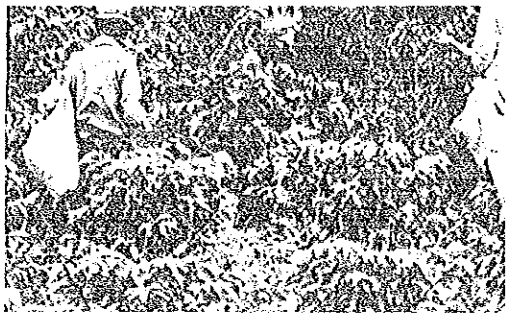
No. 2

THE REPUBLIC OF COLOMBIA

NATIONAL PLANNING DEPARTMENT (D. N. P.)
REGIONAL AUTONOMOUS CORPORATION OF QUINDIO (C. R. Q.)

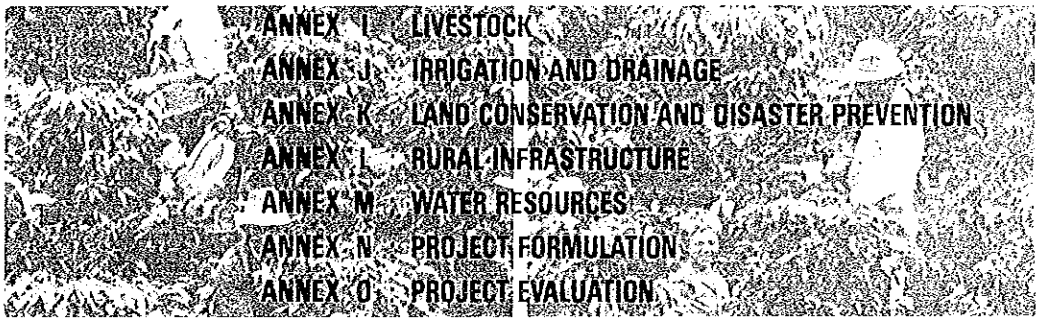
THE MASTER PLAN STUDY ON THE QUINDIO BASIN INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT



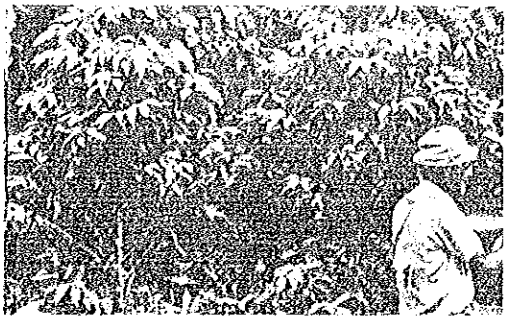
FINAL REPORT

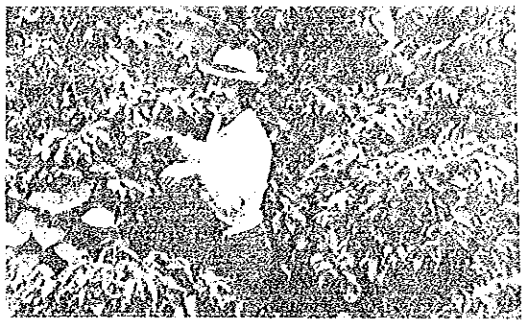
VOLUME III : ANNEXES(II)

JUNE 1988



ANNEX I LIVESTOCK
ANNEX J IRRIGATION AND DRAINAGE
ANNEX K LAND CONSERVATION AND DISASTER PREVENTION
ANNEX L RURAL INFRASTRUCTURE
ANNEX M WATER RESOURCES
ANNEX N PROJECT FORMULATION
ANNEX O PROJECT EVALUATION





JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE REPUBLIC OF COLOMBIA

NATIONAL PLANNING DEPARTMENT (D. N. P.)
REGIONAL AUTONOMOUS CORPORATION OF QUINDIO (C. R. Q.)

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VOLUME III : ANNEXES (II)

TABLE OF CONTENTS (1)

VOLUME III : ANNEXES (II)

TABLE OF CONTENTS (2)

ANNEX I : LIVESTOCK

ANNEX I. LIVESTOCK

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Annex I: LIVESTOCK

Introduction

As a part of the Master Plan Study on the Quindio Basin Integrated Agricultural Development Project, a sectoral study of the livestock and inland fishery sector has been conducted.

The study has been firstly done on existing data and reports and secondry on field reconnaissances survey, in which several livestock farms have been extensively surveyed to examine the existing conditions of livestock activities, pasture, vegetation and other natural conditions which affect livestock and fishery development.

All the study results are compiled into this chapter, consisting of three sections. Section 1 describes the present conditions of livestock and inland fishery development, including various stock raising activities, supporting activities, marketing of livestock products and other aspects. Section 2 clarifies the constraints on livestock development and prospects in the Department of Quindio. Finally, in Section 3, the livestock development plan is presented, consisting of development target, policy, strategy, projects and other measures.

I.1 Present Situation

I.1.1 General

The cattle raising is a typical and important livestock industry in Colombia, raising the third largest number of cattle in Latin American countries following to Argentina and Brazil.

The major products are beef, hides and skins. In recent years, the production of small animals such as swine and poultry has been rapidly increasing.

According to 1983 national statistics, conducted by the Ministry of Agriculture, there are 20.41 million heads of beef cattle, 4.05 million heads of dairy cattle, 2.24 million heads of swine, 2.36 million heads of sheep and 9.76 million units of poultry.

Traditionally, Colombians consume much beef which is roughly 70 percent of a kinds of meat combined (Table I.1.1.), while the other developed countries depend on cattle and sheep at about 50 percent (Table I.1.2.).
The average per capita, consumption rate of meat is 29.53 kg. Beef, the major livestock meat consumed, is 21.14 kg. The food consumption survey also shows that the average per capita, consumption of milk is 106.45 liters

and poultry egg is 140 pcs. per year respectively.

I.1.2 Livestock and Fishery Industry in the Quindio

(1) Population

According to 1983 statistics, the Quindio keeped 25,000 heads of beef cattle 0.1 % of national total, ranked 24th), 35,000 heads of dairy cattle (0.9 %, ranked 16th), 16,000 heads of swine (0.7 %, ranked 22nd), and 470 heads of sheep (0.02 %, ranked 22nd), among the 24 departments including the Terriotorios Nacionales of the country (Table I.1.3.).

The population trend of livestock and poultry is presented in Table I.1.4.

Cattle farming is most popular among the farmers; it is raised in various ecological zones, from low to high potential areas.

(2) Farming Systems

Farming of dairy cattle, swine and poultry are comparatively modern, with rearing being carried out in intensive lots, while most of the beef cattle is raised in open yards by large scale land owners. Both agricultural activities and livestock farming, exhibit differences in the scale of farming in the Quindio.

While the Quindio is self-sufficient in poultry meat and eggs, and self-sufficient rate of beef, pork and milk are low as most of the supply depends on the other departments (Table I.1.5. and I.1.6.).

(3) Cattle Farming

The cattle breeds used for dairy farming are comprised of pure breeds and crossbred of Holstein, etc. dual purpose breeds such as Normandy and Brown Swiss and its crossbred, while beef cattle breeds include various crossbred with Zebu.
Dairy farming is mainly conducted in middle to high land regions such as Armenia, Circasia, Filandia and Salento. On the other hand, beef cattle farming is a typical practice of the low lands and southern mountainous regions(Figure I.1.1.).
Large differences are observed with regards to breeds quality, management techniques and production levels, between large and small scale farms. The large farms have a high productivity and profitability level (Table I.1.7. and I.1.8.).

(4) Other Livestock Activities

The demand for pork, poultry eggs and meat has been increasing in recent times and, accordingly, the production of pork and poultry products has been increasing with large contribution by large scale swine and/or poultry farms and by investment from the non-agricultural sectors, respectively.
Most swine and poultry farms use modern improved breeds, and farming systems have been modernized in large scale farms. In response to good market prices for pork, resulting from the increasing demand, swine farming including small scale farming has become more popular in each municipalities.

There are swine breeding farms, but no poultry hatchery farms in the Quindio so that the day old chicks are procured from outside the Quindio.

The raising of sheep and goats are still minor occupation.

(5) Grassland

Cattle is mainly raised in open yards, except in the case of dairy farming in the Filandia municipality. Most of grazing is carried out with improved grassland, but natural grassland is very limited. The management of grassland, including fertilizing, weed control and renovation of land are less well conducted, higher the altitude.

The carrying capacity of the Quindio is relatively low, at 1.05 head per hectare, according to the CRQ and the FNC survey (Table I.1.9.).
Although this figure does not indicate overgrazing, present grazing seems to be close to the carrying capacity due to increasing dune deposit and the low palatability of grass, caused by lack of freshness of grassland and the trampling caused by the continuous grazing. In particular, gully erosion in some parts of the mountainous grassland can be seen at cattle passageway and in places devastated by cattle trampling. This is one of the many results of continuous grazing. Small erosion in mountain pastures occurs in grassland prepared by cleaning and tree felling, while afforestation is seldom considered. In some large scale beef cattle fattening farms in Caldas, pine trees have been planted so as to increase the moisture holding ability and accelerate the growth of pasture grasses, beside using the trees as shelter for grazing cattle.

A variety of species of pasture grass are common in the Quindio (Table I.1. 10.). In the dairy zones 80 percent or more of the pasture is well managed and intensively utilized. In the low land and mountainous regions, the pasture management has not much progressed.

(6) Inland Fishery

There are two rainbow trout culture farms, one managed by CRQ and another by

a private sector, along mountainous streams 1,800 m above the sea level. The desire to engage in rainbow trout culture has been increasing along with the high trout consumtion and demand.
The low land regions, some livestock farms and also coffee farmers are tackling experimental culture of Tilapia, Carpa and Cachama.

In addition, CRQ is planning to establish a freshwater prawn experimental station in the lower reaches of the Bamboo experimental station managed by CRQ.

(7) Prices and Marketing

Meat and Live Animals

Marketing channels for livestock and its products in the Quindio are not properly organized. The sales are usually through middlemen or licensed traders or the owner of the butchery. They purchase animals from farmers either at farm gate or livestock auction market. There are three main livestock markets (Aemenia, Circasia and Salento) which are opened regularly. Livestock sales transaction are made through price bargaining, according to external appearance only, and not regards to the weight of the animals.
One of the weaknesses of the livestock marketing systems has been lack of objective standards for grading livestock and its products in the country.

Milk

Most milk is also collected by the middlemen; some producers transport milk directly to the processing plants or processing plant employees go to the farms to collect it. Most milk produced in the Filandia and Salento municipalities destined to areas outside the Quindio.

Poultry Products

There are two poultry producer's associations, namely Huevos Hoy (Eggs) and ASOQUIN (Broiler). Some medium and large scale poultry farms sell their products through these organizations. Main livestock products consumers prices, in the Armenia market, are shown in Table I.1.11.

(8) Related Activities

Commercial Feeds

In the Quindio, commercial feeds are supplied for all types of livestock animals, mostly come from other departments. There are two commercial feed

plants in Armenia and La Tebaida with very low output capacity. There is a shortage of these feed in most of the rural towns due to inadequate supply. This makes the availability of these feeds difficult to most small scale farmers and proves even more expensive to transport them from main towns. The commercial feeds are normally used for concentrate supplementary feeding especially for milking cow, poultry and swine. Wholsale prices of commercial feed available in the Quindio are listed in Table I.1.12.

Training and Extension

The Quindio is served by very few agricultural training centers for extension staff, for livestock development. The services are extended upto location level and their major activities include A.I. and technical advice to farmer on animal husbandry and on disease control. Due to lack of sufficient facilities and equipments the objectives of these extension services have not been properly accomplished. Therefore, there is a lack technical extension staff in rural areas, thus making livestock development difficult. However, the Ministry of Agriculture, FEDECAFE, FNC etc. have made great efforts to provide skelton staffs in ICA and CENICAFE etc. who lack extension facilities and equipments.

Slaughterhouse

Every municipalities has a public slaughterhouses for cattle and swine. In almost all slaughterhouses except that in Armenia, however, there are no meat inspection systems. In addition, most slaughterhouses are located on riversides, and waste and drain water are released directly into the rivers without any treatment, thereby causing river contamination.

Tanneries

Leather factories are located near the main slaughterhouses. However, the facilities are not modern and chemical treatment facilities, in particular, are timeworn. The treated chemicals are released directly into the rivers, thereby causing river contamination too.

Meat Processing Plants

As for meat processing, there are some factories for both cutting and processing in Armenia and Calarca, and both of them are small scale. The processed products consist mostly of sausages, ham and bacon which are mainly made from pork, and produced only once a week. Therefore, most processed meat products sold in markets come from other departments.

Milk Processing Plants

There are two fresh milk processing plants in the Quindio, one of which is under operation for making yoghrt. Consequently, only about one third of the milk produced in the Quindio can be collected and the remaining is shipped outside of the Quindio.

The main livestock and fishery facilities are shown in Figure I.1.2.

Programmes for Livestock Development Credit

Presently, there are a lot of credit programmes being undertaken in the Quindio's livestock sectors. The following are the most prominent credit facilities and activities supporting the industry.

- National Federation of Coffee Grower's Credit
- Credit for the Agriculture and Livestock Fund, Law 5th, 1973
- INCORA Credit
- Cattle Fund of the Quindio

Disease Control

Among a variety of livestock diseases, the more important are: tick-bone diseases, internal parasitism, epidemic diseases such as foot and mouth disease, rinder pest, anthrax, brucellosis, hog cholera, estomatitis vesiculas, anthrax, black-leg and hemorrhagic septicemia. Disease control measures practiced in the Quindio and in the country include; annual vaccination against foot and mouth disease, rinder pest, anthrax, brucellosis and hemorrhagic septicemia.

Livestock Projects and Programmes

There are some projects and programmes which the Ministry has undertaken to improve livestock development: some of these are as follows;
- Artificial Insemination Promotion Program for Dairy Cattle (ICA)
- Broiler Production Program (Ministry of Agriculture)
- Vaccination Program for Cattle (ICA)
- Integrated Cattle Development Program (ICA)
- Goats Promotion Project (Departmental Coffee Committee)

Due to lack of sufficient facilities and equipments the objectives of these activities have not been properly accomplished.

(9) Livestock Productivity

In order to know average livestock productivities in the Quindio, farm interrview was carried out by the study team. Taking into account of the information obtained through the farm interview, milk and meat yields by breeds,

production cost, gross benefit of one hectare of cattle were also estimated based on the farm questionnaire conducted by the study team.
These results are presented in Table I.1.13, I.1.14, I.1.15, and I.1.16.
The milk yield of cows and beef cattle daily gain are varies widely by breeds, management and farm size. On the other hand, swine productivities compare favourable with that of the large and small scale farmers, because of utilization of high energy feed, intensuve management and used improved modern breeds, resulting in good productivities.

I.2 Constraints and Prospects

I.2.1 Constraints

The problems affecting the livestock industry in the Quindio may be summarized as follows;

1) Productivity of cattle differs greatly between large and small scale farms.

2) Large scale farms have been modernized, while small scale farms have been largely ignored.

3) There is lack of sufficient improved breeds for breeding stock.

4) The management of livestock feeding varies widely due to divergent climatic conditions in the Quindio. There is a great need to develop and popularise particular systems for different Agro-ecological zones in the Quindio.

5) Marketing and transportation facilities for livestock products are not well organized,

6) Prices of concentrated feeds and feedstuffs are high.

7) Supporting facilities for providing technical assistance and extension services to small scale farms are not adequately established.

8) There is a great need to establish a quality control for livestock products. This will create an incentive for the farmers to raise quality livestock products.

9) There is very low utilization of hay, silage and high energy feeds such as by-products of cereals, root crops, plantine and miscellaneous which are abundant in the Quindio.

I.2.2 Prospects

On the other hand, the livestock industry in the Quindio is favoured by

several conditions for livestock development.

First, livestock products in general are highly marketable in the whole of Colombia as well as neighbouring countries.

Second, the Quindion has a range of climates suitable for various livestock activities, including those for improved cattle breeds and other improved types of livestock breeds.

Third, most people in the Quindio have a high familiarity with stock farming either traditionally or through experience since they may have been employed by large scale farms.

Fourth, the Quindio has a high yield potential in pasture production and agricultural products with a variety of pasture grasses and crops.

Fifth, there exists a range of high energy feed materials such as cereal by-products, root crops, plantine and miscellaneous concentrate feeds including molasses, brewer's waste, etc.

I.3 Development Plan

I.3.1 Development Potential and Conditions

Based on the analysis of present situation described in the previous section, the Quindio is favoured with several conditions for livestock development. There are plenty of the existing natural resources. The meat and milk production can be increased with improving in livestock disease control, quality of pasture grasses and marketing, better farm management, application of modern technology, and introducing adaptable improved breeding stocks.

I.3.2 Development Policy

In view of long term development objectives of the nation, the objectives of livestock development in Colombia may be summarized as follows;

1) To produce meat and milk to contribute to self-sufficiency in food supply,

2) To alleviate by creating income and employment generating,

3) To improve nutritive status of people,

4) To contribute to foreign exchange earning/savings, and

5) To provide raw materials for processing industries.

Objectives for livestock development in the Quindio are naturally in line with the national policy outlined above, but emphasis is different due to conditions specific to do the Quindio. At present, the Quindio places more emphasis on meat and milk production especially for helping small farmers. Increasing meat and milk production, will help first to alleviate malnutrition problems in rural areas and second to meet growing demand in urban areas.

I.3.3 Development Target

The Quindio remaining far from self-sufficiency in livestock products particularly milk and meat, so that it is targetted to achieve the regional self-sufficiency of milk and meat for 2005. For this purpose, it is required to promote the multiplication of improved breeds in the Quindio. However, local cattle in the mountainous and lower regions have benefitted the small farms due to their high resistant characteristics against adverse conditions.

Therefore, improvement of local cattle will be envisaged to increase their productivities, maintaining their inherent favourable characteristics.

I.3.4 Development Strategy

(1) General strategy

Strategy for livestock development in the Quindio is drawn up in order to overcome the constraints by effectively capitalizing on the advantages summarized as before.
It consist of the followings;

1) To improve the overall productivity of livestock by making available sufficient number of high quality breeding stock;

2) To organize and improve stock raising activities of small scale farmers through demonstration effects of pilot farms as well as provision of training and technical extension services;

3) To promote livestock feeding systems through the improvement of fodder crop production and pasture grasses, the production of supplementary feed and the encouragement of home grown energy crops; and

4) To establish more widely intensive systems of stock raising, especially in high population density areas.

In view of present situation in the Quindio and the recent national policy emphasis, the strategy presented above should aim firstly at increasing milk production and secondry at increasing meat production.

Considering the demand for pork in Colombia, but also in other Latin American countries, it will be most effective to introduce farming of such swine, in order to develop small scale farming. Another reason supporting the avove is the fact that raising is a new industry in Colombia, while the demand for swine products has been increasing year after year. In addition, swine raising requires a small land areas and its management, compared to cattle raising, is comparatively easy. It is possible even for old men, women and children perform such work. The initial capital required is also small, resulting in a quick capital turnover. Furthermore, there are abundant agriculture by-products which can be utilized as swine feed in the Quindio; even coffee pulp is usable as a feed ingredient. The supply of pork is not sufficient the neighbouring departments.

The poultry industry which represents an attractive sector to be developed will not, however, remain as for long since non-agricultural sectors can easily invest in this industry, so that small scale farms shall be keeping their own consumption level.

(2) Sectoral Strategy

Milk Production

1) Increase quality breeds in the Quindio through artificial insemination(A.I.). Thus, good quality breeding systems will be achieved, through A.I. and/or high quality bulls.

2) As regards the regional farmer's breeding systems, e.g. A.I., they should be given facilities such as; transport, qualified and better semen preserving equipments.

3) Also, the A.I. systems currently operating in the rural areas should be centralized in small static units with portable semen preserving equipment which can be stationed at the center.

4) In those remote rural areas with poor communication systems, natural breeding will be used either through high genetic quality bulls or establishing an A.I. center.

5) Other technical packages like proper feeding systems, organized forage improvement systems, and proper concentrate supplementation should be instituted for dairy farmers so as to increase the milk production.

6) Disease and herd health programmes should be properly carried out on dairy farms through proper extension services, by the Ministry of Agriculture.

7) Milk marketing systems should be organized through dairy cooperative societies.

8) Note that transportation, storage, and processing of dairy products should be given high priority. Milk cooling facilities should be provided in high potential areas.

9) Small scale feed mills should be established in every small main town in the Quindio to both large and small scale farmers.

10) Goats should be encouraged in areas where cultivation is not favourable, especially low potential areas of the Quindio. However, goats have the habit of browsing which can be a great disadvantage, because, if allowed to do so uncontrolled, they will often kill the bushes and young trees by eating off all the leaves and the young shoots. In this way, a plantation can be easily destroyed and soil erosion made invitable. Therefore, goats farming should be introduced under intensive feeding systems such as zero grazing.

Meat Production

1) Beef production should be encouraged in large scale farms, by providing a proper disease control systems, better breeds, and good marketing systems to encourage the farmers.

2) In areas such as Quimbaya, Montenegro and La Tebaida, where most of land has been put under cultivation, as organized feed-lot cooperative society should be established to fatten steers and culled cows for meat production. This is possible particularly in high potential areas and coffee planting areas where agro by-products and coffee pulp can be used for fattening the cattle.

3) The pig industry is a very potential meat source, in the future, in this Quindio and in the country. This industry is most favourable in high potential areas where land has been used to the maximum. In these densely populated areas, pig production will increase land productivity and also increase meat productivities.

(3) Non Sectoral Strategy

1) The Quindio needs more veterinary clinic centers which will serve most livestock farmers in rural areas.

2) Pasture and fodder development; more efforts should be put in encouraging farmers to grow appropriate grasses and also legumes like leucaena or mata-raton trees which are a good source of feed nutrient for livestock. There is little doubt that leucaena and mata-raton trees are very useful and very

fast growing trees. The yield of wood from leucaena and mata-raton, on an annual basis and by volume, exceed that from almost every other trees. These trees produce fuelwood, timber and nitrogen-rich green manure.

3) Extension services of the Ministry of Agriculture should put more effort into teaching farmers to increase pasture managed with appropriate grasses, and also encourage the growing of legume grasses mixed with pasture.

4) Establish a more regular operation of livestock auction markets in the rural main towns, with scale; This will encourage livestock farmers to produce good quality animals. Organize a cooperative marketing systems. This will increase the strong power of local producers and the representation for price negotiation.

5) Introducing the fresh water fish culture; In the highlands, the culture of rainbow trout by farmers groups to be very encouraging in view the abundant water resources. The only problem is that of feed for fish. It would be necessary to establish several feed mills in the Quindio, as well as for swine and other livestock production. In low land regions, the integrated culture of pig farming and freshwater fish culture (Tilapia, Cachama, Carpa, and Catfish) offers good prospects.

6) Establishment of standards for livestock products; There is no appropriate standard regulating livestock products, at present, therefore producers pay little attention to quality. The establishment of standards for livestock, milk and meat, will increase the producer's awareness of product quality and contribute to livestock development.

I.3.5 Recommended Development Projects

(1) Establishment of training, breeding and extension service centers for small scale farmers.

At present, there are no particular facilities for training, breeding and extension services for small scale farmers. It is necessary to establish a service center and introduce new raising management systems for small scale farmers, aiming at the development of unique livestock (swine, goats and freshwater fish) raising method to meet specific situation in each municipalities, with particular emphasis on the utilization of local agro by-products for livestock and fresh water fish feed.

(2) Establishment of small feed mill for rural area.

By mixing agriculture by-products, which are abundant in the Quindio, with livestock by-products (blood-meal, bone and meat meal etc.), it will be

possible to obtain locally made cheap formular feed either as main or as supplemental feed.
Production capacity 500 tons per month.
Rough estimate initial cost: 34,000,000 Col.$

(3) Establishment of milk cooling and storage plants.

Organized commercial dairy farms produce and sell milk more efficiency. They own cooling and storage plants and well organized promotion marketing arm to advertise and sell their products. Milk are then moved to the processing plants for pasturization or further processing as butter, cheese or other milk products. Furthermore, modern lorries have coolers installed so that milk can be transported considerable distance without being spoiled.
Storage capacity: 10 k liters per week.
Rough estimate initial cost: 25,000,000 Col.$
(with lorries)

(4) Establishment of demonstration farms.

Considring the peculiarities of each municipalities, model farms will be established in each municipalities. The model farms will be mainly used for the distribution of pig breeds, the prevention of epidemic diseases and A.I. for cattle, but this will also serve to demonstrate management techniques for swine raising, grassland management, silage use, hay treatment, pasture recycling, weeding and fertilization.

(5) Development of swine production.

All the measure to encourage the development of swine industry can be most effectively taken within the package of activities under what may be called the pig industry complex project.

The pig industry complex project is planned to establish breeding center for distribution pigs to contract farmers with the provision of extension services. Meat processing, feed mill plants will also be included in this complex to process pig to be purchased from the farmers.
For more effective implementation of this project, a scheme for integrated contract farming systems should be introduced for small scale farmers.
With this scheme, farmers would raise combination of small animals including hogs or also freshwater fish with home grown or locally available feeds.
Extension and other services would be provided to them through farmer's cooperative societies, covering following;
- Extension services for farming practices most suited to each scale of operation,
- Supply of rearing stocks, e.g. feeder pigs,

- Arrangement of credit,
- Supply of construction materials for pig pen, fish pond etc,
- Veterinary services and other technical activities,
- Purchase of animals ready for market at uniform and standard prices, and
- Research on locally available feed resources such as cassava, plantine, bananas and others.

Pig manure can be utilized as an agricultural fertilizer but also as methane gas for household use and it is expected to prove a significant source of fuel to be used alternately with the firewood and charcoal necessary for the farmers in the rural areas. In the lowland areas, pig manure can be used for pond aquaculture of such freshwater fish as Tilapia, Catfish and Carpa.

Through the establishment of these production systems, in which there will be a consistent process from production through processing, it is possible to satisfy not only the local demand in the Quindio but also to export to other department or overseas, thereby opening up the possibility of foreign exchange earnings.

The future demand for pork will be influenced by prices of both pork and beef. Prices of pork and its products are at present higher than those of beef and poultry meat (Table I.1.11.). Beef prices are expected to increase, as the demand for beef generally increases as the economy develops. Thus the demand for pork will also increase, subject only to the expansion of supply capacity.

