REPUBLIC OF GUATEMALA

FLOOD CONTROL PROJECT

(ACHIGUATE AND PANTALEON RIVERS)

SUPPORTING REPORT

1.SOCIO-ECONOMY

2. HYDROLOGY

3. SEDIMENT CONTROL PLAN

4. RIVER IMPROVEMENT PLAN

5. CONSTRUCTION PLAN AND COST ESTIMATES

6. PROJECT EVALUATION

7. RIVER ADMINISTRATION SYSTEM

JANUARY 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

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I. SOCIO-ECONOMY

SOCIO-ECONOMY

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1. GENERAL

1.1 National Economic Background

The Republic of Guatemala is located in the tropic zone and extends from 13°14' to 18°30' north latitude and from 87°24' to 92°14' west longitude. The country, which is situated in the northern part of Central America, is bounded by Mexico to the north and west, by El Salvador to the southeast and by Honduras to the northeast. It faces the Caribbean Sea to the northeast and the Pacific Ocean to the southwest. The total area of the country is 108,889 km^2.

In view of geographic and economic situations, the central american countries (Guatemala, El Salvador, Honduras, Nicaragua and Costa Rica) established the Central American Common Market (CACM) in 1951 and have mutually cooperated in aspects of trade, industry and transportation. Especially, the Central American Road and the Pan American Road have greatly contributed to the development of industry and communications in the respective countries.

The countries have something in common on the social and economic aspects. That is, all of them became independent in 1821 and their mainstay is agriculture which has the staple products of maize, sugar cane, cotton, coffee, banana and beef in the stock farming. Export places main reliance on these agricultural products, excepting maize for self-supply. These goods are exported to the United States and other advanced countries. The outline of the socio-economy of the five countries is summarized in Table 1-1.

Since 1971, the Government of Guatemala has implemented three (3) economic development plans, as mentioned below:

(1) Five-Year Plan from 1971 to 1975;

(2) Five-Year Plan from 1975 to 1979; and

(3) Four-Year Plan from 1979 to 1982.

Based on these development plans and by translating the plans into action, Guatemala had an average annual economic growth of 5.2 per cent in the first and the second five-year plans for the period from 1971 to 1979. However, since 1980 the economic growth has shown a rather downward trend.

As for a new long-term economic development plan, the Government has not made any declaration of its political views and since 1982, the Government's policy has been carried out on the basis of the short-term development plan with the following major objectives:

(1) to correct the imbalance of trade;

(2) to establish sound national finance;

(3) to promote development of the agricultural, manufacturing-industrial and construction sectors;

(4) to build housing for the working class;

(5) to provide greater employment opportunities for the people;

(6) to correct the social and economic imbalance among people; and

(7) to strive for the activation of the Central American Common Market.

In principle, this short-term plan is almost the same as the preceding four-year plan (1979-1982).

The country can be roughly classified into three regions by its geographical feature; the middle highlands region, the south coastal region and the north lowlands region.

The middle highlands region consists of the Sierra Madre mountains and the basin among the mountains which run from east to west in the southern part of the country. This region has a mild climate owing to its high altitude in the tropic zone. The greater number of population of Guatemala has concentrated on the basin among the mountains because of the suitable climate for living conditions. Guatemala City, the capital, lies in this region and the slope south of the mountains is a central area for the cultivation of coffee.

The south coastal region, which lies parallel to the coastline of the Pacific Ocean, is generally flat and has fertile soil. Owing to such good natural conditions, agricultural crops are widely cultivated and also, cattle-raising is practiced on a large scale. This region, therefore, is a valuable land for Guatemala which is an agricultural country.

Lots of rivers that originate from the Sierra Madre mountains flow into the Pacific Ocean passing through this plain region. River water has been used mainly for the peiple's daily necessities and a part of it, for agriculture. On the other hand, the river basins have been frequently damaged by floods from these rivers in the rainy season. To minimize flood damage is a serious problem that had confronted the region every now and then.

The north lowlands region has tropical rain forest and is the most undeveloped region among the three regions. The immigration of farmers from other regions has been practiced since the 1950's based on the agricultural development program of the government. However, it is said that this agricultural development does not warrant any optimism because of strongly acidic soil and thin topsoil. On the other hand, petroleum and other mineral products have been developed for several years in the area near the central mountains and owing to its development, roads in this region have been fairly maintained.

Population census in Guatemala were taken four (4) times in the years 1950, 1964, 1973 and 1981 since 1950. The 1981 census placed the population of the Republic of Guatemala at 6,054,000. The average annual growth rate of population was estimated at 1.89% for the period from 1973 to 1981. The population density was 56 persons/km^2 in 1981.

The population of 10 years and over of age and the working population correspond to about 70% and 30% of the total population, respectively.

In 1981, the population of Guatemala was composed of Indigena (Indian) of 56%, Mestizo (mixed Hispanic-Indian origin) of 36%, and Blanco (Whites) of 8%. More than half of the population are within the agricultural sector. Especially, most of the Indigena are agriculture-living people and they form a society of their own by respective tribes isolated from the civilized community.

The roads are classified into four (4) categories; Pan American Road, Central American Road, National Road and Departamental Road. In 1980, the total length of the above-mentioned roads was 14,591 km, comprising the paved road of 2,887 km and the earth road of 11,704 km.

Railway of Guatemala was established by a private company in the 1890's. At present, it is operated by FEGUA, Ministry of Communications, Transportation and Public Works.

The railway in Guatemala consists of a main line and three branch lines. The main line extends from Puerto Barrios to Tecun Uman near the Mexico boundary. The total length of railways in Guatemala is 778.9 km, including 176.1 km of branch lines.

Guatemala has four (4) ports; Santo Tomas and Puerto Barrios on the Atlantic Ocean side, and San Jose and Champerico on the Pacific Ocean side. In 1981, cargoes handled amounted to some 2,120,000 tons.

Agricultural land area is 40,000 km^2, corresponding to about 37% of the total area of the country. It consists of the cultivated area of 12,000 km^2, the cultivated area and pasture of 15,000 km^2, and the pasture of 13,000 km^2.

Agriculture is the mainstay of the country and majority of the Guatemalan people are engaged in this sector. The major agricultural products are coffee, cotton, sugarcane, maize, beans, banana and beef in the stock-farming.

In 1980, the main export goods of Guatemala were coffee, cotton, sugar, beef and banana. Export of these main goods amounted to approximately 790 million Quetzales corresponding to 53% of the total amount of export.

The national budget, which has been increased in proportion to the Gross Domestic Product (GDP), amounted to Q1,480 million in

1982. However, in 1983 the budget was Q1,310 million, decreasing by some 10% of that of the previous year.

In 1980, the GDP of Guatemala was about 7,809 million Quetzales at current prices, and the per capita GDP reached 1,000 Quetzales.

Among the industrial sectors, the sectors of commercial services and agriculture occupy large percentages in the GDP, i.e., in 1980, they were 27.0% and 24.9%, respectively. However, the share of the agricultural sector shows the decreasing tendency.

Although such a decreasing trend seems to be common to most countries in the world, in Guatemala, growth in the agricultural sector has considerable effect on the growth in GDP; hence, it is necessary for the government to exert more effort to increase agricultural production and promote the development of the national economy.

1.2 Regional Economic Background

The country can be roughly classified into three regions by its geographical feature; the middle highlands region, the south coastal region and the north lowlands region. The Study Area belongs to the south coastal region consisting of five (5) departments; Escuintla, Santa Rosa, Suchitepequez, Retalhuleu and Jutiap. The five departments have 73 municipalities in total.

The region has the area of 15,000 km^2 and the population of 1.2 million. The population density of 80 persons per km^2 is somewhat higher than that (56 persons per km^2) of the whole country.

In the south coastal region, cultivated land and pasture cover more than 80% of the whole area, and except agriculture, there are no marked industries, i.e., agriculture is the basic industry of this region. However, in recent years the economic growth in the agricultural sector, that is, the share of the agricultural sector in the GDP has decreased. Therefore, further promotion of agriculture is required for the development of this region.

The region is convenient for traffic compared with the other two regions. The Central American Road, CA-2, runs from east to west through this region and CA-9 runs from north to south through the Department of Escuintla where they intersect. Furthermore, the national railway runs in parallel to CA-2 through the region and two branch lines connect between Escuintla and San Jose, and between Las Cruces and Champerico, respectively.

The region has two (2) ports; San Jose and Champerico, and the Port of San Jose lies in the Study Area. Quantities of cargo handled are about 100,000 tons a year at the Port of San Jose and about 110,000 tons a year at the Port of Champerico. The

major goods handled at both ports are cotton and coffee for the export, and industrial raw materials and fertilizer for the import.

Domestic water in the region was in 1981 supplied to 92,000 households corresponding to 41% of the whole households. This percentage is low compared with that of the whole country. It is chiefly due to the abundant supply of well and river water.

In the same year, electric power was supplied to 73,000 households, or 32% of the total number of households. Four (4) departments, except the Department of Escuintla, were supplied with electric power lower than the average of the whole country.

Although the region has such a favorable land, the inhabitants have frequently suffered devastation from floods in the rainy season every year. Almost all of the rivers in this region brought great damage from past floods. Among them, rivers such as the Coyolate, Pataya, Pantaleon, Achiguate, Guacalate, Naranja and Maria Linda brought damage to assets in the Department of Escuintla.

2. ADMINISTRATION

The Republic of Guatemala consists of some twenty departments. Each department has several municipalities as administrative substructures. Municipalities number about three hundred in the whole country.

The Department of Guatemala consists of seventeen (17) municipalities including Guatemala City, the capital, and it covers 2,126 km^2.

The Study Area is almost located in the Department of Escuintla, except for some portions in the mountain regions of the departments of Sacatepequez and Chimaltenango. The Department of Escuintla consists of thirteen (13) municipalities which cover 4,384 km^2. The Study Area extends over seven (7) municipalities; Escuintla, Santa Lucia Gotzumalguapa, La Democracia, Siquinala, Masagua, La Gomera and San Jose. Among them, the Municipality of Escuintla is the administrative center of the department.

3. POPULATION

3.1 Population Statistics, Population Density and Growth in Population

Population census in Guatemala were taken four (4) times in the years 1950, 1964, 1973 and 1981. Table 1-2 shows the population by department in the whole country. The 1981 census placed the population of the Republic of Guatemala at 6,054,000.

The average annual growth rates of population for the three periods of 1950 to 1964, 1964 to 1973 and 1973 to 1981 were estimated at 3.11%, 2.19% and 1.89%, respectively. As is evident from these figures, the growth in population of Guatemala has markedly declined in the 1970's and the growth rate of 1.89% is on the low level compared with those of other developing countries. In 1981, the population density was 56 persons/km^2 which is comparatively low.

The Department of Guatemala had the population of some 1,310,000 in 1981 including the population of 750,000 in Guatemala City. This population corresponds to 22% of that of the whole country. The average annual growth rates of population for the three periods of 1950 to 1964, 1964 to 1973 and 1973 to 1981 were estimated at 4.48%, 3.73% and 1.90%, respectively. These figures show that the concentration of population toward the urban area has been decreasing since the 1970's. The population density in the Department of Guatemala in 1981 was 617 persons/km^2 which is the highest among the 22 departments.

The Department of Escuintla had the population of some 335,000 in 1981, as shown in Table 1-2. For the period from 1950 to 1964, it had the average annual population growth rate of 5.74% which was the highest among the 22 departments. However, after that period the rate of population growth has remarkably declined and showed low rates such as 1.17% on the average per year for the period from 1964 to 1973 and 1.37% for the period from 1973 to 1981. The population density of the Department of Escuintla was 76 persons/km^2 in 1981.

In 1981, the seven (7) municipalities mentioned in Section 2 had the population of some 217,000 in total corresponding to two-thirds (2/3) of that of the Department of Escuintla. As shown in Table 1-3, this population consists of 141,000 in the five (5) municipalities containing a portion of the Achiguate river basin and 76,000 in the two (2) municipalities containing a portion of the Pantaleon river basin.

3.2 Households

Households in Guatemala were about 1,150,000 in number according to the 1981 census, as shown in Table 1-3, and the average size per household was estimated to be 5.3 persons.

In the same year, the Department of Escuintla and the above-mentioned seven (7) Municipalities had households of 65,000 and 43,000 in number, respectively, and the average sizes of 5.1 and 5.0 persons per household, respectively, i.e., the average size of family in the Study Area is a little low compared with that of the whole country.

3.3 Labor Force

The population of 10 years and over of age in 1981 was about 4,100,000 in the whole country, about 230,000 in the Department of Escuintla and about 150,000 in the Study Area, as shown in

Table 1-4. These figures correspond to 68% of the respective total population, and there is not so much difference between males and females in this percentage.

Working population in Guatemala was nearly 1,700,000, consisting of 1,450,000 males and 250,000 females. These working population corresponds to 28% of the total population, 48% of the male population and 8% of the female population, respectively. The working population in the Department of Escuintla was 96,000, comprising 88,000 males and 8,000 females. Ratio of the working population to the respective population was 29% for the total population, 51% for the males and 5% for the females. In the same year, the Study Area had the population of 64,000 in total, comprising 58,000 males and 6,000 females, and the ratio of the working population to the respective population was 30% for the total population, 52% for the males and 6% for the females.

Generally, the ratio to the working population to the total population was around 30% for the total population, nearly 30% for the male and less than 10% for the female.

4. INFRASTRUCTURES

4.1 Transportation

Road

Transportation in Guatemala depends mainly on the road traffic. The roads are classified into four (4) categories; Pan American Road, Central American Road, National road and Departmental Road. In 1980, the total length of the above-mentioned roads was 14,591 km, comprising the paved road of 2,887 km and the earth road of 11,704 km, i.e., the length of the paved road corresponds to some 20% of the total length (see Table 1-5).

The Pan American Road (hereinafter referred to as "CA-1"), which runs through Guatemala from the United States of America (USA) to South America, is a great artery of traffic in Guatemala. The Central American Road, which have 8 routes (CA-2 and CA-8 to CA-14) in Guatemala, is also an important artery of transportation.

Among national roads, CA-2 and CA-9 run through the Study Area with the former running from east to west in parallel with CA-1 extending from the boundary of El Salvador to the boundary of Mexico, and the latter, running from south to north and connecting between both the Pacific and Atlantic oceans. Besides the roads mentioned above, national road (feeder of CA-2) and several departmental roads support the transportation system in the Study Area.

The total length of roads in the Department of Escuintla was 1,321 km, consisting of the paved road of 399 km and the earth road of 922 km in 1980, as shown in Table 1-6. The length of paved roads corresponds to 30.2% of the total length of roads

in the department. This percentage of paved road is higher by 19.8% than that in the Department of Guatemala, and the roads in the Department of Escuintla are comparatively in better condition.

In 1978, the number of motor vehicles in use in Guatemala was some 134,000 in total, consisting of the passenger cars of 90,000 and the commercial vehicles of 44,000, as shown in Table 1-7. The average annual growth rate of the number of vehicles was estimated at 6.9% for the whole, 11.2% for the passenger car and 2.9% for the commercial vehicle.

Table 1-8 shows the average daily traffic volume of vehicles at several major stations on CA-1, CA-2 and CA-9. The traffic volume is the most at Sta. 900 and was approximately 8,000 vehicles per day in 1982. The average daily traffic volume at Sta. 200 located in the Project Area was some 4,300 vehicles in the same year.

The rate of average annual increase in the traffic volume on these main roads is in the range of from 1 to 8% during the decade from 1972 to 1982. The increase in traffic volume on major roads is comparatively low, and since 1977 it remained on the same level.

The average daily traffic volumes at major stations other than Sta. 200 in the Department of Escuintla are given in Table 1-9 During the period from 1978 to 1982, the traffic volume showed no marked fluctuation and as for the feeder roads of CA-2, it showed rather the decreasing tendency.

Railway

The railway in Guatemala consists of a main line and three branch lines. The main line extends from Puerto Barrios to Tecun Uman near the Mexico boundary. The total length of railways is 778.9 km including the three branch lines of 176.1 km, as shown in Table 1-10. The branch lines are composed of three lines; the Zacapa-Anguiatu line with length of 112.6 km, the Santa Maria-San Jose line with length of 33.2 km and the Las Cruces-Champerico line with length of 30.3 km.

In the Study Area, the railway runs the section of nearly 74 km, comprising 49 km for the section of Escuintla-San Jose and 25 km for the section of Santa Maria-Santa Lucia. Trains run one round trip everyday between the above-mentioned sections.

According to the report of FEGUA, the railway transported cargoes of 950,000 tons and 600,000 passengers per annum on the average for the period from 1978 to 1982, as shown in Table 1-11. Among them, cargoes of 200,000 tons and 150,000 passengers per annum were transported through the Study Area, i.e., 560 tons of cargo and 400 passengers per day, respectively.

The rail in use is single track with a narrow gauge and the transportation volume by railway is not so much as mentioned earlier. However, it still plays an important role in the transportation system of Guatemala.

Harbor

Trade in Guatemala has been mainly carried out by marine transportation, except the land and air transportations for some passengers and cargoes.

Guatemala has four (4) ports; Santo Tomas and Puerto Barrios on the Atlantic Ocean side, and San Jose and Champerico on the Pacific Ocean side. In 1981, cargoes handled amounted to some 2,120,000 tons comprising 1,240,000 tons at Santo Tomas, 660,000 tons at Puerto Barrios, 100,000 tons at San Jose and 120,000 tons at Champerico, as shown in Table 1-12. During the period from 1977 to 1981, the quantity of cargo handled grew at the average rate of 8.7% per year.

The Port of San Jose, which is located in the Study Area, has a superannuated pier jutting out into the sea. Ships of about 200 per year arrive in this port from Japan, Colombia, Liberia and other countries. Among them, Japanese ships abound in number with tonnage of 5,000 on the average. Main goods handled are cotton and coffee for the export, and metal goods, industrial raw materials and fertilizer for the import.

In 1980, the amount of trade in Guatemala was some 3,032 million Quetzales, comprizing 1,473 million Quetzales for the export and 1,559 million Quetzales for the import (see Table 1-13). During the period from 1975 to 1980, trade in Guatemala had a little excess of import over export every year except in 1977.

The average annual growth rate of trade is estimated at 17.5%, consisting of 18.8% for the export and 16.3% for the import, for the same period.

4.2 Electric Power Supply

The electrical business in Guatemala is at present operated by two corporations; Instituto Nacional de Electrificacion (INDE) and Empresa Electrico de Guatemala (EEGSA), on the ratio of 7:3.

Guatemala has 31 power plants consisting of 12 hydraulic plants and 19 thermal plants. Among them, 4 hydraulic plants and 4 thermal plants lie in the Department of Escuintla. The power produced in the Department of Escuintla, aside from local consumption, is mainly sent to the Department of Guatemala.

In 1981, the capacity, production and consumption of electric power were 446.2 kW, 1,437.6 GWH, and 1,210.4 GWH, respectively, as shown in Table 1-14. The hydroelectric and thermoelectric powers were in the ratio of 42:58 for the capacity and 24:76 for the production. The consumptions of electric

power were 319.8 GWH for residents (or 26% of the total consumption), 240.3 GWH for commerce (or 20%), and 481.7 GWH for industry (or 40%).

During the period from 1976 to 1981, the average annual growth rates of the capacity were estimated at 11% for the whole, 15% for the hydrauric power and 9% for the thermal power. On the other hand, the growth rate of production of hydraulic power is lower than that of thermal power and it was estimated at 2% and 9% on the average per annum, respectively. The average annual growth rate of the total production was estimated at 7%. As for the consumption, the annual growth rate was estimated at 6% on the average. Among the consumption sectors, commercial use showed the highest growth of 14% per annum on the average.

In 1981, electric power was supplied to 430,000 households, corresponding to 37% of the whole households in the country, as shown in Table 1-3. Rate of this supply is not too high, therefore, further development of electric power is required for this country. However, in Guatemala City electric power was supplied to 140,000 households in the same year. This corresponds to 92% of the whole households.

In the Department of Escuintla and the seven (7) municipalities which contain the Study Area, electric power was supplied to 27,500 households (or 42% of the whole) and 20,000 households (or 47%) in the same year, respectively.

4.3 Water Supply

Water supply systems in Guatemala are operated by the respective municipal governments under the control of INFOM and the other authorities concerned in the central government. In 1981, the system supplied domestic water to 600,000 households, corresponding to 50% of the whole, i.e., waterworks remain at a low level (see Table 1-3). However, in Guatemala City the diffusion of water supply for households was more than 90% as of 1981.

In the Department of Escuintla and the seven (7) municipalities, 29,000 households (or 44% of the whole) and 21,000 households (or 49%) were supplied with domestic water by the above-mentioned system in the same year. Among the seven (7) municipalities, in the Municipality of Escuintla, the system supplied households of around 80% of the whole with domestic water.

