

Population of economical activities is about 2.6 millions, and accounts for about 32% of the total population. The agriculture, forestry, and fishery sector has the largest share of about 56% in the population of economical activities. The rate of unemployment increases to the extent that rate of wholly unemployment exceeds 10%. The rate of total unemployment, including the rate of incomplete employment of 29.7%, reaches 44.2%.

The rate of illiteracy is 56.4%.

2.2 National Economy and Agriculture

2.2.1 National Economy

The gross domestic product (GDP) in 1985 was about 9.69 billion US\$. The GDP per capita was about US\$1,220. The rate of economic growth has been continued to reduce since 1980, and the rate of accumulated reduction from 1980 to 1985 has reached 18.3%. This was attributable to the reduction in export, the policy of austerity, and the reduction in actual income. The agriculture, forestry, and fishery sector kept a stable share in the GDP, which was about 25% in 1985 and the largest share in all production sectors.

The agricultural product had a high share in export, which was nearly 70% of total exports in 1985, amounting to 1.06 billion Q (FOB price). Coffee accounted for about 43% of total agricultural product exports, followed by traditional products such as cotton, bananas, sugar, and cardamom, etc. Exports have been in reduction due to reduced price and stagnant demand. On the other hand, basic material of agriculture accounted for more than 50% of total imports in 1985, about 1.18 billion Q (CIF price). Export and import trade is made with the U.S.A., Central and South American countries, EEC, etc.

The balance of international trade has been improved in recent years, however, the stagnant export of agricultural products stated above caused a deficit of Q 17 million (FOB price).

In recent years, the government finance has registered a constant deficit. However, the annual revenue reached Q 862 million in 1985 and deficit scale is being improved.

The national budget in 1987 is Q 2.5562 billion. The budget of the Ministry of Agriculture, Cattle, and Food Recourses accounts for only 4.4% of the total budget irrespective of importance as the fundamental industry of Guatemala, while emphasis is placed on education, communications and transportation, national defense, social welfare, etc.

Price index numbers markedly increased and reached 18.7% in 1985; 36.9% in 1986. Wholesale price index numbers showed a similar tendency. The rate of inflation have been exceeded 30% since 1985. Rapid inflation and high rate of unemployment have reduced actual wages while the consumption level per capita has reduced to the level in the former half of 1970s.

2.2.2 Agriculture

(1) Land use, scale, and production

In the Republic, the agricultural land area is about 3.148 million ha (1983) or about 29% of the whole nation land. Annual crops are planted in 1.33 million ha or about 42% of the whole agricultural land and perennial crops in 0.484 million ha or about 15% of the whole land. The rest, 1.334 million ha, is utilized as pasture land. The irrigated area is 74,000 ha, or about 2.4% of the whole agricultural land.

The number of a small scale farmers having 7 ha or less accounts for about 88% of all farmers however, the area owned by them is only 16.5% of all the agricultural land. On the other hand, large scale farmers having 45 ha or more account for 2.6% of the whole although they own about 65% of the total agricultural land.

Main crops are planted in the cultivated area at the rate shown below: maize accounts for 37%, coffee 14%, kidney beans 9%, sorghum 4%, and the others (cotton, corn, cardamom, etc.) 36%. Maize and coffee remain unchanged in production in recent years. Kidney beans and sorghum tend to increase while cotton tends to decrease. The output places maize over kidney beans and coffee.

Basic crops for domestic consumption such as maize, rice, kidney beans, wheat, etc. do not meet growing demand and depend partially on import. In particular, import of wheat accounts for about 30% of total imports.

All agricultural production indexes tend to decrease. In particular, the food production index per capita greatly reduces, and has been lower than the level between 1974 and 1976 since 1983.

Low productivity and great fluctuations in production are attributable mainly to the production system and insufficient infrastructure including irrigation. In addition, not a few problems exist in the agriculture sector, for example, insufficient capital, incomplete finance system, petty farmers, insufficient technical guidance, etc. are encountered.

Agriculture of the Republic has local features. The central highland covering the Study area is the center of agriculture in the Republic. The agriculture land is distributed among the mountain basin and slope land, where relatively small-scale farmers plant coffee and vegetables for export as well as traditional crops such as maize and kidney beans, etc.

