COMISIÓN MUNICIPAL DE AGUA POTABLE Y ALCANTARILLADO DE REYNOSA, TAMPS. (COMAPA)

BORDER ENVIRONMENT COOPERATION COMMISSION

COMPREHENSIVE SANITATION PROJECT FOR THE CITY OF REYNOSA, TAMPS.

BORDER ENVIRONMENT COOPERATION COMMISSION

Project Type:

Water		Closure		Public Sector	**(X)**
Wastewater	**(X)**	Rehabilitation	**(X)**	Private Sector	
Municipal Solid Waste		Expansion	**(X)**	Public/Private Venture	
Other		New Plant	**(X)**		

Main Contact:

Lic. Luis Gerardo Higareda Adam, General Manager.
Comisión Municipal de Agua Potable y Alcantarillado de Reynosa, Tamps. (COMAPA)
Pánuco y J. Escandón, Col. Longoria
C.P. 88660, Cd. Reynosa, Tamps. México
Tel. (89) 24-33-16
Fax. (89) 23-34-63

EXECUTIVE SUMMARY

GENERAL INFORMATION

The City of Reynosa lies south of the United States and north of the city of Méndez; the City of Rio Bravo lies east, while the City of Díaz Ordaz and the State of Nuevo León lie west of Reynosa. It is located 26º 04' 24'' latitude north and 98º 17' 12'' longitude west, and 125 feet above sea level.

The Reynosa sewage system was designed in a separate mode, however absence of a storm water drainage system results in large amounts of rainwater being incorporated into the system. It has both main and secondary collectors in need of repair or replacement due to their age, state of deterioration, corrosion, and obstructions

Approximately 25 percent of the lots that have municipal sewage services provided continue to dispose of their raw sewage via septic tanks and cesspools. These methods must be eliminated in order to avoid further contamination to underground resources and at the same time improve public health.

There are currently thirteen lift stations. Occasionally, when the lift station is overloaded, the collectors operate with a hydraulic load; by reducing the leakage rate, solid waste is then deposited and decomposed causing foul and unpleasant odors as well as corrosion to

the pipes. Furthermore, in some cases, when the collectors go into the hydraulic load mode, they leak into public areas. Several lift stations, such as No. 3 and No. 10, have surplus lines that discharge raw wastewater into the collecting bodies.

The City of Reynosa currently relies on an oxidation pond system for treatment of its wastewater and the plant's current capacity has been determined to be inadequate. As such, the water currently being discharged into the Rio Grande River does not comply with required norms. In the future, the treatment plant effluent will not be discharged into the Rio Grande River. The effluent will be conveyed via the Anzaldúas and Rodhe Canals to the irrigation districts.

Rehabilitation and expansion of the sewage system is required and involves replacement of the damaged pipes in the primary and secondary systems; implementation of a maintenance system; expansion of the system to provide service to the subdivisions lacking service and which will use a conventional gravity sewage system; and implementation of a program to incorporate areas that have yet to be connected to the sewage system.

With regard to the wastewater pump stations, rehabilitation and expansion of the plant's capacity is required. Both the electrical/mechanical as well as the civil engineering components must be considered. Also required is the rehabilitation, replacement or expansion of the pressure lines that discharge into the current treatment plant into the new plants.

The current WWTP exceeds its design capacity and requires rehabilitation. In addition, construction of two additional plants will help meet the future planning demands (through the year 2016). The proposed treatment consists in anaerobic ponds followed by a facultative treatment process, similar in design to Treatment Plant No. 2.

Rehabilitation and expansion projects for the municipal drainage system and the treatment plants could be carried out during the course of a 20-year period in four stages:

Stage I 1997-2001	***Stage II 2002-2006***	***Stage III 2007-2011***	***Stage IV 2012-2016***

PROJECT TASK PROGRAM

Task	Description	Stage	Cost * (dollars)
Rehabilitation of the Current WWTP No. 1	Anaerobic lagoons followed by facultative lagoons modified to piston flow.	**I**	3,439,431
Construction of the New WWTP No. 2 (“Expansion”)	Anaerobic lagoon followed by facultative lagoon.	**I**	7,091,300
Construction of the New WWTP No. 3 (New)	Design is conceptual and location will be south of WWTP No. 1.	**I**	7,847,705
Construction-Rehabilitation of Lift Stations	Need to be configured to pump maximum hourly volume during rain season, with automated emergency equipment.	**I – II**	16,974,100

Rehabilitation and Construction of the Primary Sewage System	Rehabilitation and incorporation of PVC and reinforced concrete into the 10 in (or more) diameter collectors to reach a 50 year useful life.	**I – II III – IV**	16,114,175
Rehabilitation of the Secondary Sewage System in 13 subdivisions.	PVC rehabilitation, ϕ = 8 in with hermetic joints, manholes, and installation of residential discharge s.	**I**	6,854,477
Rehabilitation of Sewage System in the Petrolera Sub-division.	PVC Rehabilitation, ϕ = 6 to 18 in with hermetic joints, manholes, and installation of residential discharges.	**I**	2,401,672
Expansion of the Sewage System in 16 sub-divisions.	PVC construction and reinforced concrete, ϕ = 8 to 36 in with hermetic joints, construction of manholes, and installation or residential discharges.	**I**	7,753,841
Regulate discharges by lots not connected to the sewage system.	Total number requiring connection is 17,493 in 37 sub-divisions in Reynosa, Tamps. and closure of latrines.	**I**	1,655,274
Long term program to Rehabilitate the Primary Sewage System.	Rehabilitation of approx. 34 miles with PVC and reinforced concrete, including a collector inspection plan and prioritization of actions through the year 2016.	**I – II III - IV**	13,266,000
		Total:	**83,397,975**

* The O&M costs are discussed in the financial section of this document

Location of the new wastewater treatment plants has been determined based on the sewage system needs as well as the availability of space. The first criterion used for (site) selection was the plant's location in proximity to these facilities. The second criterion relates to the availability of surface area for construction. Design needs and operational-economical aspects require a large surface area. For this reason, WWTP No. 1, built in 1970, was built at the existing location and there are no plans to change this site in the future. Another advantage to this site is that discharging the water into the Anzaldúas Canal does not present a problem and also avoids adverse transboundary effects by discharging the treated effluent into the Rio Grande River. In addition, the location and design of this facility, ensures that under flooding conditions the Plant will operate safely.

With regard to WWTP No. 2, the drainage system is distributed to convey wastewater to the selected site; this area currently has lots available for construction. Different localization options were analyzed in accordance with the following conditions: extension, location outside city limits, future population growth, urban growth trends, etc. After analysis of the aforementioned conditions, the most appropriate location for WWTP No. 3 was determined to be on the far east area of the city, close to the Reynosa/Pharr International Bridge, outside of the .flooding protected area boundaries.

Location of WWTP's #2 and #3 was determined in the Sub-Regional Territorial Ordinance Plan for Reynosa-Rio Bravo, Tamaulipas, prepared in October 1991. Some advantages to the location of the plants include discharging the treated effluent into the

Anzaldúas and Rodhe drains and thus avoiding negative transboundary effects. In addition, the drains are in close proximity to the plants.

Treatment of the municipal wastewater can be carried out efficiently via secondary or biological, and was selected as the most appropriate because it does not require a highly specialized workforce for operation and maintenance. Another contributing factor was its cost effectiveness since, aside from the pumping system for the raw wastewater, does not require electro-mechanical equipment.

A computerized hydraulic model was developed to review operations of the sanitary sewage facilities in Reynosa. This model was used to evaluate the existing system's capacity and to determine what facilities and hydraulic capacity are required to handle the projected flows. The model focuses on the main collector system and incorporates data from the primary sewage system, manholes, and surveys taken with the Global Positioning System (GPS), land use projections, lift station evaluations, lift station discharge pipes, and flow monitoring results.

Similar to the primary system, rehabilitation and expansion sites of the secondary system cannot by defined. In order to provide wastewater collection services, project needs have indicated that the systems must be laid along the city streets to make connections to the different domestic, commercial, service, and industrial users feasible

Due to its characteristics and availability in Reynosa and after extensive evaluations, it was concluded that the most appropriate material for rehabilitation and expansion of the secondary system is PVC. Future assumptions have indicated that the sewage system must be built with tighter restrictions to minimize flow into the collectors.

Immediate consequences of not implementing measure to rehabilitate the current systems will be reflected in the bad condition and low efficiency levels of the pumping systems, sewage system and wastewater treatment system. This situation has a direct impact on human health and the community's surroundings. Leaks tend to flow into the natural ground, contaminating underground resources; water quality will not be adequate for irrigation and will cause diseases in the farming community as well as in the consumers of these products.

In conclusion, not implementing the project will have serious impacts on human health and the environment. Specifically, discharging raw wastewater into the Rio Grande River will create transboundary effects.

HUMAN HEALTH AND ENVIRONMENT

The relationship between the environment and community's health/disease level is undeniable. Studies and experiences in countries where high levels of basic service coverage, such as waster, sanitary sewage, wastewater treatment collection and treatment, and solid waste management, among others exist, have demonstrated a

significant decrease in the prevalence of infectious/contagious diseases, specifically gastrointestinal diseases. On the other hand, in countries and cities, like the City of Reynosa, where provision of these services is not adequate, high levels of these diseases are present.

The Integral Sanitation Project for the City of Reynosa, Tamaulipas, will clearly address the sanitation problems by providing 100 percent treatment to its wastewater and reach high coverage levels for drainage and potable water. In addition, the treated effluent will comply with Official Mexican Norm 001-ECOL-96, for irrigation purposes.

In the City of Reynosa, gastrointestinal diseases and parasite related diseases have been placed third under general disease rates and are the frequent cause of death among children under the age of five. The first most common disease is respiratory ailments caused by severe changes in temperature and the generation of dust. The ratio between the rates of intestinal diseases and respiratory diseases is approximately 1:5.

The Integral Sanitation Project for the City of Reynosa, Tamaulipas has also complied with the required environmental evaluation issued by the appropriate natural resource authorities. The Environmental Impact and the Finding of No Significant Impact on Cultural and Historical Resources has also been issued.

The project will however cause adverse effects during the construction stages and operation and maintenance of the drainage systems and the wastewater treatment plants. However, the majority of the impacts can be mitigated and prevention and control measures will be undertaken as part of the project.

Transboundary environmental impacts will be positive since the project will not cause potential contamination to the soil or underground or surface water resources.

TECHNICAL FEASIBILITY

Specific design criteria have been developed to ensure that changes to the system, such as design, construction, and operation will be maintained throughout the project's projected useful life. In this manner, sewage system service with a useful life over 50 years for the different structural components (pipes, manholes, pump stations, etc.) can be assured and a useful life of more than 20 years can be assured for mechanical equipment.

The estimated current wastewater flow exceeds nominal capacity at the existing wastewater treatment plant (WWTP). Based on service area flow projections, the need for WWTP #2 is immediate while WWTP#3 will be required within the next 5 years.

Development of the Final Design of the Treatment Plant Rehabilitation and Expansion Project also provided analysis of both the treatment plant influent and effluent. Wastewater characterization, drilling, and tests to determine design constants resulted in the modification being proposed for WWTP #1. After evaluating the alternatives, it was concluded that the best option for rehabilitating the existing system was the option

consisting in the expansion of the anaerobic ponds followed by facultative ponds modified to piston flow. This option has been developed through the Final Design stages.

In accordance with the information collected during field visits, population projects, potable water and sewage services, city growth plans, land use at feasible treatment sites, and the area topography, different alternatives to expand the treatment system were established. It was determined that the best option for WWTP No.2 is the alternative consisting of anaerobic ponds followed by facultative ponds.

By the year 2001 it has been determined that a third wastewater treatment plant will be required to treat a portion of the 53.6 mgd average wastewater flow that is expected to be generated through the year 2016. WWTP #3 has been designed conceptually and its location will be east of the Reynosa-Pharr Bridge. It will have the capacity to treat 19.4 mgd. The treatment process will be similar to the pond systems and as such, will require approximately 198 acres for construction.

Pursuant to the *Ley de Equilibrio Ecológico y de Protección al Ambiente del Estado de Tamaulipas (Environmental Protection Laws of the State of Tamaulipas),* the Environmental Department of the State, the Environmental Department of the City and the Potable Water and Sewage Board of the City of Reynosa, Tamps., developed a Wastewater Reduction and Pre-Treatment Program. The program basically consists in the development of a discharge register, follow up activities on discharge quality and quantity; control via implementation of pretreatment systems, and imposing sanctions or incentives based on compliance or non-compliance with requirements.

The primary sewage system in Reynosa is approximately 64 miles in length and includes a sewage drain pipe system whose diameter is 10 in wider. The sites requiring project work were established based on the drainage system evaluation which includes: revision of wastewater plans and system information; field measurements collected with the Global Positioning System (GPS) of manholes in the primary system, and conventional measurements of the system's other components, interviews and field visits with COMAPA staff, inspections and evaluations of the man holes and lift stations, rainfall and duct flow monitoring, system inspections via Closed Circuit TV (CCTV), a Closed Circuit Sonar Inspection Technique (CCSIT), corrosion, sulfur, and hydrogen samples, and a system simulation through the load model.

After reviewing these factors and materials, it was concluded that the most appropriate materials for construction and rehabilitation of the system was PVC and reinforced concrete. Materials used to manufacture PVC and reinforced concrete must comply with CNA standards.

The main corrosion-causing agent in the sewage system is sulfuric acid. Rehabilitation of the sewage system will help reduce the production of sulfuric acid by avoiding water settling and turbidity in the water. However several areas have been identified were this situation may continue to occur and an additional protective coating must be utilized. In

areas where corrosion is likely to occur, it is necessary to increase the concrete thickness of the pipe, between the steel and pipe interior, in order to increase useful life. All concrete pipes without the epoxy layers must have a thick wall to provide the concrete with the required "endurance".

To ensure compliance with minimum requirements, several detailed and specification plans for each of the projects (both construction and rehabilitation) must be prepared. The plans must be reviewed prior to construction stages to ensure compliance.

There are approximately 1,400 manholes in the Reynosa sewage system. The manholes are generally made of brick (98% of the total) or concrete. Based on the analysis, the manholes will be made of prefabricated concrete or brick. An epoxy covering will also be provided in case they are exposed to turbidity or corrosion. Manholes will have to be replaced in sections where original pipes are rehabilitated. To increase ventilation in the system and avoid corrosion, manhole lids must have vents, except in highly populated areas or environmentally protected areas, or areas susceptible to flooding.

Based on the project useful life of the exiting pipes, estimates indicate that the complete system will require structural improvements by the year 2016. Improvements do not include the new proposed pipes to improve the load capacity or to avoid structural faults in the short term. Over 34 miles of the primary gravity system require rehabilitation improvements to extend the system's useful life.

The small drain system collects domestic, commercial, and industrial discharges. The system's length exceeds 425 miles. Approximately 92 miles require rehabilitation due to the infrastructure's age and corrosion; it is distributed in 14 subdivisions.

In addition, the sewage system must be expanded in 16 subdivisions.

Also, 37 subdivisions require to regulate discharges from lots that are not connected to the sanitary sewage system:

Pump stations are the essential component of the drainage system, as such, any faults or problems affect the entire system. The age of the pump stations ranges from one to thirty years. General recommendations were developed based on the analysis of the pump stations in order to provide immediate corrective measures to the structural, electrical, and most critical hydraulic problems.

COMAPA will be responsible for the operation and maintenance of Reynosa's potable water and sewage systems. Due to the high rate in population growth, infrastructure development and maintenance has not been sufficient to satisfy all needs.

The following maintenance plans were developed and must be extensively developed and include operation manuals in the final design projects:

1. Start Up Operation Plan.

2. Contingency Plan.
3. Safety Plan.
4. Quality Assurance Plan
5. Pollution Prevention Plan.

In developing the existing projects, the following land use plans have been taken into consideration:

- Municipal Urban Development Plan
- State Master Plan for Urban Development
- State Environmental Ordinance Plan

Development of the wastewater system is required to utilize design norms and applicable regulations by stage agencies. The Integral Sanitation Project complies with the following evaluation and design criteria:

1. "Lineamientos Técnicos para la Elaboración de Estudios y Proyectos de Agua Potable y Alcantarillado Sanitario" CNA, México 1994. (Technical Guidelines for Development of Water and Sanitary Sewage Studies and Projects)
2. "Especificaciones Generales para la Construcción de Sistemas de Agua Potable y Alcantarillado" CNA, México 1993. (General Specifications for Construction of Potable Water and Sewage Systems)
3. "Manual de Especificaciones Generales y Técnicas de Construcción de Sistemas de Agua Potable y Alcantarillado" SEDUE, México 1986. (General Specifications Manual for Construction of Potable Water and Sewage Systems)
4. "Normas de Proyecto para Obras de Alcantarillado Sanitario en Localidades Urbanas de la República Mexicana", SAHOP, México 1979. (Project Norms for Sanitary Sewage Projects in Urban Locations in the Republic of Mexico)
5. "Guía General para la Elaboración de Proyectos de Ingeniería de Sistemas de Agua Potable y Alcantarillado", SAHOP, México 1979. (General Guide for the Development of Water and Sewage Engineering Projects)
6. "Manual de Diseño para Lagunas de Estabilización" CNA, México 1994. (Design Manual for Stabilization Ponds)

With regard to the pump stations, recommendations address the pumping equipment and electrical system in accordance with NOM-001-SEMP-1994. The main specifications used are:

1. Electric Equipment Selection, CNA, Mexico, 1994,
2. Mechanical Facilities Design and Selection of Mechanical Equipment, CNA, Mexico, 1994.

Norm NOM-001-SEMP-1994, issued by the Secretary of Energy, Mines, and (Para) State Industry (SEMIP) established technical specification that electrical energy facilities must meet.

In this manner, assurances that project will be carried out in conformance with issued authorizations in order to comply with Official Mexican Norms will be undertaken. COMAPA participation during manufacturing and test processes to ensure compliance with the aforementioned norms is important.

FINANCIAL FEASIBILITY AND PROJECT MANAGEMENT

The project was analyzed to determine its financial impact on COMAPA. Additionally, the project in and of itself would have to be capable of generating the necessary cash flow and revenues. Based on population projections, planned coverage, and estimated allowances, water demand projections were prepared for Reynosa. This demand would increase from 23 mgd in 1996 to 54 mgd by the year 2016. Three alternative scenarios were developed; they vary according to the amount of grants and loans the project might receive. The analysis of the pro forma financial statements for each of these scenarios determined that the project is financially feasible if a strict prioritization order is maintained in the investment program. It involves a total investment of $660 million pesos, which represents almost the totality of Reynosa's investment for the 1998-2001 period.

A set of financial models were obtained from the three scenarios considered. They resulted in different rate/fee structures that can support the project's financial viability. As such, real annual increases of 10 and 15% to water and wastewater collection fees allow the utility to cover future operating and maintenance costs, and obtain the necessary cash flow to amortize the debt and cover physical infrastructure replacement costs. It must be noted that COMAPA's fee increases must correspond to the final project funding structure, considering grants, loans and COMAPA's own funds.

It would be convenient for COMAPA to initiate the following actions to consolidate the utility and ensure the project's financial viability: a) Establish an institutional capacity building program, including the reduction of water losses and the reinforcement of its commercial area to recover backlogs and improve collection efficiency; b) Develop a periodic program to update its user registry.

COMMUNITY PARTICIPATION

The Citizen's Committee was created on August 25, 1997. IBWC (CILA), BECC, and local Government officials were present during its creation.

Since its inception, the Committee has held ten meetings; 9 meetings were regular meetings and one was a special meeting. The Committee has been in charge of the public review process and has reviewed, discussed, and approved several key issues such as the comprehensive community participation plan, the outreach and media campaign, internal guidelines, appointment of its Chairperson, Co-Chairperson, and Secretary. It also approved and held neighborhood meetings and two public meetings. Other actions undertaken by the Committee include the development of a promotional video and flyers regarding project actions. During the public review process all project information was

made available to the community and access to information was guaranteed. Based on surveys taken, results demonstrated the community at large supports the project.

Based on the Comprehensive Community Participation Program, a total of 46 meetings were held throughout the community in the different neighborhoods, including the Citizen's Committee meetings and included the majority of the community's social sectors. Two of the meetings were held with the media and one of the two meetings was held in McAllen. The information provided to the McAllen business community, the International Environmental Committee, and the McAllen Environmental Development Committee, and the media was extensive. The experiences gained have demonstrated the project which was strongly supported b the Citizen's Committee, is supported by the community.

The use of a special bus with television sets and VCRs was implemented in order to take project information to low-income neighborhoods. At universities, 26 detailed video presentations of the project were made. Brochures were also distributed and surveys from the student body were taken to determine their opinion on the project

The television was also used for broadcasting 28 sixty-second infomercials during prime time viewing (AAA). Three interviews on informational talk shows were also part of the program. The highlight of the campaign was to include community involvement and promote community members to provide input at the Information Center of the Integral Sanitation Program. The community's response to these measures was significant.

The radio was used to transmit 324 sixty-second informational spots regarding the project. The community was also requested to provide their input at the Information Center. Eight live interviews provided extensive coverage of the Citizen's Committee's activities.

COMAPA customer bills were used to distribute a total of 20,000 flyers. An additional 10,000 double sided promotional flyers printed on both sides were also distributed. Distribution also included 1,000 posters and 5,000 full-page surveys. Outreach activities in the press included eight full-page articles in the newspaper, which described the Committee's main activities.

A telephone information line was also established and 200 calls requesting project information were received.

The following aspects were presented during the public meetings:

- Technical Presentation of the Integral Sanitation Project, Saturday, October 4th;
- Financial Presentation of the Integral Sanitation Project, Friday, October 17th;

During the course of the public meetings, a one-question survey was distributed to all the attendees: **Would your support the Integral Sanitation Project**?, and the response was positive.

All input received from the surveys, public meetings, neighborhood meetings, and media campaigns has indicated that the community strongly supports the project. The community does however demand a high quality project and intends to follow up with organized efforts.

SUSTAINABLE DEVELOPMENT

The **Comprehensive Sanitation Project**, fully complies with the principle of conservation oriented social and economic development based on the protection and rational use of natural resources, considering the needs of the present without compromising the ability of future generations to meet their own needs.

It can be assured that the construction and operation of the sanitation system will promote a reduction in the rate of diseases directly related to water use and consumption, wastewater collection and treatment, and reuse of treated wastewater. The project guarantees an adequate treatment of wastewater generated by both the existing population and that expected by the year 2016.

The comprehensive management of water and treated wastewater considers the environmental protection principle an integral part of the development process. It enhances the condition of water bodies existing at the locality and those located along the U.S.-Mexico border.

Different institutions that participate in environmental, social and economic improvement efforts have been involved in planning the wastewater collection, treatment and reuse system. Additionally, their experience has been taken into account to achieve a well balanced planning and obtain the maximum benefit from existing resources.

Through the Instituto Mexicano de Tecnología del Agua (IMTA) and with support from the North American Development Bank (NADB), COMAPA is currently developing the "Project for Locating and Recovering Losses at the Reynosa Water System's Granjas Sector". The benefits of this program must be analyzed within two contexts: economic and non economic benefits. In fact, the latter falls within the area of resource conservation and sustainable development. As such, projects for the rest of the city areas are scheduled to be developed in the short term, and they should help strengthen the utility.

