GOVERNMENT OF THE REPUBLIC OF HONDURAS

Ministry of Public Health

STUDY FOR GROUNDWATER DEVELOPMENT PROJECT IN COMAYAGUA

FINAL REPORT

APPENDIX

OCTOBER 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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IN

COMAYAGUA

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I. GENERAL

The Republic of Honduras which is located in a central mountain area of Central America is a traditional agricultural country. 60 % of labor force and 30 % of GDP are accounted for by the agricultural sector, and also 80 % of exports are the agricultural products which are represented by bananas and coffee. However, the economic growth of agricultural sector was a low rate of 3 % per annum during recent five years.

Public investment for domestic water supply has not been done sufficiently for inhabitants in the agricultural land, despite the agriculture is the most important industry of Honduras. Such insufficient investment was due to a little budget of the Government. The low service of domestic water supply for the inhabitants has led them to work for carrying water spending a part of their farming time and has brought bad disease to them by using water of inferior quality. These things came to decrease the agricultural productivity and was a hindrance to the development of Honduran economy.

The dull development of national economy will lead to decline a growth in the government budget due to a little increase in tax revenue, and as a result a favorable investment will not be able to be expected to the public social services such as domestic water supply.

As a way to break such a vicious circle, a public investment, apart from the ordinary budget of the Government, should be made for the domestic water supply to inhabitants in the farm land in order to reduce their works for obtaining water and water borne disease.

The socio-economic study is carried out to evaluate from a social and economic view-point for the groundwater development in the Comayagua valley which has been projected as a part of policies for the improvement of social environment and the promotion of economic development in the valley. The project evaluation will be discussed in the Final Report based on the project cost and the project benefit which is estimated from the socio-ecnomic data, and some parts of the social and economic situations of the country and Comayagua valley are discussed in the succeeding paragraphs of this Interim Report.

II. NATIONAL ECONOMY

2.1 Gross Domestic Product (GDP) and Gross National Product (GNP)

The Gross Domestic Product (GDP) at current price of Honduras amounted to Lps. 7,060 million in 1987 against Lps. 5,757 million in 1984 at an average growth rate of 7.0 % per annum during the period 1984-1987, but the real growth rate was 2.9 % per annum during the same period. Of the total GDP, the agricultural sector accounted for some 30 % every year since 1984. The manufacturing industrial sector which has a high value added relatively has taken second place in the GDP share, but it was only approximately 15 % of the sum of GDP and its annual growth rate was less than 1 % on average for the said period (see Table 2.1.1).

The Gross National Product (GNP) at current price increased from Lps. 6,154 million in 1984 to Lps. 7,654 million in 1987 at an average growth rate of 7.5 % per annum during the period 1984-1987, but its real growth was a low rate of 3.2 % per annum on average (see Table 2.1.1).

The per capita GNP at current price was estimated at Lps. 1,889 in 1987 increasing by Lps. 233 against Lps. 1,656 in 1984, and for this period the annual growth rate showed 4.5 % on average (see Table 2.1.1). However, the real growth rate was only 0.2 % per annum, that is , this rate indicates that the average living standards of Honduran people have not nearly risen during the period 1984-1987. It seems that such a low growth is due mainly to a stagnancy of development of the agricultural and manufacturing industrial sectors.

2.2 Agricultural and Industrial Production

1) Agricultural Production

Honduras is located in a tropical zone and produces many tropical agricultural products which are represented by maize, beans, rice, sorghum, coffee, bananas, plantains, sugar cane, african palm, cotton and tobacco. Table 2.2.1 shows these productions for the period 1982-1987. Of these products, maize, beans and rice are mainly consumed in the country as major foods of Honduran people. In recent years the production of rice has been remarkably increased, that is, it achieved higher growth rate than 12 % per annum during the above period, while the productions of maize and beans were going down at the rates of 1.1 % and 2.4 %, respectively. As a result, statistics show that the total production of these products maintained a constant volume approximately during the said period (see Table 2.2.1). Considering that the population of Honduras was increasing for this period, it shows that consumption of the staple food per capita was decreasing.

Of the principal agricultural products, bananas, coffee and sugar cane are important as major export goods of Honduras. Productions of bananas and coffee grew at an average annual rate of 1.8 % and 6.6 %, respectively for the period 1982-1987, while sugar cane was decreasing at an annual rate of 1.3 % on average during the same period, under the influence of the keen competition in the world sugar market and national recession of Honduras (see Table 2.2.1).

Apart from the agricultural crops, Honduras has an extensive cattle farming industry which is operated using the wide pastures. According to statistics, number of cattle which was carved for edibles of Honduran people and for export use as the frozen meat amounted to some 205,000 heads in 1986, and more than 50 % of the meat production in the country were made in three Departments of Francisco Morazan, Cortes and Choluteca which produced about 54,000, 39,000 and 22,000 in head in 1986, respectively. Pigs also were an important livestock as edibles for inhabitants, and the production of pork amounted to some 157,000 in head in the same year. Both Departments of Francisco Morazan and Cortes were the most producing areas of pork, and the production accounted for approximately 60 % of the total production in the country (see Table 2.2.2).

2) Industrial Production

Manufacturing Industry of Honduras, in middle- and small-scale factories, cement, produces iron bar, textiles, cigarettes, matches, sugar, and other industrial foods such as vegetable fats, beer, soft drink, liquor, etc., and almost all of them are consumed in the country except some quantities of export goods; cement, sugar, cigarettes, etc. The majority of these goods are manufactured in San Pedro Sula where is the greatest industrial zone in Honduras.

According to statistics, productions of cement, iron bar and textiles amounted to 8.728 million bags (42.5 kg / bag), 13,729 tons and 14.48 million yards in 1987 at the average annual growth rate of 6.0 %, 16.7 % and 7.6 %, respectively, since 1982 or 1984. Although sugar, vegetable fats, cigarettes and distilled liquor were produced 4.09 million quintals, 62.276 million pounds, 85.179 million boxes (20 pieces / box) and 1,323 liters in 1987, respectively, these productions were going downward at the average annual rates of 2.3 %, 2.2 %, 5.7% and 6.7 %, respectively, during the period 1982-1987 or 1984-1987 (see Table 2.2.3).

It seems that the depression of sugar industry is the inevitable under the influence of the keen competition in the world market, however, judging from categories of industrial goods manufactured at present, it may be difficult to expect a striking growth in industrial sector. It is expected to introduce manufacturing industries with a high value-added for promoting the development of Honduran economy.

2.3 External Trade

1) Export

Exports of Honduras amounted to Lps. 1,651 million in 1987 increasing by Lps. 342 million against Lps. 1,309 million in 1982. An average annual growth rate of the exports indicated 4.8 % for the above period. The exports of bananas and coffee which were the most important ones among export goods amounted to Lps. 648.5 million and Lps.

416.7 million in 1987, respectively, or the total of both exports achieved about two-third of the entire exports in 1987 expanding gradually the share in exports since 1982 . During the period 1982-1987 the growth in both exports showed the high rates of 8.2 % and 6.4 % per annum on average, respectively (see Table 2.3.1).

Besides, there were export goods such as wood, lead & zinc, frozen meat, shrimp & lobster and sugar which amounted to Lps. 76.2 million, Lps. 27.0 million, Lps. 42.2 million, Lps. 122.8 million and Lps. 39.0 million in the 1987 exports, respectively. However, the exports of these goods, except shrimp & lobster, were going downward during the said period, as shown in Table 2.3.1. The exports of shrimp & lobster were remarkably increased at an average annual rate of 17 % during the period 1982-1987 in compliance with the increased demand for them in the world market.

2) Import

Imports of Honduras amounted to Lps. 1,797 million in 1987 at an average increase rate of 4.8 % per annum since 1982, but after 1984 the increase rate was making dull, e.g. less than 1 % per annum. Major imported commodities during the above period were machinery & transportation materials, manufactured products, chemical products, oil & lubricants and food products which amounted to Lps. 415.9 million, Lps. 508.8 million. Lps. 406.0 million. Lps. 208.0 million and Lps. 178.8 million in 1987, and their increase rate for the period 1982-1987 showed 8.7 %, 5.2 %, 9.6 %, -9.4 % and 8.9 % per annum on average, respectively (see Table 2.3.2). More than 90 % of the whole imports were occupied by necessaries goods for the daily life and the social and economic activities of Honduran people.

Concerning Honduran external trade, imports exceeded exports every year for the period 1982-1987, as shown in Tables 2.3.1 and 2.3.2, and such trade deficits were always filled by a capital account and others as indicated in the succeeding paragraph.

2.4 Balance of International Payments

Generally speaking, international payments of Honduras every year have been balanced by supplementing with transfer account and capital account to make up the deficits of trade and service accounts, and the current account which consists of trade balance, service account and transfer account has always indicated deficit. According to statistics, the deficit of the current account, during the period 1982-1987, showed a decreasing tendency year by year and came to Lps. 366.6 million in 1987 decreasing by nearly 20 % from Lps. 448.8 million in 1982. Owing to the decrease in the deficit of the current account, the balance of international payments was turning for the better after 1985 (see Table 2.4.1).

The deficit of the current account in each year has been supplemented by the capital account which included the external loan, for maintaining the balance of international payments in the year concerned, hence the external loan has been accumulated year by year. The accumulated external debt at the end of 1987 was roughly estimated to be Lps. 4,000 million, consisting of Lps. 3,000 million for the government sector and Lps. 1,000 million for the private sector.

2.5 Government Finances

The Government budget amounted to Lps. 2,370 million in 1987 increasing by Lps. 887 million from Lps. 1,483 million in 1982. Growth in the budget for this period showed a high rate of 9.8 % per annum on average. The majority of the Government revenue, or 80 %, were occupied by tax revenue and debt which amounted to Lps. 1,116 million and Lps. 788 million (internal debt of Lps. 564 million and external debt of Lps. 224 million) in 1987, respectively. The tax revenue consists mainly of income tax, taxes on production, domestic trade & transactions, import duties and export duties which came to Lps. 298 million, Lps. 365 million, Lps. 345 million and Lps. 96 million in 1987, respectively. The total tax of these four categories, Lps. 1,104 million, accounted for 47 % of the Government revenue in the same year. More details are shown in Table 2.5.1.

The Government budget expenditure was chiefly composed of current expenditure, capital expenditure and public debt service which in 1987 amounted to Lps. 1,516 million, Lps. 315 million and Lps. 458 million, and which in the same year accounted for 64 %, 13 % and 19 % of the whole budget expenditure, respectively. Where, the capital expenditure means various investment expenditures of the Government, and the public debt service means a repayment for internal and external debts and their interests. The average annual growth rate of these three expenditures showed 11.8 %, 3.8 % and 25.5 % for the period 1982-1987, respectively. It was noticeable that the growth in the current expenditure showed a high rate relatively and the repayment of debt and its interest was increasing at a high rate year by year (see Table 2.5.1).

The budget expenditure of the Ministry of Public Health (Ministerio de Salud Publica) which is responsible for the present study amounted to Lps. 234 million in 1988 increasing by Lps. 40 million from the 1987 budget as shown below:

Budget Expenditure of the Ministry of Public Health

	1983	1984	1985	1986	1987	1988
Budget	185	169	173	261	194	234
Growth rate (%)	-	-8.6	2.4	50.8	-25.7	20.6

Unit: Million lempiras

An annual growth rate of the budget expenditure of the Ministry showed approximately 8 % on average for the period 1983-1988, and the budget expenditure in each year accounted for a rate between 10 and 12 % of the whole budget expenditure of the Government.

2.6 Prices and Wage

1) Prices

a. Wholesale Prices

Prices in Honduras rose at a high rate before 1982, joining with the rise in prices in the world, but since 1982 the prices have stabilized relatively. The wholesale prices showed 170.4 in general index in 1987, as 100 in 1978, at an average annual rise rate of 6.10 % for the period 1978-1987, but 2.56 % for the period 1982-1987. In the wholesale prices, the prices of domestic and imported goods showed 166.0 and 179.3 in the price index in 1987, respectively, e.g. the rise in prices of the domestic goods were generally lower than that of the imported goods, for the period 1978-1987.

In the domestic goods, the prices were making a stabilization for agricultural products, foods and chemicals, while showed the fairly high rise rate for textiles and beverages during the period 1978-1987; 164.0 and 227.0 in the price index in 1987, respectively. Petroleum showed a high price index of 211.8 in 1987, but this index was somewhat lower than that in 1982, and after 1982 its price stabilized quite due to an overproduction of oil in the world.

In the imported goods, the prices of beverages, textiles and chemicals rose considerably during the period 1978-1987, e.g. 228.8, 220.2 and 189.6 in the price index in 1987, respectively, though the prices of food and pharmaceuticals were stabilizing comparatively during the same period. These details are shown in Table 2.6.1.

b. Consumer Prices

The consumer prices indicated higher rise rate than that of the wholesale prices as the whole during the period 1978-1987; 197.8 in the general index in 1987 at an average rise rate of 7.87 % per annum during the said period. After 1982 the rise, somewhat going down, showed a rate of 4.54 % per annum on average for the period 1982-1987. In the consumer prices, the prices of housing, clothing, health care, beverages and education & entertainment showed particularly high rise rates for the period 1978-1987; 221.3, 242.6, 247.1 and 215.6 in the price index in 1987, respectively (see Table 2.6.2).

2) Wage

According to statistics, in 1987 the unemployment rate indicated about 12 % in Tegucigalpa, the capital city. In general, inhabitants in rural areas have a little opportunity for making economic activities, compared with the big cities such as Tegucigalpa and San Pedro Sula. Therefore, it is said that the unemployment will come to a fairly high rate in the whole country, especially in rural areas. A more promotion of industrial development in rural areas will be required to increase the employment opportunity of rural inhabitants.

There are no available statistics on wage of worker in Honduras, but according to some information from authorities concerned, the wage of worker is low generally, for example, it is said that at present the medium standing worker will get a salary between Lps. 500 and Lps. 1,000 per month. Judging from such a low wage level and a few employment opportunity, it will be difficult for the time being that the economic living conditions of Honduran people are greatly improved.

The Government has made efforts for development of industries throughout various economic development plans in the past for the purpose of prosperity of the country and inhabitants, on the other hand the Government has made control of the minimum wage to ensure a living standard of workers. Table 2.6.3 shows a minimum wage by economic activity which has been operated since 1981. The minimum wage ranges between Lps. 7.10 and Lps. 4.60 per day by occupation, and it does not make difference between urban and rural areas, except some occupations. The minimum wage system is important as a security for living of the worker, however, it is a problem that the 1981 minimum wage is effective at present, despite the consumer prices have risen at a rate of 4.5 % per annum on average since 1981.

III. STUDY AREA

3.1 Administration

1) General

The Republic of Honduras holds the respective independence of the three powers of administration, legislation and judicature, and the national administration is carried out by ten Ministries (Ministerio or Secretaria) as shown below:

- Ministerio de Governacion y Justicia
- Secretaria de Planificacion, Coordinacion y Presupuesto
- Secretaria de Relaciones Exteriores
- Ministerio de Hacienda y Credito Publico
- Secretaria de Recursos Naturales
- Ministerio de Economia y Comercio
- Ministerio de Trabajo y Asistencia Social
- Ministerio de Salud Publica
- Ministerio de Educacion Publica
- Ministerio de Obras Publicas y Transporte

Apart from the above Ministries, the Government has 27 unit of public enterprises such as Servicio Autonomo Nacional de Acueductos y Alcantarillados (SANAA), Empresa Nacional de Energia Electrica (ENEE) and Banco Central de Honduras (BANTRAL).

The country is administratively divided into 18 Departments under the jurisdiction of the Central Government, and the Governor of each department is appointed by the Central Government. In respective departments, there are municipalities (municipios) which amount to 289 units in the whole country. The municipality is called "city (ciudad)", "town (pueblo)" or "village (aldea)" according to the scale of population, and each municipality has a right of self-government. The head of municipality is elected by the vote of inhabitants.

The Ministry of Public Health (Ministerio de Salud Publica) which is in charge of the present study is divided into sanitary bureau, administration bureau and ten(10) special divisions at the political level, and eight(8) sanitary regional offices and twenty two(22) national hospitals at the execution level, under the jurisdiction of the Director General in the Ministry. In 1989 the Ministry has officials and employees of some 4,000 persons, consisting of 500 persons in the head office and 3,500 persons in the eight regional offices (excluding the national hospitals). The organization chart of the Ministry is illustrated in Figs. 3.1.1, 3.1.2 and 3.1.3.

2) Study Area

The Study Area which covers the whole floor of the Comayagua Valley consists of a part of both Departments of Comayagua and La Paz, and has an area of 470 square km. Administratively, the Study Area contains nine municipalities; Comayagua, Ajuterique, Humuya, Lamani, Lejamani, San Sebastian and Villa de San Antonio in the Department of Comayagua, and La Paz and Cane in the Department of La Paz. Of these municipalities, the Comayagua city, which was the capital of Honduras until 1880, at present is the capital of the Department of Comayagua and plays a central role in the social and economic aspects in the Comayagua Valley. Both Communities of San Nicolas and Flores are included in the Municipality of Villa de San Antonio, and the Community of Yarumela is contained in the Municipality of La Paz, administratively.

The Study Area has regional offices of various governmental agencies; the Ministry of Public Health (Ministerio de Salud Publica), Servicio Autonomo Nacional de Aqueductos y Alcanterillados (SANAA), Empreso Nacional de Energia Electrica (ENEE), Direccion General de Irrigacion, etc., and further Centro de Entrenanuento de Desarrollo Agricola

(CEDA), which is a development project in Secretaria de Recursos Naturales, is located in the Study Area.

Of these agencies, the Ministry of Public Health has the Second Sanitary Regional Office in the Municipality of Comayagua. This Office has functions of operation and administration on health and sanitation for inhabitants in the Region where contains three Departments of Comayagua, La Paz and Intibuca, and it administers the Santa Teresa Hospital in the Municipality of Comayagua and clinics in Municipalities of La Esperanza, Siguatepeque and Marcala. The Second Sanitary Regional Offices, except hospitals, has officials and employees of some 350 persons. General organization chart of the Regional Office is illustrated in Fig. 3.1.2.

3.2 Population

1) General

Since 1960, the population censuses of Honduras have been carried out three times; 1961, 1974 and 1988 censuses. According to the above censuses, the population of Honduras attained to 4,376,939 in 1988 against 2,656,948 in 1974 and 1,884,765 in 1961, and the population density increased from 17 persons per square km in 1961 through 24 persons per square km in 1974 to 39 persons per square km in 1988. The average annual rate of population growth showed 2.68 % and 3.63 % for the periods 1961-1974 and 1974-1988, respectively (see Table 3.2.1). This growth rate was a fairly high figure in view of the general trend of various countries.

The population of the Tegucigalpa city, the capital, attained to 595,931 in 1988 against 305,387 in 1974, and for this period it showed a high growth rate of 4.89 % per annum on average. The population of the Department of Francisco Morazan, which includes the Tegucigalpa city, became nearly 800,000 in 1988 increasing by about 350,000 against the population in 1974 at a growth rate of 4.11 % per annum during the period 1974-1988, and the population density came to more than 100 inhabitants per km^2.

The San Pedro Sula city, the second large city of Honduras, also has shown a high growth in population, that is, the population in 1988 amounted to 319,740 in 1988 increasing by nearly 60 % against that in 1974, at the growth rate of 3.38 % per annum on average. The population of the Department of Cortes, which includes the San Pedro Sula city, attained to about 650,000 in 1988 from 370,000 in 1974 at an annual growth rate of 4.05 % during the said period, and the population density in 1988 showed 163 inhabitants per km^2, e.g. the highest density among Departments of Honduras.

As against the high population density of Departments of Francisco Morazan and Cortes, respective Departments of Gracias a Dios, Olancho and Colon in the eastern region had the remarkably low densities of population which showed 2.1, 11.6 and 16.5 inhabitants per km^2 in 1988, though the population grew at the comparatively high rates of 3.63 %, 4.54 % and 4.62 %, respectively, during the period 1974-1988 (see Table 3.2.1). Such low densities of population in the said three departments indicate that the eastern region of Honduras is very behind in the social and economic development compared with other regions.

2) Study Area

The population of each Department of Comayagua, La Paz and Intibuca which constitute the Sanitary Region No.2 came to 238,790, 105,996 and 123,515 in 1988, respectively, and these population totaled up to 468,298. The average annual growth rate of population showed 4.07 %, 3.44 % and 2.99 % for the said three Departments, and 3.73 % for the Region No.2, respectively (see Table 3.2.2). Compared these growth rates with the average growth rate (3.63 %) for the whole country, the Department of Comayagua was higher, but other two Departments were lower, and as a result the growth in population of the Region No.2 showed somewhat higher rate than the average in the whole country. The population densities of the above three Departments, as shown in Table 3.2.2, ranged from 40 to 46 inhabitants per km^2 in 1988, and the average density of them, or the population density of the Region No.2

showed 44 inhabitants per km^2 which were more 5 inhabitants per km^2 than the average density for the whole country.

The population in the Study Area, as shown in Table 3.2.2, increased from 42,784 in 1961 through 62,305 in 1974 to 109,175 in 1988, and the average annual growth rate showed 2.93 % and 4.09 % for the periods 1961-1974 and 1974-1988, respectively. As for the average growth rate of population per annum for the period 1974-1988, the Study Area was almost the same as the Department of Comayagua.

The population of the Comayagua city increased from 19,055 in 1961 through 30,760 in 1974 to 59,534 in 1988 at the average annual growth rates of 3.75 % and 4.83 % for the periods 1961-1974 and 1974-1988, respectively. The population of La Paz which was a representative city in the Comayagua Valley together with the Comayagua city increased to 19,900 in 1988 against 8,876 in 1961 and 11,775 in 1974, and the growth rates during both periods from 1961 to 1974 and from 1974 to 1988 indicated 2.20 % and 3.82 % per annum on average, respectively, which were somewhat lower than the average rates in the Study Area for the said both periods.

The rate of population growth in each municipality in the Study Area was high relatively for Humuya and Villa de San Antonio together with Comayagua, and low for San Sebastian and Lamani, especially San Antonio showed a low growth rate of 1.43 % per annum on average for the period 1961-1974 and -0.10 % for the period 1974-1988 (see Table 3.2.2).

The population in urban areas of Honduras increased from 833,179 which corresponds to 31.4 % of the 1974 population in the whole country to 1751,505 corresponding to 40.0 % of the 1988 country population, or share of the rural population decreased at the opposite rate against the urban population. In the Sanitary Region No.2, the ratio of population between the urban and rural areas showed 26 : 74 in 1988 against 20 : 80 in 1974, or the growth rate of the urban population was lower compared with that of the whole country. In particular, the population growth in the urban areas in both Departments of La Paz and

Intibuca showed very low rates as shown in Table 3.2.3.

In the Study Area, the urban population increased from 27,868 (45.2 % in share) in 1974 to 59,590 (54.6 % in share) in 1988, or the urban population exceeded the rural population in 1988. Of Municipalities in the Study Area, Comayagua, Ajuterique, Lamani, Villa de San Antonio and La Paz had in the urban area population more than that in the rural area, especially the urban population in Lejamani increased from zero (0) in 1974 to 2,797 (89.6 % in share) in 1988. While the urban population in respective Municipalities of Humuya, Lamani, San Sebastian and Cane indicated still zero (0) in 1988, e.g. these municipalities had no urban area (see Table 3.2.3).

According to the Housing Censuses in 1974 and 1988, number of houses occupied in Honduras increased from 463,004 in 1974 to 809,263 in 1988 at an annual rate of 4.07 % on average for the period 1974-1988, and average number of persons per house occupied decreased from 5.74 persons in 1974 to 5.41 persons in 1988.

In the Sanitary Region No.2, the number of houses increased to 81,985 in 1988 against 48,980 in 1974 at an average annual rate of 3.75 % during the same period, and the average number of persons per house decreased somewhat from 5.81 persons in 1974 to 5.71 persons in 1988, or this number in 1988 was somewhat high compared with that in the same year in the whole country (see Table 3.2.4).

In the Study Area, the number of houses amounted to 19,814 in 1988 increasing by 9,191 against the number in 1974, or the increase rate showed 4.55 % per annum on average during the period 1974-1988. This increase rate was higher about 0.5 % than that in the whole country for the same period. Of Municipalities in the Study Area, Comayagua and Humuya showed the comparatively high increase rates of house number during the same period, or 5.41 % and 5.99 % per annum on average, respectively. On the other hand, Ajuterique, Lamani and San Sebastian indicated the low rate of increase in house number, or 2.69 %, 2.31 % and 1.05 %, respectively, for the same period (see Table 3.2.4).

The average number of persons per house in the Study Area decreased from 5.87 persons per house in 1974 to 5.51 persons per house in 1988. This number in 1988 was lower than that in the Sanitary Region No.2, though somewhat higher than that in the whole country in the same year. Regarding municipalities in the Study Area, the average number of persons per house ranged from 4.7 to 5.9 persons in 1988, and showed the lowest number of 4.78 persons for the Municipality of Cane (see Table 3.2.4).

The trend of Honduran population is summarized as follows: the population growth of Honduras showed a fairly high rate during the period 1961-1988, and this high growth was conspicuous in both Departments of Francisco Morazan and Cortes which include the two largest cities; Tegucigalpa and San Pedro Sula, respectively. As a result, the population density exceeded 100 persons in these two Departments in 1988. Such trend of more growth in urban areas also indicated in the Study Area, that is, the Comayagua city which had the largest population in the Study Area showed the highest rate of population growth during the same period, and the ratio of population between urban and rural areas altered from 45 : 55 in 1974 to 55 : 45 in 1988 in the Study Area. Besides, number of persons per house decreased by approximately 0.3 persons for the period from 1974 to 1988 in either case of the whole country and the Study Area. These facts indicate that the urbanization has been in progress rapidly for recent 15 years in the whole area of Honduras.

3.3 Agriculture

The country is divided into seven(7) agricultural regions; 1. Southern, 2.West-Central, 3. Northern, 4. Atlantic Coastal, 5. East-Northern, 6. East-Central and 7. Western. The Study Area is included in the West-Central Region (Region No.2) which consists of three Departments of Comayagua, La Paz and Intibuca. The agricultural statistics are mainly made by region, not by department.

According to the National Agricultural Census in 1974, the Agricultural Region No.2 had an agricultural area of 3,136 km^2 which corresponded to 30 % of the total area (10,599 km^2). This share of 30 % was higher than that (23 %) in the whole country. This agricultural area consisted of 1,252 km^2 in the Department of Comayagua, 784 km^2 in the Department of La Paz and 1,100 km^2 in the Department of Intibuca, and it was composed of the crop land of 985 km^2 (31 %), the pasture land of 1,252 km^2 (40 %), the forest land of 867 km^2 (28 %) and other lands of 32 km^2 (1 %). Details are shown in Table 3.3.1.

The Region No.2 has produced various crops such as maize, beans, rice, tobacco, cabbage, onions, potatoes, sugar cane, coffee and orange, etc. Of these crops, it is needless saying that main crops such as maize, beans and rice are important crops, and further cabbage, onions, potatoes and coffee also are typical crops of the Region No.2. According to the National Agricultural Study in 1984, the Region No.2 produced cabbage of 91,804 quintals, onions of 14,413 quintals, potatoes of 81,389 quintals and coffee of 548,751 quintals in the same year, which accounted for 64 %, 35 %, 97 % and 34 % of the total production in the country, respectively (see Table 3.3.2).

The Study Area where accounts for the most important part of crop land in the Region No.2 produces almost crops producing in the Region No.2. Major crops in the Comayagua valley are maize, beans, tomatoes, tobacoo, watermelons, chili peppers, coffee, onions, cucumber, etc. Of these crops, tomatoes and onions account for more than 50 % in production in the whole country, further watermelons and cabbages also are crops of significant production with the shares of about 20 % and 10 % in the country.

Land use in the Study Area can be classified into three large categories roughly; crop land of 13,000 ha, pasture land of 25,000 ha, and forest and others of 9,000 ha. Of the crop land, irrigation is executed through three large systems; Flores system, San Sebastian system and Selguapa system. In 1988 the total irrigation area amounted to about 4,000 ha which consists of the area of 1,604 ha, 231 ha and 2,157 ha in 1889, respectively (see Fig 4.2.6 in Main Report). Some 1,200 farmers utlize these irrigation system water paying the charge of Lps. 2.5 per ton, and the greater part of crops produced in the valley is made in these irrigation lands.

Apart from agricultural crops, cattle farming also is the major enterprise in the Comayagua valley. The large-scale cattle ranch is operated all over the valley, especially in the eastern part with the better pasture land. Although precise figures are not available for the area of pasture land and the number of cattle in the Project Area, it is estimated from the site information that 25,000 ha support about 25,000 heads, though with the comparatively low figure of about 1.5 ha per head in the southern area which is slow in developing the pasture land. As mentioned in Section 3.2.2, more than half of meat production of Honduras are made in three Departments of Francisco Morazan, Cortes and Choluteca. Beef, milk and cheese produced in the Comayagua Department are a comparatively few quantity but of good quality, particularly cheese gains high popularity.

In Honduras, 70 % of the farmers farms 10 % of the agricultural land on holdings of less than 10 manzanas (7 ha) each, and 6 % of the farmers operates 70 % of the land on holdings of more than 50 manzanas (35 %) each. The mean holding size is estimated at 16 manzanas (11 ha). In the Study Area, the mean holding size is about 14 ha which is somewhat higher than that in the country, but over 80 % of the farmer holdings are smaller than the mean.

The Study Area has two private factories called MASECA and Mejores Alimentos and one public agency, as enterprises concerned in the agricultural sector. MASECA and Mejores Alimentos have contributed for promoting the economic development in and around the Comayagua Valley as a milling factory of maize and as a cannery of foods, respectively. The public agency, Centro de Entrenanuento de Desarrollo Agricola (CEDA), has played a leading role for promoting the development of agriculture not only in the Comayagua Valley , but also in the country, throughout improvements of agricultural products and irrigation facilities, recommendation on agricultural policy to the Director General of Secretaria de Recursos Naturales, training for agricultural engineers, etc.

3.4 Road Communications

The Study Area is situated approximately 50 km northwest of Tegucigalpa, and the Central American Highway No.5 (CA5 Highway) which connects Tegucigalpa and San Pedro Sula runs from southeast to northwest in the Study Area through the Comayagua city. The network of main roads within the Study Area has the length of approximately 130 km which consists of paved roads of some 50 km (38 %) and unpaved roads of 80 km (62 %). This percentage of paved road length is higher than that(less than 15 %) in the whole country.

The paved roads consist of the CA5 Highway with 30 km within the Study Area, the access road with 15 km from La Paz to the CA5 Highway and the paved streets with 5 km within the Comayagua and La Paz cities, roughly. The CA5 Highway and the said access road, which are well paved by asphalt, give quick and easy access to cities or towns in municipalities of Comayagua, La Paz, Flores, San Nicolas, Yarumela and Villa de San Antonio.

Other main roads unpaved; routes of Comayagua-Ajuterique-Lejamani-La Paz-Cane with 25 km, Lamani-Villa de San Antonio with 15 km, Flores-CA5 Highway with 5 km and others with 20 km (except routes of Cane-Humuya and Cane-San Sebastian-Flores), are fairly well developed so as to be easy to get access to cities and towns concerned at all times of the year. On the other hand, some parts on routes of Cane-Humuya with 3 km and Cane-San Sebastian-Flores with 12 km are impossible to pass sometimes for the wet season due to the Humuya and Grande rivers swollen, e.g. in this case Humuya come to inaccessible.

Apart from the network of main roads, access roads to small communities are in bad condition generally. Some communities are difficult to get access by vehicle not only for the wet season, but also for the dry season. In addition to the bad condition of roads, for communities which are laborious to maintain the drinking water, a road improvement would be necessary for maintaining the basic human needs of inhabitants.

3.5 Water Supply

1) General

Domestic water supply in Honduras can be classified into three large systems; urban, rural and other special areas. The water supply in urban areas is in general carried out by Servicio Autonomo Nacional de Acueductos y Alcantarillados (SANAA), in rural areas by Ministerio de Salud Publica (MSP) and in other special areas by regional public agencies or private enterprises.

Objective areas of water supply by the SANAA are contained not only large cities such as Tegucigalpa and San Pedro Sula, but also towns and villages with 500 inhabitants or more. According to statistics, the water supply volume in 1987 by the SANAA amounted to 25.76 MCM, and its growth rate showed 2.1 % per annum on average for the period 1983-1987. This supplied water was consumed at the rates of 17.90 MCM (69 %) for domestic use, 2.98 MCM (12 %) for commercial use, 0.55 MCM (2 %) for industrial use and 4.33 MCM (17 %) for governmental use. A little water consumption in the industrial sector will be due to that Honduras has few factories comparatively and that lots of factories have water supply facilities for themselves. In the SANAA water supply system, the consumption volume of water for domestic use during the period 1983-1987 increased at an average annual rate of 5.2 %, while the water consumption volumes of commercial and industrial sectors were decreasing at the annual rates of 6.2 % and 13.3 % , respectively during the same period. It appears that this matter indicates a recession of Honduran economy for the said period (see Table 3.5.1).

2) Study Area

Existing water supply work in the Study Area is operated by the SANAA and some municipalities as shown in Table 1.2.1, Main Report. The served population in 1989 are estimated at nearly 63,000 which consist of 44,000 in the SANAA water supply system and 19,000 in the systems of six (6) municipalities of Ajuterique, Humuya, Lamani, Lejamani, San

Sebastian and Villa de San Antonio. Where, the SANAA system covers the urban areas of three (3) municipalities; Comayagua, La Paz (incl. Yarumela) and Cane. In 1989 the served ratio by these systems is estimated at nearly 60 % in all the Study Area.

The remaining 40 %, or some 46,000 inhabitants are self-sufficient in water from shallow wells and/or rivers close to respective communities. In their daily lives, usually the shallow wells are for drinking water use and the rivers are for domestic water use other than drinking. However, in case it is impossible to draw water from well due to drop of the well water level in the dry season or it is difficult to approach well due to the swollen river in the wet season, the river water is sometimes utilized for drinking water.

At present the Study Area has shallow wells of some 170 which are utilized for inhabitants at a rate of several tens of men per well on average, and the per capita water consumption appears to be in range from 20 to 30 l/c/d. Such existing shallow wells is not number to be satisfied even at present, and in the future the wells of a further increased number will be required due to the rapid growth in population and in per capita water consumption, Details of the future water demand are discussed in Section 5.2, Main Report. Almost all of the shallow wells are under the control of Ministerio de Salud Publica (MSP). An inspection is periodically carried out by the MSP officials in regard to the facilities, and water quantity and quality of shallow wells, and facilities of well, tank, etc. are cleaned and improved according to the need.

In the Study Area, a part of inhabitants, who live apart from the water supply systems of SANAA, municipalities and MSP, at present utilizes water of rivers and irrigation canals for their domestic use. This is among problem to be solved as soon as possible from the sanitary environmental point of view. Although the shallow well water is supposed to be in a favorable sanitary condition compared with surface water of river and irrigation canal, the Study Area is under the unfavorable condition which the well water is easily contaminated due to the penetration of wastewater from households and farmland to underground. Therefore it seems that improvement of the sanitary environment in the neighborhood of the shallow wells as well as increase in the number of wells are necessary to ensure the better quality and more quantity of the well water.

Tables

Table 2.1.1 GROSS DOMESTIC PRODUCT (GDP) AND GROSS NATIONAL PRODUCT, 1984 - 1987

Unit : Million lempiras

Item	1984	1985	1986	1987	Average Annual Growth Rate (%) 1984 - 1986
GDP by Economic activity at constant factor cost (1978 = 100)					
Agriculture	1,053	1,084	1,102	1,181	3.9
Mining Industry	87	89	87	75	-4.8
Manufacturing Industry	578	565	580	590	0.7
Construction	222	218	200	204	-2.8
Electricity, Gas and Water	52	55	60	60	4.9
Transportation & Communication	303	306	316	338	3.7
Wholesale & Retail	456	457	484	493	2.6
Banking, Insurance & Real estate	218	222	230	244	3.8
Dwelling property	236	254	258	272	4.8
Pub. administration & Defence	175	189	198	215	7.1
Other services	340	350	362	379	3.7
GDP at constant factor cost	3,720	3,789	3,877	4,051	2.9
Annual growth rate (%)	2.0	1.9	2.3	4.5	
GDP at market prices in real terms	4,175	4,308	4,426	4,612	3.4
Annual growth rate (%)	2.8	3.2	2.7	4.2	
Net factor payments from abroad	-197	-222	-244	-245	
GNP	3,978	4,086	4,182	4,367	3.2
Annual growth rate (%)	2.5	2.7	2.3	4.4	
Real GNP per capita (in lempiras)	1,070	1,068	1,062	1,078	0.2
at current prices					
GDP at factor cost	5,757	6,135	6,630	7,060	7.0
Annual growth rate (%)	6.2	6.6	8.1	6.5	
GNP	6,154	6,643	7,186	7,654	7.5
Annual growth rate (%)	7.0	7.9	8.2	6.5	
GNP per capita (in lempiras)	1,656	1,736	1,825	1,889	4.5

Source : Banco Central de Honduras, 1984-1986, 1985-1987

Table 2.2.1 PRINCIPAL AGRICULTURAL PRODUCTION, 1982 - 1987

Unit : Thousand quintals

Products	Production 1982	1983	1984	1985	1986	1987	Average Annual Growth Rate (%) 1982 - 1987
Maize	8,908	8,557	9,481	9,405	8,943	8,412	-1.1
Beans	1,090	988	1,099	1,115	1,114	963	-2.4
Rice	760	912	841	1,151	1,364	1,374	12.6
Sorghum	718	980	1,081	852	707	800	2.2
Coffee	1,583	1,752	1,596	1,653	1,677	2,179	6.6
Bananas	23,164	19,292	21,838	24,011	22,435	25,354	1.8
Plantains	3,370	3,572	3,615	3,779	3,953	4,024	3.6
Sugar cane	67,295	69,448	67,195	65,894	65,888	62,898	-1.3
African palm	3,101	3,777	5,721	7,632	7,422	7,832	20.4
Cotton	410	283	395	321	197	172	-15.9
Tobacco	163	163	170	116	104	106	-8.2

Source : Banco Central de Honduras

Table 2.2.2 NUMBER OF HEADS OF CATTLES AND PIGS CARVED BY DEPARTMENT, 1984 AND 1986

Unit : Number of Heads

Department	Cattle 1984 (1)	Cattle 1986 (2)	(3)= (2)-(1)	Pig 1984 (4)	Pig 1986 (5)	(6)= (5)-(4)
Honduras	239,416	205,333	-34,083	137,264	157,228	19,964
Departments						
1. Atlantida	8,741	8,917	176	9,446	7,552	-1,894
2. Colon	5,471	1,802	-3,669	2,143	2,192	49
3. Comayagua	8,326	10,459	2133	3,303	5,288	1,985
4. Copan	3,964	4,109	145	2,904	1,478	-1,426
5. Cortes	83,397	39,466	-43,931	20,992	29,679	8,687
6. Choluteca	27,984	21,724	-6,260	6,454	4,352	-2,102
7. El Paraiso	5,273	5,311	38	3,948	3,316	-632
8. Francisco Morazan	58,626	53,863	-4,763	59,529	74,605	15,076
9. Gracias a Dios	250	544	294	142	177	35
10. Intibuca	2,227	2,646	419	1,092	1,373	281
11. Islas de la Bahia	506	354	-152	153	118	-35
12. La Paz	3,602	3,408	-194	1,505	1,853	348
13. Lempira	2,396	2,170	-226	1,190	1,608	418
14. Ocotepeque	1,423	1,038	-385	968	581	-387
15. Olancho	9,359	27,544	18,185	1,931	1,497	-434
16. Santa Barbara	4,906	6,089	1183	4,158	6,037	1,879
17. Valle	3,338	2,716	-622	3,986	3,470	-516
18. Yoro	9,627	13,173	3,546	13,420	12,052	-1,368
Region No. 2 1/	14,155	16,513	2,358	5,900	8,514	2,614

Source : Anuario Estadistico, 1984, 1986, Secretaria de Planificacion y Presupuesto.
Note ; 1/ Region No.2 consists of three Departments of Comayagua, La Paz and In tibuca.

Table 2.2.3 PRINCIPAL INDUSTRIAL PRODUCTION, 1982 - 1987

Unit : Thousand

Products	Unit	Production 1982	1983	1984	1985	1986	1987	Average Annual Growth Rate (%) 1982- 1987
Cement	Bag of 42.5 Kg	6,528	11,422	12,569	8,177	7,094	8,728	6.0
Fiber cement plates	Sq. Mt	1,538	1,878	2,090	2,470	2,017	2,674	11.7
Iron bar	Kg	-	-	8,648	16,371	9,749	13,729	16.7 1/
Textiles	Yard	10,042	14,311	16,206	13,883	9,363	14,480	7.6
Wheat flour	Quintal	1,208	1,359	1,388	1,475	1,353	1,356	2.3
Sugar	Quintal	4,587	4,638	4,801	4,687	4,840	4,090	-2.3
Pasteurized milk	Liter	-	-	42,872	46,377	41,582	44,435	1.2 1/
Vegetable oil	Pound	-	-	6,597	4,619	4,606	10,807	17.9 1/
Vegetable fats	Pound	-	-	66,663	65,024	60,525	62,276	-2.2 1/
Cigarettes	Box of 20 pieces	114,072	101,221	106,936	115,594	89,644	85,179	-5.7
Matches	Box of 50 pieces	60,470	64,081	60,016	65,166	60,348	52,969	-2.6
Beer	Bottle of 12 oz.	110,546	131,160	142,398	132,204	103,781	113,903	0.6
Soft drink	Bottle of 12 oz.	444,674	489,606	516,093	533,452	405,306	461,730	0.8
Distilled liquor	liter	1,871	1,705	1,546	1,555	1,344	1,323	-6.7
Other liquor	liter	5,476	4,882	4,483	4,272	3,465	3,189	-10.2

Source : Banco Central de Honduras.

Note : 1/ Average annual growth rate for the 1984 - 1987 period.

Table 2.3.1 EXPORTS (FOB), 1982 - 1987

Unit : Million lempiras

Products	1982	1983	1984	1985	1986	1987	Average Annual Growth Rate (%) 1982 - 1987
Bananas	436.6	406.3	464.5	547.0	513.5	648.5	8.2
Coffee	306.2	302.4	338.2	370.4	644.1	416.7	6.4
Wood	89.3	80.8	69.7	68.2	64.6	72.6	-4.1
Lead & Zinc	32.4	49.6	76.1	71.8	64.9	27.0	-3.6
Silver	18.6	35.1	31.0	26.0	25.1	10.8	-10.3
Petroleum product	1.2	7.9	9.4	11.9	0.9	4.0	27.2
Frozen meat	67.8	62.7	42.4	36.3	39.9	42.2	-9.0
Shrimp & lobster	55.9	72.0	99.6	81.9	90.9	122.8	17.0
Sugar	43.2	55.7	51.3	42.9	25.0	39.0	-2.0
Tobacco	21.5	21.6	16.7	17.3	10.6	7.1	-19.9
Cotton	13.0	8.4	15.4	13.6	9.3	6.5	-12.9
Detergents	19.5	22.1	12.0	4.7	2.9	1.9	-37.2
Resin	8.5	3.1	3.3	2.9	2.6	2.7	-20.5
Cement	1.5	-	-	0.2	1.7	4.0	21.7
Canned fruits	9.4	7.8	10.1	11.6	12.4	6.5	-7.1
Others	184.6	208.1	211.0	222.5	200.1	239.1	5.3
Total	1309.2	1343.6	1450.7	1529.2	1708.5	1651.4	4.8

Source : Banco Central de Honduras.

Table 2.3.2 IMPORTS (CIF), 1982 - 1987

Unit : Million lempiras

Goods	1982	1983	1984	1985	1986	1987	Average Annual Growth Rate (%) 1982 - 1987
Food products	116.9	146.5	154.4	160.7	165.8	178.8	8.9
Beverage & tobacco	8.9	5.0	9.3	9.1	9.1	9.5	1.3
Non edible Raw materials	14.2	19.5	18.9	18.8	19.7	19.3	6.3
Oil & lubricants	340.1	327.6	359.3	317.1	194.7	208.0	-9.4
Vegetable & animal Oil & fats	10.8	9.9	13.5	14.8	15.1	16.1	8.3
Chemical products	256.8	337.6	337.4	353.8	403.9	406.0	9.6
Manufactured products	395.6	458.3	497.4	489.0	492.4	508.8	5.2
Machinery & transportation material	274.1	297.2	393.0	404.1	406.6	415.9	8.7
Others	6.3	3.6	3.6	8.8	42.8	34.9	40.8
Total	1423.7	1605.2	1786.8	1776.2	1750.1	1797.3	4.8

Source : Banco Central de Honduras.

Table 2.4.1 BALANCE OF INTERNATIONAL PAYMENTS, 1982 - 1987

Unit : Million lempiras

Account	1982	1983	1984	1985	1986	1987
1. Trade balance	-8.4	-115.2	-295.6	-179.1	34.4	-62.6
(1) Export (FOB)1/	1,353.0	1,397.3	1,474.0	1,579.2	1,782.5	1,725.1
(2) Import (FOB)	1,361.4	1,512.5	1,769.6	1,758.3	1,748.1	1,787.7
2. Service account	-500.4	-412.2	-497.3	-520.4	-561.3	-596.6
3. Transfer account	60.0	89.0	160.0	291.2	316.7	292.6
4. Current account	-448.8	-438.4	-632.9	-408.3	-210.2	-366.6
5. Capital account	254.1	388.1	648.2	510.1	259.0	353.8
6. Errors & Omissons	9.7	14.5	-21.9	-66.9	-60.6	95.3
7. Balance of international payment	-185.0	-35.8	-6.6	34.9	-11.8	82.5

Source : Banco Central de Honduras.

Note : 1/ Non monetary gold is included.

Table 2.5.1 REVENUE AND EXPENDITURE OF THE CENTRAL GOVERNMENT, 1982 - 1987

Unit : Million lempiras

Particulars	1982	1983	1984	1985	1986	1987
Revenue	1,483.2	1,632.0	2,031.2	2,146.3	2,216.5	2,369.6
Current revenue	772.7	801.5	977.3	1,091.1	1,179.8	1,320.9
Tax revenue	715.4	711.1	881.3	985.8	997.3	1,116.5
Income tax	198.8	190.3	233.9	240.6	250.2	297.9
Tax on property	7.4	7.0	8.0	8.8	8.5	10.6
Tax on production, domestic trade & transaction	237.1	233.8	292.5	326.4	333.0	365.3
Import duties	178.1	201.5	258.8	316.6	301.2	345.2
Export duties	93.3	77.8	87.3	92.5	103.5	95.8
Others taxes	0.7	0.7	0.8	0.9	0.9	1.7
Non-tax revenue	11.1	11.0	13.7	19.2	10.5	18.2
Transfer	21.0	35.5	44.8	45.9	44.2	46.7
Other revenue	25.2	43.9	37.5	40.2	127.8	139.5
Capital revenue	719.3	855.5	1060.2	1059.5	1004.7	894.7
Internal debt	408.7	487.5	460.2	555.2	565	564.4
External debt	310.6	334.2	478	389.3	313.6	224.2
Transfer	-	33.8	122	115	126.1	106.1
Others	-8.8	-25.0	-6.3	-4.3	32.0	154.0
Expenditure	1,483.2	1,632.0	2,031.2	2,146.3	2,216.5	2,369.6
Current expenditure	868.1	990.4	1,078.7	1,235.8	1,354.0	1,516.5
Consumption	749.1	860.5	963.5	1,078.0	1,178.2	1,342.3
Current transfers	119.0	129.9	115.2	157.8	175.8	174.2
Capital expenditure	261.8	276.8	406.7	351.4	329.5	315.1
Direct investment	153.5	-	-	-	-	-
Indirect investment	108.3	161.6	200.0	207.9	202.4	207.9
Pre-investment	-	115.2	206.7	143.5	127.1	107.2
Net lending	205.9	163.2	234.0	156.3	90.7	80.1
Public debt service	147.4	201.6	311.8	402.8	442.3	457.9
Internal	118.4	169.8	268.2	327.4	361.6	386.2
External	29.0	31.8	43.6	75.4	80.7	71.7

Source : Banco Central de Honduras.

Table 2.6.1 WHOLESALE PRICE INDEX, 1982 - 1987 (BASE YEAR 1978 = 100)

Goods	1982	1983	1984	1985	1986	1987	Annual Growth Rate (%) 1978 - 1987	Annual Growth Rate (%) 1982 - 1987
Domestic goods	147.3	156.4	158.0	161.2	164.9	166.0	5.79	2.42
Agricultural products	115.3	132.0	124.1	129.9	136.5	138.6	3.69	3.75
Livestock	140.6	144.3	142.9	142.8	148.7	148.8	4.51	1.14
Industrial products	157.0	165.1	169.4	172.1	174.0	174.2	6.36	2.10
Food	146.6	152.5	153.2	153.4	153.7	152.7	4.82	0.82
Beverages & tobacco	178.7	186.2	194.4	209.3	225.9	227.0	9.54	4.90
Construction materials	146.8	154.9	156.6	157.5	156.3	155.2	5.00	1.12
Textiles	122.7	145.7	163.1	159.7	159.8	164.0	5.65	5.97
Clothing	124.6	137.8	142.5	142.5	144.0	142.6	4.02	2.74
Chemicals	133.7	135.5	136.6	137.7	137.9	137.7	3.62	0.59
Petroleum	220.7	220.8	220.8	220.8	211.6	211.6	8.68	-0.84
Imported goods	156.0	173.3	176.3	175.6	177.8	179.3	6.70	2.82
Food	144.4	151.4	152.8	154.1	156.8	155.4	5.02	1.48
Beverages	198.0	258.8	264.6	237.1	228.5	228.8	9.63	2.93
Textiles	187.7	203.0	204.2	207.7	219.6	220.2	9.17	3.25
Chemicals	153.4	174.6	176.2	183.0	184.4	189.6	7.37	4.33
Pharmaceuticals	126.9	135.0	138.3	139.5	139.2	139.7	3.78	1.94
General index	150.2	162.0	164.0	165.9	169.1	170.4	6.10	2.56

Source : Banco Central de Honduras.

Table 2.6.2 CONSUMER PRICE INDEX, 1982 - 1987 (BASE YEAR 1978 = 100)

Goods	1982	1983	1984	1985	1986	1987	Annual Growth Rate (%) 1978 - 1987	1982 - 1987
Food	149.3	157.4	158.1	160.5	164.9	167.0	5.86	2.27
Housing	155.7	172.3	188.6	198.5	212.0	221.3	9.23	7.28
Clothing	200.1	217.2	228.3	234.9	240.0	242.6	10.35	3.93
Health care	160.9	177.4	186.0	189.9	192.4	197.3	7.84	4.16
Beverages & tobacco	188.5	200.5	206.6	220.3	245.8	247.1	10.57	5.56
Transportation	149.5	156.4	158.6	161.9	167.7	169.5	6.04	2.54
Education & entertainment	157.5	170.8	187.8	200.6	206.4	215.6	8.91	6.48
General index	158.4	170.9	178.9	184.9	193.0	197.8	7.87	4.54

Source : Banco Central de Honduras.

Table 2.6.3 MINIMUM WAGE BY ECONOMIC ACTIVITY, 1987

Unit : Lempiras

Economic activities	Wage: Tegucigalpa & San Pedro Sula	Wage: Rest of Country
1. Agriculture (incl. livestock)		
up to 5 workers	4.60	4.60
more than 5 workers	5.00	5.00
2. Banana & plantain crops for exploration	7.10	7.10
3. Manufacturing industries		
up to 5 workers	5.30	5.30
more than 5 workers	6.60	5.50
4. Refining and pumping of oil	7.10	7.10
5. Mining	6.60	6.60
6. Construction	5.30	5.30
7. Commerce		
up to 5 workers	5.30	5.30
more than 5 workers	5.50	5.50
8. Transportation & storage	6.60	5.50
9. Maintenance & repairing of railway	7.10	7.10
10. Loading & unloading at sea ports	-	7.10
11. Docking, maintenance & ship repairing	-	7.10
12. Financial activities	6.60	5.50
13. Craftsmen (up to 5 workers)	5.30	5.30
14. Other services	6.60	5.30

Source : Banco Central de Honduras.

Table 3.2.1 AREA, POPULATION AND POPULATION DENSITY ACCORDING TO POPULATION CENSUSES, 1961, 1974 AND 1988 (WHOLE COUNTRY)

Department	Area (km2)	Population			Annual Population Growth Rate (%)		Population Density (persons/km2)		
		1961	1974	1988	1961-1974	1974-1988	1961	1974	1988
Honduras	112,088	1,884,765	2,656,948	4,376,839	2.68	3.63	16.8	23.7	39.0
Department									
1. Atlantida	4,251	92,914	148,285	237,180	3.66	3.41	21.9	34.9	55.8
2. Colon	8,875	41,904	77,750	146,224	4.87	4.62	4.7	8.8	16.5
3. Comayagua	5,196	96,442	136,619	238,790	2.72	4.07	18.6	26.3	46.0
4. Copan	3,203	126,183	151,859	218,864	1.43	2.65	39.4	47.4	68.3
5. Cortes	3,954	200,099	369,616	644,807	4.83	4.05	50.6	93.5	163.1
6. Choluteca	4,211	149,175	193,336	293,260	2.01	3.02	35.4	45.9	69.6
7. El Paraiso	7,218	106,823	140,793	255,400	2.15	4.35	14.8	19.5	35.4
8. Francisco Morazan	7,946	284,428	453,597	797,611	3.66	4.11	35.8	57.1	100.4
9. Gracias a Dios	16,630	10,905	20,738	34,159	5.07	3.63	0.7	1.2	2.1
10. Intibuca	3,072	73,138	81,815	123,512	0.87	2.99	23.8	26.6	40.2
11. Islas de la Bahia	261	8,961	13,194	21,553	3.02	3.57	34.3	50.6	82.6
12. La Paz	2,331	60,600	66,046	105,996	0.66	3.44	26.0	28.3	45.5
13. Lempira	4,290	111,546	127,782	175,450	1.05	2.29	26.0	29.8	40.9
14. Ocotepeque	1,680	52,540	51,038	74,286	-0.22	2.72	31.3	30.4	44.2
15. Olancho	24,351	110,744	151,436	282,018	2.44	4.54	4.5	6.2	11.6
16. Santa Barbara	5,115	146,909	186,106	277,995	1.84	2.91	28.7	36.4	54.3
17. Valle	1,565	80,907	91,901	119,889	0.98	1.92	51.7	58.7	76.6
18. Yoro	7,939	130,547	195,037	329,845	3.14	3.82	16.4	24.6	41.5

Source : Poblacion y Vivienda por Departamento y Municipio, Censo 1974 y Censo 1988 (Recuento Preliminar), Secretaria de Planificacion, Coordinacion y Presupuesto.

Table 3.2.2 AREA AND POPULATION ACCORDING TO POPULATION CENSUSES, 1961, 1974 AND 1988 (STUDY AREA)

Department & Municipality	Population			Annual Population Growth Rate (%)	
	1961	1974	1988	1961-1974	1974-1988
Departments in Region-2					
1. Department Comayagua	96,442	136,619	238,790	2.72	4.07
2. Department La Paz	60,600	66,046	105,996	0.66	3.44
3. Department Intibuca	73,138	81,815	123,512	0.87	2.99
Total	230,180	284,480	468,298	1.64	3.62
Municipalities in Study Area					
1. Municipality Comayagua	19,055	30,760	59,534	3.75	4.83
2. Municipality Ajuterique	3,132	5,126	6,803	3.86	2.04
3. Municipality Humuya	581	601	1,371	0.26	6.07
4. Municipality Lamani	2,844	2,850	3,572	0.02	1.63
5. Municipality Lejamani	1,455	2,127	3,123	2.96	2.78
6. Municipality San Sebastian	1,269	1,527	1,506	1.43	-0.10
7. Municipality Villa de San Antonio 1/	4,408	6,169	11,429	2.62	4.50
8. Municipality La Paz 2/	8,876	11,775	19,900	2.20	3.82
9. Municipality Cane	1,164	1,370	1,937	1.26	2.50
Total	42,784	62,305	109,175	2.93	4.09

Source : Poblacion y Vivienda por Departamento y Municipio, Censo 1974 y Censo 1988 (Recuento Preliminar), Secretaia de Planificacion, Coordinacion y Presupuesto.

Note : 1/ Municipality Villa de San Antonio includes both communities, San Nicolas & Flores.
2/ Municipality La Paz includes community Yarumela.

Table 3.2.3 POPULATION IN URBAN AND RURAL AREAS ACCORDING TO THE 1974 AND 1988 CENSUSES

Unit : persons

Department & Municipality	1974					1988				
		Urban		Rural			Urban		Rural	
	Total	Number	%	Number	%	Total	Number	%	Number	%
Honduras	2,656,948	833,179	31.4	1,823,769	68.6	4,376,839	1,751,505	40.0	2,625,334	60.0
Department in Region-2										
1. Department Comayagua	136,619	38,535	28.2	98,084	71.8	238,790	87,705	36.7	151,085	63.3
2. Department La Paz	66,046	9,994	15.1	56,052	84.9	105,996	18,509	17.5	87,487	82.5
3. Department Intibuca	81,815	8,309	10.2	73,506	89.8	123,512	15,520	12.6	107,992	87.4
Total	284,480	56,838	20.0	227,642	80.0	468,298	121,734	26.0	346,564	74.0
Municipalities in Study Area										
1. Municipality Comayagua	30,760	15,941	51.8	14,819	48.2	59,534	36,416	61.2	23,118	38.8
2. Municipality Ajuterique	5,126	2,757	53.8	2,369	46.2	6,803	3,666	53.9	3,137	46.1
3. Municipality Humuya	601	0	0.0	601	100.0	1,371	0	0.0	1,371	100.0
4. Municipality Lamani	2,850	0	0.0	2,850	100.0	3,572	0	0.0	3,572	100.0
5. Municipality Lejamani	2,127	0	0.0	2,127	100.0	3,123	2,797	89.6	326	10.4
6. Municipality San Sebastian	1,527	0	0.0	1,527	100.0	1,506	0	0.0	1,506	100.0
7. Municipality Villa de San Antonio	6,169	2,359	38.2	3,810	61.8	11,429	5,746 [1/]	50.3	5,683	49.7
8. Municipality La Paz	11,775	6,811	57.8	4,964	42.2	19,900	10,965	55.1	8,935	44.9
9. Municipality Cane	1,370	0	0.0	1,370	100.0	1,937	0	0.0	1,937	100.0
Total	62,305	27,868	44.7	34,437	55.3	109,175	59,590	54.6	49,585	45.4

Source : Poblacion y Vivienda por Departamento y Municipio, Censo 1974 y Censo 1988 (Recuento Preliminar), Secretaia de Planificacion, Coordinacion y Presupuesto.

Note :1/ Population in the urban area of Municipality Villa de San Antonio includes the population of Flores.

Table 3.2.4 POPULATION, NUMBER OF HOUSES OCCUPIED AND AVERAGE NUMBER OF INHABITANTS PER HOUSE, 1974 AND 1988 CENSUSES

Department & Municipality	Population (persons)		Number of Houses		Increase Rate per Annum(%)	Average Number of Persons per House	
	1974	1988	1974	1988		1974	1988
Honduras	2,656,948	4,376,839	463,004	809,263	4.07	5.74	5.41
Department in Region-2							
1. Department Comayagua	136,619	238,790	23,362	42,296	4.33	5.85	5.65
2. Department La Paz	66,046	105,996	11,375	18,485	3.53	5.81	5.73
3. Department Intibuca	81,815	123,512	14,243	21,204	2.88	5.74	5.82
Total	284,480	468,298	48,980	81,985	3.75	5.81	5.71
Municipalities in Study Area							
1. Municipality Comayagua	30,760	59,534	5,231	10,931	5.41	5.88	5.45
2. Municipality Ajuterique	5,126	6,803	846	1,227	2.69	6.06	5.54
3. Municipality Humuya	601	1,371	108	244	5.99	5.56	5.62
4. Municipality Lamani	2,850	3,572	482	664	2.31	5.91	5.38
5. Municipality Lejamani	2,127	3,123	355	536	2.99	5.99	5.83
6. Municipality San Sebastian	1,527	1,506	247	286	1.05	6.18	5.27
7. Municipality Villa de San Antonio	6,169	11,429	1,152	2,123	4.46	5.36	5.38
8. Municipality La Paz	11,775	19,900	1,938	3,398	4.09	6.08	5.86
9. Municipality Cane	1,370	1,937	264	405	3.10	5.19	4.78
Total	62,305	109,175	10,623	19,814	4.55	5.87	5.51

Source : Poblacion y Vivienda por Departamento y Municipio, Censo 1974 y Censo 1988
Planificacion, Coordinacion y Presupuesto.

Table 3.3.1 AGRICULTURAL LAND USE IN DEPARTMENTS OF COMAYAGUA, LA PAZ AND INTIBUCA, 1974

Department	Total Area (1)	Total Area of Agricultural Land km2(2)	(2)/(1)	Breakdown of Agricultural Land: Crops km2	Crops %	Pasture km2	Pasture %	Forest km2	Forest %	Others km2	Others %
Honduras	112,088	26,298	23	7,186	27	13,478	51	5,330	20	304	1
Region No. 2											
Department Comayagua	5,196	1,252	24	428	34	583	47	231	18	10	1
Department La Paz	2,331	784	34	263	34	321	41	197	25	3	0
Department Intibuca	3,072	1,100	36	294	27	348	32	439	40	19	2
Total	10,599	3,136	30	985	31	1,252	40	867	28	32	1

Source : Censo Nacional Agropecuario 1974, Direccion General de Estatistica y Censos.

Table 3.3.2 AGRICULTURAL PRODUCTION IN WEST-CENTRAL REGION (REGION NO.2), 1984

Unit : Quintals

Region	Maize	Beans	Rice	Tobacco	Cabbage	Onions	Potatoes	Sugar cane	Coffee	Orange
Honduras	8,953,659	352,485	1,024,960	139,073	144,244	41,595	84,036	34,204,727	1,635,514	863,320
Western Central Region (No. II)1/	822,845	13,791	100,090	12,056	91,804	14,413	81,389	40,803	548,751	16,943
(%)	9.2	3.9	9.8	8.7	63.6	34.7	96.9	0.1	33.6	2.0

Source : Encuesta de Agricola Nacional, 1984, Ministro de Economia.

Note :1/ West-Central Region (Region No. 2) consists of three Departments of Comayagua, La Paz and Intibuca.

Table 3.5.1 WATER SUPPLY, 1983 - 1987

Unit : Thousand m^3

Item	1983	1984	1985	1986	1987	Annual Growth Rate (%) 1983 - 1987
1. Water Supply by SANAA system	23,746	24,361	25,380	25,582	25,760	2.1
2. Water consumption						
(1) Domestic	14,603	16,083	17,076	17,373	17,901	5.2
(2) Commercial	3,847	3,185	3,351	3,253	2,979	-6.2
(3) Industrial	974	694	653	605	550	-13.3
(4) Governmental	4,322	4,399	4,300	4,351	4,330	0.1

Source : Servicio Autonomo Nacional de Acueductos y Alcantarillados (SANAA).

Figures

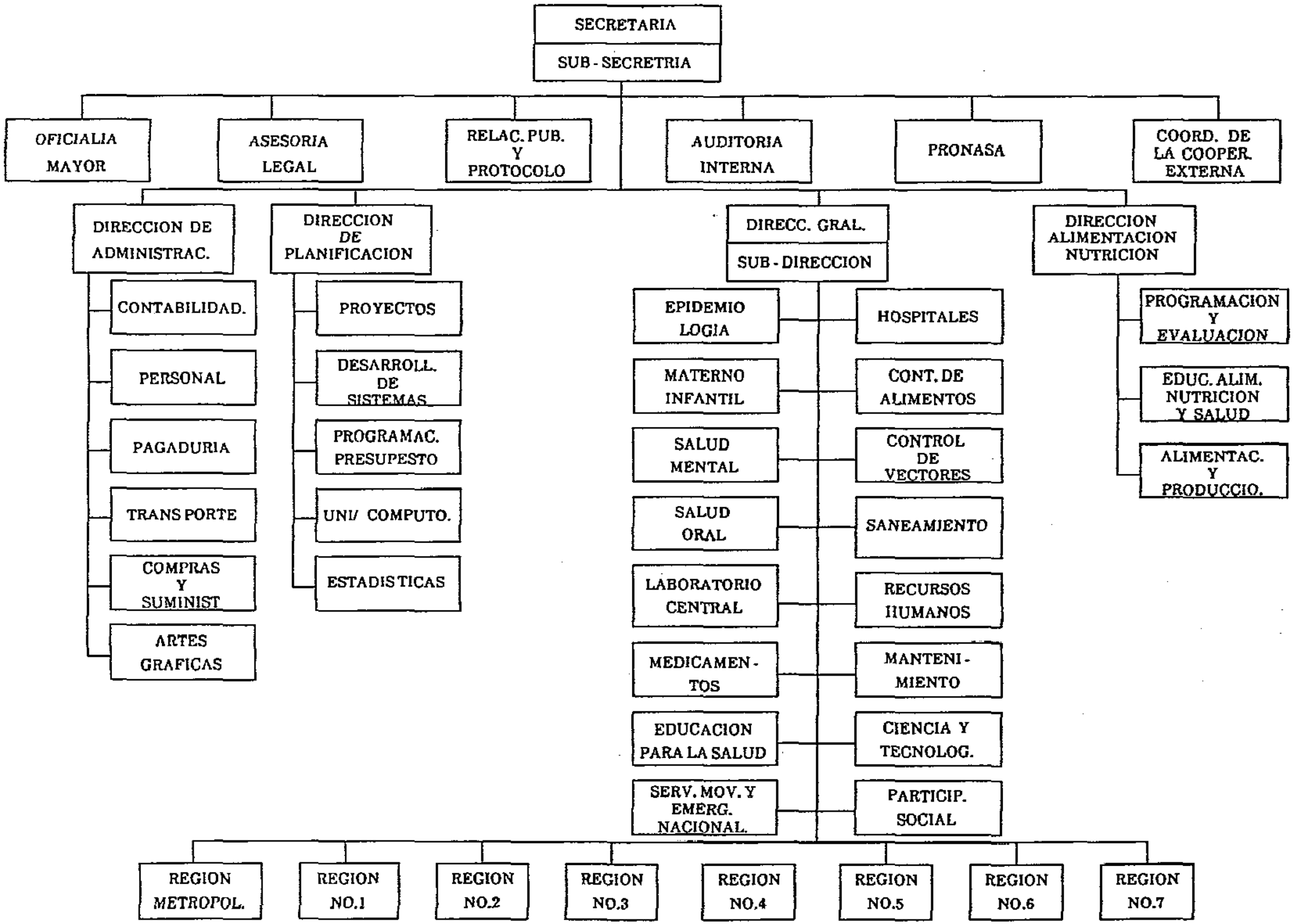

Fig. 3.1.1 ORGANIZATION CHART OF THE MINISTRY OF PUBLIC HEALTH

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

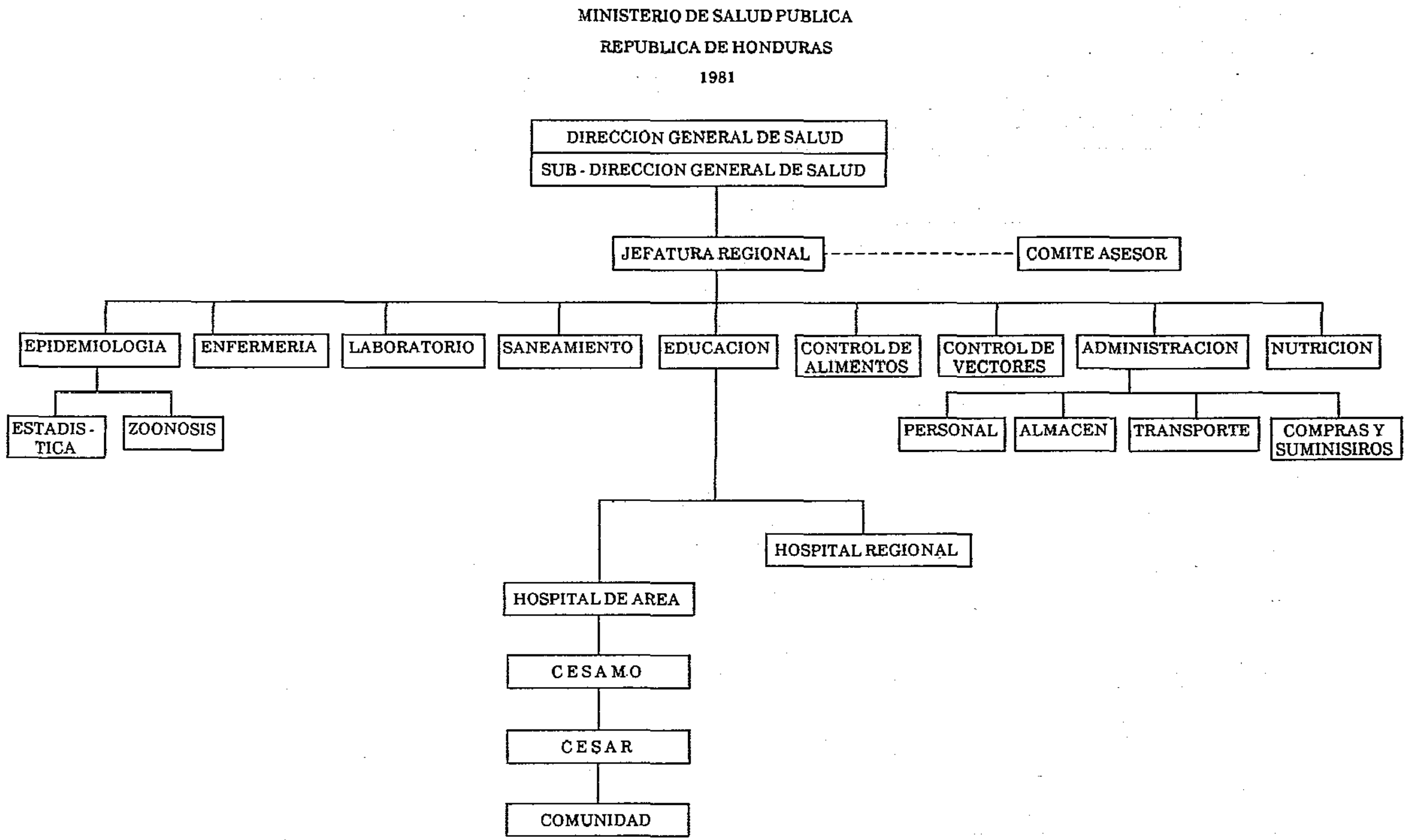

Fig. 3.1.2 ORGANIZATION CHART OF THE HEALTH REGIONS

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

ESTRUCTURA ORGANIZATIVA DE LOS NIVELES OPERATIVOS
POR AREAS Y REGIONES SANITARIAS

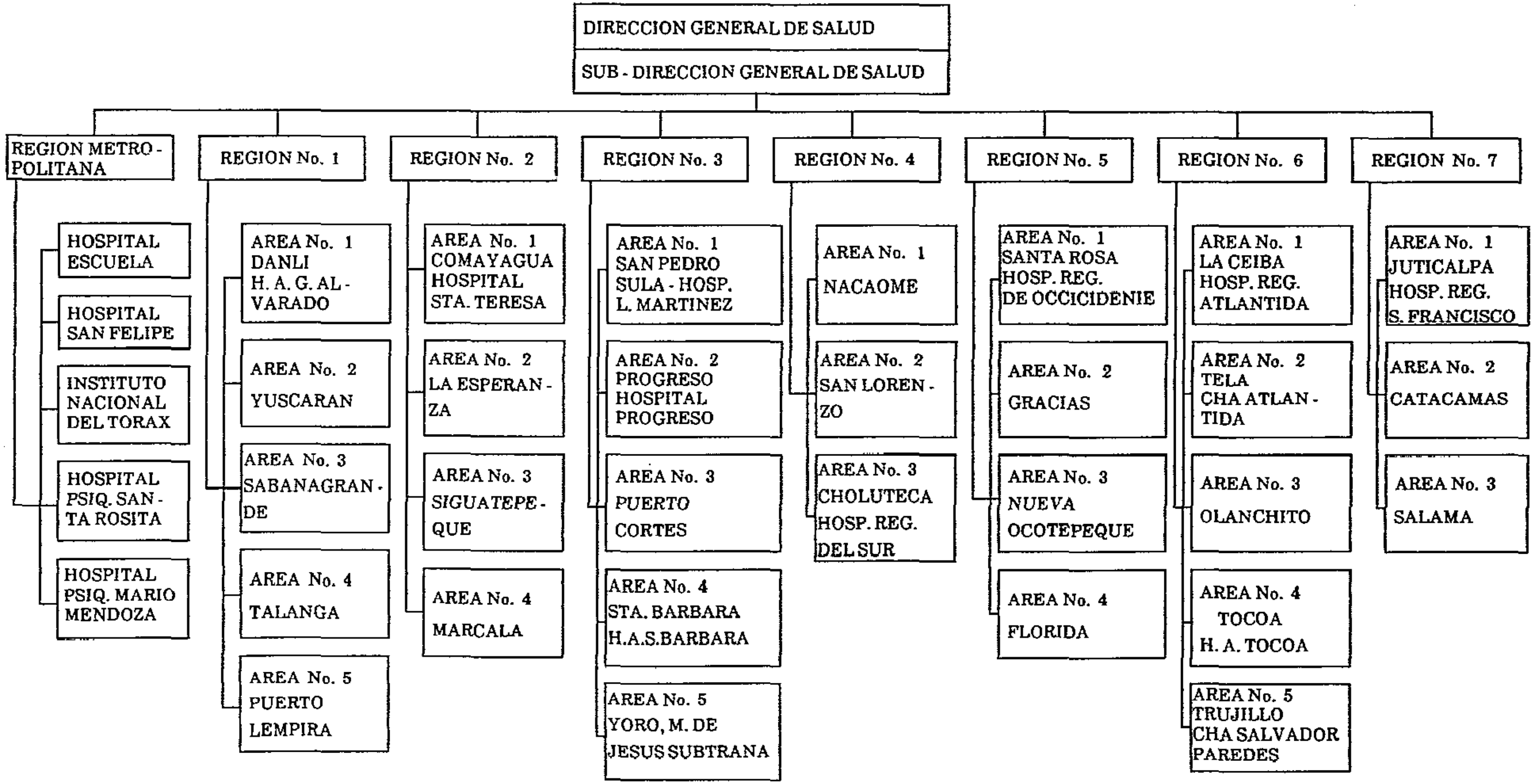

Fig. 3.1.3 ORGANIZED STRUCTURE OF THE AREA OPERATION LEVELS IN EACH HEALTH REGION

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

Annexes

ANNEX I   GODIGO SANITARIO DE LA REPUBLICA DE HONDURAS, 1967

División de Planificación

A-9

MINISTERIO DE SALUD PUBLICA
Y
ASISTENCIA SOCIAL

CODIGO SANITARIO

DE LA

REPUBLICA DE HONDURAS

Tegucigalpa, D. C.
1967

P O D E R   L E G I S L A T I V O

D E C R E T O   N U M E R O   75

E L   C O N G R E S O   N A C I O N A L,

D E C R E T A:

El siguiente

衛生法

CODIGO SANITARIO DE LA REPUBLICA DE HONDURAS

LIBRO I

DE LA SALUD PUBLICA Y DE LOS ORGANISMOS ESTATALES COMPETENTES

国の 主管

TITULO PRELIMINAR

義務

Artículo 1o.- La salud es un bien social, y es un deber del Estado y de los individuos su promoción, protección y recuperación.

Artículo 2o.- Este Código establece los derechos y deberes de los individuos, en todos aquellos asuntos que se refieren a la promoción, protección y recuperación de la salud. Constituye una ley de orden público, que prevalecerá sobre cualesquiera otras en la materia, y que obliga a todas las personas y entidades nacionales o extranjeras en la República.

TITULO I

DE LOS ORGANISMOS COMPETENTES Y DE SUS ATRIBUCIONES

Artículo 3o.- El Poder Ejecutivo realizará las acciones de protección, fomento y recuperación de la salud, por medio de la Secretaría de Salud Pública y Asistencia Social, y de los organismos técnicos de sus dependencias, en la forma que el presente Código y sus Reglamentos lo determinen.

Artículo 4o.- Son organismos competentes en materia de Salud Pública:

a) La Secretaría de Estado de Salud Pública y Asistencia Social;
b) Dirección General de Salud Pública;
c) Dirección General de Asistencia Médico-Social;
d) Los Concejos de Distrito y las Municipalidades en todo lo que se refiera a las obligaciones que este Código les imponga directamente, y aquellas que la Secretaría de Salud Pública y Asistencia Social les delegue de conformidad con la Ley;
e) Los organismos autónomos a los que una Ley Especial les encomienda actividades en la materia; y,
f) Los organismos privados nacionales o extranjeros y los internacionales a los que una ley, convenio o tratado, les autorice -

para desarrollar actividades, cooperar o asesorar en materia de salud pública, quienes estarán supeditados a la política general de la Secretaría de Salud Pública y Asistencia Social.

DE LA SECRETARIA DE SALUD PUBLICA Y ASISTENCIA SOCIAL

Artículo 5o.- Corresponde a la Secretaría de Salud Pública y Asistencia Social, dictar la política sanitaria del país, especialmente:

1.- La orientación superior y coordinación de las acciones de salud que realicen los organismos estatales, distritales, municipales, autónomos y particulares, sin exclusión alguna.

2.- Realizar los planes de acción de salud que deberán presentar para su aprobación los organismos citados en el numeral anterior.

3.- Elaborar los reglamentos de los organismos técnicos y administrativos de sus dependencias.

4.- Elaborar proyectos de reglamentos en materia de salud, y aprobar aquellos que los organismos técnicos de su dependencia presenten para su conocimiento, a fin de proveer el eficaz cumplimiento de los objetivos de salud del país.

5.- Dictar normas generales de aplicación o de interpretación técnica necesarias para la correcta aplicación de este Código y sus Reglamentos.

6.- Revisar los Presupuestos de los Organismos de Salud bajo su dependencia y gestionar su aprobación, a fin de proveer al cumplimiento de los planes aprobados.

7.- Vigilar técnica y administrativamente los organismos públicos de salud bajo su dependencia, encargados de ejecutar las acciones de salud que les confiere la ley.

8.- Mantener y promover las relaciones con los organismos internacionales de Salud Pública.

9.- Intervenir en el estudio y aprobación de los tratados, convenios y acuerdos internacionales que celebre el Gobierno de la República en materia de salud; y,

10.- Promover la construcción de Centros de Salud y Asistencia Médico-Social.

DE LA DIRECCION GENERAL DE SALUD PUBLICA

Artículo 6o.- La Dirección General de Salud Pública estará a cargo - de un Director General, que dependerá de la Secretaría de Salud Pública y Asistencia Social.

Artículo 7o.- La Dirección General de Salud Pública es el organismo - técnico, normativo y ejecutivo al que le corresponde, - directa o específicamente, realizar acciones de fomento y protección de la salud. Le corresponde asimismo, velar por el cumplimiento de las disposiciones de este Código y de sus Reglamentos.

Artículo 8o.- Para el mejor y más eficaz servicio de salud, la Dirección General de Salud Pública coordinará sus funciones con la Dirección General de Asistencia Médico-Social.

Artículo 9o.- La Dirección General de Salud Pública ejercerá sus funciones técnicas y administrativas en todo el país, por intermedio de los Distritos Sanitarios, cuya área jurisdiccional comprenderá áreas geográficas que podrán coincidir o no con la división política territorial. Los Distritos Sanitarios comprenderán todos los servicios locales de salud, cuyo número y tipo estará de acuerdo con el área geográfica y la densidad de la población que sirvan; y son los organismos encargados de realizar, en el terreno de su jurisdicción, todas las acciones de salud, de conformidad con lo que fije el reglamento de dicha Dirección.

DE LA DIRECCION GENERAL DE ASISTENCIA MEDICO-SOCIAL

Artículo 10.- La Dirección General de Asistencia Médico-Social se regirá por su Ley Orgánica y sus Reglamentos.

DIVISION DE PLANIFICACION DE LA SALUD

Artículo 11.- La División de Planificación es una dependencia asesora de la Secretaría de Salud Pública y Asistencia Social, y forma parte del sistema de planificación del país, como oficina sectorial de la planificación en salud. Sus funciones generales son las siguientes:

a) Estudiar los problemas de salud del país y los recursos con que se cuenta, y hacer las recomendaciones pertinentes en materia - de planificación de salud;

b) Formular, de acuerdo con la política del Ministerio, las metas para los planes de salud;

c) Integrar a nivel nacional los planes de salud, conforme a las - metas aprobadas sobre la base de los programas locales y nacionales;

d) Formular los reajustes periódicos del Plan Nacional de Salud - en base a su permanente evaluación;

e) Participar en la formulación del Proyecto de Presupuesto Funcional Anual del Ministerio de Salud;

f) Investigar y estudiar la forma cómo mejorar las técnicas o procedimientos para captar la información básica y perfeccionar la metodología de la Planificación en Salud y la integración de los planes de Desarrollo Económico.

Artículo 12.- Todos los organismos competentes en materia de Salud Pública, colaborarán con la División de Planificación, para el mejor desempeño de sus funciones específicas.

DE LA DIVISION DE BIOESTADISTICA 生物统计

Artículo 13.- La División de Bioestadística es una dependencia asesora de la Secretaría de Salud Pública y Asistencia Social, encargada de proporcionar las estadísticas de salud que requiera la Secretaría, para la programación y evaluación de sus actividades. Sus funciones generales son las siguientes:

a) Recopilar, elaborar y presentar las Estadísticas de Salud que necesite el Ministerio para la planificación y perfeccionamiento de sus programas;

b) Dar normas, asesorar, adiestrar y supervisar a nivel nacional, regional y local, al personal médico y encargados de la recolección de los datos básicos;

c) Realizar visitas periódicas a los establecimientos de salud, - con la finalidad de cumplir las funciones señaladas en el inciso anterior;

d) Evacuar los informes que le sean solicitados por las autoridades competentes, sobre cualquier materia de su incumbencia;

e) Diseñar los formularios necesarios para la captación de los datos básicos; y,

f) Elaborar la Memoria Anual sobre las actividades del Ministerio, con los datos suministrados por las otras dependencias.

DEL CONSEJO NACIONAL DE SALUD

Artículo 14.- El Consejo Nacional de Salud estará integrado por:

a) El Secretario de Estado en los Despachos de Salud Pública y Asistencia Social en su calidad de Presidente;

b) El Subsecretario de Estado en los Despachos de Salud Pública y Asistencia Social en su calidad de Vicepresidente;

c) El Director de Salud Pública en calidad de Secretario;

d) El Director General de Asistencia Médico-Social;

e) Un Delegado por cada uno de los Colegios Médico, Químico Farmacéutico y de Odontología;

f) El Gerente del Servicio Autónomo Nacional de Acueductos y Alcantarillados (SANAA); y,

g) El Director del Instituto Hondureño de Seguridad Social.

Artículo 15.- Actuarán en calidad de Asesores de este Consejo:

a) El representante en el país de la Oficina Panamericana Regional de la Organización Mundial de la Salud; y,

b) Los Jefes de las Divisiones Técnicas Normativas del Ministerio de Salud Pública.

Artículo 16.- Corresponden al Consejo Nacional de Salud las siguientes atribuciones:

a) Estudio y dictamen de los planes nacionales de Salud;

b) Recomendar las medidas más adecuadas, para establecer una coordinación efectiva, entre la Secretaría de Salud Pública y las otras Instituciones que en el país se ocupen de la Salud;

c) Análisis del informe anual de la Secretaría de Salud Pública; y,

d) Emitir juicio, sobre cualquier otro problema que le sea sometido a su consideración por su Presidente.

Artículo 17.- El Consejo Nacional de Salud tendrá carácter consultivo y se regirá por su Reglamento Interno. Sus Miembros desempeñarán sus cargos ad honorem.

DEL DIRECTOR GENERAL DE SALUD PUBLICA

Artículo 18.- El Director General de Salud Pública deberá ser: hondureño por nacimiento, Médico y Cirujano y Miembro del

Colegio Médico de Honduras.

Artículo 19.- Corresponde al Director General de Salud Pública, además de las facultades administrativas inherentes a su cargo, las siguientes específicas:

a) Velar por el cumplimiento de las disposiciones de este Código, de sus Reglamentos y de las normas e instrucciones que lo complementen;

b) Dictar conforme las disposiciones de la presente ley y sus reglamentos, Acuerdos y medidas de carácter general, local o particular, que sean necesarias para la protección y fomento de la Salud Pública;

c) Ordenar que se practique la Inspección Sanitaria de: edificios, viviendas, locales, mesones o cuarterías o sitios públicos o privados, a fin de realizar investigaciones sobre la observancia de esta Ley y sus reglamentos;

d) Acordar y ordenar la clausura de cualquier establecimiento comercial, industrial, lugar destinado a la permanencia o vivienda de las personas, abasto de agua potable y en fin, todo lugar en el que por infringir las disposiciones legales o reglamentarias, o los acuerdos técnicos de la autoridad sanitaria, se ponga en peligro la salud de la población;

e) Conceder y cancelar autorización para la instalación y funcionamiento de todo establecimiento en que se elaboren, manipulen, depositen o expendan alimentos y bebidas, abastos de agua potable y en general, de todos aquellos que así específicamente lo determine este Código, los Reglamentos o leyes especiales;

f) Solicitar, de los particulares o de las instituciones públicas o privadas, los datos o informaciones que estime necesarias para la mejor realización de sus funciones. Tales informaciones, deberán ser proporcionadas a la Dirección General de Salud Pública, en el plazo prudencial que fije el Director General de Salud Pública; y,

g) Solicitar la cooperación de la autoridad competente, para el cumplimiento de las medidas que ordene, tales como clausura, decomiso de mercadería u otras. Las correspondientes autoridades deberán prestar la cooperación solicitada en la oportunidad y forma que el Director por sí o por Delegado lo requiera.

市议会 district

DE LOS CONCEJOS DE DISTRITO Y DE LAS MUNICIPALIDADES

Artículo 20.- Los Concejos de Distrito y las Municipalidades tendrán las obligaciones y responsabilidades relativas a Salud Pública que esta Ley o sus Reglamentos determinen, sin perjuicio de las establecidas en su propia Ley. Les corresponde por lo tanto:

a) Proveer a la limpieza de los sitios públicos de tránsito y recreo;

b) Establecer y mantener servicios públicos para la recolección y disposición final sanitaria de las basuras, residuos y desperdicios de la vía urbana y los de origen doméstico;

c) Reglamentar y vigilar el cumplimiento de las disposiciones relativas a la conservación, limpieza e higienización exterior de los edificios públicos y particulares de cualquier naturaleza, y de los sitios baldíos o predios urbanos;

d) Establecer servicios sanitarios de uso público en plazas, parques u otros lugares de reunión y recreo, y vigilar que ellos sean mantenidos en buenas condiciones de conservación y aseo de acuerdo con las normas sanitarias que la Dirección General de Salud Pública disponga;

e) Colaborar con el Servicio Autónomo Nacional de Acueductos y Alcantarillados a fin de proveer a la correcta operación y mantenimiento de los alcantarillados y plantas de agua potable, dando cuenta de cualquier desperfecto o problema que se observe en la jurisdicción respectiva, tomando las medidas que la Dirección General de Salud Pública determine en caso de necesidad; y,

f) Mantener en buenas condiciones los servicios de agua potable y alcantarillados de su propiedad.

Artículo 21.- Cuando los Concejos de Distrito o Municipalidades dispongan de los medios y de personal entrenado, o cuando en el lugar no hubiere dependencia local de la Dirección General establecida y en funciones, podrá el Ministerio de Salud Pública delegar funciones y fijar programas mínimos para que sean cumplidos por los Concejos Distritales o las Municipalidades de la jurisdicción, bajo la asesoría técnica de la Dirección General de Salud Pública.

Artículo 22.- Todo Concejo de Distrito o Municipalidad colaborará con la Secretaría de Salud Pública y Asistencia Social al desarrollo de los programas de salud dentro de su jurisdicción.

Artículo 23.- Los Concejos de Distrito o las Municipalidades, de acuerdo con el Instituto Nacional de la Vivienda y la Dirección General de Salud Pública, determinarán los sectores industriales de cada población dentro de los cuales, únicamente, se podrán establecer o instalar nuevas fábricas o establecimientos industriales.

OTRAS INSTITUCIONES

Artículo 24.- Corresponde al Ministerio de Trabajo y Previsión Social, por intermedio de la Inspección General del Trabajo, vigilar y hacer cumplir las disposiciones legales y reglamentarias que dicte la Secretaría de Salud Pública y Asistencia Social, y proponer, de acuerdo con la Dirección General de Salud Pública, aquellas relativas a las condiciones de higiene y salubridad que deberán cumplir los establecimientos, talleres y locales industriales, y todo lugar donde se realice trabajo remunerado, a fin de proteger la salud de las personas que desarrollan allí sus actividades.

LIBRO II

ACCIONES DE PROMOCION DE LA SALUD

Artículo 25.- Corresponde a la Secretaría de Salud Pública y Asistencia Social el desarrollo de programas orientados a estimular el bienestar y salud de la población, educar a los individuos y grupos para la protección y recuperación de su salud, y la de las comunidades a que pertenecen.

TITULO I

母性

ATENCION MATERNO INFANTIL

Artículo 26.- Corresponde a la Secretaría de Salud Pública y Asistencia Social por medio de sus dependencias, prestar la debida atención a la madre durante el embarazo, parto y puerperio, y al niño hasta su edad preescolar.

Artículo 27.- La Secretaría de Salud Pública y Asistencia Social por medio de sus dependencias, vigilará técnicamente las instituciones públicas o privadas en que se preste atención materno infantil, debiendo éstas coordinar sus acciones, con los planes que la Dirección General de Salud Pública desarrolle en el país.

Artículo 28.- Las instituciones de maternidad y establecimientos análogos, públicos o privados, necesitarán de permiso previo de la Secretaría de Salud Pública y Asistencia Social para su instalación y funcionamiento, ajustándose a las exigencias técnicas y reglamentarias del caso.

Artículo 29.- La Secretaría de Salud Pública y Asistencia Social podrá suspender transitoriamente el permiso para sus actividades, o clausurar aquellos establecimientos en que se ponga en peligro la vida de la madre o del niño, o en los que la mortalidad o morbilidad de los recién nacidos sea excesivamente alta, por las deficiencias técnicas, higiénicas o sanitarias.

TITULO II

HIGIENE PREESCOLAR Y ESCOLAR

Artículo 30.- Los establecimientos destinados a la enseñanza o atención de niños en edad preescolar y escolar y, especialmente, aquellos que mantengan internados, asilos o casas de reclusión, quedarán bajo el control médico y sanitario de la Dirección General de Salud Pública.

Artículo 31.- La Dirección General de Salud Pública podrá ordenar medidas especiales cuando un establecimiento educacional, de asilo o de reclusión, se convierta o pueda convertirse en un foco de insalubridad o de diseminación de enfermedades transmisibles, que amenace la salud de la población infantil.

Artículo 32.- Las Secretarías de Educación y de Salud Pública y Asistencia Social coordinarán especialmente sus actividades para el desarrollo de planes de Educación Sanitaria, profilaxis de enfermedades transmisibles y otras que puedan determinarse por la Secretaría de Salud Pública.

Artículo 33.- Todo establecimiento privado de enseñanza, de más de cien alumnos, deberá disponer de un servicio médico y dental para la atención de sus educandos. Las escuelas y colegios del Estado serán atendidos por la Dirección General de Salud Pública, en la forma que lo determine el Reglamento respectivo.

TITULO III

N U T R I C I O N

Artículo 34.- Corresponde al Ministerio de Salud Pública y Asistencia Social, fijar las normas técnicas sobre nutrición de la población. La Dirección General de Salud Pública, en coordinación con el Ministerio de Educación Pública y demás organismos estatales y privados o extranjeros especializados, desarrollará programas nacionales de nutrición a fin de elevar el nivel alimentario de la población, orientando a la colectividad hacia un consumo racional y científico de los alimentos, con un aprovechamiento mejor de las disponibilidades del país.

Artículo 35.- Corresponderá al Ministerio de Salud proponer las leyes o reglamentos en virtud de los cuales se disponga, con carácter obligatorio, el enriquecimiento o equiparación en determinados alimentos, a fin de suplir la ausencia o insuficiencia de nutrientes en la alimentación habitual de la población; asimismo podrá obligar el enriquecimiento del agua con flúor, y la sal común con yodo, cuando sea necesario.

Artículo 36.- Los colegios, internados, asilos y establecimientos similares, públicos o privados, que proporcionen alimentación a niños o adultos, internados o recluidos, deberán especialmente cumplir las normas que sobre nutrición dicte el Ministerio de Salud.

LIBRO III

DE LAS ACCIONES PARA PROTEGER LA SALUD

TITULO I

SALUD INTERNACIONAL

Artículo 37.- Las acciones de protección internacional contra enfermedades transmisibles, se rigen por el Código Sanitario Panamericano, sus reglamentos y modificaciones, los que ratificados por el Gobierno de la República, se entienden incorporados al presente Código. El control de los puertos aéreos, marítimos y de frontera, se regirá por lo establecido en el Reglamento Sanitario Internacional de la Organización Mundial de la Salud, del cual Honduras es signataria.

Artículo 38.- Toda persona que desee ingresar al país deberá someterse a las exigencias y cumplir las formalidades sanitarias que la ley, los reglamentos y disposiciones especiales de la Dirección General de Salud Pública, establezcan.

TITULO II

DE LAS ENFERMEDADES TRANSMISIBLES

Artículo 39.- La preparación de las normas técnicas y la realización de acciones que tiendan a obtener el control o erradicación de las enfermedades transmisibles, corresponderá privativamente al Ministerio de Salud Pública y Asistencia Social.

DE LA NOTIFICACION

Artículo 40.- Es obligatorio para todo médico o profesional que haya intervenido en la atención o diagnóstico de una enfermedad transmisible, calificada como de denuncia obligatoria, o que haya -

suministrado o vendido medicamentos para su tratamiento, sea que actúe en el ejercicio privado de su profesión o desempeñando funciones oficiales, notificar a la autoridad sanitaria más próxima la aparición del caso. Igual obligación recaerá sobre toda persona que tenga conocimiento de la existencia de casos de enfermedades transmisibles de denuncia obligatoria, cuando los pacientes hayan carecido de atención médica. Quedan especialmente sujetos a esta obligación, las autoridades, en general, los directores de colegios y establecimientos similares y toda persona capacitada para hacerlo.

OTRAS MEDIDAS

Artículo 41.- Los enfermos, portadores sanos o contagiados de enfermedades transmisibles, están obligados a acatar las disposiciones y medidas que sobre aislamiento, cuarentena, tratamiento y observación disponga la Dirección General de Salud Pública, con el fin de evitar la difusión de la enfermedad, o proveer a su control y erradicación. Un reglamento dictado por la Dirección de Salud establecerá todas estas disposiciones y medidas, incluyendo las normas para la notificación mencionada en el Artículo 40 de este Código.

Artículo 42.- Los establecimientos de asistencia médica, públicos o privados están también en la obligación de acatar las medidas que la Dirección General de Salud Pública determine, con los fines expresados en el Artículo precedente, pudiendo la autoridad sanitaria inspeccionarlos con el fin de establecer el cumplimiento de tales medidas. Por su parte, la Dirección General de Salud deberá colaborar con tales establecimientos, para el mejor cumplimiento de las medidas que se impongan, si éstos así lo solicitan.

Artículo 43.- La Dirección General de Salud Pública, tendrá la facultad de ordenar la práctica periódica de exámenes clínicos o de laboratorio, de ciertos sectores o grupos de la población, cuando técnicamente lo estime necesario como medio de control de enfermedades transmisibles.

Artículo 44.- Los particulares o las instituciones públicas y privadas que por descuido, negligencia o que con ocasión de faenas industriales, o de otro tipo de trabajo favorezcan, produzcan o permitan la formación de criaderos de vectores de enfermedades transmisibles en cualesquiera de sus estados, tales como charcos, pantanos, acumulación de desperdicios u otros, serán obligados a realizar obras y trabajos o a implantar los sistemas que la Dirección General de Salud determine, dentro del plazo perentorio que fije, a fin de obtener el saneamiento de esos lugares o faenas; sin perjuicio de las sanciones que pueda imponer, o de las medidas administrativas que pueda recabar, según los casos.

Artículo 45.- Toda persona, empresa, organización o entidad pública o privada, estará obligada a cooperar con la autoridad sanitaria y a realizar obras o a tomar medidas que la Dirección General de Salud determine, cuando el Ministerio de Salud declare que una endemia constituye problema nacional, y que requiere urgente solución.

DE LAS INMUNIZACIONES

Artículo 46.- La inmunización de la población, contra enfermedades transmisibles, estará a cargo de la Dirección General de Salud Pública en la forma que establezca el reglamento mencionado en el Artículo 41, donde deberán ser incluidas estas medidas.

Artículo 47.- La vacunación y revacunación contra la viruela es obligatoria para todos los habitantes, será practicada por los servicios de salud gratuitamente, y sólo tendrán valor legal los certificados otorgados en los formularios y con los requisitos que el reglamento mencionado en el Artículo 41 establezca.

Artículo 48.- Se declara obligatoria la vacunación y revacunación contra tosferina, difteria y tétanos, en los niños hasta la edad de ocho años; se declara obligatoria la vacunación y revacunación, contra la poliomielitis, de los niños menores de siete años. La Dirección General de Salud podrá ordenar, y hacer obligatoria, la vacunación y revacunación contra otras enfermedades transmisibles, en la forma y circunstancia que estime técnicamente procedente.

epidemia 伝染病

DE LA ZOONOSIS

Artículo 49.- La Dirección General de Salud determinará la zoonosis de declaración obligatoria, y establecerá la coordinación indispensable con el Ministerio de Recursos Naturales para el control de las epizootias que puedan afectar a los seres humanos. Las medidas pertinentes para el control de la zoonosis serán incorporadas al reglamento mencionado en el Artículo 41 de este Código.

DE LA CAMPAÑA DE ERRADICACION DE LA MALARIA

Artículo 50.- Los planes o programas elaborados para erradicar la malaria se efectuarán de conformidad con lo prescrito en la "Ley de Erradicación de la Malaria", y por los procedimientos que fije su respectivo reglamento.

E P I D E M I A S

流行病

Artículo 51.- En caso de epidemia o de peligro de epidemia, compete a la Dirección General de Salud tomar y ordenar las --

las medidas que técnicamente estime necesarias para proteger a la población. Los Servicios Públicos, los Concejos de Distrito, las Municipalidades, los Servicios Autónomos y las Instituciones y Entidades Privadas, estarán obligadas a cooperar con la Dirección General de Salud en la forma que ésta lo determine.

Artículo 52.- En caso de que una epidemia represente peligro grave para la población nacional o de una zona del territorio, o en caso de que una catástrofe haga presumible el riesgo de epidemia y peligro grave, el Poder Ejecutivo podrá conferir atribuciones especiales al Ministerio de Salud Pública y a sus organismos dependientes.

DEL CERTIFICADO MEDICO DE CAUSA DE DEFUNCION

Artículo 53.- Se declara obligatorio el certificado médico de causa de defunción. Un reglamento dictado por el Ministerio de Salud Pública, establecerá las normas pertinentes.

TITULO III

Drainage environment

SANEAMIENTO DEL AMBIENTE. AGUA POTABLE

atomospher

Artículo 54.- Las poblaciones urbanas y rurales deberán disponer de agua potable, y será obligación del Servicio Autónomo Nacional de Acueductos y Alcantarillados y de las Municipalidades, dentro de su respectiva jurisdicción, atender en forma preferente al adecuado abastecimiento de agua de las poblaciones.

Artículo 55.- El agua destinada al consumo humano deberá tener las características físicas, químicas y bacteriológicas que la Dirección General de Salud Pública determine. Corresponde a la Dirección General de Salud Pública determinar los métodos y sistemas de tratamiento del agua para consumo humano, correspondiéndole el control permanente y supervisión de su potabilidad, sin perjuicio de las responsabilidades y obligaciones que competen al Servicio Autónomo Nacional de Acueductos y Alcantarillados, Concejos de Distrito y Municipalidades, en cuanto a su captación, almacenamiento y distribución.

Artículo 56.- Las personas naturales o jurídicas que deseen abrir un balneario, piscina pública o de asociación o club privado, establecimiento de aguas termales o cualesquiera otras similares, deberán solicitar permiso a la Dirección General de Salud, o a la autoridad competente en quien se haya delegado tal facultad, sometiéndose a las disposiciones reglamentarias y a aquellas especiales que el Director General de Salud pueda establecer, basado en un informe técnico.

Artículo 57.- La Dirección General de Salud ejercerá la vigilancia de todos los abastos o plantas de tratamiento de agua potable destinada para el consumo humano del país, y controlará su estado y funcionamiento, declarando periódicamente la potabilidad del agua. Podrá asimismo exigir arreglos o mejoras dentro de plazo perentorio, y ordenar la clausura de cualquier abastecimiento o planta de agua, en el que se infrinjan disposiciones legales, reglamentos u órdenes especiales de la autoridad sanitaria, con grave peligro para la población.

ELIMINACION Y DISPOSICION DE EXCRETAS Y AGUAS SERVIDAS

Artículo 58.- Toda población urbana o rural, deberá disponer de un sistema sanitario adecuado para la evacuación, eliminación y disposición final de excretas y aguas servidas.

Artículo 59.- Corresponde al Ministerio de Salud Pública y Asistencia Social, por medio de la Dirección General de Salud Pública, el control sanitario de los Servicios de Alcantarillado de las poblaciones, realizando inspecciones periódicas para impedir que tales servicios o sistemas se conviertan en foco de insalubridad.

Artículo 60.- En las poblaciones donde existan redes centrales para la conveniente disposición de excretas y aguas servidas, toda persona está obligada a su utilización; y los dueños de inmuebles deberán instalar los correspondientes servicios, conectándolos a las redes centrales de alcantarillados, de conformidad con las disposiciones reglamentarias vigentes. Corresponderá, asimismo, a los particulares el buen funcionamiento de tales servicios, dentro de sus respectivos inmuebles. En las poblaciones donde no exista red central de alcantarillado, las instituciones públicas o privadas y los particulares deberán disponer de un sistema de eliminación y disposición de aguas servidas y excretas, aprobado por el SANAA.

Artículo 61.- Corresponde en todo caso a la Dirección General de Salud Pública, el control del cumplimiento de las obligaciones de los particulares en materia de salubridad; pudiendo hacer exigencias dentro de plazos perentorios, sin perjuicio de la responsabilidad directa del Servicio Autónomo Nacional de Acueductos y Alcantarillados y de los Concejos de Distrito y Municipalidades, dentro de su jurisdicción.

Artículo 62.- El Director General de Salud, o su delegado podrá ordenar la intervención o la clausura de un sistema de tratamiento de excretas o aguas servidas, en el que se infrinjan disposiciones reglamentarias, o que constituya grave peligro para la comunidad.

Artículo 63.- Los Concejos de Distrito y las Municipalidades deberán preocuparse de establecer servicios sanitarios públicos, los que deberán ser aprobados para su instalación por la Dirección General de Salud, debiendo observarse en su funcionamiento y mantenimiento las normas establecidas en el reglamento respectivo.

Artículo 64.- Todo propietario o poseedor está obligado a dar curso a las aguas que se encuentren estancadas en su propiedad, en la forma que el Reglamento respectivo determine. En todo caso, corresponde a la Dirección General de Salud, ordenar a los particulares o a las Instituciones Públicas o Privadas, los trabajos de saneamiento necesarios para evitar que las aguas estancadas de cualquier origen, se constituyan en foco de insalubridad o contaminación.

Artículo 65.- Prohíbese descargar residuos industriales en los alcantarillados sin un adecuado tratamiento aceptado previamente por la Dirección General de Salud.

Artículo 66.- Prohíbese descargar alcantarillados, desagües o desechos industriales en lagos, lagunas, ríos, esteros o en cualquier otra fuente que sirva como abastecimiento de agua potable, a poblaciones o individuos, o que se utilice para el riego.

Artículo 67.- Prohíbese arrojar en aguas destinadas al regadío de vegetales que se consuman crudos, o a la crianza de aves y animales, residuos contaminados o que hagan presumibles la contaminación, de conformidad con las normas reglamentarias establecidas por el Ministerio de Salud Pública.

B A S U R A S

Artículo 68.- Las basuras deberán ser eliminadas sanitariamente. Corresponde a los Concejos de Distrito y a las Municipalidades organizar o asumir la responsabilidad de los servicios de limpieza, recolección, tratamiento y disposición de basuras, ciñéndose a las normas reglamentarias que fija la Dirección General de Salud.

Artículo 69.- En las poblaciones donde exista servicio público de recolección de basuras, los habitantes deberán hacer uso obligado de él, y en los lugares que no exista, los particulares deberán disponer de un sistema adecuado de disposición de basuras, de acuerdo con las normas reglamentarias que se incluyan en el reglamento pertinente.

Artículo 70.- Los propietarios o poseedores de sitios o predios baldíos, o locales abiertos, en sectores urbanos o rurales, deberán cercarlos o cerrarlos a fin de que no se acumulen en ellos basuras y desperdicios o se constituyan en criaderos de animales. Corresponderá a los Concejos de Distrito y a las Municipalidades el control del cumplimiento de esta disposición.

Artículo 71.- Si un sitio, terreno o predio constituyera foco de insalubridad, la Dirección General de Salud, previa comprobación de los hechos, podrá ordenar a las autoridades mencionadas en el Artículo 70, tomar las medidas adecuadas para cerrarlos o conservarlos en buenas condiciones de higiene.

URBANIZACION Y VIVIENDA

Artículo 72.- La Secretaría de Salud Pública dictará las normas técnicas y sanitarias pertinentes aplicables a los núcleos urbanos y rurales existentes y futuros, en colaboración con el Instituto de la Vivienda (INVA), Instituto Nacional Agrario (INA) y Servicio Autónomo Nacional de Acueductos y Alcantarillados (SANAA), en tanto se emite la Ley de Planificación del país y se crea el organismo respectivo; cumpliéndose esta condición, el Ministerio velará por el cumplimiento de las normas citadas en coordinación con el mismo, y en base al Reglamento de Saneamiento del ambiente que deberá ser aprobado oportunamente.

Artículo 73.- Los núcleos urbanos y rurales existentes y los futuros, deberán sujetar su crecimiento a las normas técnicas sanitarias contenidas en el presente Código, de conformidad al Artículo anterior.

Artículo 74.- A fin de dar cumplimiento a las disposiciones técnicas y sanitarias establecidas en el presente Código y sus Reglamentos, toda edificación, ampliación o reparación de carácter público o privado, deberá contar previamente con la autorización del organismo competente, sin perjuicio de lo que al respecto indiquen la Ley y Reglamentos del Instituto Nacional de la Vivienda.

Artículo 75.- Si una edificación, parcial o totalmente, constituye foco de infección o amenaza la salud de sus ocupantes o del vecindario, podrá la autoridad competente ordenar su reparación, desinfección o solicitar su desocupación, y no podrá ser ocupado dicho inmueble en tanto la autoridad sanitaria no otorgue su correspondiente permiso.

Artículo 76.- Se prohibe mantener en los edificios o lugares destinados a la habitación, o instalar en las poblaciones, porquerizas, establos o cualquier tipo de albergue para animales, que pueda constituirse en un foco de insalubridad.

DE LA CONTAMINACION DEL AIRE Y OTROS PELIGROS

Artículo 77.- La Dirección General de Salud tomará las medidas necesarias y dictará las órdenes del caso para proteger a la población de las molestias o riesgos de salud provenientes de:

a) Gases tóxicos, humo, polvo o emanaciones dañinas de cualquier tipo; y,

b) La presencia de insectos, roedores u otros animales. En el caso de que se compruebe peligrosidad de animales domésticos, sus propietarios o tenedores deberán proceder a su destrucción, a requerimiento de la autoridad sanitaria; y en caso de negativa o negligencia, se procederá al secuestro del animal por la autoridad sanitaria para proceder a su sacrificio.

Artículo 78.- Se prohibe la instalación de establecimientos industriales fuera de las áreas fijadas por las autoridades competentes, de modo que su funcionamiento constituya un foco de insalubridad, peligro o molestias para la población.

TITULO IV

HIGIENE INDUSTRIAL Y DEL TRABAJO

Artículo 79.- Corresponde a la Secretaría de Salud Pública y Asistencia Social, dictar las normas técnicas relacionadas con la higiene industrial y del trabajo, sin perjuicio a las disposiciones contenidas en el Código de Trabajo.

Artículo 80.- Los Concejos de Distrito y las Municipalidades no podrán otorgar permisos de funcionamiento a aquellos establecimientos industriales que no tuvieren autorización sanitaria para su instalación.

Artículo 81.- Todo establecimiento industrial deberá cumplir con las normas de higiene establecidas en el reglamento pertinente, por la autoridad sanitaria, a fin de que éste no constituya un peligro para la comunidad, a la vez que ofrezca condiciones de higiene para sus trabajadores.

Artículo 82.- La Dirección General de Salud velará por el cumplimiento de las disposiciones reglamentarias y, en caso de urgencia, dictará medidas especiales o decretará la clausura del establecimiento, si fuere necesario.

El Ministerio de Salud Pública dictará un Reglamento sobre Saneamiento del Ambiente, que contendrá todas las disposiciones sanitarias pertinentes:

a) Agua potable, eliminación y disposición de excretas, aguas ser vidas y basuras;

b) Urbanización y vivienda, contaminación del aire y otros peligros para la salud de la colectividad; y,

c) Todo lo relacionado con las normas prescritas en el Artículo 79 de este Código.

TITULO V

DE LOS ALIMENTOS Y DE SU CONTROL

Artículo 83.- Para los efectos de este Código y de los Reglamentos que se dicten sobre la materia, se entiende por alimento toda substancia o mezcla de substancias que ingerida proporcione los elementos y la energía necesarios para el desarrollo de los procesos biológicos humanos. Se incluyen dentro de esta definición las bebidas y aquellas substancias que, poseyendo o no cualidades nutritivas, se adicionan como correctivos o coadyuvantes de su calidad.

Artículo 84.- Corresponde al Ministerio de Salud Pública y Asistencia Social dictar las normas técnicas sobre alimentos, y a la Dirección General de Salud velar por el cumplimiento de tales normas en cuanto a importación, producción, elaboración, empaque, distribución, almacenaje, transporte, expendio, manipulación y propaganda.

Artículo 85.- Ninguna persona podrá importar, producir, fabricar, vender o usar en cualquier forma, alimentos alterados, adulterados, falsificados, contaminados, deteriorados o envasados en forma que no garantice su conservación, ni evite su contaminación, a juicio de la autoridad sanitaria.

Artículo 86.- Para los efectos del artículo anterior, se entenderá por alterado o deteriorado el alimento que, por causas naturales tales como la humedad, luz, temperatura, microorganismos, enzimas, parásitos, u otros fenómenos, acarrearen perjuicio o cambio en sus características físicas o químicas.

Artículo 87.- Se consideran alimentos contaminados, aquellos que contienen impurezas de origen mineral u orgánico, nocivas para el consumo humano o sospechosas de serlo. Se presume contaminado todo alimento producto de una elaboración, empaque o manipulación realizada en condiciones sanitarias defectuosas, o en contravención al reglamento respectivo.

Artículo 88.- Se considerará alimento adulterado aquel:

a) Que contenga una o varias substancias extrañas a su composición natural conocida o aceptada por los reglamentos;

b) Al que se le haya extraído parcial o totalmente cualesquiera de sus componentes, haciéndole perder parte de su valor nutritivo;

c) Al que se haya mezclado, adicionado, encubierto o coloreado, a fin de disimular su impureza o inferioridad;

d) Al que haya sido elaborado, o al que se le haya agregado substancias o productos deteriorados, sucios, impropios o nocivos para el consumo.

Artículo 89.- Se considerará alimento falsificado el alimento que:

a) Se designare o expendiere bajo nombre o calificativo que no le corresponde;

b) Si en el envase o rotulación contuviere cualquier deterioro, indicación ambigua o falsa que pueda inducir a error o engaño; y,

c) Si vendiéndose en su envase original, ha sido sustituido en todo o en parte su contenido.

Artículo 90.- Se prohibe la importación de todo alimento cuyo expendio en el país de origen no esté autorizado por la autoridad sanitaria de ese país.

Artículo 91.- Las Aduanas de la República no estarán autorizadas para proceder a la entrega de alimentos en tanto la autoridad sanitaria no lo permita.

Artículo 92.- Se prohibe la entrada al país de ganado afectado por enfermedades transmisibles al hombre. En todo caso, la carne destinada al consumo humano deberá ser sometida a inspección sanitaria, en la forma que lo indique la Dirección General de Salud en su Reglamento, contando para este fin con la colaboración de la Secretaría de Recursos Naturales.

Artículo 93.- Toda fábrica o local en que se manufacturen, manipulen o expendan alimentos, deberá obtener para su instalación, autorización de la Dirección General de Salud; y para tal efecto, deberá someter a su consideración y aprobación, los planos del local, los planos de las instalaciones, los sistemas de elaboración y los equipos que utilizará en las faenas, los que deberán cumplir con las disposiciones reglamentarias y con aquellas exigencias específicas técnicas, que la autoridad sanitaria pueda hacer en resolución expresa. El mismo requisito -

deberá ser cumplido para cualquier reforma o ampliación de locales ya autorizados.

Artículo 94.- Todos los establecimientos en donde se manipulen alimentos, deberán obtener autorización sanitaria para su funcionamiento. Dicha autorización durará un año, contado desde la fecha de su otorgamiento, vencido el cual deberá solicitarse renovación por el interesado.

Artículo 95.- Para los efectos del artículo anterior, se entiende por establecimiento de alimentos, todo lugar donde se fabriquen, almacenen, manipulen o expendan alimentos, incluyendo especialmente los hoteles, restaurantes, pensiones, internados y similares.

Artículo 96.- Se entiende por manipulador de alimentos toda persona que aplique directa o indirectamente su trabajo manual a los alimentos, de modo que pueda influir en su inocuidad, calidad o higiene. Todo manipulador de alimentos deberá someterse a los exámenes de salud que la autoridad sanitaria determine, a fin de que pueda quedar habilitado para trabajar con el correspondiente certificado de salud, el que deberá renovar anualmente, o antes si la autoridad sanitaria lo considera conveniente.

Artículo 97.- Responderán de la infracción al artículo anterior, tanto el manipulador personalmente, como el dueño del establecimiento que le permita trabajar sin su correspondiente certificado de salud.

Artículo 98.- La Dirección General de Salud ejercerá el control de la rotulación y propaganda que se realice sobre alimentos, de acuerdo con el reglamento respectivo.

Artículo 99.- Todo alimento que contenga alcohol, alcaloides, glucósidos u otras substancias que produzcan hábitos nocivos, deberá declararlo en su rotulación, en la forma que el reglamento pertinente lo determine.

Artículo 100.- Todo alimento elaborado que se venda o se distribuya deberá proceder de fábricas autorizadas, debiendo declararlo en su rotulación en la forma que la autoridad sanitaria o los reglamentos lo determinen.

Artículo 101.- Se prohibe toda propaganda que contenga indicaciones engañosas o falsas, referencias contrarias a los hechos científicos, o que en cualquier forma infrinja las disposiciones reglamentarias, o tienda a engañar al público respecto del origen, calidad, propiedades o procedencia de los alimentos.

Artículo 102.- Sin perjuicio de las multas que el Director General de Salud o su delegado puedan aplicar a las personas, por infracciones a las disposiciones de este Código o de sus reglamentos, la Dirección General de Salud podrá ordenar la clausura temporal o definitiva de cualquier establecimiento o local en que se infrinjan tales disposiciones. Podrá, asimismo, ordenar el decomiso de los alimentos adulterados, falsificados, contaminados o alterados, disponiendo su destrucción según proceda.

Artículo 103.- Con el fin de proteger la salud de la población en relación con el consumo de productos alimenticios importados, fabricados para ser exportados, y que se produzcan en el país para consumo interno, el Ministerio de Salud Pública por sí solo o en colaboración con el Ministerio de Economía y Hacienda, fijará las normas mínimas a que dichos productos deben conformarse.

TITULO VI

病気

DEL CONTROL DE LAS ENFERMEDADES NO TRANSMISIBLES Y PREVENCION DE ACCIDENTES

事故の防止

Artículo 104.- Corresponde a la Dirección General de Salud Pública preparar las normas, desarrollar acciones y disponer medidas destinadas al estudio y control epidemiológico de las enfermedades no transmisibles, mentales y por accidentes.

Artículo 105.- La Dirección General de Salud prestará asesoría y colaboración, mediante sus dependencias técnicas, a las instituciones oficiales y privadas, que dediquen sus actividades a la investigación científica o a la divulgación de métodos para prevenir tales enfermedades y accidentes.

