CHAPTER 7. FEASIBILITY STUDY ON INSTITUTIONAL MEASURES

7.1 Provision of Laws and Regulations

7.1.1 General

As described in the study for the Master Plan, there are about 35 laws and regulations concerning the environmental aspects. These are concerned with mining, forestry, erosion and sedimentation, water quality, discharge of liquid effluent, territory ordination, urban ordination, piggery activities, environmental safeguards, management of solid residues, etc.

It seems that the current environmental problems are already covered by this legal framework. Nevertheless, there are some arrangements necessary to promote the environmental improvement of the Tuy river basin, especially those connected with the installation of treatment plants by factories and piggeries.

In this Feasibility Study, arrangements are made to have a more complete coverage of the regulations regarding such incentives as tax reduction, creation of an environmental fund, imposition of pollution charge, and elaboration of water classification and water quality standards for the Tuy river basin.

7.1.2 Fiscal Incentive

Background

From the review of previous and current laws and regulations, the current states of tax reduction were obtained as shown in Table 7.1-1.

Adoption of Fiscal Incentives

According to the interview survey, at present, there are no factories availing themselves of the fiscal incentives in the income tax law due to the uncertainty of applicability to the current environmental laws. To clarify applicability, official consultations with the National Integrated Service of Tributary Administration, SENIAT (*Servicio Nacional Integrado de Administración Tributaria*) was made, emphasizing on whether or not the term "sanitary regulations" contained in the current income tax law (Art. 27, Item 10) include the environmental regulations.

SENIAT has judged that "Article 27, Item No. 10 of the current income tax law establishes the deduction of expenses for taxpayers due to fulfillment of sanitary regulations, within which the environmental regulations also can be included" (see Supporting Report, Sector G). Therefore, the fiscal incentive corresponding to tax deduction has been created, opening its adoption from February 26, 1997 which is the date of the "Judgment" by SENIAT.

Screening for Tax Deduction

(1) Current Situation of Tax Evasion

According to the latest available information, tax evasion in Venezuela has been very high in previous years, probably due to the general financial situation of the country. As can be observed, fiscal evasion has decreased in recent years due to more strict measures undertaken by SENIAT to improve the tax collection.

Income Tax Evasion in Venezuela (1992-1996)

Year	Potential Collection (US$ Million)	Effective Collection (US$ Million)	Evasion Rate (%)
1992	566	118	79.20
1993	798	303	62.08
1994	1,190	329	72.32
1995*	1,739	598	65.61
1996**	2,521	886	64.85

* Estimated; ** Projected

(2) Current Policies on Tributary Collection

In general, there are some alternatives to increase tax collection: (1) Increase of tributary rates, (2) Creation of new taxes, (3) Increase of number of taxpayers, and (4) Improvement of tax collection methods. According to the experience of SENIAT, increasing tax rates or creating new taxes or new taxpayers produced a stronger resistance from current taxpayers, and did not encourage the evaders to pay. Consequently, the current policy on this matter is to improve the collection of taxes through the reduction of evasion rate, using modern programs of fiscal control.

(3) Adoption of Screening System

To avoid giving fiscal incentives (as well as soft loans through the Environmental Fund) to tax evaders, a special screening system of applicants should be undertaken by the authorities concerned. The screening of applicants could be performed by reciprocal communication between ACRT through the Environmental Fund Office with the SENIAT authorities.

7.1.3 Environmental Fund

In the Master Plan, the establishment of an environmental fund is proposed to support factory and piggery owners to install a treatment plant of their own. In this feasibility study, a more detailed discussion is made from the legal aspects. (Discussion from the economic aspect is made in Section 7.3.)

Background

Attempts to create an Environmental Fund have been made previously, as explained below.

In July 1993, the study named "Program of Technical and Financing Assistance for the Reduction and Control of Industrial Pollution" proposed the creation of an Environmental Fund for the financing of small and medium industries. The Fund would be dependent on the National Environmental Fund which was also proposed at that time to be created. It was proposed that the Fund would be composed of US$20 million to be provided from the World Bank.

Among several reasons why the proposed Fund could not be approved by the financing institution at that time (FAO-World Bank) were the following:

- According to the study the current regulation on standards of water quality (Decree 2,224 of April 23, 1992) established that the industries should adjust the quality of their liquid effluents to the limits of the current standards by April 27, 1994. It was considered that having still enough time (from July 1993 to April 1994) to see the actions of the industries to abide by the regulations, to create an environmental fund at that moment was too early.

- To give soft conditions of financing to environmental polluting industries was considered to be so much over-protective, taking into account that they are doing a bad activity, not to say a "criminal activity".

Scope of the Environmental Fund (EF)

The resources of the EF will be used to finance soft loans for wastewater treatment facilities of factories, sand quarries, and piggeries which do not have the financial capability to absorb the investment cost, or because of high priority given by the government due to their polluting effects.

The direct administration of the funds may be undertaken by established financial entities, like the Industrial Credit Fund, FONCREI (Fondo de Credito Industrial), which covers loans to small, medium and large industries, with experience in financing treatment plant installations at many industries (more than 20) of Valencia Lake basin. Alternatively, the Corporation for the Development of Small and Medium Industry, CORPOINDUSTRIA (Corporacion para el Desarrollo de la Pequeña y Mediana Industria), may also be considered. Both of them are government-owned institutions depending on the Ministry of Industry and Commerce and can afford to give financing in better conditions than the commercial banks.

The two institutions were established for financing the secondary industry. There is one more governmental institution, FCA (Fondo de Credito Agropecuario), whose objective is to finance the primary industry in more favorable terms than the commercial banks. This organization is considered appropriate to give financial assistance to piggeries.

Proposal of Law

The proposed law to create the Environmental Fund will contain the following:

(1) Purpose

The Environmental Fund will have as main purpose the financing of investments on environmental matters for factories and piggeries in the basin, in softer conditions as compared with the commercial banks, specially regarding the interest rates and periods. The factories and piggeries will be selected according to size, volume of pollution, etc.

(2) Constitution of Resources (*Patrimonio*)

The fund will be provided by the international financing institutions.

(3) Administration of the Environmental Fund

The Environmental Fund will have two proper functions: operation/appraisal and banking. To perform the respective functions the Environmental Fund Operation Unit and the Environmental Fund Banking Unit will be established in FONCREI or CORPOINDUSTRIA. In addition, to carry out technical support services, the existing Studies, Planning and Projects Section in the Tuy River Basin Agency will be reinforced/reorganized.

There will be a Coordination Forum comprised of representatives from the Tuy River Basin Agency, the Fund, factories and piggeries for technical assistance and education purposes. A Managing Committee will be established, which consist of MANR, CORDIPLAN, Tuy agencies and financing institutions. Also, an Audit Board will be established.

For more detail refer to Subsections 7.3.2 and 7.3.3.

Legal Procedure

The legal procedure for the creation of the Environmental Fund is as follows:

(1) Elaboration of proposal of Decree at the level of ACRT.

(2) Consultation with the different General Directions of MARNR, especially those of Environment Quality, Environmental Planning and Ordination, Environmental Education, Environmental Information, and Vigilance/Environmental Control.

(3) Revision by the Legal Bureau of MARNR.

(4) Revision by legal advisers of CAJAP (Commission of Legal Advising of the Public Administration). Approval by the General Attorney of the Republic.

(5) Approval by the Ministry of MARNR.

(6) Approval by the Council of Ministries and the President.

(7) Receipt by the Presidential Secretary.

(8) Publication of Decree in the Official Gazette.

7.1.4 Pollution Charge (PC)

In the context of law enforcement, a charge system (Pollution Charge) for the discharge of wastewater, its legal framework and application procedures is proposed to be established.

<u>Proposal of Pollution Charge</u>

(1) Necessity of Pollution Charge

With the current environmental regulations, it has not been possible to obtain a quick response from the industry and piggery owners. Therefore, compulsory measures are necessary to push them further to comply with the established water quality standards. To attain this goal, the pollution charge (PC) is considered.

(2) Application of Pollution Charge

The PC will be applied to all the polluters in the study area who do not abide by the environmental regulations. Payment will be made to ACRT which will designate revenues to its activities for environmental improvement.

(3) Setting of Pollution Charge

The pollution charge will be set in the following manner:

- Selection of main parameters producing most of the pollution, like BOD, SS, Cd, Hg, toxicants , etc. (Note: In Germany, the following parameters are used: SS, COD, Hg, Cd, Toxicity in fish. Source: Dr. Ing. Klaus Digel, March, 1995, "Control de los Efluentes Líquidos y Sistema de Financiamiento, Caso: Provincia de Hessen, Alemania. Proyecto Venezolano Alemán MARNR/GTZ, Saneamiento del Río Tuy.)
- Estimation of cost of decontamination of water per unit volume (for example, a cubic meter, or a liter), based on the selected parameters.
- The estimated cost to treat the wastewater will be charged against industries or piggeries according to the degree of pollution they have. This will be the pollution charge.
- The pollution charge may be increased periodically (e.g., every year) in some percentage (e.g., 100%), in a way to force more the polluters to abide by the regulations as soon as possible.

The technical estimation for treatment cost of wastewater regarding these taxes are presented in other concerned sections.

Regarding the legal procedure for the implementation of such taxes, it should be similar to that of the Environmental Fund, and is explained in the following.

Proposal of Law

The proposed law for the creation of Pollution Charges will contain the following:

(1) Purpose

The PC shall have as its main purpose the imposition of penalty to polluters of the environment according to their pollution loads, but flexible enough to enable the polluters to reduce pollution at a cost lesser than by a single minded regulation.

The funds derived from the application of the PC will be used to support the ACRT activities.

(2) Administration of PC funds

The PC will be administered by the ACRT.

Legal Procedure

The legal procedure consists of the same steps as that of the Environmental Fund.

7.1.5 Classification and Water Quality Standards for Tuy River

Background

According to Decree 883 published in December 1995, it is stipulated that water quality standards for each water body be provided depending on their specific conditions. Therefore, the law proposed here is based on this regulation, with the purpose of specifically applying it to the Tuy River.

Necessity

The Tuy River is a water body where many industries and piggeries discharge wastewater directly or indirectly.

Specific regulations on the water of Tuy River are deemed necessary to have a more enforcing legal tool to be obeyed by the polluting factories and piggeries.

Proposal of Law

The proposed law for Classification and Standards of Quality Control of Waters of the Tuy River will contain the following information:

Classification	Location
Sub-type 1B	High and Medium Stream

Since the water quality standards of Sub-type 1B do not specify BOD and SS in the river, it is proposed to specify the standards for BOD and SS, i.e., BOD and SS shall be limited to less than 3 mg/l and 750 mg/l, repectively.

Legal Procedure

For the elaboration of specific standards for the Tuy River, the legal procedure shall be the same as that of the creation of the Environmental Fund.

7.2 Strengthening of the Function of Organization

7.2.1 General

The Tuy River Basin Agency has been created with the following main purposes: (1) to execute plans, programs and projects of environmental management; (2) to execute works directed to environmental sanitation; and, (3) to promote and coordinate the necessary financing for the execution of the works of environmental conservation either for the public or private sector.

Therefore, at the stage of project execution, the Tuy River Basin Agency will participate through the Management of Studies, Planning and Projects Department for the physical execution and through the Office of Administration and Budget for the financial execution.

After the completion of the works at the operation-maintenance stage, the participation of the Agency will be through the Territorial Management of Miranda at the City of Los Teques, which manages the High and Middle Sub-basins of Tuy River.

In the case of Hidrocapital, it has the duty to guarantee potable water, and should assume such responsibility. Then, from the part of Hidrocapital the participation of the institution at the execution stage will be through the Vice-Presidency of Conservation and Development and the Management of Investment and Development for the financing execution. After the completion of the works at the operation-maintenance stage, the participation will be through the Vice-Presidency of Operation and Maintenance of Investment and Development for the financing execution.

7.2.2 Proposed Organization for Implementation of Project

General Proposal

MARNR is presently in the process of restructuring its organization including decentralization of its function to state governments under the Venezuelan Environmental Management Project which is being financed by the World Bank and some institutions under it may be reorganized like the Tuy River Basin Agency and Hidrocapital. In this study, however, it is presumed that the present organization of the Tuy River basin Agency or, at least, its basic function of handling works in the basin are maintained, because the municipalities and state governments are not the best institutions to work on the basin-wide issues such as water pollution control.

Under the above assumption, MARNR will act as the counterpart institution for the implementation of this Study, and the offices of the Tuy River Basin Agency and Hidrocapital will coordinate the execution of the project through a Coordination Committee.

Since the Tuy River Basin Agency has no experience in executing this magnitude of project, a new section inside of the Agency, a Project Executing Unit (PEU), is proposed to be created to execute the works corresponding to the Tuy River Basin Agency. In the case of Hidrocapital, the works will be executed by the existing office of Management of Projects, Works and Contracts within the Vice-Presidency of Conservation and Development.

A general view of the execution of the several components of the project is shown in Fig. 7.2-1.

Coordination Committee

The Coordination Committee will be integrated by the representatives of MARNR, the beneficiary states of Miranda and Aragua, the municipalities of Ocumare del Tuy, Las Tejerías and others within the area, and the concerned NGOs. The Chairman will be from CORDIPLAN or MARNR. They will hold periodic meetings along the duration of the works of the Sewage Treatment Plant, in order to coordinate the activities.

Executing Unit of Tuy River Basin

For the execution of the project of Environmental Improvement of Tuy River Basin, a Project Executing Unit (PEU) shall be formed, which is proposed to be part of the Tuy River Basin Agency. It will have the general coordination of activities related to the execution of the works and the administration of financial resources, regarding the Tuy River Basin Agency, during the execution period.

The unit will be in charge of the construction of the infrastructure of the project such as sewage treatment plants.

(1) Organization and Function

The PEU would be comprised of several managements (gerencias) which would have the following functions (see Organization Chart):

(a) General Management

- To plan, lead and supervise the functioning of the several managements.
- To coordinate the procedures regarding project financing and execution aspects.

(b) Management of Financing Execution

- To prepare the documents for bidding and contracts.

- To elaborate the requests for disbursements of financial resources of the project.
- To follow up the assignment of counterpart budget.
- To keep an accounting record of all the transactions.

(c) Management of Technical Coordination

- To prepare the technical information for the elaboration of bidding and contracts.
- To coordinate the technical activities of the project.
- To lead the supervising staff in the project site. To prepare periodical progress reports.

