3.6.2   Required EIA

Based on the discussions in the previous chapters a scoping checklist is presented as follows.

Scoping check list

No	Environmental Items	Evaluations	Grounds
Socio-economic Environment			
1	Resettlement	D	No human settlement is to be removed by implementation of this project.
2	Economic activities	D	Construction or/and rehabilitation of the wastewater treatment plant and drainage network will not cause any economic activities.
3	Traffic and public facilities	D	No public facility exists the the sites.
4	Split of communities	D	Split of community by implementation of the project is not anticipated.
5	Cultural property	D	No cultural property exists in the project area.
6	Water rights and rights of common	D	No disputes with regard to fishing rights and water rights are likely to occur.
7	Health and sanitation	C	It is going to be checked in EIA.
8	Waste	B	Sludge will be generated.
9	Hazards	D	No possibility of occurrence of hazards.
Natural Environment			
10	Topography and Geology	D	No permanent change in valuable topography and geology is expected.
11	Soil Erosion	D	No forest felling is envisaged and there is no planting area involved.
12	Ground Water	D	Ground water will not be polluted.
13	Hydrological Situation	B	Change in flow pattern and quality of the water by drainage from the treatment station can be expected.
14	Coast and Sea area	D	No facilities are planned to be constructed on the coastline.
15	Flora and Fauna	D	Habitat of valuable flora and fauna does not exist.
16	Climate	D	Large scale felling and construction of high building are not planned.
17	Landscape	C	It is going to be checked in EIA.
Environmental Pollution			
18	Air Pollution	B	Impact by emission gas from the facilities or sludge transportation is anticipated.
19	Water Pollution	B	There may be change in water quality because of discharge of treated wastewater.
20	Soil Contamination	C	It is going to be checked in EIA.
21	Noise and Vibration	D	Impact on noise and vibration by facilities could be very small.
22	Ground Subsidence	D	No ground subsidence is expected.
23	Offensive Odors	B	Wastewater treatment facilities may give off offensive odor.

Classification of Evaluation: A   Serious impact will be anticipated.

                                             B   Impact will be more or less anticipated.

                                             C   Unknown (it needs investigation)

                                             D   No impact will be anticipated.

Table 3.6-1 Characteristics of effluent from Sewerage Systems

No	Sewerage Systems	Present(1997)		2020		BOD of the effluent (mg/l)	
		Wastewater Discharge (m³/day)	BOD (kg/day)	Wastewater Discharge (m³/day)	BOD (kg/day)	1997	2020
1	Caetes	10,084	1,793	11,014	329	178	30
2	Peixinhos	52,947	11,695	57,279	2,118	221	37
3	Caixa D'agua	4,866	1,538	5,134	191	316	37
4	Nova Descoberta	6,571	3,053	7,138	354	465	50
5	Aguazinha	6,211	2,854	6,569	319	459	49
6	Dois Unidos	7,580	2,631	8,243	343	347	42
7	Ponte dos Carvalhos	2,527	544	3,615	190	215	53
8	Charnequinha	1,513	336	2,174	62	222	29
9	Camaragibe/Recife 1	9,546	2,032	11,254	330	213	29
10	Camaragibe/Recife 2	3,012	620	3,220	89	206	28
11	Camaragibe 1	3,286	680	4,450	45	207	10
12	Camaragibe 2	2,506	873	3,380	141	349	42
13	**Cabanga**	**50,961**	**10,073**	**55,239**	**1,732**	**198**	**31**
14	**Cordeiro**	**14,995**	**3,550**	**16,319**	**540**	**237**	**33**
15	Caxanga	6,237	1,437	6,690	202	230	30
16	Igarassu 2	5,714	855	9,690	271	150	28
17	Ipojuca - Sede	1,640	330	2,687	113	201	42
18	Itapissuma 1	1,045	193	1,614	58	184	36
19	Itapissuma 2	1,026	213	1,574	56	208	36
20	Comportas	6,409	1,594	8,275	270	249	33
21	**Curcurana**	**16,100**	**3,403**	**21,280**	**668**	**211**	**31**
22	**Prazeres**	**25,342**	**7,965**	**32,581**	**1,260**	**314**	**39**
23	Jaboatao 1	4,647	1,526	5,956	246	328	41
24	Jaboatao 2	7,409	1,383	9,656	304	187	31
25	Ibura de Cima	5,531	2,114	6,097	281	382	46
26	Jaboatao 3	4,873	910	6,349	200	187	31
27	Bonanca	1,004	156	1,046	27	156	26
28	Moreno 1	2,833	579	2,969	101	204	34
29	Moreno 2	969	133	1,017	35	137	34
30	Moreno 3	522	107	547	19	204	34
31	Camaragibe 3	4,385	765	5,967	79	174	13
32	Sao Lourenco 1	7,371	1,116	9,619	68	151	7
33	Sao Lourenco 2	5,318	801	6,981	180	151	26
34	**Boa Viagem**	**24,588**	**5,083**	**27,794**	**865**	**207**	**31**
35	Imbiribeira	9,283	1,902	10,103	305	205	30
36	Jardim Sao Paulo	7,769	2,075	8,384	92	267	11
37	Ibura de Baixo	21,114	6,998	23,557	695	331	30
38	Ignes Andreazza	911	209	988	36	230	36
39	Mangueira	5,380	1,165	6,430	212	217	33
40	Roda de Fogo	3,576	1,124	3,892	150	314	39
41	**Janga**	**50,016**	**5,309**	**59,891**	**1,708**	**106**	**29**
42	Paulista	8,067	1,098	11,052	372	136	34
43	**Conceicao**	**9,048**	**1,408**	**12,515**	**337**	**156**	**27**
44	Apipucos	1,926	350	2,076	58	181	28
45	Curado	1,608	721	2,031	101	448	50
46	P.P. de Galinhas	404	68	621	18	169	30
47	Jardim Paulista	2,887	561	3,954	134	194	34
48	Mirueira	4,369	862	5,478	184	197	34
49	Mutirao	962	31	1,334	34	32	26
50	Nova Cruz	625	90	1,053	28	144	27
51	Parque Capibaribe	3,750	188	4,923	127	50	26
52	Parque Pirapama	3,375	491	4,845	257	145	53
53	Vila Burity	1,240	409	1,350	62	330	46
54	Vila dos Milagres	1,700	509	1,853	77	299	42
55	27 de Novembro	885	452	963	51	510	53
	Average					221	32

*Priority Project sites are shown in Bold

CPRH- Resistration

Receiving EIA-RIMA

Inform the Applicant that
the document didn't comply with
the TOR

No

AIA team have 5 days
to confirm that the document,
complies with the TOR

Applicant

Re-submit with additional
Information

Publishes notice of reception

Preliminary analysis of the
plan, preliminary opinion

EIA-RIMA
accepted

Interested public

*Written complaint
*Contributions from other Organizations
*Public meeting

*Formation of work groups
*Distribution of RIMA to relevant
organizations

Contractor

Newspaper publication:
*Gives EIA-RIMA
*Comment phase
*Public meeting

Consolidation of the analysis
EIA-RIMA

Contractor

Complies

Yes

EIA-RIMA needs
additional information

No

Send the opinion to the licensing
council for decision

EIA-RIMA approved

No

Process finishes and
Contractor is informed

Yes

Licensing Procedures

| Fig. 3.6 - 1 | Procedures for analysis of EIA/RIMA in CPRH |

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

REGIÃO METROPOLITANA
DO RECIFE
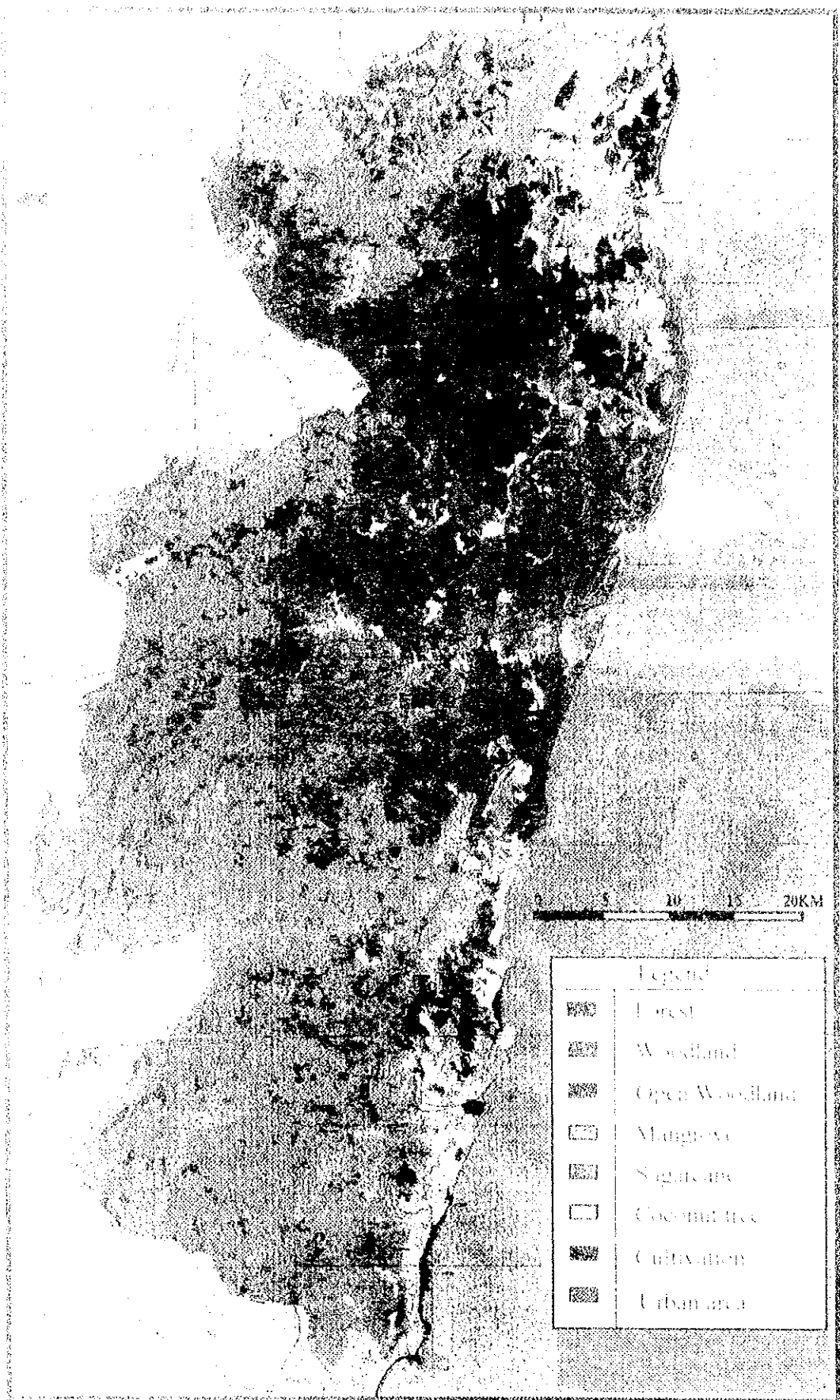MAPA DA COBERTURA VEGETAL
1998
GOVERNO DO ESTADO DE PERNAMBUCO

Legend	
■	Forest
■	Woodland
■	Open Woodland
■	Mangrove
■	Sugarcane
■	Coconut tree
■	Cultivation
■	Urban area
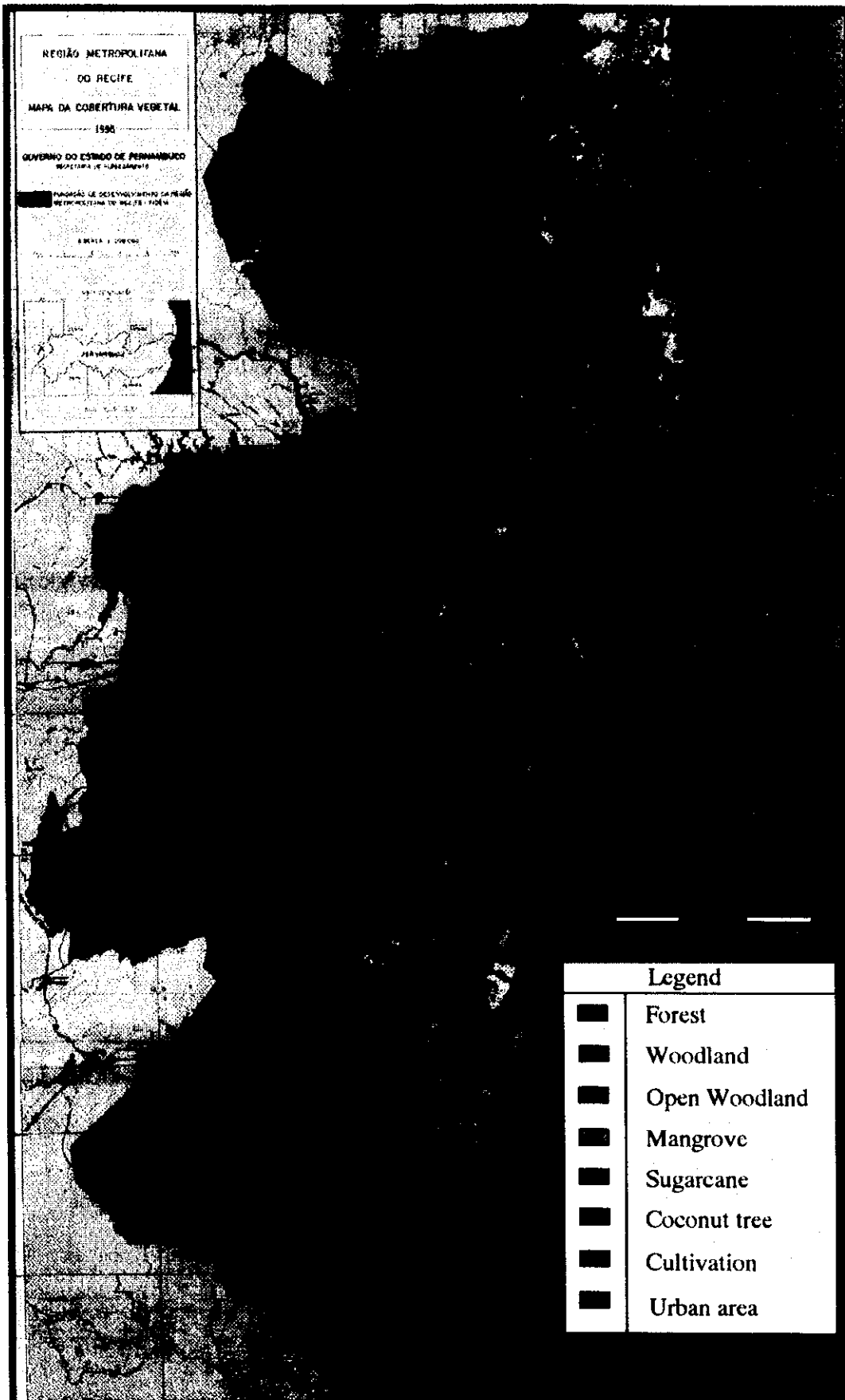
Fig. 3.6-2	Vegetation Map of the RMR

**THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE
MANAGEMENT PLAN FOR RMR**

Legend
Forest
Woodland
Open Woodland
Mangrove
Nightcane
Coconut tree
Cultivation
Urban area
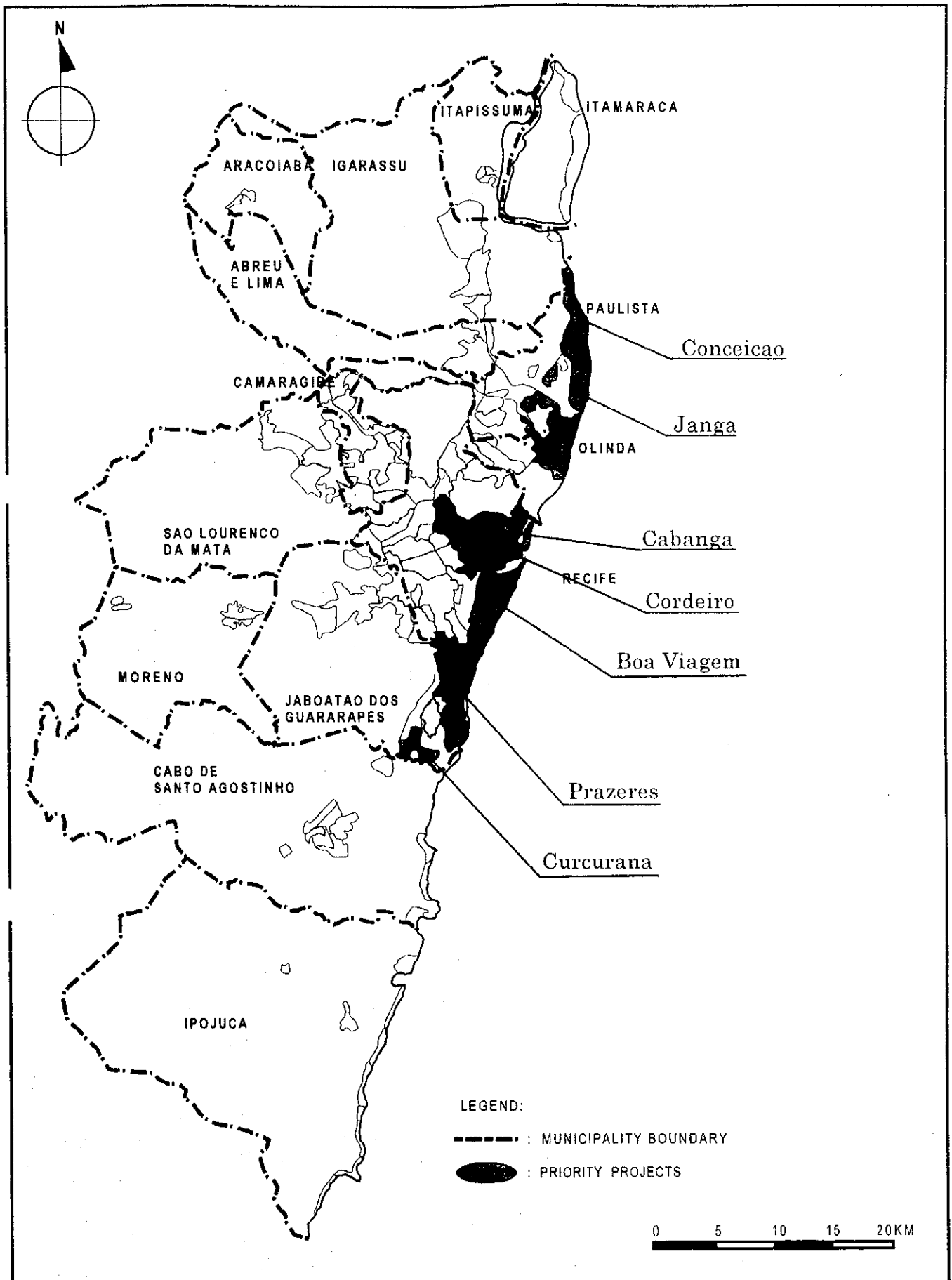
| Fig. 3.6.2 | Vegetation Map of the RMR |

| Fig.3.6-3 | LOCATION OF PROJECT SITES |

THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RMR

3.7 Project Evaluation

3.7.1 General

(1) Introduction

In this chapter, the bases of two quantitative analyses: (1) financial evaluation, and (2) economic evaluation are discussed, though the projects that will be proposed in this study are to be evaluated in their technical, social and environmental aspects as well. The financial evaluation is to inspect the proposed projects from the financial point of view, involving tests of earning capacity and financial efficiency. The economic evaluation is to examine the proposed projects from the economic point of view, testing the viability of social investment in the national economy. In addition, the socio-economic impacts of the proposed projects are discussed.

