

***APPENDIX I***

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***ENVIRONMENTAL  
EDUCATION***

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**ENVIRONMENTAL EDUCATION**

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# **APPENDIX I ENVIRONMENTAL EDUCATION**

## **CHAPTER I CURRENT EFFORTS IN ENVIRONMENTAL EDUCATION**

A list of the institutions that have some programs on environmental education in the urban area of the municipalities of the study area is shown in Table I.1.1.

### **1.1 Environmental Education at Municipal Level**

The environmental laws in force in Colombia allow to the municipalities to undertake programs of environmental education attached to the formal education. However, the development of these activities has been for many municipalities a problem due to the lack of preparation of teachers and the shortage of didactic materials that make the teacher's job easier.

The present efforts on environmental education made by municipalities that make up the study area, are similar to those presented in others municipalities of the country. Some have not developed any program, others have developed some activities through the UMATA (Municipal Unit for Technical Assistance on Livestock and Agriculture).

It is opportune to mention that in the study area, some schools and universities had developed some academic programs related to the environment that had contributed to the increasing of the public awareness on the environmental matters.

### **1.2 Environmental Education at CAR Level**

In the CAR Regional of Ubaté there is not a program on Environmental Education, only punctual activities are performed when requested by the municipalities or community. Besides, some workshops and seminars time to time is performed by CAR addressed to the community with the aim of creating the necessary awareness and changes of attitudes of the people in order to protect the environment. In some cases, there is a cooperation between CAR and the municipalities for a specific program of reforestation that includes seminars on how to plant the trees and norms of conservation and protection of the natural resources.

Additionally, CAR through the Checua Project also had introduced environmental education on the region by teaching students, officers of UMATAS and the people in general on water management, multiplicity of crops, cultivation methods and field observations. Also the Project Checua had trained teachers on the management of eroded zones.

### **1.3 Environmental Education at Prefecture Level**

The formal education in the region basically depends on the Secretary of Education of the Prefectures of Cundinamarca and Boyacá although the Municipalities also support economically in some cases the functioning of many schools of the region.

The Prefecture of Cundinamarca had enforced the Decree N° 1743 of 1994, that obligate schools' teachers to prepare the Scholar Environmental Projects which must be implemented by them in their respective communities. For the preparation of such Projects both Secretaries of the Prefecture (Environment and Education) conjointly with CAR, are giving the necessary training and advisement.

The Prefecture of Cundinamarca through its Secretary of Environment plans to conform within this year, the Environmental Network for the Fuquene Lake Basin whose headquarter will be the Ubaté City. This network shall be coordinated by the Prefecture and integrated by CAR, municipalities and other related institutions and the main objective of this network shall be the implementing of environmental education programs and the promotion of public awareness on the environment.

On the other hand, in some municipalities, the Prefecture of Cundinamarca had donated some equipment like video player, computers, etc. to the UMATA to perform their activities of environmental education addressed to farmers and students of schools.

#### **1.4 Environmental Education at Non- Governmental Organization Level**

CAR had registered 17 non-governmental organizations related to the environment, and from this number, 9 organizations are currently working, especially in the basin of Bogotá River. The list of these organizations is presented in the Table I.1.2.

Regarding to the Study Area, only one organization was detected as the most important that is operating in the region, the Fuquene Lake Foundation, which was created by 1998, by citizens mainly of Chiquinquirá city, in view of the many environmental problems that is suffering the Fuquene Lake. The main objective of this organization is the promotion of environmental campaign or environmental projects addressed to the lake recovery. Besides, this foundation had created in some municipalities of the region their corresponding branches in order to expand their activities.

According to the interview to the Director and Members of this Foundation, the technical source of their information basically is CAR, and they would like to cooperate with CAR with the implementation of projects tending to conserve the environment of the lake.

Finally, recently, CAR had contracted one non-governmental organization for training teachers of the region on environmental aspects.

## **CHAPTER II PRESENT LEVEL OF PUBLIC AWARENESS ON THE ENVIRONMENTS OF FUQUENE LAKE BASIN**

### **2.1 Results of Questionnaire Survey**

#### **2.1.1 Introduction**

A questionnaire survey was conducted to know the public awareness on the environment in the Study Area. The questionnaire was addressed for the following three levels: a) Farmers and user of the irrigation district; b) Managers of Factories and; c) Citizens.

As for the farmers or users of the irrigation district, were considered in the survey the inhabitants living in the municipalities of Ubate, Susa, Fuquene, Simijaca, Lenguazaque, Cucunuba, Guacheta, Raquira, San Miguel de Sema and Chiquinquirá. Besides, some inhabitants living in the high parts of the basin were considered in the survey.

Regarding the survey conducted for Managers of Factories, the industries whose wastewater can affect the lake were previously selected taking into consideration their sizes of big, medium and small. The industry sector in the Study Area is composed mainly by dairy factories and coal-mining. For the dairy sector, the factories that are located mainly in the Municipalities of Ubate, Simijaca and San Miguel de Sema were considered for the survey. As for the coal-mining, those located in the municipalities of Cucunuba, Lenguazaque, Guacheta and Tausa were selected for the survey.

Finally, the questionnaire was addressed for the citizens who are the most representative in the region and these are, the mayor, the priest, the director of the Health Post or the director of the Hospital, a member of the Municipal Council, a member of the Water Supply Committee, a member of the Community Action Committee, Head of the Educational Center and other people related to union trades, cooperatives or associations. The Municipalities involved for this survey were: Carmen de Carupa, Ubate, Tausa, Sutatausa, Cucunuba, Lenguazaque, Guacheta, San Miguel de Sema, Raquira, Fuquene, Susa, Simijaca, Caldas and Chiquinquirá.

#### **2.1.2 Results of the Questionnaire Survey on Public Awareness on the Environment conducted for Farmers and Users of the Irrigation District**

##### **(1) General**

The survey was carried out with 145 inhabitants living in 10 municipalities located in the area of influence of the Fuquene Lake Basin. By gender the people in the survey were distributed like this: 72.4% masculine and 27.6% feminine. The average age of the population in the survey was of 44 years old and the average of the family members who live in the same house was of 4. The livestock is composed mainly by cattle for meat and milk productions.

##### **(2) Agriculture & Livestock**

###### **(a) Production**

The following table shows values found on the agriculture & livestock production of the respondents:

Items	Average	Median
Agricultural Land Area per One respondent (ha)	13.59	5.75
Pasture Land Area per One respondent (ha)	12.43	5.0
Cattle* Number per Unit Pasture Land/per One respondent (heads/ha)	3.43	2.6
Cow Number per Unit Pasture Land/per One respondent (heads/ha)	2.01	2.6
Milk Production per Unit Pasture Land/per One respondent (lt./d/ha)	24.1	22.0
Fertilizer per Unit Agricultural Land/per One respondent		
Solid form (kg/ha/year)	405	86.9
Liquid form (lt./ha/year)	258.6	3.47
Pesticides per Unit Agricultural Land/per One respondent		
Solid form (kg/ha/year)	0.9	52
Liquid form (lt./ha/year)	4.53	1.16

\*: Total of cattle for meat and milk

(b) Agricultural Equipment

The 26.2% of the respondents said that they own a tractor, 79.7% have a water pump, and among those respondents who milk cows 12.4% indicated that they have a mechanized milking machine, and 37.9% said to have two machines.

(c) Participation in Organizations

The 49% of the respondents said that they are members of the Association of Users of the Fuquene Irrigation District, a 3.5% said to be member of an Agricultural or Livestock Cooperative, a 3.5% are members of a Peasant Association, a 16.8% are members of the Community Action Committee, a 20% are members of a Committee for Water Supply and the 7.7% are members of any agricultural or livestock union trade, however, 39.2% said that they did not belong to any kind of organization. The respondents said that the among the activities performed by these organizations can be cited the followings: Training, to administrate the water supply system, to control the price of milk, to improve the production, to maintain the roads, to work for the well being of the community.

(3) Perception of Environmental Problems

(a) Problems with the use of water for irrigation

The most serious problems affecting the municipalities of the respondents are:

Type of problem	%
Shortage of water supply from the river	4.9
Descent in the lake's water level	28.0
Failure in the facilities of the water intake	4.2
Deposit of sediments in the river or channel	32.2
Aquatic plants in the river or channel	33.6
Water contamination	31.7
There is not problem with the water	34.3
Others	13.3

Among the others problems the following were mentioned: In summer the

water is scarce and in winter is too much, iron excess in the water, flooding, not water supply is provided, lack of channels, clogging of channels.

The respondents believe that among the reasons of these problems with the water are: when opening the gates the river is filled with mud, wastewater, low water level of river, lack of maintenance of channels, poor management, lack of canalization to the lake, not removal of sediments and weeds, erosion, lack of drainage, lack of facilities, presence of aquatic plants and sediments, illegal dumping of solid waste to watercourses.

Besides, the respondents had indicated the possible solutions to these problems as follows: To open the river and deep cleaning, to expand the coverage of the channels and its cleaning, to expand a water system for all the districts (veredas), to excerpt a control in the high reaches of the basin, constant dredging of the rivers and lake, education of the people, the cleaning of the lake, gates control, water pollution control, to maintain the water level, to construct drainage and dams.

The 28.3% of the respondents said that in the dry season, they had problems with other users due to the limitations for the use of the water. Besides the following percentages of respondents had manifested that their farm is affected by flooding as follows: 7.6% more than twice a year, 19.3% twice a year, 12.4% once a year, 19.3% seldom, 41% never.

On the other hand, 25.7% knew that from now on the operation and maintenance works of the irrigation channels in the irrigation district will be transferred from CAR to the Users Association, while 74.3% have not heard about this decision. In addition, 33.1% believe that the Users Association has the ability to carry out these operation and maintenance works and 36.6% believe that the Association is not able to assume this responsibility, the 26.2% does not know about this subject and 4.1% did not answer the question.

Those who believe that the Association has not the capability, had presented the following reasons: 13.3% said due to the lack of manpower, 49% due to the lack of equipment, 58.8% due to the lack of financial resources, 37.3% due to the lack of experience and 45.1% due to technical difficulties.

(b) Water Charge

Preliminary values found indicates that on average, the users of the irrigation district services pay annually for water Col\$125,734 per one ha of irrigated area, and the median for this value is Col\$78,431. Besides, the maximum amount the users are willing to Col\$ pay for this service is in average of Col\$71,195 per one ha of irrigated area. The median for this value is Col\$29,412. The 20% of the respondents said that they could not give a precise figure on the maximum amount to pay for the irrigation water.

(4) Awareness on the Environmental Problems

Regarding the Checua Project, 44.1% have heard of this project and 39.6% know that CAR is carrying out a project on the control of the erosion, similar to the Checua Project, in the mountainous areas of the Fuquene Lake Basin, however, the 60.4% do



not know about this.

The respondents had mentioned the following benefits from the Checua Project or CAR project: water for the future, improves the soil, increases the production, preserves the water and lowers the contamination, avoid flooding, erosion control, avoids the drought, etc.

The 20.8% of the respondents recognize that their field is affected by erosion problems and 78.5% said that they do not have this problem. The 57.1% of the respondents having erosion problems are taking the steps to protect their field and 17.9% admits that they have received technical assistance from governmental entities.

The 76.1% of the respondents would be willing to change the current cultivation method in order to prevent the erosion of the soil.

The 85.5% of the respondents considers to be significant the sedimentation problems caused by the mountainous field to the down stream of rivers and lake. Besides, the 83.6% are aware that agricultural and livestock activities causes the pollution of down stream waters and the 96.5% is aware of the pollution of rivers and lakes.

The 97.2% of the respondents knows that Cucunuba and Fuquene Lakes have suffered a fast reduction in the recent years. Among the opinions of the respondents, the causes for this reduction are the following: Negligence, accumulation of sediments, lack of maintenance, land invasion, contamination and lack of reforestation, deforestation, decrease of rivers and streams flows, erosion, lack of water, lack of awareness, lack of control by the authorities, lack of dredging and cleaning, lack of rainfall, agricultural and livestock activities, the mining extract much soils, bad administration, no control is performed in the water level, the invasion of aquatic plants, water uses without any control.

The 96.5% of the people in the survey are worried if the lakes might become extinct in the future. Additionally, a great awareness is found among the respondents on the environmental damages that can be generated if the lakes decrease their sizes or become extinct and among the adverse effects the following were mentioned: shortage of water in the down stream, climate changes, pollution, production decrease and could end the agricultural and cattle farming, the water in the region will be finished, there would be a lack of water for the cities and in general it would bring death of the fauna and flora, people would be affected by diseases, migration, etc.

However, the 2.8% believe that the extinction of the lakes can bring benefits and when asked to talk more on this opinion, the respondents point these beneficial effects to the lake neighbor owners who would see their land enlarged.

The 48.3% of the people in the survey are interested in using elodea as fertilizers, the 31.5% said no and 20.3% said that they do not know anything on the subject. Those persons interested in the elodea as fertilizers said that the amount they would be willing to use is in average of 36.7 ton/ha, the median was established at 5 ton/ha for pastures. The average for crops was established at 8 ton/ha. The willingness to pay for this consumable for pasture fertilizing is in average of Col\$88,812 per ton. The median of this variable was of Col\$50,000.

Among those interested in using the elodea in crops, the willingness to pay was in

average of Col\$22,500/ton.

(5) Average Income and Expenditures of the Families

The average monthly family income was found to be of Col\$1,063,926. The median for this variable was established at Col\$300,000 and the mode at Col\$250,000.

The average monthly expenditure was found to be of Col\$785,287. The median of the expenditure was established at Col\$300,000 and the mode at Col\$200,000.

(6) Information Sources on Environmental Subjects

Radio and television stand out as the best communication means to inform the farmers and users of the irrigation district on environmental subjects.

(7) Participation of the people in Environmental Education Programs

The 83.3% said that they have never participated in any environmental education program and the 95.8 says that they would like to participate in environmental education campaigns or programs.

The 44.3% said that their children have environmental education class at school, the 30.5% said no and 22% said that they do not know.

Finally, the 78.2% stated that they have committed themselves to minimize the garbage that they discharge into the dumps, through recycling or burying/burning the garbage.

**2.1.3 Results of the Questionnaire Survey on Public Awareness on the Environment conducted for Managers of Factories**

The manager or the representative persons of the industries were interviewed with the purpose of establishing a profile of the people's awareness on the environment from this business sector's point of view.

(1) Milk-Processing Industries

(a) Production

Fourteen milk-processing industries (small 10, medium 2, big 2) were randomly selected from municipalities of the Study Area. The average production is indicated below:

Industry Size	Milk	Cheese	Yogurt
Small	-	44 kg/d	15 lt/d
Medium	37,750 lt/d	135 kg/d	44 lt/d
Big	73,333 lt/d	631 kg/d	7,193 lt/d

The average sale price of milk, cheese and yogurt is of 700 Col\$/liter, 6,000 Col\$/kg and 3,000 Col\$/liter respectively. The average physical area occupied by these industries is of 0.13 has.

The average number of employees for the small, medium and big industries are 3.5, 15 and 76.5 respectively.

The most important equipment employed for the big and medium industries are: compressor, boiler, electrical plant, ice bank, motor pumps, clarifier, pasteurizer, skimmer, packing machine, industrial stoves. The small industries have not machinery and makes the products manually at artisan level.

When respondents are asked about the main problems they deal in the industry they answer the followings: low technology, lack of equipment, deficit in energy, lack of water treatment, milk scarcity, when the milk has antibiotic residues.

From the organizational point of view, the majority of the respondents had indicated that they do not have an investment plan therefore the absence of a strategy of growth was clear.

The 35.7% of the industries surveyed participate in some kind of organization like trade unions and industrial organization. An important 64.3% indicated that they do not belong to any organization or did not answer the question. Those who belong to an organization, had indicated to the control of price of milk, milk quality, cheese marketing as main activities of the organization.

(b) Sources and Use of Water

These industries have an average water consumption of 12 m<sup>3</sup>/month, 280 m<sup>3</sup>/month and 1850 m<sup>3</sup>/month for the small, medium and big sizes and 85.7 % of them takes the water from the municipal water supply system and the remaining 14.3% from village aqueduct, wells, rivers or streams. The number of times a year that the industries are affected by the lack of water supply is as follows: 42.9% never, 7.1% one time, 21.4% twice, 7.1% three times and 21.4% do not know or not answer. According the respondents the lack of water supply are attributable to the bad use of the basin, deforestation, bad handling of wastewater, poor administration and wrong use of water.

The measure taken by the industries to counterbalance the lack of water consist in the rationalization on the water use. Among the solutions proposed by the respondents to avoid water scarcity are: water saving, rationalization, preservation of sources, reforestation, to collect waters from rainfalls, etc.

The 78.6% of the respondents manifested that it is possible to reduce the consumption of water in the industry and the 21.4% said not. Those who said that it is possible the reduction in the water consumption had manifested the manner to attain it as follows: making better use of it, work with pressure machines, reuse the water to wash the floors, using hidromatic equipment, housekeeping, etc.

(c) Handling of Wastewater

The 28.6% of these industries discharges their wastewater to the sewerage without treatment, the 50% to the sewerage with treatment and 21.4% discharges to septic tanks or oxidation ponds.

(d) Handling of Solid Waste

The type of solid waste generated by these industries consists of filters and cardboard scraps and these are collected by the factory itself (14.3%), by the Municipality (42.9%), by the people who make recycling (7.1%) and the 35.7% do not know or do not answer.

The 92.9% of the respondents said that the leachate generated in the dumping site can affect the watercourses in the vicinity and the 7.1% said they do not know anything about this subject.

(e) Environmental Awareness

100 % of the respondents stated that they know the effects of pollution that cause the discharges of untreated wastewater into watercourses and the same percentage are worry about the contamination problems of rivers and lakes. The 92.9% are aware of the effects of wastewater containing sodium hydroxide and sodium chlorate which were used in the cleaning of bottles and tanks.

The 28.6% said that they know about an erosion control project known as Checua Project, the 21.4% do not know and 50% did not answer. When asked if they know that CAR is currently carrying out an erosion control project, similar to the Checua Project in the mountainous areas of the Fuquene Lake, 35.7% declared that they know about the project and 64.3% do not know about it. The following benefits have been indicated by the respondents that could bring about a project of this nature: improves the water source, fauna, flora and avoid sedimentation, improve the water basin, recover the lake, preservation of soils and watercourses, improves the land for production, improve the environment. In addition, the 100% of the respondents had showed their interest in participate with CAR in the erosion control project if necessary.

When asked if they had received any assistance or suggestions for the erosion control from government entities, 21.4% answered Yes and 71.4 said not.

The 50% of the people in the survey believe that the mining activities cause problems of sedimentation in rivers and lakes significantly, the 28.6% do not know about this subject and 21.4% do not respond.

The 100% of the respondents know that Fuquene and Cucunuba lakes have suffered a fast reduction recently and 92.9% are very worried because these lakes might become extinct in the future. However, the 7.1% do not mind this problem. Among the causes of the fast reduction of the lakes that the people said are: sediments, general negligence, pollution and poor management of the water basin, land appropriation, erosion, lack of maintenance, deforestation, absence of the Government, construction of Hato dam, etc.

Regarding the adverse effects that could bring about the reduction of the lakes or if they become extinct, the respondent had manifested among the followings: the agriculture, the industry and the cattle raising would be affected, the economy would be affected, there would be little water supply, diseases, changes in the climate and dryness in the region which would bring a low pasture production and consequently milk scarcity, etc. In addition, the 100%

said that no benefits can be obtained from the decrease or extinction of the lakes.

Concerning the participation on environmental education programs, the 50% of the respondents had participated in any kind of education program and the 92.9% are willing to participate in environmental education campaigns or programs and 64.3% indicates that their children have environmental education classes at schools.

(f) Information Sources on Environmental Subjects

The radio and television stand out as the best communication means on environmental subjects.

(2) Coal-Mining Industries

Considering the high degree of development of the coal mining in the Fuquene Lake Basin, eleven enterprises (small 7, medium 4) were randomly selected for the survey.

(a) Production

The average production for the small enterprise ranges from 895 to 2,536 tons/year and for the medium 16,000 to 48,000 tons/year. The average unit price is of Col\$18,000/ton.

The average physical area occupied by these industries is of 19.4 has. However, considering that the enterprises surveyed were small and medium, a measure of central tendency important in this case is the median with a value of 10 has.

The average number of employees for the small and medium sizes are 7.25 and 16.8 respectively. In years of working of these industries, the average is found to be 22.2 years.

The most important equipment employed are: winch, electric pumps, lamp charger, dump trucks, compressor, fans, transportation equipment, etc.

Main operational problems indicated by the respondents are: gas production, excess of water, pumping, marketing, transportation, groundwater, energy, etc.

Among the components of the investment plan the respondents had indicated the followings: make pits and do treatments with limestone and aeration, to lighten the human work with machines improvement and transportation systems, safety, etc.

The 63.7% of the enterprises surveyed participate in some kind of organization and 36.3% indicated that they do not belong to any organization. Those who belong to an organization, had indicated to the control of commercialization as the main activities of the organization.

(b) Sources and Use of Water

The 63.6% of these mining takes the water from the village water supply

system, the 9.1% from wells, the 9.1% from spring and the 18.2% from groundwater that are found in the mines. The use that is given to the water is well defined around the domestic use. These enterprises are not affected by the lack of water supply throughout the year.

(c) Cost of Water and Willingness to Pay

On average the enterprises pays Col\$64,000/month for the water consumption and the willingness to pay for the water on average is of Col\$64,000/month.

(d) Handling of Wastewater

The 63.4% of these mining discharges their wastewater to the river or channels without treatment, and the 36.4% do to septic tanks or filtering pits.

(e) Handling of Solid Waste

The type of solid waste generated by the mining are barren soil, rotten wood and wood rubble and these are collected and disposed of by the mining enterprises in their own land.