TITULO VII

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墓地 埋葬 (死体)の発掘

CEMENTERIOS, INHUMACIONES Y EXHUMACIONES

Artículo 106.- Corresponde a los Concejos de Distrito y a las Municipalidades mantener, reglamentar y controlar los cementerios en las poblaciones de su jurisdicción, de acuerdo con el Reglamento que dictará el Ministerio de Salud Pública y Asistencia Social.

Artículo 107.- Todo cementerio o crematorio deberá tener autorización de la Dirección General de Salud Pública para su funcionamiento. Se prohibe su instalación o funcionamiento en sitios o condiciones que pusieren en peligro la salud pública o el bienestar de la comunidad.

Artículo 108.- Sólo podrán efectuarse inhumaciones en cementerios debidamente autorizados, y previa constancia de haberse expedido el certificado médico de causa de defunción y efectuado la inscripción del deceso en la correspondiente oficina del Registro Civil. Los Administradores o encargados de cementerios serán responsables del cumplimiento de la presente disposición, exigiendo el permiso correspondiente.

Artículo 109.- Los cadáveres deberán sepultarse dentro de las 24 horas siguientes a su defunción salvo que: se haya autorizado su traslado por la autoridad sanitaria; se hubiere embalsamado; fuere necesario realizar alguna diligencia judicial o investigación médica, o en otras circunstancias especiales que se mencionen en el reglamento respectivo.

Artículo 110.- La inhumación deberá ser inmediata en los casos de fallecimiento por enfermedades sujetas a cuarentenas, o en los casos que por razones sanitarias así lo determinen expresamente las autoridades sanitarias, de acuerdo con el Reglamento respectivo.

Artículo 111.- Se prohibe inhumar cadáveres e inscribir defunciones en el Registro Civil si no justificare previamente las causas del fallecimiento por el médico que asistió a la persona durante su última enfermedad, por el médico de salud o el forense de la jurisdicción, si la persona hubiere fallecido sin atención médica, o por la persona idónea que señala la ley, debiendo ceñirse las anotaciones a la clasificación de las causas de muerte adoptada por el país y de acuerdo con el reglamento del certificado médico de causa de defunción.

Artículo 112.- La exhumación de cadáveres sólo podrá realizarse por orden judicial, o con autorización expresa de la autoridad sanitaria.

Artículo 113.- Se entiende por transporte internacional de cadáveres el que se efectúa desde el país donde ocurrió el fallecimiento, al de su destino final después de la defunción o de la exhumación.

Artículo 114.- El transporte de cadáveres que se realice entre localidades fronterizas dentro de las 48 horas siguientes al fallecimiento, no estará sujeto a estas normas, si existiere convenio al respecto con el país vecino.

Artículo 115.- Para los efectos que se persiguen, se considerará como caja o ataúd impermeable, el fabricado de cualquier material que pueda ser sellado herméticamente por medio de revestimiento, interior o exterior, de caucho, metal, material plástico o de naturaleza similar; o por efecto del propio sellado, soldado, o empleo de materiales adhesivos complementarios.

Artículo 116.- Para el transporte internacional de un cadáver se requerirán los siguientes documentos:

a) Un certificado oficial de defunción, expedido por el Registro Civil;

b) Una declaración legalizada de persona autorizada a preparar el cadáver, en la que conste la forma y método en que llevó a cabo la preparación, y que el ataúd contiene sólo el cadáver en cuestión, el empaque y las ropas necesarias, y,

c) Un permiso de tránsito en el que conste el nombre, apellido y edad del fallecido, expedido por la autoridad competente del lugar en que ocurrió el fallecimiento; en igual forma se procederá cuando se trate de restos mortales exhumados.

Artículo 117.- Los cadáveres estarán sujetos a las siguientes medidas:

a) Lavado general con un desinfectante eficaz, desinfección de todos los orificios, obturación de los mismos con algodón empapado también con un desinfectante efectivo, envoltura del cadáver en una mortaja empapada por un buen desinfectante y colocación en un ataúd impermeable; o,

b) Embalsamamiento adecuado (arterias y cavidades) y colocación del cadáver en un ataúd impermeable.

Artículo 118.- El cadáver preparado para el transporte internacional debe colocarse en un ataúd impermeable. Cuando la causa del fallecimiento sea una enfermedad cuarentenable, de las definidas en el Reglamento Sanitario Internacional, el cadáver debe ser embalsamado (arterias y cavidades) y colocado en un ataúd impermeable. El ataúd impermeable deberá cerrarse herméticamente, y puede ser expedido sin ninguna otra envoltura (salvo en el caso de transporte marítimo); o bien para los fines de protección, puede ser colocado en un cajón de madera o de otro material para evitar el movimiento. También puede envolverse con una tela especialmente destinada a tal efecto.

Artículo 119.- Las disposiciones que regirán en el transporte de cadáveres, serán las siguientes:

a) Por carretera, el ataúd impermeable se transportará de preferencia en un furgón funerario cerrado, o en un camión o automóvil, siempre que se le acomode en forma que evite el movimiento;

b) Por avión, el ataúd impermeable se puede transportar además, en el compartimiento de equipaje de un avión de pasajeros o en una aeronave de carga, y se puede instalar en el féretro una abertura o válvula de seguridad con tal que se hayan tomado precauciones para evitar el escape de líquidos o gases; y,

c) Por vía marítima, el ataúd impermeable, a fin de evitar el movimiento, se colocará dentro de una caja de madera u otro material, o se envolverá en una tela especialmente destinada para tal efecto.

Artículo 120.- Las formalidades anteriores podrán ser modificadas mediante acuerdos bilaterales con otras naciones.

Artículo 121.- El traslado de cenizas no estará sujeto a medidas sanitarias u otras especiales.

LIBRO IV

回復 保康

DE LAS ACCIONES DE RECUPERACION DE LA SALUD

TITULO I

ATENCION MEDICA

Artículo 122.- La Secretaría de Salud Pública y Asistencia Social prestará atención médico-social a las personas que lo soliciten, por medio de los establecimientos públicos de su dependencia, de acuerdo con sus recursos disponibles y en la forma que establezcan sus reglamentos. Dicha atención podrá ser hospitalaria, ambulatoria o a domicilio, según los casos, y comprende la asistencia prestada a personas enfermas, pacientes obstétricas y pediátricos, incluyéndose en ella todas las acciones destinadas al diagnóstico de las enfermedades y a la recuperación de la salud.

CONTROL DE ESTABLECIMIENTOS DE ATENCION MEDICA 医务所務

Artículo 123.- Los establecimientos en que se presta atención médica y todo centro asistencial, sea que pertenezca a particulares, empresas -- privadas, instituciones religiosas u organismos autónomos, deberá solicitar permiso a la Secretaría de Salud Pública, para su instalación y funcionamiento, debiendo cumplir con las normas y requisitos sanitarios que dicha Secretaría de Estado establezca.

Artículo 124.- Todo laboratorio para diagnóstico de enfermedades humanas de cualquier tipo que sea, clínico, químico, -- biológico o relacionado con las profesiones médicas, quedará también sujeto a las exigencias sanitarias expresadas en el artículo anterior.

Artículo 125.- Los establecimientos en que se preste atención médica, o se realicen acciones directamente relacionadas con el diagnóstico o tratamiento de enfermedades o rehabilitación de pacientes, deberá estar bajo la dirección y responsabilidad de un profesional - colegiado de la rama respectiva.

Artículo 126.- La Secretaría de Salud Pública controlará el cumplimiento de estas disposiciones y de las exigencias técnicas específicas que puedan imponerse a ciertos establecimientos, según la zona de su ubicación pudiendo realizar las inspecciones que estime -- conveniente, y hacer las exigencias que estime necesarias para que se cumplan dentro de un plazo perentorio. Asimismo, podrá clausurar aquellos establecimientos, públicos o privados, donde se infrinjan disposiciones - reglamentarias que pongan en peligro la salud o la vida de las personas, - cuando se compruebe que dichas faltas ameritan tal sanción.

Artículo 127.- Ningún establecimiento en que se preste atención médica, o centro asistencial, puede poner término a sus funciones sin dar el correspondiente aviso a la Secretaría de Salud Pública y Asistencia Social o a la autoridad de salud de la jurisdicción, con una anticipación de un mes por lo menos.

CONTROL DE LA MEDICINA Y PROFESIONES AFINES

Artículo 128.- Las profesiones de Medicina y Cirugía, Odontología, - Química y Farmacia, y disciplinas afines, solamente - podrán ser ejercidas en el país por las personas que tengan título legal y estén debidamente colegiadas.

Artículo 129.- Queda prohibida toda propaganda falsa o engañosa sobre sistemas curativos que pueda inducir a error al público. La Secretaría de Salud Pública fiscalizará la propaganda que se realice, sea por radio, periódicos, televisión o cualquier otro sistema -

de difusión, pudiendo ordenar su modificación o retiro.

Artículo 130.- Se prohibe el ejercicio en el país de los llamados Naturalistas y Homeópatas, empíricos y otros que la Secretaría de Salud Pública y Asistencia Social considere perjudiciales o inútiles.

TITULO II 薬局

DE LOS ESTABLECIMIENTOS FARMACEUTICOS Y CONTROL DE DROGAS HEROICAS Y ESTUPEFACIENTES
DISPOSICIONES GENERALES

Artículo 131.- La Secretaría de Salud Pública dictará los reglamentos de carácter sanitario, sobre elaboración, importación, almacenamiento y expendio de drogas, productos medicinales, especialidades farmacéuticas y drogas heroicas y estupefacientes.

Artículo 132.- Para los efectos del artículo anterior, se entiende por carácter sanitario todo lo relacionado con las condiciones higiénicas necesarias para el buen funcionamiento de los establecimientos químico-farmacéuticos y puestos de venta de medicinas.

DEL CONTROL DE DROGAS HEROICAS Y ESTUPEFACIENTES

Artículo 133.- Créase la Junta de Control de Drogas Heroicas y Estupefacientes adscrita a la Secretaría de Salud Pública y Asistencia Social, integrada por un representante de la propia Secretaría y uno por cada uno de los Colegios Médico y Químico Farmacéutico, la cual dictará las normas reglamentarias a las que deberá ceñirse el control de importación, fabricación, purificación y expendio de las drogas heroicas y estupefacientes, declaradas así por la Oficina de Narcóticos de las Naciones Unidas en la lista vigente, y las que se declaren como tales en lo sucesivo o las que la Junta de Control incorpore mediante acuerdo.

Artículo 134.- El monto total de las importaciones y fabricación interna de drogas heroicas y estupefacientes, no podrá exceder al monto de la evaluación anual de consumo que, para tales efectos, deberá realizar la Junta de Control, y cada establecimiento no podrá sobrepasar la cuota que le asigne el mismo organismo para los efectos pertinentes. En consecuencia, para el debido control, los particulares y las empresas públicas y privadas deberán llevar un cuidadoso registro del movimiento en la forma que lo determine el Reglamento.

Artículo 135.- Queda prohibido el cultivo de la adormidera (papaver somniferum), de la coca (Erytroxyelon Coca), del Cáñamo Indiano o Mariguana (Cannabis Indica y Cannabis Sativa) y del Peyote (Lophophora Williamsili) y otras plantas que en el futuro se les pueda calificar como estupefacientes.

Artículo 136.- La importación, tráfico, exportación, venta y adquisición de la diacetilmorfina (heroína), queda sujeta a las normas reglamentarias especiales que se dispondrán.

Artículo 137.- La Dirección General de Aduanas, la Dirección General de la Tributación Directa, la Dirección General de Seguridad Pública, la Dirección General de Correos y Telégrafos, deberán comunicar inmediatamente a la Junta de Control todo caso de infracción a las disposiciones legales o reglamentarias sobre importación, exportación y tráfico de las drogas estupefacientes de que tuvieren conocimiento.

Artículo 138.- La Junta de Control podrá ordenar que se practiquen inspecciones, o se libren las correspondientes órdenes de allanamiento en su caso, previa autorización de la autoridad competente, de aquellos establecimientos, locales o habitaciones en los que sospeche o presuma que se están infringiendo las disposiciones legales o reglamentarias al control de drogas estupefacientes.

Artículo 139.- Sin perjuicio de la responsabilidad criminal, la Junta de Control podrá disponer la cancelación de los permisos otorgados, la clausura temporal o definitiva de los establecimientos en que se infrinjan las disposiciones a que se hace referencia en los artículos anteriores, y el decomiso de las substancias que hayan sido importadas, fabricadas, elaboradas, envasadas o expendidas con infracción de la ley o del reglamento.

L I B R O V

ACCIONES COMPLEMENTARIAS 神毛

TITULO I

DE LAS ESTADISTICAS VITALES Y DE LA SALUD PUBLICA

Artículo 140.- La División de Bioestadística del Ministerio de Salud Pública tendrá a su cargo la recolección, proceso, análisis y presentación de los datos estadísticos sobre Salud Pública, sin perjuicio de las atribuciones y actividades que sobre la materia, tengan otros organismos.

Artículo 141.- El Instituto Hondureño de Seguridad Social, los hospitales y clínicas privadas y, en general, todos los establecimientos de prevención y de tratamiento de enfermedades o de rehabilitación de pacientes, deberán enviar periódicamente, en la forma que lo determine el Ministerio de Salud Pública, los datos estadísticos de sus actividades.

TITULO II

DE LOS LABORATORIOS OFICIALES

Artículo 142.- La Dirección General de Salud deberá disponer de los laboratorios que sean necesarios para el ejercicio adecuado de sus funciones y de la eficaz protección de la Salud Pública. Dichos laboratorios estarán a cargo de profesionales colegiados que realizarán funciones de control, de investigación, normativas y de asesoría.

Artículo 143.- Los laboratorios de la Dirección General de Salud serán considerados laboratorios oficiales de la República y, en tal virtud, los resultados de sus exámenes, en las distintas especialidades, tendrán carácter de plena prueba para los efectos de los expedientes administrativos que se incoen por infracción a las disposiciones del Código Sanitario.

Artículo 144.- Los exámenes que los laboratorios oficiales practiquen serán gratuitos, cuando se refieran a enfermedades transmisibles y, en los demás casos, un reglamento determinará las condiciones y el arancel para que estos laboratorios practiquen análisis solicitados por particulares.

Artículo 145.- No obstante lo dispuesto en los artículos anteriores, la Secretaría de Salud Pública podrá firmar convenios con otras Instituciones Públicas o privadas, o con organismos internacionales, de conformidad con los tratados vigentes, que puedan prestar eficientemente dicho servicio en alguna de las especialidades, cuando las necesidades o posibilidades técnicas del país así lo aconsejaren.

TITULO III

DESARROLLO DE LA COMUNIDAD

Artículo 146.- La Secretaría de Salud Pública y Asistencia Social,-

considerando que su función no es sólo prevenir y curar las enfermedades y promover la salud, sino participar en la búsqueda del bienestar socio-económico de todos los hondureños, deberá cooperar con los programas de desarrollo de la comunidad, elaborados por el Instituto Nacional de Desarrollo de la Comunidad (INDECO), utilizando para ello la capacidad y potencialidad de los habitantes de dichas comunidades.

LIBRO VI

DE LAS INFRACCIONES, SANCIONES Y PROCEDIMIENTOS

TITULO I

DE LAS INFRACCIONES

Artículo 147.- Las infracciones a las disposiciones del presente Código y de sus Reglamentos, serán sancionadas en la forma que expresan los artículos siguientes, sin perjuicio de las penas a que se haga acreedor el infractor por la configuración de delitos en contra de la salud pública, en cuyo caso la autoridad sanitaria deberá, también, poner los antecedentes en conocimiento de la justicia ordinaria.

Artículo 148.- Se entiende por infracción a las disposiciones sanitarias, para los efectos de este Código, no sólo las contravenciones a las disposiciones legales o reglamentarias, sino que también las omisiones o negligencias en su cumplimiento.

TITULO II

DE LAS SANCIONES

Artículo 149.- Las sanciones aplicables por infracción a las disposiciones del presente Código, de sus Reglamentos, o de los acuerdos del Ministerio o de la Dirección General de Salud, en los -

que se haga exigencias específicas para ser cumplidas dentro de cierto plazo, por determinadas circunstancias, serán: amonestación escrita para la primera vez, y multas de acuerdo a la gravedad de la infracción, conforme a lo que dispongan los reglamentos respectivos. Las multas que se apliquen deberán enterarse en las oficinas de Hacienda respectivas, dentro del quinto día de notificadas. Si dicha multa no fuere cancelada dentro del plazo fijado, se podrá hacer efectivo el apremio personal y la conmutabilidad de la multa en prisión.

Artículo 150.- En forma independiente o complementaria, la Dirección General de Salud o su Delegado, podrá ordenar la suspensión de actividades o la clausura temporal o definitiva de todo establecimiento industrial, comercial, público o privado, planta de agua potable, o cualquier otro local en el que por cometerse infracciones a las disposiciones legales o reglamentarias, o acuerdos especiales, se pusiere en peligro la salud, o el bienestar de los habitantes.

Artículo 151.- Podrá, asimismo, ordenarse el comiso de alimentos, medicamentos, drogas u otras mercaderías alteradas, falsificadas, contaminadas o adulteradas, o que no cumplan disposiciones reglamentarias específicas, a fin de proceder a su destrucción.

TITULO III

DEL PROCEDIMIENTO EN LAS ACTUACIONES DE LA AUTORIDAD SANITARIA

Artículo 152.- Para los efectos de mantener una adecuada vigilancia de la salud pública general y del cumplimiento de las disposiciones legales y reglamentarias, el Director General de Salud por sí o por delegado y los funcionarios del servicio de salud, a quienes por nombramiento se les encomiende tales funciones, podrán inspeccionar cualquier local, vivienda y establecimiento público o privado, acreditando su calidad de tal y ateniéndose a las normas de procedimiento fijadas. Podrán asimismo estos funcionarios, tomar las muestras que sean necesarias para acreditar las infracciones o para realizar los análisis de rigor, ateniéndose al procedimiento que fije el reglamento.

Artículo 153.- Denunciada que sea una infracción, el funcionario sanitario levantará acta oficial de los hechos, la que deberá ser firmada por dos testigos, los que pueden ser vecinos, otros funcionarios del servicio, o agentes de policía, y pondrá los antecedentes en conocimiento del Jefe correspondiente a fin de que se inicie el sumario administrativo, de acuerdo con el procedimiento contemplado en el Código de Procedimientos Administrativos (Artículos 48 y 52).

Artículo 154.- Si de los antecedentes se desprendiere que está comprobada la infracción a la ley o reglamento de salud, y oído el afectado o en su rebeldía, se aplicará la sanción que corresponda sin perjuicio de hacer los arreglos, obras y tomar las medidas que la autoridad estime necesarias.

Artículo 155.- Las multas serán aplicadas por acuerdo del Director General de Salud Pública o su Delegado. Serán delegados del Director, para estos efectos, los Jefes de los Distritos Sanitarios y los funcionarios en quienes especialmente delegue esta facultad mediante acuerdo.

Artículo 156.- Los acuerdos se extenderán en el libro respectivo y deberán contener un resumen de los hechos que constituya la deficiencia sanitaria, las disposiciones infringidas, la sanción que se aplica y el plazo para pagar, si es multa. Si al mismo tiempo, se ordenara tomar ciertas medidas o realizar ciertas obras, se determinará el plazo para cumplirlas.

Artículo 157.- Los acuerdos por los que se impongan sanciones u órdenes, trabajos o medidas especiales, se notificarán en el domicilio del infractor, personalmente, pero si el infractor no estuviere o se negare a ser notificado, bastará con realizar la notificación por cédula.

Artículo 158.- Todas las autoridades y en especial, los servicios de policía y seguridad, estarán en la obligación de cooperar con la autoridad sanitaria, para el mejor cumplimiento de las disposiciones legales y reglamentarias de salud.

Artículo 159.- Para los efectos de un control conveniente del cumplimiento de las sanciones impuestas administrativamente por el Director General de Salud Pública, las oficinas fiscales de Hacienda respectivas, deberán mandar mensualmente una nómina de las multas pagadas y de las no satisfechas, a fin de que se pueda librar el correspondiente apremio personal de los infractores renuentes al pago.

Artículo 160.- Para proceder a las clausuras de los establecimientos en que se infrinjan las disposiciones legales y reglamentarias, los funcionarios de Salud colocarán carteles visibles en que se indique la calidad de "clausurado por la autoridad sanitaria", y procederán a sellar las máquinas y cerraduras a fin de impedir que se continúe el uso, la actividad o la entrada, según corresponda. De todo lo obrado se levantará un acta firmada por el funcionario y testigos si los hubiere, la que se pondrá de inmediato en conocimiento del Jefe respectivo.

Artículo 161.- En todas las diligencias que se efectúen, se cuidará de proteger en la mejor forma posible la salud pública, pero al mismo tiempo se deberá evitar molestias o perjuicios innecesarios al infractor.

Artículo 162.- En todo lo no previsto en el Libro VI, Títulos I, II y III de la presente ley, se estará a lo dispuesto en el Código de Procedimientos Administrativos.

TITULO FINAL

DISPOSICIONES FINALES Y TRANSITORIAS

Artículo 163.- Derógase el Código de Sanidad emitido por Decreto No. 104, de fecha 29 de marzo de 1910, sus reformas y demás leyes que se le opongan.

Artículo 164.- La Dirección General de Salud Pública, dentro del término de doce meses, contados a partir de la fecha en que entre en vigencia este Código, deberá presentar a la consideración de la Secretaría de Estado en los Despachos de Salud Pública y Asistencia Social, para su tramitación, todos los proyectos de reglamentos que sean necesarios, de conformidad a las disposiciones de este Código.

Artículo 165.- Las Direcciones Generales de Salud y Asistencia Social deberán realizar, conjuntamente, un estudio intensivo de un programa de integración a nivel nacional de los servicios de salud del Ministerio.

Artículo 166.- El presente Decreto entrará en vigencia desde veinte días después de su publicación en el Diario Oficial "La Gaceta".

Dado en la ciudad de Tegucigalpa, Distrito Central, en el Salón de Sesiones del Congreso Nacional, a los cinco días del mes de octubre de mil novecientos sesenta y seis.

pasan las

firmas.

MARIO RIVERA LOPEZ,
Presidente

LUIS MENDOZA FUGON,
Secretario

SAMUEL GARCIA Y GARCIA,
Secretario

Al Poder Ejecutivo

Por tanto: Ejecútese.

Tegucigalpa, D.C., 14 de noviembre de 1966.

O. LOPEZ A.

El Secretario de Estado en los Despachos de Salud Pública y Asistencia Social,

J. Antonio Peraza.

Tomado del Diario Oficial "La Gaceta", números 19.057 y 19.058, correspondientes a los días jueves 5 y viernes 6 de enero de 1967, respectivamente.

/rmr

ANNEX II LEY CONSTITUTIVA DEL SERVICIO AUTONOMO NACIONAL DE ACUEDUCTOS Y ALCANTARILLADOS, REPUBLICA DE HONDURAS, ABRIL DE 1961

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REPUBLICA DE HONDURAS

LEY CONSTITUTIVA

DEL

SERVICIO AUTONOMO NACIONAL DE

ACUEDUCTOS Y ALCANTARILLADOS

DECRETO No. 91

26 DE ABRIL DE 1961

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El Secretario de Estado en el Despacho de Trabajo y Previsión Social

Coutuna Fonseca

El Secretario de Estado en el Despacho de Recursos Naturales

Raúl Edgardo Escoto Díaz

El Secretario Ejecutivo del Consejo Superior de Planificación Económica

Manlio Dionisio Martínez Cantor.

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法令

DECRETO No. 91

EL CONGRESO NACIONAL,

CONSIDERANDO:

I. Que es deber primordial del Gobierno de la República, velar por la salud del pueblo, base del bienestar y desarrollo económico del país; y que para cumplir este objetivo, sin fines lucrativos, son factores indispensables el suministro de agua potable y -- abundante para servicio doméstico, público, comercial e industrial; así como la evacuación y tratamiento de las aguas negras y pluviales.

II. Que los servicios de agua potable, aguas negras y pluviales no pueden considerarse y resolverse desde un punto de vista local o municipal, sino nacional, porque a menudo las fuentes de abastecimiento deben servir dos o más comunidades, o porque esos servicios deben interconectarse para lograr mayor economía y eficiencia de ellos.

III. Que la Constitución de la República reconoce la necesidad de - la creación de organismos autónomos al establecer en el Título X, Capítulo V, Instituciones Autónomas, que "Para la mayor eficiencia en la administración de los intereses nacionales, para garantizar sin fines de lucro, la satisfacción de las necesidades colectivas de servicio público; y, en general, para lograr la mayor efectividad de la administración, se reconocen los organismos autónomos con criterio de descentralización de la administración pública".

IV. Que para lograr un aprovechamiento económico y efectivo de los sistemas de agua potable, así como la evacuación y tratamiento de aguas negras y alcantarillado de aguas pluviales, se hace necesario que la preparación de los proyectos, la ejecución, operación y mantenimiento de las obras requeridas, estén a cargo - de un organismo central, técnica y administrativamente capacitado.

V. Que es urgente e indispensable la creación de tal organismo central, para evitar la duplicidad de trabajo de la misma índole llevados ahora a cabo por organismos nacionales e internacionales, lo cual significa costos más altos de diseño, construcción, operación, mantenimiento y administración; así como un debilitamiento en los esfuerzos que integralmente se necesitan para considerar y resolver los mismos problemas. Esta situación, obstaculiza la recopilación, uso y distribución de datos técnicos y de costos de administración y construcción para el establecimiento de tarifas adecuadas y justas.

VI. Que sólo estableciendo una dirección central puede asegurarse la uniformidad de normas en la aplicación de los principios de Ingeniería Sanitaria para lograr economía y eficiencia en el planeamiento, diseño, construcción y administración de los servicios de agua potable, aguas negras y pluviales.

VII. Que los problemas inherentes a la captación, conducción, purificación y distribución de las aguas, así como la evacuación y tratamiento de las aguas negras y pluviales, se resuelven eficazmente sólo a través de un organismo dotado de los elementos indispensables, libre de interferencias extrañas y de la discontinuidad de programas y personal técnico que algunas veces se producen por cambios en la administración pública.

VIII. Que en más de ciento cincuenta abastecimientos de agua y más de veinte alcantarillados sanitarios construídos hasta la fecha en toda la República, cuyo costo pasa de veinte millones de lempiras y de los cuales aproximadamente dieciocho millones han sido aportados en forma cooperativa por el Estado y el Servicio Cooperativo Interamericano de Salud Pública, sin que el Estado haya obtenido reembolso alguno por su inversión.

IX. Que de los pocos fondos obtenidos por los municipios por concepto de servicios de agua y alcantarillado, la mayor parte han sido invertidos en otras actividades y sólo sumas pequeñas se han dedicado al mejoramiento y ampliación de estos sistemas, los cuales una vez que se han deteriorado proporcionan un servicio muy deficiente obligando a las municipalidades a recurrir de nuevo al gobierno central en demanda de auxilio.

X. Que el suministro de agua potable y abundante no puede ser proporcionado por municipios que no cuentan con personal técnico idóneo, quienes en la mayoría de los casos no se asesoran ni consultan a un cuerpo especializado en estos servicios para solucionar sus problemas.

XI. Que desde el punto de vista financiero, es requisito indispensable la existencia de un organismo con autoridad competente y responsable, que garantice los préstamos de las instituciones bancarias para el financiamiento de este tipo de obras.

XII. Que de la experiencia obtenida en otros países de la América Indo-Española, se ha podido establecer que para el cumplimiento de los objetivos mencionados, los mejores resultados se han logrado a través de la creación de entidades autónomas técnicamente especializadas.

POR TANTO,

DECRETA:

la siguiente:

LEY CONSTITUTIVA DEL SERVICIO AUTONOMO NACIONAL DE ACUEDUCTOS Y ALCANTARILLADOS (SANAA)

CAPITULO I

CREACION DEL SERVICIO

Artículo 1o.- Créase un organismo autónomo de servicio público, con personería, capacidad jurídica y patrimonio propios, de duración indefinida, que se llamará SERVICIO AUTONOMO NACIONAL DE ACUEDUCTOS Y ALCANTARILLADOS - SANAA-, y que se regirá por la presente ley, sus reglamentos, y en lo que no estuviere previsto, por las demás leyes del país que le sean aplicables.

CAPITULO II

OBJETO DEL SERVICIO

Artículo 2o.- El Servicio Autónomo Nacional de Acueductos y Alcantarillados, tendrá por objeto, promover el desarrollo de los abastecimientos públicos de agua potable y alcantarillados sanitarios y pluviales de todo el país, mediante:

a). El estudio, construcción, operación, mantenimiento y administración de todo proyecto y obra de esta índole, que sea de pertenencia del Distrito Central, Municipios, Juntas de Agua, Juntas de Fomento o de cualquier dependencia gubernamental, que de acuerdo con esta ley, pase a formar parte del patrimonio del Servicio;

b). El planeamiento, diseño, construcción, operación, mantenimiento y administración de obras de la misma clase emprendidas por la propia iniciativa del Servicio;

c). La representación de los intereses del Estado en lo que atañe a abastecimientos de agua y alcantarillados en las empresas particulares, que presten servicios públicos; y

d). La aprobación de diseños, planos y vigilancia durante el período de construcción de las obras de este género que con carácter particular se construyan. Entiéndese por sistemas públicos de abastecimientos de agua y alcantarillados, aquellos que prestan servicio a más de cien personas.

CAPITULO III

attribution

ATRIBUCIONES DEL SERVICIO

Artículo 3o.- Para el logro de sus finalidades, el Servicio tendrá las siguientes atribuciones:

a). Estudiar los recursos hidráulicos y su adaptabilidad a los problemas de abastecimiento de agua potable y alcantarillados;

b). Llevar a cabo la ejecución de proyectos relacionados con la captación, conducción, almacenamiento, purificación y distribución de las aguas potables para las comunidades del país, así como los relacionados con la colección, tratamiento y disposición de las aguas negras y las aguas pluviales;

c). Operar y administrar todas las instalaciones a su cargo;

d). Comprar y vender todos los servicios relacionados con él;

e). Adquirir instalaciones y vender servicios de los sistemas de agua y alcantarillado sanitario, que se consideren de beneficio;

f). Comprar y contratar materiales y equipos, dentro o fuera del país, de acuerdo con los Reglamentos que el Servicio establezca;

g). Intervenir en las actividades de abastecimientos de agua y de alcantarillados de empresas particulares, municipales y demás Instituciones autónomas, a solicitud de ellas, o de las autoridades sanitarias o municipales;

h). Negociar y contratar préstamos, dentro o fuera del país, y otorgar las garantías necesarias, previo dictamen del Banco Central de Honduras;

i). Adquirir propiedades para los fines inherentes al funcionamiento del Servicio;

j). Nombrar su personal y determinar sus facultades y deberes de acuerdo con su Reglamento;

k). Formular, reformar y derogar su Reglamento;

l). Emitir bonos, previa autorización del Banco Central de Honduras, con el fín de incrementar sus recursos;

m). Aceptar donaciones de cualquier índole, siempre que sean de origen lícito;

n). Determinar, fijar, alterar, imponer y cobrar tarifas, derechos, rentas y otros cargos por el uso de las facilidades del Servicio, por los servicios de agua, alcantarillado y otros artículos o servicios vendidos, prestados o suministrados por él, como en esta Ley se provee;

o). Ejercer completo dominio y supervisión de sus propiedades y actividades para su eficiente funcionamiento;

p). Entrar, previa notificación a sus dueños o poseedores, o a sus representantes, en cualesquiera terrenos, cuerpos de agua o propiedades, con el fin de hacer mediciones, sondeos y estudios;

q). Demandar y ser demandado como tal organismo;

r). Mejorar y ampliar las instalaciones de agua y alcantarillados bajo su jurisdicción y proveer instalaciones adicionales de la misma clase;

s). Disponer de sus propiedades, cuando lo crea conveniente, salvo de aquellas que constituyan reservas nacionales;

t). Velar por la aplicación de las leyes existentes, correspondientes a la conservación forestal y las buenas condiciones sanitarias de las cuencas hidrográficas, de los sistemas de agua ya construídos o de los que se construyan en el futuro; y,

u). ~~Realizar todos los actos necesarios o convenientes para llevar a efecto los propósitos de esta Ley.~~ Celebrar convenios de colaboración con organismos creados para la administración, operación y mantenimiento de sistemas de agua potable y alcantarillado, sin que esto implique renuncia alguna a las facultades que por la ley le corresponden.

v). Realizar todos los actos necesarios o convenientes, para llevar a efecto los propósitos de esta Ley.-

CAPITULO IV

PATRIMONIO DEL SERVICIO

Artículo 4o.- El patrimonio del Servicio Autónomo Nacional de Acueductos y Alcantarillados estará formado:

a). Por los bienes y derechos que integran los sistemas de abastecimiento de agua y alcantarillados sanitarios y pluviales y que siendo propiedad del Distrito Central, Municipios, Juntas de Agua, Juntas de Fomento o cualquier Dependencia Gubernamental, sean traspasados legalmente al Servicio;

b). Por los bienes y derechos de los sistemas de abastecimiento de agua y alcantarillado que el Servicio construya;

c). Por una subvención del Estado, que se procurará no sea menor a las asignaciones que actualmente se consignan en el Presupuesto, para el diseño, construcción y mantenimiento de abastecimientos de agua y alcantarillado a través de organismos nacionales e internacionales;

d). Por las asignaciones que el Estado, el Distrito Central, Municipios o cualquier dependencia gubernamental acuerden, para cualesquiera de los propósitos especificados en esta Ley; y,

e). Por todo ingreso o adquisición que en alguna forma lo incremente.

Artículo 5o.- El Servicio asumirá el activo y pasivo, de cualquier clase que sea, de las entidades que adquiera.

Artículo 6o- El Servicio estará sujeto, para efectos de control financiero y contable, a la fiscalización preventiva de un Auditor Interno que fungirá durante un período de tres años y cuyo nombramiento y remoción estará a cargo del Poder Ejecutivo.

Artículo 7o.- El Auditor, que será un Contador Público, autorizado, hondureño por nacimiento y mayor de veinticinco años, tendrá a su cuidado todas las funciones de vigilancia y fiscalización de los bienes y de las operaciones del Servicio. Además de las que le fije la Junta Directiva, tendrá las siguientes atribuciones:

a). Fiscalizar todas las operaciones y actividades del Servicio, verificando la contabilidad o inventarios, realizando arqueos y las otras comprobaciones que estime necesarias; examinando los diferentes balances y estados de cuentas, comprobados con los libros o documentos correspondientes y certificándolos, refrendándolos, cuando los encontrare correctos. Los arqueos y demás verificaciones que considere convenientes, los realizará por sí mismo o por medio de los funcionarios que designe;

b). Presentar informes resumidos de sus actividades de inspección y fiscalización a la Directiva, la cual podrá solicitarle, si lo creyere conveniente, el informe completo y cualquiera otra información sobre sus labores;

c). Comunicar a la Junta Directiva las irregularidades, infracciones y deficiencias que observare en las operaciones y funcionamiento del -- Servicio, en sus diferentes dependencias;

d).- Hacer las sugestiones, observaciones o recomendaciones que estime convenientes, y adoptar las medidas que fueren de su competencia, - para efectos de sanciones y correcciones de las infracciones que se - hubieren cometido;

e). Levantar las informaciones que le soliciten la Junta Directiva a la Gerencia, examinar libremente todos los libros, documentos y archivos del Servicio, y obtener de los empleados y de la Gerencia los datos e informaciones que requiera, para el buen desempeño de su cargo;

f). Llevar cuidadosamente el estudio y control de vencimientos de las - obligaciones del Servicio y vigilar que se cobren oportunamente los - créditos vencidos;

g). Asistir a las sesiones de la Junta Directiva, con voz pero sin voto, y velar porque se cumplan estrictamente las resoluciones que ella le encomiende; y,

h). Ejercer las demás funciones y atribuciones que le correspondan de — acuerdo con las leyes, reglamentos y disposiciones especiales.

Artículo 8o.- Todos los fondos del Servicio se depositarán en el Banco Central de Honduras o sus agencias de la República, pero se mantendrán en cuenta o cuentas separadas, inscritas a nombre del Servicio. Esos fondos no podrán ser apropiados ni intervenidos por el Estado. Los desembolsos se harán por el Servicio, de acuerdo con los reglamentos y presupuestos aprobados — por la Junta Directiva.

Artículo 9o.- Las Municipalidades, Instituciones Autónomas y demás corporaciones Gubernamentales, deberán traspasar al Servicio, de común acuerdo, los sistemas de agua y alcantarillado bajo su jurisdicción, para que éstos - sean administrados, operados y mantenidos por él, en el entendido de que - estos sistemas continuarán sirviendo a la comunidad y que los fondos y otros activos servirán, preferentemente para el mejoramiento, operación y mantenimiento del sistema que los produzca.

Artículo 10.- El Servicio, a medida que sus posibilidades se lo permitan, solicitará el traspaso de los sistemas de abastecimiento de agua y alcantarillado, incluyendo todas sus pertenencias, obras accesorias, servidumbres y demás derechos.

Artículo 11.- El Servicio, gozará de preferencia sobre individuos u organismos oficiales, semioficiales o privados, para el uso o aprovechamiento de cualquier cuerpo de agua u otros bienes de propiedad nacional o privada que sean considerados necesarios para el abastecimiento del agua o descargas de alcantarillados, sujetándose en lo pertinente a lo dispuesto en el Código Civil y en la Ley de Aprovechamiento de Aguas Nacionales.

Artículo 12.- A juicio del Servicio, y previa gestión hecha por el mismo ante las autoridades competentes, se declarará de utilidad pública y tendrá prioridad sobre cualquier otro servicio actual o futuro, el uso y aprovechamiento de las aguas nacionales.

Artículo 13.- El Servicio gestionará, ante las autoridades competentes, la suspensión, cancelación o enmienda de cualquier concesión, uso o aprovechamiento de aguas o recursos de propiedad nacional o privada, que se considere necesaria para fines de abastecimientos de agua o descarga de alcantarillados.

CAPITULO V

DE LA JUNTA DIRECTIVA 幹部会

Committee
congress

Artículo 14.- La Dirección y Administración del Servicio Autónomo Nacional de Acueductos y Alcantarillados, estará a cargo de una Junta Directiva, compuesta de cinco miembros propietarios y sus respectivos suplentes, en la forma siguiente:

1.- Por el Secretario de Estado en los Despachos de Salud Pública y Asistencia Social o por el Sub-Secretario en su defecto;

2.- Por un Ingeniero Sanitario o por un Ingeniero Civil con experiencia en Ingeniería Sanitaria, inscrito en el respectivo Colegio o en su defecto en la Sociedad de Ingenieros y Arquitectos;

3.- Por un Médico y Cirujano, egresado de la Universidad Nacional o incorporado conforme a la Ley;

4.- Por el Secretario de Estado en el Despacho de Recursos Naturales o por el Sub-Secretario en su defecto; y,

5.- Por un Representante de las Municipalidades, designado a través de la Secretaría de Gobernación y Justicia. Los miembros suplentes deberán llenar los mismos requisitos que los propietarios.

CAPITULO VI

REQUISITOS 必要條件

Artículo 15.- Los miembros de la Junta Directiva deberán ser personas de reconocida honorabilidad y solvencia.

CAPITULO VII

IMPEDIMENTOS 障害

第7條項

Artículo 16.- No podrán ser miembros de la Junta Directiva;

a). Los menores de 25 años;

b). Los que tengan vínculos económicos con empresas que se dediquen al suministro de materiales, equipo o servicios relacionados con abastecimiento de agua o alcantarillado;

c). Las personas que sean parientes dentro del cuarto grado de consanguinidad o segundo de afinidad entre sí;

d). Las personas que hubieren sido condenadas en juicios por causas penales;

e). Los empleados del Servicio; y,

f). Los que tengan cualquiera otra incapacidad legal para desempeñar dichas funciones.

CAPITULO VIII

ELECCION Y NOMBRAMIENTOS DE LOS MIEMBROS DE LA JUNTA DIRECTIVA

Artículo 17.- Fuera de los Secretarios de Estado en los Despachos de Salud Pública y Asistencia Social y Recursos Naturales y sus respectivos Sub-Secretarios, los demás miembros de la Junta Directiva serán elegidos de la siguiente manera:

a). El Ingeniero Sanitario o Civil y sus suplentes, serán designados por el Colegio o la Sociedad de Ingenieros;

b). El Miembro Médico y Cirujano será nombrado por el Ejecutivo, mediante la Secretaría de Salud Pública y Asistencia Social;

c). El Representante de las Municipalidades será designado por el Secretario de Gobernación y Justicia a propuesta en terna por la Dirección General de Municipalidades.

Artículo 18.- La Presidencia de la Junta Directiva estará a cargo del Secretario de Salud Pública y Asistencia Social o en su defecto, del Sub-Secretario del Ramo.

CAPITULO IX

DURACION DE LOS MANDATOS

Artículo 19.- La duración de las funciones de los miembros titulares y suplentes, a excepción de los Secretarios y Sub-Secretarios de Estado en los Despachos de Salud Pública y Asistencia Social y Recursos Naturales, será de tres años, pudiendo ser designados para nuevos períodos.

CAPITULO X

RESPONSABILIDADES

Artículo 20.- La Junta Directiva ejercerá sus funciones con absoluta independencia y bajo su exclusiva responsabilidad, dentro de las normas establecidas por esta Ley y sus Reglamentos. Todo acto, resolución u omisión de la Junta Directiva que contravenga disposiciones legales o reglamentarias y que cause perjuicios a la Organización, hará incurrir en responsabilidad personal y solidaria para con el Servicio, el Estado o terceros, a todos los directores presentes en la sesión respectiva, salvo aquellos que hubieren hecho constar su voto contrario en el acta de la sesión en que se hubiere tratado el asunto. Incurrirán también en responsabilidad personal, los que divulgaren cualquier información de carácter confidencial sobre los asuntos tratados en las sesiones, o los que aprovechen cualquier información para fines personales o en perjuicio del Servicio, del Estado o de terceros.

CAPITULO XI

DE LAS SESIONES, ASISTENCIA Y RETRIBUCIONES

会 出席 報酬

Artículo 21.- La Junta Directiva deberá celebrar sesiones ordinarias por lo menos dos veces al mes, y sesiones extraordinarias mediante la convocatoria de su Presidente o de tres de sus miembros propietarios. Los miembros titulares y el Gerente que asistan a las sesiones, tendrán derecho a percibir las dietas y gastos que fije el Reglamento. Los suplentes tendrán iguales derechos cuando asistan en sustitución de los propietarios.

CAPITULO XII

QUORUM

定数

Artículo 22.- Para que haya quórum en las sesiones ordinarias y extraordinarias, se requerirá la comparecencia de cuatro de sus miembros, de los cuales tres por lo menos, deberán ser propietarios. Las decisiones se tomarán por mayoría de votos, excepto la designación del Gerente, y del Sub-Gerente que requerirá cuatro votos por lo menos.

director

CAPITULO XIII

ATRIBUCIONES DE LA JUNTA DIRECTIVA

Artículo 23.- Serán atribuciones de la Junta Directiva: -

a). Aprobar, improbar o modificar el plan de trabajo del servicio que presente el Gerente y coordinarlo con los otros organismos gubernamentales que participen en el desarrollo económico del país;

b). Aprobar, improbar o modificar el presupuesto anual de ingresos y egresos del servicio;

c). Nombrar, suspender o remover al Gerente y al Sub-Gerente y a propuesta del primero, a los Jefes de Departamento o Sección; el Gerente y -- Sub-Gerente deberán ser personas con capacidad técnica y administrativa en esta clase de trabajos;

d). Fijar las tarifas que el servicio cobrará por la venta de los servicios de agua y alcantarillado;

e). Aprobar o improbar la memoria anual del Servicio, así como los informes financieros;

f). Emitir el Reglamento del Servicio;

g). Remover, por causas justificadas, a cualquiera de sus miembros a — excepción de los Secretarios y Sub-Secretarios de Estado; y,

h). Ejercer las demás funciones y facultades que el Reglamento indique.

CAPITULO XIV

Artículo 24.- Corresponde al Presidente de la Junta Directiva:

a). Presidir las sesiones de la Junta;

b). Velar por el estricto cumplimiento de la Ley y el Reglamento, así como las disposiciones y acuerdos de la Junta Directiva;

c). Informar a la Junta Directiva, en cada sesión, de todos los asuntos que tengan importancia para el buen funcionamiento del servicio; y,

d). Ejercer las demás funciones que le corresponden conforme a esta Ley.

CAPITULO XV

DEL GERENTE

负责人，理事

Artículo 25.- Corresponde al Gerente las siguientes atribuciones:

a). Tener a su cargo la administración inmediata del Servicio y ser responsable ante la Junta Directiva del funcionamiento correcto y eficiente del mismo y será el superior jerárquico del personal;

b). Asistir a las sesiones de la Junta Directiva;

c). Dedicar todo su tiempo al desempeño de sus funciones, las cuales serán incompatibles con el ejercicio remunerado o ad-honorem de cualquier otro cargo, excepto los de carácter docente;

d). Velar por el estricto cumplimiento de las leyes, el Reglamento y de los acuerdos y disposiciones de la Junta Directiva;

e). Informar a la Junta Directiva, en cada sesión, de los asuntos importantes relacionados con el funcionamiento del Servicio;

f). Ejercer la representación legal del Servicio;

g). Atender las relaciones del Servicio con los Poderes Públicos y con el sector privado;

h). Conferir y revocar poderes conforme al Reglamento;

i). Someter anualmente a la Junta Directiva el Proyecto de Presupuesto, la Memoria y el Balance General del Servicio;

j). Proponer a la Junta Directiva, el nombramiento, suspensión o remoción de Jefes de Departamentos y de Secciones, y nombrar, suspender o remover a los demás empleados del mismo, de conformidad con el Reglamento; y,

k). Ejercer las demás funciones y facultades que le otorgue la Ley, el Reglamento y los acuerdos de la Junta Directiva.

CAPITULO XVI

DE LAS SERVIDUMBRES

義務

Artículo 26.- El abastecimiento de agua y sistemas de alcantarillado para el servicio público, confieren el derecho de constituir servidumbres legales a favor del Servicio Autónomo Nacional de Acueductos y Alcantarillados, de conformidad con la presente ley. Estas servidumbres se constituirán con base en los planos y memorias descriptivas, aprobados por el Ministerio de Salud Pública y Asistencia Social.

Artículo 27.- Las servidumbres a que se refiere el artículo anterior son las siguientes:

a). De obras de captación de aguas;
執行 獲得

b). De conducción de aguas, incluyendo líneas de tubería, canales, viaductos y acueductos;

c). De líneas telefónicas y telegráficas;

d). De líneas de conducción de energía eléctrica;

e). De paso, para construir senderos, trochas, caminos, ferrovías, etc. y,

f). De tránsito, para la custodia, conservación y reparación de las obras e instalaciones.

Artículo 28.- Al tener necesidad el Servicio de que se imponga una o varias servidumbres contempladas en esta Ley, se presentará ante el Ministerio, e indicará la naturaleza de la servidumbre o servidumbres, precisará su ubicación y detallará el área del terreno, el nombre del propietario o propietarios -

del predio sirviente, las construcciones que deba efectuar y acompañará los correspondientes planos y memorias descriptivas.

Artículo 29.- Corresponde al Ministerio de Salud Pública y Asistencia Social imponer las servidumbres solicitadas por el Servicio, oyendo previamente al propietario del predio sirviente, si aquellas deben gravar la propiedad privada. Cuando la servidumbre ha de afectar inmuebles que pertenecen al Estado, Municipalidades o Corporaciones Públicas, el Ministerio pedirá informe previamente a la respectiva entidad. Al imponer la servidumbre, el Ministerio señalará las medidas que deberán adoptarse para evitar los peligros e inconvenientes inherentes al funcionamiento de las instalaciones comprendidas en aquella.

Artículo 30.- El dueño del predio podrá oponerse a la imposición de las servidumbres en los siguientes casos:

a). Si las servidumbres pueden establecerse sobre terreno público con una variación del trazado que no exceda del 10% del costo de éste; y,

b). Si las servidumbres pueden establecerse sobre otro lugar del mismo predio o sobre otros predios, en forma menos gravosa o peligrosa para el propietario, siempre que el Servicio pueda realizar las obras o instalaciones correspondientes en las mismas condiciones técnicas y económicos.

Artículo 31.- La oposición del interesado se sustanciará de acuerdo con el procedimiento ordinario señalado en el Código de Procedimientos Administrativos.

Artículo 32.- Al establecerse las servidumbres, el Servicio es responsable de los daños que causen en el predio sirviente.

Artículo 33.- Si al constituirse una servidumbre, quedare terreno inutilizado para su natural aprovechamiento, la indemnización deberá extenderse a ese terreno.

Artículo 34.- Expedida la resolución aprobatoria de los planos y memorias descriptivas pertinentes, el Servicio podrá hacer efectiva la servidumbre correspondiente, mediante trato directo con el propietario del predio sirviente -

respecto al monto de las compensaciones e indemnizaciones procedentes. El convenio del caso deberá adoptarse dentro del plazo máximo de noventa días, contados a partir de la referida resolución aprobatoria.

Artículo 35.- Si no se produjera el acuerdo directo, a que se refiere el - artículo anterior, el monto de las compensaciones e indemnizaciones que deben ser abonadas por el Servicio, será fijado por peritos nombrados uno por cada parte. Si los peritos no se pusieren de acuerdo, el Ministerio de Gobernación y Justicia nombrará un tercer perito con el carácter de dirimente. La tasación efectuada por el tercer perito es inobjetable en la vía administrativa, pero podrá ser controvertida judicialmente sin que ello impida la — imposición de la servidumbre.

Artículo 36.- El dueño del predio sirviente tendrá derecho a que se le abone:

a). La compensación por la ocupación del terreno necesario para la constitución de la servidumbre;

b). La indemnización por los perjuicios o por las limitaciones del derecho de propiedad que pudieren resultar como consecuencia de la — construcción o instalación propias de la servidumbre; y,

c). La compensación por el tránsito que el Servicio tiene derecho a efectuar por el predio sirviente para llevar a cabo la custodia, conservación y reparación de las obras e instalaciones.

Artículo 37.- Fijado el monto de las compensaciones e indemnizaciones - en la forma establecida en el Artículo 34, el Ministerio de Salud Pública y Asistencia Social, ordenará que el Servicio abone, dentro del término de — treinta (30) días, la suma correspondiente al propietario del predio sirviente. La falta de pago dejará sin efecto la constitución de la servidumbre.

Artículo 38.- La servidumbre caducará si no se hace uso de ella durante - el plazo de tres años computados desde el día en que se estableció dicha - servidumbre.

Artículo 39.- En caso de extinción de la servidumbre, el propietario del - predio sirviente recobrará el pleno dominio del bien gravado y no estará obligado a devolver la indemnización recibida.

Artículo 40.- El dueño del predio sirviente no podrá efectuar plantaciones, construcciones u obras de cualquier otra naturaleza, ni realizar labores que perturben o dañen el ejercicio de las servidumbres constituídas de acuerdo con esta Ley.

Artículo 41.- El dueño del predio sirviente estará obligado a permitir, bajo responsabilidad del Servicio, la entrada del personal, de empleados y obreros de éste y la del material indispensable y elementos de transporte necesarios para efectuar la construcción, revisión o reparación de las obras, instalaciones o líneas de tubería en el predio sirviente.

Artículo 42.- Si no existieran caminos adecuados para la unión del sitio ocupado por las obras e instalaciones con el camino público vecinal más próximo, el Servicio tendrá el derecho de obtener que se imponga servidumbre de paso a través de los predios que sean necesario cruzar para establecer la ruta de acceso.

Artículo 43.- La servidumbre de conducción de aguas, a que se refiere el inciso b) del Artículo 27, confiere al Servicio los:

a). El de ocupación del área de terreno necesario para la constitución de la servidumbre;

b). El de construcción sobre el área de terreno a que se refiere el inciso anterior, de las obras necesarias para los fines del Servicio;

c). El de usar el cauce de un canal preexistente en el predio sirviente, siempre que no se alteren los fines para que fué construido;

d). El de extraer piedra, arena y demás materiales de construcción existentes en el área del predio sirviente que afecta la servidumbre y que fueran necesarios para la construcción de la obra.

e). El de cercar los terrenos necesarios para las obras de captación, canales de alivio, líneas de tuberías, tanques desarenadores, sedimentadores, edificios y dependencias, caminos de acceso y en general, para todas las obras requeridas para las instalaciones de un abastecimiento de agua, de un alcantarillado sanitario o de aguas pluviales; y,

f). El de descarga de las aguas por los cauces existentes en el predio -

sirviente siempre que las condiciones de éste lo permitan.

Artículo 44.- Las obras e instalaciones correspondientes al aprovechamiento de las aguas sólo podrán ser afectadas por servidumbres de acueducto para actividades distintas de las que están destinadas, cuando se compruebe plenamente que la nueva servidumbre no perjudica a los fines del Servicio. En este caso, serán de cargo del favorecido con la nueva servidumbre los gastos que haya que realizar para hacerlo posible, y las compensaciones que deba abonar al Servicio por el uso del acueducto.

Artículo 45.- La servidumbre de líneas telefónicas y telegráficas confiere al Servicio el derecho de tender líneas por medio de postes o torres, o por conductos subterráneos a través de propiedades rurales, y el de ocupar los terrenos para cualquier obra adicional de estas líneas, que el Servicio juzgue necesario para su mejor funcionamiento.

CAPITULO XVII
PROHIBICIONES

Prohibición

Artículo 46.- El Servicio Autónomo Nacional de Acueductos y Alcantarillados no podrá:

a). Suministrar servicios de abastecimientos de aguas y alcantarillados en forma gratuita, excepto el servicio de extinción de incendios y los servicios estrictamente municipales que en la actualidad no se cobren y conforme al contrato que celebren el Servicio y las Municipalidades; y,

b). Participar en Sociedades de responsabilidad ilimitada, ni otorgar cauciones.

CAPITULO XVIII
DISPOSICIONES GENERALES Y TRANSITORIAS

Artículo 47.- El Servicio estará exento de todo impuesto o gravamen nacional, municipal o distrital, y en caso de extinción de su patrimonio deberá ser incorporado al del Estado.

Artículo 48.- El Servicio estará asesorado por las instituciones internacionales que prestan asistencia técnica y económica al Gobierno de Honduras, en esta clase de trabajo.

Artículo 49.- La presente Ley entrará en vigencia desde el día de su publicación en el diario oficial "La Gaceta".

Dado en el Salón de Sesiones del Congreso Nacional en Tegucigalpa, Distrito Central, a los veintiseis días del mes de abril de mil novecientos sesenta y uno.

Raúl Sevilla Gamero
Presidente

Francisco Lozano España
Secretario

Abraham Zúniga Rivas,
Secretario

Al Poder Ejecutivo.

Por tanto: Ejecútese.

Tegucigalpa, D.C., 9 de mayo de 1961

R. VILLEDA MORALES

El Secretario de Estado en los Despachos de Salud Pública y Asistencia Social.

R. MARTINEZ V.

Publicado en La Gaceta No. 17,382 del Martes 23 de mayo de 1961.

L A G A C E T A

Tegucigalpa, D.C. Honduras, Sábado 16 de Noviembre de 1. 976

No. 21.439

DECRETO - LEY NUMERO 155

EL JEFE DE ESTADO, EN CONSEJO DE MINISTROS,

[illegible]

CONSIDERANDO: Que de conformidad con el Decreto Legislativo No. 91, de 26 de abril de 1961, corresponde al Servicio Autónomo Nacional de Acueductos y Alcantarillados (SANAA) administrar los servicios de agua potable y alcantarillados de todo el país.

CONSIDERANDO: Que para mejorar el funcionamiento de los servicios de agua potable y alcantarillados, se hace necesaria la colaboración de las comunidades y otorgar facultades suficientes al Servicio Autónomo Nacional de Acueductos y Alcantarillados (SANAA) para celebrar convenidos con organismos comunales creados al efecto.

POR TANTO: En uso de las facultades de que está investido y habiendo oído la opinión de la Junta Directiva del SANAA

D E C R E T A:

ARTICULO 1o.- Reformar el inciso u) del Artículo 3o. del Decreto Legislativo No. 91 del 26 de abril de 1961 (Ley Constitutiva del Servicio Autónomo Nacional de Acueductos y Alcantarillados) y adicionar a dicho Artículo un inciso v), los que se leerán así: Artículo 3.- Para el logro de sus finalidades, el servicio tendrá las siguientes atribuciones: a), b), c), d), e), f), g), h), i), j), k), l), m), n), o), p), q), r), s), t), u) Celebrar convenios de colaboración con organismos creados para la administración, operación y mantenimiento de sistemas de agua potable o alcantarillado, sin que ésto implique renuncia alguna a las facultades que por la ley le -

correspondan; v) Realizar todos los actos necesarios o convenientes para llevar a efecto los propósitos de esta Ley"

ARTICULO 2o.- El presente Decreto entrará en vigencia el día de su publicación en el Diario Oficial "LA GACETA".

Dado en la ciudad de Tegucigalpa, Distrito Central, a los once días del mes de noviembre de mil novecientos setenta y cuatro.

El Jefe de Estado

OSWALDO LOPEZ ARELLANO

El Secretario de Estado en el Despacho de Gobernación y Justicia

Juan Alberto Melgar Castro

El Secretario de Estado en el Despacho de Relaciones Exteriores por Ley,

Virgilio R. Gálvez

El Secretario de Estado en el Despacho de Defensa Nacional y Seguridad Pública,

Pedro Fermín Ramírez Landa

El Secretario de Estado en el Despacho de Educación Pública

Napoleón Alcerro Oliva

El Secretario de Estado en el Despacho de Hacienda y Crédito Público

Manuel Acosta Bonilla

El Secretario de Estado en el Despacho de Economía, por ley.

Vicente Díaz.

El Secretario de Estado en el Despacho de Comunicaciones, obras públicas y Transporte, por ley,

Herman Aparicio Velásquez

El Secretario de Estado en el Despacho de Salud Pública y Asistencia Social

Enrique Aguilar Paz.

APPENDIX B

GEOPHYSICAL EXPLORATION

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I. INTRODUCTION

For the purpose of investigating of sub-surface geological structure in the whole Comayagua basin, VLF electromagnetic exploration and electric soundings were carried out from 14 June to 30 July, 1988. The total quantity carried out are shown below.

Survey Item	Quantity
VLF electromagnetic explorations	111
Electric soundings	91

The locations of measured spots of VLF electromagnetic exploration and electric sounding are shown in Figs. 2.3.1 and 3.2.1.

II. VLF ELECTROMAGNETIC EXPLORATION

2.1 Instrument used in the field work

The EM16/EM16R of VLF electromagnetic instrument was applied for the exploration. The specifications were as mentioned below:

EM16 SPECIFICATIONS

MEASURED QUANTITY	Inphase and quad-phase components of vertical magnetic field as a percentage of horizontal primary field. (i.e. tangent of the tilt angle and ellipticity).
SENSITIVITY	Inphase: +/- 150% Quad-phase: +/- 40%
RESOLUTION	+/- 1%
OUTPUT	Nulling by audio tone. Inphase indication from mechanical inclinometer and quadphase from a graduated dial.
OPERATING FREQUENCY	15-25 kHz (15-30 kHz optional) VLF Radio Band. Station selection done by means of plug-in units.
OPERATOR CONTROLS	ON/OFF switch, battery test push button, station selector switch, audio volume control, quadrature dial, inclinometer.
POWER SUPPLY	6 disposable 'AA' cells.
DIMENSIONS	53 x 21.5 x 28 cm
WEIGHT	Instrument: 1.8 kg

The VLF station received for this study is NSS. 21.4 kHz, 400 kW, radiated from Annapolice, Maryland (Coordinates: 76W27-38N59), North America.

EM16R SPECIFICATION

MEASURED QUANTITY	·Apparent Resistivity of the ground in ohm-meters ·Phase angle between E_x and H_y in degrees

RESISTIVITY RANGES	· 10 - 300 ohm-meters · 100 - 3000 ohm-meters ·1000 - 30000 ohm-meters
PHASE RANGE	0-90 degrees
RESOLUTION	·Resistivity: +/- 2% full scale ·Phase : +/- 0.5^{o}
OUTPUT	Null by audio tone. Resistivity and phase angle read from graduated dials.
OPERATING FREQUENCY	15-25 kHz VLF Radio Band. Station selection by means of rotary switch.
INTERPROBE SPACING	10 meters
PROBE INPUT IMPEDANCE	100 M-ohm in parallel with 0.5 picofarads
DIMENSIONS	19 x 11.5 x 10 cm (attached to side of EM16)
WEIGHT	1.5 kg (including probes and cable)

2.2 Theory and analysis method

The apparent resistivity (ρ_a: ohm-meters) and the phase difference between E_x and H_y can be read directly by operating a dial of the EM16/EM16R instrument. The following equation is known to show the relation between an apparent resistivity and a phase angle.

$$\rho_a = \frac{1}{\mu w} \cdot \left| \frac{E_x}{H_y} \right|^2$$

where, E_x : Component of the radial electric field,

H_y : Component of the tangential magnetic field,

μ : The magnetic permeability of the medium, (assumed = 4 x 10^{-7} Henrys per meter)

w : The angular frequency of the signal $2\pi f$, where f is the frequency in hz.

The measurement is made by orienting the instrument so that the coil is maximally coupled to H_y (determined from audio signal) and inserting the two ground probes along the direction indicated by instrument orientation.

After the audio signal is nulled by means of two controls, the phase angle and apparent resistivity values can be read directly from the instrument. The signal utilized for this survey is from NSS, Annapolice, Maryland, at a frequency of 21.4 kHz.

The apparent resistivity value and the phase angle measured in the field were analyzed to obtain the true resistivity by using "Two layer interpretation curves" attached in the manual, since the apparent resistivity consists of averaged one of several layers. The resistivity measured by EM16/EM16R can, therefore, be separated at least into the resistivities of two layers.

In order to get the resistivity value of the underlying second resistivity layer in the VLF analysis, the resistivity value and the thickness of the overlying resistivity value are applied by the result of the electric sounding for the analysis. Conversely, in case of no electric sounding was carried out in the spot of VLF measurement, the value of second resistivity layer is inferred from a result of a electric sounding spot nearby to obtain the true resistivity value of the first layer and its thickness.

2.3 Analysis result

Locations of the measured spots are shown in Fig. 2.3.1 as well as the field observation data, and analysis result is listed in Table 2.3.1 (1) to (3) and shown in Fig. 2.3.2. The followings are brief explanations on the VLF electro-magnetic exploration.

1) A mountain area on the north-northeast of the Comayagua city shows a high resistivity value of 60 ohm-m where Mesozoic sedimentary rocks and granodiorite are exposed.

2) In the western area of the basin between Ajuterique and La Paz, several places demonstrate sporadically high resistivity values ranging from 60 to 70 ohm-m, which may indicate the presences of sub-surface mounds of Mesozoic sedimentary rocks.

3) The mountain area consisting of Tertiary welded tuff has moderately low resistivity ranging from 24 ohm-m to 38 ohm-m.

4) Observed in the marginal zone of the basin along the foot of mountains are two types of the resistivity values; one 5 ohm-m to 15 ohm-m and the other higher then 20 ohm-m.

   The area of considerably lower resistivity from 5 ohm-m to 15 ohm-m is correlated with area of clayey deposits, while the other area of higher resistivity over 20 ohm-m covers that of thick and wide spread fan deposits of sand and gravels, which have been brought from main tributaries such as the Rio Conquigue, the Rio San Jose and the Rio Selguapa.

5) The central area in the basin shows moderately low resistivity values around 10 ohm-m, which indicates thick clayey deposits.

6) In several places such as Yarumela, south of Cane, moderately high resistivity values ranging from 20 ohm-m to 25 ohm-m are sporadically obtained, which may indicate a rise of high resistivity layer.

7) The area showing high resistivity suggests the presence of the gravel beds of the fan deposits, specially in parts from La Paz to Lejamani and around Flores.

III. ELECTRIC SOUNDINGS BY WENNER'S CONFIGURATION

3.1 Instrument used in the field work

The instrument of electric soundings is Mc OHM (Model 2110), Power Booster and their accessories, which was procured by JICA. The specifications are as mentioned below:

Mc OHM (Model 2110) SPECIFICATIONS

- TRANSMITTER

SUPPLY VOLTAGE	400 Vp-p
SUPPLY CURRENT	1,2,5,10,20,50,100,200 mA (Settled system)

- RECEIVER

INPUT IMPEDANCE	1 M ohm
MEASURING RANGE	-0.6 to +0.6 V, -6 to +6 V (Automatic range system)
DISSOLVING ABILITY	0.001 ohm
STACK COUNT	1,4,16,64 count

- SYSTEM

POWER	DC 12V (Attached rechargeable battery in inside or usable outside battery)
SIZE	206 x 281 x 200 mm
WEIGHT	7.5 kg

Mc OHM POWER BOOSTER SPECIFICATION

- SYSTEM

OUTPUT CAPACITY	350 mA (+/- 250 V) 500 mA (+/- 250 V) 650 mA (+/- 125 V) 800 mA (+/- 125 V)
INPUT VOLTAGE	10.5 - 14 V DC
1 CYCLE TIME	3.5 Sec.
APPLICABLE TEMP.	0 - 50 ^{o}
SIZE	200 x 280 x 120 mm
WEIGHT	3.5 kg

ACCESSORIES

- ELECTRIC WIRES WITH DRUM	4 sets of red, black, green and blue colour (each 400 m long)
- CONNECTING CABLES	1 set

- ELECTRODES 5 pieces
- TOOLS AND TESTER 1 set

3.2 Theory and analysis method

The electrical soundings with Wenner's configuration were carried out at the 91 spots in grids in the basin (see Fig. 3.2.1), and results of the field observation are compiled in the Data Book. The principal theory and interpretation method for Wenner's configuration are as follows:

Wenner's configuration

The electrode arrangement in Wenner's configuration for measurement of the resistivity is illustrated in Fig. 3.2.2 (a). Here each potential electrode is separated from the adjacent current electrode by a distance "a" which is one-third the separation of the current electrodes. for this geometry, an equation becomes

$$\rho_a = 2 \cdot \pi \cdot a \cdot \frac{V}{I}$$

Analysis method

The theory and analytical procedure for specific resistivity sounding (Wenner's method) are outlined as follows;

(a) 2-layer structure and standard curve

If in Fig. 3.2.2 (b)
depth of surface layer = d_1
specific resistivity of surface layer = ρ_1
depth underlying layer = ∞
specific resistivity of underlying layer = ρ_2

The potential difference be-tween P_1 and P_2 is nearly not affected by underlying layer.

So far as the distance between C_1 and C_2 is small compared with d_1 (Fig. 3.2.2 (b)), the current flows through surface layer.

But the electrode separation is longer, the more the potential difference will be influenced by underlying layer as shown in Fig. 3.2.2 (c) and its value is changed from one in uniform structure case, that is, the apparent specific resistivity will be changed. When $\rho_2 > \rho_1$, the apparent specific resis-tivity will increase, and vice versa as shown in Fig. 3.2.2 (d) and (e) respectively.

Accordingly, by measuring the co-relation between the electrode separation "a" and the apparent specific resistivity, we can elucidate how the specific resistivity of the underground varies with the depth.

(b) 3 or more layer structure and auxiliary curve

Analysis of 3 or more layer structure is grounded on one of 2-layer structure. It can be considered that 3-layer structure as shown in Fig. 3.2.2 (f) is equivalent to 2-layer structure (b).

If depth of first and second layer is d_1 and $d_2 - d_1$, respectively, the specific resistivity ρ_2' of equivalent single layer of the first and second layers in Fig. 3.2.2 (g) is represented as follows, since it can be thought that the specific resistivity of the first layer and that of the second layer are connected in parallel.

3.3 Analysis result

Twenty five figures, as shown in Fig. 3.3.1 (1) to (25), show resistivity profiles covering the whole Comayagua basin on sections in both N-S and E-W directions, as a result of the electric sounding. The interpretation is summarized in the Table 3.3.1 "SUMMARY OF THE SEQUENCE OF THE RESISTIVITY LAYERS". The followings are brief explanation on the analysis results of the electric soundings.

1) The layer 1 is defined to be a layer above water level, developing parallel to the ground surface on the profiles. As described on Table 3.3.1 the layer can be subdivided into two categories of resistivity values, i.e. 15 to 135 ohm-m and 11 to 80 ohm-m, depending upon difference in physical characteristics of deposits.

2) The layer 2 develops dominantly at the northwestern margin of the Comayagua basin through Lejamani, Ajuterique and the Rio Selguapa, and the eastern margin of the basin mainly along the Rio San Jose and the Rio Canquigue. The resistivity value ranges from 7 ohm-m to 54 ohm-m, with average of 20 ohm-m. This layer will correlate to the fan deposits consisting of poor-sorted sand and gravel. The layer is probably highly permeable.

3) The layer 3 is observed on outcrops around Cane in the western part of the Comayagua basin on the Rio Grande south from Villa de San Antonio. It is covered by the Layer 2 in the downstream area of the basin. This layer disappears in the eastern half and the southern part of the basin. Such setting of pervious and impervious geological units characterizes ground water recharge system of the Comayagua basin.

4) The layer 4 is the most widely developed in the Comayagua basin, and the average thickness of this layer reaches 80 m. In the southern part of the basin, the layer 4 is subdivided into such three layers as 4 (a), 4 (b) and 4 (c). The layer 4 is considered to be semi-aquifer judging from the resistivity value of average 10 ohm-m. This layer may contain sandy beds in places, specially showing higher resistivity. Portions of higher resistivity, occasionally encountered, may indicate intercalation of more pervious sandy layers in places.

5) The layer 5 is generally found in most parts of the basin except the southern end. The layer 5 indicates low resistivity of 2 to 6 ohm-m, suggesting clayey deposits.

6) At this electric soundings, high resistivity layer, suggesting the basement rock, could not be detected within the limit of sounding

depth of 200 m in the central part of the basin, except at a very few spots. The basement rock shows high resistivity ranging from 15 to 110 ohm-m as observed in the marginal area of the basin, that is, 15 to 45 ohm-m in Tertiary welded tuff, and 27 to 110 ohm-m in consolidated sediments of Mesozoic bed.

The depth to the basement rock is deemed to be more than 200 m in most parts of the basin.

3.4 Hydrogeological layers

From a comprehensive study on the geophysical exploration result and the general hydrogeological conditions of the study area, two hydrogeological layers, which are expected to be good aquifers, are identified; i.e. an aquifer with phreatic water and another with artesian water (see Fig. 3.3.1). Hydrogeological layer with the phreatic water corresponds approximately to the resistivity layers 1 to 2 and to the Alluvial fan deposits in the terms of the general geology. On the other hand, the hydrogeological layer where the artesian water flows is composed mainly of the resistivity layers 3 and 4, and it is possibly equivalent to the Diluvial lake deposits. Horizontal and vertical distribution of those hydrogeological layers is expressed by the drawings consisting of contour maps and isopack maps (Figs. 3.4.1 to 3.4.2). Those geological structures are significantly useful especially for the ground water potential study (see Appendix E).

Tables

Table 2.3.1 (1) FIELD DATA AND ANALYSIS RESULTS OF VLF EXPLORATION (1/3)

Spot	Field Data		The First Layer		The 2nd Lay.	
No.	Appa.OHM	Angle(^{o})	Resist.(ohm)	Thick.(m)	Resist.(ohm)	Loc. of neaby ES STA.
1	110	56	300	12	60	
2	40	70	100	14	7	
3	7	45	7	-	7	STA 1
4	10	36	10	9	34	STA 1 and 2
5	7	45	7	-	7	STA 1 and 2
6	15	39	10	2	21	STA 1
7	3	45	3	-	3	STA 1 and 2
8	7	43	10	20	13	STA 2
9	75	55	100	18	30	STA 96
10	20	36	10	3	33	STA 3
11	19	43	10	1	22	STA 6
12	12	35	10	20	15*	STA 7
13	9	40	6	20	15	STA 8
14	30	44	10	1	33	STA 9
15	62	44	30	1	65	STA 11
16	7	11	7	20	10	STA 12
17	8	50	30	1	6	STA 12 and 13
18	7	28	5	20	10*	STA 13
19	9	37	4	20	15*	STA 13
20	8	30	4	20	10*	STA 14
21	1	45	1	-	1	STA 14
22	9	40	6	20	10*	STA 14
23	4	44	4	20	5	STA 14
24	10	53	30	3	7	STA 15
25	21	44	10	1	22	STA 15
26	40	46.5	60	20	10*	STA 15
27	39	40	15	20	45*	STA 15 and 16
28	20	40.5	10	1	25	STA 16 and 17
29	20	45<	10	1	25	STA 17
30	3	10	1	20	15	STA 17 and 18
31	24	45	24	-	24	STA 19
32	15	43	8	20	20*	STA 20
33	9	38	10	20	20*	STA 21
34	3.5	45	3.5	-	3.5	STA 22
35	24	55	30	10	10	STA 23
36	8	45	8	-	8	STA 24
37	3	-	3	-	3	STA 24
38	16	59	30	6	7	STA 24
39	9	-	9	-	9	STA 24
40	9	45	9	-	9	STA 27

* The Resistivity value of the second layer is inferred from the nearby elcectric resistivity sounding spots.

Table 2.3.1 (2) FIELD DATA AND ANALYSIS RESULTS OF VLF EXPLORATION (2/3)

Spot No.	Field Data Appa.OHM	Field Data Angle(^{0})	The First Layer Resist.(ohm)	The First Layer Thick.(m)	The 2nd Lay. Resist.(ohm)	Loc. of neaby ES STA.
41	15	40	10	2	20	STA 28
42	20	48	30	4	15	STA 29
43	11	45	11	-	11	STA 30
44	12	40	10	4	17	STA 33
45	10	33	2	20	22*	STA 35
46	4	-	4	-	4	STA 36
47	8	42	8	10	18	STA 36
48	11	40	10	10	16	STA 37
49	12	44	10	10	13	STA 37
50	15	40	7	10	15	STA 37
51	16	40	7	10	16	STA 37
52	9	44	7	10	8	STA 40
53	10	40	10	10	16	STA 41
54	23	40	7	10	25*	STA 42
55	21	38	10	1	30	STA 46
56	20	39	10	2	25	STA 47
57	4	40	4	10	7	STA 47
58	10	33	4	7	16	STA 47
59	43	45	43	-	43	STA 48
60	8	-	8	-	8	STA 48
61	17	35	5	20	15*	STA 49
62	4	48	4	20	3	STA 50
63	19	45	19	-	19	STA 51
64	14	44	10	1	16	STA 52
65	9	38	7	10	18	STA 53
66	11	44	10	10	12	STA 54
67	20	40	10	2	25	STA 55
68	9	40	5	10	14*	STA 59
69	30	40	9	10	35*	STA 59'
70	19	48	30	4	15	STA 60
71	40	59	300	6	24	
72	41	38	9	20	50*	STA 61
73	21	45	21	-	21	STA 61
74	38	50	100	4	32	STA 61
75	20	40	10	2	26	STA 63
76	45	39	4	20	50*	STA 65
77	22	44	10	1	23	STA 66
78	20	33	10	2	30*	STA 91
79	10	30	2	20	20*	STA 68
80	10	40	10	8	18	STA 68

* The Resistivity value of the second layer is inferred from the nearby elcectric resistivity sounding spots.

Table 2.3.1 (3) FIELD DATA AND ANALYSIS RESULTS OF VLF EXPLORATION (3/3)

Spot	Field Data		The First Layer		The 2nd Lay.	
No.	Appa.OHM	Angle(°)	Resist.(ohm)	Thick.(m)	Resist.(ohm)	Loc. of neaby ES STA.
81	23	30	10	4	60	STA 68
82	9	41	8	10	17	STA 69
83	13	39	10	7	22	STA 69
84	8	31	2	2	15*	South of Cane
85	8	31	2	2	15*	STA 73
86	10	36	8	10	24	STA 74
87	17	55	20	2	12	STA 75
88	28	35	8	3	45	STA 75
89	70	45	70	-	70	STA 76
90	25	38	10	1	35	STA 76 and 77
91	30	44	10	1	32	
92	33	43	10	1	35	STA 77
93	19	36	10	2	30	STA 77 and 78
94	38	46	10	2	37	STA 78
95	32	47	20	2	30	STA 78 and 79
96	24	35	10	2	37*	STA 79
97	40	40	10	1	50	STA 79 and 80
98	29	47	30	20	27	STA 80
99	16	40	10	1	21	STA 81
100	9	40	8	20	20*	STA 81
101	15	39	10	1	22	STA 71
102	15	45	15	-	15	STA 71
103	7	43	7	10	13	STA 83
104	11	47	11	10	12	STA 83
105	19	44	10	1	20	STA 84
106	20	45	20	-	20	STA 86
107	16	40	10	1	21	STA 87
108	16	44	10	1	17	STA 88
109	22	45	22	-	22	STA 89
110	10	30	2	20	20*	STA 89
111	38	45	38	-	38	STA 89

* The Resistivity value of the second layer is inferred from the nearby elcectric resistivity sounding spots.

Table 3.3.1 SUMMARY OF THE SEQUENCE OF RESISTIVITY LAYERS

Layer	Thickness (in meter)	Resistivity (in ohm-m)	Assumed Geological Condition	Relation to Hydrogology	Typical Profile
Layer 1	0 to 30	15 to 135*	Above ground water level, the upper part of the Layer 4. Mainly sand/gravels with silt or clay of thinly intercalated.	No ground water through year. Highly permeable.	E, F, G, H, VI,VII,VIII
		11 to 81*	Above ground water level, the upper part of the Layer 2, 3. Mainly sandy silt and sand with thin clay intercalated.	do.	K, L, M, N, O, III, IV, V
Layer 2	0 to 60 (Ave. 30)	7 to 54* (Ave. 20)	Below ground water level. Sand and gravel in the margin of the basin. Sand/silt in the center of the basin. Mainly the fan deposits	Aquifer "Fair"	A, B, C, D, E, F, G, H, I, J, K, L, VI,VII,VIII
Layer 3	0 to 50 (Ave. 40, Max.120 near Cane)	1 to 15* (Ave. 3)	Maily clay and silty clay. Partly silty sand or sand at the southern area of Villa de San Antonio, 5km far away. Well developped thickly at the western area of Cane.	Aquiclude. Locally aquitard. At southern area of Villa de San Antonio	I, J, K, L, M, I, II, III
Layer 4	30 to 120 (Ave. 80)	7 to 18* (Ave. 10)	Mainly fine, well consolidated sand. Corse sand in the margin of the basin. Extremely thick in the east side of the basin.	Semi-aquifer "Good"	III, IV, V, VI,VII,VIII O, P
4(a) 4(b) 4(c)	about 30 about 60 about 30	12 to 70 7 to 30 9 to 16	In the southern parts of the basin, shown on Prof. O & P, the Layer 4 can be subdivided into the such three layers as 4(a), 4(b) and 4(c).		
Layer 5	60 to 80 (Ave. 70)	2 to 6* (Ave. 4)	Mainly clay and clayey silt. Silt develops in the margin of the basin.	Aquiclude	E, F, H, J , K
	do.	4 to 10* (Ave. 6)	Mainly clayey silt, partly sandy silt in the margin of the basin.	Aquiclude,partly aquitard.	do.
Basement		15 to 45 (Ave. 20)	Welded tuff of Tertiary age	Impermeable	A, B, C, D, E, I, O, P, Q
		27 to 110	Sedimentary rocks or granodiorite of Mesozoic age.	do.	do.

* Some exceptional high or low values in extremely thin intercalated layer are neglected.

Figures

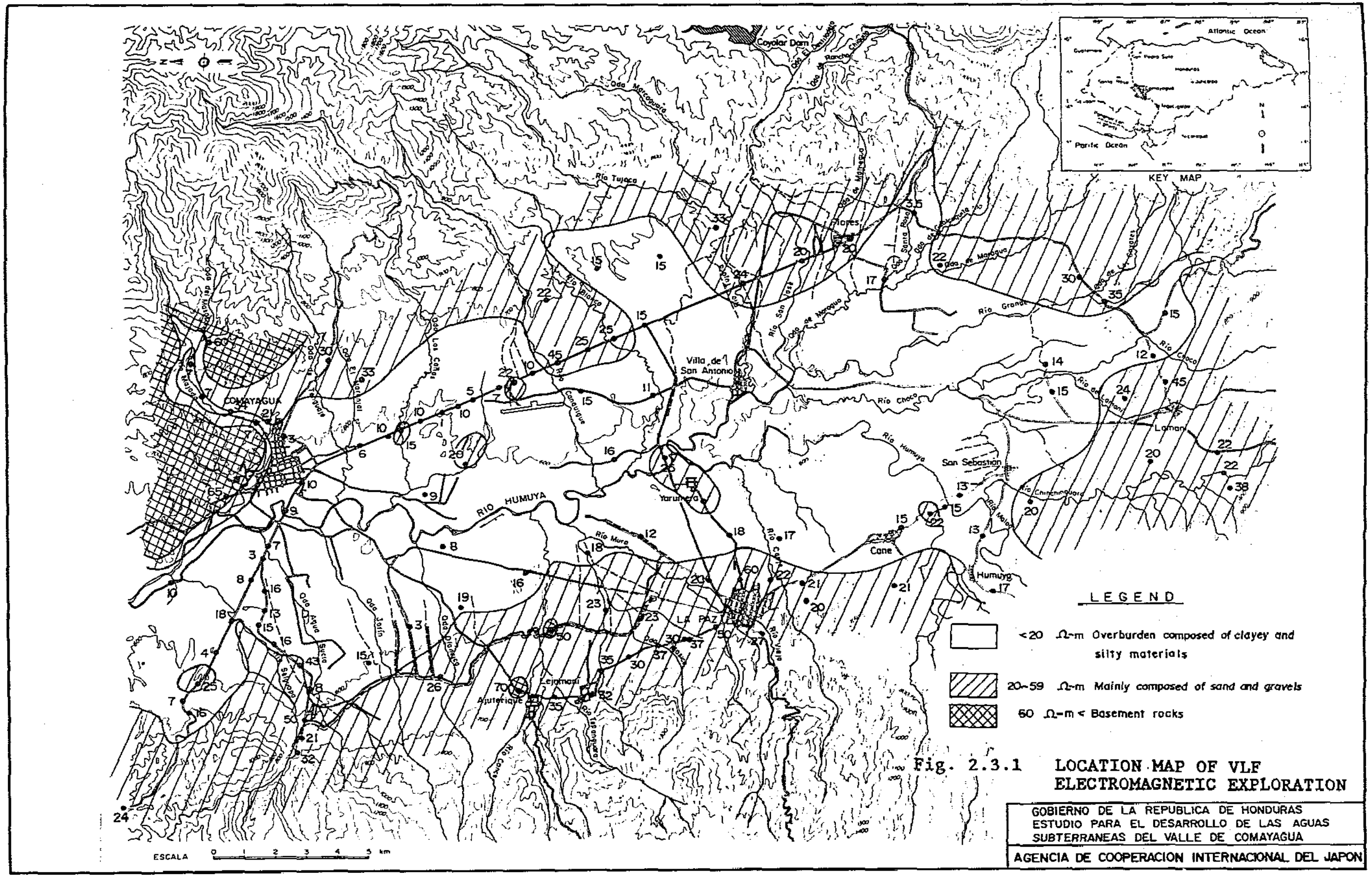

Fig. 2.3.1 LOCATION MAP OF VLF ELECTROMAGNETIC EXPLORATION

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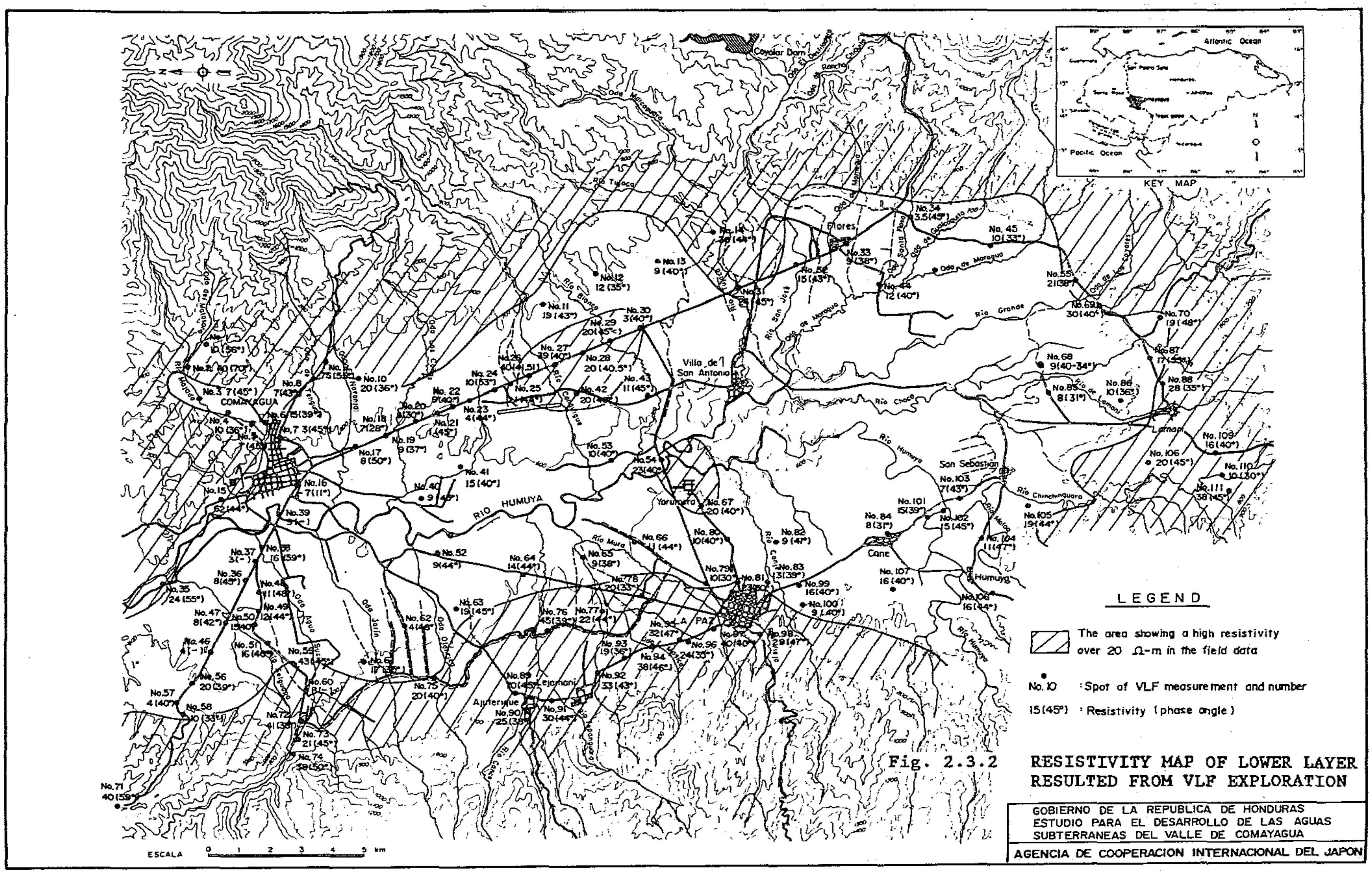

Fig. 2.3.2 RESISTIVITY MAP OF LOWER LAYER RESULTED FROM VLF EXPLORATION

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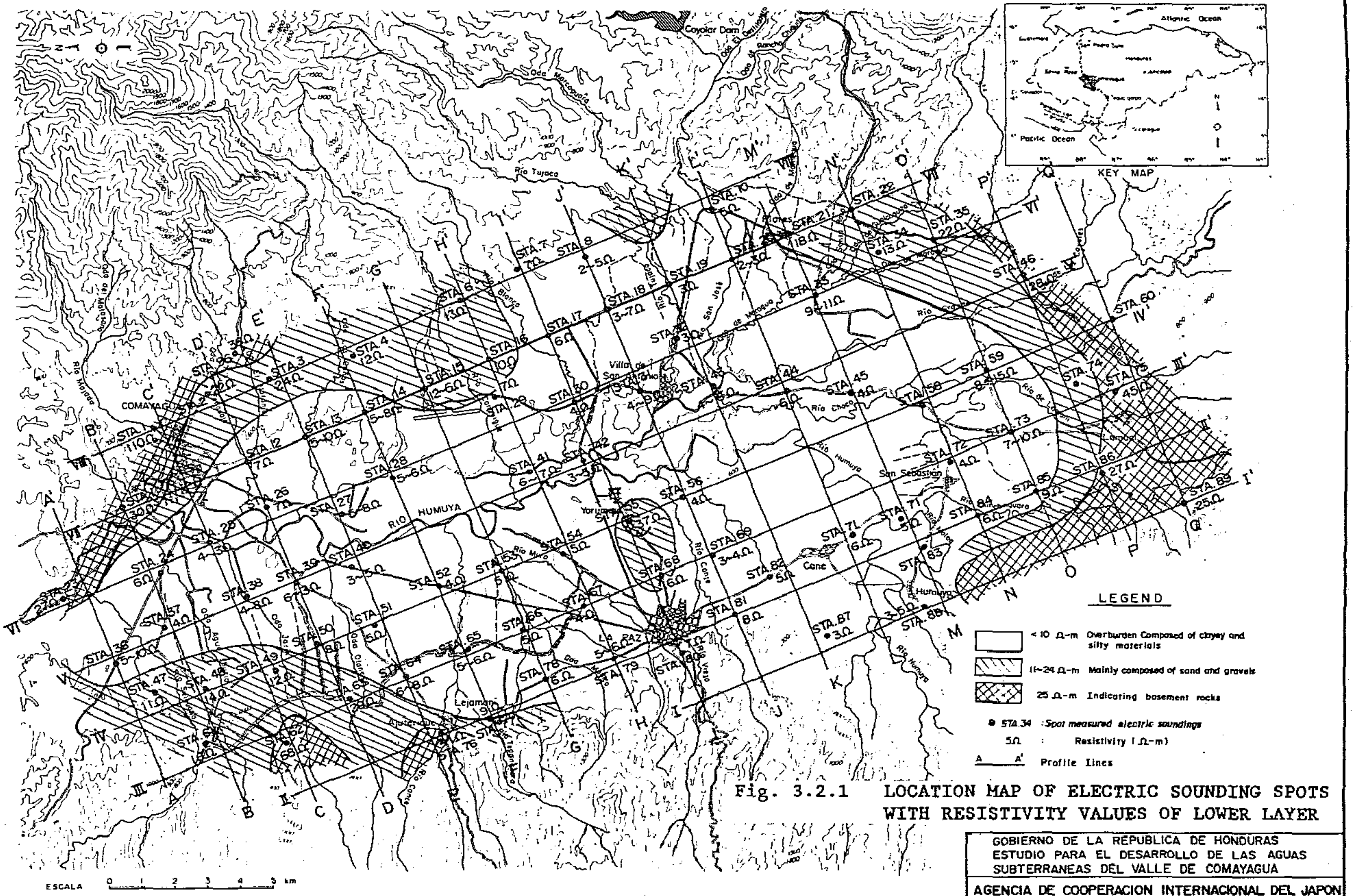

Fig. 3.2.1 LOCATION MAP OF ELECTRIC SOUNDING SPOTS WITH RESISTIVITY VALUES OF LOWER LAYER

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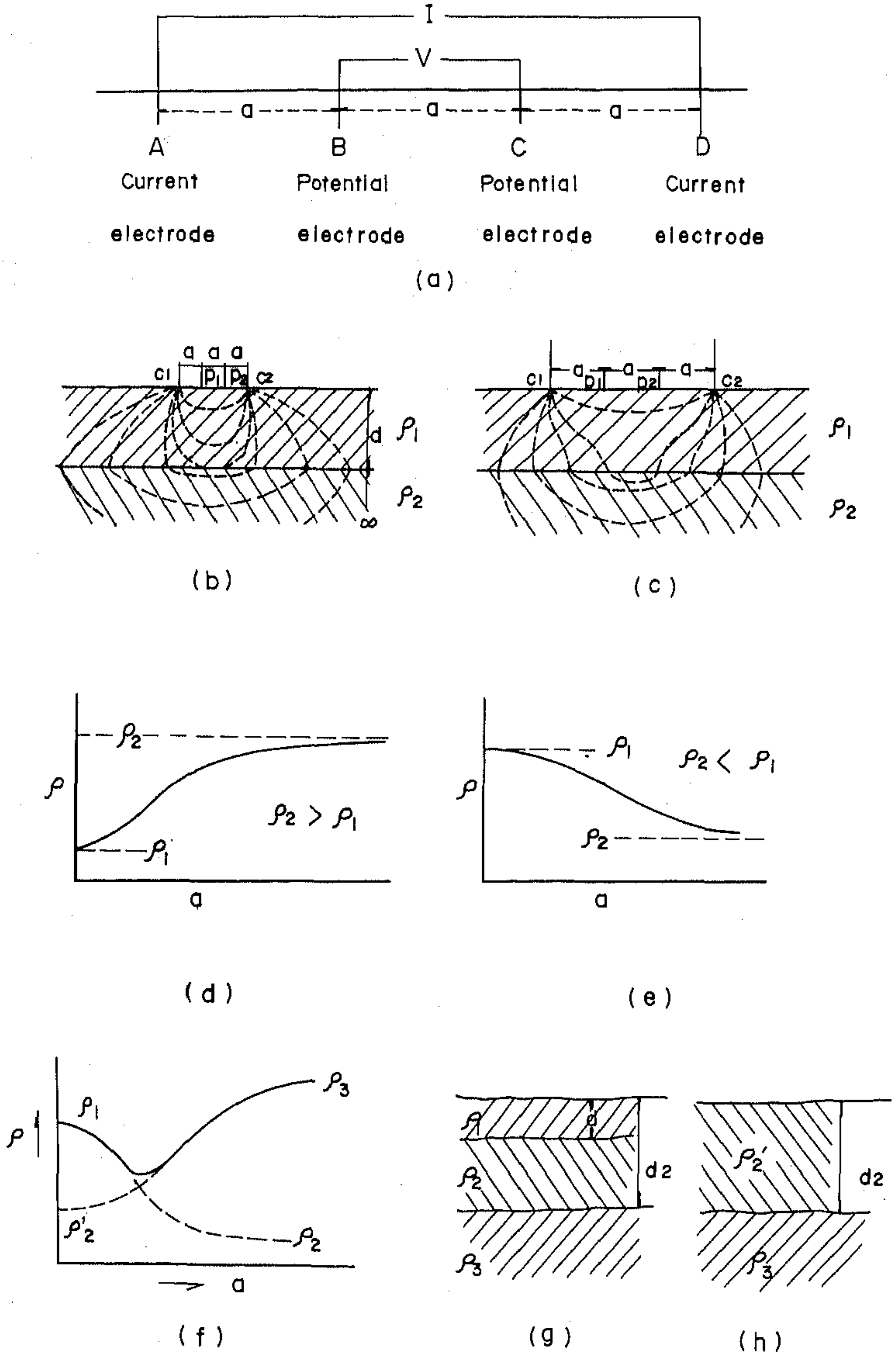

Fig. 3.2.2 EXPLANATION OF ELECTRIC SOUNDING METHOD IN WENNER'S CONFIGURATION

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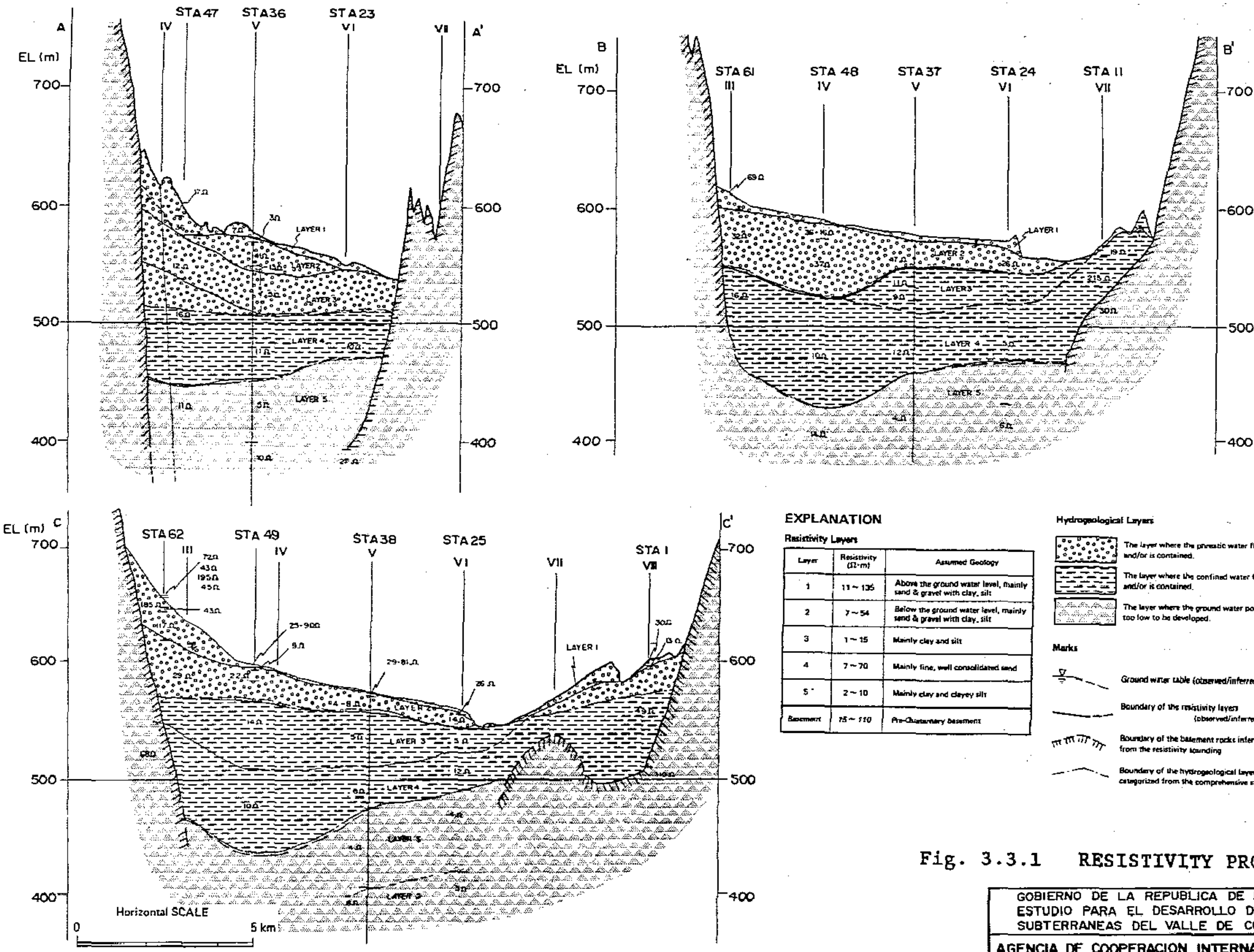


EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω·m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

The layer where the phreatic water flows and/or is contained.

The layer where the confined water flow and/or is contained.

The layer where the ground water potential is too low to be developed.

Marks

Ground water table (observed/inferred)

Boundary of the resistivity layers (observed/inferred)

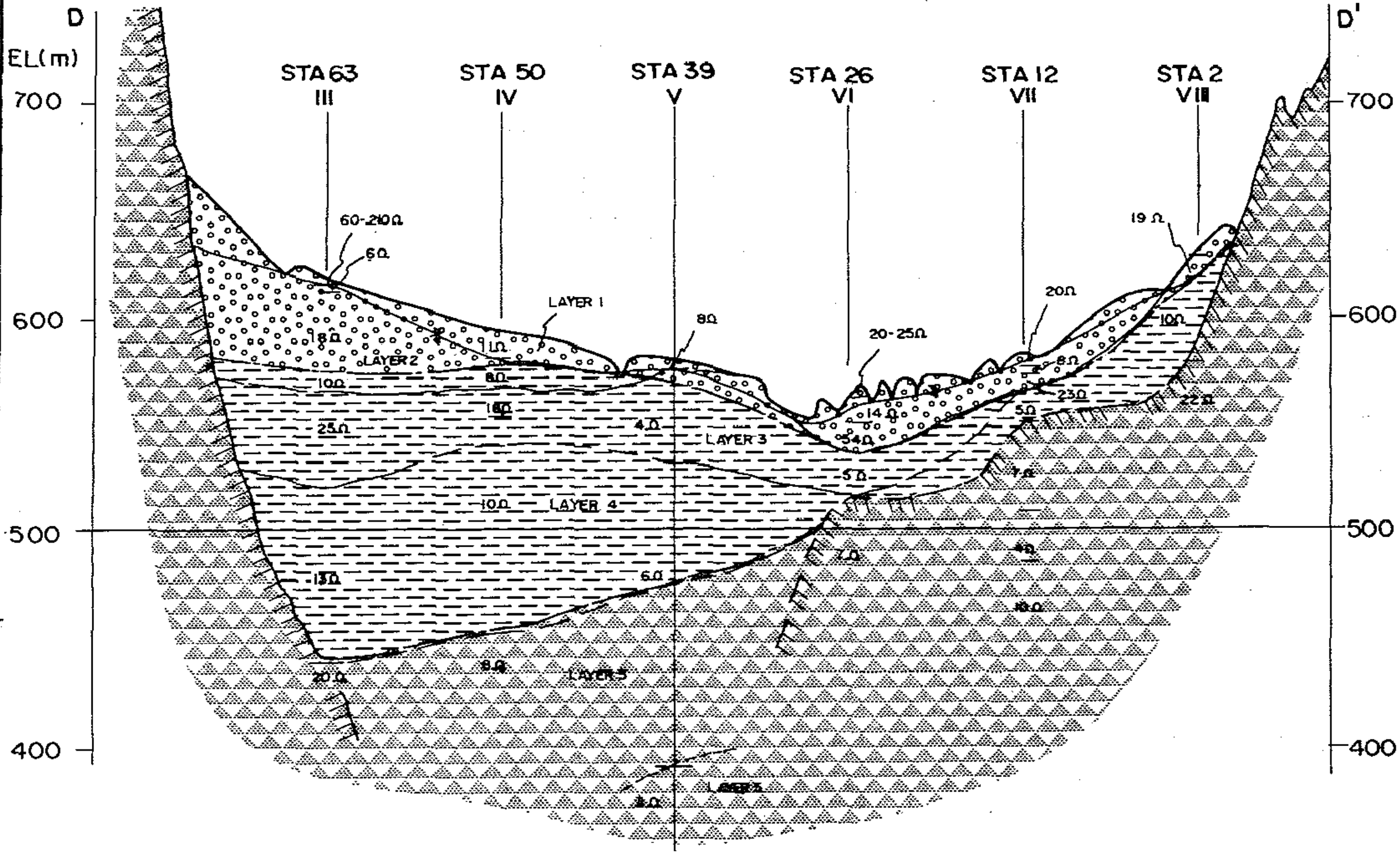
Boundary of the basement rocks inferred from the resistivity sounding

Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (1)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω·m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

The layer where the phreatic water flows and/or is contained.

The layer where the confined water flow and/or is contained.

The layer where the ground water potential is too low to be developed.

Marks

Ground water table (observed/inferred)

Boundary of the resistivity layers (observed/inferred)

Boundary of the basement rocks inferred *from the resistivity sounding*

Boundary of the hydrogeological layers categorized from the comprehensive study.

Horizontal SCALE

0 5 km

Fig. 3.3.1 RESISTIVITY PROFILE (2)

GOBIERNO DE LA REPUBLICA DE HONDURAS
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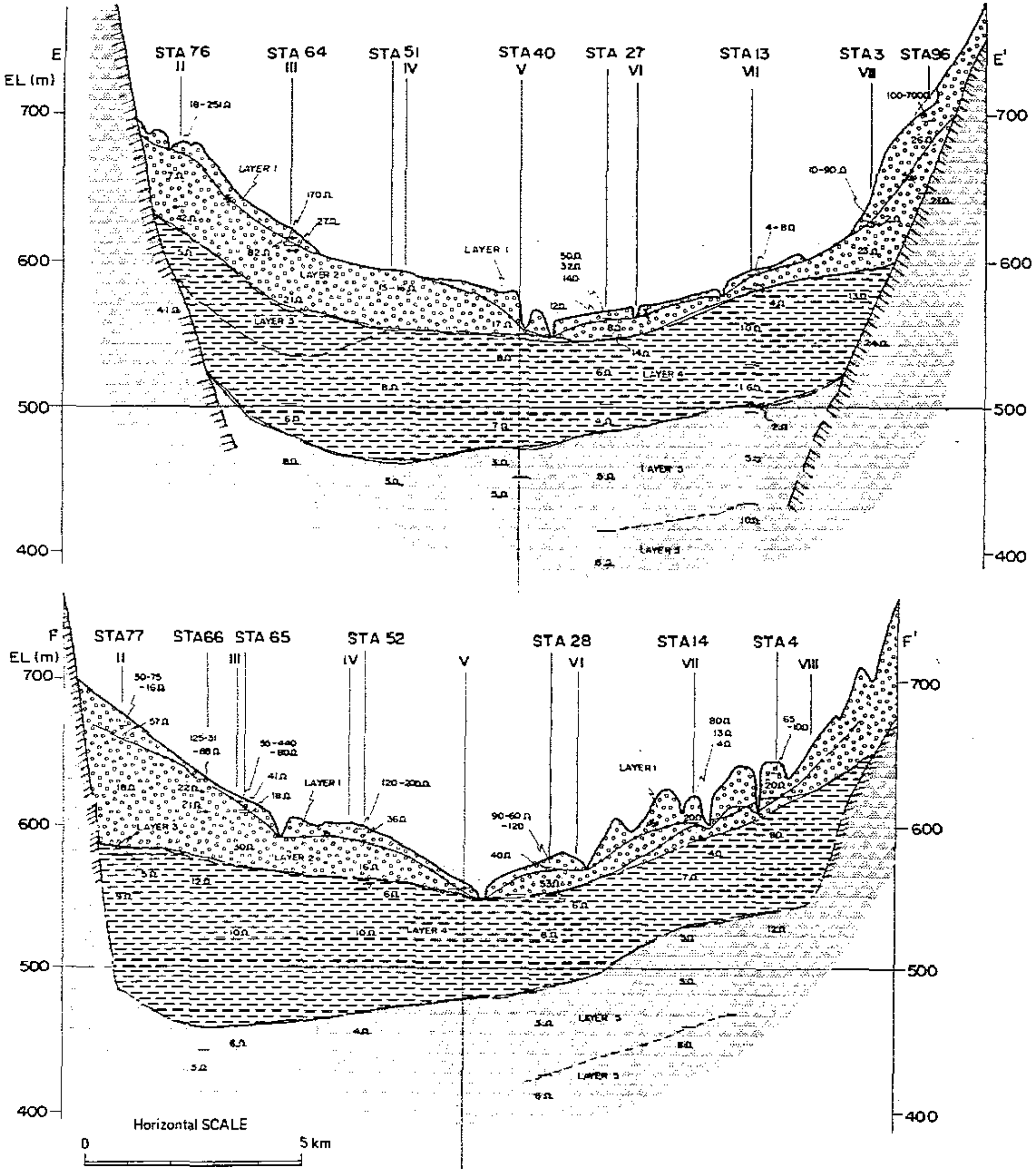
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω·m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

The layer where the phreatic water flows and/or is contained.

The layer where the confined water flow and/or is contained.

The layer where the ground water potential is too low to be developed.

Marks

Ground water table (observed/inferred)

Boundary of the resistivity layers (observed/inferred)

Boundary of the basement rocks inferred from the resistivity sounding

Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (3)

GOBIERNO DE LA REPUBLICA DE HONDURAS
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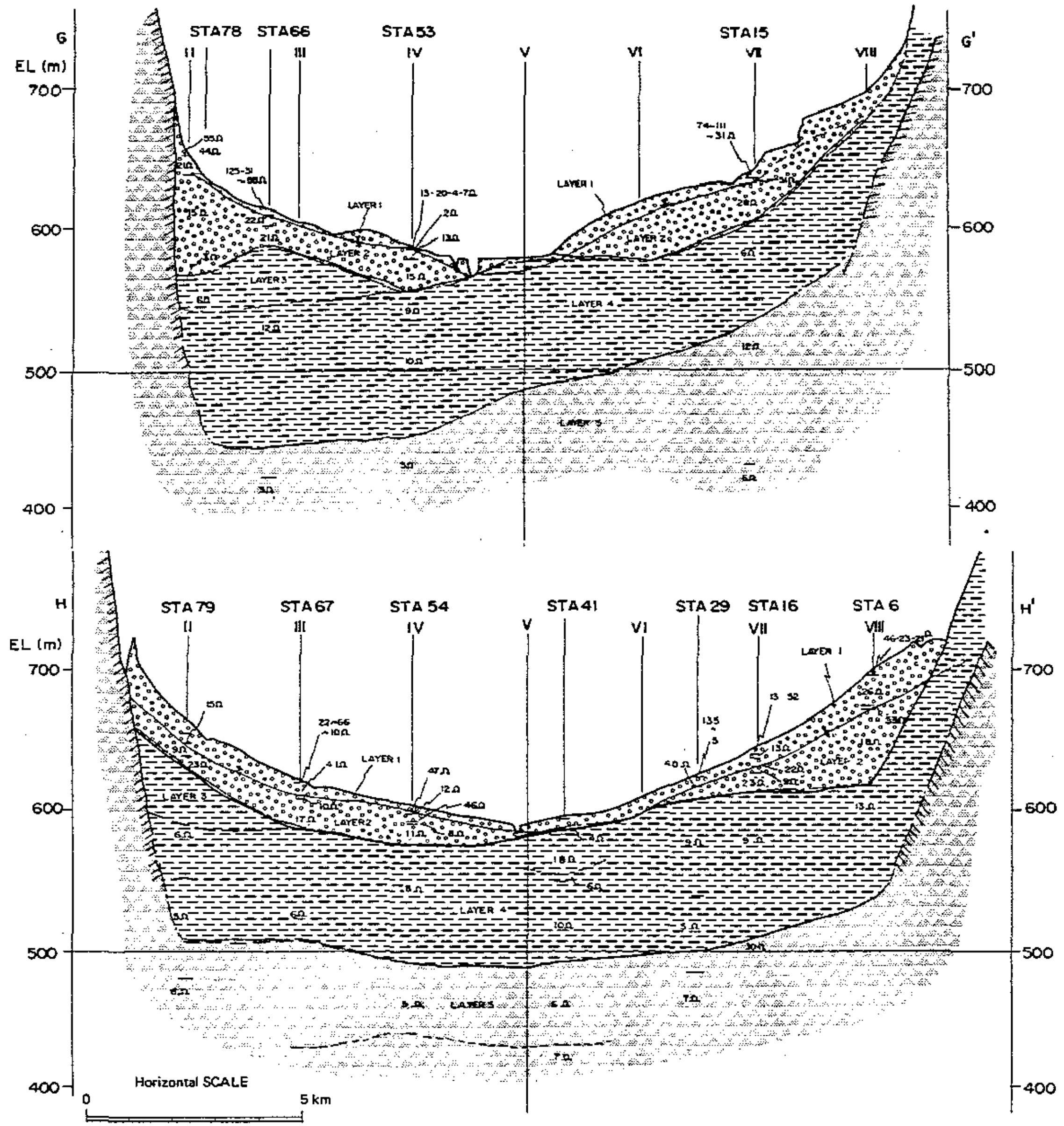

EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω-m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

The layer where the phreatic water flows and/or is contained.

The layer where the confined water flow and/or is contained.

The layer where the ground water potential is too low to be developed.

Marks

Ground water table (observed/inferred)

Boundary of the resistivity layers (observed/inferred)

Boundary of the basement rocks inferred from the resistivity sounding

Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (4)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

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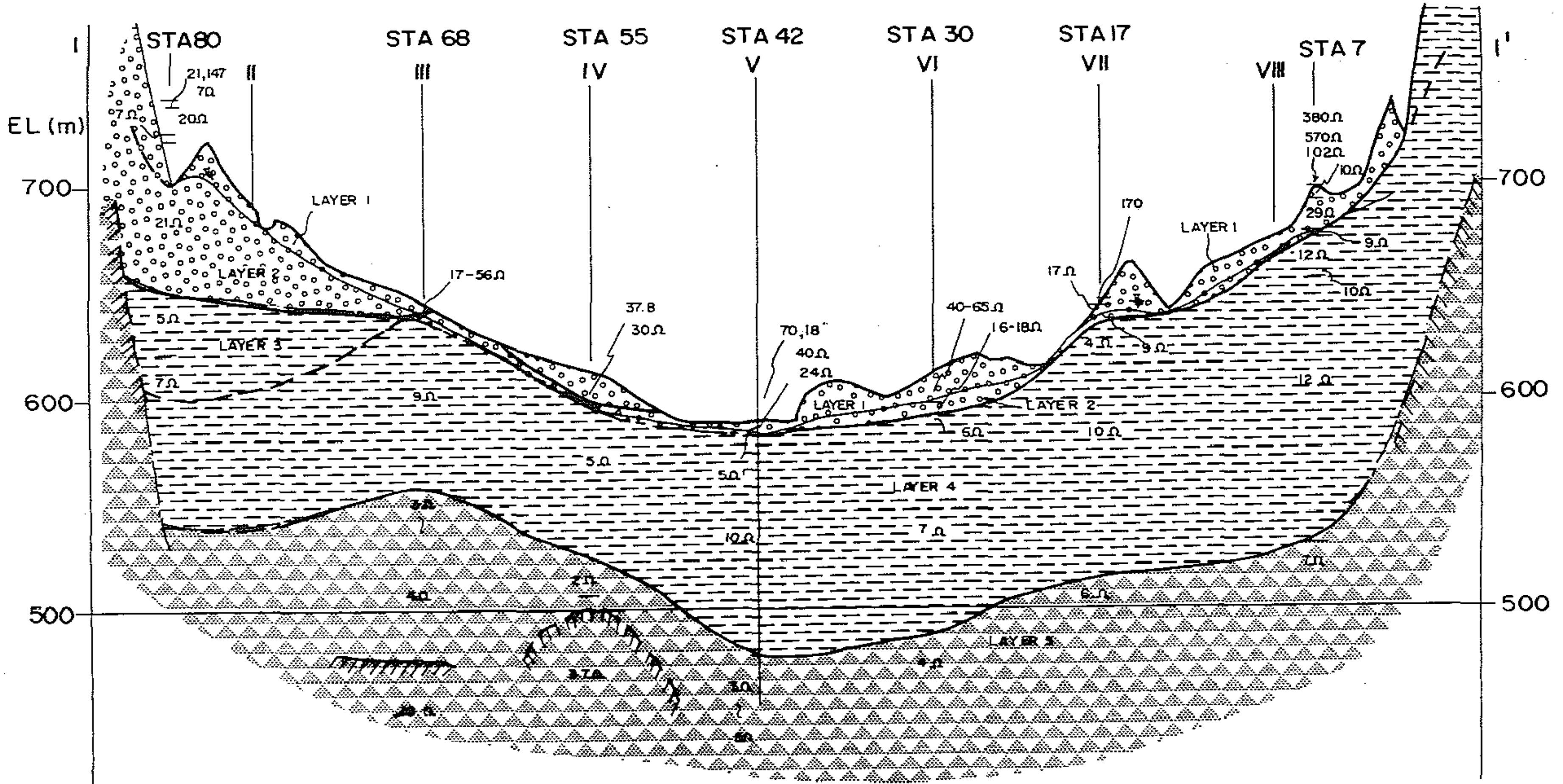


EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω-m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

- The layer where the phreatic water flows and/or is contained.
- The layer where the confined water flow and/or is contained.
- The layer where the ground water potential is too low to be developed.

Marks

- Ground water table (observed/inferred)
- Boundary of the resistivity layers (observed/inferred)
- Boundary of the basement rocks inferred from the resistivity sounding
- Boundary of the hydrogeological layers categorized from the comprehensive study.