(2) Personnel

The Staff for the operation of the Executing Agency, for each management is classified in the following way:

Personnel for the Executing Unit

Management	Staff Category	Number
General	General Manager(Civil Engr.)	1
	Assistant	1
	Executive Secretary	1
	Clerk	1
	Driver	1
Financing Execution	Lawyer	1
	Business Administration	1
	Administration Technician	1
	Driver	1
Technical Coordination	Manager (Civil Engr.)	1
	Assistant	1
	Secretary	1
	Driver	1
Site Inspection	Civil Engineer	1
	Sanitary Engineer	1
	Chemist	1
	Assistants	3
	Secretary	1
	Driver	3

(3) Equipment

The Equipment for the operation of the Executing Agency, for each management is classified in the following way:

Equipment for the Executing Unit

Management	Equipment	Number
General	Vehicle (Wagon with A/C)	1
	Copy Machine	1
	Computer/Printer	1
Financing Execution	Vehicle (Sedan with A/C)	1
	Computer and Printer	1
Technical Coordination	Vehicle (Jeep)	4
	Computer/Printer	2

The organization of the Executing Unit is shown in the attached Chart.

7.3 Establishment of Environmental Fund

7.3.1 Necessity of Environmental Fund

General

Only less than half of the existing factories are equipped with a treatment plant with sufficient capacity. If this situation is left unattended without any fundamental measures, the problem of industrial pollution will eventually get out of hand. Granted that factories want to comply with the installation of treatment plants, sometimes this is infeasible due to financial constraints.

In this connection, small and medium size enterprises frequently face special difficulties in obtaining financing because (1) their internally generated cash funds are generally limited, and (2) they are precluded from capital markets due to their size.

It often happens that a factory or a piggery has no technical knowledge about what treatment plant it has to install.

Also, there is widespread resistance to the sometimes one-sided legal actions of the government forcefully trying to attain its anti-pollution objectives. Here arises the need for education, mutual communications and information dissemination.

Against this background, the establishment of the Environmental Fund is proposed. The function of the Fund is to lend money to factories and piggeries on more favorable and softer terms than in the case of commercial banks.

There is a need for the existing section for studies, planning and projects in the Tuy River Basin Agency to be reinforced/reorganized to take care of technical assistance.

Further, there is a need for the existing section for participation, education, etc., in the Tuy River Basin Agency to be reinforced to take charge of educational matters. (Refer to Section 7.4.2.)

Results of Questionnaire Survey

(1) Factories

(a) Existing Status

Item	Total No. of Factories	Factories Using/Going to Use Internal Fund	Factories Using/Going to Use External Fund
With Treatment Plant of Sufficient Capacity	20	19	1
With Treatment Plant of Insufficient Capacity	5	3	2
No Treatment Plant	11	5	6
Total	36	27	9

(b) Desire to Utilize Environmental Fund for Future Construction, Rehabilitation, Replacement and Expansion and Desired Lending Terms:

Desire to Utilize Environmental Fund	36 Factories (100%)
Desired Lending Terms (Average):	
Amount of Loan	US$153,000
Annual Interest Rate	12% (Bs. basis)
Grace Period	3 years
Repayment Period	8 years

The prevailing situation is that the annual interest rate is 30%, there is sometimes no grace period and the repayment period is 3 to 5 years.

(2) Piggeries

(a) Existing Status

Item	Total No. of Piggeries	Piggeries Using Internal Fund	Piggeries Going to Use External Fund
With Treatment Plant of Sufficient Capacity	3	3	0
With Treatment Plant of Insufficient Capacity	7	n.a.	3
Total	10	n.a.	3

n.a. denotes not available.

(b) Desire to Utilize Environmental Fund for Future Construction and Expansion and Desired Lending Terms:

Desire to Utilize Environmental Fund	10 Piggeries (100%)
Desired Amount of Loan	US$53,000

The four piggeries gave no answer. This can be interpreted that they had no capacity even to borrow. Piggeries are typical small-scale industries.

(3) Explanation of Results of Questionnaire Survey

Results of the questionnaire survey show that most factories with treatment plants of sufficient capacity used their own internal funds in financing the construction of their plants. Around 50% of those with treatment plants of insufficient capacity and those with no treatment plants are going to utilize external funds.

In the case of piggeries, all the piggeries with treatment plants of sufficient capacity used their own internal funds in financing the construction of their plants. Those with treatment plants of insufficient capacity are either going to utilize external funds or have no capacity even to borrow.

This is the situation where there is no such institution as the Environmental Fund. All the factories and piggeries are in unanimous agreement that they would avail themselves of the Environmental Fund in the event it is created.

7.3.2 Proposed Function

Size of Fund and Financial Sources

The size of the Fund is US$23,817 thousand plus US$200 thousand for institutional setup. The financial resources of the Fund will be 100% sought from offshore.

There is an argument favoring the introduction of a matching fund to prevent clients of the Fund from misusing the borrowed money. Although such a concept is not considered here, organizational and other measures should be developed based on further detailed analysis.

Relending Terms

It is assumed that the financial resources of the Fund will be provided by external agency(ies) on the following terms based on the examples of international financing institution's practice:

(1) Lending Terms

Annual interest rate: 6% (US$ basis); grace period: 3 years; repayment period: 15 years

The above 6% comes from the current Libor of 5.5% plus commission charge

of 0.5%. Libor fluctuates from month to month. Therefore, the value is to be understood as an exemplary one in the prevailing circumstances.

For reference, there are two alternatives regarding the lending terms as shown below:

(a) Alternative 1

Annual interest rate: 2.5-5% (US$ basis); grace period: 10 years; repayment period: 25-30 years

(b) Alternative 2

Annual interest rate: 6-7% (US$ basis); grace period: 5 years; repayment period: 10-20 years

(2) Relending Terms

To accommodate the initial establishment cost, O&M cost of the Fund, the cost of technical assistance, etc., annual interest rate will be raised to 6.8% in relending to factories and piggeries as shown below:

Annual interest rate: 6.8% (US$ basis); grace period: 3 years; repayment period: 15 years

Actually loans will be provided on the bolivar basis. It is a delicate and complicated matter to determine the corresponding bolivar based interest rate from the dollar based interest rate of 6.8% as various factors such as inflationary trends in Venezuela and the exchange rate between the dollar and the bolivar are involved.

FONCREI's lending interest rate is 85% of the weighted average interest rate of the 6 main banks, that is, around 23% at the present moment. This lending policy can be a guideline when the Fund determines the bolivar based relending interest rate. The relending policies including interest rate should be decided by the Managing Committee.

(3) Favorable Treatment

Basically the relending terms should be one and the same to all factories and piggeries. However, technical assistance and related services may be provided as a grant to assist weaker companies and piggeries.

(4) Proposed Division of Functions

Item	Studies, Planning and Projects Section	Environmental Fund Operation Unit	Environmental Fund Banking Unit
Organizational Position	Tuy Agency	FONCREI or CORPOINDUSTRIA	FONCREI or CORPOINDUSTRIA
Functions	Providing assistance and services regarding technologically and financially most appropriate treatment plants	Finding potential clients, screening of loan applicants, establishment of financing terms, decision-making on financing, etc.	Relending/providing financial resources to factories, receiving repayments, handling of arrears, management of banking, etc.
Remarks	to be reinforced/ reorganized	to be added	to be added

FCA (Fondo de Credito Agropecuario) will take charge of banking functions for piggeries. However, there will be no new or additional functions for FCA accompanying the introduction of the Fund due to the limited nature in the number and financial needs of piggeries concerned.

Agreement will be made regarding the allocation of cost and profit between the three organizations.

7.3.3 Organization

Organizational Structure

As mentioned above, the existing section in the Tuy River Basin Agency will be reinforced to meet the strong needs of technical assistance, and two units will added to the organizational structures of FONCREI/CORPOINDUSTRIA to carry out the proper functions of the Fund.

Besides, a coordination forum, a board of audit and a managing committee are proposed to be established to assure that the Fund will function in a proper and stable manner. (Refer to Fig. 7.3-1.)

The internal structures of the respective organizations are as follows:

Organization	Personnel	No.	Annual Remuneration (US$)
Studies, Planning and Projects Section	Manager (Civil Engineer)	1	10,200
	Assistant Manager	1	6,000
	Civil Engineer	1	7,000
	Sanitary Engineer	1	7,000
	Chemist	1	7,000
	Secretary	1	3,600
	Clerk	1	2,500
	Driver	1	3,000
	Sub-Total	8	46,300
Environmental Fund Operation Unit	Manager (Economist)	1	10,200
	Assistant Manager	1	6,000
	Secretary	1	3,600
	Clerk	1	2,500
	Driver	1	3,000
	Sub-Total	5	25,300
Environmental Fund Banking Unit	Manager (Economist)	1	10,200
	Assistant Manager	1	6,000
	Secretary	1	3,600
	Lawyer	1	7,000
	Accountant	2	14,000
	Clerk	1	2,500
	Driver	1	3,000
	Sub-Total	8	46,300
	Total	21	117,900

A Coordination Forum is recommended to be established comprised of representatives from the Tuy River Basin Agency, the Fund, factories and piggeries, CORDIPLAN and MARNR to support the Fund. Regular meetings should be held. This is the organ for the exchange and dissemination of technical, educational and general information centering on industrial pollution, discussion for alleviation of technical and financial problems facing factories and piggeries, mediation and resolution of conflicts between the lender and borrowers, etc.

A Board of Audit will be newly introduced under the Ministry of Finance to perform external auditing functions to check/prevent financial irregularity of the Fund. Also, a Managing Committee comprised of officials from the Ministry of Finance, CORDIPLAN and MARNR will decide on the allocation of the annual budget among administrative and investment sectors, guidelines on interest rates, etc. for the Fund.

The outlines regarding the division of role/functions/power of the Fund have been described above. It is recommended that further study should be conducted such as an institutional analysis on internal structures, the number of personnel, the number/date of regular sessions, the cost to be required for the coordination forum, etc.

Operation and Maintenance Cost

Personnel cost is estimated at US$117,900 as mentioned above. To this is added the contingencies and miscellaneous costs, which are estimated at US$58,950 (50% of the above cost). Thus, the total O&M cost comes to US$176,850.

7.3.4 Necessary Facilities and Equipment

The equipment cost for the Fund is estimated as follows:

Organization	Equipment	Quantity	Cost (US$)
Studies, Planning and Projects Section	Vehicle (4 WD with A/C)	1	30,000
	Computer	1	3,500
	Copying Machine	1	4,000
Environmental Fund Operation Unit	Vehicle (4 WD with A/C)	1	30,000
	Computer	1	3,500
	Copying Machine	1	4,000
Environmental Fund Banking Unit	Vehicle (sedan with A/C)	1	20,000
	Computer	1	3,500
	Copying Machine	1	4,000
Total			102,500

Adding the contingencies and miscellaneous costs of US$97,500, the total initial investment cost is estimated at US$200,000.

7.3.5 Operation Plan

It is proposed that the process of the establishment of the Fund be started in 1997 and be completed in the middle of 2000. The Fund will start operation from the middle of 2000.

As a short-term program, the Fund will take care of the financial requirements up to the end of 2003. The Fund will be financially self-supporting; it will be a going concern trying to make profit every year.

7.4 Establishment of an Environmental Education Program

7.4.1 Background

In past years the activities on the Environmental Education aspects have been developed as shown below.

Past Activities Regarding Environmental Education (Times)

Activities	1994	1995	1996
Workshop	2	4	16
Presentation/Seminar	1	2	1
Publication in Newspapers	2	1	1
Publication of Pamphlets	1	3	1

By performing such activities the training of teachers, community representatives, and national guard members has been executed. Also last year the cleaning and afforestation of small microbasins, by getting the cooperation of the concerned people, teachers, students, public employees, national guard members, etc., was undertaken.

7.4.2 Environmental Education Program

For the effective implementation of this Study, an education program to promote public awareness on environmental issues shall be undertaken to include all the sectors involved in the basin.

The environmental education program is focused on the following three levels: (1) school, (2) the public, and (3) the manufacturers.

Thus, for the implementation of the Environmental Education Program to Promote Public Awareness, the following measures are proposed:

At the School Level

The Tuy River Basin Agency shall follow up the current cooperation agreement between the Ministry of Education and MARNR signed in March, 1996.

Based on this agreement, the Agency shall promote that all education-related institutions within the basin, from kindergarten to the highest level shall provide steady guidance on the main environmental issues. This promotion shall be coordinated with the resident associations and the existing NGOs.

The contents of the main environmental issues include water pollution problems caused by effluents from factories and piggeries and wastewater from urban centers, significance of improvement of water quality of the Tuy River, and so on.

At the General Public Level

The following program should be undertaken for education at the general public level:

- Periodic publication of the "Informative Bulletin of the Agency" (Boletín Informativo de la Agencia) : This bulletin shall be made available to the residents of the basin. Contents shall always include the current main environmental issues, laws and regulations.

- Publication of newspaper articles related to the environmental protection of the Tuy River Basin. Partial reproduction of the contents of the bulletin can be included, especially those issues related to water quality, forest fires, sand quarrying, and waste disposal. The current laws and penalties applied when violated shall be mentioned too.

At the Level of Manufacturers

The following program should be undertaken for the education at the level of manufacturers:

- Periodic workshops and seminars addressed to the manufacturers: This will produce a continuing awareness in who are in charge of large pollution sources. Also this makes the manufacturers notice the significance of

complying with the water quality standard resulting in the promotion of installation of treatment plants.

- The publication of the pamphlet "Standards of Environment Quality Control, a Guide for Manufacturers".

- Information regarding the current fiscal incentives of tax deduction, financing procedures. At present manufacturers are not aware of the existence of these facilities, and the ACRT should inform to manufacturers about their existence.

- Information on pollution charges.

In summary, the several activities of the Education Program for Environmental Awareness and their targets during the proposed period are proposed as follows:

Education Program for Environmental Awareness

Activity	Year					
	1998	1999	2000	2001	2002	2003
Workshop for:						
Teachers and Students	6	6	6	6	6	6
Residents	6	6	6	6	6	6
NGOs	6	6	6	6	6	6
Local Authorities	6	6	6	6	6	6
Seminar for General Public	2	2	2	2	2	2
Publication of Pamphlets	2	2	2	2	2	2
Publication of Newspaper Articles	12	12	12	12	12	12
Workshop (Talleres) for Manufacturers	6	6	6	6	6	6

7.4.3 Organization and Personnel

The personnel to perform these activities will be basically those currently employed in the Management of Participation, Education and Relations with the Users, a division of the Tuy River Basin Agency. Although the staff is well trained, some updating and/or training courses shall be considered for technicians. In some areas to be undertaken or strengthened with the project, new staff will be recruited as follows: Social Planner (Sociologist), Social Worker, and so on.