One complex units: 100 sow and 6 boars level.
1,600 hogs marketed per year (about 90 tons of pork)
Rough estimate initial cost: 60,000,000 Col.$
(with feed plant and pork processing plant)

I.3.6 Summary and Recommendation

	Constraints	Project Idea	M/P Recommendation
1	Insufficiency of improved livestock breeds.	Establish livestock breeding mulitiplication center.	1. Increas staff members. 2. Increase vehicles and motorcycles. 3. Improve facilities for A.I. 4. Improve function for the existing facilities 5. Introduction of bull service in remote rural area.
2	Low utilization of high energy feed. High cost of commercial feeds.	More feed mill in rural area.	1. Institutional measures to encourage private establishment. 2. Complementary undertaken with livestock by-products.
3	Tick control and other animal disease	More veterinary clinic in rural areas.	1. Establish proper institutions for management. 3. Additional livestock health control systems in rural areas for small scale farmers. 3. Improve on innoculations, research and extension on disease control programmes.
4	Under utilization of recurrents for intensive raising systems	Training for livestock husbandry.	1. Increase more livestock extension staff to reach more rural small scale farmers
5	Lack of technical package (feeding, management filled to each agro-zones).	-do- Establish demonstration farms for the rural area.	-do-

	Constraints	Project Idea	M/P Recommendation
6	Lack of proper livestock products quality control.	1. Improve livestock auction markets. 2. Weighing scale in livestock auction markets.	1. Establishment of livestock products standards. 2. Installation of cooling facilities for meat.
7	Inadequate marketing and transporting systems.	1. Net work of rural access road for milk collection. 2. Establish efficient marketing systems and channel for new livestock products. 3. Establish milk cooling and storage plant.	1. Introducing of integrated farming systems. 2. Encourage installation of milk cooling and storage facilities. 3. Acces road improvement 4. Introduction small livestock industry (pig industry complex, e.t.c.)
8	Low self-sufficiency of meat.	1. Development of swine industry. (Pig industry complex) 2. Integrated fresh water fish culture.	Contact farmers scheme. Rainbow trout, Tilapia, Catfish and Cachama.

Table I.1.1: Per Capita Consumption of Livestock Products in Colombia

Items	1980	1981	1982	1983	1984	1985	1986
Beef (kg)	22.62	23.92	22.13	20.51	21.45	21.02	21.14
Pork (kg)	3.20	3.00	2.90	3.10	3.20	3.00	3.24
Poultry (kg)	4.65	4.28	4.71	4.68	4.72	4.93	5.15
Eggs (pcs)	132.00	131.00	130.00	131.00	134.00	136.00	140.00
Milk (liter)	81.75	88.96	93.88	98.17	101.01	101.65	106.45

Source: Direction de Ganaderia, Minagricultura.

Table I.1.2: International Comparison of Per Capita Meat Consumption
(kg)

Country	Year	Beef	Pork	Poultry	Total
Argentina	1982	73.89	8.25		82.14
	1983	71.67	7.57		79.24
Brasil	1982	16.86	7.98	10.08	34.92
	1983	16.51	7.81	10.00	34.32
Chile	1982	18.35	5.67	10.11	34.13
	1983	18.35	6.03	8.51	32.89
Uruguay	1982	76.23			76.23
	1983	72.43			72.43
Canada	1982	41.06	28.35	23.27	92.68
	1983	41.63	29.87	23.60	95.15
Mexico	1982	17.69	20.57		38.26
	1983	18.82	21.73		40.55
U. S. A.	1982	47.36	28.47	29.04	104.87
	1983	48.47	30.30	29.82	108.59
COLOMBIA	1970	20.00		1.00	21.00
	1975	18.90	2.90	2.20	24.00
	1980	21.70	3.00	3.30	28.00
	1982	20.70	2.50	3.80	27.00
	1983	19.10	2.60		

Source: DANE; Poblacion y Sacrificio de Ganado Vacuno y Porcino.
FAO; Situation and Outlook for Meat Production, Feb., 1984,
Calculation; FADEGAN-Depto de Investigaciones Economicas.

Table I.1.3: Department Ranking for Livestock Numbers in Colombia (1983)

Beef Cattle			Dairy Cattle			Swine			Sheep		
Rank	Department	Numbers	Rank	Department	Numbers	Rank	Department	Numbers	Rank	Department	Numbers
1	Cordoba	2,564,000	1	Cundinamarca	1,043,342	1	Antioquia	483,216	1	Guajira	686,783
2	Territorios Nacionales	2,547,004	2	Antioquia	559,183	2	Cordoba	255,816	2	Boyaca	615,737
3	Bolivar	1,990,622	3	Boyaca	470,803	3	Boyaca	188,496	3	Cundinamarca	208,403
4	Antioquia	1,537,603	4	Valle	398,555	4	Cundinamarca	149,104	4	Magdalena	156,302
5	Cesar	1,504,132	5	Narino	315,934	5	Magdalena	127,908	5	Narino	142,093
6	Meta	1,304,215	6	Tolima	303,400	6	Bolivar	112,200	6	Antioquia	134,988
7	Santander	1,235,394	7	Atlantico	175,215	7	Narino	100,980	7	Santander	97,097
8	Magdalena	1,161,817	8	Santander	103,750	8	Santander	99,936	8	Cesar	94,729
9	Sucre	1,105,571	9	Magdalena	94,478	9	Tolima	98,736	9	Tolima	52,205
10	Caqueta	1,076,741	10	Norte de Santander	92,479	10	Valle	90,716	10	Cauca	49,732
11	Tolima	911,252	11	Cauca	85,500	11	Norte de Santander	60,588	11	Norte de Santander	26,050
12	Cundinamarca	674,222	12	Huila	82,113	12	Caldas	58,344	12	Cordoba	23,682
13	Caldas	501,893	13	Caqueta	68,725	13	Sucre	56,100	13	Caldas	21,314
14	Cauca	484,500	14	Risaralda	51,091	14	Meta	51,924	13	Bolivar	21,314
15	Huila	465,311	15	Caldas	43,140	15	Cesar	51,788	15	Huila	14,209
16	Norte de Santander	369,916	16	Quindio	35,139	16	Cauca	51,300	16	Valle	4,736
17	Boyaca	327,349	17	Meta	34,422	17	Territorios Nacionales	49,368	16	Territorios Nacionales	4,736
18	Valle	181,045	18	Cesar	27,243	18	Huila	47,124	18	Meta	2,368
19	Guajira	174,811	19	Territorios Nacionales	25,727	19	Guajira	35,904	19	Sucre	2,364
20	Narino	132,736	20	Cordoba	12,000	20	Risaralda	27,328	20	Atlantico	1,184
21	Atlantico	75,092	21	Bolivar	9,378	21	Atlantico	17,952	21	Risaralda	710
22	Choco	35,500	22	Sucre	8,427	22	Quindio	15,708	22	Quindio	473
23	Risaralda	32,965	23	Guajira	7,319	23	Choco	13,464	23	Caqueta	-
24	Quindio	24,927	24	Choco	4,500	24	Caqueta	-	24	Choco	-
Total		20,418,619	Total		4,056,863	Total		2,244,000	Total		2,361,209

Source: 1983 Statistics, Ministry of Agriculture.

Table I.1.4: Changes of Livestock and Poultry Numbers in the Quindio

(1980 - 1987: unit = head)

Year	Cattle	Swine	Poultry	Horses	Rabbits	Sheep
1980	71,064	15,000	900,000	5,640	665	260
1981	68,034	15,000	800,000	6,486	630	260
1982	74,043	15,500	732,000	6,280	685	235
1983	74,644	16,000	660,000	5,980	770	460
1984	69,000	17,000	600,000	6,000	800	500
1985	69,000	18,000	400,000	6,000	700	1,000
1986	68,600	20,000	443,000	6,000	800	1,500
1987	70,000	20,000	443,829		1,200	

Source: ICA.

Table I.1.5: Livestock Products Production and Consumption in the Quindio

(1986)

Items	Production(ton)	Consumtion(ton)	Deficit/Surplus(ton)
Beef	2,940	11,640	8,700
Pork	330	1,070	740
Poultry Meat	2,120	880	(1,240)
Poultry Egg	4,330	4,050	(280)
Milk	11,220	30,100	18,880
Fish	0	300	300

Source: URPA.

Table I.1.6: Per Capita Meat Availability by Municipality in 1985 and 1986

Municipality	Humane Population		Slaughtered Cattle Municipio (head)		Carcass Weight per Cattle (kg)		Per Capita Beef Avaulability (kg)		Slaughtered Hog Municipio (head)		Carcass Weight per Hog (kg)		Per Capita Pork Availability (kg)	
	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986	1985	1986
Armenia	187,130	191,116	26,428	26,328	175	224	26.45	30.87	10,881	11,795	59	72	3.45	4.45
Buenavista	3,275	3,233	154	202	263	216	12.36	13.47	58	72	37	28	0.66	0.62
Circasia	18,024	18,544	2,687	2,121	186	201	27.71	23.02	2,476	1,575	75	86	10.32	7.20
Calarca	52,476	52,670	7,857	8,350	214	206	32.03	32.67	4,925	4,867	51	61	4.75	3.85
Cordoba	5,055	4,843	557	610	194	211	21.35	26.62	262	238	44	61	2.28	3.00
Filandia	10,882	10,930	1,046	1,215	222	207	21.37	23.03	885	757	95	76	7.73	3.10
Genova	9,824	9,682	1,380	1,478	187	193	26.33	29.47	1,117	1,102	42	41	4.72	4.70
La Tebaida	18,503	18,503	3,044	3,301	187	195	30.76	34.85	1,426	1,547	65	106	4.99	8.84
Montenegro	29,406	29,406	4,349	4,318	194	212	28.68	31.09	2,473	2,411	76	72	6.36	5.90
Pijao	7,790	7,740	1,456	1,318	182	199	34.07	33.95	929	877	60	59	7.10	6.69
Quimbaya	29,408	29,723	3,982	3,538	192	218	26.00	25.90	1,288	979	25	24	1.08	0.78
Salento	6,087	6,040	441	455	197	199	14.26	15.01	257	257	45	48	1.91	2.02
(Barcelona)		(8,500)		800		114		10.76		779		57		5.26
Total/Average	377,863	382,430	53,381	54,834	188	214	26.39	29.56	26,977	27,256	59.5	69	4.2	4.79

Source: Tesorerias Municipales.

Table I.1.7: Estimate Production Cost of Milk and Beef in the Quindio (Col.$)

Farm No.	Type of Operation	Total No. of Cattle (head)	PRODUCTION COST Total Cost per Year	Total Cost per Year per Cattle	Milk Production Cost/liter	Beef Production Cost/kg *
1	Dairy	71	2,688,000	37,859	123	-
2	Dairy	41	2,104,000	51,317	38	-
5	Steer Production	726	17,376,810	23,935	-	132
6	Beef Fattening	550	10,943,080	19,897	-	127
9	Dual Purpose	53	785,000	18,250	57	-
14	Dual Purpose	75	851,799	11,357	25	-
15	Dairy	75	2,396,488	31,953	82	-
16	Dual Purpose	280	2,800,000	10,000	65	-
19	Dual Purpose	46	2,080,104	45,219	220	309
24	Dairy	70	8,714,000	124,486	72	-
25	Dairy	18	2,040,120	113,340	59	-
34	Dual Purpose	109	2,363,992	21,688	81	-
42	Beef Fattening	12	338,000	28,166	-	195
49	Breeding	50	1,756,000	35,120	34	-
50	Dual Purpose	80	1,468,000	18,350	40	126
51	Dual Purpose	268	15,353,987	57,291	372	397
52	Dual Purpose	200	3,006,334	15,032	65	117

* Liveweight. Data obtained field questionnaire by study team, May - June, 1987.

Table I.1.8:Average Productivity of Cattle Production in the Quindio

Cattle Breeds	Milk Production per Day (liter)	Average Daily weight gain(g)
Crossbred(Criollo with Zebu)	3.4	450
Holstein and their Crossbred	6.0	-
Normandy and their Crossbred	3.8	400

Data obtained field survey and questionnaire by study team, April - September, 1987.

Table I.1.9: Cattle Numbers and Carrying Capacity by Districts

Municipality	Total Pasture Area(ha)	Number of Cattle(head)*	Carrying Capacity
Armenia	400	2,981	7.45
Buenavista	972	1,095	1.12
Calarca	7,610	9,985	1.35
Circasia	3,414	4,648	1,36
Cordoba	4,353	1,357	0.31
Filandia	4,555	3,786	0.83
Genova	11,335	4,047	0.35
La Tebaida	2,528	10,920	4.31
Montenegro	3,942	7,938	2.01
Pijao	10,188	5,072	0.49
Quimbaya	2,152	4,208	1.95
Salento	19,580	11,605	0.59
Total	71,029	67,642	1.05

Source: Pasture Area-C.R.Q. and Comite de Cafeteros del Quindio.
Cattle Numbers-Secretaria de Agricultura. * Equibalent adult cattle.

Table I.1.10: Variety of Main Species of Pasture Grasses in the Quindio

Climate Zone	Classification		Local Name	Scientific Name	English Name
Cold	Pasture Grass	Graminae	Kikuyo	Pennisetum clandestinum Hochst. ex. Chiov.	Kikuyu grass
			Yaragua *	Hyparrhenia rufa	Jaragua grass
			Falsa poa(Heno blanco)	Holcus lanatus	Common velvet grass
			Pasto azul	Dactylis glomerata L.	Orchard grass
		Legume	Trebol blanca(blanco)	Trifolium repens L.	Ladino clover, White clover
			Sen de pradera	Centrosema sp. p.	Centro
Mild and Hot	Pasture Grass	Graminae	Estrella	Cynodon plectostachyus	African star grass
			Braquiaria	Brachiaria decumbens Stapf	Signal grass, Surinam grass
			Pangola	Digitaria decumbens Stent	Pangola grass, Finger grass
			Micay	Axonopus micay H. Garcia	-
			Puntero *	Hyparrhenia rufa	Jaragua grass
			India / Guinea	Panicum maximum Jacq.	Buffel's grass, Guinea grass,
			Pasto comun / grama	Paspalum notatum Fluegge	Bahia grass
		Soiling Crops	Imperial	Axonopus scoparius	Carpet grass, Imperial grass
			King grass	Pennisetum purpureum ptyphoides	-
			Elefante	Pennisetum purpureum Schum.	Elephant grass, Napier grass
		Legume	Amor seco pega pega	Desmodium canum	Kaimi clover
			Cascabelin	Desmodium heterocarpon	Desmodium, Florida carpon
			Mata-raton	Gliricida sepium (Jacq.)	# Fodder and nitrogen-fixing tree.

Source: Obtained from field survey by study team, 1987.

Table I.1.11: Retail Prices of Livestock Products in Armenia Market

Items	Price/kg(Col.$)	Remarks
Beef	650	with bone
Pork	700	with bone
Pork Fat	500	with skin
Chicken Meat	520	Broiler, with bone
Fresh Milk	73	untreated
Processed Milk	84	treated, plastic bag
Cheese Campesino	520	home made, traditional
Butter	800	
Mixed Ham	1,380	
Bacon	1,850	
Sausage	848	home made, traditional
Egg (white,AA)	264	
(red,AA)	280	

Sourse: Central and Super Market in Armenia, September, 1987.

Table I.1.12: Wholesale Prices of Livestock Formular Feed

Items	Type of Feed	Price at 40kg Sack
Broiler Chick	1 to 28 days	Col.$ 3,233
Broiler Finisher	after 28 days	3,167
Layer Chick	1 to 8 weeks	2,835
Layer Grower	8 to 20 weeks	2,590
Layer I	21 to 51 weeks	2,735
Layer II	after 51 weeks	2,702
Sow Gestation	Pregnant Sow	2,598
Sow Lactation	Lactation Sow	2,716
Sow Farrowing	Farrowing stage	2,619
Pig Starter	12 to 25 kg	2,817
Pig Grower	25 to 50 kg	2,683
Pig Finisher	50 to 95 kg	2,616
Dairy Feed	11 to 17 liter lactation	2,313
Calf Starter	Artificial Milk	3,067
Calf Grower	after 4 month	2,804
Horse Feed		2,503

Source: La Granaja Ltd., at La Tebaida, May, 1987.

Table I.1.13: Estimated Average Performance Data of Cattle Production

Stocking rate	1.05	head/ha.
Mortality (Birth to 6 month age)	3.5	%
(Adult Cow)	3.0	%
Proportion; Bull/Cow	1 : 20	
Birth rate	90.0	%
Calving Intervals	380.0	days
Age at first service	18	month
First calving age	28	month
Average milk production/cow/day	5	liter
Average weaning age	6 - 8	month
Average daily weight gain	0.4	kg
Slaughter weight (beef cattle)	400	kg
Slaughter age(beef cattle)	3 - 4	years

Data obtained fiels survey and questionnaire by the study team.

Table I.1.14: Outline of the Swine Industry in the Quindio

Farm Size	Small Scale Farms						Middle Scale Farms					Large Scale Farms				
Farm No.	4	8	16	23	31	40	1	25	36	46	9	43	59	54	47	10
Location	Filandia	Quimbaya	Circasia	B/Vista	Pijao	Calarca	Filandia	Cordoba	Genova	M/negro	Filandia	Calarca	Tebaida	Tebaida	M/negro	Quimbaya
No. of Sows (head) No. of Boars (head)	3 0	2 1	2 0	3 0	2 0	1 0	10 4	10 2	12 1	18 1	14 1	250 16	80 4	70 6	41 4	17 2
Total No. of Pigs (head)	12	15	19	21	16	4	50	22	57	32	100	1,500	550	246	218	158
Main Breed	Criolla	L-W	L-W-D	L-W	W-D-H	D-Crio.	L-W-H	L-W	W-D	L-W-D	L-W	L-W-D-H	L-W	L-W	L-H-D	L-W
No. of Weaned Pigs per Sow per Year (head)	18	21	16	18	18	14	18	20	14	16	20	-	20	18	10	20
Slaughter Liveweight (kg) Days to Slaughter (days)	- -	105 150	92 165	65 150	- -	- 165	- -	- -	- 150	- 165	100 180	90 180	- -	100 180	95 165	95 150
Price of Weaned Pig (Col.$) Price of Market Hog (Col.$)	6,300 -	- 220/kg	- 403/kg	- -	5,000 -	- -	6,500 -	7,000 -	7,500 -	- -	450/kg 310/kg	531.5/kg 305/kg	- 290/kg	550/kg 300/kg	550/kg 300/kg	- 320/kg
Swine Feed Kitchen Leftover Platano Yuca Liquid Whey Maize Mixed Feed Mixed Feed Price (Col.$) Others	 ○ ○ ○ - - ○ 69/kg -	 ○ - - - - ○ 82/kg ○	 ○ - - - - ○ 68/kg -	 - ○ - - - ○ - ○	 ○ ○ - - - - - ○	 - - - - - ○ 75/kg -	 ○ - - - - ○ 68/kg -	 ○ ○ - - - ○ 70/kg ○	 ○ - - - - ○ 79/kg -	 - - - - - ○ - -	 ○ ○ - - - - 67/kg ○	 - - - - - ○ 55/kg -	 - - - - ○ - - -	 - - - - - ○ - -	 - - - - - ○ 50/kg -	 - - - - - ○ 74/kg -
Hog Cholera Vaccine Parasite Control	- ○	○ ○	○ ○	○ ○	- -	○ ○	○ ○	○ -	- ○	○ ○	○ ○	○ ○	○ ○	○ ○	○ ○	○ ○
Technical Assistance Institutional Personal	○ -	- -	- ○	- -	- ○	- -	○ ○	- -	- -	- -	- ○	- ○	- ○	- -	- -	- ○
Use of Hog Manure Fertilizer Cattle Feed	- -	○ -	○ -	- -	- -	- -	- -	○ -	○ -	○ -	- -	○ -	- ○	○ ○	○ -	- -

Remarks: L=Landrace, W=Large White, D=Duroc, H=Hampshire, Crio.= Criolla.
Data obtained from field survey and questionaire conducted by study team, 1987.

Table I.1.15: Estimated Gross Benefit for Milking Cow (per head basis)

Items	Col.$
Income	
Milk sales: 180 days x 5 liter x @ Col.$ 50	45,000
Calf sales: yearling calf x @ Col.$ 40,000 x 0.96	38,400
Total Gross Income	83,400
Variable cost	
Breeding service cost	15,000
Vaccine	2,500
Veterinary cost	2,000
Insecticide	600
Salt and minerals	1,000
Pasture cost	6,500
Pasture maintenance cost	1,500
Labour cost: 1/10 manday x 365 x @ Col.$ 640	23,360
Milking shed: @ Col.$ 10,000-1,000÷10 years	900
Marketing and transport	20,000
Total variable cost	73,360
Gross margin per milking cow	10,040
Stocking rate = 1.05	
Gross margin per milking cow per hectare=	10,542

Data obtained field survey and questionnaire conducted by study team, 1987.

Table I.1.16: Estimated Gross Benefit for Beef Cattle (per head basis)

Items	Col.$
Income	
Beef cattle sale: weight 400 kg x @Col.$ 200	80,000
Total gross income	80,000
Variable cost	
1.5 year steer cost: weight 250 kg x @ 200	50,000
Vaccine	1,000
Veterinary cost	500
Insecticide	500
Salt and minerals	1,000
Pasture cost	6,500
Pasture maintenance cost	1,500
Labour cost: 1/30 manday x 365 x @ 640	7,008
Marketing and transport	5,000
Total variable cost	73,008
Gross margin per beef cattle	6,992
Stocking rate = 1.05 head per ha.	
Gross margin per beef cattle per hectare	7,341

Data obtained field survey and questionnaire conducted by study team, 1987.

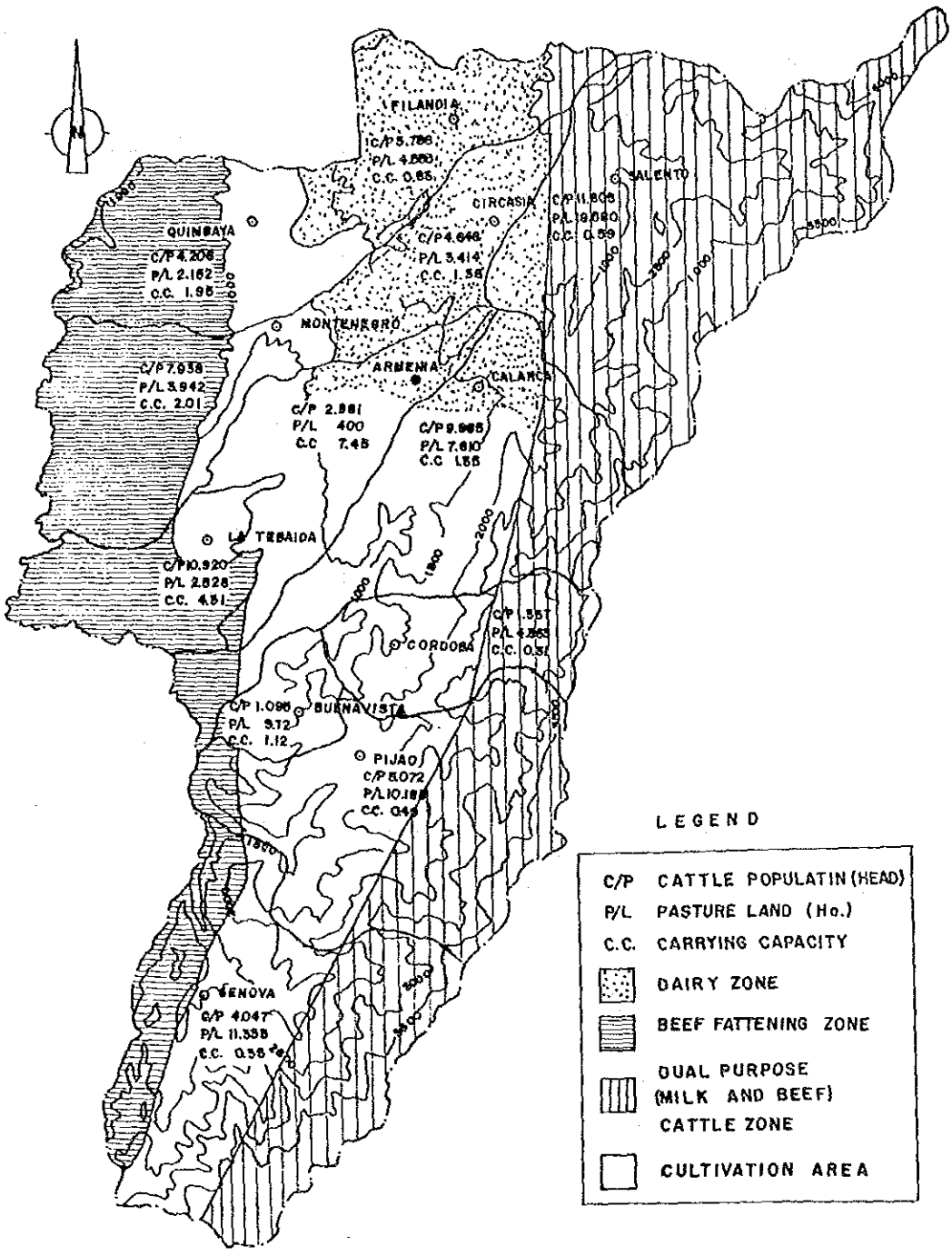


Fig. I.1.1: Cattle Raising Zone, Population, Pasture Land and Carrying Capacity

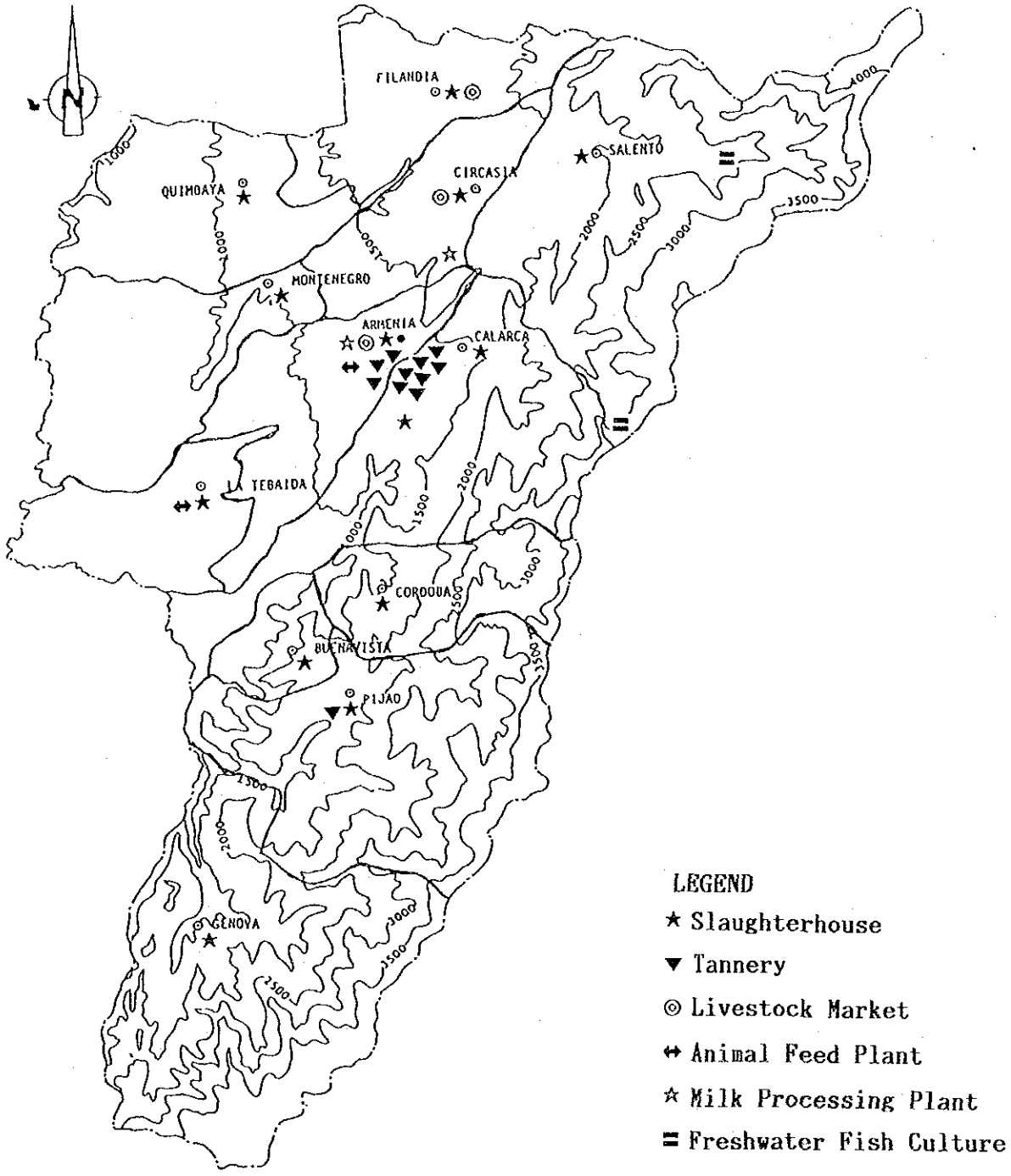


Fig. I.1.2: Main Livestock and Fishery Facilities in the Quindio

ANNEX J : IRRIGATION AND DRAINAGE

Annex J : IRRIGATION AND DRAINAGE

Table of Contents

List of Tables

List of Figures

Annex J : IRRIGATION AND DRAINAGE

J.1 Introduction

J.1.1 General

(1) Irrigation

2,000mm of annual rainfall can be expected in the Quindio, therefore no irrigation system is required all the year round under the existing agricultural management system. However, if crops always depend on natural rainfall, it would be impossible to improve agricultural management. Therefore, if irrigation system should be installed, agricultural management can be improved, as there is a considreable room for the expansion of water resources for irrigation in the Quindio.

