nesses are to be promoted seeking to legalize the informal sector. Industry is to be promoted by creating an industrial development pole in Guaxindiba.

A water transportation terminal is to be constructed at Porto da Madama, seeking to improve mass transportation which is currently dependent on buses using the already congested Rio-Niteroi bridge, and the ferry service between Rio and Niteroi. A technical study for the boat service between Sao Goncalo (Porto da Madama) and Rio de Janeiro was completed by the Transportation Secretariat of the State in 1991. Also, railroads are to be reactivated to complement the boat service between Rio and Porto da Madama, so as to spread the benefits of improved mass transportation to residents of Sao Goncalo living far from the coast.

(4) Nova Iguacu

The Municipal Development Master Plan was formulated in 1991 with a 5-year planning horizon. The Master Plan is to have jurisdiction over the Districts of Queimados and Belford Roxo, which are soon to become independent Municipalities, until such a time as the newly established Municipalities formulate their own Development Master Plans.

The Master Plan provides basic guidelines for public and private agents on matters relating to land use, rationalization of public investments, and environmental preservation and protection, with the purpose of promoting the well-being of the people and the economic growth.

On environmental matters, the Master Plan seeks recuperation of degraded areas, adoption of alternative technology for the disposal of solid wastes and sewage. Likewise, industries to be promoted are those compatible with environmental protection. In the practical implementation of projects, coordination with other surrounding Municipalities is to be pursued, so as to achieve more efficient and integrated solutions.

Zoning includes Urban Areas, Rural Areas, and Areas of Restricted Occupation. One of the Restricted Areas is the Special Environmental Interest Zone, which is defined as those areas showing characteristics worthy of preservation or recuperation from the viewpoints of fauna and flora, topography or scenery, protection of water source or water quality, and cultural or historical values.

Examples of Special Environmental Interest Zones are the Atlantic Forest, the Madureira Range, the Fazenda Sao Bernardino, and some railroad stations such as Adrianopolis, Japeri, Tingua and Rio d'Ouro. Tourism and leisure activities are to be promoted in some of the said areas such as Fazenda Sao Bernardino, Rio d'Ouro and Tingua. An example of Permanent Preservation Areas is the Tingua Biological Reserve where no activity affecting the flora and fauna is permitted.

Industrial activities, especially those of medium and large scale, should be located in the Exclusively Industrial Use Zone (ZEI) which is the Industrial District of Campo Alegre in Queimados. Small scale industries are to be permitted in Diversified Use Zones, while mini to small industries are to be permitted also in Residential Zones.

Environmental and sanitary conditions are to be improved, as preconditions for better living standards of the people, by gradually expanding sewer service coverage, by promoting community participation in the solution of sanitation problems, and by defining priority areas. Sanitation improvement is to be pursued through coordinated actions in the following areas: drainage, sewer service, solid wastes disposal, water supply, and control of disease vector.

(5) Nilopolis

The Municipal Development Master Plan, formulated in February 1992 with a 5-year planning horizon, has the objectives of improving the quality of life, socioeconomic development coordinated with the Baixada Fluminense-the Metropolitan Rio-the Rio de Janeiro State, so as to increase employment and to improve income distribution. Regional integration is to become especially relevant on environmental matters concerning drainage, water supply, sewer system and solid wastes disposal.

The objectives are to be pursued through a balanced land use, implementation of sectoral projects, and dynamization of economic activities. For these purposes, the Municipal Development Master Plan is to provide the basic framework and directives.

Land use is to be based on the following three macrozoning categories.

1. Urban macro-zone

2. Restricted use macro-zone (non-building area)

3. Special macro-zone (Gericino military camp)

Banned from urban areas are polluting industries and storage of explosives.

The infrastructure policy gives high priority to water supply, sewer works and solid wastes disposal. The Mayor is authorized to sign agreements with financial institutions, so as to implement relevant sectoral projects.

Macro-drainage of Sarapui and Pavuna Rivers, although the responsibility of the State government, is to be given support by the Nilopolis Municipal government, in coordination with other municipalities of the Baixada Fluminense.

(6) São João de Meriti

The Development Master Plan formulated in 1991 seeks a socially just and ecologically balanced land use in pursuance of people's welfare. The Master Plan is to regulate urban development and to guide actions of public and private agents.

Since the Municipality is fully urbanized, intensity of land use is to be balanced with available infrastructure and transportation, in addition to environmental considerations. New housing developments are to be located near employment sites, or viceversa. Mass transit is to be improved, and supply of basic sanitation is to be expanded with the purpose of improving standards of living.

(7) Duque de Caxias

The Municipality of Duque de Caxias has hired a consulting firm for the preparation of the Municipal Development Master Plan. The consulting firm submitted the first half of the job, "Basic Report on the Characteristics of the Municipality", in July 1992. This report contains basic information and data on natural and socioeconomic characteristics, land use, urban infrastructure, transportation systems, service infrastructure and financial resources of the Municipality.

The second half of the job, the Municipal Development Master Plan, is expected to be completed soon.

(8) Itaborai

As of October 1992, the Municipality of Itaborai had a draft of a Municipal Law to promulgate the Municipal Development Master Plan, but without convincing proof of actual passage of the law.

The draft of the law seeks to improve quality of life of the people by gradually expanding basic service infrastructure, preservation of natural resources especially soil and water, and reduction of pollution to acceptable levels.

(9) Mage

There is no Municipal Development Master Plan in Mage. However, legal provisions on their development activities are presumed to be up-to-date, since they were promulgated in 1991. These include the Zoning Law, the Land Parceling Law, and the Law on Municipal Works.

The Zoning Law provides for Preservation and Protection Areas, which are defined as forests and natural vegetation --including mangrove forests-- where land use is to strictly abide with the Federal Forestry Law.

The Land Parceling Law provides for protection of water courses. Land parceling is to be conducted only with prior approval granted by the Colonization and Agrarian Reform Institute (INCRA), by the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) and by the State Forestry Institute (IEF).

(10) Rio Bonito

The Municipality of Rio Bonito has not yet prepared the Development Master Plan. Their development guidelines are contained in their Zoning Law and Land Parceling Law, both presumably promulgated in 1979. On their own recognition, these laws are grossly outdated and inadequate for present conditions. For example, housing developments are reportedly expanding at present into areas originally classified as Areas of Permanent Preservation. These were defined as forests and vegetation existing along water courses or around water bodies, on mountain tops and on slopes exceeding 45 degrees.

(11) Cachoeiras de Macacu

This Municipality has neither a Municipal Development Plan nor zoning and related laws serving as guidelines for their development activities. However, they are actively negotiating with the Inter-American Development Bank (BID) to expand their sewer service coverage. In addition, they are in the final stages of establishing an Industrial District, in which eight industries were committed to operate as of October 1992.

2.2.1.3 The Environment in the Development Plans

The State and Municipal Development Master Plans, or zoning and related laws in the absense of such Plans, were reviewed above. They all contain provisions on environmental protection, but without sufficiently concrete details on development activities. Therefore, these Development Master Plans are not specific enough to serve as basis for estimating future socioeconomic conditions in the Guanabara Bay basin.
Ironically, Cachoeiras de Macacu, which is a Municipality without a development plan and without zoning and related laws, has taken the initiative to establish an Industrial District, and to directly negotiate with BID for financing the expansion of sewer services. The sewer infrastructure usually requires large investments, whereby Municipalities usually rely on other government institutions for the provision of these services.

Municipalities can be said to have the basic legal provisions for environmental protection. Likewise, municipal governments purport to protect the environment, and to pursue the type of economic development which is compatible with the rational utilization of natural resources, in order to avoid irreversible damages to the environment. In this regard, even in the promotion of manufacturing industries, the emphasis is on "environmentally friendly" or "non-polluting" industries.

The parts that need to be strengthened are the application or enforcement of the existing laws, and the lack of specific details on types, scales and time frames of industries and other activities to be promoted as basis for socioeconomic development. Therefore, these two weaknesses need to be dealt with by the relevant State and Federal Institutions.

Concerning the enforcement of environmental legislation, the hope can be placed on the Rio de Janeiro State Development Plan, which deals with the establishment of an "environmental crime prevention force". The implementation of this idea, if coupled with necessary financial, technical and institutional support, can turn out to be a great contribution in instilling life into the numerous environmental laws, which currently are not effectively enforced.

In reference to the promotion of "non-polluting" industries, the role of FEEMA will be critical, as one of its functions is to monitor and control industrial effluents according to established water quality standards. If the monitoring and control are effectively implemented, then manufacturing industries will indeed be "non-polluting" and "environmentally friendly".

2.2.2 Existing Environmental Improvement Projects

2.2.2.1 Rio-Reconstruction Project

The Rio-Reconstruction Project was formulated with the World Bank financing to deal with the aftermath of the disastrous flood of February 1988. The purpose of the Project was prevention of such destructive floods, and included environmental improvement measures. The Project area includes Rio de Janeiro, Baixada Fluminense (Nilopolis, Sao Joao de Meriti, Nova Iguacu, Duque de Caxias) and Petropolis, but the bulk of investments is concentrated in the Baixada Fluminense, which is the area hardest hit by the floods. The Project is administered by GEROE (Executive Group for Recuperation and Emergency Works) to carry out construction works, acquisition of equipments, provision of new services and preparation of plans for the prevention of floods. The project components that remain to be implemented are shown in **Table 2.2-1**.

The basis of the Project is environmental education and provision of services for solid wastes disposal and sewer systems, as well as implementation of programs on reforestation and resettlement of families. Drainage and dredging works target rivers and channels which flow into the Guanabara Bay, such as Sarapui, Pavuna, Cunha, Iguacu, Saracuruna and Inhomirim.

The Project has been continuously adjusted, and environmental improvement components to be implemented between 1992 and 1994 are summarized below.

Component	Foreign Cost(1)	Local Cost(1)	Beneficiaries (2)
Sewer System	10.74	16.10	1,000,000
Solid Wastes	2.36	4.38	2,000,000
Reforestation	3.98	4.38	1,200ha
Drainage	54.42	54.42	3,000,000

(1)Cost: Million U.S.$
(2)Beneficiaries: Persons, if not specified

2.2.2.2 Basic Sanitation Program

The detailed formulation of this huge environmental program was expected to be finalized in November 1992. It is composed of more than 20 projects on sewer systems, solid wastes disposal, drinking water supply and human resettlements in Municipalities adjacent to the Guanabara Bay. The foreign cost components of the projects are to be financed jointly by the Inter-American Development Bank (IDB) and the Overseas Economic Cooperation Fund (OECF) of Japan. For the administration of this Program, the Governor of Rio de Janeiro established the Executive Group for Pollution Control of the Guanabara Bay (GEDEG) through Decree No. 17136 of December 12^{th}, 1991. GEDEG has been recently changed to CODEG (Coordinating Commission for the Execution of the Pollution Control Program of the Guanabara Bay).

The original projects of the Program are listed below, and **Table 2.2-2** presents the most recent version of the Program by component groups.

1. Sewer System of the Alegria Basin and Improvement of Penha Sewage Treatment Station

2. Sewer and Sewage Treatment System in the River Basins of Pavuna/Acari/Sao Joao de Meriti

3. Sewer and Sewage Treatment System of Sarapui River Basin

4. Sewer and Sewage Treatment System No. 2 of São Goncalo

5. Expansion of Icarai Sewage Treatment Station and Undersea Marine Sewage Pipe

6. Sewer and Sewage Treatment System for North-Central Zone of Niteroi

7. Water Supply System Sectorization for the Baixada Fluminense

8. Water Supply System Sectorization for Sao Goncalo

9. Operation Improvement and Micro-metering

10. Macro-drainage and Resettlement in the Acarai River Basin

11. Macro-drainage and Resettlement in the River Basins of Faria and Timbo

12. Treatment of Hospital Wastes

13. Improvement of Gramacho Metropolitan Landfill

14. Improvement of Collection and Final Disposal of Solid Wastes in Niteroi

15. Improvement of Solid Wastes Collection and Transfer Stations of Nilopolis

16. Improvement of Solid Wastes Collection and Transfer Stations of São João de Meriti

17. Improvement of Collection and Final Disposal of Solid Wastes in Mage

18. Improvement of Collection and Final Disposal of Solid Wastes in Duque de Caxias

19. Improvement of Collection and Final Disposal of Solid Wastes in Sao Goncalo

20. Organizational and Institutional Support for Solid Wastes Management in the Rio de Janeiro State

21. Complementary Environmental Projects

22. Digital Cadaster of the Municipalities in the Guanabara Bay Basin

23. Development of Cadastral Information Center of IPLANRIO

The total cost of the Program was originally estimated at US$ 667 Million , but it has been revised up to US$ 793 Million (US$ 350 Million financed by the IDB, US$ 294.2 Million by the OECF of Japan and US$ 148.8 Million of local funds by CEDAE and the Rio de Janeiro State).

Table 2.2.1 Remaining Components of Rio-Reconstruction Project (World Bank)

Project	Start Yr.	End Yr.	Cost (Million US$) Foreign	Local		Capacity or Size	Number of Beneficiary	Executing Agency
Road System	1992	1993	19.04	6.35	ERJ	8000 cars/d	50000/d	FUNDERJ
Drainage	1992	1994	54.42	54.42	CEF	125000 ha	3000000	SERLA
Sewer Works	1992	1993	10.74	16.10	CEF	70km collector 17000 connect.	1000000	CEDAE
Solid Wastes Disposal	1993	1994	2.36	4.38	ERJ	90% coverage	2000000	SOSP
Reforestation	1992	1993	3.98	4.38	ERJ	1200 ha		FIEF
Urbanization	1992	1993		11.24	CEF	3400 plots	20000	CEHAB/ COFLUHAB
Pipeline Rehabilitation	1992	1993		3.88	CEF	5.5 km	250000	CEDAE/ CAEMPE
Civil Defense	1992	1993	6.08			23 equipments		CIVIL DEFENSE
Technical Assistance	1992	1994	13.78			37 contracts		GEROE/ Others
Land Protection	1992	1993		36.04	CEF	84 works	100000	PMN/PMP
School Rehabilitation	1991	1992		0.68	CEF	16 schools	8000	PMN
TOTAL			110.40	137.47				

Table 2.2.2 Basic Sanitation Program (IDB)

Project	Executing Agency	Investment (Mill.US$)
Component I: Sanitation		535.22
Sectorization Baixada Flum.	CEDAE	38.20
Sectorization Sao Goncalo	CEDAE	22.60
Operation Improvement	CEDAE	64.80
Alegria System	CEDAE	145.16
Pavuna System	CEDAE	73.56
Sarapui System	CEDAE	71.78
Sao Goncalo System 2	CEDAE	58.17
South Niteroi-Icarai System	CEDAE	18.08
Ilha do Governador System	CEDAE	13.05
Ilha de Paqueta System	CEDAE	2.90
Penha Sludge System	CEDAE	2.25
Sludge Disposal	CEDAE	11.27
Favelas	CEDAE	13.40
Component II: Macro-drainage		12.40
Acari River Basin	SERLA	12.40
Component III: Solid Wastes		18.30
Niteroi	SOSP	3.79
Nilopolis	SOSP	1.22
Sao Joao de Meriti	SOSP	2.09
Mage	SOSP	2.91
Duque de Caxias	SOSP	1.38
Sao Goncalo	SOSP	5.26
Institutional Strengthening	SOSP	1.65
Component IV: Complementary Environmental Projects		17.85
Pollution Control	FEEMA	4.11
Environmental Monitoring	FEEMA	2.03
Environmental Education	FEEMA/IEF/ SERLA	4.22
Institutional Strengthening	FEEMA/IEF/ SERLA/ SEMAM/ CODEG	7.49
Component V: Digital Mapping		12.30
Mapping and cadaster	CIDE	12.30

2.3 Futures Socioeconomic Framework of the Guanabara Bay Basin

2.3.1 Target Years of the Master Plan

There is no scientific method to set the target year of a water pollution control master plan. The method can only be subjective, although the degree will vary from project to project. For setting the target year, due consideration should be paid to ongoing plans and projects. State and Municipal development master plans are usually prepared with a 5-year planning horizon, which is too short for a large scale water pollution control plan. Worse yet, the reviewed State and Municipal development plans did not contain quantified details nor sector-specific goals. On the other hand, the World Bank financed Rio-Reconstruction Project is nearing completion. Consequently, the only relevant project to be taken into account to set the target year for the Master Plan for the Recuperation of the Guanabara Bay Ecosystem (hereinafter the "Master Plan") is the already mentioned "Basic Sanitation Program of the Guanabara Bay Basin" (hereinafter the "Program").

According to the loan request document submitted to BID in December 1992, the Program has five major components: Sanitation (Water Supply and Sewerage), Macro-drainage and Human Resettlement, Solid Wastes, Complementary Environmental Programs, and Digital Mapping and Tax Collection. The proposed implementation schedule spans from 1992 to 2005, originally estimated at a total cost of US$ 667 Million, later revised up to US$ 793 Million, to be jointly financed by BID, OECF of Japan, and Brazil.

The extremely large scale of the Program, and the equally large scale improvements in water quality which are expected from its implementation, make it necessary to set the target year for the Master Plan beyond the implementation period of the Program. Further, water quality improvement will not occur instantaneously after completing implementation of the Program in 2005. In addition, administrative measures, and the institutional reforms that may be needed, are estimated to require a lot of time to be implemented.

Under the foregoing considerations, the following target years are proposed for the Master Plan.

Short-term

Target year 2000: Completion of sewerage works to be implemented by the Program, that is, completion of Phase I

Medium-term

Target year 2010: Full completion of the Program; although a water quality improve ment project requires a longer time frame, the estimation of future conditions becomes even more difficult and unreliable

Long-term

The target year is not explicitly set. The goal is the recovery of the Guanabara Bay water quality to the level that prevailed during the first half of the 1960s.

2.3.2 Future Socioeconomic Scenarios

Formulation of a pollution control master plan implies the need to envisage the socioeconomic situation that is likely to prevail some time in the future (target year). This will be the result of changes in population, presence or lack of a diversity of measures that the government usually implements, leading ultimately to a particular way of life and living standards. The future socioeconomic situation defines changes in discharge of pollutants, and influences the choice of pollution control measures to be applied. The reverse is also true, that is, pollution control measures have definite effects on the future socioeconomic conditions.

2.3.2.1 Bases for Future Scenarios

The present master plan has two target years: 2000 and 2010. Socioeconomic scenarios for the two target years are to be defined in terms of (1) population, (2) coverage of basic services: water supply, sewerage and solid wastes disposal, and (3) economic activities, including changes that are bound to occur in the land area under cultivation, and the sector-specific growth rates.

(1) Population

Population projection usually falls under the jurisdiction of official institutions, because they have access to all the necessary background data and information which are frequently unavailable to outsiders. However, the two relevant official Brazilian institutions in charge of census and statistics, IBGE at the national level and CIDE at the Rio de Janeiro State level, have no population projections.

Under this situation, the alternatives are either to use the population projection of the IDB financed Basic Sanitation Program, or use past population growth trends to subjectively estimate Municipality-specific growth rates. Using the population projection of the Basic Sanitation Program has the advantage of providing consistency to the population data for plans relating to the Guanabara Bay basin, but the drawbacks are the partial coverage of the basin and the lack of breakdown by Municipality.

(2) Coverage of Basic Services

Concerning the coverage of basic services (water supply, sewerage and solid wastes disposal), the source for future socioeconomic scenarios should normally be the regional development plans. However, the reviewed State and Municipal development plans contain broad policy objectives without sector-specific quantitative goals. In addition, the planning horizon of these development plans is usually five years, shorter than the target years for the pollution control master plan.

Consequently, the IDB financed Basic Sanitation Program for the Guanabara Bay basin contains the only concrete data that can be taken into consideration in the estimation of future coverage of solid wastes disposal services in some Municipalities.

(3) Economic Activities

Estimation of types and scales of future economic activities is the most difficult proposition, especially in view of the abnormal situation of the Brazilian economy during the past decade. The hope of relying on development plans, both at the State and Municipal levels, turned out to be impractical, because such plans generally lack sector-specific quantitative goals. Encouraging , however, is the emphasis placed on promoting "environmentally friendly" or "non-polluting" industries. This opens the possibility for estimating future pollutant discharge as reductions from present levels, instead of basing on types and scales of future industrial activities.

An alternative is to estimate future economic activities on the basis of existing data, namely, various censuses (1960, 1970, 1980 and 1985) of agriculture, industry and services. The future is to be estimated by economic sector, from base figures of selected sector-specific indicators and subjectively assumed rates of growth. The growth rates of these selected indicators should keep a balance between those showing the expanding "Brazilian miracle" economy of the 1970s and those reflecting the foreign-debt ladden sluggish economy of the 1980s.