7.4.4 Equipment and Materials

For performing the mentioned activities, some basic initial equipment and materials will be necessary.(see table below.) This will be used to strengthen the Office of Programmatic Management of Participation, Education and Relations with the Users.

7.4.5 Cost Estimate

The cost estimate for new personnel and the equipment to be acquired are as follows:

Cost Estimate for Strengthening Environmental Education and Public Awareness

Personnel	Number	Cost (US$) / year
Sociologist	1	7,200
Social Worker	1	6,000
Graphic Designer	1	4,000
Logistic Support	set	2,000
Training Abroad (2 persons)	3 months	20,000
Total		40,000

Equipment	Number	Cost (US$)
Vehicle	1	30,000
Computer/Printer Set	2	7,000
Portable Computer/Printer Set	1	4,000
Copy Machine	1	4,000
Overhead Projector	1	1,000
Slide Projector	1	800
VCR	1	700
Color TV	1	700
TV Camera	1	1,500
Photographic Camera	1	300
Total		50,000

7.5 Establishment of Monitoring System

7.5.1 General

The objectives of the monitoring system follow those made in the Master Plan to collect basic information for the prevention of deterioration of water quality in the Tuy River from two aspects: (1) environmental aspect, to preserve the water of the Tuy River complying with the water quality standard, and (2) water supply source aspect, to prevent water with unfavorable quality from domestic utilization.

The structure of the monitoring system, to achieve the above objectives, was proposed in the Master Plan. In this feasibility study, the following points proposed in the Master Plan were confirmed in order to establish the plan of the system: (1) monitoring conditions including sites, parameters and frequency; (2) organization and additional personnel, additional equipment and facilities; (3) comparison between the utilization of a new laboratory belonging to ACRT and the present Central Laboratory; and, (4) necessary cost estimate.

7.5.2 Monitoring Conditions

Monitoring Conditions at Fixed Site

(1) Case 1 (Ordinary Monitoring)

(a) Site Condition

The Master Plan selected six sites on the Tuy River and three sites on the tributaries. The more information and data that can be collected at a point the more appropriate that point will be. The following table lists the conditions of the selected sites (refer to Fig. 7.5-1).

Conditions of Monitoring Site

Site	Accessibility	Point of flow measurement and water sampling
H Las Caballerizas	About. 1 km from major road, easy to pass a private yard	Measurement in the middle of the river may be possible
Las Tejerías	On a main road	Center of river
Boca de Cagua*	About 0.5 km from the main road and easy to approach by a little wild road	Center of river
Cua Bridge**	On a main road	Center of river
Ocumare Bridge*	On a main road	Center of river
S. A. de Yare	On a main road	Center of river
Caño Tiquirito	Across a passable private yard	Possible in the river
Qda. Maitana	About. 1 km from major road by a wild road	Possible in the river or from the pedestrian bridge
Qda. Charallave	On a main road	Possible in the river

* Site of continuous monitoring

** Tazón Bridge has been proposed in the Master Plan Study. However, it was found to be inaccessible so it is replaced by Cua Bridge.

(b) Frequency

Field work and sampling should be monthly in the dry season (6 times) and fortnightly in the rainy season (12 times) by conventional sampling methods. According to past data in the Tuy river basin, flow and water quality in the dry season do not tend to vary while in the rainy season they are sensitive to precipitation.

(c) Parameters

In addition to the monitoring parameters in the water quality standard Sub-Type 1B, many others are to be analyzed to evaluate the level of pollution. This Study especially recommends the following parameters: Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC), and Suspended Solid (SS), Total Nitrogen (TN) and Total Phosphorus (TP).

(2) Case 2 (Continuous Monitoring)

(a) Site Condition

Boca de Cagua and Ocumare Bridge, selected for the continuous monitoring stations are proved to be appropriate for this purpose. Moreover, the following points were examined at the site and the adequacy was confirmed:

- Condition of building foundation of the monitoring station.
- Availability of telephone lines.
- Availability of person responsible for the monitoring station.

(b) Frequency

Hourly measurement is principally required by automatic measurement equipment.

(c) Parameters

Monitoring parameters are water temperature, electric conductivity, pH, dissolved oxygen, turbidity and water level.

(d) Monitoring Station Equipment

The system has a water test tank with a sampling pump, sensors and stations with a gauge and recorder. A public telephone line sends observation data to a computer.

(e) Response to Emergency

Whenever a parameter shows abnormality or hazardous state, the same water sample should spontaneously be analyzed manually to check heavy metals or cyanide. When heavy metals or cyanide are detected in river water, Toma de Agua station should be informed of this for the purpose of taking precautionary steps.

Monitoring Conditions at Non-Fixed Site

(a) Site Condition

As in the Master Plan, pollution condition due to factories and piggeries, or urban centers should be monitored. Thus, non-fixed monitoring sites are to be at factories, piggeries and urban centers.

Attention should rather be paid to site selection: Wastewater high in organic pollutant and/or hazardous compounds should be monitored frequently.

(b) Frequency

Weekly monitoring is recommended. Two teams are to carry out monitoring activities at four sites each day. Factories discharging major pollutants should be the primary target of the monitoring.

(c) Parameters

In addition to the parameters in the standard list, the characteristic parameters detected in the wastewater from industries, urban centers and piggeries should be monitored.

Some wastewater from factories, in particular, may contain heavy metals and other toxic compounds, and thus large scale factories and other heavy metal polluters should firstly be monitored. The following table lists the recommended parameters from such factories.

Parameters to be Monitored

Industrial Category	Parameters to be Monitored
Food related industry	Parameters relating to organic pollution including TOC and DOC
Tannery and leather factory	CN, Pb, Cr^{6+}
Manufacture of paint and vanishes	Cd, CN, Cr^{6+}, Hg
Manufacture of soaps and cleaning products	CN, Pb, Cr^{6+}, Oil and grease
Production of fiberglass	CN, Pb, Cr^{6+}, As
Production of non-ferrous metals and alloys	CN, Pb, Cr^{6+}, Zn
Manufacture of metallic products	CN, Pb, Cr^{6+}
Metal plating	Cd, CN, Pb, Cr^{6+}, Hg, As, Zn
Car part factory	Cd, CN, Pb, Cr^{6+}, Hg, As
Automobile factory	CN, Pb, Cr^{6+}, As

7.5.3 Monitoring Works for Environmental Impact Assessment (EIA)

As discussed in Chapter 9, Environmental Impact Assessment, the environmental monitoring plan is proposed for the construction of sewage treatment plants at Ocumare del Tuy and Las Tejerias and sand settling pond at water intake. Among these, the monitoring for sand settling pond is expected to be covered in a routine work for monitoring at Toma de Agua by Hidrocapital.

The monitoring works for sewage treatment plants are necessary to be covered by the Tuy River Basin Agency. Since the volume of monitoring works for EIA is not so much and monitoring sites are close to the fixed monitoring sites, it is considered that the newly proposed organization for monitoring should include the additional works for EIA.

7.5.4 Laboratory

There need to be a laboratory capable of carrying out analysis on up to 300 water samples. The central laboratory in Caracas carries out all analyses and laboratory works of water samples of the Tuy River as well as those of other areas. It currently

analyzes more than 3,000 samples and has the capacity to cover the proposed monitoring work, provided staff members and equipment are increased.

The disadvantage is that it is not convenient to carry out daily monitoring work due to the location of the central laboratory being far from the monitoring sites of the Tuy River. An alternative is to build a new laboratory at a monitoring site, for instance, Ocumare del Tuy because of its general convenience.

This section compares the central laboratory and a new laboratory for the purpose of planned monitoring activities. The table below lists their features according to the required conditions for the water analysis laboratory.

Comparison between Two Laboratories

Item	Central Laboratory	New Laboratory
Driving time from monitoring sites	1.5 - 2.0 hours	0.5 - 1.0 hour
Number of personnel	At present, 17 professionals are engaged; 2 professionals to be added	6 professionals are planned
Building	Existing with a capacity to accept the work	New building with a floor space of about 300 m^2
Laboratory facilities	Additions needed	New installation needed
Equipment	Additions needed (US$250,000)	New installation needed (US$550,000)
O/M cost for the monitoring work	Same as new laboratory	Same as existing laboratory
Work volume	Based on the sample number of last 3 years, 10 to 16 times than proposed monitoring work volume (3,300 - 4,900)	300 samples in the proposed monitoring work

Even if a new laboratory can be conveniently located, it will demand a huge investment for building and maintenance relative to a limited amount of work. In an environmental improvement project for Lake Valencia, for instance, a new laboratory was built. To justify its cost, the laboratory has to receive samples of other projects too. Under these circumstances, it is not recommendable to construct a new laboratory.

7.5.5 Personnel for the Monitoring

The Tuy River Basin Agency (ACRT) should be responsible for the monitoring of the Tuy river basin. It was already found necessary to strengthen the present organization by increasing personnel and adding equipment and facilities for the monitoring work.

Staff members have to be increased at particularly ACRT's regional office and at the central laboratory in order to carry out the monitoring activities efficiently.

Specific requirements are listed below.

Work	Necessary Personnel for the Monitoring System	Existing and Available Personnel	Additional Personnel
Supervising	1	0	1 in the main Office, ACRT
Field measurement and collecting samples	6 personnel for 2 teams	4 technicians including engineers from Los Teques Office; 2 engineers and 1 technician from Ocumare Office; 1 chemist from the Central Laboratory (*)	Not necessary (1 technician for the continuous monitoring work shall also join the field work and collecting samples).
Continuous monitoring	1 technician; 1 operator for data storage	1 secretary among 4 in Ocumare Office	1 technician in Ocumare Office
Laboratory work	3 chemists; 1 biologist; 3 technicians	1 chemists; 1 pharmacologist instead of chemist; 1 biologist; 2 technicians	1 chemist in water quality section, Central Laboratory; 1 technician in water quality section, Central Laboratory
Data arrangement	1 technician or engineer	1 technician	Not necessary

* Personnel work both in the field and the laboratory.

One supervisor shall be added to the ACRT main office (Miranda Management Office) which directly controls the upper and middle Tuy basins.

Three professionals or technicians are required for two field work teams, and three chemists, three technicians and one biologist are required for analyses in the laboratory. Considering an analyst's specialty and many parameters to be monitored, it is necessary to integrate a larger number of specialists.

Since continuous care and immediate analysis for fresh samples should be required for the continuous monitoring system, the Ocumare Office needs 1 chemist-technician.

7.5.6 Necessary Equipment

The central laboratory needs additional equipment for expanded monitored parameters, particularly heavy metals, cyanide or arsenic, along with upgrading existing equipment.

For field monitoring activities, besides another set of equipment for 2 teams, turbidity meters and current meters to measure flow are needed.

Also, facilities and equipment for the continuous monitoring stations are newly required: cabinet for sensing equipment, sensors of pH, EC, DO and Temperature sensors, water level gauge and a recording device. A computer unit is also needed to store daily results.

7.5.7 Operation and Maintenance Plan

Monitoring work will be carried out every week in accordance with a schedule. Including 3 additional personnel, 18 personnel are required for the monitoring work. For the field work and sampling, six out of eight members are sufficient. These personnel will each week carry out the monitoring system at fixed and non-fixed sites. One member should daily be in charge of the continuous monitoring system.

The central laboratory needs to increase its staff due to the increase in the analysis of monitoring parameters.

For maintenance cost, different ratios to the original costs (3 to 10%) are set according to the equipment type and estimated annual maintenance cost (Table 7.5-1).

7.6 Evaluation of Institutional Measures

7.6.1 Establishment of Environmental Fund

In this section, institutional measures mean the establishment of the Environmental Fund. The values and conditions used for financial analyses are shown below.

Initial Cost	US$24,017 thousand
O&M Cost	US$177 thousand
Implementation Period	1998 to middle 2000 (establishment); middle of 2000 to 2003 (application)
Durable Life	Electro-Mechanical Equipment: 15 years; Structures and other facilities: 40 years

Two types of financial analyses are performed. One is affordability analysis and the other, projection of financial statements. Values and conditions used in both of them are shown below.

Beneficiaries

The beneficiaries are the factories and piggeries.

Financial Source, Lending Terms and Bearer of Cost

External Source	Government Budget	Lending Terms	Bearer of Cost
100%	-	shown below*	Beneficiaries

* Annual interest rate: 6%; grace period: 3 years; repayment period: 15 years

The external resources will be relent to factories and piggeries on the following terms:

- Annual interest rate: 6.8%; grace period: 3 years; repayment period: 15 years

O&M cost of the Environmental Fund and repayment cost will be borne by the beneficiaries.

Financial Capacity of Beneficiaries

Item	Total Number up to 2003	Annual Sales per Factory or Piggery (US$ thousand)	Aggregate Annual Sales (US$ thousand)
Factory	103	5,662	583,186
Piggery	27	234	6,318
Total	130	-	589,504

Affordability Analysis

Analysis was made to judge and determine if the beneficiaries are capable of bearing the cost of the Envirinmental Fund.

It was revealed that over the 14 years from 2004 to 2017 factories and piggeries will shoulder US$3,079 thousand annually.

Annual Payment as Percentage of Sales	Corresponding Annual Payment per Factory and Piggery (US$)
0.55%	31,141 (Factory) 1,287 (Piggery)

In terms of the percentage of sales, each factory or piggery will pay 0.55% of its sales annually, i.e., US$31,141 for a factory and US1,287 for a piggery. The amount appears to be not unduly burdensome.

Projection of Financial Statements

Financial statements (income statement, funds statement and balance sheet) of the project were projected on condition that the Environmental Fund collect sufficient funds from factories and piggeries to make this undertaking financially feasible.

Table 3.7.2 of Sector I in the Supporting Report shows the annual financial statements of the project for 20 years from 2000 to 2019. The tables below highlight the statements.

Annual Payment as Percentage of Sales	Corresponding Annual Payment per Factory and Piggery (US$)
0.59%	33,406 (factory) 1,381 (Piggery)

Ratio of Working Capital to Total Assets	Ratio of Revenues to Total Assets
6.8%	7.7%

7.6.2 Establishment of Monitoring and Public Education Systems

Affordability analysis was performed to judge and determine if the responsible organization will be capable of bearing the cost of institutional measures. In this

section, institutional measures means the establishment of the monitoring and public education systems.

Initial Cost	US$658 thousand
O&M Cost	US$116 thousand
Implementation Period	1998 to 1999 (Establishment of systems)
Durable Life	Electro-Mechanical Equipment: 15years; Structures and other facilities: 40 years

Responsible Organization

The MARNR will be the ministry responsible for the institutional measures.

