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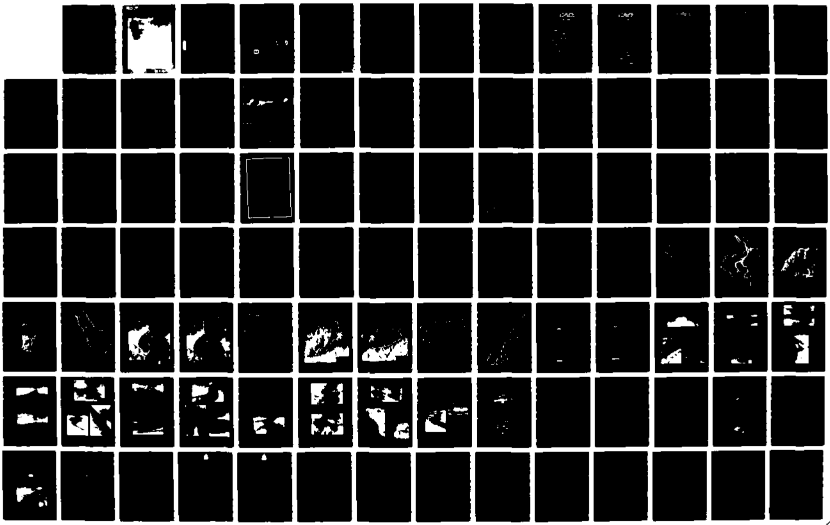

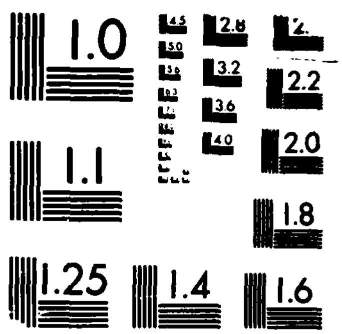

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The report consists of a reconnaissance summary of agricultural flood problems along the entire north coast of Honduras. It discusses the degree and nature of flooding in seven sectors and potential solutions.

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US ARMY CORPS OF ENGINEERS RECONNAISSANCE REPORT ON NORTH COAST OF HONDURAS FLOODING

March 1988

US Army
Corps of Engineers
South Atlantic Division
Mobile District

EXECUTIVE SUMMARY

In a letter to President Ronald Reagan, dated November 3rd, 1986, President Jose Azcona Hoyo, of the Republic of Honduras, requested the technical assistance of the U.S. Army Corps of Engineers with the problem of agricultural flooding along the north coast of Honduras. Discussions and correspondence between representatives of the Government of Honduras and the Government of the United States resulted in the tasking of the U.S. Army Corps of Engineers, South Atlantic Division, Mobile District by the U.S. Southern Command to provide a technical assistance team.

A two phase plan-of-action was developed through discussions between representatives of the Corps' Mobile District Office (MDO), U.S. Southern Command Engineering (SCEN), and the American Embassy Defense Attache Office (DAO) in Honduras. Phase I of the plan was completed on May 1st, 1987, and consisted of the determination of appropriate points of contact in Honduras, development of a mutually acceptable scope of work, and the establishment of an itinerary for the Phase II team mission.

As a result of Phase I efforts, the United States Ambassador to Honduras, the Honorable Everett Briggs, requested designation of a single point of contact and coordination for the Government of Honduras. President Azcona appointed Ingeniero Jose Emilio Torres, the Director General of Civil Works, for the Secretariat of Communications Public Works and Transportation (SECOPT), as the representative for Honduras on north coast flooding. President Azcona is a Civil Engineer also, and a colleague of Ingeniero Torres.

SECOPT officials identified six sectors along the north coast as having agricultural flood problems of particular concern. Each sector contained some portion of one or more major rivers along the coast as follows: Sector One the Rio Choloma; Sector Two the Rio Ulua and Chamelecon; Sector Three the Rio Lean; Sector Four the Rio San Juan and several other rivers; Sector Five the Rio Papaloteca and several other rivers; and Sector Six the Rio Aguan and Rio Chapagua.

Specific problems identified by SECOPT for each of the six sectors were as follows: Sector One, flooding by the Rio Choloma of the town of Choloma and downstream agricultural lands in the Sula Valley (of particular concern was also past loss of lives at Choloma during extreme flood events); Sector Two, flooding of economically important agricultural lands along the Rio Ulua and Rio Chamelecon upstream of Canal Melcher; Sector Three, flooding of land with rich soils and high potential for agricultural development along the Rio Lean; Sector Four, flooding by several rivers (the Rio San Juan particularly) again of areas with rich soils and high potential for agricultural development; Sector Five, flooding by numerous rivers (the Rio Papaloteca particularly) of small agricultural areas in the vicinity of La Ceiba; Sector Six, flooding by the Rio Aguan of highly productive and economically important agricultural lands from the Durango Bridge upstream to the town of Saba.

Phase II of the plan-of-action was completed on February 3rd, 1988. This phase consisted of meetings and field reconnaissance by the technical assistance team in Honduras. While in Honduras the MDO five man team (consisting of Mr. Mathew Laws, Civil Engineer and water resources planner as team leader; Mr. Kenneth Underwood, a hydraulic engineer; Mr. Roger Gerth, a dredging engineer; Mr. Johnny Tyson, a geotechnical engineer; and Mr. Ted McDonald, an agricultural economist) was assisted with logistics and interpretation by LTC Louis Keith, U.S. Army, DAO, and LIC Elio Viara, Political Section, American Embassy. A representative of SECOPT, Ingeniero Mario Alcides Moncada, the Chief of SECOPT's Department of Hydraulic Works, accompanied the MDO team on all field reconnaissance flights and meetings while in Honduras.

Based on field reconnaissance, meetings and discussions with various points of contact in Honduras and review of previous reports prepared by others, the MDO technical assistance team presented officials of SECOPT and representatives of the American Embassy with a two-pronged approach to the ultimate alleviation of north coast flood problems during outbriefings before leaving Honduras. This approach consisted of an early action plan and a future action plan, each to be implemented by the Government of Honduras. It should be stressed that the findings and conclusions presented in this report do not represent feasiblility level recommendations of the Corps of Engineers. But, they are intended to provide an overall understanding of the problems and indicate approaches to their resolution through more detailed computational analyses.

The Corps' team concurs with the statement that serious flood problems are being experienced in all six sectors identified by SECOPT. But, both the Sula Valley (Sectors One and Two) and the Aguan Valley (Sector Six) should be given special emphasis. Both areas are vital to a robust Honduran agricultural economy, and therefore the future of Honduras. Before large investments are made to expand agricultural development into new areas along the north coast, priority should be allocated to the development of remaining less flood-prone lands and enhancement of productivity in both the Sula and Aguan Valleys. Current efforts by the National Agrarian Institute (INA), SECOPT, and the Ministry of National Resources (MRN) to increase agricultural productivity, reduce flooding, and encourage reforestation of slash-and-burn upper basin agricultural areas, are applauded and should be intensified.

The early action plan presented consisted of: intensifying efforts to eliminate slash-and-burn agricultural practices in upper basin areas, which results in erosion of top soils and heavy sedimentation in river channels; establishing a water resources commission consisting of representatives of organizations and agencies with major interests in water project development, to provide a focal point for setting programmatic priorities and phased development of multipurpose projects (infrastructure development, agricultural development, flood control, water supply, etc.); and installing a flood warning system in the Rio Choloma basin, where flash flooding has resulted in numerous deaths at the town of Choloma.

The future action plan presented consisted of: conducting three studies by SECOPT for the economic evaluation and design of structural flood control projects proposed by the team. These studies could be followed by project implementation, if that was determined economically feasible. Generally, the proposed projects include the following measures: controlling flow from the Rio Ulua into Canal Melcher and hydraulically dredging the Rio Ulua below Canal Melcher to restore the original flow regime (to be accomplished with the Honduran 27-inch dredge operated by ENP at Puerto Cortes); constructing an enlarged channel and levees along the Rio Choloma from about 3 kilometers upstream of the town of Choloma to a point about 12 kilometers downstream into the Sula Valley; and the constructing additional relief openings in the Trujillo to Corocito Road elevated fill crossing the lower Rio Aguan.

U.S. ARMY CORPS OF ENGINEERS

PHASE II RECONNAISSANCE REPORT

NORTH COAST OF HONDURAS FLOODING

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RECONNAISSANCE REPORT

NORTH COAST OF HONDURAS FLOODING

INTRODUCTION

This report was prepared by the U.S. Army Corps of Engineers, Mobile District, in response to a request made by President Jose Azcona Hoyo, of the Republic of Honduras, to President Ronald Reagan. In President Azcona's letter to President Reagan, dated November 3, 1986, assistance by the U.S. Army Corps of Engineers was specifically requested for the purpose of reducing the damaging effects of flooding on agricultural production along the north coast of Honduras. Through correspondence and discussions between officials of the Government of Honduras (GOH), the U.S. State Department, the U.S. Department of Defense, the U.S. Department of the Army, the U.S. Army Chief of Engineers (US COE), the Corps of Engineers Water Resources Support Center (WRSC), and the American Embassy in Honduras, the South Atlantic Division (SAD) and, subsequently, the Mobile District Office (MDO) of the Corps of Engineers was tasked with providing the necessary technical assistance by U.S. Commander In Chief Southern Command (CINCSO) Quarry Heights, Panama. Coordination between the Government of Honduras and the U.S. Government team was provided by the U.S. Embassy, Tegucigalpa, Honduras. The U.S. Government team consisted of: LTC James Brink, U.S. CINCSO/SCEN Quarry Heights, Panama; LTC Lewis Keith, U.S. Army Attache, Defense Attache Office, American Embassy, Tegucigalpa, Honduras; LIC Elio Viara, Political Section, American Embassy, Tegucigalpa, Honduras; Major Walter Ennaco, U.S. COE MDO, Military Branch, Engineering Division; Mr. Mathew Laws, U.S. COE MDO, Chief of Coastal Section, Planning Division; Mr. Ted McDonald, U.S. COE MDO, Chief, Economics Section, Planning Division; Mr. Kenneth Underwood, U.S. COE MDO, Hydraulics Section, Engineering

Division; Mr. Johnny Tyson, U.S. COE MDO, Soils Design Section, Engineering Division; and Mr. Roger Gerth, U.S. COE, MDO, Navigation Section, Operations Division.

PURPOSE OF REPORT

Initial discussions between the MDO team, U.S. CINCSO/SCEN, and the USDAO Tegucigalpa, Honduras, resulted in a two-phase plan of action to provide the required technical assistance to the GOH.

Phase I - This phase consisted of a coordination visit by the MDO team leader to Tegucigalpa to establish points of contact within the GOH and the U.S. Embassy, determine the exact nature of the required assistance, determine future data required to complete Phase II, and arrange logistics and support for the Phase II team visit. Phase I was conducted from 27 April 1987 to 1 May 1987. A copy of the Phase I After Action Report is included in Appendix "A" of this report.

Phase II - This phase consisted of a five-man team mission to Honduras to participate in information gathering meetings with GOH points of contact, joint GOH and MDO team field reconnaissance of problem areas, followed by meetings and outbriefings on the MDO team's assessment of problem severity and potential alternative solutions. The Phase II team visit was conducted from 25 January 1988 to 3 February 1988.

The purpose of this report is to document the coordination and field reconnaissance conducted, generally describe the problem areas, develop potential alternative solutions, recommend some near-term implementation plans, and present a framework for developing long-term plans. Further action on the contents of this report would be the responsibility of the GOH.

SCOPE AND AVAILABLE DATA

The overall scope of this report was constrained by time, and was limited to the utilization of available data supplemented by preliminary engineering analyses only. The geographic regions along the north coast of Honduras investigated consisted of the floodplains of five river basins: the Rio Ulua/Rio Chamelecon, the Rio Choloma, the Rio Lean, the Rio San Juan, and the Rio Aguan/Rio Chapagua. Specific attention was given to the river reaches from their confluence with the Caribbean Sea upstream for a distance of about 30 to 50 kilometers (20-30 miles). The hydrologic, hydraulic, geomorphological, and socioeconomic characteristics of each area were investigated. Due to the preliminary nature of the study and this report, no detailed engineering analyses or model studies were performed. Also, although visual examination of bottom and local soil conditions were made, no soil borings or soils tests were performed.

The information utilized during the study and in the preparation of this report was obtained by aerial and ground reconnaissance during both the Phase I and Phase II missions, by telephone inquiries to private sector engineering firms and individuals with knowledge of the problem areas, as well as formal briefings and meetings with officials of the GOH and personnel assigned to the U.S. Embassy and U.S. A.I.D. in Tegucigalpa, Honduras. Topographic mapping of the north coast was also available in several scales and contour intervals. The most detailed mapping available was at a scale of 1 to 50,000 with contour intervals of 20 meters (65 feet). In addition to topographic mapping, nautical charts with depth soundings in meters (shown to a tenth of a meter) and in various scales down to 1 to 15,000 were also available. The nautical charts were produced by the U.S. Defense Mapping Agency, while the topographic maps were from several sources: the Honduran

National Institute of Geography, the U.S. Department of Defense Topographic Command, and, again, the Defense Mapping Agency. Other information utilized during the study was extracted from water resource reports previously prepared on two of the river basins, the Rio Ulua and the Rio Aguan. Mapping available in these reports, for specific basin areas where projects were proposed, was available at a scale of 1 to 5,000 with contour intervals down to 0.2 meters (about 1 foot).

Specific points of contact utilized by the MDO team while in Honduras consisted of officials of: the Honduran Secretariat of Communications Public Works and Transportation (SECOPT), the National Institute of Agriculture (INA), the National Port Authority (ENP), Standard Fruit Company, USAID, COE MDO Area Office, the U.S. Embassy Economic Counselor, the U.S. Embassy Army and Naval Attache, and the Inter-American Geological Survey Honduras. Detailed information concerning points of contact is contained in Section "D" of Appendix "A".

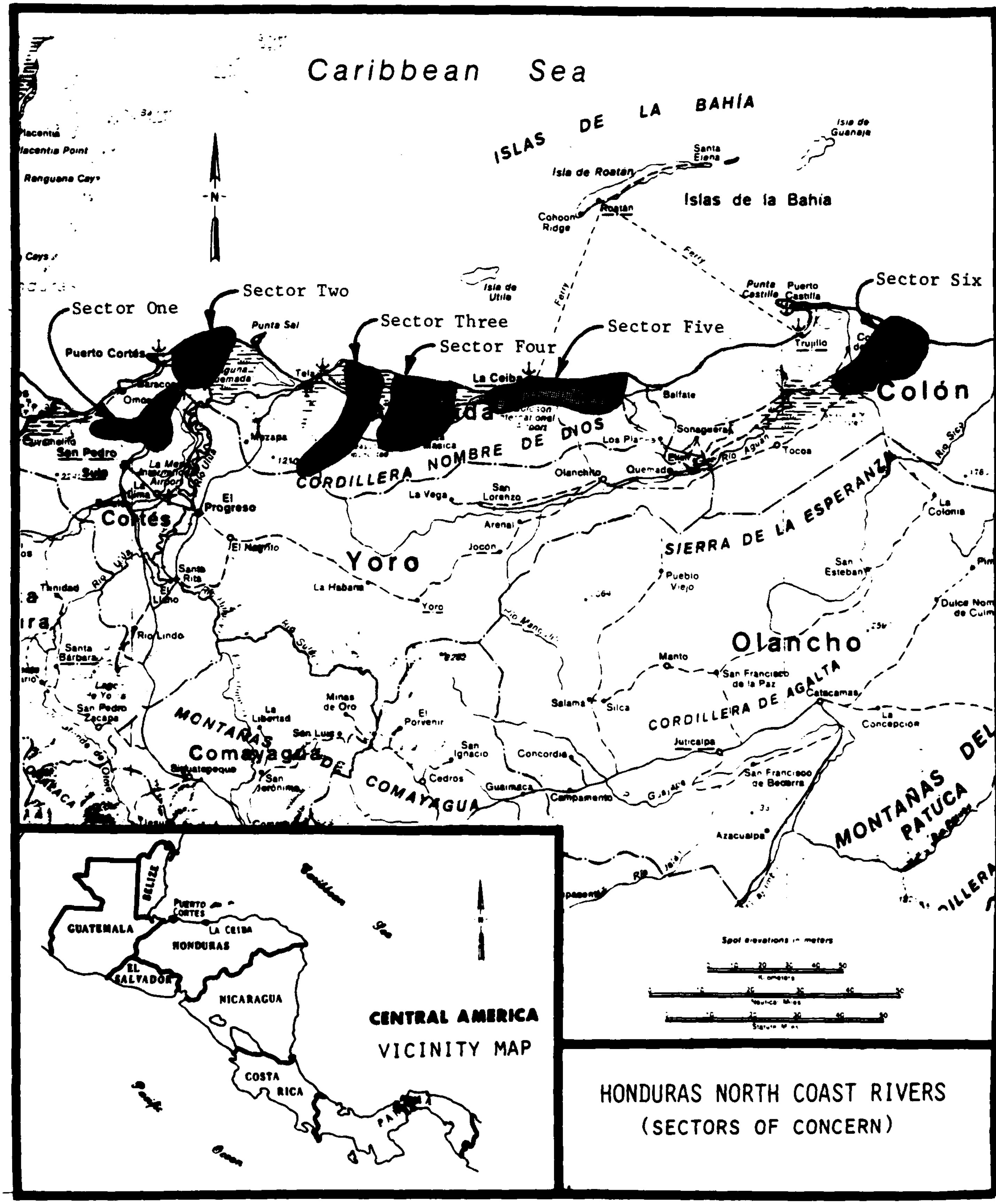
AREAS OF CONCERN

As a result of the Phase I mission, the Government of Honduras was requested by the United States Ambassador to Honduras, the Honorable Everett Briggs, to establish a more definitive scope of work for the Phase II mission, and to establish a single point of contact for coordination with the U.S. technical assistance team. In response to that request, President Azcona identified Ingeniero Jose Emilio Torres, the Director General of Civil Works for the SECOPT, as the representative of the Honduran Government on the issue of north coast flooding.

Through discussions with Ingeniero Torres and Ingeniero Mario Alcides Moncada, the Chief of the Department of Hydraulic Works under the

General Directorate of Civil Works for SECOPT, it was determined that the Government of Honduras had identified six "Sectors" along the north coast where agricultural flooding was of particular concern, each consisting of the downstream reaches of several rivers. These six "Sectors" are shown in Figure 1. More detailed drawings of each Sector are included in the rear of this report on Plates Nos. 6 through 12.

Further discussion with SECOPT officials resulted in the identification of specific problems within each Sector for the team to address. These consisted of: in Sector One, flash flooding on the Rio Choloma from the major bridge crossing at the town of Choloma downstream into Sula Valley agricultural areas; in Sector Two, the silting of the Rio Ulua from its mouth on the Caribbean upstream to the Canal Melcher, which is intensifying backwater flooding in the lower Ulua and lower Rio Chamelecon floodplains; in Section Three, silting and meandering of the Rio Lean from its mouth on the Caribbean upstream to about the town of Santa Maria, and a high groundwater table, all of which is eliminating this extremely fertile floodplain from being developed for agricultural purposes; in Sector Four, again the problem is silting of about five rivers and the lack of good local drainage to allow agricultural development; in Sector Five, the problem is flash flooding compounded by coastal littoral drift plugging the river mouths prior to the rainy season (the team and SECOPT agreed Sector Five would not be included in the Phase II scope of work); in Sector Six, the silting of the Rio Aguan channel below the Durango Bridge (the road crossing the flood plain which connects the village of Corocito to Trujillo), the plugging of the mouth by coastal littoral drift, and poor drainage in some areas, is flooding intensely developed agricultural lands in the Aguan Valley from the previously mentioned road crossing upstream to the town of Saba (it should be mentioned that flooding in the Aguan Valley extends much farther upstream, beyond the town of Olanchito, but would be relatively unaffected by work on the lower river).



HONDURAS NORTH COAST RIVERS
(SECTORS OF CONCERN)

FIGURE 1

GENERAL ASSESSMENT OF FLOOD PROBLEMS

In a general sense, each of these "Sectors" has been impacted by "slash-and-burn" agricultural practices by camposinos (peasant farmers) in the mountainous upper basin areas. These practices consist of cutting all trees on a selected steep slope and burning the site early in the dry season, to provide an area for planting. These mountain farmers get one to two crops a year from these areas before runoff during the rainy season (about May through December) erodes away the top soil. Once this has occurred, a new area is selected and the process is repeated. The Honduran Government has initiated several programs to halt this devastating activity and therefore allow revegetation. More needs to be done in this arena to begin to reduce the levels of sedimentation carried in all north coast rivers.

Of the six "Sectors" identified by the officials of SECOPT,, two bear special mention concerning their importance to the overall economy of Honduras. The Sula Valley (which contains both Sector One and Two) and the Aguan Valley (which contains Sector Six) are the key producers of Honduran agricultural exports. Their combined production makes up over 80 percent of the total Honduran agricultural economy. The most important crops grown are: bananas, African oil palm, plantain, sugar cane, pineapple, citrus (orange and grapefruit), and basic grains (corn, maize, and rice). Other crops include: coffee, cocoa, vegetables (tomato, lettuce, cabbage), beans, soybeans, mango, papaya, and melons (cassava and watermelon). Flooding in both valleys has been, and remains, a persistent problem which impacts both total yields, as well as limits the amount of suitable agricultural land.

Sector 1 - Rio Choloma. The Rio Choloma, with headwaters in the Cordillera (Mountain Range) Del Merendon in northwestern Honduras, enters the Sula Valley at the town of Choloma. The town is located approximately 25 kilometers due south of the Caribbean seaport city of Puerto Cortes and 15 kilometers north-northeast of the city of San Pedro Sula. The Rio Choloma is formed approximately 5 kilometers west-northwesterly of Choloma at the confluence of two tributary streams, the Rio La Julosa and Quebrada Del Cabro. The flood plain minimum width varies between 0.5 kilometers in the upper basin, to 1.2 kilometers in the middle portion, and near the Choloma Bridge the width is 0.8 kilometers. The Rio Choloma drops about 60 meters over a 6-kilometer distance from its upstream limit to a point on the flood plain about 1 kilometer downstream of Choloma. Its tributary streams originate in the surrounding mountains and vary in length between 3 and 7 kilometers. They fall as much as 1100 meters between their headwaters and the confluence with the Rio Choloma. Flooding on the Rio Choloma occurs, as with the other rivers along the north coast, during the rainy season (from about May through December). Because of its basin characteristics and rainfall patterns, which are common to this region, flooding along the Rio Choloma is flashy in nature with flood peaks occurring between four and six hours after significant rainfall events commence. Sediments deposited by the river were observed to consist of mainly silty sands and gravels in reaches near or downstream of Choloma, and gravel with some stones in the upstream-most river reaches. The observed tributary stream beds are composed mainly of stones and boulders.

Agricultural practices over the upper basin included slash-and-burn on the mountain sides. In the areas near and downstream of Choloma, some camposinos are encroaching on the floodplain and trying to farm some very frequently flooded areas. Following the torrential rains spawned by Hurricane Fifi in 1974, the town of Choloma was severely damaged with an accompanying heavy loss of human life. It was reported to the team by SECOPT that prior to Fifi the town had a population of 25,000, of which only 15,000 survived the devastating flooding. Other catastrophic flooding events resulted from hurricane rains in 1934 and again in 1954. During the early portion of 1988, 3 or 4 people were killed along the Rio Choloma by a flood event with a magnitude which reportedly occurs 2 or 3 times a year. Associated with each flood event are agricultural damages stemming from both the height of inundation and velocity; also due to inadequate provisions for local drainage, significant areas of agricultural land are left with standing water, and therefore are unavailable for production the remainder of the year.

Sector 2 - Rio Ulua and Chamelecon. The Rios Chamelecon and Ulua are the two major rivers in the Sula Valley of northwest Honduras. Both rivers discharge into the Caribbean Sea, with the Rio Chamelecon mouth located about 16 kilometers east-northeast of Puerto Cortes, and the Rio Ulua mouth about 9 kilometers east-northeast of the Rio Chamelecon mouth.

As was previously mentioned, the Sula Valley is one of the most significant agricultural regions in Honduras with major crops including banana, sugar cane, African palm, plantain, citrus, and cattle. Development of these agricultural lands has included flow diversion canals and flood control levees. Most of these works were implemented by the major fruit companies which shared the lead in agricultural and infrastructure development within the region (particularly the Tela Railroad Company and Standard Fruit).

The levees, most ring-type, served to protect only the cropland and structures which were enclosed within that particular levee system. Within most of the levee systems, land drainage works were constructed to lower groundwater and remove excess rainfall runoff, or remove flood water which on occasions has overtopped the levees. The levels of protection afforded by these systems is varied and not known at this time (based on conversations with officials in Honduras, they provide protection in the range of 10- to 25-year flood frequencies).

Flow diversion canals have served to transfer flows in order to reduce flood levels and to transport flow pumped from within the levee systems. Some of the canals discharge into lowland areas such as mangrove swamps while others transfer flow into other Sula Valley sub-basins.

One of the canals, Canal Melcher, also has served in the past to facilitate shallow navigation between the Rio Ulua and the Rio Chamelecon at the point where these river alignments are closest. This westerly flowing canal is approximately 2.4 kilometers long and diverts flow from the Rio Ulua into a second northerly flowing canal, which in turn empties into the mouth of the Rio Chamelecon at the Caribbean Sea. This northerly flowing canal is called Canal Del Cruce, and parallels the Rio Chamelecon and Rio Ulua along a course about midway between both. Flow from the Rio Chamelecon is also carried by Canal Melcher to the east into Canal Del Cruce. The Canal Melcher is located inland about 12 kilometers from the Caribbean Sea coast near the village El Tapon on the Rio Ulua. This canal was originally constructed by the Tela Railroad Company with a bottom width of between 20 and 40 meters and a depth of 2 to 2.5 meters. Because of the elevation differences between the thalwegs of the Rio Ulua, the Rio Chamelecon, and Canal Del Cruce, the slope of Canal Melcher was steep and thereby induced high flow velocities toward Canal Del Cruce from both rivers. Also Canal Del Cruce flows along a much straighter alignment (therefore shorter course) than either the Rio Chamelecon or the Rio Ulua. This results in Canal Del Cruce having a much steeper slope and therefore draws flow from both river channels. Over time, high flow velocities have eroded the canal bed. At present, the canal width varies between 75 and 100 meters with depths between 5 and 10 meters. As the canal enlarged, the volume of flow diverted increased to the point where it is estimated that two-thirds of the total Rio Ulua bankfull flow is now transferred to Canal Del Cruce via Canal Melcher. While decanting two-thirds of total Rio Ulua flow, the canal is transferring only a small portion of the coarser sediments which can be described as bed load.

The location of the canal intersection with the Rio Ulua is on the outside of a 180-degree river bend to the right when traveling downstream. Current patterns, which occur through bends such as this, transport the major portion of bed load sediments along the inside of the bend. Therefore, the flow drawn from the Rio Ulua by the canal is practically sediment-free except for suspended sediments which are evenly distributed within the river cross section. In other words, the canal diverts a greater proportion of flow volume than bed load sediments. As a result, the Rio Ulua cannot transport approximately 95 percent of its original bed load sediments with only one-third of the total flow that remains in the river channel below the canal. This loss in sediment transport capability has resulted in a downsizing of the Ulua flow channel toward the existing flow and sediment regime.

This loss in channel size and total flow energy has created the condition where the Rio Ulua is filling with sediment and its mouth is periodically closed off by littoral transport deposits during the low flow months. Only during the months of higher rainfall and concomitant higher river flow volume and stage does the Rio Ulua erode the littoral sand blockage and flow directly into the Caribbean Sea. But, even under these conditions, the channel of the Rio Ulua downstream of the Canal Melcher remains heavily silted and flows at only a fraction of its original depth.

Serious flooding along the Rio Ulua and Rio Chamelecon usually occurs from two to three days after the heaviest rainfall period, with river stages falling below flood levels three to four days after the flood peak. The degree of flooding severity along the Ulua and Chamelecon is dependent on the soil moisture conditions over the basin, rainfall intensity and duration, and aerial extent of the storm. Because of the basin characteristics, flooding along the Ulua and Chamelecon could be anticipated and measures could be taken to reduce the threat to both life and property prior to the arrival of the flood peak.

Flooding conditions along the lower reaches of the Ulua and especially the Chamelecon have worsened following the Canal Melcher enlargement and flow diversion into Canal Del Cruce. The increased flow into the Canal Del Cruce has increased flood frequencies, stages and durations along the lower reaches of both the Rio Chamelecon and Rio Ulua upstream from Canal Melcher. Backwater effects resulting in flooding upstream vary and are dependent on flood flow distributions between the Rio Ulua and Rio Chamelecon at the given time, and for a given rainfall distribution between drainage areas.

Sector 3 - Rio Lean. The Rio Lean is formed by headwaters in the northwestern Honduran mountains known as the Cordillera Nombre De Dios. The flood plain is flanked on both sides by steep mountains with elevations that reach 1400 meters. Flood plain width varies from about 2 kilometers near the upper basin town of Nueva Florida, to around 3.5 kilometers wide at Santa Maria, which is about 18 kilometers further down the basin. About 23 kilometers further down the basin at Atenas De San Cristobal, the width is about 4.5 kilometers. Atenas De San Cristobal is situated at the northern terminus of the mountains which form the western flood plain boundary. Downstream to the north toward the Caribbean Sea, the Rio Lean flows through coastal plain which is flat, low and wet. The Rio Lean enters the Caribbean Sea near the village of Colorado which is about 10 kilometers north of Atenas De San Cristobal.

Along the Rio Lean flood plain the river has a mild slope and is meandering to a large extent as evidenced by the meander scars and oxbow lakes present. The upper portion of the river has alternating bars in straight reaches and through the mid-portion sinuosity increases with middle bars in evidence. Once the river reaches the coastal plain, the slope flattens, sinuosity becomes extreme, and with the very low top-bank elevations, the flat lowlands are easily flooded. Flooding is likely exacerbated by the presence of a littoral drift mouth plug which develops during the low flow periods (the dry season from about January through about April).

Sediment deposits along the river are composed of clay sands, gravels, and some cobble-sized stones evident along point and middle bars in that reach above Atenas De San Cristobal. Through coastal plain reaches, the sediment deposits appeared to consist of clay sands along the point bars and mid-stream islands. The erosion of some steep mountain and hillsides where slash-and-burn type agricultural practices are ongoing is likely contributing a significant portion of the heavy sediment load now transported by the river.

Flooding problems reportedly have been made more severe by the heavy sediment loads which have raised the river bed and flood flow levels. The filling of the river bed with sediments has also caused ground water levels to rise to undesirable elevations along the flood plain. Through the coastal plain lowland reaches, the flooding conditions impact very little agricultural land, but prohibit the extension of farming and cattle production toward the north from the higher portion of the basin. As was previously stated, the soils are very rich in the lower flood plain and the officials of both SECOPT and INA would like to expand agricultural production into this region.

Sector 4 - Rio San Juan. The limits of this north coast sector extend from near the Rosita settlement on the west to near Salado Barra to the east, a distance of approximately 21 kilometers. From Salado Barra on the Caribbean Sea the sector extends southward about 13 kilometers to the mountains, Cordillera Nombre De Dios, then west-southwesterly along the mountain base about 29 kilometers to near Lombardia, and then northerly along an arm of the same mountain range for about 23 kilometers to the Caribbean Sea near Rosita.

The river alignments are relatively straight within this Sector. Eight rivers, including the Rio San Juan, flow in well-defined shallow channels northerly across the coastal plain. The rivers' discharge into the Caribbean Sea is through three well-defined outlet channels, with one of these river channels terminating in a wooded lowland area. One of the outlets also serves to drain a large lagoon. All three outlets are interconnected by lagoon-type water bodies and small navigable channels (shallow depths) which are located behind the coastal berm and parallel to the shore. During periods of low flow, as in other north coast areas, the outlets are sealed by the sandy littoral deposits which extend across the openings, periodically blocking discharge into the sea.

Sediments carried by the rivers vary from fine suspended materials to cobbles which are carried only along the headwater streams which originate in the mountains to the south and west. This area receives some of the highest average annual and peak rainfall amounts along the entire north coast. The coarser sediments, cobbles and gravels, are deposited when the steep mountain streams initially encounter the flatter slopes of the coastal plain rivers and streams. The sands are carried further toward the coast. Some suspended sediments are deposited over the lowlands when the rivers flood. During low rainfall periods when the outlets are blocked, little or no flow is discharged into the sea. During the peak portion of the rainy season, when the basin outflow significantly increases, sufficient flow energy is available to erode the plugs and maintain flow into the Caribbean.

Flooding in the basin affects the extremely limited existing agricultural efforts on the coastal plain. The raising of cattle and some crops are attempted, but flooding often forces the camposinos to retreat to high ground. In the steeper hills and mountain sides, slash-and-burn agricultural practices are employed without fear of flooding. Most agricultural areas are located along the southern portion of the coastal plain along the higher lands near the mountains. At the town of La Masica, the Honduran Department of Agriculture (INA) is experimenting with growing a new type of coffee and cocoa. The new coffee plant does not require a lot of shade, as do typical native coffees, and can be grown on flat lands (not providing the degree of shade available on the steep slopes of the mountains). Much of the northern portion of the flood plain is low and wooded or marshy. This Sector has existing infrastructure (roads and railroads) and exceptionally good soils suitable for many types of crops; therefore, both INA and SECOPT feel it should be developed.

Sector 6 - Rio Aguan. The major river within the Aguan Valley is the Rio Aguan which discharges into the Caribbean Sea at the central north coast town of Santa Rosa De Aguan. The Rio Aguan basin extends from the coast in a west-southwesterly direction a distance of about 225 kilometers and is bounded by steep mountain ranges on both the north and south. Both the Cordillera Nombre De Dios to the north and the Sierra La Esperanza to the south have peaks that exceed 1200 meters in elevation. The drainage area of the Rio Aguan at Durango is approximately 10,300 square kilometers, with the upper Aguan (above Saba) draining an area of about 7,545 square kilometers. The Aguan Valley itself extends from San Lorenzo to the sea outlet at Santa Rosa De Aguan, a total distance of about 160 kilometers, and with a maximum width of about 15 kilometers.

The Aguan River originates above the Yoro Valley in the El Pijol Mountain Range and picks up a large number of tributaries in its meandering course to the Caribbean Sea (a thalweg distance of approximately 395 kilometers). The Yaguala River and the Mame River are its principal tributaries, with catchment areas of 1,835 square kilometers and 2,096 square kilometers, respectively. Within the lower portion of the basin, two other rivers, which act as distributaries under high flow conditions, drain small sub-basins into the sea. The Rio Chapaugua discharges into the Caribbean Sea about 4.5 kilometers west-northwest of the Rio Aguan mouth. The other river, Rio Limon, flows into the sea about 19 kilometers to the east-southeast near the town of Limon.

The mean annual rainfall varies from about 900 mm in the upper Aguan to about 2,500 mm in the lower Aguan. The mean annual flow in the Aguan at Saba, for the period from 1981 to 1983, is about 140 cubic meters per second, with monthly variations reflecting the very seasonal rainfall pattern. The maximum mean daily flow was 2,020 cubic meters per second (occurring in November 1980), and the minimum mean daily flow was 11 cubic meters per second (occurred in May 1983). Therefore, the river is extremely low during the months from about January to April, with floods most likely between the months from September to December.

In the upper portion of the Aguan Valley, the Rio Aguan bed slope is steep with the river having a braided channel. That type channel has a low-flow channel that is divided into several smaller channels through many flow reaches. During higher flow stages, the flow often takes a different path as the low-water islands and bars are overtopped. Through the middle reaches of the river, the bed slope is more mild and the channel meander with point and middle bars in evidence. Along the lower reaches, the bed slope is flat and the channel very sinuous with frequent point bars.

Tributary streams of the Rio Aguan originate in the mountains and flow varying distances across the valley to the river. Because of their steep channel slopes, the tributary streams are capable of transporting large quantities of sediment with sizes sometimes greater than cobblestones. Most of the coarser materials are deposited when the streams reach the flatter slopes at the valley floor. In the upper basin some materials up to cobble size reach the main channel and other smaller sediments are deposited along the bars and islands. Through the middle portion of the Aguan Valley, from the City of Olanchito to Saba, sediments reaching the river are not as coarse as the upper river deposits. Because of the increased valley width, and lower bed slopes in both the tributaries and main channel, coarser sediments are deposited prior to reaching the Rio Aguan main stem. Insufficient flow energy is available to transport the larger sediments.

Along the lower sinuous reaches, from about Saba to the river mouth, where the valley is widest and the bed slope of the tributaries and main stem are flattest, the tributary streams contribute sediments in the smaller grain sizes. Also, through this reach the river top banks are lower than along the other reaches.

The slash-and-burn agricultural practice observed within other basins is also much in evidence along the mountains and hills which surround the Aguan Valley. Erosion of these steep denuded areas has contributed a significant portion of the sediment load which annually is transported within the basins water courses. Excessive sediment load will raise stream bed levels and thereby increase flooding potential, as well as spread undesirable sediments over highly productive agricultural lands. Cessation of the slash-and-burn practice and either natural or man-aided restoration would in time reduce the sediment load entering the basin drainage system, but existing sediment deposits throughout the water courses could present problems for many years. The Honduran Forestry Agency, under the Department of Natural Resources, has begun several initiatives to eliminate slash-and-burn practices and reforest some areas. Also, the team was told that some foreign private groups have begun to assist in these reforestation projects (one was reportedly underway in a portion of the upper Rio Aguan basin).

Flooding problems within the Aguan Valley are most severe in the lower reaches where agricultural damage is sustained primarily from the duration of flooding (Oil Palm is damaged by water over its roots for more than about three days). Flooding through the steeper upper reaches is more flashy in nature with the flood waters and excessive groundwater more quickly drained to the main stem channel. Flood flow velocities can cause crop damage at any location depending on the crops physical nature (when banana plants have fruit they are easily pushed over by flow velocity). Along the lower reach where the flow is more sluggish, flood duration can exceed five days. These lengthy durations damage or severely stresses most agricultural crops so inundated. Groundwater can also be a problem in this reach as it is naturally high, and can remain at crop damaging levels because of the longer dewatering period of this flatter land.

Crops grown over the middle and upper basin include sugar cane, citrus, corn, banana, and African palm. Throughout the valley water problems vary, with irrigation required during the dry months at certain locations and dewatering systems needed at other locations during the wet season.

Flood problems within the Rio Chapagua and Rio Limon sub-basins are limited because of the sparse population and limited agricultural development. In some areas crops such as corn and banana are raised, but the primarily agricultural activity is cattle raising on the flat and low available pasture lands.

FLOOD DAMAGE REDUCTION ALTERNATIVES

The consideration of flood damage reduction alternatives for each sector of the north coast study area was targeted at the identification of plans which were implementable and feasible from an economic, engineering, and sociological viewpoint. Because a reconnaissance study is an abbreviated effort, directed primarily at determining if further more detailed investigations will be continued under a feasibility study effort, quantified evaluation of all possible alternative plans was not performed. But some consideration was given to the appropriateness of a wide array of flood damage reduction options. Shown in Figure 2 is a listing of the many options which should be considered for flood damage reduction. The measures shown in this figure fall into one of three action categories: those that modify flooding; those that modify the floodplain; and those that modify only the economic effects of flooding. The first category includes those measures commonly termed as "structural" and the latter two categories include measures commonly termed as "nonstructural."

The first step in the consideration of damage reduction alternatives performed in this study included a review of the individual flood control measures shown in Figure 2. Many of the measures shown were eliminated from quantitative consideration due to obviously unfavorable social, economic, environmental, and engineering factors; or because such measures have already been implemented. The following paragraphs discuss each measure type and its applicability to north coast flood problems. Each of the measures considered by the MDO team were also discussed with officials of SECOPT while in Honduras.

Nonstructural measures do not attempt to reduce or eliminate flood water levels. They are directed toward lessening the damaging effects of floods by such means as regulating future development, flood

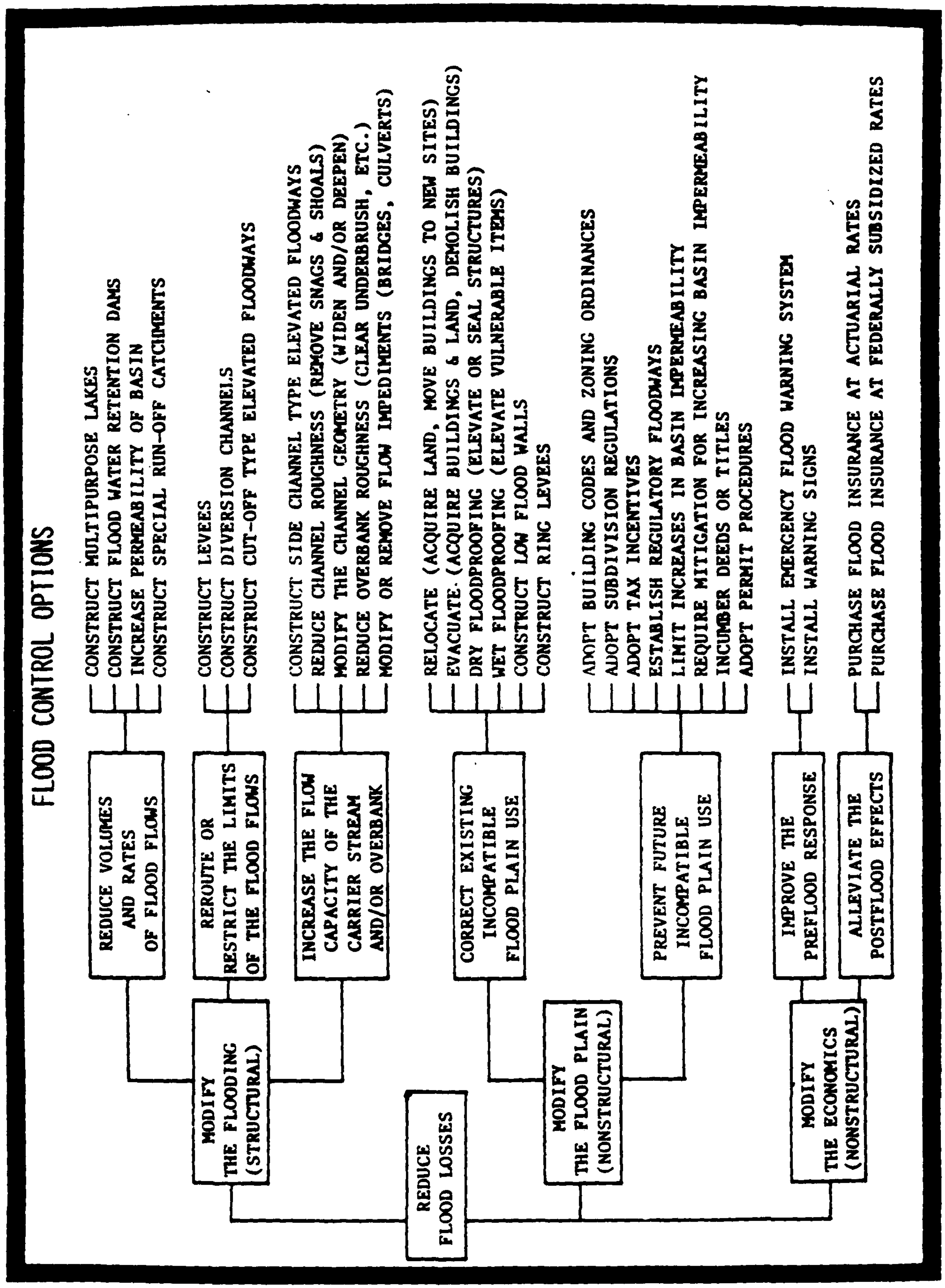

FLOOD CONTROL OPTIONS
REDUCE FLOOD LOSSES
MODIFY THE FLOODING (STRUCTURAL)
REDUCE VOLUMES AND RATES OF FLOOD FLOWS
CONSTRUCT MULTIPURPOSE LAKES
CONSTRUCT FLOOD WATER RETENTION DAMS
INCREASE PERMEABILITY OF BASIN
CONSTRUCT SPECIAL RUN-OFF CATCHMENTS
REROUTE OR RESTRICT THE LIMITS OF THE FLOOD FLOWS
CONSTRUCT LEVEES
CONSTRUCT DIVERSION CHANNELS
CONSTRUCT CUT-OFF TYPE ELEVATED FLOODWAYS
INCREASE THE FLOW CAPACITY OF THE CARRIER STREAM AND/OR OVERBANK
CONSTRUCT SIDE CHANNEL TYPE ELEVATED FLOODWAYS
REDUCE CHANNEL ROUGHNESS (REMOVE SNAGS & SHOALS)
MODIFY THE CHANNEL GEOMETRY (WIDEN AND/OR DEEPEN)
REDUCE OVERBANK ROUGHNESS (CLEAR UNDERBRUSH, ETC.)
MODIFY OR REMOVE FLOW IMPEDIMENTS (BRIDGES, CULVERTS)
MODIFY THE FLOOD PLAIN (NONSTRUCTURAL)
CORRECT EXISTING INCOMPATIBLE FLOOD PLAIN USE
RELOCATE (ACQUIRE LAND, MOVE BUILDINGS TO NEW SITES)
EVACUATE (ACQUIRE BUILDINGS & LAND, DEMOLISH BUILDINGS)
DRY FLOODPROOFING (ELEVATE OR SEAL STRUCTURES)
WET FLOODPROOFING (ELEVATE VULNERABLE ITEMS)
CONSTRUCT LOW FLOOD WALLS
CONSTRUCT RING LEVEES
PREVENT FUTURE INCOMPATIBLE FLOOD PLAIN USE
ADOPT BUILDING CODES AND ZONING ORDINANCES
ADOPT SUBDIVISION REGULATIONS
ADOPT TAX INCENTIVES
ESTABLISH REGULATORY FLOODWAYS
LIMIT INCREASES IN BASIN IMPERMEABILITY
REQUIRE MITIGATION FOR INCREASING BASIN IMPERMEABILITY
INCUMBER DEEDS OR TITLES
ADOPT PERMIT PROCEDURES
MODIFY THE ECONOMICS (NONSTRUCTURAL)
IMPROVE THE PREFLOOD RESPONSE
INSTALL EMERGENCY FLOOD WARNING SYSTEM
INSTALL WARNING SIGNS
ALLEVIATE THE POSTFLOOD EFFECTS
PURCHASE FLOOD INSURANCE AT ACTUARIAL RATES
PURCHASE FLOOD INSURANCE AT FEDERALLY SUBSIDIZED RATES

FIGURE 2

proofing of damageable development, and temporary or permanent evacuation from the flood plain. Several nonstructural measures appear to offer some low cost, and near-term implementation opportunities to reduce the impacts of flooding on crops, buildings, and those who inhabit the floodplains. These measures include: modification of existing agricultural practices in such a way as to minimize inundation damage; elimination of upper basin erosion and therefore reducing channel siltation; encouragement of the proper location of homes to reduce the chance of loss of life; provision of flood warning and flood fighting capabilities.

Structural flood damage reduction measures are those which modify the flooding characteristics of a stream in such a way as to reduce the level of losses resulting from inundation of floodplain development. Of the various options listed in Figure 2, three basic types of measures were considered during this reconnaissance study: levees, stream diversion, and channel modification.

Levees are generally constructed parallel to the stream and tie into high ground at each end, or circle the area to be protected if the terrain is not suitable for connecting the levee into higher ground. In addition, ponding areas, pumping stations, and other pertinent drainage structures are necessary to remove interior runoff from behind the line of protection. Given the extremely large volumes of runoff in each of the six sectors and the very flat and wide floodplains in the downstream river reaches, levee construction seems to be an obvious structural option for detailed consideration. Due to the complex array of irrigation and tributary channels, evaluation of the need for secondary levees and interior drainage provisions would involve extensive coincidental hydrologic analyses.

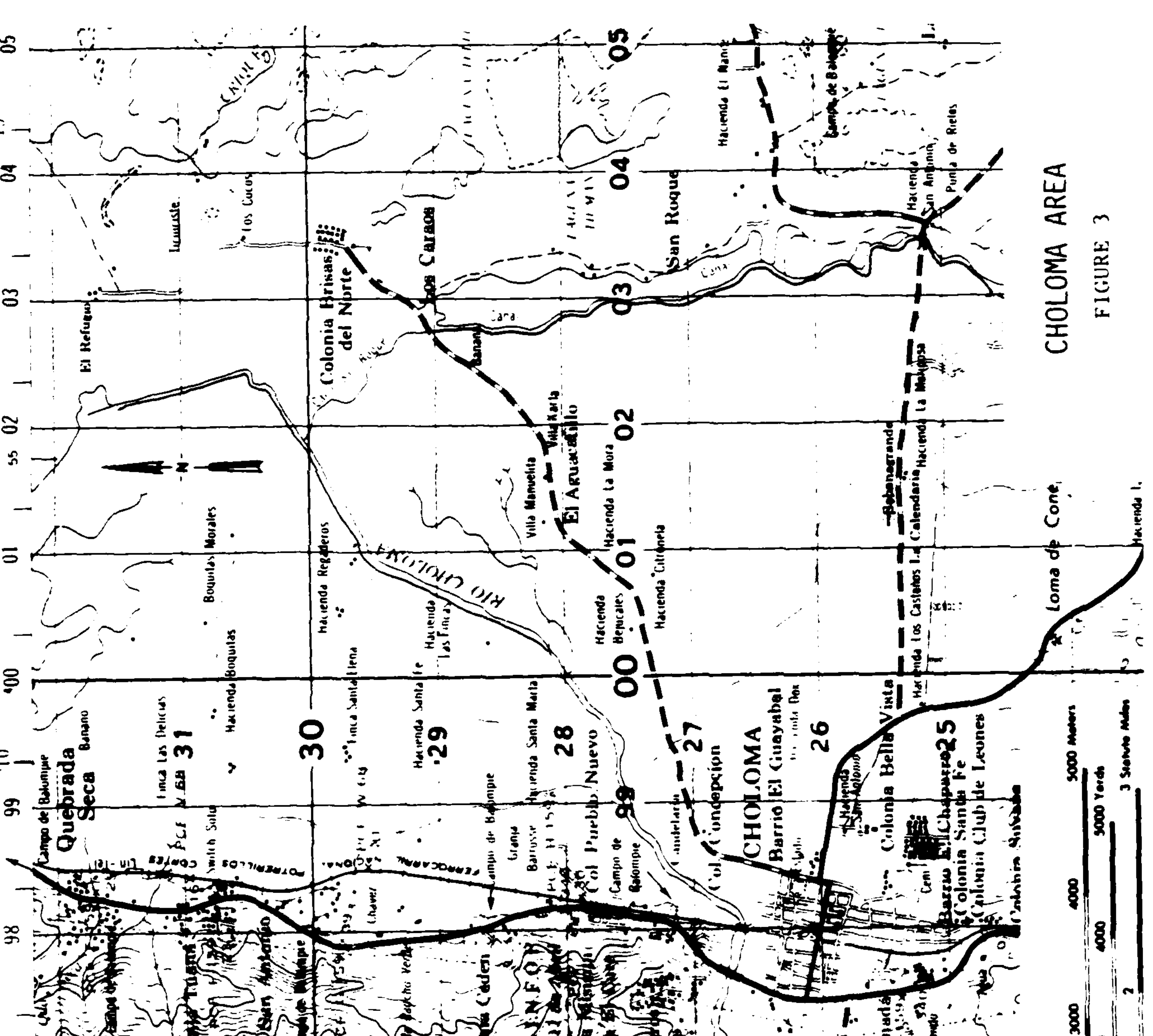
Stream diversion has been proposed in two of the sectors and may offer some economic advantages over channel enlargement at specific locations within each river basin. This topic will be discussed later with respect to specific alternative plans identified for each sector.

Channel modification is effective in reducing flood stages on most streams. Enlargement of the channel and modification of bridges and other flow impediments provide a more effective outlet for flood flows and, therefore, reduce the stages of floods. The amount of stage reduction depends on the magnitude of enlargement to the channel and the flow efficiency of other modifications. Channel enlargement should be considered in the Ulua and Aguan Basins with any further detailed study of flooding which allows hydraulic computer modeling (such as that performed by the Corps using HEC-1 and HEC-2). Channel enlargement in river reaches from the mouths upstream for a distance of about 50 kilometers (30 miles) may be beneficial in conjunction with several other measures such as levees and/or flow diversion.

Reservoirs located in the upper watersheds of rivers are often effective in reducing flood damages by temporarily storing rainfall runoff and releasing the water slowly, allowing water downstream to enter the channel and flow out ahead of the stored water. With basins as large as those along the north coast of Honduras, these type structures would probably have to be multipurpose in design to approach economic feasibility. Given the lack of a high degree of upstream urbanization, and therefore a lack of upstream navigation need, coupled with the fact that all existing and future hydropower needs are met with the El Cajon project (200-meter-high multipurpose concrete arch dam on the Rio Comayagua near the confluence with the Rio Sulaco in the upper Ulua Basin), economic justification of multipurpose dams could only be provided by the remaining purposes of flood control and water supply. At the present time, these two purposes alone would probably not provide the magnitude of economic benefits required for large multipurpose project feasibility. Therefore, for the purpose of this reconnaissance study, no further consideration was given to new reservoirs as a flood control alternative.

Alternatives appropriate in each specific river basin and river reach are discussed in the next paragraphs along with a preliminary assessment of their effectiveness.

Sector One. The primary problem in Sector One is the large amount of sediment carried by the Rio Choloma into the river reaches and flat lands downstream of the Carreteria Bufalo Cortes bridge crossing at the town of Choloma. This area is shown in detail in Figure 3. Extremely large areas of the mountainous upstream sub-basin of the Rio La Jutosa (a major tributary of the Rio Choloma), and the upper Rio Choloma itself, have been denuded by previous slash-and-burn farming. These campesino farmers are currently being relocated to the rich agricultural lands in the lower Choloma basin areas within the Sula Valley (a similar program was successfully employed in the basins upstream from San Pedro Sula). In addition to this initiative, a total of nine sediment dams are planned for the upper basin. One of the four dams planned for the Rio La Jutosa in the vicinity of the town of El Portillo has been constructed by SECOPT. This dam was inspected by the Corps team in the field on 27 January 1988. Photographs of the dam are shown in the rear of this report on Plate No. 23. The design of this dam is typical of the remaining eight to be constructed. SECOPT is to be applauded for the quality of their work in this area and for having the vision to initiate such measures. The dam is functioning as designed. This can be witnessed by the extremely coarse nature of the downstream river bed cobblestone sediments and the clarity of the water it carries. Revegetation is naturally occurring in some of the previously denuded upper basin areas, but could be accelerated by reforestation work.



CHOLOMA AREA

FIGURE 3

The Choloma Basin downstream from the town of Choloma is now being farmed by large numbers of campesinos, many of whom have located there from the mountains which lie to the west of both San Pedro Sula and Choloma. These families have experienced frequent and severe losses due to flooding. They, as well as those who live in the town of Choloma, would benefit greatly from structural flood control on the river. The previously mentioned bridge at Choloma provides for the crossing of the only major Federal road (Hwy 1) that connects the important seaport at Puerto Cortes with the industrial center of San Pedro Sula. During the flooding associated with Hurricane Fifi in 1974, it was reported that this bridge was washed out and about 10,000 people in the Choloma area lost their lives.

SECOPT has given the completion of flood control measures in Sector One their first priority, and the Corps' team concurs in this decision.

Specific measures the team considers appropriate in Sector One are:

- Reforestation of upper basin areas
- Completion of the remaining eight sediment dams
- Construction of levees and channel enlargement from a point upstream of the Choloma bridge (about 3 kilometers upstream) to a point about due east of the town of Quebrada Seca (about 9 kilometers downstream from the bridge at Choloma).