The **Plan Subregional de Ordenamiento Territorial for Reynosa-Río Bravo, Tamps. (**Subregional Territorial Organization Plan**),** is part of the State's Urban Development Plan included in the National Planing System. The plan's main objectives are: to manage population distribution in the local territory, and economic activities developed in areas with more potential; promote a comprehensive and balanced development of population centers, improve and preserve the environment at settlements; promote favorable conditions that enable residents to solve their urban development, housing, public utilities, and urban equipment needs.

COMAPA will implement a strategy to regulate domestic discharges generated by households not connected to the wastewater collection system, and those outside the service area.

1. GENERAL INFORMATION

a. Project Type

The project falls under the Wastewater Treatment priority and consists of Rehabilitation of the Current Wastewater Treatment Plant and Construction of (2) New Treatment Plants, Rehabilitation of the Wastewater Pump Stations, and Rehabilitation and Expansion of the Sanitary Sewage System.

b. Project Location

The City of Reynosa lies south of the United States and north of the city of Méndez; the City of Río Bravo lies east, while the City of Díaz Ordaz and the State of Nuevo León lie west of Reynosa. Regional maps indicate the location of the City of Reynosa.

The project is located within the 62 mile border region between Mexico and the United States, in the city of Reynosa, Tamaulipas. It is located 26º 04' 24'' latitude north and 98º 17' 12'' longitude west, and 125 feet above sea level. The City covers approximately 15 x 9.4 miles, an area that extends from the highway to Monterrey, (western perimeter), to the Pharr International Bridge, (eastern perimeter) next to the airport, and to the Rio Grande River (northern perimeter). It extends 9.4 miles to the south parallel to the Anzaldúas Canal. The site map provides details of the planning zone.

The Rehabilitation of the Wastewater Pump Stations and Rehabilitation and Expansion of the Sanitary Sewage System projects are located within the city limits.

The Wastewater Treatment Plant Rehabilitation project (WWTP I) planning area is located to the east of the City of Reynosa, on the Reynosa-Rio Bravo highway, at 2.2 miles. marker and is bordered to the north by the Rio Grande River, approximately 6.2 miles from the International Bridge. The railroad line to Matamoros and the Anzaldúas Canal border the project to the south, while the Industrial Paraíso and Delicias Addition subdivisions are located to the west.

The lot being considered for expansion of the current treatment plant (WWTP II), is located 9.4 miles from Reynosa, at the Monterrey-Río Bravo and Canal Rodhe intersection, and covers a total area of 183 acres. It is located southeast of the City, on the edge of the Rodhe Canal, and in close proximity to the Cereso Dos. (Federal Prison).

The lots for the new treatment plant (WWTP III) are located east of the City, in close proximity to the Reynosa/Pharr International Bridge.

c. Project Description and Work Tasks.

Project Description.

Human Health and Environment

Design of the Reynosa sewage system is separate however absence of a storm water drainage system results in large amounts of rainwater being incorporated into the system. It has both main and secondary collectors in need of repair or replacement due to their age, state of deterioration, corrosion, and obstructions. Sections of the primary distribution system have exceeded their original design parameters, specifically the lines close to the lift stations. This situation is causing leaks into the ground, resulting in long term contamination of the sub soil and decrease in soil capacity due to the loss of natural material. As such, the pipes may collapse due to any overflow in the pipes.

Approximately 25 percent of the lots having municipal sewage services continue to dispose of their raw sewage via septic tanks and cesspools. These methods must be eliminated in order to avoid further contamination to underground resources and at the same time improve public health.

There are currently three lift stations, two of which operate at intervals with mobile equipment. Equipment and fitting is currently being undertaken and the Roma lift station is also currently under construction. Occasionally, when the lift station is overloaded, the collectors operate with a hydraulic load; as such, a reduction in the rate of leaks, both inorganic and organic solid waste is deposited, causing anaerobic decomposing of the waste. This situation causes foul and unpleasant odors as well as corrosion to the pipes. Furthermore, in some cases, when the collectors go into the hydraulic load mode, they leak into public areas. Several lift stations, such as No. 3 and No. 10, have surplus lines that discharge raw wastewater into the collecting bodies. The area being served by the Roma lift station, currently discharges in the El Anhelo Drain and La Escondida Lagoon.

The City of Reynosa currently relies on an oxidation pond system for treatment of its wastewater. In accordance with population demands, consumption based on user type and current distribution zones the plant's current capacity has been determined to be inadequate. As such, the water currently being discharged into the Rio Grande River does not comply with required norms.

It must be noted, that the future treatment plant effluent will not be discharged into the Rio Grande River. The effluent will be conveyed via the Anzaldúas and Rodhe Canals to the irrigation districts.

Proposed Technology and Project Scope.

Due to the aforementioned reasons, rehabilitation and expansion of the sewage system is required. This process involves replacement of the damaged pipes in the primary and

secondary systems; implementation of a maintenance system based on degritting and construction of special structures (to avoid importation of sand into the system); and expansion of the secondary system in subdivisions that lack service, based on a conventional gravity sewage system.

Implementation of a program to incorporate lots not connected to the sewage system requires development of a manual describing those requirements needed to comply with national norms.

With regard to the wastewater pump stations, rehabilitation and expansion of the plant's capacity is required. Both the electrical/mechanical as well as the civil engineering components must be considered. Also required is the rehabilitation, replacement or expansion of the pressure lines that discharge into the current treatment plant, and in the future, into the new plants.

The aforementioned needs are described in the studies carried out by the International Boundary & Water Commission (IBWC/CILA) through the U.S. based company Montgomery Watson, for the City of Reynosa in 1997.

The current treatment plant exceeds its design capacity. As such, requires rehabilitation. In addition, construction of two additional plants will help meet the future planning demands (through the year 2016). The proposed treatment consists in anaerobic ponds followed by a facultative treatment process, similar in design to Treatment Plant No. 2.

Program of Project Work Tasks.

The Infrastructure Improvement Program presents the projects required to provide structural integrity and adequate capacity to the existing drainage system. It also satisfies the City's expected growth needs.

Based on available economic resources, rehabilitation and expansion projects for the municipal drainage system and the treatment plants could be carried out during the course of a 20-year period.

The Infrastructure Improvement Program is divided into four stages based on the year scheduled for project construction:

- Stage I 1997 to 2001
- Stage II 2002 to 2006
- Stage III 2007 to 2011
- Stage IV 2012 to 2016

PROJECT TASK PROGRAM

Task	Description	Stage	Cost * (dollars)
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Rehabilitation of Sewage System in the Petrolera Sub-division.	PVC Rehabilitation, ϕ = 6 to 18 in with hermetic joints, manholes, and installation of residential discharges.	**I**	2,401,672
Expansion of the Sewage System in 16 sub-divisions.	PVC construction and reinforced concrete, ϕ = 8 to 36 in with hermetic joints, construction of manholes, and installation or residential discharges.	**I**	7,753,841
Regulate discharges by lots not connected to the sewage system.	Total number requiring connection is 17,493 in 37 sub-divisions in Reynosa, Tamps. and closure of latrines.	**I**	1,655,274
Long term program to Rehabilitate the Primary Sewage System.	Rehabilitation of approx. 34 miles with PVC and reinforced concrete, including a collector inspection plan and prioritization of actions through the year 2016.	**I – II III - IV**	13,266,000
		Total:	**83,397,975**

* The O&M costs are discussed in the financial section of this document

Description of the Community.

Demographic Information.

Based on statistical information reported by the National Institute on Statistics, Geography, and Information, the Municipality of Reynosa experienced an annual growth rate of 3.57 percent during the 40-year period between 1950-1990, while the City of Reynosa experienced a 5.27 percent annual growth rate during the same period.

HISTORICAL POPULATION GROWTH

YEAR	INHABITANTS/ MUNICIPALITY	INHABITANTS/ CITY	GROWTH RATE (%)	GROWTH RATE/ CITY (%)
1950	69,428	34,087	--0--	--0--
1960	134,869	74,140	6.87	8.08
1970	150,786	137,383	1.12	6.36

1980	211,412	194,693	3.44	3.55
1990	282,667	265,663	2.95	3.16
		AVERAGE	**3.57**	**5.27**

The population projection period covers 20 years, between 1997 and 2016, and is based on the report, "Master Plan for Consolidation and Institutional Development of the Water and Sewage Operating System Municipal Commission of the City of Reynosa, Tamaulipas, carried out by the National Water Commission in 1996. In determining future population, six forecast methods were developed and are based on statistical data included in the VIII, IX, X and XI General Population and Housing Census. The following table illustrates the results:

POPULATION PROJECTION RESULTS

METHOD	POPULATION 2016	GROWTH RATE 1997-2016 (%)
Arithmetic	612,602	1.90
Geometric	1´307,038	5.84
Geometric with compound interest adjustments	900,721	3.88
Historical Growth Rate	1’101,957	4.94
Malthus	1’097,261	4.92
Method Average	**1´003,916**	**4.45**

Based on the results obtained by applying the forecast methods, it was determined to use a population base through the year 2016 the results obtained with the "method average" method, which established a population of 1,003,916 and a 4.45 percent annual growth rate.

It must be noted that demographic growth does not maintain the same growth rate constant and that it tends to decrease. For this reason, the project population should include intermediate growth rates at five-year plans as described below in the Five Year Plan Method:

POPULATION PROJECTIONS 1997-2016

INHABITANTS	AVERAGE ANNUAL GROWTH RATE (%)
420,294	
446,104	6.14
473,500	6.14
502,577	6.14
533,441	6.14
566,199	6.14
592,767	4.69
620,582	4.69
649,702	4.69
680,188	4.69
712,105	4.69
739,152	3.80
767,226	3.80
796,367	3.80
826,614	3.80
858,010	3.80
885,387	3.19
913,638	3.19
942,791	3.19
972,873	3.19
1´003,916	3.19

In conclusion, once the Comprehensive Sanitation Project is carried out the actual population affected by the project will be 420,294 inhabitants equal to the entire population.

In determining the design flow for rehabilitation of the Reynosa sanitation system, the City currently has 420,294 inhabitants and will reach 1,003,916 inhabitants at the end of the project's financial term, the year 2016.

Local Environmental Services.

The Rio Grande River provides potable water to the City of Reynosa. Collection is carried out at the Anzaldúas Deviation Dam where it is pumped to the treatment plants, Loma Linda and Benito Juárez. The treatment process consists in a pre-chlorination process, turbidity removal, flocculation, coagulation, filtering, and chlorination; a physical-chemical-bacteriological analysis of the untreated and treated water is carried out daily.

The water is then stored in two tanks. One is an surface tank that has a 7.9 million gallons capacity and the other is an underground tank with a 1.3 million gallons capacity. There is an additional underground tank with a 4 million gallons capacity that will be placed in operation in the near future. After these two tanks, pumping is carried out directly into the five distribution sectors. Metering exists for the pumped water volume at the treatment plants. COMAPA is currently developing a micro-metering project that will determine the metering points and necessary equipment.

Distribution is carried out via differential pumping based on user needs and any tank surplus. Due to the absence of regulating tanks, services are not adequately provided to the "high" sub-divisions or those located at distance from the treatment plants. Studies and projects required to address these problems are currently being undertaken.

The distribution system is currently 594 miles length and covers 90 percent of the city's needs. Based on population, it is estimated that 92.24 percent of the population is provided with potable water services while the remaining population receives its water supply via hydrants and water tank trucks.

The sewage system was designed and built to collect only wastewater, though it does have some rain water collection units included in the system. As of December 1996, there was a total of 51,777 domestic hook ups, providing service to 239,180 inhabitants, and equal to 57 percent coverage. At present, three wastewater lift stations are in operation.

As stated earlier, the City of Reynosa relies on an oxidation pond system for wastewater treatment. The ponds are located in the Northeast area, between the Anzaldúas Canal and the Rio Grande, in close proximity to the Matamoros highway extending alongside the Rio Grande River.

Project Alternatives.

Wastewater Treatment Plants.

Location of the new wastewater treatment plants has been determined based on the sewage system needs as well as the availability of space. The sewage system requires areas in close proximity to the pump/lift station in order to meet both treatment and reuse components.

The first criterion used for (site) selection was the plant's location in proximity to these facilities.

The second criterion relates to the availability of surface area for construction. Design needs and operational-economical aspects require a large surface area. For this reason, WWTP No. 1, built in 1970, was built at the existing location and there are no plans to change this site in the future. Another advantage to this site is that discharging the water into the Anzaldúas Canal does not present a problem and also avoids adverse transboundary effects by discharging the treated effluent into the Rio Grande River. In addition, the location and design of this facility, ensures that under flooding conditions the Plant will operate safely.

With regard to WWTP No. 1, the drainage system is distributed to convey wastewater to the selected site and this area has lots available for construction. Different localization options were analyzed in accordance with the following conditions: extension, locations outside city limits, future population growth, urban growth trends, etc.

After analysis of the aforementioned conditions, the most appropriate location for WWTP No. 3 was determined to be on the far east area of the city, close to the Reynosa/Pharr International Bridge, outside of the .flooding protected area boundaries.

Location of WWTP's #2 and #3 was determined in the Sub-Regional Territorial Ordinance Plan for Reynosa-Río Bravo, Tamaulipas, developed in October 1991.

Some advantages to the location of the municipal wastewater plants include discharging the treated effluent into the Anzaldúas and Rodhe drains and thus avoiding negative transboundary effects. In addition, the drains are in close proximity to the plants.

Treatment of the municipal wastewater can be carried out efficiently via secondary or biological, aerobic and anaerobic treatment systems, such as activated sludge (in one of its many forms), rotating discs, mechanically aerated ponds, spraying filters, stabilization ponds, elevated flow anaerobic reactors, or a combination of any one of these.

These systems, though simple in their general conception, require highly specialized personnel for operation and maintenance. The system that has been selected to treat Reynosa's wastewater is a biologic or secondary treatment system. It was selected because the need for specialized personnel for the facilities' operation and maintenance is

minimal and also because of its cost effectiveness. Electrical-mechanical equipment will only be required for pumping the raw wastewater.

A detailed review of the options analyzed for the treatment process is included in the technical feasibility section.

Construction and Rehabilitation of the Primary Sanitary Sewage System.
Construction and Rehabilitation of the Wastewater Pump Stations.

The U.S. company Montgomery-Watson developed a computerized hydraulic model to review operations of the sanitary sewage facilities in Reynosa. This model was used to evaluate the existing system's capacity and to determine what facilities and hydraulic capacity is required to handle the projected flows. The model focuses on the main collector system and incorporates data from the primary sewage system, manholes, and surveys taken with the Global Positioning System (GPS), land use projections, lift station evaluations, lift station discharge pipes, and flow monitoring results.

Based on several meetings held with the Binational Technical Committee (coordinated by the International Boundary & Water Commission), key parameters in hydraulic analysis were defined:

- Manning roughness coefficient
- Hydraulic capacity loss due to clotting
- Definition of construction practices for future projects
- Overloading conveyance lines
- Contributions to the system
- Speed and minimal ground slope
- Design Storm

After analysis of the possible design options, and considering technical and financial aspects, the Technical Committee proposed forming two design storm options:

- The first option is defined by a design storm with a peak factor of 5:1, which means that any water down river of the system will produce a peak flow during the monsoon season five times the average daily flow (return period is two years).
- The second option considers that the gravity system will be designed to maintain conditions without any overload during daily peak flow times and during low water seasons and with maximum flow design of 3:1 (return period is 8 months) for the lift stations (in order to include a safety factor for the monsoon season). The scenario determined the minimum size for the system to operate through the year 2016.

Furthermore, the following system conditions were analyzed during the simulation with the model.

1. The existing system under low water conditions.
2. The existing system in the year 2016 under a storm and with a 2 year return period (low water peak factor 5:1)
3. The existing system with the proposed required improvements to manage a storm with a two year return period through the year 2016 (without going into load).
4. The existing system with the proposed required improvements to maintain load conditions, during low water periods through the year 2016. Under this scenario, capacity of the lift stations was evaluated as they relate to a design storm with an 8 month return period, and represents a 3:1 peak factor for the system.
5. The existing system with the proposed required improvements to avoid overload conditions during low water conditions through the year 2016, and with the existing degritting level.

Results of the five scenarios were utilized for the following:

- Locate points where overloading in the system may occur; identify problem areas.
- Propose and design new installations in order to alleviate any system limitations.
- Obtain service area limits for the existing WWTP and proposed WWTP's.
- Prioritize proposed facilities in order to establish a construction calendar in stages.

Scenario #4 was selected as a base for the proposed Infrastructure Improvement Program (low water flow by the year 2016, and with a peak storm flow with an 8 month return period for the lift stations).

Rehabilitation and Expansion of the Secondary Sewage System.

Similar to the primary system, rehabilitation and expansion sites of the secondary system cannot by defined. In order to provide wastewater collection services, project needs have indicated that the systems must be laid along the city streets to make connections to the different domestic, commercial, service, and industrial users feasible. As such, the line sites is required and no other site selection alternatives are available.

Due to its characteristics and availability in Reynosa and after extensive evaluations, it was concluded that the most appropriate material for rehabilitation and expansion of the secondary system is PVC.

It has been assumed that in the future, all new sewage systems shall be built in accordance with tighter restriction standards in order to minimize any matter flowing into the lines. The Technical Feasibility sections provides a detailed overview of the advantages.

Project Justification.

Why project is needed.

Growth in urban zones, specifically in areas where access to potable water and sanitation services is difficult, has caused a significant reduction in the efficiency and capacity levels of these services.

With regard to the sewage system, lack of maintenance and adequate treatment of wastewater discharges has caused serious contamination problems, requiring rehabilitation and expansion of the existing systems. These efforts must include a maintenance program to address current needs and any that may arise in the future. This situation has a direct affect effect on public health.

Consequences of Not Implementing the Project.

Immediate consequences of not implementing measure to rehabilitate and improve the current systems will be reflected in the efficiency levels of the systems, the bad condition and inadequate service provided by the lift stations, the sewage system, and the wastewater treatment system. This situation has a direct impact on human health and the community's surroundings. As such, it is feared that discharges tend to leak into the natural ground, contaminating underground resources; water quality will not be adequate for irrigation and will cause diseases in the farming community as well as in the consumers of these products.

In conclusion, not implementing the project will have serious impacts on human health and the environment. Specifically, discharging raw wastewater into the Rio Grande River will create transboundary effects.

d. Conformance with International Treaties and Agreements

The Governments of the United States and Mexico have undertaken efforts of cooperation for the protection of the environment and natural resources along the border shared by these two countries. The two governments signed the Agreement for the Protection and Improvement of the Environment of the Border Region between the United States and Mexico in 1983 (The La Paz Agreement). This Agreement established the basis that provides the framework for environmental cooperation efforts.

Agenda XXI is the result of the United Nations Conference on the Environment and Development held in Rio de Janeiro in 1992. The Agenda defines a series of environmental objectives on an international level which provide general guidelines for sustainable development on a global level. It also encourages communities and the different levels of government to establish specific programs that promote sustainable development in their own communities. The Comprehensive Sanitation Program for Reynosa conforms to these objectives.

Binational agreements have continued to move cooperation efforts forward, such as the 1994 North American Free Trade Act (NAFTA). This cooperation effort seeks to improve the environment and public health while also encourages sustainable economic growth.

The Commissioners determined that the International Boundary & Water Commission (IBWC) will support border communities in their planning efforts and those communities interested in submitting wastewater management projects for certification by the BECC in order to access financing by the North American Development Bank (NADBank) or any international financing institution. This Commission established that in order to receive financial support, border sanitation problems must present any one of the following conditions:

1. Risks to human health.
2. Beneficial use of international waters is obstructed.
3. A community is affected.
4. The community supports the project.
5. The community does not have the capacity to cover the costs required for to have project certified by the BECC.

After review of the water quality monitoring results obtained from testing water along the U.S.-Mexico border, and in accordance with the terms established in Minute 289, "Conformance with Water Quality along the U.S.-Mexico Border" it was determined to give priority to the community of Reynosa, Tamaulipas.

IBWC is in charge of coordinating, consulting, administering, operating, and maintaining the sanitation and infrastructure projects along the border. IBWC, along with the State and Municipal Government and the COMAPA, has supported the Comprehensive Sanitation Program. Support documents are included in Commission Meeting Minutes, and in Minute 294, "Project Consolidation Program for Solution to Border Sanitation Problems" dated November 24, 1995.

Furthermore, based on the aforementioned agreements, the "Joint Report by the Principal Engineers and Technical Advisors Regarding the Development of the Work Plan for the Comprehensive Sanitation Projects in Cd. Acuña and Piedras Negras, Coahuila and Reynosa, Tamaulipas" dated, March 11, 1997, was prepared. The report outlines the work plan for the Comprehensive Sanitation Project for the City of Reynosa, in accordance with the agreements established in IBWC Minute 294. As stipulated in the work plan, the Binational Technical Committee was established; the committee is comprised of representatives from the responsible agencies from both countries. The scope of work were also established and constitute the framework for implementation of this project.

2. HUMAN HEALTH AND THE ENVIRONMENT.

a. Needs in the matter of Human Health and the Environment

During the last four decades we have seen an accelerated growth in our country's population. This phenomena has been more intense in large urban concentrations, which has caused severe coverage and quality problems in its main services, among which we have potable water, drainage and sewage.

The growth in the majority of the urban concentrations, specially the zones with difficult access for services such as potable water, has given rise to the adoption of temporary solutions that later on try to be considered as definite. This reduces the efficiency and causes the distribution systems to reach a high complexity, making its operation and maintenance difficult.

The coverage of potable water and drainage services in the City of Reynosa are represented in the following table, to December 31, 1996 there were 82,257 water intakes, classified as follows:

CLASSIFICATION OF INSTALLED INTAKES

TYPE OF USER	Num. OF INTAKES
Domestic	73,943
Housing Units	572
Apartments	349
Public Schools	167
Employees	553
Schools "Middle"	10
Public Services	63
Retirees	2,120
Commercial	3,822
Hotels	89
Restaurants	87
Private Schools	47
Industrial	200
Laundries	79
Tortilla Factories	112
Car Wash	44
TOTAL	**82,257**

If you consider that the number of service intakes to houses (domestic, housing units, apartments and retirees), this means 77,537 intakes and an accumulation index of 5 persons per housing unit, it is determined that for the month of December 1996, 387,685 inhabitants were supplied at the residential intake level, that with regards to the population of 420,294, it turn out that 92% of the population receives potable water through the system and the remaining 8% of the population obtains its water from hydrants and water tank trucks.

The drainage system is of a separate type, this means, it is designed and built exclusively to capture waste water, even though it has storm water discharges connected to the system.

To December 31, 1996 a total of 51,777 drainage discharges were installed, classified as follows:

CLASSIFICATION OF DISCHARGES INSTALLED

TYPE OF USER	Num. OF INTAKES
Domestic	44,643
Housing Units	515
Apartments	323
Public Schools	114
Employees	403
Schools "Middle"	9
Public Services	47
Retirees	1,952
Commercial	3,200
Hotels	80
Restaurants	84
Private Schools	45
Industrial	173
Laundries	73
Tortilla Factories	76
Car Wash	40
TOTAL	**51,777**

The number of discharge service to houses (domestic, housing units, apartments, and retirees), this represents 47,836 discharges and an accumulation index of 5 persons per housing unit, up to the month of December 239,180 inhabitants had drainage service, this represents a service coverage of 57%.