Other households who are not supplied with water by the system use water from wells, springs and rivers. The groundwater taken out from wells and springs has been used for cooking and drinking. The water of rivers is not used so much at present, but is used for a part of stock-farming, washing and laundry.

In the Study Area, although the water of rivers was at one time used for irrigation, at present it is hardly used due to the damage of the irrigation facilities such as intake and canals. Such a damage seems to be mainly caused by frequent floods.

4.4 Telecommunications

In Guatemala, telecommunications, such as telephone, radio, television and communications satellite, are operated by GUATEL.

According to the information from GUATEL, in 1983 telephone subscribers in Guatemala were about 108,000 in number, corresponding to 70% of the capacity (158,000) of telephone facilities. This number is in the ratio of one (1) set to 60 persons, and around 85% of the subscribers are in Guatemala City.

In the Department of Escuintla, telephone subscribers number about 1,050 in the same year. This is in the ratio of one (1) set to 320 persons and corresponds to 40% of the capacity (2,600) of telephone facilities in the Department. Nearly 70% of the subscribers are in the Municipality of Escuintla.

5. AGRICULTURE AND OTHER INDUSTRIES

5.1 Agriculture

Agriculture census in Guatemala were taken in 1950, 1964 and 1979. According to the 1979 census, Guatemala had farms of about 5.9 million manzanas1/ (3.9 million ha) in total, divided into farms of about 530,000 in number, as shown in Table 1-15. The average area of one farm was nearly 11 manzanas.

These farms are divided into five (5) categories by operation scale; micro-farm (1 manzana and below), sub-familiar farm (over 1 to 10 manzanas), familiar farm (over 10 to 64 manzanas), middle multi-familiar farm (over 64 to 1,280 manzanas), and large multi-familiar farm (over 1,280 manzanas).

Farms of over 10 to 64 manzanas are 10% in number and occupies 19% of the total area of farms, and farms of over 64 manzanas (45 ha) in area are less than 3% in number, but their total area amounts to over 60% of the whole farm area. On the other hand, farms of 10 manzanas and below in area are more than 85% in number, but their total area is only about 15% of the whole farm area. Such an intensive structure of farmland is characteristic of the Guatemalan agriculture.

The Department of Escuintla had farms of some 660,000 manzanas in 1979. This area increased by about 30,000 manzanas (or 5%) over that in 1964. The number of farms with over 64 manzanas in area is about 4.5% and their total area corresponds to 85% of the whole area of farmland. Whereas, farms of 10 manzanas and below are nearly 80% in number and their total area is only about 5% of the whole area of farmland. These figures show that intensive farming is highly developed in the Department of Escuintla.

Note: /1: 1 manzana = 0.7 ha

Table 1-16 shows the major agricultural productions from 1974/75 to 1979/80. In 1979/80, the productions of coffee, cotton, sugar and beef, which are the important goods for export, were 156,000 tons, 148,000 tons, 432,000 tons and 79,000 tons, respectively. There is no marked growth in production of these goods including maize and wheat, during the period from 1974/75 to 1979/80.

The Department of Escuintla is one of the most developed areas for agriculture in the country. Especially, the productions of sugarcane, cotton and cattle are ranked first in the whole country, i.e., in 1979/80 they amounted to 73%, 44% and 25% of the production in the whole country, respectively. Table 1-17 shows productions and harvested areas of major agricultural products in the Department of Escuintla. These products occupy a great portion of the exportable goods of this country and contribute to its foreign currency earnings.

5.2 Other Industries

There are no manufacturing industries to be specially mentioned, except refining factories for sugar, petroleum and cotton. Articles of folkcraft such as textiles and carving are slightly made in the domestic factories for tourists.

In the Department of Escuintla, four (4) sugar refineries process the sugarcane harvested and the manufactured goods are exported through the Port of San Jose.

6. LAND USE AND ASSETS

6.1 Land Use

Land in Guatemala is broadly classified into three (3) categories; agricultural land, forestry and others. Agricultural land area is 40,000 km^2 corresponding to about 37% of the total area of the country. It consists of the cultivated area of 12,000 km^2, the cultivated area and pasture of 15,000 km^2, and the pasture of 13,000 km^2. The forest area is some 43,000 km^2 corresponding to 40% of the total area of the country. The other lands comprise waste, lake, swamp, sand and rock, and they have an area of some 26,000 km^2 in total (see Table 1-18).

The greater part of the Department of Escuintla is used as agricultural land, i.e., the area of cultivated land and pasture covers nearly 3,800 km^2, corresponding to 87% of the area of the department. Both areas of cultivated land and pasture are in the ratio of 5:3.

Land use in the Study Area has been studied using land use maps with the scale of 1:50,000 and aerophotographs with the scale of 1:20,000. The study has been carried out by the mesh of 1 km^2 on the maps. The result is summarized in Table 1-19.

The Study Area is 130,200 ha. Pasture has an area of nearly 53,000 ha, corresponding to 40% of the Study Area and occupies the largest share. Basides the pasture, the area of cultivated land is about 34,000 ha or a quarter (1/4) of the Study Area, and much sugarcane, cotton, fruits and other agricultural crops such as maize, coffee and beans are produced. The area of uncultivated land is estimated at about 8,700 ha or 7% of the Study Area, except areas of town, road, railway and 29,000 ha of forest land which is of little utility value. The Study Area contains six (6) towns; Escuintla, Santa Lucia, Democracia, Siquinala, Masagua and San Jose. The town area is estimated at about 1,600 ha in total.

6.2 Assets

According to the housing census in 1981, houses in the Department of Escuintla numbered some 70,000, as shown in Table 1-3. It consists of 20,000 in the urban area and 50,000 in the rural area. Based on these figures, the average number per km^2 is estimated at 16 houses for the whole area of the department, 383 houses for the urban area and 12 houses for the rural area.

In 1979, cattle in the Department counts some 500,000 heads which correspond to a quarter (1/4) of the total number in the country (see Ref. 4).

The seven (7) municipalities which contain the Study Area have about 46,000 houses in total in 1981, comprising 26,000 houses in the Achiguate river basin and 20,000 houses in the Pantaleon river basin.

The railway in the Study Area has a length of 74 km, comprising 55 km in the Achiguate river basin and 19 km in the Pantaleon river basin. Of the railway facilities, two bridges over the Achiguate and the Pantaleon rivers are the most important facilities, as well as two road bridges on CA-2 over the same rivers. The detail of assets in the Study Area is described in Sector 6, Project Evaluation.

7. GROSS DOMESTIC PRODUCT

Gross Domestic Product (hereinafter referred to as GDP) of Guatemala was about 7,809 million Quetzales in 1980 at current prices as shown in Table 1-20. This amount corresponds to 4.0 times that of 1971. During the period from 1971 to 1980, the average annual growth rate of GDP is estimated at 16.9%. The per capita GDP reached 1,000 Quetzales in 1980 and its average growth rate showed 13.2% per annum for the same period.

However, the real growth of GDP for the same period is estimated at 5.2% per annum on the average. This figure is very low compared with that at current prices. It seems that the difference between both growth rates is due mainly to the rise in prices, judging that the average rate of increase of consumer prices was about 11% for the period from 1971 to 1980 (see Ref. 4). The real growth rate of GDP was 2% in 1980.

Table 1-21 shows the share in GDP for each industrial sector for 1971-1980. Among the industrial sectors, the sectors of commercial services and agriculture occupy large percentages in the GDP, i.e., in 1980, they were 27.0% and 24.9%, respectively. However, the share of the agricultural sector shows the decreasing tendency.

The annual growth rate of GDP for each industrial sector is shown in Table 1-22. Among the sectors, the growth in the mining sector is remarkably high, i.e., it showed 79.6% in 1979 and 71.2% in 1980. This seems to be due mainly to the development of petroleum. In spite of such a large growth, the degree of contribution of this sector to GDP is very low at present because its amount is less than 1% of the total amount of GDP. In 1980, the growth in GDP of the agricultural sector was only rate of 1.6%.

8. ON-GOING PROJECT

Table 1-23 shows major public works projects presently in progress in the Study Area.

In San Jose, the construction of a new port with water depth of 12 m is presently in progress and is expected to be completed in 1986 at the cost of about 300 million Quetzales. After completion of the new port, it is expected that the quantity of cargo handled will rise to around 1,000,000 tons in the completion year and reach about 2,000,000 tons in the year 2000.

In connection with the construction of the new port, the construction of a new road has been planned by CAMINOS in the section of 50 km from Escuintla to San Jose in CA-9 to augment the carrying capacity and to maintain the security of transportation. The route is located in the east side of the present road. Construction works will be executed in 1984 and 1985 at the cost of 17 million Quetzales.

REFERENCE

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2. VIII CENSO DE POBLACION 1973, Direccion General de Estadistica

3. CENSOS NACIONALES 1981, IX DE POBLACION - IV DE HABITACION, CIFRAS PRELIMINARES, Mayo de 1982, Direccion General de Estadistica

4. ANUARIO ESTADISTICO, 1976, 1979, 1980, Direccion General de Estadistica

5. CENSOS NACIONALES, IV HABITACION - IX POBLACION 1981, CARACTERISTICAS GENERALES, Direccion General de Estadistica

6. PLAN DE INVERSIONES, 1983 - 1986, Secretaria General del Consejo Nacional

7. TRANSITO POR CARRETERAS DE GUATEMALA, 1978, 1979, 1980, 1981, 1982, Direccion General de Caminos, Ministerio de Comunicacions y Obras Publicas

8. ANUARIO DE COMERCIO EXTERIOR, 1980, Direccion General de Estadistica

9. ESTADISTICAS AGRICOLAS CONTINUAS, 1975, 1976, 1977, 1978, 1979, 1980, 1981, Direccion General de Estadistica

10. INFORME FINANCIERO Y ESTADISTICO, 1971 -1981, Instituto Nacional de Electrificacion (INDE)

11. INFORME FINANCIERO Y ESTADISTICO, 1971 - 1981, Instituto Nacional de Electrificacion (INDE)

12. MAPA DE COBERTURA Y USO ACTUAL DE LA TIERRA, 1981, SGCNPE, INAFOR and IGN

13. II CENSO AGROPECUARIO 1964, Direccion General de Estadistica

14. ENCUESTAS AGRICOLAS DE GRONOS BASICOS, 1978, Direccion General de Estadistica

15. III CENSO NACIONAL AGROPECUARIO 1979, VOLUMEN III, Direccion General de Estadistica

TABLES

Table 1-1 ECONOMIC INDICATOR OF FIVE COUNTRIES IN CENTRAL AMERICA IN 1980

ITEM		GUATEMALA	EL SALVADOR	HONDURAS	NICARAGUA	COST RICA
Independence Day		15 Sept.1821	15 Sept.1821	15 Sept.1821	15 Sept. 18	15 Sept.1821
Area (km^2)		108,889	21,156	112,082	148,000	50,900
Population (thousand)		6,054/1	4,520	3,560	2,700	2,220
Race (%)	Indio	56	6	6	5	1
	Mestizo(za)	36	84	91	69	-
	Blanco	8	10	1	17	97
	Negro	-	-	2	9	2
GDP (Million U.S.Dollar)		7,809	3,277	2,362	2,134	3,395
Per Capita GDP (U.S. Dollar)		1,060	681	560	720	1,527
Rate of Economic Growth (%)		2.0	2.9/2	2.5	-	5.8
Share of Labor Force by Industry (%)	Agriculture	57	46	65	55	46
	Mining & Industries	19	20	12	16	19
	Services	24	21	23	29	35
Export (Million U.S.Dollar)		1,473	964	849	450	1,410
		Coffee, Cotton Sugar, etc.	-	Banana, Coffee Wood, etc.	Coffee, Beef Gold, etc.	-
Import (Million U.S.Dollar)		1,559	956	1,045	887	890

Source: Refs. 1, 3, 4, 5, and 8
Note: /1 : Figure in 1981
/2 : Figure in 1979

Table 1-2 POPULATION BY DEPARTMENT IN 1950, 1964, 1973, and 1981

Region	Area (km^2)	Population Censuses (Persons) 1950	1964	1973	1981	Average Annual Growth Rate of Population (%) 1950-1964	1964-1973	1973-1981	Population Density per km^2 in 1981
Republic of Guatemala	108,889	2,790,868	4,287,997	5,211,929	6,054,227	3.11	2.19	1.89	56
Departments									
Guatemala	2,126	438,913	810,858	1,127,845	1,311,192	4.48	3.73	1.90	617
El Progreso	1,922	47,874	65,582	73,176	81,188	2.27	1.22	1.31	42
Sacatepequez	465	60,124	80,942	99,710	121,127	2.15	2.34	2.46	260
Chimaltenango	1,979	121,480	163,153	193,557	230,059	2.13	1.23	2.18	116
Escuintla	4,384	123,759	270,267	300,140	334,666	5.74	1.17	1.37	76
Santa Rosa	2,955	109,836	157,040	176,198	194,168	2.59	1.29	1.22	66
Solola	1,061	82,921	107,822	126,884	154,249	1.89	1.83	2.47	145
Totonicapan	1,061	99,354	141,772	166,622	204,419	2.57	1.81	2.59	193
Quezaltenango	1,951	184,213	270,916	311,613	366,949	2.79	1.57	2.06	188
Suchitepequez	2,510	124,403	186,634	212,017	237,554	2.94	1.43	1.43	95
Retalhuleu	1,856	66,861	117,562	133,993	150,923	4.11	1.46	1.50	81
San Marcos	3,791	232,591	336,959	388,100	472,326	2.68	1.58	2.49	125
Huhuetenango	7,400	200,101	288,088	368,807	431,343	2.64	2.78	1.98	58
Quiche	8,378	174,911	249,939	300,641	328,175	2.58	2.07	1.10	39
Baja Verapaz	3,124	66,313	96,485	106,909	115,602	2.71	1.15	0.98	37
Alta Verapaz	8,686	189,812	260,498	276,370	322,008	2.29	0.66	1.93	37
Peten	35,854	15,880	26,562	64,503	131,927	3.74	10.36	9.36	4
Izabel	9,038	55,032	116,685	170,864	194,618	5.52	4.33	1.64	22
Zacapa	2,690	69,536	96,554	106,726	115,712	2.37	1.12	1.02	43
Chiquimula	2,376	112,841	149,752	158,146	168,863	2.04	0.61	0.92	71
Jalapa	2,063	75,190	99,153	118,103	136,091	2.00	1.96	1.79	66
Jutiapa	3,219	138,925	196,774	231,005	251,068	2.44	1.91	1.05	78

Source : Refs. 2, 3 and 5

Table 1-3 STATISTICS OF POPULATION AND NUMBER OF HOUSES AND HOUSEHOLDS IN THE SOUTH COASTAL REGION AND THE STUDY AREA IN 1981

Region	Area (km^2)	Population Censuses		Number of Houses		Number of Households					
		Number	Density (per km^2)	Number	Density (per km^2)	Total	Average Size of Family	With Water Services		With Electric Services	
								Number	%	Number	%
Republic of Guatemala	108,889	6,054,227	56	1,259,598	12	1,151,872	5.3	601,964	52.3	427,984	37.2
Guatemala City	184	754,243	4,099	155,592	846	152,523	4.9	140,560	92.2	142.506	93.4
South Coastal Region Department											
Esquintla	4,384	334,666	76	70,368	16	65,751	5.1	28,911	44.0	27,450	41.7
Santa Rosa	2,955	164,168	66	39,200	13	36,490	5.3	17,554	48.1	10,613	29.1
Suchitepequez	2,510	237,554	95	50,107	20	46,431	5.1	20,189	43.5	14,445	31.1
Retalhuleu	1,856	150,923	81	30,942	17	28,413	5.3	8,190	28.8	8,309	29.2
Jutiapa	3,219	251,068	78	51,968	16	47,577	5.3	16,929	35.6	11.765	24.7
Total (or average)	14,924	1,168,379	78	242,585	16	224,662	5.2	91,963	40.9	72,582	32.3
Study Area Municipalities											
Escuintla /1	332	75,442	227	15,110	46	14,893	5.1	11,474	77.0	9,862	66.2
Santa Lucuia C /2	432	44,422	103	9,513	22	8,884	5.0	3,886	43.7	3,993	44.9
La Democracia /1	320	13,059	41	2,911	9	2,595	5.0	740	28.5	740	28.5
Siquinala /1	168	8,646	51	1,621	10	1,514	5.7	849	56.1	626	41.3
Masagua /1	448	20,369	45	4,416	10	4,032	5.1	905	22.4	883	21.9
La Gomera /2	640	31,227	49	7,046	11	6,342	4.9	1,442	22.7	2,048	32.3
San Jose /1	280	23,613	84	5,392	19	4,668	5.1	1,878	40.2	2,091	44.8
Total (or Average)	2,620	216,778	83	46,009	18	42,928	5.0	21,174	49.3	20,243	47.2

Source : Ref. 5

Note: /1: contains a portion of the Achiguate river basin.
/2: contains a portion of the Pantaleon river basin.

Table 1-4 POPULATION BY AGE AND SEX GROUPS AND WORKING POPULATION IN 1981

Item	Republic of Guatemala				Department of Escuintla				Study Area /4			
	Over 10 years		Total		Over 10 years		Total		Over 10 years		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Population												
Male	2,024,311	67.1 /1	3,015,826		118,514	68.2 /1	173,895		77,952	68.9 /1	113,080	
Female	2,070,842	68.2	3,038,401		108,227	67.3	160,771		70,710	68.2	103,696	
Total	4,095,153	67.6	6,054,227		226,791	67.8	334,566		148,662	68.6	216,778	
Working Population												
Male	1,449,058	71.6 /2	1,449,058	48.0 /3	88,034	74.3 /2	88,034	50.6	58,362	74.9 /2	58,362	51.6 /3
Female	247,406	11.9	247,406	8.1	8,250	7.6	8,250	5.1	5,887	8.3	5,887	5.7
Total	1,696,464	41.4	1,696,464	28.0	96,284	42.5	96,284	28.8	64,249	43.2	64,249	29.6

Source : Ref. 5

Note: /1 and /3: percentage to the total population by the sex group.
/2: percentage to the total population of the same age by the sex group.
/4: means seven (7) municipalities shown in Table 1-3.

Table 1-5 TOTAL LENGTH OF ROADS IN GUATEMALA, 1971 - 1980

Year	Total		Paved Road		Earth Road	
	Length(km)	%	Length(km)	%	Length(km)	%
1971	10,368	100	2,333	22.5	8,035	77.5
1972	10,368	100	2,552	24.6	7,816	75.4
1973	10,368	100	2,616	25.2	7,752	74.8
1974	10,368	100	2,619	25.3	7,749	74.7
1975	13,632	100	2,638	19.4	10,994	80.6
1976	13,909	100	2,731	19.6	11,178	80.4
1977	14,139	100	2,765	19.6	11,374	80.4
1978	14,289	100	2,801	19.6	11,488	80.4
1979	14,288	100	2,850	19.9	11,438	80.1
1980	14,591	100	2,887	19.8	11,704	80.2

Source: Ref. 4

Table 1-6 TOTAL LENGTH OF ROADS IN THE DEPARTMENTS OF GUATEMALA AND ESCUINTLA IN 1980

Department	Total		Paved Road		Earth Road	
	Length(km)	%	Length(km)	%	Length(km)	%
Guatemala	1,228	100	298	24.3	930	75.7
Escuintla	1,321	100	399	30.2	922	69.8

Source: Ref. 4

Table 1-7 NUMBER OF MOTOR VEHICLES IN USE, 1971-1978

Unit: Thousand

Kind of Vehicle	Number								Average Annual Increase Rate (%) 1971 - 1978
	1971	1972	1973	1974	1975	1976	1977	1978	
Passenger Cars	43.0	54.1	65.5	70.8	76.1	82.7	83.7	90.5	11.2
Commercial Vehicles	36.0	36.9	38.0	39.1	40.1	40.9	41.3	43.9	2.9
Total	84.0	91.0	103.5	109.9	116.2	123.6	125.0	134.4	6.9

Source : Ref. 1

Table 1-8 AVERAGE DAILY TRAFFIC VOLUME OF VEHICLES AT MAJOR STATIONS ON CA-1, CA-2 AND CA-9, 1972-1982

Staion	Road	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	Average Annual Increase Rate (%) 1972 - 1982
100	CA-1	2,242	3,770	4,263	4,637	4,503	5,768	6,964	6,938	6,663	6,637	6,506	7.21
0100	CA-1	2,016	2,381	2,374	2,556	2,565	2,894	3,426	3,351	2,994	2,484	2,257	1.14
200	CA-2	2,176	2,650	2,786	3,255	2,573	3,714	3,706	4,469	4,458	4,558	4,318	7.09
900	CA-9	5,072	5,475	5,722	6,012	2,566	7,858	8,817	8,230	9,107	8,668	7,872	4.49
0900	CA-9	2,066	3,595	3,842	4,156	3,689	4,885	4,953	5,189	5,413	5,480	4,514	8.13

Source : Ref. 7

Table 1-9 AVERAGE DAILY TRAFFIC VOLUME OF VEHICLES ON MAJOR ROADS IN THE DEPARTMENT OF ESCUINTLA, 1978-1982

Station	Road	Traffic Volume 1978	1979	1980	1981	1982	Average Annual Increase Rate (%) 1978-1982
200/1	CA-2	3,706	4,469	4,548	4,558	4,318	7.09
207	CA-2	5,577	5,141	4,739	5,340	5,187	-1.83
208	CA-2	3,311	4,137	3,641	3,338	3,653	2.49
Feeder of							
0205	CA-2	1,786	1,934	1,466	1,233	1,146	-11.51
0206	"	1,441	1,403	1,622	1,184	1,155	-5.69
0207	"	1,282	1,920	1,332	1,214	1,261	-0.41
0208	"	1,194	1,115	1,199	1,088	1,311	2.36
0209	"	1,553	1,435	1,187	953	1,068	-9.81
0904	CA-9	3,432	3,449	2,944	3,185	--	-2.46
0905	"	1,689	1,723	1,521	1,398	1,678	-0.16
0906	"	839	1,118	1,296	1,280	1,479	15.23
0907	"	691	1,037	1,031	1,322	1,298	17.07

Source : Ref. 7

Note : /1 : Station 200 is situated at 78 km from the Municipality of Guatemala.

