社会開発調査部報告書

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THE STUDY ON STORMWATER DRAINAGE AND SEWERAGE MANAGEMENT PLAN FOR RECIFE METROPOLITAN AREA IN THE FEDERATIVE REPUBLIC OF BRAZIL

FINAL REPORT
SUPPORTING REPORT

JANUARY 2001

PACIFIC CONSULTANTS INTERNATIONAL/TOKYO

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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

BRAZILIAN COOPERATION AGENCY (ABC),
STATE SECRETARIAT OF PLANNING AND SOCIAL DEVELOPMENT,
STATE OF PERNAMBUCO (SEPLANDES)
FEDERATIVE REPUBLIC OF BRAZIL

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The cost estimate was made based on prevailing market price in July 2000 and expressed in US$ according to the following exchange rate.

US$1.00 = R$ 1.80 = Yen 110.00
(As of June 2000)

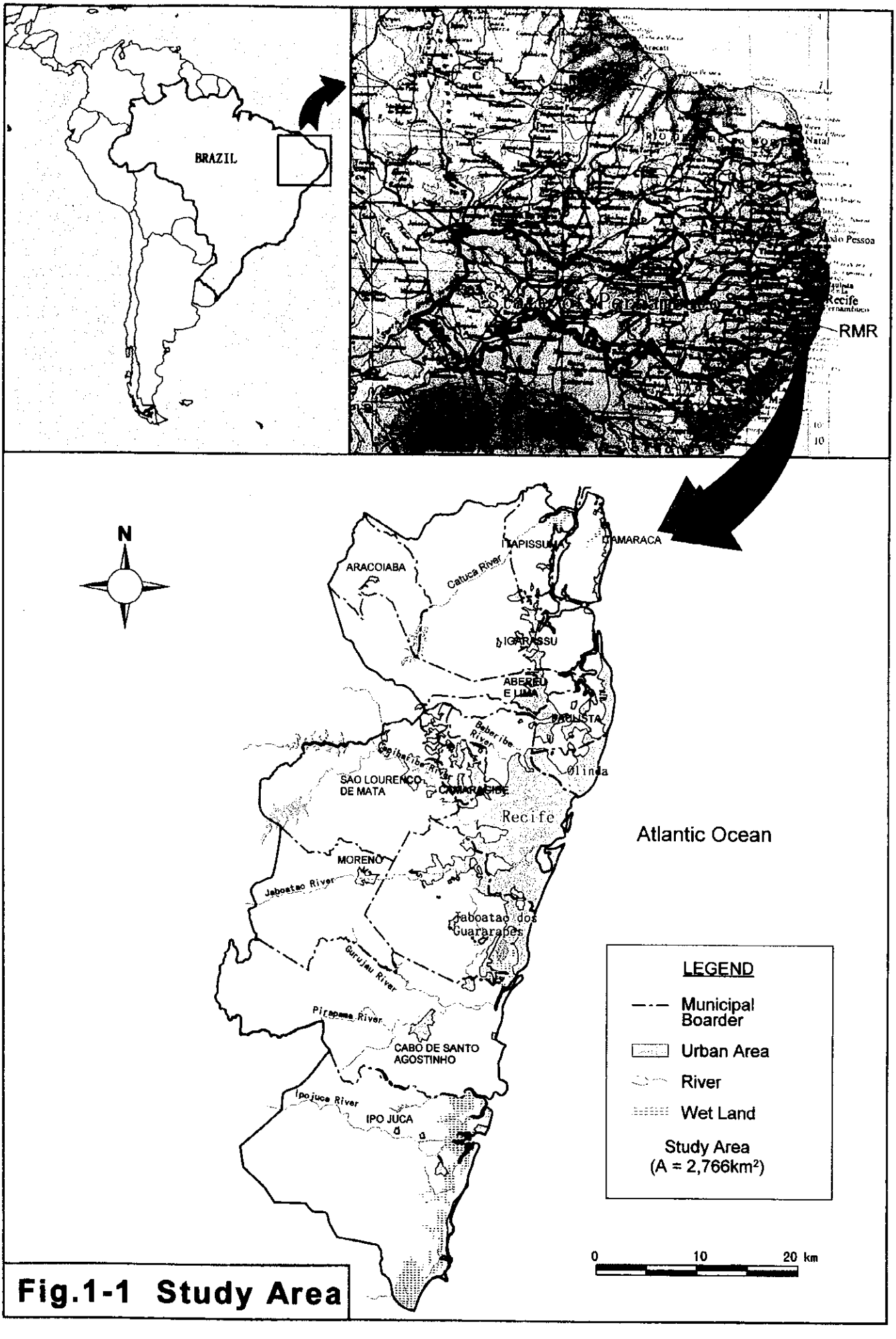

Fig.1-1 Study Area

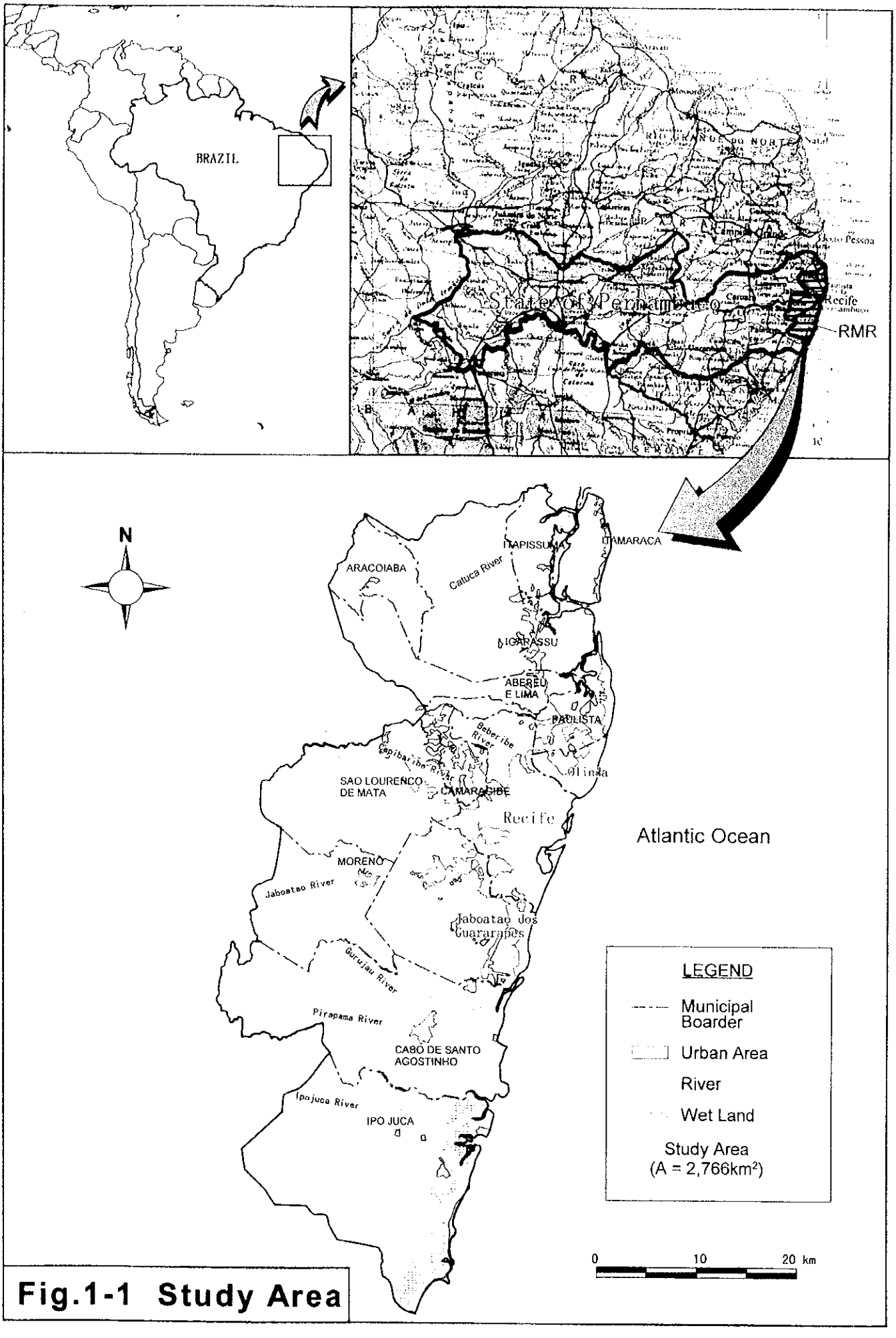

Fig.1-1 Study Area

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ABBREVIATIONS

ABC	**Brazilian Cooperation Agency** (Agência Brasileira de Cooperação)
AID	**International Development Association - IDA** (Associação Internacional de Desenvolvimento)
APM	**Water Catchment Protection Area** (Área de Proteção de Mananciais)
ARPE	**State Agency for the Regulation of Delegated Public Services in the State of Pernambuco** (Agencia Estadual de regulação dos Serviços Publicos Delegados do Estado de Pernambuco)
BC	**Central Bank of Brazil** (Banco Central do Brasil)
B/C	**Benefit Cost Ratio** (Custo-beneficio)
BID	**Inter-American Development Bank – IDB** (Banco Interamericano de Desenvolvimento)
BNB	**Bank of the Northeast of Brazil** (Banco do Nordeste do Brasil)
BIRD	**International Bank for Reconstruction and Development – IBRD** (Banco Internacional de Reconstrução e Desenvolvimento)
BNDES	**National Bank of Economic and Social Development** (Banco Nacional de Desenvolvimento Econômico e Social)
BOD	**Biological Oxygen Demand** (Demanda Biologigica de Oxigênio)
CAESB	**Water and Sewage Company of Brasilia** (Companhia de Agua e Esgostos de Brasilia)
CDRU	**Concession of Existing Use Rights** (Concessão dos Direitos de Uso Atual)
CEF	**Federal Savings Bank** (Caixa Econômica Federal)
CELPE	**Electricity Company of Pernambuco** (Companhia de Eletricidade de Peernambuco)
CFI	**International Finance Corporation** (Corporação Financeira Internacional)
CHESF	**Hydroelectric Company of São Francisco** (Companhia Hidroelétrica do São Francisco)
CIM/FIDEM	**Metropolitan Information Center** – FIDEM (Centro de Informação Metropolitana (da Fundação de Desenvolvimento Municipal))
CMMAS	**Metropolitan Chamber of the Environment and Sanitation** (Camara Metropolitana de Meio Ambiente e Saneamento)
CMN	**National Monetary Council** (Conselho Monetário Nacional)
CNPQ	**National Council of Scientific and Technological Development** (Conselho Nacional de Desenvolvimento Científico e Tecnológico)
CODECIPE	**Civil Defense Board of Pernambuco** (Coordenadoria de Defesa Civil de Pernambuco)
COFIEX	External Finance Commission (Comissão de Financiamentos Externos)
COFINS	**Tax for Social Security Financing (in place of Finsocial)** (Contribuição para o Financiamento da Seguridade Social Substituta do Finsocial)
COHAB	**State Housing Company** (Companhia de Habitação)
COMPESA	**Sanitation Company of Pernambuco** (Companhia Pernambucana de Saneamento)
COMUL	**Commission of Urbanization and Legalization** (Comissão de Urbanização e Legalização)
CONAMA	**National Environmental Council** (Conselho Nacional do Meio Ambiente)
CONDEPE	**Pernambuco Planning Institute** (Instituto de Planejamento de Pernambuco)

CONDERM	**Recife Metropolitan Region Development Council** (Conselho de Desenvolvimento da Região Metropolitana do Recife)
CONSEMA	**Environmental Council of the State of Pernambuco** (Conselho Estadual do Meio Ambiente)
C/P	**Counterpart** (Contraparte)
CODERTRENS	**Pernambuco State Metropolitan Trains Company** (Companhia Pernambucana de Trens)
CPRH	**Environment Company of Pernambuco** (Companhia Pernambucana do Meio Ambiente)
CPRM	**Mineral Resources Research Company** (Companhia de Pesquisa de Recursos Minerais)
DBO	**Biological Oxygen Demand** (Demanda Biológica de Oxigênio)
D/D	**Detailed Design**
DEZ	**Specific Guideline Zones** (Zonas de Diretrizes Específicas)
DIRES	**Health Management Region** (Diretória Regional de Saúde)
DO	**Oxygen demand** (Demanda de Oxigênio)
DS	**Sanitary Districts** (Distritos Sanitários)
EBAPE	**Supplies and Rural Development Company of the State of Pernambuco** (Empresa de Abastecimento e Extensão Rural do Estado de Pernambuco)
EE	**Pumping Station** (Estação Elevatória)
EIA	**Environmental Impact Assessment** (Estudo de Impacto Ambiental)
EIRR	**Economic Internal Rate of Return**
ELO	**Local Bureaux** (Escritórios Locais)
EMHAPE	**Pernambuco State Housing Company (former COHAB)** (Empresa Habitacional de Pernambuco)
EMLURB	**Municipal Maintenance and Cleaning Company** (Empresa para Manutenção e Limpeza Urbana)
EMPETUR	**Pernambuco Tourism Company** (Empresa de Turismo de Pernambuco)
ENDEJA	**Jaboatão dos Guararapes Development Company** (Empresa de Desenvolvimento de Jaboatão dos Guararapes
ETA	**Water Treatment Plant** (Estação de Tratamento de Água)
ETE	**Wastewater Treatment Plant** (Estação de Tratamento de Água)
FERH	**State Water Resources Fund** (Fundo Estadual para Recursos Hídricos)
FGV	**Getúlio Vargas Foundation** (Fundação Instituto Getúlio Vargas)
FIDEM	**RMR Development Foundation** (Fundação de Desenvolvimento da Região Metropolitana do Recife)
FNS	**National Health Foundation** (Fundação Nacional de Saúde)
F/S	**Feasibility Study**
GOB	**Government of Brazil** (Governo do Brasil)
GOJ	**Government of Japan** (Governo do Japão)
GDP	**Gross Domestic Product**
