CHAPTER 5
EXISTING SEWERAGE SYSTEM AND FUTURE PLANS

5.1 GENERAL

The present conditions of existing sewerage system in the Study Area is summarized in this chapter based on information available in reports of GTE and of INRH and related organizations. Description is also made on reconnaissance surveys on existing sewerage facilities and on filed surveys of cross connection carried out in this Study.

Sewerage development plans for improving the water environment of Havana Bay are summarized in this chapter based on information available in GEF Project Reports and in reports of GTE. Plans to improve the present O/M problems encountered to the existing sewerage system are also described.

5.2 EXISTING SEWERAGE SYSTEM

5.2.1 PRESENT SEWER SERVICE AREA/DISTRICTS

Sewer service area in the Study Area is shown in Figure 5.1. In the western part of the Study Area, a sewerage system has been developed. The sewer service area of about 4,500 hector is covered by the Central Sewerage System: sewer networks, pumping stations Colectors, a siphon and a main pumping station, a transmission tunnel and an outfall sewer. The sewerage system is maintained by an enterprise “Aguas de La Habana”. There are also small sewer service areas in the south eastern part of the Study Area. These small sewer service areas were developed to discharge the produced wastewater to nearby stream or river. The sewers are maintained by Water Supply & Sanitation Company of Havana East.

5.2.2 SEWERS

(1) Sewer Networks

The Central sewer networks were developed in 1905-1915, thus the sewers have been used more than 90 years. The other small sewer networks have been developed when the area was developed together with other infrastructures such as water supply and drainage facilities. The minimum diameter of sewers is 150mm.

It is reported that cross connections are practiced in the sewer service area. A survey has been conducted in this Study to identify the current situation of cross connections and understand backgrounds of cross connection practice.

(2) Colectors

The Central sewerage system has the following 9 Colectors: Norte, Sur, Sur 1, Sur 2, Sur 3, Sur 4, Paralelo al Orengo, Cerro and Centro Habana. The location of each Colector is as shown in the figure 5.1. Table below summarizes the service area covered by each Colector and the dimensions of Colectors’ diameter installed:

THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 5.1 Colectors in the Central Sewerage System
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Table 5.1 Colectors in the Central sewerage system

Colector	Service Area (ha)	Diameter (mm)
Norte	959.6	ϕ450 – ϕ1500
Sur	253.8	ϕ1500 – ϕ2100
Sur1	601.5	ϕ900
Sur2	96.2	ϕ750 – ϕ900
Sur3	280.3	ϕ600 – ϕ750
Sur4	147.2	ϕ375 – ϕ750
Cerro	622.1	ϕ675 – ϕ1350
Centro Habana	228.9	ϕ450 – ϕ750
Paraleo al Orengo	1275.4	ϕ750 – ϕ900

Source: "Analisis Hidraulico del Sistema de Alcantarillado Principal de Ciudad de La Habana"

Among the Colectors, the Colector Sur 2 is not connected to the Central sewerage system: the Colector is intercepted at the crossing with Luyanó River due to the broken siphon. Also due to damage, Colector Sur 4 discharges the wastewater into Pastrona stream. Therefore, wastewater generated in San Miguel del Padron and Guanabacoa is discharged to the nearby rivers: Luyanó and Martin Peréz and finally into the Bay.

The engineering information of the Colectors is input in a soft ware, Sewer CAD, to estimate the present capacity of each Colector. The collected engineering information on the Colectors are as follows: nominal diameter, length, invert elevation and pipe materials. The existing capacity will be calculated by using Manning formula with roughness coefficient, n-value, of 0.016 considering the age of sewers. In the course of preparation of the sewerage master plan for the Havana Bay, the estimated capacity of the existing Colector will be confirmed to have an enough capacity to convey the future wastewater volume for each Colector.

Water quality survey for existing sewer was carried out at Caballeria in October and December 2002 by CENHICA/CIMAB under this Study. The results are summarized in Chapter 6 to compare the results of wastewater discharged through drainage channels.

(3) Siphon

Between the grit and screen facility and Casablanca PS, a siphon structure is installed. The siphon made of concrete pipes of 2.13 m in diameter and 345 m in total length, is installed below 12m below the bottom of the sea and the deepest bottom is reached to 30 m below the surface of sea water.

A pipe is installed from the deepest bottom of the siphon to clean the siphon, through this pipe the sediments accumulated are removed by a pump. The cleaning pump operates at least four to six hours a day to prevent the clogging the cleaning pipe the pipe.

Because the siphon structure has been used more than 90 years, leakage of wastewater or suction of sea water may be occurred at some part of the siphon. But any tests have not been conducted to identify these phenomena. A preliminary test will be necessary to identify the leakage of wastewater or suction of sea water.

(4) Transmission Tunnel

A transmission tunnel, 1,447m in length, was installed between Casablanca PS and ocean outfall sewer. The transmission tunnel is made of concrete and has horseshoe-shaped with 2.0m in height, 2.15m in width and 30 cm in thickness. The latest rehabilitation works were done in 1991 to repair the partially breakdown inner surface. A rehabilitation plan was prepared and its the feasibility study was also completed but the implementation has not been done yet.

(5) Outfall Sewer to the ocean

An outfall sewer, 1,500mm in diameter (5 feet) and 140m in length, is installed to disposed off the wastewater at 9m below the surface of sea water. Since this sewer also has been used more than 90 years, some part of the sewer is damaged, an inspection survey conducted by divers identified cracks at pipe joins and wastewater leakage from some of these joints.

A rehabilitation plan was prepared to install two new outfall sewers of about 300m in length with 140 m long diffuser and discharge the wastewater 26m below the surface of sea water. The rehabilitation plan has not been implemented yet.

5.2.3 CROSS CONNECTION SURVEY

(1) Background and Purpose

Large amount of wastewater is discharged through main drainage channels such as Agua Dulce and Arroyo Matadero. It is reported that the main reason is that cross connections are practiced in the sewer service area. The cross connections are called as “illegal connections” in the Study Area. The detailed technical information was limited to understand the situations. Therefore, a survey on the cross (illegal) connection has been conducted in this Study to identify the current situations of cross connections and to get engineering information.

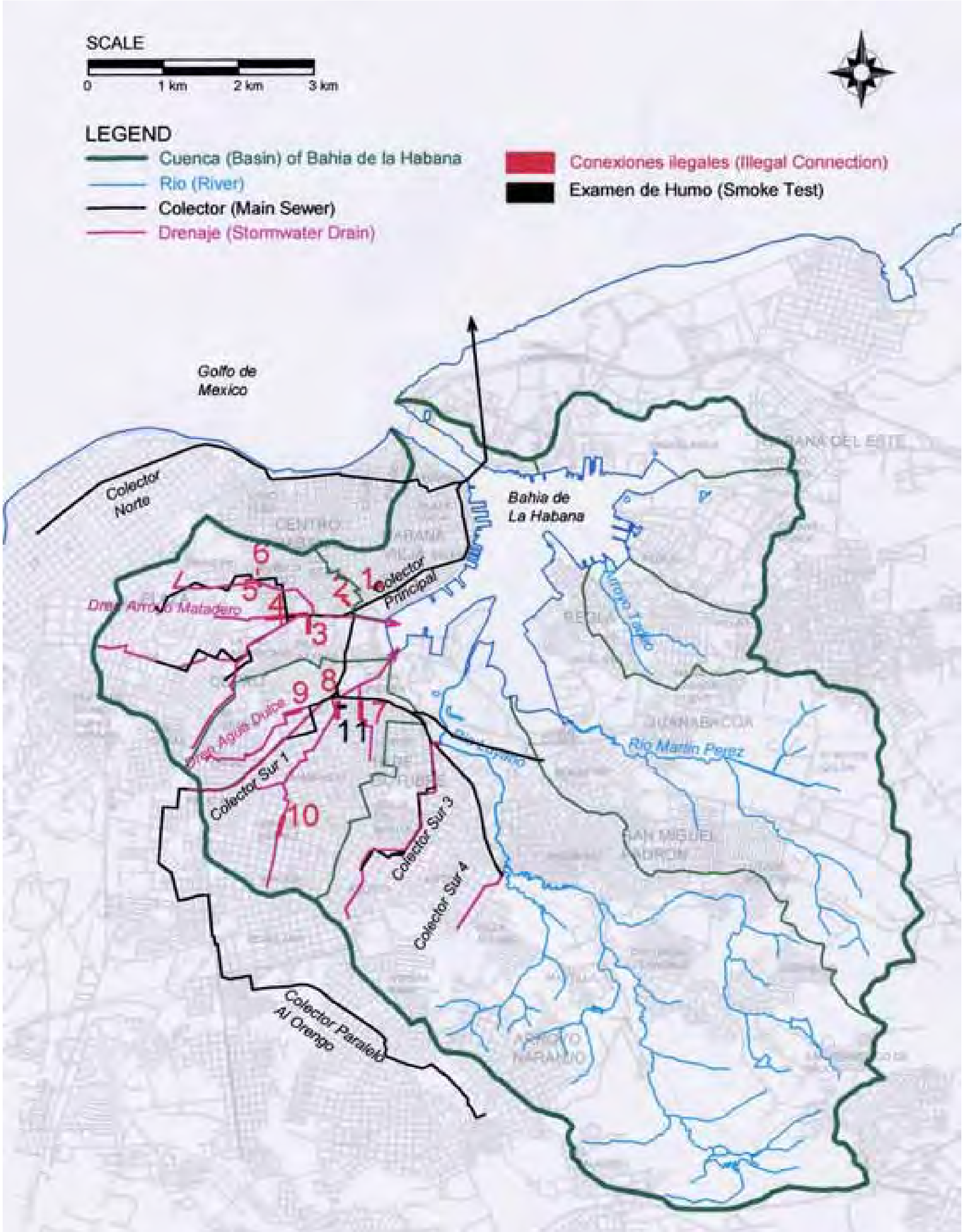
(2) Methodology

Figure 5.2 shows 10 selected locations for the cross connection survey. The pilot areas to be survey are selected from the main drainage areas of Agua Dulce, Arroyo Matadero, and San Nicolás through discussions with Cuban counterparts, considering present land use.

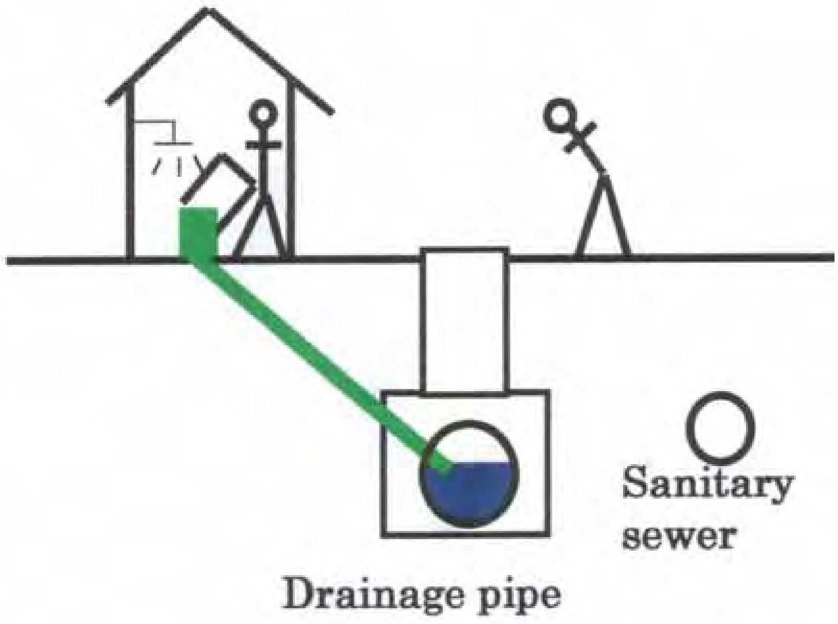
The appropriate survey method is selected from simple tests such as smoked test and/or dye-colored water test, considering the wastewater flow condition in each drainage pipe surveyed, house connection design, and other local conditions. A preliminary field survey selected the dye-colored water test as the best method because of the following reasons:

- Large volume of wastewater flowing in drainage pipe disturbs to stop the flow by plugs, thus, the smoke test is very difficult to conduct. The dye-colored water test is easy to implement, but it requires careful observation of flows in the drainage pipes and the sanitary sewers.
- No house inlet structure are installed in the house connection system, the house drains connected directly to the street sewers or drainage pipes. The smoked test is difficult to detect the smoke injected because the smoke is only detected through the broken house drains only where no house inlets.

The procedure of dye-colored water test for house connection is shown schematically and explained in Figure 5.3.



THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 5.2 Selected 10 Locations for the Cross Connection Survey
JAPAN INTERNATIONAL COOPERATION AGENCY	



Survey Procedure:

(1) To conduct a preliminary field survey to check the location of manholes, drainage pipes, street sanitary sewers, and house connection system.

(2) To explain the purpose of the dye-colored water test to house owner/wife or manager of institutions where the test is carried out.

(3) To open the related manhole of drainage pipes.

(4) To prepare dye-colored water based and put into the house drains at kitchen and toilet and inform the start of the test to the observer at the manhole.

(5) To observe the dye-colored water flowing into the drainage pipe at the manhole.

(6) When the flowing dye-colored water is identified, then the test is positive; the drains are connected to the drainage pipe illegally.

(7) Go to the next house or institution to be surveyed and

(8) To repeat the above the test until finishing the survey for the location.

THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 5.3 Procedure of Cross Connection Survey, Dye-colored Water Test Method
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(3) Survey Results

The survey results are presented in the table below:

Table 5.2 Results of Cross Connections Survey

Drainage area	Location ID No. in figure 5.2	House number surveyed	Cross connection number identified
I) San Nicolas	1	31	0
II) Arroyo Matadero	2	31	0
	3	24	0
	4	8	0
	5	33	2
	6	13	0
III) Agua Dulce	7	5	0
	8	17	1
	9	20	0
	10	35	0
Total		**217**	**3**

The results show that cross connections are not identified; almost all of house connections are connected to the sanitary sewer correctly.

However it is the fact that large volume of wastewater is flowing in the drainage channels even in dry weather conditions and eventually discharged to the Havana Bay directly without treatment. Therefore, a further cross connection survey was conducted to find out the reasons. Cross connections of sanitary sewer mains to drainage pipe/channel are found and confirmed by use of dye-colored water. And it is also made clear that those cross connection structures were installed by the ex-authority of planning, constructing and maintaining the sewers to solve an urgent problem of discharging the increased wastewater due to population growth to nearby water courses. The problem must be solved by installation of new sewers to cover the insufficient capacity of the existing sewers. This bad and makeshift practices were done under financial constraints, and unfortunately the design documents and drawings of the cross connection structures are not available, including information of their locations.

The installation of cross connection structures causes the direct wastewater discharge to the Havana Bay through the drainage channels. To solve this serious problem, a comprehensive study is required to identify the locations of cross connection structures, to investigate the structures, to prepare alternative engineering plans and to selection the most appropriate plan. The further field surveys to identify the cross connections are urgently required.

5.2.4 WASTEWATER PUMPING STATION

One wastewater pumping station is operating in the Study Area. Casablanca Pumping Station (PS) was constructed in 1908-15 together with screen, siphon, tunnel transmission and outfall sewer.

(1) Grit and Screen Removals

Three gravity grit removal channels are installed with automatic operation screen equipment. Accumulated grits and sands at the channel bottoms are removed manually based on operators experience and practices.

Three automatic type screen facilities are installed but without any house structure. Two facilities are not operated due to the malfunction of wires and winches. The automatic screen equipment is used once a day when the water level is reached to lower level during the Casablanca PS is operated. While the screens of the equipment breakdown are removed manually.

Coarse screens are also equipped at the end of grit removal channels to remove the remained screens.

A by-pass structure is installed to bypass the wastewater to the Bay in the following cases: power failure, malfunction, and emergency inspection at Casablanca PS. The by-pass structure is controlled by using steel stop log manually, no winch installed, thus a crane truck is necessary to install and remove the stop lag.

The structure and equipment are operated by three teams of operators; one team consists of three operators. Each team work the following shift: one day on duty and two days off.

The removed grits, sands and screens are kept provisionally and transferred to the solid wastes disposal sites by a truck for final disposal.

The following O/M problems are found:

- Not-efficient removal of grids and screens causes sediments at the bottom of siphon, and resulted in clogging of clean-up pipe when the pumps for clean-up stop the operation.
- Followings give public and tourists unpleasant feeling: exposure of the screen facilities without any house building of equipment and leave the grits and screens uncared for at the site.

Urgent rehabilitation of the mechanical screen equipment is recommended to minimum the accumulation of sediments at the bottom of siphon and to improve the wastewater pumps operation.

(2) Casablanca Pumping Station

The Casablanca Pumping Station (PS) was constructed in 1915. The pump equipment and accessories are replaced and rehabilitated at several times, the present pumps are installed in 1991.

The 1991 replacement works are as follows:

- replacement of three German pumps including one stand-by, capacity of 2.6 m^3/sec, pump head of 8 m, output of 256 kW
- replacement of outlet pipe, with 1.2m in diameter, 12 mm in thickness of steel pipe
- installation of Finish automatic control equipment, Variable Voltage Variable Frequency (VVVF)
- installation of control panel

After the replacement, the following repair works have been done:

- Replacement of shaft broken, twice in 2000 and on April 2002
- Replacement of three impellers worn down
- Replacement of bearings

When the shafts were broken in 2002, it took one year to repair the shafts. Because the pumps are old and their spare parts were not available in commercial markets, the shafts had to be made by order based on their own specification. It took one year to supply the shafts.

Pumps are operated manually in the followings: operator reads the water level measured by the sensor installed at the wet well, and controls the lifting capacity with the VVVF automatic controller. The automatic control system of pumps was attempted to introduce, however, the automatic controller is not used, because only one pump is possible to be operated by the automatic system of VVVF, and the accuracy of water level sensor is not high enough to use. Two pumps including one standby are used for lifting wastewater and one pump is used for cleaning the siphon.

The power is supplied through a special line from the power supply company, thus power failure is very limited except when the power supply line is checked for maintenance. When the power is cut by the power supply company, the maximum power cut time is six hours, and the information is noticed previously. Two days power cut was once occurred in 2001 when the hurricane hit. The wastewater was by-passed through the grit and screen facilities and discharged to the Havana Bay directly. Three diesel-driven power generators were installed, but these are abandoned, the spare parts of the generators had been used for other purposes.

The pumping stations are operated in the following staff: one representative, seven operators including one standby, and one office maintenance. Three teams of operators, one team consists of two operators and each team work 24hours on duty and two-days off duty.

The following problems have been identified:

- the capacity of pump wells is small, thus the water level varies greatly and resulted in hard loads to the pumps and difficulties in pumps operation.
- one of three pumps is used for cleaning the siphon only, when the cleaning pump is damaged or inspected, the cleaning pipe can be easily clogged.
- any flow measurement device is not installed, the measurement of wastewater volume pumped is essential for appropriate O/M and for preparing future rehabilitation and extension plans.

5.2.5 REHABILITATION PLAN OF EXISTING WASTEWATER TRANSMISSION FACILITIES

The wastewater transmission facilities from the siphon to the outfall sewers have been used more than 90 years, rehabilitation works are required to maintain their proper functions. The following three alternative rehabilitation plans were prepared by the Aguas de La Havana based on a study conducted by CIMAB under the instruction of INRH. But no decisions have been made to select the best alternative and no actions have been taken to implement the plan. The alternatives are summarized in the table below.

Table 5.3 Alternatives of Rehabilitation Plan for Existing Wastewater Transmission Facilities

Components	Alternative 1	Alternative 2	Alternative 3
1) Siphon	Installation of new siphon structure	Installation of new siphon structure	to be abandoned
2)Casablanca PS	Replacement of pumps, having the same specification: Q=2.6 m^3/sec, Head=8m, 3 units including 1 standby	Replacement with new specification pumps, Q=1.4 m^3/sec, Head=16m, 4 units including 1 standby	to be abandoned
3)Transmission Tunnel	Rehabilitation works for the worn-out parts of tunnel works	Rehabilitation works for the worn-out parts of tunnel works, including reinforcement work with steel plate	to be abandoned
4) New Pumping Station	New PS to be constructed, Q=2.6 m^3/sec, Head=4m, 3 units including 1 standby. Construction site is available	Not required	New PS to be constructed near the existing screen site.
5) Outfall Sewer	Two pipes, 300m in length, with diffusers of 140m long be installed. The wastewater be diffused at 26m below the sea surface.	Same as that of the alternative 1	New outfall sewer to the ocean discharge point be constructed through the bottom of canal.

Source: "Informe preliminar del Estudio de Factivilidad Económica del Emisario Playa del Chino", Department de Proyecto del Aguas de La Habana

5.2.6 WASTEWATER TREATMENT PLANT

In the Study Area, there are no wastewater treatment plants (WWTP). However, to know the engineering practice and experiences near the Study Area, two WWTPs in the city of Havana and one in Varadero were surveyed. The followings describe briefly outline of the WWTPs and major findings.

Three WWTPs are Quibú, Maria del Carmen, and Varadero. The first two WWTPs have the same process and located in the city of Havana. But Maria de Carmane WWTP, commissioned in 1984, is stopped its operation by inflow of hazardous industrial wastewater. Base on a study report on operation problems and countermeasures against the problems prepared in May 2000, rehabilitation works are being conducted.

Table below summarizes the main features of Quibú and Varadero WWTPs.

Table 5.4 Features of Two WWTPs surveyed

Item \ WWTP	Quibú	Varadero (Tahinos I)
1) Objectives and backgrounds	To improve water quality of the Quibú River, this WWTP was constructed. In 2000, the capacity was extended from 100 L/s to 300 L/sec.	To treat wastewater produced hotels in the resort area of Varadero, the WWTP was constructed by privately and commissioned in February 1992. Total wastewater treatment capacity is 1,500 m^3/day.
2) O/M organization	Mixed Company "Aguas de La Habana"	Public cooperation of water supply and sewerage "Aguas Varadero"
3) Receiving Water Body	Quibú river	Cardenas Bay
4) Influent BOD_5 conc.	Design: 250-300mg/L Records (March 2000 to July 2002): Ave. 121mg/L (Min. 62 mg/L, Max.160 mg/L)	Design: 300 mg/L
5) Treated BOD_5 conc.	Records (March 2000 to July 2002): Ave. 30mg/L (Min. 15 mg/L, Max.55 mg/L)	Design: 20 mg/L
6) Wastewater Treatment Process	Trickling Filter Process (2 screens, 2 grit chambers, 2 oil separators, 2 primary sedimentation tanks, 2 biofilters, 2 secondary sedimentation tanks, and 3 wastewater pumps and 3 sludge pumps.)	Conventional Activated Sludge Process (grit chamber, oil separator, distribution chamber, 4 aeration tank, 4 final sedimentation tanks, chlorination tank)
7) Sludge Treatment and disposal method	Anaerobic digestion, sludge drying beds, and land disposal. Anaerobic digestion is simplified system: opened tank and without external heating.	Anaerobic digestion, sludge drying beds, and land disposal. Anaerobic digestion is simplified system: opened tank and without external heating.
8) O/M Staff	Total 9 staff (1 representative, 1 water chemist, 3 team [1 operator + 1 assistant], 1 standby)	Two operators work 8-hr a day only. Automatic control is used for 24 hour operation.
9) O/M works	Spanish pumps are installed. Major repair works of electric conductor and impeller of sludge pumps are carried out at the workshop of "Aguas de La Habana"	An extended aeration operation mode: 24 hour aeration and return sludge ratio of 85%, is applied. After its commissioning, malfunction of pumps and aerators, three times clogging of diffusers, and wear and broken of ball bearings have been experienced. The repairs of equipment have been done by the Aguas Varadero.
10) Other	Wastewater is taken from a channel connected to the Quibú River. The data of DPRH indicated influent quality is lower than 50mg/L of BOD_5.	Dual power supply lines are equipped. No generators installed. No serious power failure was experienced, but three days once when the hurricane damaged the power supply plant.

Through the surveys on the exiting WWTPs, the following points are highlighted as major considerations for preparation of the Sewerage Master Plan:

- Influent BOD_5 concentration
- Industrial Wastewater
- Mechanical Equipment
- O/M technology

Low influent BOD_5 concentration is experienced in the Quibú and Maria del Carment WWTPs. The low concentration of BOD_5 affects the treatment efficiency. The applied wastewater treatment process, trickling filter process (or extended its efficiency by using plastic filters, thus this process can be called "biofilter"), is a fixed film reactor. The fixed film reactor can handle the influent of low BOD_5 concentration compared with suspended growth reactor, such as conventional activated sludge process. In the selection of appropriate wastewater treatment process, the influent BOD_5 concentration will be considered based on the wastewater quality analysis conducted in the Study.

Industrial Wastewater, not comply with industrial effluent standards, is discharged to public sewerage system, the function of biological wastewater treatment process is damaged or inhibited due to hazardous components in the industrial wastewater. The level and contents of industrial wastewater discharged to the public sewer are important to select the appropriate wastewater treatment process and sludge treatment, reuse and disposal process.

Mechanical Equipment, imported from other countries, maintained well, and repaired by own workshop if spare parts are available. It is ideal to introduce a simplified mechanical equipment and its spare parts easily available.

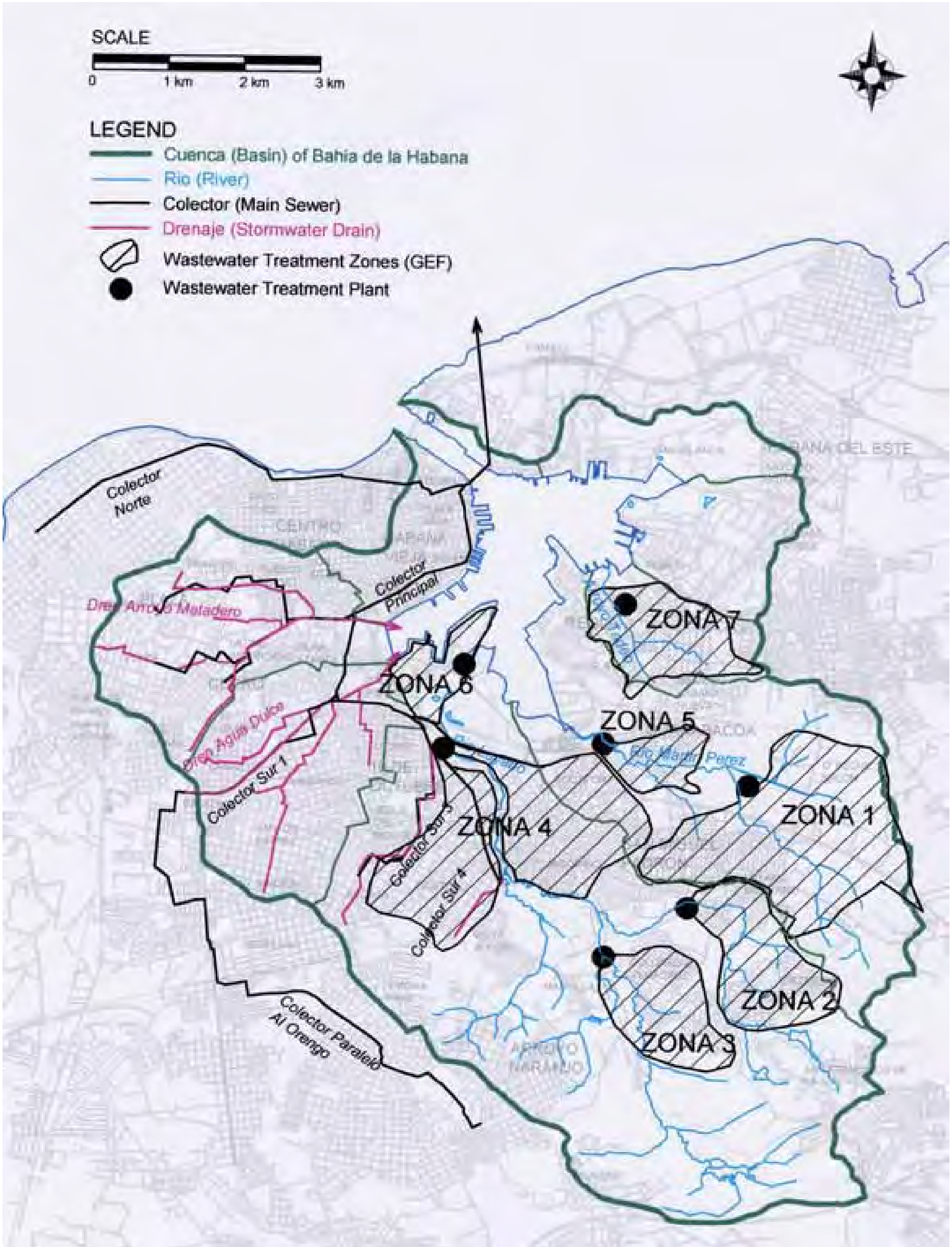
O/M technology is essential to operate the sewerage systems to contribute the improvement of water environment of the Havana Bay. In the Study Area, there is no wastewater treatment process requiring higher technology to operate and maintain. O/M technology required for wastewater and sludge treatment is one of most important factors to select the appropriate treatment process. When a suspended growth biological process, such as activated sludge process and its modified systems, is applied as a wastewater treatment system, a series of training program will be needed. In addition, some WWTPs are planned to construct in the Study Area, therefore, it is recommended to prepare and implement O/M training programs of wastewater treatment and sludge treatment/disposal using actual equipment and facilities.

5.3 PRESENT SEWERAGE DEVELOPMENT PLANS

5.3.1 GEF / UNDP PROJECT

Under the GEF Pilot Phase Project (1995-1997), "Planning and Management of Heavily Contaminated Bays and Coastal Areas in the Wider Caribbean", which included Havana Bay, several actions to rehabilitate the bay and to reduce pollution resulting from land based sources (LBS) to Caribbean Sea. Actions with respect wastewater treatment is described in the followings:

Seven wastewater treatment zones discharging directly to Havana Bay through rivers within the Havana Bay basin as shown in Figure 5.4 were identified in this Project together with existing system served by Principal Colector are selected for actions.



THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 5.4 Seven Wastewater Treatment Zones within Havana basin
JAPAN INTERNATIONAL COOPERATION AGENCY	

(1) Existing System

Principal Colector which collects wastewater from the western part of Havana Bay both within and outside the basin of the bay, which is overloaded and contributing to the pollution of Havana bay through overflows and interconnections to stormwater drains discharging to bay, is also considered for actions. Improvement in the form treating wastewater from Dren Agua Dulce is proposed at Zone 6 as described in the next paragraph.

(2) Zone 6

Wastewater treatment plant at Zone 6 is to treat wastewater pumped from Dren Agua Dulce in addition to wastewater from Zone 6. Wastewater treatment plant for Zone 6 is financed by Italian Government whereas Wastewater Pumping Station at Dren Agua Dulce is financed by the Belgian Government.

Following are the design capacity of the proposed pumping station and wastewater treatment plant.

Dren Agua Dulce Pumping Station

Total pumping capacity : 750 L/s
Number of pumps : four (4) in total where one (1) standby
Capacity of each pump : 250 L/s
Transmission main : 1 km total (ø800 mm x 300 m pumped main and ø1200 mm x 700 m gravity main)

Zone 6 Wastewater Treatment Plant

Treatment capacity : 1,000 L/s (750 L/s from Dren Agua Dulce and rest from Rio Luyano)
Treatment Process : Chemical-aided primary treatment

The Project is being delayed by unexpectedly difficult ground conditions.

(3) Zone 4

The proposed wastewater treatment plant may use an advanced activated sludge process for nutrient removal based on alternating anaerobic/anoxic/aerobic zones within treatment units. Design criteria for the plant is as shown in Table 5.5.

Table 5.5 Design Criteria for Zone 4 Treatment Plant

Design Parameter	Influent Loading	Effluent Quality
Average wastewater flow	1,100 m^3/h	
Maximum wastewater flow	2,400 m^3/h	
Organic (BOD_5) load	2,880 kg/d	< 20 mg/L
Suspended Solids (SS)		< 30 mg/L
Total Nitrogen (T-N)	528 kg/d	> 70% removal
Total Phosphorous (T-P)	120 kg/d	> 56% removal

The total cost (about US$ 3.5 million) for a wastewater treatment plant for Zone 4 was selected for funding through GEF substitute financing.

Table 5.6 Wastewater Treatment Zones and their Development Plans

Wastewater Treatment Zone	Planning Conditions	Receiving Water Body	Remarks
Zones on the Periphery of the Bay			
Principal Zone (Colector Principal)	Service area : west of Havana Bay within (1,490 ha) and outside bay basin. Served population : 900,000 (est.)	Marine outfall at Playa del Chivo (Gulf of Mexico)	Stormwater drains: Dren San Nicolas, Dren Arroyo Matadero and Dren Agua Dulce runs along with the Colector to which illegal connections, interconnections and overflows are
Zone 6	Service area : 0.5 km^2 Service population : 200,000 Wastewater : 86,400 m^3/d (including wastewater from Dren Agua Dulce)	Rio Luyano Mouth	Ongoing project for implementation of wastewater treatment plant with Italian financing and Belgian financing for wastewater pumping from Dren Agua Dulce
Zone 4	Service area : 5.4 km^2 Service population : 40,630 Wastewater : 17,280 m^3/d	Rio Luyano	Ongoing project for wastewater treatment plant construction with GEF/UNDP financing
Zone 5	Service area : 0.8 km^2 Service population : 30,000 Wastewater : 25,930 m^3/d	Rio Martin Perez	
Zone 7	Service area : 2.0 km^2 Service population : 74,000	Arroyo Tadeo	
Zones on the Inland Area of Basin			
Zone 1	Service area : 5.3 km^2 Service population : 15,925 Wastewater : 6,650 m^3/d	Rio Martin Perez	
Zone 2	Service area : 2.3 km^2 Service population : 19,685 Wastewater : 8,575 m^3/d	Rio Luyano	
Zone 3	Service area : 2.0 km^2 Service population : 13,462 Wastewater : 6,000 m^3/d	Rio Luyano	

CHAPTER 6
EXISTING DRAINAGE SYSTEM

6.1 GENERAL

The Study Area excluding the Havana Bay of about 68 km^2 can be divided into the following drainage basins: three tributary rivers, direct discharge areas in the vicinity of the bay, and the existing storm-water drainage area as shown in Figure 6.1.

The features of the drainage basins, which are not covered by the existing storm-water drainage system, can be summarized in the following:

- Luyano River basin, lying in the southern part of the Study Area: its southern boundary of divide is about 100 m high above the sea mean level, and the south eastern boundary is about 60 m high. The middle course of the basin is urbanized and the lower course is industrialized.
- Martin Peréz River basin is located in the south eastern part of the Study Area, having the highest altitude area extended to the south eastern boundary of about 50 m high above the sea mean level. The middle course of the basin is urbanized but the upper course is mainly used as farm lands.
- Tadeo River basin, located between the eastern part of the Study Area and the Martin Peréz River basin. The basin is urbanized but one-storied houses are developed mainly. The down reach of the river is covered by culvert structures.
- North Eastern natural drainage area, forming a saddle of about 20 to 30 m high above the sea level, and the surface slopes gently down to the bay. Industries are developed in this area. Oil refinery factory is located in this area.
- North natural drainage area, forming hills of about 50 m high above the sea level. The drainage area have the width of two to three hundred meters only . On the top of hill, the Casablanca Meteorological Observatory and the large Christ statue are located.

The following sections will describe general features and findings on the existing storm-water drainage system based on field reconnaissance surveys and preliminary analysis of data and information collected during Phase I of Basic Study.

6.2 EXISTING DRAINAGE SYSTEM

6.2.1 PRESENT DRAINAGE SERVICE AREA

The drainage system in the Havana City have been developed since 1908. The culvert structures and pipes of 386km in total length, 28,470 nos. street drain inlets have been installed as shown in the table below. Among them, the structures of 146km in length were constructed during 1908 and 1915 to cover the urban area of 25 km^2.

