Supporting-D
Environmental Impact Assessment

SUPPORTING - D
ENVIRONMENTAL IMPACT ASSESSMENT

1. ENVIRONMENTAL STUDY ON DAM PROJECTS

1.1 GENERAL

The Study Area is located in the mountainous area of the Central District, which includes the capital city comprising the cities of Tegucigalpa and Comayaguela. It is located at elevations between 1,000 to 2,000 m above sea level including the low and upper streams of the watersheds for dam locations.

1.2 LEGAL FRAMEWORK

Concerning the Study Area there are several environmental regulations, which can apply. They are the following:

1.2.1 LAW OF NATIONAL WATERS EXPLOITATION

According to the **Law of National Waters Exploitation**, dated from 1927 and still in use, the State has the full control of the rivers excepting those small streams that rise and end at a private property (Art.1). Regarding the water use this old law authorize the free use of waters running along natural and public rivers, either for drinking, washing clothes, containers or other objects, to take baths or drinking for livestock, although it should be according to the Regulations of the Police (Art. 9). However, it establishes that "in the channels or aqueducts of the State, although of temporary exploitation from the concessionaire, everybody can wash clothes, containers and other objects, **as far as the riverbanks are not deteriorated and do not reduce the amount (water volume) according to its original assigned water use, and conserving the original condition of cleansing**" (Art.11). Moreover, "the owner of any land can exploit water through wells, or galleries, as far as do not reduce the public or private waters of its original natural stream. In the case such works of wells or galleries threaten a danger to the public or private **waters assigned to a public service** or a pre-existing private one with rights legally acquired, **the authority, under request of the interested persons, can stop such work**". (Art. 13). If the private exploitations do not have any contract with the Government as is established in Art. 17 of such law "it is necessary a contract with the Government for the exploitation of the national waters, assigned for public or private enterprises". Finally the same law establishes that the contracts of water exploitations will give priority to the water supply of the people before the other uses like agriculture or others (Art. 24). Besides, according to the same law, any exploitation of national waters is subjected to **compulsory expropriation** due to public utility, with the corresponding compensation (Art. 26).

Nevertheless, due to its age this law does not consider the environmental aspects concerning the water resources management, and the limitations and compensations for rights of water use, which are now necessary to regulate in more strict way. Thus, a new law is being elaborated from several years ago. During February/March of this year, the draft of the General Law of Water has being under consideration of several institutions like SANAA, SERNA, ENEE, SAG and CIEL (Computing Center of Legislative Studies of the National Congress). It is expected within this year it have a final approval from the National Congress.

According to the draft of the new Law of Water the Authority of Water will be created for regulation of the uses of water. Also it establishes the creation of ***water boards*** (*juntas de agua*, in Spanish) and the concept of ***ecological discharge*** to be fixed for each water body by the Authority of Water according to a by-laws (Art.27, 29). The by-laws will define the criterions and ways for estimation of the discharges, volumes, periods and other characteristics for each type of exploitation, for zones, basins or regions, and according to the own hydrological characteristics. It also will indicate the criterions and methods of defining the ecological discharge and calculation of the compensations and indemnities comprised within the law (Art. 29).

1.2.2 FORESTRY LAW

Decree No. 85 of 10/2/1972 dictated the Forestry Law. It states that the forest zones of the rivers and streams, which comprise the water system of Tegucigalpa, are Protected Forest Zones (Art. 138). Besides, this Decree establishes the prohibition to cut or destroy trees in a belt of 150 m of each side of permanent rivers or lakes (Art. 95). Furthermore, it states that by no means the State would hand over the control of the public forest areas to private persons without the previous decision of the State Forestry Administration (Art. 37).

1.2.3 PROTECTED FORESTRY ZONES

The Sub-basin of Guacerique River was declared as Protected Forestry Zone through a Decree of 6/7/1972 published on 3/8/1972, comprising an area of 210.63 km^2.

In similar way, the Sub-basin of Tatumbla River was declared as Protected Forestry Zone through a Decree of 6/7/1972 published on 3/8/1972, comprising an area of 62.29 km^2.

Concerning to the Sub-basin of Sabacuante River, by Decree No. 72 of 27/10/1971, and published on 16/11/1972 it was declared as Protected Forestry Zone, comprising an area of 49.65 km^2. It was with the purpose of protecting the watersheds, which can provide water supply to the capital city. The Decree establishes that no one can acquire rights over the forestry areas neither making forestry exploitations in the private lands without the previous authorization from the State Forestry Administration.

These above mentioned protected areas are located inside of the study area, and are shown in *Figure D.1.1*

1.2.4 GENERAL LAW OF ENVIRONMENT

The General Law of Environment published in 1993 (Decree No. 104), prohibits the location of **human settlements, military bases, industrial installations** or other type in the influence area of the water supply sources for the people (Art. 33). Moreover, for the purpose of protection of the dams and reservoirs hydrological ordering projects shall be executed. They will start from the concept of watershed as a unit of operation and management. A hydrologic ordering plan and Environmental Impact Assessment (EIA) shall precede any project of exploitation of water in large scale.

Besides, related with the contamination aspects, this law creates incentives for the expenses on environmental protection equipment. Thus, in Art. 81, it states a reduction on the gross income tax due to investments in filters, or other technical equipment for the prevention or purification from contamination. Moreover, the acquisition of such equipments will have exemption of import, sell and other taxes.

On the other hand, the By-laws of the Gral. Law of Environment states fines from 100,000 to 1 million Lps. (US$ 6,667 to 66,667 as Aug/2000), for serious faults of the industries when contaminating substances are poured to the water streams, or when garbage is threw into roads or backyards. These and other regulations and penalties are described in *Table D.1.1*

1.2.5 AGREEMENT BETWEEN SANAA AND COHDEFOR

There is an Agreement between SANAA and COHDEFOR, signed on 3/12/1991. This document establishes responsibilities of both institutions, in the case of SANAA: the protection and integrated management of the watersheds with water supply systems already constructed or to be in the future. Also SANAA will prepare the inventory of priority basins for the water supply, with the purpose of preparing studies, diagnostics, and management plans for short, medium and long term. These actions are to be undertaken through the department of Watersheds Management, which has to initiate the coverage from the basins of the capital city and later on at the national level. On the other hand, COHDEFOR would provide technical support for the elaboration of the management plans, and would determine its technical regulations. Moreover, the basins qualified as of priority would be declared as *forestry protected zones*.

This agreement was effective for 5 years up to Dec/1996 and was not renewed until 21/12/1999 for another 5 years with possibility of extension by simple note exchange. This renewal keeps the original purposes and involves the cooperation with the Municipalities where the water supplying watersheds are located, for projects of protection and management of natural resources.

Taking into account these legal regulations, it is considered that by using the Law of Water of 1927, SANAA can request to the SERNA and/or the Public Ministry to stop any present private exploitation of the water upstream of the reservoirs of Los Laureles Dam.

Besides it is considered that by using the Law of Environment, SANAA can request the relocation of the military facilities from the area of the Guacerique basin to another place out of any watershed for Tegucigalpa, because according to the recent data provided by the military there is an exploitation of about 100 to 150 liters/sec. in average, which may correspond to a population of near 70,000 people, for domestic use. Considering the actual population of military facilities (2,835 as maximum, see section 1.7 on Population at the Basin) it is probably the water use in such facilities may be beyond the originally targeted one or the necessary for such activities, which deserve at least an investigation from SANAA.

Regarding the existing industries or urban/military settlements installed before the publication of the Law of Environment on 1993, it is already time (7 years has past) they should have adjusted to the legal regulations on these matters. On the other hand, the newly created industries or urban/military settlements or the expanded part of them, evidently have violated the Art. 33 of the Environmental Law. In fact, SANAA, through the SERNA/Public Ministry,

as the most concerned institution should look the enforcement for applying the administrative infractions and sanctions to those who do not comply the environmental regulations. Or at least should request the quick compliance of the norms and at the same time to stop any further expansion of industries, urban/military settlements, until the life span of the water supply facilities is duly guaranteed.

1.3 CANDIDATE SITES AND RESERVOIR AREAS FOR DAM PROJECTS IN MASTER PLAN

1.3.1 GENERAL

In the present study a review is undertaken about the natural conditions for location of dams at the following sites:

- Los Laureles II dam (Guacerique River, low stream)
- Quiebra Montes Dam (Guacerique River, upper stream)
- Sabacuante Dam (Sabacuante River)
- Tatumbla Dam (Las Canoas River)

The condition of land use of the basins in the study area is shown in *Table D.1.2*. It can be observed that forest cover is more abundant in the Quiebra Montes basin (about 70%). The cultivated areas in all the basins are rather small, however, the areas with pasture, no cultivated or at rest are considerable large, between 27 to 55%.

Table D.1.2 Land Use Condition in the Basins of the Study Area

Basin	Forest		Pasture, no cultivated, at rest		Cultivated		Urban		TOTAL	
	(Km2)	%	(Km2)	%	(Km2)	%	(Km2)	%	(Km2)	%
Quiebra Montes	88.06	70.44	33.80	27.04	2.46	1.96	0.69	0.00	125.00	100
Laureles II*	131.32	67.69	54.07	27.87	7.28	3.75	1.34	0.00	194.00	100
Sabacuante	34.47	43.10	44.42	55.53	1.10	1.37	0.00	0.00	80.00	100
Tatumbla	36.38	56.84	26.82	41.90	0.77	1.20	0.04	0.00	64.00	100

* Includes Quiebra Montes Basin
Adapted from ITS/C.LOTTi & Associati, 1987, Proyecto Aguas Subterráneas y Montaña El Chile para Tegucigalpa, Land Use Map, Scale 1:100,000.

A more specific consideration of each basin can be made according to the field and cartographical surveys, as follows.

1.3.2 GUACERIQUE RIVER BASIN

The Guacerique River basin is located between 1,025 to 1,985 m above sea level. The main streams are Guaralalao, Quiscamote, and Mateo. The vegetation cover is good at upstream, with pine and oak trees.

At the candidate site for Los Laureles II dam and reservoir there are predominantly no cultivated lands, with some small portion of cultivated lands at the upper part of reservoir. Some twenty (20) houses are located inside of the reservoir considering an elevation of 1,055 m above sea level.

At the candidate sites of Quiebra Montes dam and reservoir there are cultivated and no cultivated lands. No urban areas are found.

Among all the basins the most concerned one regarding the environmental conservation has been the Guacerique River basin, because is the largest one and has been subjected to social pressure with the construction of urban and military facilities at the outskirts. Also some industries have been installed inside of this basin.

According to the own inspections during this study and the most recent studies related to the

Guacerique River Basin the condition of the basin is going to deteriorate in the near future due to the tree felling and advancing of the industrial and urban expansion, especially in the lower basin. Still there are remains of some flora and fauna, which have to be protected to avoid its total extinction from the area.

According to classification of the Secretariat of Environment the precious species are divided in 3 groups: a) In danger of extinction, b) threatened, c) rare or endemic, which are those which only exists in this country or at least have not been reported from other countries.

Table D.1.3 shows the 19 species of flora still existing in the area of the basin. Among these it is predominantly abundant the pine and oak trees. Pine (pinus oocarpa) is the national tree of Honduras. No precious flora species to be threatened or in danger is found in these existing limited reports for the study area.

Table D.1.3 Flora Species in the Guacerique River Basin

No.	Local Name	Scientific Name
1	Quebracho	Lysiloma sp.
2	Carboncillo	Mimosa sp.
3	Macuelizo	Tabebuia rosea
4	Guanacaste	Enterolobium yclocarpum
5	Indio Desnudo	Bursera simarouba
6	Mutuas	Ficus sp.
7	Caulote	Guazuma ulmiflora
8	Jícaro	Crescentia alata
9	Roble (oak tree)	Quercus peduncularis
10	Encino	Quercus oleifolius
11	Pino (pine)	Pinus oocarpa
12	Pinabete	Pinus maximinoii
13	Guayabo	Psidium guajava
14	Aguacatillo	Persea sp.
15	Roble de Montaña	Quercus kinneri
16	Guama	Inga vera
17	Manzana Rosa	Eugenia jambos
18	Matasano	Casimiroa edulis
19	Nance	Byrsonima crassifolia

Sources: 1) Mario Espinal/CIDH, Jul/1997, Evaluación Ecológica Rápida Parte Baja de la Cuenca del Río Guacerique en el Area de Influencia del Embalse Los Laureles, 2) PRODESAMH, 1997, Perfil Ambiental de Honduras.

Regarding the fauna, it is found 84 species among amphibians and reptiles (39), birds (31) and mammals (24). The 47 most known species are shown in *Table D.1.4*.

According to this limited data, there are five (5) precious species of the fauna within the study area as follows: Cayman, Alligator, Rattlesnake, Ocelot and the White Tail Deer (Odocoileus Virginianus) or *Venado Cola Blanca*, which was declared as symbol of the national fauna under decree No. 36-93 of 28/6/1993. However, it is not defined the location of each of the species, which will be clarified in coming surveys. Nevertheless, it is known that some of these species live in upstream areas where the natural forest is more conserved, and then the probability of living near the reservoir or dam site is too small. The alligator is being breed at the Los Laureles reservoir as a way of conservation.

The most recent and detailed study of the land use in the lower part of the Guacerique basin including the basin of Los Laureles Dam area was undertaken by the Independent Center for the Development of Honduras (CIDH) on 1997. It comprised an area of 84.22 Km^2, and has the land use as described in *Table D.1.5*.

Table D.1.5 Land Use in the Guacerique River Basin (Low Stream)

No.	Item	Area (Km^2)
1	Broadleaves regeneration	11.7
2	Broadleaves/coniferous	11.97
3	Broadleaves young	6.53
4	Natural pasture	9.51
5	Coniferous	14.43
6	Agriculture	4.22
7	Natural pasture/savanna	3.07
8	Savanna	1.15
9	Broadleaves	2.66
10	Mixed regeneration	0.45
11	Scrubland	8.72
12	Las Tapias Village	0.45
13	Military Zone	6.25
14	Mateo City	1.76
15	Afforestation area	0.99
16	Los Laureles Reservoir	0.36
	TOTAL:	**84.22**

Source: Mario Espinal/CIDH, Jul/1997, Evaluación Ecológica Rápida Parte Baja de la Cuenca del Río Guacerique en el Area de Influencia del Embalse Los Laureles.

1.3.3 SABACUANTE RIVER BASIN

The Sabacuante River basin is located between 1,080 and 1,800 m above sea level. The main streams of the basin are: El Inglés, Santa Elena, and Milpa Grande. The vegetation cover is comprised by coniferous at the southern of the upstream, oak trees at the west, bushes and mixed forest at the center.

At the candidate site for Sabacuante dam and reservoir some small portions of cultivated lands are found; however, most of the reservoir is located in no cultivated lands with small portions of forest. No urban area is found.

1.3.4 TATUMBLA RIVER BASIN

The Tatumbla River basin is located between 1,100 and 2,000 m above sea level. It comprises the following streams, Río Grande, Carranares, Munare, El Chile. The original broad-leaved forest has been reduced but the coniferous forest remains.

At the candidate site for Tatumbla dam and reservoir some small portions of cultivated lands (about 0.5 Ha.) are found; however most of the reservoir is located in no cultivated lands with small portions of forest. No urban area is found. The town of Tatumbla is located just 1.5 km upstream of the end of the reservoir.

1.4 EXPERIENCE IN RESETTLEMENT PROJECT FOR CONCEPCION DAM

The most recent dam project is the Concepcion Dam project, constructed during 1991 to 1992. The Concepcion Village located in the basin of the reservoir was resettled to high areas of the Concepcion River downstream, calling the new place as the New Concepcion Village (Nueva Concepcion de Rio Grande), see *Figure D.1.2*. The number of houses relocated was 34 corresponding to same number of families. The compensation comprised the construction of new houses including a small plot as yard (500 m^2) and providing an area for land cultivation for every one equivalent to the one they had in the previous plot (in average some 2,200 m^2). Besides, some infrastructure for community use such as a school, a church, including the priest's house and a community center were also relocated to the new place.

Some improvements to the previous way of life were made at the new village such as installing of water supply system by pumping up from nearby wells. Besides, the sewer system using 2 septic tanks and rain drainage system were also installed. The village was connected to the electricity network, and the roads were made up to sub-grade level. The total cost of the resettling was about 2 million Lempiras (about US$ 200,000 at that time).

According to the information collected by SANAA after the resettlement, some problems arisen as consequence of the moving. The new lands are unsuitable for agriculture use as they were used to work in agriculture activities at the previous place located at the riverbanks. This is due to the poor quality of the soils and lack of water for irrigation. Having no job to do most of them have to move every day to Tegucigalpa to work as drivers, in workshops or factories. Most of the homes cook by using with firewood i.e. cutting trees from the neighborhood. They are receiving water from a nearby well, which is only for 1.5 hours every two days, and is salty. With these conditions they cannot make cultivation of vegetables because the water is not sufficient. COHDEFOR started a project of afforestation and made a nursery with the people of the village during 1997 to 1999, but finally abandoned it.

Nevertheless, the Concepción Dam was the first project where the houses and rest infrastructure were made completely, like a copy of the previous village, avoiding a simple compensation or purchase of the lands, which only produce a temporary benefit for the families but later when money goes out many problems arise. Some positive actions the beneficiaries acknowledge are: the construction of the houses, which are better than the previous ones; improvement of the transportation system, they have about 5 buses during the day, for transportation to Tegucigalpa.

They expect some other improvements such as expanding the service of the health center with a physician and a dentist, construction of workshops for teaching of skills to the young people etc.

As a conclusion of this experience it can be understood the need to conserve the activity which people is used to do, as a way of avoiding changes of works which most of them cannot afford, because have been trained along all their lives to do some specific task such as agriculture in the present case. The water supply also should be considered of high importance, because when living at the riverside they never have such constraints related with the shortage of water.

1.5 MATEO CITY HOUSING PROJECT

The environmental and social effects of the construction of a dam was analyzed by the Study of Environmental Impact Assessment (EIA).

Mateo City (Ciudad Mateo) Housing Project, which was started on December/1992, half a year

before the Environmental Law be published, was stopped by September/1995 after a continuous popular claiming for the suspension of such project.

The project is located at about 4.5 Km from the Los Laureles dam (*Figure D.1.3*). The characteristics and advance condition of the Mateo City project are described in *Tables D.1.6～D.1.8*. According to the original plan 10,915 houses would be constructed in two phases, being the first phase of 4,890 houses.

Table D.1.6 Characteristics of the Housing Project Ciudad Mateo

Sub-Project	Projected Area (Has.)	Projected No. Houses	Constructed No. Houses
Phase I:			
Altos Las Tapias	24.7	690	450
Tapias I (6/01/1993—8/09/1995)	34.8	2,000	--
Tapias II (22/12/1992—07/9/1995)	35.8	2,200	2,200
Sub-total:	**95.3**	**4,890**	**2,650**
Phase II:	?	5,110	--
Residencial Montefresco (neighbor to C. Mateo)	109.0	915	--
Sub-total:	**109.9**	**6,025**	**0**
TOTAL:	**204.3 Has.**+a	**10,915**	**2,650**

Sources:1) G. Mendez C., 1995: Informe sobre las Medidas de Mitigación Propuestas para Proteger la Calidad del Agua de la Represa Los Laureles; 2) INJUPEMP-SANAA, Oct. 1994. Dictamen sobre proceso de concepción, contratación y desarrollo del Proyecto Habitacional Ciudad San Mateo.

Table D.1.7 Type of Houses under Construction of Housing Project Ciudad Mateo

Sub-Project	Type of House	No. of Houses	Construction Area (m^2)	Total Area (m^2)
Phase I:				
Altos Las Tapias	3 Dormitories 3 Dormitories	400 290 690	67.35 115.60	126 370
Tapias I (6/01/1993—	Basic 1 Dormitory	800 700 2,000	28.02 49.92	78 98
(22/12/1992 07/9/1995)	Basic 2 Dormitories	800 500 2,000	37.79 49.92	72 78
” **Total:**		**4,890**		

Sources:1) Diana M. Dictamen Técnico Daños al Ambiente Proyecto Ciudad Guacerique, Tegucigalpa. Ministerio Fiscalía del Documentos varios

Table D.1.8 Ciudad Mateo

Sub-Project	Projected Cost (as 12/1992)		Advance (%)	Advance (%)
	Lps			
Altos Las Tapias (Hogares SOVIPE)		9,795,735.25 ¿	100.00	
Tapias I (6/01/1993 8/09/1995) Contratistas Asociados (CASA)		13,928,742.03	45.63	
Tapias II (22/12/1992 07/9/1995) CCC		15,321,616.24	40.00	
TOTAL:	**230,371,952**			

Source: INJUPEM, Documentos Estimaciones sobre

As can be observed the magnitude of the projected houses considering an average of 5-6 persons/family according to the original plan would generate a sudden concentration of population by the order of about 65,000 people, which would continue to increase quickly, producing large contamination to the Guacerique river basin.

In order to mitigate the effects of this project some measures have been proposed by a study sponsored by the SEDA/OPS/OMS as shown in *Table D.1.9*. Comparing the values of this table regarding the mitigation works, with those of the previous table regarding the cost of the main project, it can be concluded that the costs of such mitigation works are at least 25% above the main project cost. This situation arise the problem of who will absorve such cost: the contractors (being a project *´key at hand´ type*), INJUPEMP (its membership), the Government or the clients (house payers).

Table D.1.9 Mitigation Measures for the Housing Project Ciudad Mateo

Item	Cost (Million Lps.)	Cost (Million US$)
1.Construction of treatment plant for waste waters	45.45	4.545
2.Construction of retention wall for erosion control	2.80	0.28
3.Construction of lattice, filling of ditches/ rain sewer works	4.10	0.41
4.Installing of containers and system for waste disposal	2.70	0.27
5.Construction of barrier near the Guacerique River, afforestation, vigilance	1.55	0.155
6.Incidentals (1—>5)	11.40	1.14
7.Relocation of building from near the river	30.00	3.00
TOTAL:	**98.00**	**9.80**

Source: G. Méndez C., 1995: Informe sobre las Medidas de Mitigación Propuestas para Proteger la Calidad del Agua de la Represa Los Laureles, SEDA/OPS/OMS

Moreover, the initiation of the project already produced violations of several laws which guaranteed the protection of the Guacerique River basin as a forestry zone, forbidden any other use. Because of these reasons the housing project is in stand-by condition until a final decision be taken by the concerned authorities.

There are many studies related to the environmental effects of this housing project to the Guacerique River Basin. The main of these studies are mentioned in the following.

The first study is “Environmental Impact Report on Mateo City Project” (*Informe de Impacto Ambiental del Proyecto Ciudad Mateo*) elaborated by Ing. Mario Vallejo Mejía[1] on behalf of the contractor on Nov/1992, previous the start of construction of the project on Dec/1992. However, in this study no clear consideration of the effect of the project on the water quality of the Los Laureles reservoir is given. Besides, no cost analysis of the corresponding mitigation measures are considered, which are proposed without specifying who should bear it. Moreover, no complete consideration of the existing legal framework such as the Forestry Law (1972), Protected Forestry Zones (1972), Agreement between SANAA-COHDEFOR (1991), etc. is given. Unfortunately at that time there was no Environmental Law and EIA regulations. Thus, the project was started without a careful consideration of these matters.

The second study is “Environmental Impact Assessment on the Mateo City Housing Project, Preliminary Study” (*Evaluación de Impacto Ambiental del Proyecto de Viviendas San Mateo, Estudio Preliminar*), elaborated by Becky Myton (PhD)[2], on behalf of the National Comission of Environment (CONAMA), by Jan/1993, just at the beginning of the construction of such project.

[1] Mario Vallejo Mejía, 1992. Informe de Impacto Ambiental del Proyecto Ciudad Mateo de Tegucigalpa D.C.. Financiera Industrial Agropecuario, FINANSA.
[2] Becky Myton, 1993. Evaluación de Impacto Ambiental de Ciudad Mateo. CONAMA

The main recommendations by this study are the following:

- To stop the construction works of the Housing Project
- To seed the river bank with grass in order to mitigate the erosion/sedimentation produced by the clearance during the construction
- To make afforestation of the area with fruit and firewood trees
- To keep the zone as a ´forestry protected area´ such as is defined by law

A third study is "Technical Report on Damages to the Environment Attributed to the Mateo City Housing Project (Dictamen Técnico sobre Daños al Ambiente Imputados al Proyecto "Ciudad Mateo"). It was elaborated by Diana Betancourt[3] on behalf of the Public Ministery by Sept/1995.

The main conclusions of this study are:

- Planning and construction of the Mateo Housing Project violates several environmental regulations under current use in Honduras like: the General Constitution of the Republic, Forestry Law, General Law of Environment and its by-laws, Health Law.
- Given the existing legal framework, the Guacerique Sub-basin, by any chance do not comply with the conditions for the establishing human settlements.
- Records by SANAA show that in the last 2 years the amount of chemicals for the water treatment have triplicate. It is attributed to the housing project.
- Projections made by SANAA, indicate that if the housing project continues, the pressure by the population grow will accelarate, in such a way that by the year 2020 the sub-basin would contain a population larger than 300,000 inhabitants, i.e. 25 times larger than the present one (1995). Approximately 40% of it would be a direct or indirect consequence of the Ciudad Mateo hosuing project.

And finally the document recommends the following alternatives:

- To dismantle the housing project and relocate it in other site. Make a forestry restoration of the zone and elaborate a plan for the protection and management of all the Guacerique River Basin.
- To stop the project at the present level of advance. To develop the project with the number of houses already completed. Forest restoration of the basin. Establishment of mitigation measures for the environmental impacts to be produced by the people to be settled. Look for an alternate water source.
- To finalize the originally planned project of Ciudad Mateo and look for other alternative water source, because the present one would be eliminated.

A fourth study on Ciudad Mateo was elaborated by an independent consultant, Luis Ferraté[4], almost at the same time than the previous by Sept/1995, as a member of an IDB mission. His study is "Relevant Environmental Aspects of Ciudad Mateo for the Water Quality and Sedimentation of Los Laureles Reservoir" (Aspectos Ambientales Relevantes de Ciudad Mateo para la Calidad del Agua y Sedimentación del Embalse Los Laureles). He suggests three scenarios (options) to solve this problem as indicated in *Table D.1.10*

[3] Diana Betancourt, Sept/1995. Dictamen Técnico sobre Daños al Ambiente Imputados al Proyecto Ciudad Mateo. Ministerio Público.

[4] Luis Ferraté, 1995 (?). Aspectos Ambientales Relevantes de Ciudad Mateo para la Calidad del Agua y Sedimentación del Embalse Los Laureles dentro del Contexto del Proyecto de Rehabilitación, Mejoras y Ampliación del Sistema de Agua Potable de Tegucigalpa: Préstamo 799/SF-HO.

He finally concludes the following:

- Under a technical point of view and assuming the Honduras Government would construct the environmental protection works it is possible to recommend the option No. 2.
- If the Honduras Government after an analysis of its environmental management capacity, the mentioned works, the option No.1 is recommended.
- Option No.3 is not recommended due to the high social costs.

As can be observed from the previous studies most of the conclusions and recommendations are common. However, in some cases there is no cost estimation on the mitigation measures or, there is no detailed costs analysis. This point deserves a detailed economical analysis according to the proposed activities.

Thus, we estimate the solution to this problem should be undertaken in two ways:

- Legal Approach. To determine responsibilities, if any, to the persons who may have violated the law. This should not be held in low regard, as it would avoid the repetition of similar mistakes in environmental protection.
- Technical Approach. To determine the economical feasibility and consequences of going ahead with the project at least with the completed houses, and analyze the economical and environmental costs, for the present and future reservoirs life span. So it deserves a special and independent study in an overall view and not as partial part of a project.

1.6 FOREST FIRES

Forest fires are produced every year along the whole territory of Honduras during the dry season of January to May. It affect mostly to the coniferous forests, especially to the trees in the growing stage less than 1 m high, which are totally burned. The adult trees although can recover along time, they become prone to plagues and sickness. The forest fires also produce the decrease of the fauna because of the death of the adults and babies and the destruction of the habitats by the loss of covering, food and water sources.

The statistics on forest fires during 1999 up to march 2000 are shown in *Table D.1.11*. As can be observed the largest number of fires are located in the Francisco Morazan region, where the study area is located, which also correspond to the largest concentration of people. Most of the fires occur during the dry season, especially between March and April. The human hand produces about 99% of them as follows: 60% by deliberate incendiaries, 20% by cattle farmers, 15% by agriculture farmers, 4% by hunter, firewood cutters, etc.

Table D.1.11 Statistics on Forest Fires in Honduras

Region	**Year 1999**		**Year 2000**	
	No.	**Has.**	**No.**	**Has.**
South	27	1,171	31	1,086
Comayagua	271	3,721	220	4,926
East Olancho	227	6,453	164	2,898
West Olancho	163	4,813	334	4,831
Copan	174	3,875	217	3,438
Fco. Morazan	**302**	**10,978**	**122**	**9,593**
El Paraíso	278	3,683	162	5,711
Yoro	204	3,478	127	1,079
Norte-Occidente	113	3,241	121	1,313
La Mosquitia	47	13,489	40	1,232
Atlántida	14	175	5	262
TOTAL:	**1,820**	**55,077**	**1,543**	**36,369**

Source: AFE-COHDEFOR , May/2000

Table D.1.12 shows the forest fires in the watersheds of Tegucigalpa. Although the data are not complete, it can be observed that the fires are more common in the areas near to the people concentration like Guacerique river basin (the lower part within the urban area) and La Tigra Mountain (near to Valle de Angeles and San Juancito Towns). One of the most common causes in these areas are considered that when fires in cultivated areas are made for the renewal of pasture, destruction of insects, etc. the fire goes to the nearest forest and spread along it. The effects of such forest fires can be observed in the smoke on the sky of Tegucigalpa and surroundings, which every year produce the temporary cancellation of flights in the Toncontin airport, sending the arrival flights to San Pedro Sula´s airport, due to the lack of visibility, specially at the afternoon/evening hours.

In order to decrease the number and magnitude of the forest fires it is necessary a more systematic campaign of education to people during the dry season. It should be focused on to avoid the fires or take measures to control the fires when it is necessary to do. In fact the AFE-COHDEFOR has recently started an educational campaign to the auxiliary mayors of the country, and community leaders of the city districts, regarding the ways to cope with the causes of the forest fires. They indicate the need to educate people to stop throwing lit cigarettes to the roadside, avoid setting fire to agriculture lands or rubbish without making a protection road, etc.