GRDP	**Gross Regional Domestic Product**

GEPE	**Government of the State of Pernambuco** (Governo do Estado de Pernambuco)
GME	**Department of Sewerage and Sanitation** (Gerência Metropolitana de Esgotos)
GTZ	**GTZ – German Society for Technical Cooperation** (Sociedade Alemã de Cooperação Técnica)
IBRD	**International Bank for Reconstruction and Development**
IBAMA	**Brazilian Institute of the Environment and Renewable Natural Resources** (Instituto Brasileiro do Meio Ambiente e Recursos Renováveis)
IBGE	**Brazilian Institute of Geography and Statistics Foundation** (Fundação Instituto Brasileiro de Geografia e Estatística)
ICMS	**Circulation of Goods and Services Tax** (Imposto sobre Circulação de Mercadorias e Serviços)
IDB	**Inter-American Development Bank**
IEE	**Initial Environmental Examination**
INESC	**Institute of Socio-Economic Studies** (Instituto de Estudos Sócio-Econômicos)
INMET	**National Institute of Meteorology** (Instituto Nacional de Meteorologia)
INMETRO	**National Institute of Metrology, Standardization and Industrial Quality** (Instituto Nacional de Metrologia, Normalização e Qualidade Industrial)
INPC	**National Consumer Price Index** (Índice Nacional de Preços ao Consumidor)
IPEA	**Institute of Applied Economics Research** (Fundação Instituto de Pesquisa Econômica Aplicada)
IPEM	**Institute of Weights and Measures** (Instituto de Pesos e Medidas)
IRR	**Internal Rate of Return**
ITEP	**Technological Institute of Pernambuco** (Fundação Instituto Tecnológico do Estado de Pernambuco)
JICA	**Japan International Cooperation Agency** (Agencia de Cooperação Internacional do Japão)
KWF	**German Development Bank** (Kreditanstalt Fur Wiedraufbau)
MMA	**Ministry of the Environment, Water Resources and the Legal Amazon** (Ministério do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal)
MPO	**Ministry of Planning and Finance** (Ministério do Planejamento e Orçamento)
MRE	**Ministry of Foreign Affairs** (Ministério das Relações Exteriores)
MW	**Minimum Wage** (Salário Mínimo)
NPV	**Net Present Value**
NUAMPO	**Catholic University Supporting Nucleus Community Movements** (Núcleo de Apoio ao Movimento Popular da Universidade Católica)
OGU	**Federal General Budget** (Orçamento Geral da União)
O&M	**Operation and Maintenance** (Operação e Manutenção)
PBA	**Brazil in Action Program** (Programa Brasil em Ação)
PAI	**Integrated Actions Plan** (Plano de Ações Integradas)
PASS	**Social Action Program on Sanitation** (Programa de Ação Social em Saneamento)
PE	**Pernambuco [State]** (Pernambuco)
PCR	**Recife City Council** (Prefeitura da Cidade do Recife)

PDAA	**Water Supply Master Plan for the RMR** (Plano Diretor de Abastecimento de Água da RMR)
PDCR	**Recife City Master Plan** (Plano Diretor da Cidade do Recife)
PDES	**Sewerage Master Plan** (Plano Diretor de Esgotamento Sanitário)
PDM	**Metropolitan Master Plan** (Plano Diretor Metropolitano)
PDMD	**Macrodrainage Master Plan** (Plano Diretor de Macrodrenagem)
PGAI	**Project for Integrated Management of the Environment** (Projeto de Gestão Ambiental Integrada)
PIB	**Gross Domestic Product** (Produto Interno Bruto)
PLANASA	**National Plan of Sanitation** (Plano Nacional de Saneamento)
PNAD	**National Research by House Unit Sampling** (Pesquisa Nacional por Amostragem de Domicílio)
PMJG	**Jaboatão dos Guararapes City Council** (Prefeitura Municipal de Jaboatão dos Guararapes)
PMO	**Olinda City Council** (Prefeitura Municipal de Olinda)
PMSS	**Modernization Plan for the Sanitation Sector [of the Ministry of Planning]** (Plano de Modernização do Setor de Saneamento (do Ministério do Planejamento))
PMU	**Project Management Unit** (Unidade de Gerenciamento de Projeto)
PND	**National Program for Privatization** (Programa Nacional de Desestatização)
POER	**Plan for the Organization of the Recife Sewerage System** (Plano de Ordenamento do Sistema de Esgotos do Recife)
POT	**Territorial Organization Plan** (Plano de Organização Territorial (Fidem))
PPA	**Four-Year Plan** (Plano Plurianual)
PQA	**Water Pollution Control and Water Quality Program** (Projeto de Qualidade das Águas e Controle da Poluição Hídrica (das Bacias dos Rios Beberibe, Capibaribe e Jaboatão).
PQA-PE	PQA-Pernambuco State. Study of Sewerage and Drainage in RMR for preparation of Investment Program in Beberibe, Capibaribe, Jaboatao and Ipojuca Basins (Estudos de Consolidacao e Complementacao de Diagonostico Sobre a Qualidade das Aguas, Relativos ao Programa de Investimentos nas Bacias dos Rios Beberibe, Capibaribe, Jaboatao e Ipojuca)
PQA-RD	Three volumes (RD-1: 2 volumes and RD-2). Study of Macro Drainage in RMR (Estudos Sobre o Sistema de Macrodrenagem da RMR)
PQA-RE	Ten volumes (RE-1: 2, RE-2: 3 and RE-3: 5 volumes). Study of Sewerage System in RMR (Estudos de Concepcao do Sistema de Esgotos Metropolitano)
PQA-Final Report	**Sanitation Environment in RMR, Document for Investment Strategy, Final Report** (Sistema de Saneamento Ambiental da Metropolitana do Recife, Documento Estrategico de Investimentos, Relatorio Final)
PREZEIS	**Plan of ZEIS Regularization** (Plano de Regularização das ZEIS)
PRO-INFRA	**Urban Infrastructure Program** (Programa de Infra-Estrutura Urbana)
PROMATA	**Execution of Actions of the Program for the Sustainable Development of the Zona da Mata** (Programa de Execução de Ações para o Desenvolvimento Sustentado da Zona da Mata)
PRODETUR/NE	**Tourism Development Program / Northeast** (Programa de Desenvolvimento do Turismo /Nordeste)
PRÓ-METRÓPOLE	**Integrated Action Project for Low Income Areas of the RMR** (Projeto de Ação Integrada em Áreas de Baixa Renda na RMR)
PRO-MORADIA	**Alternative Housing Program for the Low-Income Population** (Programa de Alternativas Habitacionais para População de Menor Renda)