The sewerage service covers 70% of the urban area with drainpipes system. The system is designed to capture only wastewater, even though it has some storm water discharges connected to the system. The service as was mentioned covers 57% of the population, this indicates that the system is under used, that there are vacant lots connected to the system of that there are too many illegal discharges.

The City of Reynosa, Tamps., has a wastewater treatment plant with oxidation ponds, located on the Northeast end of the city, between the Anzalduas Canal and the Rio Grande. The National Water Commission, carried out an executive project in order to rehabilitate the current treatment plant, according to measurements made at the lake system's main pumping sumps the design characteristics have been exceeded, since it was constructed to treat a flow of 703 lps, and during the sampling period it was observed that there was a volume of flow of 745 lps, this represents an overflow of 6%. Based on the information gathered and on population planning, potable water and

sewerage services expansion and plans for urban area growth, an executive project was prepared for the expansion of the wastewater treatment system.

One of the most important aspects related to the potable water, drainage and sewerage systems is Public Health.

The potable water supply source for the City of Reynosa is the Rio Bravo, whose intake work is located at the Anzalduas Deviation Dam from where it is pumped to the potabilizing plants that are designed to eliminate water cloudiness and pathogens, through chlorine gas desinfection. The quality of potable water produced at the plants is adequate for human use and for consuming, as it complies with the Department of Health's standards.

PHYSICAL CHEMICAL ANALYSIS OF UNTREATED AND TREATED WATER AT POTABILIZING PLANT Num. 1 LOMA LINDA

PARAMETER ANALYZED	UNIT	UNTREATED WATER	TREATED WATER	PERMISSIBLE LIMITS
		UNITS	UNITS	
PH		8.00	7.40	6.9 a 8.5
FLAVOR		CHARACTERISTIC	CHARACTERISTIC	CHARACTERISTIC
ODOR		CHARACTERISTIC	CHARACTERISTIC	CHARACTERISTIC
COLOR (platinum cobalt scale)		10.00	1.00	20.00
CLOUDINESS (silica scale)		12.00	0.45	10.00
TOTAL ALKALINITY (as $CaCO_3$)	Mg/l	130.00	100.80	100.00
ALUMINUM	Mg/l	0.01	0.01	0.20
ARSENIC	Mg/l			0.05
BARIUM	Mg/l	1.00	1.00	1.00
CADMIUM	Mg/l	0.001	0.001	0.05
CYANIDE (as ION (N))	Mg/l	0.006	0.008	0.05
COPPER	Mg/l	0.2	0.3	0.05
FREE CHLORINE (chlorinated water)	Mg/l			0.50
FREE CHLORINE (over chlorinated)	Mg/l		**2.00**	**1.50**
HEXAVALENT CHROME	Mg/l	0.01	0.02	0.05
CALCIUM HARDNESS (as $CaCO_3$)	Mg/l	236.00	224.00	300.00
PHENOLS OR PHENOLIC COMPOUNDS	mg/l	0.01	0.01	0.01
IRON	mg/l	0.03	0.13	0.30
MAGNESIUM	mg/l	104.00	**150.00**	**125.00**
MANGANESE	mg/l	0.066	0.025	0.15
MERCURY	mg/l			0.01
NITRATES (as N)	mg/l	0.11	0.11	5.00
NITRITE (as N)	mg/l	0.008	0.013	0.05
PROTEIC NITROGEN	mg/l			0.10
CHLORIDES	mg/l	235.00	243.00	250.00
LEAD	mg/l	0.001	0.001	0.05
SELENIUM	mg/l	0.001	0.001	0.05
SULPHATES (as ION)	mg/l	240.00	250.00	250.00
ZINC	mg/l	0.03	0.04	5.00
ACMB (active subs at methylene blue)	mg/l	0.01	**1.009**	**0.50**

REFERENCE: DIAGNOSIS AND IMMEDIATE ACTION PLANT OF THE POTABLE WATER AND DRAINAGE SYSTEM FOR REYNOSA TAMAULIPAS. CIDE, S.A. DE C.V.

As can be noted, the free chlorine waste, in the potabilized water, exceeds the permissible limit for over chlorinated waters, this does not mean a health risk for the users, since this insures a chlorine residue that prevents any water contamination from the plant to the users home. The Magnesium concentration exceeds the permissible limits; therefore it will have to be eliminated from the water. The same thing happens with the parameter that sanctions the concentration of Active Substances at Methylene Blue, which is the active part of the detergents. Appearing in the human use water could have several explanations: laboratory error; sampling problems and probable natural water contamination by waste water discharges. It would be necessary to make a greater number of analytical determinations before having a reliable answer, that would allow taking the necessary measures for the case.

The relationship that exists between the environment and the health-disease relationship in a community is undeniable. In studies and experience from countries that have reached high coverage of basic services such as: potable water, drainage, treatment and disposal of treated waste water and adequate management of waste, among others, we have seen an important decrease in the prevalence of infectious-contagious diseases, specially gastrointestinal diseases. On the contrary it can be proven that countries and urban zones like the City of Reynosa, that have difficulties in providing these services adequately, there is a high rate of the diseases mentioned.

The Comprehensive Environmental Health Project for the City of Reynosa, Tamps., as was mentioned previously, includes works that will be developed in the drainage system as well as consistent with the rehabilitation and expansion of pumping sumps, such as the rehabilitation of the current oxidation ponds and the expansion of the waste water treatment system and the reuse of treated water for agriculture irrigation, therefore expecting to improve the levels of quality of life for the city's population.

The gastrointestinal diseases and parasitoid in the municipality of Reynosa, occupy third place within the general morbidity and they are the cause for frequent deaths among five year olds and younger population. The acute respiratory infections have first place in morbidity, which are caused by sudden changes in temperatures and dust generation. The ratio between intestinal infections and respiratory infections is approximately 1 to 5.

From the information gathered in relation to the incidence of gastrointestinal and parasite diseases, from 1990 to 1997, obtained from the health sector through its source SSA EPI-1-85 and EPI-1-95 SPESCIFIC PROGRAMS, where morbidity due to transmissible diseases is reported and, at a jurisdiction IV level – Reynosa, there is an increase in the growth trend rate for these diseases.

From this information we have selected the diseases that have a direct relation to water, through which it is ingested, or the one discharged from the housing unit or from the one reused. The intestinal infections are highlighted due to their importance, followed by amebiasis, ascariasis and oxyuriasis. The first disease registers 65% of the total of gastrointestinal diseases.

The total morbidity annual rates for gastrointestinal diseases vary from 549 in 1992 to 840 in 1995 (cases per 10,000 inhabitants).

It should be clarified that the rate 1996 was also considered for 1997S for the following transmissible diseases: hepatic abscess, taeniasis, basilar dysentery and trichuriasis and that the rates were extrapolated from the information obtained for that year's first semester.

Comparing the infectious-contagious disease rates from 530 persons from the City of Reynosa, for 1996, with Rio Bravo and Diaz Ordaz, in the same State of Tamaulipas, that mount to 2,098 and 616, the great disparity of these values can be observed and the rate for the City of Reynosa is the lowest one. A similar comparison with the towns of Guadalupe D.B. and Praxedis G. Gro. in the Municipality of Cd. Juarez, State of Chihuahua, whose rate for 1995 is 151, this represents 28.5% of the existing rate in the City of Reynosa for the same year and for 1996 is 198 which represents 37% of that registered in Reynosa. There is no explanation of why this in this Municipality the morbidity rate is so low compared to the ones for the City of Reynosa.

Different trends could be found by adjusting the values for morbidity rates, and the most significant ones are the ones represented in the previous figure where if an adjustment is made with a potential curve one would obtain a **pessimistic planning** and a growing trend could be observed, which would mean that by the year 2016 the morbidity rate for the population of the City of Reynosa would be 3,788 cases per 10,000 inhabitants. A less pessimistic planning, considering only the data signaling the decrease of these diseases in the last few years, has been called **current trend** and it would be expected that by the year 2016 it would reach a value of 1,004 cases per 10,000 inhabitants. If on the other hand one takes into consideration the impact the environmental projects will have on the population, one could expect an optimistic projection that would start decreasing in 1998 from a rate of 791 to one of 612, which means a cut down of 12% in this rate; later it has been considered that this rate is reduced annually 7% annually, reaching the year 2,016 with a value of 163.

Many factors should influence the environmental health issue in order for the previous proposal to became a reality, among which are outstanding: improvement of public services, nutrition, hygiene habits, healthy environment at home and a growth in the economic perception levels.

To that effect COMAPA from the City of Reynosa, will implement a strategy to normalize residential discharges from the lots that have not yet been connected to the sewerage system, as well as those that are in the areas where the service will expand. This strategy will involve the following activities:

- **identification and lot regulating program**; if it is true that we have information lots that are not connected to the sewerage system, and of those that do not have potable water service, it is necessary to update the information in order to insure the success of the regulating program. For this project we will have administrative information,

from the operating organism, and information that would have to be gathered from the field. In the operating organism, we have information from the lots where discharge connections have been made according to payment control or rights exemption due to hook-ups and/or by materials' control leaving the warehouse for hook-up work. Filed information refers to the list of potable water users from the organism, which is always updated. However, during the updating activities the necessary information will be gathered regarding water discharge from lots and we will take advantage of the support from personnel assigned to taking the readings from the meters-recorders for potable water from homes and personnel assigned to the repair and/or replacement program of damaged meters, previous training.

- **residential discharge regulation**; manuals with materials and projects specifications will be prepared or updated for sewerage and potable water facilities within the lot and the techniques to be used for canceling latrines and black wells, in order for them to meet the national standards required. Due to its importance, it is necessary to take into consideration in the regulation, the corresponding sanctions in order to guarantee the success of the regulation. The sanctions could be fining and suspension of potable water service. Also, it would be necessary to update the regulations in order to foresee the incorporation of discharges from the lots in the zones that are being developed.
- **awareness program and inspection work**; the program will be promoted before it begins, highlighting the benefits it will provide to the population, emphasizing the improvement of human conditions and inviting the users to register with the program. The lots that are not hooked up will be visited, in order to verify the information recorded and invite users to update their records with this institution and/or register in the regulation program.
- **marketing**; taking into consideration that the user will have to make improvements to the sewerage installation in his/her lot, that this program is for the benefit of the community and that the population involved is the one that has less economic resources, around 92%, it is suggested that 50% of the cost of the program be absorbed by the operating organism (COMAPA) and the other 50% by the user who will receive the benefit, giving him/her a year to pay the debt, with the condition of canceling the latrine or black well.
- **investments**; in order not to increase the current expense, due to the fact that the program is transitory, it is proposed that it be executed by contracting a specialized company.

b. Environmental Assessment.

Compliance with environmental assessment.

The project requires the submittal to the Office of Ecology from the Secretariat of Social Development (SEDESOL) in the state, an environmental assessment, for which a final document was prepared and the final report of the Environmental Impact Manifestation (EIM) as a General Mode for the Comprehensive Environmental Health Project for the City of Reynosa, Tamps., issued by SEDESOL in the state.

Description and analysis of environmental effects.

The most significant environmental effects are outlined and analyzed in detail in section V (Identification of Environmental Impacts) from E.I.M. for the Comprehensive Environmental Health Project for the City of Reynosa, Tamps., whose information is valid and applicable according to an evaluation made by SEDESOL in the state. For more details reference these documents that have been presented to the Border Environmental Cooperation Commission (BECC).

As is described in the E.I.M. previously mentioned the benefit for the community and the ecosystem en general with the Comprehensive Environmental Health for the City of Reynosa is undoubtable.

To emphasize the beneficial effect that this project will have in the comprehensive environmental health project for the City of Reynosa with regards to water quality from the Rio Grande Basin, the following is an analysis with water quality results that the National Water Commission, through its Water Quality and Sewerage Management has generated since the beginning of the sixties.

As has already been mentioned in the hydraulic region Num. 24b, Lower Bravo, it covers a surface of 136,196 Km^2, and it includes part of the states of Coahuila (81,902), Nuevo Leon (36,513) and Tamaulipas (17,781). The most important cities are Monterrey, Saltillo, Reynosa, Montemorelos, Monclova, Nueva Rosita, Sabinas Hidalgo, Piedras Negras and the City of Acuña.

The most important hydraulic works are the dams Falcon (Mexico), its main purpose is irrigation, electricity generation and avenue control; Marte R. Gomez (El Azucar) and Venustiano Carranza for irrigation and avenue control and El Retamal.

The diagnosis for water quality in the surface water bodies is carried out through the use of data from the National System Monitoring. In this region, the System operated until 1995, with 55 stations located in 23 bodies of water. To estimate water quality CNA uses the Water Quality Index (WQI), which provides the degree of water contamination to the sampling date and it is expressed in adimentional units, as ratio of the water being studied to pure water. Therefore, highly contaminated water will have a WQI closer or equal to zero and water with excellent conditions a value close to 100. The mathematical ratio that defines this index is:

$$WQI = \left(\sum_{i=1}^{n} Ii\ Wi\right) / \left(\sum_{i=1}^{n} Wi\right)$$

where:
WQU = Water Quality Index, adimensional.
Ii = Quality Index for parameter i.
Wi = Weight Average Coefficient for parameter i.
n = Total number of parameters

The number of parameters that are considered in order to determine WQI is 18; dissolved oxygen and the biochemical oxygen demand are the parameters with more weight in the WQU value. The following table includes the weight average coefficients for each one of the parameters:

PARAMETER	COEF.	PARAMETER	COEF.
PH	1.0	Electrical conductivity	2.0
Color	1.0	Alkalinity	1.0
Cloudiness	0.5	Total hardness	1.0
Greases and oils	2.0	Ammonia nitrogen	2.0
Suspended solids	1.0	Nitrate nitrogen	2.0
Dissolved solids	0.5	Phosphates	2.0
Chloride	0.5	Total coliforms	3.0
Dissolved oxygen	5.0	Fecal coliforms	4.0
Biochemical Oxygen Demand	5.0	Detergents	3.0

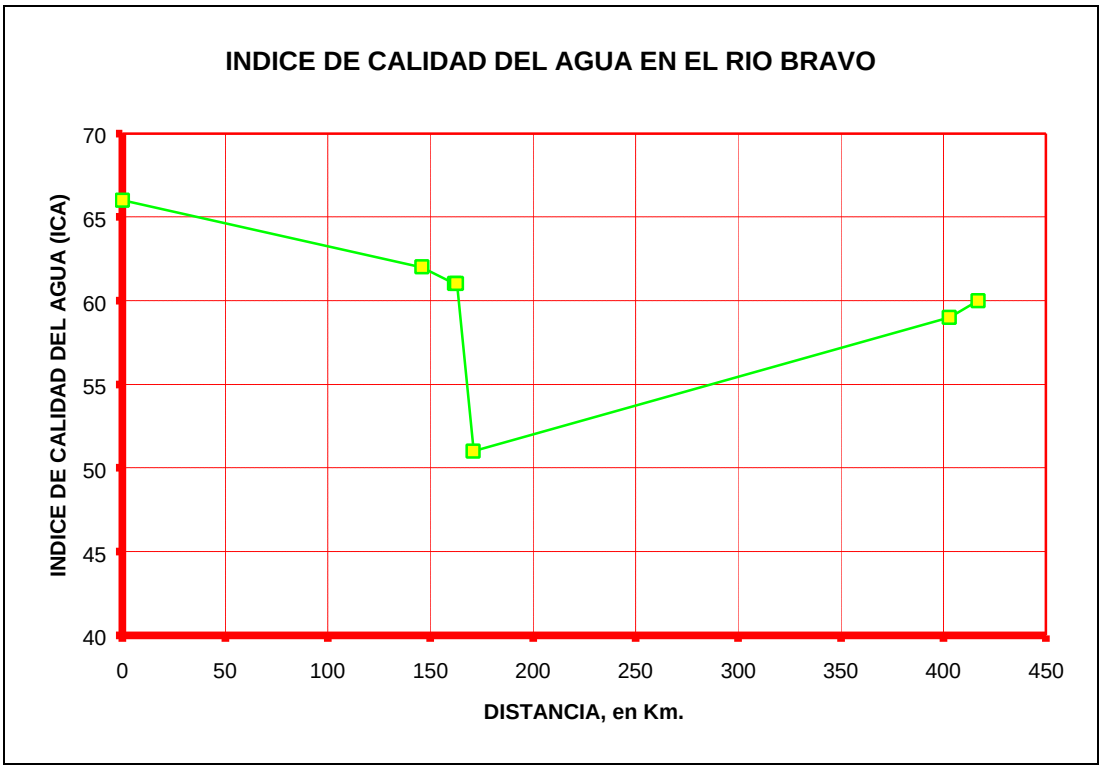
In order to evaluate the quality that the national surface waters have shown, monitored by the National System; three intervals have been established in the WQI scale; WQI values between 0 and 40 is considered that water quality is bad; between 40 and 70 regular and between 70 and 100 good. The WQI value for the stations of interest for this study, is the average obtained since the monitoring started until 1995.

The following table shows the location of the monitoring stations in question.

ESTACION	**S24b-069**	**S24b-060**	**S24b-44**	**S24b-43**	**S24b-076**	**S24b-077**	**S24b-054**
LOC	**P Falcón**	**P Anzald**	**Pte. Inter**	**Pte. Inter**	**Lag Oxid**	**P Retam**	**Pte. Inter**
WQI	**66**	**62**	**--**	**61**	**51**	**59**	**60**

The following table and graph shows the distance as well as its WQI value, from monitoring stations from Falcon Dam to the station at the Nuevo Progresso International Bridge, going through the City of Reynosa International Bridges and the station located downstream from the Anhelo drain at the Rio Grande.

	ESTAC.	NAME OF STATION	Km
1	S24b-069	FALCOM DAM GATES	0+000
2	S24b-060	ANZALDUAS RESERVOIR	146+000
3	S24b-044	INTERNATIONAL BRIDGE No. 3	162+000
4	S24b-043	REYNOSA INTERNATIONAL BRIDGE	163+000
5	S24b-076	AFTER THE OXIDATION PONDS	171+000
6	S24b-077	EL RETAMAL DAM	203+000
7	S24b-054	NUEVO PROGRESO INTERNATIONAL BRIDGE	217+000



It can be noted that in case the discharge from the lake system for waste water treatment from Reynosa (PTAR # 1) is eliminated, possibly the WQI would go from the current value of 51 to the station located upstream at the Reynosa International Bridge that is 61 and under this condition the WQI values for the stations located on the Rio Grande at the Retamal Dam with a real value of 59, would reach one of 69 and the one at the station under the Nuevo Progreso International Bridge that is possibly 60 would go up to 70.

This way if the treated waste water the discharges to the Anhelo Drain, affluent of the Rio Grande the current use of these waters, for the purpose of supplying the public with the value of 51 these are waters with a greater need for treatment, which would go to a value of 61 with the same classification but with a lesser concentration in the organic carbon matter source and coliform organisms, as appears in the following tables. The water now and after the discharges have been eliminated would continue being acceptable but not recommendable for recreational purposes. Currently, according to the index in that part of the river the quality of water is doubtful for sustaining sensitive aquatic species, but in withdrawing the discharges the water cold be apt for any species except for those that are the most sensitive. From the industrial perspective water can be classified as apt for industrial use without treatment. The current and future water quality indexes make it more acceptable for sailing and transportation of treated waste.

The nearness to stations S24b-043 (International Bridge) and S24b-076 (Oxidation Lakes) prevents the evaluation of the favorable impact of disposing of treated waste water discharges in this part of the river, at the Retamal Dam, approximately 232 km away. This could mean better quality since the WQI at this station of 59 units, whose use can be compared to those at the station upstream of discharges from the Oxidation

Lakes, could go to a value of 69 or above, due to the great capability of self-purification that the river has in this section. That value of 69 makes water get close to a regular quality, with greater expectations for public, recreational, industrial, agricultural use and mainly for aquatic life support in the Rio Grande.

COMAPA authorities are requesting CNA help, to reestablish the sampling and analysis of the Rio Grande waters, into the influence area of the Sanitation project, in order to test the efficiency of the project and to prevent any accidental failure.

In the case of impacts due to the operation of the PTAR tied to treated liquid discharges, it could be said that in general terms all the effects are positive, the most significant one being that related to use of soil for pasturing and agriculture, followed in importance flora and fauna biological conditions, physical and chemical characteristics of the environment and cultural factors.

The activity of solid waste recycling, from treatment lakes will have a positive impact if they are analyzed in adequate amounts in agricultural soil or in those where erosion or partial degradation has been observed.

In the case of **accidents**, related to the possible fault in some levee at the lake, could have an unfavorable effect in the surrounding ecosystem at the treatment plant and the neighboring urban sector. However, the experience of the current system which has been built for a little more than 25 years states that this type of catastrophes are very far from happening.

On the other hand the Comprehensive Environmental Health Project for the City of Reynosa, Tamps., will generate adverse impacts during the construction, operation and maintenance stages of the drainage system and the waste water treatment plants, however, these are cases that can be mitigated and for which the corresponding prevention and control measures have been contemplated. The main impacts, the necessary mitigation measures and the actions to be carried out in order to mitigate those adverse effects, during the rehabilitation phase, construction and operation of the environmental health system are presented in detail.

Construction of drainage system and wastewater treatment plants.

IMPACTS DETECTED	MITIGATION MEASURE	ACTIONS
Incorporation of particles to air.	Construction and material transportation control procedures	**a)** During the construction of the drainage system and the treatment plants because of the storage of materials such as sand, gravel, etc., the construction materials will be covered with canvas, plastic, cardboard or any other material that prevents dispersion. **b)** The transportation trucks will cover with canvas the upper part of the loading box where they transport the materials. **c)** The transportation trucks will not exceed the load limit in order to prevent the material from falling. **d)** The transportation trucks will follow one same access road in order to have control of the zones that may be affected due to possible spills. **e)** There will be a team of people who will periodically work cleaning the material that has fallen in the transportation route.
Affecting air quality due to the generation of particles emitted by vehicles in general and heavy machinery. .	Emissions control for vehicles in general and heavy machinery	**a)** An emissions control program will be established. **b)** All personnel will receive the adequate protective equipment. **c)** Adaptation of catalytic converters to all the exhausts from internal combustion motors from vehicles and machinery that will allow it.