Selected Indicators

Primary Sector : Area of land under cultivation by, Municipality in 1985

Secondary Sector : Number of employees by industry type, in Metropolitan Rio de Janeiro in 1985

Tertiary Sector : Number of employees in the food and lodging services, by Municipality in 1985

Another conceptually possible procedure in estimating future economic activities is to start from the population projections. Then, the economically active population can be estimated and proportionatelly distributed among economic sectors.

2.3.2.2 Assumptions for Future Scenarios

(1) Case 1 - Expected Scenario

Population growth: slowing and stabilizing

Basic Services : expanding as per IDB Program

Economy : "clean" industries and services

POPULATION GROWTH

Population growth is assumed to slow down and stabilize around the year 2005. This is the theory of the World Bank, whereby the Brazilian population growth rate will equal the replacement rate, or zero population growth (ZPG), in the year 2005. As the overall population growth rate in Brazil between 1980 and 1991 was 1.87% per year, the natural population growth rate is assumed to be a moderate 2%.

For purposes of population projection, the Municipalities of the Guanabara Bay basin were divided into four groups on the basis of past population growth trends. Then, future population growth rates were subjectively estimated by Municipality and by time span. The assumed population growth rates will be smaller the farther into the future the relevant time span is. This reflects increasing difficulties to predict the more distant future, and can be defended on grounds of the future expansion of opportunities for women's education, which is widely recognized as the most significant factor for an effective family planning.

The assumed growth rates by Municipality and by time span in the four groups are shown in **Table 3.2-1**. The four groups are the following.

"Grown" (Rio de Janeiro, Niteroi, Nilopolis, Sao João de Meriti)

"Grown" Municipalities consist of those fully urbanized, with very high population densities. Very low population growth rates were observed in the recent past and are presumed to occur in the near future in these Municipalities. Further, the very slow population growth (0.5%-0.75%) is assumed up to 2005, when population is assumed to stabilize.

The assumed population growth rates are as follows.

1992-2000: 0.5%-0.75%
2001-2005: 0.5%
2006-2010: 0.0%

"Growing" (Sao Goncalo, Itaborai, Rio Bonito)

"Growing" Municipalities consist of those presently growing or are likely to grow in the near future. This is based on the observation of on-going housing developments in Sao Goncalo and the expansive economy of Itaborai. These effects are likely to spill over onto Rio Bonito, which presently serves as the commercial center bridging Metropolitan Rio de Janeiro and the surrounding rural areas. The growth expected in "growing" municipalities is induced by the saturation of "grown" municipalities.

The assumed population growth rates are as follows.

1992-2000: 2.0%-4.0%
2001-2005: 2.5%
2006-2010: 0.5%-1.0%

"Next-to-grow" (Mage, Cachoeiras de Macacu)

"Next-to-grow" Municipalities consist of those likely to grow slightly later than the "growing" municipalities, even though chances are that they will grow at about the same time. Mage is slowly changing from an area of weekend houses and private recreation facilities to an area with houses where people normally live and from which they commute to work. Cachoeiras de Macacu, although too far for daily commuting to Metropolitan Rio de Janeiro, is likely to have a population inflow induced by the establishment of an industrial park with the cooperation of CODIN, plus the efforts to begin installation of sewer works by the Municipal government.

The assumed population growth rates are as follows.

1992-2000: 2.0%
2001-2005: 3.0%
2006-2010: 1.0%

"Possible Growth" (Duque de Caxias, Nova Iguacu)

"Possible Growth" Municipalities consist of those relatively large communities (over half a million), practically fully urbanized, but with insufficient service infrastructure. These Municipalities are assumed to have a moderate natural growth rate.

Both the World Bank and the IDB have targeted this area to improve living conditions through provision of flood control infrastructure, and services of water suppy, sewer and solid wastes disposal. Given the convenient location of these Municipalities within the Metropolitan Rio de Janeiro, if living conditions improve as a result of the World Bank and IDB projects, population inflow is likely to occur from the saturated "grown" municipalities into these "possible growth" municipalities. However, this population inflow is considered to be short lasting, quickly reaching the zero population growth stage.

The assumed population growth rates are as follows.

1992-2000: 2.0%
2001-2005: 2.5%
2006-2010: 0.0%

BASIC SERVICES

Service coverage rates of water supply, sewerage and solid wastes disposal are assumed by taking into consideration the IDB financed Basic Sanitation Program. In general, the following coverage is to be assumed.

* Municipalities with IDB Projects

  2000: 90%-100%
  2010: 100%

* Rio de Janeiro and Niteroi

  2000: 100%
  2010: 100%

* Other Municipalities

  2000: 70%
  2010: 90%

Detailed growth rates by Municipality and by time span are shown in **Tables 3.2-2, 3.2-3 and 3.2-4**.

ECONOMY

An attempt was made to reflect the Regional Development Plans, which appear to promote the service sector. Accordingly, the tertiary sector is to grow at the fastest rate. The growth of the manufacturing sector is to be relatively slow, as incentives are mainly focused on those industries without adverse environmental effects. Since manufacturing grows rather slowly, farming, in addition to the service sector, is to grow at a faster rate.

Primary Sector

The future of the primary sector is to be estimated as a function of the land area under cultivation by Municipality in 1985, which is the year with the latest available census data.

Growth rates of land area under farming were subjectively estimated by Municipality for both periods encompassing 1986-2000 and 2001-2010, as shown in **Table 3.2-5**.

Secondary Sector

The future of the secondary sector is to be assumed as a function of the number of employees by industry type in Metropolitan Rio de Janeiro in 1985, which is the year with the latest available census data. Because manufacturing activities are concentrated in Metropolitan Rio de Janeiro, it was deemed appropriate to represent the Guanabara Bay basin with these data rather than the Municipality-specific data. In addition, the selected industry types accounted for more than 80% of employment in the secondary sector in 1985.

Following a similar procedure as in the primary sector, growth rates of the number of employees by industry type were subjectively estimated for Metropolitan Rio de Janeiro for both periods encompassing 1986-2000 and 2001-2010, as shown in **Table 3.2-6**.

Tertiary Sector

The future of the tertiary sector is to be assumed as a function of the number of employees in the lodging and food service by Municipality in 1985, which is the year with the latest available census data. Following a similar procedure as in the primary and secondary sectors, growth rates of the number of employees in the lodging and food service were subjectively estimated by Municipality for the two periods encompassing 1986-2000 and 2001-2010, as shown in **Table 3.2-7**.

(2) Case 2 - Pessimistic Scenario

Population growth: increasing even after 2005

Services : lower coverage than the IDB Program

Economy : "dirty" industries keep growing

POPULATION GROWTH

The World Bank assumption of zero population growth since the year 2005 is assumed to materialize only in the Municipalities of Nilopolis and Sao Joao de Meriti, which at present have the highest population densities. Population growth is assumed to continue into the future, albeit at a slower rate. However, for the 1992-2000 period, population growth rates are assumed to be the same as in Case 1, as shown in **Table 3.2-1** and summarized below.

"Grown" Municipalities

1992-2000: 0.5%-0.75%
2001-2005: 0.5%
2006-2010: 0.0%-0.5%

"Growing" Municipalities

1992-2000: 2.0%-4.0%
2001-2005: 2.5%
2006-2010: 0.5%-1.0%

"Next-to-Grow" Municipalities

1992-2000: 2.0%
2001-2005: 3.0%
2006-2010: 1.0%

"Possible Growth" Municipalities

1992-2000: 2.0%
2001-2005: 2.5%
2006-2010: 1.0%

BASIC SERVICES

Service coverage of water supply, sewerage and solid wastes disposal is assumed to be lower than the target of the IDB financed Basic Sanitation Program. The assumed coverage rates are shown in **Tables 3.2-2 to 3.2-4** and are summarized as follows.

* Municipalities with IDB Projects

  2000: 70% - 90%
  2010: 80% - 100%

* Rio de Janeiro and Niteroi (same as Case 1)

  2000: 100%
  2010: 100%

* Other Municipalities

  2000: 50% - 70%
  2010: 70% - 90%

ECONOMY

The difference in assumptions from Case 1 concerning economic activities refers mostly to the secondary sector. Here, the manufacturing sector, including "polluting" industries, are assumed to keep growing at a faster rate than the primary and the tertiary sectors. Accordingly, the growth rates are to be relatively slower in farming and the service sectors. The assumed growth rates are shown in **Tables 3.2-5 to 3.2-7.**

2.3.3 Socioeconomic Framework in the Target Years

The socioeconomic scenarios described in Section 3.2 served as bases for estimating the socioeconomic framework for the Guanabara Bay basin in the two target years 2000 and 2010. Details are shown in **Tables 3.3-1 to 3.3-7**, and summarized in **Table 3.3-8**.

2.3.3.1 Population

The 1991 population census data for the Municipalities comprising the Guanabara Bay basin were projected to the target years with the assumed growth rates, and resulted in the summary below. Scenario 1 represents a slowing population growth, stabilizing around the year 2005 according to the World Bank theory, while Scenario 2 assumes that the population in most Municipalities keeps growing after 2005.

1991 Census	9,471,951
Scenario 1	
2000	10,629,649
2010	11,376,950
Growth rates	
1992-2000	1.29%/yr.
2001-2010	0.68%/yr.
Scenario 2	
2000	10,629,649
2010	11,670,796
Growth rates	
1992-2000	1.29%/yr.
2001-2010	0.94%/yr.

2.3.3.2 Coverage of Basic Services

The coverage of basic services in the Guanabara Bay basin, at present and the projections for the two scenarios, is presented below. The figure in parentheses refers to the percentage of the serviced population relative to total population. Scenario 1 represents achievements of coverage goals consistent with the BID Basic Sanitation Program, while Scenario 2 assumes lower coverage.

(1) Solid Wastes Disposal

Present	7,115,316 (75.1%)
Scenario 1	
2000	9,831,045 (92.5%)
2010	11,163,463 (98.1%)
Scenario 2	
2000	8,962,932 (84.3%)
2010	10,649,977 (91.3%)

(2) Water Supply

Present	7,390,507 (78.0%)
Scenario 1	
2000	10,176,766 (95.7%)
2010	11,336,825 (99.6%)
Scenario 2	
2000	9,558,759 (89.9%)
2010	11,132,674 (95.4%)

(3) Sewerage

Present	5,272,870 (55.7%)
Scenario 1	
2000	10,069,896 (94.7%)
2010	11,309,529 (99.4%)
Scenario 2	
2000	8,531,207 (80.3%)
2010	10,874,346 (93.2%)

2.3.3.3 Economy

The economic framework in the Guanabara Bay basin is described in reference to the sectoral growth rates. Scenario 1 represents a relatively slow growth rate in the manufacturing sector, due to the emphasis in the service sector and "clean" industries. Consequently, the relatively strong primary sector growth reflects absorption of some labor displaced from the manufacturing sector. Accordingly, there is an increase in the cultivated land area.

On the contrary, Scenario 2 represents a less than expected growth rate in the service sector, which coupled with the continued growth of "dirty" industry types, provide employment opportunities in the secondary sector. Accordingly, the primary sector grows relatively less and the cultivated land area is smaller.

(1) Primary Sector

Cultivated land area (ha)

Present (1985)	118,488
Scenario 1	
2000	134,916
2010	140,811
Scenario 2	
2000	122,117
2010	124,630

Primary sector growth rates (%/yr.)

Present	
1980-1985	0.56
Scenario 1	
1986-2000	0.87
2001-2010	0.43
Scenario 2	
1986-2000	0.20
2001-2010	0.20

(2) Secondary Sector

Employment in 12 selected industries

Present (1985)	346,625
Scenario 1	
2000	407,766
2010	463,193
Scenario 2	
2000	485,064
2010	581,617

Secondary sector growth rates (%/yr.)

Present	
1980-1985	-2.29
Scenario 1	
1986-2000	1.09
2001-2010	1.28
Scenario 2	
1986-2000	2.27
2001-2010	1.83

(3) Tertiary Sector

Employment in lodging and food service

Present	
1985	100,849
Scenario 1	
2000	157,456
2010	208,776
Scenario 2	
2000	136,624
2010	152,251

Tertiary sector growth rates (%/yr.)

Present	
1980-1985	2.03
Scenario 1	
1986-2000	3.01
2001-2010	2.86
Scenario 2	
1986-2000	2.04
2001-2010	1.09

Table 3.2-1 Population Growth Rate

Municipalities	Calculated				Estimated		
	60-70	70-80	80-91	1992-2000	1-5	Sc.1 6-10	Sc.2 6-10
Grown							
Nilópolis	3.02	1.70	0.37	0.5	0.5	0.0	0.0
Niteroi	2.92	1.84	0.43	0.75	0.5	0.0	0.5
Rio de Janeiro	2.62	1.66	0.43	0.75	0.5	0.0	0.5
Sao Joao de Meriti	4.73	2.79	0.58	0.5	0.5	0.0	0.0
Growing							
Sao Goncalo	5.81	3.63	1.79	3.0	2.5	0.5	0.5
Itaborai	4.78	5.62	3.16	4.0	2.5	1.0	1.0
Rio Bonito	2.32	1.27	1.09	2.0	2.5	1.0	1.0
Next-to-Grow							
Magé	6.83	3.93	1.27	2.0	3.0	1.0	1.0
Cachoeiras de Macacu	2.39	0.67	1.04	2.0	3.0	1.0	1.0
Possible Grwoth							
Duque de Caxias	5.99	2.89	1.31	2.0	2.5	0.0	1.0
Nova Igucacu	7.38	4.17	1.48	2.0	2.5	0.0	1.0

Source: Calculated from Census data

Table 3.2-2 Coverage of Solid Waste Disposal Services

Unit: %

Municipalities	Present	Scenario 1 2000	Scenario 1 2010	Scenario 2 2000	Scenario 2 2010
Cachoeiras de Macacu	-	70	90	50	70
Duque de Caxias	56	90	100	80	90
Itaborai	21	70	90	50	70
Mage	28	100	100	50	70
Nilopolis	71	90	100	80	90
Niteroi	80	100	100	100	100
Nova Iguacu	39	70	90	50	70
Rio Bonito	-	70	90	50	70
Rio de Janeiro	95	100	100	100	100
Sao Goncalo	52	90	100	70	90
Sao Joao de Meriti	59	90	100	70	90

Table 3.2-3 Coverage of Water Supply Services

Unit: %

Municipalities	Present	Scenario 1 2000	Scenario 1 2010	Scenario 2 2000	Scenario 2 2010
Cachoeiras de Macacu	-	70	90	50	70
Duque de Caxias	59	90	100	80	90
Itaborai	71	90	100	80	90
Magė	30	70	90	50	70
Nilopolis	86	100	100	100	100
Niteroi	87	100	100	100	100
Nova Iguacu	52	90	100	70	90
Rio Bonito	-	70	90	50	70
Rio de Janeiro	91	100	100	100	100
Sao Goncalo	66	90	100	80	90
Sao Joao de Meriti	73	100	100	90	100

Table 3.2-4 Coverage of Sewerage Services

Unit: %

Municipalities	Present	Scenario 1		Scenario 2	
		2000	2010	2000	2010
Cachoeiras de Macacu	-	70	90	50	70
Duque de Caxias	-	90	100	70	80
Itaborai	10	70	90	50	70
Magé	-	70	90	50	70
Nilopolis	70	90	100	80	90
Niteroi	67	100	100	80	90
Nova Iguacu	33	90	100	70	90
Rio Bonito	-	70	90	50	70
Rio de Janeiro	82	100	100	90	100
Sao Goncalo	9	90	100	70	90
Sao Joao de Meriti	-	90	100	70	90

Table 3.2-5 Growth Rates of Cultivated Land Area

Unit: %/yr

Municipalities	1980 - 1985	Scenario 1		Scenario 2	
		1986 - 2000	2001 - 2010	1986 - 2000	2001 - 2010
Cachoeiras de Macacu	-2.2	3.0	1.5	2.0	1.0
Duque de Caxias	0.4	-1.0	-2.5	-2.0	-2.5
Itaborai	-3.7	-3.0	-2.0	-3.0	-2.5
Magé	10.5	2.0	-1.0	2.0	-1.0
Nilopolis	-	0.0	0.0	0.0	0.0
Niteroi	-18.4	-5.0	-5.0	-7.0	-5.0
Nova Iguacu	2.8	2.0	-2.5	-2.0	-2.5
Rio Bonito	4.5	3.0	1.5	3.0	1.5
Rio de Janeiro	10.8	-8.0	-5.0	-10.0	-8.0
Sao Goncalo	-13.1	-7.0	-4.0	-8.0	-5.0
Sao Joao de Meriti	-	0.0	0.0	0.0	0.0

Table 3.2-6 Growth Rates of Employment in Manufacturing in Metropolitan R.J.

Unit: %/yr

Municipalities	1980 - 1985	Scenario 1 1986 - 2000	Scenario 1 2001 - 2010	Scenario 2 1986 - 2000	Scenario 2 2001 - 2010
Metallurgical	-6.5	-3.0	-2.0	2.0	2.0
Mechanical	-4.2	-2.0	-2.0	2.0	2.0
Electrical	0.4	4.0	5.0	3.0	3.0
Transportation	-4.8	3.0	2.0	2.0	1.0
Furniture	-3.9	3.0	2.0	2.0	1.0
Chemicals	3.9	2.0	1.0	4.0	3.0
Pharmaceuticals	-1.9	2.0	-2.0	2.0	2.0
Plastics	-0.5	2.0	2.0	3.0	2.0
Textiles	-7.6	-3.0	-2.0	1.0	1.0
Clothing	1.2	3.0	2.0	1.0	1.0
Foodstuff	-3.6	-3.0	-2.0	2.0	1.0
Printing	0.1	2.0	1.0	3.0	2.0

Table 3.2-7 Growth Rates of Employment in Lodging & Food Service

Unit: %/yr

Municipalities	1980 - 1985	Scenario 1 1986 - 2000	Scenario 1 2001 - 2010	Scenario 2 1986 - 2000	Scenario 2 2001 - 2010
Cachoeiras de Macacu	-	5.0	4.0	3.0	2.0
Duque de Caxias	-0.7	3.0	1.0	2.0	1.0
Itaborai	21.2	6.0	4.0	4.0	3.0
Magé	-3.8	5.0	4.0	3.0	2.0
Nilopolis	6.0	1.0	1.0	1.0	1.0
Niteroi	3.7	3.0	3.0	2.0	1.0
Nova Iguacu	-0.9	3.0	1.0	2.0	1.0
Rio Bonito	-	5.0	4.0	3.0	2.0
Rio de Janeiro	1.9	3.0	3.0	2.0	1.0
Sao Goncalo	6.5	3.0	3.0	3.0	2.0
Sao Joao de Meriti	3.9	1.0	1.0	1.0	1.0

Table 3.3-1 Population : 1991 Census and Projections

Municipalities	Present (1991)	Scenario 1 2000	Scenario 1 2010	Scenario 2 2000	Scenario 2 2010
Cachoeiras de Macacu	40,195	48,037	58,529	48,037	58,529
Duque de Caxias	664,643	794,310	898,689	794,310	944,532
Itaborai	161,274	259,544	272,956	229,544	272,956
Magé	191,359	228,692	278,641	228,692	278,641
Nilopolis	157,819	165,065	169,233	165,065	169,233
Niteroi	416,123	445,069	456,308	445,069	467,831
Nova Iguacu	1,286,337	1,537,292	1,739,305	1,537,292	1,828,027
Rio Bonito	45,093	53,891	64,084	53,891	64,084
Rio de Janeiro	5,336,179	5,707,368	5,851,487	5,707,368	5,999,245
Sao Goncalo	747,891	975,829	1,131,940	975,829	1,131,940
Sao Joao de Meriti	425,038	444,552	455,778	444,552	455,778
Guanabara Bay Basin	9,471,951	10,629,649	11,376,950	10,629,649	11,670,796

Table 3.3-2 Population Covered by Solid Wastes Disposal Services

Municipalities	Present	Scenario 1 2000	Scenario 1 2010	Scenario 2 2000	Scenario 2 2010
Cachoeiras de Macacu	-	33,626	52,676	24,019	40,970
Duque de Caxias	372,200	714,879	898,689	635,448	850,079
Itaborai	33,868	160,681	245,660	114,772	191,069
Magé	53,581	228,692	278,641	114,346	195,049
Nilopolis	112,051	148,559	169,233	132,052	152,310
Niteroi	332,898	445,069	456,308	445,069	467,831
Nova Iguacu	501,672	1,076,104	1,565,375	768,646	1,279,619
Rio Bonito	-	37,724	57,676	26,946	44,859
Rio de Janeiro	5,069,370	5,707,368	5,851,487	5,707,368	5,999,245
Sao Goncalo	388,903	878,246	1,131,940	683,080	1,018,746
Sao Joao de Meriti	250,773	400,097	455,778	311,186	410,200
Gunabara Bay Basin	7,115,316	9,831,045	11,163,463	8,962,932	10,649,977
(% of service population)	(75.1%)	(92.5%)	(98.1%)	(84.3%)	(91.3%)