(f) Environmental Awareness

The 72.7 % of the respondents stated that they know the effects of pollution that cause the discharges of untreated wastewater into watercourses. However a significant 27.3% indicated that they did not know that.

The 81.8% are worry about the contamination problems of rivers and lakes. In relation to the knowledge of the effects that mining cause on soils erosion and the discharge of waters containing iron in the rivers and lakes, the 90.9% had manifested that they know this fact.

The 72.7% said that they know about an erosion control project known as Checua Project and the 27.3% do not know. When asked if they know that CAR is currently carrying out an erosion control project, similar to the Checua Project in the mountainous areas of the Fuquene Lake, 72.7% declared that they know about the project and 27.3% do not know about it. The following benefits have been indicated by the respondents that could bring about a project of this nature: improvement of the environment, sedimentation control, permanent water services, protection of springs, improvement of the land, etc. In addition, the 90.0% of the respondents had showed their interest in participate with CAR in the erosion control project if necessary.

When asked if they had received any assistance or suggestions for the erosion control from government entities, 36.4% answered Yes and 63.6% said not.

The 63.6% of the people in the survey believe that the mining activities cause sedimentation problems in rivers and lakes significantly, the 27.3% find that this sedimentation is not very significant and 9.1% do not respond to this subject.

The 100% of the respondents know that Fuquene and Cucunuba lakes have

suffered a fast reduction recently and the same percentage are very worried because these lakes might become extinct in the future.

Regarding the adverse effects that could bring about the reduction of the lakes or if they become extinct, the respondent had manifested among the followings: the production in general will be affected, the end of the fauna and flora, destruction of the environment, pollution, the people will be affected since the majority of inhabitants depend on the lake, etc. In addition, the 100% said that no benefits can be obtained from the decrease or extinction of the lakes.

The 18.2% of the respondents had manifested to have participated in environmental education programs while 45.5% say that they have never participated. The 100% are willing to participate in environmental education campaigns or programs and 81.8% indicates that their children have environmental education classes at schools.

(g) Information Sources on Environmental Subjects

The radio and television stand out as the best communication means on environmental subjects.

**2.1.4 Results of the Questionnaire Survey on Public Awareness on the Environment conducted for Citizens**

The survey was conducted on 112 citizens living in the urban area of the municipalities located in the Study Area. The citizens were selected randomly among the people with defined professional roles of serving the community and older people linked to commercial and industrial activities in each locality. By gender the people in the survey were distributed like this: 55.4% masculine and 44.6% female. The average age of the population in the survey was of 36 years old and the average of the family members who live in the same house was of 3.5.

(1) Perception of Environmental Problems in the Municipality

According to the respondents, the most serious problems affecting the municipalities are:

Type of problem	%
The water supply system is insufficient	66.1
The sewer system is insufficient	65.2
The garbage disposal system is insufficient	73.2
Pollution of rivers or channels	71.4
Soil erosion	63.4
Sediments in rivers or channels	57.1
Excessive amount of aquatic plants in rivers or channels	32.1
Others	17.0

Under other concepts the following are included: deforestation, child malnutrition, environmental pollution, the water intake after sewage discharge of Carupa municipality.

The 68.8% of the respondents know that each municipality must from now on solve

their environmental problems, however, only 27.7% believe that their municipality has the capability to deal with environmental problems, the 65.2% do not believe and 7.1% do not know. Those respondents who do not believe in the capability of the municipality had indicated the following reasons: lack of manpower (14.3%), lack of financial resources (56.3%), lack of experience (39.3%) and technical difficulties (35.7%).

(2) Opinion on the Water Supply Service

According to the respondents, the most serious problems of the water supply system in their municipalities are: low coverage (26.8%), shortage in the supply (39.3%), poor quality of water (74.1%), old facilities (51.8%), high tariffs (10.7%), lack of maintenance (14.3%).

The 72.3% know the location of the source of water and 27.7% do not know. The average monthly charge paid by the respondents was found to be of 8,058 Col\$. However, the median indicates that this value is 3,000 Col\$ and the mode is 2,000 Col\$. A significant percentage of respondents (24.1%) had indicated that they do not know how much they pay for water supplied. The willingness to pay for water was found to be on average of 9,000 Col\$, being the median 5,000 Col\$ and the mode 2,000 Col\$. The 33.9% of the people in the survey manifested that they do not know how much this value could be.

(3) Opinion on the Sewerage Service

The most serious problems of the sewerage service indicated by the respondents are: low coverage (33.9%), old facilities (50%), there is no treatment plant (53.6%), deficient treatment system (53.6%), high tariff (6.3%), combined system (25%).

The 27.7% said that they know where the treatment plant is, the 27.7% do not know and the 39.7% know that there is no treatment plant.

The 41.1% said that they do not know how much they pay for the service. Those who answered the question an average of 3,196 Col\$ was established as the monthly value charge, however, the median found is 850 Col\$. The maximum value that they are willing to pay for this service is established with an average of 3,301 Col\$, the median for this variable is of 2,250 Col\$, however, 46.4% do not know what would be the maximum value.

(4) Opinion on the Garbage Collection Service

The most serious problems of the service indicated by the respondents are: there is no garbage collection service (7.1%), low coverage (28.6%), low frequency of collection (31.3%), high tariff (7.1%), none (11.6%) and other (44.6%). Under the other problems are indicated the followings: there is no landfill, no separation of the garbage, there is no treatment at the disposal site.

The 54.5% know the location of the disposal site, the 28.6% do not know and 15.2% say that there is no municipal disposal site. The average charge paid by the respondents for the service is of 3,361 Col\$, the median as 650 Col\$. The 37.5% said



they do not know how much they pay for this service. The maximum value they could pay for the service was established on average of 3,171 Col\$ and the median as 2,000 Col\$.

(5) Income and Average Expenses of the Families

The average family monthly income was found to be 1,063,026 Col\$. The median was established as 700,000 Col\$. The average monthly expense was established as 810,108 Col\$ and the median as 500,000 Col\$.

(6) Awareness on Environmental Problems

In opinion of the respondents, the most serious problems that causes the pollution of rivers in their municipalities are as follows: damage of water used for domestic purposes (69.6%), damage on the ecology (75.9%), bad odors (60.7%), deterioration of the landscape (64.3%), other (17.9%). Under the other the following were mentioned: the occurrence of diseases like colds, diarrhea and skin infections, the presence of mosquitoes and other insects.

As sources of the rivers pollution the people surveyed identified the followings: domestic wastewater (74.1%), industrial wastewater (46.4%), garbage (68.6%), residues from slaughterhouses (43.8%), residues from hospitals (26.8%), agrochemical products (23.2%).

The 82.1% of the respondents know that according to the law, the factories must treat their wastewater before discharging into the municipal sewerage system, the 17% indicated that they do not know this regulation. Only 8% believe that the factories complies with this law and 64.3% think that this law is not enforced.

The 81.4% said that they know about an erosion control project known as Checua Project. The 53.6% knows that CAR is currently carrying out an erosion control project, similar to the Checua Project in the mountainous areas of the Fuquene Lake and 46.4% do not know about it. Among the benefits that have been indicated by the respondents that could bring about a project of this nature are: recovery of the lake that represent the life of the region, improvement of the environment, less pollution, less soil erosion, to guarantee the water supply, recovery of soils, improvement of the basis for the agricultural economy, to avoid the sediments in the lake, to preserve the water source, protection of the flora & fauna, etc.

The 96.4% of the respondents know that Fuquene and Cucunuba lakes have suffered a fast reduction recently and 3.6% do not know. In the opinion of the people surveyed, among the causes of this reduction are: lack of maintenance, poor dredging, pollution, aquatic plants, sedimentation, land invasion, lack of concern from government entities, poor management of the land, deforestation, poor management of the agriculture and cattle raising in the high regions, reduction of springs, etc.

The 96.4% of the people in the survey are very worried because these lakes might become extinct in the future. The 2.7% said that they do not care.

Regarding the adverse effects that could bring about the reduction of the lakes or if they become extinct, the respondent had manifested among the followings: water would be scarce, end of the ecological resources, the zone becomes a desert, the

production will decrease, diseases, farms and cities with no water, climatic change, the end of the fauna and flora, pollution, social problems, etc. However, the 5.4% said that the extinction of the lakes can bring benefits specially to the neighboring landowners who would see their lands enlarged.

(7) Information Sources on Environmental Subjects

The radio and television stand out as the best communication means on environmental subjects.

(8) People's Participation in Programs of Environmental Education

The 33% of the respondents had manifested to have participated in environmental seminars, 27.7% have been in a conference on this subject, 28.6% have received specific training on the subject and 47.3% say that they have never participated in any program of environmental education. The 50.9% said that they had participated in campaigns or environmental activities organized by government entities or by some NGO. The 95.5% are willing to participate in environmental education campaigns or programs and 49.1% indicates that their children have environmental education classes at schools.

The 78.6% said that they had set out to minimize their garbage to be disposed of through recycling or burning/burying the garbage in their lands.

## **2.2 Evaluation of Present Public Awareness**

In general there is a high level of awareness of the people living in the Study Area with respect to the environmental problems that is facing currently the Fuquene Lake Basin. Almost 100% of the respondents to the questionnaire are worry if the lake might become extinct in the future, since the lake represent for them the support for the economical development and water source for domestic consumption. Near the 100% of the respondents are aware that the Fuquene and Cucunuba lakes have suffered a fast reduction in the recent years and among the causes mentioned are: lack of maintenance, poor dredging, pollution, aquatic plants, sedimentation, poor management of the water basin.

Finally, near the 100% of the people in the survey would like to participate in any environmental education program or campaign, and one of the strategies to perform this kind of programs is using the radio and television since they are the most common way currently employed by the people in the survey to receive any environmental education.

### **2.2.1 Public Awareness of Farmers and Users of the Irrigation District on the Environment**

The biggest problems manifested by the people in the survey have relation with the presence of aquatic plants and deposit of sediments in the rivers or channels and the decreasing of the lake's water level.

Almost the 80% of the respondents did not know that from now the operation and maintenance works of the irrigation channels will be transferred from CAR to the User Association. This situation can generate possible misunderstanding and no collaboration from the users with the objectives of the Association. Among the respondents who know about the decision, near the 40% believe that the Association has not the capability due mainly to the

lack of equipment, financial resources and technical resources.

A high percentage of farmers and users of the irrigation district would be willing to change the current cultivation method to prevent soil erosion although few of them had received technical assistance from governmental entities.

Almost the 50% of the respondents are interested in using elodea as fertilizers, which percentage can be improved if the subject is explained in details to the potential users.

### **2.2.2 Public Awareness of Managers of Factories on the Environment**

All the people in the survey are aware of the harmful effects of untreated wastewater when discharged into the watercourses. Besides, the 100% of the respondents have the interest to participate with CAR in the erosion control project if necessary and this fact is very important since other environmental programs can be down with the collaboration of this people.

Around the 60% of all the respondents believe that the mining activities generates problems of sedimentation in rivers and lakes significantly.

Those respondents of the mining sector have the interest of improving the conditions of their enterprises in terms of environmental protection and industrial safety, on the other hand, the milk sector had not showed any strategy to growth in the future.

More than 60% of the mining enterprises surveyed discharges their wastewater into rivers and channels without treatment while around the 30% of the milk industries surveyed discharges into the sewerage without treatment. This fact can be harmful to the quality of the rivers and lakes and the law enforcement become necessary to prevent the environmental degradation of the receiving watercourses.

### **2.2.3 Public Awareness of Citizens on the Environment**

A high percentage of the respondents in the survey had indicated as the most serious problems in their municipalities the followings: water supply system insufficient, garbage disposal and sewerage systems insufficient, pollution of rivers and channels, soil erosion, sediments and excessive amount of aquatic plants in rivers and channels.

Only 8% of the respondents believe that the factories complies with the discharging law and more than 60% think that the law is not enforced. These figures indicate a great necessity of making promotion programs to lower the pollution that can create the discharges of wastewater into watercourses without treatment.

Around 70% of the people surveyed know that the municipalities should solve their environmental problems from now on but more than 65% think that their municipalities do not have the ability to deal with this responsibility alleging as the main reasons the lack of financial resources and experience. From this it can be concluded that the municipalities of the Study Area needs some technical and financial assistance to perform their activities in the sector of environment.

## CHAPTER III PROMOTION OF ENVIRONMENTAL EDUCATION

### 3.1 Necessary Program

For the effective implementation of the projects to be recommended by this Study, an education program to promote public awareness on environmental issues shall be undertaken for all the sectors involved in the study area. Therefore, the educational program will have the following four objective levels: (1) Schools, (2) Farmers and Users of the Water District, (3) Dairy Factory Owners, and (3) General Public.

#### (1) Schools

CAR shall promote the environmental education in all educational institutions of the region, from kindergarten to the highest level and provide constant guidance on main environmental issues. This activity shall be coordinated with the Secretaries of Education and Environment depending on the Prefectures of Cundinamarca and Boyaca, with the related Municipalities and existing NGOs.

The main environmental issues to be developed shall include: the biology of the lake, the significance of the conservation of the water quality of the lake and the surrounding environment, mechanism of control of aquatic plants, control of sediments, water pollution control of the lake and main rivers, damages on watercourses caused by untreated wastewater coming from the dairy industries, slaughterhouses, solid waste disposal and sewage.

#### (2) Farmers and Users of the Water District

Before, during and after the implementation of the proposed projects by this Study, periodic seminar addressed to farmers and users of the water district shall be conducted by CAR in coordination with the related Municipalities through the UMATA (Municipal Unit for Technical Assistance on Agriculture and Livestock). The materials for the seminar shall include the overall explanation of the proposed projects and its relations with the water resources management of the basin and its significance on the preservation of the Fuquene Lake.

#### (3) Dairy Factory Owners

As indicated in the before topic, periodic seminar addressed to dairy factories owners shall be conducted by CAR in coordination with the related Municipalities. This will promote the awareness of owners about the significance of complying with the water quality standard and thus in turn promote the installation of treatment plants.

It is fundamental the preparation of a pamphlet, by CAR, on Guides and Standards to be accomplished by the dairy factories.

#### (4) General Public

The following programs shall be performed for educating the general public:

- (a) Environmental education through Radio and Television is highly recommended through the realization of discussion panels and interviews to the related authorities and citizens on environmental issues of the Fuquene Lake and its

significance on the overall socioeconomy of the region.

- (b) It is necessary to inform always the people what CAR is performing in the basin to get the understanding and cooperation of the citizens for any program or project of environmental conservation. In this sense, the publication of newspaper articles related to the environmental protection of the Fuquene Lake, is recommended. In addition the publication of a “Informative Bulletin of CAR” is also recommended to make public know about CAR activities in the region and main environmental issues. This bulletin would be available for the residents of the basin such as municipal authorities, industrial organizations, trade unions, associations and existing NGOs.
- (c) CAR is considered as the source of information on environmental subjects, therefore, seminars or conferences on how to reduce the pollutants coming from industries, slaughterhouses, sewerage, solid waste, farmlands, should be carried out and addressed to the professional people interested in the subject.

It is estimated that the program will need a yearly budget of about 25,000 US\$.

### 3.2 Personnel and Equipment

The personnel to perform these activities will be those currently employed in the Divisions of Decentralization, Community Participation and Environmental Education belonging to the Regional CAR of Ubaté and Regional CAR of Zipaquirá.

The Division of Zipaquirá is well developed with enough equipment and personnel to perform the activities of environmental education. However, in the Division of Ubaté, the equipment and the number of staff is deficient, therefore it is recommended, the acquisition of new equipment and the recruitment of new qualified staffs to make effective the implementation of the environmental education programs. Also it is recommended the training of the existing technicians in the Regional of Ubaté and Zipaquirá, mainly in those aspects related to the implementation of the projects to be proposed by this Study.

Following is presented the estimated costs of equipment necessary to implement the above mentioned activities. These will be used to strengthen the Division of Decentralization, Community Participation and Environmental Education of the Regional CAR of Ubaté.

Equipment	Quantity	Cost (US\$)
Vehicle, 4x4, all terrain	1	20,000
Copy Machine	1	4,000
Overhead Projector	1	500
Slide Projector	1	800
Video Player	1	700
Color TV	1	700
Video Camera	1	1,000
Photo Camera	1	500
Computer with printer, scanner and multimedia	1	2,000
Portable computer/video beam	1	4,000
<b>Total</b>		<b>34,200</b>

**Table I.1.1 Institutions that Perform Activities of Environmental Education in the Urban Centers of the Study Area**

Municipality	Institutions
Carmen de Carupa	UMATA, CAR, Colegio Departamental Integrado
Ubate	UMATA, CAR, Jefatura del Nucleo, Colegio Departamental de Santa Maria
Tausa	UMATA, CAR, Colegio Departamental
Sutatausa	UMATA, CAR, Colegio Sutatausa
Cucumuba	UMATA, CAR, Colegio Departamental de Cucunuba
Lenguazaque	UMATA, CAR, Colegio Nuestra Senora del Carmen
Guacheta	UMATA, CAR, Colegio Departamental Integrado
S.M.de Sema	Inspeccion de Policia, UMATA, CAR
Fuquene	UMATA, CAR, Colegio Departamental de Fuquene, Colegio Capellania
Susa	UMATA, CAR, Colegio Tisquesusa
Simijaca	Major's Office, UMATA, CAR, Colegio Agustin Parra
Caldas	UMATA, CAR
Chiquinquirá	Office of the Secretary of Education, CAR, Colegio Pio Alberto Ferro, Fundacion Fuquene
Saboya	UMATA, CAR, Asociacion de Ecologistas de Saboya, Fundacion Territorios Verdes

**Table I.1.2 Non-Governmental Organizations Registered in CAR**

Name	Major Field
1. Censat Agua Viva*	Investigation, Education, Monitoring and Vigilance
2. Cambio XXI*	Environmental Education, Investigation, Ecotourism
3. Bioarte*	Community Participation, Investigation, Environmental Procedures
4. Ceta-Consultores	Environmental Education, Consulting
5. Codecal*	Training, Community Organization, Investigation,
6. Mate*	Community Participation, Cinema, Video, Television
7. Sirena	Consulting, Community Organization, Material Didactic Production
8. Corprogreso	Methodologies for Projects, Production of Materials for Divulgaion
9. Ecorecuperar	Consulting, Evaluation, Technical Support
10. Ecoterra	Investigation, Production of Materials for Education
11. Fundacion Integrar*	Consulting, Training
12. Fundacion Comunerros	Consulting on Projects, Edition of Didactic Materials
13. Alegria de Vivir	Training, Environmental Procedures, Publications
14. Sal si puedes	Training, Community Organization, Ecotourism
15. T.A.C.T.*	Environmental Education, Community Organization, Investigation
16. Pidur*	Training, Community Organization, Design and Evaluation with the Community
17. Asprosusagua*	Consulting on Projects of natural resources conservation, Investigation

Legend: \* Currently working

***APPENDIX J***

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***INSTITUTIONAL  
ASPECTS***

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**APPENDIX J**

**INSTITUTIONAL ASPECTS**

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**APPENDIX J INSTITUTIONAL ASPECTS**  
**CHAPTER I RELATED LAWS AND REGULATIONS**

Table J.1.1 shows the Laws relevant to Environment in Colombia, but those relevant to the Study are described below:

**1.1 Laws related to Environmental Protection**

(1) Law 99, 1993

By this Law is created the Ministry of Environment, is re-structured the public sector in charge of the environment and the renewal natural resources, is organized the National Environmental System (SINA) and other provision are given.

The Law states the general principles to be followed by the Environmental Policy, the juridical nature of the corporations and the functions of the Regional Autonomous Corporations. Also the Law give provision on procedure for environmental licenses.

In addition the law establish the functions of the prefectures, municipalities, districts and indian territories, on environmental matters.

(2) Decree-Law 2811, 1974

The referred Decree-Law is denominated National Code for Natural Resources and Protection of the Environment and it is the basic and general statute on the matter.

The first part of the Code is related to general environmental policy, environmental matters and norms on its preservation. The second part is related to the property, environmental use of the renewal natural resources and general norms on natural resources such as atmosphere, air space, no maritime zone, sea and its bottom, primary energy resources, geothermal resources, earth and soil, flora, terrestrial fauna, hydrobiological resources, sanitary protection of the fauna and flora, resource of the landscape and the resources management systems.

(3) Law 9, 1979- National Sanitary Code

This law give provisions on general norms to be used as a base for necessities dispositions and regulations for the preservation, conservation and restorations of sanitary conditions related to the public health; the procedure and measures to be adopted for the regulation and control of discharges of solid waste and materials that affect or could affect the sanitary conditions of the environment.

**1.2 Laws related to Water**

(1) The Decree 2857, 1981

This Decree is related to the management of Hydrographic Basin. The article 1 of this Decree defines the concept of the basin as a physical-geographical area duly delimited, where the surface and ground waters are discharged into a natural network, which flows or can flow into a main river, into a natural reservoir, into a swamp or into the sea.

Besides, the article 3 states that all activity that can deteriorate the renewal natural resources of the basin, having or not ordering plan, must be authorized by the Administrator Entity in charge of the renewal natural resources, previous elaboration and presentation of the related environmental impact assessment. This article is applicable mainly to the construction of roads, channels, diversion of watercourses, exploitation of mining, construction of dams or other similar works.

The Decree also states that the main objective of the ordering of a basin is to have an planning use and management of its resources and the orientation and regulation of the activities of the users, in order to maintain or restore an adequate equilibrium between the economical use of the referred resources and the preservation of the physical-biota structure of the basin and particularly of its hydric resources.

(2) Decree 1449, 1977

This Decree states the obligations of landowners in relation with the protection and use of the waters.

(3) Decree 1541, 1978

Regulations on non-maritime waters are provided in this Decree, include aspects on water dominion, watercourses and riverbanks; water regulations and declaration of reserve zones; procedure to acquire the water right-use, procedure for water concessions, regimen for certain special categories of waters, conditions for construction of hydraulic works, etc.