The channel enlargement could be constructed using draglines (the river is not deep enough for hydraulic dredges). The material removed from the riverbed would be used to construct levees on both banks, and appears suitable for levee construction. A large width between the levees should be provided (about 400 meters). This will allow the Rio Choloma channel to meander within its natural band and not undermine the levees. SECOPT proposes a trapezoidal channel with dimensions of 200 meters in bottom width, a depth of about 5 meters, and side slopes of 3 horizontal to 1 vertical. The levees would have a top width of about 4 meters, with river-side side slopes of again 3 on 1, and constructed to a height of about 4 meters. Using a total improved channel length of about 12 kilometers, and assuming the existing channel is about 30 percent of the improved cross section results in a total estimated excavation quantity of about 8,600,000 cubic meters. It is pertinent to stress that these dimensions and excavation quantities are very approximate, and do not constitute a recommendation by the Corps of Engineers. Before the most cost effective design could be established, detailed hydrologic and hydraulic modeling combined with an up-to-date agricultural flood damage model would be required. Notwithstanding this fact, the sizing of this channel and associated levee work appears to the team to be reasonable given the basin characteristics and regional rainfall patterns (see Appendix B, Section C).

Considering the quantity of material to be excavated and the compaction requirements for levees of this type, a very rough approximation of cost for the described work would be about $80,000,000.

<u>Sector Two.</u> The primary problem in Sector Two is the reduced channel cross section of the Rio Ulua downstream from the Canal Melcher, and the backwater effects on the Rio Chamelecon caused by the large volume of flow currently carried in Canal Melcher. SECOPT proposes to construct a flow control structure on Canal Melcher that will only allow a small quantity of Rio Ulua flood water to enter. This structure will allow the Rio Ulua downstream of the canal to reclaim its original flow regime. In order to eliminate intensified flooding

on the Ulua upstream from the control structure, the original Ulua channel dimensions will require reestablishment. Once this is accomplished, probably by hydraulic dredge, the new flows will tend to carry sediments on to the Caribbean; but periodic dredging at the mouth of the river, and upstream for some unknown distance, will still be required.

It is interesting to note that Canal Melcher discharges the combined flow of about two thirds of the Rio Ulua and the Rio Chamelecon into a second canal which parallels the two rivers and flows in a northerly direction to enter the Caribbean at the mouth of the Chamelecon. This canal (Canal Del Cruce) has essentially taken over all the flow of the old Chamelecon channel downstream from a point about one-half the way between the villages of Baracoa and Campana. As was mentioned previously, it provides a straight and shorter (therefore steeper) route to the Caribbean than the original Rio Chamelecon channel. The old original Rio Chamelecon channel only carries significant flow when extremely large floods occur. SECOPT and others with a knowledge of these waters report that the mouth of Canal Del Cruce (and therefore the mouth of the Rio Chamelecon) carries enough flow to remain open to the Caribbean all year round, and is not plugged by net westward littoral drift during the dry season like other north coast rivers. Canal Del Cruce was also built by the Tela Railroad Company. No one could recall the exact year either canal was constructed. Maps compiled in 1969 show Canal Melcher, but not Canal Del Cruce. Maps dated 1981 show Canal Del Cruce and Canal Melcher. Canal Del Cruce was excavated through the low mangrove swamp (known as the Pantanos) with a width of about 150 meters and a depth of between 5 and 10 meters.

In considering the flat, swampy nature of the floodplain in this area of the Sula Valley (much like South Louisiana), and the large volumes of flood flows, the only structural alternatives that appear practical are levees or channel enlargement. Levees below Canal Melcher would only aggravate the current backwater problems and would not allow cultivation of the swampy lands without extensive investment in canals and drainage works to lower the groundwater. The proposal of SECOPT to construct a flow control structure and reestablish the Rio Ulua channel dimensions may be the best alternative available. Implementation of this alternative is discussed later in this report.

There are a number of existing dams in the upper basin of the Rio Ulua (El Cajon mentioned previously and several other dams on tributary rivers of the Ulua). The operation of these dams should be examined during any further detailed study, as a means to attenuate flood peaks. But, these dams would not have large effects on the very low flat reaches of either river in the vicinity of Canal Melcher.

Sector Three. The condition of the Rio Lean along its lower reaches from about the town of Santa Maria (where several major tributaries enter the river), downstream to its mouth at Colorado, is very dynamic and exhibits all the stages of a highly unstable meandering alluvial channel. A braided channel with cut-offs forming, rapidly eroding banks, and relatively no depth, does not lend itself well to traditional structural flood control measures. The team agreed that controlling the flood problem and lowering the ground water table in this long narrow basin would require levels of investment and expenditure of resources far in excess of the benefits to currently be gained. Before this problem is undertaken, all other uncultivated agriculturally suitable land should be developed. In other words, the nonstructural solution of avoiding the floodplain is the best approach in this dynamic circumstance.

Sector Four. - The largest rivers in Sector Four are the Rio San Juan and Rio Cuero. Both have headwaters and large portions of their drainage basins in the steep mountains of the Cordillera Nombre De Dios. The flood problems within this Sector stem from the combination of these steep, flashy, upper basin areas with the wide flat alluvial basin outlets to the Caribbean. As in the other north coast sectors, the most appropriate structural flood control measures appear to be channel enlargement and levee construction. This Sector could be developed for agriculture by constructing levees with excavated channel materials, and providing the necessary interior drainage. The construction of ring levees in the regions of the floodplain around La Masica would seem a logical place to start. With successful farm operations in these areas, the project works could be extended north farther down the basin toward the Caribbean. To dredge the mouths of these rivers (the Rio Quebrada del Higueral, Manga del Rio San Juan, Rio San Juan, Rio Cuero, and Rio Limon) upstream to the foothills of the Cordillera Nombre De Dios would be extremely costly and should not be done without initiation and evaluation of pilot projects combined with extensive economic analyses of alternative plans. Dredging or excavation by dragline of the five river channels in Sector Four would require some 100 kilometers of primary channel work combined with about 75 kilometers of secondary channel work. SECOPT estimated this to be approximately 77,400,000 cubic meters (101,239,200 cubic yards) of material. Dredging this amount of material, along with some unknown amount of annual maintenance material would be cost prohibitive.

Sector Six. - In previous studies of the Aguan Valley numerous recommendations have been made for the construction of many different types of water resources improvements. Some of the purposes served include: irrigation, agricultural drainage, hydroelectric power generation, and flood control. Recommendations for flood control have consisted of a wide array of measures, such as: the enlargement of the Rio Aguan channel from its mouth upstream to the vicinity of the Rio Mame (a major tributary just downstream from Olanchito); the construction of levees on both sides of the river from the Durango Bridge (near Corocito) upstream to the vicinity of Saba; the construction of several diversions of tributary flows along new alignments at the towns of Isleta, Salama, and Corocito; the construction of a large diversion of flow from the main Rio Aguan channel, in the vicinity of the town of Corocito, into the Rio Chapagua; the construction of a right overbank (southside) floodway near the Trujillo Road bridge crossing with approximate dimensions of one kilometer wide by eight kilometers long, designed to divert the entire flow of the Rio Corocito (a major tributary to the Aguan) into the Rio Bonito and Rio Limon basins; and lastly, the construction of seven major dams (the Los Encuentros Dam and Pueblo Viejo Dam on the Rio Mame; the Loma Zope Dam on the Rio Yaguala; the Cerro De La Puerta Dam, the Higuera Dam, and the Tepusteca Dam on the Rio Aguan; and the Pericon Dam on the Rio Yaguala. Five of these proposed dams would contain hydroelectric power generation capability: Los Encuentros Dam 5.9 Mw of firm annual energy, 27 Mw of installed capacity; Pueblo Viejo Dam 3.6 Mw of firm annual energy, 14.1 Mw of installed capacity; Loma Zope Dam 13.6 Mw of firm annual energy, 52.0 Mw of installed capacity; Pericon Dam 3.0 Mw of firm annual energy, 16.6 Mw of installed capacity; and the Cerro De La Puerta Dam 3.2 Mw of firm annual energy, 18.4 Mw of installed capacity. None of these dams have ever been constructed.

SECOPT is currently considering the use of a hydraulic dredge to remove existing channel siltation from the mouth of the Rio Aguan upstream for a distance of approximately 24 kilometers to the Durango Bridge. This work would include realigning the channel for a straighter flow pattern and moving its mouth about 10 kilometers to the east of its existing location. The existing channel thalweg elevation at the Durango Bridge is at about 8 meters above sea level.

At the mouth (when not closed by littoral drift), the thalweg elevation is about 1 meter below sea level. Using these elevations from the 1983 study of the Rio Aguan by Sir William Harcrow and Partners, and a total thalweg distance from the Durango Bridge to the river mouth of about 61 kilometers, results in a computed bottom slope of about 0.00013. The channel is steeper upstream from the bridge. Top bank elevations at the Durango Bridge are about 13 meters above sea level and about 1 to 2 meters at the mouth. Considering the extremely small slope of both the existing channel bottom and adjacent floodplain lands, and the extremely large flood volumes and flow rates on the Aguan at Durango Bridge (Q25 = 816 cubic meters per second, PMF = 21,100 cubic meters per second), yields the conclusion that restoring the natural channel dimensions will probably not provide a great deal of relief from flooding in areas upstream from Durango.

The Trujillo Road crossing the Rio Aguan floodplain (and the Durango Bridge) is perched (elevated fill) above the natural ground by about 5 meters and acts essentially as a dam for floods with a return period less frequent than about 2 years. The Corps' team considers the provision of additional relief bridge openings one of the most cost effective structural measures available to reduce upstream flood duration in the lower Aguan Valley. Additional openings appear to be the most cost effective option, and are likely to be justified up to about a 25-year flood flow capacity.

Previously mentioned proposals to reduce flooding with the exception of the Rio Corocito floodway, have never been constructed. Discussions with INA and SECOPT officials indicate that all past proposals suffered from the same common flaw. They all required enormous up-front capital investments, and involved extensive long-term construction efforts.

Additional flood flow openings in the perched Trujillo Road fill could be added one at a time until the needed capacity has been provided. This would also allow periodic reassessment of the effectiveness of such measures and reduce unexpected adverse effects. The specific location and design of these openings was not determined by the Corps' team. Detailed topographic survey data (about 0.5 meter contour interval) would be desirable for the siting of openings and for use in the design of local drainage upstream from the Durango Bridge. Confirmation of the effectiveness of additional relief openings should be performed using a two-dimensional hydraulic model (similar to the Corps, HEC-2 model). Information available in the 1983 basin study by Sir William Harcrow and Partners would be very helpful, but would require some field verification. This backwater information, combined with recent aerial photography of the floodplain from the Durango Bridge upstream to Saba and agricultural flood damage data from INA, should be used to produce damage-frequency and duration-damage curves for the floodplain. These data combined with estimated costs for relief openings could be used to assess cost effectiveness prior to and after project implementation (monitoring period).

A word should be said about the current activities of INA, and particularly with respect to the lower Aguan regional project, Projecto Bajo Aguan. Discussions between the Corps' team and the Assistant Regional Chief for INA, Senor Rolando Mendoza Garay (Agronomist by education and bilingual), on several occasions revealed that <u>improved local drainage to reduce flood duration in selected areas would be an extremely beneficial adjunct to any major flood control measure implemented in the Aguan Valley. Also, INA and Senor Mendoza should be complimented for their own efforts toward reducing flood damage and increasing agricultural production</u>. The cooperatives and camposinos in the valley are being educated by INA to practice what can be termed "wet flood proofing". They are told to avoid planting the very low areas immediately adjacent to the rivers with crops that are not flood resistant (those damaged by velocity and short duration flooding). Oil Palm (African palm), a major crop in the valley, can withstand velocity and up to about three days of inundation. Some farmers are also using a risk-reduction non-structural flood control technique. Senor Mendoza has observed that the large and severely damaging floods in the Aguan occur on an approximate cycle of about once every 10 years. When several years have transpired without one of these larger floods, the farmers are advised that the risk is increasing and that it is becoming more important to avoid the lowest areas. This is not (as hydrologic analysis has shown) always an effective way to totally avoid damage, but it does result in some reduction of losses.

FINDINGS AND CONCLUSIONS

Serious flood problems are being experienced in all six sectors identified by SECOPT and investigated by the Corps' team. Both the Rio Ulua and the Rio Aguan basins are vital to a robust Honduran agricultural economy, and therefore the future of Honduras. Before large investments are made to expand agricultural development into new basin areas along the north coast, priority should be given to development of remaining less flood prone areas and the enhancement of productivity in both the Sula and Aguan Valleys. <u>Current efforts by INA, SECOPT, and MRN to increase agricultural productivity, reduce flooding, and encourage reforestation of slash-and-burn areas, should be applauded and continued</u>.

On the last day of the Phase II mission in Honduras, the Corps team met with officials of SECOPT and presented a two prong approach to the alleviation of north coast flood problems. The following paragraphs describe both the early action plan and a future action plan presented to SECOPT.

Early Action Plan - The early action plan consists of two elements: the establishment of an interagency planning team and the implementation of a flood warning system in the Rio Choloma basin.

Based on discussions the Corps' team had with the many points of contact within the Honduran Government, USAID, and private sector consultants, there appears to be a need for a more unified effort toward the use and development of the water and water-related land resources of the north coast rivers. There is a considerable amount of data and studies available on both the Sula and Aguan Valley, but no real central focal point for coordination and priority-setting. Studies have been performed for both INA and SECOPT, and in some cases these two agencies have worked together with the Department of Natural Resources (example: the study by Sir William Harcrow and Partners performed in 1983 for the Rio Aguan Basin). But this study and others seem to have a common flaw. They all have proposed enormously costly construction work, which in no way reflects the available financial resources of the country, and have not attempted to provide any guidance on nonstructural responses. Basin-wide studies should be concluded with recommendations for programmatic implementation of phased construction. In other words, initial work should focus on the most cost-effective (biggest return-on-investment) project elements, of those requiring capital investments which are within some range of expected affordability. As these are completed and productivity increases, etc., further project construction could be initiated.

Toward the objective of establishing basin-wide water resource programs which reflect not only affordability but also appropriate project priorities, an ad hoc water resources commission (interagency planning team) could be formed. A tentative list of agencies that should be considered in the formation of this commission was developed by the Corps' team and is included in Appendix "C" of this report.

The broad makeup reflects the similar approaches now being taken in the United States to water resource problems (example: the newly formed Inland Waterway Users Board, which will advise the Corps on planning for changes and improvements to the inland navigation system of the United States). Some of the more key participants in such a commission would be SECOPT, INA, and MRN.

As was mentioned earlier, Sector One has been given SECOPT's top priority for flood control. Flooding of the Rio Choloma during Hurricane Fi Fi in 1974, and again in 1988, has resulted in many deaths, as well as annual losses of agricultural production. Although the flooding (velocity) during Hurricane Fi Fi washed away many of the homes in the town of Choloma, that were constructed along low areas near the river, this type of catastrophe could occur again. Some homes are beginning to be built close to the river again, and as time passes and the memory of 1974 fades, more will be built. The river serves as a location for drinking water, bathing, washing garments, swimming, and gathering. All these activities sometime go on simultaneously, and serve as a pressure to conviently locate nearby. Given the flashy nature of flooding on the Choloma (4 to 6 hours to peak) some type of flood warning system should be installed. With only a one hour warning time many lives could be saved (property could not be evacuated in this short time). Included in Appendix "C", Section "B", of this report is a detailed description of an appropriate type of system and a cost estimate for its implementation. The total cost would be about $70,000. Also shown are illustrations of its installation.

Future Action Plan. Future action to reduce flood losses along the north coast should be evaluated through the preparation of detailed feasibility studies. These studies should contain not only engineering analyses of hydrology and hydraulics, but also detailed agricultural flood damage analyses coupled with assessments of financial feasibility (financing methods and cost recovery). The suggestion of the formation of a water resources commission should assist in the determination of multipurpose project (infrastructure development, agricultural improvements, irrigation, and flood control) desirability and in assessing the priority for specific flood control projects. In the absence of the formation of a water resources commission, some minimum consultation on a regular basis between SECOPT, INA, MRN, and ENP would be very beneficial during project planning and implementation.

Utilizing cooperation between SECOPT INA, MRN, and ENP <u>the Corps' team proposes detail feasibility studies be made by SECOPT for the purpose of evaluating three specific problem areas for structural flood control projects</u>: the Rio Choloma (Sector One), the Rio Ulua/Chamelecon and Canal Melcher (Sector Two), and the Lower Rio Aguan (Sector Three). Specific evaluations should be made of the alternative plans outlined for those sectors in this report.

In regard to the removal of sedimentation in the lower Rio Ulua, and the diversion of flow from Canal Melcher back into the Rio Ulua, the Corps' team proposed detailed engineering analyses followed by construction of a pilot plan and performance monitoring.

Once detailed hydraulic analyses (modeling) have indicated that these modifications to the flows in Canal Melcher and the Rio Ulua will function as expected, a temporary blockage of flow into Canal Melcher and initial removal of sediment from the lower Rio Ulua could be performed. This pilot plan would then be followed by monitoring of flow and sediment transport in both water courses to determine its actual effectiveness in reducing backwater effects, and to assess annual maintenance quantities to be removed from the lower Rio Ulua (these could be excessive).

The Corps' team discussed the utilization of a hydraulic dredge to remove the sediments blocking the lower Ulua with SECOPT and ENP, and it appears that this would be the most cost effective construction method. Honduras currently owns one large hydraulic dredge.

On 1 February 1988, the team visited the Port Director's Office at Puerto Cortes, Honduras. The Port owns an IHC-Beaver 3300 marine pipeline dredge, which has three 1000-horsepower motors, a suction line diameter of 700 millimeters (about 27 inches), and can dredge to a depth of 16 meters (about 45 feet).

The Port presently employs the dredge about 2 months per year doing annual maintenance dredging of berthing areas at the harbor. During the remainder of the year, the dredge is utilized for land creation work. According to Ingeniero Mario Tulio Raveneau, Chief of ENP Dredging Department, except for the two months of annual port maintenance dredging, the dredge could be available to perform dredging for flood control work. He also indicated that movement of the dredge in the Caribbean to the mouth of the Ulua, and further down the coast under appropriate weather conditions, would not be a problem.

The dredge is equipped with 2,500 meters of pipeline, which would be more than adequate for the pumping distances anticipated. A typical pumping distance would be about 1,000 meters. At this length, a productivity of about 1,400 cubic meters per hour can be anticipated for work in fine to medium sand, about 1,300 cubic meters per hour in coarse sand, and about 600 cubic meters per hour in coarse sand with gravel. Production curves are shown on Plates Nos. 13 and 14. Ingeniero Raveneau also indicated that, for the type of sediments removed from berthing areas at Puerto Cortes, the production rate was about 800 cubic meters per hour.

The IHC Beaver 3300 requires about 2 meters depth of water for flotation. This is equivalent or slightly less than average for dredges of this size. This dredge is anticipated to be very effective for use at river mouths and other locations upstream as long as adequate water depth is available.

<u>The Honduran dredge could be made available to work on north coast rivers later this year (about October).</u> During the meeting with Ing Raveneau, he indicated that ENP has been discussing future use of their dredge with the countries of Guatemala and Costa Rica. Current land building operations around Puerto Cortes are expected to continue for about six to nine more months with the construction of a new road bed crossing Lagunma De Alvarado. Following completion of this work the dredge could be used on the Rio Ulua.

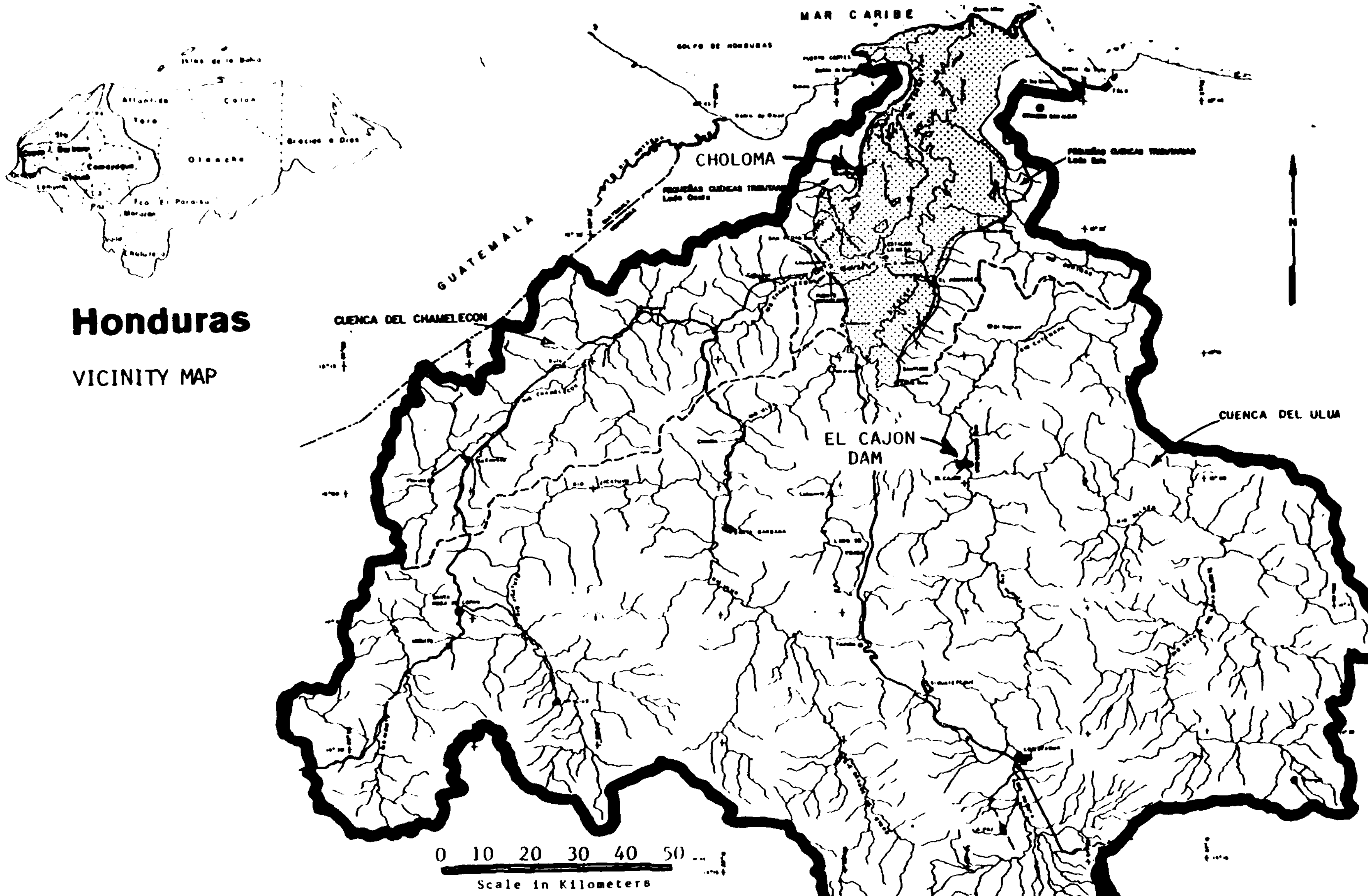
While in Puerto Cortes, the team learned that Texaco, who owns a pier facility on the point just west of the ENP berthing areas, annually removes about 100,000 cubic meters of littoral transport (sediment) during maintenance dredging of their tanker berthing areas. Although this is not an exact measure of the net westward littoral transport along the north coast of Honduras, it is some indicator of the annual amount of material which passes the mouths of rivers such as the Rio Ulua. This data can also provide some assessment of the amount of dredging which would be required to maintain an opening to the Caribbean. Assuming that about 25 percent of this volume may be dredged at the mouth of any river along the north coast, would result in an estimate of 25,000 cubic meters (32,700 cubic yards) of material requiring removal each year. At a cost of about $0.50 per cubic yard, annual maintenance for any one river mouth would total about $16,350 annually. The actual quantity of littoral drift to be dredged annually could be vary considerably, depending on the flow conditions in the river during a given year, as well as the prevailing wind conditions which drive littoral currents. Also, these quantities could be reduced if it was decided that dredging the mouth was only necessary immediately prior to the beginning of the rainy season. The estimation of annual maintenance dredging to maintain flow in these rivers will be an important element in the ultimate determination of the economic feasibility of such flood control measures. Once flow is reestablished in the Ulua it may scour and maintain itself to some natural depth, as is currently being experienced with Canal Melcher and Canal Del Cruce. It was mentioned earlier in this report that the mouth of the Rio Chamelecon and Canal Del Cruce maintains an opening to the Caribbean all year.

A very rough estimate of the cost of future feasibility studies which would be performed by the GOH/SECOPT, INA, etc) to assess project feasibility for each of the three sectors was assembled by the team, and is shown below:

	Estimated Cost in $1,000		
Study Element	Sector One	Sector Two	Sector Six
Coordination (Other Agencies, etc)	$ 60	$ 40	$ 50
Institutional/Financial	30	10	30
Agricultural/Socioeconomic	100	180	150
Hydrologic	80	130	110
Hydraulic	170	260	200
Geotechnical	130	100	90
Structural	80	50	70
Cost Estimating	20	30	40
Surveys and Mapping	350	400	350
Study Management	70	50	60
Contingencies (15%)	160	190	170
Total Study Cost	$1,250	$1,440	$1,320

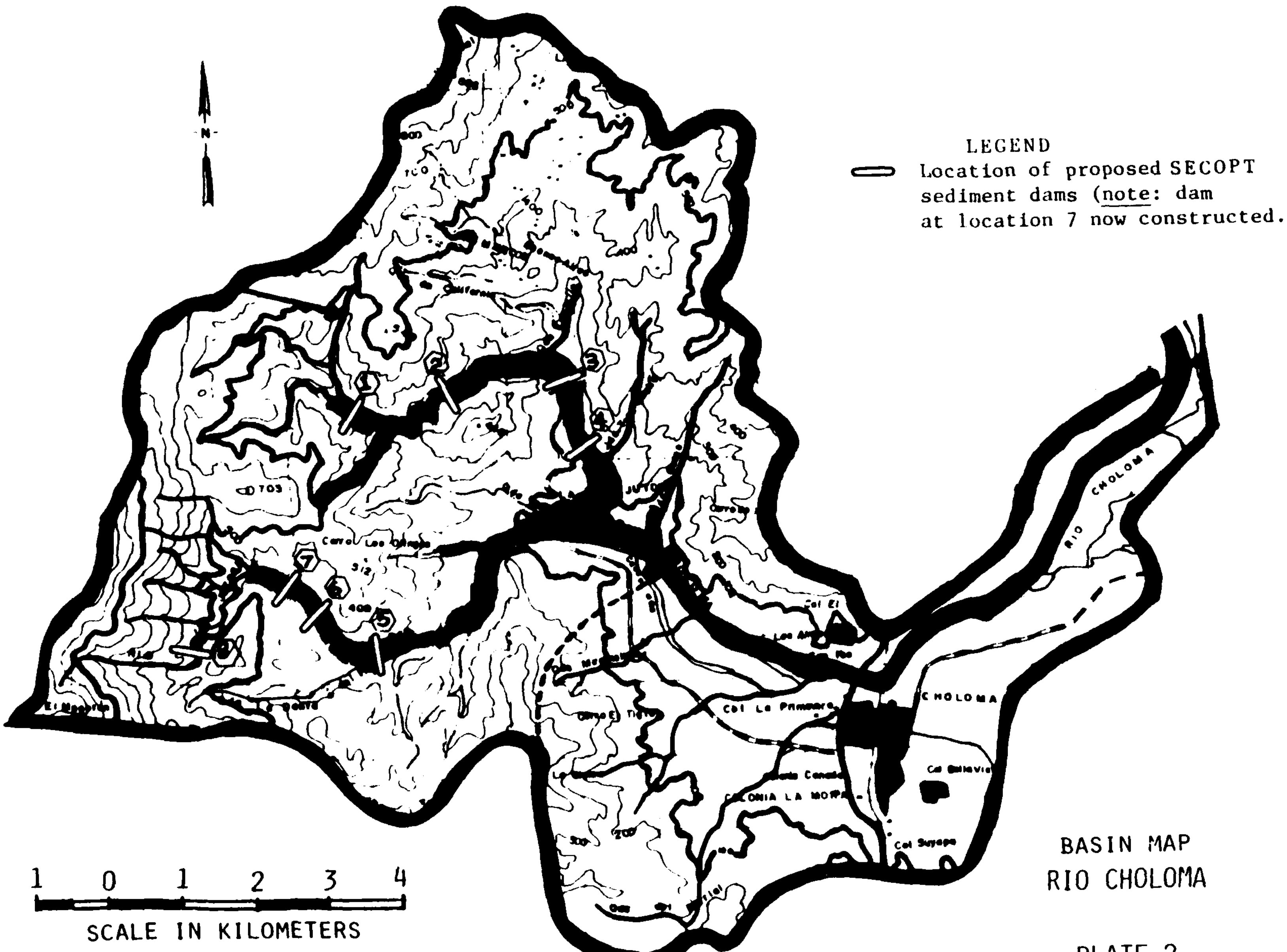
The costs shown include work to evaluate and design projects, and prepare project plans and specifications. The total estimated cost for all three sectors is roughly estimated at $4,010,000.

During the teams work in Honduras, and in later office deliberations, no attempt was made to assess potentially significant adverse environmental impacts of any structural alternatives, or how these may be reduced and avoided. Again, it is important to point out that the findings of this report do not constitute feasibility level recommendations by the U.S. Army Corps of Engineers. They are intended as guidance only, and were not based on the typically rigid computational analyses performed to assess engineering, economic or environmental feasibility.