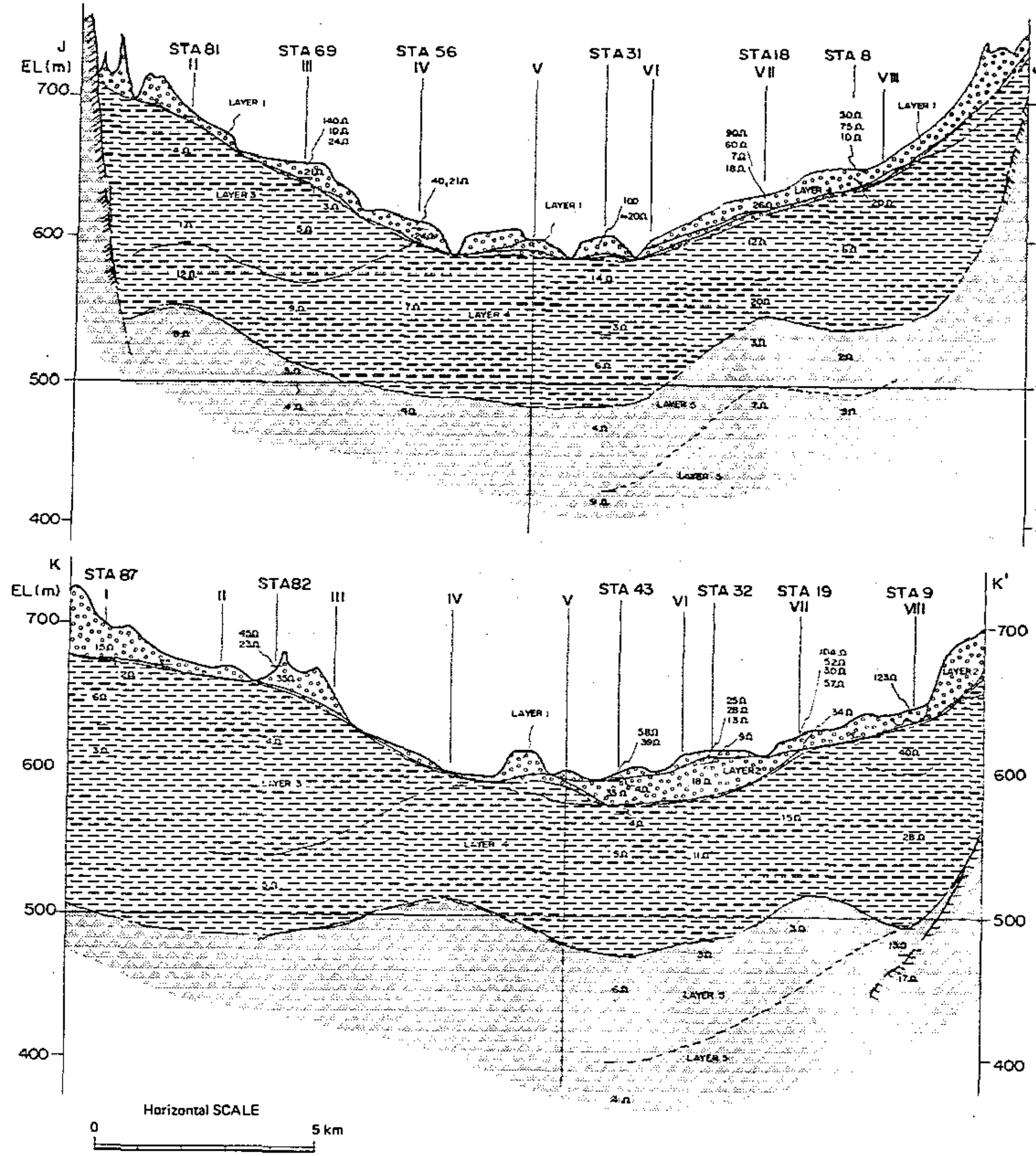
Horizontal SCALE

0 5 km

Fig. 3.3.1 RESISTIVITY PROFILE (5)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω-m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

The layer where the phreatic water flows and/or is contained.

The layer where the confined water flow and/or is contained.

The layer where the ground water potential is too low to be developed.

Marks

Ground water table (observed/inferred)

Boundary of the resistivity layers (observed/inferred)

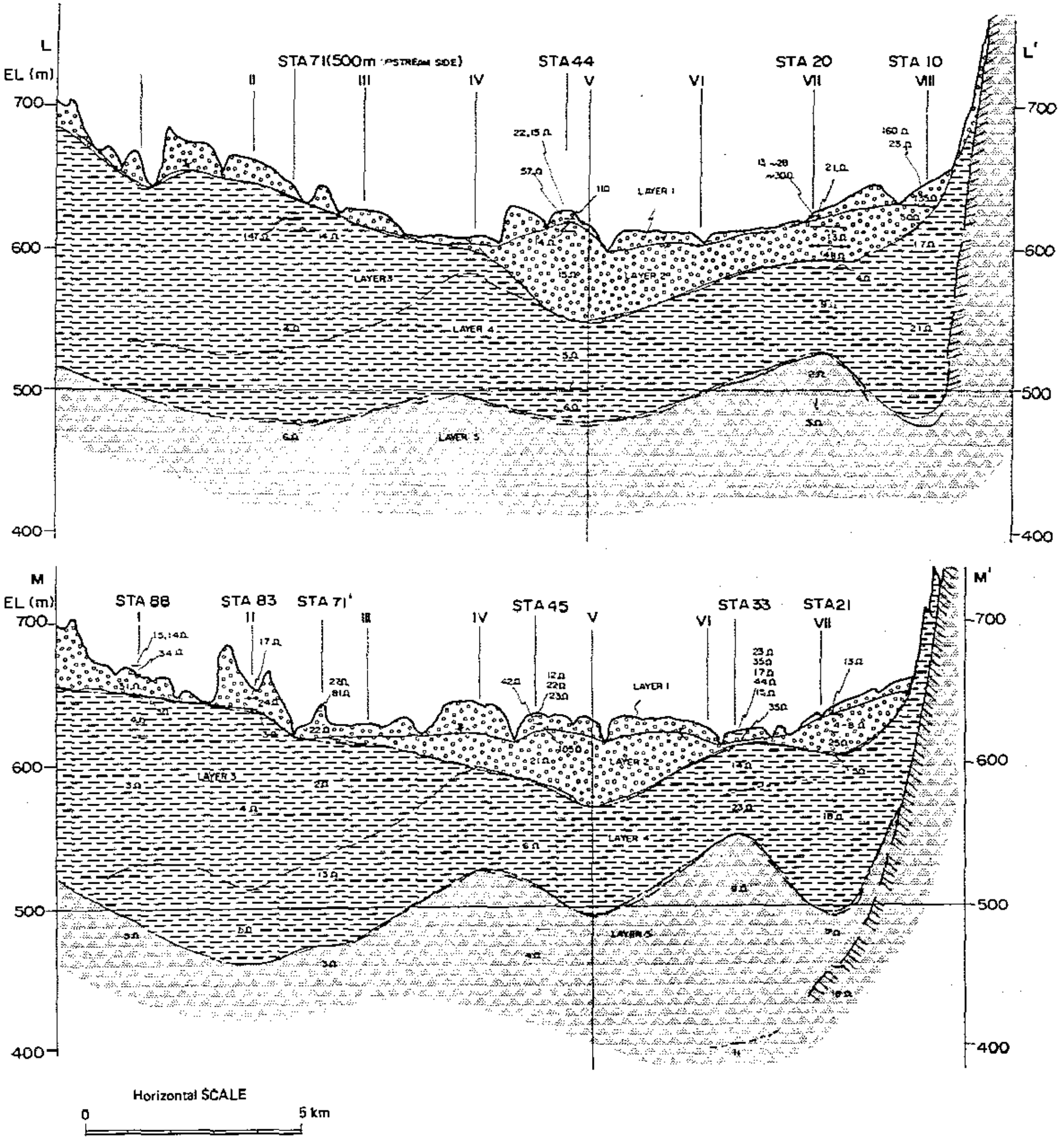
Boundary of the basement rocks inferred from the resistivity sounding

Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (6)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω-m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 64	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

- The layer where the phreatic water flows and/or is contained.
- The layer where the confined water flow and/or is contained.
- The layer where the ground water potential is too low to be developed.

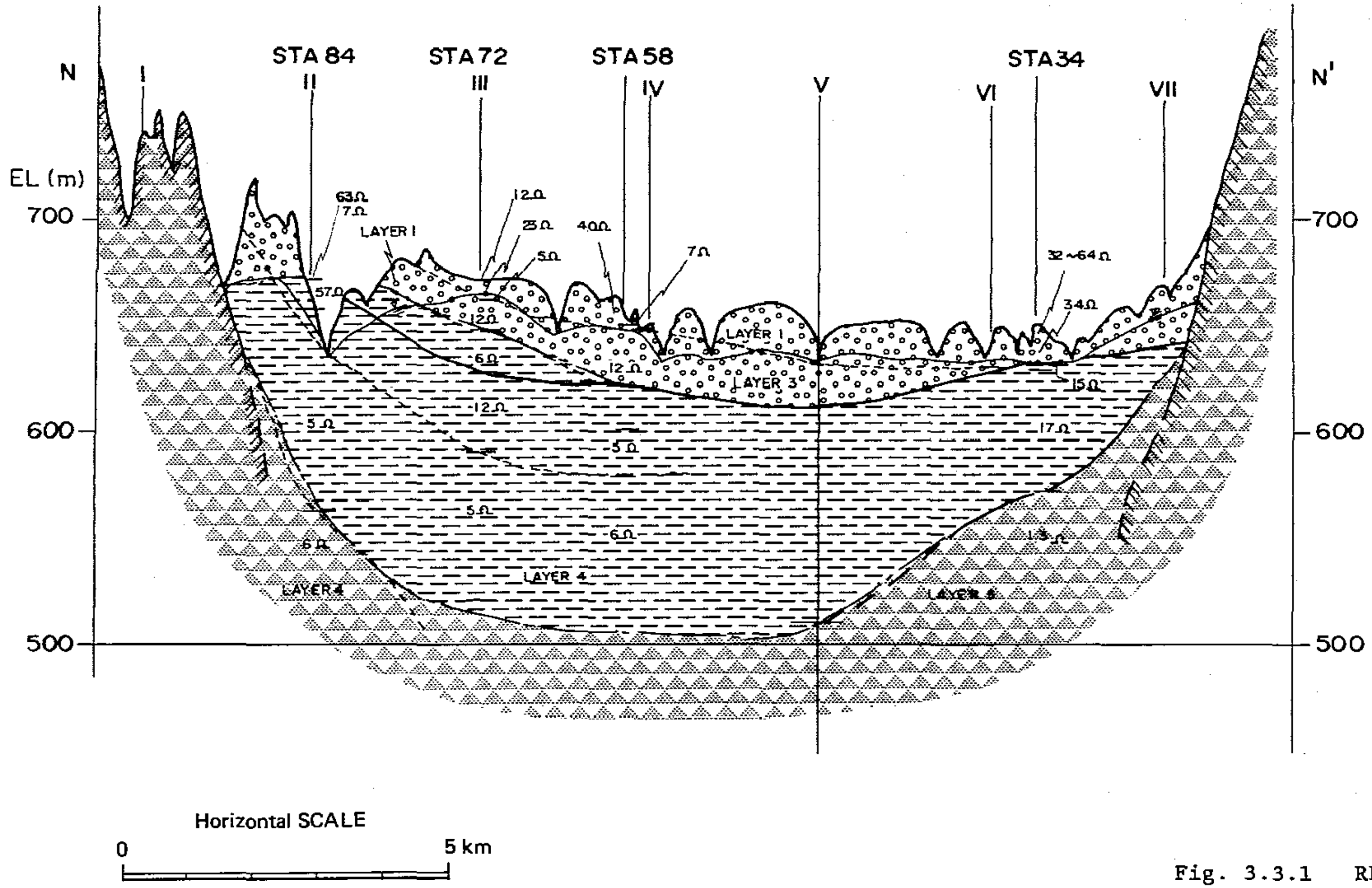
Marks

- Ground water table (observed/inferred)
- Boundary of the resistivity layers (observed/inferred)
- Boundary of the basement rocks inferred from the resistivity sounding
- Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (7)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω·m)	Assumed Geology
1	11 ～ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ～ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ～ 15	Mainly clay and silt
4	7 ～ 70	Mainly fine, well consolidated sand
5	2 ～ 10	Mainly clay and clayey silt
Basement	15 ～ 110	Pre-Quaternary basement

Hydrogeological Layers

The layer where the phreatic water flows and/or is contained.

The layer where the confined water flow and/or is contained.

The layer where the ground water potential is too low to be developed.

Marks

Ground water table (observed/inferred)

Boundary of the resistivity layers (observed/inferred)

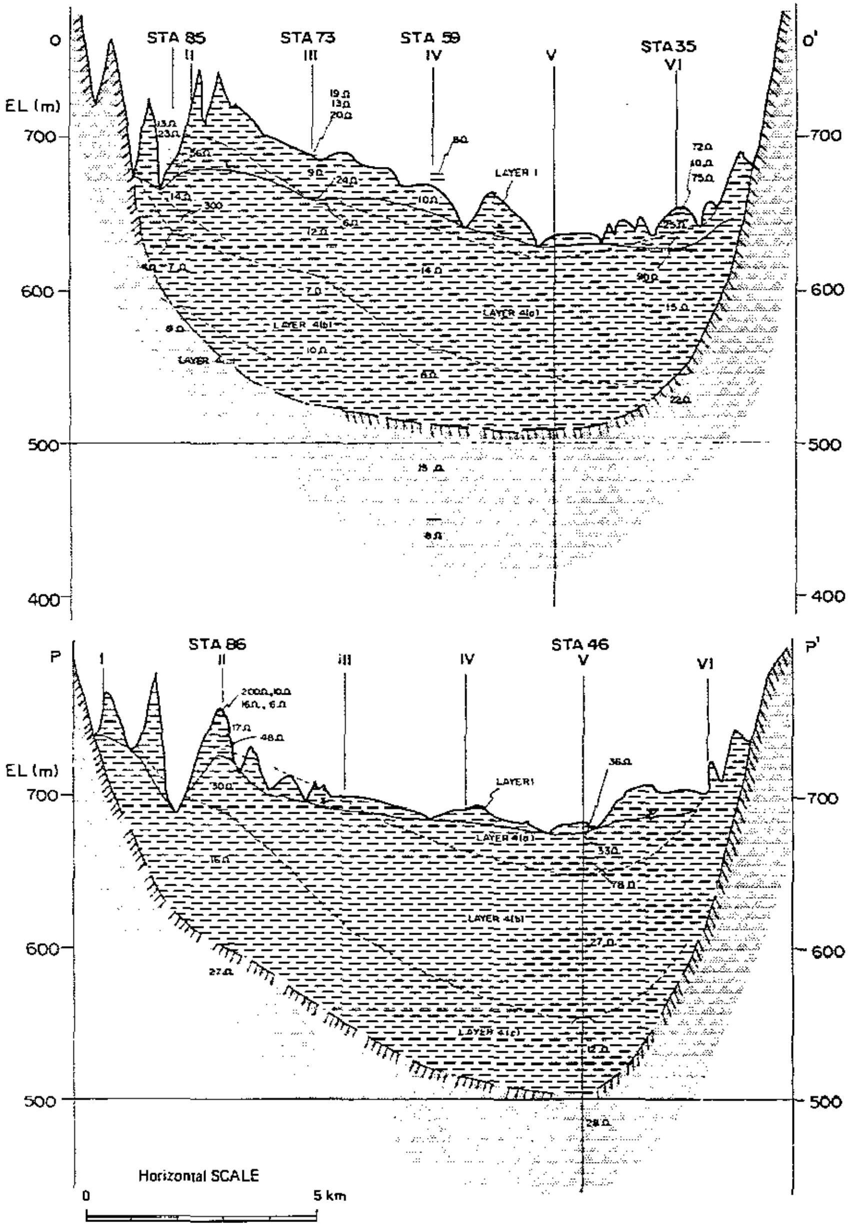
Boundary of the basement rocks inferred from the resistivity sounding

Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (8)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω·m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

The layer where the phreatic water flows and/or is contained.

The layer where the confined water flow and/or is contained.

The layer where the ground water potential is too low to be developed.

Marks

Ground water table (observed/inferred)

Boundary of the resistivity layers (observed/inferred)

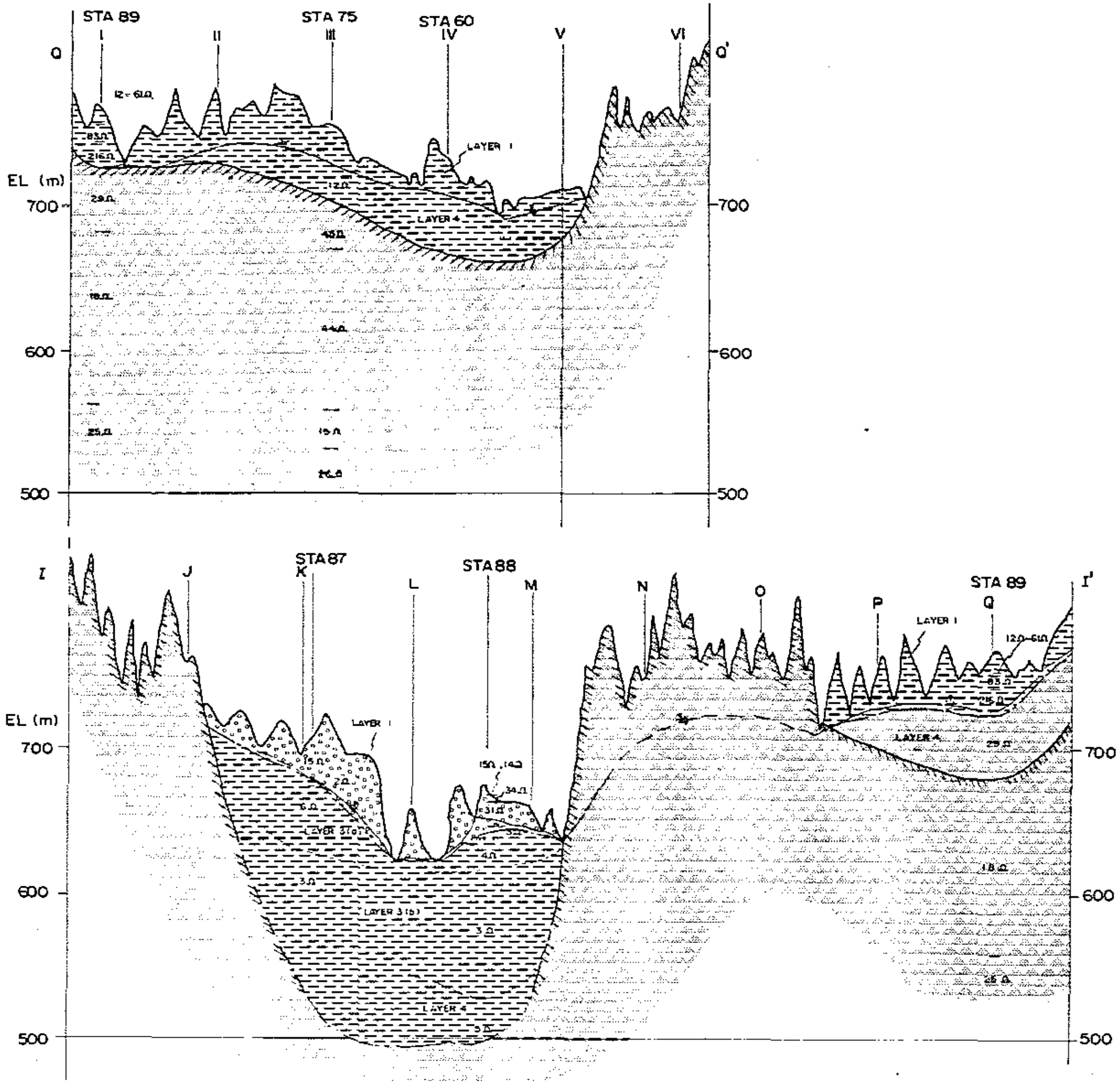
Boundary of the basement rocks inferred from the resistivity sounding

Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (9)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω·m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	*Below the ground water level, mainly sand & gravel with clay, silt*
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

The layer where the phreatic water flows and/or is contained.

The layer where the confined water flow and/or is contained.

The layer where the ground water potential is too low to be developed.

Marks

Ground water table (observed/inferred)

Boundary of the resistivity layers (observed/inferred)

Boundary of the basement rocks inferred from the resistivity sounding

Boundary of the hydrogeological layers categorized from the comprehensive study.

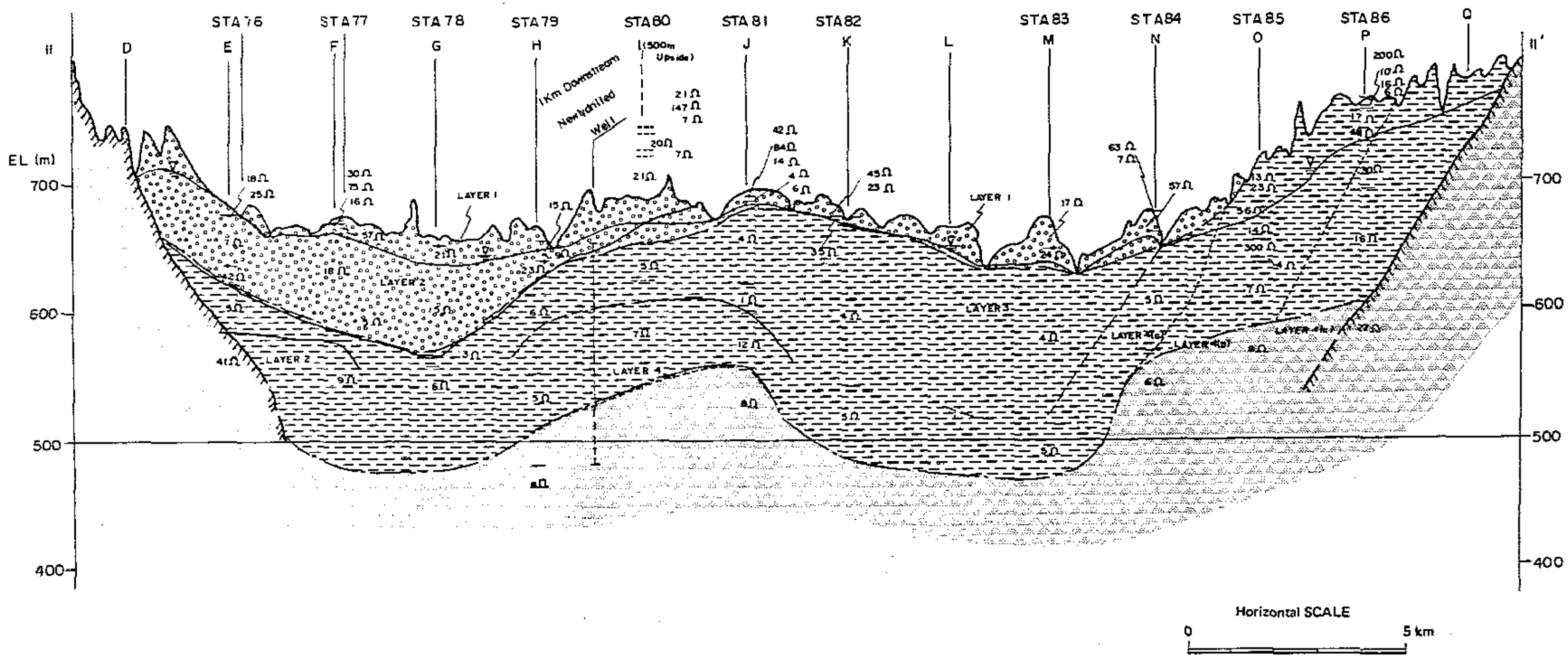
Horizontal SCALE

0 5 km

Fig. 3.3.1 RESISTIVITY PROFILE (10)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



EXPLANATION

Resistivity Layers

Layer	Resistivity ($\Omega \cdot m$)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

- The layer where the phreatic water flows and/or is contained.
- The layer where the confined water flow and/or is contained.
- The layer where the ground water potential is too low to be developed.

Marks

- Ground water table (observed/inferred)
- Boundary of the resistivity layers (observed/inferred)
- Boundary of the basement rocks inferred from the resistivity sounding
- Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (11)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS
SUBTERRANEAS DEL VALLE DE COMAYAGUA

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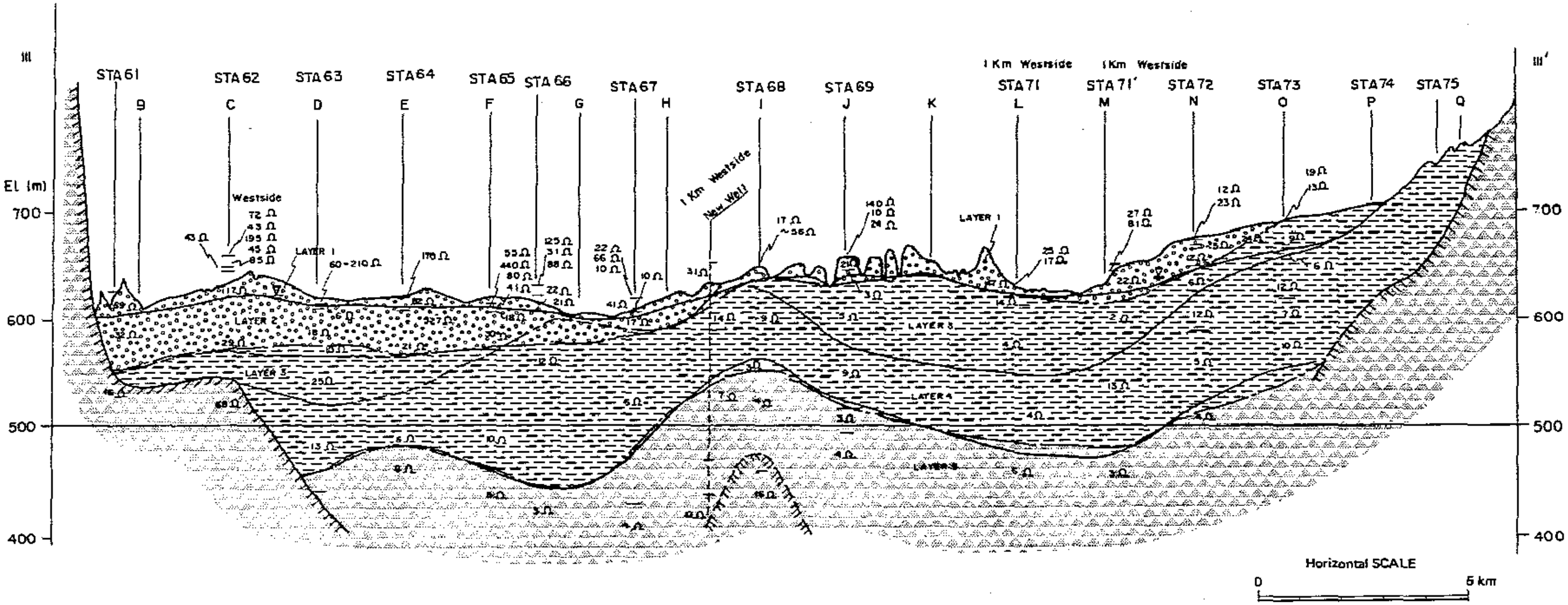


EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω·m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

- The layer where the phreatic water flows and/or is contained.
- The layer where the confined water flow and/or is contained.
- The layer where the ground water potential is too low to be developed.

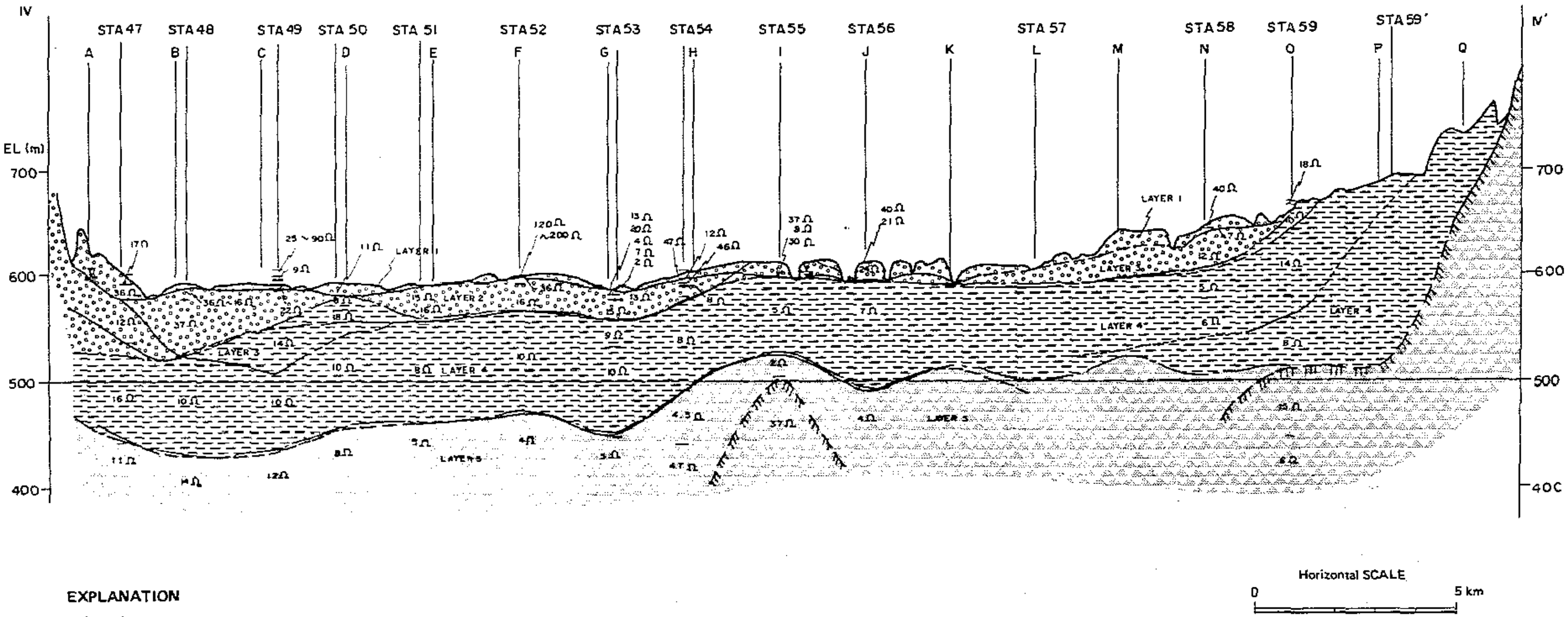
Marks

- Ground water table (observed/inferred)
- Boundary of the resistivity layers (observed/inferred)
- Boundary of the basement rocks inferred from the resistivity sounding
- Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (12)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω-m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

- The layer where the phreatic water flows and/or is contained.
- The layer where the confined water flow and/or is contained.
- The layer where the ground water potential is too low to be developed.

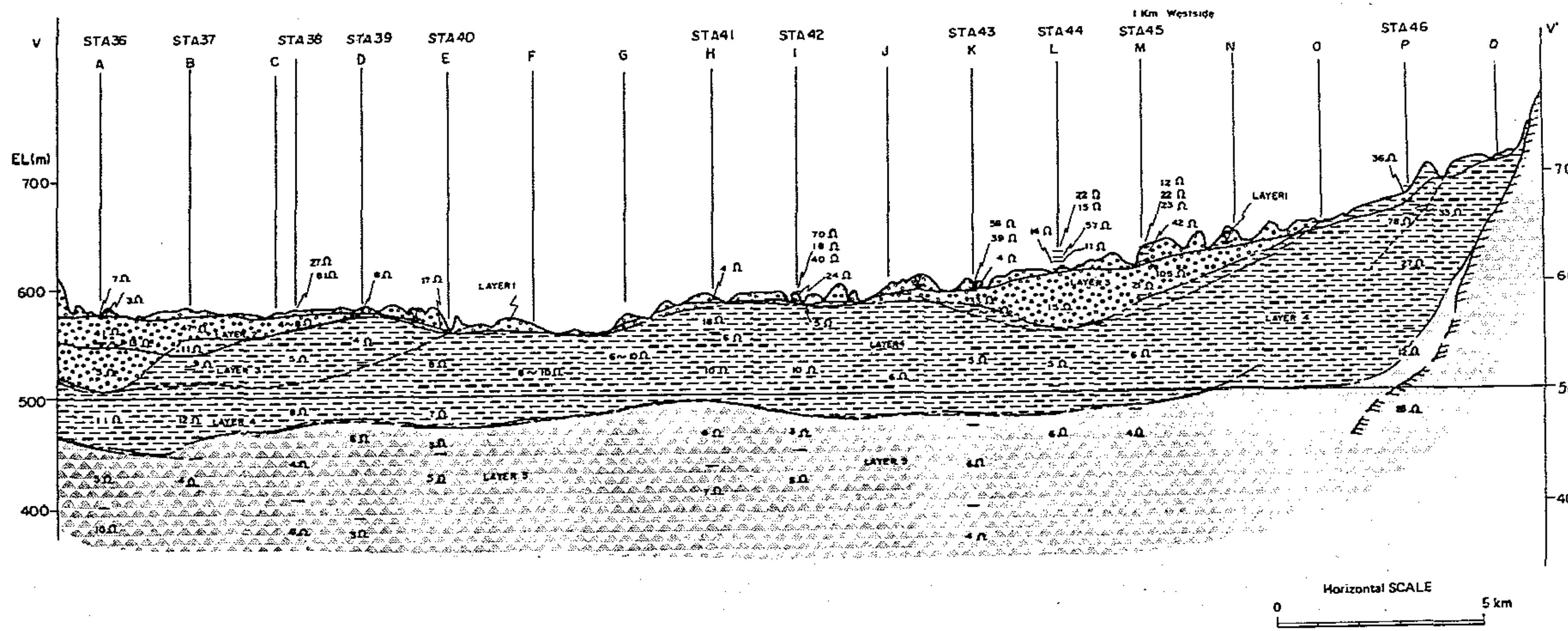
Marks

- Ground water table (observed/inferred)
- Boundary of the resistivity layers (observed/inferred)
- Boundary of the basement rocks inferred from the resistivity sounding
- Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (13)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω·m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

- The layer where the phreatic water flows and/or is contained.
- The layer where the confined water flow and/or is contained.
- The layer where the ground water potential is too low to be developed.

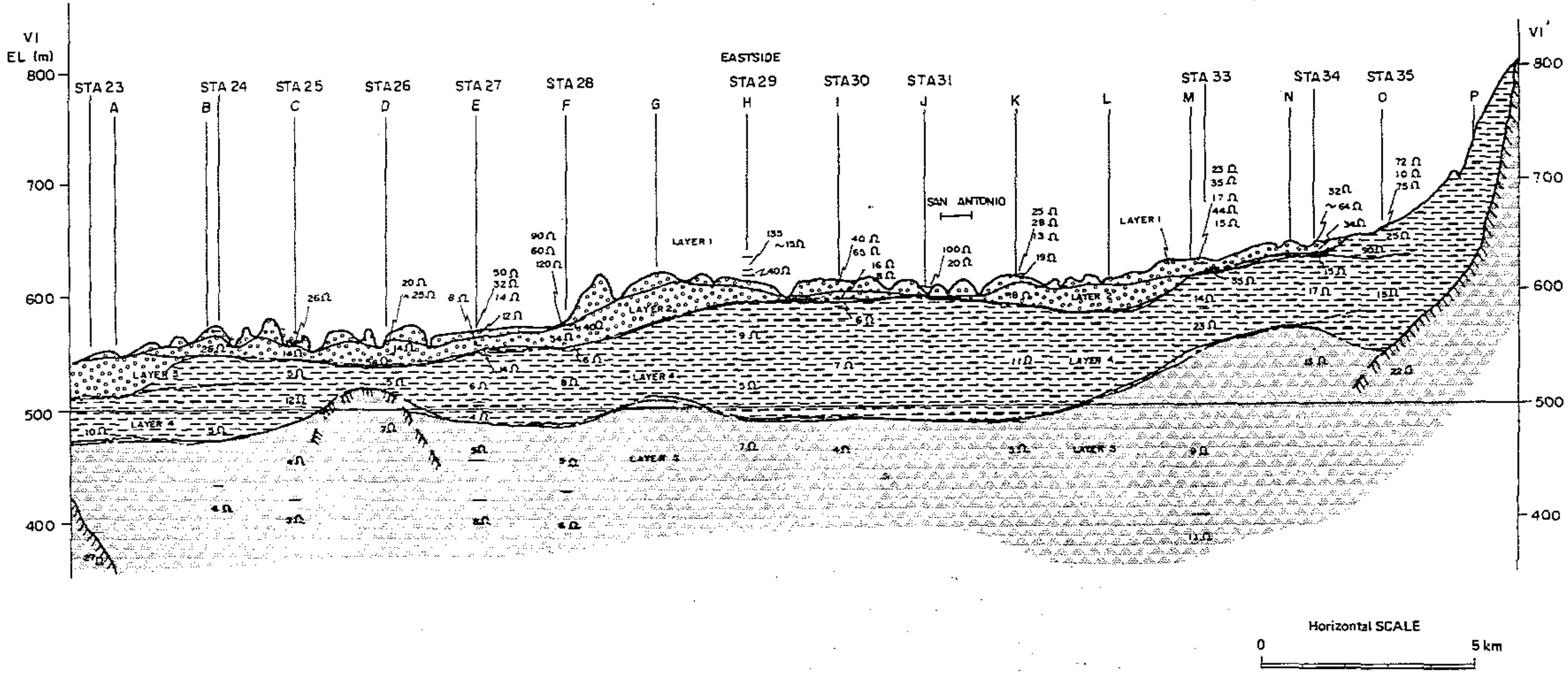
Marks

- Ground water table (observed/inferred)
- Boundary of the resistivity layers (observed/inferred)
- Boundary of the basement rocks inferred from the resistivity sounding
- Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (14)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω·m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

- The layer where the phreatic water flows and/or is contained.
- The layer where the confined water flow and/or is contained.
- The layer where the ground water potential is too low to be developed.

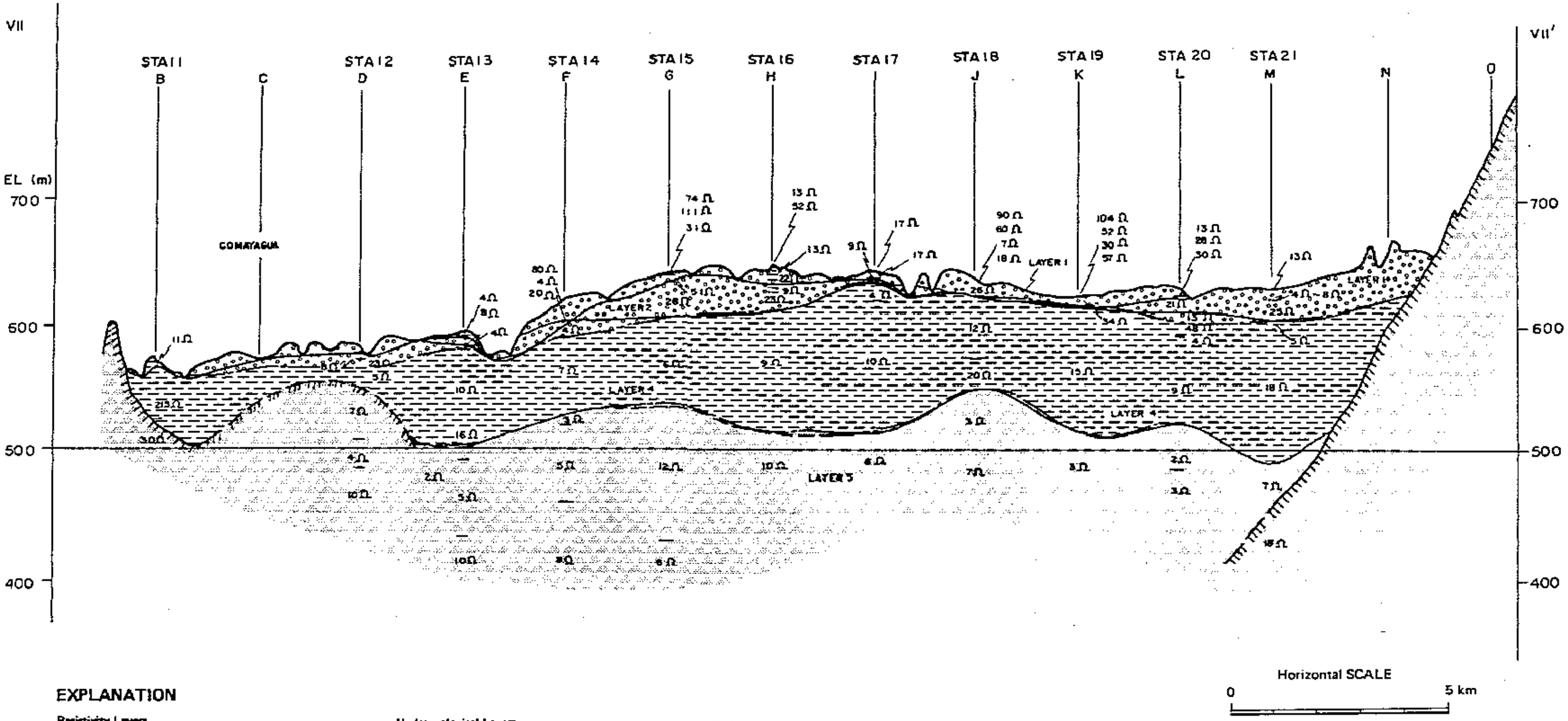
Marks

- Ground water table (observed/inferred)
- Boundary of the resistivity layers (observed/inferred)
- Boundary of the basement rocks inferred from the resistivity sounding
- Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (15)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

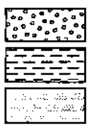


EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω·m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers



The layer where the phreatic water flows and/or is contained.

The layer where the confined water flow and/or is contained.

The layer where the ground water potential is too low to be developed.

Marks

Ground water table (observed/inferred)

Boundary of the resistivity layers (observed/inferred)

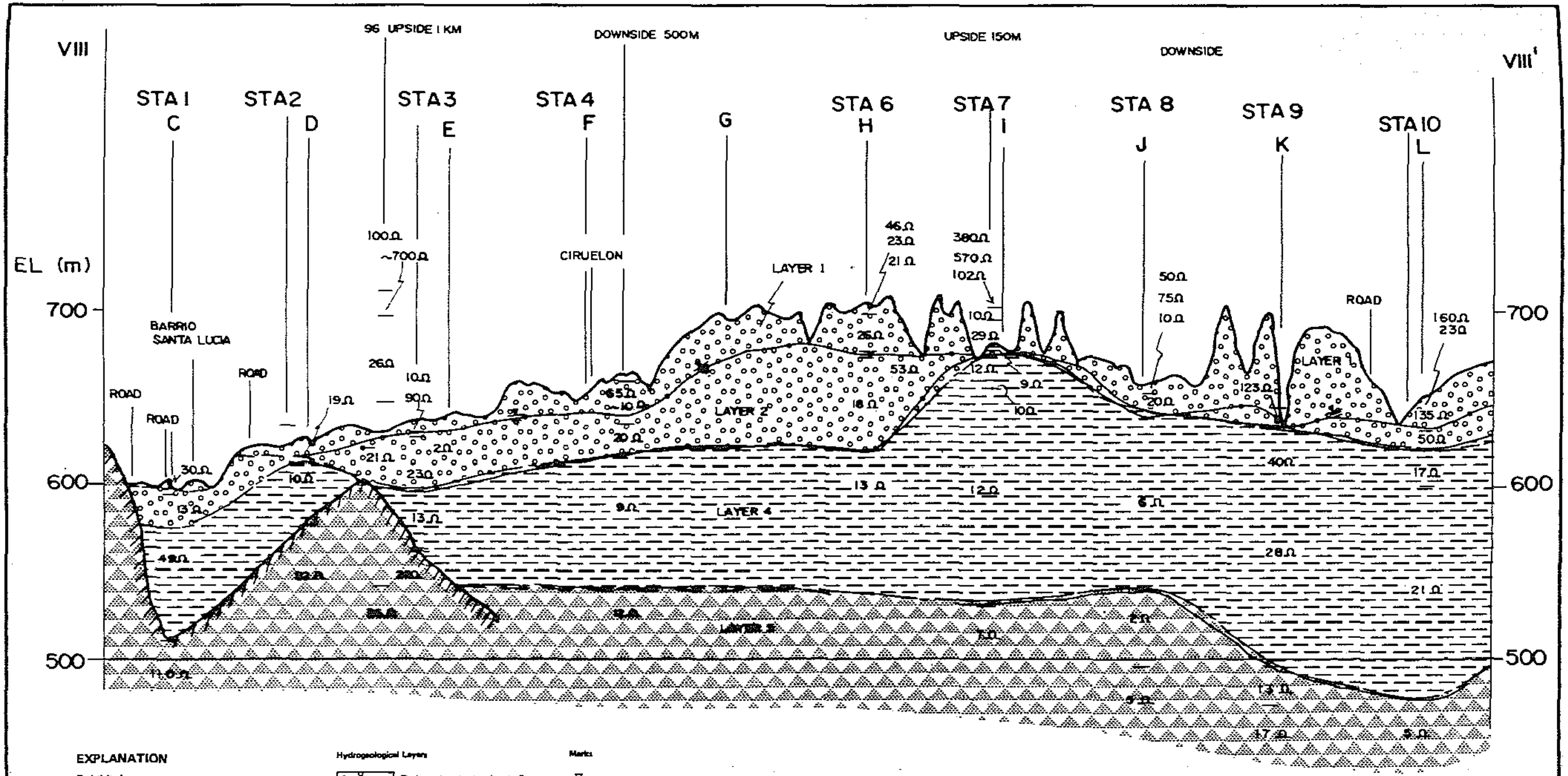
Boundary of the basement rocks inferred from the resistivity sounding

Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (16)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



EXPLANATION

Resistivity Layers

Layer	Resistivity (Ω·m)	Assumed Geology
1	11 ~ 135	Above the ground water level, mainly sand & gravel with clay, silt
2	7 ~ 54	Below the ground water level, mainly sand & gravel with clay, silt
3	1 ~ 15	Mainly clay and silt
4	7 ~ 70	Mainly fine, well consolidated sand
5	2 ~ 10	Mainly clay and clayey silt
Basement	15 ~ 110	Pre-Quaternary basement

Hydrogeological Layers

- The layer where the phreatic water flows and/or is contained.
- The layer where the confined water flow and/or is contained.
- The layer where the ground water potential is too low to be developed.

Marks

- Ground water table (observed/inferred)
- Boundary of the resistivity layers (observed/inferred)
- Boundary of the basement rocks inferred from the resistivity sounding
- Boundary of the hydrogeological layers categorized from the comprehensive study.

Fig. 3.3.1 RESISTIVITY PROFILE (17)

Horizontal SCALE

0 — 5 km

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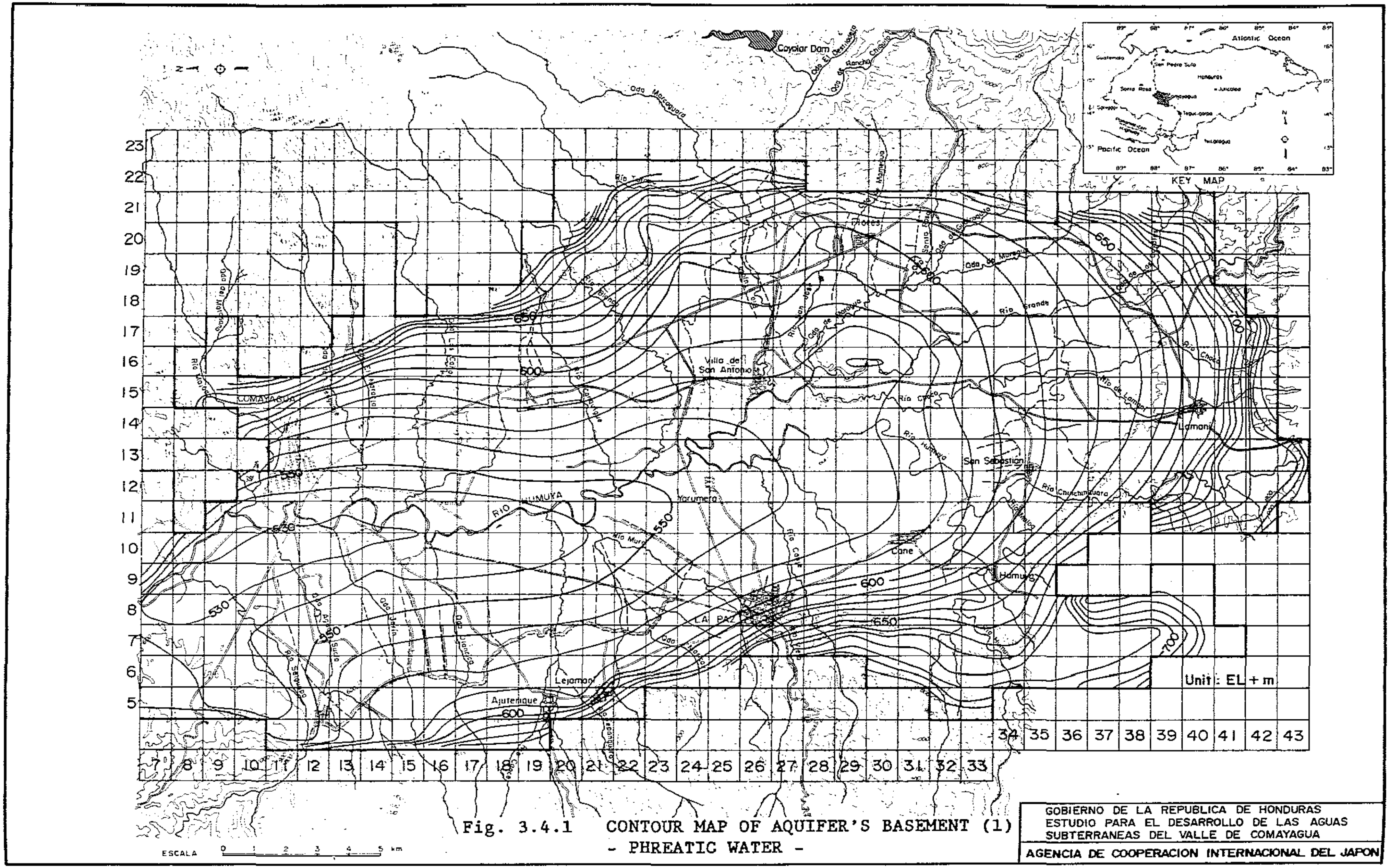

Fig. 3.4.1 CONTOUR MAP OF AQUIFER'S BASEMENT (1)
- PHREATIC WATER -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

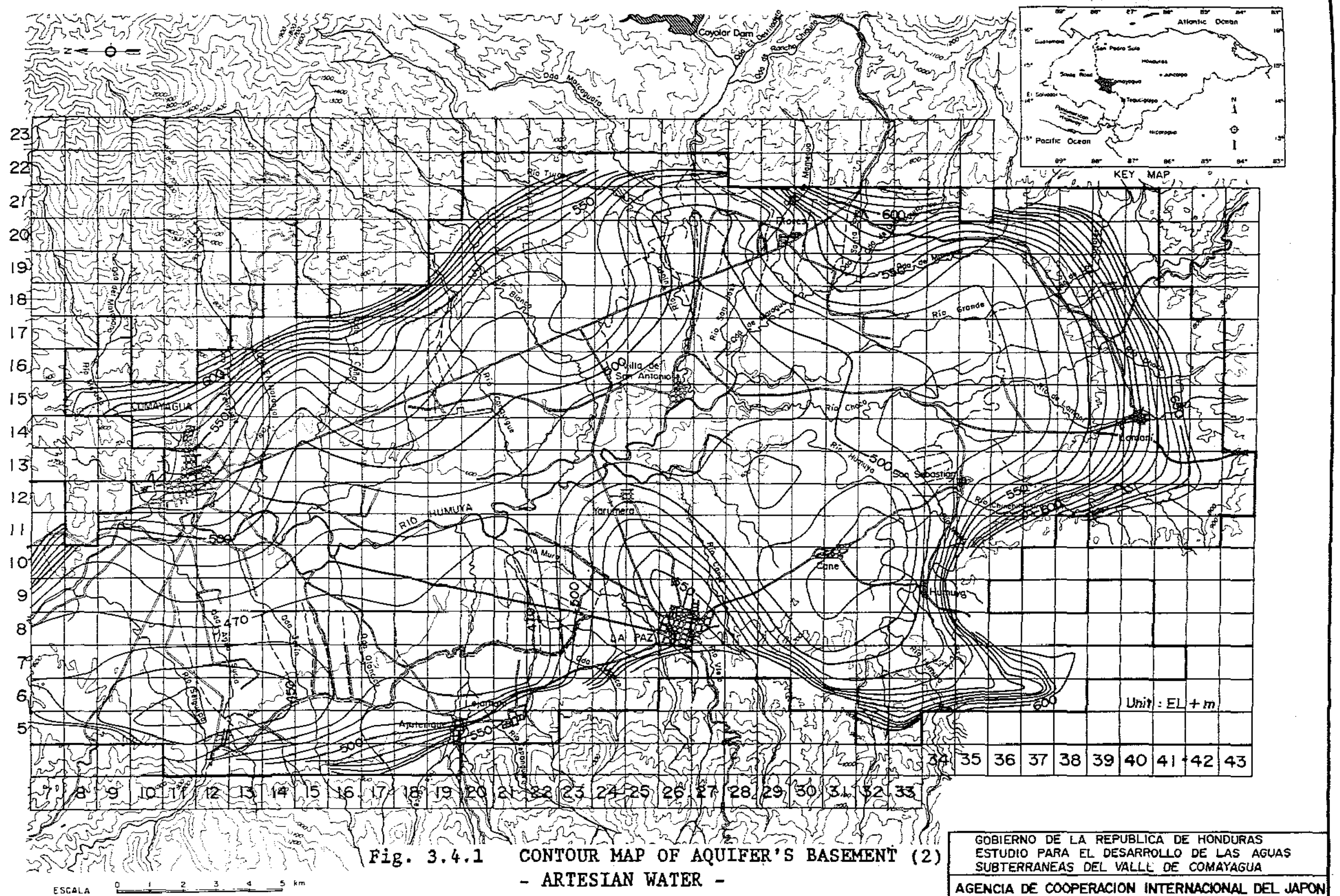

Fig. 3.4.1 CONTOUR MAP OF AQUIFER'S BASEMENT (2)
- ARTESIAN WATER -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

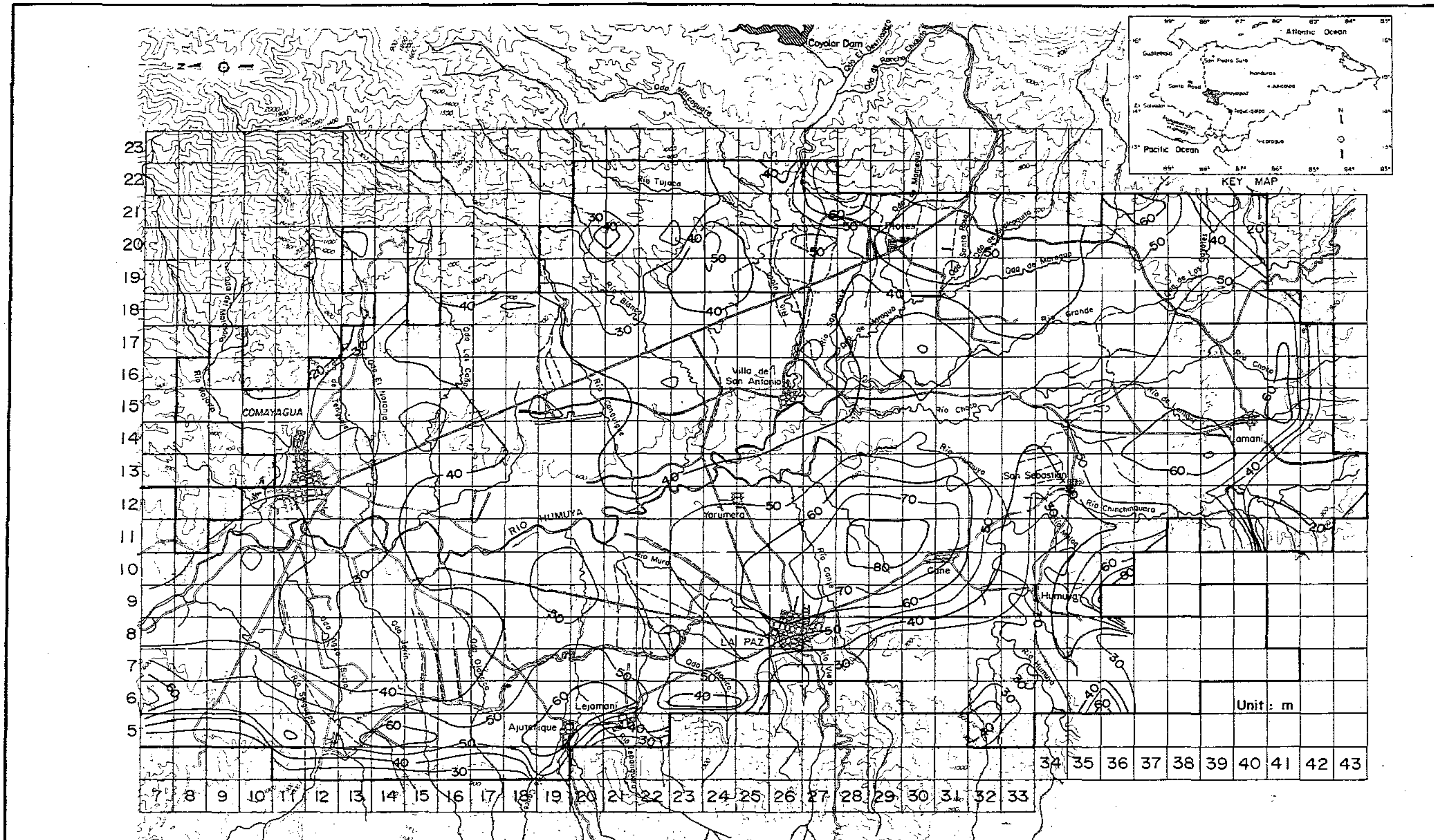

Fig. 3.4.2 ISOPACK MAP OF AQUIFER (1)
- PHREATIC WATER -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

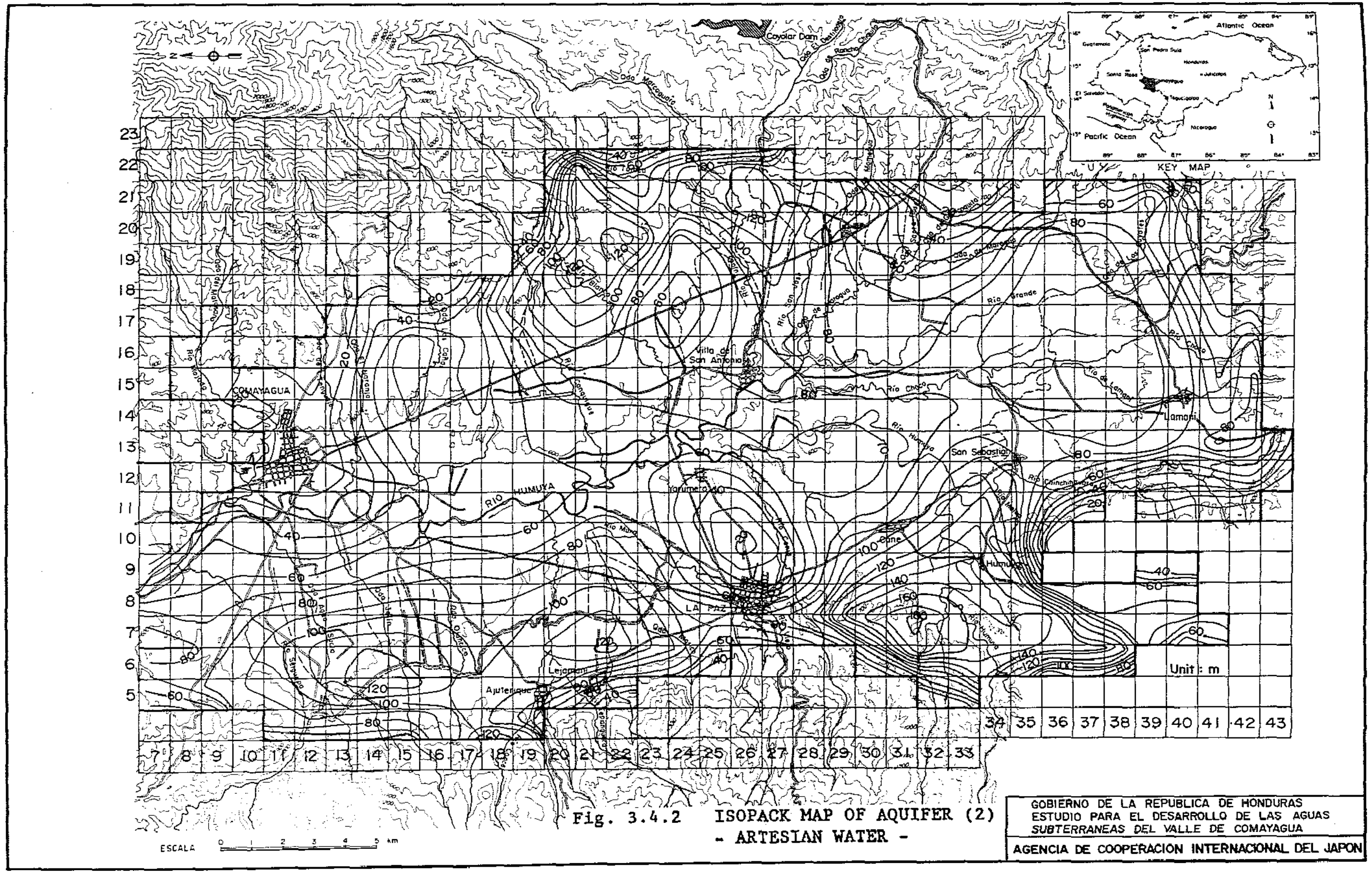

Fig. 3.4.2 ISOPACK MAP OF AQUIFER (2)
- ARTESIAN WATER -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS
SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

APPENDIX C

TEST WELL DRILLING

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ANNEXES

I. INTRODUCTION

1.1 Objectives of the Work

As described in the Scope of Work signed on the date of November 6, 1987, the Study aims

(1) to evaluate the ground water resources development potential in the Comayagua valley, and

(2) to transfer the technology to the Honduran counterpart personnel in the course of the Study.

To realize the said conditions, the well drilling was programmed at five locations in the Study area, each of which was provided with a pumping well (a test well) and an observation hole. Objectives of the well drilling are to grasp actual subsurface geological/hydrogeological conditions of the study area, to assess aquifer quality and property of aquitard, and to check the ground water chemistry.

In addition to actual drilling works, the Test Well Drilling contains installation of temporary water supply facilities at five well drilling sites. The temporary water supply facilities consisting of pumps and water tanks were planned to effectively utilize the new wells and to improve water usage circumstances in rural area.

The well drilling works with installation of the temporary water supply facilities were carried out by a selected local contractor, and the transfer of knowledge on the well drilling to MPH counterparts was done by JICA's expert through the supervisory works of the local contractor's job.

1.2 Location

Drilling points of the five test wells and/or observation holes were decided at appropriate locations in the study area considering the general geological and/or hydrogeological conditions and distribution of the existing wells.

Selected sites are listed below, and shown in Fig. 1.2.1.

(a) Las Liconas (TW-01, OH-01)
(b) San Nicolas (TW-02, OH-02)
(c) Yarumela (TW-03, OH-03)
(d) Flores (TW-04, OH-04)
(e) Lamani (TW-05, OH-05)

1.3 Contract Work

1) Preparation of technical specifications

Since all the drilling works including installation of temporary water supply facilities were scheduled to be performed by a selected local contractor under the supervision and technical advice of the JICA's expert and MPH counterparts, technical specifications for the said works were prepared in the early stage of the field investigation, the middle March 1988, in order to proceed the selection of a local contractor (see Annex I).

2) Tender call for the test well drilling

Tender document consisting of pre-qualification forms and the abovementioned technical specifications were delivered to two local contractors; i.e. Hidorosistemas and Agroconsult, on the date of March 9, 1988.

After filling up all the forms and estimating the work cost, the local contractors submitted them to the JICA study team by the date of March 31, 1988. Result of the tender evaluation by the JICA study team is shown below and tabulated in the evaluation chart (Annex II) in more detail.

Name of Contractor	Appraisal Point	Ranking	Total cost estimated (Lps)
Hidrosistemas	87	1	754,050
Agroconsult	74	2	926,212

3) Negotiation with the local contractor

According to the result of the tender evaluation, on May 9 to 10, 1988, the JICA study team negotiated with Hidrosistemas on the price of the work to be contracted. At the same time, the contract document including the technical specifications was prepared for the future contract.

4) Contract sign and commencement of the drilling

Immediately after the additional negotiation mainly on addendum on the technical specifications, the signing on the contract for the "Test Well Drilling and Pumptests" was made between the JICA study team and Hidrosistemas at the date of September 6, 1988. As shown in the Price List (Annex III) of the contract document, the total contract amount is Lps. 695,400. As a result of the additional negotiation, a memorandum was prepared and attached to the contract documents.

Following necessary preparatory works, according to the contract, Hidrosistemas commenced the actual work at the drilling sites on September 21, 1988, and all the works were completed by the middle of March 1989.

1.4 Work Quantity

1) Test well drilling

Items and quantities actually executed are shown in Table 1.4.1 in which planned quantities in the technical specifications are also shown. As shown in the table, the total drilled depths of the test wells and the observation holes are 505 m and 570 m, respectively. The total lengths of casing pipes and screens, in case of the test wells, amount to 496 m; steel pipes of 277 m and PVC pipes of 219 m, and those of the observation holes amount to 515 m resulting from steel pipes of 362 m and PVC pipes of 153 m.

2) Temporary water supply facilities

The temporary water supply facilities were designed to meet the requirement of local residents and to be suitable for the rural water supply system. The design for the present study includes an electric motor pump in a test well, a steel water tank with 5 m^3 capacity on the concrete platform, and a cylinder type hand pump on a observation hole. They are installed at the test well sites and/or nearby location for an effective well water utilization, as a model of point source facilities for the local residents.

The procurement and construction works are included in the test well drilling contract. The shop drawing of the steel water tank is presented on Fig. 1.4.1. Layout of the facilities at five sites are illustrated in Fig. 1.4.2 (1) to (10). Specifications of submersible motor pumps and hand pumps are shown in Annex IV.

1.5 Site Condition

1) General geology

The Diluvial lake deposits and the Alluvial fan deposits are the main geological units of the Comayagua basin. The Diluvial lake deposits are distributed mainly in the southern half of the basin, and composed mainly of whitish to lgrayish silt and clay sediments, while the Alluvial fan deposits containing many gravels supplied from the eastern and/or western mountains, are distributed in the northern half of the basin.

On the other hand, in the surround mountains, the Tertiary pyroclastic rocks and the pre-Tertiary hard rocks spread widely. Those pre-Quaternary rocks underlie the Quaternary deposits forming hydrogeological base rock.

The subject of the ground water development, therefore, will be the Quaternary deposits. It is expected that the maximum depth of the Diluvial lake deposits is around 200 m in the center of the basin.

2) Site geology

Since the Alluvial fan deposits are distributed in the northern half of the basin, test wells in Las Liconas, San Nicolas and Yarumela were penetrated into the Diluvial lake deposits through the Alluvial fan deposits, while the wells in Flores and Lamani were installed within the Diluvial lake deposits immediately beneath the ground surface.

3) Detailed layout of test wells and observation holes

Drill depth of each test well or observation hole was planned to be 70 to 130 m at first, and the distance between the test well and the observation hole was specified to be approximately 15 to 20 m. Detailed layout of the test well and the observation hole at each test site is shown in Table 1.5.1.

1.6 Organization

For the execution of the test well drilling works with installation of the temporary water supply facilities, JICA study team contracted with the local contractor as explained in the Section 1.1, and JICA's expert supervised the said works in cooperation with MPH counterparts. During the supervisory works of JICA's expert, he came in close contact with JICA head office and MPH so as to revise and adjust the investigation schedule and work quantities in the course of the actual drilling works.

Besides his supervisory works, JICA's expert made the transfer of knowledge against MPH counterparts through the "learning-by-doing" method.

Organization on the test well drilling is summarized as Fig. 1.6.1.

1.7 Work Progress

All the test well drilling works were commenced on the middle September, 1988 and completed by the middle March, 1989 (see Fig. 1.7.1).

Including two drill machines of which capacities were too small to properly drill the test wells and/or the observation holes of San Nicolas and Lamani, five sets of drill machines were adapted for the work. Since the two small machines with insufficient capacities were exchanged with large machines, three sets of drill machines were consequently used for the test well drilling works.

Consumed time for the drilling operation is summarized in Table 1.7.1. According to the table, the average operation day is calculated as shown below:

Average Consumed Time for Well Construction

Dimension of Well	Average Consumed Time
4" x 100 m	21 days
8" x 100 m	23 days

Extraordinary waiting time, e.g. 61 days of TW-03, was caused by the delay of procurement of steel pipes and wire-rapped screens. Although the drilling works were performed during the rainy season, it did not take so long time for the site preparation and transportation of machine and equipment because of all the sites being easily accessible.

II. TEST WELL DRILLING

2.1 Type of Test Well

The test well was constructed to be utilized as a pumping well during pumping test and a production well equipped with a electric motor pump after completion of the pumping test, while the observation hole was drilled in order to observe water level fluctuation during the pumping test and to be also utilized as a production well with a hand pump. Drill diameter of the test wells is 14.75" to 15", and the diameter of casing pipes is 8". In case of the observation holes, the diameters of drill holes and casing pipes are 10" and 4", respectively. Materials for casing pipes and screens are locally available PVC pipes, and steel pipes and wire-rapped screens imported from U.S.A.

The depths of the test wells and the observation holes are about 70 m to 120 m. In each test site, the observation hole was drilled prior to the test well in order to clarify subsurface geological conditions, aquifer systems and most appropriate depth of the test well (see the section 1.4). Screens for wells of PVC pipe casing and 4" steel pipe casing were manufactured in slotted type while the wire-rapped screens (Johnson type) were used for the wells of 8" steel pipe casing.

Immediately after completion of pipe installation (casing), gravels with diameter of about 5 m/m were packed for the filter (gravel packing) from the bottom of the hole to 10 meter-depth, and the top 10 meters were backfilled with clay and cement to prevent the percolation of sewerage from the ground surface (sanitary protection).

2.2 Drill Machine

Drill machines used for the test well drilling are shown below, meanwhile detailed specifications of the machinery and the equipment are shown in Annex V.

Drill Machine Adapted

Drill Machine	Test Well No.
SCHRAMM T64H-B (No.1)	OH-01, TW-01 OH-02, TW-02
SCHRAMM T64H-B (No.2)	OH-03, TW-03 OH-05, TW-05
GARDNER DENVER Model 1500	OH-04, TW-04

The capacities of the machineries seem not to be sufficient for the planned drilling due to superannuation, especially in case of the former two machines.

2.3 Drilling Method

Various well drilling methods have developed because geologic conditions range from hard rock such as granite and dolomite to completely unconsolidated sediments such as alluvial sand and gravel. Selection of the best drilling methods for a particular job requires an understanding of the geologic conditions and the physical limitations of the drilling rig. Table 2.3.1 gives the drilling performance of different drilling methods in various geologic formations.

In case of the study area, it was judged that the direct rotary drilling with the water-based drilling fluids and/or the cable tool (percussion) drilling are the best drilling methods, considering the site geology and limitations on adaptable machineries, equipment and materials.

As described in the section 1.7, two small percussion rigs were rejected due to insufficient drilling capacities, and consequently the direct rotary method was adapted for all the test well drilling works. The normal procedure of drilling operation is as follows,

1) Test wells:

- Drilling with a 8-inch tricone bit down to the scheduled depth using natural water mud circulation.

- After the completion of the well drilling by a 8-inch bit, the well was reamed in three steps of a 10-inch tricone bit, a 12-inch tricone bit and a 14.75-inch tricone bit.

2) Observation holes:

- Drilling with a 8-inch tricone bit down to the scheduled depth, using natural water mud circulation.

- After the completion of the well drilling by a 8-inch bit, the well was reamed by a 10-inch tricone bit.

2.4 Water-based Drilling Fluids

Drilling fluid control is essential to efficient rotary drilling. There must be proper condition of the hole size, drill pipe size, bit type, pump capabilities, and geologic conditions at the site if drilling is to proceed efficiently. The majority of rotary drilled holes are completed using a water-based drilling fluid, though drilling fluids include air, clean water, and scientifically prepared mixtures of special-purpose materials. The essential functions of a drilling fluid are to:

a. Lift the cuttings from the bottom of the hole and carry them to a settling pit.
b. Support and stabilize the borehole wall to prevent caving.
c. Seal the borehole wall to reduce fluid loss.
d. Cool and clean the drill bit.
e. Allow cuttings to drop out in the settling pit.
f. Lubricate the bit, bearings, mud pump, and drill pipe.

The selected local contractor seem not to have sufficient ability and/or knowledge on the drilling fluid control judging from many jamming troubles experienced during the drilling works, especially of the observation hole OH-05 (see the next chapter).

Although JICA's experts instructed to use such additives as bentonite and polymers properly, it is very sorry that remarkable improvement could not be made because immediate acquisition of the additives was very difficult in Honduras.

On the other hand, the mud pit should be an effective settling basin for suspended cuttings, and therefore, the mud pit is often constructed of two reservoirs; the settling part and the suction part. Sine the suspended cuttings of the wells drilled in this project contained the great amount of fine sand particles, it was essentially important to make them settle and to remove them in the proper manner. Although JICA's expert gave a technical advice to the local contractor to improve/enlarge the mud pit because he could not be satisfied with the size and/or dimension of the pit, no improvement was made during the drilling works.

2.5 Sampling

Collection of representative samples when drilling was made every 5 feet (about 1.5 meters) principally. Sampling by the direct rotary method presents several difficulties, because obtaining good samples depends largely on the skill and experience of the driller. The driller must be careful on the vertical velocity of the drilling fluid for certain rates of circulation. Since the drillers of local contractor seemed to be unskilled on this matter, JICA's expert instructed and/or advised proper way to collect samples.

As a result of observation of the samples, geological logging was made and summarized and/or arranged in Fig. 2.5.1 (1) to (10).

2.6 Well Logging

Well loggings, including the resistivity and spontaneous potential measurements, were executed for all the test wells and the observation holes.

The purpose of the well logging is to understand the geological condition, and also to exactly know aquifer position. Measurement was performed using "Mc-OHM" prepared by JICA team, and "Johnson Keck DR74" owned by the local contractor. Results of resistivity measurement are well consistent with the adjoining geo-electric sounding results.

The logging results were very helpful in determining the aquifer boundaries of Alluvial/Diluvial deposits and other formations.

Results of logging measurement are also shown in Fig. 2.5.1 (1) to (10).

2.7 Casing and Screen

Steel pipes and/or unplasticized polyvinyl chloride (PVC) pipes with diameters of 4 and 8 inches, were used for the casing of observation holes and test wells.

Slotted steel and/or PVC pipes with 4 inch diameter were installed in aquifers of observation holes. Slotted PVC pipes with 8 inch diameter were arranged to aquifers of the test wells, TW-02 and TW-05.

The slot of 4 and 8 inch pipes is about 3 mm in width and 300 mm in length, with an opening ratio of approximately 5 percent. Thicknesses of steel and/or PVC pipes with 4 inch diameter are 0.125 and 0.265 inches, respectively. PVC pipes with 8 inch diameter are 0.508 inchs in thickness, and steel pipes are 0.250 inches in thickness.

Johnson eight-inch galvanized wire-wrapped screens were used for the test wells, TW-01, TW-03 and TW-04. Opening ratios of Johnson single galvanized screens No. 60 are approximately 27.3 percent.

Screens were fit to the aquifers which were determined by lithology and electrical logging, and sank into a drilled holes immediately after electrical logging was completed.

In case of the observation holes, the assembly of steel casing pipes and screens was connected with screw couplings, while that of PVC pipes are joined together using an adhesive. Steel pipes and screens of test wells were fitted together with electric welding, and PVC pipes with 8 inch diameter were also joined by the adhesive.

The pipes and screens of the observation holes and the test wells were supported by centralizers which were arranged every 10 to 15 meter interval.

The materials used for casings and screens are summarized in Table 2.7.1.

2.8 Gravel Packing

Natural gravel is used for filling the annular space between the borehole and casing pipes of the observation holes and the test wells. It was locally collected from the river beds of the Rio Selguapa. The gravel collected from the river beds is composed of sub-rounded fragments of welded tuffs and pre-Tertiary base rocks. They were sieved from 4 to 8 mm in diameter.

The gravel was dropped into the annular space from the top using a 0.2 cubic meter bucket. In all the observation holes and the test wells, the annular space from 10 m depth to the bottom of each hole was filled up by gravel, and the volume of the gravel was calculated by counting the number of the buckets.

To avoid polluted water infiltrate into the drilled wells from ground surface, the upper most 10 m of the annular space of each wells was filled with mortar and clay.

2.9 Well Development

Well development was executed using a piston and an air compressor. Combined operation of the piston and the air compressor method was applied to the test wells, and air compressor method was used for the observation holes. The operation hours of the combined method were regulated for 48 hours, while in case of observation holes 12 hours are adopted for the well development. Actually, the operation hours of almost all the wells exceeded the scheduled hour expecting better well development. The operation of the air compressor method was regulated to lift water for 3 hours continuously with full discharge rate of 220 l/s for test wells, or 25 l/s for observation holes, and followed by one hour break time.

2.10 Pumping Test

The purpose of the pumping test is to understand the hydrogeological characteristics of the aquifer system, and also the hydraulic characteristics of the aquifer. The tests were performed by a step drawdown test, a continuous pumping test and a recovery test. Since a couple of a test well and a observation hole were drilled in each test site, both the water levels of two wells were measured at the same time during the pumping tests.

Submersible motor pumps were used for the pumping test, and yield measurement by a piezometer was continued to check the discharge rate and to keep it constant.

Results of the pumping tests are also illustrated in Fig. 2.5.1 (1) to (10).

1) Step drawdown test

The step drawdown test is executed in order to understand the aquifer characteristics in a different discharge.

Since the pumping duration of the step drawdown test should depend on aquifer conditions, one step was continued for 1 to 2 hours, and normally there were 4 steps for each well except for TW-01 and OH-01. The step drawdown test at Las Liconas (TW-01, OH-01) was stopped at the third step because available yield from TW-01 was very small and capacity of a pump installed in the well was also small.

During the step drawdown test the water level of each well more or less became stable, or showed equilibrium condition, at the end of a step except for TW-01 and OH-01.

The specific capacities of the test wells calculated from the step drawdown data, as shown in Table 2.10.1 (1), ranges 0.43 to 3.55 if the pumping result at Las Liconas is excluded.

2) Continuous pumping test and recovery test

The continuous pumping test was continued for 72 hours. The purpose of this test is to obtain the leakance factor of a confining aquifer, to know a response concerning to the delayed yield of an unconfined aquifer, and so on. Practically, the test is essential to reveal a degree of drawdown and/or influence after long-time pumping and change of water quality during the pumping. In addition, as a rule, water sample were taken from each test well at the end of the continuous pumping test.

The recovery test is to measure the water level rise after the continuous pumping is terminated. The measurement was normally continued for 12 hours or until the water level recovered to the original water level.

Both the result of the continuous pumping test and the recovery test are graphically interpreted by the Jacob's non-equilibrium method (Fig. 2.5.1 (1) to (10)). As shown in Table 2.10.1 (2) and (3) where the analysis results are summarized, the characteristics of the aquifer are briefly explained as follows:

- Judging from the pumping test result at Las Liconas, sand layers interbedded in the lake deposits have extremely low permeability showing insufficient ground water potential for future development in the northern and central part of the Comayagua basin. Therefore, this result will be omitted from the following discussions.

- Static water levels of the test wells show 7 to 36 meters from the ground surface, and the drawdown after 72-hour pumping varies 2 to 15 meters. However, excluding the test result at Lamani, the static water levels are within 11 meters from the ground surface, and the drawdown ranges 6 to 15 meters.

- Well loss is estimated at about 50 % for the Phreatic ground water (the shallow ground water) and about 10 % for the artesian ground water (the deep ground water).

- Hydraulic conductivities analyzed ranges from 3×10^{-3} cm/s to 1×10^{-2} cm/s. Since the aquifer's facies become more coarse in the southern one-third area of the basin, the relatively high hydraulic conductivity is calculated; e.g. about 1×10^{-2} cm/s

III. TROUBLE AND COUNTERMEASURE

Analysis of encountered accidents during drilling work is considered essential to clarify causes of troubles and to consequently improve drilling techniques. In the course of the drilling work of OH-05, the observation hole of Lamani, the following accidents were experienced:

1) Jamming of dills

a. Description of accident

- Date : October 1, 1988
- Time : A.M.
- Drill machine : Rotary machine - Winter Weiss (see Annex ***) -
- Accident : Drill rods were jammed at 46 m in depth due to collapse of borehole.

b. Countermeasure for recovery and cause of the trouble

After consumption of 5 days for recovery by the said machine, it was judged that the capacity of the machine was too small to recover the trouble and to continue drilling. Therefore, a larger machine (Schramm T64-HB) replaced with the initial machine was used for the recovery and successive drilling. The jammed rods were taken by the additional drilling along the rods.

It is considered that the accident was caused by (1) mis-selection of drilling rig and (2) inadequate drilling fluid control.

2) Jamming of cable and probe of a resistivity well-logging system

a. Description of accident

- Date : October 20, 1988
- Accident : In the course of a resistivity logging, when the probe reached to the bottom of the borehole, the cable and the probe were jammed.

b. Countermeasure for recovery and cause of the trouble

The cable and the probe were pulled up after dropping and rotation of drill rods, so that the cable was cut at several positions.

The trouble was probably caused by drop of cuttings during the logging, and this indicates that the drilling fluid was inadequately controlled.

3) Jamming of casings and screens

a. Description of accident

- Date : November 15, 1988
- Accident : Casings and screens were jammed at about 100 m in depth due to expanding of clayey layers into the borehole and dropping of cuttings.

b. Countermeasure for recovery and cause of the trouble

After careful circulation of drilling fluid and removal of cuttings from the borehole, casings and screens were pulled up.

It is considered that the trouble was also caused by inadequate drilling fluid control.

Considering the above-mentioned encountered accidents, the principal problem on the drilling work by the local contractor is summarized as follows;

(1) Selection of drilling rig
(2) Drilling fluid control
(3) Dropping of cuttings

IV. RECOMMENDATION

As a result of the test well drilling, it is recommended that the following matters are to be considered:

1) Drilling fluid control: It is essential to control the drilling fluid properly for well drilling without any troubles. Therefore, the drilling engineers should learn the following matters to improve their ability on the drilling fluid control:

   - Type and objectives of the drilling agents
   - Physical and chemical properties of the drilling fluids
   - Method of drilling fluid control

2) Plumbness: Stabilizers are very effective to keep the plumbness of boreholes, and therefore, it is recommended to use them throughout the drilling as a rule.

3) Drill rigs and mud pumps: Capacities of rigs and pumps are to be sufficient for planned wells. Generally, more that 1.5 times of the planned dimension is recommended for the specified capacities of the equipment. In addition, it goes without saying that maintenance of the equipment tools is very important.

4) Packing gravel: Gravel for packing should be carefully procured. Although, in case of the Study Area, gravel can be obtained from river beds in the area, it should be sieved for well fit as a filter material of production wells.

5) Backfill of clay and mortar: It should be noted that the backfill of clay material and mortar is essential for sanitary protection of a production well. It is recommended, therefore, that at least the top 10 m of the casing pipes are backfilled by the said material, as executed in all the test wells and the observation holes.

Tables

Table 1.4.1 (1) PERFORMED QUANTUTY ON TEST WELL DRILLING AND PUMPTESTS (1/2)

No.	Description	Unit	Quantity	
			Planned	Actual
1.	**TRANSPORTE**			
1.1	TRANSPORTE DESDE EL SITIO DE ORIGEN HASTA EL PROYECTO (IDA Y REGRESO)	GLOBAL	1	1
1.2	TRANSPORTE DESDE EL PROYECTO A LOS SITIOS DE PERFORACION	C/U	5	5
2.	**PERFORACION**			
2.1	PERFORACION 10"	m.l.	500	570
2.2	PERFORACION 14"*1	m.l.	500	505
3.	**INSTALACION DE TURBERIA DE REVESTI MIENTO REJILLA Y GRAVA.**			
3.1	TURBERIA DE REVESTIMIENTO DE ACERO DE 4" DE DIAMETRO.	m.l.	210	259
3.2	REJILLA DE ACERO DE 4" DE DIAMETRO (RANURADA)	m.l.	90	103
3.3	TUBERIA DE REVESTIMIENTO DE P.V.C. DE 4" DE DIAMETRO	m.l.	140	104
3.4	REJILLA DE P.V.C. DE 4" DE DIAMETRO (RANURADA O PERFORADA)	m.l.	60	49
3.5	TUBERIA DE REVESTIMIENTO DE ACERO DE 8" DE DIAMETRO	m.l.	210	186
3.6	REJILLA DE ALAMBRE REVESTIDO DE 8" DE DIAMETRO (TIPO JOHNSON No.60)	m.l.	90	91
3.7	TUBERIA DE REVESTIMIENTO DE P.V.C. DE 8" DE DIAMETRO.	m.l.	140	155
3.8	REJILLA DE P.V.C. DE 8" DE DIAMETRO (RANURADA)	m.l.	60	64
4.	**REGISTROS ELECTRICOS**	C/U	10	10
5.	**DESARROLLO**			
5.1	COMPRENSOR DE AIRE Y PISTON	C/U	5	5
5.2	COMPRESOR DE AIRE	C/U	5	5
5.3	DE BOMBA (ADICIONAL)	C/U	5	0*2

*1 : Test wells were drilled by 14-3/4 inches tricone bit, actually.

*2 : Development by pumping was omitted because air compressor method was sufficient to develop the wells.

Table 1.4.1 (2) PERFORMED QUANTITY ON TEST WELL DRILLING AND PUMPTESTS (2/2)

No.	Description	Unit	Quantity Planned	Quantity Actual
6.	**PRUEBAS DE BOMBA**			
6.1	ABATIMIENTO DE POZOS	C/U	5	5
6.2	PRUEBAS DE BOMBEO CONTINUO	C/U	5	5
6.3	OBSERVACION DE LA RECUPERACION	C/U	5	5
7.	**TAPADO TEMPORAL DEL POZO Y DE LA CIMENTACION.**	C/U	10	10
8.	**INSTALACIONES DE BOMBA**			
8.1	SUMINISTRO DE BOMBA DE MOTOR SUMERGIBLE; TH=30 O 60 m, Q=5 l/sec	C/U	5	5
8.2	MONTAJE E INSTALACION DE LA BOMBA INCLUYENDO EL SISTEMA DE CIRCUITO	C/U	5	5
8.3	SUMINISTRO E INSTALACION DE BOMBAS DE MANO	C/U	5	5
9.	**INSTALACION DE TANQUE DE AGUA**			
9.1	TRABAJOS DE BASAMENTO	C/U	5	5
9.2	MONTAJE DEL TANQUE DE AGUA INCLUYENDO SOLDADURA, PINTURA Y TRABAJOS ACCESORIOS	C/U	5	5
9.3	CONECCION DE LA TUBERIA, DESDE EL POZO AL TANQUE	C/U	5	5
9.4	OBRAS AFINES Y MISCELANEAS	C/U	5	5

Table 1.5.1 DRILLING RESULT OF OBSERVATION HOLES AND TEST WELLS

No.	Location	Well No.	Drill*1 Depth	Casing*2 Depth	Distance b/w OH & TW	Height Dif.*3 b/w OH & TW
1	Las Liconas	OH-1	100 m	67 m	18.50 m	+ 0.04 m
		TW-1	73	72		
2	San Nicolas	OH-2	130	127	15.40	+ 0.25
		TW-2	127	124		
3	Yarumela	OH-3	100	86	22.30	- 1.63
		TW-3	90	90		
4	Flores	OH-4	120	115	15.10	- 0.22
		TW-4	115	115		
5	Lamani	OH-5	120	120	17.00	+ 0.15
		TW-5	100	95		
	TOTAL	OH	570			
		TW	505			

*1. Drill Dia. ; Observation Holes ... 10 inches
Test Wells .... 14-3/4 inches

*2. Casing Dia.; Observation Holes ... 4 inches
Test Wells .... 8 inches

*3. Height Dif.; Difference between casing top elevations of a test well and a observation hole, i.e.
(El. of OH) - (El. of TW)

Table 1.7.1 DRILLING OPERATION TIMES FOR OBSERVATION HOLES AND TEST WELLS

(Unit : day)

Location	Las Liconas		San Nicolas		Yarumela		Flores		Lamani	
Well No.	OH-1	TW-1	OH-2	TW-2	OH-3	TW-3	OH-4	TW-4	OH-5	TW-5
Drill Depth (m)	100	73	130	127	100	90	120	115	120	100
Casing Depth (m)	67	72	127	124	86	90	115	115	120	95
Operation Items										
A. Site preparation, transport and installation of drilling rig	0.5	3	4	2	4	2	1	1	2	1
B. Drilling operation, logging investigations, parmanent casing & screens installation	9	13	31	23	7	13	6	7	17	17
C. Gravel Packing and development	3.5	3	8	4	2	5	5	5	5	5
D. Clay and mortar filling, construction of basement	0.5	1	1	1	1	1	1	1	1	1
E. Recovery work for accident	0	0	0	0	0	0	0	0	7	0
F. Disassembly and removal of drilling rig	0.5	1	1	1	1	1	1	1	1	1
G. Waiting time and holiday (no work due to heavy rain)	3	7	19 (3)	33	0	61	44	37	34	41
H. Total days	17	28	63	64	15	83	58	52	67	66
I. Actual operation days (H - E - G)	14	21	44	31	15	22	14	15	33	25

Table 2.3.1 RELATIVE PERFORMANCE OF DIFFERENT DRILLING METHODS IN VARIOUS TYPES OF GEOLOGIC FORMATIONS

Type of Formation	Cable Tool	Direct Rotary (with fluids)	Direct Rotary (with air)	Direct Rotary (Down-the-hole air hammer)	Direct Rotary (Drill-through casing hammer)	Reverse Rotary (with fluids)	Reverse Rotary (Dual Wall)	Hydraulic Percussion	Jetting	Driven	Auger
Dune sand	2	5	Not recommended	Not recommended	6	5*	6	5	5	3	1
Loose sand and gravel	2	5	Not recommended	Not recommended	6	5*	6	5	5	3	1
Quicksand	2	5	Not recommended	Not recommended	6	5*	6	5	5	Not recommended	1
Loose boulders in alluvial fans or glacial drift	3-2	2-1	Not recommended	Not recommended	5	2-1	4	1	1	Not recommended	1
Clay and silt	3	5	Not recommended	Not recommended	5	5	5	3	3	Not recommended	3
Firm shale	5	5	Not recommended	Not recommended	5	5	5	3	Not recommended	Not recommended	2
Sticky shale	3	5	Not recommended	Not recommended	5	3	5	3	Not recommended	Not recommended	2
Brittle shale	5	5	Not recommended	Not recommended	5	5	5	3	Not recommended	Not recommended	Not applicable
Sandstone—poorly cemented	3	4	Not recommended	Not recommended	Not applicable	4	5	4	Not recommended	Not recommended	Not applicable
Sandstone—well cemented	3	3	5	Not recommended	Not applicable	3	5	3	Not recommended	Not recommended	Not applicable
Chert nodules	5	3	3	Not recommended	Not applicable	3	3	5	Not recommended	Not recommended	Not applicable
Limestone	5	5	5	6	Not applicable	5	5	5	Not recommended	Not recommended	Not applicable
Limestone with chert nodules	5	3	5	6	Not applicable	3	3	5	Not recommended	Not recommended	Not applicable
Limestone with small cracks or fractures	5	3	5	6	Not applicable	2	5	5	Not recommended	Not recommended	Not applicable
Limestone, cavernous	5	3-1	2	5	Not applicable	1	5	1	Not recommended	Not recommended	Not applicable
Dolomite	5	5	5	6	Not applicable	5	5	5	Not recommended	Not recommended	Not applicable
Basalts, thin layers in sedimentary rocks	5	3	5	6	Not applicable	3	5	5	Not recommended	Not recommended	Not applicable
Basalts—thick layers	3	3	4	5	Not applicable	3	4	3	Not recommended	Not recommended	Not applicable
Basalts—highly fractured (lost circulation zones)	3	1	3	3	Not applicable	1	4	1	Not recommended	Not recommended	Not applicable
Metamorphic rocks	3	3	4	5	Not applicable	3	4	3	Not recommended	Not recommended	Not applicable
Granite	3	3	5	5	Not applicable	3	4	3	Not recommended	Not recommended	Not applicable

*Assuming sufficient hydrostatic pressure is available to contain active sand (under high confining pressures)

Rate of Penetration:
1 Impossible
2 Difficult
3 Slow
4 Medium
5 Rapid
6 Very rapid

Table 2.7.1 QUANTITY OF INSTALLED CASING PIPES AND SCREENS

No.	Location	Well No.	Spec. of Casing Pipes and Screens: Dia. (inch)	Depth (m)	Screen Position (m - m)	PVC pipes: blind (m)	slotted (m)	total (m)	steel pipes: blind (m)	slotted (m)	wire-wrapped (m)	total (m)
1	Las Liconas	OH-1	4	67	21-32, 35-38, 54-62	45	22	67	-	-	-	-
		TW-1	8	72	20-26, 35-41, 53-59, 63-69	-	-	-	48	-	24	72
2	San Nicolas	OH-2	4	127	12-18, 23-29, 58-63, 90-96, 113-125	-	-	-	92	35	-	127
		TW-2	8	124	12-18, 26-32, 52-55, 61-64, 93-105, 118-123	89	35	124	-	-	-	-
3	Yarumela	OH-3	4	86	15-33, 42-48, 73-76	59	27	86	-	-	-	-
		TW-3	8	90	12-34, 38-41, 46-49, 61-67, 87-90	-	-	-	53	-	37	90
4	Flores	OH-4	4	115	17-20, 43-46, 58-64, 73-76, 81-82.5, 90-91.5, 101-113	-	-	-	85	30	-	115
		TW-4	8	115	18-21, 44-47, 58-61, 73-76, 79-82, 90-93, 101-113	-	-	-	85	-	30	115
5	Lamani	OH-5	4	120	21-43, 76-80, 84-90, 113-119	-	-	-	82	38	-	120
		TW-5	8	95	29-37, 40-43, 58-61, 76-91	66	29	95	-	-	-	-
	TOTAL	OH	4	-	------	104	49	153	259	103	-	362
		TW	8	-	------	155	64	219	186	-	91	277

Table 2.10.1 (1) Result of Pumping Tests (1/3)

Location	Test	Test Well Q(l/s)	Test Well Sw(m)	Test Well SC(l/s.m)	Observ.Hole Sw (m)
Las Liconas	(S.W.L)		(2.85)		(2.63)
TW-1	Step Draw-	0.5	8.46	0.06	2.03
&	down Test	0.9	20.68	0.04	4.88
OH-1		1.1	27.87	0.04	7.77
	Continuous Pump. Test	0.7	21.88	0.03	7.17
San Nicolas	(S.W.L)		(7.10)		(7.33)
TW-2	Step Draw-	4.0	2.23	1.79	1.20
&	down Test	6.0	3.83	1.57	1.86
OH-2		8.0	5.94	1.35	2.80
		10.0	7.77	1.29	3.78
	Continuous Pump. Test	7.0	7.39	0.95	4.65
Yarumela	(S.W.L)		(8.83)		(7.38)
TW-3	Step Draw-	2.0	2.37	0.84	0.66
&	down Test	4.0	5.48	0.73	0.76
OH-3		6.2	9.11	0.68	2.05
		8.7	16.00	0.54	2.66
		11.8	31.81	0.37	2.86
	Continuous Pump. Test	6.2	14.35	0.43	2.70
Flores	(S.W.L)		(11.00)		(11.00)
TW-4	Step Draw-	5.0	2.08	2.40	0.55
&	down Test	7.4	2.91	2.54	0.93
OH-4		10.0	4.13	2.42	1.37
		13.0	5.60	2.32	1.92
	Continuous Pump. Test	12.0	6.56	1.83	3.08
Lamani	(S.W.L)		(35.61)		(35.60)
TW-5	Step Draw-	3.5	1.02	3.43	0.29
&	down Test	5.0	1.81	2.76	0.50
OH-5		7.5	2.45	3.06	0.81
		8.8	2.92	3.01	0.97
	Continuous Pump. Test	6.0	1.69	3.55	0.40

Remarks; Q : Discharge rate　　S.W.L. : Static Water Level
Sw: Drawdown
SC: Specific capacity

Table 2.10.1 (2) Result of Pumping Test (2/3)

Location	Transmissivity (m^2/day)					Pumping Rate (l/s)	Final Draw Down (m)		Radius of Infuluence (m)	Aquifer Loss of Pumping Well (m)	Well Loss	
	Test Well		Observ. Hole		Avg.		Test Well	Observ. Hole			Drawdown (m)	(%)
	CPT*1	RT*2	CPT*1	RT*2								
1. Las Liconas	2.64	3.11	1.15	1.98	2.22	0.7	21.88	7.17	98	21.88*3	0.00	0
2. San Nicolas	83.23	127.24	61.50	106.44	94.60	7.0	7.39	4.65	1,495	7.39*3	0.00	0
3. Yarumela	91.63	131.12	26.22	89.95	84.73	6.2	14.35	2.70	328	8.14	6.21	44
4. Flores	231.42	267.27	253.02	287.52	259.81	12.0	6.56	3.08	1,939	6.27	0.29	5
5. Lamani	247.09	263.56	152.05	168.23	207.73	6.0	1.69	0.40	47	1.69*3	0.00	0

Remarks. *1 : Continuous Pumping Test *2 : Recovery Test
*3 : Since Calculated value is larger than the observed drawdown, it was supposed that whole the drawdown was cuased only by the aquifer loss.

Table 2.10.1 (3) Result of Pumping Test (3/3)

Location	Result of Pumping			Transmissivity average (m^2/day)	Total Screen Length (m)	Hydraulic Conductivity (cm/sec)	Hydrogeological Condition		
	Pumping Rate(l/s)	WL of TW*1					Type of Main Aquifer	Ratio of Sand Layer*2	
		SWL(m)	PWL(m)					Shallow G/W	Deep G/W
1. Las Liconas	0.7	3.78	25.66	2.22	24.0	1.07×10^{-4} (0.093 m/day)	Artesian G/W (Deep G/W)	70% (10m)	20% (90m)
2. San Nicolas	7.0	7.08	14.47	94.60	35.0	3.13×10^{-3} (2.703 m/d)	do.	80 (33.5)	20 (116.5)
3. Yarumela	6.2	8.95	23.30	84.73	37.0	2.65×10^{-3} (2.29 m/d)	Phereatic G/W (Shallow G/W)	74 (33.5)	20 (56.5)
4. Flores	12.0	11.06	17.62	259.81	30.0	1.00×10^{-2} (8.660 m/d)	Artesian G/W (Deep G/W)	60 (25.0)	55 (90.0)
5. Lamani	6.0	35.67	37.36	207.73	29.0	8.29×10^{-3} (7.163 m/d)	do.	65 (50.0)	40 (50.0)

Remarks. *1 : WL = Water Level, TW = Test Well, SWL = Static Water Level, PWL = Pumping Water Level
*2 : Values in parentheses are the total thicknesses of each aquifer confirmed through the well drilling.

Figures

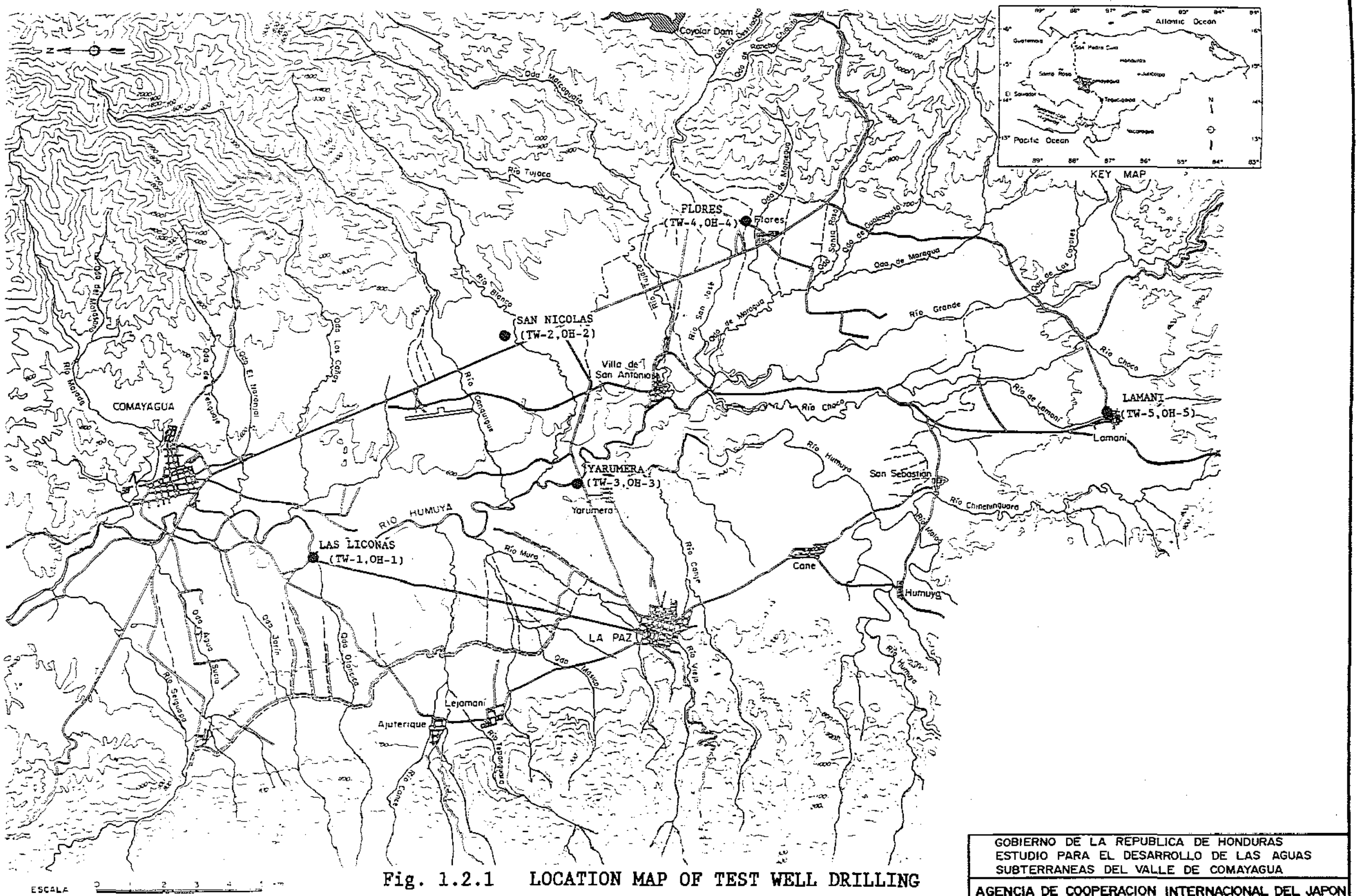


Fig. 1.2.1 LOCATION MAP OF TEST WELL DRILLING

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

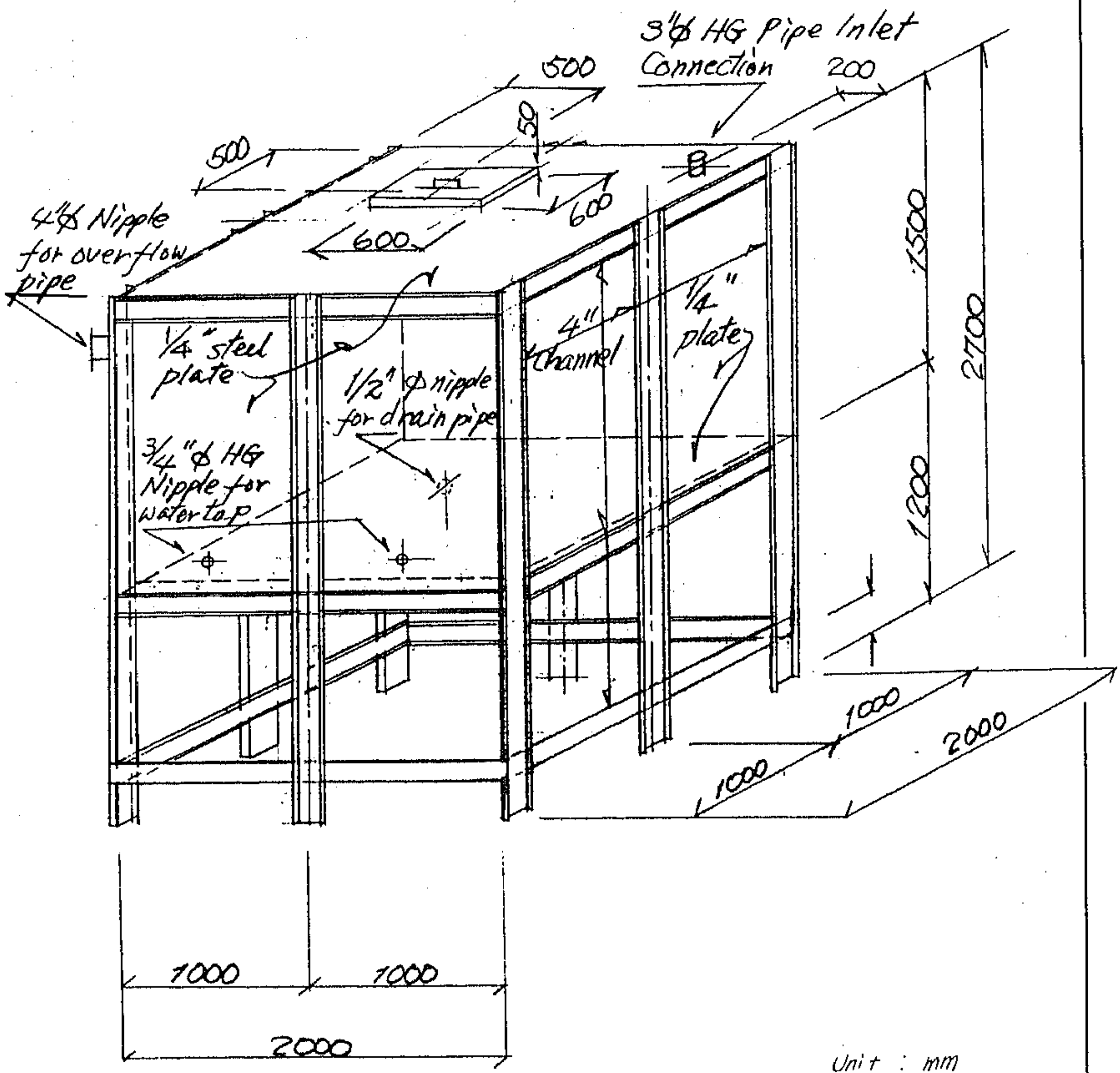


Fig 1.4.1 PERSPECTIVE STEEL WATER TANK SHOP DRAWING

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

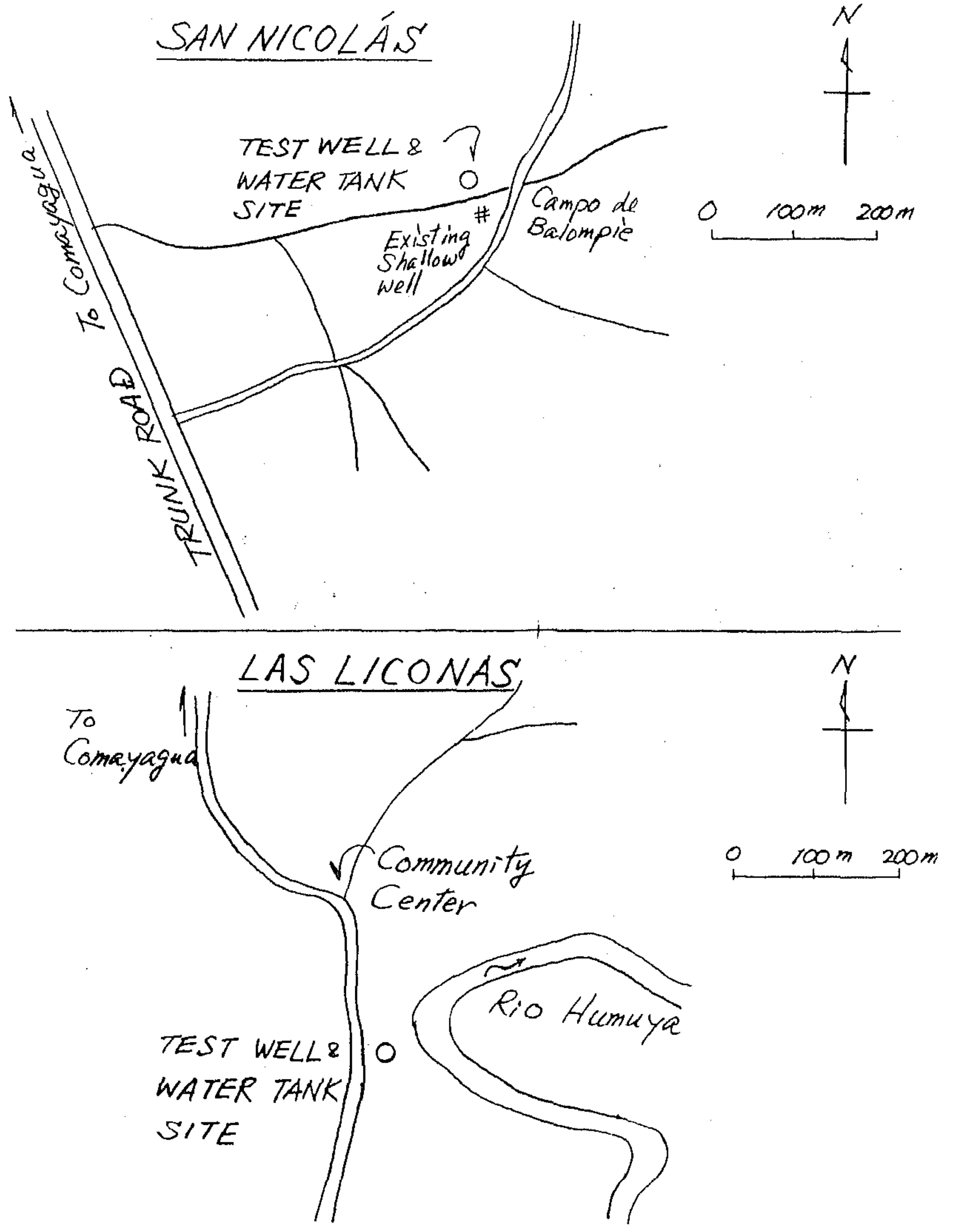
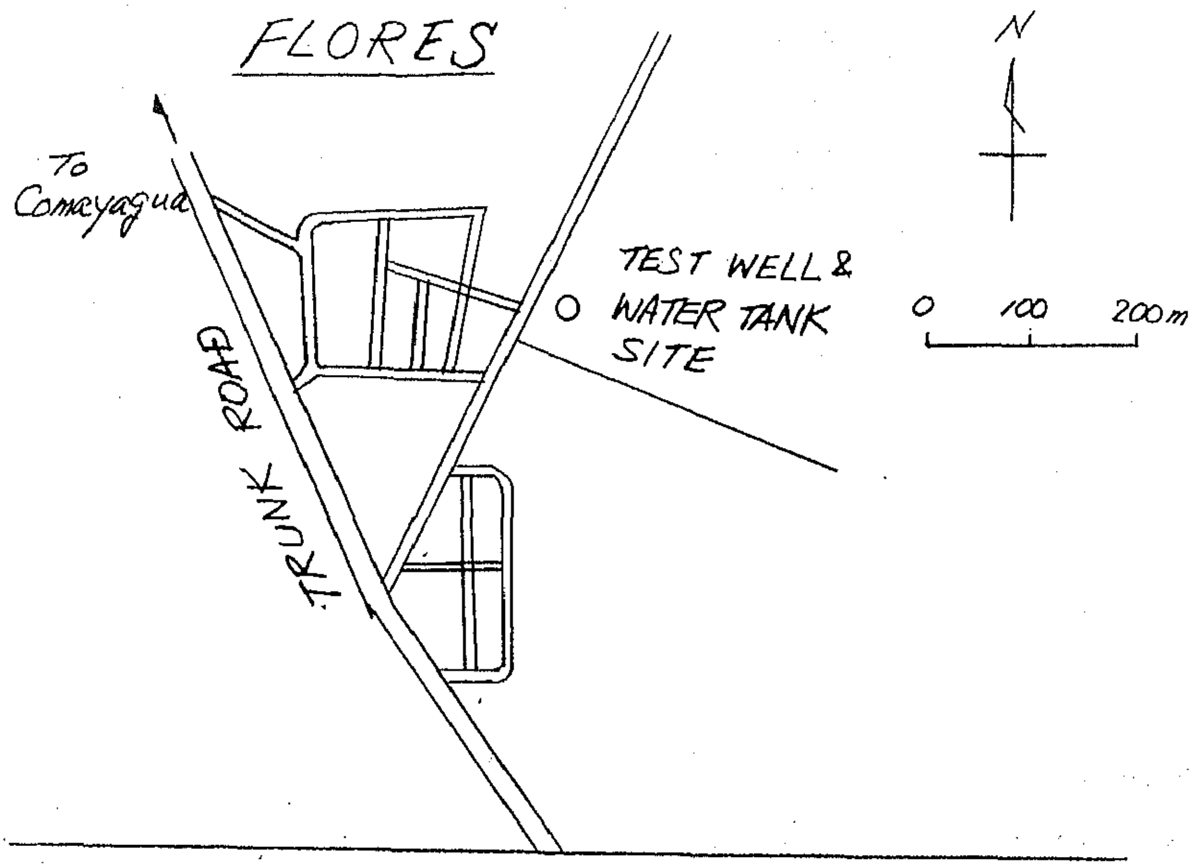


Fig 1.4.2 LAYOUT OF TEMPORARY WATER SUPPLY FACILITIES (1)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS
SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



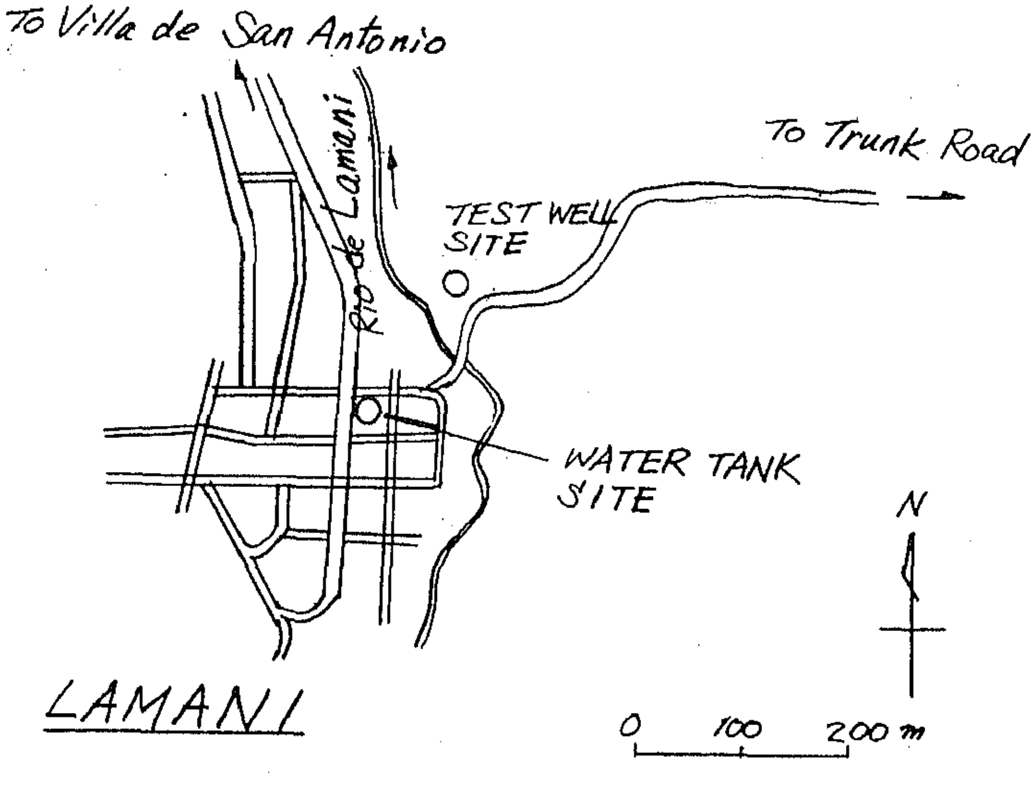


Fig 1.4.2 LAYOUT OF TEMPORARY WATER SUPPLY FACILITIES (2)

GOBIERNO DE LA REPUBLICA DE HONDURAS
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SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