(4) Decree 2314, 1986

Related to water concession

(5) Decree 1594, 1984

By this Decree are established the quality criteria to classify the watercourses. In addition, it also set the parameters, procedures and sanitary measures for wastewater discharging.

(6) Agreement 58, 1987 of CAR

By this Agreement are given norms for the management and control of the water resources quality in the working area of CAR.

In its article 26 states that waters falling under the jurisdiction of CAR are classified according its current and potential uses as follows:

(i) Class A

Correspond to the values more restrictive of the following uses: Human and domestic consumption with conventional treatment, preservation of flora and fauna, agriculture use and for livestock.

(ii) Class B

Correspond to the values more restrictive of the following uses:

preservation of flora and fauna, agriculture use and for livestock.

(iii) Class C

Correspond to the values more restrictive of agriculture use and for livestock.

(iv) Class D

Restricted agriculture use. Energy generation. Restricted industrial use

The Agreement also make provisions on discharging of wastewater on watercourses.

(7) Agreement 10, 1989 of CAR

By this Agreement are dictated norms for the management of water of public use under the jurisdiction of CAR.

(8) Law 373, 1997

By this Law is established the program for the efficient use and saving of water.

(9) Decree 475, 1998

Provide norms and criteria of physical, chemical and bacteriological quality of the water to be used for potable water supply.

### **1.3 Laws related to Solid Waste**

(1) Decree 2104, 1983

Norms related to storage, transport, treatment and disposal of solid waste are provided by this Decree.

(2) Decree 605, 1996

By this Decree is regulated the Law 142 of 1994 related to the services of collection, transport, recycling and disposal of domestic solid waste.

### **1.4 Laws related to Soils**

(1) Decrees 2655, 2656 and 2657, 1988- Mining Code

General disposition are given by this Decree to foment and order the exploration and exploitation of the minerals; define the types of mines in small, medium and large depending on the volume of material extracted; determine the restricted zones for mining activities; prohibits all mining activity to those who had not been registered; establish the conditions to be registered, licenses, etc.

(2) Resolution 0022, 1994

The Resolution 222, 1994 of the Ministry of Environment and Agreement 246, 1994

of CAR, contains provisions on compatible areas with quarries.

- (3) Decree 919, 1989

This Decree is related to the evaluation of erosive zones

### **1.5 Laws related to Land Use**

- (1) Decree-Law 2811, 1974, Natural Resources Code

This Decree-Law in the part VII of the Earth and Soils, establish general principles, uses and conservation of lands and its classification according the activities developed by the community.

- (2) National Constitution

In its article 313 corresponds to the Councils the regulation of the land use and to make the necessary provisions for the control, preservation and defense of the ecological patrimony of the municipality.

### **1.6 Laws related to Environmental Licenses**

The bellow Decrees and Regulations are related to the procedure, requirements and conditions to be followed to obtain the environmental license:

- (1) Decree 1753, 1994
- (2) Decree 2150, 1995
- (3) Resolution 655, 1996
- (4) Decree 883, 1997

### **1.7 Laws related to Public Services**

- (1) Law 60, 1993

This law dictates norms on the distribution of competencies. According to the article 2° correspond to the municipalities trough its dependencies or municipal decentralized entities, the provision of water supply, sewerage, solutions on water treatment and excreta disposal, urban cleansing, and rural basic sanitation. The same article also allows to the municipalities the concession of subsidies to the population of less economical resources in the sector of basic services.

- (2) Law 142, 1994

This law establishes the regimen of the domestic public services (water supply, sewerage, solid waste management, etc) and dictates other dispositions.

- (3) Resolution 15, 1996 of the Regulation Committee of Potable Water and Basic Sanitation

This Resolution gives the necessary tools to calculate the tariffs for potable water consumption. The same Resolution stipulates that the charge for sewerage service will be the 40 % of the charge for water supply, however, this percentage can be lower for non-conventional systems and higher for the systems that include wastewater treatment plants.

## **1.8 Laws related to the Irrigation and Drainage District**

(1) Law 3, 1961

According to the article 42 of this law, the irrigation system of Fuquene-Cucunuba was given up to CAR for its administration and management.

(2) Agreement 036, 1982 of CAR

This Agreement in consideration to the characteristics of the hydraulic system of Fuquene-Cucunuba had arranged that it must be regulated as an Irrigation and Drainage District.

(3) Agreement 031, 1991 of CAR

By this Agreement is adopted the General Regulation for the functioning of the Irrigation and Drainage District composed by the hydraulic system of Fuquene-Cucunuba.

(4) Law 41, 1993

The objective of this law is to regulate the construction of works for land adaptation taking into account the defense and conservation of the water basins. These works is to make suitable the land, to obtain an increasing in the agriculture and livestock productions.

(5) Decree 1881, 1994

By this Decree is regulated partially the law 41 of 1993.

The article 1 of this Decree defines the water concession as the title by which the environmental authority transfers to a natural or juridical person the right of water use for irrigation purposes.

## CHAPTER II ORGANIZATION OF RELATED AGENCY

### 2.1 Existing Organization of Related Agencies

#### (1) CAR Headquarters

The implementing agency of this Study is the Regional Autonomous Corporation of Cundinamarca, which is a public corporate entity, autonomous both administratively and financially.

#### (a) Functions

The functions of CAR are as follows:

- (i) To execute national policies, plans and programs, concerning the environment, which are defined by the approving law of the National Development Plan and the National Investment Plan or by the Ministry of the Environment. To execute those duties related to regional level that have been delegated according to law, within the corresponding jurisdiction;
- (ii) To act as the maximum environmental authority within the area of its jurisdiction according to the rules of superior hierarchy and complying the criteria and guidelines set forth by the Ministry of the Environment;
- (iii) To promote and develop community participation in plans and programs concerning environmental protection, sustainable development and appropriate management of the renewable natural resources;
- (iv) To coordinate the process of setting up the plans, programs, and projects of environmental development that must be formulated by all those organizations conforming the National Environmental System (NES). This shall be done within the area of their jurisdiction. To advise the Prefectures, Districts, and Municipalities of its jurisdiction in defining their environmental development plans and their programs and projects concerning the environmental protection and the protection of the renewable natural resources, so that the harmony and coherence of the policies and actions from the different regional organizations is assured;
- (v) To participate with other organizations and corresponding entities within their jurisdiction in the planning and territorial organizing process so that the environmental issue in the decisions adopted is taken into account;
- (vi) To enter into agreements with territorial authorities, other public and private organizations, and with nonprofit organizations whose mission is to defend and protect the environment and the renewable natural resources, in order to carry out, in the best way, one or many of its duties when these do not correspond to the execution of administrative duties.
- (vii) To promote and accomplish, together with national organizations inscribed and affiliated to the Ministry of the Environment and with scientific and technical organizations from the SEN, studies and



researches on environmental and renewable natural resources.

- (viii) To advise the different territorial authorities in setting environmental education plans and to carry out not formal environmental education programs, according to the national policy guidelines.
- (ix) To grant concessions, permits, authorizations and environmental licenses required by law for the use, development or mobilization of the renewable natural resources or for the development of activities that affect or could affect the environment. To grant permits and concessions for forestry developments, and concessions for the use of superficial and underground water and to establish closed season for sport hunting and fishing.
- (x) To set, within its jurisdiction area, the allowable limits of emission, discharge, transport or deposit of substances, compound products, or any other material that can affect the environment or the renewable natural resources. To prohibit, restrain or regulate the manufacture, distribution, use, disposal or pouring of substances that cause environmental degradation. These limits, restrictions and regulations, in any case, will be less strict than those defined by the Ministry of Environment.
- (xi) To exert the functions of environmental evaluation, control and monitoring of activities such as exploration, exploitation, benefit, transport, use and deposit of non-renewable natural resources, including the activities pertaining to ports, excluding the competence imputed to the Ministry of the Environment as well as other activities, projects or issues that generate or could generate environmental degradation. This function includes issuing the corresponding environmental license. The functions referred to in this numeral shall be exerted according to article 58, law 99 from 1993;
- (xii) To exert the functions of environmental evaluation, control and monitoring for the use of water, land, air and other renewable natural resources. This will include the discharging, emission, or inclusion of substances or residual liquids, solids and gases to waters, in any of its forms, to air or to the soils. It will also include the discharging or emissions that can damage or endanger the normal sustainable development of the renewable natural resources or to restrain or hamper its use for other uses. These functions include issuing the corresponding environmental licenses, permits, concessions, authorizations and safe-conducts;
- (xiii) To collect, according to the law, the contributions, fees, rights, tariffs, and fines incurred in for the use and development of the renewable natural resources. To determine the amount within its jurisdiction based on the minimum tariffs established by the Ministry of the Environment;
- (xiv) To exert the control of the mobilization, processing and commercialization of the renewable natural resources in coordination with the other “Regional Autonomous Corporations”, the territorial authorities and other police authorities, according to law and the rules;

and to issue the permits, licenses and safe-conducts for the mobilization of renewable natural resources;

- (xv) To administrate, under the tutelage of the Ministry of the Environment, the areas of the National Parks System that the Ministry delegate to them. The administration can be carried out with participation of territorial authorities and the citizens.
- (xvi) To reserve, to mark the boundaries, to administrate or to misappropriate, in the terms and conditions established by the law and the rules, the districts of integrated management, the districts of land conservation, the forestry reserves and the regional natural parks and to establish the rules for their use and operation. To administrate the National Forestry Reserves within its area of jurisdiction;
- (xvii) To impose and execute, preventing and without prejudice of the competencies imputed by law to other authorities, the police measures and the sanctions established by law, in case of violation of the regulations of environmental protection and of renewable natural resources management and to demand according to the corresponding regulations the repairing of the damages caused.
- (xviii) To order and establish the rules and guidelines to manage the hydrographic basins located within the area of its jurisdiction, according to the hierarchical superior rules and to the national policies.
- (xix) To promote and execute irrigation works, draining, protection against flooding, correction of river-beds and water streams, and the necessary land recover works in order to defend, protect and manage adequately the hydrographic basins within the territory of its jurisdiction, in coordination with the directing and executive entities of the National System for Land Adapting, according to the legal framework and to the corresponding technical foresights.

When the works related to irrigation and draining demand Environmental License according to the rules and regulations, the license must be issued by the Ministry of the Environment.

- (xx) To execute, manage, operate and maintain in coordination with the territorial authorities, the necessary projects, sustainable development programs and infrastructure works to defend and protect or to decontaminate or recover the environment and the renewable natural resources;
- (xxi) To carry out in coordination with the authorities of indigenous communities and with authorities of the lands traditionally inhabited by black communities, referred to in Law 70 from 1993, the programs and sustainable development projects and of management, development, use and conservation of renewable natural resources and of the environment;
- (xxii) To implement and operate the Environmental Information System in the area of its jurisdiction, according to the guidelines established by the

Ministry of the Environment;

- (xxiii) To carry out activities concerning analysis, monitoring, disaster prevention and control in coordination with other competent authorities. To assist these authorities in environmental issues dealing with and preventing emergencies and disasters; to carry out, with the district or municipal authorities, the programs of urban areas adaptation in high risk zones, such as erosion control, and management of river beds and reforestation.
- (xxiv) To transfer the resulting technology from research studies carried by scientific research and technical support organizations at national level that belong to the National Environmental System NES, and to technically assist, public and private organizations as well as any person on the adequate management of renewable natural resources and the preservation of the environment, in the form established in the rules and regulations and according to the guidelines set by the Ministry of the Environment;
- (xxv) To impose, distribute and collect the valorization contributions referred to the charges on the property, because of the execution of public works by the “Corporation”; to set other rights that can be charged according to the law;
- (xxvi) To give advise to territorial entities in the making of projects related to environmental issues and that must be developed with economic resources coming from the Fondo Nacional de Regalías (National Fund of Royalties) or with other similar entities.
- (xxvii) To acquire private property and patrimonial assets of public law entities, and to carry out the expropriation process before a competent authority, once the stage of direct negotiation has been done, when necessary for the execution of his duties or for the execution of works or projects required in the accomplishment of them; and to impose the necessary easement, according to law
- (xxviii) To promote and execute water provision programs to indigenous and black communities which are traditionally settled in its jurisdiction area, in coordination with competent authorities.
- (xxix) To support municipal councils, prefecture assemblies and councils from indigenous territorial entities in the planning functions granted by the National Constitution;
- (xxx) Without prejudice of the municipalities’ and districts’ attributions with respect to zoning and use of the land, according to what is stated in article 313, numeral seven of the National Constitution, the “Corporation” will establish the general rules and the maximum densities to which the house owners shall be subject in sub-urban areas and in hills and mountains, in a way that the environment and the natural resources are protected. Not less than 70% of the area to be developed in such projects shall be destined to the conservation of native existent

vegetation;

- (xxxi) To coordinate and give advice to the municipalities, indigenous zones and territorial entities with respect to the definition of their own development plans and to the establishment of rules for a better use of the lands and zones that must be destined to urban, agriculture and cattle, or industrial developments, reforestation mine works and reserves for the conservation of ecosystems. This task will be done complying with what is stated in article five, numeral 12 of law 99 from 1993, respecting the functions of Municipal councils according to what is stated in article 313, numeral 7 of the Political Constitution and of territorial indigenous entities' Councils according to what is stated in article 329 and subsequent ones of the National Constitution and other rules of the National Indigenous Legislation in force.
- (xxxii) To delegate to other public entities or to juridical private persons constituted as nonprofit entities, the execution of tasks given that they do not involve the exercise of attributions proper of the administrative authority. The sanctioning faculty cannot be delegable.
- (xxxiii) To coordinate and give advice to municipalities in permanent activities of control and environmental surveillance carried out in the respective municipality's territory, with the support of the public force, with respect to mobilization, processing, use, and commercialization of natural renewable resources or with contaminant and degrading activities of the waters, air and land.
- (xxxiv) Other duties before assigned to other authorities, related to environment and natural renewable resources, within its respective competence scope so long as they are not opposed to the ones assigned, by the National Constitution, to the territorial entities, or are contrary to law 99 from 1993 or to the powers invested upon the Ministry of the Environment;
- (xxxv) To advice territorial entities in the creation and optimization of collection systems, in order to guarantee the collection of the entity's resources.

PARAGRAPH 1.- The environmental duties and competencies corresponding to the CAR, shall be assumed, within the urban area of the Capital District, by the district administration, according to what is established in article 65 and subsequent ones of law 99 from 1993.

PARAGRAPH 2.- For this article's purpose, before the issuance of permits and concessions, a concept will be requested to the Major of the municipality where the permit or concession is to be executed.

(b) Organizational Structure and Staffing

CAR is managing the territories covering the all basin of Bogota River, including the Municipality of Girardot, and the basin of Ubate and Suarez Rivers located in Cundinamarca and Boyaca prefectures.

CAR's headquarter flowchart is shown in the chart of Fig. J.2.1. Thus, the

structure of CAR may be divided into the following components:

(i) Corporate Assembly: is the main organ of direction of the agency. It is composed by legal representatives from the entities located under its jurisdiction and they are:

- The Governors from the Prefectures of Cundinamarca and Boyaca
- The Major of the District Capital of Santa Fe de Bogota
- The Majors of the Municipalities of the jurisdiction

According to the law, the Corporate Assembly shall be set up and presided by the Governor of Cundinamarca or if is not possible, the Governor of Boyaca.

(ii) Directive Council: is the administration organ of the agency and composed by the followings:

- The Governors from the Prefectures of Cundinamarca and Boyaca or their delegates.
- One representative from the President of the Republic
- One representative from the Minister of Environment
- Four (4) Majors from the municipalities located under the jurisdiction of the Corporation and distributed in the following manner: three (3) Majors from Cundinamarca Prefecture and one (1) Major from Boyaca Prefecture, elected by the Corporate Assembly
- Two (2) representatives from the private sector
- One (1) representative from the Indian community
- Two (2) representatives from non-aim lucrative entities located in the jurisdiction of CAR whose main objective be the protection of the environment and the renewal natural resources.

According to the concept given by the Council of the State, the Major of Santa Fe de Bogota forms part of the Directive Council of the Corporation.

All members of the Directive Council shall apply the criteria of integral management of the natural resources and shall orientates the actions of the Corporation according to the national environmental policy, the priorities of the region and the general interest. The decisions taken by the Directive Council shall be denominated “Acuerdos” (Agreement) of the Directive Council.

(iii) General Director: according to the Law 99 of 1993, the General Director is the legal representative of the Corporation and its first executive

authority and will be appointed by the Directive Council for the period of three (3) years with possibility of reelection. The General Director is not an agent of the members of the Directive Council and shall act at the regional level with technical autonomy in consult with national policy. Besides, he will attend the orientations and directresses given by the territorial entities, by the people who represent the community and by the private sector.

(iv) Internal Structure: the internal structure of the Corporation will be determined by the Directive Council according to the current legal dispositions, to the necessities of the Corporation and to the policies given by the government. The current internal structure is as follows:

- Sub-Directorates: is in charge of the elaboration, coordination, operation and supervision of the programs and projects related to the environment. They depend on the General Director.
- Regional Directorates: they depend on the General Direction and coordinate their activities functionally with the Sub-directions.

The number of public employees of CAR Headquarters is of 366 persons while the number of public employees for whole CAR is 672 persons whose list by professional category is shown in Table J.2.1.

(c) Financial Aspects

The financial system of CAR is centralized in CAR Headquarters located at Bogota City where is managed the all economical and financial resources of the Corporation including its Regional Branches. Here down is presented the budget executed by CAR in 1998.

Items	1998 in Col\$
1.Expenditures of functioning	23,890,983,420
1.1 Personal	16,690,901,090
1.2 General Services	4,268,298,911
1.3 Transference	2,931,783,419
2. Investment	17,126,056,304
3. Debt	2,699,358,324
<b>Total</b>	<b>43,716,398,048</b>

As it can be seen in the above table, the expenditures incurred for the functioning of the institution is almost 60% of the budget executed for the Corporation.

(2) CAR Related Branch Offices

(a) General

To guarantee the presence of CAR in the 104 municipalities of Cundinamarca and Boyaca where have jurisdiction, the creation of Regional Directorates were promoted and they are: Regional of Zipaquira (502,704 has), Regional of

Girardot (256,730 has) with branches, Regional of Ubate (232,104 has), Regional of Fusagasuga (185,268 has), Regional of Villeta (398,542 has) with branches and Regional of Funza (133,517 has).

This Study falls under the jurisdiction of the Regional Directorates of Ubate and Zipaquirá.

(b) Functions

Main functions of the Regional Directorates are:

- (i) To execute the objectives established for the regional level according to the programs, projects, products, services and activities of the Corporation, and the competencies delegated by the General Director by means of a regulation.
- (ii) To propose to the General Director, the policies, strategies, plans, programs, projects, products, services and actions that are required for the smooth functioning of the Regional Directorate and the Corporation.
- (iii) To coordinate, to supervise and to execute the activities related to the planning, analysis and the projections of the activities of the Regional Directorate.
- (iv) To coordinate, to supervise and to execute the activities related to the environmental education, communications, coordination and community and inter-institutional participation, in its jurisdiction.
- (v) To coordinate, to supervise and to execute the activities related to the enforcement of regulation that must be fulfilled in its jurisdiction.
- (vi) To coordinate, to supervise and to execute the activities of supporting to the Scientific Sub-directorate.
- (vii) To coordinate, to supervise and to execute the activities related to the environmental quality control in its jurisdiction.
- (viii) Other subjects assigned for the General Directorate.

(c) Organizational Structure and Staffing

Since the implementation of this Study falls under the jurisdiction of the Regional Directorates of Ubate and Zipaquirá, their organizational structures and staffing are analyzed as follows:

(i) Regional Directorate of Ubate

The flowchart is shown in the chart of Fig. J.2.2. The structure may be divided into the following components:

- Directive Level: is managed by the Regional Director

- Advisement Level: involves mainly juridical aspects.
- Operative Level: is composed by coordinators or groups in charge of the execution of programs and control on the environment and the natural resources.

The number of staff assigned to the Regional of Ubate to perform the activities as environmental authority of the region is of 73 whose list is shown in Table J.2.2.

On the other hand, there are 2 different groups of staffs assigned to other activities, the first one is assigned to the management of the irrigation and drainage district and the other group is assigned to implement the Checua project. These groups, although are using the offices of the Regional of Ubate, have their own Director or chief.

The total number of CAR staff by activity that is operating in the jurisdiction of the Regional of Ubate is summarized as follows:

Activity	N° of Staff
Be the Environmental Authority	73
Management of the Irrigation and Drainage District	42
Implementation of Checua Project	21
Total	136

(ii) Regional Directorate of Zipaquira

The flowchart is shown in the chart of Fig. J.2.3. Basically, it can be concluded that the organizational structure and functions are the same as in the case of the Regional Directorate of Ubate.

The total number of staff is of 161 persons and its classification by professional category is shown in the Table J.2.3.

(d) Financial Aspects

(i) Regional Directorates of Ubate and Zipaquira

Regional Directorates are not autonomous both administratively and financially and depend directly on the general budget of CAR headquarter. Bellow is presented the expenditures incurred by the Regional Directorates of Ubate and Zipaquira. In the case of Ubate, do not include expenditures neither of the Checua Project nor the management of the irrigation and drainage district of Fuquene-Cucunuba system.



Items	1998 in Col\$	
	Ubate	Zipaquira
1.Expenditures of functioning	1,107,667,422	1,567,254,414
1.1 Personal	956,459,857	1,500,723,765
1.2 General Services	151,207,565	66,530,649
2. Investment	622,959,651	769,862,522
<b>Total</b>	<b>1,730,627,073</b>	<b>2,337,116,936</b>

(ii) Irrigation and Drainage District and Checua Project

Items	1998 in Col\$	
	District	Checua Project
1.Expenditures of functioning	974,487,656	484,499,346
1.1 Personal	578,108,635	477,147,816
1.2 General Services	396,379,021	7,351,530
2. Investment	-	1,343,573,765
<b>Total</b>	<b>974,487,656</b>	<b>1,828,073,111</b>

(3) Environmental Secretariat of the Prefecture

(a) General

Currently the Prefecture of Boyaca has not Environmental Secretariat into its structure and for this reason following is described only the functions, organizational structure and financial aspects of the Environmental Secretariat of Cundinamarca Prefecture.