The economic evaluation presents the economic efficiency of the proposed projects. In environmental projects, however, it is difficult to quantify all their benefits. In addition, it is usually difficult to identify the people responsible in the case of environmental pollution. Even in the project areas, pollution sufferers usually differ in their living circumstance from those who cause environment pollution. In this context, the economic evaluation does not always provide an appropriate indicator of project viability. The economic evaluation should be considered to present only a limited basis for decision-making in project selection.

(2) Procedure of Financial and Economic Evaluation

For the sewerage treatment projects, the proposed projects are evaluated using the two analytical methods mentioned above. The procedure of the financial and economic evaluation is illustrated in Fig. 3.7-1.

The evaluation is conducted in accordance with the conventional methodology that is commonly applied in the evaluation of development programs in Brazil with finance from the World Bank, Inter-American Development Bank and other international agencies concerned with technical and economic cooperation. The methodology suggests that the project evaluation has two steps for quantifying evaluation factors in general. Firstly, the project costs and benefits are identified and quantified in monetary terms, which arise from implementation of the proposed projects. Then, they are compared and condensed into evaluation factors. The factors are Internal Rate of Return (IRR) as a main indicator, and Net Present Value (NPV) and Benefit-Cost Ratio (B/C) as supplementary indices.

The IRR is defined as a special discount rate that satisfies the following conditions:

1) The present value of cost is obtained through discounting all the costs incurred during the economic life of the proposed project at the special rate.

2) The present value of benefit is obtained through discounting all the benefits accruing from the project during the its lifetime at the special rate.

3) As a result, the present value of cost is equal to the present value of benefit.

In the case of this IRR exceeding the opportunity cost of capital in Brazil, the proposed project could be judged to be viable economically. The NPV shows the magnitude of project incremental benefits. The B/C indicates the gap between the project efficiency and the opportunity cost of capital.

3.7.2 Financial Evaluation

(1) Overview of Financial Evaluation

Financial analysis was carried out on the basis of market values of project costs and incomes from the proposed projects. The project costs are estimated in Section 3.5. These costs reflect the actual present market conditions. The revenue of sewerage treatment services is calculated as a product of a volume of sewage treated and sewage treatment service rates laid down by COMPESA. Finally, the projects are examined in terms of financial efficiency and evaluated taking into account the financial situation.

In the master plan stage, the financial viability of the proposed project is examined by means of evaluation indices of "financial internal rate of return (FIRR)". In financial evaluation, the decisive factor for the proposed project is considered a FIRR of 12% in general. It usually reflects long-term interest rates in financial markets in the country. This rate, however, is not always an absolute standard in financial evaluation. In the case of any financial sources of lower interest rates than 12% being available for the projects, the proposed project could be viable from the financial point of view. Thus, even if the FIRR were not good enough to implement the projects from the financial viewpoint, financial difficulties would be analyzed and identified, and some countermeasures would be proposed in this study.

The evaluation above was done mainly on the supply side. The project management must also be evaluated from the viewpoint of the demand side. Affordability of the proposed projects for their beneficiaries is an important factor for the project to be accepted by the consumers. Through these analyses, this financial study proposes financial solutions and recommendations for each aspect of the projects, if they are not affordable for the consumers.

(2)   Revenue from Sewage Treatment Services

The revenue of the proposed project accrues from payment for the sewerage service connections.   The wastewater dischargers pay for sewerage service charges in accordance with their wastewater volume discharged.   COMPESA laid down the sewerage service tariff as a surcharge on water consumption in their service areas in October 1997.   Charging rates are set on the basis of sewage collection systems such as conventional and condominial systems.   Their details are shown in Table 2.7-5.

The revenue from sewage treatment services is calculated as a product of unit rates set in the tariff and sewage volume collected which is counted in accordance with water volume consumed.   The surcharge rates are applied to consumers both with and without water meters. Applying these charging rates, the monthly financial results of water supply and sewerage services are summarized for July 1999 on the basis of COMPESA's records.   The results are tabulated as follows;

Revenue from Water Supply and Sewerage Services: July 1999

Item	Unit	Water Supply	Sewerage Service	Total
Number of Connection Units Served	1000	1,210	279	-
Volume Supplied/Treated	Million m^3	26.6	3.8	-
Monthly Revenues	R$ Million	11.5	3.2	14.7
Monthly Expenses	R$ Million	16.5	2.6	19.1
Unit Revenue				
Per Connection Unit	R$/Unit	9.50	11.52	-
Per Volume	R$/m^3	0.43	0.84	-
Unit Treatment Cost				
Per Connection Unit	R$/Unit	13.64	9.21	-
Per Volume	R$/m^3	0.62	0.67	-

The actual charging rates system is complicated as tabulated in Table 2.7-5, so it is difficult to estimate precise revenue from the volume of sewage collected.   In this analysis, the charging rate applied is assumed to be R$0.84 per m^3, which is estimated in the above table. Consequently, the revenue from sewage treatment services is calculated as a product of sewage volume collected and the average unit rate of R$0.84 per m^3.

The total daily volume of treated sewage is estimated at 530 thousand m^3/day in the target year 2020.   The charged volume of sewage is estimated as the difference between the total volume of sewage and the volume of ground water infiltrating into sewer pipes.   The charged volume is calculated at 392 thousand m^3/day or 143 million m^3/year in 2020.   Then, the total revenue of the proposed projects is calculated at R$120 million per year, applying the average unit rate of R$0.84 per m^3.   These figures have been broken down for each river basin as shown in the table below.

Revenue of the Proposed Project: 2020

Item	Annual Sewage Treatment Volume (Million m³ per Year)	Annual Revenue from Sewage Treatment Services (R$ Million per Year)
Capibaribe River Basin	36.8	30.1
Beberibe River Basin	22.7	19.1
Jaboatão River Basin	26.5	22.3
Tejipio River Basin	22.1	18.6
Timbo River Basin	22.9	19.2
Other River Basins	12.1	10.1
Total	143.1	120.2

(3)   Costs for Sewage Treatment

The financial construction cost of the proposed project consists of the following major items:

(a)   Main construction cost

(b)   Compensation cost

(c)   Engineering service cost

(d)   Government administration cost

(e)   Contingency cost

The main construction cost comprises (i) expansion works of sewage collection and transport facilities and sewage treatment facilities, (ii) rehabilitation works of existing facilities. The compensation cost is paid to landowners who have land expropriated for sewage treatment plants. Other costs are estimated as some proportion of the main construction cost. The details of cost estimates were described in Section 3.5. The financial costs of the proposed project are summarized as follows.

Financial Costs of the Proposed Project

(Unit: R$ Million at 1999 constant prices)

	Description	First Phase	Second Phase	Total
1.	Construction Cost	514.5	120.0	634.5
2.	Compensation Cost	23.6	4.1	27.7
3.	Engineering Services	51.5	12.0	63.5
4.	Administration Cost	51.5	12.0	63.5
5.	Contingency Cost	51.5	12.0	63.5
	Total	692.6	160.1	852.7

These costs are rearranged into the respective river basins as follows.

Financial Costs by River Basin

(Unit: R$ Million at 1999 constant prices)

	Description	First Phase	Second Phase	Total
1.	Capibaribe River Basin	137.7	83.2	220.9
2.	Beberibe River Basin	107.8	14.8	122.6
3.	Jaboatão River Basin	178.9	23.3	202.2
4.	Tejipio River Basin	137.5	4.6	142.1
5.	Timbo River Basin	92.1	1.1	93.2
6.	Other River Basins	38.6	33.1	71.8
	Total	692.6	160.1	852.7

The construction costs are assumed to be disbursed in accordance with the construction schedule from 2003 to 2010 for the first phase and from 2011 to 2020 for the second phase. The disbursement of construction costs is tabulated in cash flow streams as shown in Tables 3.7-1 to 3.7-7.

The operation and maintenance (O&M) cost is required annually during the economic life of the proposed projects. The O&M cost was estimated at 7% of the direct construction cost. It is estimated at R$44.4 million in the target year 2020. It is recalculated at R$0.23 per m^3 of swage treated at 1999 constant prices. The details of the O&M cost are also described in Section 3.5.

(4)   Financial Efficiency

Financial expenditure and revenue during the evaluation period are shown as annual streams in Tables 3.7-1 to 3.7-7. The tables also show evaluation indices. The indices are summarized as follows.

Evaluation Indices

	Description	FIRR	B/C[1]	NPV[1] (R$ Million)
	Entire Projects	6.1%	0.58	-225
1.	Capibaribe River Basin	6.9%	0.68	-42
2.	Beberibe River Basin	7.4%	0.70	-27
3.	Jaboatão River Basin	4.7%	0.51	-66
4.	Tejipio River Basin	5.8%	0.58	-41
5.	Timbo River Basin	8.3%	0.74	-18
6.	Other River Basins	7.2%	0.71	-9

Note: *1 Discounted at 12%.

The evaluation indices of the entire projects are calculated at 6.1% for FIRR, 0.58 for B/C and minus R$225 million for NPV. The latter two values are the results applying the discount rate of 12%. From the financial point of view, accordingly, the proposed project is not said to be viable, because the FIRRs are lower than the decisive factor of 12%. However, the FIRR of the entire project indicates that the projects could be manageable, if they procure financial sources with an interest rate of less than 6.1%.

If it is desired to have the FIRR of more than 12% only through revenue increase, the charging rates for all consumers would have to be increased by 73% over present rates. The results of this countermeasure case (named Case 1) are tabulated in Table 3.7-8. It might not be acceptable for the beneficiaries to be charged the higher rates of sewerage treatment services in the present economic situation. In the future, however, the beneficiaries might accept the higher charge after their living conditions are improved owing to economic development.

On the other hand, it would be possible to make the projects viable if some subsidies for the investment costs were available. The analysis indicates that the projects would be made viable by the covering almost 53% of the capital investment cost with a subsidy. The results of this countermeasure case (named Case 2) are tabulated in Table 3.7-9.

3.7.3 Economic Evaluation

(1) Overview of Economic Evaluation

The projects proposed in this study are evaluated on the basis of two quantitative analyses: (1) financial analysis, and (2) economic analysis. The former was discussed in the previous section. The economic evaluation is to examine the proposed project from the economic point of view, testing the viability of social investment in the national economy. As mentioned before, the financial evaluation is to inspect the proposed projects from the financial point of view, involving tests of earning capacity and financial efficiency. This is the fundamental difference between the two analyses.

(2) Criteria and Assumptions of Project Evaluation

1) Criteria of Evaluation

For economic evaluation, the following criteria and assumptions are applied to calculate the evaluation indices.

Criteria of Evaluation

No.	Item	Set-up Conditions and Assumptions
1.	Base Year	Beginning of the year 2002
2.	Construction Period	The construction works in the first phase start in 2002 and continue to 2010. Then, the second phase facilities are constructed from 2011 to 2020.
3.	Disbursement Schedule	Disbursed in accordance with construction schedule
4.	Economic Life	25 years from the completion of the projects in 2020
5.	Evaluation Period	25 years from the completion of the construction works
6.	Timing of Accruing Benefits	The matured benefits will appear after the completion of the respective projects.
7.	Price Level	Costs and benefits of the projects were set down at the beginning of November 1999.
8.	Prevailing Exchange Rate	R$1.90 per US$1.00 at the official rate
9.	Opportunity Cost of Capital	12 % per annum
10.	Growth till Target Year 2020	Based on the projection in Section 3.2.

2) Assumptions for Economic Evaluation

In estimating the economic benefit, the following criteria and assumptions are applied to convert the financial market values of project benefits and costs to the economic ones.

a) Conversion Factor

Market values are usually distorted by transfer payments such as taxes and subsidies. These payments are eventually transferred to the government, which acts on behalf of society. For this reason, they should not be treated as economic costs. These have to be eliminated from the market values of cost and benefit as a whole. In Brazil, the taxes related to construction works are income tax, customs duties, local taxes, etc.

Although all the costs have to be measured as economic costs, i.e., the real costs or "opportunity costs", it is clearly impracticable to trace procurement routes and financial sources for all the project inputs, particularly at the master plan stage. Thus, taking this situation into consideration, the economic costs are assumed to be approximately 94% of the financial costs for local portions. This rate is called the standard conversion factor (SCF).

b) Shadow Wage

Prevailing wages of skilled workers are considered to reflect an opportunity cost of labor, because such workers are usually in short supply in the labor markets. Therefore, the shadow wage rate of skilled workers is fixed at 1.0. On the other hand, unskilled workers are in excess in the labor markets, due to the conditions of unemployment and underemployment. Thus, the shadow wage rate of unskilled workers is assumed to be 0.5 of the legislated wage rate, referring to the project reports concerned.

c) Land Value

Land expropriated for treatment plants is purchased by COMPESA applying the financial market value. In economic evaluation, however, land is generally evaluated on the basis of its productivity for crop cultivation, or for example, on the balance of supply and demand for non-productive land such as residential plots. Yet, in the RMR, most land expropriated for the projects is not utilized for productive activities at present and will not be in the future. In this economic evaluation, then, the value of these lands is taken as zero for the evaluation period.

(3) Project Benefits

1) Benefits from Proposed Projects

Two main important goals of the sewerage projects in the RMR are (i) to improve public health and well-being, and to maintain the ecological balance, and (ii) to maintain and develop the tourism industry based on the natural resources of the coastline.

When the former goal is attained, all inhabitants in and around the project areas will be able to enjoy their lives in improved environments. In terms of improvement of public health conditions, the urban poor should receive significant benefits from the projects. They will be relieved of the burdens of living in areas contaminated by polluted streams, rivers and soil in the project areas.

In terms of the latter goal, the natural coastal environment should be maintained through the implementation of the proposed projects. Accordingly, the regional economy of the tourism industry of the State of Pernambuco will be revitalized by means of environment improvement. The State's economy particularly relies on the tourism industry these days after the recent deterioration of manufacturing industries in the state. In fact, the state government intends to promote the tourism industry in the future.

Besides these basic benefits, the sewerage project gives various advantages to the people and to the regional economy in and around the project areas. Fig. 3.7-2 lists the benefits accruing from the sewerage projects. In the upper part of the figure, direct benefits are listed. Benefits in the lower part are considered as indirect benefits. These benefits have ripple effects on residents, the regional environment and the regional economy. On the other hand, the proposed projects may bring about negative effects on the people and the regional socio-economy. These socio-economic impacts will be discussed in Section 3.7.4.

2) Components of Quantifiable Direct Benefits

The benefits listed in the figure are further classified into two categories. They are quantifiable or tangible, and non-quantifiable or intangible. To identify indicators for economic evaluation, only tangible benefits of direct effects are quantified as project benefits. In this study, the following three benefits are chosen as tangible benefits.

Tangible Benefits With Sewerage Projects

No.	Tangible Benefits	Quantified Benefits
1)	Sewage treatment saving benefits for inhabitants	Elimination of installation and O&M costs of other treatment systems and septic tanks outside the existing sewerage collection service areas
2)	Decrease of medical expenses and losses due to absence from work	Cost reduction of medical expenses for water borne diseases, and Reduction of losses from absence from work due to water borne diseases
3)	Elimination of tourism recession owing to maintenance of tourism resources	Maintaining tourist attractions and promotion of regional industries related to tourism in the RMR

Note: Detailed benefit structure is shown in Fig. 3.7-2.

Benefits of sewerage projects are generally appreciated with willingness-to-pay of beneficiaries. The willingness-to-pay is broadly used as monetary term for usefulness, which the beneficiaries perceive, brought about by the implementation of the projects. Thus, it includes various factors; not only tangible benefits but also intangible ones. The tangible benefits selected above are only a few components of their willingness-to-pay. In this evaluation study, however, only tangible benefits above are taken into the project benefits. It must be emphasized that if indirect benefits were considered, the results would be more favorable.

Regarding the quantifiable benefits in this evaluation, the quantification procedures of the benefits are illustrated in Fig. 3.7-3.

3) Estimate of Sewage Treatment Saving

Under without-project conditions, sewage treatment in the future is assumed to expand at the pace of the past trends. Table 3.7-10 shows the growth trend of sewage treatment services in the RMR from 1994 to 1999. During these five years, the sewerage system expanded at a rate of 2.3% per annum on average. This growth rate is assumed to continue even in the future under without-project conditions. The sewerage system includes both sewer network systems established by COMPESA and other treatment systems constructed by developers.

The population served by COMPESA was estimated at 722 thousand in 1996. Of this population, however, only 640 thousand or 89% were served with sewage treatment services of COMPESA. In the same year, 106 thousand people used other sewage treatment systems. In total, 746 thousand people are provided with sewage treatment services. Septic tank systems are compulsory for people who are not connected to any other sewage treatment systems, under state law No.7269, June 1981. The septic tanks are only actually installed by people who earn more than middle income. This number of people is estimated at 936 thousand for 1996. Accordingly, the proportions of people with sewage treatment including septic tanks were 57% of the total urban population in the RMR in 1996.

If the population served with sewage treatment services grows at the rate of 2.3%, it will be 2.15 million in the target year 2020. This will include 1.09 million connected to COMPESA systems, 0.18 million to other treatment systems and 0.88 million with septic tank systems, as shown in Table 3.7-11. The percentage of people served with sewage treatment services will have increased from 57% in 1996 to 59% in 2020. These figures for 2020 are distributed between the river basins as shown in the table below. The details are shown in Table 3.7-12. Incidentally, a basin population was estimated on the assumption that it increases in proportion to the population growth of the total urban area.

Populations of River Basins in 2020

(Unit: 1000)

	River Basin	With Treatment COMPESA	Other Treatment Systems	Septic Tank Systems	Total
1.	Capibaribe River Basin	238	39	191	468
2.	Beberibe River Basin	192	32	154	378
3.	Jaboatão River Basin	199	33	160	392
4.	Tejipio River Basin	169	28	135	332
5.	Timbo River Basin	144	24	116	284
6.	Other River Basins	151	25	121	297
	Total	1,092	181	877	2,150

Unit costs of these systems are estimated as follows. The unit costs of the sewage treatment system studied in the PQA are based on the estimates of the proposed projects in Section 3.5. These costs are calculated at R$235 per beneficiary for capital investment and R$12.7 per person for O&M in economic terms.

The unit costs of other treatment systems are estimated on the basis of an example in the RMR of 1999, as shown in Table 3.7-13. The unit costs are calculated at R$120 per beneficiary for capital investment and R$6.00 per person for O&M at market values. These costs are converted to R$113 per person and R$5.60 per person in economic terms, applying a conversion factor of 0.94. The unit costs of septic tank systems are estimated as R$110 per person for the construction cost and R$6.00 per person for the O&M cost in market prices.