Table 3.3-3 Population Covered by Water Supply Services

Municipalities	Present	Scenario 1		Scenario 2	
		2000	2010	2000	2010
Cachoeiras de Macacu	-	33,626	52,676	24,019	40,970
Duque de Caxias	392,139	714,879	898,689	635,448	850,079
Itaborai	114,505	206,590	272,956	183,635	245,660
Magé	57,408	160,084	250,777	114,346	195,049
Nilopolis	135,724	165,065	169,233	165,065	169,233
Niteroi	362,027	445,069	456,308	445,069	467,831
Nova Iguacu	668,895	1,383,563	1,739,305	1,076,104	1,645,224
Rio Bonito	-	37,724	57,676	26,945	44,859
Rio de Janeiro	4,855,923	5,707,368	5,851,487	5,707,368	5,999,245
Sao Goncalo	493,608	878,246	1,131,940	780,663	1,018,746
Sao Joao de Meriti	310,278	444,552	455,778	400,097	455,778
Guanabara Bay Basin	7,390,507	10,176,766	11,336,825	9,558,759	11,132,674
(% of service population)	(78.0%)	(95.7%)	(99.6%)	(89.9%)	(95.4%)

Table 3.3-4 Population Covered by Sewerage Services

Municipalities	Present	Scenario 1		Scenario 2	
		2000	2010	2000	2010
Cachoeiras de Macacu	-	33,626	52,676	24,019	40,970
Duque de Caxias	-	714,879	898,689	556,017	755,626
Itaborai	16,127	160,681	245,660	114,772	191,069
Magé	-	160,084	250,777	114,346	195,049
Nilopolis	110,473	148,559	169,233	132,052	152,310
Niteroi	278,802	445,069	456,308	356,055	421,048
Nova Iguacu	424,491	1,383,563	1,739,305	1,076,104	1,645,224
Rio Bonito	-	37,724	57,676	26,945	44,859
Rio de Janeiro	4,375,667	5,707,368	5,851,487	5,136,631	5,999,245
Sao Goncalo	67,310	878,246	1,131,940	683,080	1,018,746
Sao Joao de Meriti	-	400,097	455,778	311,186	410,200
Guanabara Bay Basin	5,272,870	10,069,896	11,309,529	8,531,207	10,874,346
(% of service population)	(55.7%)	(94.7%)	(99.4%)	(80.3%)	(93.2%)

Table 3.3-5 Cultivated Land Area

Unit:ha

Municipalities	1985	Scenario 1 2000	Scenario 1 2010	Scenario 2 2000	Scenario 2 2010
Cachoeiras de Macacu	34,126	53,167	61,702	45,929	50,734
Duque de Caxias	5,706	4,907	3,809	4,214	3,271
Itaborai	22,654	14,346	11,722	14,346	11,137
Magé	9,084	12,226	11,057	12,226	11,057
Nilopolis	0	0	0	0	0
Niteroi	187	87	52	63	38
Nova Iguacu	5,869	7,899	6,132	4,335	3,365
Rio Bonito	23,947	37,309	43,299	37,309	43,299
Rio de Janeiro	14,270	4,085	2,446	2,938	1,276
Sao Goncalo	2,644	890	592	757	453
Sao Joao de Meriti	1	0	0	0	0
Guanabara Bay Basin	118,488	134,916	140,811	122,117	124,630

Table 3.3-6 Employment in Manufacturing in Metroploitan R.J.

Municipalities	1985	Scenario 1 2000	Scenario 1 2010	Scenario 2 2000	Scenario 2 2010
Metallurgical	32,159	20,365	16,640	43,282	52,761
Mechanical	36,679	27,090	22,135	49,365	60,176
Electrical	24,975	44,979	73,266	38,910	52,292
Transportation	30,442	47,428	57,814	40,971	45,257
Furniture	12,003	18,700	22,795	16,154	17,844
Chemicals	36,519	49,150	54,292	65,769	88,388
Pharmaceuticals	12,092	16,274	13,297	16,274	19,838
Plastics	14,001	18,844	22,971	21,813	26,590
Textiles	19,517	12,359	10,098	22,659	25,030
Clothing	52,088	81,151	98,923	60,473	66,800
Foodstuff	43,589	27,603	22,554	58,665	64,803
Printing	32,561	43,823	48,408	50,729	61,838
Metropolitan R.J.	346,625	407,766	463,193	485,064	581,617

Table 3.3-7 Employment in the Loading and Food Service

Municipalities	1985	Scenario 1 2000	Scenario 1 2010	Scenario 2 2000	Scenario 2 2010
Cachoeiras de Macacu	300	624	924	467	569
Duque de Caxias	3,230	5,032	5,558	4,347	4,802
Itaborai	1,149	2,754	4,077	2,069	2,781
Mage	567	1,179	1,745	883	1,076
Nilopolis	800	929	1,026	929	1,026
Niteroi	4,357	6,788	9,123	5,864	6,478
Nova Iguacu	3,900	6,076	6,712	5,249	5,798
Rio Bonito	500	1,039	1,538	779	950
Rio de Janeiro	80,141	124,857	167,797	107,859	119,143
Sao Goncalo	3,332	5,191	6,976	5,191	6,328
Sao Joao de Meriti	2,573	2,987	3,300	2,987	3,300
Guanabara Bay Basin	100,849	157,456	208,776	136,624	152,251

Table 3.3-8 Future Socioeconomic Framework of the Guanabara Bay Basin

Item	Unit	Present	Scenario 1 2000	Scenario 1 2010	Scenario 2 2000	Scenario 2 2010
Population	Person	9,471,951	10,629,649	11,376,950	10,629,649	11,670,796
Growth Rates	%/yr					
1992-2001		-	1.29	-	1.29	-
2001-2010		-	-	0.68	-	0.94
Basic Services						
Pop. w/solid Wastes Disp. Coverage	Person (%)	7,115,316 (75.1)	9,831,045 (92.5)	11,163,463 (98.1)	8,962,932 (84.3)	10,649,977 (91.3)
Pop. w/water supply Coverage	Person (%)	7,390,509 (78.0)	10,176,766 (95.7)	11,336,825 (99.6)	9,558,759 (89.9)	11,132,674 (95.4)
Pop. w/Sewerage Coverage	Person (%)	5,272,870 (55.7)	10,069,896 (94.7)	11,309,529 (99.4)	8,531,207 (80.3)	10,874,346 (93.2)
Economy						
Sector Growth Rates	%/yr					
Primary						
1986-2000		-	0.87	-	0.20	-
2001-2010		-	-	0.43	-	0.20
Secondary						
1986-2001		-	1.09	-	2.27	-
2001-2010		-	-	1.28	-	1.83
Tertiary						
1986-2001		-	3.01	-	2.04	-
2001-2010		-	-	2.86	-	1.09

2.4 Benefits from Water Quality Improvement of the Guanabara Bay

Evaluation of benefits from a purely environmetal improvement project poses serious difficulties in the practical application of recently developed theoretical concepts. These difficulties range from the lack of reliable and sufficiently long time-series data, to the unproven methods of data collection due to the general lack of consciousness about environmental problems among the people, who will ultimately determine the success of an environmental improvement project.

2.4.1 Assessment of Benefits

In the assessment of benefits from water quality improvements, attention should be paid to both the benefits accrued and the costs avoided. This means that benefits should include those effects easily recognized as straightforward benefits and those effects that lead to cost avoidance. The assessment of these broadly interpreted benefits entails critical problems due to the *uncertainty of information and the difficulties involved not only* in the identification of benefits but also in the quantification of identified benefits.

When a pollution abatement project is undertaken to reach desired environmental quality targets, the gathering of relevant information on the relationship between pollution and environmental quality requires very careful research and technical analysis. Even if benefits are identified as effects, for example, on expanded recreation opportunities, or on health and productivity improvements, the ensuing quantification is still extremely difficult.

2.4.1.1 Criteria for Benefit Assessment

Conceptually, the following criteria can help as guides in the identification and quantification of benefits.

(1) Complement to another good

When water quality is improved, it might generate consumption of other goods, such as the increased demand for beach areas for swimming or fishing.

(2) Infrastructure protection

Polluted waters may cause damage to industrial, transportation or household infrastructure, which requires adoption of preventive measures (additional expenditures) to protect against these adverse effects of pollution. If these expenditures in the form of increased frequency of painting, or corrosion protection, can be reduced or eliminated altogether, then the difference in expenditures can be quantified as benefits.

(3) Production input

If the pollution abatement project lowers production costs, benefits accrue either to consumers as reduced output price or to producers as increased profits.

(4) Land value appreciation

The improvement of environmental characteristics increases the value of the land as a result of intensification in agricultural, commercial or residential uses.

(5) Willingness to pay

Improvements in water quality may cause people to react positively, inducing them to show willingness to pay for the improved environmental quality. However, it is difficult to make individuals conceptualize the expected improvements in water quality, thereby leading to overestimation or underestimation of expected personal benefits, which results in an inaccurate willingness to pay.

2.4.1.2 Alternative Criteria

A broader classification of both the quantifiable and non-quantifiable categories of benefits can be as follows.

(1) Current user benefits

a. Direct use (quantifiable)

1. In water

* Recreation

Contact : swimming
Non-contact: fishing, boating

* Commercial: navigation, fishing

2. Withdrawal: industrial/commercial cooling

b. Indirect use (difficult to quantify)

1. Recreation: near water hiking, birdwatching

2. Relaxation: pleasant scenery

3. Aesthetic : enhancement of nearby site amenities

(2) Intrinsic benefits (non-quantifiable)

a. Potential use

Option value: amount that an individual may be willing to pay for the right to use a water body (over and above the expected user values) even though such a right may never be exercised

b. No use

Existence value: individual's willingness to pay simply for the knowledge that a resource exists even if never used.

* Bequest: to present or future generation

* Vicarious consumption: enjoyment from the knowledge that others are using the resource

2.4.1.3 Bases for Benefits in the Guanabara Bay Basin

A questionnaire survey was conducted on the environmental awareness of the residents in the Guanabara Bay basin. The survey showed that 93.6% of respondents regarded the bay water as dirty or very dirty, and its major causes were seen as domestic waste water by 46.7%, factory waste water by 25.6%, garbage thrown into tributary rivers or directly into the bay by 12.3%, and garbage/oil from ships by 8.7%. The resident awareness on the weight of waste water as a cause of pollution was indicated by those respondents favoring control or rigorous control of domestic waste water (92.8%) and of factory waste water (94.8%).

Facing the described situation, 89.6% of respondents thought that the Guanabara Bay water should be cleaned soon or cleaned if possible. The strong interest in improving the water quality stemmed from the present use of the bay, in which 21.3% of respondents claimed to be using the bay beaches for recreation, 21.2% using the ferry boat service, 16.9% enjoying regular strolls along beaches, 16.8% fishing as full-time profession in the bay, 9.6% fishing occasionally, and 7.9% enjoying the scenery.

The respondents planned utilization of the bay, if the bay water were to be cleaned, contrasted sharply with the present use in the weight given to fishing and recreation. In this regard, 31.3% of respondents thought they would use the bay for fishing, 30.8% for swimming and enjoying beaches, and 14.9% for practicing marine sports.

The questionnaire survey clarified the close relationship between the Guanabara Bay and the basin residents, as well as their strong interest in the improvement of the bay water quality. These provide the basic background for estimating the benefits from improving the Guanabara Bay ecosystem. From the criteria mentioned in Sections 4.1.1 and 4.1.2, the benefits from the improved Guanabara Bay ecosystem were chosen to be those that were already identified and quantified by FEEMA, as listed below.

(1) Recreation benefits: water contact

These benefits involve swimming and water sports, and depend on the number of persons swimming or practicing water sports, which in turn depend mostly on the available beach area. These benefits are underscored by the numerous bay beaches that are contaminated and hence unsuitable for recreation. Therefore, the nearby residents are forced to travel longer distances seeking cleaner beaches for recreation, which give rise to overcrowding of ocean beaches. The fact that 45.7% of respondents wanted the Guanabara Bay in the future to be clean enough for swimming/enjoying beaches and for the practice of marine sports is a good indication on the importance of these benefits.

(2) Recreation benefits: boating and fishing

These benefits involve boats of a specified tonnage class, and consist of avoidable costs in the absence of pollution in the Guanabara Bay. These avoidable costs refer to additional operation and maintenance costs due to pollution and due to longer sailing distance in search of cleaner water areas for recreation boating and fishing. These benefits are likely to accrue to the 9.6% of respondents who at present fish occasionally, as well as to recreation boaters.

(3) Commercial shipping benefits

These benefits involve avoidable dredging costs in the case of large ocean going vessels requiring wharfage within the Guanabara Bay, and avoidable operation and maintenance costs in the case of small passenger boats operating within the bay. The likely beneficiaries are the 21.2% of respondents who at present use the boat service and may enjoy lower fares which can be passed on by the boat operators as a result of reduced operation and maintenance costs.

(4) Commercial fishing benefits

These benefits involve changes in fishery production, and refer to declining shrimp catch in the Guanabara Bay in recent decades, due presumably to worsening pollution level in the bay. Conversely, if the quality of the bay water were to improve, shrimp catch would again increase. These benefits are underscored by 45.1% of respondents who thought the Guanabara Bay should be cleaned to the level of assuring increasing production of fish, shrimp and shellfish, as well as by the 31.3% of respondents who wanted to use the bay for fishing in the future.

(5) Land value appreciation

These benefits involve the land located along the shoreline of the Guanabara Bay, and refer to its value being inversely correlated with the pollution level of the bay water, that is, higher land value with clean water and lower land value with polluted water.

(6) Health improvement

This potentially large benefit will not be taken into consideration in this project, because the technique of measuring changes in human productivity poses major ethical problems. Human life or the psychological costs of illness and death should not be subject to monetary valuation, even if technically possible, except under the following restricted conditions.

The loss-of-earnings approach can be applied to value environmental effects when (a) a direct cause-and-effect relationship can be established and the etiology of the disease is clearly identifiable; (b) the precise economic value of earnings and medical care is known; and (c) the illness is relatively short, not life-threatening and without long-term effects. This means that chronic and long lasting illness, which is likely to be the health effects of environmental pollution, are hard to handle. The basic problem refers to the lack of a clear definition in the exact cut-off point between short-lasting and long-lasting illnesses.

The above three conditions do not prevail in the case of the Guanabara Bay basin. The large number of pollution sources in the basin make the relationship between cause and effect difficult to establish. Moreover, the etiology is not well established, that is, the effects of the polluted bay water cannot be translated into health consequences. These effects are likely to be debilitating but not completely disabling. For instance, in the case of parasitic infections, the valuation problem is complicated because the victim appears to be healthy but functions at less than full potential.

2.4.2 Benefit Types in the Guanabara Bay Basin

In the case of Guanabara Bay, potential benefits from mproving its water quality have been studied for nearly 20 years by Mr. Victor Coelho of FEEMA, even before establishment of FEEMA, while he was still with the Institute for Sanitary Engineering of the Science and Technology Secretariat. Mr. Coelho incorporated the basic concepts of recent theoretical evaluation methods into practical calculation procedures which are easily understood. Therefore, it was agreed to update relevant aspects of Mr. Coelho's work to make it applicable to the present situation of the Guanabara Bay basin. Accordingly, it is appropriate to describe Mr. Coelho's original work, which is the following.

Mr. Coelho estimated potential benefits stemming from the possible water utilization types, which were classified as follows:

(1) Recreation: water contact
(2) Recreation: boating and fishing
(3) Commercial shipping
(4) Commercial fishing
(5) Land value appreciation

Mr. Coelho's calculations based on 1974 data for the above water utilization types yielded the following estimated benefits.

(1) Recreation benefits: water contact

These benefits involved swimming and water sports, and were assumed to depend on the number of persons swimming or practicing water sports. The number of swimmers was calculated on the basis of the saturation population of the beaches of the Guanabara Bay as a function of the area of these beaches. The saturation population was calculated assuming 2 sq.m. of beach per swimmer in crowded beaches, and 10 sq.m. of beach per swimmer in uncrowded beaches. Then, the saturation population of the Guanabara Bay beaches was estimated at 197,340 persons.

Next, the utilization rate of beaches was estimated as a function of climate or season, day of the week, and school vacation time. The assumed beach utilization rate was expressed as percentage of the saturation population, as indicated below.

* Hot months (November to April)

Sunday:		100%
Saturday:		70%
Work days:	school vacation months	30%
	other months	15%

* *Cold months (May to October)*

Sunday:		70%
Saturday:		50%
Work days:	school vacation months	20%
	other months	10%

The resulting number of the saturation population of swimmers in the Guanabara Bay beaches was estimated at 11,922,600 persons per year.

To give monetary value to benefits from recreation swimmers, an extreme scenario was assumed whereby the Guanabara Bay beaches would be so polluted as to preclude any swimming activity. Then, the residents who wished to go swimming would have to go to ocean beaches outside the Guanabara Bay. In this case, the time spent to go to more distant beaches, and the added transportation costs could be quantified. The following was assumed.

Hourly wage (Cr$):	4.00
Hourly recreation value (Cr$)	6.00
Travel time (hours):	2.00
Transportation cost (Cr$)	2.00

For a family of 5 in which two were wage earners, the following quantification could be made.

Two hours of recreation for 2 persons (Cr$)	24.00
Transportation costs for 5 persons (Cr$)	10.00
Total for 5 persons (Cr$)	34.00
Benefit per person (Cr$)	6.80

Thus, total benefits, or avoidable costs if the Guanabara Bay beaches were safe to swim for nearly 12 million swimmers per year, would amount to Cr$81,600,000 per year.

(2) Recreation benefits: boating and fishing

To quantify this recreation benefit, the number of boats in the Guanabara Bay was classified by tonnage, with the following results.

Less than 10 ton	7,270 boats
From 10 to 20 ton	300 boats
More than 20 ton	630 boats

Boats of less than 10 ton were assumed to be suitable for recreation fishing and boating. Then, based on a questionnaire survey, the additional operation and maintenance costs due to pollution were estimated to be Cr$ 200 per boat per year.

Also assumed was that, due to increased pollution, some of these recreation boaters would prefer to go outside the Guanabara Bay. They were assumed to consist of 2,000 motor boats and 1,000 sail boats, incurring additional costs of Cr$ 50 and Cr$ 10, respectively, per boat per trip. These boaters going out of the Guanabara Bay were assumed to do so on alternate weeks, that is, 26 times a year. Then, the potential benefits, or avoidable costs if pollution was prevented, would be as follows.

O&M Costs of all boats:	7,270 x Cr$200 =	Cr$1,454,000
O&M Costs of motor boats:	2,000 x 26 x Cr$ 50 =	Cr$2,600,000
O&M Costs of sail boats:	1,000 x 26 x Cr$ 10 =	Cr$ 260,000

		Cr$4,314,000

(3) Commercial shipping benefits

The benefits, or avoidable costs, from commercial shipping were considered under the two categories of ocean going vessels and those restricting transportation services to inside the Guanabara Bay. For ocean going vessels that needed wharfage in ports within the Guanabara Bay, the benefits would consist of avoidable dredging costs. These were estimated on the basis of 10 cu.m/sec. of sewage inflow containing 4 ml/l of settling solids, resulting in 1,261,440 cu.m. per year of settled silt and mud. Dredging at the assumed unit price of Cr$ 7.00/cu.m., would cost an estimated Cr$ 8,830,000 per year.

Dredging costs would have been a lot higher if proper account was taken of the siltation resulting from the inflow of river discharge.

Benefits from passenger transportation in the Guanabara Bay was estimated under the assumptions of transportation by large ferry boats and by small high speed boats. Large ferry boats were assumed to be free of pollution damages. On the other hand, small passenger boats were assumed to require additional costs due to frequent damages to the propeller caused by floating debris. These additional costs were assumed to be 20 propeller changes per boat per year, and the need for a monthly hull painting to prevent excessive corrosion. These additional operation and maintenance costs were estimated at Cr$ 73,000 per month, amounting to Cr$ 876,000 per year for the fleet.

(4) Commercial fishing benefits

Shrimp catch in the Guanabara Bay in 1955 was 330 ton, but went down to 24 ton in 1972. The reduced shrimp catch, presumably due to increased pollution (siltation, landfill, oil spill), at the assumed unit price of Cr$ 13.00/kg amounted to Cr$ 3,978,000 per year.

The benefits from commercial fishing would have been much larger if other fish species were included.

(5) Land Value Appreciation

The value of land is undoubtedly higher if located on water bodies with clean water rather than with polluted water. Therefore, when a polluted water body is cleaned up, the value of land along its shoreline is expected to increase.