(b) Functions

The main functions are presented here down:

- (i) To participate in the elaboration of the Prefecture Development Plan and to assure that the environmental component is duly incorporated into the Plan, both in the environmental chapter as well as in the other sectors.
- (ii) To promote the execution of programs and the implementation of national, regional and sectorial policies related to the environment and the natural resources that must be developed in the Prefecture of Cundinamarca.
- (iii) To recommend in coordination with the Prefecture Planning Office, the environmental policies and orientation that must be included into territorial plans that is elaborated by the Prefecture for the whole its territory or part of it.
- (iv) To promote the inclusion of the environmental components into the programs of the other dependencies of the Prefecture and its linked entities.

- (v) To contribute in the consolidation of the Environmental System of the Prefecture and make possible the integration of the Prefecture into the National Environmental System.
- (vi) To participate in the construction of the Environmental Information System of the Prefecture, conjointly with the other entities of the Environmental System of the Prefecture.
- (vii) To propose to the Governor, the celebration of agreement and alliances considered strategic to guarantee the due coordination of the actions and environmental investment that is made by the different entities in the Prefecture of Cundinamarca.
- (viii) To collaborate with the Regional Autonomous Corporations of its jurisdiction, with the Capital district and with the Municipalities of Cundinamarca, in the execution of programs and environmental projects that are identified as priorities, according to the agreement and alliances subscribed for this purpose.
- (ix) To ensure an optimum investment of the resources designated yearly by the Prefecture for the acquisition of lands of strategic importance for the conservation of water resources, which are employed to supply water to the municipalities, located under its jurisdiction, according to the law.
- (x) To promote, to co-finance or to execute in coordination with the Regional Autonomous Corporations and other competent entities, the works and soils recovery projects, the regulation of water flow or water currents, as well as programs for the adequate management of the water basins.
- (xi) To identify and to promote the necessities studies and researches to contribute to the smooth management of environmental components which are in charge of the Prefecture.
- (xii) To actuate as a technical instance for the study or elaboration of obligatory norms projects related to the natural renewal resources and the environment.
- (xiii) To project, according to the norms, the regulatory framework for the activities of the Prefecture on environmental matter and to watch over the fulfillment of the environmental dispositions.
- (xiv) To implement environmental education and divulge programs that contributes to the creation of a better public awareness on the necessity of conservation and to realize a sustainable use of the renewal natural resources and environment.
- (xv) To give orientations on environmental subjects to be included in the programs and activities related to the disaster prevention and risk control conducted by the prefectures and to collaborate with the related entities in the prevention and control of environmental emergencies.

- (xvi) To advise the Governor in the exercise of his labors and attributions as the President or Member of the Directive Council of the Regional Autonomous Corporations that have jurisdiction in the territory of Cundinamarca.
- (xvii) To exert, in coordination with the other related entities, the functions of control and vigilance of the renewal natural resources and environment in the prefecture, and to address, with the advisement of the related Regional Autonomous Corporations, the inter-municipal activities of control and environmental vigilance.
- (xviii) To make possible the inclusion of the declaration of possible impact that can cause a project on the environment as a previous criterion for qualifying projects to be financed or saved in the Programs or Projects Bank of Cundinamarca Prefecture.
- (xix) To promote in the Prefecture, the use of incentives foreseen in the legislation, with the aim of incising in the social, industrial and citizen behavior, towards the conservation and well use of the renewal natural resources and environment.
- (xx) To participate, in the formulation of projects of national and international technical cooperation, and to promote the contract of loans and the consecution of additional financial resources for the fulfillment of environmental competencies of the Prefecture, conjointly and coordinating with the other responsible entities and organisms.

(b) Organizational Structure and Staffing

The internal Structure of the Environmental Secretariat is composed as follows:

- (i) Office of the Secretary
- (ii) Office of Environmental Policy and Information
- (iii) Environmental Protection Direction
- (iv) Environmental Promotion Direction

The total number of personnel of this Secretariat is of xx persons.

(c) Financial Aspects

The amount of money budgeted for the Environmental Secretariat for the year 1999 is shown bellow:

Concepts	Year 1999 (Col\$)
1.Expenditures of functioning	60,000,000
2. Investment	5,910,000,000
2.1 Protection of ecosystems for natural resources conservation	4,100,000,000
2.2 Management, disposal of solid waste	800,000,000
2.3 Education and environmental awareness	180,000,000
2.4 Planning and environmental ordering of the territory	100,000,000
2.5 Instrumentals programs	730,000,000
Total (1+2)	5,970,000,000

(4) Public Services Department of Representative Related Municipalities

(a) General

Basically, the basic services in the urban centers of the study area, are provided by the Municipalities through its Department of Public Services. However, in the case of Chiquinquirá City, a municipal enterprise, named EMPOCHINQUIRA, was conformed to provide the services in the city, being autonomous financially.

On the other hand, since the most of the municipalities conforming the study area have not Environmental Department, some problems of environmental concerns are attended also by the Department of Public Service or are derived to CAR.

(b) Functions

The main functions are presented here down:

- (i) To perform the operation and maintenance of the services of municipal water supply, sewerage, solid waste management, public toilets, market place and slaughterhouses.
- (ii) To collaborate with the Planning Office in the elaboration of the annual plan of investment.
- (iii) To carried out studies on the service operation in order to improve its performance.
- (iv) To supervise the construction of water supply system and sewerage in the urban and rural sectors.
- (v) To control the water quality supplied for the users as well as the methods of intakes, treatment and distribution of the water.
- (vi) To address, coordinate and control the sweeping service of streets, parks, etc.

(c) Organizational Structure and Staffing

In the Fig.J.2.4 is presented the organizational structure of the Public Service Department of Ubaté municipality, which can be taken as example

representative of the other municipalities. The average number of staff for the Department of Public Services, considering the all municipalities of the study area, is of 4 persons.

(d) Financial Aspects

The Table J.2.4 shows the total budgets of the municipalities of the study area and its relations to the budgets assigned for investment in public services and environmental projects. According to the table, the average percentage of the total municipal budget assigned to public services and environment is less than 15%.

**2.2 Institution Responsible for the Implementation of the Proposed Projects by this Study**

The bellow table presents the institutions that shall be responsible for the implementation of the proposed projects by this study:

Proposed Project Components	Institution Responsible
Improvement of Water Resources Management	CAR
Improvement of Wastewater Treatment	
Domestic wastewater	Municipalities
Industrial wastewater	Dairy Factories
Conservation of the Lake Environment	CAR
Improvement of Chiquinquirá Water Supply Treatment	Municipality (Empochiquinquirá)
Improvement of Monitoring System	CAR

**Table J.1.1 Relevant Laws to Environment in Colombia**

Subject	Norms	Contents
General	National Constitution	Right and duties of the citizens, duties of the state
	Decree-Law 2811, 1974	Renewal Natural Resources
	Law 99, 1993 and its regulations	Creation of the Ministry of Environment and the National Environmental System (SINA)
	Law 9, 1979	National Sanitary Code
	Law 11, 1986 and Law 12, 1986	Municipal Administration
	Decree 1333, 1986	Municipal Regimen Code
	Law 33, 1986 and Decree 1344, 1974	National Code of Transport and Transit
	Decree 285, 1986	Storing and Distribution of Combustibles
	Law 9, 1989	Urban Reform
	Law 135, 1994	Mechanism of citizens participation
	Decree 1855, 1994	Regional Plans of Corporations
	Decree 1753, 1994; Decree 2150,1995; Resolution 655, 1996; Decree 883,1997	Environmental Licenses
	Decree 2278, 1982	Sacrifice and Commercialization of animals
	Law 115, 1993 and Decree 1753, 1994	Environmental Education Projects
	Decree 1865, 1994	Technical assistance of CAR to Municipalities for Municipal Environmental Plan elaboration
	Air	Law 142, 1994
Law 388		Territorial Development
Law 491, 1999		Ecological Insurance and Environmental Offense
Water	Decree 2, 1982	Atmospheric emissions of points sources
	Decree 948, 1995	Atmospheric Pollution
	Decree 2857, 1981 and Decree 2024, 1982	Hydrographic Basins
	Decree 1449, 1977	Resources conservation in rural lands
	Law 475, 1998	Potable Water Quality
	Decree 1594, 1984	Water use and wastewater
	Decree 2314, 1986	Water concession
	Agreement 58, 1987 of CAR	Water and discharging
	Agreement 10, 1989 of CAR	Water of Public Use
	Agreement 031, 1991 of CAR	General Regulation for the Functioning of Fuquene-Cucunuba Irrigation and Drainage District
Flora & Fauna	Law 373, 1997	Efficiente use and water saving
	Agreement 23, 1993 of CAR	Reforestation of Hydrics banks
	Agreement 53, 1981 of CAR	Flora & Fauna
	Decree 1449, 1977	Forests Areas of Protection
	Decree 1014, 1981	Concession and permission for forest resource
Soil	Decree 1608, 1978	Wild Life
	Decree 2143, 1997	Prohibition of burning
	Decree 919, 1989	Evaluation of erosive zones
	Decree 1946, 1989; Decree 2379, 1991	Technical Assistance for Agriculture- livestock (Umatas)
	Decree 1929, 1924	
	Agreement 33, 1979 of CAR	Statute for Zoning
	Decree 919, 1989	National System for disasters
	Decree 2104, 1983	Solid Waste Management
	Decrees 2655, 2656, 2657, 1988	Mining Code
Resolution N.222, 1994 of Ministry of Environment and Agreement N.246, 1994 of CAR	Compatible Areas with quarries	
Law 41, 1993	Land Adaptation	

**Table J.2.1 List of Public Employees of whole CAR (1/3)**

Working Place	N.personnel	Profession
1. General Direction	15	3 lawyers 6 engineers 5 various profesionales 1 secretary bilingue
2. General Secretary	6	3 lawyers 3 Administrative Secretaries
3. Procedure and Control Office	12	1 engineer 2 economist 5 Administrator of Enterprise 3 accountant 1 lawyers
4. CAR - BID Project	6	1 engineer 4 administratative 1 lower
5. CHECUA Project	3	1 engineer 1 assistant ( Economist ) 1 secretary
6. Subdirectorate of Planning and Development	2	1 architect 1 technician in Systems
7. Sudirectorate of Administration and Finance	3	1 administrator of Eterprises 2 administratives
8. Subdircetion of Decentralization and Community Participation	3	1 lower
		1 administrator of Enterprises 1 secretary
9. Subdirectorate Juridical	5	3 lawyers 1 secretary 1 Publicer
10. Subdirectorate Scientific	4	3 engineers 1 secretary
11. Subdirectorate of Environmental Quality Control	4	1 engineer
		1 administrator of Enterprises 1 secretary
		1 auxiliar administrative
12. Subdirectorate of Operations	4	1 engineer 1 technician in public procedure 2 secretaries
13. Division of Planning	12	4 architects 5 economists 1 engineer 1 Technician in agriculture/livestock 1 secretary
14. Division of Financial Resources	31	1 Ingeniero 10 accounters 6 economists- Administrator of Enterprises 2 commercial secretaries and marketing 1 technician administrative 10 Auxiliars 1 specialist in international commerce

**Table J.2.1 List of Public Employees of whole CAR (cont.) (2/3)**

15. Division of Environmental Educacion and Communication	7	2 engineers 2 social communicators 2 Secretaries 1 auxiliar administrative
16. Division of Juridical Advisement	15	8 lawers 1 administrator 2 having high school diploma 3 secretaries 1 Auxiliar
17. Division of Investigation	15	7 engineers 2 Zootechnicians 2 Biologist 1 Technician in hydric resources 1 Geologist 2 Secretaries
18. Division of Environmental Quality	28	17 engineers 2 marine biologist 1 Technician in mining 1 Technician in environmental sanitation 2 Administrator 1 social worker 3 secretaries 1 operator
19. Division of Design and Construction	18	10 engineers 3 architects 1 Topographer 2 secretaries 2 operators
20. Division of Computing	14	10 engineers 1 technician in natural resources 1 technician in Administration 1 technician in mechanics 1 secretary
21. Division of Human Resources	24	2 psicologist 1 phisician 5 engineers 1 technician in industrial relation 4 Technicians in Administration 4 executive secretaries 5 auxiliars administratives
22. Division of Coordination, Interinstutional and Community Participation	8	1 engineers 2 administrator 2 lawers 1 graduated in education 1 secretary 1auxiliar



**Table J.2.1 List of Public Employees of whole CAR (cont.) (3/3)**

23. Division of Regulations and Licences	23	12 lawyers 1 technician in industrial relation 2 executive secretaries 1 technician in Systems 5 auxiliars in administration 2 qualified operators
24. Division of Technical Evaluation	27	6 engineers 5 biologist 3 chemist 1 mathematic 1 secretary 1 technician in hydric resources 9 operators 1 accountant
25. Division of Monitoring and Control	9	6 engineers 1 technician in administration 2 auxiliars administratives
26. Division of Promotion and Operations	12	5 engineers 1 veterinary surgeon 1 biologist 1 economist 3 secretaries 1 auxiliar
27. Division of Analisis and Projections	5	3 economist 1 engineer 1 secretary
28. Division of Physical Resources	51	3 engineers 2 economist 5 administrator of enterprise 1 technician in commerce 1 programming analyst 3 technician in administration 2 secretaries
29. Regional UBATE	48	9 engineers 5 lawyers 2 social communicator 7 administrator of enterprise 2 veterinary surgeon 2 Biologist 1 technician in marketing 1 Programmer of System
30. Regional FUNZA	73	
31. Regional FUSAGASUGA	40	
32. Regional GIRARDOT	37	
33. Regional VILLETA	29	
34. Regional ZIPAQUIRA	79	
<b>Total publics employees</b>	<b>672</b>	

**Table J.2.2 List of Public, Official and Contracted Employees at CAR Regional Directorate of Ubate (1998)**

Dependency	No. of Employees	Profession
Regional Directorate	2	Civil Engineer Secretary
Planning	2	Byologist Computer Engineer
Administrative	8	Enterprise Administration Technician on Administration Assistant on Administration Technician on Administration Qualified Operator Technician on Administration Technician Qualified Operator Cafetery
Service of Attention to the Users	3	Enterprise Administration Enterprise Administration Secretary
Decentralization, Community Participation and Environmental Education	2	Social Communicator Social Communicator
Juridical	11	Lawyer Lawyer Lawyer Lawyer Lawyer Lawyer Lawyer Secretary Notifier Secretary Secretary
Environmental Quality	4	Professional Secretary Secretary Secretary
Administration of the Natural Resources	9	Agricultural Engineer Zootechnics Mining Engineer Mining Engineer Technician Technician Technician Technician
Monitoring and Control	3	Market-technician Agricultural Engineer Technical
Environmental Procedures Unit	3	Agricultural Engineer Secretary Secretary
Projects and Environmental Awareness	7	Agricultural Engineer Veterinary surgeon Enterprise Administration Technician Technician Technician Technician
Special Areas	3	Forest Engineer Technician Technician
Other Areas	16	
Total	73	

**Table J.2.3 List of Public, Official and Contracted Employees of the Regional Directorate of Zipaquira (1998)**

Dependency	No. of Employees	Profession
Regional Subdirectorate	3	civil engineer administrator of enterprise high school diploma
Planning	8	architect geographical engineer economist administrator of enterprise cadaster engineer technicians on natural resources engineer of system drawer
General Secretary	16	4 high school diploma 2 technicians of system 2 technicians on natural resources secretary student of economy dental technician 4 technicians administrator of enterprise
Environmental Education	8	social communicator administrator of enterprise secretary publicer 3 high school diploma sociologist
Juridical	9	7 lawyer 2 high school diploma
Environmental Quality	30	3 civil engineers 3 agriculture engineers 2 mining engineer engineer of industrial foods 7 technicians 8 high school diploma 2 administrators mechanical engineer sanitary engineer 2 chemical engineer
Operations	60	48 labors 9 high school diploma administrator of enterprise biologist veterinary surgeon
Administration and Finance	15	social worker 2 administrator of enterprise 2 technicians 9 high school diploma auxiliar accountant
Monitoring and Control	12	industrial production engineer specialist on environmental education bacteriologist 2 technicians veterinary surgeon agriculture engineer 2 technicians secretary 2 agriculture engineer
Total	161	

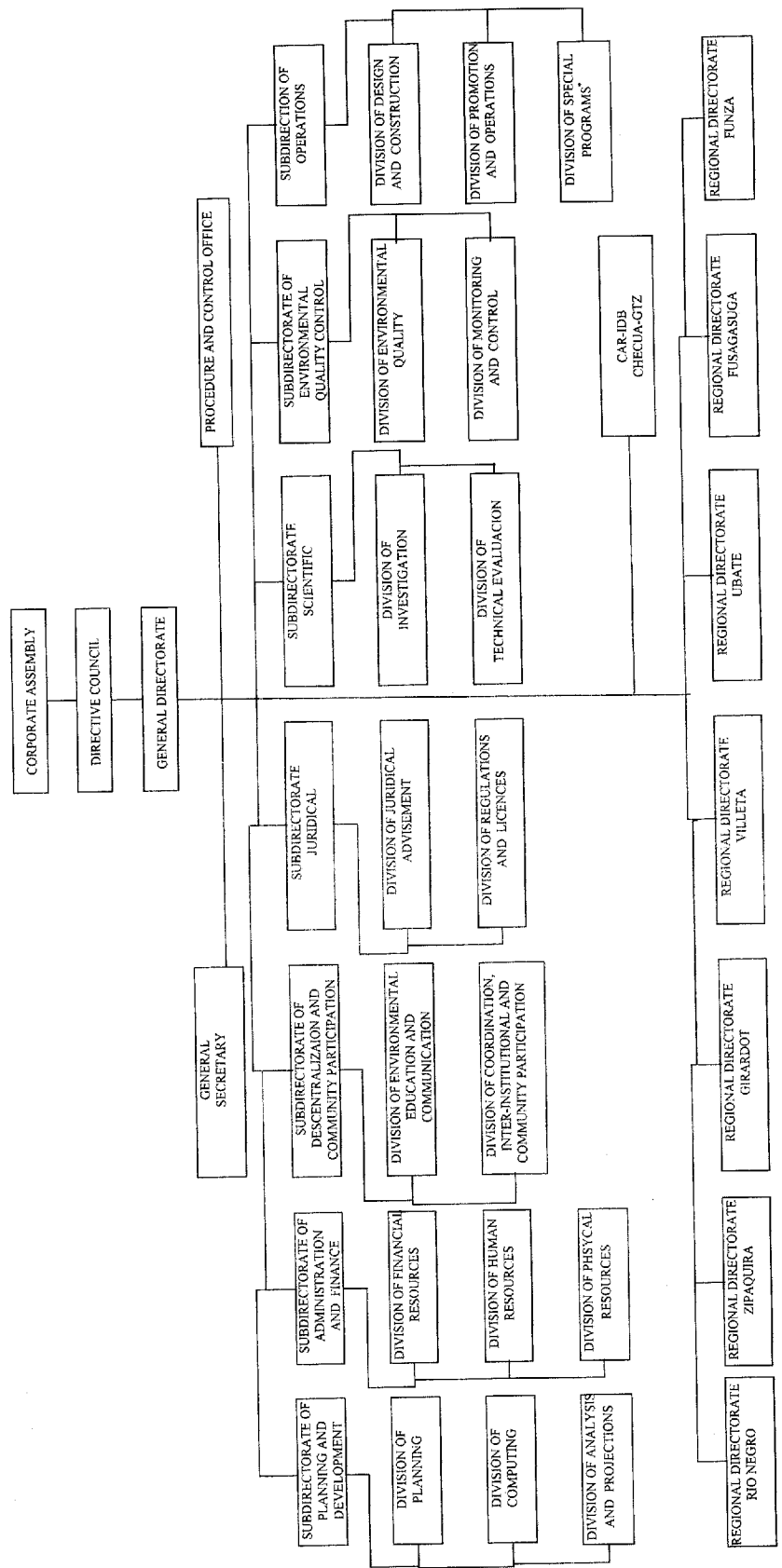
**Table J.2.4 Municipal Budget and Amount Assigned to Environmental Projects and Public Services in the Study Area**

Municipalities	Total Municipal	Budget 1999 ( thousands Col\$)										Total (1+2)	% *
		Public Services (1)					Environmental Projects (2)						
		Water Supply	Sewerage	Slaughterhouse	Solid Waste	Env. Education	Reforestation						
1. Carmen de Carupa	1,427,107	196,825	-	4,553	-	-	-	-	-	-	-	201,378.00	14.11
2. Ubaté	4,583,993	113,744	210,000	132,083	10,000	-	-	-	-	-	55,000	520,827.00	11.36
3. Tausa	1,187,467											135,133.00	11.38
4. Suratausa	1,018,265	86,000	31,000	1,000	7,800	-	-	-	-	-	14,000	139,800.00	11.77
5. Cucumaba	1,547,957	110,718	58,900	11,600	500	-	-	-	-	-	3,000	184,718.00	18.14
6. Lenguazaque	2,170,296	158,346	15,000	-	5,350	-	-	-	-	-	-	178,696.00	8.23
7. Guachetá	1,639,136	166	25,000	-	-	-	-	-	-	-	11,623	36,789.00	2.24
8. San Miguel de Sema	1,190,185	145,510	5,500	-	-	-	-	-	-	-	16,466	167,476.00	14.07
9. Ráquira	2,001,150	119,311	26,400	-	15,000	-	-	-	-	-	15,000	175,711.00	8.78
10. Fúquene	939,755	103,937	10,000	-	10,000	-	-	-	-	-	-	123,937.00	13.18
11. Susa	1,189,933	80,200	25,104	-	2,000	-	-	-	-	-	32,000	139,304.00	11.70
12. Simijaca	1,370,175	109,615	34,000	-	48,040	-	-	-	-	-	4,500	196,155.00	14.31
13. Caldas	1,017,657	98,100	16,000	-	-	-	-	3,500	-	-	32,406	150,006.00	14.74
14. Chiquinquirá	7,289,903	166,630	-	-	-	-	-	-	-	-	259,046	425,676.00	5.83
15. Saboyá	550,654	119,863	-	-	-	-	-	-	-	-	74,939	194,802.00	35.37
<b>Total</b>	<b>29,123,633</b>	<b>1,608,965</b>	<b>456,904</b>	<b>149,236</b>	<b>98,690</b>	<b>3,500.0000</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>517,980</b>	<b>2,970,408.00</b>	<b>13.01</b>

\* = percentage of total budget assigned to environmental projects and public services

\*Exchange rate: 1 US \$ = 106 ₱ = 1,920 Col\$ October 1999.