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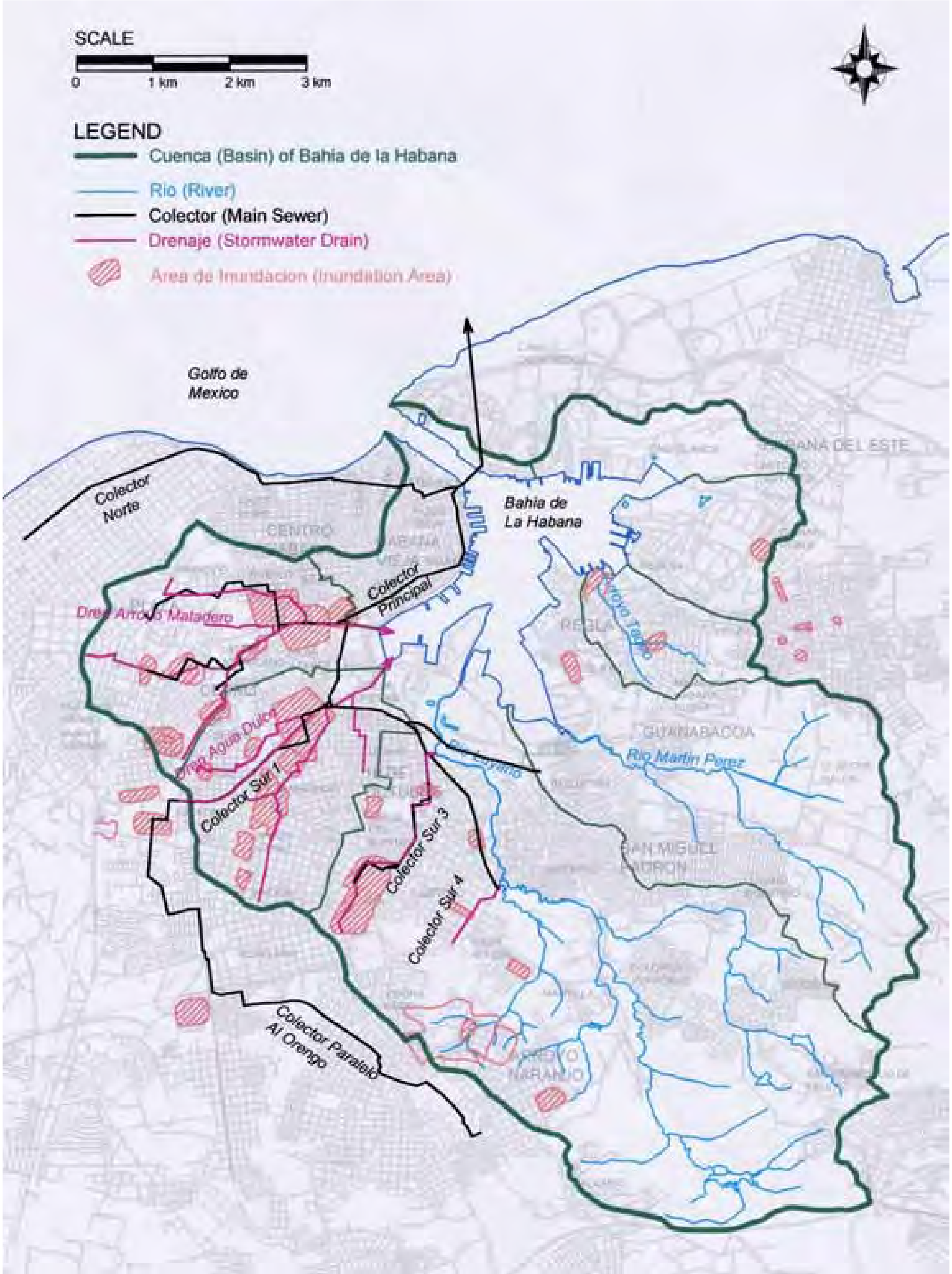


THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 6.1 Overview of Drainage Area and Existing Drainage System
JAPAN INTERNATIONAL COOPERATION AGENCY	

Table 6.1 Existing Drainage Facilities in the Havana City

Municipality	Length of the drainage chennels/pipes installed, km	Number of Inlet Structures
Habana Vieja *	70.3	1,626
Centro Habana *	65.0	2,265
Plaza de la Revolución *	65.3	4,151
Cerro *	38.3	2,192
10 de Octubre *	50.0	5,000
Playa	11.0	4,000
La Lisa	18.0	1,203
Marianao	9.6	1,800
Habana del Este	20.7	1,546
Guanabacoa	10.0	271
Boyeros	8.7	1,741
San Miguel del Padrón *	8.1	670
Arroyo Naranjo	4.0	1,250
Regla *	4.0	255
Cotorro	3.0	500
TOTAL	386.0	28,470

Note: The municipality having the mark of * is related to the Study Area.

The existing storm-water drainage networks were developed for the western part of the Study Area. Runoffs from small areas are discharged of directly to the Havana Bay or through nearby tributary rivers. Runoffs collected through drainage networks are discharged to drainage channels and discharged to the Havana Bay by gravity system, without any storm-water pumping stations. The major drainage channels are Agua Dulce, Arroyo Matadero and San Nicolas.

The Agua Dulece drainage System covers the south western part of the Study Area having about 690 hectare, an urban area including Vibora, Santos Suares, and part of Luyano. In the service area, there are so many old houses constructed more than hundred years ago. The drainage system was constructed between 1908 to 1915.

The Arroyo Matadero drainage system covers the western part of the Study Area having about 730 hectare of Cerro, Plaza, Centro Habana, and Habana Vieja Municipalities. The western boundary area is about 40 m high above the sea mean level. The first underground structure of drainage system from Infanta Avenue and Amenidad Avenue to outfall to the bay was constructed between 1908 to 1915. And the tributary drainage structures have been developed to cover the remaining area

The remaining north western part of the Study area, part of La Habana Vieja, is covered about 17 small drainage system, including the San Nicolas. The collected storm-water is being discharged to the Havana Bay directly.

6.2.2 INUNDATION AREA AND DAMAGES

Runoffs on the streets generally flow down through streets or street gutters and inflow to side gutter inlets installed at 30 to 50 m intervals, then discharged of either directly to rivers or Havana Bay or through nearby drainage channels. In May and during the rainy season between July and November, especially in October, inundation problems occur frequently, but any serious damages by flooding or inundation had not been experienced except some limited area of low-lying areas nearby the Lunayo river.

Figure 6.1 also shows the areas where occasional inundations occur. Typical inundation areas can be classified into the followings:

- low-lying area nearby the three tributary rivers,
- low-lying and flat area in the urban center,
- area where earth's surface gradient change a lot, i.e. from hill to flat area,
- area where major drainage pipes join.

In the low-lying area nearby the tributary rivers, inundation and flooding have been experienced. In the Luyano river, a flood was occurred in 1982 and caused damages to the residents and industries. Occasional inundations are experienced in the following area: Virgen del Camino, its triburary stream of Pastrana, the interception zone between Luyano Avenu and Calzada de Concha, and F street zone between 12 street and Linea de Ferrocarril.

In low-lying area and flat area in the urban center, the gradient of drainage pipes installed are generally small, thus the drainage capacity of the pipes tends to be inefficient. In the place where the general earth's surface gradients change greatly, i.e. from a hilly area to bay flat area, the drainage capacity of the pipes and channels are reduced rapidly, because the water flow rate in the drainage system is high in hilly area and becomes low rapidly in flat area. In areas where major drainage pipes join, inundation occurs when the storm-water exceeds the downstream drainage system capacity

The operation and maintenance of the storm-water drainage system in the Study is conducted by the managerial system of National Institute of Water Resources (INRH), such as Mixed Company Aguas de La Habana and Water and Supply & Sanitation Company of Havana East in the Study Area. Weekly and monthly operation and maintenance (O/M) plans are regularly prepared, executed and finally reported as a routine work. However, those O/M plans and works are limited for the street drainage pipes having diameter smaller than 20" (500mm) due to no maintenance equipment for the larger drainage system.

Any serious damages due to inundation have not been experienced in those areas. The major nuisances are interruption of smooth traffic in the area.

In any city, uncontrolled disposal of garbage and other solid wastes into drainage networks and open drainage channels will accumulate solids wastes and cause water stagnations and resulting in water contamination and odor emanation troubles. Such inundations can be frequently occurred in high population density areas. However, in the Study Area, any serious problems related to the uncontrolled disposal of solid wastes are not occurred to the existing drainage system. The appropriate solid wastes management are expected to practice continuously.

6.2.3 PHYSICAL CONDITIONS OF DRAINAGE SYSTEM

National Institute of Water Resources (INRH) and its Provincial Delegation of Resources of the City of Havana (DPRH) are responsible for planning and implementation of the storm-water drainage system in the Study Area. And as mentioned above, Mixed Company Aguas de La Habana and Water and Supply & Sanitation Company of Havana East are responsible agencies for O/M of the system in the Study Area.

Since the existing drainage system have been used more than 90 years, the capacity of the system must be reduced from the original capacity. The design capacity of the existing drainage system cannot be evaluated easily because the original design documents, design calculation papers and profiles of drainage pipes installed are not available.

The available data and information on the existing drainage system is a facility plan described in two sheets of map on a scale of 1 to 5,000, providing the location and dimensions of pipes and channels installed as shown in Figure 6.2.

In the following section, a preliminary methodology to evaluate the present capacity of the existing drainage system will be explained briefly.

6.2.4 HYDRAULIC CAPACITY OF DRAINAGE SYSTEM

As mentioned previous section, the existing drainage system cannot be examined its capacity due to limited data. Therefore, in the Study the drainage capacity of the existing drainage system will be examined and evaluated in the following manner and procedures:

- Estimation of Storm-Water Runoffs
- Estimation and evaluation of the drainage capacity of the existing major drainage facilities.

(1) Estimation of Storm-Water Runoffs

1) Basic Conditions

Storm-water runoffs will be estimated based the rational method. The rational method of hydrologic analysis consists of an empirical formula that attempts to relate rainfall and runoff through use of a single coefficient. The basic equation is:

$Q = 1/360\ CIA$

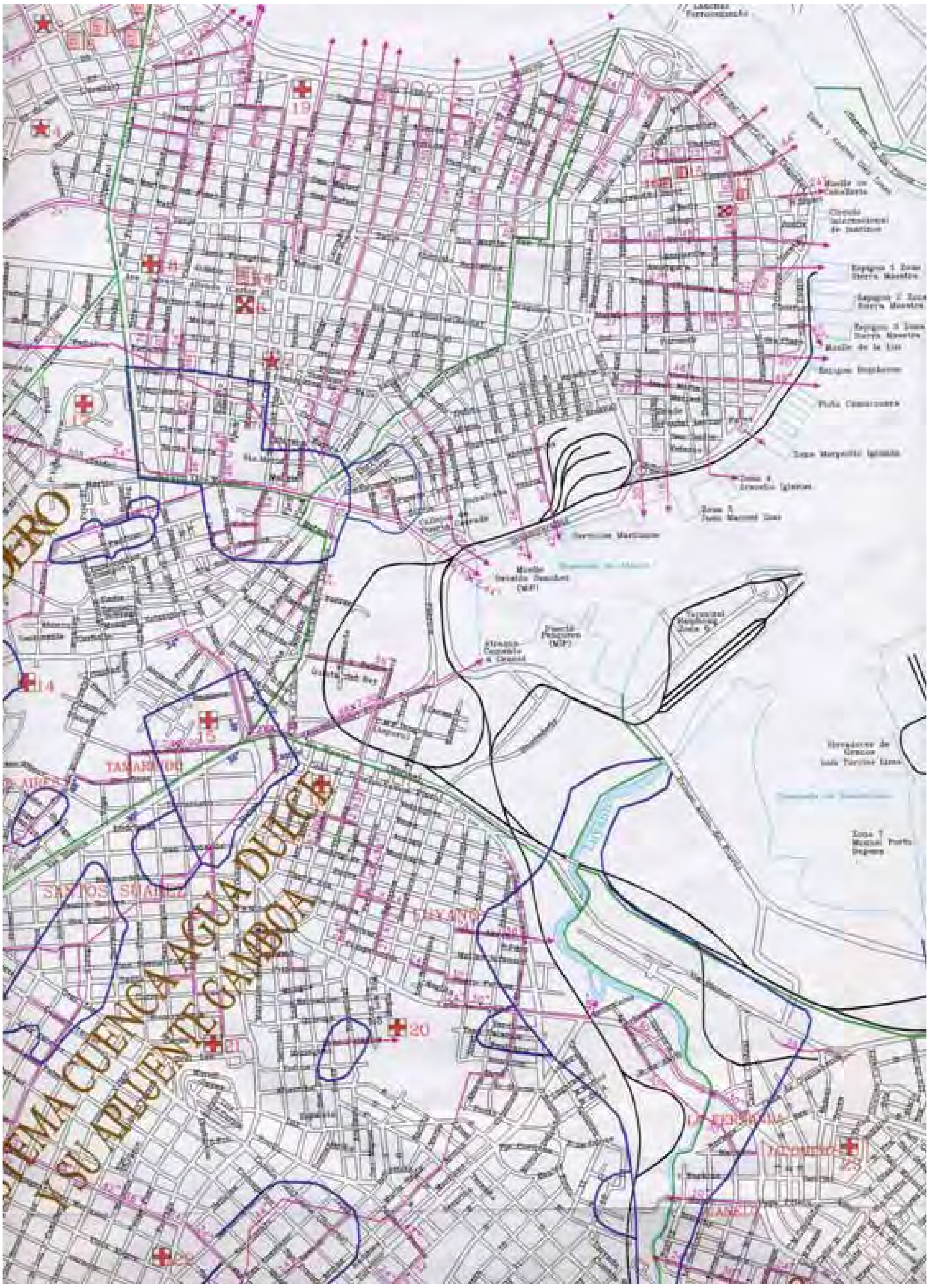
Where, Q: the peak runoff rate, m^3/sec
C: the runoff coefficient reflecting characteristics of the drainage area and the collection system.
I: the average rainfall intensity, mm/hr
A: the drainage area, ha

In the formula, the runoff coefficient will be provided based on the Cuban design criteria for each drainage area to be examined, considering drainage area conditions of land use, soil characteristics, and general slopes of the topography.

The rainfall intensity can be set based on the rainfall records at the Casablanca Meteorological Observatory, which is located in the Study Area. The analog data of rainfall recorded at the Casablanca Meteorological Observatory for 78 years from 1908 to 1985 were read to analyze to provide the relationship between rainfall intensity(mm/min) and rainfall duration (min) with parameter of probability from one to twenty percent, that is equivalent to once per one hundred years to once per five years. The analyzed data is shown in Figure 6.3. Table below shows that the rainfall intensity data.

Table 6.2 Analyzed Rainfall Data

probability (%)	Rainfall Intensity (mm/min)										
	5min	10min	20min	40min	60min	90min	120min	150min	300min	720min	1440min
1	4.28	3.38	2.64	2.06	1.71	1.40	1.20	1.09	0.74	0.47	0.27
5	3.40	2.79	2.09	1.58	1.30	1.06	0.89	0.81	0.51	0.28	0.15
10	3.12	2.49	1.90	1.39	1.15	0.93	0.79	0.67	0.43	0.21	0.11
20	2.72	2.23	1.71	1.24	1.02	0.79	0.67	0.54	0.35	0.16	0.086
probability (%)	Rainfall Intensity (mm/hr)										
	5min	10min	20min	40min	60min	90min	120min	150min	300min	720min	1440min
1	257	203	158	124	103	84	72	65	44	28	16
5	204	167	125	95	78	64	53	49	31	17	9
10	187	149	114	83	69	56	47	40	26	13	7
20	163	134	103	74	61	47	40	32	21	10	5



Source: INRH

THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 6.2 Existing Major Drainage Facilities
JAPAN INTERNATIONAL COOPERATION AGENCY	

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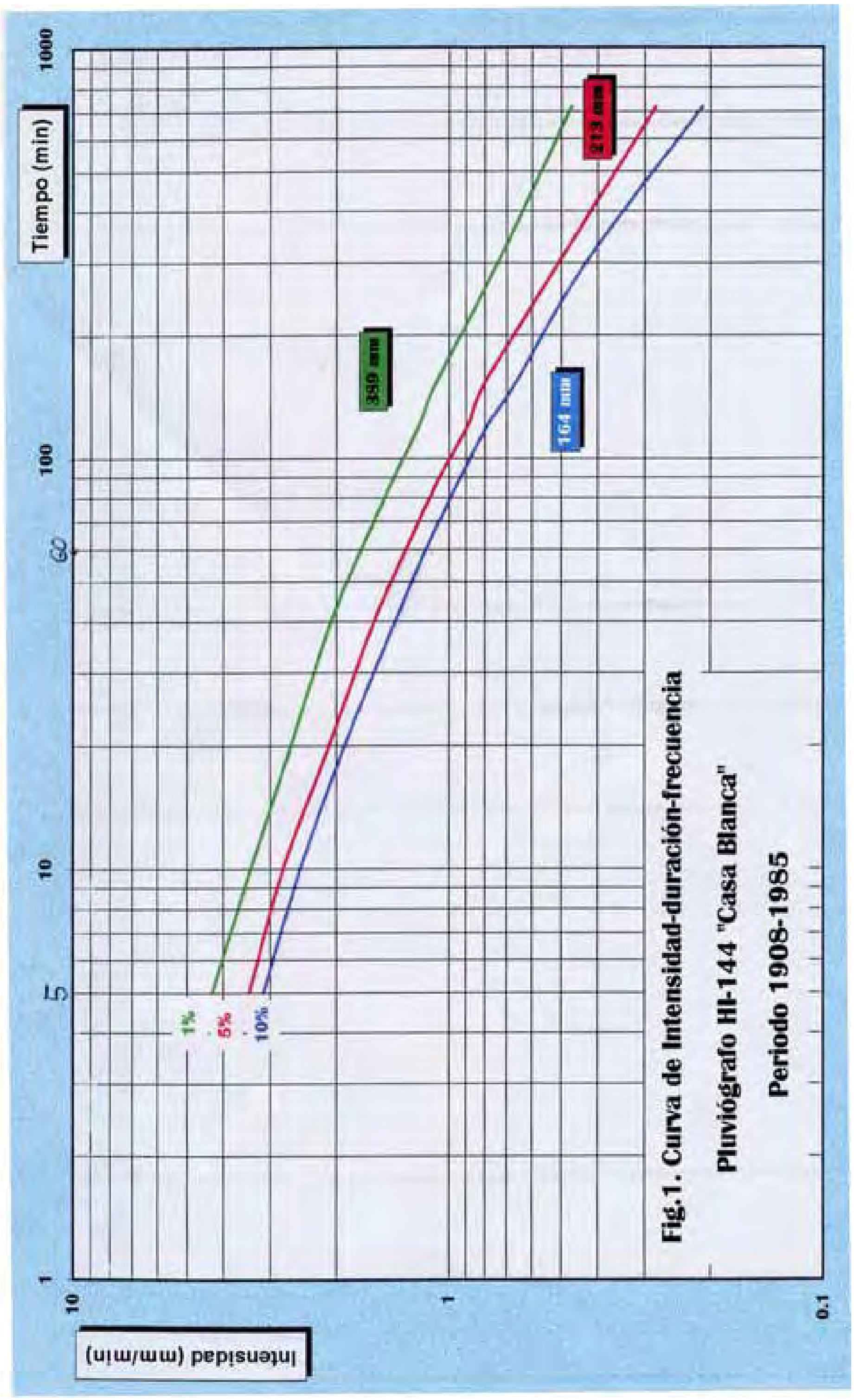

Source: "ESTUDIO SOBRE LOS CICLOS DEL AGUA EN LA HABANA, TOMO I, Ciuda de La Habana, Enero 1997", financed by METROPOLIS-UNION EUROPA

THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 6.3 Relationship between rainfall intensity and rainfall duration based on rainfall data at Casablanca Meteorological Observatory for 78 years between 1908 and 1985
JAPAN INTERNATIONAL COOPERATION AGENCY	

For the reference, the data is analyzed by the “specific coefficient methods” and provided to express the rainfall intensity as the form of “Talbot”.

$I_N = R_N \beta^{10}_N = R_N a'/(t + b)$

$\beta^{10}_N = I^{10}_N / I^{60}_N$, $I^{60}_N = R_N$

$a' = b + 60$, $b = (60\text{-}10\beta^{10}_N) / (\beta^{10}_N - 1)$

Where, β : Specific Coefficient
R: 60 min. Rainfall (mm/hr)
N: Probable Year in N years

Figure 6.4 shows the calculated Talbot-type rainfall intensity to compare the collected data.

In case of ten year return period, the Tablot-type rainfall intensity is as expressed as follows:

$I = 6{,}400 / (T + 33)$

2) Estimation of Storm-Water Runoffs in the existing drainage basins

The existing drainage area is divided into four sub-drainage basins to estimate the storm-water runoffs as shown in Figure 6.5: Dren Matadero Catchment, Dren Agua Dulce Catchment, Dren Pastrana Catchment, and Dren Lawton Catchment. These four sub-drainage basins are further divided into smaller area taken into consideration of the existing drainage pipe alignment, to estimate the storm-water runoff and to compare to the capacity of the respective existing drainage pipe.

The runoff coefficient C for the Rational method is set at 0.6 for Dren Matadero Catchment and 0.5 for other three sub-drainage basins. Time of flow, which is the required time for water to flow in a storm drain from the point of entrance to any given location beyond the inlet, is estimated as the combination of the time of concentration and the travel time in pipe as shown below:

Time of flow (System Time) = Time of Concentration + Travel Time in Pipe

= Time of Concentration + (Length of Drain/Velocity)/60

Where, the time of concentration is assumed as 5 min. and the velocity in pipe is set at 3 m/s in average.

(2) Estimation of Drainage Capacity of the major drainage system

The drainage capacity of the system will be estimated based on the dimensions of pipes and box culvert structures and earth’s surface gradients where the structures are installed. The capacity will be estimated under the effective depth of 90% by the Manning formula, using roughness coefficients, n=0.013.

The calculated drainage capacity for the respective existing drainage system is shown in Table 6.3 to Table 6.6 to compare to the respective estimated storm-water runoffs in order to evaluate the drainage capacity.

The evaluation of each drainage system is summarized below.

As an overall evaluation, almost all of the present drainage pipes do not have enough capacity. The about half capacity to the required capacity

6.2.5 OTHER FINDINGS

The separate sewer system has been developed to collect wastewater and to discharge storm-water separately. However, the results of illegal connection surveys on the existing sanitary sewer system as mentioned in the previous section 5.2, some sanitary sewer mains were connected to the drainage channels/pipes by connecting pipes and structures to mitigate the insufficient capacity of sewers instead of improving the capacity by installation additional sewers or new sewers having larger size . This makeshift practice of using drainage system make the drainage systems as one of major pollutant source to the Havana Bay.

6.3 FUTURE PLANS

There is no integrated/comprehensive drainage future plan based on a study on the present drainage situation in the Study Area. However, to solve the inundation problems and to improve the drainage situation, the responsible institutions have planed and proposed several plans, but the implementation of the proposed plan is still very limited. O/M plans for the existing drainage system are prepared regularly; weekly and monthly, and the performance of the plans is also reported.

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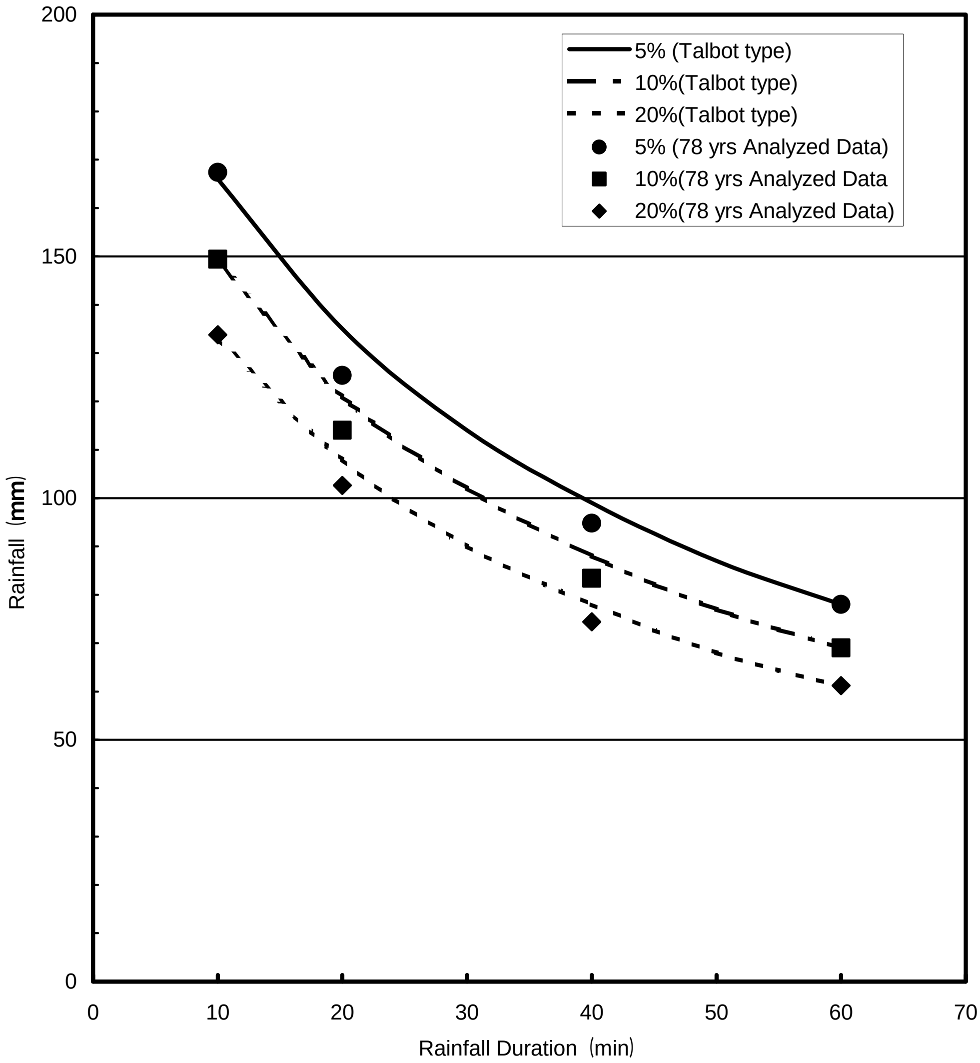


5% (20 year return period)
10% (10 year return period)
20% (5 year return period)

THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 6.4 Rainfall Intensity Expressed by Talbot-type
JAPAN INTERNATIONAL COOPERATION AGENCY	

6.4 WASTEWATER DISCHARGE FROM EXISTING DRAINAGE CHANNELS

6.4.1 EXISTING DATA

Results reported by CIMAB for Matadero and Agua Dulce are summarized in Table 6.3.

No fixed trend is observed except that the concentrations of BOD and COD in Matadero and Agua Dulce are reduced sharply in 2002 comparing with 1985 to 1994. However, the existing water quality data of drainage channels are very limited (only one date in each year), it is difficult to evaluate the changes of water quality in these drainage channels.

In addition, concentrations of T-P are higher than that of T-N, and the reason may be that some detergent factories (such as Debon Suchel located in Matadero basin, Jaiper Suchel located in Agua Dulce basin) discharged wastewater containing higher concentration of phosphorus into drainage channels.

Table 6.3 Water Quality of Drainage Channels 1985-2002

Parameter	Matadero				Agua Dulce			
	1985	1990	1994	2002	1985	1990	1994	2002
Flow, m^3/d	109,964	67,991	64,800	77,760	48,384	35,701	45,144	62,675
BOD_5, mg/L	202	307	264	115	97	123	91	83
COD, mg/L	449	697	581	144	458	475	353	139
T-N, mg/L	5.3	-	-	7.8	2.5	-	-	14.6
T-P, mg/L	-	43.4	-	13.5	16.6	23.9	6.9	30
SS, mg/L	-	-	-	291	81	-	-	85

Source: CIMAB [4)]

6.4.2 WATER QUALITY SURVEY IN DRAINAGE CHANNELS AND SEWER

(1) General

Water quality survey of drainage channels and sewer was carried in October and December 2002 by CENHICA/CIMAB under the Study. Sampling locations are shown in Figure 6.5. Table 6.4 shows the details of sampling.

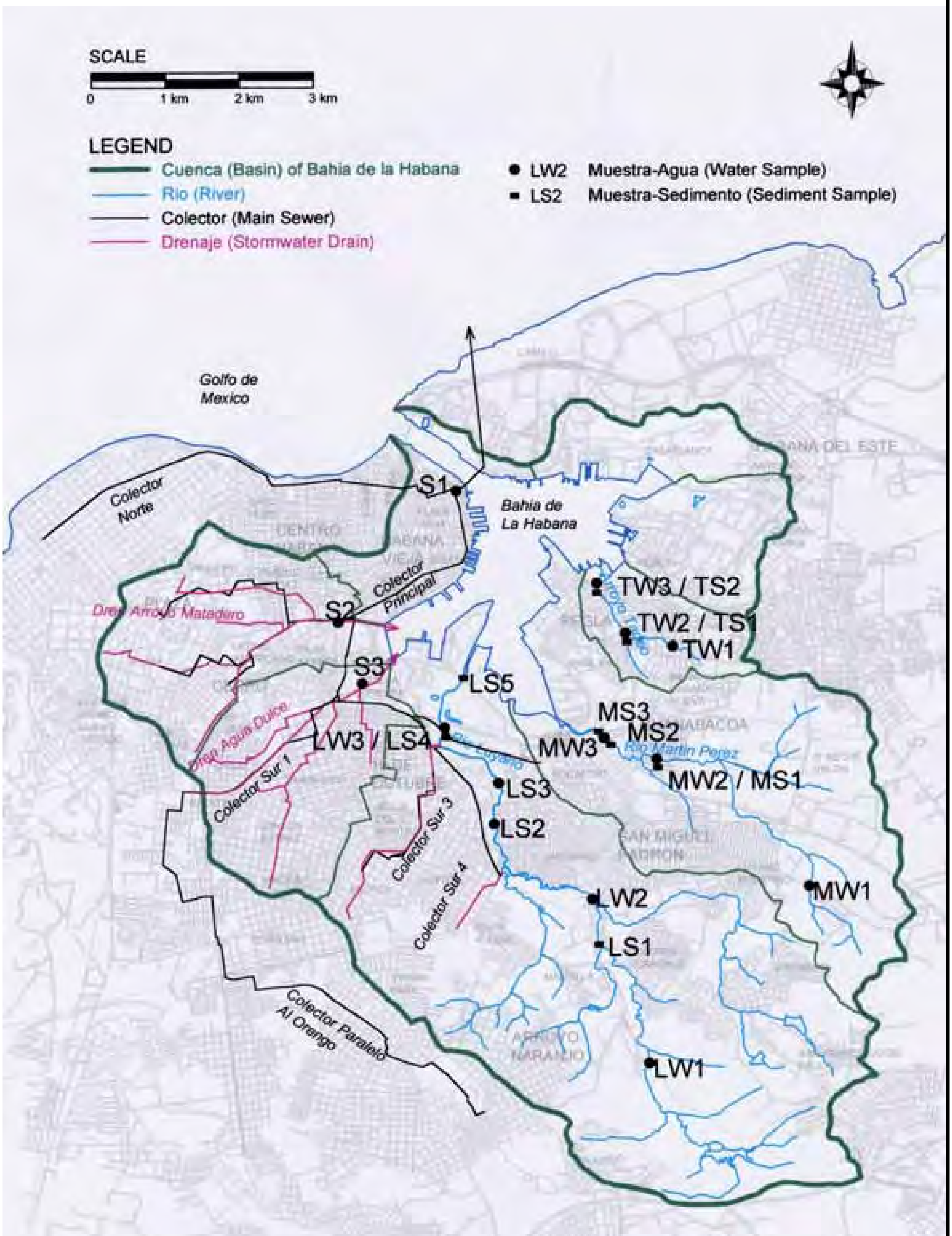
Table 6.4 Water Quality Survey in Drainage Channels and Sewer

Drainage Channels and Sewer	Water Sampling Locations and Date	
	Wet Season	Dry Season
Matadero	1 location (S2) 10-11 October 2002 (9:00 to 6:00)	1 location (S2) 17-18 December 2002 (9:00 to 6:00)
Agua Dulce	1 location (S3) 12-13 October 2002 (9:00 to 6:00)	1 location (S3) 18-19 December 2002 (9:00 to 6:00)
Caballeria	1 location (S1) 9-10 October 2002 (9:00 to 6:00)	1 location (S1) 16-17 December 2002 (9:00 to 6:00)
Total	3 locations	3 locations

Source: JICA Study Team

One composite sample was made at each location combining samples taken at hourly proportional to the river flow. Analytical parameters are as follows:

pH, Water Temperature, conductivity, COD, BOD_5, DO, SS, SO_4^{2-}, T-N, NH_4^+-N, NO_2^--N, NO_3^--N, T-P, PO_4^{3-}-P, SiO_2, Petroleum Hydrocarbon, Fecal Coliform, Phenol, Arsenic (As), Cadmium (Cd), Cobalt (Co), Copper (Cu), Iron (Fe), Total Mercury (Hg), Manganese (Mn), Nickel (Ni), Lead (Pb), Vanadium (V), and Zinc (Zn)



THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 6.5 Sampling Locations of Water Quality Survey for Drainage Channels and Sewer (S1, S2,S3)
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(2) Survey Results

1) Flow rate

Results of flowrate measurement at the outlets of Matadero and Agua Dulce and at Caballeria are shown in Figure 6.6. No significant seasonal variations of flowrates are recognized in drainage channels of Matadero and Agua Dulce. The average flowrates, based on 24 hours measurement, are close to those of existing data as shown in Table 6.3.

2) Water Quality

The major water characteristics in the drainage channels of Matadero and Agua Dulce are summarized in Table 6.5.

Table 6.5 Water Quality in Drainage Channels and Sewer

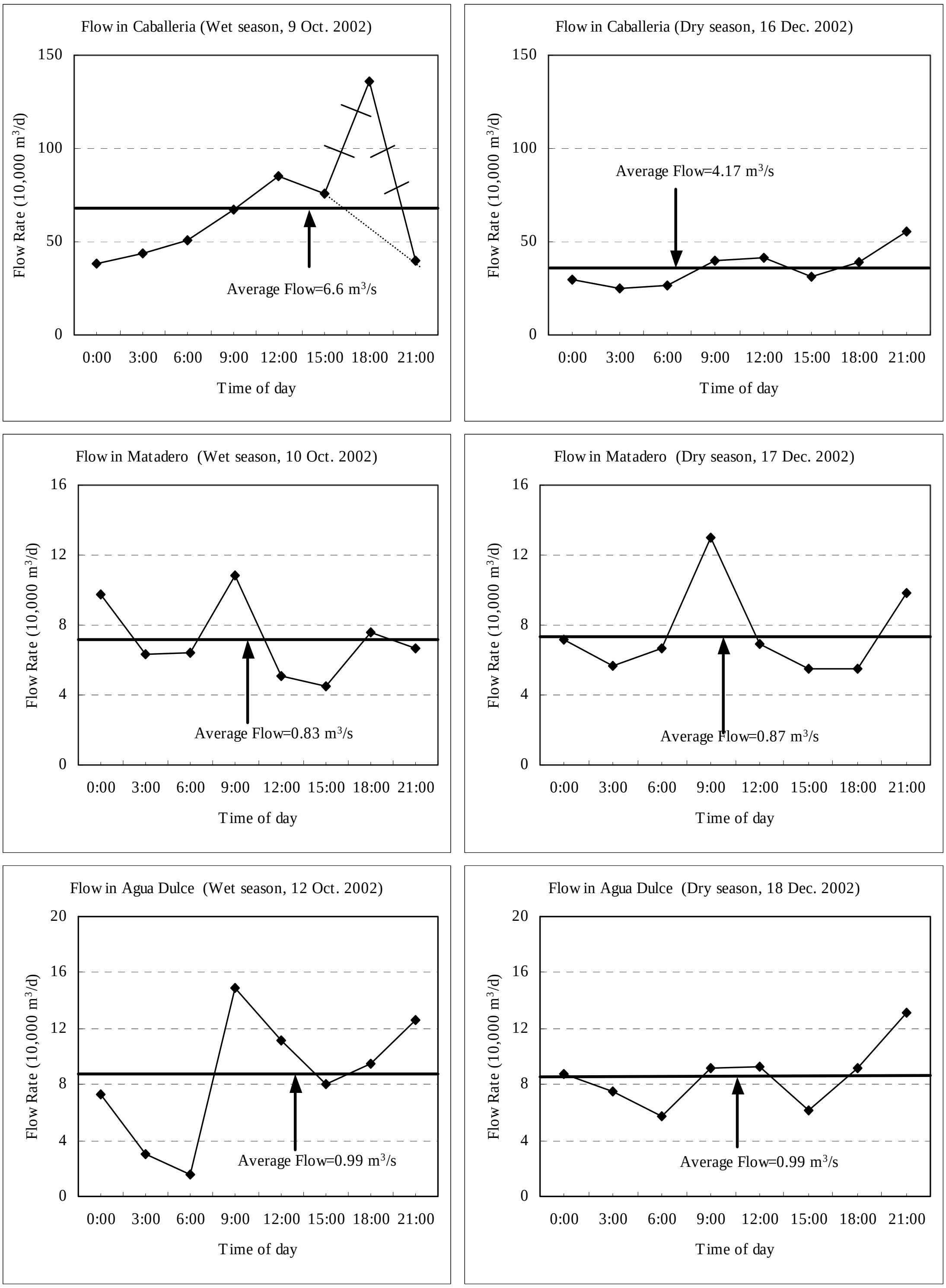
Parameter	Matadero		Agua Dulce		Caballeria (Sewer)		Cuban Standard NC27 (C)
	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	
BOD, mg/l	32	30	22	29	30	15	60
COD, mg/l	62	98	44	106	73	33	120
SS, mg/l	89	58	61	86	71	66	-
T-N, mg/l	10	8.4	7.5	9.2	6.5	8.5	20
T-P, mg/l	1.0	0.6	1.3	0.9	5.4	1.2	10
Fecal. Coliform, MPN/100ml	70×10^5	40×10^3	50×10^5	30×10^5	17×10^6	30×10^5	-

Source: JICA Study Team

It is not observed a significant difference in wastewater characteristics both in drainage channels and sewer. This indicates that the drainage channels collect and discharge wastewater having same characteristics of the wastewater in sewer.

The organic strength of wastewater in sewer both in wet and dry seasons is very weak compared to typical domestic wastewaters in ordinary separate sewer system: weak of 100 mg/L and medium strength of 200mg/L in term of BOD concentration. Existing data (Table 6.3) shows that those typical organic strength of wastewater has been experienced. Reasons why very weak strength wastewater are taken in sewer should be identified through a comprehensive surveys. One of the reasons is a dilution with runoff and infiltration/inflow of groundwater due to illegal connections as specified in previous section and may be a dilution with leaked drinking water.

High value of fecal coliform (observed at drainage channels of Matadero (0.4 to 30 x 10^5 MPN/100 mL)and Agua Dulce (30 to 50 x 10^5 MPN/100 mL) also indicates that wastewater in drainage channels contains raw sewage to a large extent.



THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 6.6 Results of Flowrates Measurement at Drainage Channels and Sewer
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CHAPTER 7
PRESENT ORGANIZATION

7.1 GENERAL

In general terms, it may be said that there are two leading agencies in charge of the water sector in Cuba.

The National Institute of Water Resources (INRH) is the governmental agency responsible for the Water Supply and Sanitation Sector. (The Ministry of Public Health also plays an important role in the control and monitoring of potable water supplies).

The Ministry of Science, Technology and Environment is the governmental agency responsible for the nation's Environmental Management

In addition, the Local Bodies of the Popular Power in Cuba are formed by the Assemblies of Popular Power established within the political-administrative jurisdictions at national**,** provincial and municipal level. They are the superior organs of government and are invested with the highest authority of the state through local administrations to direct the economic activities, production and services of a local character.