Through verbal investigations, it was foun out that the time for seeding is determined with consideration to the rainfall expected, and it is one of the restrictions to the cropping pattern. In Quindio few farmers have irrigation system with sprinklers, and they irrigate the crops (coffee, vegetables, pasture, etc) in the dry season (February and July) when there is no rainfall for one or two weeks.

As for coffee harvesting, there are two critical seasons; eight weeks and thirteen weeks after flowering. So when there is not enough water during these seasons, the quantity or quality of harvest reduce. With consideration to the meteorological condition in Quindio, it is expected that coffee irrigation has a good effect the coffee production.

The undulating topographical condition with exception of some lowlands in Quindio constitutes one of the constraints on the installation of irrigation system. Also the improvement of agricultural workability is hindered by such topographical condition. Therefore, it would be necessary to study the installation of sprinkler system with aims not only at irrigation, but also at fertilization, and disease and pest control, etc; i.e. a multi-purpose irrigation system.

(2) Drainage

From the condition of topography and soil in the Quindio, the existing drainage conditions are quiet good for the crop fields in the whole area of the Quindio, except for some lowlands. However, there are no systematic drainage facilities for the crop fields in the Quindio. Short-time high intensity rainfall can be expected, and the problem of erosion is observed at some areas. Therefore, it would be necessary to consider a erosion prevention plan.

Some lowlands suffer from poor drainage condition. There is not much rainfall and the existing farm lands are used mainly for pasture, sorgum, etc. In the case of this lands being to gain improvements for high-intensive agriculture, it would be necessary to consider drainage improvement.

J.1.2 Objective of study

The objective of the study is to understand the existing conditions of irrigation and drainage and find out optimum irrigation and drainage systems for intensive, developed agriculture at the projected area. (See Fig.J.1.1)

Should the existing agricultural management be continued without improvement, the necessity of irrigation system would not be so high. However, it would be necessary to provide an irrigation system for intensive, developed agriculture, and the installation of irrigation system will be one of the large impacts on the development of the Quindio.

On the other hand, field drainage system would be necessary for land conservation and, considering the existing condition, the establishment of field drainage system may be one of big subjects in the Quindio.

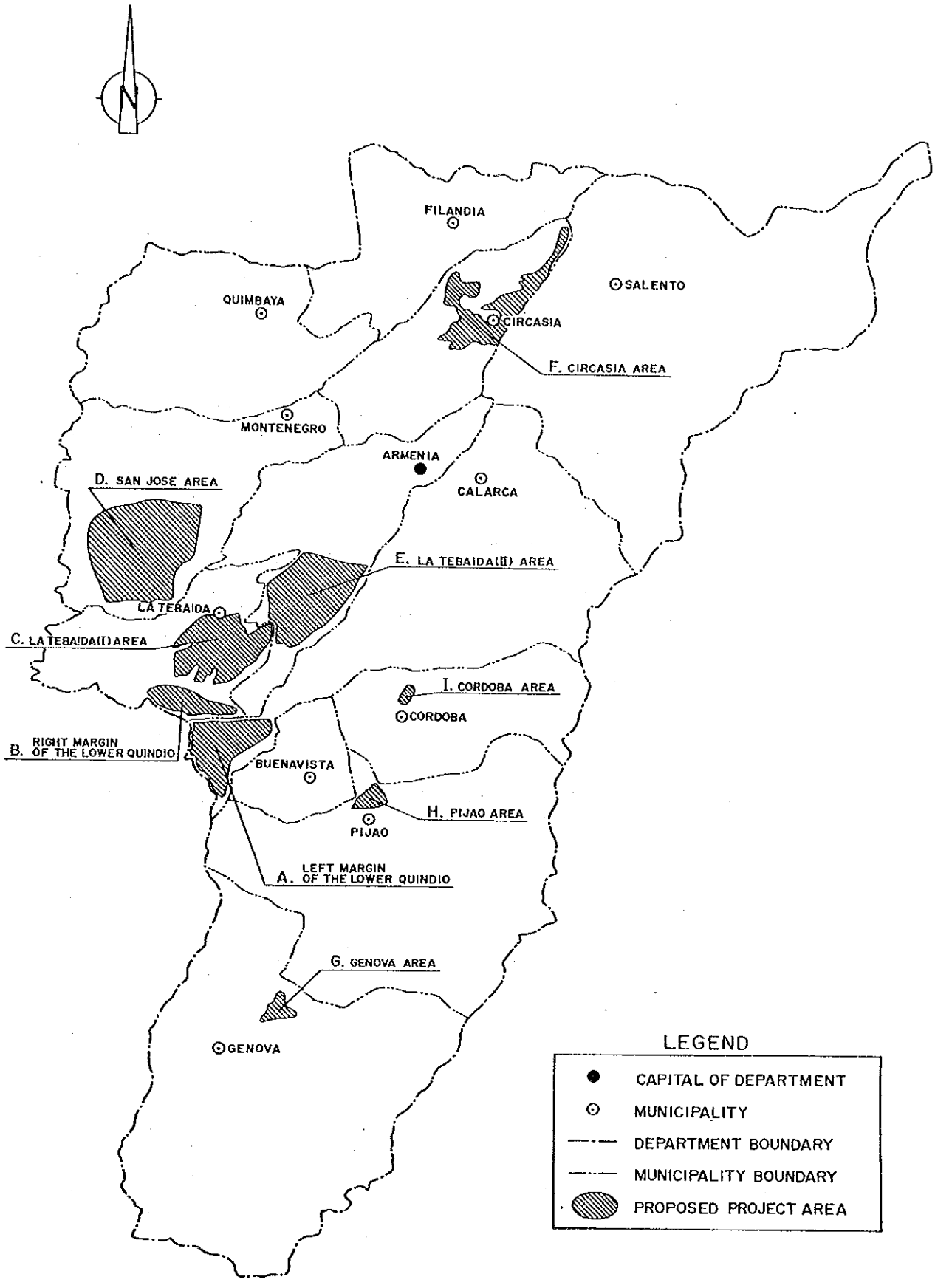


FIG. J.I.1 PROPOSED PROJECT AREAS FOR AGRICULTURAL DEVELOPMENT

J.2 Irrigation

J.2.1 Existing Condition

Most existing agricultural management systems in the Quindio rely on natural rainfall. 2,000 mm of annual rainfall is expected, and no irrigation system is required all the year round under the existing agricultural management. On the other hand, considering topographical undulation, the installation cost of irrigation system would not be so low.

Currently, the time for seeding is determined with consideration to the rainfall expected, and it is one of the restrictions on the cropping pattern. Looking at the coffee farming, the quantity and quality of harvest reduce due to drought, and the management system is not stabilized. Therefore, it would be necessary to provide irrigation system for the improvement of agricultural management in the Quindio.

Though verbal investigations, few farmers have any irrigation system with sprinklers in the Quindio, and they irrigate the crop (coffee, vegetables, pasture and etc.) during the dry season when there is no rainfall for one or two weeks.

J.2.2 Water Requirements

(1) General

Water Requirements were calculated as following manner;

(a) Calculation of Potential Evapotranspiration
(b) Calculation of Crop Water Requirements
(c) Calculation of Irrigation Water Requirements

From the monthly calculation, the sufficient effective rainfall can be expected in the Quindio and the irrigation except rice crop may be required only July and August. However, 19 continuous drought days can also be expected every year, and irrigation system will be necessary for the raising of crop quality and intensive agriculture. Therefore, an irrigation plan will be made in consideration of monthly effective rainfall, and an irrigation system will be designed based on the peak water requirement.

(2) Potential Evapotranspiration

Due to the lack of meteorological information (evaporation, wind velocity, etc), it is difficult to estimate evapotranspiration volume of crops by applying the Penman method which is recommended by HIMAT. Consequently, estimation was made, by mutual agreement between the CRQ and the Study Team, by Garcia Lopez method there results similar to Penman can be acquired for areas from 1,000 to 2,000 m at altitude.

Table J.2.1 Potential Evapotranspiration (Unit mm)

STATION	ALTITUDE	ITEM	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
LA ESPANOLA	975	TM (°C)	21.8	22.2	22.1	22.0	21.8	21.5	21.1	21.2	20.9	20.6	21.1	21.3	21.5
		HR (%)	81.3	81.1	81.3	83.3	84.0	82.6	79.0	78.0	80.8	83.3	83.7	82.9	81.8
		ETP(mm)	101	94	103	96	96	93	98	101	91	88	88	94	1144
COCORA	2500	TM (°C)	13.8	14.3	14.6	14.4	14.3	14.3	14.2	14.3	14.0	13.5	13.2	13.5	14.0
		HR (%)	79.6	79.8	81.3	81.8	81.6	79.7	74.7	74.6	78.7	82.9	85.7	83.6	80.3
		ETP(mm)	38	38	43	40	40	41	46	47	40	33	27	32	465
UNI.QUINDIO	1550	TM (°C)	19.4	19.4	19.6	19.3	18.9	19.0	19.7	19.6	19.2	18.6	18.6	18.7	19.2
		HR (%)	77.9	79.0	79.5	81.2	82.2	80.1	75.3	76.1	79.7	82.3	84.1	81.0	79.9
		ETP(mm)	86	76	85	78	76	77	92	90	79	73	69	76	955
BREMEN	2000	TM (°C)	15.0	15.6	15.6	15.3	15.4	15.9	15.1	15.3	14.9	14.8	14.7	14.4	15.2
		HR (%)	64.5	59.9	62.1	64.5	64.0	60.8	57.1	62.5	63.0	66.4	64.5	63.8	62.8
		ETP(mm)	64	67	72	64	68	73	72	68	62	60	59	59	789
EL SENA	1550	TM (°C)	18.4	18.4	18.4	18.6	18.5	18.7	19.0	19.0	18.3	18.0	17.9	18.1	18.4
		HR (%)	76.9	78.2	78.1	78.4	80.4	78.8	73.8	77.6	79.7	80.8	80.9	79.1	78.6
		ETP(mm)	79	69	77	76	75	76	88	83	72	70	67	73	905
PARAGUAYCITO	1250	TM (°C)	21.5	21.7	21.8	21.5	21.4	21.5	21.9	21.9	21.4	20.8	20.8	21.1	21.4
		HR (%)	75.5	74.7	75.9	78.9	80.4	78.5	74.0	73.6	76.0	79.2	79.9	78.3	77.1
		ETP(mm)	107	100	109	99	99	99	113	114	102	96	92	100	1230
MARACAY	1450	TM (°C)	20.4	21.0	21.0	20.4	20.4	20.7	21.0	21.3	20.4	19.8	19.9	20.0	20.5
		HR (%)	81.5	80.0	80.7	82.9	82.1	80.0	75.1	75.5	79.7	82.4	82.8	81.4	80.3
		ETP(mm)	89	87	95	84	88	91	104	106	89	83	80	86	1080
SEVILLA	1540	TM (°C)	19.2	19.3	19.5	19.2	19.1	19.2	19.6	19.6	19.2	18.6	18.6	18.9	19.2
		HR (%)	81.0	79.9	81.0	83.4	84.1	82.7	78.6	77.8	80.0	83.7	84.3	83.5	81.7
		ETP(mm)	80	74	82	74	75	75	86	88	79	71	68	74	926
ALCALA	1320	TM (°C)	21.1	21.3	21.2	20.8	20.6	20.7	21.2	21.2	20.7	20.2	20.4	20.7	20.8
		HR (%)	75.2	75.1	76.1	78.1	80.0	79.5	74.9	73.9	76.6	79.6	79.6	78.5	77.3
		ETP(mm)	104	96	104	94	93	91	106	107	96	90	89	96	1165

Note TM : Temperature
HR : Humidity
ETP : Potential Evapotranspiration

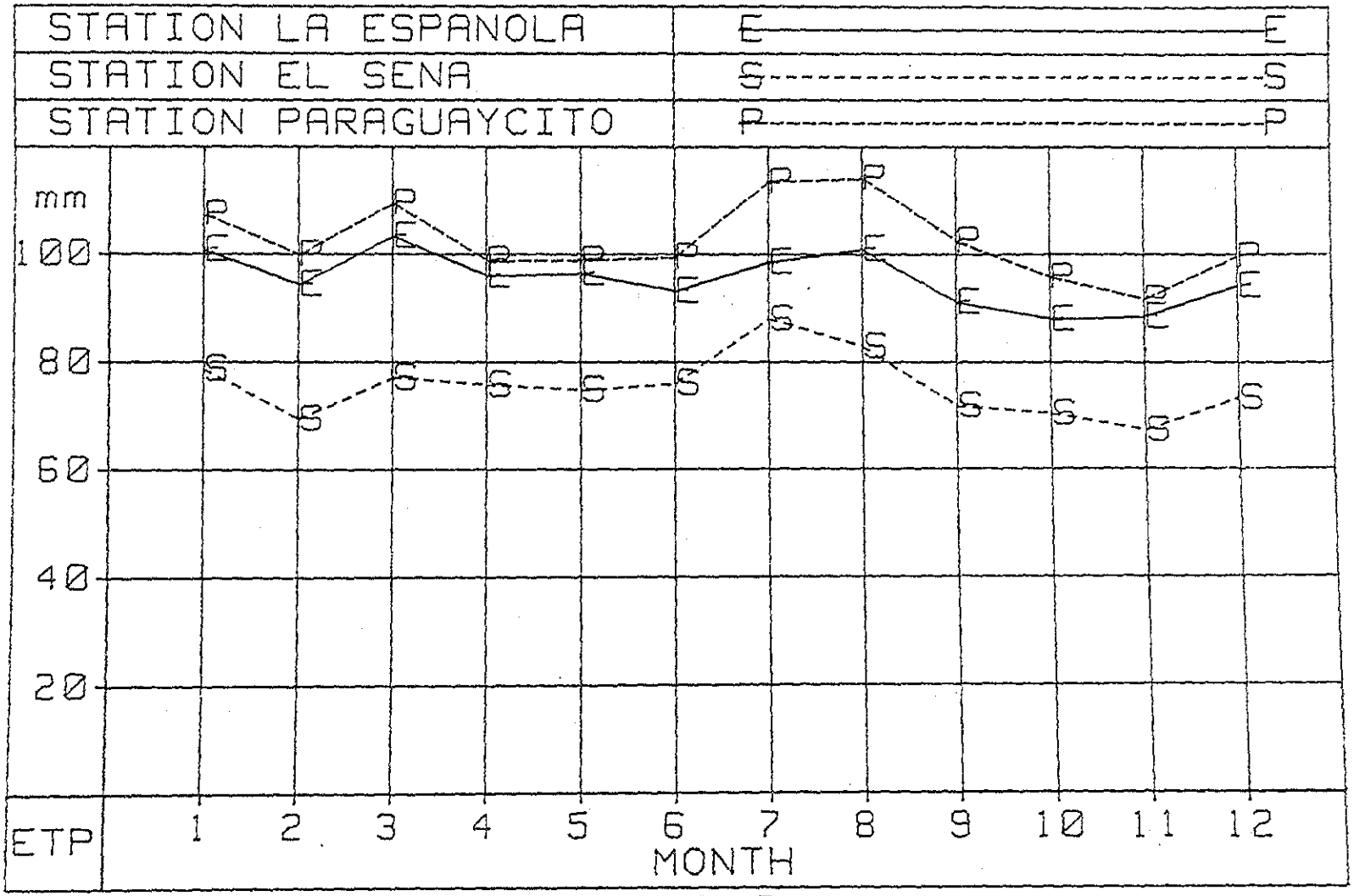


Fig. J.2.1 Potential Evapotranspiration

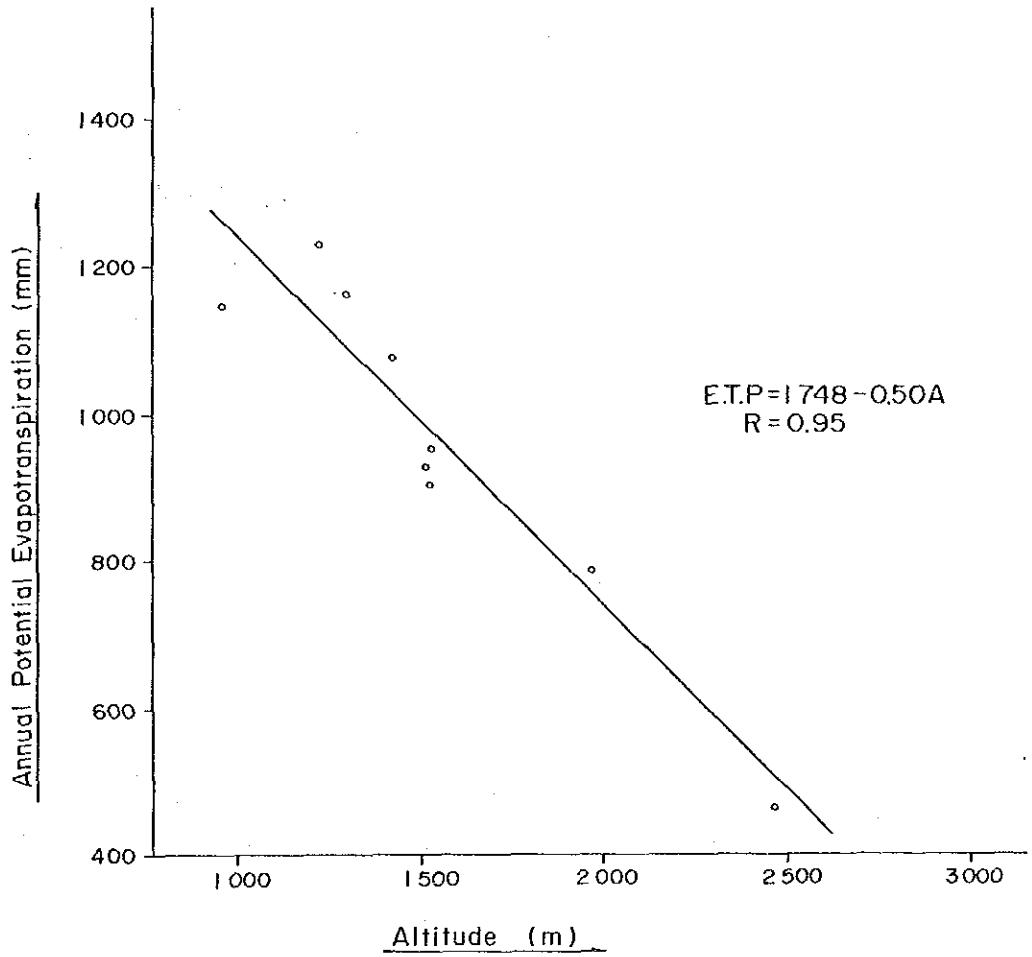


FIG. J.2.2 RELATION BETWEEN POTENTIAL EVAPOTRANSPIRATION AND ALTITUDE

$$ETP=1.21*10^{n}*(1-0.01*HR)+0.21*T-2.30$$

where ETP : Potential Evapotranspiration (mm)
HR : Humidity (%)
T : Temperature (C)
n : Coefficient n=7.45*T/(234.7+T)

The results of estimation of 10 meteorological stations of which data on humidity and temperature is shown in Table J.2.1 and Fig.J.2.1.

Approximately 1,200 mm/year of ETP is estimated for lowlands and approximately 900 mm/year is estimated for highlands and these results are similar to the study results of SENICAFE, except the results of Cocora station (altitude 2,500 m). The relation between ETP and altitude is shown in Fig.J.2.2. These ETP will be applied as evapotranspiration.

(3) Crop Water Requirements

Calculations were carried out with consideration to the following proposed irrigation areas;

Area A : left margin of the lower Quindio River 1,500 ha
Area B : right margin of the lower Quindio River 500 ha
Area C : La Tebaida 2,000 ha
Area D : San Jose 3,400 ha
Area E : La Tebaida (II) 2,500 ha
Area F : Circasia 1,600 ha
Area G : Genova 200 ha
Area H : Pijao 200 ha
Area I : Cordoba 30 ha

In accordance with the "Guideline for Predicating Crop Water Requirements (FAO 1977)" and field investigations, the crop water requirements are estimated. Based on the cropping pattern described in Annex H, the crop coefficient of development stage for each crop has been estimated as shown in Table J.2.2 and the monthly crop water requirements are calculated.

$$ETC=Kc*ETP$$

where ETC : Crop Water Requirement (mm/month)
Kc : Crop Coefficient
ETP : Evapotranspiration (mm/month)

The ETP of Praguaycito station is applied to Areas A,B,C,D and E, and ETP of El Sena station is applied for Areas F,G,H, and I.

The results of ETC for each crop and each Area are shown in Table J.2.3.

(4) Irrigation Water Requirements

Considering the proposed irrigation area, the peak water requirements for each project area are estimated.

PWR=ETC*A*10/86400/D

where PWR : Peak Water Requirement (m3/s)
A : Cropping Area (ha)
D : Days in a Month

The total of PWR of each crop equals the peak water requirement for each project area. The result is shown in Table J.2.3.

Considering effective rainfall, the mean water requirements are calculated as follows;

MWR=(ETC-ER)*A*10/86400/D

where MWR : mean water requirement (m3/s)
ER : effective rainfall (mm/month)

Considering the location, the effective rainfall for 2,5,10 and 20 years return period of the following rainfall station is applied to each Area.

Paraguaycito Station : Area A,B
La Tebaida Station : Area C,D,E
Villadora Station : Area F
Gibraltal Station : Area G
Pijao Station : Area H
Cordoba Station : Area I

These PWR and MWR mentioned above equal the net water requirements for irrigation and gross water requirements, and cold irrigation water requirements are calculated in consideration of the following irrigation efficiency;

Conveyance Efficiency (EC) 0.9
Field Canal Efficiency (EF) 0.9
Field Application Efficiency (EA) 0.7
Total Irrigation Efficiency (EI) 0.9*0.9*0.7=0.57

PWQ=PWR/EI
MWQ=MWR/EI

where PWQ : Peak Irrigation Water Requirements (m3/s)
MWQ : Mean Irrigation Water Requirements (m3/s)

The results are shown in Tables J.2.4 and J.2.6.