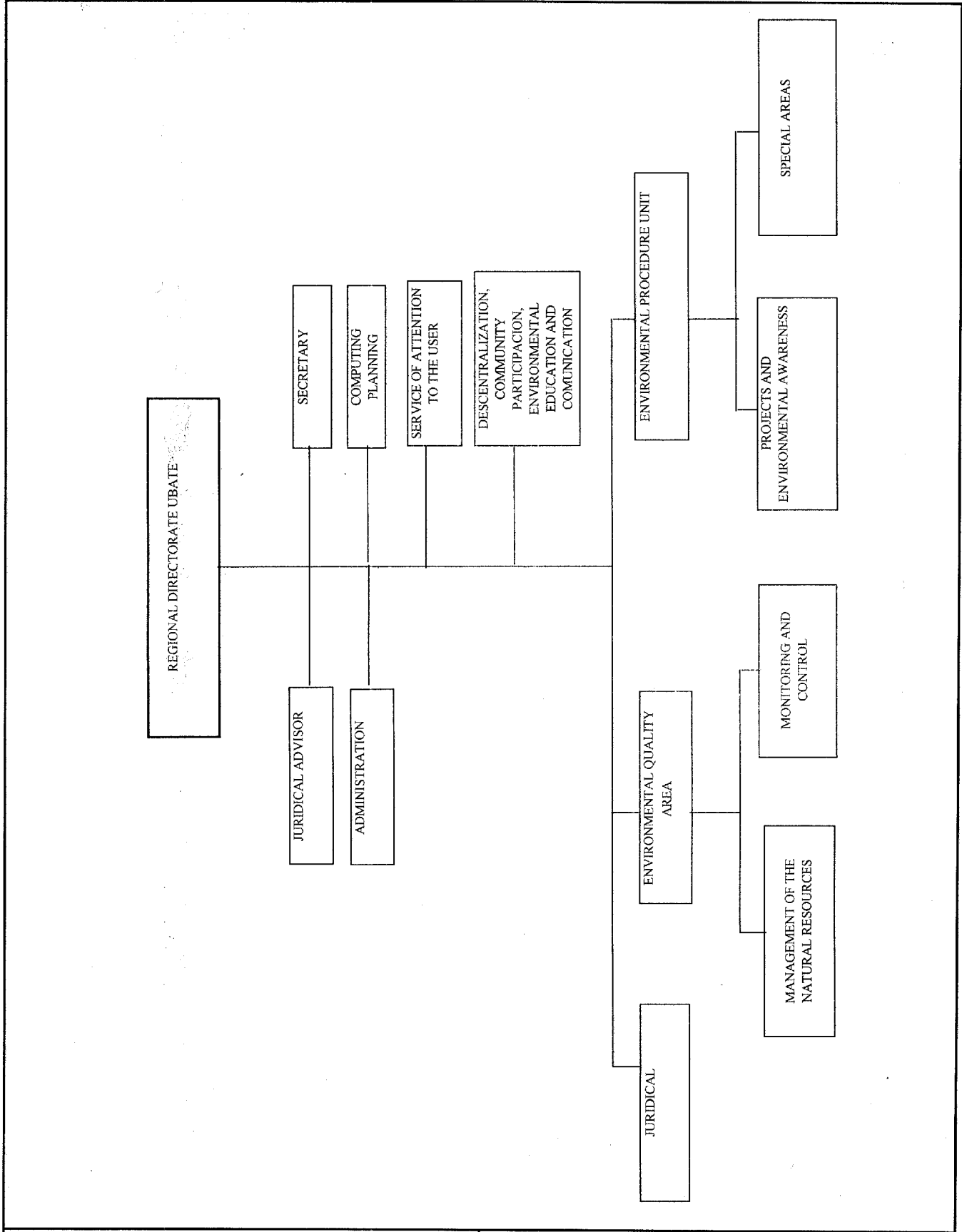
REGIONAL AUTONOMOUS CORPORATION OF CUNDINAMARCA - C.A.R.



Source: Law 99/93, Estatutes of the Corporation (Res. 498 Min. Environment), Agreement 6/95 and 10/98 C.A.R., Manual of Functions CAR. \*It is a functional division having no chief and some projects depend directly on the General Director

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 JAPAN INTERNATIONAL COOPERATION AGENCY

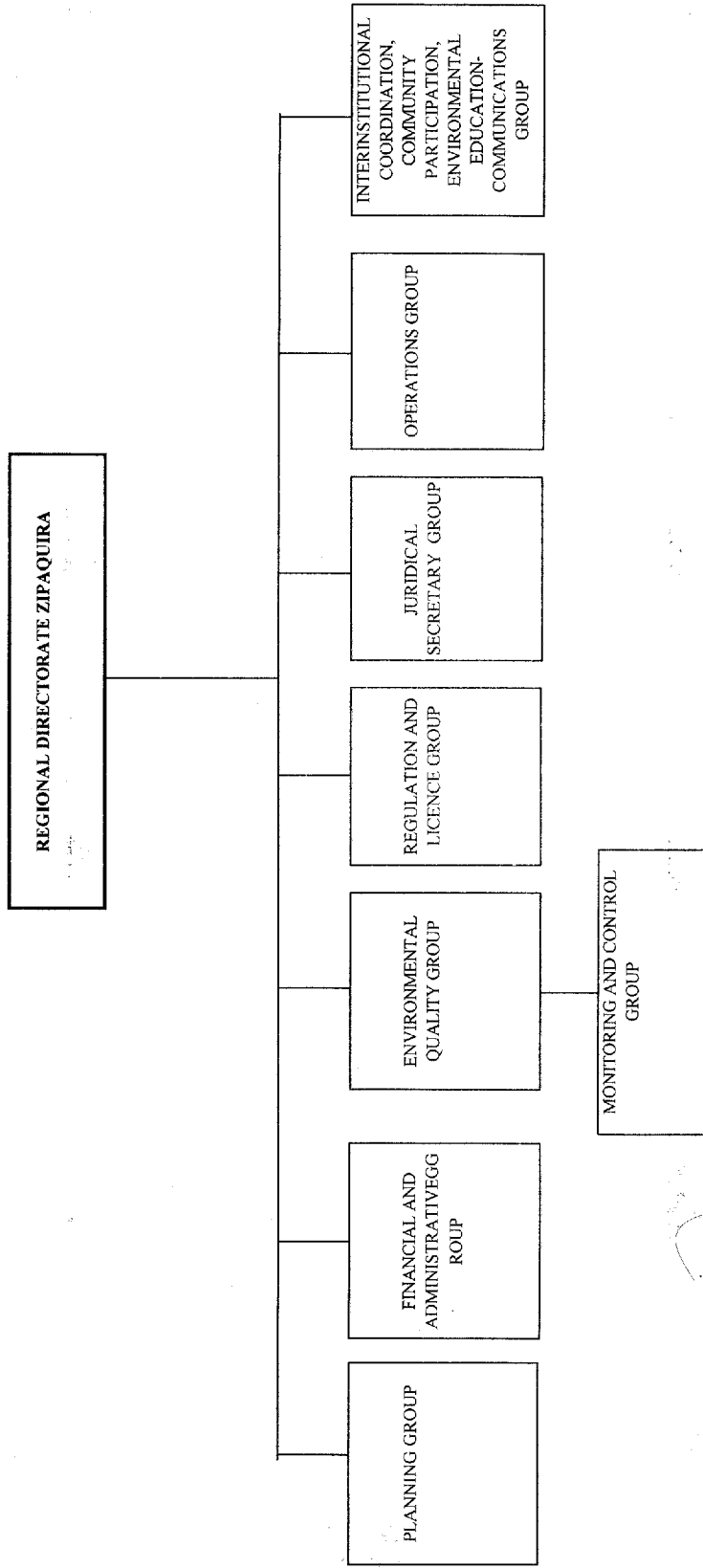
Fig.J.2.1 Flowchart of CAR Headquarter



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Fig.J.2.2 Flowchart of CAR Regional Directorate of Ubate



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Fig.J.2.3 Flowchart of CAR Regional Directorate of Zipaquira

Public Services Department-Municipality of Ubate

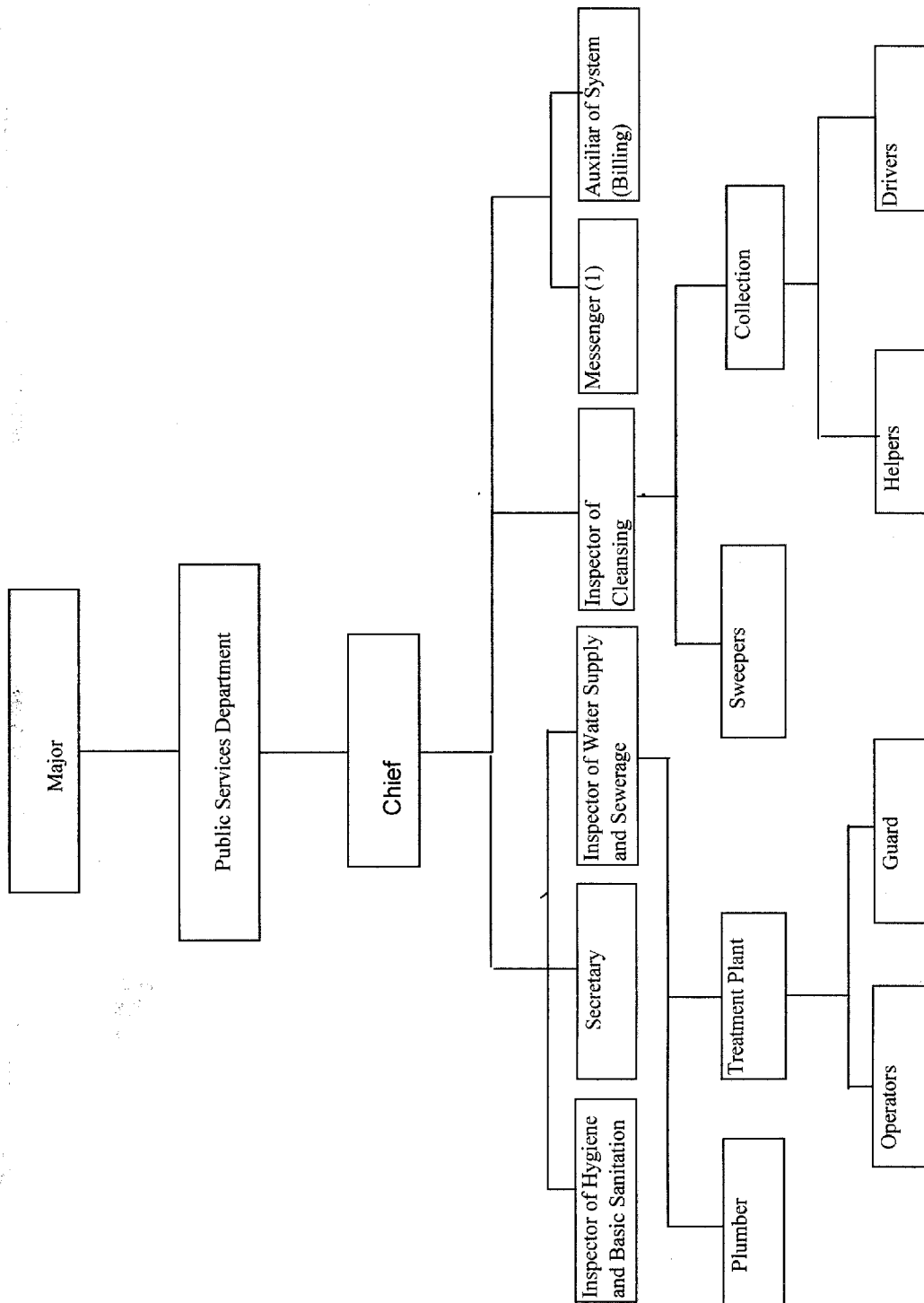


Fig.J.2.4 Flowchart of the Public Services Department-Municipality of Ubate



***APPENDIX K***

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***PROJECT  
EVALUATION***

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**APPENDIX K**  
**PROJECT EVALUATION**

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## **APPENDIX K PROJECT EVALUATION**

### **CHAPTER I ECONOMIC ANALYSIS**

#### **1.1 Methodology**

The following aspects are analyzed for economic cost estimation:

- Civil works and procurement of equipment,
- Operation, maintenance and replacement costs,
- Land acquisition, and
- Engineering services and administration cost.

The project cost is converted to economic cost by applying a conversion factor which is assumed to be 0.9. The period of 30 years is adopted as the project life of the projects, and the interval for replacement of equipment at 15 years.

Firstly, the economic viability of the projects is evaluated for each project component of the Master Plan, and, then, for the Master Plan as a whole, in terms of the following indexes:

- Economic internal rate of return (EIRR),
- Benefit-cost ratio (B/C), and
- Net present value (NPV).

#### **1.2 Water Resources and Use Management Project**

The flow for construction cost is shown in Table K.1.1 (1/3), for O&M/R cost in Table K.1.1 (2/3) ,and for benefits in Table K.1.1 (3/3), respectively. The analysis of each component is explained hereunder.

##### **1.2.1 Economic Costs**

###### **(1) Irrigation**

###### **(a) Construction Cost**

The economic construction cost is estimated at 12,503 Million Col\$.

###### **(b) O & M/R Cost**

The operation, maintenance and replacement cost for the project life is estimated at 7,369 Million Col\$.

###### **(2) Drainage**

###### **(a) Construction Cost**

No construction works is expected in this component.

###### **(b) O & M Cost**

The operation and maintenance cost for the project life is estimated at 1,015 Million Col\$.

### (3) Municipal Water Supply

#### (a) Construction Cost

The economic construction cost amounts to 648 Million Col\$.

#### (b) O & M/R Cost

The incremental operation and maintenance cost is negligible, while the replacement cost for the project life is estimated at 110 Million Col\$.

## 1.2.2 Economic Benefits

### (1) Irrigation

With the project implementation, a gross area of 6,971 ha will enjoy more water availability. This fact will bring about, consequently, the increase of production both in livestock and agricultural sectors. For economic analysis, it is assumed that the all benefited area will be used for livestock for milk production.

In order to estimate the benefit, the unit productions of some cities in the Study Area are selected, which represent the typical types of irrigation in the beneficial area. These cities are, as follows:

- Caldas: 5.0 l/ha/d of milk production (rainfed condition),
- Sutatausa: 16.8 l/ha/d of milk production (upgraded under-irrigation condition),
- Guacheta: 16.1 l/ha/d of milk production (under-irrigation condition), and
- Ubate: 22.4 l/ha/d of milk production (optimum irrigation condition).

On the other hand, to express the benefit in monetary terms, net farm-gate price of milk (unit benefit) was considered. The bellow table shows the results of benefit calculation:

Beneficial Area Type	Milk Prod. with Project (l/ha/d)	Milk Prod. without Project (l/ha/d)	Balance (l/ha/d)	Net Area* (ha)	Incremental Milk Prod. (l/d)	Unit Benefit on Farm-gate (Col\$ /l)	Benefit (Million Col\$/y)
Type-A	16.1	5.0	11.1	1,758	19,514	154	1,097
Type-B	22.4	5.0	17.4	2,176	37,862	154	2,128
Type-C	22.4	16.1	6.3	2,058	12,965	154	729
Type-D	16.8	16.1	0.7	282	197	154	11

\*Obtained by multiplying gross area by 0.9. 1US\$=1,920 Col\$ as of October 1999.

In the analysis, it is assumed that the benefit will appear from the next year of the completion of the construction.

### (2) Drainage

With the project implementation, reduction of inundation area around the Lake is expected at 170 ha. However, this benefit will not be realized throughout the entire year. It is assumed that the benefit will appear during 25% of a year (91days). To calculate the benefit, it is assumed that the all area will be used for livestock farming for milk production. The benefit is calculated, as follows:

Recovered Area* with Project (ha/y)	Milk Prod. **(l/ha/d)	Incremental Milk Prod. (l/d)	Unit Benefit on Farm-gate (Col\$/l)	Beneficial Period (d/y)	Benefit (Million Col\$ /y)
170	16	2,720	154	91	38.1

\* Around the Lake. \*\* The production of Fuquene is considered for the analysis. 1US\$=1,920 Col\$ as of October 1999.

This benefit will appear after starting the Suarez River improvement. In this study, it is proposed to start by 2002.

### (3) Municipal Water Supply

At present, the water purified by the treatment plant at Chiquinquirá does not fulfill the national standard of potable water quality. To counteract this situation, improvement of the existing facilities is proposed. It is also necessary to improve the pumping station in order to prevent cavitation.

The economic cost including the construction and replacement of these facilities amounts to 758 Million Col\$ for the project life. In this study, it is assumed that this economic cost is equivalent to the economic benefit on the water users.

### 1.2.3 Project Evaluation

The water resources and use management project is evaluated, as follows (Table K.1.1 (3/3)):

- EIRR : 26 %,
- B/C ratio : 2.2 (applying a discount rate of 10% per annum), and
- NPV : 10,899 Million Col\$ (applying a discount rate of 10 % per annum).

### 1.3 Sewerage Treatment Project

The flows for the construction cost, O&M/R cost and benefits are shown in Table K.1.2. The succeeding sections show their explanations.

#### 1.3.1 Economic Costs

##### (1) Construction Cost

The economic cost for the construction amounts to 6,282 Million Col\$.

##### (2) O & M/R Cost

The operation, maintenance and replacement cost for the project life is estimated at 13,249 Million Col\$.

### 1.3.2 Economic Benefits

Currently, 14 cities, whose urban areas locate in the Study Area, developed their sewerage systems. However, only five (5) of them have their wastewater treatment plants. This fact causes the water quality deterioration of many watercourses which receive the untreated wastewater. The construction of wastewater plants is proposed in order to improve the water quality of the receiving rivers. This will result in the improvement of public health of the population who abstract the river water for domestic water use. In addition, this project will reduce the pollution load of the rivers which are sources of water use for the agriculture and livestock.

Most of the benefits are intangible, however, the monetary benefit is estimated from the viewpoint of cost saving. This cost saving accrues from the saving of additional improvement of the water treatment plant in Chiquinquirá, as follows:

BOD in Suarez River		Balance (mg/l)	Unit Price for BOD Removal (Col\$/kg)	Intake Volume (m <sup>3</sup> /d)	Benefit (Million Col\$/y)
With Project (mg/l)	Without Project (mg/l)				
2.77	3.47	0.7	450	15,000	1.7

1 US\$=1,920 Col\$ as of October 1999.

The benefit is assumed to begin from 2011, when all the proposed sewerage treatment plants will be under operation.

## 1.4 Aquatic Plant Control Project

The flows of cost and benefit are shown in Table K1.3, while the analysis of each component is explained in the succeeding sections.

### 1.4.1 Economic Costs

#### (1) Dredging of the Lake

##### (a) Construction Cost

The economic construction cost amounts to 14,286 Million Col\$.

##### (b) O & M/R Cost

No O&M works is expected during the project life.

#### (2) Harvesting/Removal and Composting of Aquatic Plants

##### (a) Construction Cost

The economic cost in this component amounts to 9,668 Million Col\$.



(b) O & M/R Cost

The cost for operation, maintenance and replacement for the project until 2016 is estimated at 12,856 Million Col\$.

(3) Aquatic Plant Control by Grass Carp

(a) Construction Cost

The economic construction cost including grass carp procurement amounts to 1,706 Million Col\$.

(b) O & M Cost

The operation and maintenance cost for the project life is estimated at 1,238 Million Col\$.

**1.4.2 Economic Benefits**

(1) Dredging of the Lake

It is proposed to dredge the lakebed in the front zone of Bulrush to prevent the expansion of this emergent plant towards the center of the Lake. The dredging will produce organic material that will be disposed on 50 ha in the surrounding area of the Lake. This will convert the low land area to pasture land around the Lake, and result in increase of milk production, as follows:

Milk Prod. at Fuquene (l/ha/d)	Recovered Area (ha)	Incremental Milk Prod. (l/d)	Unit Benefit on Farm-gate (Col\$/l)	Benefit (Million Col\$/y)
16	50	800	154	45.0

<sup>1</sup>US\$= 1,920 Col\$ as of October 1999.

In addition, this project will contribute to decrease the anaerobic condition in the Lake by stopping the expansion of Bulrush area.

The benefit will start once dredging is performed, and it will increase gradually from 2007 to 2010, and, then, it will remain constant until the end of the project life.

(2) Harvesting/Removal and Composting of Aquatic Plants

The following benefits are expected from this component:

- Compost production,
- Reduction of water pollution damage on pasturelands around the Lake,
- Reduction of water pollution damage of Chiquiquira municipal water supply,
- Conservation of lake storage capacity,
- Improvement of landscape, and
- Improvement of aquatic life habitat.

