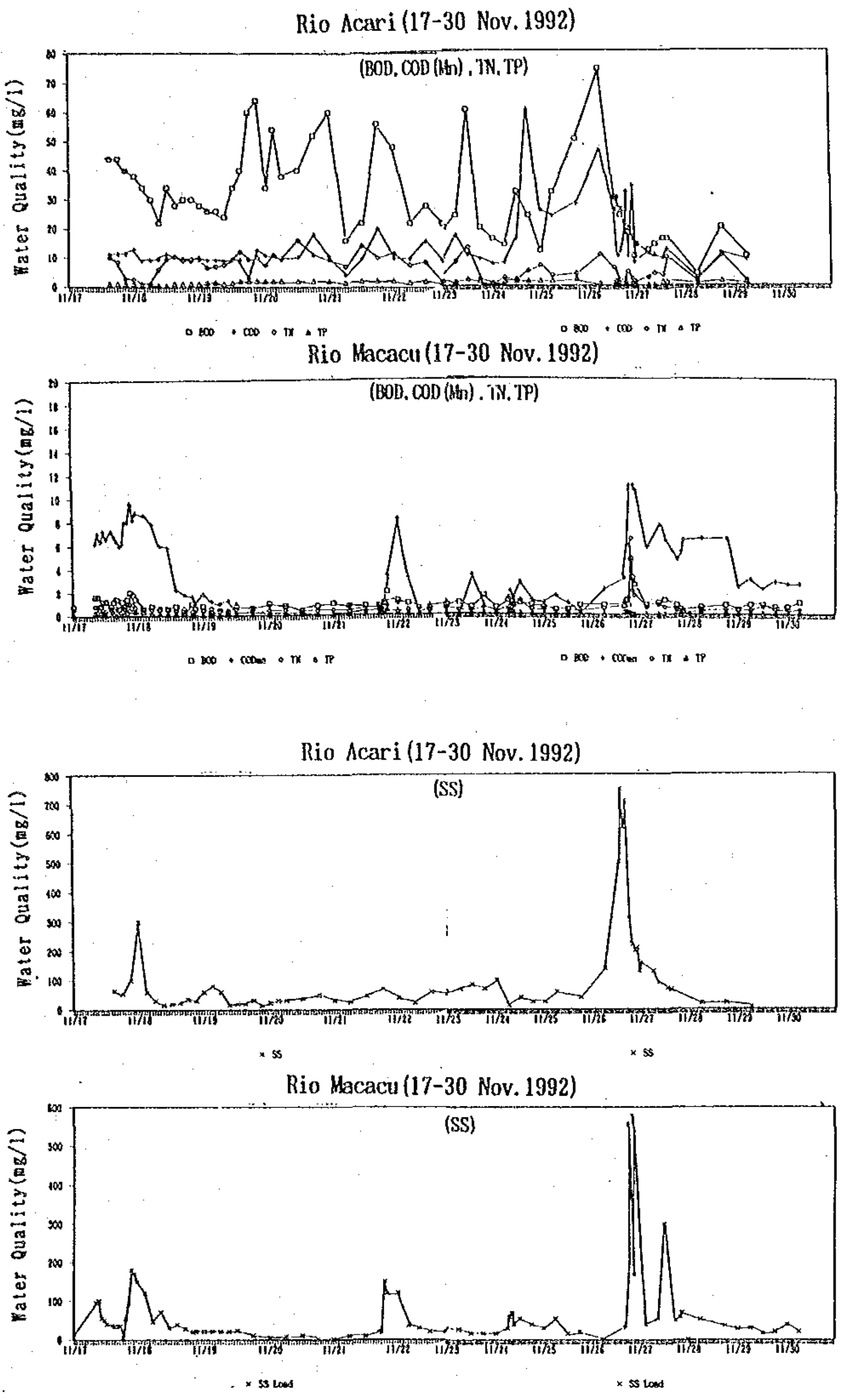


Fig. 2-16 Water Quality Change with Time in the two Model Rivers on Rainy Days

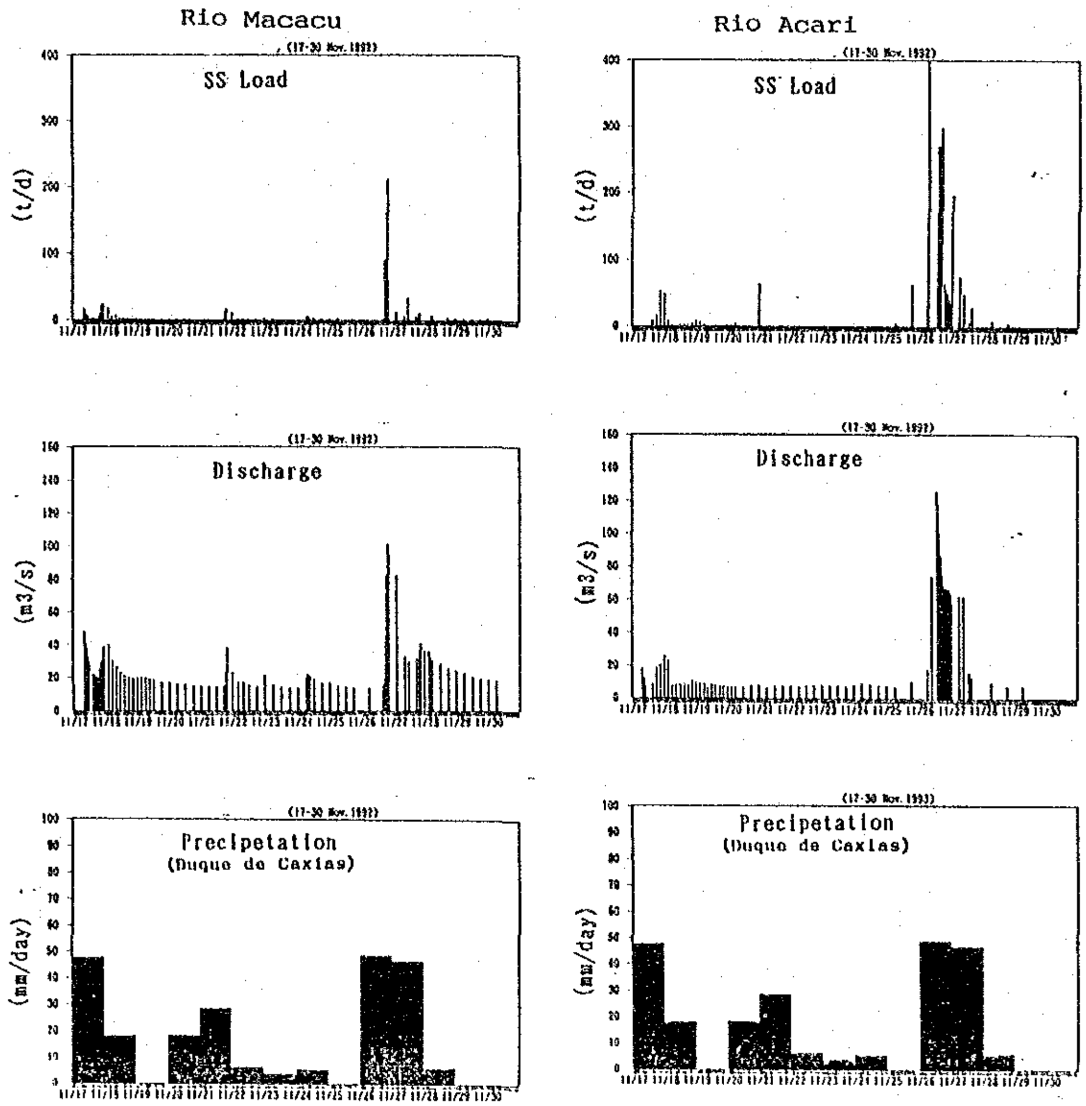


Fig. 2-17(1) Runoff Load Change with Time in the two Model Rivers in Freshet Time

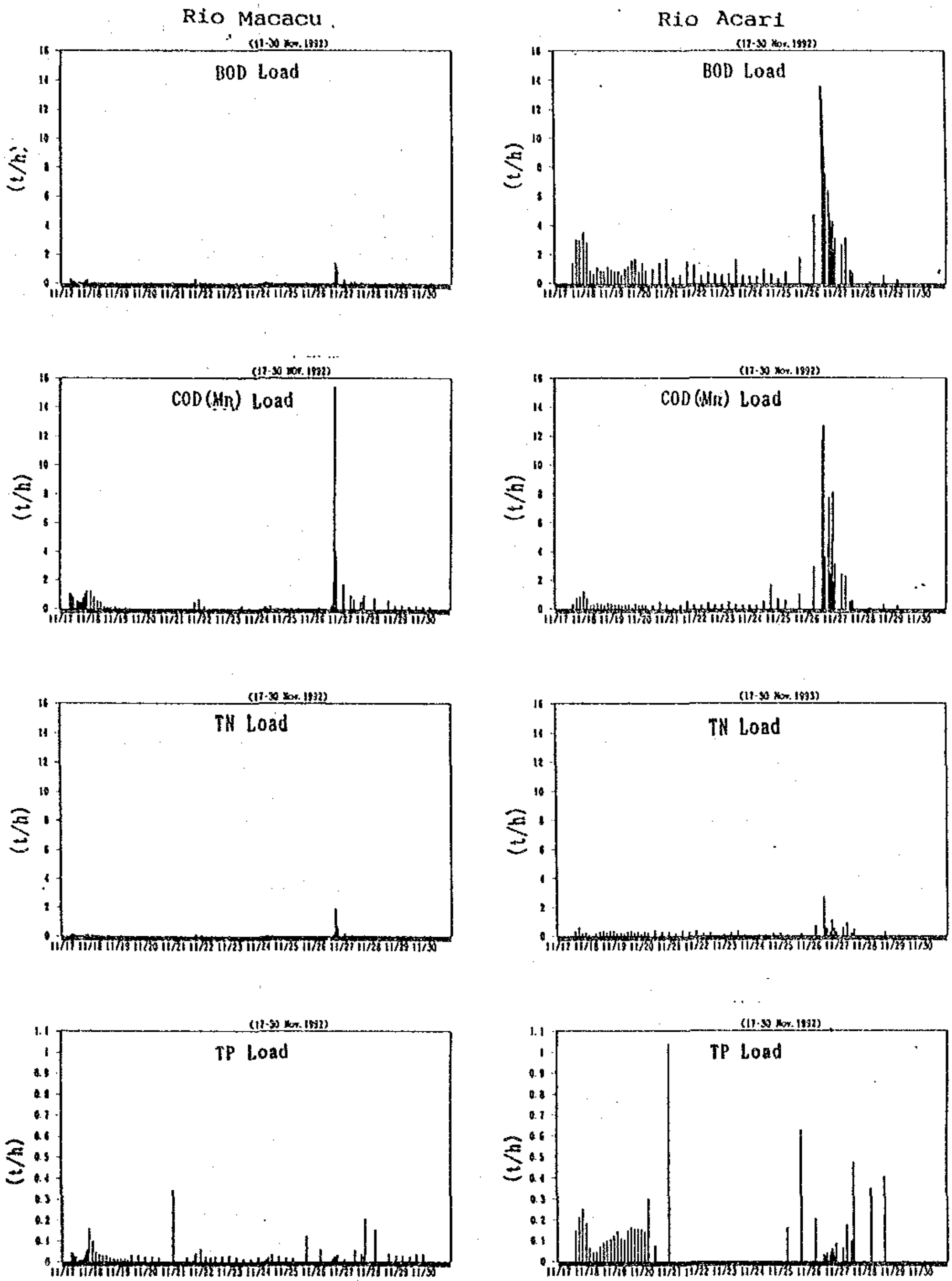
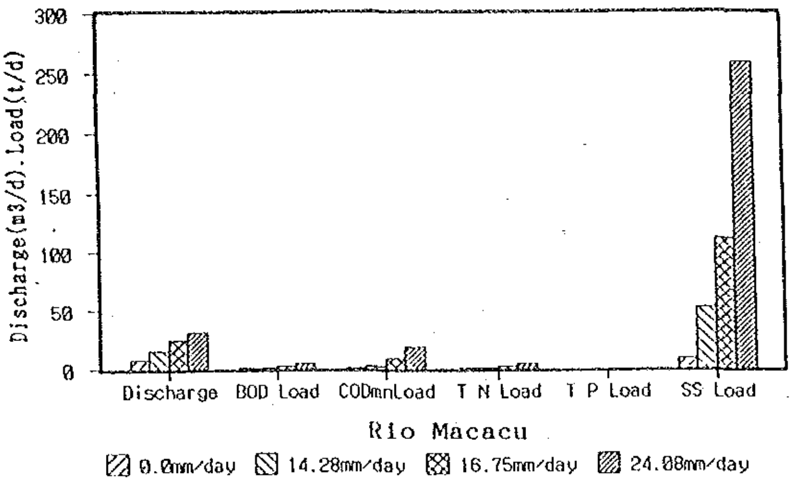


Fig. 2-17(2)Runoff Load Change with Time in the two Model Rivers in Freshet Time



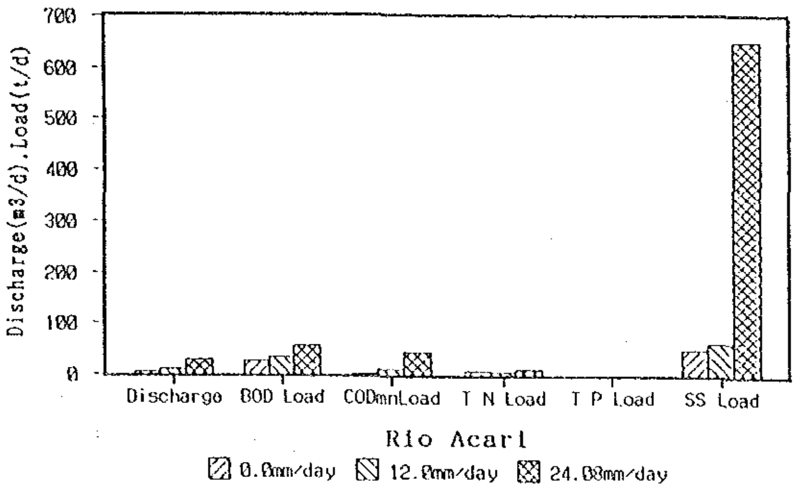


Fig. 2-18 *Runoff Load Differences with Rain Intensity*

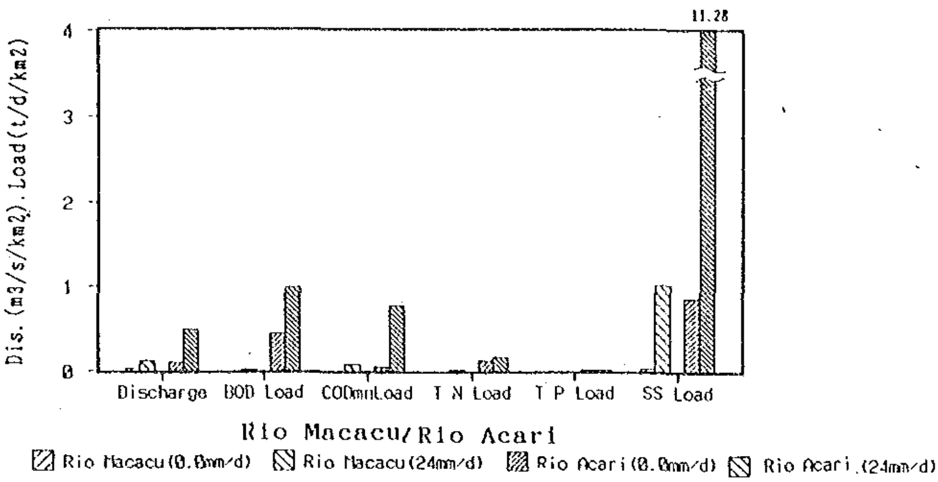


Fig. 2-19 Specific Runoff Load Differences with Rainfall Intensity between the two Model Rivers

CHAPTER 3

ESTIMATE OF RUNOFF LOAD FROM THE BASIN

Chapter 3

Estimate of Runoff Load from the Basin

3.1 Need and Function for Estimation Model of Runoff Load

According to the observation data obtained in this survey, the discharge, water quality and runoff load characteristics of the main rivers in the basin were as described in the previous sections. However, in order to estimate the annual runoff load flowing into the bay from each sub-basin with accuracy, measurements should be carried out repeatedly under different conditions and a lengthy period and tremendous effort is needing in accumulating this data.

Accordingly, a runoff load estimation model including the various factors that restrict runoff load was formulated and designed to serve the following six purposes:

(1) To estimate runoff load on rainy days (in the dry and rainy seasons),

(2) To estimate the runoff discharge and runoff load of tidal rivers,

(3) To estimate the runoff loads from uncovered areas of the observation station,

(4) To estimate the future runoff loads according to changes in population,

(5) To estimate the average runoff load over a long period of time,

(6) To estimate an accurate runoff load with the least effort.

According to the pollution *runoff mechanism* chart (**Fig.3-1**), the generated pollution load from each source, and the runoff ratio estimated from the estimated effluent load and actual river runoff load will be used to estimate the runoff load in other basins. This method is called the generated pollution load method.

However, effluent load in the basin cannot be estimated due to insufficient point and non-point source data which is fundamental to such an estimation.

Accordingly, to estimate effluent load from both point and non-point sources, this report collected the basic data on runoff and water quality of model rivers in small basins, calculated their runoff load and used these as the generated pollution load for effluent loads of the larger basins.

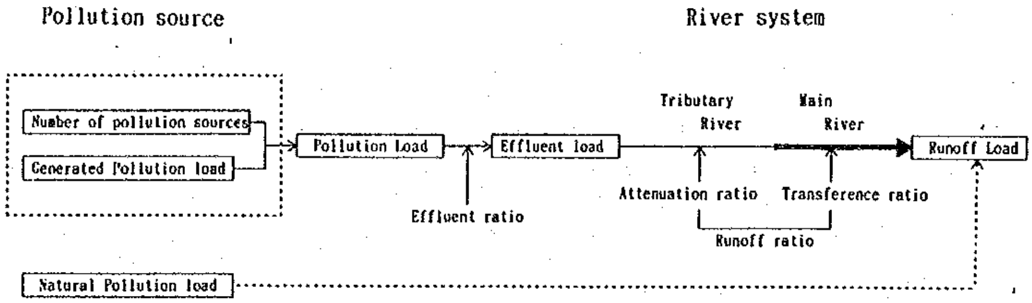


Fig. 3- 1 Pollution Runoff Mechanism

3.2 Structure of the Estimation Model of Runoff Load

(1) Model Concept

The runoff load from the Guanabara Bay basin is known to be influenced by various factors. From the results of studies carried out on the aforementioned items, rainfall conditions, land use conditions, daily human activities, and industrial activities are the main influential factors.

As the population in the basin grows and the effects of human and industrial activities expand, the size of cities increase and land use conditions change. Therefore, land utilization, human and industrial activities are represented by population density.

Accordingly, runoff load was defined as a function of population density (Dp) and precipitation (Pr) in the basin, and the following equation was established:

$$L(\text{Runoff load}) = f(Dp, Pr)$$

(2) Estimation Model for Runoff Discharge

The estimation model comprises the runoff discharge model and runoff load model. The elements of each model and their relationship are represented as follows:

Runoff discharge (Q) = base runoff discharge (Qb) +
attained runoff volume of wastewater (Qw)
+ precipitation runoff discharge (Qp)

Runoff load (L) = runoff discharge (Q) x water quality (C) x
runoff ratio (R) **(Fig.3-2)**

Runoff discharge on clear days is the value observed when the preceding period of clear days is five days or more. On the other hand, runoff discharge on rainy days is the value observed in other cases.

Runoff discharge on clear days (Qc) = Qb + Qw
Runoff discharge on rainy days (Qr) = Qb + Qw + Qp
(Fig.3-3 and 3-4)

The basic runoff load in the rainy season is larger than that in the dry season because of rainfall. Therefore, calculations of runoff load should be carried out separately for the dry season and rainy season, using different basic runoff discharge values.

The descriptions of each element are as follows:

(1) Base runoff discharge (Qb)

A base runoff discharge is the constant discharge amount mainly originating from underground water. The base runoff discharge in the natural type river, Rio Macacu, was the lowest flow measured on consecutive clear days.

(2) Attained runoff volume of Waste water (Qw)

Attained runoff volume of waste water is defined, for convenience, as the wastewater amount from every point source reaching the observation stations. It is obtained by subtracting the basic runoff discharge amount (Qb) from the runoff discharge amount (Qc) on clear days.

In future, if the data given below has been obtained, the following equation can used to calculate attained runoff volume of wastewater (Qw):

$$Qw = qi * a1 + qd * a2 + qt * a3 + ql * a4 + qe * a5$$

qi: Runoff volume of wastewater per day from factories (If data is available from the factories, the value is used. In other cases, the calculation uses wastewater volume classified for industries.

qd: Runoff volume of domestic wastewater in areas without sewage works
(population in areas without sewage works x discharge load per unit activity of source)

qt: Runoff volume of treated water discharge from existing sewage treatment plants
(Calculated from measured values. Future values are estimated according to proposed sewage works.)

ql: Runoff volume of discharge by livestock (number of domestic animals per basin x generated pollution load per unit activity of source)

qe: Other runoff volume, that is, attained runoff volume of waste water = runoff volume from each source x runoff ratio (a1-5)

(3) Precipitation discharge amount (Qp)

The precipitation runoff discharge is the rain-affected amount of water discharged. It is precisely defined as the sum of the runoff discharge measured from the point where discharge increases after rainfall until the point where the runoff discharge returns to the normal level on a clear day. For convenience, the runoff discharge amount when the mean precipitation intensity exceeded 10mm/day was used.

The precipitation runoff discharge varies depending on the scale of rainfall, rainfall intensity, basin characteristics and number of preceding clear days; in actual estimation, relation of these elements to precipitation runoff discharge should be thoroughly analyzed.

In this survey, rainfall amount and the runoff discharges of the two model rivers (natural type and urban type) were used to analyze the relationship between rainfall intensity and precipitation runoff discharge. Precipitation intensity was classified by a notch of 10mm. Runoff discharge largely varies depending on rainfall intensity even if the volumes precipitated are the same. This factor was not represented in this model.

Runoff discharge differs as precipitation varies by area. Originally, the precipitation amount to be used for the model should be the amounts measured at several stations in consideration of rainfall distribution. However, such data was not obtained. The study was, therefore, left with no choice but to use the precipitation data obtained at only one observation station in Duque de Caxias, namely Petrobas, to estimate the precipitation runoff load.

(4) Estimation Model for Runoff Load

Runoff load is represented by the following equation:

Runoff load (L) = base runoff load (Lb) + attained runoff load of waste water (Lw) + precipitation runoff load (Lp)

(a) Base runoff load (Lb) = load derived from said base runoff discharge

(b) Attained runoff load of waste water (Lw) = Runoff load in clear days minus base runoff load; this value is equivalent to point source runoff load on clear days.

(c) Precipitation runoff load (Lp) = surface runoff load according to rainfall, precipitation runoff load when rainfall intensity is 10mm/day or more.

Runoff load is obtained by using the empirical equation to represent relation between runoff discharge and runoff load. Runoff load varies to a great extent depending on the number of preceding clear days and rainfall intensity. This factor is not represented in this model because of deficiencies in the data.

(d) Runoff ratio

The process of the pollutants being discharged from their source and flowing into a river is defined as attenuation, the linear process of flowing downstream as transference, and the whole flow process from the source to the observation station as runoff.

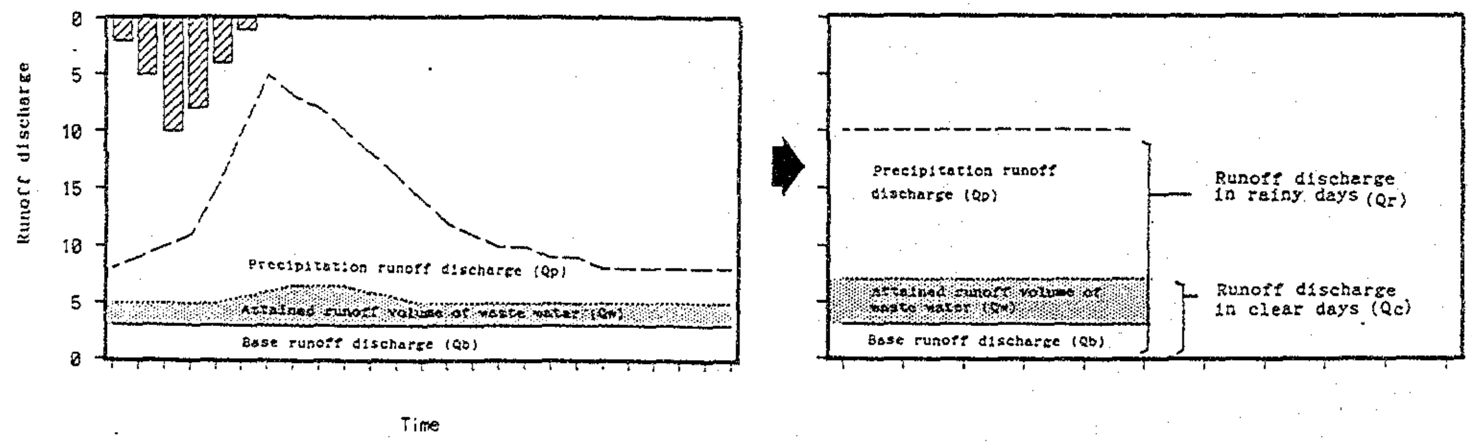


Fig. 3- 2 Schematic Hydrograph and Constitution of Discharge

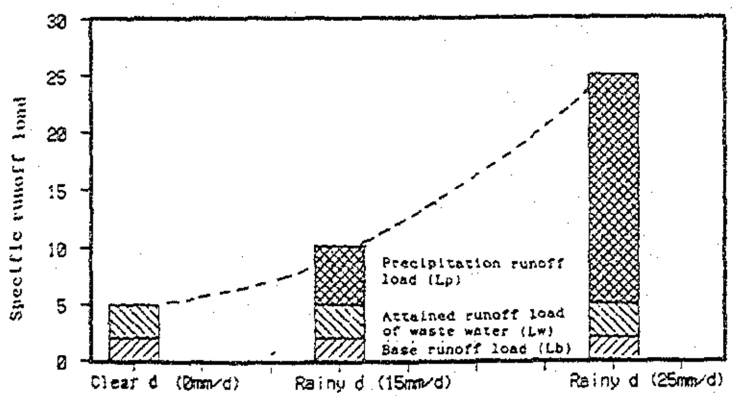


Fig. 3- 3 Runoff Load Differences between Clear Days and Rainy Days

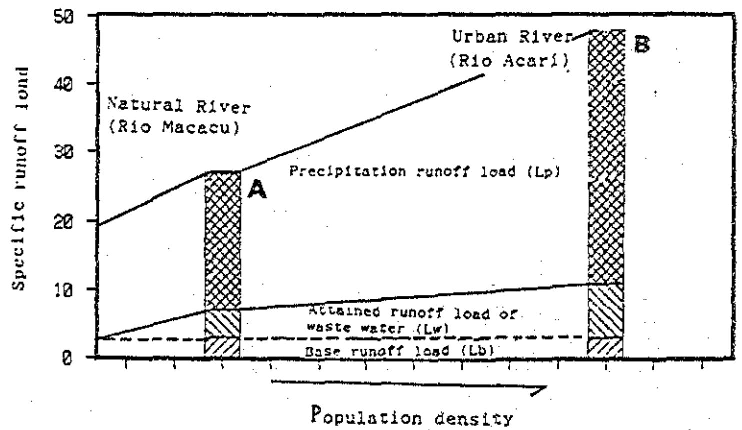


Fig. 3- 4 Runoff Load Constitution of Natural Type and Urban Type Rivers

Thus runoff ratio is the product of the attenuation ratio and transference ratio. Runoff ratio is the ratio of pollution load that reaches a reference point to all the total pollution load discharged in the basin.

Runoff ratio is influenced by the size of the basin, river bed conditions, runoff time and discharge. Of these, discharge most controls the runoff ratio thus influencing the ratio largely between clear days and rainy days. Survey results in Japan report that BOD runoff ratio is directly proportional to population density/(basin area)$^{1/2}$.

Here the relationship between the two is obtained assuming X=log(runoff ratio, %) and Y=log (population density/(basin acreage)$^{1/2}$) to calculate the discharge and runoff rate of BOD and COD(Mn). T-N, T-P and SS are assumed to be as soluble and runoff ratio is calculated by using the same equation as that for discharge.

Runoff ratio is calculated by using the observation data of a group of rivers. Runoff ratio is shown in **Fig.3-5**.

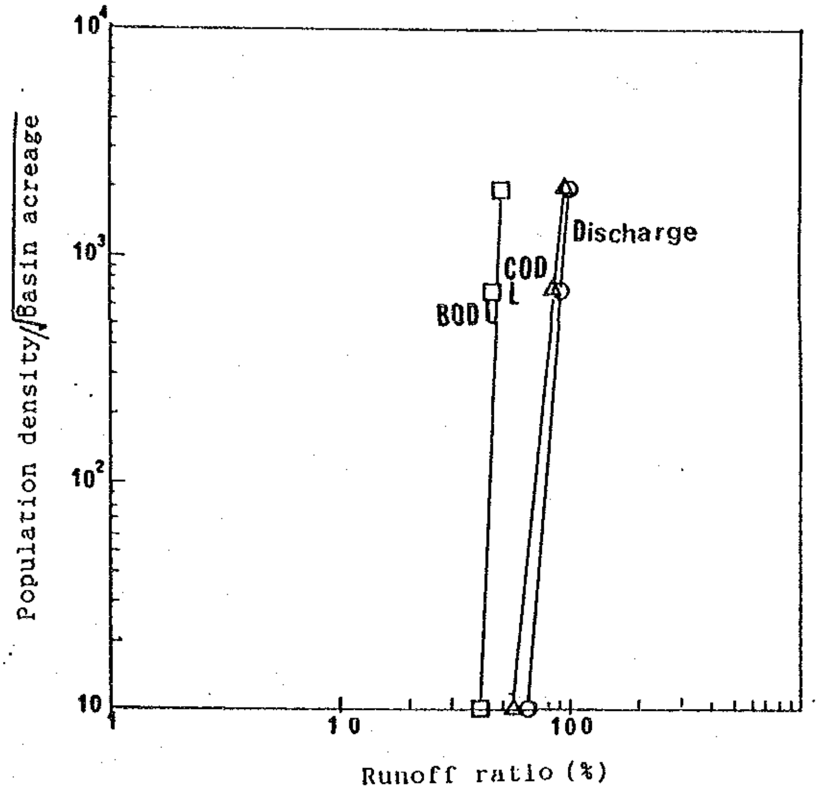


Fig. 3- 5 Relationship between Runoff Ratio and Population Density/Basin Area

3.3 Procedure for Calculation of Runoff Discharge and Runoff Load

The annual runoff load was calculated in accordance with the operation flow chart (**Fig.3-6**).

Annual runoff load = runoff load on clear days + runoff load on rainy days
= runoff load in the dry season + runoff load in the rainy season.

The specific runoff volume and specific runoff load have a linear relation on log-log diagram for suspension solids, abundant at the initial stages of rainfall.

Therefore the runoff load; for water quality parameters with high runoff ratios in the initial stages (e.g., BOD, COD,TN,TP and SS) and are discharged as suspended solids, were calculated using the regression model.

Further, the specific load of each river was determined using population density; which strongly correlates to basin land utilization and generation load-factors that largely influence specific load; as a parameter.

Runoff load on clear and rainy days was calculated using the Separation Method 1, shown in **Fig.3-7**.

Assumptions for the calculation of runoff load on clear days and runoff load on rainy days, to be carried out separately, are described below.

(1) Runoff load on clear days = base runoff load + attained runoff load
Base runoff load (discharge) = minimum value over 24-hour continuous observation (runoff load)

(2) *Calculation of the runoff ratio on clear days (re)*
Runoff ratio = runoff load (measured value)/effluent load(estimated value)
Runoff ratio of each basin was calculated from population density, basin area and the measured runoff ratio of the model rivers.

Runoff ratio on rainy days was obtained from the precipitation per day and specific runoff discharge per day.

(3) Runoff load per day on clear days = specific runoff load x basin area.

(4) Calculation of rainy days by rainfall scales
Annual precipitation is arranged as precipitation per one continuous rainfall and classified in scales of 10mm to calculate rainy days by months.

(5) Calculation of specific runoff load of each basin by rainfall graphs.
Rainfall exceeding 10mm is classified into scales of 10mm. The runoff load for the mean precipitation of rainfall scales was obtained using the regression model; then the value was multiplied by the number of rainfalls (number of rainy days) in order to calculate the runoff load of each rainfall scale.

(6) Calculation of specific runoff load of each basin on rainy days

(7) Runoff load per day on rainy days = specific runoff load per day x basin area.

(8) Runoff load per month = runoff load on rainy days in each month + runoff load on clear days in each by month

(9) Annual runoff load = runoff load in the dry season + runoff load in the rainy season

(10) Runoff loads of unsurveyed areas, downstream of observation stations, were calculated for each basin assuming that the basins are homogeneous.

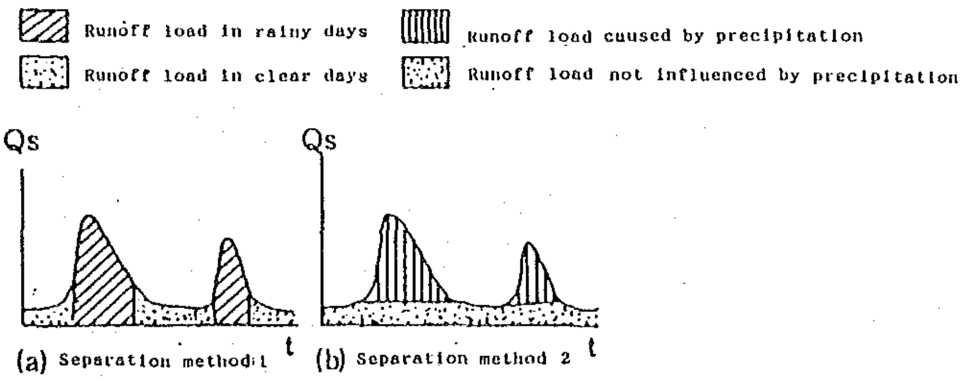


Fig. 3- 7 Concept of Separation Methods

Estimation Model of Runoff Load

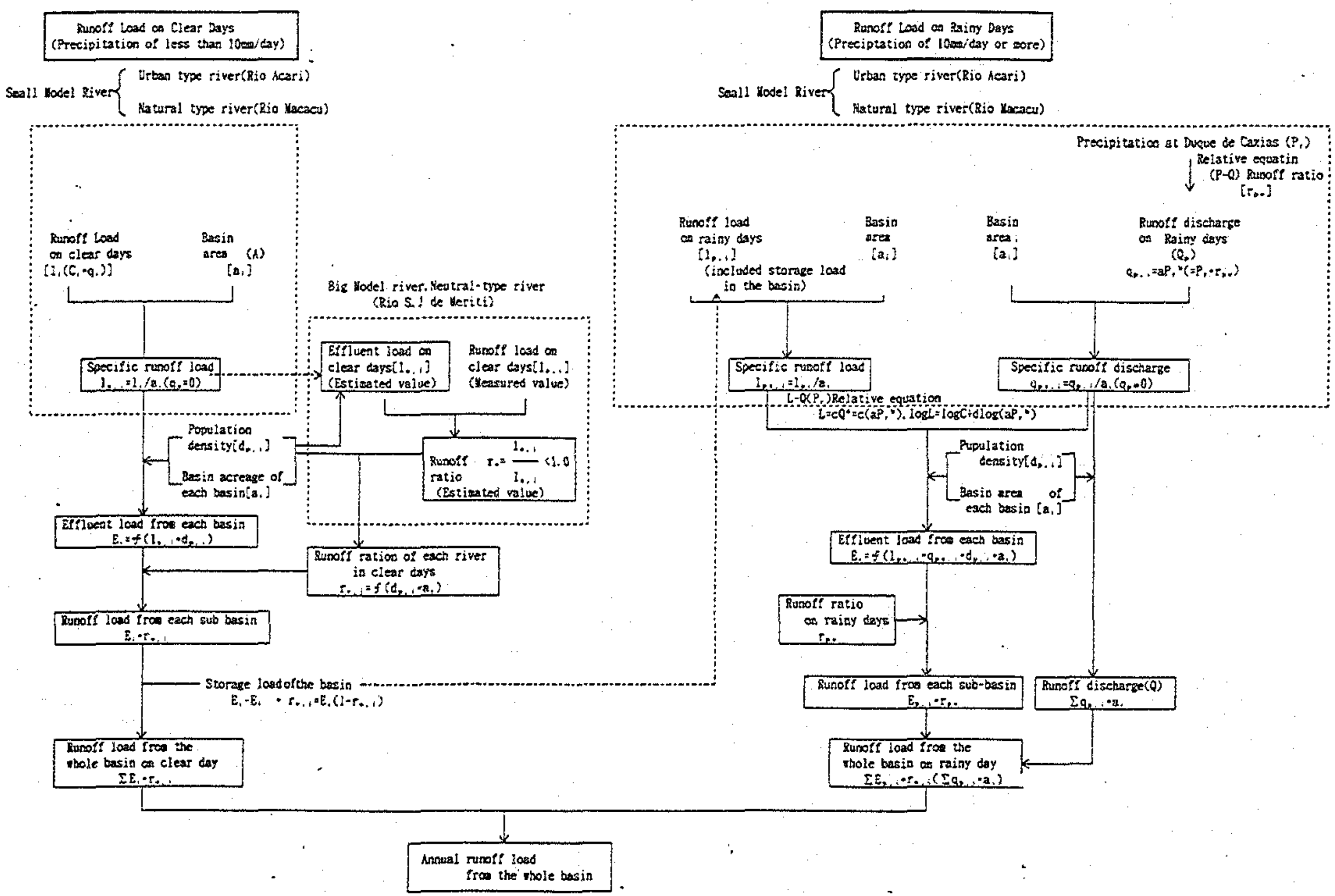


Fig. 3- 6 Procedure for Calculation of Annual Runoff Load

Here each element is defined as follows:

- Runoff load on clear days: Runoff load when precipitation per day is less than 10mm, or mean precipitation per day during the runoff period (one rainfall divided by runoff days) is less than 10mm even if precipitation per day is 10mm or more.
- Runoff load on rainy days: Runoff load when precipitation per day during the runoff period is 10mm or more.
- Number of rainy runoff days: Number of runoff days corresponding to one rainfall.
- Number of clear runoff days: Number of days per year - number of rainy runoff days.
- Dry season: Period when precipitation is relatively small in a year. April to September for 1992.
- Rainy season: Period when precipitation is relatively large in a year. October to March for 1992.

