ANNEX M: ENVIRONMENTAL IMPACT ASSESSMENT

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TABLE OF CONTENTS

M.1 Environmental Condition ..... M - 1

M.1.1 Environmental Administration ..... M - 1
M.1.2 Rules, Regulations and Guidelines ..... M - 2
M.1.3 Environmental Condition in Project Area ..... M - 3
M.1.4 Water Quality Condition in the Project Area ..... M - 5

M.2. Environmental Impact Assessment (EIA) ..... M - 7

M.2.1 The Terms of EIA ..... M - 7
M.2.2 Environmental Impact Assessment ..... M - 8
M.2.3 Assessment of the Impacts of Agricultural Chemicals ..... M - 10
M.2.4 Environmental Conservation Plan ..... M - 13

LIST OF TABLES

M.1.1	Prohibits the Importation, Manufacture, Sales and Distribution of Agrochemicals	M-16
M.1.2	Application(Selling) Condition of Agrochemicals	M-17
M.1.3	Survey area and Frequency of Water Quality	M-18
M.1.4	Results of Water Quality Analysis (1994-1995)	M-19
M.1.5	The water quality of the rivers in the area, as analyzed in past	M-22
M.1.6	Results of Water Quality Analysis of the rivers in the area, as analyzed in past	M-23
M.2.2.1	Results of Environmental Impact Assessment (Overall evaluation) without dam	M-25
M.2.2.2	Results of Environmental Impact Assessment (Overall evaluation) with dam	M-26
M.2.3.1	Runoff Ratio of Agrochemicals from Upland areas	M-31
M.2.3.2	Runoff of Agrochemicals from Paddy field areas	M-32
M.2.3.3	Estimates according to Agrochemicals Sprayed	M-33
M.2.3.4	WHO Drinking Water Guidelines (concerning Agrochemical), 1987	M-34
M.2.3.5	Results of Village Survey	M-35
M.2.3.6	Estimated Number of Farmhouses and Population that will be affected by the Dam	M-35
M 2.4.1	The Criteria used by the State of Arizona(U.S.A) in determing Water Quality	M-36

LIST OF FIGURES

M.1.1	Location of Water Quality Analysis	M-37
M.1.2	The Vacuum System	M-38
M.1.3	Water Quality of River/Spring(1994-1995)	M-39
M.1.4	Diagram for the Classification of Irrigation Water	M-40
M.1.5	Annual Change in River Water Quality (1981-1986)	M-41
M.2.1.1 (1)	Relation between Projects and Environmental Effects (without dam)	M-42
M.21.1 (2)	Relation between Projects and Environmental Effects (with dam)	M-43
M.2.1.2	The Project's Areas of Influence	M-44
M.2.2.1	Discharge Capacity of the Yuna River	M-44
M.2.3.1	Agrochemical behavior in the Environment	M-45
M.2.3.2	Location of Villages Surveyed in Areas affected by the Proposed Dam Construction	M-46
M.2.4.1	Agrochemicals Prohibited in the Dominican Republic and Other Latin American Countries	M-47

ANNEX M : ENVIRONMENTAL IMPACT ASSESSMENT

M.1 Environmental Condition

M.1.1 Environmental Administration

There are no organizations such as a "Ministry of Environment" exclusively responsible for environmental protection issues in the country at present. However, there are some government organizations which have sections or departments that are dedicated to environmental issues and policies. These organizations together with the scopes of their services are as given hereunder.

a. Department of Environment, ONAPLAN

Services: Participates in planning environmental policies and jointly coordinates environmental services of private and public sectors.

Activities: Formulates guidelines for environmental protection.

b. Watershed Management Program, INDRHI

Services: Manages and monitors the watershed of the Nizao river.

Activities: Conducts surveys on the preservation of the watershed of Nizao River (bamboo planting on the river dikes to prevent soil erosion).

c. Department of Wildlife, SEA

Services: Endeavors to achieve balance between wildlife preservation and state development activities.

Activities: Conducts activities for the conservation and protection of wildlife and the national bird "Dulus Dominicus".

d. Department of Environmental Education, SEA

Services: Promotes educational programs on environmental issues

Activities: Educates farmers, students and teachers on relevant environmental issues. Educates farmers on the proper use of agricultural fertilizers.

e. National Bureau of Parks, DNP

Services: Preserves areas with rich natural resources, areas of historical importance, and recreational areas.

Activities: Preserves and manages 13 national parks and 9 development restricted areas.

f. National Bureau of Forestry, DNF

Services: Forest presevation, protection and supervision

Activities: Sanctions forest management activities for the preservation of natural resources.

M.1.2 Rules, Regulations and Guidelines

(1) Environmental regulations

There are no general laws and ordinances on environmental issues in the Dominican Republic at present. However, an environmental protection bill has been passed to Congress, and Article 220 of this bill covers the environmental impact assessment (EIA) system.

There are also no laws pertaining to the use of water in the country. INDRHI is the agency responsible for water related issues.

The basic policies concerning water use and water quality preservation are stipulated from the 28th - 35th articles of the bill on "Laws on Environmental Protection". The implementation of water resource development projects require Presidential authorization.

Environmental regulations presently formulated refer to wildlife protection, conservation of national parks and designated areas, and the use of agricultural chemicals. The Washington Treaty, the convention on international trade of endangered species of wild fauna and flora, has been ratified by the government, but not the Ramsar Treaty, which is a convention on wetlands of international importance especially as waterfowl habitat.

(2) Environmental impact assessment (EIA)

As previously mentioned, Article 220 of the bill on "Laws on Environmental Protection" stipulates the implemention of EIA on any project with possible environmental impacts. The enactment of the bill will impose the implementation of EIA on large scale agricultural development projects.

Articles 221 and 223 respectively defines the required EIA activities and the details of EIA. The entries in the appraised report should be mentioned and is therefore enumerated below.

a. Contents of the project
b. Outline of the project area
c. Adverse environmental impacts of the project and measures to control these impacts.
d. The natural environmental impacts of the project
e. The social environmental impacts of the project
f. EIA factors and implementation method

g. Methods to mitigate adverse impacts
h. Monitoring works after project completion
I. Plans formulated in consideration of existing laws and regulations
j. Project alternatives

(3) Regulations on agricultural chemicals application

Presidential Decree 217-91 stipulates the following:

1) Prohibits the importation, manufacture, sales and distribution of 20 kinds of agricultural chemicals, e.g., Aldrin (see Table M.1.1).

2) Delegates the management of the private sector to SEA for the enforcement of the law.

3) Authorizes SEA to promote the development of varieties highly resistant to diseases so as to reduce agricultural chemical application.

M.1.3 Environmental Condition in Project Area

(1) Social envionment

a. Inhabitants:

According to the 1994 statistics, the project area has a population of 16,692 and a population density of 116.9 people/km². In comparison with the average national population growth of 2.3%, the annual population growth rate in the area for the past 10 years is only 1.1%.

The population of the area is a mixture of indigenous people and immigrants. There are no conflicts between the two as a lot of the immigrants come from neighboring areas. The population is predominantly indigenous, albeit the presence of Haitian settlers in the area to be submerged for the construction of a flood control dam at the Payabo River; these settlers migrated to the area to work in sugar cane plantations. This minority group will not impede the implementiation of the project as they have assimilated to the ways of the local people.

b. Environmental Pollution from Agrochemicals:

Exclusive of Fastac (Alpla-Cypermethrin) and several others, the agrochemicals used in the area contain low fish toxins (see Table M.1.2), are not residue-prone agrochemicals in crop and are less likely to result in biological magnification. Further, these chemicals can be hardly considered as environmental pollutants as their application is kept in small doses.

It is feared that the occassional large scale aerial spraying of agricultural chemicals in the area will cause contamination when followed by rainfall. Aerial

spraying is carried out 5 times (once for herbicide and 4 times for insecticide) within the first cropping period at an area of 25,000 tareas (1,563ha), in the project area.

c. Endemic and Epidemic Diseases:

There are no endemic diseases like Malaria in the area.

d. Domestic Waste Disposal:

Ninety percent (90%) of the population is presently equipped with pit latrines, a practice that helps prevent river water contamination. Difficulties in domestic waste disposal are not expected in consideration of the low population density and vastness of the area.

e. Historic and Cultural Relics:

There is nothing of anthropologic, antiquarian, artistic, cultural, historic or ethnologic importance in the area. Adjacent to the project area, however, is the National Park "Los Haitises".

(2) Natural envionment

a. Endangered Ecosystem:

There are no endangered species in the area as the wetlands (ponds, swamps and marshes) do not fall under the category stipulated in the Ramsar Treaty. However, these areas are famous as either habitats of snapping turtles or landing areas of migratory birds.

b. Forestry:

There are no large forest areas in the study area. Forests only constitute 11% of the area. A mangrove forest exists within the national park, "Los Haitises", adjacent to the project area.

c. Topography, Geology and Soil:

The area has a low-lying topography and a geology made up of humic soil, clay and marine sediments. Soil quality is predominantly clayey.

Forests only cover a very small part of the project area, which is mostly made up of paddy fields or grasslands. The whole area is covered with vegetation and free from soil erosion problems.

The adjacent Haitises mountain range and the mangrove forests at the downstream coasts of Yuna River and Barracote River are designated as a national park. Vegetation is carried out in the area to preserve the natural environment. Soil erosion problems hardly arise in the upstream area of Payabo

River where the Dole pineapple plantation is located.

M.1.4 Water Quality Condition in the Project Area

(1) Objectives of the survey

a. To determine whether the water quality of springs and rivers are suitable for irrigation use.

b. To determine the extent of pollution in the rivers and canals due to agrochemical use.

(2) Survey area and frequency

Sampling was carried out at ten (10) stations (8 stations within and 2 stations outside of the project area). Four (4) of the eight (8) samples were taken from springs, three (3) from rivers and one (1) from a drainage canal (Table M.1.3). The sampling stations are shown in Figure M.1.1.

(3) Items analysed and method of analysis

a. Items analysed

1.	E.C	2.	pH,
3.	DO	4.	DO (saturation degree %)
5.	Temperature	6.	Redox
7.	Salinity	8.	Ca
9.	Mg	10.	Na
11.	K	12.	CO_3
13.	HCO_3	14.	SO_4
15.	Cl	16.	SS
17.	RaS	18.	Clase
19.	$N\text{-}NO_3$	20.	$N\text{-}NO_2$
21.	N-Kjeldal	22.	TP

23. Total coliform group
24. Fecal coliform group
25. Hg
26. Agricultural items:
(Insecticides: Triclocfon, Fenitrothion, Monocrotophos; Herbicides: Bentazone, Propanil, Butachlor)

b. Water Quality Analysis

Water quality analysis, exclusive of agrochemical content in water, was carried out at the INDRHI laboratory using the APHA (1989) method. Since agrochemical analysis was difficult to conduct in the Dominican Republic, it was carried out in Japan by: (1) condensing the samples taken in Nagua in Sep-pak cartridges by means of the vacuum system (see Figure M.1.2), (2) carrying the

cartridges to Japan. Agrochemical content analysis was conducted by means of gas chromatography-mass spectrometry.

(4) Water quality analysis results

The results of the water quality analysis are shown in Table M.1.4 and Figure M.1.3. The quality of the water presently used for irrigation was classified in accordance with the US Salinity Laboratory Irrigation Water Classification Diagram by Thorne and Peterson (1964), which is incorporated in the agricultural handbook published by the United States Ministry of Agriculture (Figure M.1.4). The classification is based on the following parameters: 1) total concentration of soluble salts, 2) relative proportion of sodium to other cations, 3) concentration of boron or elements which may be toxic, 4) sodium absorption ratio ($SAR=Na^{+} / \sqrt{[(Ca^{++} + Mg^{++}) + /2]}$) when deemed necessary.

The water quality of springs and rivers is considered suitable for irrigation use as it was classified under [C2-S1]or [C1-S1].

Six (6) of the widely used agrochemicals (inseticides and herbicides) in the project area were selected for analysis. And the results show that not all of the water samples contained agrochemicals, mainly because the survey was carried out in February, the fallowing period, when only a small amount of agrochemicals, or none at all, is applied. Accordingly, the survey results proved that agrochemical use has very little impact on the environment.

(5) Annual changes in water quality

The water quality of the following rivers in the area, as analyzed in the past, is shown in Table M.1.5.

The table shows that the water quality of these rivers is suitable for upland irrigation as they fall under [C2-S1] or [C1-S1].

The annual changes in the water quality of Yuna River (El Limon) and Payabo River (Abadesa II) are shown in Figure M.1.5. Annual changes in river water quality cannot be determined from the concentrations of Ca, K and Na alone.

M.2 Environmental Impact Assessment (EIA)

M.2.1 The Terms of EIA

(1) Evaluation conditions

Environmental impact assessment (EIA) is usually carried out on projects that entail the following works:

- Rehabilitation of existing irrigation/drainage canals and farm roads
- Construction of a weir and improvement of the irrigation system
- Construction of a drainage system

(2) Environmental impacts of the project

Figure M.2.1.1(1) shows the environmental impacts of the project that excludes the construction of a disaster prevention dam, and how the objectives, contents, environmental impacts, resulting phenomena, effects of the impacts, and the countermeasures of the project are correlated with each other.

The environmental impacts of the project that entails the construction of a disaster prevention dam are shown in Figure M.2.1.1(2).

(3) Areas affected by the project

The areas to be affected are located both outside and inside the project area, and they are outlined in Figure M.2.1.2. The areas outside of the project area are located in the downstream area of the Yuna River, the Barracote River, and the Samana Bay, where drainage water from the project area flows into.

If a disaster prevention dam will be constructed, the upstream area of the Payabo River will also be affected as it will be submerged for dam construction.

Affected Areas	Relation between Areas and Project	Relative Population & Area
Project area	Farmer: Health by Agrochemicals	Residents: 16,692 (1994)*1
Yuna River Downstream	Drinking Water Source & Land Use: Paddy fields Conservation of Natural Resources: Mangrove forest	Residents: 7,454 (1981)*2 Las Coles : 5,886 Trujillo de Yuna : 1,568
Barracote River	Conservation of Natural Resources: Mangrove forest	Total area of Mangrove : 97 km^2
Samana Bay	Fisheries (shrimp, etc.) Tourism / Recreation: National Park	Fishermen: 1,539 (1980)*2 Main source of income of 1,118 residents Secondary source of income of 421 residents Tourists : 5,000 / year *2

(In case a disaster prevention dam will be constructed)

Upstream Payabo River	Forced Trnsfer of inhabitants as area will be submerged due to dam construction	Residents:2,844(1995) (elevation is less than 40m)

Source :

*1 Village Survey (JICA, 1995)

*2 PLAN DE USO Y GESTION DEL PARQUE NACIONAL LOS HAITISES Y AREAS PERFERICAS

M.2.2 Environmental Impact Assessment

The results of the environmental impact assessment on the project that excludes the construction of a dam are laid out in Table M.2.2.1. The checklist used was made based on the guidelines of JICA on environmental considerations.

The detailed results of the environmental impact assessment on the project that entails dam construction works are shown in Table M.2 2.2

(1) Impact on social environment

1) Society

Impact on Population:

Even though development of new agricultural lands (paddy fields) would raise the migration rate in the area, it would not bring about a drastic increase in population or change in population composition. Although Haitians have settled in the neighboring areas, they have assimilated to the ways of the locals and hence are not likely to cause any conflict among tribal minorities that would later hamper the progress of the project.

Impact on the Economic Activities of the Residents:

The project will provide the residents with jobs and therefore stimulate the economy in the area. The economic conditions of the area will be further revitalized with improved agricultural techniques and the production of good quality produce through the installation and construction of infrastructure that are useful to agriculture, e.g., farm roads.

Impact on Customs and Traditions:

INDRHI should carefully regulate water use as there are no laws or ordinances pertaining to the use of water at present. As there are also no laws or ordinances restricting fishing activities or riparian rights, the preservation of the water quality of water areas (Samana Bay) used for multiple purposes must be given careful consideration.

2) Impact on public health and sanitation

Increase in Agricultural Chemical Use and Contamination of Water Quality:

Water contamination may result from increase in total agricultural chemical application as paddy field areas are expanded. The residents should be told of the right amount of agricultural chemicals to use, especially during aerial spraying activities. It is also important to formulate application limits to reduce the residual toxicity of agricultural chemicals.

Increase in Domestic Waste:

At present, 90% of the residents dig their own pit latrines within their premises. The estimated increase in flush toilets in the near future is forecast to bring about an increase in domestic waste. The residents should be taught the proper usage of flush toilets.

3) Impact on cultural and historical remains

A study on the impacts of the project on the National Park "Los Haitises", which is adjacent to the project area, should be carried out.

(2) Impact on natural environment

1) Impact on important or indigenous flora and fauna:

No area within the project area is covered by the Ramsar Treaty or the Washington Treaty. There are also no development restricted areas within the project area. The study should however conduct caution with regard to wetlands that are the habitats of snapping turtles and landing areas of migratory birds.

2) Impact on land and soil quality

Soil Erosion and Ground Subsidence:

Although soil erosion problems do not prevail in the project area because of thick vegetation, special countermeasures for soil erosion should be taken as construction works might cause them.

To avoid soil contamination, the residents should be told not to use agricultural chemicals with high residual tendencies. There is, however, a small possibility that grounds composed of peat soils will cave in as a consequence of the installation of irrigation canals.

3) Impact on hydrology and water quality

Hydrology:

The construction of irrigation facilities will only have a slight impact on river flow and water level. For the formulation of the flood control and water use plans, the river downstream flow velocity and the amount of water used for intake should be taken into consideration. People monitoring river flow and the water users should regulate the intake amount.

According to the 1986 report on the agricultural development study implemented in the Aguacate and Guajabo regions, the downstream flow velocity of Yuna River was estimated to flood the El Limon survey station once every 5 years, as shown in Figure M.2.2.1, at a maximum discharge of 650m³/sec, with an inflow load to Pajabo River of 65m³/sec. The volume of water to be planned for discharge from Pajabo River to Yuna River should therefore be in accordance with the river plan to avoid any impediments.