The first five (5) benefits are tangible ones, while the last one (1) is intangible. In the succeeding sections, the tangible ones are analyzed:

(a) Compost production

The compost production of aquatic plants is proposed near the Lake. Compost will be marketed in the metropolitan area of Bogota for flower farming. To analyze this benefit, Zipaquira city is selected as a consuming area of compost for flower farming. This is because large flower farming is observed in this city, which is close to the Lake.

The current market price of compost at Zipaquira is 140,000 Col\$/ton. On the other hand, the compost selling price at the production site is estimated at 122,000 Col\$/ton. This price is obtained by deducting the transportation cost between composting site and Zipaquira city (18,000 Col\$/ton). The result of benefit calculation is, as follows:

Compost Production with Project (ton/y)	Selling Price by Project (Col\$/t)	Benefit (Million Col\$ /y)
16,100	122,000	1,964.2

1 US\$=1,920 Col\$ as of October 1999.

The above benefit corresponds to full-scale compost production, and it will start from 2005 to the end of 2016.

(b) Reduction of water pollution damage on pasturelands around the Lake

In the future, without project, the Lake water with high concentration of H<sub>2</sub>S, will irrigate the pasturelands in the surrounding area of the Lake. The H<sub>2</sub>S will damage the pasture growing, and the damage will result in the reduction of livestock production. The affected area is estimated at 500 ha. With the project implementation, the area will be conserved. The economic analysis of this benefit is shown below:

Area Protected with Project (ha)	Milk Production (l/ha/d)*	Total Milk Produced (l/d)	Unit Benefit on Farm-gate (Col\$ /l)	Benefit (Million Col\$ /y)
500	16	8,000	154	449.7

\* The production of Fuquene is considered for the analysis. 1US\$=1,920 Col\$ as of October 1999.

The benefit will appear gradually from 2005 to 2010, and from this year, it will be constant until the end of the project life.

(c) Reduction of water pollution damage on Chiquinquirá municipal water supply

Removing aquatic plants from the Lake will improve the water quality of the Suarez River. Without this project, additional purification facilities will need to be attached to the water treatment plant at Chiquinquirá. The economic cost of the additional facilities amounts to 235 Million Col\$. In this study, it is assumed that this construction cost is equivalent to the economic benefit. This economic benefit will increase gradually from project starting year, 2005, until 2016, and from this year, it will remain constant for the project life.

(d) Conservation of lake storage capacity

With the project implementation, 594,400 m<sup>3</sup> of the lake storage capacity is expected to be conserved . This economic benefit is estimated using the economic cost for constructing a dam which capacity is same to this volume. The economic unit water cost of a dam is estimated at Col\$ 176/m<sup>3</sup>, referring to the construction of Hato Dam then, the benefit is estimated at 105 Million Col\$. This benefit is counted only once in 2020.

(e) Landscape improvement

If aquatic plants are removed from the Lake, the landscape will be improved substantially. Consequently, it will trigger tourism development at the Lake. At present, 100,000 tourists visit this region per annum. Then, it is assumed that 40 % (40,000 persons) of the tourists will visit the lake region under the project condition. The annual total benefit accrued from the tourism is estimated at 800 Million Col\$, based on the assumption that tourists will spend 20,000 Col\$/person/y in the lake region. This benefit will appear gradually according to the promotion of recreational activities. The benefit will occur from 2005, and will increase until 2016, and from this year to be constant.

(3) Aquatic Plant Control by Grass Carp

The benefits of this component are mitigation of the anaerobic condition of the Lake, improvements of the landscape and habitat of aquatic life.

### 1.4.3 Project Evaluation

The aquatic plant control project is evaluated, as follows (Table K.1.3):

- EIRR : 5 %,
- B/C ratio : 0.8 (applying a discount rate of 10 % per annum), and
- NPV : -4,553 Million Col\$ (applying a discount rate of 10 % per annum).

### 1.5 Project Evaluation of the Master Plan

Table K.1.4 shows flows of the costs and benefits of the Master Plan. The flows are established following the implementation schedule of the Master Plan. The results of the project evaluation are, as follows:

- EIRR : 10 %,
- B/C ratio : 1.0 (applying a discount rate of 10 % per annum), and
- NPV : Million Col\$ (applying a discount rate of 10 % per annum).

## CHAPTER II FINANCIAL ANALYSIS

### 2.1 General

Financial analysis is conducted for three (3) project components of the Master Plan, (1) irrigation in water resources and use management project, (2) sewerage treatment and (3) compost production in aquatic plant control project.

### 2.2 Irrigation

#### 2.2.1 Existing Unit Irrigation Water Charge

In 1998, the total water charge collected by CAR was 974.5 Million Col\$ with the irrigation area of 20,337 ha, then, the unit water charge was 37,299 Col\$/ha. On the other hand, the unit water charge for 1999 is estimated at 39,537 Col\$/ha.

#### 2.2.2 Future Unit Irrigation Water Charge

The future unit irrigation water charge is assumed to increase proportionally to the growth of per capita GDP. The GDP is predicted to increase at an annual rate of 4 % (0.0 % until 2000, 4 % for 2001-2011), while the population growth rate of the whole Study Area is assumed to be 1.1 % per annum (0.0 % until 2000, 1.1 % for 2001-2011). Then, per capita GDP may increase at an annual rate of 2.9 % (0.0 % until 2000, 2.9 % for 2001-2011).

#### 2.2.3 Financial Evaluation

##### (1) Revenue and Cost Disbursement

For financial analysis, it is assumed that the revenue will increase according to the growth rate of per capita GDP in the period 2001-2011, and, thereafter, constant. The expected revenue is summarized, as follows:

Year	Irrigation Area (ha)	Unit Water Charge (Col\$/ha/y)	Revenue (Million Col\$/y)
-2000	20,337	39,537	804
2005	21,068	45,612	961
2011	24,849	54,147	1,345
2012-	24,849	54,147	1,345

On the other hand, the disbursement schedule of the construction and annual O&M costs is summarized bellow (Table K. 2.1 (1/2)):

Year	Construction Cost (Million Col\$/y)	Ave. Annual O&M Cost (Million Col\$/y)
-2000	-	-
2001-2005	5,415	1,024
2006-2010	9,634	1,137
2011-	-	1,242

1US\$= 1,920 Col.\$ as of October 1999.

(2) Conclusions

From the above tables, the annual O&M cost will be covered by the expected annual revenue. However, the revenue does not cover the construction cost at all.

As an alternative of financial source planning, it is recommended that 90 % of the initial cost be shouldered by the government, while 10 % of the initial cost and all the O&M cost be paid by the beneficiaries. Under this case, the water charge should be increase to 43,670 Col\$/ha/y for the base year 2000. The cash flows are shown in Table K.2.1 (2/2).

## 2.3 Sewerage Treatment

### 2.3.1 Existing Sewerage Charge

The proposed project comprises the construction of wastewater treatment plants in 15 places in the Study Area. At present, the sewerage systems in the Study Area are provided with only pipelines, except in the cities of Ubate, San Miguel de Sema, Cucunuba, Saboya and Lenguazaque which have wastewater treatment plant each.

The service charge is not collected in Lenguazaque, while the local municipalities subsidize their systems in San Miguel de Sema, Saboya and Cucunuba. Under these circumstances, the average unit sewerage charges of Ubate are taken into account as the representative current charges of the entire Study Area. These values are 1,865 Col\$/month/house for domestic wastewater, and 13,039 Col\$/month/factory for industrial wastewater. These unit sewerage charges are used as the bases for calculating the affordable sewerage charges in the Study Area.

### 2.3.2 Affordable Sewerage Charge under Existing Condition

(1) Domestic Wastewater

The affordable sewerage charge is estimated by comparing the existing sewerage charge and the willingness to pay for sewerage charge. The data for this comparison is based on the results of the questionnaire survey carried out by the Study Team.

(a) Existing Sewerage Charge

In the Study Area, the median value of monthly household income is 700,000 Col\$, as of June 1999. Then, the existing monthly sewerage charge of 1,865 Col\$/month/house is equivalent to 0.26 % of the monthly income (700,000 Col\$/month/house).

(b) Willingness to Pay

According to the public awareness survey, the maximum value that the people are willing to pay for sewerage service amounts to 2,250 Col\$/month/house, which is equivalent to 0.32 % of the monthly income.

From the above discussion, the affordable sewerage charge of a household is assumed to be 0.29 % of the income, which percentage is obtained by averaging the above two cases. Then, the affordable sewerage charge for domestic wastewater comes to 2,030 P/month/house.

Since the proposed project covers the construction of only treatment plants, it is assumed that 40 % of the affordable sewerage charge will be spent on the operation and maintenance of the plants. Based on this assumption, the affordable sewerage treatment charge for domestic wastewater is 812 Col\$/month/house or 0.12 % of the family income. This value will be used for the financial analysis.

(2) Industrial Wastewater

The affordable sewerage charge for industrial wastewater is obtained by multiplying the affordable sewerage charge for domestic wastewater by the ratio of actual industrial charge to actual domestic one. Based on this method, the affordable sewerage charge is calculated to be 14,193 Col\$/month/factory. Then, the affordable sewerage treatment charge for industrial wastewater is 5,677 Col\$/month/factory (40% of 14,193 Col\$/month/factory). This value will be used for the financial analysis.

**2.3.3 Affordable Sewerage Charge under Future Condition**

The future affordable sewerage charge for domestic wastewater is assumed to increase proportionally to the growth of per capita GDP. As aforementioned, the per capita GDP will increase at an annual rate of 2.9 % (0.0 % until 2000, 2.9 % for 2001-2011).

The future one for industrial wastewater is assumed to increase maintaining the same ratio to the future domestic wastewater charge, which ratio is determined under the present economic conditions.

**2.3.4 Financial Evaluation**

(1) Sewerage Revenue and Cost Disbursement

The total urban population is estimated to be 78,069 (1999-2000) and 98,439 (2011). For financial analysis, it is assumed that the population will increase at a constant growth rate in the period 2001-2011, and, thereafter, constant. The expected annual revenue obtained from the sewerage treatment charge is shown in Table K.2.2 (1/2). From this table, it can be concluded that even the O&M cost will not be covered by the estimated affordable sewerage treatment charges.

It is proposed, thus, to increase the sewerage treatment charge from 0.12 % (812 Col\$/month/house) to 0.25 % (1,776 Col\$/month/house ) of the family income (700,000 Col\$/month/house in 2000) to cover the O&M of the treatment plants. The summary of expected revenue adopting the above percentage is, as follows:

Year	Unit Sewerage Treatment Charge		Served Household Number	Served Industry Number	Annual Revenue (Million Col\$/y)
	Domestic (Col\$/month/house)	Industry (Col\$/month/factory)			
-2000	1,776	12,417	22,305	49	483
2005	2,049	14,325	24,784	49	618
2010	2,364	16,528	27,539	49	791
2011	2,432	17,003	28,125	49	831
2012-	2,432	17,003	28,125	49	831

On the other hand, the disbursement schedule of the development and annual O&M costs is summarized, as follows (for cash flow, see Table K.2.2 (2/2)):

Year	Development Cost (M Col\$/y)	Ave. Annual O&M Cost (M Col\$/y)
-2000	-	-
2001-2005	3,565	274
2006-2010	3,996	491
2011-		831

1US\$= 1,920 Col\$ as October 1999.

## (2) Conclusion

From the above tables, the annual O&M cost of the wastewater treatment plants will be fully covered by the expected annual revenue when adopting 0.25 % of the family income. Referring to the experiences in other countries, it is recommended that the initial and replacement costs be shouldered by the government, while the all O&M cost (excluding replacement cost) be paid by the beneficiaries.

## 2.4 Compost Production

### 2.4.1 Existing Market Price

As a fact, flower farming applies compost as fertilizer in the metropolitan area of Bogota. The current market price of the compost is 140,000 Col\$/ton at Zipaquira city, where many flower farming companies exist. The city locates with distance of about 60 km from the composting site.

### 2.4.2 Future Market Price

The future market price is assumed to increase proportionally to the growth of per capita GDP. As mentioned before, the per capita GDP will increase at an annual rate of 2.9 % (0.0 % until 2000, 2.9 % for 2001-2011).

### 2.4.3 Financial Evaluation

#### (1) Compost Revenue and Cost Disbursement

Firstly, pilot compost production with capacity 1,400 ton/year will be established in the period 2001-2004. Then, from 2005 until 2016, full-scale production will be implemented. For financial analysis, it is assumed that the revenue will increase according to the growth of per capita GDP in the period 2001-2011, and, thereafter, constant. The expected revenue and cost disbursement is presented in Table K.2.3 (1/4).

#### (2) Financial Internal Rate of Return

The composting is evaluated in terms of financial internal rate of return (FIRR). The FIRR is calculated for the following three (3) cases:

Case - 1: The government shoulders pilot project construction and its O&M costs, and compost produced in this period is supplied to farmers on free-charge. All the full-scale construction and its O&M/R costs are shouldered by private

sector.

Case - 2: The government shoulders pilot project construction and its O&M costs and a half of full-scale construction cost, while the half of full-scale construction cost and all the O&M/R costs are shouldered by private sector. Compost produced in pilot project is supplied to farmers on free-charge.

Case - 3: The government shoulders pilot project construction and its O&M costs and 70% of full-scale construction cost, while the remaining 30 % of full-scale construction cost and all the O&M/R costs are shouldered by private sector. Compost produced in pilot project is supplied to farmers on free-charge.

The results of FIRR calculations are, as follows:

Cases	FIRR (%)
Case-1	8
Case-2	23
Case-3	39

Case-3 shows a good FIRR, which may be attractive for private sector to participate in the compost production. The cash flows for the three (3) cases are shown in Tables K.2.3 (2/4), K.2.3 (3/4) and K.2.3 (4/4).



## CHAPTER III ENVIRONMENTAL IMPACT ASSESSMENT

### 3.1 Introduction

This study aims at assessing the environmental impacts of the proposed projects of the Master Plan to be implemented and proposing measures to mitigate the anticipated negative impacts, if any. The study is conducted based on the JICA Environmental Guidelines and relevant Colombian laws and regulations.

#### 3.1.1 Scope of Work

The scope of work for this study requires the following aspects:

- (a) Appraisal of existing environmental conditions including the nature and crucial environmental subjects in the Study Area.
- (b) The potential environmental impacts of the projects.
- (c) Proposing measures to minimize potentially negative environmental impacts of the projects, if necessary.

#### 3.1.2 Project Description

All irrigated area belongs to irrigation and drainage system of CAR (about 20,340 ha) in the Study Area, because CAR grants water rights to water users. The system area will expand to about 24,850 ha in the future. In harmony with this extension, it is necessary to strengthen the water resources and use management of the system.

All urban domestic and most of slaughterhouse/factory pollution loads discharge into rivers through 14 sewerage systems without satisfactory treatment in the Study Area. This situation worsen the water quality of rivers and lakes in the Study Area.

On the other hand, Lake Fuquene has suffered from excessive growth of aquatic plants in recent years. These aquatic plants decreased the water mirror area of the Lake and worsen its water quality. These phenomena will cause fatal damages on the ecological system and water uses of the Lake.

One objective of the Study is to formulate the Master Plan for regional environmental improvement for the basin of Lake Fuquene. The following table shows proposed projects of the Master Plan:

<i>Project and Its Components</i>	<i>Outline of Project Components</i>
<b>1. Water Resources and Use Management Project</b>	
1) Irrigation	<ul style="list-style-type: none"> <li>• Construction of irrigation facilities.</li> <li>• Introduction of optimum operation rule of Hato Dam. (beneficial area: 6,971 ha of CAR system)</li> </ul>
2) Drainage	<ul style="list-style-type: none"> <li>• Improvement of Suarez River (removal of aquatic plants).</li> <li>• Introduction of optimum operation rule of Fuquene Lake. (beneficial area: 170 ha around the Lake)</li> </ul>
3) Municipal Water Supply	<ul style="list-style-type: none"> <li>• Improvement of pumping station for Chiquinquirá municipal water supply to prevent cavitation problem. (beneficial population: future 45,500).</li> <li>• Improvement of water purification plant in Chiquinquirá. (beneficial population: future 45,500)</li> </ul>
<b>2. Sewerage Treatment Project</b>	
1) Sewerage	<ul style="list-style-type: none"> <li>• Construction of 14 sewerage treatment plants in 13 municipalities.</li> <li>• Improvement of slaughterhouse and factory wastewater treatment.</li> </ul>
<b>3. Aquatic Plant Control Project</b>	
1) Dredging of the Lake	<ul style="list-style-type: none"> <li>• Dredging of lakebed in front zone of Bulrush to avoid further invading of emergent plants into Fuquene Lake.</li> </ul>
2) Harvesting/Removal and Composting of Aquatic Plants	<ul style="list-style-type: none"> <li>• Harvesting of Brazilian Elodea by harvesting machine and removal of Water Hyacinth by trawling in Fuquene Lake.</li> <li>• Composting of harvested and removed aquatic plants.</li> <li>• Marketing of compost in the metropolitan area of Bogota.</li> </ul>
3) Aquatic Plant Control by Grass Carp	<ul style="list-style-type: none"> <li>• Aquatic plant removal by grass carp in Fuquene Lake.</li> </ul>
<b>4. Monitoring System</b>	
1) Meteorological and Hydrological Monitoring	<ul style="list-style-type: none"> <li>• Data collection and inspection of stations, etc.</li> <li>• Installment of one (1) new gauging station.</li> </ul>
2) Water Quality	<ul style="list-style-type: none"> <li>• Execution of water quality monitoring.</li> <li>• Improvement of periodical observation.</li> <li>• Improvement of laboratory.</li> </ul>
3) Aquatic Plant Control of the Lake	<ul style="list-style-type: none"> <li>• Survey of aquatic plant area.</li> <li>• Survey of fauna and flora species.</li> <li>• Survey of Bulrush frontline and bed level in the dredged lake zone.</li> <li>• Measurement of growth and consumption rates of grass carp.</li> </ul>
4) Geographic Information System (GIS)	<ul style="list-style-type: none"> <li>• Display of spatial data and link with attribute tables.</li> <li>• Analysis of spatial data.</li> <li>• Prediction of irrigation water requirement.</li> <li>• Slope stability.</li> <li>• Extracting Fuquene Lake information from aerial photo.</li> </ul>

### **3.1.3 Legislative and Regulatory Situation**

Law 99 was enacted in 1993, by which law the Ministry of Environment was created and the SINA (National Environmental System) as environmental management network was organized. Environmental license system was established in Decree 1753 in 1994. CAR manages environment of Fuquene Lake and its basin in accordance with these regulations.

Before implementation of a development project, a project entity should make an application for examination of necessity of obtaining the environmental license for the project to CAR. If CAR judges that investigation is necessary for assessing environmental impacts of this project, CAR notifies the entity of executing the investigation. At this time, CAR prepares the terms of reference of the investigation. Based on the comprehensive appraisal of this investigation by CAR, permission to issue the environmental license to the project entity is concluded by CAR.

Referring to the regulations aforementioned, the following projects should obtain the environmental license:

- Mining development,
- Flower cultivation,
- Construction of power station,
- Poultry farming,
- Pig farming,
- Pasturage, etc.

There is no necessity to obtain the environmental license when CAR implements environmental management projects. Referring to the objectives of the Master Plan, therefore, the environmental impact assessment is not legal duty for the projects of the Master Plan.

## **3.2 Environmental Status**

Existing status of various components of the environment of the Study Area is discussed below.

### **3.2.1 Physical Environment**

The basin of Lake Fuquene (Study Area: 1,752 km<sup>2</sup>) locates on the Cordillera Oriental of the Andes mountain chain, and in the center of the Study Area, Lake Fuquene exists with a surface area of 3,000 ha. The water level of the Lake is around 2,539 m (m.s.n.m). The climate in the Study Area is moderate and stable showing little seasonal change. The monthly mean temperature varies with a range of 12.0 – 13.2 °C (Ubate) and 12.4 – 13.5 °C (Chiquinquirá). The average annual rainfall increases from south to north, 700 mm in Ubate and 1,500 mm in Cucunuba. The Study Area is characterized by two (2) dry seasons (December to February and June to August) and two (2) rainy seasons (March to May and September to November).

Gentle slope forest was cleaned off for agricultural cultivation and procurement of wood logs for coal mining in the Study Area. Pine, Eucalyptus and Acacia trees have been planted in the reforestation areas. Especially, Paramos and Fuquene Lake swamp are important for their ecosystems in the Study Area. The nature and crucial subjects of the physical environment are, as follows:

(a) Erosion/Sediments

In 1982, CAR commenced Checua Project I aiming to control the soil erosion in the upstream of Checua River (tributary of Bogota River). This project was extended to the Study Area covering 43,200 ha in 1989. Checua Project II started covering 125,000 ha in the Study Area in 1995 and it will complete in 2004. Checua Project II covers all the critical soil erosion areas in the Study Area. Therefore, the soil erosion problem will be controlled by 2004 resulting in a significant reduction of the sediment flow into Fuquene Lake.

(b) Surface Water Level of Fuquene Lake

Historical Change of Water Level

During 33 years, 1966–1998, the water level of Fuquene Lake was 2,538.97 m in average and varied within a range of 71 cm. During 33 years, the annual maximum water levels have lowered while the minimum levels risen gradually. However, the annual average water levels have not changed with constant tendency.

Drainage Problems

Small dikes are constructed along the perimeter of the Lake in order to protect the low-lying areas from over-bank floods. However, wide depressed areas are inundated by piping effects of the lake water when the water levels are higher than 2,539.75 m.

(c) Surface Water Quality

Fuquene Lake

Fuquene Lake is highly eutrophic judging from T-N and T-P. However, the existing Phytoplankton in the Lake is small in number throughout the year and they count 32 species with an average population density of 5,408 cells/ml. The average concentration of Chlorophyll-a is as low as 0.92 mg/m<sup>3</sup>. These low values may be attributable to the low water temperature which is around 17 °C throughout the year.