BASIN MAP
RIO ULUA/CHAMELECON

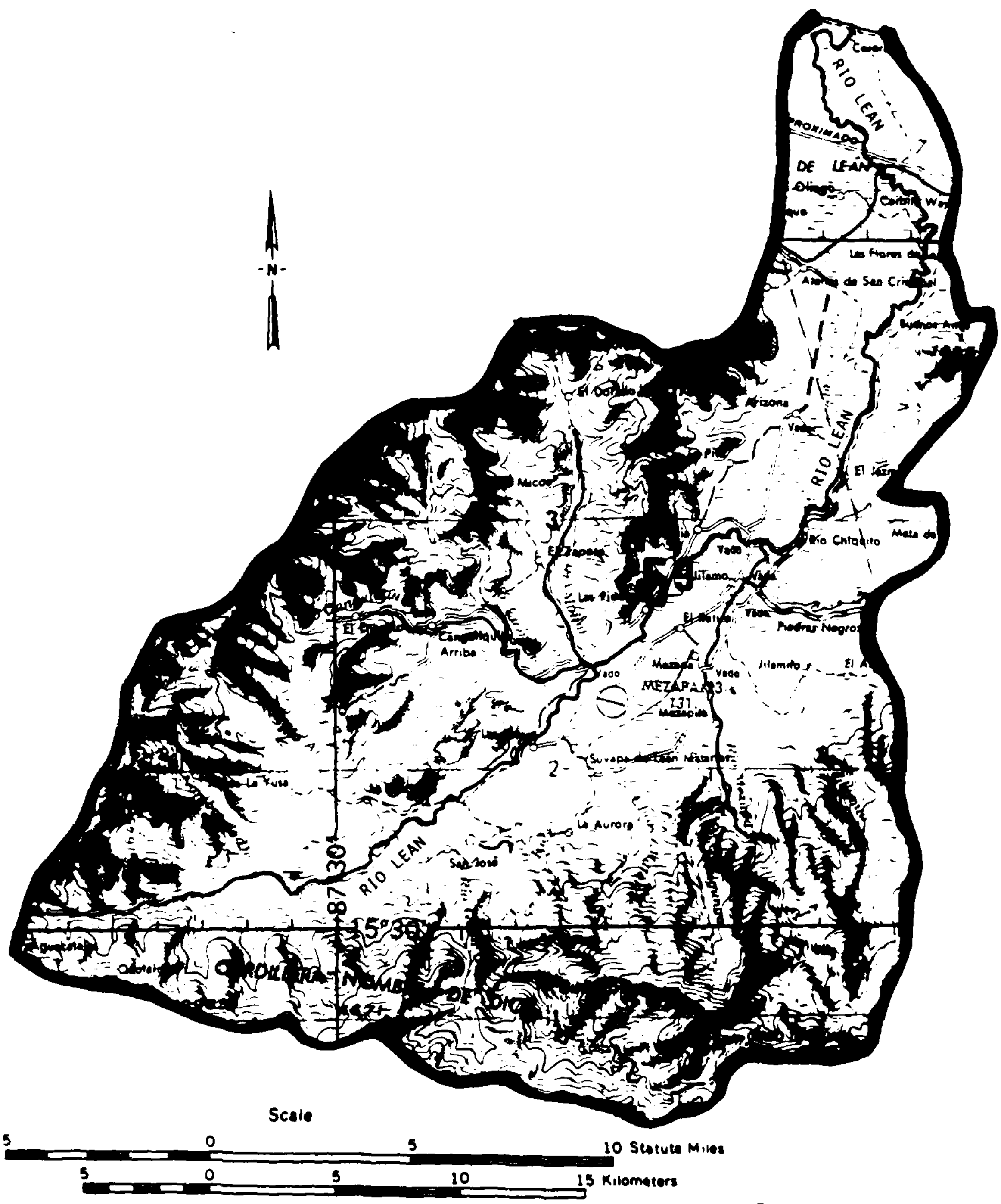
PLATE 1



BASIN MAP
RIO CHOLOMA

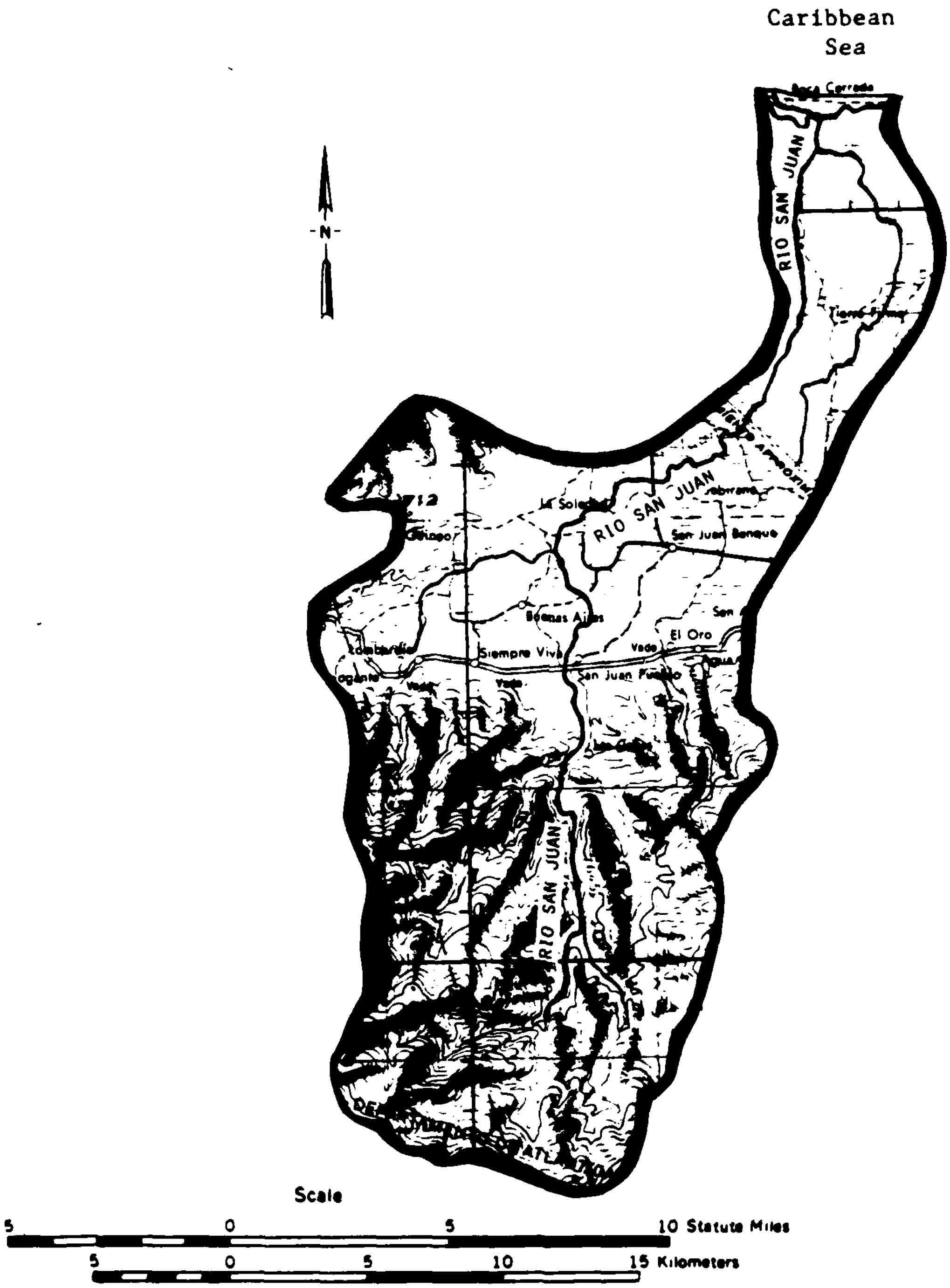
PLATE 2

Caribbean Sea



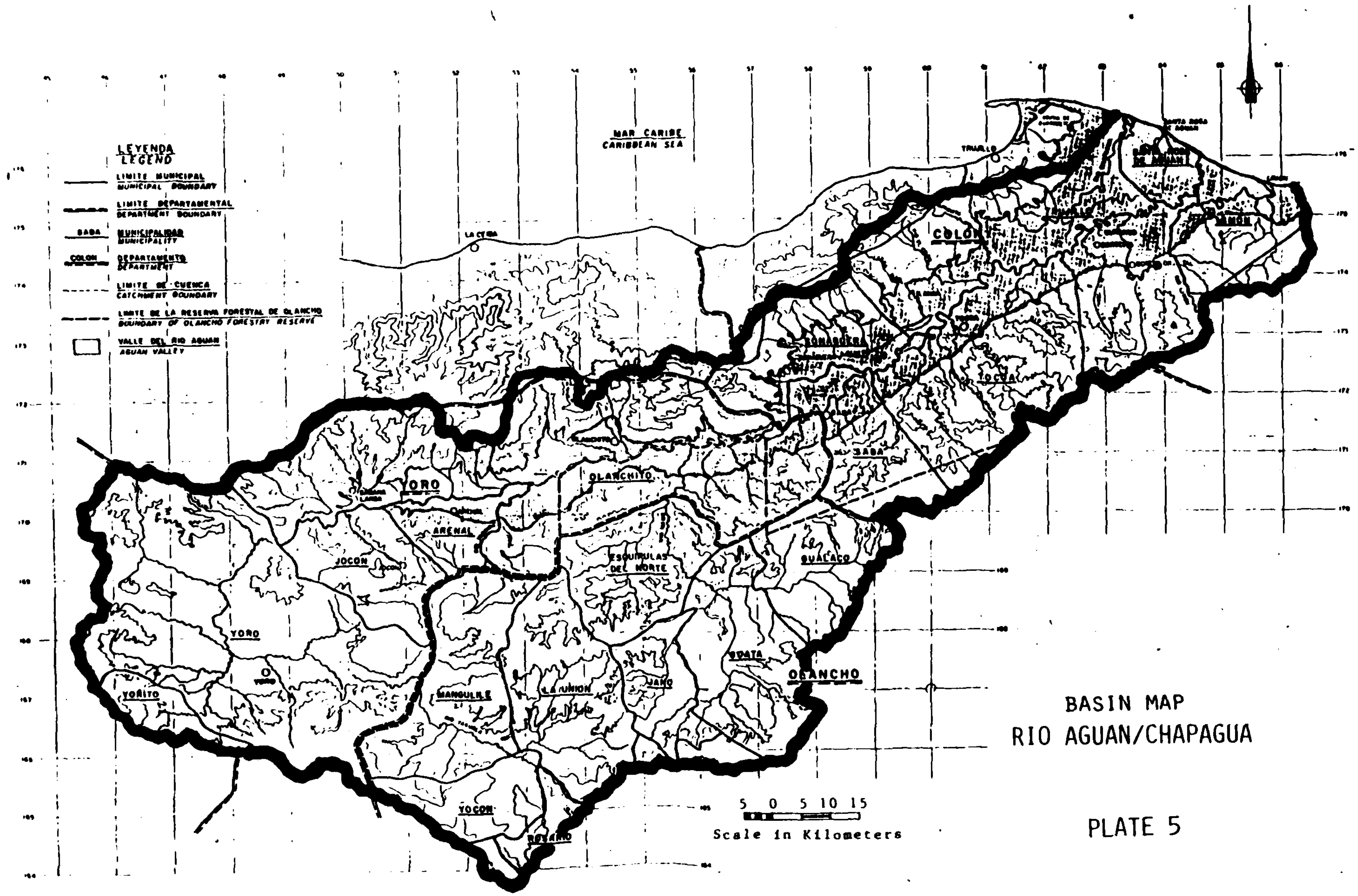
BASIN MAP
RIO LEAN

PLATE 3



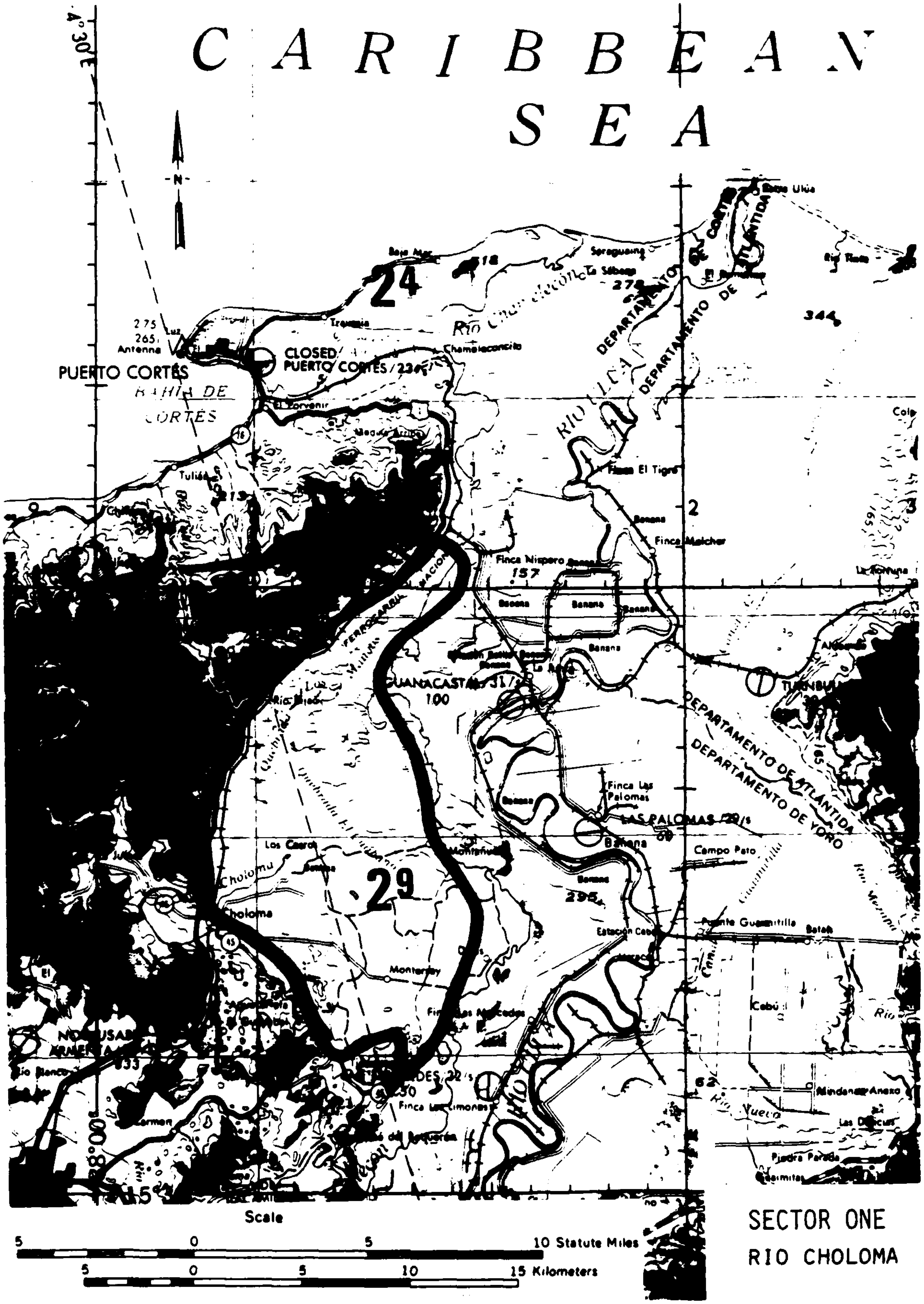
BASIN MAP
RIO SAN JUAN

PLATE 4



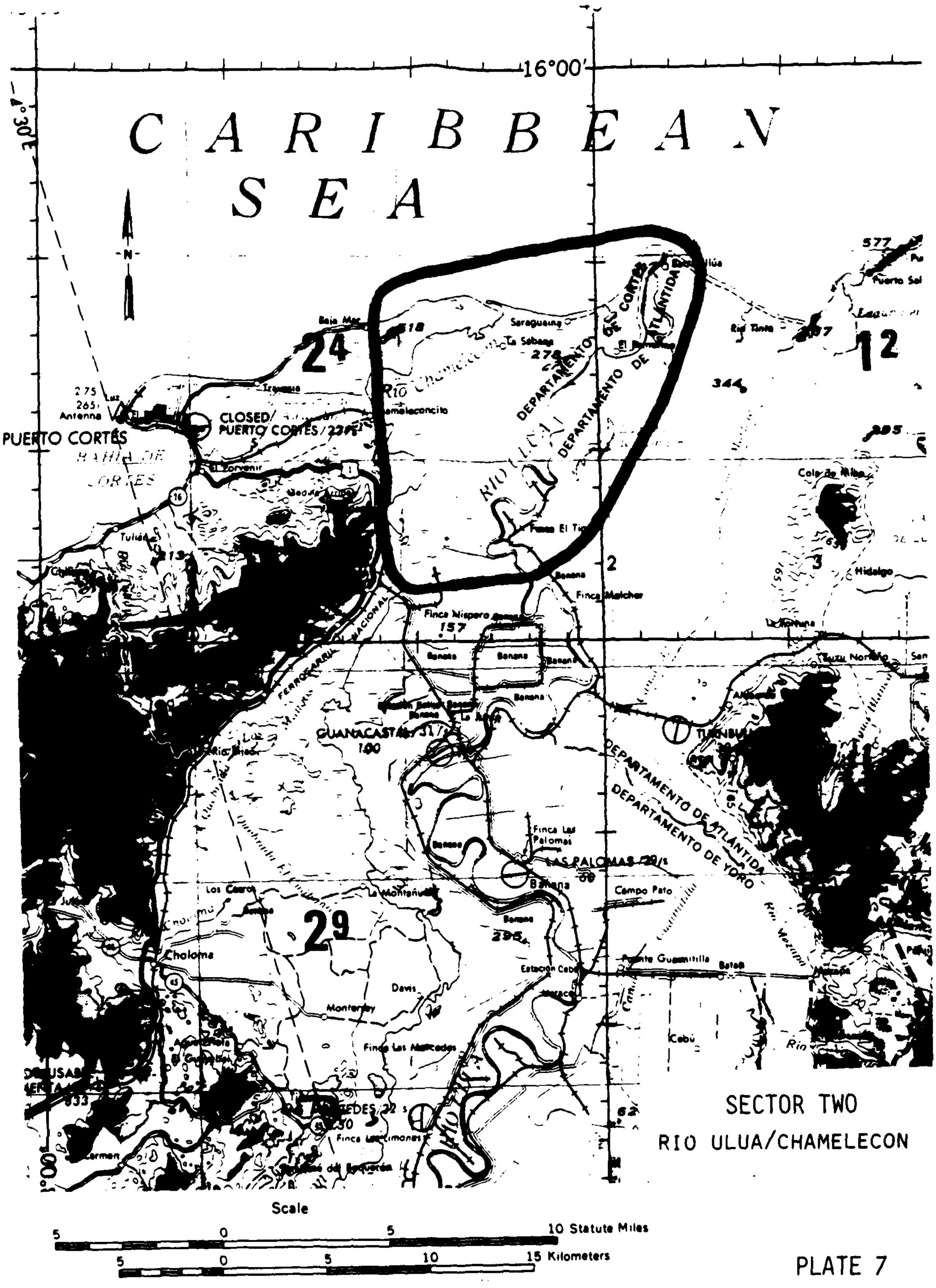
BASIN MAP
RIO AGUAN/CHAPAGUA

PLATE 5



SECTOR ONE
RIO CHOLOMA

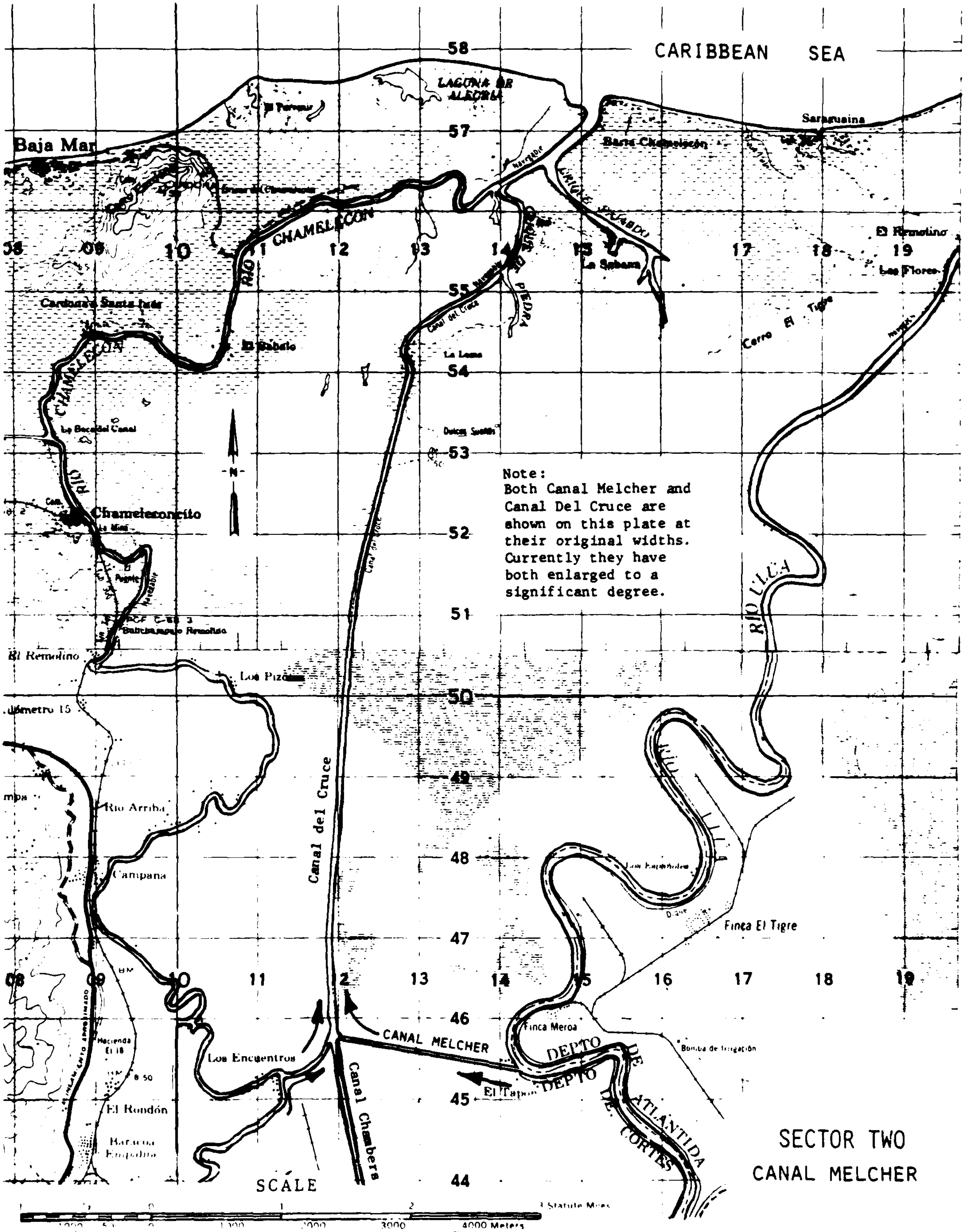
PLATE 6



SECTOR TWO

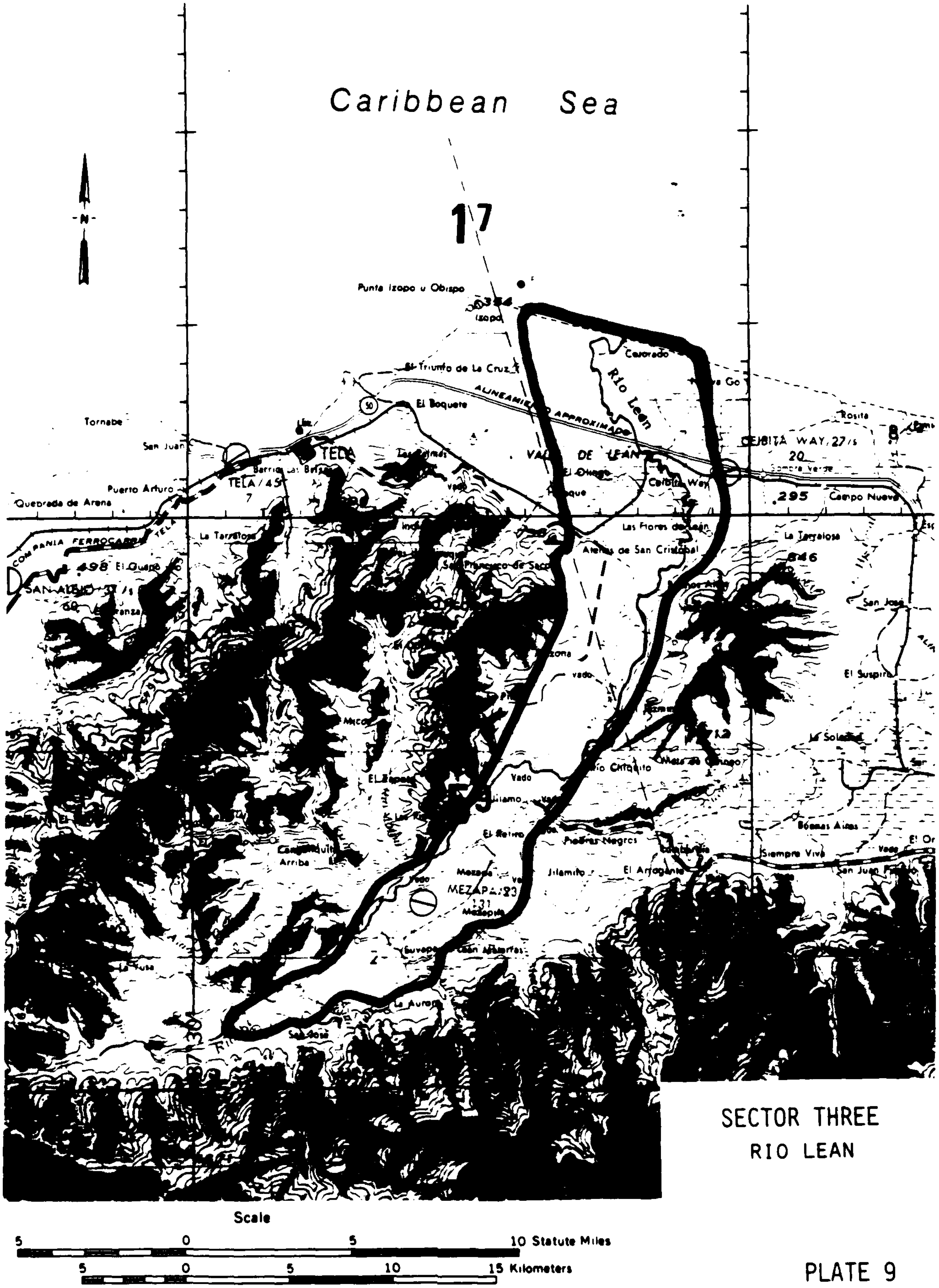
RIO ULUA/CHAMELECON

PLATE 7



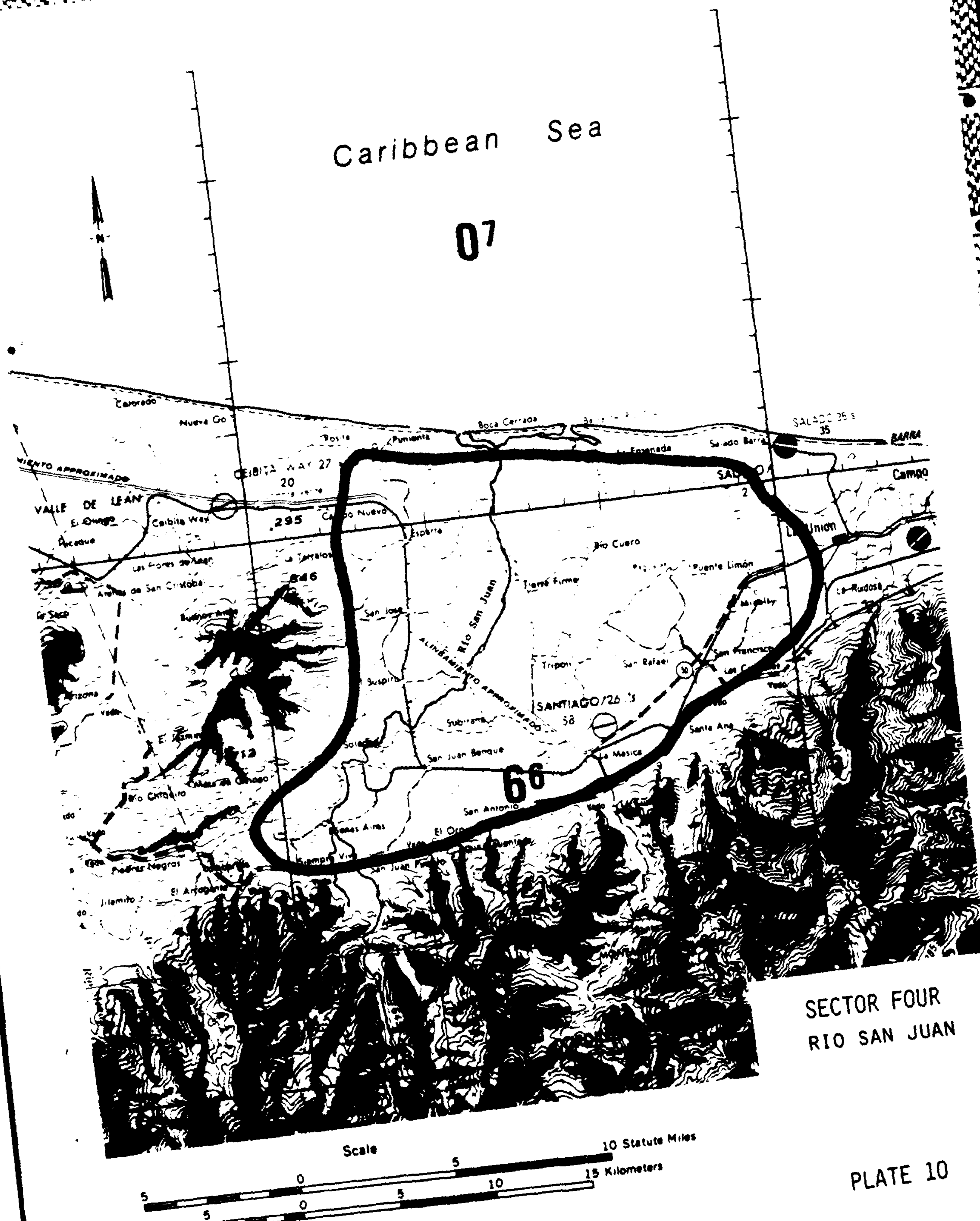
SECTOR TWO
CANAL MELCHER

PLATE 8



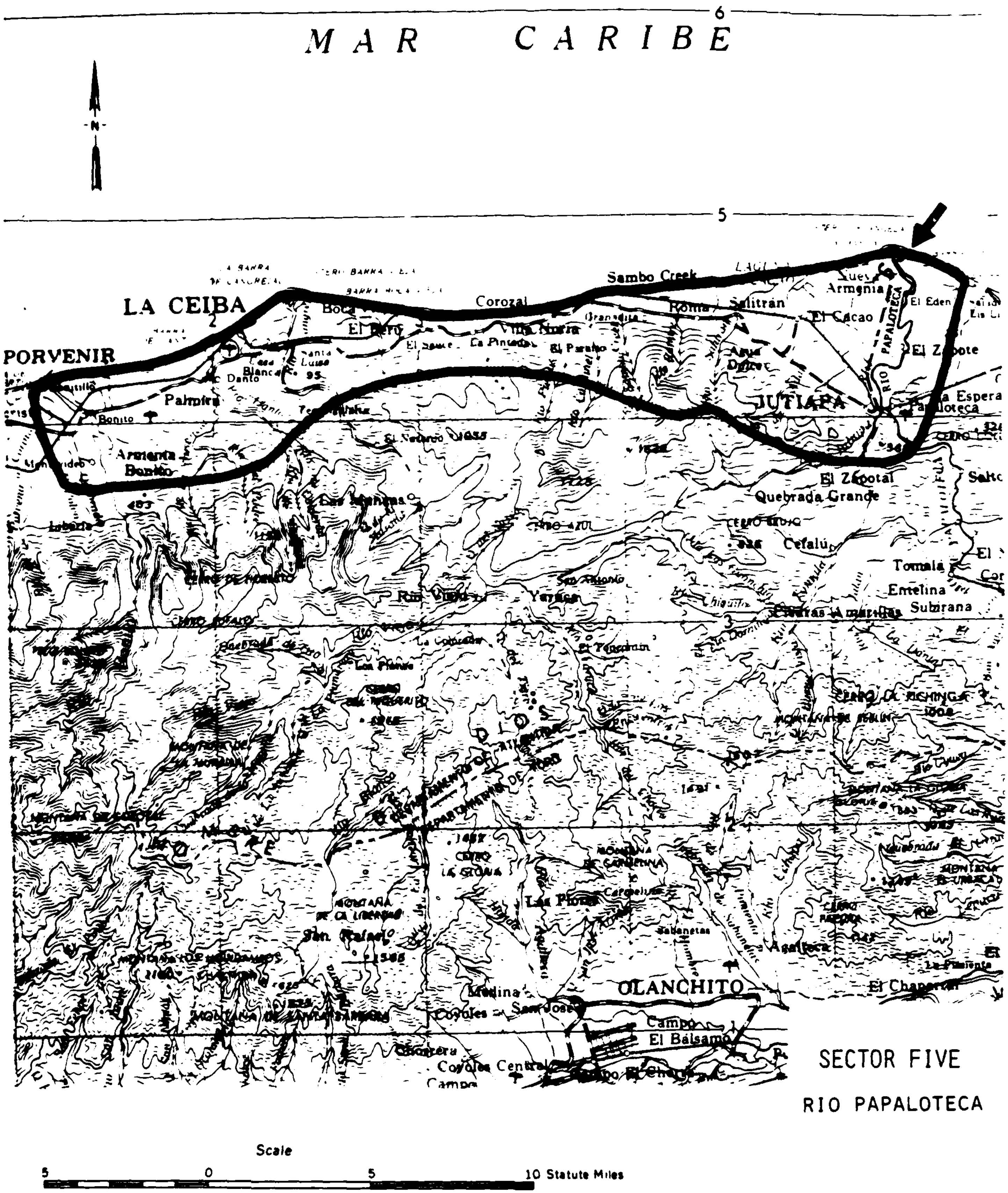
SECTOR THREE
RIO LEAN

PLATE 9



SECTOR FOUR
RIO SAN JUAN

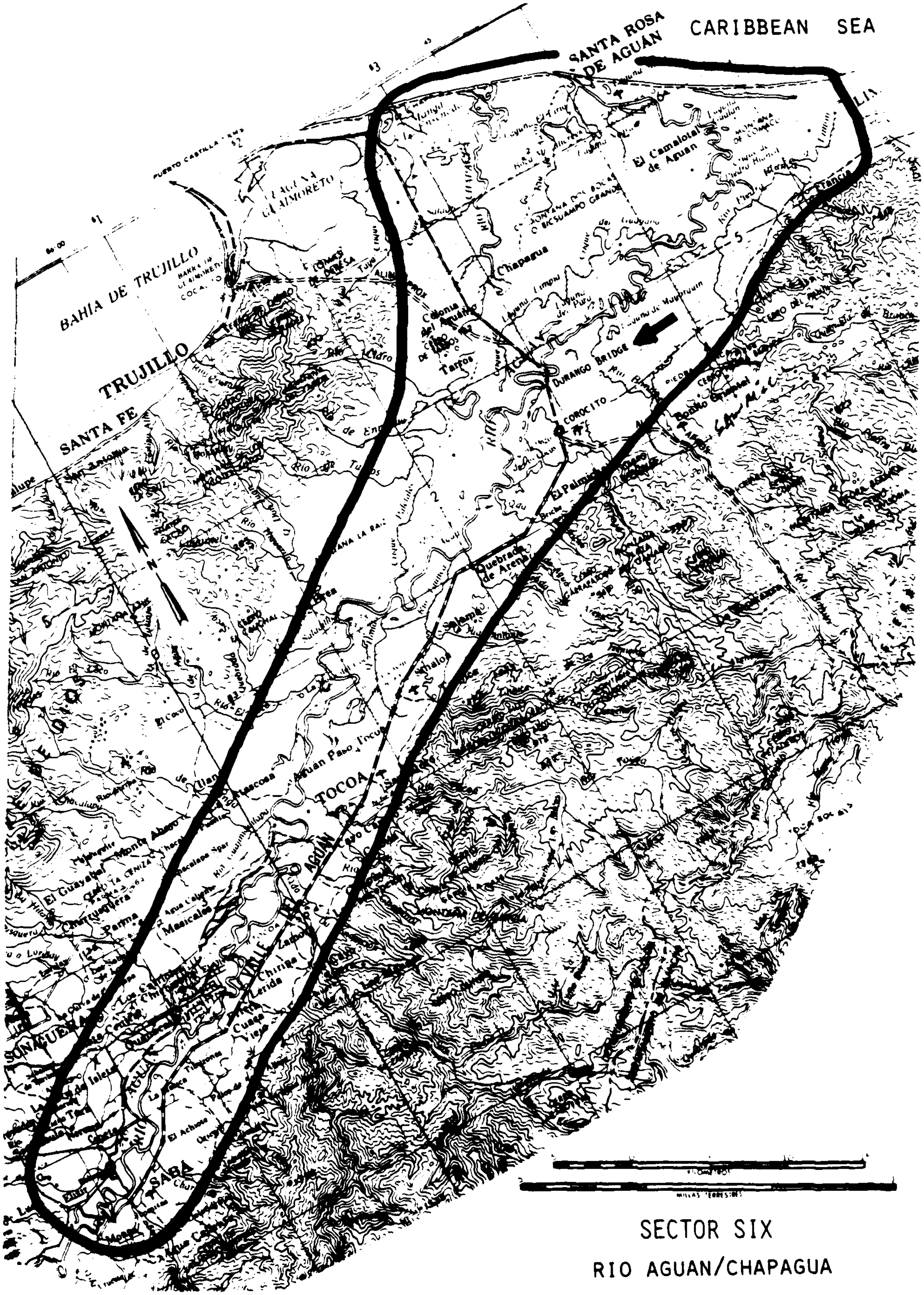
PLATE 10



SECTOR FIVE

RIO PAPALOTECA

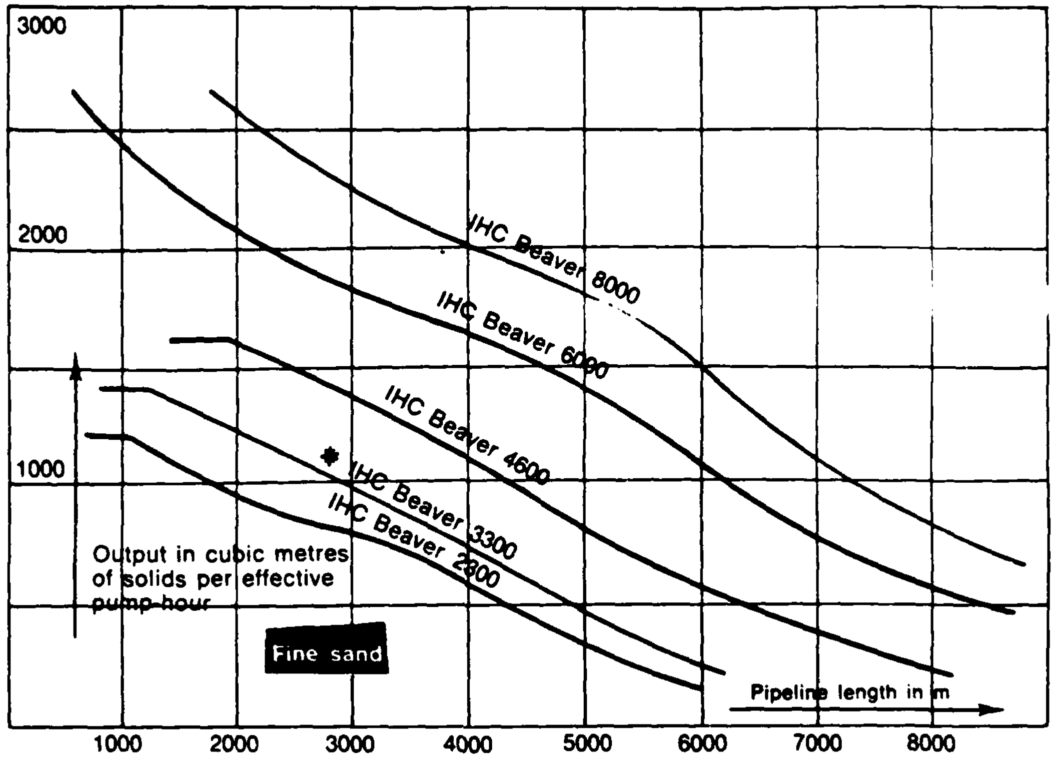
PLATE 11

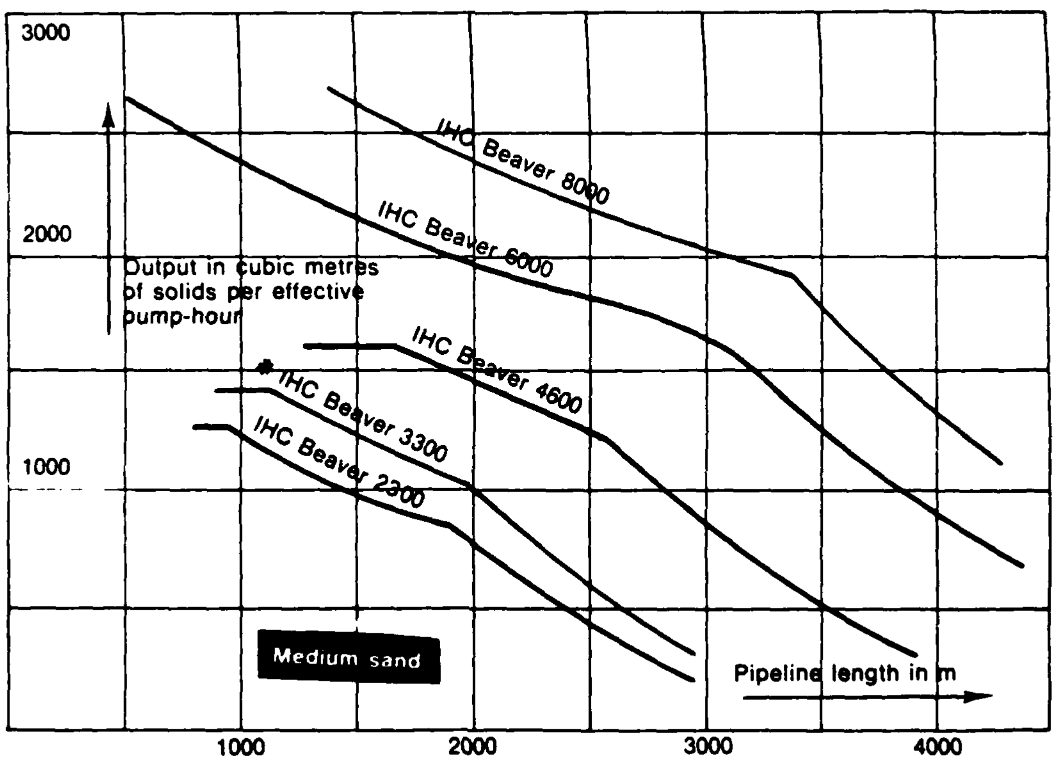


SECTOR SIX

RIO AGUAN/CHAPAGUA

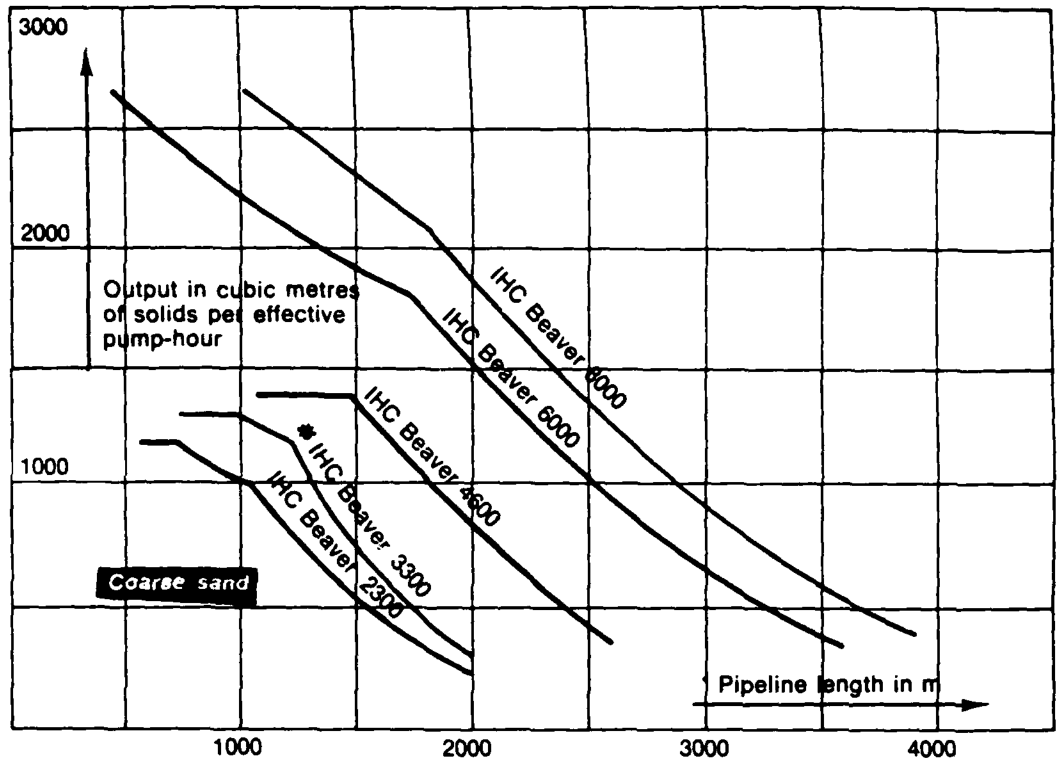
PLATE 12

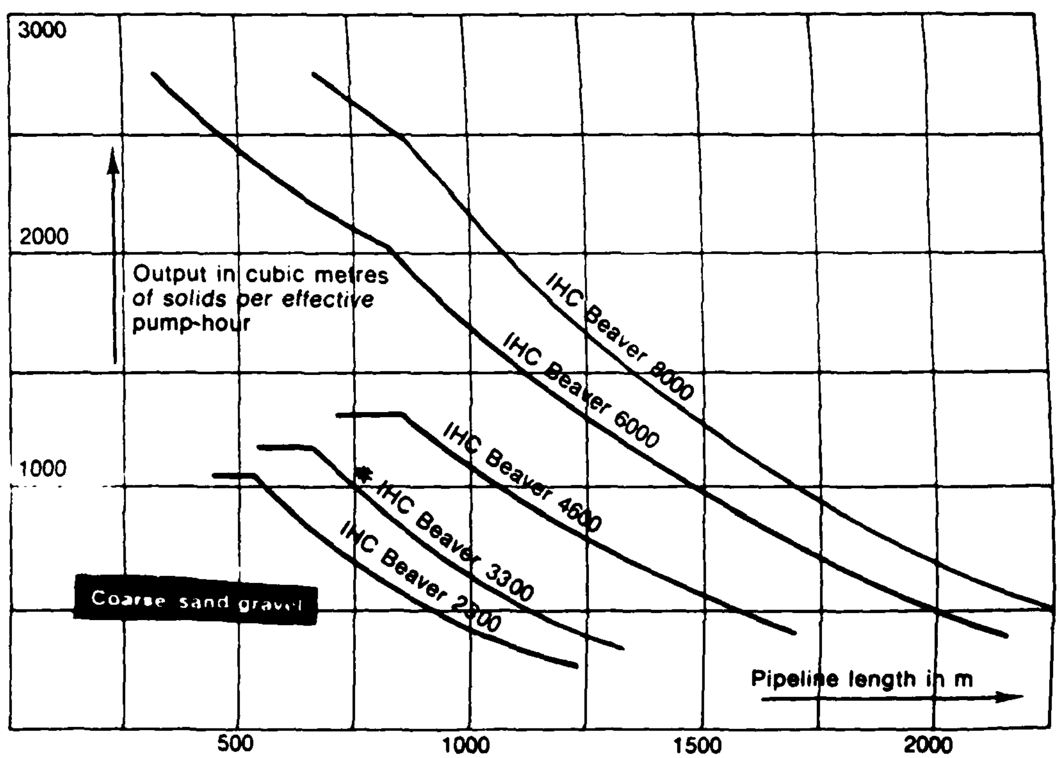




PRODUCTION CURVES, HONDURAN DREDGE

PLATE 13





PRODUCTION CURVES, HONDURAN DREDGE

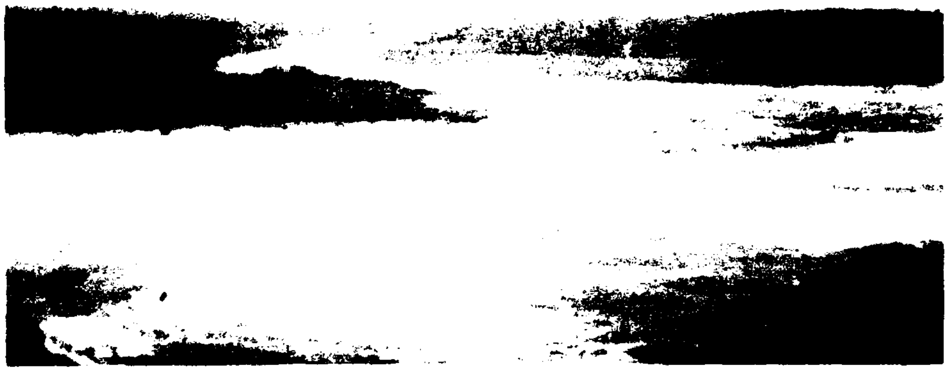
PLATE 14

Slash-and-burn agricultural practices have resulted in large areas without tree cover in steep basin areas.

Slash-and-burn areas in Rio Aguan basin.

Slash-and-burn areas in Rio Ulua basin.

PLATE 15



Looking southwest at the mouth of the Rio Ulua on the Caribbean. (Note: Littoral drift bar indicated by breaking waves just north of the river mouth).

Looking south at the mouth of the Rio Ulua on the Caribbean.

PLATE 16

Looking north at mouth of Canal Melcher and Rio Ulua (Canal Melcher in foreground flows west).

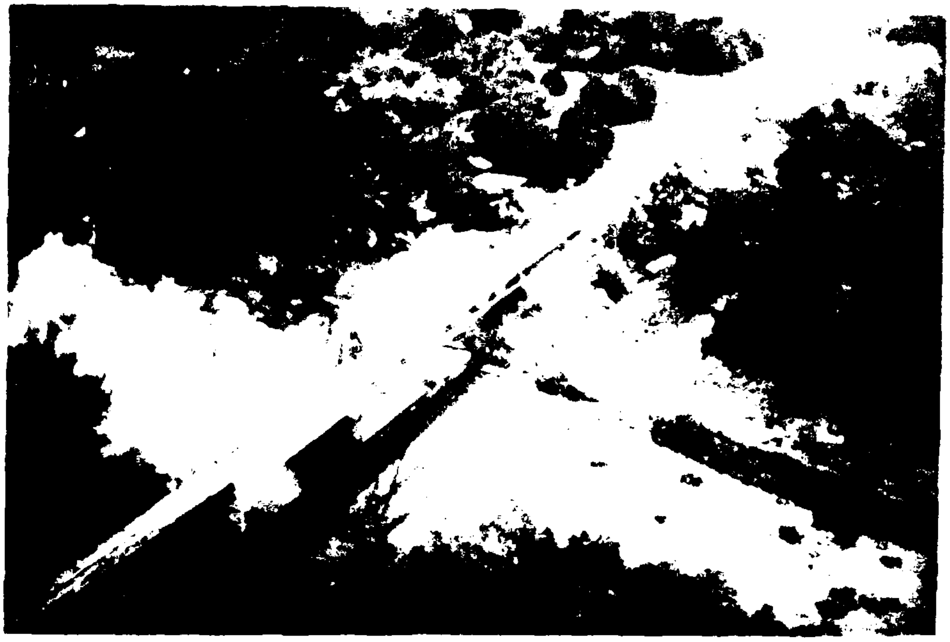
Looking south (upstream) at Rio Ulua in the vicinity of Finca Melcher (Note: Agricultural levee on left bank).

PLATE 17

Looking west at the mouth of Canal Melcher where flow from the Rio Ulua enters (Rio Ulua in foreground flows north - to the right).

Looking south at Canal Melcher just west of the town of El Tapon (Note: Erosion of south bank).

PLATE 18



Looking east at Rio Chamelecon in the vicinity of the town of Baracoa.

Looking south at the Rio Chamelecon and the Sula Valley from the vicinity of the town of Los Pizotos.

Looking east at Rio Chamelecon near the coast and the town of El Rondon.

Looking east at Canal Del Cruce on the lower Sula Valley about 5 kilometers downstream from Canal Melcher. (Flow is north - to the left).

Looking south at the mouth of both the Rio Chamelecon and Canal Del Cruce (Stays open to Caribbean all year).

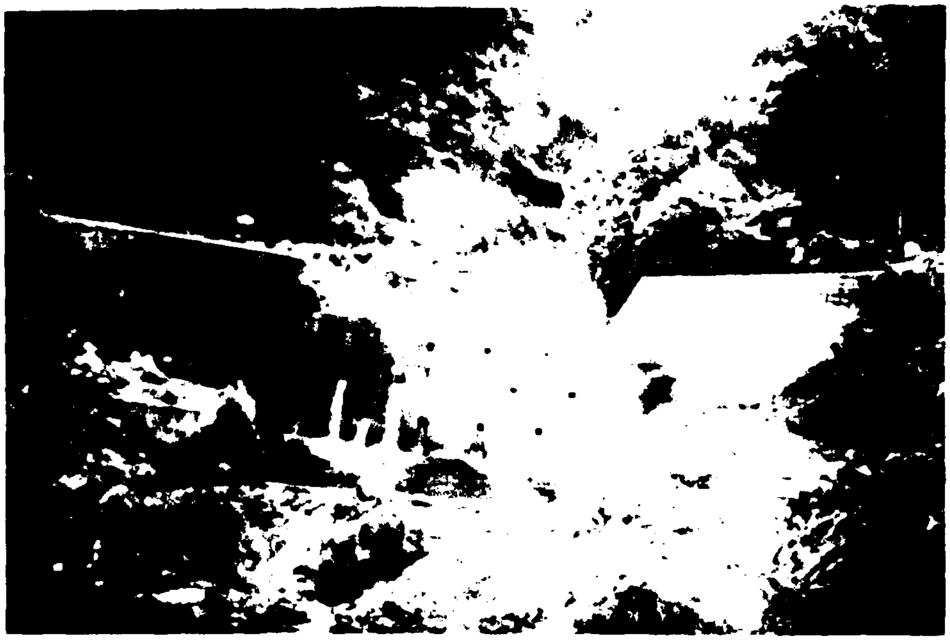
Looking east at the top of the El Cajon dam from the upstream side (Note: Emergency spillway sills in foreground).

Looking at the east abutment of El Cajon Dam from the downstream side.

Looking south down the El Cajon Reservior.

Looking west (upstream) at the Rio Choloma from the Federal Highway One bridge crossing at the town of Choloma.

Looking east (downstream) at the Rio Choloma from the Federal Highway One bridge crossing at the town of Choloma.



Looking west at the SECOPT sediment dam on the Rio Jutosa in the Rio Choloma basin.

Looking west at the SECOPT concrete sediment dam on the Rio Jutosa, and located about 8 kilometers due west of the town of Choloma.

Looking west at Rio Lean braided channel in the vicinity of the town of Buenos Aires (under flooding conditions).

Looking west at the Rio Lean channel in the vicinity of the town of El Jazmin.

Looking west at the Rio Lean channel under flood conditions near Colorado.

PLATE 24

Looking south at the Rio San Juan channel near the coast and in the vicinity of the town of Tierra Firme.

Looking north (downstream) at the Rio San Juan channel and the railroad bridge crossing in the vicinity of the town of La Soledad.

Looking northeast at the plugged mouth of the Rio Chapaqua on the Caribbean.

Looking northeast at the point where the Rio Chapaqua crosses the north coast natural dune line on the Caribbean.

PLATE 26

Looking northeast at the mouth of the Rio Aguan on the Caribbean.

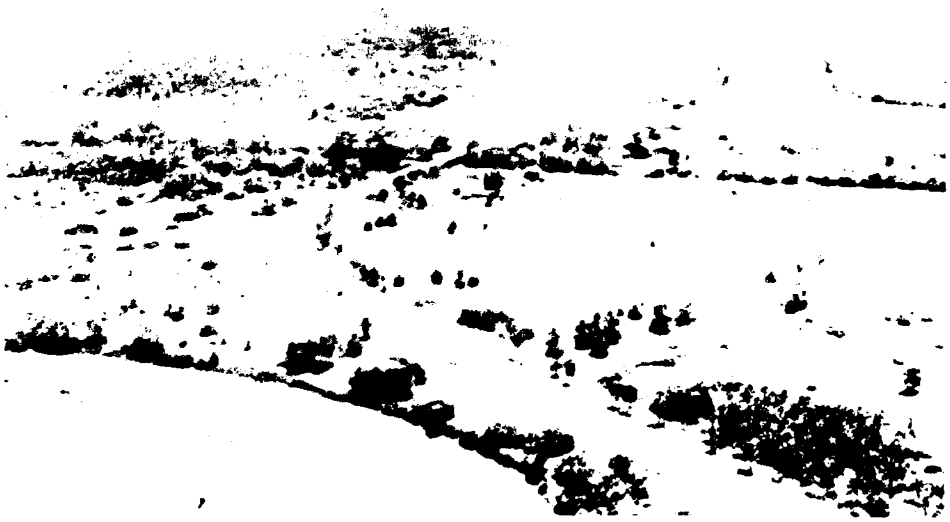
Looking northeast at the town of Santa Rosa De Aguan and the mouth of the Rio Aguan. (note the vegetated natural dune line paralleling the Caribbean coastline).

PLATE 27

Looking south across the Rio Aguan coastal marsh just downstream of the Durango Bridge.

Looking northeast at the Rio Aguan coastal marsh behind the vegetated natural dune line just upstream of Santa Rosa De Aguan.

Looking southeast at the meandering Rio Aguan channel just downstream of the Durango Bridge.



Looking south at the Durango Bridge on the Rio Aguan (Trujillo to Corocito perched road crossing of Aguan floodplain).

Looking south at the Rio Aguan channel in the vicinity of the town of Sinaloa (location of INA office for Projecto Bajo Aguan).

Looking south at the Rio Aguan channel and African oil palm planted near the river in the vicinity of the town of Sinaloa.

Looking south at the Rio Aguan channel near Tocoa (note evidence of heavy sediment loads carried by the river).

Looking south at the Rio Aguan channel near Tocoa (note sediment deposits).

Looking north at the Rio Mame (with bridge crossing) entering the south bank of the Rio Aguan, about 25 kilometers upstream from the town of Saba.

Looking generally west (upstream) at the Rio Aguan channel in the vicinity of the town of Saba.

APPENDIX A

FIELD INVESTIGATION AND COORDINATION

SECTION A

INTRODUCTION

The following appendix is included in this report to provide a record of the field investigations, meetings, points of contact, and available data, concerning the problem of north coast flooding. With respect to the available data listed in this appendix, much of these data are now on file in the Mobile District, should any future need arise where they may be helpful.

Following this page is a copy of the 3 November 1986, letter from President Azcona Hoyo to President Ronald Reagan, which requested U.S. Government assistance with the flood problems along the north coast of Honduras.

Presidencia de la República

Honduras, C. A.

November 3rd., 1986

Dear Mr. President:

We have learned that the U.S. Army Corps of Engineers-New Orleans District has requested permission to Washington to assist Honduras in the dredging of some of our rivers.

One of the main problems limiting the increase of agricultural production in Honduras is the continous flooding by some of our rivers, mainly: the Ulúa, Chamelecón, Lean and Aguan rivers.

We have spent important funds into making studies to tackle the problem of our floods but the cost of the project is so high that is beyond our means.

We understand that the U.S. Army Corps of Engineers in New Orleans has some dredges and other equipment that are no longer needed and can be used to accomplish part of this project.

We request that President Reagan assist Honduras in this important project by instructing the U.S. Army Corps of Engineers-New Orleans District to undertake the project using their technical skills, as well as their available equipment.

The additional land that will be available for agricultural purposes will help Honduras promote our Agrarian Reform and will increase our agricultural production and exports, helping us to improve our economic and social situation.

Presidencia de la República

Honduras, C. A.

The rivers flood some of the best agricultural land in Honduras and the assistance that the U.S.A. can give to Honduras in solving this problem will be highly appreciated by the people and the Government of Honduras.

Yours sincerely,

JOSE AZCONA HOYO, PRESIDENT
OF THE REPUBLIC OF HONDURAS

His Excellence
Ronald Reagan
President of the United States of America
The White House
Washington, D.C.
U.S.A.

SECTION B

PHASE I AFTER-ACTION REPORT

Following this page is a copy of the 12 May 1987 message transmitting the Phase I After-Action Report, followed by a copy of the After-Action Report itself.

1 4 MAY 87 P P UUUU

FROM CDRUSAED MOBILE AL//SAMEN-M//

USCINCSO QUARRY HEIGHTS PN//SCEN//

INFO: COMUSMILGP TEGUCIGALPA HO//

AM EMBASSY TEGUCIGALPA HO//LTC KEITH//

CDR USARSO FT CLAYTON PN//SOEN-ME//

CDR JTF-BRAVO PALMEROLA AB HO//DCS ENGR//

DA WASHINGTON DC//OSA//

DA WASHINGTON DC//DAEN-ZCM//

CDR USAEDSA ATLANTA GA//SADEN-M//

COE AREA OFFICE, HO (TELECOPY)//AREA ENGR//

UNCLAS

SUBJ: NORTH COAST OF HONDURAS DREDGING STUDY-PHASE I AFTER ACTION REPORT

~~ENNACO~~
~~MANN~~
SIMMONS
CLINTON
HUGGINS
MUELLER/
COUEY/
DM/

REF: MSG CDRUSAED MOBILE AL 161335ZAPR87, SUBJ: AGUAN VALLEY DREDGING, HONDURAS

1. PHASE I COORDINATION VISIT TO HONDURAS WAS COMPLETED 1 MAY 87. MEETINGS WITH MEMBERS OF AM EMBASSY, USAID, AND HONDURAN GOVERNMENT (GOH) WERE CONDUCTED AND AN OVERFLIGHT OF THE AGUAN VALLEY WAS

MAJ WALTER ENNACO
EN-M EXT. 3416 12 MAY 87

LTC LESLIE A. ROSE, DM

PERFORMED.

2. FINDINGS INDICATE TWO PROBLEMS HINDERING PLANNING AND COMPLETION OF THE PHASE II STUDY:

A. TECHNICAL PROBLEM: THE RIVER SYSTEMS OF THE NORTH COAST ARE VERY COMPLEX AND CONSTANTLY CHANGING. PAST STUDIES OF TWO RIVER BASINS HAVE BEEN PERFORMED WHICH INCLUDE COMPREHENSIVE PLANS AND RECOMMEND FURTHER SPECIFIC STUDIES TO SUPPORT THE PLANS. ALTHOUGH SOME SMALL RELATED FLOOD CONTROL PROJECTS HAVE BEEN IMPLEMENTED, MOST HAVE NOT BEEN ATTEMPTED DUE TO LARGE PRICE TAGS OR DISAGREEMENT AS TO THEIR APPROPRIATENESS. WITHOUT AN UNDERSTANDING OF THE INTERACTIONS OF THE VARIOUS BASIN PROJECTS, IT WOULD BE INAPPROPRIATE TO MAKE ANY HASTY RECOMMENDATIONS TO REDUCE FLOODING WITH A BASIN-WIDE PROGRAM.

B. INSTITUTIONAL PROBLEM: THERE IS STILL NO SINGLE POINT OF CONTACT (POC) IN THE GOH WHO CAN RESOLVE THE ISSUE OF WHICH SPECIFIC PROBLEMS AND WHAT GEOGRAPHIC SCOPE SHOULD BE ADDRESSED BY THE CORPS. THE GOH MUST ESTABLISH A CONSENSUS AS TO THE APPROPRIATE SCALE OF PLANS FOR IMPLEMENTATION. SOME POC FEEL PRIOR STUDY RECOMMENDATIONS WERE ON TOO LARGE A SCALE (FINANCIALLY) AND OTHERS BELIEVE THE PROBLEMS CAN ONLY BE SOLVED BY THE LARGE CONSTRUCTION PROJECTS RECOMMENDED. USAID CURRENTLY PURSUES A POLICY OF IMPLEMENTING SMALL PROJECTS (FY85-FY89) AND IT IS UNLIKELY THEY WILL FUND A MASSIVE BASIN-WIDE PLAN WHICH TRADITIONALLY WOULD BE FUNDED BY THE WORLD BANK OR INTERAMERICAN DEVELOPMENT BANK.

3. THE GOH HAS ALREADY EXPENDED RESOURCES ON MANY LARGE STUDIES AND IT SEEMS INAPPROPRIATE FOR MOBILE DISTRICT TO ADD ANOTHER STUDY TO THE PILE. TO AVOID COSTLY EXPENDITURES AND TO ENABLE MOBILE DISTRICT TO EFFICIENTLY UTILIZE INFORMATION GATHERED IN PREVIOUS STUDIES, WE RECOMMEND THE FOLLOWING:

A. SCEN ASSISTANCE IN DEVELOPING THROUGH THE AM EMBASSY A SINGLE POC (WITH AUTHORITY TO DIRECT THE STUDY EFFORT) WITHIN THE GOH NLT 18 MAY 87.

B. SCEN SHOULD DIRECT US TO REDUCE THE SCOPE OF WORK FOR PHASE II. WE SUGGEST LIMITING THE SCOPE OF WORK TO THE MOUTHS OF THE RIO ULUA, RIO LEAN, AND RIO AGUAN AND THAT THE FOCUS OF EFFORT BE DIRECTED TO FLOOD CONTROL THROUGH THE PROVISION OF MORE EFFICIENT FLOW BY ANY APPROPRIATE PHYSICAL MEANS. GIVEN THIS REDUCED SCOPE, WE BELIEVE INGINIERO MARIO MONCADA OF THE MINISTERIO DE COMMUNICACIONES, OBRAS PUBLICAS, Y TRANSPORTE (SECOPT) WOULD BE INVALUABLE AS POC IF HE WERE GIVEN AUTHORITY TO WORK WITH THE HONDURAN INSTITUTO AGRARIO (INA).

C. IF RECOMMENDATION A AND B ARE SATISFACTORY, WE RECOMMEND SCEN CONCUR WITH THE FOLLOWING PHASE II PRODUCT DESCRIPTION:

(1) A REPORT TO SOUTHCOM COMMANDER OUTLINING: NEAR TERM, SMALL SCALE PLANS FOR POSSIBLE EARLY IMPLEMENTATION; A PLAN OF STUDY TO DEVELOP MORE LONG TERM COMPREHENSIVE SOLUTIONS; ROUGH COSTS FOR THE NEAR TERM SOLUTIONS AND THE LONG TERM STUDY PLAN.

(2) PHASE II EFFORT WOULD BE ACCOMPLISHED BY SITE RECON AND MEETINGS IN HONDURAS OVER A TWO WEEK PERIOD (PREFERABLY 25 MAY-5 JUNE 87) BY A FIVE MAN TEAM. COORDINATION TO BE WITH LTC KEITH, AM EMBASSY, 18-22 MAY 87.

4. REQUEST SCEN REPLY TO RECOMMENDATIONS IN PARA. #3 NLT 18 MAY 87 IN ORDER TO COMPLETE PHASE II NLT 15 JUNE 87, AS REQUESTED. NOTE THAT POC MUST ALSO BE COORDINATED NLT 18 MAY 87.

5. COMPLETE AFTER ACTION REPORT OF PHASE I FOLLOWS THIS MESSAGE THROUGH ROUTINE CHANNELS.

6. POC THIS OFFICE: MATT LAWS OR MAJ ENNACO, AV 457-2761.

After Action Report - Phase I
North Coast of Honduras Dredging

From 27 April to 1 May 1987, Mr. Mathew M. Laws (SAMPD-FC) and Mr. Kenneth D. Underwood (SAMEN-YD) conducted Phase I of the USSOUTHCOM Engineer Support Plan. The SOUTHCOM point of contact is LTC James Brink SCEN (AV 222-4211). The purpose of the Phase I mission was to:

1. Identify Problem Areas.

2. Determine Available Data and Requirements for Additional Data.

3. Identify Points of Contact.

4. Define Scope of Work to be Accomplished in Phase II.

Meetings in Honduras included briefings by and for members of the US Embassy staff at Tegucigalpa, discussions with officials in USAID at Tegucigalpa, and discussions with various agency heads and technical advisors of the Honduran Government. While in Honduras the team was assisted by the Mobile District Construction Division Area Engineer, Mr. Leo Philips (32-5170), and by Mr. Jorge Zapata (32-7455), also assigned to the Area Office. Mr. Zapata is bilingual and was of great assistance in the team's efforts to locate contacts within the Honduran Government. The central point of contact at the Embassy is LTC Lewis Keith (9-011-504-32-3120 ext. 2310). Individuals from the Embassy who participated in discussions and briefings included:

1. LTC Lewis Keith - Army Attache, Honduras
2. CDR Richard Strum - Naval Attache, Honduras
3. V. Manuel Rocka - Pol/Mil Officer, Am Embassy
4. Ms. Janet Potash - Econ Officer, Am Embassy
5. Mr. James Magnos - Econ Officer, Am Embassy
6. Mr. Elio Viara - Pol Officer, Am Embassy
7. Mr. Rod Saubers - DNA-IAGS, Honduras (Tel 33-7435)

Representatives of USAID who were contacted in Tegucigalpa included:

1. Mr. Richard Peters - AID, Honduras
2. Mr. Val DeBeausset - AID, Honduras
3. Mr. Lynn Sheldon - Chief Engineer, AID, Honduras
4. Mr. Hugo Elvir - Engineer, AID, (Former Head of Honduran Department of Natural Resources)

Representatives of the Honduran Government in Tegucigalpa who were contacted included:

1. Lic. J. Francisco Funez - Jefe Planificacion, Instituto Nacional Agrario (INA) (Tel Oficina 32-4938)
2. Lic. Guadalupe Jerezano - Asesor Ticnico Direccion Ejecutiva Instituto National Agrario (INA) (Tel oficina 32-4938)
3. Ing. Mario Alcides Moncada, (Ingeniero Civil) - Jefe Departamento Obras Hidraulicas, Direccion General Obras Civiles, SECOPT (Tel Oficina 33-7644)

NOTE: SECOPT is Secretary of Communications, Public Works and Transportation.

4. Mr. Carlos Falck, Minister advisor to President Azcona.

During the field reconnaissance of the Rio Aquan Valley, Mr. Rolando Mendoza Garay, Sub-Jefe Regional, INA, was met in Sinaloa for discussions of flooding and agricultural problems in the lower Rio Aquan.

Additional points of contact were also identified, but circumstances did not permit a meeting or discussion. These individuals may also have pertinent information concerning problems and previously proposed solutions for flooding along the north coast:

1. Dr. Hector Tablas, Recuras Hirdrologico, Instituto Recuras Natural. (This man was once the head of the Projecto Bojo Aquan, it is not known if he is still with the Honduran Government). Projecto Bajo Aquan is the agricultural project for the lower Aquan (includes works for irrigation, flooding; and infrastructure such as roads, power, and railroads).

2. Mr. Randy Flemming, Manager of Standard Fruit Company, at LaCeiba.

3. Mr. Jorge E. Craniotis, General Manager, National Port Authority, Puerto Cortes, Honduras.

The most knowledgeable points of contact concerning flooding and agricultural development along the North Coast of Honduras were: Mr. Mario Moncada, Ms. Guadalupe Jerezano, and Mr. Rolando Garay. Mr. Moncada is a civil (hydraulic) engineer with a good technical background in the water resources problems of North Coast Rivers. He has access to a large number of comprehensive reports prepared by various international consulting firms under contract to the Honduran Government. Ms. Jerezano is the Technical Advisor to the Executive Director of the Honduran Department of Agriculture (INA). She also has access to numerous reports prepared for INA concerning agricultural development, irrigation, flooding, and infrastructure needs within the North Coast River Valleys. Mr. Garay is the regional project manager for the lower Aquan River Valley. He works with the farm cooperatives, and private developers to implement improvements in agricultural practices, management, irrigation, and flood control. He is very knowledgeable and has first hand experience with flooding in the lower valley. Mr. Garay also has copies of reports on the water resources of the Rio Aquan, and is fully aware of the numerous recommendations made by various consultants to correct flood problems. Mr. Garay and Ms. Jerezano work in close cooperation, but both are only minimally acquainted with Mr. Moncada; and, there is no close coordination between these two agencies of the government. Although the team did not have an opportunity to meet and discuss flooding problems with Mr. Craniotis, General Manager of the National Port Authority, he also has an interest in North Coast River flood problems and would need to be coordinated with on any return trips.

The areas of geographic interest included the North Coast Rivers: Rio Ulua, Rio Chamelecon, Rio Lean, all river valleys between the cities of Tela and La Ceiba, and the Rio Aquan. These rivers were identified by Mr. Mario Moncada and US Embassy representatives. Two areas of prime interest seem to be, through the discussions with Honduran Government representatives, the lower reaches (from mouth upstream for about 80,000 kilometers or about 50 statue miles) of the Rio Ulua, and the Rio Aquan. Since it was known before the Phase I trip took place that there was a special interest in the Rio Aquan, (President Azcona is from that part of Honduras) an aerial reconnaissance was made by helicopter by the team. This flight was coordinated by LTC Keith and provided by Joint Task Force Bravo out of Palmarolla. The entire Rio Aquan Valley was flown from the City of Arenal to the river mouth in the vicinity of Limon and Santa Rosa De Aquan. (Photographs and slides of pertinent features were taken along the entire river length).

Based on the discussions, meetings, and the aerial reconnaissance conducted in Honduras, there are apparently two distinct problems facing the planning and completion of a Phase II team effort: Technical and Institutional. The Technical problems center on the following points:

1. The river systems of the Rio Ulua and the Rio Aquan are physically very complex. They both are similar to the lower Mississippi River Basin in Louisiana. A meandering and dynamic river alignment with many distributaries, tributaries, and existing water resource structures (numerous levees of varying degrees of protection and complex interior drainage systems). Also, they both carry large amounts of suspended sediment and bed loads that are filling the old channel reaches at the mouths (Caribbean). Alternate river routes are developing and some encouragement by excavation has been implemented on the Ulua. This silting is apparently being aggravated by shoaling at the mouth supplied by a net westward littoral drift along the North Coast.

2. Past studies have been conducted of both river basins that include comprehensive basin wide (frame work type) plans, and project specific studies for the various facets of the comprehensive plans. All of the studies were performed by extremely reputable international water resources consulting firms such as: Charles T. Main L.T.D., NIPON, and Harza. Parts of the plans and projects recommended have been implemented; some have not been implemented, either due to their large price tags, or some disagreement as to their appropriateness.

Considering the complexity of these systems, the Corps should not make hasty recommendations, as to possible plans to reduce floodings on a basin wide basis. An understanding of the interactions of the various elements of projects which now exist in each basin will be essential to developing a reasonable course of action for future implementation.

In addition to the technical complexity of the physical water resource systems previously described, there are institutional problems with focusing on a specific scope of work for Phase II, and in developing some consensus with the Honduran Government as to the appropriate scale of plans for implementation. Some of the points of contact feel that the recommendations from prior studies were on too large in a scale, and that less costly solutions are more likely to be implementable; while others see the problems as only being solved by large construction projects similar to those recommended in prior reports. Currently, there is also no apparent single point of contact in the Honduran Government who can resolve the issue of specifically what problems, and geographically what scope, should be addressed by the Corps.

USAID is currenlty pursuing a policy of implementing small projects as opposed to very costly large scale developments. It is unlikely that funds will be made available for construction of massive basin wide plans under bilateral assistance programs in the near future, due to other priorities and the propensity of A.I.D. not to finance large infrastructure, which is traditionally financed by the World Bank or the Interamerican Development Bank. In 1984, AID prepared a strategy paper for short-term and long-term development in Honduras for fiscal years 1985 through 1989, which strongly reflects this kind of policy. These plans did not include any strong inputs into the Rio Aquan or Rio Ulua Basins.

Prior to the conduct of the Phase II work, it is requested that SOUTHCOM advise as to scope of work and assist in further developing, through the US Embassy a single point of contact within the Honduran Government. This will be required prior to 15 May 1987, in order to complete the Phase II requirements within the 15 June 1987, target date. The District believes it would be a mistake to expend the resources (manpower, funds) to complete Phase II without clearly defining the requirement, and having concensus between the proper officials of the Honduran Government and the US Embassy.

It is suggested that SOUTHCOM propose the scope of Phase II work be limited to the mouths of the Rio Ulua, Rio Lean, Rio Aquan only. That the focus of the effort be directed to flood control, through the provision of more efficient flow by any appropriate physical means. On this basis the most appropriate single point of contact with the Honduran Government would be Mr. Mario Moncada, with the authority to work with INA officials as needed. The Phase II effort would require site reconnaissance and meetings in Honduras over about a 2 week period (probably occuring from 25 May through 5 June 1987). The team to conduct such a reconnaissance would consist of the following:

1. Team Leader (Water Resources Planner/Engineer)
2. Hydraulic Engineer (River Mechanics Specialist)
3. Foundation and Soils Engineer
4. Dredging Engineer
5. Agricultural Economist

Meetings and logistics for the reconnaissance in Honduras can be arranged through the US Embassy (LTC Lewis Keith) during the week of 18 through 22 May 1987, by MDO team leader. Prior to the trip the team would be engaged in reviewing previous reports obtained during the Phase I work effort, and will be contacting the appropriate

AD-A193 635 US ARMY CORPS OF ENGINEERS RECONNAISSANCE REPORT: NORTH COAST OF HONDURAS FLOODING(U) ARMY ENGINEER DISTRICT MOBILE AL M M LAWS MAR 88 CESAM/PDFC-88/03

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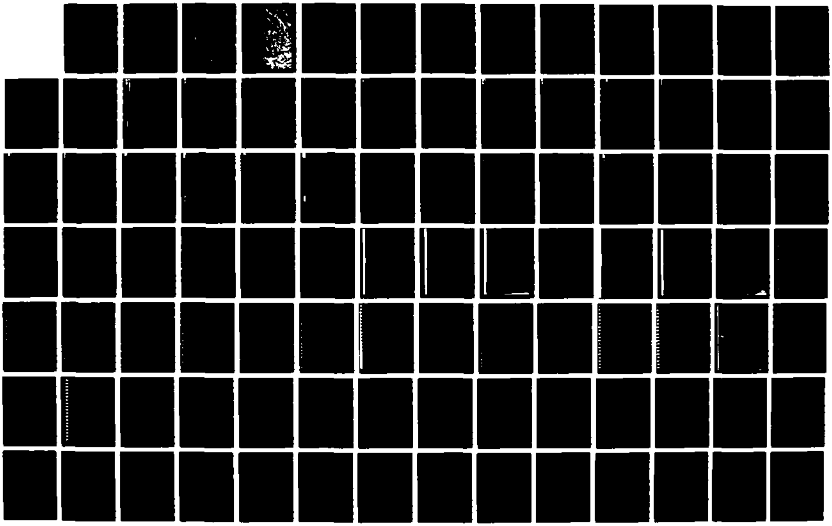
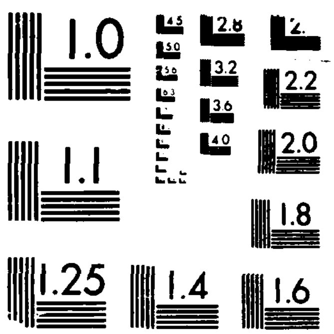




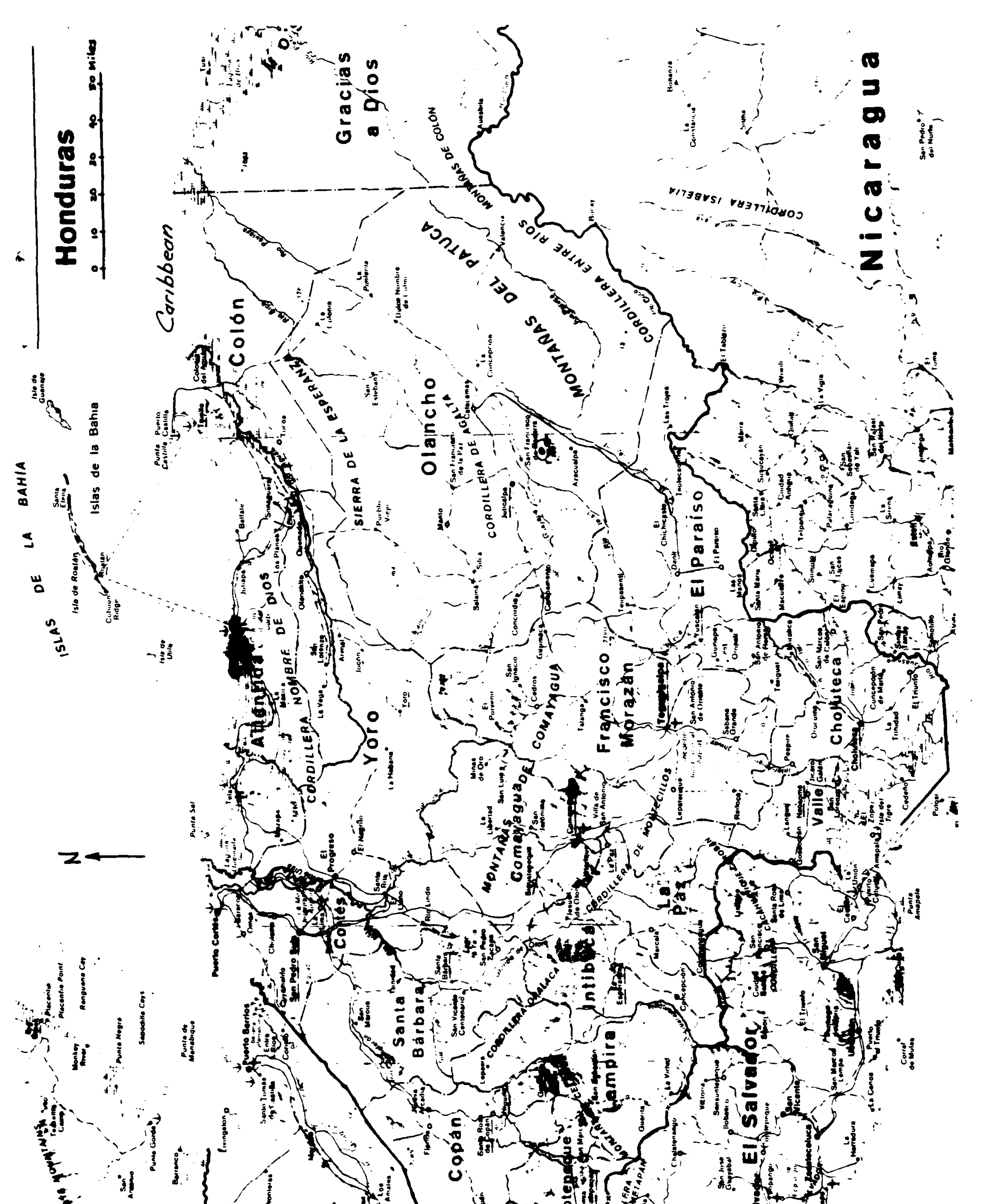
MICROCOPY RESOLUTION TEST CHART

IREAU STANDARDS-1963-A

individuals with international consulting firms who have knowledge of these river systems.