PROSANEAR	**Sanitation Program for Low Income Population** (Programa de Saneamento para Áreas de Baixa Renda)
PRO-RENDA	**Program for Providing Work Opportunities for Low-Income Populations** (Programa de Viabilização de Espaços Econômicos para a População de Baixa Renda)
RAFA	**Up-flow Anaerobic Sludge Blanket – UASB** (Reatores Anaeróbios de Fluxo Ascendente)
RE	**Sewerage Report** (Relatório de Esgotamento Sanitário)
RD	**Stormwater Drainage Report** (Relatório de Drenagem de Águas Pluviais)
RIMA	**Environmental Assessment Report** (Relatório de Impacto Ambiental)
RMR	**Metropolitan Region of Recife** (Região Metropolitana do Recife)
SABESP	**Basic Sanitation Company of the State of São Paulo** (Empresa de Saneamento Básico do Estado de São Paulo)
SANEPAR	**Sanitation Company of the State of Paraná** (Empresa de Saneamento do Estado do Paraná)
SCF	**Standard Conversion Factor**
SECTMA	**Secretariat of Science, Technology and the Environment** (Secretaria de Ciência, Tecnologia e Meio Ambiente)
SEIN	**State Secretariat of Infrastructure** (Secretaria de Infra-Estrutura do Estado)
SEMAM	**Secretariat of the Environment** (Secretariado do Meio Ambiente)
SEPLAN	**State Secretariat of Planning** (Secretaria de Planejamento do Estado)
SEPLANDES	**Secretariat of Planning and Social Development** (Secretaria do Planejamento e Desenvolvimento Social)
SEPURB	**Urban Policies Secretariat** (Secretaria de Política Urbana)
SERPRO	**Federal Data Processing Service** (Serviço Federal de Processamento de Dados)
SIIC	**Integrated System of Commercial Information** (Sistema Integrado de Informações Comerciais)
SISNAMA	**National Environmental System** (Sistema Nacional do Meio Ambiente)
SME	**Small and Medium Sized Companies** (Empresas de Pequeno e Médio Portes)
SMSA	**Metropolitan System of Environmental Sanitation** (Sistema Metropolitano de Saneamento Ambiental)
SPRRN	**Sub-program on Natural Resource Policy** (Subprograma da Política de Recursos Naturais)
SRH	**Secretariat of Water Resources** (Secretaria de Recursos Hídricos)
SS	Suspended Solids (Solidos Suspensos)
STAS	**Secretariat of Employment and Social Welfare** (Secretaria do Trabalho e da Assistência Social)
SUAPE	**Suape Port and Industrial Complex** (Complexo Industrial Portuário do Suape)
SUDENE	**Northeast Development Bureau** (Superintendência do Desenvolvimento do Nordeste)
SUS	**Unified Health System** (Sistema Único de Saúde)
TOR	**Terms of Reference**
UE	**Sewerage Unit** (Unidade de Esgotamento)
UC	**Collection Unit** (Unidade de Coleta)

UFPE	**Federal University of Pernambuco** (Universidade Federal de Pernambuco)
UGP	**Project Management Unit** (Unidade de Gerenciamento de Projeto)
UH	**Homogeneous Unit of Density** (Unidade Homogênea de Densidade)
URB-Recife	**Municipal Urban Development Company of Recife** (Empresa de Urbanização da Cidade do Recife)
URB – DIUR	**URB – Department of Urban Integration** (Diretoria de Integração Urbana)
URB – DO – DOS	**URB – Department of Civil Works – Sanitation Works Division** (Diretoria de Obras – Divisão de Obras Sanitárias – URB)
SCF	**Sewage Collection Facilities**
STF	**Sewage Treatment Facilities**
ZDE	**Specific Guideline Zone** (Zona de Diretrizes Específicas)
ZEE	**Ecological-Economic Zoning** (Zoneamento Ecológico-Econômico)
ZEIS	**Special Zone of Social Interest** (Zona Especial de Interesse Social)
ZEPA	**Special Zone of Environmental Protection** (Zona Especial de Proteção Ambiental)
ZEPH	**Special Zone for the Preservation of Historic and Cultural Heritage** (Zona Especial de Preservação do Patrimônio Histórico Cultural)
ZUM	**Zone for Urban Development of the Hills** (Zona de Urbanização de Morros)
ZUP	**Preferential Urban Development Zone** (Zona de Urbanização Preferencial)
ZUP1	**Preferential Urbanization Zone with High Potential for Construction** (Zona de Urbanização Preferencial de Alto Potencial Construtivo)
ZUP2	**Preferential Urbanization Zone with Medium Potential for Construction** (Zona de Urbanização Preferencial de Médio Potencial Construtivo)
ZUR	**Restricted Urban Development Zone** (Zona de Urbanização Restrita)

SUPPORTING REPORT A

SEWERAGE SYSTEM AND FACILITY PLAN

SUPPORTING REPORT A: SEWERAGE SYSTEM AND FACILITY PLAN

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1. GENERAL

This sewerage study has been conducted to prepare a Master Plan and to select Priority Projects for F/S after reviewing the PQA reports (RE-1 through RE-4 and other related reports) and conducting a field investigation. Supplementary data and information for the Study have been compiled in this Supporting Report.

2. STUDY AREA

2.1 Sewerage System

(1) Public sewerage of COMPESA

The existing sewerage system in the RMR is divided into two categories: major sewerage systems (large capacity) located in the central part of the RMR and independent sewerage systems (small scale) scattered in the urban area. Almost all of these systems have been constructed and are managed by the four management offices of COMPESA.

Existing Sewerage System in the RMR

System	Length of Pipe (km)	Number of Pumps		Treatment Capacity (m^3/day)	Served Population
		Total	Broken		
Major System					
Janga	441	50	23	54,919	265,919
Peixinhos	185	51	24	37,250	322,000
Cabanga	135	51	16	104,929	233,036
Southern	141	23	1	25,925	99,313
Total	902	175	10	223,021	920,126
Independent System					105,943
Total					1,026.069

Source – Diagnosis at the Sewerage System Operated by COMPESA in the RMR

According to the demographic census in 1996, 36 % of the households of the RMR are connected to the sewerage facilities of COMPESA. About 21 % of the households are connected to the sewage treatment plants as indicated in the following table.

Service Level of Sewerage in the RMR in 1996

Municipalities	Urban Population (people)	Served Population (people)	Service Rate (Population Bases) (%)
Abreu e Lima	73,113	10,085	13.8
Aracoiaba	10,289	0	0
Cabo	128,360	948	0.7
Camaragibe	113,622	0	0
Igarassu	54,874	1,001	1.8
Ipojuca	31,605	0	0
Itamaraca	11,826	0	0
Itapissuma	16,504	2,651	16.1
Jaboatao	465,708	40,059	8.6
Moreno	32,162	0	0
Olinda	350,999	116,692	33.2
Paulista	234,144	108,880	46.5
Recife	1,355,817	348,747	25.7
S. Lourenco	80,358	10,773	13.4
RMR	2,959,381	639,836	21.6

Source: PQA RE-01

(2) Independent Sewerage System

In the areas, which are not covered by the four major sewerage systems of COMPESA, there are independent sewerage systems (including condominial-type sewerage systems) and individual facilities as well as onsite sanitation facilities.

The independent sewerage systems serve mainly specific areas such as housing estates and condominial areas. Mostly their collection pipes and treatment plants are developed and located in their own plots. At present, the operation and maintenance of them are mostly under COMPESA based on a specific agreement, except for a few systems operated by URB (Urbanization Enterprise of Municipality of Recife) and EMLURB (Maintenance and Cleanliness Enterprise of Municipality).

(3) Provision for Low Income Areas

In poverty areas, only a half of the households in poverty areas are equipped with a simple septic tank. The rest relies on a pit latrine for the disposal of their waste and 2 % of the people do not even have their own toilets.

2.2 Water Consumption

The water supply system in the RMR consists of seven (7) subsystems, namely, Tapacura, Gurjau, Suape, Botafago, Alto Do Seu, Pacos and Caixa Agua. The total volume of water supplied by COMPESA in 1997 was estimated to be 292 million m^3, based on the capacities of purification plants. Due to leakage and other losses, however, the actual volume of water supplied to the consumer is estimated to be around 52 % of the total volume of water supplied.