These are converted to R$103 per person and R$5.60 per person respectively in economic terms.

The benefit of sewage treatment saving is estimated as a product of the population served with sewage treatment and unit costs corresponding to the respective systems up to the target year of 2020. Beyond 2020, the O&M costs of these systems can be eliminated under with-project conditions.

4)   Estimate of Medical Benefits

For 2020, the population without sewage treatment services was estimated at 1,510 million or 41% of the total population as shown in Table 3.7-11. Although the ratio of the population without sewerage services to the total population decreased from 43% in 1996 to 41% in 2020, the population numbers increased from 1.25 million in 1996 to 1.51 million in 2020. Consequently, sanitary conditions will not be improved by the target year 2020. Thus, the present medical situation is assumed to continue during the evaluation period.

The public health improvement benefit was estimated as a reduction of medical expenses by beneficiaries and also a reduction of labor opportunity losses due to illness. The amounts of these losses are estimated on the basis of medical data, which were provided by DIRES I, the State Secretariat of Health, and which were derived from household economic survey by IBGE in 1998. Some information not available in Brazil was quoted from foreign sources. The details of this benefit are shown in Table 3.7-14. The annual medical expenses for water borne diseases were estimated at around R$1.03 per person in 1999 at market prices. The annual labor losses were estimated at around R$1.04 per person. Then, the total annual losses due to illness caused by water borne diseases were estimated at R$2.07 per person at market prices. The losses were re-calculated at R$1.80 per person in economic terms.

5)   Estimate of the Elimination of a Tourism Recession

According to information from Secretariat of Economic Development, Tourism and Sports, the number of tourists in the RMR was 1,142 thousand in 1998. This was made up of 78 thousand foreign tourists and 1,064 thousand domestic tourists. Of the total tourists, 456 thousand stayed in accommodation such as hotels and guesthouses in 1998. This number had increased from 331 thousand in 1995, as shown in Table 3.7-15. Applying this growth trend, the number of tourists in the RMR is estimated at 3,685 thousand for the target year 2020.

As mentioned in Section 2.2.4(4), 62% of the tourists evaluated public cleanliness in the RMR as "not good". In this study, sightseeing tourists, who complain of a lack of

cleanliness in tourist spots, are assumed not to visit the RMR again.   Incidentally, sightseeing tourists were reported as being 57% foreign tourists and 28% domestic tourists.   As a result, the reduction in tourists due to sanitation problems was estimated as 669 thousand in 2020, of which 233 thousand are foreign tourists and 436 thousand domestic tourists.

In 1998, tourists spent their money as follows: US$51.4 per day per foreign tourist and US$33.2 per day per domestic tourist on average.   They stayed 10.8 days per foreign tourist and 8.6 days per domestic tourist on average.   Furthermore, the value-added rate of the tourism industry was estimated at 57.3% of gross revenue.   Applying these data, the expected losses due to the decrease of tourists visiting the RMR were calculated at R$176 million in 2020 at 1998 constant market prices.

The expected losses in 2020 were distributed between the river basins as shown in the following table.   The index for distribution was based on the rates of the expected pollution loads in the respective river basins against the total reduction of pollution load in the RMR. The reduction of pollution load by river basin is tabulated in Table 3.7-16.   The expected reduction rates by river basin are estimated at 21% for the Capibaribe, 23% for the Beberibe, 22% for the Jaboatão, 14% for the Tejipio, 16% for the Timbo and 3% for other rivers. Since the total economic losses in the RMR were estimated at R$182.1 million in 2020, the expected economic losses in the respective river basins are estimated as shown in the following table, applying the indices above.

Expected Losses due to Reduced Numbers of Tourists: 2020

River Basin		Distribution Index		Economic Losses
		Reduction (kg/day)	% Distribution	(R$ Million)*1
1.	Capibaribe River Basin	10.3	21	38.9
2.	Beberibe River Basin	11.1	23	42.0
3.	Jaboatão River Basin	10.4	22	39.5
4.	Tejipio River Basin	6.8	14	25.7
5.	Timbo River Basin	7.9	16	30.0
6.	Other River Basins	1.6	3	6.0
	Total	48.1	100	182.1

Note: *1   Economic value at 1999 constant prices, which applied a 10% annual increase and a 0.94 conversion factor to the economic price.

6)   Estimate of Economic Benefits

The total benefits were calculated as the sum of the benefits mentioned above.   Finally, the total economic benefits were estimated at R$115.5 million in 2010 and R$196.0 million in 2020.   The details of yearly benefits are shown in Tables 3.7-17 to 3.7-23.

Total Economic Benefits in 2010

(Unit: R$ Million)

River Basin	Sewage Treatment Saving	Medical Benefits	Tourism Recession Elimination	Total
1. Capibaribe River Basin	1.2	1.2	22.3	25.9
2. Beberibe River Basin	3.0	0.7	17.1	20.8
3. Jaboatão River Basin	5.8	0.8	19.6	26.2
4. Tejipio River Basin	4.4	0.8	13.4	18.6
5. Timbo River Basin	4.0	0.7	16.7	21.4
6. Other River Basins	0.4	0.2	1.3	1.9
Total	20.7	4.4	90.4	115.5

Total Economic Benefits in 2020

(Unit: R$ Million)

River Basin	Sewage Treatment Saving	Medical Benefits	Tourism Recession Elimination	Total
1. Capibaribe River Basin	1.9	1.3	38.9	42.1
2. Beberibe River Basin	0.9	1.1	42.0	44.0
3. Jaboatão River Basin	1.3	1.1	39.5	41.9
4. Tejipio River Basin	0.9	1.0	25.7	27.6
5. Timbo River Basin	0.8	0.8	30.0	31.6
6. Other River Basins	2.0	0.9	5.9	8.8
Total	7.8	6.2	182.0	196.0

(4)　Economic Costs

The cost estimate of the proposed project was described in Section 3.5. This estimate, however, was enumerated in market prices, termed the "financial value". In economic evaluation, the financial value has to be converted into economic value. The conversion procedure was discussed in Section 3.7.3(1). The total economic cost of the proposed project was calculated at R$773.5 million, with R$ 627.2 million in the first stage and R$ 146.3 million in the second stage. The costs for each river basin are broken down as shown in the following table.

Economic Costs per River Basin

(Unit: R$ Million)

River Basin	Direct Cost	Compensation Cost	Engineering Services	Administration Cost	Contingency Cost	Total
Capibaribe	152.3	0.0	16.2	13.8	15.2	197.5
Beberibe	88.5	0.0	9.4	8.0	8.8	114.7
Jaboatão	140.8	0.0	15.0	12.7	14.1	182.5
Tejipio	98.6	0.0	10.5	8.9	9.9	127.8
Timbo	66.0	0.0	7.0	6.0	6.6	85.6
Other	50.4	0.0	5.4	4.6	5.0	65.3
Total	596.5	0.0	63.5	53.9	59.6	773.5

The investment costs are disbursed in accordance with the construction schedule as shown in Fig.3.3-10. The expected disbursements of investment costs by river basin are enumerated in Tables 3.7-17 to 3.7-23.

The O&M cost is required annually during the economic life of the proposed project. The O&M unit cost in economic terms was estimated at 7% of direct construction costs. Thus, it was calculated at R$0.215 per m³. The annual O&M costs are tabulated in Tables 3.7-17 to 3.7-23.

(5) Economic Efficiency

Economic costs and benefits during the economic evaluation period are shown as annual streams in Tables 3.7-17 to 3.7-23. The tables show evaluation indices as well. The indices are tabulated in the following table.

Evaluation Indices

	Description	EIRR	B/C[*1]	NPV[*1] (R$ Million)
	Entire Projects	14.4%	1.18	90
1.	Capibaribe River Basin	14.4%	1.16	18
2.	Beberibe River Basin	18.9%	1.56	47
3.	Jaboatão River Basin	13.0%	1.08	10
4.	Tejipio River Basin	11.2%	0.94	-5
5.	Timbo River Basin	18.7%	1.54	34
6.	Other River Basins	3.7%	0.56	-13

Note: *1 Discounted at 12%.

As shown in the table above, the EIRR of the Tejipio River Basin was slightly less than the opportunity cost of capital of 12%. On the other hand, the other major basins have favorable rates of more than 12%, so these projects are feasible and should be promoted from the economic point of view. Even the Tejipio River Basin has a value approximating the opportunity cost of capital. The EIRRs of the major five river basin projects almost all exceed 12%, so the proposed projects could be viable economically. However, the projects of other river basins were rather lower than 12%, so they are not viable from the economic point of view.

However, the economic analyses were based on a lot of assumptions as mentioned in the respective sections. Accordingly, these indices should be considered to be a reference for project promotion. This standpoint is essential in projects for environmental purposes.

3.7.4 Socio-Economic Impacts

(1) Impact on Regional Economy

It is obvious that the commencement of construction works such as sewage treatment projects stimulates regional economy in the sectors related to construction works as well as the construction sector itself. In general, one unit of construction work could induce 1.50 to 2.00 units of economic effects in the national and regional economy. In other words,

construction work would bring about a 50% to 100% ripple effect on related works in various economic sectors in monetary terms. This effect could stimulate the regional economy in the State of Pernambuco.

As mentioned in Section 2.2.2, about 180 thousand people were unemployed, accounting for 13.4% of the labor force in the RMR in 1997. The investment in the proposed projects would activate the regional economy and at the same time create opportunities for temporary jobs during the construction period. Accordingly, there would be new labor opportunities for the unemployed and underemployed in the region.

(2) Impact on Public Finance

The total investment cost was estimated at R$693 million in the first phase and R$160 million in the second phase. The total amount of R$853 million in these two phases accounts for nearly 20% of the public expenditure of the state government in 1999. It also accounts for 65% of the capital expenditure. Although this amount is not disbursed within a year, it is still a heavy burden for the government. The capital expenditure of the government has relied on a foreign project assistance so far. For the implementation of these proposed projects, there would be no way other than depending on foreign financial assistance for capital cost.

The sewerage business is expected to be managed by an independent autonomous entity, in the near future. To put this policy into practice, the following basic principle should be adopted in the management of the water supply business.

(1) Under the present charging rates, the revenue from sewage treatment services does not cover the whole annual costs of sewage treatment. It should be increased to cover the whole costs including depreciation of the facilities.
(2) A working fund should be procured by the undertaking entity (COMPESA), not through public finance but through private self-financing options.
(3) Taking into consideration the re-investment and replacement to take place in the near future, any surplus in sewage treatment management should be set by for future use.

(3) Impact on Household Economy

According to the household economy survey (Table 2.2-7) the utility charge of a family accounted for R$63.5 per month or 6.9% of the total household expenditure in Recife in 1995/96. Supposing that a quarter of this expenditure was used for water and sanitation expenses, the total amount could be estimated as R$15.9 or 1.7% of the total expenditure. If a half of this expense was spent for sanitation purpose, it would amount to R$8.0 per month or 0.9% of the total expenditure in 1995/96. According to Table 2.2-7, the average household income was nearly 9 times of the minimum wage, so the average household

income was calculated at R$1,220 per month in 1999, applying the minimum wage of R$136 per month in 1999.   Accordingly, the average household would have spent R$11.0 per month for sewage treatment services in 1999.

In July 1999, the sewage treatment charge was calculated at R$0.84 per m^3 as mentioned in Section 3.7.2.   Supposing that an average family discharged 12m^3 per month of sewage, it would have spent R$10.1 per month.   This amount is less than the expected expense for sewage treatment service mentioned above.   In Case 1 discussed in Section 3.7.2(4), a 73% higher rate than the present rate is introduced for implementation of the proposed project.   In this case, the average family would spend R$17.5 per month or 1.4% of total income on sewage treatment services.   It might be difficult for people to accept a higher tariff for sewage treatment services in the present conditions.   In the future, however, people may accept the higher tariff after the regional economy grows and they have a higher income.

3.7.5   Project Evaluation

(1) Project Evaluation by River Basin

The project evaluation in each river basin was made based on the following items:

— Urgency :	Total pollution loads in the basin.
— Technical Evaluation :	Reduction in amount of BOD (kg/day).
— Financial/Economic Evaluation :	Value of FIRR/EIRR for the river basin.
— Social Environmental Impact :	Total served population, and the served population in poverty areas.

The results of the project evaluation in each river basin are shown in Table 3.7-24.   The proposed master plan is evaluated as feasible on the whole.   By the implementation of 55 sewage subsystems the master plan is expected to produce the following positive effects:

- It will expand the sewerage service area from 8,516 ha to 29,985 ha in 2020 and increase the sewage treatment level from no more than 20 % of the urban population to about 90 % in 2020.   By the expansion of sewerage service areas, living and sanitary conditions in the RMR will be improved.
- The FIRR is estimated at 6.1 % which is lower than the 12% decisive factor.   However, the projects could be manageable, if the state government procures financial sources with an interest rate of less than 6.1 %.   The financial condition of the operational body will be further improved by increasing tariffs and by utilizing government the capital investment.
- The EIRR is estimated at 14.4 %, so the projects could be viable from the economic point of view.   Although the economic analyses were based on a lot of assumptions, these indices should be considered as a reference for project promotion.
- It will improve the sanitary conditions of the poverty areas by developing the sewerage system to provide for some 885,000 inhabitants in these areas.

- The five major river basins (Capibaribe, Beberibe, Jaboatão, Tejipio and Timbo) are to have a high priority for early implementation. The Tejipio is evaluated as unfeasible in economic term but feasible in financial terms.

The result of the comprehensive evaluation by river basin is tabulated as follows:

River basin	Evaluation	
Whole basin (MP)	Very effective	A
Capibaribe:	Very effective	A
Beberibe	Very effective	A
Jaboatão:	Very effective	A
Tejipio:	Effective	B+
Timbo:	Effective	B
Others:	Less effective	C

Table 3.7-1 Financial Expenditure and Revenue Stream for Sewerage Projects in the RMI

<div align="right">(Unit: R$ Million)</div>

	Year	Expenditure Capital Investment	Expenditure O&M	Expenditure Total	Revenue	Balance
1	2002	23.6		23.6	0.0	-23.6
2	2003	58.1		58.1	0.0	-58.1
3	2004	58.1	0.0	58.1	0.0	-58.1
4	2005	93.3	0.0	93.3	0.0	-93.3
5	2006	110.0	0.1	110.1	0.2	-109.9
6	2007	118.7	2.6	121.2	6.9	-114.3
7	2008	108.3	6.4	114.7	17.4	-97.3
8	2009	81.1	10.9	92.0	29.4	-62.6
9	2010	41.2	15.7	57.0	42.6	-14.4
10	2011	11.1	21.5	32.7	58.3	25.6
11	2012	20.6	24.3	44.9	65.7	20.8
12	2013	24.4	25.4	49.8	68.8	19.0
13	2014	23.3	27.6	50.9	74.7	23.9
14	2015	23.0	29.6	52.6	80.1	27.5
15	2016	19.3	32.0	51.3	86.7	35.4
16	2017	21.3	34.8	56.1	94.3	38.1
17	2018	10.7	36.9	47.6	99.9	52.3
18	2019	5.6	39.6	45.2	107.1	61.9
19	2020	0.9	41.9	42.8	113.4	70.6
20	2021		41.9	41.9	120.1	78.2
21	2022		41.9	41.9	120.1	78.2
22	2023		41.9	41.9	120.1	78.2
23	2024		41.9	41.9	120.1	78.2
24	2025		41.9	41.9	120.1	78.2
25	2026		41.9	41.9	120.1	78.2
26	2027		41.9	41.9	120.1	78.2
27	2028		41.9	41.9	120.1	78.2
28	2029		41.9	41.9	120.1	78.2
29	2030		41.9	41.9	120.1	78.2
30	2031		41.9	41.9	120.1	78.2
31	2032		41.9	41.9	120.1	78.2
32	2033		41.9	41.9	120.1	78.2
33	2034		41.9	41.9	120.1	78.2
34	2035		41.9	41.9	120.1	78.2
35	2036		41.9	41.9	120.1	78.2
36	2037		41.9	41.9	120.1	78.2
37	2038		41.9	41.9	120.1	78.2
38	2039		41.9	41.9	120.1	78.2
39	2040		41.9	41.9	120.1	78.2
40	2041		41.9	41.9	120.1	78.2
41	2042		41.9	41.9	120.1	78.2
42	2043		41.9	41.9	120.1	78.2
43	2044		41.9	41.9	120.1	78.2
44	2045		41.9	41.9	120.1	78.2

Evaluation Indices		
NPV:	-225	Million R$ *1
B/C:	0.58	*1
FIRR:	6.1%	

Note: *1 Discounted at 12%

Table 3.7-2 Financial Expenditure and Revenue Stream for Sewerage Projects in the Capibaribe River Basin

(Unit: R$ Million)

	Year	Expenditure			Revenue	Balance
		Capital Investment	O&M	Total		
1	2002	8.95		8.95	0.00	-8.95
2	2003	14.33		14.33	0.00	-14.33
3	2004	14.33	0.00	14.33	0.00	-14.33
4	2005	18.75	0.00	18.75	0.00	-18.75
5	2006	23.51	1.35	24.86	3.66	-21.20
6	2007	17.77	3.04	20.81	8.22	-12.59
7	2008	13.32	3.48	16.81	9.43	-7.38
8	2009	13.32	3.94	17.26	10.66	-6.60
9	2010	13.32	4.71	18.03	12.74	-5.29
10	2011	1.30	5.33	6.63	14.44	7.81
11	2012	6.97	5.60	12.57	15.16	2.59
12	2013	13.18	6.18	19.36	16.72	-2.64
13	2014	10.50	6.75	17.25	18.27	1.02
14	2015	16.04	7.18	23.23	19.45	-3.78
15	2016	13.63	8.31	21.94	22.49	0.55
16	2017	14.25	9.03	23.28	24.43	1.15
17	2018	4.80	10.06	14.86	27.24	12.38
18	2019	2.57	10.64	13.21	28.79	15.58
19	2020	0.00	11.42	11.42	30.90	19.48
20	2021		11.42	11.42	30.90	19.48
21	2022		11.42	11.42	30.90	19.48
22	2023		11.42	11.42	30.90	19.48
23	2024		11.42	11.42	30.90	19.48
24	2025		11.42	11.42	30.90	19.48
25	2026		11.42	11.42	30.90	19.48
26	2027		11.42	11.42	30.90	19.48
27	2028		11.42	11.42	30.90	19.48
28	2029		11.42	11.42	30.90	19.48
29	2030		11.42	11.42	30.90	19.48
30	2031		11.42	11.42	30.90	19.48
31	2032		11.42	11.42	30.90	19.48
32	2033		11.42	11.42	30.90	19.48
33	2034		11.42	11.42	30.90	19.48
34	2035		11.42	11.42	30.90	19.48
35	2036		11.42	11.42	30.90	19.48
36	2037		11.42	11.42	30.90	19.48
37	2038		11.42	11.42	30.90	19.48
38	2039		11.42	11.42	30.90	19.48
39	2040		11.42	11.42	30.90	19.48
40	2041		11.42	11.42	30.90	19.48
41	2042		11.42	11.42	30.90	19.48
42	2043		11.42	11.42	30.90	19.48
43	2044		11.42	11.42	30.90	19.48
44	2045		11.42	11.42	30.90	19.48