Regarding the operation of the water supply and sanitation sector, in addition to the two leading agencies there are a number of extra-sectoral agencies that also contribute to the sector. The general organization chart is given in Figure 7.1, and the extra-sectoral agencies in Figure 7.2.

In the case of the City of Havana, the city itself is a province and the governing body is the Provincial People's Administrative Council. For the implementation of the law and legal base on water resources and the environment, the governing body is the Provincial Delegation of Resources of the City of Havana of the National Institute for Hydraulic Resources (DPRH).

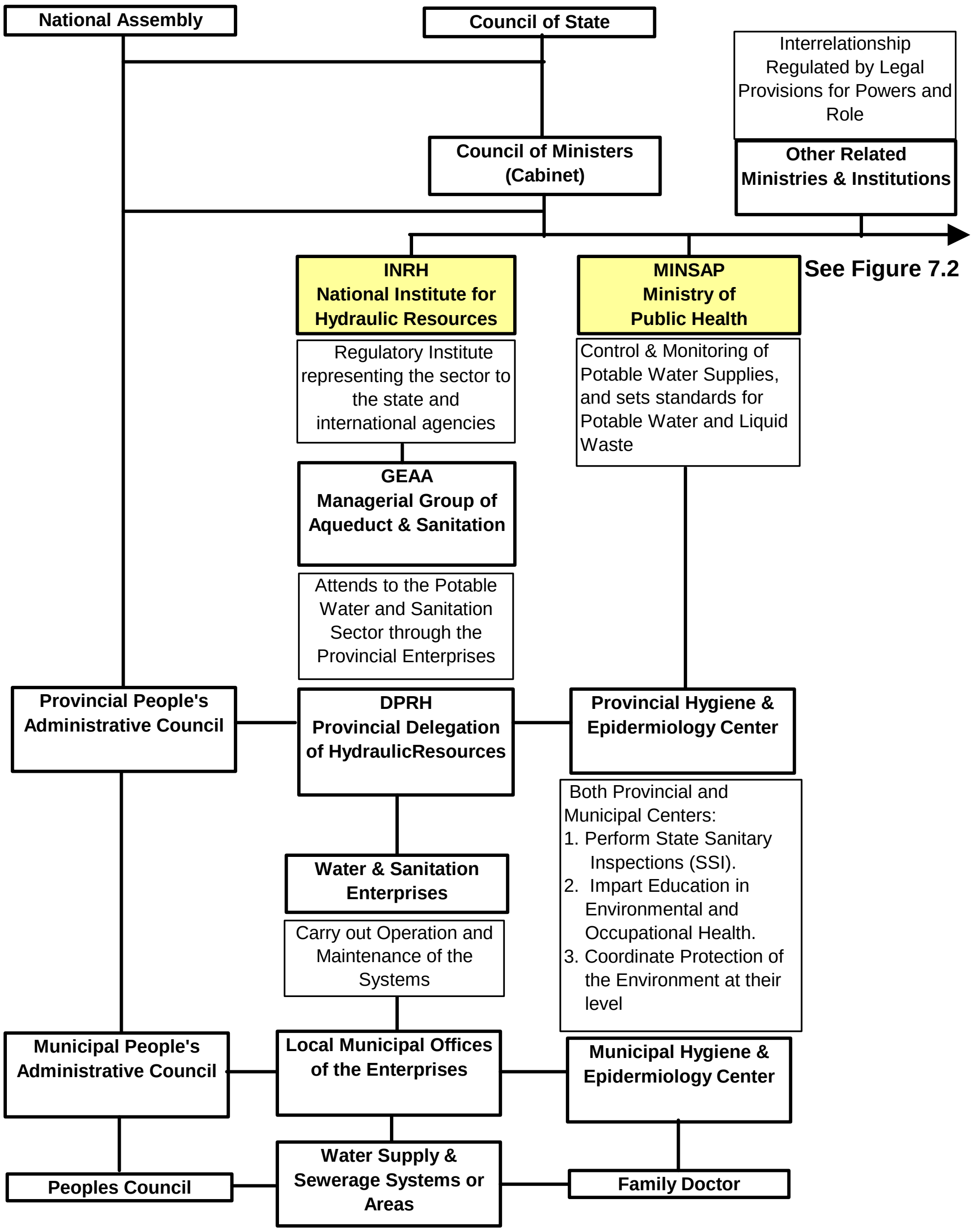
7.2 INSTITUTIONS RELATED TO HAVANA BAY WATER ENVIRONMENT

7.2.1 CENTRAL GOVERNMENT INSTITUTIONS

As stated previously, the Ministry of Science, Technology and Environment (CITMA) is the governmental agency responsible for the nation's Environmental Management, and hence is the overall central government agency responsible for matters of environmental concern to Havana Bay. In addition, the following central government institutions play an important role:

- (MINTRANS) Ministry of Transport
- (MINSAP) Ministry of Health
- (MIP) Ministry of Fisheries
- (MINAG) Ministry of Agriculture

The functions of the Ministries in relation to Havana Bay are shown in Figure 3.10.



THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 7.1 Water and Sanitation Sector, - General Organization Chart for Operation
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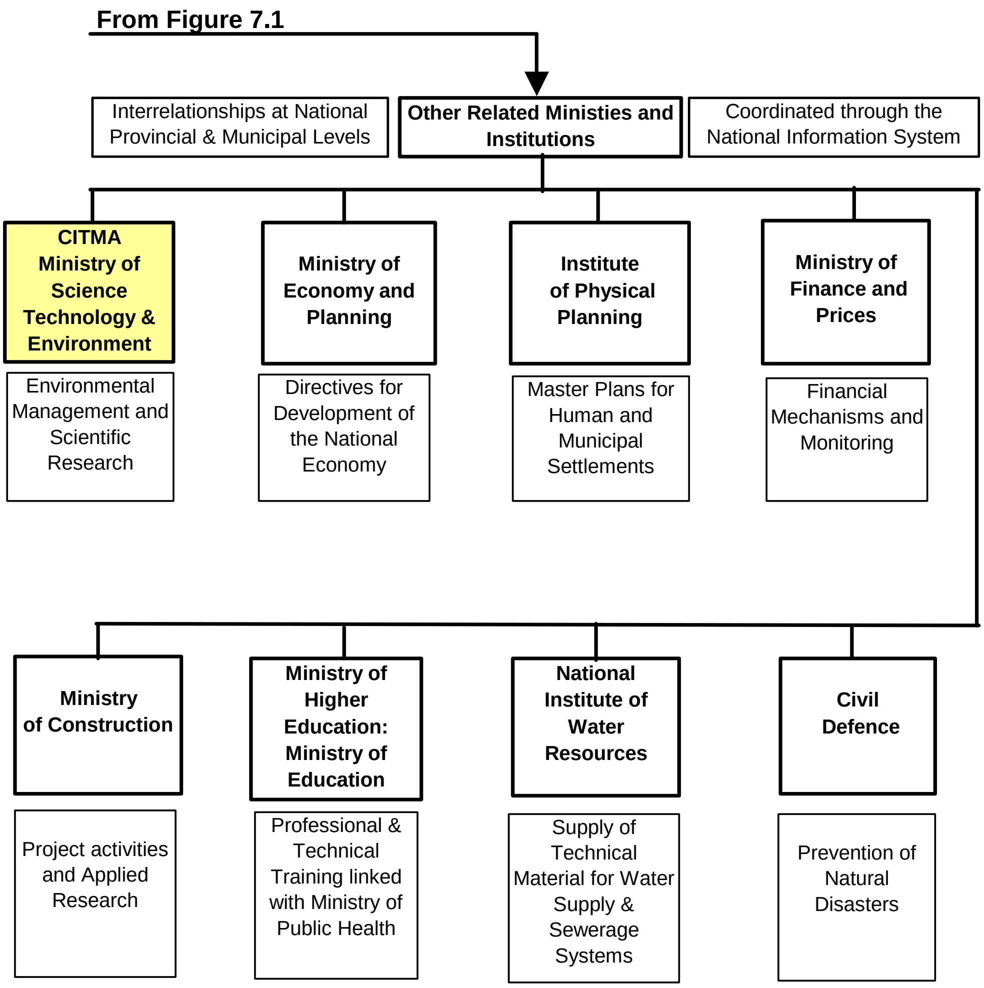

THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY JAPAN INTERNATIONAL COOPERATION AGENCY	Figure 7.2 Extra-Sectoral Agencies to the Water and Sanitation Sector

There is also a National Council for Hydraulic Basins comprising representatives of INRH and CITMA. These operate at provincial level, and for the City of Havana**,** CITMA provide the president, and IHRH the vice president.

7.2.2 OTHER INSTITUTIONS

Two of the most important institutions related to Havana bay are:

- (CENHICA) The National Center for Hydrology and Water Quality, which conducts scientific investigations, promotes technology for basin protection and produces water quality standards.
- (CIMAB) Cuba's Center for Engineering and Environmental Management of Bays and Coastal Zones, which is an enterprise agency for environmental projects and plays a role in water quality and contamination of the Bay.

Central government agencies, together with other organizations are involved in the environmental protection of the bay, including the feeder-rivers that contribute to the pollution, these are:

• Water Quality of the Bay	CIMAB and GTE (under the Ministry of Transport)
• Contamination of the Bay	CIMAB, GTE, and CITMA (Provincial level, City of Havana)
Water Quality of Rivers	"Enterprise of Hydraulic Usage" (EAH)
Contamination of Rivers	"Enterprise of Hydraulic Usage" (EAH)

EAH levies charges for the use of raw water, as well as being responsible for terrestrial waters. In addition, there is a Technical Committee, which serves as a technical, administrative and scientific body for Havana Bay.

7.3 GTE

7.3.1 OBJECTIVES AND POLICIES

The State Working group for Cleaning up Conservation and Development for the Havana Bay (GTE) was approved on 15th June, 1998 by "Acuerdo" 3300 by the Executive Committee of the Council of Ministers of the Republic of Cuba.

GTE operates under the Ministry of Transport and its president has overall responsibility, together with the Provincial Administrative Council of the Popular Power for the City of Havana, and the vice presidents of CITMA.

GTE is involved with all development activities of the Bay, together with both national and international institutions and organizations.

GTE's objectives are to elaborate, coordinate and project actions for solutions to keep control of the discharge of wastewater and to reduce the pollution load. To request from other organizations and enterprises that are direct or indirect sources of pollution of the bay, that they have short, medium, and long-term solutions to the problem. To control taxes approved by the ministry of Finance and Prices in relation to Havana Bay tourism and commerce.

From the actual situation in Havana Bay today, GTE look to the future scenario with procedures, identification of permanent solutions and alternatives in a continuous, progressive process of environmental management at local level, with the objective of:

- Rehabilitation (Working with the past)
- Resolution (Working with the present)
- Prevention (Working with the future)

7.3.2 ORGANIZATIONAL STRUCTURE

GTE is headed by a president from the Ministry of Transport who controls two vice presidents, one for liaison with CITMA and the other for liaison with the Havana City Government. There is a legal department and four vice-directors who are responsible for other sections. The Organization Chart is given in Figure 7.3.

7.3.3 ROLES AND RESPONSIBILITIES

Havana Bay is the most polluted ecosystem in the country, and has a negative impact on the environment in the Greater Caribbean Region. It imposes limitations on the development of the bay in relation to the port and maritime activities, landscape, culture, recreation and tourism.

The role of GTE is therefore to strengthen State Inspection Activities for the security, functioning and cleaning up of the bay. To consult on construction services and investment to ensure that no environmental damage results. To act as an intermediary for International Agreements, and resolutions, in pollution control and prevention, including the legal framework.

7.4 INRH (NATIONAL INSTITUTE OF WATER RESOURCES)

7.4.1 OBJECTIVES AND POLICIES

Decree Law No. 114 of 6th June 1989, created INRH as an institution of the Central State Administration to direct, execute and control the application of the government's policies related to water resources in the country and some other common functions to other agencies of the Central State Administration.

Decree Law No. 138 of 1st July 1993 regarding Terrestrial Waters, gave INRH the objective of developing the basic principles stated in the constitution of the Republic of Cuba, and in the Environment Protection and National Resources Natural Use Law on surface and underground waters.

7.4.2 ORGANIZATIONAL STRUCTURE

INRH has three major branches in the organization as follows:

- Professional Upgrading and Training Centers (2 Centers)
- Provincial Delegations (14 plus Isle of Youth)
- Managerial System

The Managerial System controls 3 groups, which are:

- Group of National Enterprises (4)
- Group of Other Enterprises (5)
- Managerial Groups

The Managerial Group also controls three groups, being:

- Managerial Group of Hydraulic Use (14 Enterprises)
- Managerial Group of Aqueducts and Sanitation (21 Enterprises)
- Managerial Group of Research, Projects and Engineering (7 Groups). (NB: CENHICA; the National Center for Hydrology and Water Quality was recently added as an Investigative Center).

The Organization Chart, showing the structures and functions of the various sections, with those applicable to this study highlighted, is given in Figure 7.4.

7.4.3 ROLES AND RESPONSIBILITIES

INRH has the following roles and responsibilities:

- To organize and direct in coordination with other government organizations, the protection of terrestrial waters, basins, natural beds, hydraulic works and facilities against pollution and other problems of deterioration and degradation, as well as the systematic control of water quality
- To determine, together with other organizations, the regulations required to protect the economic and social objects, and the environment against noxious effects on territorial waters. Organize insurance, and actions for the control, safety and good functioning of all hydraulic facilities, protecting against floods, underground drainage and the yield capacity of natural and artificial beds.
- To determine and keep updated hydraulic the data for the hydraulic potential of the country, and provide hydrological data on surface and underground water, rain and evaporation
- To propose hydraulic development strategies and to regulate and control projects and investments for hydraulic works
- To plan, regulate and control hydraulic resources, and the operation, technical surveillance and maintenance of hydraulic works and facilities
- To determine and keep updated the studies and evaluations of hydropower potential etc.
- To regulate and control aqueduct, sewerage and pluvial drainage activities
- To organize and guarantee the operation of a National Registration of Terrestrial Waters. The register will contain details of concessions, assignments, and allowances related to the use of water and its preservation, in accordance with the law

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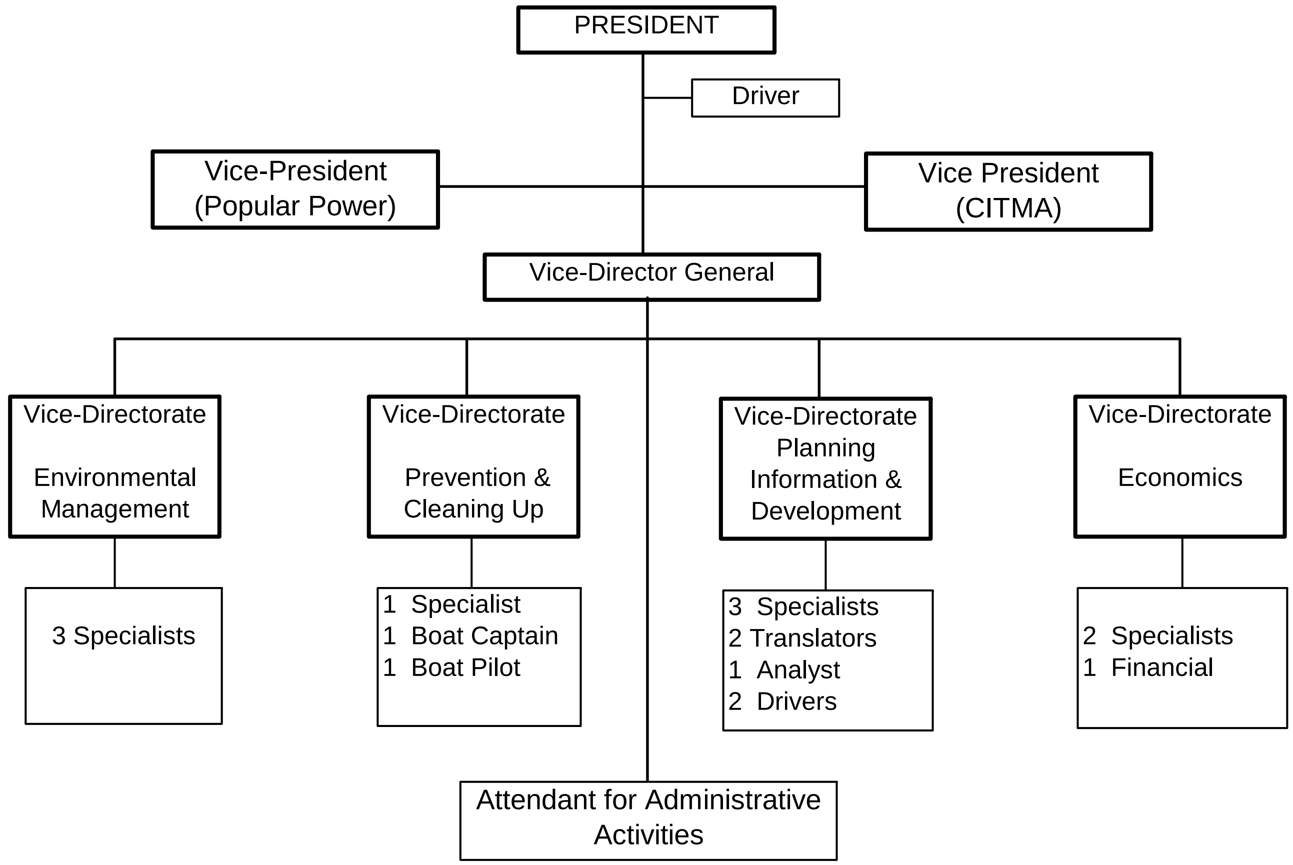
THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY

Figure 7.3
Organization Chart of GTE



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JAPAN INTERNATIONAL COOPERATION AGENCY

THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY

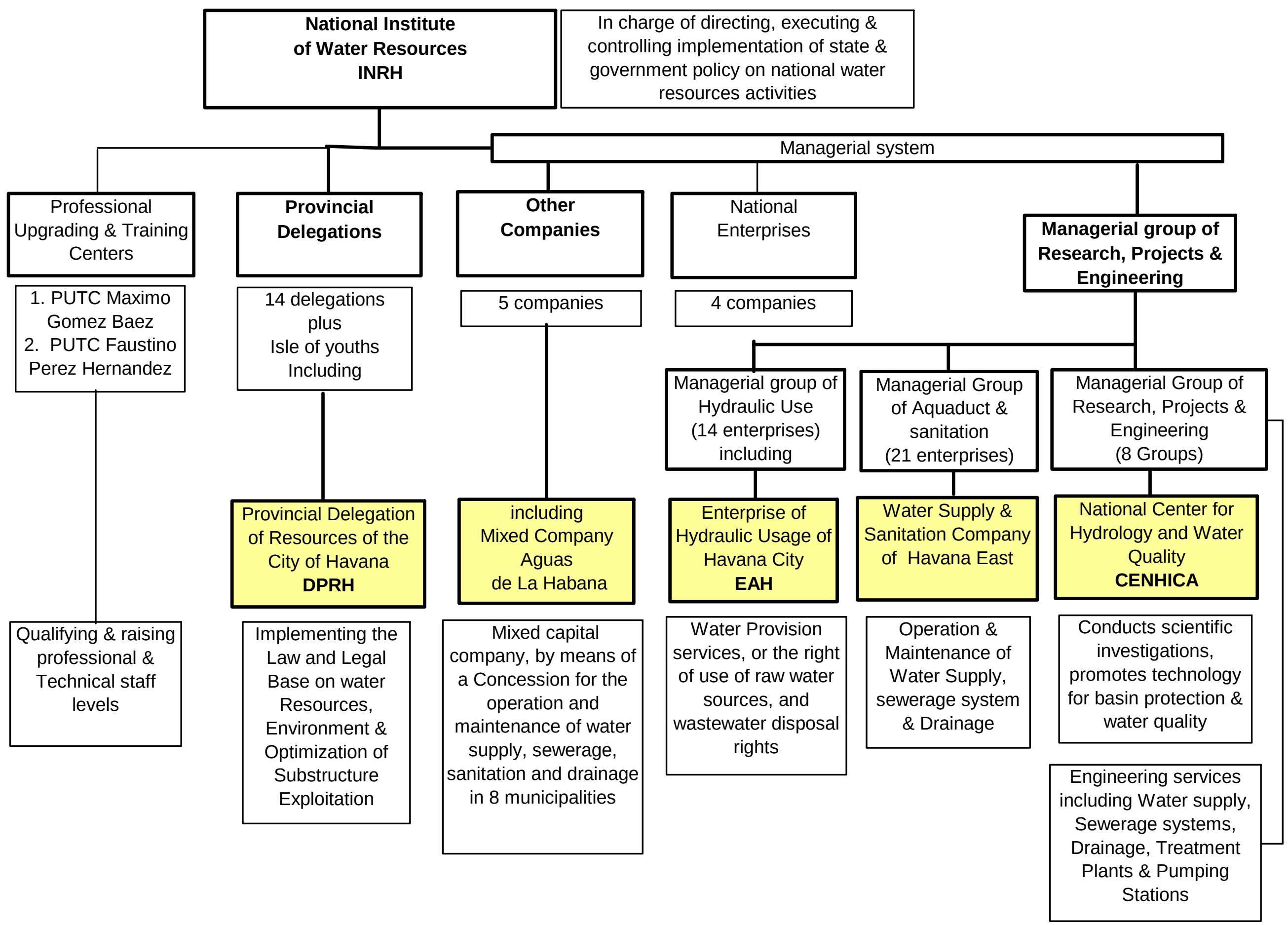


Figure 7.4
Organization Chart of INRH

7.5 CITMA (MINISTRY OF SCIENCE, TECHNOLOGY AND ENVIRONMENT)

7.5.1 OBJECTIVES AND POLICY

Law No. 81 of 1999 is the Law of the Environment and Article 11 states:

"The Ministry of Science, Technology and Environment (CITMA) is the governmental agency of the Central Administration of the State in charge of proposing environmental policy and guiding its execution through the coordination and control of the nation's environmental management, promoting its coherent integration in order to contribute to sustainable development."

The purpose of the law is to establish the legal principles to govern environmental policy and the basic legal requirements to regulate environmental management.

CITMA oversees national environmental policies to achieve the following goals:

- Increase and strengthen environmental controls to assure compliance with legislation
- Redefine procedures for assessing environmental impacts and applying resulting recommendations
- Modernize and complete national environmental legislation
- Achieve a major integration between environmental management and national science

As the institution responsible for environmental management, CITMA has a duty to uphold the objectives of the law, which are:

- To create a legal context that favors the design and development of socio-economic activities in ways that are compatible with the protection of the environment
- To establish principles to guide the actions of natural and legal persons in environmental matters, including the mechanisms for coordination among the various agencies and bodies for efficient management
- To promote public participation in environmental protection and in sustainable development
- To develop public awareness regarding environmental problems by integrating education, disclosure, and environmental information
- To regulate the development of evaluation, control and surveillance activities regarding the environment
- To foster the protection of human health, improvement of the quality of life and of the environment in general

7.5.2 ENVIRONMENTAL STRATEGY

The National Environmental Strategy is aimed at indicating the ideal ways to preserve and develop the environmental achievement of the Revolution. Cuba is serious on its drive to protect the environment as can be seen from the events starting over a quarter of a century ago.

In 1976, the environment was included in the constitution (Article 27), and a National Commission for the Protection of the Environment and Preservation of Natural Resources was created. Law No. 33 "Protection of the Environment and the Rational Use of Natural Resources" was passed in 1981, and Decree Law 118 "Structure, Organization, and function of the National System for the Protection of the Environment and its Ruling Body" was passed in

1990. (These laws were subsequently modified by the issue of Law of the Environment No. 81).

Following Cuba's participation in the Rio Earth Summit in 1992, Cuba adapted Agenda 21 into its National Program of Environment and Development, and created CITMA in 1994. The National Environmental Strategy was formulated in 1996, and is continuously updated.

CITMA oversees and coordinates the implementation of the Environmental Strategy, which is an integrated system with interrelated components, and very much a cross-cutting issue involving many other ministries and institutions. The instruments for the implementation of the strategy are:

- National Program of Environment and Development
- Environmental Planning
- Environmental Legislation
- Environmental Impact Assessment
- Environmental Licensing Process
- State Environmental Inspection
- Scientific Research and Technological Innovation
- Environmental Education and Dissemination
- Instruments for Economic Regulation
- Environmental Indicators for decision making
- International Environmental Policy

These instruments are fully described in the National Environment Strategy Second Issue/May 2000.

7.6 WATER AND SEWERAGE CORPORATIONS

7.6.1 GENERAL

The Water and Sewerage Corporations of Ciudad de la Habana fall under the jurisdiction of INRH in the Managerial Groups section (see figure 7.4). INRH's mission is to direct, supervise, control and evaluate the results of each entity.

Until 1998 the Water, Sewerage and Drainage for Cuidad de la Habana was under the jurisdiction of the IHRH Provincial Authority, DPRH. Now there are four Corporations which have as a fundamental managerial objective, the operation and maintenance of water supply services, sewerage systems, and pluvial drainage for the parts of the systems they control.

These four corporations cover a total population of about 2.188 million and an area of 727km^2, with about 4,000km of water supply distribution network, 1,600km of sewers and 120,000 septic tanks. These are:

- Aguas de la Habana
- Acueducto del Este
- Acueducto del Sur
- Acueducto del Cotorro

(1) Aguas de la Habana

This organization is the largest in the city and its service area covers most of central Havana and the western part of the city both inside and outside the Study Area. The supply area covers the municipalities of Centro Habana, Habana Vieja, Diez de Octubre, Cerro, Plaza (all forming part of the Study Area),and Marianao, Playa, and La Lisa. The population served is 1,221,130 (about 40% in the Study area), with a water supply network of about 1,792km, a sewer network of about 1,174km, and over 60,000 septic tanks. The workforce totals 2,865

Aguas de la Habana is a mixed capital company with a 45% shareholding by Barcelona Water (Grupo Aguas de Barcelona), 5% by an individual and 50% by INRH Barcelona Water are responsible for the management, and operation and maintenance of the water supply, sanitation and drainage facilities in the metropolitan area of the city. The concession commenced on 1st April 2000 and is for a period of 25 years (renewable). The former entity was the Water & sewerage Corporation del Oeste which came into being in 1998 serving only the municipalities of Marianao, Playa, and La Lisa.

(2) Acueducto del Este

Acueducto del este is a Cuban enterprise under the jurisdiction of INRH and is responsible for the operation and maintenance of the hydraulic resources and infrastructure in the eastern part of Ciudad de la Habana. The supply area covers the municipalities of Habana del Este, Guanabacoa, Regla, San Miguel del Padron (all forming part of the study area), part of the municipalities of Diez de Octubre and Cotorro, and Guanabo including the eastern beaches area. The population served is 487,839 (about 47% in the Study Area), with a water supply network of about 1,148km, a sewer network of about 562km, and about 33,500 septic tanks. The total workforce numbers 1,113

(3) Acueducto del Sur

This is a Cuban enterprise under the jurisdiction of INRH and is responsible for the operation and maintenance of the hydraulic resources and infrastructure in the southern part of Ciudad de la Habana. The supply area of 217km^2 covers the municipalities of Arroyo Naranjo and Boyeros. In addition to the piped water supply and water borne sewerage there are about 27,000 septic tanks. The total workforce numbers 723, and the enterprise was formed in 1999.

Whereas Arroyo Naranjo is inside the Study Area the population only makes up about 4% of the total Study Area population, and sewers will not be extended in this municipality by this study.

(4) Acueducto del Cotorro

This is a Cuban enterprise under the jurisdiction of INRH and is responsible for the operation and maintenance of the hydraulic resources and infrastructure in the municipality of Cotorro which is outside the study area. The supply area is about 66km^2 with a population served of 74,400. 48% of the population is connected to the sewers and there are about 4,000 septic tanks. The total workforce numbers 228, and the enterprise was formed in 1999.

(5) Major Enterprises in the Study Area

Aguas de la Habana and Acueducto del Este are the main subject of this chapter as they both have large populations within the Study area, and will be affected by any rehabilitation and extensions to the sewerage system which may result from this study.

Further detailed statistics of the operating information of these entities are given in the following Table 7.1

Table 7.1 Statistics - Aguas de la Habana & Acueducto del Este

Description	Unit	Aguas de la Habana	Acueducto del Este
Volume of Water Produced	Hm3/year	323	154
Population Served by Piped Water	Persons	1,221,130	487,839
Length of Water distribution Network	km	1,792	1,148
Population served by Tanker Truck	Persons	27,594	15,511
Ratio of Population served by Piped Water	%	98%	96%
Population connected to sewers	Persons	854,723	30,414
Length of Sewer Network	km	1,174	562
Population Served by Septic Tanks	Persons	388,000	457,425
Ratio of Population Served by Sewers	%	69%	6%
No. of Septic Tanks	Number	60,224	33,500
Cleaning of Septic Tanks	Times/year	9,873	2,790
Volume of Wastewater to sewers	Hm3/year	116	20
Volume of Wastewater Treated	Hm3/year	20	N/A
Cleaning of Sewers	Times/year	20,408	N/A
Cleaning of Storm Drainage hopper	Times/year	98,142	N/A

Source: Aguas de la Habana, Acueducto del Este

7.6.2 AGUAS DE LA HABANA

(1) General Structure

Under the direction of the General Manager and Deputy General Manager, this mixed enterprise company is comprised of eight departments as follows:

- Technical (1567 Staff)
- Engineering and Construction (174 Staff)
- Commercial (97 Staff)
- Accounting and Logistics (151 Staff)
- Information Systems (71 Staff)
- Human Resources (39 Staff)
- General Secretariat and Legal (6 Staff)
- Client Care (97 Staff)

Further details of the organization are given in Figure 7.5.

(2) Technical Department

The technical Department is responsible for the operation and maintenance of the whole hydraulic system, the six major sections are:

- Zoning & Unaccounted for Water
- Production and Electrical & Mechanical
- Operations
- Construction
- Water Pipe Maintenance
- Sewerage and Drainage

Out of a total workforce of 1,567, the Sewerage and Drainage division has 437 workers. This division is responsible for the sewerage technical section, treatment section, and the central and western sewerage and drainage bases. Further details of the organization are given in Figure 7.6.

(3) Operation & Maintenance for Sewerage & Drainage

This sub-department (2 staff) of the main Technical Department has two sections and two bases as described below:

- Technical Section (8 staff)

  The Technical Section is staffed by engineers and is mainly responsible for all technical engineering matters concerning the operation and maintenance of the sewerage system.

- Treatment Section (57 staff)

  This section deals mainly with the operation of the main Casablanca sewerage conveyance system and the small Quibu wastewater treatment plant and lagoons in the western area. The Casablanca system includes the screens, siphon, Casablanca pumping station, tunnel, and sea outfall. In addition, responsibility includes the operation of another nine sewerage pumping stations, and the emptying of the large septic tanks and disposal into various points in the collector system.

- Central Sewerage and Drainage Base (169 staff)

  Maintenance operations are carried out from this base in two areas which are:

  No. 1 La Habana Vieja and Centro Habana

  No. 2 Cerro and Diez du Octubre

- Western Sewerage and Drainage Base (201 staff)

  Maintenance operations are carried out from this base in two areas which are:

  No. 3 Marianao and Plaza de la Revolucion

  No. 4 La Lisa and Playa

The western base is also responsible for the emptying and disposal to collectors of the small domestic septic tanks and all drilling and well development for septic tanks.

(4) Engineering and Construction

This department has divisions for Investment, Planning Systems, Projects and Planning, Quality Control, Laboratory (potable water), and a Wastewater Laboratory. Further details of the organization are given in Figure 7.7.

(5) Commercial Management

The Sales Office (Commercial Department), has sections for Prime Customer Care and Collection (US$ payers), a billing section and a collection section. This office is being progressively trained to connect with branch offices in each municipality which are able to connect to the central computer system and provide customers with up to date information. In addition information regarding incidents of loss of water supply, bursts, emptying of septic tanks etc. can all be accessed.

(6) Accounting and Logistics

This department has divisions for Financial, Accounting and Administrative Control, Billing and Collection, and an administrative section for Prime Customer collection.

(7) Information System

The main divisions and sections are Internal Control, Financial, Accounting and Administration Control, Purchasing and Storage and transport.

The system installed adopts all of the corporative applications of Aguas de Barcelona, to enable the whole enterprise to be administered in an integrated manner. This unique data base provides for efficient information management, and the advanced technology forms the basis of this relatively new organization.

(8) Human Resources Department

The human Resources department has three sections being, Management and Training, Safety/Health/Work environment, and Personnel.

In the first 2 years as a mixed capital enterprise many important tasks have been carried out. The first major task was the development of an organizational structure (No. of workers and Wages etc) taking into consideration the labor legislation, Society Statutes, and the main Institutions related to Aguas de la Habana, in close collaboration with the Trade Union representatives.

At central government level, Resolution No. 50-2001 of the Ministry of Labor and Social Security establishes regulations for direct contracts with mixed enterprises labor, for workers in water supply, sewerage, sanitation and pluvial drainage.

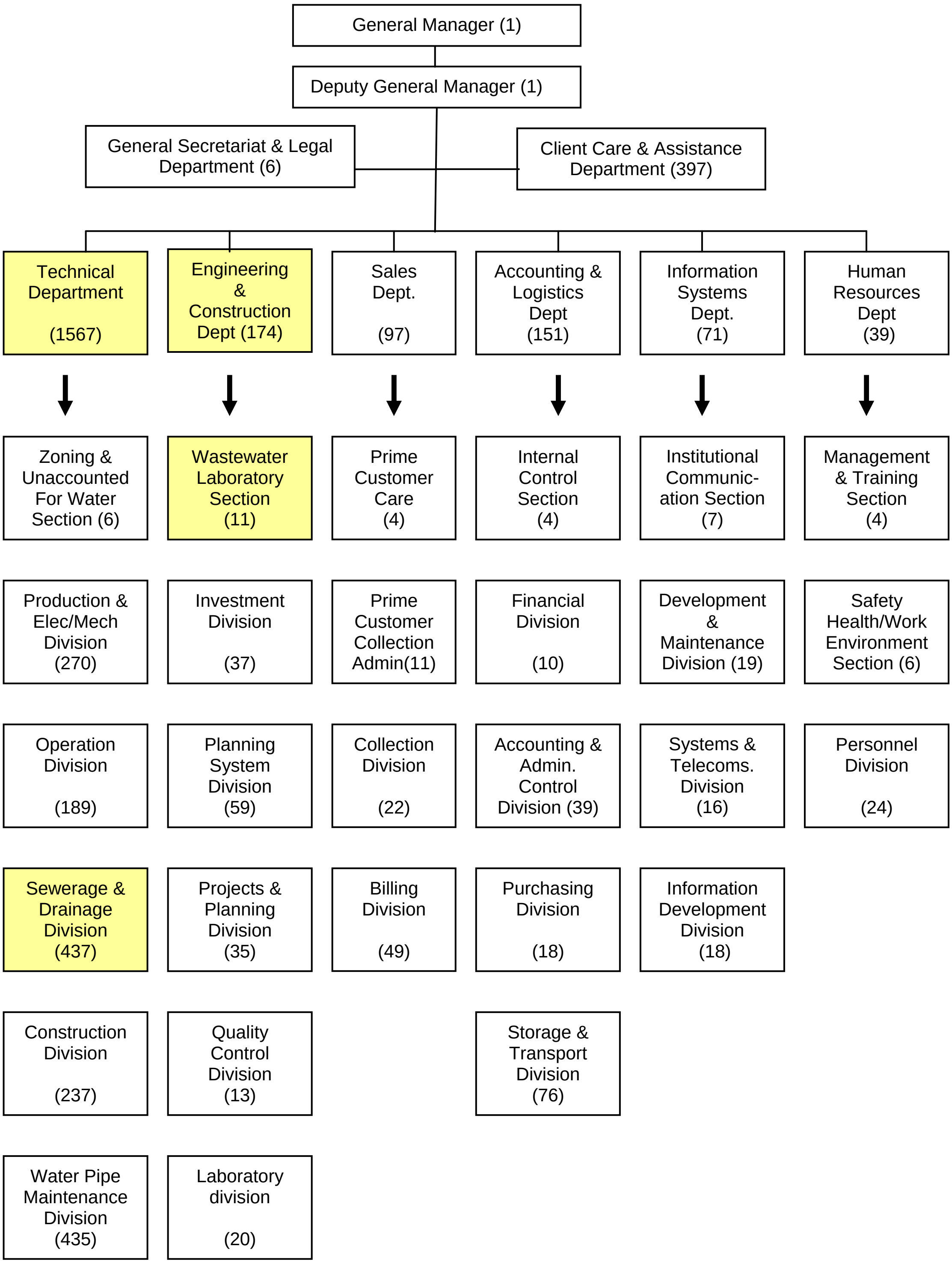
At present there are 700 professionals and technicians, one third of the payroll is female who make up 63% of the technicians. Special attention is paid to the workers, and training in 2000 and 2001 totaled over 25,000 and 32,000 hours respectively, representing 5% of the working hours. The program concentrates on security, health and the environment at the workplace.

(9) Other Services

These include a small Secretariat and Legal department, a large Customer Care department, a General Services section, a Security and Protection section, and a Mechanization division.