Water Quality:

The implementation of the project would extend paddy field acreage, which in turn would result in higher agricultural chemical and fertilizer dosage and consequently water contamination. River water is used for drinking and paddy irrigation in downstream areas where a mangrove forest and the Samana bay are located. The mangrove forest is enclosed within the National Park "Los Haitises", where development and felling activities are restricted. A shrimp breeding area also exists within the forest. It is feared the contamination of river water by drainage from the project area will adversely impact the ecological system of Samana Bay.

As previously mentioned, a farming plan that entails the minimum use of agricultural chemicals and fertilizers will only have a slight effect on the environment.

4) Impact on natural landscape and underground resources

The water quality of the picturesque Samana Bay is going to deteriorate as a result of the implementation of the project. An increase in agricultural chemical application may ruin the scenery and drive tourists away. The residents should be made aware and taught of the proper disposal of waste and excreta.

M.2.3 Assessment of the Impacts of Agricultural Chemicals

The government of the Dominican Republic is quite apprehensive about the impacts of agricultural chemical utilization on the environment. Therefore, Environmental Impact Assessment on agricultural chemical use was carried out.

(1) Agrochemicals in the atmosphere

Agricultural chemicals and fertilizers are used to kill crop damaging pests and to remove weeds. The majority of the amount released gets absorbed by the soil while the rest is diffused into the air in the form of a fine mist. The diffusion of agricultural chemicals or fertilizers sprayed is more widespread because it is carried along with the air currents.

These chemicals are also partly discharged into rivers, marshes and swamps. The gaseous particles that have reached the troposphere fall to the ground together with rain which is then adsorped by the crops and the soil. During rainy days these chemicals permeate into the ground and enter the drainage canals which are connected to the rivers, bay and the sea. Figure M.2.3.1 illustrates agrochemical behavior in the atmosphere.

(2) Agricultural chemical runoff ratio from farms

Agricultural chemical runoff ratio from farmlands varies according to the chemical properties of the products used, topography, soil characteristics, and climate. Existing runoff data were compiled and are shown in Table M.2.3.1. The runoff ratio of arganic chloride sprayed on stems and leaves to kill insects is 1% of the sprayed amount. The runoff ratio of wettable powder is estimated to amount to 2 - 5% of the applied amount. The runoff ratio fluctuates depending on the gradient of the field and the circulation rate of water. Unless heavy rain falls right after spraying, the runoff ratio of most agricultural chemicals rarely exceeds 0.5%.

A large portion of agricultural chemicals is discharged if heavy rain falls right after spraying. The amount drained if more than 10mm rainfall occurs within 2 weeks after spraying is believed to exceed 50% of the total runoff load. The average runoff ratio of a large number of agricultural chemicals amounts to 1 - 2%, and exceeds 2% during heavy rains or typhoons. Runoff ratio is also believed to be high if rain falls within a short period after spraying.

Moreover, agricultural chemicals with a solubility of 10mg/liter dissolve in surface water of which the majority flows into rivers. It is quite difficult to reduce runoff to prevent erosion. Insoluble and highly adsorptive agrochemicals adhere to soil particles and suspended matter in water and flow into the river. Their runoff can be controlled through erosion prevention measures.

The runoff ratio of agrochemicals used in farmlands and uplands in the United States was measured and is shown in Table M.2.3.1. Agricultural chemical runoff ratio was observed to be higher on bare grounds than on uplands cultivated with crops or covered with weeds. Agrochemical runoff ratio was also observed to be usually higher in paddy fields than in farmlands.

Agrochemical solubility significantly influences runoff into the water systems; highly soluble agrochemicals are more likely to have a higher runoff ratio.

Agrochemicals sprayed onto paddy fields immediately fall onto the surface water, and the runoff ratio is generally higher than on farmlands. In the study area, a large part of the agrochemicals are applied in paddy fields. Conclusively, the runoff ratio to the water systems is considerably higher than the runoff ratio from other areas where farmland agriculture predominates.

The ratio of herbicides discharged from paddy fields to rivers in Japan ranges from 1-6% as shown in Table M.2.3.2. When spraying was carried out, the concentration of agricultural chemicals in the river was measured to be very high.

(3) Impact of agricultural chemical use on the environment (Survey)

1) Survey method

a. Survey Items

The concentration of agricultural chemicals generally used in the study area in the Yuna River will be measured.

b. Survey Period

The survey will be carried out any day after application.

c. Survey Point

The agricultural chemicals used in the study area are discharged into the Yuna River through the drainage canals within the area. The survey area will be station 8 shown in Figure M.1.1.

d. Survey Method

The survey shall be carried out as follows:

- Establish the amount of agricultural chemical to be sprayed on paddy fields.
- Establish the runoff ratio at 5% based on existing data and documents.
- Calculate the concentration of the applied chemical in the survey station using the values established in a. and b.

2) Survey results

The results of the survey are shown in Table M.2.3.3.

3) Evaluation

The use of agricultural chemicals is assessed to have very little impact on river water quality as the concentration measured at the survey station was extremely low.

The survey result is also lower than the guidelines of the World Bank for drinking water, to protect public health, and therefore is not a problem (see Table M.2.3.4).

There is a need to consider the weather conditions that prevail after the time of spraying as, as previously mentioned, more than 10mm of rain within 2 weeks of spraying can bring about a 50% runoff ratio.

The use of agricultural chemicals without proper guidance could either kill or maim human beings. Therefore, farmers and their families should be given proper guidance and education with regard to the handling and use of these chemicals. To effectively do so, the low rate of literacy in the area must be taken into account in deciding which manner of teaching or guidance is to be implemented.

Since measures for the eradication of contamination by the use of agrochemicals will be applied at the pollution source, restrictions in the sales and use of these chemicals should be enforced along with monitoring activities.

(4) Impacts of the construction of the disaster prevention dam

A survey was conducted on the villages that will be affected by the dam construction work and the results are shown in Table M.2.3.5. The survey sites are shown in Figure M.2.3.2.

The estimated number of farmhouses and population that will be affected by the dam construction work are shown in Table M.2.3.6.

M.2.4 Environmental Conservation Plan

(1) Water quality preservation plan

1) Water quality monitoring

Monitoring activities should be carried out to determine the factors that contaminate water quality in the project area. The conduct of such activities usually require the establishment of water quality parameters, monitoring points and monitoring frequencies.

2) Water quality parameters

Water quality parameters should be able to clearly point out the causes of and prevention measures for water quality contamination. The selection of parameters should take into consideration the use of the water area and matters that are actually harmful to water quality. For example, the items that are used

to indicate the standards for the quality of water for domestic use and agricultural use (paddy irrigation) should be used for the assessment of the water quality of Yuna River which is used as drinking and domestic water source, agricultural (paddy fields and uplands irrigation) and livestock water source, as well as for recreational purposes and fisheries.

Degree of turbidity (organic matter), BOD which always indicates the water's purifying ability, and COD which facilitates the measurement of the total organic load in the water, will be included in the list of parameters INDRHI usually uses to monitor water for the irrigation of upland fields in dry areas. The inclusion of nitrogen and phosphorus is also recommended to cope with problems on eutrophication that have surfaced in recent years, which cannot be dealt with by the use of BOD and COD parameters alone.

The criteria used by the state of Arizona(U.S.A) in determining water quality is used as reference and is shown in Table N2.4.1.

At present INDRHI is not capable of analysing BOD, COD, TN and TP concentrations in water. INDRHI should therefore equip itself with the equipment necessary for this kind of analysis.

3) Monitoring points and frequency

Several points significantly affected by drainage water discharged from the project area will be selected for monitoring, which will be generally carried out once a month.

(2) Soil conservation plan

A soil conservation countermeasure should be formulated to prevent soil erosion in the huge Dole pineapple plantation in the upstream area of the Payabo River.

As a soil erosion countermeasure, INDRHI has formulated a forestation plan at the area upstream from where a dam is to be constructed. It should however immediately formulate the same plan for the downstream area.

(3) Environmental education plan

There is a strong possibility that the implementation of the project will adversely affect public health as it will result in increased paddy field acreage which will require more agricultural chemicals that contaminate water quality.

Improper agricultural chemical use could either kill or maim human beings. Farmers and their families should therefore be given proper guidance and education with regard to the handling and use of these lethal chemicals. Since the literacy rate in this area is low, the manner of teaching or guidance to be implemented is a major cause of concern. The measures taken to eradicate contamination by agrochemical use, e.g., impose restrictions on their sales and use (harmful ones will be prohibited

from the market), will be applied at the places where these materials are produced, hence additional measures should be taken to make sure the former ones are strictly obeyed.

The Dominican Republic has very strict regulations on agricultural chemical use. The number of agricultural chemicals prohibited in this country, which is shown in Figure M.2.4.1, is the largest in Central and South America. Nevertheless it is important to also create more regulations on the use of these chemicals.

In 1993, the Environmental Education Department of the Ministry of Agriculture started a seminar for farmers concerning agricultural chemical application methods. However, this seminar was cancelled due to shortage of funds.

Furthermore, it is important to educate the area residents on proper waste disposal method, and to encourage farmers to practice organic agriculture.

(4) Forestation plan

Farmers in the project area use firewood or propane gas for household fuel. The former is more widely used as the majority cannot afford the price of propane gas. There is a possibility that the forest area of the National Park Haitises will become a future fuel source once the supply of firewood from neighboring areas is depleted. To prevent this from happening, countermeasures that would impel farmers to plant pinon cubano within their premises as a fuel source should be introduced.

(5) Land use plan

The wetlands in the area (swamps and marshes) are habitats of snapping turtles and landing areas of migratory birds. In the formulation of the land use plan, the continued use of these wetlands should be given consideration in view of the regulation of irrigation water resource, protection of the ecosystem, and preservation of the rural landscape.

(6) River plan

The drainage plan for Payabo River should be formulated with due consideration of the Yuna River plan. To control water resource development, it is extremely necessary to immediately prepare laws pertaining to water use as ordinances relevant to water resource development are incomplete and the jurisdiction of bureaus and agencies monitoring such development activities is unclear.

(7) Irrigation drainage facilities maintenance and management plan

A new maintenance and management plan as well as an organization to take charge of this plan should be established for the maintenance and management of constructed and installed irrigation drainage facilities.

ANNEX M : TABLES

Table M.1.1 Prohibits the Importation, Manufacture, Sales and Distribution of Agrochemicals
President of The Dominican Republic (No. 217-91) 1991

Name of Agrochemical	
ALDICARB (Temik)	EDB
CAMPHECHLOR (Toxaphene)	HCH/BHC
CHLORDANE	LINDANE
HEPTACHLOR	PARAQUAT
CHLORDIMEFORM	PARATHION – Ethyl
DBCP	PARATHION – Methyl
DDT	PENTACHIOROPHENOL
ALDRIN	2,4,5 – T
DIELDRIN	MERCURY CHLORIDE
ENDRIN	PHENYL MERCURY ACETATE

Table M.1.2 Application (Selling) Condition of Agrochemicals

Trade name	Chemical Name	Note	CVMA	Pri.S*1
(1) Insecticide				
Azodrin	Monocrotophos		×*2	
Bidrin	Dicrotophos	Toxic		
Carbodan 48 FW	Carbofuran			
Cypermethrin 25% EC	Cypermethrin			×
Danitol				
Decis	Deltamethrin		×②	×
Derosal	Carbendazim			
Diazinon AG-500	Diazinon			
Diazinon 60% EC	Diazinon			
Dipterex	Triclorfon		×	
Fastac	Alpha-Cypermethrin	Toxic	×①	
Furadan 3G	Carbofuran			×
Inisan	Monocrotophos		×	×
Karate 2.5 EC	Lamda-Cyhalothrin	Toxic		×
Monocrotophos	Monocrotophos		×	×
Nuvacron 60 SCW	Monocrotophos			
Patrole	Mehtamidophos		×	
Perfekthion	Dimethoate	Toxic		×
Sumithion	Fenitrothion		×③	
Sistemin 40 EC	Dimethoate	Toxic		
Pipcord				×

Trade name	Chemical Name	Note	CVMA	Pri.S
(2) Disinfectant				
Bavistin	Carbendazim			
Bencarb	Bendiocarb	Toxic		
Cuprosan	Copper, Zineb & Maneb			
Dithane M-45	Mancozeb			
Hinosan 500 EC	Edifenphos		×	
Kasumin	Kasugamycin			
Kitazin	Iprobenfos	Toxic		
Kocide	Cupric Hydroxide			
Kumulus S	Sulfur			
Manzate 200 DF	Mancozeb			
Mertect				
Polyran DF				
Tri-Miltox				
Vondozeb	Mancozeb			
(3) Rodenticide				
Klerat	Brodifacoum	Toxic		
Ratika	Chlorophacinone	Toxic	×	

Trade name	Chemical Name	Note	CVMA	Pri.S
(4) Herbicide				
Actril DS	Ioxynil octanoate 10% & 2,4-D isooctyl 60%		×	
Aliy				
Ametrex				
Arsenal				
Banvel-D				
Basagran	Bentazone		×	
Basta	Ammonium Gulfpsinat			
Diurex 80 SC	Diuron		×③	
Facet			×	
Fenoxal	2,4-D & MCPA			×①
Fuego	Glyphosate and Paraquat			
Furore-1			×	
Fusilade			×	
Glifosato Nortox	Glyphosate-Isopropyl Amine		×①	
Gramoxone Super	Paraquat-dichloride		×	
Herbadox	Pendimethalin			
Machete	Butachlor		×	
Paradox	Paraquat			
Propadox	Propanil			
Propanil	Propanil		×	
Propanil	Propanil		×②	
Rifit	Pretilachlor		×	
Ronstar 25EC	Oxadiazon		×	
Roundup	Glyphosate		×	
Staml LV10	Propanil			
Marman 2,4-D				×②
Marman 2,4-D F06				×②

Note: CVMA (Public Sector, IAD branch office)
*1: Private Sector (Agroquimico Polanco, QUIAASA)
*2: Sell well (ex. ①: first)

Table M.1.3 Survey area and Frequency of Water Quality

No.of Sampling sites	Name of the river/canal	Frequency
1	Rio Payabo (Upstream)	5
2	El Guaragao	3
3	La Cueva	3
4	Lagunite Cristal	2
5	Laguna Cristal	2
6	Rio Payabo (Downstream)	5
7	Dren Cascarilla	5
8	Rio Yuna	4
9	Rio Nagua	1
10	Cano Colorado	1

Table M.1.4 (1) Water Quality of River/Spring (1994-1995)

Site	1 Rio Payabo (Upstream)					2 El Guaraguao			3 La Cueva			4 Lagunita Cristal		
	1	2	3	4	5	1	2	3	1	2	3	1	2	3
Item	30/08/94	07/09/94	28/09/94	08/02/95	16/02/95	30/08/94	07/09/94	28/09/94	30/08/94	07/09/94	28/09/94	30/08/94	07/09/94	28/09/94
1 Temp (°C)	Non Survey	26.7	Non Survey	25.5	23.8	26.7	23.9	24.1	23.6	25.5	23.9	Non Survey	23.8	23.8
2 SS (mg/l)		163				12	2.3	12	39	23	19		50.3	38.7
3 E·C (mS/cm)		158		220	222	445	432	430	383	346	348		338	340
4 SDT (mg/l)		100		175	119	286	260	274	245	220	222		220	218
5 PH		7.6		7.8	6.8	7	7.1	7.5	7.2	7.3	7.6		7.2	7.5
6 DO (mg/l)		7.3		9.1	10	9.7	9.5	9.4	10.3	9.7	10.8		9.1	10.6
7 Hard. (mgCaCO3/l)		65				219	205	145	200	160	214		169	200
8 Na (mg/l)		3.68		9.66	9.08	5.52	5.06	5.75	4.8	3.7	3.9		8.97	10.1
9 K (mg/l)		-		0.78	0.49	1.95	-	0.78	1.6	-	0.78		-	0.78
10 Ca (mg/l)		20		13.6	25.2	72	74	44	70	58	70		56	70
11 Mg (mg/l)		3.6		2.3	9.4	9.6	4.8	8.4	6	3.6	9.6		4.8	6
12 Cl (mg/l)		2.9				29.8	12.4	12.4	29.8	12.4	16		0.65	12.4
13 SO4 (mg/l)		<2.0				<2.0	3.36	11	<2.0	7.2	4.6		8.64	<2.0
14 Alca. (mgCaCO3/l)		100				353	315	299	324	241	291		249	257
15 RAS		0.2				0.16	0.15	0.14	0.15	0.13	0.52		0.31	0.61
16 Class		C1-S1		C1-S2	C1-S2	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1		C2-S1	C2-S1
17 N-NO3 (mg/l)		0.26				<0.02	0.17		0.2	0.16			0.18	
18 N-NO2 (mg/l)		-				0.02	-		0.017	-			-	
19 TN (mg/l)		-		*0.98	*0.42		2.81	1.78		3.03	2.03		-	2.62
20 TP (mg/l)		0.23		*50.6	*26.4	-	0.08	0.08	0.1	0.05	0.06		0.1	0.04
21 COD (mg/l)		-		*220	*196	13.4	3.9	12.5	0	11.7	5.9		-	3.95
22 BOD (mg/l)		1.1		2.5	N.D	0.3	2.7	0.5	0	0.7	2.9		1.9	0.9
23 F-Coli (MPN/l)						1500	-	910	2300		4300			4600
24 T-Coli (MPN/l)						4300	-	4300	4300		24000			4600
25 Cu (mg/l)		0.029				0.008	<0.02	0.03	0.002	<0.02	0.04		0.02	0.06
26 Hg (ng/ml)		-				1.9	0.27	0.2	1.8	0.2	0.27		-	0.41
27 Ni (mg/l)		<0.02				0.032	0.03	0.04	0.025	0.02	0.07		<0.02	0.12
28 Fe (mg/l)		1.28				0.256	0.2	<0.02	<0.02	0.32	<0.02		0.37	<0.02
29 Cr (mg/l)		0.05				<0.02	0.21	<0.02	<0.02	0.02	<0.02		0.04	<0.02
30 Discharge (m3/s)														
31 Triclofon				N.D	N.D									
32 Fenitrothion				N.D	N.D									
33 Monocrotophos				N.D	N.D									
34 Bentazone				N.D	N.D									
35 Propanil				N.D	N.D									
36 Butachlor				N.D	N.D									