Table J.2.2 (1) Crop Water Requirement of AREA A,B,C,D,E (mm/month) *** ETP of PARAGUAYCITO ***

MONTH		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ETP of PARAGUAYCITO		107	100	109	99	99	99	113	114	102	96	92	100
PAINAPPLE	Kc	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
	ETC	118.2	109.8	120.4	108.6	108.7	109.3	124.8	125.5	112.6	105.2	100.7	109.5
MAIZE	Kc	0.00	0.00	.50	.86	1.05	1.05	.80	0.00	0.00	0.00	0.00	0.00
	ETC	0.0	0.0	54.7	94.7	103.8	104.3	90.7	0.0	0.0	0.0	0.0	0.0
SOY BEEN-I	Kc	0.00	0.00	.53	.89	1.00	.98	.66	0.00	0.00	0.00	0.00	0.00
	ETC	0.0	0.0	57.9	88.0	98.8	97.0	74.3	0.0	0.0	0.0	0.0	0.0
SOY BEEN-II	Kc	.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.53	.89	1.00	.98
	ETC	70.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.1	85.2	91.5	97.2
SUNFLOWER	Kc	.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.53	.93	1.05	.98
	ETC	75.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.4	89.0	96.1	97.9
KIDNEY BEEN	Kc	0.00	.53	.89	1.00	.98	.66	0.00	0.00	0.00	0.00	0.00	0.00
	ETC	0.0	52.8	97.5	98.8	96.5	65.1	0.0	0.0	0.0	0.0	0.0	0.0
GROUNDNUT	Kc	0.00	.50	.64	.89	.95	.78	0.00	0.00	0.00	0.00	0.00	0.00
	ETC	0.0	49.9	69.6	88.0	93.9	77.7	0.0	0.0	0.0	0.0	0.0	0.0
ONION	Kc	.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.63	1.00	1.00	.99
	ETC	99.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.0	95.6	91.5	98.2
PIMENTON	Kc	.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.50	.71	1.03	1.04
	ETC	85.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.2	67.6	94.0	104.0
SORGHUM-I	Kc	0.00	0.00	.52	.85	1.00	.93	.65	0.00	0.00	0.00	0.00	0.00
	ETC	0.0	0.0	57.4	84.2	98.8	92.7	73.7	0.0	0.0	0.0	0.0	0.0
CASSAVA	Kc	1.05	.98	.50	.51	.70	.93	1.05	1.05	1.05	1.05	1.05	1.05
	ETC	112.8	97.3	54.7	50.7	68.9	92.7	119.1	119.8	107.5	100.4	96.1	104.5
COFFEE	Kc	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90
	ETC	96.7	89.8	98.5	88.9	89.0	89.4	102.1	102.7	92.1	86.1	82.4	89.6
TREE CROP	Kc	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90
	ETC	96.7	89.8	98.5	88.9	89.0	89.4	102.1	102.7	92.1	86.1	82.4	89.6
PLANTAIN	Kc	1.05	.98	.50	.59	.78	.96	1.05	1.05	1.05	1.05	1.05	1.05
	ETC	112.8	97.3	54.7	58.4	76.6	95.2	119.1	119.8	107.5	100.4	96.1	104.5

NOTE ; ETC=ETP*Kc
ETC : Crop Water Requirement (mm/month)
ETP : Evapotranspiration (mm/month)
Kc : Crop Coefficient

Table J.2.2 (2) Crop Water Requirement of AREA F,G,H,I (mm/month) *** ETP of EL SENA ***

MONTH		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ETP of EL SENA		79	69	77	76	75	76	88	83	72	70	67	73
CARROT	Kc	.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.50	.63	.86	1.00
	ETC	70.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.9	44.0	58.8	73.3
GALIC	Kc	0.00	.50	.75	1.00	1.00	.75	0.00	0.00	0.00	0.00	0.00	0.00
	ETC	0.0	34.7	57.8	75.8	74.9	57.1	0.0	0.0	0.0	0.0	0.0	0.0
CABBEAGE	Kc	.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.52	.78	.95	.95
	ETC	68.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.3	55.0	63.8	69.6
CELERY	Kc	1.00	.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.53	.77	1.00
	ETC	78.6	66.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.3	51.4	73.3
POTETO	Kc	0.00	0.00	.50	.78	1.05	1.05	.85	0.00	0.00	0.00	0.00	0.00
	ETC	0.0	0.0	38.5	58.8	78.6	79.9	74.7	0.0	0.0	0.0	0.0	0.0
PEA	Kc	1.05	.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.55	.80	1.05
	ETC	82.6	59.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.7	53.7	77.0
COFFEE	Kc	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90
	ETC	70.8	62.5	69.4	68.2	67.4	68.5	79.1	74.5	64.8	63.3	60.4	66.0
TREE CROP	Kc	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90	.90
	ETC	70.8	62.5	69.4	68.2	67.4	68.5	79.1	74.5	64.8	63.3	60.4	66.0
TOMATO	Kc	.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.50	.71	1.03	1.04
	ETC	62.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.9	49.7	69.0	76.6

NOTE : ETC=ETP*Kc
ETC : Crop Water Requirement (mm/month)
ETP : Evapotranspiration (mm/month)
Kc : Crop Coefficient

Table J.2.3 Summary of Peak Net Water Requirement (m3/s)

AREA	AREA (ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AREA A (CASE 1)	1110	.343	.164	.312	.379	.405	.403	.361	.169	.303	.364	.397	.402
AREA B (CASE 1)	350	.147	.141	.072	.068	.090	.125	.156	.157	.145	.131	.130	.127
AREA C (CASE 1)	1700	.604	.515	.539	.557	.565	.578	.531	.473	.543	.557	.569	.587
AREA D	2400	.735	.241	.566	.847	.947	1.016	.897	.268	.625	.805	.867	.889
AREA E (CASE 1)	1850	.668	.687	.680	.634	.614	.638	.705	.709	.657	.595	.588	.619
AREA F (CASE 1)	1080	.292	.259	.254	.283	.283	.285	.269	.211	.212	.232	.248	.276
AREA G	140	.044	.033	.030	.036	.038	.037	.032	.019	.024	.031	.036	.042
AREA H	140	.044	.033	.030	.036	.038	.037	.032	.019	.024	.031	.036	.042
AREA I	30	.008	.008	.008	.008	.008	.008	.009	.008	.007	.007	.007	.007
AREA A (CASE 2)	140	.062	.064	.063	.059	.057	.059	.065	.066	.061	.055	.054	.057
AREA C (CASE 2)	280	.103	.071	.081	.095	.097	.088	.030	.031	.078	.037	.036	.100
AREA E (CASE 2)	200	.072	.074	.074	.069	.066	.069	.076	.077	.071	.064	.064	.067
AREA F (CASE 2)	240	.070	.051	.040	.060	.069	.067	.045	----	.011	.038	.052	.067

Table J.2.4 Summary of Peak Gross Water Requirement (m3/s)

AREA	AREA (ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AREA A (CASE 1)	1110	.602	.287	.548	.664	.710	.706	.633	.297	.531	.639	.680	.705
AREA B (CASE 1)	350	.259	.247	.125	.120	.158	.220	.273	.275	.255	.230	.228	.240
AREA C (CASE 1)	1700	1.060	.903	.946	.977	.992	1.013	.932	.829	.963	.977	.999	1.048
AREA D	2400	1.288	.423	.993	1.486	1.661	1.782	1.574	.471	1.097	1.412	1.521	1.559
AREA E (CASE 1)	1850	1.172	1.205	1.194	1.113	1.078	1.120	1.237	1.244	1.153	1.043	1.031	1.086
AREA F (CASE 1)	1080	.503	.444	.431	.476	.477	.485	.472	.371	.367	.402	.427	.474
AREA G	140	.073	.056	.050	.060	.063	.063	.056	.034	.041	.053	.060	.070
AREA H	140	.073	.056	.050	.060	.063	.063	.056	.034	.041	.053	.060	.070
AREA I	30	.014	.014	.014	.014	.013	.014	.016	.015	.013	.012	.012	.013
AREA A (CASE 2)	140	.108	.111	.110	.103	.100	.104	.114	.115	.107	.096	.095	.100
AREA C (CASE 2)	280	.182	.124	.143	.167	.170	.154	.053	.054	.136	.170	.168	.175
AREA E (CASE 2)	200	.127	.130	.129	.120	.117	.121	.134	.135	.125	.113	.112	.117
AREA F (CASE 2)	240	.118	.084	.063	.094	.112	.110	.078	----	.017	.064	.087	.113

NOTE : Irrigation Efficiency is applied as 57% for up land crop

Table J.2.5 (1) Summary of Mean Net Water Requirement (m3/s) Return Period 1/2

AREA	AREA (ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AREA A (CASE 1)	1110	.015	.007	.008	.001	.002	.045	.107	.050	.006	----	----	.003
AREA B (CASE 1)	350	.025	.001	----	----	----	.012	.076	.055	.008	----	----	.002
AREA C (CASE 1)	1700	.046	.032	----	----	----	.009	.124	.026	.004	----	----	.002
AREA D	2300	.049	.031	----	----	----	.078	.129	.045	.012	----	----	.005
AREA E (CASE 1)	1850	.041	.039	----	----	----	----	.165	.021	----	----	----	----
AREA F (CASE 1)	1080	----	----	----	----	----	----	----	----	----	----	----	----
AREA G	140	----	----	----	----	----	----	.006	----	----	----	----	----
AREA H	140	----	----	----	----	----	----	.003	----	----	----	----	----
AREA I	30	----	----	----	----	----	----	.001	----	----	----	----	----
AREA A (CASE 2)	140	.013	.007	.008	.001	.002	.014	.033	.025	.006	----	----	.003
AREA C (CASE 2)	280	.009	.002	----	----	----	----	.007	.001	----	----	----	----
AREA E (CASE 2)	200	.004	.004	----	----	----	----	.018	.002	----	----	----	----
AREA F (CASE 2)	240	----	----	----	----	----	----	----	----	----	----	----	----

Table J.2.5 (2) Summary of Mean Net Water Requirement (m3/s) Return Period 1/5

AREA	AREA (ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AREA A (CASE 1)	1110	.026	.011	.009	.002	.002	.085	.140	.064	.010	----	----	.005
AREA B (CASE 1)	350	.033	.011	----	----	----	.025	.086	.067	.018	----	----	.005
AREA C (CASE 1)	1700	.102	.091	.013	----	----	.064	.184	.067	.011	----	----	.017
AREA D	2300	.073	.061	----	----	----	.189	.227	.066	.033	----	----	.047
AREA E (CASE 1)	1850	.113	.131	.022	----	----	.072	.246	.084	----	----	----	----
AREA F (CASE 1)	1080	----	----	----	----	----	----	.026	----	----	----	----	----
AREA G	140	0.000	----	----	----	----	.002	.012	.003	----	----	----	----
AREA H	140	----	----	----	----	----	.001	.007	.002	----	----	----	----
AREA I	30	.002	0.000	----	----	----	.002	.004	.002	----	----	----	----
AREA A (CASE 2)	140	.016	.011	.009	.002	.002	.019	.037	.030	.010	----	----	.005
AREA C (CASE 2)	280	.019	.006	.001	----	----	.003	.011	.004	----	----	----	.003
AREA E (CASE 2)	200	.012	.014	.002	----	----	.008	.027	.009	----	----	----	----
AREA F (CASE 2)	240	----	----	----	----	----	----	.002	----	----	----	----	----

Table J.2.5 (3) Summary of Mean Net Water Requirement (m3/s) Return Period 1/10

AREA	AREA (ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AREA A (CASE 1)	1110	.032	.018	.010	.002	.003	.104	.156	.071	.013	----	----	.006
AREA B (CASE 1)	350	.039	.016	----	----	----	.031	.091	.073	.022	----	----	.010
AREA C (CASE 1)	1700	.137	.121	.031	----	0.000	.101	.215	.089	.028	----	----	.023
AREA D	2300	.089	.076	----	----	.001	.254	.288	.076	.043	----	----	.037
AREA E (CASE 1)	1850	.156	.177	.053	----	----	.116	.287	.117	.024	----	----	.001
AREA F (CASE 1)	1080	----	----	----	----	----	----	.045	----	----	----	----	----
AREA G	140	.001	----	----	----	----	.004	.014	.005	----	----	----	0.000
AREA H	140	----	----	----	----	----	.001	.008	.003	----	----	----	----
AREA I	30	.003	.002	----	----	----	.004	.005	.003	.001	----	----	.002
AREA A (CASE 2)	140	.018	.014	.010	.002	.003	.021	.039	.032	.012	----	----	.006
AREA C (CASE 2)	280	.026	.008	.002	----	----	.009	.012	.005	.001	----	----	.007
AREA E (CASE 2)	200	.017	.019	.006	----	----	.013	.031	.013	.003	----	----	0.000
AREA F (CASE 2)	240	----	----	----	----	----	----	.006	----	----	----	----	----

Table J.2.5 (4) Summary of Mean Net Water Requirement (m3/s) Return Period 1/20

AREA	AREA (ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AREA A (CASE 1)	1110	.038	.024	.011	.002	.003	.121	.169	.077	.018	----	----	.017
AREA B (CASE 1)	350	.044	.021	----	----	----	.036	.095	.078	.026	----	----	.014
AREA C (CASE 1)	1700	.166	.146	.047	----	0.000	.132	.240	.111	.047	----	----	.035
AREA D	2300	.116	.089	----	----	.004	.306	.335	.088	.053	----	----	.123
AREA E (CASE 1)	1850	.191	.216	.080	----	----	.152	.320	.152	.054	----	----	.029
AREA F (CASE 1)	1080	----	----	----	----	----	----	.051	.002	----	----	----	----
AREA G	140	.004	0.000	----	----	----	.007	.016	.006	----	----	----	.002
AREA H	140	----	----	----	----	----	.002	.010	.004	----	----	----	----
AREA I	30	.004	.003	0.000	0.000	.001	.004	.006	.004	.002	----	----	.003
AREA A (CASE 2)	140	.020	.016	.011	.002	.003	.024	.041	.034	.013	----	----	.008
AREA C (CASE 2)	280	.031	.009	.003	----	----	.014	.014	.007	.002	----	----	.011
AREA E (CASE 2)	200	.021	.023	.009	----	----	.016	.035	.016	.006	----	----	.003
AREA F (CASE 2)	240	----	----	----	----	----	----	.008	----	----	----	----	----

Table J.2.6 (1) Summary of Mean Gross Water Requirement (m3/s) Return Period 1/2

AREA	AREA (ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AREA A (CASE 1)	1110	.027	.013	.014	.002	.003	.078	.187	.089	.011	----	----	.006
AREA B (CASE 1)	350	.043	.001	----	----	----	.021	.132	.097	.014	----	----	.003
AREA C (CASE 1)	1700	.080	.056	----	----	----	.015	.218	.046	.007	----	----	.004
AREA D	2300	.087	.055	----	----	----	.137	.226	.079	.021	----	----	.008
AREA E (CASE 1)	1850	.072	.069	----	----	----	----	.289	.037	----	----	----	----
AREA F (CASE 1)	1080	----	----	----	----	----	----	----	----	----	----	----	----
AREA G	140	----	----	----	----	----	----	.011	----	----	----	----	----
AREA H	140	----	----	----	----	----	----	.006	----	----	----	----	----
AREA I	30	----	----	----	----	----	----	.001	----	----	----	----	----
AREA A (CASE 2)	140	.022	.013	.014	.002	.003	.024	.058	.044	.011	----	----	.006
AREA C (CASE 2)	280	.015	.003	----	----	----	----	.013	.002	----	----	----	----
AREA E (CASE 2)	200	.008	.007	----	----	----	----	.031	.004	----	----	----	----
AREA F (CASE 2)	240	----	----	----	----	----	----	----	----	----	----	----	----

Irrigation Efficiency is applied as 57% for up land crop

Table J.2.6 (2) Summary of Mean Gross Water Requirement (m3/s) Return Period 1/5

AREA	AREA (ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AREA A (CASE 1)	1110	.045	.020	.016	.003	.003	.148	.246	.113	.017	----	----	.008
AREA B (CASE 1)	350	.059	.019	----	----	----	.044	.151	.118	.031	----	----	.008
AREA C (CASE 1)	1700	.178	.150	.022	----	----	.112	.323	.118	.019	----	----	.031
AREA D	2300	.128	.107	----	----	----	.332	.399	.115	.058	----	----	.083
AREA E (CASE 1)	1850	.198	.230	.038	----	----	.126	.432	.147	----	----	----	----
AREA F (CASE 1)	1080	----	----	----	----	----	----	.045	----	----	----	----	----
AREA G	140	0.000	----	----	----	----	.003	.020	.005	----	----	----	----
AREA H	140	----	----	----	----	----	.001	.012	.003	----	----	----	----
AREA I	30	.003	0.000	----	----	----	.004	.006	.003	----	----	----	----
AREA A (CASE 2)	140	.028	.020	.016	.003	.003	.033	.066	.052	.017	----	----	.006
AREA C (CASE 2)	280	.034	.010	.002	----	----	.005	.019	.006	----	----	----	.006
AREA E (CASE 2)	200	.021	.025	.004	----	----	.014	.047	.016	----	----	----	----
AREA F (CASE 2)	240	----	----	----	----	----	----	.004	----	----	----	----	----

Irrigation Efficiency is applied as 57% for up land crop

Table J.2.6 (3) Summary of Mean Gross Water Requirement (m3/s) Return Period 1/10

AREA	AREA (ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AREA A (CASE 1)	1110	.056	.031	.017	.003	.005	.183	.274	.125	.023	----	----	.011
AREA B (CASE 1)	350	.068	.028	----	----	----	.055	.160	.128	.039	----	----	.017
AREA C (CASE 1)	1700	.240	.213	.055	----	0.000	.177	.378	.156	.049	----	----	.051
AREA D	2300	.156	.134	----	----	.003	.445	.505	.134	.076	----	----	.132
AREA E (CASE 1)	1850	.274	.311	.093	----	----	.204	.504	.296	.043	----	----	.001
AREA F (CASE 1)	1080	----	----	----	----	----	----	.079	----	----	----	----	----
AREA G	140	.002	----	----	----	----	.008	.025	.009	----	----	----	0.000
AREA H	140	----	----	----	----	----	.002	.015	.005	----	----	----	----
AREA I	30	.006	.003	----	----	----	.006	.008	.005	.002	----	----	.003
AREA A (CASE 2)	140	.032	.024	.017	.003	.005	.038	.069	.057	.021	----	----	.011
AREA C (CASE 2)	280	.046	.013	.004	----	----	.015	.022	.009	.002	----	----	.011
AREA E (CASE 2)	200	.030	.034	.010	----	----	.022	.055	.022	.005	----	----	0.000
AREA F (CASE 2)	240	----	----	----	----	----	----	.010	----	----	----	----	----

Irrigation Efficiency is applied as 57% for up land crop

Table J.2.6 (4) Summary of Mean Gross Water Requirement (m3/s) Return Period 1/20

AREA	AREA (ha)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
AREA A (CASE 1)	1110	.067	.042	.020	.003	.005	.212	.296	.135	.031	----	----	.029
AREA B (CASE 1)	350	.077	.037	----	----	----	.064	.167	.137	.046	----	----	.024
AREA C (CASE 1)	1700	.291	.256	.083	----	.001	.231	.420	.195	.082	----	----	.097
AREA D	2300	.203	.155	----	----	.007	.536	.587	.154	.093	----	----	.216
AREA E (CASE 1)	1850	.334	.379	.141	----	----	.266	.561	.267	.095	----	----	.051
AREA F (CASE 1)	1080	----	----	----	----	----	----	.107	.003	----	----	----	----
AREA G	140	.007	0.000	----	----	----	.012	.028	.011	----	----	----	.003
AREA H	140	----	----	----	----	----	.004	.017	.007	----	----	----	----
AREA I	30	.007	.005	.001	.001	.002	.008	.010	.007	.004	----	----	.005
AREA A (CASE 2)	140	.036	.028	.020	.003	.005	.041	.072	.060	.023	----	----	.014
AREA C (CASE 2)	280	.055	.016	.006	----	----	.024	.024	.012	.004	----	----	.019
AREA E (CASE 2)	200	.036	.041	.015	----	----	.029	.061	.029	.010	----	----	.005
AREA F (CASE 2)	240	----	----	----	----	----	----	.015	----	----	----	----	----

Irrigation Efficiency is applied as 57% for up land crop

J.2.3 Irrigation System Plan

(1) General

The irrigation system plan was studied on the following three(3) components;

a) Water Source Facility
b) Main Irrigation System (including Secondary Canal)
c) Field Irrigation System

Depending on the condition of topography and the proposed cropping pattern, the basic concept of irrigation system should be considered for each proposed irrigation area. In this section, every and all main facilities required for irrigation system will be studied and their construction costs will be estimated approximately.

(2) Water Source Facilities

Considering an economical system, the possibility of using a gravity system should be considered first. However,in some cases, depending on the topographic condition, the pumping up system may be more economical. Considering the location of the project area, the same water source facilities as the existing diversion weir and driving canal for El Bosque hydroelectric power station can be expected for Area B,C and E. From the viewpoint of water resources, the study of water source is described in Annex M. The following water source facilities can be recommended for each proposed project area. In the case of a small stream being applied as a water source, the construction cost of water source facilities will be estimated in field irrigation system.

	Area A	Area B,C,E	Area D
Peak Irrigation Water Requirement	0.71 m3/s	2.49 m3/s	1.80 m3/s
Water Source	Barragan River	Quindio River	Espejo River
Intake Facility	Pumping Station	Head Works	Pumping Station
Driving Canal	--	7.0 km	1.5 km
Cost Million Col$	50	160	30
Other purpose		Hydroelectric Domestic Water	

	Area F	Area G	Area H
Peak Irrigation Water Requirement	0.50 m3/s	0.08 m3/s	0.08 m3/s
Water Source	Small Stream	Small Stream	Small Stream
Intake Facility	Portable Pump	Portable Pump	Portable Pump
Driving Canal	--	--	--
Cost	--	--	--

Note Area A : Quindio River Left Margin A.D.P.
Area B,C,E : Quindio River Right Margin A.D.P.
Area D : San Jose A.D.P.
Area F : Circasia A.D.P.
Area G,H : Genova-Pijao A.D.P.
A.D.P. : Agricultural Development Project

	Area I
Peak Irrigation Water Requirment	0.02 m3/s
Water Source	Small Stream
Intake Facility	Portable Pump
Driving Canal	--
Cost	--

a) Preliminary Layout of Head Works

Considering the existing conditions of the diversion works at El Bosque, the rehabilitation is considered for the irrigation system. The preliminary layout of rehabilitation plan for the head works is shown in Fig.J.2.3. The dimensions of the head works are summarized below:

Peak Intake Water : Total 7.22 m3/s (for Irrigation 2.44 m3/s
for Electricity 4.22 m3/s
for Domestic use 0.56 m3/s)

Total Weir Length : 181.5 m
Hight of Crest : 1.0 m
Gate : 3.1x1.9 three unit
Design Flood Discharge : 490 m3/s (50 year return period)

b) Preliminary Layout of Pumping Stations

1. Barragan Pumping Station

Considering the irrigation plan and the prevention of predictable accidents, the installation of three(3) pumps may be the most effective system. The preliminary layout is shown in Fig.J.2.4. The dimensions are summarized below:

Peak Water Discharge : 0.71 m/s
Discharge Head : 15 m
Pump : Diameter 350 mm 3 unit

2. Espejo Pumping Station

Considering the irrigation plan and the prevention of predictable accidents, the installation of four(4) pumps may be the most effective system. The preliminary layout is shown in Fig.J.2.5. The dimensions are summarized below:

Peak Water Discharge : 1.80 m/s
Discharge Head : 60 m
Pump : Diameter 450 mm 4 Unit

(3) Main Irrigation System

In the case of a small stream being applied as a water source, no main irrigation system is necessary, but merely a field irrigation

system is required. Therefore, this section deals with the main irrigation systems for the project Area A,B,C,D and E are studied.

A main irrigation system is composed of main canal, secondary canal and other related structures. Considering the existing topographic conditions, the most effective canal routes are selected as shown in Fig.J.2.6. The dimensions of each canal was designed in the consideration of the peak water requirement and the longitudinal slope. These canals were designed as the concrete lining open canals basically with 5m width of the operation road.(See Fig.J.2.7)

The typical section of irrigation canal is shown in Fig.J.2.8. Depending on the design discharge and freeboard, canal type is selected. In this study, 1/1000 of longitudinal slope is applied for the design of a canal, and several drops are considered. Uniform flow is applied for hydrological calculation and the relation between discharge and water depth of each canal type is shown in Fig.J.2.9. The result of selection of canal type is shown in Fig.J.2.10 and Table J.2.7.

The preliminary layout of the proposed pumping station in Area A is shown in Fig.J.2.11. Considering the irrigation plan, the provision of one(1) pump may be the most effective system. The dimensions are summarized below:

Peak Water Discharge : 0.25 m3/s
Discharge Head : 60 m
Pump : Diameter 350 mm 1 unit

The main irrigation system is summarized below:

	Area A	Area B	Area C	Area D	Area E
Main Canal	9.0 km	6.5 km	26.5 km	28.0 km	21.0 km
Secondary Canal	14.0 km	2.0 km	18.0 km	30.0 km	21.0 km
Total Cost million Col$	220	50	230	310	190

(Canal type V is applied for a secondary canal. The construction cost of maintenance roads is included in total cost. The cost of pumping station in Area A is considered.)