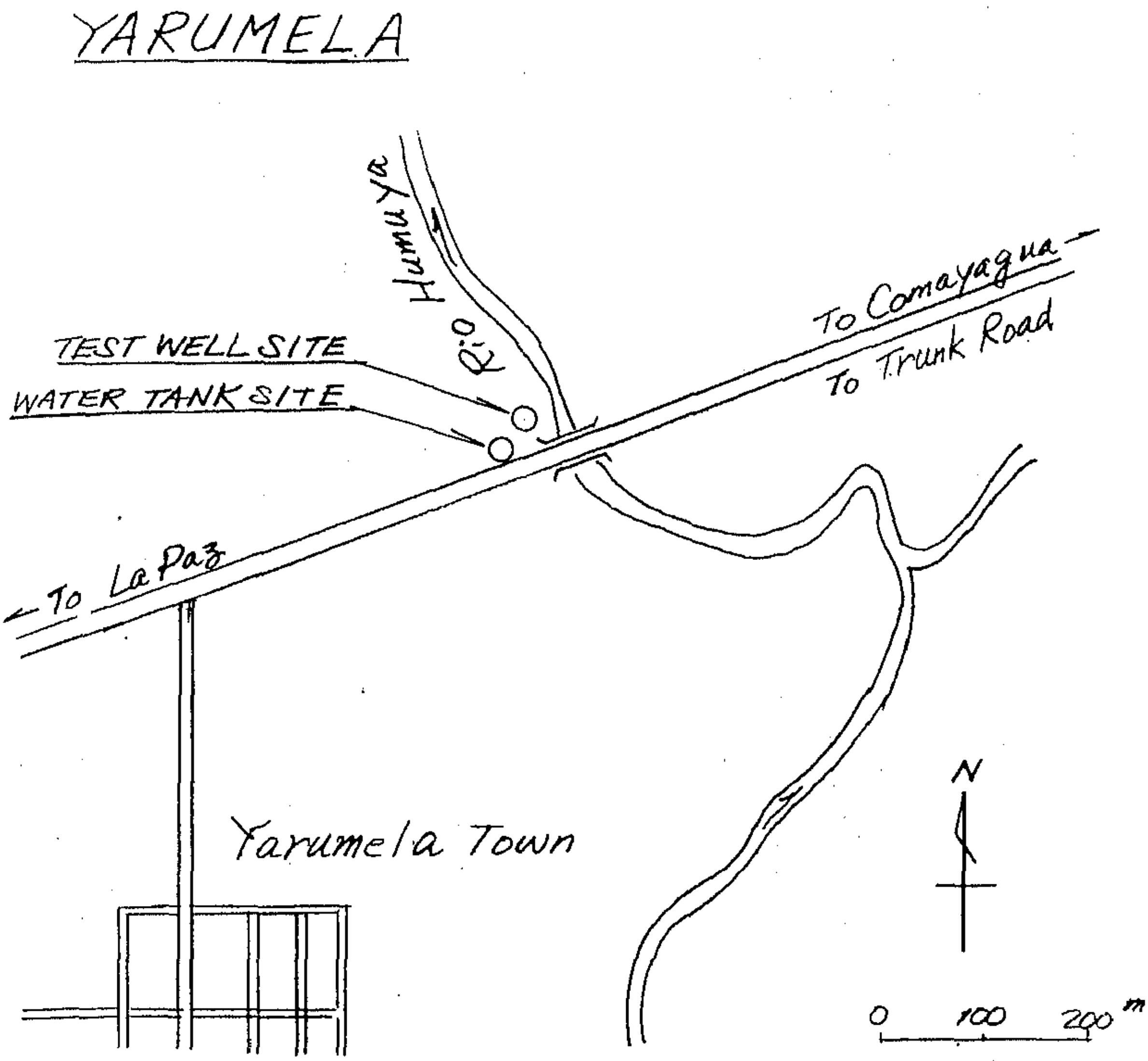

Fig 1.4.2 LAYOUT OF TEMPORARY WATER SUPPLY FACILITIES (3)

GOBIERNO DE LA REPUBLICA DE HONDURAS
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AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

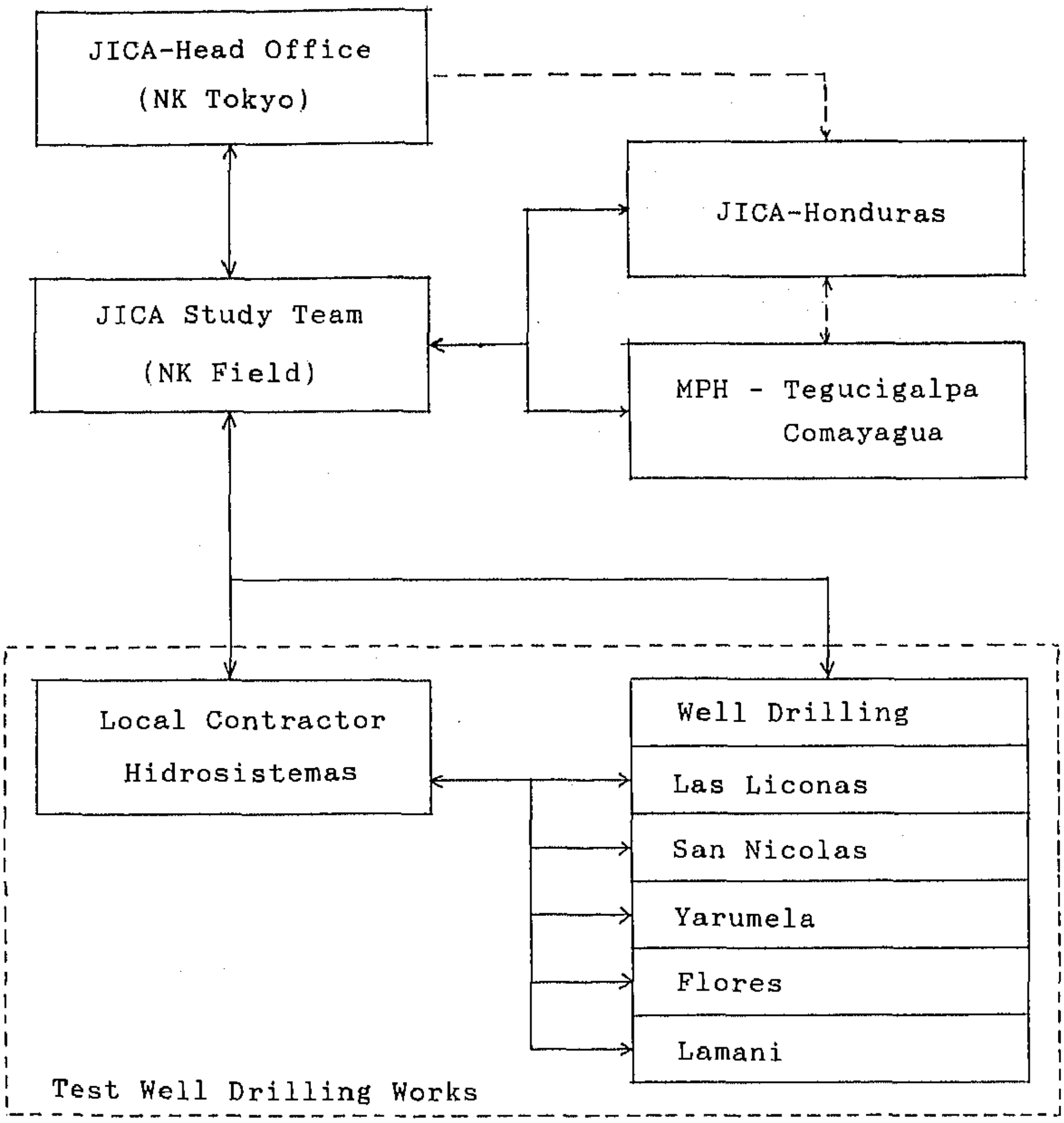

Fig 1.6.1 ORGANIZATION OF TEST WELL DRILLING WORKS

GOBIERNO DE LA REPUBLICA DE HONDURAS ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
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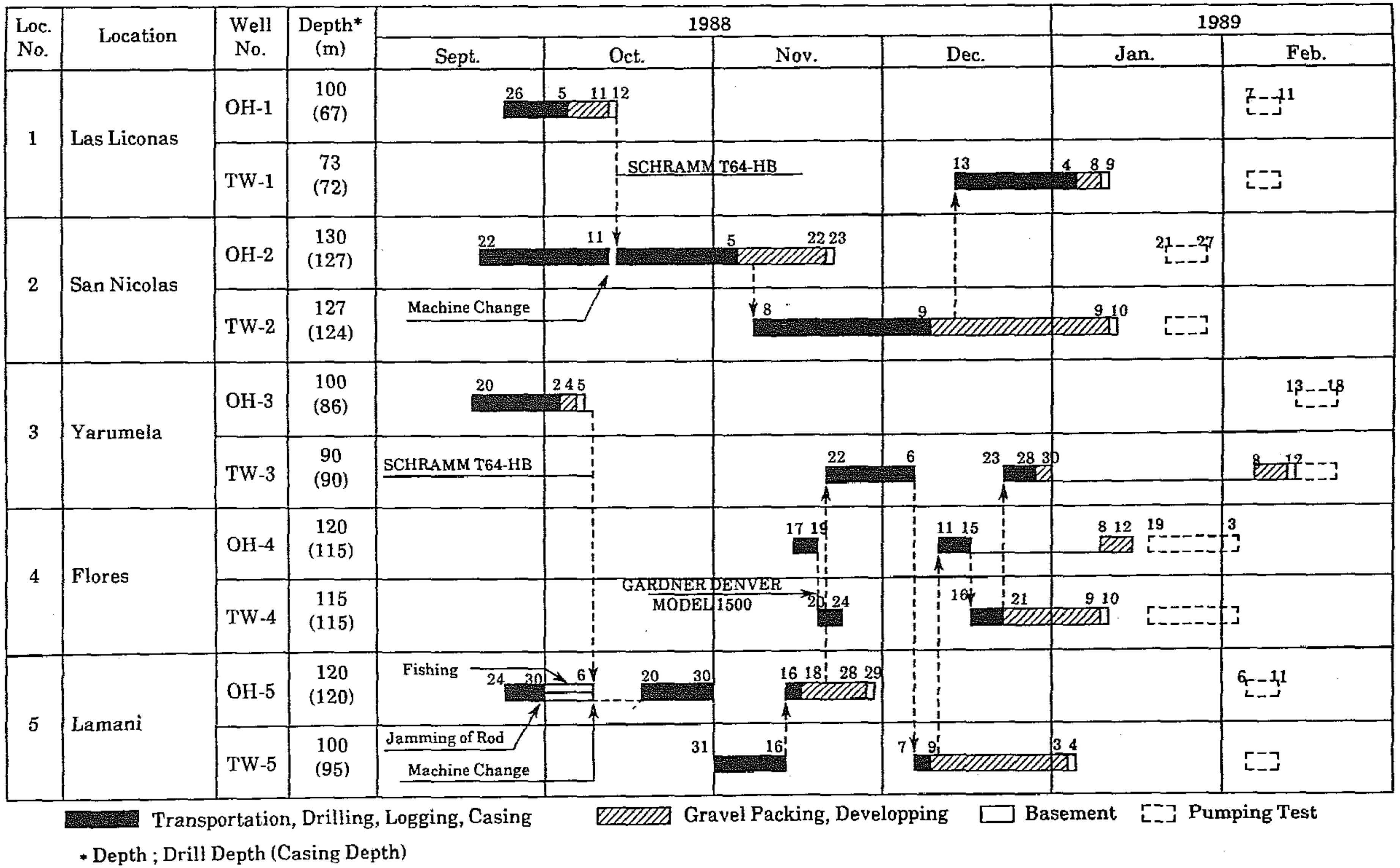
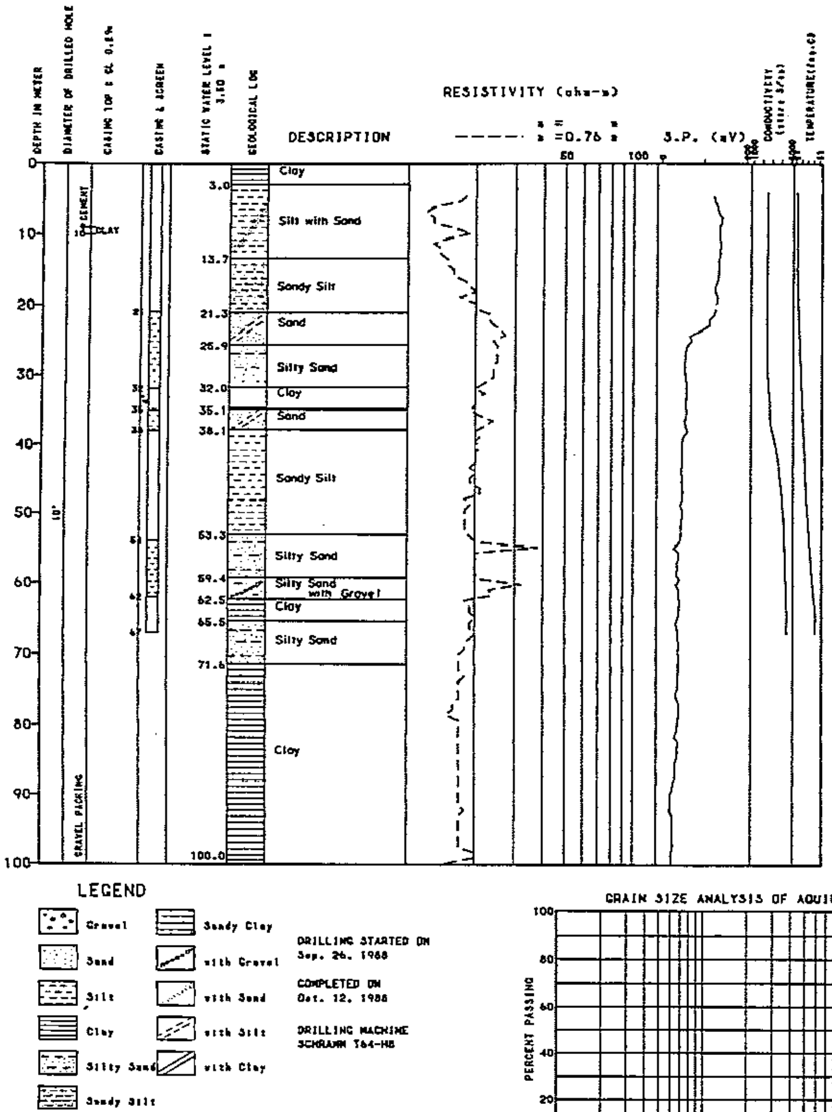
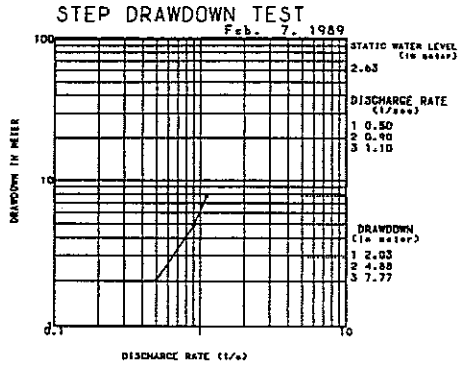
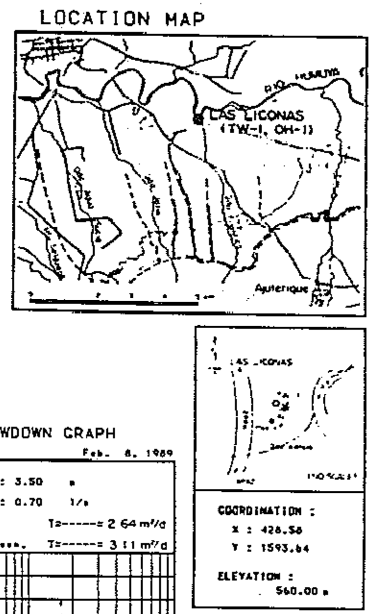


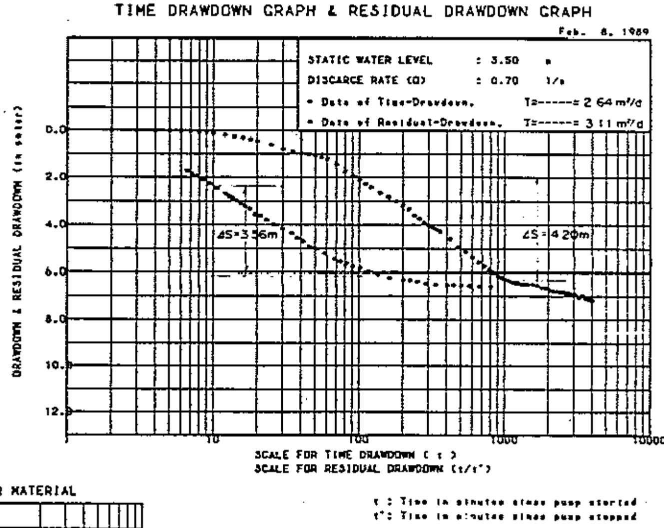
Fig 1.7.1 EXECUTION RESULTS OF TEST WELL DRILLING

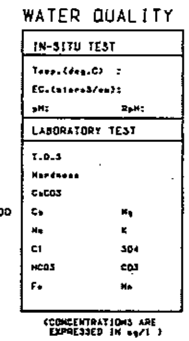
GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON











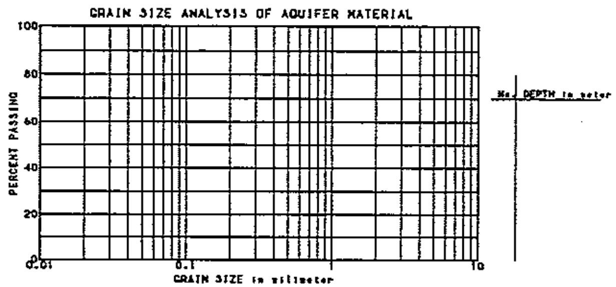


Fig. 2.5.1 WELL DRILLING RESULT (1)
- Las Liconas OH-01 -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

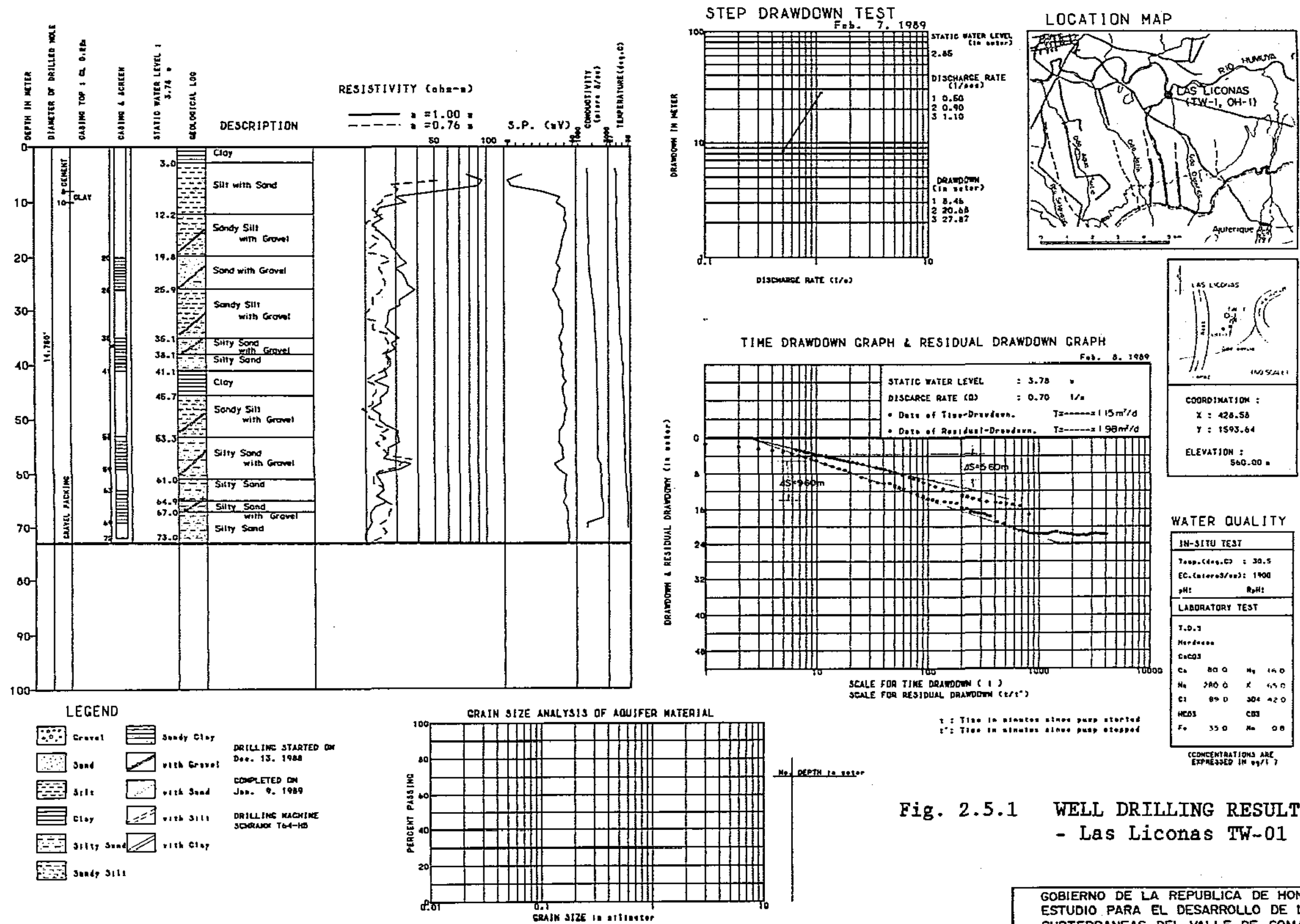


Fig. 2.5.1 WELL DRILLING RESULT (2)
- Las Liconas TW-01 -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS
SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

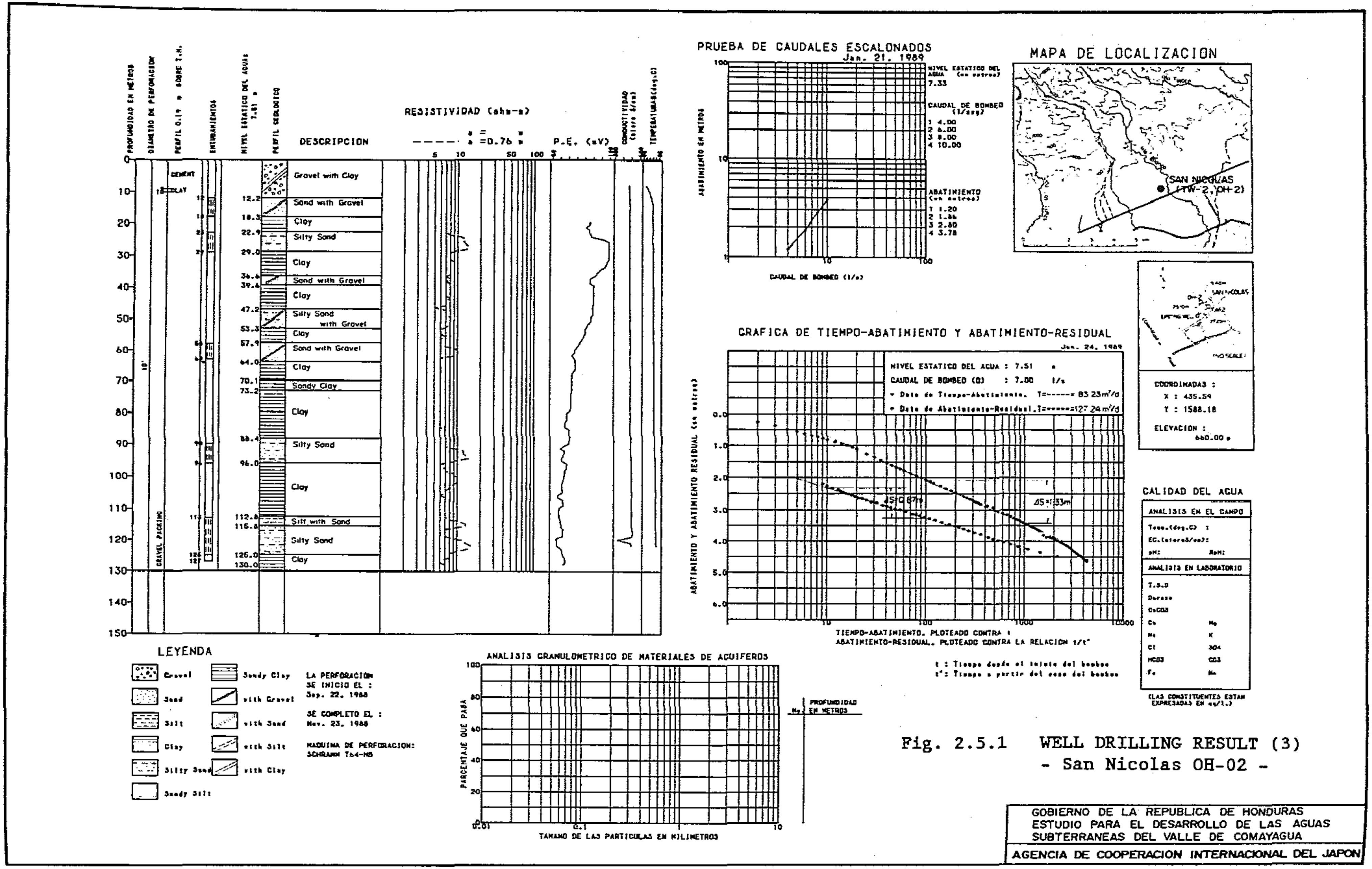
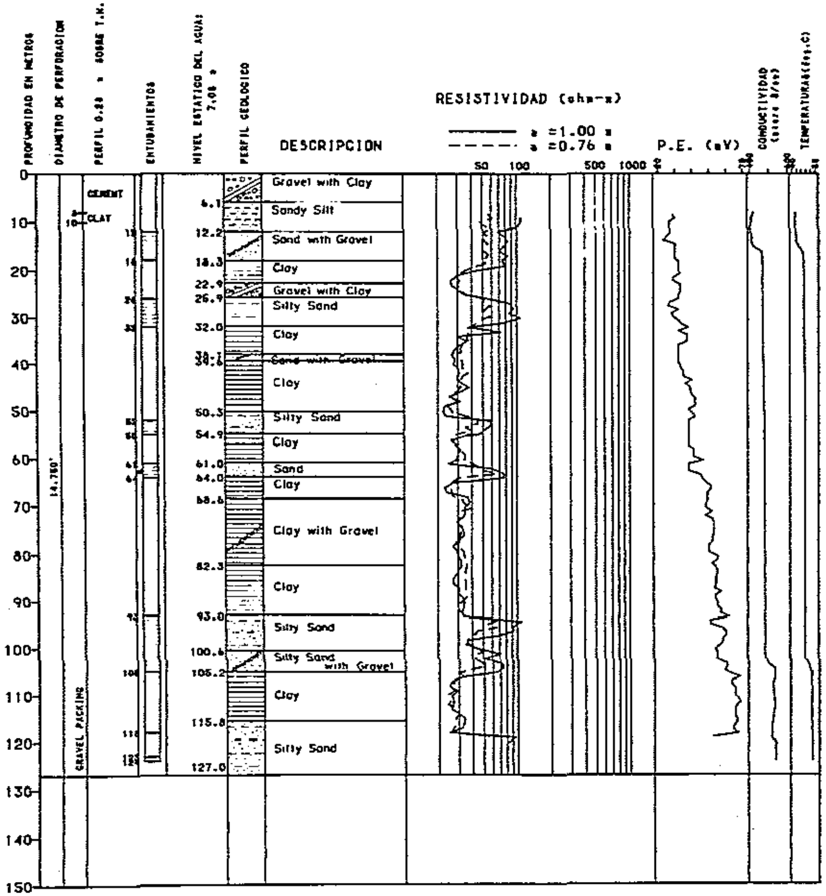
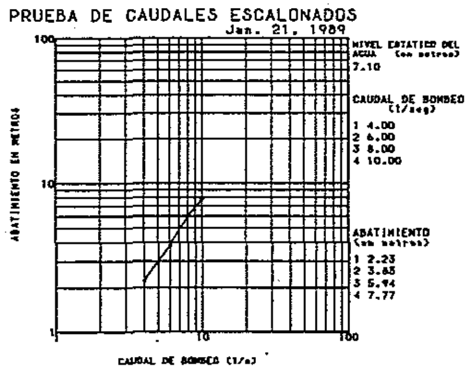
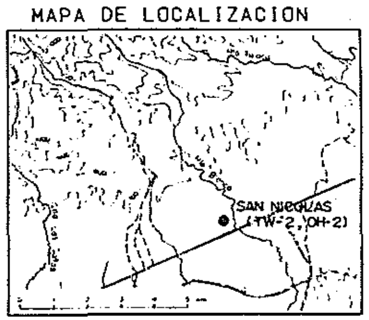


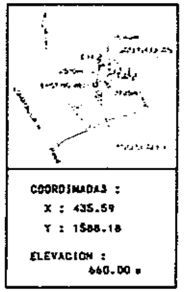
Fig. 2.5.1 WELL DRILLING RESULT (3)
- San Nicolas OH-02 -

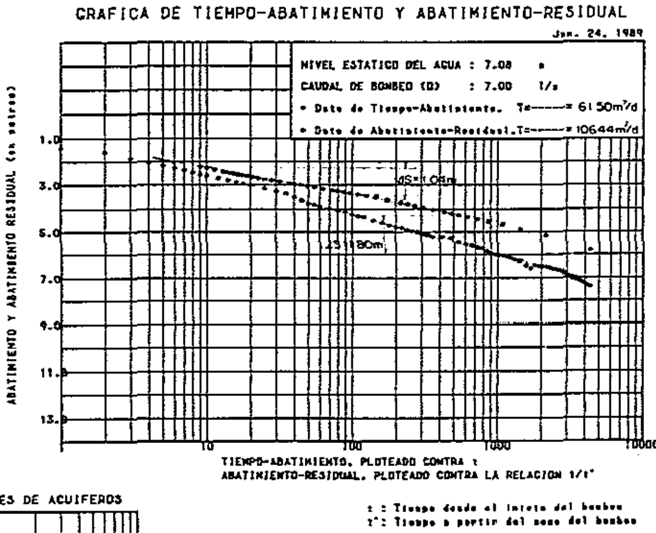
GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

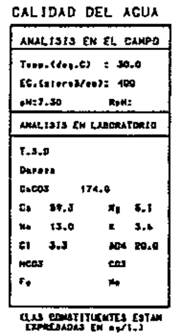


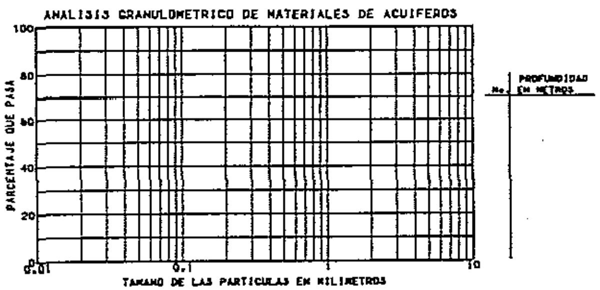












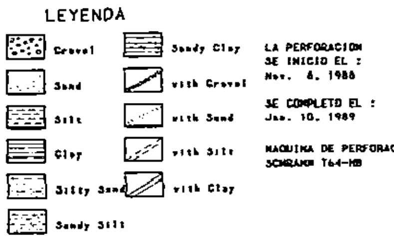
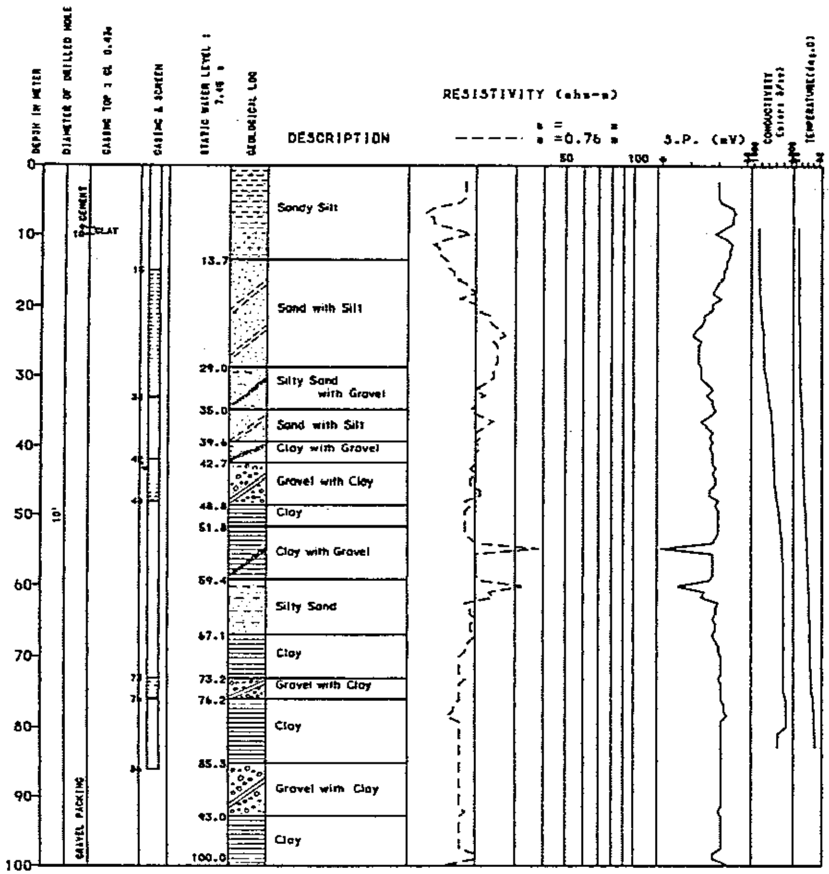
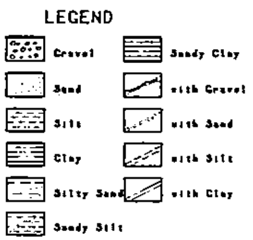


Fig. 2.5.1 WELL DRILLING RESULT (4)
- San Nicolas TW-02 -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

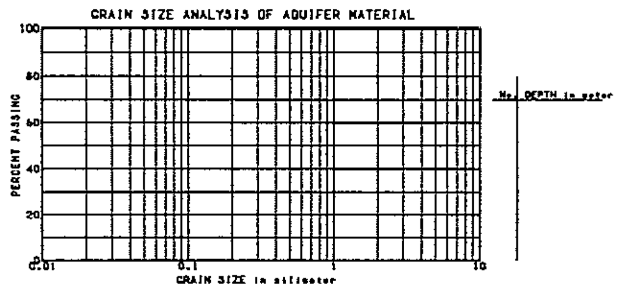


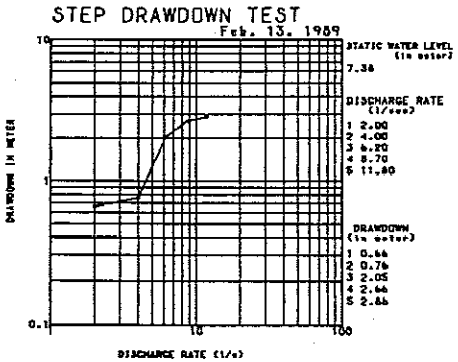


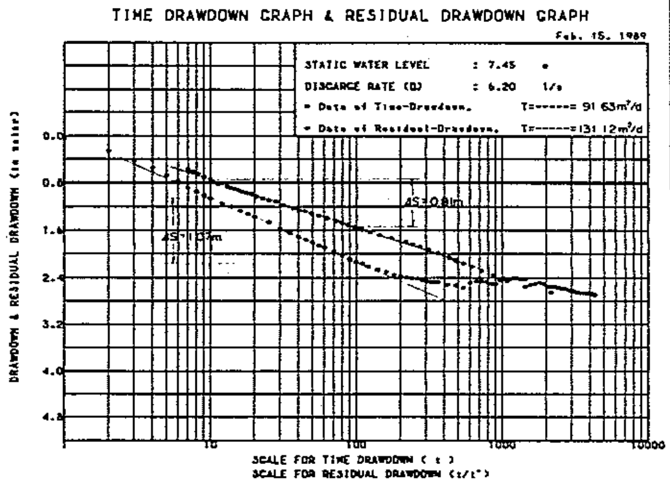
DRILLING STARTED ON Sep. 20, 1988

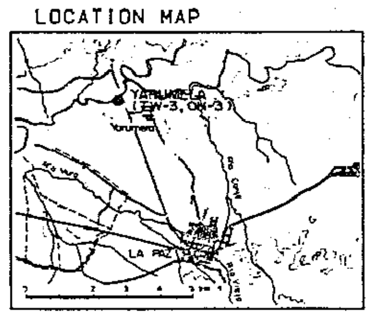
COMPLETED ON Oct. 5, 1988

DRILLING MACHINE SCHRAMM T64-HB









COORDINATION :
X : 430.94
Y : 1585.56

ELEVATION :
585.00 m

WATER QUALITY

IN-SITU TEST	
Temp.(deg.C) :	
EC.(micro S/cm):	
pH:	RpH:
LABORATORY TEST	
T.D.S	
Hardness	
CaCO3	
Ca	Mg
Na	K
Cl	SO4
HCO3	CO3
Fe	Mn

(CONCENTRATIONS ARE EXPRESSED IN mg/l)

Fig. 2.5.1 WELL DRILLING RESULT (5)
- Yarumela OH-03 -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

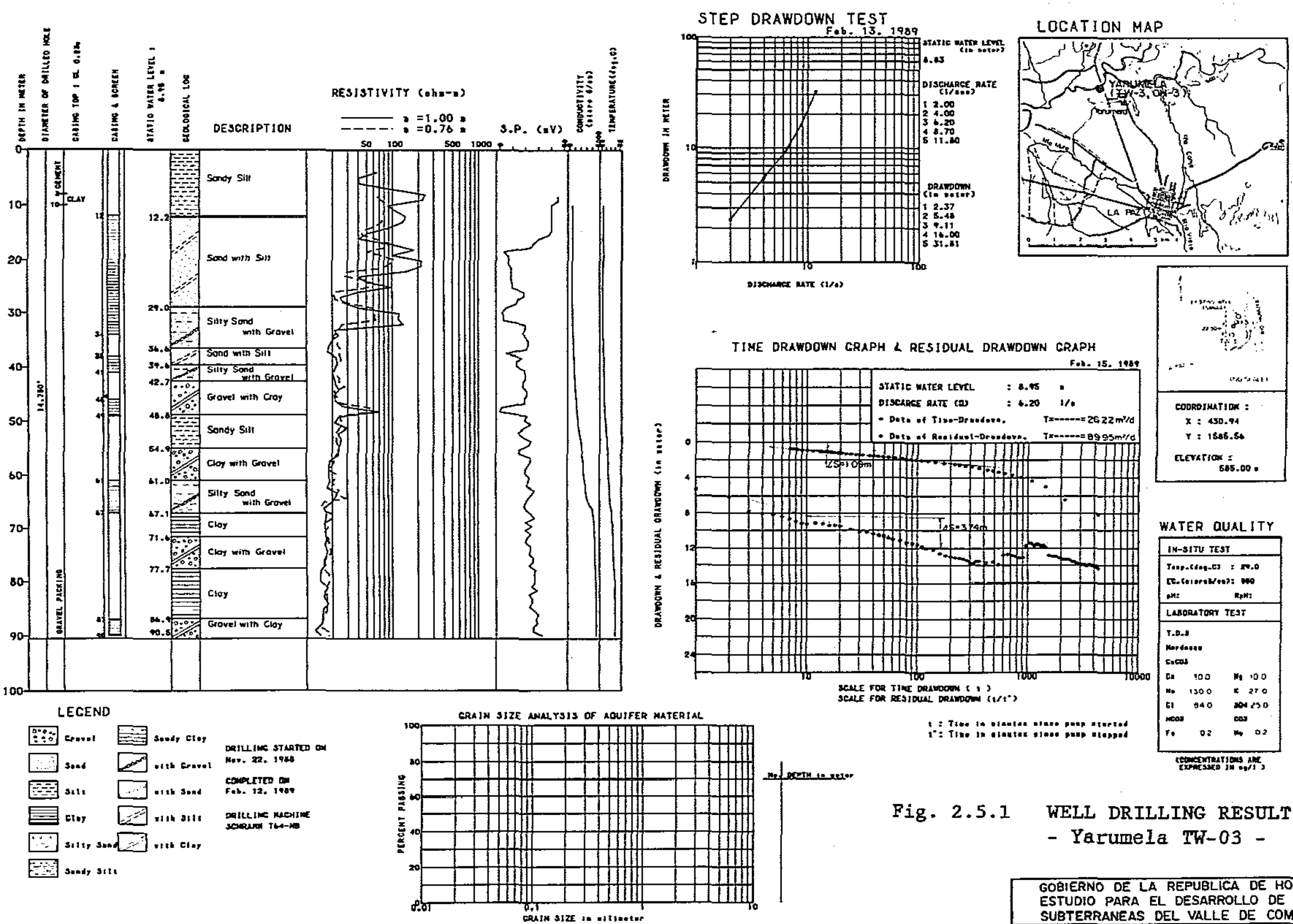


Fig. 2.5.1 WELL DRILLING RESULT (6)
- Yarumela TW-03 -

GOBIERNO DE LA REPUBLICA DE HONDURAS
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SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

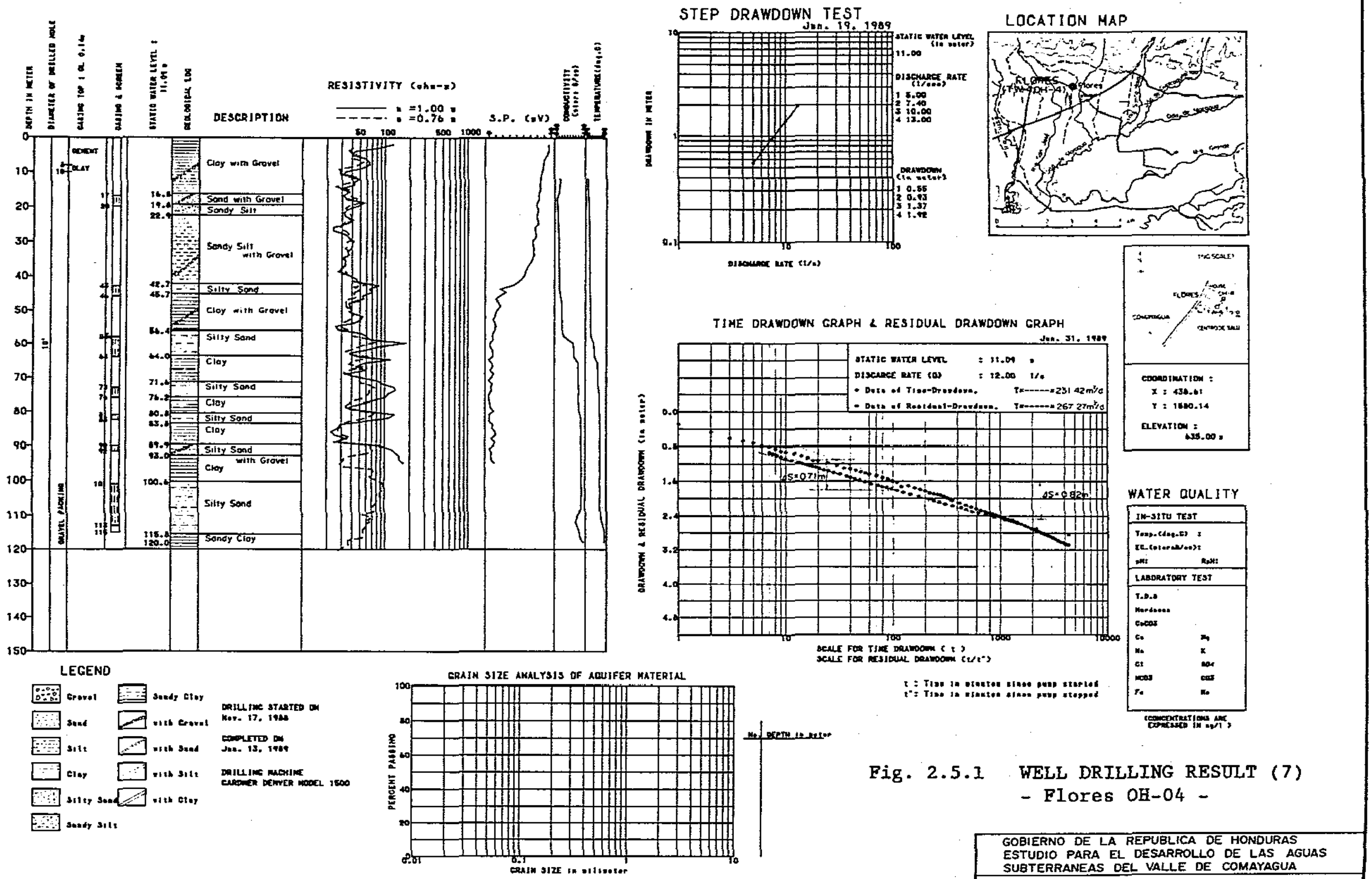

Fig. 2.5.1 WELL DRILLING RESULT (7)
- Flores OH-04 -

GOBIERNO DE LA REPUBLICA DE HONDURAS
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AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

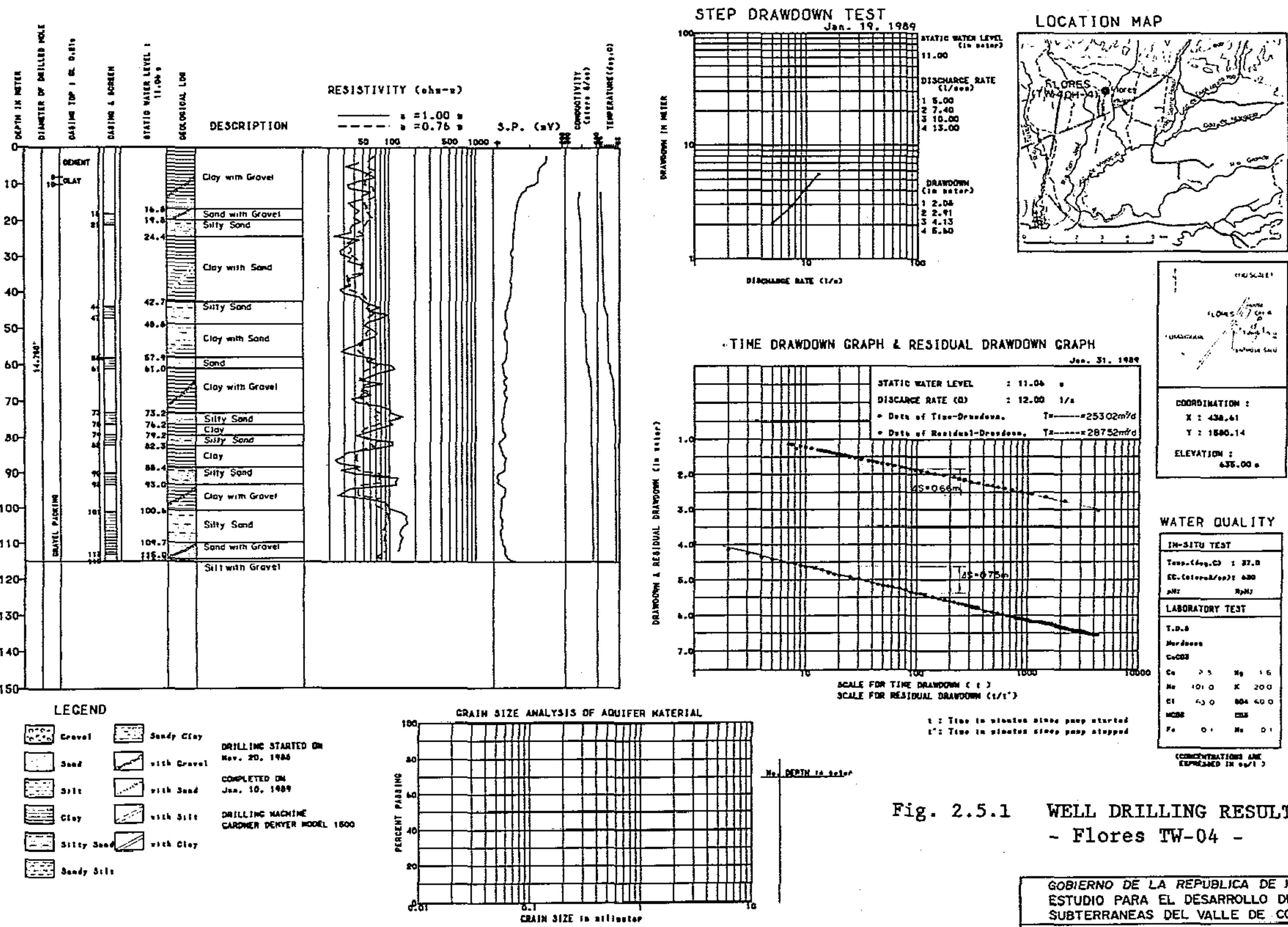

Fig. 2.5.1 WELL DRILLING RESULT (8)
- Flores TW-04 -

GOBIERNO DE LA REPUBLICA DE HONDURAS
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AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

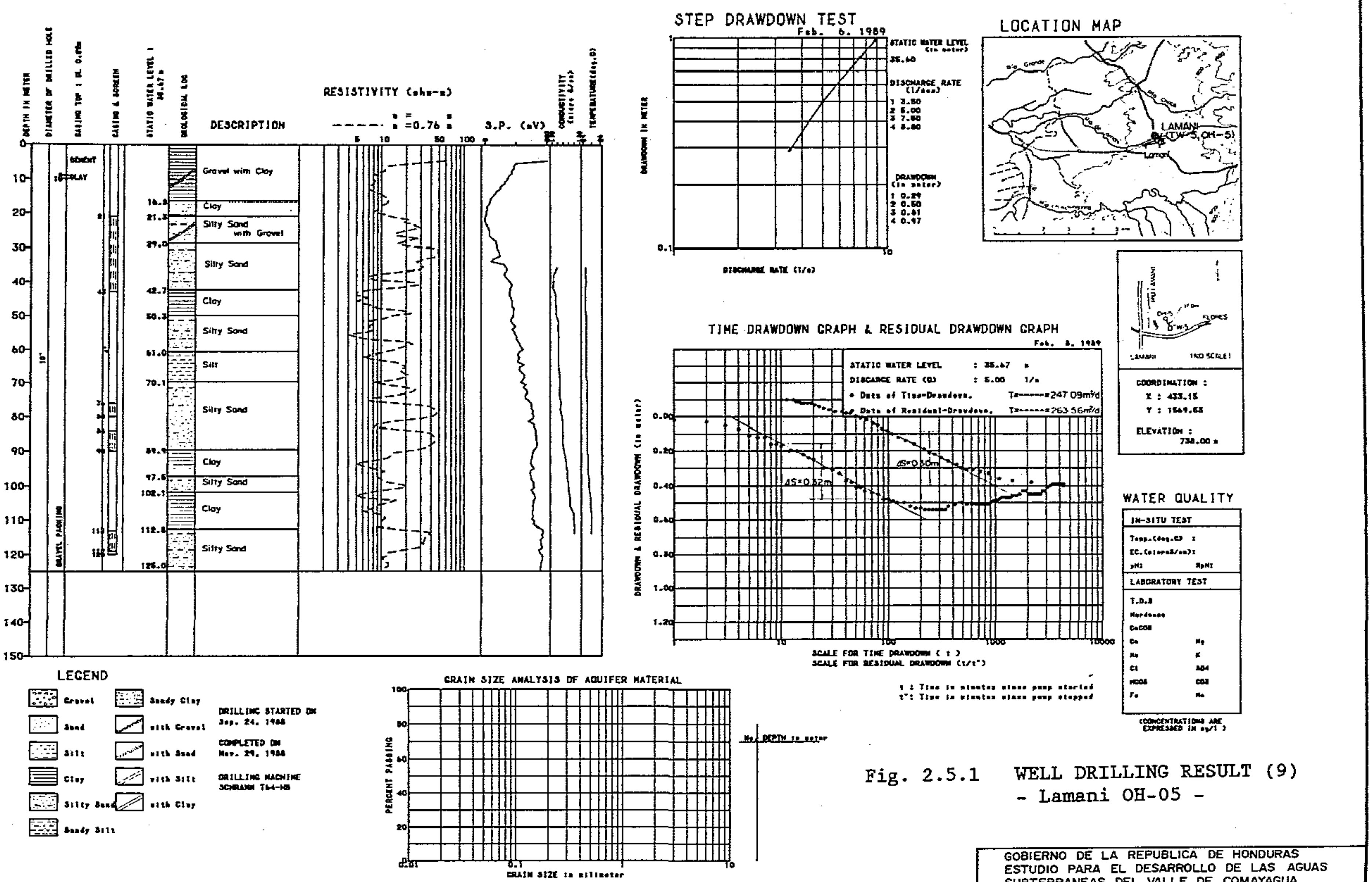

Fig. 2.5.1 WELL DRILLING RESULT (9)
- Lamani OH-05 -

GOBIERNO DE LA REPUBLICA DE HONDURAS
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AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

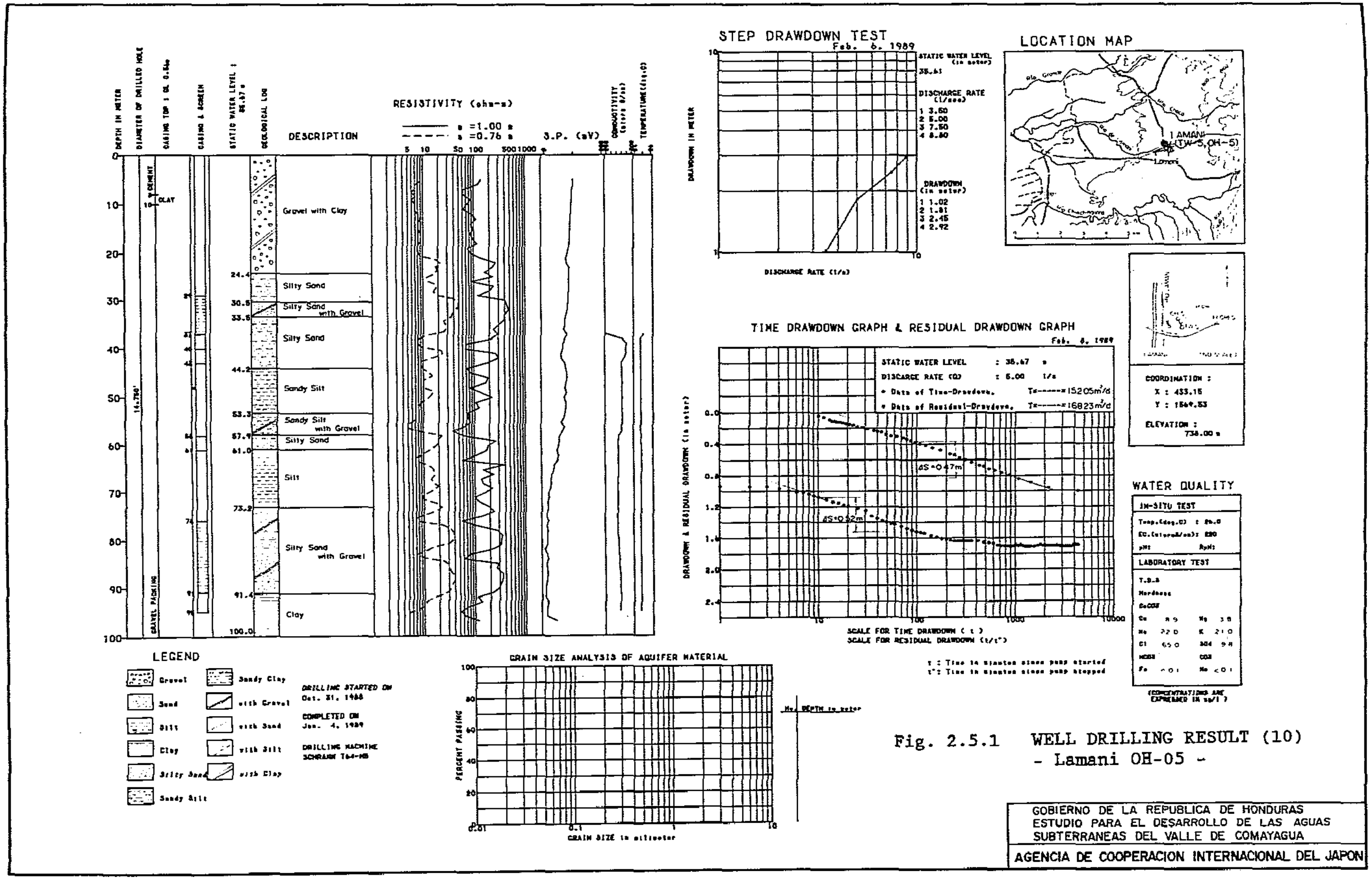


Fig. 2.5.1 WELL DRILLING RESULT (10)
- Lamani OH-05 -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

Annexes

ANNEX I TECHNICAL SPECIFICATION FOR TEST WELL DRILLING AND INSTALLATION OF TEMPORARY WATER SUPPLY FACILITIES

TABLE OF CONTENTS

LIST OF FIGURES

A. <u>TECHNICAL SPECIFICATION FOR WATER WELL DRILLING</u>

1. METHOD OF CARRYING OUT THE WORK

The Contractor shall submit to the JICA team for his approval a program of how he proposes to carry out the work. The program shall be submitted within 10 days from the date of signing the Contract. The field representative of the Contractor shall supervise the work thoroughly in order to ensure that the program submitted is strictly adhered to at all times.

2. JOB SITE

The Contractor shall propose a layout for his construction facilities, including an access road at each well site and shall stake out the area necessary for his work upon getting the JICA team's approval of the layout.

The Contractor will be provided with a site of 30 m x 20 m for a test well with a observation hole, along the existing road or passable square.

3. CONDUCTOR PIPE SETTING

Prior to drilling work, the conductor pipe shall be set vertically to a suitable depth to prevent the collapse of the surface soil and to accommodate mud water circulation.

4. METHOD OF DRILLING WORK

The Contractor shall drill a vertical hole of 14 inches in nominal diameter (N.D.) for a test well and 10 inches N.D. for a observation hole to the depth designated by the JICA team by means of ordinary rotary method and/or percussion method at his option. The depth of the test well and observation hole is not deeper than 130 m unless mutually agreed upon between the Contractor and the JICA team.

5. REAMING AND WASHING

Once the hole is opened to the depth instructed by the JICA team, the Contractor shall make a reaming run with a full gauge bit and/or hole opener to take out all obstruction for the installation of the casing and screen. Cutting slimes shall be removed by circulating drilling fluid, by operating the pump at full capacity in the case of ordinary rotary drilling, or using a sand bailer carefully in the case of the percussion method, until the sand bailer shall reach the bottom of the drilled hole smoothly without any obstruction.

6. ROCK SAMPLING

Typical cutting samples shall be taken and preserved at the site showing a record of the obtained depth every 2 meters. Samples shall not be less than 500 grams each, and shall be washed clean of drilling fluid but with little or no loss of formation material.

7. ELECTRIC LOGGING

Electrical logging shall be made prior to the installation of the casing and screen. Resistivity and spontaneous potential of the formation shall be measured, to decide the screen position, using the apparatus to be provided by the JICA team. The Contractor shall set the apparatus properly and sink the probe into the drilled hole. The JICA team will then receive the record of resistivity and spontaneous potential. The screen position shall be designated by the JICA team immediately after the interpretation.

8. PROPERTIES OF CASING AND SCREEN

The materials of steel pipe for casing and slotted pipe shall conform to the standard of ASTM. The wall thickness of the steel pipe of 8 inches N.D. shall be 0.250 inches and that of 4 inches N.D. shall be 0.125 inches.

The slot of 4 inch pipe shall not exceed 0.125 inches in width and shall have a opening ratio approximately 5 %. The screen to be fitted to 8 inch steel casing pipe shall be galvanized wire wrapped-type (Johnson type) 8 inch screen with slot of No. 60 (0.15 cm). The assembly of steel pipe and screen shall be connected tightly with coupling or electric welding.

The materials of unplasticized polyvinyl chloride (PVC) pipe for casing and slotted pipe shall conform to the standard of ASTM. The wall thickness of PVC pipe of 8 inches N.D. shall be 0.508 inches and that of 4 inches N.D. shall be 0.265 inches. The slot of the PVC pipe for screen shall not exceed 0.125 inches in width and shall have a opening ratio approximately 5%. The assembly of PVC pipe shall be connected tightly with coupling.

9. INSTALLATION OF CASING PIPE AND SCREEN

The Contractor shall install the assembly of casing pipe and screen specified under Clause 8 herein in the drilled hole. The screen shall be installed correctly to fit the aquifer which is indicated by the JICA team immediately after the interpretation of the result of the electrical logging. The assembly of casing pipe and screen of the test well shall be centralized through the drilled hole with centralizers. The installation of the assembly of the casing pipe and screen shall not be commenced before the gravel to be used is stored at the work site.

10. GRAVEL PACKING

The annular space between the assembly of casing pipe and screen and the wall of drilled hole shall be filled with gravel, which shall be clean, washed durable gravel composed of well rounded quartzitic or andesitic particles. Gravel to be used hereof shall be of a natural gradation ranging between the strict size limits of 4 mm and 8 mm in diameter. Gravel shall contain no limestone or other calciferous materials, no organic materials such as wood fragments and no lignite. Crushed rock or angular particles shall not be utilized as gravel envelope. The gravel envelope shall be a continuous medium completely filling the annular space between the assembly of casing pipe and screen and the wall of the drilled hole. Therefore, the volume of filled gravel is to be reasonably concordant with that of the annular space. Upper most part from gravel surface to a depth of 10 meters, the annular space shall be filled with clay and mortar as indicated in Fig. 2.

11. PLUMB AND ALIGNMENT

The drilled hole specified herein shall be plumb and straight to install the casing pipe and screen and to allow homogeneous gravel packing as specified in Clause 10 herein. No drastic change of the drilled hole shall be allowed. Improperly aligned screen and casing may become the cause of rejection of the tubewell. If the 8 inch casing of the test well can not contain the pump to the designated depth or if a bailer with approximately 4 inch diameter can not sink to the bottom of the assembly of casing and screen, the test well shall be abandoned.

12. DEVELOPMENT OF THE WELL

Once the gravel and the clay and/or mortar have been placed fully from the bottom of the well to land surface, the drilling fluid shall be completely flushed from the well by water. The test well shall be developed by cleaning and washing the screen using a nearly full filling bailer or suitable surging equipment, and by means of operating an air compressor of delivering 13 cubic meters per minute (450 CFM) through a double pipe at a sufficient depth relative to the screen position to simultaneously produce water from the tubewell. The observation hole shall be developed by means of operating an air compressor delivering 1.5 cubic meter per minute of air (53 CFM) through a pipe at a sufficient depth. Intermittent operation, 3 hours running and 1 hour idle time, will be recommended for effective development for a total 48 hours for each test well and 12 hours for each observation hole.

After the above-mentioned development work is completed, a suitable turbine pump or a submersible motor pump with a capacity of approximately 20 l/sec (300 GPM) shall be installed in a test well. The running test as a final development shall be carried out at almost full capacity for 12 hours.

13. STEP DRAWDOWN TEST

After an idle time of more than 12 hours since the stop of running test, the Contractor shall carry out the step drawdown test with 4 steps or a number of steps designated by JICA team. The Contractor shall measure the discharge rate at the test well with a V knotch or other suitable measure approved by JICA team, and water level changes of both the test well and the observation hole.

14. CONTINUOUS PUMPING TEST

After 24 hours idle time at least, the Contractor shall carry out the continuous pumping test under a constant pumping discharge at the rate designated by the JICA team for 72 hours at each test well. The discharge rate shall be measured by the Contractor at any time requested by the JICA team. Meantime, drawdown of water level in the test well and , if any, the observation hole shall be measured by the Contractor. If the pumping is discontinued by mechanical trouble or insufficient supply of fuels or lubricant within 72 hours, the Contractor shall resume the continuous pumping test after more than 12 hours idle time under the direction of the JICA team. Such pumping hours not satisfying the test shall not be compensated to the Contractor.

15. WELL CAP AND FOUNDATION

Upon satisfactory completion of the test well and observation hole, a concrete made foundation shall be made by the Contractor. The size of foundation is 1.7m x 1.5m x 0.1m for each observation hole and 1.0m x 1.0m x 0.1m for each test well. The test well shall have a cap with a lock to prevent the entrance of foreign material into the well and to be suitable for periodical water level observation. The test hole and observation hole shall have a cap in each.

16. SITE RESTORATION

Upon completion of the work at the site, the Contractor shall remove all his rigs, equipment, remaining materials, debris, huts and buildings and restore the site as nearly as possible to its original condition, excluding the completed well and fittings to be left at the site.

17. ABANDONMENT OF THE TUBEWELL

In the event that the contractor shall fail to sink the well to the depth specified in this Specifications, or to such depth as ordered in writing by the JICA team, or in case the well has to be abandoned because of loss of tools or for any other causes, the Contractor shall, if requested and/or directed by the JICA team, fill the abandoned hole with clay or other materials at his own expense. In the case that the screen and casing of the well can not be properly aligned, the well shall be abandoned.

18. RECORD AND REPORT

The field representative of the Contractor shall be in close contact with the JICA team to report the progress of the work. The field representative shall always report in writing to the JICA team more than 24 hours in advance of the commencement of electric logging, pump test, assembly of casing and screen, etc., required to be approved by the JICA team.

It is required to offer a simple daily report for each hole and well including the progress of drilling depth, brief description of lithology, etc. The field representative shall collect all daily reports from the drillers and summarize them within 1 or 2 days. The recording sheets will be provided by the JICA team.

B. <u>TECHNICAL SPECIFICATION OF WATER SUPPLY SYSTEM</u>

1. SUBMERSIBLE MOTOR PUMP

The Contractor shall provide (five) sets of the newly manufactured submersible motor pump with a discharge capacity of 5 liters per second, total pumping head of 30 meters for three sets and 60 meters for two sets operated with electric power available in Comayagua, including a proper switch system, discharge pipes, valves accessories and spare parts needed for the pumping operation. The Contractor shall submit the document on the submersible motor pump for the approval of JICA team within 10 days after the signing of the Contract, describing the name of manufacturer, the actual capacity, the technical specification, the operation manual and other necessary explanation.

2. INSTALLATION OF THE SUBMERSIBLE MOTOR PUMP

The Contractor shall install the submersible motor pump approved by JICA team into a successful testwell as shown on Fig. 3 "INSTALLATION OF SUBMERSIBLE MOTOR PUMP AND HAND PUMP". The discharge pipe, check valve and the submersible pump shall be connected tightly and placed on the foundation properly. The switch system shall be contained in a watertight box equipped on a boad.

3. HAND PUMP

The Contractor shall provide and installed a hand pump on each observation hole after the completion of the test hole as shown on Fig. 3. The Contractor shall submit the document on the hand pump for the approval of JICA team within 10 days after signing of the Contract.

4. OPERATION TEST

After the installation of the submersible motor pump, the Contractor shall execute the operation test for more then two hours by using a electric power generator in order to verify the capacity. In this case the Contractor shall measure the discharge rate and drawdown of the pumping water level. When the pumping capacity differs from the specified capacity more then 20 presents, such a submersible motor pump shall be changed to another newly manufactured submersible motor pump at the Contractor's own cost.

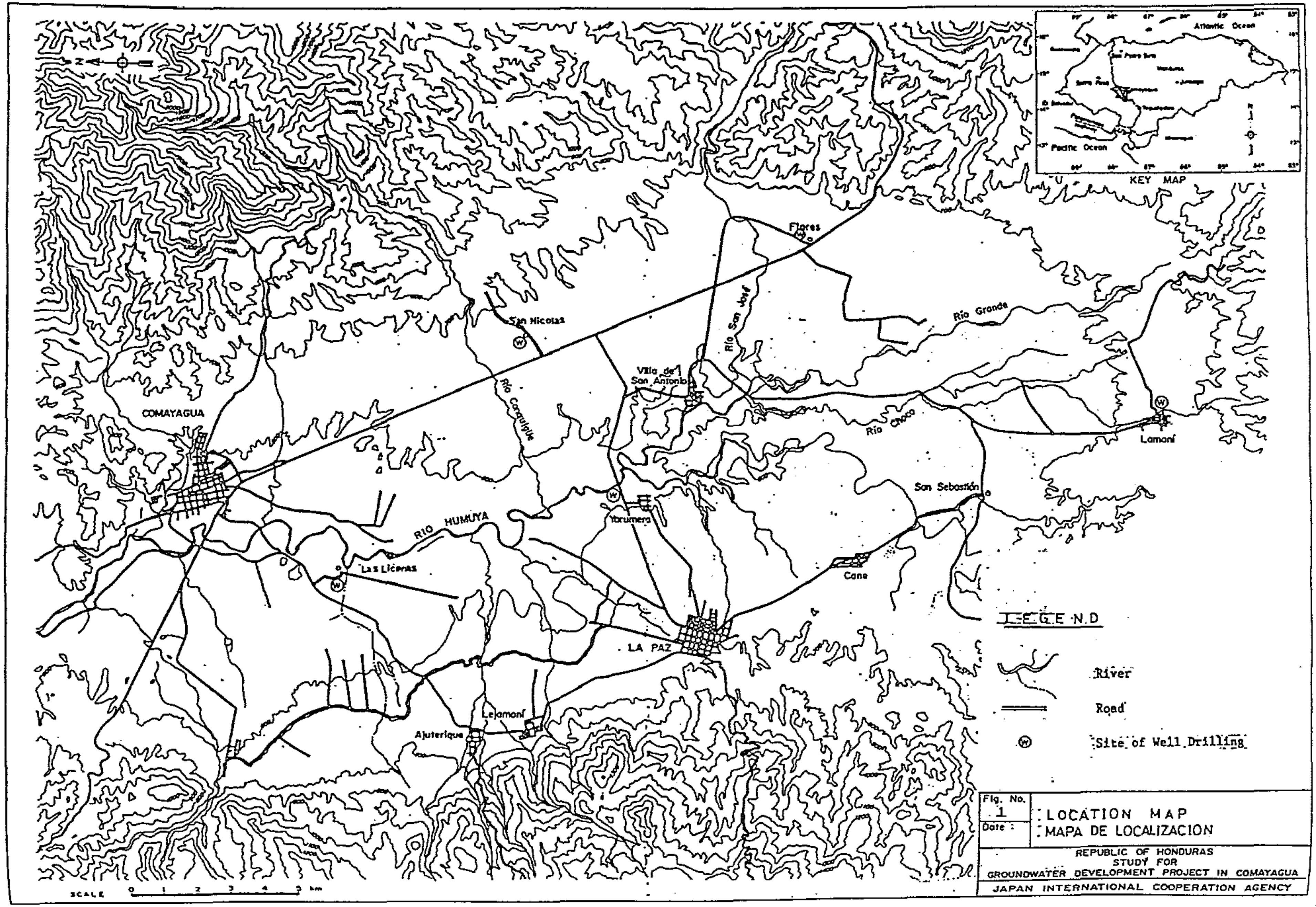
The hand pump is tested by actual use.

5. INSTALLATION OF WATER TANK

The water tank shall be constructed as specified hereinafter and shown on Fig. 4 "INSTALLATION OF WATER TANK".

The materials of steel water tank shall conform to the standard of ASTM. The steel plate and the steel angle materials shall conform to SS41.

The concrete base shall be of the reinforced concrete as shown on Fig. 4. The concrete work shall be conducted after submitting work schedule for the approval of JICA team within 10 days after the signing of the Contract.


Atlantic Ocean
Pacific Ocean
KEY MAP
COMAYAGUA
San Nicolas
Río Canquigüe
Villa de San Antonio
Río San José
Flores
Río Grande
Río Choco
Lamaní
San Sebastián
RIO HUMUYA
Yarumera
Las Liceras
Cane
LA PAZ
Lejamaní
Ajuterique
LEGEND
River
Road
Site of Well Drilling
SCALE 0 1 2 3 4 5 km
Fig. No. 1
Date :
LOCATION MAP
MAPA DE LOCALIZACION
REPUBLIC OF HONDURAS
STUDY FOR
GROUNDWATER DEVELOPMENT PROJECT IN COMAYAGUA
JAPAN INTERNATIONAL COOPERATION AGENCY

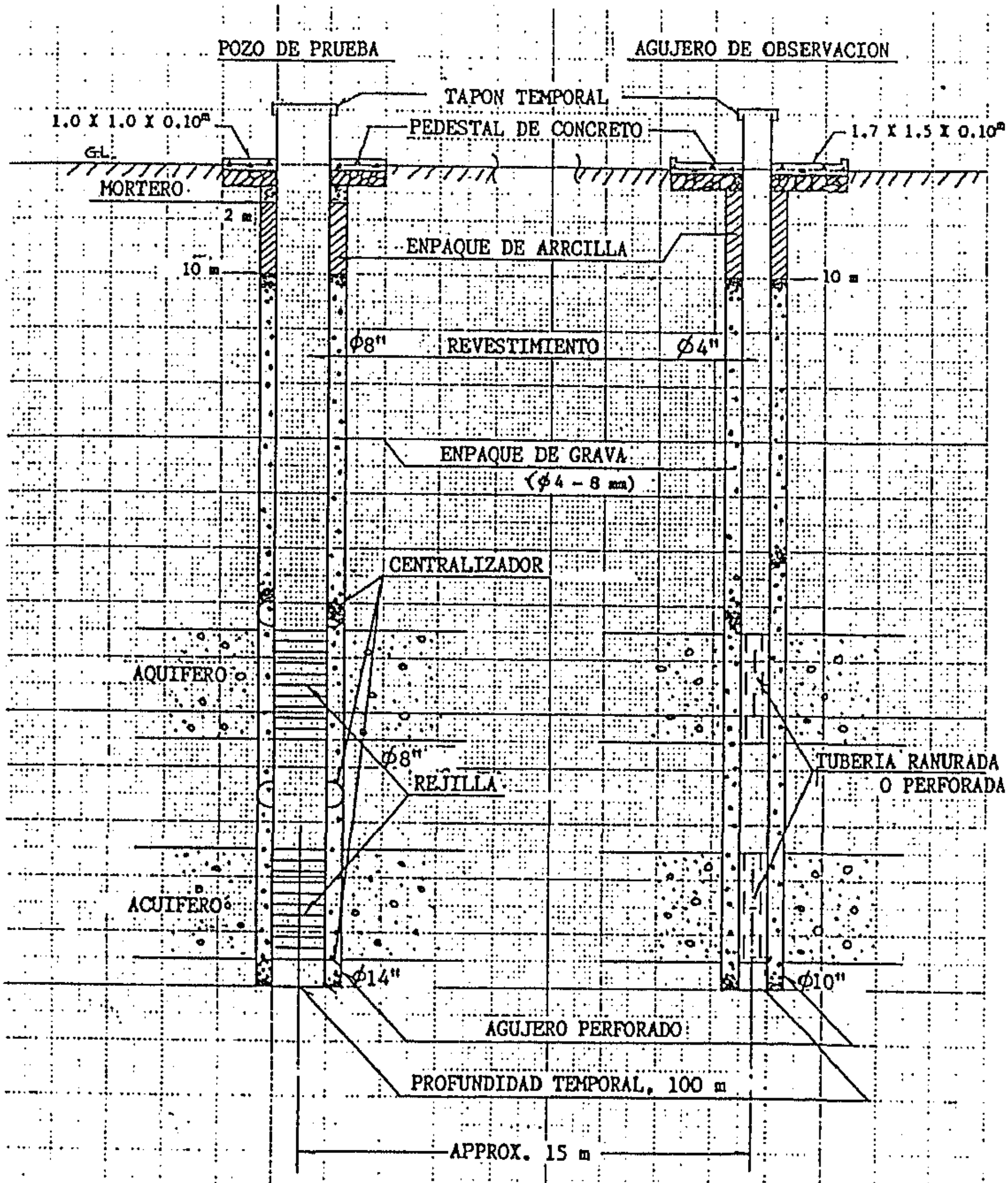


Fig. 2 PLAN OF DRILLING WORK

Fig. 2 PLAN DE LOS TRABAJOS DE PERFORACION

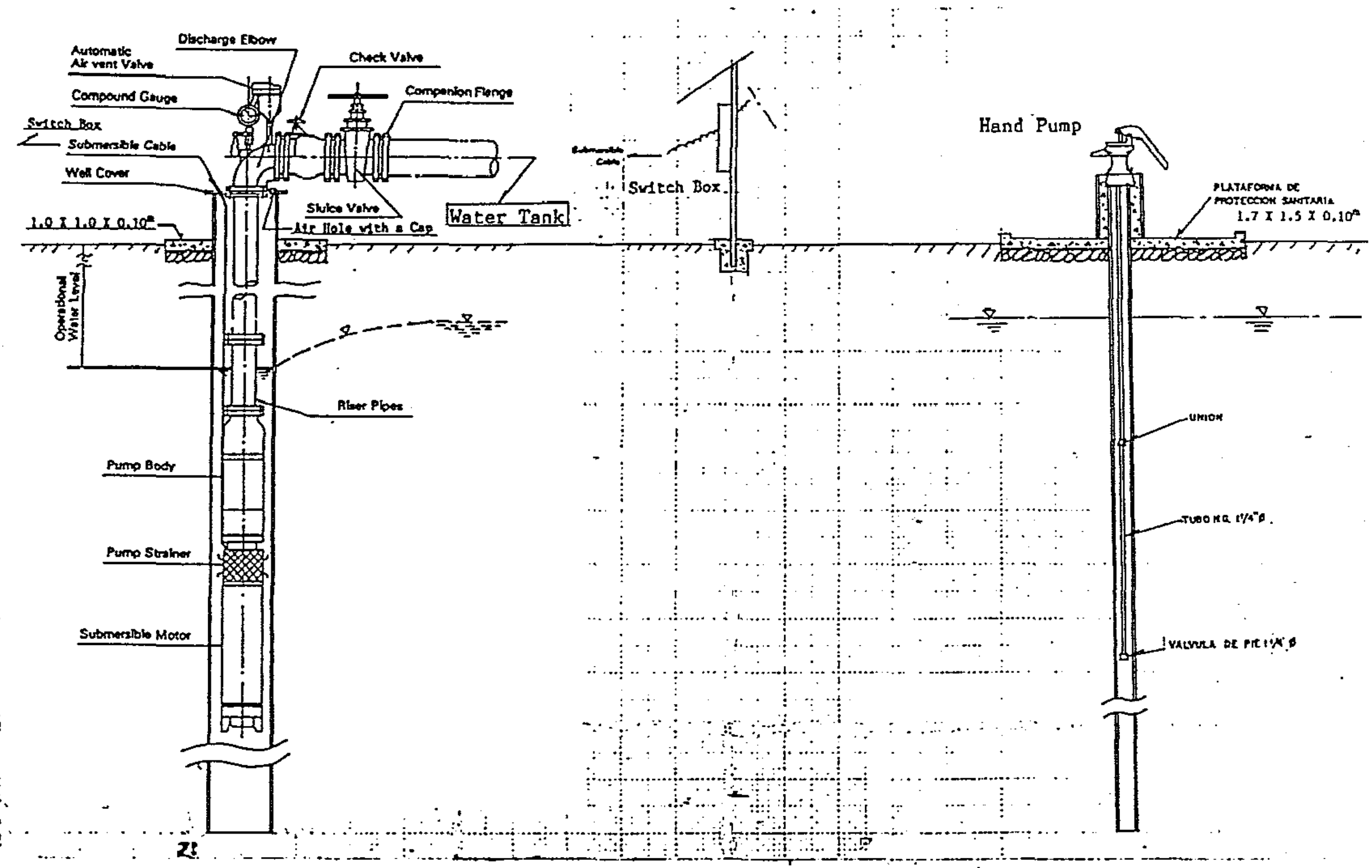


Fig. 3 INSTALLATION OF SUBMERSIBLE MOTOR PUMP AND HAND PUMP

Fig. 3 INSTALACION DE BOMBA DE MOTOR SUMERGIBLE Y BOMBA DE MANO

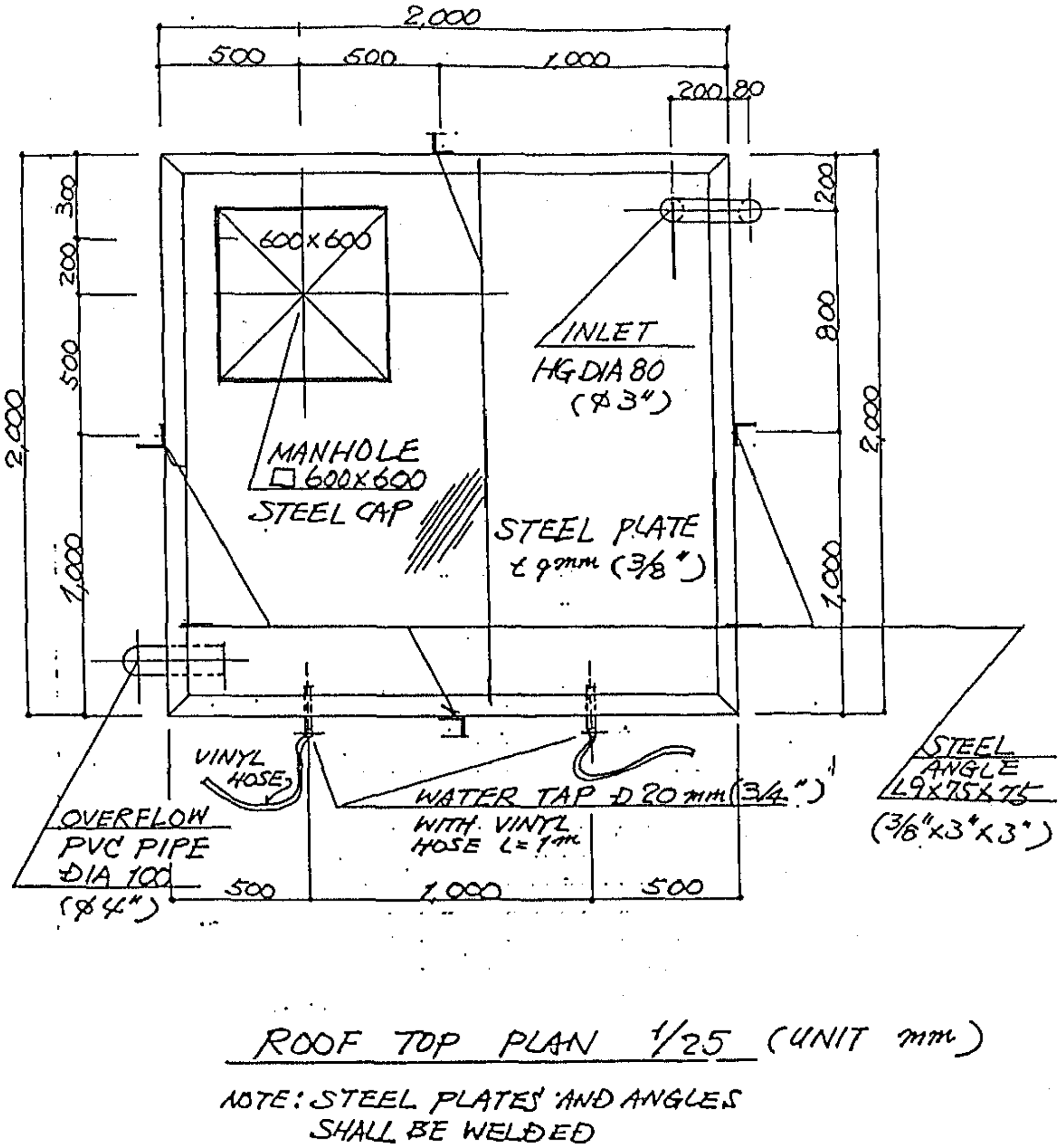


Fig. 4.1 INSTALLATION OF WATER TANK - ROOF TOP PLAN -

Fig. 4.1 INSTALACION DE TANQUE DE AGUA - VISTA EN PLANTA -

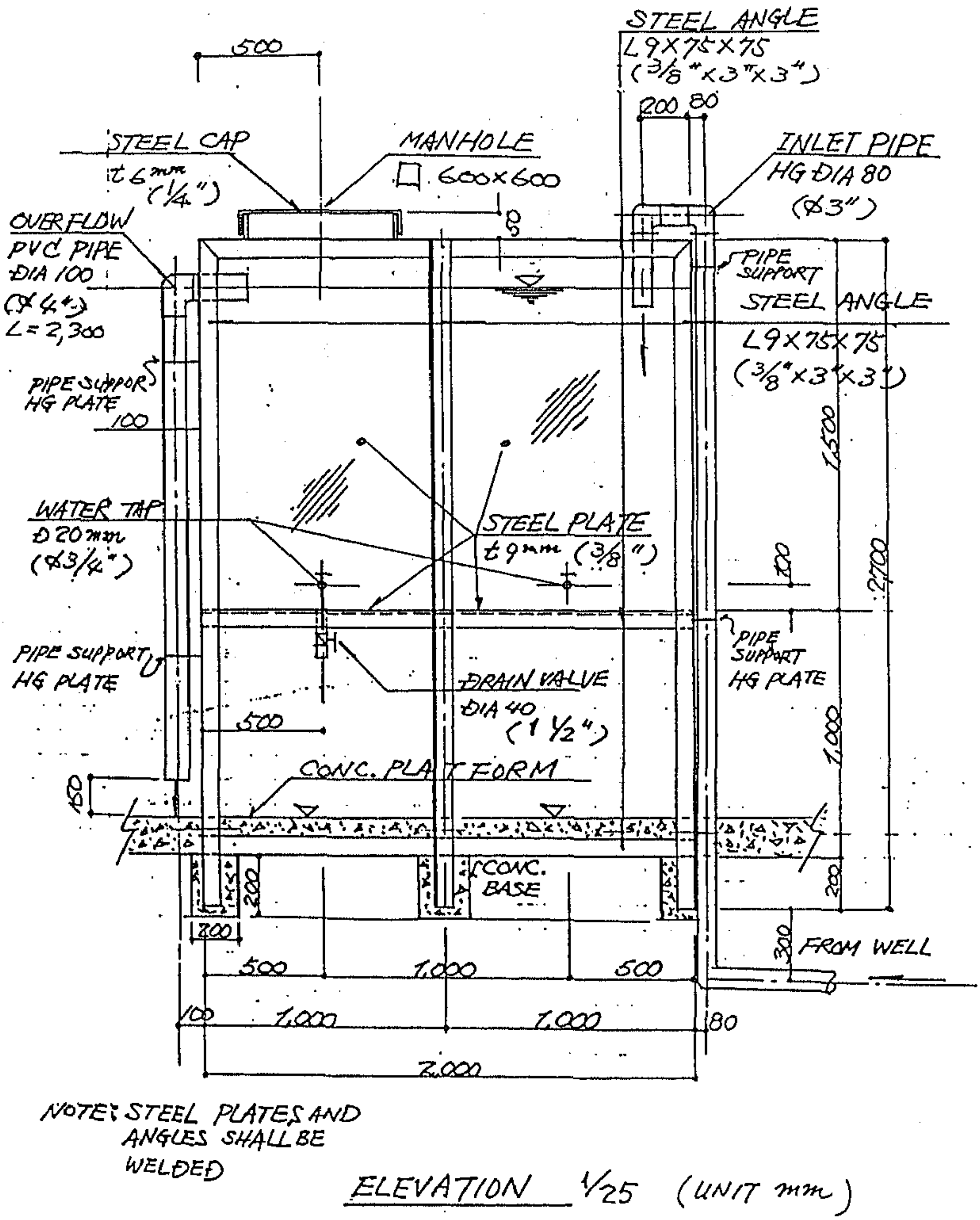
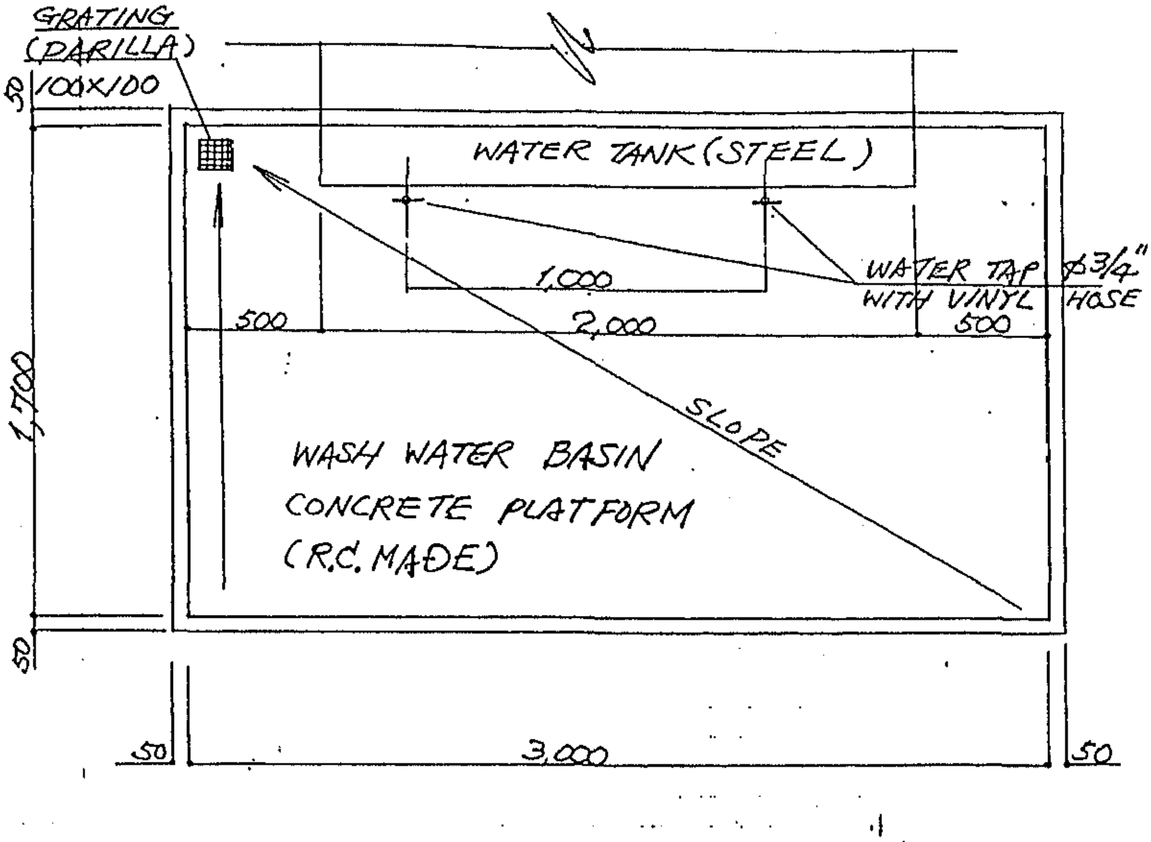


Fig. 4.2 INSTALLATION OF WATER TANK - ELEVATION -

Fig. 4.2 INSTALACION DE TANQUE DE AGUA - ELEVACION -



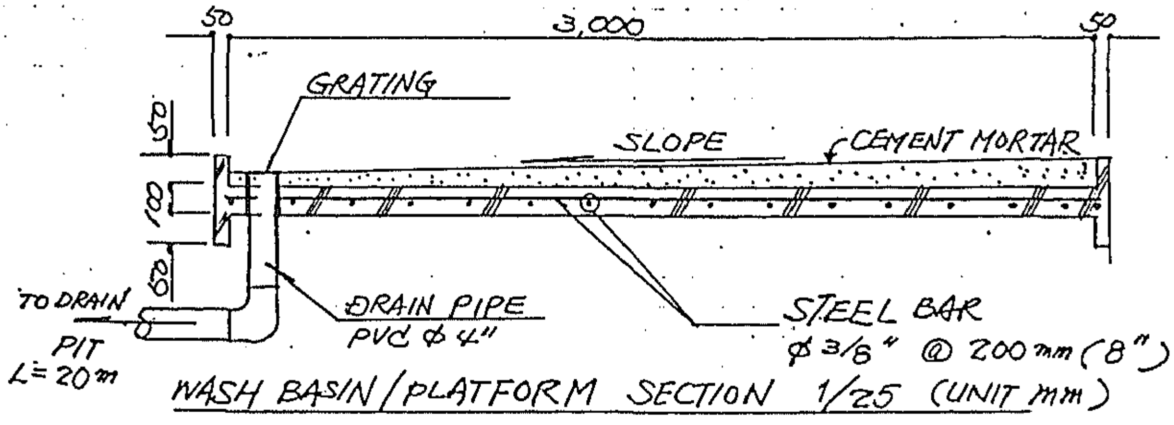


Fig. 4.3 INSTALLATION OF WATER TANK - WASH BASIN/PLATFORM SECTION -

Fig. 4.3 INSTALACION DE TANQUE DE AGUA - SECCION DE SUPERFICIE DE LAVADO -

MEMORANDUM DATED SEPTEMBER 6, 1988

DATE : September 6, 1988

MEMORANDUM

FOR

TESTWELL DRILLING AND PUMPTESTS

ON

THE STUDY FOR GROUNDWATER DEVELOPMENT PROJECT

IN COMAYAGUA

I. JICA Study Team on the Study for Groundwater Development Project in Comayagua (hereinafter called JICA Team) and HIDROSISTEMAS, S. DE C.V. (hereinafter called HIDROSISTEMAS) agreed on the contents of the "Contract for Testwell Drilling and Pumptests" after the discussion.

II. JICA Team and HIDROSISTEMAS agreed on the following addendum to the Technical Specifications of the Contract Documents.

2.1 STEP DRAWDOWN TEST

The step drawdown test under each different discharge shall be continued for two hours. The Contractor shall measure the drawdown of the test well and also the drawdown of the observation hole at an interval of 5 minutes for the first 30 minutes after the test is started, and an interval of 10 minutes thereafter.

2.2 CONTINUOUS PUMPING TEST

The Contractor shall measure the drawdown of the water levels in both the testwell and the observation hole at the following time interval during 72 hours.

Time from the Beginning	Time Interval of Measurement
0 to 10 minutes	1 minute
10 to 20 minutes	2 minutes
20 to 60 minutes	5 minutes
1 to 2 hours	10 minutes
2 to 6 hours	20 minutes
6 to 24 hours	1 hour
24 to 48 hours	2 hours
48 to 72 hours	3 hours

The Contractor shall measure the recovering of water levels with the same time interval after the pumping is stopped until water levels recover to the original water levels, or for a period of twelve (12) hours, in both the testwell and the observation hole.

2.3 SHOP/WORK DRAWINGS OF WATER SUPPLY SYSTEM

a. The Contractor shall furnish to the Engineer for review two (2) copies each of any shop/work drawings necessitated in the progress of the work as specified or directed by the Engineer, such drawings shall be submitted along with necessary calculations and specifications for approval by the Engineer.

After receipt of said shop/work drawings, the Engineer will return one copy of each drawing to the Contractor with his comments noted thereon.

b. If the drawing is returned to the Contractor marked "APPROVED", revision of said drawing will not be required and the Contractor shall immediately submit three (3) additional copies to the Engineer for his records.

c. If the drawing is returned to the Contractor marked "MAKE CORRECTIONS NOTED", the Contractor shall revise the drawings and submit three (3) additional copies to the Engineer for his records.

d. If the drawing is returned to the Contractor marked "AMEND AND RE-SUBMIT" or "REJECTED", the Contractor shall revise the drawings and submit two (2) copies of said revised drawings to the Engineer for further review. One copy will be returned to the Contractor with the Engineer's comments noted thereon.

e. No work shall be commenced on any part of the work for which the shop/work drawing was submitted, before the Engineer has reviewed the shop/work drawings and returned copies to the Contractor marked "APPROVED".

f. Revisions indicated on shop/work drawings shall be considered as changes necessary to meet the requirement of the Specifications and shall not be taken as the basis of claims for extra work. The Contractor has no claims for extension of time due to any delay resulting from making required revisions to shop/work drawings. The review of said drawings by the Engineer shall apply to the general design only and shall in no way relieve the Contractor of responsibility for errors or omissions contained therein nor shall such review operate to waive or modify any provision or requirement contained in these Contract Specifications.

2.4 PROTECTIVE COATING OF WATER SUPPLY SYSTEM

All equipment shall be finished up by protective coating. Coating shall conform to the coating schedule described below. Nonferrous and corrosion-resisting steel surfaces need not be coated by any material other than grease or lubricating oil. As a guide to the application of the various coating systems, the following lists shall apply, unless otherwise specified.

Service Condition	Paint Type
Surface Preparation	Blast
Primer	Alkyd resin
Intermediate Coat	Alkyd resin
Finish Coat	Alkyd resin

III. HIDROSISTEMAS agreed on the cooperation in the electric conductivity and water temperature logging in the test well which will be carried out by JICA Team in 24 hours or less after the pumping tests.

IV. JICA Team and HIDROSISTEMAS agreed on the presentation of the guarantee bond effective for six (6) months against the advance payment.

V. JICA Team and HIDROSISTEMAS agreed on such procedure that the refund of the advance payment shall be made in two times in the same amount and at the same time when monthly progress payments of the second and third months can be made. JICA Team will return the guarantee bond to HIDROSISTEMAS immediately after the refund of the advance payment is made by HIDROSISTEMAS. In case the monthly progress payment is not payable, that is, the amount after subtraction of the retention is insufficient for the refund of the advance payment, the return shall be postponed by the next month.

The return of the performance bond to HIDROSISTEMAS shall be made immediately after issue of a completion certificate of the contracted works to be prepared by JICA Team in accordance with Article 10.6.

Mr. M. Saito
Acting Leader of JICA Team

Ing. Carlos Irias Peralta
Gerente de HIDROSISTEMAS

Ing. Juan Rafael Delcid
Jefe de Contraparte Proyect
Honduras-Gob. Japon

ANNEX II EVALUATION RESULT OF LOCAL CONTRACTORS

EVALUATION CHART OF PREQUALIFICATION FOR WELL DRILLING AND PUMPTEST ON STUDY FOR GROUNDWATER DEVELOPMENT PROJECT IN COMAYAGUA

For; HIDROSYSTEMAS, S. DE R. L. DE C. V.

NO.	SUMMARY ITEMS	Point	
1.	Experience	(13)	15%
2.	Personnel	(14)	15%
3.	Equipment and Schedule	(28)	35%
4.	Financial Status	(12)	15%
5.	Others	(20)	20%
	Total Points	(87)	100%

NO.	BREAKDOWN OF IMPORTANT ITEM (1); Experience	Point	
1-1	Water well drilling in Honduras	(30)	40%
1-2	Water well drilling in project area	(50)	50%
1-3	Drilling techniqe assessment	(5)	10%
	Total Points	(85)	100%

NO.	BREAKDOWN OF IMPORTANT ITEM (2); Personnel	Point	
2-1	Project manager	(50)	50%
2-2	Drilling engineer	(40)	50%
	Total Points	(90)	100%

NO.	BREAKDOWN OF IMPORTANT ITEM (3); Equipment & Schedule	Point	
3-1	Rigs	(30)	30%
3-2	Drilling tools (bid, rod, collar, etc)	(5)	10%
3-3	Casing (with welding and slotting tool)	(0)	5%
3-4	Test pumps	(10)	10%
3-5	Vehicles and caravan	(5)	10%
3-6	Communication	(0)	5%
3-7	Work schedule	(30)	30%
	Total Points	(80)	100%

NO.	BREAKDOWN OF IMPORTANT ITEM (4); Financial Status	Point	
4-1	Total evaluation of capital, current ratio, debt ratio and working founds ets.	(80)	100%

NO.	BREAKDOWN OF IMPORTANT ITEM (5); Others	Point	
5-1	Reputations (by SANAA; Water supply office)	(50)	50%
5-2	Conditions of warehouse	(10)	10%
5-3	Delivery of documents	(10)	10%
5-4	Joint venture	(15)	15%
5-5	Current work load	(15)	15%
	Total Points	(100)	100%

EVALUATION CHART OF PREQUALIFICATION FOR WELL DRILLING AND PUMPTEST ON STUDY FOR GROUNDWATER DEVELOPMENT PROJECT IN COMAYAGUA

For; AGROCONSULT, S. A. DE C.V.

NO.	SUMMARY ITEMS	Point	
1.	Experience	(8)	15%
2.	Personnel	(14)	15%
3.	Equipment and Schedule	(25)	35%
4.	Financial Status	(15)	15%
5.	Others	(12)	20%
	Total Points	(74)	100%

NO.	BREAKDOWN OF IMPORTANT ITEM (1); Experience	Point	
1-1	Water well drilling in Honduras	(40)	40%
1-2	Water well drilling in project area	(0)	50%
1-3	Drilling techniqe assessment	(10)	10%
	Total Points	(50)	100%

NO.	BREAKDOWN OF IMPORTANT ITEM (2); Personnel	Point	
2-1	Project manager	(40)	50%
2-2	Drilling engineer	(50)	50%
	Total Points	(90)	100%

NO.	BREAKDOWN OF IMPORTANT ITEM (3); Equipment & Schedule	Point	
3-1	Rigs	(25)	30%
3-2	Drilling tools (bid, rod, collar, etc)	(10)	10%
3-3	Casing (with welding and slotting tool)	(5)	5%
3-4	Test pumps	(5)	10%
3-5	Vehicles and caravan	(10)	10%
3-6	Communication	(5)	5%
3-7	Work schedule	(10)	30%
	Total Points	(70)	100%

NO.	BREAKDOWN OF IMPORTANT ITEM (4); Financial Status	Point	
4-1	Total evaluation of capital, current ratio, debt ratio and working founds ets.	(100)	100%

NO.	BREAKDOWN OF IMPORTANT ITEM (5); Others	Point	
5-1	Reputations (by SANAA; Water supply office)	(45)	50%
5-2	Conditions of warehouse	(0)	10%
5-3	Delivery of documents	(0)	10%
5-4	Joint venture	(5)	15%
5-5	Current work load	(10)	15%
	Total Points	(60)	100%

ANNEX III LIST OF CONTRACT PRICES

LISTA DE PRECIOS

No.	DESCRIPCION	UNIDAD	CANTI DAD	PRECIO UNITARIO (LPS)	TOTAL (LPS)
1.	TRANSPORTE				
1.1	TRANSPORTE DESDE EL SITIO DE ORIGEN HASTA EL PROYECTO (IDA Y REGRESO)	GLOBAL	1	7,500.00	7,500.00
1.2	TRANSPORTE DESDE EL PROYECTO A LOS SITIOS DE PERFORACION	C/U	5	1,250.00	6,250.00
2.	PERFORACION				
2.1	PERFORACION 10"	m.l.	500	165.00	82,500.00
2.2	PERFORACION 14"	m.l.	500	230.00	115,000.00
3.	INSTALACION DE TURBERIA DE REVESTI MIENTO REJILLA Y GRAVA.				
3.1	TURBERIA DE REVESTIMIENTO DE ACERO DE 4" DE DIAMETRO.	m.l.	210	120.00	25,200.00
3.2	REJILLA DE ACERO DE 4" DE DIAMETRO (RANURADA)	m.l.	90	140.00	12,600.00
3.3	TUBERIA DE REVESTIMIENTO DE P.V.C. DE 4" DE DIAMETRO	m.l.	140	80.00	11,200.00
3.4	REJILLA DE P.V.C. DE 4" DE DIAMETRO (RANURADA O PERFORADA)	m.l.	60	100.00	6,000.00
3.5	TUBERIA DE REVESTIMIENTO DE ACERO DE 8" DE DIAMETRO	m.l.	210	260.00	54,600.00
3.6	REJILLA DE ALAMBRE REVESTIDO DE 8" DE DIAMETRO (TIPO JOHNSON No.60)	m.l.	90	925.00	83,250.00
3.7	TUBERIA DE REVESTIMIENTO DE P.V.C. DE 8" DE DIAMETRO.	m.l.	140	150.00	21,000.00
3.8	REJILLA DE P.V.C. DE 8" DE DIAMETRO (RANURADA)	m.l.	60	170.00	10,200.00
4.	REGISTROS ELECTRICOS	C/U	10	375.00	3,750.00
5.	DESARROLLO				
5.1	COMPRENSOR DE AIRE Y PISTON	C/U	5	6,000.00	30,000.00
5.2	COMPRESOR DE AIRE	C/U	5	1,500.00	7,500.00
5.3	DE BOMBA (ADICIONAL)	C/U	5	1,800.00	9,000.00

May 10. 1988

May 10 - 1988

10 de Mayo/88

LISTA DE PRECIOS

No.	DESCRIPCION	UNIDAD	CANTIDAD	PRECIO UNITARIO (LPS)	TOTAL (LPS)
6.	PRUEBAS DE BOMBA				
6.1	ABATIMIENTO DE POZOS	C/U	5	1,200.00	6,000.00
6.2	PRUEBAS DE BOMBEO CONTINUO	C/U	5	7,200.00	36,000.00
6.3	OBSERVACION DE LA RECUPERACION	C/U	5	750.00	3,750.00
7.	TAPADO TEMPORAL DEL POZO Y DE LA CIMENTACION.	C/U	10	450.00	4,500.00
8.	INSTALACIONES DE BOMBA				
8.1	SUMINISTRO DE BOMBA DE MOTOR SUMERGIBLE; TH=30 O 60 m, Q=5 l/sec	C/U	5	9,750.00	48,750.00
8.2	MONTAJE E INSTALACION DE LA BOMBA INCLUYENDO EL SISTEMA DE CIRCUITO	C/U	5	6,250.00	31,250.00
8.3	SUMINISTRO E INSTALACION DE BOMBAS DE MANO	C/U	5	1,050.00	5,250.00
9.	INSTALACION DE TANQUE DE AGUA				
9.1	TRABAJOS DE BASAMENTO	C/U	5	1,500.00	7,500.00
9.2	MONTAJE DEL TANQUE DE AGUA INCLUYENDO SOLDADURA, PINTURA Y TRABAJOS ACCESORIOS	C/U	5	5,000.00	25,000.00
9.3	CONECCION DE LA TUBERIA, DESDE EL POZO AL TANQUE	C/U	5	1,000.00	5,000.00
9.4	OBRAS AFINES Y MISCELANEAS	C/U	5	750.00	3,750.00
	SUB - TOTAL				662,300.00
10.	GASTOS GENERALES	%	5		33,100.00
	TOTAL (LPS)				695,400.00
	TOTAL (DOLARES U.S.A)				347,700.00

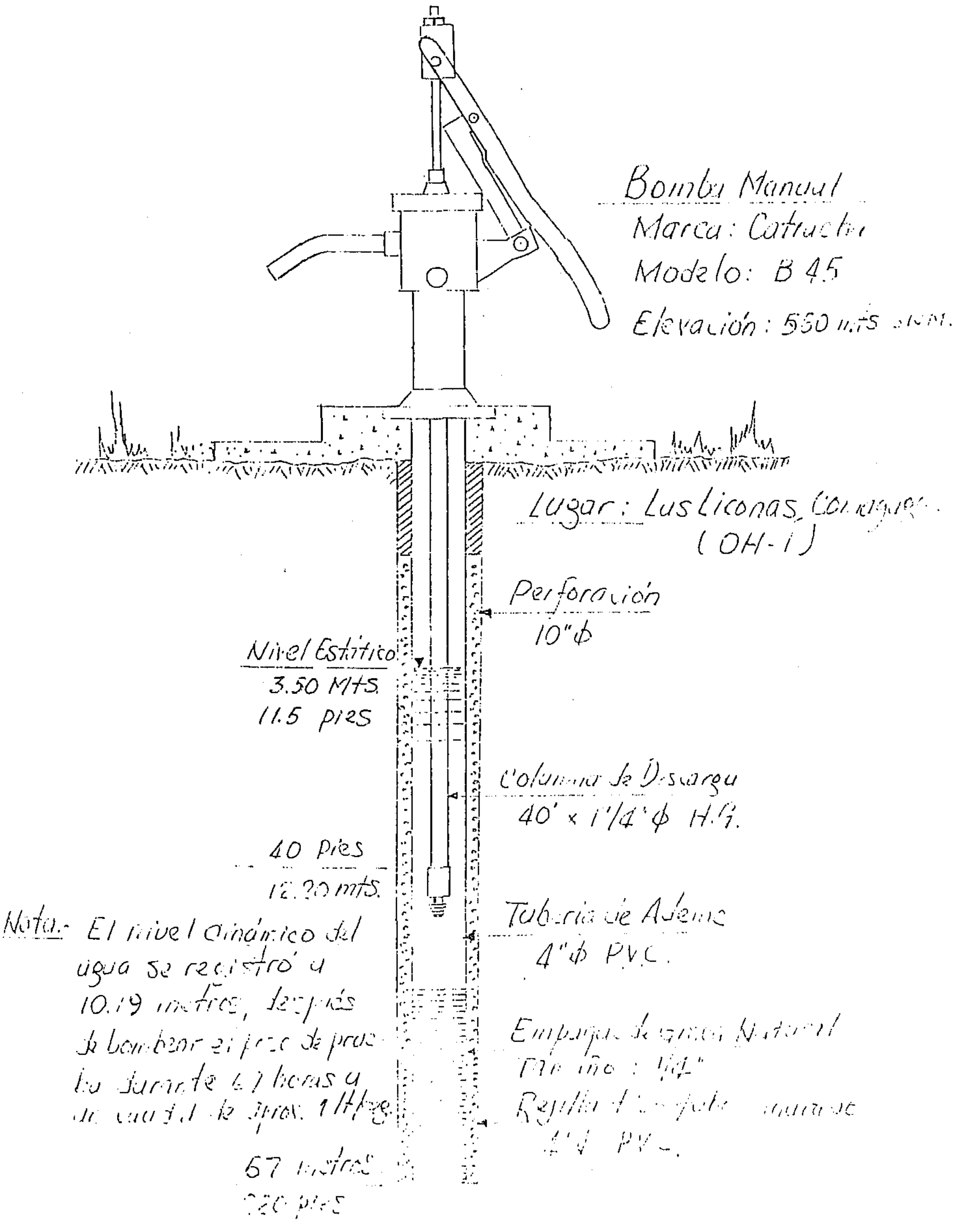
1.00$ U.S.A. = LPS. 2.00

N. Moyauto May 10, 1988

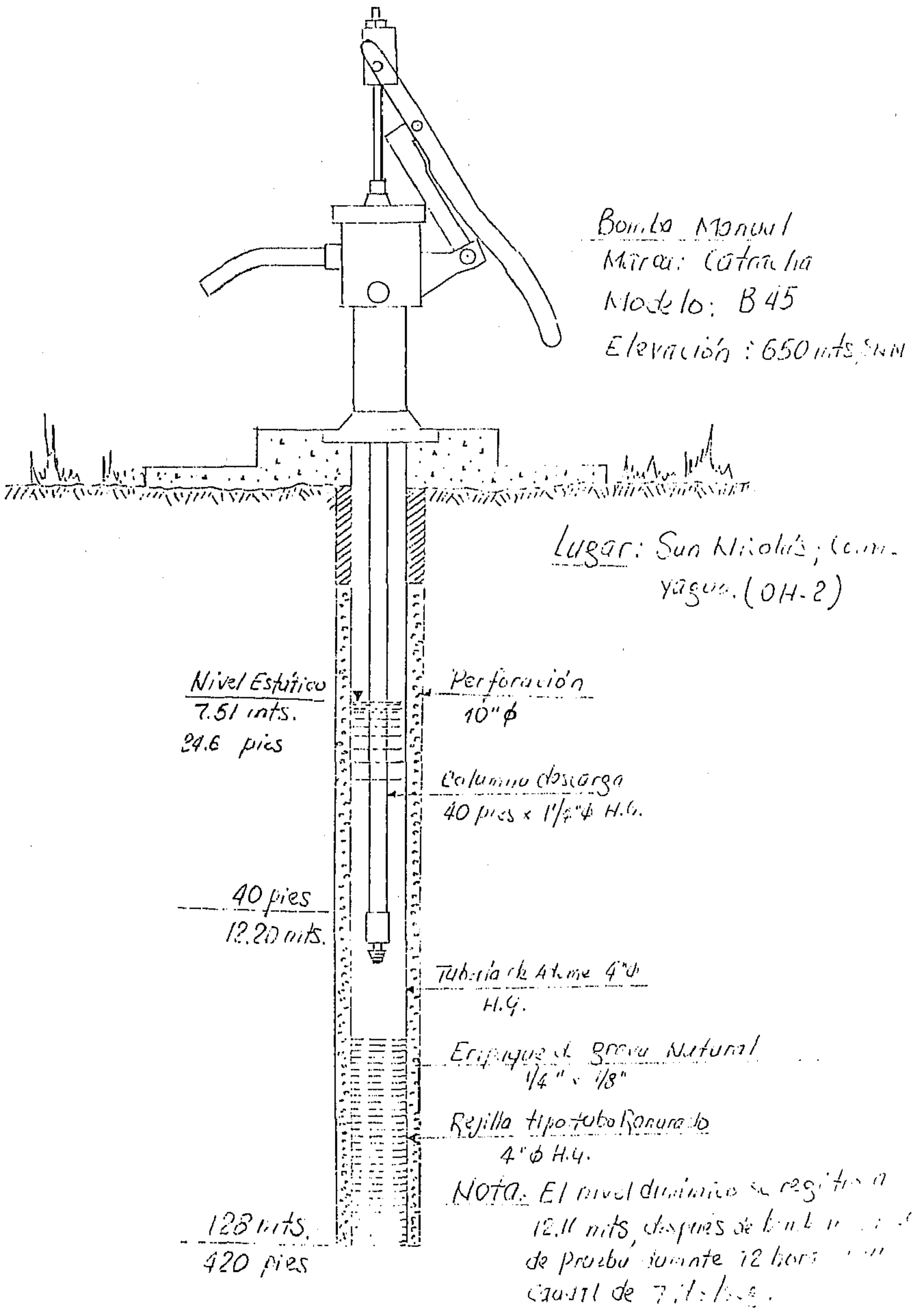
May-10-1988

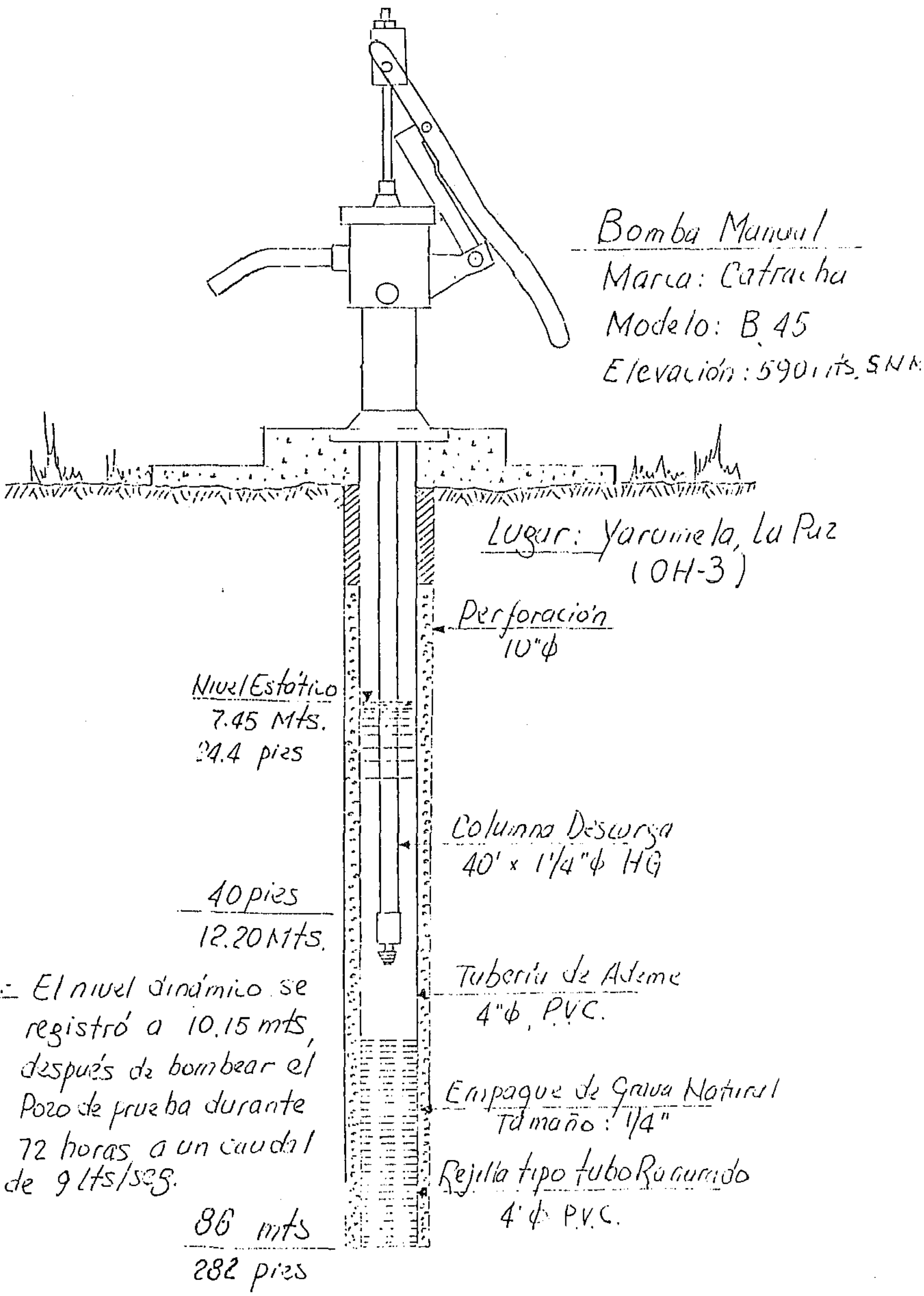
10 de Mayo/88

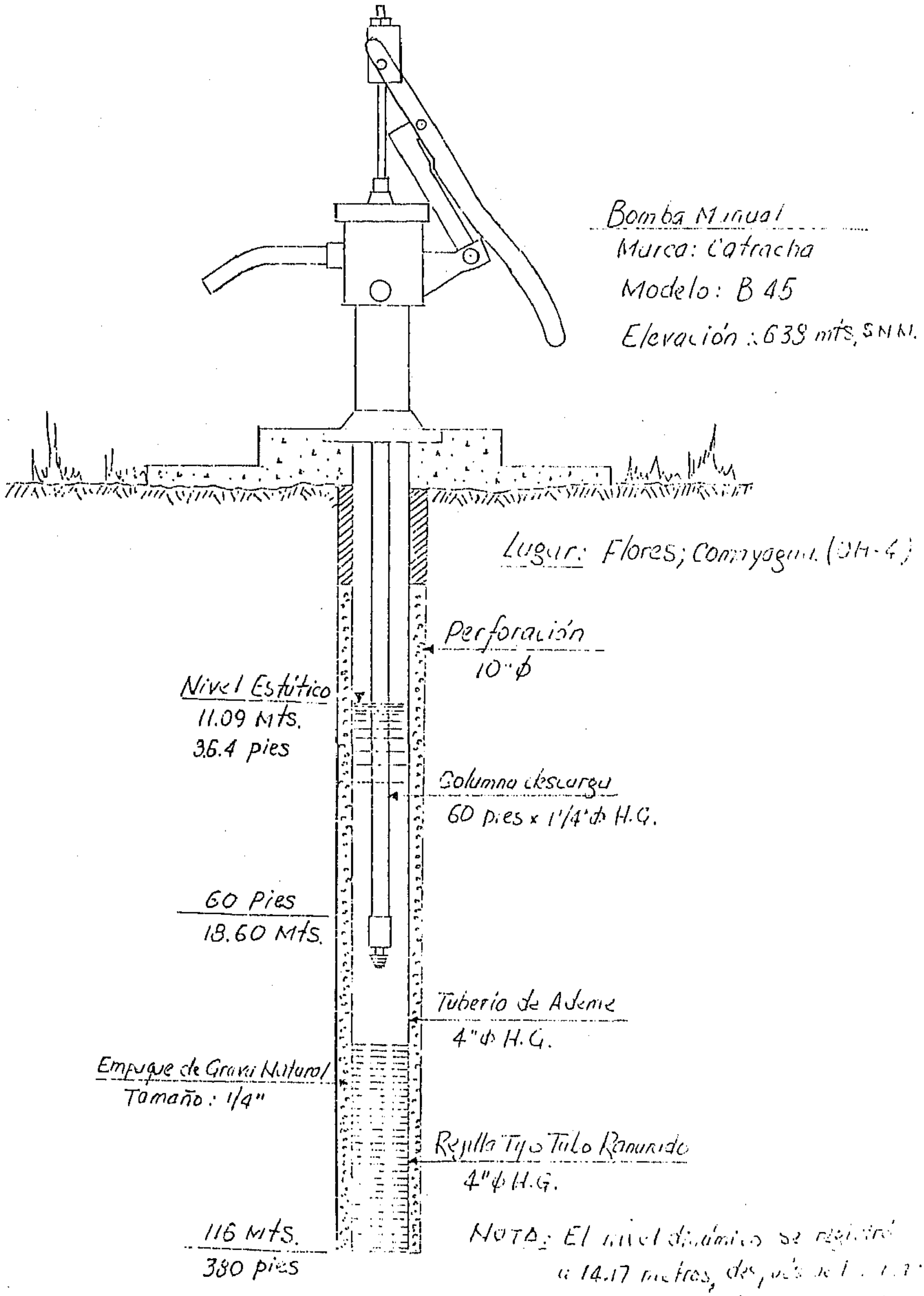
ANNEX IV SPECIFICATION OF PUMPS FOR TEMPORARY WATER SUPPLY FACILITI



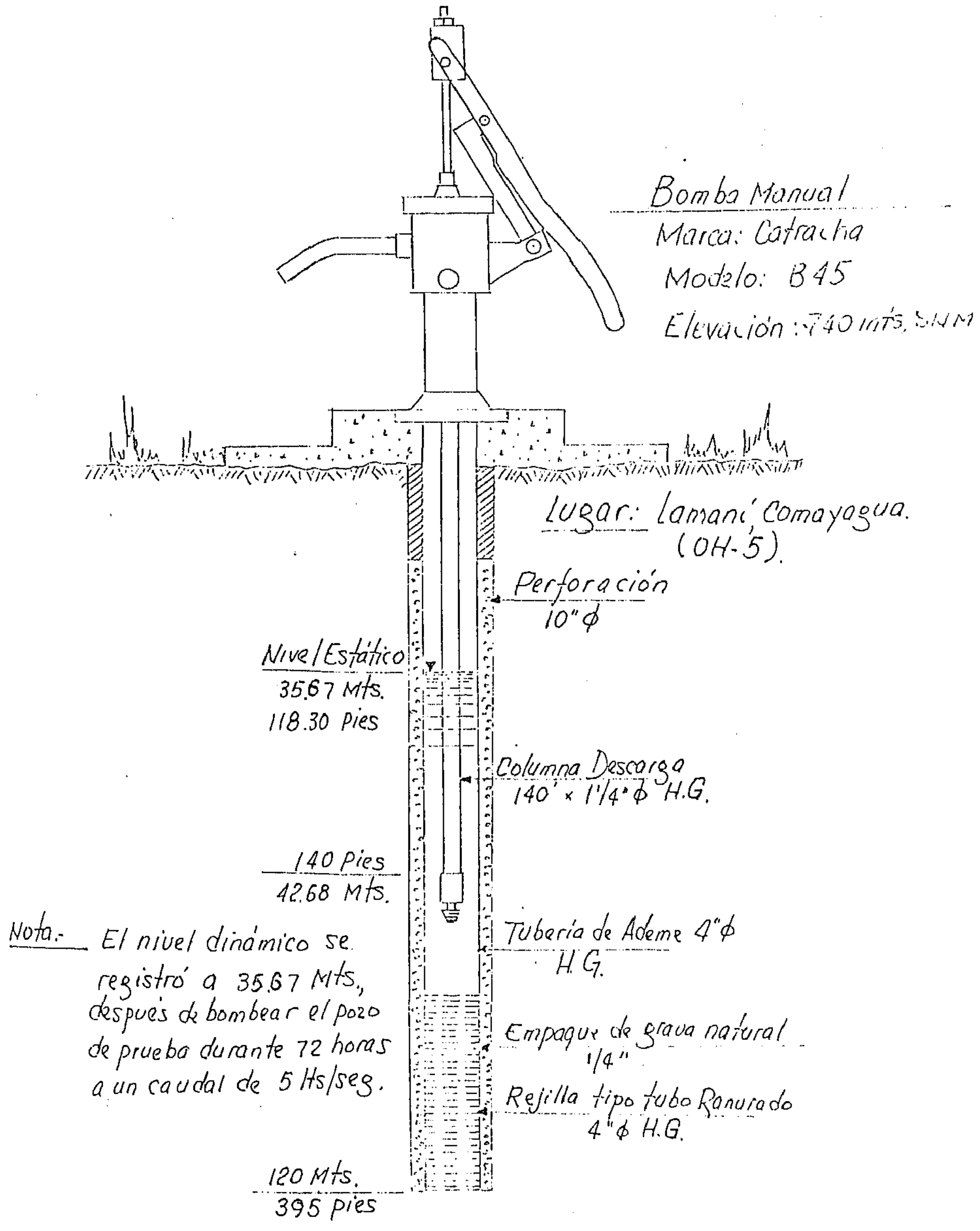
Bomba Manual
Marca: Catracha
Modelo: B 45
Elevación: 550 mts
Lugar: Las Liconas
(OH-1)
Perforación
10"φ
Nivel Estático
3.50 Mts.
11.5 pies
Columna de Descarga
40' x 1 1/4"φ H.G.
40 pies
12.20 mts.
Nota.- El nivel dinámico del agua se registró a 10.19 metros, después de bombear el pozo de prueba durante horas a un caudal de aprox. 1 lt/seg.
Tubería de Ademe
4"φ PVC.
Empaque de grava Natural
Tamaño: 1/4"
Rejilla
PVC.
67 metros
220 pies


Bomba Manual
Marca: Catracha
Modelo: B 45
Elevación : 650 mts SNM
Lugar: San Nicolás; Comayagua. (OH-2)
Nivel Estático
7.51 mts.
24.6 pies
Perforación
10" ø
Columna descarga
40 pies x 1¼" ø H.G.
40 pies
12.20 mts.
Tubería de Ademe 4" ø
H.G.
Empaque de grava Natural
1/4" x 1/8"
Rejilla tipo tubo Ranurado
4" ø H.G.
Nota: El nivel dinámico se registró a 12.11 mts, después de bombeo de prueba durante 12 horas con caudal de 7 lts/seg.
128 mts.
420 pies


Bomba Manual
Marca: Catracha
Modelo: B 45
Elevación: 590 mts. SNM
Lugar: Yarumela, La Paz
(OH-3)
Perforación
10"ϕ
Nivel Estático
7.45 Mts.
24.4 pies
Columna Descarga
40' x 1 1/4"ϕ HG
40 pies
12.20 Mts.
Nota.- El nivel dinámico se registró a 10.15 mts, después de bombear el Pozo de prueba durante 72 horas a un caudal de 9 lts/seg.
Tubería de Ademe
4"ϕ, P.V.C.
Empaque de Grava Natural
Tamaño: 1/4"
Rejilla tipo tubo Ranurado
4"ϕ P.V.C.
86 mts
282 pies



NOTA: El nivel dinámico se registró a 14.17 metros, después de [illegible] el pozo de prueba [illegible] horas a un caudal de [illegible]

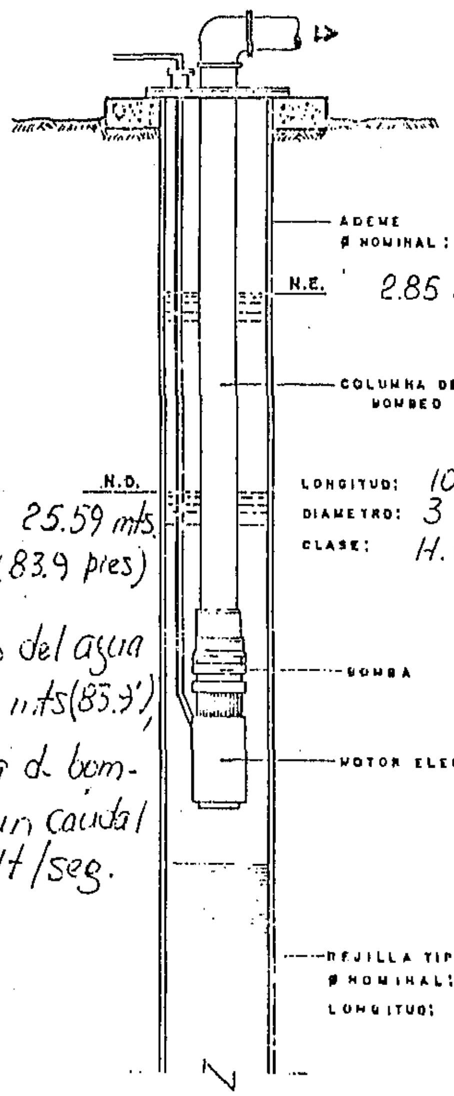

Bomba Manual
Marca: Catracha
Modelo: B45
Elevación: 740 mts. SNM
Lugar: Lamaní, Comayagua.
(OH-5)
Perforación
10"φ
Nivel Estático
35.67 Mts.
118.30 Pies
Columna Descarga
140' x 1¼"φ H.G.
140 Pies
42.68 Mts.
Nota.- El nivel dinámico se registró a 35.67 Mts., después de bombear el pozo de prueba durante 72 horas a un caudal de 5 lts/seg.
Tubería de Ademe 4"φ
H.G.
Empaque de grava natural
1/4"
Rejilla tipo tubo Ranurado
4"φ H.G.
120 Mts.
395 pies

INFORMACION PARA LA S... E INSTALACION
DEL EQUIPO DE ... O

LUGAR: LAS LICONAS. IDENTIF. TW-1 El. 560 mts SNM

DATOS DEL POZO	ESPECIFICACIONES GENERALES DE LA BOMBA
PROFUNDIDAD TOTAL: 70.12 mts (230 pies)	...A TIPO: Electro Sumergible Goulds.
DIAMETRO NOMINAL DEL ADEME: 8 pulgs; Acero-0.25"	CAPACIDAD: 120 GPM.
DIAMETRO NOMINAL DE LA REJILLA: 8 pulgs; Acero Galv.	VELOCIDAD: 3,450 RPM.
LONGITUD DEL ADEME: 45.72 mts (150 pies)	POTENCIA: 7.5 HP. EFICIENCIA: 70%
LONGITUD DE LA REJILLA: 24.4 mts (80 pies)	VOLTAJE: 230 FASES: 3 CICLAJE: 60
NIVEL ESTATICO: 2.85 mts (9.3 pies - 8 Feb/89)	CABEZA DINAMICA TOTAL: 200 pies (de Diseño)
NIVEL DINAMICO MAXIMO:	NIVEL DE INST. TAZON DE DESCARGA: 100 pies

BOMBA SUMERGIBLE



ADEME Ø NOMINAL: 8 pulgs; Acero 0.25" espesor

N.E. 2.85 mts (9.3 pies - 8 Feb/89)

COLUMNA DE BOMBEO

LONGITUD: 100 pies
DIAMETRO: 3 pulgs.
CLASE: H.G.