To quantify the above benefits, the Guanabara Bay was assumed to have a 130km perimeter or shoreline, which together with the estimated 70km coastline of the islands within the bay, would result in a 200km total shoreline. Of these, 120km of shoreline were assumed to be suitable for urbanization. Further assuming as urbanization land a 100m tract from the shoreline, the urbanization area would be 12 million sq.m., which at the average unit price of Cr$ 50/sq.m., gave a total value of Cr$ 600,000,000. A percentage of this value would accrue as benefits from improving the water quality or the ecosystem of the Guanabara Bay.

2.4.3 Valuation of the Selected Benefits

Section 4.1 presented a general classification of the possible benefits that may be expected from the improvement of the water quality of the Guanabara Bay. Benefit estimation is to be based on the procedure used by FEEMA, by updating the relevant information and expressing the value in terms of the American dollar. Of the many types of benefits estimated by FEEMA, the following update refers to the benefits from water contact recreation. Also estimated was one type of benefit that the FEEMA estimation did not quantify thoroughly, and this concerns the appreciation of the value of the land surrounding the water body.

(1) Water contact recreation benefits

These benefits refer to the value of recreation in the Guanabara Bay beaches. Benefit estimation is based on the saturation population of beaches, the hourly value of recreation, and the value of transportation.

a. Saturation population

The saturation population is a function of the beach area. **Table 4.3-1** lists the beaches in the Guanabara Bay, along with the estimated width and length. Consequently, the total beach area in the Guanabara Bay is estimated at 1,111,500 sq.m.

The beach area per person was estimated at 5 sq.m. for Flamengo, Botafogo, Icarai and San Francisco, while 10 sq.m. per person was estimated for the remaining beaches. The resulting saturation population of the Guanabara Bay beaches was estimated at 152,950 (**Table 4.3-1**).

b. Number of potential beach users per year

The number of potential beach users was estimated using the following assumptions.

Hot months (November to April)

Sunday: 100% of the saturation population
(26 days)
Saturday:70% of the saturation population
(26 days)
Weekdays:
Summer vacation (3 months): 30% of sat. pop.
(65 days)
Other months (3months): 15% of sat. pop.
(65 days)

Cool months (May to October)

Sunday: 70% of the saturation population
(26 days)
Saturday:50% of the saturation population
(26 days)
Weekdays:
Winter vacation (2 weeks): 20% of sat. pop.
(10 days)
Other months: 10% of sat. pop.
(120 days)

Table 4.3-2 shows that the number of potential beach users in the Guanabara Bay is 18,147, 518 persons.

c. Value of recreation

The value of recreation is estimated by assuming the following.

- Salary: US$100 (minimum wage)
- Monthly working hours: 176
- Hourly wage: US$0.57/hr.
- Value of recreation: 1.5 hourly wage = US$0.85
- Family size: 5, of which 2 are wage earners
- Transportation cost: US$2.00 per person round trip
- Time spent on the beach: 2 hours

Then, the value of recreation is the following.

2 hours x 2 persons x US\$0.85 =	US\$ 3.40
5 persons x US\$2.00 (transp.) =	US\$ 10.00
Total 5 persons	US\$ 13.40

The value per person per visit would be US\$13.40 divided by 5, that is, US\$2.68. This value should be multiplied by the number of potential beach users per year.

US\$2.68 x 18,147,518 persons = US\$48,635,348/year

If it is arbitrarily assumed that one/fourth of potential beach users are induced to practice water contact recreation by the cleaner water of the Guanabara Bay, then the benefits from this specific recreation type would amount to US\$ 12,158,837 per year. This is obviously an underestimation, since the basis for calculation is the minimum wage.

This is a flow of benefits to accrue over a future time period, presumed to be 30 years, during which the improvement in the Guanabara Bay water quality and the public perception of it are assumed to remain unchanged. If it is further assumed that this flow of benefits accrues between the 11^{th} year and the 30^{th} year, then the present value of contact recreation benefits discounted at 10% amounts to US\$ 39,910,045.

(2) Land value appreciation

The appreciation of the value of the land surrounding a water body is understood to be a summary measure, which includes all the beneficial effects from the water quality improvement. The land value appreciation depends on the unit value of land and the distance from the shore. The benefit estimation is based on the following.

a. Unit value of land (US$/sq.m.)

Values provided by realtors

Flamengo	US$1,260/sq.m.
Botafogo	US$1,160/sq.m.
Ramos	US$ 725/sq.m.
Urca	US$1,525/sq.m.
I. do Governador	US$ 485/sq.m.
Maua	US$ 5/sq.m.

Assumed values

Icarai	US$ 500/sq.m.
San Francisco	US$ 500/sq.m.
Remaining beaches	US$ 50/sq.m.
Non-beach	US$ 1/sq.m.

b. Distance from the beach

A study by the Environmental Protection Agency in the United States found that the improvement in water quality affected the value of the land surrounding the water body. The appreciation of the land ranged from 8% to 24%, and the value appreciation disappeared beyond 4,000 ft. from the shore.

Accordingly, the estimation of value appreciation is based on the following assummptions.

Distance from the beach	% Value appreciation
Up to 100m	24%
100m - 500m	15%
500m - 1000m	8%

c. Total value

Table 4.3-3 shows that the total value of land appreciation amounts to US$ 1,733,858,000. This is a one-time accrual of stock benefits, which are assumed to encompass all the benefits that can be derived from the improvement in the water quality of the Guanabara Bay.

If it is further assumed that the land value appreciation occurs in the 15th year, then the present value of these benefits discounted at 10% amounts to US$415,071,820.

Table 4.3.1 Area and Saturation Population of Guanabara Bay Beaches

Beach	Width (m)	Length (m)	Area (m2)	Saturation Population (1/5m2)	(1/10m2)	Total
Flamengo	100	1450	145000	29000		29000
Botafogo	140	600	84000	16800		16800
Ramos	50	600	30000		3000	3000
Vermelha	10	200	2000		200	200
Barreto	50	400	20000		2000	2000
Adao e Eva	50	100	5000		500	500
Urca	40	100	4000		400	400
Flexas	100	1000	100000		10000	10000
Icarai	140	1200	168000	33600		33600
S.Francisco	30	700	21000	4200		4200
Charitas	30	700	21000		2100	2100
Jurujuba	40	350	14000		1400	1400
Pedrinhas	50	750	37500		3750	3750
Anil	10	1000	10000		1000	1000
Maua	20	2000	40000		4000	4000
Subtotal		11150	701500	83600	28350	111950
I.Governador						
Tubiacanga	20	1200	24000		2400	2400
Gaegos	30	1500	45000		4500	4500
Dende	50	1300	65000		6500	6500
Rosa	20	1100	22000		2200	2200
Pelonias	50	600	30000		3000	3000
Grande	10	800	8000		800	800
Saco da Rosa	50	600	30000		3000	3000
Bananal	5	700	3500		350	350
Guanabara	20	1500	30000		3000	3000
Cocota	10	800	8000		800	800
Bandeiro	20	500	10000		1000	1000
Pitangueiras	10	700	7000		700	700
Zumbi	5	400	2000		200	200
Engenhoca	10	700	7000		700	700
Ribeira	10	600	6000		600	600
Jequia	20	1200	24000		2400	2400
Brava	10	500	5000		500	500
Bica	30	1900	57000		5700	5700
Eng. Velho	5	700	3500		350	350
S. Bento	5	800	4000		400	400
Galeao	5	1300	6500		650	650
Subtotal		19400	397500		39750	39750
I.Paqueta						
J.Boticario	5	1300	6500		650	650
Moreninha	5	500	2500		250	250
Gaivotas	5	350	1750		175	175
Lameiras	5	350	1750		175	175
Subtotal		2500	12500		1250	1250
TOTAL		33050	1111500	83600	69350	152950

Table 4.3.2 Area of Guanabara Bay Beaches and Number of Potential Beach Users per Year

Beach	Width (m)	Length (m)	Area (m2)	Number of Potential Beach Users per Year Hot Months: November to April Sunday	Saturday	Vac. WD	Other WD	Subtotal	Cool Months: May to October Sunday	Saturday	Vac. WD	Other WD	Subtotal	Total
Flamengo	100	1450	145000	754000	527800	565500	282750	2130050	527800	377000	58000	348000	1310800	3440850
Botafogo	140	600	84000	436800	305760	327600	163800	1233960	305760	218400	33600	201600	759360	1993320
Ramos	50	600	30000	78000	54600	58500	29250	220350	54600	39000	6000	36000	135600	355950
Vermelha	10	200	2000	5200	3640	3900	1950	14690	3640	2600	400	2400	9040	23730
Barreto	50	400	20000	52000	36400	39000	19500	146900	36400	26000	4000	24000	90400	237300
Adao e Eva	50	100	5000	13000	9100	9750	4875	36725	9100	6500	1000	6000	22600	59325
Urca	40	100	4000	10400	7280	7800	3900	29380	7280	5200	800	4800	18080	47460
Flexas	100	1000	100000	260000	182000	195000	97500	734500	182000	130000	20000	120000	452000	1186500
Icarai	140	1200	168000	873600	611520	655200	327600	2467920	611520	436800	67200	403200	1518720	3986640
S.Francisco	30	700	21000	109200	76440	81900	40950	308490	76440	54600	8400	50400	189840	498330
Charitas	30	700	21000	54600	38220	40950	20475	154245	38220	27300	4200	25200	94920	249165
Jurujuba	40	350	14000	36400	25480	27300	13650	102830	25480	18200	2800	16800	63280	166110
Pedrinhas	50	750	37500	97500	68250	73125	36563	275438	68250	48750	7500	45000	169500	444938
Anil	10	1000	10000	26000	18200	19500	9750	73450	18200	13000	2000	12000	45200	118650
Maua	20	2000	40000	104000	72800	78000	39000	293800	72800	52000	8000	48000	180800	474600
Subtotal		11150	701500	2910700	2037490	2183025	1091513	8222728	2037490	1455350	223900	1343400	5060140	13282868
I.Governador														
Tubiacanga	20	1200	24000	62400	43680	46800	23400	176280	43680	31200	4800	28800	108480	284760
Gaegos	30	1500	45000	117000	81900	87750	43875	330525	81900	58500	9000	54000	203400	533925
Dende	50	1300	65000	169000	118300	126750	63375	477425	118300	84500	13000	78000	293800	771225
Rosa	20	1100	22000	57200	40040	42900	21450	161590	40040	28600	4400	26400	99440	261030
Pelonias	50	600	30000	78000	54600	58500	29250	220350	54600	39000	6000	36000	135600	355950
Grande	10	800	8000	20800	14560	15600	7800	58760	14560	10400	1600	9600	36160	94920
Saco da Rosa	50	600	30000	78000	54600	58500	29250	220350	54600	39000	6000	36000	135600	355950
Bananal	5	700	3500	9100	6370	6825	3413	25708	6370	4550	700	4200	15820	41528
Guanabara	20	1500	30000	78000	54600	58500	29250	220350	54600	39000	6000	36000	135600	355950
Cocota	10	800	8000	20800	14560	15600	7800	58760	14560	10400	1600	9600	36160	94920
Bandeiro	20	500	10000	26000	18200	19500	9750	73450	18200	13000	2000	12000	45200	118650
Pitangueiras	10	700	7000	18200	12740	13650	6825	51415	12740	9100	1400	8400	31640	83055
Zumbi	5	400	2000	5200	3640	3900	1950	14690	3640	2600	400	2400	9040	23730
Engenhoca	10	700	7000	18200	12740	13650	6825	51415	12740	9100	1400	8400	31640	83055
Ribeira	10	600	6000	15600	10920	11700	5850	44070	10920	7800	1200	7200	27120	71190
Jequia	20	1200	24000	62400	43680	46800	23400	176280	43680	31200	4800	28800	108480	284760
Brava	10	500	5000	13000	9100	9750	4875	35725	9100	6500	1000	6000	22600	59325
Bica	30	1900	57000	148200	103740	111150	55575	418665	103740	74100	11400	68400	257640	676305
Eng. Velho	5	700	3500	9100	6370	6825	3413	25708	6370	4550	700	4200	15820	41528
S. Bento	5	800	4000	10400	7280	7800	3900	29380	7280	5200	800	4800	18080	47460
Galeao	5	1300	6500	16900	11830	12675	6338	47743	11830	8450	1300	7800	29380	77123
Subtotal		19400	397500	1033500	723450	775125	387563	2919638	723450	516750	79500	477000	1796700	4716338
I.Paqueta														
J.Boticario	5	1300	6500	16900	11830	12675	6338	47743	11830	8450	1300	7800	29380	77123
Moreninha	5	500	2500	6500	4550	4875	2438	18363	4550	3250	500	3000	11300	29663
Gaivotas	5	350	1750	4550	3185	3413	1706	12854	3185	2275	350	2100	7910	20764
Lameiras	5	350	1750	4550	3185	3413	1706	12854	3185	2275	350	2100	7910	20764
Subtotal		2500	12500	32500	22750	24375	12188	91813	22750	16250	2500	15000	56500	148313
TOTAL		33050	1111500	3976700	2783690	2982525	1491263	11234178	2783690	1988350	305900	1835400	6913340	18147518

Table 4.3.3 Estimated Value Appreciation of the Land surrounding the Guanabara Bay

	Land Area up to 1 km from the Shore					Land Value Appreciation			
Beach	Length (m)	To 100 (m2)	To 500 (m2)	To 1000 (m2)	Total (1000m2)	To 100 (US$)	To 500 (US$)	To 1000 (US$)	Total (1000US$)
Flamengo	1450	145000	580000	725000	1450	43848000	109620000	73080000	226548
Botafogo	600	60000	240000	300000	600	16704000	41760000	27840000	86304
Ramos	600	60000	240000	300000	600	10440000	26100000	17400000	53940
Vermelha	200	20000	80000	100000	200	240000	600000	400000	1240
Barreto	400	40000	160000	200000	400	480000	1200000	800000	2480
Adao e Eva	100	10000	40000	50000	100	120000	300000	200000	620
Urca	100	10000	40000	50000	100	3660000	9150000	6100000	18910
Flexas	1000	100000	400000	500000	1000	1200000	3000000	2000000	6200
Icarai	1200	120000	480000	600000	1200	14400000	36000000	24000000	74400
S.Francisco	700	70000	280000	350000	700	8400000	21000000	14000000	43400
Charitas	700	70000	280000	350000	700	840000	2100000	1400000	4340
Jurujuba	350	35000	140000	175000	350	420000	1050000	700000	2170
Pedrinhas	750	75000	300000	375000	750	900000	2250000	1500000	4650
Anil	1000	100000	400000	500000	1000	1200000	3000000	2000000	6200
Maua	2000	200000	800000	1000000	2000	240000	600000	400000	1240
Subtotal	11150	1115000	4460000	5575000	11150	103092000	257730000	171820000	532642
I.Governador									
Tubiacanga	1200	120000	480000	600000	1200	13968000	34920000	23280000	72168
Gaegos	1500	150000	600000	750000	1500	17460000	43650000	29100000	90210
Dende	1300	130000	520000	650000	1300	15132000	37830000	25220000	78182
Rosa	1100	110000	440000	550000	1100	12804000	32010000	21340000	66154
Pelonias	600	60000	240000	300000	600	6984000	17460000	11640000	36084
Grande	800	80000	320000	400000	800	9312000	23280000	15520000	48112
Saco da Rosa	600	60000	240000	300000	600	6984000	17460000	11640000	36084
Bananal	700	70000	280000	350000	700	8148000	20370000	13580000	42098
Guanabara	1500	150000	600000	750000	1500	17460000	43650000	29100000	90210
Cocota	800	80000	320000	400000	800	9312000	23280000	15520000	48112
Bandeiro	500	50000	200000	250000	500	5820000	14550000	9700000	30070
Pitangueiras	700	70000	280000	350000	700	8148000	20370000	13580000	42098
Zumbi	400	40000	160000	200000	400	4656000	11640000	7760000	24056
Engenhoca	700	70000	280000	350000	700	8148000	20370000	13580000	42098
Ribeira	600	60000	240000	300000	600	6984000	17460000	11640000	36084
Jequia	1200	120000	480000	600000	1200	13968000	34920000	23280000	72168
Brava	500	50000	200000	250000	500	5820000	14550000	9700000	30070
Bica	1900	190000	760000	950000	1900	22116000	55290000	36860000	114266
Eng. Velho	700	70000	280000	350000	700	8148000	20370000	13580000	42098
S. Bento	800	80000	320000	400000	800	9312000	23280000	15520000	48112
Galeao	1300	130000	520000	650000	1300	15132000	37830000	25220000	78182
Subtotal	19400	1940000	7760000	9700000	19400	225816000	564540000	376360000	1166716
I.Paqueta									
J.Boticario	1300	130000	520000	650000	1300	1560000	5700000	2600000	9860
Moreninha	500	50000	200000	250000	500	600000	2100000	1000000	3700
Gaivotas	350	35000	140000	175000	350	420000	2400000	700000	3520
Lameiras	350	35000	140000	175000	350	420000	3900000	700000	5020
Subtotal	2500	250000	1000000	1250000	2500	3000000	14100000	5000000	22100
Total Beach	33050	3305000	13220000	16525000	33050	331908000	836370000	553180000	1721458
Non-beach	100000	10000000	40000000	50000000	100000	2400000	6000000	4000000	12400
TOTAL	133050	13305000	53220000	66525000	133050	334308000	842370000	557180000	1733858

CHAPTER 3

POLLUTION SOURCES

CHAPTER 3

POLLUTION SOURCES

3.1 INDUSTRIAL POLLUTION SOURCES

3.1.1 Point Pollution Sources

The point pollution sources in the Guanabara Bay Basin consist of domestic sanitary sewage, industrial waste and urban solid waste. These pollution sources are managed by the following different governmental institutions:

(1) Sanitary sewage (domestic wastewater):
Companhia Estadual de Aguas e Esgoto - CEDAE

(2) Industrial waste:
Fundacao Estadual de Engenharia do Meio Ambiente - FEEMA

(3) Urban solid waste:
Companhia de Limpeza Urbana - COMLURB.
Rio de Janeiro State Government Municipalities.

3.1.1.1 Sanitary Sewage (Domestic Wastewater)

The sanitary sewage point pollution sources are divided into raw sanitary sewage point pollution sources and treated sanitary sewage point pollution sources.

(1) Raw Sanitary Sewage

Most of the sanitary sewerage basins located in the Greater Rio de Janeiro area are not covered by complete sanitary sewage systems, including wastewater collection and treatment.

In the central and north area of Rio de Janeiro City the sanitary sewage system was built over a hundred years ago. The treatment plants have stopped working, but the wastewater collection system is still working and discharging raw sanitary sewage directly into Guanabara Bay. Further, the existing urban drainage system, small channels and rivers, also contribute to Guanabara Bay, raw sanitary sewage is discharged from many points such as hospitals, sporting clubs, industry and commerce, the port, the airport and bus stations.

These discharge points are called: raw sanitary sewage point pollution sources. The sanitary sewage basins of Arsenal, Cais di Porto, Mangue, Sao Cristovao, Alegria are under CEDAE's responsibility and will be part of the future Alegria Wastewater Treatment Plant. The Paqueta Sewerage Basin, a small island located in Guanabara Bay and the North Niteroi Sewerage Basin contain wastewater collection systems and are also considered as point pollution sources.

Table 3.1-1 shows the discharge points of raw sanitary sewage, and corresponding sanitary sewerage basins.

(2) Treated Sanitary Sewage

As was mentioned before, few sanitary sewerage basins are covered by complete sanitary sewerage treatment systems. They represent a small percentage of the total sanitary sewage production that contributes to Guanabara Bay.

Table 3.1-2 shows the point pollution sources treated sanitary sewage, referring to each wastewater treatment plant. INFRAERO's Wastewater Treatment Plant, one of these points, is responsible for the sanitary sewage from the Rio de Janeiro International Airport, located on Ilha do Governador.

All the others are CEDAE's responsibility.
As a result, this table shows the remaining pollution load after treatment.

3.1.1.2 Industrial Wastewater

The industries located around Guanabara Bay are also considered point pollution sources.

FEEMA recently listed 455 factories which contributed about 90% of all organic substances discharged into Guanabara Bay. **Table 3.1-3** shows the name, location and estimated pollution loads of the 117 heaviest contributors of pollution loads into the Guanabara Bay Basin selected from the FEEMA/DECOM list arranged in 1993. Unfortunately, the COD and oil in the effluent load has not been calculated.

The example of a Questionnaire filled out by all factories is shown in **Table 3.1-4**.