Table D.1.12 Forest Fires in the Watersheds of Tegucigalpa

Year	Guacerique		Sabacuante/Tatumbla		La Tigra		Concepción	
	No.	Area (Has.)	No.	Area (Has.)	No.	Area (Has.)	No.	Area (Has.)
1993					25	671		
1994					32	380		
1995					39	1,567		
1996					18	176		
1997					50	1,220		
1998	37	2,369			54	500	6	431
1999	29	99			30	201		
2000/5	53	3,069	1		2	163	5	100

Source: SANAA, Watershed Management Dept. June/2000

1.7 POPULATION

The population in the Guacerique River basin comprise 60 villages belonging to the Municipality of the Central District (Tegucigalpa and Comayaguela) and 12 villages belonging to the Lepaterique Municipality, making a total of 14,493 inhabitants. Besides, it comprises, 13 military facilities with a maximum population of 2,835 inhabitants. It makes a grand total of 17,328 inhabitants as by 2000 (*See Tables D.1.13 and D.1.14 and Figure D.1.4*).

Thus, the population was projected considering an exponential pattern by using the following equation: $Pp=Pb(1+r)^n$

Where Pp=Projected population
Pb=Base population
r= Grow rate per year
n= Number of years

For simplicity it has been considered a sustained grow rate of 3% which is the population average global grow rate for Honduras in the past 70 years (periods 1926-1988[5], 1950-1995[6]),

[5] SECPLAN, 1989, Perfil Ambiental de Honduras, page 40.
[6] PRODESAMH, 1997, Perfil Ambiental de Honduras, page 20.

and has been considered in previous studies in projections 1995-2020[7] for the Guacerique basin. It is worthy to mention that according

to several studies it is known that grow rate in the urban area of Tegucigalpa is between 3 to 5%. However, we make the assumption that for the protection of the basin in average the grow rate will be kept as low as possible with a negligible migration, based on the legal framework, which restrain urban expansion in the protected areas. Thus, hopefully the grow rate would be kept nearest to the global for Honduras, rather than for the urban areas.

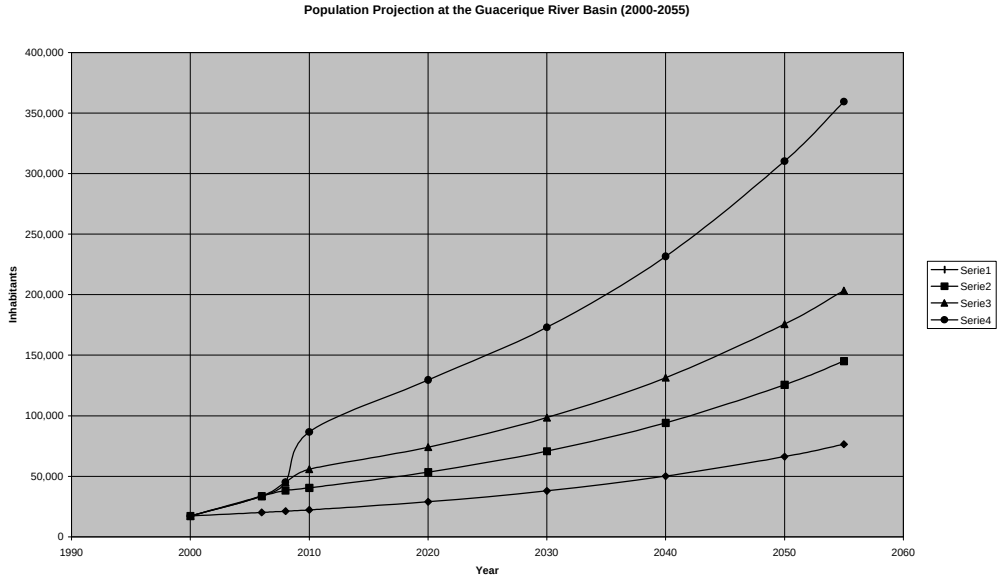

Figure D.1.4 Projection of Population at the Guacerique River Basin (2000—2055)

Therefore, in order to obtain a projection of population during the life span of the Laureles Dam I and II we made the following simplifying assumptions as follows:

- a) Population grow rate at the Guacerique basin: 3%
- b) Life Span for Los Laureles I Dam: 50 years from 2006, which is targeted as the date when the operation under new conditions of cleaned up reservoir (excavated sediment) start. Sedimentation rate will decrease to negligible values after the construction of Los Laureles II, immediately upstream, which will operate as a sediment trap.
- c) Life span for Los Laureles II Dam: 50 years (as this type of projects are designed), from 2006 when it would start operation.
- d) No. of persons/house at the Guacerique basin for year 2,000: 5.5 persons.
- e) No. of persons/house at Ciudad Mateo if it becomes inhabited : 5.1 persons, as it is the present value for urban area of Tegucigalpa (according to Gral. Directorate of Statistics and Census).
- f) Ciudad Mateo would become inhabited in three phases: year 2006: 2,650 houses already completed, 2008: 2,240 houses partially completed at present, 2010: 6,025 houses planned by the original project (Total: 10,915 houses).
- g) The population of military facilities is kept constant (do not increase) during the period.

[7] Adrián M. van der Horst, 1995. Impactos del Crecimiento de las Actividades Humanas en la Cuenca del Río Guacerique en la Cantidad y Calidad de Agua en el Embalse de los Laureles, Teguc. Honduras. Informe Final. SANAA.

It is known there are 2,067 permanent people and 2,835 when training courses or other special activities are held. This assumption is coincident with the data estimated by Segovia (1985)[8] some 15 years ago, as about 2,000 people in such facilities.

Table D.1.14 Summary of Population Projections at Guacerique Basin (2000-2055)

SCENARIO	2000	2006 Start Operat.	2008	2010	2020	2030	2040	2050	2055 Life Span
(1): CM = 0 houses	17,328	20,140	21,194	22,312	29,011	38,013	50,112	66,371	76,491
(2): CM=2,650 h. (existing houses)	17,328	33,655	38,315	40,475	53,421	70,818	94,198	125,619	145,176
(3): CM=4,890 h. (PhaseI)	17,328	33,655	45,079	55,828	74,054	98,547	131,464	175,701	203,234
(4): CM=10,915 h. (PhaseII)	17,328	33,655	45,079	86,556	129,551	173,131	231,698	310,408	359,396

Note: CM: Ciudad Mateo Housing Project

2. WATER QUALITY ANALYSES

2.1 GENERAL

The water quality analyses are regularly being executed in the 4 treatment plants managed by SANAA at the corresponding facilities of water supply like Laureles, Concepción, El Picacho and Miraflores. This last one is not operating from the damages produced by the hurricane Mitch on October/1998 to the water supply facilities of Sabacuante.

The Characteristics of these treatment plants are described as follows (*Table D.2.1*):

Table D.2.1 Characteristics of Drinking Water Treatment Plants in Tegucigalpa

Item	Laureles	Concepción	Picacho	Miraflores	Total
Design capacity (liters/sec)	670	1,200	900	No operating	2,770
Operation cap. in dry season (l/sec)	670	1,300	150	No operating	2,120
Operation cap. in wet season (l/sec)	550	1,300	600	No operating	2,450

Source: Fálope, J.D., 2000/3: Condiciones del Suministro de Agua Potable para Tegucigalpa, MDC. Honduras.

All of the operating treatment plants make the processes of aeration, sedimentation, flocculation, filtration, and chlorination.

2.2 WATER QUALITY STANDARDS IN HONDURAS

Currently several Water Quality Standards are been applied in Honduras as schematically shown in *Figure D.2.1*. They will be described in the following.

The **National Technical Standard of Drinking Water Quality** was stated by Decree No. 084 of 31/7/1995 (published on 4/10/1995). The standards are classified as shown in *Table D.2.2*.

The **Standards for Discharge of Waste Waters to Receptive Bodies and Sewerage** have been published in the official newspaper "La Gaceta" on December 13th., 1997 through the Agreement (Acuerdo) of the Secretariat of Public Health No. 058 dating from April 9th., 1996.

[8] Segovia, et al, 1985. El Programa de Monitoreo de la Calidad del Agua en la Cuenca del Río Guacerique, Tegucigalpa, SANAA/PMRN, as cited by Adrián M. Van der Horst, 1995, page 2.

The standards are divided in two sections: (1) Discharge of Wastewaters to Receiver Bodies and (2) Discharge of Wastewaters to Sewer Network.

The first section is also divided in seven groups and the second section in three groups, which are shown in *Tables D.2.3* and *D.2.4*.

Table D.2.4 Standards for Discharges of Waste Waters to Sewer Networks

Parameter	Permissible Value (mg/l)
GROUP A:	
Temperature	<40°C
PH	5.00--9.00
GROUP B:	
Mercury	0.05
Arsenic	0.10
Cadmium	0.10
Hexavalent Chrome	0.50
Total Chrome	1.00
Cyanide	0.50
Copper	1.00
Lead	0.50
Nickel	2.00
Zinc	2.00
Silver	0.20
Selenium	0.50
Sulfate	400.00
Fluorides	10.00
GROUP C:	
Phenolic Compounds	5.00
Detergents	10.00
Hydrocarbons	Absent
Biocide Substances	Absent
Radioactive Substances	Absent
Organo-Clorate Pesticides	Absent
Organo-Phosforate pesticides	Absent

Source: Technical National Standard for Drinking Water Quality, OPS/OMS, Ministry of Health, Honduras, Oct/1995

At present, under the sponsoring of several institutions like SANAA, SERNA, etc. a draft document of the **Standards of Quality for Regulation of the Hydric Resource** is being sent to the Health Ministry in order it be dictated as an *executive agreement* of such Ministry in that matter. Although it has had no compulsory strength until now, in fact has been used as a reference standard by the SANAA technical staff from as far as 4-5 years ago (1995-6). The elaboration of the draft has been in charge of an inter-institutional committee coordinated by Dra. Mirna Argueta of SANAA´s Technical Division.

According to the mentioned draft of law the assigned use of waters are classified in 8 groups as follows:

- Human Consumption
- Domestic
- Water Supply for People

- Agriculture and Livestock
- Fishing
- Industrial
- Preservation of Flora and Fauna
- Recreation

The aforementioned National Technical Standard of Drinking Water Quality already regulates the first two groups. The Group No.3 corresponds to the streams for production of drinking water. Based on the kind of water treatment to become drinkable it is sub-divided in two categories: A) Needs only a disinfection, B) Needs a conventional treatment. According to the water quality technical staff of SANAA all the rivers in use for drinking water production in the basins of Tegucigalpa area are comprised within the Category B, i.e. the rivers of Guacerique, Sabacuante, Concepcion, and the streams at El Picacho. The corresponding standards for this group and Categories are shown in *Table D.2.5*.

2.3 WATER QUALITY OBSERVATION IN THE BASIN

2.3.1 BY SANAA DURING 1999

It is worthy to take into consideration the results of water quality analysis obtained by the SANAA laboratories at the respective operating treatment plants during the last year. The location of the sampling points for the Guacerique River basin is shown in *Figure D.2.2*, and those for the Los Laureles Reservoir are shown in *Figure D.2.3*. In *Tables AD.1.1～AD.1.10* of Annex No. 1A the results are summarized. By an study of the results on these tables the following comments can be made:

The Guacerique river basin is the most deteriorated among all the basins, with values of some parameters out of the maximum permissible standards. This is more significant in the case of the contents of total and fecal coliforms in the sampling site of the military battalion (which may be produced by the batallion itself and other neighboring urban areas upstream of the Laureles Dam), which is between 5 to 25 times respectively above than the allowed values {*Tables AD.1.1* (28/1/99)and *AD.1.4(27/9/99*}. The high concentration is apparently due to the lack of treatment or leakage and large volume of the wastewater flowing into the Guacerique River. The original sources should be identified and investigated in further studies in order to decrease or eliminate such discharges. The fecal coliforms are present in the excrements, and are indicative of pathogen intestinal organisms. Another parameter which is high is that of the orthophosphates, about tree times higher than the standard, it may be related with the activities of washing using detergents in some installations/factories or along some points along the river. Excess of this parameter may produce eutrofication or over fertility within the river. Thus, SANAA can apply the content of the **Standards for Discharge of Waste Waters to Receptive Bodies and Sewerage** published on December /1997, which establish that the institution operating the sewerage system and/or the treatment plant will define the values of the parameters such as BOD, COD, and greases and oils, as well as the maximum discharge, in order the final discharge to the receptive water bodies complies with the standards (Art.10). Besides, in some other points upstream of the battalion, very small values of dissolved oxygen were found (2.8 to 4, Candelera {factory of candles}, Monterreal, Guaralalao), indicating some effects of organic waste and insufficient auto-purification process in such points, which may be harming the aquatic fauna. Specific investigation of such places should be undertaken.

In El Picacho Streams there is a high concentration of orthophosphates, as high as 65 and 375

times the allowed values for the Category B of these streams according to the Draft of Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People, which is under present use by SANAA. A careful survey of the sites of La Tigrita #5 and Jutiapa #6 where such high values are found should be undertaken. However, in general almost all of the sampled streams have higher values than the allowed and thus an overall survey is deserved, to avoid further contamination. Also a relatively high content of iron is observed in almost all the surfaces sources of El Picacho, Sabacuante and Tatumbla and at the reservoirs of Concepción and Los Laureles. The cause should be investigated but preliminary can be considered it be due to volcanic nature of these basins, where the decomposition of the basaltic, andesite and rhyolitic-ingnimbrites rocks may produce the separation of this element from the ferric oxide (Fe_2O_3), which is contained between 1 to 5% portion in these kind of rocks.

Regarding the quality of water as a result of the monitoring within the distribution network, it was found that there are some points within the city where contamination of the treated distributed water is appreciable especially at Col. La Hoya, Col. Maradiaga, Col. Miraflores, Col. Kennedy, and others, where a detailed survey to find the causes is necessary to undertake.

2.3.2 BY JICA STUDY TEAM DURING DRY AND RAINY SEASONS OF 2000

Water quality analysis were undertaken during dry season (May) and start of rainy season (July) of this year, in order to investigate the condition of the reservoirs and several rivers as sources of water supply. Besides, the condition of the water distribution in households, wells and tanks was also surveyed. In a special sampling the condition of the water downstream of Los Laureles Dam was also investigated. Location of the sampling sites is shown in *Figure 2.4*.

The results of the analysis are shown in *Tables AD.2.1* through *AD.2.5*(dry) and *Tables AD.2.6* through *AD.2.10* (rainy) and also in *Figure AD 2.1～AD.2.7* of Annex No. 1B.

2.4 INDUSTRIES/URBAN & MILITARY SETTLEMENTS IN GUACERIQUE RIVER BASIN

It has been found that some industries are located along the Guacerique River Basin. Although some of them produce effluents its magnitude is not clearly known at present. It is necessary to conduct a special survey to know the effects of their discharges into the water quality of the Guacerique River. *Table D.2.6* shows the Characteristics of such industries as reported by the Department of Watersheds of SANAA on March/2000, by DECA on June/2000 and mostly confirmed by field survey of the study team. In *Figure D.2.5* the location of these industries is shown.

Although the information about the settlement date of these developments is not complete, it can be observed a clear trend that most of them have been settled after the publication of the Gral. Law of Environment on 1993. It means that the enforcement of the law has not been enough, considering that only three of these developments (industries) have Environmental License. It means that among the 35 developments, 28 of them (13 industries, 4 urban developments {excepting 3 naturally settled villages of Mateo, Puerta de Golpe and El Empedrado} and 12 Military facilities), do not have Environmental License. Present condition for enforcing them to abide to the environmental regulations is unclear, however it is known that DECA is preparing a program for each of these developments in order to sign a contract of mitigation measures and them follow it up to the final compliance.

It is strongly recommended that the actions of DECA be coordinated with SANAA in order to produce more effective results.

Besides the Ciudad Mateo Housing Project which has been treated in detail in section 1.5, considering the effects in the water quality it is worthy to mention here a relevant housing project under operation the **Monte Real Housing Development** which is operating from around 1980. It has a total area of about 500 Has. At present it has already constructed about 17 Has., price of land is US$72/m^2 (US$50/vr^2), which is similar to middle class areas in the urban zone of Tegucigalpa. According to the owner has a potential of urban development of 10% of the total i.e. about 50 Has. which is roughly the 50% (50/95.3) of the partially developed area in Mateo City Housing project.

As is described in *Table D.2.6*, this housing project operates its wastewater with an oxidation lagoon already full, which drainage directly to the Mateo River before joining to the Guacerique River 300 m downstream. The quality of the water as shown in *Table AD.2.6* (Annex 1B) is the poorest found at the basin. Relevant parameters are summarized in *Table D.2.7*. It can be observed that the values of the parameters are excessively high in comparison to the corresponding standards for rivers, where it discharge directly. Total coliform and fecal coliform are 2,400 and 12,000 times higher than the allowed ones.

Table D.2.7 Results of Water Quality Analysis at Oxydation Lagoon of Monte Real Housing Project

No	Name of test	Units	Standards*	P#7: Resid. Monte Real, entrance to Oxidation Lagoon	P#8: Resid. Monte Real, exit of Oxidation Lagoon	Times beyond Standards
	Date			Jul/12/2000	Jul/12/2000	
	Hour	AM		10:30	10:40	
1	General Bacteria	UFC/ml		16x10^6	20x10^6	
2	Total Coliform Bacteria	/100 ml	10,000	11x10^7	24x10^6	**2,400**
3	Fecal Coliform Bacteria	/100 ml	2,000	11x10^7	24x10^6	**12,000**
4	BOD	Mg/l	6	165	170	**28**
5	Magnesium	Mg/l	1	8.16	10.56	**11**
6	Ammonia Nitrogen	Mg/l	1	11.87	18.37	**18**
7	Dissolved Oxygen	Mg/l	>4	0.26	0	**4**

* Honduras Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People (Draft as August/2000)

Finally, it is easy to foreseen that under the present control capacity of the concerned authorities (SERNA/DECA, SANAA, Public Ministry, etc.) the expected conditions for the Ciudad Mateo Housing Project would be rather similar to the above described for Monte Real Housing Development.

Regarding the **Military Facilities** they are settled at the right bank of the Guacerique River, just

immediate to the Laureles I Dam. It comprises an area of about 2 km^2 (200 Has.) and has a maximum population of 2,835 people. Although most of the facilities were located there before the publication of the Gral. Law of Environment, an expansion of them has been observed thereafter. According to the observed data on water quality during dry season of last year (28/1/99) the Total and Fecal Coliforms in the discharge of the Batallion (SANAA´s monitoring station) to the Guacerique River resulted in 46,500 (N/100ml) which corresponds to 5 to 23 times the allowed values for this river. On the other hand at the rainy season (27/9/99) at the end of Los Laureles reservoir (immediately to Batallion station) such values were of 49,500

(N/100ml), which represent 5 to 25 times the allowed values for the reservoir or the river.

Considering in such facilities there are septic tanks (only 2 treatment plants were found), some of them with evident or risky conditions of leakages the concerned authorities should try to enforce the present environmental regulations, including all the military facilities. However, considering the excessive consumption of water (120 l/sec), which makes a competition with the drinking water destined for the inhabitants of the capital city, a detailed study of the levels of consumption should be made by SANAA.

Moreover, the large area occupied by the Military Facilities in a zone with growing pressure of urbanizing makes it expect that such installations in the long term (20 to 50 years) have to be removed from this zone to make space for future developments when the life span of the dams be concluded.

Present population density at the basin is 82.5 inhabitants/km^2 and at the year 2,055 would be 365 inhabitants/km^2. However, according to the residential classification by METROPLAN the allowed density of the residential Types are between 150 inh/ha (Type R-1) to 2,000 inh/ha (Type R-8). Nevertheless, at the urban area of Tegucigalpa, including the open spaces, the average density of population at present is of 110 inh/ha. Moreover, the average residential density is 196 inh/ha.(according to the Study on the Improvement of the Urban Transportation System, JICA, 1996).

Thus, it may be estimated that the area occupied by the military facilities has a potential of receiving between 22,000 to 40,000 persons at the present average density level of Tegucigalpa, which means it is 8 to 14 times the present density of the Military facilities.

Furthermore, although it may be too distant to suggest it but from now on it may considering that the previously planned (1970´s) Government Civic Center (Centro Cívico Gubernamental) can be located in this area, when it be allowed, after the end of the lifespan of the dams. This idea is coincident with the proposal of previous study[9] directed to relocate the military installations from the areas that can be utilized as civilan areas. Our recommendations for the concerned authorities (SANAA/AMDC-METROLAN, etc.) to start discussion on this matter.

2.5 WATER QUALITY SIMULATION

As there is a controversy on Mateo City Project, a rough simulation was made on the water quality assuming different scenario of the project.

The assumptions for the simulation are as follows;

(1) Four development scenarios in the year 2020 are;

Scenario 1 the project is suspended as it is now (basin population is 29,000)

Scenario 2 existing houses are inhabited (basin population is 53,000)

Scenario 3 phase I of the project is completed (basin population is 74,000)

Scenario 4 phase II of the project is completed (basin population is 130,000)

(2) runoff ratio of Phosphorus from Mateo City is assumed to be 0.7 as it is close to the reservoir and pipe discharge is expected.

[9] JICA, Nov/1996. Mejoramiento del Sistema Vial Urbano en Tegucigalpa, Informe Fina, Vol. II, page 8-17.

(3) Runoff ratio of Phosphorus from other pollutant sources is assumed to be 0.14 according to the present population and the water quality survey in this study.

The calculation model is Vollenweider Model as follows;

$$P_l = \frac{L}{qs}\frac{1}{1+\sqrt{t_w}}$$

Where P_λ; annual average total P concentration (mg P/m3)

L; areal annual total P loading (mg P/m2 year)

q_s; hydraulic load = inflow per unit surface area (m/year)

τ_w; filling time (residence time) = volume/inflow (year)

The calculated values were plotted taking the correlation curve between the normalized annual total Phosphorus load and maximum chlorophyll-a found out in various lakes (*Figure D.2.6*). The values of chlorophyll-a correspond to the degree of eutrophication indicated in the graph.

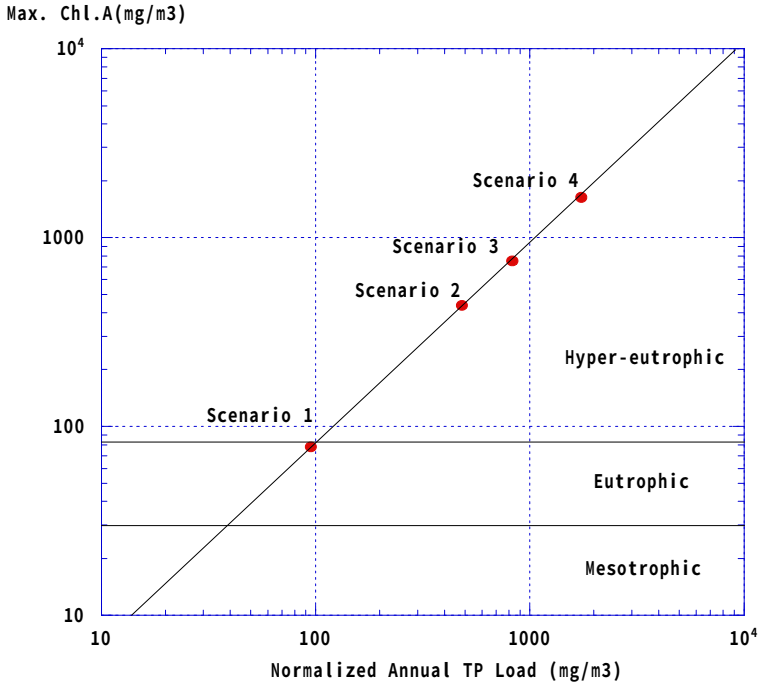

Figure D.2.6 Simulated Eutrophication of Los Laureles II Reservoir according to Different Scenario of Ciudad Mateo Project

As shown in the figure, the degree of eutrophication is quite different from Scenario 1 and other scenarios, meaning that further development of Mateo City Project with untreated water discharge will give serious negative impact on the reservoir water quality.

3. ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

The Environmental Impact Assessment (EIA) is the process to identify, estimate and describe the possible negative or positive impacts (effects or consequences) for the total environment of undertaking new developments and changing natural systems. It also proposes the mitigation measures for the negative impacts, as well as a plan for control and following up.

The EIA is required for projects like the one proposed in this study as a condition for the issuing of the Environmental License (EL). This is the permission extended by the SERNA through which is stated that the proponent of a project has complied with all the steps and requirements by law in order to start a project. Every economic activity or project (private or public) requires, previous to its authorization, concession, or granting exploitation or execution permission, of an Environmental License, which is issued by SERNA through the Directorate of Environmental Evaluation and Control (DECA).

3.1 PROCEDURES TO OBTAIN ENVIRONMENTAL LICENCE

Depending on the countries there are two different focus to decide if there is need to perform an full EIA: a) Application of a classification by categories, which is based on type and size of project, b) the realization of a preliminary study or Initial Environmental Evaluation (IEE).

According the World Bank[10] there are four categories for the classification of projects:

A: Those projects, which normally require an EIA

B: Those that need a limited environmental revision

C: Those that do not need any environmental analysis

D: Those environmentally beneficial and the projects of recovering from emergencies

In the case of Honduras according to the Technical Manual of the ´National System of Environmental Impact Assessment´ (SINEIA), for obtaining the Environmental License there are two categories of projects: I) Without need of elaboration of an EIA, II) Needs to elaborate an EIA. Moreover, to determine if a project needs an Environmental Impact Assessment (EIA) it is necessary to consider the conditions shown in *Table D.3.1*.

Thus, as this project cover several conditions established in *Table D.3.1*, which apply for the submission of EIA (Category II), it is necessary to perform it according to the local regulations.

Besides, to obtain the EL it must follow the procedure indicated in *Table D.3.2*.Basically it defines the steps and activities each of the concerned parts should follow up, i.e. the requesting agency (in the present case it will SANAA), the consultant for EIA, people, NGO´s and the environmental units related. In summary, according to it, previous to the construction of the project, SANAA will have to submit a request of EL to SERNA. It will elaborate the ToR in order SANAA contract a private consultant to elaborate the EIA. SERNA would finally issue and Environmental License after signing together a compromise with SANAA for the compliance of mitigation measures of the project.

Nevertheless, the EIA can also be elaborated according to the stages of the project as shown in *Table D.3.3*:

[10] Larry W. Canter, 1998, Manual de Evaluación de Impacto Ambiental, Mc Graw Hill, pag. 26.

Table D.3.3 Stages of Projects for Elaboration of EIA

Stage	Condition for EIA Elaboration
Pre-feasibility Study	It is recommended to perform an study of EIA to help to evaluate costs and benefits of the project
Feasibility Study	In this period the study becomes deeper
Design	EIA is compulsory, i.e. SERNA will not grant an Environmental License until the EIA be elaborated.

Source: Manual Técnico del Sistema Nacional de Evaluación de Impacto Ambiental, 1993 (?), DECA, SEDA

Therefore, considering the above, the JICA team firstly elaborated an Environmental Diagnostic by using form 002 of DECA. Secondly it elaborated the Terms of Reference (ToR) for a preliminary EIA that is being performed during the Feasibility Study by a private consultant.

The Environmental Diagnostic was performed by field, and office work. Although there are no especial negative effects on the environment the main impacts (at slight levels) defined by the Environmental Diagnostic are:

During Construction Phase:

- Clearance/Levelling activities: emission of dust and noise
- Use of explosives: noise

During Operation Phase:

- Land Use Conflicts: It affects some agricultural lands
- Biodiversity: Some fauna or flora may be affected (under study)
- Social/Economic: 20 houses should be resettled

Therefore, it was considered a full EIA should be executed and the corresponding ToR were elaborated. It was made through a consultation to the concerned authorities such as DECA, SANAA, as well as using references of similar projects in Honduras, and finally the normally accepted international rules.

Thus, the ToR and the resultant preliminary EIA will become a reference for the elaboration of the final ToR and EIA during the Design stage, by SERNA/SANAA.

By the meantime, the results of the preliminary EIA will be described in the next section.

3.2 RESULTS OF PRELIMINARY ENVIRONMENTAL IMPACT ASSESSMENT

The EIA identified several environmental impacts as a result of the project of construction of Los Laureles II dam. At the same time it has defined the corresponding mitigation measures, as shown in *Table D.3.4.*

Table D.3.4 Environmental Impacts and Mitigation Measures on the Construction of Dam Los Laureles II

No.	ENVIRONMENTAL IMPACT	MITIGATION MEASURES
1	Contamination by construction waste	Optimum construction planning in order to avoid excess use of concrete. Installation of collection system of concrete mix waste.
2	Temporary diversion of river	Diversion and protection works of river channel.
3	Noise, gas, dust, and vibration by machines	Control of vibrations and explosives. Use of silencers and catalysts for reducing noise and gas emissions. Regular watering of access roads.
4	Erosion and sedimentation at river bed	Drainage works, and covering of materials pile on site.
5	Loss of soccer field in case it is used for spoil bank	Create an alternative recreation area for the community.
6	Loss of vegetation cover	Estimation of vegetation mass usable within the inundation area. Propose method for exploitation, and propose alternative uses as compensation for the people to be resettled. Restore the vegetation cover in the area used for construction works.
7	Deterioration of water quality	Trap of sediment within the river bed during the construction to avoid discharge of turbid water to Laureles Reservoir. Installing of adequate system of water distribution, collection of waste water drainage of rain water, in temporary work area.
8	Development of economic activities	Preparation of area for temporary vendors. Agreement between vendors and the contractor.
9	Work accidents	Programs on work safety training and environmental education to workers. Safety equipment for workers should be supplied. Traffic control in the project area.
10	Resettlement of people and relocation of roads	Appropriate evaluation of houses to be relocated and land or cultivated area to be acquired by SANAA. Appropriate relocation plan taking into account the problems raised in Concepcion Dam Project. Alternative access road during the road relocation period.

Source: Borrador del Informe Final del Estudio de Impacto Ambiental (EIA) Preliminar del Proyecto de Abastecimiento de Agua para el Area Urbana de Tegucigalpa, September, 2000, JICA/SANAA/CINSA

These measures should be taken into consideration for the execution of the project and their cost should be estimated in detail at the Final EIA and project design stages.