Evaluation Indices		
NPV:	-42	Million R$ *1
B/C:	0.68	*1
FIRR:	6.9%	

Note: *1 Discounted at 12%

Table 3.7-3 Financial Expenditure and Revenue Stream for Sewerage Projects in the Beberibe River Basin

(Unit: R$ Million)

| | Year | Expenditure | | | Revenue | Balance |
		Capital Investment	O&M	Total		
1	2002	0.20		0.20	0.00	-0.20
2	2003	9.02		9.02	0.00	-9.02
3	2004	9.02	0.00	9.02	0.00	-9.02
4	2005	19.12	0.00	19.12	0.00	-19.12
5	2006	23.84	0.32	24.16	0.87	-23.29
6	2007	23.84	1.00	24.84	2.71	-22.13
7	2008	13.73	2.64	16.37	7.13	-9.24
8	2009	9.02	3.90	12.91	10.55	-2.37
9	2010	0.04	4.43	4.48	12.00	7.53
10	2011	3.69	4.62	8.30	12.50	4.20
11	2012	3.69	4.81	8.50	13.02	4.52
12	2013	3.69	5.01	8.70	13.56	4.86
13	2014	3.69	5.38	9.06	14.55	5.49
14	2015	0.00	5.76	5.76	15.59	9.83
15	2016	0.00	6.00	6.00	16.24	10.24
16	2017	0.00	6.25	6.25	16.91	10.66
17	2018	0.00	6.51	6.51	17.62	11.11
18	2019	0.00	6.78	6.78	18.35	11.57
19	2020	0.00	7.06	7.06	19.11	12.05
20	2021		7.06	7.06	19.11	12.05
21	2022		7.06	7.06	19.11	12.05
22	2023		7.06	7.06	19.11	12.05
23	2024		7.06	7.06	19.11	12.05
24	2025		7.06	7.06	19.11	12.05
25	2026		7.06	7.06	19.11	12.05
26	2027		7.06	7.06	19.11	12.05
27	2028		7.06	7.06	19.11	12.05
28	2029		7.06	7.06	19.11	12.05
29	2030		7.06	7.06	19.11	12.05
30	2031		7.06	7.06	19.11	12.05
31	2032		7.06	7.06	19.11	12.05
32	2033		7.06	7.06	19.11	12.05
33	2034		7.06	7.06	19.11	12.05
34	2035		7.06	7.06	19.11	12.05
35	2036		7.06	7.06	19.11	12.05
36	2037		7.06	7.06	19.11	12.05
37	2038		7.06	7.06	19.11	12.05
38	2039		7.06	7.06	19.11	12.05
39	2040		7.06	7.06	19.11	12.05
40	2041		7.06	7.06	19.11	12.05
41	2042		7.06	7.06	19.11	12.05
42	2043		7.06	7.06	19.11	12.05
43	2044		7.06	7.06	19.11	12.05
44	2045		7.06	7.06	19.11	12.05

Evaluation Indices		
NPV:	-27	Million R$ *1
B/C:	0.70	*1
FIRR:	7.4%	

Note: *1 Discounted at 12%

Table 3.7-4 Financial Expenditure and Revenue Stream for Sewerage Projects in the Jaboatao River Basin

(Unit: R$ Million)

	Year	Expenditure			Revenue	Balance
		Capital Investment	O&M	Total		
1	2002	6.25		6.25	0.00	-6.25
2	2003	19.03		19.03	0.00	-19.03
3	2004	19.03	0.00	19.03	0.00	-19.03
4	2005	22.66	0.06	22.73	0.17	-22.56
5	2006	26.24	0.52	26.76	1.40	-25.36
6	2007	26.24	1.23	27.48	3.34	-24.14
7	2008	30.38	2.11	32.49	5.72	-26.77
8	2009	21.54	3.52	25.06	9.52	-15.53
9	2010	7.46	4.23	11.69	11.44	-0.25
10	2011	4.53	4.91	9.44	13.29	3.85
11	2012	3.39	5.14	8.53	13.92	5.39
12	2013	5.96	5.39	11.35	14.58	3.24
13	2014	5.96	5.73	11.69	15.52	3.83
14	2015	3.39	6.43	9.82	17.42	7.59
15	2016	0.00	6.84	6.84	18.50	11.67
16	2017	0.00	7.16	7.16	19.38	12.22
17	2018	0.00	7.50	7.50	20.30	12.80
18	2019	0.00	7.86	7.86	21.27	13.41
19	2020	0.00	8.23	8.23	22.28	14.04
20	2021		8.23	8.23	22.28	14.04
21	2022		8.23	8.23	22.28	14.04
22	2023		8.23	8.23	22.28	14.04
23	2024		8.23	8.23	22.28	14.04
24	2025		8.23	8.23	22.28	14.04
25	2026		8.23	8.23	22.28	14.04
26	2027		8.23	8.23	22.28	14.04
27	2028		8.23	8.23	22.28	14.04
28	2029		8.23	8.23	22.28	14.04
29	2030		8.23	8.23	22.28	14.04
30	2031		8.23	8.23	22.28	14.04
31	2032		8.23	8.23	22.28	14.04
32	2033		8.23	8.23	22.28	14.04
33	2034		8.23	8.23	22.28	14.04
34	2035		8.23	8.23	22.28	14.04
35	2036		8.23	8.23	22.28	14.04
36	2037		8.23	8.23	22.28	14.04
37	2038		8.23	8.23	22.28	14.04
38	2039		8.23	8.23	22.28	14.04
39	2040		8.23	8.23	22.28	14.04
40	2041		8.23	8.23	22.28	14.04
41	2042		8.23	8.23	22.28	14.04
42	2043		8.23	8.23	22.28	14.04
43	2044		8.23	8.23	22.28	14.04
44	2045		8.23	8.23	22.28	14.04

Evaluation Indices		
NPV:	-66	Million R$ *1
B/C:	0.51	*1
FIRR:	4.7%	

Note: *1 Discounted at 12%

Table 3.7-5 Financial Expenditure and Revenue Stream for Sewerage Projects in the Tejipio River Basin

<div style="text-align:right">(Unit: R$ Million)</div>

	Year	Expenditure			Revenue	Balance
		Capital Investment	O&M	Total		
1	2002	5.46		5.46	0.00	-5.46
2	2003	8.05		8.05	0.00	-8.05
3	2004	8.05	0.00	8.05	0.00	-8.05
4	2005	20.53	0.00	20.53	0.00	-20.53
5	2006	24.16	0.20	24.36	0.54	-23.82
6	2007	25.91	0.62	26.53	1.68	-24.85
7	2008	25.91	1.54	27.46	4.18	-23.28
8	2009	12.36	2.56	14.93	6.94	-7.99
9	2010	6.98	4.05	11.03	10.95	-0.07
10	2011	0.26	4.47	4.73	12.10	7.37
11	2012	1.36	4.64	6.00	12.56	6.56
12	2013	0.16	5.00	5.16	13.53	8.37
13	2014	0.00	5.33	5.33	14.43	9.10
14	2015	0.75	5.54	6.29	14.98	8.69
15	2016	1.43	5.75	7.17	15.55	8.38
16	2017	0.67	6.07	6.74	16.43	9.68
17	2018	0.00	6.38	6.38	17.26	10.88
18	2019	0.00	6.62	6.62	17.92	11.30
19	2020	0.00	6.87	6.87	18.60	11.73
20	2021		6.87	6.87	18.60	11.73
21	2022		6.87	6.87	18.60	11.73
22	2023		6.87	6.87	18.60	11.73
23	2024		6.87	6.87	18.60	11.73
24	2025		6.87	6.87	18.60	11.73
25	2026		6.87	6.87	18.60	11.73
26	2027		6.87	6.87	18.60	11.73
27	2028		6.87	6.87	18.60	11.73
28	2029		6.87	6.87	18.60	11.73
29	2030		6.87	6.87	18.60	11.73
30	2031		6.87	6.87	18.60	11.73
31	2032		6.87	6.87	18.60	11.73
32	2033		6.87	6.87	18.60	11.73
33	2034		6.87	6.87	18.60	11.73
34	2035		6.87	6.87	18.60	11.73
35	2036		6.87	6.87	18.60	11.73
36	2037		6.87	6.87	18.60	11.73
37	2038		6.87	6.87	18.60	11.73
38	2039		6.87	6.87	18.60	11.73
39	2040		6.87	6.87	18.60	11.73
40	2041		6.87	6.87	18.60	11.73
41	2042		6.87	6.87	18.60	11.73
42	2043		6.87	6.87	18.60	11.73
43	2044		6.87	6.87	18.60	11.73
44	2045		6.87	6.87	18.60	11.73

Evaluation Indices

NPV:	-41 Million R$ *1
B/C:	0.58 *1
FIRR:	5.8%

Note: *1 Discounted at 12%

Table 3.7-6   Financial Expenditure and Revenue Stream for Sewerage Projects in the Timbo River Basin

(Unit: R$ Million)

	Year	Expenditure Capital Investment	O&M	Total	Revenue	Balance
1	2002	1.74		1.74	0.00	-1.74
2	2003	7.67		7.67	0.00	-7.67
3	2004	7.67	0.00	7.67	0.00	-7.67
4	2005	12.27	0.00	12.27	0.00	-12.27
5	2006	12.27	0.17	12.44	0.46	-11.98
6	2007	14.28	0.55	14.83	1.49	-13.34
7	2008	14.28	1.09	15.37	2.95	-12.42
8	2009	14.28	1.82	16.10	4.93	-11.17
9	2010	7.67	2.99	10.66	8.10	-2.56
10	2011	0.21	3.48	3.69	9.43	5.73
11	2012	0.89	3.76	4.65	10.19	5.53
12	2013	0.00	4.13	4.13	11.17	7.04
13	2014	0.00	4.46	4.46	12.06	7.61
14	2015	0.00	4.82	4.82	13.04	8.22
15	2016	0.00	5.20	5.20	14.08	8.88
16	2017	0.00	5.62	5.62	15.22	9.60
17	2018	0.00	6.08	6.08	16.44	10.37
18	2019	0.00	6.56	6.56	17.77	11.20
19	2020	0.00	7.09	7.09	19.20	12.10
20	2021		7.09	7.09	19.20	12.10
21	2022		7.09	7.09	19.20	12.10
22	2023		7.09	7.09	19.20	12.10
23	2024		7.09	7.09	19.20	12.10
24	2025		7.09	7.09	19.20	12.10
25	2026		7.09	7.09	19.20	12.10
26	2027		7.09	7.09	19.20	12.10
27	2028		7.09	7.09	19.20	12.10
28	2029		7.09	7.09	19.20	12.10
29	2030		7.09	7.09	19.20	12.10
30	2031		7.09	7.09	19.20	12.10
31	2032		7.09	7.09	19.20	12.10
32	2033		7.09	7.09	19.20	12.10
33	2034		7.09	7.09	19.20	12.10
34	2035		7.09	7.09	19.20	12.10
35	2036		7.09	7.09	19.20	12.10
36	2037		7.09	7.09	19.20	12.10
37	2038		7.09	7.09	19.20	12.10
38	2039		7.09	7.09	19.20	12.10
39	2040		7.09	7.09	19.20	12.10
40	2041		7.09	7.09	19.20	12.10
41	2042		7.09	7.09	19.20	12.10
42	2043		7.09	7.09	19.20	12.10
43	2044		7.09	7.09	19.20	12.10
44	2045		7.09	7.09	19.20	12.10

Evaluation Indices		
NPV:	-18	Million R$ *1
B/C:	0.74	*1
FIRR:	8.3%	

Note: *1 Discounted at 12%

Table 3.7-7 Financial Expenditure and Revenue Stream for Sewerage Projects in the Other River Basins

(Unit: R$ Million)

	Year	Expenditure Capital Investment	Expenditure O&M	Expenditure Total	Revenue	Balance
1	2002	0.96		0.96	0.00	-0.96
2	2003	0.00		0.00	0.00	0.00
3	2004	0.00	0.00	0.00	0.00	0.00
4	2005	0.00	0.00	0.00	0.00	0.00
5	2006	0.00	0.00	0.00	0.00	0.00
6	2007	10.63	0.00	10.63	0.00	-10.63
7	2008	10.63	0.00	10.63	0.00	-10.63
8	2009	10.63	0.00	10.63	0.00	-10.63
9	2010	5.78	1.13	6.91	3.07	-3.84
10	2011	1.12	1.46	2.57	3.94	1.36
11	2012	4.28	1.47	5.76	3.99	-1.77
12	2013	1.42	1.92	3.34	5.19	1.85
13	2014	3.11	1.94	5.05	5.26	0.20
14	2015	2.83	2.29	5.11	6.19	1.07
15	2016	4.19	2.74	6.94	7.42	0.48
16	2017	6.38	2.78	9.16	7.51	-1.64
17	2018	5.86	3.05	8.91	8.25	-0.65
18	2019	3.07	3.44	6.50	9.30	2.80
19	2020	0.88	3.69	4.57	10.00	5.43
20	2021		3.69	3.69	10.13	6.44
21	2022		3.69	3.69	10.13	6.44
22	2023		3.69	3.69	10.13	6.44
23	2024		3.69	3.69	10.13	6.44
24	2025		3.69	3.69	10.13	6.44
25	2026		3.69	3.69	10.13	6.44
26	2027		3.69	3.69	10.13	6.44
27	2028		3.69	3.69	10.13	6.44
28	2029		3.69	3.69	10.13	6.44
29	2030		3.69	3.69	10.13	6.44
30	2031		3.69	3.69	10.13	6.44
31	2032		3.69	3.69	10.13	6.44
32	2033		3.69	3.69	10.13	6.44
33	2034		3.69	3.69	10.13	6.44
34	2035		3.69	3.69	10.13	6.44
35	2036		3.69	3.69	10.13	6.44
36	2037		3.69	3.69	10.13	6.44
37	2038		3.69	3.69	10.13	6.44
38	2039		3.69	3.69	10.13	6.44
39	2040		3.69	3.69	10.13	6.44
40	2041		3.69	3.69	10.13	6.44
41	2042		3.69	3.69	10.13	6.44
42	2043		3.69	3.69	10.13	6.44
43	2044		3.69	3.69	10.13	6.44
44	2045		3.69	3.69	10.13	6.44

Evaluation Indices

NPV: -9 Million R$ *1
B/C: 0.71 *1
FIRR: 7.2%

Note: *1 Discounted at 12%

Table 3.7-8 Financial Expenditure and Revenue Stream for Sewerage Projects in the RMI
Case 1: Increasing tariffs by 73%

(Unit: R$ Million)

	Year	Expenditure			Revenue	Balance
		Capital Investment	O&M	Total		
1	2002	23.6		23.6	0.0	-23.6
2	2003	58.1		58.1	0.0	-58.1
3	2004	58.1	0.0	58.1	0.0	-58.1
4	2005	93.3	0.0	93.3	0.0	-93.3
5	2006	110.0	0.1	110.1	0.3	-109.8
6	2007	118.7	2.6	121.2	12.0	-109.3
7	2008	108.3	6.4	114.7	30.2	-84.5
8	2009	81.1	10.9	92.0	50.9	-41.1
9	2010	41.2	15.7	57.0	73.7	16.7
10	2011	11.1	21.5	32.7	100.9	68.2
11	2012	20.6	24.3	44.9	113.7	68.8
12	2013	24.4	25.4	49.8	119.1	69.2
13	2014	23.3	27.6	50.9	129.3	78.4
14	2015	23.0	29.6	52.6	138.6	85.9
15	2016	19.3	32.0	51.3	149.9	98.6
16	2017	21.3	34.8	56.1	163.1	107.0
17	2018	10.7	36.9	47.6	172.8	125.3
18	2019	5.6	39.6	45.2	185.3	140.1
19	2020	0.9	41.9	42.8	196.2	153.4
20	2021		41.9	41.9	207.7	165.8
21	2022		41.9	41.9	207.7	165.8
22	2023		41.9	41.9	207.7	165.8
23	2024		41.9	41.9	207.7	165.8
24	2025		41.9	41.9	207.7	165.8
25	2026		41.9	41.9	207.7	165.8
26	2027		41.9	41.9	207.7	165.8
27	2028		41.9	41.9	207.7	165.8
28	2029		41.9	41.9	207.7	165.8
29	2030		41.9	41.9	207.7	165.8
30	2031		41.9	41.9	207.7	165.8
31	2032		41.9	41.9	207.7	165.8
32	2033		41.9	41.9	207.7	165.8
33	2034		41.9	41.9	207.7	165.8
34	2035		41.9	41.9	207.7	165.8
35	2036		41.9	41.9	207.7	165.8
36	2037		41.9	41.9	207.7	165.8
37	2038		41.9	41.9	207.7	165.8
38	2039		41.9	41.9	207.7	165.8
39	2040		41.9	41.9	207.7	165.8
40	2041		41.9	41.9	207.7	165.8
41	2042		41.9	41.9	207.7	165.8
42	2043		41.9	41.9	207.7	165.8
43	2044		41.9	41.9	207.7	165.8
44	2045		41.9	41.9	207.7	165.8

Evaluation Indices

NPV: 1 Million R$ *1
B/C: 1.00 *1
FIRR: 12.0%

Note: *1 Discounted at 12%
          *2 Unit rate of sewage treatment services is raised by approximately 73%

Table 3.7-9 Financial Expenditure and Revenue Stream for Sewerage Projects in the RMl
Case 2: 53% of Investment Cost Subsidized

(Unit: R$ Million)

	Year	Expenditure			Revenue	Balance
		Capital Investment	O&M	Total		
1	2002	11.1		11.1	0.0	-11.1
2	2003	27.3		27.3	0.0	-27.3
3	2004	27.3	0.0	27.3	0.0	-27.3
4	2005	43.9	0.0	43.9	0.0	-43.9
5	2006	51.7	0.1	51.8	0.2	-51.6
6	2007	55.8	2.6	58.3	6.9	-51.4
7	2008	50.9	6.4	57.3	17.4	-39.9
8	2009	38.1	10.9	49.0	29.4	-19.6
9	2010	19.4	15.7	35.1	42.6	7.5
10	2011	5.2	21.5	26.8	58.3	31.5
11	2012	9.7	24.3	33.9	65.7	31.8
12	2013	11.5	25.4	36.9	68.8	31.9
13	2014	10.9	27.6	38.5	74.7	36.2
14	2015	10.8	29.6	40.4	80.1	39.7
15	2016	9.0	32.0	41.1	86.7	45.6
16	2017	10.0	34.8	44.9	94.3	49.4
17	2018	5.0	36.9	41.9	99.9	58.0
18	2019	2.7	39.6	42.2	107.1	64.9
19	2020	0.4	41.9	42.3	113.4	71.1
20	2021		41.9	41.9	120.1	78.2
21	2022		41.9	41.9	120.1	78.2
22	2023		41.9	41.9	120.1	78.2
23	2024		41.9	41.9	120.1	78.2
24	2025		41.9	41.9	120.1	78.2
25	2026		41.9	41.9	120.1	78.2
26	2027		41.9	41.9	120.1	78.2
27	2028		41.9	41.9	120.1	78.2
28	2029		41.9	41.9	120.1	78.2
29	2030		41.9	41.9	120.1	78.2
30	2031		41.9	41.9	120.1	78.2
31	2032		41.9	41.9	120.1	78.2
32	2033		41.9	41.9	120.1	78.2
33	2034		41.9	41.9	120.1	78.2
34	2035		41.9	41.9	120.1	78.2
35	2036		41.9	41.9	120.1	78.2
36	2037		41.9	41.9	120.1	78.2
37	2038		41.9	41.9	120.1	78.2
38	2039		41.9	41.9	120.1	78.2
39	2040		41.9	41.9	120.1	78.2
40	2041		41.9	41.9	120.1	78.2
41	2042		41.9	41.9	120.1	78.2
42	2043		41.9	41.9	120.1	78.2
43	2044		41.9	41.9	120.1	78.2
44	2045		41.9	41.9	120.1	78.2

Evaluation Indices

NPV: -1 Million R$ *1
B/C: 1.00 *1
FIRR: 12.0%

Note: *1 Discounted at 12%
        *2 Approximately 53% of capital investment cost is subsidized.