Noise generation and vibrations associated with the use of equipment and heavy machinery	Establishing safety and protection practices.	**a)** All personnel will receive adequate protective equipment. **b)** Only equipment and machinery will be used that due to their manufacturing specifications, their noise emissions and vibrations are within the acceptable ranges. **c)** Work areas will be isolated as much as possible, especially those places densely populated and with high commercial and industrial activity.
Increase vehicle circulation.	Alternate route program	**a)** Notices in the media regarding the zones that will be affected and the duration of the works. **b)** Scheduling of alternate routes. **c)** Adequate signs in the zones where the works are being carried out. **d)** Trained personnel to control traffic in the zones where the work is being carried out.
Soil erosion.	Constructive procedures control	**a)** Removal of vegetation layer, only and exclusively in places where the works are being carried out. **b)** Confinement of works and removal of material generated by the works, as soon as possible. **c)** In case of drainage, the filling activities of dikes and repavement, should be followed by rehabilitation work as soon as possible.
Odor generation.	Fast disposal of sludges generated by the works	**a)** Removal as soon as possible of silt product of the rehabilitation works from the drainage lines and from the current treatment plant. **b)** Use of vehicle exclusively for the transportation of these wastes for their final disposal. Therefore, it will be necessary that the transportation vehicle have a box that collects or prevents run-off from leachates produced from sludges that will have a high content of microorganisms.
Underground and surface water pollution	Constructive procedures control and impermeabilization of the bottom of the PTAR lakes.1	**a)** Remove as soon as possible materials product of hauling of construction materials and dirt movement, as well as material product of clearing and cleaning of land, to prevent the dragging of this material by water run-off, which would create an alteration in its FQB characteristics. **b)** Carry out the proposed constructive procedure to rehabilitate PTAR#1, to prevent leaks or spills from untreated raw water affecting the FQB conditions from the waste water inlet. **c)** Impermeabilization of the bottom of stabilization ponds that will be built with 30 cm width compacted clay, which should be covered with a 15 cm layer clean gauged sand, or mud in order to protect it from erosion and drying.

Drainage system and wastewater treatment plants operation.

IMPACTS DETECTED	MITIGATION MEASURES	ACTIONS
Effects on surface water quality.	Control of the wastewater treatment plants and drainage system.	**a)** Implementation of a characterization program of influents from the treatment system's PTARs every three months in order to detect possible contamination sources of industrial type. **b)** Implementation of wastewater discharge control program, commercial as well as industrial. **c)**Implementation of an adequate program for drainage system operation in order to prevent floodings and puddles that can affect the bodies of water destined for potable use, etc. **d)** Compliance with specific discharge conditions of the effluents from the PTARs. e) Implementation of preventive and corrective maintenance programs for drainage and wastewater treatment systems.
Odor generation	Alternative design for odor elimination.	**a)** Measurement of air gases and odor levels surroundings the PTARs and the pump sumps. **b)** Construction of live windbreaker barriers with species from shrubs to trees with foliage that is green year round, surroundings the PTARs. **c)** Installation of surface floating aerators to oxygenate the upper layer of the anaerobic ponds and prevent the generation of gases that produce bad odor. **d)** Desilting drainage lines and pumping stations in order to prevent raw wastewater clogging at the facilities that cause the degradation of organic matter.
Generation of waste sludges	Establishment of adequate and specific controls for management and final disposal of waste sludges	**a)** Carry out a CRETIB analysis of sludges generated by desilting of the current PTAR during rehabilitation works and produced by PTARs maintenance activities, in order to certify that they are wastes that can be disposed of in the municipal dump or as agricultural soil improvement. **b)** Disposal of waste sludges, previous draining and stabilization, at the destined site, using for this purpose the adequate transportation means. **c)** Carry out CRETIB analysis of sludges produced by the desilting of drainage lines in order to determine its final disposal. **d)** Dispose as soon as possible of waste sludges product of drainage lines

		maintenance in order to prevent health risks to the population.
Possible decrease of the level of water at "La Escondida" lake.	Conducting effluents from treated waste waters to the lake	**a)** Carry out the corresponding studies for the possible incorporation of part of the flow volume of treated wastewater to the "La Escondida" lake. **b)** Creation of protection natural reserve, preventing the use of surrounding land for urban development, that usually originate pollution due to un treated raw water discharges.

Transboundary Environmental Effects.

The possible **Transboundary** environmental effects that could be present during the rehabilitation and construction of the drainage system and the wastewater treatment plants would be reflected in the quality of water in the Rio Grande.

During the operation of these systems (drainage and treatment plants), water quality in the Rio Grande as was determined in the water analysis from the City of Reynosa, they will definitely be positive, since one of the strategic objectives of the works to be carried, is to prevent discharges in this body of water, for this reason, the quality of their water will improve with due to its capacity of self-depuration.

It is believed that there will be no **Transboundary** Environmental Impacts generated by the Comprehensive Environmental Health Project for the City of Reynosa, Tamps., since these are environmental health works that will provide benefits by increasing the waste water treatment capacity generated by the City.

c. Compliance with Applicable Laws and Regulations in Environmental Matter and Cultural Resources.

The ecological and environmental protection ordinance is regulated in the Municipality of Reynosa, Tamps., through the General Law of Ecological Balance and Environmental Protection for the State of Tamaulipas and the Directing Plan for Urban Development. Currently a proposal of Municipal Ecological Regulation is being prepared, that will include among other aspects the municipal planning and ecological ordinance authorities, ecological regulation, environmental impact, technical standards, air, water, soil, subsoil and environmental pollution prevention and control, solid waste management and final disposal, the rational recovery of natural protected areas and the control, safety, sanction and crimes control measures.

Based on article 35 BIS 2 of the General Law of Ecological Balance and Environmental Protection and its articles 11 subparagraph VII, 30, 33, 37 and 38 of the General Law of Ecological Balance and Environmental Protection for the State of Tamaulipas, as well as articles 5, 6, 7, 8 subparagraph I of its Regulation in the Matter of Environmental Impact and the Regulation with Ecological Purposes of the Minerals or Substances of Federal Authority.

The project complies with the requirements established in said ordinance, by having the authorization for the expansion and rehabilitation of the drainage lines, as well as the rehabilitation of the current waste water treatment plant and for the expansion works of treatment plants #2 and #3 in the matter of Environmental Impact by means of Document

Num. 000466 dated November 24, from the Secretariat of Social Development of the State of Tamaulipas. This authorization was granted with 51 conditions. For this reason, it will be verified that the works be carried out complying with what was authorized as well as preventing practices that are prohibited which are described in the authorization made reference to and comply with the applicable Mexican Official Standards.

- Comply with the standard values determined by the National Water Commission CNA in concession title Num. 2TAM100226/24HASG94 to the Municipal Commission for Potable Water and Sewerage System for the City of Reynosa, Tamaulipas (COMAPA), with regards to the specific treated waste water discharge conditions that are the same as is established in the Mexican Official Standard NOM-001-ECOL-96, which establishes the maximum permissible limits of contaminants in waste discharges, for reuse in agriculture activities, according to Document Num. No BOO.5.4.4.2.-104 dated February 26, 1997, from the Sewerage and Water Quality Management, of the General Technical Office dependents of the National Water Commission, responding to a request to reconsider waste water discharge conditions of discharge permit included in the before mentioned title.
- There will be compliance with the Mexican Official NOM-CCAT-003-ECOL/1993, which establishes the maximum permissible levels for contaminating gases emission from exhaust systems in automotive vehicles circulating, that use gasoline as a fuel and in NOM-CCAT-008-ECOL/1993, that establishes the maximum permissible limit of smoke opacity from the exhaust of automobiles circulating that use diesel as a fuel, for the vehicle and machinery fleet to be used during the site preparation stage and construction of the project made reference to.

In the Directing Plan of Urban Development for the State and the one for State's Urban Development and Urban Development in the Municipality there are no guidelines that state any inconveniences to carry out the works made reference to in the **Comprehensive Environmental Health Project for the City of Reynosa**, since the land where the waste water treatment plants will be built are classified as land with special use of soil, according to what is established in documents S/N, issued by the Office of Urban Development, on November 13, 1997 and document Num. PM 141-97 issued by the Municipality, dated November 12, 1997, respectively.

Also, the International Boundary and Water Commission (IBWC) Mexican section issued Document Num. 02163/97, dated November 21, 1997, addressed to the COMAPA management where it expresses no objection to carry out the works made reference to in this project.

The National Water Commission through Project Management of Potable Water and Sewerage, issued Document Num. BOO.3.1.-00726, dated November 13, 1997 where it establishes that the technology used in the projects for the waste water treatment plants for the City of Reynosa is the most viable option, within those researched, technically and economically.

With regards to complying with the legislation in the matter of Cultural Resources there is a judgement of non affection with regards to the Archeological, Historical and Cultural heritage in the zone where works related to the environmental health of the population will be carried out according to the location of the Municipality of Reynosa, and as is ratified in Document Num. 507/97 issued by the National Anthropology and History Institute, INAH Center, Tamaulipas.

The following is a summary of authorizations obtained in the Matter of the Environment and Cultural Resources.

Date obtained	Authorizations	Agency granting permit
February 26 1997	Document No.BOO.5.4.4.2.-104 Technical judgment of reconsideration of discharge conditions for COMAPA in Reynosa.	National Water Commission Contact: Ing. Ignacio Castillo Escalante. Environmental Health and Water Quality Tel: (915) 595 23 22 Fax: (915) 595 39 50
May 31 1997	Governmental agreement, through which it is declared a Natural Protected Area, classified as urban park for the area known as "La Escondida Lake", located in the Municipality of the City of Reynosa, Tamps.	General Secretariat of State Official Newspaper Government Branch of the Constitutional Government of the Free and Sovereign State of Tamaulipas.
November 12 1997	Document Num.PM 141-97 Statement from the Municipality of the City of Reynosa stating that there is no inconvenience to carry out the works referred to in this environmental health project.	Republican Constitutional City-County for Reynosa, Tamaulipas. Municipality Contact: Lic. Oscar Luebert Gutierrez.
November 13 1997	Document Num. 181-97. Statement form the Office of Urban Development stating that no guidelines could be found that state inconveniences to carry out works made reference to in this environmental health project.	Republican Constitutional City-County for Reynosa, Tamaulipas. Municipality Contact: Arq. Juan Humberto Martinez Castillo. Tel: (91-89)23 96 49
November 13 1997	Document Num. BOO.3.1.-0726 Justification of the treatment process	National Water Commission Contact: Ing. Antonio Fernández Esparza. Potable Water and Sewerage Project Manager .
November 17 1997	Document Num. 507/97 Judgement of non-affectation of Archeological, Historic and Cultural heritage in the zone.	National Institute of Anthropology and History (I.N.A.H.) Centro-Tamaulipas. Contact: Lic. Maribel Miró Flaquer.
November 21 1997	Document Num. 02163/97 Observations for the border project for environmental health for Reynosa, Tamps.	International Boundary and Water Commission between Mexico and the United States. (IBWC) Mexican Section. Contact: Ing. Cayeteno Hernández J. Tel: (91-89) 24 82 49 Fax: (91-89) 24 82 09
November 24 1997	Document Num. 000466 Judgment of the Statement of Environmental Impact document, general mode for the "Comprehensive Environmental Health Project for the City of Reynosa, Tamps.	Secretariat of Urban Development for the State of Tamaulipas. Contact: Q.I. Andrés Oscar Ochoa Pedroza. Director of Ecology. Tel y Fax: (91-131) 232-42 Ext. 229

3. TECHNICAL FEASIBILITY

The project's technical feasibility was developed in accordance with an extensive evaluation of the sewage system and is described in the following documents:

- "Plan Maestro para la Consolidación y Desarrollo Institucional del Organismo Operador Comisión Municipal de Agua Potable y Alcantarillado de la Cd. de Reynosa, Tamps. (COMAPA)" Comisión Nacional del Agua. 1996
- "Proyecto Ejecutivo para la Rehabilitación y Ampliación de las Lagunas de Estabilización de la Ciudad de Reynosa, Tamps." Comisión Nacional del Agua. 1996
- "Evaluación del Sistema Sanitario de Alcantarillado. Revisión de la Información del Manejo del Sistema. Evaluación de Aguas Residuales Industriales y Plan Preliminar de Muestreo de Aguas Residuales" Orden de Trabajo No. 2. Comisión Internacional de Límites y Aguas. (CILA/IBWC). 1997
- " Monitoreo Continuo de Flujo en 44 puntos en el Sistema de Captación de Reynosa" Orden de Trabajo No. 3. Comisión Internacional de Límites y Aguas. (CILA/IBWC). 1997
- "Levantamiento. Modelaje Hidráulico de la Red Primaria de Colección de Aguas Residuales" Orden de Trabajo No. 4. Comisión Internacional de Límites y Aguas. (CILA/IBWC). 1997
- "Levantamiento de Condiciones Internas del Drenaje e Inspección. Materiales y Métodos de Rehabilitación" Orden de Trabajo No. 5. Comisión Internacional de Límites y Aguas. (CILA/IBWC). 1997
- "Estudio de los Impactos de Ingreso de Aguas (Inflow) para el Sistema de Alcantarillado de Reynosa, Tamps." Orden de Trabajo No. 6. Comisión Internacional de Límites y Aguas. (CILA/IBWC). 1997
- "Estudio de Corrosión por Sulfuros" Orden de Trabajo No. 7. Comisión Internacional de Límites y Aguas. (CILA/IBWC). 1997
- "Reporte de Rehabilitación y Expansión de la Red de Alcantarillado de Reynosa" Orden de Trabajo No. 8. Comisión Internacional de Límites y Aguas. (CILA/IBWC). 1997
- "Proyectos Ejecutivos de Ampliación de la Red de Alcantarillado Sanitario para la Ciudad de Reynosa, Tamaulipas" COMAPA. 1997.
- "Proyectos Ejecutivos de Rehabilitación de la Red Secundaria de Alcantarillado Sanitario para la Ciudad de Reynosa, Tamaulipas" COMAPA. 1997.
- Manifestación de Impacto Ambiental Modalidad General para el Proyecto de Saneamiento Integral de la Ciudad de Reynosa, Tamaulipas" COMAPA. 1997.

There are several factors contributing to a sewage system's useful life, some of which include:

- Quality control in construction material
- Correct installation of pipes
- Anti corrosion components in the design
- Preventive maintenance

Specific design criteria have been developed to ensure that changes to the system, such as design, construction, and operation will be maintained throughout the project's projected useful life. In this manner, sewage system service with a useful life over 50 years for the different structural components (pipes, manholes, pump stations, etc.) can be assured and a useful life of more than 20 years can be assured for mechanical equipment.

A system evaluation concluded that approximately 17.9 miles of replacement or construction work is required for the gravity sewage lines; 3.6 miles of pump station discharge lines; an increase in capacity or construction of 12 pump stations, rehabilitation of the existing treatment plant, and construction of two additional plants. These works are required to provide the City of Reynosa a system with sufficient capacity through the year 2016. Design parameters are described below:

a. Appropriate Technology

Wastewater Treatment Plants

The estimated current wastewater flow exceeds nominal capacity at the existing wastewater treatment plant (WWTP). Based on service area flow projections, the need for WWTP #2 is immediate while WWTP#3 will be required within the next 5 years.

Areas with most sewage service coverage are north and central, both are Lift Station #1 (LS #1) tributaries; the central-west and southwest areas are LS #4 tributaries; and the east-side is a tributary of LS #10. The lines discharging from these three lift stations, in addition to the PEMEX LS, come together at a union structure located at the wastewater treatment plant. Wastewater is conveyed to the current treatment plant via four pressure emitters having the following characteristics:

- LS #1 conveys wastewater via a reinforced concrete emitter, 42 in diameter and 5,377 ft in length.
- LS #4 conveys wastewater via a reinforced concrete emitter, 36 in diameter and 7,016 ft in length.
- LS #10 conveys wastewater via a reinforced concrete emitter, 30 in diameter and 860 ft in length.
- PEMEX LS conveys wastewater via a reinforced concrete emitter, 24 in diameter and 2,230 ft in length.

The treatment process consists in an aerated lagoon, followed by five parallel treatment modules. Each treatment module has a 3.2 mgd capacity through a facultative pond system, an aerobic pond and a maturation pond. The configuration is described at the end of document 3.1. In accordance with the project's original data, the current treatment process consists in the following four steps:

1. The influent flows through a degritting process that is currently not in operation, then flows into a "Parshall" meter, and then into the aerated pond. The pond has a 15.2 acre hectare surface area and is 7.9 ft deep. It has fourteen 40 HP (each) mechanical aerators. The pond is rectangular in shape and is 1,566 ft in length and 448 ft wide.
2. The water is then conveyed to one of the five treatment modules. One facultative pond has a surface area of 2.9 acre and the remaining four have a 3.1 acre surface area. All ponds are 7.9 ft deep. The ponds are rectangular in shape and vary in width; their average length is 377 ft.
3. The effluent from the facultative ponds is conveyed to an aerobic pond whose surface area varies from 6.4 to 6.7 ft and measures 5.9 ft deep. The ponds are rectangular in shape and vary in width; they are 623 ft long.
4. The water is finally conveyed to the polishing or maturation ponds. These ponds have a total surface area of 6.9 acres and are 5.9 ft deep. Their shape is rectangular and they vary in width; they are 813 ft long.

The following table describes the system's main geometric characteristics in their current state:

WASTEWATER TREATMENT PLANT DATA

STEP	POND	DIMENSIONS AVERAGE (ft)	DEPTH (ft)	AREA (acres)	RETENTION (days)
1	**Mechanical Aeration**	1,566 x 448	7.9	15.2	2.430
2	**Facultative**	370 x 377 370 x 400 (4)	7.9 7.9	2.9 3.1	2.291 2.449
3	**Aerobic**	370 x 590 370 x 623	6.4 6.7	4.4 4.4	2.889 3.022
4	**Maturation**	370 x 813	5.9	6.9	4.148

The plant has an Imhoff tank that was not considered in the original project as a pre-treatment process and is currently not in operation due to deterioration.

At the end of 1994, the aerators were removed from the operation process due to operation costs involved.

The treated effluent is discharged into the 'El Anhelo" groundwater current which conveys it to a natural estuary where it remains for approximately 15 days before it is discharged into the Rio Grande River, the final receiving body.

In 1996, the National Water Commission (CNA) carried out the "Final Design Project for the Rehabilitation and Expansion of the Stabilization Ponds in Reynosa, Tamps." This project determined the treatment process for wastewater generated both presently and in the future.

Three alternatives were proposed for rehabilitation and expansion of each of the systems. Estimated project costs and operation and maintenance costs were also determined. The

most appropriate alternative was selected based on both a technical and financial evaluation for both the rehabilitation as well as the expansion project. The selected alternatives were developed through the final design stages.

In 1997, the International Boundary & Water Commission (IBWC/CILA), through Montgomery-Watson, carried out a hydraulic simulation of the collector system in the primary distribution system. The simulation was aimed at developing actions that would allow appropriate system functions. Results recommend a rehabilitation and expansion of the system for which flow distribution of the effluent into the treatment plant would differ from the Final Design flow.

AVERAGE DAILY FLOW FOR LOW WATER TREATMENT IN 2016

WASTEWATER TREATMENT PLANT	CNA FINAL DESIGN	IBWC/CILA HYDRAULIC SIMULATION
	Volume mgd	Volume mgd
No. 1 (Rehabilitation)	17.1	17.8
No. 2 (Expansion through Construction of a plant)	17.1	18.7
No. 3 (Construction of a new plant)	*19.4*	17.1
Average low water volume in 2016	53.6	53.6

19.1* **volume to treat *53.6* mgd that will be generated in 2016 (IBWC).**

The difference in volume found in the Final Design and the hydraulic analysis carried out by IBWC is not significant. For this reason, the flow volumes fall under a range that allows adequate functioning of the treatment plants.

The increase in volume will cause a **non-significant** decrease in the contaminant removal efficiency levels. Process efficiency levels must be verified through treated effluent monitoring in order to comply with discharge conditions established by the National Water Commission. Should parameters are not complied with, the surplus flow may be treated at Treatment Plant No. 3, which is only at the conceptual stages.

Wastewater Treatment Plant No. 1
(WWTP #1, Rehabilitation of the Existing System)

In accordance with the Final Design for Treatment Plant Rehabilitation and Expansion, the pond system has exceeded its design capacity. The original design had a capacity to treat an average volume of flow of 16 mgd while the average operation flow was established at 17 mgd, exceeding capacity by 6 percent.

The particular wastewater discharge conditions established by the National Water Commission (CNA) under concession No. 2TAM100226/24HASG94 and issued to the Comisión Municipal de Agua Potable y Alcantarillado of the City of Reynosa, Tamps, (COMAPA), are described below:

PARTICULAR DISCHARGE CONDITIONS

PARAMETER	AVERAGE MONTHLY CONCENTRATION	AVERAGE DAILY CONCENTRATION	LOAD Kg/day	UNIT
Grease & oils	15	25	1,620	mg/l
Floating material	none	None		3mm Screen
Sedimented solids	1	2		ml/l
T.S.S.	150	200	12,960	mg/l
BOD5 total	150	200	12,960	mg/l
Nitrogen total	40	60		mg/l
Phosphorous total	20	30		mg/l
Arsenic total	0.2	0.4		mg/l
Cadmium total	0.2	0.4		mg/l
Cyanide total	2.0	3.0		mg/l
Copper total	4.0	6.0		mg/l
Chrome total	1.0	1.5		mg/l
Mercury total	0.01	0.02		mg/l
Nickel total	2.0	4.0		mg/l
Lead total	0.5	1.0		mg/l
Zinc total	10	20		mg/l
Fecal Choliforms	1,000	2,000		NMP/100 ml

Development of the Final Design of the Treatment Plant Rehabilitation and Expansion Project also provided analysis of both the treatment plant influent and effluent; the results are described in the following table:

DESCRIPTION OF THE WWTP INFLUENT AND EFFLUENT

PARÁMETER	UNIT	L.S. No. 10	L.S. No. 4	L.S. No. 1	L.S. PEMEX	DESCRIPTION	EXIT
pH	µmbos/cm	7.27	7.23	7.15	6.90	7.18	7.00
Electrical conduct.	mg/l	1,959	1,914	1,773	1,711	1,842	2,021
Dissolved oxygen	mg/l	1.00	1.00	0.50	0.67	0.75	0.70
DBQ_5	mg/l	172	278	323	224	289	73
DQO	mg/l	306	442	477	404	448	145
Total solids	mg/l	1,313	1,303	1,311	1,251	1,305	1,578
Total floating solids	mg/l	176	185	183	109	180	188
Total settled solids	mg/l	1,137	1,119	1,128	1,143	1,125	1,390
Total dissolved solids	mg/l	1,209	1,235	1,181	1,163	1,205	1,512
Dissolved floating solids	mg/l	140	158	115	80	133	182
Dissolved settled solids	mg/l	1,069	1,074	1,066	1,083	1,070	1,390
TSS	mg/l	104.0	68.5	130.0	88.0	100.0	66.0
VSS	mg/l	36.0	26.5	68.0	28.7	46.4	6.0
FSS	mg/l	68.0	42.0	62.0	59.3	53.7	10.0
Sedimentables solids	ml/l	0.42	0.38	0.68	0.87	0.55	2.00
SAAM	mg/l	10.7	14.9	14.6	12.2	14.4	10.5
Total Phosphorous	mg/l	46.6	42.7	53.0	41.2	47.6	9.5
Calcium	mg/l	60.0	49.0	54.0	74.0	53.2	84.0
Magnesium	mg/l	59.0	61.7	59.0	41.3	59.3	63.0
Total hardness, $CaCO_3$	mg/l	397	380	383	387	383	475
Sodium	mg/l	404	346	385	346	368	416
Potassium	mg/l	39	39	39	39	39	39
Carbonates	mg/l	0	0	0	0	0	0

Bicarbonates	mg/l	366	320	353	264	335	414
Chlorides	mg/l	371	331	338	302	335	397
Sulfates	mg/l	482	488	482	524	487	508
Total acidity, $CaCO_3$	mg/l	60.2	73.1	65.3	61.5	68.1	32.5
Alkaline, $CaCO_3$	mg/l	300	263	308	217	284	340
Grease & oils	mg/l	238	176	473	171	317	96.9
N.-ammonia	mg/l	13.60	13.60	18.00	8.03	15.40	40.00
N-nitrates	mg/l	0.67	0.37	0.58	0.10	0.47	0.60
N-nitrites	mg/l	0.001	0.003	0.001	0.001	0.002	
N-organic	mg/l	7.40	7.87	9.81	10.12	8.85	
Phenols	mg/l	0.64	0.12	0.24	0.06	0.21	

In determining the design flow for rehabilitation of the pond system, consideration was given to the population of the City of Reynosa, which is 420,294 inhabitants and by the year 2016 it will have 1,003,916 inhabitants.