Besides, the draft of the preliminary EIA has found a number of protected species with vulnerability, in danger of extinction or menaced which are living at the basin, but are not directly affected by the construction of the new dam. These species of flora sum up eight (8) and are indicated in *Table D.3.5* and the species of fauna sum up ten (10) in danger and fifteen (15) threatened and are indicated in *Table D.3.6*.

Table D.3.5 Protected Species of Flora with Vulnerability in Guacerique River Basin

SCIENTIFIC NAME	COMMON NAME	ORIGIN	CATEGORY
Lysiloma semanii	Quebracho	N	V
Grevillea robusta	Gravilea	E	V
Guazuma Ulmifolia	Guacimo	N	V
Liquidambar stiraciflua	Liquidambar	N	V
Cupressus lucitanica	Ciprés	N	V
Melia melia	Paraíso	E	V
Melia azerdach	Paraíso	E	V
Alnus acuminata	Jaúl	N	V

N= Native, E= Exotic, V= Vulnerable

Source: Borrador del Informe Final del Estudio de Impacto Ambiental (EIA) Preliminar del Proyecto de Abastecimiento de Agua para el Area Urbana de Tegucigalpa, September, 2000, JICA/SANAA/CINSA

Table D.3.6 Protected Species of Fauna Living in Guacerique River Basin

SCIENTIFIC NAME	COMMON NAME	PRESENT STATUS
a) Amphibians and Reptiles		
Iguana iguana	Iguana Verde	In danger
Ctenosaura similis	Garrobo Gris	Threatened
Crotalus durissus	Serpiente Cascabel	Threatened
Micrurus nigrocintus	Verdadero Coral	In danger
Bothrops spp	Tamagas	In danger
Bolitoglossa	Salamandra	In danger
Rana pipens	Rana Café	Threatened
Similasca bandinii	Rana Manchada	Threatened
Caiman crocodilus chiapasius	Caiman	Threatened
Crocodilus acutus *	Lagarto	In danger
b) Birds		
Amazona autumnalis	Lora naranjera	Threatened
Aratinga	Perico Ligero	Threatened
Buteo nitidus blakei	Gavilán Café	Threatened
Amazona alfibrons	Lora Frente Blanca	Threatened
c) Mammals		
Canis latrans	Coyote	Threatened
Odocoileus virginianus	Venado Cola Blanca	In danger
Dasyppus novecintus	Armadillo	Threatened
Agouti paca	Guatuza	In danger
Nazua nazua	Pizote	Threatened
Felis weidii	Tigrillo	In danger
Didelphis marsupialis	Guazalo, Tacuacín	Threatened
Urocyon cineroargenteus	Zorra, Gato de Monte	In danger
Mustela frenata	Comadreja	In danger
Coendou spp	Puerco Espín	Threatened
Lutra longicaudis *	Nutria	Threatened

* These species are at the Los Laureles I reservoir

Source: Borrador del Informe Final del Estudio de Impacto Ambiental (EIA) Preliminar del Proyecto de Abastecimiento de Agua para el Area Urbana de Tegucigalpa, September, 2000, JICA/SANAA/CINSA

4. CONCLUSIONS AND RECOMMENDATIONS

1. There is no legal or technical matter which restrain the construction of Los Laureles II Dam. The restraint is for the urban/military developments and the industries. The construction of dam can go ahead; the current environmental regulations should be enforced to be complied by the existing urban developments or industries, in order the conditions of water quality do not be deteriorated further.

2. The legal framework related to the Guacerique River Basin states this as a Protected Forestry Zone (Decree of 6/7/1972). Furthermore, it is prohibited the location of human settlements, military bases, industrial installations or other type in the influence area of the water supply sources for the people (Art.33, Gral. Law of Environment). These laws only needs the concerned authorities enforce it.

3. Lacking of the enforcement of the current legal regulations related the environmental aspects of the Guacerique River Basin has produced the expansion of existing Industrial/Urban/Military Developments and the settlement of new ones. Representative examples are: a) Poultry farms (“polleras”), b) New Military Facilities, c) Housing Project like Mateo City and Monte Real. Furthermore, Only 3 industries have obtained Environmental License, in the basin.

4. Water consumption of 100 to 150 l/sec., (equivalent to a population of 70,000 persons) at the military installations reduce the available volume to be used for the Capital City, compared with only 2,835 persons in such installations. A detailed study on these matter should be undertaken. Besides, the treatment systems in such installations should be adjusted to the established regulations.

5. Mateo City Housing Project, independently of the legal background, needs a full technical study regarding the environmental impacts and the cost of the mitigation works compared with the main cost. An independent and detailed study is necessary.

6. Monte Real Housing Project, is a bad example of the housing developments without monitoring and control from the concerned authorities to enforce the law. The coliform discharges to the Mateo River are excessively high (2,400 to 12,000 times) compared with the allowed values. Considering 7 years have past after Gral. Law of Environment was published, this project should be forced to comply the regulations.

7. Although there are some focus of contamination within the basin at a general level the water quality may be judged as acceptable. The reservoir of Los Laureles and the main stream of Guacerique River mostly comply with the current standards of water quality, with the exception of mentioned places of Batallion Station and the end of Laureles Reservoir (occasionally) and Monte Real Housing Project (most probably permanent).

8. The Standards for Quality Control in Waters Bodies Assigned for Drinking Water Supply to the People is currently in use by SANAA but still is a Draft of Law, actions should be taken in order such Standards become a full Law.

9. There are some industries, which are closing (Las Virginias Poultry Farm, Publicasa). It should be avoided other industries be located in their places.

10. The existence of tax exemption incentives for the industries that purchase equipment for prevention or purification from contamination (filters, etc.) should be duly indicated to the industries and other developments.

11. There are several protected species of flora and fauna within the Guacerique basin. Among them only two are inside of the projects direct influence area. They are Otter (Nutria, Lutra longicaudis) and Alligator (Lagarto, Crocodilus acutus), which live in the reservoir of Los Laureles I. The other species are located within the basin but do not seems to be affected in direct way by dam construction. In further stages of EIA, this point should be recomfirmed..

Table D.1.1 Classification of Environmental Regulations and Penalties related to Industries (By-laws of the Gral. Law of Environment, 1993)

(a) ADMINISTRATIVE INFRACTIONS		
Light	**Medium**	**Serious**
Art. 110: - To pile up sawdust, coffee pulp, rice shells or other industrial waste in sites with possibilities of contaminating the soil and water sources - To establish industries without having approval of the SERNA* - Discharge industrial waste (non toxic) without due treatment, into soils, rivers, streams, etc. - To throw waste into the streets, lots, green areas, public buildings, rivers, road sides, roads and other prohibited	**Art. 111:** To make again one light infraction	**Art. 112:** - To discharge or throw contaminating substances, liquid, solid or gaseous, into the water streams, tanks or sewer system, without previous permission of the authority and without complying with the purification process - To throw waste from the part of the industrial enterprises, into the streets, lots, green areas, public buildings, rivers, seas, etc. - To have had three penalties due to medium infractions - To make activities which are potentially contaminating or degrading, without the corresponding environmental licenses or permissions
Fine (Lps.)		
Art. 122: 1,000--5,000	Art. 123: 5,000--100,000	Art. 124: 100,000--1,000,000
(b) ENVIRONMENTAL CRIMES (Art. 104)		
- To produce, store, import, trade, transport, use or dispose without taking into account the legal regulations, the toxic or polluting substances or products which cause of can cause risk or serious danger to the public health or the ecosystem in general - To contaminate or allow the contamination of foods and drinking	- To discharge into the atmosphere, active pollutants or potentially dangerous, which use be prohibited or have not been treated according to the technical regulations, which cause or can cause the death of persons or serious harm to the human health or the ecosystem - To discharge harmful pollutants which use is prohibited or are without previous treatment, into the continental water streams or underground, including the systems of water supply to the population, or discharge waste water into the soil or subsoil, which can cause the death of one or more persons, or serious harm to the human health or the ecosystem in general	
Sanctions		
Art. 107: - imprisonment of 1 to 5 years - permanent closure - temporary suspension - confiscation - canceling or revocation - compensation - replacement	**Art. 106:** - imprisonment of 3 to 10 years - permanent closure - confiscation - canceling or revocation - compensation - replacement	

* SERNA: Secretariat of Natural Resources and Environment

Table D.1.4 Fauna Species in the Guacerique River Basin

No.	Local Name	Scientific Name
	a) AMPHIBIANS AND REPTILES	
1	Sapo común	Bufo coccifer, bufo marinus
2	Rana	Scinax stanfferi
3	Rana Manchada	Similasca bandinii
4	**Caiman (Cayman)**	**Caiman crocodiles chiapasins → threatened**
5	**Lagarto (Alligator)**	**Crocodulus acutus → in danger**
6	Charancaco	Basiliscus vittatus
7	Pichete	Norops Sp.
8	Escorpión	Sceloporus malachiticus
9	Arranca maíz, Rimbo	Ameiva undalata
10	Talconete	Phyllodactylus Sp.
	SNAKES	
11	Boa común	Boa constrictor
12	Tamagás	Coniophanes picervittis
13	Guardacaminos	Conophis lineatus
14	Zumbadora	Drymarchon corais
15	Coral	Micrurus Sp.
16	Falso coral	Lampropeltis triangulum
17	Ratonera	Leptodeira annalata
18	Mica	Spilotes pullatus
19	**Cascabel (rattlesnake)**	**Crotalus durissus → threatened**
	b) BIRDS	
20	Garza	Bubulcus ibis
21	Zope cabeza roja	Cathartes aura
22	Paloma	Columba fasciata
23	Tijul	Crotophaga sulcirostris
24	Martín Pescador	Chloroceryle americana
25	Carpintero	Melampes aurifrons
26	Urraca	Psilorrrhinus mario
26	Zorzal	Turdus grayi
27	Zanate	Quisculus mexicanus
28	Chorcha	Icterus Sp.
	c) MAMMALS	
30	Tacuazín	Didelphys marsupialis
31	Murciélago	Glossophaga soricina
32	Vampiro	Desmodus rotundus
33	Cusuco	Dasypus novencinatus
34	Conejo	Sylvilagus brasiliensis
35	Ardilla	Sciurus deppei
36	Ratón	Heteromys demorestianus
37	Tepescuintle	Aqoti paca
38	Guatuza	Dasyprocta punctata
39	Mapache	Procyon lotor
40	Pizote	Nasua nasua
41	Coyote	Canis latrans
42	Zorro	Urocyon cinereoargentus
43	Comadreja	Mustela frenata
44	Zorrillo	Mephitis macroura
45	Nutria	Lutra longicaudis
46	**Tigrillo (Ocelot)**	**Felis wiedii → in danger**
47	**Venado cola blanca (White Tail Deer)**	**Odocoileus virginianus → threatened**

Sources: 1) Mario Espinal/CIDH, Jul/1997, Evaluación Ecológica Rápida Parte Baja de la Cuenca del Río Guacerique en el Area de Influencia del Embalse Los Laureles, 2) PRODESAMH, 1997, Perfil Ambiental de Honduras.

Table D.1.10 Options for Solving the Problem of Mateo City (according to L. Ferraté)

No.	Scenario	Problems	Cost
1	a) To abandon the project, and remove the construction materials and structures of the 4,890 houses. b) The Honduras Government or other co-responsible absorb a loss of about US$22 millions c) To restrain and prohibit the development of other new human settlements in the basin. d) To drop the contamination, erosion and deforestation produced by the human settlements, industries, military installations and other activities existing previous to the Mateo City construction.	1. Independently of abandoning it the project already produced negative environmental impacts, and risks, which will affect the Los Laureles Reservoir, which could be mitigated by making investments to reduce, control and compensate such impacts. 2. To abandon it would produce attraction for people looking for dwellings to invade it, producing a disorderly occupation with environmental and socioeconomic effects.	US$ 24.5—26 millions (minimum cost for abandoning with environmental rehabilitation)
2	a) To complete the infrastructure for the 4,890 dwellings, prohibiting the enlargement to the planned 10,000 ones. b) Additional investment would be about US$ 13 millions c) Population would be about 30,000 inhabitants (5,000 families) d) About US$ 8-9 million would be necessary for environmental impact mitigation e) To restrain and prohibit the development of other new human settlements in the basin.		US$ 43 millions for a minimum population of 75,000 persons in the basin. However, the annual population increase is 2.5-3%, so additional investments should be considered apart.
3	a) To leave Mateo City at the present condition without making additional investments for its social, environmental and economical improvement.	1. Possible loss of present and future reservoirs (Los Laureles, Quiebra Montes) and high costs in the water treatment. 2. At long term should be considered the loss of the water resource, highly contaminated, and therefore the inefficient use of the treatment plant of Los Laureles. 3. Conservative estimations indicate that keeping the water quality in a period of 10 years and to construct a new dam and treatment plant as the one of Los Laureles would need an investment between US$120 to US$150 millions. 4. There would be risks, and indirect damages to 1/3 to 2/5 of the population of Tegucigalpa when the water portion is reduced, and the epidemiological vectors increase, and furthermore the payment for the water increase.	

Adapted from Luis Ferraté, 1995 (?). Aspectos Ambientales Relevantes de Ciudad Mateo para la Calidad del Agua y Sedimentación del Embalse Los Laureles dentro del Contexto del Proyecto de Rehabilitación, Mejoras y Ampliación del Sistema de Agua Potable de Tegucigalpa: Préstamo 799/SF-HO

Table D.1.13 Population at Guacerique River Basin (1/2)

	VILLAGE NAME	HOUSES	INHABITANTS (BY 2000)
No.	A) MUNICIPALITY OF CENTRAL DISTRICT		
1	El Guayabal	67	369
2	El Mogote*	20	110
3	Uparito	3	17
4	Los Achiotes	42	231
5	Las Champas	19	105
6	Hda. Santa Fe	2	11
7	Las Anonas	9	50
8	El Suyatillo	7	39
9	Santa Clara*	12	66
10	Los Laureles	37	204
11	Jocomico	43	237
12	La Travesía	1	6
13	Los Canales	6	33
14	Hda. Los Encinos	5	28
15	Hda. Guacerique	1	6
16	Hato de los Corrales	7	39
17	Los Robles	4	22
18	Las Tapias	147	809
19	Los Pedernales	36	198
20	El Espinal	75	413
21	La Cieneguita	93	512
22	Agua Zarca	10	55
23	Milpa Redonda	8	44
24	La Anona	5	28
25	Las Trojas	2	11
26	La Sirena	3	17
27	Los Manchones	3	17
28	Portillo del Monte Redondo	23	127
29	Monte Redondo*	17	94
30	La Chorrera	1	6
31	La Montañita	1	6
32	La Calera	142	781
33	La Majada	6	33
34	Puerta de Golpe	83	457
35	Residencial Altos de Monte Real	300	1650
36	El Jicarito	31	171
37	La Gradas	4	22
38	Mulular	19	105
39	Quiscamote	32	176
40	El Guayabo	5	28
41	Los Encinos	8	44
42	Montaña de Azacualpa	7	39
43	Quiebra Montes	7	39
44	Santa Cruz Arriba	123	677
45	El Empedrado	70	385
46	Ocote Vuelto	14	77
47	Desvío de San Matías	7	39
48	El Llano	128	704
49	San Matías (Aldea)	157	864

Table D.1.13 Population at Guacerique River Basin (2/2)

No.	VILLAGE NAME	HOUSES	INHABITANTS (BY 2000)
50	La Montaña	1	6
51	Rincón de Dolores	44	242
52	La Lagunita No.2	25	138
53	El Achiotal	1	6
54	El Macuelizo	29	160
55	Los Planchones	3	17
56	Aserradero de Soto	18	99
57	Laguna del Pedregal	25	138
58	Nueva Aldea	104	572
59	Aldea Mateo	259	1425
60	El Aceituno	18	99
	Sub-total:	**2,379**	**13,085**
	B) MUNICIPALITY OF LEPATERIQUE:		
1	Palo Marcado	33	182
2	Agua Escondida (antes El Copantón)	3	17
3	Tierra Colorada	20	110
4	Planes del Cipres	25	138
5	Junacates (antes El Junacate)	26	143
6	La Mutuasa	9	50
7	El Escarbadero	63	347
8	Las Gradas	23	127
9	Potocolo	22	121
10	Guajire	14	77
11	La Montañita	6	33
12	Cabos de Hacha	12	66
	Sub-total:	**256**	**1,408**
	TOTAL:	**2,635**	**14,493**
	C) Military Facilities	**Min.(Popul)****	**Max.(Popul)****
1	Naval School	80	80
2	Instituto Superior de Educación Policial (ISEP)	60	130
3	Academia Nacional de Policía (ANAPO)	160	320
4	Dir. Gral. Educación Policial	15	15
5	Esc. Técnica del Ejército	200	200
6	Gral. Army Headquartes	500	900
7	Military Hospital (55 beds)	55	55
8	Centro de Apoyo Logístico del Ejército (CALE)	250	250
9	Escuela de Comando y Estado Mayor	17	55
10	Colegio de Defensa		
11	1er. Batallón de Infantería	200	200
12	Industria Militar (Military Industry), IMFFAA	230	230
13	Academia Militar	300	400
	Sub-total:	**2,067**	**2,835**
	GRAND TOTAL:	**16,560**	**17,328**

* At Limit of basin

** Population of Military facilities varies according to periods of training courses, etc.

Note: a rate of 5.5 persons/house was use from the average for the Fco. Morazan Dept. according to the 22nd Permanent Survey of Households of Sept/1999, publ. on March/2000

Source: 1) Pre-censo 2000, 2) Direccion Gral. De Estadísticas y Censos Programa de Encuesta de Hogares, 22ava. Encuesta Permanente de Hogares, Sept/1999, published on March 2000

Table D.2.2 Standards for Drinking Water Quality

Parameter	Permissible Max. Value (mg/l)
A: Bacteriological Parameters	
A.1: Piped Water Without Treatment:	
Total Coliform	3
Fecal Coliform	0
A.2: Piped Water With Treatment:	
Total Coliform	0
Fecal Coliform	0
B: Organoleptic Parameters	
True Color (Pt-Co)	15
Turbidity (TNU)	5
Odor	2 at 12°C, 3 at 25°C
Taste	2 at 12°C, 3 at 25°C
C: Physic-Chemical Parameters	
Temperature (°C)	18—30
PH	6.5—8.5
Residual Chlorine	5
Chloride	250
Conductivity (μs/cm)	400 (RV)
Hardness (CO_3Ca)	400 (RV)
Sulfates	250
Aluminum	0.2
Calcium	100 (RV)
Cupper	2
Magnesium	50
Sodium	200
Potassium	10
Total Dissolved Solids	1000
Zinc	3.0
D: Parameters for Unwished Substances	
Nitrates (NO_{3-})	50
Nitrites (NO_{2-})	0.1 or 3.0*
Ammonium	0.5
Iron	0.3
Manganese	0.5
Fluoride	0.7 at 25-30°C, 1.5 at 8-12°C
Hydrogen Sulfur	0.05
E: Inorganic Substances with Meaning for Health	
Arsenic	0.01
Cadmium	0.003
Cyanide	0.07
Chromium	0.05
Mercury	0.001
Nickel	0.02
Lead	0.01
Antimonium	0.005
Selenium	0.01

RV: recommended value. * If the value 3.0 is selected, the values of nitrate and nitrite should be related as: $NO_3/RV(NO_3)+NO_2/RV(NO_2) < 1$

Source: Technical National Standard for Drinking Water Quality, OPS/OMS, Ministry of Health, Honduras, Oct/1995

Table D.2.3 Standards for Discharges of Waste Waters to Receiver Bodies

Parameter	Permissible Max. Value (mg/l)
Temperature	<25°C
Color	<200.0 UC
PH	6.00--9.00
Discharged Volume	<10% Aver. Vol. receiver body
Sedimentable Solids	1.00 m/l/h
Suspended Solids	100.00 mg/l
Floating Material and Foam	Absent
BOD	50.00
COD	200.00
Greases and Oils	10.00
Total Nitrogen Kjeldahl	30.00
Ammoniacal Nitrogen	20.00
Total Phosphorus	5.00
Sulphur	0.25
Sulfates	400.00
Aluminum	2.00
Barium	5.00
Iron	1.00
Manganese	2.00
Zinc	2.00
Copper	0.50
Tin (Estaño)	2.00
Nickel	2.00
Silver	0.10
Lead	0.50
Mercury	0.01
Cadmium	0.05
Total Chrome Total	1.00
Hexavalent Chrome	0.10
Cobalt	0.50
Arsenic	0.10
Cyanide	0.50
Fluorides	10.00
Selenium	0.20
Bifenils Policlorates	Absent
Tricloroetilen	0.30
Tetracloroetan	0.10
Tetracloruro of Carbon	1.00
Dicloroetilen	1.00
Chloroform	0.03
Carbon Sulphur	1.00
Organo-Clorates Pesticides	0.05
Organo-Phosforates Pesticides	0.10
Hydrocarbon	0.50
Phenolic compounds	0.50
Detergents	2.00
Coliforms	5,000/100 ml
Radioactive Isotopes	Absent

Source: Tech. Nat. Standard for Drinking Water Quality, OPS/OMS, Health Ministry, Honduras, Oct/1995

Table D.2.5 Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People (Draft as of August/2000)

Parameter	Category A: Disinfection Permissible Max. Value (mg/l)	Category B: Conventional Treatment Permissible Max. Value (mg/l)
Turbidity (TNU)	15	600
Color (UC)	15	800
PH	6.5—8.5	6.0—9.0
Conductivity (μs/cm)	1,600	1,600
Dissolved Solids	1,000	1,000
Dissolved Oxygen	5.0	4.0
BOD	3.0	6.0
COD	10.0	20.0
Ammoniacal Nitrogen	0.5	1.0
Nitrates	50	50
Nitrites	3.0	3.0
Ortho-Phosphates	0.1	0.5
Sulfates	250	400
Chloride	600	600
Aluminum	0.2	0.2
Iron	0.3	1.0
Manganese	0.5	1.0
Zinc	3.0	3.0
Cupper	1.0	1.0
Nickel	0.02	0.02
Silver	0.05	0.05
Lead	0.01	0.05
Mercury	0.001	0.001
Cadmium	0.003	0.003
Chromium (Total)	0.05	0.05
Arsenic	0.01	0.05
Cyanide	0.07	0.07
Antimonium	0.005	0.005
Fluoride	0.7	0.7
Selenium	0.01	0.01
Sodium	200	200
Hydrocarbon	0.05	0.05
Phenol	0.002	0.002
Total Coliform (NMP)/100ml	500	10,000
Fecal Coliform (NMP)/100ml	100	2,000
α Activity (Bq/l)	0.1	0.1
β Activity (Bq/l)	1.0	1.0

Source: Draft of the Technical National Standard for Regulation of Water Uses, Ministry of Health, Honduras, as August/2000

Table D.2.6 Characteristics of Industries/Urban & Military Settlements located along Guacerique River Basin (1/3)

No.	Name/ Settled Date/EL	No. Persons (houses, etc)	Activity/Water Source and Consumption	Solid Waste	Waste Water/Effluents
A) INDUSTRIES					
1	Embotelladora La Reina (PEPSI)	?	Soft drinks industry. 7 wells (5 own, 2 external), 110—150m depth, Q=0.76—5.67 l/sec. Quse=9.86 l/sec.	Glass is sold out to recyclers. The rest is sent to the Municipality sanitary landfill.	Wastewater is channeled to a sedimentation tank and then flows to a network of 7 septic tanks. Industrial waters flow directly to Queb. El Puesto.
2	Escuela La Estancia (La Estancia School) **1.Settled:1995 2.Env. License: No**		Education. Well, 150m depth, Q=1.89 l/sec.	Garbage is sent to the AMDC sanitary landfill.	Septic tank
3	Vidrios Nacionales S.A. VINASA (Factory of glass) **1.Settled:1987 2.Env. License: Requested: 9/5/96 Issued:6/11/96**	100	Storage of glass, manufacture of doors, mirrors, meshes and screws. Periodically purchase water to fill up a tank of 20 m^3. No consumption data available.	Glass, aluminum, plastic, cardboard, garbage, suspended particles. Solid waste is transported to the Municipality sanitary landfill	Re-use the water, however, when it cannot be used any more pour it directly to the road.
4	Laboratorio de Minerales Merendón de Honduras **1.Settled:1998 2.Env. License: Requested: 9/3/99 Issued:13/12/99**	20	Research. 1 well, 120m depth, Q=1.58 l/sec.	Solid waste is sent to the Municipality sanitary landfill.	Solids retention tank + biological digestion tank
5	Granja Avícola "Las Virginias" (Poultry Farm). ***Note: At present is moving facilities from basin***	27	Brooding of chickens for production of eggs 1 well, 90m depth, Q=?, Quse=0.26 l/sec	Hen droppings, smoke emissions, garbage, ashes, unpleasant odors. Solid waste is incinerated at the backyard. Hen droppings is sold out to coffee growers	Water from the chicken sheds goes directly to the river. Employees have latrines.
6	Consorcio Avícola Privado de Hond. "Granja España" (Poultry Farm)	8	Brooding of chickens for production of eggs. Same well of "Las Virginias", Quse=0.09 l/sec	Idem	Water from the chicken sheds goes directly to the river. Employees have latrines.
7	Centro Industrial S.A., Fab. de Velas (Factory of Candles)	118	Manufacture of candles and sanitary towels. 1 well 90 m depth, Q=10.41 l/sec	Garbage, ashes. Incineration at open space	1 septic tank
8	Industria Gabriela	20-40	Manufacture textiles. 1 "malacate" well 7 m depth.	Coloring, ashes. Garbage is incinerated at open space.	Hot water. 2 septic tanks
9	Laboratorios Everest **1.Settled:1995 2.Env. License: No**	8	Antiseptical buccal products. Purchase well water to neighbor. Quse=0.09 l/sec.	Garbage. Plastics are sold out to recyclers. The rest is incinerated at the riverside.	Waste water flow to a septic tank
10	Granja Avícola "El Cortijo" **1.Settled:1969 2.Env. License: No**	17	Brooding of chicken for fattening up 1 well, 90m depth, Q=6.31 l/sec, Quse=0.53 l/sec	Hen droppings, smoke emissions, garbage, ashes, unpleasant odors, viscera and feathers. Incinerator for dead chickens. Other remains are incinerated at open space.	Water from the chicken sheds goes directly to the river. Employees have latrines.
11	Fibras Plásticas (Manufacture of plastics)	5	Manufacture of plastic accessories for electricity and plumbing	Garbage	
12	Industrias Palermo	100	Manufacture of terrazzo brick floor	Containers of raw material, garbage, suspended particles	Hot water.
13	Industria Cerámica Mateo,CEMA (Ceramic Industry)	10	Manufacture of wall bricks	Smoke emissions, garbage, ashes	Hot water

Table D.2.6 Characteristics of Industries/Urban & Military Settlements located along Guacerique River Basin (2/3)

No.	Name	No. Persons (houses, etc)	Activity/Water Source and Consumption	Solid Waste	Waste Water/Effluents
14	Maderas VBM (Wood Industry) **1.Settled:1994(?) 2.Env. License: Requested: 1994 Issued:30/1/95**	5	Sawmill and selling of wood	Sawdust, wood waste, garbage	
15	Publígrafos de Honduras (Publishing Company)	?	Manufacture of electric signs and publishing boards There is a drilled well (no more data)	Garbage. Solid waste is incinerated at the open space.	Septic tank
16	Publicasa "El Periódico" (Newspaper), recently closed	89	Edition of newspaper. There is a drilled well (no more data)	Paper, garbage. Solid waste is incinerated at the open space.	Water with ink. Septic tank.
	SUB-TOTAL:	**547+?**			
B) URBAN SETTLEMENTS					
1	Ciudad Nueva 2a. Etapa	? mostly uninhabited			
2	Las Tapias	809			
3	Ciudad Mateo (Housing Project)	2,650 full 2,240 partial (houses) *uninhabited*		Waste of building materials, organic waste, waste of machinery lubricants, domestic waste	
4	Residencial Monte Real (Housing Project) **1.Settled:1980(?) 2.Env. License: No**	1,650	6 wells, 80m depth in average. Q=1.14-1.51 l/sec. Quse=1.31 l/sec	Domestic waste, containers of lubricants, waste of building materials. A waste collection system has been set up, consisting in a collection truck, which collect sealed plastic bags on Fridays.	Waste water. All houses have sewer system, which flow to an oxidation lagoon 0.9x15x15m, already full, at the left bank of Mateo river.
5	Aldea Mateo	1,425			Latrines + septic tanks
6	Puerta de Golpe	457			Latrines
7	El Empedrado	385			Latrines
	SUB-TOTAL:	**2,267+?**			
C) MILITARY FACILITIES					
1	Escuela Naval (Naval School)	80	Donation from Laboratorio Minerales Merendón.	Domestic waste. It is collected by trucks of CALE and sent to AMDC sanitary landfill	Waste water, domestic waste. 1 septic tank: 2.5x4m
2	Instituto Superior de Educación Policial (ISEP)	60-130	Military facilities have an intake in Guacerique river at the site "Los Culucos", pumping it up a discharge of Q=120 l/sec to a tank of 380m^3. Then each 6 hours 435m^3 are treated with the process:SO_4Al+rotation+ lung tank+chlorination	Domestic waste.	Waste water, domestic waste. 2 septic tanks: 12x6x3, ?
3	Academia Nacional de Policía (ANAPO) **1.Settled:1976 2.Env. License: No**	160-320	Idem	Domestic waste.	Waste water. 3 septic tanks: 2x4x4m, 2.5x4x3m, 2.5x2.5x2m
4	Dir. Gral. Educación Policial	15	Idem	Domestic waste.	1 septic tank: 2.5x3x2m
5	Esc. Técnica del Ejército (Technical Army School) **1.Settled:1997 2.Env. License: No**	200	Idem	Domestic waste. It is collected by trucks of CALE and sent to Munic. sanitary landfill	Waste water. 1 treatment plant. Process: crushing, oxygenizing, chlorination

Table D.2.6 Characteristics of Industries/Urban & Military Settlements located along Guacerique River Basin (3/3)

No.	Name	No. Persons (houses, etc)	Activity/Water Source and Consumption	Solid Waste	Waste Water/Effluents
6	Cuartel General del Ejército (Gral. Army Headquartes)	500-900	Idem	Domestic waste. It is collected by trucks of CALE and sent to Munic. Sanitary landfill	Waste water. 2 septic tanks: 4x6x3m, 3x3x2.5m
7	Hospital Militar **1.Settled:11/8/1992** **2.Env. License: No**	55 (beds)	Idem. Quse=0.44 l/sec	Medical and domestic waste. Solid wastes: part is incinerated, another part sent to AMDC sanitary landfill.	3 septic tanks interconnected, discharging to a treatment plant, and finally discharge to the free land.
8	Centro de Apoyo Logístico del Ejército (CALE) **1.Settled:1965** **2.Env. License: No**	250	Idem	Domestic and workshops wastes. Solid waste is sent to AMDC sanitary landfill, every 2 days.	3 septic tanks: 3x3x3m. No.1: conduction pipe already obstructed, broken down, with leakage of solids. No.2: combine oily waters of workshops with sewer waters. No.3: operating
9	Escuela Comando y Estado Mayor + Colegio Defensa **1.Settled:1997(?)** **2.Env. License: No**	17-55	Idem	Domestic waste. Incinerated at open space.	2 septic tanks: 5x7x3m, 3x4x3m (constructed when 500 people lived there)
10	1er. Batallón de Infantería **1.Settled:1954** **2.Env. License: No**	200	Idem	Domestic waste. It is collected by trucks of CALE and sent to Munic. Sanitary fill	Waste water. 2 septic tanks: 8x8x3m, 3x3x2m
11	Industria Militar (Military Industry), IMFFAA	230	Idem	Garbage is carried to a crematory nearby to Academia Militar	10 septic tanks 3x3x2.5m.
12	Academia Militar **1.Settled:1985** **2.Env. License: No**	300-400	Idem. Quse=0.44 l/sec	Incinerated at open space.	
	SUB-TOTAL:	**2,835 (Max)**			

Sources: 1) Watershed Management Dept. SANAA, March, 2000 2) DECA, July 2000, unpublished data, 3) Field survey the JICA team.