Table 3.7-10 Growth Trend of Sewage Treatment Service Beneficiaries: 1994-1999

(Unit: Number of Connection: Ligacao)

	Code	Name of Management Unit	1994	1995	1996	1997	1998	1999
1	068	Igarassu	201	203	202	209	213	213
2	096	Olinda	24,474	24,671	24,674	25,605	25,862	26,667
3	107	Paulista	8,832	8,882	8,975	234	235	235
4	165	Abreu e Lima	291	296	299	306	307	309
5	169	Navarro	10	10	10	10	10	10
6	170	Paratibe	662	709	661	703	700	702
7	172	Paraia da Conceicao	474	471	470	504	502	508
8	179	Janga	3,588	3,259	3,223	3,803	3,797	3,778
9	219	Jardim Paulista	4,213	4,314	4,222	4,467	4,485	4,537
10	224	Tabajara	1	1	1	2	0	0
11	274	Maranguape I	0	0	0	12,002	8,884	8,936
12	323	Parque Res. Artur Lundgren	6,576	6,547	6,494	6,785	6,772	6,775
13	338	Conj. Residencial Caetes	5,174	5,221	5,108	5,407	5,415	5,432
14	339	Cabanga	27,230	28,020	28,508	30,781	31,343	31,960
15	340	Dois Irmaos	16,476	16,566	16,412	17,643	18,053	18,690
16	342	Jangadinha	13,065	13,063	13,205	13,346	13,607	13,669
17	344	Maranguape II	3,032	3,003	2,916	3,423	3,429	3,445
18	347	Aurora	32,183	32,682	33,250	34,413	36,088	36,457
19	360	Alto do Ceu	6,985	7,049	7,111	7,250	7,205	7,371
20	733	Ibura	5,284	5,309	5,304	5,517	5,553	5,568
21	734	Peixinhos	3,208	3,206	3,193	3,304	3,858	3,906
22	735	Jenipapo	1,152	1,158	1,115	1,499	3,393	3,229
23	743	Fernando de Noronha	0	32	58	188	182	166
24	029	Cabo	203	196	195	219	201	199
25	079	Jaboatao	1,897	1,865	1,896	1,944	1,880	1,880
26	137	Sao Lourenco da Mata	2,276	2,300	2,289	2,408	2,428	2,430
27	166	*********	498	513	0	0	0	0
28	341	Prazeres	10,070	10,076	10,091	10,210	10,951	11,436
29	766	Camaragibe	0	0	516	547	546	541
		Total	178,055	179,622	180,398	192,729	195,899	199,049
		Growth Rate (% per annum)	-	0.9	0.4	6.8	1.6	1.6
		Growth Rate (Average % per annum between 1994 and 1999)						2.3

Source: Records of Operation and Maintenance 1994-1999, COMPESA

Table 3.7-11 Growth Projection of Sewage Treatment Service Beneficiaries: 1996-2020

		1996	2000	2003	2010	2020
1.	Urban Population in RMR (Unit: 1000)	2,935	3,062	3,149	3,361	3,660
2.	Population Served by COMPESA (Unit: 1000)	722	789	843	986	1,232
3.	Population with Sewerage Treatment (Unit: 1000)					
	a. With Treatment by COMPESA	640	700	748	874	1,092
	b. By Other Treatment Systems	106	116	124	145	181
	c. With Septic Tank	936	937	938	930	877
	d. Total Population	1,682	1,752	1,809	1,949	2,150
4.	Population without Sewerage Services (Unit: 100)	1,254	1,310	1,340	1,412	1,510
5.	Percentage (%)					
	a. With Treatment by COMPESA	22	23	24	26	30
	b. By Independent System	4	4	4	4	5
	c. With Septic Tank	32	31	30	28	24
	d. Population with Treatment	57	57	57	58	59
	e. Population without Treatment	43	43	43	42	41
6.	Increment of Population with Sewerage Treatment (Unit: 1000)					
	a. With Treatment by COMPESA	-	-	-	126	218
	b. By Independent System	-	-	-	21	36
	c. With Septic Tank	-	-	-	-	-
	d. Total Population	-	-	-	147	254

Table 3.7-12 Population Distribution by River Basin: 2003-2020

Municipality / River Basin	Projected Population			Population with Above Average Income		
	2003	2010	2020	2003	2010	2020
I. Population by Municipality (Unit: 1000)						
1. Abreu e Lima	75	78	81	36	37	38
2. Araçoiaba	12	13	15	11	12	14
3. Cabo de Santo Agostinho	142	160	187	73	83	97
4. Camaragibe	126	142	164	54	61	71
5. Igarassu	81	99	130	75	92	121
6. Ipojuca	37	45	56	18	21	26
7. Itamaracá	14	18	25	11	14	20
8. Itapissuma	19	22	26	17	20	24
9. Jaboatão dos Guararapes	506	554	617	374	409	455
10. Moreno	33	33	34	16	16	16
11. Olinda	359	367	378	169	173	178
12. Paulista	261	293	337	118	132	152
13. Recife	1,396	1,444	1,506	721	746	777
14. São Lourenço da Mata	86	95	107	42	45	51
Total	3,148	3,361	3,661	1,735	1,861	2,041
II. Population by River Basin (Unit: 1000)						
1. Capibaribe River Basin	706	746	796	389	413	444
2. Beberibe River Basin	597	616	645	329	341	359
3. Jaboatão River Basin	548	601	666	302	333	372
4. Tejipio River Basin	515	536	565	284	297	315
5. Timbo River Basin	414	442	482	228	245	269
6. Other River Basins	368	420	506	203	233	282
Total	3,148	3,361	3,661	1,735	1,861	2,041

III. Population with Sewage Treatment by River Basin (Unit: 1000)

	With Treatment by COMPESA			By Other Treatment Systems		
1. Capibaribe River Basin	168	194	238	28	32	39
2. Beberibe River Basin	142	160	192	24	27	32
3. Jaboatão River Basin	130	156	199	22	26	33
4. Tejipio River Basin	122	140	169	20	23	28
5. Timbo River Basin	98	115	144	16	19	24
6. Other River Basins	87	109	151	14	18	25
Total	748	874	1,092	124	145	181

	By Septic Tank*1		
1. Capibaribe River Basin	210	206	191
2. Beberibe River Basin	178	170	154
3. Jaboatão River Basin	163	166	160
4. Tejipio River Basin	153	148	135
5. Timbo River Basin	123	122	116
6. Other River Basins	110	116	121
Total	938	930	877

Note: *1 Every house which will not be served by COMPESA or other treatment systems has to install a septic tank
under the state law No.7269, June 1981. However, low income people are assumed not to install such tanks at
present. 10% of low income people are assumed to be served by
COMPESA.

Table 3.7-13 Costs of Other Sewage Treatment Systems

Item	Unit	Amount
1. Number of Residents	Persons	657
2. Water Consumption	Liters per Capita per day	110
3. Effluent Coefficient		0.8
4. Specification of Sewerage System		
a. Septic Tank	m^3	76
b. Delivery Pipe	m	343
5. Construction Costs	R$	79,020
a. Delivery Piping	R$	23,685
b. Sand Filtration Box	R$	12,173
c. Septic Tank	R$	11,249
d. Anaerobic Filter	R$	9,969
e. Drying Bed	R$	9,170
f. Connection to Sewer System	R$	7,214
g. Preparatory Work	R$	5,559
6. Operation and Maintenance Cost	Percentage of Construction Cost	5.0
7. Unit Rates of Independent Sewerage System		
a. Unit Constrution Cost	R$ per Capita	120
b. Unit O/M Cost	R$ per Capita per Year	6.00

Source: Projeto Basico do Sistema de Esgotamento Sanitario da Cidade do Moreno - PE Bairros: Joao Paulo II e Cohab Vol. I/ii, May 1999, Companhia Pernambucana de Saneamento Compesa

Table 3.7-14 Household Medical Expenses and Losses due to Illnesss

Item			Applied Figure	Remark
1. Water Borne Diseases in the RMR				
(1) Incidence of Water borne Diseases (per 100,000 Population)				Refer to Section 2.2.4(7)
	1998	1999		
a. All Diseases	917.00	624.00	771	
b. Water Borne Diseases	48.20	79.02	64	
(2) Age Distribution for Water Borne Diseases (Number of Cases between '95 and '98 in Recife Municipality)				Refer to Section 2.2.4(7)
	Cholera	Diarrhea		
a. Up to 10 Years Old	38	178	36%	
b. 10 Years Old and Over	79	304	64%	
Total	117	482		
(3) Average Household Size			4.0	Refer to Section 2.2.1(1)
2. Economic Information of Medical Treatment				
(1) Morbidity Rate of Patients Who Stopped Doing Their Usual Activities (% of Household Member in Month)			2%	Quoted from "Water Supply Project in Cambodia, 1999", Conducted by JICA
(2) Mean Number of Days for Which They Stopped Doing Their Usual Activities (Days on Average)			6	Quoted from the same reference above
(3) Average Annual Expenditure for Medical Treatment (R$ per Household)			50	Based on the Data in Table 2.2-4 and Inflation Rate (10% per year)
3. Annual Losses due to Water Borne Diseases				
(1) Medical Expenses for Water Borne Diseases				
a. Rate of Water Borne Diseases to All Diseases			8.3%	Calculated from Data 1. (1) Above.
b. Average Annual Expenditure for Medical Treatment of Water Borne Diseases (R$ per HH)			4.14	= R$50 x 8.3%
c. Average Annual Expenditure for Medical Treatment of Water Borne Diseases (R$ per Person)			1.03	
(2) Losses through Absence from Work due to Illness				
a. Average Monthly Income per Person (R$)			526	Refer to Sec. 2.2.1(2) Applied Inflation Rate of 10%.
b. Losses through Absence from Work due to Water Borne Diseases (R$ per Household)			4.14	= 4.0 Pers. x 2% x 64% x (R$526 / 30 Day) x 6 Days
c. Average Losses through Absence from Work due to Water Borne Diseases (R$ per Person)			1.04	
(3) Annual Losses due to Water borne Diseases (R$ per Capita per Year)			2.07	= 1.03 + 1.04
(4) Annual Losses Caused by Lack of Sewerage Services (R$ per Capita per Year)			1.80	Assumed at 87% of annual losses (3) *1

Note: *1 People without water supply and sewerage services in urban areas were estimated at 9.9% and 66.2% respectively, as mentioned in Section 2.2.4(5).
Applying these rates, the weiged rate of people without sewerage services was calculated at 87%. This rate was applied as a cause for water borne diseases due to insufficiency of sewerage services.

Table 3.7-15 Economic Losses of Tourism Revenue due to Environment Pollution: 2000 to 2020

I. Information on Tourists*1 (Unit: 1000)	1995	1996	1997	1998
1. Tourists to PE State	-	-	-	1,757
2. Tourists to RMR	-	-	-	1,142
a. Foreign Tourists	-	-	-	78
b. Domestic Tourists	-	-	-	1,064
c. Tourists Staying in Hotels	331	347	431	456

	1998	2000	2010	2020
II. Estimates of Tourists (Unit: 1000)				
1. Tourists Staying in Hotels *2	456	552	1,012	1,472
2. Tourists in RMR				
a. Foreign Tourists *3	78	113	367	766
b. Domestic Tourists	1,064	1,269	2,167	2,920
c. Total	1,142	1,382	2,534	3,685
3. Tourists for Sightseeing to RMR *4				
a. Foreign Tourists	-	64	209	436
b. Domestic Tourists	-	355	607	817
c. Total	-	420	816	1,254
4. Estimated Number of Tourists after Environmental Pollution *5				
a. Foreign Tourists	-	40	130	271
b. Domestic Tourists	-	220	376	507
c. Total	-	260	506	777
5. Estimated Number of Tourists after Sanitation Problems *6				
a. Foreign Tourists	-	34	111	233
b. Domestic Tourists	-	189	323	436
c. Total	-	224	435	669

III. Economic Losses of Tourism Revenues due to Sanitation Problems (Unit: US$ Million)

	1998	2000	2010	2020
1. Decrease of Tourism Revenues due to Sanitation Problems at 1998 market prices *7				
a. Foreign Tourists	-	19.1	62.1	129.5
b. Domestic Tourists	-	54.1	92.4	124.5
c. Total	-	73.2	154.4	254.0
2. Decrease of Value Added of Tourism Revenues due to Sanitation Problems at 1998 market prices				
a. Value in US$ Million *8	-	41.9	88.5	145.5
b. Value in R$ Million *9	-	50.8	107.1	176.1

Source: (1) Tourism in Pernambuco: Selected Indicators, 1999, Secretariat of Economic Development, Tourism
and Sports

(2) Sintese do Plano Estategico de Desenvolvimento do Turismo em Pernambuco, 1999, Secretaria
de Desenvolvimento Economico, Turismo e Estports

(3) Pesquisa do Inventorio da Oferta Turistica de Pernambuco, 1999, EMPETUR

Note: *1 Data from the sources above.

*2 Regression line applied based on the trend of tourists staying in hotels in the line 1-(2)-c.

*3 The number of foreign tourists was assumed to grow at double the rate of domestic tourists,
referring to the source (2).

*4 Ratios of 57% of foreign and 28% of domestic tourists were for sightseeing in the RMR. Refer to Section 3.5

*5 62% of tourists complained about public cleanliness in towns. Refer to Section 3.5.4.

*6 86% of public cleanliness problems were assumed to be caused by sanitation problems, referring to the
following investment program of PRODETUR II (Source (1))

Infrastructure Works	Investment (US$ Million)	(%)
Basic Sanitation	46.68	86
Solid Residues	2.13	4
Environmental Protection	5.76	11
Total	54.57	100

*7 Average length of staying and average daily spending were set up as follows, referring to Section 3.5.4.

	Stay (days)	Spending (US$/day)
Foreign Tourist	10.8	51.4
Domestic Tourist	8.6	33.2

*8 Value added rate of tourism industry was 57.3%, referring to Source (1).

*9 Exchange rate: R$ 1.21 per US$ in 1998

Table 3.7-16 Reduction of Pollution Load owing to Proposed Projects

(Unit: kg/day)

| Year | Total | River Basin | | | | | |
		Capibaribe	Beberibe	Jaboatão	Tejipio	Timbo	Other Rivers
Pollution Load Under Without-Project Condition							
2003	109.0	24.5	20.7	19.0	17.8	14.3	12.7
2004	109.8	24.6	20.7	19.2	17.9	14.4	12.9
2005	110.4	24.7	20.7	19.4	17.9	14.5	13.1
2006	111.1	24.8	20.8	19.6	18.0	14.6	13.4
2007	111.8	24.9	20.8	19.8	18.0	14.7	13.6
2008	112.5	25.0	20.8	20.0	18.1	14.8	13.8
2009	113.2	25.2	20.9	20.2	18.1	14.9	14.0
2010	113.8	25.3	20.9	20.4	18.2	15.0	14.2
2011	114.4	25.3	20.9	20.5	18.2	15.0	14.4
2012	115.0	25.4	20.9	20.6	18.2	15.1	14.7
2013	115.5	25.5	20.9	20.8	18.3	15.2	14.9
2014	116.1	25.6	20.9	20.9	18.3	15.3	15.1
2015	116.6	25.6	21.0	21.0	18.3	15.3	15.3
2016	117.1	25.7	21.0	21.2	18.3	15.4	15.5
2017	117.7	25.8	21.0	21.3	18.4	15.5	15.8
2018	118.2	25.8	21.0	21.4	18.4	15.6	16.0
2019	118.8	25.9	21.0	21.6	18.4	15.6	16.2
2020	119.3	26.0	21.0	21.7	18.4	15.7	16.5
Pollution Load Under With-Project Condition							
2003	109.0	24.5	20.7	19.0	17.8	14.3	12.7
2004	109.8	24.6	20.7	19.2	17.9	14.4	12.9
2005	110.3	24.7	20.7	19.3	17.9	14.5	13.1
2006	107.4	22.7	20.3	19.0	17.9	14.1	13.4
2007	98.2	19.0	18.3	17.7	17.2	12.5	13.6
2008	83.4	16.7	13.2	14.9	15.2	9.7	13.6
2009	67.1	15.3	8.5	10.6	12.4	6.6	13.7
2010	50.8	13.5	5.4	5.8	8.7	3.6	13.7
2011	50.3	13.3	5.3	5.8	8.6	3.7	13.6
2012	49.6	12.9	5.2	5.8	8.5	3.7	13.5
2013	48.7	12.4	5.1	5.7	8.4	3.7	13.4
2014	47.8	11.9	5.0	5.6	8.2	3.8	13.2
2015	46.8	11.4	4.9	5.5	8.1	3.8	13.0
2016	45.6	10.8	4.8	5.5	7.9	3.9	12.8
2017	44.4	10.2	4.7	5.4	7.8	3.9	12.5
2018	43.1	9.6	4.6	5.3	7.6	3.9	12.1
2019	41.8	9.0	4.5	5.2	7.5	4.0	11.7
2020	40.3	8.3	4.4	5.1	7.3	4.0	11.2
Reduction of Pollution Load Owing to Proposed Projects							
2003	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2004	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2006	3.7	2.1	0.5	0.5	0.1	0.5	0.0
2007	13.6	5.9	2.5	2.1	0.9	2.2	0.0
2008	29.1	8.3	7.6	5.0	2.9	5.0	0.2
2009	46.1	9.9	12.3	9.5	5.7	8.3	0.3
2010	63.0	11.8	15.5	14.5	9.4	11.3	0.5
2011	64.1	12.1	15.6	14.7	9.6	11.4	0.8
2012	65.3	12.5	15.7	14.9	9.7	11.4	1.1
2013	66.8	13.1	15.8	15.1	9.9	11.4	1.5
2014	68.3	13.7	15.9	15.3	10.1	11.5	1.9
2015	69.8	14.2	16.1	15.5	10.2	11.5	2.3
2016	71.5	14.9	16.2	15.7	10.4	11.6	2.8
2017	73.3	15.6	16.3	15.9	10.6	11.6	3.3
2018	75.1	16.2	16.4	16.1	10.7	11.6	3.9
2019	77.0	16.9	16.5	16.4	10.9	11.7	4.6
2020	78.9	17.6	16.7	16.6	11.1	11.7	5.3

