SUPPORTING 18

WATER QUALITY SURVEY

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SUPPORTING 18 WATER QUALITY SURVEY

1. SCOPE OF WORKS - WATER SAMPLING AND ANALYTICAL PARAMETERS

Water samples were taken at specified points within and outside Guanabara Bay (*Figure 1* and *Table 1*) and measurements and analysis of samples at the site and at the laboratory were carried out.

The samples were preserved after collection at about 4°C until the time of analysis. "Standard Method for the Examination of Water and Wastewater, 19th Edition, APHA, AWWA, WEF (*Table 2*) was the reference for method of preservation for water quality parameters and method of analysis. Some measurements were carried out at the site of sampling, such as, water temperature, conductivity, salinity, Secchi disc transparency, pH and Dissolved Oxygen (DO). The equipment used for the measurements at the sites are shown in *Figure 2*. The other water quality analysis were carried out at the laboratory.

At each sampling point two samples, one from the upper and another from the lower layers of water were collected. Upper layer was approximately 30 cm bellow the water surface and lower layer approximateley 30 cm above the sediment surface. The first sampling event in July 17 and 31, 2002, represents dry season and the second sampling event in October 10, 2002 represents wet season.

Samples were collected from the following 11 sampling points:

- Eight points within Guanabara Bay, where regular monitoring is carried out by FEEMA, the State Environmental Agency (GN-000, GN-042, GN-020, GN-040, GN-043, GN-022, GN-026, GN-064).
- One point outside Guanabara Bay, where regular monitoring is carried out by FEEMA (GN-093).
- Two additional points; (GN-048, GN-050).

Location of sampling points was confirmed using hand-held GPS and their cooordinates were recorded.

2. RESULT OF SURVEY

The monitoring data collected were used to confirm the existing water quality data from FEEMA and calibrate the water quality simulation model developed for Guanabara Bay. For a more comprehensive analysis some box-plots were drawn, as shown in *Figures 3, 4, 5, 6* and *7*.

For the present analysis, the Bay has been divided into five areas: North, North-West, South-West, South-Central and South-West. The most polluted areas are the channels between the mainland and the Ilha do Governador and Ilha do Fundão (referred to as the South-West area in this report) and the area to the north-west of the Ilha do Governador (referred to as the North-West area in this report).

The South-West channels receive heavy discharges of raw and partially-treated sewage from the low income and industrial areas in the northern parts of Rio de Janeiro municipality. Very often the channels have an offensive smell and color, typical of any waterway which in becoming anoxic.

The North-West area receives a heavy load of pollution from industries and the residential areas located in the Baixada Fluminense.

The two main rivers in its sub-basin are the Rio Sarapuí and the Rio Iguaçu which join just before they flow into the Bay. Industrial discharged into this area of the Bay have led to an accumulation of lead and mercury in the sediments near the mouths of the Rio Meriti and the Rio Sarapuí /Iguaçu. This is reflected in elevated levels of lead and mercury in this western part of the Bay, though these only occasionally exceed recommended guidelines values[1] (*Table 3* and *Table 4*).

The transparency of the water in the North-West area is low, typically in the range 0.2 - 0.4m, while the surface is polluted with oil and garbage and there is little sign of aquatic life.

The growth of algae in the two areas is inhibited by the poor water quality. Total phosphorus was very high in the South-West and North-West areas, primarily due to high levels of inorganic $PO_{4.}$ Levels of total phosphorus were also high in the North part of the Bay, most of which is organic phosphorus. Existing data for the Bay[2] shows that levels of algae have been increasing rapidly in other areas of the Bay spreading outwards from the North-West area (*Table 5*).

Other indicators of water quality improve outside the South-West and North-West areas. The data may show little change in median values of dissolved oxygen, but the variability reflects plankton ativity during the day and the fact that Guanabara is becoming heavily eutrophied and their graphical presentation is whown in *Figures 3* to *7.*

Tables 3, 4 and *5* sumarize the data collected during the water quality survey and compare them to Brazilian Guidelines.

Appendices I and II present the data collected during water quality survey and some photographs taken at the sites.

Table 1 Coordinates of Sampling Points

Station ID	Latitude	Longitude
GN-000	22º 43’ 27”	43º 06’ 15”
GN-020	22º 46’ 30”	43º 13’ 50”
GN-022	22º 52’ 40”	43º 11’ 57”
GN-026	22º 50’ 52”	43º 07’ 39”
GN-040	22º 47’ 50”	43º 16’ 10”
GN-042	22º 44’ 50”	43º 09’ 50”
GN-043	22º 50’ 09”	43º 14’ 24”
GN-048	22º 49’ 42”	43º 15’ 39”
GN-050	22º 52’ 06”	43º 13’ 24”
GN-064	22º 55’ 48”	43º 08’ 00”
GN-093	22º 58’ 28”	43º 08’ 02”

[1] CONAMA Resolution Number 20, from June, 1986.
[2] Source: FEEMA’s regular monitoring.

Table 2 Analytical Parameters and Method of Analysis

Parameter	Method of Analysis
Suspended Solids	SM 2540 D (19^{th} edition/1995)
Total Dissolved Solids (TDS)	SM 2540 D (19^{th} edition/1995)
Biochemical Oxygen Demand (BOD)	SM 5210 (19^{th} edition/1995)
Faecal Coliforms	SM-9221 (19^{th} edition/1995)
Total Phosphorous (T-P)	SM 4500 P-E (19^{th} edition/1995)
Phosphates (PO_4-P)	SM 4500 P-E (19^{th} edition/1995)
Total Kjeldahl Nitrogen	SM 4500 . Norg (19^{th} edition/1995)
Ammonium Nitrogen (NH_4-N)	SM 4500 . NH_3 (19^{th} edition/1995)
Nitrates (NO_3-N)	SM 4500 . NO_3 (19^{th} edition/1995)
Nitrites (NO_2-N)	SM 4500 . NO_2 (19^{th} edition/1995)
Iron (Fe)	SM-303 B (16^{th} edition/1985)
Hexavalent Chromium (Cr^{6+})	SM 3500 Cr D (19^{th} edition/1995)
Manganese (Mn)	SM-303 B (16^{th} edition/1985)
Nickel (Ni)	SM-303 B (16^{th} edition/1985)
Copper (Cu)	SM-303 B (16^{th} edition/1985)
Zinc (Zn)	SM-303 B (16^{th} edition/1985)
Cadimium (Cd)	SM-303 B (16^{th} edition/1985)
Mercury (Hg)	SM 3500 Hg B (19^{th} edition/1995)
Lead (Pb)	SM-303 B (16^{th} edition/1985)
Polychorinated biphenyls (PCB)	SM 6630 C (19^{th} edition/1995)
Sulphates (SO_4)	SM 4500 - SO_4.E (19^{th} edition/1995)
Phenols	SM-5530 (19^{th} edition/1995)
Benz (a) pyrene	SM 6440 B (19^{th} edition/1995)
Total PAH	Grasshoff, K., Ehrhardt, M. Methods of Sea Water Analysis

Table 3 Heavy Metals - Upper Layer

Station ID		GN-000	GN-020	GN-022	GN-026	GN-040	GN-042	GN-043	GN-048	GN-050	GN-064	GN-093
Indicator	**Brazilian Guidelines**	**North**	**North-West**	**South-Central**	**South-East**	**North-West**	**North**	**South-West**	**South-West**	**South-West**	**South-East**	**South-East**
Hg (mg/L)	**1.0**	<0.10	<0.10	<0.10	<0.10	<0.10-0.25	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Pb (mg/L)	**10**	<5.0 - 15	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cd (mg/L)	**5.0**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cu (mg/L)	**50**	<2.0 - 2.0	<2.0 - 4.5	<2.0	2.0	<2.0 - 9.5	<2.0 - 3.0	4.5 - 23	2.5 - 3.0	<2.0 - 8.0	<2.0	3.5
Zn (mg/L)	**170**	<10	<10	<10	<10	<10 - 16	<10	<10	<10	<10	<10	<10

Table 4 Heavy Metals - Lower Layer

Station ID		GN-000	GN-020	GN-022	GN-026	GN-040	GN-042	GN-043	GN-048	GN-050	GN-064	GN-093
Indicator	**Brazilian Guidelines**	**North**	**North-West**	**South-Central**	**South-East**	**North-West**	**North**	**South-West**	**South-West**	**South-West**	**South-East**	**South-East**
Hg (mg/L)	**1.0**	<0.10	<0.10	<0.10	<0.10	0.15	<0.10	<0.10	0.15	<0.10	<0.10	<0.10
Pb (mg/L)	**10**	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0 - 13	<5.0	<5.0	<5.0	<5.0
Cd (mg/L)	**5.0**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cu (mg/L)	**50**	3.0	<2.0	<2.0	2.0 - 14	<2.0 - 10	4.0 - 8.5	<2.0	2.5 - 4.0	<2.0 - 5.0	<2.0	<2.0
Zn (mg/L)	**170**	<10 - 48	<10	<10	<10	130	<10	<10	<10	<10	<10	<10

Table 5 Conventional Water Quality Indicators - Upper Layer

Station ID		GN-000	GN-020	GN-022	GN-026	GN-040	GN-042	GN-043	GN-048	GN-050	GN-064	GN-093
Indicator	**Brazilian Guidelines Class 5**	**North**	**North-West**	**South-Central**	**South-East**	**North-West**	**North**	**South-West**	**South-West**	**South-West**	**South-East**	**South-East**
BOD (mg/L)	**<5.0**	4.6 - 4.8	4.0	2.0 - 2.4	<2.0 - 3.0	8.0 - 10.0	4.6 - 5.4	<2.0 - 4.0	<2.0- 18.0	10.0 - 30	<2.0 - 2.2	<2.0
DO (mg/L)	**>6.0**	5.8 - 11.3	2.8	3.4 - 7.3	5.6 - 8.2	0.1 - 0.2	7.8 - 10.4	0.4 - 2.6	4.3 - 23	<0.1 - 0.1	6.8 - 8.1	8.0
Ammonium Nitrogen (mg/L)	-	0.02 - 0.08	1.70 - 2.40	0.45 - 0.50	0.04 - 0.40	2.35 - 2.60	0.15- 0.25	1.30 - 1.80	1.40 - 1.80	2.40	0.07- 0.35	0.0-6
Total Phosphorous (mg/L)	-	0.09 - 0.10	0.40 - 0.50	0.10 - 0.15	0.04 - 0.10	0.80 - 1.0	0.09 - 0.15	0.35 - 0.45	0.40 - 0.70	0.60 - 2.30	0.09 - 0.20	0.04
Phosphates (mg/L)	-	<0.01-0.02	0.20 - 0.30	0.09	0.01- 0.05	0.50 - 1.0	0.03 - 0.30	0.30	0.20	0.50 - 1.50	0.05 - 0.20	<0.01
Transparency (m)	-	0.80-1.00	0.40-1.20	1.10-2.00	1.00	0.20-0.30	0.70-1.00	0.90-1.20	0.40-0.60	0.20-0.30	2.00-3.10	4.50