Note: Dimensions of septic tanks of military facilities are approximated.

Table D.3.1 Conditions for a Project to Submit an EIA

Category I: The project does not need to Submit an EIA		
Category II: The project needs to Submit an EIA, as follows:		
No.	**A) If some of its activities affect to:**	**B) If the project is included in the following list:**
1	Human health (contamination, vectors, etc.)	Mining (including petroleum and gas)
2	Directly or indirectly groups of populations, like ethnic, **unwilling resettlements**, colonizing new lands, etc.	Tourism
3	Cultural and anthropological values of a zone or country	Urban at large scale
4	An archeological or paleontological site	Industrial at large scale
5	**Biodiversity of a zone or country (ecosystem, flora, fauna, genetic resource)**	Irrigation and drainage at large scale
6	**Protected area**	Agriculture or cattle raising at large scale
7	Humid zone	**Dams and reservoirs**
8	Seashore zone	Toxic materials, use or handling
9	**Species threatened or in danger of extinction**	Aquiculture
10		Electrical transmission at large scale
11		Forestry at large scale
12		Transportation (roads, airports, etc.)
13		Development of energy (thermo/hydro)

Source: Manual Técnico del Sistema Nacional de Evaluación de Impacto Ambiental, DECA, 1995(?), pag. 27.
Note: In **bold face letters** are indicated the aspects concerning the present project

Table D.3.2 Procedures for Obtaining the Environmental License (EL)

	ACTIVITIES TO BE MADE BY CONCERNED PARTS			
Step (time)	**Requesting Agency (RA)**	**SERNA**	**Consultant**	**People, NGO´s, Environment Units**
1. (2 days) Register and request of EL	(1) Request of EL (2) Filling up, handing over form of register (3)Public announcement of intention to obtain EL	(1) Receive of request and opening of record (2) Notice to relevant UNA´s and NGO´s		
2. (30 days) Categorization of project and elaboration of ToR		(1) SERNA coordinates technical team formed by government institutions, municipalities and NGO´s, in order to: (1.1) Make a field inspection to fill up an **Environmental Diagnostic** (1.2) Assign an Environmental Category to the project (2) The Team make consultation with the general people (3) For projects with no need of EIA (category I) the opinion is favorable (4) For project which need EIA (category (II), **SERNA will prepare the ToR of EIA** and hand over to RA		(1) NGO´s, and community associations can send the environmental worries to SERNA, to be included in the ToR (2) UNA´s, municipalities, and NGO´s participate and collaborate with SERNA to prepare the ToR
3. (Indeterminate time) Elaboration of EIA	(1) Receive ToR and: (1.1) Accept approaches (1.2) Appeal to SERNA for modification of ToR (1.3)Contract a Consultant (1.4) Supervise consultations with the community or consultant (1.5) Supervise consultations requested by ToR with community, NGO´s, and people (1.6) Revise EIA and formally hands over to SERNA		(1) Elaborate EIA under the ToR of SERNA (2) Carry out consultations with community, NGO´s and people as established by ToR (3) Hand over EIA to RA	(1) NGO´s , communities and people participate in elaboration of EIA, according to ToR. (2) UNA´s participate in following up the EIA
4. (30 days) Revision of EIA	(1) Makes public announcement of handing over the EIA to SERNA (2) Receives decision of SERNA, according to it: (2.1) Accepts and sign compromise (2.2) Correct EIA (2.3) Appeal decision	(1)Revise EIA in collaboration of UNA´s, NGO´s, communities and people (2) Prepares technical decision on the EIA and hand over to RA. It may consist on one of the following: (2.1)Acceptation of EIA (2.2) Rejection of EIA (2.3)Request of improvement or correction of EIA	(1) Improvement or correction of EIA	(1) NGO´s, community, people will have access to the EIA and will hand over to SERNA their comments (2) UNA´s participate in revision process
5. (5 days) Granting of Environmental License		(1) SERNA grant EL to RA, after signing compromise document (2) SERNA rejects the granting of EL		

UNA´s: Environmental Units (*Unidades Ambientales*); ToR: Terms of Reference
Source: Manual Técnico del Sistema Nacional de Evaluación de Impacto Ambiental, 1993 (?), DECA, SEDA

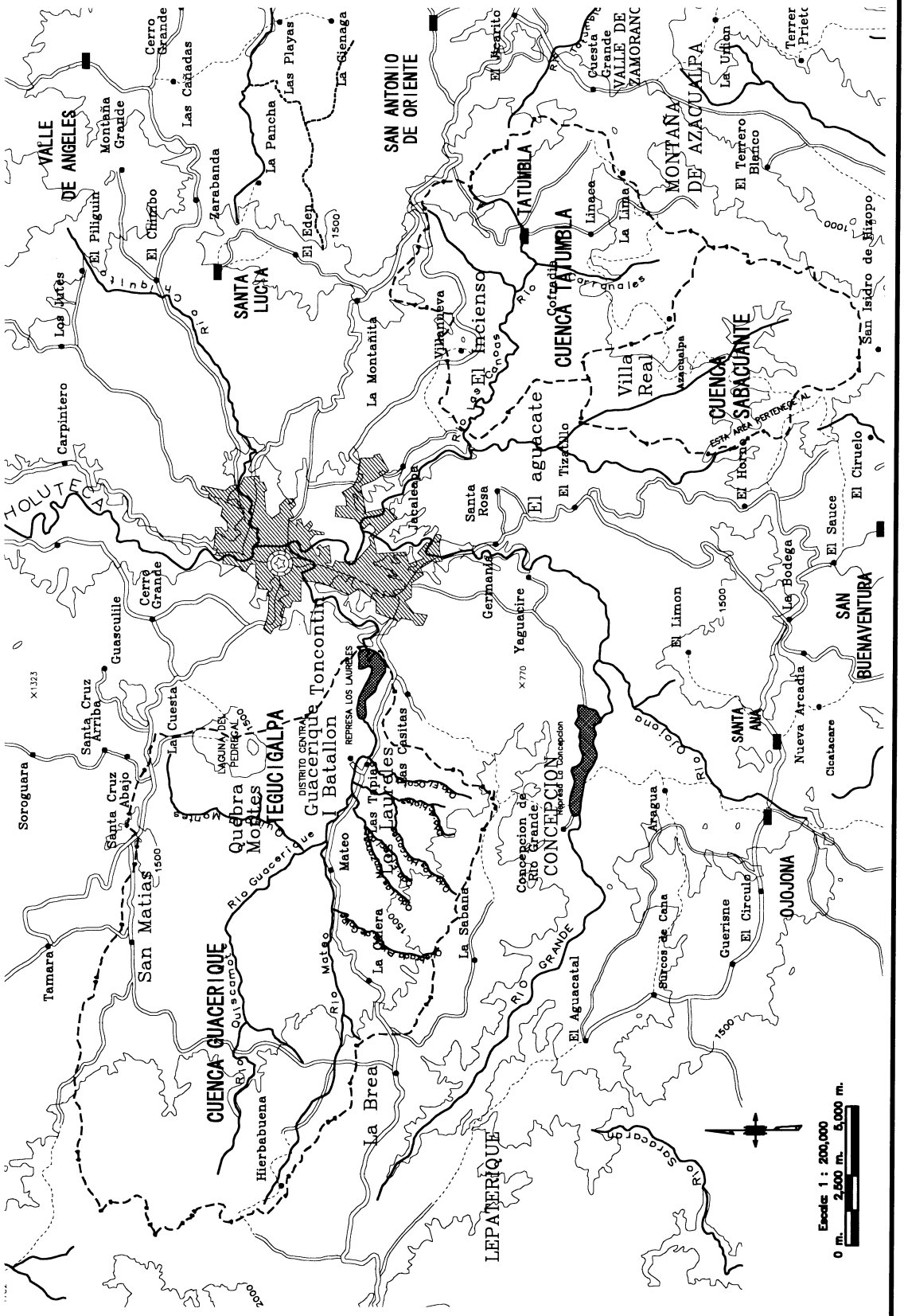

Figure D.1.1 | **Forestry Protected Zones in the Study Area**

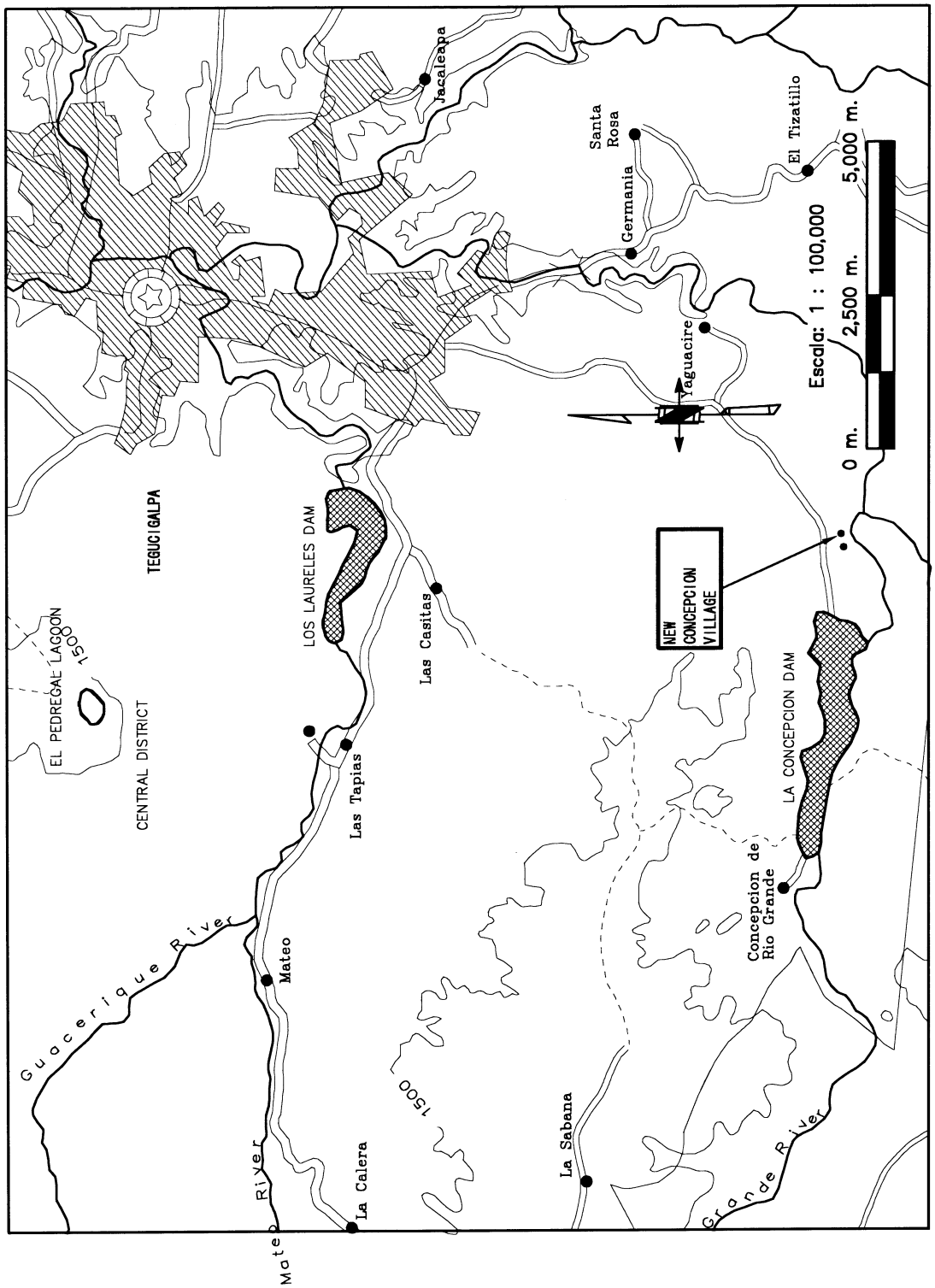

Figure D.1.2	Resettlement Project in Concepcion Dam

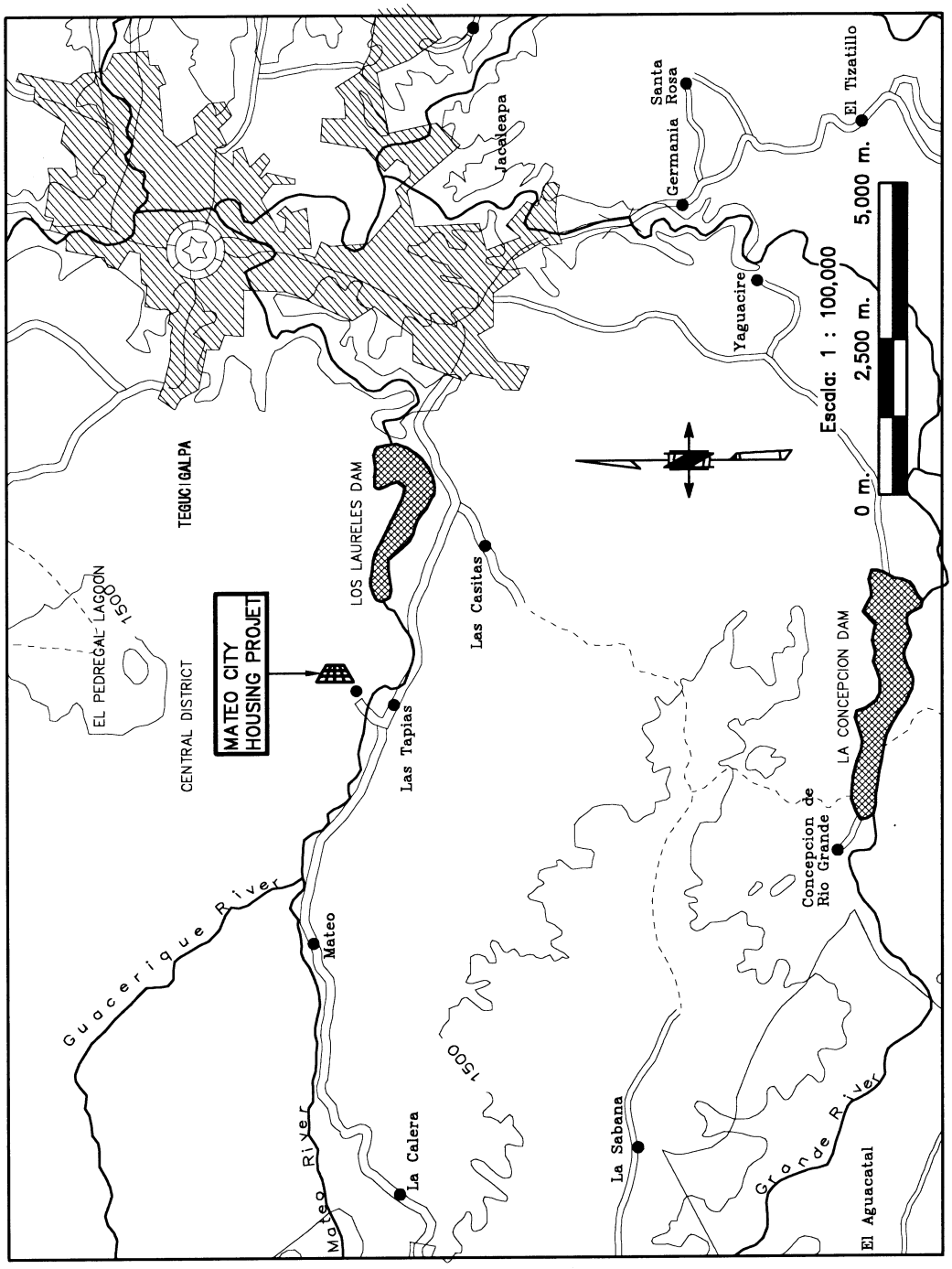

Figure D.1.3	Location of Mateo City Housing Project

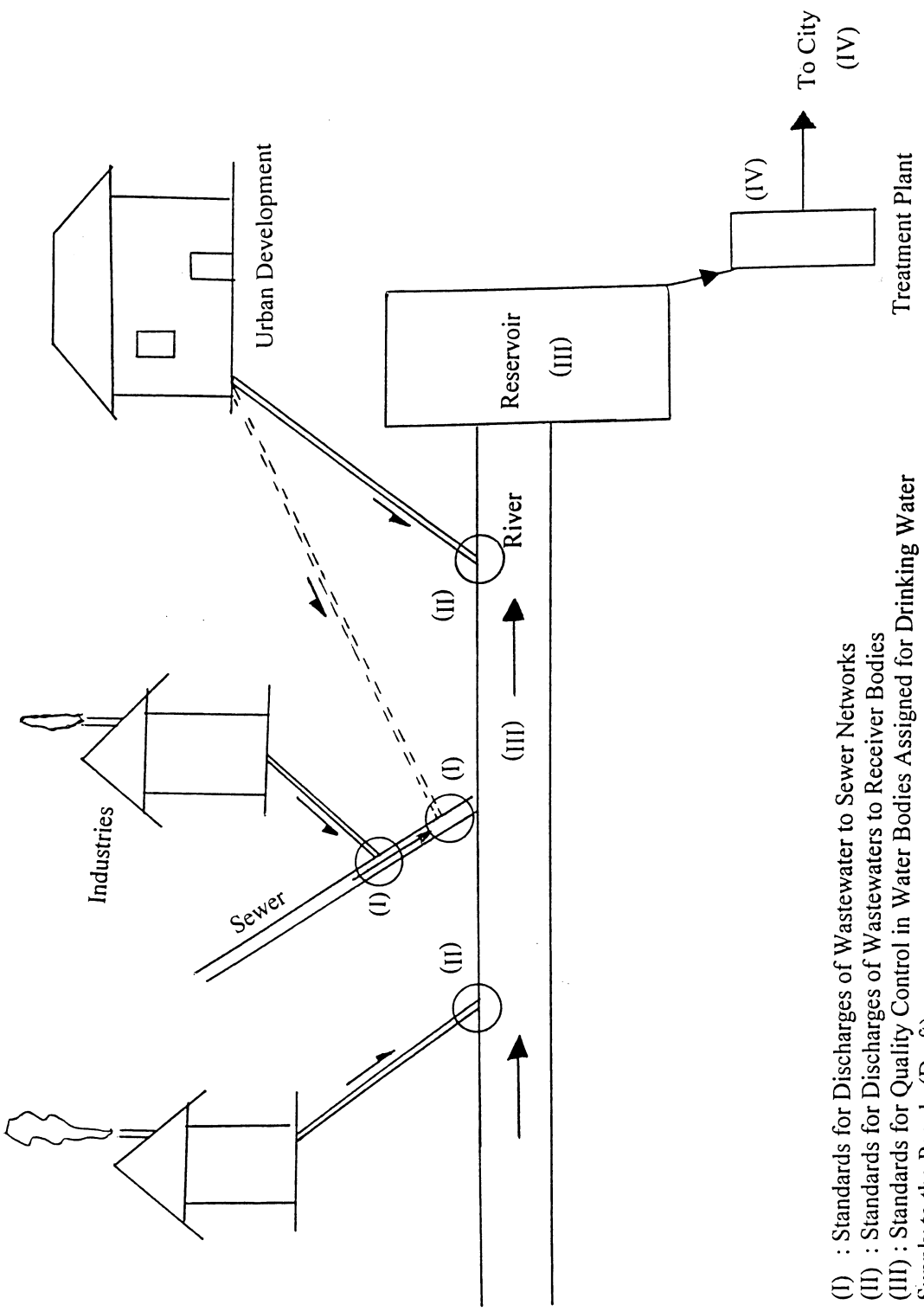

Figure D.2.1	Application of the Current Water Quality Standards along the Hydric Network