Financial Source, Lending Terms and Bearer of Cost

External Source	Government Budget	Lending Terms	Bearer of Cost
100%	-	shown below*	Responsible Organization

* Annual interest rate: 6%; grace period: 3 years; repayment period: 15 years

O&M and repayment cost will be borne by the responsible organization.

Financial Capacity of Responsible Organization

Item	MARNR
Annual Budget (US$ thousand) in 1996	210,000

The annual budget of MARNR is estimated to grow at the average annual rate of 4%.

It is revealed that over the 14 years from 2000 to 2013, the organization will shoulder US$219 thousand annually.

Percentage of Annual Budget to be Allocated by the Organization	Corresponding Budget Allocations in 1996
0.070%	US$147 thousand

In terms of the percentage of annual budget to be allocated by the organization, it will pay 0.070% of its budget annually. This corresponds to US$147 thousand in 1996 and appears to be not a heavy obligation.

CHAPTER 8. OVERALL EVALUATION FOR PROJECTS OF FEASIBILITY STUDY

8.1 Expected Benefits

This study concerns the increase of the quantity of potable water as well as the improvement of the quality of the Tuy River water. The feasibility study was carried out on the improvement of water quality. On the other hand, the pre-feasibility study was conducted on the increase of water quantity. The benefits deriving from the increase of water quantity is not mentioned here because they are to be analyzed at the feasibility study stage. Therefore, the benefits treated here are confined to those attributed to the improvement of water quality, although the improvement of the quality of the Tuy River water contributes to a stable supply of potable water.

In general, some of essential benefits which derive from the implementation of environmental improvement projects are difficult to evaluate in monetary term. Here, the benefits are presented in a descriptive manner:

Direct Benefits

As the direct benefits derived from the implementation of priority projects, the following items are enumerated:

- Water quality improvement will bring about better environment to the Tuy River. The present dirty colored and bad smelling water will change to that with less smell and less dirty color.
- The removal of BOD and turbid substances will bring about a reduction of the number of water intake suspension due to color, odor and turbidity. This will also bring about a reduction of operation and maintenance cost for the treatment of water.
- The Tuy River water can be used as a safe water resource with less coliform and heavy metals for water supply to the Caracas Metropolitan Area.
- Water supply for Caracas will be stabilized because of a reduction of water intake suspension. (It is to be noted that the increase of water quantity which is now at the pre-feasibility stage aims for a stable supply of potable water.)

Indirect Benefits

As the indirect benefits, the following effects are expected:

- As a result of water quality improvement, the value of real estate along the river course will appreciate.
- Waterborne diseases will be reduced.
- The value of the Tuy River basin will appreciate as a tourism resource.

- The existence value of the Tuy River basin will appreciate.

8.2 Economic Analysis

Economic analysis has been performed for the five projects, i.e., installation of treatment plants in factories; construction of sand settling pond for intake; construction of sewage treatment plant in Ocumare del Tuy; construction of sewage treatment plant in Las Tejerías; and, reforestation in priority areas to show the indicative values of economic criteria. (For details refer to Chapter 3 of Sector I in the Supporting Report.)

It has been revealed that the five F/S projects have a combined NPV of US$18.8 million, B/C of 1.32 and EIRR of 17.6% or 5.6 points higher than 12%, which is the bench mark opportunity cost of capital (OCC) in Venezuela.

The short-term program is thus as a whole judged to be economically highly feasible.

8.3 Financial Evaluation

The total initial cost for the six F/S projects comes to US$72 million. Its breakdown by project and by financial source is presented below:

(Unit: US$ thousand)

Project	External Source	Government Budget	Total
Construction of Sand Settling Pond for Intake	6,245	-	6,245
Construction of Sewage Treatment Plant in Ocumare del Tuy	9,367	17,396	26,763
Construction of Sewage Treatment Plant in Las Tejerías	2,274	9,094	11,368
Reforestation in Priority Areas	3,347	-	3,347
Environmental Fund	24,017	-	24,017
Institutional Measures (Exc. Environmental Fund)	658	-	658
Total	45,908	26,490	72,398

As the above table shows, foreign resources come to around US$46 million accounting for 63.0% of the total initial cost, and local resources is more than US$26 million accounting for 37%.

Usually the financial sources of externally assisted loan projects are 50% external and 50% domestic. As regards the F/S projects, however, affordability analysis shows that the cost-bearers (that is, beneficiaries and polluters) can afford to pay back up to 63% of the total initial cost. Therefore, it is recommended that the Venezuelan government and external financial agencies agree on the external versus domestic ratio mentioned above.

In this connection, it is necessary that the Venezuelan government should start discussion with external agencies such as the World Bank, IDB and OECF for financing the foreign components.

Project	Cost-Bearer	Payment in Percentage	Payment (US$)
Construction of Sand Settling Pond for Intake	Households in CMA	0.0145% of income	0.07$/month/household
Construction of Sewage Treatment Plant in Ocumare del Tuy	Households (H) and Factories(F)/Piggeries(P) in Ocumare del Tuy	0.90% of income (H), 0.17% of sales (F/P)	4.56/month/household 9,625$/year/factory 398$/year/piggery
Construction of Sewage Treatment Plant in Las Tejerías	Households (H) and Factories (F)/Piggeries (P) in Las Tejerías	0.90% of income (H), 0.22% of sales (F/P)	4.45/month/household 12,456$/year/factory 515$/year/piggery
Reforestation in Priority Areas	MARNR, Miranda State, Aragua State	0.048% of budget	234,000$/year
Environmental Fund	Factories, piggeries	0.59% of sales	33,406$/year/factory 1,381$/year /piggery
Institutional Measures (Exc. Environmental Fund)	MARNR	0.070% of budget	147,000$/year

The above table summarizes the affordability of cost-bearers for the six projects:

The repayment, O&M and replacement cost for the "construction of sand settling pond for intake" will be met from the income of CMA households. Both the ratio to income and the amount of the charge per household will be very small.

The cost of "construction of sewage treatment plant in Ocumare del Tuy" will be borne by the households and factories/piggeries of that town. Both the ratio to income and the amount of charge per household appear to be reasonable. Also, both the ratio to sales and the amount of the charge per factory/piggery appear to the reasonable.

The cost of "construction of sewage treatment plant in Las Tejerías" will be borne by the households and factories/piggeries of that town. Both the ratio to income and amount of the charge per houshold appear to be reasonable. Also, both the ratio to sales and the amount of the charge per factory/piggery appear to be reasonable.

MARNR, Miranda State and Aragua State will together shoulder the cost for "reforestation in priority areas". The ratio of payment to budget will be 0.048%, the annual payment coming to US$234 thousand. This seems to be not a heavy obligation.

Each factory and piggery will outlay 0.59% of their sales as repayments to the Environmental Fund. It means that each factory and piggery will annually pay US$33,406 and US$1,381, respectively. This is not a heavy burden.

MARNR will shoulder the cost for "institutional measures other than the Environmental Fund". The ratio of payment to budget will be 0.070%, the annual payment coming to US$147 thousand. This seems to be not a heavy obligation.

As a conclusion it can be said that all the six projects under study as the short-term program will be financially feasible.

CHAPTER 9. ENVIRONMENTAL IMPACT ASSESSMENT

9.1 General

Environmental Impact Assessment (EIA) is required as part of the feasibility study to describe characteristics of the project and potential natural and social impacts resulting from project implementation. It also proposes a suitable approach to identify significant impacts and impact sources, and proper measures are suggested to mitigate adverse effects of the project.

The EIA should be carried out for the proposed projects based on the Terms of Reference (TOR) and in accordance with the procedure and guidelines of the Republic of Venezuela (refer to Fig. 9.1--1). The TOR was submitted to the EIA Evaluation Committee of the Tuy River Basin Agency together with the Document of Intention in the middle of November, 1996. These documents were duly approved on February 21, 1997. The proposed projects were defined as the Installation of Sewerage Treatment Plant at Ocumare del Tuy and at Las Tejerías, the Construction of Sand Settling Pond at the Water Intake, and the Reforestation in Priority Areas.

The reforestation project in this case is considered non-lucrative as it is envisaged to function as a protective measure against soil erosion for the improvement of natural environment of the natural river basin. Judging from the fact that the Environmental Evaluation Standards established under the Decree No. 1257 can be applicable to commercial and industrial activities in the forestry sector, the committee has decided that the reforestation project is to be ruled out from EIA.

With regard to the Sand Settling Pond, EIA is not required either, by reason of project characteristics and its design scale. However, specific items probably needs to be evaluated from environmental point of view as it is described in the above Evaluation Standards.

Thus, in this Feasibility Study, the following studies are required:

Project	Judgment
Sewage Treatment Plant in Ocumare del Tuy	EIA required
Sewage Treatment Plant in Las Tejerías	EIA required
Sand Settling Pond at Water Intake	EIA not required, but evaluation of specific environment required
Reforestation in Priority Areas	EIA not required

Environmental impact study by Ecodipla Consultores, C.A., a selected local consulting firm duly registered with the Tuy River Basin Agency, started at the beginning of December, 1996 under the direction of the JICA study team. The study was conducted to become aware of the present conditions of each project area, and it consists of the analysis of natural environment along the river and the evaluation of social environment in the objective areas. The items covered by this environmental impact study were based on the approved TOR as shown in the table below.

Study Item		Project		
		Sewage Treatment Plant in Ocumare del Tuy	Sewage Treatment Plant in Las Tejerías	Sand Settling Pond at Water Intake
Natural Environment	Groundwater quality	Yes	Yes	No
	Sediment Analysis	Yes	Yes	Yes
	Aquatic biology	Yes	Yes	Yes
Social Environment	Land ownership	Yes	Yes	Yes
	Public awareness	Yes	Yes	Yes
	Discharge system	Yes	Yes	No
	Public health	Yes	Yes	No
	Population/economy	Yes	Yes	Yes

Note: "Yes" means that study is required, "No"means not required.

Based on the study on present conditions, environmental issue shall be further discussed to identify potential impacts and impact sources by the project, regardless of whether it is positive or negative, and it shall be considered in three different stages: pre-construction, during construction and post-construction. Should circumstances change in a negative way, some preventive or mitigative measures against adverse effects shall be advised on each stage.

In this regard, alternative design, location and technology may be reconsidered even though these were carefully analyzed and evaluated from both technical and economical points of view. The study results will certainly reflect on the significant items for the preparation of the environmental management plan and the monitoring plan.

9.2 Construction of Sewage Treatment Plant in Ocumare del Tuy

Natural Environment

The project location is plain and lowland on the right bank of the Tuy River, which is still surrounded by tropical woods. However, endangered or threatened species of animals were not observed because the area is already developed as one of the major urban centers in the river basin.

(1) Groundwater

High content of manganese is probably associated with the soil characteristics of the study area, but manganese has no harmful effects when consumed by humans. The presence of phosphorus is hardly explained in this study whether it is organic or inorganic, therefore, further detailed study is required in this connection. With regard to other inorganic chemicals, the quality is generally acceptable for drinking water.

(2) Sediment Composition

High concentration of chromium, nickel and zinc is remarkable as a result of sample analysis. The pollution sources of these heavy metals can be identified

as manufacture of metallic product, tannery and synthetic fiber factories, located in Las Tejerías, Cúa, Charallave and Ocumare del Tuy.

(3) Biological Consideration

The present aquatic-echosystem is characterized by the presence of oligochaeta which may be considered as an indicator of organic pollution. Cyanobacteria oscillatoria is the only existing fitoplankron in the water feeding on nitrogen. However, the water is not in favorable condition for zooplankton to survive. A few kinds of fishes were observed in dry season and confirmed that they were catfish and corroncho (local name).

Social Environment

As basic approach to the study on social aspects, field survey was carried out to assemble available information through questionnaire to the families and direct interview with the chief of each resident association in the community. The questionnaire covers about 10% of the total number of families in the study area. The study result on each subject is summarized as follows:

(1) Proposed Land Situation

The location of proposed land is adjacent to Hacienda Santa Ana on the right bank of the Tuy River. The land is now owned by the National Housing Institute (Instituto Nacional de la Vivienda: INAVI) for future housing development, but it still remains undeveloped and inactive. According to the master plan prepared in 1977, this 50 hectares of land is planned for residential area allowing for 300 people/ha. Since the landholder is a government entity, it seems to be not difficult to acquire the land properly for the project.

(2) Public Awareness and Concern about Sanitary Environment

River degradation is not yet a public concern, even though people's lives were once dependent upon the river about 30 years ago, playing multi-functional roles to human life. Some people realize that environment degradable situation is due to wastewater discharge; however, no measure has yet been taken.

(3) Wastewater Discharge System

The existing sewage system covers about 541 ha of land accounting for 64% of the total urban area, and the number of beneficiaries is estimated at 44,000 corresponding to 75% of the total population. The questionnaire shows that 18.5% of families discharge wastewater to quebrada or streams and 32% are to the urban drainage system.

(4) Human Health

Waterborne diseases have increased from 24,055 cases to 26,456 cases in the same period accounting for 10% up. Statistical data show that infectious and

parasitic cases are in the first rank in terms of water-related disease, followed by skin or subcutaneous tissue and digestive organ diseases.

9.3 Construction of Sewage Treatment Plant in Las Tejerías

Natural Environment

Las Tejerías has been developed as commercial and industrial area on the left bank of the Tuy River, while the right bank remains under-developed due to topographic restriction. The location of wastewater treatment plant is proposed to be on the right bank nearby the river since it is the only available land to meet both technical and economic requirements.

Two samples were collected in the study area, one from the industrial sector in the upstream and the other one from the east side edge of the same industrial zone at the confluence with Qda. Morocopo. These samples may represent present conditions on how much river environment is affected by hazardous wastewater to ground water, sediment and biological conditions.

(1) Groundwater

Groundwater is likely affected by the wastewater of various industries such as tannery, textile, metallic products and so on. It should be noted that more detailed study is required in the earliest stage possible to analyze concentration of hexavalent chromium which is known as a toxicant to human health.

(2) Sediment Composition

According to the test results of samples, the existence of a high concentration of heavy metals has been detected. This is apparently attributed to industrial waste. In this regard, paint and metallic product factories were identified as pollution sources.

(3) Biological Consideration

According the investigation, the presence of organisms has not been observed due to anoxic conditions in the riverbed. The stream-bottom echosystem seems to be extremely unfavorable at the confluence point with Qda. Morocopo.

With regard to phytoplankton, only Cyanobacteria Oscillatoria has been detected. The presence of this species may represent high concentration of nitrogen in the water, and its low density and diversity are also related to high turbidity of water. No zooplankton was observed in the study area under the present biological surface-water characteristics.