Table 1-10 RAILWAY OF GUATEMALA IN 1980

Unit: Mile (km)

From	To	Distance	
Puerto Barrios	Tecum Uman	374.6	(602.8)
Zacapa	Anguiatu	70.0	(112.6)
Santa Maria	San Jose	20.6	(33.2)
Las Cruces	Champerico	18.8	(30.3)
Total		484.0	(778.9)

Source : Information from FEGUA

Table 1-11 TRANSPORT BY RAILWAY PER ANNUM (1978 - 1982)

Item	Region	Transportation Value					
		1978	1979	1980	1981	1982	Average
Cargo (tons)							
	Northern Part /1	616,815	672,492	914,868	800,000	732,892	747,413
	Southern Part /2	213,318	222,256	231,487	210,729	153,418	206,242
	Total	830,133	894,748	1,146,355	1,010,729	886,310	953,655
Passenger (persons)							
	Northern Part /1	437,736	458,109	701,929	300,993	380,729	455,899
	Southern Part /2	90,047	214,672	378,837	25,431	51,382	152,074
	Total	527,783	672,781	1,080,766	326,424	432,111	607,973

Source: Information from FEGUA

Note : /1 means the northern part from Guatemala City
/2 means the sourthern part from Guatemala City

Table 1-12 QUANTITIES OF CARGO HANDLED AT MAIN PORTS IN GUATEMALA, 1977-1981

Unit: tons

Port	Quantities of Cargos Handled (tons)					Average Annual Increase Rate (%)
	1977	1978	1979	1980	1981	1971 - 1978
Santo Tomas	662,733	1,088,466	1,114,119	1,116,604	1,238,237	16.9
Puerto Barrios	576,177	505,310	488,521	808,143	668,778	3.6
San Jose	149,814	83,382	109,447	103,201	96,956	-10.3
Champerico	127,622	119,038	119,276	119,160	119,043	-1.7
Total	1,516,346	1,796,196	1,831,363	2,147,108	2,119,014	8.7

Source : Ref. 8
Note : Excludes the Crude Oil

Table 1-13 EXPORT AND IMPORT, 1975-1980

	Amount (Thousand Quetzales)						Average Annual Growth Rate (%)
	1975	1976	1977	1978	1979	1980	1975 - 1980
A. Export	623,621	760,333	1,160,218	1,111,602	1,217,076	1,472,796	18.8
B. Import	732,368	838,430	1,052,508	1,260,661	1,449,395	1,559,085	16.3
C. Total	1,355,989	1,598,763	2,212,726	2,372,263	2,666,471	3,031,881	17.5
D. Diff.	-108,747	-78,097	107,710	-149,059	-232,319	-86,289	
E. Export of Main Goods							
Coffee	164,154	242,952	525,884	477,435	430,301	469,775	23.4
Cotton	74,061	84,970	152,057	139,116	182,763	166,543	17.6
Sugar	116,792	116,724	92,725	45,753	52,390	75,946	-8.2
Beef	16,967	14,447	27,890	30,772	41,192	26,460	9.3
Banana	16,905	21,545	21,039	21,889	17,918	48,214	23.3
Total of E.	388,879	480,639	819,595	714,965	724,564	786,938	15.1
F. E/A(%)	62.4	63.2	70.6	64.3	59.5	53.4	

Source : Ref. 8

Table 1-14 ELECTRIC POWER, 1976-1981

Item	Electric Power						Average Annual Growth Rate(%) 1976-1981
	1976	1977	1978	1979	1980	1981	
Capacity (kw)							
Hydraulic	95.8	96.7	96.7	98.8	99.2	189.2	14.6
Thermal	163.9	213.0	255.9	269.1	269.0	259.0	9.4
Total	259.7	309.7	352.6	367.9	368.2	446.2	11.4
Production (GWH)							
Hydraulic	304.4	226.4	276.8	268.3	277.6	342.6	2.4
Thermal	729.0	974.7	1,055.1	1,146.1	1,167.4	1,095.0	8.5
Total	1,033.4	1,201.1	1,332.6	1,414.4	1,445.0	1,437.6	6.8
Consumption (GWH)							
Residential	218.8	245.7	269.9	301.2	307.3	319.8	7.9
Commercial	127.1	160.5	190.0	217.2	231.1	240.3	13.6
Industrial	405.5	471.8	520.1	542.6	511.9	481.7	3.5
Others	144.9	147.6	156.4	162.3	166.7	168.6	3.1
Total	896.5	1,025.6	1,436.4	1,223.3	1,217.0	1,210.4	6.2

Source: Refs. 10 and 11

Table 1-15 NUMBER AND AREA OF FARMS IN THE REPUBLIC OF GUATEMALA AND THE DEPARTMENT OF ESCUINTLA IN 1950, 1964 AND 1979

Kind	Number						Area (manzanas)/6					
	1950	(%)	1964	(%)	1979	(%)	1950	(%)	1964	(%)	1979	(%)
Republic of Guatemala												
1. Micro-farm /1	74,279	(21.3)	85,083	(20.4)	166,724	(31.4)	40,822	(0.8)	46,683	(0.9)	79,187	(1.3)
2. Sub-familiar/2	233,804	(67.1)	279,796	(67.0)	301,736	(56.7)	720,794	(13.6)	869,933	(17.6)	890,228	(15.2)
3. Familiar /3	33,041	(9.5)	43,656	(10.5)	49,509	(9.3)	715,472	(13.4)	928,674	(18.8)	1,115,738	(19.0)
4. Middle Multi-familiar/4	7,057	(2.0)	8,420	(2.0)	13,176	(2.5)	1,667,903	(31.4)	1,810,168	(36.7)	2,596,551	(44.2)
5. Large Multi-familiar /5	516	(0.1)	389	(0.1)	478	(0.1)	2,170,484	(40.8)	1,280,308	(26.0)	1,193,612	(20.3)
Total	348,687	(100.0)	417,344	(100.0)	531,623	(100.0)	5,315,475	(100.0)	4,926,766	(100.0)	5,875,316	(100.0)
Department of Escuintla												
1. Micro-farm	-		3,929	(22.9)	6,317	(34.8)	-		2,143	(0.3)	2,066	(0.3)
2. Sub-familiar	-		9,673	(56.3)	7,830	(43.1)	-		26,951	(4.3)	22,768	(3.3)
3. Familiar	-		2,823	(16.4)	2,978	(16.4)	-		64,345	(10.2)	71,039	(10.3)
4. Middle Multi-familiar	-		670	(3.9)	905	(5.0)	-		216,568	(34.3)	324,767	(47.2)
5. Large Multi-familiar	-		94	(0.5)	119	(0.7)	-		320,695	(50.9)	267,783	(38.9)
Total	10,662		17,189	(100.0)	18,149	(100.0)	649,588		630,702	(100.0)	688,423	(100.0)

Source: Refs. 4, 13, and 14

Note: /1: 1 manzana and below
/2: over 1 to 10 manzanas
/3: over 10 to 64 manzanas
/4: over 64 to 1,280 manzanas (= 1 caballeria = 44.8 ha)
/5: over 20 caballerias
/6: 1 manzana = 0.7 ha

Table 1-16 MAJOR AGRICULTURAL PRODUCTS OF GUATEMALA, 1974/75-1980/81

Unit: Thousand Tons

Item	Productions						
	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81
Coffee	157	139	158	168	170	156	---
Cotton	107	98	134	147	159	148	127
Sugar	405	584	501	431	395	432	488
Sugar Cane	4,624	5,763	6,541	5,224	4,622	5,053	5,985
Maize	757	800	777	906	757	1,058	---
Beans	62	73	70	78	---	---	---
Wheat	45	48	56	60	57	50	50
Beef	58	75	70	70	76	79	---

Source: Refs. 1, 4 and 9

Table 1-17 PRODUCTIONS AND HARVESTED AREAS OF MAJOR AGRICULTURAL PRODUCTS IN THE DEPARTMENT OF ESCUINTLA, 1977/78-1980/81

Item	Year			
	1977/78	1978/79	1979/80	1980/81
Sugar Cane				
Production (tons)	4,019,202	3,590,175	3,924,817	4,652,086
Harvested Area (ha)	43,615	40,311	41,367	46,871
Cotton (Raw)				
Production (tons)	-	314,591	297,077	277,076
Havested Area (ha)	-	60,713	72,511	61,285
Maize				
Production (tons)	72,986	-	64,703	-
Harvested Area (ha)	41,563	-	88,355	-
Coffee				
Production (tons)	6,351	8,242	-	-
Harvested Area (ha)	-	-	-	-
Cattle				
Production (head)	186,976	147,977	114,961	99,941
Number of Pasture	-	-	-	-

Source: Refs. 4, 9, 14 and 15

Table 1-18 LAND USE IN THE REPUBLIC OF GUATEMALA AND THE DEPARTMENT OF ESCUINTLA

Kind of Land use	Area			
	Republic of Guatemala (km^2)	(%)	Department of Escuintla (km^2)	(%)
1. Cultivated	11,715	10.8	2,307	52.6
2. Cultivated and Pasture	14,951	13.7	163	3.7
3. Pasture	13,338	12.2	1,323	30.2
Sub-total	40,004	36.7	3,793	86.5
4. Forestry	43,226	39.7	63	1.4
5. Waste	24,091	22.1	472	10.8
6. Lake and Swamp	1,274	1.2	--	--
7. Sand and Rock	294	0.3	56	1.3
Sub-total	68,885	63.3	591	13.5
TOTAL	108,889	100	4,384	100

Source : Ref. 12

Table 1-19 LAND USE IN THE STUDY AREA

Kind of Land Use	Area					
	Total		Achiguate River Basin		Pantaleon River Basin	
	(ha)	(%)	(ha)	(%)	(ha)	(%)
1. Town	1,641	1.3	1,364	1.3	277	1.3
2. Coffee and Cacao	2,262	1.7	2,009	1.8	253	1.2
3. Orchard	1,031	0.8	587	0.5	444	2.1
4. Sugar Cane	16,744	12.9	12,138	11.2	4,606	21.3
5. Palm	31	0.0	31	0.0	40	0.0
6. Banana	1,029	0.8	943	0.9	86	0.4
7. Cotton	3,932	3.0	3,102	2.9	830	3.9
8. Maize	8,571	6.6	6,879	6.3	1,692	7.8
9. Sesame	189	0.1	96	0.1	93	0.4
10. Pasture	53,448	41.1	44,821	41.3	8,627	39.9
Sub-Total (2-10)	88,878	68.3	71,970	66.3	16,908	78.3
11. Road & Railway	3,636	2.8	2,897	2.7	739	3.4
12. Forestry	29,005	22.3	26,236	24.1	2,769	12.8
13. Waste	3,831	2.9	3,474	3.2	357	1.6
14. Lake, Swamp & River	4,142	3.2	3,853	3.3	559	2.6
15. Salina	151	0.1	151	0.1	---	---
16. Sand & Rock	557	0.4	289	0.3	268	1.3
Sub-Total (12-16)	37,686	28.9	33,733	31.0	3,953	18.3
TOTAL	130,200	100	108,600	100.0	21,600	100.0

Source : Ref. 12

Table 1-20 GROSS DOMESTIC PRODUCT (GDP) OF GUATEMALA, 1971-1980

	Year										Average Annual Growth Rate (%)
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1971 - 1978
A. At Current Prices											
Total (Million Quetzales)	1,941	2,054	2,521	3,111	3,577	4,292	5,448	6,044	6,891	7,809	16.9
Annual Growth Rate (%)	-	5.8	22.8	23.4	15.0	20.0	26.9	10.9	14.0	13.3	
Per Capita (Quetzales)	346	355	423	506	564	657	809	871	963	1,060	13.2
Annual Growth Rate (%)	-	2.6	19.2	19.6	11.5	16.5	23.1	7.7	10.6	10.1	
B. At 1958 Constant Prices											
Total (Million Quetzales)	1,774	1,870	2,010	2,111	2,134	2,309	2,610	2,691	2,757	2,811	5.2
Annual Growth Rate (%)	-	5.4	7.5	5.0	1.1	8.2	13.0	3.1	2.5	2.0	
Per Capita (Quetzales)	316	323	337	343	337	353	388	388	385	381	2.1
Annual Growth Rate (%)	-	2.2	4.3	1.8	-1.7	4.7	9.9	0.0	-0.8	-1.0	

Source : Refs. 1 and 4

Table 1-21 SHARE IN GDP BY INDUSTRIAL SECTOR, 1971-1980

Industrial Origin	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1. Agriculture	27.7	28.3	27.9	27.9	28.0	27.3	26.3	25.9	25.4	24.9
2. Mining	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.5
3. Manufacturing Industries	16.0	15.7	15.9	15.7	15.1	15.6	16.0	16.2	16.3	16.7
4. Construction	1.5	1.7	1.9	1.7	1.9	3.0	3.2	3.1	3.2	3.2
5. Electricity, Gas, Water Supply	1.2	1.3	1.3	1.3	1.4	1.4	1.6	1.7	1.7	1.7
6. Transportation & Communications	5.6	5.8	6.0	6.4	6.4	6.5	6.5	6.6	6.7	6.9
7. Commercial Services	28.6	28.0	28.1	28.4	27.6	27.9	28.2	28.1	27.5	27.0
8. Financial Services	2.3	2.3	2.5	2.5	2.6	2.6	2.9	3.0	3.4	3.4
9. Housing	6.7	6.4	6.1	5.8	5.9	4.4	4.5	4.5	4.5	4.4
10. Public	4.7	4.8	4.6	4.6	5.0	5.2	4.8	4.8	4.9	5.2
11. Other Services	5.6	5.6	5.6	5.6	6.0	6.0	5.9	5.9	6.1	6.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source : Refs. 1 and 4

Table 1-22 ANNUAL GROWTH RATE OF GDP BY INDUSTRIAL ORIGIN, 1971-1980

Unit: %

Industrial Origin	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1. Agriculture	-	9.6	5.3	6.4	2.5	4.5	3.9	3.2	3.9	1.6
2. Mining	-	-12.7	7.2	22.5	7.3	26.4	14.8	55.5	79.6	71.2
3. Manufacturing Industries	-	5.5	8.1	4.6	-1.5	10.4	10.7	6.4	5.6	5.6
4. Construction	-	20.0	19.2	-6.6	15.3	73.8	12.4	3.4	6.5	3.7
5. Electricity, Gas, Water Supply	-	13.0	10.2	7.4	7.9	7.8	25.3	10.4	6.2	2.4
6. Transportation & Communication	-	12.1	10.4	13.0	2.2	9.4	7.3	7.1	5.2	8.2
7. Commercial Services	-	5.4	6.9	7.6	-1.0	8.5	9.2	4.4	2.8	1.7
8. Financial Services	-	6.9	14.3	8.2	6.2	6.0	22.2	7.9	19.2	4.5
9. Housing	-	2.0	1.9	1.9	2.9	-19.1	8.2	6.8	3.5	3.0
10. Public Administration	-	10.7	2.4	6.6	11.1	12.0	-1.0	5.5	6.7	10.6
11. Other Services	-	7.6	7.9	5.9	7.8	7.5	7.1	5.1	7.5	3.7

Source: Refs. 1 and 4

Table 1-23 ON-GOING PROJECTS IN THE STUDY AREA

Project	Location	Execution Body	Cost (10^3 Quetzales)	Period of Construction (year)
Highway Construction	Escuintla-San Jose	CAMINOS	16,675	1984 and 1985
Railway Rehabilitation	Sta. Maria-San Jose	FEGUA	6,900	1985
New Port Construction	San Jose	UNECPA	296,100	from 1980 to 1986

Source : Ref. 6

2. HYDROLOGY

HYDROLOGY

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1. GENERAL

This report represents the results of the meteorological and hydrological studies to grasp the climatic and hydrologic characteristics of the country and the Study Area and to estimate the probable flood discharges of the subject rivers. The estimated flood discharges were applied to the sediment and flood control studies.

The hydro-meteorological observation system and the climatic characteristics of the entire country are presented in Section 2. Starting from Section 3, where several aspects of meteorology are discussed, the descriptions and discussions concern the Study Area. Sections 4 and 5 deal with rainfall and river discharges, and Section 6 describes the tidal conditions.

2. NATIONWIDE OBSERVATION SYSTEM AND CLIMATIC CHARACTERISTICS

2.1 Observation System

History of Hydro-Meteorological Observation

Meteorological observations in Guatemala were officially started in 1926 by the National Observatory (ON) which was created under the Ministry of Agriculture in 1925. Some monasteries and private firms had undertaken meteorological observations before 1926, but records are missing.

After 1926, in addition to the ON, many private firms and government agencies such as the National Railway of Guatemala (FEGUA), the Guatemalan Electric Company (EEGSA), the National Institute of Electrification (INDE)1/, the National Geographic Institute (IGN)2/, the International Committee on Limits and Water (CILA)3/, the Xaya Pixcaya Unit4/, the Municipal Water Enterprise of the Municipality of Guatemala (EMPAGUA), the National Institute of Agrarian Transformation (INTA)5/, and the Institute of Science and Agriculture Technology (ICTA)6/ installed meteorological stations to serve

1/ An institution affiliated with the then Ministry of Communications and Public Works (presently, the Ministry of Communications, Transportation and Public Works).

2/ The agency under the Ministry of Communications and Public Works, which is presently, the Military Geographic Institute (IGM) under the Ministry of National Defense.

3/ The agency under the Ministry of Foreign Affairs.

4/ The agency under the Ministry of Communications and Public Works.

5/ The agency under the Ministry of Agriculture.

6/ Also under the Ministry of Agriculture.

their own purposes. Among them, the ON had been playing a major role in the meteorological observations until the creation of the National Institute of Seismology, Volcanology, Meteorology and Hydrology (INSIVUMEH). The ON installed a considerable number of meteorological stations, undertook the operation of the meteorological stations under ICTA, and collected rainfall data from FEGUA, EEGSA and many private firms.

As to streamflow, the observation started in 1961 by INDE to obtain data on water level and discharge for the hydropower projects. In addition, water level stations were installed by the ON for agricultural water supply, and the Xaya Pixcaya Unit and EMPAGUA for municipal water supply.

The hydro-meteorological observation system in Guatemala was improved by the Central American Hydro-Meteorological Project (PHCA) which commenced in 1967 for the purpose of evaluating the potentiality of water resources with aid from the United Nations. Totally, 130 meteorological and 50 water level stations were installed over the country under PHCA.

In connection with the implementation of PHCA, the Coordinating Committee on Hydrology and Meteorology (CCHM) was jointly organized by IGN, the ON and INDE. Among the three agencies, IGN took charge of the evaluation of the potentiality of water resources, the ON was given the task of administering all the meteorological stations and water level stations related to agricultural water supply, while, INDE administered water level stations related to hydropower generation and conducted studies on hydropower utilization.

For the purpose of disseminating hydro-meteorological information, CCHM had published rainfall and streamflow data, including those obtained by the other agencies, in the following three bulletins as a part of the project; namely, (1) Pluviographic Data on Hourly Rainfall (1926 to 1971), (2) Pluviographic Data on Daily Rainfall and Intensity (1926 to 1971), and (3) Hydrological Bulletin (1961 to 1976).