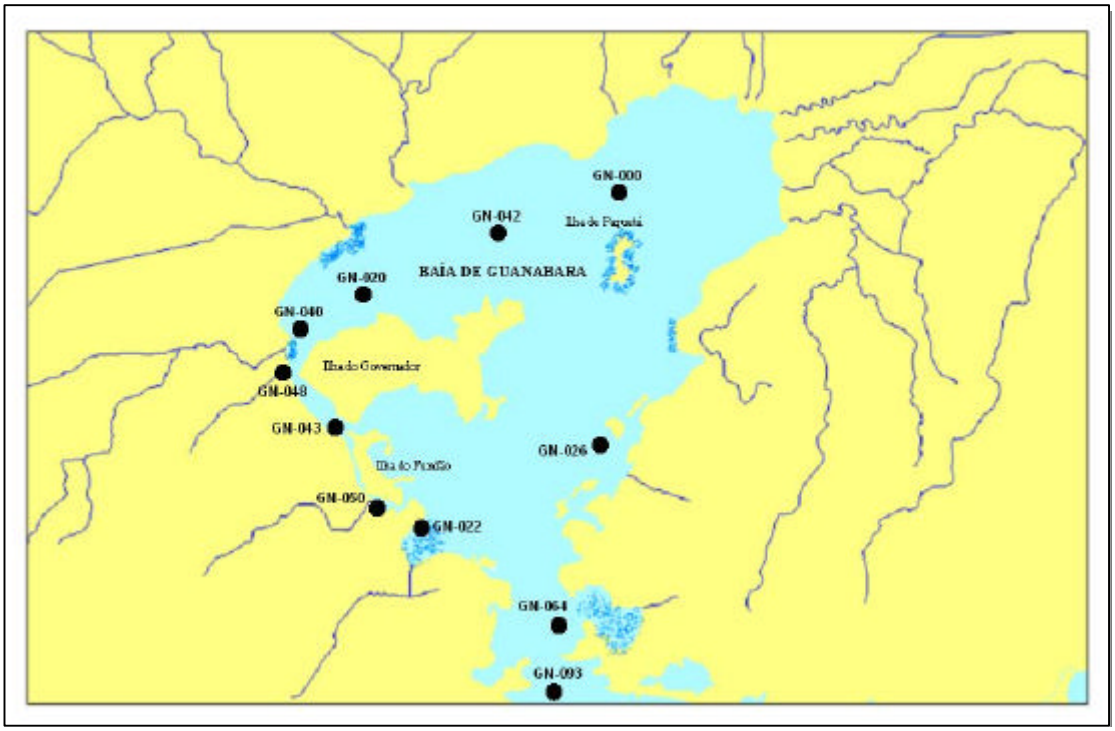


Figure 1 Sampling Points of Water Quality Survey - Guanabara Bay

- **DO Meter**

- **Condutivity Meter**

- **pH Meter**

- **Secchi Disk**

- **GPS**

Figure 2 Equipment for measurements on-site - Water Quality Survey

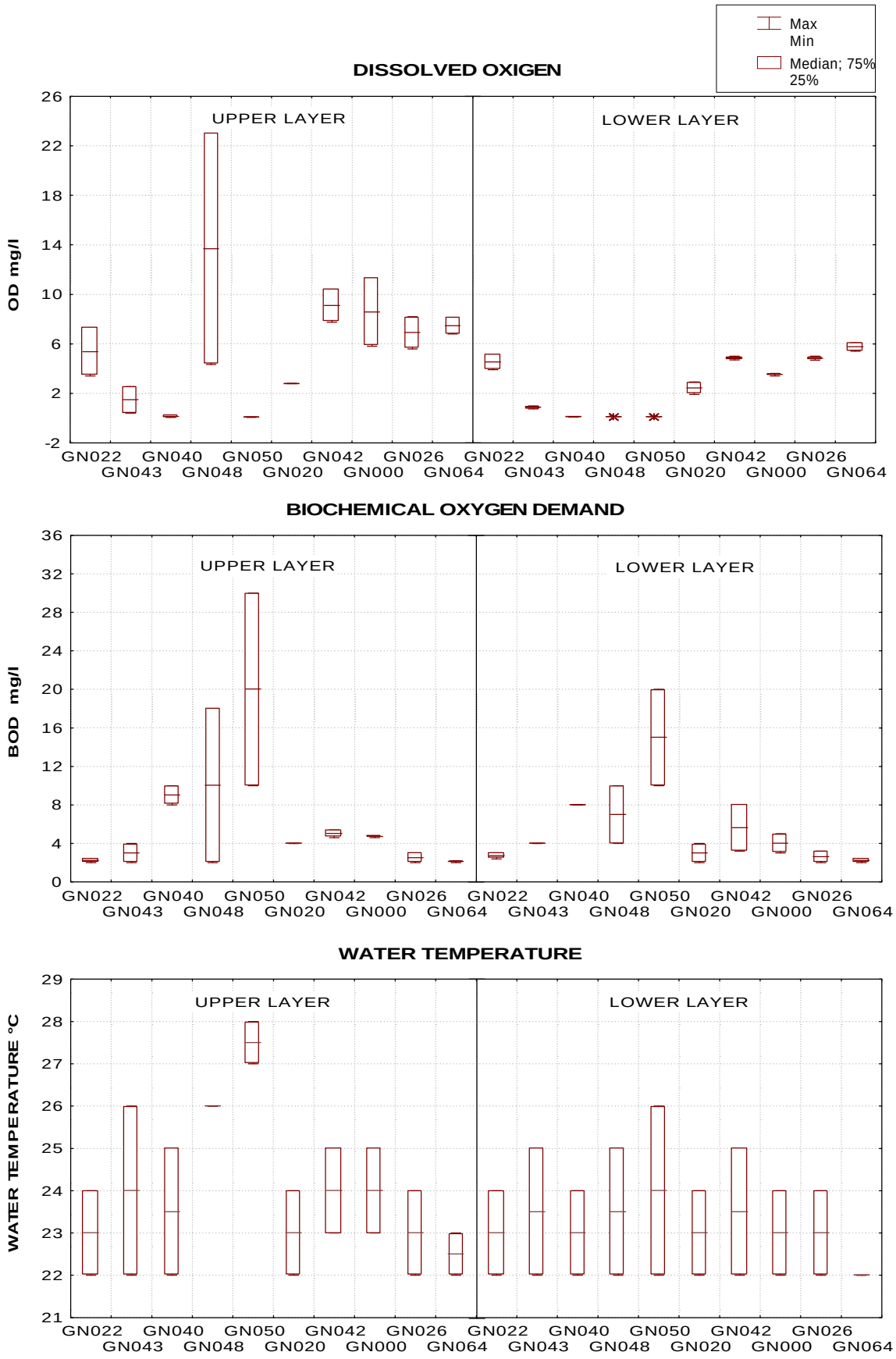


Figure 3 (1/5) Graphic Presentation of Results

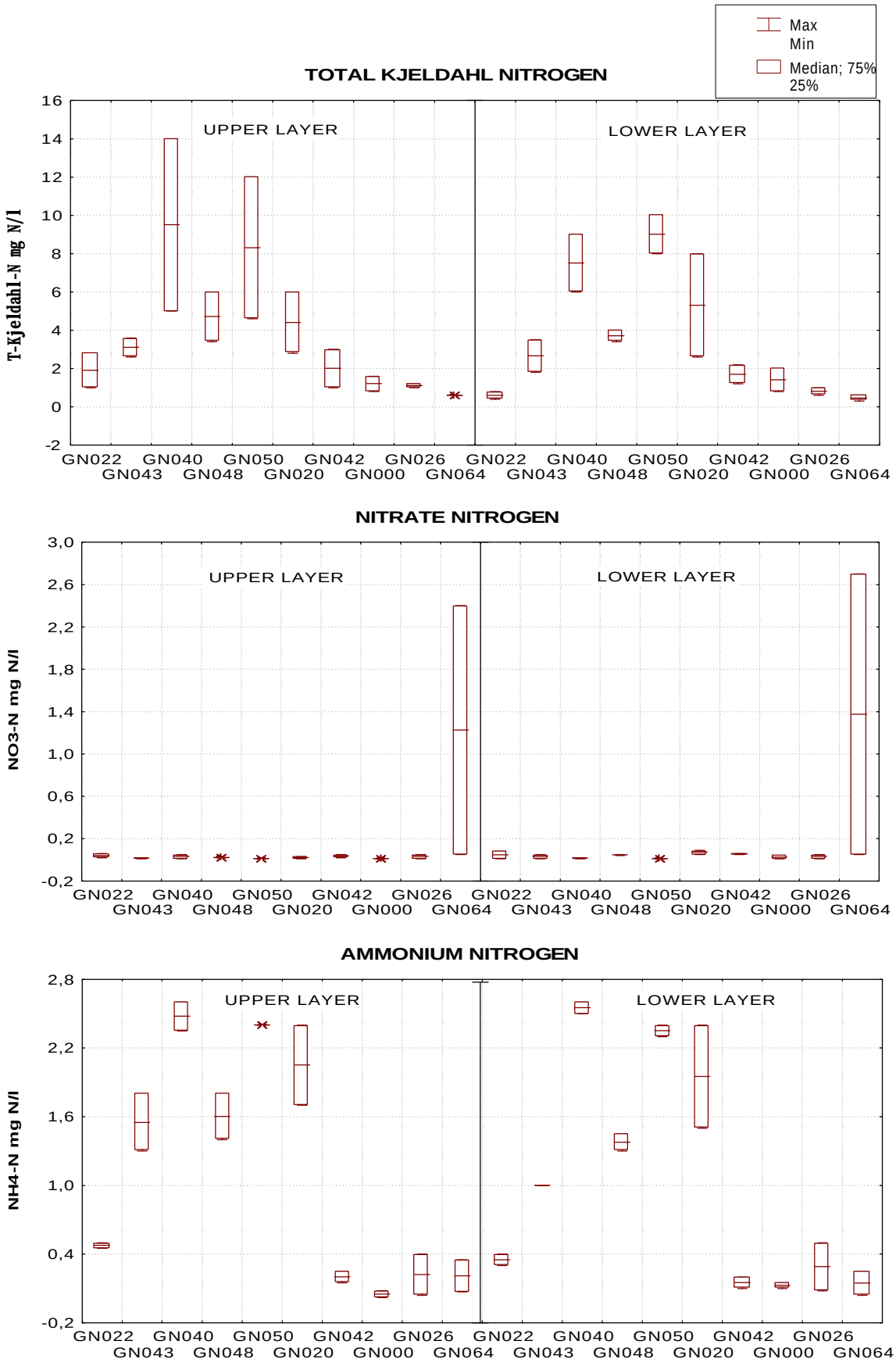


Figure 4 (2/5) Graphic Presentation of Results

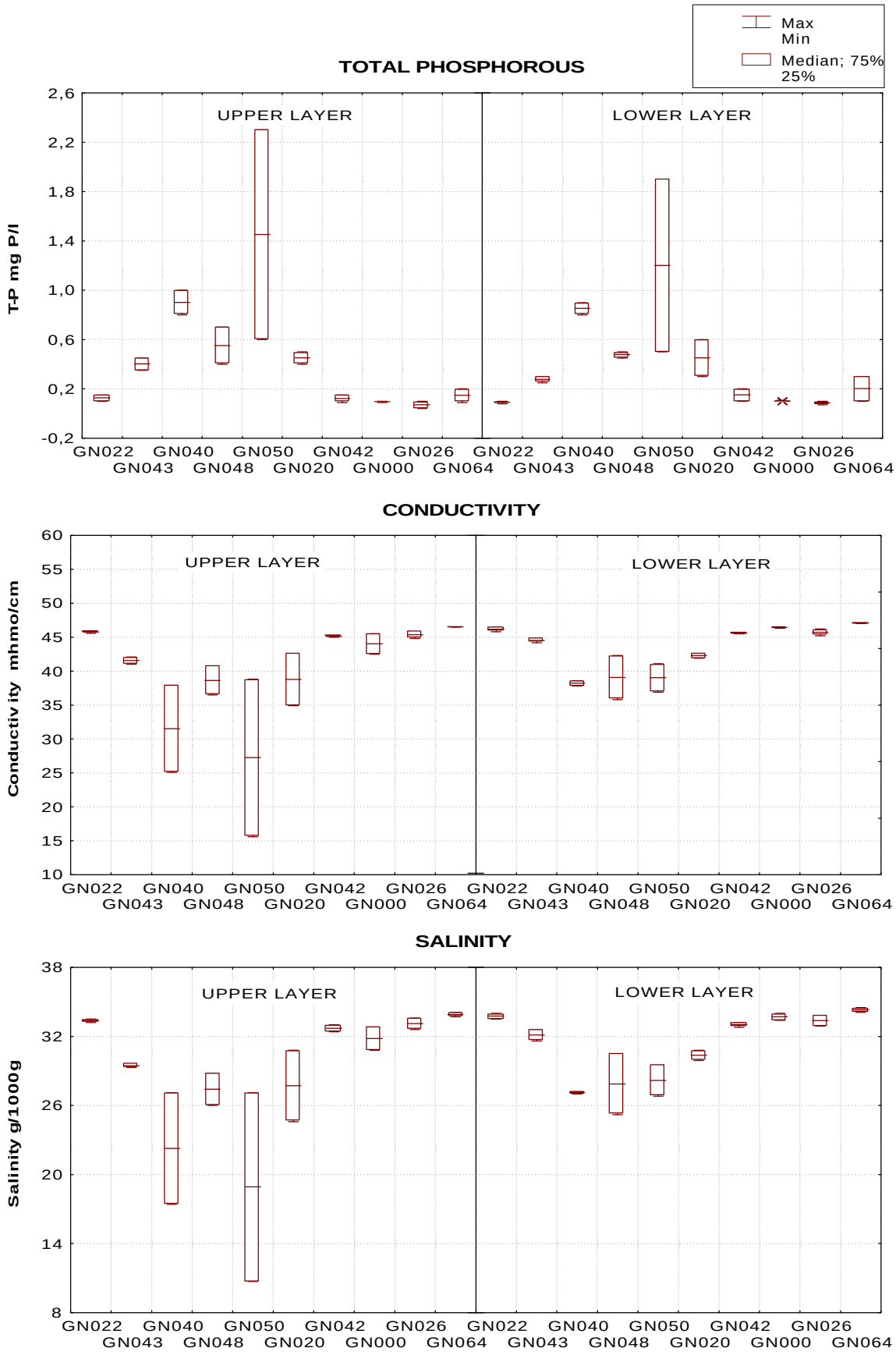


Figure 5 (3/5) Graphic Presentation of Results

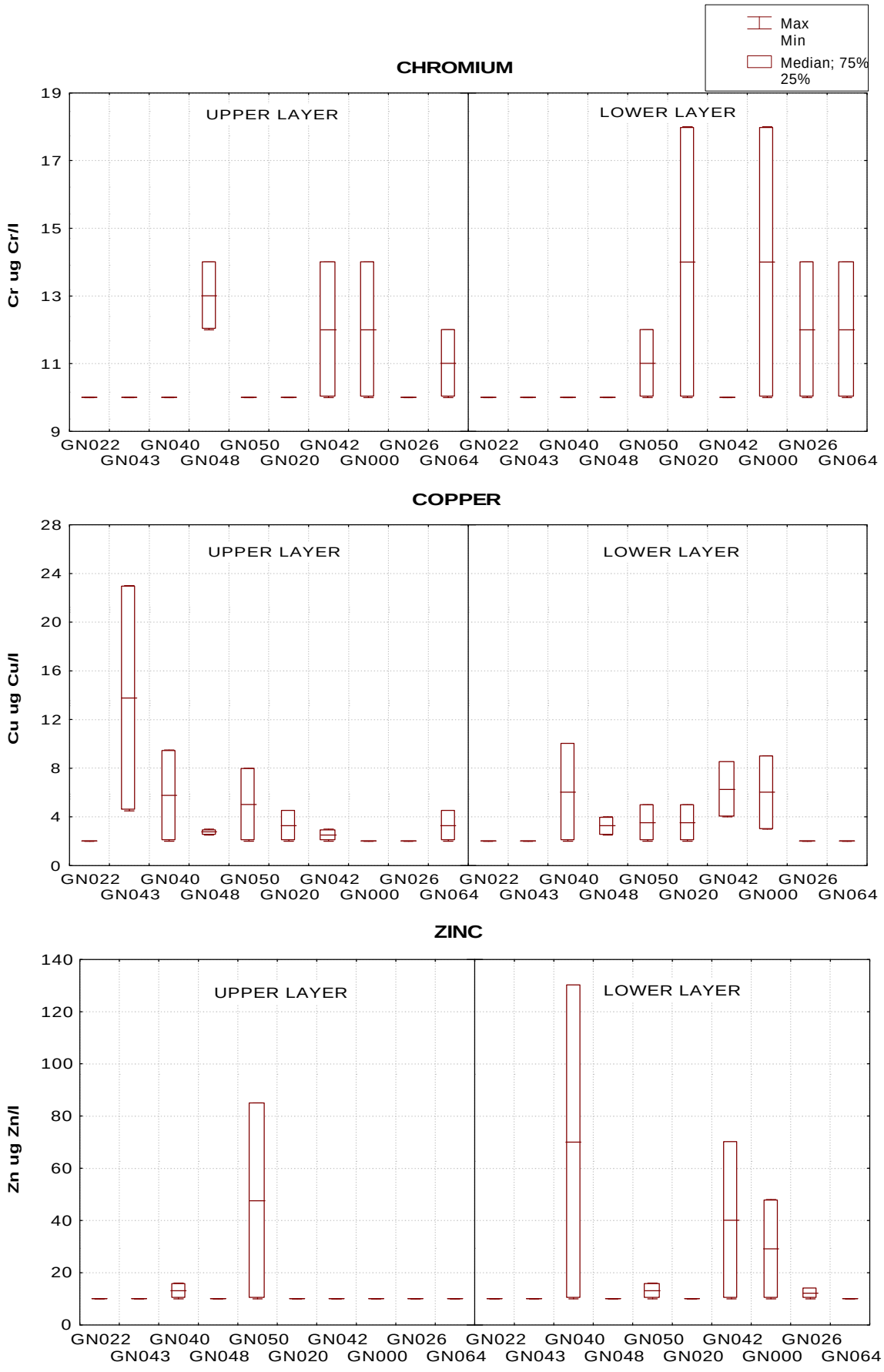


Figure 6 (4/5) Graphic Presentation of Results

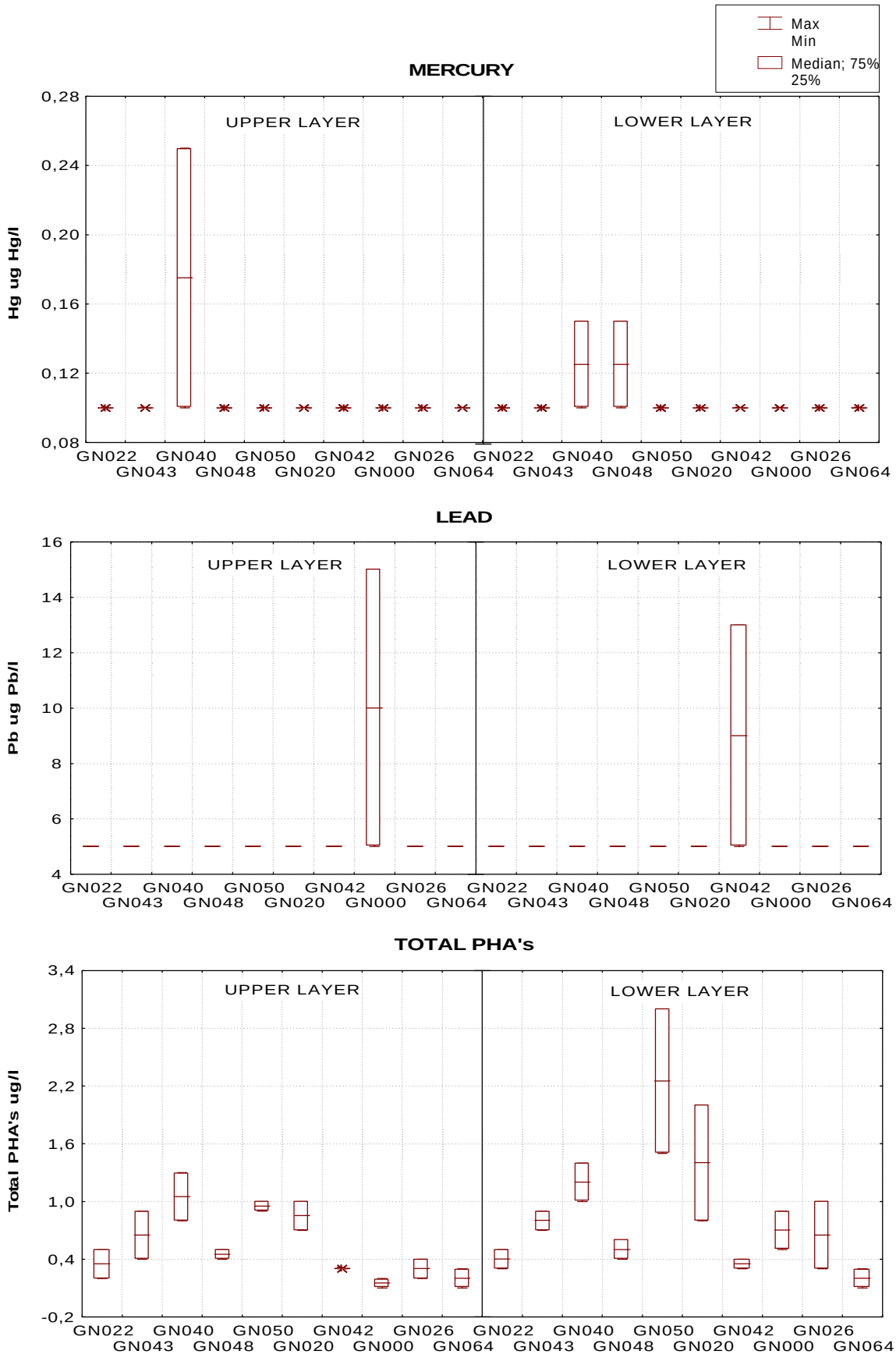


Figure 7 (5/5) Graphic Presentation of Results

APPENDIX 18-I

WATER QUALITY DATA
July and October, 2002

WATER QUALITY SURVEY - BAÍA DE GUANABARA
JICA STUDY
UPPER LAYER
DRY SEASON - JULY 17 AND 31 / 2002

	GN000	GN020	GN022	GN025	GN026	GN040	GN042	GN043	GN047	GN048	GN050	GN064	GN306
LATITUDE	22°43'27"	22°46'30"	22°52'40"	22°55'18"	22°50'52"	22°47'50"	22°44'50"	22°50'09"	22°54'30"	22°49'42"	22°52'06"	22°55'48"	22°56'09,4"
LONGITUDE	43°06'15"	43°13'50"	43°11'57"	43°06'47"	43°07'39"	43°16'10"	43°09'50"	43°14'24"	43°07'08"	43°15'39"	43°13'24"	43°08'00"	43°08'11,8"
PARAMETERS													
SAMPLE TEMP.(ºC)	23.0	22.0	22.0	22.0	22.0	22.0	23.0	22.0	22.0	26.0	27.0	22.0	22.0
AIR TEMPERATURE (ºC)	35.0	26.0	28.0	23.0	28.0	27.0	35.0	27.0	23.0	34.0	35.0	23.0	24.0
CONDUCTIVITY (mMHO/cm)	43	43	46	47	45	38	45	42	47	37	16	47	47
TRANSPARENCY (m)	1.00	1.20	2.00	2.00	1.00	0.20	1.00	1.20	2.00	0.40	0.20	3.10	3.00
SALINITY (G/1000 G)	30.8	30.8	33.5	33.9	32.6	27.1	33.0	29.6	34.0	26.0	10.7	33.7	34.0
TURBIDITY (UT)	-	10	2.0	4.0	3.0	10		4.5	2.0	-	-	2.0	2.0
DO (mg/L)	11.3	2.8	3.4	7.9	5.6	0.2	10.4	0.4	7.6	23	<0.1	6.8	6.7
B.O.D (mg/L)	4.6	4.0	2.0	2.8	<2.0	8.0	4.6	4.0	<2.0	18	30	<2.0	<2.0
pH (U. pH)	8.3	7.8	7.8	8.1	8.0	7.5	8.5	7.7	8.1	8.9	7.0	8.1	8.1
SUSPENDED SOLIDS (mg/L)	40	60	30	30	40	25	50	30	30	70	50	30	55
TOTAL FILTRABLE SOLIDS (mg/L)	57,300	34,700	37,900	61,900	37,800	34,600	34,700	39,200	38,500	55,700	8,800	37,900	38,700
TOTAL SOLIDS (mg/L)	-	34,800	38,000	62,000	37,900	34,700	-	39,300	38,500	-	-	37,900	38,700
VOLATILE SOLIDS (mg/L)	-	5,170	6,900	29,200	6,800	8,500	-	5,000	50	-	-	5,000	5,120
VOLAT.SUSPENDED SOLIDS (mg/L)	20	-	-	-	-	-	20	-	-	65	50	-	-
TOT. KJELDAHL NITROGEN (mg N/L)	0.8	2.8	1.0	1.4	1.0	5.0	1.0	2.6	1.0	6.0	12	0.6	0.8
NITRITE NITROGEN (mg N/L)	0.001	0.01	0.006	0.01	0.03	0.002	0.02	0.01	0.02	0.02	0.003	0.02	0.02
NITRATE NITROGEN (mg N/L)	0.01	0.03	0.06	0.07	0.05	0.05	0.05	0.02	0.06	0.02	<0.01	0.05	0.07
AMMONIUM NITROGEN (mg N/L)	0.02	1.70	0.50	0.20	0.40	2.35	0.15	1.80	0.25	1.80	2.40	0.35	0.30
ORTOPHOSPHATE (mg P/L)	<0.01	0.20	0.09	0.01	0.05	0.50	<0.01	0.30	0.04	0.20	1.50	0.05	0.05
TOTAL PHOSPHOROUS (mg P/L)	0.10	0.40	0.10	0.09	0.10	0.80	0.09	0.45	0.10	0.70	2.30	0.09	0.09
PHENOLS (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
CYANIDE (mg CN/L)	-	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	-	<0.01	<0.01
SULPHATES (mg SO4/L)	4,400	2,400	2,760	3,080	3,040	2,080	4,700	1,840	3,280	3,600	400	2,920	2,800
CHROMIUM (ug Cr/L)	<10	<10	<10	<10	<10	<10	<10	<10	<10	14	<10	<10	<10
IRON (ug Fe/L)	55	390	20	40	32	120	20	80	10	150	270	12	10