* Figures not used in the analysis

Table M.1.4 (2) Water Quality of River/Spring (1994/1995)

Site	5 Laguna Cristal			6 Rio Payabo (Downstream)					7 Dren Cascarilla				
	1	2	3	1	2	3	4	5	1	2	3	4	5
Item	30/08/94	07/09/94	28/09/94	30/08/94	07/09/94	28/09/94	08/02/95	16/02/95	30/08/94	07/09/94	28/09/94	08/02/95	16/02/95
1 Temp. (°C)	Non Survey		24.2	25	26.9	26.3	25.9	24.5	30.6	29.7	28.4	26.3	27
2 SS (mg/l)			38	11	71	25			6	2.3	27.5		
3 E·C (mS/cm)		350	389	332	237	285	212	344	459	477	450	417	445
4 SDT (mg/l)			249	272	150	181			294	310	288	234	235
5 PH		7.2	7.7	7.6	7.5	7.9	7.2	6.5	7.4	7.4	7.7	7.9	6.6
6 DO (mg/l)			11	7.9	8.1	8.3	10.3	8.7	4.6	2.6	2.7	3.9	2
7 Hard. (mgCaCO3/l)			180	154	115	204			219	200	219		
8 Na (mg/l)		6.9	32.2	11.3	3.91	16.6	9.9	6.8	12.8	20.5	4.6	10.4	8.5
9 K (mg/l)		-	0.39	2.3	-	1.96	1.17	0.75	3.51	-	2.35	3.13	2.73
10 Ca (mg/l)		62	64	48	32	66	52.4	52.4	68	70	74	62	68
11 Mg (mg/l)		3.6	4.8	8.4	8.4	9.6	10.4	10.4	12	6	8.4	17.5	10.4
12 Cl (mg/l)		12.4	10.7	17.4	12.4	15.6	15.6	14.2	20.9	22.7	10.7	21	21
13 SO4 (mg/l)		9.6	<2.0	3.84	14.4	11	-		9.6	12	5.8	-	
14 Alca. (mgCaCO3/l)		266	299	249	149	199			282	332	324		
15 RAS		0.23	0.31	0.4	0.16	0.21			0.38	0.63	0.12		
16 Class		C2-S1	C2-S1	C2-S1	C1-S1	C2-S1	C1-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1
17 N-NO3 (mg/l)		0.19		0.14	0.19				0.13	114			
18 N-NO2 (mg/l)		-		0.024	-				0.021	-			
19 TN (mg/l)		3.25	2.29		2.48	2.29	*0.79	*0.65		2.04	3.22	*0.65	*0.7
20 TP (mg/l)		0.17	0.03	0.08	0.12	0.1	*52.4	*2	0.2	0.44	0.07	*48.8	*3.2
21 COD (mg/l)		-	1.8	1.71	37.1	26.2	*117.6	*424	52.3	5.9	11.4	*186.2	*156.8
22 BOD (mg/l)		0.9	0.5	0.5	1.3	3.9	N.D	N.D	0.8	1.5	2.9	8.5	N.D
23 F-Coli (MPN/l)			4300	910	-	2300			2400	-	2100		
24 T-Coli (MPN/l)			9300	2400	-	2300			2400	-	9300		
25 Cu (mg/l)		0.02	0.05	0.024	0.02	0.03			0.005	<0.02	0.04		
26 Hg (ng/ml)		-	0.34	2.8	0.61	0.2			1.4	0.2	0.3		
27 Ni (mg/l)		<0.02	0.1	0.041	0.02	0.04			0.035	0.02	0.08		
28 Fe (mg/l)		0.2	<0.02	0.221	0.77	0.39			0.022	0.22	0.07		
29 Cr (mg/l)		0.05	<0.02	<0.02	<0.02	<0.02			<0.02	<0.02	<0.02		
30 Discharge (m3/s)													
31 Triclofon							N.D	N.D				N.D	N.D
32 Fenitrothion							N.D	N.D				N.D	N.D
33 Monocrotophos							N.D	N.D				N.D	N.D
34 Bentazone							N.D	N.D				N.D	N.D
35 Propanil							N.D	N.D				N.D	N.D
36 Butachlor							N.D	N.D				N.D	N.D

* Figures not used in the analysis

Table M.1.4 (3) Water Quality of River/Spring (1994-1995)

Site	8 Rio Yuna					9 Rio Nagua		10 Cano Colorado	
	1	2	3	4	5				
Item	30/08/94	07/09/94	28/09/94	08/02/95	16/02/95	08/02/95	16/02/95	08/02/95	16/02/95
1 Temp. (°C)	Non Survey	28.6	30.5	26.6	27.2	Non Survey	27.6	Non Survey	28.8
2 SS (mg/l)		26.5	22.5						
3 E-C (mS/cm)		327	333	320	408		1395		1025
4 SDT (mg/l)		210	211	267	228		907		651
5 PH		8	8.3	8	6.7		6.4		6.4
6 DO (mg/l)		8.5	10.6	10.2	9.7		6.2		5
7 Hard. (mgCaCO3/l)		144	169						
8 Na (mg/l)		3.6	17.9	13.8	14.7		189.8		137.5
9 K (mg/l)		-	1.56	2.35	1.83		8.18		5.95
10 Ca (mg/l)		36	62	35	45		46		33
11 Mg (mg/l)		13.2	3.6	16.2	17.5		36.1		32.6
12 Cl (mg/l)		9.14	12.4	22.4	24.5		319.9		237.1
13 SO4 (mg/l)		22.6	7.2	-	-		-		-
14 Alca. (mgCaCO3/l)		183	224						
15 RAS		0.13	0.58						
16 Class		C2-S1	C2-S1	C2-S1	C2-S1				
17 N-NO3 (mg/l)		0.15	-						
18 N-NO2 (mg/l)		-	-						
19 TN (mg/l)		-	1.69	*0.61	*0.42		*0.79		*0.93
20 TP (mg/l)		0.17	0.1	*45.6	*4		*2		*6
21 COD (mg/l)		-	5.9	*191	*406		*200.9		*444
22 BOD (mg/l)		4.1	0.9	N.D	N.D		N.D		N.D
23 F-Coli (MPN/l)		-	910						
24 T-Coli (MPN/l)		-	4300						
25 Cu (mg/l)		0.02	0.06						
26 Hg (ng/ml)		-	0.41						
27 Ni (mg/l)		<0.02	0.15						
28 Fe (mg/l)		0.45	0.23						
29 Cr (mg/l)		0.05	<0.02						
30 Discharge (m3/s)									
31 Triclofon				N.D	N.D		N.D		N.D
32 Fenitrothion				N.D	N.D		N.D		N.D
33 Monocrotophos				N.D	N.D		N.D		N.D
34 Bentazone				N.D	N.D		N.D		N.D
35 Propanil				N.D	N.D		N.D		N.D
36 Butachlor				N.D	N.D		N.D		N.D

* Figures not used in the analysis

Table M.1.5 The water quality of the rivers in the area, as analysed in the past

	Name of river/spring	Survey period	Frequency (times)
1.	El Guaraguao	11.10.1979 – 22.05.1980	3
2.	Rio Yuna (Villa Riva)	08.04.1980 – 25.03.1985	18
3.	Rio Yuna (El Limon)	20.01.1981 – 25.03.1985	25
4.	Rio Payabo (Abadesa II)	23.05.1979 – 20.11.1986	35

Table M.1.6 (1) Results of Water Quality Analysis of the rivers in the area, as analysed in the past

Rio Yuna (El Limon)

Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	01-81											04-82					02-83					02-84			03-85
Item	20/01/81	15/03/81	10/04/81	09/05/81	11/05/81	12/05/81	27/05/81	28/05/81	21/09/81	19/10/81	11/11/81	15/12/81	21/04/82	13/05/82	16/05/82	05/11/82	01/02/83	07/03/83	22/08/83	13/10/83	18/11/83	14/02/84	10/04/84	04/12/84	25/03/85
1 PH	8	8	8	8	8	8	8	8	9	8	8	8	8	7	8	9	8	9	8	8	8	7	8	8	8
2 E-C(mS cm)	375	310	220	320	335	275	368	300	390	300	350	380	400	400	320	365	385	340	370	350	330	240	310	340	320
3 DO(mg/l)																									
4 DO(%SAT)																									
5 Temp.(℃)																									
6 Redox(mV)																									
7 Sal(PPT)																									
8 Ca(mg/l)	3	2	1	2	2	1	2	2	2	1	1	2	2	3	2	2	2	2	2	2	2	1	2	2	2
9 Mg(mg/l)	0	1	1	1	1	1	1	2	2	1	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
10 Na(mg/l)	1	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	0	1	0	0	0
11 K(mg/l)	0																								
12 CO3(mg/l)					0		0		0	0	0	0			0	0	0	0	0	0	0		0	0	0
13 HCO3(mg/l)	3	2	2	3	3	2	3	3	3	2	3	3	3	4	2	3	3	2	3	3	3	2	2	3	2
14 SO4(mg/l)	0	0	0	0	0				0			0	0		0	0	0	0	0	0	0	0	0	0	0
15 Cl(mg/l)	1	1	0	0	1	0	0	0	1	0	0	1	1	0	0		1	1	1	1	1	0	0	0	1
16 SS(mg/l)		0		0	3	3	3	0	0	1	0	0	0	4	0	0	0	0	0	0	0	1	0	0	0
17 RAS																									
18 CLASS	C2-S1	C2-S1	C1-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C2-S1	C1-S1	C2-S1	C2-S1	C2-S1
19 N-NO3(mg/l)																									
20 NO2(mg/l)																									
21 NO3(mg/l)																									
22 TP(mg/l)																									
23 T-Coli(MPN)																									
24 F-Coli(MPN)																									
25 Hg(ng/ml)																									
26 Disch.(m3/s)	52	57	365	283	530	534	573	581	65	102	594	83	47	404	104	33	32	43	48	37	44	541	34	67	

Rio Yuna(Villa Riva)

Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Item	20/01/81	17/02/81	15/03/81	21/09/81	21/04/82	20/08/82	05/11/82	01/02/83	07/03/83	22/08/83	13/10/83	18/11/83	10/04/84	25/07/84	04/12/84	25/03/85
1 PH	8	8	8	8	8	8	9	8	9	8	8	8	8	8	8	8
2 E-C(mS/cm)	375	312	332	410	330	310	360	380	350	370	360	360	310	260	340	320
3 DO(mg/l)																
4 DO(%SAT)																
5 Temp.(℃)																
6 Redox(mV)																
7 Sal(PPT)																
8 Ca(mg/l)	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2
9 Mg(mg/l)	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
10 Na(mg/l)	1	0	0	1	0	0	0	1	1	1	0	1	0	0	0	1
11 K(mg/l)	0	0														
12 CO3(mg/l)				0	0	0	0	0	0	0	0	0	0	0	0	0
13 HCO3(mg/l)	3	2	3	3	2	3	2	3	2	3	3	3	2	2	3	2
14 SO4(mg/l)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Cl(mg/l)	1	0	1	1	1	0	1	1	1	1	1	1	0	0	0	1
16 SS(mg/l)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17 RAS																
18 CLASE	C2-S2	C2-S2	C2-S2	C2-S2	C2-S2	C2-S2	C2-S2	C2-S2	C2-S2	C2-S2	C2-S2	C2-S2	C2-S2	C2-S2	C2-S2	C2-S2
19 N-NO3(mg/l)																
20 NO2(mg/l)																
21 NO3(mg/l)																
22 TP(mg/l)																
23 T-Coli(MPN)																
24 F-Coli(MPN)																
25 Hg(ng/ml)																
26 Disch.(m3/s)	40	119	27		42	23		44	40	54	27	37	34	76	60	54

Table M.1.6 (2) Results of Water Quality Analysis of the rivers in the area, as analyssed in the past

Rio Payabo(Abadesa II)

Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	03/81					03/82						02/83				01/84					01/85					03/86				
Item	11/03/81	22/05/81	21/08/81	29/09/81	27/10/81	05/02/82	22/05/82	07/06/82	30/06/82	20/08/82	10/12/82	03/02/83	05/04/83	24/08/83	12/01/84	15/05/84	25/06/84	03/08/84	13/09/84	24/10/84	15/01/85	14/02/85	20/03/85	18/04/85	20/09/85	12/03/86	15/07/86	07/10/86	30/10/86	20/11/86
1 Ph	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
2 E-C(mS/cm)	225	225	200	250	255	220	250	250	215	205	220	205	200	220	190	200	250	260	270	270	210	230	230	220	270	210	350	215	250	215
3 DO(mg/l)																														
4 DO(%SAT)																														
5 Temp.(°C)																														
6 Hardness(mg/l)																														
7 Sal(PPT)																														
8 Ca(mg/l)		2	2	1	2	1	2	2	2	1	1	1	1	1	1	1	2	2	2	2	1	2	2	1	2	1	2	1	2	1
9 Mg(mg/l)		1	0	1	1	1	0	0	0	1	0	0	1	1	1	1	1	0	0	1	0	0	1	1	0	1	1	1	0	0
10 Na(mg/l)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
11 K(mg/l)	0																													
12 CO3(mg/l)					0			0			0							0						0	0	0	0	0		
13 HCO3(mg/l)	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
14 SO4(mg/l)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 Cl(mg/l)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16 SS(mg/l)	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
17 RAS																														
18 CLASS	C1-S1	C2-S1	C1-S1	C2-S1	C2-S1	C1-S1	C2-S1	C2-S1	C1-S1	C1-S1	C1-S1	C1-S1	C1-S1	C1-S1	C1-S1	C1-S1	C2-S1	C2-S1	C2-S1	C1-S1	C1-S1	C1-S1	C1-S1	C1-S1	C2-S1	C1-S1	C2-S1	C1-S1	C2-S1	C1-S1
19 N-NO3(mg/l)																														
20 NO2(mg/l)																														
21 NO3(mg/l)																														
22 TP(mg/l)																														
23 T-Coli(MPN)																														
24 F-Coli(MPN)																														
25 Hg(mg/l)																														
26 Dissch.(m3/s)	1	17	18	3	2	1	7	6	7	2	2	1	1	6	2	1	3	2	6	4	1	1	8	6	8	15	5	4	9	6

Guaraguao

Site	1	2	3	4	5
Item	11/10/79	12/05/80	22/05/80	27/05/80	20/06/80
1 Ph	7	7	7	7	7
2 E-C(mS/cm)	400	360	320	320	320
3 DO(mg/l)					
4 DO(%SAT)					
5 Temp.(°C)					
6 Hardness(mg/l)					
7 Sal(PPT)					
8 Ca(mg/l)	162	199	167	178	201
9 Mg(mg/l)	81	25	47	56	23
10 Na(mg/l)	10	30	3		
11 K(mg/l)					
12 CO3(mg/l)	0	0	0	0	0
13 HCO3(mg/l)	229	274	201	187	362
14 SO4(mg/l)	8	10	23	20	250
15 Cl(mg/l)	20	10	11	10	90
16 SS(mg/l)					
17 RAS					
18 CLASS					
19 N-NO3(mg/l)					
20 NO2(mg/l)					
21 NO3(mg/l)					
22 TP(mg/l)					
23 T-Coli(MPN)		70000	2300	2300	24000
24 F-Coli(MPN)					
25 Hg(mg/l)					
26 Dissch.(m3/s)					

Table M.2.2.1 Results of Environmental Impact Assessment (Overall evaluation) without dam

General Evaluation

(1) Social Environment

	Environmental Issues	Evalu-ation	Future countermeasurerses
4.	Conflict among communities and people (new settlers and host people)	C	
5.	Impact on native people (many Haitian inhabitants live in the surroounding area)	C	
6.	Population increase (population in the project area increase due to new settlers)	B	
7.	Drastic change in population composition	B	
8.	Changes in bases of economic activites (economic activities of people forced to reside somewhere else will be changed)	C	
10.	Increase in income disparities	B	To grasp the conditions that may lead to income disparities
11.	Modification of water rights and fishing rights (riparian)	C	To adjust water-use among downstream beneficiaries
14.	Increased use of agro-chemicals	B	Adjustment of water-use through the implementation of the project. Diffusion of organic farming.
17.	Residual tendency of agro-chemicals	C	Establish and popularize appropriate agrochemical application method.
18.	Increase in domestic wastes	C	Establishment of domestic waste desposal method
(2) Natural Environment			
20.	Changes in vegetation	C	
22.	Degradation of ecosystems with biological diversity (Increased encroachment on habitats of snapping turtles and migratory birds)	C	Establishment of its relevance to land utilization
24.	Destruction of wetlands and peatlands	C	Establishment of its relevance to land utilization
31.	Soil contamination by agrochemicals and others	C	Establishment and popularization of appropriate agrochemical and fertilizer application methods.
33.	Devastation of hinterland	C	Establishment of its relevance to land utilization
34.	Ground subsidence	C	Establishment of its relevance to land utilization
35.	Change in surface water hydrology (river discharge is influenced by design flood discharge)	A	Making a flood control plan for Payabo river
37.	Inundation and flooding	A	Construction of gate ito facilitate O/M
38.	Sedimentation	A	Formulation of countermeasures for soil erosion during construction works. Making a watershed protection program to prevent soil erosion.
42.	Eutrophication	C	Establishment and popularization of appropriate agrochemical and fertilizer application methods.
44.	Change in water temperature	C	
46.	Damage to landscape	C	Establish and popularize appropriate agrochemical and fertilizer application methods; disposal methods