N.D. 25.59 mts (83.9 pies)

Nota.- El nivel dinámico del agua se registró a 25.59 mts (83.9'), después de una prueba de bombeo de 67 horas, a un caudal aproximado de 1 lt/seg.

BOMBA Goulds Modelo 100H07 120 GPM a 200

MOTOR ELECTRICO Franklin - 7.5 HP - 230 V - 3F

REJILLA TIPO: Johnson, Galvan, ranura ...
Ø NOMINAL: 8 pulgs.
LONGITUD: 80 pies.

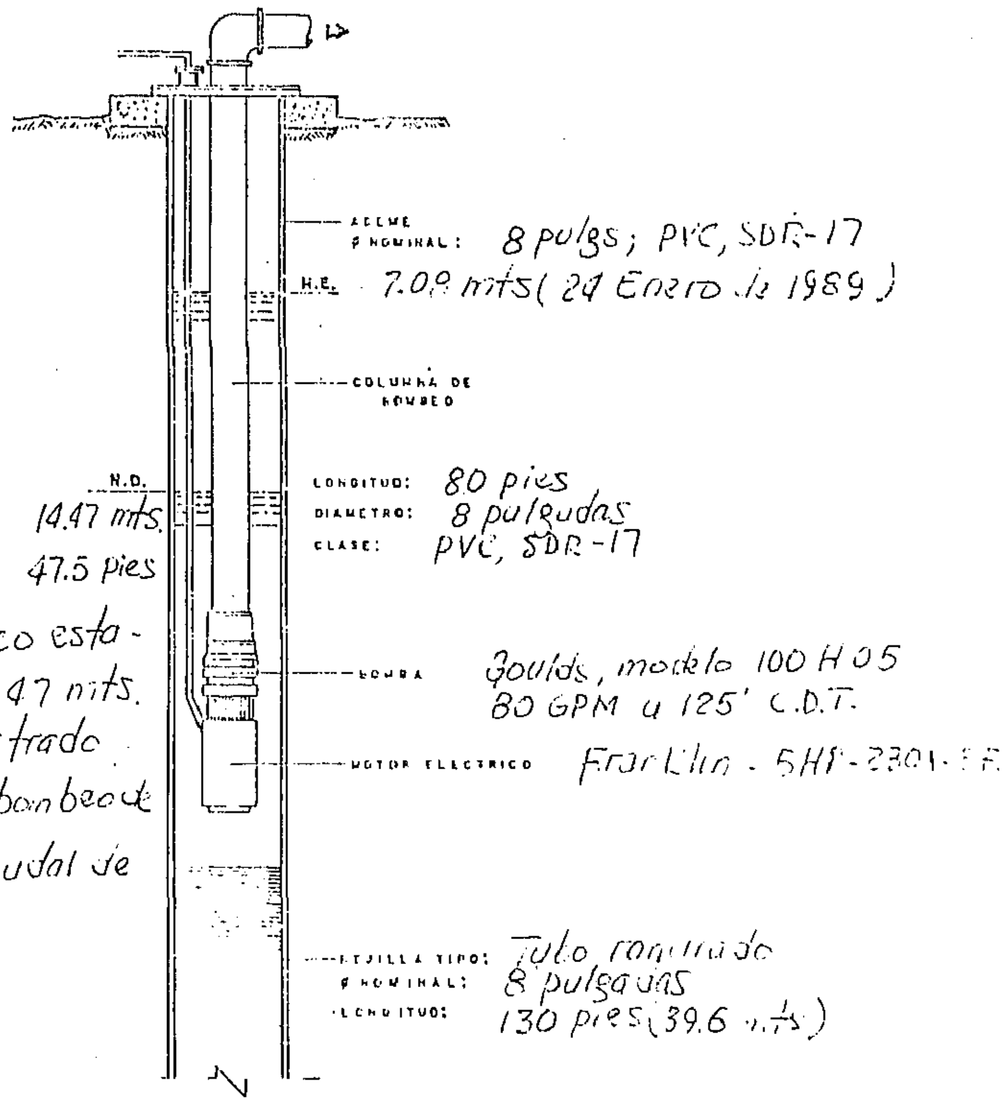
ESQUEMA DE INSTALACION

..FORMACION PARA LA S... ... E INSTALACIO.
DEL EQUIPO DE ... O

LUGAR: SAN NICOLAS (TN-2) Elev. 650 mts. SNM.

DATOS DEL POZO	ESPECIFICACIONES GENERALES DE LA BOMBA
PROFUNDIDAD TOTAL: 127 mts (416 pies)	...A TIPO: Electro Sumergible Goulds.
DIAMETRO NOMINAL DEL ADEME: 8 pulgs; PVC, RD17	CAPACIDAD: 80 GPM
DIAMETRO NOMINAL DE LA REJILLA: 8 pulgs, PVC, RD17	VELOCIDAD: 3450 RPM
LONGITUD DEL ADEME: 87.3 mts (286 pies)	POTENCIA: 5 HP EFICIENCIA: 70%
LONGITUD DE LA REJILLA: 130 pies (39.6 mts)	VOLTAJE: 230 FASES: 3 CICLAJE: 60
NIVEL ESTATICO: 7.08 mts (23.2 pies).	CABEZA DINAMICA TOTAL: 125 pies (de diseño)
NIVEL DINAMICO MAXIMO:	NIVEL DE INST. TAZON DE DESCARGA: 80 pies

BOMBA SUMERGIBLE



Nota.- El nivel dinámico estabilizado fue de 14.47 mts. (47.5 pies), registrado con una prueba de bombeo de 72 horas a un caudal de 7 lts/seg.

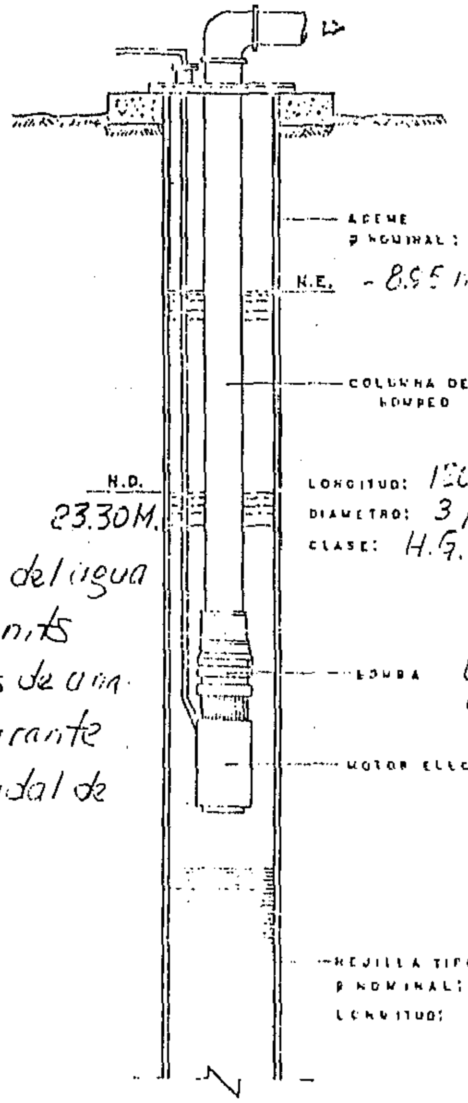
ESQUEMA DE INSTALACION

..FORMACION PARA LA S.. E INSTALACIO DEL EQUIPO DE O

LUGAR: YARUMELA. IDENT: TW-3 . Elev. 590 m. SNM

DATOS DEL POZO	ESPECIFICACIONES GENERALES DE LA BOMBA
PROFUNDIDAD TOTAL: 90.25 mts (296 pies)	..A TIPO: ElectroSumergible.- Goulds
DIAMETRO NOMINAL DEL ADEME: 8 pulgs.-Acero, 025"	CAPACIDAD: 80 GPM.
DIAMETRO NOMINAL DE LA REJILLA: 8 pulgs.-Acero galv.	VELOCIDAD: 3,450 RPM.
LONGITUD DEL ADEME: 176 pies.	POTENCIA: 5 H.P. EFICIENCIA: 70%
LONGITUD DE LA REJILLA: 120 pies; efectivos.	VOLTAJE: 230 FASES: 3 CICLAJE: 60
NIVEL ESTATICO: 8.95 mts. (15 Febrero/89)	CABEZA DINAMICA TOTAL: 125 pies.
NIVEL DINAMICO MAXIMO:	NIVEL DE INST. TAZON DE DESCARGA: 120 pies

BOMBA SUMERGIBLE



Nota:- El nivel dinámico del agua se registró a 23.30 mts (76.4 pies), después de una Prueba de bombeo durante 72 horas, a un caudal de 9 lts/seg.

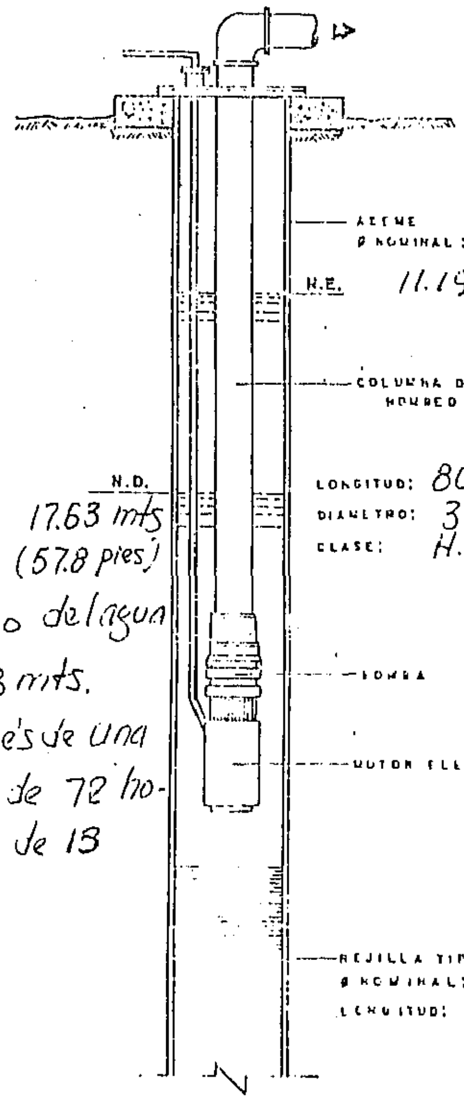
ESQUEMA DE INSTALACION

INFORMACION PARA LA S... DE INSTALACION DEL EQUIPO DE ...O.

Lugar: Flores - TW 4 — Elev. 638 mts. SN.M

DATOS DEL POZO		ESPECIFICACIONES GENERALES DE LA BOMBA	
PROFUNDIDAD TOTAL:	380 pies (116 mts)	... TIPO:	Electro Sumergible Goulds.
DIAMETRO NOMINAL DEL ADEME:	8 pulgs; Acero-0.25"	CAPACIDAD:	80 GPM.
DIAMETRO NOMINAL DE LA REJILLA:	8 pulgs; Acero galv.	VELOCIDAD:	3,450 RPM
LONGITUD DEL ADEME:	280 pies (85.4 mts.	POTENCIA:	5 HP — EFICIENCIA: 70%
LONGITUD DE LA REJILLA:	100 pies (30.6 mts)	VOLTAJE:	230 — FASES: 3 — CICLAJE: 60
NIVEL ESTATICO:	11.19 mts (36.7 mts)	CABEZA DINAMICA TOTAL:	125 pies (de diseño)
NIVEL DINAMICO MAXIMO:		NIVEL DE INST. TAZON DE DESCARGA:	80 pies.

BOMBA SUMERGIBLE



Nota.- El nivel dinámico del agua se registró a 17.63 mts. (57.8 pies), después de una Prueba de bombeo de 72 horas, a un caudal de 13 lts/seg.

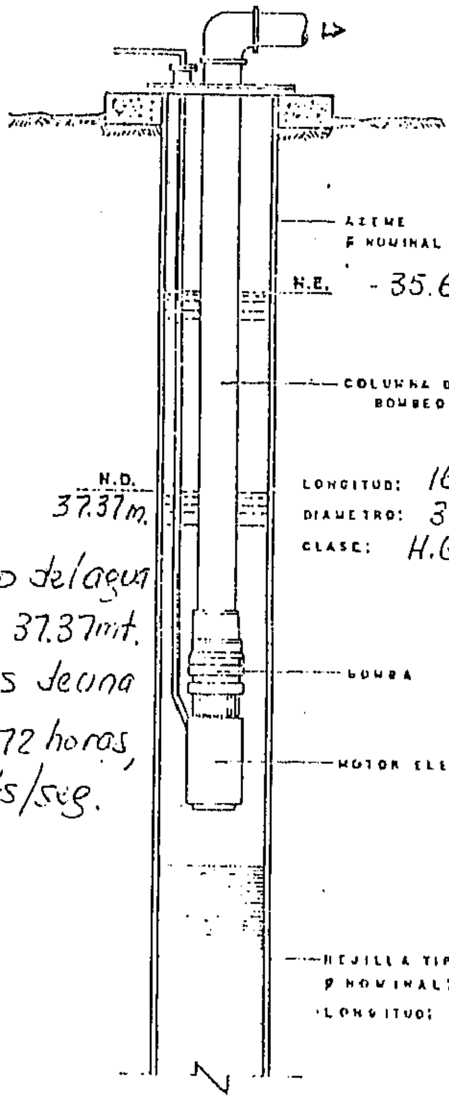
ESQUEMA DE INSTALACION

INFORMACION PARA LA S... DE INSTALACION DEL EQUIPO DE ... O

LUGAR: LAMANI — IDENTIFIC. TW-5.-El.740,...

DATOS DEL POZO	ESPECIFICACIONES GENERALES DE LA BOMBA
PROFUNDIDAD TOTAL: 95 mts (312 pies)	...BA TIPO: Electro Sumergible Gou...
DIAMETRO NOMINAL DEL ADEME: 8 pulg, PVC-RD 17	CAPACIDAD: 120 GPM.
DIAMETRO NOMINAL DE LA REJILLA: 8 pulg PVC-RD 17	VELOCIDAD: 3450 RPM
LONGITUD DEL ADEME: 65 mts (213 pies)	POTENCIA: 7.5 HP — EFICIENCIA: 70%
LONGITUD DE LA REJILLA: 30 mts (Aprox. 100 pies)	VOLTAJE: 230 — FASES: 3 — CICLAJE: 50
NIVEL ESTATICO: 35.67 mts (117 pies)	CABEZA DINAMICA TOTAL: 200 pies (de diseño)
NIVEL DINAMICO MAXIMO:	NIVEL DE INST. TAZON DE DESCARGA: 160 pies

BOMBA SUMERGIBLE



Nota.- El nivel dinámico del agua se registró estable a 37.37 mt. (122.6 pies), después de una prueba de bombeo de 72 horas, a un caudal de 5 lts/seg.

ESQUEMA DE INSTALACION

Goulds

Submersible Turbine Pumps

MODEL 100H

For 6" and larger wells

SPECIFICATIONS

Capacities: to 180 GPM.
Heads: to 955 feet
Best efficiency point: 100 GPM
Horsepower: 5-10 HP — 1 Phase
5-25 HP — 3 Phase
60 HZ, 3500 RPM
Discharge connection: 3" NPT
Rotation: Counterclockwise when looking into discharge.
Recommended for 6" wells or larger.

FEATURES

Powered for Continuous Operation: All ratings are within the working limits of the motor manufacturer. Pump can be operated continuously with no fear of damage to the motor.

Completely Field Serviceable: Easy to install and service. All parts easily dismantled if field service is ever necessary. No special tools needed. No shipping back to factory.

Diverse Application: Designed or industrial, municipal and agricultural water needs.

Bearings: Replaceable marine bearings, fluted rubber to pass sand and reduce abrasion.

Shaft Sleeves: Replaceable stainless steel, hex driven, sleeves protect shaft from any abrasives.

Pump Shaft: Precision straightened stainless steel hex shaft. (8-13 stage units use corrosion resistant monel shafts).

Bowls: Cast iron turbine bowl design assembled with replaceable pressed-in bronze wear rings.

Impellers: Bronze impellers dynamically balanced for smooth operation.

Coupling: Heavy duty stainless steel, splined coupling for maximum load-carrying characteristics.

Suction Strainer: Stainless steel strainer restricts gravel and other debris from entering the pump.

Cable Guard: Stainless steel cable guard surrounds and protects motor leads.

Fasteners: All fasteners are stainless steel.

Franklin Electric Motor: Stainless steel casing and epoxy coated end bells resist corrosion. Water filled design provides a constant supply of lubrication. Hermetically sealed stator assures moisture free windings. Durable Kingsbury type thrust bearing absorbs all thrust. Replaceable motor lead assembly.

System Components: The basic pump-motor unit includes a three wire motor lead. A control box is supplied as standard equipment with all single phase units. A magnetic starter with three-leg protection is required with all three-phase units. Magnetic starter and heaters must be ordered separately.

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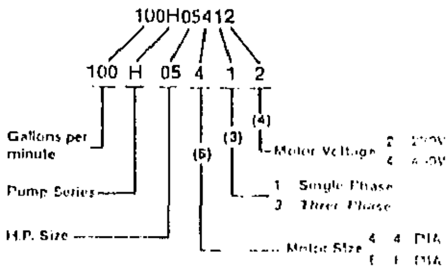
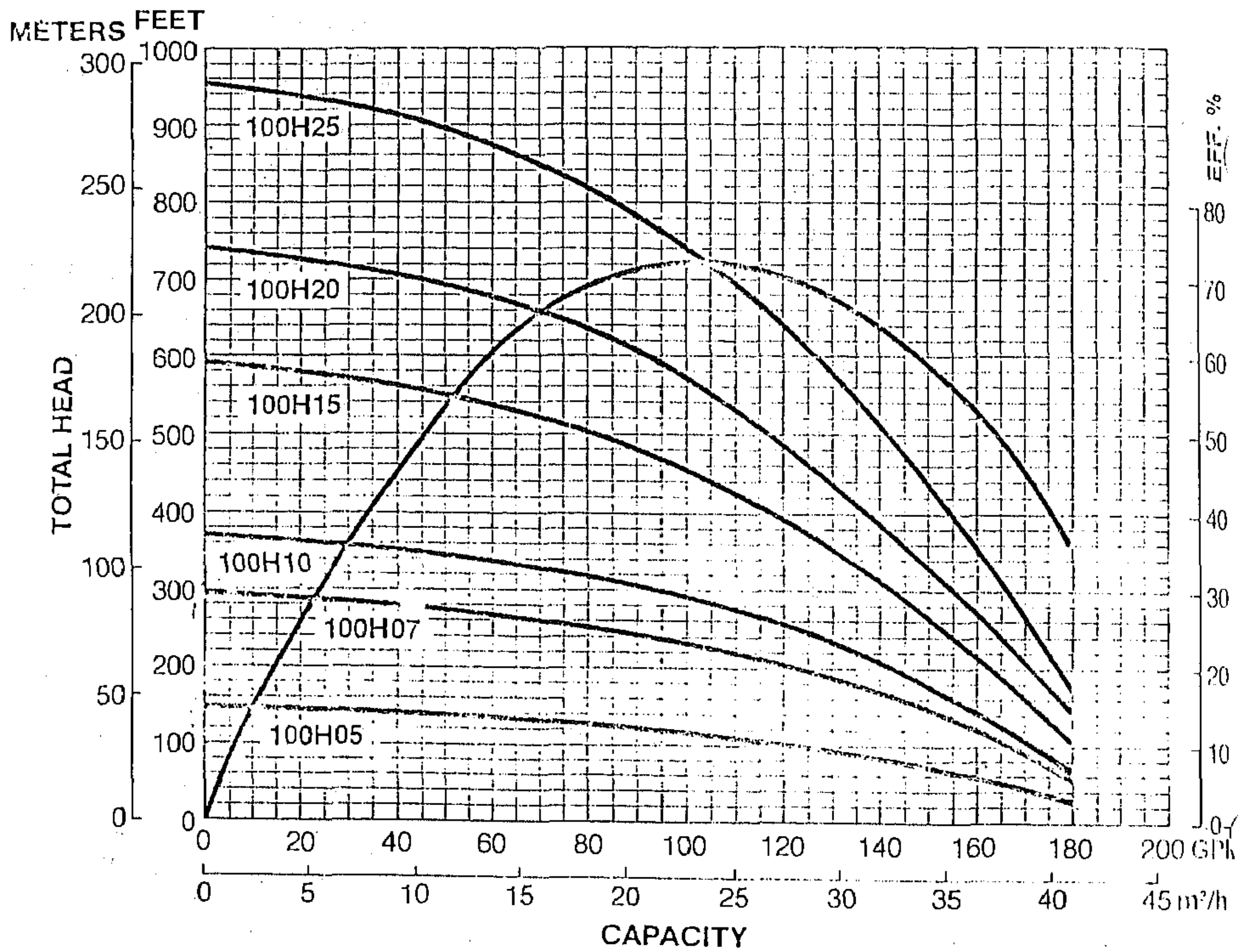
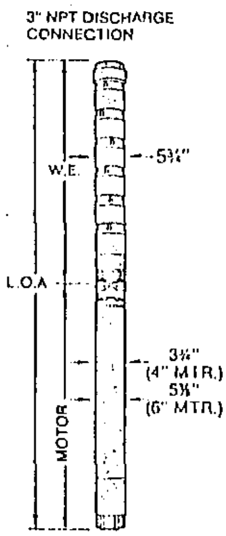




DIMENSIONS AND WEIGHTS

(All dimensions in inches and weight in lbs.) (Do not use for construction purposes.)

HP	Stages	Model Number	Motor Length	W.E. Length	L.O.A.	Weight
5	2	100H05412	28½	18	46½	111
7½	4	100H07612	30¾	29¼	60	238
10	5	100H10612	34⅜	34¼	68⅝	238
5	2	100H05432 100H05434	28½	18	46½	111
7½	4	100H07632 100H07634	28	29¼	57¼	189
10	5	100H10632 100H10634	30¾	34¼	65	222
15	8	100H15632 100H15634	34⅛	49¼	83⅜	283
20	10	100H20632 100H20634	38⅜	59¼	116⅝	336
25	13	100H25632 100H25634	42⅜	74¼	116⅝	401



MATERIALS OF CONSTRUCTION

Part Name	Material
Shaft & Coupling	300 Series SS*
Spline Protector	Neoprene
Motor Adapter & Discharge Head	Cast Iron
Suction Screen	300 Series SS
Shaft Sleeve	300 Series SS
Bowl	Cast Iron
Marine Bearing	Buna "N"
Impeller	Bronze
Cotter Pin	300 Series SS
Wear Ring	Bronze
Fasteners	300 Series SS
Cable Guard	300 Series SS

*8 through 13 stage units use Monel Shafts.

ANNEX V SPECIFICATION OF EQUIPMENT USED FOR TEST WELL DRILLING

E Q U I P O S

UTILIZADOS EN LOS TRABAJOS DE PERFORACION - DE POZOS.

Se anexan las especificaciones y características de los equipos de perforación - utilizados.- El comportamiento de los Sistemas de Perforación se indican a continuación.

I.- **Lodos de Perforación.-** El Valle de Comayagua presenta estratos considerables de arcilla.- Por consiguiente, se - volvió más necesario en la mayoría de los casos a reducir. los grados de viscosidad con la eliminación de los lodos con la inyección de mayores cantidades de agua.

Cuando se consideró necesario, la bentonita - empleada fue de la marca Aqua-Gel producida - por la NL Baroid/ NL. Industries, Inc. de los Estados Unidos de América.- El sistema de perforación empleado por los equipos rotativos - fué el de circulación directa; la viscosidad se verificaba mediante en embudo Marsh, de Baroid.

2.- **Equipos de Perforación.-**

2.1 **Perforadora de Percusión Hillman.-** En el pozo testigo de San Nicolás - (O H - 1), se utilizó una perforadora de Percusión marca Hillman (equivalente a la BE-20 , Bucyrus-Erie).- Se descontinuó su empleo por - la inhabilidad de sostener derrumbes y el riesgo de rescatar un ademado muy profundo; la profundidad alcanzada apenas llegó a 70 pies.- Se abandonó el pozo.

.../...

2.2 **Perforadora Rotativa -Winter Weiss.-** El modelo utilizado en el Pozo testigo de Lamaní (O H -5) es equivalente a la Gardner Mayhew 1000.- Fallas mecánicas y la rotura de las barras de perforación condujo a decidir sacarla del proyecto.- La profundidad alcanzada fué de 135 pies.

2.3 **Perforadora Roto-Percutora Schramm.-** Con la eliminación de las perforadoras Percutora y Rotativa livianas, el proyecto se realizó con el empleo de perforadoras roto-percutoras Schramm modelo T64-HB.- Con estos equipos se perforarán los pozos testigos y de prueba de "Las Liconas, Yarumela, San Nicolás y Lamaní".

2.4 **Perforadora Rotativa Gardner - Denver.-** Para acelerar la ejecución de la obra, los pozos testigos y de Prueba de Flores, fueron perforados con una perforadora Gardner Denver modelo 15 W.- La ampliación del pozo testigo, y las enturbadas y desarrollos de ambos pozos se efectuó con una Perforadora Schramm T 64-HB.

3.- Registros Eléctricos.-

Los registros geofísicos de resistividad eléctrica y de potencial espontáneo fueron corridas con un resistivímetro Johnson Keck.- Modelo DR -74.- Había disponibilidad en el proyecto de un registrador de rayos gamma modelo GR - 71, y de un Calibrador de Pozo modelo HC - 70.

Los registros de resistividad corridas por HidroSistemas fueron verificadas por un equipo análogo marca "OYO" del grupo de estudio de JICA.

E Q U I P O S

UTILIZADOS EN PRUEBAS DE BOMBEO.

1.- **GENERADORES ELECTRICOS.**

1.1 Generador # I.

Generador Inglés marca K & M.

Capacidad: 17.5 Kilovatios - 430/215 Voltios.

3 Fases - 60 Ciclos.

Velocidad: 1800 RPM.

1.2 Generador # 2.

Generador marca ONAN, Modelo 17, 5RAJF -18R.

Serie Nº. C790400518.

Capacidad: 17.5 Kilovatios - 230/ 115 Voltios.

3 Fases - 60 Ciclos.

Velocidad: 1800 RPM.

2. **BOMBAS DE AFORO.**

2.1 Bomba de Aforo # I.

Bomba Eléctro-Sumergible marca Grundfos

7942 Tipo SE 35-8

Capacidad: 30 - 50 M^3/hr. a 56-26 metros.

110 - 185 gals. Imperials/min. a 184 - 84 pies.

Número de etapas: 8

Velocidad: 2700 RPM - 415 Voltios - 3 Fases.

.../...

* **NOTA:** **Este equipo fué utilizado con el generador K & M. en las Pruebas de los Pozos de Yarumela, San Nicolás, Flores y-Lamaní.**

2.2 Bomba de Aforo # 2.

Bomba Sumergible marca "Red Jacket", modelo 8 DC.
Capacidad: 30 GPM.
Número de etapas: 5
Velocidad: 3500 RPM. - 230 Voltios - 3 Fases.

* **NOTA:** **Este equipo se usa con el generador Inglés en la prueba del Pozo "Las Liconas" (TW -1).**

2.3 Bomba de Aforo # 3.

Es una bomba Sumergible de reserva es marca Goulds.
Modelo : 6 HS.
Capacidad: 180 GPM. a 325 pies de carga dinámica total.
Velocidad: 3500 RPM. - 230 Voltios - 3 Fases.

3.- SONDAS ELECTRICAS DE NIVEL DE AGUA.

Se utilizaron dos Sondas acústicas de fabricación inglesa y dos Sondas eléctricas de indicador visual de fabricación local.- Su efectividad fué excelente.

.../...

4.- MEDIDORES DE CAUDAL DE AGUA.

Para medir el flujo de agua se emplearon Vertederos de Orificio circular de "4 X 3", 4" X 2" y 1 1/2" X 1?, calibrados en sitio.- Con las cargas piezométricas se ajustaban con válvula de control.

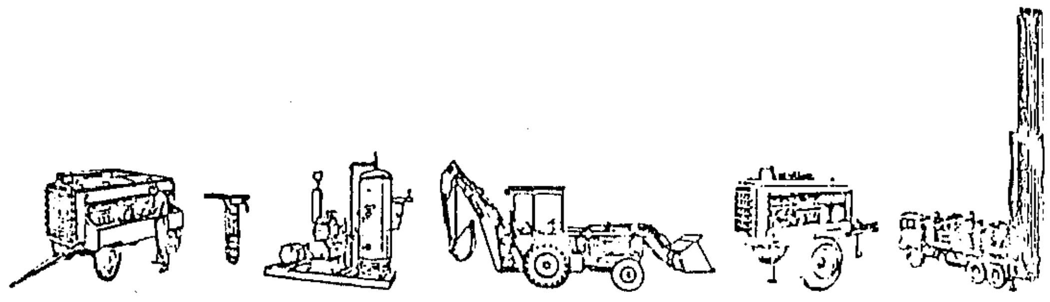
-***-

STANDARD EQUIPMENT: Hydraulic controls, "Micro-Feed" penetration rate control, "Watch-Dog" down pressure regulation, 3 Hydraulic outriggers, Mast lift cylinders, "Lazy Susan" pipe rack, Breakout cylinder with wrench, Pipe sling, Holding and guide slips, Instrument panel, gauges and throttle system, with engine and compressor as listed below

	SERIES "S"				SERIES "H"		
Model No.	KT42A	KT64	KT66	T66-B	KT42H-A	KT64H	T64H-B
COMPRESSOR							
cfm @ 100 psi	250	400	600	600	—	—	—
m³/min @ 7 kg/cm²	7.08	11.34	17	17	—	—	—
cfm @ 250 psi	—	—	—	—	200	425	425
m³/min @ 17.6 kg/cm²	—	—	—	—	5.67	12.04	12.01
BORE & STROKE CYLINDERS							
1st Stage - Inches	4½" x 4¾"	5" x 6"	4½" x 4¾"	4½" x 4¾"	4½" x 4¾"	4½" x 4¾"	4½" x 4¾"
Millimeters	114 x 120.6	127 x 152	114 x 120.6	114 x 120.6	114 x 120.6	114 x 120.6	114 x 120.6
No. of Cylinders	6	6	6	6	5	4	4
2nd Stage - Inches	—	—	—	—	4½" x 4¾"	3½" x 4¾"	3½" x 4¾"
(Hi-Pressure only) Millimeters	—	—	—	—	114 x 120.6	89 x 120.6	89 x 120.6
No. of Cylinders	—	—	—	—	1	2	2
Engine-Detroit Diesel							
Model	6V71	8V71	8V71N	8V71N	6V71	8V71N	8V71N
r.p.m.	1350	1500	1600	1600	1200	1600	1600
Dimensions							
Length - Ft., Inches				31'			31'
Meters				9.45			9.45
Width - Ft., Inches	Depends on Truck Chassis Furnished	Depends on Truck Chassis Furnished	Depends on Truck Chassis Furnished	8'	Depends on Truck Chassis Furnished	Depends on Truck Chassis Furnished	8'
Meters				2.44			2.44
Height - (Mast Erect)							
Ft., Inches				33'1"			33'1"
Meters				10.1			10.1
(Transport)							
Ft., Inches				11'4"			11'4"
Meters				3.46			3.46
Weight - (Operating)							
Pounds				38800			38800
Kilograms				17600			[illegible]
MAST TYPE	Tubular	Tubular	Tubular	Structural	Tubular	Tubular	Structural
HYDRAULIC SYSTEM All Models							
Capacity	85 Gal	85 Gal	85 Gal	85 Gal	85 Gal	85 Gal	85 Gal
	322 Liters	322 Liters	322 Liters	322 Liters	322 Liters	322 Liters	322 Liters
Pressure	1500 psi	1500 psi	1500 psi	1500 psi	1500 psi	1500 psi	1500 psi
	105.6 kg/cm²	105.6 kg/cm²	105.6 kg/cm²	105.6 kg/cm²	105.6 kg/cm²	105.6 kg/cm²	105.6 kg/cm²
PUMPS							
Type	Gear	Tandem Vane	Tandem Vane	Tandem Vane	Gear	Tandem Vane	Tandem Vane
g.p.m.	28	37/6.4	38/6.8	38/6.8	25	38/6.8	38/6.8
liters/min.	105.98	140/24.22	143.6/25.7	143.6/25.7	94.5	143.6/25.7	143.6/25.7
Type	Vane	Vane	Vane	Vane	Vane	Vane	Vane
g.p.m.	5.5	22.5	24	24	5	24	24
liters/min.	20.82	85.16	90.84	90.84	18.93	90.84	90.84
ROTATION SPEEDS,* r.p.m.	27, 41 & 81	44, 66 & 130	40, 60 & 118	40, 60 & 118	24, 36 & 72	40, 60 & 118	40, 60 & 118
ELECTRICAL SYSTEM - VOLTS	12	24	24	24	12	24	24
DRILLING DATA							
Max. Hole Size							
Rotary - Inches	5⅝"	6¾"	7⅞"	7⅞"	4¾"	6¾"	6¾"
Rotary - Millimeters	143	171	200	200	120.6	171	171
Rotatool - Inches	5"	7"	7"	7"	4¾"	7"	7"
Rotatool - Millimeters	127	178	178	178	120.6	178	178
Min. Hole Size							
Drag Bit - Inches	3"	3"	3⅞"	3⅞"	3"	3⅞"	3⅞"
Drag Bit - Millimeters	76.2	76.2	98.4	98.4	76.2	98.4	98.4
Pull Down Pressure							
Pounds	12000	18500	18500	29000	12000	18500	29000
@psi	1500	1900	1900	1500	1500	1900	1500
kg	5450	8410	8410	13200	5450	8410	13200
@ kg/cm²	105.6	134	134	105.6	105.6	134	105.6

*Standard speeds are listed. Other speed combinations and gear ratios available for varied drilling conditions.

SCHRAMM

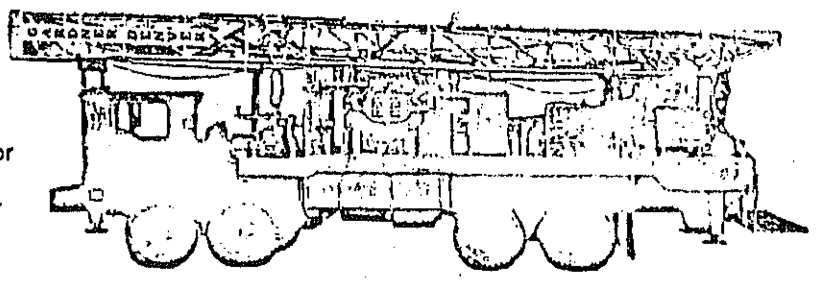


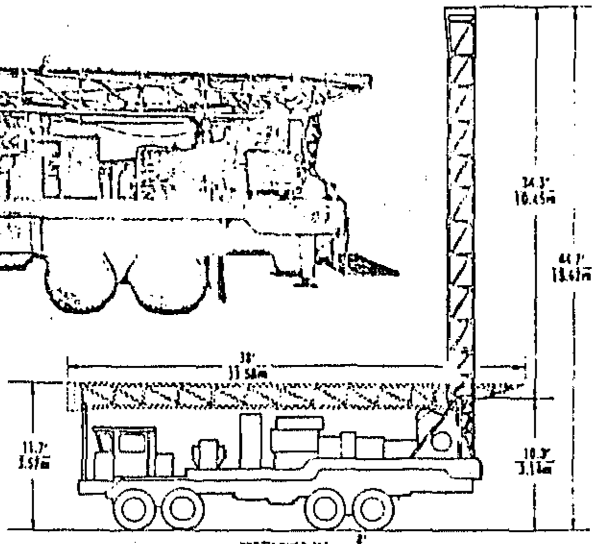
PORTABLE • TOOLS • STATIONARY • PNEUMATRACTOR • HI-PRESSURE • ROTADRILL

BULLETIN RWW71

GARDNER-DENVER — GARDNER-DENVER Since 1859

15W WATER WELL DRILLING RIG





The Model 15W is designed for air or mud water well drilling, low or high pressure air for rotary drilling or in-the-hole percussion drilling.

FEATURES:

- *Self-sufficient and moves as single unit.*
- *Compact, fast and portable.*
- *All controls grouped at driller's position.*
- *Excels in performance for hammer or rotary drilling.*
- *Economical and operates with minimum crew.*

MODEL 15W DRILLING RIG SPECIFICATIONS

RATED CAPACITY	Drill Pipe Size	Recommended Depth—with traveling block	
	2⅜" (60 mm)	2500' (762 m)	
	2⅞" (73 mm)	2000' (610 m)	
	3½" (89 mm)	1500' (457 m)	
	4½" (114 mm)	1250' (381 m)	
	Casing load to 20,000 lbs. (9,074 kg) using traveling block.		
CHAIN CASES	*Power Take-Off*	*Power Transfer*	
	Split shaft, full torque, 8 strand chain	6 strand chain	
	Roller bearing mounted, heat treated shafts and sprockets; pressure pump lubrication	Ball bearing mounted shafts and sprockets. splash type lubrication.	
ROTARY TABLE	Standard	Optional	
	7½" (191 mm) hydraulically retractable.	10" (254 mm) hydraulically retractable.	
Type	Spiral bevel cut ring gear and pinion.		
Transmission	Five speeds forward, one reverse, with two-speed gear reduction.		
Clutch	Lipe Rollway 14" single plate with slip feature for hammer drilling		
DRUMS	Drilling Line	Hoisting Line	Sand Line
Barrel Diameter & Length	8" x 7¾" (203 x 197 mm)	8" x 7¾" (203 x 197 mm)	6½" x 17" (165 x 432 mm)
Brakes	Single 6" x 22" (152 x 559 mm)	Single 6" x 22" (152 x 559 mm)	Single 4" x 16" (102 x 406 mm)
Clutches	PO-214	PO-214	PO-311
Max. single line pull (bare drum)	15,000 lbs. (6,804 kg)	15,000 lbs. (6,804 kg)	10,000 lbs. (4,536 kg)
Spooling Capacity	450' (137 m) ⅝" (15.9 mm)	450' (137 m) ⅝" (15.9 mm)	1500' (457 m) 5/16" (8.2 mm)
PULLDOWN	Hydraulically-actuated chain-feed type, 2" (50.8 mm) pitch pulldown chains.		
MAST	38' (11.7 m) over-all length		
Construction	Tubular, four-way, box-type, electrically welded.		
Crown	6—11½" (292 mm) ball bearing sheaves, angle mounted over hoisting and drilling drums. 2—10¼" (260 mm) pulldown sheaves. 2—10¼" (260 mm) sand line sheaves.		
Capacity	60,000 lbs. (27,200 kg)		
HYDRAULIC SYSTEM	Vickers oil pump 17 gpm (64 liters), rated 2,500 psi (176 kg/cm²)		
Mast raising cylinders	Twin, double-acting, telescoping cylinders, with check valves.		
Leveling jacks	Three hydraulic jacks, one on front of carrier, two on rear of drill		
KELLY BAR	4½" (114 mm) O.D. x 24' (7.3 m) long, with three 1" (25.4 mm) drive pins.		
SWIVEL	*Heavy duty, ball-bearing type, 2" (50.8 mm) watercourse. Bearing capacity 32,800 lbs. (14 878 kg) at 100 rpm.*		
MUD PUMP	Gardner-Denver duplex FG-FXG, 5" x 6" (127 x 152 mm), 150 gpm (568 liters) at 75 strokes per minute. Optional FD-FXD, 5" x 8" (127 x 203 mm), 182 gpm (689 liters) at 70 strokes per minute.		
AIR COMPRESSOR	Gardner-Denver WEJ 7⅜" x 5" x 6" (187 x 127 x 152 mm) six cylinder, two-stage, water cooled, with tube-type radiator-intercooler-aftercooler.		
Free Air Delivery	525 cfm (14.87 cu. m) at 125 psig (8.79 kg/cm²). 510 cfm (14.44 cu. m) at 250 psig (17.58 kg/cm²)		
Lubrication	Pressure pump system.		
CycloBlower (Optional)	Gardner-Denver ASCOL-13 CycloBlower complete with precooler for WEJ compressor, free air delivery 650 cfm (18.41 cu. m) at 150 psig (10.55 kg/cm²)		
WATER INJECTION	Pressure pump system, 8 gpm (30 liters) with hydraulic drive.		
AIR LUBRICATOR	Pressure pump system with mechanical drive, for hammer drilling.		
CONTROLS	Located at driller's position—full air clutches on drawworks and sandreel; air-actuated clutches on mud pump, air compressor, rotary and pulldown; air-actuated hand throttle. Control panel includes tachometer, starter button, oil pressure gauge and water temperature gauge. Optional emergency kill switch.		
DRIVES	Input—torque tube *Rotary table—torque tube* Drawworks—torque tube Sandreel—chain	Hydraulic pump—direct coupled *Mud pump—V-belt* Air compressor—V-belt	
DRILL FRAME	Structural steel, electrically welded.		
DRILL CARRIER	8 x 4, 205" (5.2 m) wheelbase, 58 lb. H-beam frame, 335 Cummins diesel, and 13 speed Road Ranger transmission.		
Dimensions	38' (11.58 m) long, 8' (2.44 m) wide, 11'-8" (3.55 m) high.		
Weights	Front tandem 20,000 lbs. (9,072 kg), rear tandem 39,000 lbs. (17 690 kg).		

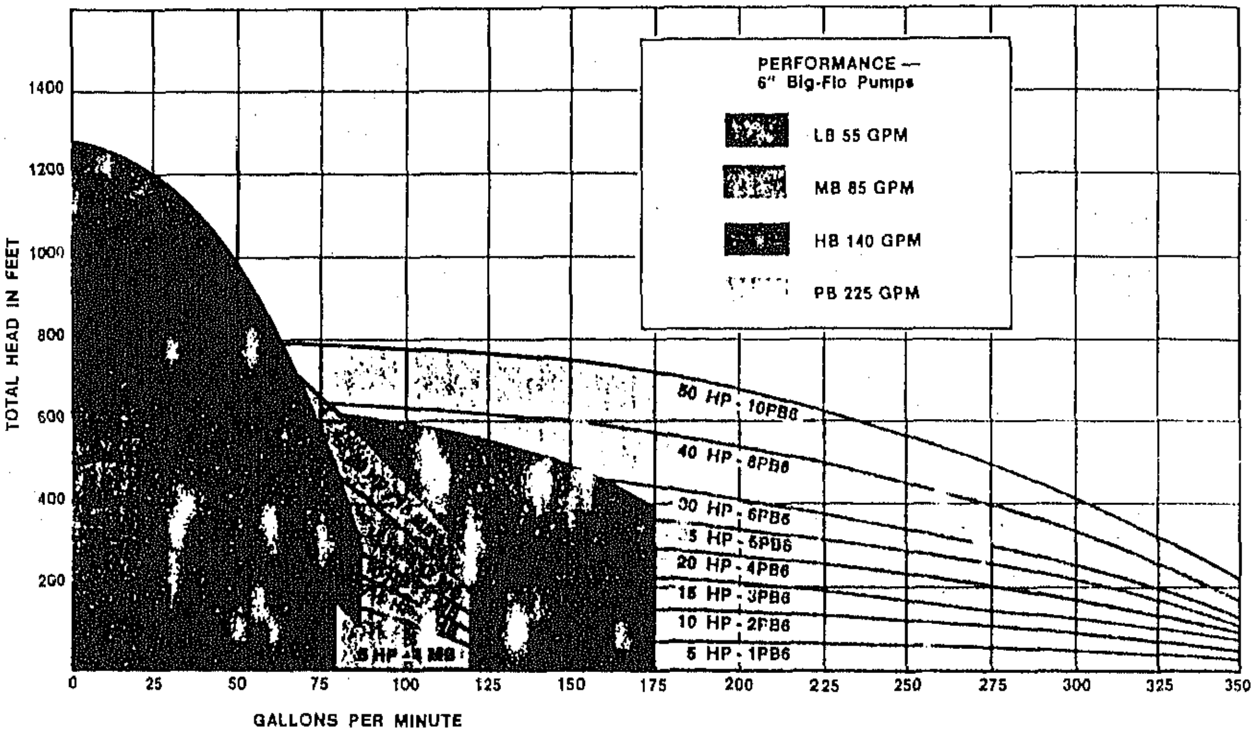
TYPICAL OPERATING SPEEDS—MODEL 15W

Power take-off output speed	1200 rpm†	Drawworks line speed*	310 fpm (94 m)	
Mud pump	75 strokes per minute	Sandreel line speed*	300 fpm (91 m)	
Air compressor speed	1000 rpm	Rotary table speed	7½" Table 8 to 204 rpm	10" Table 10 to 254 rpm

†Average speed

*Based on initial wrap on drum.

performance



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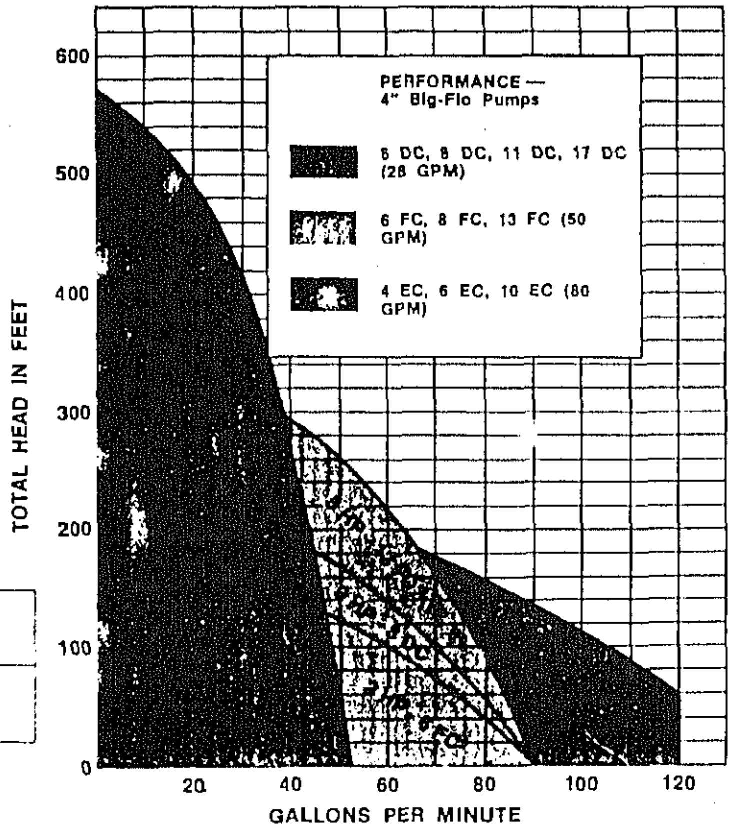

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APPENDIX D

WATER QUALITY ANALYSIS

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I. INTRODUCTION

The water quality analysis aims to determine the suitability of ground water for portable water supply, and at the same time, to afford necessary water quality parameters for interpretation of the hydrogeological structure and the mechanics of ground water flow in the study area.

To realize the objectives above-mentioned, the following two approaches to the water quality analysis were planned at the beginning of the field investigation of this project.

a. The analysis to determine the suitability for the potable water supply, and

b. the analysis necessary for the comprehensive study of the hydrogeological condition of the study area.

On the other hand, the water quality analysis was scheduled in both the dry season and the rainy season, because remarkable contrast in ground water environment such as recharge amount from surface water, yields and static water levels of existing wells, etc. has been observed and/or inferred between two seasons. Accordingly, it seems very probable that the ground water quality also changes seasonally very much.

1) The analysis for the potable water supply

The "Centro de Salud Alonzo Soazo (DIRECCION GENERAL DE SALUD)" in Tegucigalpa is one of the bureaus of MPH, and has the most authorized chemical laboratory in Honduras, i.e. DIVISION DE CONTROL DE ALIMENTOS (Food Control Laboratory). Furthermore, in the Study Area, a regional office of "REGION SANITARIA No 2", which is also under the control of "DIRECCION GENERAL DE SALUD", has a laboratory (Portable Laboratory) in Comayagua. Suitability for the potable water supply, therefore, is judged on the basis of the results of the analysis performed by MPH at those laboratories.

Items analyzed by MPH, in case of the rainy season, are as follows;

pH, Colour, Hardness, Organic material, Fe, Ca, Mg, Cl, Coliform group, NO_2, NO_3, NH_4

On the other hand, analyzed items in the dry season are as follows;

Organic material, Total Coliform, Fecal Coliform, NO_2, NO_3, NH_4, PO_4, SO_4

2) The analysis for the hydrogeological study

Ground water chemistry changes as water flows through the subsurface environment, increasing in dissolved solids and major ions. The analysis of ground water chemistry could, therefore, be useful to study the ground water behavior. The sampled water from the test wells, excluding the water from TW-02, was brought to Japan by the JICA team and chemically analyzed in Tokyo. The other water samples for the hydrogeological study was tested principally by means of potable water testing kit supplied by JICA. In the field investigations, this work was mainly made by the JICA's expert, and the main items investigated and/or analyzed were as follows;

Temperature, pH, Ec, Na, K, Ca, Mg, Cl, NO_3-N, NO_2-N, F, NH_4-N, Total-Fe, Zn, pH4.8 (M-O) Alkalinity, Total Hardness, SiO_2 (dry season only), Mn (dry season), Soluble-Fe (dry season)

II. ACTIVITIES ON THE WATER QUALITY ANALYSIS

2.1 Preparation of the temporary laboratory

As MPH provided the JICA team with a room in new regional office of Comayagua in the Second Field Investigation stage, June 17, 1988, the JICA's expert performed the following preparatory works necessary for chemical and physical examinations of water, on both field works in the rainy and the dry seasons.

- Preparation of standard solutions for items to be analyzed
- Standardization of ion-meters supplied by JICA

In parallel with the above-mentioned preparatory works, a volume of 120 liters of distilled water was prepared in Tegucigalpa and carried to the temporary laboratory, using 20-liter PVC containers.

Environment and condition of the temporary laboratory such as space, furniture, electricity, and so on, is sufficient for the water quality analysis except for the water supply. The existing water supply is frequently cut off, and a large amount of suspended substances are expected from an appearance of tap water.

According to the international standard rules of chemical laboratories, all the glass-ware are to be submerged in chromium-sulfuric acid through a night after usage, and prior to re-use, they are to be washed up by the tap water and finally rinsed out several times in the distilled water.

In case of the temporary laboratory for our analysis, it is very difficult to follow the standard rule because of shortage of the chromium-sulfuric acid. However, the tap water has relatively low electric conductivity of less than 50 micro-mho/cm, and no sign of contamination judging from an analysis results by means of a simple testing kit. The followings can be used as an practical rule for our work.

- rinse out the glass-wares in detergent first
- then, rinse out them three times in the tap water
- finally, rinse out three times in the distilled water

2.2 Sampling

1) Sampling date and number of samples

In the dry season from 14 to 30 of June 1988, totally 26 samples; five samples of the river water and 20 samples from existing wells, were collected for the purpose of chemical and physical analyses. Among the 26 samples, 20 samples including the river water samples are subject to the bacteriological analysis.

On the other hand, in the rainy season from January 21 to February 4 of 1989, 20 samples consisting of five river water samples and 15 well water were analyzed both on the bacteriological and on the hydro-geological items. In addition to those analysis, water samples from the newly drilled test wells were also analyzed in the rainy season.

Locations where the water samples were collected are shown in Fig. 2.2.1. Values obtained in the various tests performed in the different laboratories are shown in Table 2.2.1 to 2.2.3.

2) Sampling procedure

One-liter poly-ethylene bottles with screw caps were used for the water sampling in order to analyze chemical and physical properties of the water.

Prior to water sampling, the bottles and other apparatuses such as a PVC bucket and a two-liter beaker with handle, were rinsed out twice in the water to be sampled. Following the in-situ measurements of water temperature and electric conductivity, the bottles were filled with sample water and the screw caps were carefully and tightly fastened so that tiny air bubbles would remain around the top of the bottles.

In case of the water sampling for the bacteriological analyses, experts of JICA and/or MPH sterilized his hand using sanitary cotton dipped in ethyl alchol. The poly-propylene bags filled with water to be analyzed were stored in a portable ice-box immediately after the sampling.

2.3 Physical and Chemical Examination

1) Specification of the apparatuses

In regard to the activities of the JICA's expert, physical and chemical analyses of the surface water and ground water were performed by means of the pH-meter, Ion-meter and the simple water quality testing kit supplied by JICA, in case of the rainy season. In addition, in the dry season, the JICA Study Team prepared HACH's portable colorimeter, and used it for the analysis of SiO_2 and NH_4.

Details of the supplied instruments are described below;

a. The pH-meter and Ion-meter

Type : Model IM-7B (Toa Electric Ltd.)

Functions : Determination of ion concentration and pH value or potential difference of water are possible by means of replacing electrodes.

Measuring Range :

Ion concentration	0.01 to 10,000 ppm
pH	0 to 14
Potential difference	0 to +/- 700 mV

Indicator Accuracy :

Ion	1% of full scale on the scale width
pH	+/- 0.05 pH
mV	+/- 10 mV

b. Simple water quality testing kit

Type : Model WAS-D2 (Kyoritsu Chemical Research Ltd.)

Function : By means of the simplified colorimetric method or the test paper method, the following properties of water can be determined;

Turbidity, Colour, pH, NO_2-n, Ammonia-N, Total-Hardness, Residual Chlorine, Total-Fe, Zn, COD, NO_3, Chloride, Cr-Hexavalent, Cu, Bacteria, Coliform group.

2) Method of determination

Methods and/or apparatuses adapted to determine the concentration of each constituent are as follows;

pH	: pH-meter (Glass electrode GST-5211c)
Na	: Ion-meter (Ion electrode Na-115B)
K	: Ion-meter (Ion electrode K-135)
Ca	: Ion-meter (Ion electrode Ca-135)
Cl	: Ion-meter (Ion electrode Cl-125B)
F	: Ion-meter (Ion electrode F-125)
NO_3-N	: Ion-meter (Ion electrode N-135)
NO_2-N	: Colorimetric method (Simplified Testing Kit)
NH_4-N	: Do. (in the dry season, HACH's portable colorimeter was used)
Total Fe	: Do.
Zn	: Do.
MO-Alkalinity	: Titrimetric Method (Hach Titrator)
Total Hardness	: Titrimetric Method (Simplified Testing Kit)
Mg	: Calculation (rainy season), Titrimetric Method (dry season)
SiO_2	: Colorimetric method (HACH's portable colorimeter)

In order to determine the concentration of major ions, each ion-electrode was employed in combination with the reference-electrode HS-305-DS. Prior to the determination, calibration of the apparatuses was carried out, using the standard solutions.

In case of the pH-meter, three different standard solutions were used for the calibration; i.e. those of pH 4, 7 and 9. Two different concentration levels, such as 10 ppm and 1,000 ppm or 1 ppm and 100 ppm of the standard solutions, were applied for the calibration of the ion-meter.

Ion-electrode does not indicate the concentration directly but the activity and/or strength of the specific ion. Therefore, only in a case that activity of an ion in a water sample is kept in the same activity of a standard solution, the concentration of the ion can be obtained and/or calculated because it is proportional to the activity indicated by the ion-meter.

For the purpose of determination of the ionic concentration accurately, ionic strength adjuster added equally to the standard solution and the sampled water in the volume rate of one to ten.

On the other hand, in the dry season, MPH prepared HACH's new portable analytical apparatus and MILLI-PORE's precise filtering type Coliform testing apparatus in the Comayagua laboratory, and utilized them effectively.

III. RESULTS OF ANALYSIS

3.1 General

Obtained values from the various determinations performed by the different laboratories were summarized as shown in Table 2.2.1 to 2.2.3.

In case of the field activity in the rainy season, as shown in Table 2.2.1, 26 samples including five river water were applied for the physical and chemical analyses, and 14 items of constituents were determined. However, it should be noted that the Mg ion concentrations are the calculated value based on the concentrations of Ca ion and Total Hardness and the concentration of sulfate (SO_4) ion could not be determined due to shortage of reagent in the food control laboratory in Tegucigalpa.

It is rather difficult to outline the chemical properties of the surface and/or ground water without the sulfate data. The characteristics of surface and/or ground water are classified according to the composition of cation and anion, and sulfate ion plays an important role as a constituent of anion.

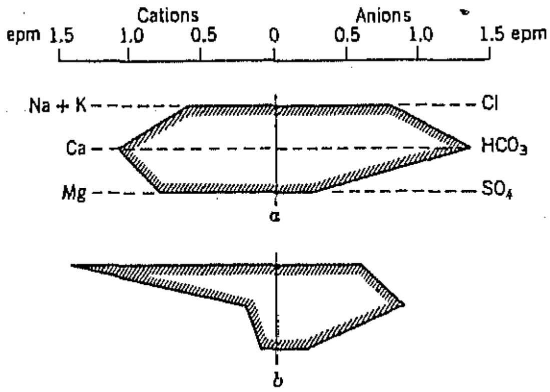
To improve the said condition, 24 items including SO_4 and Mg were analyzed on 26 water samples which comprise 21 samples of existing wells and 5 samples of river water, in the dry season (see Table 2.2.2).

In addition, water samples from the test wells, comprising of 5 samples at the end of continuous pumping test and 4 in-situ samples as shown in Table 2.2.3, were collected also in the dry season.

1) Stiff Diagram

Chemical analyses of a large number of samples yield an unwieldly mass of data. As a result, various graphs and maps are prepared for the purpose of summarizing the salient facts derived from the analyses. Among those drawings, resulting diagrams commonly known as Stiff Diagrams are very useful when a rapid qualitative comparison of many analyses is required.

Stiff Diagrams, as shown in the figure below, have three parallel equally spaced coordinate axes, upon which determined values of six major ions are plotted. The total of these six ions amounts to 95 to 99% of total solute dissolved in natural and unpolluted water. Connecting these six points, concave and/or convex hexagonal shape will be obtained, and the shape and size vary according to the composition ratio and concentration of constituent ions.



Stiff Diagrams which are prepared on the basis of the analysis results of 31 surface and/or ground water samples in the Comayagua basin, are shown in Fig. 3.1.1 to 3.1.2. Comparing the shapes and sizes of diagrams, it is understood that the surface and/or ground water in the study area have rather obvious characteristics probably corresponding to the hydrogeological condition. Further discussions will be made based mainly on the diagrams, and the characteristic of each constituent of water is described in the following clauses.

3.2 Chemical Properties of the Water

1) Water temperature

Temperature of the surface and/or ground water in the study area varies in the range as shown below;

	River water (°C)		Water from Well (°C)	
	Rainy	Dry	Rainy	Dry
Max.	27.0	26.0	31.0	31.0
Min.	22.0	19.0	24.5	25.0
Mean	25.1	22.6	27.9	26.9

The mean value of the river water is about 3 to 4 °C lower than that of the water sampled from the existing wells, and this suggests that the river water originating from the rainfall in the surrounding mountains runs off and/or reaches to the basin in a short time lag.

Considering a wide variation in the ground water temperature, it seems very probable that the hydrogeological environment remarkably affects the water temperature. On the other hand, seasonal fluctuation on the water temperature of ground water is not clear.

2) The pH value

Result of measurement of pH is summarized below;

	River water		Water from Well	
	Rainy	Dry	Rainy	Dry
Max.	8.0	8.80	7.75	8.10
Min.	7.2	7.40	6.8	6.80
Mean	7.5	8.20	7.2	7.2

In general, the pH value of water which contains few amount of dissolved solids tends to lean towards the acidic side due to dissolution of carbon in the dioxide-bicarbonate-carbonate system. Therefore, it is supposed that the relatively high pH values of the river water were derived from the existence of minute suspended substances, probably Kaoline or Montmorillonite, which could easily pass through the No. 5A filter paper and give the filtered water pale yellow tint.

The mean pH value of the well water is in slightly alkalic side, while several samples show the pH value of slightly acidic side, suggesting a rapid infiltration of surface water into underground.

The obtained pH values of ground water are within the desirable level for drinking use according WHO's standard (1971).

3) Electric and/or specific conductance (EC)

Measurement result of EC is summarized below;

	River water (micro-mho/cm, 25°C)		Water from Well (micro-mho/cm, 25°C)	
	Rainy	Dry	Rainy	Dry
Max.	170	184	3906 (1001)*	930
Min.	43	47	176 (176)*	131
Mean	74	87	733 (574)*	487

* Figures in parentheses are obtained excluding the data of No. 35 well.

The electric conductivity of the water is proportional to the sum of dissolved ions, and ordinarily the total of all the ions is nearly equal to the sum of Na, K, Mg, MO-Alkalinity, Cl and SO_4. Accordingly, It is very probable that the EC value is well concordant with the Hardness of water (see Table 3.2.5). In addition, EC of water is related also to water temperature when the measurement of EC is made.

In case of the measurement result of the rainy season, the extraordinary high EC value detected from the water of No. 35 well pushes up the mean EC value of the ground water. Exclusive of this data, as shown in the table described above, the mean EC value is calculated as 574 micro-mho/cm at 25 °C.

EC values of the river water are generally very low, reflecting very few amount of dissolved ionized substances, while the well water shows considerably high EC values. It seems that, as soon as the surface water infiltrate into underground of the study area, the water rapidly dissolves the substances from the stratum along water pass which mainly consists of the Diluvial lake deposits and contains ample soluble inorganic substances.

Water from No. 35 well, showing extraordinary high EC value, probably indicates the local particular hydrogeological condition characterized by the concentration of carbonate rocks such as marl, and so on. Judging only from the EC value, the water from this well is to be out of consideration for the portable use.

As shown in Tables 2.2.1 and 2.2.3, the average EC value of river water in the dry season is slightly larger than that in the rainy season. On the other side, the average value of the ground water in the rainy season somewhat larger than that in the dry season.

The EC map of the ground water is shown in Fig. 3.2.1 where the areas with low and high EC values are bordered by the line of 100 micro-mho/cm. Since the distribution of the areas with high EC ground water seems to have no relation with the configuration of ground surface, it is supposed that the great amount of the dissolved solids are irregularly supplied from the Quaternary deposits.

On the other hand, judging from the result of the periodical measurement of the EC value, seasonal change of the EC is not clear in the ground water circumstances of the Study Area (ref. the section 4.1.4 of the Main Report).

4) Cation (Na, K, Ca, Mg)

Results of the determination of Cation, i.e. Na, K, Ca and Mg, are summarized in the following tables;

a. Na

	River water (mg/litre)		Water from Well (mg/litre)	
	Rainy	Dry	Rainy	Dry
Max.	39	8.5	900	125
Min.	2.9	3.5	13	9.2
Mean	11.6	6.0	86.5	44.2

b. K

	River water (mg/litre)		Water from Well (mg/litre)	
	Rainy	Dry	Rainy	Dry
Max.	5.2	4.4	95	26
Min.	1.5	0.9	1.7	3.3
Mean	3.4	2.6	18.2	13.2

c. Ca

	River water (mg/litre)		Water from Well (mg/litre)	
	Rainy	Dry	Rainy	Dry
Max.	29	34	105	96.9
Min.	2.2	2.8	5.2	6.0
Mean	7.8	9.8	52.6	46.0

d. Mg

	River water (mg/litre)		Water from Well (mg/litre)	
	Rainy	Dry	Rainy	Dry
Max.	6	3.9	43	41.0
Min.	1	0.7	3	1.7
Mean	2.6	1.66	17.4	11.2

The range of various cation concentrations above-mentioned suggests that the surface water dissolves ions, especially Ca and Na ions, from the surrounding lake deposits, in the process of filtrating into underground and during the prolonged subsurface journey to the wells.

Table 3.2.3 shows the proportion of individual ions among the total amount of cation quantitatively determined, namely the per cent constituents of cation.

In the rainy season, relatively great amount of suspended yellow minute particles gives yellow tint to the sample water from the river-

44. In such case, the sampled water is usually characterized by the high pH value and the extraordinary low concentration of anion which might be equilibrate with cation. The total cation of the water amounts 2.08 me/litre, while the sum of Cl and Alkalinity is 0.60 me/litre, as known from Table 3.2.3. Although, in order to hold the electric balance, this results forces the existence of sulfate ion in a amount of some 70 mg/litre in this water, it is very doubtful that such high concentration is dissolved in the surface water comparing to the other analysis results and following the further discussion described below.

As for the singularity of the water sample from the river-44, it is considered that the high concentration of Na ion is caused by the existence of Na saturated clay minerals. The clay minerals easily pass through the No. 5C filter paper, and when the determination of Na concentration is made by means of the ion-meter, the ion-electrode detects the high density of Na ions adsorbed on the surface of clay particles.

These Na ions attract OH^- ions around them, and locally the electric equilibrium is held. Accordingly, the pH electrode senses the high density of OH^- ions and indicates high pH value.

As shown in Tables 3.2.1, 3.2.3 and 3.2.5, in case of river water, the average percentage of (Ca+Mg) increases slightly in the rainy season, while the cation composition of the ground water does not show remarkable difference between the dry and rainy season.

The average cation concentration of well water indicates that the (Ca+Mg) ions are slightly predominant over (Na+K) ions. In general, however, the Soft water with low EC value shows the less concentration of (Na+K) than that of (Ca+Mg), while the Hard water with high EC value contains the larger amount of (Ca+Mg) in mol ratio than (Na+K).

5) Anion (Cl, MO-Alkalinity and SO_4)

There exists various constituents of anion, and they are classified into such two groups as the group 1 consisting of MO-Alkalinity, Carbon-Dioxide, Bicarbonate, Carbonate system) and the group 2 of NO_2, NO_3, F^-, PO_4 and other trace anion.

Except for waste water and highly contaminated surface/ground water, the concentrations of anion contained in the group 2 are usually so low as to affect the balance between total amount of anion and cation. Therefore, the total anion results in summing up MO-Alkalinity, Cl and SO_4, in the same manner as the total cation is obtained by totaling Na, K, Ca and Mg. Those constituents is principally expressed in the unit of me/litre. Relating to almost all of surface and/or shallow ground water, total values of both anion and cation are nearly equal to the identical sample.

In the rainy season, MO-Alkalinity and Cl were determined actually, and the results of analyses are shown in Table 2.2.1. Based on the obtained data, it is theoretically possible to estimate the concentration of the sulfate ion; that is, summing up the values of Cl and MO-Alkalinitya first, and subtract the sum from the total cation. The result of the estimation adapted for the identical samples are shown in Table 3.2.4. In case that the balance between the total cation and the total anion is well kept in the sampled water, it is considered that the resultant indicates the concentration of the sulfate ion. Among the 26 samples, however, calculation results of eight samples show minus value. It is supposed that little sulfate exists in those samples and/or the determinations were incorrect, and in the remaining 18 samples, fairly large amount of sulfate exists.

The ionic composition of anion in dry season is shown in Tables 3.2.2, 3.2.4 and 3.2.5. Consequently, it is concluded that the predominant ion among the generally important anion is MO-Alkalinity, and it occupies about 70 % of total anion both for the river water and the well water (see Fog. 3.2.2).

6) Relationship between cation and anion

The mean value of MO-Alkalinity shows 0.8 to 0.75 me/litre in case of the river water, and 5.15 to 4.39 me/litre of the ground water. Summarily in relation to the dominant constituents of cation such as Na and Ca, large differences between the river water and the ground water are found as summarized below;

	Cation (Na+Ca,me/l)		Anion (MO-Alkalinity,me/l)	
	Rainy	Dry	Rainy	Dry
River Water	0.9	0.75	0.8	0.75
Well Water	6.4	4.77	5.15	4.39

Those obtained values suggests that, once the surface water infiltrates into underground, (Na+Ca) and Carbonate are dissolved simultaneously from the diluvial lake deposits, and as the water flows along the said geological condition, the dissolution continues with increase of the total ion concentration, keeping the balance between the total cation and the total anion.

7) Water quality of newly drilled test wells

The analysis results of the pumped water from the test wells are shown in Table 2.2.3. From the view point of hydrogeology, the pumped water can be divided into such two groups as (1) the water collected from TW-01 and TW-03, and (2) the water from TW-02, TW-04 and TW-05.

The water samples which belong to the first group are characterized by the great amount of dissolved solids, high EC values and high concentration of ammonium ion. (Na+K) ions occupy about 75 % of cation and MO-Alkalinity occupies 72 % to 88 % of anion.

On the other side, the second group shows no sign of anaerobic environment. (Ca+Mg) content of TW-02 occupies 84 % of the cation, and MO-Alkalinity occupies 87 % of the anion content. Almost all of the cation, in case of TW-04, are occupied by (Na+K) ions, whereas, with respect to anion, the amount of MO-Alkalinity and ($Cl+SO_4$) is approximately equal. TW-05 yields the Soft water with low EC value and few dissolved solids, which is the most suitable for potable use (see Table 3.2.5).

3.3 Characteristics affecting Human Health

1) Coliform group bacteria

The determinations of coliform group bacteria were performed by the portable laboratory in Comayagua. The results are shown in Table 2.2.1 to 2.2.3.

In the rainy season, Coliform group bacteria is found in 18 samples, while 20 samples were tested. The bacterial counts of three samples are too numerous to count. This was partly caused by the unskilled procedures in the determination. The method employed for the determination is the membrane filter method which is prescribed in the eleventh edition of "the standard method for the examination of water and waste water".

Although, no fecal Coliform were found in the samples of No. 33 well (sample No. 6) and No. 154 well (No. 9), 0.8 mg/l of NH_4-N which is the maximum value among 20 samples and 2.64 mg/l of NO_2-N were detected in the latter sample. The co-existence of ammonium and nitrite ions in an identical sample water indicates the strong contamination caused by human excrement. Considering the environments of these wells and the actual condition of usage, it is said that the determination results of these two water samples are unreliable. However, needless to say, it is not concluded that all the well water are contaminated by the migration of bacteria from the ground surface.

On the other side, in the dry season, Total coliform or fecal coliform were detected from all the surface water samples, while in 12 samples of 15 well water samples, total coliform and fecal coliform were also detected, indicating the sign of the migration of surface water into the well.

In case of the newly drilled test wells, since a few or none of total coliform were founded, it is judged that water from these wells are good quality with regard to microbiology.

As a result of the above discussion, regular dosage of calcium-hypochlorite and improvement of structures are recommended for all the wells.

2) Nitrite, Nitrate and Ammonium ions

Determination results of nitrite, nitrate and ammonium ions are shown in Table 2.2.1 to 2.2.3 and 3.2.7, in which all the results examined at two or three laboratories are described together in order to compare the obtained value and accuracy.

In "the international standards for drinking water" prepared by WHO (1963 and 1971), the desirable and/or maximum allowable values on nitrite and ammonium ions are missed. According to the standard, the "drinking water" is defined as the supplied water with treatment, i.e. the water filtered, settled and sterilized with chlorine gas. In the process of chlorination, ammonium and nitrite easily oxidized to nitrate. As a result, only one criterion of the nitrate concentration is necessary in case of the treated water, and WHO recommended under 10 ppm for the desirable value of the nitrate ion.

However, in the study area, the well and/or river water is supplied for portable use without treatment. In such a case, criterion on nitrite and ammonium ions are to be prescribed. Therefore MPH recommends the desirable value of nitrite to be "0 to trace" for the potable water, and has tentatively provided a criterion on the nitrate concentration in potable water to be 15 ppm.

According to the analysis results of both seasons, of four samples from the existing wells and one sample of the test well, the nitrate concentration exceeds 10 ppm. Applying the Honduran criterion, two samples of existing wells W-32 and W-5 exceed this criterion.

Nitrite and ammonium ion were detected in almost all the water samples. It is ordinarily well known that coexistence of ammonium ion and nitrite ion indicates a contamination by animal or human excretion, but it seems too hasty to conclude that the surface and/or shallow ground water are completely contaminated, because ammonium ion can be fed into the ground water from anaerobic state probably caused by the diluvial lake sediment rich in organic material (see Table 3.2.6 and Fig. 3.2.3).

3) Fluoride ion

Results of the analysis are shown in Table 2.2.1. According to WHO's standard, the desirable value for drinking water is under 1.5 ppm. MPH recommends the same value, and only one sample (No. 35 well) exceeds this criterion.

According to the analysis results of both seasons, it is very probable that content of fluoride does not exceed the standard value of WHO or MPH in general. Consequently, it is concluded that the serious problem on fluoride content does not exist for potable use.

4) Phosphate ion

Concentration of phosphate ion is in a range from 0 to 2.0 ppm. Average concentrations of river water and ground water are 0.1 ppm and 0.49 ppm, respectively. It is inferred that the origin of the phosphate in the river or well water is detergents or fertilizer, considering the present condition of the ground water usage. At many existing wells, it is frequently observed that waste water of washing poured into the wells.

5) Zinc

In case of zinc, WHO prescribed such standards as 5.0 ppm of the desirable value and 15.0 ppm of the maximum allowable value for drinking water, and MPH followed the standards of WHO.

As shown in the analysis results (Table 2.2.1), four samples among all the samples show relatively high concentrations of zinc which are approximately equal to and/or exceeding the criterion. Considering that the concentrations were obtained by means of the simplified testing kit, more accurate analytical method is strongly requested in the next field investigation.

6) Total dissolved solids (TDS)

Relating to the TDS, U.S. Public Health Service prescribed in the "Drinking Water Standards" that the concentration of TDS should be within 500 ppm, and Japanese Standards for drinking water adopt the same value.

According to the results of analysis in dry season, TDS values of existing wells; W-63, W-109, W-122 and W-149, exceed this limit, showing rather high EC values more than 700 micro-S/cm.

IV. CONCLUSION AND RECOMMENDATION

1) The river water which pours into Comayagua basin from the surrounding mountains is characterized by the soft water and/or low concentration of inorganic ions, and is generally suitable for potable use except for the existence of coliform. However, as soon as the river water flows into the flat plain, it infiltrates into the subsurface sediments and leaches out various inorganic matters and becomes the Hard water with high concentration of dissolved solids.

2) In the Alluvial fan deposits spreading northeast and northwest of the Study Area, it is found that inorganic ion concentrations of the ground water are relatively low and the water is suitable for potable use.

3) In the center to northern area of the basin, the ground water in relatively shallow aquifers are applicable to potable use, while the deep ground water is unsuitable for potable use due to high concentration of ammonium ion resulted from the anaerobic environment.

4) Since various kinds of waste water easily infiltrate into the subsurface sediments surrounding the shallow dug wells, the polluted water is finally mixed with the shallow ground water or the well water. In addition, it was inspected through the field investigation that animals freely access to almost all the existing wells, and therefore, it is very difficult to keep the wells clean. Garbage and animal excrement were occasionally observed at some wells.

5) Considering the present condition of the ground water usage at the rural areas, the well environment and the well structure should be urgently improved by means of, for example, fence installation and concrete pavement around the well, and construction of sewage ditch paved with concrete. In addition regular dosage of calcium hypochlorite for all wells are recommended.

6) Although MPH had prepared the regional laboratory in Comayagua for the analysis of potable water supply, it seems that facilities and apparatus in the laboratory and skill of operators are not adequate so far. Therefore, it is strongly recommended that the improvement of laboratory facilities should be pursued as early as possible and training of operators should be continued so far as they become sufficiently skillful.

Tables

Table 2.2.1 (1) RESULTS OF WATER QUALITY ANALYSIS PERFORMED IN RAINY SEASON (MIDDLE JUNE,1988) (1/3)

No.	Sample Date	Sample Site	W.Temp ^{o}C	EC (microS/cm) in-situ	EC (microS/cm) at $t=25^{o}C$	PH Ref.1	Na mg/l Ref.2	K mg/l Ref.2	Ca mg/l Ref.2	Mg mg/l Ref.3	Cl mg/l Ref.2
1	6/21	R-5	22.0	160	171	8.00	2.9	1.5	29	6	4.3
2	6/21	R-14	27.0	66	63	7.50	7.2	5.2	2.9	2	4.9
3	6/21	R-19	25.0	47	47	7.65	4.3	3.2	2.2	1	4.2
4	6/21	R-25	26.5	46	45	7.30	4.5	3.7	2.2	2	3.6
5	6/20	R-44	25.0	43	43	7.22	39	3.5	2.5	2	4.3
1	6/21	W-2	27.0	220	211	6.55	21	9	12	5	21
2	6/17	W-6	29.5	1100	1001	7.15	104	10	42	38	35
3	6/21	W-8	29.0	380	349	7.15	21	1.7	49	12	2.7
4	6/21	W-16	27.5	470	445	7.85	31	22	52	9	5.5
5		W-21									
6	6/20	W-26	27.0	760	728	7.40	50	30	65	25	59
7	6/20	W-28	25.5	270	267	6.95	15	9	31	7	7.5
8	6/20	W-32	26.0	710	695	7.22	17	11	100	35	22
9	6/20	W-33	28.5	220	204	6.95	21	4.5	13	10	4.7
10	6/21	W-35	28.5	4200	3900	7.75	900	95	92	11	180
11	6/18	W-51	27.0	540	517	6.85	36	9.3	60	13	8
12	6/18	W-63	30.0	700	631	7.35	58	24	55	9	11
13	6/21	W-81	28.0	600	563	7.05	70	20	38	11	18
14	6/21	W-87	28.5	410	381	7.05	45	26	22	4	10
15	6/21	W-92	26.0	180	176	6.95	21	8.9	5.2	7	3.2
16	6/17	W-109	28.0	920	863	7.05	73	21	70	26	18
17	6/18	W-122	29.0	835	767	6.95	43	5	95	22	9
18	6/21	W-126	27.5	980	929	7.25	30	17	105	43	11
19	6/20	W-141	27.0	660	632	6.80	47	20	58	28	10
20	6/17	W-142	31.0	1000	883	7.45	105	23	38	6	33
21	6/21	W-149	24.5	800	809	7.25	95	10	42	41	20
22	6/21	W-154	30.0	460	414	7.50	13	5.5	65	3	4.7

Remarks : *1 Ref.1 : Determined by glass-electrode
*2 Ref.2 : Determined by ion-electrode
*3 Ref.3 : Calculated from Ca and total Hardness
All the items were analyzed by JICA Study Team.

Table 2.2.1 (2) RESULTS OF WATER QUALITY ANALYSIS PERFORMED IN RAINY SEASON (MIDDLE JUNE,1988) (2/3)

No.	Sample Date	Sample Site	NO_3-N mg/l Ref.2	NO_2-N mg/l Ref.4	F mg/l Ref.2	NH_4-N mg/l Ref.4	Total-Fe mg/l Ref.4	Zn mg/l Ref.4	PH4.8-Alkal. mg/l as $CaCO_3$ Ref.5	Total Hardness mg/l as $CaCO_3$ Ref.5
1	6/21	R-5	0.8	<0.006	0.1	<0.4	<0.2	<0.5	80	95
2	6/21	R-14	0.9	<0.006	0.1	0.5	<0.2	0.5	31	15
3	6/21	R-19	1.3	<0.006	0.1	<0.4	<0.2	<0.5	33	10
4	6/21	R-25	0.9	<0.006	0.1	<0.4	0.2	<0.5	32	13
5	6/20	R-44	1.0	<0.006	0.1	0.5	<0.2	0.5 - 1.0	24	15
1	6/21	W-2	5.5	<0.006	0.1	0.5	0.2	<0.5	64	50
2	6/17	W-6	2.7	<0.006	0.4	<0.4	<0.2	5	466	260
3	6/21	W-8	1.3	<0.006	0.4	<0.4	<0.2	<0.5	160	170
4	6/21	W-16	1.1	<0.006	0.4	<0.4	0.2	<0.5	242	165
5		W-21								
6	6/20	W-26	4.8	<0.006	0.3	<0.4	<0.2	<0.5	298	265
7	6/20	W-28	1.6	0.02 - 0.006	0.2	<0.4	<0.2	5.0	144	105
8	6/20	W-32	7.7	0.1 - 0.03	0.2	<0.4	<0.2	<0.5	248	395
9	6/20	W-33	2.8	0.02 - 0.006	0.3	<0.4	<0.2	5.0	108	75
10	6/21	W-35	36	0.02	4.5	<0.4	<0.2	<0.5	468	275
11	6/18	W-51	1.9	<0.006	0.5	<0.4	<0.2	0.5	236	205
12	6/18	W-63	1.7	0.02 - 0.006	0.2	1.6 - 2.0	<0.2	<0.5	292	175
13	6/21	W-81	2.5	<0.006	0.4	<0.4	<0.2	0.5	192	140
14	6/21	W-87	2.4	<0.006	0.4	<0.4	<0.2	<0.5	168	70
15	6/21	W-92	0.6	<0.006	0.3	<0.4	<0.2	2.0	106	40
16	6/17	W-109	3.7	<0.006	0.2	<0.4	<0.2	0.5	351	280
17	6/18	W-122	2.3	0.05 - 0.015	0.9	<0.4	<0.2	2.0	336	330
18	6/21	W-126	3.0	<0.006	0.6	<0.4	<0.2	<0.5	284	440
19	6/20	W-141	1.7	<0.006	0.3	<0.4	0.5	2.0	458	260
20	6/17	W-142	2.8	0.05 - 0.015	1.4	<0.4	<0.2	<0.5	380	120
21	6/21	W-149	2.4	<0.006	1.1	<0.4	<0.2	5.0 - 10.	260	275
22	6/21	W-154	1.4	0.2 - 0.06	0.2	<0.4	<0.2	<0.5	216	175

Remarks ; *1 Ref.2 : Determined by ion-electrode
*2 Ref.4 : Determined by the simplified testing kit(pack-test)
*3 Ref.5 : Determined by titration
All the items were analized by JICA Study Team.

Table 2.2.1 (3) RESULTS OF WATER QUALITY ANALYSIS PERFORMEO IN RAINY SEASON (MIDDLE JUNE,1988) (3/3)

No.	Sample Site	Organic Material (mg/l)	Total Coliform Filtered Volume (ml)	Coliform Colonies (nos.)	Col.Density in 100 ml (nos.)	Observations
1	R-5	0.0	2	32	1600	
2	R-14	13.6	2	12	600	
3	R-19	4.0	2	25	1250	
4	R-25	6.4	5	23	460	Campo lleno
5	R-44	13.6	3	2	65	Campo lleno
1	W-2	1.6	2	*2	*1	Campo lleno total
2	W-6					
3	W-8	0.0	5	10	200	Disperasas
4	W-16	0.0	5	3	60	Disperasas
5	W-21					
6	W-26	12.0	1	12	1200	
7	W-28	0.0	1	8	800	
8	W-32	0.8	3	*1	*1	U.S.Formation de B
9	W-33	1.6	0.5	0	0	
10	W-35	4.8	5	7	140	
11	W-51					
12	W-63					
13	W-81	4.0	4	8	200	Campo lleno total
14	W-87	2.4	5	*1	*1	Campo lleno total
15	W-92	0.0	3	7	233	Disperasas
16	W-109					
17	W-122					
18	W-126	0.0	5	8	160	
19	W-141	0.0	0.5	12	2400	
20	W-142					
21	W-149	8.0	5	3	60	Disperasas
22	W-154	8.0	5	0	0	2 Colonias

Remarks : *1 : No se pudo leer *2 : No se pudo leer campo lleno
U.S.Formation de B : Una sola formacion de bacterias
All the items were analized by MPH counterpart.

Table 2.2.2 (1) RESULTS OF WATER QUALITY ANALYSIS PERFORMED IN DRY SEASON (END JANUARY, 1989) (1/3)

No.	Sample Date	Sample Site	W.Temp °C	EC (microS/cm) in-situ	EC (microS/cm) at t=25°C	PH	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Cl mg/l	SO_4 mg/l	SiO_2 mg/l
1	1/26	R-5	19.0	160	184	8.40	3.5	0.9	34.0	3.9	2.6	17	35
2	1/26	R-14	24.0	46	47	8.40	4.2	2.1	2.8	1.0	3.1	2	57.5
3	1/26	R-19	24.0	53	54	8.80	5.5	3.2	3.2	0.7	3.1	6	70
4	1/25	R-25	26.0	79	77	8.00	8.5	4.4	4.4	1.0	3.2	2	75
5	1/25	R-44	20.0	63	71	7.40	8.5	2.6	4.4	1.7	2.8	40	54
1	1/25	W-2	25.0	160	160	6.00	21	6.2	6.0	2.2	12	14	100
2		W-6											
3		W-8											
4	1/26	W-16	26.0	440	431	8.00	31	20	44.8	14.1	5.5	-	137.5
5	2/17	W-21	28.5	500	464	6.80	58	17	29.0	6.6	54.0	47	
6	1/25	W-26	25.0	730	730	7.30	56	26	71.3	16.5	52	18	157.5
7	1/25	W-28	26.0	380	372	6.80	21.5	11.5	48.0	5.1	6.5	43	112.5
8	1/25	W-32	29.0	730	671	6.90	18	10	96.9	16.5	25	80	65
9	1/25	W-33	28.0	140	131	7.00	9.2	3.3	10.0	2.2	3.7	12	77.5
10		W-35											
11	1/26	W-51	26.0	270	264	7.10	14	6.4	30.4	9.7	9.5	33	82.5
12	1/26	W-63	29.0	790	726	7.50	51	23	78.5	10.7	17.5	-	112.5
13	1/26	W-81	26.0	460	450	7.10	40	16	35.2	4.9	18	2	157.5
14	1/26	W-87	26.0	330	323	7.10	41	21.5	12.8	1.9	18	14	142.5
15	1/26	W-92	26.0	140	137	7.10	17	8.2	6.4	1.7	3.5	-	160
16	1/25	W-109	25.0	750	750	7.50	105	19	75.3	23.6	14.5	170	155
17	1/26	W-122	26.0	950	930	8.10	125	7	51.3	41.0	10	200	92.5
18		W-126											
19		W-141											
20		W-142											
21	1/25	W-149	28.0	900	844	7.20	85	10.5	73.7	14.6	15.5	135	127.5
22	1/26	W-154	31.0	460	406	7.40	14.5	5.1	66.4	8.5	3.8	24	97.5

Remarks ; All the items were analized by JICA Study Team except for SO_4

Table 2.2.2 (2) RESULTS OF WATER QUALITY ANALYSIS PERFORMED IN DRY SEASON (END JANUARY, 1989) (2/3)

No.	Sample Date	Sample Site	NO_3-N*2 mg/l	NO_2-N*2 mg/l	F*1 mg/l	NH_4*2 mg/l	NH_4-N*2 mg/l	Total-Fe mg/l	Zn mg/l	PH4.8-Alkal.*1 mg/l as $CaCO_3$	Total Hardness*3 mg/l as $CaCO_3$	PO_4*2 mg/l
1	1/26	R-5	4.4	0.01	0.12	0.167	0.13			94.9	101	0.07
2	1/26	R-14	3.54	0.0165	0.06	0.1806	0.14			17.0	11	0.08
3	1/26	R-19	8.8	0.0109	0.08	0.064	0.05			21.1	11	0.0
4	1/25	R-25	4.4	0.0109	0.1	0.296	0.23			31.1	15	0.3
5	1/25	R-44	6.16	0.016	0.1	0.0387	0.03			24.1	18	0.03
1	1/25	W-2	4.4	0.033	0.08	0.516	0.4			40.0	24	0.3
2		W-6										
3		W-8										
4	1/26	W-16	6.6	0.008	0.35	0.038	0.03			233.0	170	0.09
5	2/17	W-21	3.0	3.4		0.04		1.5		160.0	100	0.4
6	1/25	W-26	4.4	0.01	0.26	0.129	0.1			270.5	246	0.05
7	1/25	W-28	8.8	0.016	0.16	0.051	0.04			131.0	141	0.5
8	1/25	W-32	35.2	0.01	0.18	0.193	0.15			177.0	310	0.56
9	1/25	W-33	0	0.01	0.25	0.038	0.03			42.4	34	0.3
10		W-35										
11	1/26	W-51	0	0.008	0.20	0.683	0.53			93.0	116	0.45
12	1/26	W-63	0	0	0.26	8.256	6.4			375.0	240	0.35
13	1/26	W-81	13.2	0.009	0.21	0.09	0.07			147.0	108	0.32
14	1/26	W-87	11.0	0.01	0.25	0.154	0.12			106.0	40	0.1
15	1/26	W-92	5.28	0.0109	0.26	0.18	0.14			69.6	23	0.63
16	1/25	W-109	13.2	0.016	0.25	0.129	0.1			334.0	285	0.6
17	1/26	W-122	4.4	0.0165	1.55	0.412	0.32			385.0	296	0.15
18		W-126										
19		W-141										
20		W-142										
21	1/25	W-149	5.28	0.01	1.05	0.064	0.05			297.0	244	0.05
22	1/26	W-154	3.5	0.128	0.20	0.528	0.41			202.0	201	0.24

Remarks ; *1 : analized by JICA Study Team.
*2 : analized by MPH counterpart.
*3 : calculated from concentrations of Ca and Mg ions.

Table 2.2.2 (3) RESULTS OF WATER QUALITY ANALYSIS PERFORMED IN DRY SEASON (END JANUARY, 1989) (3/3)

No.	Sample Site	Organic Material (mg/l)	Total Coliform (1) Filtered Volume (ml)	Total Coliform (2) Coliform Colonies (nos.)	Total Coliform (3) Col.Density in 100ml (nos.)	Coliform Fecales Sample-1 (1) Fil.Vol.	Sample-1 (2) Col.Colo.	Sample-1 (3) Col.Dens.	Sample-2 (1) Fil.Vol.	Sample-2 (2) Col.Colo.	Sample-2 (3) Col.Dens.	Mean of Col.Dens.
1	R-5	2.3	0.2	4	2000	0.1	2	2000	0.5	3	600	1300
2	R-14	8.0	0.1	3	3000	0.5	2	400	0.5	35	7000	3700
3	R-19	2.4	0.1	1	1000	0.1	2	2000	0.5	15	3000	2500
4	R-25	0.8	0.2	5	2500	0.1	2	2000	0.5	4	800	1400
5	R-44	1.2	0.1	0	0	0.1	91	91000	0.5	45	9000	50000
1	W-2	3.2	0.5	1	200	1.0	1	100	5.0	14	280	190
2	W-6											
3	W-8											
4	W-16	2.4	0.2	0	0	1.0	0	0	0.5	0	0	0
5	W-21											
6	W-26	10.4	5.0	68	1360	5.0	20	400	1.0	8	800	600
7	W-28	5.6	0.5	32	6400	0.2	19	9500	0.5	34	6800	8150
8	W-32	6.4	0.5	37	7400	0.5	18	3600	1.0	12	1200	2400
9	W-33	1.2	0.5	0	0	0.5	0	0	1.0	0	0	0
10	W-35											
11	W-51	16.0	0.2	4	2000	0.1	7	7000	0.5	9	1800	4400
12	W-63	28.2	0.1	53	53000	0.1	0	0	0.5	2	400	200
13	W-81	3.2	0.5	2	400	1.0	2	200	2.0	7	350	275
14	W-87	8.0	0.1	2	2000	0.1	7	7000	0.5	16	3200	5100
15	W-92	0.8	5.0	0	0	10.0	0	0	5.0	0	0	0
16	W-109	5.6	2.0	4	200	1.0	6	600	0.5	4	800	700
17	W-122	1.6	0.1	3	3000	0.1	4	4000	0.5	3	600	2300
18	W-126											
19	W-141											
20	W-142											
21	W-149		10.0	5	50	5.0	0	0	2.0	4	200	100
22	W-154	0.0	5.0	14	280	1.0	7	700	5.0	0	0	350

Remarks ; All the items were analized by MPH counterparts.

Table 2.2.3 WATER QUALITY OF TEST WELLS

No.	Sample Date	Sample Site	W.Temp °C	EC (microS/cm) in-situ	EC (microS/cm) at t=25°C	PH	Na mg/l	K mg/l	Ca mg/l	Mg mg/l	Cl mg/l	SO_4 mg/l	SiO_2 mg/l
1	2/13	TW-1	30.5	1900	1695		280.0	65.0	80.0	16.0	89.0	42.0	
2	2/16	*TW-1(23m)	29.0	1800	1654		320.0	79.0	92.0	18.0	100.0	< 5.0	
3	2/16	*TW-1(57m)	29.0	1900	1746		340.0	86.0	80.0	18.0	100.0	< 5.0	
4	1/27	TW-2	30.0	400	360	7.30	13.0	3.6	59.3	5.1	3.3	20.0	92.5
5	2/17	TW-3	29.0	850	781	6.80	130.0	27.0	30.0	10.0	84.0	25.0	
6	2/20	*TW-3(30m)	28.5	1100	1021	6.80	180.0	34.0	38.0	13.0	64.0	23.0	
7	2/20	*TW-3(48m)	28.5	1600	1486	6.70	260.0	47.0	49.0	21.0	100.0	21.0	
8	2/3	TW-4	37.0	640	506		101.0	20.0	2.3	1.6	63.0	60.0	
9	2/10	TW-5	26.0	220	215		22.0	21.0	8.9	3.8	65.0	9.8	

* : In-situ sampling

No.	Sample Site	NO_3-N mg/l	NO_2-N mg/l	F mg/l	NH_4 mg/l	NH_4-N mg/l	Total-Fe mg/l	Zn mg/l	PH4.8-Alkal. mg/l as $CaCO_3$	Total Hardness** mg/l as $CaCO_3$	PO_4 mg/l
1	TW-1	< 0.5	< 0.01		38.0		35.0		790	266	1.2
2	*TW-1	< 0.5	< 0.01		47.0		15.0		1020	304	
3	*TW-1	< 0.5	< 0.01		51.0		11.0		1040	274	0.4
4	TW-2	2.6	0.00	0.20	0.06	0.05			174	169	0.1
5	TW-3	< 0.5	< 0.01		16.0		0.2		380	116	
6	*TW-3	< 0.5	< 0.01		24.0		9.6		520	148	0.3
7	*TW-3	< 0.5	< 0.01		45.0		11.0		800	209	2.0
8	TW-4	< 0.5	< 0.01		< 0.02		0.1		150	12	0.9
9	TW-5	22.0	< 0.01		0.03		< 0.1		57	38	1.2

* : In-situ sampling ** : calculated from the concentrations of Ca and Mg ions (T.H. = 2.5*Ca + 4.1*Mg).