In 1976, INSIVUMEH was created under the Ministry of Communications and Public Works as a comprehensive research organization for the study on hydro-meteorology, seismology and volcanology, for the purpose of protection of lives and properties from natural disasters and with the object of simplifying the observation and records keeping system as much as possible. INSIVUMEH was organized by integrating the ON and the observation sections of both INDE and IGN, which were the major hydro-meteorological observation agencies composing CCHM.

All the stations under the ON, IGN, Xaya Pixcaya Unit and CILA, and some number of stations under INDE and EMPAGUA were taken over by INSIVUMEH.

All the records of the stations operated by the above agencies, except those of INDE, FEGUA, EEGSA and private sectors, were also taken over by INSIVUMEH. Regarding FEGUA and EEGSA, they continue to operate their own stations.

Present Observation System and Available Data

The agencies undertaking hydro-meteorological observations and the number of their respective stations in operation are as follows:

Agency	Meteorology	Water Level	Tide
INSIVUMEH	157	38	1
FEGUA	22	-	-
EEGSA	5	-	-
INDE	38	42	-
EMPAGUA	-	9	-
Total	222	89	1

(1) Meteorological Stations

Table 2-1 shows all the meteorological stations in operation under INSIVUMEH, including the stations under FEGUA and EEGSA. INSIVUMEH classified all the meteorological stations into four (4) categories according to their observation items, as shown in Table 2-2, which classification is included in Table 2-1. Rainfall is observed in all the stations which are mostly located in the south coastal region and in the vicinity of Guatemala City, as shown in Fig. 2-1, and which include 55 stations with automatic recorders. Besides the rainfall, some stations observed temperature, evaporation, relative humidity, sunshine, wind and air pressure.

The meteorological stations under INDE are shown in Table 2-3, together with their classification (refer to Table 2-4). All stations observe rainfall, including the 13 stations with automatic recorders, and some stations observe almost the same meteorological items as INSIVUMEH. The stations are mainly located in six (6) river basins, such as Suchiate, Samala, Maria Linda, Los Esclavos, Cahabon and Chixoy, where hydropower generation projects are being operated or proposed, as indicated in Fig. 2-2.

As to data, only INSIVUMEH has been publishing its yearly observations in the Meteorogical Bulletion since 1976.

(2) Hydrological Stations

(a) Water Level Stations

All stations under INSIVUMEH, INDE and EMPAGUA, including the stations that no longer exist, are shown in Tables 2-5, 2-6, and 2-7 and also in Figs. 2-3, 2-4 and 2-5, respectively.

The stations under INSIVUMEH were installed in almost all rivers except for the six rivers mentioned above where INDE administers the observation. The stations under EMPAGUA were located only in the upstream of Motagua River for the water supply system of Guatemala City.

With regard to discharge observation, only low-flow measurements have been executed by means of the current meter. Flood discharges are estimated by the use of rating curves which are prepared only on the basis of the low-flow measurements.

The water level and discharge records from 1977 to 1980 at each station under INSIVUMEH and INDE have been published by the respective agencies in the Hydrological Bulletin.

(b) Tide Stations

Three (3) tide stations were installed, as shown in Table 2-8 and in Fig. 2-3, but only the station in Santo Tomas de Castilla is being operated and maintained by INSIVUMEH. There is no tide station in the Pacific Ocean side.

2.2 Climatic Characteristics

Guatemala is located in the tropic zone, but it has a diversity of climate because of irregular terrain composed of high mountain ranges and low-lying lands. In addition, the cyclones which hit the country characterizes its climate.

The country can be roughly classified into three (3) regions according to the geographical feature; namely, the central highlands region, the south coastal region and the north lowlands region.

The central highlands region comprises the Sierra Madre and the Altos Cuchumatanes mountain ranges and the area surrounded by them. This region has a mild climate owing to its high altitude. The south coastal region is the area facing the Pacific Ocean, south of the Sierra Madre, and has a tropical climate. The northern lowlands region is the flat area in the Yucatan, north of the Altos Cuchumatanes, and also has a tropical climate.

The climatic characteristics of each region are shown in the isotherm of mean annual temperature and the isohyet of mean annual rainfall in Figs. 2-6 and 2-7, respectively.

Air temperature shows its dependence on the altitude. Mean annual temperature ranges from 27°C to 28°C in the south coastal and the northern lowlands regions; while that in the central highlands region where Guatemala City is located is some 19°C.

The temperature in each region is almost invariable throughout the year. The difference in mean monthly temperature between the

hottest months (April and May) and the coldest months (December and January) ranges only from 2 to 3°C.

Since temperature is almost uniform throughout the year, the season is classified according to rainfall, i.e., the rainy season and the dry season. In the central highlands and the south coastal regions, the rainy season continues from May to the end of October or to mid-November and the rainiest month is September. In the northern lowlands region, there is hardly any dry season. As to the amount of rainfall, there is generally more rainfall in the south coastal region and in the northern lowlands region than in the central highlands region, though there is a big fluctuation caused by the geographical features in the area.

There are two (2) heavy rainfall areas; one is the southern slope of the Sierra Madre and the other is the northern slope of the Altos Cuchumatanes, since an abrupt ascent of the humid air from the Pacific and the Atlantic oceans causes heavy rain. The mean annual rainfall in these areas amounts to more than 4,000 mm. In the central highlands region, due to loss of humidity on both slopes, the mean annual rainfall reaches only up to 500 mm in some areas.

The heavier rainfall in the country is caused by the cyclones which come from the two tropical cyclone zones; namely, the North Atlantic Ocean Zone and the Northeast Pacific Ocean Zone. Tropical storms and hurricanes[1/] from the North Atlantic Ocean Zone annually rose 8.3 times. Tropical cyclones that hit the country one or two times a year occur from May to mid-December, and the occurrence frequency is at its highest level in mid-September. The tracks of the cyclones that affected Guatemala are shown in Fig. 2-8.

Over the Northeast Pacific Ocean Zone, the tropical storms and hurricanes occur at an average of 15.3 times a year. They develop from May to November and the frequency reaches the peak in September. The hurricanes David in September 1979 and Paul in September 1982 inflicted much damage to the country. Likewise, tropical cyclones in the Northeast Pacific Ocean Zone affect the country several times a year and their tracks are shown in Fig. 2-9.

3. METEOROLOGY IN THE STUDY AREA

3.1 Observations

Totally, there are seven (7) meteorological stations in and around the Study Area where meteorological items such as air temperature, relative humidity, wind, sunshine hour, evaporation and

1/ Tropical cyclones are classified into three (3) types according to the maximum sustained surface wind velocity (1-min mean) near the center; namely, (1) tropical depression of 33 knots or less, (2) tropical storm of 34 to 63 knots inclusive, and (3) hurricane of 64 or more knots.

air pressure are observed in addition to the observation of rainfall. The location of these meteorological stations are shown in Fig. 2-10 and code number, their names, supervising agency, observation items and operation periods are tabulated in Table 2-9. (As to their location and elevation, refer to Table 2-14.)

The observation of air temperature started in the 1960's and is done at all the aforesaid seven stations. Relative humidity and evaporation are available at four (4) and two (2) stations, respectively, from the early 1970's. Sunshine hour, air pressure, and wind were observed at only one (1) station in the Pacific Coast for 4 years from 1970 to 1973. As to the wind, the data is missing so that information cannot be obtained.

3.2 Air Temperature

Table 2-10 shows the maximum, mean and minimum monthly air temperatures at the selected five (5) stations which are believed to represent the climatic features of the Study Area. Air temperature in the Study Area is generally uniform throughout the year, while it becomes lower at the higher altitudes.

The mean annual air temperatures at San Jose and El Recuerdo, which are the lowest and the highest in altitude among the stations, were recorded at 27.0°C and 15.0°C, respectively. The highest temperature usually occurs in March through May and the lowest, in December through February. (Refer to Fig. 2-11.)

3.3 Relative Humidity

The mean monthly relative humidity is summarized in Table 2-11 for totally four (4) stations in and around the Study Area. Relative humidity is uniformly high and its annual mean ranges from 70 to 80%.

The seasonal variation of relative humidity is almost conformable to the rainfall pattern in the area. Usually, the higher relative humidity is observed in the rainy season from May to October and the lower in the dry season from November to April. (Refer to Fig. 2-12.)

3.4 Sunshine

Daily sunshine hour is recorded only at San Jose Station, and the annual mean is 7.8 hours/day.

The mean sunshine hours in the dry season and the rainy season are 9.2 hours and 6.5 hours, respectively (refer to Table 2-12).

3.5 Evaporation

There are only two (2) pan evaporimeter stations, i.e., Sabana Grande and Camantulul.

The mean monthly evaporation records are tabulated in Table 2-13 and shown in Fig. 2-13. The mean annual pan evaporation is 1,245 mm at Sabana Grande and 1,583 mm at Camantulul.

4. RAINFALL IN THE STUDY AREA

4.1 Observations

Rainfall stations in and around the Study Area are enumerated in Table 2-14 and their locations are plotted in Fig. 2-14.

Rainfall observation in the area started in 1909 at Morelia Station in Pantaleon River Basin, and a total of 48 rainfall stations has been installed; 32 stations in the Study Area and 16 stations nearby. Presently, however, only 6 stations in the Study Area and 11 stations located near the Study Area are in operation. Observation by automatic recorders commenced in the Study Area in 1969. Four (4) stations and three (3) stations were installed inside and outside of the Study Area, repectively, but only one station in the Study Area is presently in operation. The observation records of these stations include missing and suspensions. This accounts for the fact that long records are found only in a small number of stations.

Out of the observed record of the existing seventeen (17) stations, the records since 1975 of San Andres Osuna Station, which is located at the outskirt of Fuego Volcano, are unrealiable, on the ground of showing too high rainfall from 1975 to 1979 and too low from 1980 compared with the former records. As a result, data of San Andres Osuna Station since 1975 were not used for this study.

4.2 Rainfall Characteristics

The isohyetal map of the mean annual rainfall in the Study Area is indicated in Fig. 2-15.

The higher the altitude becomes, the more the rainfall increases and on the southern slopes from the Fuego Volcano, rainfall reaches the maximum. On the other hand, rainfall decreases in the high lands in Guacalate River Basin that are situated behind the Fuego, Acatenango and Agua volcanoes because of the loss of humidity on the slope. At San Jose (4.0 m MSL), located at the Pacific Coast, the mean annual rainfall is 1,100 mm. At Ceylan Station (1,100 m MSL) and Los Tarros Station (700 m MSL), which are located at the southern slope of Fuego Volcano, the rainfall reaches to 4,400 mm and 4,800 mm a year, respectively. At Los Aposentos (1,776 m MSL) which is located in the highland, mean annual rainfall is only 930 mm.

Owing to such rainfall characteristics, the basin mean annual rainfall for Achiguate Reference Point I[1/] amounts to 3,500 mm, but that at Achiguate Reference Point II[2/], where Guacalate

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1/ Upstream area of CA-2 Road Bridge (Catchment Area: 205.1 km^2).

2/ Upstream area of the confluence with Mazate River (Catchment Area: 956.2 km^2).

River flows, decreases to 2,400 mm, while that of Pantaleon Reference Point[1/] is 3,300 mm.

The monthly variations of rainfall at the seven (7) stations which are considered to represent the rainfall characteristics in the basin are tabulated in Table 2-15 and shown in Fig. 2-16. Some ninety percent of the annual rainfall take place in the rainy season and especially, June and September have a relatively high monthly rainfall compared to the other months in the rainy season.

4.3 Basin Rainfall

Annual maximum basin rainfall were calculated for the basins of the three reference points to estimate probable rainfall.

The isohyetal method is used to estimate the basin rainfall in consideration that the areal distribution of rainfall in the Study Area is strongly affected by geophysical condition and that the other methods cannot determine the distribution of rainfall because of the limited number of available rainfall stations.

The annual maximum daily rainfall for the basins for 22 years from 1961 to 1982 are shown in Table 2-16. The largest values of daily basin rainfall for the 22-year period are 184.6 mm/day, 140.2 mm/day and 170.0 mm/day for Achiguate Reference Point I, Achiguate Reference Point II and Pantaleon Reference Point, respectively, all of which were caused by Hurricane Francelia on September 5, 1969.

4.4 Probable Rainfall

The probable rainfall for the basins of the three reference points were estimated by the use of the Gumbel Method with the Thomas plotting position. The calculated probable rainfalls are presented in Table 2-17. The data for 5-, 10- and 30-year return periods are as shown the following table.

Return Period	Achiguate Reference Point I	Achiguate Reference Point II	Pantaleon Reference Point
5-year	126	82	112
10- "	151	105	135
30- "	188	140	169

The daily basin rainfall on September 5, 1969 for the three reference points corresponds to a 30-year return period.

1/ Upstream area of CA-2 Road Bridge (Catchment Area: 115.0 km^2). Catchment area including sub-basin: 150 km^2.

5. RUNOFF IN THE STUDY AREA

5.1 Observations

Water Level

There is only one stream gauge, i.e., Alotenango Station, in Achiguate River Basin. However, this station is located in the upper stream of Guacalate River, the biggest tributary of Achiguate. Runoff characteristic of Guacalate is much different from that of the Achiguate main river and the Pantaleon river basins. Therefore, the data of this station cannot be applied to this study.

From the foregoing situation in the Study Area, it is necessary to apply the records of the neighboring rivers for the purpose of estimating the probable discharge and to construct the flood hydrograph.

Totally, twelve (12) stations are or were in operation in the neighboring rivers, of which, the observation in the Madre Vieja and Maria Linda rivers started in 1962 or 1963 and the others commenced in the early 1970's by means of automatic recorders. All the gauges can hourly observe water stages with an automatic recorder. (Refer to Table 2-18, and in Fig. 2-17 for their locations.)

Runoff Discharge Measurement

Aside from the water level stations, low flow measurements at two points in Achiguate River and at one point in Pantaleon River (refer to Fig. 2-18), were executed by means of a current meter about ten times from 1964 to 1971.

As to the runoff discharge in the twelve (12) stations, INSIVUMEH and INDE had carried out discharge observations, but only for low flows, and prepare the rating curves at their respective stations.

5.2 Probable Flood Discharge

To estimate the probable discharge, the two methods, i.e., the flood runoff analysis by the probable rainfall in which the probable discharge is calculated from the probable basin rainfall through flood runoff model and the direct discharge analysis in which runoff discharge records are used, were generally applied.

For the application of both the above analyses, hourly runoff discharge in the subject area is necessary. Since hourly records are not obtainable in the Study Area, the flood runoff and direct discharge analyses are not applicable to this study. There is no other way to estimate the probable discharge in the Study Area except taking the probable discharge of the neighboring river basins having similar features.

With regard to the Achiguate river basin, the flood mark at the national railway bridge of the biggest flood which occurred on

September 5, 1969 caused by Hurricane Francelia was recorded in the design drawing of the said bridge. The flood peak discharge estimated from the flood mark can be used for the inspection of the probable discharge of Achiguate/Pantaleon river estimated from neighboring rivers.

Selection of Available Station

The observing conditions of twelve (12) stations and river basin features were investigated in order to select the stations which were used for the estimation of the probable discharge in the Study Area. Table 2-19 shows the observing condition of each water level station.

From the results of the investigation, the Montecristo and the San Miguel Moca stations, both in Nahualate River, were decided to be utilized for the discharge computation, because the observation condition of both stations are good and Nahualate River Basin has the similarities to the Achiguate and the Pantaleon river basins as enumerated below:

(1) river configuration, such as shape of catchment area, river length and gradient, etc.:

(2) geological conditions of the river basins, which were formed by the volcanic sedimentation; and

(3) rainfall depth and distribution in both river basins.

Annual Maximum Discharge

To estimate the flood discharge at Montecristo and San Miguel Moca along Nahualate River, the rating curves as shown in Fig. 2-19 are newly constructed by using the Manning's Formula as presented in the following:

$$Q = AR^{0.67}I^{0.5}/n \quad \text{..... (Eq. 1-1)}$$

where, Q ; discharge (m^3/s)
A ; flow section area (m^2)
R ; hydraulic radius (m)
I ; riverbed gradient
n 1/; Manning's roughness coefficient ($s/m^{0.33}$)

As for the cross section at Montecristo and San Miguel Moca, refer the Fig. 2-20.

The annual maximum flood discharges at the Montecristo and the San Miguel Moca stations were computed from the observed annual maximum flood water level through the rating curve. The results of the computation are shown in Table 2-20. Operations in San Miguel Moca Station were suspended in 1972 and 1977.

1/ The value of n is estimated at 0.04 in consideration of river conditions.

Probable Flood Discharge

The probable flood discharge at the Montecristo and the San Miguel Moca stations were estimated by the use of the Gumbel Method with the Thomas plotting position from the annual maximum flood. The estimated probable discharges are tabulated in Table 2-21.

On the basis of the above, the relationship between the probable specific discharge and the catchment areas was drawn as shown in Fig. 2-21.

The relationship was checked by the peak discharge of the 1969 flood estimated from the flood mark in Achiguate River, and as a result, the estimated peak discharge of Achiguate River coincides with that of Nahualate River as described below.

The flood peak discharge at the flood mark at the Achiguate railway bridge (catchment area: 217.0 km^2) was estimated at approximately 1,200 m^3/s, which corresponds to 5.52 $m^3/s/km$ in specific discharge. The return period of the flood is estimated at 30-year from that of the basin rainfall on the same day. On the other hand, the flood discharge of 30-year return period obtained from the relationship between the probable specific discharge and the catchment area in Nahualate River is estimated at 1,190 m^3/s.

Table 2-22 shows the probable flood discharges at the three reference points at several return periods and Table 2-23 indicates the probable discharges at three supplementary points which are required for the sediment and flood control plan.

The probable flood discharges of 5-, 10- and 30-year return periods at the three reference points are as shown in the following table.

Return Period	Achiguate Reference Point I (m^3/s)	Achiguate Reference Point II (m^3/s)	Pantaleon Reference Point (m^3/s)
5-year	750	970	710
10- "	920	1,250	870
30- "	1,190	1,670	1,110

5.3 Flood Hydrograph

Since there exists no available data for the estimation of the hydrograph in the Achiguate and the Pantaleon rivers, the flood hydrographs at each reference point in both river basins were as well prepared based on the flood hydrographs of Nahualate River Basin, in similar condition as the estimation of probable discharge.

Nahualate River has two (2) gauging stations as previously mentioned, i.e., Montecristo and San Miguel Moca, in which flood hydrographs were observed. Taking such hydrograph features of the gauging stations into account, as the catchment area, basin gradient, etc., the flood hydrographs at the Montecristo and the San Miguel Moca stations in Nahualate River were applied to those of Achiguate Reference Point I/Pantaleon Reference Point and Achiguate Reference Point II, respectively.

Model hydrograph is in general used for the project formulation because of standardizing various kinds of the actually observed flood hydrographs. To make the model hydrograph at each reference point, flood duration, time of flood peak, base flow, and runoff coefficient were studied.

The model hydrographs of the three reference points are shown in Figs. 2-22, 2-23 and 2-24, and the constructed flood hydrographs of each reference point corresponding to the flood peak discharges of 30-, 10- and 5-year return periods are shown in Figs. 2-25, 2-26 and 2-27, respectively.

6. TIDE IN THE STUDY AREA

Tide observations were executed from 1945 to 1975 at the pier of FECUA in San Jose Port. The recorded observations are inadequately precise to be adopted for the study due to poor maintenance.

Consequently, INSIVUMEH has been analyzing and publishing estimated tide levels at San Jose Port in the Physical Characteristics of Sea Water in Santo Tomas de Castilla, San Jose and Champerico, 1963-1980, based on the tide level at La Union Port, El Salvador, mentioned in the Tide Table West Coast of North and South by the U. S. Department of Commerce.

From the same calculation, the mean water spring and mean water neap were estimated at 0.80 and -0.78 m above mean sea level, respectively, during the rainy season from 1978 to 1982.