(Rating)
A: Expected to bring about i serious impacts
B: Expected to bring about is slight impact
C: unclear (requiring studies, but may be clarified in the course of the project)

Table M.2.2.2 (1) Results of Environmental Impact Assessment (Overall evaluation) with dam

(1) Environmentally Sensitive Areas in Project Site or Vicinity

Environmentally Sensitive Areas	Applicable or Not					
	In Project Area			Vicinity of Project Area		
	Appl.1)	N.A.2)	Unknown.3)	Appl.	N.A	Unknown
(1) Specifically designated areas						
1. Habitat of fauna and flora listed in CITES	□	■	□	□	■	□
2. Wetland designated under the Ramsar Convention	□	■	□	□	■	□
3. Heritage sites listed in the World Heritage Convention	□	■	□	□	■	□
4. National parks, natural reserves, etc.	□	■	□	■	□	□
(2) Socioeconomically sensitive areas						
5. Areas inhabited by indigenous peoples, ethnic minorities	□	■	□	■	□	□
6. Historical remains, cultural asssts, aesthetic sites	□	■	□	■	□	□
7. Areas likely to suffer from significant negative economic impacts	□	■	□	■	□	□
(3) Environmentally sensitive natural lands						
8. Arid and semi-arid lands (including savanna, rangeland, etc.)	□	■	□	□	■	□
9. Tropical rain forest and wildlands	■	□	□	■	□	□
10. Wetlands	■	□	□	■	□	□
11. Peat lands	■	□	□	■	□	□
12. Mangrove forests	□	■	□	■	□	□
13. Coral reefs	□	■	□	□	■	□
14. Mountainous, steep-sloped, erodible or devastated lands	□	■	□	■	□	□
15. Closed water bodies such as lakes, swamps or reservoirs	□	■	□	■	□	□

Notes:1)Appl.:Applicable, 2)N.A:Not Applicable, 3)Unknown:Not readily Known

Table M.2.2.2 (2) Results of Environmental Impact Assessment (Overall evaluation) with dam

(2) RESULT OF EVALUATION (Continued)

(1) Social Environment

Environmental Impacts	Definition	Evaluation	Evaluation Bases
(1) Socioeconomy			
(1)-1 Society			
1. Planned residential settlement area	Construction of settlement area to accommodate the settlers, nomads, landless farmers, etc. migrating in the area due to the contruction of new farmlands, reclamation of areas and promotion of new irrigation projects	D	
2. Involuntary resettlement	Forced resettlment or transfer of inhabitants of an area due to the submersion of the said area for development projects	A	Forced transfer of inhabitants in a submersion area due to construction of disaster prevention dam
3. Substantial changes in way of life	Change in the peoples way of life, particularly in the role of women in family & society due to agricultural and rural development	(A)	Possitive Impacts:Mitigation of women's household chores(washing, drawing water by new irrigation network
4. Conflict among communities and peoples	Friction due to conflicting interests between beneficiaries and non-beneficiaries, people in favor of and those against development, new settlers and host people involved in development and outsiders, people in the project area and those affected in the surrounding area	B	Friction due to conflicting interests between new settlers and host people
5. Impact on native peoples	Adverse effects of development on local communities composed partly or entirely of indigenous peoples (including tribal groups), low caste groups, ethnic minorities, or nomads	B	A lot of Haitian inhabitants in the submersion area due to construction of disaster prevention dam
(1) 2 Demography			
6. Population increase	Significant population increase in the project or surrounding area due to development	B	Population in the submersion area increases to seek for compensaiton
7. Drastic change in population composition	Drastic change in population composition in the project or surrounding area due to development	B	The birth rate increase in the project area
(1)-3 Economy			
8. Changes in bases of economic activities	Forced or involuntary relocation of economic bases or means of livelihood such as farmland, fishing grounds, etc., under a project due to land acquisition, changes in land use regulation, or deterioration of areas of economic concern.	B	Forced relocation due to construction of disaster prevention dam
9. Occupational change and reduced job opportunities	Forced or involuntary occupational change due to land acquisition and loss or deterioration of means or bases of economic activities;includes reduced job opportunities due to farm mechanization	B	Inhabitants in the submersion are forced to change economic activities
10. Increase in income disparities	Increase in income disparities among groups brought about by development; implies relative impoverishment of the economically weak	B	Increase in income disparities among groups brought about by development
(1) 4 Customs and Traditions			
11. Modification of water rights and fishing rights (riparian)	Modification or revision of water or fishing (riparian) rights due to adverse effects of development	C	Disturbance of existing water use in the downstream area
12. Changes in social and institutional structures	Changes in social and institutional structures as a result of establishment of new, or modification of existing, rural organizations due to development	[B]	Possitive Impacts:Systematization by means of farmer's economic growth
13. Changes in existing social systems and customs	Changes in existing social systems and customs as a result of development activities	B	Inhabitants of forced resettlement change in terms of social systems and customs

Criteria of evaluation

A: The project will induce significant environmental impacts(SEI)

B: The project will not likely induce SEI.

C: The SEI of the project is not clear.

D: The project will not induce any SEI.

Table M.2.2.2 (3) Results of Environmental Impact Assessment (Overall evaluation) with dam

(2) RESULT OF EVALUATION (Continued)

(1) Social Environment(Continued)

Environmental Impacts	Definition	Evaluation	Evaluation Bases
(2) Health and sanitation			
14. Increased use of agrochemicals	Increased use of pesticides due to intensification of agriculture, introduction of high-yielding varieties & new crops and irrigation development	B	Increased paddy field acreage.
15. Outbreak of endemic diseases	Spreading of endemic diseases due to the adverse effects of development	D	
16. Spreading of epidemic diseases	Spreading of epidemic diseases due to the adverse effects of development	D	
17. Residual tendency of agrochemicals	Accumulation in the natural environment(soil, water, etc.) of agrochemicals or chemical substances with high residual tendency such as organo chloric insecticides, etc.	C	Limited application or total lack of regulations to control toxic agrochemical use. Misuse of agrochemicals.
18. Increase in domestic wastes	Increase in domestic wastes due to population increase	B	Increased use of water closets. (flush toilets)
(3) Cultural properties			
19. Destruction of historic remains and cultural properties	Direct or indirect destruction of sites, structures, and remains of archaeological, historical, religious, cultural, or aesthetic value as result of development	D	

(2) Natural Environment

Environmental Impacts	Definition	Evaluation	Evaluation Bases
(4) Biological and ecological environment			
20. Changes in vegetation	Direct or indirect deterioration or degradation of vegetation due to development activities including removal of vegetation cover, alteration of land use, deforestration, alteration of environmental conditions, etc.	C	Alterations in land use.
21. Negative impacts on important or indigenous fauna and flora	Adverse effects on important or indigenous animal & plant species due to destruction of or changes in habitats	D	
22. Degradation of ecosystems with biological diversity	Degradation of ecosystems that allow wild species of plants and animals to withstand external stress	C	Increased encroachment on habitats of snapping turtles and migratory birds.
23. Proliferation of exotic and/or hazardous species	Introduction of pathogenic agents or spreading of hazardous species to create an environment conducive to their propagation	C	
24. Destruction of wetlands and peatlands	Direct extinction of wetlands or peatlands by development activities such as large scale earth filling; or indirect extinction through drying and decomposition due to changes in hydrological regime	C	
25. Encroachment of tropical rain forests and wildlands	Deforestations for implementation of development projects	D	
26. Destruction of mangrove forests	Disappearance of mangrove forests due to direct destruction, or deterioration of supporting environmental conditions	D	
27. Degradation of coral reefs	Encroachment resulting from deterioration of the supporting environment due to sedimentation, etc.	D	

Criteria of evaluation
- A: The project will induce significant environmental impacts(SEI)
- B: The project will not likely induce SEI.
- C: The SEI of the project is not clear.
- D: The project will not induce any SEI.

Table M.2.2.2 (4) Results of Environmental Impact Assessment (Overall evaluation) with dam

(2) RESULT OF EVALUATION (Continued)

(2) Natural Environment (Continued)

Environmental Impacts	Definition	Evaluation	Evaluation Bases
(5) Soil and land resources			
(5) 1 Soil			
28. Soil erosion	Land destruction and simultaneous removal of particles (as of soil) by running water, waves and currents, etc.	D	
29. Soil salinization	Phenomena in which soluble salts accumulate in the surface layer of soils thereby consequently affecting crop growth	D	
30. Deterioration of soil productivity	Deterioration of soil productivity due to leaching and decomposition of nutrients, nutrient absorption by plants, surface soil erosion, salinization, failure in soil management, etc.	D	
31. Soil contamination by agrochemicals and others	Accumulation of highly residue prone agrochemicals in soil	C	
(5) 2 Land resources			
32. Devastation or desertification of land	Deterioration of land productivity or desertification due to artificial or natural impacts	D	
33. Devastation of hinterland	Devastation of areas surrounding the project area as a result of secondary or indirect impacts of development	C	
34. Ground subsidence	Settlement of ground caused by the dehydration or drying of wetlands, peat swamp, or reclaimed lands, or excessive exploitation of groundwater	C	
(6) Hydrology, water quality and air			
(6) 1 Hydrology			
35. Changes in surface water hydrology	Alteration in river discharge or water level due to reservoir construction, irrigation water intake, or drainage	A	Incurs water shortages downstream. Alteration in river discharge due to to design flood discharge of the dam
36. Changes in groundwater hydrology	Changes in the groundwater recharge mechanism or groundwater table due to infiltration of irrigation water and exploitation of groundwater	D	
37. Inundation and flooding	Overflowing of a river onto the surrounding land or the surging of sea water onto the coastal land.	A	Overflowing of a river due to inadequate control of check gates.
38. Sedimentation	Settlement of transported sediment in rivers, estuaries, and reservoir	A	Settlement of transported sediment in reservoir of the dam
39. Riverbed degradation	Degradation of riverbeds in lower basin areas due to insufficient sediment load to maintain riverbed level	A	Decrease in sediment load due to construction of the dam
40. Obstruction of inland navigation	Adverse impacts of development activities on navigation.	D	
(6) 2 Water quality and temperature			
41. Water pollution and deterioration of water quality	Deterioration of water quality due to developent activities	B	Induces water pollution downstream
42. Eutrophication	Accumulation in water of nutritive soluble salts such as nitrate and phosphate	C	
43. Sea water intrusion	Intrusion of a salt water wedge along a riverbed	D	
44. Change in water temperature	Adverse impact of low irrigation water temperature on crops	C	
(6) 3 Atmosphere			
45. Air pollution	Diffusion of agrochemicals , sand dust and odoriferous particles such as exhaust from vehicles and machinery into the air	D	
(7) Landscape and mining resources			
46. Damage to landscape	Direct or indirect negative effects on features of landscape as a result of development	C	The polluted condition of the Samana bay waters is caused by various human activities
47. Obstruction of mining resources exploitation	Development activities impede the exploitation of mining resources	D	

Criteria of evaluation

A: The project will induce significant environmental impacts(SEI).
B: The project will not likely induce SEI.
C: The SEI of the project is not clear.
D: The project will not induce any SEI.

Table M.2.2.2 (5) Results of Environmental Impact Assessment (Overall evaluation) with dam

(3) General Evaluation

(1)Social Environment

	Environmental Issues	Evaluation	Future courses of action
2.	Involuntary resettlement	A	To ensure resettlment area for inhabitants of forced transfer
4.	Conflict among communities and peoples	B	To adjustment conflict by official organization
5.	Impact on native peoples (many Haitian inhabitants lives in the subsersion area of a dam)	B	Without discrimination between Dominican and Haitian inhabitan
6.	Population increase(population in the subsersion area will increase as the dam construction project will offer compersation to the residents)	B	
7.	Drastic change in population composition	B	
8.	Changes in bases of economic activities (economic activities of people forced to reside somewhere else will change)	B	
9.	Occupational change and reduced job opportunities (inhabitants forced to resettle will also be forced to change their economic activities)	B	
10.	Modification of water rights and fishing	B	To grasp the conditions that may lead to income disparities
11.	Modificaiton of water rights and fishing rights (riparian)	C	To adjust water use among downstream beneficiaries.
13.	Change in existing social systems and customs (inhabitants forced to resettle are also forced to change their social systems and customs)	C	
14.	Increased use of agrochemicals	B	Adjustshment of water use through the implemention of the project. Diffusion of organic farming.
17.	Residual tendency of agrochemicals	C	Establish and popularize agrochemical applicaiton method
18.	Increase in domestic wastes	C	Establishment of domestic waste disposal method

(2)Natural Environment

20.	Changes in vegetation	C	
22.	Degradation of ecosystems with biological diversity (increased cocroachment on habitats of snapping turtles and migratory birds)	C	Establishment of its relevance to land utilization
23.	Proliferation of exotic and/or hazardous species	C	
24.	Destruciton of wetlands and peatlands	C	Establishment of its relevance to land utilization
31.	Soil contamination by agrochemicals and others	C	Establishment and popularization of appropriate agrochemical and fertilizer application methods
33.	Devastation of hinterland	C	Establishment of its relevance to land utilization
34.	Ground subsidence	C	Establishment of its relevance to land utilization
35.	Changes in surface water hydrology (river discharge is influenced by design flood discharge)	A	Making a flood control plan for Payabo river
37.	Inundation and flooding	A	Construction of gate to facilitate O/M
38.	Sedimentation	A	Formulation of countermeasures for soil erosion during construction works. Making a watershed protection program to prevent soil erosion.
39.	Riverbed degradation	A	
42.	Eutrophication	C	Establishment and popularization of appropriate agrochemical and fertilizer aspplication methods
44.	Change in water temperature	C	
46.	Damage to landscape	C	Establish and popularize appropriate agrochemical and fertilizer application methods; establish domestic waste disposal methods

(Rating)
A: Expected to incur serious impacts
B: Expected to incur a slight impact
C: Unclear (requiring studies, but may be clarified in the course of the project)

Table M.2.3.1 Runoff Ratio of Agrochemicals from Upland areas

(Source: Leonard, 1990)

Agro-chemical	Amount Applied (kg/ha)	Place	Cultivated Crop	Runoff Concentration (μ g/kg)	Runoff Ratio (%)	Research
■Runoff by Natural Rainfall						
Alachlor	2.24	Iowa	Corn		0.96	Baker, 1979
Atrazine	Every kind	Ohio	Corn	480	0–5.7	Triplett, 1978
Atrazine	1.5–4.0	Georgia	Corn	1900	0.2–1.9	Leonard, 1970
Atrazine	2.24	Iowa	Corn		2.1	Baker, 1979
Atrazine		Maryland	Corn	16.9	1	Wu, 1980
Azinphosmethyl		Louisiana	Sugar Cane	250	0.55	Smith, 1983
Cyanazine	1.4–1.6	Georgia	Corn	180	0.07–1.0	Leonard, 1979
Cyanazine	2.24	Iowa	Corn		2.1	Leonard, 1979
Cyanazine	1.1–1.7	Pennsylvania	Corn		0.7–5.7	Hall, 1984
2,4-D		Oregon	Grass		0.014	Norris, 1982
2,4-D		Canada	Wheat	31	4.1	Nicholaichuk, 1983
Diphenamid	2.3–3.5	Georgia	Soybean	2070	0.1–7.2	Leonard, 1979
Ethoprop		Georgia	Soybean	283	0.1	Rohde, 1979
Fonofos	1.12	Iowa	Corn		0.36	Baker, 1979
Fenvalerate		Louisiana	Sugar Cane		0.56	Smith, 1983
Glyphosate	1.1–9.0	Ohio	Corn	100	1.9	Edwards, 1980
Paraquat	1.5–15	Georgia	Corn		3.4–10.9	Leonard, 1979
Permethrin	0.11	Louisiana	Cotton	<1	<1	Carrol, 1981
Picloram	2.8	Arizona	Pinyon-Juniper	320	1.1	Johnsen, 1980
Picloram		Oregon	Grass		0.35	Norris, 1982
Simazine	Every kind	Ohio	Corn	1200	0–5.4	Triplett, 1978
Trifluralin	1.12	Georgia	Soybean	38	0.17	Rohde, 1980
Trifluralin	1.12	Georgia	Soybean	21	0.1–0.3	Leonard, 1979
Toxaphene		Mississippi	Cotton		0.5–1	McDowell, 1981
■Runoff from Irrigation Field						
Chlorpyrifos	1–2.9	California	Cotton	480	0.02–0.24	Spencer, 1985
Cycloate	2.9	California	Sugar beat	6.2	0.03	Spencer, 1985
Diazinon	0.5–2.7	California	Sugar beat	22	0.04–0.07	Spencer, 1985
DCPA	3.4–7.6	California	Cotton	189	1.12–1.4	Spencer, 1985
Endosulfan	1.7–6.0	California	Lettuce	104	0.19–0.62	Spencer, 1985
Ethylan	3.2	California	Lettuce	8	0.008	Spencer, 1985
Alachlor	2.5	Iowa		5000	1.7–22	Spencer, 1985
Alachlor	2.1	Iowa		78–220	1.0–8.6	Spencer, 1985
Atrazine	2.5	Iowa			3.7	Gaynor, 1981
Atrazine	2.1	Iowa		83–141	1.0–5.7	Baker, 1982
Cyanazine	2.24	Iowa	Corn	1300	11	Baker, 1982
Fenofos	1.2	Iowa	Corn	19–41	1.8	Baker, 1982
Fluometuron	4.4			0.87	<1	Wiese, 1981
Propachlor	2.5	Iowa		3800	0.8–13	Baker, 1979
Propachlor	2.1	Iowa		59–173	0.8–6.1	Baker, 1979
Terbutryne					0.3	Gaynor, 1981

Table M.2.3.2 Runoff of Agrochemicals from Paddy field areas

(Source: Maru)