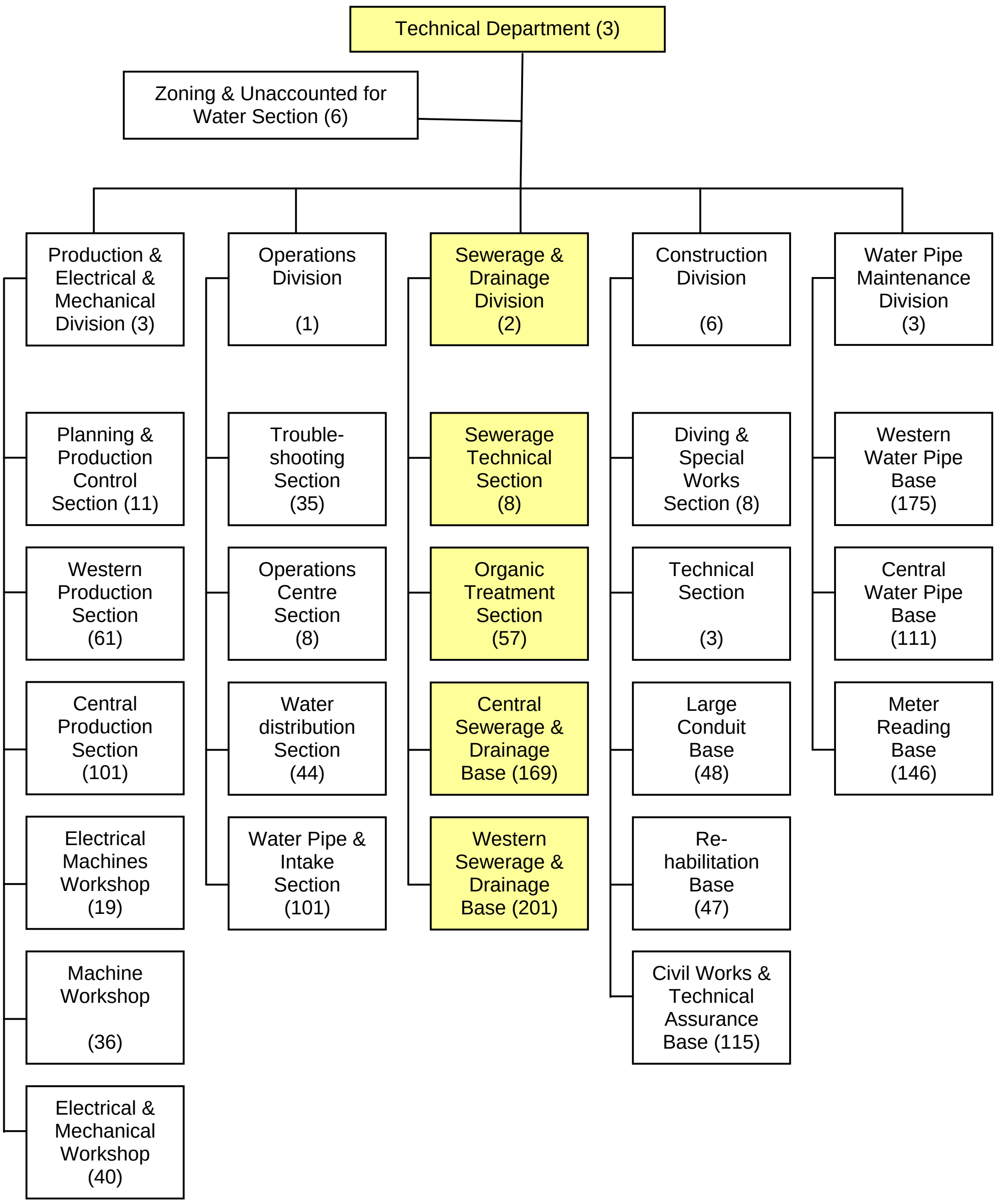
(10) Support Offices

Support offices include 8 workshops, 10 bases, and 15 commercial offices.



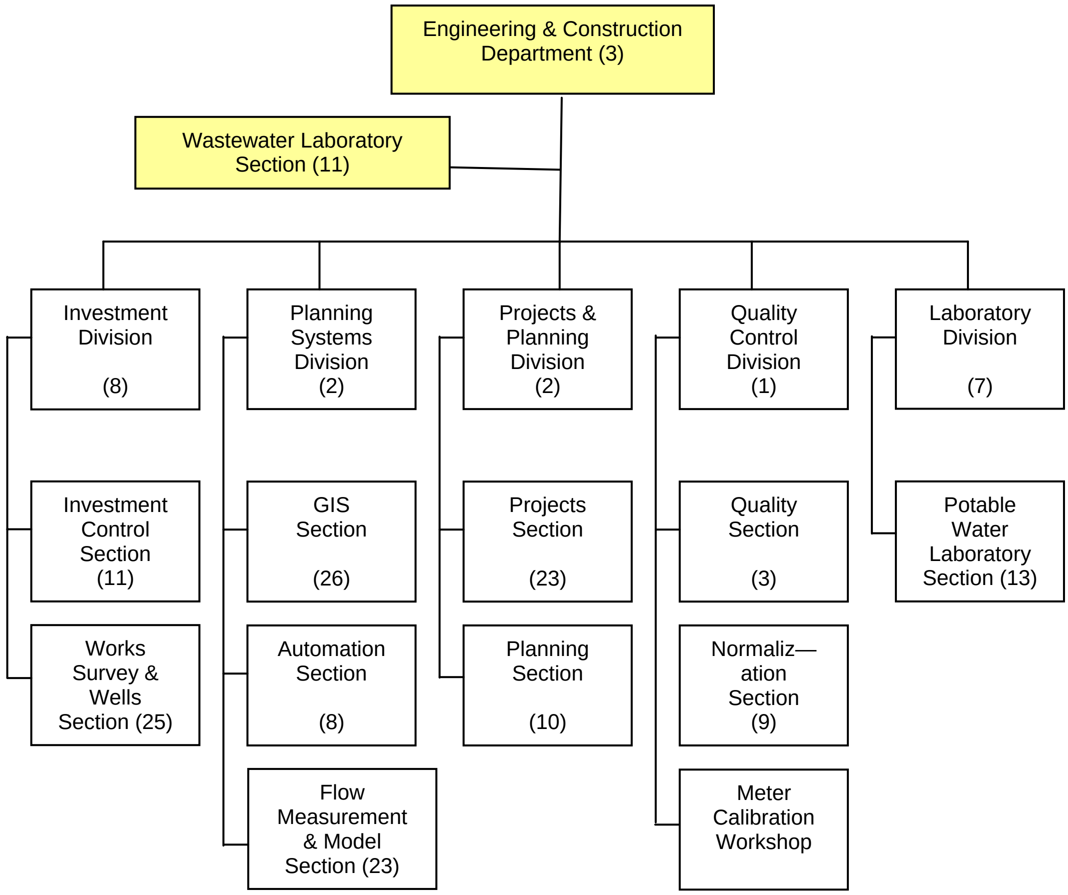
THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 7.5 Organization Chart of Aguas de la Habana
JAPAN INTERNATIONAL COOPERATION AGENCY	

Source: Aguas de la Habana (No. of Employees at 1st September 2002)



THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 7.6 Organization Chart for the Technical Department of Aguas de la Habana
JAPAN INTERNATIONAL COOPERATION AGENCY	

Source: Aguas de la Habana (No. of Employees at 1st September 2002)



THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 7.7 Organization Chart for the Engineering & Construction Department of Aguas de la Habana
JAPAN INTERNATIONAL COOPERATION AGENCY	

Source: Aguas de la Habana (No. of Employees at 1st September 2002)

7.6.3 WATER & SEWERAGE CORPORATION DEL ESTE

(1) General Structure

Under the direction of the General Manager and Deputy General Manager, this Cuban enterprise has three small sections dealing with legal, auditing and enterprise restructuring. At the next level there are four departments for the projection and control of the enterprise. These are:

- Economy and Finance (7 Staff)
- Personnel (39 Staff)
- Engineering (13 Staff)
- Commercial (Sales) (5 Staff)

(2) Basic Enterprise Units

Below the four departments there are four Basic Enterprise Units which provide management and support, these are:

- Logistics & Equipment Unit

  The areas of responsibility of this unit include logistics, equipment, and internal services for the Enterprise.

- Accounting Unit

  The basic accounting for the enterprise has been simplified by the use of the computerized billing system at Aguas de la Habana. There is a charge for the provision of this service.

- Water supply Unit

  This unit has a staff of 539 and is responsible for water production, operation, and maintenance of the water distribution network. Testing of potable water is the responsibility of the Ministry of Health.

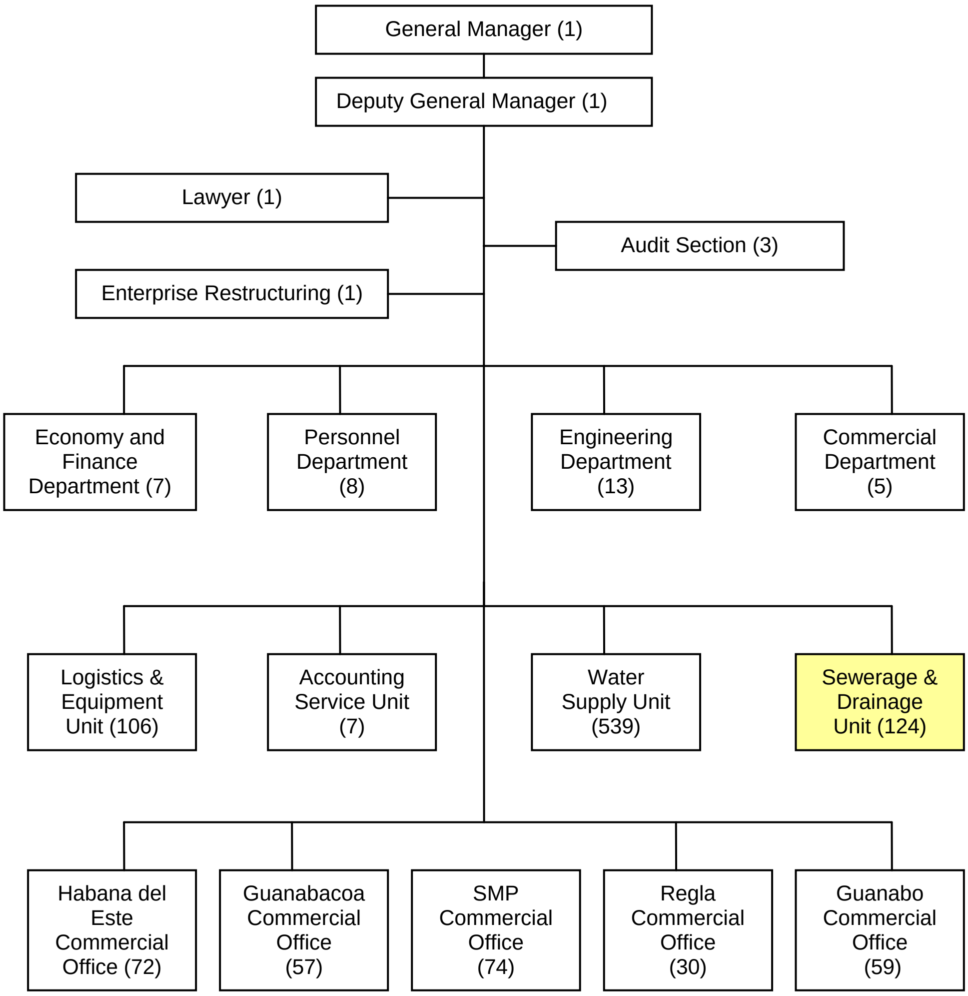
- Sewerage and Drainage Unit

  This unit has a staff of 124 and is responsible for maintenance of both the sewer and drainage networks, and for the cleaning of septic tanks. In addition, the unit is responsible for the operation and maintenance of one pumping station and the Wastewater treatment plant (oxidation ponds) in the Guanaboa area. Analysis of wastewater is the responsibility of this enterprise and testing is done by Aguas de la Habana for a fee.

(3) Other Services

The next level deals with billing and collection at the five commercial offices located in Habana del Este (3 brigades), Guanabacoa (4 brigades), San Miguel del Padron (4 brigades), Regla and Guanaboa (1 brigade each).

Further details of the organization are given in Figure 7.8.



THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 7.8 Organization Chart of Acueducto del Este
JAPAN INTERNATIONAL COOPERATION AGENCY	

Source: Acueducto del Este

CHAPTER 8
CURRENT FINANCIAL SITUATION

8.1 CENTRAL GOVERNMENT

The central Government budgets from 1996 through 2001 (Table 8.1) have been relatively stable. Both the revenues and the expenditures have kept approximately the same ratios against GDPs. As the result, the fiscal deficit has remained under 3 percent since 1996 that can be viewed as a sound level.

Increases in tax rates, together with new taxes, user charges and price increases on non-essential goods, were introduced to reduce in those years. Direct taxation is being reintroduced, and a new tax-collecting system is being developed.

There is no information segregated into water and sanitation sector in the expenditure. The However the expenditures for public health that include this spending have increased. They have been about 1.6 billion pesos in 1999, 1.7 billion in 2000, and 1.8 billion in 2001, accounting for around 11 percent of the expenditure and 6 percent of GDP during those years.

Other big items on the spending side are education, social security, and subsidy for state enterprises. Education spending has considerably increased. Social security payment had been reduced in constant peso terms. Subsidy for state enterprises that is mainly composed of subsidy for loss and subsidy for price difference has been steadily reduced.

Table 8.1 State Finance

(Million pesos at current prices)

	1996	*1997*	*1998*	*1999*	*2000*	*2001*
REVENUE						
Direct Taxes	1,892.7	2,745.8	3,137.5	3,554.6	3,976.9	4,353.6
Profits tax	468.5	849.6	1,131.8	1,333.3	1,534.5	1,717.5
Employment tax	248.9	562.3	706.1	817.1	970.0	1,102.2
Personal income tax	216.1	263.4	274.6	288.8	291.2	286.1
Social security contributions	959.2	1,070.5	1,025.0	1,115.4	1,181.2	1,247.8
Indirect Taxes	5,512.9	5,329.9	5,543.3	6,336.3	6,732.3	6,386.1
Sales tax	5,079.0	4,876.2	5,076.4	5,786.4	6,130.7	5,721.6
Service tax	433.9	453.7	466.9	549.9	601.6	664.5
Non-taxation income	4,837.2	4,127.9	3,821.2	3,528.3	4,206.0	4,293.8
Payments by state enterprises	2,685.0	2,014.7	1,907.5	1,514.8	1,553.5	1,661.2
Other non-tax income	2,152.2	2,113.2	1,913.7	2,013.5	2,652.5	2,632.6
TOTAL REVENUE	12,242.8	12,203.6	12,502.0	13,419.2	14,915.2	15,033.5
EXPENDITURE						
Current expenditure for budgeted activity	6,938.6	6,807.8	7,081.6	8,122.2	9,233.3	10,405.5
Education	1,421.3	1,453.9	1,509.7	1,829.6	2,094.6	2,368.6
Public health	1,190.3	1,265.2	1,344.9	1,553.1	1,683.8	1,796.6
Defense	496.7	637.5	537.1	752.3	879.6	1,273.8
Social Security	1,630.2	1,635.9	1,705.1	1,785.7	1,785.6	1,870.3
Administration	397.5	431.2	437.8	457.4	509.1	565.2
Housing and communal services	462.4	487.6	565.5	684.3	763.0	827.2
Productive area	154.6	155.5	159.0	156.7	172.7	163.5
Culture and arts	165.2	164.7	168.8	191.0	233.8	310.7
Science and technology	113.6	109.2	104.1	128.1	154.3	163.6
Sports	117.5	121.5	125.9	140.7	158.0	163.4
Social assistance	128.4	135.2	145.4	157.6	178.8	215.2
Other activities	473.3	475.2	484.6	517.8	620.0	687.4
Change in inventory, accounts payable and others	187.6	-264.8	-206.3	-232.1	-	-
Current expenditure for enterprise activity	2,605.7	2,236.2	2,588.4	2,669.8	3,075.7	2,622.2
Subsidy for loss	1,624.4	1,350.0	1,139.4	770.3	586.1	393.4
Subsidy for price difference	867.3	757.9	1,352.0	1,781.2	2,218.9	1,900.2
Fund for production stabilization	-	-	-	-	100.0	-
Other allocation	114.0	128.3	97.0	118.3	170.7	328.6
Economic assistance to agricultural cooperatives	600.6	718.1	384.8	199.5	98.9	63.8
Capital spending	2,043.4	1,839.0	1,580.8	2,063.0	1,749.3	1,989.7
Extraordinary spending	239.1	680.6	1,000.0	555.6	-	-
Fund for budget stabilization	-	-	-	-	1,000.0	140.0
Reserve						
Financial operation	386.1	380.9	426.1	420.8	430.2	549.8
TOTAL EXPENDITURE	12,813.5	12,662.6	13,061.7	14,030.9	15,587.4	15,771.0
Balance	- 570.7	- 459.0	- 559.7	- 611.7	- 672.2	- 737.5
% of GDP	-2.5%	-2.0%	-2.4%	-2.3%	-2.4%	-2.5%

Source: National Statistics Office, *Annual Statistics of Cuba 2001*

8.2 LOCAL GOVERNMENT

The study area is located in the City of Havana Province. Under this province there are 15 municipalities, out of which 10 municipalities are included in the Study Area. Those 10 municipalities are Plaza de la Revolución, Centro Habana, La Habana Vieja, Regla, La Habana del Este, Guanabacoa, San Miguel del Padrón, Diez de Octubre, Cerro, and Arroyo Naranjo. Those province and municipalities has its own governments. The budgets and the production of those local governments are analyzed subsequently.

8.2.1 CITY OF HAVANA PROVINCIAL GOVERNMENT

The budget of the City of Havana has not been made available to the study team. It is said that revenues of provincial governments include revenues from provincial companies, employment tax, sales tax, and vehicle ownership tax. The expenditures include education, public health, and social security. The production of major activities in the City of Havana is shown in Table 8.2.

Table 8.2 Production of the City of Havana

(Year 2002, Unit: Million peso)

Manufacturing		
Electric energy	20	
Fuel	262	
Mining and metal	40	
Mining and non-metal	6	
Construction machine	9	
Electric machines	33	
Metal products	27	
Chemical	91	
Paper	35	
Printing	45	
Wood processing	12	
Construction material	53	
Glass and ceramic	2	
Textile	6	
Garment	31	
Leather	14	
Food processing	257	
Fish processing	76	
Beverage and tobacco	112	
Other industrial activities	59	
Total		1,189
Construction		76
Agriculture		33
Transport		
Goods transport	181	
Personal transport	153	
Total		333
Tourism		329
Grand Total		1,627

Notes:
- This breakdown of production includes only selected items in a "basket".
- Total production of Havana City in 2002 was 5,821 million peso.
- Both the 1,627 and the 5,821 million pesos include production outside Havana City. If a company is headquartered in Havana City and its operation is extended to outside Havana City, the production in other provinces are also included.

Source: Havana City Territorial Office of Statistics

8.2.2 MUNICIPAL GOVERNMENT

The budgets of the 10 municipalities (Plaza de la Revolución, Centro Habana, La Habana Vieja, Regla, La Habana del Este, Guanabacoa, San Miguel del Padrón, Diez de Octubre, Cerro, and Arroyo Naranjo) have not been made available to the study team. Productions of those municipalities are summarized in Table 8.3. The production data are rather erratic. One of the reasons is that state economic planning decides the level of production of a particular industry based on the economic situation. As a result, municipalities that include affected industries may be also affected. Erroneous production reports submitted by each enterprise to the authority might also contribute to data incorrectness.

Table 8.3 Production of Municipalities

(Unit: million pesos)

Municipality	1999	2000	2001
Plaza de la Revolucion	296	172	161
Centro Habana	141	155	162
La Habana Vieja	417	281	196
Regla	324	499	562
La Habana del Este	98	93	106
Guanabacoa	98	134	119
San Miguel del Padron	104	107	93
Diez de Octubre	151	198	151
Cerro	264	259	272
Arroyo Naranjo	107	118	138
Total	2,002	2,013	1,959

Note: All data ara production within municipality.
Source: Havana City Territorial Office of Statistics

(1) Plaza de la Revolución

This municipality is politically important because of concentration of governmental functions. In terms of industrial activities, the production is medium among the 10 municipalities. Metallurgy industry and production of motor and turbine are noticeable (Table 8.4). Some industry has a positive production in 2000 and zero production in 2001, or vice versa. One of the reasons is that state economic planning decides the production of a particular industry based on the economic situation. Erroneous production reports may also explain this phenomenon.

Table 8.4 Production of Plaza de la Revolución

(Thousand peso)

Industry	Year 2000	Year 2001
Ferrous metallurgy	20,300	
Production of motor and turbine	14,030	
Production of machine for metal works	3,010	
Production of technology machine and equipment	3,776	2,608
Production of construction machine and equipment		3,311
Production of professional equipment	5,114	
Production of other non-electric equipment and machine	740	
Repair and maintenance of vehicle	8,297	
Production of motorcycle and bicycle	2,624	3,862
Repair and maintenance of motorcycle and bicycle	475	378
Production of ship	301	3,952
Repair and maintenance of electronic equipment	588	329
Production of technical means for computer	1,053	
Production of furniture and principal accessory	1,097	602
Production of other metallic products	816	245
Production of pharmaceutical product	2,470	
Production of plastic article	1,539	
Production of paper, cardboard and paper pulp	3,133	
Printing	2,253	11,955
Production of wooden furniture	11,339	27
Production of asphalt product	1,150	
Production of refractory product	7	
Production of garment		429
Production of shoes		6,165
Construction	56,020	113,460
Others	31,380	13,522
Total	171,510	160,842

Source: Havana City Territorial Office of Statistics

(2) Centro Habana

The production size is medium among 10 municipalities. Fertilizer and pharmaceutical product occupy a considerable share of the production.

Table 8.5 Production of Centro Habana

(Thousand peso)

Industry	Year 2000	Year 2001
Electric energy	910	
Ferrous metallurgy	9,619	
Repair and maintenance of motor and turbine	1,300	1,163
Production of technology machine and equipment	1,625	3,399
Production of professional equipment	91	
Production of vehicle	132	99
Repair and maintenance of vehicle		3,381
Repair and maintenance of motorcycle and bicycle	235	149
Repair and maintenance of ship	5,511	
Repair and maintenance of equipment and industrial accessory		2,420
Repair and maintenance of industrial apparatus	184	
Production of furniture and principal accessory	686	989
Production of fertilizer	13,858	13,875
Production of painting, coloring and pigment	3,376	
Production of pharmaceutical product	15,100	14,979
Production of plastic article	7,174	
Printing		2,340
Production of wooden furniture	105	833
Stone cutting	343	
Production of concrete and prefabricated concrete piece	2,057	937
Production of refractory product	926	
Production of glass and glass product		1,787
Production of garment	696	1,163
Construction	68,371	105,819
Others	22,853	8,295
Total	155,151	161,629

Source: Havana City Territorial Office of Statistics

(3) La Habana Vieja

The production from 1999 to 2001 is the second biggest among 10 municipalities. This municipality has the oldest history of development. Thus, the economic activities include various manufacturing industries and commerce. A soap factory is one of large producers.

Table 8.6 Production of La Habana Vieja

(Thousand peso)

Industry	Year 2000	Year 2001
Electric energy	1,681	
Gas manufacturing	8,861	7,208
Ferrous metallurgy	2,672	
Motor and turbine	5,772	5,523
Production of technology machine and equipment	6,099	5,043
Production of vehicle	196	
Repair and maintenance of vehicle	67	18
Repair and maintenance of motorcycle		262
Production of machine and industrial apparatus		1,329
Production of electronic equipment	141	
Production of furniture and principal accessory	693	491
Production of metallic structure product	690	
Production of metallic structure product		66
Production of soap and perfume	23,550	
Production of pharmaceutical product	10,246	5,698
Printing	16,313	2,834
Production of wooden container	4,945	
Production of wooden furniture	287	896
Stone cutting	8	
Production of concrete and prefabricated concrete piece	7,820	
Production of glass and glass product	74	
Production of garment		4,210
Tanning of hide	5,599	
Production of shoes	5,012	6,270
Production of other leather goods		5,463
Construction	72,412	132,986
Others	107,592	17,860
Total	280,730	196,157

Source: Havana City Territorial Office of Statistics

(4) Regla

The industrial production is the biggest among the 10 municipalities. Oil refinery is the largest industry. Various heavy and light industries also exist.

Table 8.7 Production of Regla

(Thousand peso)

Industry	Year 2000	Year 2001
Oil refinery	354,517	419,310
Oil and lubricant		6,352
Ferrous metallurgy	14,695	
Production of ship		1,362
Repair and maintenance of ship		18,381
Production of metallic structure product	634	
Production of other metallic products	3,082	3,228
Production of soap and perfume	2,004	
Production of plastic article	29,836	
Printing	2,095	
Production of wooden furniture	409	
Production of garment		967
Production of leather shoes		1,034
Construction	73,372	101,951
Others	18,201	9,214
Total	498,844	561,798

Source: Havana City Territorial Office of Statistics

(5) La Habana del Este

The production size is relatively small among 10 municipalities. Metallic structure product and vehicle stand out in the production data. Tourism also accounts for considerable part of production.

Table 8.8 Production of La Habana del Este

(Thousand peso)

Industry	Year 2000	Year 2001
Ferrous metallurgy	2,672	
Production of technology machine and equipment	4,881	
Production of vehicle	9,468	9,604
Production of technical means for computer		4,678
Production of furniture and principal accessory	83	78
Production of metallic structure product	1,022	11,566
Production of soap and perfume		6,794
Production of veterinary product	4,414	179
Production of plastic article	4,793	4,986
Production of paper, cardboard and paper pulp	118	
Printing	569	
Production of wooden furniture	4,922	1,288
Stone cutting	1,053	
Production of concrete and prefabricated concrete piece	848	1,176
Production of refractory product	2,002	411
Production of lacework		620
Production of garment		1,350
Production of leather shoes	4,313	4,817
Construction	16,728	46,675
Others	34,740	11,325
Total	92,627	105,544

Source: Havana City Territorial Office of Statistics

(6) Guanabacoa

The production size is relatively small among 10 municipalities. Metallurgy and its related production characterize the industrial activity of this municipality.

Table 8.9 Production of Guanabacoa

(Thousand peso)

Industry	Year 2000	Year 2001
Ferrous metallurgy	30,455	3,653
Non-ferrous metallurgy	11,535	
Production of machine for metal works	2,464	2,636
Production of technology machine and equipment	2,354	6,054
Production of other non-electric equipment and machine	3,064	657
Production of vehicle	2,221	2,228
Repair and maintenance of vehicle	2,262	
Production of ship	315	
Repair and maintenance of equipment and industrial accessory	4,371	
Production of general hardware		13,943
Production of metallic structure product	5,903	16,307
Production of other metallic products	717	1,346
Basi inorganic chemical	2,319	8,960
Production of technical means for computer		225
Production of tire and tube	4,682	2,692
Production of plastic article	1,040	1,155
Production of wooden furniture	668	1,026
Stone cutting	8,277	6,705
Production of concrete and prefabricated concrete piece	4,068	2,665
Production of yarn and textile	4,522	1,043
Production of lacework		2,532
Production of garment	1,236	2,095
Production of leather shoes		3,684
Construction	24,174	30,611
Others	16,949	8,696
Total	133,596	118,913

Source: Havana City Territorial Office of Statistics

(7) San Miguel del Padrón

The production size in 2001 is the smallest among 10 municipalities. A major weight of production comes from relatively high-tech industries such as computer related ones.

Table 8.10 Production of San Miguel del Padrón

(Thousand peso)

Industry	Year 2000	Year 2001
Ferrous metallurgy	1,870	
Non-ferrous metallurgy		2,027
Production of machine for metal works		3,859
Production of technology machine and equipment	11,243	7,919
Repair and maintenance of construction machine and equipment		1,512
Production of other non-electric equipment and machine	634	
Production of vehicle		15,088
Production of electronic equipment	4,870	
Production of technical means for computer	12,945	
Production of general hardware	3,481	3,590
Production of furniture and principal accessory	694	1,821
Production of metallic structure product	605	
Production of other metallic products	3,430	3,004
Production of soap and perfume	8,645	
Production of tire and tube		1,368
Production of plastic article		2,498
Printing	8,954	
Production of wooden container	6,112	1,380
Production of door and window	528	522
Production of wooden furniture		1,185
Production of concrete and prefabricated concrete piece		6,593
Production of refractory product	39	
Production of garment		270
Construction	16,172	25,611
Others	26,666	14,255
Total	106,891	92,502

Source: Havana City Territorial Office of Statistics

(8) Diez de Octubre

The production size is medium among 10 municipalities. Machinery, tires, and printing stand out among industrial productions.

Table 8.11 Production of Diez de Octubre

(Thousand peso)

Industry	Year 2000	Year 2001
Electric energy	12	
Ferrous metallurgy	8,518	
Repair and maintenance of motor and turbine	4,626	1,113
Production of technology machine and equipment	17,270	20,852
Repair and maintenance of construction machine and		544
Production of professional equipment		440
Production of vehicle		1,378
Production of motorcycle and bicycle	3,764	9,602
Repair and maintenance of motorcycle	246	76
Production of machine and industrial apparatus		1,299
Production of furniture and principal accessory	721	360
Production of metallic structure product	708	167
Production of other metallic products	6,121	4,184
Production of painting, coloring and pigment		1,247
Production of soap and perfume	823	
Production of pharmaceutical product	880	
Production of veterinary product	5,563	
Production of tire and tube	27,530	
Production of plastic article	452	72
Printing	25,233	
Production of wooden container	8,925	3,759
Production of door and window	1,274	1,310
Production of wooden furniture	1,330	1,141
Stone cutting	2,214	
Production of concrete and prefabricated concrete piece	7,271	135
Production of lacework	552	1,302
Production of garment		998
Construction	62,501	96,127
Others	11,009	5,030
Total	197,543	151,136

Source: Havana City Territorial Office of Statistics

(9) Cerro

The production of 2001 is the second biggest among 10 municipalities. This municipality is one of the oldest among the 10 municipalities. The range of industrial products produced here is quite wide. Soap and perfume product, pharmaceutical product, and vehicle related product stand out.

Table 8.12 Production of Cerro

(Thousand peso)

Industry	Year 2000	Year 2001
Electric energy	3,795	
Ferrous metallurgy	7,774	
Production of motor and turbine	1,059	
Motor and turbine	2,750	2,297
Production of technology machine and equipment	1,034	3,807
Production of construction machine and equipment	3,516	
Repair and maintenance of construction machine and equipment	16,182	
Production of professional equipment	5,346	1,821
Production of other non-electric equipment and machine	6,312	5,812
Production of vehicle	12,414	8,150
Repair and maintenance of vehicle	1,173	106
Repair and maintenance of motorcycle	379	548
Production of ship	234	
Repair and maintenance of equipment and industrial accessory		353
Repair and maintenance of electronic equipment	922	
Production of technical means for computer	1,530	
Production of furniture and principal accessory	2,028	2,133
Production of metallic structure product	3,214	1,869
Production of other metallic products	8,270	6,100
Production of painting, coloring and pigment		102
Production of soap and perfume		43,006
Production of pharmaceutical product	12,773	18,353
Production of veterinary product	3,045	
Production of tire and tube	1,399	2,749
Production of plastic article	192	721
Other chemical production	70	
Production of paper, cardboard and paper pulp		2,946
Printing	3,804	10,013
Production of wooden container	2,458	2,380
Production of door and window	1,651	2,047
Production of wooden furniture	1,734	2,927
Stone cutting	1,749	170
Production of concrete and prefabricated concrete piece	3,208	7,407
Production of refractory product	3,601	
Production of lacework		548
Production of garment	2,190	3,209
Production of shoes		173
Construction	111,844	127,192
Others	31,194	15,245
Total	258,840	272,182

Source: Havana City Territorial Office of Statistics

(10) Arroyo Naranjo

The production size is relatively small among 10 municipalities. Repair and maintenance of electronic equipment, production of metallic product, and production of asphalt product are the biggest industrial activities among others.

Table 8.13 Production of Arroyo Naranjo

(Thousand peso)

Industry	Year 2000	Year 2001
Ferrous metallurgy	5,878	
Production of vehicle	4,023	
Production of technology machine and equipment	1,592	
Repair and maintenance of vehicle		163
Production of machine and industrial apparatus	834	1,165
Repair and maintenance of equipment and industrial accessory	3,038	
Production of machine and industrial apparatus	3,035	2,408
Repair and maintenance of electronic equipment		14,221
Production of general hardware	8,253	
Production of furniture and principal accessory		17
Production of metallic structure product		16,111
Production of other metallic products	453	81
Production of pharmaceutical product	3,739	
Production of tire and tube	7,793	
Production of plastic article	1,116	
Production of asphalt product	16,726	
Production of concrete and prefabricated concrete piece	2,009	6,940
Production of refractory product	1,211	929
Production of garment		289
Construction	39,307	85,262
Others	18,601	10,245
Total	117,609	137,830

Source: Havana City Territorial Office of Statistics

8.3 INRH (National Institute of Water Resources)

INRH is the Cuban organization responsible for nationwide water and wastewater management, which is also a key collaborator of this study. The financial data of INRH has not been made available to the Study Team.

8.4 WATER SUPPLY AND WASTEWATER CORPORATIONS

There exist three water and wastewater companies in the study area, which are Aguas de La Habana (Havana Water), Acueducto del Este (East water), and Acueducto Sur (South water). The distribution of population in each service area is summarized in Table 8.14. The five out of 10 municipalities included in the study area are served by Aguas de La Habana. Population-wise, these five municipalities account for about two thirds of total population in the study area. Acueducto del Este covers four municipalities and 29 percent of the population. The coverage of Acueducto Sur is marginal, accounting for one municipality and only four percent of the total population in the study area. The financial situations of the companies are analyzed in subsequent subchapters.

Table 8.14 Population Distribution and Service Coverage of Water Companies

Municipality	Population in Study Area	%	Water service provider
Plaza	18,702	2%	Aguas de La Habana
Centro Habana	69,860	9%	Aguas de La Habana
Habana Vieja	105,104	14%	Aguas de La Habana
10 de Octubre	212,988	28%	Aguas de La Habana
Cerro	97,317	13%	Aguas de La Habana
Regla	41,748	5%	Acueducto del Este
Habana del Este	15,293	2%	Acueducto del Este
Guanabacao	24,328	3%	Acueducto del Este
San Miguel	145,690	19%	Acueducto del Este
Arroyo Naranjo	31,007	4%	Acueducto Sur
Total	762,037	100%	

Source: Study Team

8.4.1 AGUAS DE LA HABANA (HAVANA WATER)

Aguas de La Habana (Havana water) is a Cuban-Spanish joint venture company, which was created in January 2000 and started the operation in April the same year. Prior to 2001, another state company under INRH provided water and sewerage service to the service area of Aguas de La Habana. The financial data of the company is only available from 2000. The financial status of Aguas de La Habana is presented in balance sheets (Table 8.15), income statements (Table 8.16), and application of funds (Table 8.17).