Monthly water consumption per household in 1997, 1998 and 1999 measured by COMPESA is shown in the table below. In 1998 and 1999 COMPESA could not supply enough water because of the extreme draught.

Actual Monthly Water Consumption

Municipality	Water consumption / household (m^3/month)		
	1997	1998	1999 *
Abureu e Lima	18.7	15.7	11.18
Aracoiaba	26.3	19.9	14.27
Cabo	31.3	23.1	18.35
Camaragibe	28.3	19.9	14.22
Igarassu	26.8	18.9	13.92
Ipojuca	26.0	18.7	13.73
Itamaraca	25.9	18.7	13.78
Ipissuma	25.6	18.7	13.82
Jaboatao	28.5	21.5	15.07
Moreno	27.1	20.8	14.82
Olinda	27.6	21.9	15.89
Paulista	26.2	21.3	15.62
Recife	32.1	26.2	16.80
Sao Lourenco da Mata	31.9	25.9	16.59

* Average of January to September for 1999 values

2.3 Present O&M Organization of COMPESA

Present organization, main function and staff numbers are summarized and shown in Table A. 2-1 (1/7)~(7/7).

2.4 Machinery and Material Owned by COMPESA (GME)

The O&M equipment and machinery owned by the GME are at a minimum level for O&M works and are only capable of cleaning and simple repair work, but not adequate for overhauling of large electrical and mechanical equipment on their own. Some of these machines for O&M require repairing themselves.

Table A.2-2 shows a list of major O&M equipment owned by GME.

2.5 Ongoing Projects

As of May 2000, some sewerage projects for Recife and Moreno are under preparation by COMPESA. They are still under study, but some of them are at the tender preparation stage.

TableA.2-3 shows the outline of projects and their costs.

3. MASTER PLAN

3.1 Planning Conditions

(1) Target area

This master plan aims to improve the pollution of water bodies in order to restore the urban environment of the RMR. This is realized by improving the sewerage system and reducing the pollution loads from the urban area. The target area for the Master Plan of sewerage management for the RMR is the urban area proposed for the target year of 2020.

The urban area proposed in the PQA is applied for the Master Plan after reviewing the Metropolitan Development Plan (PDM) of 1983 and the land use plan of the municipality of Recife. During the study of PQA in 1997, land use plan was under preparation in the municipalities of Olinda and Cabo. Other cities do not have land use plan. The urban area is 316.61 km^2 and 364.25 km^2 for 1997 and 2020 respectively.

(2) Future population

Population in 1997 and 2020 projected is applied in the Master Plan. Present and future urban areas and population by municipality are shown in the following table.

(3) Unit volume of wastewater

1) Domestic wastewater

Calculation of per capita consumption in the PQA Per capita water consumption was estimated based on the water meter records from January to July 1997. For this period, measurement was carried out each month to aquifer more accurate record of water consumption and the average monthly consumption was estimated on the basis of the data acquired. It was calculated separately for Municipalities, ELOs, and consumption types (domestic, commercial, industrial and public use).

The population data, expressed in population density (person/household), used for the calculation of this average monthly consumption was derived from the national census of 1991.

During the course of the PQA study, it was found that there are considerable differences in water consumption even within a same municipality; it ranges between 14 to 22m^3 in Recife and Jaboatao, 13 to 27m^3 for Paulista, 16 and 21m^3 in Olinda. For the other municipalities, on the other hand, the difference is not as remarkable as in the above municipalities. These

differences were considered to reflect the social and economic inequality among the households.

The PQA used the following five systems as good models for projection of future water consumption because they were considered to be least affected by the recent water rationing and to represent the water consumption with no rationing: Itamaraca, Itapisma, Arasoiba, Paua, Marero and Nova Cruz. .

In addition to these analyses, plans and study reports from other municipalities were taken into consideration to produce the future unit water consumption values. The following is an example of such a study in the state of Sao Paulo.

In a study carried out in the city of Santos in 1995, three categories for water consumption were proposed and households were put under any of the three categories according to their average monthly water consumption. They are cities whose principal economic activity is tourism, cities whose principal economic activities are tourism and others, and cities depending on the other types of economic activities.

In this study, there is no such classification as commercial, industrial and public use. Consumers are all classified into ordinary domestic use and major consumers were neglected. In another study on the water supply system of the Metropolitan area of Sao Paulo, the future water consumption for 2015 was proposed to be raised up to $25m^3$ for Sao Paulo and to $22m^3$ for the other cities.

In the RMR, future water consumption for 2020 was set at 18, 20, and $26m^3$/month for the three categories that were determined considering the income level of the people in each area of the RMR and based on the water consumption data by ELO of COMPESA. The problem of water rationing (regular suspension of supply) is widespread in many ELOs of the RMR at present and the situation is expected to improve in future. With this categorization it is considered possible to cover the future increase in consumption brought about by the termination of recent rationing of water. This categorization was applied even to the areas with no adequate data.

The design water consumption is based on the actual measurement data. If water meters are installed in the areas of ZEIS and illegal occupation which have a large share of population in the RMR, this is expected to deter the reckless water use by the population, resulting in decrease in consumption. In the PQA it is suggested that the planning and determination of unit water consumption should consider this future decrease in consumption in these areas.

PROSANEAR recommends an average monthly water consumption of $15m^3$ (100liter/capita/day) for people in poverty areas, based on the idea that meals and sanitary facilities are the major items in terms of water consumption. For the other consumers, the unit water consumption was calculated by assuming the average number of family members in a household being 4.3.

Table A.3-1 to Table A.3-4 summarizes the water supply records discussed in the PQA.

In this way the PQA proposed the future unit water consumption values which reflect actual current consumption pattern and also can accommodate future changes in consumption. The figures are considered reasonable especially because it takes into account possible inflow of poor population into the RMR in future. Thus, the same figures are adopted for unit water consumption in the Master Plan.

The PQA proposed the unit water consumption for four (4) categories (ELO districts) depending on their socio-economic activities, which will affect wastewater volume. Unit volume of wastewater for each category is obtained by multiplying water consumption by an empirical coefficient of 0.8. Proposed water consumption and wastewater volume are shown below. Corresponding population to give the total wastewater volume will multiply these figures.

Proposed Water Consumption and Wastewater Discharge

ELO District (LINK) (Management District of COMPESA)	Wastewater Discharge (liter/capita)			Daily Water Consumption (liter/capita)
	Daily average	Daily maximum	Hourly maximum	
Cabanga, Alto do Céu, Aurora, Dois Irmãos, Prazeres, Pau Amarelo e Olinda	160	190	285	200
Jangadinha, Ipojuca, Nossa Senhora do Ó, Camela, Ponte dos Carvalhos, Pontezinha, Cabo, Abreu e Lima, Igarassú, Cruz de Rebouças, Nova Cruz, Itamaracá, Paulista, Peixinhos e São Lourenço da Mata	125	150	225	155
Ibura, Jenipapo, Jordão, Jaboatão, Moreno, Bonança, Vera Cruz, Caetés, Itapissuma e Camaragibe, Navarro, Paratibe, Jardim Paulista, Maranguape II, Araçoiaba, Cidade Tabajara, Nossa Senhora da Luz	110	130	195	140
ZEIS and Informal Areas	80	100	150	100

2) Major consumers

The PQA defined major consumers as ones (as a unit of water consumption) who used more than $500m^3$/month of water. These consumers, such as large apartment buildings, small

domestic plants, hotels and restaurants, are located in Recife, Olinda and Abreu e Lima and their wastewater is incorporated into domestic wastewater.
These consumers and their daily water consumption are shown below.

Major Consumers and Daily Water Consumption

Municipality	Number of Consumers	Daily Consumption (m^3/day)
Recife	62	5,189
Olinda	4	142
Abreu e Lima	1	35
Total	67	5,366

Wastewater volume for the major consumers is obtained by multiplying water consumption by an empirical coefficient of 0.8. The proposed total wastewater volume is 4,293 m^3/day (daily average). Details of water consumption by major consumers are listed in Table A.3-5.

Large-scale wastewater (discharge of more than 500 m^3/month) discharged from those major consumers has similar nature to domestic wastewater in terms of hourly discharge variation in volume.

Therefore, the design wastewater discharge is proposed to be calculated as follows:

Daily maximum: Daily average discharge x 1.2

Hourly maximum : Daily maximum discharge x 1.5

The total design wastewater volume will be estimated by summing up the result from (i) and (ii) and also taking into account the ground water infiltration as well.

(4) Wastewater Discharge

Municipality	Area (ha)	Population (person)	Wastewater Discharge (m^3/ day)		
			Daily Average	Daily Maximum	Hourly Maximum
Abure e Lima	1,184	80,596	14,782	16,657	22,428
Aracoiaba	118	14,986	2,158	2,458	3,432
Cabo	1,575	186,685	30,140	34,807	48,808
Camaragibe	2,912	162,809	29,525	32,905	43,068
Igarassu	1,761	104,077	20,497	23,059	30,785
Ipojuca	1,101	55,366	11,606	12,966	17,071
Itamaraca	1,256	24,595	8,500	9,115	10,960
Itapissuma	248	26,040	3,936	4,457	6,149
Jaboatao	5,471	616,627	95,754	110,391	153,769
Moreno	433	33,717	5,579	6,254	8,445
Olinda	2,648	377,804	60,136	69,849	99,054
Paulista	3,832	337,216	62,306	70,850	97,998
Recife	11,761	1,506,301	233,737	271,544	382,069
Sao Lourenco da Mata	2,125	107,141	22,487	25,139	33,118
RMR	36,425	3,633,960	601,142	690,450	957,154

(5) Pollution Load

1) Unit pollution load

As proposed in the PQA, unit BOD load for domestic wastewater of 54 g/capita/day, based on the Brazilian Standard, is used for the Master Plan. The SS load of 60 g/capita/day is added in the planning of wastewater treatment, though it was not included in the PQA.