Table 3.1 - 1 Point Pollution Sources - Raw Sanitary Sewage (RSS)

DISCHARGE POINT	DISCHARGE POINT LOCATION	SEWERAGE BASIN	PUMPING STATION	FLOW (l/s)	SEWERAGE BASIN AREA (ha)	SEWER SYSTEM LENGTH (km)	POPULATION (Inhabitants)	FLOW (m^3/d)	POLLUTION LOAD (kg BOD/d)
RSS - 01	Arsenal	Cais do Porto	ES - 41	32,0	346	68	150.000	38.400	9.216
RSS - 02		Arsenal	ES - 34	N.I					
RSS - 03	Cais do Porto	Mangue	ES - 44	130,0	62	10	30.000	7.680	1.843
		Gamboa	ES - 42	N.I	N.I	N.I	N.I	-	-
RSS - 04	Canal Mangue	Mal. Hermes	ES - 43	5,5	N.I	N.I	N.I	-	-
		S. Cristovão	ES - 45	390,0	4529	275	1.000.000	256.000	61.440
RSS - 05	Cajú	Alegria	ES - 46	1170,0	3980	300	800.000	204.800	49.152
RSS - 06	Toque Toque	Niteroi Centro Norte	Toque Toque	N.I	1877	N.I	193.037	46.329	9.265
RSS - 07	José Bonifácio	Paquetá	José Bonifácio	N.I	92	11	3.254	651	176

Remark: for N.I read "no information".

Table 3.1 - 2 Point Pollution sources - Treated Sanitary Sewage (TSS)

POINT SOURCE	WASTEWATER TREATMENT PLANT	RECEIVING BODY	BOD EFFLUENT (mg/l)	FLOW (m^3/day)	POLLUTION LOAD (kg BOD/day)
TSS-01	ETE-Penha	Guanabara Bay	20	122.746	2.493,5
TSS-02	ETIG	Guanabara Bay	26	22.977	698,5
TSS-03	ETEG	Guanabara Bay	78	3.959	305,4
TSS-04	ETAR-AIRJ	Guanabara Bay	84	2.401	201,7
TSS-05	ETAR-TECA	Guanabara Bay	50	1.002	50,1
TSS-06	ETE-Icaraí	Guanabara Bay	27	60.480	1.633,0
TSS-07	ETE-Realengo	Acarí River	9	2.968	27,1
TSS-08	ETE-Acarí	Acarí River	7	11.340	80,1
TOTAL				227.873	5.489,4

Reference:

1 - TSS-01, TSS-02, TSS-03, TSS-06, TSS-07 and TSS-08 flow and pollution load average values, based on Annual Report, 1991.
Operation and Treatment Division.
Wastewater Superintendence.
Operation and Maintenance Directory - CEDAE

2 - TSS-04 and TSS-05 flow and BOD effluent are average values based on Monthly Reports.
Faulhaber Operation and Maintenance Engineering S/A.
INFRAERO.

Reference:

1-Points RSS-01, RSS-02, RSS-03, RSS-04, RSS-05

1.1-Domestic sewage per capita flow = 256 l/hab.d and average BOD = 240 mg/l:
Alegria Wastewater Treatment Plant Design.
Report No.4. Calculation and Description Memorial
Multiservice Consultant Engineering S/A
1991.

1.2-Pumping station flow, sewerage basin area, sewer system length and population.
North Area of Rio de Janeiro Sewerage System Final Report, 1991.
Wastewater Superintendence.
Operation and Maintenance Directory - CEDAE

2-Point RSS-06

2.1-Domestic sewage per capita flow = 240 l/hab.d, sewerage basin area and population:
Niteroi Centro Norte Sewage Final Disposal Design.
STE Consultant Engineering S/A.
August, 1988.

2.2-Average BOD = 200 mg/l:
Ponta de Areia Wastewater Treatment Plant Design.
STE Consultant Engineering S/A.
January, 1991.

3-Point RSS-07

3.1-Population:
National Demographic Research, 1991
Brazilian Institute of Geographic and Statistics - IBGE.

3.2-Domestic Sewage per capita flow equals to 200 l/hab.d:
Technical Normalization NB-41 (Septic Tank).
Brazilian Association of Technical Normalization - ABNT

3.3-Pollution load per capita equals to 54g. BOD/hab.d based on CEDAE's usual application for wastewater characterization.

Table 3.1-3 Major Industrial Pollution Sources

Sub-Basin	Factory No.	Industry Category	Effl. Load (kg/day) BOD	COD	OIL	Receiving Body
1	007	1	2131	3493	32	Guanabara B.
5	001	1	6700	10287	42	Guanabara B.
	004	1	2400	3050	58	"
	008	1	2095	6000	167	"
	009	1	1940			"
	027	1	800	1967	14	"
	034	1	660	3000	90	"
	044	1	510	1350	468	"
	047	1	480			"
	062	1	380			"
	113	7	220			"
	050	2	450			"
8	057	1	405	1090		Alcantara R.
	066	8	376			"
	107	4	240			"
9-3	049	1	480			Cacerebu R.
10-6	005	3	2304	3292		Soberbo R.
12	071	8	346			Roncador R.
16-2	021	8	921	3168		Piabeta R.
16-3	002	4	4400			Saracuruna R.
	130	4	170			"
	078	4	320			"
	017	8	1200			Estrela R.
17-1	015	4	1320	3247	396	Iguacu R.
	026	1	820			"
	031	1	720			"
	061	4	380			"
	065	1	378			"
	072	1	340			"
	074	4	330	3247	396	"
	082	7	316			"
	087	4	300			"
	088	4	300			"
	090	4	300			"
	098	4	270			"
	102	4	260			"
	114	4	220			"
	122	4	190			"
	138	4	160			"
	018	4	1200			Tomada C.
	075	4	330			"

(continued)

Sub-Basin	Factory No.	Industry Category	Effl. Load (kg/day) BOD	COD	OIL	Receiving Body
17-5	076	1	322	1000	140	Iguacu R.
17-6	013	8	1500			Tinas R.
	016	1	1290			Sarapui R.
	083	1	312			"
	121	4	195			"
	036	1	600			Caboclo R.
	119	1	200			Queimado R.
18	029	4	792			Tomada C.
	086	4	308			"
	137	14	160			Guanabara B.
19-1	010	1	1800			Meriti R.
	115	4	210			"
	067	14	375			"
	120	7	195			"
	020	1	1120			Acari R.
	045	1	500			"
	081	8	318			"
	089	4	300			"
	099	4	269	1277		"
	100	8	260			"
19-2	144	4	145			Acari R.
20	030	1	720			Guanabara B.
	042	8	520			
	035	1	643			Jraja R.
	038	14	530			"
	040	1	530			"
	056	3	420			"
	085	8	310			"
	043	8	515			Penha C.
	092	8	290			"
	143	4	145			"
	104	4	250			"
	111	4	230			"
21	006	2	2300			Timbo R.
	019	3	1122			"
	033	4	688			"
	041	1	520			"
	048	1	480			"
	058	8	382			"
	073		330			Timbo R.
	123	7	190			"
	124	7	190			"
	125	8	180			"

(continued)

Sub-Basin	Factory No.	Industry Category	Effl. Load (kg/day) BOD	COD	OIL	Receiving Body
	011	1	1760			Jacare R.
	059	4	380			"
	080	4	320			"
	105	4	240			"
	132	14	170			"
	037	1	589			Cunha C.
	060	4	380			"
	068	14	360			"
	093	4	288			"
	052	3	430			Faria R.
	053	2	420			"
	108	4	240			"
	012	1	1700			RSS-05(?)
21	126	4	180			"
	101	4	260			RSS-05
	103	4	260			"
22	064	14	380			RSS-05
	069	4	360			"
	077	1	320			"
	079	14	320			"
23	046	7	500			Maracana R.
	054	8	420			"
	116	14	210			"
	133	14	170			"
	134	7	160			"
	136	14	160			"
	096	14	280			RSS-03
	097	14	270			"
	117	7	210			"
24	003	2	4000	4800	25	RSS-01
	032	1	700			RSS-02
	051	14	448			Guanabara B.
25	094	8	284			STP-3 (ETEG)

Ind. No. : Industry No. registered in FEEMA/DECON Inventory
Category : Industrial Category
1 : Food   2 : Beverage   3 : Paper
4 : Chemicals   7 : Pharmaceutical
8 : Textile   14 : Others (Plastics, Mechanicals, Landry, Printing etc.)
The columns of COD and Oil will be filled up by FEEMA/DCON

Table 3.1-4 Questionaire Table for factories

Feema	SISTEMA DE LICENCIAMENTO DE ATIVIDADES POLUIDORAS-SLAP	Nº PROCESSO	
	CADASTRO DE INDÚSTRIAS DE TRANSFORMAÇÃO (MODELO SIMPLIFICADO)	RUBRICA	FL.

PARA USO EXCLUSIVO DA FEEMA

01 CÓDIGO EMPRESA	03 DATA CAD.	DIA	MES	ANO	05 CÓDIGO ATIVIDADE	COORDENADAS UTM (Km) 07 NORTE	09 ESTE

REFERÊNCIA CARTOGRÁFICA				ZONEAMENTO		21 BACIA HIDROGRÁFICA
ESC. 11	13 FL.	15 QUADR	17 NUMERO	19 CÓDIGO	DESCRIÇÃO	

23 INSC. ESTADUAL	25 C. G. C./CPF

PRINCIPAL ATIVIDADE EXERCIDA

FUNCIONAMENTO

27 DATA INIC.		
29 HORAS FUNC. P/DIA		31 DIAS FUNC. P/SEM.

REG CONSELHO REGIONAL

33 CREA-5ª Rg	
35 CRQ - 1ª Rg	
37 CRF 7	

IDENTIFICAÇÃO DA ATIVIDADE

39 RAZÃO SOCIAL	
41 NOME DE FANTASIA	
43 UNIDADE	

ENDEREÇO DA ATIVIDADE

45 LOGRADOURO					
47 BAIRRO/ LOCALIDADE		47 COD. BAIRRO		49 CEP	
51 TEL.	53 MUNICÍPIO	53 CÓD. MUNIC.	DISTRITO 55 RA		55 CÓD. DIST/RA

ENDEREÇO DO ESCRITÓRIO

57 LOGRADOURO					
59 BAIRRO/ LOCALIDADE		59 CÓD. BAIRRO		61 CEP	
63 TEL.	65 ( ) MUNICÍPIO			65 CÓD. MUNIC.	

67 STATUS		69 CARACTERISTICA ATIVIDADE		ÁREA (m²)	Nº DE FUNCIONÁRIOS
EM ATIVIDADE NORMAL	018	ÚNICA NO ESTADO	067	71 PRODUÇÃO	77 ADMINISTRAÇÃO
EM IMPLANTAÇÃO	026	PRINCIPAL	075	73 CONSTRUÍDA	79 PRODUÇÃO
EM PROJETO DE IMPLANTAÇÃO	034	DEPENDENTE	083	75 TOTAL	
DESATIVADA	042				
PARALISADA	059				

REPRESENTANTE JUNTO À FEEMA

81 NOME					
83 CARGO		85 TEL.		87 RAMAL	

DECLARO SEREM VERDADEIRAS AS INFORMAÇÕES PRESTADAS	PARA USO EXCLUSIVO DA FEEMA RECEPÇÃO
LOCAL E DATA	
NOME	
CARGO NA EMPRESA	
ASSINATURA	
IDENTIDADE / CIC	

10938/26 1104-B

Feema

SISTEMA DE LICENCIAMENTO DE ATIVIDADES POLUDORAS-SLAP

CADASTRO DE INDÚSTRIAS DE TRANSFORMAÇÃO

(MODELO SIMPLIFICADO)

Nº PROCESSO | RUBRICA | FL.

101 PRODUTOS FABRICADOS

PARA USO EXCLUSIVO DA FEEMA			PRODUTOS	CAPACIDADE DE PRODUÇÃO ANUAL	UNIDADE DE MEDIDA
101 CÓDIGO DO PRODUTO	CÓD. UNID. MEDIDA	QUANTIDADE			

107 FONTES DE ENERGIA

TIPO	107 CÓD.	QUANTIDADE	UNIDADE
ÓLEO COMBUSTÍVEL APF/BPF	018		m^3 / ANO
ÓLEO COMBUSTÍVEL BTE	026		m^3 / ANO
ÓLEO COMBUSTÍVEL E	034		m^3 / ANO
ÓLEO COMBUSTÍVEL EPM	042		m^3 / ANO
ÓLEO COMBUSTÍVEL OC4	059		m^3 / ANO
ÓLEO COMBUSTÍVEL DIESEL	067		m^3 / ANO
QUEROSENE	075		m^3 / ANO
CARVÃO ANTRACITO	083		t / ANO
CARVÃO BETUMINOSO	091		t / ANO
LIGNITO	109		t / ANO
COQUE	116		t / ANO
CARVÃO VEGETAL	124		t / ANO
GÁS DE PROCESSO (gerado na indústria)	133		mil m^3/ANO
GÁS NATURAL (de Campos)	140		mil m^3/ANO
GLP (de bujão)	158		m^3/ ANO
GÁS DE NAFTA (de rua)	166		m^3/ ANO
BAGAÇO	174		t / ANO
LENHA	181		t / ANO
ENERGIA ELÉTRICA	190		KWH / MES
	992		

RESÍDUOS INDUSTRIAIS

ESTADO(S) FÍSICO(S) DO(S) RESÍDUO(S)

LÍQUIDO

113 QUANTIDADE / ANO | 115 UNIDADE

SÓLIDO

117 QUANTIDADE / ANO | 119 UNIDADE

SEMI - SÓLIDO

121 QUANTIDADE / ANO | 123 UNIDADE

125 DESTINO FINAL DO(S) RESÍDUO(S)

ATERRO SANITÁRIO MUNICIPAL		018
ATERRO PRÓPRIO		026
REAPROVEITAMENTO P/ TERCEIROS		034
QUEIMA AO AR LIVRE		042
INCINERADOR		059
ESTOCAGEM		067
REAPROVEITAMENTO PRÓPRIO		075
		992

CONSUMO DE ÁGUA

PRODUÇÃO (m^3 / DIA)			135 TOTAL (m^3 / DIA)
127 INCORPORADA AO PRODUTO	129 CIRCUITO ABERTO RESFRIAMENTO	131 DEMAIS ÁGUAS DA PRODUÇÃO	

137 FONTES DE ABASTECIMENTO

1 REDE PUBLICA CEDAE	2 REDE PÚBLICA MUNICIPAL	3 POÇO FREÁTICO	5 MANANCIAL DE SUPERFÍCIE
Nº MATRÍCULA NA CIA DE ÁGUAS	Nº MATRÍCULA NA CIA DE ÁGUAS	4 POÇO PROFUNDO	6 OUTROS

Feema	SISTEMA DE LICENCIAMENTO DE ATIVIDADES POLUIDORAS-SLAP	Nº PROCESSO	
	CADASTRO DE INDÚSTRIAS DE TRANSFORMAÇÃO (MODELO SIMPLIFICADO)	RUBRICA	FL.

201 MATÉRIAS PRIMAS UTILIZADAS

PARA USO EXCLUSIVO DA FEEMA			MATÉRIA PRIMA	CONSUMO ANUAL	UNIDADE DE MEDIDA
201 CÓDIGO DO PRODUTO	CÓD. UNID. MEDIDA	QUANTIDADE			

207 PONTOS DE DESCARGA DE EFLUENTES LÍQUIDOS

ORIGEM	E S G O T O S A N I T Á R I O		
CORPO RECEPTOR		PARA USO EXCLUSIVO DA FEEMA	
		CÓD. S. ESGOTAMto	CÓD. BACIA HIDROGRÁFICA
ORIGEM			
CORPO RECEPTOR		PARA USO EXCLUSIVO DA FEEMA	
		CÓD. S. ESGOTAMto	CÓD. BACIA HIDROGRÁFICA
ORIGEM			
CORPO RECEPTOR		PARA USO EXCLUSIVO DA FEEMA	
		CÓD. S. ESGOTAMto	CÓD. BACIA HIDROGRÁFICA
ORIGEM			
CORPO RECEPTOR		PARA USO EXCLUSIVO DA FEEMA	
		CÓD. S. ESGOTAMto	CÓD. BACIA HIDROGRÁFICA
ORIGEM			
CORPO RECEPTOR		PARA USO EXCLUSIVO DA FEEMA	
		CÓD. S. ESGOTAMto	CÓD. BACIA HIDROGRÁFICA

213 PONTOS DE EMISSÃO PARA ATMOSFERA

CHAMINÉ (1) DUTO (2) EQUIP. (3)	FONTE DE EMISSÃO	TIPO DE EMISSÃO: PARTICULAS (1)	GASES (2)
☐		☐	☐
☐		☐	☐
☐		☐	☐
☐		☐	☐
☐		☐	☐
☐		☐	☐
☐		☐	☐
☐		☐	☐

10938/26 1104 - B

Feema	SISTEMA DE LICENCIAMENTO DE ATIVIDADES POLUIDORAS--SLAP	Nº PROCESSO	
	CADASTRO DE INDÚSTRIAS DE TRANSFORMAÇÃO (MODELO SIMPLIFICADO)	RUBRICA	FL.

301 ESTOCAGEM

MATERIAL ESTOCADO		PARA USO EXCLUSIVO DA FEEMA			
QUANTIDADE MÉD. ANO	UNID. MEDIDA	301 CÓDIGO DO PRODUTO	CÓD. UNID. MEDIDA	QUANTIDADE	C.FORMA
FORMA					
MATERIAL ESTOCADO		PARA USO EXCLUSIVO DA FEEMA			
QUANTIDADE MÉD. ANO	UNID. MEDIDA	CÓDIGO DO PRODUTO	CÓD. UNID. MEDIDA	QUANTIDADE	C.FORMA
FORMA					
MATERIAL ESTOCADO		PARA USO EXCLUSIVO DA FEEMA			
QUANTIDADE MÉD. ANO	UNID. MEDIDA	CÓDIGO DO PRODUTO	CÓD. UNID. MEDIDA	QUANTIDADE	C.FORMA
FORMA					
MATERIAL ESTOCADO		PARA USO EXCLUSIVO DA FEEMA			
QUANTIDADE MÉD. ANO	UNID. MEDIDA	CÓDIGO DO PRODUTO	CÓD. UNID. MEDIDA	QUANTIDADE	C.FORMA
FORMA					
MATERIAL ESTOCADO		PARA USO EXCLUSIVO DA FEEMA			
QUANTIDADE MÉD. ANO	UNID. MEDIDA	CÓDIGO DO PRODUTO	CÓD. UNID. MEDIDA	QUANTIDADE	C.FORMA
FORMA					
MATERIAL ESTOCADO		PARA USO EXCLUSIVO DA FEEMA			
QUANTIDADE MÉD. ANO	UNID. MEDIDA	CÓDIGO DO PRODUTO	CÓD. UNID. MEDIDA	QUANTIDADE	C.FORMA
FORMA					
MATERIAL ESTOCADO		PARA USO EXCLUSIVO DA FEEMA			
QUANTIDADE MÉD. ANO	UNID. MEDIDA	CÓDIGO DO PRODUTO	CÓD. UNID. MEDIDA	QUANTIDADE	C.FORMA
FORMA					

400 DESCRIÇÃO DO(S) PROCESSO(S) E OPERAÇÕES INDUSTRIAIS

SENDO NECESSÁRIO FOLHAS EXTRAS PARA DESCRIÇÃO DOS PROCESSOS, ANEXE-AS AO FORMULÁRIO INDICANDO O Nº DE PÁGINAS, UTILIZANDO ——› |__|__| PÁGINAS.

GUANABARA BAY SEWERAGE BASINS

1 - ALEGRIA SEWERAGE BASIN

1.1 - Population: 1.521.183 inhabitants.

1.2 - Domestic sewage per capita flow: 256 l/hab.d.

1.3 - BOD = 240 mg/l

Reference:

Alegria Wastewater Treatment Plant Design.
Report No.4. Calculation and Description Memorial.
Multiservice Consultants Engineering S/A.
1991.

Remark:

1.1 - Arrangement from Great Area Water Supply Master Plan.
Cedae, 1985.

1.2 - Evaluation on water consumption per capita in several Cedae's Water Districts.
July, 1990.

1.3 - BOD affluent to the Treatment Plant, according to Cedae's research and determination.

2 - PENHA SEWERAGE BASIN

2.1 - Population = 750.000 inhabitants.

Reference:
North Area of Rio de Janeiro Sewerage System.
Final Report, 1991.
Wastewater Superintendence.
Operation and Maintenance Directory - Cedae.

2.2 - Domestic sewage per capita flow = 163 l/hab.d.

2.3 - Average BOD = 217 mg/l

Reference:
Annual Report, 1991.
Operation and Treatment Division.
Wastewater Superintendence.
Operation and Maintenance Directory - Cedae.

Remark: 2.2 - Average flow of Penha Wastewater Treatment Plan equals to 122.774 m^3/d

3 - ILHA DO GOVERNADOR SEWERAGE BASIN

3.1 - Population = 197.005 inhabitants.

Reference: National Demographic Research, 1991.
Brazilian Institute for Geographics and Estatistics - IBGE.

3.2 - Domestic sewage per capita flow = 359 l/hsb.d.