3.4 Setting of Parameters

(1) Runoff ratio (re)

The relationship between runoff ratio on clear days (X) and population density/(basin acreage)$^{1/2}$ (Y) can be calculated using the following equation: Y = a*X^b (see **Fig.3-5**). Runoff ratio on rainy days is assumed to be 1.0, because it is included in the relationship between precipitation and runoff discharge.

Indicator	Equation	Coefficient of correlation
Discharge (TN, TP, SS)	$Y=3.382*X^{14.73}$	0.995
BOD	$Y=4*10^9*X^{29.79}$	0.999
CDD (Mn)	$Y=5.70*X^{11.97}$	0.995

(2) Runoff discharge (mean discharge)(Q)

The relationship between discharge (Q) and precipitation (mean precipitation (Pr)) in the model rivers can be obtained using the following equation:

$$Q = aPr^b$$

River Name	Equation	Coefficient of correlation
Rio Macacu	$Q=0.00106R^{1.525}$	0.967
Rio Acari	$Q=0.00279R^{1.626}$	0.991

(3) Runoff load (L)

The relationship between runoff discharge (Q) and runoff load(L) can be determined through the following equation:

Empirical equation: $L = cQ^{d}$

Therefore,

$$\log L = \log c + d * \log(aPr^{b})$$

Indicator	Equation	Coefficient of correlation	Equation	Coefficient of correlation
BOD Load	$L= 0.045Q^{0.599}$	0.832	$L= 1.463Q^{0.640}$	1.000
COD(Mn) Load	$L= 10.998Q^{2.447}$	0.975	$L= 3.170Q^{1.847}$	0.993
TN Load	$L= 0.328Q^{1.497}$	0.986	$L= 0.192Q^{0.266}$	0.861
TP Load	$L= 0.040Q^{1.632}$	0.934	$L= 0.011Q^{-0.293}$	0.996
SS Load	$L=190.957Q^{2.506}$	0.997	$L=37.200Q^{1.811}$	0.969

* $L: t/d/km^2$, $Q: m^3/s/km^2$

(4) specific discharge (Qs) and specific runoff load (Ls) by Population Density (D)

The relationship between population density (Dp) and specific runoff load (L) can be obtained using the following equations:

$$Ls\ (Qs) = e * Dp + f$$

Dp : population density ($people/km^2$)
e,f: coefficients
Mean rainfall in runoff period; <10mm/day, 10-20mm/day, 20-30mm/day, 30-40mm/day

Established precipitation : 0mm/day, 15mm/day, 25mm/day, 35mm/day

Indicator	Precipitation	Instituted Precipitation	Dry Season	Rainy Season
Discharge	0-10mm/day	<10mm/day	Qs=0.0105D+0.0251	Qs=0.0101D+0.0305
	10-20mm/day	15mm/day	Qs=0.0243D+0.0444	Qs=0.0239D+0.0471
	20-30mm/day	25mm/day	Qs=0.0584D+0.0817	Qs=0.0580D+0.0845
	30-40mm/day	35mm/day	Qs=0.1027D+0.1278	Qs=0.1023D+0.1306
BOD Load	0-10mm/day	<10mm/day	Ls=0.0641D+0.0022	Ls=0.0582D+0.0035
	10-20mm/day	15mm/day	Ls=0.0865D+0.0035	Ls=0.0865D+0.0040
	20-30mm/day	25mm/day	Ls=0.1357D+0.0044	Ls=0.1356D+0.0049
	30-40mm/day	35mm/day	Ls=0.1824D+0.0052	Ls=0.1823D+0.0057
COD(Mn) Load	0-10mm/day	<10mm/day	Ls=0.0072D+0.0012	Ls=0.0057D+0.0026
	10-20mm/day	15mm/day	Ls=0.0264D+0.0066	Ls=0.0264D+0.0073
	20-30mm/day	25mm/day	Ls=0.1209D+0.0432	Ls=0.1209D+0.0432
	30-40mm/day	35mm/day	Ls=0.3275D+0.1537	Ls=0.3274D+0.1543
TN Load	0-10mm/day	<10mm/day	Ls=0.0123D+0.0010	Ls=0.0152D+0.0010
	10-20mm/day	15mm/day	Ls=0.0167D+0.0028	Ls=0.0167D+0.0028
	20-30mm/day	25mm/day	Ls=0.0202D+0.0088	Ls=0.0202D+0.0088
	30-40mm/day	35mm/day	Ls=0.0222D+0.0190	Ls=0.0222D+0.0190
TP Load	0-10mm/day	<10mm/day	Ls=0.0036D+0.0000	Ls=0.0026D+0.0000
	10-20mm/day	15mm/day	Ls=0.0021D+0.0002	Ls=0.0021D+0.0002
	20-30mm/day	25mm/day	Ls=0.0016D+0.0008	Ls=0.0016D+0.0008
	30-40mm/day	35mm/day	Ls=0.0012D+0.0019	Ls0.0012D+0.0019
SS Load	0-10mm/day	<10mm/day	Ls=0.0470D+0.0251	Ls=0.1107D+0.0231
	10-20mm/day	15mm/day	Ls=0.3241D+0.1026	Ls=0.3242D+0.1020
	20-30mm/day	25mm/day	Ls=1.4298D+0.6874	Ls=1.4298D+0.6868
	30-40mm/day	35mm/day	Ls=3.7660D+2.5073	Ls=3.7661D+2.5067

(5) Specific runoff load (Ls)

(a) Base runoff (Qb) and base load (Lb)
Base runoff and base load were obtained from the data (minimum runoff discharge) of the 24-hour observation conducted on the natural type river, Rio Macacu.

Discharge ($m^3/s/km^2$)	BOD Load ($t/d/km^2$)	COD(Mn) Load ($t/d/km^2$)	TN Load ($t/d/km^2$)	TP Load ($t/d/km^2$)	SS Load ($t/d/km^2$)
0.031	0.005	0.002	0.001	0.000	0.020

(b) Specific runoff discharge per day (Qs) and specific runoff load per day (Ls) on clear days
Specific runoff discharge per day and specific runoff load per day were obtained from the data of the 24-hour observation conducted in Rio Macacu and Rio Acari on clear days.

River Name	Discharge ($m^3/s/km^2$)	BOD Load ($t/d/km^2$)	COD(Mn) Load $t/d/km^2$)	TN Load ($t/d/km^2$)	TP Load ($t/d/km^2$)	SS Load ($t/d/km^2$)
Rio Macacu	0.032	0.006	0.003	0.002	0.000	0.034
Rio Acari	0.108	0.444	0.046	0.116	0.020	0.861

(c) Runoff discharge (Qp) and runoff load (Pr) on rainy days
The runoff discharge and runoff amount on rainy days were obtained from the data of the observations conducted on the two model rivers, on rainy days.

Natural type river (Rio Macacu)

Precipitation (mm/day)	Discharge ($m^3/s/km^2$)	BOD Load ($t/d/km^2$)	COD(Mn) Load ($t/d/km^2$)	TN Load ($t/d/km^2$)	TP Load ($t/d/km^2$)	SS Load ($t/d/km^2$)
14.28	0.063	0.005	0.008	0.005	0.0005	0.203
16.75	0.094	0.008	0.035	0.008	0.001	0.432
24.08	0.119	0.016	0.074	0.016	0.001	1.014

Urban type river (Rio Acari)

Precipitation mm/day	Discharge ($m^3/s/km^2$)	BOD Load ($t/d/km^2$)	COD(Mn) Load ($t/d/km^2$)	TN Load ($t/d/km^2$)	TP Load ($t/d/km^2$)	SS Load ($t/d/km_2$)
12.00	0.177	0.567	0.157	0.106	0.018	1.089
24.08	0.481	0.990	0.772	0.165	0.013	11.264

(6) Precipitation (Pr) (Data obtained from the Petrobras observation station at Duque de Caxias, 1992)

Mean precipitation in the runoff period was classified by rainfall scales, and number of rainy days by rainfall scales was obtained (see **Table 3-1**).

(7) Basin area (A) and Population density (D)

Basin area covered by observation stations, uncovered area, whole basin area and population density are shown in **Table 3-2** and **3-3**.

Table 3- 1 Rainy Days during the Survey Period by Rainfall Scales (1992)

	Rainy season			Dry season						Rainy season		
Precipetation	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
<10mm/d	19	26	27	27	29	30	29	30	28	23	15	28
10-20mm/d	4	0	3	0	2	0	2	0	0	5	5	0
20-30mm/d	8	3	1	3	0	0	0	0	0	3	7	3
30mm< /d	0	0	0	0	0	0	0	0	3	0	3	0
	31	29	31	30	31	30	31	30	31	31	30	31

Table 3- 2 Details of Basin Areas of the 25 Major Rivers Surveyed

NO	NAME	Basin Area NO.	Basin Area (A)=(B)+(C) (A)km2	Covered Basin Area (B)km2	Uncovered Basin Area (C)km2	Population of Basin Area	Population Density (*10^3/km2)
1 C1780	CANAL CANTO DO RIO	2	7.40	7.40	0.00	41,745	5.64
2 BM760	RIO BOMBA	5	26.20	3.40	22.80	183,099	6.99
3 IB810	RIO IMBOASSU	6	30.80	11.60	19.20	138,636	4.50
4 AN740	RIO ALCANTARA	8	144.60	58.50	68.80	470,420	3.25
5 MT820	RIO MUTONDO	8		5.50			
6 GX720	RIO GUAXINDIBA	8		11.80			
7 CC622	RIO CACEREBU	9	846.70	758.40	88.30	336,193	0.40
8 GP600	RIO GUAPIMIRIM	10	1253.10	1233.70	19.40	69,853	0.06
*9 MC967	RIO MACACU	10-3	256.00	256.00	0.00	18,577	0.07
*10 SB998	RIO SOBERBO	10-6	132.40	45.20	87.20	17,911	0.14
11 MG580	CANAL DE MAGE	11	18.30	4.60	13.70	8,458	0.46
12 RN560	RIO RONCADOR	12	111.40	107.00	4.40	36,370	0.33
13 IR540	RIO IRIRI	13	27.80	8.40	19.40	10,684	0.38
14 SR500	RIO SURUI	14	68.80	53.20	15.60	12,910	0.19
15 ES400	RIO ESTRELA	16	342.50	342.50	0.00	302,495	0.88
*16 IN460	RIO INHOMIRIN	16-2	139.00	139.00	0.00	84,106	0.61
*17 SC420	RIO SARACURUNA	16-3	186.00	186.00	0.00	194,173	1.04
18 IA260	RIO ICUACU	17-1~5	562.80	544.20	18.60	758,010	1.35
19 SP300	RIO SARAPUI	17-6	165.50	159.80	5.70	1,012,275	6.12
20 SJ220	RIO S.J.DE MERITI	19	164.50	163.50	1.00	1,492,458	9.07
*21 AC241	RIO ACARI	19-2	57.90	57.90	0.00	438,076	7.57
22 IJ200	RIO IRAJA	20	35.70	27.30	8.40	500,276	14.01
23 PN180	CANAL DO PENHA	20	-	-	0.00		
24 CN100	CANAL DO CUNHA	21	63.60	60.50	3.10	815,389	12.82
25 MN000	CANAL DO MANGUE	23	42.80	42.80	0.00	500,876	11.70
	TOTAL		3912.50	3604.10	308.40	6,690,147	1,709.94

*:Tributary river (Excluded from Total amount)

Table 3- 3 Area, Population and Population Density by Sub-Basin

Name	Basin Area NO.	Basin Area (A)=(B)+(C) (A)km2	Covered Basin Area (B)km2	Uncovered Basin Area (C)km2	Covered Ratio(%) (B/A*100)	Population	Population Density (*10^3/km2)
B.-CHARITAS	1	9.40	0.00	9.40	0	53,310	5.67
CANAL CANTO DO RIO	2	7.40	7.40	0.00	100	41,745	5.64
B.-CATEDRAR	3	7.80	0.00	7.80	0	37,458	4.80
B.-NORTE CENTRO	4	7.90	0.00	7.90	0	43,607	5.52
RIO BOMBA	5	26.20	3.40	22.80	13	183,099	6.99
RIO IMBOASSU	6	30.80	11.60	19.20	38	138,636	4.50
B.-ITAOCA	7	6.40	0.00	6.40	0	31,925	4.99
RIO ALCANTARA	8	144.60	75.80	68.80	52	470,420	3.25
RIO CACEREBU	9	846.70	758.40	88.30	90	336,193	0.40
RIO GUAPIMIRIM	10	1253.10	1233.70	19.40	98	69,853	0.06
CANAL DE MAGE	11	18.30	4.60	13.70	25	8,458	0.46
RIO RONCADOR	12	111.40	107.00	4.40	96	36,370	0.33
RIO IRIRI	13	27.80	8.40	19.40	30	10,684	0.38
RIO SURUI	14	68.80	53.20	15.60	77	12,910	0.19
B.-MAUA	15	28.90	0.00	28.90	0	8,541	0.30
RIO ESTRELA	16	342.50	342.50	0.00	100	302,495	0.88
RIO IGUACU	17-1~5	562.80	544.20	18.60	97	758,010	1.35
RIO SARAPUI	17-6	165.50	159.80	5.70	97	1,012,275	6.12
B.-CABO DO BRITO	18	27.00	0.00	27.00	0	132,091	4.89
RIO S.J.DE MERITI	19	164.50	163.50	1.00	99	1,492,458	9.07
RIO IRAJA	20	35.70	27.30	8.40	76	500,276	14.01
CANAL DO CUNHA	21	63.60	60.50	3.10	95	815,389	12.82
B.-S.CRISTOVAO	22	6.60	0.00	6.60	0	60,011	9.09
CANAL DO MANGUE	23	42.80	42.80	0.00	100	500,876	11.70
B.-BOTAFOGO	24	26.00	0.00	26.00	0	358,622	13.79
I. DO GAVANADOR	25	38.20	0.00	38.20	0	153,903	4.03
I. DO FUNDAO	26	5.40	0.00	5.40	0	5,277	0.98
I. DE PAQUETA	27	1.70	0.00	1.70	0	3,254	1.91
I. DO ENGENHO	28	1.30	0.00	1.30	0	11,034	8.49
I. DE S.CRUZ	29	1.40	0.00	1.40	0	4,851	3.47
	Total	4080.50	3604.10	476.40	88	7,594,031	

3.5 Calculation Results and its Validation

(1) Calculation results

The total runoff load of the 20 largest rivers (basin area covered: 3,604.1 km^2), determined using the parameters defined in 3.4 and following the steps described in **Fig.3-6**, is shown in **Fig. 3-8** and **Table 3-4**. The calculation was based on the precipitation data in 1992 and the population data in 1991. **Fig.3-9** and **Table 3-5** show the annual runoff loads on clear days and rainy days and in the rainy and dry seasons, and also the runoff load not influenced by precipitation and runoff load caused by precipitation.

The daily mean discharge of the 20 rivers directly flowing into the bay was estimated at 190.2 m^3/s, with a BOD load of 258.5 tons/day and a TN load of 91.9 tons/day.

40 to 50% of the annual discharge and BOD load, and 20% of the annual TN load were estimated to runoff from the basin during the rainy season (55 days in a year).

The runoff load ratio on rainy days was calculated based on the results of observations conducted after a short spell of rainfall of comparatively light intensity, hence, this ratio may be smaller than actuality. Yet the ratio of the runoff load in the rainy season to the annual load is significantly large.

By the way, the importance of the runoff load on rainy days was only recognized in Japan from the 1980s (the survey results are shown in **Table 3-6**).

(2) Comparison of the estimate value and measured value

Fig.3-10 compares of the estimate values and measured values. As far as this figure is concerned, the model used here closely reflects the measured values and the transition tendencies of the values. Accordingly, this model is effective in predicting runoff load from the basin.

(3) Estimation of runoff load from the entire basin area including uncovered basin area

Runoff loads for the rainy/dry season and annual runoff load in

1992 calculated by the estimation model are shown in **Table 3-7.**

(a) Annual runoff load

The mean runoff discharge per day from the entire basin (basin area covered: 4,080.5 km^2) was estimated at 230.2 m^3/s, and the BOD and TN loads in the runoff load are 330.6 tons/day and 116.2 tons/day respectively. **Fig.3-11** shows the contribution ratio of each basin for various water quality items. BOD was observed to have been largely contributed by the Rio S.J.de Meriti (16.1%), Rio Sarapui (10.8%), Canal do Cunha (9.0%) and Rio Iguacu (7.8%). The runoff discharge and runoff load of each sub-basin are shown in **Fig.3-12.** (see **Appendix IX**)

(b) Runoff load during rainy and dry seasons

The ratio of the runoff loads in the rainy season and the dry season is of 6:4 in terms of BOD and TN. Yet, as aforementioned, the runoff discharge and runoff load during the rainy season; *calculated based on the data from observations that were conducted* (1) during a rainfall cycle preceded by a short period of clear days, (2) a light rainfall intensity of 25mm/day and (3) with a serious mistake of missing the measurement of the first flush; are likely to be smaller than the actual values.

On these grounds, the ratio of the rainy and dry seasons was revised to 7:3 in 1992.

TP load in the rainy and dry seasons had a ratio of 4:6, contrary to the other items, supposedly because data on water quality used in the calculation was obtained in the second rainfall observation, and the inorganic phosphorus concentration was not obtained as it was not detected during the first rainfall.

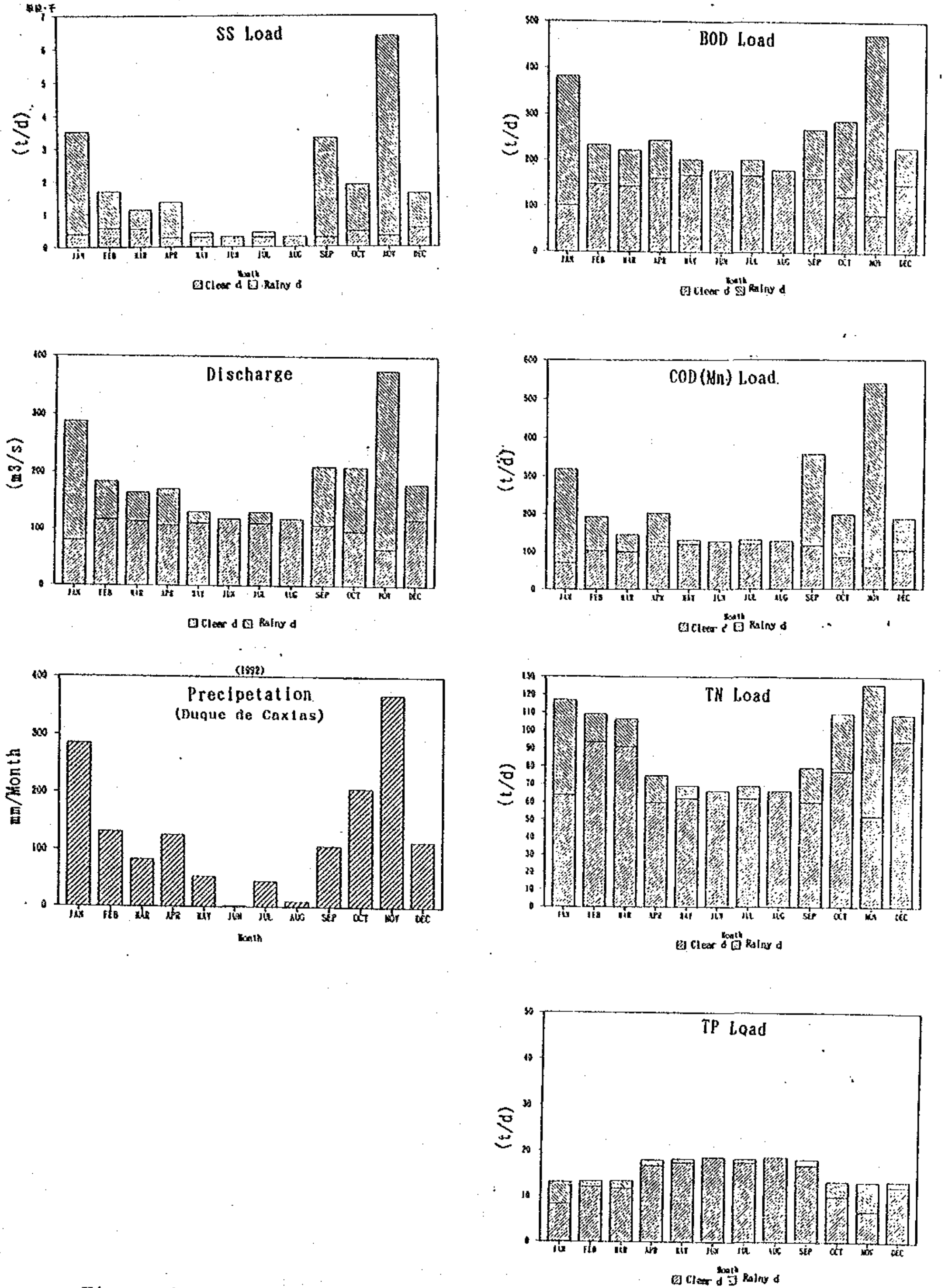


Fig. 3- 8 Estimated Monthly Runoff Load from the 20 Rivers

Table 3- 4 Estimated Runoff Load from the 20 Rivers

No	Name	Covered Basin Area (Km2)	NO.	Basin Area (Km2)	Population	Population Density (p/km2)	Land use Type
1 C1780	CANAL CANTO DO RIO	7.40	2	7.40	41.745	5.64	Urb/S.T
2 BM760	RIO BOMBA	3.40	5	26.20	183.099	6.99	Urban
3 IB810	RIO INBOASSU	11.60	6	30.80	136.636	4.50	Urban
4 AN740	RIO ALCANTARA	58.50	8	144.60	470.420	3.25	Urban
5 MT220	RIO MUTONDO	5.50	8			3.25	Urban
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban
7 CC622	RIO CACERIBU	758.40	9	846.70	336.193	0.40	N/A
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69.853	0.06	N/A
*9 MC967	RIO MACACU	256.00	10-3	256.00	18.577	0.07	N/A
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17.911	0.14	N/A
11 MG580	CANAL DE MAGE	4.60	11	18.30	8.458	0.46	N/A
12 RN560	RIO RONCADOR	107.00	12	111.40	36.370	0.33	N/A
13 IR540	RIO IRIRI	8.40	13	27.80	10.684	0.38	N/A
14 SR500	RIO SURUI	53.20	14	68.80	12.910	0.19	N/A
15 ES400	RIO ESTRELA	342.50	16	342.50	302.495	0.88	N/A
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84.106	0.61	N/A
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194.173	1.04	N/A
18 IA250	RIO IGUACU	544.20	17-1~5	562.80	758.010	1.35	N/A
19 SP300	RIO SARAPUI	159.20	17-6	165.50	1.012.275	6.12	Urban
20 SJ220	RIO S. J. DE MERITI	162.50	19	164.50	1.492.458	9.07	Urban
*21 AC241	RIO ACARI	57.90	19-2	57.90	438.076	7.57	Urban
22 IJ200	RIO IRAJA	27.30	20	35.70	500.276	14.01	Urban
23 PN180	CANAL DO PENHA	-	20	-			
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815.389	12.82	Urban
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500.876	11.70	Urb/S.T
TOTAL		3604.10		3912.50			

No	Rainy season Discharge (m3/s)	BOD Load (t/d)	CODmn Load (t/d)	TN Load (t/d)	TP Load (t/d)	SS Load (t/d)
1	1.10	2.15	1.70	0.73	0.10	16.60
2	0.60	1.23	0.97	0.42	0.06	9.40
3	1.45	2.67	2.13	0.91	0.12	21.01
4	5.74	9.63	7.75	3.27	0.42	77.97
5	0.56	0.92	0.75	0.33	0.04	7.45
6	1.19	1.96	1.60	0.69	0.09	15.89
7	30.91	16.05	20.07	9.09	0.66	222.35
8	40.20	5.84	17.66	8.52	0.31	215.06
*9	8.70	1.43	3.89	1.91	0.07	46.35
*10	1.66	0.39	0.81	0.40	0.02	9.24
11	0.21	0.12	0.14	0.07	0.01	1.49
12	4.33	1.92	2.63	1.23	0.08	29.08
13	0.36	0.18	0.23	0.11	0.01	2.48
14	2.01	0.60	1.05	0.51	0.03	11.86
15	17.40	15.43	15.05	6.55	0.63	160.29
*16	6.40	4.39	4.79	2.16	0.18	51.52
*17	10.12	9.89	9.31	4.04	0.41	98.01
18	32.25	36.83	32.72	13.88	1.49	343.88
19	24.21	49.21	37.91	15.73	2.13	378.89
20	34.07	74.90	56.98	23.63	3.28	565.28
*21	10.53	22.24	17.14	7.17	0.99	169.27
22	8.51	19.64	15.05	6.36	0.91	146.15
23	0.00	0.00	0.00	0.00	0.00	0.00
24	17.23	39.56	30.15	12.64	1.79	295.05
25	11.30	25.59	19.57	8.23	1.16	191.36
TOTAL	233.77	304.43	264.12	112.88	13.31	2712.55

No	Dry season Discharge (m3/s)	BOD Load (t/d)	CODmn Load (t/d)	TN Load (t/d)	TP Load (t/d)	SS Load (t/d)
1	0.73	1.54	1.27	0.52	0.14	6.19
2	0.41	0.89	0.75	0.31	0.08	3.50
3	0.96	1.90	1.57	0.64	0.17	7.84
4	3.70	6.75	5.44	2.20	0.58	29.12
5	0.37	0.66	0.55	0.22	0.06	2.80
6	0.78	1.39	1.15	0.47	0.12	5.97
7	18.76	10.49	10.94	3.62	0.77	90.27
8	23.43	3.36	7.89	1.87	0.21	92.27
*9	5.18	0.85	1.79	0.44	0.05	19.96
*10	1.02	0.25	0.40	0.11	0.02	3.95
11	0.13	0.08	0.08	0.03	0.01	0.61
12	2.68	1.26	1.43	0.46	0.09	11.97
13	0.23	0.12	0.13	0.04	0.01	1.03
14	1.24	0.38	0.54	0.16	0.03	5.02
15	10.79	10.40	9.14	3.37	0.82	62.38
*16	3.99	2.95	2.81	1.00	0.23	20.52
*17	6.33	6.72	5.81	2.18	0.54	37.93
18	20.01	25.01	20.65	7.91	1.99	131.05
19	15.61	34.62	27.25	11.21	3.01	139.52
20	22.13	52.99	41.77	17.31	4.69	207.43
*21	6.90	15.81	12.65	5.23	1.42	62.42
22	5.70	14.15	11.57	4.82	1.32	53.87
23	0.00	0.00	0.00	0.00	0.00	0.00
24	11.41	28.32	22.80	9.50	2.59	108.48
25	7.50	12.33	14.82	6.17	1.68	70.46
TOTAL	146.61	212.66	179.74	70.83	18.37	1029.78

No	Mean Value Discharge (m3/s)	BOD Load (t/d)	CODmn Load (t/d)	TN Load (t/d)	TP Load (t/d)	SS Load (t/d)
1	0.92	1.84	1.49	0.62	0.12	11.40
2	0.51	1.06	0.86	0.36	0.07	5.45
3	1.21	2.29	1.85	0.77	0.15	14.43
4	4.72	8.19	6.59	2.73	0.50	53.54
5	0.46	0.79	0.65	0.27	0.05	5.13
6	0.98	1.68	1.57	0.58	0.11	10.93
7	24.84	13.27	15.51	6.36	0.72	156.81
8	31.87	4.60	12.77	5.20	0.26	153.66
*9	6.94	1.14	2.84	1.18	0.06	33.15
*10	1.34	0.32	0.60	0.25	0.02	6.60
11	0.17	0.10	0.11	0.05	0.01	1.05
12	3.51	1.59	2.03	0.85	0.09	20.52
13	0.30	0.15	0.18	0.08	0.01	1.75
14	1.63	0.49	0.79	0.33	0.03	8.44
15	14.10	12.92	12.09	4.96	0.72	111.33
*16	5.19	3.67	3.80	1.58	0.21	36.02
*17	8.22	8.31	7.56	3.11	0.47	67.97
18	26.13	30.92	26.69	10.90	1.74	237.47
19	19.91	41.92	32.58	13.47	2.57	259.20
20	28.10	63.94	49.38	20.47	2.98	386.36
*21	8.72	19.03	14.89	6.20	1.20	115.84
22	7.11	16.90	13.31	5.59	1.11	100.01
23	0.00	0.00	0.00	0.00	0.00	0.00
24	14.32	33.94	26.48	11.07	2.19	201.76
25	9.40	21.96	17.20	7.20	1.42	130.91
TOTAL	190.19	256.54	221.93	91.85	15.84	1871.16

*: Tributary river (excluded from Total amount)
N/A : Natural and Agricultural use
Urban : Urban use
Urb/S.T: Urban Use with Sewage Treatments

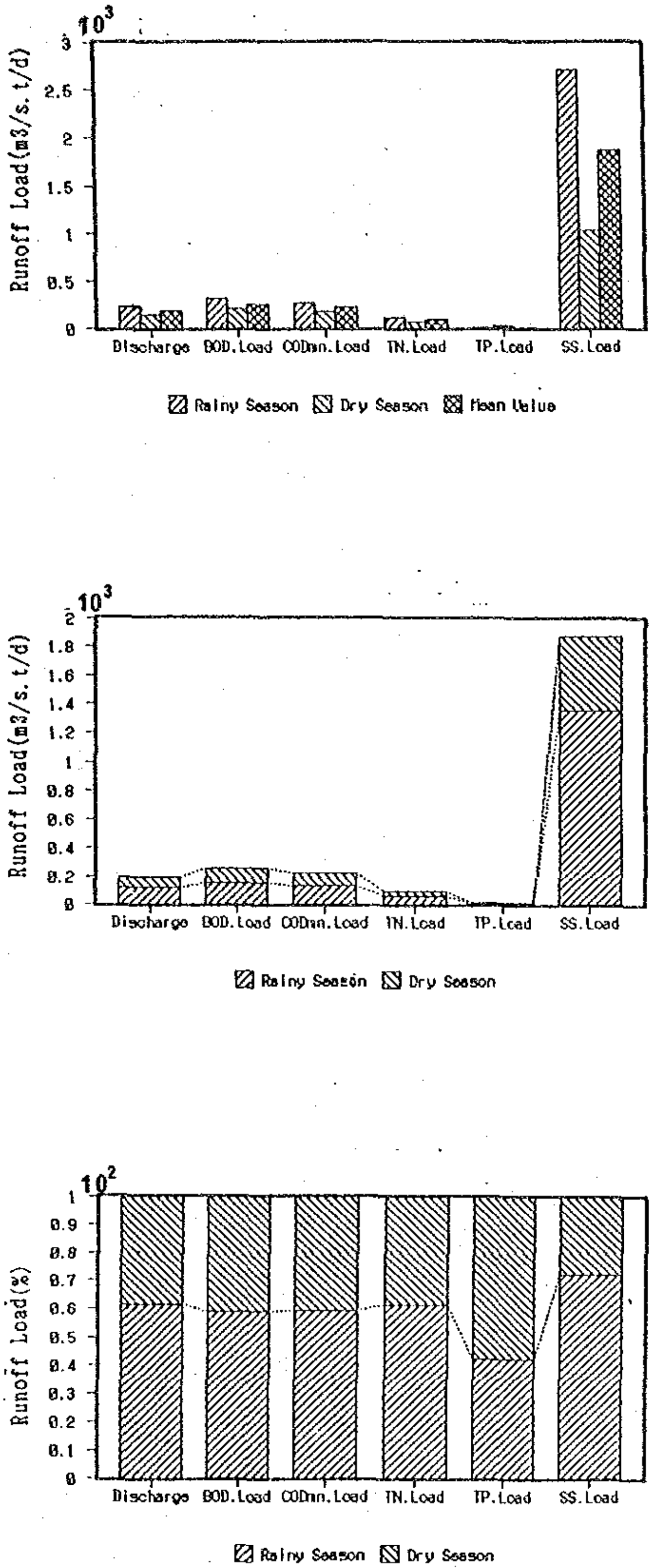


Fig. 3- 9 Difference in Estimated Runoff Load between Rainy Season and Dry Season

Table 3- 5 Estimated Total Runoff Load from the 20 Rivers

(Clear days/ Rainy days, Rainy season/Dry sesason, Runoff Load not influenced by Precipitation/ Runoff Load caused by precipitation)

Clear day /Rainy day

	Discharge		BOD Load		COD(Mn)Load		TN Load		TP Load		SS Load	
	(m3/s)	%	(t/day)	%	(t/day)	%	(t/day)	%	(t/day)	%	(t/day)	%
Clear day(<10mm/day):231days	105.18	55	147.29	57	103.51	47	70.71	77	13.91	88	384.23	21
Rainy day(10mm</day): 55days	85.01	45	111.26	43	118.42	53	21.14	23	1.93	12	1486.93	79
Mean Value	190.19	100	258.54	100	221.93	100	91.85	100	15.84	100	1871.16	100

Rainy season /Dry season

	Discharge		BOD Load		COD(Mn)Load		TN Load		TP Load		SS Load	
Season	(m3/s)	%	(t/day)	%	(t/day)	%	(t/day)	%	(t/day)	%	(t/day)	%
Rainy season(Oct-Mar.1992)	233.77	61	304.43	59	264.12	60	112.88	61	13.31	42	2712.55	72
Dry season (Apr-Sep.1992)	146.61	39	212.66	41	179.74	40	70.83	39	18.37	58	1029.78	28
Mean Value	190.19	100	258.54	100	221.93	100	91.85	100	15.84	100	1871.16	100

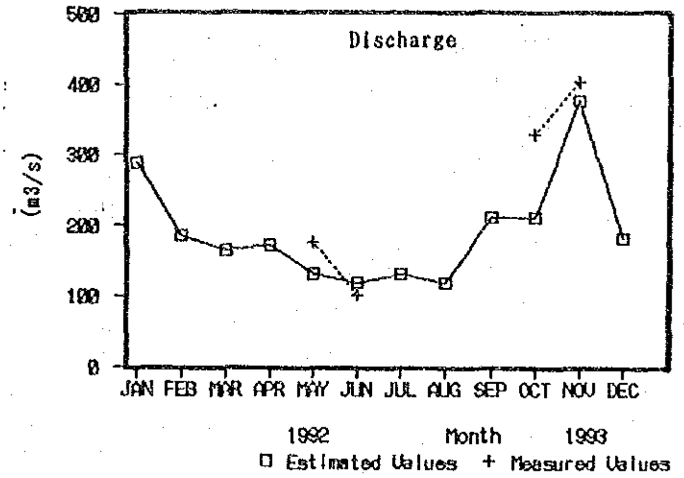
Runoff Load not influenced by precipitation /Runoff Load caused by precipitation

	Discharge		BOD Load		COD(Mn)Load		TN Load		TP Load		SS Load	
	(m3/s)	%	(t/day)	%	(t/day)	%	(t/day)	%	(t/day)	%	(t/day)	%
Runoff Load not influenced by precipitation	116.30	61	162.86	63	114.45	52	78.19	85	15.38	97	424.86	23
Runoff Load caused by precipitation	73.89	39	95.68	37	107.48	48	13.66	15	0.46	3	1446.31	77
	190.19	100	258.54	100	221.93	100	91.85	100	15.84	100	1871.16	100

Table 3- 6 Runoff Load Ratio on Clear Days and Rainy Days in Japan
(Runoff Load (%))

(1980-1989)

River Name	COD(Mn) Clear/ days	COD(Mn) Rainy/ days	T - P Clear/ days	T - P Rainy/ days	T - N Clear/ days	T - N Rainy/ days	Runoff Load, Separation Method, etc.
R. Sandagawa	(Urban type river)						Runoff load tank model
1985	48.6	51.4	40.9	59.1	60.9	39.1	Separation method 2.
R. Ohtsu	(Natural type river)						Precipitation of 1 mm or
1988	29.7	70.3	34.3	65.7	36.4	63.6	less within 12 hours assumed a rainy day, using L-Q regression model equation.
R. Nogawa	(Urban type river)						75% of annual load value
1987	44.0	56.0	--	--	--	--	was assumed as low flow
1988	51.4	48.6	--	--	--	--	and clear day.
1989	27.5	72.5	--	--	--	--	
R. Tamagawa	(Urban type river)						75% of annual load value
1985	44.8	55.2	--	--	--	--	was assumed as small water
1986	64.9	35.1	--	--	--	--	amount and clear day.
1987	63.6	36.4	--	--	--	--	
1988	28.2	71.8	47.4	52.6	--	--	
1989	46.9	53.1	59.5	40.5	--	--	
R. Tomoegawa	(Urban type river)						Clear days assumed no in-
1980/81	56.1	43.9	53.0	47.0	70.1	29.9	fluence of runoff by pre-
1981	55.1	44.9	52.8	47.2	69.7	30.3	cipitation. The following
1981/82	59.5	40.5	62.0	38.0	73.7	26.3	is the number of days deducted from the clear days.
							10 mm/day over +1 day
1987	61.5	38.5	68.9	31.1	94.5	5.5	20 mm/day over +2 days
1988	40.4	59.6	35.9	64.1	63.1	36.9	30 mm/day over +3 days
1989	49.6	50.4	45.3	54.7	71.0	29.0	50 mm/day over +4 days
R. Sannougawa	(Natural type river)						Once per each season.
1979.80	18.4	81.6	32.7	67.3	61.5	38.5	4 time per year. L-Q regression model equation.