Average Wastewater Flow	**Current Population**	**Contribution (17/420,294) x 1,000,000**
mgd	**(inhabitants)**	**gallons/capita/day**
17	420,294	40.4

The estimated contribution of 40.4 gal/cap/day represents 51 percent of the estimated supply of 79.8 gal/cap/day. Design parameters for the pond system rehabilitation and expansion were based on wastewater analysis and information collected during field visits.

PARÁMETER	**VALUE**	**UNIT**
Average minimum annual temperature	15.3	º C
Average temperature-hottest month	30.1	º C
Temperature of the wastewater (26-32)	29.0	º C
pH (6.5-7.2)	7.18	mg/l
BOD_5 total (172-323)	289	mg/l
BOD_5 soluble (hypothetical criterion)	225	mg/l
Sedimentable Solids (0.38-0.87)	0.55	mg/l
Suspended Solids (88-130)	100	mg/l
Fecal Choliforms	$3.0X10^6$	NMP/100 ml

Treatability tests were carried out to determine biodegradable constants and fecal choliform removal constants in order to redesign the treatment systems. The following values were obtained:

CONSTANTS (day^{-1})	**VALUE**
Kan	0.645
Kf	0.783
Kban	2.118
Kbf	2.418

an = anaerobic (@ T= 29 º C)
f = facultative (@ T= 29 º C)

The description/characterization and gauging process along with tests to determine design constants supported the selection of the following options for WWTP #1:

OPTION	TREATMENT
1	Anaerobic pond followed by facultative pond
2	Anaerobic pond followed by expanded facultative pond
3	Anaerobic ponds followed by facultative ponds modified with piston flow

Anaerobic pond followed by facultative pond system

Once the pond system has had all grit and sand removed, it must be modified into three anaerobic ponds. The facultative ponds will have dividing levees removed, perpendicular to the direction of flow. These modifications will only allow treatment of 9.8 mgd of the actual 17.1 mgd. Technical descriptions are presented in the following table:

		PONDS	
DESCRIPTION	**UNIT**	**ANAEROBIC**	**FACULTATIVE**
Length (*)	ft	447	1,824
Width(*)	ft	436	377
Depth	ft	8.5	6.6
No. of ponds		3	5
Area	Acre	4.5	15.8
Effluent BOD_5	mg/l	100	30
Effluent Fecal Choliforms	NMP/100 ml	$3x10^6$	< 1000
Hydraulic Return period	Days	4.39	17.85
Volume of flow/pond	mgd	3.3	2.0

(*) From top to top.

The advantages to the system are:

- Only the existing system must have sand removed and have middle dividers lightly modified
- The entire existing structure can be used.
- Fecal choliforms and BOD5 comply with proposed modifications.

The disadvantages to this system are:

- Only 57% of the actual volume measured would be treated.
- Alternative solutions are required to provide treatment to the remaining volume.

Anaerobic pond followed by expanded facultative pond system

In order to include the current volume of flow 17.1 mgd, the option to make use of the existing infrastructure and extend the levees lengthwise is presented. Five anaerobic ponds would be constructed for a five facultative pond module. The technical description/characteristics are described in the following table:

CHARACTERISTICS	UNIT	PONDS	
		ANAEROBIC	FACULTATIVE
Length	ft	216	3,990
Width	ft	377	377
Depth	ft	9.8	6.6
No. of Ponds		5	5
Área	acre	1.9	34.6
Effluent BOD_5	mg/l	100	30
Fecal Choliforms	NMP/100 ml	$1x10^5$	$1x10^5$
Hydraulic Return time	Days	1.76	21.6
Volume of low / ponds	mgd	3.4	3.4

The advantages to this system are:

- Current volume demands are met, reduction in BOD_5 and fecal choliforms in accordance with norms established for wastewater reclamation
- All existing infrastructure is used with the proposed modification.

The disadvantages to the system are:

- Need to acquire approximately double surface area;
- Need to demolish current facilities used for laboratory, offices, Imhoff tank, and drying bed.

Anaerobic ponds followed by facultative ponds modified to piston flow

The general pond would be expanded lengthwise in the direction of the current flow. This area may then be used to make four anaerobic ponds that are divided into pairs; each pair will have two units in a row in order to discharge their effluent into one facultative pond that will operate with a piston flow system. Sections along the levees will be opened and the dividing levees will be removed in the facultative pond. These modifications may be made once all sand has been removed from the system. In this manner, one flow would 'zig-zag' through all five modules in the facultative ponds. The technical description is presented below:

CHARACTERISTICS	UNIT	ANAEROBIC PONDS		FACULTATIVE
		PRIMARY	SECUNDARY	POND
Length	ft	702	482	10,477
Width	ft	372	372	377
Depth	ft	13	13	8
No. of Ponds		2	2	1
Area	acres	6	4.1	90.8
Effluent BOD_5	mg/l	246.8	224.9	52.27
Fecal Choliforms	NMP/100 ml	1.96X106	1.53X106	4.85
Hydraulic Return time	Days	2.493	1.464	12.900
Volume of flow / ponds	mgd	8.6	8.6	17.1

The advantages to this system are:

- BOD and fecal choliform requirements for reclamation purposes are met, current flow needs are also met.
- The existing area is only increased by 18% to treat the 17.1 mgd flow.
- The current infrastructure is completely used.
- The anaerobic pond, 13 ft deeps, allows greater sludge storage.
- By having less area than the prior option, construction time is also decreased.

The disadvantages to this system are:

- Additional surface land area is required.
- Construction of two additional anaerobic ponds is required.

After evaluating the alternatives described above, it was concluded that the best option for rehabilitating the existing system was the 3rd option. This option involved expanding the anaerobic ponds followed by facultative ponds modified to piston flow. This option has been developed through the Final Design stages. The facilities distribution plan is included in the final document, illustration 3.2.

In accordance with the calendar established for the rehabilitation project, that will take approximately one year, a construction process that does not impede or delay wastewater treatment is required. Delaying the existing treatment process would generate a negative environmental impact on the surroundings due to raw, untreated wastewater discharges into the receiving body during the project implementation. To avoid any negative impact, a construction process was developed for the pond rehabilitation process and is described in the Environmental Impact Statement, General Terms, 1997, as part of the Integral Sanitation Project for Reynosa, Tamaulipas.

The remaining components, such as construction of roadways, internal drainage system, security booth, lighting, office facilities, perimeter fencing, etc. will be carried out at the same time the stabilization ponds are constructed, in accordance with the activity calendar described in the Work Program of the Environmental Impact Statement.

Wastewater Treatment Plant No. 2
(WWTP #2-Expansion through a new plant)

In accordance with the information collected during field visits, population projects, potable water and sewage services, city growth plans, land use at feasible treatment sites, and the area topography, different alternatives to expand the treatment system were established and are described below:

OPTION	TREATMENT
1	Anaerobic pond followed by facultative pond.
2	Anaerobic pond followed by aerated facultative pond and sedimentation.
3	Aerated facultative ponds followed by sedimentation ponds and effluent chlorination process.

Anaerobic pond followed by facultative pond.

This option includes five anaerobic ponds followed by five facultative ponds. The technical characteristics of this pond system are described below:

CHARACTERISTICS	UNITS	PONDS ANAEROBIC	PONDS FACULTATIVE
Length	ft	344	3,698
Width	ft	259	344
Depth	ft	13.1	8.2
No. of ponds		5	5
Area	acre	2.0	29.3
Effluent BOD_5	mg/l	181.15	29.00
Fecal Choliforms	NMP/100 ml	$8.85x10^5$	1.0
Hydraulic Return time	days	1.874	20.488
Volume of flow / ponds	mgd	3.4	3.4

The advantages to the system are:

- Compliance with existing norms regarding BOD_5 and fecal choliforms.
- No chlorine application required to effluent resulting in low operation and maintenance costs
- Allows module size to increase (3.1 mgd) in accordance with increase in population over the years.

Some of the disadvantages to the system are:

- The area is relatively large (173 acres), making land acquisition difficult.

Anaerobic pond followed by aerated facultative pond and sedimentation.

This alternative is based on the removal of measured organic material, such as BOD_5, in order to reach values under 100 mg/l. However, it does not meet fecal choliform standards that must be under 1000 NMP/100 ml., requiring chlorine application at concentration levels of 3 mg/l. Technical description of this option is described below:

CHARACTERISTICS	UNITS	PONDS ANAEROBIC	PONDS FACULTATIVE	PONDS SEDIMEN-TATION
Length	ft	492	866	777
Width	ft	118	118	118
Depth	ft	9.8	7.9	8.9
No. of ponds		5	5	5
Area	acres	1.2	2.3	2.1
Effluent BOD_5	mg/l			30
Fecal Choliforms	NMP/100 ml	$3x10^6$		160
Hydraulic Return time	Days	1.5	1.7	0.58 (14 hrs)
Volume of flow / ponds	mgd	3.4	3.4	3.4
Power	HP		180	
Chlorine in Effluent	mg/l			3

The advantages to this system are:

- A smaller surface area (than the one required before) is required.
- Allows for growth in modules by 3.4 mgd
- Complies with norms for BOD_5 removal
- Less construction area results in a considerably shorter implementation period.
- System has higher operational controls.

Some of the disadvantages to the system are:

- Chlorine needed to comply with choliform standards (chlorination booth, equipment, etc.)
- Greater costs in operation and maintenance for energy and electro-mechanical equipment.
- Higher level of personnel training required for system operations.

Aerated facultative ponds followed by sedimentation ponds and chlorination.

With this option only the biochemical oxygen demand is removed. This requires a chlorination process of the treated effluent in order to comply with particular discharge conditions of 1000 NMP/100 ml of fecal choliforms with the same amount of chlorine. In addition, this alternative requires aeration equipment to carry out the wastewater treatment process. The technical description of this option is described in the following table:

CHARACTERÍSTICS	UNITS	PONDS	
		MECHANICALLY AERATED FACULTATIVE POND	SEDIMENTATION POND
Length	ft	866	777
Width	ft	118	118
Depth	ft	7.9	8.9
No. of ponds		5	5
Area	acres	2.3	2.1
Effluent BOD_5	mg/l		30
Fecal Choliforms	NMP/100 ml		225
Hydraulic Return time	days	1.7	0.58 (14 hrs)
Volume of flow / ponds	mgd	3.4	3.4
Power	HP	280	
Chlorine in effluent	mg/l	3	

The advantages to this system are:

- The area required is less than the area required for the first alternative.
- Land acquisition is less difficult, less area required.

- Available area (173 acres) is sufficient to provide treatment through the year 2016.
- Construction time is much less than time required under option #1.
- Better system controls compared to option #1.
- Complies with BOD_5 norms.
- Allows for 3.4 mgd increase for each module.

The disadvantages to the system are:

- Higher operation and maintenance costs required for the electro-mechanical equipment.
- Requires personnel training for system operations.
- Infrastructure and storage needs for chlorine application require additional costs with inherent risks.

It was determined that the best option for WWTP No.2 is the first alternative, consisting of anaerobic ponds followed by facultative ponds. This alternative was developed through the Final Design stages. The facilities distribution plan is included in the final document, illustration 3.3

Design of the anaerobic and facultative ponds includes outer levees with a 2:1 slope, compacted to 90% with the Proctor test. The upper width of the levee (crown) will be 3 meters wide to allow vehicles to drive on it. To access pond system, access ramps will also be constructed.

In accordance with the geo-technical studies carried out, up to 30% of the excavated material will be utilized and mixed with clay and lime to make the levees. Excavation will not be deep and risk of reaching water tables is not present.

WWTP No. 2 includes construction of a single story office building that will include: waiting area, support staff area, two offices, laboratory, storeroom, and two bathrooms. Structure will include bearing walls made of red flat brick, foundation, drop panels, concrete trusses, full length foot bearings, and alloy beams.

Expansion construction stages are described below:

1. Site preparation (removing trees, shrubs, and weed growth)
2. Construction of access roads, bathrooms, building perimeter fencing and security booth.
3. Removing vegetation from area where modules will be constructed; construction of levees with approved bank material and with mechanical equipment and experienced personnel in accordance with Final Design.
4. Construction of pretreatment system, office building, and exterior lighting. Installation of electrical substation and emergency equipment.
5. Construction of elevated tank and electrical control room; lift station and access bridge to the lift station, and construction of collector.

The activities described above will be carried out in accordance with the activity calendar described in the Work Program included in the Environmental Impact Statement document.

Wastewater Treatment Plant No. 3
(WWTP #3, Conceptual Design)

By the year 2001 it has been determined that a third wastewater treatment plant will be required to treat a portion of the 53.6 mgd average wastewater flow that is expected to be generated through the year 2016, which is the planning horizon for this project.

WWTP #3 has been designed conceptually and its location will be east of the Reynosa-Pharr Bridge. It will have the capacity to treat 19.4 mgd. The treatment process will be similar to the pond systems and as such, will require approximately 198 acres for construction. Initially, the area required will be less than the established requirement.

Illustration 3.4, found at the end of the document, describes the proposed service areas for each of the wastewater treatment plants. The boundaries of the areas served by each plant have been defined in accordance with a fair division of the average low water flow through the year 2016.

Preliminary Project for Installation of Aerators at the Wastewater Treatment Plants

As part of the Environmental Impact Statement and according to Secretariat of Social Development of the State of Tamaulipas (Cd. Victoria, Tamaulipas), regarding any possible foul odors from the anaerobic ponds during the wastewater treatment process, the following options are presented as a potential solution to this problem.

The first option consists in the construction of a wind proof barrier that includes the use of shrubs and trees and year round evergreens planted in concentric circles spaced every 1,639 ft. Gases would be measured approximately 1 mile around the treatment plants.

Should this alternative not provide the expected results, a general preliminary project that includes surface aerators to equip the treatment systems would also be presented. The aerator preliminary project is proposed for rehabilitation of the existing plant.

The preliminary project consists in the introduction of a mechanical surface aeration system in the anaerobic ponds. The project will eliminate gases causing the odors and will not affect the lower layer of the pond water where anaerobic processes occur. The number of aerators being considered under the preliminary project is 20, each having 5 HP's, and 6 of them will be placed in each of the primary anaerobic ponds and 4 in each of the secondary anaerobic ponds.

Similar to the rehabilitation process, the possibility of presenting the final design of the expansion project for a second time was considered necessary. The anaerobic ponds

would include installation of the surface aerators. The number of aerators considered in the preliminary project is 20, each would be 5 HP, and each of the anaerobic ponds would have 4 aerators.

For both rehabilitation as well as expansion, the connection will be a transformer set-up on a "CFE" structural post, type "IT-3" for the 23 kv and 400 amperes system. Circuit distribution and characteristics, as well as the Motor Control Center are described in diagrams E-01 (one-wire), E-02 (power and ground distribution, electrical control room), and E-03 (power and ground distribution plant).

Preliminary project development, itemization, caliber calculations conductor report, electrical plans, and one-wire diagrams are described in greater detail in the Environmental Impact Statement of the Comprehensive Sanitation Project of Reynosa, Tamaulipas.

Reduction and Pre-Treatment of Industrial, Commercial, and Service Industry Wastewater

The principal water contamination problems found in Reynosa are described below. They are divided into actions that degrade water quality in the municipal collectors and water bodies due to industry and urbanization.

a. Industry
   - Discharges by industries that are not registered and do not comply with city regulations.
   - Discharges that do not comply with norms into receiving bodies, contaminating materials carried resulting from industrial processes.
   - Absence of contamination prevention and control facilities needed for adequate disposal of industrial discharges into the drainage system.

b. Commercial
   - Absence of facilities in the internal structure for adequate disposal of garbage, oil, and grease into the municipal sewage and drainage system.

c. Laundries and Dry Cleaning
   - Discharge sulfates, phosphates, detergents, and industrial solvents.

d. Hotels and residential areas
   - Discharge detergents, acids, grease that impact the sewage system.
   - Dispose wastewater from industrial, commercial, and residential septic tanks.

e. Services
   - Hydrocarbons that do not comply with norms are discharged into the sewage and drainage system. They are discharged from motor vehicle lube & oil jobs, motor and paint shops; clinical and photography laboratories, medical units, washing facilities for tank-cars with hazardous waste.

COMAPA has taken these factors into consideration and is in the process of developing a Wastewater Reduction and Pretreatment Program. In developing the program it developed two questionnaires to identify characteristics of water being discharged by industry.

1. AR-01.
2. AR-01/MQ

Questionnaire AR-01 collects general information. It has seven sections and is similar in format to questionnaire AR-01/MQ:

A. General Information
B. Business Activity
C. Water Supply
D. Information on sewage or pipes.
E. Other information on wastewater discharges during process
F. Treatment
G. Plant operational characteristics

Questionnaire AR-01/MQ has twelve sections to collect different types of information and are divided in the following manner:

A. General Business Information-name, address, etc.
B. Business activity-to determine whether water is used in different processes
C. Water Supply-to determine source supplies and average water use
D. Information on sewage and pipes-are discharges into the sewage system or into septic tanks.
E. Information regarding wastewater discharges in process. Variations in wastewater flow in process, type of wastewater discharges, maximum average, presence of automatic sampling equipment, changes or expansion of the process during the next three years; existence of water recycling or reclamation system.
F. Discharge Characteristics. Presentation of contaminants used in each process, such as metals, neutral bases, extractable acids, miscellaneous hazardous substances, etc.
G. Treatment. Information on the type of treatment applied, if applicable.
H. Operational Characteristics of the Plant. Work schedule, number of shifts, commercial activity, etc.
I. Leak Prevention. Existence of container units for chemical storage, existence of sifters in the storage units, existence of contingency plan in case of accidental leakage.
J. Process Report Information. Notification of a discharge report of samples taken to COMAPA, development of a organic toxic substance management plan.
K. Compliance. Compliance with federal, state, and local requirements.

L. Authorization and Compliance. Statement indicating all previous information is true and correct and may be verified by COMAPA, in case of false information, appropriate sanctions will be applied.

Furthermore, a directory of all industry types located in the City of Reynosa has been developed. A list of all registry numbers for industrial wastewater discharges has also been developed.

Pursuant to the *Ley de Equilibrio Ecológico y de Protección al Ambiente del Estado de Tamaulipas (Environmental Protection Laws of the State of Tamaulipas),* the Environmental Department of the State, the Environmental Department of the City and the Potable Water and Sewage Board of the City of Reynosa, Tamps., the following program with the following objectives is hereby presented.

- Maintain environmental balance and natural resource conservation.
- Prevent and control contamination of local and regional water resources
- Control quantity and quality of wastewater contributions into the sewage and treatment systems in order to optimize life and operation of the system.

The program basically consists in the development of a discharge register, follow up activities on discharge quality and quantity; control via implementation of pretreatment systems, and imposing sanctions or incentives based on compliance or non-compliance with requirements.

The program will operate based on the following aspects:

1. The drainage system user must register discharges with authorities, must adhere to information requirements established in the specific questionnaire.
2. The user must submit yearly a wastewater quality and quantity report on water discharged into the drain system. In accordance with results, authorities may require as many water quality reports as deemed necessary. Water quality studies must be carried out by a laboratory certified by the National Sample Laboratories System.
3. The user must comply with maximum allowable limits for the parameters established under NOM-031-ECOL-93.
4. The Potable Water and Sewage Board, pursuant to Section 5.3 of NOM--031-ECOL-93, may establish additional water quality parameters and may also establish more stringent parameters than those described, in order to optimize wastewater drainage and treatment system operations.
5. To comply with discharge condition, the User must install, if necessary, treatment systems that will allow lower values than the parameters established.
6. If water supply should contain any of the regulated parameters, party responsible for discharge shall not be liable, but shall have the right to have authorities establish, via prior request, particular discharge conditions, that take into consideration the above.

7. The user shall have the right to be exempt from submitting the water quality analysis report and present future sample results, regarding any parameters that technically prove that cannot be generated in their production processes, nor resulting from their raw materials, via a technical reports including a representative analysis of the affluent, that covers all the parameters established as a condition by the officials.
8. Non compliance with requirements established in this regard will result in application of sanctions pursuant to the State Environmental Laws, Chapter IV.
9. Compliance with requirements will be encouraged through implementation of an incentive program ranging from monetary incentives to public recognition.
10. The Potable Water and Sewage Board of Reynosa may carry out, if required, water quality monitoring additional to those carried out by the User.

Construction and Rehabilitation of the Primary Sanitary Sewage System.

The sewage system consists in the following components:

- Drain pipes (sewage lines 8 in diameter or less)
- Secondary collectors (10 to in diameter)
- Collectors (24 to 48 in lines)
- Pump stations

The primary sewage system in Reynosa is approximately 64.4 miles length and includes a sewage drain pipe system whose diameter is 18 in wider.

Based on the evaluation of the sewage system and information provided by COMAPA, the following problems are described according to their magnitude and recurrence.

- Collapsed pipes
- Large amount of submerged pipes, specifically up stream from the lift stations.
- Severe clogging in the sewage system caused by:
    - Leaks in areas not paved
    - Insufficient maintenance in pipes
- Significant percentage of areas without coverage
- Insufficient capacity in the primary lines
- Functioning of system in a joint manner.

The project has identified approximately 18 miles in the primary system where the load conditions have exceeded original design capacity. Also, the age of the pipes has also caused problems in the system. As such, the system requires rehabilitation.

Based on the problems described above and a report prepared by COMAPA, a list of priority zones has been developed. The main reason being collapsed pipes, insufficient conveyance capacity, as well as lines working at full capacity.

- Central area
- Cumbres area
- Pánuco Collector
- Centro Viejo Collector
- Del Valle Collector
- Del Valle collector #2
- Mainero Collector
- Rodriguez Subdivision
- Aquiles Serdán Subdivision
- Lázaro Cárdenas Subdivision
- El Anhelo Subdivision
- Petrolera Subdivision
- Benito Juárez Collector
- Reynosa - Lampacitos Collector
- Industrial Maquiladora Subdivision
- Casa Bella Subdivision

The sites requiring project work were established based on the drainage system evaluation which includes: revision of wastewater plans and system information; field measurements collected with the Global Positioning System (GPS) of manholes in the primary system, and conventional measurements of the system's other components, interviews and field visits with COMAPA staff, inspections and evaluations of the man holes and lift stations, rainfall and duct flow monitoring, system inspections via Closed Circuit TV (CCTV), a Closed Circuit Sonar Inspection Technique (CCSIT), corrosion, sulfur, and hydrogen samples, and a system simulation through the load model.