Decomposition of the withered aquatic plants and detritus consume oxygen in the lake water resulting in making the water anaerobic. At present, wide area is under anaerobic in the Lake, in which area the water colors black emitting toxic substance of H<sub>2</sub>S, especially under the floating Water Hyacinth islands.

Rivers

All urban domestic and most of slaughterhouse/factory pollution loads discharge into rivers through 14 sewerage systems in the Study Area. Out of these 14 sewerage systems, however, only five (5) systems (Ubate, Cucunuba, Lenquazaque, S.M. de Sema and Saboya) have treatment plants. Especially, the wastewater from the sewerage systems of Ubate and Chiquinquira much affects the downstream water quality in drought periods.

### 3.2.2 Socio-Cultural Environment

The Study Area comprises 17 municipalities which belong to Cundinamarca and Boyaca prefectures. Out of 17 municipalities, 14 urban centers locate in the Study Area. The population of the Study Area is 181,000 (urban 76,000, rural 105,000) persons (1998). About 10 % and 90 % of the populations fall under agricultural sector in the urban and rural areas, respectively. The major industries are agriculture, livestock farming, milk production, cattle slaughtering and coal mining. Pastures, maize, potato, beans, etc. are cultivated on flat lands as well as mountain/hill areas. Generally speaking, farming size on flat lands is large and on mountain/hill areas is small. Property along lakefront (30 m width) is government-owned legally. However, there are unlawful landholders in the reclaimed lakefront of Fuquene. Women share work with men in milking cows. Otherwise, they carry out household jobs. The nature and crucial subjects of the socio-cultural environment are, as follows:

(a) Irrigation System

At present, CAR grants water rights to water users and collects water charges. Based on the results of questionnaire survey (Appendix I), water users pay annually for water 125,734 Col\$ (US\$ 65) in average per one ha of irrigated area, and the median value is 78,431 Col\$ (US\$ 41). Besides, the maximum amount the users are willing to pay for this service is 71,195 Col\$ (US\$ 37) in average per one ha of irrigated area. The median for this value is 29,412 Col\$ (US\$ 15). This users' mind can be explained with that about 30 % of the respondents answered they had problems with other users due to the limitations of the water in dry season.

(b) Public Health

Public Health

Public health services are provided through health offices, hospitals and health centers managed by the Ministry of Public Health. Major diseases affecting the population are respiratory infections, water borne diseases, lung diseases, skin infections, arterial hypertension, etc.

Treated Water Quality in Chiquinquirá

The treated water quality in Chiquinquirá does not satisfy the national standard of portable water in turbidity, pH and iron. There is no evidence of diseases accrue from this water quality.

(c) Archaeology and Historical Treasures

The notable historic sites and cultural heritages in the Area are cathedrals, especially one in Chiquinquirá.

### 3.2.3 Biological Environment

In the Study Area, there are four (4) reserved areas (5,338 ha in total) and one (1) under processing reserved area (23,573 ha). The said four (4) reserved areas consist of three (3) Protective Forest Zones (4,938 ha in total) and one (1) Integrated Management District (400 ha). These reservations aim at conservation of Paramos which function as important stream source areas and are valuable ecosystems from the viewpoint of biodiversity.

The surrounding area of Fuquene Lake is nationally recognized wetland. However, Colombia is not a member nation of Ramsar Convention (Convention on Wetlands of International Importance Especially as Waterfowl Habitat). The nature and crucial subjects of the biological environment are, as follows:

(a) Potentially Endangered Species

Colombia is a member nation of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). In the Study Area, the following species are identified as potentially endangered ones through consulting with CITES-listed species:

Scientific Name	General Name	Appendix	Remarks
<b>FAUNA</b>			Confirmed by 1979 study and by the Study Team at mountain/hill areas.
<i>(Mammalia. Carnivora. Canidae)</i>			
Duscicyon culpaeus	Culpaeo	CITES• II	
<b>FLORA</b>			Confirmed by the Study Team along roads and surrounding areas of the Lake.
<i>(Cactaceae)</i>			
Cactaceae spp.	Cactus	CITES• II	
<i>(Orchidaceae)</i>			
Orchidaceae spp.	Orchids	CITES• II	

(b) Aquatic Plants in Fuquene Lake

Species

Species of the existing major aquatic plants are Burlush, Water Hyacinth and Elodea. Burlush grows in the shallow littoral zone of the Lake, Water Hyacinth grows floating in the shallower water area and Elodea propagates being submerged under the water.

Excessive Growth of Aquatic Plants

The Lake has suffered from excessive growth of these aquatic plants in the recent years. The water mirror area has decreased from 3,100 ha in 1940 to 1,400 ha in 1999 due to expansion of Burlush and Water Hyacinth. Elodea grows under the water mirror area shallower than 4.0 m occupying 90 % of the total water mirror area.

Elodea is an exotic species and it appeared in mid of 1980's. The densely growing Elodea facilitates the expansion of Burlush and Water Hyacinth. The expansion of Burlush and Water Hyacinth has accelerated after emergence of Elodea and its expansion speed in the recent 10 years is estimated at 50 ha per year. It is expected that about 90 % of the Lake might be covered by aquatic plants (Burlush and Water Hyacinth) in 2020 without any control measures.

(c) Problems Caused by Excessive Aquatic Plants in Fuquene Lake

Reduction of Storage Capacity of the Lake

Reduction of the storage capacity is estimated at 740,100 m<sup>3</sup> and 981,100 m<sup>3</sup> in 1999 and 2020, respectively. These values equivalent to 1.5 % and 2.0 % of the storage capacity (50 million m<sup>3</sup> with W.L. 2,539 m).

Deterioration of Lake Water Quality

Excessive growth of aquatic plants makes the lake water anaerobic, and the entire lake deposits are under an anaerobic condition allowing no lives in the deposits. The water quality will worsen in the future in accordance with aquatic plant growing. This will cause fatal damages not only on the aquatic lives but also on the water uses in the surrounding areas.

Blocking of Water Flow

The excessive aquatic plants block the outlet of the Lake and those in the Suarez River also block its river flow. This blocking results in flood damages around the Lake and damages on the water use of the River.

### **3.3 Potential Environmental Impact and Mitigatory Measures**

Potential environmental impacts of the proposed projects, both positive and negative are discussed in the succeeding sections alongwith recommended mitigatory measures where necessary.

#### **3.3.1 Impacts on Physical Environment**

(a) Hydrology/Hydraulics of Fuquene Lake

Water Level

The drainage component will decrease the high water levels of the Lake, and result in the reduction of inundation area of 170 ha around the Lake.

Outlet Water Flow

The aquatic plant control project will improve the discharge capacity of the Lake outlet, and result in the reduction of flood damages around the Lake and damages on the water use of the Suarez River.

Storage Capacity

The aquatic plant control project will save 590,000 m<sup>3</sup> of the storage capacity of the Lake due to the reduction of aquatic plant biomass.

(b) Surface Water Quality

Fuquene Lake

The proposed sewerage treatment will improve the water quality of the Lake, from 33 mg/l to 32 mg/l in COD, from 2.0 mg/l to 1.8 mg/l in T-N, and from 0.09 mg/l to 0.07 mg/l in T-P. This water quality improvement will result in the alleviation of damages on the aquatic lives and water uses in the surrounding

areas.

The excessive aquatic plants of the Lake will make the lake water serious anaerobic, containing a toxic substances of H<sub>2</sub>S. This will cause fatal damages on the water uses and aquatic lives in the surrounding of the Lake. The proposed aquatic plant control project will settle these problems.

Fecal matters of grass carp, which will be adopted in the aquatic plant control project, are non-digestive and non-negligible in terms of volume aspect. Its impact on the water quality however will be negligible from the viewpoints of load balance in Fuquene Lake.

#### Rivers

All the sewerage in the Study Area will be treated to 40 mg/l in BOD with the sewerage component. With this treatment, the water quality of the Ubate River (Pte. Colorado) will be improved from 8 mg/l to 4 mg/l in BOD. Similarly, the water quality of the Suarez River (after effluent of Chiquinquirá sewerage) will be improved from 21 mg/l to 5 mg/l in BOD.

#### (c) Atmosphere

##### Dredging of the Lake Bed

The component of dredging of the Lake will generate about 480,000 m<sup>3</sup> of the lake bed materials. The dredged bed materials will be dumped on the neighboring pasture lands, especially on the low-lying lands which will be prone to habitual inundation.

The choice of the dredging method (e.g., pneumatic soil transportation dredging system) could minimize negative impacts on the water quality and atmosphere in and around the Lake. In addition to this, the land reclamation will release the lands from flood problems.

##### Composting of Aquatic Plants

Based on the compost experiment, the composting of aquatic plants will be free of dust, noise and odors.

##### Construction Phase

No doubt during construction the site areas will be subject to atmospheric pollution due to dust, noise and odors. Nevertheless, it would be a temporary phase and its effects will disappear when the project execution is completed.

### **3.3.2 Socio-Cultural Impacts**

#### (a) Agriculture

The irrigation and drainage components will improve the irrigation and drainage conditions of about 7,140 ha in the Study Area, and result in additional production of about 73,300 liter/day of milk. The additional milk production will value at about 4,000 million Pesos (US\$ 2.1 million) per year, as of October 1999. Production of additional milk will increase agro-industry activities in the Study Area.



(b) Socio-Economy

Increase in agricultural production, rise in income and local employment prospects will have beneficial impact on the living standards for most of the people in the project area relating to the irrigation and drainage components. Land ownership patterns are not expected to undergo any minor change and the relationship between the land lords and share-croppers is likely to remain the same.

(c) Public Health

The improvement of pumping station in municipal water supply component will secure the stable municipal water supply for Chiquinquirá.

The treated water quality of Chiquinquirá will fulfill the national standard of portable water after the improvement of purification plant in municipal water supply component. This will improve the living amenity of Chiquinquirá.

(d) Sludge Disposal

The proposed treatment systems of wastewater are stabilization pond and aerated lagoon. The generated sludge from the treatment will be dried by solar evaporation once in about 2 years, and this dried sludge will be utilized in farming. Odors of the treatment facilities will not worsen the living environment of the Study Area because their locations will be with distances from residential areas.

(e) Resettlement

There will be no resettlement due to the projects.

(f) Water Rights

At present, the water charges in the Study Area are determined based on the conditions of underground water table, area, distance from canal and so on, and not on the volumes of consumed water. The water rights will be granted to new water users following this water charge system. The proposed optimum operation of Hato dam/Lake and proposed additional irrigation facilities will increase available water use per hectare in the future. Therefore, no adverse impacts will be given on the existing water users.

(g) Composting

The composting of the harvested and removed aquatic plants and marketing of this compost will save the cost for aquatic plant control of CAR. This cost saving will enhance the environmental management of CAR financially. Moreover, the aquatic plant control of the Lake will be difficult without the composting. This is because there will be no disposal sites for dumping gigantic volume of the harvested and removed aquatic plants.

### 3.3.3 Impacts on Biological Resources

(a) Potentially Endangered Species

As all the project sites will be on agricultural lands or in the Lake area, no impact is expected in this sphere.

(b) Aquatic Plant Control of Fuquene Lake

Aquatic Ecosystem

The aquatic plant control project will completely eliminate Water Hyacinth, whose existence was recorded in 1979 firstly. This project will also diminish the biomass of Elodea to 20 % of the existing one. The existence of Elodea was recorded in 1986 at first. On the other hand, the current high speed expansion of Burlush toward the lake center will be controlled by the dredging of the lake bed. Thus, the current excessive aquatic plants of the Lake will be cleared off to a desirable level.

There are no lives in the deposits because the entire lake deposits are under an anaerobic condition. Only worms and leeches are found in the roots of Water Hyacinth.

In addition, there are only four (4) species of fish of which exotic species are a kind of carp and gold fish. The proposed aquatic plant control will not damage on their habitat.

Therefore, there will be no meaningful biological impacts with this project.

Grass Carp

Approximately 44,000 fingerlings of sterile triploid grass carp will be released in the Lake. An electrical fish barrier will be constructed at the upper portion of the Suarez River to block the grass carps swimming downward from the Lake. The careful selection of sterile triploid grass carps and construction of electrical fish barrier could prevent ecosystem change outside the Study Area due to grass carp escaping into the Magdalena River.

(c) Reserved Areas/Paramos

As the projects do not include any land reformation in the reserved areas/paramos, no change is expected in this sphere.

### 3.4 Conclusions of Environmental Impact Assessment

In the overall assessment, the projects' positive impacts outweigh the negative ones. The most important positive impact is to put on the break to the regression of Fuquene Lake. The existence of Fuquene Lake is irreplaceable natural gift to the Study Area as well as the nation. Fuquene Lake is the environmental endowment of the Study Area from the viewpoints of physical, socio-cultural and biological resources.

Other major positive impacts include increase in agricultural production, reduction of flood damages around the Lake, improvement/stabilization of municipal water supply for Chiquinquirá, improvement of surface water quality in the Lake and rivers, and betterment in

socio-economic conditions. The possible negative impacts may be avoidable by the recommended mitigatory measures.

## **REFERENCES**

- 1) Environmental Consideration Guidelines in Development Study, JICA, January 1994.
- 2) Laws of Colombia for Environmental Licenses:
  - Decree 1753, 1994,
  - Decree 2150, 1995,
  - Resolution 655, 1996,
  - Decree 883, 1997.

**Table K.1.1 (1/3) Flow of Construction Cost of  
Water Resources and Use Management Project**

(Unit: Million Colombian Pesos)

N.	Year	Construction Cost			Total
		Irrigation	Drainage	Municipal Water Supply	
1	2001	0	0	0	0
2	2002	1,832	0	54	1,886
3	2003	720	0	129	849
4	2004	1,227	0	153	1,380
5	2005	827	0	163	990
6	2006	825	0	149	974
7	2007	1,612	0	0	1,612
8	2008	1,650	0	0	1,650
9	2009	1,916	0	0	1,916
10	2010	1,894	0	0	1,894
11	2011	0	0	0	0
12	2012	0	0	0	0
13	2013	0	0	0	0
14	2014	0	0	0	0
15	2015	0	0	0	0
16	2016	0	0	0	0
17	2017	0	0	0	0
18	2018	0	0	0	0
19	2019	0	0	0	0
20	2020	0	0	0	0
21	2021	0	0	0	0
22	2022	0	0	0	0
23	2023	0	0	0	0
24	2024	0	0	0	0
25	2025	0	0	0	0
26	2026	0	0	0	0
27	2027	0	0	0	0
28	2028	0	0	0	0
29	2029	0	0	0	0
30	2030	0	0	0	0
<b>Total</b>		12,503	0	648	13,151

Note) 1US\$=1,920 Colombian Pesos as of October 1999.

**Table K.1.1 (2/3) Flow of O/M/R Costs of  
Water Resources and Use Management Project**

(Unit: Million Colombian Pesos)

N.	Year	O/M/R Costs			Total
		Irrigation	Drainage	Municipal Water Supply	
1	2001	0	0	0	0
2	2002	0	35	0	35
3	2003	0	35	0	35
4	2004	0	35	0	35
5	2005	86	35	0	121
6	2006	112	35	0	147
7	2007	147	35	0	182
8	2008	166	35	0	201
9	2009	230	35	0	265
10	2010	264	35	0	299
11	2011	314	35	0	349
12	2012	314	35	0	349
13	2013	314	35	0	349
14	2014	314	35	0	349
15	2015	314	35	0	349
16	2016	314	35	0	349
17	2017	314	35	0	349
18	2018	314	35	110	459
19	2019	314	35	0	349
20	2020	314	35	0	349
21	2021	314	35	0	349
22	2022	314	35	0	349
23	2023	398	35	0	433
24	2024	314	35	0	349
25	2025	314	35	0	349
26	2026	314	35	0	349
27	2027	314	35	0	349
28	2028	314	35	0	349
29	2029	314	35	0	349
30	2030	314	35	0	349
<b>Total</b>		<b>7,369</b>	<b>1,015</b>	<b>110</b>	<b>8,494</b>

Note) 1US\$=1,920 Colombian Pesos as of October 1999.

Table K.1.1 (3/3) Flow of Cost Benefit of Water Resources and Use Management Project

N.	Year	Total Cost	Irrigation										Drainage	Municipal Water Supply	Total Benefit	B-C			
			Sura.P	Suta.E	Cap-I.E	Lenguaza que	Cap-2.P	M/M-U	Honda.E	Susa.P	Susa.E	Simijaca.E					Old-S.P	Merchan.P	Merchan.E
1	2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2002	1,921	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54	92	-1,829
3	2003	884	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	129	-717
4	2004	1,415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	153	-1,224
5	2005	1,111	375	0	643	0	0	0	0	0	0	0	0	0	0	0	38	163	108
6	2006	1,121	375	89	643	0	428	0	0	0	0	0	0	0	0	0	38	149	601
7	2007	1,794	375	89	643	0	1,114	0	0	0	0	0	0	0	0	0	38	0	465
8	2008	1,851	375	89	643	0	1,114	0	0	0	0	0	0	0	0	0	38	0	642
9	2009	2,181	375	89	643	0	1,114	0	0	179	0	234	0	0	0	0	38	0	948
10	2010	2,193	375	89	643	0	1,114	11	0	179	239	234	0	0	0	0	38	0	1,186
11	2011	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,379
12	2012	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
13	2013	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
14	2014	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
15	2015	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
16	2016	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
17	2017	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
18	2018	459	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	110	4,112
19	2019	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
20	2020	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
21	2021	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
22	2022	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
23	2023	433	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
24	2024	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
25	2025	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
26	2026	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
27	2027	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
28	2028	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
29	2029	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
30	2030	349	375	89	643	427	1,114	11	196	179	239	234	73	102	282	0	38	0	3,653
Total		21,645	9,750	2,225	16,718	8,540	27,164	231	3,920	3,938	5,019	5,382	1,606	2,244	6,204	92,941	758	0	94,804

1 US\$= 1,920 Colombian Pesos as of October 1999.

EIRR =	25.98%	Discount rate (%)	B/C	PV		NPV
				Cost	Benefit	
		25.98	1.0	4,118	4,117	0
		15.00	1.6	6,874	11,229	4,356
		10.00	2.2	9,270	20,169	10,899

**Table K.1.2 Flow of Cost Benefit of Sewerage Treatment Project**

(Unit: Million Colombian Pesos)

N.	Year	Construction Cost	O&M/R Cost	Total Cost	Total Benefit	B-C
1	2001	527	0	527	0	-527
2	2002	575	0	575	0	-575
3	2003	575	0	575	0	-575
4	2004	596	92	687	0	-687
5	2005	690	92	781	0	-781
6	2006	533	142	675	0	-675
7	2007	829	142	971	0	-971
8	2008	685	212	897	0	-897
9	2009	769	263	1,031	0	-1,031
10	2010	503	403	906	0	-906
11	2011	0	538	538	2	-536
12	2012	0	538	538	2	-536
13	2013	0	538	538	2	-536
14	2014	0	538	538	2	-536
15	2015	0	538	538	2	-536
16	2016	0	538	538	2	-536
17	2017	0	538	538	2	-536
18	2018	0	720	720	2	-718
19	2019	0	538	538	2	-536
20	2020	0	1,123	1,123	2	-1,121
21	2021	0	538	538	2	-536
22	2022	0	805	805	2	-803
23	2023	0	616	616	2	-614
24	2024	0	578	578	2	-577
25	2025	0	538	538	2	-536
26	2026	0	538	538	2	-536
27	2027	0	538	538	2	-536
28	2028	0	538	538	2	-536
29	2029	0	538	538	2	-536
30	2030	0	538	538	2	-536
Total		6,282	13,249	19,531	34	-19,497

Note) 1US\$= 1,920 Colombian Pesos as of October 1999.