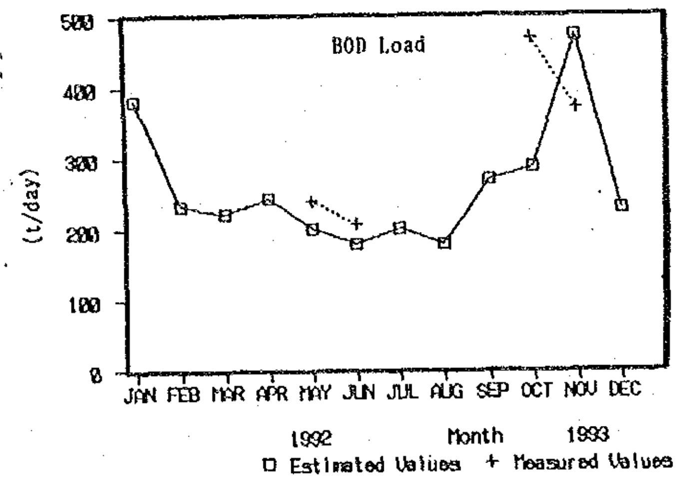


Fig. 3-10 Comparison of Estimated Runof Load with Measured One

Table 3- 7 Estimated Runoff Loads from the Entire Basin (1991)

Basin No.		Name	Covered Basin Area (Km²)	NO.	Basin Area (Km²)	Population	Population Density (10^3/km²)	Land use Type	Mean Value: Discharge (m^3/s)	BOD Load (t/d)	CODmn Load (t/d)	TN Load (t/d)	TP Load (t/d)	SS Load (t/d)
	1	B. -CHARITAS	9.40	1	9.40	53,310	5.67	Urban	1.17	2.35	1.89	0.79	0.15	14.52
Eastern	2	CANAL CANTO DO RIO	7.40	2	7.40	41,745	5.64	Urb/S.T	0.92	1.84	1.49	0.62	0.12	11.40
Basin	3	B. -CATEDRAR	7.80	3	7.80	37,458	4.80	Urban	0.86	1.65	1.33	0.56	0.11	10.33
	4	B. -NORTE CENTRO	7.90	4	7.90	43,607	5.52	Urban	0.96	1.92	1.55	0.65	0.12	11.91
	5	RIO BOMBA	26.20	5	26.20	183,099	6.99	Urban	3.75	8.00	6.33	2.65	0.51	48.90
	6	RIO IMBOASSU	30.80	6	30.80	138,636	4.50	Urban	3.14	6.02	4.81	2.00	0.38	38.02
	7	B. -ITAOCA	6.40	7	6.40	31,925	4.99	Urban	0.73	1.41	1.14	0.48	0.09	8.80
Northeastern	8	RIO ALCANTARA	144.60	8	144.60	470,420	3.25	Urban	11.48	20.07	16.01	6.60	1.20	131.48
Basin	9	RIO CACEREBU	846.70	9	846.70	336,193	0.40	N/A	27.67	14.80	17.28	7.08	0.80	174.97
	10	RIO GUAPIMIRIM	1253.10	10	1253.10	69,853	0.06	N/A	32.36	4.67	12.97	5.28	0.26	156.07
	11	CANAL DE MAGE	18.30	11	18.30	8,458	0.46	N/A	0.67	0.38	0.44	0.18	0.02	4.16
	12	RIO RONCADOR	111.40	12	111.40	36,370	0.33	N/A	3.65	1.66	2.11	0.88	0.09	21.36
	13	RIO IRIRI	27.80	13	27.80	10,684	0.38	N/A	0.97	0.49	0.59	0.25	0.03	5.77
	14	RIO SURUI	68.80	14	68.80	12,910	0.19	N/A	2.09	0.63	1.02	0.43	0.04	10.90
	15	B. -MAUA	28.90	15	28.90	8,541	0.30	N/A	0.96	0.40	0.53	0.22	0.02	5.36
Northwestern	16	RIO ESTRELA	342.50	16	342.50	302,495	0.88	N/A	14.10	12.92	12.09	4.96	0.72	111.33
Basin	17.1~5	RIO IGUACU	562.80	17-1~5	562.80	758,010	1.35	N/A	27.01	31.97	27.58	11.26	1.80	245.53
	17.6	RIO SARAPUI	165.50	17-6	165.50	1,012,275	6.12	Urban	20.61	43.40	33.72	13.94	2.66	268.38
	18	B. -CABO DO BRITO	27.00	18	27.00	132,091	4.89	Urban	2.93	5.75	4.58	1.91	0.36	36.03
	19	RIO S. J. DE MERITI	164.50	19	164.50	1,492,458	9.07	Urban	28.27	64.33	49.68	20.59	4.01	388.70
	20	RIO IRAJA	35.70	20	35.70	500,276	14.01	Urban	9.25	22.04	17.30	7.26	1.44	130.49
Western	21	CANAL DO CUNHA	63.60	21	63.60	815,389	12.82	Urban	15.04	35.66	27.80	11.62	2.30	212.01
Basin	22	B. -S. CRISTOVAO	6.60	22	6.60	60,011	9.09	Urban	1.21	2.67	2.14	0.90	0.18	16.04
	23	CANAL DO MANGUE	42.80	23	42.80	500,876	11.70	Urb/S.T	9.40	21.96	17.20	7.20	1.42	130.91
	24	B. -BOTAFOGO	26.00	24	26.00	358,622	13.79	Urban	6.68	15.84	12.48	5.24	1.04	93.81
	25	I. DO GAVANADOR	38.20	25	38.20	153,903	4.03	Urban	3.59	6.66	5.33	2.22	0.41	42.54
Island	26	I. DO FUNDAO	5.40	26	5.40	5,277	0.98	N/A	0.25	0.23	0.22	0.09	0.01	1.93
	27	I. DE PAQUETA	1.70	27	1.70	3,254	1.91	N/A	0.11	0.14	0.13	0.05	0.01	1.02
	28	I. DO ENGENHO	1.30	28	1.30	11,034	8.49	Urban	0.23	0.50	-0.41	0.17	0.03	3.00
	29	I. DE S. CRUZ	1.40	29	1.40	4,851	3.47	Urban	0.13	0.22	0.18	0.08	0.01	1.40
		Total			4080.50	7,594,031			230.16	330.59	280.34	116.18	20.37	2337.07

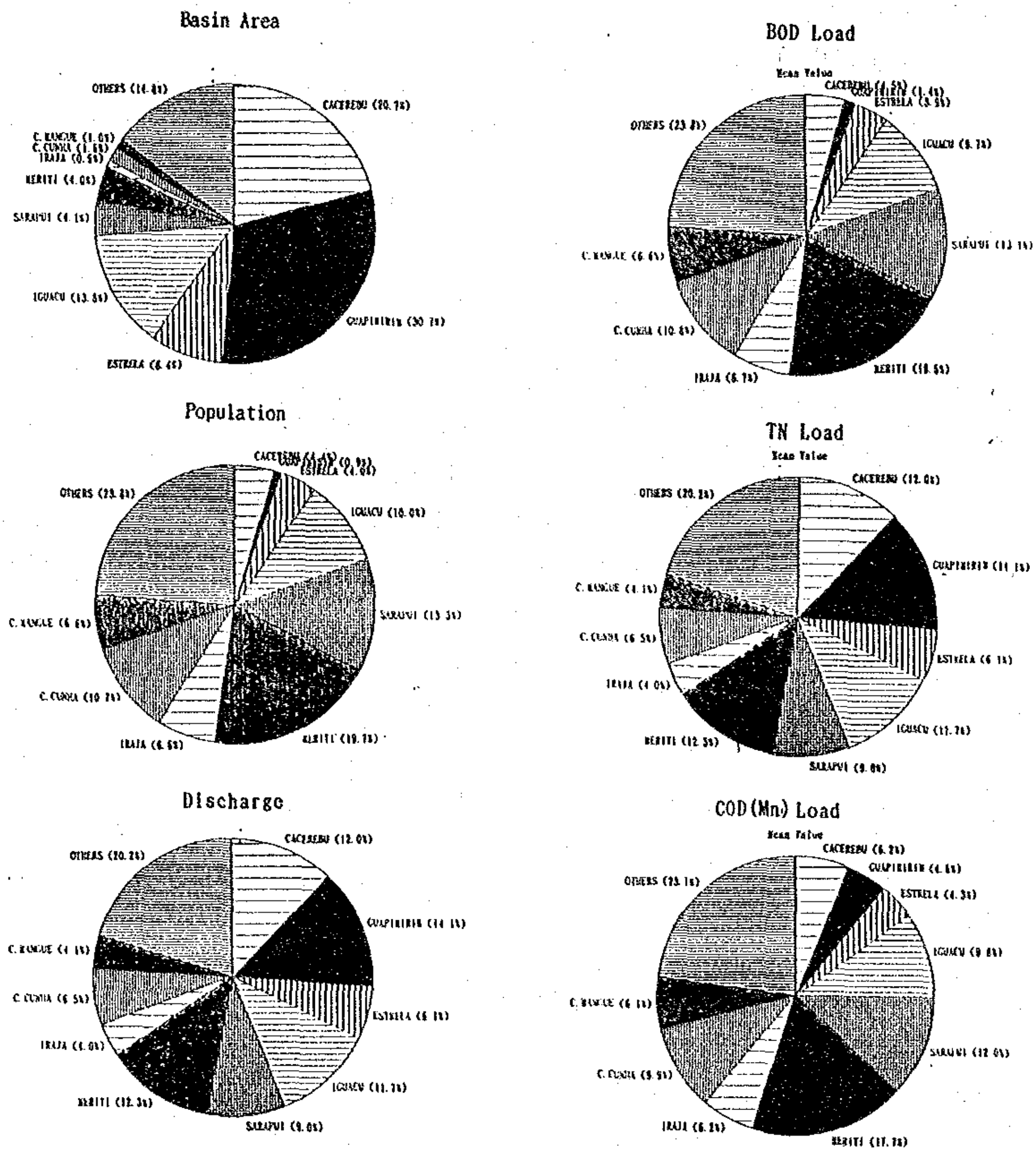


Fig. 3-11 Contribution Ratio of Estimated Runoff Load by Each Basin

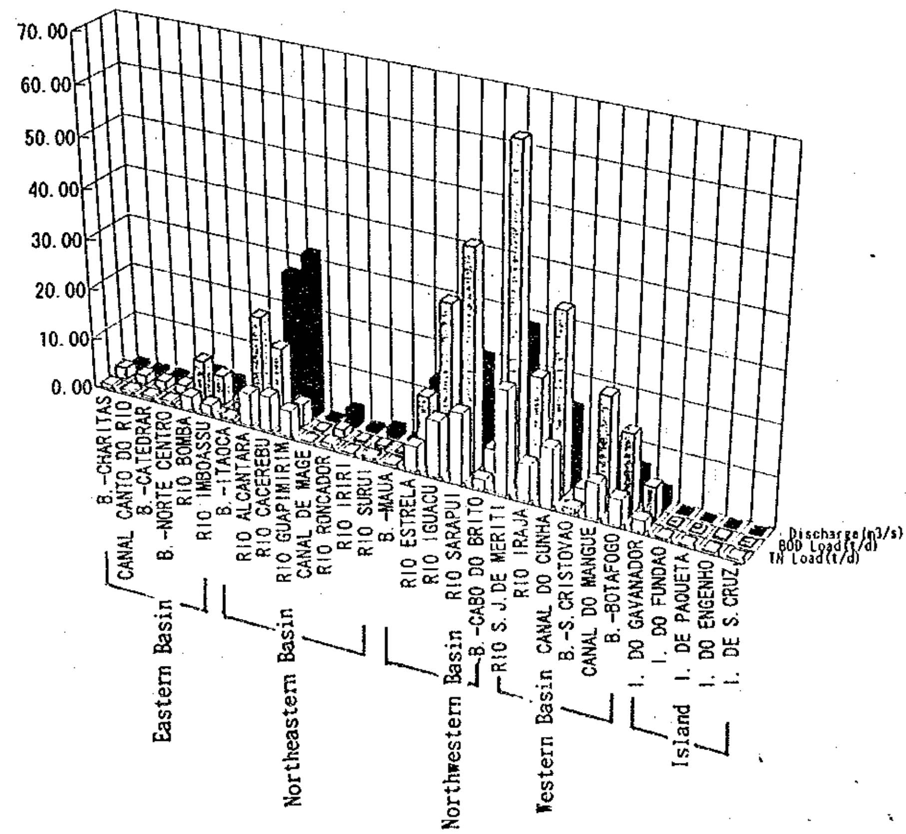


Fig. 3-12 Estimated Runoff Load from Each Sub-Basin

CHAPTER 4

DETAILS OF RUNOFF LOAD FROM THE BASIN

Chapter 4

Details of Runoff Load from the Basin

Pollutants flow into the bay through various routes, some of them via rivers or stormwater drains, and some directly from the pollution sources (factories, waste treatment plants, sewage disposal plants, etc.). Here, the total runoff load is calculated after obtaining the runoff load of each route.

4.1 Runoff Load Flowing into the Bay through Rivers and Stormwater Drains

Fig.4-1 *and* **Table 4-1** *show the runoff load flowing into the bay* from each area. According to the position of their mouths in the bay, rivers were classified into the following five groups: eastern basin (sub-basin Nos.1 to 6), northeastern basin (sub-basin Nos.7 to 14), Northwestern basin (sub-basin Nos. 15 to 18), western basin (sub-basin Nos.19 to 24) island basin (sub-basin Nos. 25 through 29). Due to differences in water quality items, 45 to 51% of the total runoff load comes from the western basin and about 30% from the northwestern basin. 35% of the total runoff discharge is contributed by the northeastern basin, and although this amount is larger than the western or northwestern basins, it only supplies 12 to 18% of the total runoff load.

Besides the rivers, stormwater drains also discharge runoff load into the bay. Separate sewers were installed in Rio de Janeiro a century ago. Yet since the construction of treatment plants they were never upgraded, rain water drains were used as sewers and there are 5 open outlets around Rio de Janeiro port, and another one north of Niteroi.

CEDAE estimated the BOD load flowing into the bay directly from the five outlets was about 36 tons/day (no data was available for RSD-02). However, since this figure was calculated based on pump capacity, runoff ratio was not considered. No data on the discharge *outlet in northern Niteroi, outside of Jurujuba Bay,* was obtained.

4.2 Runoff Loads Flowing into the Bay Directly from the Pollution Sources on the Coastal Areas

Among the various pollution sources along the coast of the bay, factories, that are located on the downstream side of the observation stations, discharge about 24 tons of BOD per day, sewage treatment plants (6 plants of Penha, ETEIG, ETEG, ETAR-AIRJ, ETAR-TECA and Icarai) discharge about 5.4 tons per day, and waste disposal plants (leachate), about 0.3 tons a day. The total BOD load totals approximately 30 tons a day.

Food factories (seafood processing factories among others) that are located between Niteroi and San Goncalo in the eastern area make up about 75% of the total load discharged by factories in the basin.

The total runoff load in terms of BOD load that flows into the bay was estimated as 360.53 tons a day by adding the runoff load of 330.59 tons/day from rivers and rain water drains to the runoff load of 29.94 tons/day from pollution sources on the coast.

Details are shown in **Table 4-2** and **Fig. 4-2**.

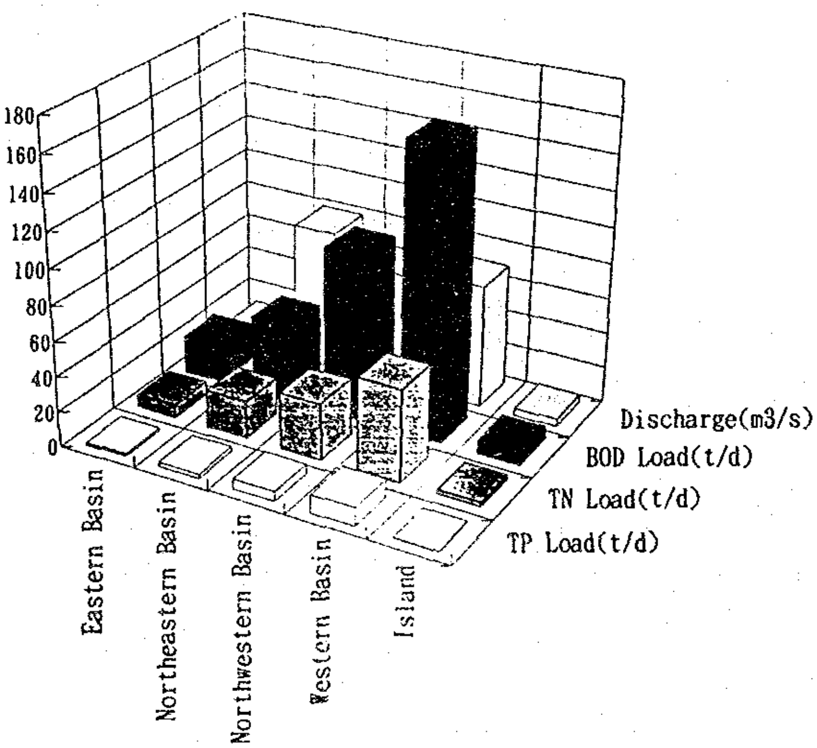


Fig. 4- 1 Runoff Load from Each Area

Table 4- 1 Details of BOD Load from Each Area

SN(1991)

	No.	Name	1991 BOD.Load (t/d)
River	1	B.-CHARITAS	2.35
	2	CANAL CANTO DO RIO	1.84
	3	B.-CATEDRAR	1.65
	4	B.-NORTE CENTRO	1.92
	5	RIO BOMBA	8.00
	6	RIO IMBOASSU	6.02
River Sub Total			21.79
Ind	007		2.13
	001		6.70
	004		2.40
	008		2.10
	009		1.94
	027		0.80
	034		0.66
	044		0.51
	047		0.48
	062		0.38
	113		0.22
Industry Sub Total			18.32
WWTP			1.63
SWDS			
Eastern Sub Total			41.736
River	7	B.-ITAOCA	1.41
	8	RIO ALCANTARA	20.07
	9	RIO CACEREBU	14.80
	10	RIO GUAPIMIRIM	4.67
	11	CANAL DE MAGE	0.38
	12	RIO RONCADOR	1.66
	13	RIO IRIRI	0.49
	14	RIO SURUI	0.63
River Sub Total			44.11
Ind			
Industry Sub Total			
WWTP			
SWDS			
Northeastern Sub Total			44.112
River	15	B.-MAUA	0.40
	16	RIO ESTRELA	12.92
	171	RIO IGUACU	31.97
	172	RIO SARAPUI	43.40
	18	B.-CABO DO BRITO	5.75
River Sub Total			94.43
Ind	015		1.32
	018		1.20
	075		0.33
	029		0.79
	086		0.31
	137		0.16
Industry Sub Total			4.11
WWTP			
SWDS			0.30
Northwestern Sub Total			98.841
River	19	RIO S.J.DE MERITI	64.33
	20	RIO IRAJA	22.04
	21	CANAL DO CUNHA	35.66
	22	B.-S.CRISTOVAO	2.67
	23	CANAL DO MANGUE	21.96
	24	B.-BOTAFOGO	15.84
River Sub Total			162.50
Ind	030		0.72
	042		0.52
	051		0.45
Industry Sub Total			1.69
WWTP			2.45
SWDS			
Wester Sub Total			166.641
Island	25	I. DO GAVANADOR	6.66
	26	I. DO FUNDAO	0.23
	27	I. DE PAQUETA	0.14
	28	I. DO ENGENHO	0.50
	29	I. DE S.CRUZ	0.22
Island Sub Total			7.75
Ind			
Industry Sub Total			0.28
WWTP			1.16
SWDS			
Islands Sub Total			9.195
		Total	360.53

Table 4- 2 Details of BOD Load from the Basin

	Runoff Load from the basin(A)	Direct Runoff Load from Point Source(B)			Total (A)+(B)
	River(t/d)	Industry(t/d)	WWTP(t/d)	SWDS(t/d)	(t/day)
Eastern Basin (1-6)	21.79	18.32	1.63	--	41.74
Northeastern Basin (7-14)	44.11	--	--	--	44.11
Northwestern Basin (15-19)	94.43	4.11	--	0.30	98.84
Western Basin (20-24)	162.50 (RSD:36.00)	1.69	2.45	--	166.64
Island (25-29)	7.75	0.28	1.16	--	9.19
Total	330.59	24.40	5.24	0.30	360.53

Remarks
WWTP : Wastewater treatment plant
SWDS : Solid waste disposal site
RSD : Raw sewage drain-pipes

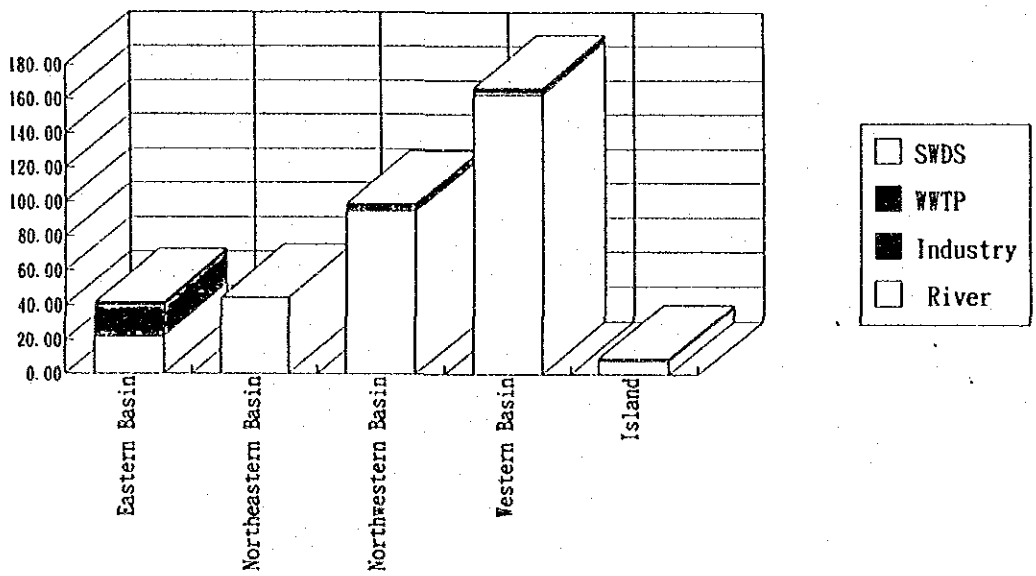


Fig. 4- 2 Estimated Runoff Load (BOD) from Each Area

CHAPTER 5

THE FUTURE RUNOFF LOAD FROM THE BASIN

Chapter 5

The Future Runoff Load from the Basin

5.1 Calculation Method

In Chapter 12 of the Main Report, the future socio-economic conditions in the basin were forecast and population was estimated for two different scenarios using the Merkmal parameter. In this chapter, the future runoff loads from the Guanabara Bay basin will be estimated for 3 cases (2000, 2010-1, 2010-2) in accordance with the scenarios.

The estimated basin population in each scenario is based on the population by administrative unit shown in the Main Report, **Table 12.3-1**, and if every basin populations are determined using the weighted mean method, the basin population and population density are as shown in **Table 5-1** to **5-2**, **Fig.**5-1.

The future runoff load calculated in Chapter 3 (Potential Model of pollutant runoff load) will be used along with population density as parameters.

Finally, the present statistical relation of the BOD/capita in the estimation model is assumed to remain the same in the future.

5.2 Estimation Results and Evaluation

The runoff load calculations for 1991 and the two scenarios, 2000, 2010-1, 2010-2, are shown in **Table 5-3**. Further, **Fig.**5-2 indicates the annual changes in runoff load for the worst case scenerio (2010-2). Along with population increase, the BOD load in 2010 was estimated to be 415 t/day, that is an 85 t/day increase from 1991.

Fig.5-3 shows the runoff loads for BOD and TN from each sub-basin.

Table 5- 1 Future Population in the Basin (1991-2010)

Basin	No.	Name	Basin Area (Km2)	NO.	(1991) Population (persons)	(2000) Population (persons)	(2010-1) Population (persons)	(2010-2) Population (persons)
	1	B.-CHARITAS	9.40	1	53,310	57,042	58,641	59,707
Eastern	2	CANAL CANTO DO RIO	7.40	2	41,745	44,667	45,920	46,754
Basin	3	B.-CATEDRAR	7.80	3	37,458	40,080	41,204	41,953
	4	B.-NORTE CENTRO	7.90	4	43,607	46,659	47,968	48,840
	5	RIO BOMBA	26.20	5	183,099	227,043	256,339	258,170
	6	RIO IMBOASSU	30.80	6	138,636	180,227	209,340	209,340
	7	B.-ITAOCA	6.40	7	31,925	41,503	48,207	48,207
Northeaster	8	RIO ALCANTARA	144.60	8	470,420	592,729	672,701	677,405
Basin	9	RIO CACEREBU	846.70	9	336,193	450,499	534,547	534,547
	10	RIO GUAPIMIRIM	1253.10	10	69,853	83,624	102,684	102,684
	11	CANAL DE MAGE	18.30	11	8,458	10,150	12,349	12,349
	12	RIO RONCADOR	111.40	12	36,370	43,644	53,100	53,100
	13	RIO IRIRI	27.80	13	10,684	12,821	15,599	15,599
	14	RIO SURUI	68.80	14	12,910	15,492	18,849	18,849
	15	B.-MAUA	28.90	15	8,541	10,249	12,470	12,470
Northwester	16	RIO ESTRELA	342.50	16	302,495	362,994	423,493	435,593
Basin	17.1~5	RIO IGUACU	562.80	17-1~5	758,010	909,612	1,023,314	1,076,374
	17.6	RIO SARAPUI	165.50	17-6	1,012,275	1,153,994	1,255,221	1,305,835
	18	B.-CABO DO BRITO	27.00	18	132,091	158,509	178,323	187,569
	19	RIO S.J.DE MERITI	164.50	19	1,492,458	1,611,855	1,671,553	1,716,327
	20	RIO IRAJA	35.70	20	500,276	535,295	550,304	560,309
Western	21	CANAL DO CUNHA	63.60	21	815,389	872,466	896,928	913,236
Basin	22	B.-S.CRISTOVAO	6.60	22	60,011	64,212	66,012	67,212
	23	CANAL DO MANGUE	42.80	23	500,876	535,937	550,964	560,981
	24	B.-BOTAFOGO	26.00	24	358,622	383,726	394,484	401,657
	25	I. DO GAVANADOR	38.20	25	153,903	164,676	169,293	172,371
Island	26	I. DO FUNDAO	5.40	26	5,277	5,646	5,805	5,910
	27	I. DE PAQUETA	1.70	27	3,254	3,482	3,579	3,644
	28	I. DO ENGENHO	1.30	28	11,034	11,806	12,137	12,358
	29	I. DE S.CRUZ	1.40	29	4,851	5,191	5,336	5,433
		Total	4080.50		7,594,031	8,636,028	9,336,661	9,564,782

Table 5- 2 Future Population Density in the Basin (1991-2010)

Basin	No.	Name	Basin Area (Km2)	NO.	(1991) Population Density (10^3/km2)	(2000) Population Density (10^3/km2)	(2010-1) Population Density (10^3/km2)	(2010-2) Population Density (10^3/km2)
	1	B.-CHARITAS	9.40	1	5.67	6.07	6.24	6.35
Eastern	2	CANAL CANTO DO RIO	7.40	2	5.64	6.04	6.21	6.32
Basin	3	B.-CATEDRAR	7.80	3	4.80	5.14	5.28	5.38
	4	B.-NORTE CENTRO	7.90	4	5.52	5.91	6.07	6.18
	5	RIO BOMBA	26.20	5	6.99	8.67	9.78	9.85
	6	RIO IMBOASSU	30.80	6	4.50	5.85	6.80	6.80
	7	B.-ITAOCA	6.40	7	4.99	6.48	7.53	7.53
Northeaster	8	RIO ALCANTARA	144.60	8	3.25	4.10	4.65	4.68
Basin	9	RIO CACEREBU	846.70	9	0.40	0.53	0.63	0.63
	10	RIO GUAPIMIRIM	1253.10	10	0.06	0.07	0.08	0.08
	11	CANAL DE MAGE	18.30	11	0.46	0.55	0.67	0.67
	12	RIO RONCADOR	111.40	12	0.33	0.39	0.48	0.48
	13	RIO IRIRI	27.80	13	0.38	0.46	0.56	0.56
	14	RIO SURUI	68.80	14	0.19	0.23	0.27	0.27
	15	B.-MAUA	28.90	15	0.30	0.35	0.43	0.43
Northwester	16	RIO ESTRELA	342.50	16	0.88	1.06	1.24	1.27
Basin	17.1~5	RIO IGUACU	562.80	17-1~5	1.35	1.62	1.82	1.91
	17.6	RIO SARAPUI	165.50	17-6	6.12	6.97	7.58	7.89
	18	B.-CABO DO BRITO	27.00	18	4.89	5.87	6.60	6.95
	19	RIO S.J.DE MERITI	164.50	19	9.07	9.80	10.16	10.43
	20	RIO IRAJA	35.70	20	14.01	14.99	15.41	15.69
Western	21	CANAL DO CUNHA	63.60	21	12.82	13.72	14.10	14.36
Basin	22	B.-S.CRISTOVAO	6.60	22	9.09	9.73	10.00	10.18
	23	CANAL DO MANGUE	42.80	23	11.70	12.52	12.87	13.11
	24	B.-BOTAFOGO	26.00	24	13.79	14.76	15.17	15.45
	25	I. DO GAVANADOR	38.20	25	4.03	4.31	4.43	4.51
Island	26	I. DO FUNDAO	5.40	26	0.98	1.05	1.07	1.09
	27	I. DE PAQUETA	1.70	27	1.91	2.05	2.11	2.14
	28	I. DO ENGENHO	1.30	28	8.49	9.08	9.34	9.51
	29	I. DE S.CRUZ	1.40	29	3.47	3.71	3.81	3.88
		Total	4080.50		1.86	2.12	2.29	2.34

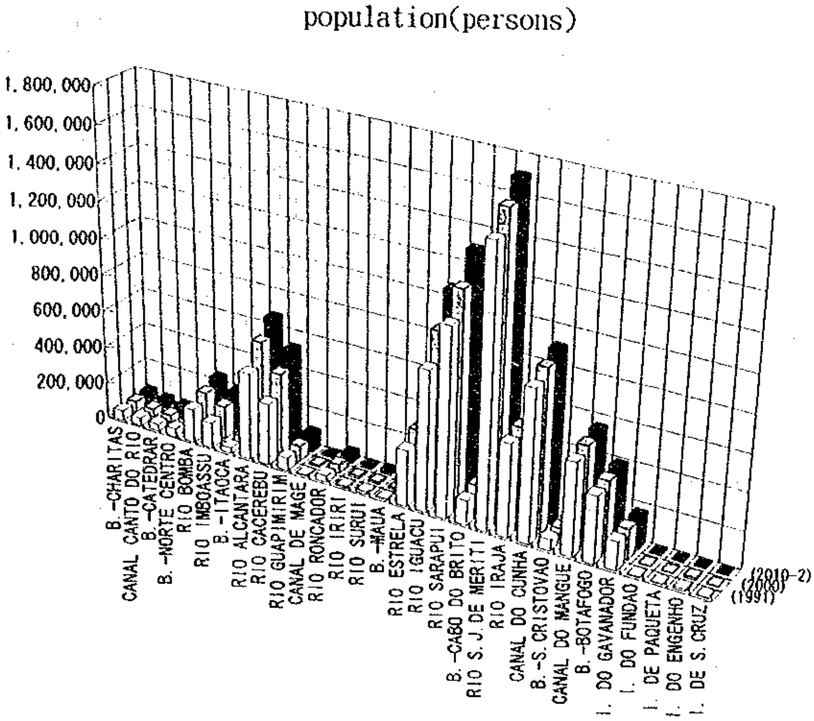
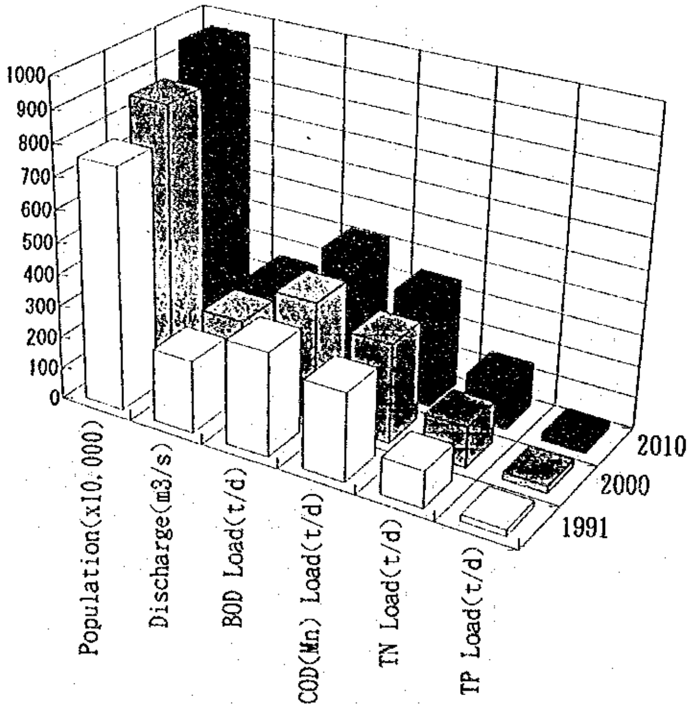


Fig. 5-1 The Future Population in the Basin (1991 - 2010)



Index	1991	2000	2010-1 (Scenario 1)	2010-2 (Scenario 2)
Population (persons)	7,594,031	8,636,028	9,336,661	9,564,782
Baasin Area (Km2)	4,080.50	4,080.50	4,080.50	4,080.50
Discharge (m3/s)	230.16	247.16	258.60	262.27
BOD Load (t/d)	330.59	375.40	405.42	415.33
COD(Mn) Load (t/d)	280.34	314.21	336.83	344.37
TN Load (t/d)	116.18	130.24	139.62	142.76
TP Load (t/d)	20.37	23.17	25.04	25.68
SS Load (t/d)	2,337.07	2,651.46	2,827.82	2,886.12

Fig. 5- 2 Future Runoff Loads from the Basin (1991 - 2010)

Table 5- 3 Estimation Runoff Load for BOD and TN from Each Sub-Basin

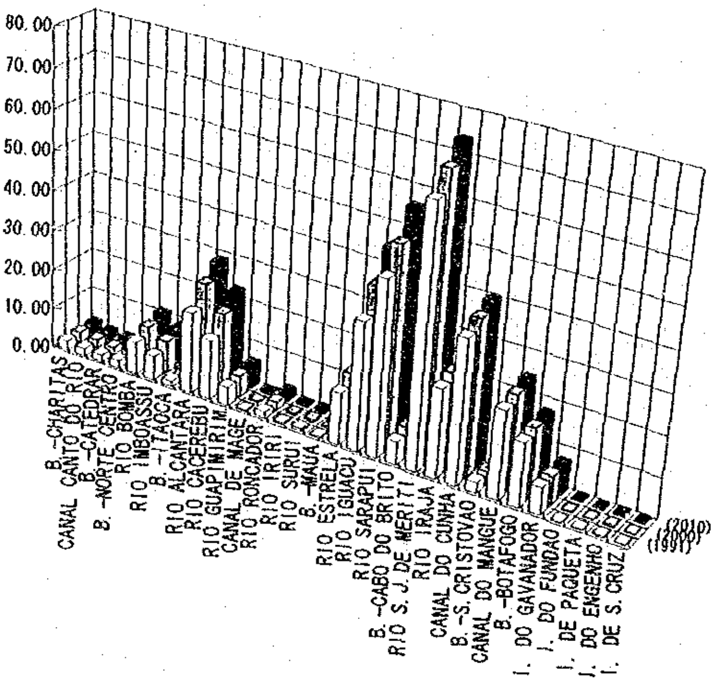
(BOD)