The CCTV inspection was carried out with a television camera in 12,836 ft of pipes, ranging in diameter from 18 to 48 in. Where discharge conditions did not allow the use of the CCTV, the CCSIT was used to provide a continuous exploration of the pipes via high definition sonar color and varied vision cameras. The inspection results have indicated problems in the system. Problems in the structure, service, and construction failures were identified. Based on this analysis, several areas in the system were identified with extreme corrosion; immediate and corrective actions are recommended in the next two years in order to prevent any catastrophic structural damages.

A system to monitor rainfall and the load in the lines over a six-week period was implemented. Thirty-nine meters were installed to measure the flow by gravity. The meters were installed at key locations to register not only the flow but also water accumulation areas in the sub basins up river and down river. Bucket rain-meters were installed in nine locations throughout Reynosa at lift stations and public buildings. Doppler pressure meters were installed at the exit manifolds of the pressure lines at seven lift stations in order to register the volume flow and discharge speed.

Rehabilitation of the sanitary sewage system includes repair, upgrade, and replacement work to restore the structure's integrity and also provide anti corrosive protection.

The improvement program consists in four stages, each of which will take five years. The first stage, 1998-2001, will include work to the most critical areas as well as construction. Each of the projects, their localization and construction, is described in the project plans for the Primary System at the end of this document.

The materials that will be commonly utilized in the municipal lines are:

- Simple concrete
- Reinforced concrete
- Asbestos cement (A-C)
- Poly-Vinyl Chloride (PVC)
- High Density Polyethylene (HDPE)

The following factors were considered during the material selection process:

- Flow characteristics
- Useful life
- Resistance to acids, alkaline, etc.
- Convenience for management and installation
- Availability
- Costs

After reviewing these factors and materials, it was concluded that the most appropriate materials for construction and rehabilitation of the system was PVC and reinforced concrete. The 24 in pipes or smaller will be PVC, which was determined to be the most resistant and cost effective; the 24 in or wider pipes will be made of reinforced concrete with thick high alkalinity resistant walls.

Decisions were reached in accordance with materials most available in Reynosa, which are PVC and reinforced concrete. Furthermore, price comparison indicated that the price of PVC increases considerably when diameters exceed 24 in when compared to the price of reinforced concrete. Also, with pipes having a greater diameter, availability tends to be limited.

Materials used to manufacture PVC and reinforced concrete must comply with CNA standards. These norms are described later in this document.

The main corrosion-causing agent in the sewage system is sulfuric acid. This acid is produced in great turbidity areas and also areas where water settles for long periods of time. Several protection systems are available for the sewage system to minimize corrosion caused by acids and other agents. Development of these systems has been addressed in studies carried out by the International Boundary & Water Commission for the City of Reynosa.

The anti-corrosion protective overlaps will not be necessary where PVC is used. However, reinforced concrete pipes will require the protective overlaps.

Rehabilitation of the drainage system will significantly reduce the amount of sulfuric acid being generated. It will avoid water settling and turbidity. Though a reduction of turbidity will be experienced, complete elimination throughout the system will not be possible. Areas subject to turbidity will include a protective overlap; in these areas, surface preparation, temperature, humidity, quality control, and inspection will be very important to ensure correct adhesion between the overlap and the surface. The most important factor that determines the success outcome of an overlap system, is strict application and adherence to test and inspection procedures.

Several protective overlap systems were considered; these include epoxy, polyester, polyurethane, or layers of carbon epoxy tar. After analyzing each of these, it was determined that the most appropriate would be epoxy layers.

In areas where corrosion is likely to occur, it is necessary to increase the concrete thickness of the pipe, between the steel and pipe interior, in order to increase useful life. All concrete pipes without the epoxy layers must have a thick wall to provide the concrete with the required "endurance".

To provide ventilation and specifically to reduce the generation of sulfuric acid, pipes must not operate with full loads. For this reason, the pipes were configured to work with a full load only during peak flow conditions.

The hydraulic or load analysis was developed with a Manning equation, typically used for pipes. Based on experiences, coefficient rugosity values for the existing conditions and proposed condition according the conditions of the pipes, were recommended. Furthermore, to avoid material deposits in the pipes and damage caused by high speed (flow), allowable slope values were used.
To ensure compliance with minimum requirements, several detailed and specification plans for each of the projects (both construction and rehabilitation) must be prepared. The plans must be reviewed prior to construction stages to ensure compliance.

There are approximately 1,400 manholes in the Reynosa sewage system. The manholes are generally made of brick (98% of the total) or concrete (prefabricated concrete rings). The manhole lids and rims are frequently made of steel or concrete for two reasons:

1. The concrete rims and lids can be made at their facilities
2. The steel lids are frequently stolen.

The manholes are standard except the special connection boxes, which have been built along the lines with the widest diameter of the primary system.

Based on the analysis, the manholes will be made of prefabricated concrete or brick. An epoxy covering will also be provided in case they are exposed to turbidity or corrosion. In its reports, the International Boundary & Water Commission, recommends protecting the manholes both in the construction as well as the rehabilitation project.

Manholes will have to be replaced in sections where original pipes are rehabilitated. Recommendations indicate the manhole rim be made of cast iron and it be placed above street level (2-3 in) in order to reduce sand and rainfall entering the system. In areas away from thoroughfares, they must be 12 in above street level.

To increase ventilation in the system and avoid corrosion, manhole lids must have vents, except in highly populated areas or environmentally protected areas, or areas susceptible to flooding. Furthermore, PVC escape pipes must be installed every 656 ft, from the manhole to a post, away from residential homes or nearby buildings. These pipes help reduce corrosion by increasing the airflow through the hole and can be built to appear like posts in order to reduce visual impacts on the surroundings.

The manhole must not have stairs as they tend to create problems during maintenance. Elimination of rungs avoids serious safety hazards due to corrosion in the concrete and iron on the steps.

Construction and Rehabilitation of the Sewage System will require frequent inspections to ensure procedures conform to design plans.

Long Term Rehabilitation of the Sanitary Sewage System

Based on the project useful life of the exiting pipes, estimates indicate that the complete system will require structural improvements by the year 2016. Improvements do not include the new proposed pipes to improve the load capacity or to avoid structural faults in the short term. Over 34 miles of the primary gravity system require rehabilitation improvements to extend the system's useful life. Improvements to these lines must be carried out in the next twenty years.
Additional corrosion inspections, inspections with CCTV, and field investigations must be carried out to evaluate each system line to establish a priority list for pipe replacement. Assuming the existence of similar conditions in the pipes, the drainage located down river would be the rehabilitation priority. A fault in this zone would affect a larger service area.

After review the line conditions, pipes must be rehabilitated with appropriate technology during the same period, replacement work takes place. Approximately 34 miles in drainage pipes, ranging from 10 to 48 in diameter will be included in the long-term rehabilitation program. Each five-year phase of the Infrastructure Improvement Program, a fourth of the lines, have been budgeted for replacement. Priority for line rehabilitation must be determined based on the field inspection program.

Rehabilitation of the Secondary System and Expansion of the Sanitary Sewage System.

The oldest sewage lines in the system were installed in 1957 in order to provide service to the Central area, the area south of the Anzaldúas Canal, the Refinery, and the Petrolera Subdivision. During the 60's the system was expanded to reach the eastern and western areas of the city. After a slow growth period during the 70's, the 80's brought a rapid growth rate in coverage.

The small drain system collects domestic, commercial, and industrial discharges. The system's length exceeds 680 km. Approximately 147 km. require rehabilitation to the infrastructure's age and corrosion; it is distributed in 14 subdivisions. The normal drain-pipe diameter is 20 cm. and made of simple concrete. Some new developments have used PVC and obtained good results. The minimum slope used is 0.004

The main actions to be undertaken, by subdivisions, is described in the Rehabilitation and Expansion plan for the sewage system and which is included at the end of the document.

Rehabilitation of the Secondary Sewage System.

1. **Colonia Del Prado** Installatoin of 8,426 ft with PVC pipes, 8 in diameter with hermetic joints, installation of 373 domestic discharge connections.
2. **Colonia Anzaldúas** Installation of 20,292 ft with PVC pipes, 8 in diameter with hermetic joints, installation of 385 domestic discharge connections.
3. **Colonia Bella Vista.** Installation of 17,639 ft with PVC pipes, 8 in diameter with hermetic joints, installation of 434 domestic discharge connections.
4. **Colonia Simón Rodríguez.** Installation of 7,213 ft with PVC pipes, 8 in diameter with hermetic joints, installation of 487 domestic discharge connections.
5. **Colonia Rosita.** Installation of 12,787 ft with PVC pipes, 8 in diameter with hermetic joints, installation of 312 domestic discharge connections.
6. **Colonia Altamira.** Installation of 8,066 ft with PVC pipes, 8 in diameter with hermetic joints, installation of 113 domestic discharge connections.
7. **Colonia Beatty.** Installation of 7,016 ft with PVC pipes, 8 in diameter with hermetic joints, installation of 243 domestic discharge connections.
8. **Colonia Ayuntamiento.** Installation of 37,803 ft with PVC pipes, 8 in diameter with hermetic joints, installation of 308 domestic discharge connections.
9. **Colonia Chapultepec.** Installation of 4,000 with PVC pipes, 8 in diameter with hermetic joints, installation of 98 domestic discharge connections.
10. **Colonia Prolongación Longoria.** Installation of 17,213 ft with PVC pipes, 8 in diameter with hermetic joints, installation of 992 domestic discharge connections.
11. **Colonia Longoria.** Installation of 39,803 ft with PVC pipes, 8 in diameter with hermetic joints, installation of 257 domestic discharge connections.
12. **Zona Centro.** Installation of 127,869 ft with PVC pipes, 8 in diameter with hermetic joints, installation of 3,417 domestic discharge connections.

13. **Colonia Petrolera.** Installation of 22,190 ft with PVC pipes, 6 in diameter, 40,413 ft with PVC pipes, 8 in diameter, 800 ft with PVC pipes, 10 in diameter, 744 ft with PVC pipes, 12 in diameter, 2,200 ft with PVC pipes, 15 in diameter, and all pipes will have hermetic joints. *Replacement of the Collector in the Colonia Petrolera.* Installation of 4,049 ft of pipes with PVC, 18 in diameter with hermetic joints.
14. **Colonia Rodríguez.** Installation of 103,737 ft with PVC pipes, 8 in diameter with hermetic joints, installation of 1,363 domestic discharge connections.

Expansion of the Sewage System.

1. **Colonia Jarachina.** Installation of 25,354 ft with PVC pipes, 8 in diameter, 1,377 ft of PVC pipes, 12 in diameter; 2,583 ft of PVC, 18 in diameter; 1,770 ft of PVC, 24 in diameter; all pipes will have hermetic joints; construction of 240 manholes and installation of 298 domestic discharge connections.
2. **Colonia Lampacitos.** Installation of 42,570 ft with PVC pipes, 8 in diameter with hermetic joints, construction of 91 manholes, and installation of 676 domestic discharge connections.
3. **Colonia M. Maza de Juárez y 15 de Enero.** Installation of 22,213 ft with PVC pipes, 8in diameter, 3,459 ft of PVC pipes, 12 in diameter, all with hermetic joints, construction of 107 manholes, and installation of 879 domestic discharge connections. ***Conclusion of the Margarita Maza de Juárez Collector.*** Conclusion of 2,748 ft of reinforced concrete pipes, 36 in diameter with hermetic joints, 148 ft of steel pipes, 36 in diameter, and construction of 10 manholes.
4. **Colonia Americo Villareal.** Installation of 19,833 ft with PVC pipes, 8 in diameter, 2,295 ft of PVC pipes, 15 in diameter, 2,052 ft with reinforced concrete, 30 in diameter, 295 ft with reinforced concrete, 36 in diameter, all with hermetic joints, construction of 80 manholes, and installation of 1,000 domestic discharge connections.
5. **Colonia Voluntad y Trabajo.** Installation of 28,285 ft with PVC pipes, 8 in diameter, 4,656 ft of reinforced concrete, 30 in diameter, all with hermetic joints, construction of 129 manholes, and installation of 717 domestic discharge connections.
6. **Colonia Satélite I.** Installation of 39,869 ft with PVC pipes, 8 in diameter with hermetic joints, construction of 122 manholes, and installation of 845 domestic discharge connections.
7. **Colonia Satélite II.** Installation of 30,626 ft with PVC pipes, 8 in diameter with hermetic joints, construction of 88 manholes, and installation of 735 domestic discharge connections.
8. **Colonia Independencia.** Installation of 46,413 ft with PVC pipes, 8 in diameter; 3,279 ft of PVC with 12 in diameter, 5,105 ft of PVC, 15 in diameter, all will have hermetic joints, construction of 160 manholes, and installation of 965 domestic discharge connections.
9. **Colonia Cereso.** Installation of 6,400 ft with PVC pipes, 12 in diameter with hermetic joints, construction of 24 manholes, and installation of 1 domestic discharge connections.

10. **Colonia Juan Escutia.** Installation of 8,292 ft with PVC pipes, 8 in diameter with hermetic joints and installation of 1 domestic discharge connections.
11. **Colonia Nuevo Amanecer.** Installation of 6,816 ft with PVC pipes, 8 in diameter with hermetic joints, construction of 29 manholes, and installation of 243 domestic discharge connections.
12. **Colonia Leyes de Reforma.** Installation of 8,528 ft with PVC pipes, 8in diameter, 2,328 ft of PVC, 18 in diameter, all with hermetic joints, construction of 45 manholes, and installation of 336 domestic discharge connections.
13. **Colonia Lucio Blanco.** Installation of 30,000 ft with PVC pipes, 8 in diameter, 672 ft of PVC, 12 in diameter, 1,607 ft of PVC, 15 in diameter, 4,964 ft of PVC, 18 in diameter, all with hermetic joints, construction of 136 manholes, and installation of 710 domestic discharge connections.
14. **Colonia Esperanza.** Installation of 35,443 ft with PVC pipes, 8 in diameter, 1,443 ft of PVC, 12 in diameter, 480 meters of PVC, 61 cm. in diameter, all with hermetic joints, construction of 126 manholes, and installation of 503 sanitary discharges.
15. **Colonia Moderna.** Installation of 8,593 ft with PVC pipes, 8 in diameter with hermetic joints, construction of 26 manholes, and installation of 503 sanitary discharges.
16. **Colonia Praderas de Oriente.** Installation of 7,790 ft with PVC pipes, 8 in diameter, 508 ft of PVC, 12 in diameter, all will have hermetic joints, construction of 24 manholes, and installation of 250 sanitary discharges.

Regularization Of The Discharges At Lots Not Connected To The Sanitary Drainage System.

This is a very serious environmental and human health problem. With regard to the technical aspects, a specifications manual and sanitary facility installation project will be developed. The facilities will be located in the lot. The technology used to eliminate the use of latrines and cesspools will also be developed in order to comply with national requirements.

The following subdivisions (colonias) have been identified with this problem and will be included in the discharge regularization program.

LIST OF DISCHARGES THAT WILL BE INTEGRATED INTO THE SANITARY SEWAGE SYSTEM

Code No.	SUBDIVISION (COLONIA)	No. of discharges
1-B	Capitán Carlos Cantú	687
2-B	Roma	97
3-B	Las Torres	1,408
4-B	Hidalgo, Santa Cecilia	164
5-B	Solidaridad	269
6-B	Campestre	174
7-B	Reynosa 2000, Rancho Grande	297
8-B	Paraíso, S. de la Garza	325

Code No.	SUBDIVISION (COLONIA)	No. of discharges
1-C	Benito Juárez	2,350
2-C	Pedro J. Méndez	1,732
3-C	Granjas Económicas del Norte	613
4-C	Fracc. Reynosa	499
5-C	Narciso Mendoza	209
6-C	Arco Iris	1,179
7-C	Prol. Cumbres	439
8-C	Esfuerzo Nacional	296

9-B	M. Tarrega, La Curva	206
10-B	Presa La Laguna	500
11-B	Unidos Podemos	545
12-B	La Amistad	206
13-B	Bernabe Sosa	26
14-B	Francisco Villa	71
15-B	Revolución Verde	108
16-B	Tamaulipas	856
17-B	Jacinto López	1,012
18-B	Mitras	154
19-B	Emiliano Zapata	67
20-B	Industrial	274
21-B	Burocrática	561

9-C	Bienestar	126
10-C	López Mateos	62
11-C	Del Parque, Loma Linda	33
12-C	Fracc. Moderno	26
13-C	El Maestro	301
14-C	Almaguer	356
15-C	López Portillo	1,046
16-C	Fidel Velazquez	219

Code Numbers B and C indicate the type of material in which excavation will be carried out. The total number of discharges under type B is 8,007 and with type C is 9,489; the total number of discharges is 17,493.

Construction and Rehabilitation of the Wastewater Pump Stations.

Pump stations are the essential component of the drainage system, as such, any faults or problems affect the entire system. The age of the pump stations ranges from one to thirty years.

The City's level relief and the fact it is intersected in several locations by canals and irrigation drains (Anzaldúas, Rhode, Las Mujeres, and El Anhelo), require it to have pump stations to convey and discharge its wastewater to the treatment plant. All pumps are started and stopped manually. Due to this operation, eleven of the thirteen stations are manned 24 hours a day.

A problem commonly found in all the pump stations is the clogging experienced in the sumps which is caused by the absence of degritters. During the manhole reconaissance program carried out by Montgomery-Watson in 1997, 139 manholes located up river from the pump stations, were found to be operating under hydraulic load and clogged conditions.

The problems that must be addressed with the pump stations are described in general terms below:

- Sumps are clogged because of an absence of degritters
- Control booths are not weather proof
- Pumping equipment is old and/or lack of maintenance
- Operation efficiency levels are 50% or less
- Deteriorated motor control center
- Pipe finishing, equipment is deteriorated and multiple general faults in structures
- Serious problems in the majority of the sumps:

- Insufficient capacity
- Clogging caused by lack of degritters
- Insufficient maintenance
- Electrical problems
- Los efficiency levels in equipment (%)

General recommendations were developed based on the analysis of the pump stations in order to provide immediate corrective measures to the structural, electrical, and most critical hydraulic problems.

- Seal sump to avoid leakage
- Install solid material collection systems throughout the system and rehabilitate existing ones.
- Remove sand and solid material from sump
- Paint motors, pumps, and valve boxes at all stations with anticorrosive paint
- Evaluate and activate telemetry system at all plants
- Install a mobile pump and an electrical generator at Station No. 12, until new pumps are purchased and installed. This temporary system can be rotated throughout the different plants according to needs.
- Evaluate, rehabilitate, and test all control panels and existing electrical components.

To ensure compliance with study recommendations carried out by CILA, the corresponding final design projects will be developed. The design package will be reviewed before construction stages begin.
The works required to increase the pumping system's capacity are described in the project plans that are included at the end of this document.

b. Operation and Maintenance Plan

COMAPA will be responsible for the operation and maintenance of Reynosa's potable water and sewage systems. Due to the high rate in population growth, infrastructure development and maintenance has not been sufficient to satisfy all needs.

Maintenance of the system is understood as preservation of units in order to impede the interference of foreign factors with the proper functioning of the process during its useful life. Maintenance is divided into preventive and corrective maintenance, and also in continuous or permanent and periodic maintenance. Preventive maintenance is carried out daily or more than once a day (if required). Periodic maintenance is not required on a daily basis but is required for the process and preservation of the facilities.

Preventive maintenance of the collector system includes regular cleaning of the sewage, implementation of anti-corrosive control measures, inspection of the sewage system to identify areas requiring rehabilitation or replacement, and maintenance of the system's pump stations. These activities are critical in maintaining the system free of excessive sand, and to minimize overload conditions, and also maintain the system's structural integrity.

With regard to the ponds, preventive maintenance consists in among other activities, cleaning the screens, removing thick material that is caught or floating material, revision of the slopes, fences, and adjoining areas. Periodic maintenance consists in unclogging ponds, measuring flow, repairing fencing, signs, painting anything affected by corrosion, and finally changing out any pipes and accessories damaged by weathering or by any strong components found in wastewater.

The recommendations described below must be carried out comprehensively and must be included in the operation manuals of the final design projects.

Operations Start Up Plan.

Operations consist in the activities that are carried out routinely in order to maintain the sewage system functioning. The operation of a treatment system consists in all daily activities aimed a maintaining adequate functioning, including general inspections.

Operations begin at the pre-start up stage of a pond and continue through the stabilization stage, continue through the operation described. In addition to adequate maintenance, it must also be permanent and sustained. In this manner, appropriate functioning of the ponds is maintained and high repair costs are avoided.

To control adequate pond functioning, daily verification of the process is required. Also required is analyze wastewater feeding into the system as well as the final effluent in accordance with the previously established sampling and analysis program. Verification consists in detecting changes in the process units, observing various physical factors such as variations in the flow, tank levels, formation of foam in the units, appearance of the effluent, and water color, all of which indicate changes in the development of the biologic treatment processes. A change in any of these factors requires an investigation to identify the causes in order to determine the corrective measure to be taken.

Sewage system clean up is divided into two parts: the primary system and secondary system. Because replacement of the entire primary system in the next twenty years has been proposed, focus must then be placed on cleaning the secondary system. Because the secondary system conveys water into the primary system, sand must be removed as it conveys down stream towards the primary system.

Secondary system clean up program consists in two teams working full time with Vactor equipment. The primary system will only require one team and a Vactor truck. The secondary system will also require three winch teams to clear those areas that are extremely clogged and also remove garbage that cannot be removed with the Vactor equipment.

During development of the final design, operation and maintenance manuals must be provided for the mechanical and electrical equipment. Personnel recommendations includes operators at each of the main pump stations (#1, #4, #10, and WWTP #2), in

addition to the two maintenance teams. One team would work the large pump stations and the second team, the small stations.

Operation of the pump station consists in starting and shutting off the equipment in accordance with the established program or existing needs (particularly during rainfall). Also included is the Inspection of the mechanical and electrical equipment's general condition and inspection of the different areas of the city in order to establish programs to address any problems detected. The pump stations must include meters to monitor daily operations times and an automatic system to alternate pumping. The sumps will be required to have ventilation holes and a minimum storage volume to ensure adequate pump cooling.

Contingency Plan.

During implementation of the rehabilitation and expansion project, crossings with municipal services will be established. Crossings will be provided with electricity, telephone service, water, PEMEX lines, etc. They will also encourage project development under the final design project.

The treatment plants will have emergency electrical energy plants, in addition to the electrical substation described in the final design.

During mechanical and electrical equipment maintenance at the pump stations, repair time should be as short as possible. Electrical and mechanical equipment should be standardized with one manufacturer in order to minimize the amount of replacement parts. Some components that should be kept are the following:

- Two sets of mechanical shaft seals for each pump model;
- Two sets of wearing rings for each pump model;
- One set of bearings for each pump and motor;
- Three sets of gaskets for each pump model
- One immersible cable with required length, with terminal equipment for each pump model;
- Spare fuses;
- Spare transformer for each motor control center;
- Spare bulbs and indicator lights for the control panel in the required colors.