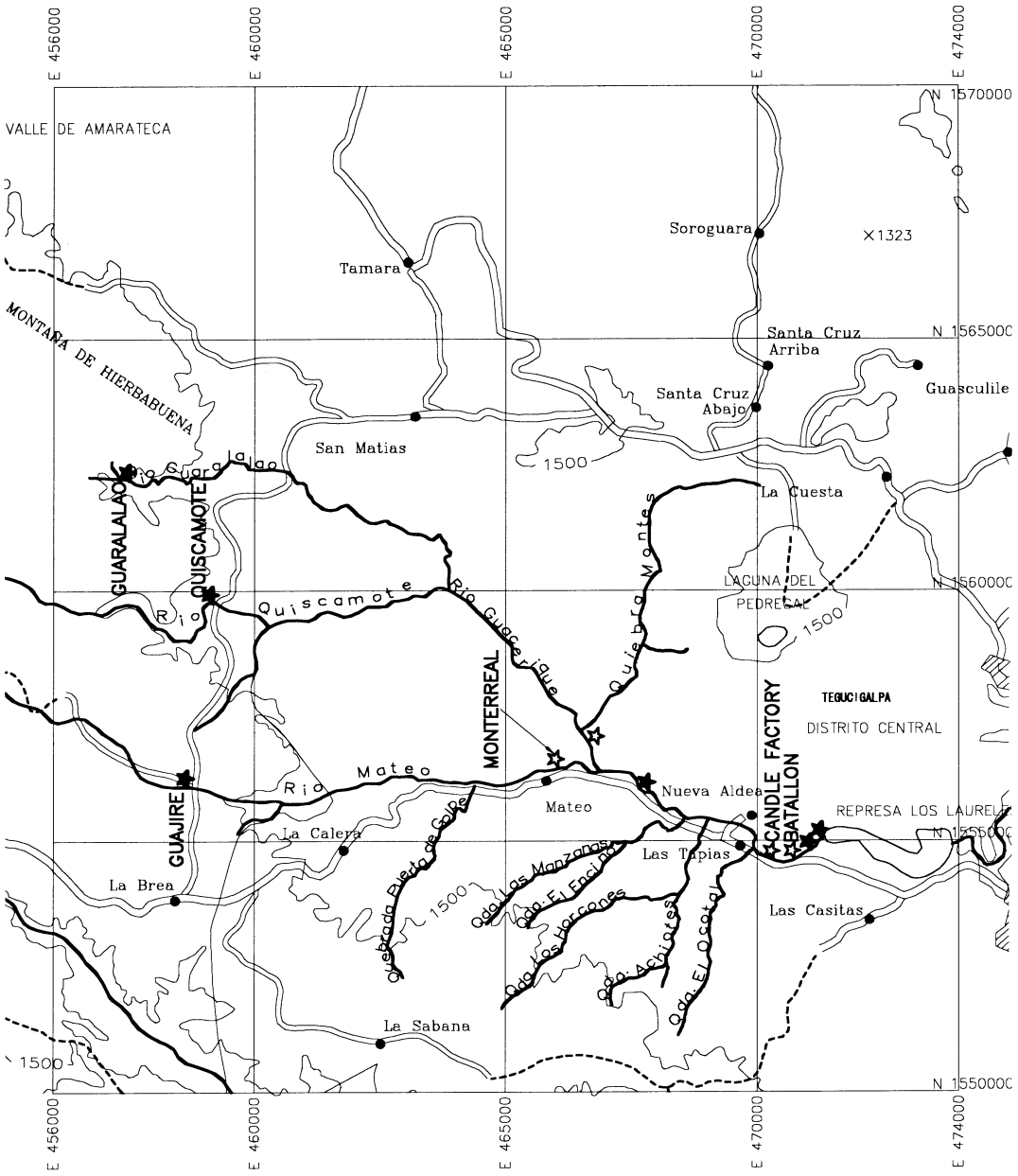

Figure D.2.2	Sampling Point at Guacerique River Basin

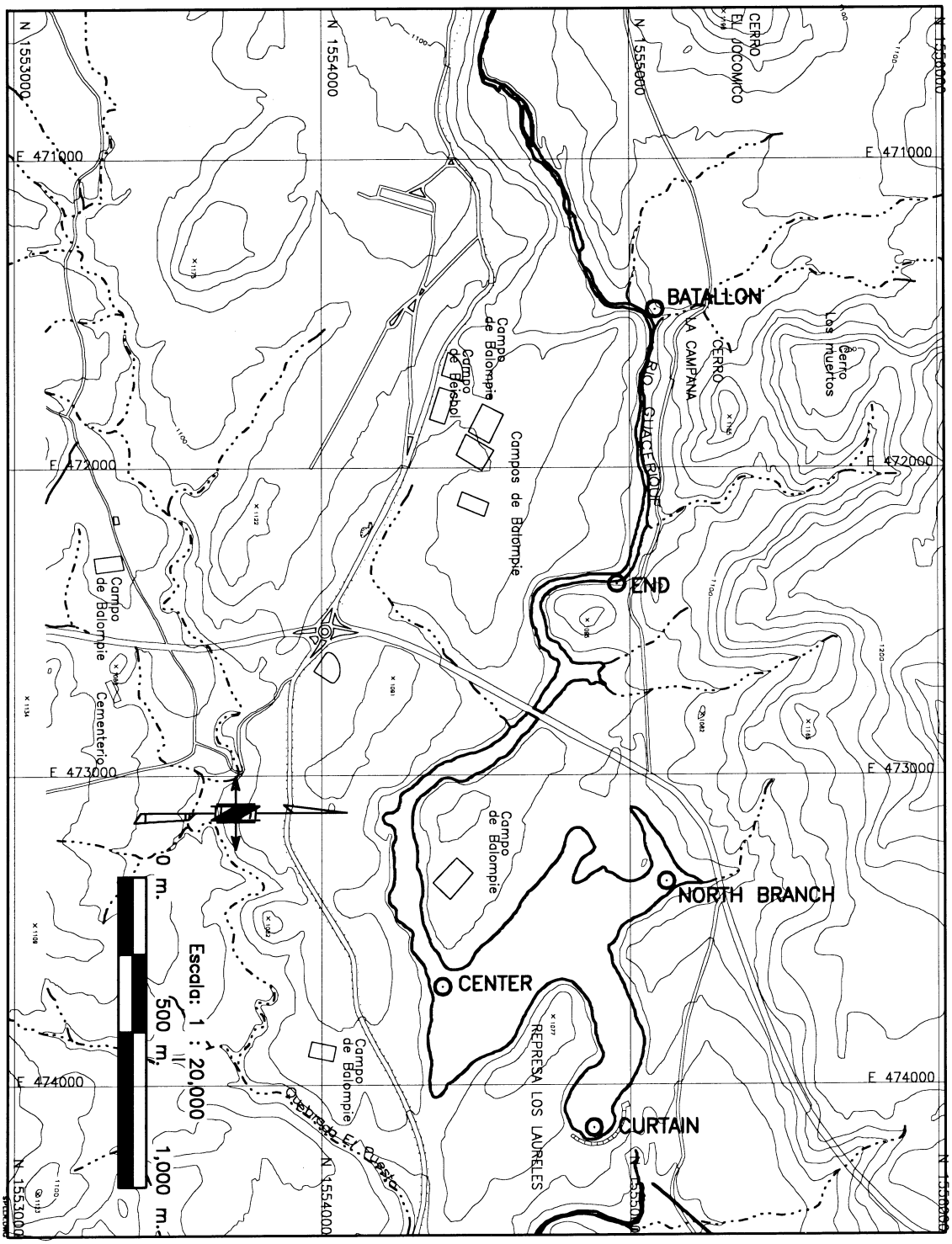

Figure D.2.3	Sampling Point at Los Laureles Reservoir

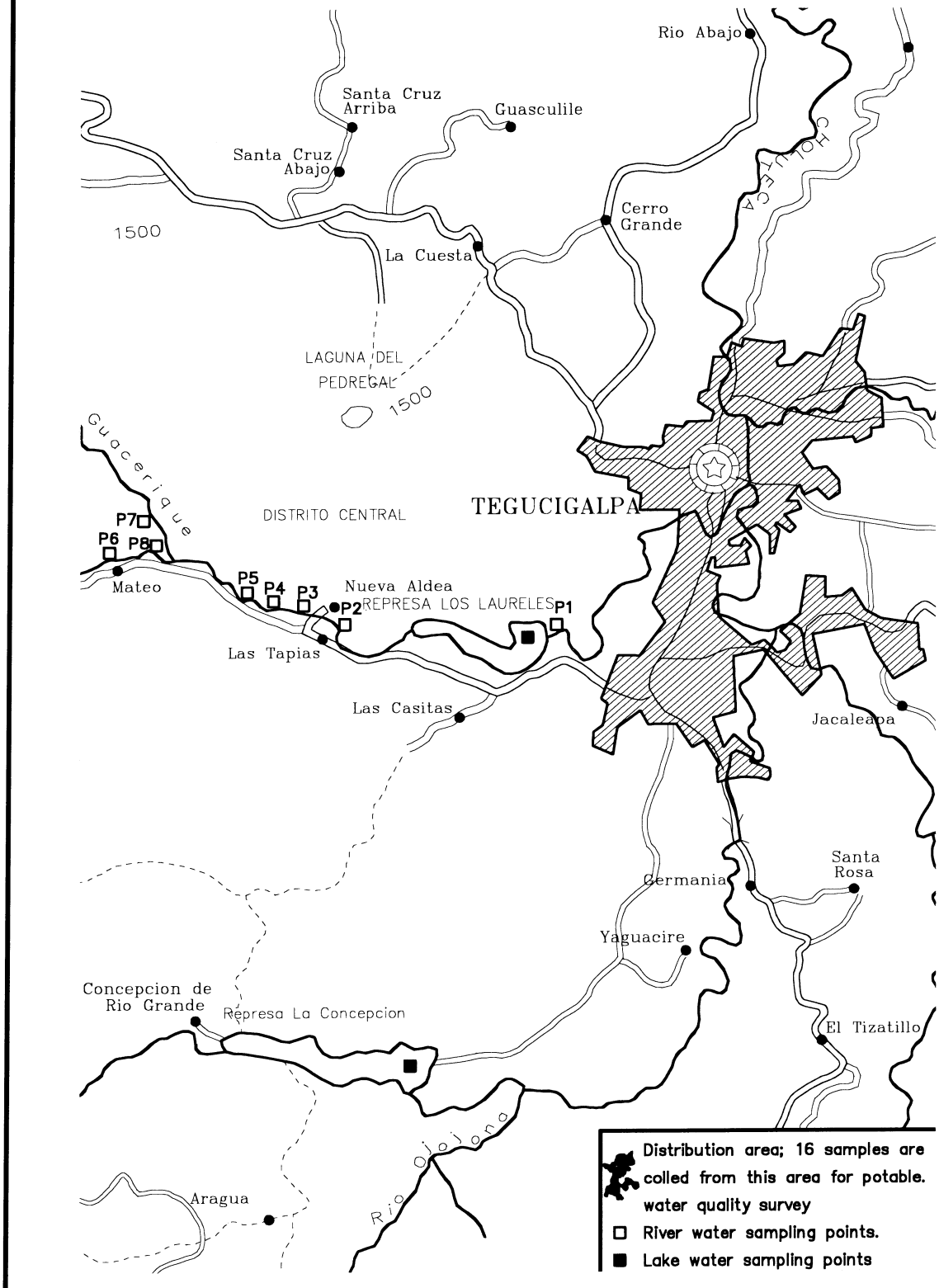

Figure D.2.4	Sampling Point for Water Quality Survey by JICA Study

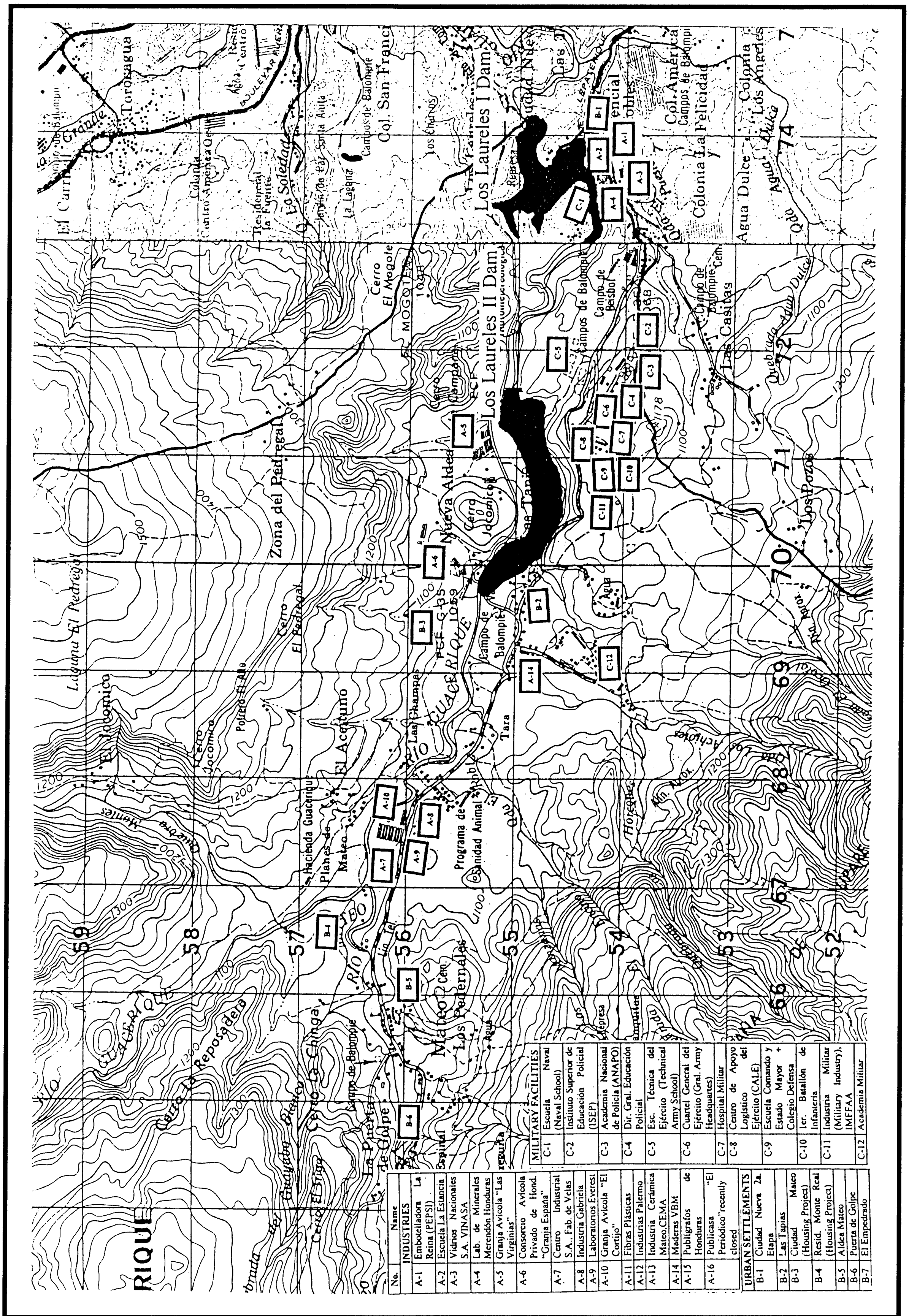

Figure D.2.5	Location of Industries/Urban & Military Settlements at Guacerique River Basin

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ABBREVIATIONS

Name	Spanish	English
AFE-COHDEFOR	Administración Forestal del Estado-Corporación Hondureña de Desarrollo Forestal	Forestry Administration of the State-Honduran Forestry Development Corporation
AMDC	Alcaldía Municipal del Distrito Central	Municipality of the Central District
CESCCO	Centro de Estudios sobre Control de Contaminantes	Center of Studies on Control of Polluting Agents
COHDEFOR	Corporación Hondureña de Desarrollo Forestal	Honduran Forestry Development Corporation
CONAMA(previous)	Comisión Nacional del Medio Ambiente	National Commission on Environment
BID	Banco Interamericano de Desarrollo	Interamerican Development Bank
DC	Distrito Central	Central District
DECA	Dirección de Evaluación y Control Ambiental	Directorate of Environmental Evaluation and Control
DGEC	Dirección General de Estadísticas y Censos	General Directorate of Statistics and Census
ENEE	Empresa Nacional de Energía Eléctrica	National Electricity Enterprise
FNUAP	Fondo de Población de las Naciones Unidas	United Nations Population Fund
FAO	Organización para la Alimentación y la Agricultura	Food and Agriculture Organization
INJUPEMP	Instituto Nacional de Jubilaciones y Pensiones de los Empleados y Funcionarios del Poder Ejecutivo	National Institute of Pensions of the Employees and Functionaries of the Executive Power
JICA	Agencia Internacional de Cooperación de Japón	Japanese International Cooperation Agency
METROPLAN	Oficina de Planificación Urbana de la AMDC	Urban Planning Office of AMDC
OPS	Organización Panamericana de la Salud	Panamerican Health Organization (PHO)
OMS	Organización Mundial de la Salud	World Health Organization(WHO)
PNUD	Programa de las Naciones Unidas para el Desarrollo	United Nations Development Program (UNDP)
SANAA	Servicio Nacional Autónomo de Acueductos y Alcantarillados	National Autonomous Service of Water and Sewerage
SECOPT (previous)	Secretaría de Comunicaciones, Obras Públicas y Transporte	Secretariat of communications, Public Works and Transport
SECPLAN (previous)	Secretaría de Planificación, Coordinación y Presupuesto	Secretariat of Planning, Coordination and Budget
SEDA (previous)	Secretaría del Ambiente	Secretariat of Environment
SERNA	Secretaría de Recursos Naturales y Ambiente	Secretariat of Natural Resources and Environment
SETCO	Secretaría Técnica de Cooperación Internacional	Technical Secretariat of International Cooperation
SOPTRAVI	Secretaría de Obras Públicas, Transporte y Vivienda	Secretariat of Public Works, Transportation and Housing

ANNEX No.1

WATER QUALITY ANALYSES

A) BY SANAA DURING 1999 (Tables AD.1.1—AD.1.9)
B) BY JICA STUDY TEAM DURING DRY/RAINY SEASONS 2000
(Tables AD.2.1 —AD.2.6, Figures AD.2.1～ AD.2.7)

Table AD.1.1 Water Quality at Guacerique River (1999)

No.	Name of Test	*Standard (FWPCA) (mg/L) max*	*Standard (Honduras, Draft) (mg/L) max*	#1 (Batallón) (28/1/99)	#1 (Batallón) (18/2/99)	#1 (Batallón) (1/10/99)	#2 (Candelera) (28/1/99)	#2 (Candelera) (18/2/99)	#2 (Candelera) (1/10/99)	#3 (Monterreal) (28/1/99)	#3 (Monterreal) (18/2/99)	#3 (Monterreal) (1/10/99)	#4 (Juajire) (28/1/99)	#4 (Juajire) (18/2/99)	#4 (Juajire) (1/10/99)	#5 (Quiscamote) (28/1/99)	#5 (Quiscamote) (18/2/99)	#5 (Quiscamote) (1/10/99)	#6 (Guaralalao) (28/1/99)	#6 (Guaralalao) (18/2/99)	#6 (Guaralalao) (1/10/99)
	A) BACTERIOLOGICAL																				
1	Bactery (N/100ml)																				
2	Fecal Coliform Bacteria (N/100ml)	*2,000*	*2,000*	**46,500**	900	40	1,100	700	0	900	600	0	500	400	0	0	0	320	700	4,000	20
3	Total Coliform Bacteria (N/100ml)	*10,000*	*10,000*	**46,500**	1,200	2,200	1,100	1,000	4,300	2,000	1,400	1,900	800	400	600	200	0	1,500	800	6,400	2,400
	B) PHYSIC-CHEMICAL																				
1	Fe+3					0.75			0.75			0.38			0.38			0.38			0.5
2	Mn+2					2.07			1.96			2.39			1.48			1.27			2.17
3	N-NH3					0.62			0.26			0.12			0.19			0.16			0.56
4	NO2-		*3*	0	0.01	0.01	0.01	0	0.01	0.01	0.01	0	0	0	0.01	0	0	0	0	0	0.01
5	NO3-	*10*	*50*	0	0.8	1.4	0.5	0.6	1.2	0.5	0.6	1.8	1.3	1	1.7	1.2	0.9	1.4	1.8	0.6	1.3
6	O2 Disuelto	*>4*	*>4*	7	5.5	11.2	7.7	**4**	11.4	7.7	**2.8**	11.4	8.4	4.3	11.2	8.4	**3.3**	11.4	9	**2.8**	11.35
7	O-PO4-		*0.5*	**1.48**	0.49		**0.68**	0.31		**0.69**	0.32		**0.71**	**0.54**		**0.65**	0.29		0.25	0.31	
8	pH (in situ)	*6--8.5*	*6--9.0*			**5.00**			6.50			6.80			6.80			6.80			6.8
9	pH (Lab.)	*6--8.5*	*6--9.0*	7.99	8.00	7.05	7.65	7.80	7.25	7.65	7.45		7.45	7.40	7.15	7.55	7.45	7.20	7.45	7.15	7.18
10	Total Solids			62	16	174	102	52	210	60	62	174	6	68	146	16	76	166	98	36	118
11	Temperaturea (oC)	*30*				29			20						18			21			19

ND: No Detected

FWPCA:Federal Water Pollution Control Administration, Maximum Contaminant Concentrations Allowable in Sources of Public Water Supplies (USA)

Note: Values in **bold letters** are out of the standards

Sources: 1) Quality Control Laboratory, Metropolitan Division, SANAA

2) Health Ministry, 2000, Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People (Draft as June 2000)

3) W.F. Chen, 1995, The Civil Engineering Handbook; pp. 171

Table AD.1.2 Water Quality at Sabacuante and Tatumbla Rivers (1999)

No.	Name of Test	*Standard (FWPCA) (mg/L) max*	*Standard (Honduras, Draft) (mg/L) max*	Queb. Sabacuante (4,11/5/99)	Queb. Sabacuante (4/8/99)	Queb. Sabacuante (11/10/99)	Queb. Tatumbla (4,6/5/99)	Queb. Tatumbla (11,12,18/5/99)
	A) BACTERIOLOGICAL							
1	Bactery (N/100ml)			6,920	1,200	25,000	1,400	12,000
2	Fecal Coliform Bacteria (N/100ml)	*2,000*	*2,000*	21	14	100	16	40
3	Total Coliform Bacteria (N/100ml)	*10,000*	*10,000*	100	150	100	90	80
	B) PHYSIC-CHEMICAL							
1	Al+3		*0.2*	0.02	0.035	0.037	0.008	0.075
2	Alkalinity (Total)			39.54	12.75	11.61	13.95	9.03
3	Ca+2			16.8	5.6	8.98	12.8	4.9
4	Cl-	*250*	*600*	12.9	6.3	1.36	13.20	2.27
5	CO2			0			0	
6	CO3-			0	0	0	0	0
7	Color (Pt-Co unit)	*75*	*800*	22.5	45	175	17.5	175
8	Conductivity(us/L)	-	*1600*	102	32	42	60	32
9	Cu			1.08	0.19	0.77	0.95	0.65
10	Cyanide (Cn-)	*0.2*	*0.07*	0.005	0.01	0.005	0.005	0.005
11	Chromium (Cr6+)			0.22	0.09	0.02	0.21	0.05
12	Dissolved Solids	*500*	*1,000*	51	16	21	30	16
13	DO	*>4*	*>4*	2.75		11.2	2.4	11.2
14	Fe+3			0.125	0.125	0.75	0.125	0.25
15	Hardness (Ca)			42	14	22.44	32	12.44
16	Hardness (Mg)			34	0	18.36	40	28.56
17	Hardness (Total)			76	14	40.8	72	40.8
18	HCO3-			39.54	12.75	11.61	13.95	9.03
19	Mg+2			8.26	0	4.46	9.72	6.94
20	Mn+2			1.04		0.67	1.14	0.56
21	Nitrate (as NO3-)	*10*	*50*	1.1	2	0.8	0.4	1
22	Nitrites (as NO2-)		*3*	0	0.01	0	0	0.01
23	N-NH3			0.05	0.14	0.16	0.1	0.33
24	Odor			Odorless	Odorless	Odorless	Odorless	Odorless
25	O-PO4-		*0.5*	**0.69**		**3.7**	**1.19**	**0.57**
26	Organic Material			2.9	4		2.2	
27	pH (in situ)	*6--8.5*	*6--9*					
28	pH (Lab)	*6--8.5*	*6--9*	7.1	6.38	7.7	6.2	7
29	pH Sat	*6--8.5*	*6--9*	8.6	9.5	9.45	9.05	9.85
30	Saturation Index			-1.5	-3.12	-2.75	-2.82	-2.85
31	SO4--	*250*	*400*	3.7	6	4.7	4.7	7.7
32	Temperature	*30*		24	19	18	22	19
33	Total Solids			70	60	108	32	102
34	Turbidity (NTU)		*600*	4.3	21	61	3.1	64
	C) HEAVY METALS							
1	Arsenic (As)	*0.05*	*0.05*	ND		ND	ND	ND
2	Cadmio (Cd)	*0.01*	*0.003*	ND		ND	ND	ND
3	Cupper (Cu)	*1.0*	*1.0*	0.04		0.042	0.01	0.05
4	Iron (Fe)	*0.3*	*1.0*	**2.42**		**1.002**	**1.56**	0.649
5	Lead (Pb)	*0.05*	*0.05*	ND		ND	ND	ND
6	Manganese (Mn)	*0.05*	*1.0*	1		0.006	0.62	ND
7	Potassium (K)			0.09		1.12	0.12	1.11
8	Sodium (Na)		*200*	2.14		3.053	1.85	2.409

ND: No Detected

FWPCA:Federal Water Pollution Control Administration, Maximum Contaminant Concentrations Allowable in Sources of Public Water Supplies (USA)

Note: Values in **bold letters** are out of the standards

Sources: 1) Quality Control Laboratory, Metroplitan Division, SANAA

2) Health Ministry, 2000, Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People (Draft)

3) W.F. Chen, 1995, The Civil Engineering Handbook; pp. 171

Table AD.1.3 Water Quality at El Picacho (1999)

No.	Name of Test	*Standard (FWPCA) (mg/L) max*	*Standard (Honduras, Draft) (mg/L) max*	Picacho (Jucuaras #1) (26/4/99), (3,7/5/99)	Picacho (Jucuaras #2) (26/4/99), (3,7/5/99)	Picacho (Jucuaras #3) (26/4/99), (4/5/99)	Picacho (Jucuaras#7) (20,25/10/99)	Picacho (La Tigra #4) (27/4/99), (3,7/5/99)	Picacho (La Tigrita #5) (27/4/99), (3,7/5/99	Picacho (Jutlapa #6) (27/4/99), (3,7/5/99	Picacho (Jutlapa) (1,2,4/11/99)	Picacho (SJ Juncales #7) (29/4/99), (4,6,11/5/99)	Picacho (SJ Juncales) (19,25/10/99)	Picacho (Trojes #8) (29/4/99), (4,6,11/5/99)	Picacho (Trojes) (19,25/10/99)	Picacho (Cañas #9) (29/4/99), (4/5/99)	Picacho (El Carrizal #5) (20/10/99)	Picacho (Carrizal #10) (1/5/99), (4,6,11/5/99)	Picacho (Jaboneras #11) (1/5/99), (4,6,11/5/99)
	A) BACTERIOLOGICAL																		
1	Bactery (N/100ml)			3,800	8,300	4,480	186,000	6,200	100	15,500	62,000	15,500	248,000	18,600	155,000	34,100	93,000	2,000	1,840
2	Fecal Coliform Bacteria (N/100ml)	*2,000*	*2,000*	2	30	59	20	48	0	0	0	36	0	0	0	7	10	0	0
3	Total Coliform Bacteria (N/100ml)	*10,000*	*10,000*	70	30	300	700	48	0	0	0	80	0	0	300	30	600	20	0
	B) PHYSIC-CHEMICAL																		
1	Al+3		*0.2*	0.008	0.13	0.11	0.11	0.019	0.03	0.14	0.08	0.011	0.07	0.07	0.03	0.017	**0.26**	0.04	0.0019
2	Alkalinity (Total)			16.28	15.11	10.46	9.03	6.97	69.78	9.3	3.87	17.44	7.74	6.97	10.32	70.94	19.5	10.46	32.56
3	Ca+2			6.4	12.8	8.8	2.45	9.6	50.4	5.6	8.16	13.6	3.26	16.4	7.34	44.8	12.24	12.8	24.8
4	Cl-	*250*	*600*	5.7	5.4	5.4	0.45	5.4	8.2	8.2	3.47	8.2	2.27	6.8	1.36	10.4	2.72	9.7	10
5	CO2			0	0	0		IS	IS	IS	0	0	0	0	0	6.95		0	2.32
6	CO3-			0	0	0	0	0	0	0	0	0	0	0	3.87	8.14	10.32	0	0
7	Color (Pt-Co unit)	*75*	*800*	12.5	32.5	32.5	60	32.5	187.5	12.5	12.5	22.5	75	22.5		22.5	67.5	27.5	12.5
8	Conductivity(us/L)	-	*1600*	38	60	40	25	36	160	55	47	80	39	98	72.5	210	66.5	55	118
9	Cu			0.66	0.6	0.63	0.79	0.73	0.76	0.24	0.54	0.61	0.79	0.52	0.41	0.54	0.59	0.67	0.65
10	Cyanide (Cn-)	*0.2*	*0.07*	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
11	Chromium (Cr6+)			0.25	0.26	0.25	0	0.23	0.24	0.26	0.01	0.26	0	0.21	0.01	0.24	0	0.24	0.24
12	Dissolved Solids	*500*	*1,000*	19	30	20	12.5	18	80	27.5	23.5	40	19.5	49	36.25	105	33.25	27.5	59
13	DO	*>4*	*>4*					6.1	**2.8**	5.9	10.2	**3.7**	11.5	**4**	11.2	4.3	11.6	4.5	4.3
14	Fe+3			0.05	0.75	0.125	0.25	0.125	8.75	0.125	0.38	0.75	0.5	0.75	0.5	0.38	0.125	1.5	0.38
15	Hardness (Ca)			16	32	22	6.12	24	126	14	20.4	34	8.16	42	18.36	112	30.6	32	62
16	Hardness (Mg.)			70	32	74	14.28	48	0	60	6.12	30	14.28	34	14.28	40	8.76	60	32
17	Hardness (Total)			86	64	96	20.4	72	126	74	26.52	64	22.44	76	32.64	152	38.76	92	94
18	HCO3-			16.28	15.11	10.46	9.03	6.97	69.78	9.3	3.87	17.44	7.74	6.97	6.45	62.8	9.03	10.46	32.56
19	Mg+2			17.01	7.77	17.98	3.47	11.66	0	14.58	1.49	7.29	3.47	8.26	3.47	9.72	2.13	14.58	7.77
20	Mn+2			0.86	0.99	0.97	0.94	1.02	3.5	0.92	0.38	0.99	1.22	0.95		1.2		1.47	1.11
21	Nitrate (as NO3-)	*10*	*50*	0.2	0.2	0.3	1.3	0.4	0.1	0.1	0.2	0.2	1.1	0.3	1	0.6	0.9	0.8	0.4
22	Nitrites (as NO2-)		*3*	0	0	0	0	0.02	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0.01	0	0.01
23	N-NH3			0.05	0.06	0.05	0.16	0.17	0.38	0.05	0.096	0.05	0.06	0.01	0.037	0.03	0.1	0.04	0
24	Odor			Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless		Odorless	Odorless	Odorless	Odorless
25	O-PO4-		*0.5*	**0.69**	**2.17**	**2.1**	**4.16**	**3.07**	**32.09**	**187.9**	**0.29**	**1.2**	**0.91**	**0.63**	**8.6**	**63.1**	**1.9**	**0.66**	**0.78**
26	Organic Material			2.4	3.4	3.4		2.8	3.7	1.6	2.8	2.8	3.7	1.8	3.4	2.5		1.4	1.5
27	pH (in situ)	*6--8.5*	*6--9*																
28	pH (Lab.)	*6--8.5*	*6--9*	6.8	7	6.8	6.4	6.4	6.2	**4.6**	**5.5**	6.6	**5.8**	**5.2**	6.5	7.85	6.75	6.2	7.15
29	pH Sat	*6--8.5*	*6--9*	9.5	9.2	9.7	10				9.9	9.15	9.75	9.4	9.6	8.1	9.2	9.4	8.65
30	Saturation Index			-2.7	-2.2	-2.9	-3.6				-4.4	-2.55	-3.95	-4.2	3.1	-0.25	-2.45	-3.2	-1.5
31	SO4-	*250*	*400*	2.7	3.8	3.5	7.1	9	2.3	10.3	9.15	9.8	11.9	21.1	11.9	24.6	9.3	9.3	12.1
32	Temperature	*30*		17	15.5	16	20				17	18		20	18	19.5	19	23	23.5
33	Total Solids			56	30	110	40	38	238	32	26	82	134	60	90	108	136	190	110
34	Turbidity		*600*	1.9	4.5	4.6	42	9.8	53	1.3	9.9	3.2	45	4.2	79	3.9	48	6.3	2.8
	C) HEAVY METALS																		
1	Arsenic (As)	*0.05*	*0.05*	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
2	Cadmio (Cd)	*0.01*	*0.003*	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND
3	Cupper (Cu)	*1*	*1*	ND	ND	ND	0.05	ND	ND	ND	0.019	0.002	ND	0.007	0.014	ND		0.01	0.01
4	Iron (Fe)	*0.3*	*1*	0.19	**1.32**	0.54	**1.988**	**1.48**	**15.8**	**1.77**	**6.717**	**1.86**	**3.765**	**1.06**	**1.034**	**1.16**		0.57	0.18
5	Lead (Pb)	*0.05*	*0.05*		ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND	ND
6	Manganese (Mn)	*0.05*	*1*	0.34	0.14	0.02	ND	0.21	0.17	0.1	0.075	0.97	ND	**1.38**	ND	**1.27**			0.76
7	Potassium (K)			5.19	4.19	4.41	1.078	0.97	1.94	1.32	0.548	0.22	0.64	0.15	0.582	0.12		0.05	0.03
8	Sodium (Na)		*200*	2.54	2.61	2.57	2.732	1.52	2.71	1.29	14.47	5.39	3.288	2.22	3.639	4.75		4.47	4.62

ND: No Detected

FWPCA:Federal Water Pollution Control Administration, Maximum Contaminant Concentrations Allowable in Sources of Public Water Supplies (USA)

Note: Values in **bold letters** are out of the standards

Sources: 1) Quality Control Laboratory, Metroplitan Division, SANAA

2) Health Ministry, 2000, Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People (Draft as June 2000)

3) W.F. Chen, 1995, The Civil Engineering Handbook; pp. 171

Table AD.1.4 Water Quality at Los Laureles Reservoir (1999)

No.	Name of Test	*Standard (FWPCA) (mg/L) max*	*Standard (Honduras, Draft) (mg/L) max*	Laureles Dam #1 (End) (17/2/99)	Laureles Dam #1 (End) (2/3/99)	Laureles Dam #1 (End) (18/3/99)	Laureles Dam #1 (End) (27/9/99), (5,15,25/10/99	Laureles Dam #2 (Center) (17/2/99)	Laureles Dam #2 (Center) (2/3/99)	Laureles Dam #2 (Center) (18/3/99) 22,23/3/99	Laureles Dam #2 (Center) (27/9/99), (5,15,25/10/99	Laureles Dam #3 (Curtain) (17/2/99)	Laureles Dam #3 (Curtain) (2/3/99)	Laureles Dam #3 (Curtain) (18/3/99)	Laureles Dam #3 (Curtain) (27/9/99), (5,15,25/10/99	Laureles Dam #4 (North Channel) (17/02/99)	Laureles Dam #4 (North Channel) (2/03/99)	Laureles Dam #4 (North Channel) (18/03/99)	Laureles Dam #4 (North Channel) (27/9/99)	Laureles Dam #5 (raw water) (27/9/99)
	A) BACTERIOLOGICAL																			
1	Bactery (N/100ml)						42,800				70,200				24,200					
2	Fecal Coliform Bacteria (N/100ml)	*2,000*	*2,000*	**2,200**	1,400	300	**49,500**	0	0	0	1,650	0	0	0	670	0	0	0	1,090	**2,560**
3	Total Coliform Bacteria (N/100ml)	*10,000*	*10,000*	1,400	1,400	220	**49,500**	0	0	0	1,650	0	0	0	2,500	0	0	0	1,600	2,560
	B) PHYSIC-CHEMICAL																			
1	Al+3		*0.2*				0.009				0.06			0.14	0.087				0.11	0.1
2	Alkalinity (Total)						27.09			56.66	21.93			58.88	23.22			57.77	21.93	24.51
3	Ca+2					36	10.61			20	4.9			20	8.16			18.4	8.16	14.69
4	Cl-	*250*	*600*				1.36				1.36			11.8	1.36				1.36	0.45
5	CO2													2.32						
6	CO3-					0	0			0	0			0	0			0	0	0
7	Color (Pt-Co unit)	*75*	*800*			42.5	97.5			22.5	127.5			22.5	162.5			22.5	150	**875**
8	Conductivity(us/L)	-	*1600*			160	72			130	64			185	66			210	68	52
9	Cu						0.47				0.64			0.12	0.61				0.71	0.77
10	Cyanide (Cn-)	*0.2*	*0.07*				0.005				0.005			0.005	0.005				0.005	0.005
11	Chromium (Cr6+)					80	0.02				0.02			0.21	0.02				0	0.07
12	Dissolved Solids	*500*	*1,000*				36			65	32			92.5	33			105	34	26
13	DO	*>4*	*>4*	6.9	**3.05**	**3.8**	12.2	6	7.3	6.8	11.2	6.5	7.6	6.75	11	5.8	7.4	6.3	10.9	8.25
14	Fe+3						0.38				0.5			0.125	0.38				0.38	3
15	Hardness(Ca)					90	26.52			50	12.24			50	20.4			46	20.4	36.72
16	Hardness (Mg)					48	8.16			24	24.48			23	16.32			28	26.52	20.4
17	Hardness (Total)					138	34.68			74	36.72			73	36.72			74	46.92	57.12
18	HCO3-					108.88	27.09			56.66	21.93			58.88	23.22			57.77	21.93	24.51
19	Mg+2					11.66	1.98			5.83	5.95			5.59	3.97			6.8	6.44	4.96
20	Mn+2						1.29				1.56			1.07	1.05				0.96	1.03
21	Nitrate (as NO3-)	*10*	*50*	0.4	0	0.3	1	0.4	0	0.3	1.3	0.5	0	0.3	1.5	0.5	0	0.3	1.6	3
22	Nitrites (as NO2-)		*3*	0	0.05	0.1	0.01	0	0.05	0.01	0.01	0	0.05	0.01	0.01	0	0.05	0.01	0.01	0.01
23	N-NH3						0.22				0.4			0.15	0.44				0.48	0.66
24	Odor						Odorless				Odorless				Odorless				Odorless	Odorless
25	O-PO4-		*0.5*	0.25	0.015	0.27	0.5	0.24	0.0075	**0.79**	**2.05**	0.26	0.0075	**0.59**	**0.74**	**3.3**	0.0075	**1.15**	**0.79**	0.43
26	Organic Matter													3.3						
27	pH (in situ)	*6--8.5*	*6--9*		6.8		7		6.8		6.8		6.8		6.8		6.8		6.8	
28	pH (Lab)	*6--8.5*	*6--9*	7.15	6.45	6.8	6.8	7.6	6.58	7.3	6.82	7.4	7.5	7.4	6.95	7.45	7.39	7.2	7	6.8
29	pH Sat	*6--8.5*	*6--9*				9.1				9.45			3.4	9.15				9.2	9.3
30	Saturation Index						-2.3				-2.63			1	-2.2				-2.2	-2.5
31	SO4--	*250*	*400*				4.76				7.86			6.15	7.86				9.05	8.09
32	Temperature	*30*		21	25	25	22	23	24	24	23	22	24	23	23	23		25	24	18
33	Total Solids			182	148		158	66	98	222	166	60	48	146	172		64	158	172	818
34	Turbidity (NTU)		*600*			24	51			7.1	51			6.7	78			10	74	390
	C) HEAVY METALS																			
1	Arsenic (As)	*0.05*	*0.05*				ND			ND	ND				ND					ND
2	Cadmio (Cd)	*0.01*	*0.003*				0.015			ND	0.002				ND					ND
3	Cupper (Cu)	*1*	*1*				0.044			0.005	0.035				0.032					0.083
4	Iron (Fe)	*0.3*	*1*				**2.878**			0.694	**1.292**				**1.86**					**27.69**
5	Lead (Pb)	*0.05*	*0.05*				ND			ND	ND				ND					ND
6	Manganese (Mn)	*0.05*	*1*				0.046			ND	0.03				0.008					0.229
7	Potassium (K)						3.86			2.35	3.22				1.69					2.24
8	Sodium (Na)		*200*				3.13			3.58	5.534				2.92					1.9628