Table 3.7-17   Economic Cost and Benefit Stream for Sewerage Projects in the RMF

(Unit: R$ Million)

| | Year | Cost | | | Benefit | | | Total | Balance |
		Capital Investment	O&M	Total	Treatment Saving	Medical Issues	Tourism Recession		
1	2002	0.0		0.0				0.0	0.0
2	2003	54.5		54.5				0.0	-54.5
3	2004	54.5	0.0	54.5	0.0	0.0	0.0	0.0	-54.5
4	2005	87.5	0.1	87.6	0.0	0.0	0.3	0.3	-87.3
5	2006	103.2	2.4	105.6	0.9	0.5	9.5	10.9	-94.6
6	2007	111.3	6.1	117.3	4.6	1.4	25.0	30.9	-86.5
7	2008	101.5	10.2	111.7	11.0	2.4	44.5	57.9	-53.8
8	2009	76.1	14.8	90.9	16.1	3.4	67.1	86.5	-4.3
9	2010	38.6	20.3	58.9	20.8	4.4	90.4	115.5	56.6
10	2011	6.6	22.8	29.4	4.7	4.8	101.3	110.7	81.3
11	2012	19.3	23.9	43.2	5.0	4.8	106.4	116.3	73.0
12	2013	22.9	26.0	48.8	5.5	5.0	114.4	124.9	76.0
13	2014	21.8	27.8	49.6	5.8	5.2	122.9	133.9	84.2
14	2015	21.6	30.1	51.7	6.2	5.4	132.9	144.4	92.8
15	2016	18.1	32.7	50.8	6.7	5.7	143.5	155.8	105.0
16	2017	20.0	34.7	54.7	6.8	5.7	152.3	164.9	110.2
17	2018	10.0	37.2	47.2	7.2	5.9	162.9	176.0	128.8
18	2019	5.3	39.4	44.7	7.5	6.1	172.0	185.6	140.9
19	2020	0.8	41.7	42.5	7.9	6.2	182.0	196.1	153.6
20	2021		41.7	41.7	0.4	6.2	182.1	188.7	147.0
21	2022		41.7	41.7	0.4	6.2	182.1	188.7	147.0
22	2023		41.7	41.7	0.4	6.2	182.1	188.7	147.0
23	2024		41.7	41.7	0.4	6.2	182.1	188.7	147.0
24	2025		41.7	41.7	0.4	6.2	182.1	188.7	147.0
25	2026		41.7	41.7	0.4	6.2	182.1	188.7	147.0
26	2027		41.7	41.7	0.4	6.2	182.1	188.7	147.0
27	2028		41.7	41.7	0.4	6.2	182.1	188.7	147.0
28	2029		41.7	41.7	0.4	6.2	182.1	188.7	147.0
29	2030		41.7	41.7	0.4	6.2	182.1	188.7	147.0
30	2031		41.7	41.7	0.4	6.2	182.1	188.7	147.0
31	2032		41.7	41.7	0.4	6.2	182.1	188.7	147.0
32	2033		41.7	41.7	0.4	6.2	182.1	188.7	147.0
33	2034		41.7	41.7	0.4	6.2	182.1	188.7	147.0
34	2035		41.7	41.7	0.4	6.2	182.1	188.7	147.0
35	2036		41.7	41.7	0.4	6.2	182.1	188.7	147.0
36	2037		41.7	41.7	0.4	6.2	182.1	188.7	147.0
37	2038		41.7	41.7	0.4	6.2	182.1	188.7	147.0
38	2039		41.7	41.7	0.4	6.2	182.1	188.7	147.0
39	2040		41.7	41.7	0.4	6.2	182.1	188.7	147.0
40	2041		41.7	41.7	0.4	6.2	182.1	188.7	147.0
41	2042		41.7	41.7	0.4	6.2	182.1	188.7	147.0
42	2043		41.7	41.7	0.4	6.2	182.1	188.7	147.0
43	2044		41.7	41.7	0.4	6.2	182.1	188.7	147.0
44	2045		41.7	41.7	0.4	6.2	182.1	188.7	147.0

Evaluation Indices	NPV:	90 Million R$ *1
	B/C:	1.18 *1
	EIRR:	14.4%

Note: *1 Discounted at 12%

Table 3.7-18   Economic Cost and Benefit Stream for Sewerage Projects in the Capibaribe River Basin

(Unit: R$ Million)

	Year	Cost			Benefit				
		Capital Investment	O&M	Total	Treatment Saving	Medical Issues	Tourism Recession	Total	Balance
1	2002	0.00		0.00				0.00	0.00
2	2003	13.43		13.43				0.00	-13.43
3	2004	13.43	0.00	13.43	0.00	0.00	0.00	0.00	-13.43
4	2005	17.58	0.00	17.58	0.00	0.00	0.00	0.00	-17.58
5	2006	22.04	1.27	23.31	0.28	0.10	1.41	1.78	-21.53
6	2007	16.67	2.85	19.52	1.37	0.30	4.54	6.21	-13.31
7	2008	12.49	3.27	15.77	2.41	0.76	12.38	15.54	-0.22
8	2009	12.49	3.70	16.19	2.49	1.08	18.94	22.51	6.31
9	2010	12.49	4.43	16.92	3.07	1.19	22.30	26.56	9.64
10	2011	0.00	5.01	5.01	1.23	1.20	23.43	25.87	20.85
11	2012	6.54	5.26	11.80	1.41	1.21	24.63	27.25	15.45
12	2013	12.36	5.81	18.17	1.52	1.21	25.89	28.62	10.46
13	2014	9.85	6.34	16.19	1.62	1.26	28.03	30.90	14.71
14	2015	15.04	6.75	21.80	1.69	1.30	30.32	33.31	11.51
15	2016	12.78	7.81	20.59	1.80	1.31	31.86	34.98	14.38
16	2017	13.36	8.49	21.85	1.79	1.32	33.49	36.60	14.75
17	2018	4.50	9.46	13.96	1.85	1.33	35.20	38.38	24.42
18	2019	2.41	10.00	12.41	1.84	1.34	36.99	40.17	27.76
19	2020	0.00	10.73	10.73	1.89	1.35	38.88	42.12	31.39
20	2021		10.73	10.73	0.10	1.35	38.88	40.32	29.59
21	2022		10.73	10.73	0.10	1.35	38.88	40.32	29.59
22	2023		10.73	10.73	0.10	1.35	38.88	40.32	29.59
23	2024		10.73	10.73	0.10	1.35	38.88	40.32	29.59
24	2025		10.73	10.73	0.10	1.35	38.88	40.32	29.59
25	2026		10.73	10.73	0.10	1.35	38.88	40.32	29.59
26	2027		10.73	10.73	0.10	1.35	38.88	40.32	29.59
27	2028		10.73	10.73	0.10	1.35	38.88	40.32	29.59
28	2029		10.73	10.73	0.10	1.35	38.88	40.32	29.59
29	2030		10.73	10.73	0.10	1.35	38.88	40.32	29.59
30	2031		10.73	10.73	0.10	1.35	38.88	40.32	29.59
31	2032		10.73	10.73	0.10	1.35	38.88	40.32	29.59
32	2033		10.73	10.73	0.10	1.35	38.88	40.32	29.59
33	2034		10.73	10.73	0.10	1.35	38.88	40.32	29.59
34	2035		10.73	10.73	0.10	1.35	38.88	40.32	29.59
35	2036		10.73	10.73	0.10	1.35	38.88	40.32	29.59
36	2037		10.73	10.73	0.10	1.35	38.88	40.32	29.59
37	2038		10.73	10.73	0.10	1.35	38.88	40.32	29.59
38	2039		10.73	10.73	0.10	1.35	38.88	40.32	29.59
39	2040		10.73	10.73	0.10	1.35	38.88	40.32	29.59
40	2041		10.73	10.73	0.10	1.35	38.88	40.32	29.59
41	2042		10.73	10.73	0.10	1.35	38.88	40.32	29.59
42	2043		10.73	10.73	0.10	1.35	38.88	40.32	29.59
43	2044		10.73	10.73	0.10	1.35	38.88	40.32	29.59
44	2045		10.73	10.73	0.10	1.35	38.88	40.32	29.59

Evaluation Indices   NPV: 18 Million R$ *1

B/C: 1.16 *1

EIRR: 14.4%

Note: *1 Discounted at 12%

Table 3.7-19   Economic Cost and Benefit Stream for Sewerage Projects in the Beberibe River Basin

(Unit: R$ Million)

	Year	Cost			Benefit				Balance
		Capital Investment	O&M	Total	Treatment Saving	Medical Issues	Tourism Recession	Total	
1	2002	0.00		0.00				0.00	0.00
2	2003	8.46		8.46				0.00	-8.46
3	2004	8.46	0.00	8.46	0.00	0.00	0.00	0.00	-8.46
4	2005	17.93	0.00	17.93	0.00	0.00	0.00	0.00	-17.93
5	2006	22.35	0.30	22.65	0.30	0.24	4.43	4.97	-17.68
6	2007	22.35	0.94	23.29	1.58	0.52	10.22	12.32	-10.98
7	2008	12.88	2.48	15.35	3.85	0.57	12.04	16.45	1.10
8	2009	8.46	3.66	12.12	3.82	0.61	13.96	18.39	6.27
9	2010	0.00	4.17	4.17	3.03	0.70	17.13	20.86	16.69
10	2011	3.46	4.34	7.80	0.58	0.76	19.43	20.77	12.97
11	2012	3.46	4.52	7.98	0.59	0.76	20.42	21.78	13.80
12	2013	3.46	4.71	8.17	0.63	0.80	22.55	23.99	15.83
13	2014	3.46	5.05	8.51	0.67	0.84	24.67	26.18	17.68
14	2015	0.00	5.42	5.42	0.70	0.86	26.29	27.84	22.43
15	2016	0.00	5.64	5.64	0.78	0.95	30.43	32.16	26.52
16	2017	0.00	5.87	5.87	0.82	0.98	33.10	34.91	29.04
17	2018	0.00	6.12	6.12	0.89	1.05	36.94	38.88	32.76
18	2019	0.00	6.37	6.37	0.92	1.06	39.09	41.07	34.69
19	2020	0.00	6.64	6.64	0.95	1.09	42.00	44.04	37.40
20	2021		6.64	6.64	0.05	1.09	42.00	43.14	36.50
21	2022		6.64	6.64	0.05	1.09	42.00	43.14	36.50
22	2023		6.64	6.64	0.05	1.09	42.00	43.14	36.50
23	2024		6.64	6.64	0.05	1.09	42.00	43.14	36.50
24	2025		6.64	6.64	0.05	1.09	42.00	43.14	36.50
25	2026		6.64	6.64	0.05	1.09	42.00	43.14	36.50
26	2027		6.64	6.64	0.05	1.09	42.00	43.14	36.50
27	2028		6.64	6.64	0.05	1.09	42.00	43.14	36.50
28	2029		6.64	6.64	0.05	1.09	42.00	43.14	36.50
29	2030		6.64	6.64	0.05	1.09	42.00	43.14	36.50
30	2031		6.64	6.64	0.05	1.09	42.00	43.14	36.50
31	2032		6.64	6.64	0.05	1.09	42.00	43.14	36.50
32	2033		6.64	6.64	0.05	1.09	42.00	43.14	36.50
33	2034		6.64	6.64	0.05	1.09	42.00	43.14	36.50
34	2035		6.64	6.64	0.05	1.09	42.00	43.14	36.50
35	2036		6.64	6.64	0.05	1.09	42.00	43.14	36.50
36	2037		6.64	6.64	0.05	1.09	42.00	43.14	36.50
37	2038		6.64	6.64	0.05	1.09	42.00	43.14	36.50
38	2039		6.64	6.64	0.05	1.09	42.00	43.14	36.50
39	2040		6.64	6.64	0.05	1.09	42.00	43.14	36.50
40	2041		6.64	6.64	0.05	1.09	42.00	43.14	36.50
41	2042		6.64	6.64	0.05	1.09	42.00	43.14	36.50
42	2043		6.64	6.64	0.05	1.09	42.00	43.14	36.50
43	2044		6.64	6.64	0.05	1.09	42.00	43.14	36.50
44	2045		6.64	6.64	0.05	1.09	42.00	43.14	36.50

Evaluation Indices		
NPV:	47	Million R$ *1
B/C:	1.56	*1
EIRR:	18.9%	

Note: *1 Discounted at 12%

Table 3.7-20   Economic Cost and Benefit Stream for Sewerage Projects in the Jaboatao River Basin

(Unit: R$ Million)

	Year	Cost			Benefit				
		Capital Investment	O&M	Total	Treatment Saving	Medical Issues	Tourism Recession	Total	Balance
1	2002	0.00		0.00				0.00	0.00
2	2003	17.84		17.84				0.00	-17.84
3	2004	17.84	0.00	17.84	0.00	0.00	0.00	0.00	-17.84
4	2005	21.25	0.06	21.31	0.01	0.01	0.25	0.28	-21.03
5	2006	24.61	0.49	25.10	0.18	0.12	2.15	2.44	-22.65
6	2007	24.61	1.16	25.77	0.80	0.27	5.26	6.32	-19.45
7	2008	28.49	1.99	30.47	2.07	0.44	9.28	11.79	-18.69
8	2009	20.20	3.31	23.50	4.66	0.71	15.87	21.25	-2.25
9	2010	7.00	3.97	10.97	5.80	0.83	19.62	26.26	15.29
10	2011	3.18	4.62	7.79	0.96	0.93	22.87	24.77	16.98
11	2012	3.18	4.84	8.01	1.01	0.94	24.04	26.00	17.98
12	2013	5.59	5.07	10.65	1.04	0.95	25.27	27.25	16.60
13	2014	5.59	5.39	10.98	1.08	0.97	26.97	29.03	18.05
14	2015	3.18	6.05	9.22	1.20	1.06	30.38	32.64	23.41
15	2016	0.00	6.43	6.43	1.22	1.08	32.39	34.69	28.26
16	2017	0.00	6.73	6.73	1.24	1.09	34.04	36.37	29.64
17	2018	0.00	7.05	7.05	1.26	1.10	35.78	38.14	31.09
18	2019	0.00	7.39	7.39	1.29	1.12	37.60	40.00	32.62
19	2020	0.00	7.74	7.74	1.31	1.13	39.52	41.96	34.22
20	2021		7.74	7.74	0.07	1.13	39.52	40.71	32.98
21	2022		7.74	7.74	0.07	1.13	39.52	40.71	32.98
22	2023		7.74	7.74	0.07	1.13	39.52	40.71	32.98
23	2024		7.74	7.74	0.07	1.13	39.52	40.71	32.98
24	2025		7.74	7.74	0.07	1.13	39.52	40.71	32.98
25	2026		7.74	7.74	0.07	1.13	39.52	40.71	32.98
26	2027		7.74	7.74	0.07	1.13	39.52	40.71	32.98
27	2028		7.74	7.74	0.07	1.13	39.52	40.71	32.98
28	2029		7.74	7.74	0.07	1.13	39.52	40.71	32.98
29	2030		7.74	7.74	0.07	1.13	39.52	40.71	32.98
30	2031		7.74	7.74	0.07	1.13	39.52	40.71	32.98
31	2032		7.74	7.74	0.07	1.13	39.52	40.71	32.98
32	2033		7.74	7.74	0.07	1.13	39.52	40.71	32.98
33	2034		7.74	7.74	0.07	1.13	39.52	40.71	32.98
34	2035		7.74	7.74	0.07	1.13	39.52	40.71	32.98
35	2036		7.74	7.74	0.07	1.13	39.52	40.71	32.98
36	2037		7.74	7.74	0.07	1.13	39.52	40.71	32.98
37	2038		7.74	7.74	0.07	1.13	39.52	40.71	32.98
38	2039		7.74	7.74	0.07	1.13	39.52	40.71	32.98
39	2040		7.74	7.74	0.07	1.13	39.52	40.71	32.98
40	2041		7.74	7.74	0.07	1.13	39.52	40.71	32.98
41	2042		7.74	7.74	0.07	1.13	39.52	40.71	32.98
42	2043		7.74	7.74	0.07	1.13	39.52	40.71	32.98
43	2044		7.74	7.74	0.07	1.13	39.52	40.71	32.98
44	2045		7.74	7.74	0.07	1.13	39.52	40.71	32.98

Evaluation Indices   NPV: 10 Million R$ *1

B/C: 1.08 *1

EIRR: 13.0%

Note: *1 Discounted at 12%

Table 3.7-21   Economic Cost and Benefit Stream for Sewerage Projects in the Tejipio River Basin

(Unit: R$ Million)

| | Year | Cost | | | Benefit | | | | |
		Capital Investment	O&M	Total	Treatment Saving	Medical Issues	Tourism Recession	Total	Balance
1	2002	0.00		0.00				0.00	0.00
2	2003	7.55		7.55				0.00	-7.55
3	2004	7.55	0.00	7.55	0.00	0.00	0.00	0.00	-7.55
4	2005	19.25	0.00	19.25	0.00	0.00	0.00	0.00	-19.25
5	2006	22.65	0.19	22.84	0.04	0.04	0.57	0.65	-22.19
6	2007	24.30	0.58	24.88	0.22	0.13	1.83	2.19	-22.70
7	2008	24.30	1.45	25.75	1.09	0.32	4.73	6.14	-19.61
8	2009	11.59	2.41	14.00	2.34	0.51	8.15	10.99	-3.01
9	2010	6.55	3.80	10.35	4.46	0.78	13.36	18.60	8.25
10	2011	0.00	4.20	4.20	0.70	0.83	14.94	16.48	12.27
11	2012	1.28	4.36	5.64	0.74	0.83	15.71	17.28	11.64
12	2013	0.15	4.70	4.85	0.79	0.87	17.13	18.79	13.94
13	2014	0.00	5.01	5.01	0.82	0.90	18.51	20.23	15.22
14	2015	0.71	5.20	5.91	0.83	0.90	19.45	21.18	15.27
15	2016	1.34	5.40	6.74	0.84	0.91	20.44	22.19	15.45
16	2017	0.63	5.71	6.34	0.87	0.93	21.87	23.67	17.33
17	2018	0.00	6.00	6.00	0.90	0.95	23.27	25.11	19.11
18	2019	0.00	6.22	6.22	0.91	0.95	24.45	26.31	20.09
19	2020	0.00	6.46	6.46	0.92	0.96	25.70	27.58	21.12
20	2021		6.46	6.46	0.05	0.96	25.70	26.70	20.24
21	2022		6.46	6.46	0.05	0.96	25.70	26.70	20.24
22	2023		6.46	6.46	0.05	0.96	25.70	26.70	20.24
23	2024		6.46	6.46	0.05	0.96	25.70	26.70	20.24
24	2025		6.46	6.46	0.05	0.96	25.70	26.70	20.24
25	2026		6.46	6.46	0.05	0.96	25.70	26.70	20.24
26	2027		6.46	6.46	0.05	0.96	25.70	26.70	20.24
27	2028		6.46	6.46	0.05	0.96	25.70	26.70	20.24
28	2029		6.46	6.46	0.05	0.96	25.70	26.70	20.24
29	2030		6.46	6.46	0.05	0.96	25.70	26.70	20.24
30	2031		6.46	6.46	0.05	0.96	25.70	26.70	20.24
31	2032		6.46	6.46	0.05	0.96	25.70	26.70	20.24
32	2033		6.46	6.46	0.05	0.96	25.70	26.70	20.24
33	2034		6.46	6.46	0.05	0.96	25.70	26.70	20.24
34	2035		6.46	6.46	0.05	0.96	25.70	26.70	20.24
35	2036		6.46	6.46	0.05	0.96	25.70	26.70	20.24
36	2037		6.46	6.46	0.05	0.96	25.70	26.70	20.24
37	2038		6.46	6.46	0.05	0.96	25.70	26.70	20.24
38	2039		6.46	6.46	0.05	0.96	25.70	26.70	20.24
39	2040		6.46	6.46	0.05	0.96	25.70	26.70	20.24
40	2041		6.46	6.46	0.05	0.96	25.70	26.70	20.24
41	2042		6.46	6.46	0.05	0.96	25.70	26.70	20.24
42	2043		6.46	6.46	0.05	0.96	25.70	26.70	20.24
43	2044		6.46	6.46	0.05	0.96	25.70	26.70	20.24
44	2035		6.46	6.46	0.05	0.96	25.70	26.70	20.24