2) Pollution load

Based on the above unit pollution load of BOD and SS, total pollution load of BOD and SS in the RMR in 2020 is estimated at 197.1ton/day and 219.0ton/day respectively (refer to Main Report Table 3.3-3).

Municipality	Area (ha)	Population (person)	Pollution Load (kg/ day)		Wastewater Quality (mg/l)	
			BOD	SS	BOD	SS
Abure e Lima	1,184	80,596	4,364	4,849	295	328
Aracoiaba	118	14,986	809	899	375	417
Cabo	1,575	186,685	10,081	11,201	334	372
Camaragibe	2,912	162,809	8,792	9,769	298	331
Igarassu	1,761	104,077	5,620	6,245	274	305
Ipojuca	1,101	55,366	2,990	3,322	258	286
Itamaraca	1,256	24,595	1,328	1,476	156	174
Itapissuma	248	26,040	1,406	1,562	357	397
Jaboatao	5,471	616,627	33,298	36,998	348	386
Moreno	433	33,717	1,821	2,023	326	363
Olinda	2,648	377,804	20,444	22,716	340	378
Paulista	3,832	337,216	18,210	20,233	292	325
Recife	11,761	1,506,301	82,159	91,288	352	391
Sao Lourenco da Mata	2,125	107,141	5,786	6,428	257	286
RMR	36,425	3,633,960	197,108	219,009	328	364

Note: the Population density estimates Population of each municipality in 2020

(6) Microorganism Removal by Treatment Methods

The Microorganism Removal by Various Sewage Treatment Methods is shown in Table A.3-6.

3.2 Sludge Disposal

(1) Sludge

The total amount of sludge generated in 55 treatment systems for the Master Plan is expected to be 256.7 ton/day (when wet, equivalent to around 100milion tons/year) for the year 2020. This amount is enough to cover 20,000 ha of farmland of maze and beans when 50ton/ha is used, according to the study of CAESA (the counterpart of COMPESA in the state of). If the sludge is disposed of in the ground, it requires an area specially allocated for that purpose. Although there is one controlled solid waste disposal site in the RMR (The Muribeca disposal site located in Jaboatao and owned by the city of Recife), it is not designed to accommodate sludge from sewage treatment plants. Therefore the present facility plan should be revised to accommodate the sludge. Four new disposal sites are being planned and studied by FIDEM and the UFPE. Of the four, Mirueira and Aguazinha are planned as controlled disposal site and suitable to accommodate sludge from sewage treatment. In order to accommodate

sludge in these disposal sites, their planned volume and effluent treatment facilities should be reviewed and revised if necessary and appropriate measures should be planned to prevent the contamination of soil due to the leaching out of liquid from the sludge. The planning of sludge disposal requires confirmation of state policy on this matter.

Table A.3-7, Table A.3-8 shows the Sludge Generation Projection by Municipalities and the list of agricultural land in the RMR. Fig. A.3-1 shows the planned disposal destinations of sludge generated in the seven treatment stations.

(2) Septic Tank Sludge

The sludge from septic tanks in the RMR is collected by private companies and taken to Janga treatment station where the sludge is dumped. The Janga treatment plant, even after the expansion proposed in the Master Plan, will not be able to accommodate all the sludge from septic tanks in the other parts of the RMR. Therefore more treatment plants designed to treat the sludge should be constructed or the sludge should be at least disposed of in the treatment plants in each sewerage system.

It is technically possible to treat septic tank-sludge in sewage treatment plants. In this case it is recommended that a septic tank sludge intake facility be installed to facilitate the input of sludge into the plant. It is also necessary for the authority to carry out appropriate education of people for the purpose of abolishing the use of septic tanks to have them connected to the public sewerage system.

The cost for the disposal of septic tank sludge is R$6 for a dump truck-full of sludge (6 – 10m3) at present. The monthly disposal amount in Janga treatment plant is usually from 200 to 400 truck-full.

3.3 Comparison of PQA and Proposed Master Plan

Planning Item	PQA	Proposed Master Plan
1. Target year	2020	2020: Same as PQA
2. Sewerage service area	36,321 ha	36,425 ha: Revised after checking
3. Population served	3,635,040	3,635,040: Same as PQA
4. Unit sewage volume	100 – 200 l/day	100 – 200 l/day: Same as PQA
5. Unit pollution load BOD SS	 54 g/person/day Not planned	 54 g/person/day: Same as PQA 60 g/person/day: Added
6. Industrial wastewater	To be regulated by CPRH	To be regulated by CPRH: Same as PQA
7. No. of subsystems for whole urban area	87 subsystems	86 subsystems: Revised after checking
8. Plan for 2020 1) No. of subsystems 2) Population served	 57 subsystems 2.88 million (80 % of whole urban)	 55 subsystems: Excluded the low density areas 3.29 million: 90 % of whole urban)
9. Secondary treatment	Not clearly proposed	Proposed in Phase 1
10. Disinfecting	Proposed in Phase 2	Proposed in Phase 2:
11. Phase 1 projects 1) No. of subsystems 2) Population served	 41 subsystems 2.05 million (71 % of whole urban)	 25 subsystems: 2.75 million: 83 % of whole urban)
12. Phase 2 projects 1) No. of subsystems 2) Population served	 16 subsystems 1.25 million	 30 subsystems: 0.55 million:

4. FEASIBILITY STUDY

4.1 Sewerage Improvement Plan

(1) Proposed Unit Wastewater Flow

Unit wastewater generation for 2020 was calculated by district (ELO) in consideration of their commercial activities and living standards of the people. The results are classified into four categories and shown below.

ELO District (LINK) (Management District of COMPESA)	Wastewater Flow (liter/capita)		
	Daily average	Daily maximum	Hourly maximum
Cabanga, Alto do Céu, Aurora, Dois Irmãos, Prazeres, Pau Amarelo e Olinda	160	190	285
Jangadinha, Ipojuca, Nossa Senhora do Ó, Camela, Ponte dos Carvalhos, Pontezinha, Cabo, Abreu e Lima, Igarassú, Cruz de Rebouças, Nova Cruz, Itamaracá, Paulista, Peixinhos e São Lourenço da Mata	125	150	225
Ibura, Jenipapo, Jordão, Jaboatão, Moreno, Bonança, Vera Cruz, Caetés, Itapissuma e Camaragibe, Navarro, Paratibe, Jardim Paulista, Maranguape II, Araçoiaba, Cidade Tabajara, Nossa Senhora da Luz	110	130	195
ZEIS and Informal Areas	80	100	150

(2) Basic Plan

1) Conceiçao System

(a) Project Site

The Conceiçao System is in the Municipality of Paulista, and is defined geographically as follows: northern border - the Timbo river estuary, western border - the Timbo estuary and the Poty cement works, southern border - the Janga system, and eastern border - the Atlantic Ocean. Two state highways cross the system: the PE 1 highway with heavy traffic at

weekends to the eastern boundary, and the PE 22 to the western boundary. The total area of the system is 853 ha.

The land use is mostly residential use with commerce along the PE 1. Most residences are single family dwellings (one or two stories), built as villa residences. Their owners belong to the middle and upper classes and live in other municipalities of the RMR. The other houses are inhabited by the middle to lower classes on a permanent basis. There is a housing estate known as Conceicao/Dona Duda. There is also Veneza Water Park, located between the beaches at Nossa Senhora do O and Conceico, together with marinas for sailing and motor boats, various seaside bars and restaurants. Within the system there is a space available for development of residential areas.

As for the topography, the ground levels vary from 1.0 m to 5.8 m. The areas near the sea and the Timbo river estuary are very flat; the ground levels vary from 1.0 m to 2.0 m.

Regarding sanitary conditions, there are little drainage facilities. Only the Conceicao/Dona Duda housing estate has a SES, including a collector network and a pumping station, which conveys the sewage to the Timbo (Janga) ETE. In the villa residences, owned by the middle or upper classes, the sanitary system used is a septic tank with porous pipes. In the low income areas, the sewage is conveyed to soak away.

In areas where wastewater is difficult to be absorbed by the soil, it is very common to use small soakaways just for toilet wastes. The rest of the wastewater from the household is discharged to drainage ditches or culverts leading to the estuary or the beach. The maintenance of these systems is precarious, even those of the higher income residents.

The area is ideal for tourism, because of the beach and the Timbo river estuary. The water sports are common on the coast there. Restaurants and bars are another strong attraction to the region, as they serve seafood. One example is Sea Paradise which, besides offering good food, takes visitors on boat trips around the mouth of the Timbó River. Various tourist amenities are being constructed in the area of the system, such as the Veneza Water Park located between the beaches at Nossa Senhora do Ó and Conceicao, and also marinas for sailing and motor boats and various bars and restaurants along the coast, at the seaside.

(b) Planning Context

This system includes the UEs 01, 02 and 03 of Paulista defined in the Plan of Sewerage and Stormwater Drainage Management of the RMR and in the PQA – Program of Water Quality of the RMR. This delineation has not been altered.

In terms of the concept of the SES, the sewage produced in the housing estate, which takes the wastewater to be treated at the Timbo ETE, will be diverted to the new ETE of the Conceicao system, for geographic reasons.