NICKEL(ug Ni/L)	<5.0	<5	<5	<5	<5	<5	<5.0	<5	<5	<5.0	<5.0	<5	<5
COPPER (ug Cu/L)	2.0	4.5	<2.0	12	2.0	<2.0	3.0	4.5	9.0	3.0	8.0	4.5	3.5
ZINC (ug Zn/L)	<10	<10	<10	55	<10	<10	<10	<10	<10	<10	85	<10	<10
CADMIUM (ug Cd/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MERCURY (ug Hg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
LEAD (ug Pb/L)	15	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
BENZO a PYRENE(ug/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB's(ug/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total PAH's (ug/l)	0.2	0.7	0.5	0.8	0.4	1.3	0.3	0.9	0.6	0.5	0.9	0.3	0.4
FAECAL COLI (MPNmil/100ml)	<0.023	8.0	5.0	0.13	0.23	1,600	<0.023	80	0.23	2.3	160	1.3	5.0

WATER QUALITY SURVEY - BAIA DE GUANABARA
JICA STUDY
MIDLE LAYER
DRY SEASON - JULY 17 AND 31 / 2002

	GN8000	GN8022	GN8025	GN8026	GN8043	GN8047	GN8048	GN8064	GN8306
LATITUDE	22°43'27"	22°52'40"	22°55'18"	22°50'52"	22°50'09"	22°55'18"	22°49'42"	22°55'48"	22°56'09,4"
LONGITUDE	43°06'15"	43°11'57"	43°06'47"	43°07'39"	43°14'24"	43°06'47"	43°15'39"	43°08'00"	43°08'11,8"
PARAMETERS									
SAMPLE TEMP. (ºC)	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
AIR TEMPERATURE (ºC)	35.0	28.0	-	28.0	27.0	-	34.0	-	-
CONDUCTIVITY(mMHO/cm)	45	46	47	45	45	47	41	47	47
SALINITY (G/1000 G)	32.8	33.8	34.0	32.8	32.4	34.1	29.4	34.0	34.1
TURBIDITY (UT)	-	1.0	2.5	4.0	2.0	2.0		2.0	1.5
DO (mg/L)	3.3	4.2	7.3	4.9	1.2	7.0	1.0	6.2	6.1
B.O.D (mg/L)	4.0	<2.0	<2.0	2.4	4.0	<2.0	8.0	<2.0	<2.0
pH (U. pH)	8.3	7.9	-	8.1	7.8	-	8.2	-	-
SUSPENDED SOLIDS (mg/L)	70	30	40	40	30	50	90	30	30
TOTAL FILTRABLE SOLIDS (mg/L)	40,500	38,800	87,000	37,700	56,600	38,400	44,600	70,400	43,700
TOTAL SOLIDS (mg/L)	-	38,900	87,000	37,800	56,700	38,400	-	70,400	43,800
VOLATILE SOLIDS (mg/L)	-	22,300	36,300	36,300	18,000	5,800	-	37,100	3,800
VOLAT.SUSPENDED SOLIDS (mg/L)	50	-	-	-	-	-	70	-	-
TOT. KJELDAHL NITROGEN (mg N/L)	0.8	0.6	0.6	1.0	1.6	1.0	3.6	0.50	0.50
NITRITE NITROGEN (mg N/L)	0.001	0.02	0.02	0.03	0.03	0.02	0.04	0.02	0.015
NITRATE NITROGEN (mg N/L)	0.01	0.05	0.07	0.02	0.03	0.08	0.03	0.06	0.04
AMMONIUM NITROGEN (mg N/L)	0.06	0.40	0.20	0.50	1.10	0.20	1.70	0.30	0.20
ORTOPHOSPHATE (mg P/L)	<0.01	0.07	0.02	0.05	0.20	0.03	0.30	0.04	0.04
TOTAL PHOSPHOROUS (mg P/L)	0.20	0.10	0.08	0.10	0.30	0.08	0.50	0.09	0.07
PHENOLS (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
CYANIDE (mg CN/L)	-	0.01	0.01	0.01	0.01	0.01	-	0.01	0.01
SULPHATES (mg SO4/L)	3,600	3,600	2,600	2,760	2,920	2,480	3,700	3,160	3,320
CHROMIUM (ug Cr/L)	<10	<10	<10	<10	<10	<10	<10	<10	<10
IRON (ug Fe/L)	40	20	<10	48	70	18	85	24	26
NICKEL(ug Ni/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
COPPER (ug Cu/L)	6.5	<2.0	6.5	4.5	<2.0	13	5.0	7.5	6.0
ZINC (ug Zn/L)	14	14	14	<10	14	60	<10	<10	26
CADMIUM (ug Cd/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MERCURY (ug Hg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
LEAD (ug Pb/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
BENZO a PYRENE(ug/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB's(ug/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total PAH's (ug/l)	1.0	0.5	1.0	0.6	0.6	1.0	0.3	0.6	0.5
FAECAL COLI (MPNmil/100ml)	<0.023	2.3	0.17	13	0.30	0.13	0.30	24	2.3