TABLES AND FIGURES

Table 2-1 (1/4) METEOROLOGICAL STATIONS IN GUATEMALA UNDER INSIVUMEH, FEGUA AND EEGSA

RIVER SYSTEM		CODE	NAME	TYPE	EL. (m. MSL)	LATITUDE	LONGITUDE	OBSERVATION PERIOD
1.2	Suchiate	17.02.01	Tecun Uman FEGUA	D	20	14°40'23"	92°08'07"	1934-
		17.03.01P	Catarina	B	233	14°51'20"	92°04'38"	1969-
		17.22.01	El Porvenir	D	980	14°57'53"	91°54'36"	1965-
		17.24.02	Las Madrecitas	C	1980	14°55'11"	91°55'11"	1969-
1.3	Naranjo	13.07.19	Vizcaya	D	940	14°45'05"	91°46'44"	1924-
		13.07.20	La Violeta	D	1280	14°45'12"	91°43'38"	1971-
		17.01.03P	San Marcos	D	2358	14°57'24"	91°48'11"	1971-
		17.06.01	Chiguilá	D	1120	14°47'40"	91°47'22"	1957-
		17.07.01	Alabama Grande	D	884	14°50'34"	91°55'38"	1934-
		17.07.05	El Rosario	D	820	14°51'48"	91°57"15"	1934-
		17.07.12	La Colonia	C	660	14°49'31"	91°57'20"	1969-
		17.10.02	El Baluarte	D	1220	14°48'35"	91°48'45"	1955-
		17.10.06	La Victoria	D	980	14°47'37"	91°50'27"	1965-
		17.10.07	Las Casas	D	1250	14°48'40"	91°48'32"	1965-
		17.10.08	La Primavera	D	1170	14°48'00"	91°49'00"	1965-
		17.10.09	Santa Teresa Canopa	C	480	14°45'29"	91°52'31"	1971-
		17.22.03	Santa Teresa	D	325	14°58'48"	91°59'45"	1929-
1.4	Ocosito	13.06.01	Coatepeque FEGUA	D	490	14°42'15"	91°51'32"	1934-
		13.06.02	Monte Grande	D	340	14°41'55"	91°55'15"	1922-
		13.06.05	La Paz	D	20	14°36'32"	91°59'21"	1972-
		13.07.06	Esmeralda	C	980	14°42'14"	91°42'57"	1934-
		13.07.21	San Jerónimo	C	1000	14°42'40"	91°45'22"	1971-
		13.10.02	Santa Anita	D	470	14°39'27"	91°50'20"	1966-
		13.11.02	San Antonio Morazan	D	690	14°39'29"	91°46'45"	1957-
		15.01.02	La Esperanza	D	50	14°25'32"	91°52'52"	1954-
		15.01.04	Las Delicias	B	160	14°28'37"	91°40'52"	1959-
		15.01.08	Aeropuerto Retalhuleu	A	205	14°31'19"	91°41'48"	1965-
		15.03.02P	El Asintal	B	325	14°34'54"	91°43'20"	1969-
		15.06.02	Las Fuentes	D	320	14°37'23"	91°37'32"	1958-
1.5	Samalá	13.09.07	Santa Marta	D	860	14°39'29"	91°35'09"	1951-
		13.14.03P	Labor Ovalle	A	2400	14°52'12"	91°31'09"	1970-
		15.06.05	San Luis	D	490	14°36'44"	91°37'27"	1962-
		15.09.01P	Los Brillantes	B	345	14°34'18"	91°37'54"	1934-
		21.01.04P	Jucnanep	D	2500	14°56'07"	91°22'54"	1966-
		21.01.05P	Santa Lucia La Reforma	C	1400	15°08'10"	91°14'57"	1977-
		21.06.01P	San Fco. El Alto	D	2620	14°56'46"	91°26'20"	1977-
1.6	Sis-Ican	20.01.01	Mazatenango FEGUA	D	371	14°31'42"	91°30'10"	1934-
		20.01.03P	Chojojá	B	440	14°32'43"	91°29'24"	1971-
		20.02.04	Villa Juan Carlos	C	334	14°32'51"	91°34'27"	1963-
		20.05.01	París	D	1005	14°38'31"	91°31'23"	1956-
		20.10.03	Las Nubes	C	1185	14°39'08"	91°29'48"	1960-
1.7	Nahualate	05.12.09P	Tiquisate	B	70	14°17'10"	91°22'21"	1969-
		19.19.02	Monte de Oro	C	1020	14°33'00"	91°14'33"	1937-
		19.19.05	Monte Quina	C	1040	14°33'24"	91°15'53"	1940-
		20.03.01	Bella Flor	C	640	14°34'58"	91°20'10"	1957-
		20.03.05	La Abundancia	D	620	14°34'56"	91°22'25"	1937-
		20.03.06	Los Angeles	C	1020	14°35'50"	91°20'47"	1957-
		20.06.01	Rio Bravo FEGUA	D	151	14°23'50"	91°19'40"	1934-
		20.08.01	Palo Gordo FEGUA	D	242	14°29'23"	91°24'36"	1934-
		20.15.01	Chinán	D	480	14°32'23"	91°20'34"	1934-
		20.19.03	La Asunción	D	600	14°28'28"	91°13'41"	1953-
		20.19.05	La Moca	D	940	14°32'00"	91°14'10"	1929-
		20.19.07	San Fco. Miramar	D	810	14°30'17"	91°12'28"	1934-
1.8	Atitlán	19.01.05	Arqueca	C	2300	14°48'40"	91°11'32"	1972-
		19.12.01	San Pedro La Laguna	D	1600	14°41'32"	91°16'10"	1958-
		19.13.02	Chirijox	D	2680	14°49'20"	91°20'27"	1966-
		19.19.04	Santiago Atitlán	B	1592	14°37'56"	91°13'53"	1970-

Note: The code number with "P" means the station is equipped with automatic rainfall recorder.

(CONTINUED)

Table 2-1 (2/4) METEOROLOGICAL STATIONS IN GUATEMALA UNDER INSIVUMEH, FEGUA AND EEGSA

RIVER SYSTEM		CODE	NAME	TYPE	EL. (m, MSL)	LATITUDE	LONGITUDE	OBSERVATION PERIOD
1.9	Madre Vieja	20.04.02	Cocales	C	220	14°23'14"	91°11'50"	1954-
		20.04.04	Los Torrales	C	840	14°31'20"	91°08'10"	1934-
		20.04.05	Patulul FEGUA	D	220	14°23'14"	91°11'50"	1934-
		20.04.06	El Vesubio	E	1483	14°32'51"	91°09'43"	1954-
		20.12.02P	La Concha	B	680	14°26'58"	91°11'01"	1975-
1.10	Coyolate	03.02.01	Las Delicias	E	1000	14°31'32"	91°01'12"	1929-
		03.05.02P	El Recuerdo	C	2200	14°37'00"	90°54'32"	1967-
		03.07.07	San Carlos Miramar	B	1060	14°30'20"	91°04'32"	1950-
		03.12.06	Peña Plata	C	620	14°27'05"	91°05'20"	1947-
		05.10.03	Los Tarros	D	700	14°23'50"	90°59'36"	1935-
		05.10.08	Camantulul	B	280	14°19'28"	91°03'27"	1970-
		20.19.10	El Carmen	C	180	14°19'00"	91°09'30"	1972-
1.12	Achiguate	03.01.02P	Los Aposentos	C	1776	14°38'02"	90°48'12"	1970-
		05.01.09	San Andres Osuna	C	760	14°22'40"	90°55'20"	1925-
		05.01.14P	Sabana Grande	B	730	14°22'03"	90°49'52"	1969-
		05.06.05	Santa María FEGUA	D	125	14°12'57"	90°50'22"	1934-
		16.01.01	Antigua EE	D	1530	14°33'20"	90°43'54"	1934-
		16.02.01	El Porrero	D	1518	14°31'43"	90°45'59"	1910-
1.13	María Linda	05.01.02	Escuintla FEGUA	D	347	14°18'00"	90°47'10"	1934-
		05.01.03	Escuintla EE	D	440	14°18'23"	90°46'07"	1946-
		05.01.17P	El Chupadero	B	270	14°16'05"	90°47'33"	1972-
		05.06.07	Santillana del Mar	C	140	14°12'40"	90°47'10"	1968-
		05.07.01	María Santísima	C	620	14°21'18"	90°44'42"	1958-
		05.07.03	Palín FEGUA	D	1130	14°23'58"	90°41'50"	1935-
		05.07.05	San José Bella Vista	D	900	14°23'03"	90°44'25"	1957-
		05.08.02	Puerto San José FEGUA	D	4	13°55'36"	90°49'11"	1934-
		05.08.05	Puerto San José	A	6	13°56'19"	90°50'12"	1956-
		06.01.00P	INSIVUMEH	A	1502	14°35'11"	90°31'58"	1928-
		06.01.10P	Tanque El Guarda	C	1525	14°36'43"	90°31'45"	1966-
		06.01.32P	Radio Sonda	E	1496	14°32'15"	90°36'36"	1974-
		06.02.01	Amatitlán EE	D	1158	14°26'57"	90°36'30"	1940-
		06.16.02	La Laguna EE	D	1200	14°27'01"	90°33'42"	1947-
		06.16.03	Morán	D	1220	14°28'52"	90°32'00"	1934-
		06.16.05	Villa Canales FEGUA	D	1220	14°29'10"	90°32'07"	1945-
1.15	Los Esclavos	06.09.02	San Antonio Las Vert.	D	1705	14°31'37"	90°23'15"	1966-
		06.09.03P	La Soledad	B	1650	14°30'29"	90°23'40"	1968-
		06.09.08	Finca El Maguey	D	1850	14°30'10"	90°25'57"	1969-
		18.01.01	Santa Isabel	C	893	14°16'41"	90°18'00"	1934-
		18.01.02	La Perla	D	960	14°16'56"	90°18'05"	1942-
		18.01.03P	Los Esclavos	B	737	14°15'10"	90°16'42"	1964-
		18.04.01	La Morena	C	740	14°10'47"	90°22'48"	1935-
		18.07.03	El Valle	C	1008	14°24'00"	90°15'00"	1952-
1.16	Paz	10.09.01	Jalpatagua	C	557	14°08'10"	90°00'30"	1958-
		10.11.02P	Montufar	A	10	13°48'39"	90°08'11"	1971-
		10.13.01P	Quezada	B	890	14°16'44"	90°02'18"	1969-
1.17	Lempa	04.04.02P	Esquipulas	A	1000	14°33'32"	89°20'31"	1971-
		09.03.03P	Ceibita	B	961	14°29'27"	89°53'10"	1964-
		10.02.01	Agua Blanca FEGUA	D	890	14°31'16"	89°36'30"	1941-
		10.03.01P	Asunción Mita	B	478	14°20'04"	89°42'10"	1960-
		10.03.02	Anguiatú FEGUA	D	492	14°21'06"	89°34'45"	1934-

Note: The code number with "P" means the station is equipped with automatic rainfall recorder.

(CONTINUED)

Table 2-1 (3/4) METEOROLOGICAL STATIONS IN GUATEMALA UNDER INSIVUMEH, FEGUA AND EEGSA

RIVER SYSTEM		CODE	NAME	TYPE	EL. (m, MSL)	LATITUDE	LONGITUDE	OBSERVATION PERIOD
2.1	Grande de Zacapa	04.01.01	Chiquimula FEGUA	D	424	14°47'55"	89°32'48"	1948-
		04.02.01P	Camotán	B	471	14°49'14"	89°22'22"	1967-
		04.05.02P	Ipala FEGUA	C	827	14°37'05"	89°37'08"	1934-
		04.05.04P	Ipala	B	828	14°37'27"	89°36'50"	1971-
		22.01.01	Zacapa FEGUA	D	184	14°57'55"	89°32'36"	1934-
		22.03.02P	La Fragua	A	210	14°57'51"	89°35'04"	1971-
2.2	Motagua	03.11.01P	San Martín Jilotepeque	B	1810	14°46'43"	90°47'19"	1969-
		03.14.01P	Sta. Cruz Balanyá	B	2080	14°41'02"	90°54'58"	1971-
		06.01.02	Guatemala FEGUA	D	1489	14°37'40"	90°30'40"	1934-
		06.01.03	Guatemala EE	D	1505	14°38'25"	90°31'06"	1940-
		06.01.05	Timoteo Santiago	D	1470	14°40'00"	90°29'25"	1963-
		06.01.09P	Planta La Brigada	D	1610	14°38'42"	90°34'15"	1954-
		06.01.12	Planta Santa Luisa	C	1560	14°37'20"	90°28'30"	1954-
		06.01.14P	Planta Cambray	D	1600	14°34'20"	90°29'40"	1954-
		06.01.17P	Florida Zona 5	C	1470	14°38'12"	90°29'35"	1967-
		06.01.20P	Fábrica de Tubos	D	1520	14°36'36"	90°33'02"	1964-
		06.01.21	Presa Teocinte	D	1620	14°33'50"	90°23'00"	1951-
		06.01.26	Jardín Botánico	C	1490	14°36'56"	90°30'45"	1969-
		06.09.06	Aldea Contreras	D	1550	14°35'38"	90°22'26"	1970-
		06.09.07	El Pajón	D	1940	14°33'22"	90°26'10"	1979-
		06.09.09	La Negra	C	1700	14°33'44"	90°23'27"	1970-
		06.09.10	San Ramón Las Nubes	D	2300	14°34'25"	90°20'36"	1970-
		06.10.02	El Pilar	D	2000	14°42'22"	90°42'44"	1970-
		06.12.01	San Pedro Ayampuc	B	1240	14°46'35"	90°27'17"	1969-
		06.13.02	San Pedro Sacatepéquez	C	2102	14°41'05"	90°38'35"	1971-
		06.15.02	Piedra Parada	D	1850	14°34'18"	90°26'38"	1970-
		06.16.04	San Agustín Las Minas	C	1300	14°31'50"	90°31'12"	1957-
		08.01.01P	Puerto Barrios FEGUA	C	2	15°44'00"	88°36'10"	1973-
		08.01.04	Puerto Barrios	A	2	15°44'16"	88°35'30"	1973-
		08.04.01	Creek	C	55	15°18'32"	88°57'41"	1934-
		08.04.03	Quiriguá FEGUA	C	73	15°16'11"	89°04'12"	1934-
		08.04.04	Tenedores FEGUA	D	26	15°33'12"	88°37'45"	1934-
		08.04.07	Los Amates	B	76	15°15'09"	89°05'52"	1971-
		08.05.02	Pownee Playitas	C	59	15°21'16"	88°49'17"	1934-
		08.05.04	Santo Tomás de Castilla	C	30	15°35'46"	88°34'25"	1971-
		09.01.02P	Porrero Carrillo	B	1800	14°45'50"	89°56'00"	1971-
		12.03.01P	Morazán	B	360	14°55'54"	90°09'07"	1971-
		12.04.01	Sanarate FEGUA	D	812	14°47'02"	90°12'11"	1934-
		12.05.01	La Montañita	C	1360	14°42'48"	90°08'11"	1967-
		12.06.01	El Rancho FEGUA	D	274	14°55'00"	90°00'27"	1935-
		14.05.02	Chinique	B	2000	15°03'22"	91°02'41"	1972-
		14.17.01P	Chichicastenango	B	2071	14°56'51"	91°06'44"	1945-
		22.06.02P	La Unión	B	1100	14°58'00"	89°17'34"	1971-
		22.07.01P	Pasabién	B	480	15°02'14"	89°40'57"	1969-
2.3	Izabal Dulce	08.03.06P	Las Vegas	B	10	15°40'43"	88°37'53"	1971-
		08.04.06P	Mariscos	B	1	15°25'00"	89°05'00"	1970-
2.4	Polochic	01.07.02	Constancia	C	54	15°18'02"	89°43'32"	1955-

Note: The code number with "P" means the station is equipped with automatic rainfall recorder.

(CONTINUED)

Table 2-1 (4/4) METEOROLOGICAL STATIONS IN GUATEMALA UNDER INSIVUMEH, FEGUA AND EEGSA

RIVER SYSTEM		CODE	NAME	TYPE	EL. (m, MSL)	LATITUDE	LONGITUDE	OBSERVATION PERIOD
2.4	Polochic (Continued)	01.07.07	Jolomijix	C	760	15°15'33"	89°45'18"	1966-
		01.07.08	El Porvenir	C	300	15°16'25"	89°44'35"	1966-
		01.07.10P	Panzos	A	18	15°23'50"	89°38'38"	1957-
		01.07.12	Papalha	B	120	15°18'20"	89°56'13"	1969-
		01.07.13	Miralvalle	C	28	15°18'30"	89°43'55"	1974-
		01.11.05	Semay	C	1038	15°24'32"	89°48'10"	1955-
		01.11.10	Mocca	C	1020	15°21'35"	89°55'28"	1911-
		01.14.01	Argentina	C	609	15°19'07"	90°00'07"	1958-
		01.14.04	La Concepción	C	1500	15°16'09"	90°07'30"	1958-
		02.06.03	Chilascó	D	1360	15°07'20"	90°06'55"	1959-
2.5	Cahabon	01.01.07P	Santa Margarita	C	1325	15°30'00"	90°22'00"	1956-
		01.01.08P	Cobán	A	1328	15°28'03"	90°24'23"	1970-
		01.02.02	Cahabón	B	318	15°36'30"	89°48'38"	1972-
		01.03.02	Chajcar	C	1219	15°29'00"	90°11'04"	1956-
		01.11.09	Sepamac	D	680	15°30'22"	89°41'47"	1963-
3.1	Cuilco	07.06.02	Cuilco	B	1120	15°24'25"	91°57'00"	1972-
3.2	Selegua	07.01.02P	Huehuetenango	A	1902	15°19'12"	91°28'12"	1969-
		07.19.02P	San Pedro Necta	B	1600	15°29'42"	91°45'49"	1971-
		07.31.02	Todos Santos	B	2500	15°30'15"	91°36'12"	1971-
3.5	Ixcan	07.20.02	San Pedro Solama	B	2400	15°39'10"	91°26'06"	1971-
3.6	Xaclbal	14.03.02	La Perla	C	1280	15°36'54"	91°06'40"	1964-
		14.08.01P	Nebaj	B	1906	15°23'53"	91°08'32"	1969-
3.7	Salinas (Chixoy)	01.03.05	Chiquixji	D	1175	15°33'53"	90°17'10"	1956-
		01.03.06	Rexaha	D	1197	15°33'00"	90°16'22"	1956-
		01.03.09	Secol	D	868	15°38'58"	90°19'00"	1956-
		01.05.01P	San Augustin Chixoy	A	140	16°04'21"	90°26'30"	1972-
		02.02.02	Cubulco	B	994	15°06'32"	90°36'51"	1980-
		02.06.04P	San Jerónimo	B	979	15°03'40"	90°14'00"	1961-
		02.06.05	Las Antras	D	1200	15°04'07"	90°12'59"	1968-70 1973-
		14.10.01P	Sacapulas	B	1196	15°17'16"	91°05'11"	1968-
3.8	Pasion	11.09.01	Poptún	D	475	16°19'29"	89°25'18"	1946-
		11.09.05P	Mi Ilusión	B	121	15°58'47"	89°16'46"	1969-
		11.11.02P	El Porvenir	A	125	16°31'29"	90°28'22"	1967-
3.9	Usumacinta	11.03.02	San Fernando	C	100	16°46'03"	90°46'31"	1967-
3.10	San Pedro	11.01.05	Flores	A	115	16°55'44"	89°53'29"	1973-
		11.03.04P	Urrutia	A	100	16°53'58"	91°02'07"	1980-
		11.05.05P	San Pedro Mactún	A	60	17°15'25"	90°45'10"	1973-

Note: The code number with "P" means the station is equipped with automatic rainfall recorder.