The Phase II product would consist of a report to the SOUTHCOM Commander which would outline near term, small scale, plans for possible early implementation; and present a plan of study to develop more long term comprehensive plans. The Phase II Report would also include the establishment of the appropriate costs for further study, and the rough cost of implmentation of near term alternative solutions to flooding. A plan of implementation for both the near term solutuions, and further study would also be presented. SOUTHCOM concurrence in the Phase II product description is also requested by 15 May 1987. A key element in any further study of long term basin wide solutions would be the development of a coordinating team consisting of representatives of the Corps, US Embassy, USAID, and the appropriate agencies of the Honduran Government, as well as local community officials. This type of effort would be very costly, time consuming, and should not be undertaken without some reasonable assurance that financing of construction could be obtained. Too many large studies have already been performed at great expense for the Corps to add to the pile. Maintenance of Corps credibility would require some concensus of implementation feasibility during Phase II before any costly further work is undertaken.

MATHEW M. LAWS, III
Chief, Coastal Section
Planning Division
Mobile District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Yoro
Cortés
Santa Bárbara
Copán
Ocotepeque
Lempira
Intibucá
La Paz
Comayagua
Francisco Morazán
El Paraíso
Choluteca
Valle
Nicaragua
El Salvador
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SIERRA DE LA ESPERANZA
CORDILLERA DE AGALTA
MONTAÑAS DEL PATUCA
MONTAÑAS DE COLÓN
CORDILLERA ENTRE RIOS
CORDILLERA ISABELIA
CORDILLERA DE MONTECILLOS
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San Pedro Sula
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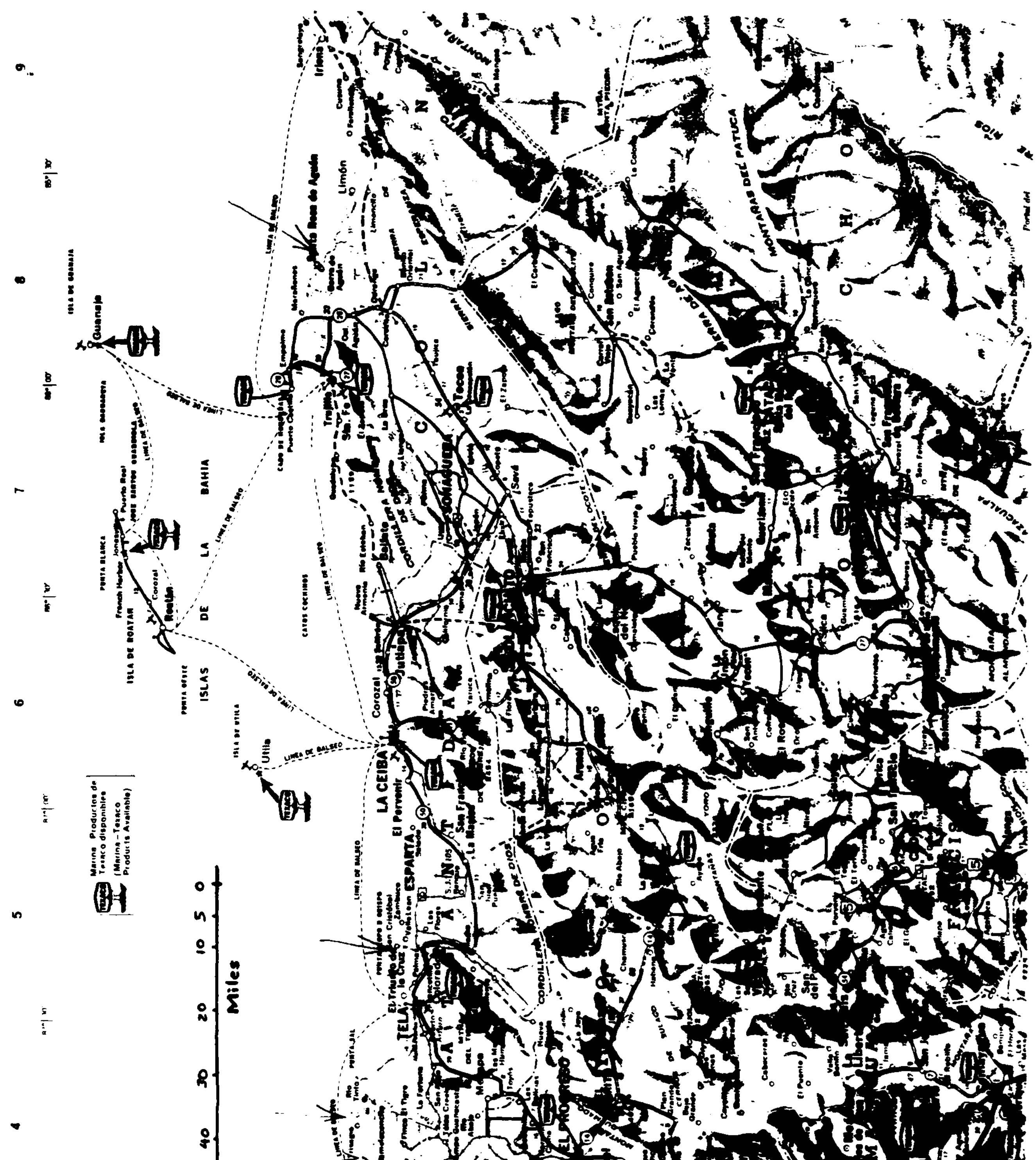
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Roatán
Utila
Guanaja
PUERTO CORTES
TELA
LA CEIBA
ESPARTA
Trujillo
Limón
LINEA DE BALSEO

SECTION C

TRIP ITINERARY

TEAM MEMBERS

CORPS

Matt Laws - Chief, Coastal Section, CESAM-PD-FC (Team Leader)
Ted McDonald - Chief, Economic Analysis Section, CESAM-PD-FS
Kenneth Underwood - Hydraulic Engineer, CESAM-EN-YD
Johnny Tyson - Geotechnical Engineer, CESAM-EN-FS
Roger Gerth - Civil Engineer, CESAM-OP-ON

U.S. EMBASSY

LTC Lewis Keith - Army Attache, DAO
Lic. Elio Viara - Political Section (interpreter/attorney)

MONDAY 25 JANUARY 1988

Travel to Tegucigalpa, Honduras (arrive 1630 hrs).
Pick up by COE Area Office (Jorge Zapata) transportation to Hotel Alameda. Contact LTC Keith to coordinate time for Tuesday meetings.

TUESDAY 26 JANUARY 1988

Meeting at U.S. Embassy at 0800 with LTC Keith and staff with team to coordinate ground transportation requirements and reconfirm meeting time with SECOPT officials. Meeting at 0930 with team and SECOPT (Ing. Torres and Ing. Moncada). Depart SECOPT at 1530 enroute to meeting with Embassy staff at 1600. Depart U.S. Embassy at 1730 enroute to hotel.

WEDNESDAY 27 JANUARY 1988

Depart Hotel Alameda at 0600 enroute to Palmerola. Arrive JTF Bravo 0730. Depart JTF Bravo (Eagle 75) via helicopter for field reconnaissance. Passengers to include: Corps team, Mr. Viara, Ing. Moncada.

Flight Plan - Palmerola to La Florida at the confluence of the Rio Lean and Rio Alao. Flying north following the Rio Lean to its mouth on the Caribbean Sea at Colorado. Then flying west along the north coast following the coast line to the mouth of the Rio Ulua at Barra Ulua. Then flying south along the path of the Rio Ulua to the vicinity of Finca El Tigre where a canal joins the Rio Ulua with the Rio Chamelecon. Land to inspect canal. Resume flight following Rio Ulua to the bridge near La Junra. Then flying north west to Puerto Cortes and Laguna de Alvarado. From the vicinity of Traresia on the Laguan then fly east along the north coast to the mouth of the Rio Chamelecon. Then turn south to fly along the path of the Rio Chamelecon to the vicinity of Campana where a canal from the Rio Ulua joins the Rio Chamelecon. Land to inspect the canal. Resume the flight by continuing to follow the Rio Chamelecon up to the mouth of the Rio Choloma near Los Carros. Then fly along the Rio Choloma to the sediment dam on its tributary near El Portillo. Land and inspect the dam. Return to Palmerola. Return from Palmerola via U.S. Embassy vehicle and driver to Hotel Alameda in Tegucigalpa.

THURSDAY 28 JANUARY 1988

Depart Hotel Alameda at 0600 enroute to Palmerola. Arrive at JTF Bravo 0730. Depart JTF Bravo (Eagle 85) via helicopter for field reconnaissance. Passengers to include: Corps team (less Mr. McDonald), Mr. Viara, Ing. Mancada.

Flight Plan - Palmerola to Saba on the Rio Aguan (refuel between at appropriate point). Land in Sinaloa to meet with Mr. Rolando Mendoza Garay GOH-INA Sub Jefe Bajo Aguan. From Sinaloa fly along the Rio Aguan to the Durango Bridge. Land at bridge to inspect channel. Resume flight along Rio Aguan to Santa Rosa de Aguan on the Caribbean. From the mouth of the Rio Aguan fly west along the north coast to Limon and the mouth of the Rio Limon. Then fly upstream along the Rio Limon to Francia (distance about 30 miles). From Francia continue to follow the Rio Limon (now called the Rio Piedra Blanca until it joins the Rio Aguan (distance about 25 miles). Then fly west directly to the town of Tarros. From Tarros fly north following the path of the

Rio Chapaqua. Land at the major bridge crossing near Colonia del Aguan to inspect channel. Resume flight along path of Rio Chapaqua to its mouth on the Caribbean between Santa Rosa de Aguan and Maranones. Then fly west along the north coast to La Ceiba. Refuel at Goloson, then fly west along the north coast to the mouth of the Rio San Juan near Boca Cerrada. Turn south and fly along the path of Rio San Juan to La Soledad. Return to Palmerola.

NOTE: Due to weather conditions (heavy fog at ground level) flight was grounded in La Ceiba overnight. Flight plan was resumed on Friday 25 January 1988.

FRIDAY 29 JANUARY 1988

Field reconnaissance as described above completed with return flight into Tegucigalpa. Team picked up at international airport by U.S. Embassy vehicle and returned to Hotel Alameda. LTC Keith was contacted and remainder of Phase II mission was rescheduled and recoordinated (since one day was lost).

SATURDAY 30 JANUARY 1988

Team meeting to discuss field reconnaissance results and begin writing briefings.

SUNDAY 31 JANUARY 1988

Team departs Hotel Alameda and Tegucigalpa via Embassy vehicle and driver enroute to San Pedro Sula at 0830. Arrive Hotel Copanto at 1100. Afternoon work by team on briefings and report.

MONDAY 1 FEBRUARY 1988

Team departs Hotel Copanto at 0730 enroute to Puerto Cortes (with Elio Viara). Meeting with Ing. Marco Tulico Ravenau, Director of Dredging Department, Honduran Port Authority (ENP), at 0900. Meetings and discussions with several officials in the Puerto Cortes area. (Ing. Hector Martinez, Chief of Hydrographic Section (ENP); Ing. Carvajal, Assistant Chief of Hydrographic Section (ENP); Ing. Julio Ortiz, Manager of Operations, Texaco docks). Team deports Puerto Cortes at 1330 enroute to Tegucigalpa. Arrive Hotel Alameda at 1800.

TUESDAY 2 FEBRUARY 1988

Team departs Hotel Alameda at 0800 enroute to U. S. Embassy. Discussion with U. S. Embassy staff from 0830 to 0930 on tone and content of SECOPT outbriefing by the team. Team conducts outbriefing for SECOPT officials (Ing. Jose Emilio Torres, Director General of Civil Works) from 1000 to 1200. Team returns to U.S. Embassy at 1330 for outbriefing of Embassy officials. Return to Hotel Alameda at 1630.

WEDNESDAY 3 FEBRUARY 1988

Team departs Tegucigalpa at 0600 enroute to Mobile, Alabama.

SECTION D

POINTS OF CONTACT

U.S. EMBASSY, HONDURAS

1. LTC Lewis Keith - Army Attache (Tel 32-3120 ext. 2310)
2. CDR Richard Strum - Naval Attache
3. V. Manuel Rocka - Pol/Mil. Officer
4. Ms. Janet Potash - Econ Officer
5. Mr. James Magnor - Econ Officer
6. Lic. Elio Viara - Pol Officer (Tel 32-3121/29 ext. 2248)
7. Mr. Rod Saubers - DNA-IAGS (Tel 33-7435)

U.S. AID, HONDURAS

1. Mr. Lynn Shelden - Chief Engineer
2. Mr. Val DeBeausset - Agricultural Engineer
3. Mr. Hugo Elvir - Engineer (former Director of Honduran Department of Natural Resources)

INSTITUTO NATIONAL AGRARIO (INA)

(National Institute of Agriculture)

1. Lic J. Francisco Funez - Jefe Planificacion (Chief of Planning) (Tel 32-4938)
2. Lic Guadalupe Jerezano - Asesor Ticnico Direccion Ejecutiva (technical assistant to the Executive Director) (Tel 32-4938)
3. Rolando Mendoza Garay - Sub-Jefe Regional Projerto Bajo Aguan (Tel in Tegucigalpa 32-2562, Radio at Sinaloa 32-1739)

SECRETARIAT OF COMMUNICATIONS PUBLIC WORKS AND TRANSPORTATION (SECOPT), DIRECCION GENERAL DE OBRAS CIVILES

1. Ing. Jose Emilio Torres - Director General of Civil Works (Tel 33-4525)
2. Ing. Mario Alcides Moncada - Jefe Departmento of Obras Hidraulicas (Chief of Hydraulic Works) (Tel 33-7644)

EMPRESA NATIONAL PORTUARIA (ENP)

(National Port Authority)

1. Ing. Casanova - Director
2. Ing. Maranda - Vice Director
3. Ing. Marco Tulio Raveneau - Jefe Departmento Dragado (Chief of Dredging Department) (Tel 55-0435/25)
4. Ing. Pio Alvarez - Direccion Dragado Operations (Director Dredging Operations)
5. Ing. Hector Martinez - Jefe Departmento Hydragraphic (Chief of Hydragraphic Department)
6. Ing. Carvajal - Sub-Jefe Departmento Hydragraphic (Assistant Chief of Hydragraphic Department)

INSTITUTO RECURAS NATURAL

(Institute of Natural Resources)

1. Dr. Hector Tablas - Jefe Departmento Irrigation (Chief Of Irrigation Department, PHD in Agricultural Engineering)

STANDARD FRUIT COMPANY, HONDURAS

1. Mr. Randy Flemming - General Manager La Ceiba (Tel 42-6820)

U. S. ARMY COE AREA OFFICE

1. Maj Randy Riggins - Area Engineer (Tel 32-5170)
2. Mr. Jorge Zapata - Assistant

SECTION E

AVAILABLE DATA SUMMARY

REPORTS PREVIOUSLY PREPARED BY OTHERS

1. A Prefeasibility Investigation, Sula Valley Development, Honduras C. A. prepared by Jordan/Avent and Associates, Montgomery Street, San Francisco, California, September 1984 (USAID PIO/T No. 522-9103-3-40050). (Document is in English.)

2. A Flood Control Mitigation Plan, Plan De Desarrollo Para Mitigacion De Avenidas En El Valle De Sula, prepared by the Tela Railroad Company's Department of Engineering, Tegucigalpa, Honduras C.A., December 1980. (Document is in Spanish.)

4. The Feasibility Study On The Aguan Valley Agricultural Development Project (Saba - Olanchito Area) Draft Final Report, Volume I - Main Report, prepared by Japan International Cooperation Agency (JICA), Tegucigalpa, Honduras, C.A., March 1985. Also available was Volume II - Appendices, and Volume III - Drawings. (These are bilingual documents.)

5. A Basin Wide Study of Water Resources, Plan Maestro Hidraulico Integral Para El Valle Del Rio Aguan, Volume I - El Plan Maestro, prepared by Sir William Halcrow and Partners, Consulting Engineers and Architects, Tegucigalpa D. C., and London, England, December 1983. Also available was Volume VI - Schematic Drawings. (These documents are bilingual.)

6. A Study and Project Designs for Hydraulic Works on the Lower Aguan (Saba to mouth), Proyecto Estudios y Disenos De Obras Hidraulicas Del Bajo Aguan, prepared by a consortium of Charles T. Main International, Inc., Boston, USA, Consultores Latin Americanos Associates, Lima, Peru, and Gabinete Tecnico, S.A. de C.V., Tegucigalpa, Honduras, June 1981. (Documents are in Spanish.)

APPENDIX B

REFERENCE DATA
(METEOROLOGICAL, HYDROLOGICAL, AND AGRICULTURAL)

SECTION A

INTRODUCTION

Information available in the referenced studies included agricultural, hydrologic, and meteorologic data which was monitored at various stations along the north coast. Depending on the particular station, data collection efforts varied and included observations of stream flow and stage, water quality, sediment load, plus the meteorologic parameters of rainfall, temperature, relative humidity, evaporation, sunshine duration, and wind speed. Selected data extracted from the reports is included in Section B for the Aguan Valley, and Section C for the Sula Valley. Data collection efforts within both the Rio Lean and San Juan Basins is ongoing, but not as extensive as those in the Aguan and Sula Valley Basins extend into the areas of the Rio Lean and Rio San Juan. Selected agricultural data are presented in Section D.

SECTION B

LIST OF

AGUAN VALLEY DATA

SECTION B

LIST OF

AGUAN VALLEY DATA CONTINUED

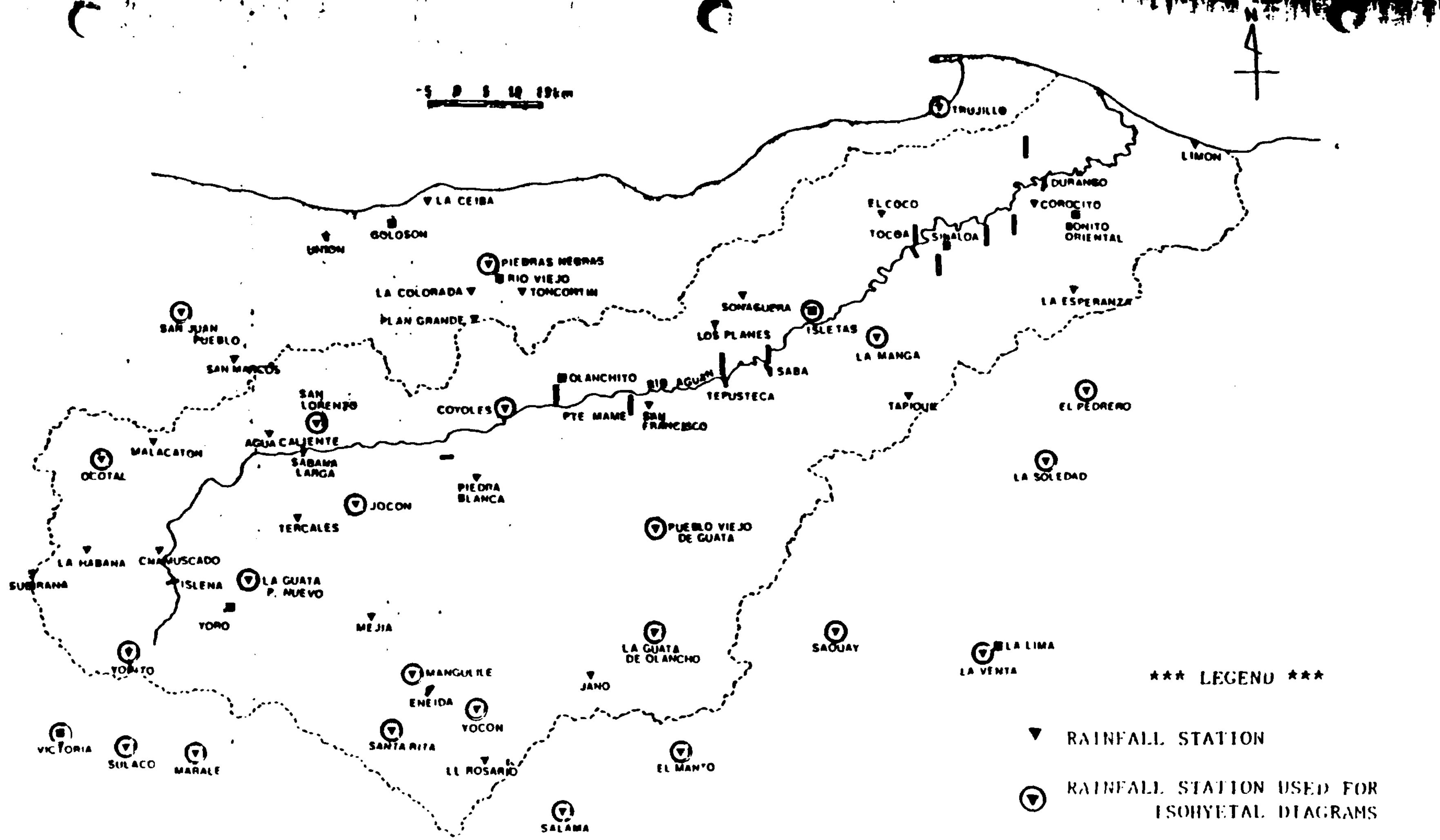


Fig. B-1 HYDROMETEOROLOGICAL STATIONS IN THE AGUAN RIVER BASIS

SOURCE : THE HYDRAULIC MASTER PLAN FOR THE AGUAN RIVER BASIN

NOTE: STATIONS LOCATIONS ARE APPROXIMATE

Table B-8 Details of Flow Recording Stations

STATION	LOCATION LAT.	LONG.	ELEVATION	TYPE
1. ISLENA	15°10'36"	87°12'30"	560	A, S
2. ENEIDA	15°01'15"	86°47'54"	620	A, S
3. SABANA LARGA	15°23'43"	86°59'23"	260	A, S
4. TEGUAJAL	15°21'54"	86°45'27"	160	A, S
5. PTE. OLANCHITO	15°27'28"	86°32'17"	120	A, S
6. PTE. MAME	15°25'50"	86°27'50"	120	A, S, M
7. TEPUSTECA				S, M
8. PTE. SABA	15°31'29"	86°14'02"	70	A, S, M
9. PTE. REFORMA AGRARIA	15°42'20"	86°00'30"	34	S, M
10. SAN ISIDRO	15°38'14"	85°58'24"	80	A, S
11. QDA. DE ARENA				S
12. PASO DEL AGUAN (Briches)				S
13. PTE. DURANGO	15°48'36"	85°47'00"	12	A, S
14. AGUA AMARILLA	15°21'26"	85°48'48"	6	M

NOTES: A - Autographic Recorder

S - Staff Gauge

M - Maximum Water Level Recorder

Table B-1 (1) Summary of Available Data for the Daily Rainfall Stations

	STATION	LOCATION LAT.	LOCATION LONG.	ELEVATION (m.a.s.l.)	RECORD (1950 – 1960 – 1970 – 1980)
1.	VICTORIA	14°56'	87°24'	360	65
2.	SULACO	14°53'	87°13'	700	65
3.	MORAZAN	15°20'	87°36'	240	65
4.	MARALE	14°53'	37°08'	650	65
5.	SUBIRANA	15°12'06"	87°26'52"	870	79
6.	YORITO	15°04'	87°17'	760	68
7.	LA HABANA	15°13'34"	87°20'54"	800	79
8.	CHAMUSCADO	15°13'49"	87°14'07"	615	79
9.	YORO	15°08'18"	87°07'35"	660	80
0.	OCOTAL	15°23'	87°20'	700	68
1.	LA GUATA, PUEBLO NUEYO	15°13'	87°00'	700	68
2.	P.DE CONEJO, SANTA RITA	14°57'30"	86°50'47"	870	80
3.	MALACATON	15°23'52"	87°14'52"	900	79
4.	ROSARIO	14°54'19"	86°42'06"	780	79
5.	MANGULILE	15°04'	86°49'	970	68
6.	MEJIA	15°17'29"	86°52'28"	560	80
7.	SALAMA	14°50'	86°36'	1,300	68
8.	TERCALES	15°17'04"	87°00'53"	970	80
9.	YOCON	15°00'	86°43'	700	68

ource: The Hydraulic Master Plan for the Aguan River Basin

Table B-1 (2) Summary of Available Data for the Daily Rainfall Stations

	STATION	LOCATION LAT.	LOCATION LONG.	ELEVATION (m.a.s.l.)	RECORD (1950 1960 1970 1980)
20.	AGUA CALIENTE	15°24'50"	87°03'29"	390	53
21.	JOCON	15°17'	86°53'	500	68
22.	SAN JUAN PUEBLO	15°36'	87°12'	70	71
23.	SAN MARCOS	15°31'50"	87°06'49"	220	79
24.	SAN LORENZO	15°25'20"	87°57'12"	320	72
25.	JANO	15°01'46"	86°30'32"	800	79
26.	MANTO	14°56'	86°23'	600	68
27.	PIEDRA BLANCA	15°19'31"	86°42'31"	480	79
28.	LA GUATA, OLANCHO	15°06'	86°24'	970	68
29.	LA UNION	15°01'14"	86°42'31"	780	81
30.	ESQUIPULAS NORTE	15°19'	86°33'	360	82
31.	COYOLES	15°29'	86°41'	305	36
32.	PUEBLO VIEJO DE GUATA	15°14'	86°52'	900	68
33.	PLAN GRANDE	15°36'	86°44'	530	73
34.	GOLOSON	15°47'	86°47'	5	71
35.	LA COLORADA	15°38'25"	86°44'37"	360	73
36.	OLANCHITO	15°31'10"	86°34'20"	150	50
37.	STANDARD	15°47'	86°50'	25	28

Table B-1 (3) Summary of Available Data for the Daily Rainfall Stations

	STATION	LOCATION LAT.	LOCATION LONG.	ELEVATION (m.a.s.l.)	RECORD (1950 – 1960 – 1970 – 1980)
38.	PIEDRAS NEGRAS	15°41'	86°43'	180	72
39.	RIO VIEJO	15°40'	86°42'	260	73
40.	TONCONTIN	15°39'	86°41'	320	73
41.	SAGUAY	15°07'	86°03'	625	73
42.	SAN FRANCISCO	15°26'	86°25'	140	80
43.	LA VENTA	15°04'30"	85°53'	520	73
44.	LAS LIMAS	15°06'06"	85°47'48"	840	66
45.	LOS PLANES	15°37'	86°24'	200	28
46.	SONAGUERA	15°31'19"	86°16'17"	90	80
47.	ISLETAS	15°37'	86°10'	50	58
48.	TAPIQUIL	15°29'06"	86°01'30"	440	80
49.	LAS MANGAS	15°33'35"	86°03'40"	180	80
50.	LA SOLEDAD	15°20'48"	85°46'	388	74
51.	EL COCO	15°44'44"	86°03'24"	50	80
52.	SINALOA	15°41'28"	85°57'42"	20	80
53.	EL PEDRERO	15°29'	85°41'	270	73
54.	LA ESPERANZA	15°38'	85°43'	120	80
55.	TRUJILLO	15°55'	85°59'	3	50
56.	COROCITO	15°46'51"	85°47'37"	12	80
57.	PUERTO CASTILLA	16°01'	80°01'	3	80
58.	LIMON	15°02'	85°30'	3	

Table B-2 (1) Summary of Available Data for Climate Stations

	STATION	LOCATION LAT.	LOCATION LONG.	ELEVATION (m.a.s.l.)	TYPE	RECORD 1970 72 74 76 78 1980
1.	VICTORIA	14°56'	87°24'	360	T,RH,E,P	
2.	MORAZAN	15°20'	87°36'	240	T,RH,E,P	
3.	SUBIRANA	15°12'06"	87°26'56"	870	T,P	
4.	LA HABANA	15°13'34"	87°20'54"	800	T,RH,PG,P	
5.	CHAMUSCADO	15°13'49"	87°14'07"	615	T,PG,P	
6.	YORO	15°08'18"	87°14'07"	660	T,RH,E,S,P	
7.	MALACATON	15°23'52"	87°14'52"	900	T,P	
8.	EL ROSARIO	14°54'19"	86°42'06"	780	T,PG,P	
9.	MEJIA	15°17'29"	86°52'28"	560	T,PG,P	
10.	TERCALES	15°17'04"	87°00'53"	970	T,P	
11.	LA UNION	15°01'14"	86°42'31"	780	T,RH,PG,P	
12.	JANO	15°01'46"	86°30'32"	800	T,PG,P	
13.	ESQUIPULAS DEL NORTE	15°19'	86°33'	360	T,P	
14.	OLANCHITO	15°31'10"	86°34'20"	150	T,RH,E,W,P	
15.	SAN FRANCISCO	15°26'	86°25'	140	T,P	
16.	LAS LIMAS	15°06'06"	85°47'48"	500	T,RH,E,P	
17.	TAPIQUIL	15°29'06"	86°01'30"	440	T,PG	
18.	LAS MANGAS	15°33'35"	86°03'40"	180	T,P	
19.	SINALOA	15°41'28"	85°57'42"	20	T,RH,E,S,PG	

Source: The Hydraulic Master Plan for the Aguan River Basin

Table B-2 (2) Summary of Available Data for Climate Stations

STATION	LOCATION LAT.	LOCATION LONG.	ELEVATION (m.a.s.l.)	TYPE	RECORD 1970	72	74	76	78	1980
20. LA ESPERANZA	15°38'	85°43'	120	T,RH,P						
21. COROCITO	15°46'51"	85°47'37"	12	T,P						
22. PUERTO CASTILLA	16°01'	80°01'	3	T,S,PG,P						
23. EL PANTANO	15°08'18"	87°07'35"	660	PG,P						
24. AGUA CALIENTE	15°24'50"	87°03'29"	390	PG,P						
25. PIEDRA BLANCA	15°19'31"	86°42'31"	480	PG,P						

Notes:

Type refers to measurement of following parameters:

T - Temperature; RH - Relative Humidity

E - Evaporation; P - Daily rainfall

PG - Autographic rainfall; S - Sunshine duration

W - Wind speed

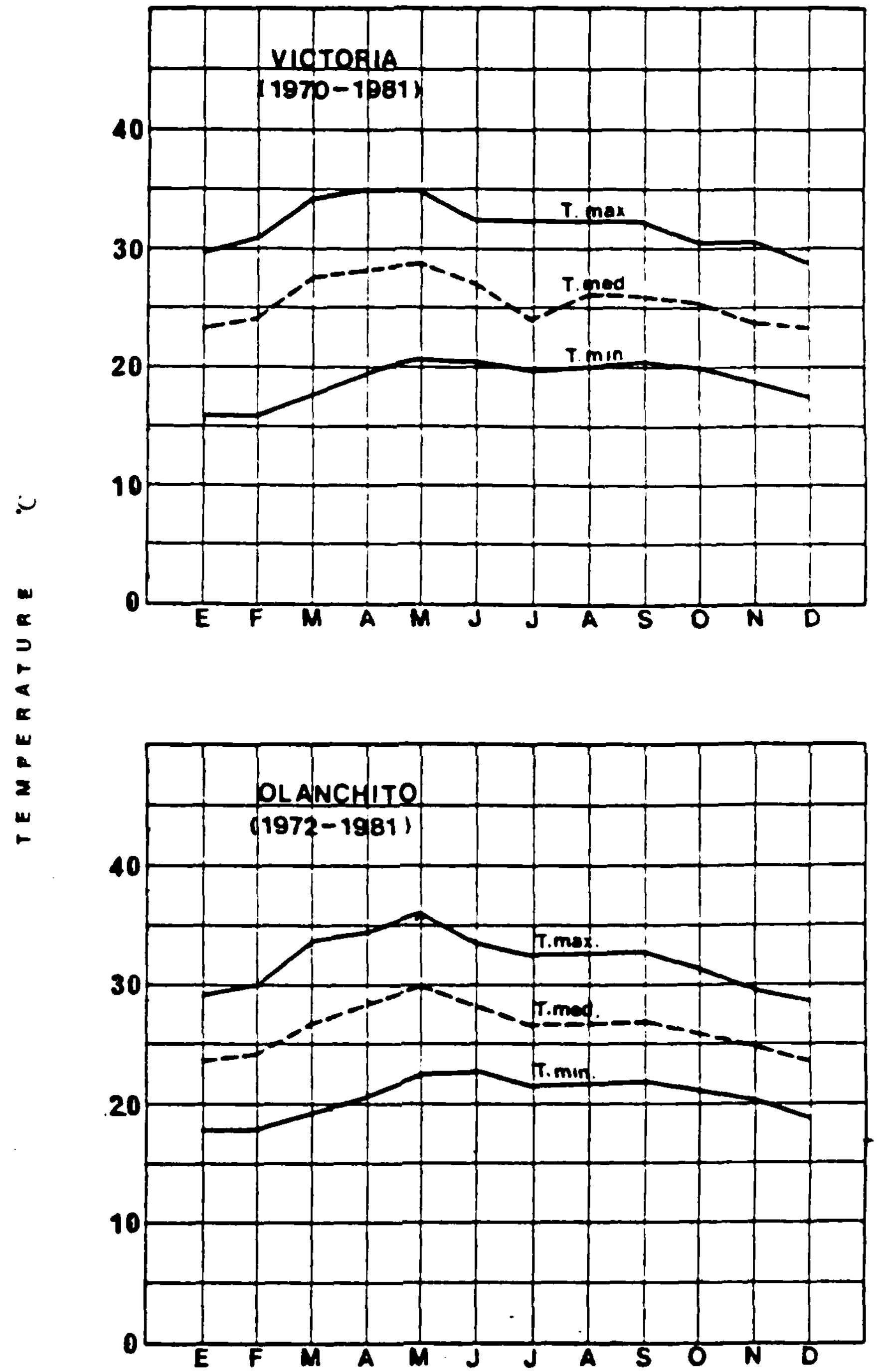


Fig. B-2 MEAN MONTHLY TEMPERATURE FOR UPPER AGUAN

SOURCE: THE HYDRAULIC MASTER PLAN FOR THE AGUAN RIVER BASIN

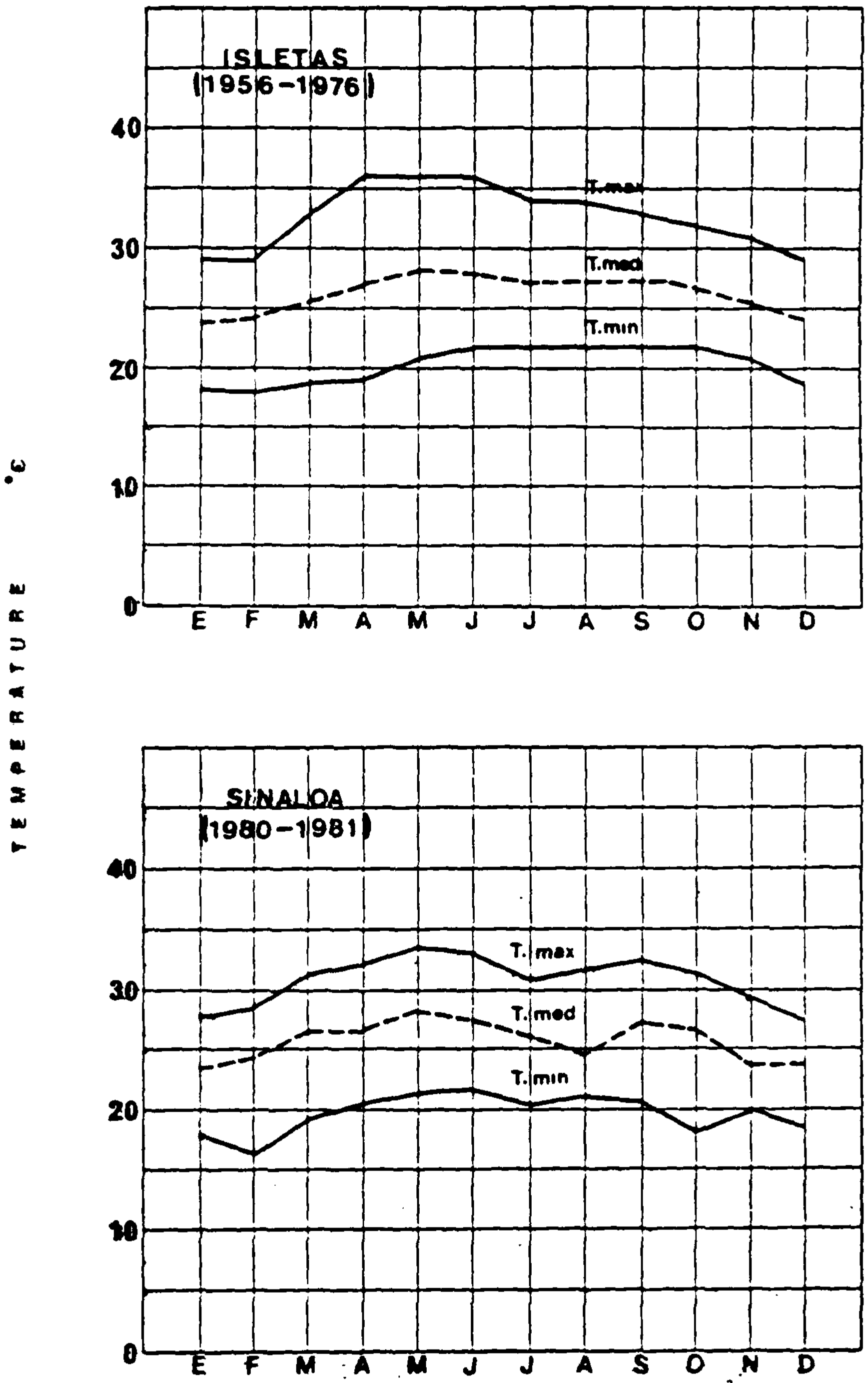


Fig. B-3 MEAN MONTHLY TEMPERATURE FOR LOWER AGUAN

SOURCE: THE HYDRAULIC MASTER PLAN FOR THE AGUAN RIVER BASIN

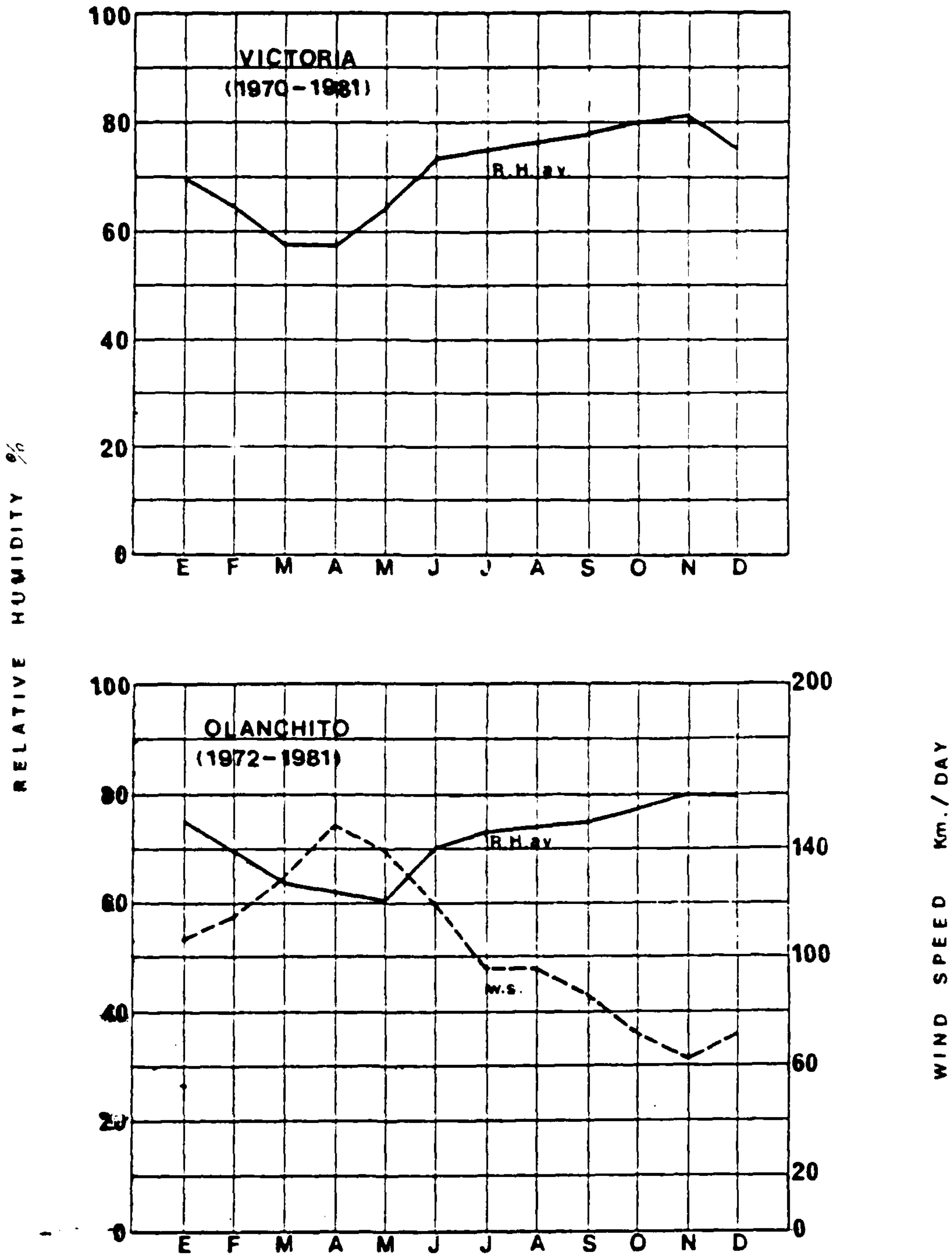


Fig. B-4 MEAN MONTHLY RELATIVE HUMIDITY AND WIND SPEED FOR UPPER AGUAN

SOURCE: THE HYDRAULIC MASTER PLAN FOR THE AGUAN RIVER BASIN

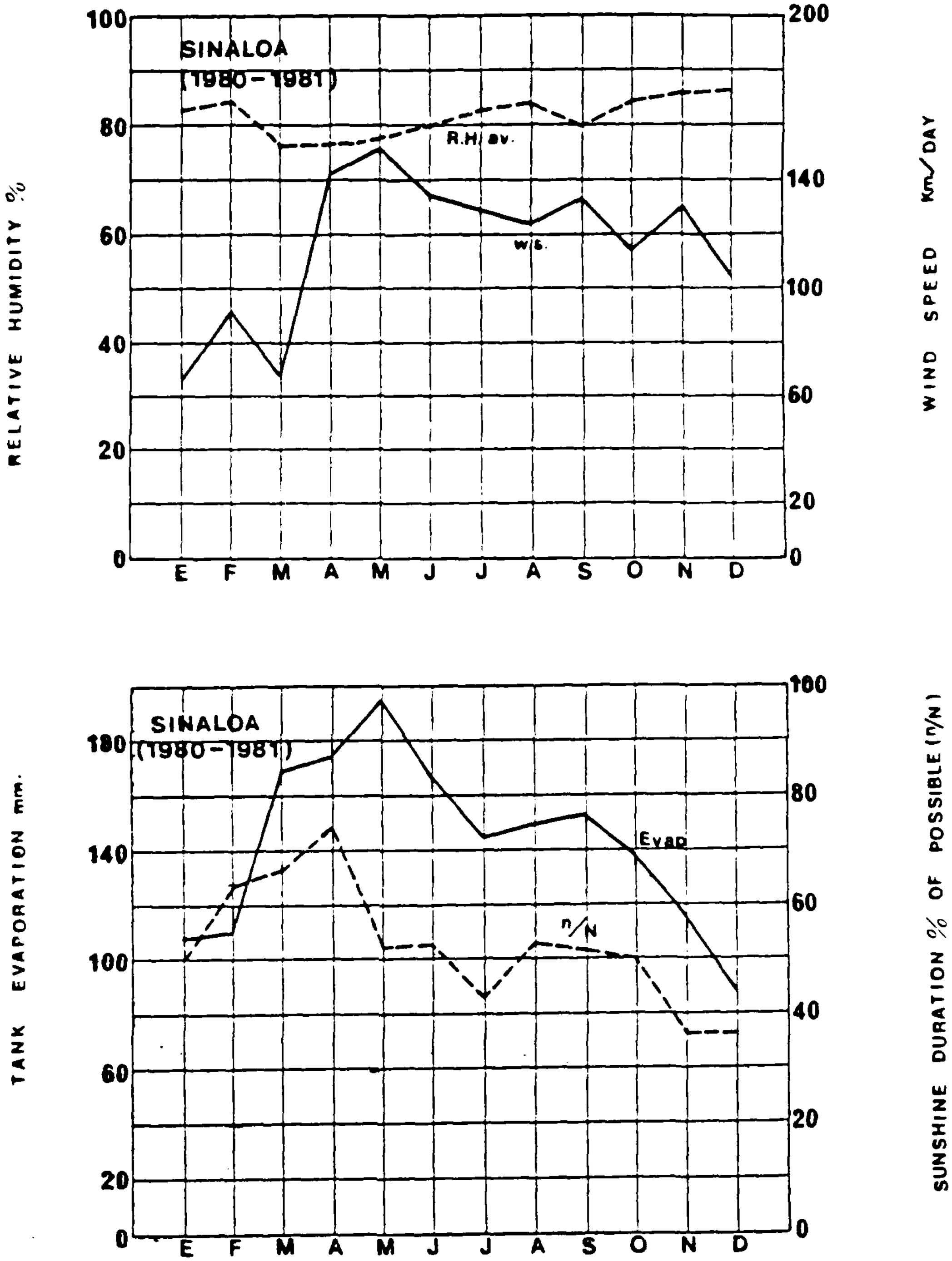


Fig. B-5 MEAN MONTHLY RELATIVE HUMIDITY, WIND SPEED AND SUNSHINE DURATION FOR LOWER AGUAN

SOURCE: THE HYDRAULIC MASTER PLAN FOR THE AGUAN RIVER BASIN

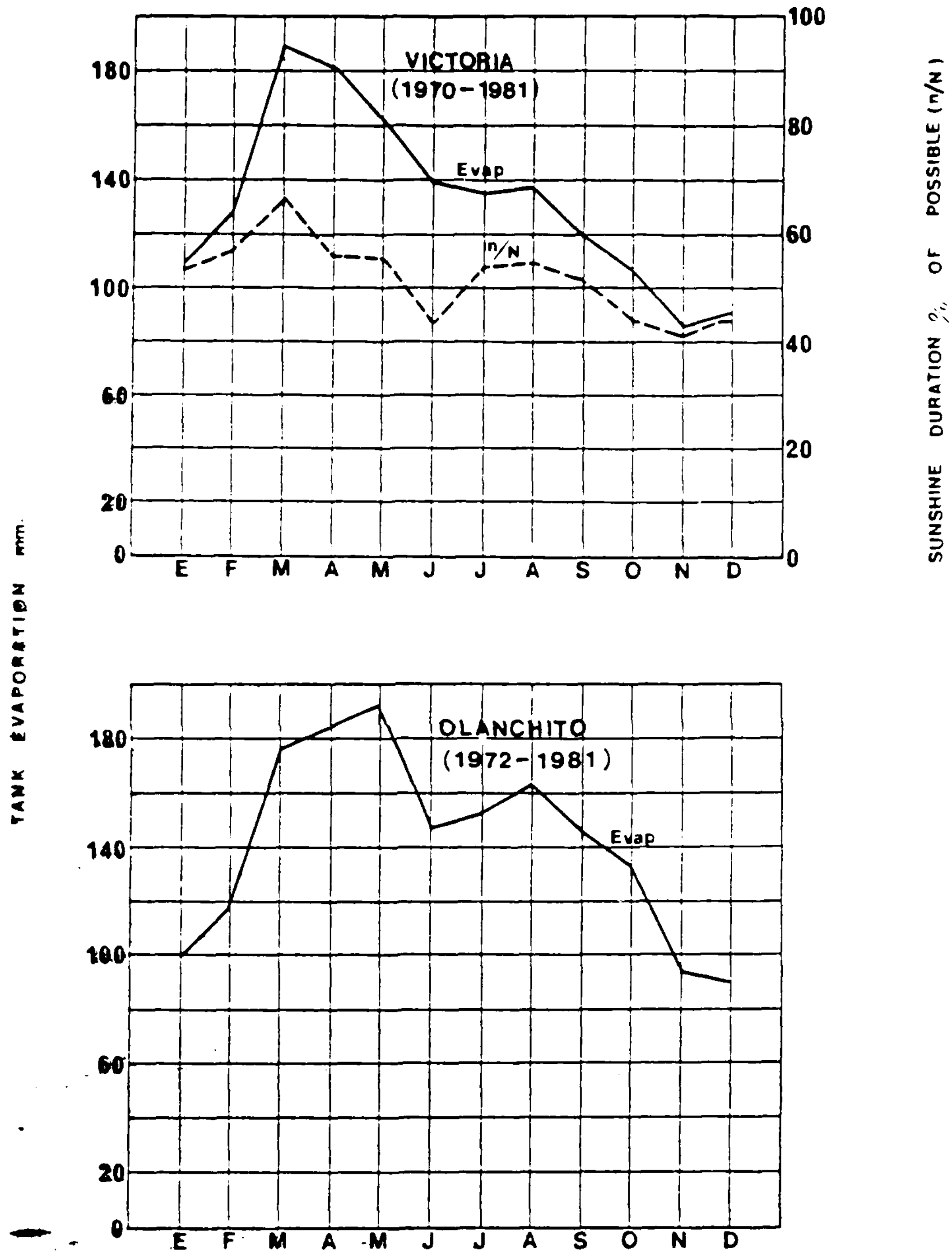
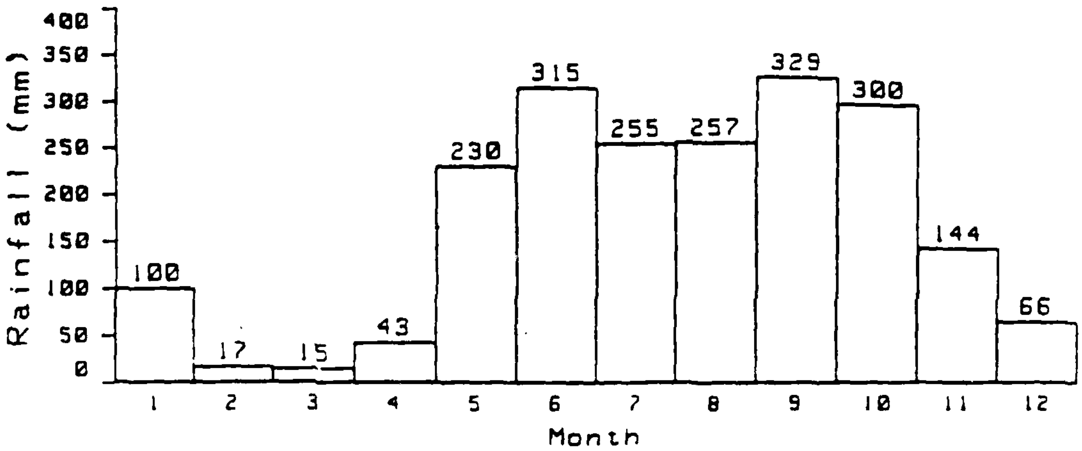
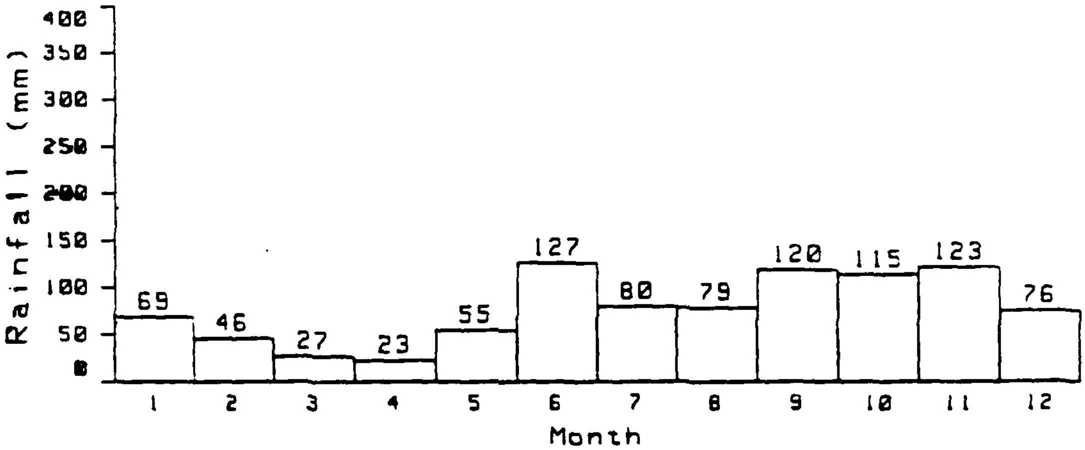


Fig. B-6 MEAN MONTHLY EVAPORATION AND SUNSHINE DURATION FOR UPPER AGUAN

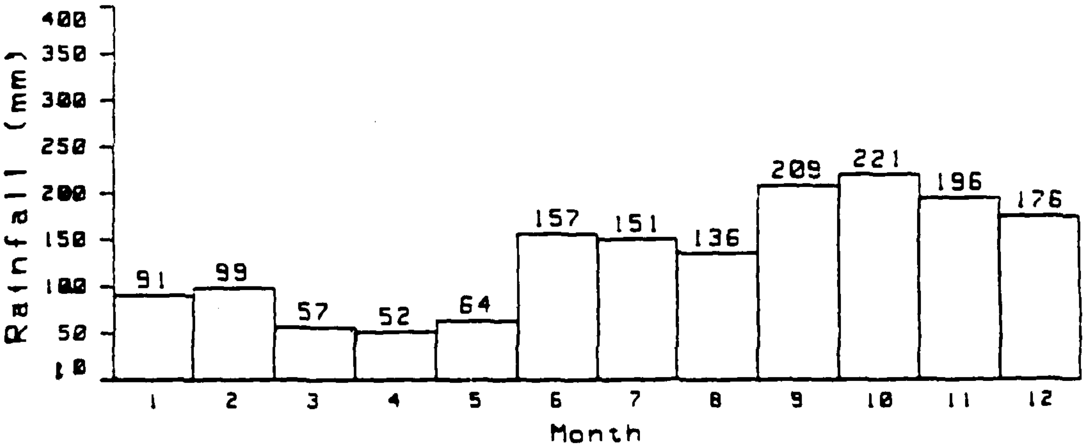
SOURCE: THE HYDRAULIC MASTER PLAN FOR THE AGUAN RIVER BASIN