3.3 - BOD = 243 mg/l.

Reference: Annual Report, 1991.
Operation and Treatment Division.
Wastewater Superintendence.
Operation and Maintenance Diretory - Cedae.

Remark: Average flow Ilha do Governador Wastewater Treatment Plant equals to 22.977 m^3/d.

4 - PAVUNA MERITI ACARI SEWERAGE BASIN

4.1 - Population = 1.611.378 inhabitants.

4.2 - Domestic sewage per capita flow = 210 l/hab.d.

4.3 - BOD = 224 mg/l.

Reference: Pavuna Meriti Acari Sewerage System Conception Study.
STE Consultants Engineering S/A.
February, 1992

5 - SARAPUI SEWERAGE BASIN

5.1 - Population: 998.644

Reference: Rio de Janeiro Great Area Sewerage Master
STE Consultants Engineering S/A
1991.

5.2 - Domestic sewage per capita flow = 154 l/hab.d.

Reference: Sarapui Sewerage System Design.
Aquacon Consultants Engineering S/A.
1992.

5.3 - BOD = 168 mg/l

Reference: Sarapui Sewage Treatment Plant Design.
IESA Consultants Engineering S/A.
1992.

6 - IGUACU BOTAS SEWERAGE BASIN
7 - CAMPOS ELISEOS SEWERAGE BASIN
8 - SURUI SEWERAGE BASIN
9 - CACHOEIRAS DE MACACU SEWERAGE BASIN

There is no design in study developed for these sewerage basins up-to-date, so it will be impossible to have some information or data.

10 - SÃO GONCALO SEWERAGE BASIN

10.1 - Population 846.833 inhabitants

Reference: São Goncalo Sewerage System Conception study.
Encibra Consultants Engineering S/A.
1989.

10.2 - Domestic sewage per capita flow = 200 l/hab.d.

10.3 - BOD affluent = 270 mg/l.

Reference: São Goncalo Wastewater Treatment Plant Design.

March, 1992.

11 - NITEROI CENTRO NORTE SEWERAGE SYSTEM

11.1 - Population = 193.037 inhabitants.

11.2 - Domestic sewage per capita flow = 240 l/hab.d.

Reference: Niteroi Centro Norte Sewage Final Disposal Design.
STE Consultant Engineering.
August, 1988.

11.3 - BOD = 200 mg/l

Reference: Ponta de Areia Wastewater Treatment Plant Design.
STE Consultant Engineering.
January, 1991.

Remark:
11.1 - and 11.2 - Arrangement from the Great Area Water Supply Master Plan Cedae, 1985.
Population and average wastewater flow estimated for 1990.

12 - NITEROI SUL SEWERAGE BASIN

12.1 - Population = 245.000 inhabitants.

12.2 - Domestic sewage per capita flow = 200 l/hab.d.

12.3 - BOD = 270 mg/l
Reference: Icarai Wastewater Treatment Plant design.
Cedae

Remark:
12.1 - Based on National Demographic Research, 1960.

13 - PAQUETA SEWERAGE BASIN

13.1 - Population = 3.254 inhabitants

Reference: National Demographic Research, 1991
Brazilian Institute for Geographic and Estatistics - IBGE

13.2 - Domestic sewage per capita flow = 200 l/hab.d.

13.3 - Pollution load per capita = 54 g BOD/d

Reference: Domestic sewage per capita flow based on Technical Normatization, ABNT
NB-41 - Septic Tank
Pollution load per capita base on application as usual by Cedae, for wastewater characterization.

3.1.2 Production of Raw Sanitary Sewage and Urban Solid Waste

3.1.2.1 Production of Raw Sanitary Sewage

Table 3.1-5 shows the total production of raw sanitary sewage for each sewerage basin of Guanabara Bay, considering the total flow and the pollution load. The calculation was made applying the domestic sewage per capita flow and the average BOD of each sewerage basin, according to the reference listed previously.

Table 3.1-5 Total Production of Raw sanitary Sewage in Guanabara Bay Sewerage basins

SEWERAGE BASIN	POPULATION (inhabitants)	TOTAL FLOW (m^3/d)	POLLUTION LOAD (kg BOD/d)
Alegria	1:521.183	389.422	93.461
Penha	750.000	122.746	26.635
Ilha do Governador	197.005	70.724	17.186
Pavuna,Meriti,Acarí	1.611.378	338.389	75.799
Sarapuí	998.644	153.791	25.836
Iguaçú-Botas	N.I	N.I	N.I
Campos Elíseos	N.I	N.I	N.I
Suruí	N.I	N.I	N.I
Cachoeiras Macacú	N.I	N.I	N.I
São Gonçalo	846.833	169.366	45.729
Niteroi Cento Norte	193.037	46.328	9.265
Niterói Sul	245.000	49.000	13.230
Paquetá	3.254	651	176

3.1.2.2 Production of Urban Solid Waste

Table 3.1-6 shows the urban solid waste production for each city in the Great or Rio de Janeiro area.
The population is based on the National Demographic Research, 1991.
Brazilian Institute for Geographic and Statistics - IBGE.
The per capita production is based on Guanabara Bay Ecosystem Recuperation.

Table 3.1-6 Urban Solid Waste Production

CITY	POPULATION (Inhabitants)	PER CAPITA PRODUCTION (kg/hab.d)	URBAN SOLID WASTE PRODUCTION (kg/d)
D. de Caxias	635.338	0,646	410.428
Itaboraí	161.398	0,670	108.136
Magé	191.249	0,689	131.770
Nilópolis	157.936	0,656	103.606
Niteroi	435.658	0,823	358.546
Nova Iguaçú	1.293.611	0,689	891.198
Rio de Janeiro	5.473.343	0,890	4.871.275
S.J. Meriti	424.689	0,670	284.541
São Gonçalo	778.820	0,574	447.043
TOTAL	9.552.042	-x-	7.660.643

The Urban Solid Waste Production is not the influence values for the Guanabara Bay (landfill) as it show in table 1.3.1.

3.2 SEWER SYSTEMS AND SEWAGE TREATMENT PLANT

3.2.1 Sewer Systems

CEDAE is responsible for the implementation, control and operation of the Greater Rio de Janeiro Sewer Systems.
The existing sewer systems of the Greater Rio de Janeiro area (wastewater collection systems) are shown in **Table 3.1-2** as point pollution sources.

In Greater Rio de Janeiro, - the central and northern areas of Rio de Janeiro City, Paqueta Island, Centro Norte and Icarai areas of Niteroi City are covered by sewer systems.

The Central and northern areas of Rio de Janeiro City contain several sewerage basins by system, according to **Table 3.2-1**.

Paqueta Island has 11km of sewer pipelines, the final disposal point of the sewage is Guanabara Bay.

Niteroi Central Norte located in Niteroi City has km of sewer pipeline.
Icarai also located in Niteroi City has km of sewer pipeline and the final disposal of the sewage is Guanabara Bay

Table 3.2-1 Sewerage Sub-basins Sewer System Characteristics

SEWERAGE SUBBASIN	TOTAL AREA (ha)	SEWER SYSTEM AREA (ha)	SEWER SYSTEM LENGTH (km)	SERVED POPULATION (Inhabitants)	SEWERAGE FINAL DISPOSAL
Irajá	1.450	1.355	165	200.000	Penha S.T.P
Penha	1.987	1.876	223	750.000	Penha S.T.P
Timbó Faria	1.739	1.285	144	300.000	Penha S.T.P
Alegria	3.980	2.858	300	800.000	Guanabara Bay
S. Cristovão	4.010	1.904	220	1.000.000	Guanabara Bay
Catumbí	519	516	55	N.I	Guanabara Bay
Mangue	62	62	10	30.000	Guanabara Bay
Centro	346	346	68	150.000	Guanabara Bay
Fundão	446	160	22	N.I	Penha S.T.P
I. Governador	N.I	N.I	178	250.000	I.Governador STP

3.2.2 Sewage Treatment Plants

(1) Details of Existing Sewage Treatment Plants(**Fig. 3.2-1**)

The existing sewage treatment plants were characterized as treated point pollution sources in this chapter. The characteristics and details of each treatment plant are shown in the following figures.

(2) Operation and Maintenance Cost of Sewage Treatment Plants

As samples the operation and maintenance costs of Penha and Ilha do Governador Sewage Treatment Plants are shown in **Table 3.2-2** for the year of 1991.

Table 3.2-2 Operation and Maintenance Cost of Penha and Ilha do Governador Sewage Treatment Plants.

1991	S T P - PENHA			S T P - ILHA DO GOVERNADOR		
	FLOW	TOTAL COST	COST/FLOW	FLOW	TOTAL COST	COST/FLOW
	m^3/mês	U$/mês	U$/$m^3$	m^3/mês	U$/mês	U$/$m^3$
JAN	3.749.760	62.591,08	0,02	707.574	19.718,16	0,03
FEB	3.757.795	43.705,79	0,01	714.145	23.067,91	0,03
MAR	3.376.339	44.194,99	0,01	651.228	25.344,46	0,04
APR	3.760.473	41.329,57	0,01	725.826	23.533,31	0,03
MAY	3.618.950	42.874,65	0,01	700.468	22.844,39	0,03
JUN	3.760.473	47.355,77	0,01	716.671	26.709,33	0,04
JUL	3.636.576	43.203,68	0,01	683.516	26.959,91	0,04
AUG	3.735.201	41.526,70	0,01	626.880	26.966,80	0,04
SEP	3.760.473	38.258,80	0,01	591.457	24.012,87	0,04
OCT	3.639.168	28.868,10	0,01	686.038	20.730,67	0,03
NOV	3.760.473	23.435,28	0,01	743.478	19.451,32	0,03
DEC	3.633.984	27.301,65	0,01	724.649	21.438,55	0,03

REMARKS: From September to November the dollar rose enough to cause a lower cost for the plants.
See FINANCIAL MARKET in the next page.

Fig.3.2-1(1) Details of Sewage Treatment Plants (PENHA)

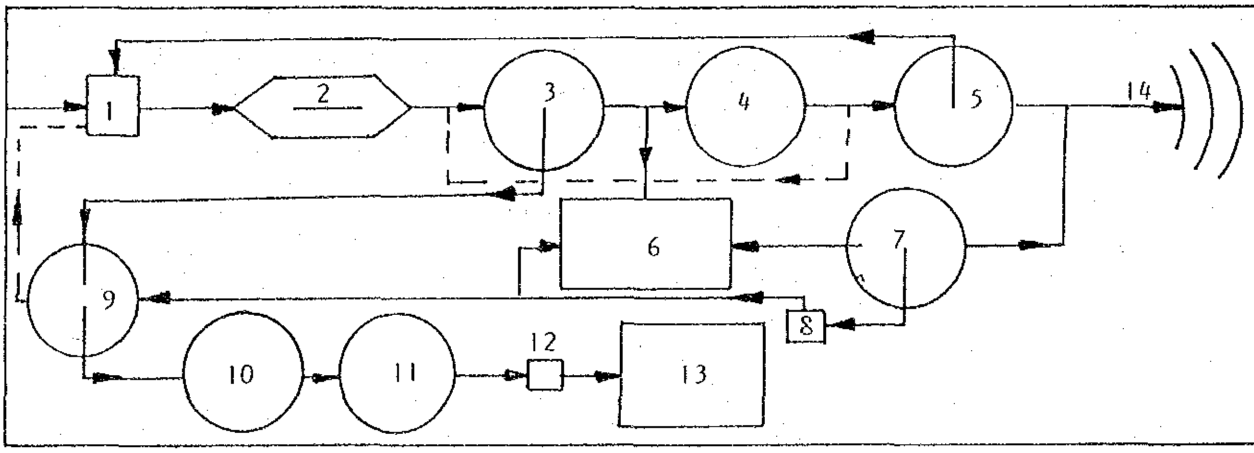
FACILITY: PENHA Sewage Treatment Plant
RESPONSIBLE PLANT: CEDAE

ADDRESS: Rio de Janeiro - Av. Brasil - Penha
POPULATION: 750.000
PER CAPITA FLOW: 230 l/hab/day
AVERAGE FLOW: 1.400 l/s

MAX FLOW: 1.600 l/s
TREATMENT TYPE: Biological

BOD (INFLUENT) : 190
BOD (EFFLUENT) : 17 mg/l

EFFICIENT: 91%



1 - Raw Sewage Pump Station
2 - Grit Chamber
3 - Primary Sedimentation Tank
4 - Tricling Filter
5 - Secundary Sedimentation Tank
6 - Aeration Tank
7 - Secundary Sedimentation Tank
8 - Recirculation Pump Station
9 - Thickner
10 - Primary Digester Tank
11 - Sludge Pump Station
12 - Secundary Digester Tank
13 - Pressure Filter
14 - Receiving Body: Baía de Guanabara

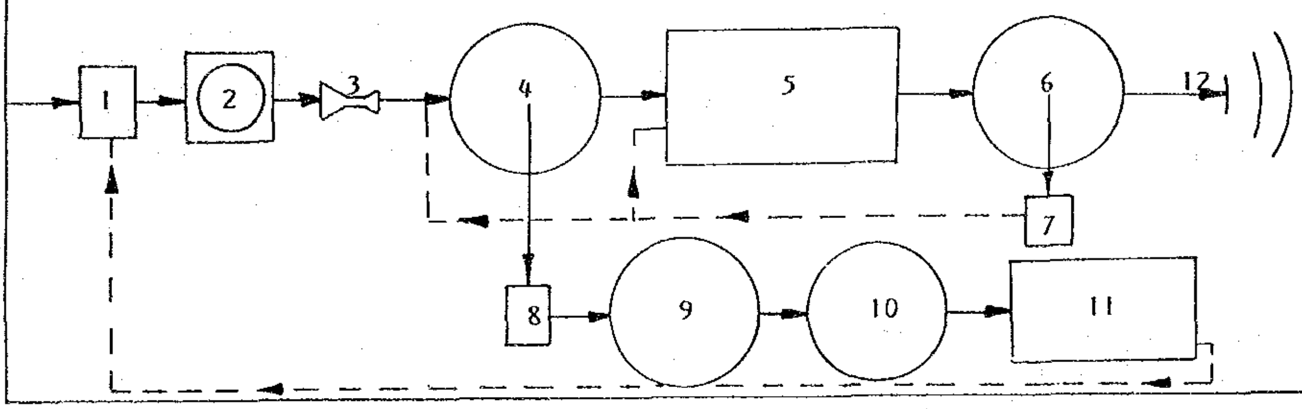
Note: Treatment type: Biological
Tricklings Filter 37,8% (influent flow)
Activated sludge 77,5 % (effluent flow)

Fig.3.2-1(2) Details of Sewage Treatment Plants (ETIG)

FACILITY: ETIG Sewage Treatment Plant
RESPONSIBLE PLANT: CEDAE

ADDRESS: Rio de Janeiro - Estrada do Galeão - Ilha do Governador
POPULATION: 64.000
PER CAPITA FLOW: (1)
AVERAGE FLOW: 200 l/s
MAX FLOW: 360 l/s
TREATMENT TYPE: Activated Sludge

BOD (INFLUENT): 200 mg/l
BOD (EFFLUENT): 10 mg/l
EFFICIENT: 95%



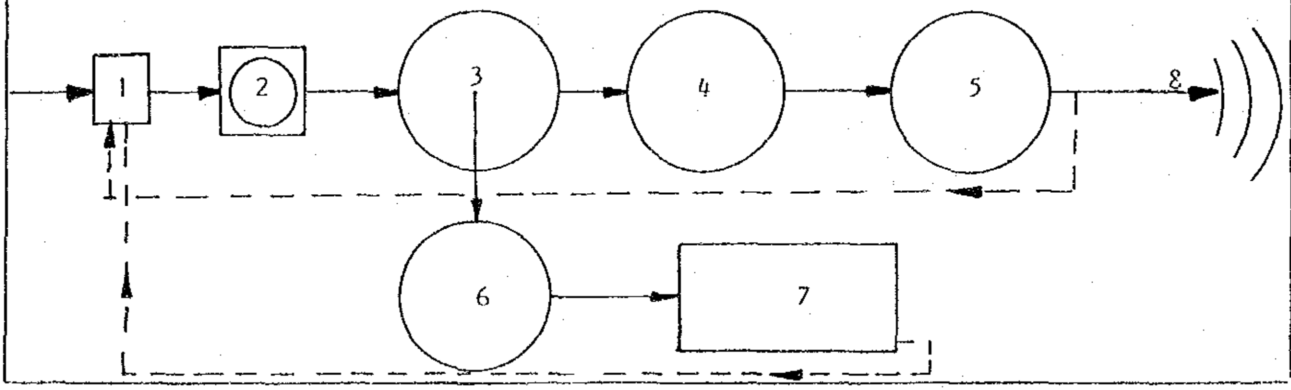
1 - Raw Sewage Pump Station
2 - Grit Chamber
3 - Flowmeter
4 - Primary Sedimentation Tank
5 - Aeration Tank
6 - Secundary Sedimentation Tank
7 - Recirculation Pump Station
8 - Sludge Pump Station
9 - Primary Digester
10 - Secundary Digester
11 - Drying Beds
12 - Receiving Body: Baía de Guanabara

Note: Covers only 40% of the population in the civil area (1)

Fig.3.2-1(3) Details of Sewage Treatment Plants (ETEG)

FACILITY: ETEG Sewage Treatment Plant
RESPONSIBLE PLANT: Air Ministry

ADDRESS: Rio de Janeiro, Praia São Bento - Ilha do Governador
POPULATION: (1)
PER CAPTA FLOW: (1)
AVERAGE FLOW: 40 l/s   MAX FLOW: 70 l/s
TREATMENT TYPE: Trickling Filter
BOD: (INFLUENT): 290 mg/l
BOD: (EFFLUENT): 29 mg/l   EFFICIENT: 90 %



1 - Raw Sewage Pump Station
2 - Grit Chamber
3 - Primary Sedimentation Tank
4 - Tricling Filter
5 - Secundary Sedimentation Tank
6 - Primary Digester Tank
7 - Dryng Beds
8 - Receiving Body: Baía de Guanabara

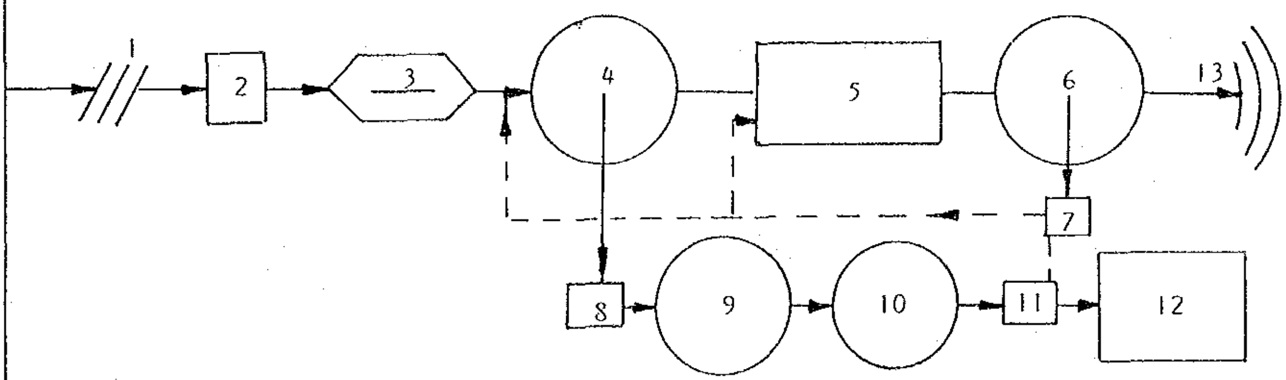
Note:
(1) Temporary ocupation (air force base)
(1) It'is operated by CEDAE

Fig.3.2-1(4) Details of Sewage Treatment Plants (ETAR)

FACILITY: ETAR sewage Treatment Plant
RESPONSIBLE PLANT: Air Ministry

ADDRESS: Rio de Janeiro - Estrada dos Maracajas S/N. - Ilha do Governador
POPALATION: (1)
PER CAPITA FLOW : (1)
AVERAGE FLOW: 28 l/s
MAX FLOW: 55 l/s
TREATMENT TYPE: Activated Sludge