WATER QUALITY SURVEY - BAIA DE GUANABARA
JICA STUDY
LOWER LAYER
DRY SEASON - JULY 17 AND 31 / 2002

	GN9000	GN9020	GN9022	GN9025	GN9026	GN9040	GN9042	GN9043	GN9047	GN9048	GN9050	GN9064	GN9306
LATITUDE	22°43'27"	22°46'30"	22°52'40"	22°55'18"	22°50'52"	22°47'50"	22°44'50"	22°50'09"	22°54'30"	22°49'42"	22°52'06"	22°55'48"	22°56'09,4"
LONGITUDE	43°06'15"	43°13'50"	43°11'57"	43°06'47"	43°07'39"	43°16'10"	43°09'50"	43°14'24"	43°07'08"	43°15'39"	43°13'24"	43°08'00"	43°08'11,8"
PARAMETERS													
SAMPLE TEMP. (ºC)	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
AIR TEMPERATURE (ºC)	35.0	26.0	28.0	-	28.0	27.0	35.0	27.0	-	34.0	35.0	-	-
CONDUCTIVITY (mMHO/cm)	46.5	42.6	46.5	47.0	45.2	37.8	45.6	44.8	47.1	42.3	41.1	47.1	47.3
SALINITY (G/1000 G)	34.0	30.8	34.0	34.0	32.9	27.0	33.2	32.6	34.1	30.5	29.5	34.1	34.5
TURBIDITY (UT)	-	4.5	2.0	2.0	4.0	20		2.0	2.5			2.0	2.0
DO (mg/L)	3.4	2.9	3.9	7.0	4.7	0.1	4.7	1.0	6.7	<0.1	<0.1	6.1	5.9
B.O.D (mg/L)	3.0	4.0	3.0	<2.0	<2.0	8.0	3.2	4.0	<2.0	10	20	<2.0	<2.0
pH (U. pH)	8.2	7.8	8.0	-	8.1	7.6	8.3	7.9	-	7.9	7.2	-	-
SUSPENDED SOLIDS (mg/L)	75	40	20	35	40	50	50	40	40	50	120	35	40
TOTAL FILTRABLE SOLIDS (mg/L)	48,400	31,200	37,000	38,700	35,600	39,100	48,300	38,600	39,200	37,200	43,700	80,900	39,100
TOTAL SOLIDS (mg/L)	-	31,300	37,100	38,800	35,600	39,100	-	38,600	39,300	-	-	81,000	39,100
VOLATILE SOLIDS (mg/L)	-	1,400	6,800	1,040	4,300	5,500	-	4,800	5,000	-	-	51,500	5,500
VOLAT.SUSPENDED SOLIDS (mg/L)	55	-	-	-	-	-	25	-	-	30	100	-	-
TOT. KJELDAHL NITROGEN (mg N/L)	0.8	2.6	0.40	1.0	1.0	6.0	1.2	1.8	1.0	3.4	10	0.6	0.10
NITRITE NITROGEN (mg N/L)	0.02	0.02	0.02	0.02	0.03	0.002	0.02	0.04	0.02	0.04	0.002	0.02	0.01
NITRATE NITROGEN (mg N/L)	0.04	0.05	0.08	0.04	0.05	0.02	0.06	0.05	0.06	0.04	<0.01	0.05	0.03
AMMONIUM NITROGEN (mg N/L)	0.15	1.50	0.40	0.20	0.50	2.50	0.20	1.00	0.30	1.45	2.30	0.25	0.20
ORTOPHOSPHATE (mg P/L)	<0.01	0.20	0.08	0.02	0.05	0.50	<0.01	0.20	0.05	0.25	1.00	0.05	0.03
TOTAL PHOSPHOROUS (mg P/L)	0.10	0.30	0.10	0.08	0.10	0.80	0.10	0.25	0.08	0.50	1.90	0.10	0.06
PHENOLS (mg/L)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
CYANIDE (mg CN/L)	-	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	-	-	<0.01	<0.01
SULPHATES (mg SO4/L)	1,400	2,120	2,640	4,320	2,480	1,760	4,000	2,800	3,880	2,900	2,800	2,800	3,040
CHROMIUM (ug Cr/L)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	12	<10	<10
IRON (ug Fe/L)	38	180	26	70	130	95	30	130	55	80	150	18	12
NICKEL(ug Ni/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
COPPER (ug Cu/L)	9.0	5.0	<2.0	7.5	<2.0	<2.0	8.5	<2.0	9.0	4.0	5.0	<2.0	5.0
ZINC (ug Zn/L)	48	<10	<10	<10	14	<10	70	<10	<10	<10	16	<10	<10
CADMIUM (ug Cd/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MERCURY (ug Hg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
LEAD (ug Pb/L)	<5.0	<5.0	5.0	<5.0	<5.0	<5.0	13	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
BENZO a PYRENE(ug/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.26	<0.01	<0.01
PCB's(ug/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total PAH's (ug/l)	0.5	0.8	0.5	0.7	1.0	1.4	0.4	0.7	1.1	0.6	1.5	0.3	0.3
FAECAL COLI (MPNmil/100ml)	<0.023	8.0	1.3	0.080	0.23	1600	<0.023	13	0.23	24	160	1.3	0.13

WATER QUALITY SURVEY - BAÍA DE GUANABARA

JICA STUDY

UPPER LAYER

WET SEASON - OCTOBER 10 / 2002

	GN000	GN020	GN022	GN026	GN040	GN042	GN043	GN048	GN050	GN064	GN093
LATITUDE	22°43'27"	22°46'30"	22°52'40"	22°50'52"	22°47'50"	22°44'50"	22°50'09"	22°49'42"	22°52'06"	22°55'48"	22°58'28"
LONGITUDE	43°06'15"	43°13'50"	43°11'57"	43°07'39"	43°16'10"	43°09'50"	43°14'24"	43°15'39"	43°13'24"	43°08'00"	43°08'02"
PARAMETERS											
SAMPLE TEMP. (ºC)	25.0	24.0	24.0	24.0	25.0	25.0	26.0	26.0	28.0	23.0	23.0
AIR TEMPERATURE (ºC)	23.0	-	27.0	28.0	27.0	-	-	-	-	30.0	30.0
CONDUCTIVITY (mMHO/cm)	46	35	46	46	25	45	41	41	39	47	47
TRANSPARENCY (m)	0.80	0.40	1.10	1.00	0.30	0.70	0.90	0.60	0.30	2.00	4.50
SALINITY (G/1000 G)	32.8	24.6	33.2	33.6	17.4	32.4	29.3	28.8	27.1	34.1	34.5
DO (mg/L)	5.8	2.8	7.3	8.2	0.1	7.8	2.6	4.3	0.1	8.1	8.0
B.O.D (mg/L)	4.8	4.0	2.4	3.0	10.0	5.4	<2,0	<2,0	10.0	2.2	<2.0
pH (U. pH)	7.9	7.3	8.2	8.2	7.2	7.9	7.5	7.5	7.2	8.2	8.2
SUSPENDED SOLIDS (mg/L)	50	60	55	40	36	60	30	60	50	40	60
TOTAL FILTRABLE SOLIDS (mg/L)	36,100	24,200	72,100	47,600	8,800	36,900	44,300	32,400	38,600	42,200	41,600
TOT. KJELDAHL NITROGEN (mg N/L)	1.6	6.0	2.8	1.2	14	3.0	3.6	3.4	4.6	0.6	0.30
NITRITE NITROGEN (mg N/L)	0.001	0.007	0.04	0.02	0.004	0.007	0.007	0.01	0.005	0.01	0.004
NITRATE NITROGEN (mg N/L)	<0.01	0.01	0.02	<0.01	<0.01	0.02	<0.01	0.02	0.01	2.4	2.7
AMMONIUM NITROGEN (mg N/L)	0.08	2.40	0.45	0.04	2.60	0.25	1.30	1.40	2.40	0.07	0.06
ORTOPHOSPHATE (mg P/L)	0.02	0.30	0.09	0.01	1.0	0.03	0.30	0.20	0.50	0.20	<0.01
TOTAL PHOSPHOROUS (mg P/L)	0.09	0.50	0.15	0.04	1.0	0.15	0.35	0.40	0.60	0.20	0.04
PHENOLS (mg/L)	0.02	0.01	<0.001	<0.001	0.05	0.007	<0.001	0.006	0.03	<0.001	<0.001
SULPHATES (mg SO4/L)	3,400	2,600	3,200	2,600	440	3,100	2,700	2,300	1,600	3,300	2,900
CHROMIUM (ug Cr/L)	14	<10	<10	<10	<10	14	<10	12	<10	12	<10
IRON (ug Fe/L)	22	220	34	150	150	32	80	80	140	60	42
NICKEL(ug Ni/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
COPPER (ug Cu/L)	<2.0	<2.0	<2.0	2.0	9.5	<2.0	23	2.5	<2.0	<2.0	<2.0
ZINC (ug Zn/L)	<10	<10	<10	<10	16	<10	<10	<10	<10	<10	<10
CADMIUM (ug Cd/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MERCURY (ug Hg/L)	<0.10	<0.10	<0.10	<0.10	0.25	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
LEAD (ug Pb/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
BENZO a PYRENE(ug/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total PAH's (ug/l)	0.10	1.0	0.20	0.20	0.80	0.30	0.40	0.40	1.0	0.10	0.10
FAECAL COLI (MPNmil/100ml)	-	-	0.80	0.80	-	-	-	-	-	0.23	0.30

WATER QUALITY SURVEY - BAÍA DE GUANABARA

JICA STUDY

MIDDLE LAYER

WET SEASON - OCTOBER 10 / 2002

	GN8000	GN8022	GN8026	GN8043	GN8048	GN8064	GN8093
LATITUDE	22°43'27"	22°52'40"	22°50'52"	22°50'09"	22°49'42"	22°55'48"	22°58'28"
LONGITUDE	43°06'15"	43°11'57"	43°07'39"	43°14'24"	43°15'39"	43°08'00"	43°08'02"
PARAMETERS							
SAMPLE TEMP. (℃)	25.0	24.0	24.0	25.0	25.0	22.0	22.0
CONDUCTIVITY (mMHO/cm)	46	46	46	44	42	47	47
SALINITY (G/1000 G)	32.8	33.2	33.7	31.1	29.8	34.3	34.5
DO (mg/L)	5.4	5.4	5.1	0.9	0.2	5.7	6.0
B.O.D (mg/L)	3.2	7.2	2.4	4.0	20	2.4	<2.0
pH (U. pH)	7.9	8.2	8.2	7.5	7.5	8.2	8.1
SUSPENDED SOLIDS (mg/L)	80	75	60	60	50	50	60
TOTAL FILTRABLE SOLIDS (mg/L)	37,500	38,500	41,100	33,100	23,700	47,200	70,900
TOT. KJELDAHL NITROGEN (mg N/L)	1.4	2.6	1.2	2.8	5.0	0.6	0.30
NITRITE NITROGEN (mg N/L)	0.003	0.04	0.01	0.009	0.008	0.005	0.004
NITRATE NITROGEN (mg N/L)	0.08	<0.01	0.02	0.02	0.03	0.02	0.06
AMMONIUM NITROGEN (mg N/L)	0.04	0.20	0.04	1.40	1.40	0.05	0.04
ORTOPHOSPHATE (mg P/L)	0.02	0.06	<0.01	0.30	0.30	0.01	0.01
TOTAL PHOSPHOROUS (mg P/L)	0.10	0.15	0.08	0.40	0.40	0.03	0.04
PHENOLS (mg/L)	0.02	<0.001	<0.001	0.006	<0.001	0.01	0.002
SULPHATES (mg SO4/L)	3,400	<10	3,200	3,000	2,700	3,600	3,600
CHROMIUM (ug Cr/L)	<10	<10	<10	<10	<10	16	<10
IRON (ug Fe/L)	<10	26	80	95	130	38	38
NICKEL(ug Ni/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
COPPER (ug Cu/L)	<2.0	<2.0	2.0	22	2.5	<2.0	<2.0
ZINC (ug Zn/L)	<10	<10	<10	<10	<10	<10	<10
CADMIUM (ug Cd/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.5
MERCURY (ug Hg/L)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
LEAD (ug Pb/L)	<5.0	15	<5.0	<5.0	<5.0	<5.0	<5.0
BENZO a PYRENE(ug/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total PAH's (ug/l)	0.50	0.20	0.60	0.90	0.40	0.10	0.10
FAECAL COLI (MPNmil/100ml)	-	0.80	0.70	-	-	0.05	0.08

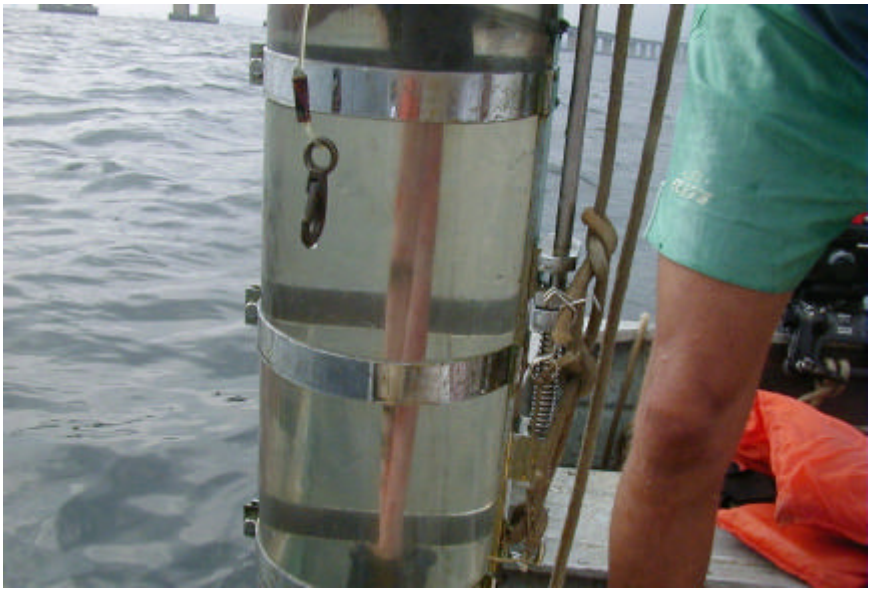
WATER QUALITY SURVEY - BAÍA DE GUANABARA
JICA STUDY
LOWER LAYER
WET SEASON - OCTOBER 10 / 2002