Basin	No.	Name	Basin Area (Km2)	NO.	(1991) BOD Load (t/d)	(2000) BOD Load (t/d)	(2010-1) BOD Load (t/d)	(2010-2) BOD Load (t/d)
Eastern Basin	1	B.-CHARITAS	9.40	1	2.35	2.51	2.59	2.63
	2	CANAL CANTO DO RIO	7.40	2	1.84	1.97	2.03	2.07
	3	B.-CATEDRAR	7.80	3	1.65	1.77	1.82	1.85
	4	B.-NORTE CENTRO	7.90	4	1.92	2.06	2.12	2.16
	5	RIO BOMBA	26.20	5	8.00	9.96	11.26	11.34
	6	RIO IMBOASSU	30.80	6	6.02	7.85	9.13	9.13
Northeaster Basin	7	B.-ITAOCA	6.40	7	1.41	1.84	2.14	2.14
	8	RIO ALCANTARA	144.60	8	20.07	25.33	28.79	28.99
	9	RIO CACEREBU	846.70	9	14.80	19.46	22.90	22.90
	10	RIO GUAPIMIRIM	1253.10	10	4.67	5.22	5.97	5.97
	11	CANAL DE MAGE	18.30	11	0.38	0.45	0.55	0.55
	12	RIO RONCADOR	111.40	12	1.66	1.96	2.35	2.35
	13	RIO IRIRI	27.80	13	0.49	0.58	0.69	0.69
	14	RIO SURUI	68.80	14	0.63	0.74	0.88	0.88
Northwester Basin	15	B.-MAUA	28.90	15	0.40	0.47	0.56	0.56
	16	RIO ESTRELA	342.50	16	12.92	15.44	17.96	18.47
	17.1~5	RIO IGUACU	562.80	17-1~5	31.97	38.30	43.06	45.29
	17.6	RIO SARAPUI	165.50	17-6	43.40	49.56	53.97	56.17
	18	B.-CABO DO BRITO	27.00	18	5.75	6.91	7.79	8.20
Western Basin	19	RIO S.J.DE MERITI	164.50	19	64.33	69.56	72.17	74.14
	20	RIO IRAJA	35.70	20	22.04	23.61	24.28	24.73
	21	CANAL DO CUNHA	63.60	21	35.66	38.20	39.29	40.02
	22	B.-S.CRISTOVAO	6.60	22	2.67	2.86	2.94	2.99
	23	CANAL DO MANGUE	42.80	23	21.96	23.52	24.19	24.64
	24	B.-BOTAFOGO	26.00	24	15.84	16.97	17.45	17.78
Island	25	I. DO GAVANADOR	38.20	25	6.66	7.13	7.33	7.47
	26	I. DO FUNDAO	5.40	26	0.23	0.25	0.26	0.26
	27	I. DE PAQUETA	1.70	27	0.14	0.15	0.16	0.16
	28	I. DO ENGENHO	1.30	28	0.50	0.53	0.55	0.56
	29	I. DE S.CRUZ	1.40	29	0.22	0.23	0.24	0.24
		Total	4080.50		330.59	375.40	405.42	415.33

(TN)

Basin	No.	Name	Basin Area (Km2)	NO.	(1991) TN Load (t/d)	(2000) TN Load (t/d)	(2010-1) TN Load (t/d)	(2010-2) TN Load (t/d)
Eastern Basin	1	B.-CHARITAS	9.40	1	0.79	0.85	0.87	0.89
	2	CANAL CANTO DO RIO	7.40	2	0.62	0.67	0.69	0.70
	3	B.-CATEDRAR	7.80	3	0.56	0.60	0.62	0.63
	4	B.-NORTE CENTRO	7.90	4	0.65	0.70	0.72	0.73
	5	RIO BOMBA	26.20	5	2.65	3.29	3.72	3.75
	6	RIO IMBOASSU	30.80	6	2.00	2.60	3.01	3.01
Northeaster Basin	7	B.-ITAOCA	6.40	7	0.48	0.62	0.72	0.72
	8	RIO ALCANTARA	144.60	8	6.60	8.25	9.33	9.39
	9	RIO CACEREBU	846.70	9	7.08	8.43	9.43	9.43
	10	RIO GUAPIMIRIM	1253.10	10	5.28	5.46	5.70	5.70
	11	CANAL DE MAGE	18.30	11	0.18	0.21	0.24	0.24
	12	RIO RONCADOR	111.40	12	0.88	0.97	1.09	1.09
	13	RIO IRIRI	27.80	13	0.25	0.28	0.31	0.31
	14	RIO SURUI	68.80	14	0.43	0.46	0.51	0.51
Northwester Basin	15	B.-MAUA	28.90	15	0.22	0.25	0.28	0.28
	16	RIO ESTRELA	342.50	16	4.96	5.71	6.47	6.62
	17.1~5	RIO IGUACU	562.80	17-1~5	11.26	13.14	14.56	15.23
	17.6	RIO SARAPUI	165.50	17-6	13.94	15.88	17.28	17.99
	18	B.-CABO DO BRITO	27.00	18	1.91	2.29	2.58	2.71
Western Basin	19	RIO S.J.DE MERITI	164.50	19	20.59	22.26	23.10	23.73
	20	RIO IRAJA	35.70	20	7.26	7.78	8.01	8.16
	21	CANAL DO CUNHA	63.60	21	11.62	12.45	12.81	13.05
	22	B.-S.CRISTOVAO	6.60	22	0.90	0.97	0.99	1.01
	23	CANAL DO MANGUE	42.80	23	7.20	7.71	7.94	8.08
	24	B.-BOTAFOGO	26.00	24	5.24	5.62	5.79	5.89
Island	25	I. DO GAVANADOR	38.20	25	2.22	2.37	2.43	2.48
	26	I. DO FUNDAO	5.40	26	0.09	0.10	0.10	0.10
	27	I. DE PAQUETA	1.70	27	0.05	0.06	0.06	0.06
	28	I. DO ENGENHO	1.30	28	0.17	0.19	0.19	0.19
	29	I. DE S.CRUZ	1.40	29	0.08	0.08	0.08	0.09
		Total	4080.50		116.18	130.24	139.62	142.76

BOD Load(t/d)



TN Load(t/d)

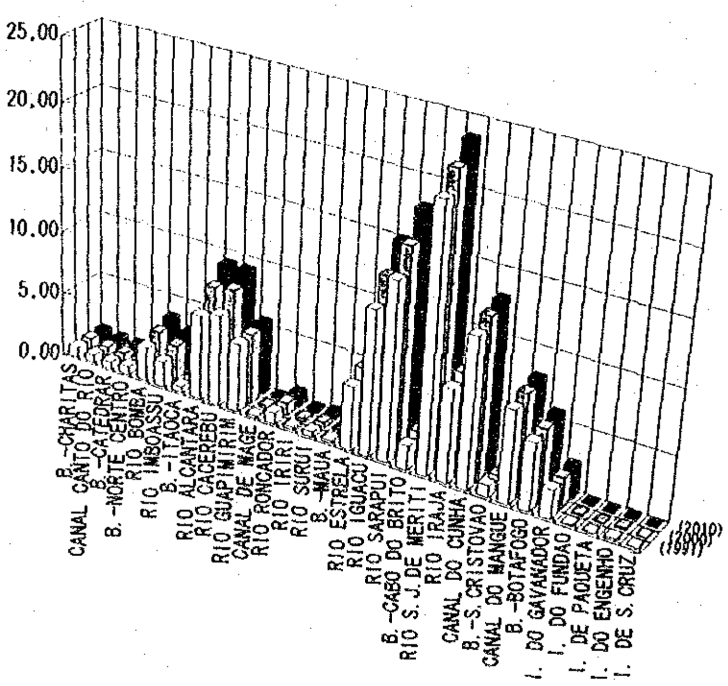


Fig. 5- 3 Future Runoff Loads from Each Sub-Basin

CHAPTER 6

RUNOFF LOAD ESTIMATION RESULTS THROUGH INFLOW LOAD REDUCTION MEASURES

Chapter 6

Runoff load estimation results through inflow load reduction measures

6.1 Runoff load estimation results through reduction measures

Runoff load was estimated for the following 4 cases:

(1) Runoff load in 2000 (primary treatment) and 2010 (secondary treatment) if the sewage treatment plants are completed under the IDB/OECF Program.

(2) Runoff load in 2010 if the sewage treatment plant (primary treatment) are completed in urban areas outside the target area.

(3) Runoff load in 2010 if the ocean outfall system is completed following the construction of the treatment plants (primary treatment) by 2000 under the IDB/OECF Program.

Ocean outfall (1) draft: (B-1)	To discharge the waste from the southern part of the Meriti basin and the southern part of the TOQUE-TOQUE sewage treatment district utside the bay.
Ocean outfall (2) draft: (B-2)	To discharge the waste from the southern part of the PENHA sewage treatment district and the southern part of the TOQUETOQUE sewage treatment district outside the bay.
Ocean outfall (3) draft: (B-3)	To discharge waste from the southern part of the ALEGRIA and FUNDAO sewage treatment district and the eastern area of southern TOQUETOQUE sewage treatment district outside the bay.
Ocean outfall (4) draft: (B-4)	To discharge the waste from the southern part of the BOTAFOGO sewage treatment district and the southern part of the ICARAI sewage treatment district outside the bay.

Ocean outfall drafts are shown in **Fig.6-1**.

(4) Runoff load in 2010 with the construction of a retarding ponds

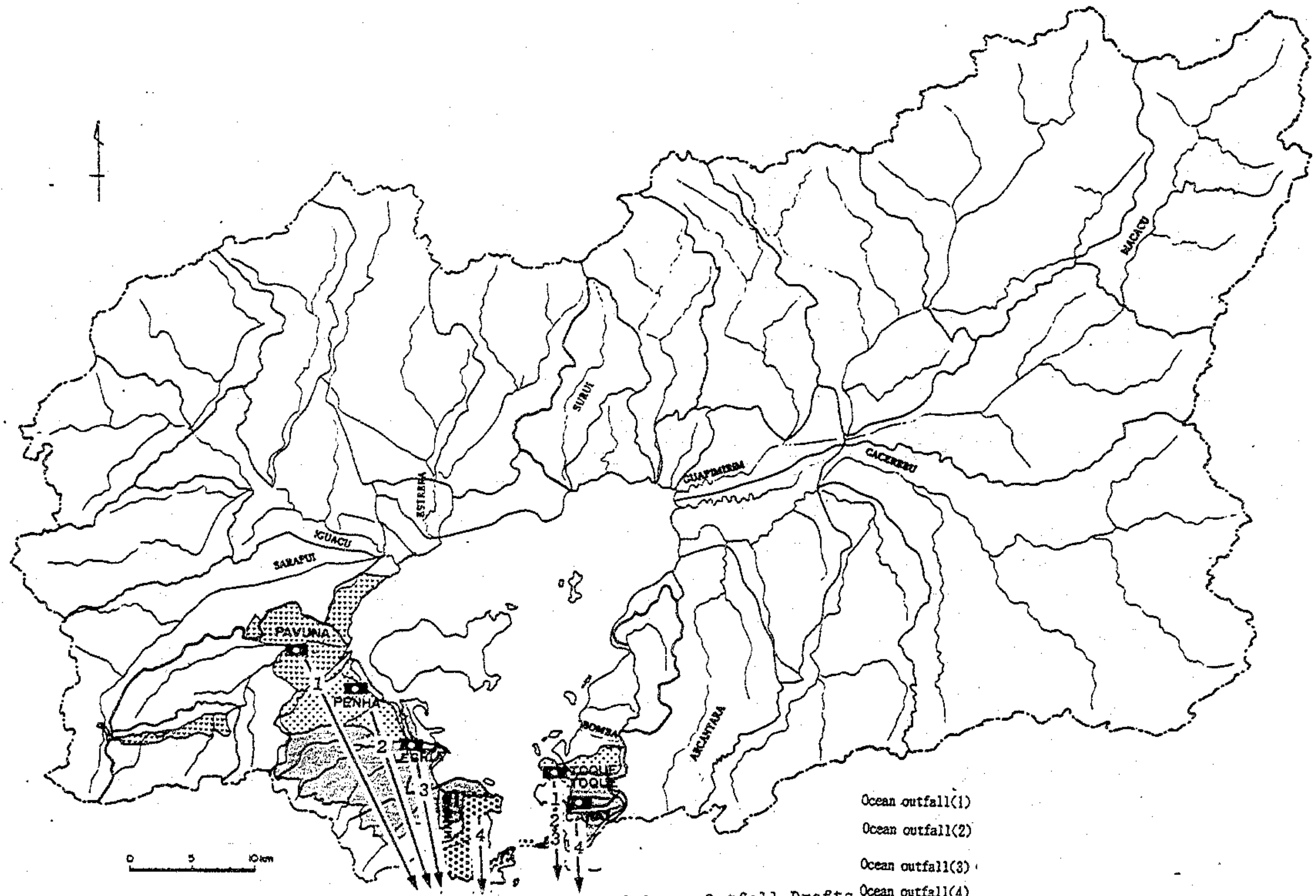


Fig. 6- 1 Project Area of Ocean Outfall Drafts

Adopted Design

ITEM		1	2	3(B-1)	3(B-2)	3(B-3)	3(B-4)	4
Target Year	2000	2010	2010	2010	2010	2010	2010	2010
Project Area(km^2)	271.4	271.4	752.4	271.4	271.4	271.4	271.4	271.4
Measures Primary Treatment	x	X	X	X	X	X	X	
Secondary Treatment		X	X					
Additional Primary Treatment			X					
Ocean Outfall				X	X	X	X	

6.2 Points to be considered for the calculation

The runoff ratio in areas with sewers varies from that without sewers. Runoff loads are determined using the runoff ratio as a parameter, however the results of the calculations may largely differ according to the actual set up of the sewers.

The sum of the areas with sewers and the areas where sewers are to be constructed with sewers under the IDB/OECF Program will be, for calculation purposes, called the area with sewers, and the runoff load will be determined by multiplying the area with the runoff ratio of the area with sewers(**Fig. 6-2**).

This study assumed that population in the basin is evenly distributed. Given this assumption, the population in areas with sewers *and therefore the evaluation of the load reduction could* have been underestimated.

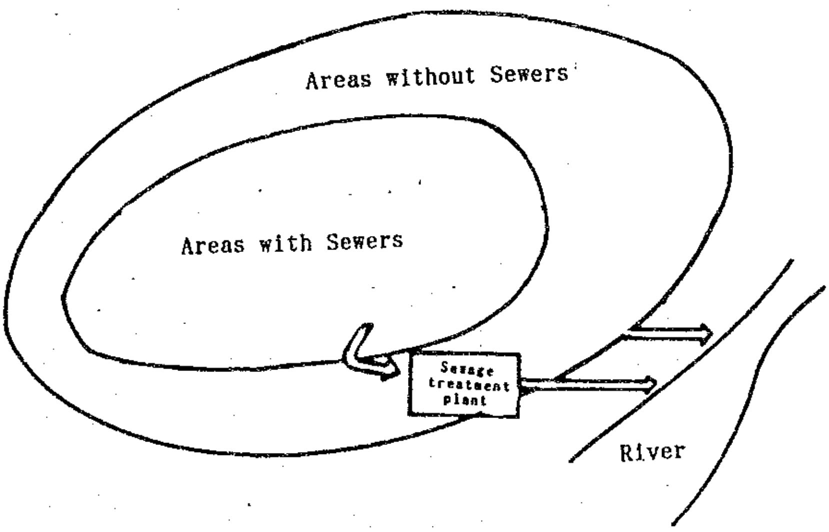


Fig.6-2 : Runoff ratio of the areas with and without sewers

6.3 Terms of Calculation

The parameters for the calculation were established as shown below:

(1) Runoff ratio of the areas with and without sewers

Using the WADA (1980) data, the runoff ratio in areas with sewers is as shown below, while the runoff ratio of the basin will be the weighted average of the areas with and without sewers.

In addition, the present runoff ratio of areas without sewers is assumed not to change.

Parameters	Areas with Sewers Primary Treatment	Secondary Treatment	Areas without Sewers
Discharge	100 %	100 %	100 %
BOD	49	18	100
TN	90	82	100
TP	95	91	100

The BOD value was determined by using the value (*1) obtained from the results of a study on the drainage system (combined sewer system) of Yabata river basin. The BOD value used is shown in **Fig.6-3**. TN and TP values were determined by using the BOD value actually measured.

*1 Source: Yasuhiko Wada: Non point source load quantity and its impact on the water environment, the 16th Health Engineering Research Institute Debate Article, Vol. 16, 1980.

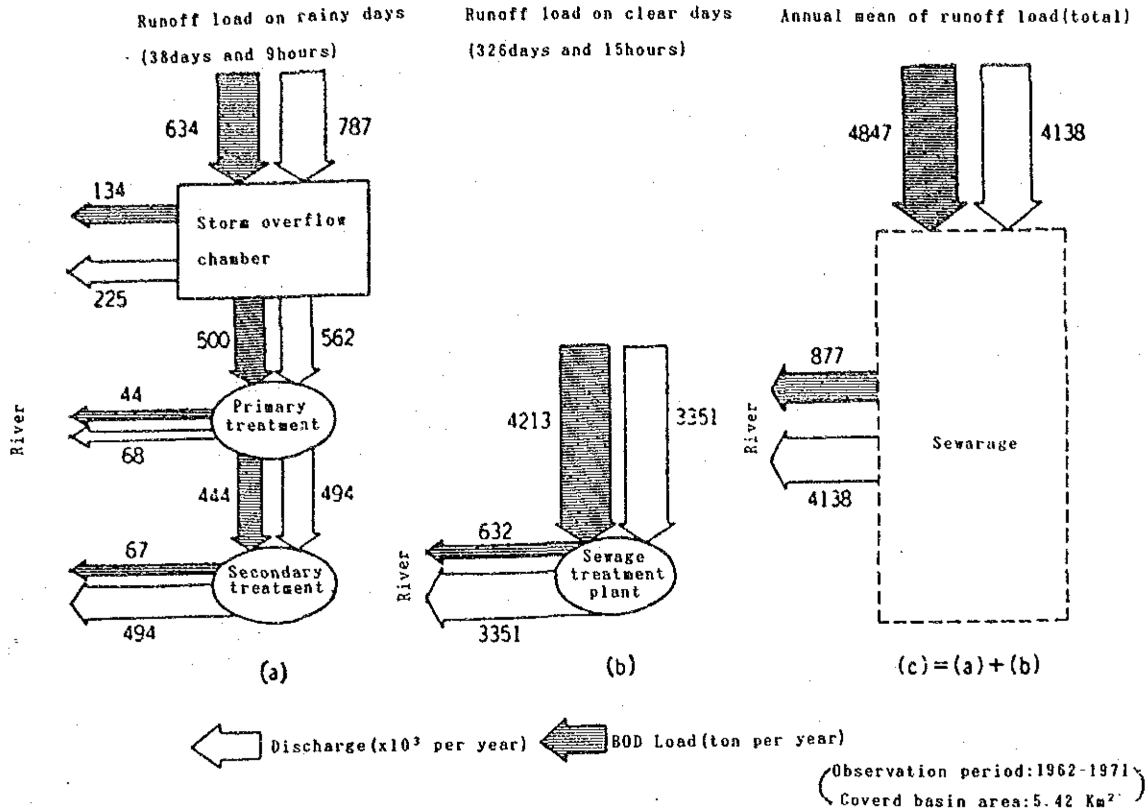


Fig. 6- 3 Material Balance on the Sewer System in Yabata River Basin

(2) Waste Removal Ratio of the Sewage Treatment Plant

The waste removal ratio of the sewage treatment plant used to determine the runoff ratio of areas with sewers is as shown below:

Parameters	Areas with Sewers Primary Treatment	Secondary Treatment
Discharge	100 %	100 %
BOD	50	90
TN	10	20
TP	5	10

(3) Ocean Outfall Runoff Ratio

The runoff ratio of areas with sewers to be adopted in the ocean outfall was based on *1 data and shown below. The remaining runoff load in areas with sewers is assumed to be discharged outside the bay through the ocean outfall.

Parameters	Areas with Sewers
BOD	2.9 %
TN	9.5
TP	9.5

TN and TP values are estimated to have a ratio similar to Discharge.

(4) Load Removal Ratio of the Retardation Ponds

The load removal ratio of the retardation ponds was established as shown below. The load removal ratio for the first flush of the retarding ponds of Matsuura (1987) (*2), which has a storage capacity of 200,000 m^3, ratio of COD removed is 24%, 8% of TN, and 16% of TP. These values were used to determine the load removal ratio of the retardation ponds. The COD (Mn) ratio will also be used to also obtain the BOD ratio.

The maximum rainfall to be used for the calculation of the storage capacity of the retarding ponds will be set at 20mm/day for the effective use of the facilities.

Parameters	Areas with Sewers
BOD	24 %
TN	8
TP	16

*2 Source: Mushiake, ed. : Conservation and Recuperation of the water environment, Sankaido (October 1987)

6.4 Estimation Results and Evaluation

(1) Estimation Results

The runoff load estimation results with countour measurments are shown in **Table 6-1 (Appendix X).**

Fig.6-4 compares of runoff load of areas with sewage treatment and area without sewage treatment (1991-2010).

(2) Evaluation

The discharge load results based on the inflow load reduction countermeasures are shown in **Fig.6-5**, and **Table 6-2**. The effects of each reduction countermeasure for 2010 will be compared.

- Number (2) countermeasure will be used for BOD; the ocean outfall countermeasure (3) which will discharge treated sewage outside the bay will be used for TN and TP.

- Countermeasures that are highly attainable are (a) secondary treatment under the IDB/OECF Program, and (b) the ocean outfall (2) draft. The inflow load that can be removed through these countermeasures, in terms of BOD, is approximately the same at about 100 t/day.

- However, for the improvement of the bay water quality, countermeasure (3) is supposedly very effective, and cost-effective in terms of maintenance and management.

- The previously mentioned countermeasure (1) alone will not be enough to attain the target bay water quality (to reduce the BOD in the load inflowing to the bay to 280 t/day). Hence, the primary treatment under the IDB/OECF Program intended for urban areas (614.8km2) outside the target area will be added to the secondary treatment under the same program. This is considered effective in possibly attaining the target bay water quality.

- The load reduction effects of the countermeasure involving the construction of retardation ponds is lower than the estimated value.

Even through the construction of a retarding pond totaling 9.4km^2 (water depth 2.0m), an annual mean load of only 10.4 tons/day (3%) can be effectively reduced.

The Comparative Table on Countermeasures (2010)

Countermeasure	method	reduced volume (BOD Load t/d)	effect impact extent	direct effect	continuity	expenses construction expenses	O/M expenses	subject technological economic environmental
load reduction								
1		101	◎	◎	△	○	○	
2		155	◎	◎	△	△	○	
3(B-1)		106	◎	◎	◎	△	◎	
3(B-2)		99	◎	◎	◎	△	◎	
3(B-3)		91	◎	◎	◎	△	◎	
3(B-4)		67	◎	◎	◎	△	◎	
4		(13)	○	△	○	△	○	
River dredging			○	○	△	△	○	
Afforestation			○	○	△	△	○	
Release load sludge removal			○	△	△	△	△	
Promote seawater circulation widening of navigational route			○	○	△	△	△	

◎ : Excellent

○ : Good

△ : Average

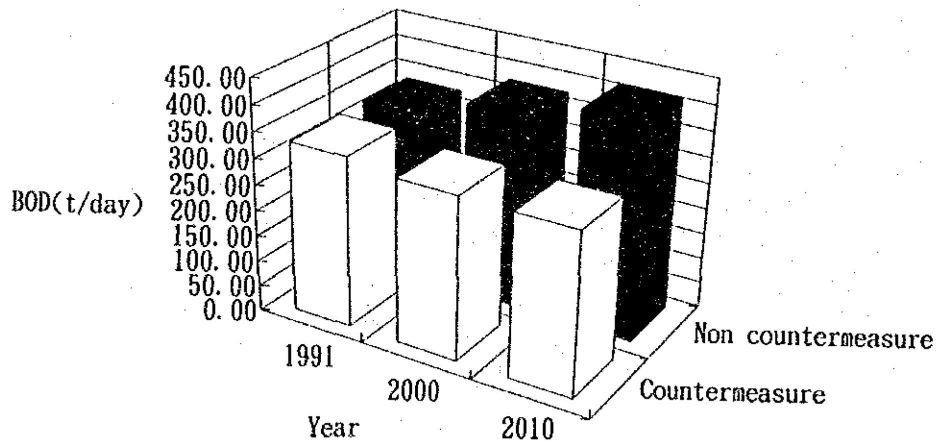


Fig. 6- 4 Runoff Load of Area with Sewage Treatment and Area without Sewage Treatment

Table 6-1 Runoff Load with the IDB/OECF Program

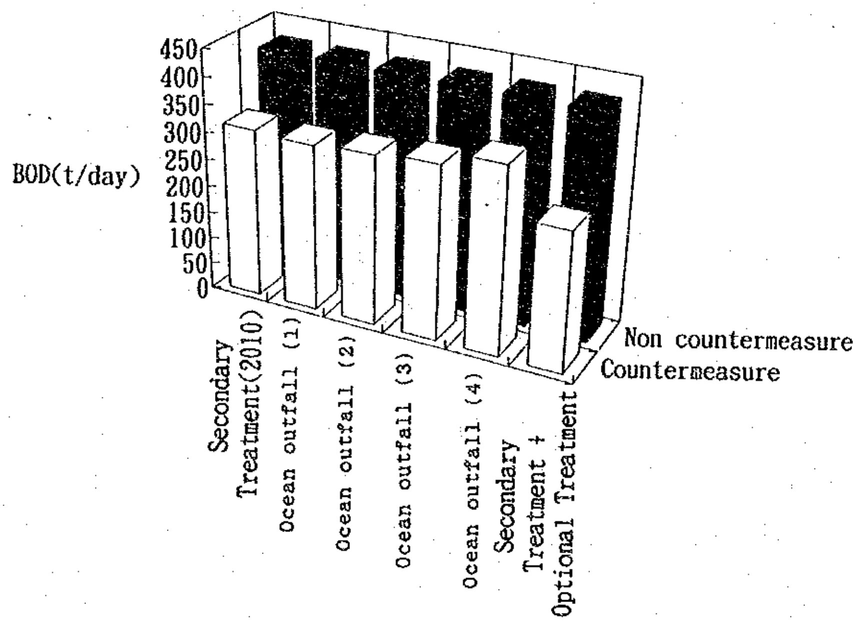
Index		Non-Sewerage Treatment 1991	Primary Sewerage Treatment 2000	Secondary Sewerage Treatment 2010
Population	(persons)	7,594,031	8,636,028	9,564,782
	(%)	100	114	126
Discharge	(m3/s)	230.16	247.16	262.27
	(%)	100	107	114
BOD Load	(t/d)	330.59	316.38	313.87
	(%)	100	96	95
TN Load	(t/d)	116.18	126.45	135.47
	(%)	100	109	117
TP Load	(t/d)	20.37	22.80	24.96
	(%)	100	112	123

Table 6-2 Runoff Load with the Ocean Outfall Draft

Index		Non-Sewerage Treatment	Ocean outfall(1) with Sewerage Treatment	Ocean outfall(2) with Sewerage Treatment	Ocean outfall(3) with Sewerage Treatment	Ocean outfall(4) with Sewerage Treatment
Population	(persons)	9,564,782	9,564,782	9,564,782	9,564,782	9,564,782
	(%)	100	100	100	100	100
Discharge	(m3/s)	262.27	225.78	231.18	235.70	253.73
	(%)	100	86	88	90	97
BOD Load	(t/d)	415.33	309.58	316.36	324.02	348.23
	(%)	100	75	76	78	84
TN Load	(t/d)	142.76	114.29	118.08	122.49	136.37
	(%)	100	80	83	86	96
TP Load	(t/d)	25.68	20.15	20.94	21.67	24.42
	(%)	100	78	82	84	95

Table 6-3 Runoff Load with Retardation Pond Program

Index		Non-Sewerage Treatment	Retardation pond Program	Reduced Runoff Load
Population	(persons)	7,594,031	7,594,031	0
	(%)	100	100	0
Discharge	(m3/s)	230.16	-	-
	(%)	100	0	
BOD Load	(t/d)	330.59	320.16	10.43
	(%)	100	97	3
TN Load	(t/d)	116.18	116.07	0.11
	(%)	100	100	0
TP Load	(t/d)	20.37	-	-
	(%)	100	0	



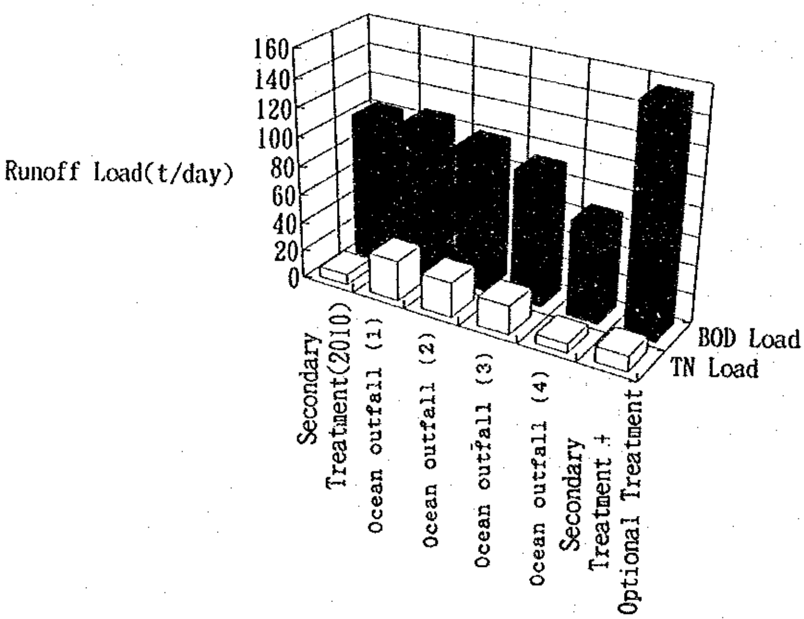


Fig. 6- 5 BOD Load from the Basin with Countour Measurements and without Countour Measurements

Table 6- 4 Runoff Load from the Basin with Countour measures and without Countour measures

Name of Countermeasure	Year	Runoff Load of Non-Countermeasure				Runoff Load by Countermeasure				Reduction Load by Countermeasure			
		Discharge (m3/s)	BOD Load (t/d)	TN Load (t/d)	TP Load (t/d)	Discharge (m3/s)	BOD Load (t/d)	TN Load (t/d)	TP Load (t/d)	Discharge (m3/s)	BOD Load (t/d)	TN Load (t/d)	TP Load (t/d)
Non-Treatment(1991)	1991	230.16	330.59	116.18	20.37	230.16	330.59	116.18	20.37	0.00	0.00	0.00	0.00
Primary Treatment(2000)	2000	247.16	375.40	130.24	23.17	247.16	316.38	126.45	22.80	0.00	59.02	3.79	0.37
Secondary Treatment(2010)	2010	262.27	415.33	142.76	25.68	262.27	313.87	135.47	24.96	0.00	101.46	7.29	0.72
Ocean outfall(1)	2010	262.27	415.33	142.76	25.68	225.78	309.58	114.29	20.15	36.49	105.75	28.47	5.53
Ocean outfall(2)	2010	262.27	415.33	142.76	25.68	231.18	316.36	118.08	20.94	31.09	98.97	24.68	4.74
Ocean outfall(3)	2010	262.27	415.33	142.76	25.68	235.70	324.02	122.49	21.67	26.57	91.31	20.27	4.01
Ocean outfall(4)	2010	262.27	415.33	142.76	25.68	253.73	348.23	136.37	24.42	8.54	67.10	6.39	1.26
Secondary Treatment + Optional Treatment	2010	262.27	415.33	142.76	25.68	262.27	260.17	132.00	24.63	0.00	155.16	10.76	1.05

CHAPTER 7

THE WATER QUALITY OBSERVATION METHOD PROPOSED FOR TIDAL RIVERS

Chapter 7

The Water Quality Observation Method Proposed for Tidal Rivers

River water quality monitoring will be carried out based on the following two objectives: to maintain the river water quality standard and to determine the runoff load in Guanabara Bay.

The river observation stations established in this project are either located in non tidal or tidal zones. The observation stations of rivers discharging large water volumes and loads into Guanabara Bay are mainly located in tidal zones. The water quality and discharge of tidal rivers undergoes complex changes due to tidal effects, therefore, the establishment of monitoring stations within this area should be avoided.

In terms of accessibility, only a few stations, apart from those to be established, are considered as suitable monitoring sites. However, since water quality monitoring in tidal zones must be continuously carried out, the following observation methods are deemed appropriate.

7.1 Observation to Determine the Pollution Level in Rivers

The river water quality standard was established as the government's target to maintain the water quality appropriate for the use of the river.

It is, therefore, desirable to carry continuous observations on rainy days, once every month, 1 - 4 times a day.

The pollution level in tidal zones should is best measured by (1) selecting ebb tidal periods from the tidal level chart, (2) confirming that sea water influence is minimized a electric conductivity and salinity concentration meter should be used.

Although samples from non tidal rivers should be taken at a depth of 20% of the river depth from the water surface, it is necessary to take samples from several depths in tidal rivers in accordance with the degree of mixting of the water in the upper and lower layers.

For example, a total of 4 samples were taken from the upper and lower layers on the right and left banks of the Rio S.J.de Meriti, a comparatively deep and wide river, is very much desired to analyze water quality in terms of the degree the water from the upper and lower layers has mixed.

The proposed water quality measurement plan for each river (sampling frequency, sampling water level, lateral flow velocity) is as shown in **Table 7-1**.

7.2 Measurements to Determine Runoff Load in Clear Days

Due to the complex changes in the discharge and water quality in the tidal zones and the periodical use of the current, tidal influence can be removed by measuring the mean discharge and water quality in two tidal periods and in similar tidal phases, and by taking the mean of these two measurements.

Therefore, it is better to determine the load of tidal rivers through the quasi-constant analysis of the results of the 24 hour continuous measurement (continuous measurements carried out in the 2 tidal periods at an interval of 1 or 2 hours). There are specifically 3 methods used for analysis: the tidal prism method, the method using the mixing coefficient, and the method using the dispersion equation. Since these methods may not bring favorably accurate results, the numerical value of the non-constant dispersion equation method will be used for precise calculations.

As previously mentioned, the state of the water quality in the tidal zones, which varies due to the mixture of fresh and sea water, should be fully understood.

Generally, a weakly mixed type is indicated when the ratio of natural flow and tidal prism (difference between the water volume in the tidal zone during high tide and ebb tide) exceeds 0.7; a ratio ranging from 0.2 - 0.5 indicates a partially mixed-type, while less than 0.1 possibly indicates a well mixed type.

The calculation method that can be presently used is one for tidal rivers categorized under the well mixed type. Hence, the other mixture categories will either be treated like the well mixed type by using the mean concentration of salinity measured at different depths, or will be calculated as being made up of 2 layers which are divided by the boundary of salinity discontinuity.

The mean flow and load discharged into Guanabara Bay will be actually determined by calculating the flow and load of the 9 large tidal rivers, starting with the Rio S.J.de Meriti. The tidal level disparities of these rivers will be calculated by carrying out 24 hour measurements on clear days (continuous measurements in the two tidal periods at 1 or 2 hour intervals) in average periods, once in the rainy season and again in the dry season; the measured value should be subject to quasi-constant analysis. Recording all sampling times is, therefore, very important.

7.3 Measurements to Determine the Runoff Load on Rainy Days

The runoff load on rainy days will be determined using the runoff load estimation model, and the method to be used to determine regression is simple and accurate (see **Fig.7-1**).

In this survey, the Rio Acari and Rio Macacu were selected as the urban and natural type model rivers, and the relation of the urban area ratio and runoff load was determined. In the future, the relation of the urban area ratio and runoff load should be further studied by carrying out observations on clear and rainy days in model rivers (non tidal rivers) whose land use conditions are neither urban nor natural, but somewhere in between.

It is also important to determine the runoff load in the first flush which occurs due to shift in seasons.

The following points should be heeded upon in the water quality analysis on rainy days:

(1) The concentration of pollutants is well known to be high in the first stage of rainfall. Therefore, a 15 minute interval should be taken for observations in medium and small size rivers, 30 - 60 minute interval for large rivers; after the appearance of the peak flow volume, measurements in medium and small size rivers should be carried out at an interval of 30 - 60 minutes and 1 - 3 hours for large rivers.

(2) As a rule, measurement on rainy days should be continuously carried out from the time directly prior to rainfall until the flow has returned to the amount it was before rainfall.

7.4 Measurements to Determine the Annual Runoff Load

Annual runoff load will be determined by summing the runoff load on clear days and rainy days.

The load discharged in Guanabara Bay should be measured monthly and seasonally as water quality in the bay is considered to also vary monthly and seasonally.