Agro-chemical (Herbicide)	Amount Applied (l)	Place	Cultivated Crop	Runoff Volume (kg)	Runoff Ratio (%)	Research
Butachlor	37.30	Chiba Pref. (Japan)	Rice	164.7	2.32	Maru
Oxadiazon	11.33	Chiba Pref. (Japan)	Rice	92.7	4.31	Maru
CNP	77.96	Chiba Pref. (Japan)	Rice	16.1	0.11	Maru
Dymron	43.76	Chiba Pref. (Japan)	Rice	250.4	3.01	Maru
Chlomethoxyfen	6.87	Chiba Pref. (Japan)	Rice	19.5	1.49	Maru
Pyrazolate	15.07	Chiba Pref. (Japan)	Rice	8.9	0.31	Maru
Molinate	63.09	Chiba Pref. (Japan)	Rice	714.0	5.96	Maru
Simetryn	38.61	Chiba Pref. (Japan)	Rice	414.8	5.65	Maru
Thiobencarb	37.56	Chiba Pref. (Japan)	Rice	102.6	1.44	Maru
Dimethametryn	1.58	Chiba Pref. (Japan)	Rice	8.0	2.65	Maru
Piperophos	5.98	Chiba Pref. (Japan)	Rice	27.8	2.45	Maru

Table M.2.3.3 Estimates according to Agrochemicals Sprayed

Agrochemicals	Brand	Active Ingredient	Ratio of Active Ingredient (%)	Amount Applied A (kg/ha)	Toxicity to Humanbeings and Livestock	Toxicity to Fish	Area sprayed B (ha)	Amount of Agrochemicals AXB (kg)	Time of Application	Quantity of Active Ingredient Applied Annually (kg)	Runoff Ratio (%)	Runoff Load (Total) (kg/y)	Load Ratio in Payabo Basin (39.2%)	Load Ratio in Cascarilla Basin (60.8%)	Estimate R.Yuna st.No.8 (μg/ℓ)
Herbicide	Machete	Butachlor	2.5	30	Normal	B	16,220	486,600	Jan.Jul.	12,165	5	608	238	370	0.079
	Basagran	Bentazon	11.0	30	Normal	A	16,220	486,600	Mar.Oct	53,526	5	2676	1049	1627	0.349
Insecticide	Sumithion	Fenitrothin	50.0	2	Normal	B	16,220	32,440	Apr.May.Oct. Nov.	16,220	5	811	318	493	0.106
Bactericide	Hinosan 500EC	Edifenphos	30.0	2	Normal	B	16,220	32,440	Apr.May.Oct. Nov.	9,732	5	487	191	296	0.064

Table M.2.3.4 WHO Drinking Water Guidelines (concerning Agrochemical), 1987

Agrochemical	GLs ($\mu g/\ell$)
DDT (total isomers)	1
Aldrin and dieldrin	0.03
Chlordane (total isomers)	0.3
Hexachlorobenzene	0.01
Heptachlor and heptachlor epoxide	0.1
Gamma-HCH (lindane)	3
Methoxychlor	30
2,4-D	100
Alachlor	0.3
Atrazine	2
Bentazone	25
MCPA	0.5
Metolachlor	5
Molinate	7
Pendimethalin	17
Propanil	175
Pyridate	60
Simazine	17
Trifluralin	170

Table M.2.3.5 Results of Village Survey

	Village name	Number of Farmhouses	Agriculture	Non-Agriculture	Village Population	Dominican	Haitian	Establishment (New/Old)
*1	Los Yayas	35	14	21	200	185	15	New
2	Los Guineo	150	20	130	800	750	50	Old
3	R. Esperanza	25	20	5	140	70	70	Old
4	R. Luna	35	14	11	136	83	53	Old
*5	Bella Vista	200	110	90	1500	250	1250	Old
6	Nuevo Ambiente	30	30	0	200	200	0	New
*7	Rincon Claro	200	132	68	1000	985	15	New
8	Manaties Bono	26	26	0	150	150	0	Old
*9	Chamucada	20	20	0	80	80	0	Old
10	La Abadasa	40	40	0	180	180	0	Old
11	La Lagerua	9	4	5	40	6	34	New
*12	Los Manaties	16	16	0	64	64	0	New
	Total	786	446	330	4490	3003	1487	
	*Subtotal	471	292	179	2844	1564	1280	

*Villages in the submersion area

Table M.2.3.6 Estimated Number of Farmhouses and Population that will be affected by the Dam

Classification	No. of Farmhouse	It's Population
Water level lower than 20m above sea level	16	64
Water level lower than 40m above sea level	471	2,844

Table M.2.4.1 The Criteria used by the State of Arizona (U.S.A.) in determining Water Quality

Appendix B. Allowable Limits for Protected Uses

PARAMETER	PROTECTED USES					
	DWS	FBC	IHC	A&W	Agl	AgL
TRACE SUBSTANCES (MAXIMUM ALLOWABLE LIMITS), (mg/l)						
ARSENIC (AS As)	0.05D	0.05D	a	0.05D	2.0T	0.20T
BARIUM (AS Ba)	1.00D	1.00D	a	NS	NS	NS
BORON (AS B)	NS	NS	a	NS	1.00T	NS
CADMIUM (AS Cd)	0.01T	0.01T	a	0.01D[b]	0.05T	0.05T
CHROMIUM (AS Cr HEXAVALENT PLUS TRIVALENT)	0.05D	0.05D	a	0.05D	1.00T	1.00T
COPPER (AS Cu)	1.00D	NS	a	0.05D	5.00T	0.50T
LEAD (AS Pb)	0.05D	0.05D	a	0.05D[d]	10.00T	0.10T
MANGANESE (AS Mn)	NS	NS	a	NS	10.00T	NS
MERCURY (AS Hg)	0.0020T	0.0020T	a	0.0002T[d]	a	0.0100T
SELENIUM (AS Se)	0.010D	0.010D	a	0.050T	0.02T	0.050T
SILVER (AS Ag)	0.050D	0.050D	a	0.050D	NS	NS
ZINC (AS Zn)	5.000D	NS	a	0.500D	10.00T	25.00T
AMMONIA (AS UN-IONIZED NH_3)	NS	NS	NS	0.02	NS	NS
CYANIDES (AS CYANIDE ION-& COMPLEXES)	0.20	0.20	a	0.02[d]	NS	0.20
PHENOLICS	0.005	0.005	a	0.005	NS	0.005
SULFIDES (TOTAL)	NS	NS	NS	0.10[d]	NS	NS

NOTES:

a. Too little is known about adverse health effects for this use to adequately select number.

b. For cold water fishery protected use the maximum allowable cadmium concentration is 0.001mg/l.

d. The allowable limit for this use is set at less than the curre-minimum level of detection. The limit necessary to adequately protect this use is lower. Until appropriate analytical procedures with lower detection limits are available, this particular limit is considered to be violated only when the number herein listed is reached or exceeded. Compliance requires concentrations be less than but not equal to the number listed.

1. Abbreviations used in this Appendix:
   FBC = Full Body Contact
   IHC = Incidental Human Contact
   A&W = Aquatic and Wildlife. The letter 'c' subindexed to Aquatic and Wildlife indicates a cold water fishery.
   Agl = Agricultural Irrigation
   AgL = Agricultural Livestock Watering
   DWS = Domestic Water Source
   WWTP = Wastewater Treatment Plant
2. A unique water. Limits developed on 3 site-specific basis for each stream segment or lake. See R9-21-303 for current sites.
3. An effluent dominated water: Uses supported by limits developed on a site-specific basis for each stream segment. See Section R9-21-301 for applicable limits.

出典：Arizona Water Quality Standards, ARIZ. ADMIN. R. & REGS. R9-21-201(13) Appendix A (1987)
R9-21-209(C) Appendix B (1987)

ANNEX M : FIGURES

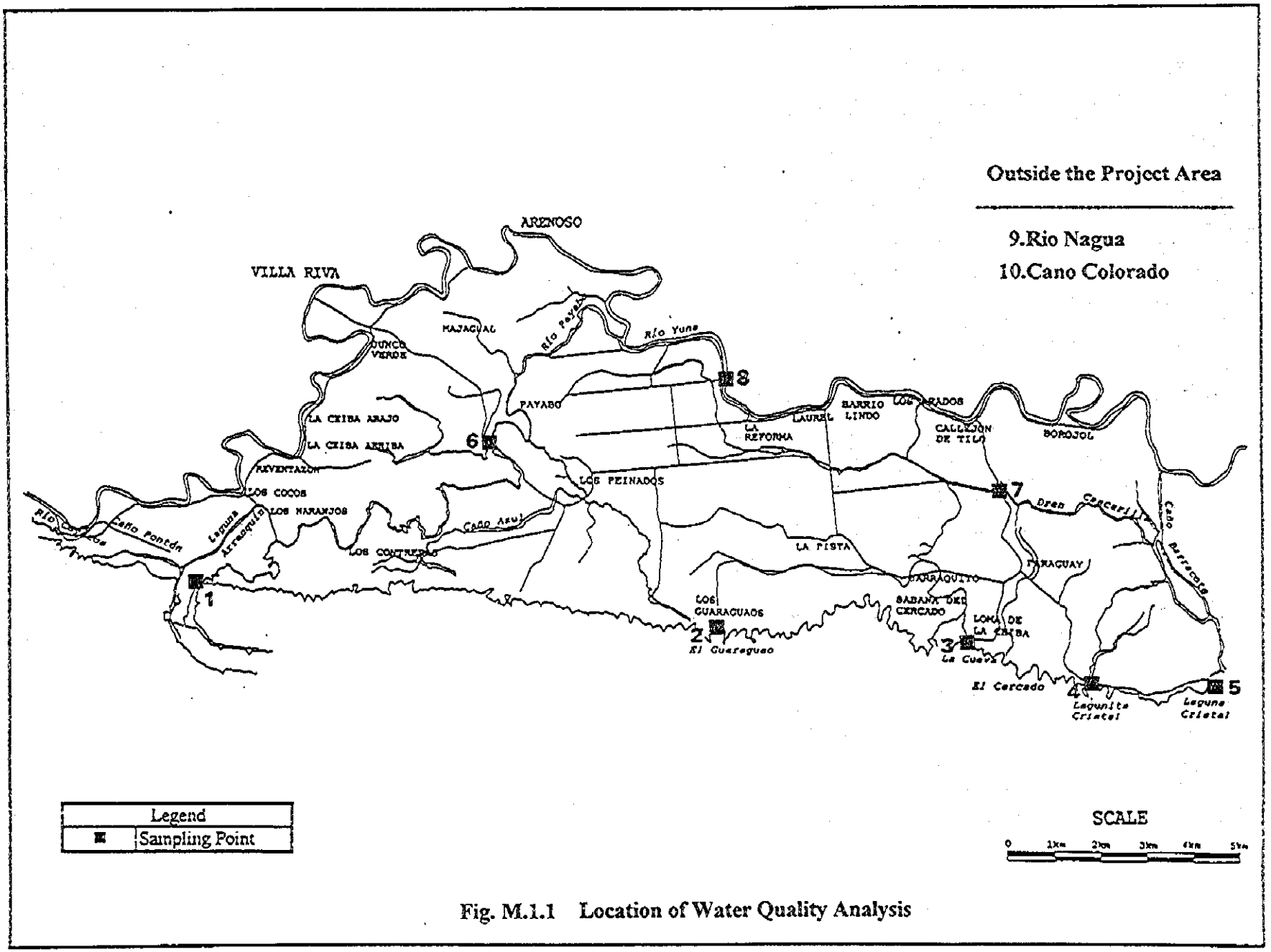


Fig. M.1.1 Location of Water Quality Analysis

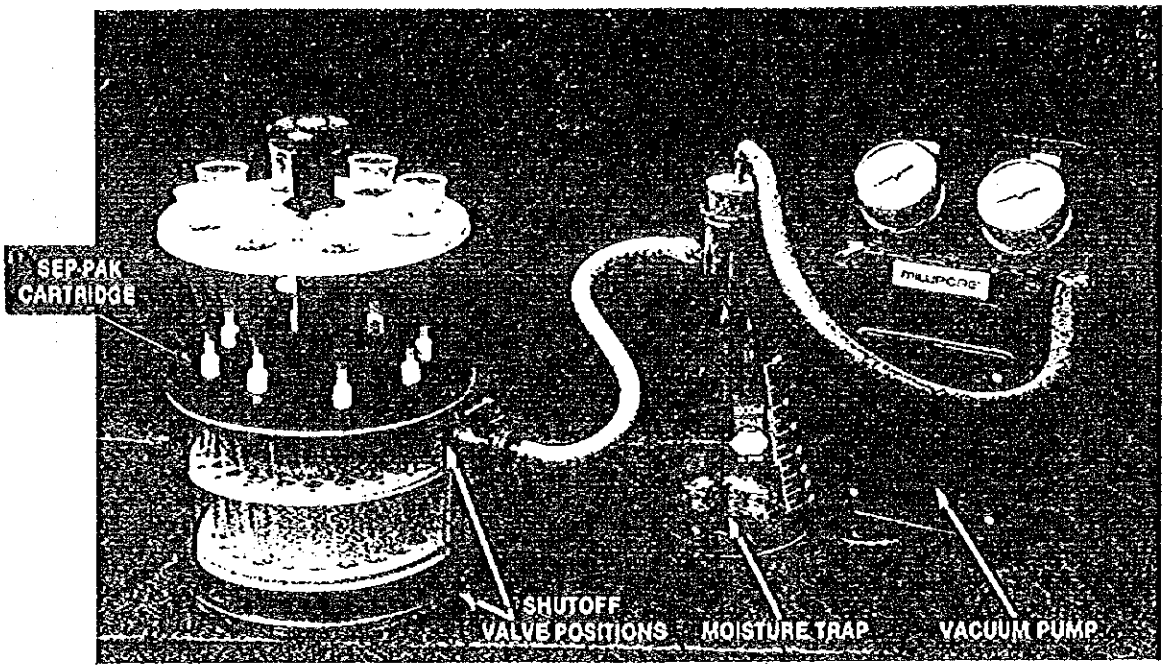
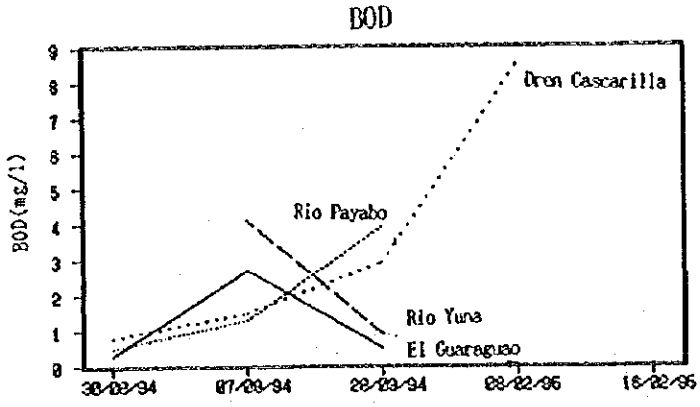
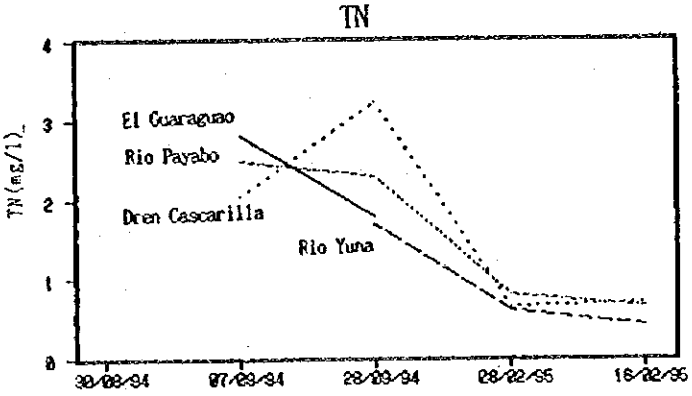