No.	Sample Site	Organic Material (mg/l)	Total Coliform (1) Filtered Volume (ml)	Total Coliform (2) Coliform Colonies (nos.)	Total Coliform (3) Col.Density in 100ml (nos.)	Coliform Fecales Sample-1 (1) Fil.Vol.	Sample-1 (2) Col.Colo.	Sample-1 (3) Col.Dens.	Sample-2 (1) Fil.Vol.	Sample-2 (2) Col.Colo.	Sample-2 (3) Col.Dens.	Mean (nos.)
1	TW-1		20	3	15							
2	TW-2	3.2	10	0	0	10.0	0	0	20.0	0	0	0
3	TW-3		10	20	200							
4	TW-4		30	2	7							
5	TW-5		20	6	30							

Table 3.2..1 CATION COMPOSITION OF WATER SAMPLES

--- Rainy Season (middle June, 1988) --- (uinit : me/l)

No.	Sample Site	Na	K	Ca	Mg	Total	Na+Ca
1	R-5	0.13	0.04	1.45	0.49	2.11	1.58
2	R-14	0.31	0.13	0.14	0.16	0.74	0.45
3	R-19	0.19	0.08	0.11	0.08	0.46	0.30
4	R-25	0.21	0.09	0.11	0.16	0.57	0.32
5	R-44	1.71	0.09	0.12	0.16	2.08	1.83
	Mean	0.51	0.09	0.39	0.21	1.19	0.90
1	W-2	0.91	0.23	0.61	0.41	2.16	1.52
2	W-6	4.52	0.26	2.11	3.13	10.02	6.63
3	W-8	0.91	0.04	2.45	0.99	4.39	3.36
4	W-16	1.35	0.56	2.59	0.74	5.24	3.94
5	W-21						
6	W-26	2.17	0.77	3.24	2.06	8.24	5.41
7	W-28	0.65	0.23	1.55	0.58	3.01	2.20
8	W-32	0.74	0.28	4.99	2.88	8.89	5.73
9	W-33	0.91	0.12	0.65	0.82	2.50	1.56
10	W-35	39.15	2.42	4.59	0.91	47.07	43.74
11	W-51	1.57	0.24	2.99	1.07	5.87	4.56
12	W-63	2.52	0.61	2.74	0.74	6.61	5.26
13	W-81	3.04	0.51	1.91	0.91	6.37	4.95
14	W-87	1.96	0.66	1.11	0.33	4.06	3.07
15	W-92	0.91	0.23	0.26	0.58	1.98	1.17
16	W-109	3.18	0.54	3.49	2.14	9.35	6.67
17	W-122	1.87	0.13	4.74	1.81	8.55	6.61
18	W-126	1.31	0.43	5.24	3.54	10.52	6.55
19	W-141	2.04	0.51	2.89	2.31	7.75	4.93
20	W-142	4.57	0.59	1.91	0.49	7.56	6.48
21	W-149	4.13	0.26	2.11	3.37	9.87	6.24
22	W-154	0.57	0.14	3.24	0.25	4.20	3.81
	Mean	3.76	0.46	2.64	1.43	8.30	6.40

--- Dry Season (end January, 1989) --- (uinit : me/l)

No.	Sample Site	Na	K	Ca	Mg	Total	Na+Ca
1	R-5	0.15	0.02	1.70	0.32	2.19	1.85
2	R-14	0.18	0.05	0.14	0.08	0.45	0.32
3	R-19	0.24	0.08	0.16	0.06	0.54	0.40
4	R-25	0.37	0.11	0.22	0.08	0.78	0.59
5	R-44	0.37	0.07	0.22	0.14	0.80	0.59
	Mean	0.26	0.07	0.49	0.14	0.95	0.75
1	W-2	0.91	0.16	0.30	0.18	1.55	1.21
2	W-6						
3	W-8						
4	W-16	1.35	0.51	2.24	1.16	5.26	3.58
5	W-21	2.52	0.43	1.45	0.54	4.94	3.97
6	W-26	2.44	0.66	3.56	1.36	8.02	5.99
7	W-28	0.94	0.29	2.40	0.42	4.05	3.33
8	W-32	0.78	0.26	4.84	1.36	7.24	5.62
9	W-33	0.40	0.08	0.50	0.18	1.16	0.90
10	W-35						
11	W-51	0.61	0.16	1.52	0.80	3.09	2.13
12	W-63	2.22	0.59	3.92	0.88	7.61	6.14
13	W-81	1.74	0.41	1.76	0.40	4.31	3.50
14	W-87	1.78	0.55	0.64	0.16	3.13	2.42
15	W-92	0.74	0.21	0.32	0.14	1.41	1.06
16	W-109	4.57	0.49	3.76	1.94	10.76	8.32
17	W-122	5.44	0.18	2.56	3.37	11.55	8.00
18	W-126						
19	W-141						
20	W-142						
21	W-149	3.70	0.27	3.68	1.20	8.85	7.38
22	W-154	0.63	0.13	3.31	0.70	4.77	3.94
23	TW-1	12.18	1.66	3.99	1.32	19.15	16.17
24	TW-2	0.57	0.09	2.96	0.42	4.04	3.53
25	TW-3	5.65	0.69	1.50	0.82	8.66	7.15
26	TW-4	4.39	0.51	0.11	0.13	5.14	4.50
27	TW-5	0.96	0.54	0.44	0.31	2.25	1.40
	Mean	2.60	0.42	2.18	0.85	6.04	4.77

Table 3.2.2 ANION COMPOSITION OF WATER SAMPLES

--- Rainy Season (middle June,1988) --- (unit : me/l)

No.	Sampl Site	(1) M-O Alk	(2) Cl	(3) (1)+(2)	(4) Total C	(4)-(3)	Estimat. Sulfate
1	R-5	1.61	0.12	1.73	2.11	0.38	0.38
2	R-14	0.62	0.14	0.76	0.74	-0.02	
3	R-19	0.66	0.12	0.78	0.46	-0.32	
4	R-25	0.64	0.11	0.75	0.57	-0.18	
5	R-44	0.48	0.12	0.6	2.08	1.48	1.48
	Mean	0.8	0.12	0.92	1.19		0.93
1	W-2	1.28	0.59	1.87	2.11	0.24	0.24
2	W-6	9.32	0.99	10.31	10.02	-0.29	
3	W-8	3.21	0.08	3.29	4.39	1.1	1.1
4	W-16	4.84	0.16	5	5.24	0.24	0.24
5	W-21						
6	W-26	5.96	1.66	7.62	8.24	0.62	0.62
7	W-28	2.88	0.21	3.09	3.01	-0.08	
8	W-32	4.96	0.62	5.58	8.89	3.31	3.31
9	W-33	2.18	0.13	2.31	2.5	0.19	0.19
10	W-35	9.36	5.08	14.44	47.07	32.63	32.63
11	W-51	4.72	0.23	4.95	5.87	0.92	0.92
12	W-63	5.84	0.31	6.15	6.61	0.46	0.46
13	W-81	3.84	0.51	4.35	6.37	2.02	2.02
14	W-87	3.36	0.28	3.64	4.06	0.42	0.42
15	W-92	2.12	0.09	2.21	1.98	-0.23	
16	W-109	7.02	0.51	7.53	9.35	1.82	1.84
17	W-122	6.72	0.25	6.97	8.55	1.58	1.58
18	W-126	5.68	0.31	5.99	10.52	4.53	4.53
19	W-141	9.16	0.28	9.44	7.75	-1.69	
20	W-142	6.16	0.93	7.09	7.56	0.47	0.47
21	W-149	5.21	0.56	5.77	9.87	4.1	4.1
22	W-154	4.32	0.13	4.45	4.2	-0.25	
	Mean	5.15	0.66	5.81	8.29		3.42

M-O Alk. : M-O Alkalinity   Total C : Total Cation

- Dry Season (end January,1989) --- (unit : me/l)

No.	Sampl Site	(1) M-O Alk	(2) Cl	(3) SO4	(4) Total A	(5) Total C	(6) Sulfate E
1	R-5	1.9	0.07	0.35	2.32	2.19	0.22
2	R-14	0.34	0.09	0.04	0.47	0.45	0.02
3	R-19	0.42	0.09	0.12	0.63	0.54	0.03
4	R-25	0.62	0.09	0.04	0.75	0.78	0.07
5	R-44	0.48	0.08	0.83	1.39	0.8	0.24
	Mean	0.75	0.08	0.28	1.11	0.95	0.12
1	W-2	0.8	0.34	0.29	1.43	1.55	0.42
2	W-6						
3	W-8						
4	W-16	4.66	0.16	0	4.82	5.26	0.44
5	W-21	3.20	1.52	0.92	5.64	4.94	0.22
6	W-26	5.41	1.47	0.37	7.25	8.02	1.15
7	W-28	2.62	0.18	0.9	3.7	4.05	1.25
8	W-32	3.54	0.71	1.67	5.92	7.24	3
9	W-33	0.85	0.1	0.25	1.2	1.16	0.21
10	W-35						
11	W-51	1.86	0.27	0.69	2.82	3.09	0.96
12	W-63	7.5	0.49	0	7.99	7.61	0
13	W-81	2.94	0.51	0.04	3.49	4.31	0.86
14	W-87	2.12	0.51	0.29	2.92	3.13	0.51
15	W-92	1.4	0.1	0	1.5	1.41	0
16	W-109	6.68	0.41	3.54	10.63	10.76	3.69
17	W-122	7.7	0.28	4.16	12.14	11.55	3.59
18	W-126						
19	W-141						
20	W-142						
21	W-149	5.94	0.44	2.81	9.19	8.85	2.48
22	W-154	4.04	0.11	0.50	4.65	4.77	0.62
23	TW-1	15.8	2.51	0.88	19.19	19.15	0.84
24	TW-2	3.48	0.09	0.42	3.99	4.04	0.47
25	TW-3	7.6	2.37	0.52	10.49	8.66	-1.31
26	TW-4	3.00	1.78	1.25	6.03	5.14	0.36
27	TW-5	1.14	1.83	0.20	3.17	2.25	-0.72
	Mean	4.39	0.77	0.94	6.10	6.04	0.91

M-O Alk. : M-O Alkalinity   Total A : Total Anion = (1)+(2)+(3)
Total C : Total Cation   Salfate E : SO4 estimated = (5)-(1)-(2)

Table 3.2.3 PERCENT CONSTITUENTS OF CATION

--- Rainy Season (middle June, 1988) ---

No.	Sample Site	Na %	K %	Ca %	Mg %	Cation %
1	R-5	6	2	69	23	100
2	R-14	42	18	19	22	100
3	R-19	41	17	24	17	100
4	R-25	37	16	19	28	100
5	R-44	82	4	6	8	100
	Mean	42	11	27	20	100
1	W-2	42	11	28	19	100
2	W-6	45	3	21	31	100
3	W-8	21	1	56	23	100
4	W-16	26	11	49	14	100
5	W-21					
6	W-26	26	9	39	25	100
7	W-28	22	8	51	19	100
8	W-32	8	3	56	32	100
9	W-33	36	5	26	33	100
10	W-35	83	5	10	2	100
11	W-51	27	4	51	18	100
12	W-63	38	9	41	11	100
13	W-81	48	8	30	14	100
14	W-87	48	16	27	8	100
15	W-92	46	12	13	29	100
16	W-109	34	6	37	23	100
17	W-122	22	2	55	21	100
18	W-126	12	4	50	34	100
19	W-141	26	7	37	30	100
20	W-142	60	8	25	6	100
21	W-149	42	3	21	34	100
22	W-154	14	3	77	6	100
	Mean	35	7	38	21	100

--- Dry Season (end January, 1989) ---

No.	Sample Site	Na %	K %	Ca %	Mg %	Cation %
1	R-5	7	1	78	15	100
2	R-14	40	11	31	18	100
3	R-19	44	15	30	11	100
4	R-25	47	14	28	10	100
5	R-44	46	9	28	18	100
	Mean	37	10	39	14	100
1	W-2	59	10	19	12	100
2	W-6					
3	W-8					
4	W-16	26	10	43	22	100
5	W-21	51	9	29	11	100
6	W-26	30	8	44	17	100
7	W-28	23	7	59	10	100
8	W-32	11	4	67	19	100
9	W-33	34	7	43	16	100
10	W-35					
11	W-51	20	5	49	26	100
12	W-63	29	8	52	12	100
13	W-81	40	10	41	9	100
14	W-87	57	18	20	5	100
15	W-92	52	15	23	10	100
16	W-109	42	5	35	18	100
17	W-122	47	2	22	29	100
18	W-126					
19	W-141					
20	W-142					
21	W-149	42	3	42	14	100
22	W-154	13	3	69	15	100
23	TW-1	63	9	21	7	100
24	TW-2	14	2	73	11	100
25	TW-3	65	8	17	10	100
26	TW-4	85	10	2	3	100
27	TW-5	43	24	19	14	100
	Mean	40	8	38	14	100

Table 3.2.4 PERCENT CONSTITUENTS OF ANION

--- Rainy Season (middle June, 1988) ---

No.	Sample Site	M-O Alk. me/l	Cl me/l	Total A me/l		M-O Alk. %	Cl %	Total A %
1	R-5	1.61	0.12	1.73	:	93	7	100
2	R-14	0.62	0.14	0.76	:	82	18	100
3	R-19	0.66	0.12	0.78	:	85	15	100
4	R-25	0.64	0.11	0.75	:	85	15	100
5	R-44	0.48	0.12	0.6	:	80	20	100
	Mean	0.8	0.12	0.92	:	85	15	100
1	W-2	1.28	0.59	1.87	:	68	32	100
2	W-6	9.32	0.99	10.31	:	90	10	100
3	W-8	3.21	0.08	3.29	:	98	2	100
4	W-16	4.84	0.16	5	:	97	3	100
5	W-21							
6	W-26	5.96	1.66	7.62	:	78	22	100
7	W-28	2.88	0.21	3.09	:	93	7	100
8	W-32	4.96	0.62	5.58	:	89	11	100
9	W-33	2.18	0.13	2.31	:	94	6	100
10	W-35	9.36	5.08	14.44	:	65	35	100
11	W-51	4.72	0.23	4.95	:	95	5	100
12	W-63	5.84	0.31	6.15	:	95	5	100
13	W-81	3.84	0.51	4.35	:	88	12	100
14	W-87	3.36	0.28	3.64	:	92	8	100
15	W-92	2.12	0.09	2.21	:	96	4	100
16	W-109	7.02	0.51	7.53	:	93	7	100
17	W-122	6.72	0.25	6.97	:	96	4	100
18	W-126	5.68	0.31	5.99	:	95	5	100
19	W-141	9.16	0.28	9.44	:	97	3	100
20	W-142	6.16	0.93	7.09	:	87	13	100
21	W-149	5.21	0.56	5.77	:	90	10	100
22	W-154	4.32	0.13	4.45	:	97	3	100
	Mean	5.15	0.66	5.81		90.14	9.86	100.00

Remarks M-O Alk. : M-O Alkalinity
Total A : Total Anion

--- Dry Season (end January, 1989) ---

No.	Sample Site	M-O Alk. me/l	Cl me/l	SO4 me/l	Total A me/l	M-O Alk. %	Cl %	SO4 %	Total A
1	R-5	1.90	0.07	0.35	2.32	82	3	15	100
2	R-14	0.34	0.09	0.04	0.47	72	19	9	100
3	R-19	0.42	0.09	0.12	0.63	67	14	19	100
4	R-25	0.62	0.09	0.04	0.75	83	12	5	100
5	R-44	0.48	0.08	0.83	1.39	35	6	60	100
	Mean	0.75	0.08	0.28	1.11	68	8	25	100
1	W-2	0.80	0.34	0.29	1.43	56	24	20	100
2	W-6								
3	W-8								
4	W-16	4.66	0.16	0	4.82	97	3	0	100
5	W-21	3.20	1.52	0.92	5.64	57	27	16	100
6	W-26	5.41	1.47	0.37	7.25	75	20	5	100
7	W-28	2.62	0.18	0.9	3.7	71	5	24	100
8	W-32	3.54	0.71	1.67	5.92	60	12	28	100
9	W-33	0.85	0.1	0.25	1.2	71	8	21	100
10	W-35								
11	W-51	1.86	0.27	0.69	2.82	66	10	24	100
12	W-63	7.50	0.49	0	7.99	94	6	0	100
13	W-81	2.94	0.51	0.04	3.49	84	15	1	100
14	W-87	2.12	0.51	0.29	2.92	73	17	10	100
15	W-92	1.40	0.1	0	1.5	93	7	0	100
16	W-109	6.68	0.41	3.54	10.63	63	4	33	100
17	W-122	7.70	0.28	4.16	12.14	63	2	34	100
18	W-126								
19	W-141								
20	W-142								
21	W-149	5.94	0.44	2.81	9.19	65	5	31	100
22	W-154	4.04	0.11	0.5	4.65	87	2	11	100
23	TW-1	15.80	2.51	0.88	19.19	82	13	5	100
24	TW-2	3.48	0.09	0.42	3.99	87	2	11	100
25	TW-3	7.60	2.37	0.52	10.49	72	23	5	100
26	TW-4	3.00	1.78	1.25	6.03	50	30	21	100
27	TW-5	1.14	1.83	0.20	3.17	36	58	6	100
	Mean	4.39	0.77	0.94	6.10	75	9	16	100

Remarks M-O Alk. : M-O Alkalinity
Total A : Total Anion

Table 3.2.5 RELATIONSHIP BETWEEN ELECTRIC CONDUCTANCE AND TOTAL CONCENTRATION OF IONIC SUBSTANCES

--- Rainy Season (middle June, 1988) ---

No.	Sample Site	E.C. 25 oC M.S/cm	Total Hardness as CaCO3 mg/l	Cation Total me/l	Cation Na+K me/l (%)	Cation Ca+Mg me/l (%)	Anion Total me/l	Anion M-O Alk me/l (%)	Anion Cl+E.SO4 me/l (%)
1	R-5	171	95	2.11	0.17 (8)	1.94 (92)	2.11	1.61 (76)	0.50 (24)
2	R-14	63	15	0.74	0.44 (59)	0.30 (41)		0.62	
3	R-19	47	10	0.46	0.27 (59)	0.19 (41)		0.66	
4	R-25	45	13	0.57	0.30 (53)	0.27 (47)		0.64	
5	R-44	43	15	2.08	1.80 (87)	0.28 (13)	2.08	0.48 (23)	1.60 (77)
	Mean	74	30	1.19	0.60 (53)	0.60 (47)	2.10	0.80 (50)	1.05 (51)
1	W-2	211	50	2.16	1.14 (53)	1.02 (47)	2.11	1.28 (61)	0.83 (39)
2	W-6	1001	260	10.02	4.78 (48)	5.24 (52)		9.32	
3	W-8	349	170	4.39	0.95 (22)	3.44 (78)	4.39	3.21 (73)	1.18 (27)
4	W-16	445	165	5.24	1.91 (36)	3.33 (64)	5.24	4.84 (92)	0.40 (8)
5	W-21								
6	W-26	728	265	8.24	2.94 (36)	5.30 (64)	8.24	5.96 (72)	2.28 (28)
7	W-28	267	105	3.01	0.88 (29)	2.13 (71)		2.88	
8	W-32	695	395	8.89	1.02 (11)	7.87 (89)	8.89	4.96 (56)	3.93 (44)
9	W-33	204	75	2.50	1.03 (41)	1.47 (59)	2.50	2.18 (87)	0.32 (13)
10	W-35	3900	275	47.07	41.57 (88)	5.50 (12)	47.07	9.36 (20)	37.71 (80)
11	W-51	517	205	5.87	1.81 (31)	4.06 (69)	5.87	4.72 (80)	1.15 (20)
12	W-63	631	175	6.61	3.13 (47)	3.48 (53)	6.61	5.84 (88)	0.77 (12)
13	W-81	563	140	6.37	3.55 (56)	2.82 (44)	6.37	3.84 (60)	2.53 (40)
14	W-87	381	70	4.06	2.62 (65)	1.44 (35)	4.06	3.36 (83)	0.70 (17)
15	W-92	176	40	1.98	1.14 (58)	0.84 (42)		2.12	
16	W-109	863	280	9.35	3.72 (40)	5.63 (60)	9.35	7.02 (75)	2.33 (25)
17	W-122	767	330	8.55	2.00 (23)	6.55 (77)	8.55	6.72 (79)	1.83 (21)
18	W-126	929	440	10.52	1.74 (17)	8.78 (83)	10.52	5.68 (54)	4.84 (46)
19	W-141	632	260	7.75	2.55 (33)	5.20 (67)		9.16	
20	W-142	883	120	7.56	5.16 (68)	2.40 (32)	7.56	6.16 (81)	1.40 (19)
21	W-149	809	275	9.87	4.39 (44)	5.48 (56)	9.87	5.21 (53)	4.66 (47)
22	W-154	414	175	4.20	0.71 (17)	3.49 (83)		4.32	
	Mean	732	203	8.30	4.23 (51)	4.07 (49)	9.20	5.15 (70)	4.18 (30)

M-O Alk. : M-O Alkalinity
E.SO4 : Estimated Sulfate

--- Dry Season (end January, 1989) ---

No.	Sample Site	E.C. 25 oC M.S/cm	Total Hardness as CaCO3 mg/l	Cation Total me/l	Cation Na+K me/l (%)	Cation Ca+Mg me/l (%)	Anion Total me/l	Anion M-O Alk me/l (%)	Anion Cl+SO4 me/l (%)
1	R-5	184	101	2.19	0.17 (8)	2.02 (92)	2.32	1.90 (82)	0.42 (18)
2	R-14	47	11	0.45	0.23 (51)	0.22 (49)	0.47	0.34 (72)	0.13 (28)
3	R-19	54	11	0.54	0.32 (59)	0.22 (41)	0.63	0.42 (67)	0.21 (33)
4	R-25	77	15	0.78	0.48 (62)	0.30 (38)	0.75	0.62 (83)	0.13 (17)
5	R-44	71	18	0.80	0.44 (55)	0.36 (45)	1.39	0.48 (35)	0.91 (65)
	Mean	87	31	0.95	0.33 (47)	0.62 (53)	1.11	0.75 (68)	0.36 (32)
1	W-2	160	24	1.55	1.07 (69)	0.48 (31)	1.43	0.80 (56)	0.63 (44)
2	W-6								
3	W-8								
4	W-16	431	170	5.26	1.86 (35)	3.40 (65)	4.82	4.66 (97)	0.16 (3)
5	W-21	464	100	4.94	2.95 (60)	1.99 (40)	5.64	3.20 (57)	2.44 (43)
6	W-26	730	246	8.02	3.10 (39)	4.92 (61)	7.25	5.41 (75)	1.84 (25)
7	W-28	372	141	4.05	1.23 (30)	2.82 (70)	3.70	2.62 (71)	1.08 (29)
8	W-32	671	310	7.24	1.04 (14)	6.20 (86)	5.92	3.54 (60)	2.38 (40)
9	W-33	131	34	1.16	0.48 (41)	0.68 (59)	1.20	0.85 (71)	0.35 (29)
10	W-35								
11	W-51	264	116	3.09	0.77 (24)	2.32 (75)	2.82	1.86 (66)	0.96 (34)
12	W-63	726	240	7.61	2.81 (37)	4.80 (63)	7.99	7.50 (94)	0.49 (6)
13	W-81	450	108	4.31	2.15 (50)	2.16 (50)	3.49	2.94 (84)	0.55 (16)
14	W-87	323	40	3.13	2.33 (74)	0.80 (26)	2.92	2.12 (73)	0.80 (27)
15	W-92	137	23	1.41	0.95 (67)	0.46 (33)	1.50	1.40 (93)	0.10 (7)
16	W-109	750	285	10.76	5.06 (47)	5.70 (53)	10.63	6.68 (63)	3.95 (37)
17	W-122	930	296	11.55	5.62 (49)	5.93 (51)	12.14	7.70 (63)	4.44 (37)
18	W-126								
19	W-141								
20	W-142								
21	W-149	844	244	8.85	3.97 (45)	4.88 (55)	9.19	5.94 (65)	3.25 (35)
22	W-154	406	201	4.77	0.76 (16)	4.01 (84)	4.65	4.04 (87)	0.61 (13)
23	TW-1	1965	266	19.15	13.84 (72)	5.31 (28)	19.19	15.80 (82)	3.39 (18)
24	TW-2	360	169	4.04	0.66 (16)	3.38 (84)	3.99	3.48 (87)	0.51 (13)
25	TW-3	781	116	8.66	6.34 (73)	2.32 (27)	10.49	7.60 (72)	2.89 (28)
26	TW-4	506	12	5.14	4.90 (95)	0.24 (5)	6.03	3.00 (50)	3.03 (50)
27	TW-5	215	38	2.25	1.50 (67)	0.75 (33)	3.17	1.14 (36)	2.03 (64)
	Mean	553	151	6.04	3.02 (49)	3.03 (51)	6.10	4.39 (71)	1.71 (29)

M-O Alk. : M-O Alkalinity

Table 3.2.6 CHANGE OF AMMONIUM CONCENTRATION DURING PUMPING TEST OF TW-3

Step Drawdown Test (Date : Feb. 13, 1989 Static Water Level : 8.83 m)

Step	Discharge Rate Q (l/sec.)	Drawdown Sw (m)	Temperature T (^{o}C)	Electric Conductance in-situ (M.S/cm)	Electric Conductance at T=25^{o}C (M.S/cm)	NH4-N (mg/l)
1	2.0	2.37	30.0	2,100	1,892	53.0
2	4.0	5.48	29.0	1,300	1,195	32.5
3	6.2	9.11	29.0	1,100	1,011	20.0
4	8.7	16.00	28.0	980	919	19.0
5	11.8	31.81	28.5	1,100	1,021	21.0

Time-Drawdown Test (Date : Feb. 15 to 18, 1989 Static Water Level : 8.95 m)

No.	Time since pumping started t (min)	Discharge Rate Q (l/sec.)	Drawdown Sw (m)	Temperature T (^{o}C)	Electric Conductance in-situ (M.S/cm)	Electric Conductance at T=25^{o}C (M.S/cm)	NH4-N (mg/l)
1	20	7.7	9.53	29.0	1,100	1,011	23.5
2	90	6.2	11.95	29.0	1,100	1,011	20.5
3	200		13.00	29.0	870	800	17.5
4	380		13.54	29.0	810	744	14
5	560	5.2	13.93	29.0	840	772	14
6	930		13.10	(25.0)	(760)	760	(14)
7	1,290		11.58	(28.0)	(810)	760	(12)
8	1,460	4.6	11.88	29.0	820	754	12
9	1,640		12.84	29.0	830	763	14
10	2,000	4.7	13.28	29.0	840	772	14
11	2,370		13.39	(24.0)	(780)	798	(13)
12	2,730		13.76	(25.5)	(800)	791	(15)
13	2,900	4.7	13.89	29.0	850	781	15
14	3,080		13.93	28.5	860	799	16
15	3,440	4.7	14.10	28.5	840	780	14
16	3,810		14.05	(22.5)	(820)	868	(16)
17	4,170		14.19	(24.5)	(820)	829	(16)
18	4,290	4.6	14.35	28.0	860	807	16

* Figures in parentheses are values measured and/or analized at 3 to 9 hours later after sampling.

Table 3.2.7 (1) COMPARISON OF ANALYTICAL RESULTS OF IDENTICAL SAMPLES (1/2)

No.	Sample Site	Total Hardness (mg/l)			Cl (mg/l)			Ca (mg/l)		Mg (mg/l)	
		Labo-1	Labo-2	Labo-3	Labo-1	Labo-2	Labo-3	Labo-1	Labo-3	Labo-1	Labo-3
1	R-6	30.00	34.20	15.00	No Data	19.43	4.30	12.00	2.50	0.00	2.00
2	R-7	90.00	102.60	95.00	17.50	19.43	4.30	40.00	29.00	0.00	6.00
3	R-17	15.00	17.10	15.00	11.70	17.66	4.90	4.00	2.90	0.60	2.00
4	R-22	15.00	17.10	10.00	17.50	19.43	4.20	2.00	2.20	0.00	1.00
5	R-28	10.00	17.10	13.00	17.50	17.66	3.60	1.00	2.20	0.00	2.00
1	W-2	50.00	51.30	50.00	17.50	39.00	21.00	30.00	12.00	0.00	5.00
2	W-6			260.00			35.00		42.00		38.00
3	W-8	155.00	188.10	170.00	17.50	19.43	2.70	46.00	49.00	9.70	12.00
4	W-16	185.00	171.00	165.00	23.40	17.66	5.50	38.00	52.00	12.20	9.00
5	W-26	285.00	256.50	265.00	99.40	59.17	59.00	82.00	65.00	9.70	25.00
6	W-28	90.00	119.70	105.00	No Data	11.77	7.50	38.00	31.00	15.80	7.00
7	W-32	198.00	376.20	395.00	35.10	23.54	22.00	130.00	100.00	0.00	35.00
8	W-33	70.00	85.50	75.00	No Data	11.77	4.70	114.00	13.00	0.00	10.00
9	W-35	190.00	427.50	275.00	309.80	243.70	180.00	120.00	92.00	17.00	11.00
10	W-51			205.00			8.00		60.00		13.00
11	W-63			175.00			11.00		55.00		9.00
12	W-81	115.00	119.70	140.00	46.80	39.00	18.00	38.00	38.00	7.30	11.00
13	W-87	65.00	85.50	70.00	81.80	23.54	10.00	34.00	22.00	0.00	4.00
14	W-92	33.00	34.20	40.00	5.80	11.77	3.20	10.00	5.20	0.00	7.00
15	W-109			280.00			18.00		70.00		26.00
16	W-122			330.00			9.00		95.00		22.00
17	W-126	408.00	513.00	440.00	29.20	23.54	11.00	137.00	105.00	24.30	43.00
18	W-141	330.00	273.60	260.00	No Data	29.14	10.00	76.00	58.00	12.20	28.00
19	W-142			120.00			33.00		38.00		6.00
20	W-149	225.00	222.30	275.00	35.10	17.66	20.00	72.00	42.00	1.20	41.00
21	W-154	190.00	239.40	175.00	43.80	19.43	4.70	80.00	65.00	0.00	3.00

Remarks Labo-1 : The Food Control Laboratory in Tegucigalpa
Labo-2 : The Portable Laboratory in Comayagua

Table 3.2.7 (2) COMPARISON OF ANALYTICAL RESULTS OF IDENTICAL SAMPLES (2/2)

No.	Sample Site	NO3-N (mg/l)		NO2-N (mg/l)			NH4-N (mg/l)		Total Fe (mg/l)		
		Labo-2	Labo-3	Labo-1	Labo-2	Labo-3	Labo-2	Labo-3	Labo-1	Labo-2	Labo-3
1	R-6	0.00	1.00	0.002	0.070	<0.006	0.600	0.500	0.80	0.50	<0.20
2	R-7	4.40	0.80	0.000	0.070	<0.006	0.000	<0.400	0.00	0.02	0.20
3	R-17	4.40	0.90	0.000	0.000	<0.006	0.750	0.500	0.20	0.20	<0.20
4	R-22	4.40	1.30	0.000	4.400	<0.006	0.400	<0.400	0.20	0.28	<0.20
5	R-28	0.00	0.90	0.000	0.000	<0.006	0.600	<0.400	0.30	0.24	0.20
1	W-2	17.60	5.50	0.001	0.070	<0.006	0.000	0.500	0.30	0.22	0.20
2	W-6		2.70			<0.006		<0.400			<0.20
3	W-8	8.80	1.30	0.000	0.030	<0.006	0.000	<0.400	0.00	0.00	<0.20
4	W-16	4.40	1.10	0.000	4.400	<0.006	0.000	<0.400	0.00	0.00	0.20
5	W-26	17.60	4.80	0.000	0.030	<0.006	0.000	<0.400	0.00	0.12	<0.20
6	W-28	8.80	1.60	0.000	0.030	0.02 - 0.006	0.000	<0.400	0.00	0.12	<0.20
7	W-32	30.80	7.70	0.012	2.640	0.10 - 0.030	0.000	<0.400	0.00	0.00	<0.20
8	W-33	13.20	2.80	0.004	0.070	0.02 - 0.006	0.000	<0.400	0.00	0.00	<0.20
9	W-35	110.00	36.00	0.000	110.000	0.020	0.200	<0.400	0.30	0.00	<0.20
10	W-51		1.90			<0.006		<0.400			<0.20
11	W-63		1.70			0.02 - 0.006		1.6 - 2.0			<0.20
12	W-81	4.40	2.50	0.000	0.070	<0.006	0.000	<0.400	0.10	0.00	<0.20
13	W-87	8.80	2.40	0.001	0.200	<0.006	0.000	<0.400	0.30	0.02	<0.20
14	W-92	0.00	0.60	0.000	0.000	<0.006	0.300	<0.400	1.00	1.00	<0.20
15	W-109		3.70			<0.006		<0.400			<0.20
16	W-122		2.30			0.05 - 0.015		<0.400			<0.20
17	W-126	8.80	3.00	0.000	8.800	<0.006	0.200	<0.400	0.00	0.00	<0.20
18	W-141	4.40	1.70	0.001	0.030	<0.006	0.000	<0.400	0.40	0.80	0.50
19	W-142		2.80			0.05 - 0.015		<0.400			<0.20
20	W-149	0.00	2.40	0.001	0.030	<0.006	0.000	<0.400	0.20	0.20	<0.20
21	W-154	4.40	1.40	0.000	2.640	0.20 - 0.006	0.800	<0.400	0.20	0.14	<0.20

Remarks Labo-1 : The Food Control Laboratory in Tegucigalpa
Labo-2 : The Portable Laboratory in Comayagua

Figures

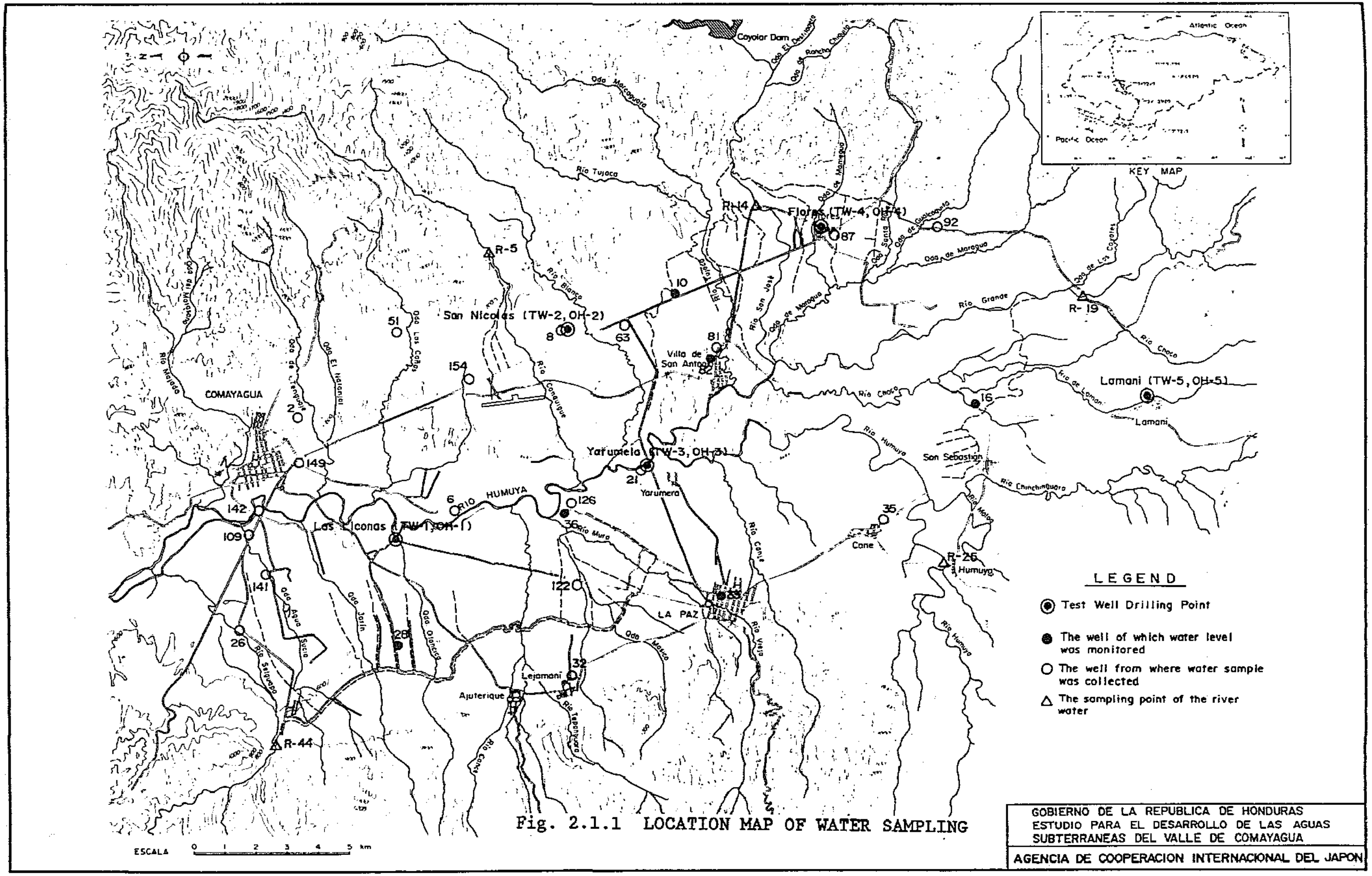


Fig. 2.1.1 LOCATION MAP OF WATER SAMPLING

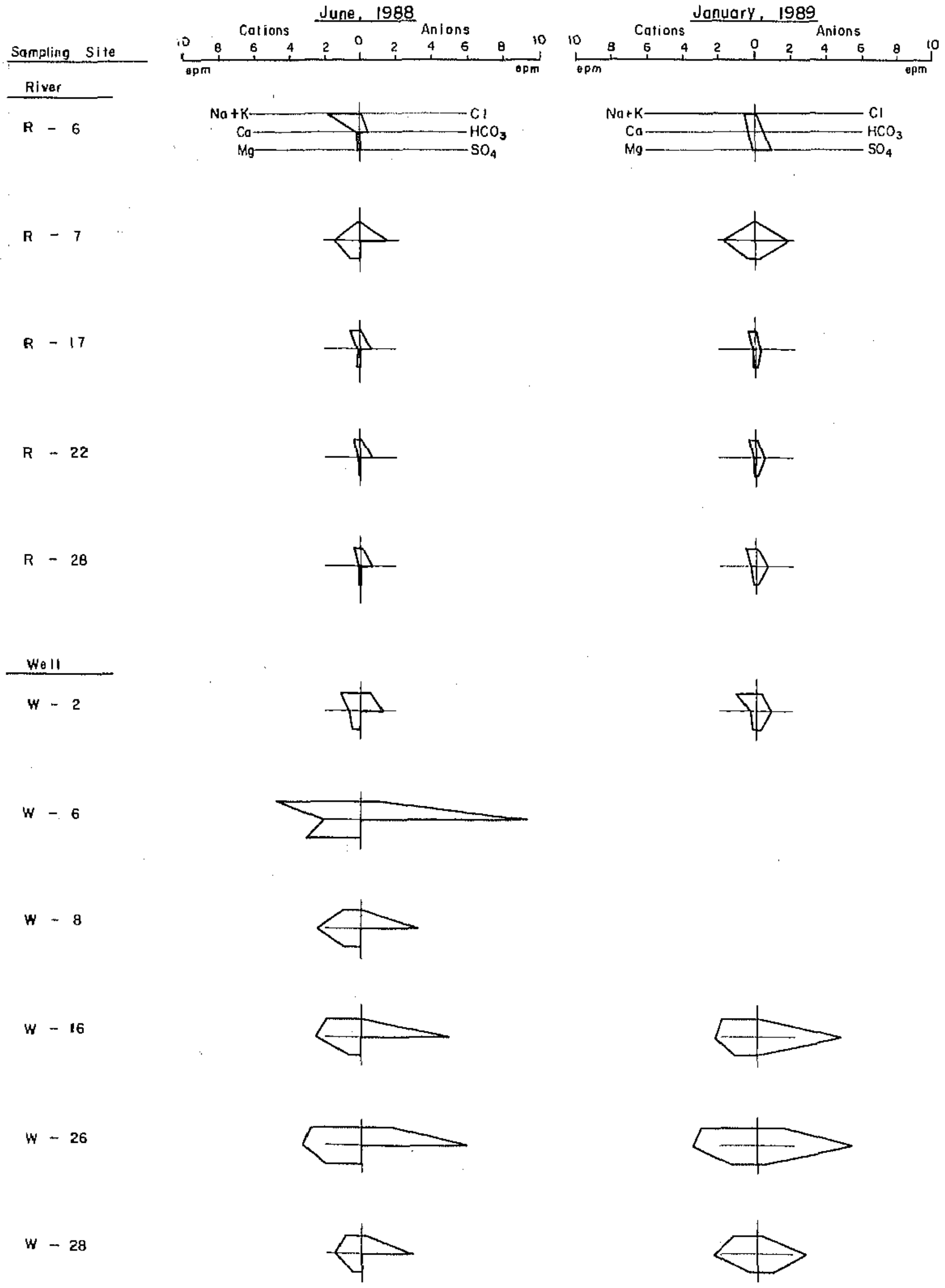


Fig. 3.1.1 STIFF DIAGRAM OF SAMPLED WATER (1)

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ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

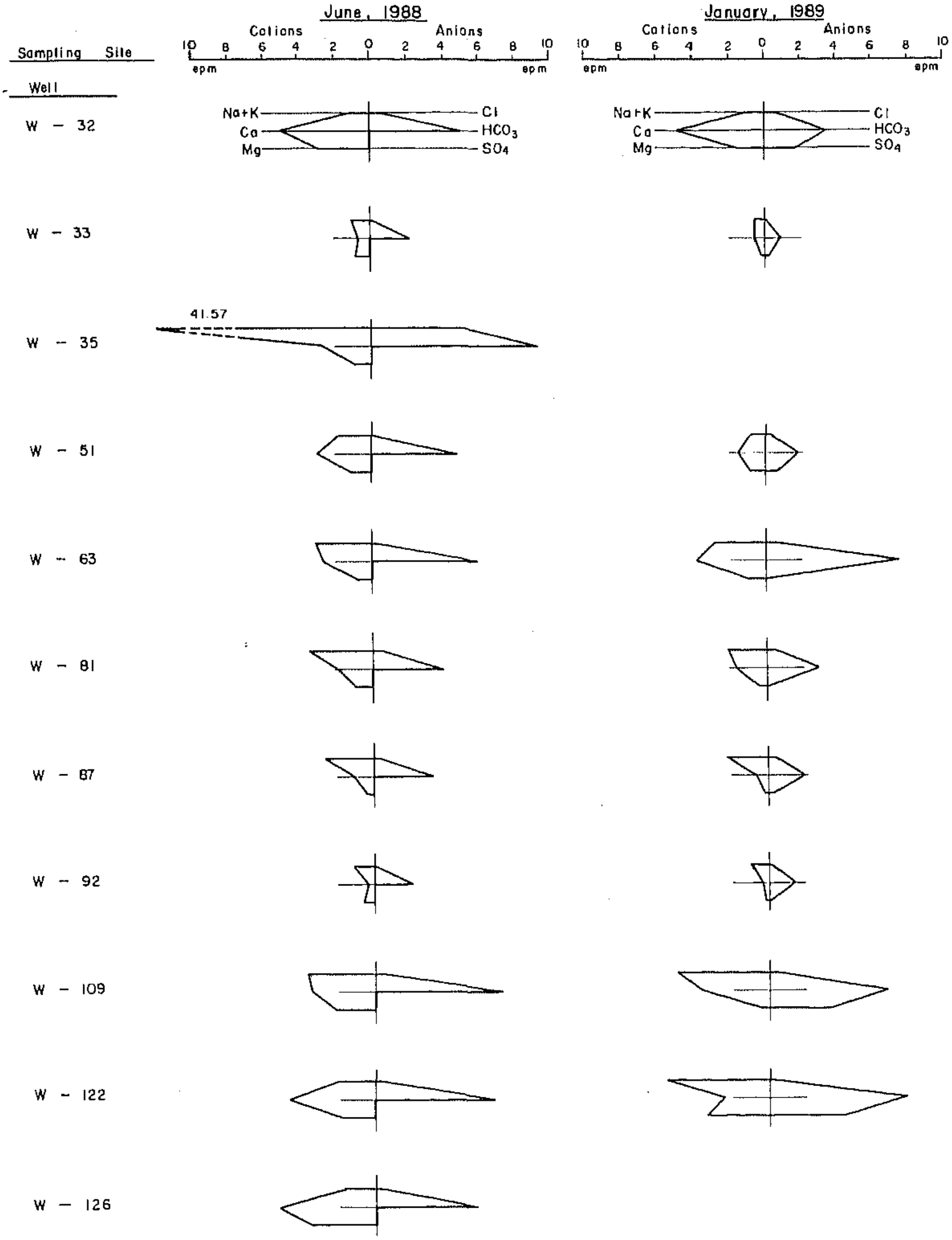

Fig. 3.1.1 STIFF DIAGRAM OF SAMPLED WATER (2)

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ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

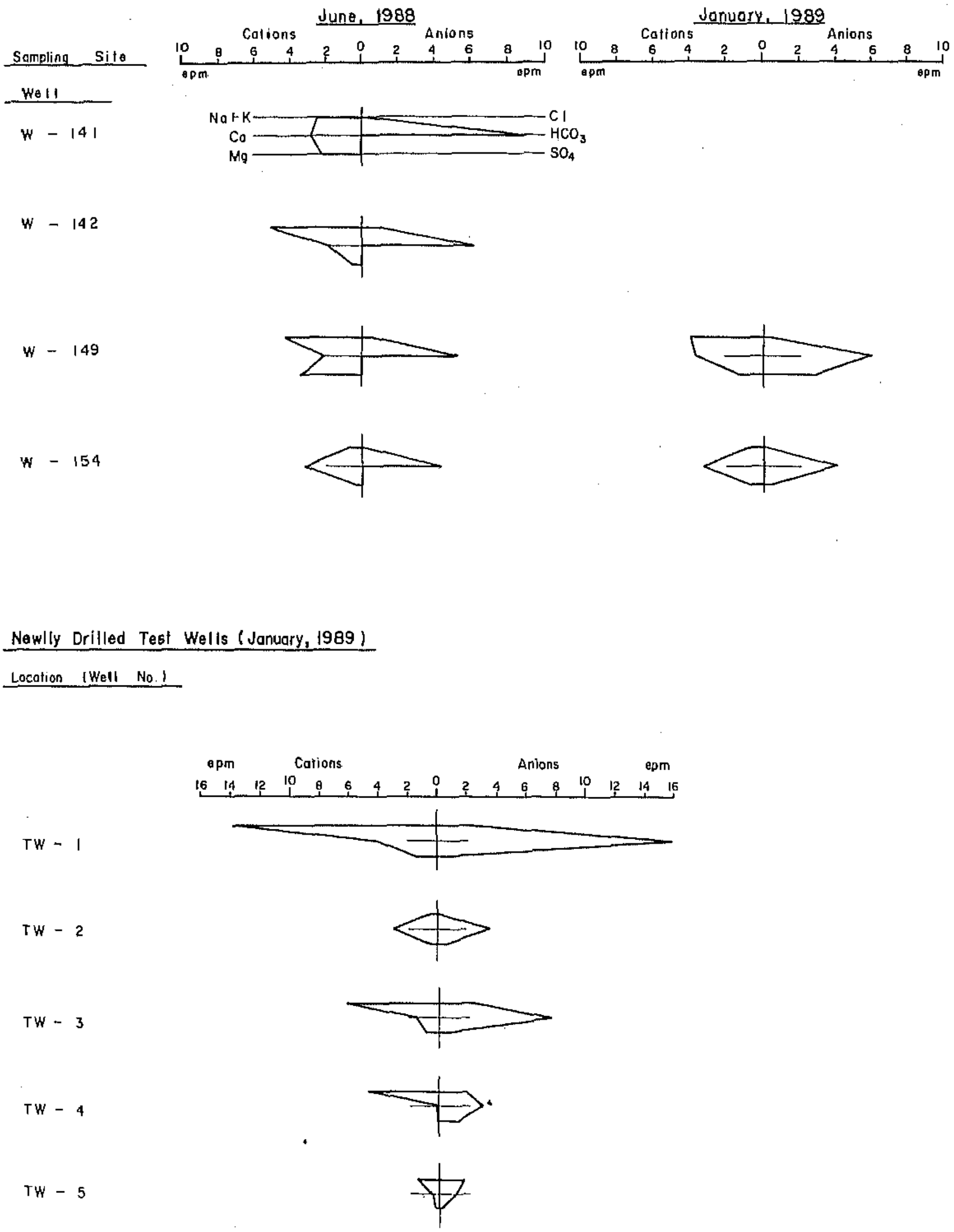

Fig. 3.1.1 STIFF DIAGRAM OF SAMPLED WATER (3)

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ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
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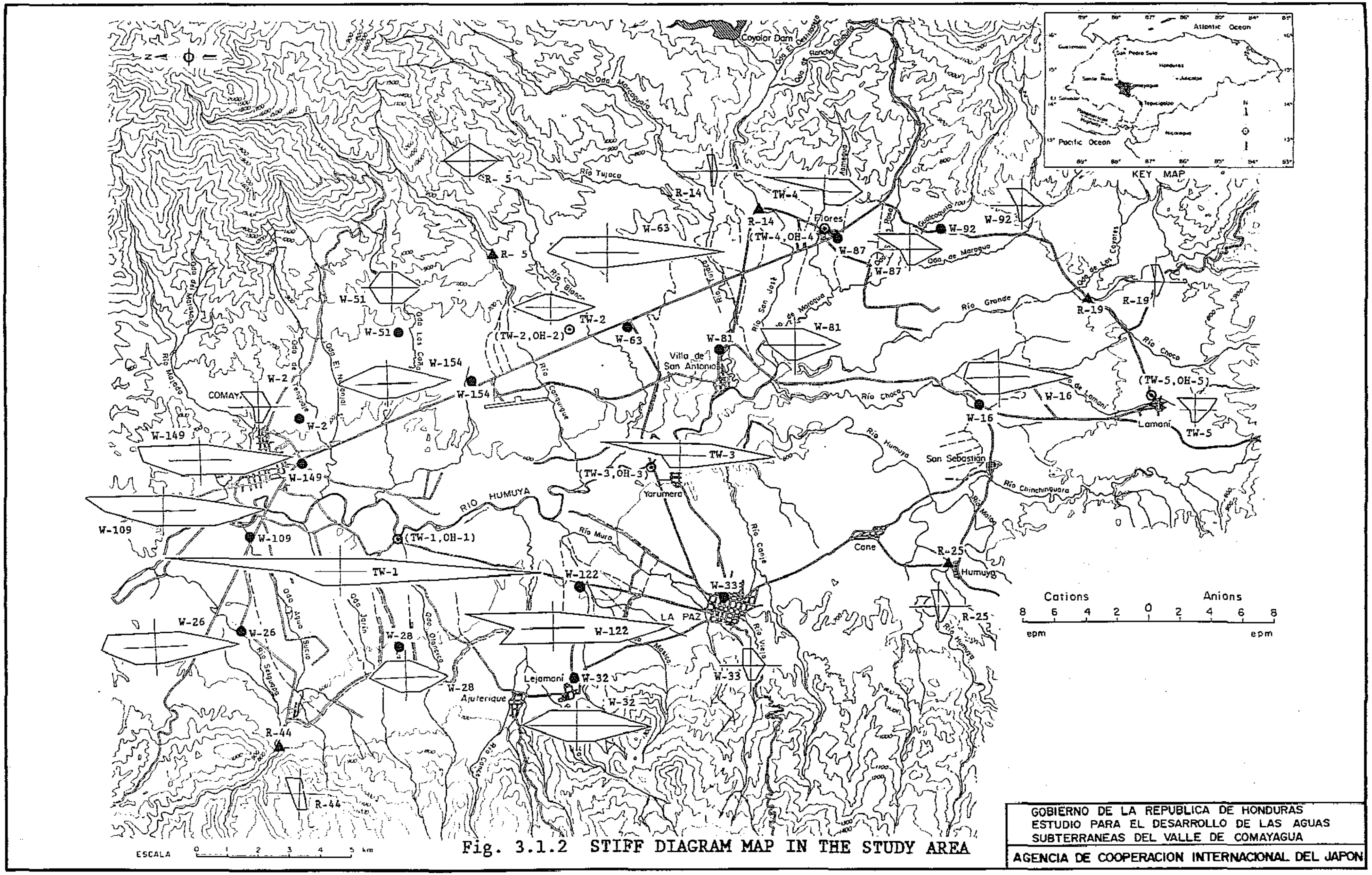

Fig. 3.1.2 STIFF DIAGRAM MAP IN THE STUDY AREA

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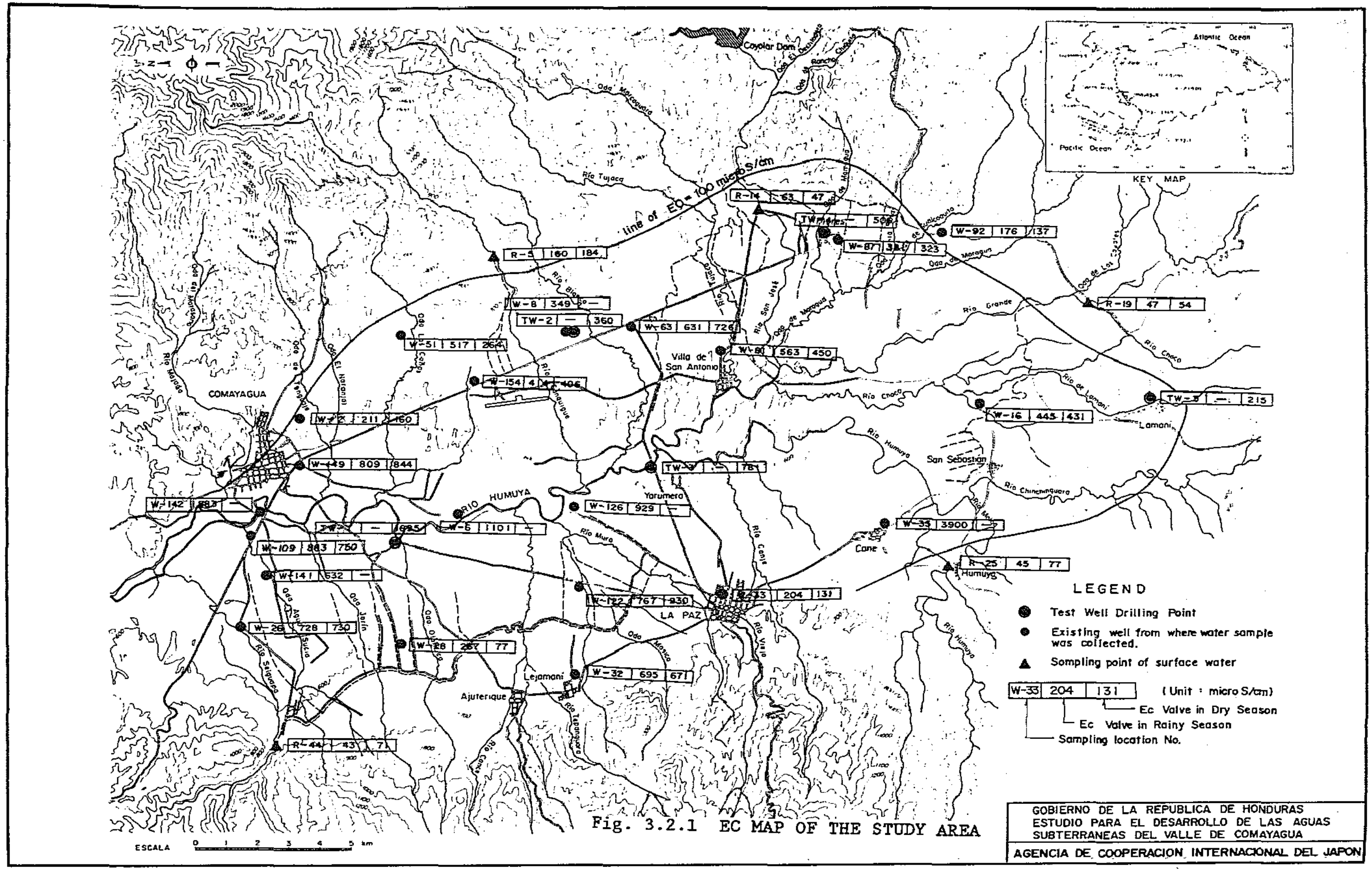

Fig. 3.2.1 EC MAP OF THE STUDY AREA

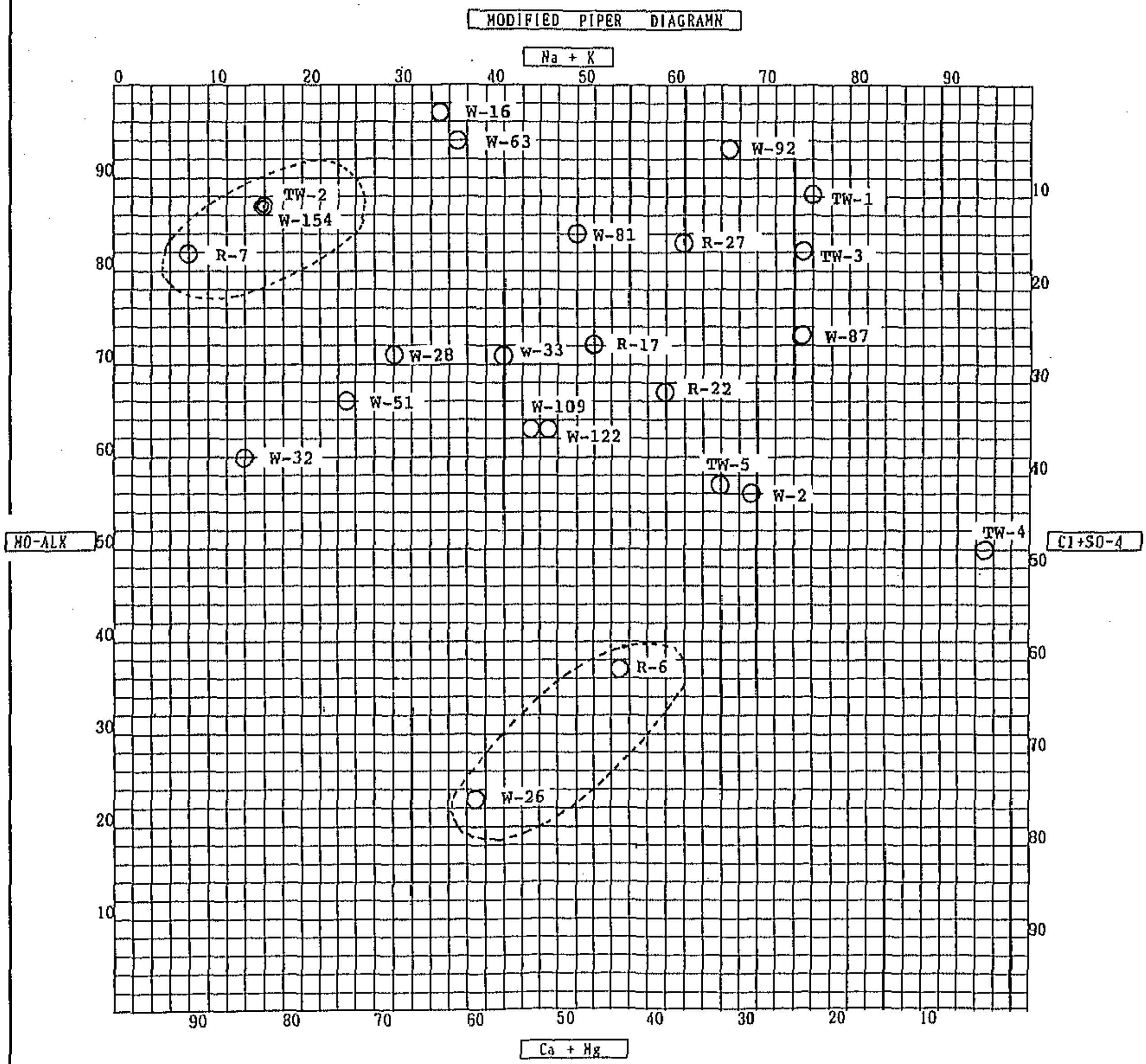

Fig. 3.2.2 MODIFIED PIPER DIAGRAM

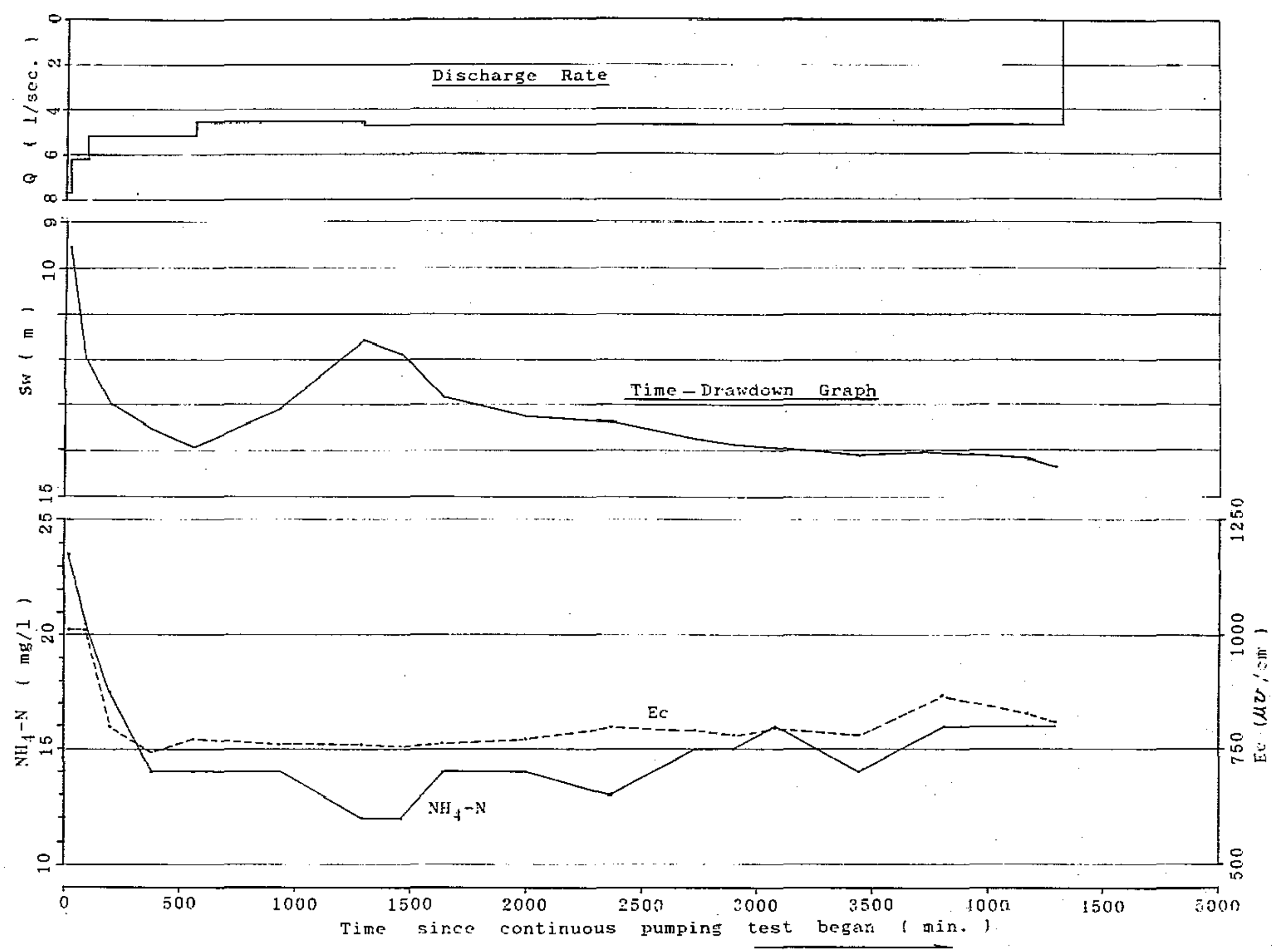

Fig. 3.2.3 CHANGE OF AMMONIUM CONCENTRATION DURING PUMPING TEST OF TW-03

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AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

APPENDIX E

METEORO-HYDROLOGICAL AND WATER BALANCE STUDY

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I. METEOROLOGY

1.1 Rainfall

In relation to the Comayagua valley, rainfall data of 18 stations are available (ref. Table 1.1.1 and Fig. 1.1.1). Within the catchment area of the Humuya River, as shown in Fig. 1.1.2, annual mean rainfall is 1235 mm at Siguatepeque (El.1080 m) according to data from 1956 to 1988 and 888 mm at Flores (El.580 m) for the years from 1945 to 1988. About 80% of annual precipitation falls during May to October at Siguatepeque, and more than 90% falls during May to October at Flores.

For the future water balance analysis of the Comayagua basin, the rainfall data of twelve stations are adaptable. Data usable for the analysis are only those of period from 1965 to the present, even though a few stations have record since 1945.

Since almost all of the rainfall records are intermittent data, it is necessary to interpolate the missing data. As the result of preliminary study based on the existing data, the followings were concluded:

- No correlation is seen between annual rainfall and ground height (Fig. 1.1.3).

- Years which correspond to the hydrological standard years, such as 1/2, 1/10 and 1/20 drought years, are not always common to all the meteorological stations (Table 1.1.2).

Consequently, Missing annual rainfalls of a station were accordingly interpolated from existing data of another station adapting an appropriate correlation between two stations. To obtain the best correlation, the correlation coefficients between the selected twelve stations were estimated (Table 1.1.3). Results of the interpolation, i.e. supplemented annual rainfall of each station is shown in Table 1.1.4.

Basin rainfall for the whole Humuya basin from 1967 to 1988 was estimated by the Thiessen Method. For this calculation, supplemented annual rainfall data of ten stations were utilized as shown in Fig. 1.1.4. Based on the obtained annual point rainfall, annual basin rainfall for each return period was extracted by means of the Plotting Position analysis. Result of the analysis is tabulated below and shown in Fig. 1.1.5.

hydrological standard year	actual annual basin rainfall year	rainfall (mm)	rainfall (MCM)
normal year (1/2 drought year)	1983	1287.5	2643.6
1/10 drought year	1986	882.3	1811.6
1/20 drought year	1972	771.2	1583.5

Furthermore, basin daily rainfall from 1967 to 1988 were obtained in the same manner as adapted for the calculation of the annual basin rainfall. Daily basin rainfalls calculated here are utilized on the purpose of calibration of tunk model in runoff study (ref. chapter III). The calculated basin daily rainfall series for hydrological standard year 1972, 1983, 1986 and for 1988 are graphically shown in Fig. 1.1.6.

1.2 Temperature

It is very probable that mean temperature correlates with ground elevation. Yearly mean temperature at Siguatepeque (EL.1080 m) is 21 °C in the average from 1953 to 1988. Monthly mean temperature during March to October varies from 21 °C to 23 °C, while it shows the value of less than 20 °C from November to February.

On the other hand, yearly mean temperature at Flores (El.650 m) is 24 °C in the average from 1958 to 1988. Monthly mean temperature varies from 22 °C to 26 °C.

Monthly mean temperature at the above two stations is shown in Table 1.2.1 and Fig. 1.2.1 and summarized below.

Monthly Mean Temperature (^{o}C)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Siguatepeque (1953-1988)	18	19	21	23	23	22	22	22	22	21	19	18	21
Flores (1958-1988)	22	23	25	26	26	25	25	25	25	24	23	23	24

1.3 Evaporation

Observed annual pan evaporation at Siguatepeque rages from 1000 mm to 1600 mm and that one at Flores rages from 1600 mm to 2200 mm. Observed annual mean pan evaporations are 1498 mm at Siguatepeque and 1960 mm at Flores as shown in Table 1.2.1 and Fig. 1.3.1.

Potential evapotranspiration which is necessary to estimate actual evapotranspiration loss from the land surface and to perform the water balance analysis, is calculated by multiple of 0.7 as pan coefficient.

According to the calculation result tabulated below, potential annual evapotranspiration at Siguatepeque is estimated at about 1050 mm and about 1370 mm at Flores. In the study area, moisture supply to the evaporating surface is limited by the shortage of rainfall, particularly during the dry seazon from November to April, so actual evaporation from the basin is far less than potential evaporation. According to the runoff simulation in chapter III , annual actual evaporation is estimated to be about 50% of annual basin rainfall.

Monthly Evaporation and Potential Evapotranspiration (mm)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Siguatepeque (1972-1988)													
pan	98	116	158	169	158	131	147	135	112	100	86	88	1498
potential	67	81	111	118	111	92	103	95	78	70	60	62	1049
Flores (1974-1988)													
pan	161	183	240	221	182	144	153	154	128	131	123	139	1960
potential	113	128	168	155	127	101	107	108	89	92	86	97	1372

1.4 Relative humidity

There is no large fluctuation in monthly mean relative humidity. Monthly mean relative humidity at Siguatepeque ranges from 67% to 83%. The values of March to May are slightly small comparing with other months. At Flores, the relative humidity ranges from 52% to 69% and shows relatively low value during February to April. Monthly mean relative humidity at the above two stations are shown in Table 1.2.1 and Fig 1.4.1 and summarized below.

Monthly Mean Relative Humidity (%)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Siguatepeque (1972-1988)	79	75	69	67	72	77	76	78	81	83	83	82	77
Flores (1974-1988)	60	56	52	53	59	67	64	64	68	69	67	63	62

1.5 Wind velocity

Monthly mean wind velocity at Siguatepeque and Flores are shown in Table 1.2.1 and Fig. 1.5.1. According to the registered data summarized below, magnitude of seasonal fluctuation in monthly mean wind velocity is very small, especially at Flores, while remarkable contrast between two stations is observed.

Monthly Mean Wind Velocity (m/s)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Siguatepeque (1980-1988)	1.4	1.9	2.0	2.1	2.0	1.3	1.7	1.8	1.2	1.4	1.5	1.5	1.7
Flores (1984- 1988)	5.3	4.2	4.6	3.6	2.8	2.0	3.0	2.4	1.8	3.5	3.4	3.8	3.4

1.6 Sunshine hour

Monthly sunshine hour at Siguatepeque and Flores is summarized below and shown in Table 1.2.1 and Fig. 1.6.1. Similarly to the wind velocity, contrast between monthly sunshine hours of two stations is rather clear. In the view point of the seasonal fluctuation, the maximum value is recorded in March and relatively low values are known from September to November at the both stations.

Monthly Sunshine Hour (hours)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Siguatepeque (1972-1988)	187	191	234	208	183	188	206	214	168	152	155	167	188
Flores (1974-1988)	215	233	265	199	212	175	185	205	176	190	196	208	205

II. HYDROLOGY

2.1 Existing runoff data

For the Comayagua valley, there are two existing runoff gauging stations; i.e. La Encantada and Las Higueras. The former is located at the outlet of the Comayagua valley, and the latter is located at almost center of the middle reach of the valley (Fig. 1.1.1). Runoff data for 22 years from 1967 to 1988 were collected for both stations.

For the water balance study of the whole basin, the runoff data of La Encantada is highly useful. Hydrographs of this station for the hydrological standard years are shown in Fig. 1.1.6 respectively. Annual total runoff at La Encantada is 178.8 MCM in 1972, 379.1 MCM in 1983 and 197.5 MCM in 1986 which correspond to about 11%, 14% and 11% of annual basin rainfall respectively.

hydrological standard year	year	total annual runoff at La Encantada (MCM)
normal year (1/2 drought year)	1983	379.1
1/10 drought year	1986	197.5
1/20 drought year	1972	178.8

2.2 Result of runoff measurement

In order to pursue the hydrological analysis and to assess the ground water potential in the study area by means of water balance analysis, it is necessary to obtain sufficient information about surface runoff. However, there are only two existing runoff gauging stations in the study area at present as mentioned above.

Besides, the First, Second and Third Field Investigation were scheduled to be performed in the dry season and the rainy season respectively. The periodical runoff measurement was performed ten times in total at the selected four sections on several tributaries of the Humuya river during all the field investigation period. Those sections were chosen according to the following criteria.

(a) To locate near the boundary between mountain and flat plain
(b) To locate near the confluence with main river (the Humuya river)
(c) To locate around the middle reach of the above two sections
(d) Sections which are easily accessible

The sections where the runoff measurement was carried out by the JICA's expert and MPH counterpart, amount 38 points as shown in Fig. 2.2.1. The results obtained are shown in Table 2.2.1.

According to the measurement result, it is generally said that the runoff of rivers is remarkably different in the dry and rainy season and surface runoff increases in a short time due to heavy rainfall in the rainy season. In Some sections, however, runoff is almost constant through the both seasons.

In the dry season, extremely small discharge, which has finally dried up in some tributaries, were measured at the sections between the mountain area and the confluence with the main river, while considerable amount of flow discharge was measured at some tributaries in the mountain area. After the heavy rainfall in the rainy season, flow discharge increases in great magnitude even in the tributaries dried up in the dry season.

2.3 Land Use and Irrigation System

1) Land use

To grasp the land use condition in the study area, collection of related data and field reconnaissance were performed during the field investigations. According to the result of the investigation, the study area is principally classified into such five categories of irrigation area, pasture land, residential area, military base and unutilized scrub land. As shown in the land use map (Fig. 2.3.1), almost all of the valley are occupied by the irrigation area, pasture land and unutilized scrub land. The area where irrigation water is supplied by DGRH is about 7100 ha, and constitutes the main part of the irrigation area in the valley.

2) Irrigation system

Three irrigation systems which are operated by DGRH exists in the study area; that is , Flores system, San Sebastian system and Selguapa system. The planned area and the cropping area registered by branch offices of DGRH in each municipality are summarized below and the distribution of main canal is shown in Fig. 2.2.1.

irrigation system	planned area (ha)	registered cropping area (ha)
Flores system	3761	1604
San Sebastian system	200	231
Selguapa system	3130	2157

Maize, rice and tomato are main agricultural products relating to the three irrigation systems, and ratio of their cropping area against the whole registered cropping area is about 80% in Flores , 70% in San Sebastian and 55% in Selguapa. In case of the Selguapa system, ratio of coffee and bean is rather high, about 35%, so that the total of them reaches about 90% of the whole registered area. Detailed cropping pattern in the registered cropping area is shown in Table 2.3.1.

On the other hand, the data on the actual service of the irrigation systems during 1987 was obtained from the regional office of DGRH in Comayagua city. Monthly water use in 1987 for irrigation and area of each agricultural product are shown in Table 2.3.1. Maximum water use and maximum irrigation area among the monthly records for each irrigation system are summarized below. These data of irrigation water use were used for water balance analysis using tank model as mentioned in the following section.

irrigation system	max.water use (10^3CM)	max.irrigation area (ha)	month
Flores system	1857.2	1083.2	February
San Sebastian system	353.6	151.8	January
Selguapa system	1674.0	1046.8	March

III. RUNOFF STUDY

3.1 Water balance analysis

Objective of this study is to clarify the water balance condition and then to estimate ground water potential in total volume to be supplied to the study area. For this analysis tank model was utilized as mentioned in section 3.3. The following formula represents the basic concept of water balance from aspect of estimation of ground water potential in a basin, that is, ground water potential is estimated as the result of taking place evaporation and surface runoff from total rainfall volume.

$$G = R - E - SR$$

where,

G : ground water potential
R : total rainfall volume in basin
E : actual evaporation
SR : surface runoff volume as river flow

Tank model was constructed for Las Higueras and La Encantada respectively of which the daily runoff data during the period from 1967 to 1988 are available. The applied tank model is a simple model composed of four tanks arranged vertically in series (see Fig. 3.3.1). After construction of the standard initial model adaptable for the study area, the model calibration was carried out. At such four sub-basins as Tenguaje, Ranchitos, Chilcares and Humuya where the periodical runoff measurement was being executed, the runoff simulation was also performed by applying the Las Higueras model in order to compare the estimated runoff with observed, and finally check the reliability of the model.

3.2 Procedure of simulation study

(1) In this study two kinds of tank model as shown in Fig. 3.3.1 were established to simulate the suface runoff and ground water potential, that is, one is for runoff hydrograph at Las Higueras gauging station

(Las Higueras model) and the other is for runoff hydrograph at La Encantada gauging station (La Encantada model). Detail process of simulation is described in the following section.

(2) Calibration of the model was made by changing the outlets' parameters so far as to obtain the good fit to 5-day mean runoff. In the case of this study, the enphasis was put on obtaining the good fit to base flow rather than to hydrograph in flooding because it is considered that the source of ground water is mainly depend on the base flow condition.

(3) Calibration was perfomed by means of trial and error method and the best fit model was adopted for estimation of ground water potential in the whole basin.

(4) The recharge amount for the ground water obtained through the water balance study will be utilized as input data for ground water model simulation (see chapter IV).

3.3 Simulation model

1) Basic concept of tank model

A tank of the model is basically considered to have three holes with some runoff coefficient assumed; one at the bottom and two at the side as shown in Fig. 3.3.1. Water flowing into the tank flows out through these holes in proportion to each coefficient of hole. In runff analysis, it is generaly considered that water released from the side hole corresponds to runoff into river channel and water from the bottom hole infiltrate into deeper layer in the ground.

The depth of water released from a hole is given as follows :

$$I = a * H$$

where, I : depth of water released (mm/day)

a : coefficient of hole

H : water depth above the hole in a tank

As shown in Fig. 3.3.1, in the course of the simulation daily basin rainfall is put into the top tank and the depth of water released from each hole is calculated by the above equation. The water from the bottom hole is put into the second tank and the same process is repeated up to the forth one. The runoff depth into river channel is given as the sum of the water released from the side holes.

2) Assumption in tank calculation

For the purpose of simulating the natural runoff process in the study area more faithfully, the proper definitions are given of four tanks vertically combined on the basi of the following assumption.

a. top - the third tank

- outflow through side outlet of the top tank represents flood peak discharge.

- outflow through side outlet of the second tank have influence on the initial rising up compornent and the recession compornent of the peak hydrograph.

- outflow through side outlet of the third tank represents base flow, which is comparatively constant because of gradual runoff from ground water storage.

- for the simulation of surface runoff,the same type of model can be applied both at Las Higueras and at La encantada.

b. the forth tank

- outflow from the forth tank was assumed to represent ground water which was recharged to the aquifer as well as base flow.

- infiltration to the underground occurres not in the mountain area but in the flat area, especialy the infiltration volume in the boundary area between the both areas is large judging from the result of hydrogeological investigation.

- for Las Higueras model, outflow through lower side outlet corresponds to ground water to be recharged to phreatic aquifer where exists at shallow part in the ground and outflow through bottom outlet corresponds to ground water to be recharged to confined aquifer where exists at deeper part. Of these two outflow, phreatic ground water finay flows out to river channnel upstream of Las Higueras gauging station.

- while, at La Encantada it is supposed that both phreatic and confined ground water finaly flows out to river channel upstream of La Encantada gauging station judging from the distribution of impervious base rock in the basin. Therefore bottom outlet of the forth tank is closed.

- fluctuation of storage depth in the forth tank represents the seasonal fluctuation of the ground water level.

3.4 Input data

1) Evaporation from the tank

Loss due to evaporation is expressed by subtracting the depth of daily evaporation from the upper three tanks. In case there is no storage in the top tank, evaporation loss is taken place from the second tank and the same process is repeated up to the third tank. It is assumed that there is no evaporation loss from the forth tank.

Evaporation loss from tank is calculated from observed pan evaporation data descrived in section 1.3. In this study monthly mean evaporation from 1974 to 1988 at Flores, which is supposed to represent the evaporation condition of flat area in the basin, was adopted.

2) Basin rainfall

As described in section 1.1, interpolated point dily rainfall data at ten stations are utilized in order to obtain the basin rainall. In this study basin daily rainfall series were obtained for six basins in total as described in section 3.1 respectively.

3) Irrigation water use

There are three irrigation systems in the study area and irrigation water is supplied to each system. The intake points are located in upstream of runoff gauging stations, therefore irrigation water was added to observed runoff discharge at gauging station on the purpose of calibrating the tank model under the natural condition.

A part of Selguapa irrigation area is contained in Chilcares sub-basin and the irrigation water supplied to this irrigation area is taken from another basin. Therefore this irrigation water was added to basin rainfall as input data to the top tank for estimation of runoff volume at Chilcares point.

3.5 Calibration

The simulation model was clibrated to have a good fit to 5-day mean runoff at the runoff gauging station. At first calibration at Las Higueras was carried out. And then calibration of La Encantada model, which is a completely same model with Las Higueras model except for the parameters of the fourth tank, was excuted. Comparison between observed runoff volume and calculated volume is given in Table 3.5.1 for the selected hydrological standard year. Hydrograph is shown in Fig. 3.5.1 and Fig. 3.5.2.

In general simulated hydrographs have a good fit for base flow portion of observed discharge. But there seemed to be large deference for peak flood. This deference results from some factors as given below.

- insufficiency of the density of observation station

- use of basin rainfall derived by averaging observed point rainfall; the influence of point rainfall pattern is decreased by the process.

- insuccessful measurement of peak flood; it is generaly considered that relation between rainfall volume and runoff volume is not linear, that is, runoff ratio of large flood is larger than that of smaller one, but as shown in Fig. 3.5.3 runoff ratio of observed peak flood is almaost constant.

On theother hand, since the standard model for the Study Area was constructed, the runoff simulation at the four monthly runoff measurement points was performed mainly for the purpose of a comparison between the observed and simulated runoff. As shown in Table 3.7.1, this model obtains rather good fit between the actual and the estimated runoff.

Although in general for Tenguaje, Chicares and Humuya sub-basin the estimated values are larger than observed values, the estimated values for Ranchitos basin are smaller. This result shows that it is difficult to estimate the runoff in Ranchitos basin using Las Higueras model which contains the infiltration compornent in flat area, because mountain area prevails on the basin. However this means the assumption on the model , that is, infiltration to the underground are does not occur in the mountain area and direct runoff ratio is very large, to be appropreate.

At the same time storage depth in the fourth tank was obtained and fluctuation of the depth was compared with the seasonal fluctuation of water level in existing well observed from May to December in 1988. As shown in Fig. 3.5.4, it is considered that general trend of the fluctuation is represented by this model.

Accordingly, it is concluded that Las Higueras model represents the general runoff process in the study area in spite of the considerable restriction to be expected in the model simulation.

3.6 Ground water potential

Ground water potential in the study area was computed by putting the basin rainfall for the whole study area into Las Higueras model. As shown in Table 3.6.1, average annual recharge volume for the ground water was estimated at about 100 thousand m^3/day in the whole basin, and the total recharge is evenly shared for the phreatic and the confined ground water which are categorized as the aquifer system in the Study Area (see the section 4.1.6 of the Main Report). Although the ratio of the annual ground water recharge to the annual rainfall usually remains within 1 %, the calculation result is reasonably admitted considering that the recharge occurs only at the flat plain (about 25 % of the catchment area) and the geological components of the flat plain generally show rather low permeability.

IV. GROUND WATER MODEL SIMULATION

4.1 Procedure of analysis

The objectives of this study are to demonstrate the simplest simulation model that could account for the principal features of ground water flow in the aquifer and to examine the condition of ground water level under the future ground water development.

As shown in Table 3.6.1, some 52,000 m^3/day of total volume is recharged into each of the phreatic and confined ground water in the Study Area. At first simulation of the present ground water level by the numerical model was excuted under the assumed production (discharge) amount from the existing wells. Model calibration was made by means of comparing the calculated results with the actually observed ground water level in existing wells.

Instanteneous water level observation in existing wells was carried out in May and June during the field investigation in 1988. It is considered that the water level at the time of observation is influenced by the recharge volume during the antecedent period. For the calibration of ground water level at present condition, therefore, 52,000 m^3/day of the daily mean recharge volume from June in 1987 to May in 1988 was used as input data to the simulation model.

Following to the construction of the simulation model adaptable for the study Area, the future drawdown of ground water level was predicted by putting the additional ground water discharge according to the future development plan. Detail description of the simulation model is made in the following section.

4.2 Mathematical simulation model

Ground water flow in an aquifer is assumed to be governed by partial differential equation with two independent variables as shown below.

$$\frac{d}{dx} \left(T \frac{dh}{dx} \right) + \frac{d}{dy} \left(T \frac{dh}{dx} \right) = S \frac{dh}{dt} + W(x,y,t)$$

$$T = k\ m$$

$$S = s\ m$$

h : piezometric head (m)

T : transmissivity (m^2/day)

k : permeability (m/day)

S : Strativity or coefficient of storage (no dimension)

s : specific strage (1/m)

m : saturated thickness of aquifer (m)

W : recharge and discharge in and/or from aquifer (m^3/day)

The above equation represents ground water flow in confined aquifer. Since it is assumed that saturated thickness of aquifer is constant in confined aquifer, transmissivity is given as mesh data in the calculation territory by deciding permeability from hydrogeological aspects (see Fig.4.3.1).

While, in phreatic aquifer the saturated thickness of aquifer is equivalent to static head of phreatic water table, that is, saturated thickness of aquifer is considered to be dependent variable of ground water level. However in case that drawdown of water level due to pumping is small in comparison with the static head of natural water table, it can be assumed that saturated thickness in phereatic aquifer is also given as constant similar to the case of confined aquifer.

It is, accordingly, said that the above formula can be applied for both cases of confined and phreatic aquifer.

And further in case of the present study, the numerical model was formulated on the assumption that the ground water flow remains and will remain steady even though the ammount of the rainfall varies seasonally and yearly. As known from the result of the water balance study and the present and/or future conditions of the water resource development, the natural recharge and the discharge from the wells are remarkably constant through years so as to keep the hydro static level almost stable. Therefore, it seems possible to neglect the time factor such as the strativity or the coefficient of storage in the equation.

The numerical analysis of the model was performed by finite difference method which is used to solve regional aquifer problems posed in a horizontal two dimension scale. In the numerical calculation, some points of fixed water level are provided as boundary condition on the basis of assuming that ground water flows out into the river channel at these points.

4.3 Model calibration

The model calibration was performed by two dimensional steady state equation using parameter of aquifer transmissivity. Hydraulic head in the aquifer was computed by finite difference method with given boundary condition as described in the preceding section. Calibration of the model was carried out by comparing the calculated head with observed head by using the water level map in 1988.

In the actual model operation, the transmissivity, the recharge volume and the production rates from existing wells are necessary to be allocated in the simulation model. The distribution map of these data in the calculation territory are shown in Fig. 4.3.1 to 4.3.3 respectively.

AS shown in the above data distribution map, transmissivity and recharge volume is especialy large in the boundarey area between mountain area and flat plain, while in the flat plain within the valley smaller values are given. Total production volume from existing wells at present amounts to about 7,700 m^3/day, of which 3,500 m^3/day is being developed from phreatic ground water and 4,200 m^3/day from the confined ground water.

Simulated water level map for the phreatic ground water and the comparison result with observrd water level are shown in Fig. 4.3.4 and Fig. 4.3.5 respectively. The ground water level is simulated with defference between 0 m and 30 m on the whole. Considering the calculation condition as given below, it is concluded that the magnitude of the error is under the acceptable limit for the model simulation.

- Insufficient observed data, namely the density of existing well in the study area is small, therefore it is not said that the observed water level map itself is made with high degrees of accuracy.

- Accordingly, mesh system with 1 km of node distance was adopted and the calculation result or observed data given as a mesh value represents a mean value for area of 1 km^2, which has such topographic characteristics as an existence of the relatively deep gouges and the considerable undulation.

Similarly, simulated water level map for confined ground water and the comparison result with observed water level are obtained as shown in Fig. 4.3.4 and Fig. 4.3.5 respectively. The defference between simulated value and observed value ranges from 0 m to 35 m on the whole. It is considered that this result is also allowable according to the same reason as the case of phreatic groud water.

4.4 Model prediction

For the purpose of predicting the drawdown of ground water level under the future ground water use, model simulation was performed taking into account the future ground water development plan in the year 2000.

According to the ground water development plan, the total water volume to be newly developed by the year 1996 is about 4,800 m^3/day, of which the shares for the phreatic and the confined ground water are estimated at 3,400 m^3/day and 1,400 m^3/day respectively. And in the north region of Comaysgua valley the major part of the development water is dependent on the phreatic ground water, while in the south region it is dependent on the confined ground water.

Consequently, the total water production in the year 2000 is estimated to be about 12,500 m^3/day, consisting of 7,000 m^3/day from phreatic ground water and 5,500 m^3/day from confined ground water, by adding existing production volume to the development volume assuming that production volume from existing wells is not changed in 2000.

52,000 m^3/day of the total recharge volume amounted in the yeay of 1972 (the 1/20 drought year) was equally put into and/or allocated to both the phreatic and the confined ground water. The distribution condition of recharge volume used for simulation is shown in Fig. 4.3.2.

Ground water level map in 2000 and the drawdown map of the both aquifers, which were prepared on the basis of the model prediction, are shown in Fig. 4.4.1 and Fig. 4.4.2. As shown in the figures, the maximum drawdown in the phreatic and the confined ground water are estimated at about 7 m and 9 m respectively. It is also noticed that the relatively large drawdown are inferred in the areas such as the north region of the Study Area in case of the phreatic ground water and the south region in the confined ground water, due to the concentration of the ground water development at the relating areas.

Tables

Table 1.1.1 DESCRIPTION OF METEORO-HYDROLOGICAL DATA

I. Meteorological Stations and Data Available

Station name	Observation period	Meteorological data: Daily/monthly Rainfall	Temperature	Relative Humidity	Wind Velocity	Evaporation	Sun Shine Hour
Siguatepeque	1956 - 1988[1/]	D/M	M	M	M	M	M
El Tarado	1958 - 1971[1/]	M	M	-	-	-	-
Flores	1945 - 1988[1/]	D/M	M	M	M	M	M
Lamani	1956 - 1979	D/M	-	-	-	-	-
El Coyolar	1958 - 1988[1/]	D/M	M	M	-	M	-
Comayagua	1943 - 1974[1/]	D/M	D	-	-	-	-
El Horno	1965 - 1976	M	-	-	-	-	-
Villa de San Antonio	1955 - 1958	M	M	-	-	-	-
Playitas	1965 - 1988[1/]	D/M	M	M	M	M	M
Las Botijas	1965 - 1988[1/]	D/M	-	-	-	-	-
San Jose de Pane	1969 - 1971	M	-	-	-	-	-
La Laguna	1965 - 1988	D/M	-	-	-	-	-
La Mora	1970 - 1988	D/M	-	-	-	-	-
Zambrano	1968 - 1988	D/M	-	-	-	-	-
Lepaterque	1969 - 1988	D/M	-	-	-	-	-
Santa Clara	1967 - 1988	D/M	M	M	-	M	-
La Paz	1943 - 1956[1/]	D/M	-	-	-	-	-
Ajuterique	1965 - 1967[1/]	D/M	-	-	-	-	-

Remarks 1. Intermittent data D : Daily data - : No data
M : Monthly data

II. Hydrological Stations and Data Collected

Station name	Observation period	Daily/Monthly Runoff data
Humuya en Las Higueras	1967 - 1988[1/]	D / M
Humuya en La Encantada	1967 - 1988[1/]	D / M

Remarks 1. Intermittent data D : Daily data
M : Monthly data

Table 1.1.2 HYDROLOGICAL STANDARD YEAR OF EACH STATION

Meteorological Station	Hydrological standard year: normal year	Hydrological standard year: 1/10 drought year	Hydrological standard year: 1/20 drought year
Siguatepeque	1979	1986	1972
Flores	1983	1986	1967
Lamani	1970	1972	1976
El Coyolar	1980	1986	1972
Playitas	1982	1977	1986
Las Botijas	1985	1982	1975
La Laguna	1983	1979	1986
La Mora	1979	1971	1972
Zambrano	1985	1978	1972
Lepaterique	1983	1972	1986
Santa Clara	1973	1980	1972

Remark Normal year : 1/2 drought year

Table 1.1.3 CORRELATION COEFFICIENT IN ANNUAL RAINFALL OF OBSERVATION STATIONS

Meteorological Station	Siguate-peque	Flores	Lamani	El Coyolar	El Horno	Playitas	Las Botijas	La Laguna	La Mora	Zambrano	Lepate-rique	Santa Clara	Comayagua
Siguatepeque	-	0.70	0.44	0.79	0.82	0.74	0.25	0.68	0.58	0.72	0.78	0.42	0.04
Flores		-	0.54	0.89	0.79	0.29	0.30	0.23	0.28	0.80	0.92	0.67	0.25
Lamani			-	0.39	0.88	0.47	0.14	0.49	0.67	0.58	0.08	0.62	0.23
El Coyolar				-	0.97	0.32	0.28	0.32	0.46	0.80	0.91	0.55	
El Horno					-	0.46	0.46	0.35	0.79	0.88	0.93	0.63	
Playitas						-	0.01	0.71	0.35	0.74	0.68	0.55	
Las Botijas							-	0.16	0.29	0.29	0.24	0.23	
La Laguna								-	0.74	0.07	0.39	0.12	
La Mora									-	0.27	0.52	0.02	
Zambrano										-	0.87	0.73	
Lepaterique											-	0.53	
Santa Clara												-	

Table 1.1.4 SUPPLEMENTED ANNUAL RAINFALL BY EACH STATION

unit : MM

Year	Meteorological Station											
	Siguate-peque	Flores	Lamani	El Coyolar	El Horno	Playitas	Las Botijas	La Laguna	La Mora	Zambrano	Lepate-rique	Santa Clara
1966	1879.0	946.2	1890.9	1047.2	1189.0	1549.0	1193.0	1658.0	2323.5	1325.6	1299.8	1505.4
1967	2572.9	618.6	961.0	704.9	874.0	1603.4	1084.8	1646.6	2316.9	719.0	874.1	1129.6
1968	1048.5	934.6	1647.0	1021.3	1167.0	823.5	1186.4	1098.3	1780.0	1428.8	1303.6	1796.4
1969	2722.1	1257.9	3213.9	1619.6	1806.0	1679.7	1517.1	1699.1	2369.5	1611.1	1918.7	1781.5
1970	1131.4	1210.3	1663.5	1097.8	1177.0	972.6	1459.1	1099.9	1232.4	1372.6	1586.8	1466.6
1971	1046.4	787.4	2309.9	963.4	974.0	882.8	1285.1	976.0	1214.0	914.7	1164.5	1125.0
1972	726.4	555.4	753.4	440.3	611.0	865.1	1098.3	662.3	1025.8	629.1	762.8	1428.4
1973	1074.7	798.6	1822.5	915.9	1083.0	888.2	1254.0	1048.6	1464.3	1024.5	1286.0	1265.2
1974	1298.2	979.9	1516.4	989.4	1105.0	878.7	994.3	1063.9	2111.0	1283.8	1345.8	1232.6
1975	1193.4	936.5	903.2	1091.3	1191.0	1004.5	736.7	1324.6	1838.5	1165.0	1297.6	1585.5
1976	1690.0	1032.3	1923.7	1068.5	1176.2	1190.8	1109.4	2782.1	3007.9	1109.8	1473.3	1334.1
1977	1189.8	746.1	1196.4	749.1	892.7	793.7	1618.5	1597.5	2819.7	870.1	1017.3	1158.5
1978	1277.5	779.0	1126.1	813.5	949.8	925.3	1110.6	1648.8	3241.0	787.8	1129.1	1154.8
1979	1182.1	852.4	1071.7	991.1	1107.5	866.7	1724.7	967.2	1740.7	1154.4	1461.2	1536.3
1980	1095.3	895.1	1668.0	956.6	1076.8	901.1	1273.2	1032.5	1443.8	970.2	1263.9	1070.3
1981	1604.9	1015.0	1930.7	1071.4	1178.7	871.1	1436.0	1251.7	2057.7	1311.2	1474.4	1440.0
1982	1127.2	698.8	1031.0	676.8	828.5	908.8	927.6	1160.9	1543.4	813.3	1027.8	1107.2
1983	1093.7	940.4	1485.3	876.3	1005.6	827.6	1294.1	1124.2	2299.2	906.2	1232.5	1079.2
1984	1550.9	1004.6	1762.4	997.9	1113.5	920.8	1355.6	1133.7	2081.0	1122.1	1352.7	1425.8
1985	1000.8	718.0	1034.3	677.6	829.2	799.1	1277.9	1018.3	1705.3	1043.7	1099.2	1203.1
1986	839.3	638.1	922.7	630.3	787.2	639.0	1111.9	910.3	1464.4	706.4	722.5	1015.9
1987	933.9	870.9	1268.3	780.6	920.6	734.9	943.7	1084.5	1150.6	788.2	1217.0	1297.3
1988	1341.3	983.4	1980.7	1094.7	1199.4	1151.7	1005.5	1497.0	2513.1	1326.0	1551.9	1570.3
Mean	1331.3	878.2	1525.3	925.0	1054.0	986.0	1217.3	1282.0	1945.4	1060.2	1254.9	1335.2

Table 1.2.1 (1) METEOROLOGICAL DATA OF HYDROLOGICAL STANDARD YEAR (1/3)

I. Monthly Rainfall

unit : mm

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
SIGUATEPEQUE													
1983(nomal year)	17.8	7.0	1.7	32.2	24.6	169.8	198.3	179.7	199.9	128.8	72.8	61.1	1093.7
1986(1/10 drought)	29.0	13.5	10.2	15.3	80.6	164.3	75.0	94.4	176.2	93.2	74.7	13.9	840.3
1972(1/20 drought)	15.7	71.7	0.8	53.8	51.4	110.3	71.3	72.6	132.2	88.9	35.2	22.5	726.4
Average(1956-1988)	22.4	20.7	14.7	33.7	141.4	170.3	151.0	185.2	236.7	158.4	60.0	40.2	1234.6
Flores													
1983(nomal year)	4.3	5.0	2.8	32.7	58.8	221.9	57.0	166.2	244.7	85.2	47.6	14.2	940.4
1986(1/10 drought)	7.5	20.5	0.0	0.0	129.4	74.1	52.9	74.6	126.3	94.0	58.7	0.1	638.1
1972(1/20 drought)	1.5	2.5	0.0	35.0									
Average(1945-1988)	1.8	6.2	7.2	33.4	129.3	170.3	104.3	125.8	171.8	106.9	25.2	6.2	888.3

II. Monthly Mean Temperature

unit : deg.C

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	MEAN
SIGUATEPEQUE													
1983(normal year)	19.1	20.4	22.4	23.6	24.8	23.5	22.5	22.5	22.1	21.0	20.5	19.5	21.8
1986(1/10 drought)	17.7	19.6	19.0	21.7	22.9	22.0	21.6	22.1	21.7	20.8	20.4	19.0	20.7
1972(1/20 drought)	19.5	18.5	21.7	23.9	24.2	23.7	23.2	22.4	22.4	21.4	20.2	20.1	21.8
Average(1953-1988)	18.1	19.1	21.4	22.6	23.0	22.4	21.9	21.8	21.7	20.7	19.3	18.3	20.9
FLORES													
1983(normal year)	23.2	24.8	26.3	27.1	28.5	26.3	26.0	25.9	25.0	24.5	24.2	23.2	25.4
1986(1/10 drought)	22.0	24.2	23.6	27.9	26.7	25.7	25.4	26.1	25.1	24.3	24.1	23.4	24.9
1972(1/20 drought)					no	data							
Average(1958-1988)	22.1	23.2	24.7	25.8	25.9	25.0	24.8	24.9	24.5	23.9	22.9	22.5	24.1

Table 1.2.1 (2) METEOROLOGICAL DATA OF HYDROLOGICAL STANDARD YEAR (2/3)

III. Monthly Pan Evapolation unit : mm

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
SIGUATEPEQUE													
1983(nomal year)	99.2	119.0	174.5	149.0	198.9	144.8	137.6	147.6	117.8	100.6	91.4	108.2	1588.6
1986(1/10 drought)	79.2	116.6	137.0	172.7	136.3	130.8	135.2	141.6	119.3	92.5	96.2	82.4	1439.8
1972(1/20 drought)	121.6	95.0	169.9		138.4	137.9	149.0	137.0	125.1	98.2			1172.1
Average(1956-1988)	97.8	116.3	158.1	168.9	157.9	131.2	146.8	135.4	112.0	99.6	86.3	88.0	1498.3
Flores													
1983(nomal year)	171.0	175.1	233.7	178.1	192.7	132.1	151.4	138.8	124.3	128.4	110.3	132.6	1868.5
1986(1/10 drought)	152.5	180.8	235.4	236.3	157.7	162.5	184.3	176.0	124.8	122.2	117.1	142.0	1991.6
1972(1/20 drought)													
Average(1945-1988)	160.8	183.4	239.8	221.2	181.5	144.4	153.4	154.3	127.6	130.8	123.2	139.2	1959.7

IV. Monthly Mean Relative Humidity unit : %

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
SIGUATEPEQUE													
1983(nomal year)	80.0	75.0	66.0	72.0	69.0	77.0	79.0	76.0	81.0	83.0	83.0	82.0	76.9
1986(1/10 drought)	85.0	73.0	74.0	63.0	70.0	77.0	75.0	75.0	78.0	81.0	81.0	81.0	76.1
1972(1/20 drought)	75.0	73.0	64.0	60.0	66.0	70.0	70.0	71.0	75.0	78.0	76.0	75.0	71.1
Average(1956-1988)	79.1	74.8	69.3	66.8	71.9	76.6	76.3	77.6	80.8	83.3	82.9	82.1	76.7
Flores													
1983(nomal year)	70.0	65.0	60.0	65.0	58.0	76.0	70.0	70.0	78.0	77.0	75.0	70.0	69.5
1986(1/10 drought)	64.0	61.0	60.0	57.0	68.0	70.0	66.0	68.0	75.0	77.0	75.0	72.0	67.8
1972(1/20 drought)													
Average(1945-1988)	59.7	55.6	51.9	53.3	59.0	66.6	63.5	64.4	67.8	68.6	66.5	62.7	62.4

Table 1.2.1 (3) METEOROLOGICAL DATA OF HYDROLOGICAL STANDARD YEAR (3/3)

V. Monthly Mean Wind Velocity

unit : m/s

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
SIGUATEPEQUE													
1983(nomal year)	1.8	2.0	2.0	1.9	2.0	1.0	2.0	2.0	1.0	1.0	2.0	2.0	1.7
1986(1/10 drought)	1.0	1.0	2.0	2.0	2.0	1.0		1.0	1.0	1.0	1.0	1.0	1.3
1972(1/20 drought)													
Average(1956-1987)	1.4	1.9	2.0	2.1	2.0	1.3	1.7	1.8	1.2	1.4	1.5	1.5	1.7
Flores													
1983(nomal year)													
1986(1/10 drought)	5.0	2.0	6.0	4.0	3.0	3.0	4.0	3.0	3.0		2.0	3.0	3.5
1972(1/20 drought)													
Average(1945-1988)	5.3	4.2	4.6	3.6	2.8	2.0	3.0	2.4	1.8	3.5	3.4	3.8	3.4

VI. Monthly Sunshine Hour

unit : hour

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	TOTAL
SIGUATEPEQUE													
1983(nomal year)	143.4	144.9	196.8	140.6	208.8	170.4	173.8	222.3	167.7	169.7	161.9	205.0	2105.3
1986(1/10 drought)	156.1	227.8	226.2	244.5	159.6	188.7	215.0	231.0	179.8	158.1	197.7	168.7	2353.2
1972(1/20 drought)	204.4	180.3	270.4	188.0	165.2	198.1	178.3	201.3	178.0	162.4	192.9	167.3	2286.6
Average(1956-1988)	187.1	190.5	234.0	207.8	183.4	188.4	205.6	214.1	168.0	152.0	154.6	166.9	2252.4
Flores													
1983(nomal year)	183.4	195.2	247.8	155.3	238.9	183.5	150.3	198.8	181.6	197.6	188.0	224.0	2344.4
1986(1/10 drought)	206.3	255.0	258.6	248.7	175.6	169.2			173.3	186.6	213.6	221.2	2108.1
1972(1/20 drought)													
Average(1945-1988)	215.2	232.7	265.4	198.6	211.5	175.3	185.2	204.7	175.6	190.1	195.5	207.6	2457.3

Table 2.2.1 RESULT OF RUNOFF MEASUREMENT

Point No.	River Name	Discharge (cms) 1988 Mar.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	1989 Jan.
R-1	Qda.JARIN	LT. 0.01	-	-							
*R-2	Qda.TENGUAJE	LT. 0.01	LT. 0.01	0.27	0.09	1.00		0.45	0.12	0.09	0.07
R-3	Qda.LAS CANAS	0.00	LT. 0.01	0.30							
R-4	Qda.OLANCICA	0.06	0.05	0.05							
*R-5	Rio CANQUIGUE	0.12	0.16	3.00	0.68	1.96		2.74	1.29	0.15	0.75
R-6	Rio TEPANGUARA	0.01	-	-							
R-7	"	0.00	-	-							
*R-8	"	LT. 0.01	LT. 0.01	1.23	0.83			1.91	0.07	0.00	0.04
R-9	Rio CANQUIGUE	0.00	0.00	-							
R-10	Rio HUMUYA	existing station									
R-11	Rio YARUMELA	0.09	-	-							
R-12	Rio TUJACA	0.20	0.02	-							
R-13	"	0.00	LT. 0.01	-							
R-14	Rio SAN JOSE	0.60	MT. 0.6	1.00							
R-15	Qda.SANLA	0.01	LT. 0.01	0.10							
R-16	Qda.GUALCOQUITA	0.01	LT. 0.01	0.10							
R-17	Qda.MARAGUA	LT. 0.01	LT. 0.01	MT. 1.0							
R-18	Qda.LOS COYOTES	0.00	LT. 0.01	-							
R-19	Rio GRANDE	0.20	MT. 0.2	5.00							
R-20	Rio CHOCO	0.00	0.00	0.07							
R-21	Rio LAMANI	LT. 0.01	0.05	0.10							
R-22	Rio CHOCO	0.03	-	-							
R-23	Qda.AGUA SALADA	0.00	-	-							
R-24	Rio HUMUYA	0.15	-	5.00							
*R-25	"	0.20	0.18	2.50	0.30	1.70		1.82	1.03	0.31	0.51
R-26	Qda.OLANCICA	0.00	-	-							
R-27	Rio SAN JOSE	-	0.60	-							
R-28	Qda.MARAGUA	-	0.10	-							
R-29	Rio GRANDE	-	0.20	-							
R-30	Rio MOLOA	-	0.05	1.20							
R-31	Rio CHINCHINGUAR	-	0.03	0.80							
R-32	Rio CANJE	0.00	0.00	-							
R-33	Qda.MARAGUA	-	0.10	-							
R-34	Qda.CANITO	0.00	0.00	-							
R-35	Qda.MOLINO	0.00	0.00	-							
R-36	Qda.MIRA	0.00	0.00	-							
R-37	Rio CANCE	0.00	0.00	0.30							
R-38	Qda.CANGUARITA	0.00	0.00	0.40							
R-39	Qda.SICAGUARA	0.00	0.00	0.50							
R-40	Qda.JARIN	0.00	0.00	-							
R-41	Qda.TENGUAJE	0.00	0.00	-							
R-42	Qda.SECA	0.00	0.00	-							
R-43	Rio SELGUAPA										
R-44	Rio SELGUAPA										
R-45	Rio GRANDE										

Remarks LT. : Less than MT. : More than * : Monthly measurement point

Table 2.3.1 (1) MONTHLY ACTUAL CROPPING AREA AND WATER USE IN 1987 (1/3)

I. Irrigation system : Flores

--- Cropping area (ha) ---

Crops	Resistere area	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Tomato	238	167.5	162.90	182.0	160.8	64.2	18.4	4.0	8.2	23.8	25.9	85.6	
Maize	529	140.0	144.40	203.7	329.5	167.1	58.3	1.2	30.8	32.9	32.4	99.4	
Fruits	4	36.6	17.50	50.4	44.1	22.9	2.2	0.0	0.0	0.0	0.0	24.3	
Tabacco	40	35.0	13.30	5.1	4.0	0.0	0.0	0.0	0.0	1.9	11.0	40.4	
Beans	76	31.3	13.00	40.6	20.1	0.0	0.0	0.0	0.2	0.7	7.0	15.6	
Rice	513	28.5	31.00	21.7	29.2	53.7	221.9	206.7	589.2	664.1	590.1	512.2	
Pasture	0	18.4	54.60	57.6	46.7	27.1	0.0	0.0	0.0	0.0	5.1	41.8	
Vegetables	0	12.1	15.40	46.2	17.3	1.6	0.2	0.0	0.0	0.0	0.0	0.0	
Peppers	20	8.9	21.90	17.3	20.3	9.3	1.9	0.0	2.1	5.6	4.0	23.8	
Onion	71	5.1	8.40	0.0	11.7	4.2	0.0	0.0	0.0	0.0	0.0	0.0	
Cucumber	9	4.7	6.70	0.0	0.0	0.0	0.5	1.2	0.0	0.0	1.6	6.1	No Data
Tapioca	0	4.4	7.00	3.7	3.7	0.0	0.0	0.0	0.0	0.0	0.0	7.2	
Papaw	4	3.5	4.90	0.0	0.0	0.0	2.2	0.0	1.2	6.5	1.6	14.7	
Watermelon	1	3.3	3.00	0.0	4.2	0.0	0.0	0.0	0.0	0.0	4.2	16.8	
Sorguhm	22	1.9	0.70	12.6	2.8	6.5	0.0	6.3	0.0	0.0	2.3	7.5	
Coffee	56	1.4	72.80	27.3	28.0	0.7	0.7	0.0	0.0	0.0	0.0	52.5	
Livestock	0	0.2	3.10	7.0	13.5	23.3	10.3	0.7	0.0	0.0	0.0	14.5	
Sugar cane	0	0.0	3.30	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Squash	1	0.0	0.00	0.0	1.6	2.1	0.0	0.0	0.0	0.0	0.0	0.0	
Cabbage	0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.40	
Avocado	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Lemon	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Guava	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total	1603	502.8	583.9	679.6	737.5	382.7	316.6	220.1	631.7	735.5	685.3	963.6	

--- Water use (x 1000 m**3) ---

Crops	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Tomato	287.2	279.20	312.0	275.6	110.0	31.6	6.8	14.0	40.8	44.4	146.8	
Maize	240.0	247.60	349.2	564.8	286.4	100.0	2.0	52.8	56.4	55.6	170.4	
Fruits	62.8	30.00	86.4	75.6	39.2	4.0	0.0	0.0	0.0	0.0	41.6	
Tabacco	60.0	22.80	8.8	6.8	0.0	0.0	0.0	0.0	3.2	18.8	69.2	
Beans	53.6	22.40	69.6	34.4	0.0	0.0	0.0	0.4	1.2	12.0	26.8	
Rice	48.8	53.20	37.2	50.0	92.0	380.4	354.4	1010.0	1138.4	1011.6	878.0	
Pasture	31.6	93.60	98.8	80.0	46.4	0.0	0.0	0.0	0.0	8.8	71.6	
Vegitables	20.8	26.40	79.2	29.6	2.8	0.4	0.0	0.0	0.0	0.0	0.0	
Peppers	15.2	37.60	29.6	34.8	16.0	3.2	0.0	3.6	9.6	6.8	40.8	
Onion	8.8	8.40	0.0	20.0	7.2	0.0	0.0	0.0	0.0	0.0	0.0	
Cucumber	8.0	11.60	0.0	0.0	0.0	0.8	2.0	0.0	0.0	2.8	10.4	No Data
Tapioca	7.6	12.00	6.4	6.4	0.0	0.0	0.0	0.0	0.0	0.0	12.4	
Papaw	6.0	8.40	0.0	0.0	0.0	4.0	0.0	2.0	11.2	2.8	25.2	
Watermelon	5.6	5.20	0.0	7.2	0.0	0.0	0.0	0.0	0.0	7.2	28.8	
Sorghum	3.2	1.20	21.6	4.8	11.2	0.0	10.8	0.0	0.0	4.0	12.8	
Coffee	2.4	124.80	46.8	48.0	1.2	1.2	0.0	0.0	0.0	0.0	90.0	
Livestock	0.8	4.80	12.0	23.2	40.0	17.6	1.2	0.0	0.0	0.0	24.8	
Sugar cane	0.0	5.60	7.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Squash	0.0	0.00	0.0	2.8	3.6	0.0	0.0	0.0	0.0	0.0	0.0	
Cabbage	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	
Total	862.4	994.8	1165.2	1264.0	656.0	543.2	377.2	1082.8	1260.8	1174.8	1652.0	

Table 2.3.1 (2) MONTHLY ACTUAL CROPPING AREA AND WATER USE IN 1987 (2/3)

II. Irrigation system : San Sebastian

--- Cropping area (ha) ---

Crops	Resistere area	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Tomato	49	62.3	52.7	53.5	33.3	35.9	30.8	9.1	32.0	46.4	49.0		
Rice	42	42.5	42.5	42.6	42.5	43.2	42.5	42.5	91.5	88.4	66.0		
Maize	69	41.5	37.1	48.3	54.6	28.0	22.4	0.9	9.1	11.2	10.3		
Watermelon	0	2.1	3.3	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Tobacco	0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	No Data	
Pasture	0	1.1	4.0	0.0	1.4	1.6	0.0	0.0	0.0	0.0	0.0		
Fruite	0	0.7	1.1	0.1	0.4	0.2	0.0	0.0	0.0	0.0	0.0		
Peppers	0	0.5	0.4	0.0	0.5	0.7	0.2	0.6	0.2	0.2	0.7		
Onion	0	0.0	0.0	1.4	5.3	4.9	1.4	0.0	0.0	0.0	0.0		
Cabbage	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7		
Beans	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.2		
Cucumber	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0		
Coffee	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Soy bean	42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Total	231	151.8	141.1	152.5	138.0	114.5	97.3	53.1	133.7	146.2	126.9		

--- Water use (x 1000 m**3) ---

Crops	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Tomato	149.2	120.4	115.6	76.0	82.0	70.4	22.4	73.2	106.0	112.0		
Rice	97.2	97.2	97.2	97.2	98.8	97.2	97.2	209.2	202.0	150.8		
Maize	94.8	84.8	110.4	124.8	64.0	51.2	0.2	20.8	25.6	23.6		
Watermelon	4.8	7.6	15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Tobacco	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	No Data	
Pasture	2.4	9.2	0.0	3.2	3.6	0.0	0.0	0.0	0.0	0.0		
Fruites	1.6	2.4	0.4	0.8	0.4	0.0	0.0	0.0	0.0	0.0		
Peppers	1.2	0.8	0.0	1.2	1.6	0.4	0.4	0.4	0.4	1.6		
Onion	0.0	0.0	3.2	12.0	11.2	3.2	0.0	0.0	0.0	0.0		
Cabbage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6		
Beans	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.4		
Cucumber	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0		
Total	353.6	322.4	342.0	315.2	261.6	222.4	120.2	305.6	334.0	290.0		

Table 2.3.1 (3) MONTHLY ACTUAL CROPPING AREA AND WATER USE IN 1987 (3/3)

III. Irrigation system : Selguapa
--- Cropping area (ha) ---

Crops	Resistere area	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Onion	104	317.8	298.3	350.3	281.0	186.8	95.0	22.3					
Maize	902	309.0	309.3	348.0	333.3	193.8	102.5	11.0					
Tomato	208	132.2	131.0	139.8	143.3	142.8	64.8	24.5					
Watermelon	14	28.8	26.0	20.5	11.3	0.8	0.0	0.0					
Pasture	0	21.0	31.5	17.3	9.3	3.0	11.3	14.5					
Maize & Bean	0	16.5	30.8	21.5	13.5	0.0	0.0	0.0					
Cucumber	58	13.5	47.8	61.0	53.3	25.5	13.3	6.3					
Beans	261	10.3	17.5	31.8	8.5	12.5	0.0	0.0					
Coffee	480	9.8	5.5	9.8	8.8	3.5	0.5	0.0					
Livestoc	0	9.3	19.3	19.3	16.3	10.0	3.8	0.0			No Data		
Sugar cane	0	8.5	4.5	5.3	7.0	4.0	3.0	0.0					
Peppers	3	7.5	4.3	2.3	2.5	0.0	2.0	0.5					
Tapioca	14	5.3	4.0	4.5	4.5	2.5	0.8	0.0					
Papaw	0	4.3	6.5	3.3	7.5	7.3	0.0	0.0					
Sorguhm	0	2.8	1.5	1.5	2.8	2.3	7.0	0.5					
Fruits	0	2.3	10.3	8.3	6.8	2.5	5.3	0.0					
Cabbege	0	0.8	0.0	1.8	1.0	2.3	0.5	0.0					
Squash	0	0.5	0.0	0.0	0.0	0.0	0.0	0.0					
Maize&Tapioca	0	0.0	0.5	0.5	0.0	0.0	0.0	0.0					
Rice	91	0.0	0.0	0.0	0.0	0.0	22.0	55.5					
Vegitabl	22.00	0.0	0.0	0.0	0.0	0.8	0.0	0.0					
Total	2157	900.2	948.6	1046.8	910.7	600.4	331.8	135.1					

--- Water use (x 1000 m**3) ---

Crops	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Onion	508.4	477.2	560.4	449.6	298.8	152.0	35.6					
Maize	494.4	494.8	556.8	333.2	310.0	164.0	17.6					
Tomato	211.2	209.6	223.6	229.2	228.4	103.6	39.2					
Watermelon	46.0	41.6	32.8	18.0	1.2	0.0	0.0					
Pasture	33.6	50.4	27.6	14.8	4.8	18.0	23.2					
Maize & Bean	26.4	49.2	34.4	21.6	0.0	0.0	0.0					
Cucumber	21.6	76.4	97.6	85.2	40.8	21.2	10.0					
Beans	16.4	28.0	50.8	13.6	20.0	0.0	0.0					
Coffee	15.6	8.8	15.6	14.0	5.6	0.8	0.0					
Livestock	14.8	30.8	30.8	26.0	16.0	6.0	0.0			No Data		
Sugar cane	13.6	7.2	8.4	11.2	6.4	4.8	0.0					
Peppers	12.0	6.8	3.6	4.0	0.0	3.2	0.8					
Tapioca	8.4	6.4	7.2	7.2	4.0	1.2	0.0					
Papaw	6.8	10.4	5.2	12.0	11.6	0.0	0.0					
Sorghum	4.4	2.4	2.4	4.4	3.6	11.2	0.8					
Fruits	3.6	16.4	13.2	10.8	4.0	8.4	0.0					
Cabbege	1.2	0.0	2.8	1.6	2.0	0.8	0.0					
Squash	0.8	0.0	0.0	0.0	0.0	0.0	0.0					
Maize & Tapioca	0.0	0.8	0.8	0.0	0.0	0.0	0.0					
Vegetables	0.0	0.0	0.0	0.0	1.2	0.0	0.0					
Rice	0.0	0.0	0.0	0.0	0.0	35.2	88.8					
Total	1439.2	1517.2	1674.0	1256.4	958.4	530.4	216.0					

Table 3.5.1 RESULT OF RUNOFF STUDY BY THE TANK MODEL SIMULATION

unit : mcm

	Las Higueras								La Encantada							
	1972		1983		1986		1988		1972		1983		1986		1988	
Month	OBS.	CALC.	OBS.	CALC.	OBS.	CALC.	OBS.	CALC.	OBS.	CALC.	OBS.	CALC.	OBS.	CALC.	OBS.	CALC.
1	4.92	5.48	3.19	5.32	3.59	5.45	2.73	5.16	11.81	13.42	10.07	7.45	2.65	10.56	8.81	7.46
2	3.96	5.40	5.41	4.86	3.16	4.80	2.58	4.80	9.45	9.46	6.49	5.74	8.70	7.06	8.17	5.95
3	3.73	5.40	6.01	5.24	3.35	5.28	2.66	5.09	8.19	7.31	7.67	6.33	7.70	6.40	7.38	6.34
4	5.48	7.40	5.82	14.40	5.72	5.08	2.96	17.88	9.87	12.10	7.93	13.77	7.13	6.14	7.14	16.24
5	16.08	66.35	4.64	15.00	5.02	69.45	3.61	59.95	14.64	50.66	4.95	21.41	8.91	73.12	8.74	63.26
6	104.03	42.97	3.40	259.79	5.95	67.34	62.12	231.42	36.01	101.18	31.43	370.66	23.77	104.72	88.24	392.73
7	10.31	6.24	0.51	39.62	3.65	7.62	0.51	157.49	12.27	23.30	37.72	55.08	17.50	19.55	99.31	273.01
8	13.99	5.68	1.39	151.83	5.72	18.41	95.60	204.19	18.01	14.46	25.48	87.08	21.16	27.14	135.25	317.65
9	9.26	33.75	1.61	102.13	15.66	76.46	181.19	161.37	29.74	74.18	112.50	268.80	49.17	141.08	247.90	329.23
10	9.15	34.87	1.47	0.84	15.86	64.75	54.81	54.59	35.82	65.86	102.49	243.11	39.01	87.21	102.29	172.54
11	6.84	6.14	2.00	32.79	7.64	13.34	17.71	6.80	16.73	9.30	46.81	72.99	29.15	35.70	37.51	27.85
12	3.88	5.23	1.66	7.27	5.38	5.20	9.74	5.36	8.09	6.35	20.15	26.03	14.43	9.13	24.01	23.30

Note OBS. : Observed monthly runoff volume calc. : Calculated monthly runoff volume

Table 3.5.2 COMPARISON BETWEEN OBSERVED AND CALCULATED RUNOFF

Year : 1988

Tenguaje (c.a.=20.0 km2)			Ranchitos (c.a.=42.3 km2)			Chilcares (c.a.=62.3 km2)			Humuya (c.a.=207.4 km2)		
date	obsvd. (cms)	calcltd. (cms)	date	obsvd. (cms)	calcltd. (cms)	date	obsvd. (cms)	calcltd. (cms)	date	obsvd. (cms)	calcltd. (cms)
3/15	LT.0.01	0.024	3/15	0.12	0.057	3/18	LT.0.01	0.148	3/18	0.20	0.428
5/19	LT.0.01	0.023	5/25	0.16	0.056	5/25	LT.0.01	0.146	5/25	0.18	0.425
6/24	0.27	0.742	6/24	3.00	2.419	6/24	1.23	1.683	6/24	2.50	19.757
7/	0.09	0.081	7/	0.68	0.711	7/	0.83	0.994	7/	0.30	0.436
8/	1.00	1.075	9/	1.96	1.771	8/			9/	1.70	1.628
10/	0.45	0.430	10/	2.74	1.999	10/	1.91	1.897	10/	1.82	1.901
11/	0.12	0.105	11/	1.29	0.426	11/	0.07	0.157	11/	1.03	1.394
12/	0.09	0.075	12/	0.15	0.071	12/	0.00	0.157	12/	0.31	0.455

note : Runoff measurement from Mar. to Jun. was carried out by JICA study team.
Runoff measurement from Jul. to Dec. was carried out by MPH counterpart.

Table 3.6.1 SURFACE AND GROUND WATER BALANCE BY TANK MODEL SIMULATION
(Estimation of G/W potential in whole basin.)

Year	(1) Rainfall (mm)	(2) Runoff (mm)	(3) Evaporation (mm)	Ground Water Recharge Volume (4) Total (mm)	(m3/day)	phreatic (mm)	confined (mm)	(5)* (2)+(3)+(4) (mm)	G/W ratio to rainfall (%)
1967	1398.4	762.6	629.6	17.4	98120	8.7	8.7	1409.7	1.2
1968	1266.9	573.0	670.4	17.6	99087	8.8	8.8	1261.0	1.4
1969	2205.9	1434.4	702.5	17.9	100966	9.0	9.0	2154.9	0.8
1970	1282.7	594.8	670.8	18.3	103149	9.2	9.2	1284.0	1.4
1971	1297.0	656.9	624.5	18.4	103543	9.2	9.2	1299.8	1.4
1972	771.1	201.3	601.1	18.4	103419	9.2	9.2	820.8	2.4
1973	1240.9	556.5	660.4	18.1	101810	9.0	9.0	1235.0	1.5
1974	1316.6	590.3	706.5	18.3	102710	9.1	9.1	1315.1	1.4
1975	1142.7	547.2	584.2	18.3	102845	9.1	9.1	1149.7	1.6
1976	1661.6	908.7	734.7	18.5	104004	9.2	9.2	1662.0	1.1
1977	1273.7	555.6	716.4	18.4	103734	9.2	9.2	1290.5	1.4
1978	1346.7	529.5	799.7	18.4	103723	9.2	9.2	1347.7	1.4
1979	1166.6	389.9	761.6	18.5	104116	9.3	9.3	1170.0	1.6
1980	1220.9	550.2	660.9	18.6	104600	9.3	9.3	1229.7	1.5
1981	1473.5	723.3	716.1	18.7	104926	9.3	9.3	1458.1	1.3
1982	1015.4	392.4	630.1	18.8	105534	9.4	9.4	1041.2	1.8
1983	1287.7	557.0	698.6	18.7	105118	9.3	9.3	1274.2	1.5
1984	1419.5	736.2	655.4	19.0	106963	9.5	9.5	1410.6	1.3
1985	1031.8	353.9	679.4	19.0	106884	9.5	9.5	1052.3	1.8
1986	882.5	267.6	632.5	18.8	105939	9.4	9.4	918.9	2.1
1987	1004.9	373.6	628.6	18.7	104949	9.3	9.3	1020.9	1.9
1988	1552.9	772.0	742.8	18.8	105489	9.4	9.4	1533.6	1.2
Ave.	1284.5	592.1	677.6	18.4	103710	9.2	9.2	1288.2	1.5

* Deficit between (1) and (5) is supplied from the storage of the previous year and the surplus is added to the storage.