Design of the emergency energy supply system must be included in the design of the pump station. Equipment must have sufficient capacity to supply electrical energy to critical areas as well as to the entire electrical equipment. Nominal capacity must meet required energy needs in order to operate pumps simultaneously. The generator must operate with a diesel motor that should have an internal combustion tank and sufficient capacity to ensure a minimum of two hours functioning at maximum capacity. Furthermore, location of the generator must ensure adequate ventilation to the radiator.

Safety Plan.

The purpose of the inspection program is to check the greatest number of lines and well in the shortest amount of time possible. Inspection includes measuring dissolved sulfur and hydrogen sulfur concentration levels, measuring pH levels, physical inspection of the manhole walls and visible entry and exit pipes. A CCTV inspection will be done in approximately 197 ft in order to identify pipes requiring immediate rehabilitation.

Personnel and recommended equipment consists in two inspection teams; one team will be equipped with the CCTV truck. This team will also carry out quality assurance inspections in construction.

Rehabilitation sites for the drainage system are all within city limits and project implementation must include scheduling street closing (detours) to avoid accidents during excavation; adequate signage, fencing, and lighting. A disc type cutter for asphalt and concrete pavement is recommended.

When excavation occurs on paved streets, the backfilling should be tampered to a level that will allow asphalt layers. For non-paved areas, tampering should be up to 15 cm. above the top edge of the pipe; backfilling should be layered enough to have a small layer of dirt over the ground level. Ditch and roadbed filling must be carried out as quickly as possible after the rehabilitation process to avoid any safety risks or installations faults.

Quality Assurance Plan.

A quality assurance program will be implemented in the design and construction phases of the project to improve infrastructure. Compliance with all recommended design standards and specified materials will be considered essential.

Studies and projects to increase Utility efficiency levels will also be carried out. Specifically, a water quality, sand, soil and climate control laboratory will also be included. Mechanisms for macro and micro metering of water, both for first use water and wastewater, must also be developed.

As stated earlier, an information and quality monitoring system of the physical and chemical characteristics will be established for all wastewater discharged into the drainage system. The aim of the program is to avoid discharges of industrial water with high levels of contaminants that would be toxic to the treatment's biologic processes. The monitoring system will be implemented to control quality of the treatment plant's effluent and ensure reliable water for reclamation in agriculture.

Due to limited resources and treatment costs, an awareness program regarding efficient domestic, commercial, service, and industrial water use is currently being developed.

The personnel in charge of operations at the treatment plant will be trained to ensure compliance with particular discharge conditions established on COMAPA by the National Water Commission. Furthermore, adequate operation of the systems will enhance the useful life of the operation.

With regard to the pump station, automatic operations with flotation circuit breakers, an alarm system to indicate when maximum water levels are reached, and a deactivation unit when minimum levels are reached. The stations' ignition and switch off must be operated via radio-modem. The base radio will be located at COMAPA main offices and must comply with communication systems requirements established by the Secretary of Communication and Transportation.

Pump station automation must include installation of a control panel with a programmable logical controller and a level sensing device, a low level alarm, a visual alarm, a high level sound alarm, a phase failure protector, and back-up energy equipment connection.

COMAPA will develop an "Information Management System," (IMS), that will provide the necessary tools for information management. The system will allow efficient and effective management of the maintenance program. The IMS will use an integrated database to receive, store, and manage the information required for wastewater facility operations.

Pollution Prevention Plan.

The treatment and reclamation system will require certain project to be conformed for the management and final disposal of sludge stored in the pond system. According to chemical composition results, samples taken from the pond system, and in accordance with official Mexican Norms NOM-052-ECOL-93, it was determined that they are not corrosive, reactive, explosive, toxic, flammable, or biologically infectious. Analysis of toxic metal elements determined it is under maximum allowable limits in accordance with NOM-051-ECOL-1994, and in some cases were not detected or its concentration level was under the detectable limits. With regard to organic compounds and toxic volatile organic material, identified via gas chromotography, 44 of the analyzed substances do not exceed the maximum allowable limits pursuant to NOM-052-ECOL-93. No concentrations under the detection limit were detected or registered. *Escherichia coli, Salmonella s.p.p. Staphylococcus aureus,* a health hazard, was not detected. For this reason, sludge may be used for agricultural purposes in areas that have over extended their producing capacity. The following actions are included in the pollution prevention program and will be implemented in the construction stages of the WWTP and sewage system.

Contamination Type and Description	Mitigation Plan
Compacting and Scenario. The construction process implies compacting ground with certain consequences when particles are discharged into the environment and visibility is affected.	a) Reduction in particle emission. b) Use of special equipment to remove particles, such as electrostatic precipitators, cyclones, etc.

Erosion. Removal of vegetation prior to construction and cut and filling operations promote erosion. Drainage services will be for the entire city and will present negative effects on the health of the residents.	The laying of the system will be carried out in sections, avoiding excavated material to be deposited in surrounding areas for long periods of time and reducing inconveniences for the community. The material will be removed as quickly as possible.
Waste Control. The waste removed from the conveyance system will generate sediment that must be treated and disposed of in confined areas in order to avoid health problems.	The silt will be removed and treated after water is removed via composting or stabilization for reclamation or final disposal.
Drilling and explosions. The use of drills during ditch construction will cause health problems caused by noise. The nature of the explosions is associated with the accumulation of gases in the sewage system.	Reduction in the levels of noise will be achieved by obtaining reductions at the source. Programs to monitor wastewater quality and plans to safeguard both system operators and the community at large will be implemented.
Air Quality. Air quality will be affected by engine combustion that affects the health of both the operators as well as the community.	A gas emission control program will be implemented and operators will be provided safety equipment.
Transportation System. The drainage projects will traffic on roadways and will lead to traffic jams on the roadways.	A plan for alternate routes for adequate vehicular travel will be developed.
Noise and Vibrations. Construction stages are associated with the use of equipment and vehicles that will affect both operators and residents.	Safety practices for operator protection prior to construction and operations of the system will be established.
Services. Wastewater control will increase the community's health.	Information campaigns to encourage residents to establish sewage connections will be implemented. Though service is provided, traditional methods are still in practice.
Changes in soil and construction. Operations will promote soil erosion and the carrying of material into the drainage system. There is a possibility that introduction of explosive substances, such as gasoline, may generate toxic gases and/or explosions.	De-silting areas in close proximity to the pipes and paving streets once construction project is complete. Establish a monitoring system to detect gases and flammable substances in order to avoid accumulation and explosiveness.
Air Quality. Problems with odors currently generated in the system by raw wastewater settling. The foul odors worsen when residential areas are in close proximity to the treatment facilities.	The problem will be addressed to a large extent once system is rehabilitated. An additional alternative to built structures that will allow gases to be vented into the atmosphere will be evaluated, as described earlier.
Biologic Conditions. Rehabilitation works for WWTP #1 and the new plant (WWTP #2), consider removal of the existing vegetation cover, will promote changes in habitat, and alter fauna.	The possibility of only eliminating the vegetation cover in areas where the ponds will be built will be evaluated. Alterations to the surrounding vegetation will be avoided.
Air Quality. During certain times of the year, adverse conditions will be present at the treatment plants and their surroundings caused by foul odors resulting from wastewater decomposition process.	Environmental monitoring programs must be established. Construction of tree barriers to break wind currents and lead them away from their path to surrounding residential areas.

The potential for wastewater reclamation is high. Using it for agricultural purposes or irrigation of municipal landscaping, recreational lakes or for cooling in industrial processes would be an additional benefit. In addition, industrial contamination of wastewater would be controlled. Programs to evaluate the impact of these actions on public health will be established.

Little data is available regarding the real amount and quality of individual discharges by the potential main industrial users in Reynosa. As such, the wastewater characterization program consists in the following two stages:

Stage I defines the general scope and the objectives of the contamination prevention program in accordance with wastewater quality and general characteristics of the sewage system. The samples and analysis at selected sites in the sewage system will determine the industrial component in Reynosa in specific geographic areas, including the City's main industrial parks. This stage will also reveal the characteristics of domestic wastewater by identifying any potential contaminant affecting the collection and treatment system.

Step II focuses on the specific characterization of the industry as a basis for the development of pretreatment requirements and implementation of a proactive waste minimization program.

c. Compliance with Applicable Design Regulations and Standards

In developing the existing projects, the following land use plans have been taken into consideration:

- Municipal Urban Development Plan
- State Master Plan for Urban Development
- State Environmental Ordinance Plan

Development of the wastewater system is required to utilize design norms and applicable regulations by stage agencies. The Comprehensive Sanitation Project complies with the following evaluation and design criteria:

1. "Lineamientos Técnicos para la Elaboración de Estudios y Proyectos de Agua Potable y Alcantarillado Sanitario" CNA, México 1994. (Technical Guidelines for Development of Water and Sanitary Sewage Studies and Projects)
2. "Especificaciones Generales para la Construcción de Sistemas de Agua Potable y Alcantarillado" CNA, México 1993. (General Specifications for Construction of Potable Water and Sewage Systems)
3. "Manual de Especificaciones Generales y Técnicas de Construcción de Sistemas de Agua Potable y Alcantarillado" SEDUE, México 1986. (General Specifications Manual for Construction of Potable Water and Sewage Systems)
4. "Normas de Proyecto para Obras de Alcantarillado Sanitario en Localidades Urbanas de la República Mexicana", SAHOP, México 1979. (Project Norms for Sanitary Sewage Projects in Urban Locations in the Republic of Mexico)
5. "Guía General para la Elaboración de Proyectos de Ingeniería de Sistemas de Agua Potable y Alcantarillado", SAHOP, México 1979. (General Guide for the Development of Water and Sewage Engineering Projects)
6. "Manual de Diseño para Lagunas de Estabilización" CNA, México 1994. (Design Manual for Stabilization Ponds)

Hydraulic design aspects and construction recommendations for the sewage system conform to document #1 which identifies the design criteria used by the now defunct Secretary of Human Settlements and Public Works. Document #2 provides guidelines for the project's construction stages.

In response to the problem caused by wastewater leaks into the subsurface (as stated earlier, is a serious problem), the National Water Commission published norm NOM-001-CNA-1995. The norm established the degree of air tightness for sanitary systems, the characteristics of pipe materials, and installation requirements. Rehabilitation of existing systems or installation of new pipes must meet or exceed requirements established in this norm.

Construction of the pipe types to be used in Reynosa, is regulated by several standards. These Mexican norms regulate the material quality and resistance, pipe dimensions, connections and seals in the sanitary system pipes.

Compliance with the following Mexican norms is required for pipe manufacturing:

MEXICAN NORMS FOR MANUFACTURING OF PIPES

NORM	TITLE
NMX-C-401-1996-ONNCE	Construction Industry, specifications for simple concrete pipe with hermetic joints.
NMX-C-402-1996-ONNCE	Construction Industry, specifications for reinforced concrete pipe with hermetic joints.
NMX-E-111-1994-SCFI	Plastics Industry, pipes and connections, elastomer rings used as seals in PVC pipes, specifications.
NMX-E-211/1-1994-SCFI y NMX-E-211/2-1994-SCFI	Plastics Industry, PVC pipes and connections without plasticizer with hermetic elastomer joints, used for sewage systems, specifications.
NMX-E-215/1-1994 SCFI y NMX-E-215/2-1994-SCFI	Plastics Industry, PVC pipes and connections without plasticizer with elastomer hermetic joints, metric series, used for sewage systems. Specifications.
NMX-E-216-1994-SCFI	Plastics Industry, polyethylene pipes, high density polyethylene pipes for sewage systems. Specifications.
NMX-E-222/1-1994 SCFI	Plastics Industry, PVC pipes and connections with out plasticizer with longitudinally structured walls with hermetic elastomer joints, used in sewage systems. Specifications.
NMX-T-021-1994-SCFI	Rubber Industry, rubber rings used as seals in asbestos cement pipes.

In conclusion the materials used in the manufacturing of PVC and reinforced concrete pipes are established in CNA guidelines, referred to NMX-E-211/1/1994-SCFI and NMX-C-402-1996-ONNCEE, respectively and by reference in relevant standards established by the American Society for Testing Materials (ASTM).

With regard to the pump stations, recommendations address the pumping equipment and electrical system in accordance with NOM-001-SEMP-1994. The main specifications used are:

1. Electric Equipment Selection, CNA, Mexico, 1994,
2. Mechanical Facilities Design and Selection of Mechanical Equipment, CNA, Mexico, 1994.

Document #1 is a consulting tool for equipment and material selection. Document #2 is a comprehensive manual on pumping equipment.

Norm NOM-001-SEMP-1994, issued by the Secretary of Energy, Mines, and (Para) State Industry (SEMIP) established technical specification that electrical energy facilities must meet.

Electrical energy is supplied by the Comisión Federal de Electricidad (CFE). This government agency is in charge of generating, leading, and distributing energy. CFE will install all equipment required to supply energy in accordance with requirements submitted by the user.

In accordance with Specifications and Norms described and on this information, Montgomery-Watson developed recommendations for design and construction of the sanitary sewage system.

In this manner, assurances that project will be carried out in conformance with issued authorizations in order to comply with Official Mexican Norms will be undertaken. COMAPA participation during manufacturing and test processes to ensure compliance with the aforementioned norms is important.

4. FINANCIAL FEASIBILITY AND PROJECT MANAGEMENT

A) Financial Feasibility

The two basic goals of the study were:

1. To evaluate the sanitation project and determine its financial impact on COMAPA. The project should in and of itself be capable of generating adequate cash flows and revenues to effectively cover its operation and maintenance costs. The project should not results in losses for COMAPA.
2. Determine if COMAPA, including the sanitation project, is financially solid and solvent, considering that it needs to simultaneously address other investment projects.

Following are the main premises for the development of the financial study:

Demographics

Population projections used in the development of the study estimate that Reynosa had 420,294 residents in the year 1996. Growth rates shown in Table 1 represent COMAPA's official data, and were used in the Montgomery Watson study.

TABLE 1
POPULATION PROJECTIONS (1997-2010)

YEAR	PROJECTED POPULATION (# OF RES.)	ANNUAL GROWTH RATE (%)
1996	420,294	6.14
1997	446,104	6.14
1998	473,500	6.14
1999	502,577	6.14
2000	533,441	6.14
2001	566,196	6.14
2002	592,767	4.69
2003	620,582	4.69
2004	649,702	4.69
2005	680,188	4.69
2006	712,105	4.69
2007	739,152	3.80
2008	767,226	3.80
2009	796,367	3.80
2010	826,614	3.80
2011	858,010	3.80
2012	885,387	3.19
2013	913,638	3.19
2014	942,791	3.19
2015	972,873	3.19
2016	1'003,916	3.19

Source: Reynosa Water and Wastewater Collection Master Plan, CNA, 1996.

According to the above table, from 1996 to 1997, Reynosa's population increased by 6.14%. For the year 2016, Reynosa's population will have increased by 125.04%, i.e. it will be 2.25 times the 1997 population.

Allowances

Allowances were obtained from COMAPA's data on amount of water pumped, billing, and financial statements. The average allotment is 55 gal/cap/day.

Interest Rates

The following interest rates were considered:

1. An 8% real annual rate on unpaid balances for the Comprehensive Sanitation Project.
2. Different rates for potable water and wastewater collection. A 15% real rate was considered, since it is the average rate used for loans recently restructured by COMAPA, and a 5% real prime rate.
3. Discount rate used to calculate the project's Net Present Value (NPV): 12% real annual rate.

1) Financial Statements - Historical

Information regarding the tility's financial status was developed using annual current prices. Comparative financial statements to December 31, 1993 to 1996 and August 31, 1997, were analyzed. The following was drawn from these statements:

1. The relationship between receivable assets and short-term liabilities went down from 6.4 times in 1994 to 1.84 times during the first half of 1997, gradually diminishing during the study period. The purpose of the recent fee increase —effective September 1, 1997, was to rectify this trend.
2. Statements of earnings collected show that during the study period the utility consistently increased its net revenue as a result of a greater coverage. Operation, maintenance and administrative and management costs are in average 93.3%.

The accounts receivable vs. average collection ratio indicates that the utility, since the beginning of the study period, has maintained an average of 90 days billed before collection. The profit margin vs. sales ratio for water and sewage services, which in the case of the utility represents net income (before taxation), indicates that for the last four years, the utility has maintained low water and wastewater collection rates/fees. Fee increases in 1996 and 1997 improved this situation.

The recent increase in long term liabilities is a result of works developed. With its current coverage levels, and fees that are effective until August, 1997, the utility has been able to cover its debt service requirements. The financial evaluation of the utility shows that this relationship has been reduced from 0.81 in 1993 to 0.47 by the first half of 1997. As such, for every peso the utility owes in the long term, it pays an average 0.47 cents in the

short term. The financial ratio between the utility's net revenue and its net worth shows this relationship has been less than 1% during the study period. This condition should change when management of revenues and collection efficiencies are improved.

2) Financial Statements - Pro forma

Based on population projections, planned coverage and estimated allowances, a projection of drinking water demands in Reynosa was prepared. Demand will increase from 1,016 lps in 1996 to 2,369 by the year 2016. Potable water losses, estimated to be 31% in 1996, will gradually decrease until they reflect a 20% loss rate by the year 2000. Recovery periods, average fees by type of user, and estimations of operating and maintenance expenses, as well as estimation of water billing, collection, payment defaults, costs and revenues at COMAPA were prepared for the 1996-2016 period. 1996 and 1997 net operating revenues coincide with the most recent calculations. This has served as a guide to adjust COMAPA's original financial model, which was the basis for this analysis. The change reflects a model that is closer to reality.

Data about funding required for COMAPA's projects was analyzed, along with an amortization and interest payment program. Long-term debt coverage will reduce in the first years due to additional loans. In the best case scenario, such financial ratio will increase from 0.47 in 1997 to 0.58 in average the first 5 years. Contributions from international organizations, federal, state and local governments were considered to compare revenue streams, loans and debt service during the project planning period. Pro forma financial statements were developed to determine the financial and economic status of the Reynosa project. In developing pro forma financial statements, the following components were considered:

1. Different scenarios that depend upon the amount of grant funding and loans obtained for the project. Results of this analysis appear in the Sensitivity Analysis section below.
2. Water and wastewater collection investments. The last figures estimated for the development of the comprehensive sanitation project reflected $660.25 million pesos, including the corresponding 10% value added tax and comprehensive engineering services.
3. Although the project requires an investment of $660.25 million pesos, COMAPA will have to invest an additional amount in potable water works to help ensure an adequate supply to meet future requirements. The same can be said about wastewater collection tasks not included in the comprehensive sanitation project. Undoubtedly, the main priority will always be to provide an adequate water supply and coverage. Water and sewage capital investments were used as variables in the financial analysis. The Capital Investment Budget for both water and sewerage in 1998-2016 amounts $506.5 million pesos for water and $552.4 million pesos for the sewerage system.

From this we can draw that amounts to be invested in water, wastewater collection and sanitation must coincide with a strict set of priorities, which depends upon COMAPA's economic and financial capabilities, the population it serves, and the amount of grants it

receives. Investments are scheduled for water, wastewater collection and sanitation services. These should help the utility in having an adequate distribution and improving the services provided to Reynosa residents. Furthermore, a revenue increase is expected for the utility as a result of a better water service quality, which shall contribute to the utility's long term growth and strengthening. The Project Work Tasks Program requires investments for fixed and variable assets such as land, machinery, and equipment.

3) Financial Structure of the Project

The investment amount proposed is $ 660,250,517.51 (six hundred sixty million, two hundred fifty thousand, five hundred seventeen 51/100 pesos), including a 10% value added tax. At the exchange rate considered in the analysis (8.25 pesos X 1.00 dollar), the total in U.S. dollars would be $80,030,365.76 (eighty million, thirty thousand, three hundred sixty-five 76/100).

The following three scenarios were presented to develop the project's feasibility analysis. In them, the amount of contributions by funding sources was modified, and contributions were classified as grants by the Mexican Federal government and international organizations, and funds that must be contributed by the utility, whether they come from the Tamaulipas State Government, the City of Reynosa, loans, or COMAPA's own funds.

PROPOSED FINANCIAL STRUCTURE

SCENARIO 1

FUNDING SOURCE	PESOS	U.S. DOLLARS	%
Grants[1]	487,000,781	59,030,397	**73.76**
COMAPA's Contribution	173,249,735	20,999,967	**26.24**
Local and State funds	110,525,936	13,397,083	16.74
Loan	62,723,799	7,602,884	9.50
Project Total	**660,250,517**	**80,030,365**	**100**

SCENARIO 2

FUNDING SOURCE	PESOS	U.S. DOLLARS	%
Grants	448,970,351	54,420,648	68
COMAPA's Contribution	**211,280,165**	**25,609,716**	**32**
Local and State funds	102,338,830	12,404,706	15.5
Loan	108,941,335	13,205,010	16.5
Project Total	**660,250,517**	**80,030,365**	**100**

SCENARIO 3

FUNDING SOURCE	PESOS	U.S. DOLLARS	%
Grants	224,485,175	27,210,324	34
COMAPA's Contribution	**435,765,341**	**52,820,040**	**66**
Local and State funds	110,525,936	13,397,083	16.74
Loan	325,239,404	39,422,957	49.26
Project Total	**660,250,517**	**80,030,365**	**100**

[1] Non-reimbursable grants from international organizations and the Mexican Federal Government

The above tables reflect only proposed financial structures. For each of these scenarios, financial statement projections were developed to support the project's feasibility. The definition of the project's final financial structure will be later developed by the NADB in a joint effort with the U.S. Environmental Protection Agency, the Mexican Federal Government, and COMAPA.

4) Capital Improvement Budget

Wastewater collection and sanitation investments have been scheduled (Comprehensive Sanitation Project) to help achieve an adequate distribution and improve services provided to Reynosa residents.

Furthermore, a revenue increase is expected for the utility as a result of an improved water service quality, which shall contribute to the utility's long term growth and strengthening. The following table presents the Project Work Tasks Program:

TABLE 2

USE OF FUNDS (thousands of Mexican pesos)					
INVESTMENT PROGRAM	**1998-2001**	**2002-2006**	**2007-2011**	**2012-2016**	**TOTAL**
WASTEWATER COLLECTION	388,386.52	84,200.96	49,824.77	0.00	522,412.30
Pumping stations	110,288.47	5,944.13	0.00	0.00	116,232.60
Sewerage	246,828.19	39,169.51	10,737.45	0.00	296,735.15
Long term rehab.	31,269.86	39,087.32	39,087.32	0.00	109,444.50
SANITATION	137,838.26	0.00	0.00	0.00	137,838.26
SUM	526,224.78	84,200.96	49,824.77	0.00	660,250.51

NOTE: These costs include 10.0% Value Added Tax

The project's investment timetable shows expenditures for the following items:

1. Pumping facilities
2. Wastewater collection lines and hookups for discharge
3. Treatment plants

Expenditures for land, equipment and other types of fixed assets are also included.