	GN9000	GN9020	GN9022	GN9026	GN9040	GN9042	GN9043	GN9048	GN9050	GN9064	GN9093
LATITUDE	22°43'27"	22°46'30"	22°52'40"	22°50'52"	22°47'50"	22°44'50"	22°50'09"	22°49'42"	22°52'06"	22°55'48"	22°58'28"
LONGITUDE	43°06'15"	43°13'50"	43°11'57"	43°07'39"	43°16'10"	43°09'50"	43°14'24"	43°15'39"	43°13'24"	43°08'00"	43°08'02"
PARAMETERS											
SAMPLE TEMP. (ºC)	24.0	24.0	24.0	24.0	24.0	25.0	25.0	25.0	26.0	22.0	21.0
CONDUCTIVITY (mMHO/cm)	46	42	46	46	39	46	44	36	37	47	48
SALINITY (G/1000 G)	33.4	29.9	33.5	33.8	27.2	32.8	31.6	25.2	26.8	34.5	34.8
DO (mg/L)	3.6	1.9	5.1	5.0	0.1	5.0	0.8	0.1	0.1	5.4	5.2
B.O.D (mg/L)	5.0	2.0	2.4	3.2	8.0	8.0	4.0	4.0	10.0	2.4	<2.0
pH (U. pH)	8.0	7.2	8.2	8.2	7.1	7.9	7.6	7.5	7.2	8.2	8.2
SUSPENDED SOLIDS (mg/L)	70	50	50	50	100	70	50	50	40	9.0	50
TOTAL FILTRABLE SOLIDS (mg/L)	38,600	25,300	39,500	67,600	8,100	36,600	91,800	38,200	31,400	40,500	69,700
TOT. KJELDAHL NITROGEN (mg N/L)	2.0	8.0	0.8	0.6	9.0	2.2	3.5	4.0	8.0	0.30	0.30
NITRITE NITROGEN (mg N/L)	0.001	0.008	0.02	0.01	0.009	0.009	0.06	0.008	0.003	0.05	0.003
NITRATE NITROGEN (mg N/L)	<0.01	0.09	<0.01	0.01	<0.01	0.05	0.01	0.05	<0.01	2.7	0.15
AMMONIUM NITROGEN (mg N/L)	0.10	2.40	0.30	0.08	2.60	0.10	1.00	1.30	2.40	0.04	0.05
ORTOPHOSPHATE (mg P/L)	0.02	0.40	0.04	<0.01	0.70	0.03	0.20	0.30	0.40	0.30	0.30
TOTAL PHOSPHOROUS (mg P/L)	0.10	0.60	0.08	0.07	0.90	0.20	0.30	0.45	0.50	0.30	0.30
PHENOLS (mg/L)	0.006	0.006	<0.001	<0.001	0.04	0.006	<0.001	0.01	0.003	0.004	0.003
SULPHATES (mg SO4/L)	2,900	2,000	3,300	3,200	1,200	3,300	4,200	3,100	2,100	2,600	2,900
CHROMIUM (ug Cr/L)	18	18	<10	14	10	<10	10	10	<10	14	<10
IRON (ug Fe/L)	360	32	26	90	600	<10	80	180	60	<10	44
NICKEL(ug Ni/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
COPPER (ug Cu/L)	3.0	<2.0	<2.0	2.0	10	4.0	<2.0	2.5	<2.0	<2.0	<2.0
ZINC (ug Zn/L)	<10	<10	<10	<10	130	<10	<10	<10	<10	<10	<10
CADMIUM (ug Cd/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
MERCURY (ug Hg/L)	<0.10	<0.10	<0.10	<0.10	0.15	<0.10	<0.10	0.15	<0.10	<0.10	<0.10
LEAD (ug Pb/L)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
BENZO a PYRENE(ug/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total PAH's (ug/l)	0.90	2.0	0.30	0.30	1.0	0.30	0.90	0.40	3.0	0.10	0.20
FAECAL COLI (MPNmil/100ml)	-	-	0.14	0.23	-	-	-	-	-	0.30	0.23

APPENDIX 18-II

PHOTOGRAPHS
July and October, 2002

Photographs from Water Quality Survey – Guanabara Bay



GN-022 – July, 2002

GN-020 – Surroundings – July, 2002

Photos from Water Quality Survey - Guanabara Bay

Near Ramos Beach GN-043 – July, 2002

GN-000 – Surroundings – October, 2002

Photos from Water Quality Survey - Guanabara Bay

Water Samplimg Equipment

Measurements on-site

SUPPORTING 19

ENVIRONMENTAL IMPACT ASSESSMENT

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1. INTRODUCTION

1.1 OBJECTIVES

According to "Scope of Work for the Study on Management and Improvement of the Environmental Conditions of Guanabara Bay in Rio de Janeiro, the Federative Republic of Brazil (hereinafter referred as "the Study")" agreed upon between the State Secretariat of Sanitation and Water Resources, the State of Rio de Janeiro (SESRH) which is reorganized to the State Secretariat of Environment and Urban Development (SEMADUR) since January 2003 and Japan International Cooperation Agency (JICA), Environmental Impact Assessment (herein after referred as "the EIA study") has been carried out based on the relevant laws and regulations in Brazil with reference to JICA's Environmental Consideration Guidelines and JBIC Environmental Guidelines for ODA Loans. The objectives of the EIA study are as follows:

- To review the existing environmental conditions in the EIA study area.
- To assess environmental impacts of the proposed projects.
- To propose countermeasures for mitigating impacts and environmental monitoring plan.

The EIA study area covers directly or indirectly influenced by following projects, namely:

- Acari Project:
  Extension of the wastewater collection system and construction of WWTP in Acari Sewer District.
- Bangu Project:
  Installation of a wastewater collection system and construction of WWTP in Bangu Sewer District.
- Pavuna Project:
  Extension of the wastewater collection system and expansion of the wastewater treatment plant (WWTP) in Pavuna Sewer District.
- Sarapuí Project:
  Extension of the wastewater collection system and expansion of WWTP in Sarapuí Sewer District.

1.2 LEGAL FRAMEWORK OF THE EIA IN STATE OF RIO DE JANEIRO

1.2.1 GENERAL

The methodology and procedure for EIA are outlined in the Federal Law No. 6938 which sets out national policy for environment and CONAMA Resolution 001/86 which defines the fundamental elements for preparation of EIA.

The Licensing System of Polluting Activities - SLAP was created by the State Decree No. 1633 (21/12/1977) in accordance with the Decree-Law No. 134 of 16/June/1975.

The SLAP provides three types of environmental licenses, namely:

- Licenca Previa (LP):
  is an initial license, which targets Feasibility Study (F/S) or basic planning stage. Expiration period for LP follows project schedule but not greater than 5 years.
- Licenca de Instalacao (LI):
  is a license for implementation, which targets Detailed Design (D/D) or construction stage. Expiration period for LI follows project schedule but not greater than 6 years.
- Licenca de Operacao (LO):
  is a license for operation, which targets Operation and Maintenance (O/M) stage. Expiration period for LO follows PBA (refer to following paragraph), with minimum of 4 and maximum 10 years.

The license renewal is compulsory in case of the license expiration or modification of the licensed project. As for the sewerage project, competent organization for the approval of licensing is FEEMA.

- LP is necessary in planning stage to proceed to next D/D stage. EIA study is required to obtain LP for general environmental concerning project. However, LP would be issued without the EIA study when the project is judged to contribute to environmental improvement. In general, LP can be issued to sewerage project without conducting EIA in case the project does not require ocean outfall or land reclamation.
- LI is necessary in project implementation stage. Plano de Basica Ambiental (PBA), which proposes concrete program for mitigating negative impact including procedure, time schedule and estimated cost based on the EIA study, shall be proposed by engineering consultant responsible for D/D.
- LO is necessary in O/M stage. It determines that the responsible for the WWTP should submit an effluent analysis for FEEMA appraisal each three months.

As mentioned above, proposed F/S projects would not be required to conduct EIA to obtain LP according to the case study of the past projects or interview from relevant competent organization such as CEDAE or FEEMA. However, the EIA study has been conducted according to the Terms of Reference (TOR) of the Study in order to elaborate the F/S projects from the point of view of environmental consideration.

EIA situation and relationship between environmental licensing system and project implementation is summarized in *Figure 1*.

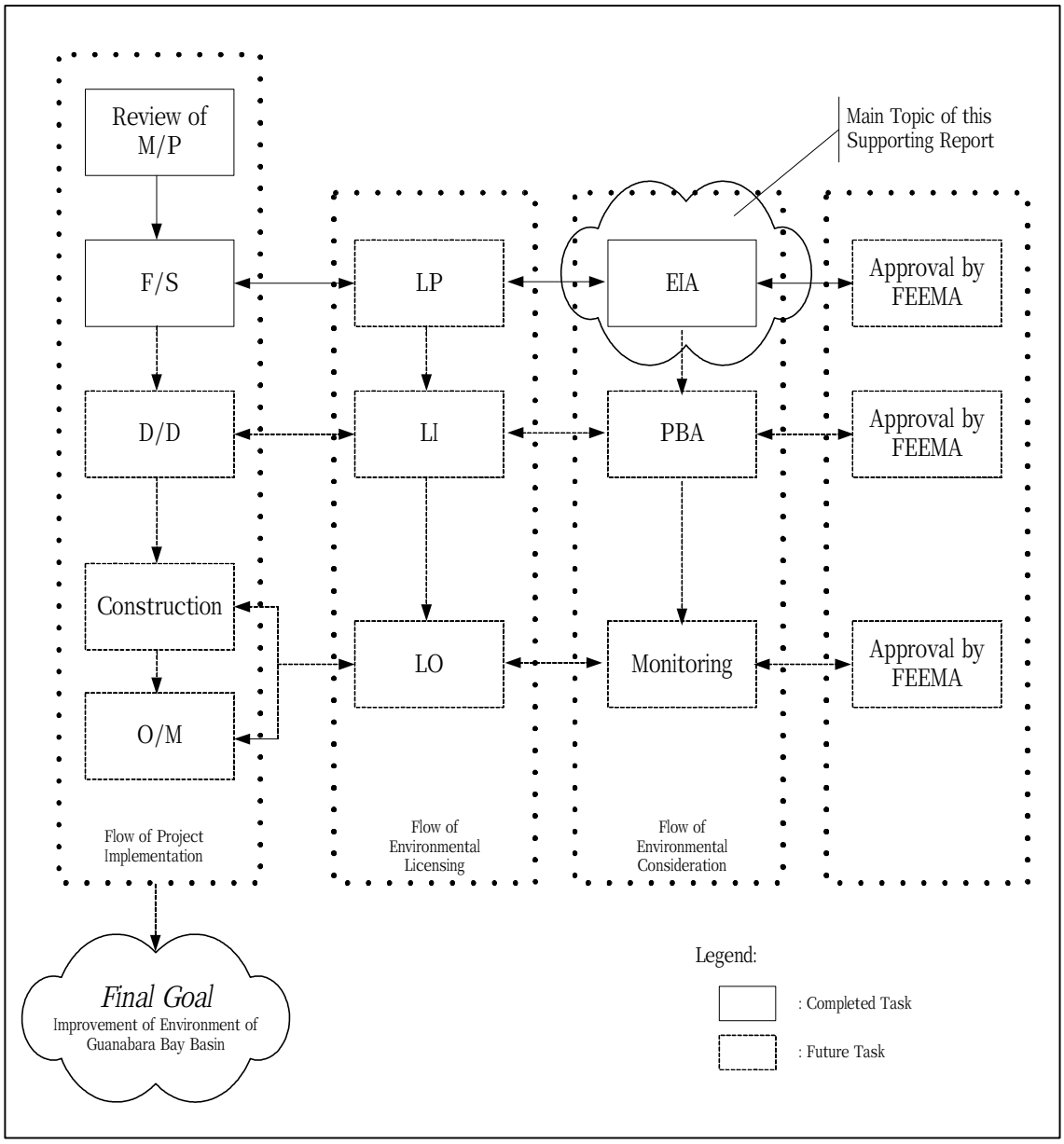


Figure 1 Relationship between EIA Procedure and Project Implementation in State of Rio de Janeiro

1.2.2 CONTENTS OF EIA

According to the relevant laws and regulations regarding EIA, such as CONAMA Resolution 001/86 and DZ-041.R13, the following contents are focused in the EIA study:

- Project Description.
- Definition of the area that would be directly or indirectly influenced by the impacts of the project implementation.
- Environmental description of the project influenced area.
- Analysis and evaluation of impacts.
- Definition of mitigation steps for negative impacts.

1.3 THE REGULATIONS REFERRED BY THE EIA STUDY

The major regulations referred by the EIA study are outlined below:

1.3.1 FEDERAL LEGISLATION

(1) Law on Environment Policy and Licensing

- Law No. 6.938/81 - National Environment Policy:
  provides the National Environment Policy, its purposes and formulation, and application mechanisms.
- Decree No. 88.351/83:
  rules Law No. 6.938/81 and Law No. 6.902/81 and institutes the National Environment Council (CONAMA).
- Decree 99.274:
  rules Law 6938/81 and lists the guiding principles of the environment policy:
- CONAMA Resolution No. 009/87:
  provides the open court in the projects submitted to evaluation of the environment impacts.
- CONAMA Resolution No. 013/90:
  rules licensing of activities in areas surrounding the preservation units, defining which activities may disturb the Unit's biota.
- CONAMA Resolution No. 002/96:
  provides on the implementation of a preservation unit linked to the relevant environment impact activities, in order to repair the environment damages caused by harm to forests or to ecosystems.
- CONAMA Resolution No. 237/97:
  establishes the rules on environment licensing.

(2) Law on Water Resources

- Decree No. 24.643/34, Code of Waters:
  provides code of waters.
- CONAMA Resolution No. 020/86:
  determines the classification of the fresh, brackish and salt water of the national territory.
- Law No. 9.433/97:
  establishes the National Policy of Water Resources and creates the National Management System of Water Resources.

(3) Protection of Forest

- Law No. 4.771/65:
  establishes the Forest Code
- Law No. 7.754/89:
  establishes measures for protection of forests in upstream of river basin.

(4) Sound Pollution

- CONAMA Resolution No. 001/90:
  establishes criteria and standards for emission of noises.

1.3.2 STATE LEGISLATION

(1) Environmental Policy and Licensing

- Decree-law No. 39/75:
  institutes FEEMA and establishes standards and rules, personnel training and rendering of services for rational utilization of environment.

- Decree-law No. 134/75:
  settles the prevention of environment pollution in State of Rio de Janeiro.
- Decree No. 1.633/77:
  partly rules decree-law No. 134 and establishes the licensing system of polluting activities.
- Law No. 1.356/88:
  establishes the procedures connected with the preparation, analysis and approval of the environment impact studies.
- Law No. 1.898/91:
  provides way on the performance of environmental audits.
- NA-052:
  deals with necessary submittals in the licensing system of polluting activities - SLAP.
- DZ-215.R-01:
  is guideline on control of organic biodegrading load in liquid effluents of non-industrial origin.
- DZ-041.R/13:
  is guideline for performance of the EIA study and the Respective Environment Impact Report (RIMA).

(2) Water Resources

- Decree No. 57/75:
  establishes the competence and approves the basic structure of the State Superintendence of Rivers and Lakes (SERLA).
- Law No. 650/83:
  provides the state policy of protection of lakes and watercourses.
- Law No. 1.700/90:
  establishes Guanabara Bay's environment protection steps.
- Decree No. 17.774/92:
  provides the Guanabara Bay pollution abatement program.
- Law No. 3.239/99:
  establishes the state Policy of water resources.

(3) Protection of Forest

- Law No. 1.315/88:
  establishes the forest policy of State of Rio de Janeiro.

(4) Air Pollution

- Decree No. 779/67:
  approves the regulation for control of air pollution in the State.

(5) Noise pollution

- Decree-law No. 112/69:
  establishes the noise protection standards.
- Law No. 126/77:
  provides the protection against noise pollution.