Table 8.15 Balance Sheets of Aguas de La Habana

	US$-denominated (US$ 000)			Peso-denominated (Peso 000)			Total (1peso:US$1*) (US$ 000)			Total (26peso:US$1**) (US$ 000)		
	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2002
Assets												
Fixed assets												
Information system	255	255	667			208	255	255	875	255	255	675
Property, plant and equipment	8,744	11,230	11,877	707	934	1,206	9,451	12,164	13,083	8,771	11,266	11,923
Construction work in progress	560	776		996	989	(53)	1,556	1,765	(53)	598	814	(2)
Accumulated depreciation	(499)	(1,588)	(2,772)	(55)	(165)	(295)	(554)	(1,753)	(3,067)	(501)	(1,594)	(2,783)
Total fixed assets	9,060	10,673	9,772	1,648	1,758	1,066	10,708	12,431	10,838	9,123	10,741	9,813
Inventories	2,910	3,640	3,292	1,697	1,202	1,044	4,607	4,842	4,336	2,975	3,686	3,332
Account receivables												
Clients	622	666	719	695	1,781	509	1,317	2,447	1,228	649	735	739
INRH	911	39	369	243	607	759	1,154	646	1,128	920	62	398
Receipt portfolio	1,747	1,700	1,920	7,269	5,098	4,194	9,016	6,798	6,114	2,027	1,896	2,081
Various debtors	2,093	2,907	586	1,516	5,797	3,171	3,609	8,704	3,757	2,151	3,130	708
Public administrations				343	712	563	343	712	563	13	27	22
Provisions	(12)	(48)	(343)	(322)	(543)	(844)	(334)	(591)	(1,187)	(24)	(69)	(375)
Total account receivables	5,361	5,264	3,251	9,744	13,452	8,352	15,105	18,716	11,603	5,736	5,781	3,572
Financial accounts												
Cash	1,470	378	417	1,632	6,157	3,284	3,102	6,535	3,701	1,533	615	543
Deposit	(43)	(15)	(177)	1	(30)	(230)	(42)	(45)	(407)	(43)	(16)	(186)
Total financial accounts	1,427	363	240	1,633	6,127	3,054	3,060	6,490	3,294	1,490	599	357
Total assets	18,758	19,940	16,555	14,722	22,539	13,516	33,480	42,479	30,071	19,324	20,807	17,075
Liabilities and equity												
Equity												
Capital	8,000	8,000	8,000				8,000	8,000	8,000	8,000	8,000	8,000
Reserves		11	19		1,442	2,179		1,453	2,198		66	103
Retained earnings	151	160	181	2,200	2,792	2,598	2,351	2,952	2,779	236	267	281
Total equity	8,151	8,171	8,200	2,200	4,234	4,777	10,351	12,405	12,977	8,236	8,334	8,384
Long-term liabilties	4,901	5,733	5,489				4,901	5,733	5,489	4,901	5,733	5,489
Current liabilties												
Other financial liablities	112	95	80	593			705	95	80	135	95	80
Debt to AGBAR Group	433	659	839	25			458	659	839	434	659	839
Creditors	4,810	4,759	1,163	8,993	7,753	3,657	13,803	12,512	4,820	5,156	5,057	1,304
Public administrations	125	33	26	347	23	293	472	56	319	138	34	37
Municipal creditors					2,243	2,785		2,243	2,785		86	107
Other creditors	226	490	758	2,564	8,286	2,004	2,790	8,776	2,762	325	809	835
Total current liabilities	5,706	6,036	2,866	12,522	18,305	8,739	18,228	24,341	11,605	6,188	6,740	3,202
Total liabilities and equity	18,758	19,940	16,555	14,722	22,539	13,516	33,480	42,479	30,071	19,324	20,807	17,075

* The official exchange rate that can be used for accounting purporses

** US$1 is convertible to 26 Cuban pesos which is the legal but unofficial rate only used for personal transaction.

Source: Aguas de La Habana

Table 8.16 Income Statements of Aguas de La Habana

	US$-denominated (US$ 000)			Peso-denominated (Peso 000)			Total (1peso:US$1*) (US$ 000)			Total (26peso:US$1**) (US$ 000)		
	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2002
Water supply												
Revenue from water supply	5,699	7,892	8,068	19,123	26,719	26,366	24,822	34,612	34,434	6,435	8,920	9,082
Materials and subcontracting cost	(717)	(1,302)	(983)	(1,232)	(1,599)	(2,917)	(1,949)	(2,901)	(3,900)	(764)	(1,363)	(1,095)
Direct personnel cost				(2,711)	(3,918)	(4,357)	(2,711)	(3,918)	(4,357)	(104)	(151)	(168)
Water purchase				(430)	(562)	(749)	(430)	(562)	(749)	(17)	(22)	(29)
Water pipe rent				(1,760)	(2,298)	(2,121)	(1,760)	(2,298)	(2,121)	(68)	(88)	(82)
Energy cost				(5,457)	(7,742)	(7,734)	(5,457)	(7,742)	(7,734)	(210)	(298)	(297)
Income from water supply	4,982	6,591	7,085	7,533	10,601	8,488	12,515	17,192	15,573	5,272	6,998	7,412
Sewerage												
Revenue from sewerage services	693	902	866	4,042	5,744	5,925	4,735	6,645	6,791	848	1,123	1,094
Materials and subcontracting cost	(131)	(248)	(238)	(215)	(744)	(652)	(346)	(992)	(890)	(139)	(276)	(263)
Direct personnel cost				(719)	(927)	(996)	(719)	(927)	(996)	(28)	(36)	(38)
sewer rent				(440)	(494)	(477)	(440)	(494)	(477)	(17)	(19)	(18)
Energy cost				(168)	(249)	(304)	(168)	(249)	(304)	(6)	(10)	(12)
Income from sewerage	562	654	629	2,500	3,329	3,496	3,062	3,983	4,124	658	782	763
Infrastructure construction												
Revenue	1,510	2,642	3,735	650	1,435	1,541	2,160	4,077	5,276	1,535	2,698	3,795
Construction materials	(1,255)	(2,461)	(3,522)	(565)	(1,320)	(1,399)	(1,820)	(3,781)	(4,922)	(1,277)	(2,512)	(3,576)
Income from infrastructure construction	255	182	213	85	115	142	340	293	355	258	186	218
Other activities												
Revenue	832	1,088	829	1,506	2,604	1,804	2,338	3,692	2,633	890	1,188	899
Expenses	(1,200)	(2,021)	(1,494)	(1,070)	(1,642)	(159)	(2,270)	(3,663)	(1,652)	(1,241)	(2,084)	(1,500)
Provision from INRH	534	651					534	651		534	651	
Income from other activities	166	(281)	(664)	436	962	1,645	602	680	981	183	(244)	(601)
Indirect activity												
Vehicle costs	(1,784)	(2,096)	(1,998)	(469)	(373)	(589)	(2,253)	(2,469)	(2,587)	(1,802)	(2,111)	(2,021)
Other indirect costs	(1)			(1,119)	(1,661)	(1,792)	(1,120)	(1,661)	(1,792)	(44)	(64)	(69)
Indirect activity costs	(1,785)	(2,096)	(1,998)	(1,588)	(2,034)	(2,381)	(3,373)	(4,130)	(4,379)	(1,846)	(2,174)	(2,090)
									0			
Income from operation activities	4,181	5,049	5,264	8,966	12,972	11,390	13,147	18,021	16,654	4,526	5,548	5,702
Administrative overheads												
Auxiliary revenues	15	70		22	72	0	37	142	0	16	72	0
Administrative personnel cost	(918)	(874)	(811)	(5,073)	(7,108)	(7,320)	(5,991)	(7,982)	(8,131)	(1,113)	(1,147)	(1,092)
General administration cost	(1,563)	(1,629)	(1,436)	(1,339)	(2,036)	(1,966)	(2,902)	(3,664)	(3,402)	(1,615)	(1,707)	(1,512)
Information system cost	(113)	(69)	(144)	(24)	(47)	(26)	(137)	(116)	(170)	(114)	(71)	(145)
Total administrative costs	(2,579)	(2,501)	(2,390)	(6,414)	(9,119)	(9,312)	(8,993)	(11,621)	(11,702)	(2,826)	(2,852)	(2,749)
Depreciation and provision	(511)	(1,120)	(1,544)	(377)	(331)	(580)	(888)	(1,452)	(2,124)	(526)	(1,133)	(1,566)
Financial costs	(232)	(548)	(401)	(21)	(2)	0	(253)	(550)	(401)	(233)	(548)	(401)
Technical assistance and extraordinary costs	(708)	(719)	(748)	46	(728)	1,100	(662)	(1,447)	352	(706)	(747)	(705)
Net income	151	160	181	2,200	2,792	2,598	2,351	2,952	2,778	236	267	280

* The official exchange rate that can be used for accounting purposes

** US$1 is convertible to 26 Cuban pesos which is the legal but unofficial rate only used for personal transaction.

Source: Aguas de La Habana

Table 8.17 Sources and Application of Funds of Aguas de La Habana

	US$-denominated (US$ 000)			Peso-denominated (Peso 000)			Total (1peso:US$1*) (US$ 000)			Total (26peso:US$1**) (US$ 000)		
	2000	2001	2002	2000	2001	2002	2000	2001	2002	2000	2001	2002
Sources of funds												
Depreciation	499	1,089	1,184	55	110	130	554	1,199	1,314	501	1,093	1,189
Operating profit	151	10	21	2,200	592		2,351	602	21	236	33	21
Borrowing by loan	4,901	832					4,901	832		4,901	832	
Capitalization and reserve	8,000	11	8		1,442	737	8,000	1,453	745	8,000	66	36
Decrease of construction work in progress			776			1,041			1,817			816
Total sources	13,551	1,942	1,989	2,255	2,144	1,908	15,806	4,086	3,897	13,638	2,024	2,062
Application of funds												
Increase of capital assets	(9,304)	(2,487)	(647)	(1,703)	(227)	(272)	(11,007)	(2,714)	(919)	(9,370)	(2,496)	(657)
Increase of information system	(255)		(412)			(208)	(255)		(620)	(255)		(420)
Increase of construction work in progress		(216)			6			(210)			(216)	
Decrease of long-term loan			(244)						(244)			(244)
Decrease of retained earnings						(194)			(194)			(7)
Total applications	(9,559)	(2,703)	(1,303)	(1,703)	(221)	(674)	(11,262)	(2,924)	(1,977)	(9,625)	(2,712)	(1,329)
Net sources/applications of funds	3,992	(761)	685	552	1,923	1,235	4,544	1,162	1,920	4,013	(687)	733
Increase (decrease) in working capital												
Increase in stocks	(2,910)	(730)		(1,697)			(4,607)	(730)		(2,975)	(730)	
Increase in accounts receivable	(5,373)	(855)	(603)	(10,066)	(6,100)	(152)	(15,439)	(6,955)	(755)	(5,760)	(1,090)	(609)
Increase in deposit	(1,470)	(28)	(39)	(1,633)	(2,552)		(3,103)	(2,580)	(39)	(1,533)	(126)	(39)
Increase in other assets		(5)						(5)			(5)	
Decrease in accounts payable		(159)	(3,617)		(2,182)	(10,379)		(2,341)	(13,996)		(243)	(4,016)
Decrease in cash	43	1,092	163		31	3,073	43	1,123	3,236	43	1,093	281
Decrease in stocks			348		495	158		495	506		19	354
Decrease in accounts receivable		957	2,611		419	5,252		1,376	7,863		973	2,813
Increase in accounts payable	5,706	489	447	12,522	7,966	813	18,228	8,455	1,260	6,188	795	478
Increase in insolvency provision	12		5	322			334		5	24		5
Change in working capital	(3,992)	761	(685)	(552)	(1,923)	(1,235)	(4,544)	(1,162)	(1,920)	(4,013)	687	(733)

*The official exchange rate that can be used for accounting purposes

**US$1 is convertible to 26 Cuban pesos which is the legal but unofficial rate only used for personal transaction.

Source: Aguas de La Habana

Aguas de La Habana is registered as a joint venture that can generate the revenues in two types of currency, US dollars and Cuban pesos. Customers who have US dollar revenue are charged their water bills in US dollar. Customers who have no US dollar earnings are simply charged their water bills in peso. Customers who have both US dollar and peso earnings are supposed to be charged proportionately to US dollar and peso ratio. The assets, liabilities, and equity are also divided into US$ and Cuban peso. There is no market-driven exchange rate between US$ and Cuban peso, however there is the official exchange rate of US$1 to 1 peso. There also exists a legal but unofficial exchange rate of US$1 to 26 pesos, which is only used for personal transaction and cannot be used for accounting purposes.

There were two important factors that adversely affected the revenue of the company. Firstly, the Ministry of Finances and Prices promulgated a ministerial instruction by which hard currency earning customers are allowed to pay a part of their bills in Cuban pesos. This instruction aimed to alleviate the shortage of hard currency that had been experienced by those hard currency earners. The effect of this instruction was stronger in the year 2001 and the number of hard currency earning customers who paid a part of water bills in pesos had increased. As Aguas de La Habana's dollar revenues were derived from those hard currency earners, the company's dollar revenue did not increase as much as planned. The second factor was that an increasing number of large users including hotel industry were taking water from their own wells instead of using the piped water of Aguas de La Habana. This tendency is continuing under the circumstances where the tourism industry is trying to save the operating expenses in response to the business downturn after the September 11 attacks.

Financial ratio analysis was made to measure the soundness of Aguas de La Habana. The five ratios computed were the return on assets (ROA), current ratio, debt to equity ratio, operating ratio, and debt service coverage ratio. Because of the dual currency nature of the company, each ratio was computed for both US$ and peso portions. To conveniently grasp the overall company's value, peso portions were converted to US$ portions by using the two different exchange rates. The five financial ratios were also computed for those combined figures. The results are summarized in Table 8.18.

Table 8.18 Key Financial Ratios of Aguas de La Habana

Indicator	Year	US$	Peso	Total (Ps1=US$1)*1	Total (Ps26=US$1)*2
Return on assets *3 (Overall profitability)	2001	0.2%	3.7%	1.9%	0.3%
	2002	0.2%	3.6%	1.9%	0.4%
Current ratio (Liquidity)	2001	0.9	1.1	1.0	0.9
	2002	1.2	1.3	1.3	1.2
Debt-to-equity ratio (Debt management)	2001	1.4	4.3	2.4	1.5
	2002	1.0	1.8	1.3	1.0
Operating ratio (Expenditure level)	2001	1.0	1.1	1.1	1.0
	2002	1.0	1.1	1.1	1.0
Debt service coverage ratio *4 (Cash flow)	2001	2.6	n.a.	8.7	2.9
	2002	2.8	n.a.	7.6	3.0

Notes:
*1: Conversion rate of US$1=1 peso is used.
*2: Conversion rate of US$1=26 pesos is used.
*3: Total assets are computed as simple average of beginning and ending balance of the year.
*4: Financial costs are regarded as interest payments.
Source: Calculated from data of Aguas de La Habana

(1) Return on assets

The return on assets (ROA) ratio shows how effectively the company is generating income given its asset base. ROA is defined as net income divided by total assets. This figure provides an indication of the ability to earn a reasonable return on all the assets. A higher ratio provides some indication of future growth prospects for water supply and sewerage operation. An ever-increasing ROA may not necessarily be a positive situation. And excessively high ROA ratio resulting from increasing net income may indicate that the company is charging its customers more than required to operate the system. If the ROA is higher because of decreasing total assets, it may indicate the company is not adequately investing in capital replacement from its net income. The required level of ROA varies depending on countries and times. Generally it should be between 2 to 10 percent. In the case of Aguas de La Habana, the ROAs are low in all currency bases. This is mainly due to the shortage of net income caused by the previously mentioned two factors (government price intervention and demand stagnation). Also it can be said that the water and sewerage rates are determined by INRH not to burden domestic customers, which means ROA cannot be so high because of the rate constraint. In a reverse side, the company received subsidies from INRH in 2000 and 2001 to compensate the lost revenue due to the government price instruction. Had it not been for this subsidy, the company would have a net loss. This price subsidy discontinued in 2002.

(2) Current ratio

The current ratio (current assets divided by current liabilities) has a positive effect on the health of the water company, because it is a rough indication of a company's ability to service its current obligations. The higher the current ratio, the greater the buffer between current obligations and a company's ability to meet those obligations. If ratios are very high over a sustained period of time, it may suggest that the company is not exercising the best use of cash or that water rates are artificially high. It is said that a viable water company should have a current ratio of at least 1.6. Aguas de La Habana's current ratio improved in 2002 but was still around 1.3 in all currencies, which means the company did not have enough cushion to meet current liabilities.

(3) Debt-to-equity ratio

The debt-to-equity ratio indicates the relative dependence of a company on debt and its ability to use additional credit without impairing its risk-bearing ability. The ratio of total debt to total equity has a negative effect on water system health. The higher the ratio, the larger the risk of financial difficulty. A company with a high debt-to-equity ratio often finds that creditors are reluctant to provide additional funds. A lower ratio indicates greater long-term financial safety. Debt-to-equity ratios should typically be between 2 and 3. Aguas de La Habana's debt-to-equity ratios in 2001 were 1.4 in the US$ account and 4.3 in the peso account. The ratios improved in 2002, becoming 1.0 in US$ and 1.8 in peso. This might indicate that the company would have a flexibility to borrow a fund both in US$ and peso.

(4) Operating ratio

The operating ratio (gross revenue divided by operating and maintenance expenses) is most significant to represent the level of expenditures. The operating ratio measures the costs and revenues associated with providing water and sewerage services. O/M costs include those expenses that arise from the sale, supply, and distribution of water, including general and administrative expenses. Depreciations are usually included as well. The higher the operating ratio, the higher the revenue over expenses. An operating ratio should be above 1.0 for a company to be self-supporting. Aguas de La Habana's operating ratios were above 1.0 by a narrow margin in all currencies, which can be viewed as the lowest level for a self-supporting company.

(5) Debt service coverage ratio

The debt service coverage ratio - i.e., cash flow (defined as net income plus depreciation) divided by principal repayment and interest expense – is an indicator of whether the company can cover its current debt obligations. To be financially sound, a water company must demonstrate the ability to generate sufficient revenue to cover current expenses plus the repayment of loans - i.e., the cash flow necessary to meet obligations and pay debt. By meeting its current and future capital needs, the system has the capacity to remain healthy and viable. If a debt service coverage ratio is less than one, the company does not generate sufficient cash to meet current principal and interest payments. Generally a debt service coverage ratio above 1.5 is adequate for water company health. Aguas de La Habana's debt service coverage ratios were high in 2002, being 7.6 under the Ps1:US$1 computation and 3.0 under the Ps26:US$1 computation. Those high levels of debt-to-equity ratios were correlated with the low debt-to equity ratios, meaning that the company had a capacity to borrow more funds and serve the debt.

8.4.2 ACUEDUCTO DEL ESTE (EAST WATER)

The main financial data of Acueducto del Este (East Water) is shown in Table 8.19. The company's peso revenue in 2001 was 10.6 million pesos, or about 30 percent of that of Aguas de La Habana. The profit before tax of peso portion was 0.963 million pesos, which was about one third of that of Aguas de La Habana.

Table 8.19 Main Financial Data of Acueducto del Este

(Peso 000)

	2000	2001
Tangible fixed assets	1,523	3,596
Accumulated depreciation of tangible fixed assets	939	1,136
Inventory	625	292
Net sales	7,022	10,579 *
Operation cost	6,426	9,624
Profit before tax	647	963
Income tax payable	226	376
Material costs	404	774
Salary and wages	1,876	3,221
Other labor costs	727	1,240
Of which: Employment tax	469	805
Depreciation and amortization	962	72
Other monetary costs	414	988

* Comprised of water (9682), sanitation (37), and other services (860)
Source: Computed from data of Havana City Territorial Office of Statistics

8.4.3 ACUEDUCTO SUR (SOUTH WATER)

The main financial data of Acueducto Sur (South Water) is shown in Table 8.20. The company's 8.252-million peso revenue in 2001 was about a quarter of that of Aguas de La Habana. The profit before tax of peso portion was 1.785 million peso that was about 60 percent of that of Aguas de La Habana.

Table 8.20 Main Financial Data of Acueducto Sur

(Peso 000)

	2000	2001
Tangible fixed assets	1,250	1,893
Accumulated depreciation of tangible fixed assets	1,117	1,292
Inventory	228	227
Net sales	5,466	8,252
Operation cost	4,648	6,626
Profit before tax	816	1,785
Income tax payable	271	640
Material costs	328	659
Salary and wages	1,470	2,573
Other labor costs	544	1,001
Of which: Employment tax	367	643
Depreciation and amortization	1,117	1,196
Other monetary costs	583	2,328

Source: Computed from data of Havana City Territorial Office of Statistics

8.5 USER CHARGES

8.5.1 WATER AND SEWERAGE TARIFF

In Cuba, utility tariffs are determined under state controlled pricing system where utility prices tend to be set lower than actual production or service cost. This is because utility service partly has social welfare character. Water and wastewater service prices are not exceptional. All water companies use a uniform water and sewerage tariff without regard to locational difference. The tariff comprises two parts in terms of currency. The first part is peso-denominated tariff (Table 8.21) that is applied to Cuban locals and peso earners. Those who are applied include most of domestic and industrial users who are ordinary Cubans and have little access to hard currency. The other part is US dollar-denominated tariff (Table 8.22) and applied to hard currency earners, including resident aliens, foreign company's branch in Cuba, and Cuban companies in tourism industry whose considerable part of revenues are hard currencies. The current tariff has been unchanged since its introduction in 1997 however, for Aguas de La Habana (Havana Water), a price tariff increase is scheduled to be approved in 2003. According to the plan, the increase rates will be approximately 20 percent.

Both in the peso-denominated tariff and in the US dollar-denominated tariff, volumetric rates are predominant. Some users are applied uniform volume rate, whereas others are applied progressive rate or volumetric rate with increasing-block schedule. For example, hotels are billed according to the number of rooms registered and actual consumption volume. Domestic users are also charged on the basis of volumetric rate with increasing-block schedule. Unmetered domestic users however are charged flat rate of 1 peso per person per month for water.

Sewerage charges are based on constant volumetric rate on water use. Thus, hotels that earn hard currency are charged 20 percent of water bill as sewerage bill, whereas most of other sewer users are charged 30 percent of water bill. Septic tank users are charged desludging fee according to track capacity and trip distance. If the exchange rate of 1 US dollar to 26 pesos is applied, the US dollar denominated tariff is 13 to 20 times as high as the peso-denominated tariff in case of rates for hotels.

Connection fees also differ between local customers and hard-currency earners. State entities classified as local customers pay 1000 pesos plus installation cost for both water connection and sewer connection. In case of local domestic users, connection fees of both water and sewerage are less than 50 pesos. Hard currency earners pay US$1000 plus installation cost for both water and sewer connection.

Table 8.21 Water and Sewerage Tariff for Cuban Locals and Peso Earners

State sector	Potable water	Hotel	< 500 liter / room / day		1.00 Peso / m3
			500 - 750 liter / room / day		1.25 Peso / m3
			751 - 1000 liter / room / day		1.50 Peso / m3
			1001 - 1250 liter / room / day		1.75 Peso / m3
			> 1250 liter / room / day		2.00 Peso / m3
		Commercial			1.20 Peso / m3
		Industry or other production processing	Within standard consumption volume		0.35 Peso / m3
			Above standard consumption volume		0.60 Peso / m3
		Consumer in water supply restriction area			Standard rate + 20% surcharge
		Consumer in agricultural area			0.30 Peso / m3
		Vessel	Supply in less than 12 hours		3.00 Peso / m3
			Supply in more than 12 hours		2.00 Peso / m3
		Connection fee to water supply system			1,000 Peso + installation cost
		Consumer supplied by water tank truck	Consumer's own truck		0.35 Peso / m3
			Water company's truck	Consumer within 10 km	5.00 Peso / m3
				Consumer within 10 - 20 km	10.00 Peso / m3
				Consumer outside 20 km	20.00 Peso / m3
	Non-potable water	Consumer served by pipe	Within standard consumption index		0.30 Peso / m3
			Above standard consumption index		0.40 Peso / m3
		Consumer supplied by his own water tank truck			0.30 Peso / m3
		Consumer in agricultural area			0.30 Peso / m3
	Sewerage	User served by sewer			30% of water bill
		Connection fee to sewer system			1,000 Peso + installation cost
		Septic tank user	Desludged by 4.5 m3 truck	User within 10 km	15.00 Peso / trip
				User within 10 - 20 km	17.00 Peso / trip
				User outside 20 km	20.00 Peso / trip
			Desludged by 4.5 - 6.5 m3 truck	User within 10 km	16.00 Peso / trip
				User within 10 - 20 km	18.00 Peso / trip
				User outside 20 km	21.00 Peso / trip
			Desludged by over 6.5 m3 truck	User within 10 km	22.00 Peso / trip
				User within 10 - 20 km	24.00 Peso / trip
				User outside 20 km	26.00 Peso / trip
Domestic sector	Potable water	Metered consumer	< 3 m3 / person / month		0.25 Peso / m3
			3 - 4.5 m3 / person / month		0.50 Peso / m3
			4.5 - 6 m3 / person / month		0.75 Peso / m3
			6 - 7.5 m3 / person / month		1.00 Peso / m3
			> 7.5 m3 / person / month		1.50 Peso / m3
		Unmetered consumer (for registered family members)			1.00 Peso / person / month
		Consumer supplied by water tank truck	Contingent service		Free
			Regular service		1.00 Peso / person / month
		Service pipe connection and meter installation fee		13 mm diameter	110.00 Peso
				18 mm diameter	152.00 Peso
				25 mm diameter	220.00 Peso
				> 25 mm diameter	Installation cost
	Sewerage	User served by sewer			0.30 Peso / person / month
		Septic tank user		User within 10 km	12.00 Peso / trip
				User within 10 - 20 km	14.00 Peso / trip
				User outside 20 km	17.00 Peso / trip

Table 8.22 Water and Sewerage Tariff for Foreigners and Hard Currency Earners

Water	Hotel	< 500 liter / room / day	0.50 US$ / m3
		500 - 750 liter / room / day	0.75 US$ / m3
		751 - 1000 liter / room / day	1.00 US$ / m3
		1001 - 1250 liter / room / day	1.25 US$ / m3
		> 1250 liter / room / day	1.50 US$ / m3
	Commercial		1.20 US$ / m3
	Industry or other production processing	Within standard consumption volume	0.35 US$ / m3
		Above standard consumption volume	0.60 US$ / m3
	Foreign consumers	Residence and embassies	1.00 US$ / m3
		Office and representatives	1.20 US$ / m3
	Watering for greenery area and golf course		0.25 US$ / m3
	Vessel	Supply in less than 12 hours	3.00 US$ / m3
		Supply in more than 12 hours	2.00 US$ / m3
	Consumer in water supply restriction area		Standard rate + 20% surcharge
	Connection fee to water supply system		1,000 US$ + installation cost
	Consumer supplied by water tank truck	Consumer's own truck	0.35 US$ / m3
		Water company's truck	2.50 US$ / m3
Sewerage	User served by sewer	Hotel, residence, embassy, commercial firm	20% of water bill
		Industry or other production processing	30% of water bill
	Connection fee to sewer system		1,000 US$ + installation cost
	Septic tank user		35.00 US$ / trip

8.5.2 BILLING AND COLLECTION

(1) Classification of Customers

The water companies in Cuba classify the customers into three types, namely the hard currency earner, the state entity, and the domestic user. Hard currency earners are the customers who gain income by mostly foreign currencies, including hotels, restaurants, foreign joint ventures, embassies, and non-Cuban residents. Hard currency earners are allowed to pay their bills in combination of US dollar and Cuban peso. The mixture ratio of two currencies is predetermined by the Ministry of Economy and Planning. State entities are mostly state companies and institutions that do not have access to hard currency income sources. Domestic users are usual Cuban households. Aguas de La Habana's customer information such as the number of accounts and billing amounts by customer category are summarized in Table 8.23.

Table 8.23 Customer Classification of Aguas de La Habana

Year	Classification	Hard currency earners	State entities	Domestic users	Total
2001	Number of customers	3,659	10,553	320,718	334,930
	Billing in US$ *	8,794,000			8,794,000
	Billing in peso *		16,574,000	15,888,000	32,462,000
2002	Number of customers	4,473	10,581	329,592	344,646
	Billing in US$ *	8,661,473			8,661,473
	Billing in peso *		15,688,140	16,064,000	31,752,140

* Billing includes water and sewerage.
Source: Aguas de La Habana

(2) Meter Reading, Billing and Collection Process

At Aguas de La Habana, meter reading is performed monthly by meter readers. Approximately 40 meter readers cover 50,000 meters installed. The meter readers visit customers by foot or motorcycle, depending on areas and customer types that are taken care of. In reading meters of some large consumers or primary consumers, handy computer terminal have been in use.

The meter penetration rate is 100 percent for the hard currency earning customers. Their meters have been replaced for last three years and all are functional. The meter penetration rate for large state entity users is also high. Those meters installed at large state entity users are also functional, but some smaller users do not have functional meters, in which case meters are not read.

Meters are installed at most of the domestic users, meters, however the performances of many meters are unreliable due to mechanical defectiveness or agedness. If the meter of a domestic user is not functional, the user is charged flat rate, which is merely 1 peso per registered family member. It is said that there exist a number of illegal water use drawn from the flat rate connections.

Each meter reader carries a record book in which data read or illegibility of meter are manually recorded on customer meter site. Meter readers post the record of meter reading from the record book to customer slips. The customer slips are sent to the Billing Division of the Sales Department for data processing. After the data processing and data validation, bills are printed out. Printed bills are directly delivered by meter readers.

Domestic customers can pay the bills either at commercial offices or directly to meter readers who deliver the bills. Direct payment from bank account is also available for prime customers such as hard currency earning customers and large users.

CHAPTER 9
ENVIRONMENTAL EDUCATION PROGRAMS

9.1 GENERAL

Cuba places great importance on Environmental Education in the knowledge that major environmental problems have been caused by lack of environmental awareness and education. Law No. 81, Law of the Environment, includes education in its basic concepts and defines the term "Environmental Education" as follows:

"a continuous and permanent process forming an integral part of the education of all citizens, oriented so that through the acquisition of knowledge, development of habits, skills, attitudes, and the formation of values, relations among and between humans, and the rest of society and nature are harmonized to guide the orientation of economic, cultural and social processes toward sustainable development".

Through the Law, there is a National Environmental Information System, which among other objectives, guarantees all parties the information required to understand matters related to the environment.

CITMA has the responsibility to develop strategies of environmental education, and contribute to their implementation, promoting the execution of programs in all sectors of the economy and services, social groups and the public in general. For these purposes CITMA has established coordination with the Ministries of Education, Higher Education, and Culture, together with other state agencies and bodies and the media. This demonstrates the cross cutting nature of Environmental Education.

Instruments for the control and management of Environmental Management are:

- National strategy of Environmental Education
- Agreement with important sectors of the economy
- Development of environmental education programs in the territories
- Participation of the community in the solution to the problems
- Information policy of the environmental agency
- Perception studies

The objectives of the National Strategy for Environmental Education (1997) are:

- Strengthening of the institutional capacity
- Education and capacity building of human resources
- Introduce the environmental dimension in formal education
- Introduce the environmental dimension in the informal education process
- Development and strengthening of the availability and access to information
- Introduce the environmental dimension in the process of communication and publicity

It is the responsibility of all state agencies and bodies to promote and execute activities with their workers, social groups, and the population with which they interact to increase knowledge and awareness of environmental issues. Coordination with other Ministries, state agencies etc. is shown in Figure 9.1.

JAPAN INTERNATIONAL COOPERATION AGENCY

THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY

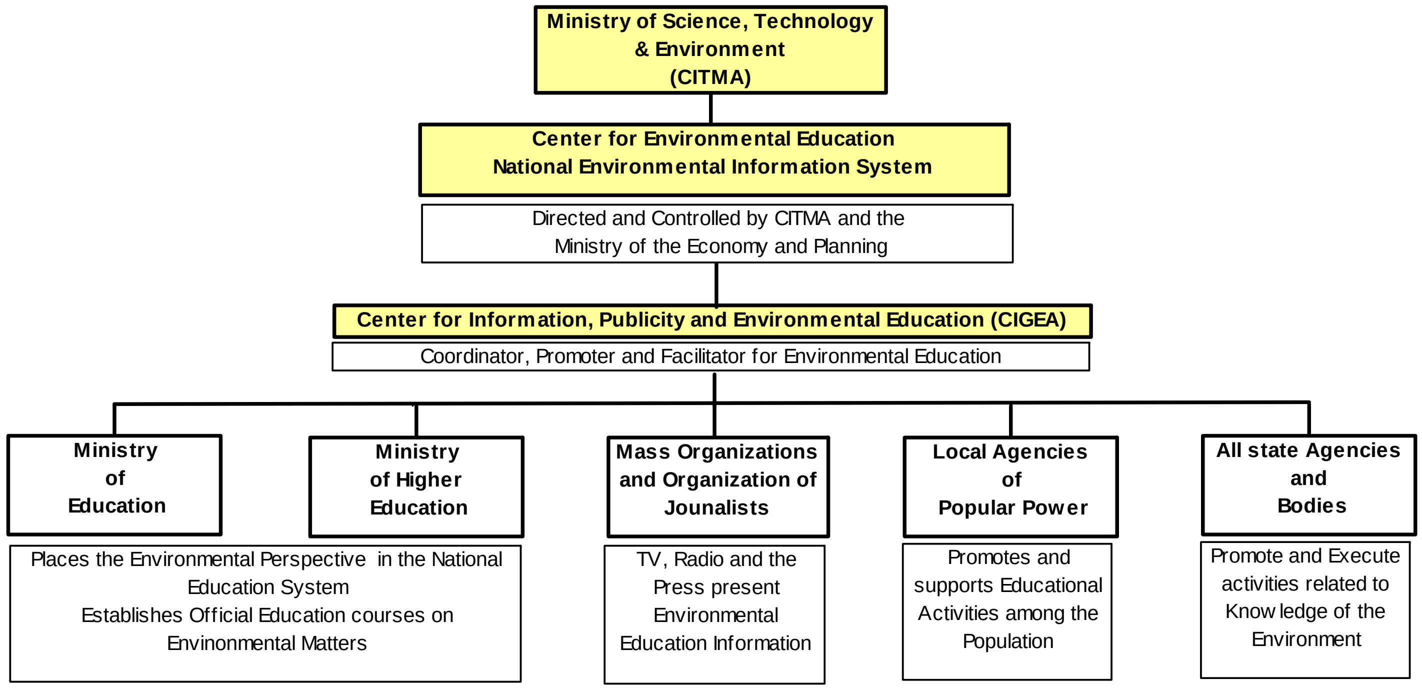


Figure 9.1
National Environmental Education system

9.2 CURRENT STATUS OF ENVIRONMENTAL EDUCATION IN CUBA

9.2.1 NATIONAL PROGRAMS

Cuba has a sophisticated framework of education in its National Environmental and Development Program, Environmental law, Environmental Strategy etc. Both the Center for Environmental Education and the Center for Information, Publicity and Environmental Education produce good quality information on environmental policy and Strategy.

The Ministry of Education has programs suitable for all levels of schools, and the mass media, particularly television, have been active in disseminating environmental education in special programs suitable for schools and the general public. Programs are regularly broadcast in the environmental section of the educational channel.

However, it is recognized that more needs to be done, and in the National Environmental Strategy, Second Issue, May 2000, the following requirements are recognized:

- To redirect and enhance education towards sustainable development. Conduct activities in a harmonious, systematic and coherent way, and involve every government organization and institution, social organizations and the whole population.
- To expand the development of environmental education activities entailing community involvement and to improve citizen’s awareness on sustainable development, using creatively the accumulated participative experience of the Cuban social project.
- To upgrade the role of mass media in accomplishing an integrated environmental education for the whole population and community involvement in resolving environmental problems.

9.2.2 PROGRAMS SUPPORTED BY INTERNATIONAL ORGANIZATIONS AND DONOR COUNTRIES

Several International Organizations and Donor Countries have ongoing grant projects with GTE. The Global Environmental Facility (GEF) under UNDP were active in environmental education during 1996/7 whilst preparing their document on “Planning and Management of Heavily Contaminated Bays and Coastal Areas in the Wider Caribbean; Final Report May 1998”.

GEF/GTE involved school children in a project that traced the life of Havana Bay from The time of Christopher Columbus to the present day, and looked at the environmental problems. UNDP will once again be involved in another project in the near future.

The Carl Duisberg Institute of Germany has a large training program for managers and technicians, and the German government is cooperating with Spanish institutions on environmental education. Canada is involved with the Urban Institute in the design of a communications program and environmental education.

Belgium has a project for urban solid waste management, which includes environmental education, and they will also be involved in the construction of a wastewater treatment plant. They also plan to create an Environmental Education Information Center at the existing offices of GTE, and a diagnostic unit.

Italy is providing a grant for cleaning up the Luyano River, construction of an emergency plant to retain floating solids, and treatment of river water. The project includes an environment diagnostic unit for the health sector, and results are being evaluated.

9.3 PROPOSED ENVIRONMENTAL EDUCATION PROGRAM

9.3.1 GENERAL

The subject of environmental education was first discussed with the GTE management and the study team counterparts to ensure no duplication of effort since other international and donor countries include some form of education in there programs.

GTE have some funds in their budget for environmental education and they have a small team of experts. It was acknowledged that the population in general does not have information on the problem of pollution of the Bay and on the importance of drainage and sewerage. They know little of the work being carried out by GTE, and have limited access to the Bay because of the industrial and commercial activities surrounding the Bay.

GET are not only involved in the clean up of the Bay, but also in the renovation, restoration and future planning of the shoreline, involving physical planning of the port, shipping activities in consideration of environmental issues. It is envisaged that zoning will take place for commercial, industrial, shipping and institutional use of the bay frontage, and that future plans will include better access for the public and tourists to the proposed shops and restaurants etc. that will form part of the waterfront.

Some environmental activities have been carried out by GTE, posters and an information leaflet have been produced, but there is no specific program to raise awareness of the problem of pollution to the bay.

It was agreed that this program should target children and youth, the general population and the agencies of INRH directly involved with Bay, the rivers, the drainage and the sewerage systems. It was further agreed that the CITMA National Environment Strategy (1997), the CITMA National Program for Environment and Development (1995), and in particular the CITMA National Strategy for Environmental Education (1997), produced in collaboration with UNESCO, would be followed. The Ministry of Education and the Mass Media (Television, radio and the Journalists Association) would be involved in the program.

9.3.2 PROPOSED ENVIRONMENTAL EDUCATION PROGRAM

(1) Study Approach

In addition to providing technical solutions, this program will promote Environmental Education as a tool to reduce pollution.

(2) Public Relations

Public Relations is an important activity to promote public awareness, hence this study includes an environmental education program to promote public awareness and concerns with the Havana Bay clean up activities.

(3) Objectives

The objectives of the program are:

- To publicize the problem of pollution to Havana Bay and create awareness of the work being carried out by GTE to clean up Havana Bay
- To educate people on the pollution caused to Havana Bay by the sewerage system, drainage, rivers, and industry
- To promote participation by agencies, institutions, children and youth, and citizens in general in the campaign to clean up Havana Bay

(4) Participants

The participants to the program will be:

- GTE Havana Bay in cooperation with the JICA Study Team
- INRH and CITMA
- Ministry of Education
- Directorate of Provincial Education
- Directorate of Municipal Education
- National Television and Radio, and the Journalists Association
- NGO ProNatureleza

(5) Beneficiaries

- Children and Youth
- Citizens in General
- INRH: (DPRH,EAH, Mixed Company Aguas de la Habana, Water supply and Sanitation Company of East Havana)

(6) Program for Children and Youth

The program for children and youth will be carried out under the Ministry of Education in cooperation with the directorates of Provincial and Municipal Education. Four schools have been chosen to participate, one primary and one secondary school in the municipalities of Havana Vieja and San Miguel del Padron.

Havana Vieja municipality was chosen because it borders on the bay where twenty of the industries are located, and San Miguel del Padron because this municipality is bordered by the rivers Luyano and Martin Perez.

The schools have been visited by representatives of GTE/JICA Study Team, together with Environmental Specialists from the Ministry of Education and the Directorate of Municipal Education. These schools are typical of schools in general in Cuba are well equipped with computers, television sets and video recorders.

Awareness of the importance of the environment is already very high in the schools since the environment is included in the curriculum and national television broadcasts environmental programs for schools on its education channel. All of the schools showed work that had been done on previous environmental projects and were briefed on the specific project to be carried out for Havana Bay.

All schools will have a special environmental group assigned to the project, and the program will commence with visits to the bay and feeder rivers, followed by the provision of educational material in the form of an information leaflet and poster. A specially produced video will be provided on the pollution problem of Havana Bay. The children and youth will produce paintings, drawings, essays and poems to depict the pollution problem, and will attempt to provide solutions.

The program will end with a festival near the bay, where the work done by the schools will be displayed for the benefit of other children and youth, and citizens in general. Special T-Shirts and caps will be provided bearing the logo of the project to promote the work being carried out by GTE in cooperation with the JICA Study Team.