Fig. M.1.2 The Vacuum System





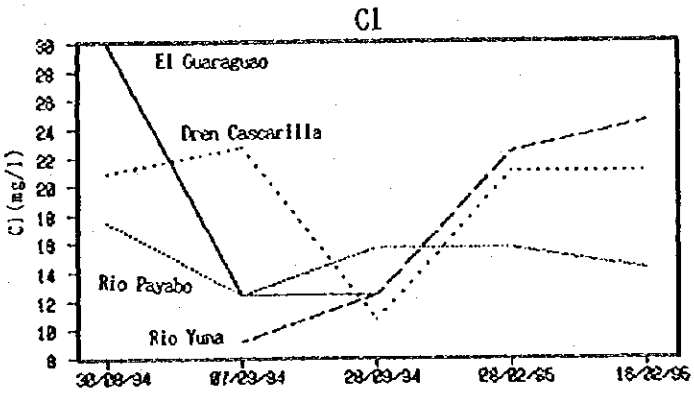
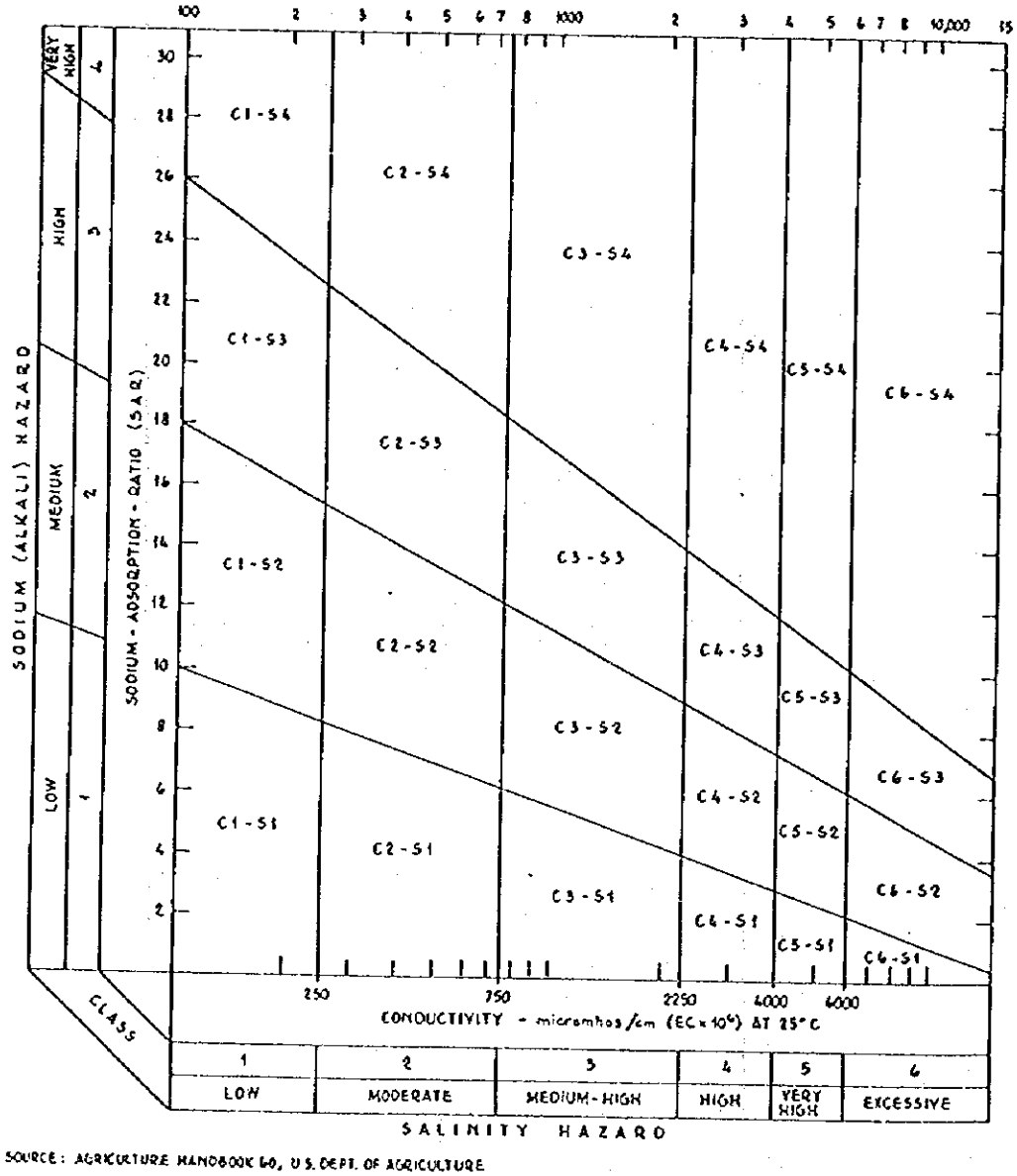


Fig. M.1.3 Water Quality of River/Spring (1994-1995)

The relative activity of sodium ions in exchange reactions with soil are expressed in the Sodium Adsorption Ratio:

$$SAR = \frac{Na^{+}}{\sqrt{((Ca^{++}+Mg^{++})/2)}}$$



SOURCE: AGRICULTURE HANDBOOK 60, U.S. DEPT. OF AGRICULTURE

Source Thorne & Peterson (1964)

Fig. M.1.4 Diagram for the Classification of Irrigation Water

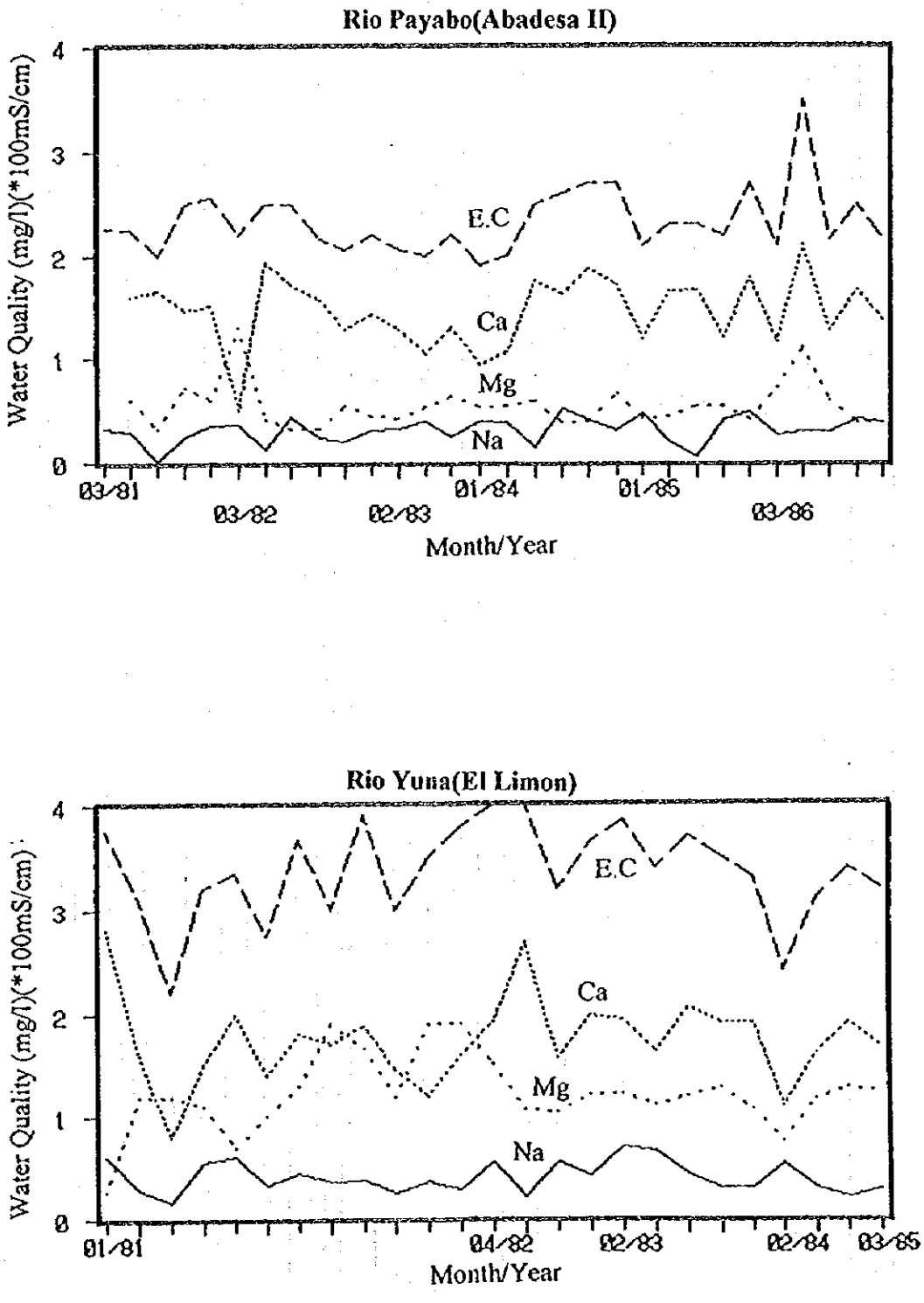


Fig. M.1.5 Annual Change in River Water Quality (1981-1986)

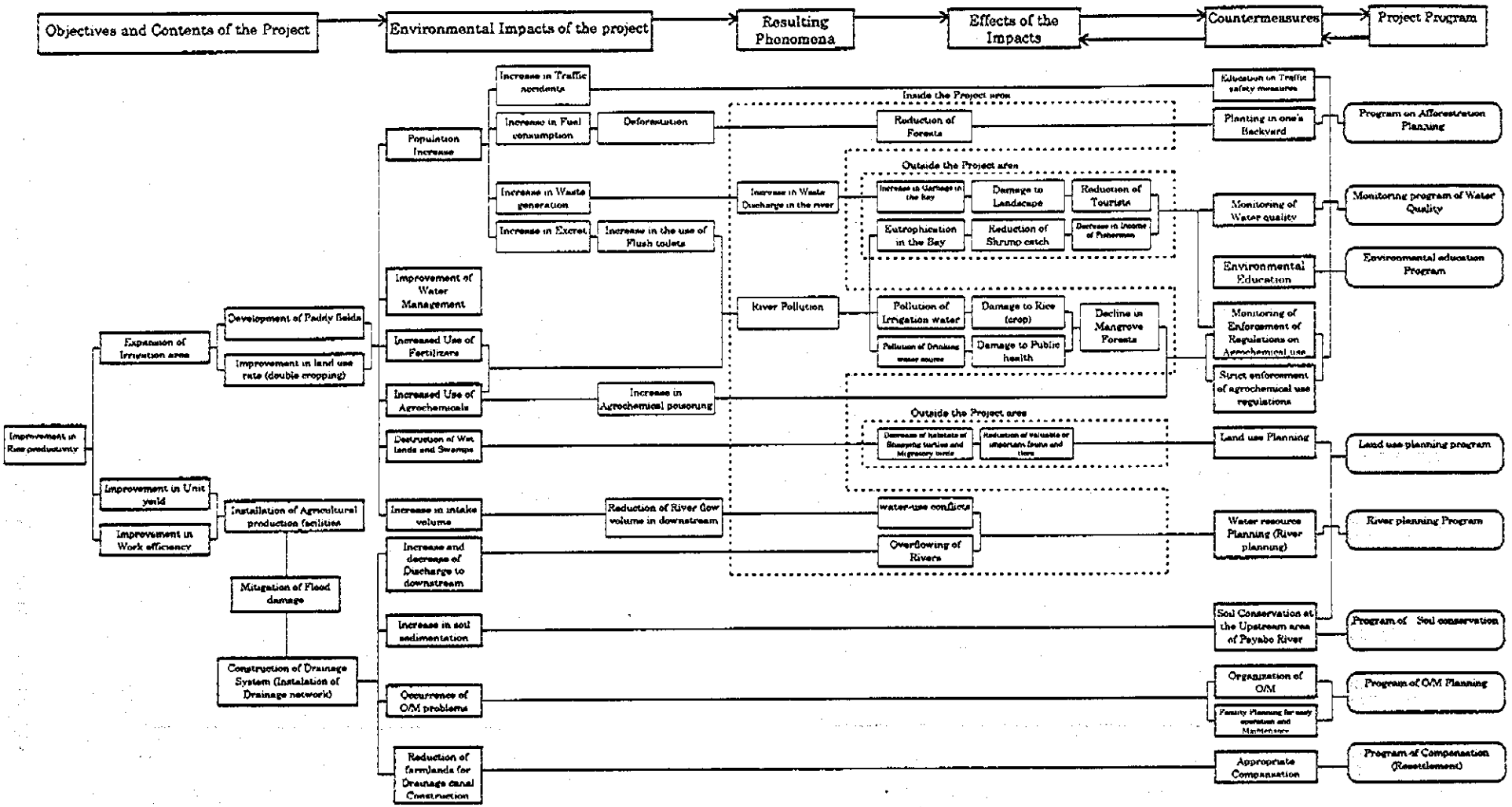


Fig. M.2.1.1 (1) Relation between Projects and Environmental Effects (without dam)

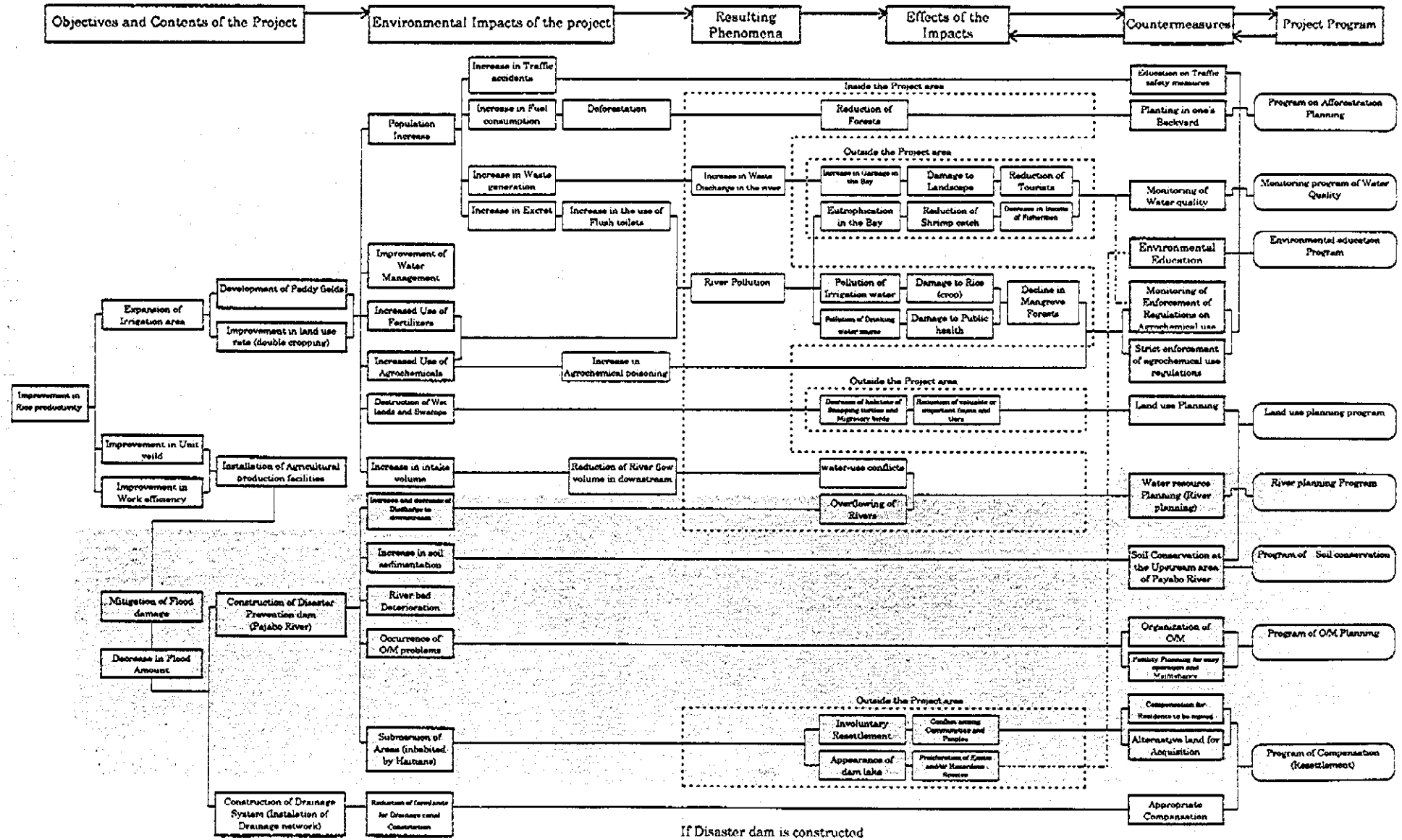


Fig. M.2.1.1 (2) Relation between Projects and Environmental Effects (with dam)

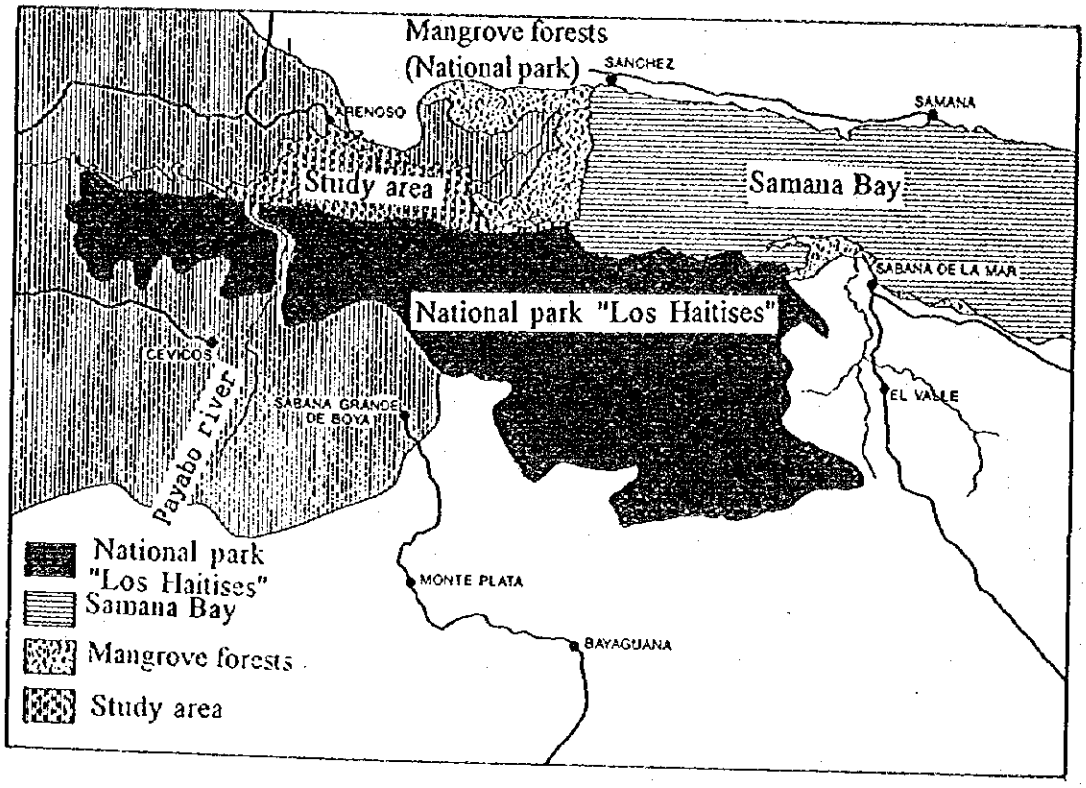


Fig. M.2.1.2 The Project's Areas of Influence

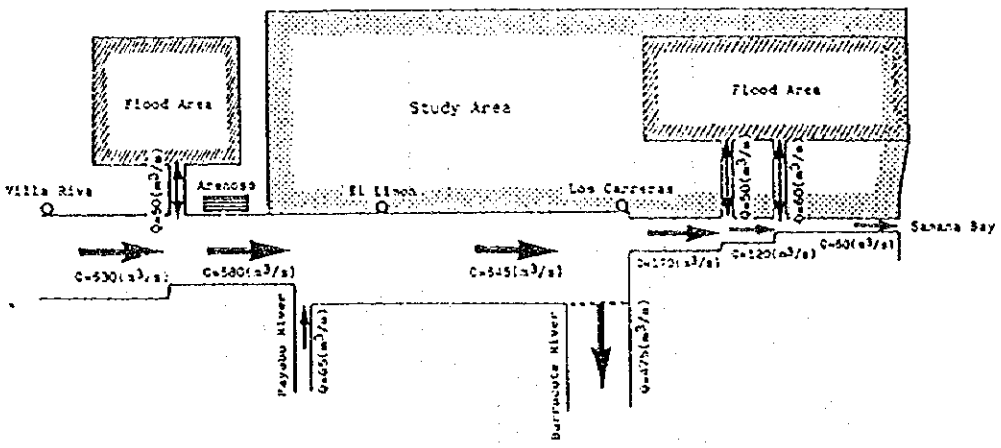


Fig. M.2.2.1 Dishcarge Capacity of the Yuna River

(Metcalf, R. L., Sanborn, J. R., 1975)