(4) Field Irrigation System

Considering the topographic and soil conditions, a spray irrigation system could be employed as a field irrigation system. Some parts of Area A and B can be employed a surface irrigation system, however, considering its workabilty, it is estimated that a spray irrigation system is more effective than a surface irrigation system. One unit of the field irrigation system is composed of a pump, pipes and sprinklers, and approximately two(2) ha of irrigation area is covered by this unit in one time using three or four

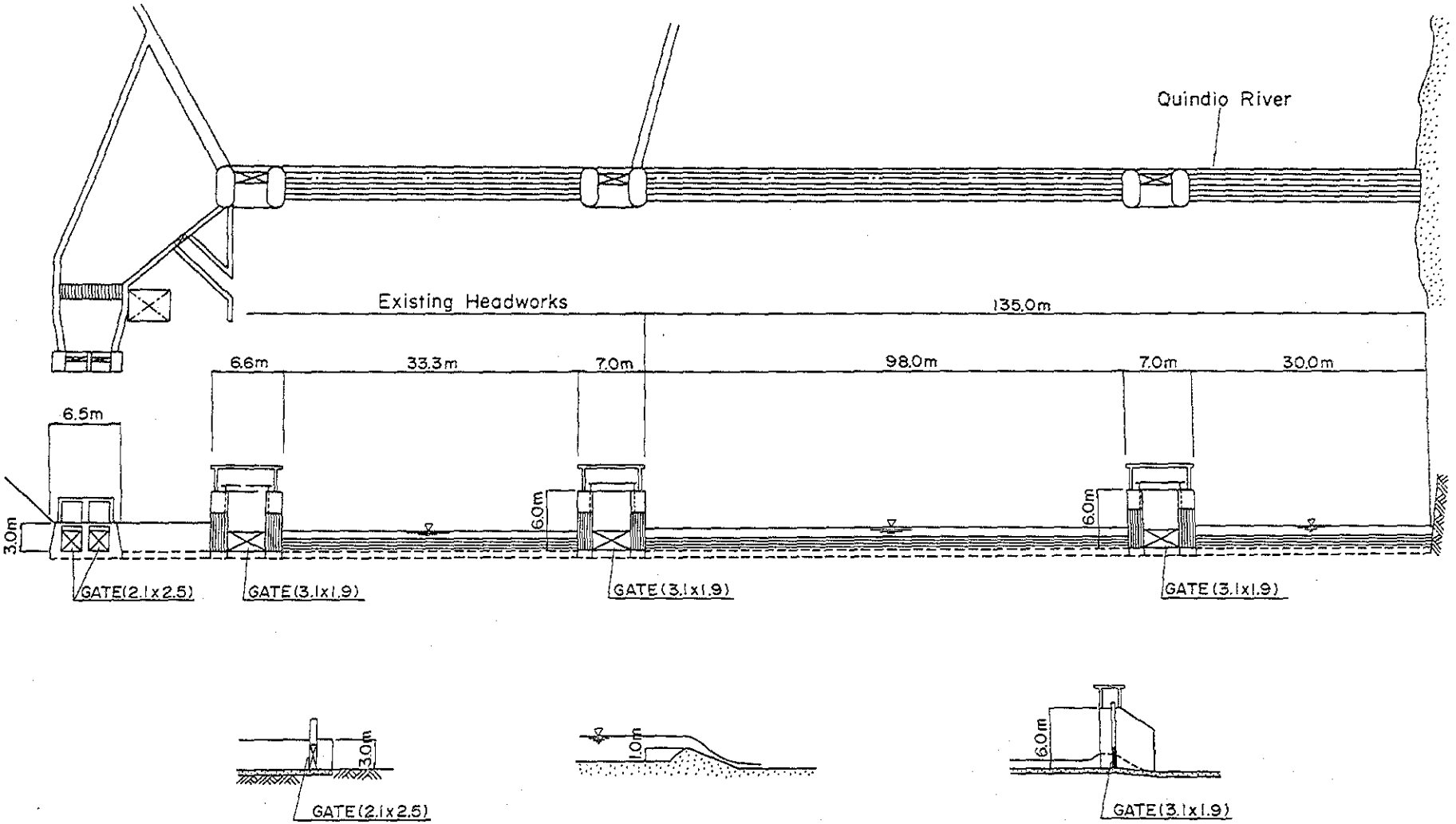
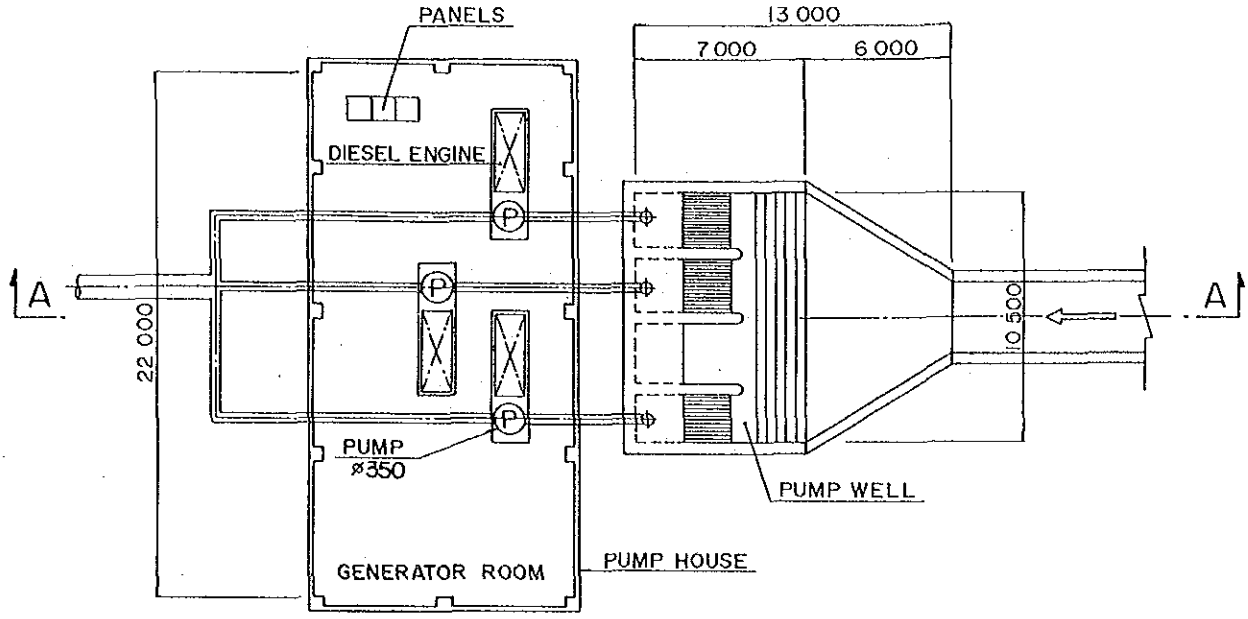
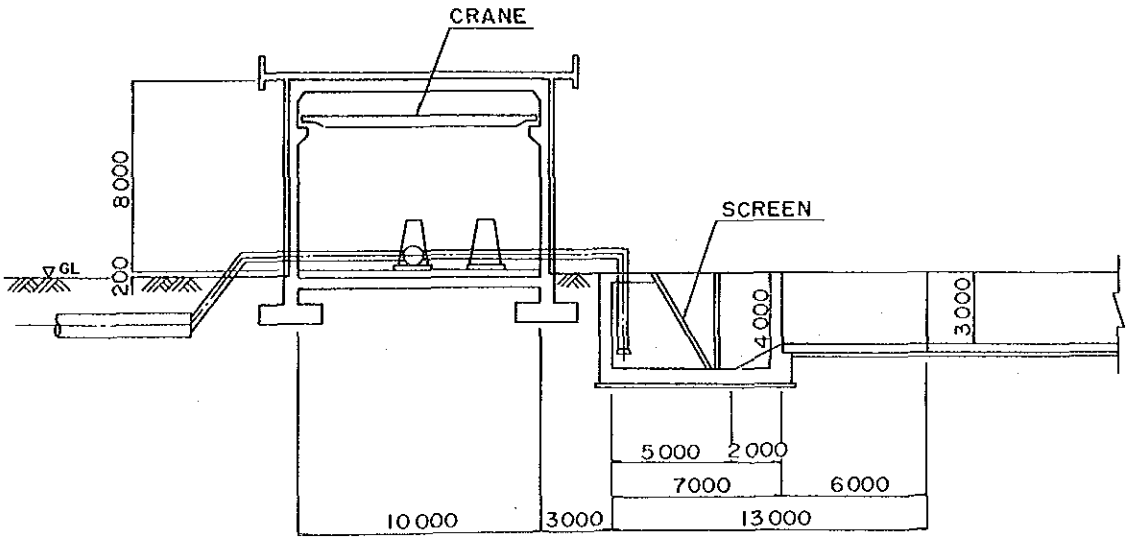


FIG. J.2.3 PRELIMINARY LAYOUT OF HEAD WORKS

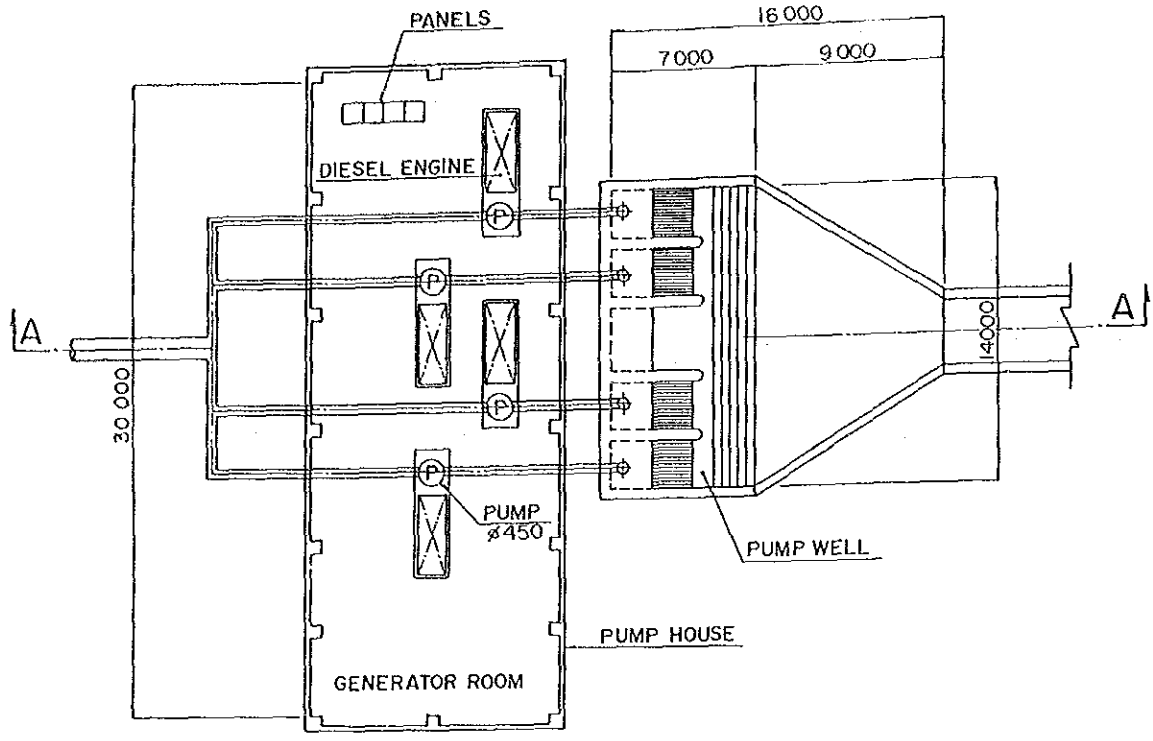


PLAN

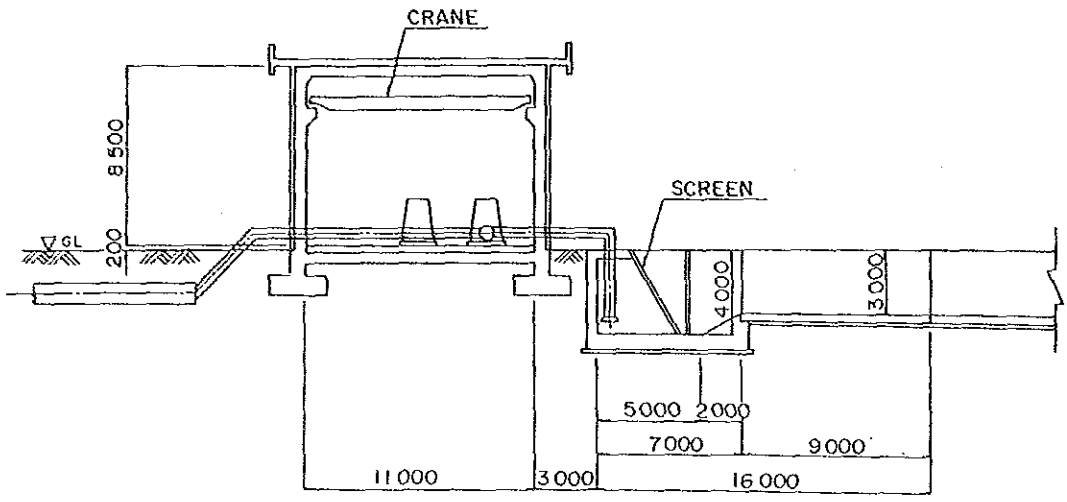


SECTION A-A

FIG. J.2.4 PLAN OF PUMPING STATION (BARRAGAN)



PLAN



SECTION A–A

FIG. J.2.5 PLAN OF PUMPING STATION (ESPEJO)

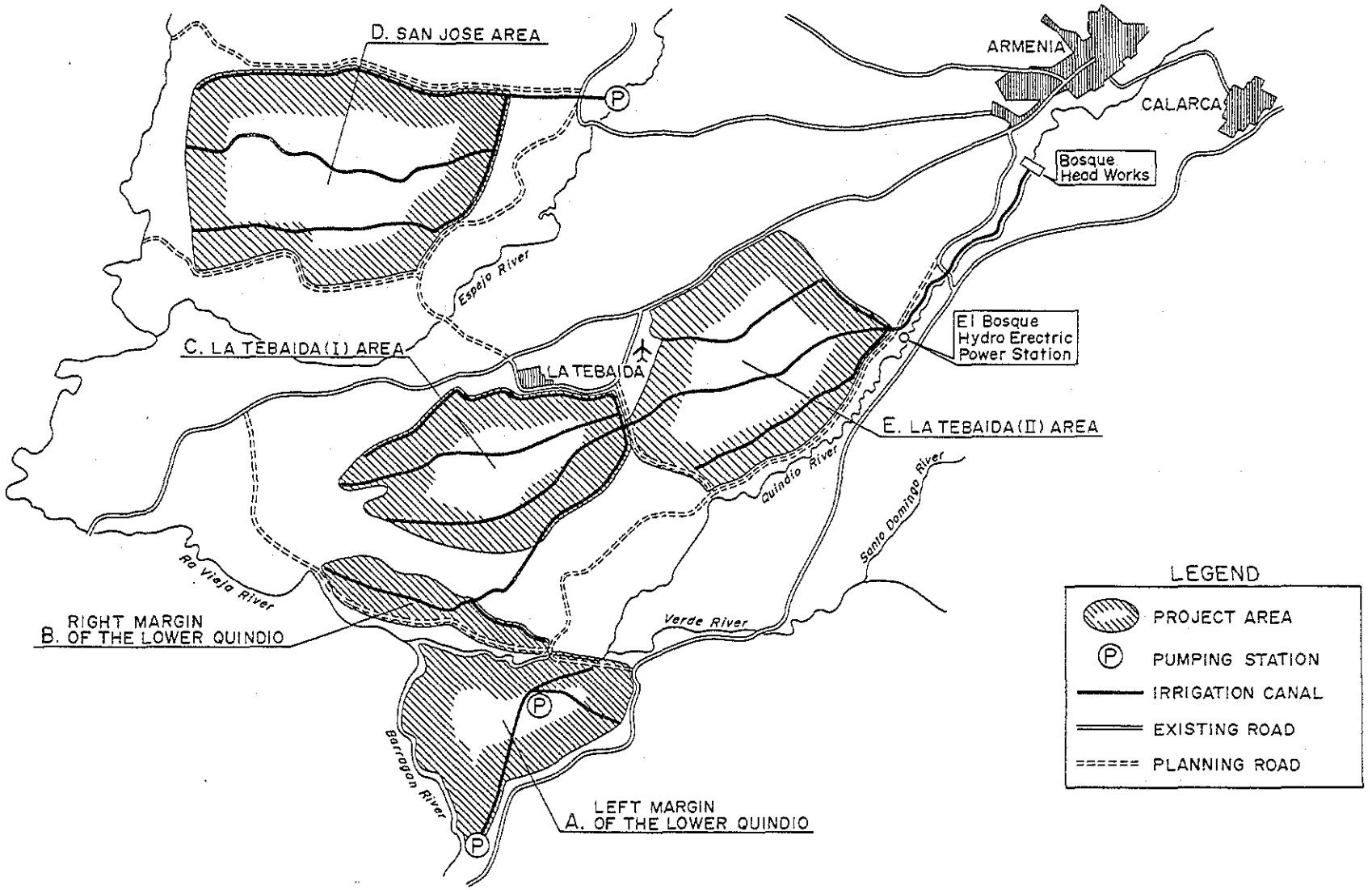
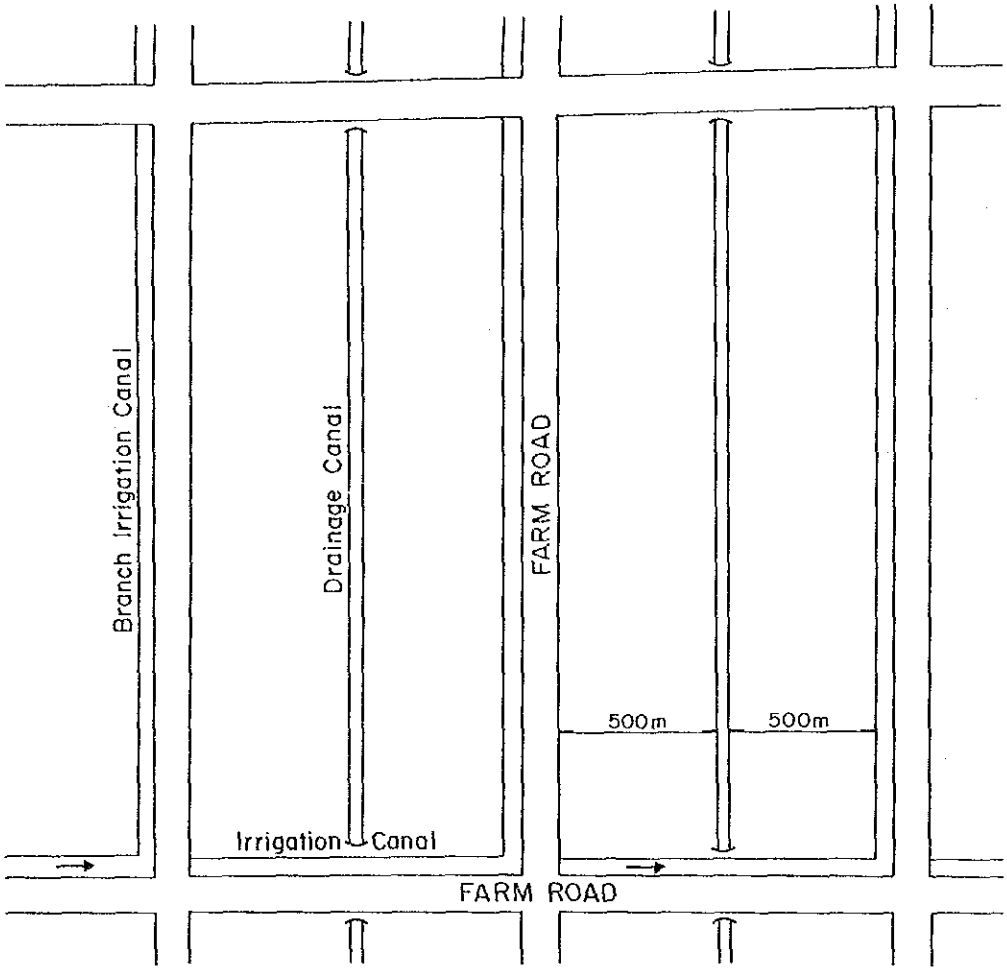
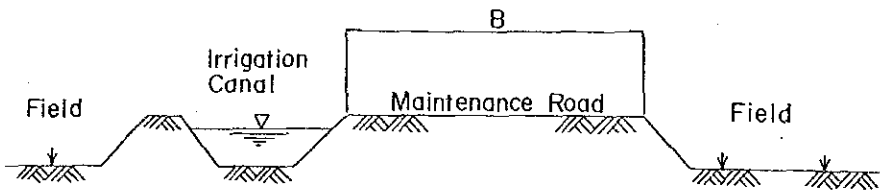


FIG. J.2.6 PROPOSED ROUTE OF IRRIGATION CANAL

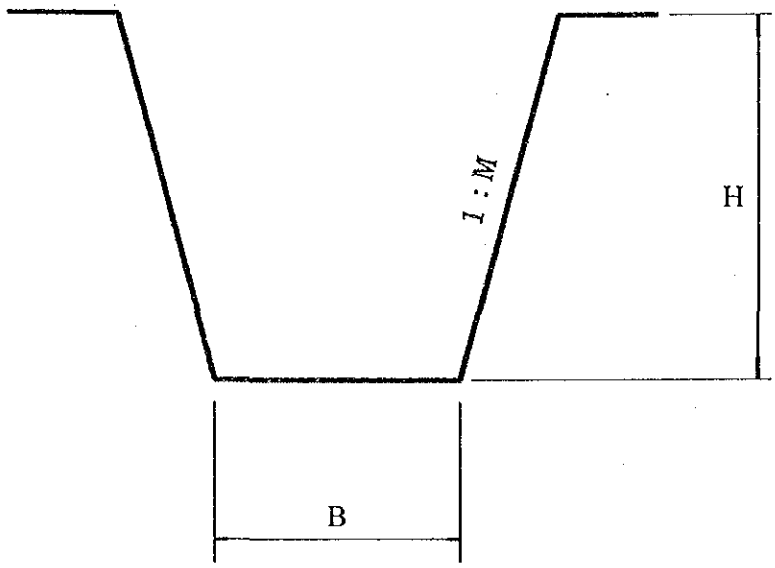


STANDARD FARM LOT



SECTION OF IRRIGATION CANAL

FIG. J.2.7 STANDARD FARM LOT



Type	Width of Botom B (m)	Height of Canal C (m)	Said Slope	Remark
Ⅰ	0.60	1.70	1.62	Rihabilitation
Ⅱ	1.00	1.50	1.00	New Constraction
Ⅲ	1.00	1.00	1.00	〃
Ⅳ	0.50	1.00	1.00	〃
Ⅴ	0.50	0.50	1.00	〃

FIG. J. 2. 8 TYPICAL SECTION OF CANAL

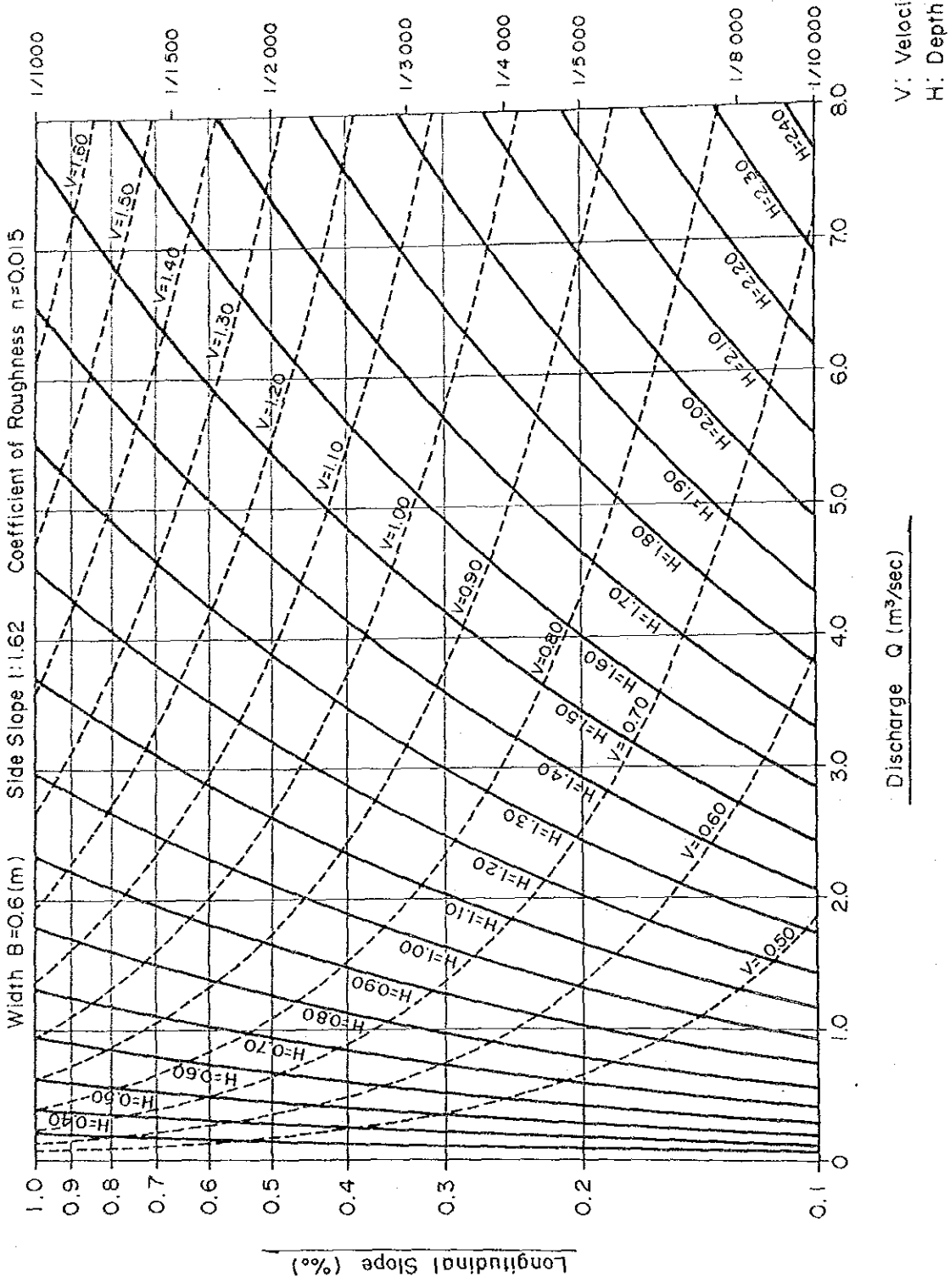


FIG. J.2.9 CANAL DISCHARGE AND WATER DEPTH CURVE (I)