(6) Sludge Disposal

- Law No. 2.661/96
  establishes manner for sludge disposal from WWTP

1.4 EIA IMPLEMENTING ORGANIZATION AND SPECIALISTS

The EIA Study was carried out by entrusting it to a qualified local consultant, namely:

- Name of Local Consultant: Consultoria Ambiental Ltda (CAL)
- Address: Rua da Assembleia, No. 98/23 andar, Centro, Cep 20011-000, Rio de Janeiro, RJ
- Tel: (21) 526-7426 / 526-7427
- E-mail: cal@alternex.com.br

The specialists participated in the EIA study are summarized in *Table 1.*

Table 1 List of Specialists Participated in the EIA Study

Name	Education	Function
Margarida Maria de Sá	M.Sc. Environment	General Coordination
Maria de Fátima Rodrigues da Cunha	M.Sc. Hydric Resources	Joint Coordination
Sebastião Pinheiro Cordovil	Forest Engineer	Biotic Studies
Nair Palhano Barbosa	Sociologist	Socioeconomic Studies
Francisco Lombardo	Transportation Engineer	Traffic Studies
Marcelo Neiva	Civil Engineer	Sanitation Studies
Cláudio Casiush	Lawyer	Environment Legislation
Jane Costa Tavares	M.Sc. Sanitation	Hydrologic Studies/ Climatology
André Monsores	Geologist	Geological and Pedologic Studies
Hamilton Garboggini Pinho dos Santos	Biologist	Fauna Studies
Renato Casado	Civil Engineer	Sanitation Studies
Marilda Azevedo	Civil Engineer	Sanitation and Water Quality Studies

2. EIA FOR THE FEASIBILITY STUDY

2.1 GENERAL

This EIA study covers the contents as specified in the previous section in accordance with relevant laws and regulations:

- Project Description is described in 2.2,
- Definition of the area that would be directly or indirectly influenced by the impacts of the project implementation is described in 2.3,
- Environmental description of the project influenced area is described in 2.4,
- Analysis and evaluation of impacts is described in 2.5 and,
- Definition of mitigation steps for negative impacts is also described in 2.5.

2.2 DESCRIPTION OF THE FEASIBILITY STUDY (F/S) PROJECTS

The details of proposed projects in F/S Study are summarized in *Table 2* to *Table 5.* General Layout and arrangement of each facility are shown in Chapter 7 of the Main Report.

Table 2 Summary of Acari Project

Item		Description
1.	**Fundamentals**	
	Construction Period	Sewers: from January 2006 to December 2009 WWTP: from January 2007 to December 2008
	Sewered Area (ha)	Existing: 730 F/S: 3,100 Total: 3,830
	Sewered Population (as of 2020)	Total: 390,200
2.	**Sewer**	
	Collection System (km)	Existing: 134 F/S: 582 Total: 716
3.	**Waste Water Treatment Plant**	
	Treatment Process	Wastewater: Activated Sludge Method Sludge: Digesting, Dewatering and Thermal Drying
	Treatment Capacity (L/s, Average Daily)	Existing: - F/S: 1,100 Total: 1,100
	Influent Quality	BOD (mg/L): 230 SS (mg/L): 250
	Effluent Quality	BOD (mg/L): 20 SS (mg/L): 20
	Receiving Water Body	Rio Sapopemba (tributary of Rio Acari, which interflows Rio Pavuna)
	Sludge Disposal Method	Landfill
4.	**Project Cost**	
	Construction Cost (US$ 1,000)	Collection System: 72,918 WWTP: 28,293 Total: 101,211
	Annual Operation and Maintenance Cost (US$ 1,000/year)	Total: 2,850

Source: JICA Study Team

Table 3 Summary of Bangu Project

Item		Description
1.	**Fundamentals**	
	Construction Period	Sewers: from January 2006 to December 2009 WWTP: from January 2007 to December 2008
	Sewered Area (ha)	Existing: - F/S: 1,870 Total: 1,870
	Sewered Population (as of 2020)	Total: 363,200
2.	**Sewer**	
	Collection System (km)	Existing: - F/S: 430 Total: 430
3.	**Waste Water Treatment Plant**	
	Treatment Process	Wastewater: Activated Sludge Method Sludge: Digesting, Dewatering and Thermal Drying
	Treatment Capacity (L/s, Average Daily)	Existing: - F/S: 1,000 Total: 1,000
	Influent Quality	BOD (mg/L): 230 SS (mg/L): 250
	Effluent Quality	BOD (mg/L): 20 SS (mg/L): 20
	Receiving Water Body	Rio das Tintas (tributary of Rio Sarapuí)
	Sludge Disposal Method	Landfill
4.	**Project Cost**	
	Construction Cost (US$ 1,000)	Collection System: 54,795 WWTP: 26,935 Total: 81,730
	Annual Operation and Maintenance Cost (US$ 1,000/year)	Total: 2,490

Source: JICA Study Team

Table 4 Summary of Pavuna Project

Item		Description	
1.	**Fundamentals**		
	Construction Period	Sewers:	from January 2005 to December 2008
		WWTP:	from January 2006 to December 2007
	Sewered Area (ha)	Existing:	4,900
		F/S:	3,700
		Total:	8,600
	Sewered Population (as of 2020)	Total:	1,029,600
2.	**Sewer**		
	Collection System (km)	Existing:	704
		F/S:	718
		Total:	1,422
3.	**Waste Water Treatment Plant**		
	Treatment Process	Wastewater:	Activated Sludge Method
		Sludge:	Dewatering and Thermal Drying
	Treatment Capacity (L/s, Average Daily)	Existing:	1,500
		F/S:	1,500
		Total:	3,000
	Influent Quality	BOD (mg/L):	200
		SS (mg/L):	240
	Effluent Quality	BOD (mg/L):	8
		SS (mg/L):	20
	Receiving Water Body	Rio Pavuna	
	Sludge Disposal Method	Landfill	
4.	**Project Cost**		
	Construction Cost (US$ 1,000)	Collection System:	90,449
		WWTP:	14,872
		Total:	105,321
	Annual Operation and Maintenance Cost (US$ 1,000/year)	Total:	3,323

Source: JICA Study Team

Table 5 Summary of Sarapuí Project

Item		Description	
1.	**Fundamentals**		
	Construction Period	Sewers:	from January 2005 to December 2008
		WWTP:	from January 2006 to December 2007
	Sewered Area (ha)	Existing:	7,300
		F/S:	600
		Total:	7,900
	Sewered Population (as of 2020)	Total:	825,900
2.	**Sewer**		
	Collection System (km)	Existing:	1,057
		F/S:	103
		Total:	1,160
3.	**Waste Water Treatment Plant**		
	Treatment Process	Wastewater:	Activated Sludge Method
		Sludge:	Dewatering and Thermal Drying
	Treatment Capacity (L/s, Average Daily)	Existing:	1,500
		F/S:	1,000
		Total:	2,500
	Influent Quality	BOD (mg/L):	200
		SS (mg/L):	240
	Effluent Quality	BOD (mg/L):	8
		SS (mg/L):	20
	Receiving Water Body	Rio Sarapuí	
	Sludge Disposal Method	Landfill	
4.	**Project Cost**		
	Construction Cost (US$ 1,000)	Collection System:	14,416
		WWTP:	11,741
		Total:	26,157
	Annual Operation and Maintenance Cost (US$ 1,000/year)	Total:	1,836

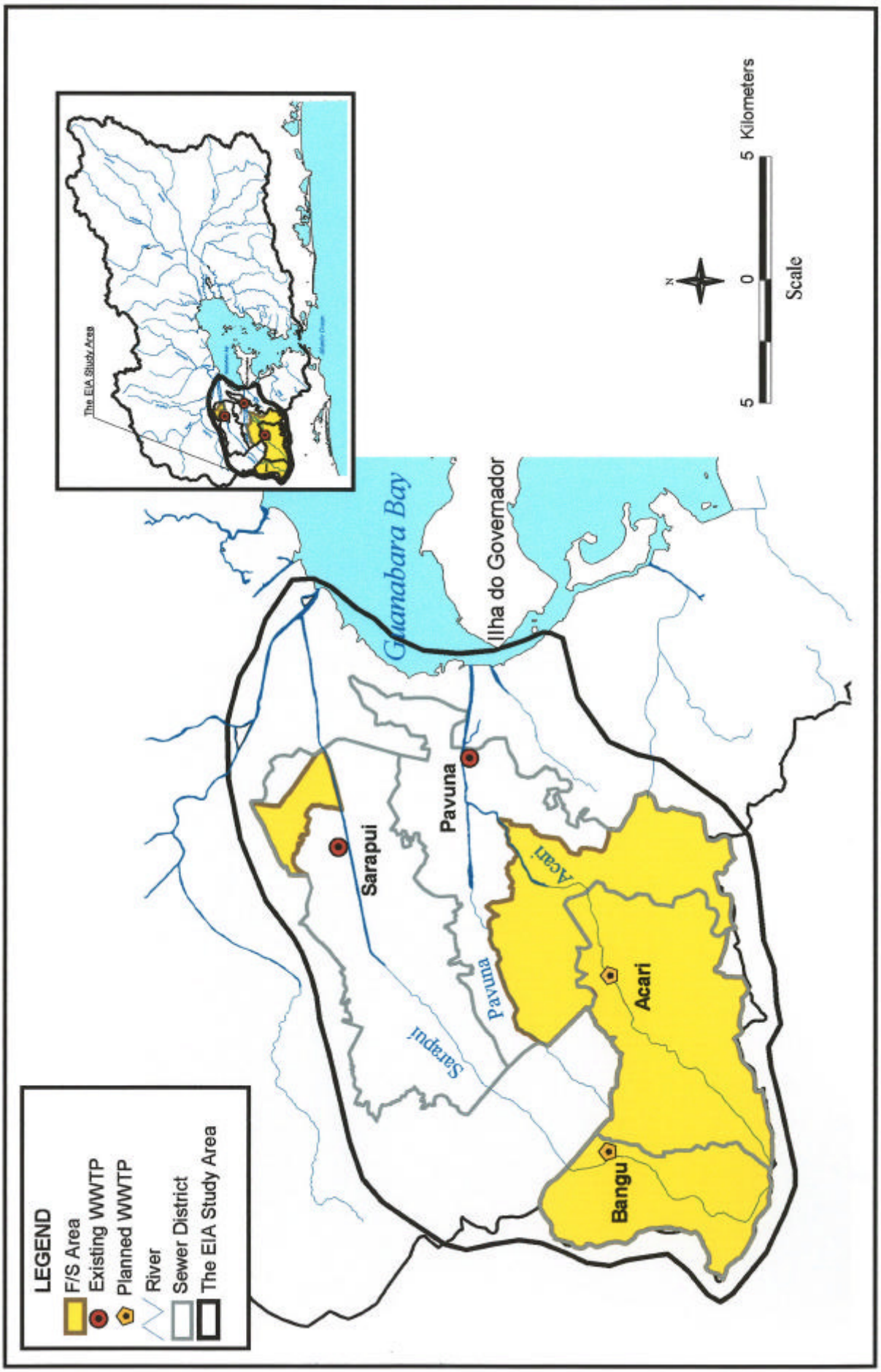
Source: JICA Study Team

2.3 DEFINITION OF THE INFLUENCED AREA BY THE F/S PROJECTS

Extent of the EIA Study area is defined as the area directly or indirectly influenced by the implementation of the F/S projects. Study area for this EIA covers following municipalities either entirely or partly:

- Rio de Janeiro
- São João de Meriti
- Belford Roxo
- Duque de Caxiasb
- Nilópolis
- Nova Iguaçu

Location map of the EIA study area is outlined in *Figure 2.*


LEGEND
F/S Area
Existing WWTP
Planned WWTP
River
Sewer District
The EIA Study Area
Guanabara Bay
Ilha do Governador
Sarapui
Pavuna
Acari
Bangu
Sarapui
Pavuna
Acari
The EIA Study Area
N
Scale
0
5
5 Kilometers

2.4 DESCRIPTION OF THE ENVIRONMENT

This section provides specific environmental characteristics in the EIA study area. For general aspects of the whole of Guanabara Bay Basin area are summarized in Chapter 2 of the Main Report.

2.4.1 CLIMATE

Fundamental characteristics of climate in the EIA Study area are summarized in *Table 6.*

Table 6 Summary of Climatic Characteristics in the EIA Study Area

Item	Description
Climate Classification	The EIA study area is classified as humid or sub-humid mesothermal climate.
Rainfall	• Average monthly total rainfall in the EIA Study area varies from 38 mm in July to 165 mm to January. • Average annual total rainfall is 1,689 mm/year.
Temperature	• The average annual temperature in the EIA study area is 22°C. • The average monthly temperature in January (hottest season) is 26.5°C. • The average monthly temperature in July is 21.0°C. • Maximum temperature in the hottest season reaches around 42°C and minimum temperature in the coldest season falls around 8°C.
Relative Humidity	The relative humidity is fairly steady through the year from 77 % to 80 %.
Wind	• Prevailing wind direction from September to February is southwest. • Prevailing wind direction from March to August is northeast.

Source: INMET, GEO-RIO (Fundação Instituto de Geotecnica do Municipio do Rio de Janeiro: Foundation of Geotechnical Institution of Rio de Janeiro Municipality)

2.4.2 HYDROLOGICAL FEATURE

Fundamental characteristics of hydrological feature in the EIA Study area are summarized in *Table 7.*

Table 7 Summary Hydrological Feature in the EIA Study Area

Item	Description
General	The EIA study area is comprised of the basins of Rio Sarapuí and Rio Pavuna. Rio Acari is a tributary of Rio Pavuna, and Rio das Tinatas is a tributary of Rio Pavuna.
Rio Sarapuí	Length: 30 km Area of Basin: 162 km^2
Rio Pavuna	Length: 15 km Area of Basin: 162 km^2

Source: This EIA Study

General characteristics of the flow rates at the proposed WWTP are summarized in *Table 8.*

Table 8 Flow rate of Receiving River at Proposed WWTP

River	Average Monthly Flow (m^3/s)	Average Weekly Minimum Flow (m^3/s)	Flood Outflow by Return Period (m^3/s)	
	Long Term	10 year	20-year	100-year
Rio Sarapuí (Sarapuí WWTP)	5.27	1.32	199	275
Rio das Tintas (Bangu WWTP)	1.03	0.253	39	54
Rio Pavuna (Pavuna WWTP)	6.88	1.73	467	603
Acari (Acari WWTP)	1.72	0.513	124	152

Source: CPRM (Companhia de Pesquisa de Recursos Minerais)

2.4.3 WATER QUALITY

Typical water quality in Rio Acari, Rio Pavuna and Rio Sarapuí, which will be the receiving rivers of the WWTP's effluents is summarized in this section. Location of sampling points are shown in *Figure 3* and results are outlined in *Figure 4*.

The analysis of water quality clearly shows that all rivers are significantly polluted by organic matter.