Table 2-2 CLASSIFICATION OF METEOROLOGICAL STATIONS UNDER INSIVUMEH, FEGUA AND EEGSA

Type	Number of Elements	Elements
A	5 or more than 5	Rainfall, Temperature, Evaporation, Relative Humidity and one element or more from Sunshine, Wind, Air Pressure and Radiation
B	4	Rainfall, Temperature, Evaporation, and Relative Humidity
C	2	Rainfall and Temperature
D	1	Rainfall

Table 2-3 METEOROLOGICAL STATIONS IN GUATEMALA UNDER INDE

	River System	Code	Name	Type	El. (m.MSL)	Latitude	Longitude	Observation Period
1.5	Samalá	13.24.11	Zunil	D	1,716.00	14°44'39"	91°29'12"	1971-
		13.24.02	Santa María	P	1,777.00	14°45'23"	91°31'44"	1977-
1.10	María Linda	15.01.07	El Salto	D	110.00	14°29'[illegible]"	90°41'[illegible]"	1939-
		15.01.11	San Luis	D	90.00	14°20'[illegible]"	91°45'[illegible]"	1939-
		05.01.14	Casa de Maquinas Jurún Marinalá	D	34.00	14°17'[illegible]"	90°43'[illegible]"	197--
		05.07.04	Palín	D	1,027.00	14°24'[illegible]"	90°42'[illegible]"	1939-
		05.07.06	Jurun Marinalá	P	900.00	14°23'18"	90°42'46"	1970-
		05.09.05	Agua Caliente	P	721.00	14°17'20"	90°39'[illegible]"	197[illegible]-
		06.08.07	Compuertas Amatitlán	P	1,150.00	14°29'10"	90°39'[illegible]"	197[illegible]-
		06.17.04	Guatemala Sur	P	1,480.00	14°32'35"	90°35'[illegible]"	197[illegible]-
		16.02.06P	La Pastoria	P	1,720.00	14°16'29"	90°30'[illegible]"	1973-
1.15	Los Esclavos	16.01.06	La Providencia	D	1,191.00	14°17'27"	90°14'05"	1972-
		16.12.03	Media Legua	D	1,260.00	14°11'[illegible]"	90°15'20"	1972-
2.3	Izabal Dulce	01.02.03	Chajbelen	D	460.00	15°36'05"	89°40'29"	1977-
		01.11.12	Sepamac	P	840.00	15°32'16"	89°42'35"	1977-
		01.11.13	Seamay	D	940.00	15°34'30"	89°48'[illegible]"	1977-
		02.04.07	Purulha	D	1,[illegible]"	15°[illegible]"	90°[illegible]"	197[illegible]-
2.5	Cahbón	01.03.11	Sasar	P	1,660.00	15°35'10"	90°03'[illegible]"	1979-
		01.03.12	Caquipec	P	1,620.00	15°35'[illegible]"	90°12'[illegible]"	197[illegible]-
		01.03.13	Xecacac	P	940.00	15°29'31"	90°[illegible]"	197[illegible]-
		01.04.02	San Juan Chamelco	P	1,310.00	15°28'[illegible]"	90°20'[illegible]"	197[illegible]-
		01.07.11	Chahabonc[illegible]to	D	[illegible]	15°27'[illegible]"	89°33'[illegible]"	197[illegible]-
		01.08.03p	San Cristobal	P	1,385.00	15°21'[illegible]"	90°[illegible]"	197[illegible]-
		01.08.04p	Las Pacayas	P	1,600.[illegible]	15°16'[illegible]"	90°31'[illegible]"	197[illegible]-
		01.08.05p	Cerro la Laguna	P	2,[illegible]	15°23'[illegible]"	90°31'[illegible]"	197[illegible]-
		11.11.06	El Volcan	D	840.00	15°[illegible]"	89°[illegible]"	19[illegible]-
3.7	Salinas (Chixoy)	01.01.05	Cubilquitz	D	619.00	15°[illegible]"	90°[illegible]"	197[illegible]-
		01.08.06p	La Providencia	P	830.00	15°25'39	5°[illegible]"	197[illegible]-
		01.0[illegible].07p	La Navidad	P	1,[illegible]	15°24'[illegible]"	9°[illegible]"	197[illegible]-
		13.17.02p	Estancia de la Virgen	D	1,[illegible]	15°[illegible]"	91°[illegible]"	197[illegible]-
		14.01.01	Santa Cruz del Quiche	P	[illegible]	15°[illegible]"	91°[illegible]"	197[illegible]-
		14.03.05p	Chajul	D	1,[illegible]	15°29'[illegible]"	91°[illegible]"	197[illegible]-
		14.11.01p	San Andres Sajcabaja	D	1,[illegible]	15°[illegible]"	90°[illegible]"	197[illegible]-
		14.12.01p	San Antonio Ilotenango	D	1,[illegible]	15°[illegible]"	91°[illegible]"	1977-
		14.14.01	Quiñal	D	[illegible]	15°[illegible]"	90°[illegible]"	197[illegible]-
		14.15.06p	Chicaman	D	1,[illegible]	15°[illegible]"	90°[illegible]"	1977-
		14.16.07p	El Paradillo	D	1,[illegible]	15°[illegible]"	91°[illegible]"	1977-
		14.16.03p	Comitancillo	D	1,[illegible]	15°[illegible]"	91°[illegible]"	197[illegible]-

Note: The code number with "P" means the station is equipped with automatic raifall recorder.

Table 2-4 CLASSIFICATION OF METEOROLOGICAL STATIONS UNDER INDE

Type	Number of Elements	Elements
B	6	Rainfall, Temperature, Evaporation, Relative Humidity, Sunshine and Wind.
C	2	Rainfall and Temperature
D	1	Rainfall

Table 2-5 (1/2) WATER LEVEL STATIONS IN GUATEMALA UNDER INSIVUMEH

RIVER SYSTEM	CODE	NAME	CATCHMENT AREA (Km2)	EL. (m.MSL)	LOCATION LATITUDE	LOCATION LONGITUDE	OBSERVATION PERIOD AUTOMATIC RECORDER	OBSERVATION PERIOD STAFF GAUGE
1.1 Coatán	17.27.01H	Cuntaj	140.68	2120.00	15°13'20"	92°05'20"	1971-	1971
1.2 Suchiate	17.11.01H	Malacatán	394.63	360.00	14°54'25"	92°57'42"	1974-	
	17.22.01H	Parf	11.50	1220.00	14°58'24"	91°55'00"	1971-1979	1971-1975
	17.24.01H	Coritzia	53.63	1160.00	14°57'58"	91°54'15"	1971-1980	1971-1980
	17.24.02H	Chayen	83.50	750.00	14°54'55"	91°56'52"	1971-1979	1971-1982
1.3 Naranjo	13.06.01H	Coatepéque	500.81	290.94	14°43'05"	91°52'25"	1971-	1971-
	13.07.01H	Chuvá	90.31	290.00	14°44'05"	91°43'45"	1975-1979	1971-1979
	17.14.01H	Melendres II	149.22	20.00	14°42'52"	92°05'50"	1971-1978	1971-
	17.14.02H	Pajapita	185.03	40.00	14°44'10"	92°02'58"	1971-1979	1971-1978
	17.23.01H	Corral Grande	167.50	1705.88	14°54'04"	91°45'20"	1971-	1971-
1.4 Ocosito	15.01.01H	Caballo Blanco	461.62	47.79	14°29'57"	91°51'03"	1969-	1969-
1.5 Samalá	13.05.01H	Cantel	701.04	2453.89	14°48'33"	91°27'03"	1965-1978	1965-70, 72,74-75 76-78
	13.09.01H	Candelaria	861.12	719.52	14°39'04"	91°33'55"	1962-	1962-75, 76-
	21.06.01H	Cañón del Brujo	129.00	2482.00	14°56'57"	91°27'00"	1979-1983	
1.6 Sis Ican	20.01.01H	Bracitos	483.50	16.40	14°15'20"	91°33'28"		1970-1974
	20.02.01H	La Máquina	155.75	27.38	14°18'48"	91°36'15"	1970-74,76-	1970-74, 76-
1.7 Nahualate	05.12.01H	Barrilas	190.00	67.12	14°17'48"	91°20'05"	1970-75	1970-75
	19.08.01H	Paquibo	38.08	1679.34	14°40'56"	91°19'42"		1966-74, 76-79
	19.13.01H	Sta Catarina Ixt.	144.70	1670.39	14°46'08"	91°21'20"		1962-79
	20.03.01H	Montecristo	120.88	228.99	14°28'46"	91°21'31"	1972-	1973-
	20.11.01H	San Miguel Mocá	619.50	176.23	14°27'32"	91°22'27"	1970-	1970-
	20.17.01H	San Mauricio	1190.69	30.21	14°14'19"	91°26'56"	1971-77	1971-77
1.8 Atirlán	19.02.01H	Concepción Pocrero	38.29	1888.97	14°47'30"	91°08'25"	1967-79	1967-
1.9 Madre Vieja	03.06.02H	Panibaj	165.15	631.23	14°30'08"	91°05'18"	1962-62, 70-75	1962-73, 76-79
	19.10.01H	Sto. Tomás Perdido	22.92	1168.38	14°35'07"	91°07'15"	1964-69, 70-	1964-69, 70-
	19.10.02H	Pte. Quixayá	8.00	797.02	14°31'52"	91°07'48"	1965-70, 72-	1965-70, 72-
	19.10.04H	Vert. Quixayá	10.00	153.18	14°30'55"	91°07'28"		1969-75, 76-79
	19.10.05H	Vert. Sta. Teresa	24.69	668.68	14°31'00"	91°07'18"		1968-75, 76-79
	20.04.01H	Palmira	363.88	386.91	14°26'50"	91°08'28"	1963-	1963-
1.10 Coyolate	03.06.03H	La Presa	74.84	2061.55	14°39'46"	90°59'05"	1971-76	1971-1980
	05.05.01H	Cerro Colorado	1154.38	42.19	14°10'00"	91°10'29"		1970-1980
	20.04.02H	Pte. Coyolate	511.88	213.87	14°22'35"	91°08'12"	1971-	1972-
1.11 Acomé	05.05.02H	La Comera	212.06	25.63	14°04'20"	91°02'58"	1971-75, 76-80	1971-75, 76-81
1.12 Achiguate	03.03.01H	Pte. Itzapa	27.35	1740.00	14°38'31"	90°49'17"	1981-83	1981-82
	03.04.01H	Pte. Parramos	19.45	1718.00	14°36'57"	90°48'22"	1981-82	1981-82
	16.10.01H	Alotenango	328.05	1350.00	14°28'56"	90°48'26"	1980-	1974-
1.13 María Linda	05.01.01H	Calvillo	36.61	400.00	14°19'30"	90°45'50"		1974-
	05.02.01H	Las Guacamayas	671.69	54.92	14°08'45"	90°37'57"	1968-83	1968-83
	18.11.01H	El Pino	0.72	1022.18	14°20'30"	90°23'30"		1963-
1.15 Los Esclavos	18.10.01H	Poza Escondida	54.62	1435.92	14°26'26"	90°07'55"		1962-79
	18.10.02H	El Portezuelo	14.00	1406.70	14°25'57"	90°08'12"		1962-
1.16 Paz	10.09.01H	El Jobo	1595.63	297.18	14°01'00"	89°54'25"	1967-80	1967-81
1.17 Ostúa Guija	09.03.01H	Casa de Tablas	321.25	1005.00	14°31'35"	89°55'25"	1965-79	1965-
	10.03.01H	El Jircaral	99.70	460.00	14°16'55"	89°41'25"		1966-
	10.03.02H	El Guayabo	44.20	421.10	14°14'10"	89°31'25"	1976-77	1976-77
	10.03.03H	Las Lechuzas	873.75	470.00	14°21'15"	89°42'45"	1964-1979	1965-78
	10.03.05H	Los Llanitos	320.00	460.00	14°19'15"	89°41'38"		1966-1979
	10.03.06H	La Montañita	55.63	514.70	14°15'04"	89°42'55"		1964-1979

(CONTINUED)

Table 2-5 (2/2) WATER LEVEL STATIONS IN GUATEMALA UNDER INSIVUMEH

RIVER SYSTEM		CODE	NAME	CATCHMENT AREA (Km2)	EL. (m. MSL)	LATITUDE	LONGITUDE	OBSERVATION PERIOD	
								AUTOMATIC RECORD	STAFF GAUGE
1.17	Ostúa Guija (Continued)	10.03.07H	Tasannattes	64.03	432.13	14°14'15"	89°33'08"		1966-80
		10.03.08H	Las Cruces	1474.38	420.00	14°13'00"	89°37'00"	1967-79	1967-
		10.04.01H	Ateucatempa	5.60	586.37	14°12'25"	90°41'40"		1963-77
2.1	Grande de Zacapa	04.02.01H	Camotán	1413.12	410.34	14°49'20"	89°22'15"	1969-	1969-
		10.02.01H	Log de Ipala	0.00	1489.09	14°33'07"	89°38'38"		1973-82
2.2	Motagua	02.03.01H	Concuá II	2524.06	607.16	14°52'10"	90°34'50"	1966-1980	1966-79
		03.01.01H	El Tesoro	145.96	1719.21	14°40'46"	90°51'15"	1962-1978	1962-81
		06.03.01H	San Ant. Las Flores	231.94	1102.35	14°45'25"	90°30'10"	1972-1977	1971-79
		08.05.01H	Morales	14452.53	33.11	15°28'47"	88°49'15"	1969-	1969-
		09.01.01H	Puente Jumay	102.69	1345.84	14°38'21"	89°58'43"		
		12.04.01H	Panajax	1502.75	407.71	14°52'12"	90°23'54"	1970-1979	1970-
		12.06.01H	Pte. Orellana	5802.88	264.64	15°55'07"	90°00'07"	1969-	1969-
		14.17.01H	Chiché	208.18	1846.78	14°58'57"	91°04'42"	1972-1979	1972-79
		22.07.01H	Pasabién	78.82	290.79	15°02'36"	89°41'08"		1964-
2.3	Izabal Dulce	08.02.01H	El Estor	589.60	0.95	15°31'40"	89°20'00"	1970-1979	1970-
		08.04.01H	Mariscos	589.60	0.2	15°25'38"	89°04'44"		1970-
2.4	Polochic	01.07.02H	Panzós	2158.12	5.66	15°23'40"	89°37'51"	1969-1979	1969-79
		01.07.03H	Talemán	1541.68	19.30	15°20'00"	89°44'00"	1969-1979	1969-79
		01.07.04H	Boca Nueva	168.78	12.34	15°22'24"	89°45'00"	1969-	1969-
		01.07.05H	Matucuy	944.60	66.10	15°17'45"	89°53'25"	1971-1979	1971-79
		01.14.01H	Tucurú	69.39	443.09	15°18'34"	90°05'35"		1973-79
		02.01.01H	Chilascó	67.20	1830.67	15°07'05"	90°06'39"	1962-1979	1962-70
2.5	Cahabón	01.03.03H	San Pedro	38.45	1330.00	15°27'15"	90°18'30"		1976-80
		01.08.01H	San Cristobal Verapaz	0.45	1378.60	15°21'35"	90°28'30"		1964-79
2.6	Sarstún	08.03.01H	Modesto Mendez	1377.19	9.94	15°53'46"	89°13'45"	1971-	1971-
		11.09.01H	San Pedro Cadenas	1377.19	2.83	15°56'45"	89°14'39"	1971-79	1971-79
3.1	Cuilco	07.06.01H	Cuilco	1602.70	1108.93	15°24'18"	91°54'10"	1971-	1971-
3.2	Selegua	07.04.01H	Xemal	463.35	1498.42	15°24'22"	91°42'15"	1964-1979	
		07.08.01H	Chojil	1022.59	627.80	15°42'05"	91°54'45"	1971-	1971-
3.3	Nentón	07.01.01H	La Laguna	655.63	745.00	15°45'90"	91°45'80"	1976-1979	1976-79
		07.01.03H	Nentón	261.25	790.00	15°48'10"	91°44'30"	1976-1980	1976-79
3.7	Salinas (Chixoy)	01.05.01H	San Augustin Chixoy	10908.40	131.51	16°14'21"	90°36'30"	1971-1982	1967-81
		02.06.02H	Maranzas	90.19	148.02	16°06'18"	90°11'27"		1966-79
3.8	La Pasión	11.03.01H	Paso de Piedra	730.25	115.35	16°37'57"	90°12'16"		1972-81
		11.11.01H	El Porvenir	12156.00	120.00	16°31'10"	90°29'00"	1967-	1967-
		11.12.01H	Machaquilá	384.50	429.89	16°23'36"	89°26'40"		1973-78
3.9	Usumacinta	11.03.02H	San Fernando						1966-74
		11.03.04H	Urrutia		100.00	16°53'58"	91°02'07"	1979-1981	1977-81
3.10	San Pedro	11.01.01H	San Miguel Petén	99.00	109.90	16°56'02"	89°53'24"	1971-1976	1971-
		11.05.01H	San Pedro Martín					1975-	1973-

Table 2-6 WATER LEVEL STATIONS IN GUATEMALA UNDER INDE

	River System	Code	Name	(Km²) Catchment Area	(m. MSL) El.	Latitude	Longitude	Observation Period: Automatic Recorder	Staff Gauge
1.2	Suchiate	17.24.07H	Las Gradas	9.38	1,290.0	14°58'43"	91°53'59"		1966-
1.5	Samala	13.01.01H	Tecún Umán	216.25	1,515.0	14°50'43"	91°29'08"	1980-	
		13.24.02H	El Tunel	708.75	1,195.0	14°46'18"	91°30'10"	1979-	
		13.24.03H	Chuyul	6.42	2,200.0	14°47'38"	91°27'52"		1979-
		13.24.04H	Chintima	15.33	2,220.0	14°47'29"	91°28'12"		1979-
		13.24.05H	Pachamixa	7.38	2,220.0	14°48'28"	91°28'42"		1979-
1.12	Achiguate	05.01.03H	Monte María	-	722.0	14°28'22"	90°40'00"	1972-	
		05.01.04H	Desv. Monte María	-	725.0	14°23'23"	90°49'02"		1973-
		05.01.05H	San Diego	17.56	620.0	14°22'18"	90°48'25"		1979-1984
1.13	María Linda	05.01.02H	Vertedero El Salto	-	320.0	14°18'15"	90°15'17"	1970-	
		05.07.02H	Palín	567.19	1,116.3	14°23'48"	90°41'30"	1971-	
		05.07.03H	Desaren Jutún Mar I y II	-	1,908.5	14°23'15"	90°42'40"		1976-
		05.07.04H	El Farol	528.64	1,140.0	14°24'25"	90°40'35"		1977-
		05.07.05H	Toma El Farol	-	135.0	14°24'18"	90°42'32"		1977-
		06.02.01H	El Morlón	15.20	1,187.2	14°28'54"	90°36'25"	1961-	
		06.02.03H	Comp. Michatoya	399.31	1,186.8	14°29'10"	90°36'45"	1970-	
		06.02.04H	Las Mamacas	485.01	1,180.0	14°26'38"	90°38'40"	1974-	
		18.08.01H	Agua Caliente II	343.25	982.1	14°17'28"	90°20'29"	1977-1982	
		18.08.02H	Las Lomas	321.44	787.3	14°18'20"	90°28'18"	1972-1982,	1984-
		18.08.06H	El Morro	84.60	760.0	14°17'32"	90°31'25"		1977-1982
1.15	Esclavos	18.01.01H	La Sonrisa	966.40	760.6	14°15'52"	90°15'22"	1968-1982, 1984-	1968-
		18.04.01H	Chiquimulilla	589.75	56.4	14°00'45"	90°17'35"	1971-1984	
		18.04.02H	Sinacantán	1,233.85	340.0	14°06'50"	90°21'40"	1975-	
2.2	Motagua	08.05.02H	Las Quebradas	41.34	135.0	15°23'05"	88°44'45"		1976-1984
		22.07.02H	El Tule	48.40	581.2	15°04'27"	89°37'04"		1965-
2.3	Izabal Dulce	01.01.01H	Chiš	61.49	1,275.0	15°27'30"	90°22'30"		1975-
		01.03.01H	Chajcar	881.88	1,048.9	15°29'07"	90°11'10"	1962-	
		01.03.02H	Carchá	87.50	1,200.0	15°27'48"	90°17'15"		1971-
		01.03.04H	Chicuc I	36.18	957.0	15°29'41"	90°06'25"		1979-1984
		01.03.05H	Chicuc II	36.18	957.0	15°29'41"	90°06'25"		1979-1984
		01.06.01H	Lanquín	-	275.4	15°36'05"	89°57'45"	1971-	
		01.06.02H	Chipap	1,773.14	184.1	15°34'03"	89°55'05"	1971-	
		01.07.01H	Cahabonchito	-	20.7	15°27'36"	89°32'55"	1968-	
		01.07.02H	Chulac	2,350.50	42.5	15°30'58"	89°37'12"	1978-	
		01.08.06H	Valparaiso	99.50	1,490.0	15°20'15"	90°25'20"		1975-
		01.11.01H	El Volcán	103.43	480.0	15°28'55"	89°53'53"	1978-	
		08.02.02H	El Boquerón	312.38	20.0	15°33'30"	89°17'04"		1976-
		08.02.03H	Seacacar	300.43	90.0	15°35'12"	89°17'18"	1976-	
3.2	Belice	11.04.01H	El Cruzadero	2,011.13	130.3	16°59'05"	89°15'40"	1972-	
		11.04.02H	El Arenal	3,632.20	90.1	17°00'40"	89°08'30"	1972-	
		11.04.03H	Chiquibal	1,386.25	100.0	16°53'56"	89°11'11"	1979-	
3.5	Ixcan	07.27.01H	Yulquisis	1,270.00	270.0	15°51'02"	91°08'25"	1980-	
3.6	Xaclbal	14.03.03H	Xaclbal	725.00	290.0	15°47'46"	91°05'22"	1980-	
3.7	Salinas (Chixoy)	01.01.02H	Salchichaj	257.33	255.0	15°36'30"	90°36'38"		1976-1982
		01.01.03H	Chamá	6,096.32	240.0	15°35'58"	90°37'52"		1980-1982
		01.08.04H	Los Ganchos	6,092.94	290.0	15°30'47"	90°36'47"	1974-	
		01.08.05H	Quixal II	52.96	295.0	15°29'35"	90°36'35"	1975-	
		01.08.07H	San José	5,541.75	900.0	15°19'21"	90°29'10"	1975-	
		01.08.08H	Pita Floja I	5,883.88	450.0	15°26'32"	90°42'10"		1975-1983
		01.08.09H	Pambón	5,938.06	480.0	15°26'22"	90°39'33"		1975-1983
		01.08.10H	Pita Foja II	27.75	480.0	15°26'20"	90°42'21"		1975-1983
		01.08.11H	Las Cureñas	5,743.88	600.0	15°22'30"	90°42'05"		1975-1983
		01.08.12H	Quixalito	10.33	335.0	15°29'10"	90°35'45"		1976-1983
		02.02.01H	Chicruz	3,589.12	750.0	15°12'42"	90°35'09"	1972-1983	
		02.02.02H	Calí	336.81	760.0	15°13'03"	90°34'50"		1972-1983
		02.02.03H	Panxic	484.44	755.0	15°12'25"	90°35'00"		1972-1983
		02.06.01H	Las Astras II	153.30	990.0	15°04'09"	90°13'28"	1980-	
		14.03.01H	Santa María Copan	848.75	290.0	15°43'01"	90°47'25"	1976-1982	
		14.03.02H	El Playón	7,820.19	260.0	15°41'25"	90°52'15"	1976-1983	
		14.10.01H	Chisiguan	2,245.00	1,161.4	15°17'40"	91°04'08"	1969-	
		14.10.02H	Pie del Aguila	480.85	1,250.0	15°18'30"	91°10'15"		1977-
		14.15.01H	Las Torres	5,698.00	568.2	15°21'30"	90°39'30"	1962-1983	
		14.16.01H	El Paradillo	1,363.00	1,459.0	15°16'00"	91°19'00"	1976-	