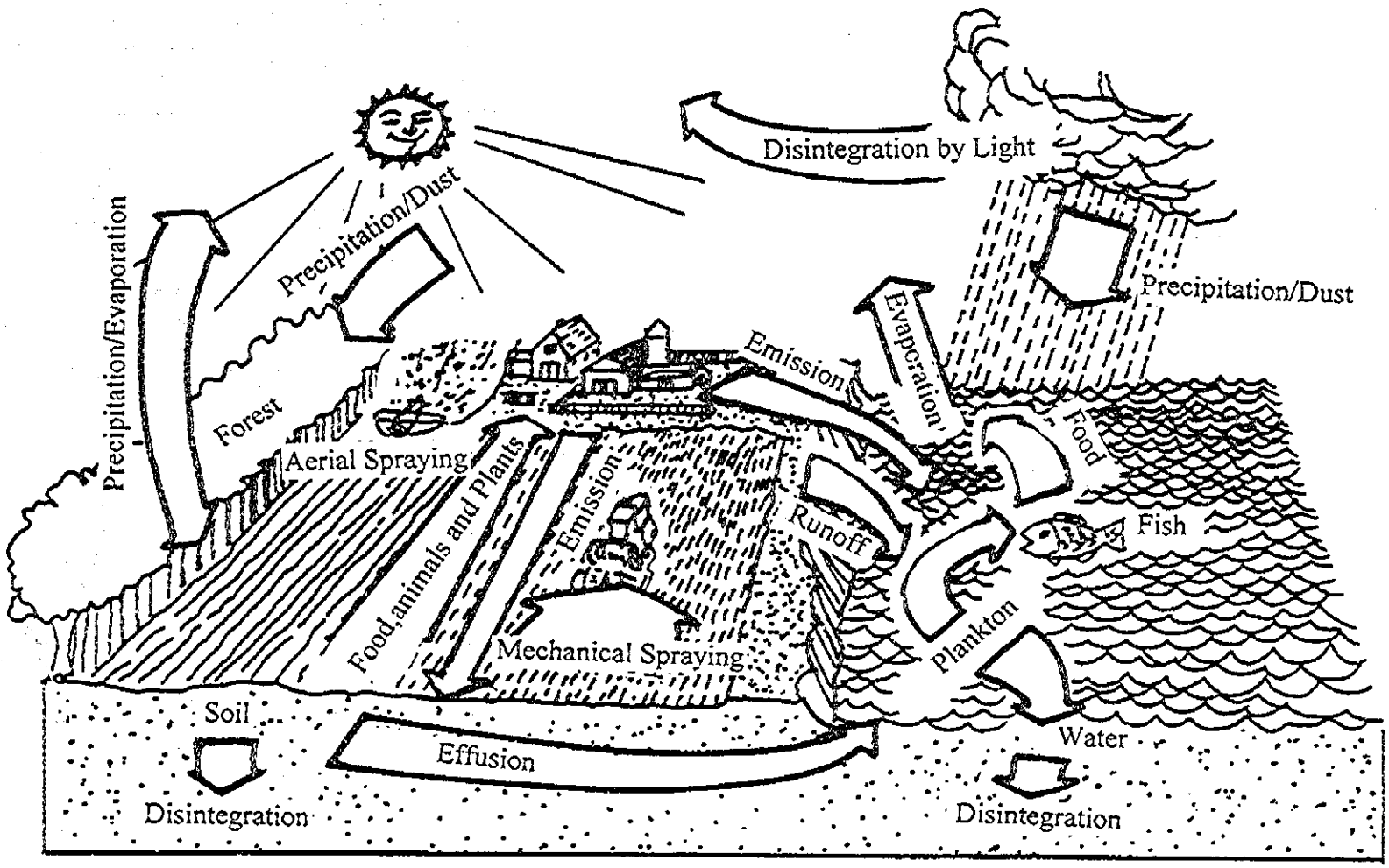


Fig. M.2.3.1 Agrochemical behavior in the Environment

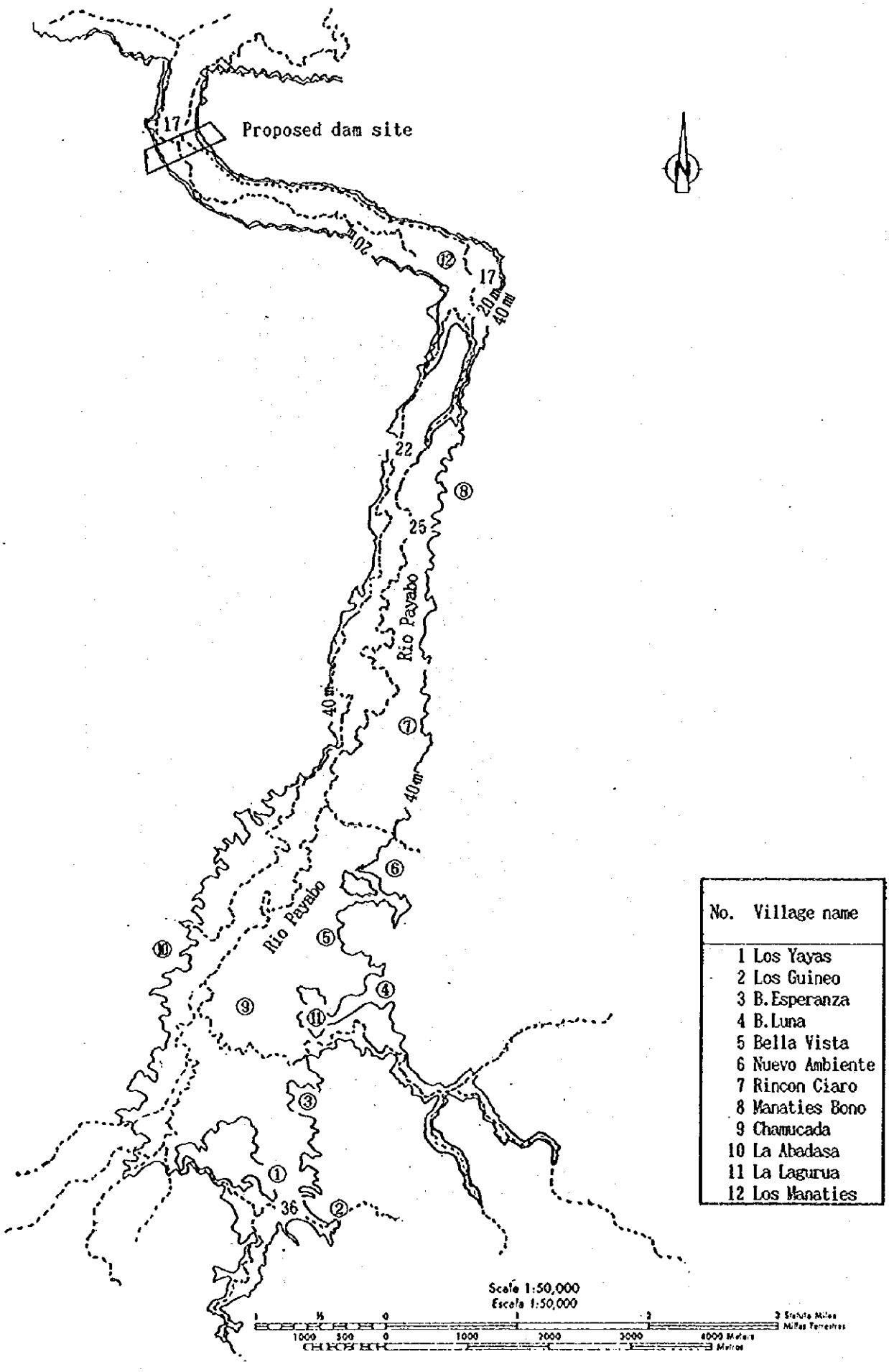
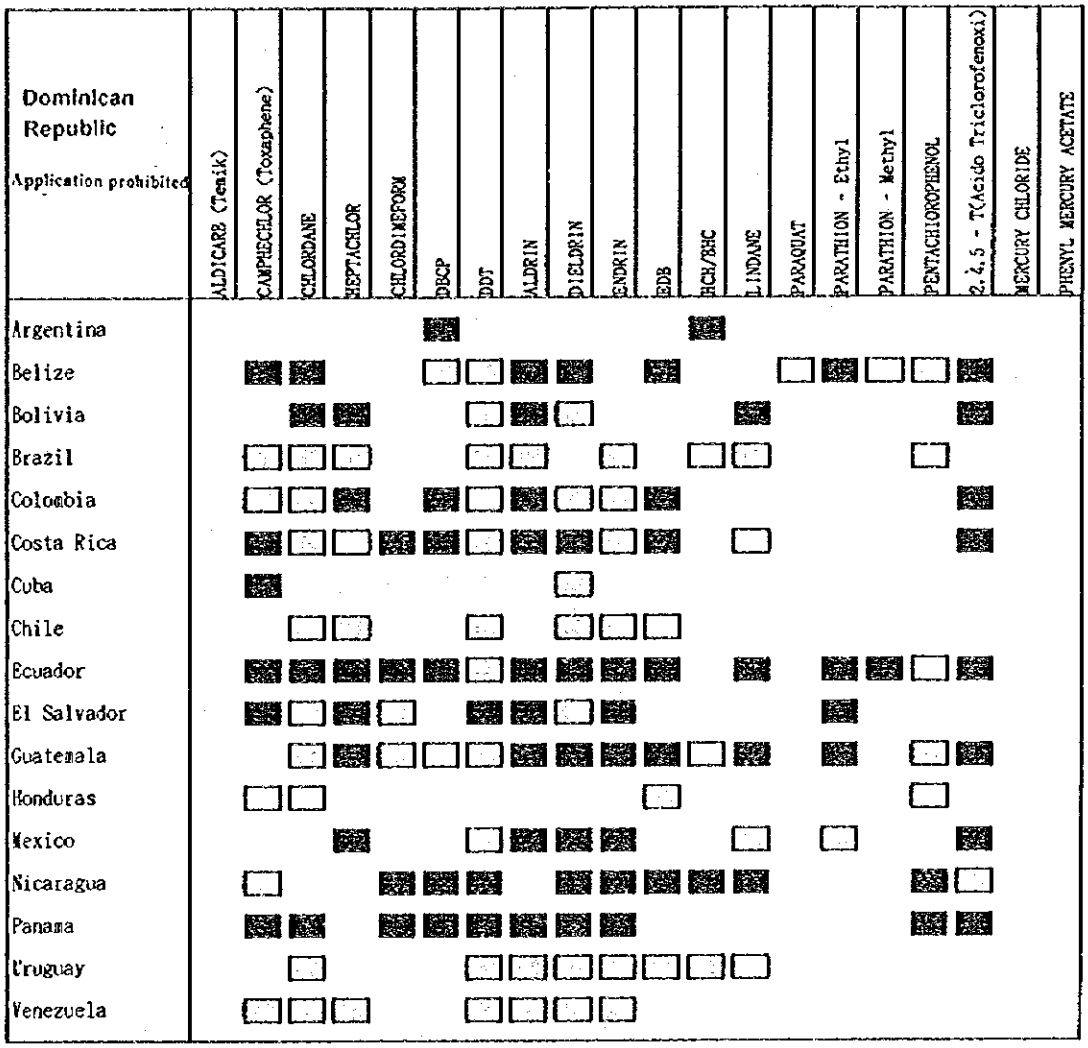


Fig. M.2.3.2 Location of Villages Surveyed in Areas affected by the Proposed Dam Construction



Application prohibited
Dangerous(Application in Special case)
Application possible

Source:-Presidente de la Republic Dominicana (Numero217-91) 1991
-Enlace No.11,Boletin de la Red Accion en Plaguicidas de America Latina
RAP-AL Junio 1989,Quito,Ecuador

Fig. M.2.4.1 Agrochemicals Prohibited in the Dominican Republic and Other Latin American Countries

ANNEX N : FORMULATION OF THE ALTERNATIVE PLAN A AND ITS ECONOMIC ANALYSIS

ANNEX N : FOMULATION OF THE ALTERNATIVE

PLAN A' AND ITS ECONOMIC ANALYSIS

N.1 Foreword ---------- N - 1

N.2 Features of the plan ---------- N - 1

N.2.1 Irrigation System ---------- N - 1
N.2.2 Land Use ---------- N - 2

N.3 Benefits and Cost of the plan ---------- N - 2

N.3.1 Agricultural production ---------- N - 2
N.3.2 Construction Cost (See Table N.1) ---------- N - 3
N.3.3 Water Charge ---------- N - 3
N.3.4 Project Benefits ---------- N - 3
N.3.5 Project Cost ---------- N - 4
N.3.6 Economic Internal Rate of Return (EIRR) ---------- N - 4

N.4 Sumamary ---------- N - 4

List of Tables

N.1 Construction Cost ---------- N - 5

List of Figures

N.1 Irrigation Canal Network Plan ---------- N - 7

ANNEX N : FOMULATION OF THE ALTERNATIVE PLAN A' AND ITS ECONOMIC ANALYSIS

N.1 Foreword

Within the present Feasibility Study on the Limon del Yuna Agricultural Development Project, three (3) alternative plans (Alternative Plan A, B-1, and B-2) were presented and the Alternative Plan A was selected as the optimum plan among three plans justified by its technical adaptability and economic profitability. Therefore, the Study team recommended to implement the project based on the Alternative Plan A. The aforementioned three alternative plans were formulated through exchange of opinions between the Study team and the Dominican counterpart personnel during the field works in the Dominican Republic.

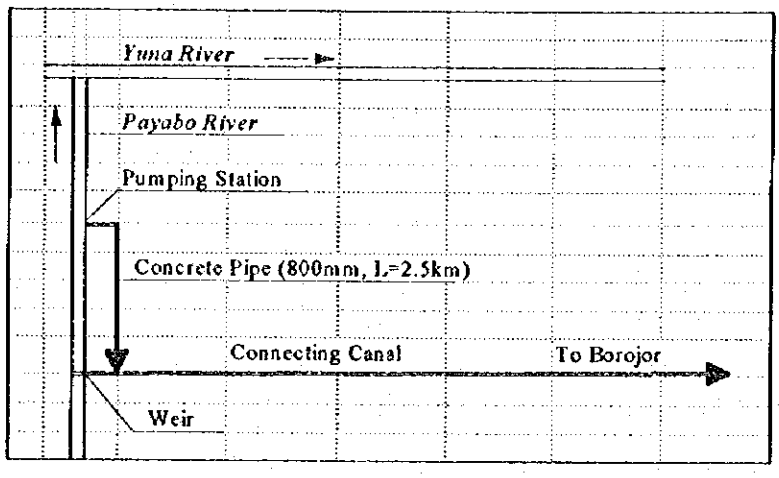
Nevertheless, after completing the field works, it is reported that the settlement of persons evacuated from the Los Haitises National Park is in progress in the lands covered by pasture where it is proposed to construct a reservoir in the Alternative Plan A. Faced with this situation, the Dominican side manifested their anxiety about sacrificing the pasture land for construction of a reservoir, and the same anxiety was presented in the comments on the Draft Final Report in such manner as they requested the Study team to prepare a water intake development plan which is substitutable to the construction of the reservoir.

So as to relax the anxiety of the Dominican side cited before, the Study team has formulated a plan (the Alternative A') which aims to irrigate the same area as contemplated in the Alternative Plan A, not by constriction of a reservoir but by installation a pumping station and has evaluated its technical and economic feasibility as presented hereinafter.

N.2 Features of the plan

N.2.1 Irrigation System

A pumping station to substitute for a reservoir shall be placed at about 2 km upstream of the Payabo river from its confluence with the Yuna river. Water to be pumped up from this station will be supplied to the main irrigation canal connecting the weir which is proposed at the Payabo river with the Borojor irrigation block, as shown below. No substantial modification in the irrigation canal network is contemplated in comparison with the Alternative Plan A (See Fig. N.1 Irrigation Canal Network Plan).



Outline of the pump is shown as follows:

Design Intake Volume : 0.637 (m3/s)
Actual Pump Head : 15 (m)
Type of Pump : Submersible Motor Pump

N.2.2 Land Use

The pasture land to be scarified by construction of a reservoir (about 140 ha) proposed in the Alternative plan A can be used for livestock farming as it is done at present. However, about half of the pasture area is in the habit of being inundated.

N.3 Benefits and Costs of the plan

N.3.1 Agricultural Production

The pasture land (140 ha) will contribute to increasing agricultural production with a value of RD$4.3 million (1.2%) in comparison with the Alternative Plan A.