(7) Program for Citizens in general

The program for citizens in general will use the National Mass Media system, for broadcasting on radio and the screening of the special video on Havana Bay on the national education channel. GTE will hold a press conference with the group of scientific, technical and environmental journalists in the Journalists Association to give information on the program, and they will be updated as the program proceeds. The press will therefore be fully and continuously briefed on the project.

The information leaflet and poster will also be made available, and the general public will have the opportunity of visiting the festival of art by the children and youth, further raising the awareness of GTE and the clean up of Havana Bay.

(8) Program for INRH Agencies

GTE/JICA Study Team have already met with CIGEA and the Ministry of Education for a briefing on the requirements of the institutional program. CIGEA and the Ministry of Education described their roles in the production of environmental material and the dissemination of information. It was clear that both are experienced and equipped to assist with this program.

Specific information will be provided by GTE/JICA Study Team and it is anticipated that premises will be made available for workshops at the university in Arroyo Naranjo and at the Jose Verona University. Participants for the workshops will be selected from DPRH, EAH, Mixed Company Aguas de la Habana and the Water Supply and Sewerage Company of Havana East.

Participants will receive environmental education material and will be instructed on the problem of pollution to Havana Bay. On completion of the course, the participants will be expected to disseminate the information to their colleagues at the work place.

(9) Educational Material

The following education material will be produced

GTE/JICA Study Team will provide material specific to the pollution problem of Havana Bay, from information already available to GTE and from the Progress Report to be produced by the JICA Study Team at the end of Phase 1 of the Study.

An identifier (Logo), a leaflet for children, a leaflet for adults, and a poster have already been produced and are being put forward for comment and approval. The artwork was carried out by SAF Design Group from information provided by GTE/JICA Study Team.

A proposal for the production of a video on the problem of pollution to Havana Bay has been received from the NGO ProNaturaleza, based on information provided by GTE/JICA Study Team. ProNaturaleza may also produce a radio program.

The Ministry of Education can provide general environmental education material and CIGEA have environmental education material on the water and sewerage sector. They can produce specific material on Havana Bay on CD from information provided by GTE/JICA Study Team.

(10) Output

Environmental education is a continuous process and the output from this program will be educational material will be available for all children and youth in the City of Havana. The education authorities have the capacity and the schools have the equipment to continue this program throughout the city.

The education material produced for the INRH agencies will be available for use with other government agencies and institutions, and may be used for education of the staff and workers in the Industrial Sector in the City of Havana.

9.3.3 IMPLEMENTATION PLAN OF THE ENVIRONMENTAL EDUCATION PROGRAM

The Implementation Plan is in three parts. The initial preparation of the program being from July to September 2002, followed by more detailed preparation by the JICA Study Team counterparts to the end of the year. Execution of the program will take place from January to March 2003.

Full details of the proposed implementation program are shown in Figure 9.2.

JAPAN INTERNATIONAL COOPERATION AGENCY

THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY

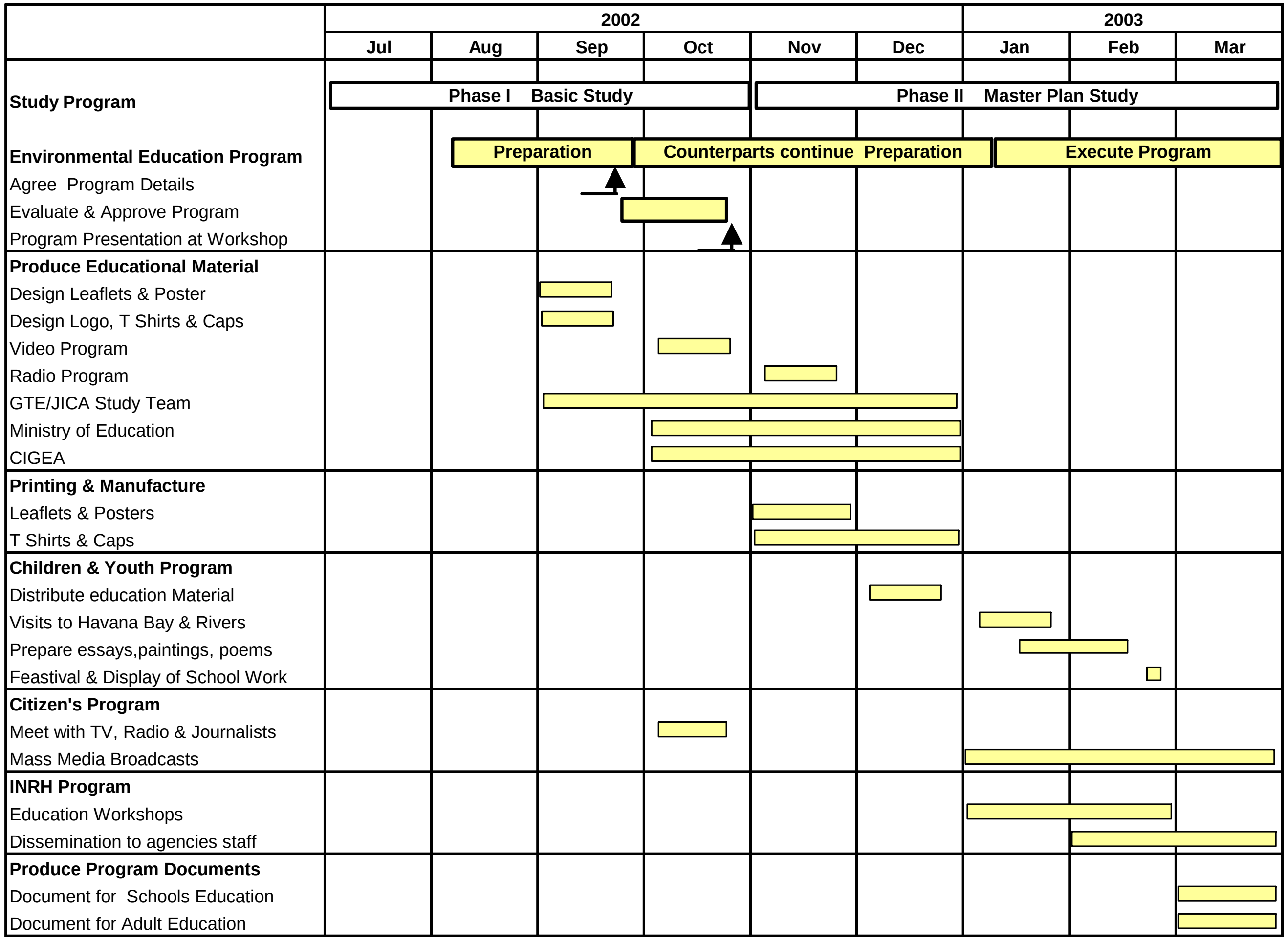


Figure 9.2 Implementation Plan - Environmental Education Plan

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9.4 EVALUATION OF EXECUTED ENVIRONMENTAL EDUCTATION PROGRAMS

9.4.1 EXECUTED ENVIRONMENTAL EDUCATION PROGRAMS

(1) General

The execution of the program generally followed the original proposal in terms of the three separate programs for Children and Youth, Citizens in general and the INRH Agencies directly involved with the Bay, the rivers, the drainage and the sewerage system. However, the involvement of CIGEA and the Ministry of Education at national, provincial and municipal level was only at the initial program planning meetings, and they did not take part in the activities as originally envisaged. In addition there was no contact with the Journalists Association pending completion of the video and radio programs.

(2) Overall Execution of the program

Due to staffing problems at GTE there was no counterpart available during the period October-December 2002. Hence, the video and radio programs were not progressed, and no further education material was produced. In addition the manufacture and printing of leaflets, posters and T shirts was not progressed in accordance with the Implementation Plan shown in Figure 9.2.

Preparation of the above mentioned items took place during January and the first half of February 2003, allowing implementation of the schools and INRH program to commence in the second half of February.

In order to assist with implementation, GTE suggested the appointment of a facilitator with the necessary communication skills to develop the methodology for implementation of the schools and INRH programs**,** and to report on the conclusions of the initial workshops. Due to the production time required for the video and radio programs for the citizens program these would only be available by early March. A detailed implementation program is shown in Figure 9.3.

(3) Objectives

The objectives of the program, as detailed in section 9.3.2 (3), being to publicize the problem of pollution, create awareness, educate people on the causes of pollution and to promote participation in the campaign to clean up Havana Bay have been partially met and more will be achieved as implementation progresses.

(4) Participants

Revised details of participants are as follows:

GTE in cooperation with the JICA Study Team
INRH (services of a counterpart for the INRH/DPRH program)
CITMA (attendance at planning meeting & provision of education material)
Ministry of Education (attendance at planning meetings)
Provincial/Municipal Education (attendance at planning meetings)
NGO ProNaturaleza (production of video & radio programs)
SAF Designer Group (graphic design of Logo, Leaflets, posters, T shirts & caps)
Facilitator (methodology, implementation & reporting on workshops)

(5) Beneficiaries

The actual beneficiaries to date were:

Children & Youth (Primary and Secondary schools in the Study Area)
INRH (DPRH, EAH, all Havana Water and Sewerage Enterprises)

(6) Program for Children & Youth

The following schools had previously been selected for the initial program:

Havana Vieja Angela Landa Primary School and Jinete Chullima Secondary school

San Miguel del Padron Caridad Gonzalez Venegas Primary School and 12th de Septiembre Secondary School

The program commenced for the schools in the municipality of Havana Vieja on 18th and 19th February. Two groups were chosen at each school, one belonging to an existing environmental, cultural and historical group, the other with less experience. To test the level of awareness of both groups to the environmental problems of the bay, the facilitator questioned the pupils and asked then to produce a picture of their impression of the bay. Generally, the groups chose solid waste and oil leaking from ships as the major source of pollution, and a source of danger to the fish.

The leaflets and posters were then produced and circulated which immediately revised the opinions of the pupils to include sewage, drainage and industry in their list of pollutants. The pupils agreed that the leaflets and posters were very attractive and informative and proposed various ways for schools to assist with the prevention of pollution to the Bay. Pupils were then given T shirts and caps specially designed for the program as a further means of publicizing the pollution problem. The facilitator will prepare a full report on the proceedings.

The activities continued with further work at the schools on their impressions of the environmental problem of the Bay, followed by visits by the schools to Havana Bay and the sources of pollution on 28th February.

As a finale to the initial schools program, a Festival was held at the Centro Estudiantil, Jose de la Luz y Caballero in Habana Vieja on Saturday 1st March at which selected material prepared by the schools was displayed, and drawings were prepared by the pupils during the event.

The Festival commenced at 10.00am with welcoming speeches from the President of GTE, the

JICA representative in Cuba and the principal of Jose de la Luz y Caballero in Habana Vieja. The drawing competition then commenced for the school children.

In addition to the 100 children from the four participating schools in Habana Vieja and San Miguel del Padron, six children from the municipalities of 10th de Octubre, Regla, Habana del Este, and Centro Habana, also participated since it is planned to extend the program to other schools in the Ciudad de la Habana. Various other children from JICA, and GTE also took part in the competition bringing the number of participants to over 150.

Whilst the judges selected the best poems, essays and artwork from work previously prepared, and from the drawings prepared during the festival, the participants and guests were entertained by a cultural group from the centre. Prizes for the best work were then presented by an environmental education specialist from the Ministry of Education, and this very successful Festival closed at 1.30pm.

(7) Program for Citizens in general

Implementation of this program has not yet commenced. The NGO ProNaturaleza, was engaged to produced both the radio programs and video in consultation with GTE/JICA Study Team for location selection, script development and approval.

Three CD's for radio were to be produced with each CD containing two of a series of six environmental education programs and ten copies of each CD were ordered to allow the series to be broadcast on all the radio channels available to the Ciudad de Habana area. The series is scheduled to be broadcast commencing in March 2003 at 7.00 pm to attract a large family audience, by as many radio channels as possible. Each part will be broadcast once or twice a month and the whole series of programs will be completed in about a six month period.

Development of the 12 minute video commenced with meetings to agree primary information on the project and elaboration of the script for use on the National Television educational channel (and for use in schools which are equipped with VCR's and TV's). This was followed by approval of the script, and definitions of places and elements to use in the video. Shooting commenced on 31st January in close liaison with GTE/JICA Study Team and includes shots of the workshops for schools and INRH. After editing and post-production tasks were completed, the video was finalized in early March 2003.

(8) Program for INRH agencies

This program commenced with the facilitator preparing the methodology required and the activities to be carried out during the workshop. The workshop took place on 20th February in the conference room at EAH, the participants selected were a mixed group of engineers, technicians, and staff from the departments of personnel, public relations, commercial, information, and communications from the following organizations:

Aguas de la Habana	(2)
Acueducto del Este	(7)
Acueducto del Cotorro	(1)
Acueducto del Sur	(2)
DPRH	(2)
EAH	(8)

The participants were divided into two groups and two separate workshops were held, each of approximately one hour. The methodology adopted by the facilitator was first to split the group into two and ask one team to prepare a letter which Christopher Columbus would have written to the Queen of Spain when he first saw Havana Bay, and the other team if he saw it as it is today. The letters for the original sighting of the Bay generally described the beauty of the Bay and the abundance of birds and fishes, and the mythical sighting for today described the seriously contaminated environment.

The leaflet for adults was then handed out and the poster displayed. Discussions were then held regarding the problems and solutions to the pollution of the Bay. Some of the major issues raised were:

Direct discharge into the Bay by industry, and no action taken to enforce the law

Lack of attention by the authorities on solid waste removal

Lack of an adequate sewerage and drainage system

Government should take action against all polluters, both enterprises and individuals

Suitable tariffs should be charged for the various discharges of wastewater

Technical solutions take a great deal of time and money and must be accompanied by environmental education to ensure the success of such projects

Industry, ships and people lack awareness of the pollution problem they are creating

Lack of environmental education

Create awareness by publicity. Use television and radio, work with children

Environmental education material does exist, but it must be refined and circulated

The participants agreed that the leaflet provided good information on the responsibilities of GTE, and the poster provide good information on the pollution problem and the proposed solutions which are brief but to the point, and easy to read as the details are separated by attractive and informative graphics and pictures.

On conclusion of the workshop, in addition to the leaflets and posters, the participants were given T shirts and caps to further assist with the publicity of the program, and a document prepared by the JICA Study team on the general aspects of pollution to Havana Bay.

It was clear that the awareness of the participants had been raised and that the information provided would further enhance their understanding of the problem and serve as a tool to educate their fellow workers.

(9) Educational and Publicity Material

The material produced for this program was as follows:

Leaflets for children and youth	(5,000 copies)
Leaflets for adults	(5,000 copies)
Posters for general use	(5,000 copies)
T shirts for children and youth	(400 No.)
T shirts for Adults	(400No.)
Caps for children and youth	(200 No.)
Caps for adults	(200 No.)
Identifier (Logo) for use with the above	(Item)
A video for national TV and schools	(2 No. Originals + 30 copies)
A six part radio program	(3 No. CD's+ 10 copies each)
General information (JICA Study Team) (25 copies)	
General Information (CIGEA)	(1 Diskette)

Due to time constraints the only educational material used in the program to date has been the leaflets and poster. JICA study Team produced course material for the INRH (DPRH) adult program however this document was not discussed, but handed out to the participants at the end of the Workshop.

The document describes the general problem of pollution to Havana Bay, the institutions responsible for the water sector and environmental matters, the legal instruments available to protect the environment and details of other national and donor financed environmental educational programs.

9.4.2 OVERALL EVALUATION OF THE EXECUTED PROGRAMS

(1) General

A major constraint which had to be overcome was the relatively short time period over which the program was to be implemented, due to the preparation time lost between Phase I and Phase II of this study. In addition, the timing for implementation, which requires completion at Interim Report stage, did not make it possible to include the technical findings of the Master Plan in the education program.

Since the program is incomplete, it is not possible to give a full evaluation at this point in time. However, the objects of publicizing the problem of pollution to Havana Bay and creating awareness of the GTE clean up program on the pollution caused by the sewerage and drainage system, the rivers and industry were partially met by the brief schools and INRH programs

This program may be considered as the beginning of much longer program to be continued by GTE. It has put to the test the cooperation and coordination between the various entities as required by the Environmental Law (No. 81), and set out in the Environmental Strategy Document.

Actual implementation took place over a period of only two weeks. However, on the progress to date, the program is considered to be successful in terms of producing education material. The GTE/JICA Study Team, together with a graphical designer, producing high quality environmental education and publicity material specific to Havana Bay, in the form of leaflets, posters, T shirts and caps. The video and radio programs were produced for the citizens program but only became available at the end of the Master Plan study.

(2) Program for Children and Youth

The methodology adopted by the facilitator for the schools program proved to be very successful in establishing the awareness of two different groups (one experienced and the other not so experienced) and developing a high level of interest with the discussions and the leaflet and poster which were much admired by the pupils.

At the end of the hour long sessions, the pupils had learned much on several other reasons for pollution to the bay they had not thought about and were aware of the GTE program for cleaning up the bay.

The pupils already have many ideas on how to create awareness both inside and outside of the school and the leaflets and posters will reach their family and doubtless many more people in the their neighborhood. The Festival was very successful in bringing together pupils from all over the city to share their knowledge in a friendly competition.

(3) Program for Citizens in general

This program will be evaluated later during Phase III of this Study as the programs are expected to be ready by early March this year.

(4) Program for INRH Agencies

The methodology adopted for the workshops provoked lively debate and raised many issues regarding the main causes of pollution to the Bay, the possible solutions, the role and responsibilities of INRH, and the availability of information to create awareness and explain the pollution problems.

The responses gave clear indications of the concern over pollution by industry, shipping, rivers, sewers, drains and some sections of the public, indicating a possible lack of proper systems, no enforcement of the law, no punishment and no charges for polluters.

In addition, the workshop highlighted the fact that whereas some information did exist on the pollution of the bay it was not readily available for dissemination by the majority against a background of an urgent need to provide environmental education to the widest possible audience.

The point made at the workshop, that any technical solution must be accompanied by a strong environmental educational program must be noted and acted upon, and it was pleasing to observe that the leaflet and poster provided good basic information for what must be considered as the beginning of a sustainable adult education program.

9.4.3 RECOMMENDATIONS FOR FUTURE PROGRAMS

(1) General

Future programs would benefit from a much longer period both for preparation and implementation. Ideally, more time is needed for discussions, the logistics of getting the various parties together, obtaining the necessary approvals required for such items as the content of leaflets and posters, scripts for radio programs and video films, purchase and printing of education and publicity material etc. It should also be borne in mind that government officials and counterpart staff have other duties to perform and are not available on a full time basis as is the case for the study team.

Also, due to the timing of the program which was required to be complete at the same time as the Interim Report of the Master Plan Study, it was not possible to include the final technical information and solutions of the Master Plan to the problem of pollution to Havana Bay, in the environmental education material.

It may be better in future programs to plan and agree the education program during Phase I (Basic study), prepare the educational and publicity material and commence implementation during Phase II (Master Plan Study), allowing time during Phase III (Feasibility study) to complete the educational material from the Master Plan Report, and continue and complete the implementation program.

Environmental Education is considered by all to be a continuous process to sustain the raised level of awareness of the target groups to protect and improve the environment they live in.

This program was carefully planned to provide education and publicity material beyond the initial phase to enable GTE to continue all of the program. If finance is available, future programs could allow for some further funding to ensure the success of the continuation of the program over a one to two year period.

(2) Program for Children and Youth

It is recommended that the schools program continues as it is, under the general direction of GTE, but with the local education authorities and teachers replacing the facilitator.

This schools program can easily be extended to many more schools in Ciudad de la Habana using the same methodology. There are sufficient leaflets and posters for at least another 200 schools, and the report to be produce by the facilitator should be sufficient for the local education authorities and teachers to continue the program with minimal input from GTE.

(3) Program for Citizens in general

It is recommended that CIGEA be involved to ensure that the television and radio programs are properly coordinated through the Mass Organizations and Organization of Journalists (see Figure 8.1, National Environmental Educational System).

(4) Program for INRH Agencies

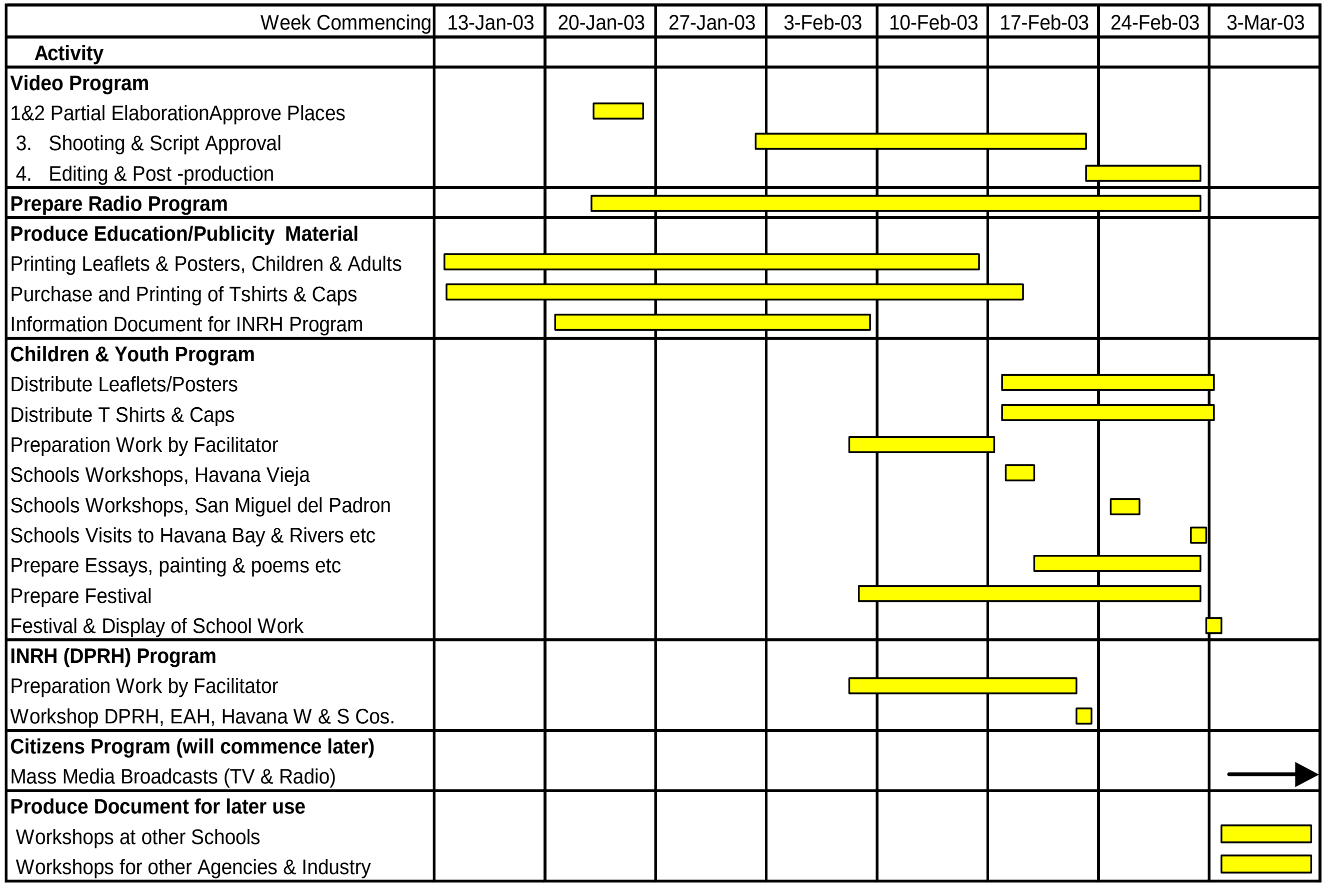
The workshops should be continued in basically the same format for more of the staff of DPRH, EAH and the four water and sewerage corporations of Havana. These workshops should also be extended to cover CITMA, CIMAB, CENHICA and all other ministries and enterprises associated with Havana Bay, as an introduction to the problem. It is also recommended that the workshops be extended to include personnel from the Factories around the bay.

It is further recommended that more environmental educational course material be developed and introduced at seminars to be held in addition to the introductory workshops. The initial course material handed out at the workshop only gives general information on the problem, the institutions involved and the laws on the environment.

It is suggested that the technical elements of the Master Plan are summarized to form a document which will detail among other things, the pollution load, the strategy of water pollution control and the sewerage system master plan to 2020. This can be done by GTE (in cooperation with the JICA study team if possible).

Participants at seminars should be carefully grouped in accordance with their profession and academic level; for example, executives, professional engineers, water quality experts, technicians, and workers from other disciplines. The requirements and depth of presentations at each seminar will need to be varied to suit each particular group.

CIGEA should be involved in the program to ensure that the National Environmental Strategy is followed in terms of Environmental Education and Dissemination.



JAPAN INTERNATIONAL COOPERATION AGENCY

THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY

Figure 9.3
Executed Environmental Education Programs

CHAPTER 10
STRATEGY FOR WATER POLLUTION CONTROL IN HAVANA BAY

10.1 GENERAL

10.1.1 EXISTING USES OF HAVANA BAY

Havana Bay, with its world heritage sites and important historical monuments located at its entrance, is an essential part of many important tourist attractions in the City of Havana. The bay forms part of the elegant view of El Morro and La Cabaña sited on the eastern and western sides of the bay's entrance channel.

The promenade along the entrance channel to Havana Bay and its continuation along Malecon is of indispensable value to citizens of Havana City (*Habaneros*) for its use as recreational area and also as an area for recreational fishing. It influences hearts and minds of every *Habanero*. The promenade along the entrance channel is also a dropping off and collection point for the hundreds of thousands of tourists who visit Havana City every year.

Aesthetic aspect of the entrance channel of Havana Bay has significant impact to the *Habaneros* and to the tourists.

Further, Havana Bay is one of the major industrial and commercial port of Cuba and also attracts luxury cruise liners sailing the Caribbean Sea with over a thousand ships arriving every year. Its contribution to the national economy is significant. Port of Havana Bay is also an important port in the wider Carribean sea.

In addition to serving as the shipping port for raw material and products for major industries along the coast of the bay, it also serves as a source of cooling water and finally as a receptor for their effluents. There are also many workshops along the coast of the bay for repair to ships etc.

The bay also serves as a transportation link between eastern and western parts of the Havana City. Commuters travel by passenger ship across the bay between two points on eastern side of the bay, namely Casa Blanca and Regla and one on western side of the bay namely Muelle de Luz.

Bay as part of the tourist attractions and as a major port has substantial role to the economy of Cuba. From the above, the need to protect the bay's environment to fulfill its role to the national economy cannot be overemphasized.

10.1.2 PERCEPTION OF EXISTING WATER ENVIRONMENT

To understand the 'public' perception of the water environment problems and their priority, a workshop was carried out in which the participants including the counterparts staff were from most of the stakeholder institutions of Havana Bay. An introduction of the bay's environment problems and its uses and on the participatory method for identifying and prioritizing the problems were provided prior to activities by the participants in two groups (a total of 24 participants and seven observers). From the results of the activity of the participants, the following can be concluded:

Major water environmental problems are:

- oil and grease (hydrocarbons)
- organic pollution

- eutrophication
- heavy metals
- bacterial pollution

And the main limitations identified are financing, inadequate laws and regulations and inadequate sewerage and drainage infrastructure.

10.1.3 FUTURE USES

When considering the future uses, existing uses described in the previous section still remain. A study by HINES-MITRANS envisaged to remodel the western coast of the bay from Sierra Maestra de San Francisco to Atares to construct several facilities such as hotels, convention centers, amphitheatre, port facilities for yachts etc. These uses will require improvement of water quality which remains deteriorated around Atares due to untreated wastewater discharges.

10.2 WATER ENVIRONMENT GOALS

10.2.1 FUTURE WATER ENVIRONMENT

Considering the enormous investment and time horizon required to implement the improvement of the sewerage and drainage infrastructure and in the absence of implementation plans for any additional uses of bay in the near future, it is prudent to limit the future water environment goals to protect against pollution which will impair the existing uses. The first step in the improvement of water environment of the bay is to prevent the progress of water pollution which will adversely affect the existing uses. Floating oil/grease in all parts of the bay and progressive pollution in the coves of Atares, Guasabacoa and Marimelena as evidenced by very low levels of dissolved oxygen, dark color of water (due to septicity) and accumulation of sediments will destroy the aesthetic quality and will hinder the port functions of the bay. For example, accumulation of sediment and garbage around the mouth of Arroyo Tadeo on the western coast of the bay hinder the ship movement to the workshops and industries located there.

10.2.2 WATER QUALITY GOALS

(1) Draft Coastal and Bay Water Quality Standards

A standard for water quality for bays and coastal areas is in the preparatory stage, namely "*Vertimiento De Aguas Residuales a Las Costas y Aguas Marinas - Especificaciones*", which classifies uses into six categories. Categories are as follows:

Class A - Coral reef areas, areas for ecological conservation or protected areas

Class B - Marine areas reserved for bathing and recreational activity where persons contact with water

Class C - Marine areas for fishery development

Class D - Marine areas where sea water is used as cooling water for power generation

Class E - Bay areas developed for port activity

Class F - Marine areas without specific use

Table 10.1 shows the environmental quality standards for the water bodies suitable for their functions in terms of dissolved oxygen and total coliform concentration. Port use of Havana Bay fits into the Class E water body.

Table 10.1 Draft Coastal and Bay Water Quality Standards

Parameter	Unit	Type Water Body				
		Class A	Class C	Class D	Class E	Class F
Dissolved oxygen (DO)	mg/L	5.0	5.0	4.0	3.0	2.0
Total coliforms	MPN/100 mL	100	250	250	1000	5000

Note: Standards for Class B are not available.

Figure 10.1 shows the existing DO levels in comparison with the classification of water bodies in the proposed standards.

Existing conditions as measured in this Study in year 2002 at coves of the bay, namely Atares, Guasabacoa and Marimelena, do not satisfy Class E water body. DO levels at Atares was below Class F and at Guasabacoa was Class F. At Marimelena, it varied between that of Class D and F. At Centro, it was between Class C and F and that at the Entrance Channel was between Class C and E.

There are no standards for oil/grease (or hydrocarbons) in a water body, except for effluent standard being specified for discharges to the water body. Draft effluent quality standards for oil/grease to Class E water body being 5 mg/L while that for a Class F water body being 50 mg/L. For reference the hydrocarbon concentration of refinery effluent was 42 mg/L in this Study and was 240 mg/L in year 1997 which are much higher than the draft standards for Class E water body.

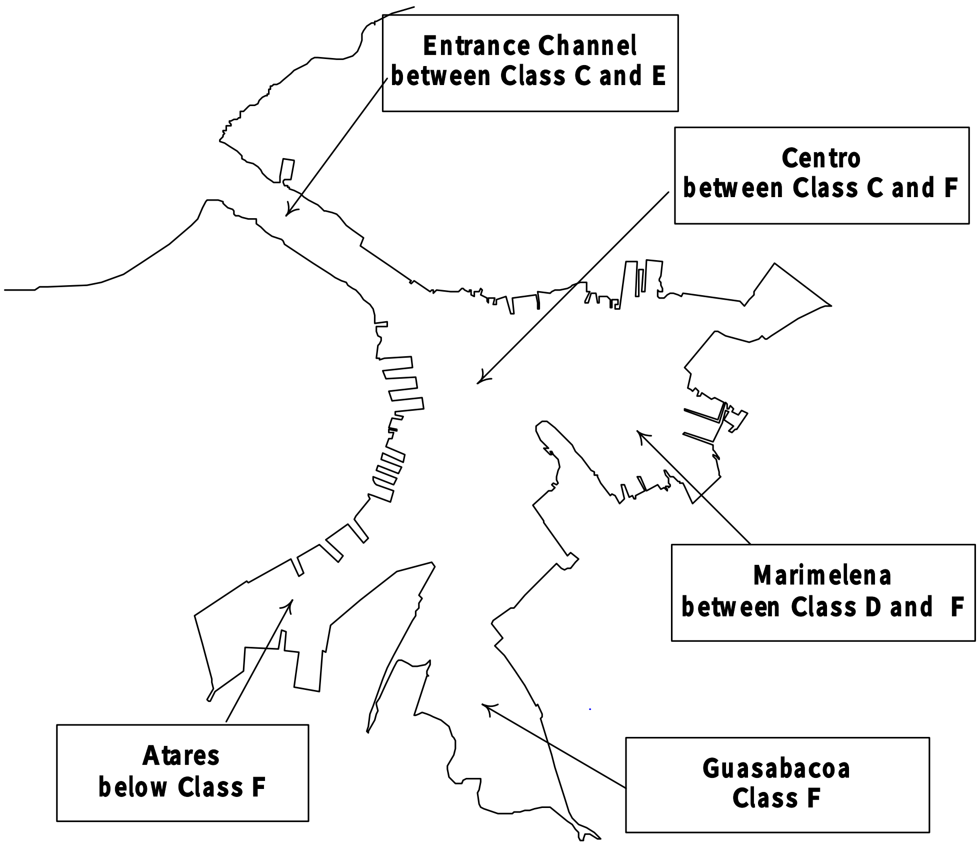
Achievement of the water quality for Class E water body still falls short in terms of oil/grease (hydrocarbon) pollution which affect the aesthetic quality of bay.

(2) Water Quality Goals

Water quality goals necessary for maintaining existing uses:

Goal 1 : To achieve the draft standards for Class E water body in terms of dissolved oxygen levels (3 mg/L)

Goal 2 : To achieve the draft effluent standards for discharge to Class E water body in terms of oil/grease (below 5 mg/L)



Note: Comparison is to the DO levels measured in this Study.

Draft Coastal and Bay Water Quality Standards

Parameter	Unit	Type Water Body				
		Class A	Class C	Class D	Class E	Class F
Dissolved oxygen (DO)	mg/L	5.0	5.0	4.0	3.0	2.0
Total coliforms	MPN/100 mL	100	250	250	1000	5000

Note: Standards for Class B are not available.

Class A - Coral reef areas, areas for ecological conservation or protected areas
Class B - Marine areas reserved for bathing and recreational activity where persons in direct contact with water
Class C - Marine areas for fishery development
Class D - Marine areas where sea water is used as cooling water for power generation
Class E - Bay areas developed for port activity
Class F - Marine areas without specific use

THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 10.1 Comparison of DO Levels in Havana Bay (Year 2002) to Draft Standards
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10.3 SCENARIO OF POLLUTION CONTROL

10.3.1 ROLE OF STAKEHOLDERS OR POLLUTERS

Table 10.2 shows the goals and key sectors in which action is required. An increase of dissolved oxygen levels will require that the organic pollution load to the bay be reduced and action is required to control sewerage, drainage and industrial wastewater. Industries and workshops along the coast of the bay and in the basin are required to take action to reduce oil/grease discharge to the bay.

Table 10.2 Goals and Responsibilities of Sector

Goal	Key Sector in which action required		
	Sewerage	Drainage	Industry
Increase dissolved oxygen level	O	O	O
Reduce floating oil, grease etc.			O

In addition, environmental education is required to increase the environmental awareness of the population and environmental monitoring to evaluate the progress and effectiveness of pollution control measures. The role of environmental monitoring is specifically important because of the deficiency of data on the pollution mechanism of the bay. It is obvious that achievement of the goals by the implementation of a sewerage/drainage system improvement alone is not feasible and concerted action of sewerage/drainage system and that of industry will be necessary to achieve tangible results. For example, the presence of an oil/grease film on the surface of the bay water will be detrimental to the transfer of atmospheric oxygen.

10.3.2 WASTEWATERS MANAGED BY SEWERAGE SCHEME

Wastewater treatment managed by sewerage schemess mainly remove organic matter and nutrients to some extent. Removal of oil/grease and other toxic materials such as heavy metals will not be possible and will hinder the functioning of wastewater treatment.

Wastewaters managed by sewerage scheme will be limited to domestic, commercial, and institutional wastewater together with industrial wastewater which complies with discharge standards to the public sewers. Large industrial wastewater, with special characteristics such as that of the refinery which will hinder the treatment together with other wastewater, needs to be treated separately. Further, industrial wastewater which does not comply with the discharge standards to public sewers should be treated by the industry itself prior to discharge to public sewers.

Wastewater treatment technology available to reduce organic pollution load is in two steps namely primary treatment and secondary treatment. The level of secondary treatment indicates the maximum amount of removal possible with the sewerage system.

10.3.3 INDUSTRIAL WASTEWATER

As discussed in the previous section, industrial wastewater treatment shall be the responsibility of industries and its acceptance to the sewerage scheme is on the precondition that they comply with the discharge standards to public sewers.

Further, in terms of the organic pollution load discharged to the bay, the industrial load remains equally as high as that discharged by sewerage/drainage and almost all of the discharged load is by the refinery. The effect of sewerage and drainage improvement to the Marimelena area is very small compared to the load of the refinery and the improvement of dissolved oxygen levels in Marimelena requires that the organic load from the refinery be reduced as well.

10.4 WATER QUALITY MONITORING SYSTEM

10.4.1 EXISTING WATER QUALITY MONITORING SYSTEM

According to available information, water quality monitoring on Havana Bay, industrial wastewater, tributary rivers (Luyano River, Martin Perez River and Tadeo River) and drainage channels (Agua Dulce, Matadero and San Nicolas) is implemented by several organizations such as CIMAB, CENHICA, universities and the laboratory of Quibu Wastewater Treatment Plant (WWTP). The monitoring location, sampling frequency and measurement/analysis item are summarized in Table 10.3.

CIMAB started the water quality monitoring on Havana Bay from 1980. Now, as shown in Table 10.3, CIMAB is in charge of the monitoring on water quality of the Bay, the factories discharging wastewater into Havana Bay directly, as well as the sediments of Havana Bay. Besides the periodical monitoring mentioned above, CIMAB also carries out the water quality monitoring on tributary rivers (only at the river mouth) and drainage channels in some projects financed by GTE or other organizations (such as Italian consultant and GEF).