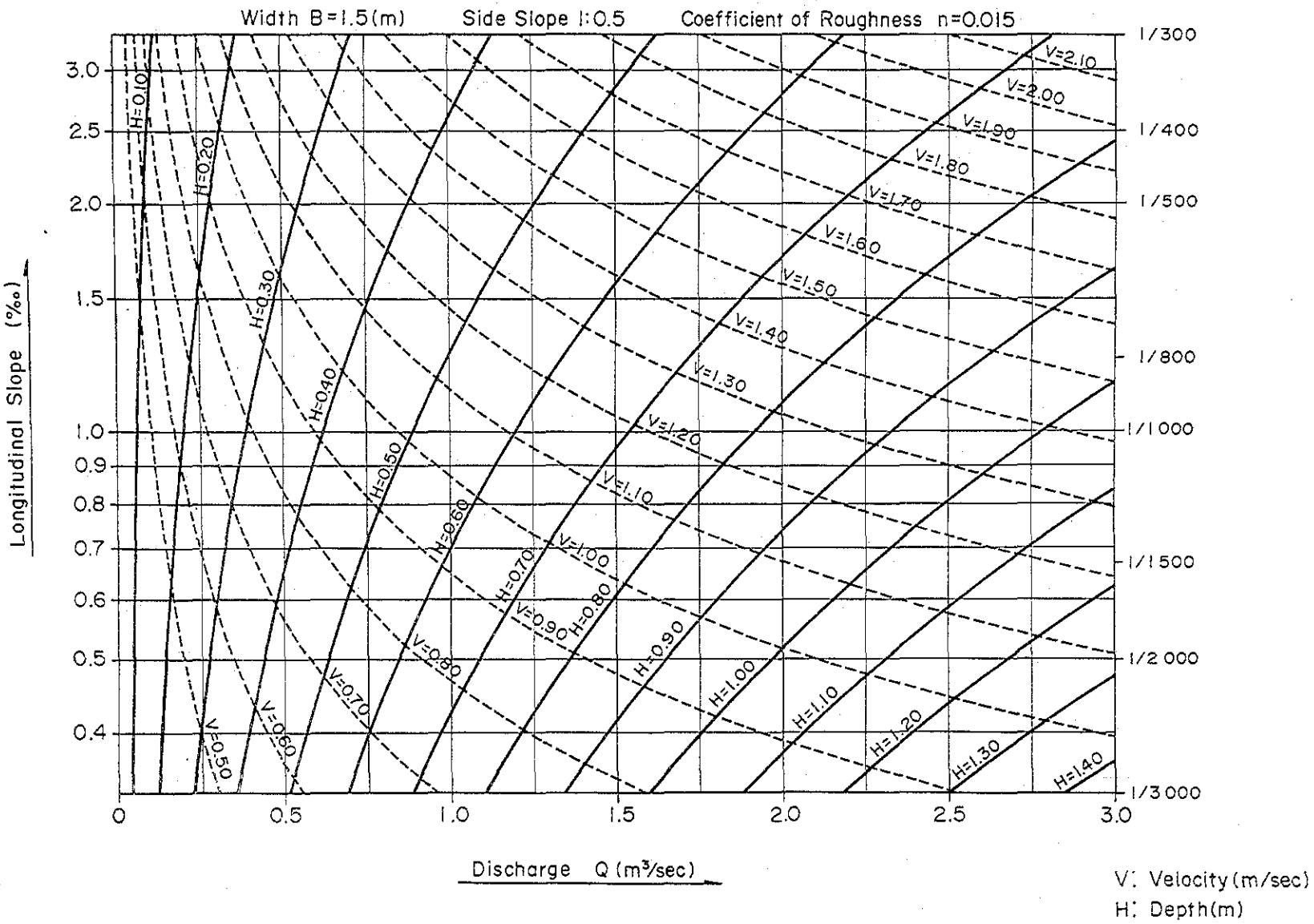


FIG. J.2.9 CANAL DISCHARGE AND WATER DEPTH CURVE (2)

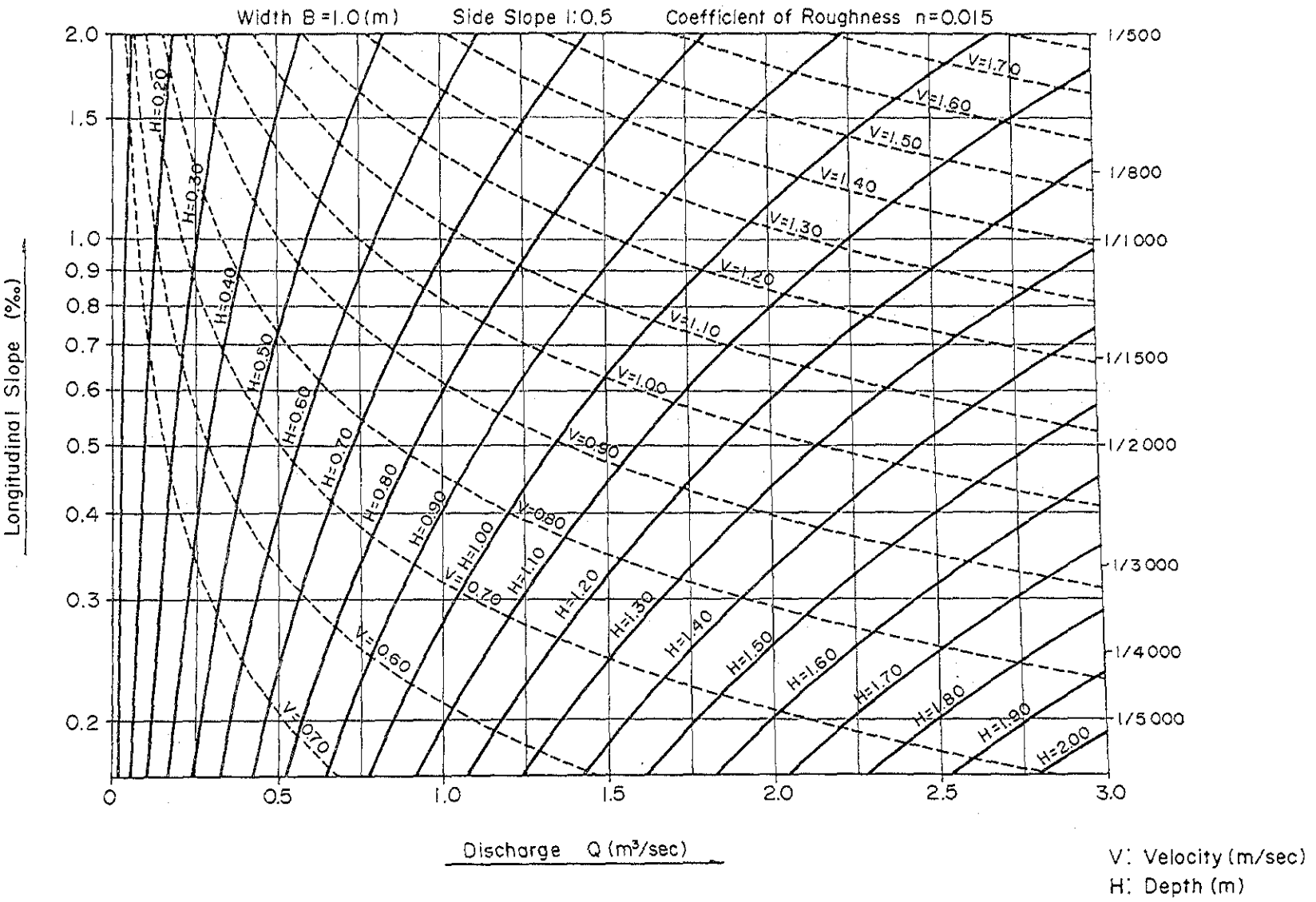


FIG. J.2.9 CANAL DISCHARGE AND WATER DEPTH CURVE (3)

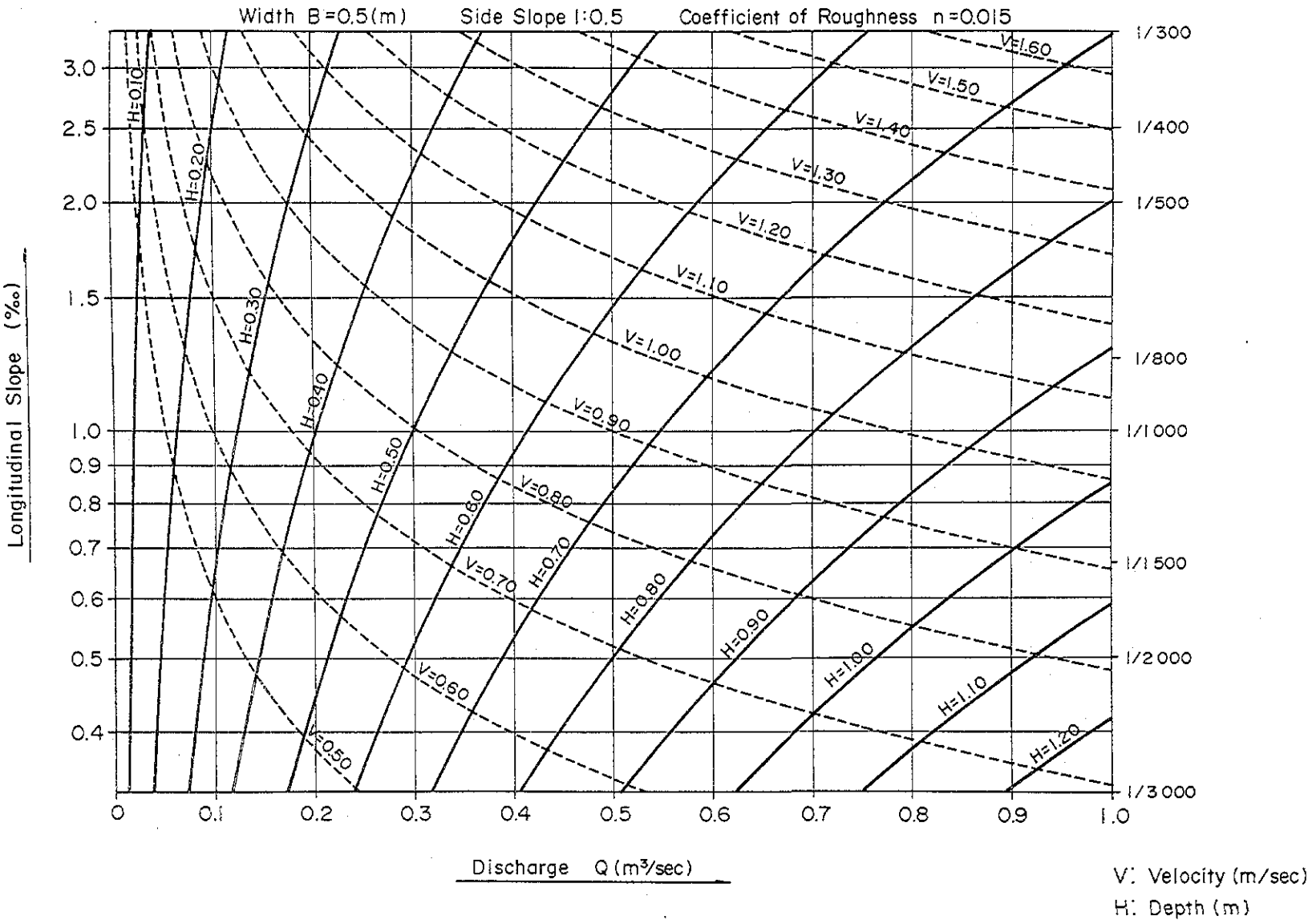
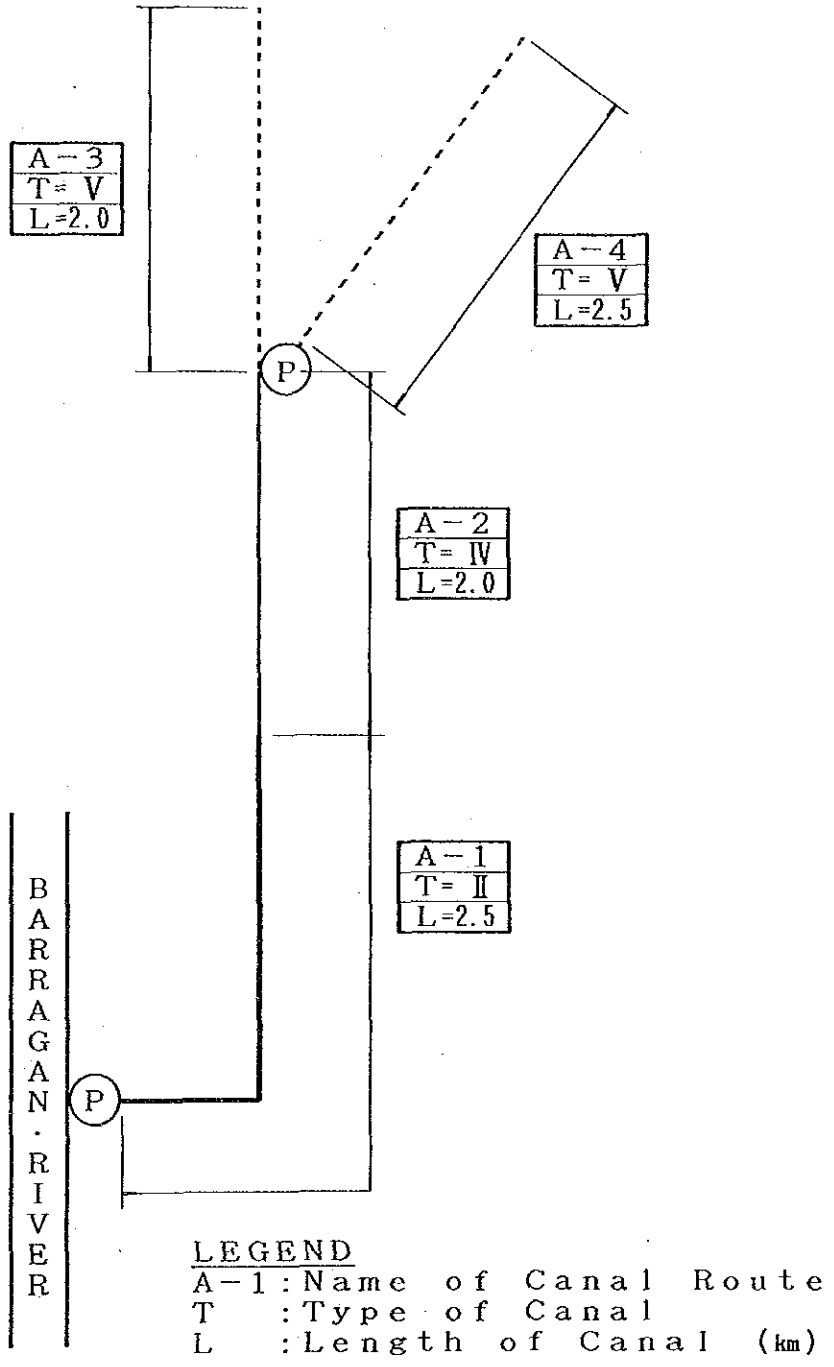


FIG. J.2.9 CANAL DISCHARGE AND WATER DEPTH CURVE (4)

Table J.2.7 Summary of Irrigation Canal Length

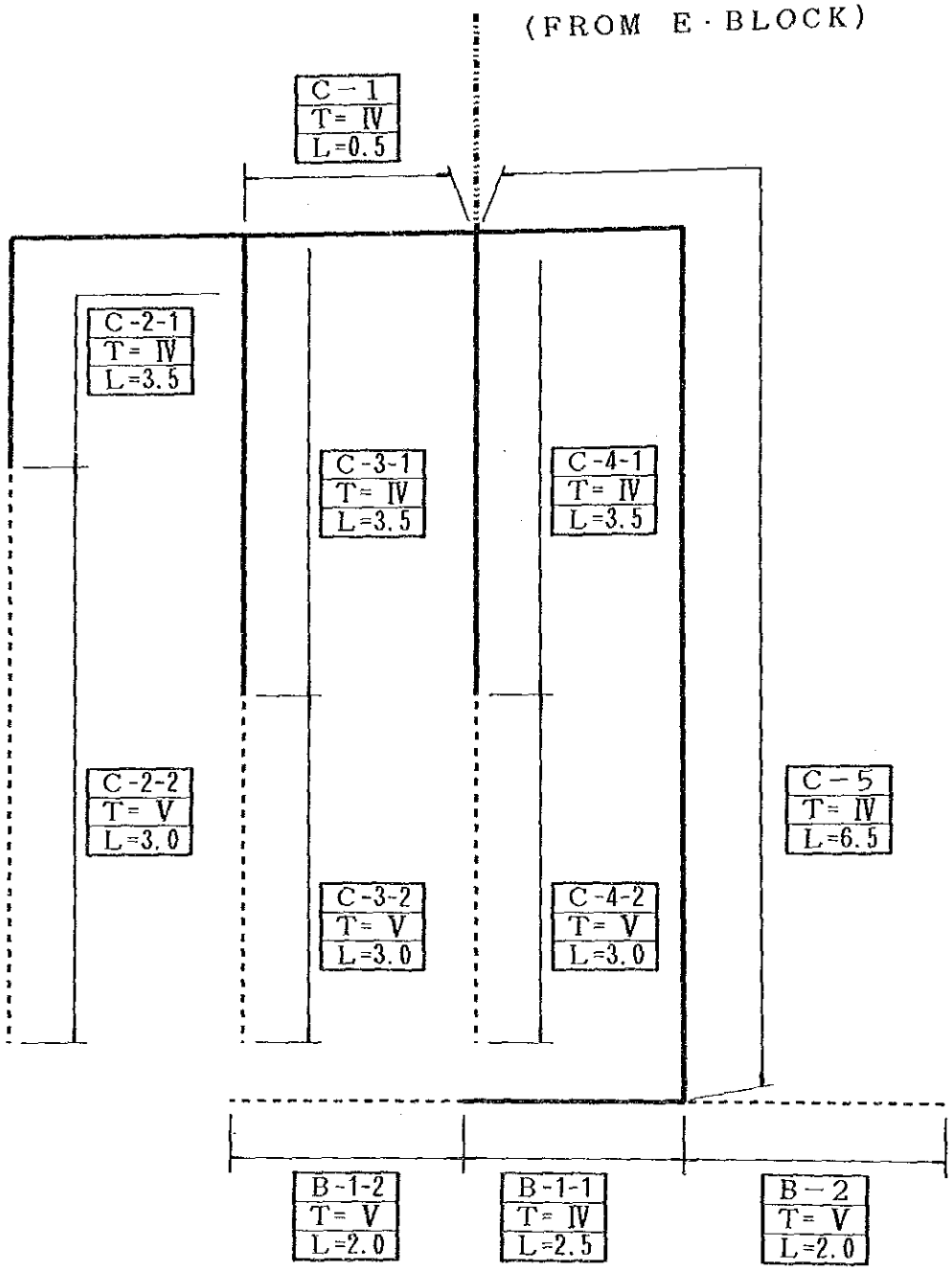
Unit: Km

Type	B×H (m)	Area					Total Lsength	Remark
		A	B	C	D	E		
Ⅰ	0.6X1.7	—	—	—	—	7.0	7.0	Rihabilitation
Ⅱ	1.0X1.5	2.5	—	—	1.5	8.0	9.5	New Constraction
Ⅲ	1.0X1.0	—	—	—	8.0	—	10.0	〃
Ⅳ	0.5X1.0	2.0	2.5	17.5	12.0	9.5	43.5	〃
Ⅴ	0.5X0.5	4.5	4.0	9.0	8.0	3.5	29.0	〃
Total		9.0	6.5	26.5	29.5	28.0	99.5	



Area・A

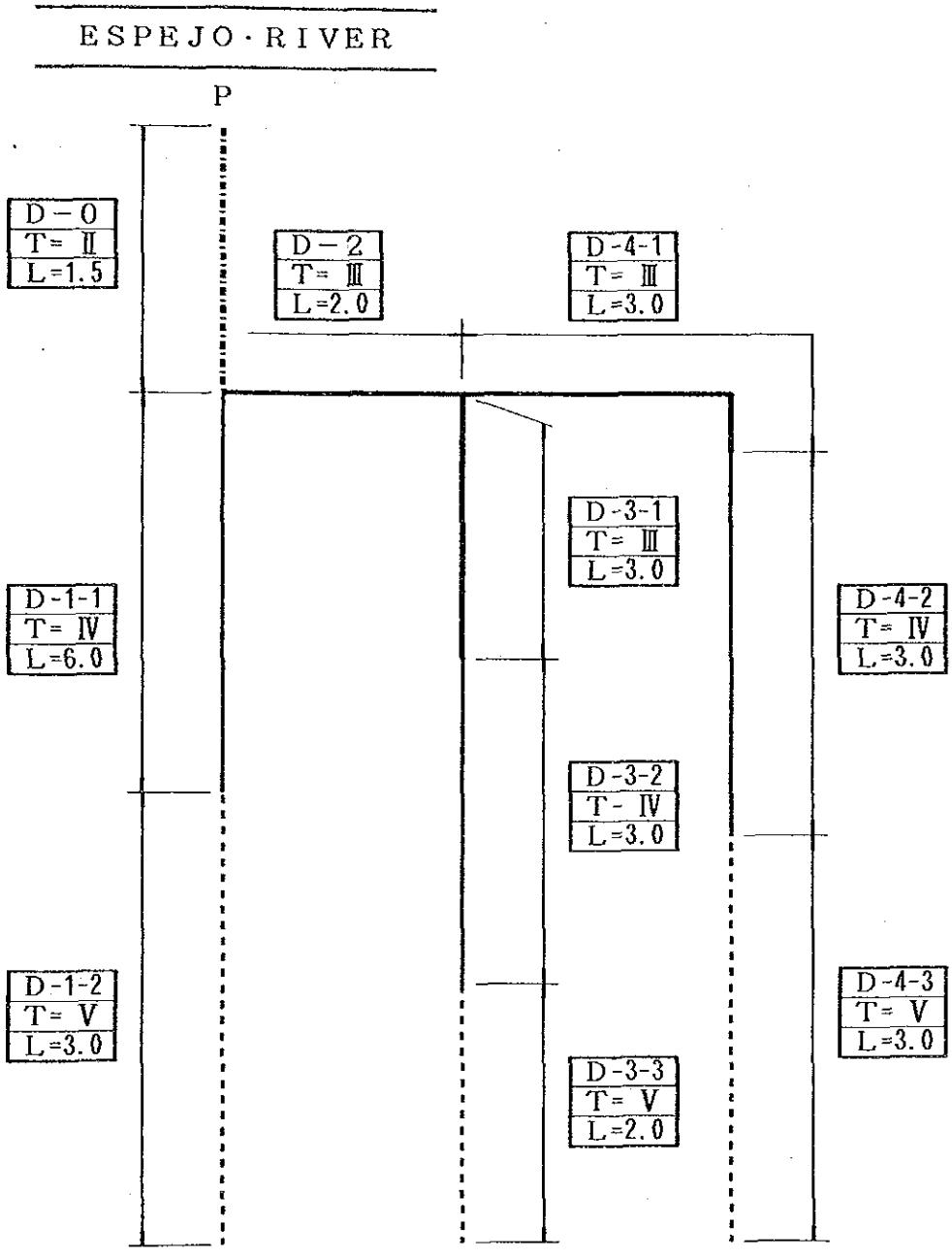
FIG. J. 2. 10 IRRIGATION SYSTEM PLAN (1)



LEGEND
C, B－1 : Name of Canal Route
T : Type of Canal
L : Length of Canal (km)

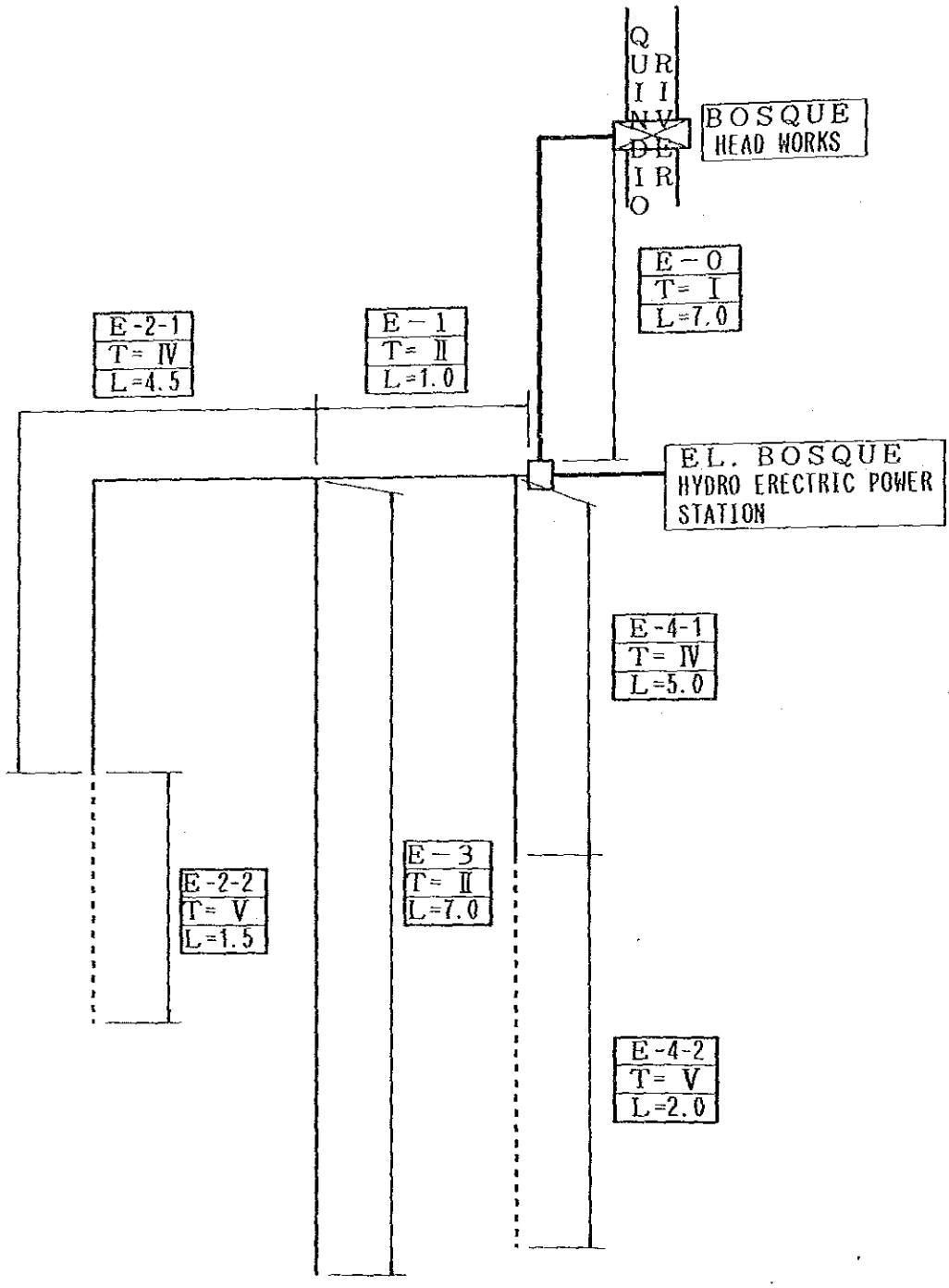
Area・C, B

FIG. J. 2. 10 IRRIGATION SYSTEM PLAN (2)