Evaluation Indices	NPV:	-5 Million R$ *1
	B/C:	0.94 *1
	EIRR:	11.2%

Note: *1 Discounted at 12%

Table 3.7-22 Economic Cost and Benefit Stream for Sewerage Projects in the Timbo River Basin

(Unit: R$ Million)

	Year	Cost			Benefit				Balance
		Capital Investment	O&M	Total	Treatment Saving	Medical Issues	Tourism Recession	Total	
1	2002	0.00		0.00				0.00	0.00
2	2003	7.19		7.19				0.00	-7.19
3	2004	7.19	0.00	7.19	0.00	0.00	0.00	0.00	-7.19
4	2005	11.50	0.00	11.50	0.00	0.00	0.00	0.00	-11.50
5	2006	11.50	0.16	11.66	0.08	0.05	0.96	1.10	-10.57
6	2007	13.39	0.52	13.91	0.58	0.15	3.10	3.84	-10.07
7	2008	13.39	1.03	14.42	1.61	0.29	6.12	8.02	-6.40
8	2009	13.39	1.71	15.10	2.76	0.45	10.19	13.39	-1.71
9	2010	7.19	2.81	10.00	4.02	0.68	16.69	21.40	11.39
10	2011	0.00	3.27	3.27	0.68	0.74	18.91	20.33	17.06
11	2012	0.83	3.54	4.37	0.70	0.75	19.87	21.32	16.95
12	2013	0.00	3.88	3.88	0.73	0.77	21.19	22.68	18.80
13	2014	0.00	4.19	4.19	0.74	0.77	22.27	23.78	19.59
14	2015	0.00	4.53	4.53	0.76	0.78	23.40	24.94	20.42
15	2016	0.00	4.89	4.89	0.78	0.79	24.60	26.16	21.27
16	2017	0.00	5.29	5.29	0.79	0.79	25.85	27.44	22.16
17	2018	0.00	5.71	5.71	0.81	0.80	27.17	28.79	23.07
18	2019	0.00	6.17	6.17	0.83	0.81	28.56	30.20	24.03
19	2020	0.00	6.67	6.67	0.85	0.82	30.02	31.68	25.01
20	2021		6.67	6.67	0.04	0.82	30.02	30.88	24.21
21	2022		6.67	6.67	0.04	0.82	30.02	30.88	24.21
22	2023		6.67	6.67	0.04	0.82	30.02	30.88	24.21
23	2024		6.67	6.67	0.04	0.82	30.02	30.88	24.21
24	2025		6.67	6.67	0.04	0.82	30.02	30.88	24.21
25	2026		6.67	6.67	0.04	0.82	30.02	30.88	24.21
26	2027		6.67	6.67	0.04	0.82	30.02	30.88	24.21
27	2028		6.67	6.67	0.04	0.82	30.02	30.88	24.21
28	2029		6.67	6.67	0.04	0.82	30.02	30.88	24.21
29	2030		6.67	6.67	0.04	0.82	30.02	30.88	24.21
30	2031		6.67	6.67	0.04	0.82	30.02	30.88	24.21
31	2032		6.67	6.67	0.04	0.82	30.02	30.88	24.21
32	2033		6.67	6.67	0.04	0.82	30.02	30.88	24.21
33	2034		6.67	6.67	0.04	0.82	30.02	30.88	24.21
34	2035		6.67	6.67	0.04	0.82	30.02	30.88	24.21
35	2036		6.67	6.67	0.04	0.82	30.02	30.88	24.21
36	2037		6.67	6.67	0.04	0.82	30.02	30.88	24.21
37	2038		6.67	6.67	0.04	0.82	30.02	30.88	24.21
38	2039		6.67	6.67	0.04	0.82	30.02	30.88	24.21
39	2040		6.67	6.67	0.04	0.82	30.02	30.88	24.21
40	2041		6.67	6.67	0.04	0.82	30.02	30.88	24.21
41	2042		6.67	6.67	0.04	0.82	30.02	30.88	24.21
42	2043		6.67	6.67	0.04	0.82	30.02	30.88	24.21
43	2044		6.67	6.67	0.04	0.82	30.02	30.88	24.21
44	2045		6.67	6.67	0.04	0.82	30.02	30.88	24.21

Evaluation Indices   NPV: 34 Million R$ *1

B/C: 1.54 *1

EIRR: 18.7%

Note: *1 Discounted at 12%

Table 3.7-23   Economic Cost and Benefit Stream for Sewerage Projects in Other River Basins

(Unit: R$ Million)

| | Year | Cost | | | Benefit | | | Total | Balance |
		Capital Investment	O&M	Total	Treatment Saving	Medical Issues	Tourism Recession		
1	2002	0.00		0.00				0.00	0.00
2	2003	0.00		0.00				0.00	0.00
3	2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	2006	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	2007	9.96	0.00	9.96	0.00	0.00	0.00	0.00	-9.96
7	2008	9.96	0.00	9.96	0.00	0.00	0.00	0.00	-9.96
8	2009	9.96	0.00	9.96	0.00	0.00	0.00	0.00	-9.96
9	2010	5.42	1.07	6.48	0.37	0.24	1.25	1.86	-4.62
10	2011	0.00	1.37	1.37	0.54	0.32	1.66	2.51	1.15
11	2012	4.02	1.39	5.40	0.57	0.32	1.75	2.63	-2.77
12	2013	1.34	1.80	3.14	0.77	0.42	2.36	3.55	0.41
13	2014	2.92	1.83	4.74	0.81	0.43	2.48	3.72	-1.02
14	2015	2.65	2.15	4.80	0.99	0.51	3.03	4.53	-0.27
15	2016	3.93	2.58	6.51	1.24	0.61	3.77	5.63	-0.88
16	2017	5.98	2.61	8.59	1.31	0.62	3.96	5.90	-2.69
17	2018	5.49	2.87	8.36	1.51	0.69	4.52	6.71	-1.64
18	2019	2.88	3.23	6.11	1.77	0.78	5.28	7.84	1.73
19	2020	0.82	3.47	4.30	1.99	0.84	5.90	8.73	4.43
20	2021		3.47	3.47	0.10	0.84	5.98	6.92	3.45
21	2022		3.47	3.47	0.10	0.84	5.98	6.92	3.45
22	2023		3.47	3.47	0.10	0.84	5.98	6.92	3.45
23	2024		3.47	3.47	0.10	0.84	5.98	6.92	3.45
24	2025		3.47	3.47	0.10	0.84	5.98	6.92	3.45
25	2026		3.47	3.47	0.10	0.84	5.98	6.92	3.45
26	2027		3.47	3.47	0.10	0.84	5.98	6.92	3.45
27	2028		3.47	3.47	0.10	0.84	5.98	6.92	3.45
28	2029		3.47	3.47	0.10	0.84	5.98	6.92	3.45
29	2030		3.47	3.47	0.10	0.84	5.98	6.92	3.45
30	2031		3.47	3.47	0.10	0.84	5.98	6.92	3.45
31	2032		3.47	3.47	0.10	0.84	5.98	6.92	3.45
32	2033		3.47	3.47	0.10	0.84	5.98	6.92	3.45
33	2034		3.47	3.47	0.10	0.84	5.98	6.92	3.45
34	2035		3.47	3.47	0.10	0.84	5.98	6.92	3.45
35	2036		3.47	3.47	0.10	0.84	5.98	6.92	3.45
36	2037		3.47	3.47	0.10	0.84	5.98	6.92	3.45
37	2038		3.47	3.47	0.10	0.84	5.98	6.92	3.45
38	2039		3.47	3.47	0.10	0.84	5.98	6.92	3.45
39	2040		3.47	3.47	0.10	0.84	5.98	6.92	3.45
40	2041		3.47	3.47	0.10	0.84	5.98	6.92	3.45
41	2042		3.47	3.47	0.10	0.84	5.98	6.92	3.45
42	2043		3.47	3.47	0.10	0.84	5.98	6.92	3.45
43	2044		3.47	3.47	0.10	0.84	5.98	6.92	3.45
44	2045		3.47	3.47	0.10	0.84	5.98	6.92	3.45

Evaluation Indices

NPV: -13 Million R$ *1

B/C: 0.56 *1

EIRR: 3.7%

Note: *1 Discounted at 12%

Table 3.7-24 Project Evaluation by River Basin

3.7-40

River Basin	Generated BOD Load (kg/day) / Percentage (%) of the total Load	Basic Conditions — Area (ha)	Basic Conditions — Population In 2020	Basic Conditions — Reduction of BOD Load (kg/day) by Master Plan	Basic Conditions — Construction cost (1000 R$)	Urgency — Based on the total pollution loads in the basin		Technical Evaluation — Based on the reduced amount of BOD kg/day and		Economic Evaluation — Based on the value of EIRR for the river basin		Financial Evaluation — Based on the value of FIRR for the river basin		Social Environmental Impact — Based on Served population (Served population in poverty area)		Evaluation as a whole	
Capibaribe	43,839 (22.2 %)	9,265	790,709	41,815	161,999	Very large	A	Very large	A	14.4%	A	6.9%	A	757,620 (185,568)	A	Very effective	A
Beberibe	34,209 (17.4 %)	4,586	640,041	29,814	94,099	Large	B +	Large	B +	18.9%	A	7.4%	A	622,150 (332,152)	A	Very Effective	A
Jaboatão	35,139 (17.8 %)	5,445	650,726	35,139	149,743	Very large	A	Very large	A	13.0%	A	4.7%	B	650,726 (187,095)	A	Very effective	A
Tejipio	30,366 (15.4 %)	4,629	561,128	29,366	104,871	Large	B	Large	B	11.2%	B	5.8%	A	542,596 (179,475)	A	Effective	B +
Timbo	25,874 (13.1 %)	5,077	478,766	24,088	71,209	Large	B	Large	B	18.7%	A	8.3%	A	445,679 (Non)	C	Effective	B
Other six river basins	27,681 (14.0 %)	7,423	51,259	14,786	53,599	Less	C	Small	C	3.7%	C	7.2%	A	273,831 (902)	C	Less effective	C
Whole Basins (M/P)	197,108 (100 %)	36,425	3,633,960	178,438	634,520	Very large	A	Very large	A	14.4%	A	6.1%	A	3,292,602 (885,192)	A	Very effective	A

Evaluation criteria

Evaluation Item	A	B	C
Technical evaluation	Above 10,000kg/day	10,000~5,000 kg/day	Below 5,000 kg/
Economic evaluation	Above 12%	12% - 10%	Below 10%
Financial evaluation	Above 5%	5% - 2%	Below 2%
Social environmental evaluation	Very high	High	Low

Sewerage System Plan
& Cost Estimation

Existing Condition

Growth in Existing Areas

RMR Regional
Development Plan

Sewerage Treatment Load

With-Project

Sewerage Project
Formulation

Economic Evaluation

Economic Cost

Without Project

Financial
Construction Cost

Economic
Construction Cost

Sewerage Treatment Cost
under Present System

Recession of Tourism due to
Damage to Tourism
Resources

Conversion Factors

Benefits Expected from
Sewerage System

Medical Expenses and
Losses due to Illness

Financial
O/M Cost

Economic
O/M Cost

Economic Benefit of
Sewerage Project

Economic Benefit

Economic Efficiency

Economic Evaluation
& Recommendation

Present Sewerage
Treatment Services Tariff

Financial Efficiency

Financial Revenue from
Sewerage Treatment Services

Affordability of Sewerage System
for Beneficiaries

Financial Evaluation
& Recommendation

Financial Evaluation
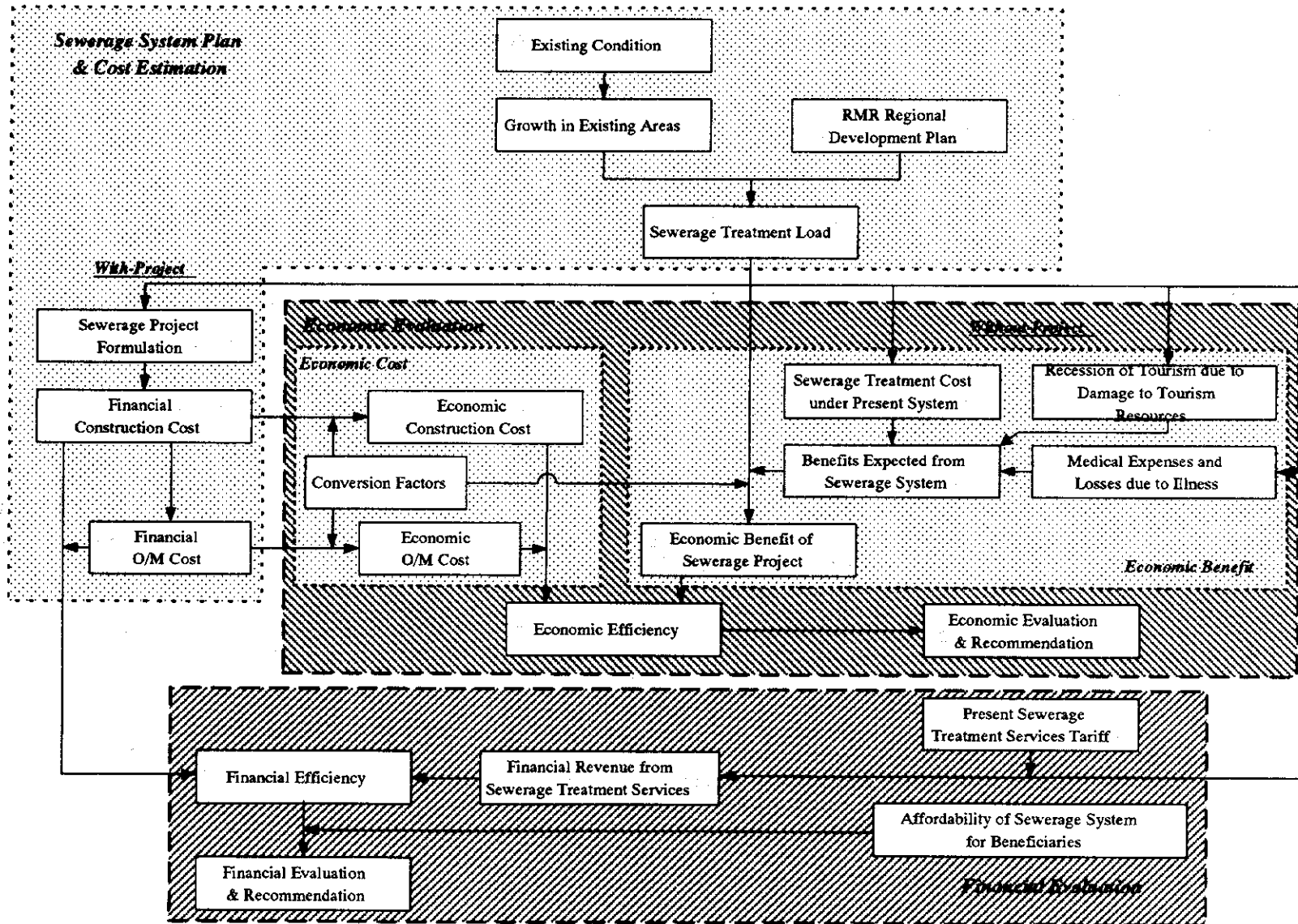
Fig. 3.7 - 1   Evaluation Procedure of Sewerage Projects

Fig. 3.7 - 1   Evaluation Procedure of Sewerage Projects

Benefits of Sewerage System
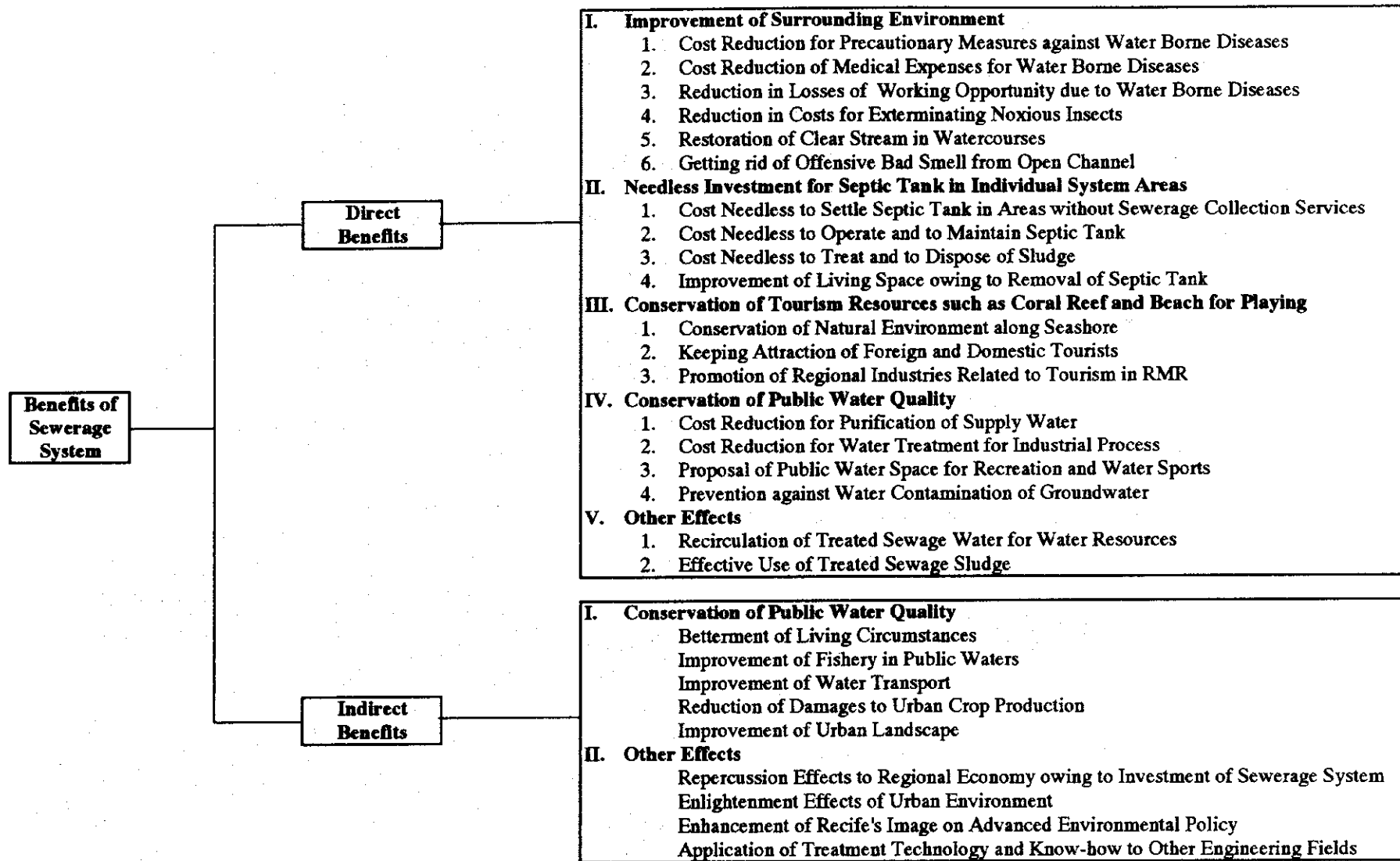
Direct Benefits