CENHICA is generally in charge of the water quality monitoring on tributary rivers of the Bay and the factories discharging wastewater into the tributary rivers, while the laboratory of Quibu WWTP mainly conducts water quality monitoring on the sewers and treated wastewater of WWTP. In some cases, local universities (such as CUJAE University) are also hired to carry out water quality monitoring on tributary rivers.

The Enterprise of Hydraulic Usage (EAH) set up a water quality monitoring system for 3 tributary rivers, Quibu WWTP and lagoons, Dams etc. in April 2000.

Table 10.4 shows the number of staff, major analysis instruments, analysis items and the capacity of analysis in the laboratories of these monitoring organizations. The major problems of existing water quality monitoring system are also summarized and analyzed as shown in Table 10.5 based on observations, and discussion with and visits to these organizations.

10.4.2 RECOMMENDATION FOR FUTURE WATER QUALITY MONITORING SYSTEM

Based on the results of reviewing the existing water quality monitoring system in the basin of Havana Bay and discussions with related organizations, some recommendations on future water quality monitoring system are given as follows:

- To establish a unified and periodic water quality monitoring system (including unitary monitoring locations and analysis items) to monitor seawater quality inside and outside (baseline) of the Bay, water quality and flowrates of 3 tributary rivers, drainage channels, and industrial wastewater quality of factories, including sediment quality.
- GTE will take responsibility for the financing of this monitoring system and for integrating the water quality database and for sharing all of the information with related organizations.
- GTE will possess its own small boat to ensure that the monitoring of water quality can be conducted at any time if necessary.

The recommended monitoring system (sampling points and frequency, analysis and measurement items etc.) is summarized and shown in Table 10.6. Furthermore the approximate cost (only direct cost, i.e. personnel and transportation costs for sampling and analysis costs) for the recommended monitoring system is estimated to be about US$ 50,300 in each year.

Table 10.3 Existing Water Quality Monitoring System

Analysis Organization	Monitoring Location		Frequency	Analysis and Measurement Parameters	Standard	Monitoring Agency	Other Financial Source
CIMAB	Inside of the Bay	5 points (Atares, Guasabacoa, Marimelena Centro, Canal) 3 layers (0, 5 and 10 m)	2 times/year (wet season and dry season)	pH, DO, EC, Water Temp., Salinity, TSS, NH_4-N, NO_2-N, NO_3-N, PO_4-P, T-P, SiO_3, HC, Chlorophyll-a, Plankton, Coliform, Co, Cu, Fe, Mn, Ni, Pb, Zn, Mo etc. 24 items	Water Environmental Standard for Fishing Purposes	GTE	GEF
	Outside of the Bay	2 points (Chivo, San Lazaro)×3 layers	-ditto-	-ditto-	-ditto-	GTE	
	Industrial Wastewater	12 to 15 factories discharging wastewater into the Bay directly	1 time/year	pH, Water Temp., TS, TSS, BOD, COD_{Cr}, T-N, T-P, HC and Flowrate	Discharge Standards	GTE	GEF
	Sediment in the Bay	5 points (Atares, Guasabacoa, Marimelena Centro, Canal) Superficial sediment	1 time/2 years	Water content, HC, T-N, Clostridium Perfringens, Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn, Mo etc.	No	GTE	
	Tributary Rivers	2 points (Luyano Via Blanca, Martin Perez Via Blanca)	Temporary	pH, DO, EC, Water Temp., Cl, Salinity, TS, TSS, BOD, COD_{Cr}, NH_4-N, Org-N, T-N, PO_4-P, T-P, SO_4, HC, Coliform, Cd, Cr, Cu, Hg, Ni, Pb, Zn, etc.	NC27, Class C	GTE	Italian consultant
	Drainage Channels	2 points (Agua Dulce, Matadero)	Temporary	Flowrate, pH, EC, COD, BOD, Cl, Salinity, TSS etc.	NC27, Class C		Italian consultant
CENHICA	Tributary Rivers	Upstream, middle stream and downstream of 3 tributary rivers (Luyano River, Martin Perez River and Tadeo River)	2 times/year	pH, DO, EC, Water Temp., Cl, Salinity, SS, BOD, COD_{Cr}, NH_4-N, NO_2-N, NO_3-N, T-N, PO_4-P, T-P, Coliform, Cd, Cr, Cu, Hg, Ni, Pb, Zn and flow rate etc.	NC27, Class C	GTE, Enterprise of Hydraulic Usage (EAH)	
	Industrial Wastewater	Factory discharging wastewater into the tributary rivers of the Bay	2 times/year	pH, Water Temp., TS, TSS, BOD, COD_{Cr}, T-N, T-P, HC and Flowrate	Discharge Standards	GTE	
	Sewers	None	-	-	-	-	
	Drainage Channels	None	-	-	-	-	
	Sediment of River	None	-	-	-	-	
Laboratory of Quibu WWTP	Sewers	2 points (Caballeria and Casablanca)	1 time/month	pH, DO, Water Temp., EC, DO, SS, BOD, COD, Cl^- etc.	NC27	Agua de La Habana	
CUJAE University	Tributary Rivers	Upstream, middle stream and downstream of 3 tributary rivers	2 times/year	pH, EC, BOD, COD_{Cr}, Coliform	NC27, Class C	Enterprise of Hydraulic Usage (EAH)	Since 2000

Table 10.4 Current State of Water Quality Analysis Organization

Analysis Organization	No. of Staff	Major Analysis Instruments	Analysis Parameters	Technical Level and Capacity of Analysis
Laboratory of CIMAB	13	General instruments for manual analysis, GC, LC, ICP, UV/VIS, IF and other precision analysis instruments	Water Temp., pH, DO, EC, Salinity, SS, COD, BOD, T-N, NH_3, NO_2^-, NO_3^-, T-P, PO_4^{3-}, SO_4^{2-}, SiO_3, HC, Chl-a, Plankton, Coliform, Phenol, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, V, Zn etc.	High technical level, Manual analysis: 30 samples/d Instrumental analysis: 40 samples/d
Laboratory of CENHICA	16	General instruments for manual analysis, GC, AS, ICP and other precision analysis instruments	Water Temp., pH, DO, EC, Salinity, SS, COD, BOD, T-N, NH_3, NO_2^-, NO_3^-, T-P, PO_4^{3-}, SO_4^{2-}, SiO_3, Chl-a, Plankton, Coliform, Phenol, As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, V, Zn etc.	High technical level, Manual analysis: 20-30 samples/d Instrumental analysis: 20 samples/d
Laboratory of Quibu WWTP	6	General instruments for manual analysis	Water Temp., pH, DO, EC, SS, COD, BOD, Cl^- etc.	Normal technical level, Manual analysis: 6-18 samples/d
Laboratory of CUJAE University	8	General instruments for manual analysis, GC, GC-MS, and AS	Water Temp., pH, DO, EC, SS, COD, BOD, T-N, NH_3, NO_2^-, NO_3^-, T-P, PO_4^{3-}, SO_4^{2-}, Cl^-, Coliform etc.	High technical level, Manual/instrument analysis: 20 samples/d

AS: Atomic Absorption Spectrometer
GC: Gas Chromatograph
GC-MS: Gas Chromatograph-mass Spectrometer
ICP: Inductively Coupled Plasma Emission Spectroscopy
IF: Infrared Spectrophotometer
LC: Liquid Chromatograph
UV/VIS: Ultraviolet/Visible Spectrophotometer

Table 10.5 Major Problems of Existing Water Quality Monitoring System

Items	Content
Organization	Up to now, multiple organizations (such as GTE, Enterprise of Hydraulic Usage (EAH), GEF and others) take the responsibility for monitoring of the Bay, tributary rivers, factories, sewers and drainage channels, which results in the difference in sampling location, sampling frequency and analysis parameters. 1) No unified water quality monitoring system 2) No comprehensive database on water and sediment quality 3) No system established yet to share the monitoring information
Budget	GTE doesn't have enough budget for monitoring the water quality of the Bay, tributary rivers, especially for factories and drainage channels.
Sampling	1) Both GTE and CIMAB don't have a boat, therefore, the water quality monitoring on the Bay can't be conducted to the schedule with tidal pattern. 2) The measurement of flowrates in tributary rivers is insufficient especially for Tadeo River. 3) Based on the available information, there is no monitoring on the sediments of tributary rivers, except that Havana University conducted a survey on the sediments of Martin Perez River from 1999 to 2000.
Analysis	1) Almost every laboratory is facing the problem of lack of chemical reagents and incomes for renewal of analysis instruments. 2) For some analysis items (such as heavy metals), different analysis methods are adopted in different analysis organizations, which results in poor comparability of the same item. 3) BOD, COD and T-N (total nitrogen) in the seawater of the Bay have not been analyzed, however these items are very important for evaluating eutrophication situation of the Bay.
Others	There is no unified database of water quality of the Bay, tributary rivers, factories, sewers and drainage pipes. Moreover, sharing of the water quality data is insufficient.

Table 10.6 Recommended Future Water Quality Monitoring System

Item	Water in Havana Bay		Water in Tributary Rivers		Industrial Wastewater		Drainage Channels		Sediment in the Bay	
	Point & Frequency	Items	Point & Frequency	Items	Point & Frequency	Items	Point & Frequency	Items	Point & Frequency	Items
A (Basic Items)	Inside of the Bay: 5 points×3 layers Frequency: 1time/month Outside of the Bay: 2 points×3 layers Frequency: 2 times/year Location: see Fig. 3.2	pH, EC (or Salinity), Transparency; DO and Water Temp. (1 m interval in vertical direction)	3 tributary rivers ×3 points/river (Up, middle and down streams of Luyano, Martin Perez and Tadeo) Frequency: 1time/month	pH, Transparency, DO, Water Temp., EC	Outlets of 10 factories discharging high pollution load Frequency: 1time/year	pH, Water Temp., EC	2 drainage channels (Agua Dulce and Matadero): Frequency: 1time/month	pH, Water Temp., EC	Sediments inside of the Bay: Frequency: 5 points ×1 time/year;	Water content, TVS
B (Organic Items etc.)	Inside of the Bay: 5 points×3 layers Frequency: 4 times/year Outside of the Bay: 2 points×3 layers Frequency: 2 times/year	COD_{Mn} BOD, SS T-N, NH_4-N NO_2-N, NO_3-N T-P, PO_4-P	3 tributary rivers ×3 points/river Frequency: 1time/month	COD_{Cr} , COD_{Mn} BOD, SS T-N, NH_4-N NO_2-N, NO_3-N T-P, PO_4-P	-ditto-	COD_{Cr} BOD SS T-N T-P	2 drainage channels: Frequency: 4 times/year	COD_{Cr} BOD SS T-N T-P	Sediments inside of the Bay: Frequency: 5 points ×1 time/year	TOC, T-N, T-P
C (Biological Items)	Inside of the Bay: 5 points×3 layers Frequency: 4 times/year	Chlorophyll-a Plankton Coliform	-ditto-	Coliform	-	-	-ditto-	Coliform	-	-
D (Heavy Metals and Others)	Inside of the Bay: 5 points×1 layer (surface) Frequency: 1 times/year	As, Cd, Cr, Cu, Hg, Ni, Pb, Zn, and HC	3 tributary rivers ×3 points/river Frequency: 1time/year	As, Cd, Cr, Cu, Hg, Ni, Pb, Zn, and HC	-ditto-	As, Cd, Cr, Cu, Hg, Ni, Pb, Zn, HC and others.	2 drainage channels: Frequency: 1 times/year	As, Cd, Cr, Cu, Hg, Ni, Pb, Zn, HC and others.	-ditto-	As, Cd, Cr, Cu, Hg, Ni, Pb, Zn, HC
Flowrate	-		Point: mouths of 3 tributary rivers, Frequency: 2 times/year (24 hours survey)		Point: outlet of each factory, Frequency: occasional (24 hours survey)		Outlet of each WWTP: 1time/day; Agua Dulce and Matadero: 2 times/year (24 hours)		-	
Cost,US$/year	20,400		23,800		3,400		1,800		900	

*: Composite sample (for sea water, sediment of the Bay: 2-3 times; for water quality of tributary rivers, factories and drainage channels: 4-6 times) is recommended.

CHAPTER 11
PLANNING AND DESIGN BASES OF SEWERAGE SYSTEM

11.1 TARGET YEAR FOR PLANNING

To carry out the master planning for the improvement of an economically viable sewerage system, the elements of work necessary are forecast and generally defined in successive stages to meet the present and future needs of the Study Area up to the year 2020.

The Master Plan should, therefore, be compatible with sound projections of population increase, development programs, water consumption, income growth, and other national and local socio-economic factors affecting the future of the Study Area. The base year for future projections of planning framework is set in the year 2001, because almost all data available during the master plan study phase is that of the year 2001 with some exceptional cases.

11.2 SEWERAGE PLANNING AREA

Table 11.1 summarizes the sewerage planning area covers a total of about 6,500 ha comprising 5,700 ha within Havana Bay basin and 800 ha out the basin as illustrated in Figures 11.1. The area of 100 ha covered by other sewerage scheme and the area covered by on-site sanitation or factories are excluded in the Study. The sewer planning area was selected to encompass all feasible wastewater collection areas consistent with topography, probable future population concentrations and distributions, and future housing development districts.

Table 11.1 Sewerage Planning Area (Year: 2020)

Item	**Area**	Remarks
1. Sewerage Planning Area in this Study	**6,432.2** ha	
within Havana Bay Basin	5,665.3 ha	
out of Havana Bay Basin	766.9 ha	
Total	6,432.2 ha	
2. Sewerage Planning Area by other scheme	**97.1** ha	
5. On-site Treatment	**1,086.6** ha	
Sanitation	851.0 ha	
Factory	235.6 ha	
Total	1,086.6 ha	

Source: JICA Study Team

11.3 POPULATION

11.3.1 POPULATION IN THE STUDY AREA

The future population in Havana City (La Ciudad Habana) is projected to decrease slightly is as shown in the following table.

Table 11.2 Population in Havana City

Year	**1996**	**2000**	**2005**	**2010**	**2015**	**2020**
Population	*2204,333	2,185,076	2,168,404	2,151,562	2,135,747	2,110,256

Note: * Census Data

Source: "PROJECCION DE LA POBLACION NIVEL NACIONAL Y PROVINCIAL, Período 2000-2025", OFICINA NACIONAL DE ESTADITICAS CENTRO DE ESTUDIOS DE POBLACION Y DESARROLLO"

Since any projection of future population for municipalities in Havana City are not available, the future population related to the Havana Bay basin is projected, taking into account recent population trend, present and future land use, and future trend of economics. Table 11.3 shows the projected population: the total population of ten municipalities will be increased and those will be increased in peri-urban area, but those in urban center will be decreased or stabled at present level.

Table 11.3 Population of ten municipalities related to Havana Bay basin

Municipality related Havana Bay basin	* 1996	2001	2005	2010	2015	2020
Plaza de la revolucion	172,064	172,045	172,500	173,000	173,500	**174,000**
Centro habana	165,058	150,877	149,200	147,100	145,100	**143,000**
Habana vieja	102,831	94,966	94,300	93,600	92,800	**92,000**
Regla	42,032	42,390	43,400	44,600	45,800	**47,000**
La habana del este	180,308	185,468	197,600	212,700	227,900	**243,000**
Guanabacoa	106,015	106,374	110,700	116,100	121,600	**127,000**
San miguel del padron	155,436	154,323	159,500	166,000	172,500	**179,000**
Diez de octubre	240,713	229,626	228,900	227,900	227,000	**226,000**
Cerro	138,506	135,261	136,300	137,500	138,800	**140,000**
Arroyo naranjo	195,954	199,720	204,800	211,200	217,600	**224,000**
Total	1,498,917	1,471,050	1,497,200	1,529,700	1,562,600	**1,595,000**

Source: JICA Study Team

The total population within the basin is set at 800,000 in 2020 as the same level of 1996. The population of each municipality within the Havana Bay basin was estimated based on the census data and other detailed data and information in 1996. The ratio of the population within the basin against the total population is used to estimate the future population of each municipality within the basin in 2020. Table 11.4 summarize the population distribution within the basin. These population figures will be used for sewerage planning bases.

Table 11.4 Population Projection within Havana Bay basin

Municipality related Havana Basin	* 1996	2001	2005	2010	2015	2020
Plaza de la revolucion	9,395	9,400	9,400	9,400	9,500	**9,500**
Centro habana	86,106	78,700	77,800	76,800	75,700	**74,600**
Habana vieja	105,178	95,000	94,400	93,600	92,800	**92,000**
Regla	41,798	42,200	43,100	44,300	45,500	**46,700**
La habana del este	15,025	15,500	16,500	17,700	19,000	**20,200**
Guanabacoa	24,354	24,400	25,400	26,700	27,900	**29,200**
San miguel del padron	145,880	144,800	149,700	155,900	162,000	**168,200**
Diez de octubre	239,768	228,700	228,000	227,100	226,200	**225,300**
Cerro	97,507	95,200	96,000	96,900	97,900	**98,800**
Arroyo naranjo	31,087	31,700	32,500	33,500	34,500	**35,500**
Total	796,098	765,600	772,800	781,900	791,000	**800,000**

*:**Estudio de Diagnostico sobre Asentamiento Humano en la Cuenca Bahia dela Habana**

Source : JICA Study Team

11.3.2 SEWER SERVICE POPULATION

Table 11.5 summarize sewer service population; a target population to be served by public sewerage system.

Table 11.5 Sewer Service Population (Year: 2020)

Item	**Population**	Remarks
1. Population in Ciudad Habana	2,110,256	
2. Population within Study Area (Havana Bay Basin)	800,000	
3. Sewer Service Population in this Study	**884,700**	
within Havana Bay Basin	**725,600**	
out of Havana Bay Basin	**159,100**	
Total	884,700	
4. Population in other sewerage scheme	19,900	
5. Population served by on-site Treatment	54,500	
Sanitation	54,500	
Factory	0	
Total	54,500	

Source: JICA Study Team

11.4 WASTEWATER GENERATION

11.4.1 GENERAL

Wastewater is classified into following four categories based on water supply conditions and each categorized wastewater generation is estimated as follows:

1) Domestic Wastewater = Per Capita Water Consumption Rate X Wastewater Generation Rate X Population

2) Small pollution source of commercial, institutional and industrial wastewater = Per Capita Water Consumption Rate X Wastewater Generation Rate X Population

3) Large pollution source of commercial, and institutional wastewater = Water consumption data X Wastewater Generation Rate

4) Large pollution source of industrial wastewater = Water consumption data X Wastewater Generation Rate

In the following section, the wastewaters generation is estimated at present (year 2001) and for the target year of 2020.

The present wastewater generation is estimated based on the water consumption and wastewater generation estimation of 1996 survey results Base on the water supply and sewerage study, "Estudio Sobre Los Ciclos del Agua en la Habana, Tomo II, Primera Parte, 1997", and adjusted with economic growth between 1995 and 2001.

The future wastewater generation in 2020 is estimated based on the Cuban Norm of water supply and actual water supply data for large water consumer together with a future economic growth up to 2020.

More detail of description of how to estimate the wastewater generation will be presented in the followings.

11.4.2 PER CAPITA WATER CONSUMPTION

(1) Present Water Consumption

1) Domestic Water

Based on the water supply and sewerage study, "Estudio Sobre Los Ciclos del Agua en la Habana, Tomo II, Primera Parte, 1997", the 1996 average domestic water consumption per capita in the municipalities related Havana Bay is estimated around 178 lpcd, (metered consumer: 160 lpcd and non-meter consumer: 190 lpcd).

2) Commercial, Institutional and Industrial Water for Small Consumers

The survey report also estimated that the average per capita water consumption of small scale consumers (less than $50m^3$/day) was 50 lpcd in 1996.

3) Commercial, Institutional and Industrial Water for Large Consumers

The average per capita water consumption of large scale consumers (more than $50m^3$/day) was 49 lpcd.

(2) Future Water Consumption

Based on Cuban Standards (Norm 53-91, 1983) for planning and design of Water Supply System, the water consumption in the target year is set to estimate the future wastewater generation rate. Table 11.6 shows the water demand in the Cuban Norm.

Table 11.6 Water Demand by Category

Population Size			Water Demand (lpcd)				
			Domestic	Commercial	Public	Industry(small)	Total
Less than		2,000	145	87	44	15	291
2,000	to	10,000	160	96	48	16	320
10,000	to	25,000	175	105	51	18	349
25,000	to	50,000	190	112	57	19	378
50,000	to	100,000	200	116	59	20	395
100,000	to	250,000	215	125	62	22	424
250,000	to	500,000	220	132	66	23	441
More than		500,000	225	135	68	23	451

Note: All figures above included water loss of 15 to 20% in water distribution system.

11.4.3 PER CAPITA WASTEWATER GENERATION

(1) Present Per Capita Wastewater Generation

Based on the present water consumption data of 1995 survey, the per capita wastewater generation rate at present (2001) is set as shown in Table 11.7.

Table 11.7 Present Per Capita Wastewater Generation

Item	Unit	1995 data	Present (2001)	Remarks INRH study*
1. Per capita domestic water consumption, (Net value)	lpcd	178	(187)	178 lpcd
2. Non-domestic water consumption by small water consumer (Net value))	lpcd	50	(120)	50 lpcd
3. **Per capita domestic wastewater generation**	lpcd	160	**168**	---
4. **Non-domestic wastewater generation by small water consumer**	lpcd	50	**110**	---
5. Per capita wastewater generation in 1996, except large user (3+4)	lpcd	210	---	---
6. Overall per capita wastewater generation, including large water consumer in 1996 level	lpcd	---	---	288 lpcd (270 lpcd, without I/I)

Note: * source: "Analisis Hidraulico del Sistema de Alcantarillado Principal de Ciudad de La Habana, 1996"

1) Domestic Wastewater

Per capita domestic wastewater generation rate can be estimated based on the per capita water consumption rate. The domestic wastewater generation rate is generally within 0.7 to 1.0, because some portion of water supplied is used for gardening, car wash, etc.,

When the generation rate is assumed at 0.8 to 0.9, the domestic per capita wastewater generation rate is estimated by multiply the present per capita water consumption of 187 lpcd (see Table 11.8) with the ratio:187 lpcd x (0.8 to 0.9) = 150 to 168 lpcd.

2) Non-domestic Wastewater

Based on latest water consumption data, the average water per capita water consumption, the non-domestic wastewater generation rate for small consumers is estimated: 100 to 120 lpcd. With assuming that almost all water used will be discharged to sewer , i.e. wastewater generation rate of 0.9 to 1.0, the present per capita non-domestic small user is about 110 lpcd (=(100 to 120) x (0.9 to 1.0)= 90 to 110 lpcd.

Wastewater generation from the large water consumers is estimated based on the water consumption records of 1995, 2000 and 2002 for each consumer.

(2) Future Per Capita Wastewater Generation

Table 11.8 summarizes the future per capita wastewater generation rates are set by category for planning purposes, base on the Cuban Norm of Water Demand with assuming wastewater generation rate of 0.9.

Table 11.8 Future Per Capita Wastewater Generation

Item	Unit	Domestic	Commercial	Public	Small Industry
Per capita water consumption (Norma Cubana)	lpcd	220	132	66	23
Water use not discharged to sewer	*lpcd*	-	-	*20*	-
Loss accounted in the norm	%	15			
Net per capita water consumption	lpcd	187	112	39	20
			171		
Wastewater generation rate	%	90			
Net wastewater generation rate	lpcd	168.3 => **168**	153.9 =>**154**		

Source: JICA Study Team

11.4.4 WASTEWATER GENERATION

Table 11.9 summarizes the wastewater generation.

Table 11.9 Summary of Wastewater Generation

Item	**Population**		**Wastewater Generation (m^3/d)**	
	2001	**2020**	**2001**	**2020**
1. Within Study Area (Havana Bay Basin)	**765,800**	**800,000**	**240,300**	**256,900**
2. Total in the Study	**862,600**	**884,700**	**268,600**	**315,900**
2.1 Domestic wastewater generation	-	-	145,000	148,600
2.2 Non-domestic wastewater generation by small user	-	-	94,900	136,300
2.3 Non-domestic wastewater generation by large user	-	-	28,800	31,000
3. Sewerage total within Havana Bay basin	**703,500**	**725,600**	**216,500**	**256,800**
3.1 Domestic wastewater generation	-	-	118,200	121,900
3.2 Non-domestic wastewater generation by small user	-	-	77,400	111,700
3.3 Non-domestic wastewater generation by large user	-	-	20,900	23,200
4. Sewerage total out of Havana Bay basin	**159,100**	**159,100**	**52,100**	**59,100**
4.1 Domestic wastewater generation	-	-	26,700	26,700
4.2 Non-domestic wastewater generation by small user	-	-	17,500	24,500
4.3 Non-domestic wastewater generation by large user	-	-	7,900	7,900
5. Other sewerage scheme	**14,900**	**19,900**	**4,200**	**6,400**
6. On-site Treatment	**47,400**	**54,500**	**13,200**	**24,000**
Sanitation	47,400	54,500	13,200	17,600
Factory	0	0	6,400	6,400

Source: JICA Study Team

11.4.5 DESIGN POLLUTION LOAD

(1) Domestic Wastewater

For sewerage planning purpose, the following per capita pollutants loads are used to estimate domestic origin pollutants. The unit load of BOD are set based on the data of Cuba as discussed in Chapter 4 and those of SS, T-N and T-P are set based on typical domestic wastewater concentrations in literature.

Table 11.10 Per Capita Pollutant Load

Per capita pollutant load	- 40 g BOD_5 /capita/d
	- 40 g SS* /capita/d
	- 7.4 g T-N/capita/d
	- 1.9 g T-P/capita/d

Source: JICA Study Team

(2) Non-domestic Wastewater by small water users

Per capita pollutant load of non-domestic wastewater discharged by small water users are set assuming followings:

- water quality is similar to grey water component of domestic wastewater
- ratio of pollutant load generated by toilet use (excreta) and grey water (sullage) is assumed based on literature as follows:

Table 11.11 Per Capita Pollutant Load in toilet wastewater and grey water

Load (g/capita/d)	BOD_5	SS	T-N	T-P
- toilet	18	18	5.2	1.3
- grey water	22	22	2.2	0.6

Note: For T-N and T-P, their ratio in toilet and grey water is 70% : 30% respectively.

(3) Non-domestic Wastewater by large water users

Non-domestic wastewater discharged from large water consumers (commercial, institutional and industrial) are estimated under the following conditions:

- water quality survey indicated that the effluent quality exceeded the values acceptable for discharge to public sewer, especially for food processing industries.
- For food processing industries, future effluent quality for discharge into public sewer is set to the maximum concentration acceptable for discharge to public sewers (300 mg/L BOD5, 300 mg/L SS, 50 mg/L T-N and 10 mg/L T-P)
- Average effluent quality of electrical/machinery industries is set at 100 mg/L BOD5, 100 mg/L SS, 15 mg/L T-N and 5 mg/L T-P
- Approximate volume ratio of food processing to electrical/machinery industry is 70 % : 30%

11.5 INFLOW/INFILTRATION

Because of defective sewer joints, broken or cracked sewer pipes and manholes, and incorrectly connected storm-water drainage pipes to sanitary sewers, a significant amount of undesirable infiltrates an surface water inflows to the sewers are un avoidable. The average infiltration and inflow (I/I) into sewers generally range between 10 to 15 percent of the dry weather wastewater flows.

The geographic conditions prevailing in Havana region and sewer installation practice of relatively shallow depth suggest that the groundwater infiltration appears to be of rather low side.

The previous planning and design report on existing sewer system “Analisis Hidraulico del Sistema de Alcantarillado Principal de Ciudad de La Habana, 1996”, estimated that the I/I rate is $5m^3$/ha/dia for Colector Norte and Sur, and $3m^3$/ha/dia for other collectors. And the I/I rate is also estimated as per capita: 19.4 lpcd.

In view of such conditions, a fixed I/I rate of 20 to 40 lpcd is considered to be of a reasonable assumption, and this fixed rate will be added to all wastewater flowing conditions.

11.6 REQUIRED LEVEL OF WASTEWATER TREATMENT

11.6.1 INTRODUCTION

In the planning of sewerage system, level of wastewater treatment is determined based on the water quality objectives of receiving water bodies. Water quality objectives of the water bodies depends on the intended use of water bodies for example navigation, source of cooling water for industries, fishing etc. To achieve and maintain the water quality objectives, either water quality standards for the water bodies or discharge standards to the water bodies are set. In some cases, both standards are also set.

In case of new sewerage system in the Havana Bay Basin, wastewater effluent can be discharged either within the bay basin to Havana Bay through rivers or directly to sea through a sea-outfall.

For discharge within the bay basin, receiving water bodies are the rivers and the bay. For rivers, discharge standards are set by NC-27 (1999) "Discharge Standards to Inland Surface Waters". Rio Luyano and Rio Martin Perez are in the category of Type B rivers for agriculture use. For Havana Bay, as discussed in Chapter 10, one of the water quality goal is set to a minimum of 3 mg/L of DO corresponding to Class E water body. By carrying-out water quality simulation for different scenarios of sewerage system development, required level of treatment is determined to achieve the water quality goal. Level of treatment to be adopted shall satisfy discharge standards to rivers as well as the water quality goal of the bay.

For discharge to sea, effluent standards set under the Land Based Sources Protocol (LBS Protocol) which followed the Cartagena Convention to protect the environment of Greater Caribbean need to be satisfied.

11.6.2 LEVEL OF WASTEWATER TREATMENT REQUIRED FOR DISCHARGE TO BAY

To determine the level of wastewater treatment, water quality simulation for several scenarios of pollution reduction was carried out. Scenarios include primary treatment, secondary treatment and advanced treatment of pollution load generated within area covered by the sewerage system and other measures such as pollution reduction of refinery wastewater effluent, reduction of internal sediment load etc. Basic conditions used to calculate the pollution load for different scenarios, results of water quality simulation and the conclusions are described in Appendix 7 Development of Havana Bay Water Quality Simulation Model. Description pertaining to the determination of wastewater treatment level is in the followings.

(1) Basic Conditions of Water Quality Projection

Out of the several scenarios studied, following scenarios are pertinent for discharge within the bay. They are:

Case 2 - Future (2020) with implementation of only GEF/UNDP Projects (Zone 4 and Zone 6)

Case 4 - Secondary treatment in new sewerage system and elimination of cross-connections in existing sewerage system

Case 5 - Primary treatment in new sewerage system and elimination of cross-connections in existing sewerage system

Case 6 - Advanced treatment in new sewerage system and elimination of cross-connections in existing sewerage system

Case 2 represents future condition in year 2020 with on-going GEF/UNDP projects for Zone 4 and Zone 6 are completed and without implementation of any other projects. In this case, pollutant load reduction will be for Dren Agua Dulce which will be diverted and treated together with industrial wastewater near the mouth of Rio Luyano and for part of the areas in Luyano-Abajo (Zone 6).

In Case 4, provision of secondary wastewater treatment in all of the sewer districts in Rio Luyano, Rio Martin Perez and in Arroyo Tadeo and elimination of pollution load discharged through stormwater drains generated in the existing sewerage system through improvement of cross-connections is considered. Case 4 signifies what could be achieved by new wastewater treatment system proposed in terms of organic pollution load reduction.

In Case 5, wastewater treatment level in the new sewerage system if primary treatment is provided in the new sewerage system instead of secondary treatment as in Case 4. Therefore, organic pollution load reduction will be less than that can be achieved in Case 4.

Case 6 in which effect of enhanced removal of nutrients through advanced treatment to the wastewater generated in the new sewerage system is considered.

(2) Estimated Pollution Load Discharge to the Bay

Based on the conditions described in the previous section, estimates of pollutant load discharge for the scenarios were made. Several assumptions are necessary for this estimation. They are as follows:

1. Industrial and domestic wastewater constitute approximately 25% of river flow in Rio Luyano and Rio Martin Perez presently based on an analysis by CIMAB and DPAA (1998). For Arroyo Tadeo which is an urban stream, the ratio is assumed to be 90% due to extremely small catchment (2.6 km^2) and its urban nature. Based on these river flow, which results from natural processes was separated from the contribution of industrial and domestic wastewaters. Water quality of river due to natural processes is assumed to be the

values measured at the most upstream water sampling points in this Study. River flow and its quality or load were estimated by considering the natural portion of river flow and that contributed by wastewater. Table 11.12 shows the assumed river quality.

Table 11.12 Upstream River Quality

Parameter	Rio Luyano	Rio Martin Perez	Arroyo Tadeo
River flow (excluding wastewater), m^3/d	86,120	46,590	800
BOD, mg/L	6	3	13
T-N, mg/L	0.6	3.5	7.8
T-P, mg/L	0.09	0.2	1.2
SS, mg/L	18	62	58
DO, mg/L	7	7	1

Source: Study Team

2. For the cases without implementation of any project other than GEF/UNDP, wastewater load generated is expected to undergo degradation prior to reaching the bay. To account of this degradation, load generated is multiplied by a factor defined as run-off ratio which is the ratio between load discharged to the load generated. Run-off ratio in each sewer district is assumed at 90%.

3. Wastewater treatment efficiency for various level of wastewater treatment is assumed as follows:

Table 11.13 Wastewater Treatment Efficiency (Assumed)

Parameter	Primary Treatment	Secondary Treatment*	Advanced Treatment
BOD_5	40 %	90 %	95%
SS	50 %	90 %	95%
T-N	15 %	15 %	65%
T-P	15 %	15 %	75%

* - conventional activated sludge process

4. Wastewater treatment efficiency for treatment plants at Zone 4 and Zone 6 area are based on treatment plant design data. Average influent and effluent concentrations are as follows:

Table 11.14 Influent and Effluent Quality for Zone 6 WWTP (UNDP)

Parameter	Influent	Effluent
BOD_5, mg/L	90	30
T-N*, mg/L	26	5
T-P, mg/L	10	5

* Kjeldahl Nitrogen

Table 11.15 Influent and Effluent Quality for Zone 4 WWTP (Italian)

Parameter	Influent	Effluent
BOD_5, mg/L	109	20
T-N*, mg/L	20**	14**
T-P, mg/L	5**	2.5**

* Kjeldahl Nitrogen

** calculated based on design data available for influent loads and % removals

5. Degradation of treated wastewater effluent between the point of WWTP discharge and the point of entry to bay is assumed to be negligible due to very short travel time (within a few hours) and lower concentration of organic matter remaining in secondary treated wastewater effluent for further biodegradation.

Tables 11.16 to 11.19 show the results of estimate for wastewater discharge to the Bay for Case 2, Case 4, Case 5 and Case 6.

Table 11.16 Case 2 - Future (2020) with GEF Projects Only

Sewer District	Source (River System)	Flow	BOD_5	T-N	T-P	SS
		m^3/d	kg/d	kg/d	kg/d	kg/d
Luyanó-abajo	Luyanó	196,837	13,979	2,102	996	24,429
Luyanó-arriba						
Martin Pérez-abajo	Martin Pérez	84,328	7,035	1,344	307	9,784
Martin Pérez-arriba						
Tadeo	Tadeo	10,635	1,729	307	76	1,754
Existing (Central)						
San Nicholas	San Nicholas	8,554	1,320	145	79	352
Matadero	Matadero	77,760	8,942	610	1,053	22,728
Agua Dulce	Agua Dulce	-	-	-	-	-
Refinery		*6,406*	*21,723*	*54*	*1*	
Total		384,519	54,728	4,562	2,512	32,226

Table 11.17 Case 4 : Secondary Treatment

Sewer District	Source	Flow	BOD_5	T-N	T-P	SS
	(River System)	m^3/d	kg/d	kg/d	kg/d	kg/d
Luyanó-abajo	Luyanó	153,637	1,838	1,755	449	2,872
Luyanó-arriba						
Martin Pérez-abajo	Martin Pérez	84,328	906	1,167	263	3,655
Martin Pérez-arriba						
Tadeo	Tadeo	10,635	208	262	65	220
Existing (Central)						
San Nicholas	San Nicholas					
Matadero	Matadero					
Agua Dulce	Agua Dulce					
Refinery		*6,406*	*21,723*	*54*	*1*	
Total		255,005	24,676	3,238	778	6,746

Table 11.18 Case 5 : Primary Treatment

Sewer District	Source	Flow	BOD_5	T-N	T-P	SS
	(River System)	m^3/d	kg/d	kg/d	kg/d	kg/d
Luyanó-abajo	Luyanó	153,637	8,446	1,755	449	8,158
Luyanó-arriba						
Martin Pérez-abajo	Martin Pérez	84,328	4,736	1,167	263	6,719
Martin Pérez-arriba						
Tadeo	Tadeo	10,635	1,167	262	65	987
Existing (Central)						
San Nicholas	San Nicholas					
Matadero	Matadero					
Agua Dulce	Agua Dulce					
Refinery		*6,406*	*21,723*	*54*	*1*	
Total		255,005	36,073	3,238	778	15,864

Table 11.19 Case 6 : Advanced Treatment

Sewer District	Source	Flow	BOD_5	T-N	T-P	SS
	(River System)	m^3/d	kg/d	kg/d	kg/d	kg/d
Luyanó-abajo	Luyanó	153,637	1,178	753	138	2,211
Luyanó-arriba						
Martin Pérez-abajo	Martin Pérez	84,328	523	576	84	3,272
Martin Pérez-arriba						
Tadeo	Tadeo	10,635	113	114	20	124
Existing (Central)						
San Nicholas	San Nicholas					
Matadero	Matadero					
Agua Dulce	Agua Dulce					
Refinery		*6,406*	*21,723*	*54*	*1*	
Total		255,005	23,536	1,497	243	5,607

(3) Results of Water Quality Projection

Figures 11.1 to 11.5 shows the comparison of simulated water quality distribution in the bay in terms of DO, BODd, NH_4-N, PO_4-P and Chl-a for Case 2, Case 4, Case 5 and Case 6.

1) DO

Significant improvement in DO can be observed between Case 2 and Case 4. DO levels reach 3 mg/L in Atares which is the most polluted part of the bay in terms of organic pollution. With Case 5 i. e. primary treatment DO levels in Atares fall below 3 mg/L and therefore not sufficient to achieve water quality goals. Improvement of DO levels in Atares in Case 4 is due to improvement of DO levels resulting in Guasabacoa with secondary treatment as there will be no change in the pollution input to Atares which receives wastewater through drains.