(c) Wastewater Flow and Pollution Load

• Served population in 2020	62,440	persons
• Sewerage area in 2020:	853	ha (100%)
1. New construction area	853	ha (100%)
2. 2. Area covered by existing system	0	ha (0.0%)
• Wastewater Flow in 2020:		
1. Daily Average	13,135	m^3/day
- Population	9,450	m^3/day
- Major Consumers	0	m^3/day
- Design Infiltration	3,685	m^3/day
2. Daily Max	14,900	m^3/day
3. Hourly Max	20,508	m^3/day
• Pollution Load in 2020		
1. BOD	3,372	kg/day
2. SS	3,747	kg/day

The Computation table for Wastewater Flow in Conceicao System is shown in Table A.4-1.

(d) Main Facility Layout

The Layout Plan of the Janga System is shown in Fig 4.2-2.

- Trunk sewers

The main collectors are planned along PE 1 and PE 22. The diameters of the sewer are ranged from 200mm to 700mm. The gravity and pressure flow sewers in Conceicao System are planned and shown in Table A.4-10 and Table A.4-11. The longitudinal profile of proposed sewer is shown in the Data Book.

- Pumping station

Besides the existing pumping station, which serves the Conceicao/Dona Duda housing estate, 4 pumping stations are proposed. There are 3 stations to the left of the PE 22 going from south to north, two of which are near the Timbo river estuary; one in the road parallel to the PE 22 and the other one is in a road perpendicular to it, before the two PEs meet, and the third

is at the side of the PE 22, belongs to the UE 03. The last one is in Afonso Pena Street, near the mouth of the River Timbo (UE 01).

- Sewage Treatment Facilities and Receiving Body

The topography of the sewage treatment facilities is flat low-lying area. The site is owned by a cement company (CIMENTO POTY). The site has an adequate land space for the proposed sewage treatment facilities. The treated water is planned to be discharged into the Timbo River.

2) Janga System

(a) Project Site

The Janga System partly covers two municipalities of Olinda and Paulista. Its boundary is as follows: to the north – Conceicao System, to the south – Peixinhos Systems, to the east – Atlantic Ocean, and to the west – the Paulista System. The Janga System covers totally or partly the neighborhoods of Bairro Novo, Ouro Preto, Jatobá, Fragoso, Casa Caiada, Jardim Atlântico, Rio Doce, and the neighborhood of Cidade Tabajara in Olinda. In Paulista, it covers the districts of Janga and Pau Amarelo, both with coastal strips, and the sub-districts of Tururu, Engenho Maranguape, Maranguape II, and I occupied by housing estates. The highway PE 1 crosses the system in Paulista, as well as the highways PE 15 and 22. In Olinda, the Matadouro Canal, the Fragoso and Doce rivers also cross the system. The total area of the Janga System is 3,954 ha.

Residential occupation prevails, especially in the Rio Doce district where the former COHAB (Pernambuco State Housing Company) has constructed several housing estates for low and middle class populations. In the districts of Casa Caiada and Janga there has been a tendency for the construction of tall apartment buildings, mainly for the middle class population. However, due to the erosion of the coastline, the real estates companies are leaving aside this area. The neighborhoods of Engenho Maranguape and Maranguape I and II, in Paulista, are also occupied by housing estates. The expansion area in Olinda is located between the highway PE 15, Maranguape I and COHAB Rio Doce (housing estate). In Paulista, the expansion will take place mainly vertically with the construction of apartment buildings in the districts of Janga and Pau Amarelo.

As for topography, the areas closer to the coastline are flat (districts of Bairro Novo, Casa Caiada, Janga and Pau Amarelo) while in the other areas the declivity favors the run-off of water. The levels vary from 1m to 55m. The Matadouro Canal as well as the Fragoso and

Doce rivers have their margins almost completely occupied by destitute families, and due to the flat topography the drainage problems are persistent.

As for sanitary conditions, although the region has sewerage system infrastructure such as collectors, trunk sewers and pump stations as well as a treatment plant, sanitary conditions are precarious because few residences are connected to the system. As a result, the beaches are polluted since the drainage water that also contains sewage flows into the sea. Olinda is the municipality that includes most of this existing sewerage system, while in Paulista only the Maranguape areas and two housing estates located in Janga have a sewerage system. The collected sewage is conveyed to the Timbó Treatment Station, or Janga as it is also known. Secondary level treatment is carried out through the utilization of activated sludge followed by the discharge of the effluent into the Timbó River. The collection system is of the conventional type, and trunk sewers can be found at a depth of up to 8m. The neighborhood of Cidade Tabajara does not have a sewerage system. In the apartment buildings and residences not covered by the system, mainly occupied by the middle class population, the treatment system is composed of septic tanks that are usually connected to the storm water drainage system. In those areas occupied by a low-income population, the sewage is conveyed to pits called soakaways. The maintenance of both types of sewage treatment is precarious, even for those used by higher income residents.

The main tourist attraction is the coastline. However, due to the sea pollution caused by the discharge of untreated sewage this attraction is in decadence. In Olinda city, tourism is the main economic activity due to the importance of its historical sites. Also the street Carnival in Olinda is very popular, attracting thousands of people from all over the country.

(b) Planning Context

This system is composed of UE 22 and UE 23 in Olinda, UE 04 to UE 07 and UE 09 in Paulista, defined by the Plan of Sewerage and Stormwater Drainage Management of the RMR and by the PQA – Program of Water Quality of the RMR. According to these documents, UE 06 corresponds to the Mutirao system. However, as a consequence of the COMPESA decision not to reactivate the treatment plant of this system, this UE was integrated into the Janga system. An area located in the municipalities of Olinda and Paulista, more specifically to the right side of highway PE 15, which was not considered by the PQA, was included in this study. Especially the municipality of Olinda, as available for expansion considers this area.

(c) **Wastewater Flow and Pollution Load**

- Served population in 2020 322,450 person
- Sewerage area in 2020: 3,954 ha (100%)
  1. New construction area 2,665 ha (67.4%)
  2. Area covered by existing system 1,289 ha (32.6%)
- Wastewater flow in 2020:
  1. Daily Average 64,464 m^3/day
  2. Daily Max 73,585 m^3/day
  3. Hourly Max 102,382 m^3/day
- Pollution Load in 2020
  1. BOD 17,423 kg/day
  2. SS 19,358 kg/day

The Computation table for Wastewater Flow in Janga System and Schematic Sewerage Flow Diagram in Janga System are shown in Table A.4-2 and Fig.A.4-9.

(d) Main Facility Layout

The Layout Plan of the Janga System is shown in Fig 4.2-3.

- Trunk sewers

In this system, the route of the new collectors is included in UE 22 in Olinda, UR 04 and UE 05 in Paulista, as well as the new area incorporated in the present study. Two collectors are proposed along the Fragoso river. They can be considered as trunk sewers, one on each side of the river, to convey the contribution of Cidade Tabajara, in Olinda, and the contribution of the new area to the existing Rio Doce trunk sewer, which conveys the sewage to EEJ3 in Pedras Altas. The main crossings of this system are as follows: three to cross the PE 15, and two to cross the Fragoso river. Concerning the existing structure, i.e. the trunk sewers, a pre-evaluation of their capacity was carried out, and it will be further detailed in a future phase of the project.

The Computation table for Design of the gravity and Pressure flow sewer in Janga System are shown in Tables A.4-12 to A.4-15.

The Longitudinal Profile of Proposed Sewer to Janga System is compiled in the Data Book.

- Pumping station

Besides the existing 13 pumping stations, which serve parts of Olinda and the municipality of Paulista – two housing estates and the neighborhoods of Mutirão (Engenho Maranguape), Maranguape I and II, another 5 pump stations were proposed in the municipality of Paulista. The existing pump station of Fragoso (EEJ 01) is to receive all the sewage from the UEs in Olinda, Maranguape I (belonging to Paulista), and from the expansion areas of both municipalities. In the present system, the Maranguape I contribution is conveyed from the pump station EEJ 06 to the pump station EEJ 05 in Maranguape II.

- Sewage treatment facilities and receiving body

Some additional facilities are planned to be constructed immediately next to the existing sewage facilities. The site has an area of 6.0 ha and it is owned by COMPESA. The treated water is planned to be discharged into the main stream of the Timbo River, as is the case with the existing plant.

3) Cabanga System

(a) Project Site

The Cabanga System is in Recife. Its boundaries are as follows: to the north – Capibaribe river and Peixinhos System, to the south – Jiquiá and Tejipio rivers and Prazeres System, to the east – the Atlantic Ocean, and to the west – the Cordeiro System, Mangueira and Boa Viagem. The total area of the system is 2,671 ha.

The occupation in this system is very diversified, although there is a predominance of commercial and public use in some neighborhoods (Santo Antonio, Sao José and Bairro do Recife). The Bairro do Recife neighborhood stands out because of its rehabilitation, with the restoration of old buildings to be used as bars, restaurants and office buildings. The neighborhoods of Paissandú and Ilha do Leite are being occupied by hospitals and clinics, and are becoming the largest medical center in the North/Northeast of the country. Residential occupation, mainly tall apartment buildings and single residences, mostly used by the high and middle class population, prevails in some neighborhoods (Espinheiro, Aflitos, Graças, Torre, Madalena and Boa Viagem). A square meter of land in Boa Viagem Avenue is the most expensive in Pernambuco State. The middle-low and low classes populations occupy mainly the neighborhoods of Santo Amaro, Mustardinha, Afogados, Jiquia, Pina, and Brasília Teimosa. There, residential occupation also prevails, although with smaller apartment buildings, housing estates, and single residences. This area also includes several public buildings, hospitals, colleges, and others, some of them of historical and architectural value. Expansion will take place vertically with the construction of buildings.