Figures

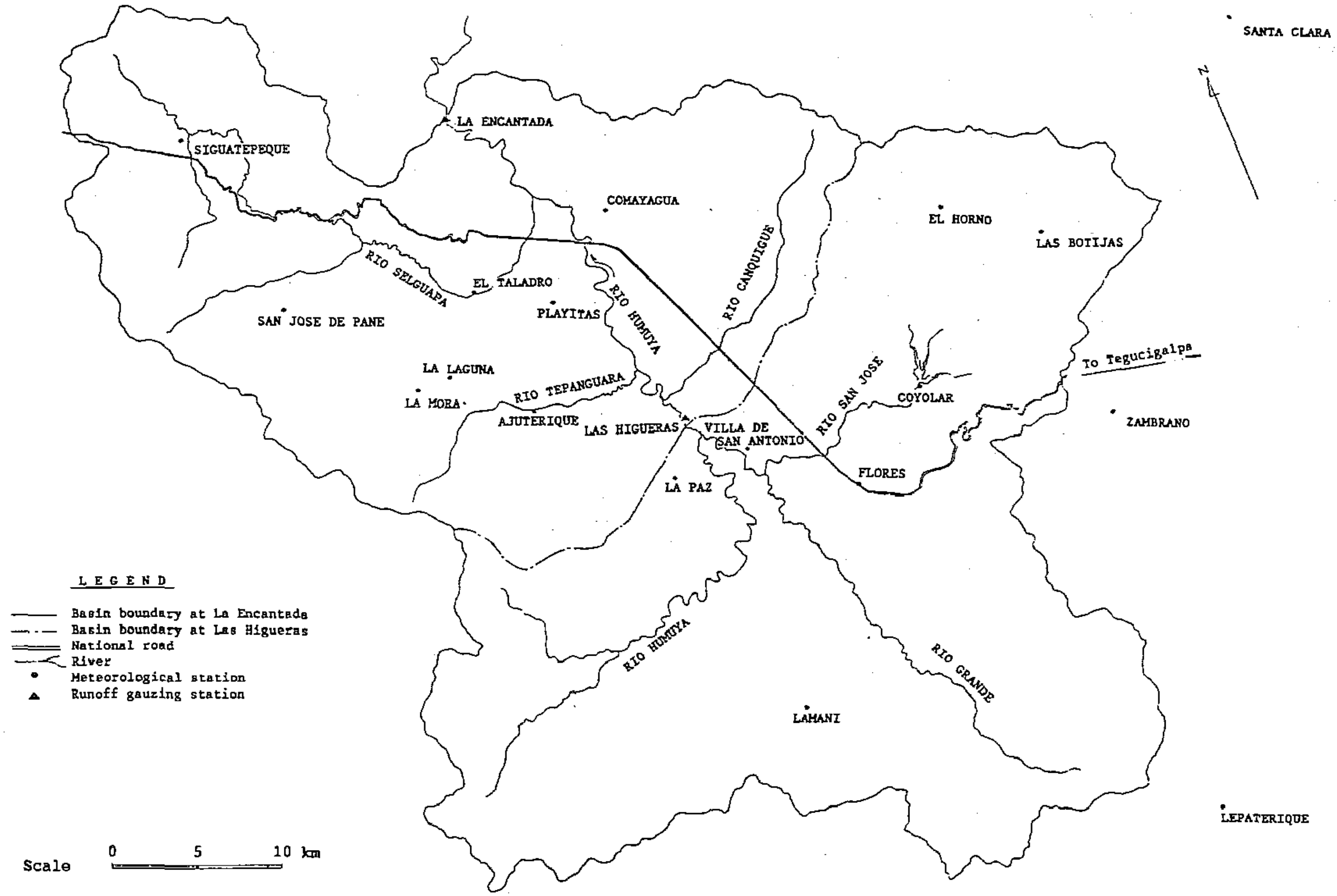

Fig. 1.1.1 LOCATION MAP OF METEORO-HYDROLOGICAL STATIONS

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ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

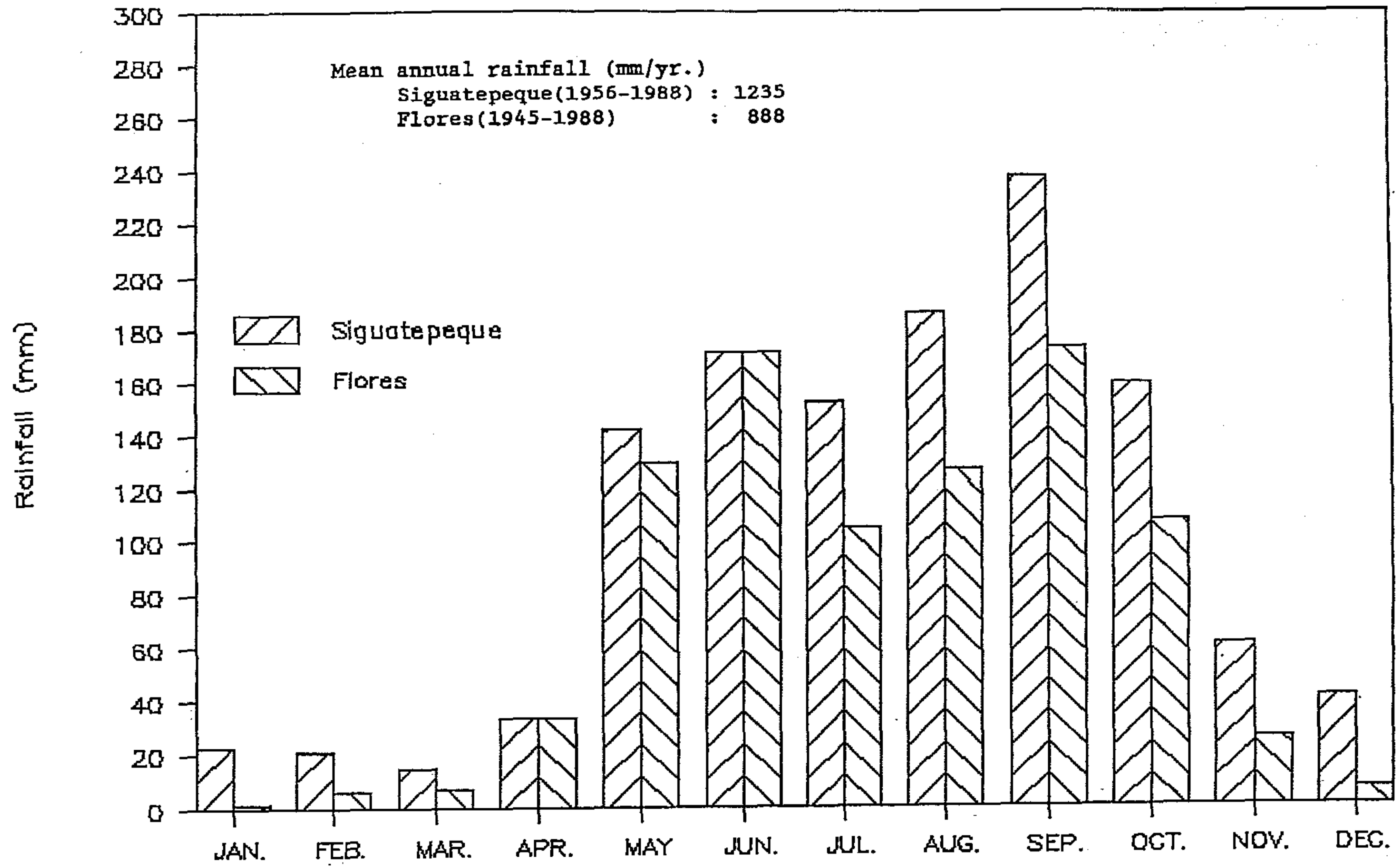

Fig. 1.1.2 MONTHLY RAINFALL OF REPRESENTATIVE STATIONS

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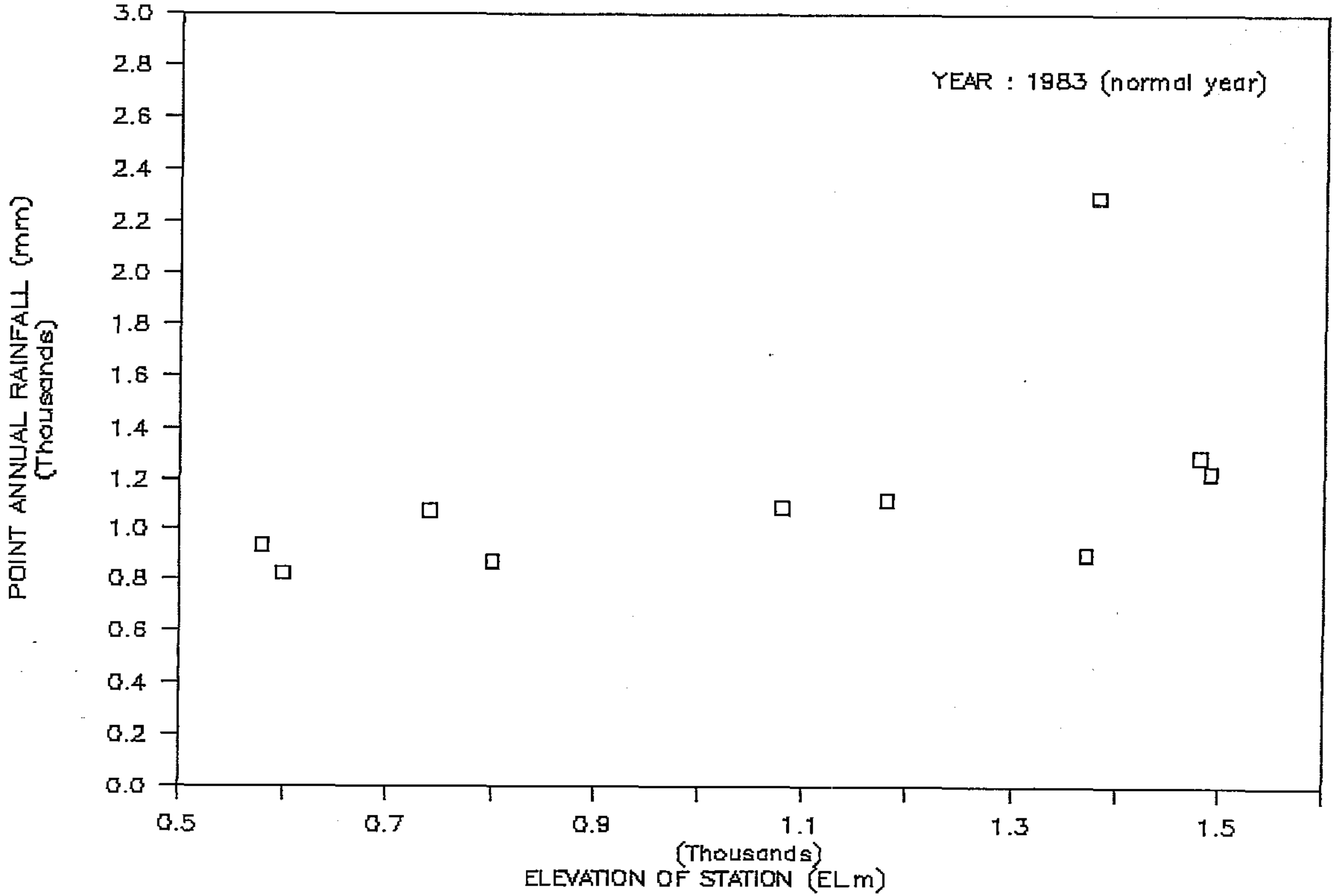

Fig. 1.1.3 CORRELATION BETWEEN ANNUAL RAINFALL AND ELEVATION OF STATIONS

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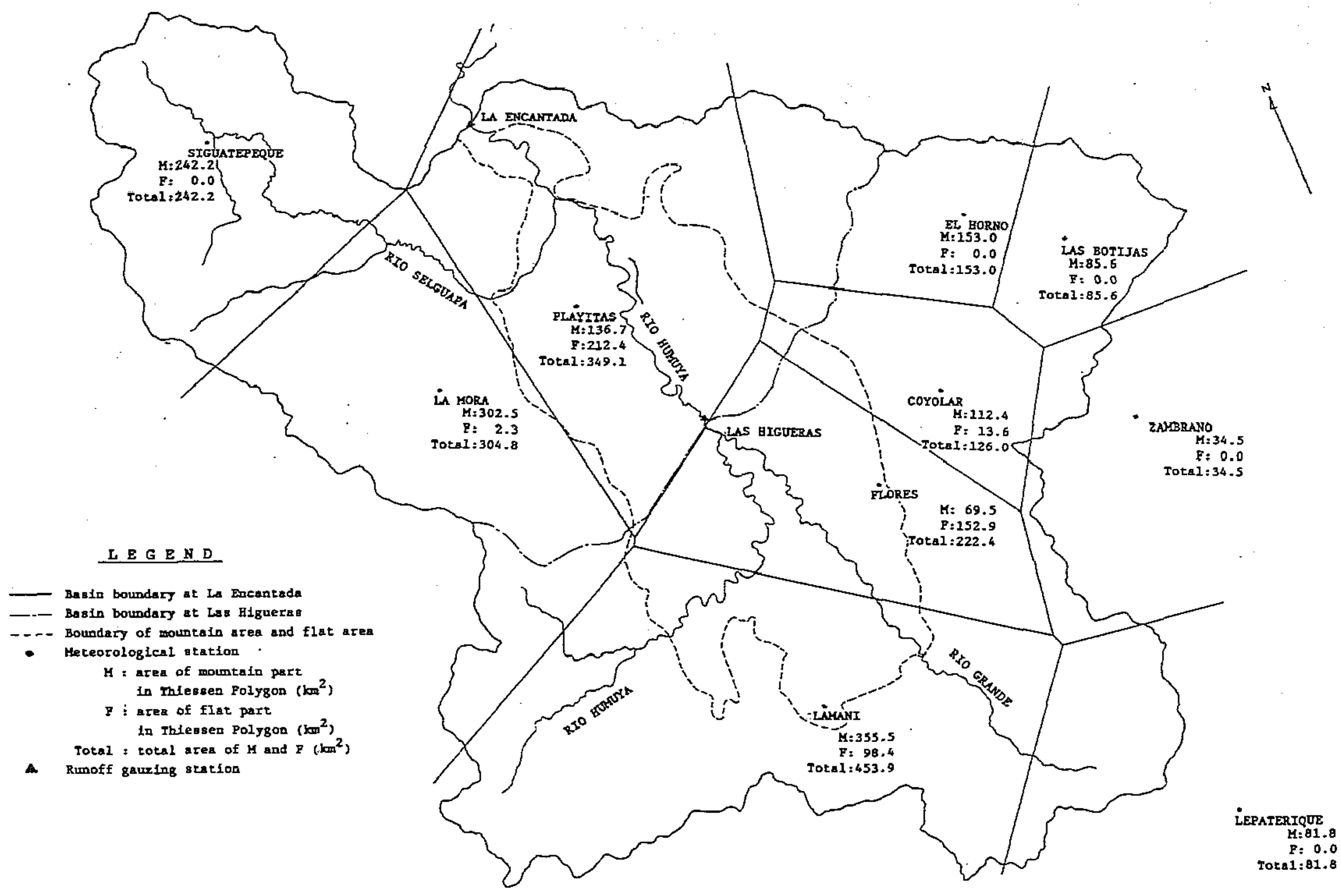

Scale 0 5 10 km

Fig. 1.1.4 AREA ALLOCATION BY THIESSEN POLYGON

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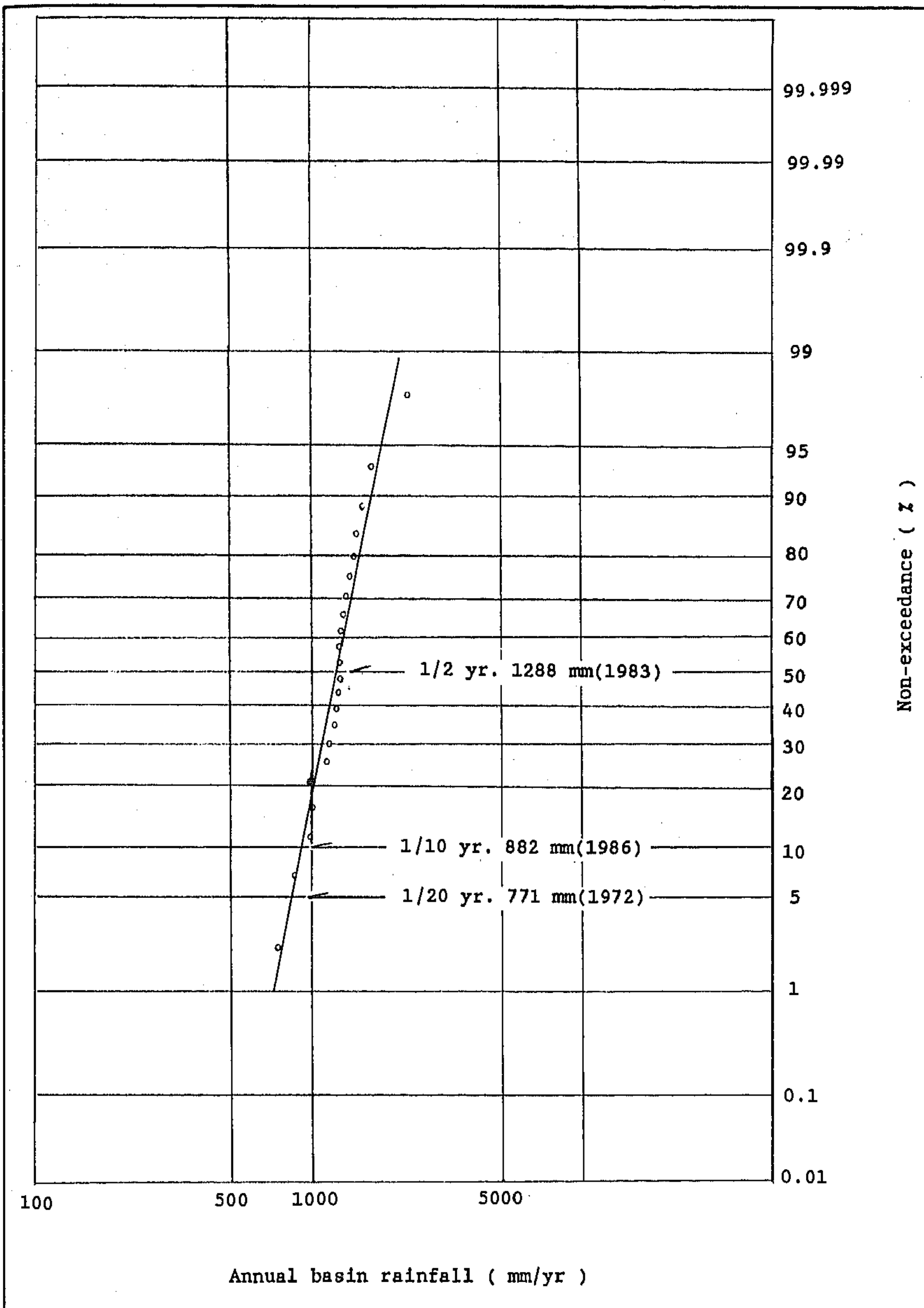

Fig. 1.1.5 PROBABLE DISTRIBUTION OF ANNUAL BASIN RAINFALL FOR THE WHOLE HUMUYA BASIN

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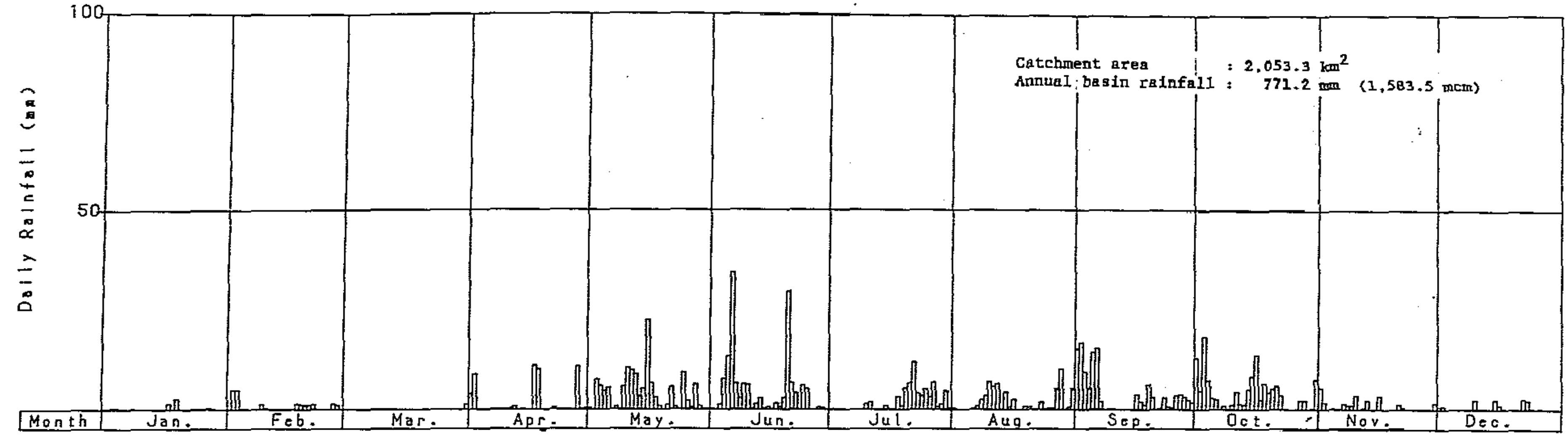
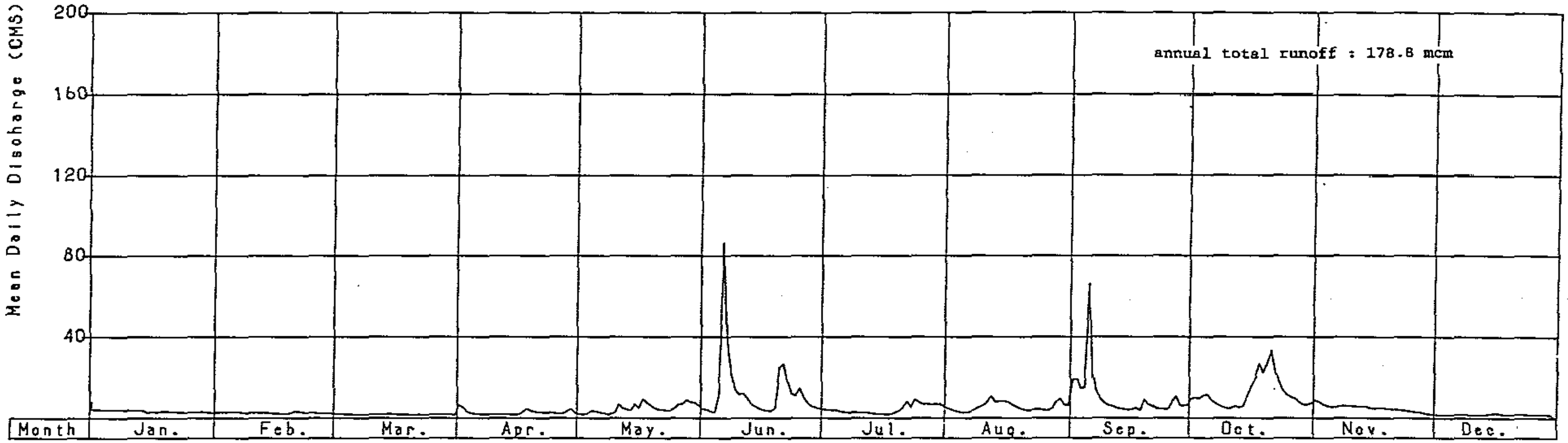


Basin Rainfall at La encantada Year : 1972



STATION NAME : Las Encantada Year : 1972

Fig. 1.1.6 ESTIMATED BASIN DAILY RAINFALL AND OBSERVED DAILY RUNOFF (1)

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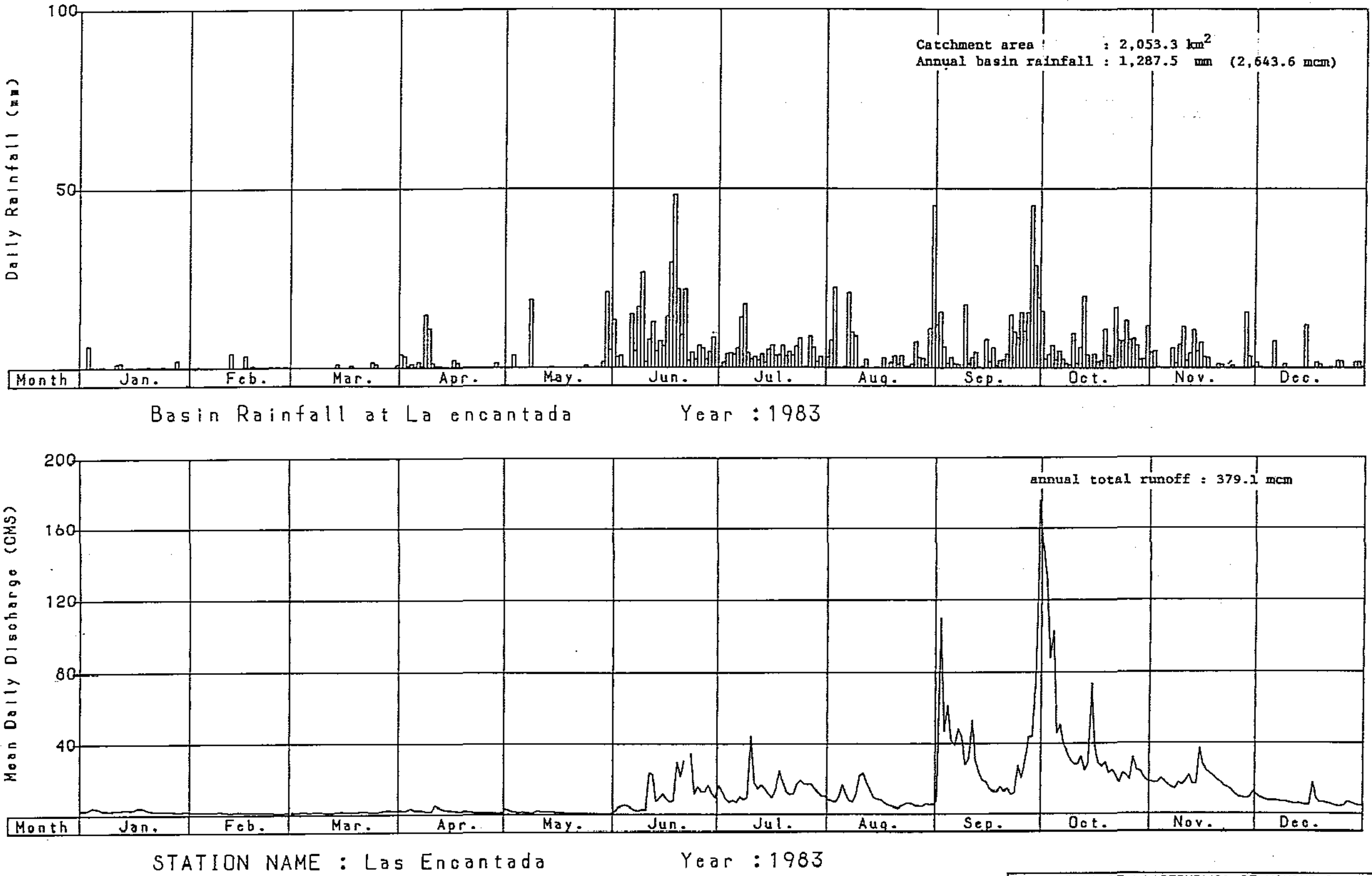

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SUBTERRANEAS DEL VALLE DE COMAYAGUA

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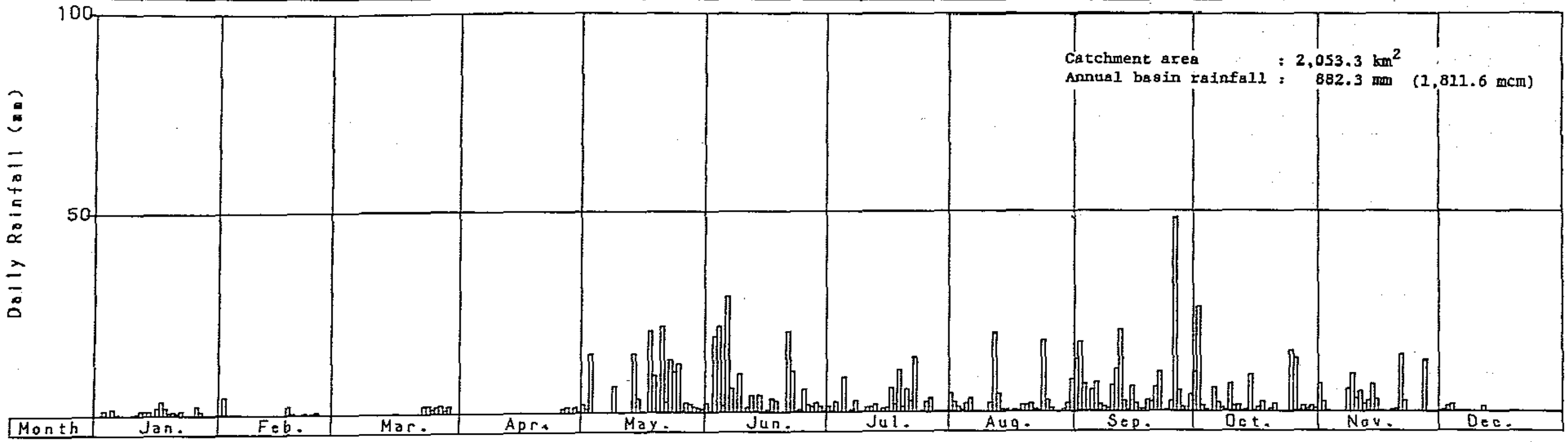
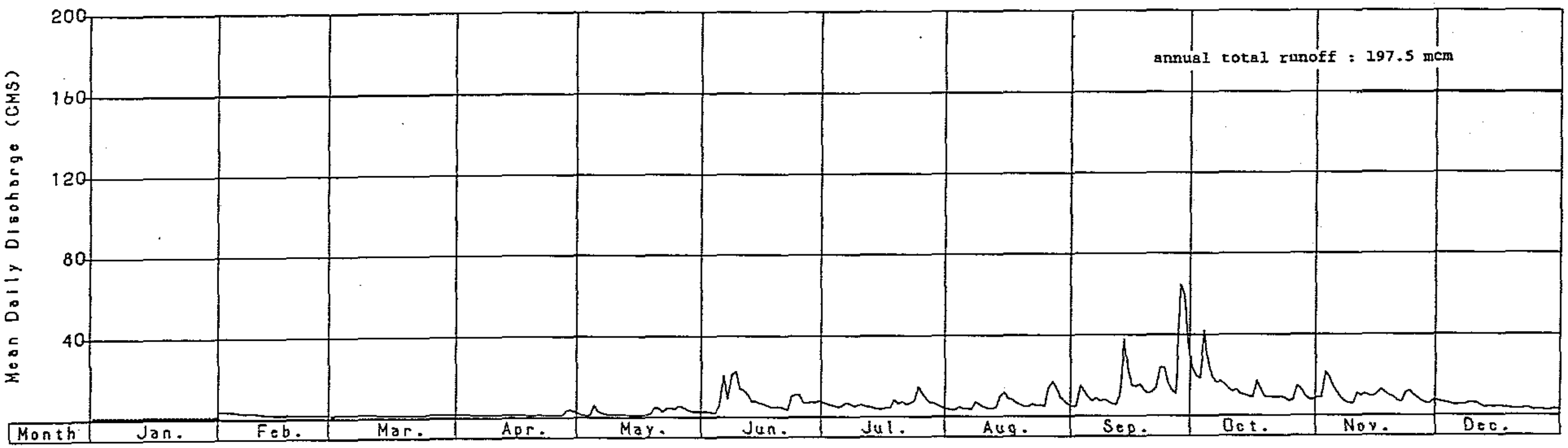
Fig. 1.1.6 ESTIMATED BASIN DAILY RAINFALL AND OBSERVED DAILY RUNOFF (2)



Basin Rainfall at La encantada Year :1986



STATION NAME : Las Encantada Year :1986

Fig. 1.1.6 ESTIMATED BASIN DAILY RAINFALL AND OBSERVED DAILY RUNOFF (3)

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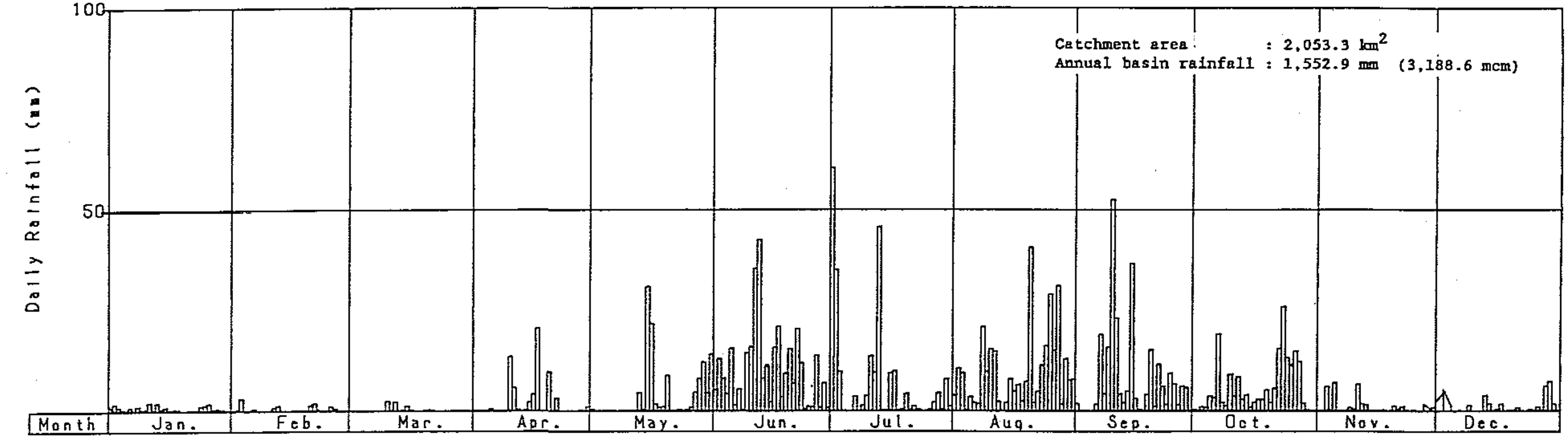
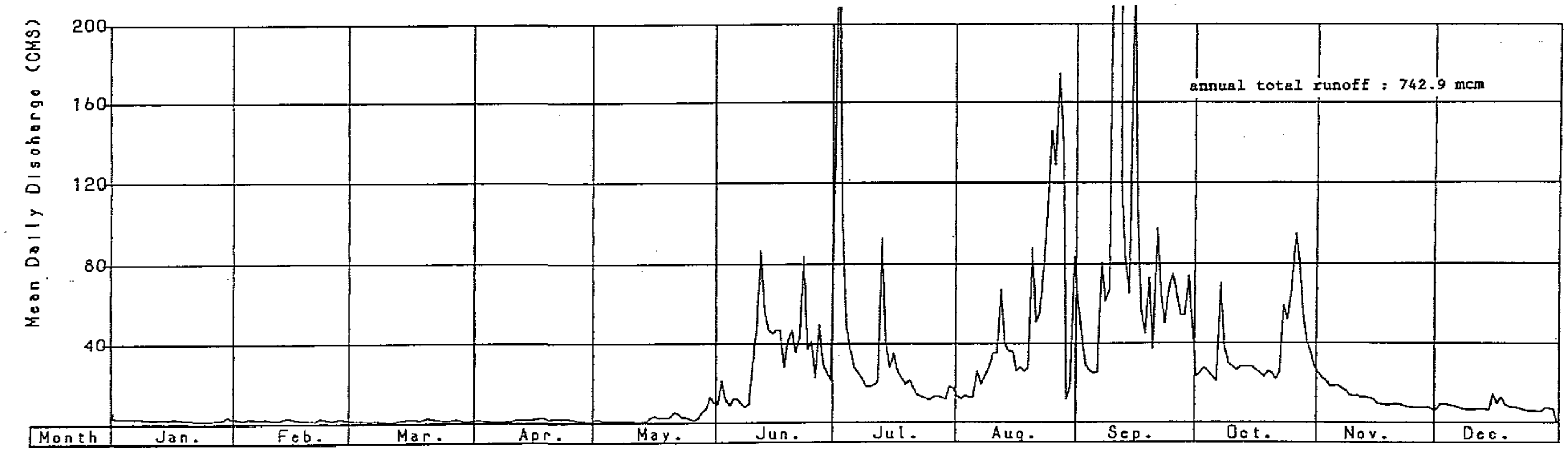
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



Basin Rainfall at La encantada Year :1988



STATION NAME : Las Encantada Year :1988

Fig. 1.1.6 ESTIMATED BASIN DAILY RAINFALL AND OBSERVED DAILY RUNOFF (4)

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ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

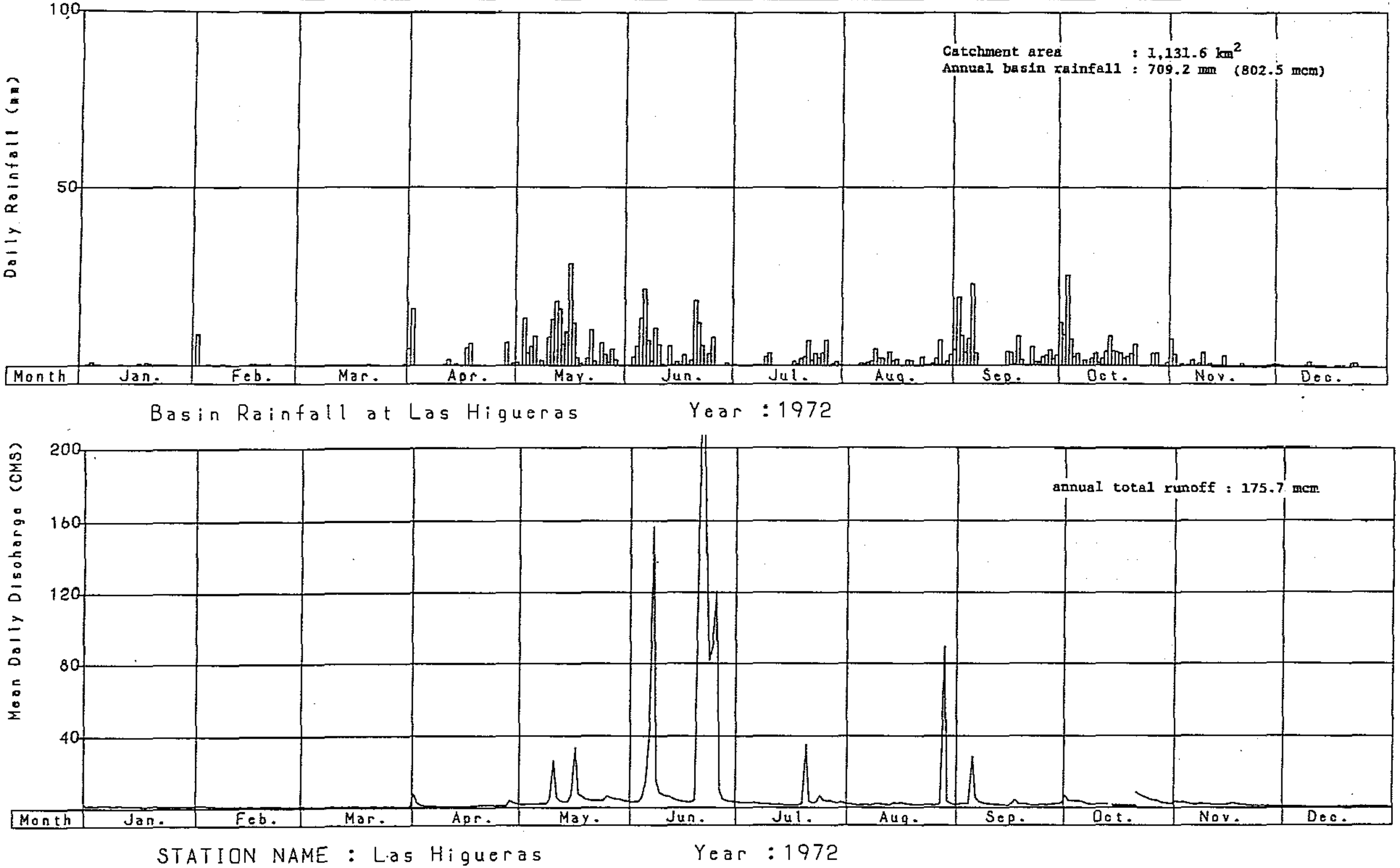

Fig. 1.1.6 ESTIMATED BASIN DAILY RAINFALL AND OBSERVED DAILY RUNOFF (5)

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ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

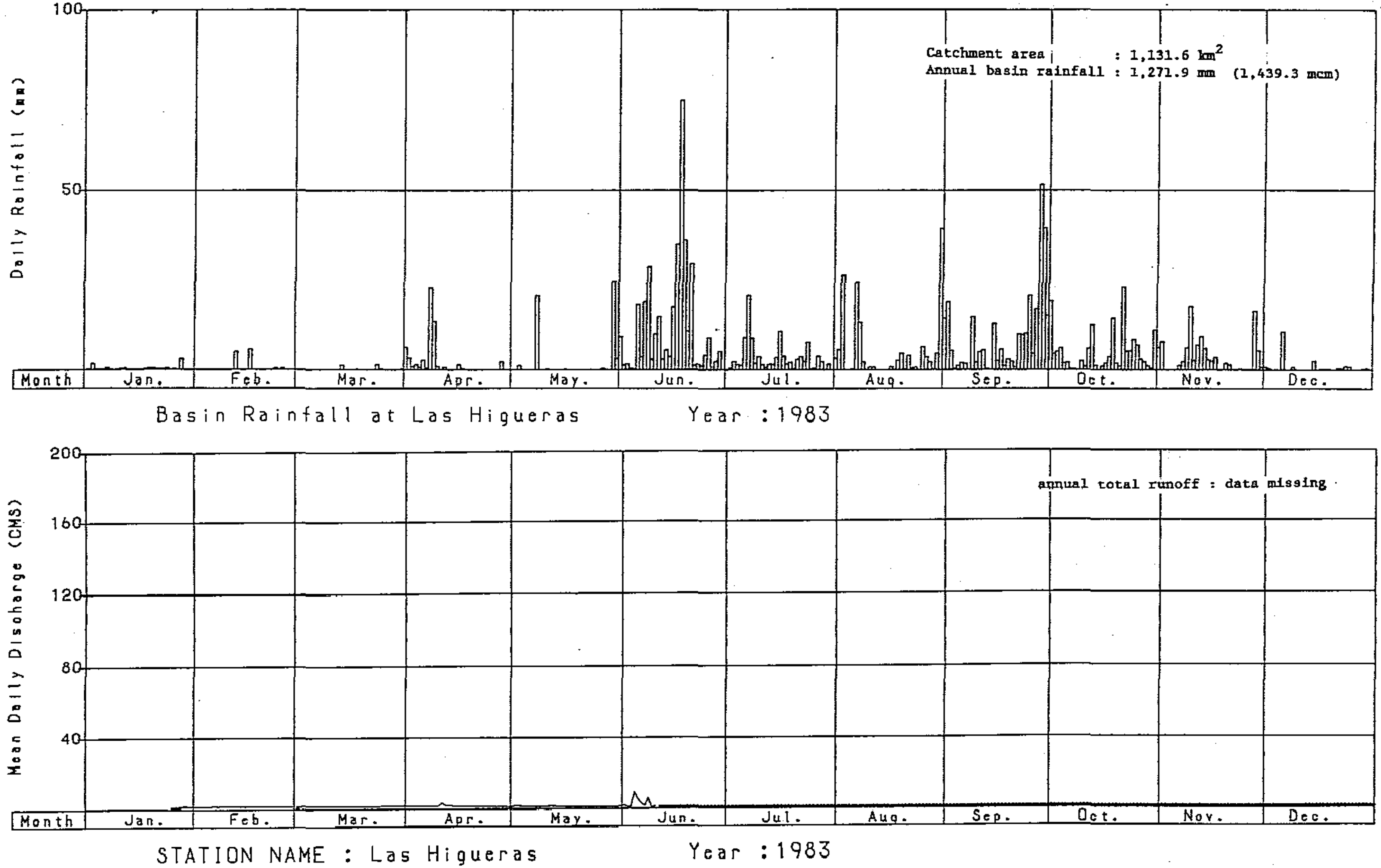

Fig. 1.1.6 ESTIMATED BASIN DAILY RAINFALL AND OBSERVED DAILY RUNOFF (6)

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ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

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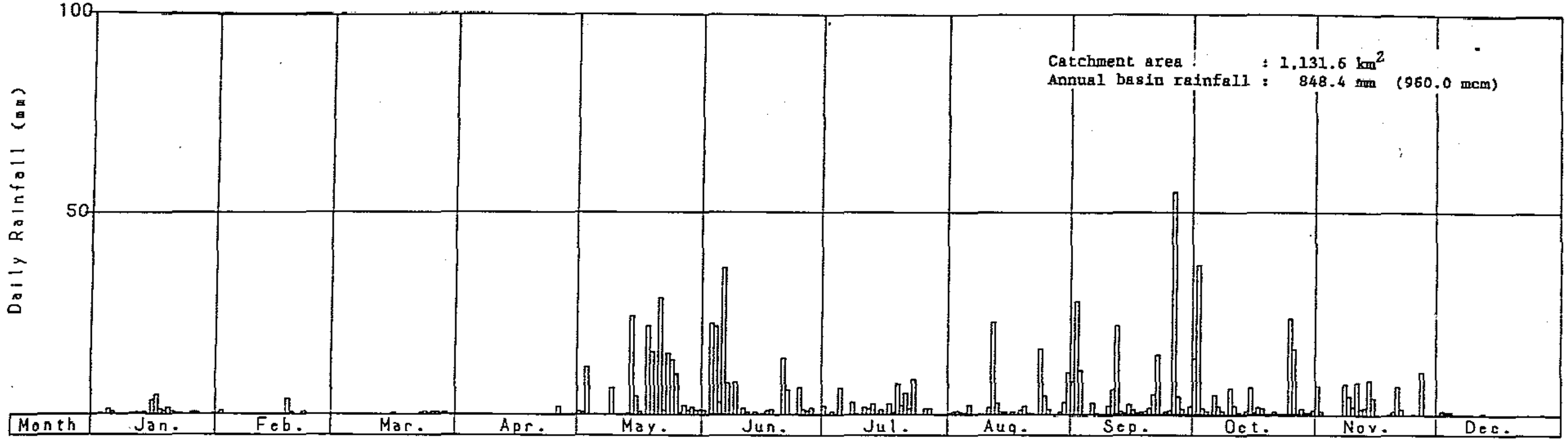
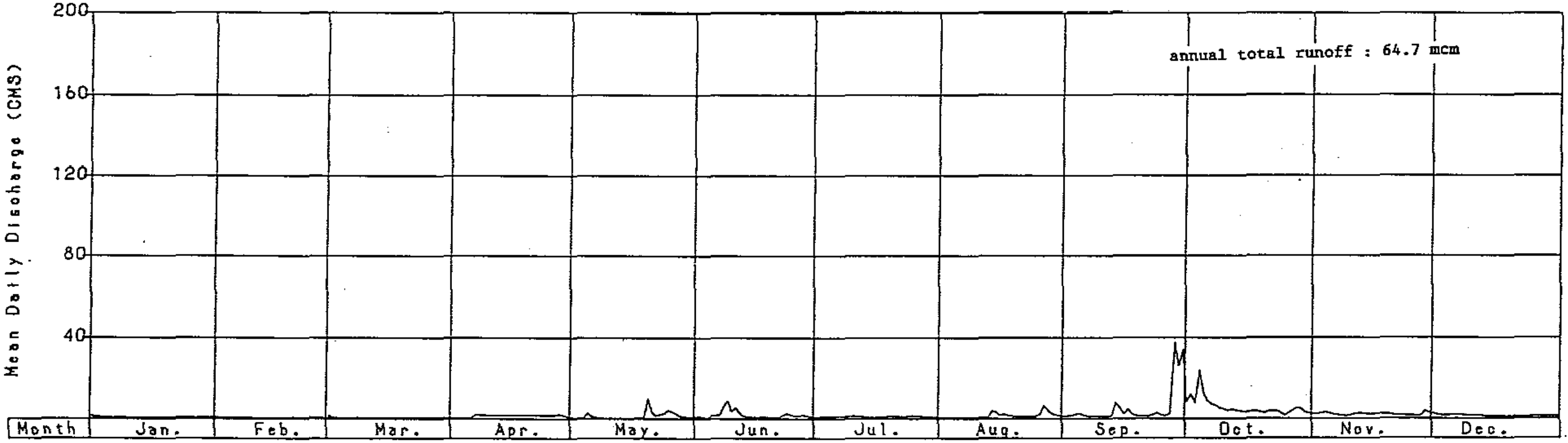


Basin Rainfall at Las Higueras Year : 1986

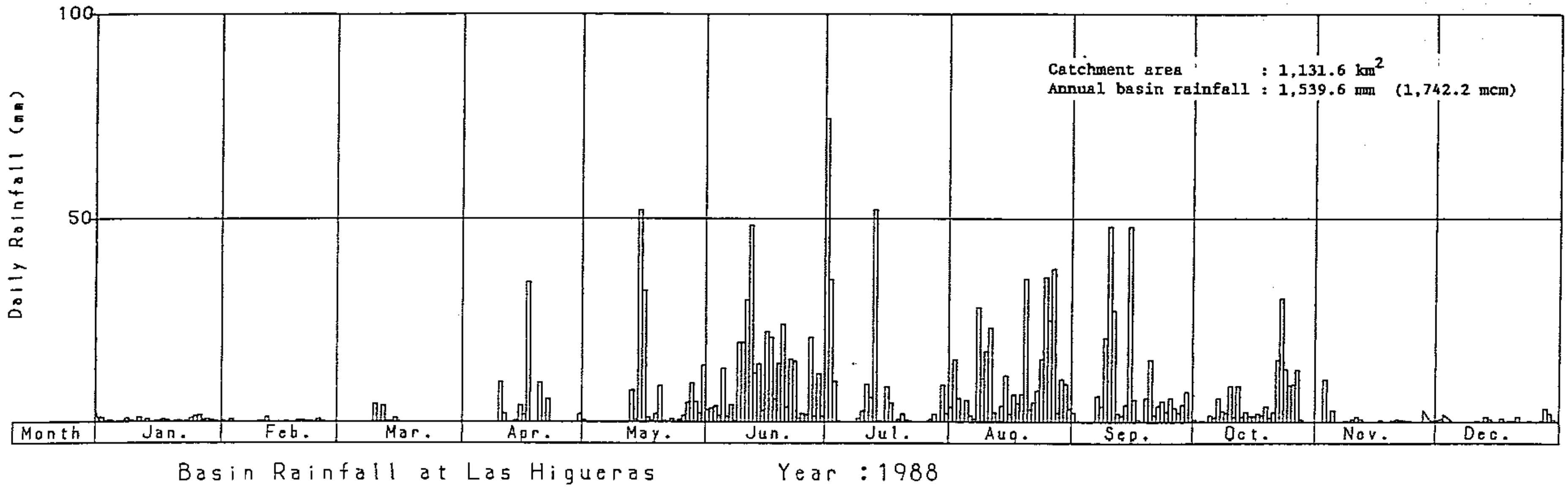


STATION NAME : Las Higueras Year : 1986

Fig. 1.1.6 ESTIMATED BASIN DAILY RAINFALL AND OBSERVED DAILY RUNOFF (7)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



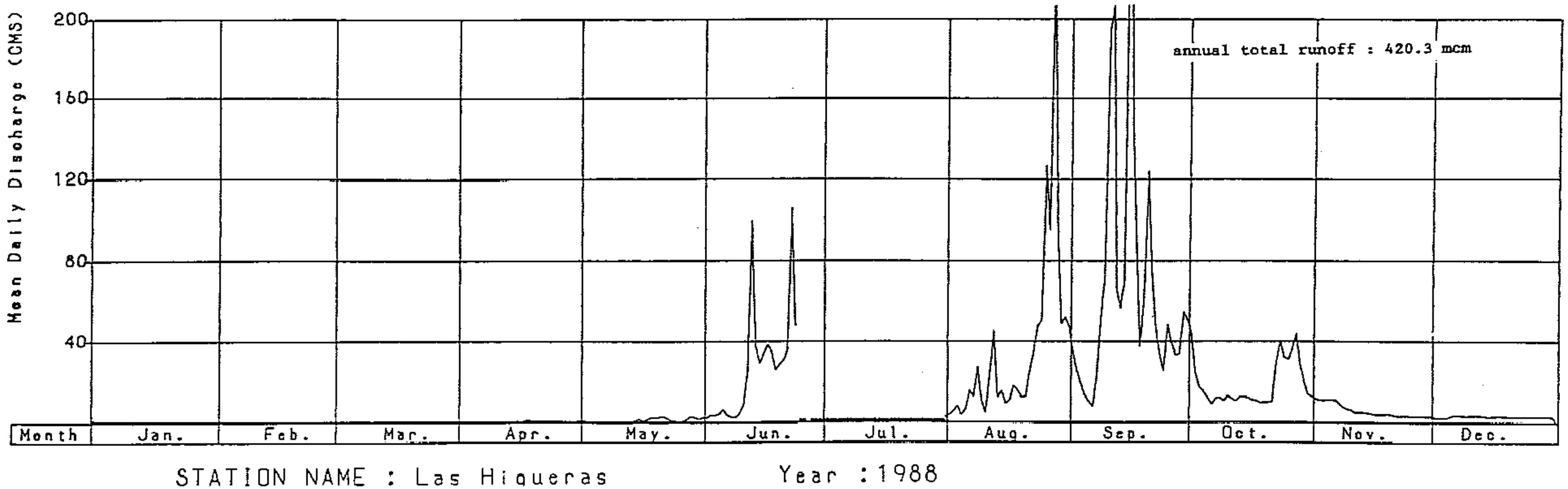


Fig. 1.1.6 ESTIMATED BASIN DAILY RAINFALL AND OBSERVED DAILY RUNOFF (8)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

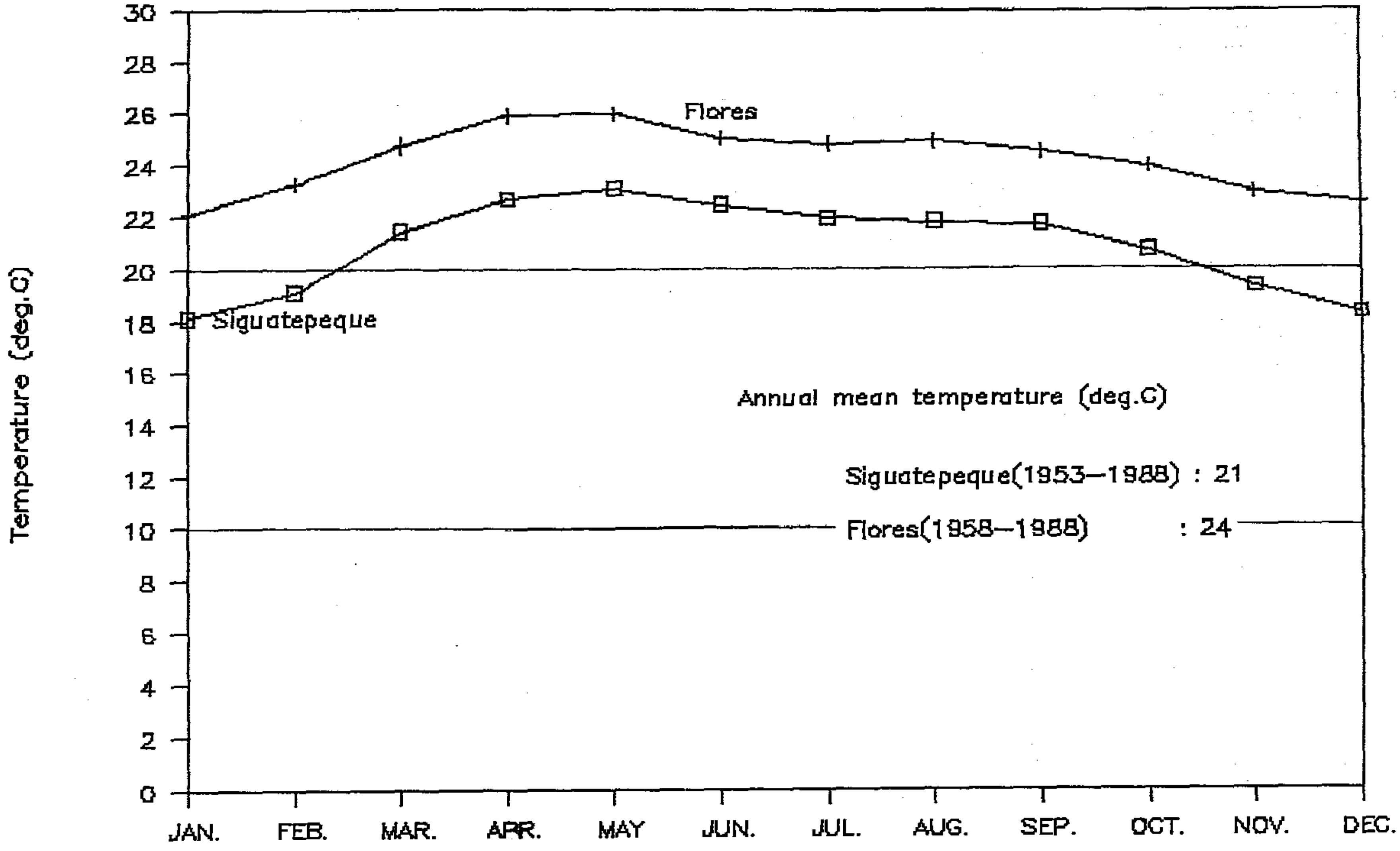


Fig. 1.2.1 MONTHLY MEAN TEMPERATURE OF REPRESENTATIVE STATIONS

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

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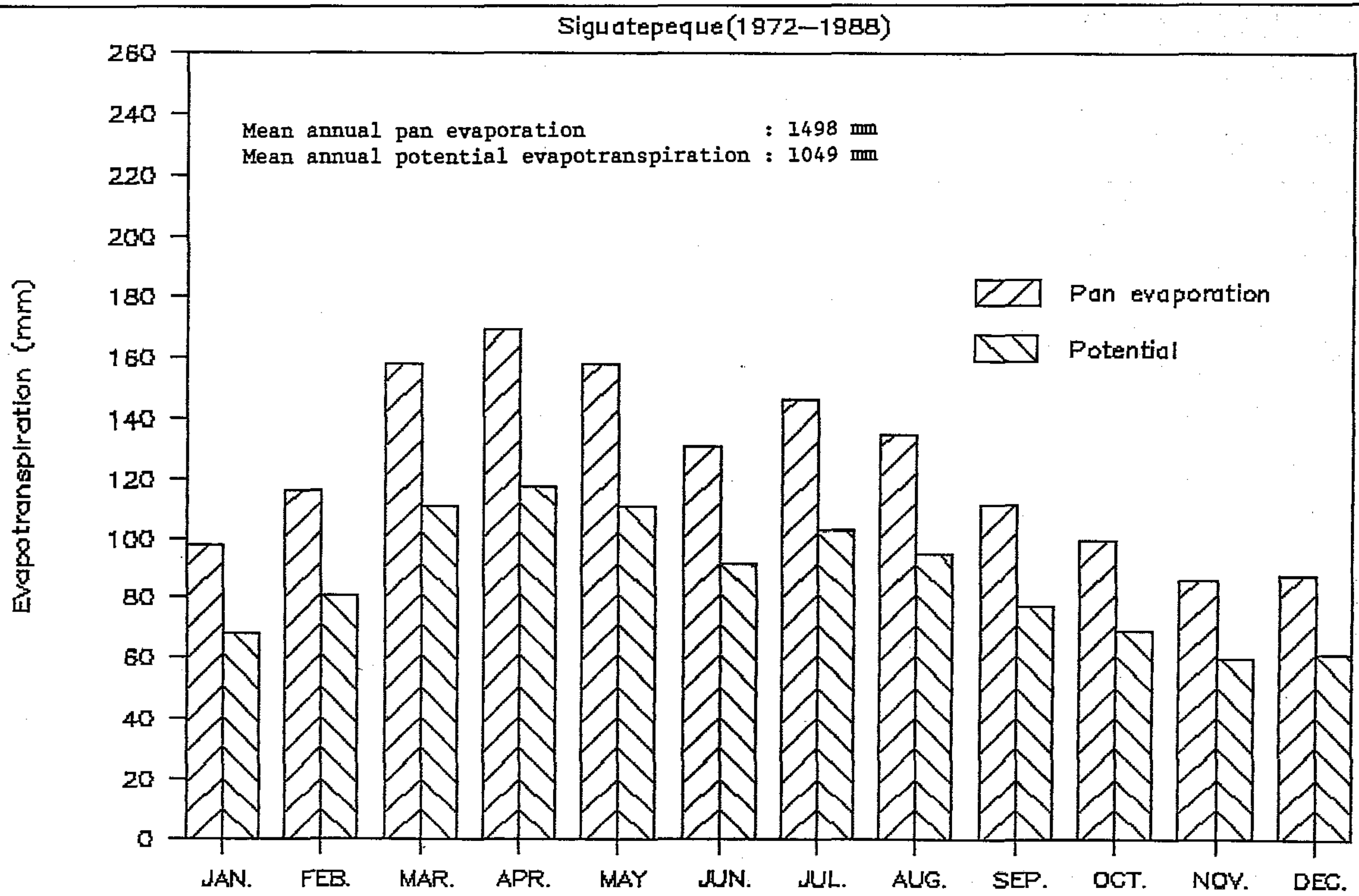

Fig. 1.3.1 MONTHLY PAN EVAPORATION AND POTENTIAL EVAPORATION OF REPRESENTATIVE STATIONS (1)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

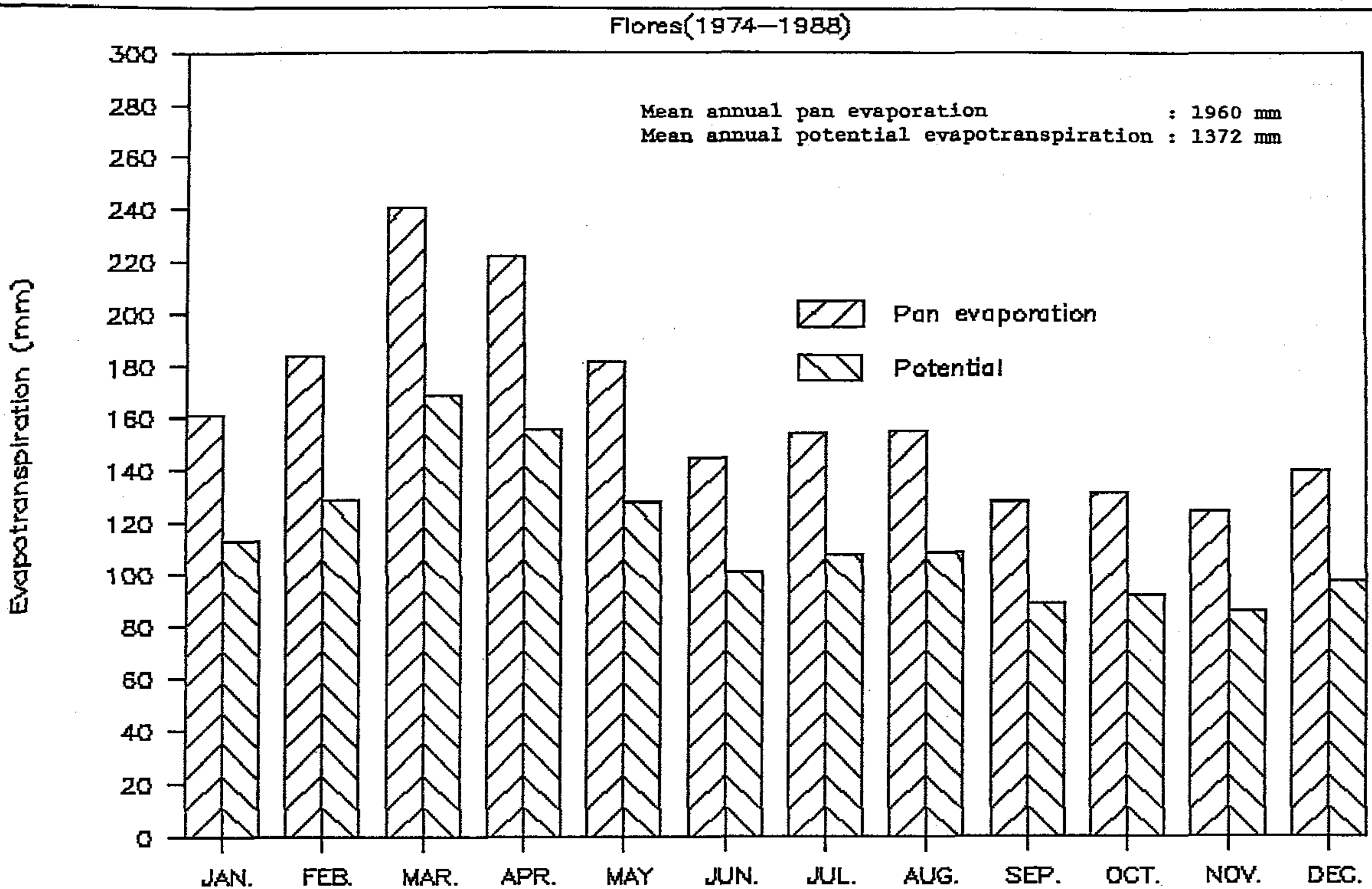

Fig. 1.3.1 MONTHLY PAN EVAPORATION AND POTENTIAL EVAPORATION OF REPRESENTATIVE STATIONS (2)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

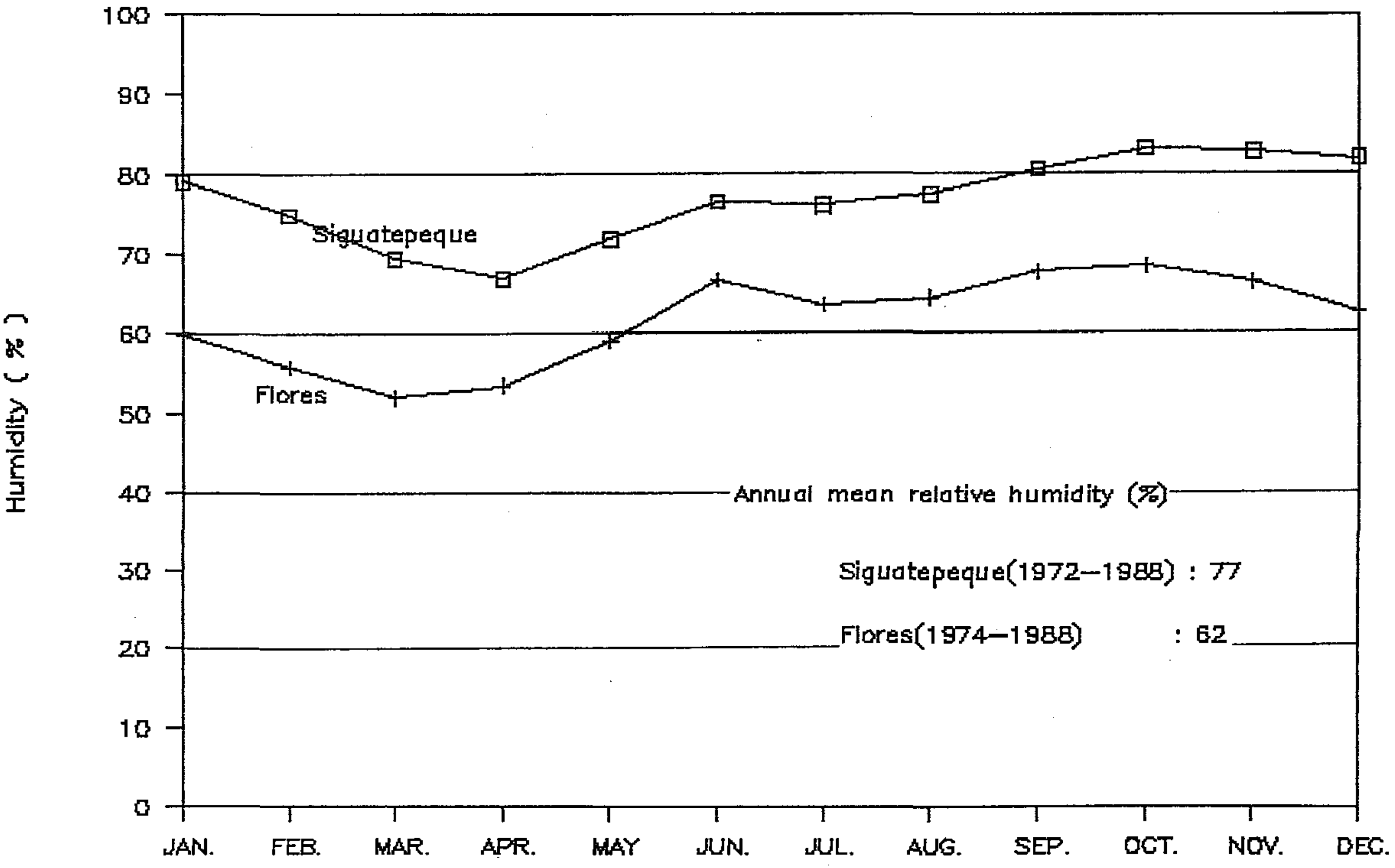

Fig. 1.4.1 MONTHLY MEAN RELATIVE HUMIDITY OF REPRESENTATIVE STATIONS

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

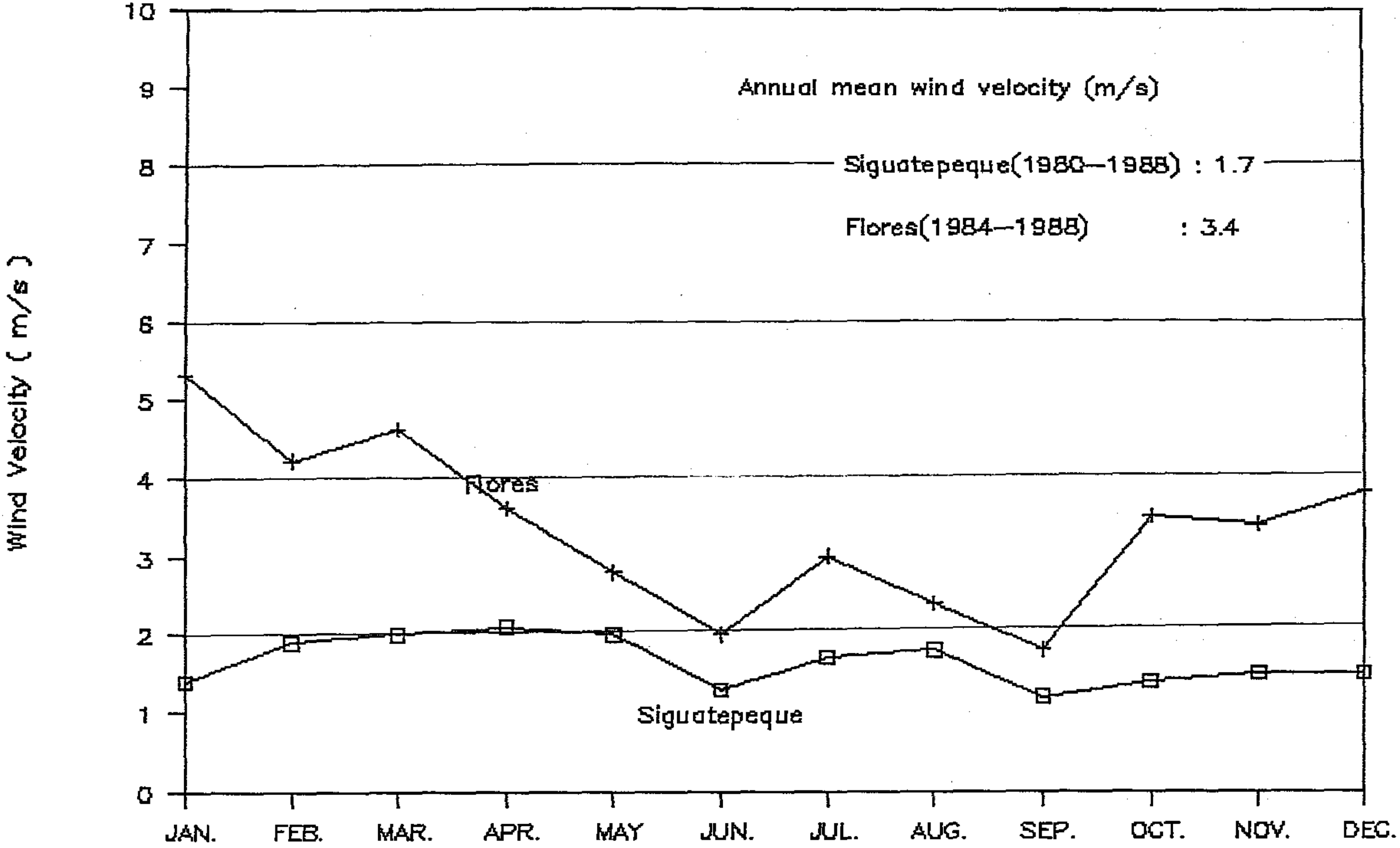

Fig. 1.5.1 MONTHLY MEAN WIND VELOCITY OF REPRESENTATIVE STATIONS

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

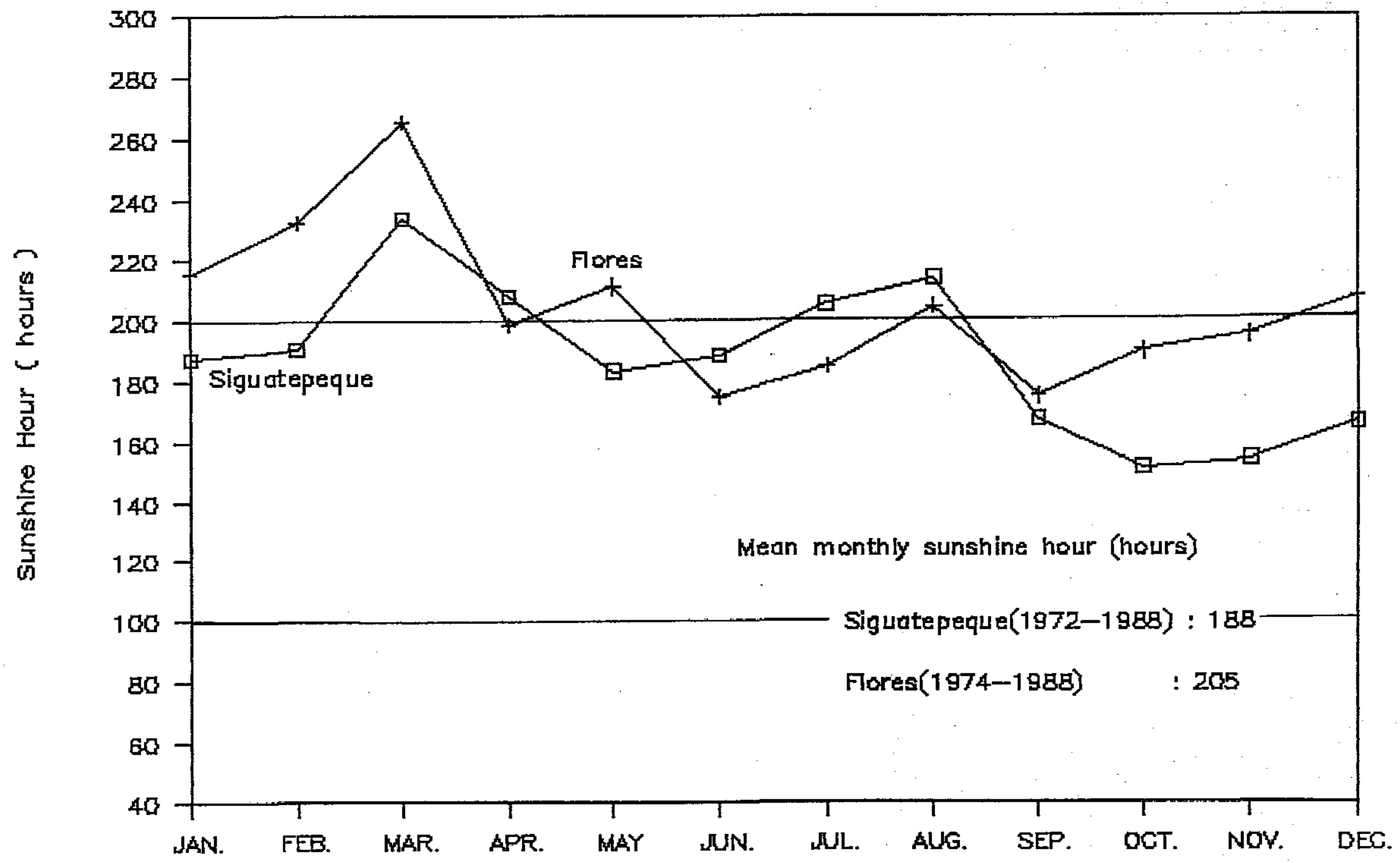

Fig. 1.6.1 MONTHLY SUNSHINE HOUR OF REPRESENTATIVE STATIONS

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

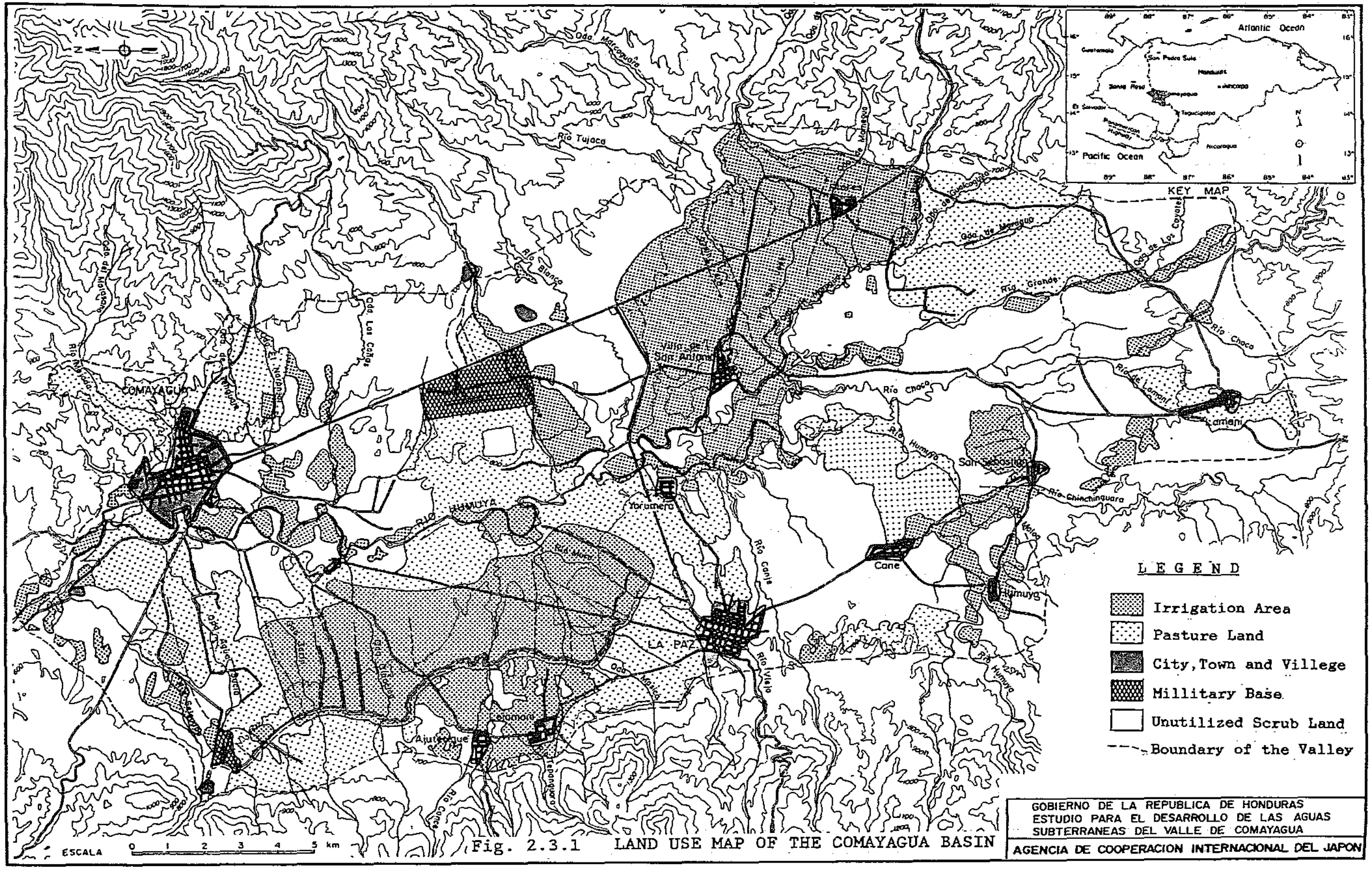

Fig. 2.3.1 LAND USE MAP OF THE COMAYAGUA BASIN

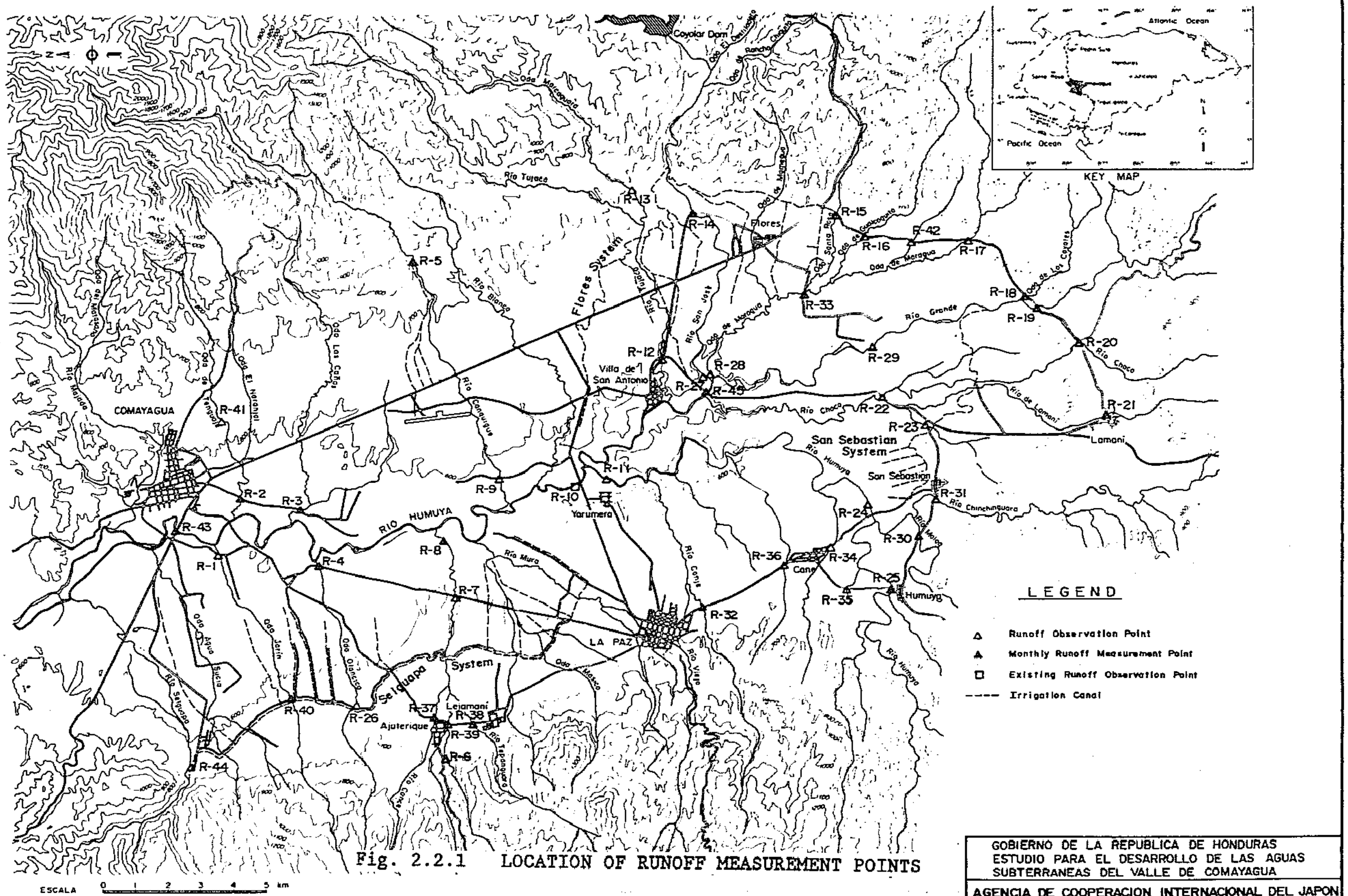

Fig. 2.2.1 LOCATION OF RUNOFF MEASUREMENT POINTS

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

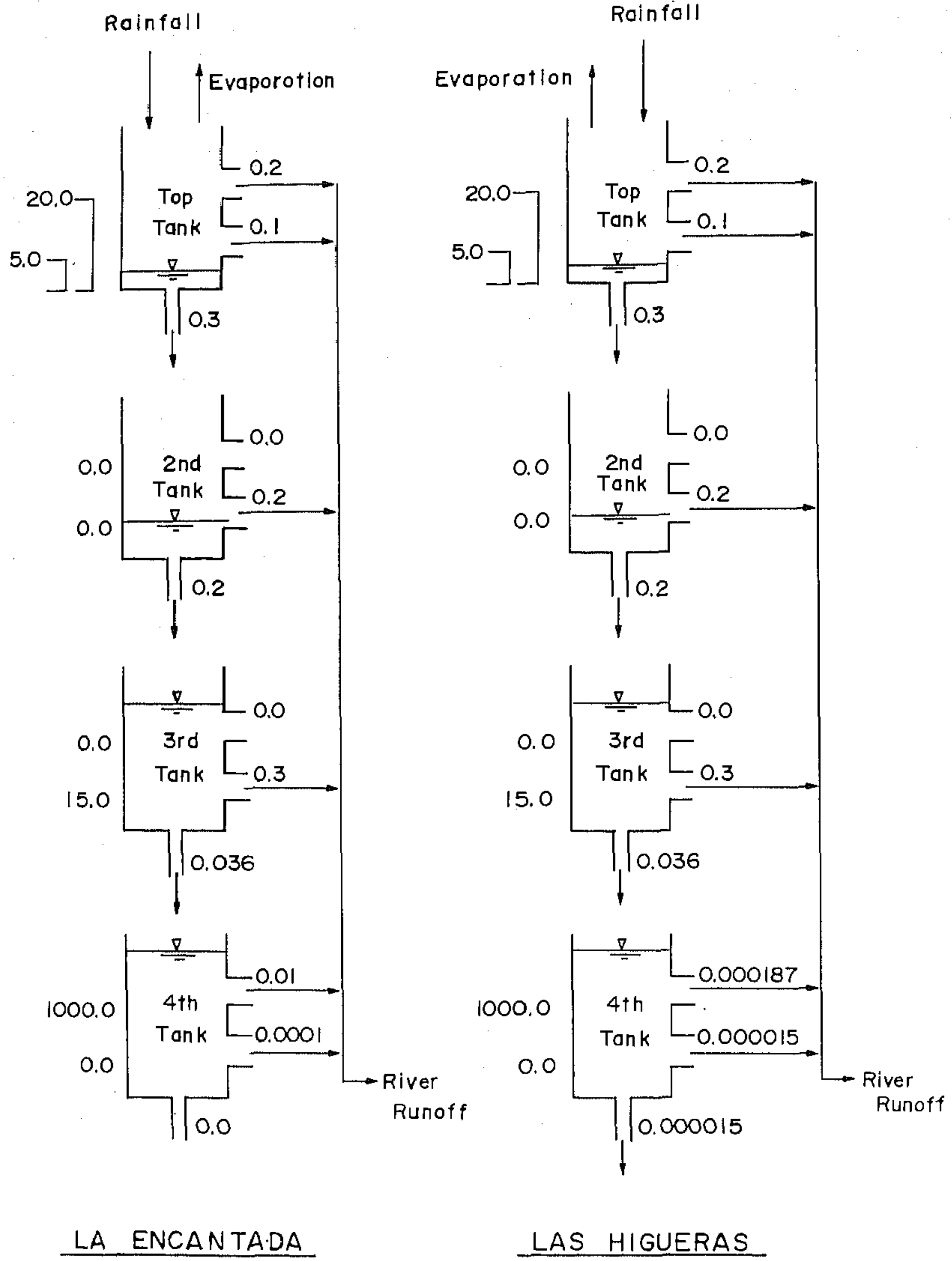

Fig. 3.3.1 TANK MODELS APPLIED FOR THE RUNOFF STUDY

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ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

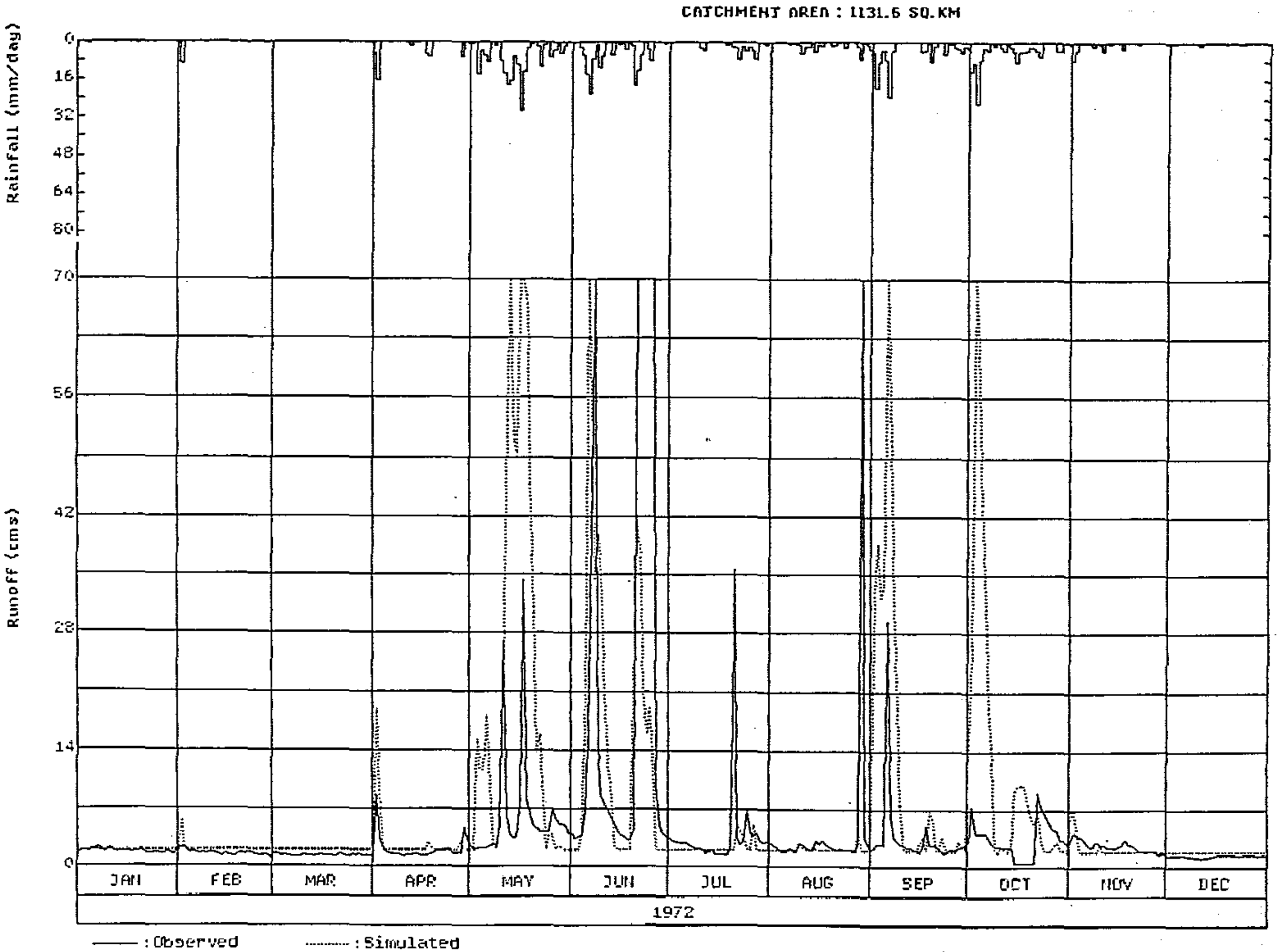


Fig. 3.5.1 SIMULATED HYDROGRAPH BY THE LAS HIGUERAS MODEL (1)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

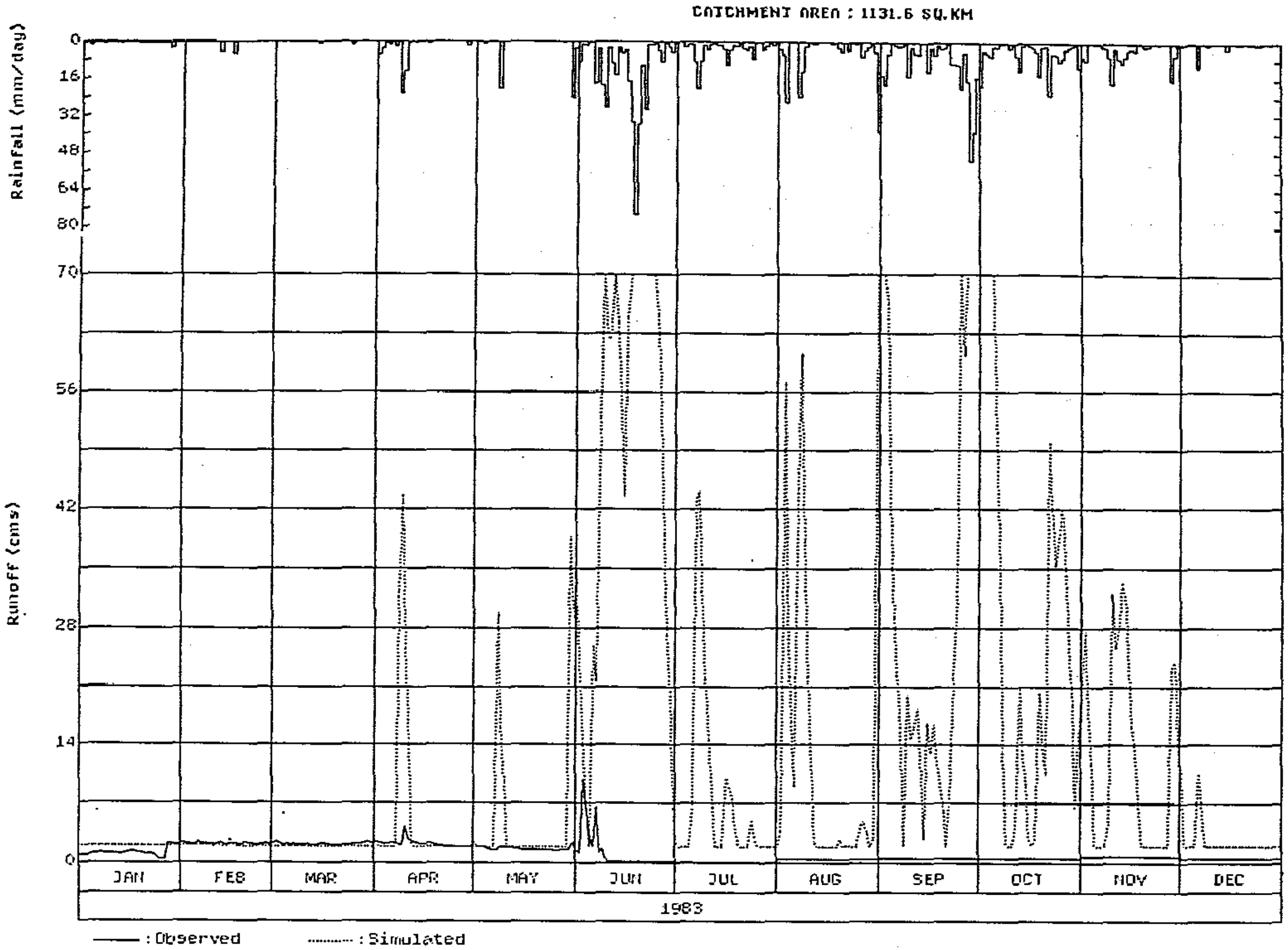


Fig. 3.5.1 SIMULATED HYDROGRAPH BY THE LAS HIGUERAS MODEL (2)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

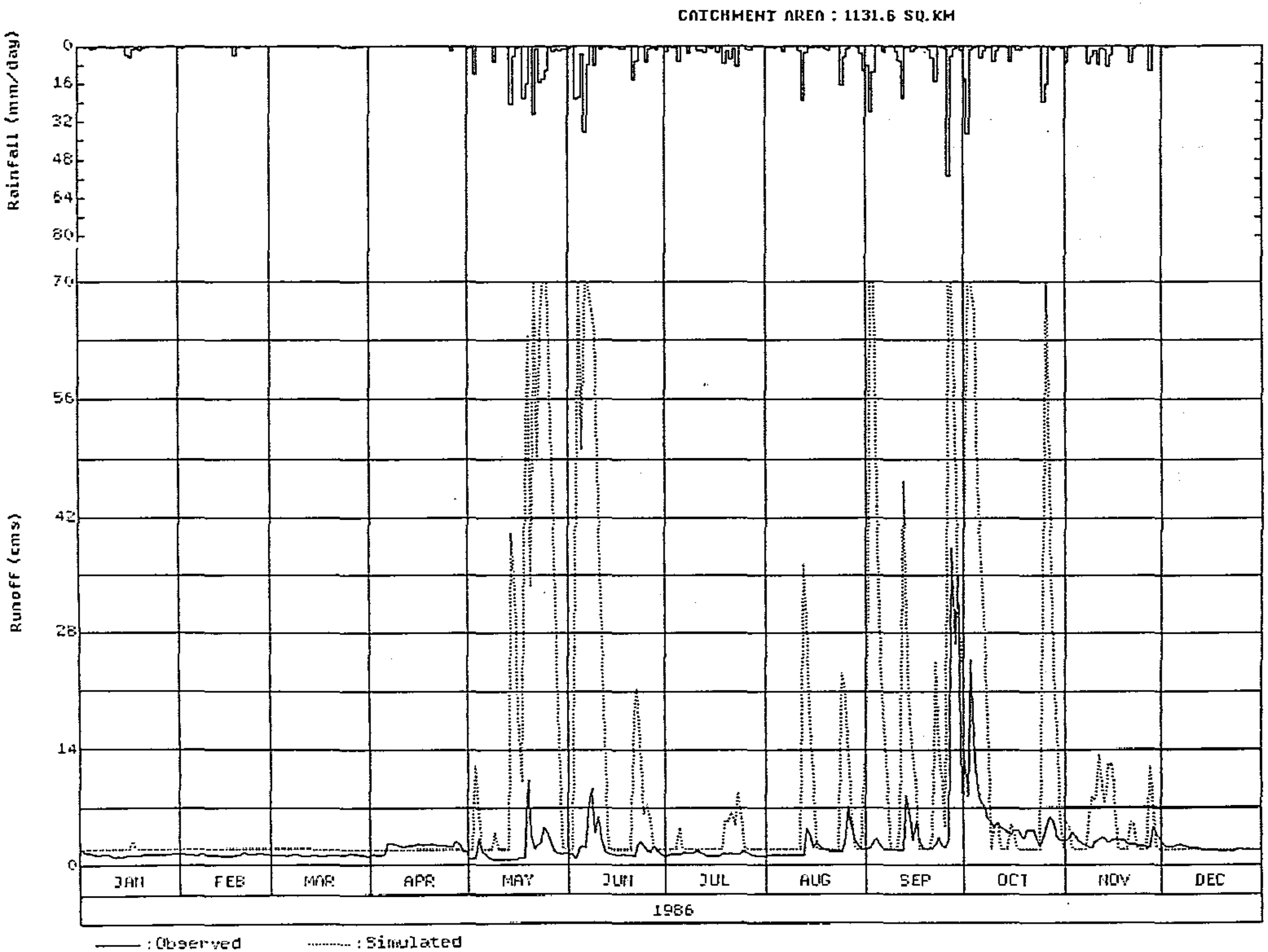


Fig. 3.5.1 SIMULATED HYDROGRAPH BY THE LAS HIGUERAS MODEL (3)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

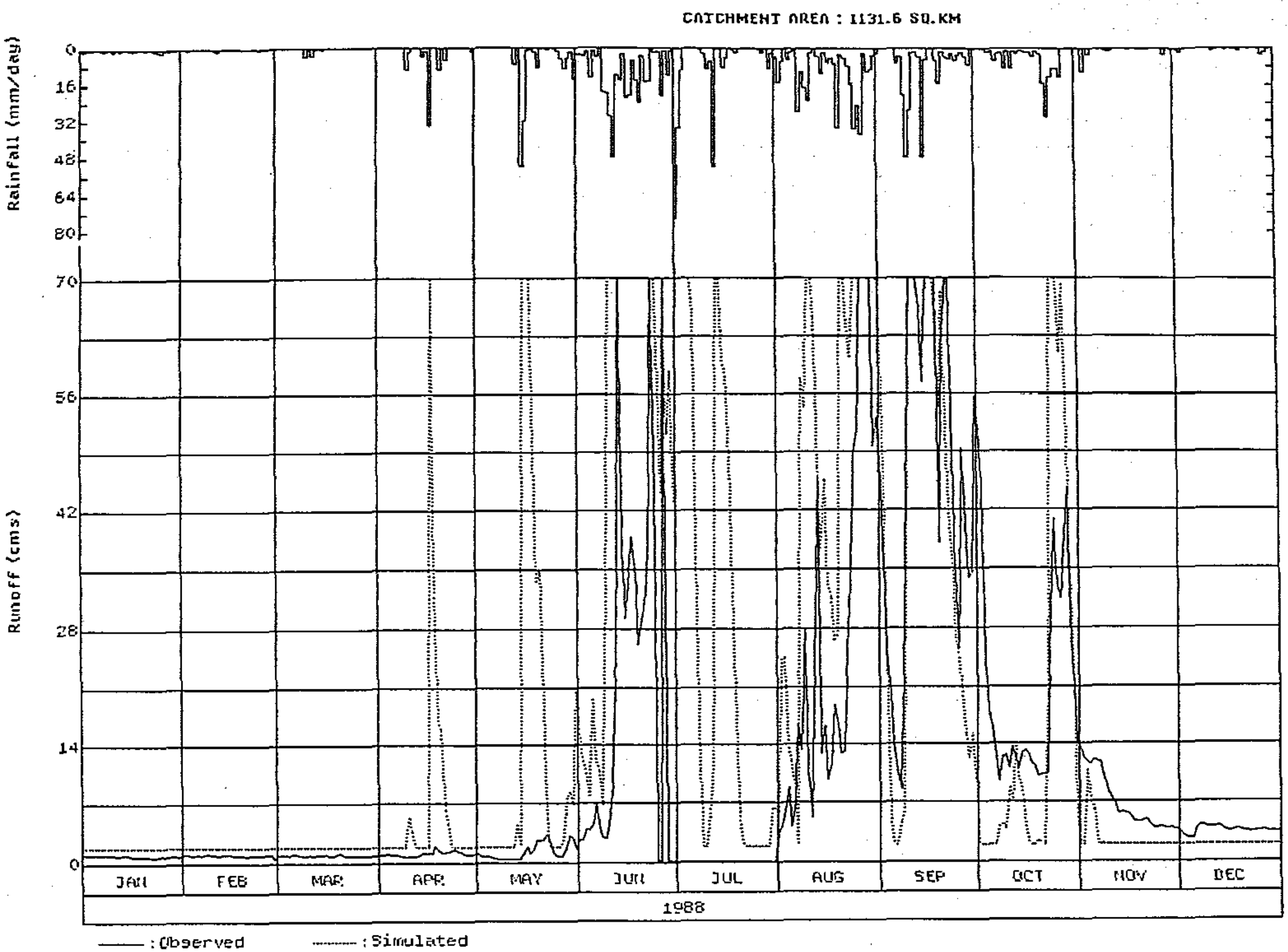


Fig. 3.5.1 SIMULATED HYDROGRAPH BY THE LAS HIGUERAS MODEL (4)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

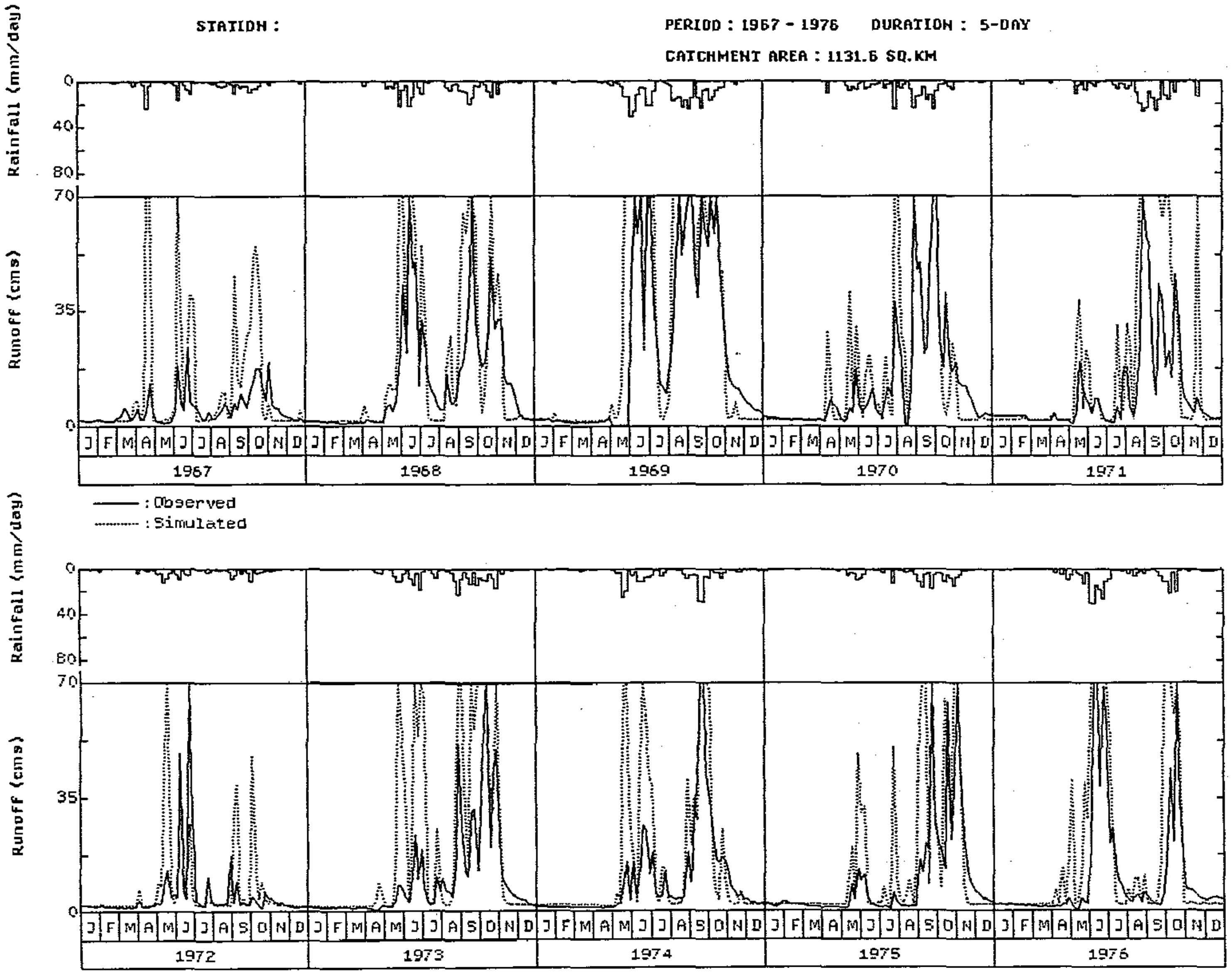


Fig. 3.5.1 SIMULATED HYDROGRAPH BY THE LAS HIGUERAS MODEL (5)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS
SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

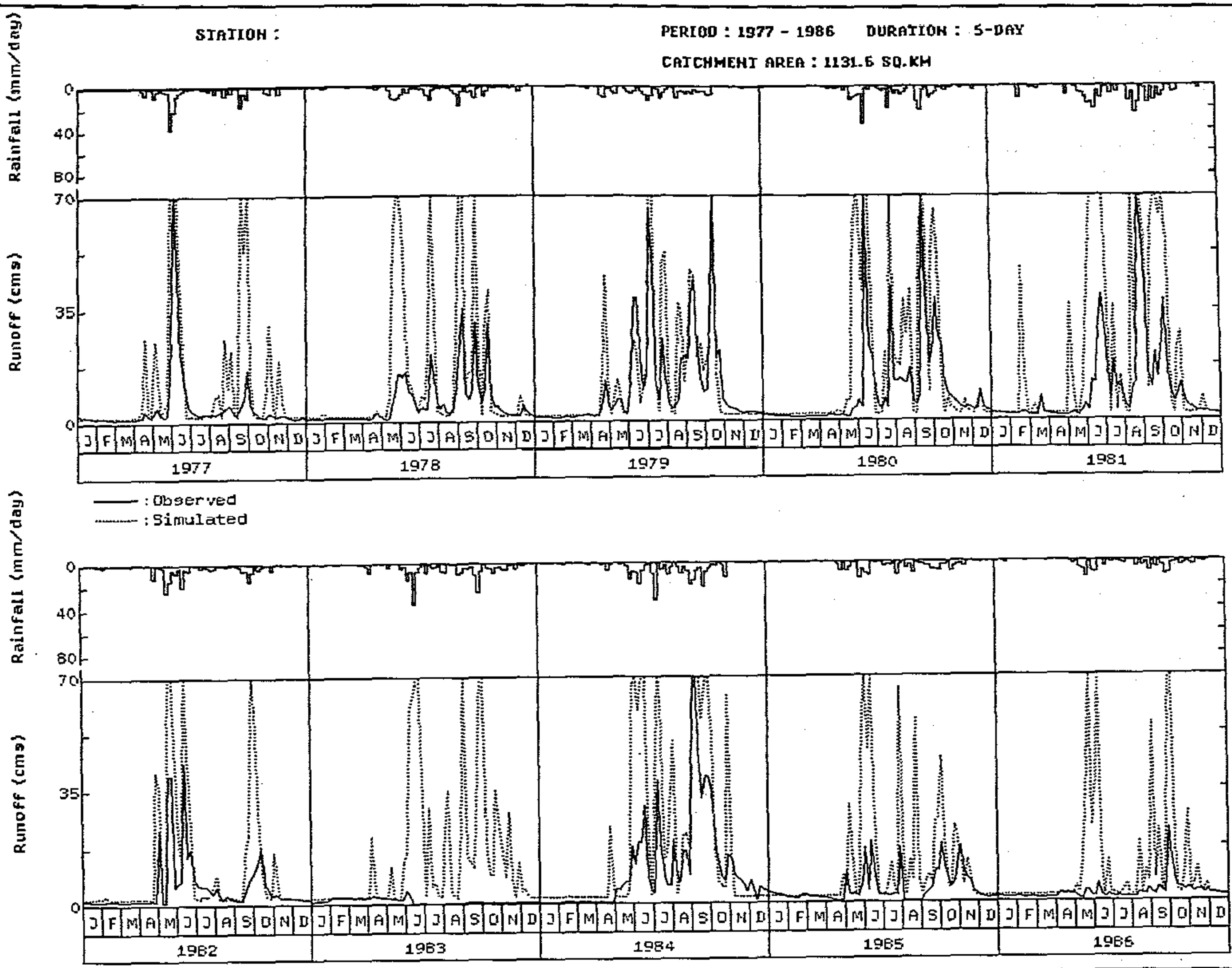
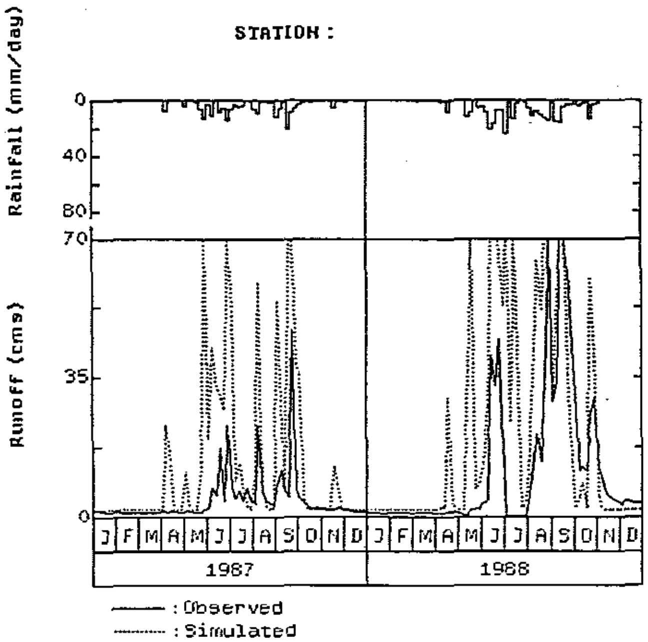


Fig. 3.5.1 SIMULATED HYDROGRAPH BY THE LAS HIGUERAS MODEL (6)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



PERIOD : 1987 - 1988 DURATION : 5-DAY

CATCHMENT AREA : 1131.6 SQ.KM

Fig. 3.5.1 SIMULATED HYDROGRAPH BY THE LAS HIGUERAS MODEL (7)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS
SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

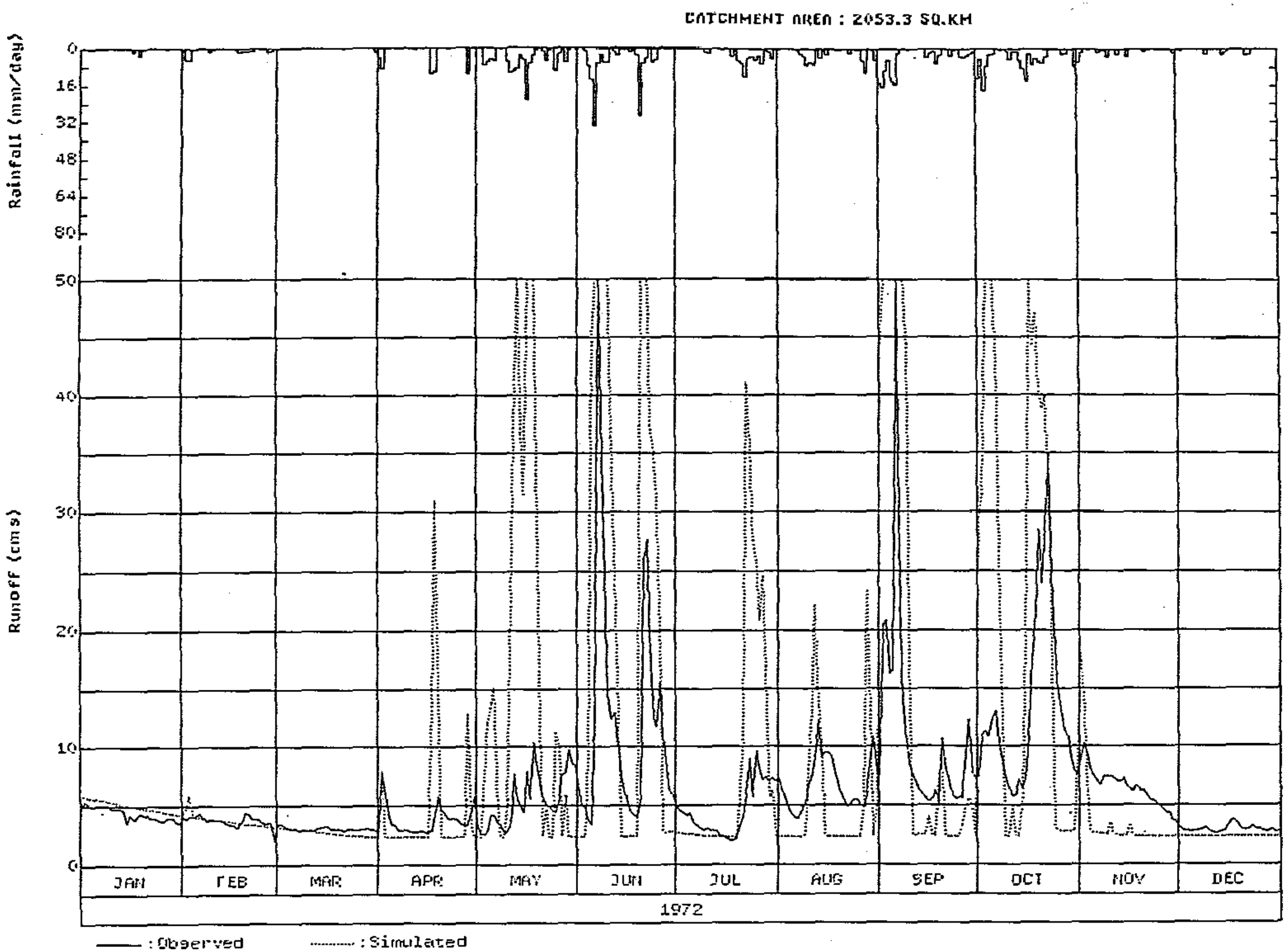


Fig. 3.5.2 SIMULATED HYDROGRAPH BY THE LA ENCANTADA MODEL (1)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