Water quality is so degraded that the present aquatic ecosystem does not allow nekton to provide suitable habitat or refuge. Consequently, no fish was observed in the study area.

Social Environment

(1) Proposed Land Situation

The proposed land is located at Hacienda Guaremal on the right bank of the Tuy River and owned by a single private person. The total area is estimated at 20 hectares. Practically the land is not used for specific purposes, but it is allowed to be developed only for public services. The landowner is now in a position to negotiate with any responsible agency or institution on selling his property.

(2) Public Awareness and Concern about Sanitary Environment

People are more concerned about sanitary environment as compared with the case of Ocumare del Tuy. An oxygen pond was once constructed on the left bank of the Tuy River in the community of Los Jabillos in an effort to improve wastewater disposal system. At present it is out of function, because residents of the said community strongly protested against the pond for the disagreeable stench. People's protest is further generated against the sand quarry company in Barrio Simon Bolivar, demanding the installation of a proper treatment plant. In an interview or questionnaire survey, they show a positive reaction to participate in the project.

(3) Wastewater Discharge System

According to the Urban Management Plan (Plan de Ordenacion Urbanistica: POU) prepared by MINDUR in 1991, wastewater is discharged into two different types of sewage systems, one for industry and the other type for domestic use. The covering rate is nearly 69% of the total population. However, these systems are not in full operation due to the canal's deterioration and lack of maintenance.

(4) Human Health

Waterborne diseases occur frequently in the municipality, and 4,603 cases were reported in 1994. This number was reduced to 3,725 in 1995 and then increased to 5,273 in 1996. No reason is given for the fluctuation of numbers. Diarrhea ranks first in water-related diseases followed by gastric complications.

9.4 Construction of Sand Settling Pond at the Water Intake

Since the project is not likely to affect the natural and social environment, significant impact is, in principle, not predicted. Nevertheless, a study was conducted to evaluate some specific items which are potentially susceptible to environmental degradation in accordance with the approved TOR. For the natural environmental aspect, investigation was made regarding the sediment and biological condition as summarized below. As for the social environmental aspect, only land acquisition was considered to be significant. However it is not a subject to be discussed, since the

proposed land is owned by Hidrocapital. Consequently, attention was paid to the study on the natural environment.

Natural Environment

The project site is located opposite to the present water intake facility of Hidrocapital and isolated from the urban center of San Francisco de Yare. The natural environmental conditions are as follows:

(1) Sediment Composition

Sediment contains outstandingly high concentration of heavy metals at the downstream of the study area. Sediment is easily accumulated at the low and flat zone with all materials carried from upstream resulting in high concentration of heavy metals.

(2) Biological Consideration

Benthonic community is dominated by the presence of Oligochaeta at sampling in both stations, but its density is lower in the more bio-degraded stream bottom. With regard to plankton, cells have not been observed in the sample probably because of high turbidity of water. However, there are bacteria in the same sample, of which type could not be determined.

Fishes were not observed in the course of field investigation, but according to an interview with local people, catfish can be observed in the study area during dry season when turbidity becomes less.

9.5 Predictable Impact and Mitigative Measures

Predictable Impact Items

Impact prediction is based on all activities relating to project implementation. Considering project characteristics, it has to lead to a positive way in improving present environments in the Tuy river basin. Nevertheless, adverse impacts can also be predicted in the process of implementation, and proper measures should be taken to protect or minimize negative effects accordingly. In parallel, impact significance is evaluated on each predictable impact item, which is picked up based on the study on environmental conditions as shown below:

Environmental Condition	Predictable Impact Items
Natural Conditions	Water quality of Tuy River, Sediment, Aquatic biology
Social Conditions	Generation of stench and insects, Illegal land use, Traffic congestion, Noise, Dust

Predictable Impact Items for Sewage Treatment Plant

Since the construction of sewage treatment plants at Ocumare del Tuy and Las Tejerías has the same project nature, the predictable impacts for both cases are evaluated in the same manner.

(1) Expected High Impact Items

The following impacts in general are predicted to break out in a high level:

- Illegal land use in the project site.
- Generation of stench and insects from the sewage treatment plant.
- Sludge produced in the sewage treatment plant.

(2) Expected Moderate Impact Items

The following impacts are predicted to break out int a moderate level:

- Traffic congestion during the construction stage.
- Deterioration of water quality during the construction stage.
- Sediment produced during the construction stage.

(3) Expected Low Impact Items

The following impacts are predicted to break out, although it may be in a low level:

- Noise and dust during construction stage.
- Aquatic biology.

Predictable Impact Items for Sand Settling Pond

Judging from the nature of the project, the construction of a sand settling pond seems to have similar impacts as shown below:

(1) Expected High Impact Items

The following impact in general is predicted to break out in a high level:

- Illegal land use in the project site

(2) Expected Moderate Impact Items

The following impacts are predicted to break out in a moderate level:

- Traffic congestion during the construction stage
- Deterioration of water quality during the construction stage
- Sediment produced during the construction stage

(3) Expected Low Impact Items

The following impacts are predicted to break out, although it may be in a low level:

- Noise and dust during construction stage.
- Aquatic biology.

Mitigative Measures for Predictable Impacts

To cope with the predictable impacts, the following mitigative measures are considered. Predictable impacts and mitigation measures are summarized in Table 9.5-1.

(1) Illegal Land Use

Illegal land use in the project site may sometimes occur if the proposed site is not properly controlled by the responsible agency to prevent invasion by third parties. It is advisable to provide a fence around the construction site soon after the land has been legally acquired, and security guards should be permanently stationed in the site to keep the land from entry of unauthorized people.

(2) Generation of Stench and Insects

Disagreeable smell and insects may be generated from the sewage treatment plant, so that measures in the trickling filter system are proposed in the project to reduce these adverse effects to the minimum possible extent. It should be emphasized that operation and maintenance of the plant are essential as mitigation measures.

(3) Sludge

Sludge produced in the treatment plant can be used for agricultural compost or may be disposed in the landfill site at Bonanza. These ideas are based on the assumption that contents of hazardous materials are within the allowable limits (Decree No. 2211).

(4) Traffic Condition

During the construction period, traffic congestion should be avoided in order not to create any inconvenience to the residents. Work schedule and number of mobilized vehicles should be previously informed to the Local Government as well as the Tuy River Basin Agency for approval, and the contractor should assume the responsibility for traffic control of access roads, construction sites and other project--affected areas.

(5) Water Quality and Sediment

Water quality of the river and sediment are also assessed as negative impacts in the construction stage. Both of them are determined to be moderate in

significance, because under the present circumstances, these qualities are already too degraded to identify as significant impact, and adverse impact may be easily controlled if the construction is properly managed.

(6) Noise and Dust

Minor impacts are predicted for noise and dust during the construction stage because the project site is relatively far from the residential area. However, proper measures should be taken to satisfy the requirements specified in Decree No. 2217 and No. 638, respectively. Public consensus about the project is absolutely necessary prior to construction, and for noise control, the work schedule should be prepared in such a way that the operation of heavy equipment is limited to the daytime only. For dust control, attention should be drawn to the earth-moving work during dry season. Watering may be required for access roads as well as excavation and filling works. It is also important to cover soil materials with sheet while transporting them from and to construction sites.

(7) Aquatic Biology

With regard to aquatic biology, it may have some adverse impacts during construction due to spilt soil or construction scrap, so that protective net or fence should be placed to keep the river from absorbing bio-degradable materials.

9.6 Environmental Management Plan

As described in the previous section, predictable impacts and appropriate measures for the construction of sewage treatment plants and sand settling pond can be put to practical use for the preparation of the environmental management plan. Managing items for construction of these structures are specified in each stage of project implementation describing impact source, measuring standard and strategic approach. Management location and responsible organization should also be mentioned in this regard.

The overall view of the environmental management plan is shown in Table 9.6-1 (Sewerage Treatment Plan) and Table 9.6-2 (Sand Settling Pond).

Pre-Construction Stage

Public protest and demonstration may arise if project location is not mutually agreed between project executor and residents or land acquisition is not successfully achieved. Public hearing should take place in project-affected communities prior to project implementation, and land issue should be discussed to settle the problem through negotiation with landowner(s).

Construction Stage

Impact sources will be mainly civil works for project implementation. Noise, dust and traffic congestion are controllable to some extent by adjusting working hours and the

number or speed of mobilized vehicles. It is also important to follow respective standards determined under the presidential decree. On the other hand, river environment represented by water quality, sediment and aquatic biology can be controlled by means of construction management in an effort not to worsen the present situation.

As a matter of course, the project will create employment opportunities. An effective action needs to be taken to recruit local manpower as much as possible under the guidance of the Local Government as well as the Tuy River Basin Agency or Hidrocapital. Employment generation will lead to the increase in family income and may help vitalize the local economy as a result.

Post-Construction Stage

All items to be managed in the post-construction stage are basically related to the operation and maintenance of facilities. The Tuy River Basin Agency should take the initiative in environmental management for by-products of the treatment plant such as stench, insects and sludge. The landfill site at Bonanza may be designated as a potential disposal place for sludge if its composition meets the requirement determined under Decree No. 2211 (maximum allowable concentration of toxic substances for leachate).

For a strategic approach to management, competent personnel should be placed at sites to engage in operation and maintenance of facilities, and thereby systematic functions can be achieved to satisfy minimum requirements for the prevention of environmental degradation.

For the control of illegal land use, the Tuy River Basin Agency or Hidrocapital should make every effort to have public comprehension about the project in collaboration with the Local Government and the Regional Government as well. Thus, particular attention needs to be paid to the land issue so as not to create any negative social impact.

9.7 Environmental Monitoring Plan

Based on the identification of natural and social environmental impacts, monitoring should be carried out as follow-up action after facility construction. In general, it can be undertaken in such a way that the Tuy River Basin Agency or Hidrocapital should establish a monitoring system at an early stage possible and be engaged in regular site inspections, field measurements and sample analyses. Besides these fundamental activities, monitoring location, frequency and duration should be determined taking account of significance and effectiveness on each monitoring item.

The environmental monitoring plan is presented in Table 9.7-1 (Sewage Treatment Plant) and in Table 9.7-2 (Sand Settling Pond).

Natural Environmental Aspects

The Tuy River Basin Agency should assume the responsibility for monitoring such items as sediment, aquatic biology, surface water and groundwater. Sampling is required every six months at the selected point for EIA to evaluate how much aquatic environmental quality is improved through the project.

It is desirable to establish the monitoring duration to cope with the target year of the mid-term program. Sample analysis should include all parameters employed in the EIA. Moreover, COD for groundwater and Cadmium (Cd) for sediment are suggested to be included in the monitoring. With regard to sampling and quality analysis of surface water, it is advisable to coordinate with GTZ in promoting monitoring work.

In establishing the monitoring plan, it is also important to focus on by-products of the treatment plant. Wastewater quality should be checked weekly at the inlet and outlet of the plant, trying to detect especially concentration of heavy metals.

Monitoring will certainly help evaluate effectiveness and function of the treatment system in both industry and the proposed plant, and it will provide determinant factors to judge if sludge is allowable as a disposable material for the landfill site. No limit is defined as to monitoring period for the by-products.

Social Environmental Aspects

The Tuy River Basin Agency is in charge of monitoring noise, dust and traffic congestion during the construction period. Monitoring should be carried out once a month at construction sites, relevant communities and roads where potential impact is considered high due to the operation of equipment.

Information on water-borne diseases should be collected tri-monthly from Distrito Sanitario No. 2 since groundwater quality is expected to be improved by the project on the assumption that surface water is interrelated with groundwater. Furthermore, impact study on stench and insects needs to be conducted periodically based on public opinion and interview.

Hidrocapital, the executing agency for the project of sand settling pond, will take charge of monitoring work for water supply operation and turbidity at pre-treatment plant. This is to evaluate the function of the improved water intake facility as well as the water supply system. Monitoring frequency is proposed to be once a week for turbidity and once every three months for water supply operation.

Illegal land use of project site is one of the major items in a monitoring plan. Acquired land should be properly managed and controlled by the Tuy River Basin Agency or Hidrocapital, and no trespassing should be allowed for any unauthorized person. In this regard monitoring has no limit of duration.

Table 9.5-1 Predictable Adverse Impacts and Mitigation Measures

Predictable Impact	Impact Stage	Assessment of Impact Significance	Mitigation Measures
Illegal land use	Pre-construction Post-construction	High	Proposed land should be under strict surveillance of Tuy River Basin Agency or the Local Government to prevent illegal land use or invasion of third parties. Fencing and employment of security guard are advisable in this regard.
Noise	Construction	Low	Work schedule should be informed in public through the Local Government, and care needs to be taken as regards heavy equipment of which operation should be limited to daytime only.
Dust	Construction	Low	Watering is desirable for earth moving work or access road. Soil materials should be covered with sheet.
Traffic congestion	Construction	Moderate	Number of mobilized equipment and vehicles should be controlled taking account of present traffic conditions and proposed work schedule.
Water quality of the river	Construction	Moderate	Protective net or fence should be placed on the river edge to keep the stream from absorbing spilt soil and construction scrap or waste.
Sediment	Construction	Moderate	Sediment accumulated in the Tuy River channel should not be used for construction materials. It is required to dispose sedimenbt at designated site.
Aquatic biology	Construction	Low	Same measure as mentioned in the item "water quality" is required not to worsen present stream-ecosystem in the course of construction.
Generation of stench and insects	Post-construction	High	Competent personnel should be placed to deal with proper operation and maintenance of sewage treatment plant
Sludge	Post-construction	High	Sludge produced in treatment plant should be disposed in landfill site at Bonanza on condition that its composition is not detrimental to the environment.

CHAPTER 10. PRE-FEASIBILITY STUDY FOR SECUREMENT OF WATER QUANTITY

10.1 Subject Plans for Pre-Feasibility Study

Subject plans for pre-feasibility study are as follows:

(1) Effective Utilization of Existing Reservoir

The Ocumarito Reservoir is full to capacity for 4.3 months of the year on the average. During this period, water is spilled from Ocumarito Reservoir and is finally flown down at Toma de Agua. Accordingly, the utilization plan for the Ocumarito River is studied to minimize the spill at Toma de Agua in the rainy season.

(2) Development of New Dams

Construction of dams on tributaries to minimize spill at Toma de Agua in the rainy season is considered. Guare Dam and El Peñón Dam are the possible ones. The El Peñón Dam Plan is considered in combination with the effective utilization of the existing reservoirs.

The pre-feasibility study has been conducted as presented below.