Unit: RD$x1000/year

Crops	Without Project	Plan A	Plan A'	Balance
Paddy	146,250	312,368	312,368	0
Upland	1,642	9,307	9,307	0
Sub-total	147,892	321,675	321,675	0
Beef	12,464	10,811	11,949	0
Milk	17,088	14,808	16,367	1,559
Sub-total	29,552	25,619	28,316	2,697
Total	177,444	347,294	349,991	4,256

N.3.2 Construction Cost (See Table N.1)

As the construction cost of the reservoir is almost equivalent to that of the pumping station, so the difference of cost between the Alternative Plan A and the Alternative Plan A' is insignificant as indicated in the table below.

Item	Plan A			Plan A'			Balance		
	Local Portion	Foreign Portion	Total	Local Portion	Foreign Portion	Total	Local Portion	Foreign Portion	Total
Total Project Cost	109,151	190,969	300,120	108,623	191,355	299,978	-523	386	-142
(Reservoir)	(1,025)	(5,885)	(6,910)	(-)	(-)	(-)			
(Pumping Station)	(-)	(-)	(-)	(513)	(6,220)	(6,773)			

N.3.3 Water Charge

The sum of annual operation and maintenance cost for the irrigation system will increases by 6.7% with construction of a pumping station, which will result in raising water charge by 7%.

	Plan A	Plan A'
M(RD$): Annual total operation and maintenance cost	6,494,000	7,044,000
SA1(ha): Irrigable area up to 10 ha	10,110	
SA2(ha): Irrigable area larger than 10 ha	3,190	
FC(RD$)Unit water charge	197	214
TA1(RD$): Water charge up to 10 ha	394	428
TA2(RD$): Water charge larger than 10 ha	788	856

N.3.4 Project Benefits

On the basis of the economic farm-gate price and production cost, the benefits of the project at economic price is estimated as given below. Without sacrificing, pasture land an incremental net return of agricultural output will be raised by a value of RD$469 (0.7%) in comparison with the Alternative Plan A.

Unit: RD$ x1000

Items	Plan A	Plan A'	Balance
Incremental Net Return of Agricultural Production	66,597	67,066	469
Avoidance of Loss in Agricultural Production	1,678	1,678	-
Total	68,275	68,744	469

N.3.5 Project Cost

The initial investment cost for both plans is converted into economic price as shown in the following table.

Unit: RD$ x 1000

Cost Items	Plan A	Plan A'	Balance
Construction Works	249,100	248,982	-118
Acquisition of Machinery	17,179	17,179	0
General Administration	4,350	4,350	0
Consulting Services	53,168	53,168	0
Physical Contingency	32,380	32,365	-15
Total of Investment Cost	356,177	356,044	-133
O/M Cost (year)	3,067	3,327	260
Replacement of machinery	17,179	17,179	0
Replacement of structures	3,256	3,576	320

N.3.6 Economic Internal Rate of Return (EIRR)

The economic internal rate of return (EIRR), which was calculated based on the above cited benefits and cost, turned out to be equal for both plans as calculated in the table below.

	Plan A	Plan A'	Balance
EIRR (%)	14.7%	14.7%	0

N. 4 Summary

Although an incremental benefits of the Alternative Plan A' are slightly higher than that of the Alternative Plan A, this increase in benefit will be invalidated by rise in operation and maintenance cost. Consequently, the EIRR for both plans is almost the same. Even though the economic return is equal, the undermentioned reasons suggests that the Alternative Plan A is more benefitable than the Alternative Plan A'.

(1) About half of the pasture area is in the habit of being inundated. In such area agricultural productivity remains in relatively low.

(2) Large amount of budget might be spent annually for operation and maintenance of the pumping station. When the pump does not work, a considerable loss in harvest is anticipated. It is desirable that pump should be restricted to inevitable use.

(3) Problem of the settlement of persons evacuated from the Los Haitises National Park might should not be substantially solved even if they are authorized to settle at the site they have occupied. Thus, it is advisable that the Government should propose settlement plan in view of re-locating the said persons.

ANNEX N : TABLES

Table.N .1 CONSTRUCTION COST (1/2)

Description	Unit	Alternative Plan A				Alternative Plan A'			
		Q'y	Local Currency	Foreign Currency	Total	Q'y	Local Currency	Foreign Currency	Total
1.Preparation Works	LS	1	3,274,525	5,729,076	9,003,601	1	3,258,693	5,740,649	8,999,343
2.Water Source Facilities									
1).Head Works									
a.Payabo River No.I	Set	1	1,328,983	680,076	2,009,059	1	1,328,983	680,076	2,009,059
b.Payabo River No.II	"	1	397,784	323,072	720,856	1	397,784	323,072	720,856
c.Cevicos River	"	1	912,158	388,718	1,300,876	1	912,158	388,718	1,300,876
d.Canal Cascarilla	"	1	577,111	449,553	1,026,664	1	577,111	449,553	1,026,664
2).Intake Works (Spring)									
a.Cano Ponton	Set	2	351,713	95,772	447,485	2	351,713	95,772	447,485
b.Guaraguao	"	2	75,481	50,077	125,558	2	75,481	50,077	125,558
c.La Cueva	"	1	29,531	24,369	53,900	1	29,531	24,369	53,900
d.El Cercado	"	1	130,931	101,760	232,691	1	130,931	101,760	232,691
e.Lagunita Cristal	"	2	75,481	50,077	125,558	2	75,481	50,077	125,558
3).Spring Levee	LS	1	381,362	2,480,776	2,862,138	1	381,362	2,480,776	2,862,138
4).Spillway (at Cano Ponton)	Set	1	531,236	375,192	906,428	1	531,236	375,192	906,428
5).Reservoir (Guaraguao)	LS	1	1,024,581	5,885,396	6,909,977	0	0	0	0
6).Pumping Station									
a.No.1 Pumping Station	LS	0	0	0	0	1	0	0	0
b.No.2 Pumping Station	"	0	0	0	0	1	0	0	0
c.No.3 Pumping Station	"	1	190,931	1,253,620	1,444,551	1	190,931	1,253,620	1,444,551
d.No.4 Pumping Station	"	1	114,471	965,881	1,080,352	1	114,471	965,881	1,080,352
e.No.5 Pumping Station	"	1	190,931	1,253,620	1,444,551	1	190,931	1,253,620	1,444,551
e.No.6 Pumping Station	"	0	0	0	0	1	512,700	6,259,600	6,772,300
Sub-total			6,312,685	14,377,959	20,690,644		5,800,804	14,752,163	20,552,967
3.Irrigation Facilities									
1).Irrigation Canal									
a.Main Canal	LS	1	45,120,898	41,571,241	86,692,139	1	45,120,898	41,571,241	86,692,139
b.Secondary Canal	LS	1	13,603,784	11,808,137	25,411,921	1	13,603,784	11,808,137	25,411,921
c.Tertiary Canal	"	1	2,033,072	89,464	2,122,536	1	2,033,072	89,464	2,122,536
2).Division Works									
a.Type-I	Set	59	1,195,306	992,376	2,187,682	59	1,195,306	992,376	2,187,682
b.Type-II	"	37	950,906	795,058	1,745,964	37	950,906	795,058	1,745,964
c.Type-III	"	175	782,887	651,335	1,434,222	175	782,887	651,335	1,434,222
3).Road Crossing Work	Set	59	1,589,792	1,282,692	2,872,484	59	1,589,792	1,282,692	2,872,484
4).Syphon (River Cross)	Set	1	307,991	188,846	496,837	1	307,991	188,846	496,837
5).Intake Works (for Return Flow)	Set	7	152,076	111,110	263,186	7	152,076	111,110	263,186
Sub-total			65,736,712	57,490,259	123,226,971		65,736,712	57,490,259	123,226,971
4.Drainage Facilities									
1).Drainage Canal									
a.Main Canal	LS	1	1,170,696	2,216,104	3,386,800	1	1,170,696	2,216,104	3,386,800
b.Secondary Canal	"	1	4,641,257	3,829,029	8,470,286	1	4,641,257	3,829,029	8,470,286
c.Tertiary Canal	"	1	6,878,849	4,735,364	11,614,213	1	6,878,849	4,735,364	11,614,213
2).Sluiceway	Set	2	369,674	1,941,179	2,310,853	2	369,674	1,941,179	2,310,853
2).Outlet Works	Set	8	462,622	846,829	1,309,451	8	462,622	846,829	1,309,451
3).Road Crossing Work	Set	53	1,269,265	1,318,607	2,587,872	53	1,269,265	1,318,607	2,587,872
4).Syphon (River Cross)	Set	1	1,684,452	1,437,708	3,122,160	1	1,684,452	1,437,708	3,122,160
Sub-total			16,476,815	16,324,820	32,801,635		16,476,815	16,324,820	32,801,635

Table.N.1 CONSTRUCTION COST (2/2)

Description	Unit	Alternative A				Alternative B-1			
		Q'ty	Local Currency	Foreign Currency	Total	Q'ty	Local Currency	Foreign Currency	Total
5.Flood Control Works									
1).Payabo River	LS	1	1,186,551	14,292,620	15,479,171	1	1,186,551	14,292,620	15,479,171
2).Canal Cascarilla	"	1	592,439	5,941,972	6,534,411	1	592,439	5,941,972	6,534,411
Sub-total			1,778,990	20,234,592	22,013,582		1,778,990	20,234,592	22,013,582
6.Road Works									
1).Road									
a.Main Road	LS	1	4,159,554	25,654,221	29,813,775	1	4,159,554	25,654,221	29,813,775
b.Farm Road	"	1	7,537,385	46,249,843	53,787,228	1	7,537,385	46,249,843	53,787,228
c.Village Road	LS	1	204,864	1,263,328	1,468,192	1	204,864	1,263,328	1,468,192
2).Bridge									
a.Payabo River	Set	1	1,620,459	1,498,669	3,119,128	1	1,620,459	1,498,669	3,119,128
b.Canal Cascarilla	"	1	640,397	561,940	1,202,337	1	640,397	561,940	1,202,337
Sub-total			14,162,659	75,228,001	89,390,660		14,162,659	75,228,001	89,390,660
7. Farm Land Consolidation									
1).Payabo Area	LS	0	0	0	0	1	0	0	0
2).Ponton Area	"	0	0	0	0	1	0	0	0
Sub-total			0	0	0		0	0	0
7.O/M Office	LS	1	1,408,440	1,584,495	2,992,935	1	1,408,440	1,584,495	2,992,935
Total			109,150,826	190,969,202	300,120,028		108,623,113	191,354,979	299,978,093

ANNEX N : FIGURES

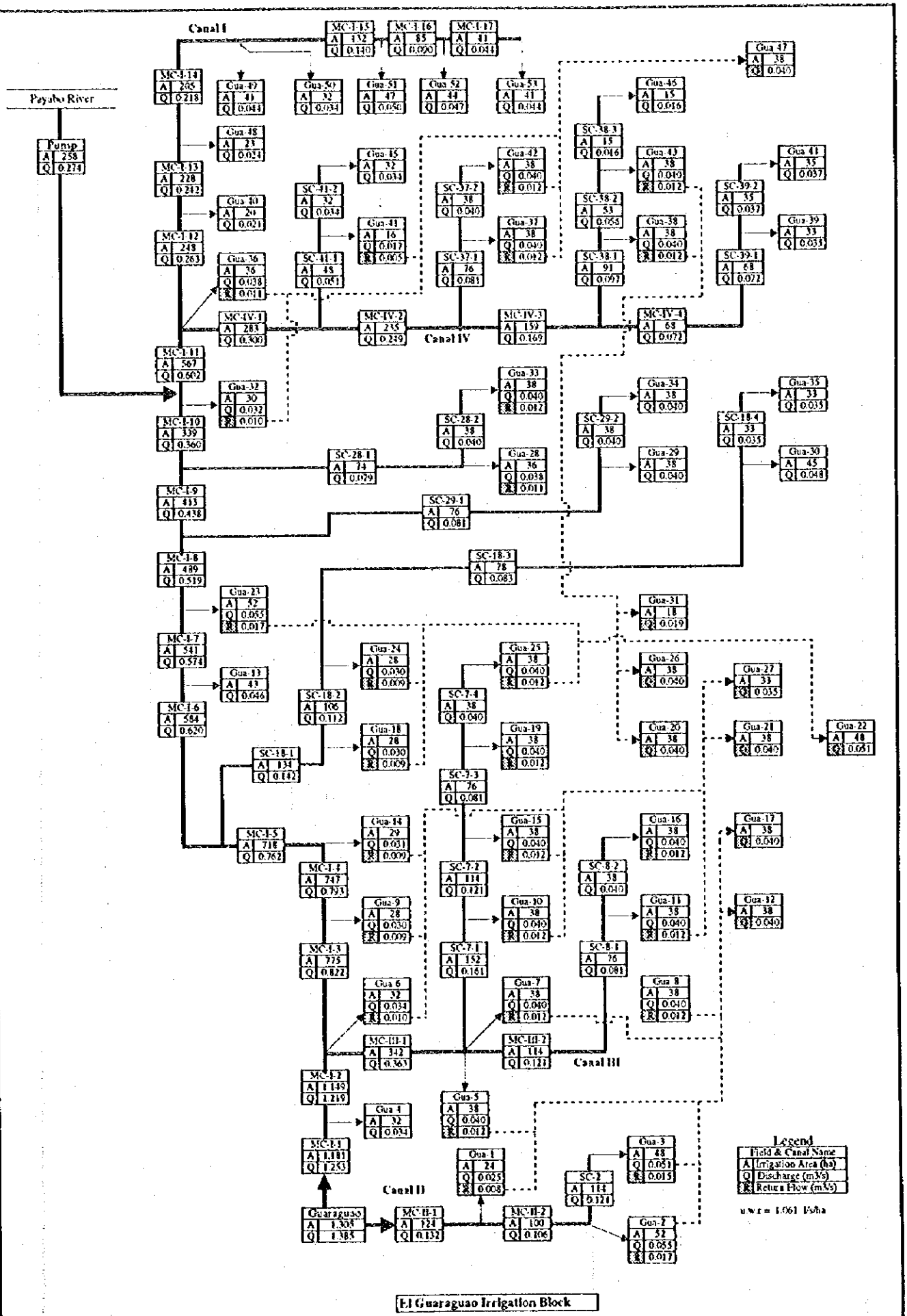


Fig N.1 Irrigation Canal Network Plan (Alternative A') 1/2

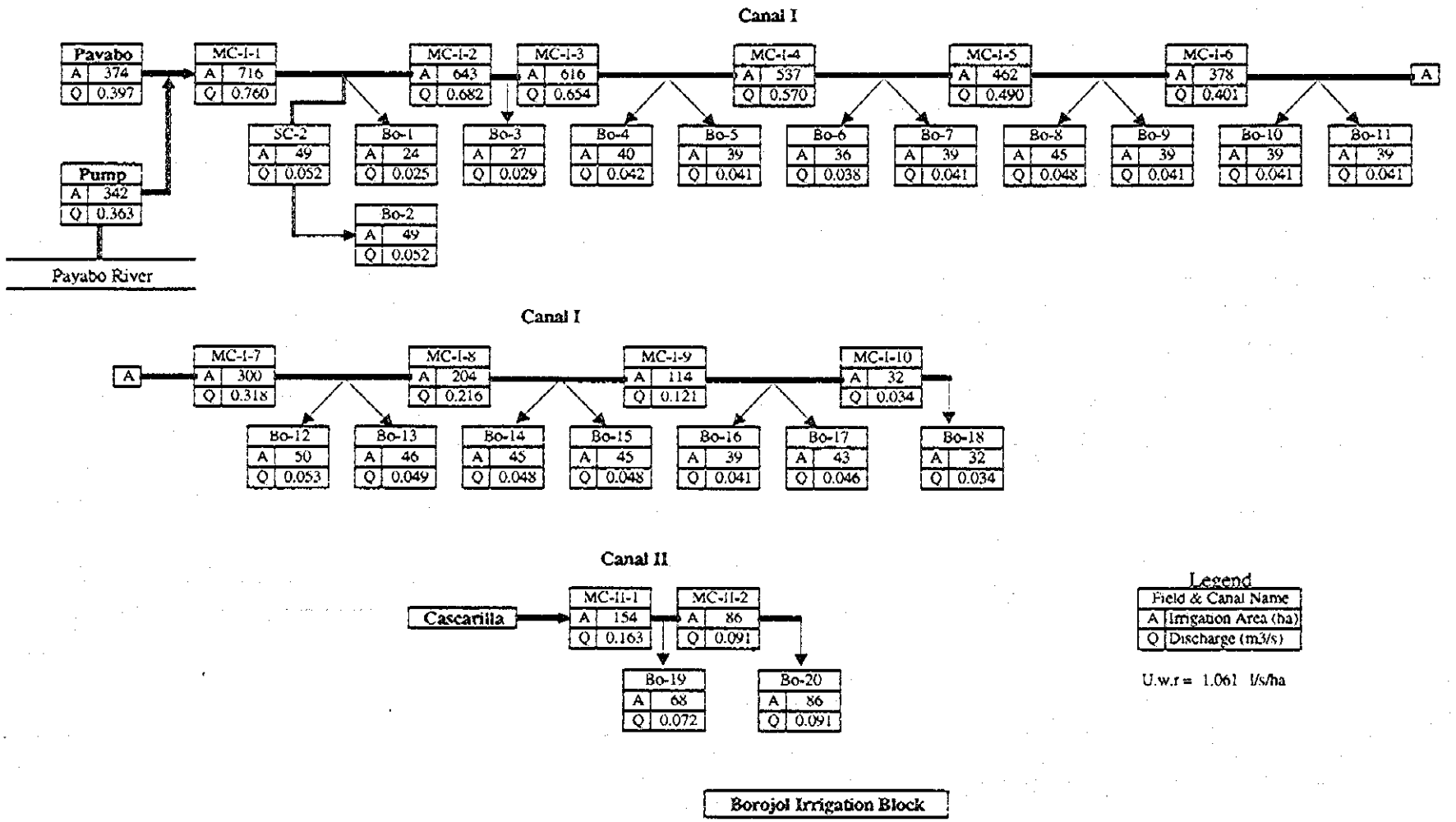


Fig N.1 Irrigation Canal Network Plan (Alternative A') 2/2

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