Table 7- 1 The Proposed Water Quality Measurement Plan for Each River

No	Name	Covered Basin Area (Km2)	NO.	Frequency of Measurement: Hourly Change Measurement (13 times within a day)	Frequency of Measurement: Regular Measurement (Once a month)	Discharge Measurement: Number of Measurement lines for Velocity (No. of lines)	Sampling Depth (No. of Points)
1 CI780	CANAL CANTO DO RIO	7.40	2		12	4	
2 BM760	RIO BOMBA	3.40	5		12	2	
3 IB810	RIO IMBOASSU	11.60	6		12	2	
4 AN740	RIO ALCANTARA	58.50	8		12	1	
5 MT820	RIO MUTONDO	5.50	8		12	1	
6 GX720	RIO GUAXINDIBA	11.80	8		12	2	
7 CC622	RIO CACEREBU	758.40	9	2	12	3	
8 GP600	RIO GUAPIMIRIM	1233.70	10	2	12	4	
*9 MC967	RIO MACACU	256.00	10-3		12	3	
*10 SB998	RIO SOBERBO	45.20	10-6		12	4	
11 MG580	CANAL DE MAGE	4.60	11		12	2	
12 RN560	RIO RONCADOR	107.00	12		12	2	
13 IR540	RIO IRIRI	8.40	13		12	1	
14 SR500	RIO SURUI	53.20	14		12	2	
15 ES400	RIO ESTRELA	342.50	16	2	12	5	
*16 IN460	RIO INHOMIRIM	139.00	16-2		12	2	
*17 SC420	RIO SARACURUNA	186.00	16-3		12	2	
18 IA260	RIO IGUACU	544.20	17-1~5	2	12	3	
19 SP300	RIO SARAPUI	159.80	17-6	2	12	2	
20 SJ220	RIO S.J.DE MERITI	163.50	19	2	12	5	2
*21 AC241	RIO ACARI	57.90	19-2		12	4	
22 IJ200	RIO IRAJA	27.30	20	2	12	3	
23 PN180	CANAL DO PENHA	-	20		12	3	
24 CN100	CANAL DO CUNHA	60.50	21	2	12	3	
25 MN000	CANAL DO MANGUE	42.80	23	2	12	3	
	TOTAL	3604.10					

Notes;twice a year(once during dry season,once during rainy season)

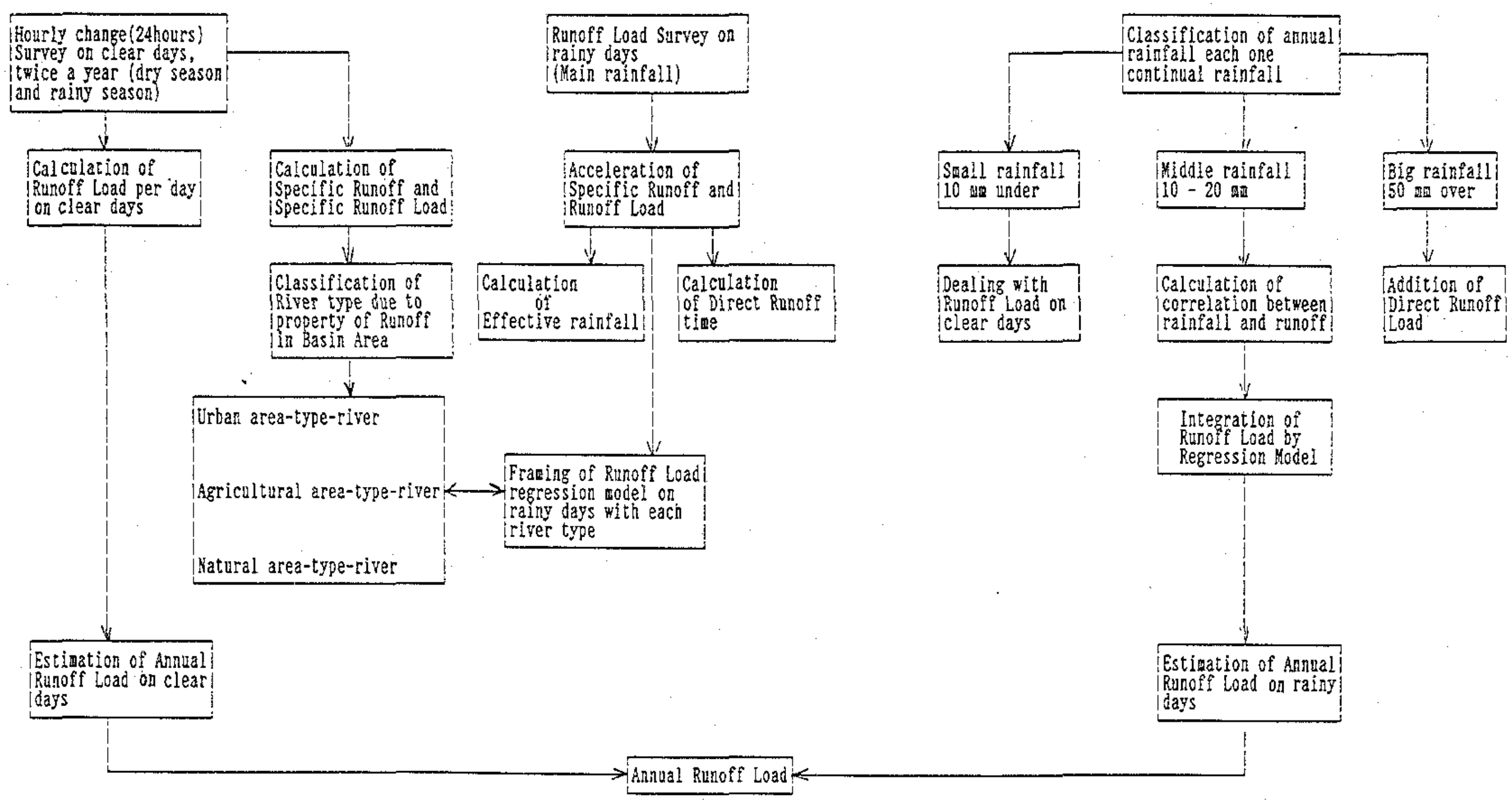


Fig. 7- 1 The Proposed Runoff Load Estimation Model

APPENDIX

APPENDIX 1

RESULTS OF REGULAR SURVEY ON THE MAJOR 25 RIVERS ON CLEAR DAYS

Table APP. 1-1 Mean Water Quality of Regular Survey (May 1992 to Apr. 1993)

(BOD) (1992 - 1993)

(unit : mg/l)

No	Name	Covered Basin Area (Km2)	NO.	Basin Area (Km2)	Population Number	Population Density (p/km2)	Land use Type	1	2	3	4	5	6	7	8	9	Mean Value	Class
								1992						1993				
								MAY	JUN	AUG	SEP	OCT	NOV	FEB	MAR	APR		
1 CI780	CANAL CANTO DO RIO	7.40	2	7.40	41.745	5.64	Urb/S.T	24	26	20	<2	40	4	40	60	18	26.0	④
2 BM760	RIO BOMBA	3.40	5	26.20	183.099	6.99	Urban	80	105	40	40	100	48	130	80	50	74.8	④
3 IB810	RIO IMBOASSU	11.60	6	30.80	138.636	4.50	Urban	12	10	4	2	8	8	6	4	25	8.8	③
4 AN740	RIO ALCANTARA	58.50	8	144.60	470.420	3.25	Urban	140	150	-	150	330	140	*2900	960	90	613.8	④
5 MT820	RIO MUTONDO	5.50	8			3.25	Urban	40	116	30	40	90	24	70	45	70	58.3	④
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban	12	9	20	4	12	1	8	18	20	11.6	④
7 CC622	RIO CACEREBU	758.40	9	846.70	336.193	0.40	N/A	20	5	12	2	8	2	3	12	16	8.9	③
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69.853	0.06	N/A	8	<2.0	<2.0	<2.0	2	1	<2.0	2	4	2.8	①
*9 MC967	RIO MACACU	256.00	10-3	256.00	18.577	0.07	N/A	<2	<2.0	<2.0	<2.0	<2.0	0	<2	<2.0	<2.0	1.8	①
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17.911	0.14	N/A	96	160	120	13	20	13	50	13	12	55.2	④
11 MG580	CANAL DE MAGE	4.60	11	18.30	8.458	0.46	N/A	42	50	30	16	12	20	40	12	30	28.0	④
12 RN560	RIO RONCADOR	107.00	12	111.40	36.370	0.33	N/A	<2	4	3	<2	<2.0	2	<2.0	<2.0	<2.0	2.3	①
13 IR540	RIO IRIRI	8.40	13	27.80	10.684	0.38	N/A	3	3	4	4	12	12	3	4	10	6.2	③
14 SR500	RIO SURUI	53.20	14	68.80	12.910	0.19	N/A	3	6	6	<2	<2.0	2	5	3	2	3.5	②
15 ES400	RIO ESTRELA	342.50	16	342.50	302.495	0.88	N/A	6	12	40	4	20	4	10	20	20	15.1	④
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84.106	0.61	N/A	2	2	4	<2	3	1	2	4	<2.0	2.6	①
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194.173	1.04	N/A	13	5	20	2	20	3	7	10	6	9.7	③
18 IA260	RIO IGUACU	544.20	17-1~5	562.80	758.010	1.35	N/A	8	12	20	6	10	8	6	8	4	9.2	③
19 SP300	RIO SARAPUI	159.80	17-6	155.50	1.012.275	6.12	Urban	24	35	40	20	30	16	18	20	30	25.9	④
20 SJ220	RIO S.J.DE MERITI	163.50	19	164.50	1.492.458	9.07	Urban	20	38	40	16	10	16	12	40	30	24.7	④
*21 AC241	RIO ACARI	57.90	19-2	57.90	438.076	7.57	Urban	40	68	-	-	40	6	16	30	50	35.7	④
22 IJ200	RIO IRAJA	27.30	20	35.70	500.276	14.01	Urban	90	65	30	20	60	64	16	40	65	50.0	④
23 PN180	CANAL DO PENHA	-	20	-				40	117	30	12	70	44	12	50	70	49.4	④
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815.389	12.82	Urban	50	53	25	14	80	44	20	45	120	50.1	④
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500.876	11.70	Urb/S.T	70	65	20	14	30	76	30	30	65	44.4	④
	TOTAL	3604.10		3912.50	6.690.147													

*:excluded data

Class 1: 3mg/l or less
2: 5mg/l or less
3: 10mg/l or less
4: 10mg/l more

Table APP. 1-1 Mean Water Quality of Regular Survey (May 1992 to Apr. 1993)

(COD(Cr)) ·· (1992 - 1993)

(unit : mg/l)

No	Name	Covered Basin Area (Km2)	NO.	Basin Area (Km2)	Population Number	Population Density (p/km2)	Land use Type	1	2	3	4	5	6	7	8	9	Mean Value
								1992						1993			
								MAY	JUN	AUG	SEP	OCT	NOV	FEB	MAR	APR	
1 CI780	CANAL CANTO DO RIO	7.40	2	7.40	41.745	5.64	Urb/S.T	38	51	100	60	130	70	75	70	75	74.3
2 BM760	RIO BOMBA	3.40	5	26.20	183.099	6.99	Urban	80	119	110	140	360	210	320	100	280	191.0
3 IB810	RIO IMBOASSU	11.60	6	30.80	138.636	4.50	Urban	-	-	-	-	-	-		1440		1440.0
4 AN740	RIO ALCANTARA	58.50	8	144.60	470.420	3.25	Urban	140	249	-	350	925	25		-		337.8
5 MT820	RIO MUTONDO	5.50	8			3.25	Urban	69	124	120	140	260	90	110	60	160	125.9
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban	33	28	70	40	60	40	30	40	55	44.0
7 CC622	RIO CACEREBU	758.40	9	846.70	336.193	0.40	N/A	25	16	-	40	30	40	50	40	40	35.2
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69.853	0.06	N/A	9	10	10	55	15	15	10	30	30	20.4
*9 MC967	RIO MACACU	256.00	10-3	256.00	18.577	0.07	N/A	6	4	<10	15	<10	15	<10	10	<10	10.0
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17.911	0.14	N/A	270	230	220	60	75	50	80	15	30	114.4
11 MG580	CANAL DE MAGE	4.60	11	18.30	8.458	0.46	N/A	180	79	50	80	70	70	60	40	120	83.2
12 RN560	RIO RONCADOR	107.00	12	111.40	36.370	0.33	N/A	17	10	20	10	20	15	<10	15	14	14.5
13 IR540	RIO IRIRI	8.40	13	27.80	10.684	0.38	N/A	61	23	-	40	65	50	50	35	40	45.5
14 SR500	RIO SURUI	53.20	14	68.80	12.910	0.19	N/A	52	16	30	15	20	15	30	15	16	23.2
15 ES400	RIO ESTRELA	342.50	16	342.50	302.495	0.88	N/A	38	-	-	-	-	30	20	40	40	33.6
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84.106	0.61	N/A	13	9	20	15	30	<10	20	<10	10	15.2
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194.173	1.04	N/A	38	18	40	6	30	15	25	10	35	24.1
18 IA260	RIO IGUACU	544.20	17-1~5	562.80	758.010	1.35	N/A	45	15	-	40	-	40	65	25	30	37.1
19 SP300	RIO SARAPUI	159.80	17-6	165.50	1.012.275	6.12	Urban	38	40	100	75	75	60	70	20	140	68.7
20 SJ220	RIO S.J.DE MERITI	163.50	19	164.50	1.492.458	9.07	Urban	-	43	430	55	220	170	60	40	140	144.8
*21 AC241	RIO ACARI	57.90	19-2	57.90	438.076	7.57	Urban	49	84	-	-	110	50	30	50	130	71.9
22 IJ200	RIO IRAJA	27.30	20	35.70	500.276	14.01	Urban	90	74	90	60	210	120	70	40	190	104.9
23 PN180	CANAL DO PENHA	-	20	-				54	159	-	60	320	90	20	60	210	121.6
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815.389	12.82	Urban	56	57	100	60	180	90	50	45	250	98.7
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500.876	11.70	Urb/S.T	70	81	130	40	185	160	130	60	185	115.7
TOTAL		3604.10		3912.50	6.690.147												

Table APP. 1-1 Mean Water Quality of Regular Survey (May 1992 to Apr. 1993)

- (COD(Mn)) (1992 - 1993)

(unit:mg/l)

No	Name	Covered Basin Area (Km2)	NO.	Basin Area (Km2)	Population Number	Population Density (p/Km2)	Land use Type	1	2	3	4	5	6	7	8	9	Mean Value
								1992 MAY	1992 JUN	1992 AUG	1992 SEP	1992 OCT	1992 NOV	1993 FEB	1993 MAR	1993 APR	
1 CI780	CANAL CANTO DO RIO	7.40	2	7.40	41.745	5.64	Urb/S.T	9.3	10.5	10.2	10.2	11.6	10.0	4.0	23.0	11.0	11.1
2 BM760	RIO BOMBA	3.40	5	26.20	183.099	6.99	Urban	20.2	32.5	9.2	11.8	56.0	9.8	62.0	11.8	11.4	25.0
3 IB810	RIO IMBOASSU	11.60	6	30.80	138.636	4.50	Urban	11.3	9.5	10.6	12.6	10.0	7.8	9.6	9.4	23.0	11.5
4 AN740	RIO ALCANTARA	58.50	8	144.60	470.420	3.25	Urban	21.5	23.5	-	92.0	116.0	460.0	620.0	11.6	22.8	170.9
5 MT820	RIO MUTONDO	5.50	8			3.25	Urban	17.5	26.5	9.8	11.0	50.0	11.0	22.0	11.0	21.6	20.0
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban	9.1	9.3	9.0	10.4	11.2	9.6	11.2	14.8	10.0	10.5
7 CC622	RIO CACEREBU	758.40	9	846.70	336.193	0.40	N/A	8.9	6.5	8.8	10.4	10.0	9.4	9.0	12.2	10.4	9.5
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69.853	0.06	N/A	6.9	3.5	3.8	9.6	7.2	5.8	3.4	7.2	7.4	6.1
*9 MC967	RIO MACACU	256.00	10-3	256.00	18.577	0.07	N/A	2.1	1.9	1.8	3.4	3.0	1.8	2.2	5.8	0.8	2.5
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17.911	0.14	N/A	32.5	52.5	36.0	10.2	11.8	10.4	24.0	9.2	7.0	21.5
11 MG580	CANAL DE MAGE	4.60	11	18.30	8.458	0.46	N/A	25.5	24.5	10.2	22.0	10.6	10.2	11.4	9.8	21.0	16.1
12 RN560	RIO RONCADOR	107.00	12	111.40	36.370	0.33	N/A	4.5	3.1	4.0	5.4	6.6	3.8	4.0	5.0	3.4	4.4
13 IR540	RIO IRIRI	8.40	13	27.80	10.684	0.38	N/A	21.5	12.5	8.6	11.2	12.0	11.0	10.6	9.2	12.0	12.1
14 SR500	RIO SURUI	53.20	14	68.80	12.910	0.19	N/A	5.1	5.3	5.6	4.6	8.0	4.8	5.2	8.2	5.4	5.8
15 ES400	RIO ESTRELA	342.50	16	342.50	302.495	0.88	N/A	7.9	9.5	14.0	9.2	7.8	5.4	9.0	7.6	2.4	8.1
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84.106	0.61	N/A	3.1	3.3	4.8	4.0	6.4	2.2	3.0	4.0	2.4	3.7
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194.173	1.04	N/A	5.5	2.7	6.6	2.6	7.0	1.0	2.2	3.0	2.6	3.7
18 IA260	RIO IGUACU	544.20	17-1~5	562.80	758.010	1.35	N/A	8.1	7.7	16.0	10.6	9.0	1.8	7.2	7.0	5.6	8.1
19 SP300	RIO SARAPUI	159.80	17-6	165.50	1.012.275	6.12	Urban	9.3	10.3	20.0	10.4	9.6	9.2	10.4	9.6	20.0	12.1
20 SJ220	RIO S.J.DE MERITI	163.50	19	164.50	1.492.458	9.07	Urban	9.1	49.5	24.0	10.0	3.2	24.0	10.2	8.4	15.0	17.0
*21 AC241	RIO ACARI	57.90	19-2	57.90	438.076	7.57	Urban	9.1	21.5	-	-	11.2	1.0	10.4	7.0	19.5	11.4
22 IJ200	RIO IRAJA	27.30	20	35.70	500.276	14.01	Urban	21.2	19.5	26.0	10.0	1.6	10.8	11.2		22.0	15.3
23 PN180	CANAL DO PENHA	-	20	-				10.0	28.5	28.0	10.4	5.6	10.4	10.6		22.0	15.7
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815.389	12.82	Urban	9.7	10.5	20.0	9.8	4.6	10.4	10.0	3.6	27.0	11.7
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500.876	11.70	Urb/S.T	10.1	25.5	14.0	7.8	12.0	10.6	-	7.6	18.4	13.3
TOTAL		3604.10		3912.50	6.690.147												

Table APP. 1-1 Mean Water Quality of Regular Survey (May 1992 to Apr. 1993)

(TN) (1992 - 1993)

(unit : mg/l)

No	Name	Covered Basin Area (Km2)	NO.	Basin Area (Km2)	Population Number	Population Density (p/km2)	Land use Type	1	2	3	4	5	6	7	8	9	Mean Value
								1992						1993			
								MAY	JUN	AUG	SEP	OCT	NOV	FEB	MAR	APR	
1 CI780	CANAL CANTO DO RIO	7.40	2	7.40	41.745	5.64	Urb/S.T	7.65	17.11	20.05	10.51	22.12		13.08	12.13	14.11	14.6
2 BM760	RIO BOMBA	3.40	5	26.20	183.099	6.99	Urban	8.02	40.05	24.13	15.45	28.07		34.05	17.21	20.02	23.4
3 IB810	RIO IMBOASSU	11.60	6	30.80	138.636	4.50	Urban	3.16	9.08	3.94	2.44	4.05		1.83	3.10	4.01	4.0
4 AN740	RIO ALCANTARA	58.50	8	144.60	470.420	3.25	Urban	5.50	22.08	70.14	11.60	15.08		35.00	21.01	18.01	24.8
5 MT820	RIO MUTONDO	5.50	8			3.25	Urban	21.20	30.07	20.17	13.40	29.06		23.02	9.30	15.01	20.2
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban	6.09	15.07	16.09	6.95	4.60		16.01	5.50	5.10	9.4
7 CC622	RIO CACEREBU	758.40	9	846.70	336.193	0.40	N/A	1.21	2.13	1.43	2.23	1.76		1.05	1.44	1.65	1.6
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69.853	0.06	N/A	0.90	0.36	0.75	0.96	1.36		0.46	1.06	1.31	0.9
*9 MC967	RIO MACACU	256.00	10-3	256.00	18.577	0.07	N/A	0.75	0.51	0.75	0.55	0.90		0.41	1.30	0.40	0.7
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17.911	0.14	N/A	1.04	2.15	1.55	1.42	1.31		0.52	0.81	0.51	1.2
11 MG580	CANAL DE MAGE	4.60	11	18.30	8.458	0.46	N/A	12.03	3.82	18.04	7.15	8.09		10.00	7.00	8.04	9.3
12 RN560	RIO RONCADOR	107.00	12	111.40	36.370	0.33	N/A	0.62	1.12	1.53	0.81	0.71		0.81	0.32	0.71	0.8
13 IR540	RIO IRIRI	8.40	13	27.80	10.684	0.38	N/A	1.43	1.91	1.29	0.91	4.31		1.46	0.44	0.60	1.5
14 SR500	RIO SURUI	53.20	14	68.80	12.910	0.19	N/A	0.93	0.91	1.31	0.60	1.46		1.01	0.37	0.60	0.9
15 ES400	RIO ESTRELA	342.50	16	342.50	302.495	0.88	N/A	2.84	4.09	4.04	1.32	2.42		1.63	1.08	2.00	2.4
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84.106	0.61	N/A	1.63	1.77	2.06	1.31	1.72		1.24	3.86	0.76	1.8
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194.173	1.04	N/A	2.48	2.20	2.27	1.41	3.01		1.63	4.25	1.27	2.3
18 IA260	RIO IGUACU	544.20	17-1~5	562.80	758.010	1.35	N/A	2.43	4.15	10.04	3.39	5.02		4.03	6.00	3.14	4.8
19 SP300	RIO SARAPUI	159.80	17-6	165.50	1.012.275	6.12	Urban	20.16	24.03	10.18	10.40	10.01		10.08	15.05	16.01	14.5
20 SJ220	RIO S.J.DE MERITI	163.50	19	164.50	1.492.458	9.07	Urban	20.07	17.10	13.03	9.90	10.04		9.03	13.01	12.02	13.0
*21 AC241	RIO ACARI	57.90	19-2	57.90	438.076	7.57	Urban	9.03	18.21	-	-	11.04		10.03	8.06	10.03	11.1
22 IJ200	RIO IRAJA	27.30	20	35.70	500.276	14.01	Urban	24.11	21.04	10.46	8.00	14.05		14.01	9.12	9.01	13.7
23 PN180	CANAL DO PENHA	-	20	-				22.10	19.04	10.22	9.60	21.04		13.01	7.04	12.01	14.3
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815.389	12.82	Urban	16.10	14.06	10.50	8.80	17.03		10.04	5.06	17.01	12.3
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500.876	11.70	Urb/S.T	19.09	12.51	8.41	8.35	12.06		10.40	13.02	13.03	12.1
TOTAL		3604.10		3912.50	6.690.147												

Table APP. 1-1 Mean Water Quality of Regular Survey (May 1992 to Apr. 1993)

(TP) (1992 - 1993)

(unit : mg/l)

No	Name	Covered Basin Area (Km2)	NO.	Basin Area (Km2)	Population Number	Population Density (p/km2)	Land use Type	1	2	3	4	5	6	7	8	9	Mean Value
								1992						1993			
								MAY	JUN	AUG	SEP	OCT	NOV	FEB	MAR	APR	
1 CI780	CANAL CANTO DO RIO	7.40	2	7.40	41.745	5.64	Urb/S.T	1.00	1.50	1.40	0.65	2.10	1.00	1.60	1.00	0.30	1.17
2 BM760	RIO BOMBA	3.40	5	26.20	183.099	6.99	Urban	3.00	4.00	3.00	2.70	4.20	2.00	6.00	3.20	2.45	3.39
3 IB810	RIO IMBOASSU	11.60	6	30.80	138.636	4.50	Urban	0.60	1.00	0.60	0.50	0.70	0.45	0.50	0.45	0.65	0.61
4 AN740	RIO ALCANTARA	58.50	8	144.60	470.420	3.25	Urban	2.50	4.00	62.00	4.30	11.00	30.00	22.00	9.00	2.70	16.39
5 MT820	RIO MUTONDO	5.50	8			3.25	Urban	3.00	4.00	3.20	2.90	4.30	2.50	4.00	1.20	2.80	3.10
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban	1.50	2.00	2.50	0.60	1.20	1.00	3.20	1.40	0.65	1.56
7 CC622	RIO CACEREBU	758.40	9	846.70	336.193	0.40	N/A	0.20	0.10	0.10	0.40	0.20	0.45	0.15	0.60	0.30	0.28
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69.853	0.06	N/A	0.09	0.05	0.04	0.10	0.15	0.10	0.09	0.04	0.07	0.08
*9 MC967	RIO MACACU	256.00	10-3	256.00	18.577	0.07	N/A	0.08	0.05	0.04	0.07	0.09	0.08	0.08	0.25	0.05	0.09
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17.911	0.14	N/A	0.20	0.40	0.25	0.10	0.20	0.08	0.20	0.20	0.05	0.19
11 MG580	CANAL DE MAGE	4.60	11	18.30	8.458	0.46	N/A	2.00	3.00	2.50	1.30	0.60	1.50	2.20	0.80	0.80	1.63
12 RN560	RIO RONCADOR	107.00	12	111.40	36.370	0.33	N/A	0.10	0.09	0.20	0.08	0.06	0.08	0.07	0.20	0.15	0.11
13 IR540	RIO IRIRI	8.40	13	27.80	10.684	0.38	N/A	0.35	0.20	0.25	0.20	0.45	0.30	0.30	0.30	0.20	0.28
14 SR500	RIO SURUI	53.20	14	68.80	12.910	0.19	N/A	0.15	0.25	0.20	0.07	0.10	0.10	0.20	0.25	0.10	0.16
15 ES400	RIO ESTRELA	342.50	16	342.50	302.495	0.88	N/A	0.35	1.00	0.70	0.20	0.45	0.20	0.30	0.40	0.30	0.43
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84.106	0.61	N/A	0.20	0.20	0.20	0.09	0.10	0.08	0.15	0.15	0.08	0.14
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194.173	1.04	N/A	0.20	0.10	0.10	0.09	0.20	0.08	0.15	0.06	0.07	0.12
18 IA260	RIO IGUACU	544.20	17-1~5	562.80	758.010	1.35	N/A	0.50	1.50	1.40	0.60	0.75	0.35	1.00	0.40	0.45	0.77
19 SP300	RIO SARAPUI	159.80	17-6	165.50	1.012.275	6.12	Urban	2.00	3.50	1.60	1.20	1.70	2.00	3.10	2.10	2.20	2.16
20 SJ220	RIO S.J. DE MERITI	163.50	19	164.50	1.492.458	9.07	Urban	2.00	2.00	2.00	0.80	1.20	2.00	1.70	1.90	1.45	1.67
*21 AC241	RIO ACARI	57.90	19-2	57.90	438.076	7.57	Urban	2.00	3.00	-	-	1.65	1.50	1.70	1.80	2.35	2.00
22 IJ200	RIO IRAJA	27.30	20	35.70	500.276	14.01	Urban	3.00	3.00	1.20	1.00	2.15	2.00	2.20	2.30	1.80	2.07
23 PN180	CANAL DO PENHA	-	20	-				3.00	3.00	1.30	0.80	3.45	2.00	2.40	2.70	2.00	2.29
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815.389	12.82	Urban	3.00	2.00	1.10	0.70	2.00	2.00	2.00	1.90	1.70	1.82
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500.876	11.70	Urb/S.T	3.50	2.00	1.10	0.70	2.60	2.00	2.00	1.80	1.75	1.94
TOTAL		3604.10		3912.50	6.690.147												

Table APP. 1-1 Mean Water Quality of Regular Survey (May 1992 to Apr. 1993)

(DO) (1992 - 1993)

(unit : mg/l)

No	Name	Covered Basin Area (Km2)	NO.	Basin Area (Km2)	Population Number	Population Density (p/km2)	Land use Type	1	2	3	4	5	6	7	8	9	Mean Value
								1992						1993			
								MAY	JUN	AUG	SEP	OCT	NOV	FEB	MAR	APR	
1 CI780	CANAL CANTO DO RIO	7.40	2	7.40	41.745	5.64	Urb/S.T	2.5	3.1	3.8	3.8	2.0	2.1	1.6	3.2	2.7	2.8
2 BM760	RIO BOMBA	3.40	5	26.20	183.099	6.99	Urban	2.5	1.8	2.6	2.0	1.8	1.5	0.8	0.6	1.5	1.7
3 IB810	RIO IMBOASSU	11.60	6	30.80	138.636	4.50	Urban	2.1	2.0	3.1	2.7	1.1	2.2	4.3	4.2	1.1	2.5
4 AN740	RIO ALCANTARA	58.50	8	144.60	470.420	3.25	Urban	4.5	2.3	5.2	5.9	2.1	3.8	1.1	6.1	4.2	3.9
5 MT820	RIO MUTONDO	5.50	8			3.25	Urban	0.4	0.5	0.9	1.2	0.0	0.5	1.5	5.1	0.5	1.2
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban	0.3	0.4	0.4	1.7	0.4	0.9	0.6	4.5	2.6	1.3
7 CC622	RIO CACEREBU	758.40	9	846.70	336.193	0.40	N/A	0.4	1.9	3.4	2.7	1.0	1.3	2.6	1.8	0.7	1.8
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69.853	0.06	N/A	3.2	1.1	2.4	3.9	6.7	5.4	3.3	4.2	4.0	3.8
*9 MC967	RIO MACACU	256.00	10-3	256.00	18.577	0.07	N/A	7.9	1.7	8.8	8.9	5.7	8.9	3.3	7.9	8.9	6.9
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17.911	0.14	N/A	2.5	1.3	1.2	7.5	2.6	8.1	1.4	7.0	7.2	4.3
11 MC580	CANAL DE MAGE	4.60	11	18.30	8.458	0.46	N/A	2.4	0.4	0.4	0.9	0.5	0.2	0.9	2.8	1.1	1.1
12 RN560	RIO RONCADOR	107.00	12	111.40	36.370	0.33	N/A	7.3	1.9	6.6	7.7	4.8	7.9	3.9	6.9	7.7	6.1
13 IR540	RIO IRIRI	8.40	13	27.80	10.684	0.38	N/A	0.8	0.5	2.7	1.7	0.4	0.8	1.6	2.1	0.7	1.3
14 SR500	RIO SURUI	53.20	14	68.80	12.910	0.19	N/A	2.9	1.7	7.8	4.7	5.7	4.2	2.9	4.9	4.5	4.4
15 ES400	RIO ESTRELA	342.50	16	342.50	302.495	0.88	N/A	0.4	0.3	0.4	1.6	0.1	0.7	3.2	2.3	0.4	1.0
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84.106	0.61	N/A	2.8	1.7	1.2	5.4	7.0	0.5	1.7	5.4	6.3	3.6
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194.173	1.04	N/A	1.5	0.7	0.5	6.6	1.4	7.3	1.6	4.6	5.2	3.3
18 IA260	RIO IGUACU	544.20	17-1~5	562.80	758.010	1.35	N/A	0.3	0.3	0.8	3.0	0.2	0.6	1.1	3.3	0.4	1.1
19 SP300	RIO SARAPUI	159.80	17-6	165.50	1.012.275	6.12	Urban	0.3	0.3	0.2	3.4	0.3	0.3	1.0	0.4	0.3	0.7
20 SJ220	RIO S.J. DE MERITI	163.50	19	164.50	1.492.458	9.07	Urban	0.4	0.3	0.2	0.3	0.0	0.2	2.2	0.6	0.2	0.5
*21 AC241	RIO ACARI	57.90	19-2	57.90	438.076	7.57	Urban	2.3	0.3	-	-	0.0	7.0	1.8	2.2	0.1	2.0
22 IJ200	RIO IRAJA	27.30	20	35.70	500.276	14.01	Urban	0.3	0.3	1.1	4.1	0.0	0.2	0.9	0.6	0.2	0.9
23 PN180	CANAL DO PENHA	-	20	-				0.3	0.4	0.3	0.3	0.3	0.2	1.1	0.6	0.2	0.4
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815.389	12.82	Urben	0.2	0.4	0.3	2.0	0.4	0.2	1.5	0.2	0.3	0.6
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500.876	11.70	Urb/S.T	0.6	0.5	0.5	2.0	0.4	0.5	1.2	0.6	0.3	0.7
	TOTAL	3604.10		3912.50	6.690.147												

Table APP. 1-1 Mean Water Quality of Regular Survey (May 1992 to Apr. 1993)

(Total Coli x 1000) (1992 - 1993)

(MPN/100ml)

No	Name	Covered Basin Area (Km2)	NO.	Basin Area (Km2)	Population Number	Population Density (p/km2)	Land use Type	1	2	3	4	5	6	7	8	9	Mean Value
								1992						1993			
								MAY	JUN	AUG	SEP	OCT	NOV	FEB	MAR	APR	
1 CI780	CANAL CANTO DO RIO	7.40	2	7.40	41.745	5.64	Urb/S.T	3000		9000	>160	9000	5000	3000	2300	8000	5050
2 BM760	RIO BOMBA	3.40	5	26.20	183.099	6.99	Urban	50000		5000	>160	16000	24000	50000	90000	24000	42333
3 IB810	RIO IMBOASSU	11.60	6	30.80	138.636	4.50	Urban	800		80	90	240	500	23	1300	300	527
4 AN740	RIO ALCANTARA	58.50	8	144.60	470.420	3.25	Urban	22000		230	>160	30000	90000	16000	90000	50000	49667
5 MT820	RIO MUTONDO	5.50	8			3.25	Urban	30000		13000	>160	9000	30000	50000	30000	17000	27667
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban	300		170	50	500	300	80	30000	170	5225
7 CC622	RIO CACEREBU	758.40	9	846.70	336.193	0.40	N/A	5		-	30	17	21	3	50	23	20
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69.853	0.06	N/A	24		-	30	500	5	23	23	13	98
*9 MC967	RIO MACACU	256.00	10-3	256.00	18.577	0.07	N/A	30		-	-	90	230	1300	50	230	322
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17.911	0.14	N/A	24000		-	>160	110	30	50	1600	2200	4665
11 MG580	CANAL DE MAGE	4.60	11	18.30	8.458	0.46	N/A	90000		2400	>160	2300	16000	160000	50000	G1600	53317
12 RN560	RIO RONCADOR	107.00	12	111.40	36.370	0.33	N/A	230		22	50	5	130	50	50	80	91
13 IR540	RIO IRIRI	8.40	13	27.80	10.684	0.38	N/A	50		23	3	300	300	80	30	30	132
14 SR500	RIO SURUI	53.20	14	68.80	12.910	0.19	N/A	30		1300	24	230	300	50	240	50	150
15 ES400	RIO ESTRELA	342.50	16	342.50	302.495	0.88	N/A	300		-	160	80	-	2400	300	800	776
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84.106	0.61	N/A	230		2400	>160	230	-	130	800	300	338
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194.173	1.04	N/A	230		110	50	130	-	130	230	110	166
18 IA260	RIO IGUACU	544.20	17-1~5	562.80	758.010	1.35	N/A	3000		-	>160	2300	340	2100	2300	8000	3007
19 SP300	RIO SARAPUI	159.80	17-6	165.50	1.012.275	6.12	Urban	50000		-	>160	8000	8000	1700	24000	13000	17450
20 SJ220	RIO S.J.DE MERITI	163.50	19	164.50	1.492.458	9.07	Urban	13000		-	>160	80000	-	24000	8000	28000	30600
*21 AC241	RIO ACARI	57.90	19-2	57.90	438.076	7.57	Urban	50000		-	-	23000	-	30000	G16000	30000	29800
22 IJ200	RIO IRAJA	27.30	20	35.70	500.276	14.01	Urban	30000		-	>160	230000	160000	160000	G16000	9000	100833
23 PN180	CANAL DO PENHA	-	20	-				13000		-	>160	300000	90000	90000	G16000	9000	86333
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815.389	12.82	Urban	13000		-	>160	130000	90000	30000	G16000	3000	47000
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500.876	11.70	Urb/S.T	3000		-	>160	50000	-	50000	16000	1300	24060
TOTAL		3604.10		3912.50	6.690.147												

*:Tributary river(excluded from Total amount)
N/A : Natural and Agricutural use
Urban : Urban use
Urb/S.T: Urban Use with Sewage Treatments

Table APP. 1-2 Mean Runoff Load of Regular Survey (May 1992 to Apr. 1993)

Discharge .   (1992 - 1993)

No	Name	Covered Basin Area (Km2)	NO.	Basin Area (Km2)	Population Number	Population Density (p/km2)	Land use Type	1	2	3	4	5	6	7	8	9	Mean Value
								1992						1993			
								MAY	JUN	AUG	SEP	OCT	NOV	FEB	MAR	APR	
1 C1760	CANAL CANTO DO RIO	7.40	2	7.40	41.745	5.64	Urb/S.T	2.378	0.428			0.590	0.792	0.739	1.007	0.880	1.0
2 BM760	RIO BOMBA	3.40	5	26.20	183.099	6.99	Urban	0.109	0.124			0.129	0.162	0.095	0.060	0.092	0.1
3 IB810	RIO IMBOASSU	11.60	6	30.80	138.636	4.50	Urban	2.325	1.000			3.557	5.520	6.481	6.492	1.232	3.8
4 AN740	RIO ALCANTARA	58.50	8	144.60	470.420	3.25	Urban	0.067	0.051			0.081	0.066	0.036	0.121	0.121	0.1
5 MT820	RIO MUTONDO	5.50	8			3.25	Urban	0.208	0.167			0.159	0.398	0.122	0.110	0.194	0.2
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban	0.000	0.000			0.063	0.127	0.013	0.131	0.297	0.1
7 CC622	RIO CACEREBU	758.40	9	846.70	336.193	0.40	N/A	31.146	9.593			22.543	64.627	21.251	61.415	35.595	35.2
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69.853	0.06	N/A	27.218	10.992			39.847	76.334	31.239	133.665	55.268	53.5
*9 MC967	RIO MACACU	256.00	10-3	256.00	18.577	0.07	N/A	4.605	3.528			7.330	17.154	8.137	12.040	8.561	8.8
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17.911	0.14	N/A	1.019	0.721			1.054	2.651	0.832	1.990	2.020	1.5
11 MG580	CANAL DE MAGE	4.60	11	18.30	8.458	0.46	N/A	0.166	0.440			0.747	0.608	0.542	0.439	0.209	0.5
12 RN560	RIO RONCADOR	107.00	12	111.40	36.370	0.33	N/A	5.043	2.785			11.206	18.135	4.285	10.930	6.028	8.3
13 IR540	RIO IRIRI	8.40	13	27.80	10.684	0.38	N/A	0.062	0.018			0.605	0.808	0.291	1.905	0.142	0.5
14 SR500	RIO SURUI	53.20	14	68.80	12.910	0.19	N/A	4.943	2.971			5.418	4.138	2.490	7.504	3.655	4.4
15 ES400	RIO ESTRELA	342.50	16	342.50	302.495	0.88	N/A	14.065	23.354			54.223	27.846	47.778	40.166	22.322	32.8
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84.106	0.61	N/A	0.936	0.393			5.772	4.566	1.762	2.940	2.429	2.7
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194.173	1.04	N/A	2.514	2.292			3.803	3.523	2.405	2.430	3.935	3.0
18 IA260	RIO IGUACU	544.20	17-1~5	562.80	758.010	1.35	N/A	40.871	12.163			71.746	75.754	37.904	36.044	27.403	43.1
19 SP300	RIO SARAPUI	159.80	17-6	165.50	1.012.275	6.12	Urban	6.919	9.232			38.994	43.830	28.230	26.463	14.461	24.0
20 SJ220	RIO S.J. DE MERITI	163.50	19	164.50	1.492.458	9.07	Urban	29.455	10.417			56.067	53.595	9.706	28.905	33.887	31.7
*21 AC241	RIO ACARI	57.90	19-2	57.90	438.076	7.57	Urban	7.410	8.504			6.661	6.367	6.955	5.786	7.496	7.0
22 IJ200	RIO IRAJA	27.30	20	35.70	500.276	14.01	Urban	1.523	5.367			3.062	3.546	2.343	3.968	1.158	3.0
23 PN180	CANAL DO PENHA	-	20	-				0.683	0.682			1.378	0.951	0.880	0.681	2.095	1.1
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815.389	12.82	Urban	4.853	8.140			12.927	17.692	3.852	9.873	5.039	8.9
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500.876	11.70	Urb/S.T	3.018	3.014			5.125	8.686	3.717	8.605	3.620	5.1
TOTAL		3604.10		3912.50	6.690.147			175.05	100.94	0.00	0.00	328.47	403.62	201.99	378.48	213.76	