10.2 Unit Benefit for the Securement of Water Quantity

Unit benefit for the calculation of benefit of the water resources development plan has been determined. Two kinds of values are deemed applicable for the unit benefit in the present study; namely, the unit construction cost of the Tuy IV-Taguaza-Cuira system and the annual production cost of the Tuy System used by Hidrocapital for the evaluation of new projects.

The following table presents the summary of the values obtained in the analysis (for details, see Sector F).

System	Unit construction/Marginal cost (US$/m^3)
Taguaza-Taguacita Interconnection	0.262
Tuy IV-Taguaza (overall)	0.143
Tuy IV-Cuira	0.109
Annual production cost of Tuy System	0.327

As the unit benefit, the annual production cost of the Tuy System has been applied considering the effectiveness of project implementation in comparison with the present system.

10.3 Utilization Plan for the Ocumarito River

Due to its small capacity compared to the catchment area, Ocumarito Reservoir is full to capacity for 4.3 months of the year on average. During this full capacity period, water is spilled from Ocumarito Reservoir to the downstream and it flows down the Tuy River without use.

Two options have been studied to utilize the spilling water from Ocumarito Reservoir. One is to divert water from the Ocumarito Reservoir through a diversion pipeline (Ocumarito-Lagartijo Diversion Plan) to the Lagartijo Reservoir. The Lagartijo Reservoir has a larger capacity. The water is finally sent to the Tuy I or II systems of Hidrocapital.

The other option is to pump up water to be spilled from the Ocumarito Reservoir directly to the pipeline of the Tuy III system (Ocumarito-Tuy III Pumping Plan). The water is to be sent to the Caujarito treatment plant together with the water pumped from the Camatagua Reservoir. In this plan, the amount of water equivalent to the amount to be pumped from the Ocumarito Reservoir is stored in the Camatagua Reservoir saving energy at pumping stations between Camatagua and Tunnel de Las Ollas.

For the Ocumarito-Lagartijo Diversion Plan, a plan with the combination of the planned El Peñón Dam has also been studied. El Peñón damsite is located in the upstream of Lagartijo Reservoir. If Lagartijo Reservoir is in the full supply level when water is to be diverted from Ocumarito Reservoir, El Peñón Reservoir could be used to store water to keep sufficient vacant capacity at Lagartijo Reservoir.

The general concept of the study in this section is illustrated in Fig. 10.3-1.

10.3.1 Hydrological and Hydraulic Data

Hydrological data necessary for the analysis are river flow data and reservoir operation records. Actually, observed data and simulated value in the existing study have been used.

10.3.2 Topographical and Geological Condition

Maps with a scale of 1/5,000 are available for the study area. On the right bank of the Tuy River, along the stretch between the Ocumarito-Tuy confluence and Lagartijo lies an alluvial plain, approximately 1 km wide. Beyond this point is mountainous terrain from which the Súcuta and Lagartijo rivers flow.

According to the geological map, the right bank of the Tuy River in this stretch is dominated by Paracotos formation. The Paracotos formation consists of metamorphic rocks of the Mesozoic Cretaceous. A possible route of the Ocumarito-Lagartijo diversion pipeline is along the foot of the mountains, the border of Paracotos formation and terrace deposits. The possible route of the pipeline for the pumping plan is in the mountainous terrain.

The Paracotos formation contains much schistosity. The schistosity generally trends east-west to northeast-southwest and dips southward. Accordingly, trends and dips of the schistosity should be taken into consideration for the excavation works. It is especially important in the south-facing slopes. No large faults cross the proposed line. Although there are numerous minor faults, none of them would affect the installation of the pipeline.

10.3.3 Major Features of the Existing Structures and Facilities

The existing structures and facilities related to the present plan are reservoirs, and intake and transmission facilities.

(1) Reservoirs

The reservoirs related to the present plan are Ocumarito, Lagartijo, Taguacita and Camatagua.

(2) Intake, Transmission and Other Facilities

Intake and transmission facilities related to the present plan include the Ocumarito treatment plant, intake and transmission facilities of Lagartijo and Taguacita reservoirs, intake facility of Toma de Agua for the Tuy River, the transmission facilities of Tuy I and II systems, and the transmission pipeline of the Tuy III system.

(a) Ocumarito Treatment Plant

The Ocumarito treatment plant is located on the right bank of the Ocumarito River in the downstream area of Ocumarito Dam. The water taken at Ocumarito Reservoir is purified at the plant and supplied as domestic water to urban areas of the so-called middle Tuy area. The installed capacity of the treatment plant is 1.06 m^3/s

(b) Taguacita-Tuy-Lagartijo Intake and Transmission System

The target intake from the three sources of Taguacita Reservoir, Lagartijo Reservoir and the Tuy River is approximately 8 to 9 m^3/s. General intake rules are summarized as follows:

- Available water is taken from Taguacita Reservoir
- Available water is taken from the Tuy River.
- The deficit of water to the total amount of approximately 9 m^3/s is taken from Lagartijo Reservoir.
- If Lagartijo Reservoir is full, priority is given to the intake from Lagartijo Reservoir.

(c) Tuy III System

The plan and longitudinal profile of the Tuy III system are presented in Fig. 10.3-2. As shown in the illustration, the pipeline crosses Ocumarito Reservoir by a bridge and passes the 1.5 km point from Ocumarito Dam. A piezometric profile is also presented in the illustration.

10.3.4 Optimization of Ocumarito-Lagartijo Diversion Plan

The optimization has been conducted for the cases with and without the construction of El Peñón Dam.

(1) Necessary Structures

Structures considered for the optimization study are an intake at Ocumarito Dam, a diversion tunnel to pass through the right bank abutment and a diversion pipeline to divert water from the outlet of the tunnel to Lagartijo Reservoir.

(2) Confirmation of the Prerequisite for Planning

The following conditions have been considered as prerequisite for the optimization study.

- The simulation period is selected for the 20 years from 1959 to 1978. Verification is made for reservoir operation condition, e.g., average storage water, spilling and/or empty periods.
- The installed capacity of 1.06 m^3/s is considered to be taken at Ocumarito Reservoir. The idea of expansion of the plant is not taken into consideration.
- The Caicita diversion structure is to divert water from Camatagua Reservoir to Ocumarito Reservoir. Supply through Caicita diversion to the Ocumarito treatment plant is taken into consideration only for the deficit in the supply to the Ocumarito treatment plant, and it will not affect reservoir operation.
- Rainfall in and evaporation from the reservoir are taken into consideration. For Taguacita Reservoir, these are not considered because the effect is minimal.

(3) Diversion Water Volume from Ocumarito Reservoir

The following table shows the possible amount of water to be diverted from Ocumarito Reservoir by the diversion capacity:

Diversion capacity m^3/s	Average annual diverted water (potential)	
	mcm/year	m^3/s
0.5	6.09	0.19
1.0	10.5	0.33
2.0	15.4	0.49
3.0	17.9	0.57
4.0	19.5	0.62
5.0	20.3	0.64

(4) Newly Developed Water by Ocumarito-Lagartijo Diversion without El Peñón Dam

Simulation has been conducted to obtain newly developed water by diversion from Ocumarito Reservoir to Lagartijo Reservoir. In the case of diversion from Ocumarito Reservoir, the capacity of the intake from the three sources of Taguacita, Toma de Agua and Lagartijo has been determined at 9.6 m^3/s, an installed capacity.

Simulation Results of Lagartijo Reservoir

Item	Unit	Diversion capacity (m^3/s)						
		0	0.5	1.0	2.0	3.0	4.0	5.0
Average stored water volume		28.4	33.7	37.4	40.7	41.7	42.1	42.3
At or above $78\times10^6 m^3$	month /year	0.3	0.4	0.9	1.4	1.6	1.6	1.7
At or below $20\times10^6 m^3$	month /year	5.0	4.0	3.5	3.4	3.3	3.3	3.3
Average intake (from Lagartijo)	m^3/s	3.73	3.89	3.97	4.05	4.06	4.06	4.06
Average total intake *1	m^3/s	8.53	8.69	8.78	8.85	8.86	8.86	8.86
Average annual increment	$\times10^6 m^3$	0.0	5.1	7.8	10.2	10.6	10.6	10.6
Average spill	m^3/s	0.08	0.11	0.16	0.24	0.31	0.36	0.39

Note *1: Total intake is of Taguacita, Toma de Agua and Lagartijo.

(5) Newly Developed Water by Ocumarito-Lagartijo Diversion with El Peñón Dam

Simulation has been conducted to obtain newly developed water by diversion from Ocumarito Reservoir to Lagartijo Reservoir in the case with El Peñón Dam. In this case, it is considered that water spilled from Lagartijo Reservoir is stored in El Peñón Reservoir in advance within the capacity.

Intake from the three sources of Taguacita, Toma de Agua and Lagartijo has been determined at 9.6 m^3/s, an installed capacity as in the case without El Peñón Dam.

The simulation results are as follows:

Annual Average Total Intake (Taguacita, Toma de Agua, Lagartijo)

Item	Unit	Diversion capacity (m^3/s)						
		0	0.5	1.0	2.0	3.0	4.0	5.0
Without El Peñón	$\times 10^6 m^3$	269.11 0.00	274.24 5.13	276.91 7.80	279.31 10.20	279.67 10.56	279.74 10.63	279.74 10.63
El Peñón $10\times10^6 m^3$	$\times 10^6 m^3$	269.61 0.50	274.74 5.63	278.11 9.00	280.88 11.77	281.51 12.40	281.80 12.69	281.93 12.82
El Peñón $20\times10^6 m^3$	$\times 10^6 m^3$	270.11 1.00	275.24 6.13	278.75 9.64	282.05 12.94	282.78 13.67	283.07 13.96	283.21 14.10
El Peñón $30\times10^6 m^3$	$\times 10^6 m^3$	270.61 1.50	275.74 6.63	279.25 10.14	282.97 13.86	283.78 14.67	284.07 14.96	284.21 15.10
El Peñón $40\times10^6 m^3$	$\times 10^6 m^3$	271.11 2.00	276.24 7.13	279.75 10.64	283.47 14.36	284.52 15.41	285.07 15.96	285.21 16.10

Note: Upper row: total intake; Lower row: increment

(6) Cost Curve for Optimization

Cost curves for intake, diversion pipeline and El Peñón Dam have been prepared for the optimization study.

Annual cost of intake and diversion pipeline has been obtained as the sum of annual construction cost and annual operation and maintenance cost. Annual construction cost has been calculated with the present worth of an annuity factor of 0.11 (design life of 30 years and an interest rate of 12%).

Q	Construction	O&M	Total
m^3/s	$ mil	$ mil	$ mil
0.5	1.20	0.11	1.31
1.0	1.66	0.15	1.81
2.0	2.14	0.19	2.33
3.0	2.57	0.23	2.80
4.0	2.79	0.25	3.04
5.0	3.08	0.28	3.36

Annual cost of El Peñón Dam has been obtained as the sum of annual construction cost and annual operation and maintenance cost. Annual construction cost has been calculated with a present worth of the annuity factor of 0.11 (design life of 50 years and an interest rate of 12%).

Effective capacity	Construction	O&M	Total
$\times 10^6 m^3$	$ mil	$ mil	$ mil
10	1.86	0.34	2.20
20	2.18	0.40	2.58
30	2.38	0.43	2.81
40	2.56	0.47	3.03

(7) Benefit-Cost Comparison of Alternative Development Cases

On the basis of the simulation results, the intake and diversion capacity of 0, 0.5, 1, 2, 3, 4 and 5 m^3/s for each without and with various capacity cases of El Peñón Dam are considered.

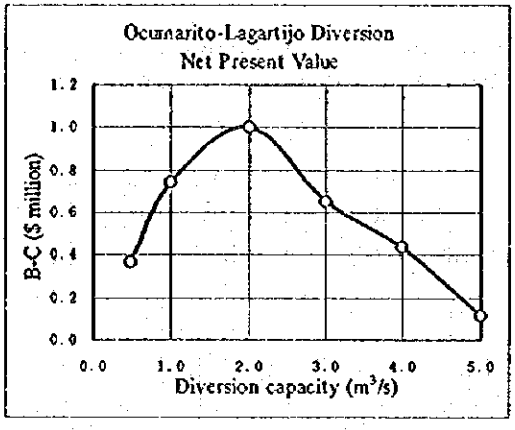
The following table shows the Annual Net Present Value (B-C), Benefit-Cost Ratio (B/C) and unit cost per cubic meter of water. The case with El Peñón Dam is the case with the effective capacity of $30\times10^6 m^3$, the best case among those with El Peñón Dam.

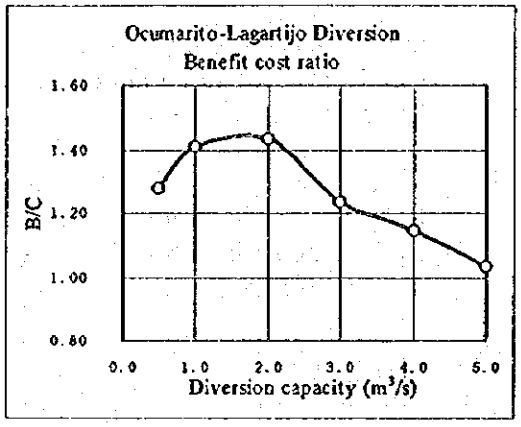
Diversion Capacity	Ave. Annual Diverted Water	Ave. Annual Diverted Water	Annual Benefit (B)	Annual Cost (C)	B-C	B/C	Unit Cost
m^3/s	mcm/yr	m^3/s	$mil/yr	$mil/yr	$mil/yr		$/m^3$
Without El Peñón							
0.5	5.13	0.16	1.68	1.31	0.37	1.28	0.255
1.0	7.80	0.25	2.55	1.81	0.74	1.41	0.232
2.0	10.20	0.32	3.34	2.33	1.01	1.43	0.228
3.0	10.56	0.33	3.45	2.80	0.65	1.23	0.265
4.0	10.63	0.33	3.48	3.04	0.44	1.14	0.286
5.0	10.63	0.33	3.48	3.36	0.12	1.03	0.316
With El Peñón of $30\times10^6 m^3$							
0	0.50	0.05	0.49	2.81	-2.32	0.17	1.873
0.5	6.63	0.21	2.17	4.12	-1.95	0.53	0.621
1.0	10.14	0.32	3.32	4.62	-1.30	0.72	0.456
2.0	13.86	0.44	4.53	5.14	-0.61	0.88	0.371
3.0	14.67	0.47	4.80	5.61	-0.81	0.86	0.382
4.0	14.96	0.47	4.89	5.85	-0.96	0.84	0.391
5.0	15.10	0.48	4.94	6.17	-1.23	0.80	0.409

Note *1: Unit benefit is US$0.327.