YOCON



COYOLES



ISLETAS

Fig. B-7 MEAN MONTHLY RAINFALL AT SELECTED STATION

SOURCE: THE HYDRAULIC MASTER PLAN FOR THE AGUAN RIVER BASIN

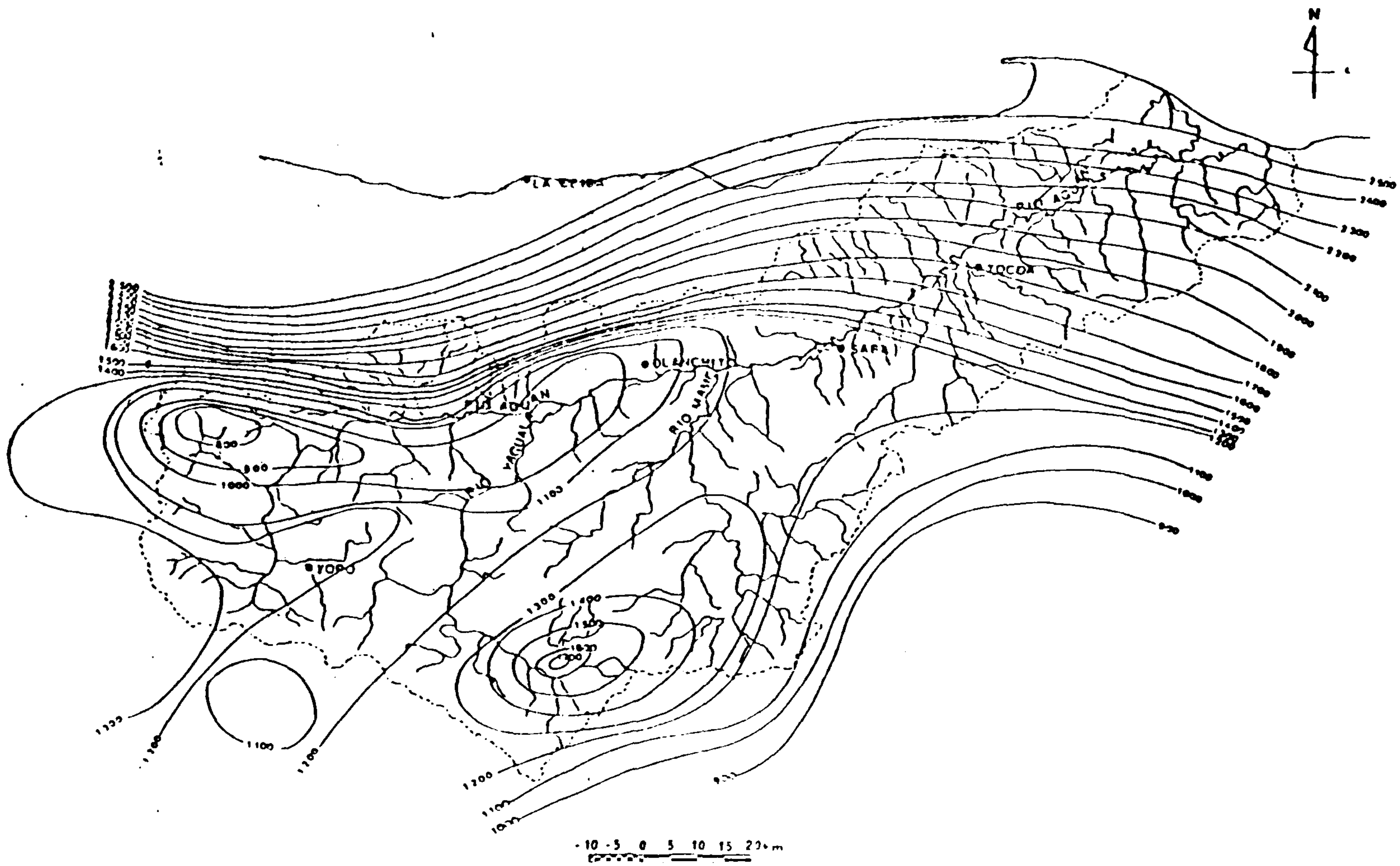


Fig. B-8 MEAN ANNUAL RAINFALL (mm) PERIOD (1973 - 1981)

SOURCE : THE HYDRAULIC MASTER PLAN FOR THE AGUAN RIVER BASIN

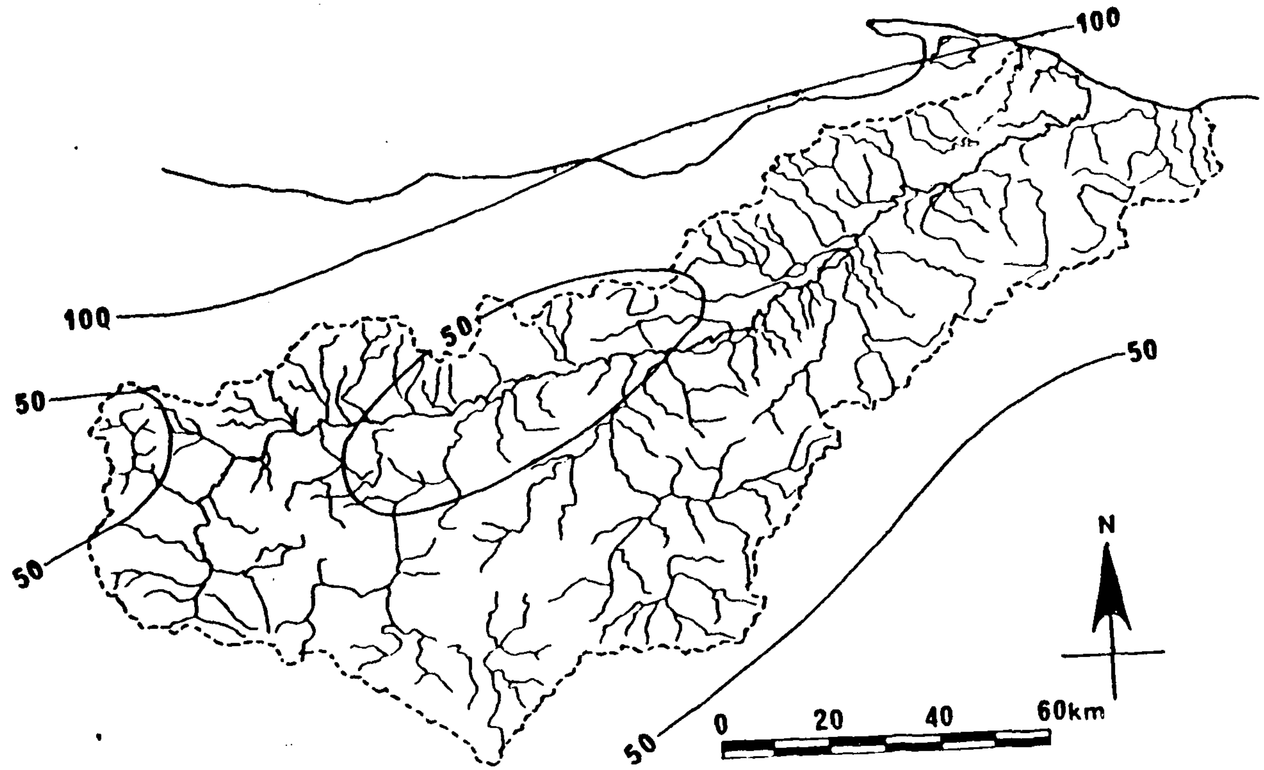


Fig. B-9-(1) MEAN RAINFALL mm PERIOD MARCH - MAY. 1973 - 1981

SOURCE : THE HYDRAULIC MASTER PLAN FOR THE AGUAN RIVER BASIN

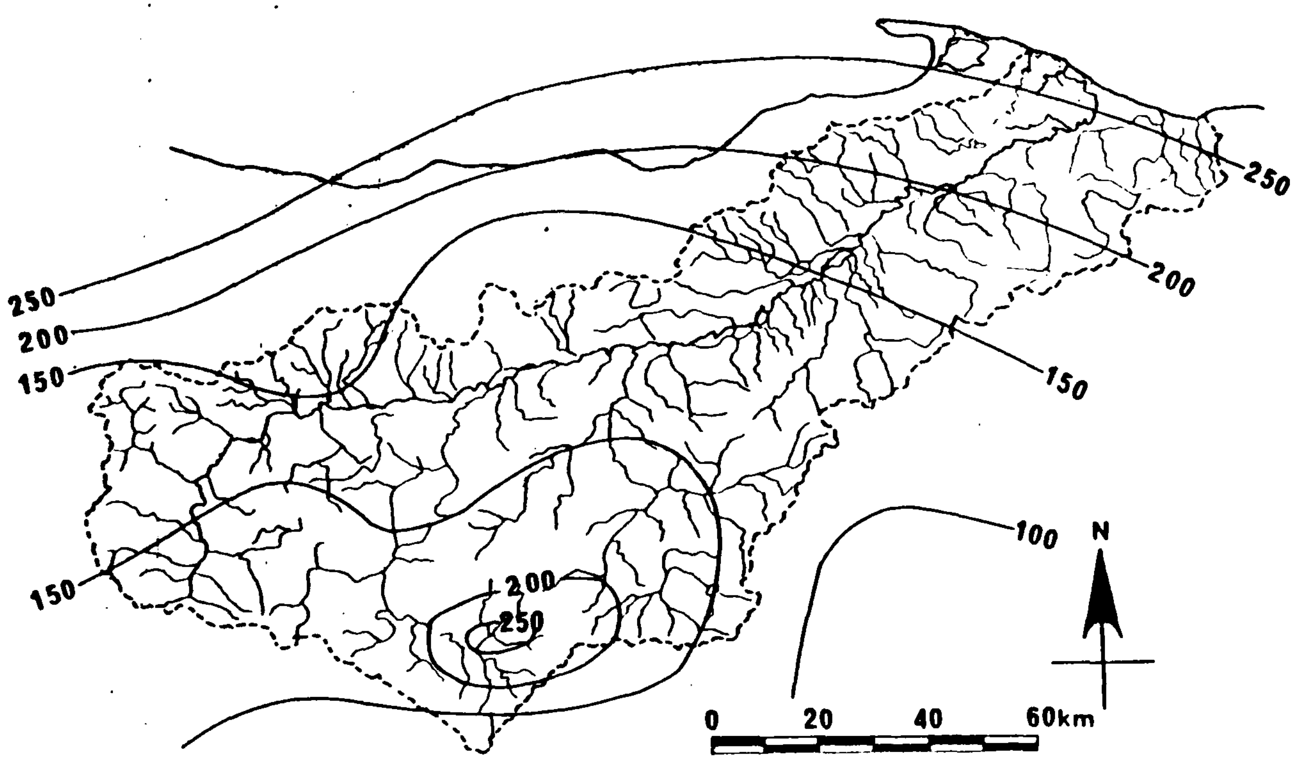


Fig. B-9-(2) MEAN RAINFALL mm PERIOD JUNE - AUGUST. 1973 - 1981

SOURCE: THE HYDRAULIC MASTER PLAN FOR THE AGUAN RIVER BASIN

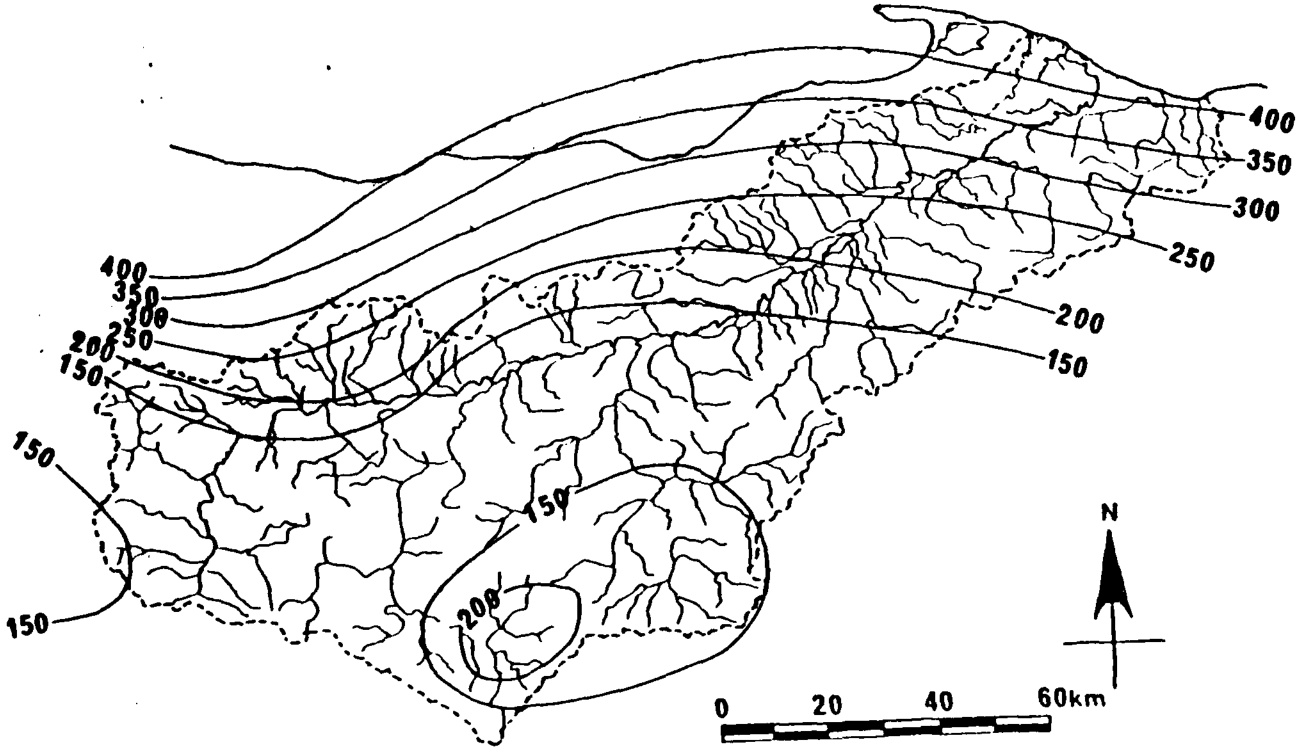


Fig. B-10-(1) MEAN RAINFALL mm PERIOD SEPTEMBER - NOVEMBER. 1973 - 1981

SOURCE: THE HYDRAULIC MASTER PLAN FOR THE AGUAN RIVER BASIN

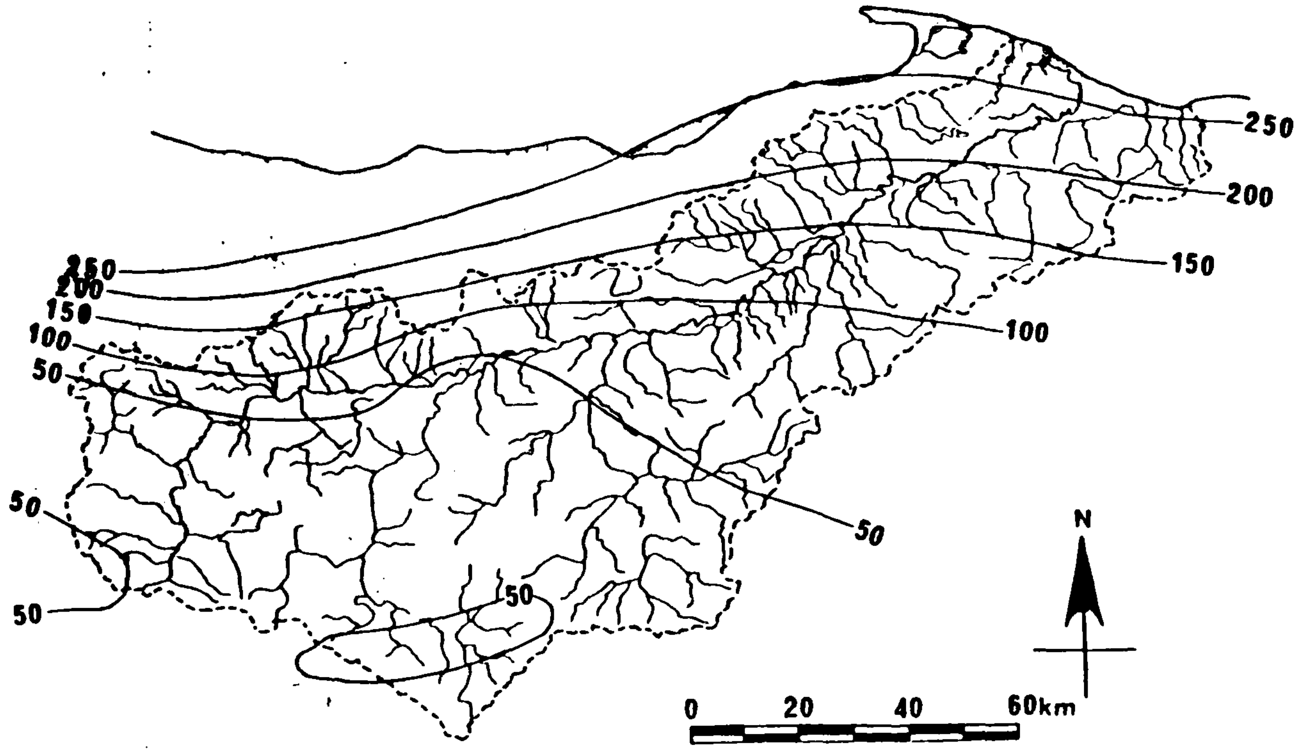


Fig. B-10-(2) MEAN RAINFALL mm PERIOD DECEMBER - FEBRUARY, 1973 - 1981
SOURCE: THE HYDRAULIC MASTER PLAN FOR THE AGUAN RIVER BASIN

CUADRO II-4

PRECIPITACION MAXIMA 24 HORAS DE DURACION PARA DIFERENTES PERIODOS DE RETORNO EN LAS AREAS DE DRENAJE DE LOS RIOS DE LA ZONA DE ESTUDIO

Nombre del Cauce	10 Años (Pulg)	25 Años (Pulg)	50 Años (Pulg)	100 Años (Pulg)
Río Aguan en Puente Durango	4.57	5.30	6.0	6.7
Río Aguan en confluencia Río Tocoa	4.60	5.34	6.03	6.76
Río Aguan en confluencia Río Juguaca	4.76	5.52	6.24	7.0
Río San Pedro	5.57	6.46	7.30	8.19
Río Cuaca	5.57	6.46	7.30	8.19
Río Jaguaca	5.63	6.53	7.38	8.28
Río Tocoa	5.74	6.66	7.52	8.44
Río Guapinol	5.67	6.58	7.43	8.33
Río Taujica	5.66	6.57	7.41	8.32
Río Monga	5.68	6.59	7.44	8.35
Río Corocito	5.67	6.58	7.43	8.33
Quebrada de Ceibita	5.71	6.62	7.48	8.40
Quebrada de Arena	5.69	6.60	7.45	8.36
Quebrada de Agua	5.72	6.64	7.49	8.41
Quebrada de Los Cocos	5.71	6.62	7.48	8.39
Río Mame	5.21	6.06	6.84	7.67
Río Cuyamel	3.45	4.00	4.52	5.07

CUADRO III-34

PRECIPITACION MAXIMA PROBABLE CON DIFERENTES PERIODOS DE RETORNO EN EL RIO AGUAN

Especificación	En Conf. R.Jaguaca	En Conf. R. Tocoa	En el Pte. Durango
a) Precipitación Max.1:10 años (P_{10}) de la curva de probabilidades, diario.	5.1"	5.1"	5.1"
b) Area de la cuenca (a) Millas^2.	2603.0	3699.0	3949.0
c) Precipitación Max.24 horas			
$P_{max24} = P_{10} x 1.13$*	5.76"	5.76"	5.76"
d) Coeficiente (c) de la cuenca.	0.33	0.33	0.33
e) Precipitación Max.24 horas en función del área (P_{a-10})**			
$P_{a-10} = P_{max24}(100-C\sqrt{a}):100$	4.76	4.60	4.57
f) Precipitación Max.24 horas con otros períodos de retorno.			
$P_{a-25} = P_{a-10} \times 1.16$	5.52	5.34	5.30
$P_{a-50} = P_{a-10} \times 1.31$	6.24	6.03	6.00
$P_{a-100} = P_{a-10} \times 1.47$	7.00	6.76	6.70

* Rainfall Intensities, George H. Hargreaves, 1980

** Introduction to Hidrometeorology, J.P. Bruce, R.H. Clark

CUADRO III-35

PRECIPITACION MAXIMA VS DURACION Y AREA DE LA CUENCA EN EL VALLE AGUAN

(En Milimetros)

Area de la Cuenca Km^2	Duración de la Precipitación en Horas 6	12	18	24	30	36	48	60	72	96
25.6	400	715	908	963	1015	1045	1078	1118	1130	1130
256	350	658	813	880	913	948	972	1005	1015	1020
512	335	640	785	855	883	918	943	970	980	990
1280	313	615	743	818	840	875	900	923	933	943
2560	280	565	685	755	790	823	843	860	873	885
5120	235	443	563	620	658	683	710	730	743	763
12800	135	243	333	388	438	460	493	505	525	545
25600	83	165	215	265	303	328	368	390	410	433
51200	58	108	145	188	220	240	280	313	338	355

CUADRO III-36

PRECIPITACION MAXIMA PARA DIFERENTES PROBABILIDADES DE OCURRENCIA Y DURACION EN EL VALLE BAJO AGUAN*

(En mm)

Duración Min	Hor	Probabilidad de Ocurrencia en Años 1:5	1:10	1:25	1:50	1:100
5		27	32	36	40	
15		36	41	47	53	
30		42	49	56	63	
60		51	59	67	75	
	2	60	70	79	89	
	3	66	76	89	102	114
	6	79	91	107	122	132
	12	91	112	127	142	163
	24	112	130	147	165	188
	36	122	145	168	183	208
	48	132	158	180	196	224

Calculado en base Boletín #40 para 75°W y 40°N

CUADRO III-9

REGISTROS DE PRECIPITACION

(mm)

Estación Isletas:

AÑO	MAY.	JUN.	JUL.	AGOS.	SEP.	OCT.	NOV.	DIC.	ENE.	FEB.	MAR.	ABR.	ANUAL
1958-59				162	267	259	131	189	181	6	56	57	
1959-60	65	114	50	63	186	114	452	147	139	101	222	83	1736
1960-61	104	166	167	102	94	66	209	213	257	131	31	22	1562
1961-62	89	46	166	113	163	187	115	172	267	12	36	37	1403
1962-63	134	115	131	117	148	374	246	91	68	81	91	0	1596
1963-64	98	39	139	91	167	158	207	194	123	98	7	0	1321
1964-65	32	52	106	56	157	361	206	149	124	75	49	15	1382
1965-66	67	135	131	127	251	164	164	162	153	154	129	5	1642
1966-67	208	258	70	78	88	180	212	141	248	178	19	62	1742
1967-68	24	28	36	57	114	182	416	149	177	177	105	0	1465
1968-69	172	85	95	80	225	138	291	363	82	38	53	0	1625
1969=70	157	185	71	156	260	55	279	225	111	90	101	0	1690
1970-71	118	143	167	73	122	86	438	211	43	133	58	153	1745
1971-72	41	193	27	152	166	76	240	102	98	90	43	1	1229
1972-73	37	79	72	67	121	196	119	132	88	54	33	1	999
1973-74	97	118	113	162	174	139	174	128	65	111	42	18	1341
1974-75	50	130	62	94	525	431	188	96	85	213	12	0	1886
1975-76	48	12	45	74	126	283	204	224	164	67	4	29	1280
1976-77	70	211	(93)	(116)	(89)	(157)	(72)	(213)	(42)	(38)	(26)	(100)	1227
1977-78	(145)	(318)	(207)	(86)	(93)	(136)	(162)	(78)	(154)	(61)	(166)	(14)	1620

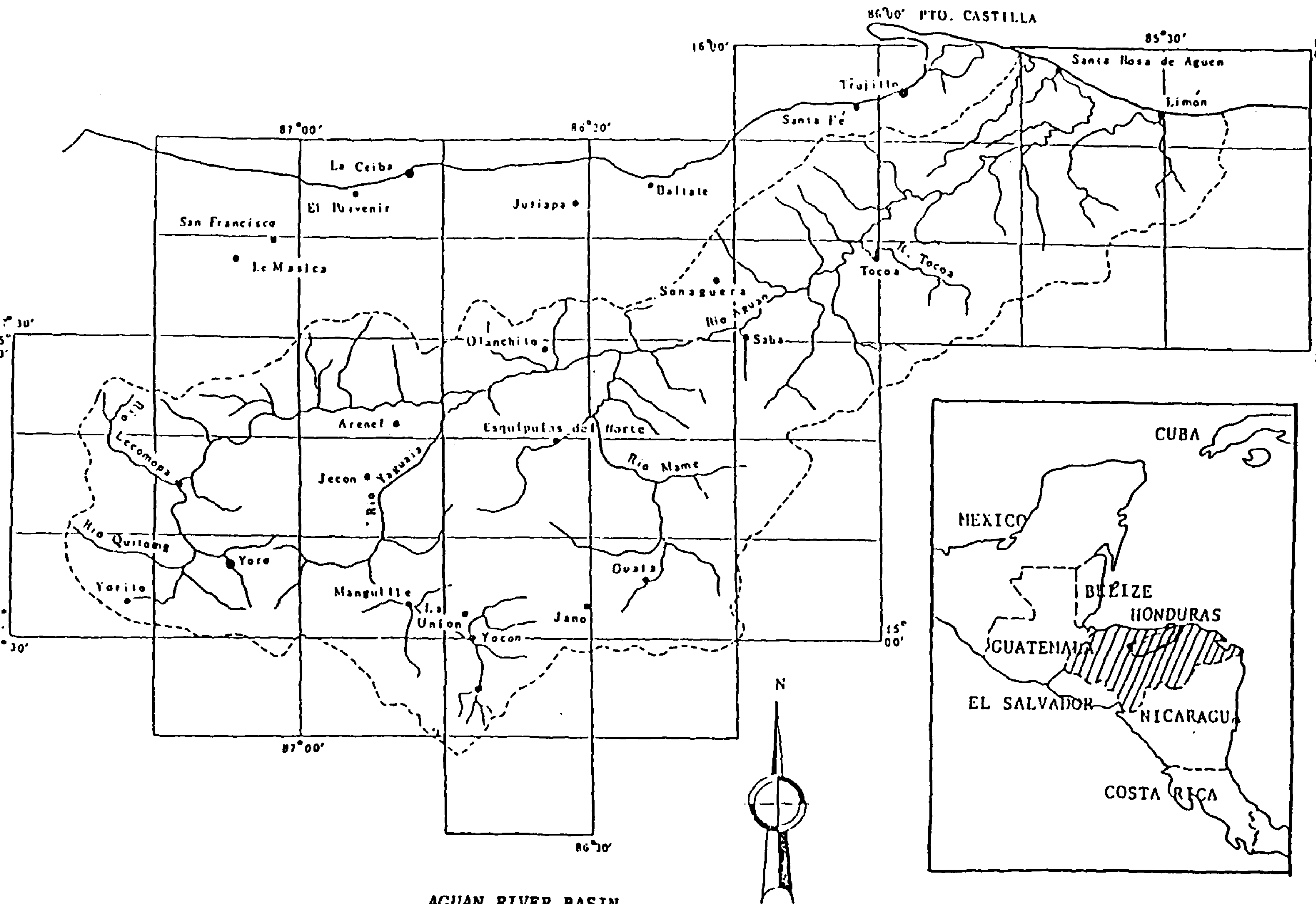


Fig. 3-1 AGUAN RIVER BASIN
CUENCA DEL RIO AGUAN

CUADRO III-30

PRINCIPALES TRIBUTARIOS Y OTRAS QUEBRADAS MENORES DEL VALLE BAJO AGUAN

Cauce	Area de Drenaje Km^2	(m^3/seg) Descarga Max. Probable Q_{10}	Q_{25}	Q_{50}	Dimensión Puente Sobre Carretera (m) Largo x Altura
I Márgen Derecha					
1) R.Jaguaca	120.0	430.00	530.00	600.00	48 x 3
2) Tr.del Balsamo	5.0	85.00	110.00	125.00	32 x 3
3) Q.El Balsamo	24.0	190.00	240.00	270.00	18 x 3
4) Cr.del Tepusteca	1.0	37.00	46.00	54.00	2 x 2
5) Cr.del Tepusteca	2.5	60.00	75.00	105.00	2 x 2
6) Q.Tepusteca	5.0	85.00	110.00	125.00	18 x 3
7) Q.los Cocos	20.0	184.00	214.00	243.00	32 x 3
8) Q.Monga	1.0	0.75	0.83	0.97	2 x 2
9) Q.Agua Caliente	5.0	2.86	3.18	3.72	2 x 2
10) R.Monga	40.0	240.00	300.00	350.00	48 x 3
11) Q. La Pava	3.5	2.12	2.37	2.76	12 x 2
12) Q. Regaderos	10.5	125.00	157.00	180.00	12 x 2
13) Tr.de Regaderos	1.0	0.75	0.83	0.97	6 x 2
14) Tr.del Achiote	1.0	0.75	0.83	0.97	24 x 3
15) Q.El Achiote	14.5	147.00	185.00	208.00	24 x 3
16) Cr.El Achiote	2.0	1.13	1.48	1.73	24 x 3
17) Q.de Calmuyo	5.0	85.00	110.00	125.00	Tributa a Q.Honda
18) Q.de Orica	7.0	100.00	126.00	150.00	Tributa a Q.Honda
19) Q.Honda	18.0	162.00	200.00	230.00	24 x 2
20) Q.Seca	7.8	105.00	132.00	158.00	36 x 2.5
21) Q.Prieta	3.0	1.87	2.08	2.43	24 x 2
22) Cr.Quaca	0.5	0.42	0.47	0.55	42 x 2
23) R.Quaca	250.0	615.00	760.00	820.00	96 x 4
24) Tr.de San Pedro	2.0	1.33	1.48	1.73	42 x 3
25) R.San Pedro	257.0	620.00	770.00	850.00	72 x 3
26) Q.Collmita	11.0	125.00	160.00	180.00	24 x 2
27) Q.Zarca	3.0	66.00	84.00	96.00	24 x 2
28) R.Guapinol	58.0	300.00	365.00	418.00	36 x 2.5
29) Cr.Benegas	2.5	1.60	1.79	2.09	36 x 2
30) Dren. Principal	1.0	0.75	0.83	0.97	6 x 1.5
31) Q.Ceibita	15.0	150.00	190.00	210.00	24 x 2
32) Cr.Ceibita	3.0	66.00	84.00	96.00	24 x 2
33) R.Tocoa	200.0	550.00	690.00	790.00	60 x 4
34) Q. del Antigual	5.0	85.00	110.00	125.00	2 x 2
35) Q.del Tigre	2.0	54.00	68.00	72.00	2 x 2
36) Cr.Yucatán	1.0	37.00	46.00	54.00	16 x 2
37) Q.Yucatán	2.0	54.00	68.00	72.00	16 x 2
38) Dren.Yucatán	1.0	0.75	0.83	0.97	2 x 2
39) Dren.Sinaloa	0.5	0.42	0.47	0.55	2 x 1
40) R. Taujica	76.0	334.00	425.00	486.00	24 x 2
41) R. Viejo	10.0	120.00	150.00	172.00	52 x 4
42) Q.Juan Antonio	13.0	137.00	175.00	213.00	24 x 3

Cauce	Area de Drenaje Km^2	Descarga Max. Probable (m^3/seg) Q_{10}	Q_{25}	Q_{50}	Dimensión Puente Sobre Carretera (m) Largo x Altura
43) Cr. Pedroso	3.0	66.00	84.00	96.00	10 x 2
44) Cr. Brichito	3.0	1.87	2.08	2.43	6 x 2
45) Q. de Arena	30.0	210.00	264.00	300.00	54 x 4
46) Cr. S.N.	2.0	1.33	1.48	1.73	12 x 2
47) Cr. S.N.	2.0	1.33	1.48	1.73	16 x 2
48) Cr. S.N.	2.0	1.33	1.48	1.73	12 x 2
49) Cr. S.N.	2.0	1.33	1.48	1.73	6 x 2
50) Q. de Agua	14.0	145.00	182.00	206.00	36 x 3
51) Cr. S.N.	2.0	1.33	1.48	1.73	6 x 2
52) Q. de Briche	6.0	90.00	120.00	140.00	48 x 3
53) Cr. S.N.	1.0	0.75	0.83	0.97	12 x 2
54) Cr. S.N.	2.5	60.00	75.00	85.00	12 x 2
55) Q. Pablo Martínez	2.0	1.33	1.48	1.73	16 x 2
56) Q. Palmichal	2.0	1.33	1.48	1.73	12 x 2
57) Q. Arenosa	3.0	66.00	84.00	96.00	32 x 3
58) Q. Corocito	73.0	325.00	415.00	470.00	24 x 3
59) R. Tepi	8.0	108.00	136.00	160.00	33 x 3
60) R. Bonito	200.0	550.00	690.00	790.00	32 x 3.50
II Márgen Izquierda					
1) R. El Terrero	40.0	240.00	300.00	350.00	No cruza camino
2) R. Montes de Oro	12.0	130.00	168.00	220.00	10 x 3
3) R. Ponciano	55.0	286.00	360.00	412.00	Tributa a Q. La Pita
4) Q. La Pita	19.0	165.00	210.00	240.00	15 x 3
5) R. Sonanguera	180.0	522.00	648.00	756.00	Tributa Churrusquera
6) R. Churrusquera	45.0	256.00	324.00	369.00	Tributa al Ilanga
7) R. Guijiniquilapa	40.0	240.00	300.00	350.00	100 x 4
8) R. Ilanga	68.0	312.00	394.00	450.00	Tr. en Guijiniquilapa
9) R. El Coco	127.0	430.00	550.00	620.00	48 x 3
10) R. El Saladillo	14.0	145.00	182.00	206.00	16 x 4
11) R. Chapaguita	76.0	334.00	425.00	[illegible]	40 x 5
12) Q. Dona Juan	7.0	100.00	126.00	[illegible]	Tr. al Chapaguita
13) T. Tarros	15.0	150.00	190.00	210.00	No cruza camino
14) R. De Enmedio	12.0	130.00	168.00	190.00	No cruza camino
15) R. El Claro	21.0	176.00	214.00	250.00	No cruza camino
III Cruces entre Corocito y Río Chapagua					
1) Cr. Corocito	2.0	1.33	1.48	1.73	3 x 2
2) Dren. Corocito	1.0	0.75	0.83	0.97	2 x 1.8
3) Cr. S.N.	Aliviadero	109.00	135.00		24 x 2.5
4) Cr. S.N.	Aliviadero	451.00	557.00		118 x 3.2
5) Cr. S.N.	Aliviadero	172.00	205.00		40 x 2.5
6) Cr. S.N.	Aliviadero	451.00	557.00		200 x 3.0
7) Cr. S.N.	Aliviadero	78.00	95.00		16 x 2.5
8) Cr. S.N.	Aliviadero	[illegible]	299.00		60 x 3.0

CUADRO III-30 (Continuación)

Cauce	Area de Drenaje Km^2	(m^3/seg) Descarga Max.Probable Q_{10}	Q_{25}	Q_{50}	Dimensión Puente Sobre Carretera(m) Largo x Altura
9) R. Aguán (Durango)	10,228	690.00	816.00		124 x 4.0
10) Cr. S.N.	Aliviadero	140.00	168.00		32 x 2.5
11) Dren	Aliviadero	9.00	11.00		2 x 2
12) Dren	Aliviadero	9.00	11.00		2 x 2
13) Cr. S.N.	Aliviadero	371.00	409.00		32 x 6
14) Cr. S.N.	Aliviadero	482.00	575.00		48 x 6
15) R. Chapagua	70	324.00	387.00		192 x 5

R (Río)

Q (Quebrada)

Cr. (Crique)

S.N (Sin Nombre)

T (Tributario)

CUADRO II-3

DESCARGA MAXIMA PROBABLE CARACTERISTICO

DE LOS RIOS EN EL AREA DE ESTUDIO

Nombre del Cauce	PMF * Pico m^3/seg	Tiempo al Pico (hrs)	Area de Drenaje Km.	Creager "C"
*Río Aguan en Puente Durango	21,100	45	10,228.0	111
Río Aguan en confluencia Río Tocoa	25,300	39	9,582.0	137
Río Aguan en confluencia Río Jaguaca	28,200	30	6,743.0	174
Río San Pedro	2,880	18	250.8	82
Río Cuaca	2,820	18	251.7	81
Río Jaguaca	2,235	7.5	123.0	97
Río Tocoa	2,465	13.5	201.1	80
Río Guapinol	910	3.75	60.4	62
Río Taujica	1,436	7	75.2	85
Río Monga	780	2.5	41.1	68
Río Corocito	1,141	9.0	73.8	68
Quebrada de Ceibita	390	1.75	15.7	68
Quebrada de Arena	490	3.25	30.5	53
Quebrada de Agua	179	1.5	12.5	37
Quebrada de Los Cocos	410	2.0	18.5	63
Río Mame	10,145	20	2,076.7	101
Río Cuyamel	388	14	48.6	30

CUADRO II-5

DESCARGA PICO PARA DIFERENTE PERIODO DE PERIODO DE RETORNO DE LOS MAS IMPORTANTES RIOS EN EL AREA DE ESTUDIO

Nombre del Cauce	* Tiempo de Pico (Hr)	10 años m^3/seg.	25 años m^3/seg.	50 años m^3/seg.	100 años m^3/seg.
Río Aguan en Puente Durango	63.0	3,400	4,000	4,650	5,260
Río Aguan en confluencia Río Tocoa	57.0	3,820	4,540	5,207	5,950
Río Aguan en confluencia Río Jaguaca	51.0	3,840	4,550	5,212	5,950
Río San Pedro	10.5	600	710	810	920
Río Cuaca	11.0	620	730	830	940
Río Jaguaca	7.0	600	710	800	910
Río Tocoa	12.0	590	690	790	890
Río Guapinol	3.75	280	320	360	410
Río Taujica	7.0	390	460	520	590
Río Monga	3.75	310	350	400	440
Río Corocito	8.0	260	310	350	390
Quebrada de Ceibita	3.25	150	180	200	230
Quebrada de Arena	4.0	180	210	240	270
Quebrada de Agua	3.5	97	113	122	144
Quebrada de Los Cocos	1.7	167	194	220	247
Río Mame	16	2,279	2,695	3,085	3,503
Río Cuyamel	6.5	117	138	157	178

* Iniciandose en el momento que el agua en el cauce comienza a subir.

CUADRO II-2

CARACTERISTICAS GEOGRAFICAS
DE LOS RIOS EN EL AREA ESTUDIADA

Nombre del Cauce	Cuenca Km.^{2}	Longitud Km.	H max m.	H min m.
Río Aguan en Puente Durango	10,228.0	292.0	1180.0	10.0
Río Aguan en confluencia Río Tocoa	9,582.0	238.0	1180.0	40.0
Río Aguan en confluencia Río Jaguaca	6,743.0	163.0	1180.0	90.0
Río San Pedro	250.8	38.2	1270.0	50.0
Río Cuaca	251.7	40.3	1210.0	55.0
Río Jaguaca	123.0	19.0	1180.0	120.0
Río Tocoa	201.1	31.7	1280.0	40.0
Río Guapinol	60.4	19.0	1370.0	40.0
Río Taujica	75.2	17.1	1080.0	40.0
Río Monga	41.1	12.8	1280.0	90.0
Río Corocito	73.8	21.9	500.0	30.0
Quebrada de Ceibita	15.7	7.7	970.0	50.0
Quebrada de Arena	30.5	13.3	540.0	15.0
Quebrada de Agua	12.5	7.3	280.0	20.0
Quebrada de Los Cocos	18.5	9.5	1070.0	95.0
Río Mame	2,076.7	94.4	1440.0	95.0
Río Cuyamel	48.6	21.5	780.0	60.0

HIDROGRAMA DE DESCARGAS MAXIMAS DEL RIO AGUAN CON PROBABILIDADES DE OCURRENCIA 1:10 AÑOS Y 1:25 AÑOS EN JAGUACA, TOCOA Y PTE. DURANGO.

PIES CUBICOS POR SEGUNDO

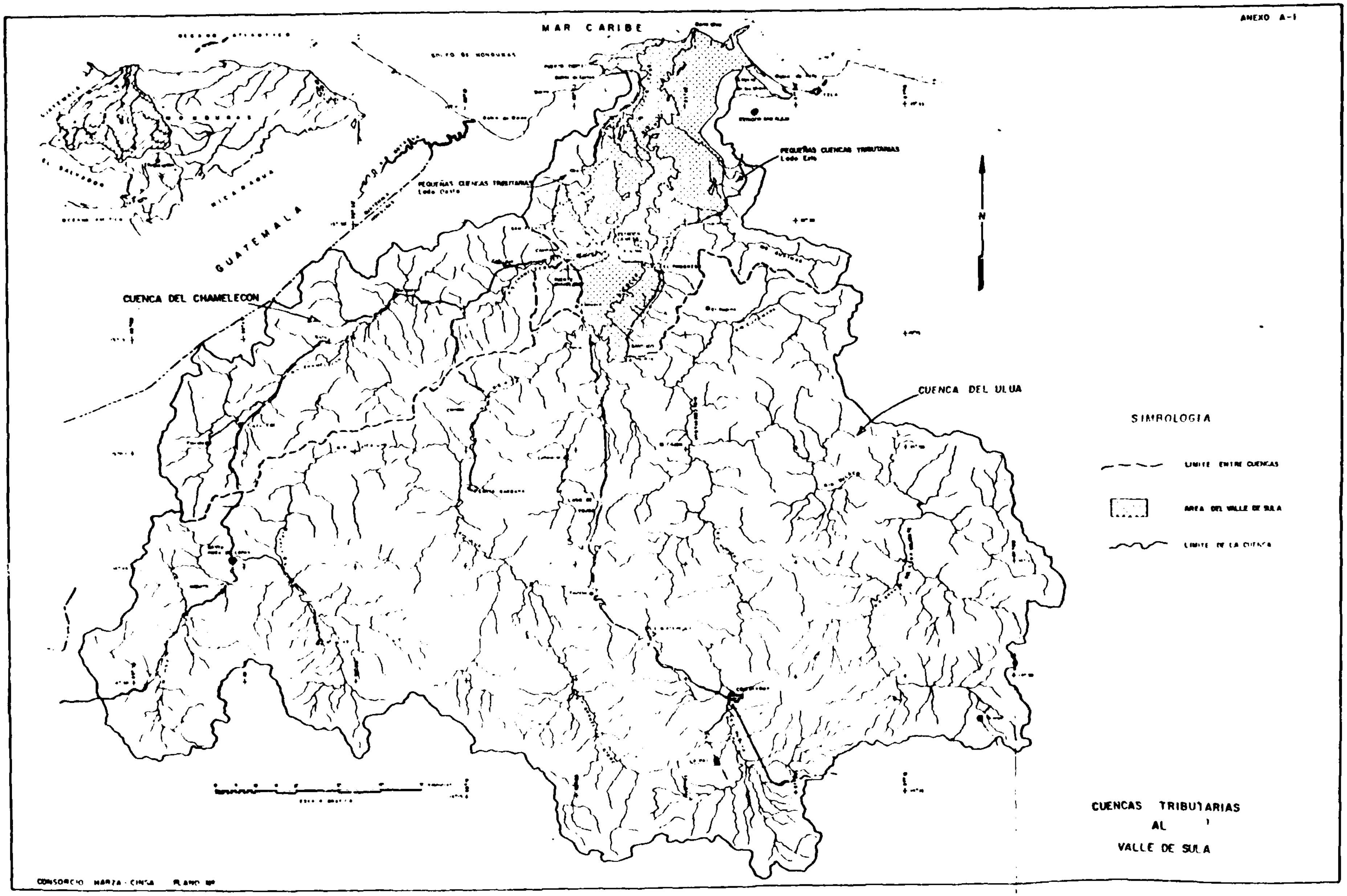
Tiempo desde inicio de lluvia (horas)	Confluencia R. Jaguaca 1:10 años	Confluencia R. Jaguaca 1:25 años	Confluencia R. Tocoa 1:10 años	Confluencia R. Tocoa 1:25 años	Confluencia Pte. Durango 1:10 años	Confluencia Pte. Durango 1:25 años
30	0	0	0	0	0	0
33	177	324	54	137	26	66
36	8133	10013	3543	4457	1722	2194
39	30820	37217	13721	16767	7806	9551
42	68462	81987	30554	37024	17533	21237
45	108293	129067	54947	66220	31608	38075
48	132750	157758	83611	100320	49613	59530
51	136391	161774	109376	130803	70175	83890
54	125373	148457	127200	151734	89720	196930
57	107733	127343	135782	161619	105421	125312
60	90887	107222	135290	160730	116321	137929
63	77108	90804	128186	152053	121513	143750
66	65477	77030	117791	139520	121236	143130
69	55821	65673	104861	124157	117046	137946
72	47596	56008	93955	111257	110323	129834
75	50969	48171	83941	99431	102223	120150
78	35309	41441	74825	88666	92648	108831
81	29980	35111	66583	78869	84365	99094
84	24481	18616	58602	89334	76175	89490
87	19055	22255	50872	60090	68780	80830
90	14743	17217	43503	51283	61478	72274
93	11163	13035	36686	43166	54447	64025
96	8453	9870	30687	36060	47820	56242
99	6430	7514	25660	30137	41634	48972
102	4819	5623	21392	25113	35932	42261
105	3506	4087	17860	20973	30631	36024
108	2408	2803	14813	17390	26274	30898
111	1597	1855	12093	14197	22439	26391
114	1147	1332	10007	11749	19315	22720
117	830	963	8350	9801	16601	19533
120	594	689	6912	8111	14410	16958
123	419	487	5642	6621	12471	14674
126	298	346	4714	5535	10696	12583
129	204	237	3938	4627	9061	10657
132	136	158	3266	3836	7711	9070
135	86	99	2665	3137	6677	7855
138	48	55	2122	2487	5768	6785
141	22	25	1620	1893	4947	5817
144	6	7	1147	1336	4199	4938
147	0	0	760	884	3633	4274
150	35	40	710	803	3371	3965
153	0	0	434	504	2717	3178
156	0	0	328	381	1461	1697
159	0	0	245	235	1067	1244
162	0	0	181	311	817	954
165	0	0	130	151	632	739
168	0	0	46	57	424	500
171	15	18	198	205	586	698
174	0	0		[illegible]	252	[illegible]
177	0	0			206	

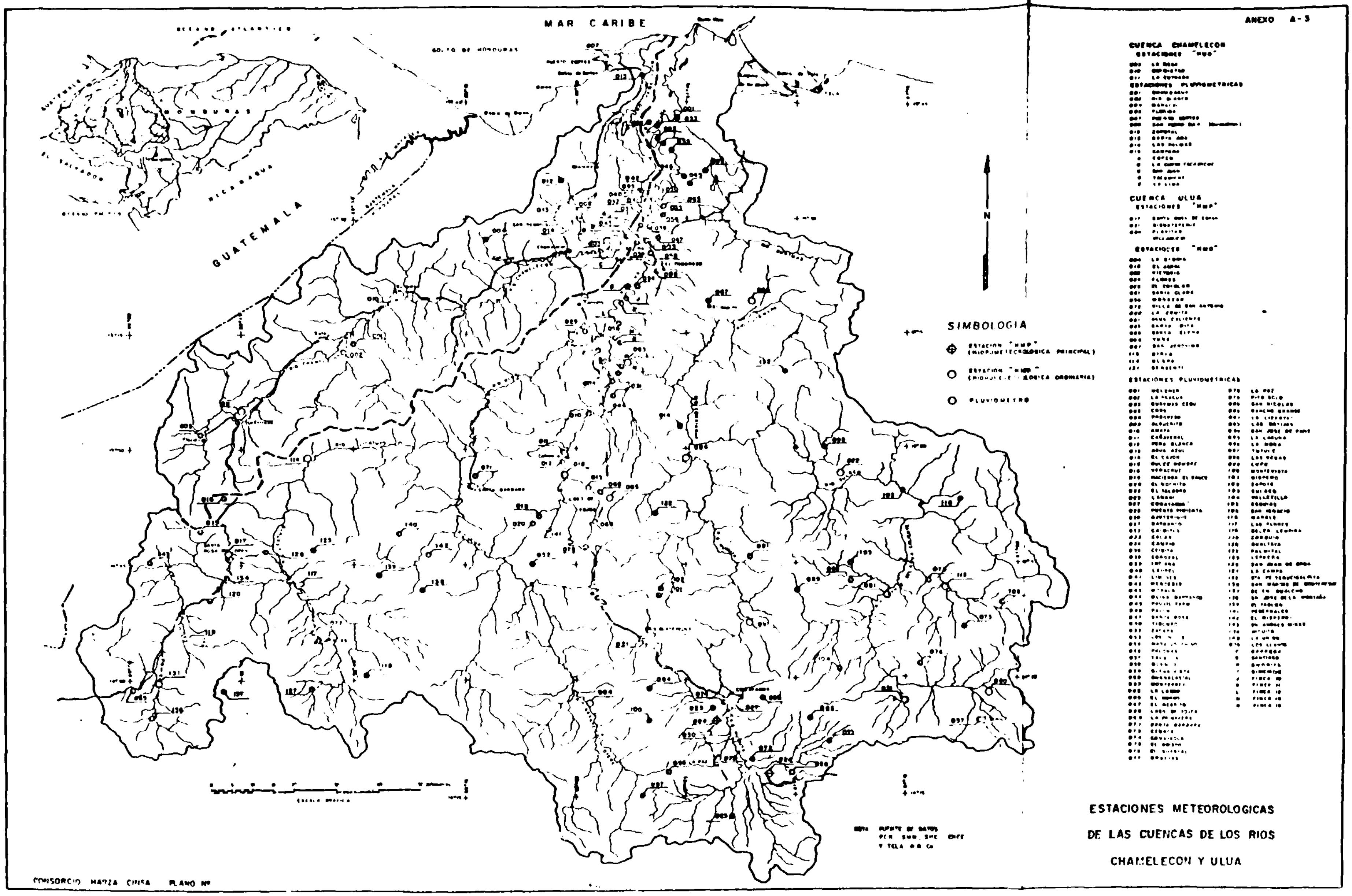
SECTION C
LIST OF
SULA VALLEY DATA

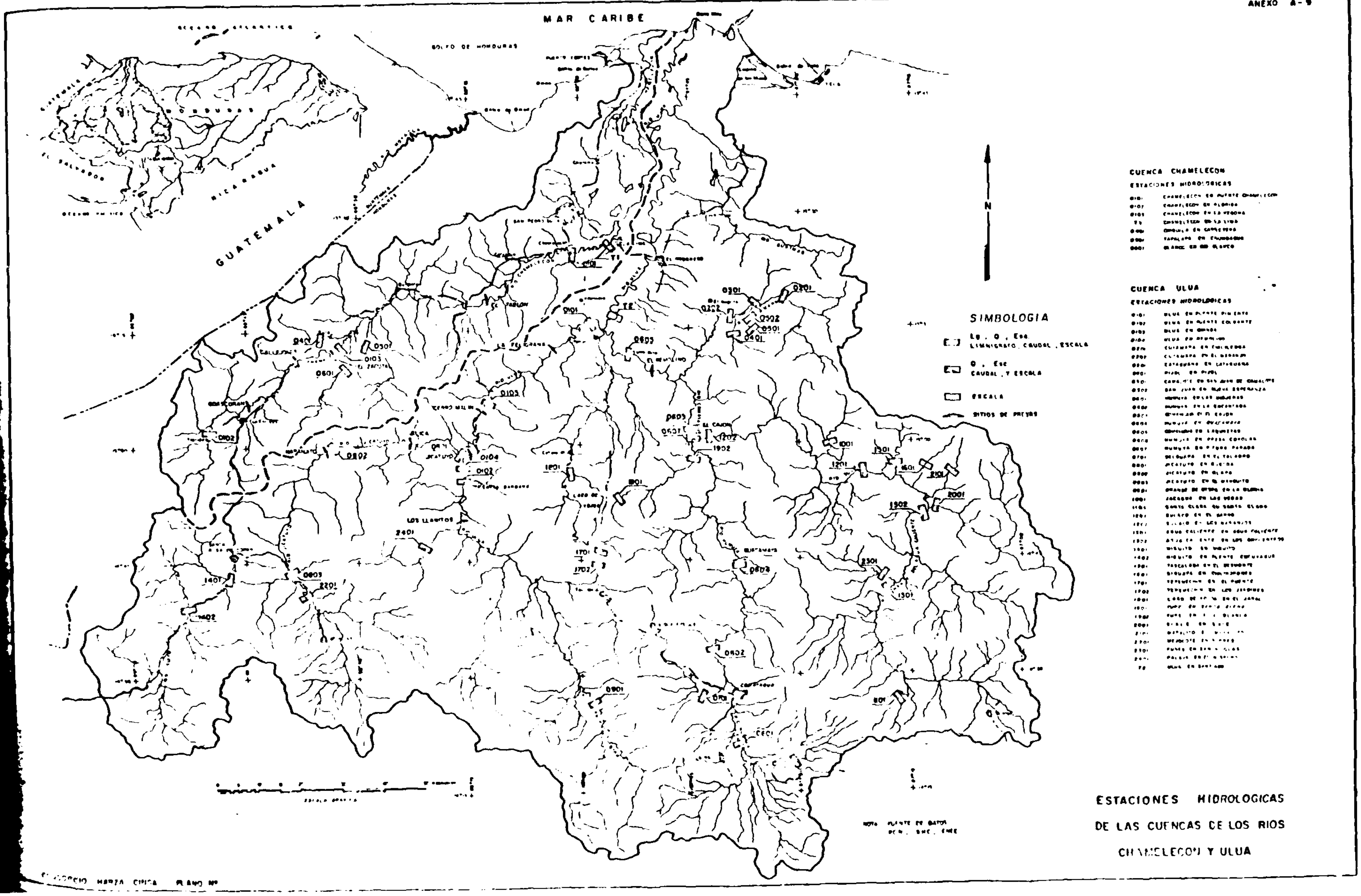
SECTION C

LIST OF

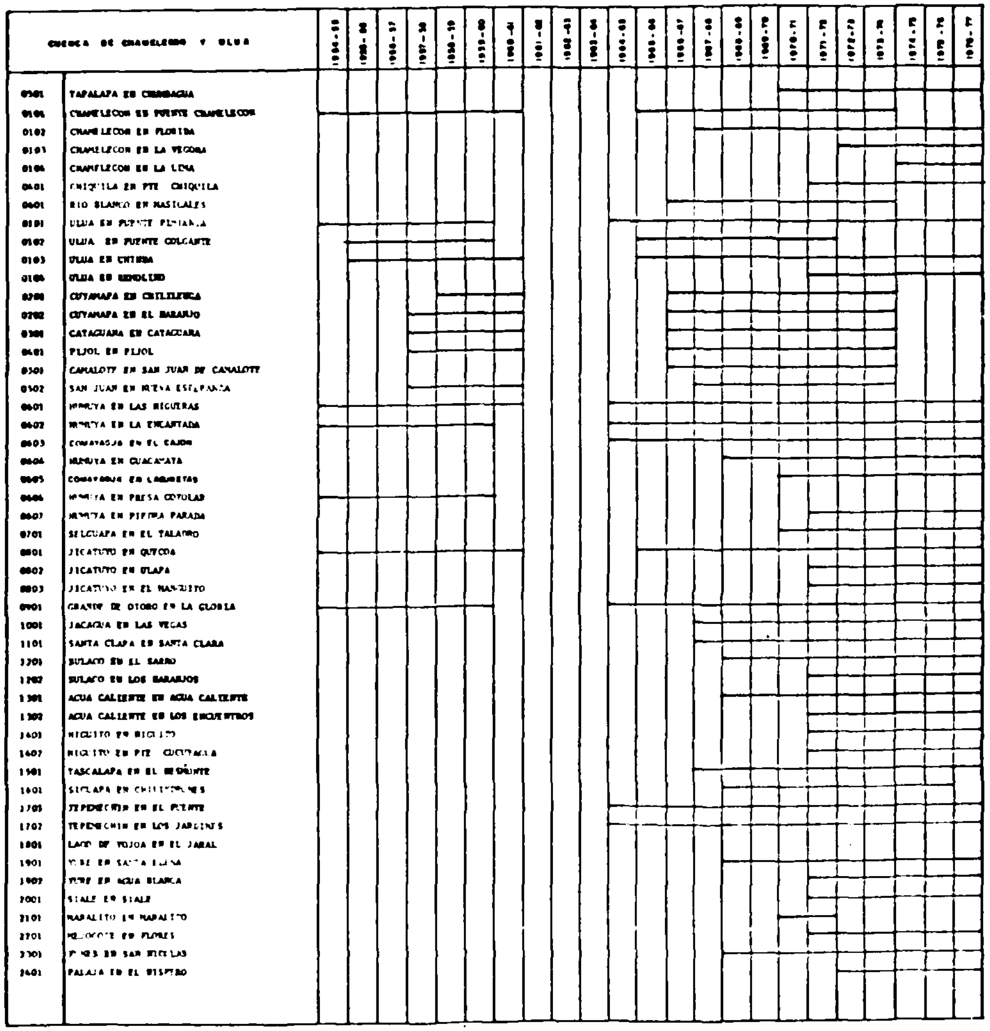
SULA VALLEY DATA CONTINUED


ANEXO A-1
MAR CARIBE
GOLFO DE HONDURAS
GUATEMALA
PEQUEÑAS CUENCAS TRIBUTARIAS
Lado Este
PEQUEÑAS CUENCAS TRIBUTARIAS
Lado Oeste
CUENCA DEL CHAMELECON
CUENCA DEL ULUA
N
SIMBOLOGIA
LIMITE ENTRE CUENCAS
AREA DEL VALLE DE SULA
LIMITE DE LA CUENCA
CUENCAS TRIBUTARIAS
AL
VALLE DE SULA
CONSORCIO HARZA-CINSA PLANO Nº