Table 2-7 WATER LEVEL STATIONS IN GUATEMALA UNDER EMPAGUA

River System	Name	Catchment (Km2)	EL. (m.MSL)	Latitude	Longitude	Observation Period	
						Automatic Recorder	Staff Gauge
Motagua	Molino Tesoro	55.80	1969.57	14°55'08"	91°06'25"	1975-	
	Chipaca	40.15	2015.00	14°54'58"	91°04'27"	1975-	
	Panquiac	17.07	1958.50	14°55'18"	91°03'17"		1975-
	Pajuliboy	20.16	1953.54	14°54'40"	91°02'30"	1975-	
	Palima	88.19	1904.65	14°54'27"	91°02'40"	1975-	
	Panimacac	66.82	1620.35	14°49'56"	90°54'08"	1976-	
	Tululche	57.46	1721.20	15°00'28"	90°58'35"	1975-	
	Choaxan	46.14	1708.43	15°01'00"	90°58'35"		1975-78
	Cacabal	7.47	1749.62	15°01'50"	90°58'18"		1975-76

Table 2-8 TIDE STATIONS IN GUATEMALA

Code	Name	Latitude	Longitude	Observation Period
05.10.01 0	San José	13°54'53"	90°49'08"	1945-75
15.02.01 0	Champerico	14°17'25"	91°54'59"	1967-68
08.01.01 0	Santo Tomas de Castilla	15°41'37"	88°37'14"	1964-

Table 2-9 EXISTING METEOROLOGICAL DATA

Code	Name	Observation Period					
		Temperature	Humidity	Evaporation	Sunshine	Air Pressure	Wind
03.05.02	El Recuerdo	1967-	---	---	---	---	--
05.01.09	San Andrés Osuna	1938-40 1961-	---	---	---	---	--
05.01.14	Sabana Grande INSIVUMEH	1970-	1970-76 1979-	1974-76 1978-	---	---	--
05.01.17	El Chupadero INSIVUMEH	1972 1974-	1974-	---	---	---	--
05.07.01	María Santísima	1968-	---	---	---	---	--
05.08.05	San José Aero-Puerto INSIVUMEH	1970-74 1977-	1971-73 1978-80 1982-	---	1970-73	1970-73 1977-	1970-73
05.10.06 05.10.08	Camantilul INSIVUMEH	1965-	1970-	1975-	---	---	--

Note: Location of San José Aeropuerto; Latitude; 13°56'19"
Londitude; 90°50'12"
Elevation; 6 m

As for the location of the other stations, see Table 2-14 EXISTING RAINFALL DATA.

Table 2-10 MONTHLY MEAN TEMPERATURE

(Unit: °C)

Code	Name of Station	Item	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
05.08.05	Puerto San José INSIVUMEH	Max.	31.5	32.2	32.8	33.4	31.6	30.7	31.8	31.5	30.6	31.3	31.7	31.9	31.6
		Ave.	25.7	26.2	27.5	28.3	28.3	27.3	27.9	27.5	26.4	26.8	27.0	26.4	27.0
		Min.	18.4	18.5	20.6	22.2	23.5	22.5	22.5	22.7	22.8	22.6	21.9	19.5	21.6
05.01.17	El Chupadero INSIVUMEH	Max.	33.9	34.8	34.7	33.6	33.0	32.1	33.0	32.7	32.0	32.6	33.0	33.5	33.2
		Ave.	25.8	25.6	26.5	26.1	26.3	25.8	25.9	25.9	25.3	25.6	26.0	25.9	25.9
		Min.	20.0	20.2	21.2	21.5	21.4	21.7	21.5	21.2	21.0	21.0	20.8	19.6	20.9
05.10.08	Camantulul	Max.	32.1	33.1	33.7	33.5	32.0	31.0	31.0	31.6	30.8	30.8	31.3	31.7	31.8
		Ave.	24.1	25.5	25.6	26.0	25.7	25.3	25.5	25.0	24.8	24.7	24.8	24.2	28.0
		Min.	16.0	16.1	17.5	18.8	20.2	20.0	19.7	19.2	19.6	18.7	18.2	16.5	18.5
05.01.09	San Andrés Osuna	Max.	27.4	28.3	28.0	28.2	27.4	26.6	26.4	27.7	26.3	26.5	26.9	27.3	27.2
		Ave.	24.3	24.8	24.8	24.8	24.6	24.0	23.9	24.0	23.7	23.8	24.1	24.2	24.2
		Min.	21.3	21.4	21.3	21.5	21.8	21.5	21.4	21.4	21.2	21.2	21.3	21.1	21.4
03.05.02	El Recuerdo	Max.	20.7	21.0	22.0	21.8	22.4	20.5	21.1	20.7	20.3	20.9	21.2	21.8	21.2
		Ave.	13.4	13.6	14.8	15.4	16.5	15.7	15.8	15.6	15.3	15.5	14.8	14.2	15.0
		Min.	6.2	6.2	7.7	9.0	10.7	10.9	10.5	10.6	10.4	10.1	8.4	6.7	8.9

Table 2-11 MONTHLY MEAN RELATIVE HUMIDITY

(Unit: %)

Code	Name of Station	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
05.01.14	Sabana Grande	69.00	67.27	72.55	75.64	85.45	86.91	82.55	82.73	79.64	85.73	76.36	70.91	77.90
05.01.17	El Chupadero	70.44	65.44	66.22	69.44	77.78	81.89	79.33	78.78	80.44	81.33	76.22	67.89	74.60
05.08.05	San Jose Aero-puerto	75.38	71.50	73.88	73.88	80.00	82.38	80.88	82.38	84.88	83.88	79.25	75.00	78.52
05.10.08	Canantulul	76.17	73.50	73.58	75.08	83.42	85.50	84.33	84.67	85.92	86.67	81.67	78.83	80.78

Table 2-12 MONTHLY MEAN SUNSHINE HOUR

(Unit: hour/day)

Code	Name of Station	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
05.08.05	San Jose Aero-puerto	9.65	9.55	9.20	7.95	5.20	5.25	7.00	7.60	6.55	7.50	9.50	9.15

Table 2-13 MONTHLY MEAN EVAPORATION

(Unit: mm/day)

Code	Name of Station	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
05.01.14	Sabana Grande	4.7	4.8	3.9	3.4	2.4	2.7	3.1	2.8	2.1	2.9	4.1	4.2	1244.9*
05.10.08	Camantulul	4.7	5.4	5.4	4.9	4.2	3.9	4.0	4.2	3.8	3.5	4.0	4.1	1583.1*

Note : *: Unit mm/year

Table 2-14 (1/3) EXISTING RAINFALL DATA

CODE	NAME	LATITUDE	LONGITUDE	(m.MSL) ELEVATION	OBSERVATION PERIOD		REMARKS
					DAILY RAINFALL	HOURLY RAINFALL	
03.01.02	Los Apocentos ICTA	14°38'02"	90°48'12"	1776	1961-	1980	Guacalate
03.02.01	Las Delicias	14°31'32"	91°01'12"	1000	1929-		Out of Basins
03.05.02	El Recuerdo	14°37'00"	90°54'32"	2200	1967-	67-70 and 72-80	Out of Basins
03.12.01	Argentina	14°25'50"	91°00'55"	840	1961-1974		Out of Basins
03.12.04	Montevideo	14°27'08"	90°58'02"	990	1952-1954		Pantaleon
03.12.05	Morelia	14°25'15"	90°56'58"	900	1909-1959 and 62-63		Pantaleon
03.12.09	Santa Sofía	14°24'29"	90°58'11"	780	1911-1954 and 58-63		Pantaleon
05.01.02	Escuintla FEGUA	14°17'44"	90°47'00"	347	1934-		Out of Basins
05.01.04	Ceylan	14°23'57"	90°53'51"	1080	1958-1979		Ceniza
05.01.05	Concepcion	14°19'54"	90°47'09"	425	1934-1953		Guacalate
05.01.06	El Salto	14°17'55"	90°45'23"	200	1940-1980		Out of Basins
05.01.07	Los Cerritos	14°15'20"	90°49'08"	200	1948-1951		Guacalate
05.01.08	Sabana Grande	14°22'56"	90°49'45"	730	1950-1969		Guacalate
05.01.09	San Andres Osuna	14°22'40"	90°55'20"	760	1923-1952 and 1958-		Ceniza
05.01.10	San Antonio el Jute	14°23'18"	90°50'54"	770	1951-1955		Achiguate
05.01.13	Guacalate INDE	14°16'05"	90°48'21"	247	1965-1970	69-70	Guacalate
05.01.14	Sabana Grande INSIVUMEH	14°22'03"	90°49'52"	730	1970-	1969-	Guacalate
05.01.15	Mauricio INSIVUMEH	14°15'37"	90°48'02"	227	1970-1973	72-73	Guacalate

(CONTINUED)

Table 2-14 (2/3) EXISTING RAINFALL DATA

CODE	NAME	LATITUDE	LONGITUDE	(m.MSL) ELEVATION	OBSERVATION PERIOD		REMARKS
					DAILY RAINFALL	HOURLY RAINFALL	
05.01.17	El Chupadero INSIVUMEH	14°16'05"	90°47'33"	270	1974-	1974-1981	Out of Basins
05.04.01	Obispo FEGUA	14°15'00"	90°57'38"	220	1934-1969		Achiguate
05.04.03	Cuncuncito	14°13'17"	90°54'26"	119	1971-1972		Achiguate
05.06.04	Obero FEGUA	14°02'00"	90°49'55"	32	1934-1975		Out of Basins
05.06.05	Sta. Maria FEGUA	14°12'57"	90°50'22"	125	1934-		Guacalate
05.07.01	Maria Santisima	14°21'18"	90°44'42"	620	1958-		Out of Basins
05.07.03	Palin FEGUA	14°23'58"	90°41'50"	1130	1935-		Out of Basins
05.07.05	San Jose Bella Vista	14°23'03"	90°44'25"	900	1957-		Out of Basins
05.08.02	San Jose FEGUA	13°55'36"	90°49'11"	4	1934-		Out of Basins
05.10.03	Los Tarros	14°23'50"	90°59'36"	700	1935-1939 and 1949-		Out of Basins
05.10.05	Sta. Lucia FEGUA	14°19'02"	91°01'12"	340	1934-1979		Pantaleon
05.10.07	Belen	14°16'18"	91°05'47"	142	1966-1975		Out of Basins
05.10.08	Camantulul INSIVUMEH	14°19'28"	91°03'27"	280	1970-	1972-1979	Out of Basins
05.11.01	El Milagro	14°17'44"	90°58'25"	320	1956-1963		Mazate
05.11.02	La Suiza INSIVUMEH	14°19'51"	90°54'50"	280	1970-1972		Out of Basins
16.01.01	Antigua E.E.	14°33'20"	90°43'54"	1530	1934-		Guacalate
16.02.01	El Potrero	14°31'43"	90°45'59"	1518	1910-1980		Guacalate

(CONTINUED)

Table 2-14 (3/3) EXISTING RAINFALL DATA

CODE	NAME	LATITUDE	LONGITUDE	(m.MSL) ELEVATION	OBSERVATION PERIOD		REMARKS
					DAILY RAINFALL	HOURLY RAINFALL	
16.14.01	Florencia	14°33'31"	90°40'58"	1980	1933-1975		Guacalate
16.15.01	Sta. Maria de Jesus INSIVUMEH	14°29'34"	90°42'34"	2065	1972-		Out of Basins
I-1	Volcan de Agua INSIVUMEH	14°29'53"	90°45'27"	1980	1978-1983		Guacalate
I-2	Pastores INSIVUMEH	14°35'34"	90°46'00"	1800	1978-1983		Guacalate
I-3	San Sebastian INSIVUMEH	14°31'04"	90°49'03"	1560	1978-1983		Guacalate
I-4	El Rejon INSIVUMEH	14°37'04"	90°43'15"	2240	1978-1983		Guacalate
I-5	Chimaltenango INSIVUMEH	14°39'19"	90°48'27"	1720	1978-1983		Guacalate
I-6	Parrojas INSIVUMEH	14°35'15"	90°50'46"	1780	1978-1983		Guacalate
I-7	Volcan Acatenango INSIVUMEH	14°31'19"	90°51'17"	2460	1980-1983		Guacalate
I-8	Santiago Zamora INSIVUMEH	14°32'36"	90°48'20"	1600	1978-1983		Guacalate
I-9	Michigan INSIVUMEH	14°30'44"	90°48'16"	1440	1980-1983		Guacalate
I-10	Concepcion INSIVUMEH	14°32'38"	90°51'45"	2240	1979-1983		Guacalate
I-11	Tempixque INSIVUMEH	14°30'33"	90°48'33"	1460	1978-1983		Guacalate

Note: E.E.: GUATEMALAN ELECTRIC COMPANY
FEGUA: NATIONAL RAILWAY OF GUATEMALA
ICTA: INSTITUTE OF SCIENCE AND AGRICULTURE TECHNOLOGY
INSIVUMEH: NATIONAL INSTITUTE OF SISMOLOGY, VOLCANOLOGY, METEOROLOGY AND HIDROLOGY

The other stations are under private FINCA.

The code which starts from I-1 is numbered tentatively by the study team to show the location.

Table 2-15 MONTHLY MEAN RAINFALL

(Unit: mm)

Code	Name of Station	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Remarks
05.08.02	San José FEGUA	0 (0)	0 (0)	4.7 (1)	28.1 (2)	79.1 (6)	236.4 (13)	155.3 (10)	156.7 (10)	240.4 (12)	137.8 (8)	57.6 (2)	5.7 (1)	1101.8 (60)	1960-79
05.10.05	Santa Lucía FEGUA	11.2 (1)	11.5 (1)	34.0 (3)	133.4 (7)	316.7 (14)	484.0 (20)	357.1 (17)	404.3 (18)	567.6 (19)	471.9 (19)	154.1 (7)	23.0 (1)	2968.8 (125)	1960-79
05.01.02	Escuintla FEGUA	3.7 (2)	9.9 (1)	24.4 (2)	100.3 (7)	324.4 (14)	565.9 (19)	284.2 (15)	334.9 (16)	571.3 (21)	340.4 (15)	125.5 (5)	9.6 (1)	2594.5 (111)	1960-79
05.01.04	Ceylan	21.8 (2)	28.4 (3)	76.0 (5)	204.1 (11)	605.8 (21)	767.0 (26)	484.2 (21)	583.4 (23)	797.5 (28)	576.3 (24)	180.2 (8)	41.5 (4)	4366.2 (172)	1960-79
05.10.03	Los Tarros	29.0 (3)	34.2 (3)	80.0 (5)	235.8 (10)	517.1 (17)	736.9 (22)	614.0 (20)	650.5 (21)	865.9 (24)	749.0 (22)	256.5 (10)	55.0 (2)	4824.4 (156)	1960-79
16.02.01	El Potrero	3.2 (1)	5.7 (1)	6.7 (1)	22.4 (2)	83.7 (7)	206.4 (15)	128.5 (10)	133.9 (10)	196.8 (14)	77.3 (6)	20.6 (2)	1.8 (1)	887.0 (70)	1960-79
03.01.02	Los Aposentos	3.6 (1)	3.8 (1)	3.9 (1)	23.0 (3)	107.9 (10)	184.8 (16)	128.5 (12)	154.3 (14)	201.8 (16)	95.3 (14)	17.8 (3)	3.2 (2)	927.9 (93)	1971-79

Table 2-16 ANNUAL MAXIMUM DAILY BASIN RAINFALL

Rank	Achiguate				Pantaleon	
	Reference Point I		Reference Point II		Reference point	
	Date	mm/day	Date	mm/day	Date	mm/day
1	05/09/69	184.6	05/09/69	140.2	05/09/69	170.0
2	20/09/82	153.4	01/11/61	102.3	01/11/61	135.0
3	01/11/61	144.0	20/09/82	94.4	08/08/66	110.9
4	08/08/66	134.2	11/06/65	61.9	21/08/74	98.7
5	28/07/70	123.6	21/09/67	61.3	31/08/64	94.8
6	31/08/64	121.7	31/08/64	60.3	19/09/82	92.8
7	04/06/68	108.2	17/09/77	60.1	08/09/65	81.3
8	17/09/77	101.3	08/08/66	55.6	17/09/77	80.9
9	21/09/67	99.1	28/07/70	54.9	29/10/81	78.7
10	09/09/75	83.7	31/08/73	54.7	04/07/68	78.2
11	11/06/65	78.3	22/09/63	53.1	08/06/73	77.9
12	03/10/76	77.8	04/06/68	52.8	14/07/75	76.4
13	20/10/63	77.1	09/09/75	51.2	28/07/70	75.9
14	13/10/71	74.1	01/06/78	48.5	23/09/80	74.9
15	31/08/73	71.3	13/09/79	47.9	13/10/71	74.5
16	13/09/79	66.4	29/10/81	45.6	13/09/79	71.1
17	01/06/78	66.3	22/06/74	44.3	14/07/78	70.7
18	09/10/72	64.7	17/09/62	43.7	25/09/62	70.0
19	29/10/81	64.4	12/06/80	38.3	20/10/63	69.5
20	22/06/74	61.7	03/10/76	36.1	05/10/76	68.9
21	12/06/80	59.6	08/10/72	33.4	21/09/67	63.9
22	25/09/62	56.5	13/10/71	32.5	15/10/72	52.5

Table 2-17 PROBABLE DAILY BASIN RAINFALL

Return Period (Year)	Achiguate		Pantaleon
	Reference Point I (CA=205.1 Km^2)	Reference Point II (CA=956.2 Km^2)	Reference Point (CA=150.0 Km^2)
100	229	178	208
50	206	159	186
30	188	140	169
20	174	127	157
10	151	105	135
5	126	82	112
2	88	47	76

Table 2-18 EXISTING WATER LEVEL DATA (AUTOMATIC) IN AND AROUND THE STUDY AREA

River System	Code	Name	Catchment Area (km^2)	(m. MSL) EL.	Latitude	Longitude	Observation Period
Achiguate	16.10.01H	Alotenango	328.05	1350.00	14°28'56"	90°48'26"	1980-
Nahualate	20.03.01H	Montecristo	120.88	228.99	14°28'46"	91°21'31"	1972-
	20.11.01H	San Miguel Moca	619.50	176.23	14°27'32"	91°22'27"	1970-
	20.17.01H	San Mauricio	1190.69	30.21	14°14'19"	91°26'56"	1970-75, 77
Madre Vieja	03.06.02H	Panibaj	165.15	631.23	14°40'08"	91°05'18"	1962-68, 70-75
	20.04.01H	Palmira	363.88	386.91	14°26'50"	91°08'28"	1963-68, 73-77,81-
Coyolate	20.04.02H	Puente Coyolate	511.88	213.87	14°22'40"	91°08'12"	1971-
	05.05.01H	Cerro Colorado	1154.38	42.19	14°10'00"	91°10'29"	1971-76
Acome	05.05.02H	La Gomera	212.06	25.63	14°04'20"	91°02'58"	1972-76, 78-80
Maria Linda	18.08.02H	Las Lomas	321.44	787.44	14°18'20"	90°28'18"	1972-82
	18.08.01H	Agua Caliente I	343.25	682.13	14°17'28"	90°30'29"	1962-76
	18.08.01H	Agua Caliente II	343.75	628.10	14°17'28"	90°30'29"	1977-82
	05.02.01H	Las Guacamayas	671.69	54.91	14°08'45"	90°37'57"	1968-83

Table 2-19 OBSERVING CONDITION OF WATER LEVEL STATIONS NEAR ACHIGUATE AND PANTALEON RIVERS

River	Code	Name	Observing condition
Nahualate	20.03.01H	Montecristo	Good.
	20.11.01H	San Miguel Moca	Relatively Good. Suspention in 1972 and 77.
	20.17.01H	San Mauricio	Overflow in upper Stream. Short observation period (From 1970 to 75 and 77).
Madre Vieja	03.06.02H	Panibaj	Short observation period due to frequent suspention. especially from 1962 to 68.
	20.04.01H	Palmira	Short observation period due to frequent suspention.
Coyolate	20.04.01H	Puente Coyolate	Overflow in upper stream.
	05.05.01H	Cerro Colorado	Overflow in upper stream. Short observation period (From 1971 to 76).
Acome	05.05.02H	La Gomera	Overflow in upper stream.
Maria Linda	18.08.02H	Las Lomas	Short ovservation period due to suspention. in 1976, 77, 79 and 80.
	18.08.01H	Agua Caliente	Influence by confluence of tributary.
	05.02.01H	Las Guacamayas	Short observation period due to suspention in 1972,74 and from 78 to 81.