2) BODd

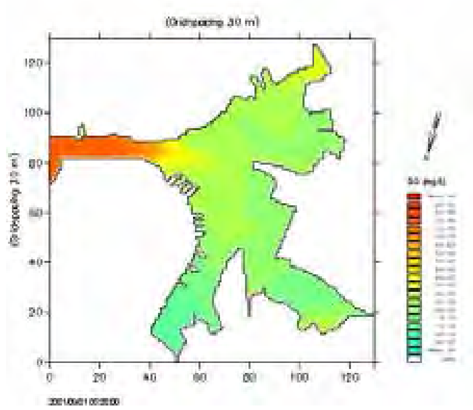
Difference in BODd concentration (dissolved bio-degradable organic matter) in Guasabacoa between Case 4 (secondary treatment) and Case 5 (primary treatment) is due to level of treatment whereas no significant improvement between Case 4 (secondary treatment) and Case6 (advanced treatment) can be observed.

3) NH_4-N and PO_4-P

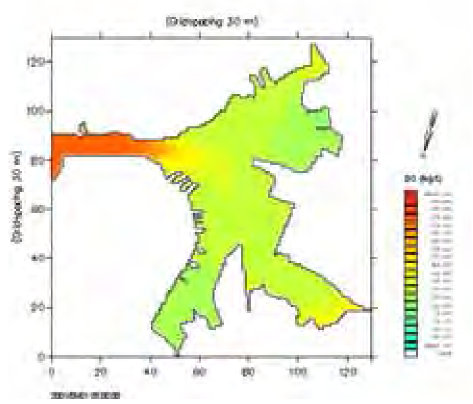
In case of nutrients, significant improvement in Gusabacoa can be observed in Case 6 (advanced treatment) due to removal of nutrients.

4) Chl-a

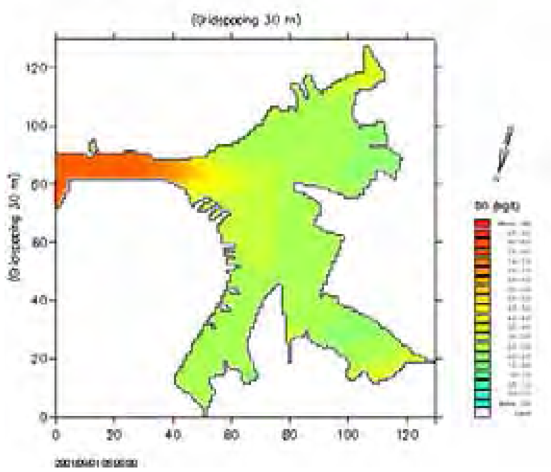
Simulated Chl-a concentration in Case 4 (secondary treatment) is approximately 6 µg/L which is similar to the levels observed outside the bay. With Case 6 (advanced treatment) overall reduction of Chl-a concentration in all parts of the bay is observed.



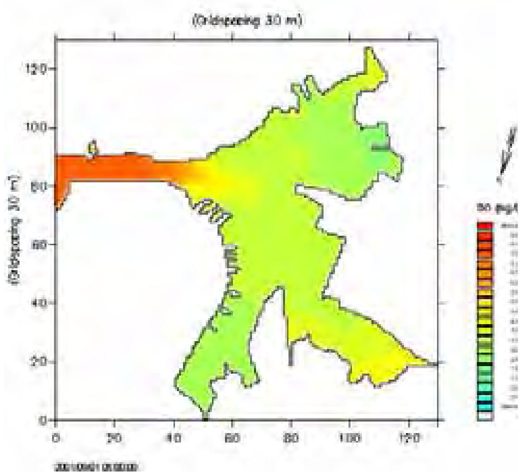
Case 2 DO



Case 4 DO

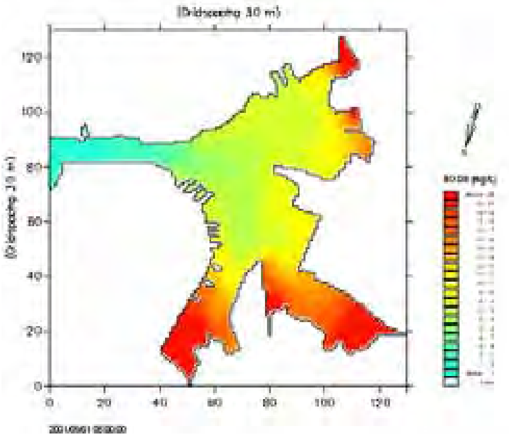


Case 5 DO

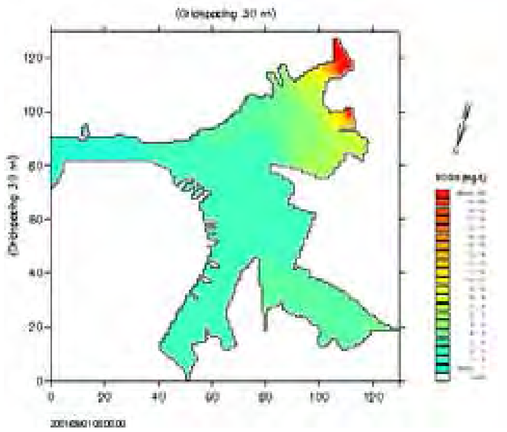


Case 6 DO

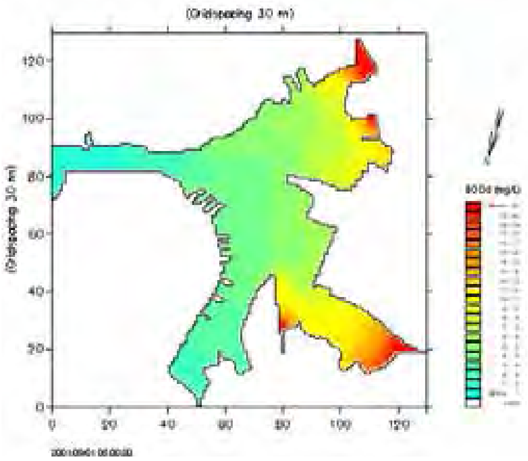
THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 11.1 Results of DO Levels for Different Levels of Wastewater Treatment
JAPAN INTERNATIONAL COOPERATION AGENCY	



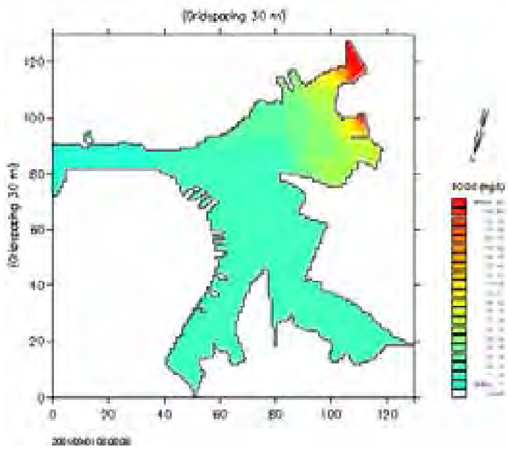
Case 2 BODd



Case 4 BODd

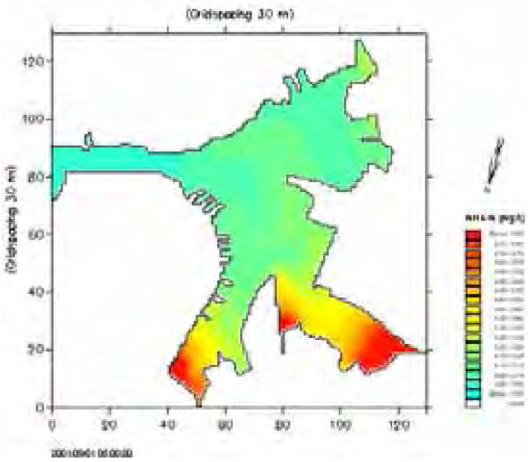


Case 5 BODd

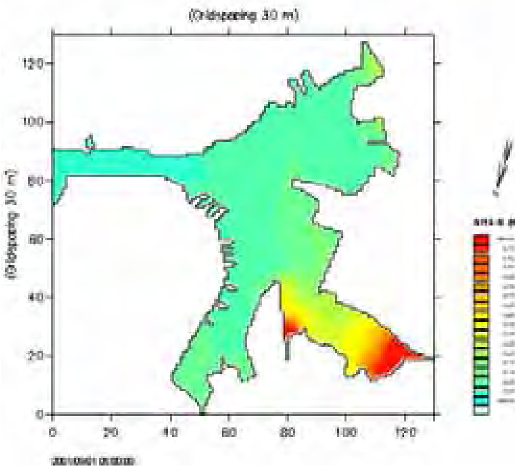


Case 6 BODd

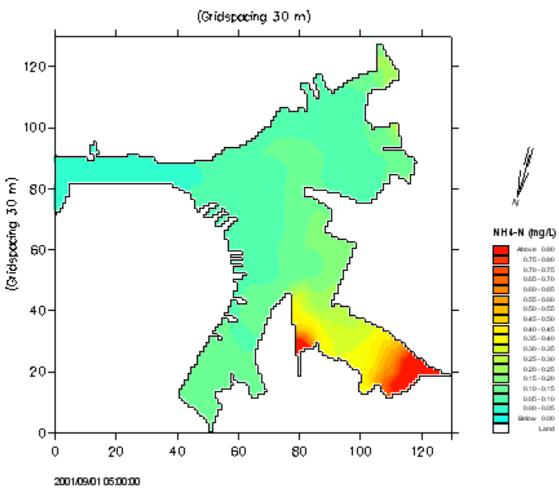
THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 11.2 Results of BODd Levels for Different Levels of Wastewater Treatment



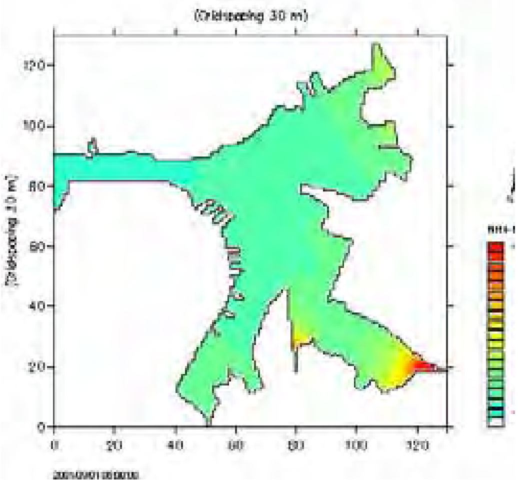
Case 2 NH_4-N



Case 4 NH_4-N

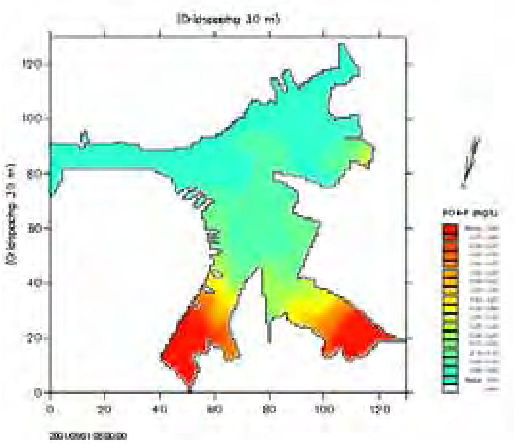


Case 5 NH_4-N

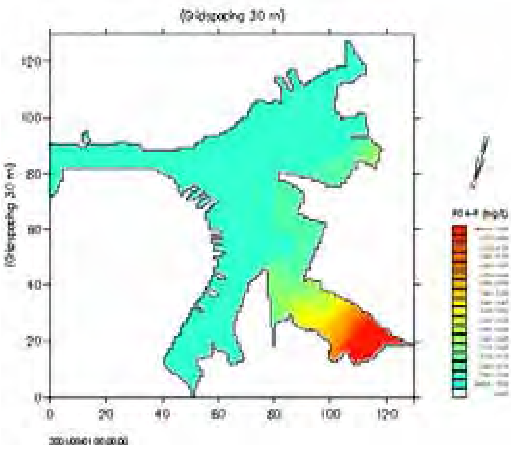


Case 6 NH_4-N

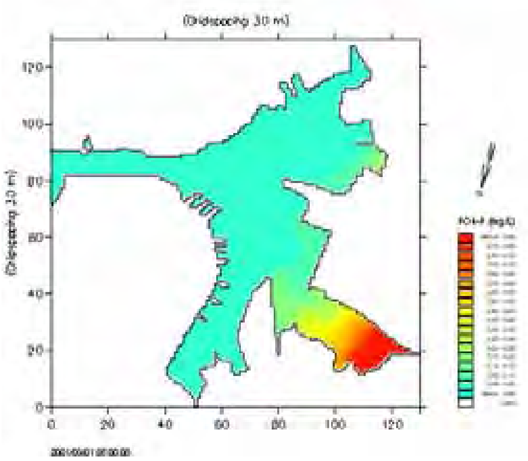
THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 11.3 Results of NH_4-N Levels for Different Levels of Wastewater Treatment



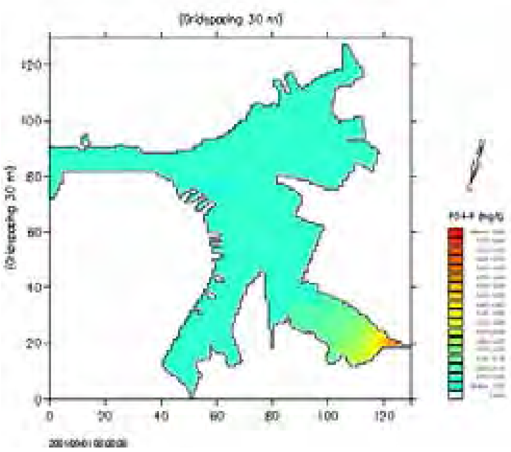
Case 2 PO_4-P



Case 4 PO_4-P

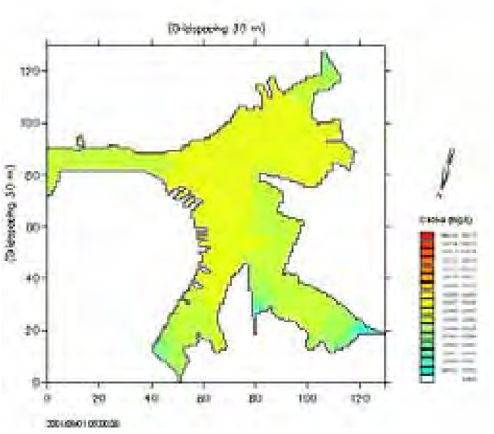


Case 5 PO_4-P

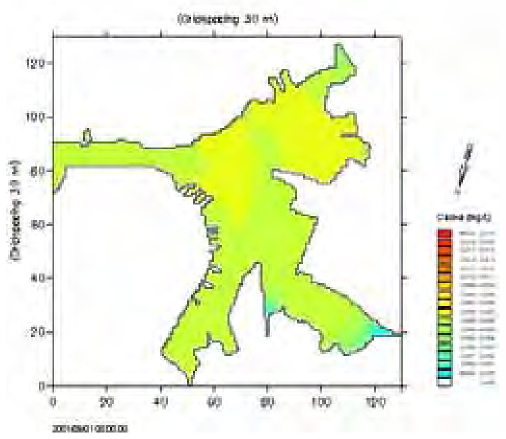


Case 6 PO_4-P

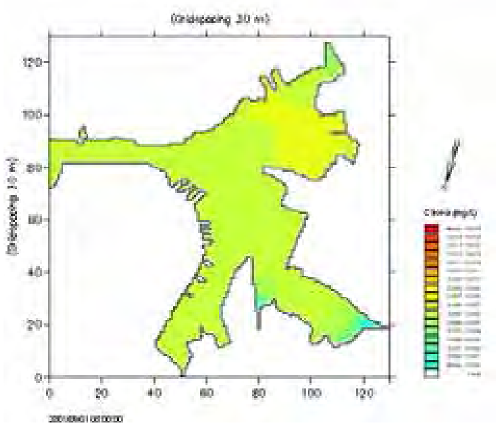
THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 11.4 Results of PO_4-P Levels for Different Levels of Wastewater Treatment



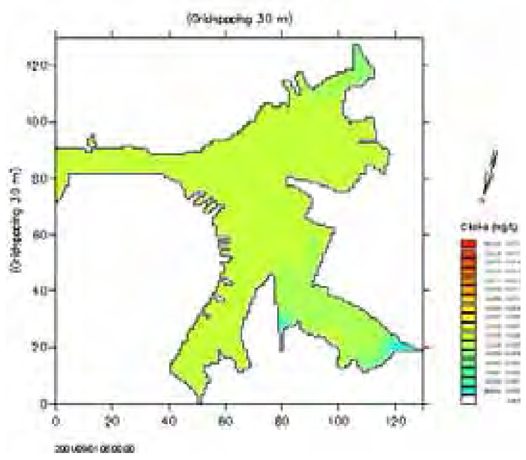
Case 2 Chl-a



Case 4 Chl-a



Case 5 Chl-a



Case 6 Chl-a

THE DEVELOPMENT STUDY ON THE IMPROVEMENT OF SEWERAGE AND DRAINAGE SYSTEM FOR THE HAVANA BAY	Figure 11.5 Results of Chl-a Levels for Different Levels of Wastewater Treatment

(4) Level of Wastewater Treatment

Based on the comparison of simulation results and the required water quality goal of minimum DO level of 3 mg/L in the bay the followings can be said.

To achieve minimum DO level of 3 mg/L in Atares where DO level is the lowest, it is necessary to provide secondary treatment to all the wastewater generated in the new sewerage system.

With secondary wastewater treatment for wastewater generated in the new sewerage system, simulation results do not show tendency of eutrophication. With the limitation in the number of data sets available and its extreme scatter especially in the data of total nitrogen and total phosphorous load to the bay and Chl-a which is the index of eutrophication, need for the provision of advanced wastewater treatment could not be justified at this stage.

It is therefore concluded that development of new sewerage system shall be with secondary wastewater treatment to reduce the organic pollution load which severely affects coves of Atares and Guasabacoa.

It should be noted, the secondary treatment level required to achieve water quality goal of 3 mg/L is more stringent than that required to satisfy the discharge standards for Inland Surface Waters (BOD_5 of 40 mg/L) considering the raw sewage quality of 200 mg/L.

11.6.3 LEVEL OF WASTEWATER TREATMENT REQUIRED FOR DISCHARGE TO SEA

Effluent discharge standards under the LBS Protocol pertaining to sewerage system serving population of Havana Bay basin is as shown in Table 11.20.

Table 11.20 Effluent Standards to Sea Outfall

Parameter	Concentration
Total Suspended Solids	150 mg/L
BOD_5	150 mg/L
pH	5 ～ 10
Fats, oil, and grease	50 mg/L
Floatables	Not visible

Considering the raw wastewater quality of 200 mg/L with improvement of cross-connections, primary treatment will be sufficient to satisfy the above standards.

11.7 SEWERAGE SYSTEM DESIGN CONSIDERATIONS

11.7.1 WASTEWATER COLLECTION SYSTEM

The principal items on wastewater collection system design criteria are summarized in this section. Sanitary sewers are planned and designed on the basis of the following criteria:

(1) Design Period

Sanitary sewers are designed for the design flow in year 2020.

(2) Design Factors

In determining the required capacities of sanitary sewers the following factors are to be considered:

- Maximum hourly wastewater flow; (The overall wastewater generation rate) x (M Factor by Harmon Equation) + Inflow/Infiltration;
- Additional maximum wastewater flows from large water consumer such as factories;
- Topography of the area, watersheds, ground surface slopes, etc.;
- Depth of excavation for sewers, in general less than 6 m; and
- Pumping requirements.

(3) Pipe Diameters and Materials

Pipe diameters and materials used for the design of sewers are shown in Table 11.21. Public sewers are to be not less than 200 mm in diameter except for house connection pipes.

Table 11.21 Pipe Materials and Diameters used in Design

External Diameter (mm)	Internal Diameter (mm)	Material
200	176	HDPE
250	216	HDPE
315	271	HDPE
400	343	HDPE
500	427	HDPE
630	535	HDPE
800	678	HDPE
1000	851	HDPE
1200	1030	HDPE
	1200 above	Concrete

Note: HDPE stands for High Density Polyethylene

(4) Velocity of Flow

All sewers should be designed and constructed to give mean velocities, when flowing 60 percent depth, of not less than 0.6 m/sec, based on the Manning's formula. The velocity shall not exceed 3 m/second in any type of sewers to protect sewer erosion. The sewer slopes shall be such that flow the wastewater with mean velocities of more than 0.6 m/sec when flowing full.

(5) Design Capacity Allowance

Design capacity allowance for the rehabilitated existing Colector and for the proposed new Colector is set as shown in the table below.

Table 11.22 Design Capacity Allowance for Colectors

Diameter (mm)			Capacity Allowance		Hydraulic Specific Curbs	
			allowance against to the capacity	Total capacity against to the design maximum hourly flow	Water depth in sewer	Water depth ratio against to the Full depth
200	to	600	100%	2 times	$H=H_{full}$ x	0.5
700	to	1500	50% to 100%	1.5 to 2 times	$H=H_{full}$ x	(0.5 to 0.59)
1650	to	3000	25% to 50%	1.25 to 1.5 times	$H=H_{full}$ x	(0.59 to 0.64)

Source: JICA Study Team

(6) Design Formulas

The Manning's formula shall be used in principle for gravity sewers. The roughness coefficients, n-values, are assumed as follows: 0.016 for the evaluation of the present capacity of the existing sewers; 0.013 for new concrete pipes; 0.010 for plastic pipes or for plastic materials coating the inner wall as rehabilitation work.

While for the pumped main or pressured main, the Hazen-Williams formula is used and the roughness coefficient, C-value of 110 set for a ductile iron pipe with inner cement mortar lining.

(7) Pipe Connections

When a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the sewer crown of both sewers at the same elevation.

11.7.2 PUMPING STATIONS

Although sewers are designed in principle to flow the wastewater by gravity, there may be some locations where aid of lift pumping stations can be economically justifiable. In such cases, the wastewater pumping stations may be designed. All pumping equipment, piping and conduits shall be designed to carry the expected peak flow rates.

For a large pumping station to lift the wastewater sub-main or main sewers should generally be of a dry well type. Provision shall be made to facilities removing pumps and motors. Suitable and safe means of access shall be provided to dry wells of pumping stations and shall be provided to wet wells containing either bar screens or mechanical equipment requiring inspection or maintenance.

For intermediate wastewater pumping stations require for lifting the wastewater of branch and/or sub-main sewers should be of submersible type provided in a manhole or similar structures. Submersible pumps shall be readily removable and replaceable without dewatering the wet wells and with continuity of operation of the other unit or units.

11.7.3 WASTEWATER TREATMENT PLANT

(1) Wastewater Treatment Process

As an appropriate method as the biological secondary wastewater treatment, the following five methods are selected to compare the treatment principle, performance and applicability to the local conditions of the Study Area. The treatment principle and the results of comparison are shown in the Table 11.23 and Table 11.24, respectively.

- Conventional Activated Sludge Process (CAS)
- Oxidation Ditch Process (OD)
- Aerated Lagoon (AL)
- Lagoon (LG)
- Conventional Trickling Filter Process (TF)

Among the five wastewater treatment methods, the LG and the AL are easier and cheaper to operate and maintain but require large land area to construct the facilities. Difficulties in obtaining a large area required are obstacles to apply these methods to the Havana Bay basin.

Under a severe condition of land area available in the Havana Bay basin, the CAS process is the most applicable treatment method but requires high technology and experience as well as high expenses to construct, operate and maintain.

Table 11.23 Wastewater Treatment Principle of Selected Methods

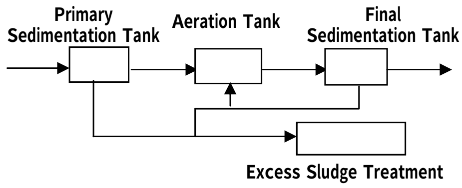
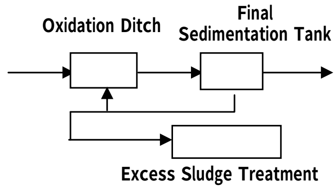
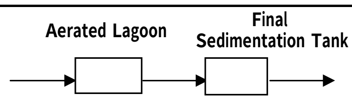
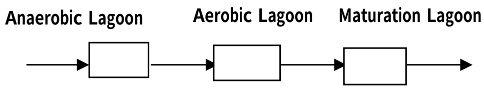
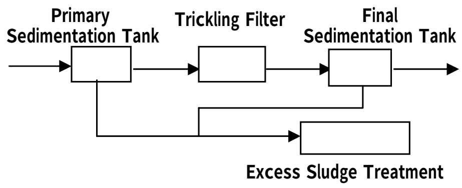
Methods	Process Component	Process Principle
Conventional Activated Sludge (CAS) Process		Wastewater Influent is mixed with the returned sludge from the final sedimentation tank. The oganic matters are oxidized and assimilated by the aerbic bacterias (aerobic heterotrops) grown up in the sludge.
Oxidation Ditch (OD) Process		Wastewater influent is mixed with the activated sludge in the Ditch. The organic matters are oxidized and assimilated by the activated sludge. The hydraulic retention time is longer than the conventional activated sludge process.
Aerated Lagoon (AL)		Organic matters in the wastewater influent is oxidized and assimilated by the aerobic bacterias grownup in the lagoon. The aerobic conditions can be kept by mechanical surface
Lagoon (LG)		Organic matters are degraded and assimilated by the bacterias under the both aerobic and anaerobic conditions. The aerobic conditions are generated by photosynthesis of algae.
Conventional Trickling Filter (TF) Process		While the wastewater influent flows through the suface of filter media, the organic matter is absorbed, oxidized and assimilated by the bio-film or bio-slime attached and grown on the filter media. When the bilofilm becomes too thick, the biofilm will be detached from the filter media. The detached biofilm is settled in the final sedimentation tank to treat at excess sludge treatment facility.

Table 11.24 Comparison of Five Wastewater Treatment Methods

Evaluation Item		**Conventional Activated Sludge Process (CAS)**	**Oxidation Ditch Process (OD)**	**Aerated Lagoon (AL)**	**Lagoon (LG)**	**Conventional Trickling Filter Process (TF)**	**Remarks**
Pollutant Removal Rate	BOD（%）	90(85－95)	90(85－95)	85（80—95）	85（80—95）	85（80－90）	
	SS（%）	90(85－95)	90(85－95)			85（80－90）	
Cost comparison	Construction	Very high	Expensive than TF	Cheaper than TF	Cheap	High	
	O/M	Very high	Expensive than TF	Cheaper than TF	Cheap	High	
Land area requirements for comparison		1	2	5	13.3	1.7	
Treatment performance	Against Flow variations	When the flow varies highly, flow adjustment tanks are required to install.	Reaction tank volume, hydraulic retention time of about one day, is large enough to adjust the flow variations, but the loads to the final sedimentation tanks will be increased.	Since lagoon volume is large enough, or hydraulic retention time of about two to six days is long enough, this process is strong against the flow variation.	Since the lagoon volume is very large, or hydraulic retention time of several weeks, this process is very strong against the flow variation.	Flexibility against the flow variation is depended on the fixed film growth conditions. When the fixed film is removed due to flow variations, special operation such as increasing number of filters operating will be required.	
	Against Pollution Loads	The same as the above.	Due to the same reason above, this process is stronger than the AS process.	Due to the above reason, this process is strong against the loads variation.	Due to the above reason, this process is strong against the loads variation.	Due to varieties of bacteria slime formed, this process is strong against the loads variation.	
	Main Treatment Characteristics	A bulking phenomenon can be occurred. Proper operation can protect the occurrence of bulking phenomenon. An installation of anaerobic tank prior to the aeration tank is also an appropriate protection measure.	Since mixed liquor is aerated long hours and the sludge settleability becomes lower, the supernatant discharge easily from the final sedimentation tank. Therefore, the surface loadings to the sedimentation tanks shall be set at lower value than those of AS.	Treatment performance depends on the oxygen supply capacity of aerators、proper operation and maintenance of the aerator is the key of the performance.	Weather conditions and dominant biological species in the lagoons are keys for the wastewater treatment performance.	Easy algae grown-up on the surface of filter media disturbs the uniform wastewater feeding and causes lower treatment performance. Removal of algae from the filter media is essential to maintain the performance.	
	The case when the treated wastewater quality becomes worse	When the settleability of activated sludge becomes worse, treatment performance becomes worse. In case a bulking phenomenon is occurred, the performance becomes the worst.	When the settleability of activated sludge becomes worse, treatment performance becomes worse.	When the oxygen supply capacity of surface aerator becomes lower.	In case of inconvenient weather conditions, such as rainy and low temperature.	When the biofilm or bio-slime formed on the surface of filter media is detached.	

Table 11.24 (Continued) Comparison of Five Wastewater Treatment Methods

Evaluation Item		Conventional Activated Sludge Process (CAS)	Oxidation Ditch Process (OD)	Aerated Lagoon (AL)	Lagoon (LG)	Conventional Trickling Filter Process (TF)	Remarks
Operation and Maintenance	Major Mechanical Equipment	Sludge collector at the primary sedimentation tank, Blower, Diffuser, Sludge pumps, Sludge collector at the final sedimentation tank. Various kinds of equipment are required.	Aerator, Sludge pumps, Sludge collector at the final sedimentation tank. Smaller kinds and numbers required compared to those of AS.	Surface aerator	No mechanical equipment is required to treat the wastewater.	Sludge collector at the primary sedimentation tank, Feeder pump, Distributor, and Sludge collector at the final sedimentation tank. Various kinds of equipment are required but more simple than those of AS.	
	Operation and Maintenance of the facility	Many facilities and equipment are required to operate and maintained regularly. Proper operation of returned sludge is very important for the good performance. This process requires many skilled operators and regular inspection.	Since the number of facilities and equipment requiring regular inspection is small, daily regular inspection is applicable. Proper operation of returned sludge is also required.	Regular inspection and Periodical Maintenance of surface aerators are required as well as the maintenance of lagoon.	Operation and Maintenance of the lagoon is very simple and does not require high technology. Equipment required regular inspection is very limited.	Number of facilities and equipment requiring regular inspection is small. This process does not require high technology.	
	Number of Staff for operation and maintenance	Large number of staff is required.	Small number of staff is required.	Medium number of staff is required between the case of lagoon and conventional trickling filter process.	Smallest number of staff is required.	Small number of staff is required.	
	Power Requirements	Large	Large	Large	No requirement	Small	
	Availability of the equipment	Since many kinds and large number of equipment are required, the availability is difficult.	Since the varieties of equipment are smaller than AS, the availability will be increased.	Since the surface aerator is major equipment, the availability is easy.	No mechanical equipment is required for treatment.	Many kinds but simple structured equipment is required, the availability may be increased to that of AS.	
	Sludge generation	Sludge volume produced is large. The sludge treatment and disposal is required.	Sludge volume produced is smaller than the AS process. The sludge treatment and disposal is required.	Sludge volume produced is between OD process and lagoon.	Sludge generation is quite small. Sludge accumulated in the lagoon is removed once a few years. Sludge treatment is not required.	Sludge volume produced is smaller than the AS process. The sludge treatment and disposal is required.	
	Sludge Quality	Under the proper operation, the sludge settleability is good. When the bulking phenomena occurred, the settleabiligy becomes bad.	The sludge settleability is worse than that of AS due to the longer aeration. Sluge dewaterability is lower to a mechanical method.	Due to longer aeration, the sludge settleability is worse than that of AS. But the sludge is stabled for treatment and disposal.	The sludge is settled and stabled in the lagoon. Sludge disposal from the lagoon is easy.	Since the sludge is mainly formed of the detached biofilm from the filter media, the setteability of sludge is good and sludge separation at the final sedimentation tank is easy.	

Table 11.24 (Continued) Comparison of Five Wastewater Treatment Methods

Evaluation Item		Conventional Activated Sludge Process (CAS)	Oxidation Ditch Process (OD)	Aerated Lagoon (AL)	Lagoon (LG)	Conventional Trickling Filter Process (TF)	Remarks
In case of power failure, adverse impacts and counter measures to be taken	Adverse impacts to the Havana Bay	The wastewater influent will be discharged without any treatment.	The same as AS.	The same as AS.	Once the wastewater influent is flowed into lagoons, the wastewater can be treated.	The same as AS.	
	Minimum capacity requirement of self power generator to maintain the process functions	Large (mainly for blowers and sludge pumps)	Large (mainly for aerators and sludge pumps)	Medium (mainly for surface aerators)	No requirement	Small (mainly for circulating pumps)	
Wastewater Treatment Plants (WWTP) uses the process in Cuba		WWTP at Varadero	WWTP at Trinidad	Not yet identified	WWTP at Varadero	WWTPs at Quibu and Maria de Carmen	
Adverse Environmental Impacts (Offensive odor, Noise, Vibration, etc.,)		Offensive odor produced from sludge treatment facilities will give adverse impacts to the surrounding areas, mitigation measures such as establishing buffer zone shall be taken. Prevention measures against noise and vibration generated by blowers shall be also taken, if necessary.	Offensive odor produced from sludge treatment facilities will give adverse impacts to the surrounding areas, mitigation measures against offensive odor shall be taken if necessary.	Mitigation measures against offensive odor shall be taken. Large area required for construction will give impacts to the habitats and ecology of the area.	The same as those of aerated lagoon.	Filter fly will be generated. Offensive odor will be produced from the primary sedimentation tank and sludge treatment facilities.	
Applicability of staged construction of treatment facilities	Applicability of Staged construction based on wastewater influent flow and quality	Possible	Possible	Possible but separated development of lagoon will require higher cost.	The same as the aerated lagoon.	Possible.	
	Performance when the wastewater influent quality is much lower than the design quality.	When the influent BOD concentration is lower than 100mg/L, difficulty in keeping proper MLSS concentration in the aeration tank may cause poor performance.	The same as that of AS.	No problems in the performance.	No problems in the performance.	No problems in the performance, due to an appropriate bio-film or bio-slime will be formulated.	
Applicability of the process to the new wastewater treatment plants in the Study Area (Havana Bay).		This process is applicable. In case of limited land area available but required to treat large volume of wastewater, mostly occurred in urban areas, this process is mostly applicable. However, this process requires higher construction and O/M costs and skilled operators to operate properly. It is essential to prepare comprehensive training programs of the operators.	The O/M of this process is easier than that of AS, however, this process may be difficult to apply for the Study Area because enough land area cannot be available.	This process is easy to operate and requires less land areas than those of lagoons. However, it is difficult to obtain the proper land area to construct the process.	This process is cheapest to construct and O/M among the process and is easy to operate. However, it is very difficult to obtain the proper land area to construct the process.	This process is easier to operate and cheaper in construction and O/M costs than those of AS. Land area requirement is larger than that of AS but smaller than those of other processes. The applicability of this process will be examined to the available land area.	

(2) Sludge Treatment Methods

Sludge treatment process consists basically following unit processes such as sludge thickening, anaerobic digestion without heating and sludge drying bed or mechanical sludge dewatering. This sludge treatment process is already practiced in Quibu and Maria del Carmen Wastewater Treatment Plants in the Havana city except the mechanical sludge dewatering.

Sludge thickening is aimed to reduce the sludge volume. A gravity thickening tank is applied basically for this purpose. Anaerobic digestion is aimed to facilitate degradation, volume reduction and stabilization of the sludge. An opened to the air type digester without any heating system is applied for this purpose.

Sludge dewatering and drying is aimed to reduce sludge volume and easy to handle for disposal. Sludge drying beds and mechanical sludge dewatering are compared as shown in the table below. The sludge drying bed is easy to operate and cheaper in construction and O/M costs and better for sludge re-use such as agricultural or greeneries. However, it requires large land area to construct and more space in urban areas when any mitigation measures are needed to the offensive odor generated. As a conclusion, sludge drying beds are planned basically when the land area will be available enough, and mechanical sludge dewatering units are introduced to cover the remaining sludge to be treated. In case when the land area is very limited, the combination of sludge thickening and mechanical dewatering will be also planned.

Dewatered and dried sludge will be disposed off at sanitary land disposal site in principle.

Table 11.25 Comparison of Sludge Dewatering Process

Parameters	Sludge Drying Bed	Mechanical Dewatering
Water Content	Possibly reduced up to 60%.	Possibly reduced up to 80%.
Land area requirements	Large area is required to construct. The applicability will be examined based on the drying period of 11 days: design value applied to the Quibu WWTP	Very limited area is enough to install the mechanical equipment: Belt-press dewatering equipment.
Easiness to O/M and required technology level	Visual inspection of sludge drying conditions and removal of dried sludge are required. Any high skills are not required ◎	It is required the daily inspection and regular maintenance for the equipment, and regular preparation and adjustment of coagulant aid. Technology and skills are needed to operate and O/M of the equipment. △
Availability of the equipment and spare parts	Valves and piping works are major facilities, thus the spare parts are easily available. ◎	Mechanical equipment and coagulant aids are necessary to import from other countries, thus the spare parts are also not easily available. △
Adverse environmental impacts to the surrounding area	Offensive odor will be generated from the sludge drying bed. Near residential areas some mitigation measures require more land area of buffer zone to reduce the odor. △	Offensive odor will be generated. Expensive mitigation measures can be taken at the house building: closing building or introducing deodorization equipment. △
Construction Cost	Low ◎	High △
O/M Cost	Low ◎	High △
Reuse of Sludge	Agricultural usage is promising because urban agriculture is popular using organic fertilizer. ◎	Water content is higher and direct reuse of sludge may be difficult. △
Experience in Cuba	Experienced or practiced in Quibu, Maria del Carmen, others WWTPs ◎	Limited experience and planned at WWTP to be constructed partially financed by Italy government. △

Note: Figures in above tables show a three ranked evaluation: ◎ good, ○ fair, △ not good