ANEXO A-3
MAR CARIBE
GOLFO DE HONDURAS
GUATEMALA
HONDURAS
EL SALVADOR
NICARAGUA
N
CUENCA CHAMELECON
ESTACIONES "HMO"
ESTACIONES PLUVIOMETRICAS
CUENCA ULUA
ESTACIONES "HMP"
ESTACIONES "HMO"
ESTACIONES PLUVIOMETRICAS
SIMBOLOGIA
PLUVIOMETRO
ESCALA GRAFICA
ESTACIONES METEOROLOGICAS
DE LAS CUENCAS DE LOS RIOS
CHAMELECON Y ULUA
CONSORCIO HARZA CINSA PLANO No


ANEXO A-9
MAR CARIBE
GOLFO DE HONDURAS
GUATEMALA
SIMBOLOGIA
Lg, Q, Esc
LIMNIGRAFO, CAUDAL, ESCALA
Q, Esc
CAUDAL, Y ESCALA
ESCALA
SITIOS DE PRESAS
CUENCA CHAMELECON
ESTACIONES HIDROLOGICAS
CUENCA ULUA
ESTACIONES HIDROLOGICAS
ESTACIONES HIDROLOGICAS
DE LAS CUENCAS DE LOS RIOS

ANEXO A-II



NOTA FUENTE DE DATOS
P.C.H., S.H.C., ENEE

ESTACIONES HIDROLOGICAS EN LA CUENCA DE LOS RIOS CHAMELECON Y ULUA

PERIODO DE OPERACION

[illegible]	ESTACION	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	TIPO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	PERIODO DE MEDIDA DE	HASTA
21	[illegible]															
01[illegible]	CHAMELECON EN [illegible]	CORTES	15°[illegible]	88°01'[illegible]	40	3,[illegible]*	Lm		x	x	SHC	11-56	05-73	[illegible] 60/09-65	11-56	06-73
0102	CHAMELECON EN FLORIDA	COPAN	15°01'[illegible]	88°[illegible]'36"	470	216*	Lm		x	x	SHC	01-66			05-66	04-76
0103	CHAMELECON EN [illegible]	SANTA BARBARA	[illegible]	88°32'[illegible]	210	[illegible]*	Lm		x	x	SHC	07-71		[illegible] 12/04/75	05-71	04-76
	CHAMELECON EN LA LIMA	CORTES	[illegible]	88°55'[illegible]	30		Lm			x	T.R.R.	Sin dato				12-76
0401	[illegible] EN [illegible]	SANTA BARBARA	[illegible]	88°[illegible]	255	227*	Lm			x	SHC	10-69		08 10/09 71	10-69	01-77
0501	[illegible]	SANTA BARBARA	[illegible]	88°[illegible]'35"	340	237*	Lm		x	x	SHC	05-70			05-70	04-76
06	RIO BLANCO EN EL [illegible]	SANTA BARBARA	15°12'[illegible]	88°57'57"	360	227*	Lm		x	x	SHC	07-66	11-74		07-66	10-76
22	CUENCA DEL ULUA															
0101	ULUA EN PTE. PIMIENTA	CORTES	15°15'55"	87°58'10"	30	8,982*	Lg	x	x	x	SHC	11-56		05 60/12-63	11-56	12-76
0102	ULUA EN [illegible]	SANTA BARBARA	14°55'[illegible]	88°13'32"	170	[illegible]*	Lm		x	x	SHC	01-55	01-68	[illegible] 10/12-65	01-55	04-68
0103	ULUA EN CHINDA	SANTA BARBARA	15°02'04"	88°11'56"	90	8,454*	Lg	x	x	x	SHC	01-55		[illegible] 62/01 65	01-55	04-76
0104	ULUA EN REMOLINO	SANTA BARBARA	14°58'[illegible]	88°15'35"	150	7,808*	Lg	x	x	x	SHC	07-71			07-71	04-76
	SANTIAGO	CORTES	15°17'04"	87°54'42"	35		Lm			x	T.R.R.	Sin dato			06-64	12-76
0201	[illegible] EN [illegible]	YORO	[illegible]	87°32'[illegible]	230	396	Lm		x	x	SHC	01-58	05-70	05 60/04-66	01-58	04-70
0202	[illegible] EN EL BARATO	YORO	15°14'50"	87°40'00"	130	715	Lm		x	x	SHC	05-57	05-74	[illegible] 60/04 66	05-57	07-74
0301	[illegible] EN CATA[illegible]	YORO	15°18'00"	87°35'10"	175	79	Lm		x	x	SHC	05-57	05-74	11 60/04 66,05 71/10-71	05-57	05-66
0401	[illegible] EN [illegible]	YORO	15°16'00	87°38'48	230	80	Lm		x	x	SHC	05-57	04-74	01 60/12 65,01 67/04 67	05-57	05-73
0501	[illegible] EN SAN [illegible]	YORO	15°16'52"	87°37'12"	226	4	Lm		x	x	SHC	02-65	04-68		02-66	05-67
0502	SAN JUAN EN [illegible]	YORO	15°15'30	87°35'32"	240	17.0	Lm		x	x	SHC	05-57	04-74	07 60/01 64,01 67/04 67	05-57	05-67
0601	[illegible] EN SAN [illegible]	COMAYAGUA	14°[illegible]'50"	87°38'20"	580	1,093	Lm		x	x	SHC	09-56		[illegible] 60/07 66	09-56	04-76
0602	[illegible] EN LA ENCANTADA	COMAYAGUA	14°37'42"	87°[illegible]'41"	530	1,833	Lg	x	x	x	SHC	08-56		[illegible]	08-56	04-76
0603	COMAYAGUA EN EL CAJON	COMAYAGUA	15°01'[illegible]	87°44'44"	100	8,607*	Lg	x	x	x	ENEE	02-66			01-66	12-75
0604	[illegible]	COMAYAGUA	[illegible]	[illegible]	[illegible]	2,595*	Lg	x	x	x	SHC	05-68			05-68	04-76
[illegible]	[illegible]	CORTES - YORO	15°16'[illegible]	[illegible]	30	10,012*	Lg	x	x	x	ENEE	05-70			05-70	12-76
0606	HUMUYA EN PRESA COYOLAR	COMAYAGUA	14°19'06"	87°30'52"	760	187	Lg	x		x	SHC	Sin dato			09-56	11-59
0607	HUMUYA EN PIEDRA PARADA	COMAYAGUA	15°01'08"	87°44'30"	110	3,616	Lg	x	x	x	ENEE	05-71			05-71	12-76
0701	[illegible] EN EL TALADRO	COMAYAGUA	14°27'06"	87°43'27"	610	196	Lm		x	x	SHC	05-71	05-71			
0801	[illegible] EN [illegible]	SANTA BARBARA	14°59'16"	88°16'12"	150	6,231	Lg	x	x	x	SHC	01-55		01 60/12 65	01-55	04-75
0802	[illegible] EN [illegible]	SANTA BARBARA	14°59'44"	88°[illegible]'12"	310	5,[illegible]*	Lg	x	x	x	ENEE	05-71			05-71	04-76
0803	[illegible] EN EL [illegible]	COPAN - LEMPIRA	14°[illegible]'30"	88°39'22"	640	3,037	Lg	x	x	x	ENEE	05-71		05 13/06-75	05-71	12-76
0901	GRANDE DE OTORO EN LA GLORIA	INTIBUCA	14°24'22"	87°58'38"	600	940	Lg	x	x	x	SHC	11-56		[illegible] 59/06 65	05-56	04-75
1001	[illegible] EN LAS [illegible]	YORO	15°[illegible]'03"	87°26'02"	395	212	Lm		x	x	SHC	05-67			05-67	12-76
1101	SANTA CLARA EN SANTA CLARA	FCO. MORAZAN	14°26'38"	87°16'46"	225	55	Lm		x	x	SHC	05-67	01-71		05-67	12-70
1201	SULACO EN EL [illegible]	YORO	14°56'20"	87°22'30"	350	5,870	Lg	x	x	x	SHC	05-71			05-71	04-75
1202	SULACO EN LOS [illegible]	YORO	15°00'40"	87°42'50"	220	5,230	Lg	x	x	x	ENEE	05-71			05-71	12-76
1301	AGUA CALIENTE EN AGUA CALIENTE	COMAYAGUA	14°40'56"	87°17'20"	650	1,767	Lg	x	x	x	SHC	05-68			05-68	04-76
1302	AGUA CALIENTE EN LOS [illegible]	COMAYAGUA - F.M.	14°51'10"	87°12'35"	500	5,513	Lm		x	x	ENEE	05-71	05-73		05-71	04-73
1401	HIGUITO EN HIGUITO	COPAN - LEMPIRA	14°42'55"	88°46'55"	370	1,377	Lm		x	x	ENEE	05-71	05-73		05-71	04-73
1402	HIGUITO EN PUENTE CUCUYAGUA	COPAN	14°39'00"	88°52'40"	710	1,022	Lm		x	x	ENEE	05-71	05-73		05-71	04-73
1501	[illegible] EN EL [illegible]	YORO	14°5[illegible]'18"	87°17'32"	400	160	Lm		x	x	SHC	05-67			05-67	04-73
1601	[illegible] EN [illegible]	YORO	14°55'45"	87°13'23	550	67	Lm		x	x	SHC	04-68	10-74	12 18/04-69	04-68	09-74
1701	[illegible] EN EL [illegible]	COMAYAGUA	14°46'04"	87°57'45"	660	58	Lm		x	x	ENEE	05-64	05-74		05-64	07-74
1702	[illegible] EN LOS [illegible]	COMAYAGUA	14°44'36	87°57'43	600	49	Lg	x	x	x	[illegible]	05-64	02-74		05-64	04-73
1801	LAGO DE YOJOA EN EL JARAL	SANTA BARBARA	14°56'18"	88°01'09"	635		Lm			x	ENEE	Sin dato			Sin dato	Sin dato
1901	YURE EN SANTA ELENA	CORTES	14°53'02"	87°56'30"	600	36	Lg	x	x	x	ENEE	05-68	05-73		05-68	04-73
1902	YURE EN AGUA BLANCA	COMAYAGUA	14°58'08"	87°46'10"	250	308	Lm		x	x	ENEE	05-71			07-71	04-72
2001	SIALE EN SIALE	FCO. MORAZAN	14°53'35"	87°31'12"	500	610	Lm		x	x	ENEE	01-71			01-71	12-76
2101	MARALITO EN MARALITO	YORO	14°55'48"	87°09'25"	650	118	Lm		x	x	SHC	01-70	10-70		01-70	09-70
2201	MEJOCOTE EN FLORES	LEMPIRA	14°42'29"	88°37'53"	500	1,093	Lm		x	x	ENEE	05-71	05-73		05-71	04-73
2301	FLORES EN SAN NICOLAS	COMAYAGUA	14°42'33"	87°18'52"	550	315	Lm		x	x	SHC	05-68			05-68	04-76
2401	PALAJA EN EL [illegible]	SANTA BARBARA	14°41'38"	88°20'53"	650	320	Lm		x	x	ENEE	05-71				

*/ AREA CALCULADA EN OFICINA HARZA - CINSA

[illegible] DE LAS AREAS DE DRENAJE FUERON TOMADAS DE LOS BOLETINES DEL SERVICIO HIDROLOGICO Y CLIMATOLOGICO

ESC ESCALA — LG LIMNIGRAFO — SHC SERVICIO HIDROLOGICO Y CLIMATOLOGICO — T.RR. Co. TELA RAILROAD COMPANY

Q CAUDAL — LM LIMNIMETRO — ENEE EMPRESA NACIONAL DE ENERGIA ELECTRICA

NOTA: FUENTE DE DATOS

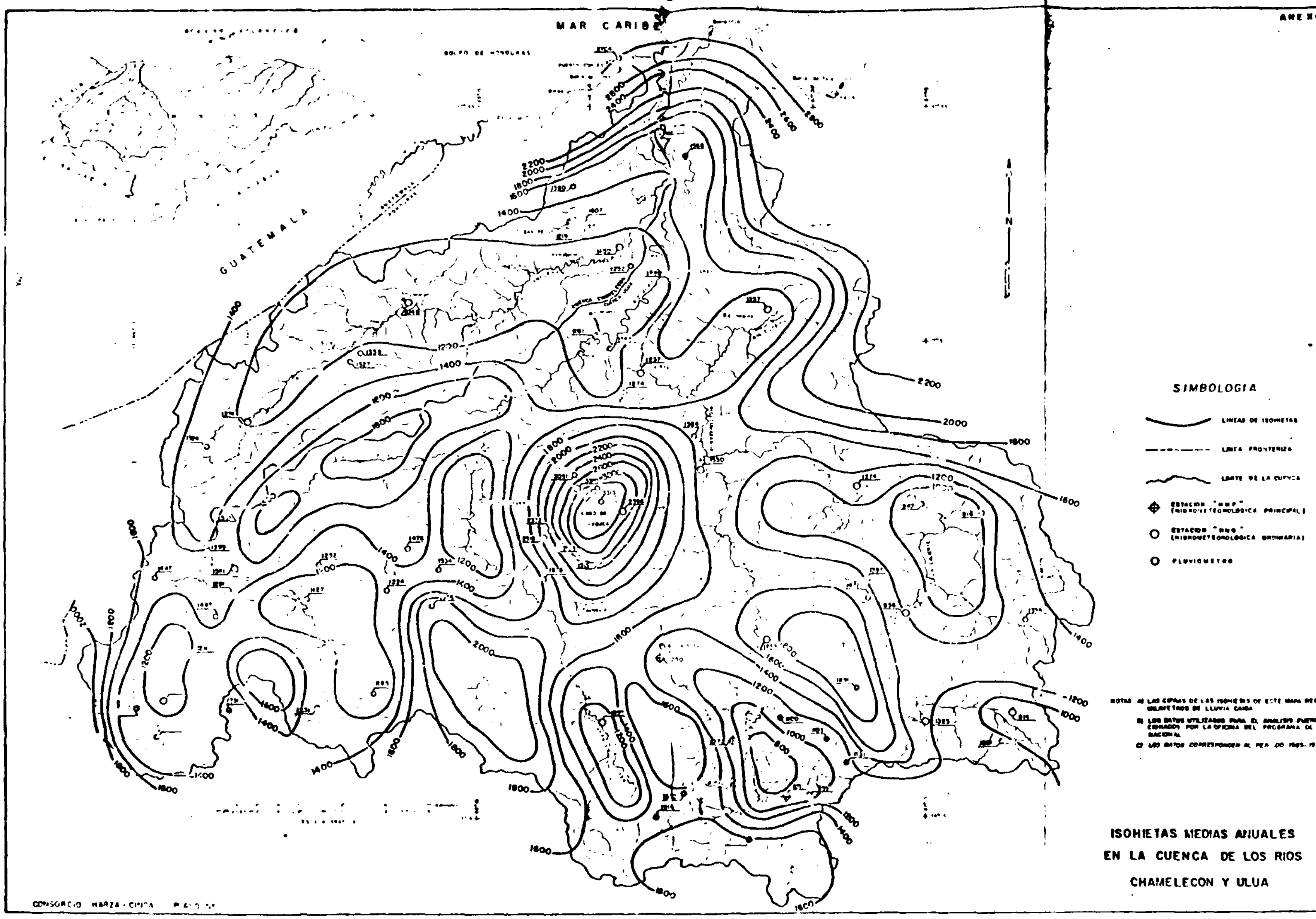
S H C SERVICIO HIDROLOGICO Y CLIMATOLOGICO
P C N PROGRAMA DE CATASTRO NACIONAL
E N E E EMPRESA NACIONAL DE ENERGIA ELECTRICA
T RR Co TELA RAILROAD COMPANY

LAS ESTACIONES FUERON LOCALIZADAS EN LAS HOJAS CARTOGRAFICAS DEL INSTITUTO GEOGRAFICO NACIONAL (I.G.N.), DE DONDE SE TOMARON SUS COORDENADAS

ESTACIONES HIDROLOGICAS DE LAS CUENCAS DE LOS RIOS CHAMELECON Y ULUA

HARZA-C[illegible] PLANO Nº

ANEXO A-7



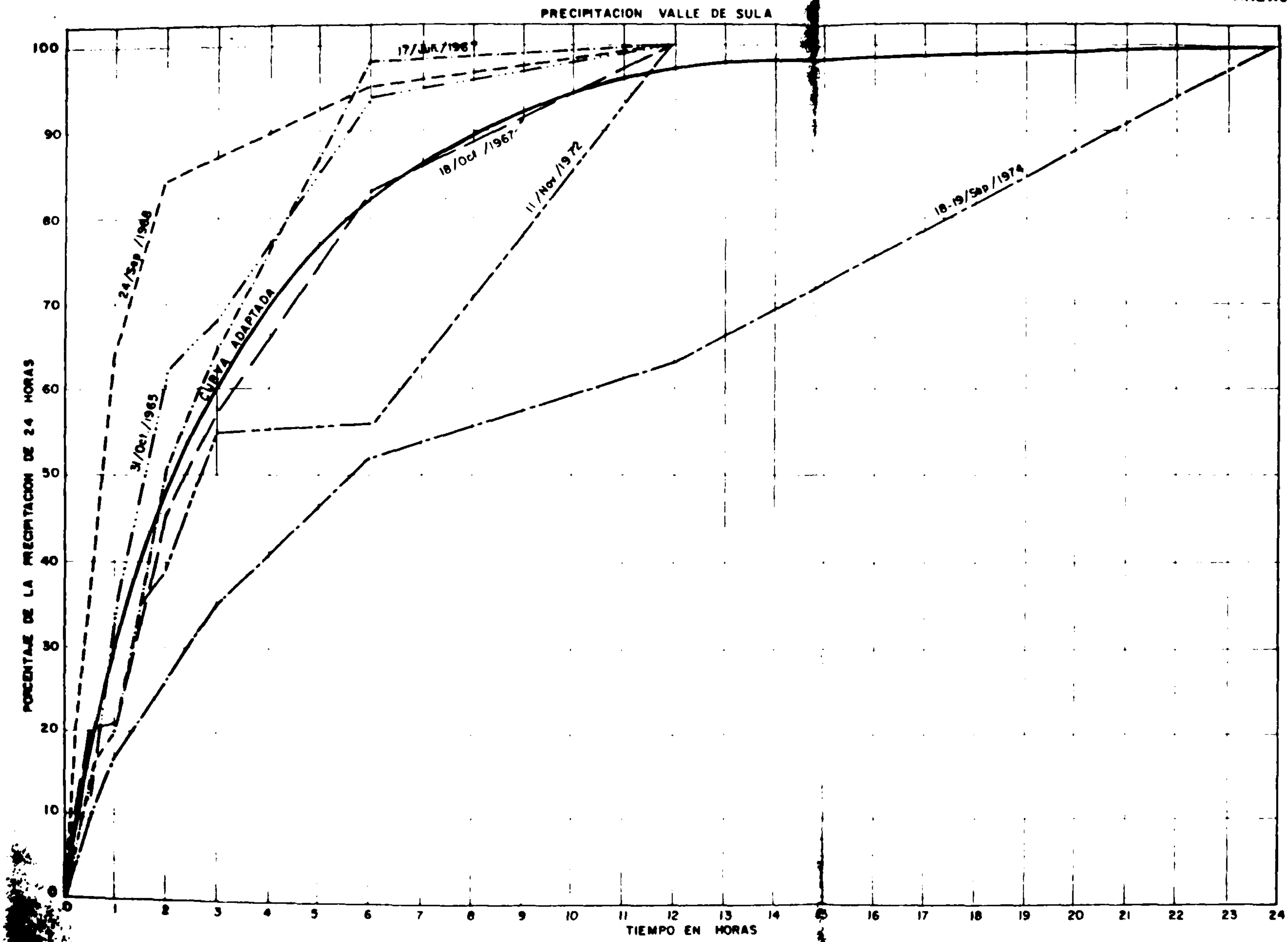
NOTAS a) LAS CIFRAS DE LAS ISOHIETAS DE ESTE MAPA REPRESENTAN MILIMETROS DE LLUVIA CAIDA

b) LOS DATOS UTILIZADOS PARA EL ANALISIS FUERON PROPORCIONADOS POR LA OFICINA DEL PROGRAMA DE CATASTRO NACIONAL

c) LOS DATOS CORRESPONDEN AL PERIODO 1965-1975

ISOHIETAS MEDIAS ANUALES EN LA CUENCA DE LOS RIOS CHAMELECON Y ULUA

ANEXO A-18



CURVA PRECIPITACION VRS. DURACION

TABLA A-1

PRECIPITACIONES PROMEDIO MENSUALES (mm)

CLAVE	ESTACION	PERIODO DE REGISTRO	En.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Agt.	Sep.	Oct.	Nov.	Dic.
23-001	CHUMBAGUA	24-25	48	36	27	37	95	245	188	167	208	162	104	80
23-003	LA MESA	12-14	63	48	25	27	67	153	84	88	153	143	143	102
23-007	PTO. CORTES	45-46	282	142	120	94	124	163	184	190	228	468	450	365
23-008	BARANDILLAS	33-34	72	48	52	37	86	162	158	120	180	174	147	121
23-010	QUIMISTAN	6-7	53	44	6	29	75	159	111	120	144	102	94	63
23-011	LA ENTRADA	3-5	(32)	(23)	(2)	(39)	(121)	(377)	(138)	(142)	(172)	(121)	(66)	(49)
	CAMPANA	9-11	212	160	65	41	52	105	178	188	214	320	422	284
	COPEN	8-9	77	56	27	33	70	123	96	107	169	148	186	131
	LA LIMA	50-51	65	49	33	28	70	133	119	106	162	154	157	109
25-002	LA FRAGUA	8	176	102	50	56	33	104	161	107	160	236	287	179
25-004	LA GLORIA	13-16	10	5	5	37	130	196	153	159	218	111	27	12
25-006	EL PROGRESO	44-46	94	70	44	40	77	165	159	136	185	194	213	145
25-017	STA.ROSA DE COPAN	28-31	40	28	26	43	148	295	241	204	310	169	83	63
25-018	EL JARAL	13-14	135	93	65	58	184	413	494	459	481	335	206	148
25-020	EL MOCHITO	19-22	54	41	27	36	135	367	371	344	410	262	105	57
25-022	VICTORIA	9-11	25	20	15	41	141	206	174	175	234	187	52	19
25-027	COMAYAGUA	25-27	10	11	19	34	110	175	120	160	197	144	39	16
25-029	PTE. PIMIENTA	9-10	46	60	18	10	82	202	143	138	190	129	116	67

Valores entre paréntesis promedio de 5 años ó menor.

TABLA A-1

PRECIPITACIONES PROMEDIO MENSUALES (mm)

CLAVE	ESTACION	PERIODO DE REGISTRO	En.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Agt.	Sep.	Oct.	Nov.	Dic.
23-001	CHUMBAGUA	24-25	48	36	27	37	95	245	188	167	208	162	104	80
23-003	LA MESA	12-14	63	48	25	27	67	153	84	88	153	143	143	102
23-007	PTO. CORTES	45-46	282	142	120	94	124	163	184	190	228	468	450	365
23-008	BARANDILLAS	33-34	72	48	52	37	86	162	158	120	180	174	147	121
23-010	QUIMISTAN	6-7	53	44	6	29	75	159	111	120	144	102	94	63
23-011	LA ENTRADA	3-5	(32)	(23)	(2)	(39)	(121)	(377)	(138)	(142)	(172)	(121)	(66)	(49)
	CAMPANA	9-11	212	160	65	41	52	105	178	188	214	320	422	284
	COPEN	8-9	77	56	27	33	70	123	96	107	169	148	186	131
	LA LIMA	50-51	65	49	33	28	70	133	119	106	162	154	157	109
25-002	LA FRAGUA	8	176	102	50	56	33	104	161	107	160	236	287	179
25-004	LA GLORIA	13-16	10	5	5	37	130	196	153	159	218	111	27	12
25-006	EL PROGRESO	44-46	94	70	44	40	77	165	159	136	185	194	213	145
25-017	STA.ROSA DE COPAN	28-31	40	28	26	43	148	295	241	204	310	169	83	63
25-018	EL JARAL	13-14	135	93	65	58	184	413	494	459	481	335	206	148
25-020	EL MOCHITO	19-22	54	41	27	36	135	367	371	344	410	262	105	57
25-022	VICTORIA	9-11	25	20	15	41	141	206	174	175	234	187	52	19
25-027	COMAYAGUA	25-27	10	11	19	34	110	175	120	160	197	144	39	16
25-029	PTE. PIMIENTA	9-10	46	60	18	10	82	202	143	138	190	129	116	67

Valores entre paréntesis promedio de 5 años ó menor.

Hoja 2/2

PRECIPITACIONES PROMEDIO MENSUALES (mm)

CLAVE	ESTACION	PERIODO DE REGISTRO	En.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Agt.	Sep.	Oct.	Nov.	Dic.
25-036	CEIBITA	8	86	60	21	27	51	123	109	124	192	133	199	114
25-056	MORAZAN	7-10	58	53	19	19	92	194	157	132	229	155	145	83
25-059	BUENA VISTA	8	93	88	25	35	62	148	149	167	212	143	234	134
25-065	LA LABOR	22-24	4	6	13	39	136	224	205	171	248	143	37	15
25-071	STA. BARBARA	8-9	26	15	8	28	72	166	208	210	227	112	65	46
25-077	GRACIAS-LEMPIRA	14-18	20	8	12	32	113	223	115	157	205	125	47	19
25-078	LA PAZ	7-11	4	7	3	26	121	189	153	118	206	125	29	7
25-084	PLAYITAS	5-8	6	6	6	56	120	(140)	103	120	173	145	39	9
25-087	SAN JERONIMO	5-7	21	14	6	61	158	(243)	153	246	(336)	(226)	77	36
25-099	LUPO	7	95	87	19	50	33	114	113	139	146	184	219	136
25-114	ULAPA	3-6	(33)	(11)	(3)	(10)	(95)	(270)	(150)	(173)	(194)	(127)	58	23
27-002	TELA	32-33	264	163	94	88	104	137	181	217	224	383	424	383
46-202														
46-203	LA ESPERANZA													
56-001	LA VENTA													

TABLA A-47

Frecuencia de Tormentas para las cuencas que rodean el Valle de Sula

Area y Estación	Años de Registros	Precipitación max. de 24 hrs. (mm) 10 años	20 años	50 años
Area Costera				
La Ceiba	22	360	430	520
Tela	19	340	400	450
Valle de Sula				
Vertiente Oriental				
El Progreso	8	240	330	440
Buena Vista	8	220	270	360
Vertiente Occidental y Valle				
La Fragua	8	250	320	430
Ceibita	8	270	350	520 1/
Copén	8	220	270	430
Lupo	7	240	340	580 1/
Campana	11	240	290	360
La Mesa	12	190	260	340
La Mesa-Barandillas	33	160	190	240
Adoptado para el Valle de Sula y Cuencas adyacentes		240 2/	300 2/	400 2/

1/ Estos estimados son dudosos debido al gran coeficiente de desviación comparado con las otras estaciones de la región.

2/ Ligeramente mayor que el promedio de Progreso, Buena Vista, La Fragua, Copén, Campana y La Mesa. Los datos de Ceibita y Lupo no fueron utilizados en el cálculo del promedio, debido al desproporcionadamente elevado coeficiente de desviación. Los datos de La Mesa mas Barandillas no fueron utilizados en el cálculo del promedio debido a que la precipitación en el área de San Pedro Sula es menor que en el Valle de Sula y las areas adyacentes en consideración tal como se muestra en el mapa de hisoyetas promedio anual.

TABLA A-44

CAUDALES MAXIMOS ANUALES (m^3/s) 1/

AÑO	LA LIBERTAD (2599 Km^2)	EL CAJON (8607 Km^2)	CHINDA (8456 Km^2)
1955/56			(1905)
56/57			(1394)
57/58			(2018)
58/59			(2670)
59/60			(3168)
65/66			(1982)
66/67		(1094)	(2297)
67/68		(870)	(1623)
68/69	(893)	(1869)	(3086)
69/70	867	--	(3149)
70/71	1662	1611	(2234)
71/72	520	1515	(1982)
72/73	287	833 2/	1245 2/
73/74	466	496	(2594)
74/75	918	4662 2/	(4476)
75/76	1863	1550	2690

1/ Los caudales entre paréntesis fueron estimados multiplicando el caudal medio diario máximo anual, por la razón del caudal máximo instantáneo al caudal medio diario máximo para los años en que no existen registros de limnígrafo.

Las razones utilizadas fueron:

1.5 para Chinda y el Cajón; 1.65 para la Libertad.

2/ Valores obtenidos de la máxima lectura de escala y ecuación de caudales, excede el valor calculado según 1/

TABLA A-45

FRECUENCIA DE CRECIENTES EN ESTACIONES SELECCIONADAS

ESTACION	AREA (km^2)	CRECIENTE (m^3/s) 10 años	20 años	50 años	100 años
La Libertad	2,599	1900	2500	3300	4000
El Cajón	8,607	3280	4250	5700	7000
Chinda	8,456	3720	4250	4950	5450
Pte.Chamelecon	3,177	1670	1910	2270	2500

TABLA A-5

CAUDALES MEDIOS MENSUALES (m^3/s)

ESTACION: PUENTE PIMIENTA

RIO: ULUA AREA TRIBUTARIA: 8,982 Km^2

AÑO	MAYO	JUNIO	JULIO	AGOS.	SEPT.	OCT.	NOV.	DIC.	ENERO	FEB.	MAR.	ABR.	ANUAL
1954-55	62.6*	202.1*	215.3*	254.2*	456.3*	408.5*	276.0	201.0	162.0	165.0	142.0	135.0	223.3
1955-56	134.0	154.0	298.0	472.0	335.0	612.0	398.0	199.0	161.0	71.0	54.7	49.0	244.8
1956-57	109.0	449.0	309.0	187.0	468.0	526.0	292.0	164.0	180.0	72.8	56.1	46.6	238.3
1957-58	69.6	213.0	217.0	374.0	658.0	428.0	167.0	137.0	95.8	73.0	56.7	42.1	210.9
1958-59	56.0	228.0	345.0	191.0	305.0	447.0	156.0	131.0	99.6*	72.7*	52.6*	43.1	177.3
1964-65	62.6*	202.1*	215.3*	254.2*	456.3*	408.5*	223.8*	143.0	75.4	43.1	53.7	22.7	180.1
1965-66	29.7	66.3	69.6	131.0	378.0	461.0	319.0	150.0	99.6*	72.7*	52.6*	43.1*	156.1
1966-67	95.1	298.0	385.0	254.0	336.0	304.0	218.0	162.0	128.0	119.0	69.0	59.4	202.3
1967-68	35.0	129.0	129.0	149.0	196.0	281.0	211.0	86.2	51.9	43.9	33.8	28.0	114.5
1968-69	56.7	425.0	216.0	171.0	413.0	382.0	282.0	206.0	109.0	59.1	42.5	43.1	200.5
1969-70	76.5	307.0	318.0	473.0	843.0	464.0	176.0	178.0	84.7	80.3	54.7	39.5	257.9
1970-71	45.6	119.0	345.0	366.0	606.0	321.0	207.0	169.0	75.6	59.6	35.8	36.6	198.9
1971-72	42.7	59.6	108.0	292.0	644.0	361.0	152.0	54.9	47.7	72.7*	33.9	26.5	157.9
1972-73	38.9	85.4	102.0	156.0	176.0	112.0	65.0	51.5	38.0	38.0	22.4	23.3	75.7
1973-74	41.9	169.0	129.0	339.0	291.0	489.0	111.0	77.3	50.0	44.0	41.1	30.2	151.0
1974-75	62.6*	237.0	199.0	165.0	619.0	532.0	166.0	103.0	69.0	45.0	31.0	22.0	187.6
1975-76	45.2	91.8	59.7	93.5	577.0	407.0	384.0	187.0	166.0	104.0	61.5	43.1*	185.0

* Valores correspondientes al promedio de la serie de cada mes.

TABLA A - 8

CAUDALES MEDIOS MENSUALES (m^3/s)

ESTACION: ULAPA 1/

RIO: JICATUYO AREA TRIBUTARIA: 3,653. Km^2

AÑO	MAYO	JUNIO	JULIO	AGOST.	SEPT.	OCT.	NOV.	DIC.	ENERO	FEB.	MAR.	ABR.	ANUAL
1954-55	22.9*	74.5*	82.2*	101.3*	178.3*	160.0*	76.7*	49.4*	(19.7)	(22.1)	(15.3)	(13.8)	68.0
1955-56	(13.5)	(18.7)	(116.0)	(155.7)	(106.4)	(176.4)	(123.8)	(68.4)	(43.5)	(20.4)	(17.3)	(15.8)	73.0
1956-57	(28.5)	(46.0)	(108.2)	(52.4)	(116.3)	(121.7)	(76.9)	(58.4)	(51.3)	(27.1)	(20.7)	(19.1)	60.6
1957-58	(26.2)	(68.0)	(82.6)	(119.5)	(184.2)	(106.7)	(49.9)	(46.0)	(34.8)	(26.5)	(21.8)	(17.5)	65.3
1958-59	(25.6)	(98.2)	(135.1)	(82.2)	(135.5)	(147.2)	(49.5)	(36.3)	(41.4)	(25.6)	(20.7)	(18.9)	68.0
1959-60	(24.3)	(48.1)	(46.7)	(88.6)	(165.3)	(277.6)	(78.7)	(53.1)	32.6*	24.5*	17.9*	15.3*	72.7
1964-65	22.9*	74.5*	82.2*	101.3*	178.3*	160.0*	76.7*	49.4*	32.6*	(22.5)	(15.0)	(11.3)	68.8
1965-66	(17.2)	(43.2)	(51.7)	(68.4)	(152.2)	(176.0)	(120.2)	(60.9)	(49.9)	(44.2)	(31.4)	(24.1)	70.0
1966-67	(40.7)	(123.1)	(154.3)	(109.2)	(150.1)	(128.8)	(88.3)	(66.2)	(51.0)	(44.9)	(28.7)	(24.8)	84.2
1967-68	(15.6)	(49.2)	(48.5)	(60.6)	(86.5)	(119.9)	(86.1)	(37.9)	(23.2)	(20.7)	(15.7)	(14.1)	48.2
1968-69	(27.4)	(187.4)	(94.3)	(77.3)	(312.4)	(176.0)	(100.0)	(74.4)	(38.8)	(22.0)	(17.7)	(17.6)	95.4
1969-70	(29.8)	(118.5)	(136.9)	(201.2)	(286.8)	(163.2)	(77.6)	(73.0)	(36.8)	(35.1)	(23.5)	(18.8)	100.1
1970-71	(21.6)	(34.2)	82.2*	(137.3)	(257.0)	(121.7)	(85.1)	(69.8)	(33.7)	(27.7)	(17.0)	(16.9)	75.4
1971-72	18.0	28.9	49.6	148.2	151.4	178.5	51.3	23.2	15.2	16.4	10.0	9.9	58.4
1972-73	17.5	47.6	43.8	(64.5)	65.9	24.4	18.7	20.5	12.5	11.3	(10.4)	7.0	28.7
1973-74	16.7	(69.4)	(48.8)	(141.5)	139.7	253.2	33.9	30.4	14.3	12.8	12.1	8.8	65.1
1974-75	25.6	172.4	95.1	69.7	293.5	201.2	34.0	25.5	15.4	10.6	8.8	6.1	79.8
1975-76	18.7	39.8	21.7	44.9	250.0	188.0	153.0	46.4	40.2	26.7	18.3	16.3	72.0

1/ Valores entre parentesis obtenidos por correlación con la Estación Chinda en el Río Ulda.

* Valores correspondientes al promedio de la serie de cada mes.

TABLA A-9

CAUDALES MEDIOS MENSUALES (m^3/s)

ESTACION: LAGUNETAS 1/

RIO: COMAYAGUA   AREA TRIBUTARIA: 10.012 Km^2

AÑO	MAYO	JUNIO	JULIO	AGOST.	SEPT.	OCT.	NOV.	DIC.	ENERO	FEB.	MAR.	ABR.	ANUAL
1966-67	(214.0)	(346.0)	(352.0)	(241.0)	(317.0)	(299.0)	(134.0)	(107.0)	(85.1)	(82.6)	(72.1)	(81.3)	194.3
1967-68	(53.7)	(219.0)	(134.0)	(115.0)	(149.0)	(270.0)	(147.0)	(83.8)	(66.7)	(59.2)	(51.6)	(48.8)	116.5
1968-69	(86.6)	(392.0)	(219.0)	(203.0)	(402.0)	(490.0)	(256.0)	(120.0)	(85.9)	(66.5)	(57.9)	(54.1)	202.8
1969-70	78.4*	170.6*	169.1*	197.3*	321.8*	364.1*	195.2*	101.6*	81.3*	71.6*	(60.3)	(57.8)	155.8
1970-71	57.7	116.0	282.0	439.0	542.0	565.0	(231.0)	(131.0)	123.4	107.0	48.8	35.5	223.2
1971-72	40.5	66.4	82.0	196.8	258.7	306.2	109.1	62.4	44.5	42.7	30.0	29.9	105.8
1972-73	48.1	71.9	73.0	141.9	177.3	237.0	83.4	39.4	38.5	43.9	23.4	23.6	83.5
1973-74	50.4	108.6	122.7	143.0	185.4	241.5	83.0	53.8	35.0	30.8	26.6	17.9	91.6
1974-75	43.8	96.6	118.0	134.7	(567.0)	450.0	236.0	174.2	136.7	114.2	93.3	80.5	187.1
1975-76	98.9	119.3	117.0	161.7	461.2	418.3	(477.0)	142.8	115.8	97.8	77.1	85.8	197.7
1976-77	90.1	170.6*	191.1	197.3*	158.8	364.1*	195.2*	101.6*	81.3*	71.6*	54.1*	51.5*	143.9

1/ Valores entre paréntesis obtenidos por correlación con la Estación El Cajón en el Río Humuya.

* Valores correspondientes al promedio de la serie de cada mes.

TABLA A-13

CAUDALES MEDIOS MENSUALES (m^3/s)

ESTACION: PTE. CHAMELECON 1/

RIO: CHAMELECON AREA TRIBUTARIA 3,177 Km^2

AÑO	MAYO	JUNIO	JULIO	AGOST.	SEPT.	OCT.	NOV.	DIC.	ENERO	FEB.	MAR.	ABR.	ANUAL
1954-55	12.7*	43.8*	44.9*	42.2*	73.7*	64.8*	70.0	44.4	28.0	27.5	17.6	13.5	40.3
55-56	10.3	13.6	110.0	84.6	95.6	101.0	105.0	81.7	56.6	25.6	15.2	11.2	59.2
56-57	11.3	64.1	39.7	19.6	46.2	47.6	72.9	62.9	97.7	48.5	22.1	14.0	45.6
57-58	11.6	28.7	22.7	41.6	76.9	65.1	38.6	43.3	22.5	16.1	11.6	8.0	32.2
58-59	6.9	27.0	62.4	29.9	40.7	58.7	28.8	29.0	26.8	15.4	10.7	7.9	28.7
59-60	7.6	35.2	18.6	24.7	27.0	48.2	61.5	44.2	38.9*	28.5*	18.8*	12.6*	30.5
64-65	12.7*	43.8*	44.9*	42.2*	73.7*	64.8*	66.3*	56.8*	38.9*	28.5*	18.8*	12.6*	42.0
65-66	12.7*	43.8*	44.9*	42.2*	60.9	67.6	106.0	75.4	55.5	44.9	29.5	22.9	50.5
66-67	17.4	64.1	62.6	46.7	65.7	82.7	101.0	72.0	49.2	45.9	36.1	25.5	55.7
67-68	9.2	50.8	33.1	20.3	39.1	93.2	81.3	52.3	39.2	36.8	26.2	15.9	41.5
68-69	31.1	99.0	48.8	53.3	111.0	75.7	74.9	89.5	47.3	29.2	18.2	12.6*	57.6
69-70	16.4	56.5	75.6	130.0	230.0	85.2	99.0	157.0	59.7	49.2	34.6	21.9	84.6
70-71	21.3	23.4	57.8	72.3	176.0	96.5	91.6	84.3	41.5	34.8	18.0	14.4	61.0
71-72	19.6	23.5	21.5	18.3	42.2	33.0	51.2	23.3	15.9	21.2	12.3	8.1	24.2
72-73	9.2	17.8	18.7	23.2	16.9	11.8	8.6	11.7	8.8	9.7	6.2	6.0	12.4
73-74	(5.4)	(48.5)	(32.2)	(36.9)	(32.7)	(62.6)	(26.4)	(22.0)	(12.9)	(9.2)	18.8*	(4.2)	26.0
74-75	(7.3)	(80.0)	(65.1)	(23.8)	73.7*	64.8*	(45.6)	(37.3)	(21.2)	(12.8)	(7.5)	(3.7)	36.9
75-76	(5.2)	(25.4)	(5.9)	(7.6)	(43.9)	(44.3)	(63.9)	(36.0)	38.9*	28.5*	(17.0)	12.6*	27.4

1/ Valores entre paréntesis obtenidos por correlación con la Estación La Vegona en el Río Chamelecón.

* Valores correspondientes al promedio de la seria de cada mes

TABLA A-48

CARGA DE SEDIMENTOS EN SUSPENSION

Río	Estación	Area Tributaria. Km^2	Sedimentos en Suspensión (Ton/Km^2/año) 1970-71	1971-72	1972-73	Promedio Ton/km^2/año	m^3/km^2/año
Comayagua	El Cajón	8607	1228	162	179	523	418
Humuya	Piedra Parada	3616	-	315	617	466	373
Jicatuyo	Ulapa	3653	-	206	197	202	162
Higuito	Higuito	1572	-	602	48	542	434
	Promedio						347

TABLA A-3

EVAPORACION TANQUE Vrs. EMBALSE[1/] (mm)

MES	MORAZAN Tanque[2/]	MORAZAN Embalse	ULAPA Tanque[2/]	ULAPA Embalse	SAN JERONIMO Tanque[2/]	SAN JERONIMO Embalse	QUIMISTAN Tanque[2/]	QUIMISTAN Embalse
ENERO	94	87	106	99	105	98	100	93
FEBRERO	110	102	133	124	174	162	95	88
MARZO	169	157	219	203	202	188	156	145
ABRIL	183	170	199	185	178	166	150	140
MAYO	175	163	198	184	184	171	157	146
JUNIO	146	136	155	144	149	139	128	119
JULIO	145	135	155	144	142	132	143	133
AGOSTO	139	129	159	148	160	149	120	112
SEPTIEMBRE	130	121	148	138	139	129	103	96
OCTUBRE	115	107	109	101	112	104	70	65
NOVIEMBRE	81	75	103	96	96	89	80	74
DICIEMBRE	92	86	94	87	95	88	73	68

1/ Evaporación en embalse = evaporación en tanque x 0.93

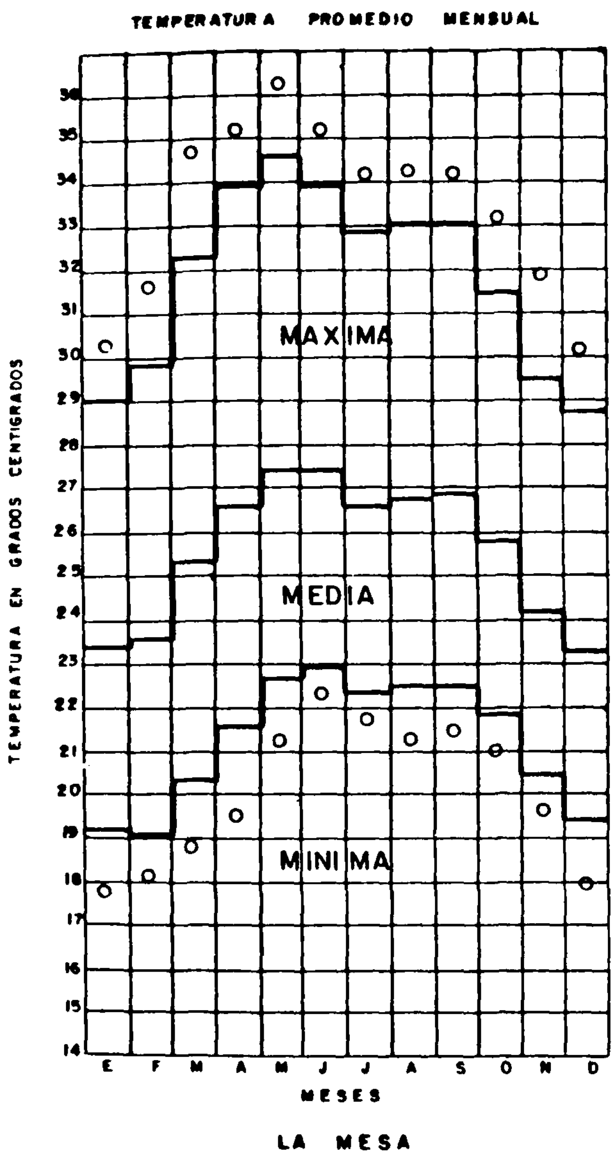
2/ Los tanques de evaporación están pintados de blanco.

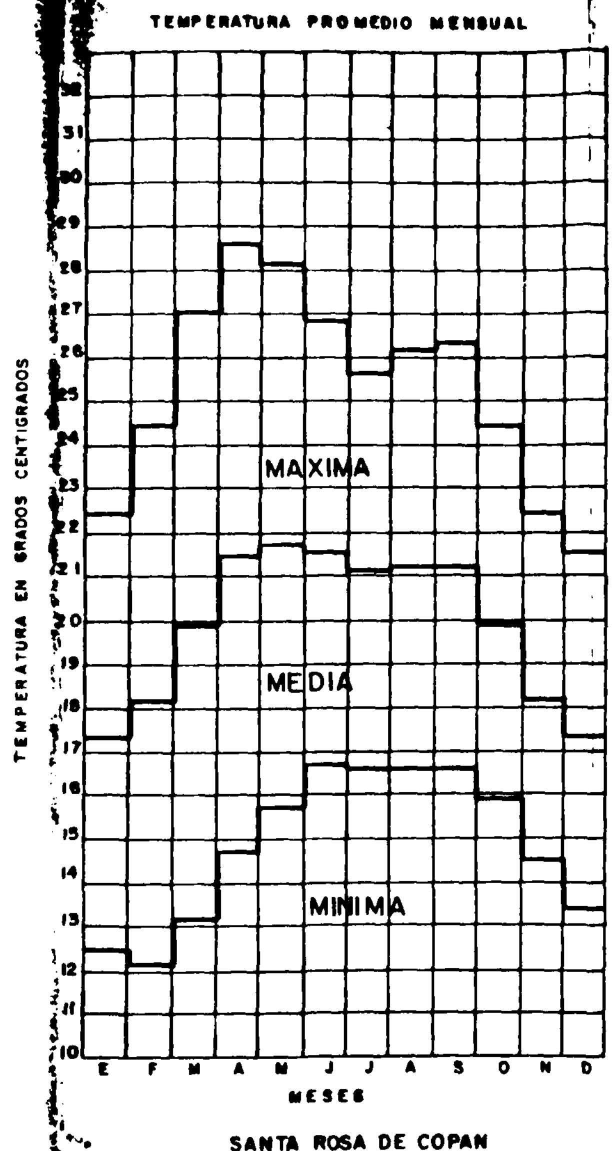
TABLA A-42

RESUMEN DE LA EVAPORACION NETA DE LOS EMBALSES (mm)

Embalse	Enero	Febrero	Marzo	Abril	Mayo	Junio	Julio	Agosto	Sept.	Oct.	Nov.	Dic.	Anual
La Feligrana	43	58	143	156	82	6	0	0	0	14	0	43	545
Cerro Malín	60	89	187	155	91	0	0	0	0	4	28	37	651
Jicatuyo	79	110	196	171	115	31	0	1	0	0	54	54	811
Los Llanitos	82	108	195	168	110	22	0	28	0	11	52	56	832
Jilica	52	93	178	162	107	0	0	0	0	0	34	25	651
Naranjito	40	75	177	141	80	0	0	0	0	0	28	37	578
El Remolino	55	40	132	145	89	0	0	23	0	0	1	28	513
El Cajón	56	58	143	148	65	0	0	0	0	0	18	42	530
Guacamaya	60	139	171	153	68	0	0	0	0	0	0	0	591
El Tablón	63	51	131	125	87	0	41	14	0	0	9	22	543
El Zapotal	54	48	129	111	79	0	20	0	0	0	0	10	451
Callejones	59	54	131	124	90	0	28	0	0	0	10	10	506
Goascorán	64	51	131	117	86	0	20	0	0	0	11	30	510

ANEXO A-B





Nota:
REGISTROS EXTREMOS O
PERIODO DE REGISTROS 11 AÑOS

TEMPERATURA PROMEDIO MENSUAL
DE
ESTACIONES METEOPOLOGICAS SELECCIONADAS

TABLA A-2

TEMPERATURAS PROMEDIO MENSUALES (°C)

Hoja 1/3

CLAVE	ESTACION	PERIODO DE REGISTRO	TEMP.	En.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Agt.	Sept.	Oct.	Nov.	Dic.
23-003	LA MESA	12 años	Media:	23.4	23.5	25.3	26.6	27.5	27.4	26.7	26.8	26.9	25.8	24.1	23.3
			Max:	29.0	29.8	32.4	33.9	34.5	33.9	32.9	33.0	33.0	31.4	29.3	28.6
			Min:	19.3	19.0	20.3	21.5	22.7	22.9	22.4	22.4	22.6	22.0	20.5	19.6
23-008	BARANDILLAS	11 años	Media:	23.2	24.2	26.0	27.4	27.9	27.9	27.1	27.5	27.5	25.8	24.8	23.6
			Max:	28.5	30.4	32.4	33.8	34.0	33.7	32.4	33.2	33.0	30.7	29.6	28.0
			Min:	18.0	17.8	19.5	20.9	21.7	22.1	21.8	21.7	22.0	20.9	20.0	19.0
23-010	QUIMISTAN	6 años	Media:	(23.5)	(23.6)	(25.5)	27.2	28.6	27.8	27.1	27.0	27.1	(25.5)	(24.2)	(23.3)
			Max:	(29.6)	(30.4)	(32.5)	(34.0)	34.6	33.0	32.4	32.5	32.4	(30.4)	(29.4)	(28.7)
			Min:	(18.1)	(19.2)	(17.2)	18.9	21.3	21.9	21.0	21.0	21.7	(20.7)	(19.0)	(18.0)
23-011	LA ENTRADA	4 años	Media:	(21.9)	(24.3)	(26.2)	(26.1)	(27.5)	(25.4)	(25.3)	(24.8)	(25.2)	(23.9)	(23.2)	(21.7)
			Max:	(27.6)	(29.0)	(33.1)	(33.2)	(32.0)	(30.7)	(30.0)	(30.2)	(30.2)	(28.6)	(28.0)	(26.5)
			Min:	(15.6)	(14.4)	(16.6)	(15.6)	(20.0)	(19.8)	(19.4)	(19.4)	(19.3)	(18.8)	(17.9)	(16.4)
25-004	LA GLORIA	13-15	Media:	23.2	23.8	26.5	27.5	27.4	26.4	25.7	25.7	25.6	24.6	23.5	22.8
		12-16	Max:	28.8	30.2	34.0	34.4	34.0	32.0	30.8	30.9	30.6	29.1	28.2	27.9
		9-11	Min:	17.3	16.7	18.3	19.5	20.4	20.4	19.9	20.3	20.3	20.2	18.3	17.3
25-006	EL PROGRESO	7-8	Media:	24.5	24.8	26.9	27.8	27.8	27.7	27.5	27.8	27.4	27.6	25.5	24.4
			Max: 1/												
			Min: 1/												
25-017	STA. ROSA COPAN	23-25	Media:	17.3	17.9	19.9	21.1	21.6	21.4	21.0	21.1	21.1	19.8	18.3	17.3
		24-25	Max:	22.4	24.0	27.0	28.2	27.9	26.7	25.6	26.1	26.2	24.3	22.5	21.6
		23-25	Min:	12.7	12.2	13.3	14.7	15.8	16.9	16.8	16.7	16.8	16.0	14.7	13.4

Valores entre paréntesis promedio de 5 años ó menor.