As shown in the table above, in the case of the effective capacity of $30\times10^6 m^3$ for El Peñón Reservoir, the average annual diverted water increases by $3.66\times10^6 m^3$ (=13.86-10.20). The benefit increase by El Peñón Dam is accordingly US$1.19 million. The increase in the annual cost is, on the other hand, US$2.44 million and this corresponds to the unit cost of $\$0.768/m^3$. It is accordingly concluded that El Peñón Dam is uneconomical.

The following illustration compares the Annual Net Present Value (B-C) and Benefit-Cost Ratio (B/C) in the case without El Peñón Dam.





As illustrated above, both B-C and B/C are the maximum with the diversion capacity of 2 m^3/s. The diversion capacity is accordingly determined at 2 m^3/s considering the higher value of B-C and B/C. The construction cost is estimated at US$19.44 million.

10.3.5 Optimization of Ocumarito-Tuy III Pumping Plan

The Ocumarito-Tuy III Pumping Plan is to pump up water from Ocumarito Reservoir to the pipeline of Tuy III System to minimize spill from the reservoir. The equivalent amount of water is to be saved in Camatagua Reservoir, and reduce the energy required by Pumping Station No. 31 and the Manonal booster pumping station.

(1) Necessary Structures

Structures considered for the optimization study are pumps and a pipe connecting the pumps to the pipeline of the Tuy III System.

(2) Confirmation of the Prerequisites for Planning

The following conditions have been considered as prerequisites for the optimization study:

- The simulation period is selected for 20 years from 1959-78 for the same reason as the Ocumarito-Lagartijo diversion plan.
- The installed capacity of 1.06 m^3/s is considered to be taken daily at Ocumarito Reservoir, the same condition as the Ocumarito-Lagartijo diversion plan.
- The Caicita diversion structure is to divert water from Camatagua Reservoir to Ocumarito Reservoir. Supply through Caicita diversion to the Ocumarito treatment plant is into consideration only for the deficit in the supply to the Ocumarito treatment plant, and it will not affect reservoir operation.

(3) Diversion Water Volume by Pumping Capacity

The diversion water volume by the pumping capacity is the same as that calculated for Ocumarito-Lagartijo diversion plan as follows:

Diversion Capacity	Average Annual Diverted Water	
m^3/s	mcm/year	m^3/s
0.5	6.09	0.19
1.0	10.5	0.33
2.0	15.4	0.49
3.0	17.9	0.57
4.0	19.5	0.62
5.0	20.3	0.64

(4) Cost Curve for Optimization

Cost curves for the pumping station, the connecting pipeline and operation cost have been prepared for the optimization study.

Annual cost has been obtained as the sum of annual construction cost and annual operation and maintenance cost. Annual construction cost has been calculated with the present worth of annuity factor of 0.12 (design life of 15 years for pumps, 30 years for pipes and 50 years for civil structures, and interest rate of 12%).

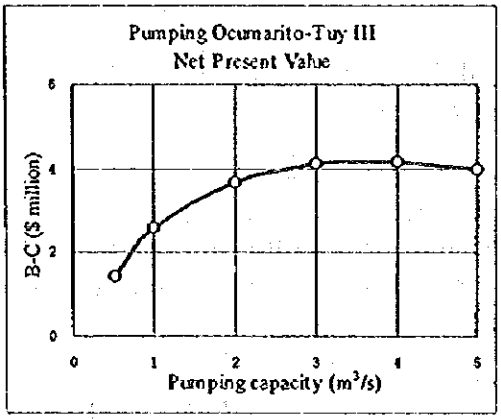
Pumping capacity	Construction	O&M	Total
m^3/s	$ mil	$ mil	$ mil
0.5	0.395	0.183	0.578
1.0	0.517	0.328	0.846
2.0	0.749	0.622	1.371
3.0	0.815	0.898	1.713
4.0	1.043	1.175	2.218
5.0	1.186	1.453	2.639

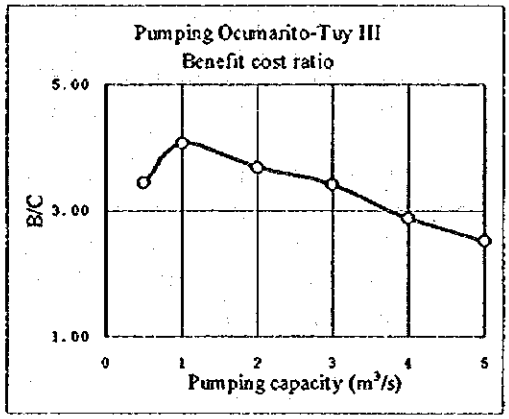
(5) Benefit-Cost Comparison of Alternative Development Cases

On the basis of the simulation results, the pumping and diversion capacity of 1, 2, 3, 4 and 5 m^3/s have been considered. The following table and figures show the Annual Net Present Value (B-C), Benefit-Cost Ratio (B/C) and unit cost per cubic meter of water.

Diversion Capacity	Ave. Annual Diverted Water	Ave. Annual Diverted Water	Annual Benefit (B)	Annual Cost (C)	B-C	B/C	Unit Cost
m^3/s	mcm/yr	m^3/s	$mil/yr	$mil/yr	$mil/yr		$/m^3$
0.5	6.09	0.19	1.99	0.578	1.414	3.45	0.095
1.0	10.5	0.33	3.43	0.846	2.588	4.06	0.081
2.0	15.4	0.49	5.04	1.371	3.665	3.67	0.089
3.0	17.9	0.57	5.85	1.713	4.141	3.42	0.096
4.0	19.5	0.62	6.38	2.218	4.159	2.88	0.114
5.0	20.3	0.64	6.64	2.638	4.000	2.52	0.130

The following illustration compares the Annual Net Present Value (B-C) and Benefit-Cost Ratio (B/C).





The Annual Net Present Value is the highest value with the pumping capacity of 4 m^3/s while the benefit-cost ratio takes the highest value with a pumping capacity of 1 m^3/s. The values of B/C are high in all cases at more than 3. The values of B-C for the pumping capacity of 3, 4 and 5 are almost the same. Accordingly, the pumping capacity of 5 m^3/s is recommendable.

10.3.6 Preliminary Design and Cost Estimate

Preliminary design and cost estimate for Ocumarito-Tuy III Pumping Plan are presented below.

Preliminary Design

See Fig. 10.3-3 for the layout plan of Ocumarito-Tuy III Pumping Plan. The preliminary design has been undertaken as follows:

The site selected for the pumping station was chosen for the following reasons: an existing road runs by the proposed site so the site is accessible from the construction and operation point of view, the pumping station is situated in a part of the reservoir not likely to be significantly affected by sediment or submerged debris, and near a point of sufficient elevation for the installation of a surge shaft.

The pumping station, shown in Fig. 10.3-4, is proposed to be founded on the rock base. Vertical pumps pump the water to the Tuy III pipeline approximately 2 km from the pumping station. Debris and fish are to be kept out by use of a manually cleaned trash rack.

Cost Estimate

Construction cost has been estimated as follows:

Item	Cost (US$ million)
Construction (incl. preparatory works)	
Transmission Pipeline (1,500 mm × 3,000 m)	2.29
Pump (1.0 m^3/s × 200 m × 6 unit)	3.12
Excavation and removal	0.69
Concrete	0.61
Reinforcing bar	0.15
Sub-Total	6.86
Engineering and administration (15%)	1.03
Physical contingency (25%)	1.98
Total	9.87

10.4 Guare Dam Plan

The Guare River is a right bank tributary of the Tuy River with a catchment area of 185 km^2. It flows into the Tuy River at Tácata. The Guare Dam plan is to develop water resources by the construction of a dam on the Guare River.

A preliminary study (hereinafter called as the INOS Study) was conducted by INOS in 1962. The present pre-feasibility study has been conducted through field investigation and review of the existing data and information as well as referring to the results of the INOS Study

10.4.1 Topographical Condition

The proposed site of the Guare Dam is located on the Guare River 1.5 km upstream of the confluence with the Tuy River (see Fig. 10.4-1). The catchment area at the proposed damsite is 183 km^2 occupying almost all 185 km^2 of the Guare River basin. The proposed damsite is located in a narrow gorge and the upstream side provides a favorable topography, a wider valley, to create a reservoir.

The topography of the damsite is characterized by a thin ridge projecting along the left bank downstream to upstream. The width of ridge at the crown of the proposed dam is approximately 45 m. The elevation of the ridge top near the proposed dam axis is approximately EL 360 m.

The width of the river itself at the proposed damsite is approximately 15 m. There is, however, a 50 m-wide flat plain on the right bank. The slopes of both left and right banks are steep at approximately 40°.

10.4.2 Geological Condition

The upper and middle basins of the Tuy River are geologically in the northern zone of Venezuela (coastal mountains). Mainly Mesozoic strata exists in the area. The Mesozoic strata consists of metamorphosed accumulated rocks and volcanic rocks, and small masses of intruded rocks, e.g., serpentine and diorite, occur at places. Regional geological structure is characterized by a series of faults mainly of east-west to northwest-southeast orientation.

Mesozoic Cretaceous metamorphic rocks are widely distributed in the area of the proposed damsite. Calcareous phyllite dominates, schists, red phyllite and serpentine are also found. Phyllite is generally hard, but is fragile in the schistosity phase. The schistosity is much developed in red phyllite and serpentine. Covering layers are talus and terrace deposits. Talus deposits are distributed locally and terrace deposits are distributed widely along the Guare River forming plains.

Many wrench faults occurred in the Cenozoic. Tácata Fault is an obvious one in this area. A major fault in the proposed damsite area is a branch fault of the Tácata fault, see Fig. 10.4-2. It is not a large fault with a 20 cm-thick clayey layer and a 2 m-thick fragmented zone. It is not clear if this fault is active or not.

10.4.3 Land Use in the Reservoir Area

The results of a survey by INOS have been reviewed based on aerial photographs and field investigation. The breakdown of land use is as follows:

Land Use	Area (ha)
Non-used mountains and hills	120
Cultivated land	100
Total	220

10.4.4 Hydrological Data

Discharge measurements on the Guare River have been conducted at Río Arriba (catchment area of 92 km^2) since 1978. However, the data contain many gaps, and full data exists for only four non-continuous years of 1978, 1889, 1991 and 1992. In this study, the river flow is estimated based on the observed values of the Ocumarito River at El Desecho which is located nearby and the condition is similar.

10.4.5 Related Development Plans

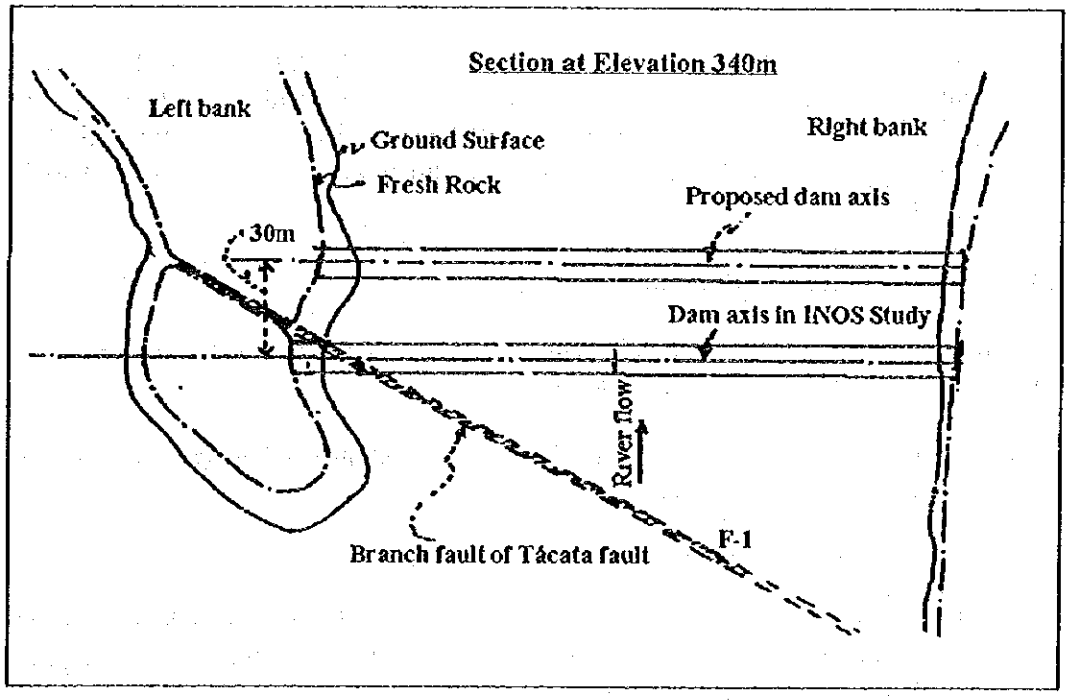
In the Guare river basin, there is a plan to develop nickel mining in the west end. It is called "*Project of Loma de Hierro, Miranda and Aragua States*". The plan is at the stage of environmental impact assessment with the Tuy River Basin Agency as the evaluator. In the present study, it is considered that all wastewater and wastes would be treated properly and no negative effects are anticipated from the mining plan.

10.4.6 Determination of Dam Axis

The dam axis has been determined at 30 m downstream from the one proposed in the INOS Study. The reasons are as follows:

- A branch fault of the Tácata fault runs along the former dam axis, and it should be avoided.
- It is more economical to place the dam axis on the downstream side since water stoppage works for the narrow left bank ridge are reduced, although the necessary space for the construction of a spillway should be maintained on the ridge.
- The elevation of the right bank ridge becomes low when the dam axis is on the downstream side; the shift of axis of 30 m creates no problem

The sketch of the topography and geological condition at the proposed dam site is presented as follows:



10.4.7 Confirmation of H-A-V Curve

The curve for the relation of Height-Area-Volume for the proposed reservoir has been developed based on the 1/5,000 maps. The curve is presented in Fig. 10.4-3.

10.4.8 Determination of Dam Type

A center core rockfill type dam has been proposed in the INOS Study. This study also selected the same type of dam for the following reasons:

- The construction costs for the case of a rockfill type dam and a concrete gravity dam have been compared as follows and the rockfill dam is more economical being about a half the cost of the concrete gravity dam:

Item	Cost	Calculation
Rockfill dam		
Dam body	$\$24\times10^6$	$1.2\times10^6 m^3\times\$20/m^3$
Spillway	$\$ 8\times10^6$	$30{,}000 m^3\times\$250/m^3$
Total	$\$ 2\times10^6$	
Concrete gravity dam		
Dam body/spillway	$\$63\times10^6$	$250{,}000 m^3\times\$250/m^3$

- The clayey material for the center core is considered to be available in the vicinity of the damsite, although only thin layers were found inside the reservoir area.