ND: No Detected

FWPCA:Federal Water Pollution Control Administration, Maximum Contaminant Concentrations Allowable in Sources of Public Water Supplies (USA)

Note: Values in **bold letters** are out of the standards

Sources: 1) Quality Control Laboratory, Metroplitan Division, SANAA

2) Health Ministry, 2000, Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People (Draft as June 2000)

3) W.F. Chen, 1995, The Civil Engineering Handbook; pp. 171

Table AD.1.5 Water Quality at Concepcion Reservoir (1999)

Table D.2.3.5 Water Quality at Concepcion Reservoir (1999)											
No.	Name of Test	*Standard (FWPCA) (mg/L) max*	*Standard (Honduras, Draft) (mg/L) max*	Concepción Dam #1 (End) (5/10/99), (7,15,25/10/99	Concepción Dam #2 (End) (14/4/99)	Concepción Dam #2 (End) (5/10/99)	Concepción Dam #3 (14/4/99)	Concepción Dam #3 (Centro) (5,7,15,25/10/99)	Concepción Dam #4 (Curtain) (14,,20/4/99)	Concepción Dam #4 (Curtain) (5,7,15,25/10/99)	Concepción Dam (raw water) (6,7,15/10/99)
	A) BACTERIOLOGICAL										
1	Bactery (N/100ml)			217,000	12,000	93,000	9,000	155,000	10,000	24,000	3,160
2	Fecal Coliform Bacteria (N/100ml)	*2,000*	*2,000*	110	0	50	0	90	0	40	0
3	Total Coliform Bacteria (N/100ml)	*10,000*	*10,000*	110	160		20		0		0
	B) PHYSIC-CHEMICAL										
1	Al+3		*0.2*	0.011	0.02	0.033	0.0025	0.037	0.06	0.017	0.017
2	Alcalinity (Total)			18.06	89.99	28.38	37.77	46.44	24.44	25.8	15.94
3	Ca+2			4.9	32	9.79	12	8.98	8.8	12.24	14.69
4	Cl-	*250*	*600*	0.45	3.6	1.36	3.2	0.45	0.7	2.27	0.91
5	Cn-			0.005	0.01	0.005	0.005	0.005	0.01	0.005	0.005
6	CO2				0		0		0		
7	CO3--	*75*	*800*	0	0	0	0	16.77	4.45	0	2.13
8	Color (UC)	-	*1600*	175	750	250	22.5	275	875	275	350
9	Conductivity (Mhoms/cm)			54	220	64	120	61	60	58	35
10	Cr+6	*0.2*	*0.07*	0.01	0.27	0.02	**0.25**	0.01	**0.28**	0	0.01
11	Cu			0.95	0.42	0.59	0.21	0.53	0.79	0.37	1.14
12	Dissolved Solids	*500*	*1,000*	27	110	32	60	30.5	30	29	17.5
13	DO	*>4*	*>4*	9.2	5	7.6	9	8.7	9	8.8	11.05
14	Fe+3			0.38	12.5	0.25	0.25	0.25	1.5	0.38	3
15	Hardness (Ca)			12.24	80	24.48	30	22.44	22	30.6	36.72
16	Hardness (Mg)			38.76	0	6.12	8	0	8	0	0
17	Hardness (Total)			51	80	30.6	38	22.44	30	30.6	36.72
18	HCO3-			18.06	89.99	28.38	37.77	29.67	19.99	25.8	13.81
19	I Sat			-2.65	-1.35	-2.5	-0.95	-2.65	-2.3	-2.33	-2.03
20	Mg+2			9.42	0	1.49	1.94	0	1.94	0	0
21	Mn+2			0.95	4	0.84	0.34	1.09	1.7	1.19	1.61
25	Nitrate (as NO3-)	*10*	*50*	1	0.3	2.9	0.5	2.8	1	1.4	1.2
24	Nitrite (as NO2-)		*3*	0	0.01	0.01	0	0	0.01	0	0.01
22	Mo				9.5		3.8		6.4		
23	N-NH3			0.44	0.37	0.77	0.1	0.89	0.08	0.43	0.57
26	Odor			Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless
27	O-PO4-		*0.5*	**1.89**	**1.3**	**6.24**	0.023	**0.92**	**0.73**	**1.99**	**0.87**
28	pH (in situ)	*6--8.5*	*6--9*	6.80	6.00	6.80	7.20	6.80	**5.80**	7.00	
29	pH (Lab.)	*6--8.5*	*6--9*	6.85	6.90	6.60	7.85	**5.95**	7.10	6.62	6.90
30	pH Sat	*6--8.5*	*6--9*	9.5	8.25	9.1	8.8	8.8	9.4	8.95	9.2
31	SO4--	*250*	*400*	6.9	5.3	11.03	3.5	6.95	8.4	7.14	6.77
32	Temperature (oC)	*30*		24	25	23	26	26	22	24	23.5
33	Total Solids			146	404	186	86	212	454	196	220
34	Turbidity (NTU)		*600*	71	260	79	6.4	92	280	92	120
	C) HEAVY METALS										
1	Arsenic (As)	*0.05*	*0.05*	ND				ND		ND	ND
2	Cadmium (Cd)	*0.01*	*0.003*	ND				ND		ND	ND
3	Cupper (Cu)	*1*	*1*	0.037				0.024		0.06	0.07
4	Iron (Fe)	*0.3*	*1*	0.517				0.792		**1.268**	**1.689**
1	Lead (Pb)	*0.05*	*0.05*	ND				ND		ND	ND
2	Manganese (Mn)	*0.05*	*1*	0.003				ND		0.007	0.026
3	Potasium (K)			2.99				3.19		1.09	4.127
4	Sodium (Na)		*200*	3.53				2.172		4.174	2.292

ND: No Detected

FWPCA:Federal Water Pollution Control Administration, Maximum Contaminant Concentrations Allowable in Sources of Public Water Supplies (USA)

Note: Values in **bold letters** are out of the standards

Sources: 1) Quality Control Laboratory, Metroplitan Division, SANAA

2) Health Ministry, 2000, Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People (Draft as June 2000)

3) W.F. Chen, 1995, The Civil Engineering Handbook; pp. 171

Table AD.1.6 Water Quality at Los Laureles Treatment Plant (After Treatment) (1999)

No.	Name of Test	*Standard WHO (mg/L) max*	*Standard Honduras (mg/L) max*	January	February	March	April	May	June	July	August	September	October	November	December
	A) BACTERIOLOGICAL														
1	Bactery (N/100ml)			320	360	54	70	196	160	565	45	225	35	580	239
2	Fecal Coliform Bacteria (N/100ml)	*0*	*0*	0	0	0	0	0	0	0	0	0	0	0	0
3	Total Coliform Bacteria (N/100ml)	*0*	*0*	0	0	0	0	0	0	0	0	0	0	0	0
	B) PHYSIC-CHEMICAL														
1	Al+3	*0.2*	*0.2*	0.021	0.08	0.078	0.026	0.028	0.43	0.097	0.094	0.52	0.26	0.031	0.026
2	Alkalinity (Total)			29.7	39.19	48.58	63.43	68.17	38.72	24.03	24.73	15.68	19	20.45	32
3	Ca+2														
4	Cl2	*250*	*250*	2.7	2.3	2.2	2.1	1.7	1.3	1.6	1.8	1.4	2.01	2.07	2.1
5	CO2			0	0	0	4.63	0	0	0	0	0	0	4.63	0
6	CO3-														
7	Color (Pt-Co unit)	*15*	*15*	4.9	2.5	4.73	9.2	14.2	12.7	9.9	6.7	12.1	6.82	6.82	9.1
8	Conductivity(us/cm)		*400 (RV)*	169.10	185.10	200.77	221.00	283.60	280.00	198.60	172.60	181.57	149.98	132.79	142.80
9	Cu		*2*												
10	Cyanide (Cn-)	*0.1*	*0.07*	0.01	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
11	Chromium (Cr6+)			0.22	0.25	0.26	0.25	0.19	0.25	0.21	0.01	0.01	0.04	0.03	0.01
12	Dissolved Solids (Total)	*1,000*	*1,000*												
13	Dissolved Oxygen			-	-	-	7.73	3.71	4.2	4.65	4.75	8.65	-	11.7	12.6
14	Fe+3														
15	Hardness(Ca)	*500*	*400 (RV)*	25.18	56	81.89	98.6	136	97	150	157	150.47	89.61	76.02	64.7
16	Hardness (Mg)														
17	Hardness (Total)														
18	HCO3-														
19	Mg+2														
20	Mn+2														
21	Nitrate (as NO3-)	*10*	*50*	1	0	0.5	0.6	0.4	0.3	0.5	3.2	0.1	0.2	-	-
22	Nitrites (as NO2-)	*1(EPA)*	*0.1/3.0**	0.005	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
23	N-NO3			0.005	0.003	0	0.002	0.045	0.035	0	0.003	0.056	0.009	0.061	0.02
24	Odor	*Odorless*	*0 (RV)*												
25	O-PO4-			0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
26	Organic Matter			1.9	1.7	2.3	3.4	5.7	1.1	1.4	1.3	4.6	0.4	5.4	1.4
27	pH (in situ)														
28	pH (Lab)	*6.5--8.5*	*6.5--8.5*	6.7	6.98	6.66	7.16	6.94	6.78	6.99	6.75	6.35	6.95	6.75	6.9
29	pH Sat			8.95	8.6	8.35	8.2	8	8.85	8.3	8.8	8.8	8.9	9.05	8.8
30	Saturation Index			-2.11	-1.15	-1.95	-1.12	-0.91	-2.07	-0.98	-2.88	-2.1	-1.85	-1.69	-2.17
31	SO4--	*400*	*250*	18	13.1	14.4	14.2	27.1	45.7	32.1	29.98	41.4	28.6	13.1	11.7
32	Temperature (oC)		*18--30*	21.5	21.5	22.43	24.1	25	23.5	22.03	23.3	20.5	18.92	18.35	18.83
33	Total Solids			83.5	94	95.6	111.7	133	208.4	88.5	96	105	117.5	58.5	71.5
34	Turbidity (NTU)	*5*	*5*	2.57	0.98	0.92	0.47	1.2	2.4	2.8	2.4	**5.24**	2.87	2.89	2.6
	C) HEAVY METALS														
1	Arsenic (As)	*0.05*	*0.01*	0	0	-	-	-	-	-	-	-	-	-	-
2	Cadmio (Cd)	*0.005*	*0.003*												
3	Cupper (Cu)	*1*	*2*	0.15	0.15	0.12	0.21	0.15	0.17	0.17	0.17	0.18	0.17	0.15	0
4	Iron (Fe)	*0.3*	*0.3*	0.05	0.05	0.025	0.038	0.09	0.038	0.025	0.038	0.085	0.025	0.019	0.025
5	Lead (Pb)	*0.05*	*0.01*												
6	Manganese (Mn)	*0.3*	*0.5*	0.065	0.05	0.22	**1.23**	**1.7**	**1.02**	0.31	0.26	0.31	0.019	0.034	0.019
7	Potassium (K)		*10*												
8	Sodium (Na)	*200*	*200*												

ND: No Detected, RV: Recommended Value
EPA: U.S. Environmental Protection Agency
* If the value 3.0 is selected, the values of nitrate and nitrite should be related as: NO3/RV(NO3)+NO2/RV(NO2) < 1
Note: Values in **bold letters** are out of the standards
Sources: 1) Quality Control Laboratory, Metroplitan Division, SANAA
2) Health Ministry/OPS/WHO,1995/10, National Technical Standard for the Drinking Water Quality
3) W.F. Chen, 1995, The Civil Engineering Handbook; pp. 171

Table AD.1.7 Water Quality at Concepcion Treatment Plant (After Treatment) (1999)

No.	Name of Test	*Standard WHO (mg/L) max*	*Standard Honduras (mg/L) max*	January	February	March	April	May	June	July	August	September	October	November	December
	A) BACTERIOLOGICAL														
1	Bactery (N/100ml)			12	7	5	22	33	35	193	172	26	25	15	15
2	Fecal Coliform Bacteria (N/100ml)	*0*	*0*	0	0	0	0	0	0	0	0	0	0	0	0
3	Total Coliform Bacteria (N/100ml)	*0*	*0*	0	0	0	0	0	0	0	0	0	0	0	0
	B) PHYSIC-CHEMICAL														
1	Al+3	*0.2*	*0.2*	0.88	0.32	0.55	0.12	0.21	0.078	0.12	0.195	0.097	0.055	0.04	0.27
2	Alkalinity (Total)			17.3	22.89	35.15	22.95	17.5	24.57	26.26	21.54	21.54	11.89	13.51	8.3
3	Ca+2														
4	Cl2	*250*	*250*	2.8	2.66	2.77	2.89	2.19	1.84	1.6	1.84	1.8	1.7	1.9	2.24
5	CO2			0	0	0	0	0	0	0	0	0	0	0	0
6	CO3-														
7	Color (Pt-Co unit)	*15*	*15*	6.4	3.23	3.6	5.19	3.03	3	3.8	2.69	2.6	2.6	2.6	2.6
8	Conductivity(us/cm)		*400 (RV)*	117.00	122.66	140.96	118.64	118.03	107.80	109.28	107.78	99.10	95.10	95.00	83.10
9	Cu		*2*												
10	Cyanide (Cn-)	*0.1*	*0.07*	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
11	Chromium (Cr6+)			0.16	0.24	0.22	0.28	0.21	0.22	0.24	0	0	0	0.03	0.01
12	Dissolved Solids (Total)	*1,000*	*1,000*												
13	Dissolved Oxyen			-	-	-	9.45	5.1	4.65	4.85	4.75	5.2	11.7	-	13.25
14	Fe+3														
15	Hardness(Ca)	*500*	*400 (RV)*	36.1	44.81	53.3	46.24	54.69	64.88	75.62	72.69	71	43	81.17	47
16	Hardness (Mg)														
17	Hardness (Total)														
18	HCO3-														
19	Mg+2														
20	Mn+2														
21	Nitrate (as NO3-)	*10*	*50*	0.6	0.4	0.6	1.3	0.2	0.2	0	0	0.2	0.2	-	-
22	Nitrites (as NO2-)	*1(EPA)*	*0.1/3.0**	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
23	N-NO3			0.015	0.005	0.025	0.015	0.015	0.015	0	0.015	0	0.03	0.019	0.024
24	Odor	*Odorless*	*0 (RV)*												
25	O-PO4-			0	0.023	0.011	0.023	0.011	0.069	0.023	0.023	0.023	0.023	0.023	0.023
26	Organic Matter			2.2	2.4	1.4	1.4	2.1	1.9	0.7	0.2	2.6	1.3	2	1.3
27	pH (in situ)														
28	pH (Lab)	*6.5--8.5*	*6.5--8.5*	**5.6**	6.18	7.69	7.53	6.9	7.13	7.55	7.09	6.98	6.42	6.59	**5.53**
29	pH Sat			9.6	9.75	9	8.8	8.6	8.7	8.4	8.4	9.2	9.2	8.85	10.05
30	Saturation Index			-4.9	-5.43	-3.57	-0.15	-0.35	-1.31	-1.16	-1.51	-2.65	-2.65	-1.93	-5.31
31	SO4--	*400*	*250*	37.5	36.7	34.5	28.9	25.95	35.05	15.4	24.9	20.8	20.45	12.72	14.7
32	Temperature (oC)		*18--30*	20.66	21.25	22.16	23.5	23	23	23.1	23.8	23	22.2	22.2	21.5
33	Total Solids			46.66	61	48.33	71	49	59	49	50	40	33	77	21
34	Turbidity (NTU)	*5*	*5*	3.2	1.72	2.07	3.15	1.33	0.96	1.22	0.58	0.65	0.83	0.85	0.6
	C) HEAVY METALS														
1	Arsenic (As)	*0.05*	*0.01*	0	0	-	-	-	-	-	-	-	-	-	-
2	Cadmio (Cd)	*0.005*	*0.003*												
3	Cupper (Cu)	*1*	*2*	0.17	0.17	0.12	0.16	0.16	0.14	0.16	0.16	0.15	0.15	0.17	0
4	Iron (Fe)	*0.3*	*0.3*	0.05	0.05	0.04	0.05	0.025	0.05	0	0.063	0.038	**1.038**	0.025	0.025
5	Lead (Pb)	*0.05*	*0.01*												
6	Manganese (Mn)	*0.3*	*0.5*	0.2	0.12	0.29	0.335	0.39	0.36	0.31	0.41	0.225	0	0.0155	0.0105
7	Potassium (K)		*10*												
8	Sodium (Na)	*200*	*200*												

ND: No Detected, RV: Recommended Value
EPA: U.S. Environmental Protection Agency
* If the value 3.0 is selected, the values of nitrate and nitrite should be related as: NO3/RV(NO3)+ NO2/RV(NO2) < 1
Note: Values in **bold letters** are out of the standards
Sources: 1) Quality Control Laboratory, Metroplitan Division, SANAA
2) Health Ministry/OPS/WHO,1995/10, National Technical Standard for the Drinking Water Quality
3) W.F. Chen, 1995, The Civil Engineering Handbook; pp. 171

Table AD.1.8 Water Quality at Picacho Treatment Plant (After Treatment) (1999)

No.	Name of Test	*Standard WHO (mg/L) max*	*Standard Honduras (mg/L) max*	January	February	March	April	May	June	July	August	September	October	November	December
	A) BACTERIOLOGICAL														
1	Bactery (N/100ml)			350	9,310	10	1,000	140	40	0	60	45	170	100	730
2	Fecal Coliform Bacteria (N/100ml)	*0*	*0*	0	0	0	0	0	0	0	0	0	0	0	0
3	Total Coliform Bacteria (N/100ml)	*0*	*0*	0	0	0	0	0	0	0	0	0	0	0	0
	B) PHYSIC-CHEMICAL														
1	Al+3	*0.2*	*0.2*	0.44	0.26	0.049	0.087	0.095	0.032	0.16	0.72	0.29	0.043	0.048	0.018
2	Alkalinity (Total)			20.26	21.32	36.37	44.17	23.21	15.47	16.93	16.44	11.44	15.69	16.52	16.12
3	Ca+2														
4	Cl2	*250*	*250*	2.8	2.73	2.8	2.58	2.71	2.49	2.91	2.76	2.7	2.68	2.65	2.78
5	CO2			0	2.32	0	0	2.32	0	0	0	16.21	0	9.26	0
6	CO3-														
7	Color (Pt-Co unit)	*15*	*15*	5.42	3.83	3.43	2.71	3.54	3.97	6.7	4.71	6.75	8.34	4.07	3.75
8	Conductivity(us/cm)		*400 (RV)*	92.51	82.04	67.83	70.51	76.75	87.17	75.66	74.42	79.84	75.01	74.05	73.50
9	Cu		*2*												
10	Cyanide (Cn-)	*0.1*	*0.07*	0	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
11	Chromium (Cr6+)			0.24	0.23	0.24	0.26	0.25	0.21	0.2	0.01	0.03	0	0.02	0.01
12	Dissolved Solids (Total)	*1,000*	*1,000*												
13	Dissolved Oxygen			-	-	-	4.3	-	-	-	5.7	5.4	12.6	9.6	13.3
14	Fe+3														
15	Hardness(Ca)	*500*	*400 (RV)*	39.6	40.66	49.84	79.92	92.48	111.38	110	98.08	94.15	88.72	70.28	73.8
16	Hardness (Mg)														
17	Hardness (Total)														
18	HCO3-														
19	Mg+2														
20	Mn+2														
21	Nitrate (as NO3-)	*10*	*50*	0.8	0.5	0.3	0.6	0.6	0.2	0.7	2.9	0.8	0.4	1	-
22	Nitrites (as NO2-)	*1(EPA)*	*0.1/3.0**	0	0.01	0.01	0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
23	N-NO3			0.01	0.01	0.015	0	0.035	0	0.005	0.015	0	0.03	0.04	0.015
24	Odor	*Odorless*	*0 (RV)*												
25	O-PO4-			0.023	0.023	0.011	0.023	0.023	0.023	0.023	0.023	0.023	0.07	0.023	0.023
26	Organic Matter			1	1.2	0.7	1.8	1.6	0.6	0.3	1.5	0.8	0.5	0.7	0.9
27	pH (in situ)														
28	pH (Lab)	*6.5--8.5*	*6.5--8.5*	7.49	7.52	7.70	7.31	7.00	6.90	7.05	6.98	6.54	6.84	6.80	6.74
29	pH Sat			9.2	8.8	9	8.6	9	9	8.6	8.45	9.15	9.3	9.1	9.2
30	Saturation Index			-0.66	-0.52	-2.04	-1.94	-1.97	-2.55	-1.2	-1.21	-1.05	-2.96	-2.6	-2.59
31	SO4--	*400*	*250*	16	15.3	9.98	12	17.1	12	13.2	14.5	17.9	17.53	11.67	10.3
32	Temperature (oC)		*18--30*	17.35	17.5	18.5	19.8	21.5	20.5	18	19.75	19.5	16	19.25	17.6
33	Total Solids			74	65	56	80	45	50	62	46	76	67	14	52
34	Turbidity (NTU)	*5*	*5*	1.51	1.93	1.02	0.81	1.37	1.08	2.28	1.55	3.73	4.09	2.29	0.85
	C) HEAVY METALS														
1	Arsenic (As)	*0.05*	*0.01*	0	0	-	-	-	-	-	-	-	-	-	-
2	Cadmio (Cd)	*0.005*	*0.003*												
3	Cupper (Cu)	*1*	*2*	0.16	0.12	0.13	0.17	0.14	0.15	0.15	0.14	0.15	0.15	0.15	0.02
4	Iron (Fe)	*0.3*	*0.3*	0.088	0.05	0.05	0.05	0.05	0.088	0.025	0.025	0.038	0.038	0.075	0.038
5	Lead (Pb)	*0.05*	*0.01*												
6	Manganese (Mn)	*0.3*	*0.5*	0.036	0.12	0.26	0.225	0.47	0.25	0.28	0.27	0.23	0.057	0.037	0.018
7	Potassium (K)		*10*												
8	Sodium (Na)	*200*	*200*												

ND: No Detected, RV: Recommended Value
EPA: U.S. Environmental Protection Agency
* If the value 3.0 is selected, the values of nitrate and nitrite should be related as: NO3/RV(NO3)+NO2/RV(NO2) < 1
Note: Values in **bold letters** are out of the standards
Sources: 1) Quality Control Laboratory, Metroplitan Division, SANAA
2) Health Ministry/OPS/WHO,1995/10, National Technical Standard for the Drinking Water Quality
3) W.F. Chen, 1995, The Civil Engineering Handbook; pp. 171

Table AD.1.9 Water Quality at the Distribution Network (April/1999)

No	Sampling Point	TURB.	Color	pH	Cl/R	TEMP.	COND.	ALCAL.	Bacteriology		
									Bact.	C.tot.	C.fec.
	Allowable Max. Value	5	15	6.5-8.5	5	18-30	400(RV)			0	0
1	Col.María Cristina	1.20	7.5	7.05	1.0	23.0	190.00	34.44	60	0	0
2	Col.El Chile	0.43	5.0	7.20	0.8	22.5	230.00	62.21			
3	Col.Barrio Abajo	0.44	7.5	7.20	1.0	23.0	198.00	51.10			
4	Col.La Concordia	0.36	5.0	7.80	1.5	24.0	125.00	24.44			
5	Col.Los Dolores	0.33	5.0	7.60	1.5	22.5	120.00	23.33			
6	Bo.La Leona	0.32	2.5	9.20	1.3	19.5	138.00	29.99			
7	Bo.La Ronda	2.20	7.5	7.82	1.5	21.5	155.00	36.66			
8	Col.Pagoda	3.90	12.5	7.00	1.0	25.0	182.00	22.88			
9	Col.Tepeyac	0.37	5.0	7.00	0.6	27.0	175.00	21.10			
10	Col.Palermo	**5.80**	12.5	7.38	0.7	22.0	140.00	35.55			
11	Col.Ruben Dario	**7.60**	12.5	7.22	0.8	24.0	190.00	28.88			
12	Col.Argentina	4.20	12.5	7.35	1.2	24.0	210.00	34.44			
13	Col.Lomas del Guijarro	**8.90**	**17.5**	7.20	1.2	24.5	198.00	26.66			
14	Col.Payaquí	4.30	12.5	7.35	1.0	22.5	200.00	29.99			
15	Col.La Primavera	**19.00**	**100.0**	7.22	1.2		225.00	16.67			
16	Col.Monseñor Fiallos	0.79	12.5	7.45	0.8	25.5	190.00	28.89	80.0	0	0
17	Col.Monseñor Fiallos,c.#1139	0.44	12.5	7.39	0.7	25.0	220.00	57.77			
18	Bo.Guadalupe	3.70	12.5	7.05	0.8	24.2	221.00	30.00			
19	Col.Alameda	2.40	15.0	7.21	0.7	24.2	225.00	30.00			
20	Bo.El Manchén	0.81	12.5	7.10	1.0	24.5	210.00	16.67			
21	Col.Reforma	0.86	12.5	7.65	0.8	25.5	620.00	48.88			
22	Bo.Casamata	0.94	12.5	8.05	1.5	22.1	135.00	18.89			
23	col.Campo cielo	1.70	12.5	7.30	0.8	24.0	260.00	39.99	180.0	0	0
24	Col.Hoya,frent.floristeria	1.30	7.5	7.40	1.0	26.0	222.00	37.21			
25	Col.La Hoya casa #412	0.51	7.5	7.20	0.9	25.5	180.00	29.07	2,800.0	0	0
26	Col.La Hoya,La Carreta	1.20	7.5	7.75	0.0	24.5	210.00	63.96	24,800.0	0	0
27	Col.La Hoya La Carreta	0.48	7.5	7.20	0.5	24.5	200.00	51.17	3,200	0	0
28	Col.Bendeck	0.43	7.5	7.20	0.8	23.5	220.00	62.80			
29	Col.El Contry	0.74	7.5	7.18	0.8	27.5	205.00	52.33			
30	Col.Monseñor Fiallos	0.44	7.5	7.20	1.0	27.0	202.00	65.12			
31	Col.Zapote Centro	0.42	7.5	7.40	1.0	26.5	230.00	66.29			
32	Col.Zapote Norte	0.78	7.5	7.50	1.0	27.0	225.00	62.80			
33	Col.Tiloarque	2.30	12.5	7.55	1.0	23.5	265.00	38.37			
34	Col.Flor del Campo	2.80	12.5	7.80	1.0	22.5	222.00	20.93			
35	Col.Henry Merrian	2.60	12.5	7.80	1.2	22.5	225.00	17.45			
36	Col.Alamo	1.80	12.5	7.78	1.0	24.0	270.00	39.54			
37	Col.Atlántis	2.10	12.5	7.80	1.2	24.0	275.00	40.70			
38	Col.Maradiaga	1.90	12.5	7.80	1.0	25.0	268.00	41.86			
39	Col.Primavera	2.40	12.5	7.60	1.5	25.5	270.00	40.70			
40	Bo.Villa Adela	0.55	7.5	7.45	0.7	24.5	310.00	76.75			
41	Bo.Concepción	0.58	7.5	7.40	0.4	26.5	315.00	77.98	60.0	0	0
42	Bo.Lempira	0.78	12.5	7.30	0.8	26.0	312.00	67.45			
	Average	2.3	12.1	7.5	1.0	24.3	223.4	40.5			
	V. Max.	19.0	100.0	9.2	1.5	27.5	620.0	78.0			
	V. Min.	0.3	2.5	7.0	0.0	19.5	120.0	16.7			
	% de Fails to Standards	9.5	4.8	2.4	2.4						0

Note: Values in **bold letters** are out of the standards

Source: Quality Control Laboratory, Metropolitan Division, SANAA

Table AD.1.10 Water Quality at the Distribution Network (July/1999)