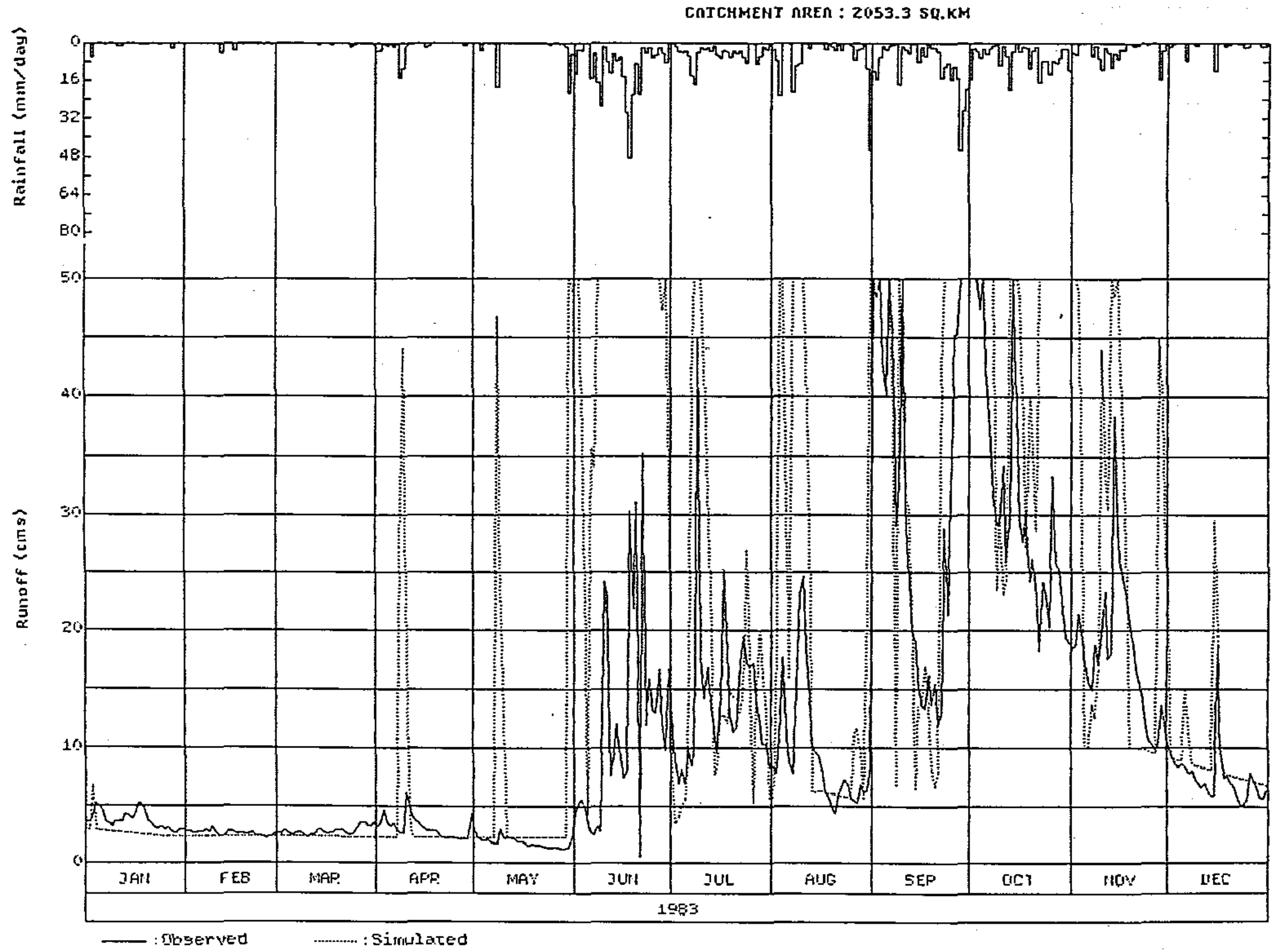


Fig. 3.5.2 SIMULATED HYDROGRAPH BY THE LA ENCANTADA MODEL (2)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

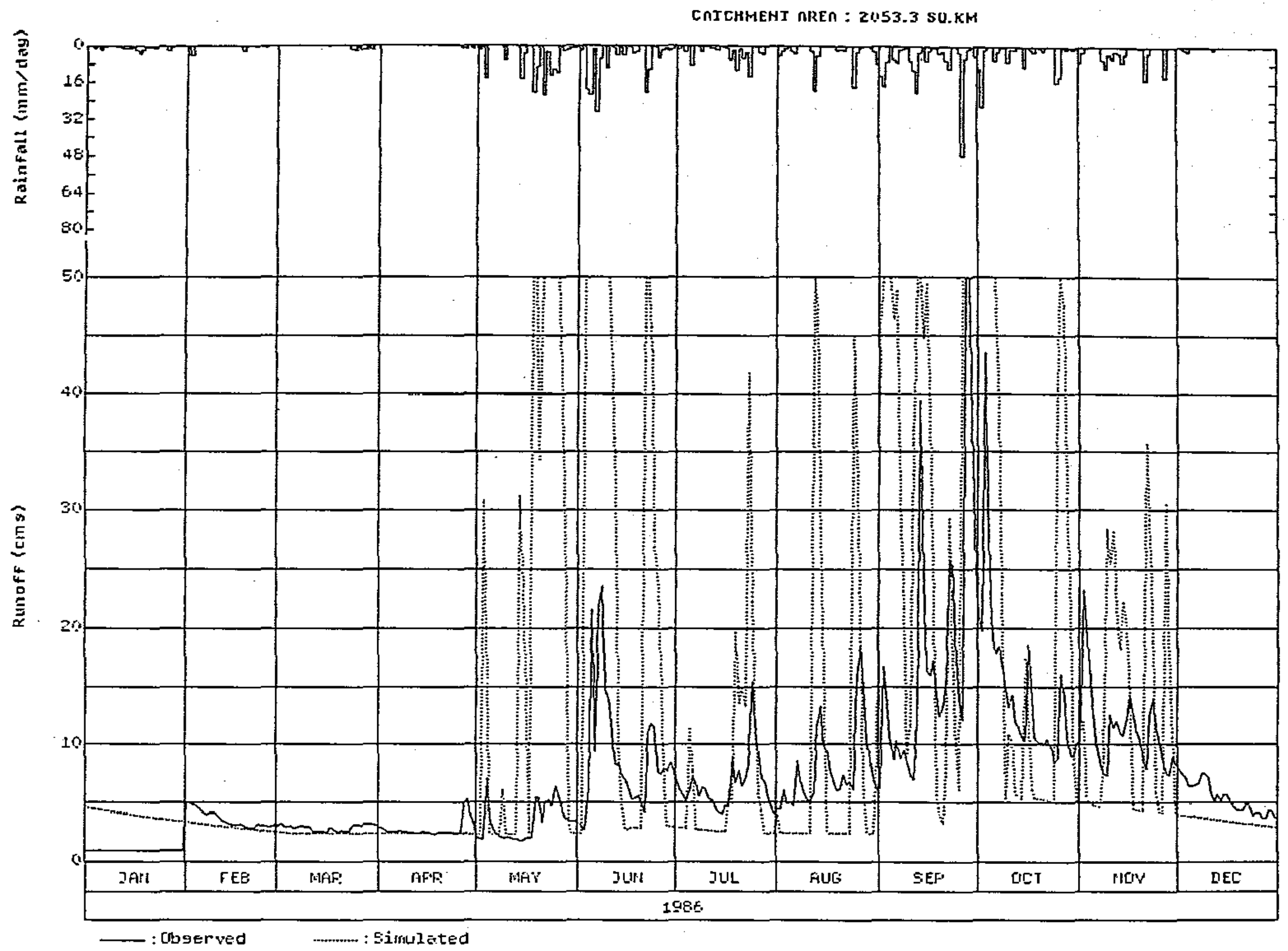


Fig. 3.5.2 SIMULATED HYDROGRAPH BY THE LA ENCANTADA MODEL (3)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

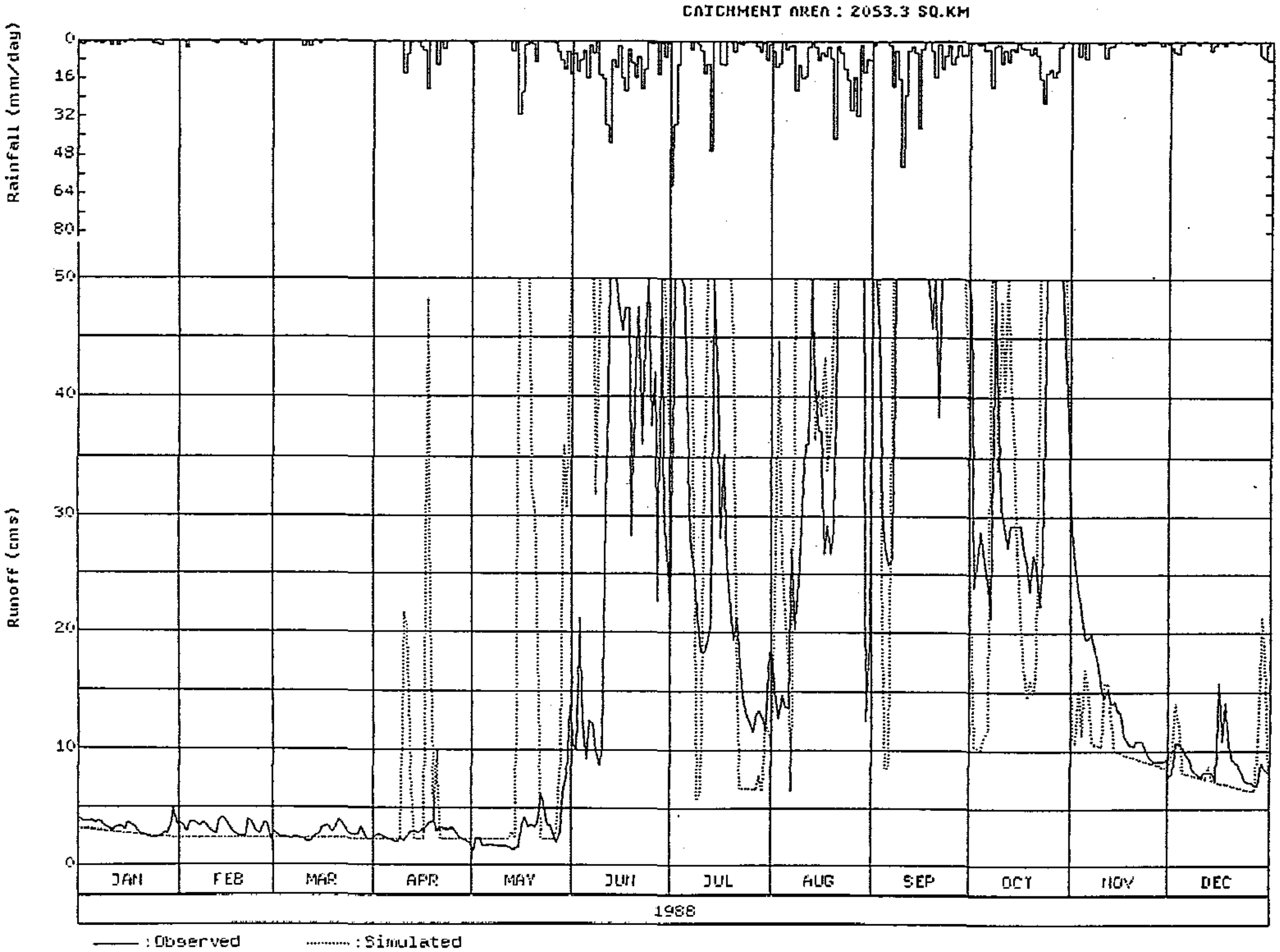


Fig. 3.5.2 SIMULATED HYDROGRAPH BY THE LA ENCANTADA MODEL (4)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

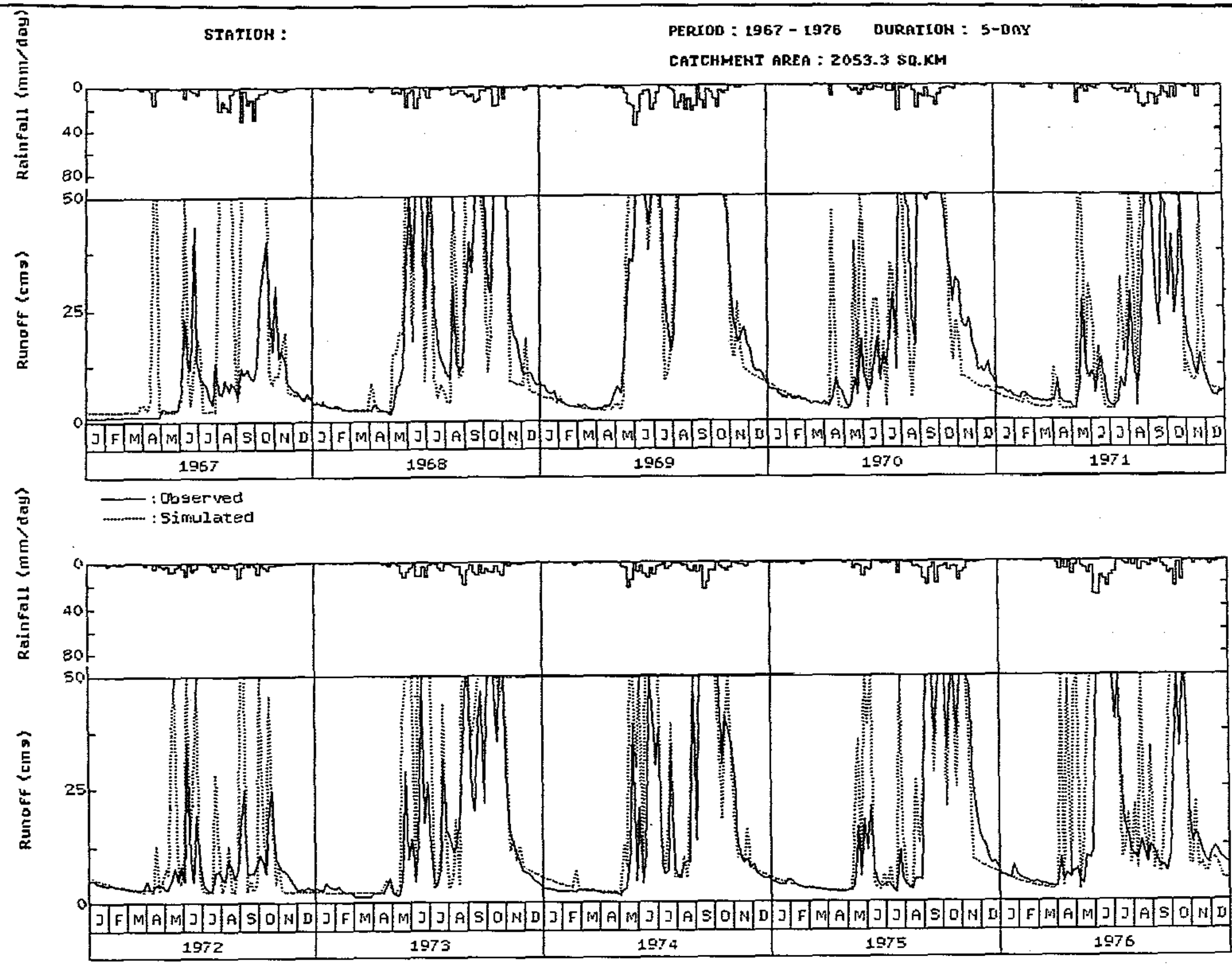


Fig. 3.5.2 SIMULATED HYDROGRAPH BY THE LA ENCANTADA MODEL (5)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

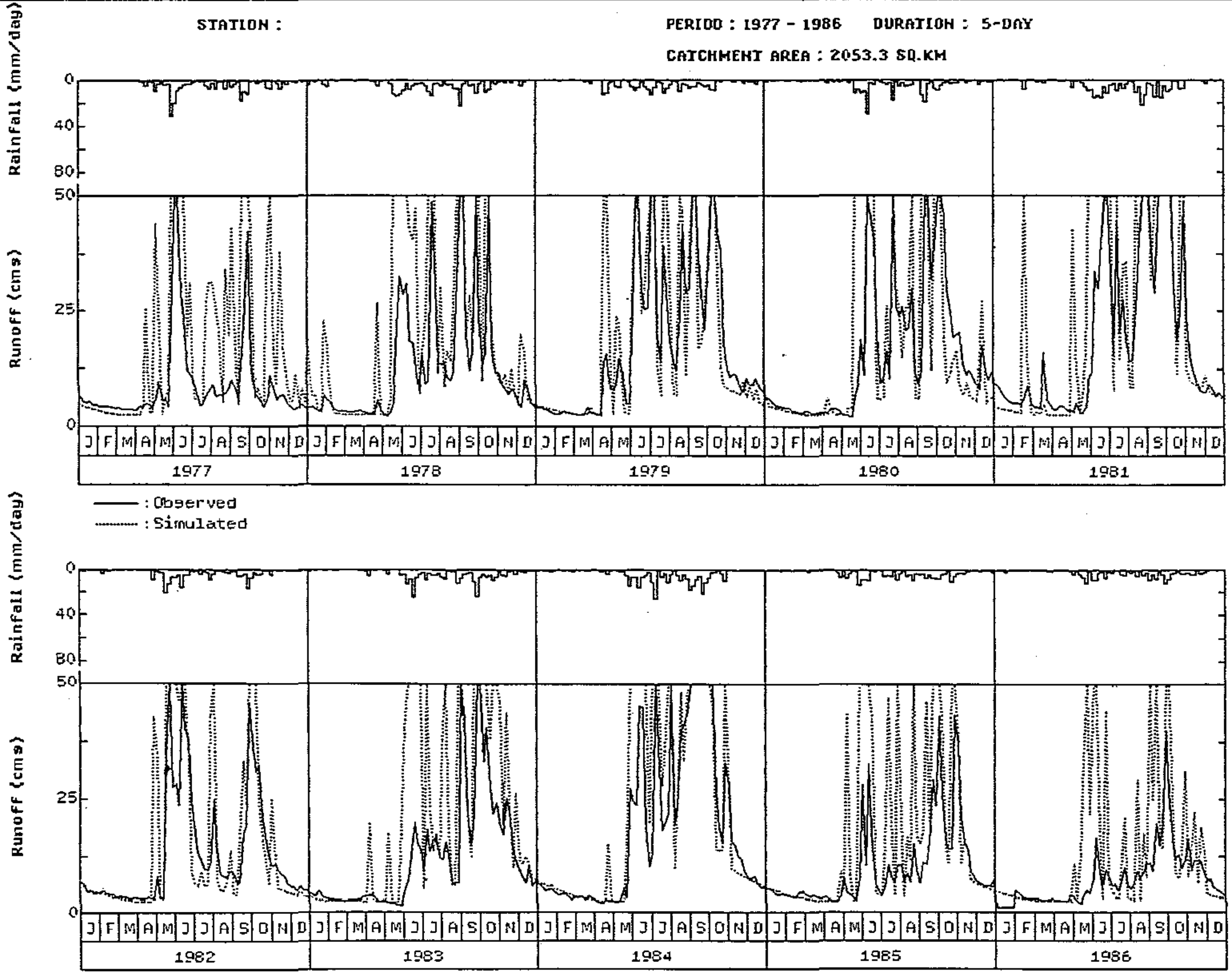
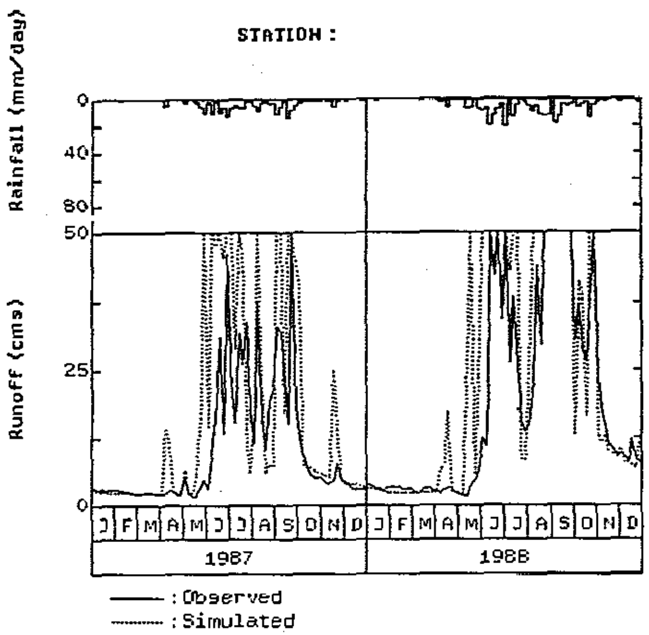


Fig. 3.5.2 SIMULATED HYDROGRAPH BY THE LA ENCANTADA MODEL (6)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON



PERIOD : 1987 - 1988 DURATION : 5-DAY

CATCHMENT AREA : 2053.3 SQ.KM

Fig. 3.5.2 SIMULATED HYDROGRAPH BY THE LA ENCANTADA MODEL (7)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

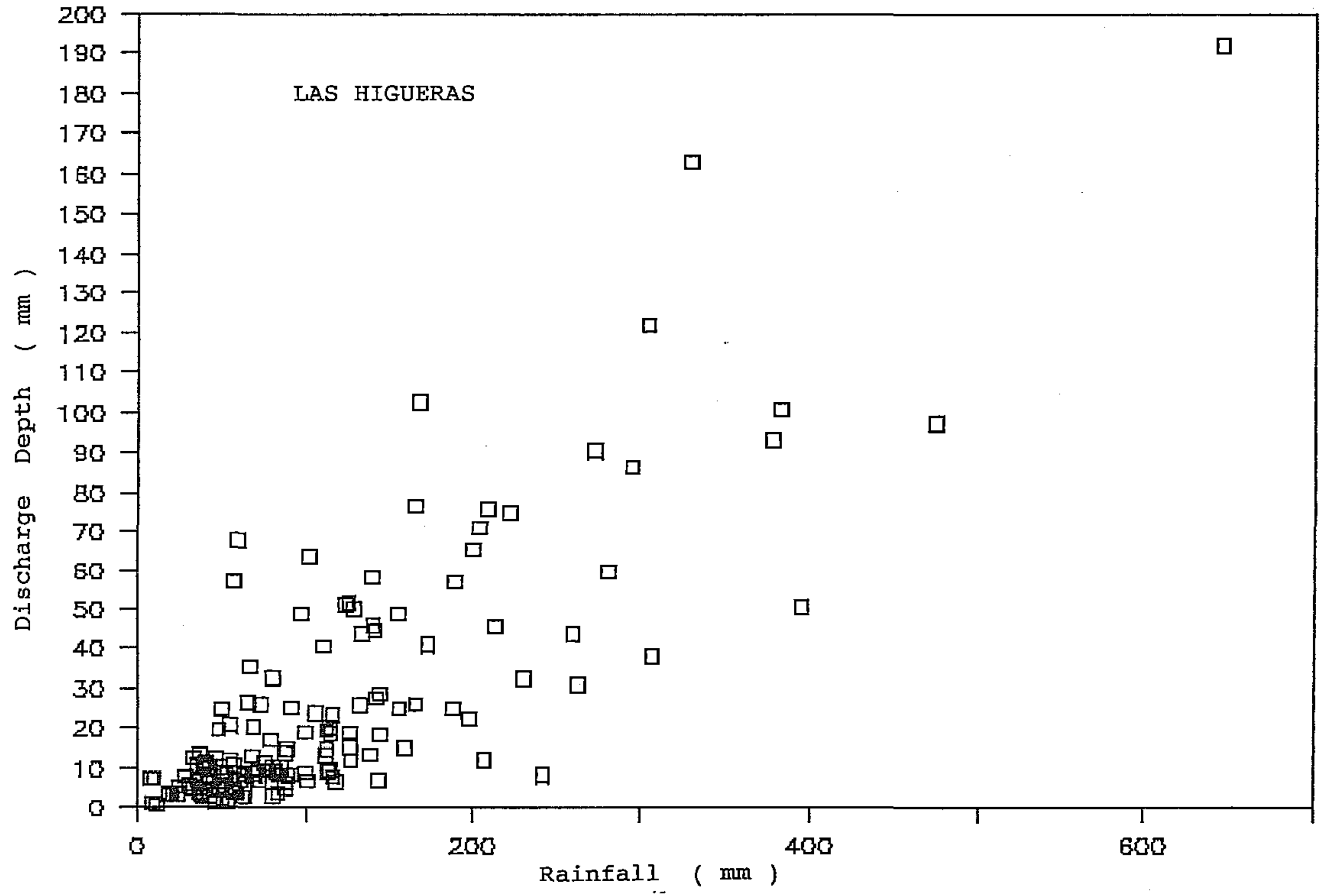


Fig. 3.5.3 RELATION BETWEEN BASIN RAINFALL AND PEAK FLOOD DEPTH (1)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDID PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

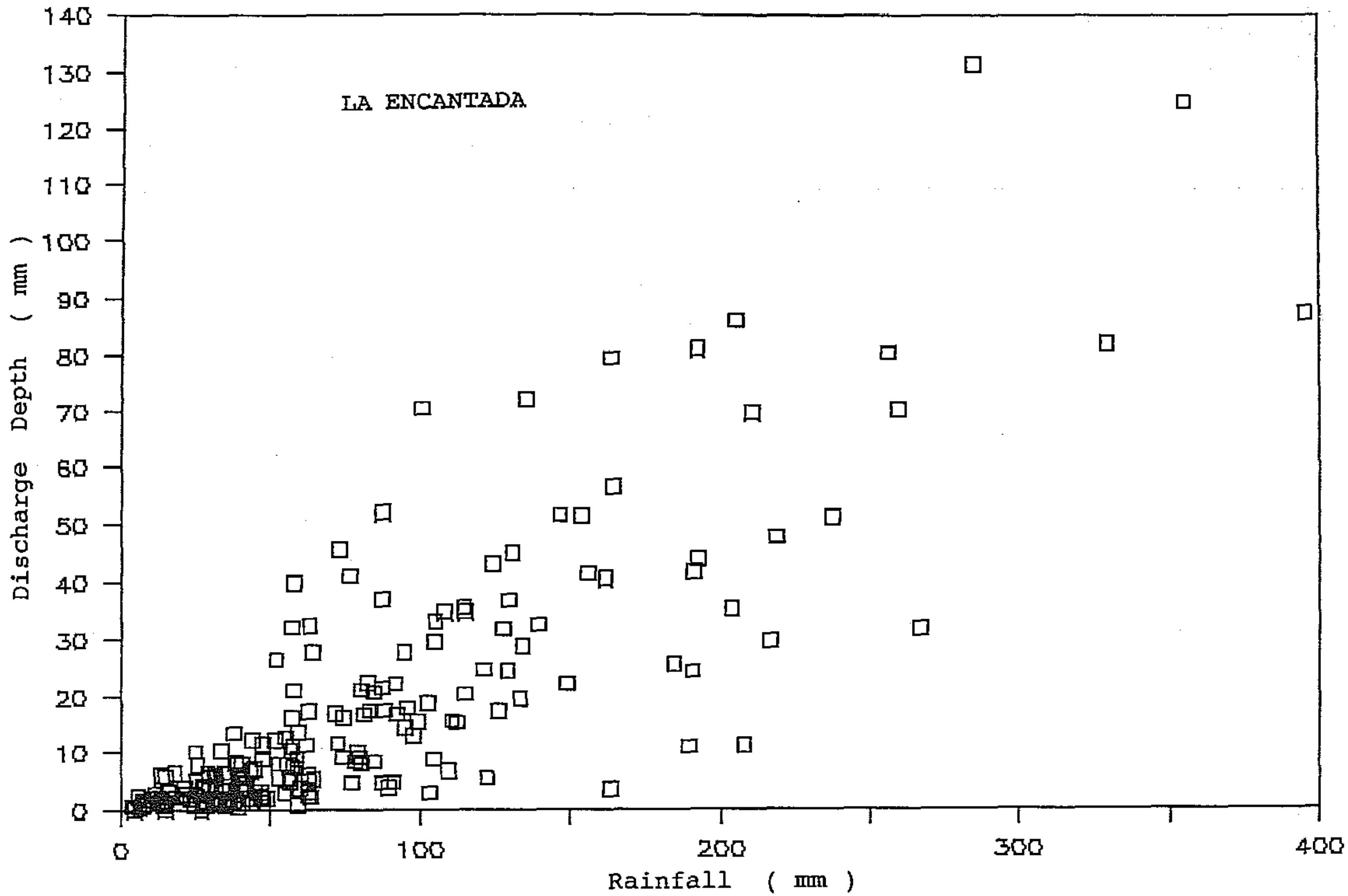


Fig. 3.5.3 RELATION BETWEEN BASIN RAINFALL AND PEAK FLOOD DEPTH (2)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

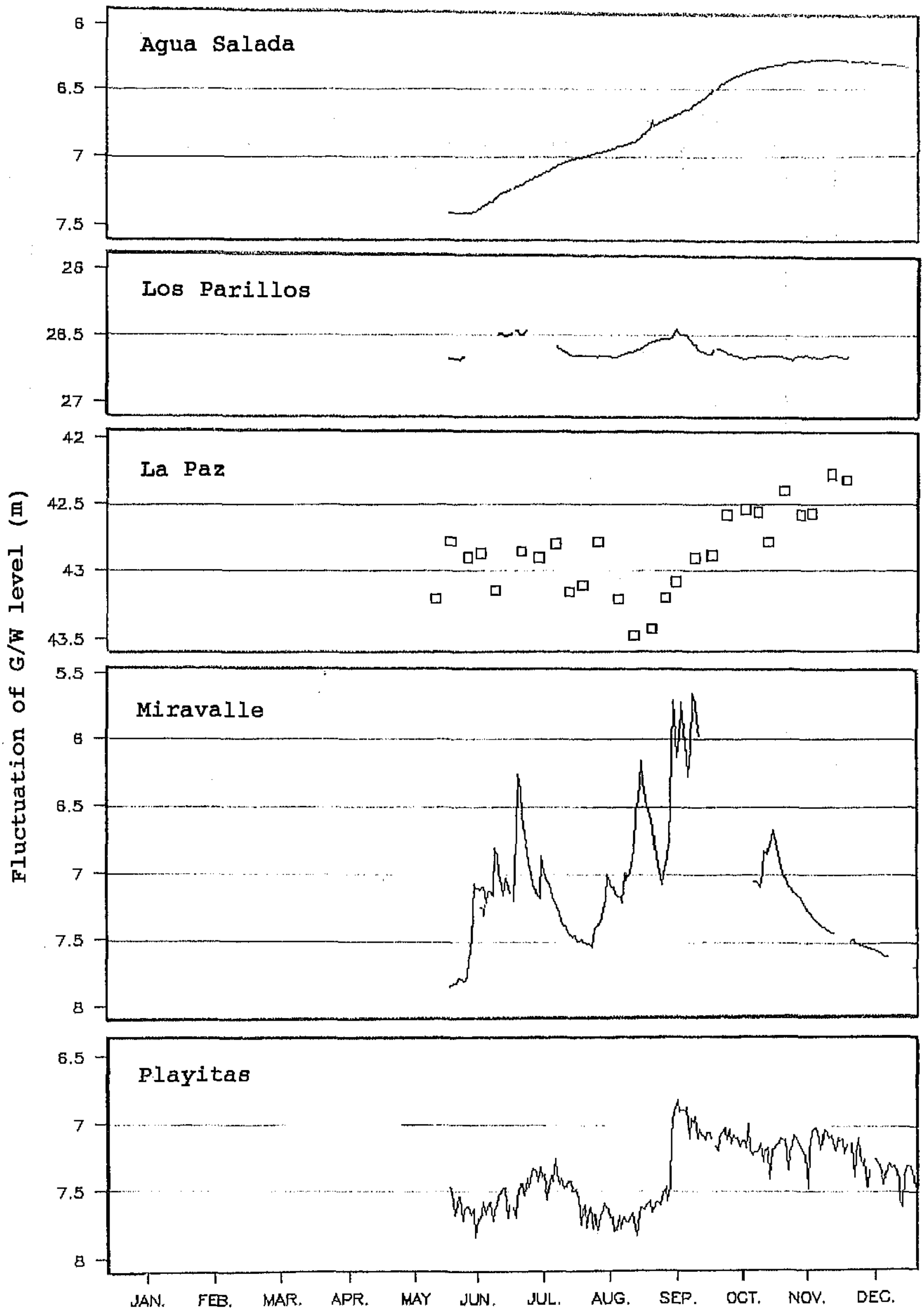


FIG. 3.5.4 COMPARISON OF THE SEASONAL FLUCTUATION BETWEEN OBSERVED AND SIMULATED GROUND WATER LEVEL (1)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

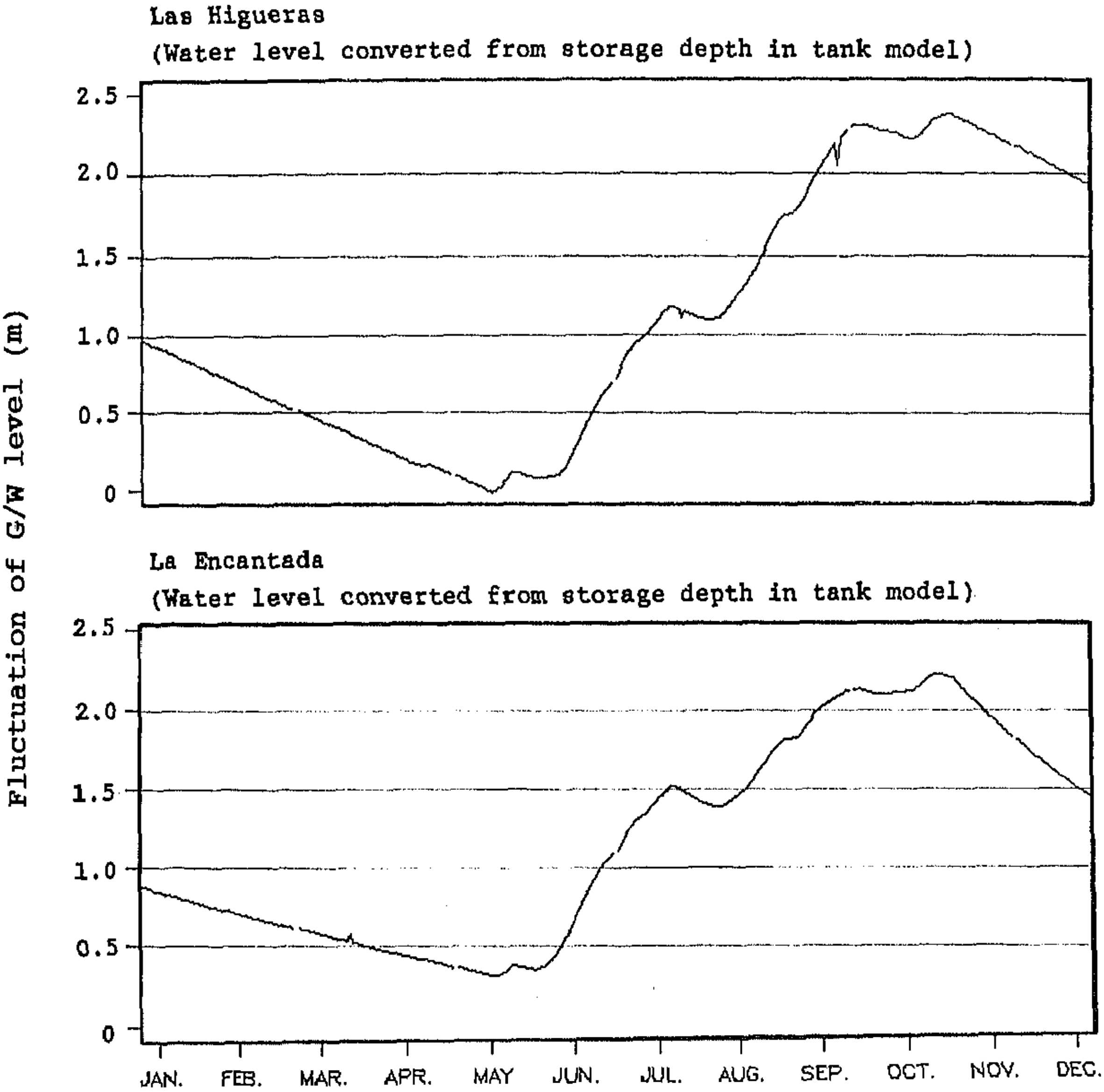


FIG. 3.5.4 COMPARISON OF THE SEASONAL FLUCTUATION BETWEEN OBSERVED AND SIMULATED GROUND WATER LEVEL (2)

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

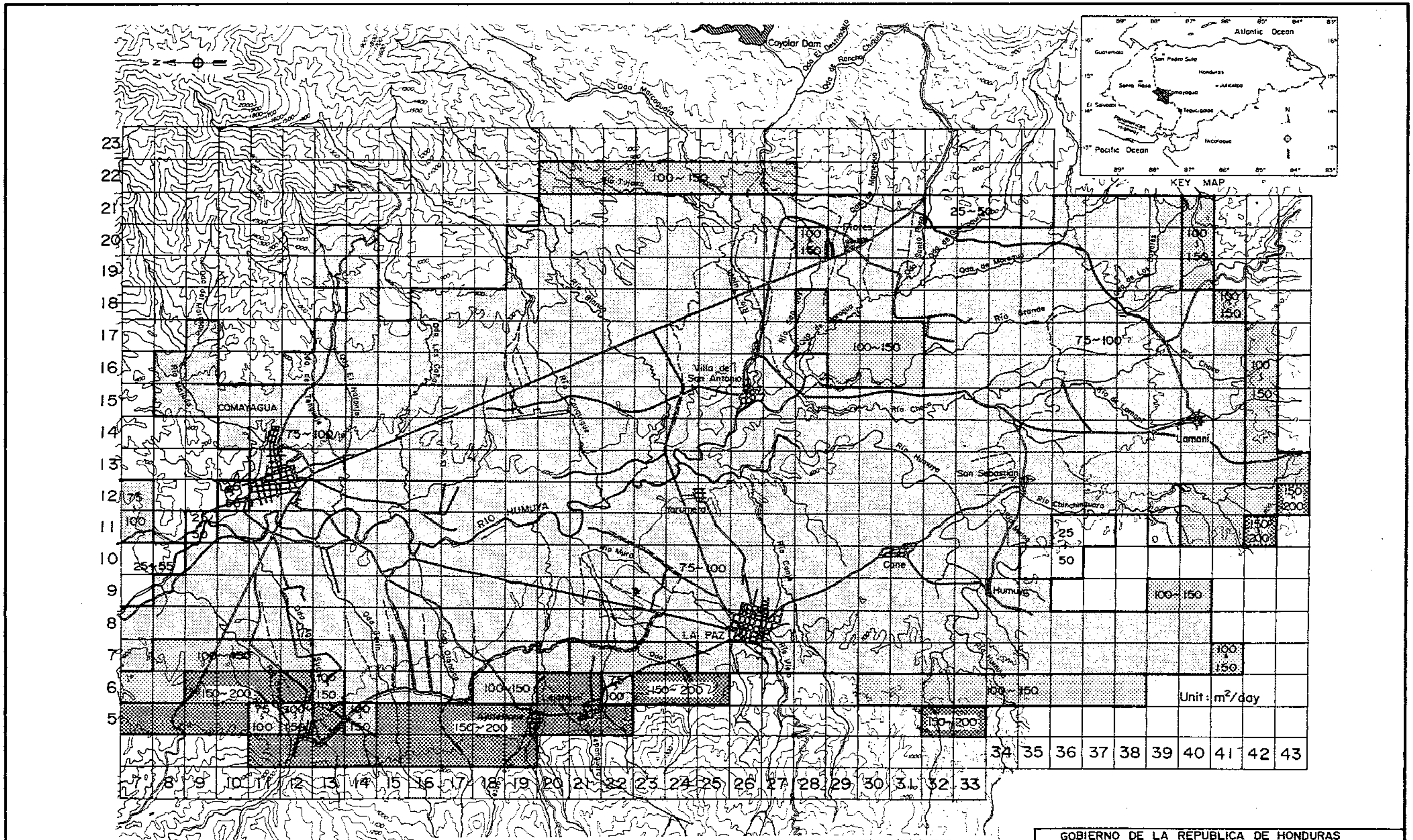


Fig. 4.3.1 DISTRIBUTION MAP OF TRANSMISSIVITY (1)
- PHREATIC WATER -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

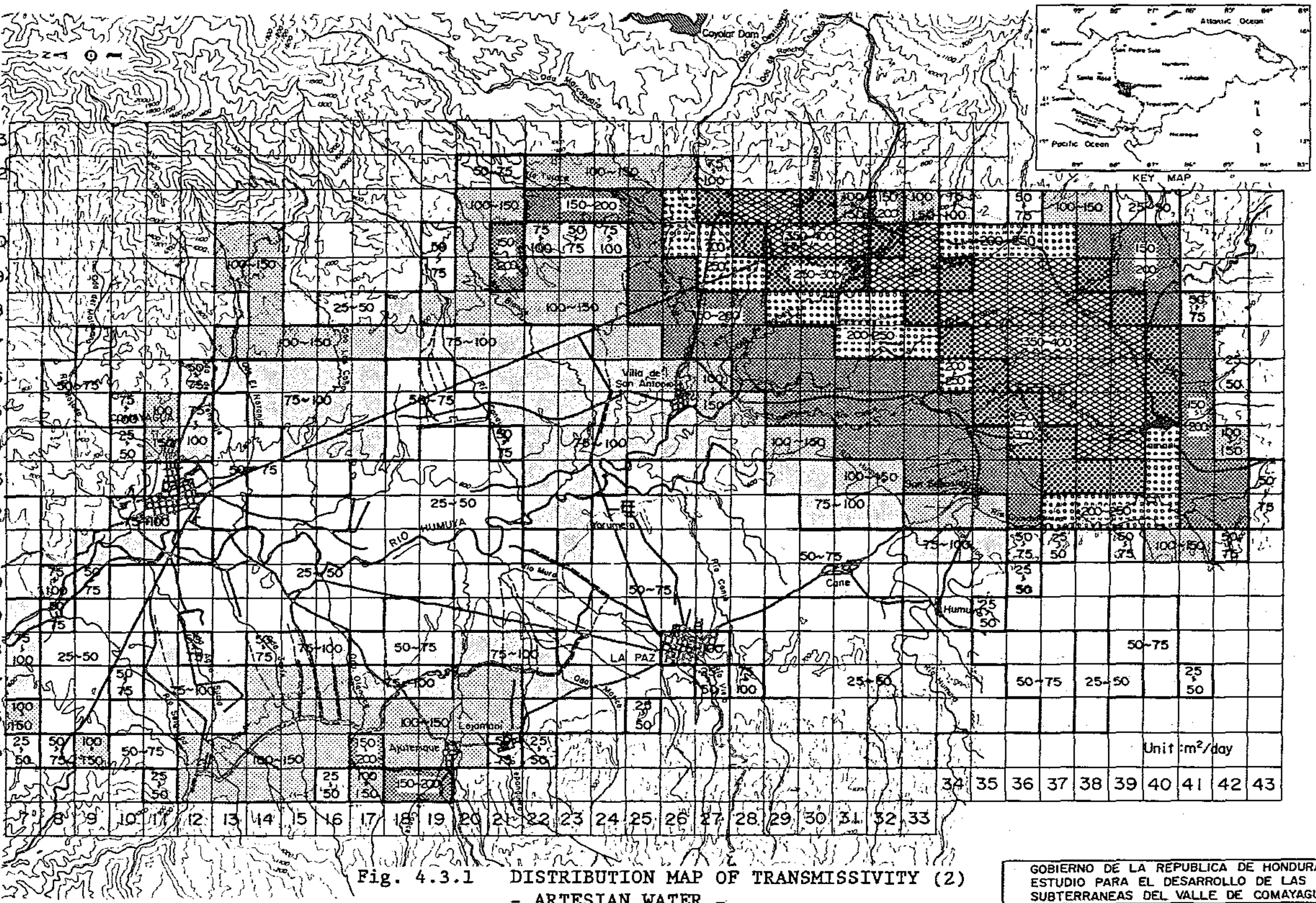


Fig. 4.3.1 DISTRIBUTION MAP OF TRANSMISSIVITY (2)
- ARTESIAN WATER -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

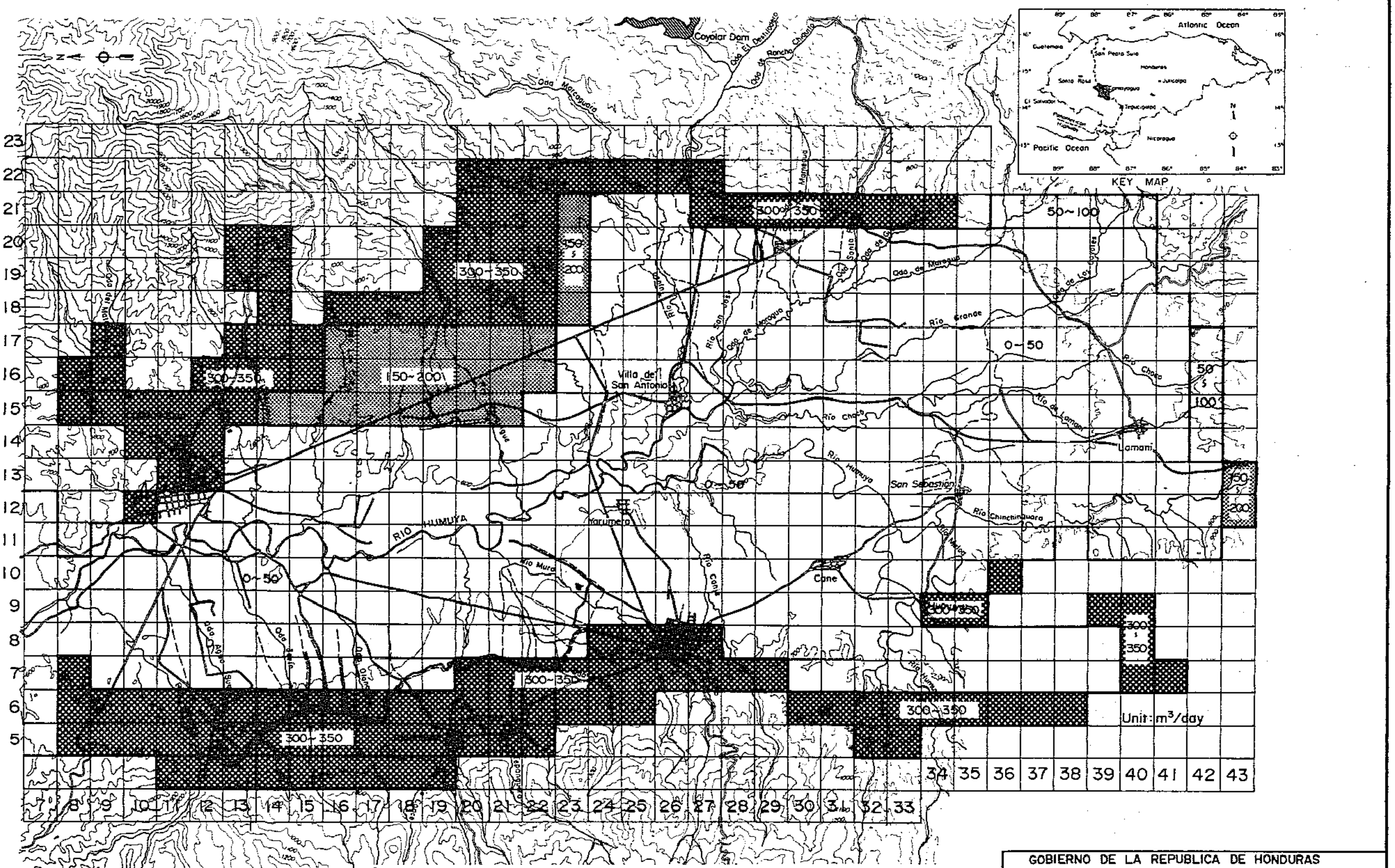


Fig. 4.3.2 DISTRIBUTION MAP OF ESTIMATED RECHARGE (1)
- PHREATIC WATER -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

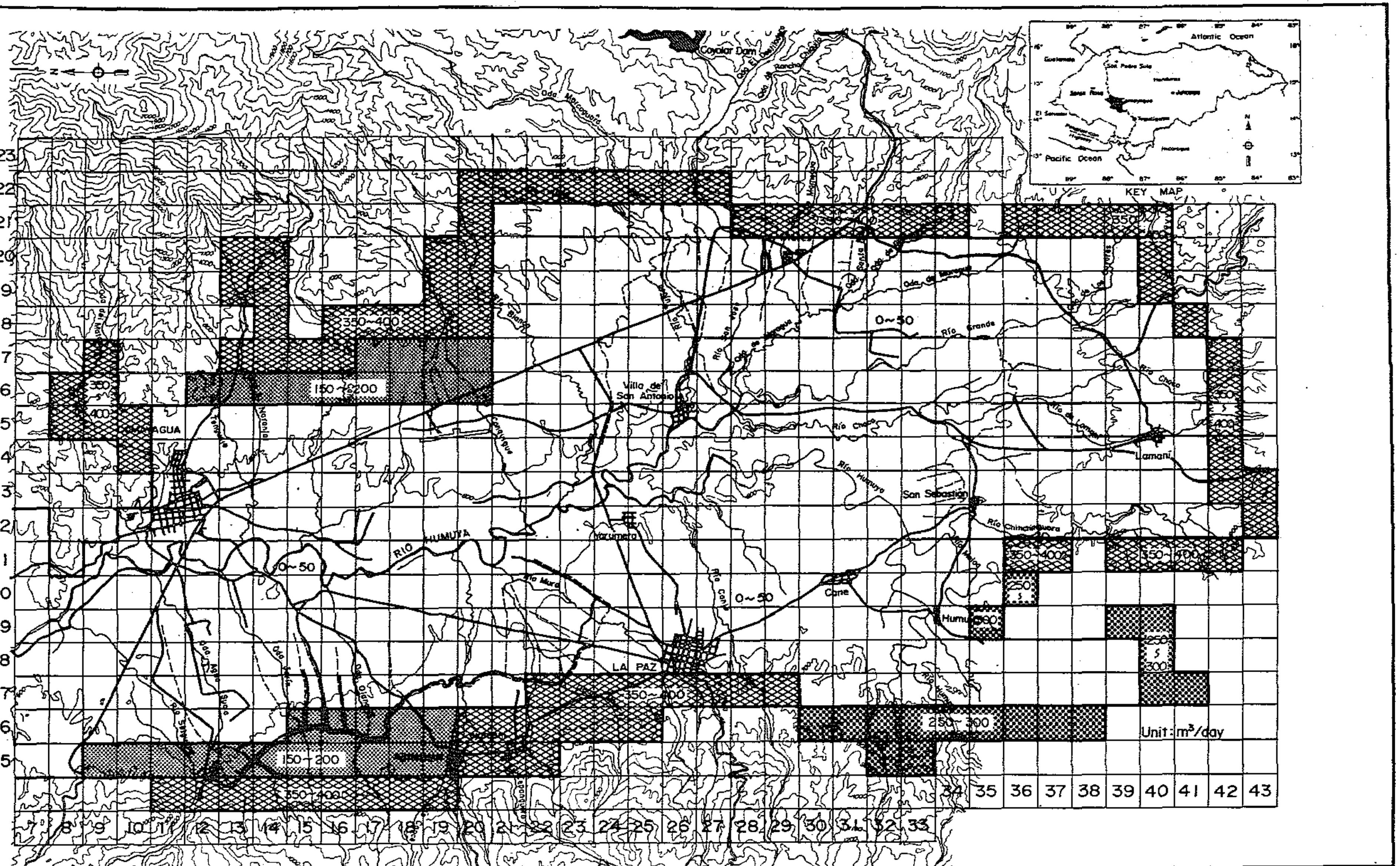


Fig. 4.3.2 DISTRIBUTION MAP OF ESTIMATED RECHARGE (2)
- ARTESIAN WATER -

ESCALA 0 1 2 3 4 5 km

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

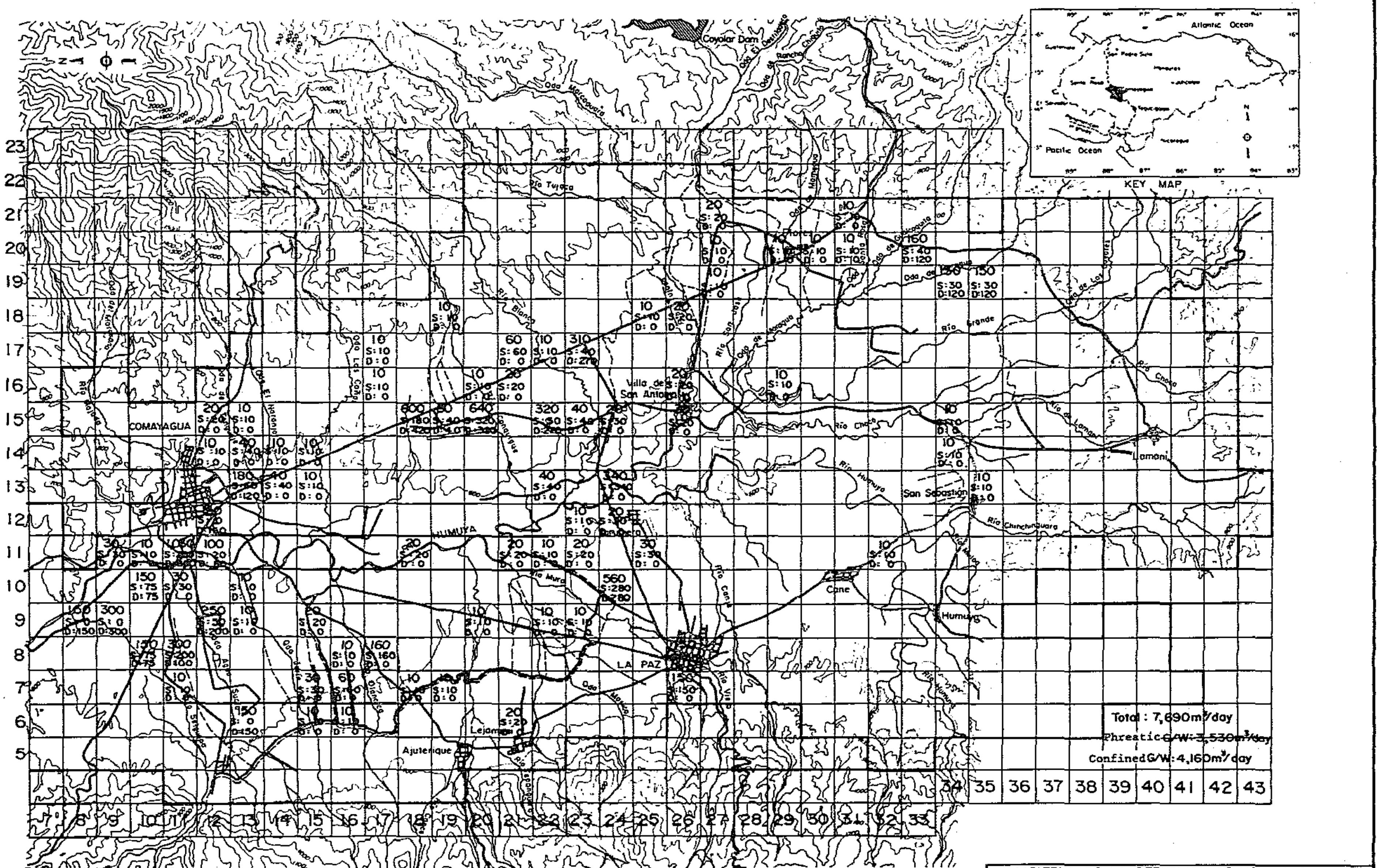


Fig. 4.3.3 GROUND WATER PRODUCTION FROM WELLS (1)
- PRESENT CONDITION -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

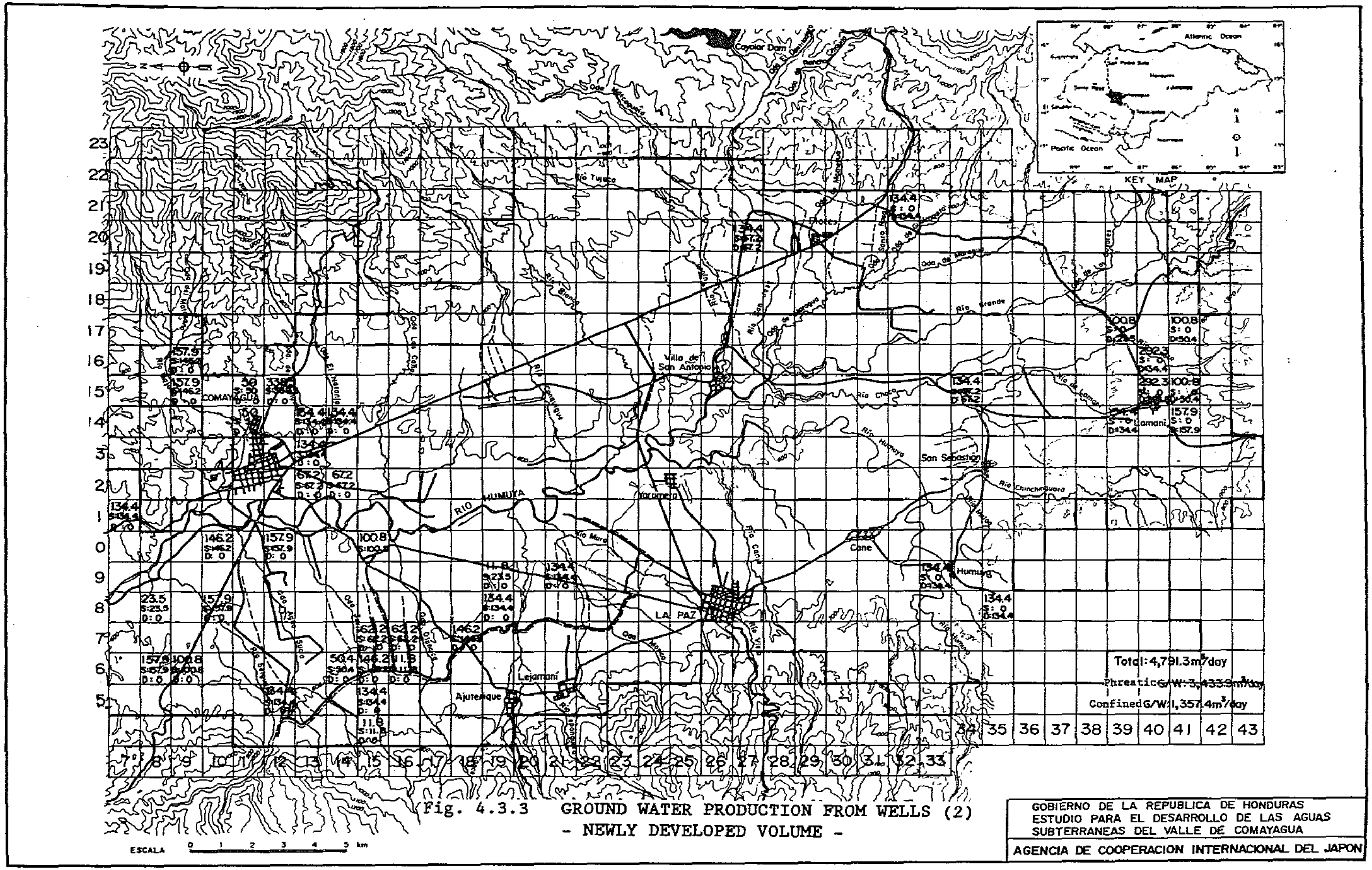


Fig. 4.3.3 GROUND WATER PRODUCTION FROM WELLS (2)
- NEWLY DEVELOPED VOLUME -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

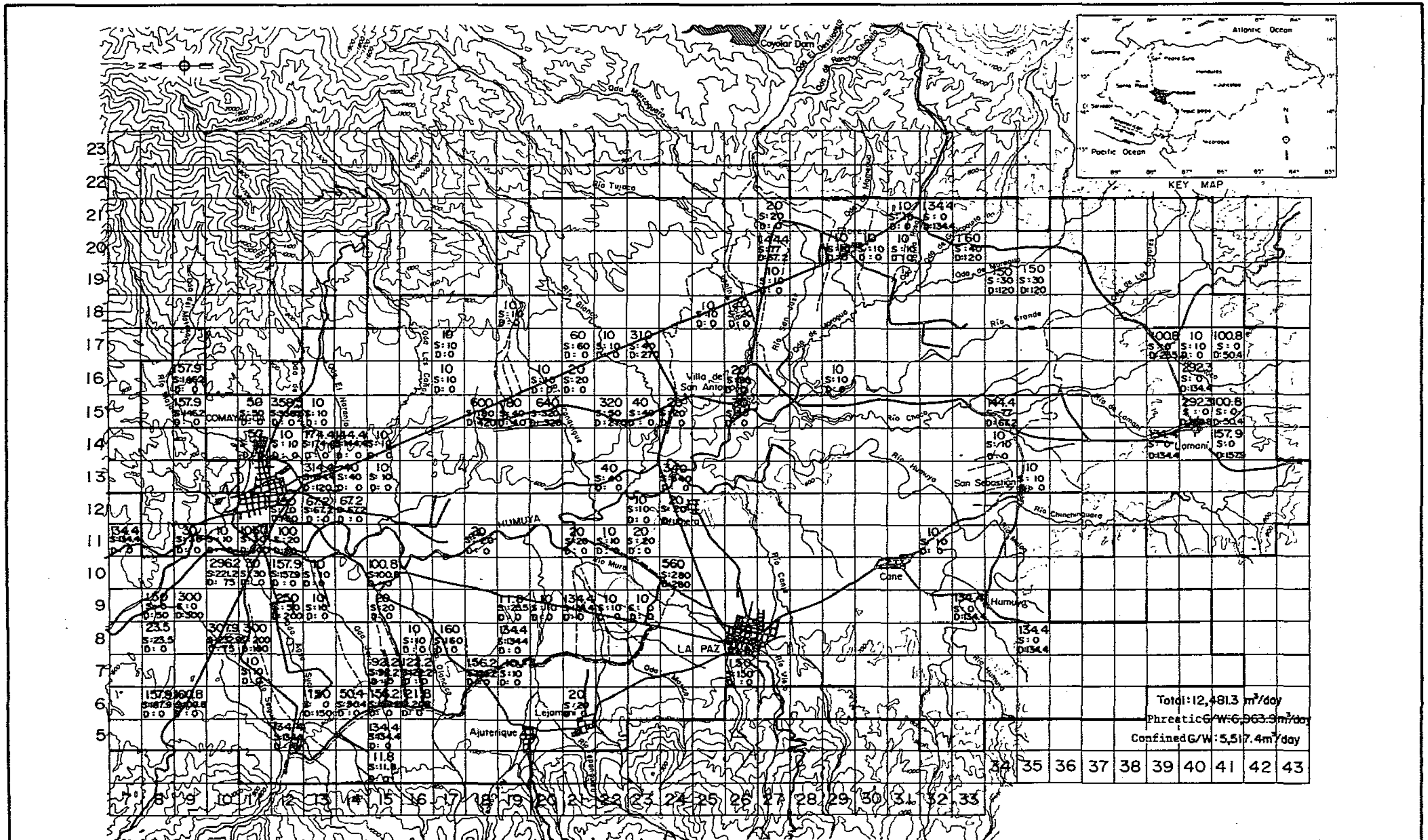


Fig. 4.3.3 GROUND WATER PRODUCTION FROM WELLS (3)
- TOTAL PRODUCTION VOLUME IN 2000 -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

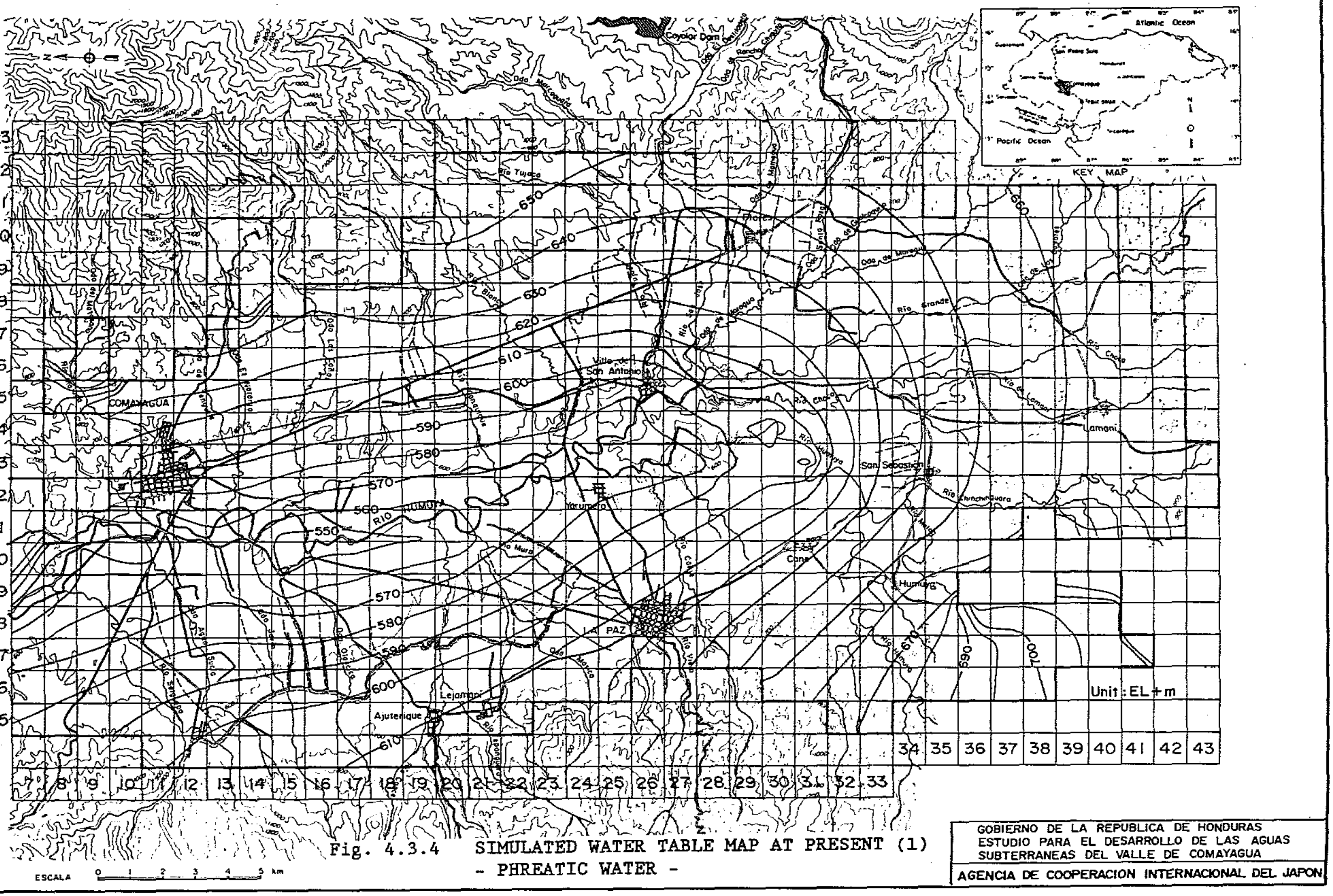


Fig. 4.3.4 SIMULATED WATER TABLE MAP AT PRESENT (1)
- PHREATIC WATER -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

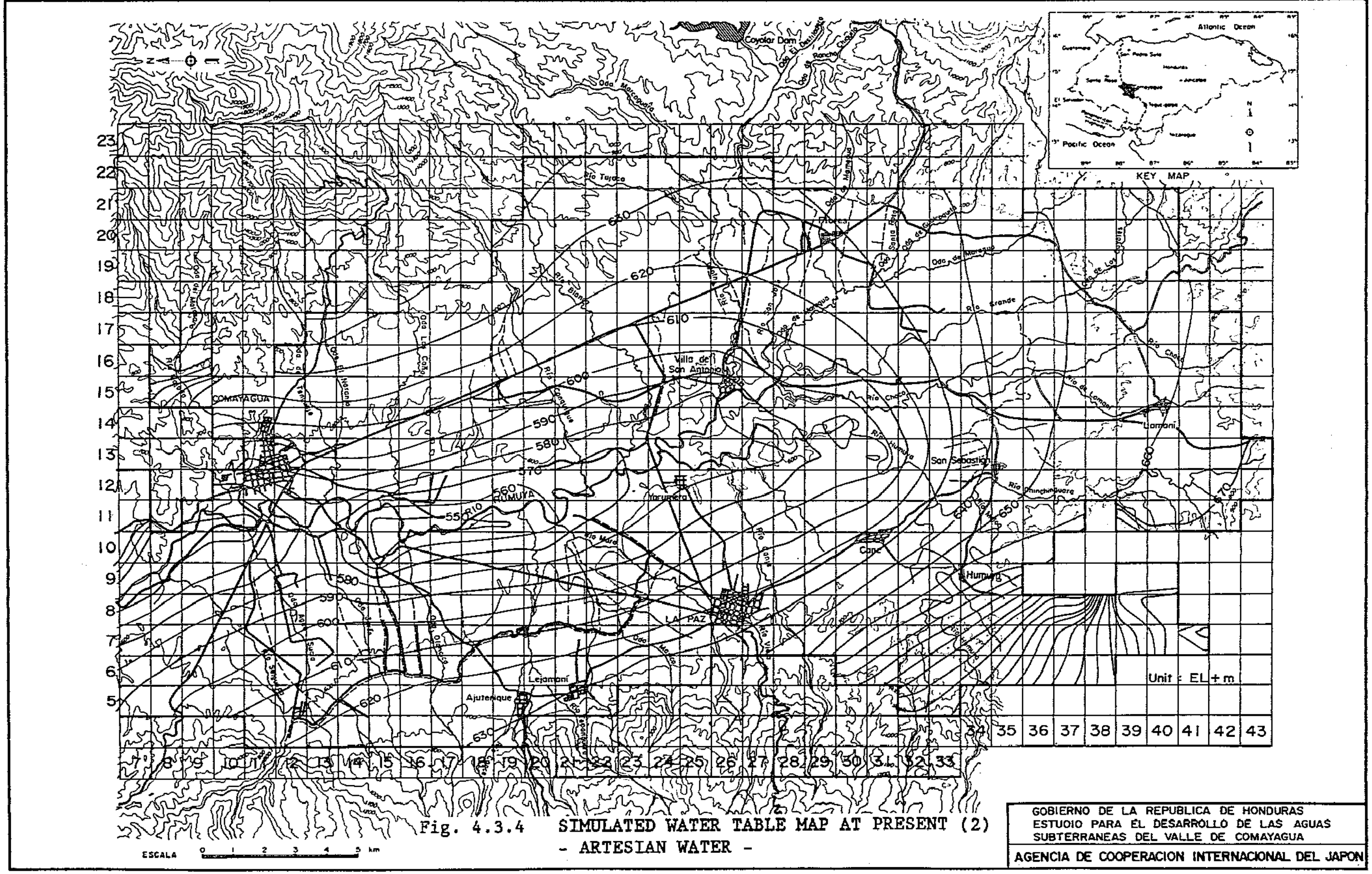


Fig. 4.3.4 SIMULATED WATER TABLE MAP AT PRESENT (2)
- ARTESIAN WATER -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

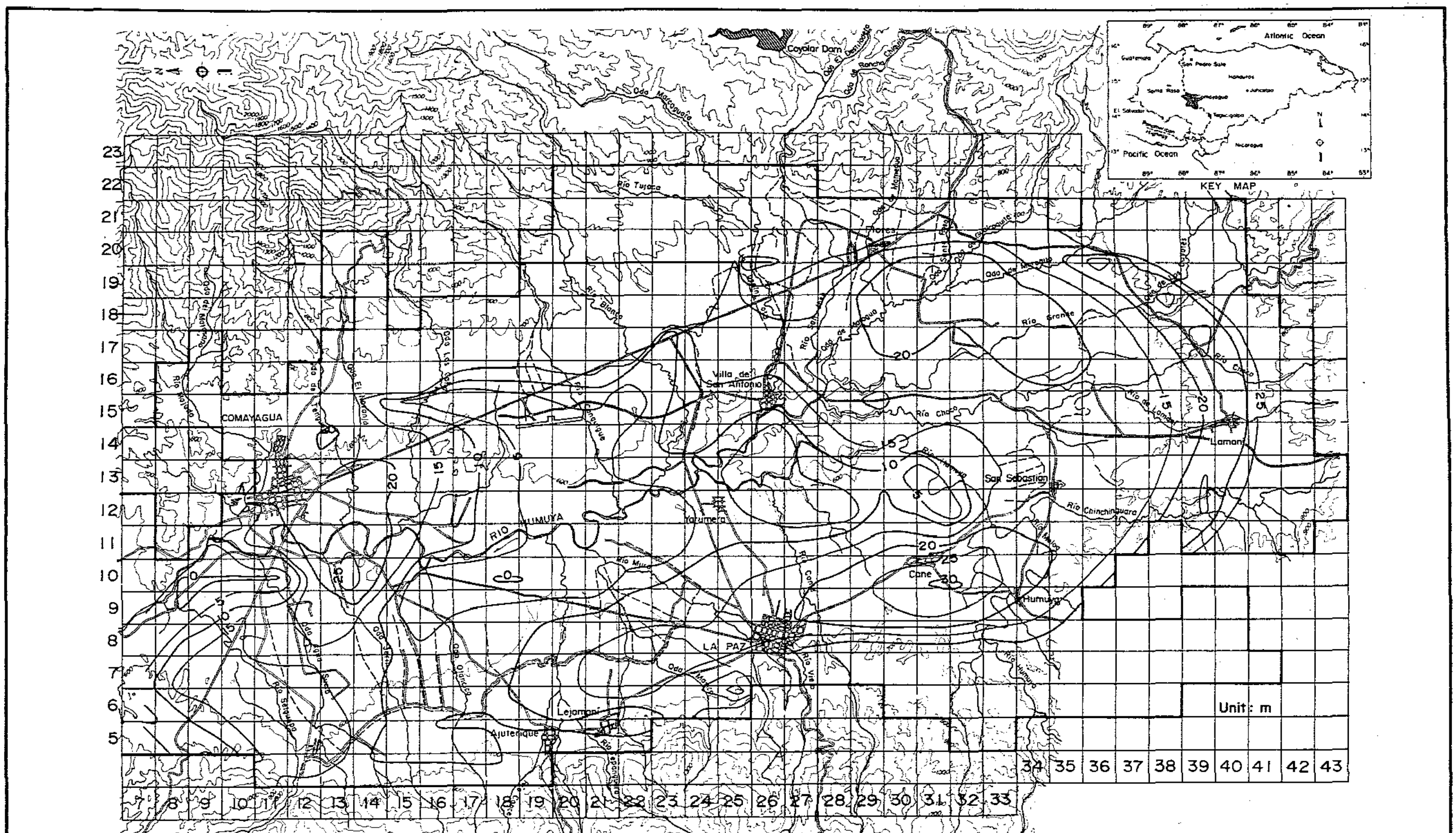


Fig. 4.3.5 DIFFERENTIAL MAP BETWEEN OBSERVED AND SIMULATED WATER TABLE (1) - PHREATIC WATER -

ESCALA 0 1 2 3 4 5 km

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

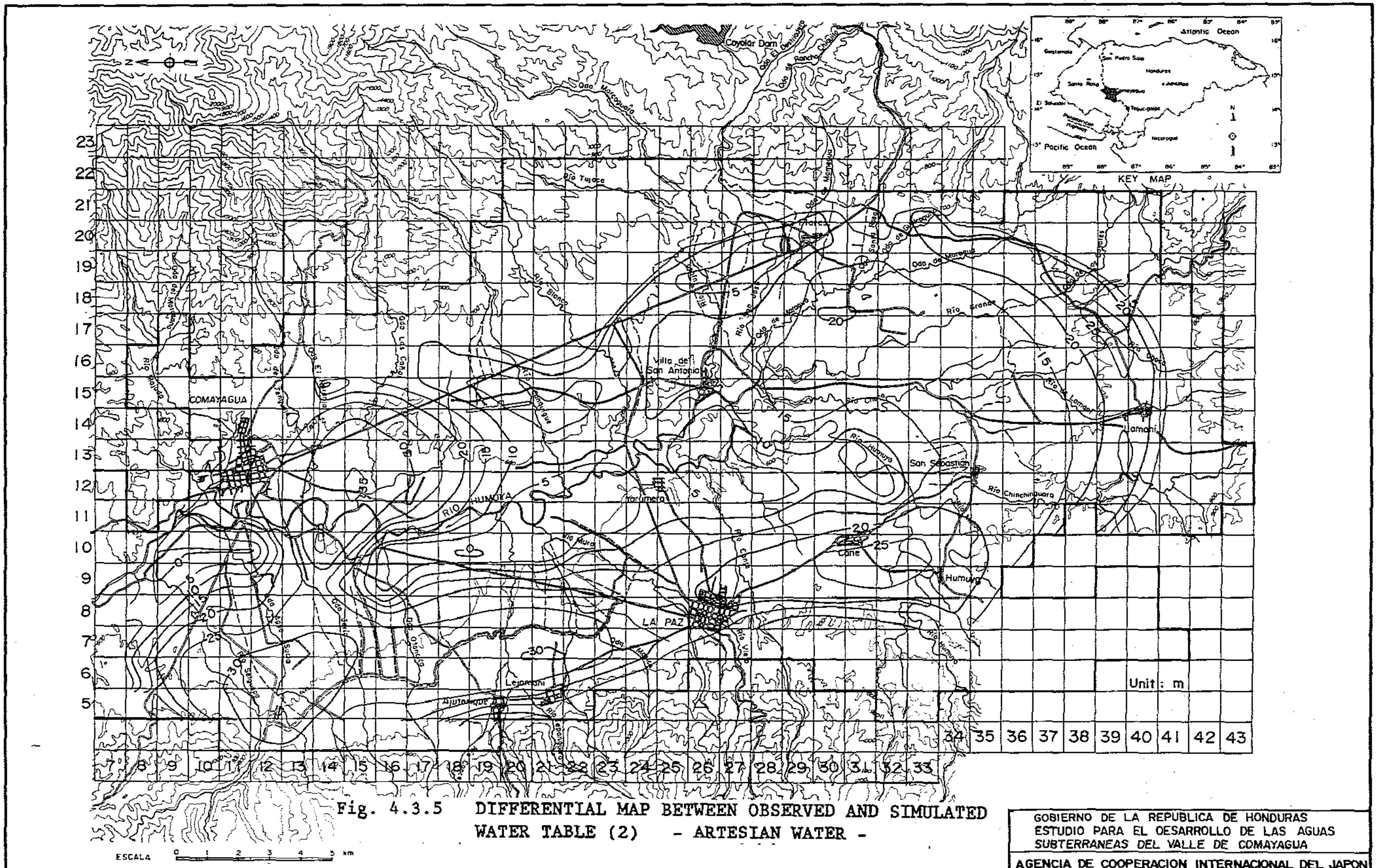


Fig. 4.3.5 DIFFERENTIAL MAP BETWEEN OBSERVED AND SIMULATED WATER TABLE (2) - ARTESIAN WATER -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

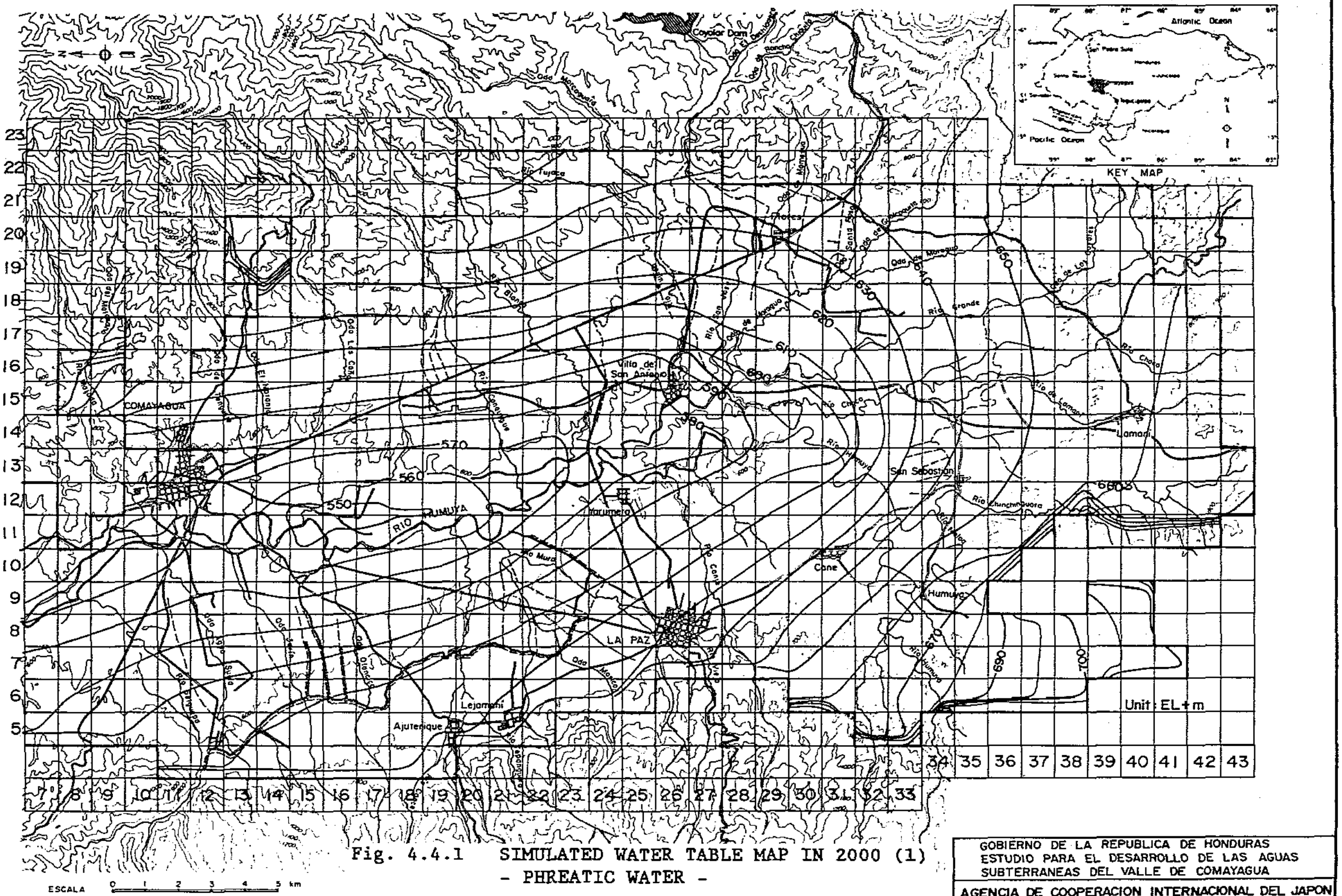


Fig. 4.4.1 SIMULATED WATER TABLE MAP IN 2000 (1)
- PHREATIC WATER -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

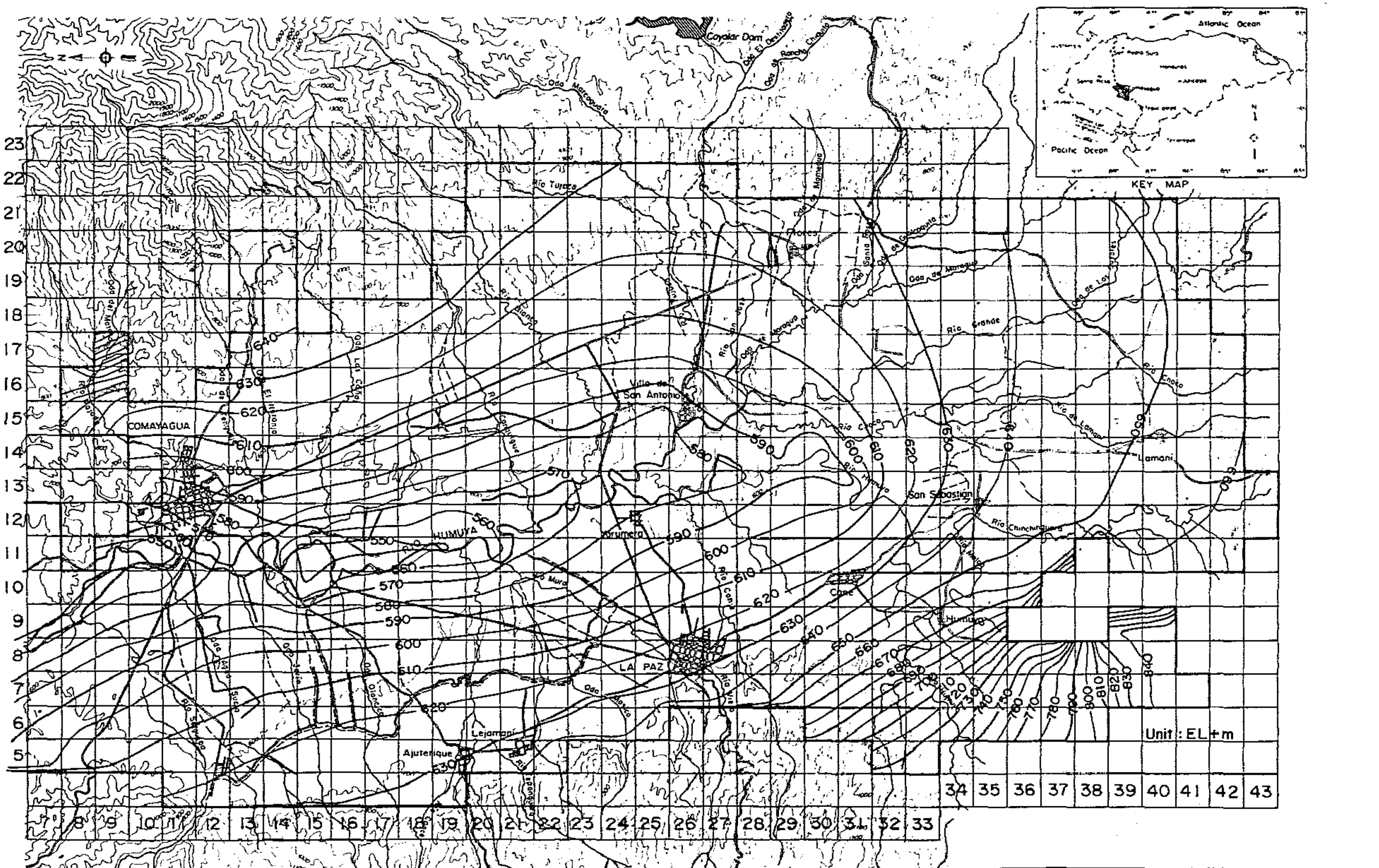


Fig. 4.4.1 SIMULATED WATER TABLE MAP IN 2000 (2)
- ARTESIAN WATER -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

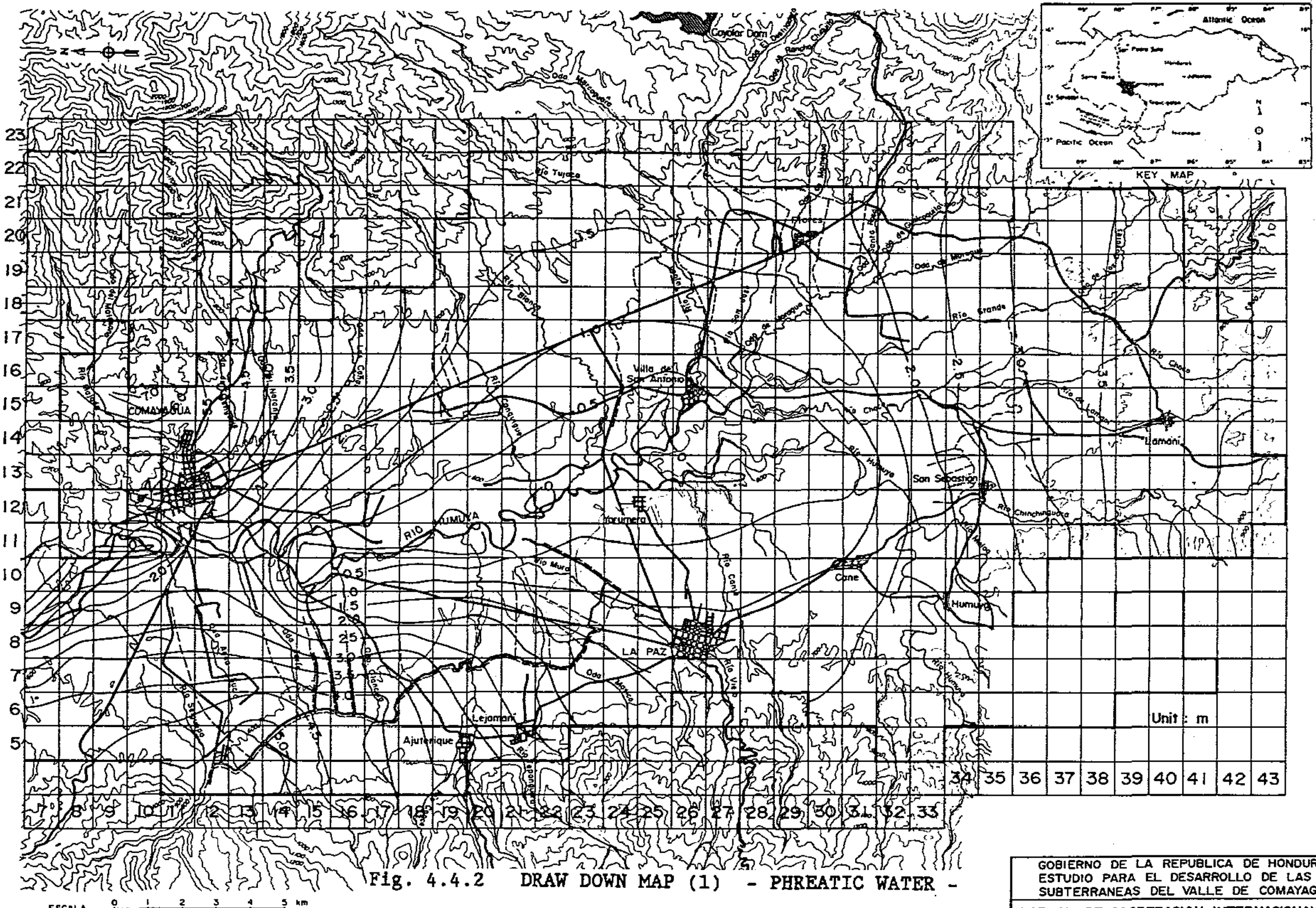


Fig. 4.4.2 DRAW DOWN MAP (1) - PHREATIC WATER -

GOBIERNO DE LA REPUBLICA DE HONDURAS
ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON

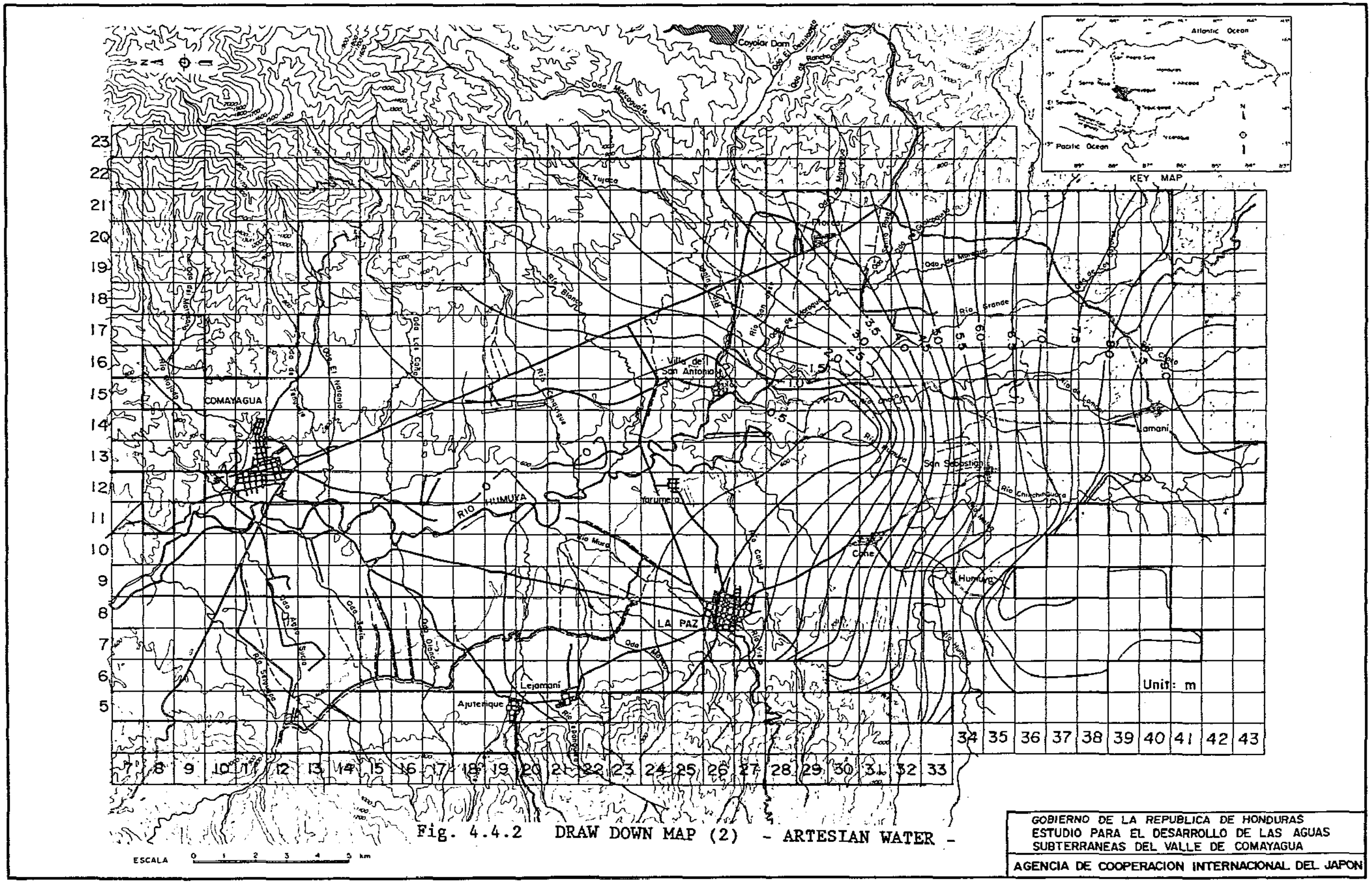


Fig. 4.4.2 DRAW DOWN MAP (2) - ARTESIAN WATER -

APPENDIX F

SCOPE OF WORK
AND
MINUTES OF MEETING

SCOPE OF WORK ON STUDY FOR GROUNDWATER DEVELOPMENT PROJECT IN COMAYAGUA

SCOPE OF WORK

ON

STUDY

FOR

GROUNDWATER DEVELOPMENT PROJECT

IN

COMAYAGUA

THE REPUBLIC OF HONDURAS

Agreed Upon Between
Ministry of Public Health
and
The Japan International Cooperation Agency

Tegucigalpa, November6, 1987

R. Villeda

Dr. RUBEN VILLEDA BERMUDEZ
Minister of Public Health
Government of the Republic
of Honduras.

Mr. MICHIO KANDA
Leader of the Preliminary
Study Team, Japan International
Cooperation Agency.

R.

1. INTRODUCTION

In response to the request of the Government of the Republic of Honduras (hereinafter referred to as "Honduras"), the Government of Japan decided to implement the Study on the Groundwater Development Project in Comayagua (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programmes of the Government of Japan, will undertake the Study in close cooperation with the Ministry of Public Health (hereinafter referred to as "MPH") and authorities concerned of the Government of Honduras. The present document sets forth the Scope of work for the Study.

2. OBJECTIVE OF STUDY

The objective of the Study will be

(1) To evaluate the groundwater resources development potential in Comayagua

(2) To transfer the technology to the Honduras counterpart personnel in the course of the Study.

3. STUDY AREA

The Study Area covers the Comayagua basin (approximately 400 Km^2) in Comayagua.

4. SCOPE OF THE STUDY

The Study shall include the following:

(1) Collection and Review of data

1) socio-economic background

R. [signature]

2) development plans

3) physical conditions

a) topography

b) geology and hydrogeology

c) hydrology and meteorology

d) river conditions

4) water supply and demand

5) previous study on ground water

6) water-supply facilities

(2) Field Survey

1) field reconnaissances

a) topography and geology

b) land use

c) existing wells

d) water-supply facilities

2) geological survey (electric prospective survey)

3) water quality analysis

4) hydrological observation

a) well-registration

b) well-leveling

c) groundwater level

d) surface water

5) test well drilling and related investigations

a) test well drilling

b) electrical logging

c) pumping test

d) water quality

A. SES

(3) Analysis and Evaluation of groundwater potential

1) hydrological and geological analysis

2) hydrological and water balance analysis

3) quantitative analysis on groundwater potential

4) water demand forcast

(4) Programming on the groundwater development project

1) criteria to choose well location and preliminary design

2) selection of the optimun scheme

3) cost estimation

4) implementation program

5) management and organizations

6) operation and maintenance plan

7) environmental effect

5. STUDY SCHEDULE

The Study, in principle, will be conducted in accordance with the tentative schedule shown in the attached sheet.

6. REPORT

JICA will prepare and submit the following reports in English to the Government of Honduras

(1) Inception Report

Twenty (20) copies at the commencement of the work in Honduras

(2) Progress Report

Twenty (20) copies within eight (8) months after the commencement of the Study

(3) Interim Report

Twenty (20) copies within fourteen (14) months after the commencement

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of the Study

(4) Draft Final Report

Twenty (20) copies within eighteen (18) months after the commencement of the Study

The Government of Honduras will submit their comments within forty-five (45) days receipt of Draft Final Report

(5) Final Report

Thirty (30) copies within forty-five (45) days after the receipt of the comments on the Draft Final Report

7. UNDERTAKING OF THE GOVERNMENT OF HONDURAS

(1) To facilitate smooth conduct of the Study, the Government of Honduras shall take necessary measures:

1) to secure the safety of the JICA study team;

2) to permit the members of the JICA study team to enter, leave and sojourn in Honduras for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees;

3) to exempt the members of the JICA study team from taxes, duties and any other charge on equipment, machinery and other materials brought into Honduras for the conduct of the Study;

4) to exempt the members of the JICA study team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to he members of the JICA study team for their services in connection with the implementation of the Study;

5) to provide necessary facilities to the JICA study team for the remittance as well as utilization of the funds introduced into Honduras from Japan in conncetion with the implementation of the

Study;

6) to secure permission for entry into private properties or restricted area for the conduct of the Study;

7) to secure permission for the JICA study team to take all data and documents (including photographs) related to the Study out of Honduras to Japan;

8) to provide medical services as needed. Its expenses will be chargeble on members of the JICA study team;

9) to secure permission to use walkie-talkies and other wireless telecommunication for execution of the field survey.

(2) The Government of Honduras shall bear claims, if any arises against the members of the JICA study team resulting from, occurring in the course of or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the JICA study team.

(3) MPH shall act as a counterpart agency to the JICA study team and also as coordinating body in relation with other governmental and non-governmental organizations concernes for the smooth and appropriate implementation of the Study.

(4) MPH shall, at its own expense, provide the JICA study team with the following items, in cooperation with relevant organizations, if necessary.

1) available data (including maps) and informations related to the Study

2) counterpart personnel

3) suitable office with necessary equipment and furniture

4) credentials or identification cards

R. B.

5) vehicles with drivers

8. UNDERTAKING OF JICA

For the implementation of the Study, JICA will take the following measures:

1) to dispatch, at its own expense, study teams to Honduras;

2) to pursue technology transfer to the Honduras counterpart personnel in the course of the Study;

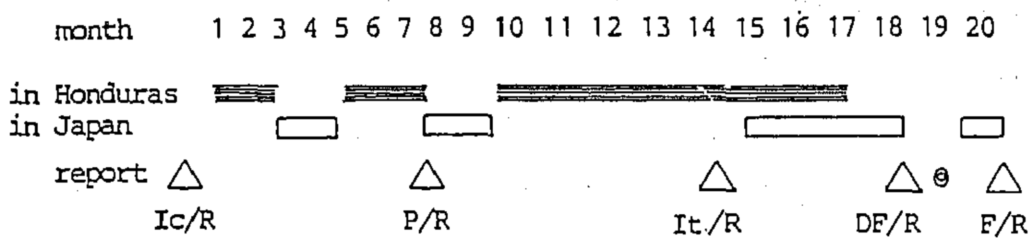
3) to carry out necessary works in Japan;

9. CONSULTATION

JICA and MPH shall consult with each other in respect of any matter that may arise from or in connection with the Study.

Attachment

TENTATIVE SCHEDULE



LEGEND

Ic/R: INCEPTION REPORT
P/R : PROGRESS REPORT
F/R : FINAL REPORT

It/R: INTERIM REPORT
DF/R: DRAFT FINAL REPORT
⊖ : COMMENT

MINUTES OF MEETING ON STUDY FOR GROUNDWATER DEVELOPMENT PROJECT IN COMAYAGUA

MINUTES OF MEETING

ON STUDY FOR GROUNDWATER DEVELOPMENT PROJECT

IN COMAYAGUA, THE REPUBLIC OF HONDURAS

In response to the request of the Government of the Republic of Honduras,the Government of Japan dispatched the preliminary survey team (the Team), for the study on the groundwater development project in Comayagua (the Study) from October 28 to November 6, 1987 through the Japan International Cooperation Agency (JICA), the official agency responsible to the Government of Japan.

The Team, headed by Mr.MICHIO KANDA, head of second development survey division of the social development cooperation department in JICA, and Honduras officials concerned headed by Dr.RUBEN VILLEDA BERMUDEZ, Minister of Public Health had a series of discussions and exchanged their views on the Scope of Work for the Study(the S/W) that was prepared by JICA through analyzing data regarding the Study that was sent to the Governmet of Japan by the Government of Honduras.

Through the discussions, both sides have mutually agreed to the S/W and the results emphasized in the course of the discussions are as follows:

1. The Study Area

   Both sides agreed that the Study would be implemented in the Comayagua basin, about 400 Km^2, as shown in the attached map.

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2. Effective Implementation

(1)The Team expressed the necessity of having a coordination commitee consisting of members from the following organizations.

1) Ministry of Public Health (MPH)
2) The National Service of Aqueducts and Potable Water (SANAA)
3) Ministry of Planning Coordination and Budgeting
4) Ministry of the Interior
5) Ministry of Natural Resources, and
6) Ohthers, if necesarry.

The MPH agreed to utilize the existing coordination committee to implement the Study effectively.

(2) The Team strongly requested that the MPH would formulate a counterpart team consisting of the following fields to insure a smooth transfer of technology in the course of the Study, and the MPH agreed to formulate the following counterpart team with expertise in the following fields.

1) Leader
2) Geology and hydrology
3) Water balance
4) Water quality
5) Electric prospecting
6) Well drilling
7) Water supply facilities planning

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3. Implemention Schedule

Both sides understood the necessity of having the Study start in the dry season, as soon as possible.

4. Report

The MPH requested that the reports for each stage would be translated into Spanish for the purpose of an effective utilization, and the Team understood that it will be necessary that a summary of each report be written in Spanish.

5. Undertaking of the Governement of Honduras

(1) As for the item 7 (1), 1) and 2) 3) in the S/W the MPH requested to be informed the names of the members on the JICA Study team and survey equipments necessary for the Study as early as possible, and the Team understood the necessity.

(2) As for the item 7 (1), 6) in the S/W the MPH expressed the difficulty in obtaining permission for entry into the military base.

(3) As for the item 7 (1), 9) in the S/W the MPH requested to be informed the detailed information of the type of walkie-talkies as early as possible, and the Team understood the necessity.

(4) Both sides agreed that the MPH should prepare suitable offices in Tegucigalpa and Comayagua.

6. Provision of equipments

The MPH strongly requested that the provision of the following equipments would be necessary for the Study.

(1) Four (4) wheel drive cars	2 units
(2) Water level recorder	1 set
(3) Water quality analysis equipment	1 set

The Team understood the necessity of this request for the smooth implementation of the Study.

7. Others

(1) The MPH requested that a temporary water supply facility would be established after well tests and the Team understood the necessity in view of the effective implementation of the Study.

(2) After the Study is completed, the MPH emphasized the importance and necessity that the water supply facilities would be established step by step taking into consideration the social and economic conditions of each area.

8. Attachment Sheet

(1) Map of the Study Area

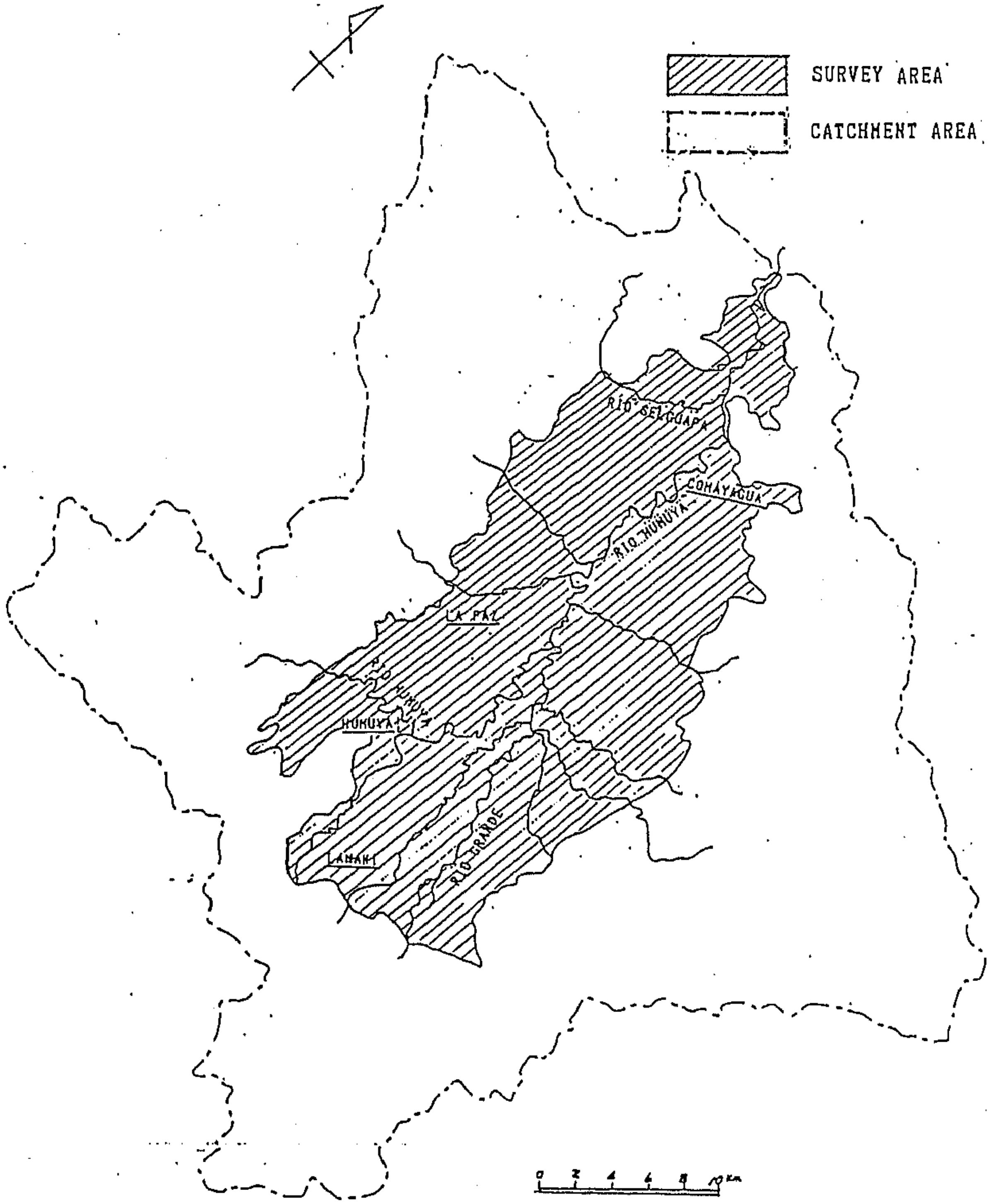
(2) List of Attendance

Tegucigalpa, November 6, 1987

Dr. RUBEN VILLEDA BERMUDEZ	Mr. MICHIO KANDA
Minister of Public Health,	Leader of the Preliminary
Government of the Republic	Study Team ,The Japan
of Honduras	International Agency

ATTACHMENT

(1) MAP OF THE STUDY AREA



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(2) List of Attendance

Japanese Side

1) JICA Team

Ing.	Michio	KANDA	Leader
Ing.Ms.	Makoto	AOKI	Cooperation Policy
Ing.	Atsuo	MATSUDA	Coordination
Dr.	Ryohei	IMAMURA	Hydrogeology and Geology
Ing.	Mikio	OHASHI	Water Supply Planning

2) JICA Honduras Office

Lic.	Hogaku	TSURUMAKI	Representative

3) Translator

Ing.MS.	JOAQUIN	GUARDADO	Hydrology
Ing.MS.	CESAR	MORALES	Hydrogeology

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Honduran Side

1) Ministry of Public Health

Dr. RUBEN VILLEDA BERMUDEZ	Minister
Dr. JOSE T. OQUELI	Vice-Minister
Ing.JUAN RAFAEL DEL CID F.	Director of Rural Water and Sanitary Environment Project
Dr. J. BENJAMIN RIVERA N.	Director of Promotion and Environmental Sanitary Division
Dr. LUIS ROBERTO ESCOTO	Sub-Director of Planning Division
Dr. DANILO VELAZQUEZ	Head of Department International Affairs
Lic.MAYRA ESPINOZA	Assistant of Planning Division

2) Ministry of Planning Coordination and Budgeting

Lic.ROGELIO ORTEGA ANDINO	Vice-Minister
Dr. RAMON SERNA	Director of International Cooperation
Lic.GUADALUPE HUNG P.	Sub-Director of International Cooperation

3) Ministry of Natural Resources

Ing.Katsumi MASUBUCHI	JICA Expert

R.

MINUTES OF MEETING signed on February 26, 1988

MINUTES OF MEETING
ON INCEPTION REPORT AND FIELD INVESTIGATION
OF STUDY FOR GROUNDWATER DEVELOPMEN PROJECT
IN COMAYAGUA

1.- The study for Groundwater Development Project in Comayagua" has been initiated since February 11, 1988, by the team comprising by Dr. N. Miyamoto the Leader of the Team and Ing. M. Saito, Hydrogeologist., dispatched by Japan Internatio nal Cooperation Agency (J.I.C.A. Team), in accordance with the "Scope of Work on Study for Groundwater Development Project in Comayagua" signed between the Minister of Public Health and the leader of the preliminary study team of the Japan International Cooperation Agency on November 6, 1987.

2.- The Inception Report was prepared after the initial field investigation and is submitted to the Minister of Public Health on February 26, 1988. The method and the work schedule for the study were discussed between the JICA team and the counterparts headed by Ing. J. R. Delcid of the Minister of Public Health (MPH), and are agreed on by both parties.

3.- The offices for the study work were prepared both at MPH in Tegucigalpa and at the Regional Hospital of the 2nd health Regiōn in Comayagua. Counterparts of MPH were also assigned and are cooperating with JICA experts both in Tegucigal pa and in Comayagua.

4.- Through the field investigation so far, five (5) sites for test well drilling work were selected at:

-Las Liconas
San Nicolas
Yarumela
Cane
Lamaní

The occupation of the land neccessary for the drilling work is to be made by MPH.

5.- Upon the arrival of other experts of JICA team comprising by Ing. I. Tanabe Hydrologist, Ing. S. Sasaki, Water supply system engineer, on February 27, and Dr. K. Oono, Socio-Economist on March 2, 1988, the first field investiga tion is continued till march 23 1988. JICA team and the counterparts team of the MPH intend to carry out the study successfully.

N.M.

6.- The JICA team was requested by the Ministry of Public Health to convey to the Japanese Government to train the counterpart personnel in the course of the study in Japan, in 1988.

Tegucigalpa, D.C. February 26, 1988

DR. RUBEN VILLEDA BERMUDEZ MINISTRY OF PUBLIC HEALTH	DR. NOBORU MIYAMOTO LEADER OF JICA TEAM

LIST OF HONDURAN PARTICIPANTS

R. Villeda Bermúdez	Minister of Public Health
J. B. Rivera	Sanitation Department Chief
J.R. Delcid	Counterparts Project Chief

JAPANESE TEAM MEMBERS

N. Miyamoto	Team Leader
H. Tsurumaki	Director Of JICA-Honduras
M. Saito	Hydrogeologist
A. Matsuda	Staff JICA.

MINUTES OF MEETING signed on August 23, 1989

MINUTES OF MEETING
ON THE DRAFT FINAL REPORT
OF THE STUDY FOR GROUNDWATER DEVELOPMENT PROJECT
IN COMAYAGUA

The Draft Final Report on the "Study for Groundwater Development Project in Comayagua" was submitted to the Ministry of Public Health in 20 copies of English text and in 20 copies of Spanish version on August 18, 1989.

The Draft Final Report describes the result of the study carried out by the Japan International Cooperation Agency Team in cooperation with the counterpart team of the Ministry of Public Health, and the plan of the groundwater development project for rural water supply in Comayagua.

The meeting on the explanation of the Draft Final Report was held on August 22, 1989 at the Ministry of Public Health and the discussion was made among the persons from MSP, SANAA and SECPLAN who concerned the project and other persons who were invited to the meeting.

It is concluded that the result of the study is deemed reasonable and that the plan of ground water development is suitable for achieving the target of rural water supply in Comayagua.

The comments on the Draft Final Report are as follows;

(1) the item "summary" and the section 6.1 are to be replaced by the revised ones which were explained at the said meeting, and

(2) minor mis-printed letters are to be corrected.

The Ministry of Public Health will make additional comments to JICA study team within 20 days after the date of signing on the Minutes, if required.

Tegucigalpa. D.C.
August 23, 1989

Dr. José Trinidad Oquelí
~~Ministro de Salud Pública~~
por Ley

Dr. Noboru MIYAMOTO
Leader of the Study Team of Japan
International Cooperation Agency

MINUTES OF MEETING signed on March 17, 1989

ESTUDIO PARA EL DESARROLLO DE LAS AGUAS SUBTERRANEAS DEL VALLE DE COMAYAGUA
STUDY FOR GROUNDWATER DEVELOPMENT PROJECT IN COMAYAGUA

AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON
JAPAN INTERNATIONAL COOPERATION AGENCY

MINUTES OF MEETING ON THE INTERIM REPORT AND FIELD INVESTIGATION OF THE STUDY FOR GROUNDWATER DEVELOPMENT PROJECT IN COMAYAGUA

1. The field work on the main investigation stage of the "Study for Groundwater Development Project in Comayagua" has been carried out successfully by the team dispatched by Japan International Cooperation Agency (JICA) in cooperation with the counterpart team of the Ministry of Public Health since the beginning of May 1988, in accordance with the detailed work schedule described in the Interim Report.

2. The Interim Report was prepared based on field investigation and study, and is submitted to the Ministry of Public Health on March 17, 1989. The Interim Report presents the progress of the work, the project findings and the analysis of the collected data regarding socio-economy, hydrological and geohydrological environment, hydrogeology and groundwater, and plan of water supply system. The Interim Report was studied carefully and accepted by the Ministry. However, in consideration of the present situation of water supply system in Comayagua to be improved urgently, it is agreed on to study further a reasonable construction time schedule for the final report.

3. JICA team well execute further study in Tokyo on groundwater potential, planning and design of water supply system and socio-economic analysis concerning the project for the preparation of the draft of the final report, which will be made probably in July 1989.

4. Throughout the field investigation, five test wells with an observation well which are equipped with water supply facilities were constructed in the Comayagua basin. The Ministry of Public Health will carefully maintain those wells and water supply facilities for effective use in future.

Tegucipalpa, D.C. March 17, 1989

Dr. Jose Trinidad Oquelí
Vice-Minister of
Ministry of Public Health

Dr. Noboru Miyamoto
Leader of the Study Team of
Japan International Cooperation
Agency

JICA