- The drilling investigation made in the INOS Study did not identify a quarry site for rock material (size of rock of 0.5-1.0 m) and concrete aggregate. Although farther investigation is needed especially of sandstone and shale areas, not for metamorphic rocks, rock and aggregate are considered to be available in the vicinity.

10.4.9 Study on Water Diversion Method

The flow regulated by the reservoir will be used for domestic water supply. This study examines two means of water diversion and intake:

- Regulated flow is released into the Guare River just downstream of the dam and taken at Toma de Agua.

- Water is diverted to Caujarito treatment plant of the Tuy III system.

For the first option, the water is to be used in the Tuy I and II systems where the water transmission and treatment is currently at capacity. On the other hand, Caujarito treatment plant has sufficient capacity. Accordingly, in this study, the second option is selected.

In the second option, the discharge from the Guare River downstream of Guare Dam decreases. This means that the water quality of the Tuy River downstream from the confluence with the Guare River is worsened. Accordingly, for this option, periodic releases of water is also considered.

10.4.10 Optimization of Development Scale

The optimum dam height has been determined considering topographical conditions, economic advantage, etc., as follows:

(1) Possible Maximum Dam Height

The maximum crest elevation is approximately EL 355 m in accordance with the topography of the left bank ridge. The possible maximum normal water level is thus determined at EL 351 m subtracting a surcharge capacity and freeboard of 4 m from the possible crest elevation of EL 355 m. The possible maximum gross storage capacity of the reservoir is 60×10^6 m^3 according to the H-A-V curve.

(2) Sedimentation Capacity

Sedimentation capacity is determined at 6.6×10^6 m^3.

(3) Possible Development Water by Reservoir Scale

Annual average flow to be developed has been calculated by simulation of reservoir operation. The conditions of calculation are:

- The regulated flow is 95% assured water. This means the flow is available for 95% of simulation period.
- Rainfall and evaporation from the reservoir are taken into account.
- A river maintenance flow of 0.38 m^3/s is used.

The simulated values are:

Max. reservoir capacity ($\times10^6$m^3)	20	25	30	35	40	50	60
Intake capacity (m^3/s)	1.12	1.35	1.55	1.71	1.85	1.93	1.99
Annual ave. intake (10^6m^3)	33.6	40.4	46.7	51.4	55.4	57.9	59.8
Annual ave. intake (m^3/s)	1.07	1.28	1.48	1.63	1.76	1.84	1.90
Annual ave. spill (10^6m^3)	26.0	20.0	14.5	10.3	6.7	4.6	2.9
Efficiency (%) *1	46	55	64	70	76	79	82

Note: *1: Efficiency is the ratio of annual average flow to the inflow to the reservoir

(4) Cost Curve

The cost for the construction and maintenance of the dam and diversion and intake facilities have been considered.

Annual cost has been obtained as the sum of annual construction cost and annual operation and maintenance cost. Annual construction cost has been calculated with the present worth of annuity factor of 0.11 (design life of 50 years and an interest rate of 12%).

Gross capacity	Dam		Diversion		Total
	Construction	O&M	Construction	O&M	
$\times 10^6 m^3$	$ mil	$ mil	$ mil	$ mil	$ mil
20	2.72	0.49	4.31	0.22	7.74
25	3.10	0.56	4.44	0.29	8.39
30	3.36	0.61	4.57	0.36	8.90
35	3.69	0.67	4.69	0.40	9.45
40	3.98	0.72	4.79	0.45	9.94
50	5.05	0.92	4.85	0.47	11.29
60	7.43	1.35	4.87	0.49	14.14

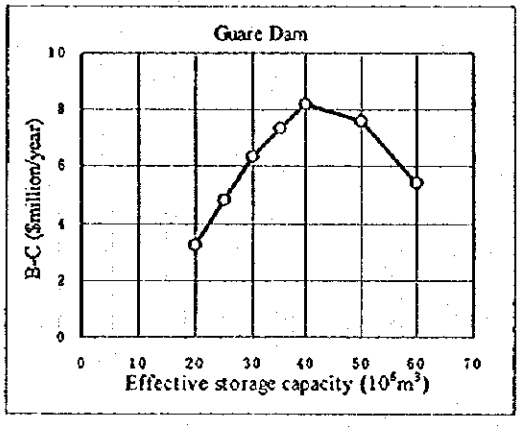
(5) Benefit-Cost Comparison of Alternative Development Cases

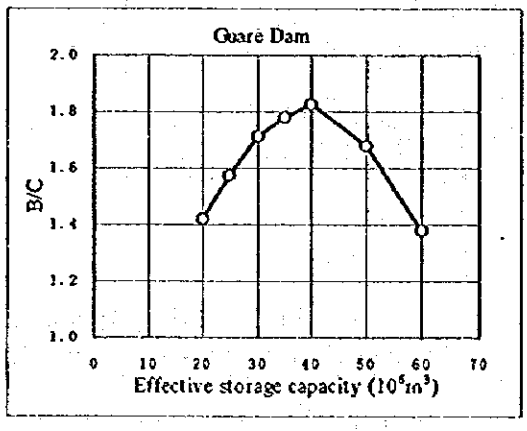
The following table and illustrations show the Annual Net Present Value (B-C), Benefit-Cost Ratio (B/C) and unit cost per cubic meter of water.

Effective storage capacity	Dam height	Ave. Annual Diverted Water		Annual Benefit (B)	Annual Cost (C)	B-C	B/C	Unit Cost
$\times 10^6 m^3$	m	$\times 10^6 m^3/yr$	m^3/s	$mil/yr	$mil/yr	$mil/yr		$/m^3
20	49	33.6	1.07	11.0	7.74	3.26	1.42	0.230
25	52	40.4	1.28	13.2	8.39	4.83	1.58	0.208
30	56	46.7	1.48	15.3	8.90	6.36	1.72	0.191
35	59	51.4	1.63	16.8	9.45	7.36	1.78	0.184
40	61	55.4	1.76	18.1	9.94	8.19	1.82	0.179
50	66	57.9	1.84	18.9	11.29	7.65	1.68	0.195
60	70	59.8	1.90	19.6	14.14	5.42	1.38	0.236

Note *1: Unit benefit is $0.327/$m^3$

The following illustration compares the Annual Net Present Value (B-C) and Benefit-Cost Ratio (B/C).





As illustrated above, both B-C and B/C are the maximum with the gross storage capacity of $40 \times 10^6 m^3$. The gross storage capacity has been accordingly determined at 40 m^3/s considering the higher value of B-C and B/C.

10.4.11 Preliminary Design and Cost Estimate

Preliminary Design

Principal design features of Guare Dam are the following:

Item	Value
Reservoir	
Gross storage capacity	$40.0\times10^6 m^3$
Effective storage capacity	$33.4\times10^6 m^3$
Sedimentation capacity	$6.6\times10^5 m^3$
Surcharge Water Level (SWL)	EL 350.0 m
Normal Water Level (NWL)	EL 346.0 m
Low Water Level (LWL)	EL 322.0 m
Riverbed Elevation	EL 285.0 m
Effective depth	24 m
Surface area at SWL	174 ha
Catchment area	183 km^2
Annual average flow	2.3 m^3/s
Dam	
Type	Center core rockfill
Crest elevation	EL 352.0 m
Height	67 m
Freeboard	2 m
Crest length	225 m
Crest width	10 m
Volume of dam	1,110,000 m^3
Slope Upstream face	1 : 2.5
Downstream face	1 : 2.25
Spillway	
Type	Tunnel spillway
Surcharge capacity	$7.9\times10^6 m^3$
Design discharge	600 m^3/s
Dimension	8 m-diameter
Diversion works	
Design flow	350 m^3/s
Diversion tunnel	Standard horseshoe type i = 1/50, 6 m-diameter
Coffer dam	Crest elevation: EL 315.0 m
Intake	
Domestic water	Intake tower, 3-span ϕ500 steel sluice
Maintenance flow	Inclined sluice of 3-span ϕ150 steel sluice, 0.09 m^3/s

Cost Estimate

Construction cost has been estimated as below.

Item	Cost (US$ million)
Preparatory works	1.32
Construction of dam	17.24
Construction of spillway and intake	2.45
Pumping station and diversion pipe	31.92
(Sub-total)	52.93
Engineering and administration (15%)	7.94
Physical contingency (25%)	15.22
Total	76.10

CHAPTER 11. CONCLUSION AND RECOMMENDATION

11.1 Conclusion

The Master Plan that has been formulated in this Study to secure a potable water supply with acceptable water quality and to establish a sustainable pollution control system consists of two stages: the Short-Term Program and the Mid-Term Program targeting the year 2010.

To facilitate the realization of the Master Plan, priority projects in the Short-Term program with the target year of 2003 have been selected and their feasibility examined.

It has been identified that as a whole the priority projects are technically feasible and financially viable.

11.2 Recommendation

Arrangement for Project Implementation

(1) Justification of the Master Plan

The environmental improvement of the Tuy River is crucial; hence, the Master Plan formulated for the purpose should be considered as a part of the Venezuelan National Development Plan.

(2) Implementation of Priority Projects

The priority projects are technically feasible and financially viable as a whole; hence, it is recommended that they be promoted to the next stage of implementation at the earliest possible opportunity. (The necessary procedure toward implementation is shown in the ANNEX in Volume 3.)

(3) Arrangement of Loan from Available Financing Source

To implement the projects, it is necessary to obtain a loan from an international financing agency. Therefore, it is recommended that appropriate action be taken to arrange a loan from an available financing source.

(4) Promotion of Institutional Measures

The priority projects are composed of physical and institutional measures. To implement the physical measures smoothly, it is necessary to arrange the institutional measures first. Since most institutional measures with the exception of the Environmental Fund can be provided with less financial burden, it is recommended that the arrangement of institutional measures be promoted along with the arrangement of the loan.

(5) Promotion of Legal Arrangement

New laws are proposed to be enacted to establish the Environmental Fund and to impose pollution charges for the purpose of promoting the installation of sewage treatment plants by factories and piggeries. In this study, only the outlines of the laws are introduced, because the enactment of new laws will need further study to clarify details such as scope, conditions, applicability, functions of authorities and so on. In this connection, it is recommended that a study should be started immediately by the Tuy River Basin Agency to define the contents of laws for the early realization of legal arrangements.

(6) Consideration of Restructuring and Decentralization

MARNR is presently in the process of strengthening its organization including decentralization of its function to state governments under the Venezuelan Environmental Management Project which is being financed by the World Bank, and some institutions under it may be reorganized like the Tuy River Basin Agency and Hidrocapital. In this study, however, it is presumed that the present organization of the Tuy River Basin Agency or, at least, its basic function of handling works in the basin is maintained. If ever the present organization is reorganized, it is recommended that its function to realize the project components proposed in this study is maintained considering the significance of the projects and the extent of the study area.

(7) Arrangement for Land Acquisition for Physical Measures

To implement the physical measures such as sewage treatment plants and sand settling pond, it is necessary to acquire land for the facilities. In this connection it is recommended that action be taken to acquire land for the structures as early as possible.

(8) Promotion of Cooperation and Understanding from Local People

For the execution of physical measures including the installation of treatment plants for factories and piggeries, the construction of sewerage system and reforestation, it is necessary to strengthen the cooperation and to deepen the understanding of local people. Information about the project should be advertised from time to time to obtain their cooperation and understanding.

(9) Consideration of Environmental Impact Assessment

In the study of environmental impact assessment, several impacts have been identified. Although these impacts are not serious, mitigating measures are proposed together with impact management and monitoring plans. For project implementation, these measures and plans should be taken into account.

Further Study in the Next Study Stage

(1) Study on Sewage Treatment Plant and Sewage Drainage Network

As the most suitable sewage treatment plant at present, the trickling filter method has been selected because of its technical and economical advantages, though it requires a larger space than the other systems like the activated sludge method. Since the adequacy of the system will depend on space availability and the sewage volume to be received, system improvement should be examined in stages in the future according to the future increase of population. Also, development of sewage drainage network should be examined in the future according to the area of urban development.

(2) Study on the Establishment of Sewage Charge System

To establish the sewage charge system, it is necessary to firstly identify who should pay. Then the sewage charge to be imposed to polluters (and beneficiaries) will be set depending on their discharged wastewater volume (and amount of water consumption). In this F/S study, only the alternatives of cost bearers for the construction and O&M costs of the sewage system have been examined for financial evaluation. Hence, the sewage charge system as well as cost sharing should be examined further after confirmation of the cost by detailed design.

(3) Utilization of Sludge and Treated Wastewater

The sewage treatment plant will discharge sludge and treated wastewater as a result of the treatment process, and these are high in organic nutrients. Since these can be used as fertilizer for agricultural production, utilization of such products should be considered in neighboring farming areas.

(4) Construction of Sand Settling Pond

As a measure to secure the water quantity, a sand settling pond at Toma de Agua has been proposed and the effectiveness of this measure which depends on the sediment materials transported in the river has been confirmed based on the limited data observed in the feasibility study level. For the further study, it is necessary to collect more information on sediment materials in the river water.

(5) Securement of Water Quantity

For the securement of water quantity, several measures have been examined in the pre-feasibility study level to select the optimum ones. The measures include: (1) torrent diversion; (2) Ocumarito - Lagartijo diversion, (3) Ocumarito - Lagartijo diversion with El Peñón Dam, (4) Ocumarito - Tuy III system pumping, and (5) Guare Dam and it has been concluded that the Ocumarito - Tuy III system pumping and the Guare Dam have economic advantages and therefore selected as the Short-Term Program measures.

Since the study for these measures has been only on the pre-feasibility level, it is necessary to conduct a feasibility study as early as possible.

(6) Items to be Examined for the Establishment of Pollution Charge

The following items are proposed to be further examined to establish the pollution charge: polluters and water quality levels for which pollution charge is to be applied, rate of charge, system of charge collection, and monitoring of polluters. These items should be examined by a further study by the Tuy River Basin Agency, which may be undertaken with technical cooperation from JICA. For that purpose, references on legislation such as France, Spain, Germany and so on are proposed to be collected.

(7) Collection of More Information for Further Study

The study has been conducted based on the limited information collected. Since the information on water quality and quantity is essential to precisely analyze the environmental condition, more detailed data and information should be produced for further study through early establishment of the monitoring system.