Table K.1.3 Flow of Cost Benefit of Aquatic Plant Control Project

(Unit: Million Colombian Pesos)

N.	Year	Construction Cost			Total(1)	O&M/R Costs			Total (2)	Total Cost (1) + (2)			Benefits			Total Benefits	B-C
		Comp.1	Comp.2	Comp.3		Comp.1	Comp.2	Comp.3		Comp.1	Comp.2	Comp.3	Comp.1	Comp.2	Comp.3		
1	2001	0	1,162	0	1,162	0	95	0	95	1,256	0	171	0	171	-1,086		
2	2002	348	0	0	348	0	189	0	189	537	0	171	0	171	-366		
3	2003	0	1,706	0	1,706	0	189	23	212	1,918	1	171	0	172	-1,746		
4	2004	0	8,506	0	8,506	0	95	45	140	8,646	1	171	0	172	-8,474		
5	2005	0	0	0	0	0	909	45	954	954	1	2,125	0	2,127	1,173		
6	2006	1,161	0	0	1,161	0	909	45	954	2,115	1	2,287	0	2,288	173		
7	2007	3,194	0	0	3,194	0	909	45	954	4,148	7	2,448	0	2,454	-1,693		
8	2008	3,194	0	0	3,194	0	2,277	45	2,322	5,516	18	2,609	0	2,627	-2,889		
9	2009	3,194	0	0	3,194	0	909	45	954	4,148	29	2,770	0	2,799	-1,349		
10	2010	3,194	0	0	3,194	0	926	45	971	4,165	40	2,931	0	2,971	-1,194		
11	2011	0	0	0	0	0	909	45	954	954	45	3,018	0	3,063	2,109		
12	2012	0	0	0	0	0	909	45	954	954	45	3,104	0	3,149	2,195		
13	2013	0	0	0	0	0	909	45	954	954	45	3,190	0	3,235	2,281		
14	2014	0	0	0	0	0	909	45	954	954	45	3,276	0	3,321	2,368		
15	2015	0	0	0	0	0	909	45	954	954	45	3,363	0	3,408	2,454		
16	2016	0	0	0	0	0	909	45	954	954	45	3,449	0	3,494	2,540		
17	2017	0	0	0	0	0	0	45	45	45	45	1,485	0	1,530	1,485		
18	2018	0	0	0	0	0	0	45	45	45	45	1,485	0	1,530	1,485		
19	2019	0	0	0	0	0	0	45	45	45	45	1,590	0	1,635	1,590		
20	2020	0	0	0	0	0	0	45	45	45	45	1,485	0	1,530	1,485		
21	2021	0	0	0	0	0	0	45	45	45	45	1,485	0	1,530	1,485		
22	2022	0	0	0	0	0	0	45	45	45	45	1,485	0	1,530	1,485		
23	2023	0	0	0	0	0	0	45	45	45	45	1,485	0	1,530	1,485		
24	2024	0	0	0	0	0	0	45	45	45	45	1,485	0	1,530	1,485		
25	2025	0	0	0	0	0	0	45	45	45	45	1,485	0	1,530	1,485		
26	2026	0	0	0	0	0	0	45	45	45	45	1,485	0	1,530	1,485		
27	2027	0	0	0	0	0	0	45	45	45	45	1,485	0	1,530	1,485		
28	2028	0	0	0	0	0	0	45	45	45	45	1,485	0	1,530	1,485		
29	2029	0	0	0	0	0	0	45	45	45	45	1,485	0	1,530	1,485		
30	2030	0	0	0	0	0	0	45	45	45	45	1,485	0	1,530	1,485		
Total		14,286	9,668	1,706	25,660	0	12,856	1,238	14,094	39,754	997	56,144	0	57,141	17,387		

(Note)

Comp.1= Dredging of the Lake Bed

Comp.2=Harvesting /Removal and Composting of Aquatic

Comp.3= Aquatic Plants Control by Grass Carp

1 US\$= 1,920 Colombian Pesos as of October 1999.

B/C	PV		Discount rate(%)	EIRR = 5.25%
	Cost	Benefit		
0.6	15,582	9,823	15.00	
0.7	18,274	12,990	12.00	
0.8	20,458	15,905	10.00	
1.0	27,411	27,407	5.25	
1.2	31,922	36,822	3.00	

**Table K.1.4 Flow of Cost Benefit of Master Plan Projects**

(Unit: Million Colombian Pesos)

N.	Year	Construction Cost			O&M/R Costs			Total Cost (1) + (2)	Benefits			Total Benefits	B-C	
		Comp.1	Comp.2	Comp.3	Comp.1	Comp.2	Comp.3		Comp.1	Comp.2	Comp.3			
1	2001	0	527	1,162	0	0	95	1,783	0	0	171	171	-1,612	
2	2002	1,886	575	348	35	0	189	3,033	92	0	171	263	-2,770	
3	2003	849	575	1,706	35	0	212	3,377	167	0	172	339	-3,038	
4	2004	1,380	596	8,506	35	92	140	10,748	266	191	172	363	-10,385	
5	2005	990	690	0	121	92	954	2,846	1,166	1,219	0	2,127	3,346	499
6	2006	974	533	1,161	147	142	954	3,911	1,242	1,722	0	2,288	4,010	99
7	2007	1,612	829	3,194	182	142	954	6,912	1,277	2,259	0	2,454	4,714	-2,199
8	2008	1,650	685	3,194	201	212	2,322	8,264	2,734	2,493	0	2,627	5,120	-3,144
9	2009	1,916	769	3,194	265	263	954	7,360	1,481	3,129	0	2,799	5,928	-1,432
10	2010	1,894	503	3,194	299	403	971	7,264	1,673	3,379	0	2,971	6,350	-914
11	2011	0	0	0	349	538	954	1,840	1,840	4,002	2	3,063	7,066	5,226
12	2012	0	0	0	349	538	954	1,840	1,840	4,002	2	3,149	7,153	5,312
13	2013	0	0	0	349	538	954	1,840	1,840	4,002	2	3,235	7,239	5,399
14	2014	0	0	0	349	538	954	1,840	1,840	4,002	2	3,321	7,325	5,485
15	2015	0	0	0	349	538	954	1,840	1,840	4,002	2	3,408	7,411	5,571
16	2016	0	0	0	349	538	954	1,840	1,840	4,002	2	3,494	7,498	5,657
17	2017	0	0	0	349	538	45	932	932	4,002	2	1,530	5,534	4,602
18	2018	0	0	0	459	720	45	1,224	1,224	4,112	2	1,530	5,644	4,420
19	2019	0	0	0	349	538	45	932	932	4,002	2	1,530	5,534	4,602
20	2020	0	0	0	349	1,123	45	1,517	1,517	4,002	2	1,635	5,639	4,122
21	2021	0	0	0	349	538	45	932	932	4,002	2	1,530	5,534	4,602
22	2022	0	0	0	349	805	45	1,199	1,199	4,002	2	1,530	5,534	4,335
23	2023	0	0	0	433	616	45	1,094	1,094	4,002	2	1,530	5,534	4,440
24	2024	0	0	0	349	578	45	972	972	4,002	2	1,530	5,534	4,561
25	2025	0	0	0	349	538	45	932	932	4,002	2	1,530	5,534	4,602
26	2026	0	0	0	349	538	45	932	932	4,002	2	1,530	5,534	4,602
27	2027	0	0	0	349	538	45	932	932	4,002	2	1,530	5,534	4,602
28	2028	0	0	0	349	538	45	932	932	4,002	2	1,530	5,534	4,602
29	2029	0	0	0	349	538	45	932	932	4,002	2	1,530	5,534	4,602
30	2030	0	0	0	349	538	45	932	932	4,002	2	1,530	5,534	4,602
Total		13,151	6,282	25,660	45,093	8,494	14,094	35,837	80,930	94,804	34	57,141	151,979	71,049

(Note)

Comp. 1= Water Resources and Use Management Project

Comp. 2= Sewerage Development Project

Comp. 3= Aquatic Plants Control Project

1US\$= 1,920 Colombian Pesos as of October 1999.

PV		B/C	NPV
Cost	Benefit		
26,874	21,055	0.8	-5,819
36,083	36,080	1.0	-3
51,524	68,972	1.3	17,447

**Table K.2.1 (1/2) Financial Analysis under Existing Irrigation Water Charge**

(Unit: Million Colombian Pesos)

N.	Year	Construction Cost	O&M/R Cost	Total Cost	Revenue	Balance
1	2001	0	1,017	1,017	827	-189
2	2002	2,035	1,017	3,052	851	-2,200
3	2003	877	1,017	1,894	876	-1,018
4	2004	1,496	1,017	2,513	901	-1,611
5	2005	1,007	1,053	2,060	961	-1,099
6	2006	1,005	1,083	2,088	1,016	-1,071
7	2007	1,967	1,122	3,089	1,084	-2,005
8	2008	2,013	1,143	3,156	1,136	-2,020
9	2009	2,338	1,159	3,497	1,185	-2,312
10	2010	2,311	1,180	3,491	1,242	-2,249
11	2011	0	1,242	1,242	1,345	103
12	2012	0	1,242	1,242	1,345	103
13	2013	0	1,242	1,242	1,345	103
14	2014	0	1,242	1,242	1,345	103
15	2015	0	1,242	1,242	1,345	103
16	2016	0	1,242	1,242	1,345	103
17	2017	0	1,242	1,242	1,345	103
18	2018	0	1,242	1,242	1,345	103
19	2019	0	1,242	1,242	1,345	103
20	2020	0	1,242	1,242	1,345	103
21	2021	0	1,242	1,242	1,345	103
22	2022	0	1,242	1,242	1,345	103
23	2023	0	1,336	1,336	1,345	9
24	2024	0	1,242	1,242	1,345	103
25	2025	0	1,242	1,242	1,345	103
26	2026	0	1,242	1,242	1,345	103
27	2027	0	1,242	1,242	1,345	103
28	2028	0	1,242	1,242	1,345	103
29	2029	0	1,242	1,242	1,345	103
30	2030	0	1,242	1,242	1,345	103
<b>Total</b>		<b>15,049</b>	<b>35,749</b>	<b>50,798</b>	<b>36,990</b>	<b>-13,809</b>

1US\$=1,920 Colombian Pesos as of October 1999.

**Table K.2.1 (2/2) Financial Analysis under Proposed Irrigation Water Charge**  
(Unit: Million Colombian Pesos)

N.	Year	Construction Cost	O&M/R Cost	Total Cost	Revenue	Balance
1	2001	0	1,017	1,017	914	-103
2	2002	204	1,017	1,221	940	-280
3	2003	88	1,017	1,105	968	-137
4	2004	150	1,017	1,167	996	-171
5	2005	101	1,053	1,154	1,061	-92
6	2006	101	1,083	1,184	1,123	-61
7	2007	197	1,122	1,319	1,197	-122
8	2008	201	1,143	1,344	1,254	-90
9	2009	234	1,159	1,393	1,309	-84
10	2010	231	1,180	1,411	1,372	-40
11	2011	0	1,242	1,242	1,486	244
12	2012	0	1,242	1,242	1,486	244
13	2013	0	1,242	1,242	1,486	244
14	2014	0	1,242	1,242	1,486	244
15	2015	0	1,242	1,242	1,486	244
16	2016	0	1,242	1,242	1,486	244
17	2017	0	1,242	1,242	1,486	244
18	2018	0	1,242	1,242	1,486	244
19	2019	0	1,242	1,242	1,486	244
20	2020	0	1,242	1,242	1,486	244
21	2021	0	1,242	1,242	1,486	244
22	2022	0	1,242	1,242	1,486	244
23	2023	0	1,336	1,336	1,486	150
24	2024	0	1,242	1,242	1,486	244
25	2025	0	1,242	1,242	1,486	244
26	2026	0	1,242	1,242	1,486	244
27	2027	0	1,242	1,242	1,486	244
28	2028	0	1,242	1,242	1,486	244
29	2029	0	1,242	1,242	1,486	244
30	2030	0	1,242	1,242	1,486	244
<b>Total</b>		<b>1,505</b>	<b>35,742</b>	<b>37,247</b>	<b>40,856</b>	<b>3,609</b>

Note) 1US\$=1,920 Colombian Pesos as of October 1999.

FIRR= 10.0%

Proposed Irrigation Water Charge = 43,670 Peso/ha/y for the year 2000.

Discount rate(%)	R/C	PV		NPV
		Cost	Revenue	
15.00	0.96	7,891	7,595	-296
10.00	1.00	11,470	11,469	-1
5.00	1.05	18,921	19,803	882

**Table K.2.2 (1/2) Financial Analysis under Existing Sewerage Treatment Charge**

(Unit: Million Colombian Pesos)

N.	Year	Construction Cost	O&M/R Cost	Total Cost	Revenue	Balance
1	2001	614	234	848	232	-616
2	2002	697	234	931	244	-687
3	2003	697	234	931	256	-675
4	2004	722	335	1,057	269	-789
5	2005	835	335	1,171	282	-888
6	2006	637	391	1,028	297	-731
7	2007	1,000	391	1,391	312	-1,079
8	2008	824	469	1,293	328	-965
9	2009	925	525	1,450	344	-1,106
10	2010	610	681	1,291	362	-929
11	2011	0	831	831	380	-451
12	2012	0	831	831	380	-451
13	2013	0	831	831	380	-451
14	2014	0	831	831	380	-451
15	2015	0	831	831	380	-451
16	2016	0	831	831	380	-451
17	2017	0	831	831	380	-451
18	2018	0	1,033	1,033	380	-653
19	2019	0	831	831	380	-451
20	2020	0	1,481	1,481	380	-1,101
21	2021	0	831	831	380	-451
22	2022	0	1,128	1,128	380	-748
23	2023	0	918	918	380	-538
24	2024	0	876	876	380	-496
25	2025	0	831	831	380	-451
26	2026	0	831	831	380	-451
27	2027	0	831	831	380	-451
28	2028	0	831	831	380	-451
29	2029	0	831	831	380	-451
30	2030	0	831	831	380	-451
Total		7,561	21,729	29,291	10,522	-18,768

Note: Existing sewerage treatment charge is 0.12 % of the family income (700,000 Peso/month/household).

1US\$=1,920 Colombian Pesos as of October 1999.

**Table K.2.2 (2/2) Financial Analysis under Proposed Sewerage Treatment Charge**

(Unit: Million Colombian Pesos)

N.	Year	Construction Cost	O&M/R Cost	Total Cost	Revenue	Balance
1	2001	614	234	848	507	-340
2	2002	697	234	931	533	-398
3	2003	697	234	931	560	-371
4	2004	722	335	1,057	588	-469
5	2005	835	335	1,171	618	-553
6	2006	637	391	1,028	649	-379
7	2007	1,000	391	1,391	682	-709
8	2008	824	469	1,293	716	-577
9	2009	925	525	1,450	753	-698
10	2010	610	681	1,291	791	-500
11	2011	0	831	831	831	0
12	2012	0	831	831	831	0
13	2013	0	831	831	831	0
14	2014	0	831	831	831	0
15	2015	0	831	831	831	0
16	2016	0	831	831	831	0
17	2017	0	831	831	831	0
18	2018	0	1,033	1,033	831	-202
19	2019	0	831	831	831	0
20	2020	0	1,481	1,481	831	-650
21	2021	0	831	831	831	0
22	2022	0	1,128	1,128	831	-297
23	2023	0	918	918	831	-87
24	2024	0	876	876	831	-45
25	2025	0	831	831	831	0
26	2026	0	831	831	831	0
27	2027	0	831	831	831	0
28	2028	0	831	831	831	0
29	2029	0	831	831	831	0
30	2030	0	831	831	831	0
Total		7,561	21,729	29,291	23,012	-6,278

Note: Proposed Sewerage Treatment Charge is 0.25 % of family income.

1 US\$=1,920 Colombian Pesos as of October 1999.

**Table K.2.3 (1/4) Flow of Cost Revenue of Compost Production**

(Unit: Million Colombian Pesos)

N.	Year	Construction Cost	O&M/R Cost	Total Cost	Revenue	Balance
1	2001	1,404	105	1,509	0	-1,509
2	2002	0	210	210	0	-210
3	2003	0	210	210	0	-210
4	2004	10,285	105	10,390	0	-10,390
5	2005	0	1,010	1,010	2,266	1,256
6	2006	0	1,010	1,010	2,332	1,322
7	2007	0	1,010	1,010	2,399	1,390
8	2008	0	2,530	2,530	2,469	-61
9	2009	0	1,010	1,010	2,541	1,531
10	2010	0	1,029	1,029	2,614	1,585
11	2011	0	1,010	1,010	2,690	1,680
12	2012	0	1,010	1,010	2,690	1,680
13	2013	0	1,010	1,010	2,690	1,680
14	2014	0	1,010	1,010	2,690	1,680
15	2015	0	1,010	1,010	2,690	1,680
16	2016	0	1,010	1,010	2,690	1,680
17	2017	0	0	0	0	0
18	2018	0	0	0	0	0
19	2019	0	0	0	0	0
20	2020	0	0	0	0	0
21	2021	0	0	0	0	0
22	2022	0	0	0	0	0
23	2023	0	0	0	0	0
24	2024	0	0	0	0	0
25	2025	0	0	0	0	0
26	2026	0	0	0	0	0
27	2027	0	0	0	0	0
28	2028	0	0	0	0	0
29	2029	0	0	0	0	0
30	2030	0	0	0	0	0
<b>Total</b>		<b>11,688</b>	<b>14,285</b>	<b>25,973</b>	<b>30,761</b>	<b>4,788</b>

Note) 1US\$=1,920 Colombian Pesos as of October 1999.

FIRR= 4.64%

Discount rate (%)	R/C	PV		NPV
		Cost	Revenue	
15.00	0.7	11,180	7,729	-3,451
12.00	0.8	12,861	9,868	-2,993
10.00	0.8	14,214	11,708	-2,506
4.64	1.0	19,167	19,167	0

**Table K.2.3 (2/4) Financial Analysis for Compost Production (Case-1)**

(Unit: Million Colombian Pesos)

N.	Year	Construction Cost	O&M/R Cost	Total Cost	Revenue	Balance
1	2001	0	0	0	0	0
2	2002	0	0	0	0	0
3	2003	0	0	0	0	0
4	2004	10,285	0	10,285	0	-10,285
5	2005	0	1,010	1,010	2,266	1,256
6	2006	0	1,010	1,010	2,332	1,322
7	2007	0	1,010	1,010	2,399	1,390
8	2008	0	2,530	2,530	2,469	-61
9	2009	0	1,010	1,010	2,541	1,531
10	2010	0	1,029	1,029	2,614	1,585
11	2011	0	1,010	1,010	2,690	1,680
12	2012	0	1,010	1,010	2,690	1,680
13	2013	0	1,010	1,010	2,690	1,680
14	2014	0	1,010	1,010	2,690	1,680
15	2015	0	1,010	1,010	2,690	1,680
16	2016	0	1,010	1,010	2,690	1,680
17	2017	0	0	0	0	0
18	2018	0	0	0	0	0
19	2019	0	0	0	0	0
20	2020	0	0	0	0	0
21	2021	0	0	0	0	0
22	2022	0	0	0	0	0
23	2023	0	0	0	0	0
24	2024	0	0	0	0	0
25	2025	0	0	0	0	0
26	2026	0	0	0	0	0
27	2027	0	0	0	0	0
28	2028	0	0	0	0	0
29	2029	0	0	0	0	0
30	2030	0	0	0	0	0
<b>Total</b>		<b>10,285</b>	<b>13,655</b>	<b>23,940</b>	<b>30,761</b>	<b>6,821</b>

Note) 1US\$=1,920 Colombian Pesos as of October 1999.

FIRR=

8.01%

Discount rate (%)	R/C	PV		NPV
		Cost	Revenue	
15.00	0.8	9,511	7,729	-1,782
8.01	1.0	13,973	13,973	0
5.00	1.1	16,864	18,516	1,653



**Table K.2.3 (3/4) Financial Analysis for Compost Production (Case-2)**

(Unit: Million Colombian Pesos)

N.	Year	Construction Cost	O&M/R Cost	Total Cost	Revenue	Balance
1	2001	0	0	0	0	0
2	2002	0	0	0	0	0
3	2003	0	0	0	0	0
4	2004	5,142	0	5,142	0	-5,142
5	2005	0	1,010	1,010	2,266	1,256
6	2006	0	1,010	1,010	2,332	1,322
7	2007	0	1,010	1,010	2,399	1,390
8	2008	0	2,530	2,530	2,469	-61
9	2009	0	1,010	1,010	2,541	1,531
10	2010	0	1,029	1,029	2,614	1,585
11	2011	0	1,010	1,010	2,690	1,680
12	2012	0	1,010	1,010	2,690	1,680
13	2013	0	1,010	1,010	2,690	1,680
14	2014	0	1,010	1,010	2,690	1,680
15	2015	0	1,010	1,010	2,690	1,680
16	2016	0	1,010	1,010	2,690	1,680
17	2017	0	0	0	0	0
18	2018	0	0	0	0	0
19	2019	0	0	0	0	0
20	2020	0	0	0	0	0
21	2021	0	0	0	0	0
22	2022	0	0	0	0	0
23	2023	0	0	0	0	0
24	2024	0	0	0	0	0
25	2025	0	0	0	0	0
26	2026	0	0	0	0	0
27	2027	0	0	0	0	0
28	2028	0	0	0	0	0
29	2029	0	0	0	0	0
30	2030	0	0	0	0	0
<b>Total</b>		<b>5,142</b>	<b>13,655</b>	<b>18,797</b>	<b>30,761</b>	<b>11,964</b>

Note) 1US\$=1,920 Colombian Pesos as of October 1999.

FIRR= 22.87%

Discount rate (%)	R/C	PV		NPV
		Cost	Revenue	
30.00	0.9	3,116	2,723	-393
22.87	1.0	4,325	4,325	0
20.00	1.1	4,998	5,295	297

**Table K.2.3 (4/4) Financial Analysis for Compost Production (Case-3)**

(Unit: Million Colombian Pesos)

N.	Year	Construction Cost	O&M/R Cost	Total Cost	Revenue	Balance
1	2001	0	0	0	0	0
2	2002	0	0	0	0	0
3	2003	0	0	0	0	0
4	2004	3,085	0	3,085	0	-3,085
5	2005	0	1,010	1,010	2,266	1,256
6	2006	0	1,010	1,010	2,332	1,322
7	2007	0	1,010	1,010	2,399	1,390
8	2008	0	2,530	2,530	2,469	-61
9	2009	0	1,010	1,010	2,541	1,531
10	2010	0	1,029	1,029	2,614	1,585
11	2011	0	1,010	1,010	2,690	1,680
12	2012	0	1,010	1,010	2,690	1,680
13	2013	0	1,010	1,010	2,690	1,680
14	2014	0	1,010	1,010	2,690	1,680
15	2015	0	1,010	1,010	2,690	1,680
16	2016	0	1,010	1,010	2,690	1,680
17	2017	0	0	0	0	0
18	2018	0	0	0	0	0
19	2019	0	0	0	0	0
20	2020	0	0	0	0	0
21	2021	0	0	0	0	0
22	2022	0	0	0	0	0
23	2023	0	0	0	0	0
24	2024	0	0	0	0	0
25	2025	0	0	0	0	0
26	2026	0	0	0	0	0
27	2027	0	0	0	0	0
28	2028	0	0	0	0	0
29	2029	0	0	0	0	0
30	2030	0	0	0	0	0
<b>Total</b>		<b>3,085</b>	<b>13,655</b>	<b>16,740</b>	<b>30,761</b>	<b>14,021</b>

Note) 1US\$=1,920 Colombian Pesos as of October 1999.

FIRR= 39.43%

Discount rate (%)	R/C	PV		NPV
		Cost	Revenue	
40	1.0	1,552	1,541	-11
39.43	1.0	1,588	1,588	0
30	1.1	2,396	2,723	328