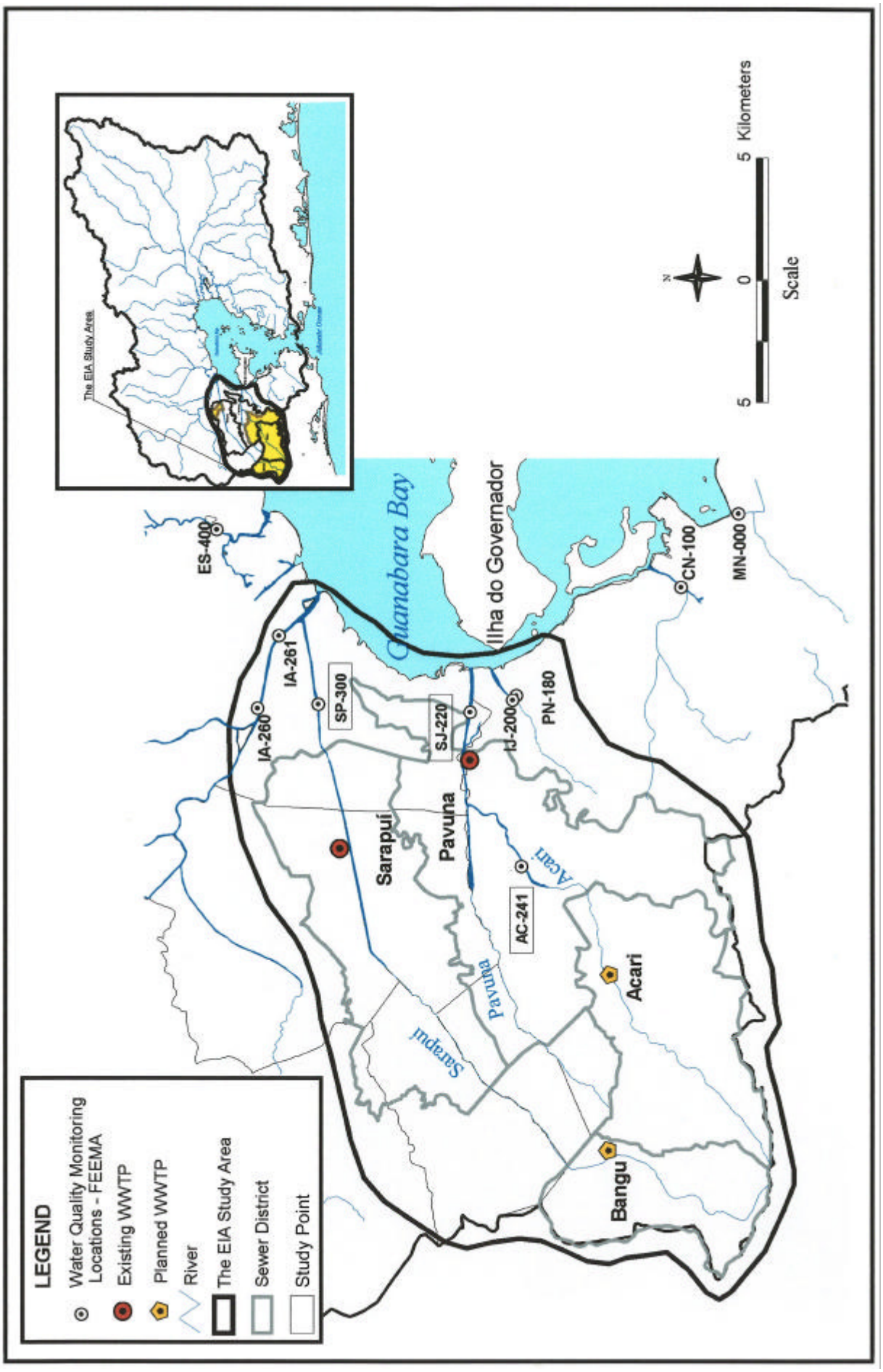
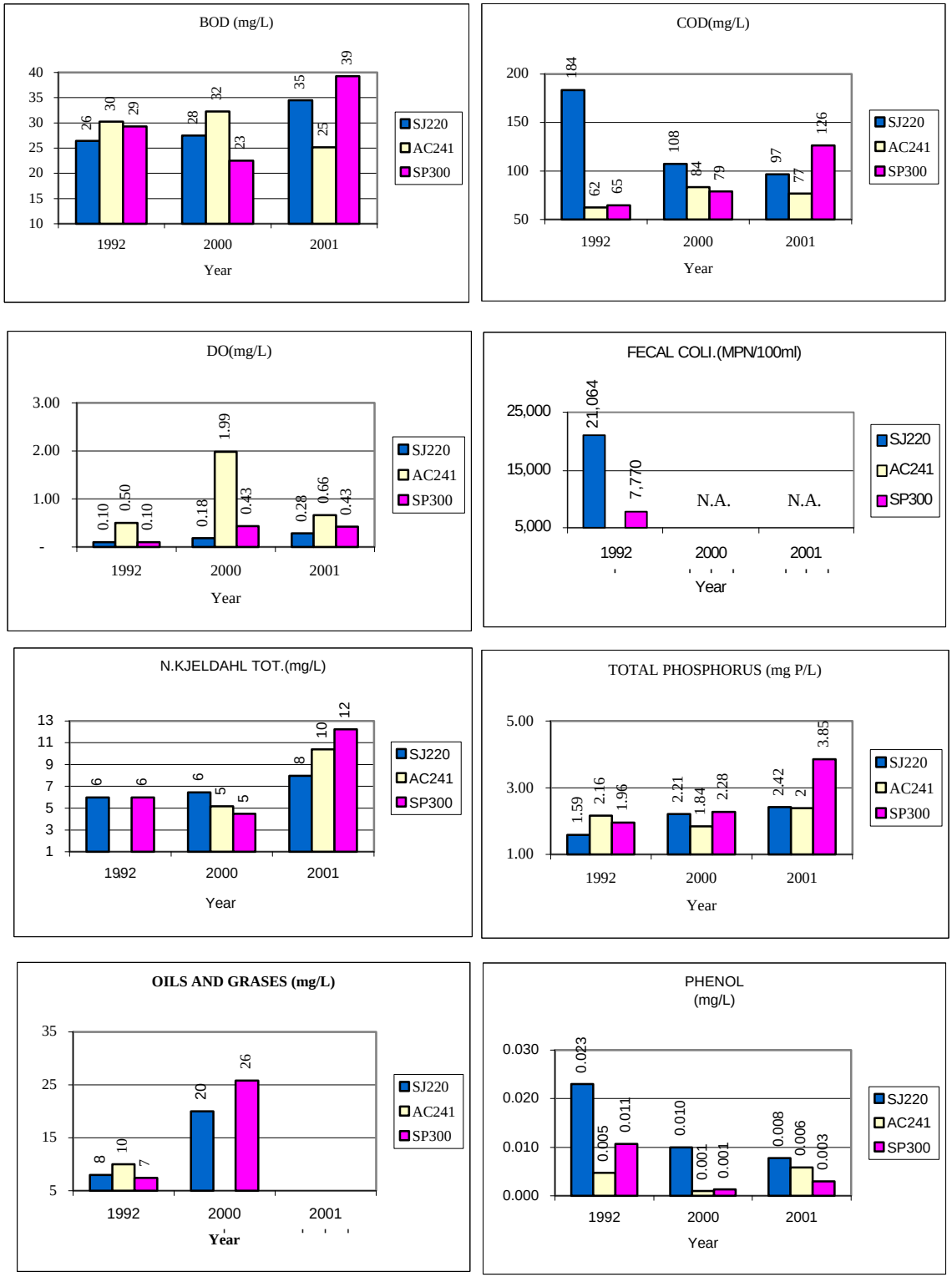


Figure 3 Water Quality Monitoring Locations in the EIA Study Area



Note:
N.A. means “Not Available”.
Refer to Figure 3 for location of SJ220, AC241 and SP300.
Source: FEEMA

Figure 4 Water Quality in Rio Acari, Rio Pavuna and Rio Sarapuí

2.4.4 GEOLOGICAL ASPECTS

(1) Specific Aspect of River Basin of Rio das Tintas

Rio das Tintas is located in the upstream of Rio Sarapuí.

The predominant landscape in Rio das Tintas basin is ample lowlands with Pedra Branca saw, which is included in the Coastal and Interior Massive Unit, in the background.

The lithological association with the morphologies is evident. In the lowlands occur the Quaternary sediments, Fluvio - Lagoonal Deposits, unconsolidated, with layers interleaving of sand, gravels and clay, with predominance of the sandy levels. The thicknesses can vary since 1 meter even at least 10 meters.

In Pedra Branca saw and in the Coqueiros Hill occur the Granites rocks where bloom granites and granites gneisses, crossed by aplitic veins and pegmatite. In the base of the hills with larger altitudes and declivities occur talus deposits, badly selected and unconsolidated material, and colluviums. In lower and rounded hills is commoner residual soils coverage.

In the basin extreme north occur alkaline rocks, in Mendanha's saw, intrusive, usually leucocratic, composed by nepheline syenites and syenites. Associates to these rocks occurred residual soils, generally loamy for silt - loamy predominantly low thick.

The hydro geological information it allows to individualize two principal aquifers systems, which can be interconnected. The first is an unconfined porous aquifer related to Fluvio - Lagoonal Deposits, alluvium quaternary sediments. The second system is fractured, unconfined to semi-confined, with secondary permeability associated to the fractures in the crystalline rocks, granites or alkaline. The fractured system occurs in every area, even though the rocks are overcast for other materials.

The Bangu WWTP is located in the Sardinhas, Cabral and Tintas rivers confluence. The area is located in the fourth part, northeast, of the Tintas river basin, in the lowland, in completely flat terrains over the Fluvio - Lagoonal Deposits

(2) Specific Aspect of River Basin of Rio Sarapuí

The Sarapuí River is affluent of Iguaçu River, and it proceeds receiving this name downstream of the Tintas and Sardinhas rivers confluence.

The dominant geomorphologic features in the area are three: Intrusive Alkaline Massifs, Colluvial - Alluvial - Marine Plain, and Isolated Hills (Dantas, 2001).

In the Sarapuí basin river can be found, in the lowlands areas, two distinct litho logical units that occur along the canal of the river. The first, in the superior half of the Sarapuí river course, corresponds to the Fluvio - Lagoonal Deposits. The second, in half inferior of the course of the Sarapuí River corresponds to the Fluvio - Lagoonal - Marine Deposits.

In the extreme west of the basin occur the rocks associates to Mendanha's Alkaline Massif, intrusive, usually leucocratic, composed by nepheline syenites and syenites. Also occurs the Metasedimentar Rocks Unit, composed by gneisses and migmatites rocks, rich in grenade, biotite, kyanite and quartzfeldspatics. The predominant Unit in the Sarapuí river basin is the Granitoids Rocks composed by microcline gneisses, porphyritic, with intense compositional and textural variation, could enrich in biotite, grenade and hornblende.

In the Sarapuí river basin can be described two aquifer systems, both unconfined, the first, with preferentially primary permeability, due to porosity of the Quaternary sediments, which it can be sub-divided in two parts, one where occur the Fluvio - Lagoonal Deposits, with predominance of sandy levels and high permeability, and another to the Fluvio - Lagoonal - Marine Deposits, with organic clays predominance, with low permeability and plaudit regions. The second aquifer system is the fractured, which occurs in every extension of the basin, in the crystalline rocks, even though these be overcast for thick residual soils, or overlaid to the sediments described above.

The Sarapuí WWTP is located near to the Jardim Metrópole district, in the east part of the basin, in the lowland, in completely flat terrains over the Fluvio - Lagoonal - Marines Deposits.

(3) Specific Aspect of River Basin of Rio Pavuna

The Pavuna river springs is near to the southeast limit of the Gericinó military area, in the Periquitos and Boa Vista hills, passing to be called Pavuna from the confluence of Pau and Cabral rivers.

The dominant landscapes in the Pavuna's River basin are the lowland and the isolated hills with valleys lumbered by Fluvio - Lagoonal sediments, forming in the east a monotonous relief, practically plane and for west the predominance of rounded hills.

In the intermediary passage of Pavuna's river, along the canal occur Fluvio - Lagoonal Deposits sediments with low thick, not overtaking a dozen of meters.

In the inferior passage of Pavuna's river occur Fluvio - Lagoonal - Marines Deposits with lateral extension more widespread that the previously described, composed by Quaternary unconsolidated sediments, with sands and organic dark ash clays predominance. The Metasedimentar Rocks Unit characteristic, in the Pavuna's river basin is identical to the other basins. The Granitoid Rocks Unit does not introduce significant variations of the characteristics described previously. In the west basin part in the Granite Rocks domain occur residual soils formed from this rocks with silted and sandy - silt composition. These soils tend to be low thickness, varying poorly, could arrive to less of a dozen of meters.

The aquifer systems in the Pavuna's river basin area are similar to describe to the Sarapuí River basin. Occur two aquifer systems, a porous, associate to the Quaternary sediments deposited near to the rivers beds and another, fractured, associate to occurrence of crystalline rocks.

The Pavuna's WWTP is located near to the Vigário Geral district, in the margin of the Pavuna river, in the east basin part, in the lowland, in completely flat terrains over the Fluvio - Lagoonal - Marine Deposits.

(4) Specific Aspect of River Basin of Rio Acari

The Acari River is formed from the confluence of several other rivers. The Marinho river springs in the lowland, in the west portion of the basin, so, from the confluence with the Piraquara River, who spring in Pedra Branca saw, changing it name to Marangá River. For downstream change name again to Sapobemba's River and from the confluence with Afonsos' River, who also is born in Pedra Branca Sierra, go by called Acari River.

The Acari River basin only superimposes to two Geomorphologic Units defined by Dantas (2001). The first, it occurs in every south extension of the basin, is the Coastal and Interior Massif Unit, with mountainous relief and scarped boards, serving as a hydrographic divisor well

marked in the local topography. The second, Colluvial - Alluvial - Marines Plains Unit extends for all central and north basin portions, dominating the landscape. Low amplitude hills relief sustains the north hydrographic limit, contact between the Plains Units and the Isolated Hills Unit that occurs to north of the basin.

The Geological Units keep a direct relation with the Geomorphologic Units. In the lowlands occur the Quaternary unconsolidated sediments, Fluvio - Lagoonal Deposits with thicknesses varying even at least a dozen of meters.

In Pedra Branca Sierra in the extreme southwest of the basin occurs the Granite Rocks Unit. The residual soils generated from these rocks, in the basin area, tend to be low thickness, occurring in accentuated declivity locations. The Metasedimentar Rocks Unit characteristic, in the Acari river basin, is identical to ones described previously. The soils generated by these rocks are low thick, where occur larger declivities and increasing significantly where declivity is low. The Granitoids Rocks Unit can generate thick residual soils, in the low declivities regions, in the extreme north of the basin, near Gericinó's military area, and shallower soils in the area of the Pedra Branca Park.