BOD (INFLUENT) : 300 mg/l
BOD (EFFLUENT): 30 mg/l
EFFICIENT: 90%



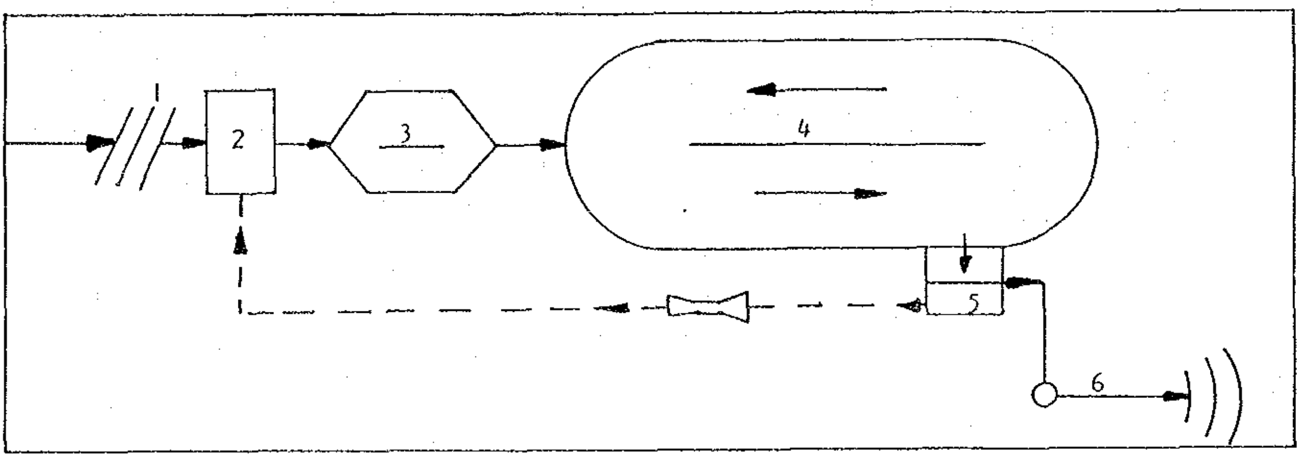
1 - Bars Screen
2 - Raw Sewage Pump Station
3 - Crit Chamber
4 - Primary Sedimentation Tank
5 - Aeation Tanks
6 - Secundary Sedimentation Tank
7 - Recirculation Pump Station
8 - Sludge Pump Station
9 - Primary Digester
10 - Secundary Digester
11 - Digester Pump Station
12 - Drying Beds
13 - Receiving Body: Baía de Guanabara

Note:
(1) Temporary Ocupation (air port)

Fig.3.2-1(5) Details of Sewage Treatment Plants (ETAR-TECA)

FACILITY: ETAR-TECA Sewage Treatment Plant.
RESPONSIBLE PLANT: Air Ministry

ADDRESS: Rio de Janeiro, Galeão - Ilha do Governador
POPULATION: (1)
PER CAPTA FLOW (1)
AVERAGE FLOW: 6,6 l/s
MAX FLOW: 12 l/s
TREATMENT TYPE: Oxidation Ditch
BOD (INFLUENT): 270 mg/l
BOD (EFFLUENT): 27 mg/l
EFICIENT: 90%



1 - Bars Screen
2 - Raw Sewage Pump Station
3 - Grit Chamber
4 - Oxidation Ditch
5 - Recirculation Pump Station
6 - Receiving Body: Baía de Guanabara

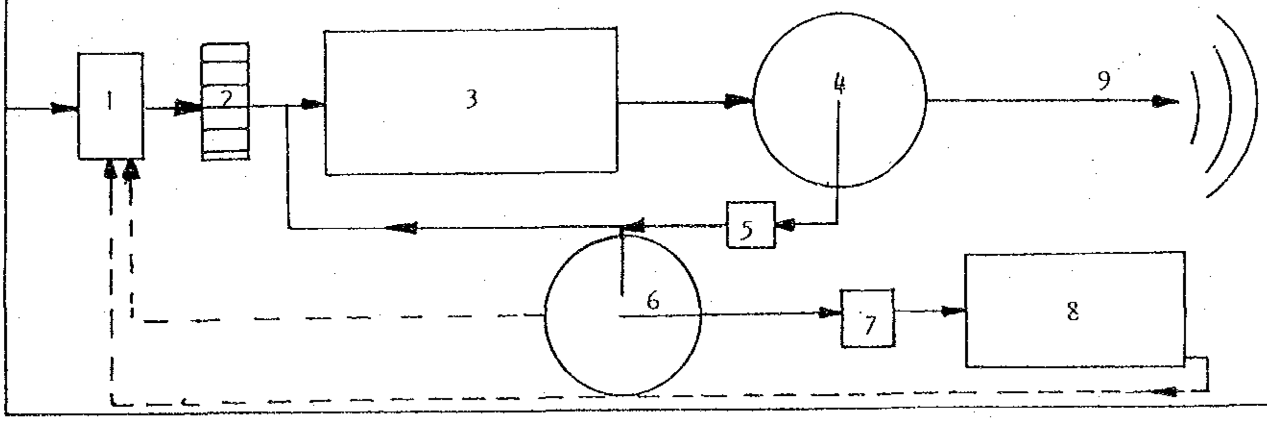
Note: Temporary Acupation (air port) (1)

Fig.3.2-1(6) Details of Sewage Treatment Plants (ICARAI)

FACILITY: ICARAÍ Sewage Treatment Plant
RESPONSIBLE PLANT: CEDAE

ADDRESS: Rio de Janeiro - Niteroi
POPULATION: 251.000
PER CAPTA FLOW: 225 l/hab. day
AVERAGE FLOW: 654 l/s
MAX FLOW: 980 l/s
TREATMENT TYPE: Activated Sludge

BOD (INFLUENT): 240 mg/l
BOD (EFFLUENT): 12 mg/l
EFICIENT: 95%

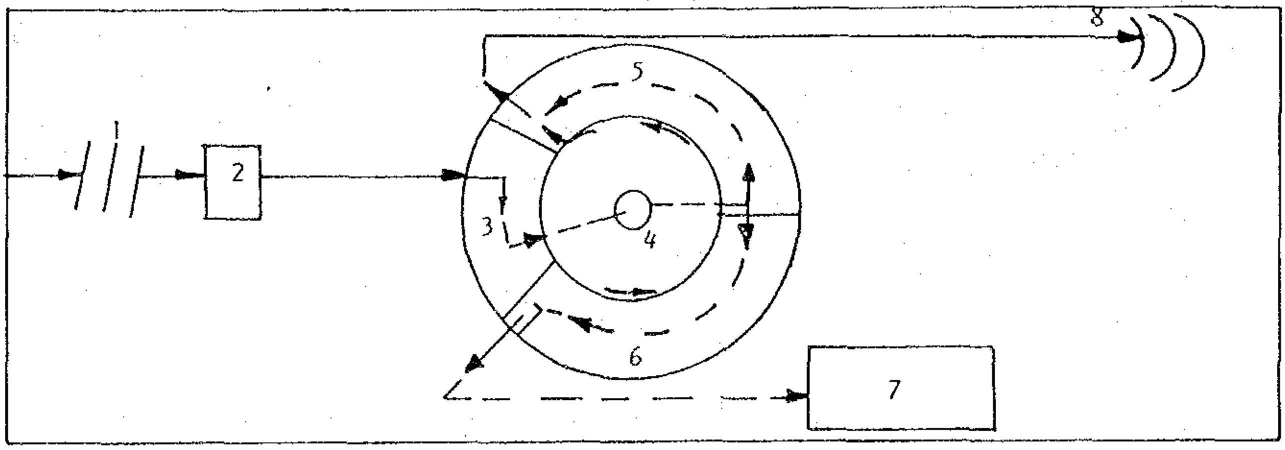


1 - Raw Sewage Pump Station
2 - Micro Screen
3 - Aeration Tanks
4 - Secundary Sedimentation Tank
5 - Recirculation Pump Station
6 - Thickner
7 - Sludge Pump Station
8 - Pressure Filter
9 - Receiving Body: Baía de Guanabara

Fig.3.2-1(7)Details of Sewage Treatment Plants (ACARI)

FACILITY: ACARI Sewage Treatment Plunt
RESPONSIBLE PLANT: CEDAE

ADDRES: Rio de Janeiro - Deodoro - Vila Militar
POPULATION: 69.120
PER CAPTA FLOW: 225 l/hab. day
AVERAGE FLOW: 180 l/s
MAX FLOW: 325 l/s
Treatment type: Activated sludge
BOD (INFLUENT): 240 mg/l
BOD (EFFLUENT): 12 mg/l
EFICIENT: 97%



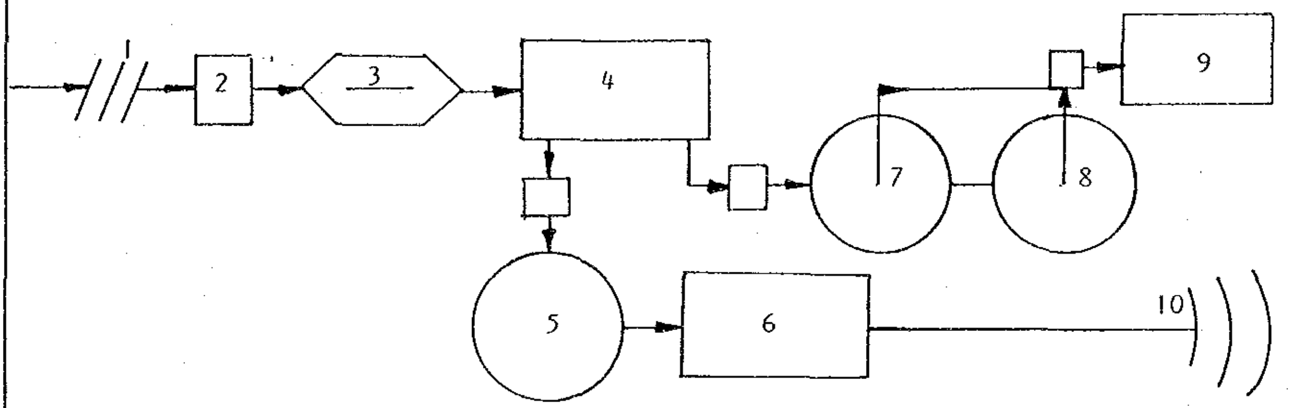
1 - Bars screen
2 - Raw sewage pump station
3 - Aeration tank
4 - Sedimentation tank
5 - Rearation tank
6 - Aerobic Degester
7 - Drying beds
8 - Receiving Body: Rio Acarí

Note:
Rio Acarí is Guanabara bay influent.

Fig.3.2-1(8) Details of Sewage Treatment Plants (REALENGO)

FACILITY: REALENGO Sewage Treatment Plant.
RESPONSIBLE PANT: CEDAE

ADDRESS: Rio de Janeiro - Estrada da Água Branca - Realengo
POPULATION: 18.500
PER CAPTA FLOW: 224 l/hab. day
AVERAGE FLOW: 48 l/s
MAX FLOW: 80 l/s
TREATMENT TYPE: Trickling Filter
BOD (INFLUENT): 240 mg/l
BOD (EFFLUENT): 24 mg/l
EFICIENT: 90%



1 - Bars screen
2 - Raw sewage pump station
3 - Grit chamber
4 - Primary sedimentation tank
5 - Trikcling filter
6 - Secundary sedimentation tank
7 - Aerobic digester tank
8 - Aerobic digester tank
9 - Drying beds
10 - Receiving body: Rio Acarí

Note:

Rio Acarí is Guanabara bay influent.

3.2.3 Water Quality of Sewage Discharge

Table 3.2-3 shows the average wastewater characteristics of Penha, Ilha do Governador and Acari Sewage Treatment Plants.

Table 3.2-3 Characteristics of Effluent Sewage

LABORATORY ANALYSIS	STP PENHA	STP I.GOVERNADOR	STP ACARI
pH	6,5	6,8	6,7
Settleable Solids (mg/l)	3,0	5,3	5,4
Total solids (mg/l)	485,0	572,0	535,0
Fixed total solids (mg/l)	175,0	263,0	158,0
Suspended solids (mg/l)	146,0	184,0	278,0
Fixed suspended solids (mg/l)	39,0	36,0	45,0
BOD (mg/l)	114,0	150,0	235,0
Grease (mg/l)	-	12,0	-
Fecal coliform (NMP/100 ml)	50×10^6	30×10^6	30×10^6

Reference: Niterói Centro Norte Sewerage System Conception Study.
STE Consultants Engineering S/A.
July, 1988.

3.2.4 Water Use volume

The total water consumption in November 1992, according to each CEDAE's Water District, located at Guanabara Bay Basin, is given in **Table 3.2-4.**

Table 3.2-4 Water Consumption

CEDAE's WATER DISTRICT	RESIDENTIAL (m^3/Month)	COMMERCIAL (m^3/Month)	INDUSTRIAL (m^3/Month)	PUBLIC (m^3/Month)	TOTAL (m^3/Month)
Niterói	2.515.460	341.623	87.787	177.714	3.122.586
São Gonçalo	3.070.183	247.685	102.107	41.107	3.461.078
Cach.Macacú	43.195	2.800	21	3.300	49.318
Paquetá	44.381	1.751	-	4.639	50.772
Piabetá	192.700	12.082	65	1.900	206.747
Alcantara	847.961	102.408	35.322	4.871	990.563
Cascadura	4.402.498	446.815	152.654	122.016	5.123.984
Deodoro	4.112.399	195.189	106.605	228.641	4.642.834
Centro	4.122.021	1.674.271	285.243	846.228	6.927.764
Tijuca	3.348.490	449.288	416.166	271.310	4.485.256
Meier	3.752.567	367.423	254.114	143.121	4.517.226
Ramos	3.275.491	524.279	399.279	230.375	4.430.015
I.Governador	1.073.181	195.007	29.518	113.901	1.411.608
D.Caxias	1.901.233	206.022	24.523	43.244	2.175.023
J.Primavera	750.953	26.474	43.200	87.278	907.907
Queimados	568.738	29.084	19.748	25.143	642.715
Nova Iguaçú	2.296.505	250.663	70.263	40.644	2.658.076
Belford Roxo	2.300.814	153.746	247.584	11.526	2.713.671
S.J.Meriti	2.178.558	242.494	15.997	55.925	2.492.975
Nilópolis	808.968	56.858	2.146	30.039	898.013

CHAPTER 4

INDUSTRIAL WASTEWATER CONTROL AND ITS CHARACTERIZATION

CHAPTER 4

INDUSTRIAL WASTEWATER CONTROL AND ITS CHARACTERIZATION
- Monitoring Results of Industrial Wastewater

4.1 Current Situation of Industrial Wastewater

The Guanabara Bay basin constitutes one of the most important industrial parks in the country it accounts for, approximately, 6,000 potentially polluting factories involved in various activities, including chemical, petrochemical, food, textile, beverage, metal finishing, etc.

The oil refinery at Duque de Caxias, part of the PETROBRAS petrochemical complex, contributes greatly in terms of industrial pollution. Its liquid effluents contain, significant amounts of oil and other organic matter, heavy metals, phenols and toxic organic substances that are possibly carcinogenic or mutagenic.

Many seafood producing factories located in the municipalities of Niteroi and Sao Goncalo generate large volumes of effluents with high concentrations of oil and organic matter, releasing also, unpleasant smells which incommodes the inhabitants of the region. Almost all factories in this industry do not have treatment facilities.

In the metal finishing sector, the total pollution discharged from the many small scale factories contributes significantly.

In 1988, it was estimated that about 9.5 t/d of oil was discharged into the bay, 3.5 t/d from the Duque de Caxias refinery, 1.0 t/d from the marine terminal, 2.8 t/d from other industries and 2.2 t/d from the 40 shipyards and 2,000 gasoline stands.

An oil control plan started in 1988 to reduce by, approximately 50% to oil discharged into Guanabara Bay. It was planned to install small scale oil separators in each gasoline stand to control of discharge of oil but this plan was unsuccessful doe to the economic recession.

Currently 23 plants have disposal treatment facilities in operation and 13 others are in the process of constructing. The names of these plants are listed in **Table 4.1-1** and **Table 4.1-2**.

Table 4.1-1 Industries with Treatment Facilities

No.	Name of Industry
01	Sidney Ross (Sanofi Winthop Farmaceutica)
02	Ciba Greigy
03	Refrigerante Niteroi S/A
04	Rio de Janeiro Refrescos S/A (Bangu)
05	Pan-Americana S/A Industria Quimica
06	Bayer do Brasil
07	Petroflex/Nitriflex Industria e Comercio S/A
08	Industria de Conservas Santa Iria
09	Fabrica Unidas Tecidos, Rendas e Bordados
10	Shell Brasil S.A.
11	SPAM
12	Cia. Fluminense de Tecidos S/A
13	Fabrimar
14	IAB
15	S/A Marvin
16	Industria Alimenticia Beira Alta
17	Cibran - Cia. Brasileira de Antibioticos
18	Sadia Concordia S/A Industrias e Comercios
19	Vulcan Material Plastico
20	Solutec
21	Cooperative Central de Produtores de Leite Sao Goncalo
22	Denar Quimica S/A
23	Texaco do Brasil S/A Produtos de Petroleo

Table 4.1-2 Industries with Treatment Facilities (in course of constsruction)

No.	Name of Industry
01	Cibraple S/A
02	Kibon Industrias Alimenticias S/A
03	Reduc - Petroleo Brasileiro S/A
04	Quaker Alimentos e Conservas Conqueiros S/A
05	Refinaria de Petroleo Manguinhos
06	IFF - Essencias e Fragancias
07	Conservas Ribeiro S/A
08	Rio de Janeiro Refrescos S/A (Bonsucesso)
09	Getec - Guanabara Quimica Industrial S/A
10	Refinaria Piedade S/A
11	Rioquimica S/A
12	Tasa Lubrificantes Ltda.
13	Bloch Editores S/A

4.2 FEEMA Monitoring Program

FEEMA selected recently 455 factories which contribute 90% of all organic matter discharged into Guanabara Bay.

Total BOD, heavy metals and oil loads generated by all factories are estimated at 120 t/d, 0.55 t/d and 4.8 t/d, respectively.

To effectively control these pollution sources, FEEMA recently drew up an industrial waste control program for the Guanabara Bay basin following a request from the I.D.B.

According to this program, FEEMA will obligate 455 factories to treat their wastewater during the 4 years of the program. These factories are listed in **Table 4.2-1.**

The expected reduction of BOD, heavy metals and oil loads for each year is shown in **Table 4.2-2.**

Table 4.2-3 shows the names and location and estimated pollution loads of the 150 heaviest contributors of pollution loads in the Guanabara Bay basin selected by FEEMA, taking into consideration their activities.

Fig. 4.2-1 shows the general geographical distribution in the Guanabara basin of these factories. As it can be seen, most of the factories are located on the west and north west sides of the Guanabara basin, especially, in the Rio Timbo-Faria tributary basin. Further, food and chemical industries predominate, in terms of number as well as BOD loads, corresponding, to 55 to 59% of the total pollution loads from all factories. **Table 4.2-4** ranks the industries in terms of contribution of BOD.

Fig. 4.2-2 presents, schematically, the discharge of industrial BOD loads into the tributary basins. The Niteroi and Sao Goncalo regions, where there is a conglomeration of seafood producers, constitute the greatest BOD load contributors in the Guanabara basin, followed by the Rio Timbo-Faria and Rio Iguacu tributaries.

Fig. 4.2-3 compares industry and domestic BOD loads flowing into each tributary basin to demonstrate the point source pollution distribution. Domestic loads were estimated, based on the population of each tributary basin (1991), *multiplied by 50g BOD/cap./day.*

The Sao Joao de Meriti and Sarapui basins generate relatively large BOD loads composed, only 10 and 5% of industrial source. This situation is totally different to the Niteroi and Sao Goncalo tributaries, where industrial sources are almost 1.8 times greater.

In the Rio Timbo-Faria basin, also, industrial BOD is discharged in appreciable amounts.

The explanation mentioned above concerns only organic loads. According to FEEMA data, approximately 75 factories in the metal finishing are mainly responsible for 362 kg of heavy metals.

Finally, FEEMA plans to improve oil control efficiency, including, almost 2000 gasoline stands that constitute one of the most important pollution sources.