									Bacteriology		
No	Sampling Point	TURB.	Color	pH	Cl/R	TEMP.	COND.	ALCAL.	Bact.	C.tot.	C.fec.
	Allowable Max. Value	5	15	6.5-8.5	5	18-30	400(RV)			0	0
1	Col. Florencia Norte	1.80	7.5	7.60	0.1	23.0	175.00	18.60	240	0	0
2	Col. Florencia Norte	1.80	7.5	8.40	0.2	23.0	160.00	23.26	240	0	0
3	Col. Florencia Norte	2.60	12.5	8.05	0.2	23.0	170.00	25.58	240	0	0
4	Col. San Luis	1.90	7.5	8.30	0.6	22.0	210.00	27.91	1,800	0	0
5	Col. Calpules	0.39	10.0	6.60	0.6	22.0	135.00	11.43			
6	Col. los Angeles	3.20	12.5	7.20	0.5	23.5	150.00	24.42			
7	Col. América	0.44	12.5	7.22	0.5	23.5	160.00	23.26		0	0
8	Col. Altos de Toncontin	1.90	**32.5**	7.24	0.5	24.0	140.00	20.93		0	0
9	Col. Loarque	0.83	**30.0**	7.50	0.5	24.0	140.00	26.74			
10	Col. Rio Grande	0.50	**22.5**	7.60	0.5	24.0	140.00	25.58			
11	Col. Jardines de Loarque	0.52	**22.5**	7.80	0.5	23.5	140.00	27.91			
12	Col. el Mirador	0.61	**22.5**	7.65	0.5	23.5	138.00	26.74			
13	Col. Satelite	0.41	**22.5**	7.70	0.5	23.0	140.00	25.58			
14	Col. Maradiaga	2.25	**22.5**	6.75	0.5	23.0	180.00	16.28			
15	Col. las Colinas	0.60	**17.5**	7.30	0.5	23.0	160.00	18.61			
16	Col. Villa Adela	1.70	7.5	6.60	0.2	22.5	240.00	17.44	40	0	0
17	Col. Primavera	2.30	12.5	7.30	0.5	22.0	190.00	19.77			
18	Col. Maradiaga	1.80	**17.5**	7.30	0.6	23.0	195.00	20.93			
19	Col. Maradiaga	1.80	**22.5**	7.45	0.2	24.0	170.00	18.61	60	0	0
20	Col. Maradiaga	0.34	12.5	7.79	0.5	23.2	155.00	20.93	1,600	0	0
21	Col. Bella Oriente	2.30	**65.0**	7.30	1.5		180.00	25.58			
22	Col. Miraflores	4.70	**90.0**	7.00	1.0	23.0	180.00	13.96	900	0	0
23	Col. Miraflores	4.20	**90.0**	7.25	0.8	23.0	180.00	22.10			
24	Col. Kennedy	0.79	**22.5**	7.30	0.4	23.0	155.00	20.93	2,200	0	0
25	Hospital Escuela	0.70	12.5	7.45	0.1	23.5	180.00	23.26	2,000	0	0
26	Barrio Concepción	2.30	7.5	7.60	0.5	25.0	260.00	30.23			
27	Barrio Villa Adela	4.30	12.5	7.00	0.6	24.5	198.00	22.09		0	0
28	Col. Rodríguez	4.60	12.5	6.98	1.5	25.0	195.00	22.09		0	0
29	Col. Primavera	2.40	10.0	7.30	1.2	23.5	200.00	18.60		0	0
30	Col. Atlantis	3.90	12.5	7.20	0.6	24.0	195.00	20.93			
31	Col. El Alamo	1.90	7.5	7.25	1.0	23.0	202.00	22.09			
32	Col. Maradiaga	2.40	7.5	7.42	0.6	22.5	170.00	25.58			
33	Col. Tiloarque	1.80	10.0	7.30	1.5	25.0	160.00	19.77			
34	Col. Flor del Campo	1.60	12.5	7.85	0.6	24.5	190.00	29.07			
35	Col. Henrry Merrian	1.30	12.5	7.80	0.5	23.5	180.00	24.42			
36	Centrol de Salud Monterr	1.90	17.5	6.60	1.0	25.0	150.00	19.77			
37	Col. Monterrey	2.20	17.5	6.60	1.0	25.0	140.00	9.304	1,040	0	0
38	Col. Universidad Norte	1.60	12.5	8.40	0.2	26.0	155.00	32.56	320	0	0
39	Col Universidad Norte	0.63	12.5	7.40	0.5	26.5	160.00	24.42	100	0	0
40	Col. Mirador del Loarque	0.78	12.5	7.10	0.5	26.5	140.00	23.26	20	0	0
41	Barrio las Crucitas	2.70	17.5	7.20	0.5	22.0	180.00	18.61			
42	Barrio las Crucitas	0.94	12.5	7.19	0.5	23.0	180.00	18.61			
43	Col. Obrera	0.09	12.5	6.90	0.6	22.0	185.00	15.12			
44	Col. Las Ayestas	2.20	12.5	6.95	1.0	22.0	180.00	16.28			
45	Col. Los Profesores	0.92	12.5	6.82	1.0	21.5	178.00	15.12			
46	Col. Guamilito	0.79	12.5	6.95	0.8	22.0	178.00	20.93			
47	Barrio El Centavo	0.91	12.5	7.20	0.7	23.0	190.00	18.61			
48	Col. Las Brisas	3.90	12.5	7.00	0.7	23.0	178.00	19.77			
	Average	1.8	21.7	6.7	0.6	21.6	159.3	21.4			
	V. Max.	5.0	90.0	8.4	5.0	26.5	260.0	32.6			
	V. Min.	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
	% de Fails to Standards	0.0	35.4	0.0	12.5					0	0

Note: Values in **bold letters** are out of the standards

Source: Quality Control Laboratory, Metropolitan Division, SANAA

Table AD.2.1 Vertical Sampling at Concepcion and Los Laureles Dam: Dry season (7 Samples)

No	Name of Test	Units	*Standards* *	P#1: 0 m	P#2: 3 m	P#3: 6 m	P#4: 9 m	P#5: 12 m	P#6: 15 m	P#7: 35 m
1	Date			May/17/2000	May/17/2000	May/17/2000	May/17/2000	May/17/2000	May/17/2000	May/17/2000
2	Conductivity	ms	*1,600*	69.2	71.2	69.7	66.2	64.5	63.4	64.3
3	Temperature	C	*400*	26	25	23	24	24	24	24
4	Dissolved Oxygen	mg/l	*>4*	7.04	7.56	7.3	7.3	7.8	7.7	7.23
5	pH		*6-9*	6.3	6.4	6.6	6.3	6.4	6.5	6.5
6	Turbidity	NTU	*600*	44.3	45.1	46.3	47.8	47.6	49.9	48.7
7	Total Dissolved Soli	mg/l	*1,000*	49.4	49.2	48.8	46.3	45.2	44.6	45.1
8	Manganese	mg/l	*1.0*	0.125	0.122	0.126	0.108	0.106	0.114	0.447

* Honduras Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People (Draft as of June/2000)

Note 1: Sampling and Tests by Laboratorio de Analisis Industriales MQ

Note 2: Values in **bold face letters** are out of the standards

No	Name of Test	Units	*Standards* *	P#1: 0 m	P#2: 3 m	P#3: 6 m	P#4: 9 m	P#5: 11 m	P#6: 12 m	P#7: 15 m
1	Date			May/17/2000	May/17/2000	May/17/2000	May/17/2000	May/17/2000	May/17/2000	May/17/2000
2	Conductivity	ms	*1,600*	214	209	192.4	174.6	181.4	177.8	163.5
3	Temperature	C	*400*	26	25	25	24	24	25	25
4	Dissolved Oxygen	mg/l	*>4*	4.1	6.65	6.38	6.84	6.52	6.78	6.52
5	pH		*6-9*	7.2	6.8	6.4	6.6	6.5	6.4	6.8
6	Turbidity	NTU	*600*	40.9	99.1	98.3	89.2	97.1	92.2	94.3
7	Total Dissolved Soli	mg/l	*1,000*	136.2	134.2	127.1	122.3	121.2	118.3	114.6
8	Manganese	mg/l	*1.0*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

* Honduras Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People (Draft as of June/2000)

Note 1: Sampling and Tests by Laboratorio de Analisis Industriales MQ

Note 2: Values in **bold face letters** are out of the standards

Table AD.2.2 Water Quality Analysis in Rivers: Dry Season (6 samples)

No	Name of test	Units	*Standards**	**P#1: Río Planta Los Laureles**	**P#2: Río Casa Lopez Arellano**	**P#3: Río en el puente, carretera a Mateo**	**P#4: Río Guacerique**	**P#5: Río Mateo**	**P#6: Río en el puente, después de Mateo**
1	Date			May/17/2000	May/17/2000	May/17/2000	May/17/2000	May/17/2000	May/17/2000
2	Hour	AM		7:30	8:05	8:15	8:35	8:35	8:35 AM
3	Temperature	C		26	24	24	23	22	25
4	Turbidity	NTU	*600*	30.1	34.7	35.8	34.9	23.3	17.49
5	Sulfate	mg/l	*400*	56	7	9	11	16	1
6	Alkali	mg/l		169.6	21.2	31.8	21.2	36	16.96
7	Anion Surfactant	mg/l		0.157	0.018	0.058	0.009	0.005	0.041
8	Calcium	mg/l		40	4.8	10.4	4	11.42	4
9	Chloride	mg/l	*600*	42.1	10.53	28.7	10.53	13.4	12.44
10	General Bacteria	UFC/ml		$10x10^4$	$26x10^2$	$10x10^2$	$47x10^2$	$46x10^2$	$33x10^2$
11	Total Coliform Bacteria	/100 ml	*10,000*	$11x10^4$	$24x10^2$	$11x10^2$	$11x10^2$	$46x10^2$	$29x10^2$
12	Fecal Coliform Bacteria	/100 ml	*2,000*	**$11x10^4$**	**$24x10^2$**	$11x10^2$	$11x10^2$	**$46x10^2$**	**$29x10^2$**
13	Color	UPC	*800*	110	267	293	296	209	161
14	Conductivity	ms	*1,600*	669	102.3	219	95.8	169.2	91.4
15	BOD	mg/l	*6*	6	2.2	3	3	2	2
16	Total Phosphorous	mg/l		0.37	0.326	0.57	0.26	0.22	0.26
17	Iron	mg/l	*1*	**1.7**	**3.4**	**5**	**4.5**	**2.27**	**3**
18	Magnesium	mg/l	*1*	**14.5**	**1.44**	**3.36**	**2.88**	**3.43**	**1.92**
19	Manganese	mg/l	*1*	**1.9**	0.065	0.1	0.104	0.073	0.036
20	Nitrate (as NO3-)	mg/l	*50*	6	2.73	4.53	1.85	3.87	2
21	Nitrites (as NO2-)	mg/l	*3*	0.235	0.004	0.015	0.004	0.01	0.007
22	Ammonia Nitrogen	mg/l	*1*	**3.7**	0.33	0.1	0.22	0.11	0.22
23	Total Nitrogen	mg/l		15.5	3.28	4.78	4.78	11.43	3.37
24	Dissolved Oxygen	mg/l	*>4*	6.91	7.43	7.04	7.3	7.69	6.97
25	pH		*6-9*	7	6.2	7	6.6	6.8	6.5
26	Potassium	mg/l		10.55	4.37	3.6	3.134	4.16	4
27	Sodium	mg/l		54.87	12.9	19.2	13.4	10.6	24.8
28	Suspended Solids	mg/l		20	11.33	23.3	27.3	21	6
29	Total Dissolved Solids	mg/l	*1,000*	516	78.2	150.2	73.4	127.8	69.2

* Honduras Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People (Draft as of June/2000)

Note 1: Sampling and Tests by Laboratorio de Analisis Industriales MQ

Note 2: Values in **bold face letters** are out of standards. Point #1 is not compared (only reference) because is downstream of dan

Table AD.2.3 Drinking Water Analysis (Dry Season)

No	Name of Test	Units	*Standards**	W-1 (well) Pozo Carrizal	W-2 (well) Pozo Hasbun	(treatment plant) Planta los Laureles	LL-R-1 (reservoir) Filtros Los Laureles	LL-R-2 (reservoir) Tanque el Retiro	LL-H-1 (house) Casa Lomas Country #100	LL-H-2 (house) Casa El Retiro
1	Date			May/23/2000	May/23/2000	May/23/2000	May/23/2000	May/23/2000	May/23/2000	May/23/2000
2	Hour	AM		10:25	11:40	11:15	10:05	10:50	10:08	10:55
3	Water Temperature	C	*18-30*	28	30	24	22	25	26	25
4	Turbidity	NTU	*5*	1.96	0.49	2.79	1.34	1.58	0.93	0.95
5	Alcalinity	mg/l		120.8	163.2	27.5	19.08	23.32	38.2	27.5
6	Residual Chlorine	ppm	*5*	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
7	Calcium	mg/l	*100 (RV)*	32.6	10.6	20.4	15.5	17.1	19.6	17.9
8	General Bacteria	UFC/ml		340	20	30	N.D. *	N.D. *	720	776
9	Fecal Coliform Bacteria	/100 ml	*0*	**23**	<3	<3	<3	<3	3	3
10	Color	UPC		4	0	0	0	0	0	7
11	Iron	mg/l	*0.3*	0.15	0.1	0.09	0.2	0.1	0.15	0.15
12	Chloride	mg/l	*250*	170	20	52	50	45	48	20
13	Magnesium	mg/l	*50*	10.3	0.49	2.45	3.4	3.4	2.9	2.45
14	Manganese	mg/l	*0.5*	0.06	<0.001	0.054	0.03	0.03	0.12	0.095
15	Nitrate (as NO3-)	mg/l	*50*	2.03	1.22	1.84	1.73	1.57	1.13	1.55
16	Nitrite (as NO2-)	mg/l	*0.1*	0.021	<0.001	<0.001	<0.001	0.004	<0.001	<0.001
17	Ammonium Nitrogen	mg/l	*0.5*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
18	pH		*6.5-8.5*	**6.2**	**6.2**	**6.4**	**5.2**	**6**	**6.3**	**6.3**
19	Potassium	mg/l	*10*	**11.6**	**11.4**	3.9	4.44	4.11	4.2	4.14
20	Sodium	mg/l	*200*	101.8	75.7	23.6	64.8	23.5	81.4	14
21	Total Dissolved Solids	mg/l	*1,000*	434	191.9	141.9	133.2	137.5	142.5	137.3
22	Sulfate	mg/l	*250*	55	10	33	37	38	31	36

N.D. : No detected RV: Recommended Value

* Health Ministry/OPS/WHO,1995/10, National Technical Standard for the Drinking Water Quality

Note 1: Sampling and Tests by Laboratorio de Analisis Industriales MQ

Note 2: Values in **bold face letters** are out of the standards

Table AD.2.4 Drinking Water Analysis (Dry Season)

No	Name of Test	Units	*Standards**	CO-P (treatment plant) Planta Concepción	CO-R-1 (reservoir) Tanque Altos de Toncontin	CO-R-2 (reservoir) Tanque Monterrey	CO-H-1 (house) Casa Altos de Toncontin	CO-H-2 (house) Casa Monterrey	PI-P (treatment plant) Planta Picacho	PI-R-1 (reservoir) Tanque Linderos
1	Date			May/23/2000	May/23/2000	May/23/2000	May/23/2000	May/23/2000	May/23/2000	May/23/2000
2	Hour	PM		12:35	1:10	2:30	1:20	2:35	3:25	4:10
3	Water Temperature	C	*18-30*	21	22	24	25	24	24	28
4	Turbidity	NTU	*5*	0.59	0.62	1.1	1.05	0.76	2.3	0.96
5	Alcalinity	mg/l		16.9	21.2	21.2	19.1	19.1	14.8	16.9
6	Residual Chlorine	ppm	*5*	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
7	Calcium	mg/l	*100 (RV)*	7.3	9.8	9.8	10.6	10.6	9.8	9.8
8	General Bacteria	UFC/ml		N.D.	N.D.	15	10	N.D.	N.D.	N.D.
9	Fecal Coliform Bacteria	/100 ml	*0*	<3	<3	<3	<3	<3	<3	<3
10	Color	UPC		4	0	0	0	0	3	0
11	Iron	mg/l	*0.3*	0.1	0.09	0.2	**2.2**	0.2	**2.2**	0.1
12	Chloride	mg/l	*250*	11	8	20	9	8	7	5
13	Magnesium	mg/l	*50*	1.5	1.4	1.9	1.5	1.5	2.4	8.2
14	Manganese	mg/l	*0.5*	0.342	0.087	0.073	0.094	0.083	0.028	0.021
15	Nitrate (as NO3-)	mg/l	*50*	0.94	0.92	0.94	0.95	0.89	1.08	1.17
16	Nitrite (as NO2-)	mg/l	*0.1*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
17	Ammonium Nitrogen	mg/l	*0.5*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
18	pH		*6.5-8.5*	**6.3**	**5.8**	**6.2**	**6**	**6.3**	**6.4**	6.5
19	Potassium	mg/l	*10*	3.29	3.02	3.16	3.35	3.02	2.23	2.21
20	Sodium	mg/l	*200*	10.3	9.5	13.1	7.5	7.5	4.6	6.6
21	Total Dissolved Solids	mg/l	*1,000*	72.8	84.4	84.2	83.6	81.2	88.7	79.1
22	Sulfate	mg/l	*250*	19	22	20	21	22	23	25

N.D. : No detected RV: Recommended Value

* Health Ministry/OPS/WHO,1995/10, National Technical Standard for the Drinking Water Quality

Note 1: Sampling and Tests by Laboratorio de Analisis Industriales MQ

Note 2: Values in **bold face letters** are out of the standards

Table AD.2.5 Drinking Water Analysis (Dry Season)

No	Name of Test	Units	*Standards**	PI - R - 2 (reservoir) Tanque Travesía	PI - H - 1 (house) Casa El Cerrito	PI - H - 2 (house) Casa La Travesía
1	Date			May/23/2000	May/23/2000	May/23/2000
2	Hour	PM		4:35	4:16	4:50
3	Water Temperature	C	*18-30*	23	25	28
4	Turbidity	NTU	*5*	1.02	2.84	1.12
5	Alcalinity	mg/l		16.9	12.7	23.3
6	Residual Chlorine	ppm	*5*	N.D.	N.D.	N.D.
7	Calcium	mg/l	*100 (RV)*	9.8	9.8	15.5
8	General Bacteria	UFC/ml		N.D.	N.D.	33
9	Fecal Coliform Bacteria	/100 ml	*0*	<3	<3	<3
10	Color	UPC		0	0	0
11	Iron	mg/l	*0.3*	0.1	0.2	0.2
12	Chloride	mg/l	*250*	14	9	7
13	Magnesium	mg/l	*50*	1.5	1.5	2.4
14	Manganese	mg/l	*0.5*	0.007	0.05	0.01
15	Nitrate (as NO3-)	mg/l	*50*	1.63	1.33	1.06
16	Nitrite (as NO2-)	mg/l	*0.1*	<0.001	<0.001	<0.001
17	Ammonium Nitrogen	mg/l	*0.5*	<0.1	<0.1	<0.1
18	pH		*6.5-8.5*	**6.2**	**6.4**	6.5
19	Potassium	mg/l	*10*	1.78	2.24	2.29
20	Sodium	mg/l	*200*	7.5	5.5	6.5
21	Total Dissolved Solids	mg/l	*1,000*	70.5	76.8	111.2
22	Sulfate	mg/l	*250*	16	21	33

N.D. : No detected RV: Recommended Value

* Health Ministry/OPS/WHO,1995/10, National Technical Standard for the Drinking Water Quality

Note 1: Sampling and Tests by Laboratorio de Analisis Industriales MQ

Note 2: Values in **bold face letters** are out of the standards

Table AD.2.6 Water Quality Analysis in Rivers: Rainy Season (8 samples)

No	Name of test	Units	*Standards**	**P#1: Río Planta Los Laureles**	**P#2: Río Casa Lopez Arellano**	**P#3: Río en el puente, carretera a Mateo**	**P#4: Río Guacerique**	**P#5: Río Mateo**	**P#6: Río en el puente, después de Mateo**	**P#7: Resid. Monte Real, entrada a Laguna Oxid.**	**P#8: Resid. Monte Real, salida de Laguna Oxid.**
1	Date			Jul/01/2000	Jul/01/2000	Jul/01/2000	Jul/01/2000	Jul/01/2000	Jul/01/2000	Jul/12/2000	Jul/12/2000
2	Hour	AM								10:30	10:40
3	Temperature	C		23	6.8	20	23		22	28	25
4	Turbidity	NTU	*600*	16.32	21.2	32.3	14.67		15.02	53.6	48.2
5	Sulfate	mg/l	*400*	8	54	11	20		34	30	80
6	Alkali	mg/l		307.4	25.4	25.44	33.92	27.56	27.56	254.4	307.4
7	Anion Surfactant	mg/l		4.32	0.014	0.009	0.013	0.01	0.014	9.06	9.84
8	Calcium	mg/l		47.2	4.07	4.07	8.14	4.88	4.07	20	20
9	Chloride	mg/l	*600*	54.6	8.61	10.52	7.65	6.7	4.78	37.3	79.4
10	General Bacteria	UFC/ml		$24x10^4$	$34x10^3$	$48x10^3$	$30x10^2$	$80x10^3$	$77x10^2$	$16x10^6$	$20x10^6$
11	Total Coliform Bacteria	/100 ml	*10,000*	**$46x10^5$**	**$24x10^4$**	**$12x10^4$**	**$93x10^3$**	**$24x10^4$**	$24x10^2$	**$11x10^7$**	**$24x10^6$**
12	Fecal Coliform Bacteria	/100 ml	*2,000*	**$75x10^4$**	**$3x10^3$**	**$3x10^3$**	$3x10^2$	$7x10^2$	$9x10^2$	**$11x10^7$**	**$24x10^6$**
13	Color	UPC	*800*	165	145	229	117	109	134	530	738
14	Conductivity	ms	*1,600*	838	86.3	81.2	101.2	65.9	75.4	789	1056
15	BOD	mg/l	*6*	13.6	1.72	1.75	0.82	2.32	2.68	**165**	**170**
16	Total Phosphorous	mg/l		0.37	0.27	0.36	0.23	0.27	0.35	10.27	11.09
17	Iron	mg/l	*1*	**2.5**	**1.2**	**2**	**0.8**	1	1	0.5	0.65
18	Magnesium	mg/l	*1*	**22**	**1.95**	**1.46**	**1.25**	**1.46**	**1.95**	**8.16**	**10.56**
19	Manganese	mg/l	*1*	**2**	0.058	0.043	0.001	0.001	0.001	0.3	0.2
20	Nitrate (as NO3-)	mg/l	*50*	0.73	0.83	0.86	0.85	0.62	0.68	1.58	1.69
21	Nitrites (as NO2-)	mg/l	*3*	0.043	0.012	0.024	0.019	0.016	0.012	0.018	0.037
22	Ammonia Nitrogen	mg/l	*1*	**13.2**	<0.1	<0.1	<0.1	<0.1	0.11	**11.87**	**18.37**
23	Total Nitrogen	mg/l		22.5	1.5	1.03	0.375	1.03	0.84	32.5	41.25
24	Dissolved Oxygen	mg/l	*>4*	6.11	7.5	7.8	6.6	7.6	7.24	**0.26**	**0**
25	pH		*6-9*	7	6.8	6.6	7	6.6	7	7.2	6.8
26	Potassium	mg/l		15.5	4.3	1.97	3.36	3.18	3.75	11.06	11.95
27	Sodium	mg/l		84	12.47	13.41	14	11.15	11.15	109.1	171.4
28	Suspended Solids	mg/l		18	5	8	1	3	1	228	120
29	Total Dissolved Solids	mg/l	*1,000*	613	63.7	58.8	73.2	47.4	54.4	550	738

* Honduras Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People (Draft as of June/2000)

Note 1: Sampling and Tests by Laboratorio de Analisis Industriales MQ

Note 2: Values in **bold face letters** are out of standards. Point #1 is not compared (only reference) because is downstream of dam.

Table AD.2.7 Vertical Sampling at Concepcion and Los Laureles Dam: Rainy season (7 Samples)

No	Name of Test	Units	*Standards* *	P#1: 0 m	P#2: 3 m	P#3: 6 m	P#4: 9 m	P#5: 12 m	P#6: 15 m	P#7: 40 m
1	Date			Jul/01/2000	Jul/01/2000	Jul/01/2000	Jul/01/2000	Jul/01/2000	Jul/01/2000	Jul/01/2000
2	Conductivity	ms	*1,600*	64.9	56.6	59.2	81.9	59.4	64.2	79.6
3	Temperature	C	*400*	26	24	24	26	28	24	28
4	Dissolved Oxygen	mg/l	*>4*	6.91	6.51	7.11	7.04	7.31	6.98	6.78
5	pH		*6-9*	6.4	6.2	6.2	6.3	6.6	6.6	6.5
6	Turbidity	NTU	*600*	41.9	42.2	43.3	43.1	43.9	48.1	85.8
7	Total Dissolved Soli	mg/l	*1,000*	45.6	42.4	42.1	41.2	41.3	45.3	52.6
8	Manganese	mg/l	*1.0*	0.051	0.051	0.038	0.089	0.09	0.111	0.697

* Honduras Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People (Draft as of June/2000)

Note 1: Sampling and Tests by Laboratorio de Analisis Industriales MQ

Note 2: Values in **bold face letters** are out of the standards

No	Name of Test	Units	*Standards* *	P#1: 0 m	P#2: 3 m	P#3: 6 m	P#4: 9 m	P#5: 12 m	P#6: 15 m	P#7: 28 m
1	Date			Jul/01/2000	Jul/01/2000	Jul/01/2000	Jul/01/2000	Jul/01/2000	Jul/01/2000	Jul/01/2000
2	Conductivity	ms	*1,600*	92.8	93.7	83.5	81.9	76.9	74.9	67.9
3	Temperature	C	*400*	27	26.7	25	26	26	26	26
4	Dissolved Oxygen	mg/l	*>4*	6.58	7.24	6.77	7.31	6.91	7.31	7.11
5	pH		*6-9*	7	6.3	6.5	6.2	6.4	6.2	6.4
6	Turbidity	NTU	*600*	25.7	26.7	40.1	48.2	47.8	48.8	50.7
7	Total Dissolved Soli	mg/l	*1,000*	64.5	66.4	59.8	56.8	54.2	52.8	45.3
8	Manganese	mg/l	*1.0*	0.009	0.072	0.054	0.14	0.12	0.119	0.456

* Honduras Standards for Quality Control in Water Bodies Assigned for Drinking Water Supply to the People (Draft as of June/2000)

Note 1: Sampling and Tests by Laboratorio de Analisis Industriales MQ

Note 2: Values in **bold face letters** are out of the standards

Table AD.2.8 Drinking Water Analysis (Rainy Season)

No	Name of Test	Units	*Standards**	W-1 (well) Pozo Carrizal	W-2 (well) Pozo Hasbun	LL-P (treatment plant) Planta los Laureles	LL-R-1 (reservoir) Filtros Los Laureles	LL-R-2 (reservoir) Tanque el Retiro	LL-H-1 (house) Casa Lomas Country #100	LL-H-2 (house) Casa El Retiro
1	Date			Jul/3/2000	Jul/4/2000	Jul/1/2000	Jul/3/2000	Jul/3/2000	Jul/3/2000	Jul/1/2000
2	Hour			09:20 a.m.	10:00 a.m.	07:50 a.m.	11:00 a.m.	11:00 a.m.	11:10 a.m.	11:05 a.m.
3	Water Temperature	C	*18-30*	23	20	26	22	27	25	26
4	Turbidity	NTU	*5*	1.15	0.44	1.52	2.5	1.26	1.14	1.27
5	Alcalinity	mg/l		133.56	163.24	25.44	19	23.32	19	27.5
6	Residual Chlorine	ppm	*5*	N.D.	0.1	N.D.	0.6	N.D.	N.D.	N.D.
7	Calcium	mg/l	*100 (RV)*	33.6	9.6	7.32	12.8	13	14.4	13
8	General Bacteria	UFC/ml		360	45	10	N.D.	N.D.	N.D.	6
9	Fecal Coliform Bacteria	/100 ml	*0*	**23**	<3	<3	<3	<3	<3	<3
10	Color	UPC		0	0	0	0	0	0	0
11	Iron	mg/l	*0.3*	0.3	0.15	0.18	0.25	0.3	0.3	0.3
12	Chloride	mg/l	*250*	31.58	9.57	9.57	12.44	10.52	12.44	10.5
13	Magnesium	mg/l	*50*	8.88	1.44	1.44	2.88	2.45	1.44	2.44
14	Manganese	mg/l	*0.5*	0.091	0.017	0.007	0.077	0.001	0.013	<0.001
15	Nitrate (as NO3-)	mg/l	*50*	6.1	0.52	1.43	1.6	1.38	1.19	1.43
16	Nitrite (as NO2-)	mg/l	*0.1*	0.044	0.011	0.001	0.01	0.004	0.011	0.005
17	Ammonium Nitrogen	mg/l	*0.5*	0.11	<0.1	0.11	<0.1	<0.1	0.11	<0.1
18	pH		*6.5-8.5*	6.8	6.8	6.8	7.2	6.2	6.8	6.6
19	Potassium	mg/l	*10*	9.63	12.77	3.48	3.4	3.4	3.3	3.74
20	Sodium	mg/l	*200*	58.67	72.7	19.8	9.2	11.76	12.42	12
21	Total Dissolved Solids	mg/l	*1,000*	410	278	102.9	97.2	101.8	103.4	102
22	Sulfate	mg/l	*250*	75	8	29	30	35	31	34

N.D. : No detected RV: Recommended Value

* Health Ministry/OPS/WHO,1995/10, National Technical Standard for the Drinking Water Quality

Note 1: Sampling and Tests by Laboratorio de Analisis Industriales MQ

Note 2: Values in **bold letters** are out of the standards

Table D.2.9 Drinking Water Analysis (Rainy Season)

No	Name of Test	Units	*Standards**	CO-P (treatment plant) Planta Concepción	CO-R-1 (reservoir) Tanque Altos de Toncontin	CO-R-2 (reservoir) Tanque Monterrey	CO-H-1 (house) Casa Altos de Toncontin	CO-H-2 (house) Casa Monterrey	PI-P (treatment plant) Planta Picachó	PI-R-1 (reservoir) Tanque Linderos
1	Date			Jul/1/2000	Jul/1/2000	Jul/3/2000	Jul/1/2000	Jul/3/2000	Jul/3/2000	Jul/3/2000
2	Hour			10:15 a.m.	10:30 a.m.	12:55 a.m.	10:35 a.m.	01:00 p.m.	10:00 a.m.	01:30 p.m.
3	Water Temperature	C	*18-30*	22	20	26	25	25	25	20
4	Turbidity	NTU	*5*	0.49	0.91	0.69	1.02	0.75	4.83	2.62
5	Alcalinity	mg/l		19	14.8	16.96	16.9	16.96	8.48	8.48
6	Residual Chlorine	ppm	*5*	0.1	0.1	0.1	0.1	0.1	0.4	0.4
7	Calcium	mg/l	*100 (RV)*	6.51	7.32	8.8	8.14	8.8		
8	General Bacteria	UFC/ml		14	20	N.D.	N.D.	41	N.D.	N.D.
9	Fecal Coliform Bacteria	/100 ml	*0*	<3	<3	3	<3	3	<3	<3
10	Color	UPC		0	0	0	0	0	16	0
11	Iron	mg/l	*0.3*	N.D.	0.12	0.14	0.17	0.14	1.25	0.5
12	Chloride	mg/l	*250*	9.57	9.57	10.52	9.57	12.44	9.57	8.61
13	Magnesium	mg/l	*50*	2.93	1.95	1.44	1.95	1.44	0.96	1.44
14	Manganese	mg/l	*0.5*	0.33	0.041	0.101	0.22	0.14	0.038	0.012
15	Nitrate (as NO3-)	mg/l	*50*	1	0.93	0.52		0.53	0.81	0.76
16	Nitrite (as NO2-)	mg/l	*0.1*	0.004	0.005	0.01	0.62	0.01	0.005	<0.001
17	Ammonium Nitrogen	mg/l	*0.5*	<0.1	0.11	0.1	<0.1	0.1	<0.1	<0.1
18	pH		*6.5-8.5*	**6.2**	**6.4**	6.8	6.6	6.6	7	7
19	Potassium	mg/l	*10*	3.77	3.96	3.62	4.05	3.51	1.57	2.05
20	Sodium	mg/l	*200*	7.13	6.15	8.72	13	8.72	4.36	5.28
21	Total Dissolved Solids	mg/l	*1,000*	73.6	70.5	73.6	72.8	72.4	52.3	49.6
22	Sulfate	mg/l	*250*	16	16	25	25	24	21	21