Notes : 1) * Tributary river(excluded from Total amount)
2) AUG, SEP: Not measured of discharge

N/A : Natural and Agricutural use
Urban : Urban use
Urb/S.T: Urban Use with Sewage Treatments

Table APP. 1-2 Mean Runoff Load of Regular Survey (May 1992 to Apr. 1993)

(BOD 1992 - 1993)

No	Name	Covered Basin Area (Km2)	NO.	Basin Area (Km2)	Population Number	Population Density (p/km2)	Land use Type	1	2	3	4	5	6	7	8	9	Mean Value
								1992						1993			
								MAY	JUN	AUG	SEP	OCT	NOV	FEB	MAR	APR	
1 CI780	CANAL CANTO DO RIO	7.40	2	7.40	41,745	5.64	Urb/S.T	4.93	0.96			2.04	0.27	2.55	5.22	1.37	2.5
2 BM760	RIO BOMBA	3.40	5	26.20	183,099	6.99	Urban	0.75	1.12			1.11	0.67	1.07	0.41	0.40	0.8
3 IB810	RIO IMBOASSU	11.60	6	30.80	138,636	4.50	Urban	2.41	0.86			2.46	3.82	3.58	2.24	2.79	2.6
4 AN740	RIO ALCANTARA	58.50	8	144.60	470,420	3.25	Urban	0.81	0.66			2.66	0.80	9.02	10.04	0.94	3.6
5 MT820	RIO MUTONDO	5.50	8			3.25	Urban	0.72	1.67			1.24	0.83	0.74	0.43	1.17	1.0
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban	0.00	0.00			0.07	0.01	0.01	0.20	0.51	0.1
7 CC622	RIO CACEREBU	758.40	9	846.70	336,193	0.40	N/A	53.82	4.14			15.58	11.17	5.14	63.68	49.21	29.0
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69,853	0.06	N/A	18.81	1.90			6.89	5.28	5.40	27.72	19.10	12.2
*9 MC967	RIO MACACU	256.00	10-3	256.00	18,577	0.07	N/A	0.80	0.61			1.27	0.59	1.41	2.08	1.48	1.2
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17,911	0.14	N/A	8.45	9.97			1.82	2.98	3.59	2.27	2.02	4.4
11 MG580	CANAL DE MAGE	4.60	11	18.30	8,458	0.46	N/A	0.60	1.90			0.77	1.05	1.87	0.46	0.54	1.0
12 RN560	RIO RONCADOR	107.00	12	111.40	36,370	0.33	N/A	0.87	0.96			1.94	2.51	0.74	1.89	1.04	1.4
13 IR540	RIO IRIRI	8.40	13	27.80	10,684	0.38	N/A	0.02	0.01			0.63	0.84	0.08	0.66	0.12	0.3
14 SR500	RIO SURUI	53.20	14	68.80	12,910	0.19	N/A	1.28	1.64			0.94	0.72	1.12	2.07	0.63	1.2
15 ES400	RIO ESTRELA	342.50	16	342.50	302,495	0.88	N/A	7.29	24.21			93.70	9.62	41.28	69.41	38.57	40.6
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84,106	0.61	N/A	0.19	0.07			1.60	0.47	0.37	1.02	0.42	0.6
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194,173	1.04	N/A	2.82	0.99			6.57	0.91	1.50	2.10	2.18	2.4
18 IA260	RIO IGUACU	544.20	17-1-5	562.80	758,010	1.35	N/A	28.25	12.61			61.99	52.36	20.96	24.91	9.47	30.1
19 SP300	RIO SARAPUI	159.80	17-6	165.50	1.012,275	6.12	Urban	14.35	27.92			101.07	60.59	42.90	45.73	37.48	47.3
20 SJ220	RIO S.J.DE MERITI	163.50	19	164.50	1.492,458	9.07	Urban	50.90	34.20			48.44	74.09	10.06	99.90	87.84	57.9
*21 AC241	RIO ACARI	57.90	19-2	57.90	438,076	7.57	Urban	25.61	49.96			23.02	3.30	9.61	15.00	32.38	22.7
22 IJ200	RIO IRAJA	27.30	20	35.70	500,276	14.01	Urban	11.84	30.14			15.87	19.61	3.24	13.71	6.50	14.4
23 PN180	CANAL DO PENHA	-	20	-				2.36	6.89			8.33	2.63	0.91	2.94	12.67	5.2
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815,389	12.82	Urban	20.96	37.27			89.35	67.26	6.66	38.39	52.24	44.6
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500,876	11.70	Urb/S.T	18.25	16.93			13.28	57.04	9.63	22.30	20.33	22.5
TOTAL		3604.10		3912.50	6.690,147			239.24	206.02	0.00	0.00	468.36	371.15	167.97	432.30	342.94	

Notes : 1) * Tributary river(excluded from Total amount)
2) AUG, SEP: Not measured of discharge

N/A : Natural and Agricutural use
Urban : Urban use
Urb/S.T: Urban Use with Sewage Treatments

Table APP. 1-2 Mean Runoff Load of Regular Survey (May 1992 to Apr. 1993)

(COD(Cr)) (1992 - 1993)

No	Name	Covered Basin Area (Km2)	NO.	Basin Area (Km2)	Population Number	Population Density (p/km2)	Land use Type	1	2	3	4	5	6	7	8	9	Mean Value
								1992						1993			
								MAY	JUN	AUG	SEP	OCT	NOV	FEB	MAR	APR	
1 CI780	CANAL CANTO DO RIO	7.40	2	7.40	41.745	5.64	Urb/S.T	7.81	1.89			6.63	4.79	4.79	6.09	5.70	5.4
2 BM760	RIO BOMBA	3.40	5	26.20	183.099	6.99	Urban	0.75	1.27			4.01	2.94	2.63	0.52	2.23	2.1
3 IB810	RIO IMBOASSU	11.60	6	30.80	138.636	4.50	Urban	0.00	0.00			0.00	0.00	0.00	807.71	160.75	138.4
4 AN740	RIO ALCANTARA	58.50	8	144.60	470.420	3.25	Urban	0.81	1.10			6.47	0.14	0.00	0.00	0.00	1.2
5 MT820	RIO MUTONDO	5.50	8			3.25	Urban	1.24	1.79			3.57	3.09	1.16	0.57	2.68	2.0
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban	0.00	0.00			0.33	0.44	0.03	0.45	1.41	0.4
7 CC622	RIO CACEREBU	758.40	9	846.70	336.193	0.40	N/A	68.35	13.26			58.43	223.35	91.80	212.25	123.02	112.9
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69.853	0.06	N/A	21.16	9.31			51.64	98.93	26.99	346.46	143.25	99.7
*9 MC967	RIO MACACU	256.00	10-3	256.00	18.577	0.07	N/A	2.55	1.13			6.33	22.23	7.03	10.40	7.40	8.2
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17.911	0.14	N/A	23.77	14.33			6.83	11.45	5.75	2.58	5.24	10.0
11 MG580	CANAL DE MAGE	4.60	11	18.30	8.458	0.46	N/A	2.58	2.98			4.52	3.68	2.81	1.52	2.17	2.9
12 RN560	RIO RONCADOR	107.00	12	111.40	36.370	0.33	N/A	7.41	2.36			19.36	23.50	3.70	14.17	7.29	11.1
13 IR540	RIO IRIRI	8.40	13	27.80	10.684	0.38	N/A	0.33	0.04			3.40	3.49	1.26	5.76	0.49	2.1
14 SR500	RIO SURUI	53.20	14	68.80	12.910	0.19	N/A	22.21	4.00			9.36	5.36	6.45	9.73	5.05	8.9
15 ES400	RIO ESTRELA	342.50	16	342.50	302.495	0.88	N/A	46.18	0.00			0.00	72.18	82.56	138.81	77.14	59.6
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84.106	0.61	N/A	1.05	0.31			14.96	3.95	3.04	2.54	2.10	4.0
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194.173	1.04	N/A	8.25	3.47			9.86	4.57	5.19	2.10	11.90	6.5
18 IA260	RIO IGUACU	544.20	17-1~5	562.80	758.010	1.35	N/A	158.91	15.76			0.00	261.81	212.87	77.86	71.03	114.0
19 SP300	RIO SARAPUI	159.80	17-6	165.50	1.012.275	6.12	Urban	22.72	31.91			252.68	227.21	170.74	45.73	174.92	132.3
20 SJ220	RIO S.J.DE MERITI	163.50	19	164.50	1.492.458	9.07	Urban	0.00	38.70			1065.72	787.20	50.32	99.90	409.90	350.2
*21 AC241	RIO ACARI	57.90	19-2	57.90	438.076	7.57	Urban	31.37	61.72			63.31	27.51	18.03	25.00	84.20	44.4
22 IJ200	RIO IRAJA	27.30	20	35.70	500.276	14.01	Urban	11.84	34.31			55.56	36.76	14.17	13.71	19.01	26.5
23 PN180	CANAL DO PENHA	-	20	-				3.19	9.37			38.10	13.15	1.52	3.53	38.01	15.3
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815.389	12.82	Urban	23.48	40.09			201.04	137.57	16.64	38.39	108.84	80.9
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500.876	11.70	Urb/S.T	18.25	21.09			81.92	120.08	41.75	44.61	57.86	55.1
TOTAL		3604.10		3912.50	6.690.147			417.22	229.23	0.00	0.00	1862.74	2025.68	732.19	1867.75	1410.76	

Notes : 1) * Tributary river(excluded from Total amount)
2) AUG.SEP: Not measured of discharge

N/A : Natural and Agricutural use
Urban : Urban use
Urb/S.T: Urban Use with Sewage Treatments

Table APP. 1-2 Mean Runoff Load of Regular Survey (May 1992 to Apr. 1993)

(COD(Mn)) (1992 - 1993)

No	Name	Covered Basin Area (Km2)	NO.	Basin Area (Km2)	Population Number	Population Density (p/km2)	Land use Type	1	2	3	4	5	6	7	8	9	Mean Value
								1992						1993			
								MAY	JUN	AUG	SEP	OCT	NOV	FEB	MAR	APR	
1 CI780	CANAL CANTO DO RIO	7.40	2	7.40	41.745	5.64	Urb/S.T	1.91	0.39			0.59	0.68	0.26	2.00	0.84	1.0
2 BM760	RIO BOMBA	3.40	5	26.20	183.099	6.99	Urban	0.19	0.35			0.62	0.14	0.51	0.06	0.09	0.3
3 IB810	RIO IMBOASSU	11.60	6	30.80	138.636	4.50	Urban	2.27	0.82			3.07	3.72	5.38	5.27	1.34	3.1
4 AN740	RIO ALCANTARA	58.50	8	144.60	470.420	3.25	Urban	0.12	0.10			0.81	2.62	1.93	0.12	0.24	0.9
5 MT820	RIO MUTONDO	5.50	8			3.25	Urban	0.31	0.38			0.69	0.38	0.23	0.10	0.36	0.4
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban	0.00	0.00			0.06	0.11	0.01	0.17	0.26	0.1
7 CC622	RIO CACEREBU	758.40	9	846.70	336.193	0.40	N/A	23.95	5.39			19.48	52.49	16.52	64.74	31.98	30.6
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69.853	0.06	N/A	16.23	3.32			24.79	38.25	9.18	83.15	35.34	30.0
*9 MC967	RIO MACACU	256.00	10-3	256.00	18.577	0.07	N/A	0.84	0.58			1.90	2.67	1.55	6.03	0.59	2.0
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17.911	0.14	N/A	2.86	3.27			1.07	2.38	1.73	1.58	1.22	2.0
11 MG580	CANAL DE MAGE	4.60	11	18.30	8.458	0.46	N/A	0.37	0.93			0.68	0.54	0.53	0.37	0.38	0.5
12 RN560	RIO RONCADOR	107.00	12	111.40	36.370	0.33	N/A	1.96	0.75			6.39	5.95	1.48	4.72	1.77	3.3
13 IR540	RIO IRIRI	8.40	13	27.80	10.684	0.38	N/A	0.12	0.02			0.63	0.77	0.27	1.51	0.15	0.5
14 SR500	RIO SURUI	53.20	14	68.80	12.910	0.19	N/A	2.18	1.36			3.74	1.72	1.12	5.32	1.71	2.4
15 ES400	RIO ESTRELA	342.50	16	342.50	302.495	0.88	N/A	9.60	19.17			36.54	12.99	37.15	26.37	4.63	20.9
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84.106	0.61	N/A	0.25	0.11			3.19	0.87	0.46	1.02	0.50	0.9
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194.173	1.04	N/A	1.19	0.53			2.30	0.30	0.46	0.63	0.88	0.9
18 IA260	RIO IGUACU	544.20	17-1~5	562.80	758.010	1.35	N/A	28.60	8.09			55.79	11.78	23.58	21.80	13.26	23.3
19 SP300	RIO SARAPUI	159.80	17-6	165.50	1.012.275	6.12	Urban	5.56	8.22			32.34	34.84	25.37	21.95	24.99	21.9
20 SJ220	RIO S.J.DE MERITI	163.50	19	164.50	1.492.458	9.07	Urban	23.16	44.55			15.50	111.13	8.55	20.98	43.92	38.3
*21 AC241	RIO ACARI	57.90	19-2	57.90	438.076	7.57	Urban	5.83	15.80			6.45	0.55	6.25	3.50	12.63	7.3
22 IJ200	RIO IRAJA	27.30	20	35.70	500.276	14.01	Urban	2.76	9.04			0.42	3.31	2.27	3.84	2.20	3.4
23 PN180	CANAL DO PENHA	-	20	-				0.59	1.68			0.67	0.82	0.81	0.62	3.98	1.3
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815.389	12.82	Urban	4.07	7.38			5.14	15.90	3.33	3.07	11.75	7.2
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500.876	11.70	Urb/S.T	2.63	6.51			5.31	7.95	3.34	5.65	5.75	5.3
TOTAL		3604.10		3912.50	6.690.147			126.58	118.46	0.00	0.00	213.28	306.09	141.81	271.83	184.93	

Notes : 1) * Tributary river(excluded from Total amount)
2) AUG.SEP: Not measured of discharge

N/A : Natural and Agricutural use
Urban : Urban use
Urb/S.T: Urban Use with Sewage Treatments

Table APP. 1-2 Mean Runoff Load of Regular Survey (May 1992 to Apr. 1993)

(TN) (1992 - 1993)

No	Name	Covered Basin Area (Km2)	NO.	Basin Area (Km2)	Population Number	Population Density (p/km2)	Land use Type	1	2	3	4	5	6	7	8	9	Mean Value
								1992						1993			
								MAY	JUN	AUG	SEP	OCT	NOV	FEB	MAR	APR	
1 C1780	CANAL CANTO DO RIO	7.40	2	7.40	41.745	5.64	Urb/S.T	1.57	0.63			1.13	0.73	0.84	1.06	1.07	1.0
2 BM760	RIO BOMBA	3.40	5	26.20	183.099	6.99	Urban	0.08	0.43			0.31	0.32	0.28	0.09	0.16	0.2
3 IB810	RIO IMBOASSU	11.60	6	30.80	138.636	4.50	Urban	0.63	0.78			1.24	0.41	1.02	1.74	0.45	0.9
4 AN740	RIO ALCANTARA	58.50	8	144.60	470.420	3.25	Urban	0.03	0.10			0.11	0.22	0.11	0.22	0.19	0.1
5 MT820	RIO MUTONDO	5.50	8			3.25	Urban	0.38	0.43			0.40	0.67	0.24	0.09	0.25	0.4
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban	0.00	0.00			0.03	0.06	0.02	0.06	0.13	0.0
7 CC622	RIO CACEREBU	758.40	9	846.70	336.193	0.40	N/A	3.26	1.77			3.43	3.99	1.94	7.64	5.07	3.9
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69.853	0.06	N/A	2.12	0.34			4.66	3.57	1.23	12.22	6.24	4.3
*9 MC967	RIO MACACU	256.00	10-3	256.00	18.577	0.07	N/A	0.30	0.15			0.57	1.33	0.28	1.36	0.30	0.6
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17.911	0.14	N/A	0.09	0.13			0.12	0.09	0.04	0.14	0.09	0.1
11 MG580	CANAL DE MAGE	4.60	11	18.30	8.458	0.46	N/A	0.17	0.15			0.52	1.08	0.47	0.27	0.15	0.4
12 RN560	RIO RONCADOR	107.00	12	111.40	36.370	0.33	N/A	0.27	0.27			0.69	0.53	0.30	0.30	0.37	0.4
13 IR540	RIO IRIRI	8.40	13	27.80	10.684	0.38	N/A	0.01	0.00			0.23	0.05	0.04	0.07	0.01	0.1
14 SR500	RIO SURUI	53.20	14	68.80	12.910	0.19	N/A	0.40	0.23			0.68	0.11	0.22	0.24	0.19	0.3
15 ES400	RIO ESTRELA	342.50	16	342.50	302.495	0.88	N/A	3.45	8.26			11.35	3.54	6.71	3.75	3.86	5.8
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84.106	0.61	N/A	0.13	0.06			0.86	0.30	0.19	0.98	0.16	0.4
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194.173	1.04	N/A	0.54	0.44			0.99	0.37	0.34	0.89	0.43	0.6
18 IA260	RIO IGUACU	544.20	17-1~5	562.80	758.010	1.35	N/A	8.58	4.37			31.13	3.16	13.20	18.69	7.43	12.4
19 SP300	RIO SARAPUI	159.80	17-6	165.50	1.012.275	6.12	Urban	12.05	19.17			33.73	46.33	24.58	34.41	20.00	27.2
20 SJ220	RIO S.J.DE MERITI	163.50	19	164.50	1.492.458	9.07	Urban	51.08	15.39			48.65	42.75	7.57	32.49	35.18	33.3
*21 AC241	RIO ACARI	57.90	19-2	57.90	438.076	7.57	Urban	5.78	13.38			6.35	4.71	6.03	4.03	6.50	6.7
22 IJ200	RIO IRAJA	27.30	20	35.70	500.276	14.01	Urban	3.17	9.76			3.72	4.78	2.84	3.13	0.90	4.0
23 PN180	CANAL DO PENHA	-	20	-				1.30	1.12			2.51	1.33	0.99	0.41	2.17	1.4
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815.389	12.82	Urban	6.75	9.89			19.02	29.28	3.34	4.32	7.41	11.4
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500.876	11.70	Urb/S.T	4.98	3.26			5.34	9.54	5.15	9.68	4.07	6.0
TOTAL		3604.10		3912.50	6.690.147			100.28	76.35	0.00	0.00	168.86	152.45	71.07	130.87	95.30	

Notes : 1) * Tributary river(excluded from Total amount)
2) AUG, SEP: Not measured of discharge

N/A : Natural and Agricutural use
Urban : Urban use
Urb/S.T: Urban Use with Sewage Treatments

Table APP. 1-2 Mean Runoff Load of Regular Survey (May 1992 to Apr. 1993)

(TP) (1992 - 1993)

No	Name	Covered. Basin Area (Km2)	NO.	Basin Area (Km2)	Population Number	Population Density (p/km2)	Land use Type	1	2	3	4	5	6	7	8	9	Mean Value
								1992						1993			
								MAY	JUN	AUG	SEP	OCT	NOV	FEB	MAR	APR	
1 CI780	CANAL CANTO DO RIO	7.40	2	7.40	41.745	5.64	Urb/S.T	0.21	0.06			0.11	0.07	0.10	0.09	0.02	0.1
2 BM760	RIO BOMBA	3.40	5	26.20	183.099	6.99	Urban	0.03	0.04			0.05	0.03	0.05	0.02	0.02	0.0
3 IB810	RIO IMBOASSU	11.60	6	30.80	138.636	4.50	Urban	0.12	0.09			0.22	0.21	0.28	0.25	0.07	0.2
4 AN740	RIO ALCANTARA	58.50	8	144.60	470.420	3.25	Urban	0.01	0.02			0.08	0.17	0.07	0.09	0.03	0.1
5 MT820	RIO MUTONDO	5.50	8			3.25	Urban	0.05	0.06			0.06	0.09	0.04	0.01	0.05	0.1
6 GX720	RIO GUAXINDIBA	11.80	8			3.25	Urban	0.00	0.00			0.01	0.01	0.00	0.02	0.02	0.0
7 CC622	RIO CACEREBU	758.40	9	846.70	336.193	0.40	N/A	0.54	0.08			0.39	2.51	0.28	3.18	0.92	1.1
8 GP600	RIO GUAPIMIRIM	1233.70	10	1253.10	69.853	0.06	N/A	0.21	0.05			0.52	0.66	0.24	4.04	0.33	0.9
*9 MC967	RIO MACACU	256.00	10-3	256.00	18.577	0.07	N/A	0.03	0.02			0.06	0.12	0.06	0.26	0.04	0.1
*10 SB998	RIO SOBERBO	45.20	10-6	132.40	17.911	0.14	N/A	0.02	0.02			0.02	0.02	0.01	0.03	0.01	0.0
11 MG580	CANAL DE MAGE	4.60	11	18.30	8.458	0.46	N/A	0.03	0.11			0.04	0.08	0.10	0.03	0.01	0.1
12 RN560	RIO RONCADOR	107.00	12	111.40	36.370	0.33	N/A	0.04	0.02			0.06	0.13	0.03	0.19	0.08	0.1
13 IR540	RIO IRIRI	8.40	13	27.80	10.684	0.38	N/A	0.00	0.00			0.02	0.02	0.01	0.05	0.00	0.0
14 SR500	RIO SURUI	53.20	14	68.80	12.910	0.19	N/A	0.06	0.06			0.05	0.04	0.04	0.16	0.03	0.1
15 ES400	RIO ESTRELA	342.50	16	342.50	302.495	0.88	N/A	0.43	2.02			2.11	0.48	1.24	1.39	0.58	1.2
*16 IN460	RIO INHOMIRIM	139.00	16-2	139.00	84.106	0.61	N/A	0.02	0.01			0.05	0.03	0.02	0.04	0.02	0.0
*17 SC420	RIO SARACURUNA	186.00	16-3	186.00	194.173	1.04	N/A	0.04	0.02			0.07	0.02	0.03	0.01	0.02	0.0
18 IA260	RIO IGUACU	544.20	17-1~5	562.80	758.010	1.35	N/A	1.77	1.58			4.65	2.29	3.27	1.25	1.07	2.3
19 SP300	RIO SARAPUI	159.80	17-6	165.50	1.012.275	6.12	Urban	1.20	2.79			5.73	7.57	7.56	4.80	2.75	4.6
20 SJ220	RIO S.J.DE MERITI	163.50	19	164.50	1.492.458	9.07	Urban	5.09	1.80			5.81	9.26	1.43	4.75	4.25	4.6
*21 AC241	RIO ACARI	57.90	19-2	57.90	438.076	7.57	Urban	1.28	2.20			0.95	0.83	1.02	0.90	1.52	1.2
22 IJ200	RIO IRAJA	27.30	20	35.70	500.276	14.01	Urban	0.39	1.39			0.57	0.61	0.45	0.79	0.18	0.6
23 PN180	CANAL DO PENHA	-	20	-				0.18	0.18			0.41	0.16	0.18	0.16	0.36	0.2
24 CN100	CANAL DO CUNHA	60.50	21	63.60	815.389	12.82	Urban	1.26	1.41			2.23	3.06	0.67	1.62	0.74	1.6
25 MN000	CANAL DO MANGUE	42.80	23	42.80	500.876	11.70	Urb/S.T	0.91	0.52			1.15	1.50	0.64	1.34	0.55	0.9
	TOTAL	3604.10		3912.50	6.690.147			12.53	12.27	0.00	0.00	24.25	28.95	16.68	24.22	12.06	

Notes : 1) * Tributary river(excluded from Total amount)
2) AUG.SEP: Not measured of discharge

N/A : Natural and Agricutural use
Urban : Urban use
Urb/S.T: Urban Use with Sewage Treatments

Table APP. 1-3 Monthly Runoff Load of Regular Survey (May 1992 to Dec. 1993)

(May. 1992)

NO		Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TP (mg/l)	Runoff Load BOD Load (t/day)	COD(Cr)Load (t/day)	COD(Mn)Load (t/day)	TN Load (t/day)	TP Load (t/day)
1	CI780	7.40	2.378	24.0	38.0	9.3	7.65	1.00	4.93	7.81	1.91	1.57	0.21
2	BN760	3.40	0.109	80.0	80.0	20.2	8.02	3.00	0.75	0.75	0.19	0.08	0.03
3	IB810	11.60	2.325	12.0	-	11.3	3.16	0.60	2.41	0.00	2.27	0.63	0.12
4	AN740	58.50	0.067	140.0	140.0	21.5	5.50	2.50	0.81	0.81	0.12	0.03	0.01
5	*T820	5.50	0.208	40.0	69.0	17.5	21.20	3.00	0.72	1.24	0.31	0.38	0.05
6	GX720	11.80	0.000	12.0	33.0	9.1	6.09	1.50	0.00	0.00	0.00	0.00	0.00
7	CC622	758.40	31.146	20.0	25.4	8.9	1.21	0.20	53.82	68.35	23.95	3.26	0.54
8	GP600	1233.70	27.218	8.0	9.0	6.9	0.90	0.09	18.81	21.16	16.23	2.12	0.21
9	*C967	256.00	4.605	2.0	6.4	2.1	0.75	0.08	0.80	2.55	0.84	0.30	0.03
10	SB998	45.20	1.019	96.0	270.0	32.5	1.04	0.20	8.45	23.77	2.86	0.09	0.02
11	*G580	4.60	0.166	42.0	180.0	25.5	12.03	2.00	0.60	2.58	0.37	0.17	0.03
12	RN560	107.00	5.043	2.0	17.0	4.5	0.62	0.10	0.87	7.41	1.96	0.27	0.04
13	IR540	8.40	0.062	3.0	61.0	21.5	1.43	0.35	0.02	0.33	0.12	0.01	0.00
14	SR500	53.20	4.943	3.0	52.0	5.1	0.93	0.15	1.28	22.21	2.18	0.40	0.06
15	ES400	342.50	14.065	6.0	38.0	7.9	2.84	0.35	7.29	46.18	9.60	3.45	0.43
16	IN460	139.00	0.936	2.4	13.0	3.1	1.63	0.20	0.19	1.05	0.25	0.13	0.02
17	SC420	186.00	2.514	13.0	38.0	5.5	2.48	0.20	2.82	8.25	1.19	0.54	0.04
18	IA260	544.20	40.871	8.0	45.0	8.1	2.43	0.50	28.25	158.91	28.60	8.58	1.77
19	SP300	159.80	6.919	24.0	38.0	9.3	20.16	2.00	14.35	22.72	5.56	12.05	1.20
20	SJ220	163.50	29.455	20.0	-	9.1	20.07	2.00	50.90	0.00	23.16	51.08	5.09
21	AC241	57.90	7.410	40.0	49.0	9.1	9.03	2.00	25.61	31.37	5.83	5.78	1.28
22	IJ200	27.30	1.523	90.0	90.0	21.0	24.11	3.00	11.84	11.84	2.76	3.17	0.39
23	PN180	-	0.683	40.0	54.0	10.0	22.10	3.00	2.36	3.19	0.59	1.30	0.18
24	CN100	60.50	4.853	50.0	56.0	9.7	16.10	3.00	20.96	23.48	4.07	6.75	1.26
25	*N000	42.80	3.018	70.0	70.0	10.1	19.09	3.50	18.25	18.25	2.63	4.93	0.91
	Total	3604.10	175.052						239.24	417.22	126.58	100.28	12.53

*Tributary rever

(Jun. 1992)

NO		Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TP (mg/l)	Runoff Load BOD Load (t/day)	COD(Cr)Load (t/day)	COD(Mn)Load (t/day)	TN Load (t/day)	TP Load (t/day)
1	CI780	7.40	0.428	26.0	51.0	10.5	17.11	1.50	0.95	1.89	0.39	0.63	0.06
2	BN760	3.40	0.124	105.0	119.0	32.5	40.05	4.00	1.12	1.27	0.35	0.43	0.04
3	IB810	11.60	1.000	10.0	-	9.5	9.08	1.00	0.86	0.00	0.82	0.78	0.09
4	AN740	58.50	0.051	150.0	249.0	23.5	22.08	4.00	0.66	1.10	0.10	0.10	0.02
5	*T820	5.50	0.167	116.0	124.0	26.5	30.07	4.00	1.67	1.79	0.38	0.43	0.06
6	GX720	11.80	0.000	9.0	28.0	9.3	15.07	2.00	0.00	0.00	0.00	0.00	0.00
7	CC622	758.40	9.593	5.0	16.0	6.5	2.13	0.10	4.14	13.26	5.39	1.77	0.08
8	GP600	1233.70	10.992	2.0	9.8	3.5	0.36	0.05	1.90	9.31	3.32	0.34	0.05
9	*C967	256.00	3.528	2.0	3.7	1.9	0.51	0.05	0.61	1.13	0.58	0.15	0.02
10	SB998	45.20	0.721	160.0	230.0	52.5	2.15	0.40	9.97	14.33	3.27	0.13	0.02
11	*G580	4.60	0.440	50.0	78.5	24.5	3.82	3.00	1.90	2.98	0.93	0.15	0.11
12	RN560	107.00	2.785	4.0	9.8	3.1	1.12	0.09	0.96	2.36	0.75	0.27	0.02
13	IR540	8.40	0.018	3.4	23.2	12.5	1.91	0.20	0.01	0.01	0.02	0.00	0.00
14	SR500	53.20	2.971	6.4	15.6	5.3	0.91	0.25	1.64	4.00	1.36	0.23	0.06
15	ES400	342.50	23.354	12.0	-	9.5	4.09	1.00	24.21	0.00	19.17	8.26	2.02
16	IN460	139.00	0.393	2.0	9.2	3.3	1.77	0.20	0.07	0.31	0.11	0.06	0.01
17	SC420	186.00	2.292	5.0	17.5	2.7	2.20	0.10	0.99	3.47	0.53	0.44	0.02
18	IA260	544.20	12.163	12.0	15.0	7.7	4.15	1.50	12.61	15.76	8.09	4.37	1.58
19	SP300	159.80	9.232	35.0	40.0	10.3	24.03	3.50	27.92	31.91	8.22	19.17	2.79
20	SJ220	163.50	10.417	38.0	43.0	49.5	17.10	2.00	34.20	38.70	44.55	15.39	1.80
21	AC241	57.90	8.504	68.0	84.0	21.5	18.21	3.00	49.96	61.72	15.80	13.38	2.20
22	IJ200	27.30	5.367	65.0	74.0	19.5	21.04	3.00	30.14	34.31	9.04	9.76	1.39
23	PN180	-	0.682	117.0	159.0	28.5	19.04	3.00	6.89	9.37	1.68	1.12	0.18
24	CN100	60.50	8.140	53.0	57.0	10.5	14.06	2.00	37.27	40.09	7.38	9.89	1.41
25	*N000	42.80	3.014	55.0	81.0	25.0	12.51	2.00	16.93	21.09	6.51	3.26	0.52
	Total	3604.10	100.938						206.02	229.23	118.46	76.35	12.27

*Tributary rever

Table APP. 1-3 Monthly Runoff Load of Regular Survey (May 1992 to Dec. 1993)

(Aug. 1992)

NO		Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TP (mg/l)	Runoff Load BOD Load (t/day)	COD(Cr)Load (t/day)	COD(Mn)Load (t/day)	TN Load (t/day)	TP Load (t/day)
1	CI780	7.40		20.0	100.0	10.2	20.05	1.40					
2	BM760	3.40		40.0	110.0	9.2	24.13	3.00					
3	IB810	11.60		4.0	-	10.6	3.94	0.60					
4	AN740	58.50		-	-	-	70.14	62.00					
5	MT820	5.50		30.0	120.0	9.8	20.17	3.20					
6	GX720	11.80		20.0	70.0	9.0	16.09	2.50					
7	CC622	758.40		12.0	-	8.8	1.43	0.10					
8	GP600	1233.70		2.0	10.0	3.8	0.75	0.04					
9	MC967	256.00		2.0	10.0	1.8	0.75	0.04					
10	SB938	45.20		120.0	220.0	36.0	1.55	0.25					
11	MG580	4.60		30.0	50.0	10.2	18.04	2.50					
12	RN560	107.00		2.8	20.0	4.0	1.53	0.20					
13	IR540	8.40		4.0	-	8.6	1.29	0.25					
14	SR500	53.20		5.6	30.0	5.6	1.31	0.20					
15	ES400	342.50		40.0	-	14.0	4.04	0.70					
16	IN460	139.00		4.0	20.0	4.8	2.06	0.20					
17	SC420	186.00		20.0	40.0	6.6	2.27	0.10					
18	IA260	544.20		20.0	-	16.0	10.04	1.40					
19	SP300	159.80		40.0	100.0	20.0	10.18	1.60					
20	SJ220	163.50		40.0	430.0	24.0	13.03	2.00					
21	AC241	57.90		-	-	-	-	-					
22	IJ200	27.30		30.0	90.0	26.0	10.46	1.20					
23	PN180	-		30.0	-	28.0	10.22	1.30					
24	CN100	60.50		25.0	100.0	20.0	10.50	1.10					
25	MN000	42.80		20.0	130.0	14.0	8.41	1.10					
	Total	3604.10	0.000						0.00	0.00	0.00	0.00	0.00

*Tributary rever

(Sep. 1992)

NO		Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TP (mg/l)	Runoff Load BOD Load (t/day)	COD(Cr)Load (t/day)	COD(Mn)Load (t/day)	TN Load (t/day)	TP Load (t/day)
1	CI780	7.40		2.0	60.0	10.2	10.51	0.65					
2	BM760	3.40		40.0	140.0	11.8	15.45	2.70					
3	IB810	11.60		2.0	-	12.6	2.44	0.50					
4	AN740	58.50		150.0	350.0	92.0	11.60	4.30					
5	MT820	5.50		40.0	140.0	11.0	13.40	2.90					
6	GX720	11.80		4.0	40.0	10.4	6.95	0.60					
7	CC622	758.40		2.0	40.0	10.4	2.23	0.40					
8	GP600	1233.70		2.0	55.0	9.6	0.96	0.10					
9	MC967	256.00		2.0	15.0	3.4	0.55	0.07					
10	SB998	45.20		13.0	60.0	10.2	1.42	0.10					
11	MG580	4.60		16.0	80.0	22.0	7.15	1.30					
12	RN560	107.00		2.0	10.0	5.4	0.81	0.08					
13	IR540	8.40		4.0	40.0	11.2	0.91	0.20					
14	SR500	53.20		2.0	15.0	4.6	0.60	0.07					
15	ES400	342.50		4.0	-	9.2	1.32	0.20					
16	IN460	139.00		2.0	15.0	4.0	1.31	0.09					
17	SC420	186.00		2.4	6.0	2.6	1.41	0.09					
18	IA260	544.20		6.0	40.0	10.6	3.39	0.60					
19	SP300	159.80		20.0	75.0	10.4	10.40	1.20					
20	SJ220	163.50		16.0	55.0	10.0	9.90	0.80					
21	AC241	57.90		-	-	-	-	-					
22	IJ200	27.30		20.0	60.0	10.0	8.00	1.00					
23	PN180	-		12.0	60.0	10.4	9.60	0.80					
24	CN100	60.50		14.0	60.0	9.8	8.80	0.70					
25	MN000	42.80		14.0	40.0	7.8	8.35	0.70					
	Total	3604.10	0.000						0.00	0.00	0.00	0.00	0.00

*Tributary rever

Table APP. 1-3 Monthly Runoff Load of Regular Survey (May 1992 to Dec. 1993)

(Oct. 1992)