Area・D

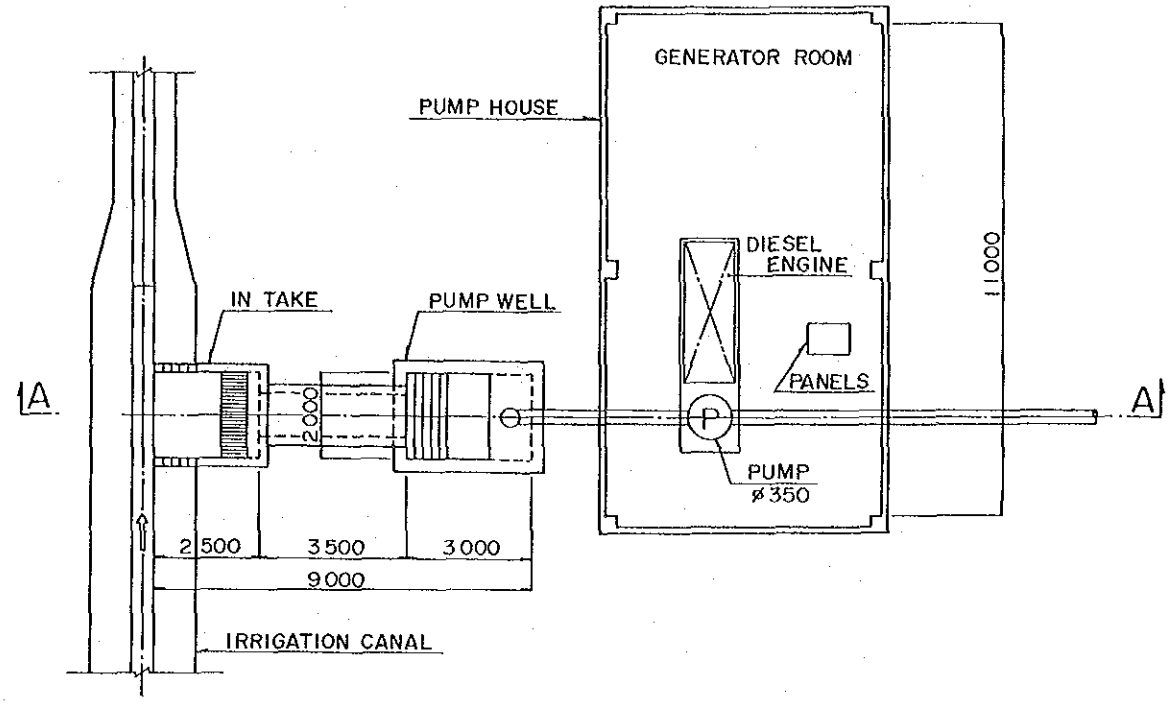
FIG. J. 2. 10 IRRIGATION SYSTEM PLAN (3)



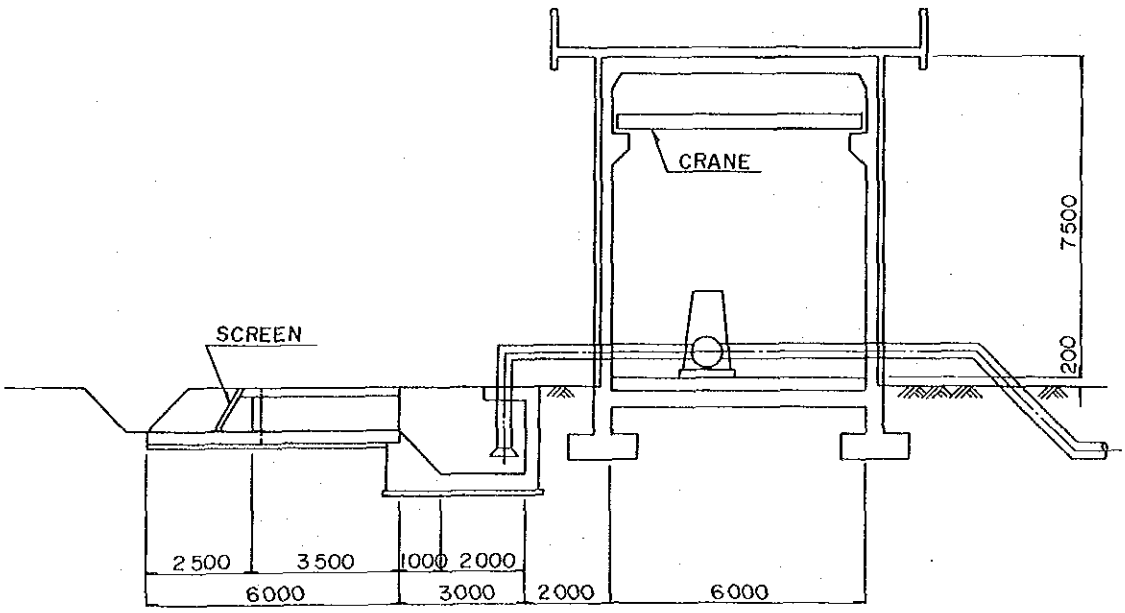
LEGEND
E-1 : Name of Canal Route
T : Type of Canal
L : Length of Canal (km)

Area-E

FIG. J. 2. 10 IRRIGATION SYSTEM PLAN (4)



PLAN



SECTION A-A

FIG. J.2.11 PLAN OF PUMPING STATION (AREA A)

hours. Approximately from 10 to 12 mm/hour of irrigation density can be applied, and approximately one week may be applied as an irrigation interval. Therefore, this unit can be covered from 30 to 40 ha of irrigation area. Depending on the topographic condition and the proposed crop, the type of spray irrigation system may vary.

The standard unit of the field irrigation system is summarized below:

Portable pump : Discharge 1,200 l/min Diameter 125 mm Head 30 m
Pipe : Diameter 100 mm (120 pieces/10m)
Spray Gun : 4 unit
Sprinkler : 40 set

Considering the topographic condition and the irrigation plan of each project area, the proposed number of field irrigation system units are suggested below:

	Area A	Area B	Area C	Area D	Area E
No. of Units	37	12	57	77	62
Cost million Col$	330	110	500	680	550

	Area F	Area G	Area F	Area I
No. of Units	36	5	5	1
Cost million Col$	320	50	50	10

J.2.4 Coffee Irrigation

As for coffee harvesting, there are two critical periods. (See Fig.J.2.12)

One is a period of eight weeks after flowering. So when there is not enough water for this season, the quantity of coffee harvest will reduce. There is no official information available about reduction rate, however, one of the owners who have coffee farms with irrigation system in Armenia said that 40% of his coffee harvest may reduce for every 3 years in case of no irrigation due to droughty damage and reduction can be decreased up to 10% by irrigation.

The other is a period of thirteen weeks after flowering. So when there is not enough water in this season, the quality of coffee harvest will reduce. The same owner said that 30% of his coffee harvest may reduce every 3 years in case of no irrigation due to droughty damage and reduction can be decreased up to almost 0% by irrigation.

Coffee flowering depends on the patterns of dry and wet seasons; after the dry season, coffee trees will be affected by the first rainfall and their flowering is started. Therefore, in the case of no rainfall for period of eight weeks or thirteen weeks after

flowering, coffee harvest may reduce. Considering the characteristics of the rainfall patterns in the Quindio, the probability of suffering coffee harvest damage is not so low. Therefore, a good effect of coffee irrigation may be expected for higher coffee harvest. The agro-meteologists of CENICAFE in Chin China have the same opinion.

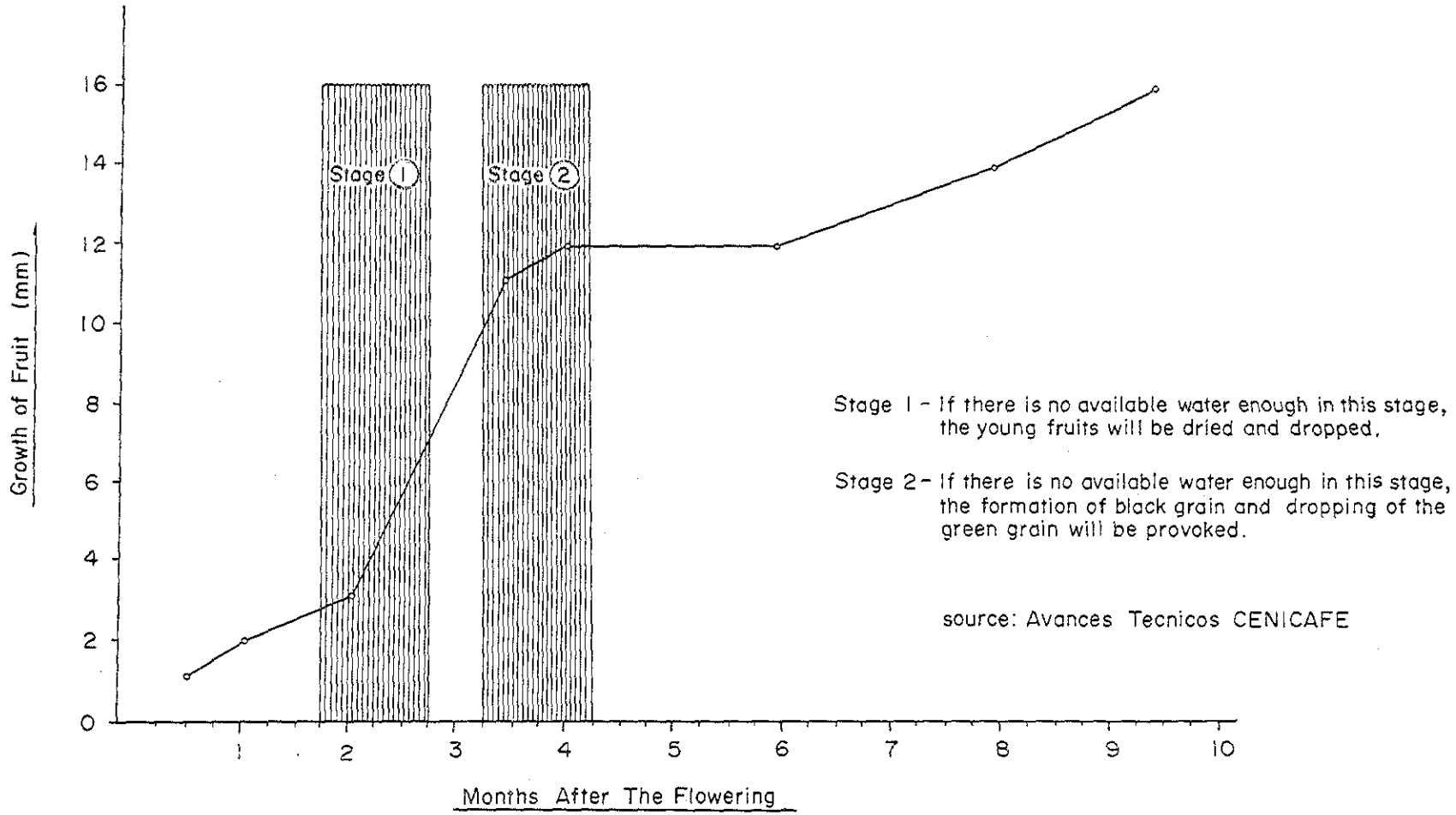


FIG. J.2.1 1 GROWTH CURVE OF COFFEE FRUIT

J.3 Drainage

J.3.1 Existing Condition

From the conditions of topography and soil in the Quindio, The drainage condition is quite good at the crop fields in the whole area of the Quindio except some parts of lowland.

Currently, there is no systematic drainage facilities for the crop fields. However, short-time rainfall with a high intensity for occurs, and a problem of erosion observed at some places. Considering the land conservation, it would be necessary to establish a drainage system where people suffer big damage due to erosion.

On the other hand, poor drainage is observed at lowlands area in the both margins of the lower Quindio River and this poor drainage may be one of the big restrictions which prevent the growth of crops. Currently, this area is mainly used for pasture, sorgum etc. In case this land receives improvements for high, intensive agriculture, it would be necessary to consider drainage improvement.

J.3.2 Drainage System Plan

(1) General

This section deals with the study of the drainage system plan for the agricultural project area. The drainage plan or prevention disaster plan for other place where the big problem has been observed is described in Annex K.

The drainage system plan is studied on the following components;

a) Estimation of rainfall intensity
b) Estimation of flood discharge
c) Preliminary design of drainage system

Depending on the topographic condition in the Quindio, the rivers or small streams are expectant as a main drainage system. Therefore, based on the canal which would be connected to a river or small stream, a field drainage system is studied.

(2) Estimation of Rainfall Intensity

Due to the lack of hourly rainfall data, rainfall intensity is estimated using the following formula;

$$i=R24/24*(24/t)^n$$

where i : Rainfall Intensity (mm/hour)
R24 : 24-hour Rainfall (mm)
t : Duration Time (hour)

n : Coefficient (2/3)

As in the case of the effective rainfall, the maximum 24-hour rainfall at the following stations was used for the project area.

Maximum 24-hour Rainfall (mm)

Name of Station	Project Area	Return Period 1/2	1/5	1/10	1/20
Paraguaycito :	Area A,B	81.3	92.8	99.5	105.4
Tebaida :	Area C,D,E	86.8	105.3	116.4	126.4
Villadora :	Area F	99.0	126.2	143.9	159.9
Gibraltal :	Area G	56.3	76.4	89.6	102.1
Pijao :	Area H	85.6	105.3	117.3	128.1
Cordoba :	Area I	74.3	90.6	100.6	109.5

The rainfall intensity frequency is shown in Fig.J.3.1.

(3) Estimation of Flood Discharge

The flood discharge is estimated by using the Rational Formula;

$$Q=f*i*a/3.6$$

where Q : Peak Flood Discharge (m3/s)
f : Design Runoff Coefficient (Considering the safety of area, 0.8 of coefficient is applied)
a : Catchment Area (km2)
i : Rainfall Intensity on the Duration time (mm/hr)

Depending on the existing topographic condition, duration time and rainfall intensity vary. Considering the existing topographic condition at the project area, the existing rivers or small streams are expectant as a main drainage system. Therefore, considering the canal which would be connected to a river or small stream, approximately from 0.05 km2 to 0.1 km2 of catchment area for each drainage canals is estimated, and, form 30 minutes to 60 minutes of the duration time (time for arrival at the existing river or small stream) is expected in these project area.

The peak flood discharge for the design of a drainage canal in each case is shown in Table J.3.1.

(4) Preliminary Design of Drainage System

The preliminary layout of drainage system is shown in Fig.J.2.7. Considering the peak flood discharge, from 1/500 to 1/1000 of longitudinal slope is applied and the canal type V shown in Fig.j.2.8 can be applied for drainage canal. The drainage systems at each project area are summarized as follows;

	Area A	Area B	Area C	Area D	Area E
Length of Drainage canal	15 km	6 km	16 km	27 km	23 km
Cost million Col$	5.7	2.3	6.1	10.3	8.6

	Area F	Area G	Area H	Area I
Length of Drainage canal	16 km	2 km	2 km	--
Cost million Col$	6.1	0.8	0.8	--

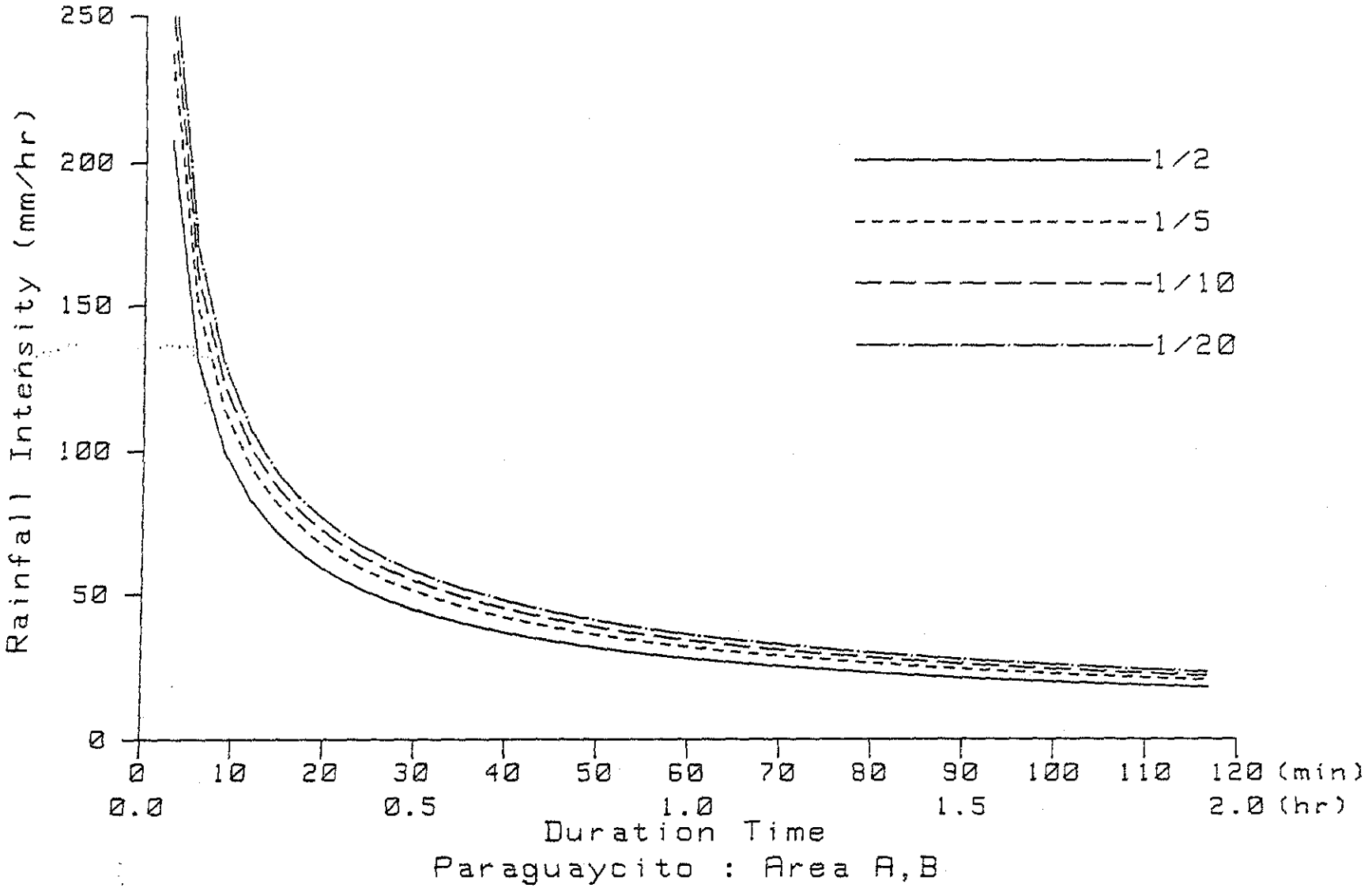


FIG.J.3.1 Frequency Intensity Duration Curve (1)

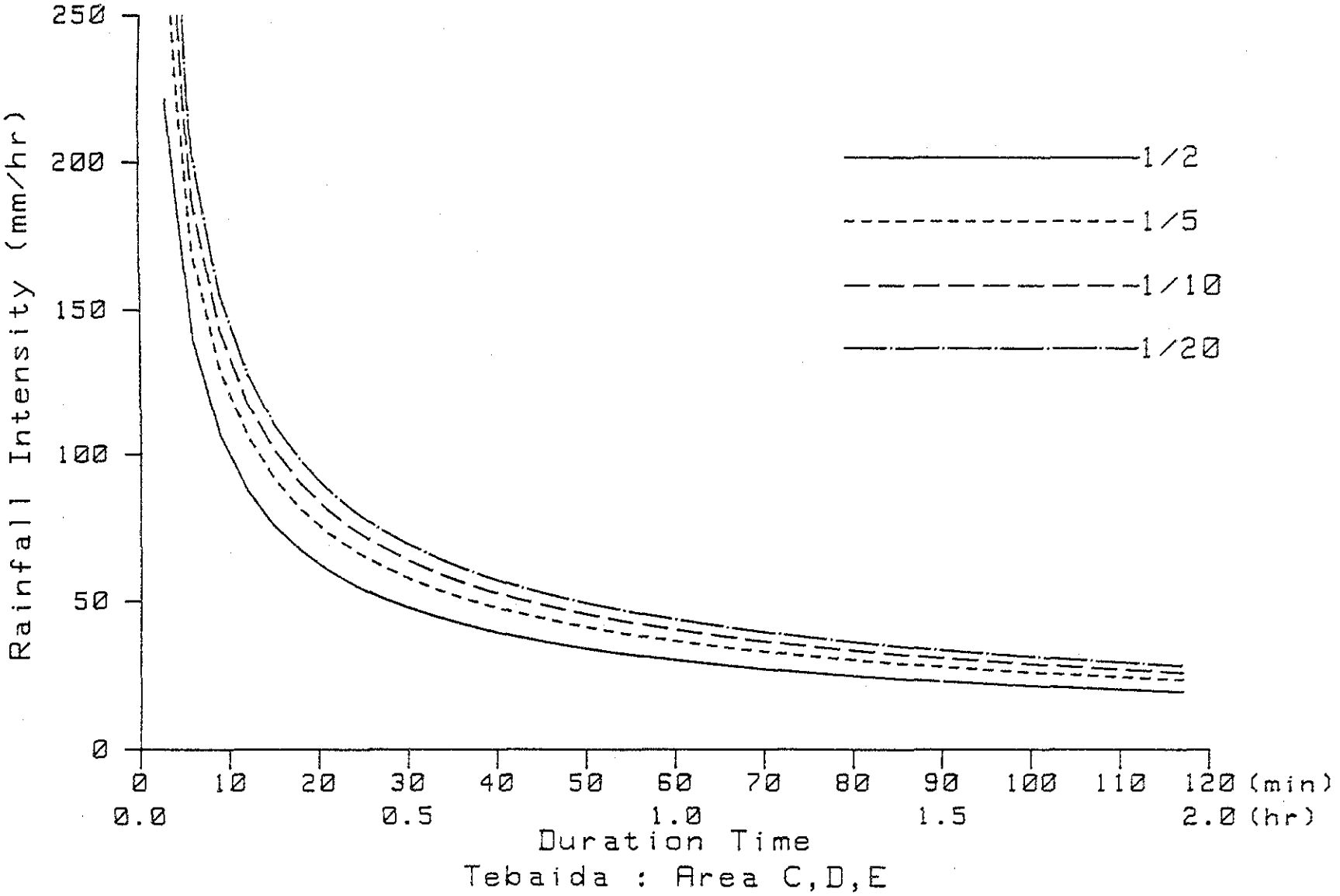


FIG.J.3.1 Frequency Intensity Duration Curve (2)

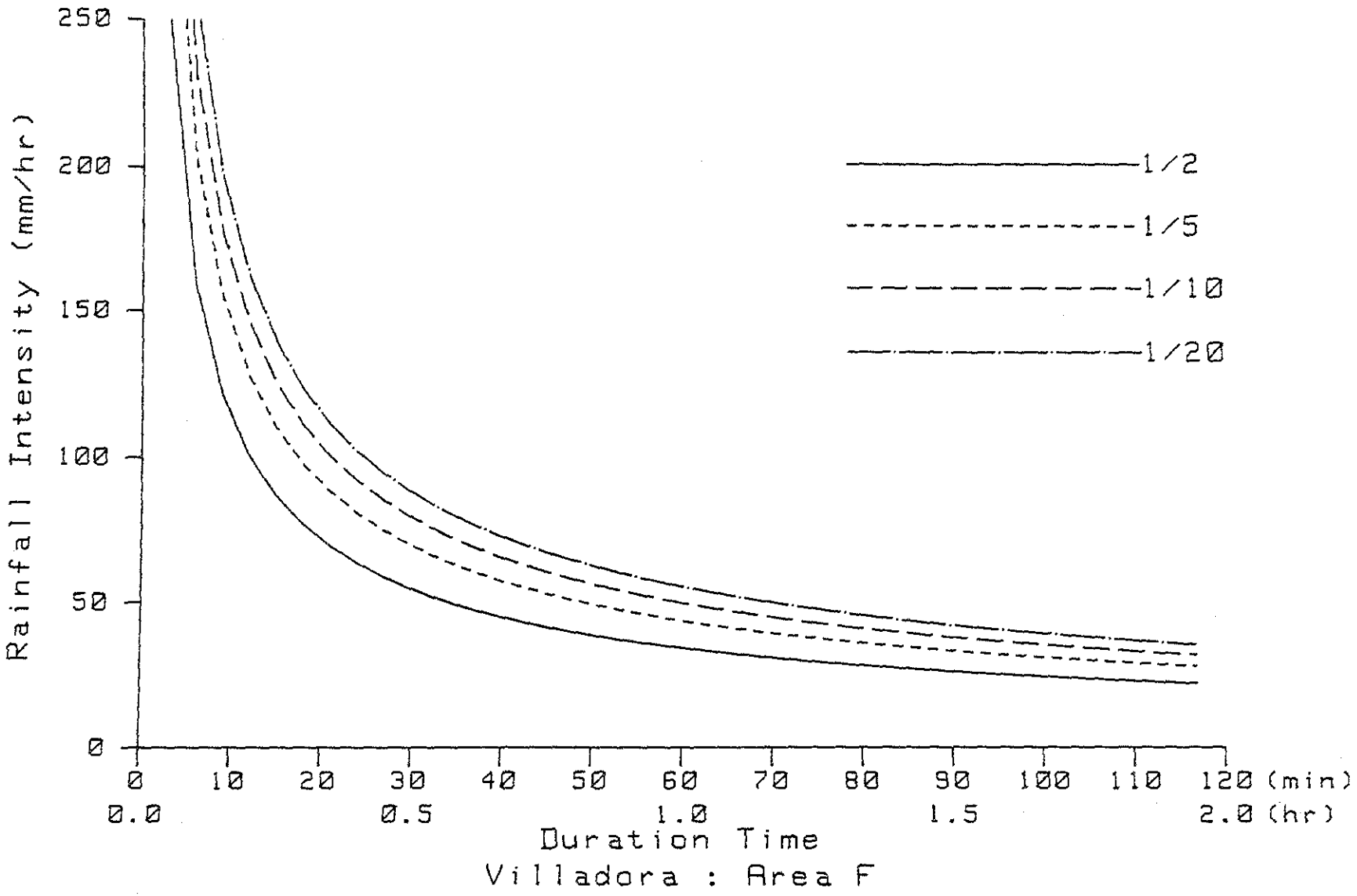


FIG.J.3.1 Frequency Intensity Duration Curve (3)