1/ No existe información

TEMPERATURAS PROMEDIO MENSUALES (°C)

CLAVE	ESTACION	PERIODO DE REGISTRO	TEMP.	En.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Agt.	Sept.	Oct.	Nov.	Dic.
25-018	EL JARAL	9-12	Media:	20.4	20.9	23.0	24.4	25.3	24.7	23.9	24.0	24.1	22.9	21.3	20.4
		8-11	Max:	24.7	25.7	28.7	30.4	30.7	29.3	28.1	28.3	28.5	26.7	25.0	24.3
		7-10	Min:	15.6	15.0	15.9	17.1	18.0	18.8	18.0	18.1	18.7	18.3	16.9	15.7
25-022	VICTORIA	7-10	Media:	23.0	23.6	26.7	27.9	28.5	27.2	26.3	26.2	26.3	25.4	23.8	22.9
		6-9	Max:	29.0	30.4	33.9	34.9	34.4	32.4	31.9	32.1	31.6	30.4	29.4	28.4
		8-9	Min:	16.3	15.7	17.7	19.4	20.5	20.3	19.8	20.2	20.6	20.4	18.6	16.8
25-027	COMAYAGUA	11-15	Media:	21.5	22.5	24.3	25.6	26.6	25.4	25.2	25.6	25.1	24.6	23.4	23.1
		11-15	Max:	28.6	31.2	33.5	34.3	34.8	32.6	32.3	32.7	31.9	31.3	29.8	29.8
		11-15	Min:	14.6	13.8	14.9	17.1	18.5	18.3	18.1	18.5	18.3	17.9	17.1	16.4
25-056	MORAZAN	8-9	Media:	23.6	23.9	26.1	27.7	28.9	27.5	26.9	27.1	27.2	26.2	24.6	23.8
		8-9	Max:	29.0	29.5	32.4	34.6	35.2	33.3	32.3	32.2	32.4	31.0	29.2	28.9
		8-9	Min:	18.6	18.0	19.3	21.0	22.7	22.7	21.7	21.7	21.9	21.5	19.9	19.2
25-078	LA PAZ	7	Media:	23.5	24.0	25.2	26.8	27.6	27.5	26.9	27.2	27.1	26.5	24.2	24.1
		7	Max:	28.3	29.1	31.0	33.2	33.7	32.8	32.0	32.5	32.5	31.6	28.3	28.5
		7	Min:	18.6	18.8	19.2	20.4	21.5	22.2	21.7	21.7	21.8	21.4	20.2	19.7
25-084	PLAYITAS	5-7	Media:	22.6	23.3	26.2	26.9	26.5	(25.8)	25.1	25.2	24.7	24.2	22.8	22.3
		5-7	Max:	28.4	29.5	32.8	33.2	32.7	(30.8)	30.4	30.6	29.8	28.8	27.4	27.4
		5-7	Min:	16.5	16.0	17.4	19.3	20.3	(20.0)	19.4	19.6	19.8	19.8	18.1	16.7
25-087	SAN JERONIMO	5-6	Media:	(22.8)	23.0	(25.3)	27.0	27.2	26.8	25.7	25.7	(25.4)	(24.7)	(25.0)	(22.2)
		5-6	Max:	(28.4)	30.8	(34.4)	34.9	34.5	32.6	31.5	31.3	(31.0)	(29.7)	(28.6)	(27.5)
		5-6	Min:	(16.7)	15.1	(16.1)	19.0	19.9	20.9	19.9	20.1	(19.9)	(19.6)	(18.6)	(16.5)

Valores entre paréntesis promedio de 5 años ó menor.

TEMPERATURAS PROMEDIO MENSUALES (°C)

CLAVE	ESTACION	PERIODO DE REGISTRO	TEMP.	En.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Agt.	Sept.	Oct.	Nov.	Dic.
25-114	ULAPA	4-5	Media:	(23.3)	(23.4)	(26.6)	(28.6)	(28.7)	(28.0)	(26.9)	(27.1)	(27.0)	(25.6)	(25.2)	(23.3)
		* no proc.	Max:												
		* no proc.	Min:												
56-001	LA VENTA		Media:	20.0	20.9	22.7	24.2	24.5	23.7	22.9	23.2	23.3	22.8	21.3	20.2
			Max:	25.5	27.5	29.7	31.4	30.7	28.7	27.5	28.4	28.6	27.4	25.7	25.0
			Min:	14.2	14.1	15.4	16.8	18.1	18.6	18.3	17.9	18.1	18.2	16.9	15.3

Valores entre paréntesis promedio de 5 años ó menor.

* Datos aún no procesados

SECTION D

GENERAL AGRICULTURAL DATA

INTRODUCTION

This section contains information extracted from previous reports documenting the nature and extent of agricultural activity in the Aguan River Basin. Basically agricultural activities are not subject to radical changes over a short period of time. Commercial export of bananas, citrus, palm oil, and fruits are the mainstay of the agrarian economy. Flooding in the Sula Valley and Aguan Valley is responsible for considerable losses on an annual basis. The governmental infrastructure for dealing with agricultural problems has sought and proposed projects for the overall alleviation of flooding in the past.

AGUAN VALLEY

(Information extracted from "The Feasibilility Study on the Aguan Valley Agricultural Development Project (Saba - Olanchito Area)", March 1985, Japan International Cooperative Agency).

I. Glossary of Terms

II. Land Use and Cropping Pattern

III. Infrastructure (Agricultural)

IV. Soils and Land Classification

(Information from July 1981 Study by the Consortium of Charles T. Main International, Consultores Latinamericanos Associates, and Gabinete Tecnico, S.A.

V. Infrastructure Lower Aguan Project (Bajo Aguan)

VI. Curves Showing Monthly Distribution of Production for Selected Agricultural Products

GLOSSARY OF ABBREVIATIONS

AID	:	U.S. Agency for International Deve
ANACH	:	National Association of Honduran Cooperat...
BANADESA	:	National Agricultural Development Bank
B/C	:	Benefit - Cost Ratio
CACM	:	Central America Common Market
COPALMA	:	Agri-industrial Cooperative for African Oil Palm
CESAMO	:	Healthy Center with Doctor
COHBANA	:	Banana Corporation of Honduras
CESAR	:	Rural Healthy Center
COHDEFOR	:	National Forestry Corporation
CONSUPLANE	:	National Economic Planning Council
CONSUPLANE/UN	:	CONSUPLANE/UN Project for the Integrated Development of the Aguan Region
CONSUDE	:	Swiss Corporation for Development
CORFINO	:	Olancho Industrial Forestry Corporation
CASAGO	:	Cooperative of Multiple Services, Agriculture and Livestock
EACI	:	Isletas Cooperative of Banana Growers
EIRR	:	Economic Internal Rate of Return
ENEE	:	National Power Corporation
FECORAH	:	Honduran Federation of Land Reform Cooperatives
FNH	:	National Railway Corporation
FIRR	:	Financial Internal Rate of Return
GDP	:	Gross Domestic Product
GRP	:	Gross Regional product
IDB	:	Inter-American Development Bank
IHMA	:	Honduran Agricultural Marketing Institute
INA	:	National Agrarian Institute

4.5 Land Use and Cropping Plan

(1) In irrigated Area

CROP		Cultivated Area (ha)	Yield (t/ha)	Production (t)	Price (Lps/t)	Gross Return (Lps)	Unit Cost (Lps/ha)	Total Cost (Lps)	Net Return (Lps)
MAIZE	A	(3,712) 1)	2.5	9,280	350	3,248,000	657	2,438,784	809,216
	P	(4,604)	5.0	23,020	350	8,057,000	745	3,429,980	4,627,020
RICE	A	302	2.6	785.2	460	361,192	800	241,600	119,592
	P	1,577	5.0	7,885	460	3,627,100	1,020	1,608,540	2,018,560
BEANS	A	(258)	1.1	283.8	920	261,096	500	129,000	132,096
	P	(2,573)	1.5	3,859.5	920	3,550,740	570	1,466,610	2,084,130
SOYBEAN	A	-	-	-	-	-	-	-	-
	P	(1,200)	2.5	3,000	555	1,665,000	667	800,400	864,600
CASSAVA	A	21	9	189	160	30,240	800	16,800	13,440
	P	221	20	4,420	160	707,200	2,193	484,653	222,547
TARO	A	-	-	-	-	-	-	-	-
	P	200	35	7,000	160	1,120,000	3,264	652,800	467,200
PLANTAIN	A	7	15	105	150	15,750	1,087	7,609	8,141
	P	207	35	7,245	150	1,086,750	1,687	349,209	737,541
ORANGE	A	130	25	3,250	110	357,500	1,100	143,000	214,500
	P	130	50	6,500	110	715,000	1,701	221,130	493,870
COCOA	A	-	-	-	-	-	-	-	-
	P	2,300	1.5	3,450	3,245	11,195,250	1,478	3,399,400	7,795,850
MANGO	A	-	-	-	-	-	-	-	-
	P	300	30	9,000	160	1,440,000	1,102	330,600	1,109,400
PAPAYA	A	-	-	-	-	-	-	-	-
	P	50	25	1,250	160	220,000	1,230	61,500	138,500
OTHER FRUTS	A	15	10	150	80	12,000	10	150	11,850
	P	15	12	180	80	14,400	15	225	14,175
PINEAPPLE	A	-	-	-	-	-	-	-	-
	P	400	25	10,000	360	3,600,000	2,045	818,000	2,782,000
TOMATO	A	-	-	-	-	-	-	-	-
	P	(600)	40	24,000	110	2,640,000	2,662	1,597,200	1,042,800
TOTAL	A	4,445 2)		14,043		4,285,778		2,976,943	1,308,835
	P	14,377 3)		110,809.5		39,618,440		15,220,247	24,398,193

Note: 1) Figure in Parenthesis means cultivated area for postrera season
2) Primavera season: 2,249 ha, Postrera season: 2,196 ha
3) Primavera season: 9,100 ha, Postrera season: 5,277 ha
4) A: Actual P: Plan

(2) In Non-irrigated Area

CROP		Cultivated Area (ha)	Yield (t/ha)	Production (t)	Price (Lps/t)	Gross Return (Lps)	Unit Cost (Lps/ha)	Total Cost (Lps)	Net Return (Lps)
MAIZE	A	-	-	-	-	-	-	-	-
	P	(600) 4)	3	1,800	350	630,000	671	402,600	227,400
CASSAVA	A	-	-	-	-	-	-	-	-
	P	400	9	3,600	160	576,000	800	320,000	256,000
TARO	A	-	-	-	-	-	-	-	-
	P	400	16	6,400	160	1,024,000	1,180	472,000	552,000
COCOA	A	-	-	-	-	-	-	-	-
	P	300	0.7	210	3,240	680,400	790	237,000	443,400
MANGO	A	-	-	-	-	-	-	-	-
	P	200	15	3,000	160	480,000	950	190,000	290,000
ORANGE	A	-	-	-	-	-	-	-	-
	P	2,800	25	70,000	110	7,700,000	900	2,520,000	5,180,000
PASTURE	A	7,712	6	46,272	16.6	768,115.2	20	154,240	613,875.2
	P	2,300	10	23,000	16.6	381,800	45	103,500	278,300
TOTAL	A	7,712		46,272		768,115.2		154,240	613,875.2
	P	7,000		108,010		11,472,200		4,245,100	7,227,100
GRAND TOTAL	A	12,157 5)		60,315		5,053,893.2		3,131,183	1,922,710.2
	P	21,377 6)		218,819.5		51,090,640		19,465,347	31,625,293

Note:
5) Figure in Parenthsis means cultivated area for postrera season
6) Primavera season: 9,961 ha, Postrera season: 2,196 ha
7) Primavera season: 15,800 ha, Postrera season: 5,577 ha
8) A: Actual P: Plan

3.7 Agricultural Production

3.7.1 Bananas and Oil Palm

(1) Banana

Bananas are grown on a commercial scale in two estates at Coyoles and at Isletas. The total net area at Coyoles is 3,962 ha and isletas 2,030 ha. Both plantations were originally established by the Standard Fruit Company, so they are structurally similar.

The plantation at Isletas is under the control of the Empresa Asociative Campesina in Isletas (EACI). EACI was formed in 1975, from the ex-workers of the Standard Fruit Company, following that company's abandonment of the plantations. EACI has 1,118 members. The terms of a five year contract between the Standard Fruit Company and COHBANA (Banana Cooperation of Honduras) binds the company to purchase all bananas of export quality produced at Isletas. The price a box at preset is Lps. 5.63.

The differences between Coyoles and Isletas plantation, which is reflected in average yields of 72 ton/ha at Coyoles and 43 ton/ha at Isletas respectively, and that improvements have been achieved at Coyoles in irrigation drainage, fertilization and pest control. But at Isletas, soil is slightly less well-drained and rainfall is nearly double.

The irrigation systems of both plantations are fundamentally similar. Watering is chiefly used, but lately, at Coyoles a drip irrigation system was installed and shows good results, because water is used in proportion to the water requirements of the plants. The rainfall deficit at Coyoles is more serious than Isletas, and Coyoles needs all-year (300 days a year) irrigation.

Fertilizer is applied on basis of leaf analysis, and KCl, urea and phosphate are generally used. Fertilizer is applied through the pipe of irrigation system.

The varieties of banana plant are Cavendish and Ecuatoriano. The Ecuatoriano variety has high yield and is little damaged by the wind because it is low in height.

The most common diseases are Sigatoka and Moko. Dihtance, benlate and methyl bromide are effective for these. Insecticide is not used, but the plastic film bags for fruit are used to control insects, which transmit diseases such as, Atracnosis and Ojo Bajo.

Bananas are exported every week: usually 72 thousand boxes and at least 42 thousand boxes a week. Bananas are cut at the stage of 77-84 days to export to Europe and 84 days to U.S.A.

(2) Oil Palm

The total gross area planted in Phase I, & II Lower Aguan Project is 10,500 ha. The crop requires a humid-tropical climate without a pronounced dry season. It tolerates a moist soil water regime, though it is seriously affected by water-logging and rotting of arrows occurs frequently.

Fertilizer was little applied in the first three years after planting. Fertilization is given based on the results of leaf-analysis. In practice ammonium sulphate of 21% N, and potassium Chloride of 60% K_2O is recommended. In 1982, a program of fertilization was operated with good results of 65% of total area. In 1984, it is expected to rise to 80%.

Occurrence of diseases and insects is very little and insignificant. Herbicides are recommended for weed control. Cart transportation is used from the field to the plant. This costs is paid by the plant at a price of Lps. 0.38/ton. The internal transportation in the plantation is practiced by a tractor with a wagon. In practice, the cart pulled by a mule, is used economically without hurting the root system of the plants, and doesn't harden the soil much.

Imports of palm oil were some 9,500 tons in 1981; 1,900 tons in 1982.

Since the end of 1983, Honduras has sold palm oil on the international market. Principal buyers are likely to be England, Italy, Central and Latin America. In 1983, exports were 2,000 tons to England, and 1,000 tons to Nicaragua.

The price of fruits is as follows:

A) Bulk L. 130.00/ton

B) Cluster L. 127.00/ton

The price of oil in the interior market is L. 1,200.00/ton, in the international market L. 1,600.00/ton, F.O.B. at the Port of Castilla.

3.7.2 Citrus

(1) Oranges

In December 1983 the total gross area of oranges was 916 ha in the neighborhood of Sonaguera, and this is increasing due to new planting. The Association of Citrus Cultivators of Sonaguera is established and the members are 220. In practice, only 150 members have planted oranges and the rest will plant from this year. Next year, the new plantation area planned will be 2,100 ha.

Production in the previous year ('82 - '83) was 80 million fruits. At present, production of 120 million fruits is estimated. These fruits will be purchased by the company, Griffin and Brand at price L. 165.00/ton. Griffin and Brand is Northamerican company, which at present gives citrus cultivators help for the purpose of purchasing orange fruits.

The help consists of complete technical assistance to the established farm, and to new cultivated areas. The company offers all the necessary financial assistance from clearing of the field to harvesting the crops, including all necessary control substances to get excellent production.

When the yield of the new plantations begins, the fruits will be processed at the juice plant in San Pedro Sula. The sales price of the juice is excellent and future prospects all seem good. Orange juice will be exported to Central America and the U.S.A.

In 1983, the oranges, produced at Sonaguera, were exported to the Netherlands and some other countries and were sold in the interior market at L. 20.00 to L. 70.00 a thousand.

Seed is sowed in rainy season from October to December. Control of weeds is practiced by hand. Insect injury is insignificant. The most common diseases are Comosis and Exocortis.

There is a region of 130 ha of oranges between Saba-Olanchito, adjoining the Aguan river. Fruits are for local use.

(2) Grapefruit

Since 1977, INA has assisted cooperatives to establish grapefruit plantations and the total area reached 913 ha in 1981. However, it decreased rapidly afterwards, because of decreasing exports. The total net area of grapefruits is 429 ha in 1984.

Due to poor external quality of grapefruit, only a small proportion of production has been exported to data. Non-exportable fruit has been processed into concentrate juice at the Standard Fruit Company's plant in La Ceiba, but subsequently the market for grapefruit juice declined and substantial quantities of grapefruit were buried. The quality of the juice was considered acceptable for the European market, but too acid for Central and North American taste, due to delivery of under-ripe fruits.

The packing plants which is situated at Chiripa is expected to produce 70 million boxes, which will be purchased by Griffin and Brand. Price for a box, F.O.B. at Chiripa is L. 4.20.

The most common diseases are, Comosis y Exocortis. The control of Comosis is practiced by CaO and Antracol. Exocortis is controlled by applying the fertilizer including Borax.

3.7.3 Basic Grains

(1) Maize

The primavera crop is sowed in May, June or July, with the first adequate rain, and is harvested in October or November. The postrera crop is sowed in November, December or January, and is harvested in April or May. The total area of maize is 1,694 ha in primavera and 2,019 ha in postrera.

The primavera crop is harvested in rainy season, and therefore the most serious problem is the high moisture content of the grain at harvest, generally around 22%, and associated with fungus infection.

Consequently, 10% of primavera crop is not sold.

Although both IHMA stores in Olanchito and Tocoa have grain drier, they are not extensively used.

Land preparation is commonly done by tractor of INA, with a heavy harrow in excellent cooperatives, but is practiced only by slash and burn with machete in inactive cooperatives. Sowing is generally done by hand, several seeds being dropped into a small hole made by a pointed bar. The majority is farm-saved seed to grow to a height of about 2 m in period of 120 - 130 days, less in the postrera and more in the primavera. Synthetics tuxpena is occasionally grown. This is said to yield perhaps 30% more and grain is easier to separate from the cob.

Almost no fertilizer is applied to maize. A significant number of farmers apply herbicides as a supplement to hand weeding. The two popular products are 2.4D and Gramaxone.

Corn earworm and stemboarer are the most serious insects, but no pesticides are applied. The yield is obtained 1.8 - 3 ton/ha from both primavera and postrera. But yield of primavera crop is generally less than postrera as is case in the cooperatives, as shown in Table 3-13, because of fungus diseases in humid season.

(2) Rice

Although, rice is desired by farmers to cultivate on a large scale because of good yield and high price, the total area is 302 ha only, because the seeding period is liable to delay due to the weather, and intensive labour is required for weeding, bird scaring and harvesting.

Rice is cultivated in the primavera season in this area. The seeding period is varied from May to September. Rice is rainfed and grown on land with imperfect drainage system and the seeding period becomes late on sandy soil and early on clay soil. Harvesting time ranges from September to January.

The farm-saved seed is used by half of the cooperatives. The improved varieties CICA 6 and CICA 8 are used occasionally by advanced cooperatives. No fertilizer is applied. Herbicides, Stam LB 10 and 2.4D are used as a supplement to hand weeding. No fungicides and insecticides are applied. The yield is obtained 2-4 ton/ha.

3) Beans

Beans are crops of low water requirement like maize and with one time weeding, leaves of beans cover the field, saving a lot of trouble. Most beans are produced on the steep hilly slopes. Conditions during the wet season encourage fungus diseases. Consequently, postrera cultivation is more than primavera. At present, total area is 80 ha in primavera season and 178 ha in postrera season.

Beans as primavera crop are sowed in May or June and harvested in August or September; as a postrera crop they are sowed in December or January and harvested in February and March.

The most commonly used variety is the native kind of the bush-bean, San Moreno, but climbers are sometimes used to grow up the old maize stalks.

Fertilizer, herbicide, fungicide and insecticide are not applied. Yield is 1-1.5 ton/ha.

3.7.4 Other Agricultural Products

(1) Cassave and Plantains

Both cassave and plantains are the important subsistence crops and are cultivated in small patches of many household gardens. Cassave has both sweet and bitter types and yield is 20 ton/ha. Plantains are unduly affected by black Sigatoka. Yield is about 20 ton/ha. Lately the cultivated area of these products has increased.

(2) Other Fruit Trees

Ciruela, mongo, lemon, avocado, papaya, soursop and zapodilla are cultivated in many household gardens. Among these fruits the ciruela is the most prominent.

3.7.5 Agricultural Industry Products

(1) Agro-industry Products

In the study area, there are no processing plants of industrial and horticultural crops. However, lately the production of palm oil, grapefruit juice and orange juice have increased gradually due to an abundance of materials produced in lower Aguan Valley.

As the oil palm planted in lower Aguan grew rapidly, palm oil increase every year and Honduras, once an importer of palm oil, became an export country. And the orange juice plant is under construction in San Pedro Sula expecting the production of new plantation at Sonaguera. Furthermore, the Standard Fruit Company is the major exporter of pineapple from their plantation at Montecristo near La Caiba. Pineapple, in addition to being exported fresh, is juiced for export as concentrate. These activities, in the neighborhood of lower Aguan, and in La Ceiba or in San Pedro Sula, would give this middle Aguan Valley good stimulation.

3.7.6 Livestock

(1) Outline

In the Republic of Honduras, cattle raising has traditionally been the most popular sector of livestock production. According to the statistics of the FAO Production Yearbook (1981), the number of livestock animals raised in the country has changed as shown in the table below.

Number of Animals Raised in Honduras

(Unit: thousand of head)

Animal	1969 - 71	1971	1980	1981
Horse	173	149	150	151
Dairy cattle	1,573	2,234	2,262	2,336
Minch cow	308	342	338	334
Swine	545	531	534	580
Sheep	3	5	5	5
Goat	18	22	22	22
Chicken	2,903	4,445	4,808	4,900

(Source: FAO Production Yearbook,Vol. 35)

As in other developing countries, in Honduras the small-scale pig and chicken farms have been rapidly increasing compared with the traditional cattle farms.

Yoro Province, where the study area is located, has the forth largest land area of a total of 18 provinces in the country. LATINOCONSULT, S.A. (1984) estimates that the number of cattles raised in this province is 251,675, ranking the second largest share or occupying about 9.3 percent of total number of cattle in the country. The livestock, cattle raising in particular, is one of the most important sectors in Yoro Province (See Appendix , Table E-28).

The livestock (cattle raising) in the study area extends to the left bank, from Olanchito to El Juncal, and on the in right bank, from Olanchito to the Jaguaca River, of the Aguan River. A cattle breed capable of producing both milk and meat has been bred in the study area for a long time, mainly for milk production. The majority of the cattle farming is managed on large-scale farms, called "Hacienda".

In Olanchito, central part of livestock production in the middle Aguan River Basin, there is an organization of livestock farm owners called SAGO (Sociedad de Agricultores y Ganaderos Olanchito). The SAGO's data as given in table below shows the status of cattle raising in this area.

Status of Cattle Farms in the Middle Aguan River Basin

Division	Area	No. of farms for cattle raising	Total No. of cattle raised	Average No. of cattle per farm
STUDY AREA	Olanchito - El Juncal	31	5,549	178
	Olanchito - Rio Jaguaca	56	13,024	232
	(Subtotal)	(87)	(18,573)	(213)
OUTSIDE STUDY AREA	Olachito - San Lorenso	126	22,554	178
	El Okote - Alenaru	86	15,398	189
	(Subtotal)	(212)	(37,952)	(179)
TOTAL		299	56,525	189

Average land area per farm: 202 ha.
Average area of pasture per farm: 186 ha.
Max. farm area: 707 ha.
Min. farm area: 35 ha.
Average No. of cattle per farm: 189 ha.
Average No. of minch cow capable of producting milk: 51 heads
Average volume of milk obtained per head per day: 2.5 liter
Average No. of pasture divisions per farm: 15 divisions
Area of one division per farm: 13 ha.

(Source: SAGO, Memorandum, Aug. 31, 1984)

The number of cattle raised in the area mentioned in the above table occupies 22 percent of the whole Yoro Province.

Livestock (cattle raising) can be considered a very important sector in the middle Aguan River Basin.

Livestock (cattle raising) in the study area can be classified into two types of farms: a) individual farms and b) immigrant cooperative member's farms concentrating in Sector 5, between the Jaguaca River and the Monga. In case of the latter type of farm, almost all production are usually self-consumed by members of cooperatives, and the number of cattle is fewer than that of the former type of farm.

A questionnaire was conducted in respect to cattle farms with the exception of immigrant cooperative members. The survey results are summarized below and also given in Appendix, Table E-29.

1) The improvement of pasture has been unexpectedly achieved at a higher level. About 80 percent of total pasture has already been improved.

2) The study area is equipped with various kinds of pastures suitable for cattle raising, which is advantageous for rearing cattle in terms of feeding management compared with the Upper Aguan River Basin Area.

3) There are many farmers who do not belong to the SAGO.

4) The cattle farms in the study area have less experience than those in the Upper Aguan River Basin.

5) Many farmers have not been rendered any technical extension services.

6) The number of farmers who get loans from banks is less in the study area than those outside the study area.

7) Many farms are raising pigs and chickens together with cattle in the study area. Pigs are particularly popular among those farms.

8) More answers have been collected in on questionnaires from non-members of SAGO than those from SAGO's members.

In the middle Aguan River Basin, various kinds of livestock animals such as sheep, pigs, chickens and even bees, are raised besides cattle. However, most of them are for self-consumption of farmers practicing non-systematic raising methods. The breed presently practiced is mainly Criollo (native breed) or a crossbreed with Criollo and improved breeds. In addition, the prevailing raising method in the area is a ultra-extensive one with a mono-feeding of cornmeal and without measures against the prevention of diseases such as vaccinations, parasite control, etc.

In recent years, "Pig Farming Project" and "Poultry Farming Project" for rural women have been launched and implemented under the direction of MRN and financial aid from foreign countries in the Aguan River Basin. Through these projects, the interest in livestock production has been increasing among medium- and small-scale farmers.

The outline of new agriculture projects for rural women in the middle Aguan River Basin with financial aid from foreign countries are shown in Appendix, Table E-30.

(2) Cattle Breeds

The breeds of cattle currently raised in Honduras consist of F1 cross or ternary cross among Brahman, Brown Swiss, Holstein and Criollo. In addition, some farms are raising Simmental, Charolais and Santa Gertudis as Bulls. Natural insemination is common but some large-scale farms are employing artificial insemination by applying frozen seman imported from U.S.A.

(3) Dairy Production

Due to the lack of refrigeration facilities at most farms, the cows are milked only once a day at about 4:0(a.m. every morning. The raw milk is delivered directly to the neighboring markets for sale as well as for cheese/cream producing plants located in the Aguan Valley.

The LEYDE (Leche y Derivado Compania), a milk processing company, with its base in La Ceiba, collects raw milk in the area between Saba and the Jaguaca River, and transports it to their refrigeration plant in Jutiapa. They do not collect raw milk in the upper area of the Aguan River from Olanchito. It is estimated that the volume of milk obtained is over 4 liters/head/day in the rainy season and less than 1-3 liters/head/day in the dry season, with an average of approximately 2.0 - 2.6 liters/head/day.

(4) Dairy Plant

There are three dairy plants in the upper and middle Aguan River Basin. The principal products of these plants are cheese and cream and production is carried out with technical assistance from Switzerland.

One of these plants is at El Juncal on the left bank of the Aguan River. The outline of each dairy plant in the middle Aguan River Basin is shown in Appendix, Table E-31.

(5) Pasture

As the questionnaire indicates, it is considered that about 80 percent of the pastures are the improved and pasture management is well conducted on the large-scale farms. Although soil fertilization and regular turnover plowing are not practiced, weeding is done completely by hand.

The pasture is extensively utilized for each cycle of pasturage only, and very often to do forage, hay, and silage.

The species of main grasses are shown in Appendix, Table E-32 of which the most important grasses are Guinea Grass and Merkeron. The area where the Merkeron is planted has a higher production potentiality.

Leguminosae grass has not been planted yet as a cattle feed, but Leucaena is only one plant which is presently used as a farm's fence among Leguminosae. Along the Aguan River, namely, in the right bank from Olanchito to the Jaguaca River and in the left bank from Olanchito to El Juncal, mountain slopes are well utilized for cattle raising and pasture control by burning is partly carried out.

(6) Beef Cattle production

The dual purpose of beef cattle production is conducted in the study area. Mainly, steers are grown to be sacrificed as beef cattle and feifers are used for replacement of milking cows. The growth of cattle for beef production is extremely low, and the average liveweight is 300 - 400 kg, at around 30 months after birth. The growth beef cattle, except those of the large-scale farms, are mainly delivered to La Ceiba, San Pedro Sula and Tegucigalpa by middleman's trucks (livestock merchants). Through the two packing plants located in San Pedro Sula, some of beef is exported to U.S.A. as a boneless frozen cut meat. The reputation on beef cattles produced at the survey area, however, is not so high among the packers due to the existence of many parasites, the low meat ratio, and so on.

An approximate estimation of beef cattle productivity is given, (See Appendix, Table E-33), which is prepared through the questionnaire.

(7) Public Slaughterhouse

There are public slaughterhouses in Olanchito, Saba, El Ocote, etc., and these are mainly used for slaughtering and processing of the culling cattle and the Criollo for local consumption. As well as dairy plants, the slaughterhouses are not equipped with refrigeration facilities, so the slaughtering and processing are started at 1:00 a.m. and the products are transported to the markets at 5:00 a.m. The slaughterhouse in Olanchito, in which an average of 3 - 4 heads of cattle and 2 - 3 heads of pig are processed daily, are not well equipped with adequate machinery, environment and sanitation.

(8) Price of Livestock products

The price of each livestock products in the study area in August and September, 1984 were as follows:

Producer's Price (Ex-Farm Price)

Milk (LEYDE buying price)	0.48 Lps./litre
Milk (for local dairy plant)	0.35 Lps./litre
Beef (delivery price to retailer	0.60 Lps./lbs. (1.32 Lps./kg)
Pork (delivery price to retailer)	1.0 - 1.2 Lps./lbs. (2.2 - 2.64 Lps/kg)
Chicken Egg (non-selective and unwashed)	0.15 - 0.20 Lps./pc.

The price of milk tends to go up at 10 - 15% in dry season due to the decline in production, while the price of beef tends to go down at 10 - 20% in January and February due to the concentration of post-havesting.

Consumer's Price at Olanchito

Beef (1st grade), frozen	2.0 Lps./lbs. (4.4 Lps.kg)
Beef (1st grade), fresh	1.8 Lps./lbs. (3.96 Lps./kg)
Pork, frozen	1.7 Lps./lbs. (3.74 Lps./kg)
Pork, fresh	1.5 Lps./lbs. (3.3 Lps./kg)
Milk (not treated)	0.4 Lps./ (3/4 litre) (0.53 Lps./litre)
Chicken Egg	0.2 Lps./pc.
Chicken Meat (frozen broiler)	1.8 Lps./lbs. (3.96 Lps./kg)
Cheese (local type)	1.3 Lps./lbs. (2.86 Lps./kg)
Cream	2.3 Lps./lbs. (0.56 Lps./kg)
Sausage (homemade)	3.9 Lps./lbs. (8.58 Lps./kg)
Fish (both freshwater and seawater fishes)	2.0 Lps./lbs. (4.4 Lps./kg)
Powder Milk (imported, made in Holland)	6.0 Lps./450 g
Cornbeef (made in U.S.A.)	7.3 Lps./198 g
Luncheon Meat (made in U.S.A.	7.5 Lps./395 g

Note: 1) All canned meat and dairy products are imported.

2) Broiler is produced in San Pedro Sula.

3) Frozen beef and pork are preserved in cold storages.

Comparison of Consumer's Price of Major Livestock Products in Olanchito and San Pedro Sula

(Unit: Lps.)

Products	Oranchito	San Pedro Sula
Beef (1st grade)	2.00/lbs.	2.40/lbs.
Pork	1.70/lbs.	2.40/lbs.
Chicken Meat	1.80/lbs.	1.70/lbs.
Chicken Egg	0.20/lbs.	0.15/pc.
Fish (Freshwater and seawater fishes)	2.00/lbs.	1.50/lbs.

The prices of beef and pork in Olanchito are cheaper than those in San Pedro Sula. As mentioned before, the meat produced in Olanchito comes from culling cattle and Criollo, so it cannot be concluded that producer's price is cheaper in Olanchito than those in San pedro Sula.

(9) Outline of Livestock in Neighboring Provinces

In the neighboring provinces such as La Ceiba of Atlantida province, Trujillo of Colon Province, and San pedro Sula of Cortes Province, the modern feeding systems for cattle, pigs and chickens have started to be applied, and the special bread for each species has been introduced.

In particular, at Tumbador Ranch in Trujillo, the Beemfaster (the special hybrid for beef cattle crossbred among ¼ Short Horn ¼ Heleford and ½ American Brahman) is raised under technical guidance conducted by Florida University, U.S.A. The body weight of this breed reaches to 2,000 pounds in 24 - 30 months. The livestock production techniques has been rapidly improved as proved by the success of Embrio Transfer, etc.

(10) Marketing of Livestock Products

The marketing channel of livestock products in the middle Aguan River Basin is complicated as illustrated in Appendix, Fig. E-2. The middleman (livestock merchants and brokers), so called "Intermediario", has expanded his business to cover every site of the study area, and is dealing with all livestock products including beef cattle, steers, breeding stocks, pig, chicken egg, cheese and cream.

Some of these middlemen have their own cattle farms. It is assumed that many of them earn high profits, because they buy beef cattle at cheaper prices early in the dry season and stock them for growing further fat at their own farm. Most of these retailers come from La Ceiba, San Pedro Sula and Tegucigalpa, but some of them own the afore-mentioned large-scale farms around Olanchito.

The prices for livestock products except dairy products are negotiated and set by outer size of animals and weighing for each animal is not realized. The dealing system usually result in disadvantage for producers.

There are no standards established to estimate the quality of livestock products. Consequently, producers do not pay much attention to the quality, and tend to raise animals in the easiest way. It is envisaged that the interferences of the retailers will be much strengthened as the infrastructures in the study area will be improved in the future.

(11) Training and Extension Services

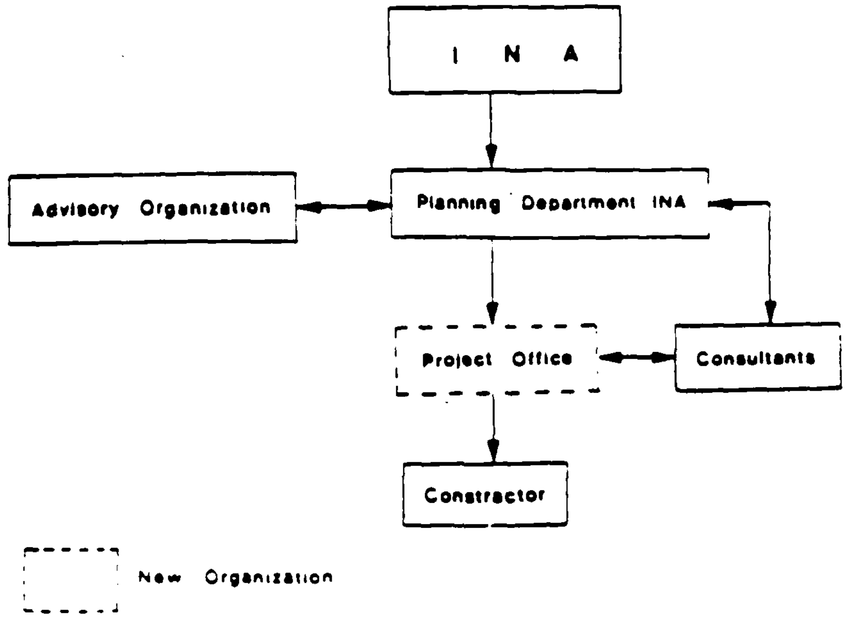
The assistance and extension services are provided by INA to the cooperative of Agrarian Reform and by M.R.N. to the existing individual farmers who have their own land, although cooperation between these two organizations does not seem to be closely related. There is a local office of M.R.N. in Olanchito, with about 15 personnel including two veterinarians. This local office undertakes various activities such as artificial insemination of cattle, technical guidance on pasture improvement, research and prevention of animal diseases. Due to the lack of equipment, education, training, experience, etc., it does not seem that the objectives of this local office are fully accomplished.

In accordance with the results of the questionnaire survey, only 24 percent of farmers living between Olanchito and the Jaguaca River and only 4 percent of farmers living between Olanchito and EJ Juncal are receiving technical assistance.

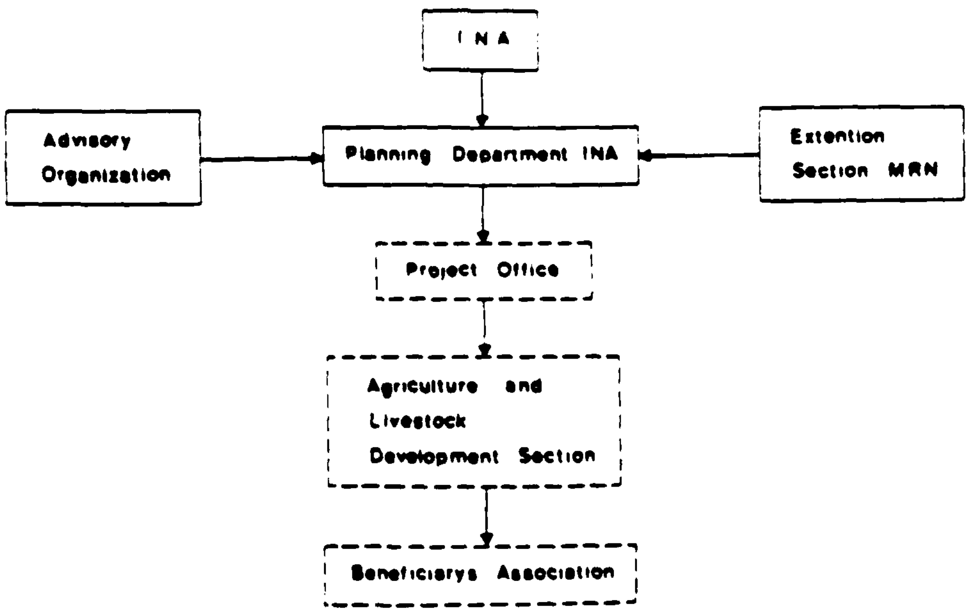
This situation should get better with the improvement of agricultural infrastructure. The organization chart of the local office of MRN in Olanchito is shown in Appendix, Fig. E-3.

(12) Animal Disease

Presently, there is no appearance of serious animal infectious diseases such as Foot and Mouth Disease, African Swine Fever, Pseudo Rabies, as reported in South American and Caribbean Island countries. The animal diseases appeared in the study area at present include external parasites during dry seasons, impediment in breeding caused from unbalanced nutrition, and mastitis, in addition to Hemorrhagic Septicemia, Sysmptomatic Anthrax (Black-leg) which can be prevented by vaccination. At medium- and small-scale farms, they do not apply vaccination and the ultra-extensive method is done for animal raising. In this regard, the establishment of an animal disease prevention system to achieve further livestock development is required.



5.3 After the commencement of the Project, INA is to work closely with MRN and other organizations concerned in order to provide farmers with the necessary extension and training.



.) Private Sector

It is recognized that the private sector can contribute with its managerial capacity and initiative in finding out investment opportunities to the creation of new sources of new job opportunities.

2) Public Sector

Central Government:

Conducts the policy of the country in the every field of economic and social activity. In this context, it will be required to rationalize the ensemble of rules and legal mechanism and the juridical and administrative structure.

Autonomous Organizations:

Need to rationalize the assignation of its resources, simplification in the procedure and efficiency in the fulfillment of their objectives.

Public Enterprises:

Have the function to promote and regulate the country.

Local Authorities:

Will carry out its role in relation to the implementation of programs and projects designated for the fulfillment of necessities among peoples under their jurisdiction.

4 Agriculture

4.1 Agricultural Sector in the National Economy

Agriculture is the country's most important economic sector, accounting directly for 30% of GDP and indirectly for a significant proportion of other economic activities. It provides employment for 58% of the economically active population and generates more than 80% of export earnings. (See Appendix, Table A-6.)

4.2 Agricultural Products

The principal agricultural products of Honduras are banana, coffee, maiz, sugarcane, bean, etc. Among these, banana, coffee and sugarcane are export crops. In addition to these crops, cotton is also produced for export. (See Appendix, Table A-7 and A-8.)

Banana production has returned to the output levels prior to the 1974 hurricane, and of which 60 to 65% is exported. Coffee production has doubled during 1972 and 1982, mainly in response to higher prices in the export market. More than 80% of production is exported. The production of sugarcane has increased steadily at 7.5% a year.

These export crops are cultivated principally in large farms and companies. In case of banana, production and export is largely controlled by the multinational companies: United Brands in the Sula Valley and Standard Fruit Company in the Aguan River.

Meanwhile, among small farmers subsistence agriculture is widespread and two-thirds of their crops are for household consumption. Maize, the staple diet of the rural population, is predominant among these crops, about half of their agricultural production. But the production of maize does not supply domestic requirements, and in some years Honduras has resorted to imports. (See Appendix, Table A-9.)

2.4.3 Landholding

Large farms with holdings more than 500 hectares amount to 0.2% of the total number of farms in Honduras and hold 22% of the total farm land, while small farmers with holdings below 5 hectares represent 64% of the total number of farms, but they hold only about 9% of the total farm land. Also the proportion of rented land in the holdings of small farmers is high. (See Appendix, Table A-10.)

2.4.4 Under-utilization of Rural Labor

Under-utilization of rural labor is large. About 60% of the available man-days in small and medium farms are not utilized. The rate of under-utilization is about 63% in small farms (0-5 has) and diminishes to about 55% in farms of the 10-20 hectares group. (See Appendix, Table A-11.)

Apart from the seasonality of main crops, under-utilization of labor derives from the structural problem of small farms with too much labor and not enough land. Thus the small farmer is forced to work as hired labor in larger farms, particularly at harvest time.

Aside from the excess labor in rural areas, an undetermined number of peasants had no land. Estimated ranged up to 120,000 families in 1974 (most likely a smaller number). They seek employment as laborers in the larger farms or migrate to the cities.

2.5 Agrarian Reform

2.5.1 Objective

The Agrarian Reform Program aims at improved land utilization through the transfer of unused or under-utilized land from large landowners to landless rural families, while, at the same time, strengthening the modern entrepreneurial sector in agriculture.

2.5.2 Executive Agency - Agrarian Reform Institute

The Agrarian Reform Institute (INA), principally responsible for official institutional support of the agrarian reform, deals with land acquisition and distribution, organization and management, training and technical support of the settler groups, and with guarantees for farm credit issued by the official agricultural bank.

2.5.3 Present Condition

By 1982 the Agrarian Reform has settled 50,000 peasant families (12% of rural families) on about 210,000 hectares. About 39,000 remain in the settlements and about 11,000 families have abandoned them because they did not receive enough production land or support services or could not adapt to hard living conditions in some areas.

Since 1978, INA has concentrated its resources on the potentially most productive 9 areas, and among them the Lower Aguan Valley Project is the most important. (See Appendix, Table A-12.)

2.5.4 Agricultural Production

Rough estimates indicate that agricultural value added in the reform sector is about 10% of the country's agricultural value-added originating in crop production. The reform sector's share of value-added varies by crops. Basic grains production is still dominant in the reform sector although significant progress is taking place with the production of African palm, banana, rice and other commercial crops. There is growing awareness that all reform groups must participate in higher earning afforded by cash crops. (See Appendix, Table A-13)

2.5.5 Problems

The problems of the agrarian reform are as follows:

INA's titling has been very slow. About 85% of the groups and 70% of the distributed land have not been titled.

INA's capacity to perform other functions than acquisition and redistribution of land is limited. These functions are to assist the campesino groups to become established, to obtain essential services and resources, and to train them in organizations and management.

In addition to these, marketing is a serious problem with the exception of settlements producing cash crops under special arrangements with marketing intermediaries.

3.5.4 Summary of Soil property

The details of the soil property in the area became clear from field observation and laboratory analysis. The suitability of the soils for agriculture uses was summarized in the study.

Properties of each soil series are given in Table 3-10.

In the fine texture, well drained alluvium, Aguan clay loam and Tepusteca loam series, a wide range of upland crops can be grown because of good to moderate drainage and high fertility. However, the fine texture well drained alluvium series in susceptible to flooding because it occupies the lowest terrace along the rivers. Olanchito sandy loam series has limited potential for crop cultivation because of gravel. Grass land can be recommended for cultivation in the area.

Drainage of Ilanga sandy clay, Taujica clay loam and Jahuaca clay loam series is moderate but partially poor. Root rotting of maize was partially observed in these areas. If adequate drainage is provided in these areas, a wide range of upland crops could be grown and yield could be increased.

Fine texture, poorly drained alluvium is severally limited for crop cultivation because of poor drainage. Soil moisture is too high to cultivate such crops as maize and beans on this soil.

3.5.5 Land Classification

The land classification was undertaken to evaluate the land capability in the study area.

The land classes have been tentatively difined based principally on the system employed by the U.S. Bureau of Reclamation and its specifications were partially modified to fit for the purpose of the study.

The land classification has been made in principle to each soil series. These soil series then have been classified into three classes (Class 1, 2 and 3) of arable land and one class (Class 4) of non-arable land.

The following are general description of land classes in the study area.

Class I : Land in this class have few limitations for its use. The soils are suitable to the wide range of crops, keeping capable of producing substantial and relatively high yields at reasonable cost. The land is merely flat or slightly undulating. The soils are well drained and easily worked. They are either fairly well supplied with land nutrients or highly responsive to fertilizers.

Class II : The soils in this class have some limitations for the introduction of crops and require moderate conservation practice for their use. The limitations are a bit and the practices are easily applied. They are measurably lower than Class I in reproductive capacity and more easily to farm.

Class III : This class of land comprises land to be considered marginably suitable for crop cultivation. But, there are some restricted suitability in this land, because it is less reproductive compared with that of class I and II.

Class IV : Land included in this class have severe non-correctable limitation which prevent normal tillage of cultivated crops. This class of land is extended only steep area of the study area.

The result of land classification are summerized below. (See Fig. S-4.)

Land Classification

Class	Area (HA)	%
I	12,900	67
II	3,490	18
III	1,110	6
IV	1,740	9
Total	19,240	100

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COAST OF HONDURAS FLOODING(U) ARMY ENGINEER DISTRICT
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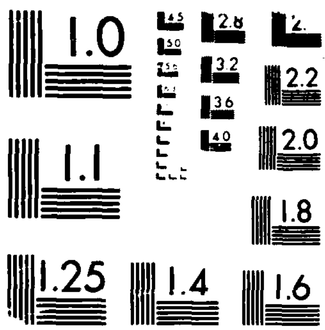


MICROCOPY RESOLUTION TEST CHART

UREAU STANDARDS 1963 A

CUADRO II-18

BENEFICIARIOS DIRECTOS: COOPERATIVAS

Sector	Grupo #	Socios #	Población Total #	(1979) Ingreso Promedio Anual Por Socio Lps.
Tocoa-Sabá	20	856	5,660	844.20
Tocoa-Corocito	18	952	5,732	885,80
Margen Izquierda	21	697	4,498	1,541.94
Sabá-Río Jahuaca	9	454	2,965	No Información
TOTAL	68	2,959	18,855	1,090.65

2.6.4.2 Impactos Negativos

El Proyecto propuesto tendrá serios impactos negativos para Isletas y las tierras bajas entre la carretera Corocito-Trujillo y el mar. Estas zonas estan fuera del área de estudio contratado. Si se ejecuta, el Proyecto propuesto causaría severas inundaciones, dando lugar a daños al cultivo y ganadería, y probablemente abandono de algunas comunidades. Aproximadamente 53,500 personas o sea 58% de los habitantes y 55% de la ganadería en el Bajo Aguán se halla en estas áreas.

2.6.5 Recomendaciones Generales

2.6.5.1 Impacto del Proyecto en Otras Areas

El impacto socioeconómico de las obras civiles propuestas, en los sectores de Isletas y Corocito-Francia, serán negativos como consecuencia de la implementación de las obras de control de inundaciones y drenaje nece sarias en el área de contrato, sino se realiza nada en la margen izquierda, por consiguiente, no se recomienda ejecutar las obras de la margen derecha mientras no se considere posibles efectos negativos en la izquierda.

2.6.5.2 Infraestructura Básica:

La falta de infraestructura básica ha sido uno de los mayores problemas en la historia del Proyecto Bajo Aguán.

Recomendaciones:

a) Es necesario adecuadas facilidades de salud que permita a las cooperativas y otros residentes locales acceso garantizado y facilidades apropiadas.

b) El agua potable deberá instalarse en el área cuanto antes. Esto requerirá en primer lugar la perforación de pozos .

c) Los programas de mejoramiento de viviendas, educación y otras facilidades públicas, deberían implementarse lo antes posible.

d) En sabá-Río Jaguaca: se requiere caminos secundarios, utilizables en cualquier condición climatica y debería construirse la carretera principal a las cooperativas. b) Los trabajos de irrigación deberá construirse para asegurar, que el programa básico de granos planeado, basado en dos cultivos por año y aplicación de riego, sea posible desarrollar.

e) En la margen izquierda: a) Deben tomarse acciones inmediatas para mejorar las casas y condiciones de vida en general. b) El camino principal debería reubicarse a tierras más altas para, evitar inundaciones crónicas y cortes de la vía.

2.6.5.3 Organización y Administración del Proyecto Bajo Aguán:

Las recomendaciones en relación con la organización y administración del Proyecto Bajo Aguán son las siguientes:

a) Organizar la corporación del Bajo Aguán.Debe establecerse una corporación del Bajo Aguán o un organismo coordinador que tenga total control y responsabilidad sobre las actividades en el área,de acuerdo al presente estudio y cualquier otro futuro.(figura II-8). Incluría las organizaciones cooperativas, BANADESA, Recursos Naturales, INA y Funciones Auxiliares.

b) Deberá crearse una organización de cooperativas, que represente a todas y que eventualmente asuma las actuales responsabilidades del INA en la organización cooperativa y desarrollo Social. Esto permitiría al INA retirarse del Bajo Aguán en algunos años, y emplear sus recursos en acciones de Reforma Agraria en otros lugares de Honduras.

c) BANADESA debería ser responsable de todos los aspectos financieros. En relación con el Proyecto Bajo Aguán ,esto relevaría al INA de las responsabilidades de pago del préstamo hecho al Proyecto.

d) La oficina de Recursos Naturales debería ser la responzable de todas las acciones de extensión, experimentación agrícola y semilleros, establos experimentales, mecanización agrícola, y proveer los insumos agrícolas básicos.

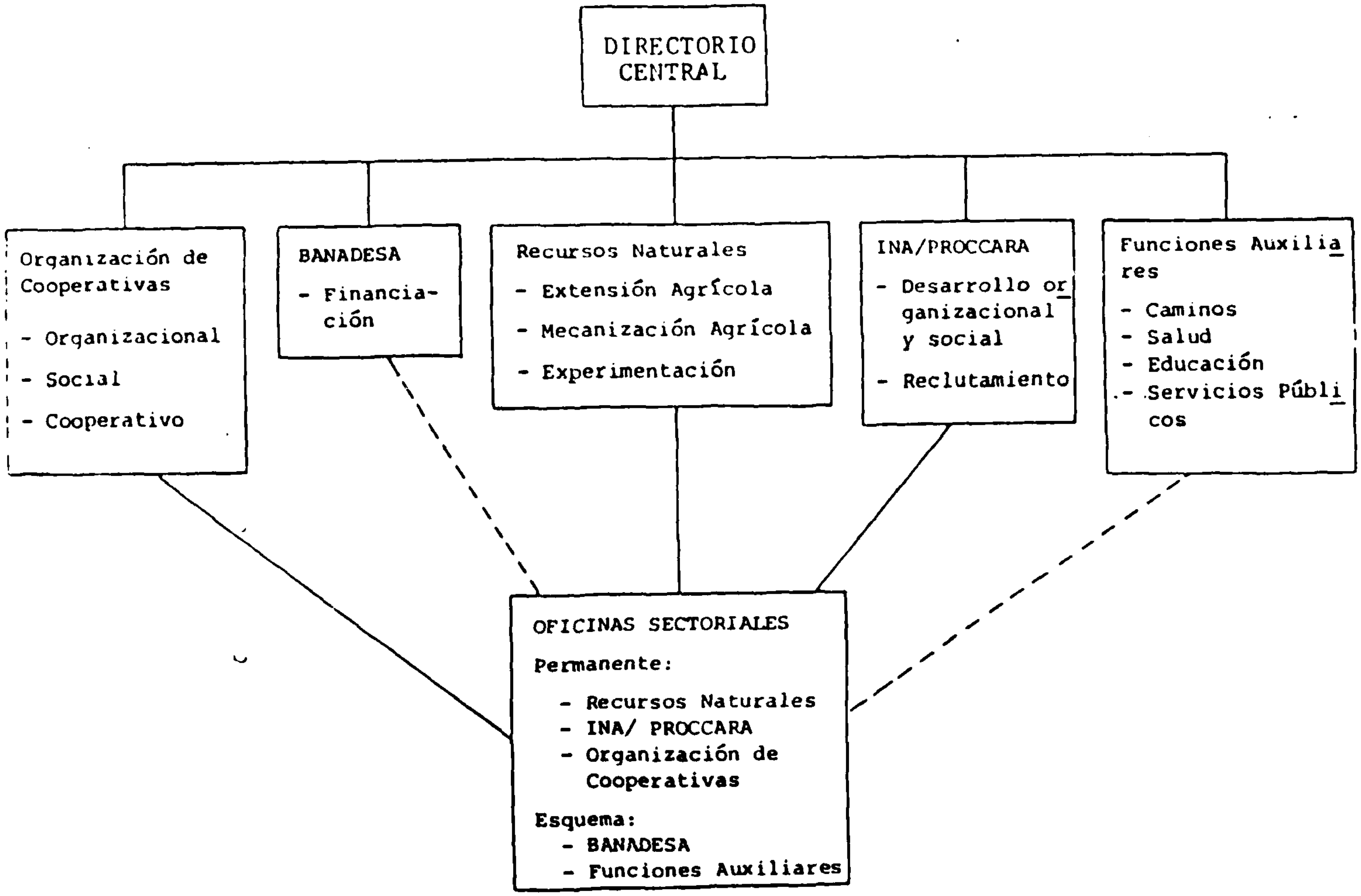
e) INA debería ser responzable de la organización y desarrollo social de las cooperativas y acciones de Reforma Agraría, su función original.

f) Cada sector en el Proyecto Bajo Aguán debería tener una oficina central. Esta oficina debe incluir: extensión agrícola/mecanización agrícola; INA-PROCCARA; la organización de cooperativas; y BANADESA.

G) Organización de la Producción de Cítricos debe establecerse una organización para la producción.

FIGURA II-8

ESTRUCTURA DE ORGANIZACION RECOMENDADA PARA LA CORPORACION DEL BAJO AGUAN



2.6.5.4 Asistencia Técnica

La asistencia técnica ha confrontado problemas de coordinación, efectividad y calidad del servicio dado, y la falta de suficientes fondos y experiencia del personal.

A) El servicio de extensión debería:

a) Ser organizado de tal manera que una organización sea responsable de todo el servicio de extensión.

b) Ser responzable de la coordinación del plan de cultivo y necesidades de crédito de las cooperativas, de tal manera que las necesidades de crédito se puedan presentar a BANADESA varios meses antes que el préstamo se requiera, esto facilitaran a BANADESA planear mejor sus programas de préstamo.

c) En cada cooperativa, se debe entrenar a dos o tres socios interesados en recibir capacitación como agentes de extensión agrícola. Estos asistentes trabajarían en su propia cooperativa y serían el mejor enlace entre la cooperativa y los agentes de extensión. Los asistentes serían responzables en la preparación de las necesidades de las cooperativas.

B) Demostración de cítricos:

Las plantaciones de cítricos no han progresado con la velocidad de la palma. Se recomienda que se desarrolle un área piloto en una de las cooperativas actualmente con cítricos. Esta área piloto demostraría la efectividad del riego y de técnicas agrícolas apropiadas.

C) Economía Doméstica:

En cada cooperativa una parte de la tierra debería reservarse para la producción de granos básicos, verduras y ganadería menor, para consumo doméstico. El programa recomendado ayudaría a lograr los requerimientos domésticos y mejorar substancialmente el nivel nutricional de los miembros de las cooperativas.