With respect to topography, the most important feature is that this region covers the reclaimed flatland of Recife, thus it is very flat, presenting serious drainage problems in the neighborhoods of Coelhos, Ilha do Leite, Paissandu and Mustardinha. The levels vary from 2m to 6m. The Capibaribe River as well as the Derby-Tacaruna Canal, the latter bordered by the Agamenon Magalhaes Avenue, cross the system.

As for sanitary conditions, this is the only system that in almost all of its territory has a sewerage system operated by COMPESA. This system was constructed at the beginning of the 20th century, and was designed by the well-known engineer Saturnino de Brito. The system has a primary treatment station, i.e., the treatment is by sedimentation and the sludge is further treated in anaerobic digesters and drying yards. The effluent is discharged into the Pina estuary. In general, collection is of the conventional type, except for some systems constructed by the Recife authorities (ZEIS João de Barros and Mustardinha neighborhood) which are of the condominial type. Retiro and Coque, and some parts of Mustardinha, Coelhos, and Ilha do Leite neighborhoods are not served. In this area, for apartment buildings and residences used by the high and middle class population, sewage treatment is composed of septic tanks followed by porous pipes. For residences of the low-income populations, the sewage is conveyed to pits called soakaways. The maintenance of both types of sewage treatment facilities is precarious, regardless of social class.

Regarding tourism, this activity is concentrated in the neighborhoods of Bairro do Recife and Boa Viagem. As already mentioned, the Bairro do Recife neighborhood has been partially rehabilitated by the Recife Authorities. This project is being extended to the nearby neighborhood of Sao José. In Boa Viagem, the main attraction is the beach. It is almost 100% free from sewage pollution. This occurs because the sewage generated in the neighborhood is discharged into the canals, which in turn flow into the swampy area located in the Pina estuary. It could be an environmental attraction if it were not wasn't for the sewage pollution. The nearby neighborhood of Pina is also becoming a gastronomic and leisure center, promoted by the Recife Authorities. Two massive popular festivals take place in this region: Recifolia, a carnival-like street festival in Boa Viagem avenue, and the traditional Carnival itself in the neighborhoods of Bairro do Recife and Sao Jose.

(b) Planning Context

This system is composed of UEs 44, 45, 46, 85, 87, 88, 89, 94, 95, 96 and 97 in Recife, defined by the Plan of Sewerage and Stormwater Drainage Management of the RMR and by the PQA – Program of Water Quality of the RMR, and by the Sewerage Districts D1, D2, D2A, D3, D4, D5, D6, D6A, D7, D9 and D15, defined by COMPESA. UEs 85 and 87

belonged to the Boa Viagem system. However due to topographic conditions and to the existence of a collection network in UE 87, which conveys the contribution to the collector C-1 of district D15, it was decided to remove them from this system. This facilitated the geographic delimitation between the Boa Viagem and Cabanga systems. Consequently, the downstream section of Setúbal canal, up to Cândido Ferreira Avenue (limit with the Prazeres system), will belong to the Cabanga system. Another alteration was the modification of the UE 96 limit, after discussions with COMPESA. Only the area comprising the locality known as Ponte do Maduro will belong to this UE, while the rest will become part of district D14, which in turn is part of the Peixinhos system.

(c) Wastewater Flow and Pollution Load

•	Served population in 2020	306,690	person
•	Sewerage area in 2020:	2,671	ha (100%)
	1. New construction area	1,176	ha (44.0%)
	2. Area covered by existing system	1,495	ha (56.0%)
•	Wastewater flow in 2020:		
	1. Daily Average	57,381	m^3/day
	2. Daily Max	66,374	m^3/day
	3. Hourly Max	93,791	m^3/day
•	Pollution Load in 2020		
	1. BOD	17,443	kg/day
	2. SS	19,381	kg/day

The Computation table for Wastewater flow in Cabanga System and Schematic Sewerage Flow Diagram in Cabanga System are shown in Table A.4-3.

(d) Main Facility Layout

The Layout Plan of the Cabanga System is shown in Fig 4.2-4.

- Trunk sewers

In this system, new collectors were designed in UEs 44, 45 and 95, i.e., in Mustardinha, Madalena (Retiro), and Coque. The areas served by these UEs do not have heavy traffic, except for Abdias De Carvalho Avenue, the limit between UEs 44 and 45, in which no collector was designed. In UE 95, two crossings will be necessary at the railway in order to convey the sewage from this UE to district D1. The UEs 46, 85, 87, 88, 89, 94, 96 and 97 have a totally or partially existing system. UE 87 is partially served by the collection network implemented within its area. For UEs 88 and 89 there is already a COMPESA collection

network project. As regards the main collectors in the sewerage districts, the pre-evaluation of their capacity was carried out and this will be further detailed in a future phase of the project. The Computation table for Design of the gravity and Pressure flow sewer in Cabanga System are shown in Tables A.4-16 to A.4-18.

The Longitudinal Profile of Proposed Sewer to Cabanga System are planned and compiled in the Data Book.

- Pumping stations

Besides the 20 existing pumping stations (including one on going pump station), which serve the existing districts, another 6 pumping stations were proposed. Their distribution is as follows: two in the Prado neighborhood (UE 44), and the biggest one which is to serve all the UE, to be located near Estrada dos Remédios; One in the Madalena neighborhood (Retiro – UE 45); three in the locality of Coque (UE 95); and one between Coque and the São José neighborhood.

- Sewage Treatment Facilities and Receiving Bodies

Some additional facilities are planned to be constructed adjacent to the existing treatment facilities. The plot for expansion is owned by COMPESA and currently used as a soccer field. The treated sewage is planned to be discharged into the Pina River as the case with the existing plant.

4) Boa Viagem System

(a) Project Site

The Boa Viagem System is in the municipalities of Jaboatao dos Guararapes and Recife. The main boundaries are the Jordao river – to the north, Prazeres System – to the south, Cabanga System – to the east, and the Imbiribeira, Airport and Ibura de Cima Systems to the west. The boundaries with the Prazeres and Cabanga Systems are defined, respectively, by the 4 De Outubro Avenue and the Setubal canal. The western boundary is defined by the highway BR 101/South (Ibura de Cima System) and Mascarenhas de Moraes avenue (Airport and Imbiribeira Systems). Also near the western boundary, there is the RFFSA railway (future surface metro) and the Jordao River. The total area of the system is 1,203 ha.

Occupation is mostly residential, with tall apartment buildings between the Jordão river and the Setúbal canal, in the neighborhood of Boa Viagem, occupied by the middle to upper classes; to the west of the same neighborhood, between the Jordao river and Mascarenhas de Moraes avenue, there are smaller buildings, and single family homes occupied by the middle class. In the neighborhoods of Jordao Alto and Jordao Baixo, there are mostly single family

homes occupied by the lower class and local commerce. There is also a shopping center here – Shopping Center Recife – the largest in Latin America, as well as small shopping arcades, in the neighborhood of Boa Viagem. Also in this neighborhood there are hotels, office buildings near the shopping center, besides motels along General Mac. Artur avenue, a continuation of Antonio Falcao avenue, which is in the Cabanga System. In this system, there are also some Air Force facilities – 2nd COMAR, near the Copacabana and Armindo Moura avenues. Expansion is only possible vertically, in the neighborhood of Boa Viagem.

With respect to topography, this system can be divided into two areas with different characteristics. The one beyond Mascarenhas de Moraes avenue presents, in the western part of the system, levels varying from 10m to 70m, making it a very irregular area. The other area, located before this one, despite levels varying from 1.0 m to 12.0 m, has predominantly a flat topography with levels varying from 1.0 m to 4.0 m. In this area, the presence of a river (Jordao) and a canal (Setubal) favors this flatland condition.

The middle to upper classes occupy the neighborhood of Boa Viagem, and the low class, predominate in other areas. Next to the Shopping Center, there is a low-income settlement, whose area has been defined by the Recife Council – PCR, as a ZEIS – special zone of social interest. Its name is Entre Apulso (Enter Uninvited).

Sanitary conditions are precarious. In apartment buildings and individual dwellings, occupied by the high and middle classes with higher incomes, the treatment system is composed of a septic tank and porous pipes. In low-income areas, sewage produced in individual dwellings is conveyed to pits called soakaways. In areas where absorption of wastewater by the soil is difficult, it is very common to use small soakaways just for toilet wastes. The rest of the wastewater produced is directed to culverts or channels for rainwater drainage, which discharge into the Jordao River and the Setubal canal. The maintenance of these septic tanks is precarious, even those of the higher income population.

As for tourism, there are actually no attractions except for Shopping Center Recife. However, as the system borders on the Prazeres and Cabanga Systems, which include the beaches and other tourist attractions, it can be said that it interferes with tourism in the region as a large area of mangrove marshes between the Pina and Jordao rivers is immediately downstream of the system.

(b) Planning Context

This system is composed of UEs 15 and 17 in Jaboatão, and UEs 68, 78, 79, 80, 81, 82, 83, 84 and 86 in Recife, defined by the Plan of Sewerage and Stormwater Drainage Management of

the RMR and by the PQA – Program of Water Quality of the RMR. Within these studies, UEs 85 and 87 belong to the Boa Viagem system. However, due to topographic characteristics and due to the fact that there is a trunk sewer in UE 87, which conveys the contribution into collector C-1 of district D15, these Ues are transferred to the Cabanga system. Part of UEs 15 and 17, originally belonging to the Boa Viagem system, was incorporated into the Prazeres system.