The south coastal land is low land developed on a fan-shaped alluvium, where many large-scale farmers mainly plant cotton, sugar canes, and bananas, and are engaged in livestock raising. The northern low land is also owned by many large-scale farmers engaged in sugar cane planting, livestock, and forestry, but most of the land is left underdeveloped.

(2) Agricultural development plan

The Government of Guatemala takes cognizance of importance of agriculture in national economy and gives high priority to the agriculture sector in the Five-year National Development Plan. The Government has so far promoted the price support policy of agricultural products, production materials, etc., but the recent development strategy places emphasis on improvement of the agricultural system and the agriculture of infrastructure development, such as expansion of irrigation agriculture, diversification of crops, expansion and improvement of agricultural product processing and distribution considering financial limit. The strategy is also focused on acquisition of foreign exchange through expanded export of agriculture products, improvement of productivity of small-scale farmers, creation of employment opportunities, and improvement of food situations.

The strategy of the agriculture sector in National Development Plan is as below.

- Securing land and water resource
- Organizing middle- and small-scale farmers
- Re-establishment of technical development and technique popularization
- Proper distribution of fund source
- Stabilization of agriculture product price
- Establishment of infrastructure of agriculture production
- Promotion and propulsion of agriculture product processing
- Promotion and acceleration of export
- Reinforcement of food production system, etc.

The Government places emphasis on expansion of irrigation facilities over other strategies in order to effectively utilized land and water resources. At present, the Government controls 25 irrigation areas in five administrative region of DIGESA-DIRYA, which cover about 15,000 ha and are mostly located in the central highland. The Government has intention to put the irrigation project into practice for additional 28,000 ha by the year of 1990, and to position the Monjas irrigation area as the top priority area and make it the model of the future irrigation agriculture development project.

**CHAPTER 3 PRESENT CONDITIONS OF
THE STUDY AREA**

CHAPTER 3 PRESENT CONDITION OF THE STUDY AREA

3.1 Location, Topography, Climate, and Administration

The Study area is Monjas Basin, which is situated in latitude 14°30' North and longitude 89°52' West, in the southeast of the Republic. The Study area extend about 7,100 ha out of 9,000 ha which is the total area of the Basin. The Basin has an altitude of 940 m to 1,000 m, surrounded by a mountain zone with an altitude of 1,200 m to 1,500 m. The Ostua River flows from west to east on the north side of the center of the Basin, and joins branches such as Guirila, Mojarritas, Juan Cano, etc. before flowing out of the east end of the Basin.

The annual average air temperature is about 22°C, with few difference in a day and month. The annual average precipitation is about 1,000 mm and rainfall days is estimated about 95. The 95% of precipitation is concentrated on a wet season from May to October, leaving dry the other season from November to April.

As to the ecology of the Study area, natural vegetation is classified in a subtropical arid forest zone, and most of the flat land is utilized as agriculture land. The flat land has relatively fertile soil suitable for agriculture production.

Most of the part of the Basin belongs to Monjas Community (Municipio), Jalapa Department, and the part of the south area belongs to El Progreso Community and Santa Catarina Mita Community, Jutiapa Department. Monjas urban area is located at the center of the Basin, and about 150 km away from the Capital; a national highway connects Monjas with the Capital.

The central administration ranks Monjas Community as village (Pueblo), Class 3, which is composed of the urban area, 12 middle villages (aldea) and 13 small villages (Caserito).

3.2 Socio-economic Conditions

3.2.1 Population

Jalapa and Jutiapa Department have populations of about 169,000 and 319,000 in 1986, respectively. The rate of population increase is 2.2% and 1.9% (1980 - 1985), respectively, which are much lower than the national average of 2.8%. The expected life at birth is 55.9 and 56.7, shorter than the national average by about 3.0 and 2.3.

Population forecast indicates that Jalapa and Jutiapa Department will have populations of 241,000 and 433,000 in the year of 2000, respectively.

Survey in 1981 shows that the Study area has a population of 14,130, which is composed of 11,728 in Monjas Community, 1,657 in El Progreso Community, and 745 in Santa Catarina Mita Community. The population is composed of 3,334 families, about 40% of which is in Monjas urban area. Population of economical activities is about 37% of the whole population, higher than the national average.