	NO	Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TP (mg/l)	Runoff Load BOD Load (t/day)	COD(Cr)Load (t/day)	COD(Mn)Load (t/day)	TN Load (t/day)	TP Load (t/day)
1	CI780	7.40	0.590	40.0	130.0	11.6	22.12	2.10	2.04	6.63	0.59	1.13	0.11
2	BW760	3.40	0.129	100.0	360.0	56.0	28.07	4.20	1.11	4.01	0.62	0.31	0.05
3	ID810	11.60	3.557	8.0	-	10.0	4.05	0.70	2.46	0.00	3.07	1.24	0.22
4	AN740	58.50	0.081	380.0	925.0	116.0	15.08	11.00	2.66	6.47	0.81	0.11	0.08
5	MT820	5.50	0.159	90.0	260.0	50.0	29.05	4.30	1.24	3.57	0.69	0.40	0.06
6	GX720	11.80	0.063	12.0	60.0	11.2	4.60	1.20	0.07	0.33	0.06	0.03	0.01
7	CC622	758.40	22.543	8.0	30.0	10.0	1.76	0.20	15.58	58.43	19.48	3.43	0.39
8	GP600	1233.70	39.847	2.0	15.0	7.2	1.36	0.15	6.89	51.64	24.79	4.66	0.52
9	MC967	256.00	7.330	2.0	10.0	3.0	0.90	0.09	1.27	6.33	1.90	0.57	0.06
10	SB998	45.20	1.054	20.0	75.0	11.8	1.31	0.20	1.82	6.83	1.07	0.12	0.02
11	MG580	4.60	0.747	12.0	70.0	10.6	8.09	0.60	0.77	4.52	0.68	0.52	0.04
12	RN560	107.00	11.206	2.0	20.0	6.6	0.71	0.06	1.94	19.36	6.39	0.69	0.06
13	IR540	8.40	0.605	12.0	65.0	12.0	4.31	0.45	0.63	3.40	0.63	0.23	0.02
14	SR500	53.20	5.418	2.0	20.0	8.0	1.46	0.10	0.94	9.36	3.74	0.68	0.05
15	ES400	342.50	54.223	20.0	-	7.8	2.42	0.45	93.70	0.00	36.54	11.35	2.11
16	IN460	139.00	5.772	3.2	30.0	6.4	1.72	0.10	1.60	14.96	3.19	0.86	0.05
17	SC420	186.00	3.803	20.0	30.0	7.0	3.01	0.20	6.57	9.86	2.30	0.99	0.07
18	IA260	544.20	71.746	10.0	-	9.0	5.02	0.75	61.99	0.00	55.79	31.13	4.65
19	SP300	159.80	38.994	30.0	75.0	9.6	10.01	1.70	101.07	252.68	32.34	33.73	5.73
20	SJ220	163.50	56.067	10.0	220.0	3.2	10.04	1.20	48.44	1065.72	15.50	48.65	5.81
21	AC241	57.90	6.661	40.0	110.0	11.2	11.04	1.65	23.02	63.31	6.45	6.35	0.95
22	JJ200	27.30	3.062	60.0	210.0	1.6	14.05	2.15	15.87	55.56	0.42	3.72	0.57
23	PN180	-	1.378	70.0	320.0	5.6	21.04	3.45	8.33	38.10	0.67	2.51	0.41
24	CN100	60.50	12.927	80.0	180.0	4.6	17.03	2.00	89.35	201.04	5.14	19.02	2.23
25	WN000	42.80	5.125	30.0	185.0	12.0	12.06	2.60	13.28	81.92	5.31	5.34	1.15
	Total	3604.10	328.467						468.36	1862.74	213.28	168.86	24.25

*Tributary rever

(Nov. 1992)

	NO	Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TP (mg/l)	Runoff Load BOD Load (t/day)	COD(Cr)Load (t/day)	COD(Mn)Load (t/day)	TN Load (t/day)	TP Load (t/day)
1	CI780	7.40	0.792	4.0	70.0	10.0	10.68	1.00	0.27	4.79	0.68	0.73	0.07
2	BW760	3.40	0.162	48.0	210.0	9.8	23.19	2.00	0.67	2.91	0.14	0.32	0.03
3	IB810	11.60	5.520	8.0	-	7.8	0.85	0.45	3.82	0.00	3.72	0.41	0.21
4	AN740	58.50	0.066	140.0	25.0	460.0	38.50	30.00	0.80	0.14	2.62	0.22	0.17
5	MT820	5.50	0.398	24.0	90.0	11.0	19.39	2.50	0.83	3.09	0.38	0.67	0.09
6	GX720	11.80	0.127	1.0	40.0	9.6	5.51	1.00	0.01	0.44	0.11	0.06	0.01
7	CC622	758.40	64.627	2.0	40.0	9.4	0.72	0.45	11.17	223.35	52.49	3.99	2.51
8	GP600	1233.70	76.334	0.8	15.0	5.8	0.54	0.10	5.28	98.93	38.25	3.57	0.66
9	MC967	256.00	17.154	0.4	15.0	1.8	0.90	0.08	0.59	22.23	2.67	1.33	0.12
10	SB998	45.20	2.651	13.0	50.0	10.4	0.39	0.08	2.98	11.45	2.38	0.09	0.02
11	MG580	4.60	0.608	20.0	70.0	10.2	20.52	1.50	1.05	3.68	0.54	1.08	0.08
12	RN560	107.00	18.135	1.6	15.0	3.8	0.34	0.08	2.51	23.50	5.95	0.53	0.13
13	IR540	8.40	0.808	12.0	50.0	11.0	0.70	0.30	0.84	3.49	0.77	0.05	0.02
14	SR500	53.20	4.138	2.0	15.0	4.8	0.32	0.10	0.72	5.36	1.72	0.11	0.04
15	ES400	342.50	27.846	4.0	30.0	5.4	1.47	0.20	9.62	72.18	12.99	3.54	0.48
16	IN460	139.00	4.566	1.2	10.0	2.2	0.77	0.08	0.47	3.95	0.87	0.30	0.03
17	SC420	186.00	3.523	3.0	15.0	1.0	1.21	0.08	0.91	4.57	0.30	0.37	0.02
18	IA260	544.20	75.754	8.0	40.0	1.8	0.48	0.35	52.36	261.81	11.78	3.16	2.29
19	SP300	159.80	43.830	16.0	60.0	9.2	12.24	2.00	60.59	227.21	34.84	46.33	7.57
20	SJ220	163.50	53.595	16.0	170.0	24.0	9.23	2.00	74.09	787.20	111.13	42.75	9.26
21	AC241	57.90	6.367	6.0	50.0	1.0	8.55	1.50	3.30	27.51	0.55	4.71	0.83
22	JJ200	27.30	3.546	64.0	120.0	10.8	15.60	2.00	19.61	36.76	3.31	4.78	0.61
23	PN180	-	0.951	32.0	160.0	10.0	16.21	2.00	2.63	13.15	0.82	1.33	0.16
24	CN100	60.50	17.692	44.0	90.0	10.4	19.15	2.00	67.26	137.57	15.90	29.28	3.06
25	WN000	42.80	8.686	76.0	160.0	10.6	12.71	2.00	57.04	120.08	7.95	9.54	1.50
	Total	3604.10	403.615						371.15	2025.68	306.09	152.45	28.95

*Tributary rever

Table APP. 1-3 *Monthly Runoff Load of Regular Survey (May 1992 to Dec. 1993)*

(Feb. 1993)

NO		Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TP (mg/l)	Runoff Load BOD Load (t/day)	COD(Cr)Load (t/day)	COD(Mn)Load (t/day)	TN Load (t/day)	TP Load (t/day)
1	CI780	7.40	0.739	40.0	75.0	4.0	13.08	1.60	2.55	4.79	0.26	0.84	0.10
2	BW760	3.40	0.095	130.0	320.0	62.0	34.05	6.00	1.07	2.63	0.51	0.28	0.05
3	IB810	11.60	6.481	6.4	-	9.6	1.83	0.50	3.58	0.00	5.38	1.02	0.28
4	AN740	58.50	0.036	2900.0	-	620.0	35.00	22.00	9.02	0.00	1.93	0.11	0.07
5	WT820	5.50	0.122	70.9	110.0	22.0	23.02	4.00	0.74	1.16	0.23	0.24	0.04
6	GX720	11.80	0.013	8.0	30.0	11.2	16.01	3.20	0.01	0.03	0.01	0.02	0.00
7	CC622	758.40	21.251	2.8	50.0	9.0	1.05	0.15	5.14	91.80	16.52	1.94	0.28
8	GP600	1233.70	31.239	2.0	10.0	3.4	0.46	0.09	5.40	26.99	9.18	1.23	0.24
9	MC967	256.00	8.137	2.0	10.0	2.2	0.41	0.08	1.41	7.03	1.55	0.28	0.06
10	SB998	45.20	0.832	50.0	80.0	24.0	0.52	0.20	3.59	5.75	1.73	0.04	0.01
11	MG580	4.60	0.542	40.0	60.0	11.4	10.00	2.20	1.87	2.81	0.53	0.47	0.10
12	RN560	107.00	4.285	2.0	10.0	4.0	0.81	0.07	0.74	3.70	1.48	0.30	0.03
13	IR540	8.40	0.291	3.2	50.0	10.6	1.46	0.30	0.08	1.26	0.27	0.04	0.01
14	SR500	53.20	2.490	5.2	30.0	5.2	1.01	0.20	1.12	6.45	1.12	0.22	0.04
15	ES400	342.50	47.778	10.0	20.0	9.0	1.63	0.30	41.28	82.56	37.15	6.71	1.24
16	IN460	139.00	1.762	2.4	20.0	3.0	1.24	0.15	0.37	3.04	0.46	0.19	0.02
17	SC420	186.00	2.405	7.2	25.0	2.2	1.63	0.15	1.50	5.19	0.46	0.34	0.03
18	IA260	544.20	37.904	6.4	65.0	7.2	4.03	1.00	20.96	212.87	23.58	13.20	3.27
19	SP300	159.80	28.230	18.0	70.0	10.4	10.08	3.10	43.90	170.74	25.37	24.58	7.56
20	SJ220	163.50	9.706	12.0	60.0	10.2	9.03	1.70	10.06	50.32	8.55	7.57	1.43
21	AC241	57.90	6.955	16.0	30.0	10.4	10.03	1.70	9.61	18.03	6.25	6.03	1.02
22	IJ200	27.30	2.343	16.0	70.0	11.2	14.01	2.20	3.24	14.17	2.27	2.84	0.45
23	PN180	-	0.880	12.0	20.0	10.6	13.01	2.40	0.91	1.52	0.81	0.99	0.18
24	CN100	60.50	3.852	20.0	50.0	10.0	10.04	2.00	6.66	16.64	3.33	3.34	0.67
25	MN000	42.80	3.717	30.0	130.0	10.4	16.03	2.00	9.63	41.75	3.34	5.15	0.64
	Total	3604.10	201.994						167.97	732.19	141.81	71.07	16.68

*Tributary rever

(Mar. 1993)

NO		Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TP (mg/l)	Runoff Load BOD Load (t/day)	COD(Cr)Load (t/day)	COD(Mn)Load (t/day)	TN Load (t/day)	TP Load (t/day)
1	CI780	7.40	1.007	60.0	70.0	23.0	12.13	1.00	5.22	6.09	2.00	1.06	0.09
2	BW760	3.40	0.060	80.0	100.0	11.8	17.21	3.20	0.41	0.52	0.06	0.09	0.02
3	IB810	11.60	6.492	4.0	1440.0	9.4	3.10	0.45	2.24	807.71	5.27	1.74	0.25
4	AN740	58.50	0.121	960.0	-	11.6	21.01	9.00	10.04	0.00	0.12	0.22	0.09
5	WT820	5.50	0.110	45.0	60.0	11.0	9.30	1.20	0.43	0.57	0.10	0.09	0.01
6	GX720	11.80	0.131	18.0	40.0	14.8	5.50	1.40	0.20	0.45	0.17	0.06	0.02
7	CC622	758.40	61.415	12.0	40.0	12.2	1.44	0.60	63.68	212.25	64.74	7.64	3.18
8	GP600	1233.70	133.665	2.4	30.0	7.2	1.06	0.35	27.72	346.46	83.15	12.22	4.04
9	MC967	256.00	12.040	2.0	10.0	5.8	1.30	0.25	2.08	10.40	6.03	1.36	0.26
10	SB998	45.20	1.990	13.2	15.0	9.2	0.81	0.20	2.27	2.58	1.58	0.14	0.03
11	MG580	4.60	0.439	12.0	40.0	9.8	7.00	0.80	0.46	1.52	0.37	0.27	0.03
12	RN560	107.00	10.930	2.0	15.0	5.0	0.32	0.20	1.89	14.17	4.72	0.30	0.19
13	IR540	8.40	1.905	4.0	35.0	9.2	0.44	0.30	0.66	5.76	1.51	0.07	0.05
14	SR500	53.20	7.504	3.2	15.0	8.2	0.37	0.25	2.07	9.73	5.32	0.24	0.16
15	ES400	342.50	40.166	20.0	40.0	7.6	1.08	0.40	69.41	138.81	26.37	3.75	1.39
16	IN460	139.00	2.940	4.0	10.0	4.0	3.86	0.15	1.02	2.54	1.02	0.98	0.04
17	SC420	186.00	2.430	10.0	10.0	3.0	4.25	0.06	2.10	2.10	0.63	0.89	0.01
18	IA260	544.20	36.044	8.0	25.0	7.0	6.00	0.40	24.91	77.86	21.80	18.69	1.25
19	SP300	159.80	26.463	20.0	20.0	9.6	15.05	2.10	45.73	45.73	21.95	34.41	4.80
20	SJ220	163.50	28.905	40.0	40.0	8.4	13.01	1.90	99.90	99.90	20.98	32.49	4.75
21	AC241	57.90	5.786	30.0	50.0	7.0	8.06	1.80	15.00	25.00	3.50	4.03	0.90
22	IJ200	27.30	3.968	40.0	40.0	11.2	9.12	2.30	13.71	13.71	3.84	3.13	0.79
23	PN180	-	0.681	50.0	60.0	10.6	7.04	2.70	2.91	3.53	0.62	0.41	0.16
24	CN100	60.50	9.873	45.0	45.0	3.6	5.06	1.90	38.39	38.39	3.07	4.32	1.62
25	MN000	42.80	8.605	30.0	60.0	7.6	13.02	1.80	22.30	44.61	5.65	9.68	1.34
	Total	3604.10	378.481						432.30	1867.75	271.83	130.87	24.22

*Tributary rever

Table APP. 1-3 Monthly Runoff Load of Regular Survey (May 1992 to Dec. 1993)

(Apr. 1993)

NO		Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TP (mg/l)	Runoff Load BOD Load (t/day)	COD(Cr)Load (t/day)	COD(Mn)Load (t/day)	TN Load (t/day)	TP Load (t/day)
1	CI780	7.40	0.880	18.0	75.0	11.0	14.11	0.30	1.37	5.70	0.84	1.07	0.02
2	BM760	3.40	0.092	50.0	280.0	11.4	20.02	2.45	0.40	2.23	0.09	0.16	0.02
3	IB810	11.60	1.292	25.0	1440.0	12.0	4.01	0.65	2.79	160.75	1.34	0.45	0.07
4	AN740	58.50	0.121	90.0	-	22.8	18.01	2.70	0.94	0.00	0.24	0.19	0.03
5	*T820	5.50	0.194	70.0	160.0	21.6	15.01	2.80	1.17	2.68	0.36	0.25	0.05
6	GX720	11.80	0.297	20.0	55.0	10.0	5.10	0.65	0.51	1.41	0.26	0.13	0.02
7	CC622	758.40	35.595	16.0	40.0	10.4	1.65	0.30	49.21	123.02	31.98	5.07	0.92
8	GP600	1233.70	55.268	4.0	30.0	7.4	1.31	0.07	19.10	143.25	35.34	6.24	0.33
9	*C967	256.00	8.561	2.0	10.0	0.8	0.40	0.05	1.48	7.40	0.59	0.30	0.04
10	SB998	45.20	2.020	11.6	30.0	7.0	0.51	0.05	2.02	5.24	1.22	0.09	0.01
11	*G580	4.60	0.209	30.0	120.0	21.0	8.04	0.80	0.54	2.17	0.38	0.15	0.01
12	RN560	107.00	6.028	2.0	14.0	3.4	0.71	0.15	1.04	7.29	1.77	0.37	0.08
13	IR540	8.40	0.142	10.0	40.0	12.0	0.60	0.20	0.12	0.49	0.15	0.01	0.00
14	SR500	53.20	3.655	2.0	16.0	5.4	0.60	0.10	0.63	5.05	1.71	0.19	0.03
15	ES400	342.50	22.322	20.0	40.0	2.4	2.00	0.30	38.57	77.14	4.63	3.86	0.58
16	IN460	139.00	2.429	2.0	10.0	2.4	0.76	0.08	0.42	2.10	0.50	0.16	0.02
17	SC420	166.00	3.935	6.4	35.0	2.6	1.27	0.07	2.18	11.90	0.88	0.43	0.02
18	IA260	514.20	27.403	4.0	30.0	5.6	3.14	0.45	9.47	71.03	13.26	7.43	1.07
19	SP300	159.80	14.461	30.0	140.0	20.0	16.01	2.20	37.48	174.92	24.99	20.00	2.75
20	SJ220	163.50	33.887	30.0	140.0	15.0	12.02	1.45	87.84	409.90	43.92	35.18	4.25
21	AC241	57.90	7.496	50.0	130.0	19.5	10.03	2.35	32.38	84.20	12.63	6.50	1.52
22	IJ200	27.30	1.158	65.0	190.0	22.0	9.01	1.80	6.50	19.01	2.20	0.90	0.18
23	PN180	-	2.095	70.0	210.0	22.0	12.01	2.00	12.67	38.01	3.96	2.17	0.36
24	CN100	60.50	5.039	120.0	250.0	27.0	17.01	1.70	52.24	108.84	11.75	7.41	0.74
25	*N000	42.80	3.620	65.0	185.0	18.4	13.03	1.75	20.33	57.86	5.75	4.07	0.55
Total		3604.10	213.758						342.91	1410.76	184.93	95.30	12.06

*Tributary rever

(May. 1993)

NO		Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TP (mg/l)	Runoff Load BOD Load (t/day)	COD(Cr)Load (t/day)	COD(Mn)Load (t/day)	TN Load (t/day)	TP Load (t/day)
1	CI780	7.40	0.875	72.0	250.0	8.4	18.09	1.56	5.44	18.90	0.64	1.37	0.12
2	BM760	3.40	0.121	310.0	530.0	7.8	32.08	2.74	3.55	5.54	0.08	0.34	0.03
3	IB810	11.60	0.420	12.0		7.8	9.07	1.09	0.44	0.00	0.28	0.33	0.04
4	AN740	58.50	0.064	160.0	500.0	7.6	16.32	1.97	0.88	2.76	0.04	0.09	0.01
5	*T820	5.50	0.044	140.0	300.0	7.8	24.09	2.15	0.53	1.14	0.03	0.09	0.01
6	GX720	11.80	0.021	12.0	90.0	5.4	19.90	1.74	0.02	0.16	0.01	0.04	0.00
7	CC622	758.40	23.207	8.0	20.0	3.6	11.36	0.16	16.04	40.10	7.22	22.78	0.32
8	GP600	1233.70	21.908	4.0	40.0	2.0	0.72	0.08	7.57	75.71	3.79	1.35	0.15
9	*C967	256.00	5.459	0.4	6.0	0.6	0.51	0.05	0.19	2.83	0.28	0.24	0.02
10	SB99S	45.20	1.026	28.0	30.0	5.0	0.85	0.11	2.48	2.66	0.44	0.08	0.01
11	*G580	4.60	0.268	50.0	130.0	20.0	11.58	1.65	1.16	3.01	0.46	0.27	0.04
12	RN560	107.00	2.922	2.8	100.0	2.0	1.19	0.09	0.71	25.25	0.50	0.30	0.02
13	IR540	8.40	0.108	10.0	40.0	4.8	0.86	0.26	0.09	0.37	0.04	0.01	0.00
14	SR500	53.20	2.020	8.0	60.0	2.6	1.29	0.17	1.40	10.47	0.45	0.23	0.03
15	ES400	342.50	19.037	6.0	-	2.8	2.82	0.41	9.87	0.00	4.61	4.64	0.67
16	IN460	139.00	1.984	30.0	30.0	3.2	1.85	0.13	5.14	5.14	0.55	0.32	0.02
17	SC420	186.00	2.033	8.0	40.0	4.8	2.00	0.06	1.41	7.03	0.84	0.35	0.01
18	IA260	514.20	15.853	20.0	60.0	4.0	6.05	0.80	27.39	82.18	5.48	8.29	1.10
19	SP300	159.80	6.389	40.0	80.0	30.0	17.19	1.51	22.08	44.16	16.56	9.49	0.83
20	SJ220	163.50	37.401	50.0	110.0	40.0	16.31	1.43	161.59	355.49	129.27	52.71	4.62
21	AC241	57.90	6.733	70.0	160.0	26.0	17.22	1.62	40.72	93.08	15.13	10.02	0.94
22	IJ200	27.30	5.321	80.0	200.0	60.0	24.20	1.80	36.78	91.95	27.58	11.13	0.83
23	PN180	-	0.663	52.0	110.0	5.2	12.42	1.38	2.98	6.30	0.30	0.71	0.08
24	CN100	60.50	11.092	50.0	140.0	30.0	15.31	1.47	47.92	134.17	28.75	14.67	1.41
25	*N000	42.80	7.254	40.0	130.0	20.0	15.29	1.19	25.07	81.48	12.53	9.58	0.75
Total		3604.10	154.991						371.51	979.15	238.63	138.41	11.06

*Tributary rever

Table APP. 1-3 Monthly Runoff Load of Regular Survey (May 1992 to Dec. 1993)

(Jun. 1993)

NO		Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TP (mg/l)	Runoff Load BOD Load (t/day)	COD(Cr)Load (t/day)	COD(Mn)Load (t/day)	TN Load (t/day)	TP Load (t/day)
1	CI780	7.40	0.608	13.0	93.0	4.6	11.35	1.05	0.68	4.89	0.24	0.60	0.06
2	BW760	3.40	0.116	145.0	596.0	5.8	28.59	2.28	1.45	5.97	0.06	0.29	0.02
3	IB810	11.60	1.627	12.0		5.6	5.72	0.81	1.69	0.00	0.79	0.80	0.11
4	AN740	58.50	0.036	280.0	372.0	6.2	21.37	2.33	0.87	1.16	0.02	0.07	0.01
5	WT820	5.50	0.161	124.0	329.0	6.2	38.28	2.16	1.72	4.58	0.09	0.53	0.03
6	GX720	11.80	0.065	8.0	62.0	4.0	11.17	1.06	0.04	0.35	0.02	0.05	0.01
7	CC622	758.40	32.228	2.0	20.0	3.0	1.61	0.14	5.57	55.69	8.35	4.48	0.39
8	GP600	1233.70	27.234	1.6	17.0	1.8	0.69	0.09	3.76	40.00	4.24	1.62	0.21
9	MC967	256.00	5.628	0.6	50.0	1.4	0.92	0.04	0.29	24.31	0.68	0.45	0.02
10	SB998	45.20	0.933	23.2	70.0	5.6	1.05	0.09	1.87	5.64	0.45	0.08	0.01
11	WG580	4.60	0.322	52.0	142.0	6.2	13.62	1.49	1.45	3.95	0.17	0.38	0.04
12	RN560	107.00	2.756	1.2	9.0	2.4	1.10	0.08	0.29	2.14	0.57	0.26	0.02
13	IR540	8.40	0.101	2.0	28.0	4.8	0.81	0.18	0.02	0.24	0.04	0.01	0.00
14	SR500	53.20	2.891	1.6	16.0	1.8	1.11	0.11	0.40	4.00	0.45	0.28	0.03
15	ES400	342.50	37.980	12.0	-	3.8	3.30	0.32	39.38	0.00	12.47	10.83	1.06
16	IN460	139.00	2.368	4.0	13.0	3.8	1.45	0.16	0.82	2.66	0.78	0.30	0.03
17	SC420	186.00	2.661	46.0	85.0	7.4	2.52	0.09	10.58	19.54	1.70	0.58	0.02
18	IA260	544.20	44.040	16.0	208.0	3.4	27.43	0.65	60.88	791.45	12.94	104.37	2.47
19	SP300	159.80	11.680	30.0	80.0	4.8	10.03	1.50	30.27	80.73	4.84	10.12	1.51
20	SJ220	163.50	16.614	40.0	210.0	5.2	12.07	1.30	57.42	301.44	7.46	17.33	1.87
21	AC241	57.90	6.716	30.0	100.0	4.2	10.05	1.50	17.41	58.03	2.44	5.83	0.87
22	IJ200	27.30	4.150	110.0	400.0	5.8	11.02	1.60	39.44	143.42	2.08	3.95	0.57
23	PN180	-	0.294	60.0	270.0	5.6	15.01	1.60	1.52	6.86	0.14	0.38	0.04
24	CN100	60.50	9.190	25.0	250.0	5.2	8.04	1.30	19.85	198.50	4.13	6.38	1.03
25	WN000	42.80	3.759	40.0	200.0	5.2	10.09	1.20	12.99	64.96	1.69	3.28	0.39
	Total	3604.10	195.852						279.71	1710.34	60.79	166.02	9.87

*Tributary rever

(Jul. 1993)

NO		Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TP (mg/l)	Runoff Load BOD Load (t/day)	COD(Cr)Load (t/day)	COD(Mn)Load (t/day)	TN Load (t/day)	TP Load (t/day)
1	CI780	7.40	0.643	18.0	106.0	7.8	12.98	0.89	1.00	5.89	0.43	0.72	0.05
2	BW760	3.40	0.243	70.0	70.0	7.4	25.74	1.89	1.47	1.47	0.16	0.54	0.04
3	IB810	11.60	3.268	12.0		5.4	6.65	0.86	3.39	0.00	1.52	1.88	0.24
4	AN740	58.50	0.062	150.0	229.0	7.8	14.82	1.88	0.80	1.23	0.04	0.08	0.01
5	WT820	5.50	0.034	112.0		8.0	12.38	2.01	0.33	0.00	0.02	0.04	0.01
6	GX720	11.80	0.053	20.0	77.0	7.4	15.90	2.10	0.09	0.35	0.03	0.07	0.01
7	CC622	758.40	31.504	<2.0	18.0	3.4	2.13	0.13	0.00	49.00	9.25	5.80	0.35
8	GP600	1233.70	20.461	3.6	12.0	1.0	0.91	0.08	6.36	21.21	1.77	1.61	0.14
9	MC967	256.00	3.856	1.4	20.0	2.0	0.57	0.01	0.47	6.66	0.67	0.19	0.01
10	SB998	45.20	0.899	60.0	69.0	8.2	0.98	0.16	4.66	5.36	0.61	0.08	0.01
11	WG580	4.60	0.227	52.0	132.0	7.4	15.94	1.69	1.02	2.59	0.15	0.31	0.03
12	RN560	107.00	1.604	3.2	14.0	2.8	1.38	0.12	0.44	1.94	0.39	0.19	0.02
13	IR540	8.40	0.153	16.0	51.0	6.0	0.95	0.22	0.21	0.67	0.08	0.01	0.00
14	SR500	53.20	2.727	2.0	19.0	2.4	0.89	0.13	0.47	4.48	0.57	0.21	0.03
15	ES400	342.50	18.923	8.0	-	2.2	3.55	0.52	13.08	0.00	3.60	5.80	0.85
16	IN460	139.00	1.715	4.0	16.0	3.2	1.25	0.28	0.59	2.37	0.47	0.19	0.01
17	SC420	186.00	1.416		44.0	7.2	1.46	0.17	0.00	5.38	0.88	0.18	0.02
18	IA260	544.20	29.428	16.0	68.0	5.2	6.32	1.01	40.68	172.90	13.22	16.07	2.57
19	SP300	159.80	17.475	40.0	96.0	7.2	16.34	2.52	60.39	144.94	10.87	24.67	3.80
20	SJ220	163.50	31.209	68.0	238.0	7.0	13.67	1.54	183.36	641.76	18.88	36.86	4.15
21	AC241	57.90	6.521	38.0	62.0	5.8	12.74	1.23	21.41	34.93	3.27	7.18	0.69
22	IJ200	27.30	1.620	140.0	268.0	7.0	23.61	2.11	19.60	37.51	0.93	3.30	0.30
23	PN180	-	0.372	440.0	1427.0	14.0	22.09	3.87	14.14	45.86	0.45	0.71	0.12
24	CN100	60.50	2.924	56.0	223.0	6.4	12.96	1.31	14.15	56.34	1.62	3.27	0.33
25	WN000	42.80	3.011	80.0	339.0	7.0	10.77	1.15	20.81	88.19	1.82	2.80	0.30
	Total	3604.10	165.941						381.80	1276.33	65.84	101.96	13.36

*Tributary rever

Table APP. 1-3 Monthly Runoff Load of Regular Survey (May 1992 to Dec. 1993)

(Aug. 1993)

	NO	Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	TN (mg/l)	TP (mg/l)	Runoff Load BOD Load (t/day)	COD(Cr)Load (t/day)	COD(Mn)Load (t/day)	TN Load (t/day)	TP Load (t/day)
1	CI780	7.40	0.557	36.0	103.0	2.0	11.47	1.21	1.73	4.96	0.10	0.55	0.06
2	BM760	3.40	0.152	144.0	385.0	6.2	26.09	2.44	1.89	5.06	0.08	0.34	0.03
3	IB810	11.60	2.579	6.0		5.0	4.88	0.72	1.34	0.00	1.11	1.09	0.16
4	AN740	58.50	0.037	250.0	412.0	6.2	18.94	2.27	0.80	1.32	0.02	0.06	0.01
5	MT820	5.50	0.092	100.0	180.0	6.0	23.95	2.38	0.79	1.43	0.05	0.19	0.02
6	GX720	11.80	0.050	28.0	94.0	5.4	18.53	2.23	0.12	0.41	0.02	0.08	0.01
7	CC622	758.40	32.806	6.0	28.0	2.2	1.69	0.14	17.01	79.36	6.24	4.79	0.40
8	GP600	1233.70	20.858	<2	6.0	1.0	0.83	0.07	0.00	10.81	1.80	1.50	0.13
9	MC967	256.00	3.716	1.4	2.0	0.4	0.53	0.06	0.45	0.64	0.13	0.17	0.02
10	SB998	45.20	0.225	60.0	82.0	6.0	1.22	0.10	1.17	1.59	0.12	0.02	0.00
11	MG580	4.60	0.190	44.0	250.0	6.0	18.23	1.72	0.72	4.10	0.10	0.30	0.03
12	RN560	107.00	0.909	3.2	10.0	2.2	0.91	0.14	0.25	0.79	0.17	0.07	0.01
13	IR540	8.40	0.070	6.8	310.0	6.2	1.65	0.40	0.04	1.87	0.04	0.01	0.00
14	SR500	53.20	2.053	3.0	27.0	1.4	0.80	0.16	0.53	4.79	0.25	0.14	0.03
15	ES400	342.50	49.622	8.0	-	2.4	1.77	0.37	34.30	0.00	10.29	7.59	1.59
16	IN460	139.00	1.163	2.4	12.0	1.8	1.67	0.21	0.24	1.21	0.18	0.17	0.02
17	SC420	186.00	0.420	3.2	14.0	3.2	1.36	0.08	0.12	0.51	0.12	0.05	0.00
18	IA260	544.20	16.330	10.0	74.0	4.6	3.04	1.31	14.11	104.41	6.49	4.29	1.85
19	SP300	159.80	24.069	22.0	81.0	6.6	12.86	2.32	45.75	168.44	13.73	26.74	4.82
20	SJ220	163.50	22.126	50.0	181.0	8.0	11.26	1.89	95.58	346.02	15.29	21.53	3.61
21	AC241	57.90	5.346	48.0	180.0	5.6	7.68	1.51	22.17	83.14	2.59	3.55	0.70
22	IJ200	27.30	1.924	150.0	456.0	6.4	29.40	1.94	24.94	75.80	1.06	4.89	0.32
23	PN180	-	0.416	360.0	860.0	13.5	45.47	2.52	12.94	30.91	0.49	1.63	0.09
24	CN100	60.50	3.706	56.0	146.0	6.0	12.85	1.41	17.93	46.75	1.92	4.11	0.45
25	MN000	42.80	2.933	110.0	361.0	7.4	18.40	1.54	27.88	91.48	1.88	4.66	0.39
	Total	3604.10	181.479						298.65	978.71	61.12	84.57	14.01

*Tributary rever

(OCT. 1993)

	NO	Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	T-N (mg/l)	T-P (mg/l)	Runoff Load BOD LOAD (t/day)	CODcrLOAD (t/day)	CODmnLOAD (t/day)	T-N LOAD (t/day)	T-P LOAD (t/day)
1	CI780	7.40	0.657	90.0	90.0	6.4	18.87	1.70	5.11	5.11	0.36	1.07	0.10
2	BM760	3.40	0.164	160.0	250.0	7.2	32.85	2.56	2.27	3.54	0.10	0.47	0.04
3	IB810	11.60	2.303	12.0	-	5.0	3.14	0.53	2.39		0.99	0.62	0.10
4	AN740	58.50	0.054	120.0	508.0	14.0	26.43	3.30	0.56	2.37	0.07	0.12	0.02
5	MT820	5.50	0.101	-	127.0	4.2	24.29	2.58		1.11	0.04	0.21	0.02
6	GX720	11.80	0.038	20.0	36.0	6.4	13.65	2.32	0.07	0.12	0.02	0.04	0.01
7	CC622	758.40	14.669	8.0	76.0	4.8	1.09	0.15	10.14	96.32	6.08	1.39	0.19
8	GP600	1233.70	15.110	2.0	13.0	1.6	1.08	0.08	2.61	16.97	2.09	1.41	0.10
9	MC967	256.00	6.173	2.0	35.0	1.0	0.34	0.05	1.07	18.67	0.53	0.18	0.03
10	SB980	45.20	0.628	40.0	35.0	7.2	1.40	0.23	2.17	1.90	0.39	0.08	0.01
11	MG580	4.60	0.051	30.0	145.0	6.0	13.48	1.76	0.13	0.64	0.03	0.06	0.01
12	RN560	107.00	0.677	1.6	28.0	2.0	1.84	0.13	0.09	1.64	0.12	0.11	0.01
13	IR540	8.40	0.099	4.0	-	6.4	1.22	0.23	0.03		0.05	0.01	0.00
14	SR500	53.20	1.763	16.0	-	3.8	2.17	0.29	2.44		0.58	0.33	0.04
15	ES400	342.50	46.375	20.0	-	3.6	2.05	0.46	80.14		14.42	8.21	1.85
16	IN460	139.00	0.361	5.6	8.0	3.0	2.08	0.40	0.18	0.26	0.10	0.07	0.01
17	SC420	186.00	0.490	<2	11.0	0.8	1.98	0.19	0.08	0.47	0.03	0.08	0.01
18	IA260	544.20	44.241	6.0	83.0	2.8	6.14	1.29	22.93	317.26	10.70	23.48	4.92
19	SP300	159.80	18.287	20.0	225.0	5.4	14.05	2.06	31.60	355.50	8.53	22.20	3.25
20	SJ220	163.50	25.889	20.0	378.0	5.6	12.04	1.68	44.74	845.51	12.53	26.94	3.76
21	AC241	57.90	5.331	80.0	92.0	4.4	13.34	1.35	36.85	42.38	2.03	6.15	0.62
22	IJ200	27.30	1.228	20.0	252.0	1.4	8.92	1.07	2.12	26.74	0.15	0.95	0.11
23	PN180	-	1.370	60.0	396.0	6.7	9.45	1.78	7.10	46.87	0.79	1.12	0.21
24	CN100	60.50	6.965	40.0	50.0	6.6	8.21	1.58	24.07	30.09	3.97	4.94	0.95
25	MN000	42.80	3.283	10.0	55.0	4.8	7.40	1.10	2.84	15.60	1.36	2.10	0.31
	TOTAL	3604.10	183.324						241.37	1765.39	62.99	95.78	16.01

Table APP. 1-3 Monthly Runoff Load of Regular Survey (May 1992 to Dec. 1993)

(NOV. 1993)

NO		Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	T-N (mg/l)	T-P (mg/l)	Runoff Load BOD LOAD (t/day)	CODcrLOAD (t/day)	CODmnLOAD (t/day)	T-N LOAD (t/day)	T-P LOAD (t/day)
1	C1780	7.40	0.705	40.0	102.0	6.6			2.44	6.21	0.40		
2	BM760	3.40	0.078	72.0	187.0	5.5			0.49	1.26	0.04		
3	IB810	11.60	6.339	2.0	-	4.4			1.10		2.41		
4	AN740	58.50	0.029	3100.0	4460.0	6.4			7.77	11.17	0.02		
5	MT820	5.50	0.123	80.0	187.0	5.2			0.64	1.99	0.06		
6	GX720	11.30	0.014	40.0	125.0	5.5			0.05	0.15	0.01		
7	CC622	758.40	24.121	8.0	-	0.0			16.67		0.00		
8	GP600	1233.70	27.334	4.0	17.0	2.4			9.45	40.15	5.67		
9	MC967	256.00	5.824	1.6	<10	5.8			0.81	5.03	2.92		
10	SB980	45.20	0.913	5.0	34.0	5.6			0.39	2.68	0.44		
11	MG580	4.60	0.415	40.0	544.0	6.6			1.43	19.51	0.24		
12	RN560	107.00	4.759	4.0	16.0	2.8			1.64	6.58	1.15		
13	IR540	8.40	0.627	10.0	-	6.6			0.54		0.36		
14	SR500	53.20	8.727	22.0	-	5.0			16.59		3.77		
15	ES400	342.50	66.412	6.0	-	4.0			34.43		22.95		
16	IN460	139.00	0.567	-	-	-							
17	SC420	186.00	1.208	-	-	-							
18	IA260	544.20	18.945	30.0	577.0	3.6			49.11	944.46	5.89		
19	SP300	159.80	13.967	20.0	141.0	5.8			24.13	170.15	7.00		
20	SJ220	163.50	44.353	50.0	326.0	6.2			191.60	1249.26	23.76		
21	AC241	57.90	5.609	-	-	-							
22	IJ200	27.30	1.432	50.0	266.0	5.4			6.19	32.91	0.67		
23	PN180	-	1.023	50.0	237.0	6.4			4.42	20.95	0.57		
24	CN100	60.50	2.708	44.0	170.0	5.8			10.29	39.78	1.36		
25	MN000	42.80	1.761	20.0	163.0	4.4			3.04	24.80	0.67		
TOTAL		3604.10	223.872						382.02	2569.33	76.97		