Table 4.2-1 Chronogram of the Industrial Control

Year	Number of Industries with Control	Accumulated Number
01	50	50
02	100	150
03	150	300
04	155	455

Table 4.2-2 Reduction of Pollutatant Loads expected or Each Year (kg/d)

Year	BOD	Heavy Metal	Oils
01	62,998	72	950
02	26,812	89	552
03	4,513	150	185
04	3,009	51	428
Total	97,332	362	2,185

Table 4.2-4 Rank of the industries in term of conribution of BOD Loads

TYPE OF INDUSTRY	NUMBER OF INDUSTRY	BOD LOADS (ton/day)
FOOD	38	41.5
CHEMICAL	44	16.4
TEXTILE	20	8.4
BEVERAGE	3	7.1
PAPER	3	4.4
PHARMACY	8	3.2
LAUNDRY	4	2.8
GRAPHIC	4	0.9
OTHERS	26	5
Total	150	89.8

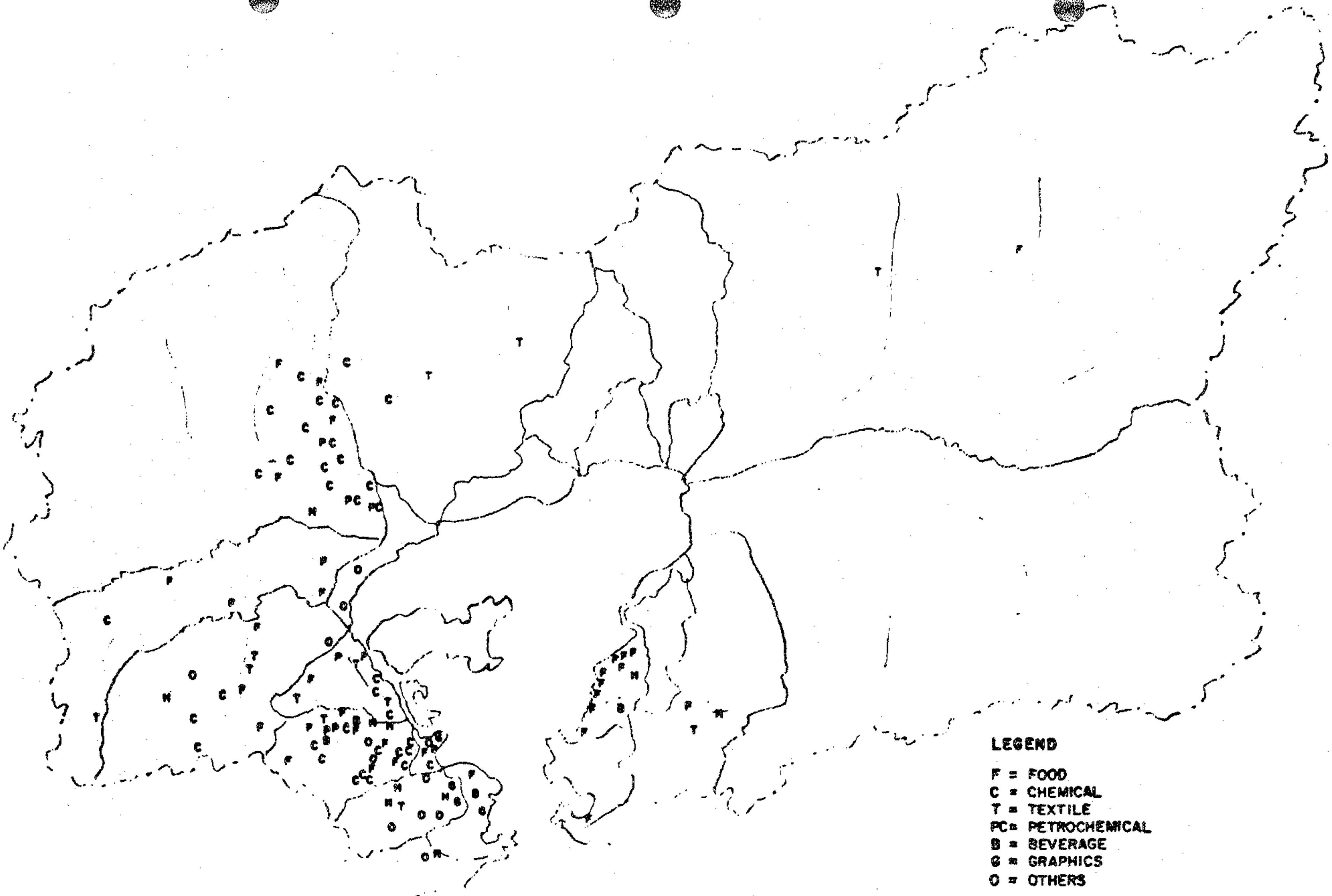


Fig. 4.2-1 Location of The Most Heaty Contributors in Function of Industrial Activies.

Table 4.2-3 Name of Industries with Location and BOD loads

nº	N A M E	U T M Coordinates North	U T M Coordinates East	T y p e	B O D (Kg/d)	Recieving Body
001	QUAKER ALIMENTOS			FOOD	6700	BAIA DE GUANABARA
002	RIOQUIMA	7497.15	676.[illegible]	CHEMICALS	4400	RIO SARACURUNA
003	CIA CERVEJARIA BRAHMA - CENTRO	7465.34	684.86	BEVERAGE	4000	REDE CANAL CUNHA
004	CONSERVAS PIRACEMA	7472.82	695.44	FOOD	2400	BAIA DE GUANABARA
005	CIBRAPEL			PAPER	2304	RIO SOBERBO
006	RIO DE JANEIRO REFRESCOS S/A	7470.17	677.58	BEVERAGE	2300	RIO TIMBO
007	ATLANTIC IND CONSERVAS			FOOD	2131	BAIA DE GUANABARA
008	METAL FORTY			FOOD	2095	BAIA DE GUANABARA
009	FRIDUSA - FRIGORIFICOS IND DE ALIMENTOS			FOOD	1940	BAIA DE GUANABARA
010	FERNANDES COUTINHO MATADOURO LTDA	7477.56	670.51	FOOD	1800	RIO S.J.DE MERITI
011	ABATEDOURO TODAVES	7467.48	678.99	FOOD	1760	RIO JACARE
012	KIBON S/A	7466.47	680.50	FOOD	1700	
013	CIA PROG IND FABRICA BANGU			TEXTILE	1500	RIO DAS TINTAS
014	DISTRIBUIDORA CARNES DA BAIXADA			FOOD	1320	
015	REDUC	7487.05	678.25	PETROCHEMICALS	1320	RIO IGUAÇU
016	FRIGORIFICO SANTA LUCIA LTDA	7483.21	674.70	FOOD	1290	RIO SARAPUI
017	CIA NACIONAL DE TECIDOS NOVA AMERICA	7498.03	680.63	TEXTILE	1200	RIO ESTRELA
018	ENQ - EMPRESA NACIONAL DE Q IMICA	7487.74	677.91	CHEMICALS	1200	RIO IGUAÇU RIO DA BOTA
019	FABRICA DE PAPEL TANNURI			PAPER	1122	RIO TIMBO
020	ABATEDOOURO MADUREIRA			FOOD	1120	REDE RIO ACARI
021	MULTIFABRIL S/A	7501.17	687.96	TEXTILE	921	RIO PIABETA
022	TOALHEIRO BRASIL LTDA	7459.[illegible]	681.26	LAUNDRY	912	EMISS. IPANEMA
023	LAVANDERIA DOS HOTEIS SEMILARES			LAUNDRY	860	RIO JOANA
024	CONVERBRAS S/A INDUSTRIAL			FOOD	860	BAIA DE GUANABARA
025	REFRIGERANTE CONVENCAO	7470.80	646.84	BEVERAGE	829	RIO DOS CACHORROS
026	GRANJA DOS FALCOES	7492.72	675.33	FOOD	820	RIO IGUAÇU
027	CONSERVAS RIBEIRO			FOOD	800	BAIA DE GUANABARA
028	RICHARDSON MERREL MOURA BRASIL S/A			PHARMACEUTICALS	794	REDE EMIS.IPANEMA
029	PETROFLEX/NITRIFLEX	7486.60	679.60	PETROCHEMICALS	792	RIO IGUAÇU
030	VIVAMAR S/A IND E COM			FOOD	720	REDE RIO IRAJA
031	DALLARI S/A CARNES E DERIVADOS			FOOD	720	RIO IGUAÇU
032	ABATEDOURO PIF-PAF	7466.30	685.55	FOOD	700	REDE B.GUANABARA
033	FLORASYNTH FRAGRANCIA E AROMA LTDA			CHEMICALS	688	REDE RIO F.TIMBO
034	CONSERVAS RUBI	7474.64	696.03	FOOD	660	BAIA DE GUANABARA
035	PRODUTOS ALIMENTICIOS PIRAQUE			FOOD	643	REDE RIO IRAJA
036	AÇUCAR PEROLA IND E COM LTDA	7479.87	673.52	FOOD		R O CABOCLO
037	REFINARIA PIEDADE			FOOD	589	CANAL DO CUNHA
038	LAVANDERIA EVEREST LTDA	7475.78	674.85	LAUNDRY	530	REDE RIO IRAJA
039	TOALHEIRO MAIAMI			LAUNDRY	530	
040	FABRICA IMPERIO			FOOD	530	REDE RIO IRAJA
041	SANTA MONICA ALIMENTICIOS LTDA			FOOD	520	RIO TIMBO
042	DE MILLUS - AV BRASIL	7475.70	676.04	TEXTILE	520	RIO IRAJA
043	DE MILLUS - LOBO JUNIOR			TEXTILE	515	REDE ETE PENHA
044	UNIÃO BRASILEIRA DE CONSERVAS	7474.30	695.44	FOOD	510	BAIA DE GUANABARA
045	ABATEDOURO CARIOCA	7470.02	670.06	FOOD	500	RIO ACARI
046	CIBRAN	7463.47	678.91	PHARMACEUTICALS	500	RIO MARACANÃ
047	SUL ATLANTIC DE ALIMENTOS S/A IND E COM	7474.40	695.51	FOOD	480	BAIA DE GUANABARA
048	PLUS - VITA S/A			FOOD	480	RIO TIMBO
049	ALICE SATELITE COM E IND DE ALIMENTOS	7484.05	726.69	FOOD	480	RIO CACEREBU
050	SOC IND REFRIGERANTES FLEXA	7473.34	698.32	BEVERAGE	450	RIO INBUAÇU

Table 4.2-3 Name of Industries with Location and BOD loads

nº	N A M E	U T M Coordinates North	U T M Coordinates East	T y p e	B O D (Kg/d)	Recieving Body
051	BLOCH EDITORES S/A			GRAPHIC ARTS	448	
052	GRETISA S/A FABRICA DE PAPEL	7469.06	676.84	PAPER	430	RIO FARIA
053	COCA - COLA AV SUBURBANA	7467.91	676.34	BEVERAGE	420	RIO FARIA
054	IRMAK IND TEXTIL ESPECIALIZADA S/A	7462.93	679.92	TEXTILE	420	RIO MARACANÃ
055	SAX QUIMICA FINA E HIDROCARBONTEOS LTDA			CHEMICALS	420	
056	INDIPEL COM E IND DE EMBAL E ARTEF DE PAPEL	7475.91	674.99	PAPER	420	RIO IRAJA
057	CCPL - SÃO GONÇALO	7472.45	703.42	FOOD	405	RIO ALCANTARA
058	CIA SAYONARA INDUSTRIAL	7470.94	677.74	TEXTILE	382	RIO TIMBO
059	IRWIN INDUSTRIAL E COMERCIAL LTDA			CHEMICALS	380	RIO JACARÉ
060	RECUPERADORA DE TAMBORES BENFICA LTDA			CHEMICALS	380	CANAL DO CUNHA
061	QUIMITEC PRODUTOS QUIMICOS LTDA	7491.35	676.40	CHEMICALS	380	RIO IGUAÇU
062	IBEP INDUSTRIAL BENEFICIADORA DE PESCADO LTDA			FOOD	380	BAIA DE GUANABARA
063	OFICINA DO CROM					
064	ISHIKAWAJIMA DO BRASIL ESTALEIROS S/A	7469.06	683.47	MECHANICAL	380	BAIA DE GUANABARA
065	CONCENTRADOS NACIONAIS	7490.35	676.12	FOOD	378	RIO IGUAÇU
066	ULTRAKOR BENEFICIAMENTO TEXTIL LTDA	7471.42	703.10	TEXTILE	376	RIO ALCANTARA
067	ALBINO MENDES CIA LTDA			M.N.M.	375	RIO PAVUNA
068	LEITE DE ROSAS S/A INDUSTRIA E COSMETICOS			PERFUMERY	360	REDE C.DO CUNHA
069	CIA ATLANTIC DE PETROLEO	7467.29	682.75	CHEMICALS	360	BAIA DE GUANABARA
070	PRODUTOS QUIMICOS LTDA			CHEMICALS	348	
071	FABRICA UNIDAS DE TECIDOS RENDAS E BORDADOS S/A	7505.68	701.26	TEXTILE	346	RIO RONCADOR
072	LATICINIO CAPIVARI IND COM LTDA	7492.12	675.48	FOOD	340	RIO IGUAÇU
073	FIAÇÃO ESPERANCA S/A	7470.40	677.66	TEXTILE	330	REDE TIMBO-FARIAS
074	ATLAS INDUSTRIAS QUIMICAS E COMERCIO LTDA			CHEMICALS	330	RIO IGUAÇU
075	BADUC	7488.20	675.80	PETROCHEMICALS	330	CANAL DA TOMADA
076	SPAM	7482.60	659.93	FOOD	322	RIO IGUACU
077	PESCARA - COMPLEXO FRIGORIFICA LTDA	7469.18	682.36	FOOD	320	BAIA DE GUANABARA
078	ALFA RIO QUIMICA FAB DE POLISULFETO DE SODIO	7493.10	679.78	CHEMICALS	320	RIO ESTRELA
079	THOMAZ DE LA RUE			GRAPHIC ARTS	320	REDE B. GUANABARA
080	GLAXO DO BRASIL			CHEMICALS	320	RIO JACARE
081	BENCAFIL S/A BENEFICIADORA CARIOCA	7476.30	671.57	TEXTILE	318	RIO ACARI
082	MONTEDISON FARMACEUTICA S/A			PHARMACEUTICALS	316	REDE B.GUANABARA
083	INDUSTRIA DE CARNES SILVANIA DE NILOPOLIS	7477.96	662.79	FOOD	312	RIO SARAPUI
084	CIBRASA IND E COM DE TABACOS LTDA			FUME	310	
085	FABRICA DE ESTOPAS GREGORIANO LTDA			TEXTILE	310	RIO IRAJA
086	FABR - PETROBRAS DISTRIBUIDORA S/A			CHEMICALS	308	BAIA DE GUANABARA
087	IPANEMA PRODUTOS QUIMICOS LTDA	7492.26	675.22	CHEMICALS	300	RIO IGUAÇU
088	BRASPOL POLIMEROS			CHEMICALS	300	RIO IGUAÇU
089	IND QUIMICA GONZALES CONDE			CHEMICALS	300	RIO ACARI
090	ENCA - PRODUTOS QUIMICOS			CHEMICALS	300	RIO IGUAÇU
091	COMPANHIA AROMATICA BRASILEIRA AGRICOLA			CHEMICALS	300	
092	NOVA COR BENEFICIAMENTO TEXTIL LTDA	7471.57	679.54	TEXTILE	290	REDE B.GUANABARA
093	CARLOS PEREIRA IND QUIMICAS S/A	7466.83	680.68	CHEMICALS	288	REDE C. DO CUNHA
094	VARIG S/A VIAÇÃO AEREA RIOGRANDENSE	7476.10	681.85	OTHERS	284	REDE ETE.I.GOVERN
095	ZAP TEXTIL INDUSTRIAL	7364.36	638.55	TEXTILE	280	
096	O DIA INDUSTRIAS GRAFICAS LTDA	7465.06	685.42	GRAPHIC ARTS	280	
097	O GLOBO EMPRESA JORNALISTICA BRASILEIRA	7465.44	685.20	GRAPHIC ARTS	270	
098	CURTUME BRASILIA ARTE COUROS LTDA			CHEMICALS	270	RIO IGUAÇU
099	CIBA - GEIGY			CHEMICALS	269	RIO ACARI
100	BENCAFIL S/A BENEF CARIOCA DE FIOS TEXTEIS IND	7476.30	671.57	TEXTILE	260	RIO ACARI

Table 4.2-3 Name of Industries with Location and BOD loads

nº	N A M E	U T M Coordinates North	East	T y p e	B O D (Kg/d)	Recieving Body
101	UNIÃO FABRIL EXPORTADORA - UFE			CHEMICALS	260	REDE B.GUANABARA
102	BRIOSOL IND E COM DE MATERIAL DE LIMPEZA LTDA	7490.14	676.09	CHEMICALS	260	RIO IGUAÇU
103	RHEEM EMPREENDIMENTOS	7467.88	681.59	CHEMICALS	260	REDE B.GUANABARA
104	IND DE SABOES NEUTRAL LTDA	7471.37	678.88	CHEMICALS	250	
105	COLADES - INDUSTRIA QUIMICA LTDA			CHEMICALS	240	RIO JACARE
106	MARVELLOS IND COM MAT LIMPEZA E PROD QUIM			CHEMICALS	240	
107	FARMOQUIMICA S/A	7470.40	704.33	PHARMACEUTICALS	240	
108	CASTROL DO BRASIL LTDA			CHEMICALS	240	RIO FARIA
109	DIVINA DAMA IND E COM LTDA	7483.85	642.06	CHEMICALS	232	RIO IRAJA
110	ESTOPAS GUARANI IND E COM LTDA			TEXTILE	232	
111	EIFEL IND E COM DE SABÃO LTDA	7470.64	679.57	CHEMICALS	230	REDE
112	REFILUBI - RE-REFINADORA DE OLEOS LUBRIFIC LTDA			TEXTILE	230	
113	LABORATORIOS B BRAUN S/A			PHARMACEUTICALS	220	BAIA DE GUANABARA
114	INCOMEX S/A ENG IND E COM	7491.54	676.14	CHEMICALS	220	RIO IGUAÇU
115	COLORKIT IND E COM DE TINTAS	7478.50	675.75	INK	210	RIO MERITI
116	BOTONIFICIO F GOMES	7466.26	682.22	PLASTIC	210	RIO MARACANÃ
117	MAKROS IND FARMACEUTICA	7465.12	685.36	PHARMACEUTICALS	210	
118	FARMAC PRODS FARMACEUTICOS			PHARMACEUTICALS	210	
119	CAR GILL AGRICOLA			FOOD	200	RIO QUEIMADO
120	ALFREDO BUCHHEIN			PHARMACEUTICALS	195	RIO PAVUNA
121	POLVIL QUIMICA INDUSTRIAL LTDA			CHEMICALS	195	RIO SARAPUI
122	COLORTIN S/A INDS QUIMICAS			CHEMICALS	190	RIO IGUAÇU
123	INSULA IND E COM DE COSMETICOS	7470.50	679.65	PHARMACEUTICALS	190	RIO TIMBO
124	BARRENE IND FARMACEUTICA	7470.11	679.25	PHARMACEUTICALS	190	RIO TIMBO
125	MARIALVA TEXTIL S/A	7470.52	677.66	TEXTILE	180	RIO TIMBO
126	CYANAMID QUIMICA DO BRASIL LTDA	7467.18	681.66	CHEMICALS	180	
127	ORWEL QUIMICA S/A			CHEMICALS	172	
128	GRUPO QUIMICA INDUSTRIAL LTDA			CHEMICALS	170	
129	LEE PRODUTOS QUIMICOS E FARMACEUTICOS LTDA	7468.16	640.40	CHE/PHAR	170	
130	NITRITEC INDUSTRIA QUIMICA	7499.12	675.02	CHEMICALS	170	RIO SARACURUNA
131	MAGLIA CONFECÇÕES			TEXTILE	170	
132	CIA DE CIGARROS SOUZA CRUZ - AV SUBURBANA	7468.54	679.00	FUME	170	RIO JACARE
133	CIA DE CIGARROS SOUZA CRUZ - TIJUCA	7461.74	679.11	FUME	170	RIO MARACANÃ
134	SANOFI PHARMA DO BRASIL LTDA	7464.83	679.15	PHARMACEUTICALS	160	
135	DEFARIA LABORATORIO COM DIST LTDA				160	
136	LAB LEITE DE COLONIA STUDART S/A IND COM	7463.76	682.41	PERFUMERY	160	
137	ANCORA COM E IND DE ESTOPAS LTDDA	7480.34	675.88	OTHERS	160	BAIA DE GUANABARA
138	PROQUISA COM E IND DE PRODS QUIMICOS LTDA	7491.92	674.76	CHEMICALS	160	RIO IGUAÇU
139	PRODUTOS INDUSTRIAIS OXIDEX LTDA			CHEMICALS	160	
140	IND QUIMICAS ROSA LTDA			PERFUMERY	155	
141	EKA QUIMICA LTDA			CHEMICALS.	150	
142	SENGAL DA BAHIA COND IND E COM LTDA			FOOD	148	
143	PROQUIMICA LTDA	7472.71	678.49	CHEMICALS	145	CANAL PENHA
144	IND DE CARROCERIAS BUGRE LTDA	7470.02	667.82	CHEMICALS	145	RIO ACARI
145	SAYONARA INDUSTRIAL			TEXTILE	140	
146	FABRICA DE TINTAS			CHEMICALS	140	
147	CARIOCA DE ARTEFATOS DE PAPEL S/A			PAPER	140	
148	INDUSTRIA E COMERCIO S/A			FOOD	135	
149	QODOR QUIMICA IND LTDA			CHEMICALS	135	
150	SAINT GERMAIN CRISTAIS DE SEGURANÇA LTDA	7471.29	647.94	CHEMICALS	130	