2.6.5.5 Utilización de Recursos:

La subutilización de la tierra y el hecho que las cooperativas, con pocas excepciones, no hayan logrado el nivel de miembros (5 ha/socio) originalmente previsto, es visto por INA como el mayor problema. Las siguientes serían las recomendaciones: a) Reasignación de las tierras potencialmente agrícolas; b) Cambio del énfasis al Mono-Cultivo en el Proyecto; c) Modificar la relación de asentamiento cooperativo original de 5 ha/socio; y d) Modificar el salario actualmente pagado a los miembros de cooperativa.

2.6.5.6 Desarrollo Cooperativo:

El desarrollo de cooperativas en organizaciones estables y viables se ha dificultado por presión económica, malas condiciones de vida, alto grado de deserción, asistencia técnica mediocre, mala administración de Proyectos, y la formación socio cultural de los socios. Las siguientes son las recomendaciones al respecto: 1) Mejorar la asistencia técnica para el desarrollo social y organizacional; 2) Asentar nuevas cooperativas; y 3) Integrar nuevos socios en las cooperativas existentes.

2.7 Agricultura y Ganadería

2.7.1 Agricultura

El área actual de cultivo dentro de los límites del Proyecto es de 21,406 ha, de las cuales el 47% corresponde a palma africana, el 39% a maíz y el 8% a cítricos.

2.7.1.1 Uso Actual de la Tierra

Con el análisis de las fotografías aéreas y las investigaciones para diseñar los sistemas de riego y drenaje se ha podido establecer los siguientes grados de utilización de la tierra en el área del proyecto:

Categoría	Margen Derecha (Has)	Margen Izquierda (Has)	Total (Has)
1. Tierras con cultivos permanentes (principalmente) y desmontadas	13,830	7,800	21,630
2. Tierras poco utilizadas	8,900	200	9,100
3. Tierras aptas pero sin uso	4,400	2,000	6,400
4. Tierras enmontadas utilizables	0	6,000	6,000
5. Tierras inundadas	2,300	300	2,600
6. Cauce del río y depresiones	4,370	4,100	8,470
7. Centros urbanos	1,000	0	1,000
TOTAL	34,800	20,400	55,200

Asímismo, por la información proporcionada por los organismos gubernamentales que operan en la zona, se ha establecido el siguiente patrón de cultivos (con cifras correspondientes al año 1979).

C U L T I V O	Margen Derecha (Has)	Margen Izquierda (Has)	Total Has	
Palma africana	6,814	3,146	9,960	46.52
Cítricos	1,786	0	1,786	8.34
Plátano	124	235	359	1.68
Maíz	5,057	3,321	8,378	39.14
Arroz	538	46	584	2.73
Frijol	45	186	231	1.08
Hortalizas	10	29	39	0.18
Otros cultivos	70	0	70	0.33
TOTAL	14,443	6,963	21,406	100.00

La información desagregada para cada uno de los sectores y por cooperativas, se presenta en el informe de diagnóstico del sector agrario.

2.7.1.2 Aspectos Agro-económicos

El patrón de cultivos de la zona se caracteriza por la predominancia de cultivos permanentes (palma africana y cítricos) y maíz. Esta cédula de cultivos está condicionada por los aspectos físico ambientales, por el apoyo técnico y crediticio que brindan el INA y la Secretaría de Recursos Naturales, así como por la tradición agrícola de la zona.

Las prácticas tecnológicas más avanzadas son aplicadas en el cultivo de palma y cítricos y en menor proporción, en el cultivo del maíz; pudiéndose indicar que tales prácticas no alcanzan a satisfacer los requerimientos de un nivel de tecnología media en todas las áreas cultivadas. El resto de cultivos se conducen mayormente bajo sistemas tecnológicos rústicos.

La utilización de insumos es bastante deficiente en términos de cantidad, calidad y oportunidad, desconociéndose en la mayoría de los casos el nivel técnico-económico de aplicación. Aparentemente la transferencia de tecnología en aspectos productivos y de gestión empresarial no está dando los resultados esperados.

En cuanto a los créditos, estos están orientados a apoyar a los cultivos que son promovidos por el Gobierno. La Secretaría de Recursos Naturales atiende a los cultivos anuales (maíz, frijol y arroz) mediante crédito otorgado por la Agencia Internacional para el Desarrollo (AID). Los cítricos son apoyados con fondos provinientes del Préstamo BID. El INA brinda apoyo crediticio al cultivo de la palma africana mediante crédito también otorgado por el BID. El Banco Nacional de Fomento complementa los requerimientos de crédito de los agricultores en el área.

En cuanto al mercadeo de los productos, las principales restricciones se presentan a la producción de cítricos. En efecto, la falta de adecuadas vías de comunicación (que se agrava con la presencia de las lluvias) y de infraestructuras de comercialización que permitan conservar la fruta originan grandes pérdidas a los agricultores. A ello hay que agregar el hecho de que la calidad de la fruta no sea buena y limita la posibilidad de conquistar mercados foráneos estables y seguros. En el caso de la palma africana, esta tiene mercado asegurado en las plantas extractoras de aceite.

La asistencia técnica carece del dinamismo, y en el presente año, se ha visto restringida por las limitaciones económicas que ha afrontado el INA. En este campo se nota la falta de coordinación entre las Instituciones del Gobierno que de una u otra forma participan en las actividades del sector agrario, y, es más, se aprecia pugna entre los planes que cada una de ellas apoya.

Los servicios de maquinaría agrícola son en su mayoría brindadas por el INA, pero su nivel de eficacia está asociado con la disponibilidad de recursos de dicha Institución.

2.7.1.3 Producción

A continuación se presentan los registros de producción de fruta de palma por campaña, aceite, almendra, producción de cítricos y producción de cultivos asistidos por la Secretaría de Recursos Naturales. Estos últimos no se dan por cooperativa sino que corresponden a valores promedios del lugar, tanto en la primera siembra como en la segunda.

El Cuadro II-19 muestra la producción de fruta de palma en la Campaña de 1976 correspondiente a la plantación sembrada en 1971.

El Cuadro II-20 corresponde a la producción obtenida en la campaña 1977 según año de plantación graficándose en la Figura II-19 la distribución mensual de la producción.

El Cuadro II-21 corresponde a la producción de fruta distribuida mensualmente en el año 1977. La Figura II-10 muestra la producción de fruta en la Campaña 1978 y la distribución de fruta de 1979 se presenta en la Figura II-11 de distribución mensual.

El resumen de la producción de fruta según campaña se presenta en la Figura II-12.

CUADRO II-19

PRODUCCION DE FRUTA POR COOPERATIVA AÑO 1976

CULTIVO DE LA PALMA

COOPERATIVA	SUPERFICIE (HAS)	PRODUCCION DE FRUTA (TON)	RENDIMIENTO (TON/HA)
Salamá	115	372.2	3.2
San Isidro	83	158.5	1.9
Central Bajo Aguán	56	204.9	3.6
15 de Mayo	6	18.6	3.1
Estación Experimental	22	63.7	2.9
TOTAL	282	817.9	2.9

CUADRO II-20

PRODUCCION DE FRUTA POR COOPERATIVA Y AÑO DE PLANTACION

CULTIVO DE LA PALMA AÑO 1977

AÑO DE PLANTACION	COOPERATIVA	SUPERFICIE (HAS)	PRODUCCION DE FRUTA (TON)	RENDIMIENTO (TON/HA)
1971	Salamá	115	1338	11.6
	San Isidro	83	853	10.3
	Central Bajo Aguán	56	648	11.6
	15 de Mayo	6	72	12.0
	Sub-Total	260	2911	22.20
1972	Salamá	34	272	8.0
	13 de Junio	14	86.5	6.2
	Zamora	5	28.0	5.6
	Estación Experimental	22	192.3	8.7
	Sub-Total	75	578.8	7.7
1973	15 de Mayo	12	23.0	1.9
	TOTAL	347	3512.8	10.12

CUADRO II-21

DISTRIBUCION MENSUAL DE LA PRODUCCION DE FRUTA AÑO 1977
CULTIVO DE PALMA

M E S E S	PRODUCCION DE FRUTA (TON.)	PORCENTAJE
Enero	144.04	4.1
Febrero	70.26	2.0
Marzo	101.88	2.9
Abril	122.96	3.5
Mayo	175.65	5.0
Junio	210.78	6.0
Julio	316.17	9.0
Agosto	421.56	12.0
Septiembre	474.26	13.5
Octubre	632.34	18.0
Noviembre	597.21	17.0
Diciembre	245.69	7.0
T O T A L A Ñ O	3512.80	100.0

La planta Isidro Sabio Cacho (ISC) luego de adaptaciones hechas amplió su capacidad de 3 a 6 toneladas por hora. La otra planta la HFF tiene una capacidad de 6 toneladas por hora, por lo que la capacidad del conjunto es de 12 toneladas por hora.

Las Figuras II-13 y II-14 resume la producción de aceite y almendra en 1978 y 1979.

La Figura II-15 resume la producción de aceite y almendras según año de campaña.

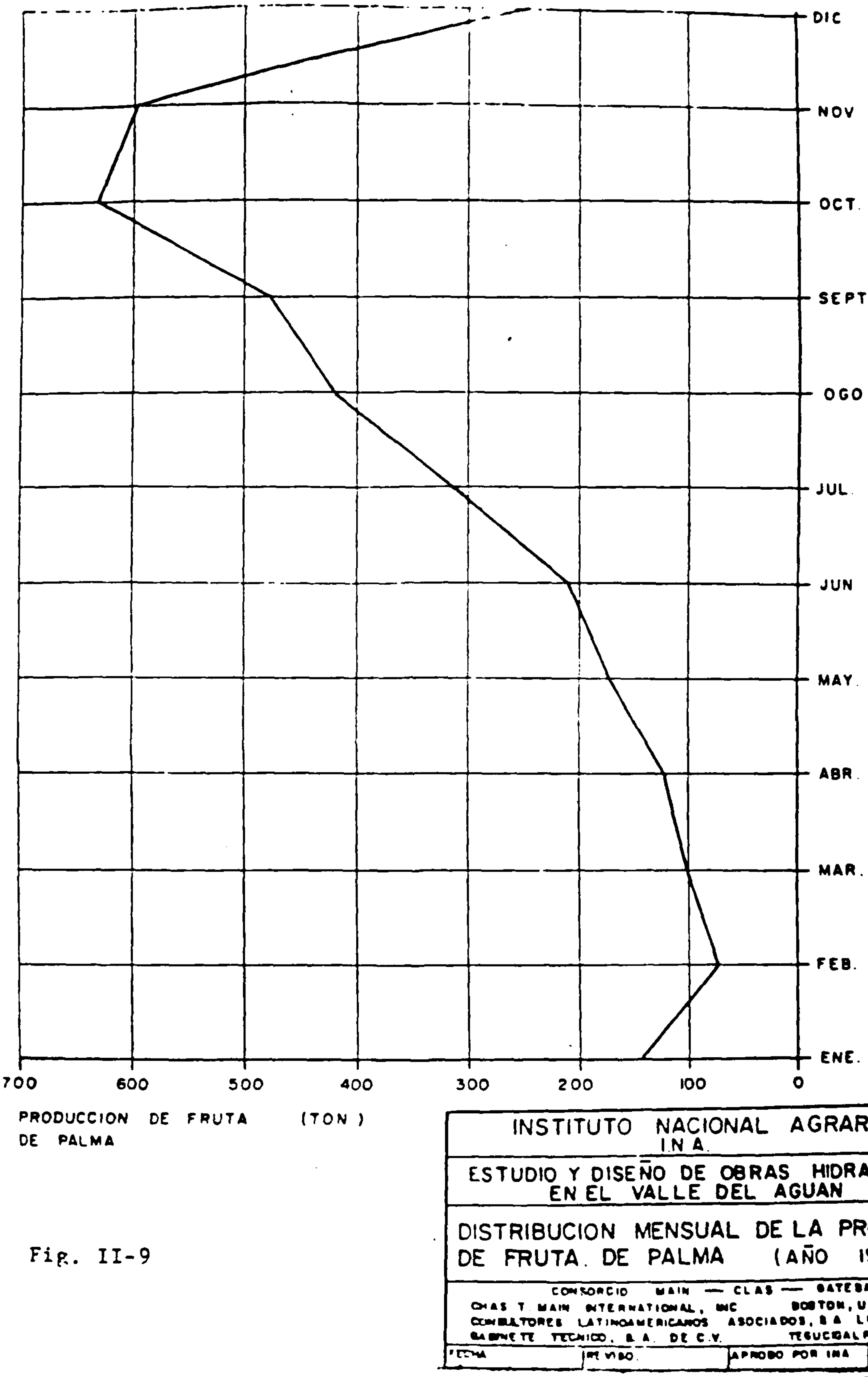
En el Cuadro II-22 aparece la producción de cítricos por cooperativa durante 1979 mientras que en el Cuadro II-23 se presentan los cultivos asistidos por la Secretaría de Recursos Naturales así como sus costos de producción. En este último cuadro la primera siembra de primavera es la que se efectuó de Marzo a Octubre de 1979 mientras que la segunda comenzó en Octubre de 1979 y finalizó en Marzo 1980. En el cultivo de maíz sistema rústico el rendimiento fué de 1818 y 2045 Kg/Ha., mientras que la producción en sistema tecnificado fué de 2500 y 3409 Kg/Ha. De igual manera el costo de producción por hectárea en el sistema rústico fué de Lps.215 mientras que el costo en el sistema semitecnificado fué de Lps.345 por hectárea.

2.7.2 Ganadería

2.7.2.1 Especies Existentes

Actualmente hay existencia de ganado bovino en tres cooperativas del Proyecto. Al momento de recopilarse la información solo se disponía de un número bastante aproximado de tal existencia por cooperativa la que se indica en el Cuadro II-24 no habiéndose podido desagregar en vacas, toros y terneros.

No existe ninguna otra explotación primaria. Aunque en pequeña escala rezagos de actividad, pero sin importancia económica por lo que puede decirse que este tipo de explotación está en vías de extinción. La existencia actual en la cooperativa Salamá no excede de 10 cerdos que sumados a la proveniente de la cooperativa Los Leones servirían de inicio a un nuevo proyecto a nivel de porqueriza modelo usando en la misma, tecnología intermedia con materiales del lu-



INSTITUTO NACIONAL AGRARIO I.N.A.			
ESTUDIO Y DISEÑO DE OBRAS HIDRAULICAS EN EL VALLE DEL AGUAN			
DISTRIBUCION MENSUAL DE LA PRODUCCION DE FRUTA DE PALMA (AÑO 1977)			
CONSORCIO MAIN — CLAS — GATESA CHAS T. MAIN INTERNATIONAL, INC. BOSTON, U.S.A. CONSULTORES LATINOAMERICANOS ASOCIADOS, S.A. LIMA, PERU GABINETE TECNICO, S.A. DE C.V. TEGUCIGALPA, HONDURAS			
FECHA	REVISO	APROBO POR INA	HOJA

Fig. II-9

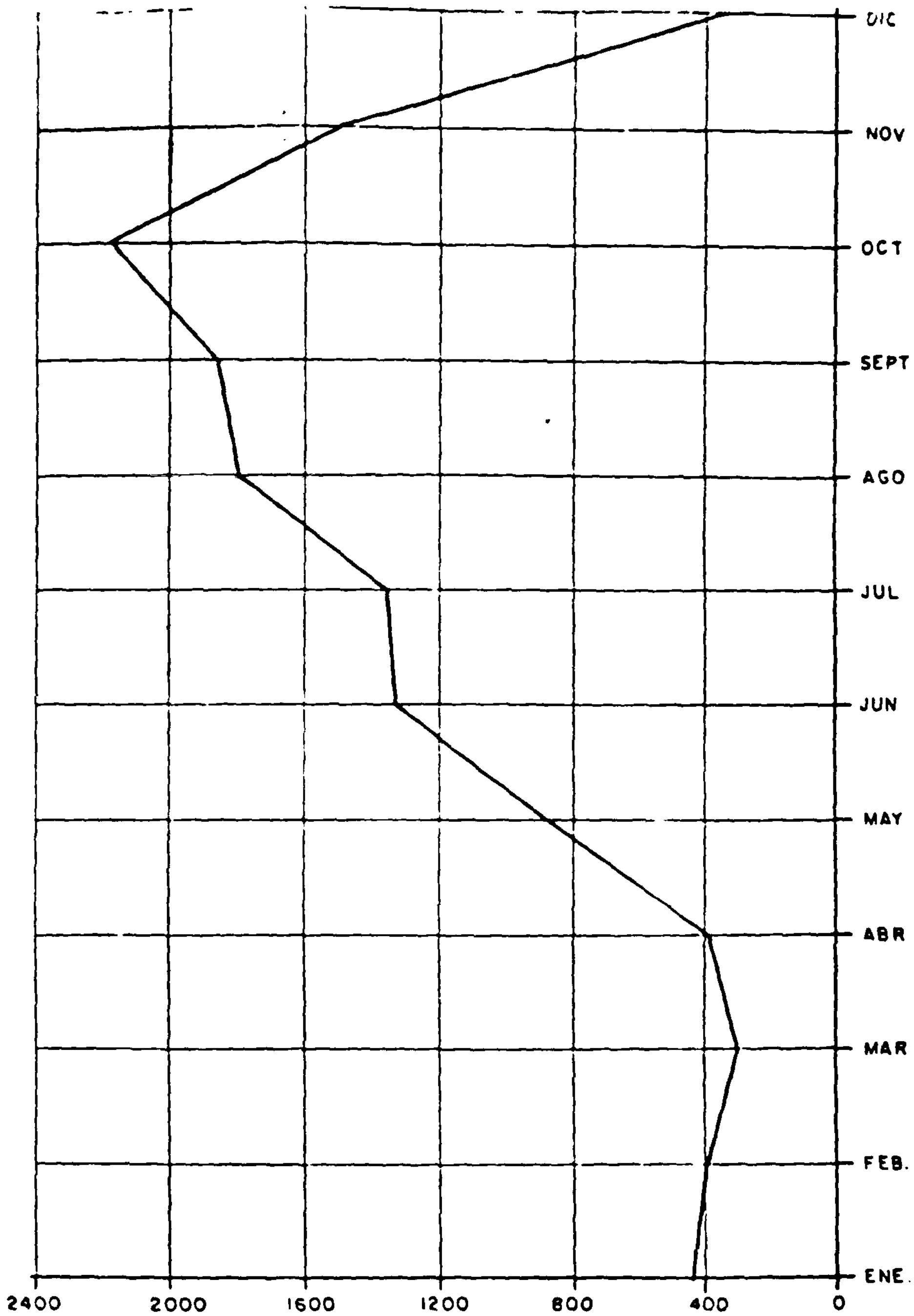


Fig. II-11

INSTITUTO NACIONAL AGRARIO INA
ESTUDIO Y DISEÑO DE OBRAS HIDRAULICAS EN EL VALLE DEL AGUAN
DISTRIBUCION MENSUAL DE LA PRODUCCION DE FRUTA DE PALMA (AÑO 1979)
CONSORCIO MAIN — CLAS — GATESA CHAS T. MAIN INTERNATIONAL, INC. BOSTON, U.S.A. CONSULTORES LATINOAMERICANOS ASOCIADOS, S.A. LIMA, PERU GABINETE TECNICO, S.A. DE C.V. TEGUCIGALPA, HONDURAS

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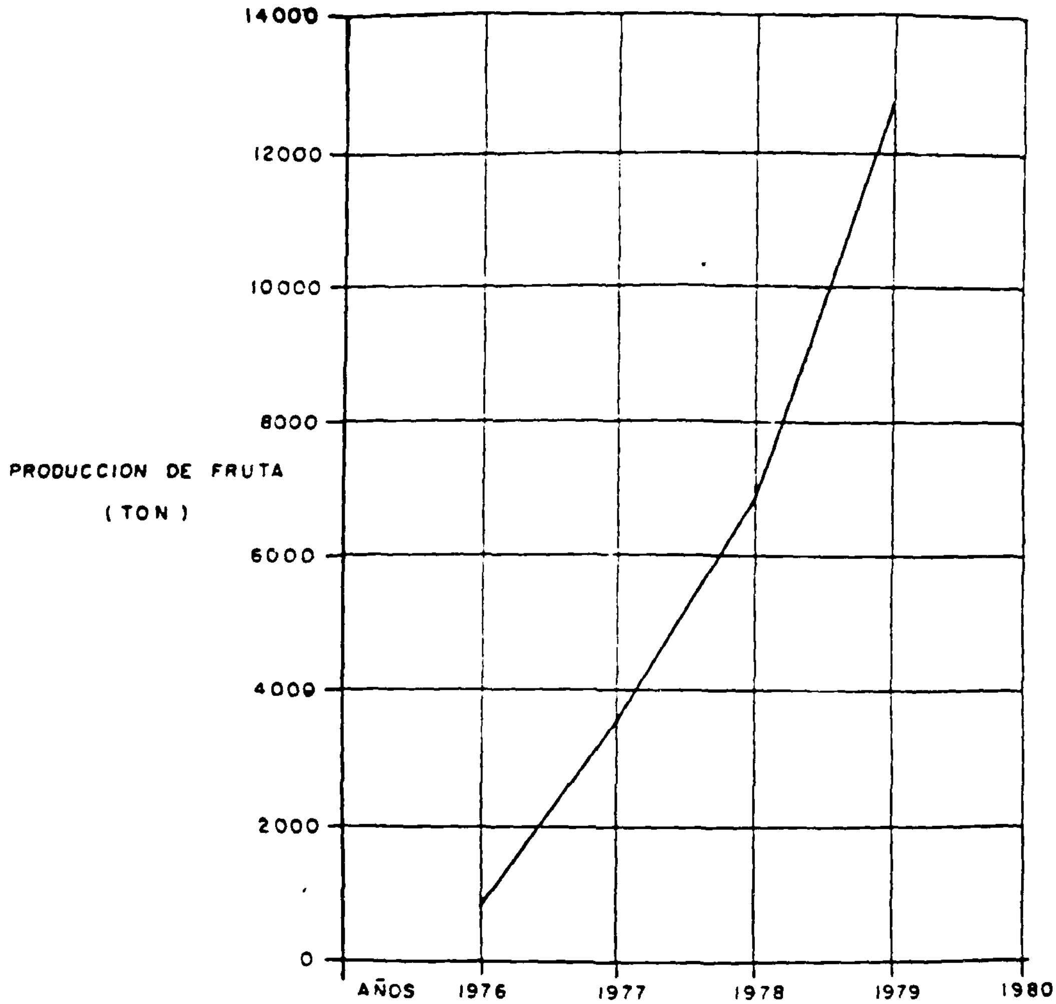


Fig. II-12

INSTITUTO NACIONAL AGRARIO I.N.A.			
ESTUDIO Y DISEÑO DE OBRAS HIDRAULICAS EN EL VALLE DEL AGUAN			
PRODUCCION DE FRUTA SEGUN AÑO DE CAMPAÑA "CULTIVO DE LA PALMA"			
CONSORCIO MAIN — CLAS — GATESA CHAS T. MAIN INTERNATIONAL, INC. BOSTON, U.S.A. CONSULTORES LATINOAMERICANOS ASOCIADOS, S.A. LIMA, PERU GABINETE TECNICO, S.A. DE C.V. TEGUCIGALPA, HONDURAS			
FECHA	REVISO	APROBO POR INA	HOJA

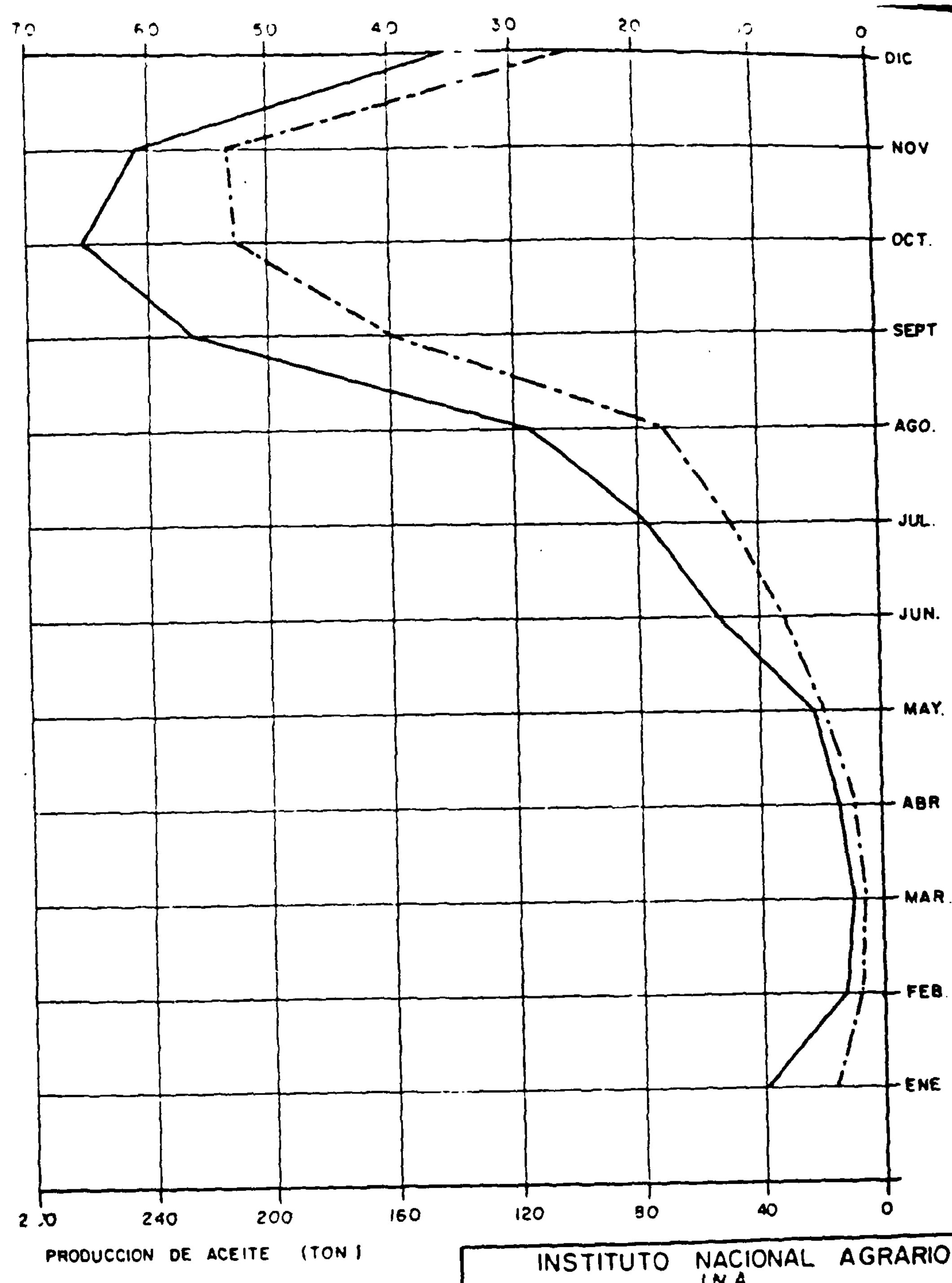


Fig. II-13

DISTRIBUCION MENSUAL DE LA PRODUCCION DE ACEITE Y ALMENDRA (AÑO 1978)

——— PRODUCCION DE ACEITE

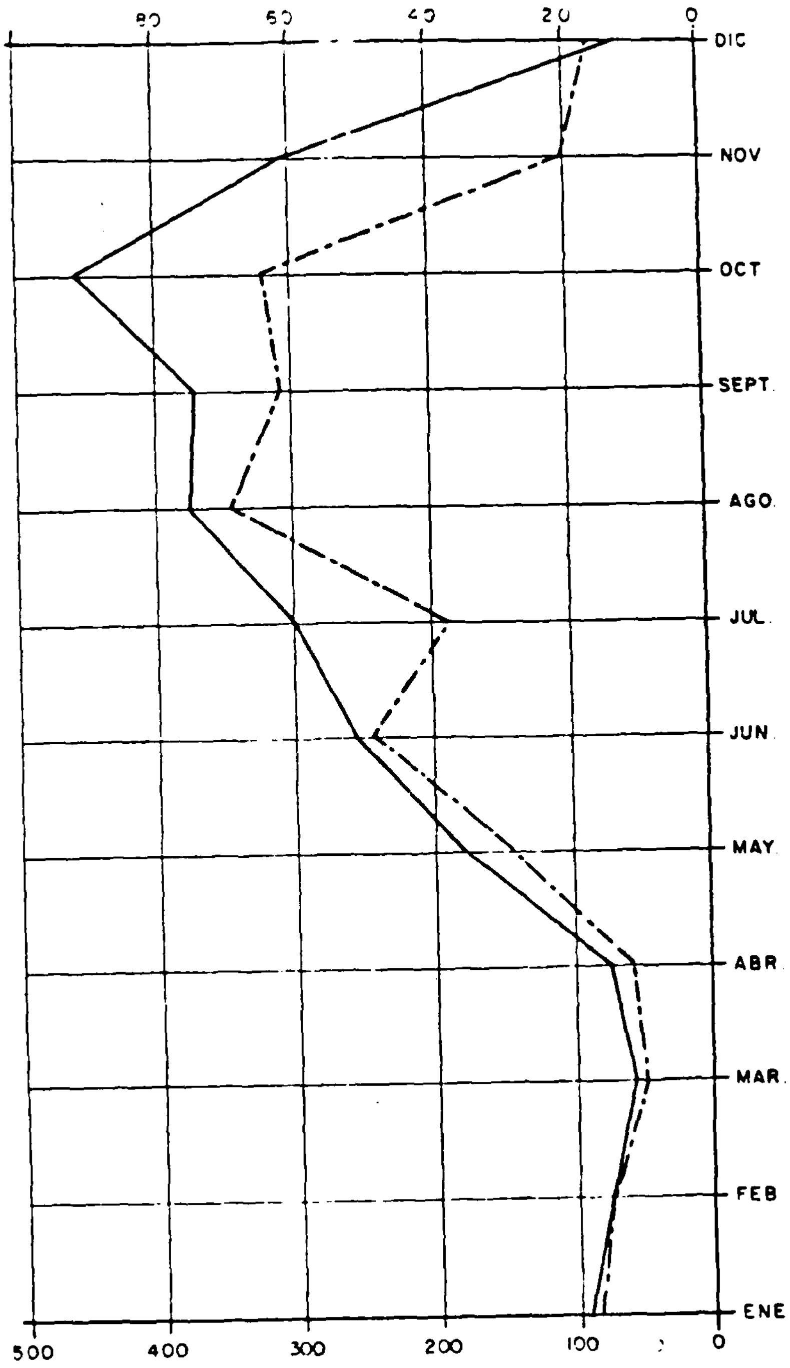
—·—·— PRODUCCION DE ALMENDRA

INSTITUTO NACIONAL AGRARIO
INA

ESTUDIO Y DISEÑO DE OBRAS HIDRAULICAS EN EL VALLE DEL AGUAN

DISTRIBUCION MENSUAL DE LA PRODUCCION DE ACEITE Y ALMENDRA (AÑO 1978)

CONSORCIO MAIN — CLAS — GATESA
CHAS T MAIN INTERNATIONAL, INC BOSTON, U.S.A.
CONSULTORES LATINOAMERICANOS ASOCIADOS, S.A. LIMA, PERU
GABINETE TECNICO, S.A. DE C.V. TEGUCIGALPA, HONDURAS



PRODUCCION DE ACEITE

PRODUCCION DE ALMENDRA

Fig. II-14

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ESTUDIO Y DISEÑO DE OBRAS HIDRAULICAS EN EL VALLE DEL AGUAN

DISTRIBUCION MENSUAL DE LA PRODUCCION DE ACEITE Y ALMENDRA (AÑO 1979)

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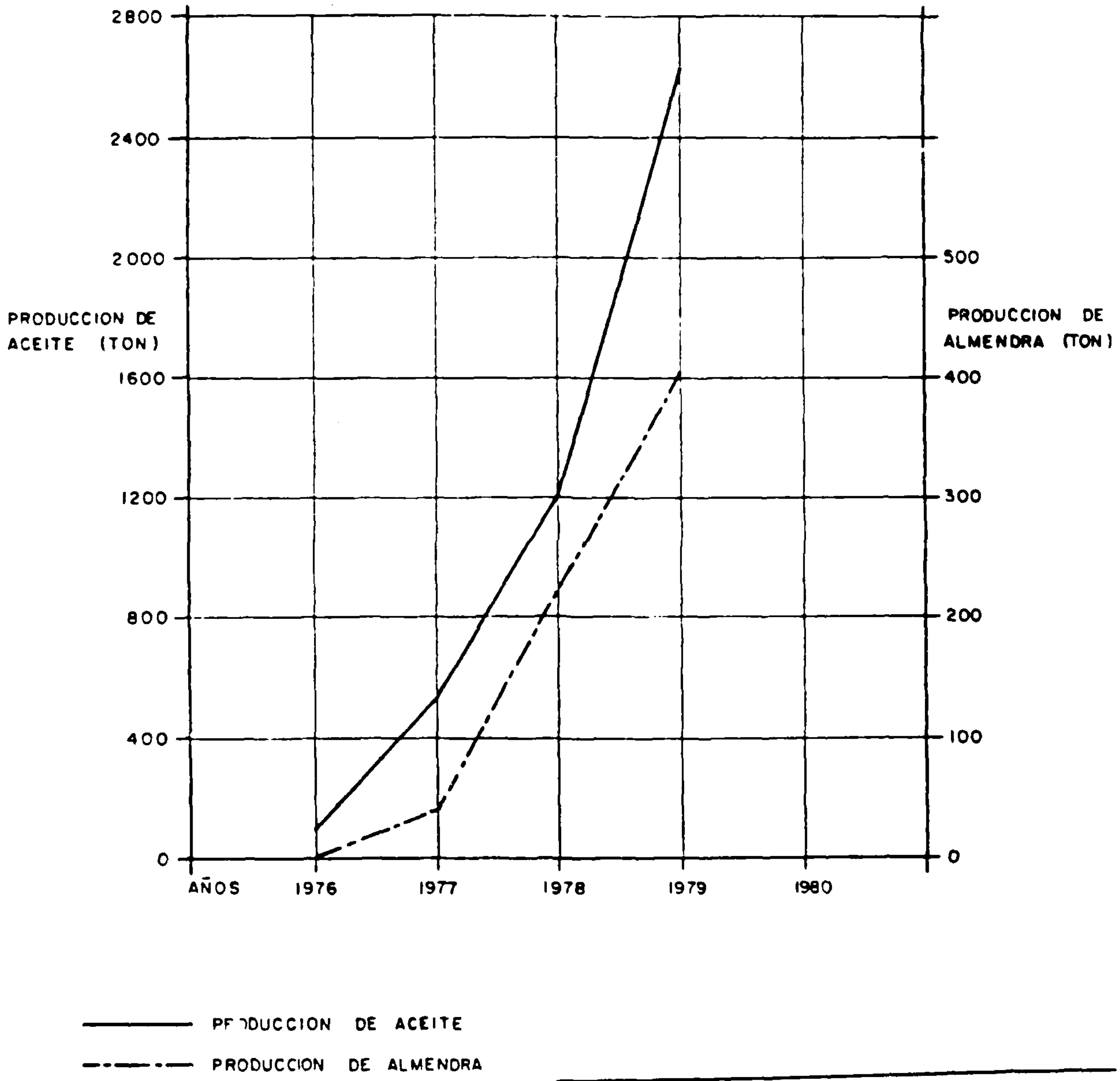

Fig. II-15

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I.N.A.

ESTUDIO Y DISEÑO DE OBRAS HIDRAULICAS EN EL VALLE DEL AGUAN

PRODUCCION DE ACEITE Y ALMENDRA SEGUN AÑO DE CAMPAÑA

CONSORCIO MAIN — CLAS — SATEBA
CHAS T MAIN INTERNATIONAL, INC BOSTON, U.S.A.
CONSULTORES LATINOAMERICANOS ASOCIADOS, S.A. LIMA, PERU

APPENDIX C

EARLY ACTION PLAN DETAILS

SECTION A

INTRODUCTION

This appendix contains more detailed discussions of two elements of the Corps' team's suggestions for an early action plan to address north coast flood problems. These elements are: installation of a flood warning system on the Rio Choloma, and the formation of a water resources commission (interagency planning team).

SECTION B

FLOOD WARNING SYSTEM

a. Operation: Such a system has been developed by the California-Nevada River Forecast Center of the Western Region of the National Weather Service that provides local flood warning in cooperation with local authorities. This system, now installed in a number of communities across the country, is based upon Automated Local Evaluation in Real Time or "A.L.E.R.T." These systems have already demonstrated a highly cost effective capability to protect life and property in flood plain areas.

b. The ALERT" system utilizes:

(1) Automatic precipitation and river gages.

(2) Automatic data collection and processing equipment (Base Station).

(3) Future expandability to handle computerized hydrologic and meteorologic analysis techniques (software), to help define the location and magnitude of the flood hazard.

c. The system will sense the current rainfall amount and the river depth, and transmit the data by radio to the selected base station. For estimating purposes two repeater stations are also included to maintain line-of-sight communications between the remote gage and the base station. The base station will receive the data, process it and display the information on a CRT screen. A typical arrangement of equipment is shown on Chart C-1.

d. Equipment: The field equipment will consist of a combination river/rain gage and at least two repeater stations.

(1) Combination river/rain gage: The river/rain gage in a flood warning system is a modular, self-contained, self-powered, event-reporting unit. Each 1.0mm (.04 inch) increment of precipitation, as measured by a

tipping bucket mechanism, causes the electronics and radio package to transmit a two-digit station identification code and a two-digit precipitation accumulation value to the base station on an appropriate radio frequency (Chart C-2).

(2) The precipitation gage utilizes a modular design, comprised of components for precipitation measurement, structural support, and data transmission. The structural component of the gage is fabricated from a 12-inch diameter aluminum irrigation pipe of sufficient height (about 12 feet) to provide a buried well for shielding onsite electronics and stabilizing the battery and electronics from vandalism. The 12.0-inch diameter pipe provides a 30.5mm (1.2-inch) orifice while serving as a support for the antenna system. Precipitation is caught in an aluminum funnel assembly and is measured by the tipping bucket mechanism.

(3) The river gage utilizes a pressure transducer liquid level sensor, accurate to 1%. This sensor is anchored in the riverbed in such a way that turbulent flow occurs around the sensors keeping silt from depositing on the inlet screen. The sensor is connected by a buried wire to the remote unit's transmitter where the signal is relayed to the base station.

(4) This type of river gage was selected because of its ability to be placed relatively far from the river bank. This gage can be placed on a nearby ridge to provide line-of-site communications between the remote gage and the base station. This river gage also has the same structural and electronic components as the rain gage. With the rain gage and the river gage in the same housing, considerable savings can be realized over two separate units.

(5) Considerations in the design of the river/rain gage field unit include:

(a) A whip antenna with ground plane mounted to eliminate drip into the rain gage orifice.

(b) A straight-sided gage to reduce the vertical lift over the orifice induced by sloped-sided or shouldered gages.

(c) A large orifice diameter to compensate for the pressure jump effect at the leading edge of the orifice which tends to carry precipitation across the throat of smaller gages.

(d) Electronics located below ground for temperature stabilization and protection from vandalism.

(e) No ground level doors or openings, also to discourage vandalism.

(f) An internal clock which sends regular check signals for verification of system operation.

(g) An integral accumulator which prevents loss of volumetric data if transmissions are occasionally blocked.

(h) Modular electronic components for simplified maintenance.

(i) Rechargeable gel-cell battery supply with adequate power for over two years of data transmissions between charges.

(j) A simple cylindrical container with minimal environmental impacts.

(k) Gages are designed for nominal servicing on an annual basis.

(l) Additional remote units can be added with minimal impact on the existing system.

(6) <u>Base Station</u>: The base station for the ALERT system consists of an automatic data collection and processing center which receives the data transmitted from the field station. Radio transmissions from the remote station to the base station are line-of-sight. Topography between

the gaging site and the receiving site will most likely necessitate a radio-relay installation at location and elevation sufficient for line-of-sight receipt and retransmission of signals.

(7) The data collection and processing equipment will be located at a facility which has the responsibility for the flood warning. The components consist of:

(a) A radio receiver with antenna for the receipt of the event reporting signals from the remote stations.

(b) A dedicated micro or mini computer system for the collection and display of the data with peripheral equipment.

(c) Dedicated software that interpets the data and displays it on a real time basis.

(d) A constant power supply for full operation during power outages.

(8) The base station operates in a fully automatic mode 24 hours a day, continuously receiving, processing, and making available for display the precipitation and stream flow data.

(9) Repeater Station. The repeater station is housed in a stand pipe similar to the remote river/rain gage. Two antennas, one omni-directional and the other directional, receive and retransmit the data signal to the base station. The repeater is designed to be placed on high ground between the remote river/rain gage and the base station. To minimize maintenance requirements, a solar cell panel can be used to recharge the gel-cell battery. As with the remote gage, the electronics package and the battery are located beneath grade in the base of the unit. The entire repeater package consisting of the housing, battery, electronics package, solar panel and antennas are installed as a unit for ease in installation.

e. Installation. The remote river/rain gage is to be located in an area where topographical features do not interfere with the rainfall collection. Deep valleys, gullys, and ridges could cause erronous readings of rainfall data because of wind blown rain. The liquid level sensor is to be connected to the radio transmitter by way of a buried cable. For this reason, the soil between the liquid level sensor and the radio transmitter should be of sufficient depth to adequately bury the transducer wire there by providing protection from animal and human damage.

(1) The repeater station should be located at a site and elevation that provides line-of sight communictions between the remote gages and the base station. If the terrain is especially rough, or the distance long between the two units, additional repeater stations may be required.

(2) Both the remote station and the repeater packages are installed by mounting the stand pipe in a hole and backfilling with concrete. There is no onsite assembly required except for the antennas and the solar cell panel. Estimated installation time is 4 hours once the crew and equipment is at the site. Each of the elements lends itself well to transportation by helicopter to the installation site.

(3) Security against theft and vandalism could be provided by locating the units at remote inaccessible sites, by providing barbed-wire fencing around each remote site or by locating the remote equipment in already secured areas where possible.

f. Operation and Maintenance: After installation, the base station should be in an area that is manned 24 hours a day. Because of the self-reporting aspect of the system, however, there is no need for constant monitoring of the base station. The system can be set to give off an alarm whenever a specified rainfall rate or river height has been reached. Trained personnel could then monitor the incoming data and issue warnings based on experience and judgement. The warnings could be given not only to the base commander, but also to any local officials responsible for the safety of the nearby populace.

(1) The maintenance of the remote and repeater stations would largely be limited to the replacement of the gel-cell battery because of age and the repair and replacement of antennas, wire and possibly even the stand pipe due to vandalism, terrorism, or storm damage.

(2) Normal routine maintenance should include:

(a) The cleaning and adjusting of the tipping bucket mechanism.

(b) The removal, cleaning and replacement of the liquid level sensor.

(c) The exchange of the discharged battery.

(d) A complete check of all wires, antennas and solar panels for damage.

(e) A complete electronics check of the data retrevial, storage, and transmission assemblies for all remote equipment.

(3) The vendor can train the local operators in proper maintenance techniques and schedules. From the experience of the vendor and other agencies, maintenance costs will run from $3,000 to $5,000 per year, the higher figure being for high hazard areas.

The equipment can be expected to remain operational with scheduled maintenance for up to 10 years according to the vendor, assuming normal wear and tear. With proper care, the base station equipment shall become obsolete long before replacement becomes necessary.

(4) System Setup and Training: As part of the overall contract the vendor can install and calibrate the equipment and train all key personnel. Because this "ALERT" system is relatively simple, no advanced training is required. A service contract from the vendor is a possible item to be included in the original contract.

g. Cost Estimate. The flood warning system proposed for the site will consist of the following major items:

(1) 1 - Combination River/Rain Gage Assembly

(2) 1 - Complete Base Station

(3) 2 - Packaged Repeater Station

(4) 1 - Set of Spare Equipment

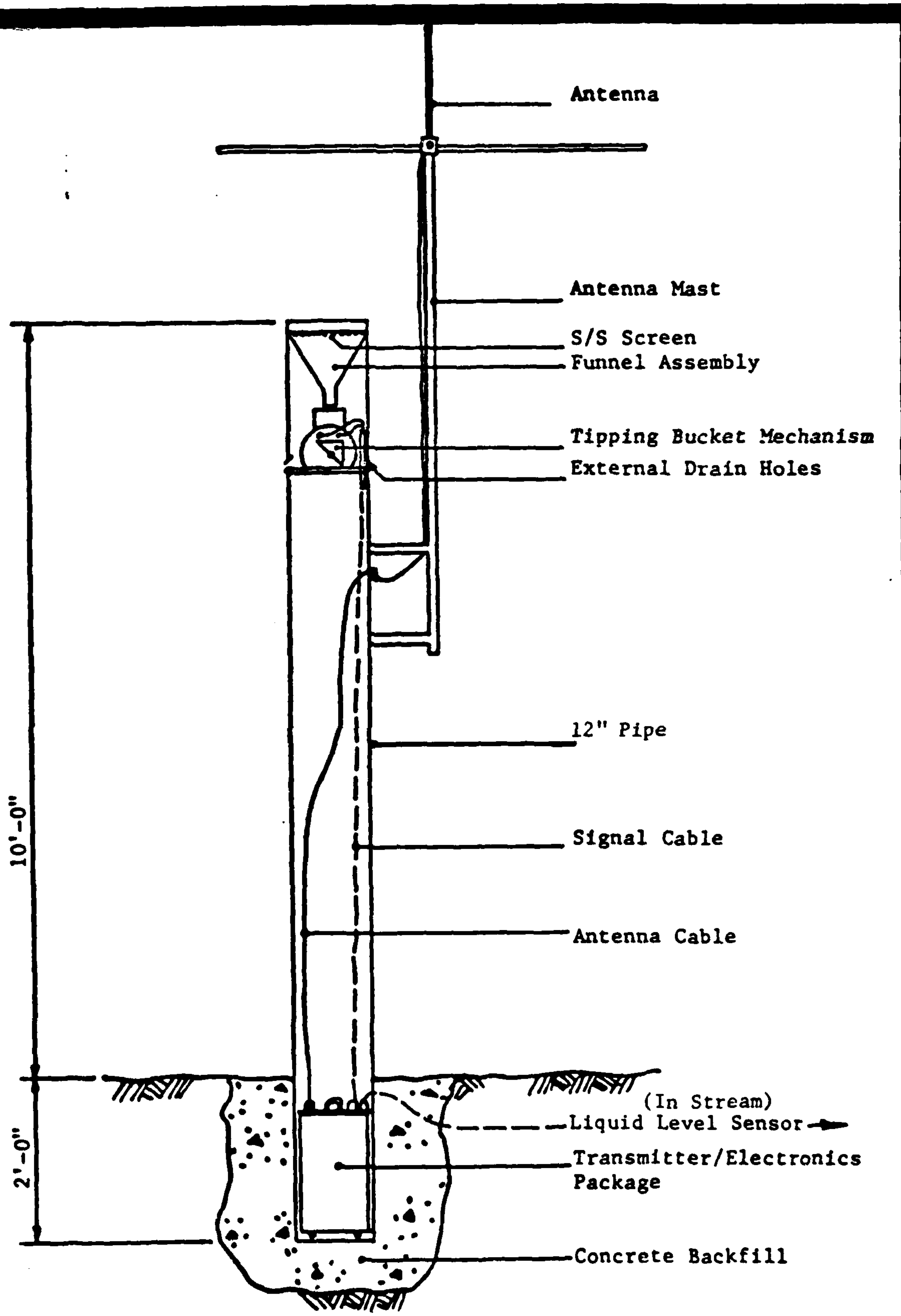
(5) 1 - Set of Test Equipment

(6) Job - Complete installation, calibration and training of personnel by the vendor.

(a) The entire system, including the hardware, software, installation and training can be obtained from the sole vendor, Sierra-Misco, Inc. of Berkely, California.

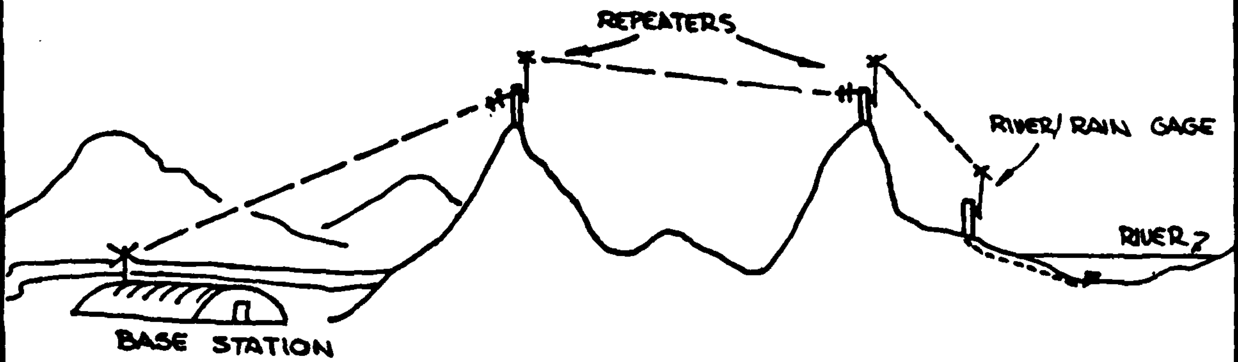
(b) The prices obtained in this preliminary estimate were obtained directly from Sierra-Misco on 5 February 1985.

DESCRIPTION OF WORK	QUANITITY	UNIT	UNIT COST	TOTAL COST
1. Combination River/Gage Gage Remote Station	1	ea	4,340	$ 4,340
2. Base Station				
a. OMNI-Receive Only Ant	1	ea	220	$ 220
b. Data Receiver/Decoder	1	ea	2,900	2,900
c. Alert Micro Computer w/CRT	1	ea	7,000	7,000
d. Dot Matrix Printer	1	ea	500	500
e. Constant Power Supply	1	ea	775	775
f. Misc. Connectors	-	Job	1,000	1,000
6. Software	-	Job	750	750
3. (Package) Repeater Station	2	ea	6,200	$12,400
4. Spare Equipment				
a. Antenna (Mast & Tripod)	1	ea	220	$ 220
b. Transmitter (with battery)	1	ea	3,000	3,000
c. Tipping Bucket Mechanism	1	ea	300	300
d. Battery recharger	1	ea	75	75
5. Test Equipment				
a. Watt Meter	1	ea	400	$ 400
b. Remote Station Tester	1	ea	3,600	3,600
6. Installation and Supervision (Training)	-	Job	8,100	$ 8,100
7. Shipping	-	Job	1,000	$ 1,000
			SUBTOTAL	$45,680
10-1/2% GSA Discount on Equipment				$-3,840
			SUBTOTAL	$41,840
20% Contingencies				$ 8,160
Coordination and Implementation				$16,000
			TOTAL	$66,000



Self-Reporting River/Rain Station

CHART C-1



TYPICAL INSTALLATION
NOT TO SCALE

CHART C-2

SECTION C

INTERAGENCY PLANNING TEAM

Based on discussions the Corps' team had with the many points of contact within the Honduran Government, USAID, and private sector consultants, there appears to be a need for a more unified effort toward the use and development of the water and water-related land resources of the north coast rivers. There is a considerable amount of data and studies available on both the Sula and Aguan Valley, but no real central focal point for coordination and priority-setting. Studies have been performed for both INA and SECOPT, and in some cases these two agencies have worked together with the Department of Natural Resources (example: the study by Sir William Harcrow and Partners performed in 1983 for the Rio Aguan Basin). But this study and others seem to have a common flaw. They all have proposed enormously costly construction work, which in no way reflects the available financial resources of the country, and have not attempted to provide any guidance on nonstructural responses. Basin-wide studies should be concluded with recommendations for programmatic implementation of phased construction. In other words, initial work should focus on the most cost-effective (biggest return-on-investment) project elements, of those requiring capital investments which are within some range of expected affordability. As these are completed and productivity increases, etc., further project construction could be initiated.

Toward the objective of establishing basin-wide water resource programs which reflect not only affordability but also appropriate project priorities, an ad hoc water resources commission (interagency planning team) could be formed. A tentative, and perhaps partial, list of agencies that should be considered in the formation of this commission was developed by the Corps' team. The broad makeup reflects the similar approaches now being taken in the United States to water resource problems (example: the newly formed Inland Waterway Users Board, which will advise the Corps on planning for changes and improvements to the inland navigation system of the United States).

Water Resource Commission

(Tentative list of agencies to consider)

National Economic Planning Council (CONSUPLANE)
National Agrarian Institute (INA)
Ministry of Natural Resources (MRN)
Secretariat of Communication, Public Works and Transportation (SECOPT)
National Port Authority (ENP)
COPEM (The Emergency Management Agency of Honduras)
U.S. Embassy (Observer)
U.S. Agency for International Development (USAID) (Observer)
Japan International Cooperation Agency (JICA) (Observer)
National Agricultural Development Bank (BANADESA)
National Forestry Corporation (COHDEFOR)
Agri-industrial Cooperative for African Oil Palm (COPALMA)
Banana Corporation of Honduras (COHBANA)
National Power Corporation (ENEE)
Honduran Federation of Land Reform Cooperatives
National Railway Corporation (FNH)
Inter-American Development Bank (observer)
Honduran Agricultural Marketing Institute (IHMA)
National Union of Compesinos (UNC)
Honduran Federation of Land Reform Cooperatives (FECORAH)
Selected Private Sector Representatives (example: Standard Fruit Company)

The final membership of such a commission would of course be decided by the Government of Honduras. If some level of technical assistance from the U.S. Army Corps of Engineers was desirable, then appropriate steps to establish this must be initiated by the Government of Honduras. Guidance for obtaining technical assistance is contained in U.S. COE Engineering Regulation 1-1-23 dated April 1979 entitled "Technical Assistance to Foreign Governments." This regulation established policy, assigns responsibilities, and provides guidance and procedures for technical assistance furnished to friendly foreign governments by the Corps of Engineers. Additional guidance is contained in a letter of instruction from DAEN-IA dated 1 December 1981. The subject of this letter is "Technical Assistance to Friendly Nations". It provides information, instruction, and guidance in the development of technical assistance programs for friendly nations. The major focus of this assistance is the exchange of technology relating primarily to capital projects and infrastructure development. The programs are accomplished under the Foreign Assistance Act (FA) of 1961, as amended, and administered by the Department of State through the Trade Development Program (TDP) Agency for International Development (AID).

On the following page a list is presented showning the path of request for assistance and the particular interest of each reviewer.

REQUESTS FROM FRIENDLY NATIONS FOR TECHNICAL ASSISTANCE FROM THE U.S. ARMY CORPS OF ENGINEERS

Interest in obtaining the technical assistance of the U.S. Army Corps of Engineers is pursued by a written request through the below listed channels and completed by the development, approval and signing of a Memorandum of Agreement between the U.S. Army Corps of Engineers and the interested nation. The U.S. Army Corps of Engineers must not compete with private sector consultants, therefore this question should be addressed specifically in any request for assistance.

PATH OF REQUEST	INTEREST OF APPROVER 1/
U.S. Embassy - Friendly Nation	Priority of Needs in Country/U.S. Presence
U.S. State Department - Washington	Friendly Government/International Policy
Office of Management and Budget (OMB) Washington	Competition with Private Enterprize (Consultants)
Department of Defense (DOD)-Washington	National Defense/Security
Assistant Secretary of the Army for Civil Works (ASA(CW)) - Washington	Civil Works Mission of the Corps of Engineers
Chief of Engineers Office (OCE) - Washington	Manpower to do the work requested

1/ Based on information provided by Mr. Frank A. DiMatteo, Chief, International Affairs Office, OCE.

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