For the replacement of assets, financial projections consider allocations for equipment depreciation, construction, and installations, which provide the necessary capital surplus to replace equipment. However, this action will not be needed during the project's planning period, considering the average useful life of the equipment and other fixed assets.

5) Operation and Maintenance - Historical

Between 1993 and 1995, operating costs increased by 7% annually, and starting in 1996 and up to the first half of 1997, expenses went up 30%. This substantive increase is primarily an effect of operating needs resulting from water and wastewater collection works developed in 1996. Sewerage lines were rehabilitated and expanded, potable water lines were introduced, and storage tanks were built at pumping stations.

The amortization of pumping equipment and the water treatment system, as well as the operation of valves, among other operating components, have an impact on operating costs. Additionally, investments to improve the efficiency of water services by the year 1996 resulted in a total 33 mgd distributed to Reynosa through the Loma Linda water treatment plant (with capacity for 1,500 lps). As such, larger allocations are required to operate the system. Operating expenses have increased by 49.6%, going from 30.6 million in 1993 to 45.8 million pesos in 1996.

Operating and maintenance costs represent in average 47% of the water and wastewater collection revenues. As such, from each peso collected, 0.47 cents are earmarked to maintain water services in adequate condition.

Compared to the utility's total capital, operating and maintenance costs currently represent 9% of the capital. The ratio was 24% in 1993.

Operating and maintenance costs will increase in the future to meet the demands of a larger population.

6) Operation and Maintenance - Pro forma

Operating and maintenance programs were developed for the project by the firm Montgomery Watson but have not been yet validated in detail by COMAPA. These costs will represent an average 59% of the utility's revenue during the planning period. These O&M costs, although potentially final from the technical standpoint, are only preliminary in nature from the financial perspective. The utility will be able to increase its revenues by a larger percentage than what was estimated in pro forma financial statements. As such, the impact of these costs will be reduced.

Pro forma financial statements for the project show that in the three proposed scenarios, fee increases provide the utility with the necessary resources to cover O&M costs, in addition to debt service requirements and other financial expenses.

7) Sensitivity Analysis

The impacts of modifying fees, interest rates, and the percentage of completion of water and wastewater collection projects were analyzed. The original financial model was run to determine results by changing critical variables. Major independent or combined variables were: amount of grants; amount of loans for the project and corresponding

interest rate; other investments by COMAPA during the planning period that are not part of the project and may include loan components with higher interest rates than those considered in the study.

Additionally, water and wastewater collection fees were increased annually. Wastewater collection fees will be increased in 1999 in the following percentages: 20% for residential users, 30% commercial users, and 40% for industries. These increases are calculated over potable water fees. This modeling allowed the utility to establish fee increases needed for each scenario. Thus, critical variables are: a) Amount of non-reimbursable grants received by the project; b) additional annual revenues the utility may will be able to collect, such as those from an improved collection efficiency, a bigger customer base and its institutional strengthening program.c) amount of fee increases COMAPA is able to effectively establish, thus increasing consistently its annual revenues.

B. FEE/RATE MODEL

1) Fees/Rate Schedules - Historical

In February, 1996, fees were increased by 10%. In July, 1996, a second 15% increase was established. Fees remained fixed until September 1, 1997, when a 20% increase was established for domestic and public users, along with a 25% increase for commercial users and 30% for industrial users.

Final average fees were the basis for financial projections. The utility intends to maintain a fee/rate structure similar to the existing one by applying annual increases to user fees. These will be the basis for cash flow projections to provide sufficient funds to cover current and future operating and maintenance costs, to amortize the debt, and cover equipment replacement costs. Average fees will be adjusted annually with different increases for each type of user (domestic, commercial, etc.).

According to the results of the analysis of the different financial scenarios for COMAPA, annual 10 to 15 percent increases to water and wastewater collection services provide the utility with sufficient funds to cover operating and maintenance costs, as well as amortization of the debt and replacement of physical structures, with an amount equal to 100% of the investment program contained in the COMAPA's Water Master Plan. Specific results are shown in the corresponding attachments.

Average Rates

According to COMAPA officials, current rates and hookup and meter installation fees presented in Tables 2 and 3 were used to determine billing for each type of water, wastewater collection and sewage service user. Average water and wastewater collection rates resulted in 5.7 $/ccf (pesos per hundred of ft^3) and 1.9 $/ccf, respectively.

TABLE 3
RATES

As of September 1st, 1997

Ranges	Domestic	Commercial	Industrial
0-15	15.70	34.06	38.15
16-30	1.40	2.64	2.95
31-50	1.63	3.04	3.40
51-70	1.88	3.59	4.02
71-110	2.11	3.98	4.45
111-150	2.32	4.51	5.05
151-250	2.62	4.95	5.54
>250	2.71	5.26	5.89

TABLE 4
CHARACTERIZATION OF FEES BY TYPE OF USER

Type of User	Domestic	Commercial	Industrial
01.- Domestic	*		
02.- Commercial		*	
03.- Industrial			*
04.- Hotels		*	
05.- Tenement houses	*		
06.- Apartments	*		
07.- Schools	*		
08.- Laundries			*
09.- Tortilla factories			*
10.- Restaurants		*	
11.- Washhouses			*
12.- Employees	*		
13.- High Schools and Colleges		*	
14.- Private Schools		*	
15.- Public Services	*		

TABLE 5

SEWER FEES TO BE APPLIED STARTING IN 1999
20% over potable water fees for domestic type users
30% over potable water fees for commercial type users
40% over potable water fees for industrial type users

The above results provide grounds to conclude the following regarding the project's financial evaluation:

1. A final prioritization of water and wastewater collection works must be developed, once the project's financial structure is defined.

2. Fee increases will correspond to the financial structure that is finally adopted for the project. According to the financial scenarios considered, the project is feasible if annual 10 to 15% fee increases are applied.
3. The project is financially viable because it generates an adequate flow to cover all its costs and financial obligations, and provides favorable cash balances at all times. It would be convenient for COMAPA to carry out the following actions to consolidate the utility and ensure the project's financial viability: a) Establish an institutional capacity building program that includes a reduction of physical losses; and reinforcing its commercial area to regain backlogs and improve collection efficiency; b) Develop a periodic program to update its user registry.

C) PROJECT MANAGEMENT

Organizational Structure

See Attachment D

Institutional Capacity and Legal Framework

To support COMAPA, the NADB, through its Institutional Development Program (IDP), has hired the Instituto Mexicano de Tecnología del Agua (IMTA) to develop a study to detect water losses and recovery options. This will help reinforce the utility's institutional and administrative capacity, facilitating the granting of loans by banking institutions.

In this regard, and according to the ordinance that created COMAPA, the corresponding governmental mandate confers it with power as a decentralized public organization with its own legal capacity and capital.

This means COMAPA is a public entity established in agreement with Articles 31 and 32 of the Tamaulipas Water and Wastewater Collection Service Act (Ley del Servicio de Agua y Alcantarillado del Estado de Tamaulipas) and other applicable laws and regulations. This enables the utility to undertake rights and obligations.

Guarantees usually provided by individuals and organizations to obtain loans vary in nature, and may be: endorsement, mortgage, securities, and trusts. Other legal actions may be executed if not prohibited by law.

In this case, mortgages and securities are not considered appropriate, since properties that may be used by COMAPA to guarantee payment of the loan in case of default are being used for public services, and as such, belong to the public property system. This prevents the utility from using mortgages and securities. If the utility fails to make loan payments, the property would be seized. This is prohibited by law, unless the assets are no longer needed to provide the service (which is unlikely), and the procedure established by Article 6 of the State Public Treasury Act (Ley de Hacienda Pública del Estado) is carried out to use securities or mortgages to collect the amount owed, whether these apply to properties or real estate that is no longer useful to the utility.

In light of the above, endorsement is the suggested alternative. With it, the banking institution could select one of the two aforementioned guarantees. It must be noted that obtaining an endorsement requires a strict bureaucratic procedure, specially in the case of a Federal Government endorsement, which would pose a difficulty. The utility may opt for requesting an endorsement from the State Government, which would be sufficient to guarantee the loan.

5. COMMUNITY PARTICIPATION

a. Comprehensive Community Participation Plan

Local Steering Committee.

Requirements for public participation in projects developed officially not only enriches government efforts but also creates a modern scenario where members of society and government assume commitments, share risks, take advantage of opportunities, and enjoy the benefits obtained from raising the standards of living and wellbeing of the community.

In this regard, the Border Environment Cooperation Commission has focused significantly on Community Participation and has established fundamental criteria in this regard. Projects must comply with these criteria before they are certified and have an impact on the development of the community.

For this reason the Citizen's Committee was created on August 25, 1997. IBWC (CILA), BECC, and Local Government officials were present during its creation.

Since its inception, the Committee has held ten meetings; 9 meetings were regular meetings and one was a special meeting. The Committee has been in charge of the public review process and has reviewed, discussed, and approved several key issues such as the comprehensive community participation plan, the outreach and media campaign, internal guidelines, appointment of its Chairperson, Co-Chairperson, and Secretary. It also approved and held neighborhood meetings and two public meetings. Other actions undertaken by the Committee include the development of a promotional video and flyers regarding project actions. During the public review process all project information was made available to the community and access to information was guaranteed. Based on surveys taken, results demonstrated the community at large supports the project.

Meetings with Local Organizations.

Based on the Comprehensive Community Participation Program, a total of 46 meetings were held throughout the community in the different neighborhoods, including the Citizen's Committee meetings. The meetings included participation from industry, press, environmentalists, employer's associations, women's volunteer organizations, medical associations, religious groups, youth groups, charity groups, service clubs like the Rotary and Lions Club, parent associations, and political party representatives. Attendance was extensive and included the majority of the community's social sectors.

Two of the 46 meetings were held with the media and one of the two meetings was held in McAllen. The information provided to the McAllen business community, the International Environmental Committee, and the McAllen Environmental Development Committee, and the media was extensive.

Experiences gained during the process have demonstrated support for the project and the Citizen's Committee enthusiastically participated in the process.

Public Access to Project Information.

The use of a special bus with television sets and VCRs was implemented in order to take project information to low-income neighborhoods. The video was eight minutes in duration and there were 18 copies of it available for widespread use. At universities, 26 detailed video presentations of the project were made. Brochures were also distributed and surveys from the student body were taken to determine their opinion on the project.

The television was also used for broadcasting 28 sixty-second infomercials during prime time viewing (AAA). The broadcast was a synthesis of the video presented at the neighborhood meetings. Three interviews on informational talk shows were also part of the program. The highlight of the campaign was to include community involvement and promote community members to provide input at the Information Center of the Comprehensive Sanitation Program. The community's response to these measures was significant.

The radio was used to transmit 324 sixty-second informational spots regarding the project. The community was also requested to provide their input at the Information Center. Eight live interviews provided extensive coverage of the Citizen's Committee's activities.

COMAPA customer bills were used to distribute a total of 20,000 flyers. An additional 10,000 double sided promotional flyers printed on both sides were also distributed. Distribution also included 1,000 posters and 5,000 full-page surveys. Outreach activities in the press included eight full-page articles in the newspaper, which described the Committee's main activities.

A telephone information line was also established and 200 calls requesting project information were received.

Public Meeting.

Public Review Meetings to address all issues related to the:

Technical Presentation of the Comprehensive Sanitation Project. Saturday, October 4th.

At this meeting the Citizen's Committee and its members were introduced to the public. Information on the BECC review and certification process was also introduced. An overview of the project development was presented on a video that had been developed for this purpose. A question and answer session and public comment session followed.

During these sessions several concerns regarding the time required for rehabilitation, the amount to be funded by government agencies, and other technical questions were raised.

Financial Presentation of the Comprehensive Sanitation Project. Friday, October 17th

The second public meeting was held approximately two weeks after the first. The main objective of the second meeting was to present the project's financial aspects.

General interest information was presented during the first part of the meeting and included the Citizen's Committee Activity Report; project impact under the framework of the logo "your input matters" was also discussed.

The promotional video was then presented after which, Chemist Noelia García, Head of the City's Environmental Division provided a presentation on the project's advantages and benefits. Dr. Miguel Angel López, Jurisdiction #4 Representative from the Secretary of Health also provided comments regarding the Secretary's main objectives and as such it strongly supports the project.

COMAPA gave the presentation regarding the project's financial program. The investment required by the project for the next five years was also presented. In addition, it was noted that the project involves rehabilitation of the current lagoon system as well as incorporation of the new projected lagoons. The rate increase was also described for industrial, commercial, and domestic users. Survey results from the neighborhood meetings were also presented and showed the following:

- 84 percent responded favorably to the project
- 10 percent did not respond
- 6 percent responded negatively to the project

A question and answer session was also held during the meeting. Community members presented several concerns regarding local, state, and federal funding participation, and certification progress. All concerns were addressed and those present at the meeting expressed their support of the project.

b. Report Documenting Public Support

During the course of the public meetings, a one-question survey was distributed to all the attendees: **Would your support the Comprehensive Sanitation Project?**

Results indicated the following:

1st meeting:	132 attendees	87 questionnaires returned
		85 positive
		2 negative

2nd meeting:	117 attendees	76 questionnaires returned
		75 positive
		1 negative

All input received from the surveys, public meetings, neighborhood meetings, and media campaigns has indicated that the community strongly supports the project. The community does however demand a high quality project and intends to follow up with organized efforts.

Comments opposed to the project reflect a general skepticism and mistrust regarding resource management, project quality, and timing.

Lastly, we have concluded that this type of Public Review process, carried out by the community members, demonstrates that community participation must be incorporated into all governmental actions in order for credibility and cooperative development to be established.

The report in its entirety including photographs, minutes, and other support information documenting public approval has been submitted to the Border Environment Cooperation Commission (BECC) and is attached herein.

6. SUSTAINABLE DEVELOPMENT

A. Definition and Principles.

Sustainable development is defined as, "*Conservation oriented social and economic development that emphasizes the protection and sustainable use of resources, while addressing both current and future needs, and present and future impacts of human actions",* as defined in the Border XXI environment program developed by U.S. and Mexican authorities. This definition is based on the internationally accepted sustainable definition from the Rio Declaration on Environmental Development: *development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*

According to the definition of sustainable development the Comprehensive Sanitation Project of the City of Reynosa full complies with the precepts of economic and social development based on environmental conservation and protection and the rational use of natural resources. It considers the needs of the present without compromising the ability of future generations to meet their own needs.

In meeting principle #1 that states that humans are at the center of all concerns for sustainable development and they are entitled to lead a healthy and productive life in harmony with nature. Construction and operations of the sanitation systems will promote a decrease in diseases directly related with the use and consumption of inadequate water, diseases related to wastewater collection and conveyance, and the treatment and reclamation of treated wastewater.

Principle #2 states that the right to development must be fulfilled so as to equitably meet the developmental and environmental needs of present and future generation. This project fully complies with these needs by guaranteeing the sanitation of the current population and the population projected for the year 2016. It also ensures environmental protection for use by future generations.

In evaluating comprehensive management systems for the use of direct source water and the treated effluent, the precepts defined in Principle #3 are addressed. This principle defines environmental protection as an integral part of the development process and also ensures improvement in quality of the existing water bodies/resources in the City as well as those located on the border between the United States and Mexico.

Principle #4 states that the stakeholders must be part of any activity related to the sanitation project. As such, border residents have participated in the decision-making process regarding the infrastructure consisting in the sewage and treatment systems and the wastewater reclamation project. This project has the least possible impact on the urban setting and on the environmental ecosystem. Furthermore, experiences and efforts of the different institutions involved in environmental, social, and economic endeavors

within all sectors of the society have been brought together for better balanced development planning and better use of scarce resources.

The Comprehensive Sanitation Project for the City of Reynosa, Tamaulipas will generate both positive and negative impacts during the different stages of development, such as sewage system and treatment plant construction, operation and maintenance. In this regard, specific mitigation measures are required for all adverse impacts.

In Reynosa, Tamps., environmental ordinances and environmental protection are regulated by the Ley General and the Ley Estatal (local and state regulations) and the Director Plan for Urban Development. Currently, a Municipal Environmental Regulation is being developed. The Regulation will address matters related to municipal planning authorities and environmental ordinances and regulations; environmental impact issues, norms, technology. It will also focus on air, water, ground, underground resource, and environmental pollution prevention and control measures; solid waste management and disposal; the rational use of protected natural areas; control and safety measures; sanctions and offenses.

The main effects identified and requiring mitigation measures, as well as actions that will be taken for each of these are described in the Human Health and Environment section contained in this document.

b. Institutional and Human Capacity Building.

The production and supply of potable water involves certain costs, therefore, losses during production and/or supply is equal to money wasted. For this reason it is important to determine what is being lost in order to keep leaks at a minimum and thus maximize available financial and material resources.

COMAPA is currently carrying out the "Loss Localization and Recovery Program in the Farming Sector, Potable Water System of Reynosa" through the Instituto Mexicano de Tecnología del Agua (IMTA) (Mexican Institute for Water Technology) and support from the North American Development Bank (NBank).

By installing flow and pressure meters to define consumption and control flow volumes in the distribution system, the project aims to separate the Granjas Sector from the distribution system. With the information collected, an evaluation of the consumption levels will be carried out. Field activities as well as project outreach activities to increase community participation in reporting leaks and lack of pressure will help determine where the actual water leaks occur. In this manner, leaks can be repaired and maximum operation conditions for the distribution system can be obtained.

The project's benefit analysis, developed by COMAPA, must be divided into two sections, economic benefit and non-economic benefits. The non-economic benefits are addressed in resource conservation and sustainable development. Along the Northern border there are several institutions highly interested in conservation, efficient use, and

sustainable development; these organizations consider economic benefits secondary in nature.

NON-ECONOMIC BENEFITS	ECONOMIC BENEFITS
1. Resource Conservation.	1. Savings in production costs.
2. Greater attention to demands.	2. Increase in product sales volume.
3. Increased efficiency.	3. Savings in repair costs to connections.
4. Improved institutional image.	4. Savings in repair costs for leaks in distribution pipes.
5. Greater community participation.	
6. Greater reliability in macro-metering systems.	
7. Greater reliability in micro-metering systems.	

Development of the potable water recovery and loss program for other sectors of the city has been scheduled for the near term future. The program will strengthen the Utility.

c. Conformance with Applicable Local and Regional Conservation and Development Plans.

The **Potable Water, Sewage, and Sanitation Program** established by the Federal Government in May 1990, aims to address existing backlogs and meet increasing demands for water and sewage. It also involves developing municipal, state, and national capacities to promote environmental conservation, decrease wastewater contamination as well as support consolidation of the operating systems. It will also strive to ensure autonomy of the utilities as well as improve their service efficiency levels in the short-term future.

The **Potable Water and Sewage Program in Urban Areas** (APAZU) is a funding source for implementation of the proposed project in the *Master Plan for Institutional Consolidation and Development of the Operating Organism.* Implementation of projects included in the Program will be under the Decentralized Operating Systems that are directly responsible for potable water, sewage, and sanitation services at the municipal level. Several federal agencies, such as the National Water Commission (CNA) and BANOBRAS, are participating in the program.

The Master Plan for Institutional Consolidation and Development of the Operating System outlines the goals for consolidating and expanding services provided by the operating system in accordance with resource planning and needs with long term projections. The objectives defined are realistic and easily adaptable to the changing needs. Furthermore, it strives to reach and find viable decisions and factors for the operating system to attain healthy and strong growth.

The **Sub-Regional Territorial Ordinance Plan of Reynosa and Rio Bravo, Tamaulipas**, was developed under the State Urban Development Plan and the National Planning System. Its main objectives are:

d. Natural Resource Conservation.

Efficient and correct operations of the wastewater treatment plant will clearly lead to benefits for the community and the ecosystem in general. Some of the effects caused by the project, in order of importance, are, air quality, changes to the soil, construction, and services. On the other hand, some of the benefits obtained include: community benefits, biologic conditions, service systems, community structure, and water resources as described in the Human Health and Environment section contained herein.

With regard to impacts caused by operation of the wastewater treatment plants and relating to effluent discharges, all effects are, in general, positive. Land use for grazing and agriculture is the most significant impact, followed by biologic conditions of flora and fauna, and the physical and chemical characteristics of the environment and cultural factors.

Solid waste recycling activities resulting from the treatment pond system will have a positive impact once they are adequately applied to agricultural areas or in areas where erosion or partial degradation has occurred.

Water District No. 26 (Lower Río San Juan) will obtain the highest level of benefit from the wastewater treatment plant. A total of 180,687 acres are irrigated and are distributed in the municipalities as follows:

MUNICIPALITY	SURFACE AREA (acres)
Reynosa	9,061
Río Bravo	11,628
Díaz Ordaz	3,599
Camargo	3,351
Miguel Alemán	7,564
Mier	715
TOTAL	180,687

e. Community Development

Potable water coverage in the City of Reynosa is currently at 93 percent of the population; the remaining 7 percent receive water through hydrants or water tank trucks. The sewage system covers 70 percent of the city with small drain systems; however, current data indicates that service coverage is actually at 57 percent. This indicates that the system is being under utilized or a large amount of non-registered discharges are taking place.

In this regard, COMAPA of Reynosa, will implement a strategy to regulate domestic discharges of lots that have not been connected to the sewage system. It will also regulate service to lots where service will be expanded. The strategy involves the activities described below:

- **Lot identification and regularization program.** Current information is available on lots not connected to the system as well as on lots that do not rely on water services. However this information must be updated to ensure the regularization program's success. In this regard, administrative information, information on the operating system, and other field visit information must be collected. The operating system has obtained background information on lots connected according to billing controls, connection exemption rights, and/or material controls leaving the warehouse for connection work. The field information includes the potable water user registry maintained by the system and which is regularly updated. However during project implementation, information required and related to water discharges from lots will be collected. The information will be used to support personnel carrying out meter readings of those meters that are registered at the actual residence and will also help personnel assigned to carry our repair and/or replacement work of damaged meters. Personnel will be provided with training prior to the program.
- **Domestic Discharge Regulation.** Specification manuals will be developed and/or updated. Materials and projects for the sanitary and potable water facilities in the lots must comply with the specifications. They must also comply with the techniques for closing latrines and privies in accordance with national standards. Regulations must also include appropriate sanctions to ensure success of the regularization process. Sanctions may include fines and water service suspension. In addition, regulations must be modified in order to include discharges from all lots from the zones being developed.
- **Awareness and Work Inspection Program.** Before the program's initial stages are underway, outreach activities will be implemented. Outreach will include information regarding benefits to the community and will highlight the improvement in quality of life. It will also encourage users to register in the program. Visits to non-serviced lots will be carried out in order to verify registry information and also encourage users to update their records at the system and/or register in the regularization program.
- **Marketing.** Because users will be required to make the modifications to their own sanitary facility and the program will provide benefits to the entire community, and also because approximately 92 percent of the community involved in the program lacks the resources, COMAPA will cover 50 percent of the costs. The user will be required to cover the remaining 50 percent. Payment facilities will be made available to the users to pay expenses within a year. The program however will require users to close their latrines or cesspools.
- **Investments.** Because the program is considered a temporary project, implementation is being proposed through the contracting of specialized firms to avoid increased revenue expenditures.