N.D. : No detected RV: Recommended Value

* Health Ministry/OPS/WHO,1995/10, National Technical Standard for the Drinking Water Quality

Note 1: Sampling and Tests by Laboratorio de Analisis Industriales MQ

Note 2: Values in **bold letters** are out of the standards

Table AD.2.10 Drinking Water Analysis (Rainy Season)

No	Name of Test	Units	*Standards**	PI - R - 2 (reservoir) Tanque Travesía	PI - H - 1 (house) Casa El Cerrito	PI - H - 2 (house) Casa La Travesía
1	Date			Jul/3/2000	Jul/3/2000	Jul/3/2000
2	Hour	PM		2:20 p.m.	1:40 p.m.	2:20 p.m.
3	Water Temperature	C	*18-30*	25	23	23
4	Turbidity	NTU	*5*	1.42	1.63	1.65
5	Alcalinity	mg/l		12.72	10.6	23.32
6	Residual Chlorine	ppm	*5*	0.4	0.2	N.D.
7	Calcium	mg/l	*100 (RV)*	7.2	7.2	12
8	General Bacteria	UFC/ml		N.D.	N.D.	142
9	Fecal Coliform Bacteria	/100 ml	*0*	<3	<3	<3
10	Color	UPC		0	0	0
11	Iron	mg/l	*0.3*	0.2	0.2	0.2
12	Chloride	mg/l	*250*	8.61	9.57	7.65
13	Magnesium	mg/l	*50*	1.44	0.96	0.96
14	Manganese	mg/l	*0.5*	0.001	0.01	0.001
15	Nitrate (as NO3-)	mg/l	*50*	0.84	0.63	0.45
16	Nitrite (as NO2-)	mg/l	*0.1*	<0.001	<0.001	<0.001
17	Ammonium Nitrogen	mg/l	*0.5*	0.11	<0.1	0.11
18	pH		*6.5-8.5*	6.6	6.6	7
19	Potassium	mg/l	*10*	1.58	2.09	1.6
20	Sodium	mg/l	*200*	6.3	6.25	6.58
21	Total Dissolved Solids	mg/l	*1,000*	47.2	50.3	72.6
22	Sulfate	mg/l	*250*	19	19	20

N.D. : No detected RV: Recommended Value

* Health Ministry/OPS/WHO,1995/10, National Technical Standard for the Drinking Water Quality

Note 1: Sampling and Tests by Laboratorio de Analisis Industriales MQ

Note 2: Values in **bold face letters** are out of standards

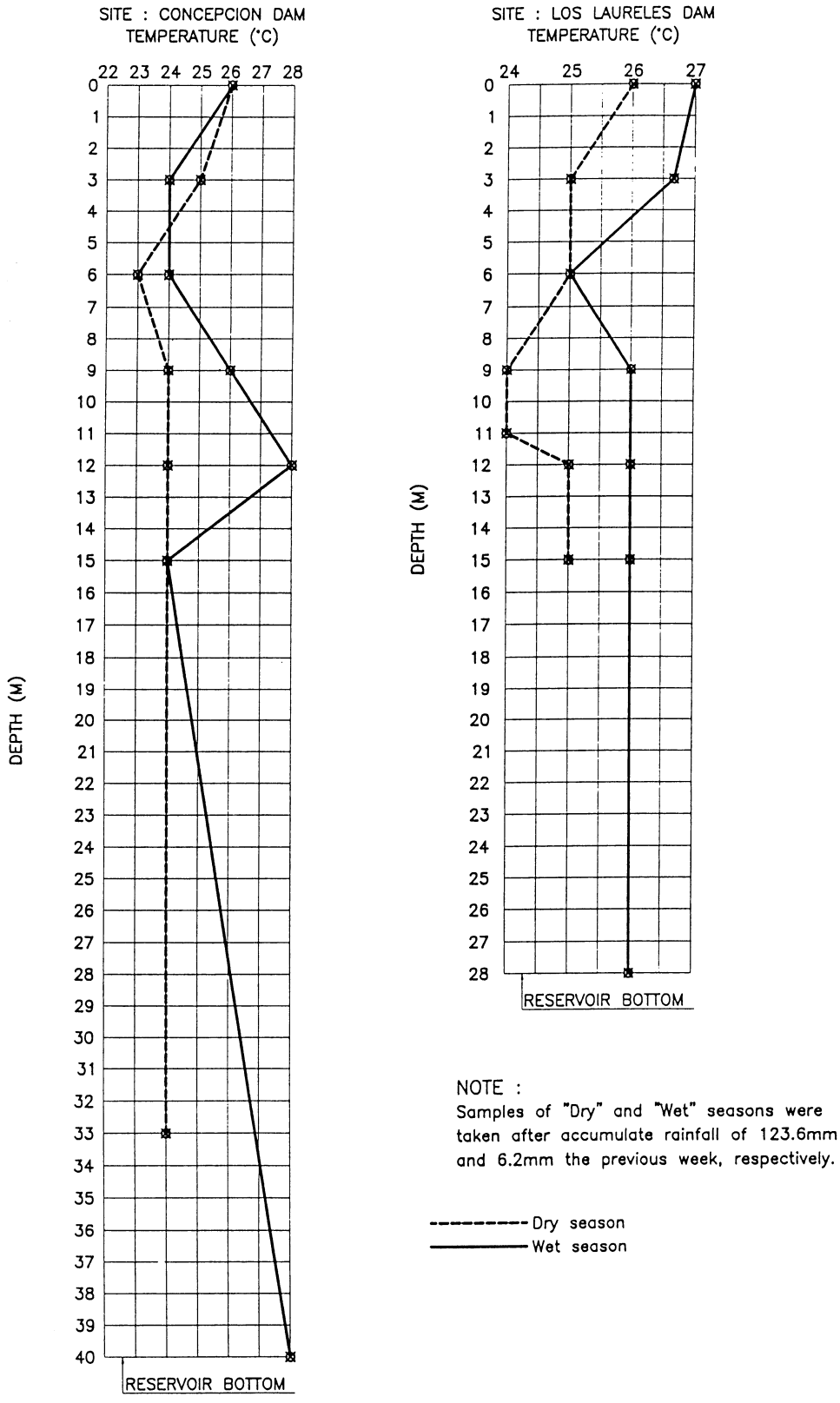


Figure AD.2.1 **Profile of Temperature at Reservoirs**

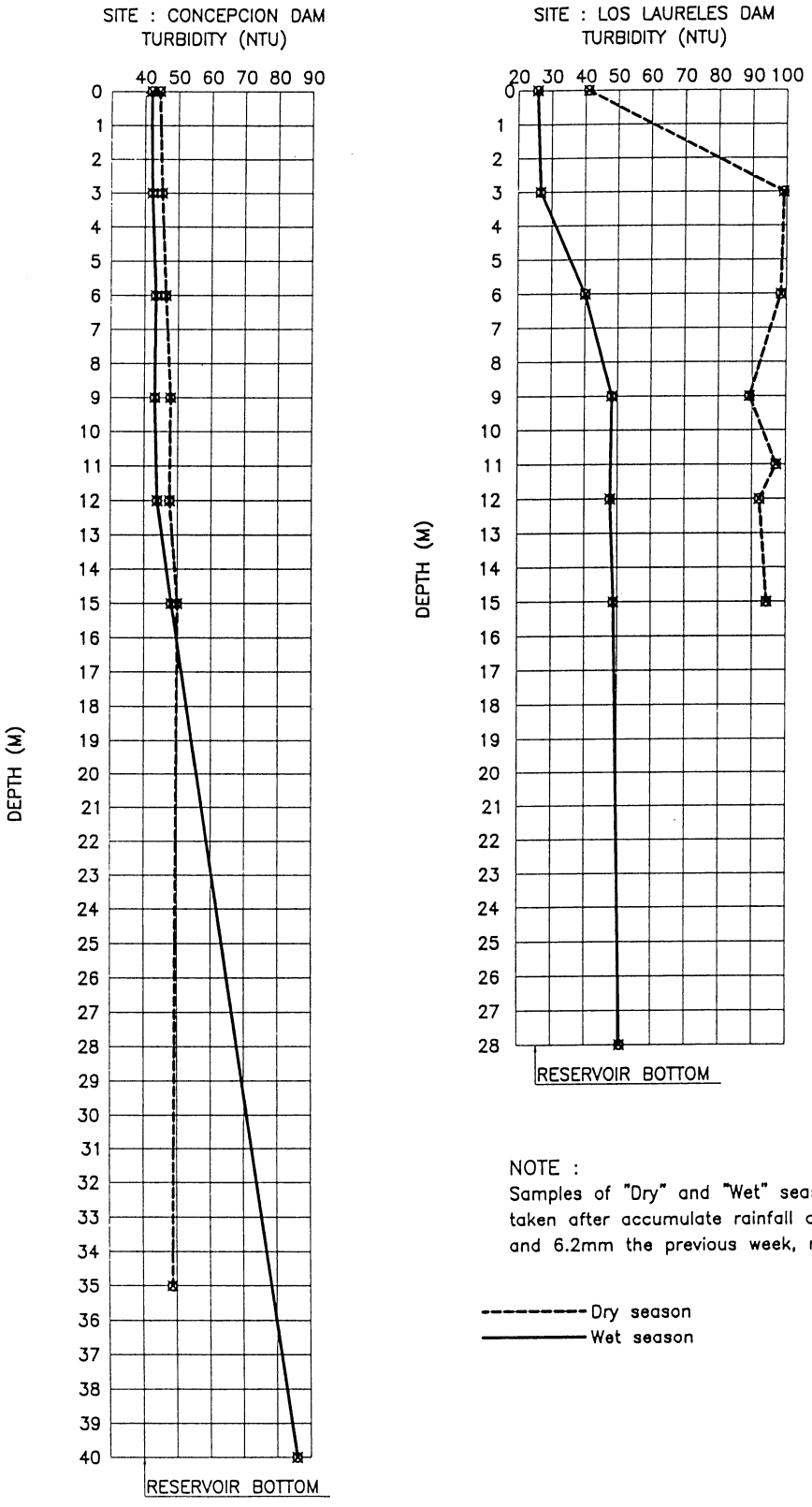


Figure AD.2.2 **Profile of Turbidity at Reservoirs**

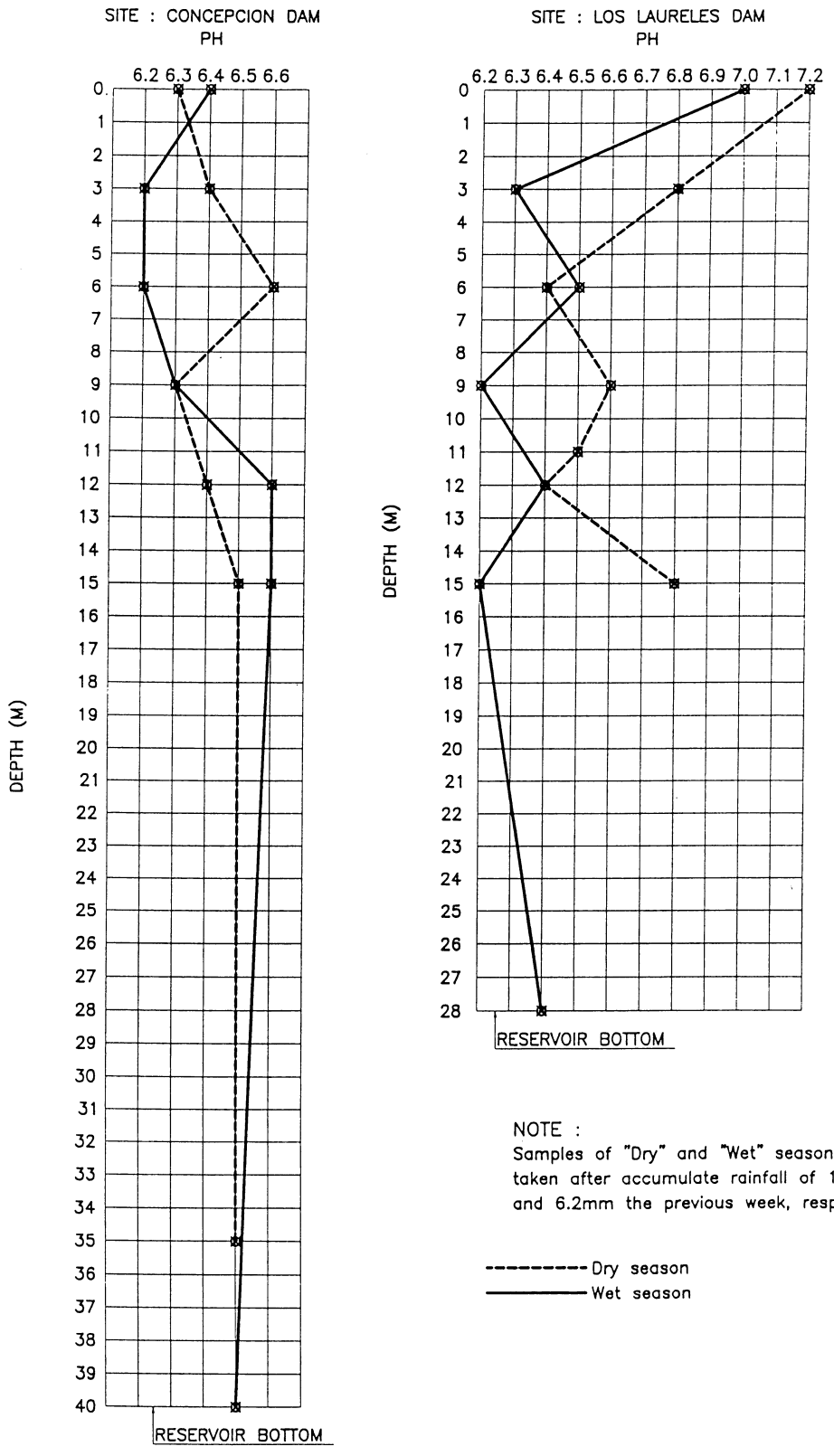
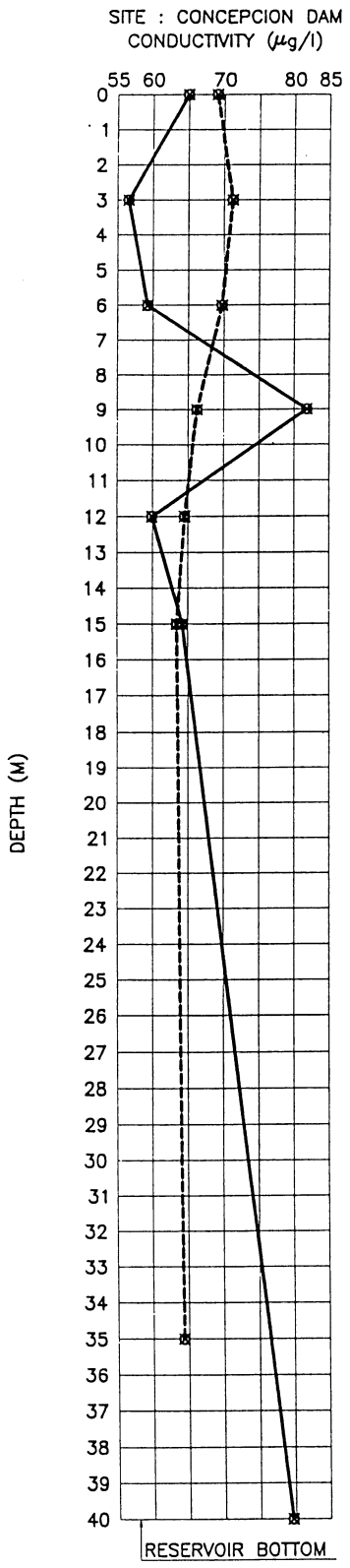
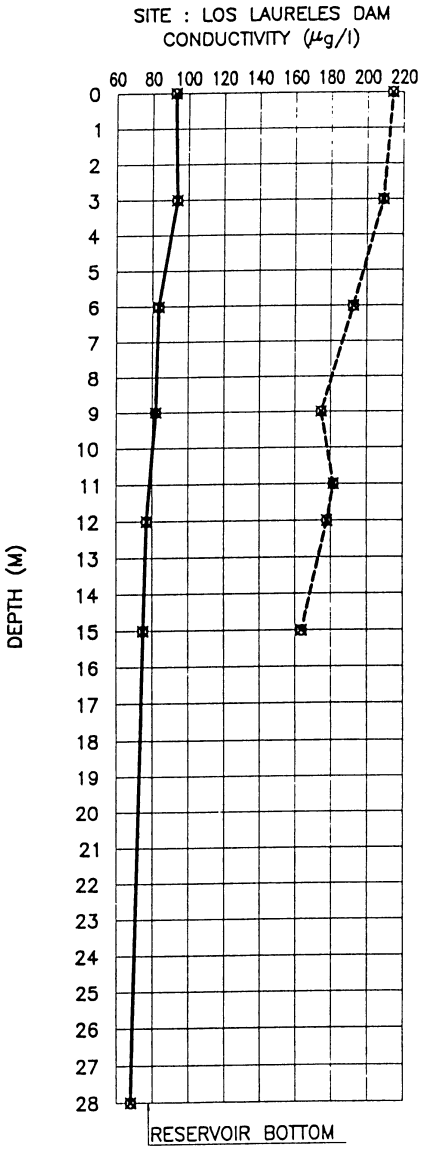


Figure AD.2.3 **Profile of PH at Reservoirs**





NOTE :
Samples of "Dry" and "Wet" seasons were taken after accumulate rainfall of 123.6mm and 6.2mm the previous week, respectively.

---------- Dry season
———— Wet season

Figure AD.2.4 | **Profile of Conductivity at Reservoirs**

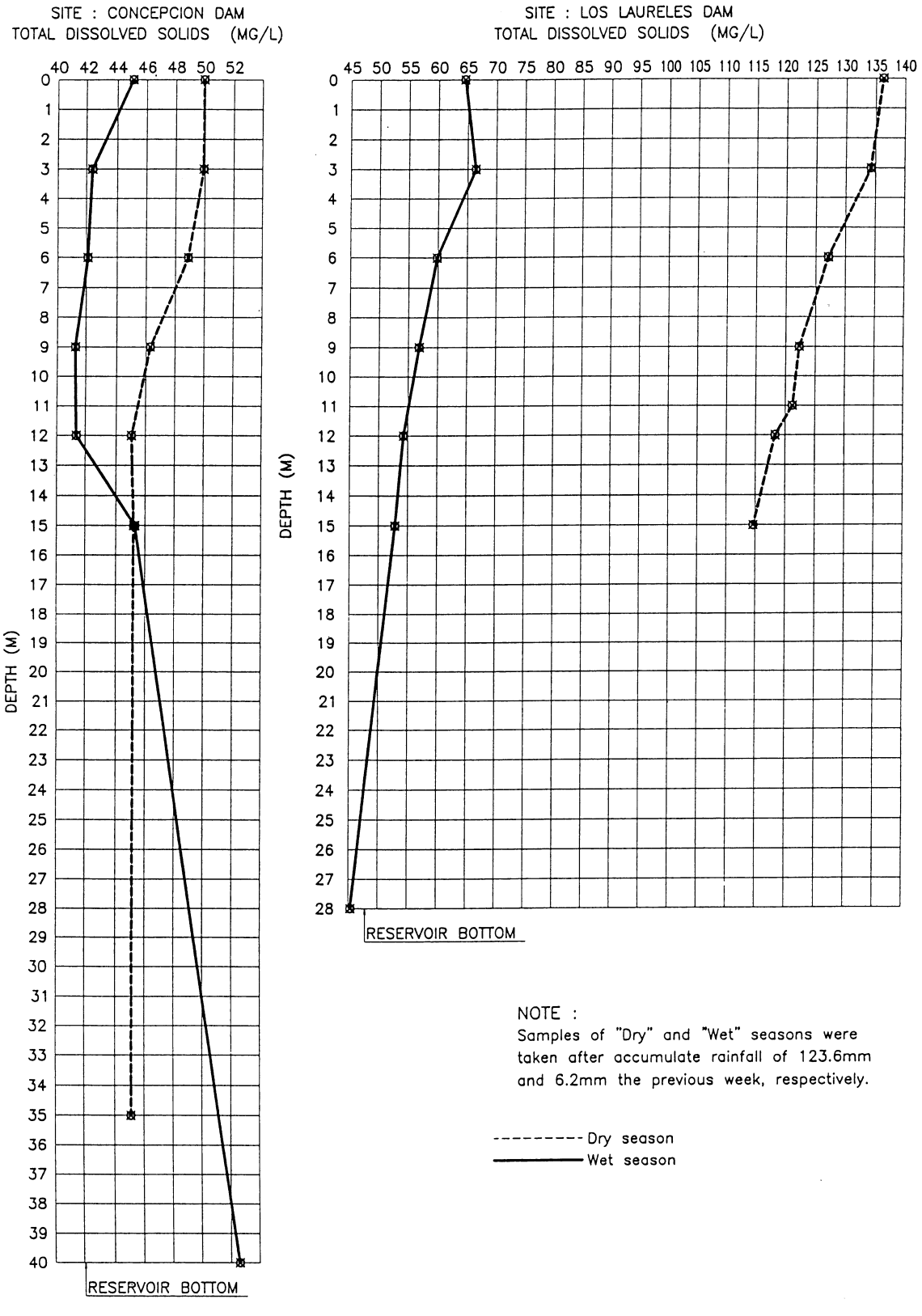


Figure AD.2.5 | **Profile of Total Dissolved Solids at Reservoirs**

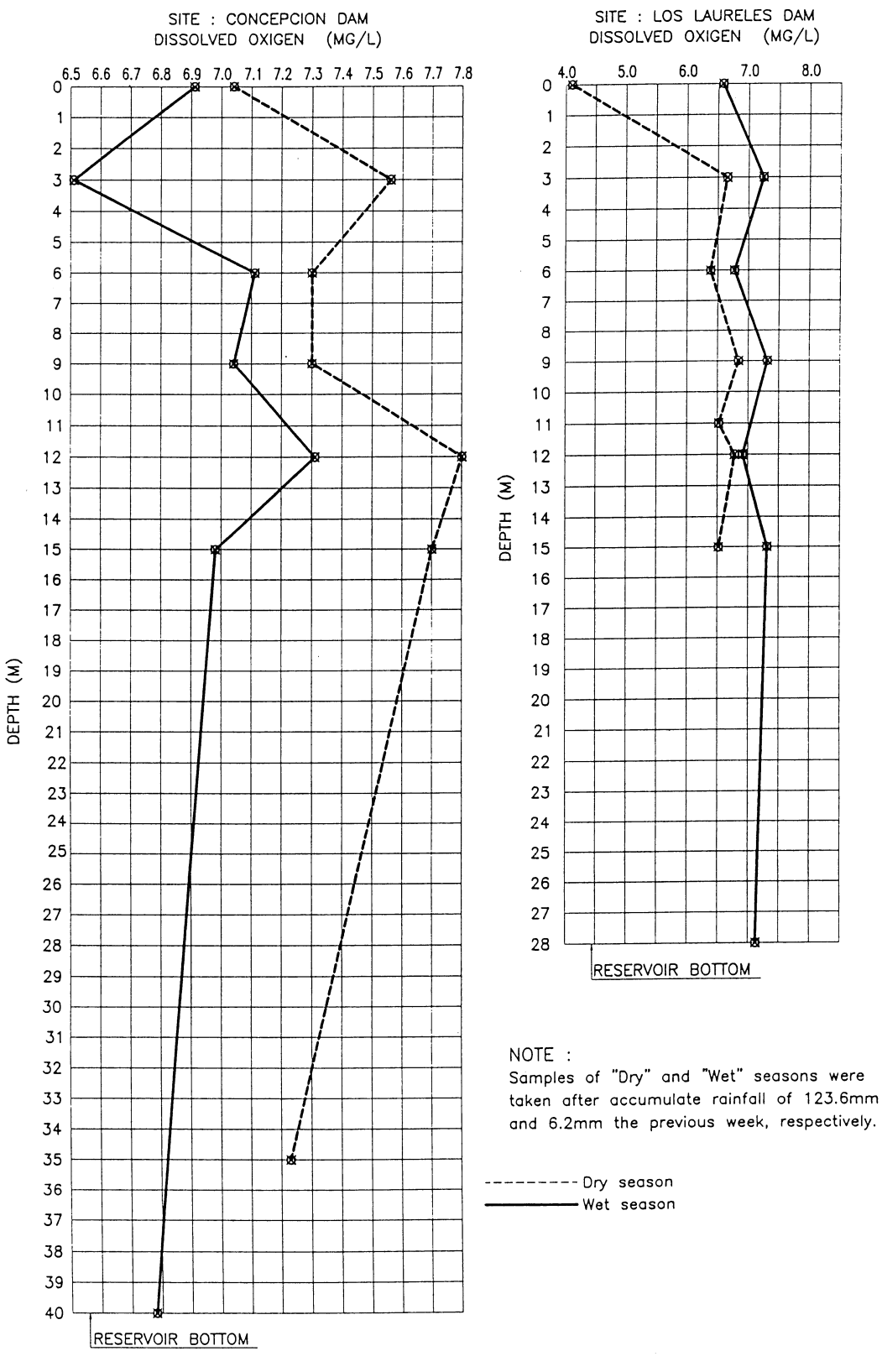


Figure AD.2.6 **Profile of Dissolved Oxigen at Reservoirs**

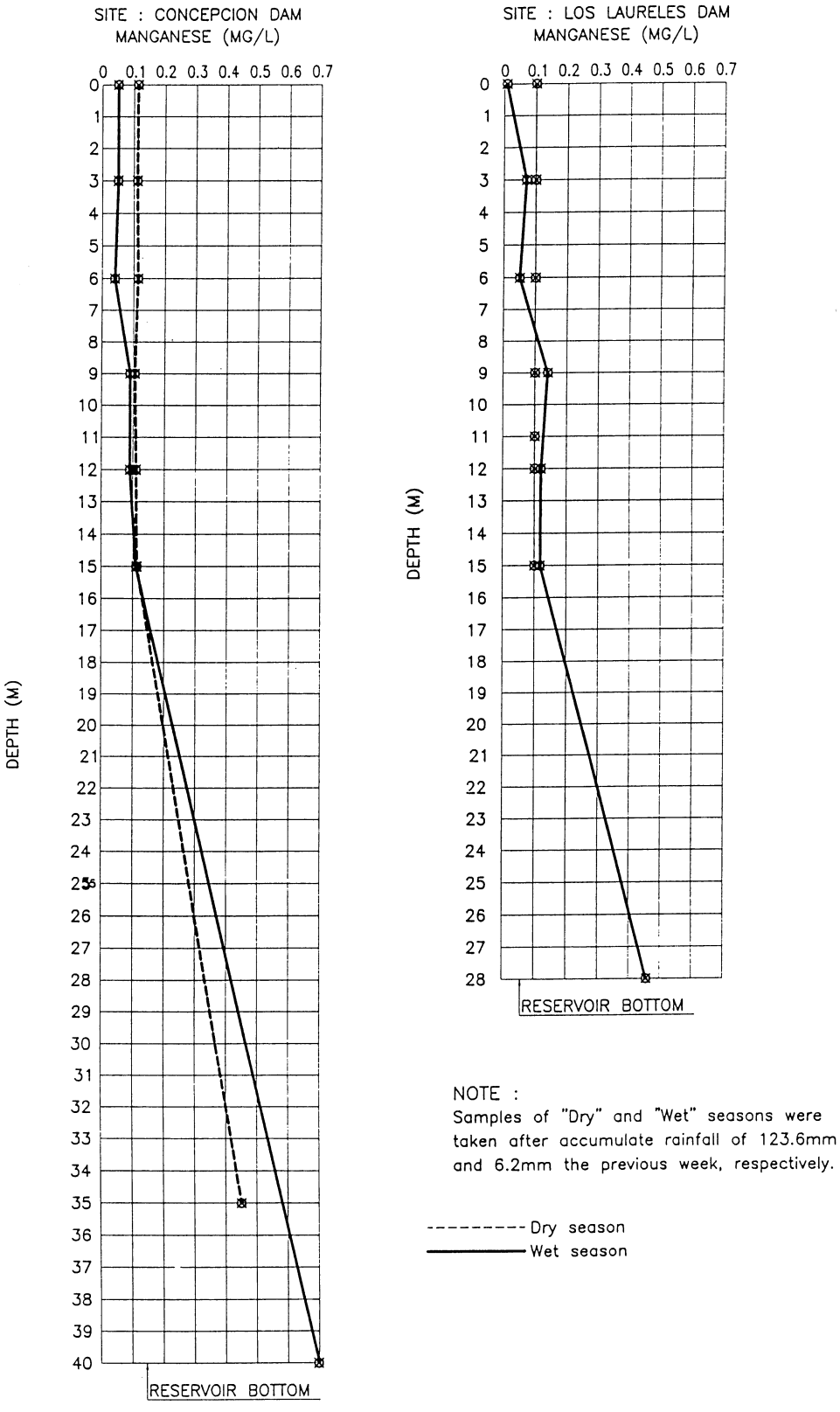


Figure AD.2.7 **Profile of Manganese at Reservoirs**