In the Acari river basin can be individualized two aquifer systems, besides absence information. The first would be unconfined aquifer related porous to Fluvio - Lagoonal Deposits, with original water level shallow or crop out. The thickness can vary and it occurs in every central and north basin portion, superimposed to the second system, fractured type, unconfined or semi-confined, with secondary permeability associate to fractures in the crystalline rocks. The fractured system occurs in every area, even though the rocks are overcast for other material.

The Acari WWTP is located in the margin of the Acari River, for amount of the confluence with Afonsos' River and near Brasil Avenue, in lowland region, in completely flat terrains over the Fluvio - Lagoonal Deposits.

2.4.5 FLORA AND FAUNA

(1) Flora

Based on the results of the survey on flora, no precious/endangered specie is identified in the EIA study area. Additionally, there is no virgin forest in the EIA study area. However, riverside area of Rio das Tintas near proposed site of Bangu WWTP is a protected area by the Forest Code.

Results of the field survey on dominant/major species of flora in/around proposed WWTP sites are summarized in the following *Table 9.*

Table 9 Summary of Survey Results on Flora in Proposed WWTP Site

Site	Dominant/Major Species of Flora
Acari WWTP	• Capim coloniao *(Panicum maximum)* • Castor oil plant *(Recinus Communis)*
Bangu WWTP	• Vines *(Thumbergia alata-jasmin-sombra, Ipomoea acuminata, Ipomoea sp., Banisteriopsis sp.)* • Castor bean plant *(Recinuscommunis)* • Cambara verdadeiro *(Manihot sp., Lantana camara)* • Assa-peixe *(Vernonia)* • Caruru-verde *(Amarantus viridis)* • Capim coloniao *(Panicum maximum)* • Marica *(Mimosa bimucronata)* • Jamelao *(Eugenia jambolana)* • Para-raio *(Melia azederach)* • Ipe-banana *(Sparatosperma leucanthum)*
Pavuna WWTP	No natural vegetation in WWTP site
Sarapuí WWTP	No natural vegetation in WWTP site

Note: Name of specie is either local or English name followed by scientific name

(2) Fauna

Based on the results of the survey on fauna, no precious/endangered specie is identified in the EIA study area.

Results of the field survey on dominant/major species of Fauna in/around proposed WWTP sites are summarized in the following *Table 10.*

Table 10 Summary of Survey Results on Fauna in/around Proposed WWTP Site

Site	Dominant/Major Species of Fauna
Acari WWTP	• Opossum *(Didelphis marsupialis)*
Bangu WWTP	• Lapwing *(Vanellus chilensis)* • Heron-vaqueira *(Bulbucus ibis)* • Caldo-de-feijao *(Columbina talpacoti)* • Anu *(Crotopaga ani)* • Black vulture *(Coragyps atratus)* • Trinca-ferro (*Salator similis)* • Thrush *(Turdus sp.)* • Tiziu *(Volatina jacarina)* • Coleirinho *(Sporophila caerulescens)*
Pavuna WWTP	No wild animal/bird in/around WWTP site
Sarapuí WWTP	No wild animal/bird in/around WWTP site

Note: Name of specie is either local or English name followed by scientific name

2.5 IDENTIFICATION, EVALUATION AND MITIGATION OF IMPACTS ON ENVIRONMENT

2.5.1 IDENTIFICATION OF POSSIBLE IMPACTS

Following items are focused as possible impacts and evaluated according to relevant Federal and State regulations on EIA, with reference to JICA's Environmental Consideration Guidelines and JBIC Environmental Guidelines for ODA Loans.

(1) Planning / Design Stage

- Resettlement caused by land acquisition
- Disturbance caused by geotechnical survey

(2) Construction Stage

- Impacts on fauna and flora
- Erosion
- Impacts on traffic flow
- Impacts on health of workmen and residents near construction site
- Impacts on daily life of residents near construction site (discuss about confliction between workmen and residents)
- Increase of employment opportunities
- Impacts on public utilities
- Dust and noise

(3) Operation Stage

- Public health improvement
- Water quality improvement
- Impacts on traffic flow
- Increase of employment opportunities
- Noise and odor
- Sludge disposal

Mitigation measures for possible negative impacts and optimization measures are described in following section.

2.5.2 EVALUATION AND MITIGATION/OPTIMIZATION MEASURE FOR POSSIBLE IMPACTS

The EIA study identified possible negative/positive impacts and proposed mitigation/optimization measures. These measures will be taken into consideration in detailed design stage to prepare technical specification of the proposed projects. *Table 12* summarizes evaluation of possible impacts and its mitigation/optimization measures. This mitigation/optimization measure will be a guide for proposing concrete PBA (Plano de Basica Ambiental: Basic Environmental Plan), which includes procedure, time schedule and estimated cost.

(1) Resettlement Caused by Land Acquisition

Acari WWTP will be constructed within confined existing plant area, which will be demolished before construction. For Bangu WWTP, it is already confirmed that there is no need to relocate residents and land acquisition procedure is currently in progress. For the expansion of Pavuna and Sarapuí WWTP's, installation of new facilities and construction work will be within confined existing site.

For installation of trunk sewer and pumping station, appropriate locations have already been identified in preliminary design conducted in the Study.

Therefore there is no need for relocation by implementation of the F/S Projects.

(2) Disturbance Caused by Geotechnical Survey

Geotechnical survey activities may cause confliction if fails to have mutual understandings with local residents. CEDAE should take necessary actions, such as distribution of information prior to the geotechnical survey.

(3) Impacts on Fauna and Flora

In this EIA study, a survey on flora and fauna in/around the proposed projects site was conducted. The results indicate that there are no precious fauna and flora in/around the project area. Therefore impacts on fauna and flora are considered as negligible.

However it is recommended that special care should be taken for the protection of all trees, relocation of nest of bird if necessary in detailed design and construction stage, especially in/around proposed Bangu WWTP site.

(4) Erosion

Proposed project sites are flat and require no large-scale reclamation. Therefore negative impacts caused by erosion will be negligible.

However it is recommended that the contractor should take special attention in excavation work or collection of soil for importing material, especially during the rainy season.

(5) Impacts on Traffic Flow

In the construction stage, open excavation work for pipe installation might need to block traffic. And delivering of the material for construction, such as importing soil material could cause increase of traffic. Such impact is only temporary and can be minimized by appropriate construction schedule and keeping close contact and coordination with relevant competent departments for traffic such as DER or CET-Rio (Companhia de Engenharia de Trafego do Rio de Janeiro: Traffic Engineering Corporation of Rio de Janeiro)

In the operation stage, traffic would increase because of carrying out of sewage sludge but it will not be significant.

Therefore it is judged that impact of traffic will not be significant.

(6) Impacts on Health of Workmen and Residents near Construction Site

Health and safety for workmen and residents shall be well-considered in the construction stage. The contractor should conduct health examination for workers in regular basis. Additionally, the contractor should monitor, if there is any health problem caused by construction work, by conducting interview, arranging a contact desk for residents' complain and so on.

(7) Impacts on Daily Life of Residents near Construction Site

Construction work such as pipe installation work may disturb daily traffic. Such impact will be only temporary and can be minimized by appropriate construction scheduling and distribution of information to local residents.

Additionally, introducing labor from outside of the construction site might unease people living near the construction site. The contractor should be responsible for keeping discipline of workers so that there should be no confliction with local residents.

(8) Increase of Employment Opportunities

Many working opportunity will be expected in the construction stage. Additionally, 228 of new working opportunity (80 personnel for O/M work for sewer and 148 personnel for O/M work for WWTP) would be expected in operation stage according to preliminary design of the Study. (Refer to Chapter 7 of Main Report)

Therefore it is evaluated that the impact of the proposed F/S projects will be positive from the regional socioeconomic viewpoints. Moreover, if given the priority to local residents around the construction sites in the employment, it could contribute to the promotion of understandings on the F/S Projects.

(9) Impacts on Public Utilities

Installation work of sewer collector may have some impact to other utilities such as water distribution pipes, gas, telephone and TV cables. To protect and avoid any damage to the public utilities, careful design and review of existing drawings and site survey are required both in the planning and the construction stage.

(10) Dust and Noise

During construction stage, the operation of construction machinery and earthwork may generate dust and noise. It is difficult to avoid such impacts completely, however, can be minimized by appropriate preventive measures, such as:

- Covering stored materials with plastic or other materials.
- Covering materials loaded on trucks.
- Sprinkling exposed areas with water for dust control.
- Minimizing traffic over exposed surfaces.
- Respect working hours.

(11) Water Quality and Public Health Improvement

Comparing to the scenarios with-project versus without-project, F/S projects significantly contribute to the reduction of pollution load as shown in *Table 11*.

Table 11 Comparison of With and Without F/S Projects

Name of Project	Pollution Load Discharged into River							
	BOD (kg/d)		TN (kg/d)		TP (kg/d)		F. coli (10^9/d)	
	W/O	W	W/O	W	W/O	W	W/O	W
Sarapuí and Bangu	26,200	13,900	10,060	8,950	2,570	2,330	695,925.00	257,447.97
Pavuna and Acari	46,200	22,470	12,620	10,490	3,210	2,890	991,590.30	416,172.96

Remarks:
- "W/O" stands for "Without-Project" and "W" stands for "With-Project"
- Pollution Load of BOD: 54 g/capita/d, TN: 10 g/capita/d, TP: 2.5 g/capita/d, F.coli: 10^9 MPN/capita/d,
- Removal Ratio of BOD: 90 %, TN: 25 %, TP: 20 %, F. coli: 90 %
- Source: This EIA Study, based on the estimated population in 2010.

By implementing the F/S projects, it is estimated that:

- 47 % of total BOD load and 63 % of total F. coli load will not be discharged into Rio Sarapuí any more.
- 51 % of total BOD load and 58 % of total F. coli load will not be discharged into Rio Pavuna any more.

Therefore it is judged that the F/S projects can significantly contribute to reduction of organic pollutant or fecal coliform, which will certainly lead to improvement of water quality and public health.

(12) Noise and Odor

During operation stage, the operation of machinery such as blowers and pumps may generate noise and odor. It is difficult to avoid such impacts completely however can be minimized by appropriate preventive measures, such as:

- Appropriate operation and maintenance.
- Regular monitoring.

(13) Sludge Disposal

Sewage sludge is properly dewatered and dried to lead final landfill disposal. Currently, Gramacho Landfill Site is considered as a major candidate for final landfill disposal.

In Rio de Janeiro, sewage sludge is disposed in landfill site as well as municipal solid waste. According to the preliminary design conducted in the Study, daily production of municipal solid waste is estimated as 800 g/capita/day (wet basis), while daily production of sewerage sludge generated from the proposed F/S projects estimated as 45 g/capita/day (dry basis). Considering above estimation, daily production of sewage sludge is estimated to be at most 4 to 5 % of the daily production of municipal solid waste. Therefore it is judged that quantity of sewage sludge will not be significant from the point of view of quantity of waste.

However, data on the quality of sewage sludge is not available. Therefore it is recommended that sewage sludge should be sampled and analyzed for monitoring of heavy metals in regular basis.

Table 12 Summary of Possible Impacts and its Mitigation/Optimization Measures

Possible Impacts	Evaluation	Proposed Mitigating / Optimizing Measures
During Planning / Design Stage		
Resettlement caused by land acquisition	Negligible	-
Disturbance caused by geotechnical survey	Negative but temporary and can be minimized	• Distribution of information leaflets • Arrangement of contact desk for residents
During Construction Stage		
Impacts on fauna and flora	Negative but temporary and can be minimized	• Applying protection measure for trees to minimize cutting • Reuse of cut and removed raw vegetal material • Adequate disposal of vegetal material • Consideration for transplantation of trees or nest
Erosion	Negative but temporary and can be minimized	• Avoid earth movement close to rivers • Applying preventive measures against erosion especially in rainy season
Impacts on traffic	Negative but temporary and can be minimized	• Submission of transport plan for the work by the contractor of civil work • Mutual agreement and coordination with relevant competent department responsible for traffic. • Arrangement of adequate precaution and safety measures • Appropriate repair and reinstatement work
Impacts on health of workmen and residents near construction site	Negative but temporary and can be minimized	• Periodical health examination for labors • Arrangement of contact desk for residents • Conducting opinion inquiry to residents to monitor degree of satisfaction • Preparation of prevention program for possible accident
Impacts on daily life of residents near construction site	Negative but temporary and can be minimized	• Publicize construction schedule to residents, especially for mobilization of heavy-equipment • Education program to maintain discipline of labors in order to avoid confliction with local residents • Arrangement of contact desk for residents • Conducting opinion inquiry to residents to monitor degree of satisfaction
Increase of employment opportunities	Positive	• Collecting information on eligible local labor • Giving priority for employment to the labor living in the nearby communities
Impacts on public utilities	Negative but temporary and can be minimized	• Collecting information on existing public facility • Preparation of repair work plan when/where disturbance of public utilities cannot be avoided
Dust and noise	Negative but temporary and can be minimized	• Sprinkling of water to avoid generation of dust • Respect of work hours • Avoid noise levels above 85 dB close to dwelling according to the guideline stipulated in ABNT, MB-268
During Operation Stage		
Public health improvement	Positive	• Appropriate operation and treatment • Regular Monitoring
Water quality improvement	Positive	• Improvement of current monitoring system
Impacts on traffic	Negligible	-
Increase of employment opportunities	Positive	• Collecting information on eligible local labor • Giving priority for employment to the labor living in the nearby communities
Noise and odor	Negative and continuous but can be minimized	• Appropriate operation and maintenance • Regular Monitoring
Sludge disposal	Negative and continuous but can be minimized	• Appropriate operation and treatment • Regular Monitoring of the quality of sludge

3. CONCLUSION AND RECOMMENDATIONS

Based on the result of the EIA study, the following conclusions can be drawn:

- The F/S projects as a whole have positive impacts:
  - To the water environment and the public health though water quality improvement in the operation stage.
  - To the social environment through increase job opportunities both in the construction and the operation stage.
- Following possible impacts are identified as negative impact during the planning/design stage and the construction stage but they are only temporary and can be minimized by preventive consideration and appropriate countermeasures:
  - Disturbance caused by geotechnical survey
  - Impacts on fauna and flora
  - Erosion
  - Impacts on traffic flow
  - Impacts on health of workmen and residents near construction site
  - Impacts on daily life of residents near construction site
  - Impacts on public utilities
  - Dust and noise
- Following possible impacts are identified as negative and continuous impact but can be minimized by prior consideration and appropriate countermeasures:
  - Noise and odor
  - Sludge disposal
- It is recommended that monitoring system should be established for the following purpose:
  - To evaluate positive impact by the F/S projects quantitatively.
  - To monitor WWTP operation in order to cope with negative continuous impact.