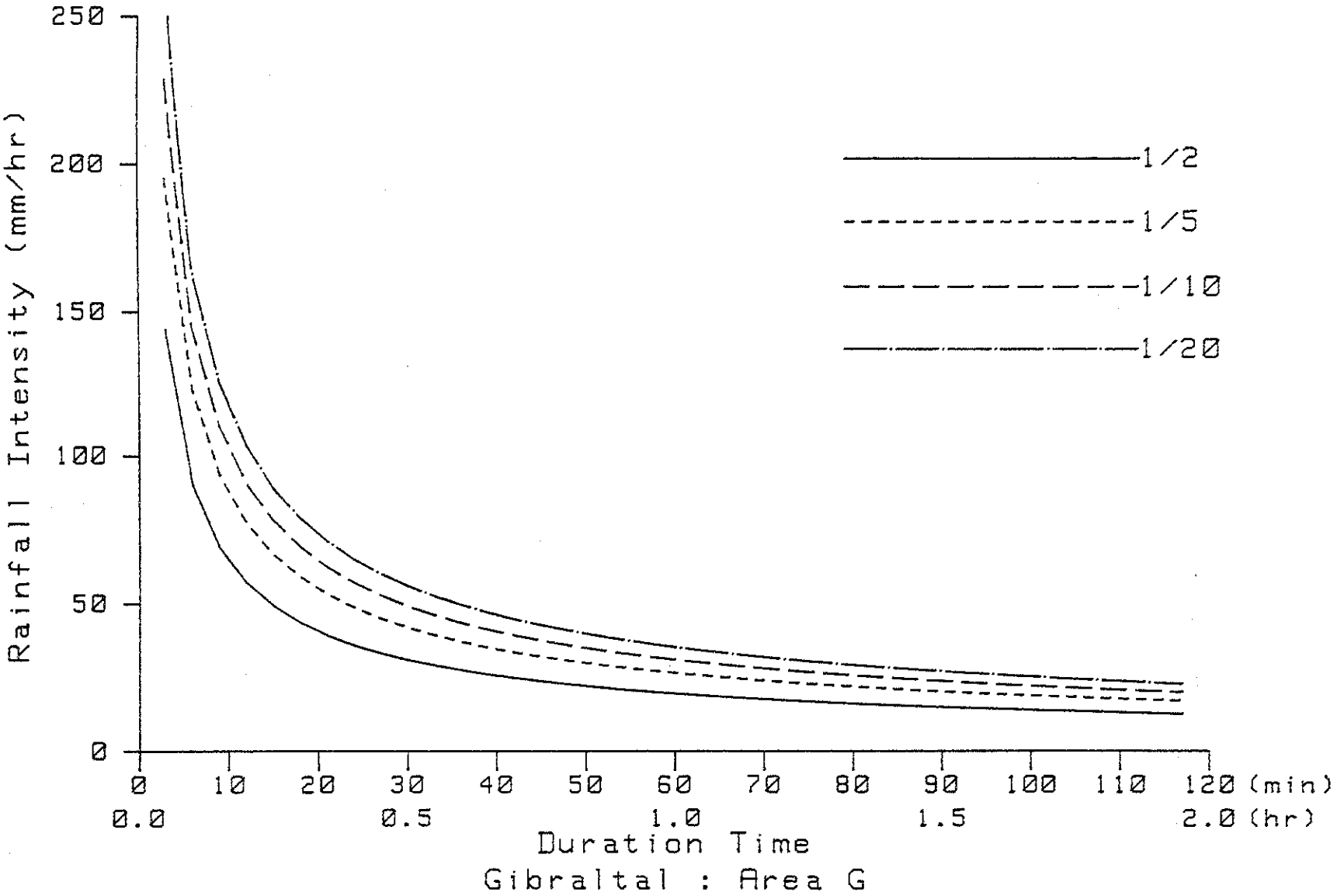


FIG.J.3.1 Frequency Intensity Duration Curve (4)

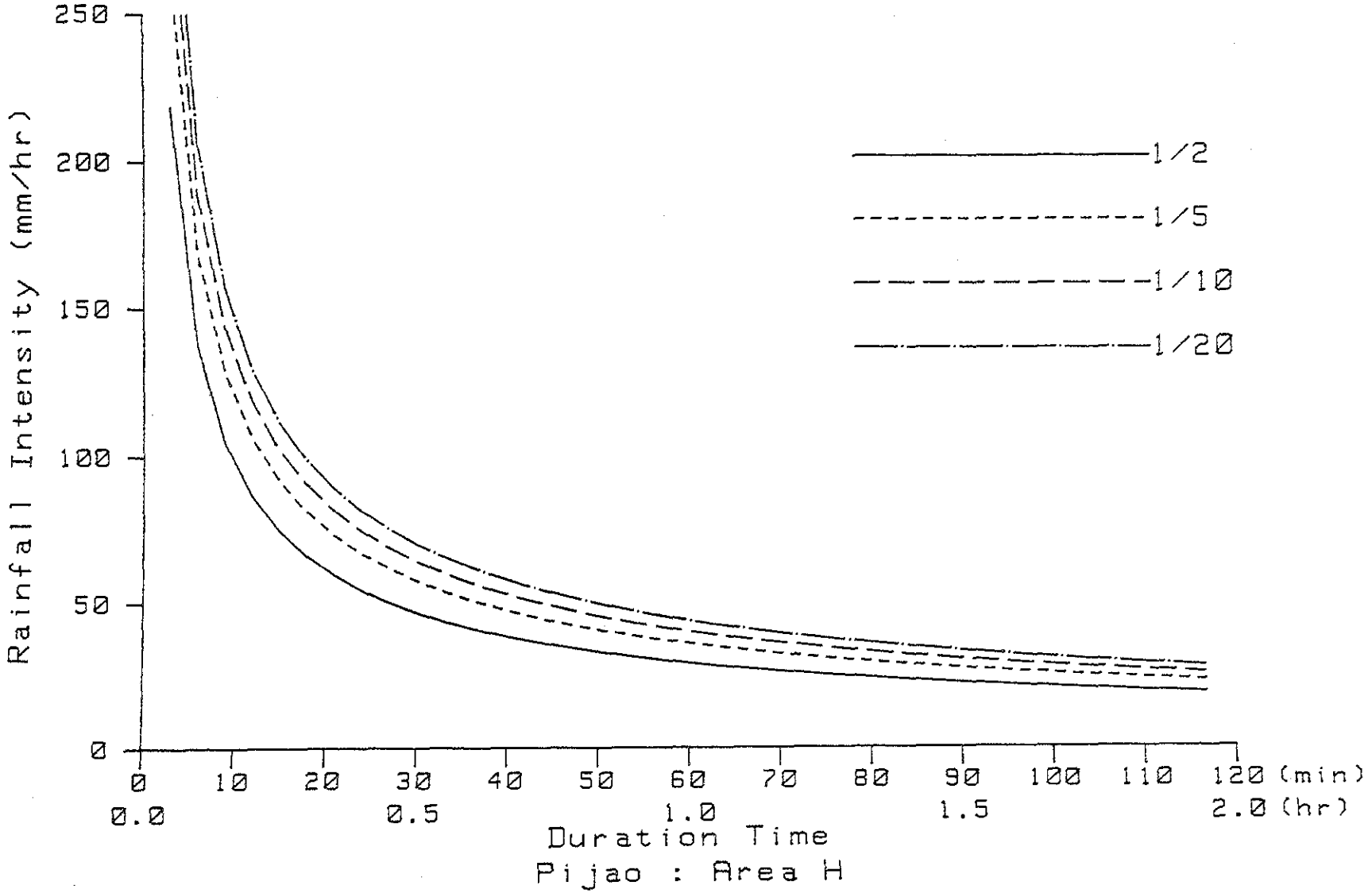


FIG.J.3.1 Frequency Intensity Duration Curve (5)

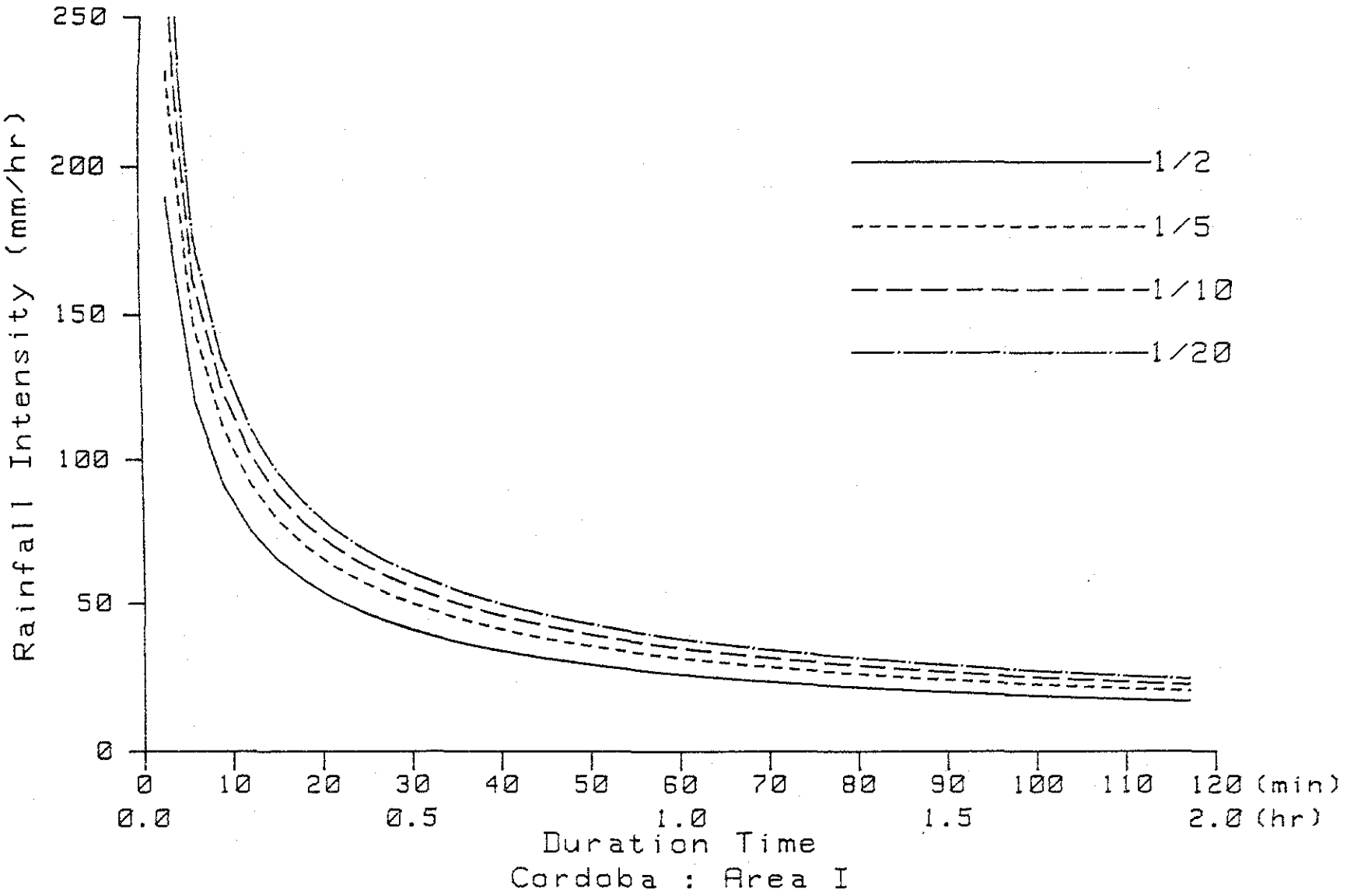


FIG.J.3.1 Frequency Intensity Duration Curve (6)

Table J.3.1 Peak Flood Discharge in Project Area

Rainfall Station & Scale of Basin		Return Period 1/2 i (mm/hr)	Q (m3/s)	Return Period 1/5 i (mm/hr)	Q (m3/s)	Return Period 1/10 i (mm/hr)	Q (m3/s)	Return Period 1/20 i (mm/hr)	Q (m3/s)
(24-hr Max.Rainfall mm)		(81.3)		(92.8)		(99.5)		(105.4)	
Paraguaycito	Small	44.7	.5	51.1	.6	54.8	.6	58.0	.6
Area A,B	Middle	34.1	.6	39.0	.6	41.8	.7	44.3	.7
	Large	28.2	.6	32.2	.7	34.5	.8	36.5	.8
(24-hr Max.Rainfall mm)		(86.8)		(105.3)		(116.4)		(126.4)	
Tebaida	Small	47.8	.5	57.9	.6	64.1	.7	69.6	.8
Area C,D,E	Middle	36.5	.6	44.2	.7	48.9	.8	53.1	.9
	Large	30.1	.7	36.5	.8	40.4	.9	43.8	1.0
(24-hr Max.Rainfall mm)		(99.0)		(126.2)		(143.9)		(159.9)	
Villadora	Small	54.5	.6	69.5	.8	79.2	.9	88.0	1.0
Area F	Middle	41.6	.7	53.0	.9	60.4	1.0	67.2	1.1
	Large	34.3	.8	43.8	1.0	49.9	1.1	55.4	1.2
(24-hr Max.Rainfall mm)		(56.3)		(76.4)		(89.6)		(102.1)	
Gibraltal	Small	31.0	.3	42.0	.5	49.3	.5	56.2	.6
Area G	Middle	23.6	.4	32.1	.5	37.6	.6	42.9	.7
	Large	19.5	.4	26.5	.6	31.1	.7	35.4	.8
(24-hr Max.Rainfall mm)		(85.6)		(105.3)		(117.3)		(128.1)	
Pijao	Small	47.1	.5	57.9	.6	64.6	.7	70.5	.8
Area H	Middle	35.9	.6	44.2	.7	49.3	.8	53.8	.9
	Large	29.7	.7	36.5	.8	40.7	.9	44.4	1.0
(24-hr Max.Rainfall mm)		(74.3)		(90.6)		(100.6)		(109.5)	
Cordoba	Small	40.9	.5	49.9	.6	55.4	.6	60.3	.7
Area I	Middle	31.2	.5	38.0	.6	42.2	.7	46.0	.8
	Large	25.8	.6	31.4	.7	34.9	.8	38.0	.8

Note : i=Rainfall Intensity (mm/hr) Q=Peak Flood Discharge (m3/s)

J.4 Design of High Priority Project (I)

J.4.1 Basic Concept

Considering the existing conditions of agricultural management, the time of training will be required for the management of intensive agriculture using irrigation system. Therefore, it is better to introduce irrigation system for small area at initial stage, and to expand irrigation area after getting the know how of using irrigation as step by step.

Considering the time schedule of the Master Plan, the area for vegetable and approximately 10% of coffee may be selected for the irrigation area. Depending on the cropping patterns in the project area, following irrigation area will be suggested at the initial stage.

Area A :	Irrigation area	Vegetable	140 ha
Area C :	Irrigation area	Vegetable	200 ha
		Coffee	80 ha
Area E :	Irrigation area	Coffee	200 ha
Area F :	Irrigation area	Vegetable	240 ha
Total			860 ha

J.4.2 Design of Irrigation System

(1) Water Requirements

The irrigation water requirements are shown in Table J.2.3 - J.2.6 and design water requirements are summarized below:

Area A : 0.11 m3/s (Peak Gross Water Requirement)
Area C : 0.18 m3/s (Peak Gross Water Requirement)
Area E : 0.14 m3/s (Peak Gross Water Requirement)
Area F : 0.12 m3/s (Peak Gross Water Requirement)

(2) Water Source Plan

In the case of large amount of the peak water requirements is required, the head works or pumping station will be required. However, the water requirements are so small in this case that it would not be necessary to construct big facilities of water source. Therefore small streams in project areas will be available for the water sources.

27 days of the continuous drought days will be expected for 5 years return period. Therefore, water volume of 27 days for the peak gross water requirement should be prepared for the intensive agricultural management. Considering to topographic conditions of project areas, the several reservoirs will be available at the point on the small stream with adequate watershed when the river discharge less than water requirement. The total required water

volume of reservoirs was estimated with consideration to the water requirement and the droughty river discharge pattern for 5 year return period.

The droughty river discharge pattern is estimated as 7.14 l/s/km2 for first 20 days and 5.08 l/s/km2 for next 7 days. The required volume of reservoirs is calculated as follows;

	Area A	Area C	Area E	Area F
Water requirement	0.11 m3/s	0.18 m3/s	0.14 m3/s	0.12 m3/s
Proposed watershed	35 km2	25 km2	25 km2	30 km2
Droughty discharge (First 20 days)	0.25 m3/s	0.18 m3/s	0.18 m3/s	0.21 m3/s
Required flow from reservoirs	--	--	--	--
Droughty discharge (Next 7 days)	0.18 m3/s	0.13 m3/s	0.13 m3/s	0.15 m3/s
Required flow from reservoirs	--	0.05 m3/s	0.01 m3/s	--
Total Water Volume of Reservoirs	--	30,000 m3	6,000 m3	--

Following two types of reservoirs can be considered

Type A Concrete weir type	Type B Farm pond type
Hight of weir : 4 m Length of weir : 17 m Volume of water reservoir : 2,000 m3 Construction cost : 8.0 million Col$	Depth of pond : 2.5 m Area : 1500 m2 Volume of water reservoir : 3,000 m3 Costruction cost : 3.4 million Col$

The water source plan for the high priority project is summarized below:

	Area A	Area C	Area E	Area F
Numbers of Reservoirs	--	10(type B)	3(type A)	--
Total Cost millon Col$	--	34	24	--

(2) Main Irrigation System

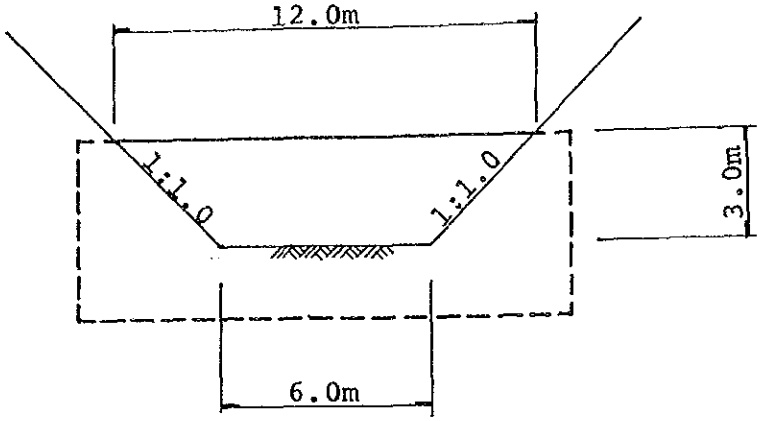
In the case of small stream being applied as water source, main irrigation system is not necessary for irrigation system. Because the small stream can be used as main irrigation canal. Therefore the main irrigation system is not designed in this case.

(3) Field Irrigation System

According to the preliminary layout given in Section J.2.3, the spray irrigation system is applied for vegetables and coffee, and the field irrigation systems are summarized as follows;

	Area A	Area C	Area E	Area F
No.of Set	5	10	7	8
Cost million Col$	44	88	62	71

FRONT VIEW OF WEIR



SECTION OF WEIR

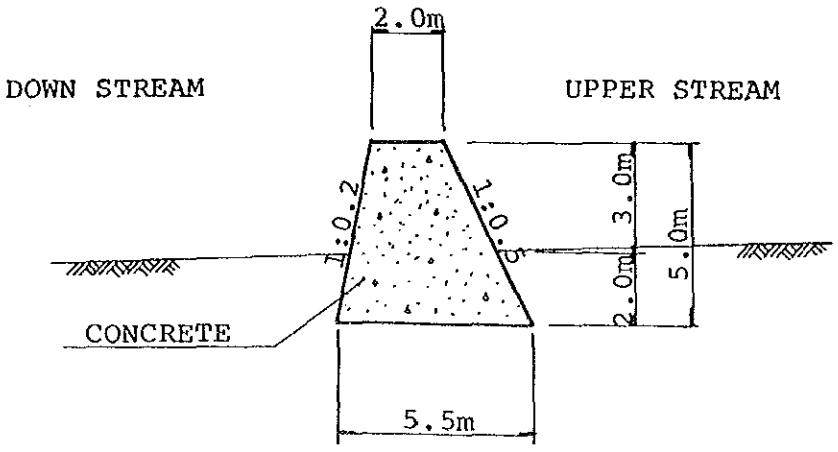
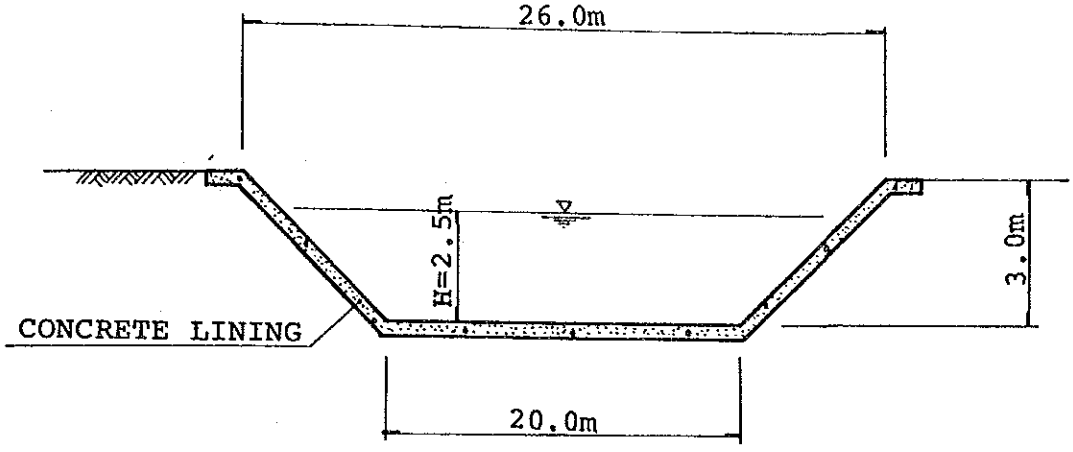


FIG.J 4.1. PRELIMINARY DESIGN OF WATER RESERVOIR

SECTION OF FARM POND



PLAN OF FARM POND

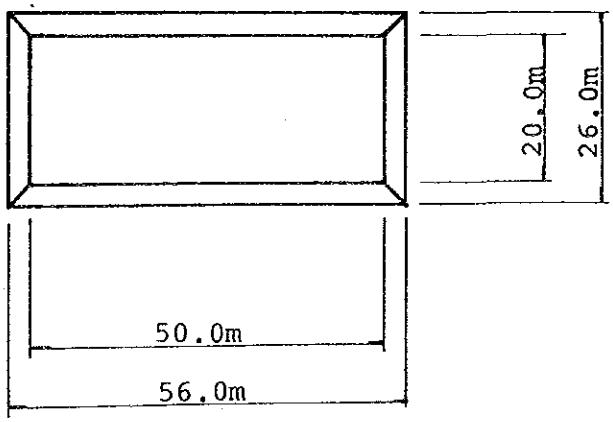


FIG.J.4.2 PRELIMINARY DESIGN OF FARM POND

ANNEX K : LAND CONSERVATION AND DISASTER PREVENTION

ANNEX K LAND CONSERVATION AND DISASTER PREVENTION

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

K.1 INTRODUCTION

This report is prepared in accordance with the Scope of Works dated July 28, 1986 for the Master Plan Study on the Quindio Basin Integrated Agricultural Development Project.

This report presents the results of a study of land conservation and disaster prevention, which is one of important sectors in the integrated agricultural development of the Quindio.

The study consists of the field works and the home office works. The field works were carried out in cooperation with C.R.Q. staff in the study area which is the whole Quindio province, covering approximately 200,000 ha.

The home office works contain the findings of the present conditions in and around the study area, development concept, project formulation, project evaluation and implementation. In addition to these studies, recommendations are made, based on the results of the study.

K.2 APPROACH AND METHODOLOGY OF THE STUDY

K.2.1 APPROACH FOR MASTER PLAN STUDY

The conservation of farmlands, a natural resource of a country, is one of the important factors for agricultural development.

In the future, to keep stable agricultural production, the fertile soil which makes high producing capacity of crops possible always needs to be ensured on the land by maintaining the potential of existing farming land. Once the potential of farming land has become low due to soil loss, it can never be regained completely and one needs to make every effort possible to restore and improve the farming land. If attention is not paid to farming and conservation, disaster such as flood damage might frequently occur downstream of the watershed, due to sedimentation caused by soil loss.

In integrated agricultural development, the scope of land conservation and disaster prevention is very wide and encompasses much more than more physical works for erosion control. It comprises in fact a comprehensive approach to soil, water and farm management, in which all physical land conservation practices contribute towards the overall targets of

improving and maintaining soil fertility, soil-water-plant relationships, and through these the attainment of sustained high crop yields.

However, there are some factors working against the land conservation and disaster prevention. For example, investments which are required to repair the damage caused by the misuse of natural resources over many generations is often beyond the capacity of the local economy. But one carried out in the upper parts of watershed will benefit the lower parts, and the whole river basin with local society, towns and industries as well.

With this as background, the master plan for the land conservation and disaster prevention is studied, concentrating on natural conservation of the watershed. Then the project is formulated, considering all possible items relating to conservation of farm land which should raise agricultural productivity along the lines of integrated agricultural development.

K.2.2 METHODOLOGY OF THE STUDY

In the integrated agricultural development for the study area, the following methodology has been taken for the master plan study on land conservation and disaster prevention:

- Grasp of existing condition and assessment

  In the survey and assessment for land conservation and disaster prevention, all physical and human resources have to be considered.

  To identify special features of erosion and/or disaster problems in the entire study area, a field survey was carried out, concentrating on comments made by farmers. Almost no damage caused by these problems in the past have been recorded.

  Then, based on the existing land use map made from diagnosis of the study area by means of remote sensing technique, the land use capability of the whole area including mountain area was evaluated, concentrating on the existing condition of land conservation and disaster prevention, and also land classification map which probably is the most important in the integrated agricultural development was made, from the viewpoint of countermeasures for land conservation and disaster prevention.

- Abstract of present state and establishment of development strategy

  From the result of the field survey, the present states that might restrict integrated agricultural development in the future were summarized for not only the natural condition of land but also serious problems regarding agricultural management, such as unplanned development of watershed, misuse of land utilization and farming management and so on.

  The development strategy for land conservation and disaster prevention was set up, taking into account these matters. This strategy composes a part of basic concept for integrated agricultural development.

- Formulation of the project

  Based on the land classification map and development strategy, the projects were selected along the criteria for the integrated agricultural development in the Quindio, and possible priority projects for development were identified. Then the project costs were estimated, and project evaluation and implementation were studied.