(DEC. 1993)

NO		Basin Area (Km2)	Discharge (m3/s)	Water Quality BOD (mg/l)	COD(Cr) (mg/l)	COD(Mn) (mg/l)	T-N (mg/l)	T-P (mg/l)	Runoff Load BOD LOAD (t/day)	CODcrLOAD (t/day)	CODmnLOAD (t/day)	T-N LOAD (t/day)	T-P LOAD (t/day)
1	C1780	7.40	0.657	96.0	250.0	7.4			5.45	14.19	0.42		
2	BM760	3.40	0.164	60.0	155.0	7.4			0.85	2.20	0.10		
3	IB810	11.60	2.303	12.0	-	6.8			2.39		1.35		
4	AN740	58.50	0.054	1600.0	2130.0	39.0			7.46	9.94	0.18		
5	MT820	5.50	0.101	44.0	194.0	6.4			0.38	1.69	0.06		
6	GX720	11.80	0.038	8.0	126.0	5.2			0.03	0.41	0.02		
7	CC622	758.40	14.669	7.0	-	5.8			8.87		7.35		
8	GP600	1233.70	15.110	10.0	20.0	3.0			13.06	26.11	3.92		
9	MC967	256.00	6.173	-	-	-							
10	SB980	45.20	0.628	-	-	-							
11	MG580	4.60	0.051	50.0	100.0	7.2			0.22	0.44	0.03		
12	RN560	107.00	0.677	12.0	17.0	4.2			0.70	0.99	0.25		
13	IR540	8.40	0.099	20.0	-	7.8			0.17		0.07		
14	SR500	53.20	1.763	12.0	-	5.8			1.83		0.88		
15	ES400	342.50	46.375	12.0	-	4.4			48.08		17.63		
16	IN460	139.00	0.381	10.0	30.0	3.4			0.33	0.99	0.11		
17	SC420	186.00	0.490	30.0	30.0	3.2			1.27	1.27	0.14		
18	IA260	544.20	44.241	-	-	-							
19	SP300	159.80	18.287	-	-	-							
20	SJ220	163.50	25.889	-	-	-							
21	AC241	57.90	5.331	44.0	88.0	7.0			20.27	40.53	3.22		
22	IJ200	27.30	1.228	-	-	-							
23	PN180	-	1.370	-	-	-							
24	CN100	60.50	6.965	-	-	-							
25	MN000	42.80	3.283	-	-	-							
TOTAL		3604.10	183.324						89.49	55.98	32.26		

Table APP. 1-4 Results of River Water Quality Analysis of Regular Survey

NO. OF STATION : 1 (CI-780) RIVER NAME : Canal Canto do Rio 1992 | 1993

NO. OF SAMPLING			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DATE OF SAMPLING			MAY 04	JUN 17	AUG 26	SEP 29	OCT 19	NOV 19	FEB 11	MAR 11	APR 12	MAY 24	JUN 22	JUL 20	AUG 18	OCT19	NOV18	DEC15
General number of the laboratory			6091	6908	9108	10921	11969	13419	1774	2756	4777	7762	9089	10939	12576	15511	16815	18535
CODE	PARAMETER	UNITY																
	Time	H	10.25	8.50	8.10	8.55	9.15	9.45	9.00	10.00	9.45	10.05	8.20	8.10	8.15	8.35	8.10	8.25
02062F	Air temperature	C	29.00	22.00	19.00	25.00	30.00	25.50	32.00	25.00	30.00	26.50	20.00	22.00	22	24.90	26.00	27.00
02061F	Water temperature	C	26.48	23.50	22.50	23.60	26.66	25.64	30.00	20.30	26.80	24.58	22.61	23.55	23.29	27.70	28.43	28.53
02080F	Transp. (tube)	cm	15.0	22.5			5.5	6.0	0.5	6.0	8.0	5.0	7.0	10.0	5.0	1.0	5.0	3.0
02043F	Conduct. (field)	mS/cm						0.44	0.45	0.36		0.38	0.30	0.31	0.34	0.38	0.36	0.4
02042F	Conduct. (field)	uS/cm	500	500	493	429	0.48				483	-						
17300F	Salinity (field)	‰	0.24	0.25	0.30	0.20	0.23	0.21				-						
10300F	pH (field)		6.70	7.13	5.93	6.43	7.23	7.45	-	5.90	6.33	6.59	6.45	6.67	6.68	6.67	6.89	6.33
08102F	DO (field)	mg/l	2.5	3.1	3.8	3.8	2.0	2.1	1.6	3.2	2.7	1.6	4.0	3.8	3.5	1.6	-	-
06600L	Cyanide	mg CN/l	0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.020	0.010	0.015	0.030	<0.010	0.018	0.015	0.189		*
08202L	BOD (total)	mg/l	24	26	20	<2	40	4	40	60	18	72	13	18	36	90	40	96
08205L	Dissolved BOD	mg/l	20		8	<2						-						
08301L	COD (total)	mg/l	38	51	100	60	130	70	75	70	75	250	93	106	103	90	102	250
08303L	Dissolved COD	mg/l	-		35	25						-						
06534L	Phenol	mg/l	0.000	0.003	<0.001	0.001	<0.001	<0.001	0.004	0.002	0.005	0.004	0.006	0.008	0.011	0.006	0.001	0.009
15408L	Total Phosphorus	mg P/l	1.00	1.50	1.40	0.65	2.10	1.00	1.60	1.00	0.30	1.56	1.05	0.89	1.21	1.70		*
15406L	Diss. Phosphorus	mg P/l	1.00	0.40	0.10	0.20						-						
15252L	Orthophoshate	mg P/l	0.65	0.25	0.05	0.20	0.20			-	0.15	0.45	0.06	0.11	0.18	0.22	0.22	0.08
	Organic Phosph	mg P/l	0.35	1.25	1.35	0.45	1.90			-	0.15	1.11	0.99	0.77	1.03	1.48		
07556L	Ammonia Nitrogen	mg N/l	2.80	3.40	12.00	3.20	15.00		12.00	3.60	5.00	6.40	3.98	3.87	4.73	3.82	4.58	4.83
07306L	Nitrate Nitrogen	mg N/l	0.09	0.10	0.04	0.45	0.09		<0.01	0.08	0.07	0.077	0.198	0.084	0.086	0.070	0.042	0.05
07209L	Nitrite Nitrogen	mg N/l	0.060	0.010	0.005	0.060	0.030		0.080	0.050	0.040	0.008	0.010	0.020	0.014	0.007	0.014	0.014
07008L	Kjeldahl Nitrogen	mg N/l	7.50	17.00	20.00	10.00	22.00	10.50	13.00	12.00	14.00	18.00	11.14	12.86	11.37	18.79		*
07054L	Diss. Kjeldahl N.	mg N/l	7.00	6.00	12.00	9.00						-						
07407L	Organic Nitrogen	mg N/l	4.70	13.60	8.00	6.80	7.00		1.00	8.40	9.00	11.60	7.16	8.99	6.64	14.97		
07408L	Diss. Organic N.	mg N/l	4.20	2.60	0.00	5.80						-						
07801L	Total Nitrogen	mg N/l	7.650	17.110	20.045	10.510	22.120		13.080	12.130	14.110	18.09	11.35	12.98	11.47	18.87		
07802L	Diss. Nitrogen	mg N/l	7.150	6.110	12.045	9.510						-						
08402L	Total OC alcaline	mg/l	9.3	10.5	10.2	10.2	11.6	10.0	4.0	23.0	11.0	8.4	4.6	7.8	5.8	6.4	6.6	7.4
08403L	Diss. OC alcaline	mg/l	-		7.4	8.4						-						
08101L	DO	mg/l	2.8	3.2			1.4		1.6			-						
06522L	Hexan extractable	mg/l	<4	<4	8	<4	4	<4	<4			-						
10401L	Suspended Solids	mg/l	32	45	70	50	70	40	40	80	45	90	210	53	67	110	38	215
08306L	TOC	mg/l	*									35	18	14	23	27	18	58
08307L	Dissolved TOC	mg/l	*									-						
36111L	Fecal Coli x1000	MPN/100ml	3000.00		1300.00	>160	800.00	3000.00	1100	2300	5000	11000	1300	1700	8000	3000	300	G16000
36101L	Total Coli x1000	MPN/100ml	3000.00		9000.00	>160	9000.00	5000.00	3000	2300	8000	50000	1700	17000	13000	30000	300	G16000
48004L	Cadmium	mg Cd/l	0.000	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
82004L	Lead	mg Pb/l	<0.02	0.04	<0.02	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02
29005L	Copper	mg Cu/l	<0.005	0.010	<0.005	0.020	0.020	0.040	0.010	0.015		-	0.010	<0.005	<0.005	0.015	0.005	0.140
24101L	Chromium IV	mg Cu/l	<0.01	<0.01	<0.01	<0.01	<0.01					-						
24002L	Chromium	mg Cr/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	<0.01	<0.01	<0.01
80013L	Mercury	ug Hg/l	0.10	0.15	0.30	<0.10	0.10	0.10	0.25	0.40	0.10	0.15	<0.10	<0.10	0.1	0.40	<0.10	1.40
30003L	Zinc	mg Zn/l	0.050	0.060	0.100	0.030	0.120	0.015	<0.005	0.050	0.200	0.060	0.040	0.020	0.030	0.700	0.040	0.900
18001L	pp'DDT	ug/l	<0.001		<0.001	<0.001						-						
18022L	op'DDE	ug/l	<0.001		<0.001	<0.001						-						
18023L	pp'DDE	ug/l	<0.001		<0.001	<0.001						-						
18013L	pp'DDD	ug/l	<0.001		<0.001	<0.001						-						
18170L	PCB's	ug/l	<0.01		<0.01	<0.01						-						

Table APP. 1-4 Results of River Water Quality Analysis of Regular Survey

NO. OF STATION : 2 (BM-760) RIVER NAME : Rio Bomba 1992 1993

CODE	PARAMETER	UNITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	DATE OF SAMPLING		MAY 04	JUN 17	AUG 26	SEP 29	OCT 19	NOV 19	FEB 11	MAR 11	APR 12	MAY 24	JUN 22	JUL 20	AUG 18	OCT19	NOV18	DEC15
	General number of the laboratory		6092	6910	9109	10922	11970	13420	1775	2757	4778	7763	9090	10940	12577	15512	16816	18536
	Time	H	11.40	10.15	8.35	9.15	10.00	10.30	9.30	10.50	10.40	10.50	9.10	9.05	9.00	9.25	8.50	9.00
02062F	Air temperature	C	31.00	25.00	19.00	25.00	30.00	27.00	32.00	26.50	27.00	27.00	21.00	23.00	24.00	27.00	27.00	30.00
02061F	Water temperature	C	26.30	22.50	21.00	22.70	27.79	26.84	30.00	23.30	26.30	23.76	20.84	22.20	21.81	27.47	28.29	28.47
02080F	Transp. (tube)	cm	7.5	7.0			5.5	5.0	0.1	7.0	7.0	2.5	4.0	6.0	2.5	1.0	2.5	2.0
02043F	Conduct. (field)	mS/cm					0.62	0.62	0.59	0.58		0.58	0.42	0.19	0.25	0.56	0.11	0.52
02042F	Conduct. (field)	uS/cm	610	500	495	536					687							
17300F	Salinity (field)	‰	0.29	0.26	0.30	0.30	0.29	0.29										
10300F	pH (field)		6.96	7.21	6.44	6.64	7.53	7.65	-	6.20	6.41	6.43	6.88	6.84	6.67	6.97	6.92	6.67
08102F	DO (field)	mg/l	2.5	1.8	2.6	2.0	1.8	1.5	0.8	0.6	1.5	0.1	1.5	1.8	2.6	1.3	-	-
06600L	Cyanide	mg CN/l	0.020	0.020	0.040	<0.010	<0.010	0.010	0.030	0.040	0.030	0.093	0.070	0.027	0.043	0.163		*
08202L	BOD (total)	mg/l	80	105	40	40	100	48	130	80	50	340	145	70	144	160	72	60
08205L	Dissolved BOD	mg/l	40		18	10												
08301L	COD (total)	mg/l	80	119	110	140	360	210	320	100	280	530	596	70	385	250	187	155
08303L	Dissolved COD	mg/l	-		40	60												
06534L	Phenol	mg/l	0.020	0.018	0.010	0.090	0.040	0.020	0.030	0.020	0.030	0.022	0.029	0.036	0.030	0.030	0.029	0.032
15408L	Total Phosphorus	mg P/l	3.00	4.00	3.00	2.70	4.20	2.00	6.00	3.20	2.45	2.74	2.28	1.89	2.44	2.56		*
15406L	Diss. Phosphorus	mg P/l	2.00	3.00	2.30	1.50												
15252L	Orthophoshate	mg P/l	1.50	3.00	2.10	1.40	3.55			-	1.30	1.58	1.37	1.05	1.46	2.43	2.34	1.86
	Organic Phosph	mg P/l	1.50	1.00	0.90	1.30	0.65			-	1.15	1.17	0.90	0.84	0.99	0.13		
07556L	Ammonia Nitrogen	mg N/l	3.00	3.50	13.00	3.70	20.00		20.00	6.00	6.00	8.80	7.33	5.72	8.06	8.43	6.97	5.14
07306L	Nitrate Nitrogen	mg N/l	0.02	0.05	0.09	0.25	0.07		0.04	0.20	0.01	0.073	0.022	0.029	0.024	0.040	0.027	0.01
07209L	Nitrite Nitrogen	mg N/l	0.000	0.001	0.040	0.200	0.002		0.009	0.009	0.010	0.003	0.014	0.003	0.004	0.008	0.005	0.003
07008L	Kjeldahl Nitrogen	mg N/l	8.00	40.00	24.00	15.00	28.00	23.00	34.00	17.00	20.00	32.00	28.55	25.71	26.06	32.80		*
07054L	Diss. Kjeldahl N.	mg N/l	7.00	20.00	20.00	15.00												
07407L	Organic Nitrogen	mg N/l	5.00	36.50	11.00	11.30	8.00		14.00	11.00	14.00	23.20	21.22	19.99	18.00	24.37		
07408L	Diss. Organic N.	mg N/l	4.00	16.50	7.00	11.30												
07801L	Total Nitrogen	mg N/l	8.020	40.051	24.130	15.450	28.072		34.049	17.209	20.020	32.08	28.59	25.74	26.09	32.85		
07802L	Diss. Nitrogen	mg N/l	7.200	20.051	20.130	15.450												
08402L	Total OC alcaline	mg/l	20.2	32.5	9.2	11.8	56.0	9.8	62.0	11.8	11.4	7.8	5.8	7.4	6.2	7.2	5.5	7.4
08403L	Diss. OC alcaline	mg/l	-		7.4	10.6												
08101L	DO	mg/l	1.6	2			1.2		0.1									
06522L	Hexan extractable	mg/l	14	27	<4	5	9	<4	14									
10401L	Suspended Solids	mg/l	260	80	45	150	135	50	180	50	50	320	37	134	147	260	104	95
08306L	TOC	mg/l	*									73	70	<5	<5	15	10	42
08307L	Dissolved TOC	mg/l	*															
36111L	Fecal Coli x1000	MPN/100ml	24000.00		5000.00	>160	9000.00	24000.00	30000	50000	13000	90000	23000	50000	13000	500000	90000	16000
36101L	Total Coli x1000	MPN/100ml	50000.00		5000.00	>160	16000.00	24000.00	50000	90000	24000	160000<	30000	50000	24000	900000	160000	16000
48004L	Cadmium	mg Cd/l	0.000	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
82004L	Lead	mg Pb/l	<0.02	0.04	<0.02	0.10	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	0.04	<0.02	<0.02
29005L	Copper	mg Cu/l	<0.005	0.030	<0.005	0.020	0.030	<0.002	0.020	0.015			0.015	0.005	<0.005	0.020	0.010	<0.005
24101L	Chromium IV	mg Cu/l	<0.01	<0.01	<0.01	<0.01	<0.01											
24002L	Chromium	mg Cr/l	<0.01	0.01	0.03	<0.01	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
80013L	Mercury	ug Hg/l	<0.01	0.35	<0.10	<0.10	0.20	<0.10	0.50	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	0.30	0.10	0.20
30003L	Zinc	mg Zn/l	0.080	0.120	0.030	0.040	0.005	0.010	0.010	0.040	0.040	0.060	0.070	0.060	0.050	0.090	0.060	0.030
18001L	pp' DDT	ug/l	<0.001		<0.001	<0.001												
18022L	op' DDE	ug/l	<0.001		<0.001	<0.001												
18023L	pp' DDE	ug/l	<0.001		<0.001	<0.001												
18013L	pp' DDD	ug/l	<0.001		<0.001	<0.001												
18170L	PCB's	ug/l	<0.01		<0.01	<0.01												

Table APP. 1-4 Results of River Water Quality Analysis of Regular Survey

NO. OF STATION : 3 (IB-810) RIVER NAME : Rio Imboassu 1992 1993

NO. OF SAMPLING			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DATE OF SAMPLING			MAY 05	JUN 17	AUG 26	SEP 29	OCT 22	NOV 24	FEB 11	MAR 11	APR 12	MAY 24	JUN 22	JUL 20	AUG 18	OCT19	NOV18	DEC15
General number of the laboratory			6159	6911	9110	10923	1224	13647	1776	2758	4779	7764	9091	10941	12578	15513	16817	18537
CODE	PARAMETER	UNITY																
	Time	H	10.10	11.00	9.00	9.35	17.40	9.00	40.00	11.10	11.30	11.30	9.45	9.45	9.30	10.10	9.10	9.25
02062F	Air temperature	C	28.00	24.00	21.00	25.00	21.00	28.00	33.00	27.00	31.00	26.00	23.00	24.00	25.00	29.00	28.00	30.00
02061F	Water temperature	C	25.58	22.00	19.20	21.90	23.70	25.45	30.00	26.40	25.90	22.54	19.49	21.39	20.93	28.28	29.17	29.23
02080F	Transp. (tube)	cm	9.0	17.0			8.0	8.0	5.0	8.0	8.0	5.0	6.0	10.0	6.00	3.0	5.0	5.0
02043F	Conduct. (field)	mS/cm					34.67	32.32	3.73	-		28.85	30.4	33.73	0.23	43.39	46.79	33.16
02042F	Conduct. (field)	uS/cm	30560	34910	37500	26900					18960							
17300F	Salinity (field)	‰	18.71	23.30	23.10	15.90	22.41	19.84										
10300F	pH (field)		7.04	7.17	6.38	6.77	7.36	7.55	-	6.50	6.67	6.95	6.64	6.54	6.83	7.00	7.10	7.12
08102F	DO (field)	mg/l	2.10	2.0	3.1	2.7	1.1	2.2	4.3	4.2	1.1	3.5	2.3	0.8	3.7	4.1	-	-
06600L	Cyanide	mg CN/l	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.025	0.015	0.003	0.018	0.005		*
08202L	BOD (total)	mg/l	12	10	4	2	8	3	6.4	4	25	12	12	12	6	12	2	12
08205L	Dissolved BOD	mg/l	8		4	2												
08301L	COD (total)	mg/l	-	-	-	-	-	-		1440						-	-	-
08303L	Dissolved COD	mg/l	-		-	-												
06534L	Phenol	mg/l	<0.001	0.000	<0.001	<0.001	0.002	<0.001	0.001	0.004	0.008	0.009	0.005	0.002	0.003	0.003	0.010	<0.001
15408L	Total Phosphorus	mg P/l	0.60	1.00	0.60	0.50	0.70	0.45	0.50	0.45	0.65	1.09	0.81	0.86	0.72	0.53		*
15406L	Diss. Phosphorus	mg P/l	0.20	0.70	0.20	0.10												
15252L	Orthophoshate	mg P/l	0.15	0.50	0.10	0.10	0.20			-	0.20	1.01	0.24	0.48	0.43	0.19	0.27	0.21
	Organic Phosph	mg P/l	0.45	0.50	0.50	0.40	0.50			-	0.45	0.08	0.58	0.38	0.29	0.34		
07556L	Ammonia Nitrogen	mg N/l	0.90	2.70	3.10	1.50	1.55		0.45	0.50	1.20	2.90	2.28	1.92	1.75	0.42	0.60	0.95
07306L	Nitrate Nitrogen	mg N/l	0.10	0.05	0.07	0.35	0.04		<0.01	0.07	<0.01	0.047	0.050	0.051	0.019	0.085	0.053	0.10
07209L	Nitrite Nitrogen	mg N/l	0.060	0.030	0.070	0.090	0.010		0.030	0.030	0.008	0.022	0.009	0.010	0.031	0.050	0.043	0.081
07008L	Kjeldahl Nitrogen	mg N/l	3.00	9.00	3.80	2.00	4.00	0.80	1.80	3.00	4.00	9.00	5.66	6.59	4.83	3.00		*
07054L	Diss. Kjeldahl N.	mg N/l	2.00	5.00	3.20	1.80												
07407L	Organic Nitrogen	mg N/l	2.10	6.30	0.70	0.50	2.45		1.35	2.50	2.80	6.10	3.38	4.67	3.08	2.58		
07408L	Diss. Organic N.	mg N/l	1.10	2.30	0.10	0.30												
07801L	Total Nitrogen	mg N/l	3.160	9.080	3.940	2.440	4.050		1.830	3.100	4.008	9.07	5.72	6.65	4.88	3.14		
07802L	Diss. Nitrogen	mg N/l	2.160	5.080	3.340	2.240												
08402L	Total OC alcaline	mg/l	11.3	9.5	10.6	12.6	10.0	7.8	9.6	9.4	23.0	7.8	5.6	5.4	5.0	5.0	4.4	6.8
08403L	Diss. OC alcaline	mg/l	-		6.6	9.6												
08101L	DO	mg/l	3	2.8			2		5									
06522L	Hexan extractable	mg/l	<4	<4	6	<4	8		13									
10401L	Suspended Solids	mg/l	140	30	90	150	20	70	70	60	30	65	95	48	80	119	105	110
08306L	TOC	mg/l	*									15	14	11	16	11	19	28
08307L	Dissolved TOC	mg/l	*															
36111L	Fecal Coli x1000	MPN/100ml	500		50	24	80	220	8	500	170	230	170	50	140	800	80	130
36101L	Total Coli x1000	MPN/100ml	800		80	90	240	500	23	1300	300	500	900	80	220	800	130	130
48004L	Cadmium	mg Cd/l	0.030	0.085	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0,002	0.075
82004L	Lead	mg Pb/l	0.10	1.00	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0,02	0.14
29005L	Copper	mg Cu/l	0.090	0.040	0.005	0.050	0.100	<0.002	<0.005	0.040			<0.005	<0.005	<0.005	<0.005	<0,005	0.040
24101L	Chromium IV	mg Cu/l	<0.01	<0.01	<0.01	<0.01	<0.01											
24002L	Chromium	mg Cr/l	0.01	0.03	<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	<0,01
80013L	Mercury	ug Hg/l	0.10	<0.10	<0.10	<0.10	0.10	<0.10	0.35	0.03	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	<0,10	0.20
30003L	Zinc	mg Zn/l	0.020	0.070	0.020	0.020	0.030	<0.005	<0.005	0.015	0.080	0.008	0.010	<0.005	<0.005	0.015	0.005	0.060
18001L	pp'DDT	ug/l	<0.001		<0.001	<0.001												
18022L	op'DDE	ug/l	<0.001		<0.001	<0.001												
18023L	pp'DDE	ug/l	<0.001		<0.001	<0.001												
18013L	pp'DDD	ug/l	<0.001		<0.001	<0.001												
18170L	PCB's	ug/l	<0.01		<0.01	<0.01												

Table APP. 1-4 Results of River Water Quality Analysis of Regular Survey

NO. OF STATION : 4 (AN-740) RIVER NAME : Rio Alcantara 1992 1993

CODE	PARAMETER	UNITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	NO. OF SAMPLING		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	DATE OF SAMPLING		MAY 04	JUN 17	AUG 26	SEP 29	OCT 19	NOV 19	FEB 11	MAR 11	APR 12	MAY 24	JUN 22	JUL 20	AUG 18	OCT19	NOV18	DEC15
	General number of the laboratory		6093	6914	9112	10925	11972	13422	1778	2760	4781	7765	9092	10942	12579	15514	16818	18538
	Time	H	13.5	12.20	9.40	10.15	11.21	11.30	11.00	12.15	12.25	12.10	10.50	10.55	10.15	10.35	9.30	9.55
02062F	Air temperature	C	32.00	26.00	22.50	24.00	32.00	32.00	36.00	28.90	32.00	26.00	27.00	28.00	26.00	30.00	30.00	31.50
02061F	Water temperature	C	26.87	25.50	23.00	23.00	29.06	26.98	32.00	28.80	26.90	24.40	23.37	24.06	23.40	28.88	31.08	30.04
02080F	Transp. (tube)	cm	5.00	9.0			4.5	2.5	0.1	2.0	2.5	2.0	2.5	2.5	2.5	1.0	1.5	2.0
02043F	Conduct. (field)	mS/cm					0.61	0.95	1.6	0.68		0.47	0.39	0.25	0.47	0.24	0.89	0.31
02042F	Conduct. (field)	uS/cm	490	470	1553	492					409							
17300F	Salinity (field)	%	0.23	0.23	0.90	0.30	0.27	0.46										
10300F	pH (field)		6.92	7.15	4.93	6.56	6.92	6.88	-	5.40	6.31	6.43	9.83	6.96	6.58	6.60	5.84	6.24
08102F	DO (field)	mg/l	4.5	2.30	5.2	5.9	2.1	3.8	1.1	6.1	4.2	0.3	4.3	3.5	1.7	5.1	-	-
06600L	Cyanide	mg CN/l	<0.010	<0.010	0.030	<0.010	<0.010	<0.010	<0.010	0.030	0.020	0.077	0.085	0.013	0.023	0.172		*
08202L	BOD (total)	mg/l	140	150	-	150	380	140	2900	960	90	160	280	150	250	120	3100	1600
08205L	Dissolved BOD	mg/l	100			80												
08301L	COD (total)	mg/l	140	249	-	350	925	25		-		500	372	229	412	508	4460	2130
08303L	Dissolved COD	mg/l	-		-	170												
06534L	Phenol	mg/l	0.010	0.007	0.003	0.003	0.006	0.020	0.100	0.010	0.001	0.000	0.027	0.021	0.017	0.010	0.026	0.025
15408L	Total Phosphorus	mg P/l	2.50	4.00	62.00	4.30	11.00	30.00	22.00	9.00	2.70	1.97	2.33	1.88	2.27	3.30		*
15406L	Diss. Phosphorus	mg P/l	2.00	2.00	58.00	2.50												
15252L	Orthophoshate	mg P/l	0.10	2.00	53.00	2.30	10.00			.	1.25	1.23	1.90	1.09	1.67	3.07	45.00	15.90
	Organic Phosph	mg P/l	2.40	2.00	9.00	2.00	1.00			.	1.45	0.74	0.43	0.79	0.60	0.23		
07556L	Ammonia Nitrogen	mg N/l	2.20	2.70	11.00	2.30	10.00		9.00	2.10	1.70	2.90	2.37	3.17	3.71	4.63	6.80	2.32
07306L	Nitrate Nitrogen	mg N/l	<0.01	0.07	0.12	0.50	0.08		<0.01	<0.01	<0.01	0.281	0.285	0.017	2.884	0.126	2.326	0.65
07209L	Nitrite Nitrogen	mg N/l	0.000	0.010	0.020	0.100	0.001		0.004	0.008	0.010	0.038	0.045	0.006	1.020	0.108	2.227	0.594
07008L	Kjeldahl Nitrogen	mg N/l	5.50	22.00	70.00	11.00	15.00	38.00	35.00	21.00	18.00	16.00	21.04	14.80	15.04	26.20		*
07054L	Diss. Kjeldahl N.	mg N/l	4.50	6.00	60.00	9.00												
07407L	Organic Nitrogen	mg N/l	3.30	19.30	59.00	8.70	5.00		26.00	18.90	16.30	13.10	18.67	11.63	11.33	21.57		
07408L	Diss. Organic N.	mg N/l	2.30	3.30	49.00	6.70												
07801L	Total Nitrogen	mg N/l	5.500	22.080	70.140	11.600	15.081		35.004	21.003	18.010	16.32	21.37	14.82	18.94	26.43		
07802L	Diss. Nitrogen	mg N/l	4.500	6.080	60.140	9.600												
08402L	Total OC alcaline	mg/l	21.5	23.5	-	92.0	116.0	460.0	620.0	11.6	22.8	7.6	6.2	7.8	6.2	14.0	6.4	39.0
08403L	Diss. OC alcaline	mg/l	-		-	92.0												
08101L	DO	mg/l	3.8	3.2			0.8		0.1									
06522L	Hexan extractable	mg/l	45	23	8	<4	<4	5	80									
10401L	Suspended Solids	mg/l	200	35	340	180	85	200	420	420	80	95	153	122	151	357	421	150
08306L	TOC	mg/l	*									21	209	59	95	215	148	150
08307L	Dissolved TOC	mg/l	*															
36111L	Fecal Coli x1000	MPN/100ml	14000		80	>160	24000	11000	9000	50000	11000	22000	3000	30000	16000<	24000	9000000	500
36101L	Total Coli x1000	MPN/100ml	22000		230	>160	30000	90000	16000	90000	50000	28000	8000	30000	160000<	80000	9000000	500
48004L	Cadmium	mg Cd/l	<0.002	0.006	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
82004L	Lead	mg Pb/l	<0.02	0.04	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02
29005L	Copper	mg Cu/l	<0.005	0.020	0.010	0.030	0.003	0.020	0.020	0.015			0.015	<0.005	0.010	0.010	0.010	0.015
24101L	Chromium IV	mg Cu/l	<0.01	<0.01	<0.01	<0.01	<0.01											
24002L	Chromium	mg Cr/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	<0.01	<0.01	<0.01
80013L	Mercury	ug Hg/l	<0.10	0.50	0.70	<0.10	0.15	0.10	1.40	0.35	<0.10	<0.10	<0.10	<0.10	0.10	0.10	<0.10	0.10
30003L	Zinc	mg Zn/l	0.050	0.060	0.300	0.090	0.100	0.030	0.060	0.050	0.050	0.100	0.060	0.030	0.030	0.090	0.140	0.160
18001L	pp'DDT	ug/l	<0.001		<0.001	<0.001												
18022L	op'DDE	ug/l	<0.001		<0.001	<0.001												
18023L	pp'DDE	ug/l	0.01		<0.001	<0.001												
18013L	pp'DDD	ug/l	<0.001		<0.001	<0.001												
18170L	PCB's	ug/l	<0.01		<0.01	<0.01												

Table APP. 1-4 Results of River Water Quality Analysis of Regular Survey

NO. OF STATION : 5 (MT-820) RIVER NAME : Rio Mutondo 1992 1993

CODE	PARAMETER	UNITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	DATE OF SAMPLING		MAY 0.5	JUN 17	AUG 26	SEP 29	OCT 19	NOV 19	FEB 11	MAR 11	APR 12	MAY 24	JUN 22	JUL 20	AUG 18	OCT19	NOV18	DEC15
	General number of the laboratory		6160	6913	9111	10924	11971	13421	1777	2759	4780	7766	9093	10943	12580	15515	16819	18539
	Time	H	10.55	11.40	9.25	10.00	10.55	11.15	10.30	11.45	12.05	12.30	10.25	10.35	10.00	10.20	9.30	9.45
02062F	Air temperature	C	29.50	27.00	22.00	25.00	32.00	30.00	34.00	28.20	31.50	24.00	24.00	27.00	27.00	29.00	30.00	32.00
02061F	Water temperature	C	26.63	24.00	21.50	22.70	29.00	26.70	32.00	28.70	28.70	24.73	22.19	23.93	23.38	28.17	28.46	28.90
02080F	Transp. (tube)	cm	10.0	6.0			4.5	2.5	0.3	5.0	8.0	2.5	2.5	2.5	2.5	1.0	2.5	4.0
02043F	Conduct. (field)	mS/cm					0.67	0.78	0.52	0.49		0.17	0.24	0.44	0.44	0.31	0.09	0.16
02042F	Conduct. (field)	uS/cm	610	630	488	560					538							
17300F	Salinity (field)	‰	0.29		0.30	0.30	0.30	0.37										
10300F	pH (field)		7.04	6.97	6.74	6.57	7.29	7.44	-	5.90	6.14	6.81	6.90	6.81	6.87	7.01	6.84	6.52
08102F	DO (field)	mg/l	0.4	0.5	0.9	1.2	0.0	0.5	1.5	5.1	0.5	4.8	1.4	1.0	3.0	0.4	-	-
06600L	Cyanide	mg CN/l	0.030	<0.010	0.055	<0.010	0.015	<0.010	0.030	0.040	0.035	0.073	0.070	0.015	<0.001	0.156		*
08202L	BOD (total)	mg/l	40	116	30	40	90	24	70	45	70	140	124	112	100	-	60	44
08205L	Dissolved BOD	mg/l	28		20	12												
08301L	COD (total)	mg/l	69	124	120	140	260	90	110	60	160	300	329		180	127	187	194
08303L	Dissolved COD	mg/l	-		35	50												
06534L	Phenol	mg/l	<0.001	0.043	0.007	0.010	0.040	0.020	0.030	0.010	0.006	0.027	0.090	0.040	0.037	0.030	0.021	0.050
15408L	Total Phosphorus	mg P/l	3.00	4.00	3.20	2.90	4.30	2.50	4.00	1.20	2.80	2.15	2.16	2.01	2.38	2.58		*
15406L	Diss. Phosphorus	mg P/l	2.00	3.00	1.70	1.20												
15252L	Orthophoshate	mg P/l	0.30	3.00	1.80	1.10	4.00			-	1.30	1.38	1.98	1.81	1.60	1.87	2.32	1.36
	Organic Phosph	mg P/l	2.70	1.00	1.40	1.80	0.30			-	1.50	0.78	0.18	0.19	0.78	0.71		
07556L	Ammonia Nitrogen	mg N/l	9.50	3.70	11.00	3.40	17.00		17.00	2.30	5.00	7.60	5.98	5.52	7.24	6.33	7.22	5.11
07306L	Nitrate Nitrogen	mg N/l	1.20	0.06	0.15	0.20	0.06		<0.01	1.30	<0.01	0.088	0.014	0.038	0.050	0.016	0.039	0.01
07209L	Nitrite Nitrogen	mg N/l	0.000	0.005	0.020	0.200	0.002		0.020	1.000	0.010	0.002	0.006	0.005	0.023	0.004	0.010	0.003
07008L	Kjeldahl Nitrogen	mg N/l	20.00	30.00	20.00	13.00	29.00	19.00	23.00	7.00	15.00	24.00	38.26	12.34	23.88	24.27		*
07054L	Diss. Kjeldahl N.	mg N/l	18.00	18.00	15.00	7.00												
07407L	Organic Nitrogen	mg N/l	10.50	26.30	9.00	9.60	12.00		6.00	4.70	10.00	16.40	32.28	6.81	16.64	17.34		
07408L	Diss. Organic N.	mg N/l	8.50	14.30	4.00	3.60												
07801L	Total Nitrogen	mg N/l	21.200	30.065	20.170	13.400	29.062		23.020	9.300	15.010	24.09	38.28	12.38	23.95	24.29		
07802L	Diss. Nitrogen	mg N/l	19.200	18.065	15.170	7.400												
08402L	Total OC alcaline	mg/l	17.5	26.5	9.8	11.0	50.0	11.0	22.0	11.0	21.6	7.8	6.2	8.0	6.0	4.2	5.2	6.4
08403L	Diss. OC alcaline	mg/l	-		7.6	10.6												
08101L	DO	mg/l	1	0.2			0		0.1									
06522L	Hexan extractable	mg/l	67	27	11	<4	15	<4	6									
10401L	Suspended Solids	mg/l	80	100	130	110	85	170	170	300	140	70	180	228	169	160	237	125
08206L	TOC	mg/l	*									15	-	25	51	48	38	20
08307L	Dissolved TOC	mg/l	*															
36111L	Fecal Coli x1000	MPN/100ml	8000		3000	>160	1400	30000	8000	30000	7000	17000	13000	24000000	30000	80000	24000	0.8
36101L	Total Coli x1000	MPN/100ml	30000		13000	>160	9000	30000	50000	30000	17000	90000	50000	24000000	90000	130000	30000	3
48004L	Cadmium	mg Cd/l	<0.002	0.006	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.025
82004L	Lead	mg Pb/l	<0.02	0.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	0.20	<0.02	0.16
29005L	Copper	mg Cu/l	<0.005	0.020	<0.005	0.030	0.020	0.012	0.010	0.030			0.020	0.005	<0.005	0.020	0.015	0.040
24101L	Chromium IV	mg Cu/l	<0.01	<0.01	<0.01	<0.01	<0.01											
24002L	Chromium	mg Cr/l	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
80013L	Mercury	ug Hg/l	<0.10	0.25	0.15	<0.10	0.10	<0.10	0.15	0.15	<0.01	<0.10	<0.10	0.15	0.10	0.50	0.40	0.15
30003L	Zinc	mg Zn/l	0.050	0.030	0.040	0.040	0.080	0.020	<0.005	0.080	0.050	0.090	0.070	0.050	0.090	0.090	0.080	0.020
18001L	pp' DDT	ug/l	<0.001		<0.001	<0.001												
18022L	op' DDE	ug/l	<0.001		<0.001	<0.001												
18023L	pp' DDE	ug/l	<0.001		<0.001	<0.001												
18013L	pp' DDD	ug/l	<0.001		<0.001	<0.001												
18170L	PCB's	ug/l	<0.01		<0.01	<0.01												