(c) Wastewater Flow and Pollution Load

•	Served population in 2020	157,010	person
•	Sewerage area in 2020:	1,203	ha (100%)
	1. New construction area	1,203	ha (100%)
	2. Area covered by existing system	0	ha (0%)
•	Wastewater flow in 2020:		
	1. Daily Average	27,087	m^3/day
	2. Daily Max	31,337	m^3/day
	3. Hourly Max	44,408	m^3/day
•	Pollution Load in 2020		
	1. BOD	8,525	kg/day
	2. SS	9,472	kg/day

The Computation table for Wastewater flow in Boa Viagem System is shown in Table A.4-5.

(d) Main Facility Layout

The Layout Plan of the Boa Viagem System is shown in Fig 4.2-5.

- Trunk sewers

For routing the main collectors, busy highways are avoided, such as Barão de Souza Leão Avenue, Ribeiro de Brito and Ernesto de Paula Santos streets, in the neighborhood of Boa Viagem. However, in the streets and avenues that border the Setúbal canal and the Jordão river, for example Visconde de Jequitinhonha street and Almirante Neves street, collectors are necessary in order to receive the contributions that topographically should be send to the margins of these water bodies. The diameters of the collectors are from 150mm to 600mm. These systems have three crossings over the Jordão river, one by way of a pressure pipe and the other two through collectors, three crossings at the railway, and one in Mascarenhas de Moraes avenue, close to Estrada da Batalha, with a diameter of 500mm, to convey the sewage

collected in UEs 15 (Jaboatão) and 68 (Recife) to UE 81. All the contribution collected upstream of the railway will be sent directly to the pumping station before treatment.

The Computation table for Design of the gravity and Pressure flow sewer in Boa Viagem System are shown in Tables A.4-19 and A.4-20. The longitudinal profile of proposed sewer is planned and compiled in the Data Book.

- Pumping stations

Pumping station EEC-20, located in UE 81, is unlikely to be utilized, as well as EEC-19, located in UE 84, which is to be replaced by a new one to be located at a more appropriate level. Consequently, 5 pumping stations are proposed, distributed as follows: one near Guararapes Airport, in the neighborhood of Jordão (UE 68); one in the neighborhood of Setúbal, between the Setúbal canal and Visconde de Jequitinhonha street (UE 84); two in the neighborhood of Boa Viagem (UE 82 and UE 79, this last one before the treatment plant); and one in the neighborhood of Imbiribeira (UE 78), which is located close to the interception of the Jordão river with the Tejipió river.

- Sewage Treatment Facilities and Receiving Bodies

The service area of Boa Viagem spreads over the catchment area of the Jordao River. The planned site for the sewage treatment facilities is located downstream, close to the river mouth. This makes the collection of sewage easy and efficient. Although the site is on privately owned land, the owner agreed that the site might be used for the construction of a sewage treatment facilities. The site has adequate land for large facilities that are easy to be constructed and require a minimal level of maintenance. The treated water is planned to be discharged into the Jordao River.

4) Cordeiro System

(a) Project Site

The Cordeiro System is in Recife. The boundary is as follows: northern –Capibaribe river; southern - Roda de Fogo, Mangueira and Cabanga Systems: eastern - the Cabanga System; and western - Caxangá and Cidade Universitária Systems. The southern and western boundaries, respectively, are defined by a part of Abdias De Carvalho Avenue and by the BR 101/South highway. The eastern boundary is made up of various streets in the neighborhoods of Torre and Madalena. The total area of the System is 1,054 ha.

Occupation is mostly residential with commerce mainly along Caxangá Avenue. Public buildings are in some specific areas. Most residential occupation is of single family dwellings of one or two stories. The population is middle to low class, the latter predominating in the

"Villas". There are some buildings in Cordeiro with middle class occupation and other lower ones forming housing estates. The houses are of simple brick construction, while along some canals and the Capibaribe river itself, there are houses of wattle and daub. This population living on the banks of the canals and the Capibaribe River, mainly near Vila Santa Luzia, is destitute.

Prof. Antonio Coelho Park is within the area and houses the Animal Fair every November, which attracts participants from all over the state and from neighboring states. There are also state government buildings in the park. The Pernambuco Jockey Club, a prison, (Bom Pastor), the SUDENE building and the administration building of the Pernambuco Federal University – UFPE are also located in the area of this system, which borders on the Cabanga system. There is no area for expansion except vertically (construction of buildings) which is already occurring around Caxanga Avenue.

In terms of topography, although the levels vary from 8.00m to 2.00m, there are areas, such as Engenho do Meio, where the levels vary from 7m to 6.5m, meaning this area is very flat. In the neighborhoods of Zumbi and Torre, more precisely between the roads José Osorio, Conselheiro Teodoro and Dom Manoel da Costa there is a low point which makes drainage difficult in this area, resulting in the necessity to raise the sewage produced to integrate it into the proposed system.

With respect to sanitary conditions, there is little wastewater drainage in the area. The existing systems mainly serve the "Villas" and are practically all of the condominial type except that which serves the neighborhood of Engenho do Meio, which does not provide treatment, and Vila Santa Luzia. The most recent, and the only one with its own treatment, was introduced by COMPESA in 1998 to serve Vila Sao João. The sewage from Vila Santa Luzia is collected and directed to a pump station there, which pumps it to the neighborhood of Santana, on the other side of the Capibaribe River, from where it continues to the Peixinhos ETE. According to URB Recife the system in the Skylab area is being restored.

Most of the networks existing in other areas should not be made use of, because of their present state. In isolated buildings and houses, occupied by the middle class, septic tanks are used, followed by porous pipes. In low-income areas, sewage produced in isolated houses is conveyed to soakaways. In areas where absorption of wastewater by the soil is difficult, it is very common to use small soakaways just for toilet wastes. The rest of the wastewater produced in the house is directed to rainwater ditches or culverts leading to the Cavouco, Caiara and Santa Rosa canals and to the River Capibaribe. The maintenance of these

systems is precarious, even when they serve those of a higher income bracket. The banks of the Caiara and Santa Rosa canals need treatment.

As regards tourism, there are no attractions in this system except at the time of the Animal Fair. The PCR has three projects for the region, the Caiara Park, where the ETE of this system will be located, and two road projects, one alongside the Capibaribe river, Beira Rio avenue, continuing from the Cabanga system, and another which cuts through the system, the Third Ring Road, along the General San Martim and Prof. Estevão Francisco da Costa avenues, in the neighborhood of Cordeiro.

(b) Planning Context

This system is made up of the UEs 39, 40, 41, 42, 43 and 54 in Recife, defined by the Plan of Sewerage and Stormwater Drainage Management of the RMR and by the PQA – Program of Water Quality of the RMR. UE 54 belongs to the system Roda do Fogo, but although it has a collection system, its sewage is not treated at present. It is decided to shift the UE 54 from the Roda do Fogo system to the Cordeiro system. Its sewage will be conveyed to UE 42.

To facilitate the geographic delineation of the system, part of UE 53, also belonging to the Roda de Fogo system, is to be covered by the Cordeiro system.

The boundary with the Cabanga system, particularly in the neighborhood of Torre, is to be more clearly defined.

Although the sewage from Vila Santa Luzia is sent to the Peixinhos system, crossing the Capibaribe River, this sewage too, for geographical reasons, is to be treated in the new ETE in the Cordeiro system.

(c) Wastewater Flow and Pollution Load

• Served population in 2020	109,230	person
• Sewerage area in 2020:	1,054	ha (100%)
1. New construction area	946	ha (89.7%)
2. Area covered by existing system	108	ha (10.3%)
• Wastewater Flow in 2020:		
1. Daily Average	19,308	m^3/day
2. Daily Max	22,245	m^3/day
3. Hourly Max	31,091	m^3/days
• Pollution Load in 2020		
1. BOD	5,898	kg/day

2. SS 6,553 kg/day

The Computation table for Wastewater flow in Cordeiro System is shown in Table A.4-6.

(d) Main Facility Layout

The Layout Plan of the Cordeiro System is shown in Fig 4.2-6.

- Trunk sewers

As a basic premise for the layout of the principal collectors, the major traffic routes were avoided, especially Caxangá avenue.

The project includes collectors with diameters varying from 200mm to 500mm along the banks of the Cavouco canal, Mário Alvarez Pereira avenue, Santa Rosa canal, Caiara canal, Zumbi canal and the Capibaribe river, the future Beira Rio avenue, to receive the contributions of sewage from areas which naturally drain towards these banks.

The Computation tables for Design of the gravity and Pressure flow sewer in Cordeiro System are shown in Tables A.4-21 and A.4-22.

The longitudinal profile of proposed sewer to the Cordeiro system is planned and compiled in the Data Book.

- Pumping stations

Besides the two existing pumping stations which serve the neighborhood of Engenho do Meio and Vila Santa Luzia, six more were proposed: one in the neighborhood of Monsenhor Fabrício (UE 40), one in Bomba Grande, on the banks of the Caiara canal (UE 40), two in Cordeiro, one being part of the treatment plant (UE 40) and the other on the banks of the Cavouco canal (UE 42), two in Torre, one of which will be near Vila Santa Luzia, and one in Madalena, on the banks of the Zumbi canal.

- Sewage Treatment Facilities and Receiving Body

The planned construction site for the sewage treatment facilities is located between the Capibaribe River and a planned road. The site is owned by the state of Pernambuco. The area of the site is sufficient even taking into account the park planned next to it. The sewage, after treatment, will be discharged into the Capibaribe River.