Table 2-20 ANNUAL MAXIMUM DISCHARGE AT MONTECRISTO AND SAN MIGUEL MOCA STATIONS

	20.03.01H Montecristo CA=120.88 Km^2			20.11.01H San Miguel Moca CA=619.50 Km^2		
Rank	Date	H(m)	Q(m^3/sec)	Date	H(m)	Q(m^3/sec)
1	22/07/79	4.10	755.9 (6.25)	19/09/78	2.95	1,207.8 (1.95)
2	23/08/81	4.00	714.1 (5.91)	20/09/74	2.44	787.4 (1.27)
3	25/05/74	3.83	646.7 (5.35)	25/08/73	2.25	712.0 (1.15)
4	23/07/80	3.50	546.1 (4.52)	28/08/71	2.17	705.4 (1.14)
5	25/08/73	3.50	546.1 (4.52)	23/07/80	2.10	704.2 (1.14)
6	10/09/75	3.34	486.4 (4.02)	11/09/75	2.08	698.9 (1.13)
7	07/10/78	3.08	396.0 (3.28)	30/08/79	2.06	690.5 (1.11)
8	23/09/72	2.63	266.6 (2.21)	14/09/70	1.98	657.9 (1.06)
9	01/10/77	2.36	240.4 (1.99)	23/10/81	1.98	657.9 (1.06)
10	01/09/76	1.99	190.6 (1.58)	01/09/76	1.52	431.6 (0.70)

Table 2-21 PROBABLE DISCHARGE AT MONTECRISTO AND SAN MIGUEL MOCA STATIONS

Unit: m^3/s

Return Period (Year)	20.03.01H Montecristo CA=120.88 Km^2	20.11.01H San Miguel Moca CA=619.50 Km^2
100	1300 (10.75)	1860 (3.00)
50	1160 (9.60)	1650 (2.66)
30	1060 (8.77)	1490 (2.41)
10	830 (6.87)	1150 (1.86)
5	680 (5.62)	920 (1.49)

( ): Specific Discharge ($m^3/s/km^2$)

Table 2-22 PROBABLE DISCHARGE AT REFERENCE POINTS

Unit: m^3/s

Return Period	Achiguate		Pantaleon
	Reference Point I CA=205.1 Km^2	Reference Point II CA=956.2 Km^2	Reference Point CA=150.0 Km^2
50	1310 (6.39)	1860 (1.95)	1220 (8.13)
30	1190 (5.80)	1670 (1.75)	1110 (7.40)
20	1090 (5.31)	1520 (1.59)	1020 (6.80)
10	920 (4.49)	1250 (1.31)	870 (5.80)
5	750 (3.66)	970 (1.01)	710 (4.73)
2	480 (2.34)	550 (0.56)	470 (3.13)

( ) : Specific Discharge $(m^3/s/km^2)$

Table 2-23 PROBABLE DISCHARGE AT SUPPLEMENTARY POINTS

Unit: m^3/s

Return Period (Year)	Ceniza CA=112.7 Km^2	Achiguate A /1 CA=92.4 Km^2	Achiguate B /2 CA= 327.0 Km^2
50	1150 (10.20)	1090 (11.80)	1460 (4.46)
30	1050 (9.32)	1000 (10.82)	1320 (4.04)
20	960 (8.52)	920 (9.96)	1210 (3.70)
10	820 (7.28)	790 (8.55)	1010 (3.09)
5	680 (6.03)	660 (7.14)	810 (2.47)
2	460 (4.08)	450 (4.87)	500 (1.53)

Note: /1 Achiguate A: Above the confluence with Ceniza River
/2 Achiguate B: Above the confluence with Guacalate River
( ) : Specific discharge ($m^3/s/km^2$)

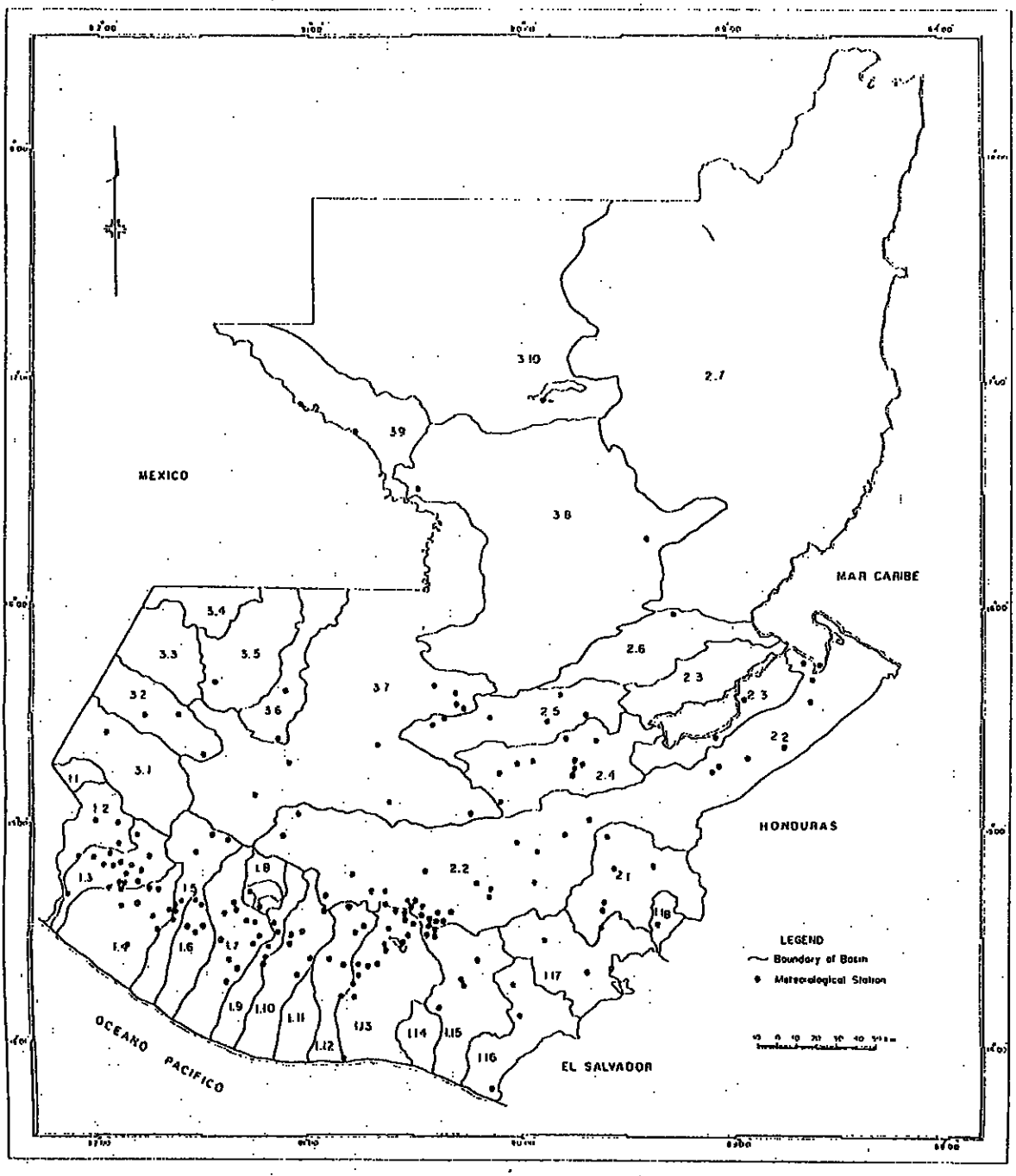

Fig. 2-1 LOCATION OF METEOROLOGICAL STATIONS IN GUATEMALA UNDER INSIVUMEH, FEGUA AND EEGSA

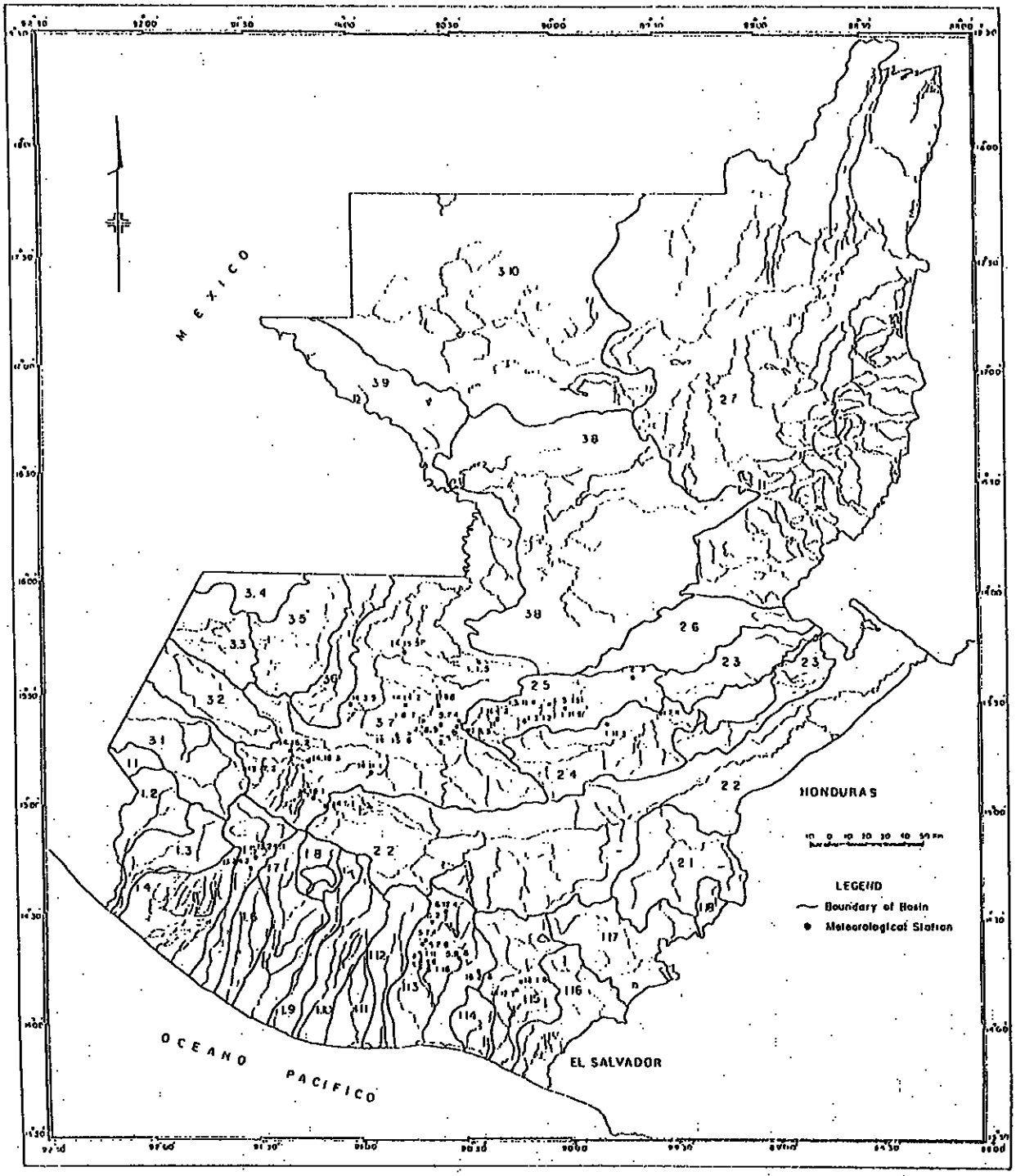

Fig. 2-2 LOCATION OF METEOROLOGICAL STATIONS IN GUATEMALA UNDER INDE

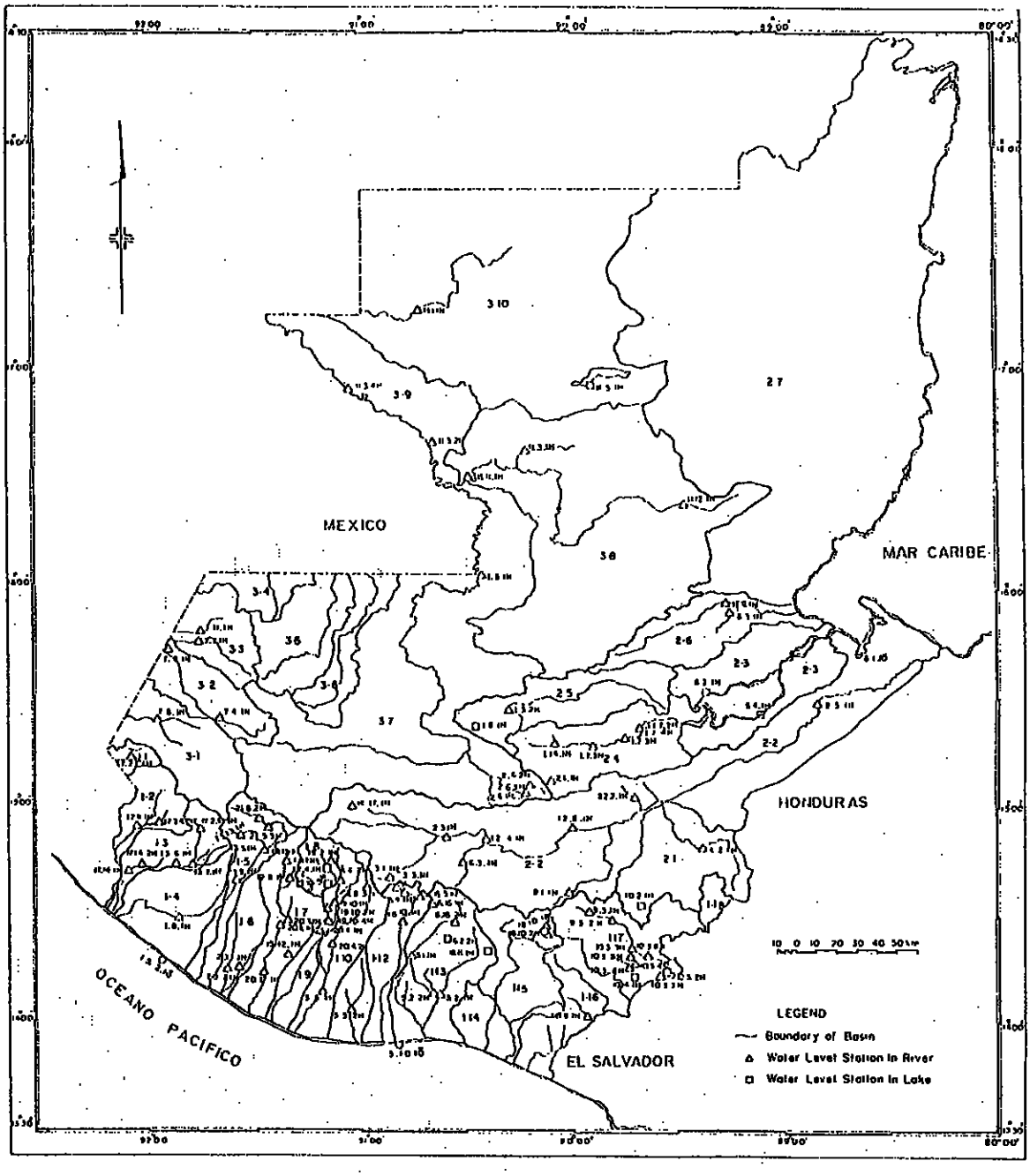

Fig. 2-3 LOCATION OF WATER LEVEL STATIONS IN GUATEMALA UNDER INSIVUMEH

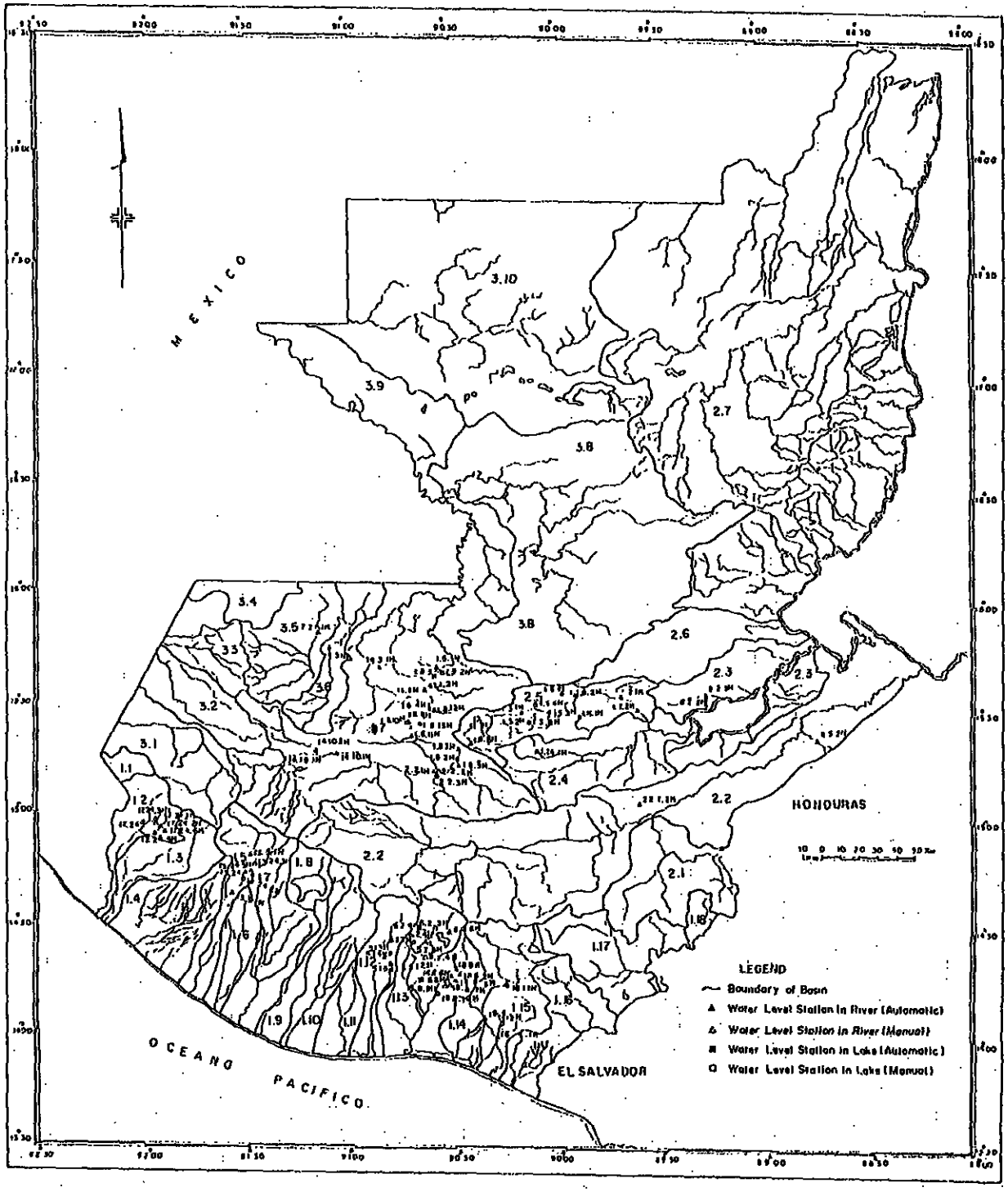

Fig. 2-4 LOCATION OF WATER LEVEL STATIONS IN GUATEMALA UNDER INDE