I. **Improvement of Surrounding Environment**
   1. Cost Reduction for Precautionary Measures against Water Borne Diseases
   2. Cost Reduction of Medical Expenses for Water Borne Diseases
   3. Reduction in Losses of Working Opportunity due to Water Borne Diseases
   4. Reduction in Costs for Exterminating Noxious Insects
   5. Restoration of Clear Stream in Watercourses
   6. Getting rid of Offensive Bad Smell from Open Channel
II. **Needless Investment for Septic Tank in Individual System Areas**
   1. Cost Needless to Settle Septic Tank in Areas without Sewerage Collection Services
   2. Cost Needless to Operate and to Maintain Septic Tank
   3. Cost Needless to Treat and to Dispose of Sludge
   4. Improvement of Living Space owing to Removal of Septic Tank
III. **Conservation of Tourism Resources such as Coral Reef and Beach for Playing**
   1. Conservation of Natural Environment along Seashore
   2. Keeping Attraction of Foreign and Domestic Tourists
   3. Promotion of Regional Industries Related to Tourism in RMR
IV. **Conservation of Public Water Quality**
   1. Cost Reduction for Purification of Supply Water
   2. Cost Reduction for Water Treatment for Industrial Process
   3. Proposal of Public Water Space for Recreation and Water Sports
   4. Prevention against Water Contamination of Groundwater
V. **Other Effects**
   1. Recirculation of Treated Sewage Water for Water Resources
   2. Effective Use of Treated Sewage Sludge

Indirect Benefits

I. **Conservation of Public Water Quality**
   Betterment of Living Circumstances
   Improvement of Fishery in Public Waters
   Improvement of Water Transport
   Reduction of Damages to Urban Crop Production
   Improvement of Urban Landscape
II. **Other Effects**
   Repercussion Effects to Regional Economy owing to Investment of Sewerage System
   Enlightenment Effects of Urban Environment
   Enhancement of Recife's Image on Advanced Environmental Policy
   Application of Treatment Technology and Know-how to Other Engineering Fields

Fig. 3.7 - 2   Benefit Structure of Sewerage Treatment System in RMR

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┌─────────────────────────────────────────────────────────────────────────────────────────┐
│                      Socio-Economic Framework in Target Year 2020                         │
└─────────────────────────────────────────────────────────────────────────────────────────┘
            │                                                              │
            ▼                                                              ▼
┌──────────────────────────────────────┐            ┌──────────────────────────────────────┐
│ With-Project Conditions  (Proposed    │            │ Without-Project Conditions  (Trend     │
│ Scenario)                             │            │ Scenario)                             │
└──────────────────────────────────────┘            └──────────────────────────────────────┘
```

Propose Sewerage System in Master Plan	Tourism Development Plan in State and RMR	Water Borne Disease Information in Cities Advanced in Sewerage System	(1) Sewerage Systems under Past Trend (2) Independent Systems	Research of Tourists' purpose and Attractiveness	Water Borne Disease under Present Sewerage Conditions
Investment Plan and O/M Plan	Number of Tourists Coming into RMR under Improved Environment	Number of Water Borne Disease Case under Low Morbidity Rates	Investment and O/M Costs for Systems Above	Number of Tourists in RMR under Exacerbated Environment	Number of Water Borne Disease Case under High Morbidity Rates
Estimates of Investment and O/M of Proposed Sewerage System	Revenue from Tourism in RMR	Medical Care Costs and Opportunity Labor Wages of Suffers	Elimination of Investment and O/M Costs Above	Revenue from Tourism in RMR	Medical Care Costs and Opportunity Labor Wages of Suffers

Loss of Revenue from Tourism	Increment of Medical Care and Loss of Labor Wages

Conversion Factors

Economic Costs of Investment and O/M of Proposed System	Economic Analysis and Evaluation	**Economic Benefits** of With-Project Case

Fig. 3.7 - 3   Flow Diagram of Economic Analysis and Evaluation

3.8 Implementation Organization

3.8.1 Institutional Component

The proposed projects are a large-scale undertaking which comprise many planning components. For implementation of the project, a leading agency always has to coordinate organizations and agencies concerned with the proposed projects. It also makes arrangement with the federal government and international financing organization in order to procure financial sources for the project.

Thus, the leading agency is formally established as a project management unit (PMU). The PMU would rather be set up under SEPLANDES, since its major function is coordination of agencies concerned. Thus, the PMU has to have a coordination committee including representatives of agencies concerned in addition to the executive secretariat. The committee is composed of representatives from SEIN, SRH, COMPESA, CONDEPE, FIDEM, ITEP and CPRH as well as SEPLANDES.

After completion of this feasibility study, the PMU has to be created as a preparation agency by the time of commencement of the proposed projects. In order to procure from international or local financial organizations, the PMU has to ask the State House to authorize a permission of finance. After that, the state government gets an approval from the competent agency of foreign loans in the federal government, i.e., External Financial Commission (COFIEX or Comissão de Financiamentos Externos) under Ministry of Planning, Budget and Management (MP or Ministério do Planejamento, Orçamento e Gestão). Besides, the permission from the Upper House is prerequisite for the project entity to procure international loans, under consideration of allowance of debt services.

In terms of environment assessment, the proponent of the proposed project (PMU) has to get licenses from the competent agency at the respective implementation stages. The proposed projects are located in state territory, so the CPRH is competent to issue licenses from the state standpoint, referring to the National Policy of Water Resources (Federal Law No.9443m 18[th] of January 1997). The PMU might conduct environmental studies under guidance of the CPRH.

3.8.2 Prospect of Project Implementation

Until the time of project completion, the state government will have to deal with the various tasks. The major tasks are classified into three categories. They are (a) administrative or legal formalities, (b) procurement of finances for project implementation and (c) construction of the projects. After the JICA study, the first task for the PMU is to settle financial sources

for the project in the first stage. The external loans are expected to cover a sizable portion of the capital investment. Thus, the PMU has to commence negotiating with the agencies concerned. Just after the prospects for finances are settled, the PMU starts to get various licenses such as environmental license and water right license (not yet established at present) from the agencies concerned as well as construction negotiations with the agencies concerned. Besides, the PMU works out the schedule of project construction.

3.9   Priority Projects for the F/S

3.9.1   General

The water of the rivers and channels has been polluted and the environmental conditions are deteriorating in the RMR.   The restoration of environmental conditions is an urgent matter for the RMR to cope with by reducing the pollution load of the five major river systems.

In order to restore the aquatic environment, it is essential for the RMR to improve and to expand the existing sewerage systems.   The priority projects for the F/S are selected from the sewerage projects on the basis of technical and environmental aspects.   It is concluded that the most effective measure would be to rehabilitate and expand existing sewerage systems located in the major river basin, which are most polluted.

3.9.2   Priority Projects

About 90 % of the BOD pollution load from the urban area in the RMR was estimated to be discharged from the five major rivers, i.e., the Capibaribe, Beberibe, Jaboatao, Tejipio and Timbo rivers, which flow through the central part of the RMR.   It is necessary for the RMR to reduce the pollution load from these five river basins by improvement and expansion of the existing sewerage systems in order to restore the urban environment.

There are many inactive sewerage units, which are either not working or not fulfilling their principal functions.   These sewerage units discharge a large volume of untreated sewage into water bodies and no proper measures have been taken so far.   This is accelerating the deterioration of the urban environment.   The RMR should improve and expand inactive sewerage units.

In the selection of priority projects for the F/S the sewerage systems proposed in the Master Plan are studied and evaluated according to the following criteria:

- Effectiveness in reducing the pollution loads in the four major rivers i.e., the Capibaribe, Jaboatao, Tejipio and Timbo Rivers in the RMR,
- Existence of systems with inactive sewerage units,
- Existence of systems composed of sewerage units located near the major rivers.

The Beberibe River, one of the five major rivers, was not evaluated because the Beberibe River basin had already been selected for the Pro-Metropole (Project of Infrastructure in Low-income Areas of the RMR) financed by the World Bank, which involves the construction or

improvement of drainage and sewerage systems, including the major sewerage subsystem in the basin.

All the systems were studied and compared to single out the most effective one for each of the four major river basins and the following seven (7) sub-systems were selected for priority projects:

1) **Conceicao system (Timbo River basin)**

   This system is located in the newly developed coastal area in the lower reach of the Timbo River and requires construction of a new sewerage system including treatment plant. The implementation of the system is expected to reduce BOD pollution load of 3,372 kg/day to 3035kg/day (90% reduction within the subsystem, about 12 % in the river basin). The improved system is expected to serve a population of 62,000 in 2020.

2) **Janga system (Timbo River basin)**

   This system is the largest system in the Timbo River basin, located in the new urban area and includes the Janga treatment plant, which is one of the four major existing treatment plants. Rehabilitation / extension of the existing sewer system and treatment plant are required. The improvement of the system is expected to reduce BOD pollution load by 15,370 kg/day (90% reduction in the system, about 59 % in the river basin) and the system is expected to serve a population of 316,000 in 2020.

3) **Cabanga system (Capibaribe River basin)**

   This system is the largest system in the Capibaribe River basin located in the lower reach, and includes the Cabanga treatment plant that is one of the four major existing treatment plants. Rehabilitation and extension of the existing sewer system and treatment plant is required. By the improvement of this system, the BOD pollution load is expected to be reduced by 15,587 kg/day (about 90% reduction in the system, 35.5 % in the river basin) and the system is expected to serve a population of 304,000 in 2020.

4) **Boa Viagem system (Tejipio River basin)**

   This system is the largest system in the Tejipio River basin, located in the new coastal urban area in the lower reach, and requires construction of a new sewerage system including treatment plant. By the implementation of the system, the BOD pollution load is expected to be reduced by 7,784 kg/day (about 90% reduction in the system, 26 % in the river basin) and the system is expected to serve a population of 159,000 in

2020.

5) Cordeiro system (Capibaribe River basin)

This system is the second largest system in the Capibaribe River basin, located to the west of the Cabanga system, and requires rehabilitation / extension of the existing sewer system and construction of a new treatment plant. By the improvement of the system, the BOD pollution load is expected to be reduced by 4,862 kg/day (about 90% reduction in the system, 11 % in the river basin) and the system is expected to serve a population of 100,000 in 2020.

6) Prazeres system (Jaboatao River basin)

This system is the largest system in the Jaboatao River basin, located in the new coastal urban area in the lower reach, and requires rehabilitation / expansion of the existing sewer system and construction of a new treatment plant. By the improvement of the system, the BOD pollution load is expected to be reduced by 11,343 kg/day (90% reduction in the subsystem, 32 % in the river basin) and the system is expected to serve a population of 233,000 in 2020.

7) Cucurana system (Jaboatao River basin)

This system is the second largest system in the Jaboatao River basin, located in the new coastal urban area in the lower reach, and requires rehabilitation / expansion of the existing sewer system and construction of a new treatment plant. By the improvement of the system the BOD pollution load is expected to be reduced by 6,008 kg/day (90% reduction in the system, about 17 % in the river basin) and the system is expected to serve a population of 124,000 in 2020.

The effects of the proposed priority projects were assessed in technical, financial, economic, social and environmental terms, and the results are shown in Table 3.9-1. The order of priority of the systems is assumed as follow:

Priority -1: Cabanga, Janga, Boa Viagem
Priority - 2: Cordeiro, Prazeres
Priority - 3: Cucurana, Conceicao

The locations of the priority sewerage systems are shown in Fig. 3.9-1.

Table 3.9-1 Basic Data for Priority Projects

System	River Basin	BOD load generated in the River Basin (kg/day) (Ratio (%) of the total BOD load in the RMR)	Basic Conditions Area (ha)	Population in 2020.	BOD load (kg/day)	Construction cost (1000R$)	Urgency Based on the river basin and location.		Technical Evaluation Based on the reduction amount of BOD load kg/day, and reduction rate (%) of the total load from the basin.		Social Environmental Impact Based on the served population in the system and the served population in the poverty areas.		Impacts by Construction		Evaluation as a whole	
Conceição	Timbo	25,874 (13.1%)	710	62,445	3,372	23,779	Urgent	B	Reduction amount of BOD: 3,035 kg/day, Reduction rate:14%	C	Served population: 62,445 Served population in poverty area: No data.	C	No significant impacts expected	B	Effective	B
Janga	Timbo	25,874 (13.1%)	2,879	316,075	17,078	63,443	Very urgent	A	Reduction amount of BOD: 15,370 kg/day, Reduction rate: 71%	A	Served population: 316,075 Served population in poverty area: No data.	A	No significant impacts are expected.	A	Very effective	A
Cabanga	Capibaribe	43,839 (22.2%)	2,260	304,394	17,319	40,836	Very urgent	A	Reduction amount of BOD: 15,587 kg/day, Reduction rate: 41%	A	Served population: 304,394, Served population in poverty areas: 67,116 (22%)	A	No significant impacts expected.	A	Very effective	A
Boa Viagem	Tejipio	30,366 (15.4%)	1,281	159,314	8,649	49,936	Very urgent	A	Reduction amount of BOD: 7,784 kg/day, Reduction rate:29%	B	Served population: 159,314, Served population in poverty area:32,952 (21%)	A	Some impacts to the housing area nearby.	C	Very effective	A-
Cordeiro	Capibaribe	43,839 (22.2%)	675	100,048	5,403	23,026	Urgent	B	Reduction amount of BOD: 4,862 kg/day, Reduction rate: 13%	C	Served population: 100,048 Served population in poverty areas: 29,215 (29%)	B+	Some impacts to the surrounding poverty area nearby.	C	Effective	B+
Prazeres	Jaboatao	35,139 (17.8%)	1,548	233,403	12,604	60,185	Very Urgent	A	Reduction amount of BOD: 11,343 kg/day, Reduction rate: 36%	A	Served population: 233,403, Served population in poverty areas:104,196 (44%)	A	Impacts unknown	B	Effective	B
Curcurana	Jaboatao	35,139 (17.8%)	910	123,636	6,676	35,720	Urgent	B	Reduction amount of BOD: 6,008 kg/day, Reduction rate:19%	B	Served population: 123,636, Served population in poverty area:19,135 (15%)	B-	No significant impacts expected.	A	Effective	B-

Evaluation criteria

Evaluation Item	A	B	C
Technical evaluation	Above 10,000 kg/day	10,000~5,000 kg/day	Below 5,000 kg/
Social environmental evaluation	Very high	High	Low

3.10   Action Plan

3.10.1   Proposed Tasks

The major tasks proposed in the Master Plan are:

(1)   **Establishment of an implementation organization for execution of the Master Plan:**

For sustainable implementation of the master plan the following supports are to be required:

- Establishment of a Project Management Unit (PMU) for the Master Plan under SEPLANDES,
- Development of human resources for implementation of the Master Plan and O&M.

(2)   **Execution of preventive measures to reduce pollution loads for improvement of the urban environment:**

1) Implementation of 55 sewerage systems in two phases in order to reduce the pollution loads from the urban area in the RMR:

- Phase 1:   7 priority sewerage systems, and 18 other sewerage systems,
- Phase-2:   30 sewerage systems.

2) Control of the effluent discharge from industries through regular monitoring of water quality by the CPRH:

A large part of the pollution loads is estimated to be discharged from industries in the RMR.   In order to reduce the pollution loads in the RMR it is necessary for the CPRH to control the effluent discharge from the industrial sector in order to improve the environmental conditions in the RMR.

3) Promotion of the environmental education:

It is necessary for the RMR to promote environmental education on preventive measures to improve the river environment, including a river clean campaign.

(3)   **Improvement of stormwater drainage facilities,**

1) Installation and observation of automatic rain gauges to improve the existing hydrological network and the hydrological data,

2) Review of the hydraulic design conditions, based on the new rainfall data observed,

3) Detailed design and construction of the drainage projects in the PQA,

4) Preparation of river improvement plan for the major reaches.

(4)   Execution of development studies:

    1) River basin management for major rivers in the RMR,

    2) Water resources management in the RMR,

    3) Solid waste management for the RMR.

    4) River improvement for the major reaches in the RMR.

3.10.2   Action

The tasks proposed in the Master Plan are planned to be executed in two phases and complete by 2020.   The actions required in each phase are planned as follows:

1)   Phase 1 (From 2001 to 2010)

- To establish a preparation committee for early implementation of the Master Plan immediately after the Study,
- To establish a Project Management Unit (PMU) before the implementation of the major tasks of Phase 1,
- To prepare a human resources development program in the detailed design stage,
- To start rising funds for the projects proposed in the phase 1.

(Sewerage)
- To procure consultants for engineering services for the projects,
- To prepare detailed design and tender documents for the projects,
- To procure contractors for the construction works,
- To supervise the construction works,
- To conduct O&M activities,
- To promote environmental education,
- To execute development studies.

(Drainage)
- To install automatic rain gauges and observe rainfall of short duration, and execution of basic river surveys,
- To review of the hydraulic design conditions, based on the observed data and topographic conditions,
- To design and construct the drainage projects in the PQA,
- To implement the drainage projects in the PQA,

- To promote environmental education,
- To prepare river improvement plan for the major reaches.

2) Phase 2 (From 2011 to 2020)

(Sewerage)
- To prepare for the projects in Phase ,
- To procure consultants for engineering services for the projects,
- To prepare detailed design and tender documents for the projects,
- To procure contractors for the construction works,
- To supervise the construction works,
- To conduct routine O&M activities,
- Promotion of environmental education.

(Drainage)
- To establish the design conditions,
- To review the flood control and drainage conditions,
- To prepare optimum flood control and drainage improvement for the major river basin.