PUBLIC WORKS DEPARTMENT
THE GOVERNMENT OF GOA
THE REPUBLIC OF INDIA

No.

STUDY ON AUGMENTATION OF WATER SUPPLY AND SANITATION FOR THE GOA STATE IN THE REPUBLIC OF INDIA

Volume II
Main Report: Master Plan

November 2006

JAPAN INTERNATIONAL COOPERATION AGENCY

NIHON SUIDO CONSULTANTS CO., LTD.
and
NJS CONSULTANTS CO., LTD.

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PREFACE

In response to a request made by the Government of Republic of India, the Government of Japan decided to conduct the Study on Augmentation of Water Supply and Sanitation for the Goa State in the Republic of India and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to India a study team headed by Mr. Takemasa MAMIYA of Nihon Suido Consultants Co., Ltd. between March 2005 and October 2006. The study team was composed of members from Nihon Suido Consultants Co., Ltd. and NJS Consultants Co., Ltd. JICA also established an Advisory Committee headed by Mr. Yoshiki OMURA, Senior Advisor, Institute for International Cooperation JICA, which, from time to time during the course of the study, provided specialist advice on technical aspects of the study.

The team held discussions with the officials concerned of the Government of the Republic of India and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared present report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of India and Government of Goa for their close cooperation extended to the team.

November, 2006

Ariyuki MATSUMOTO
Vice-President
Japan International Cooperation Agency

November, 2006

Mr. Ariyuki MATSUMOTO
Vice-President
Japan International Cooperation Agency

Letter of Transmittal

Dear Sir,

We are pleased to submit to you this Final Report on the Study on Augmentation of Water Supply and Sanitation for the Goa State in the Republic of India. This report incorporates the views and suggestions of the authorities concerned of the Government of Japan, including your Agency. It also includes the comments made on the Draft Final Report by Public Works Department of the Government of Goa and Ministry of Urban Development of the Government of the Republic of India and other government agencies concerned of the Republic of India.

The Final Report comprises a total of six volumes as listed below.

Volume I	: Executive Summary
Volume II	: Main Report: Master Plan
Volume III	: Main Report: Feasibility Study
Volume IV	: Annex for Master Plan
Volume V	: Annex for Feasibility Study
Volume VI	: Drawings

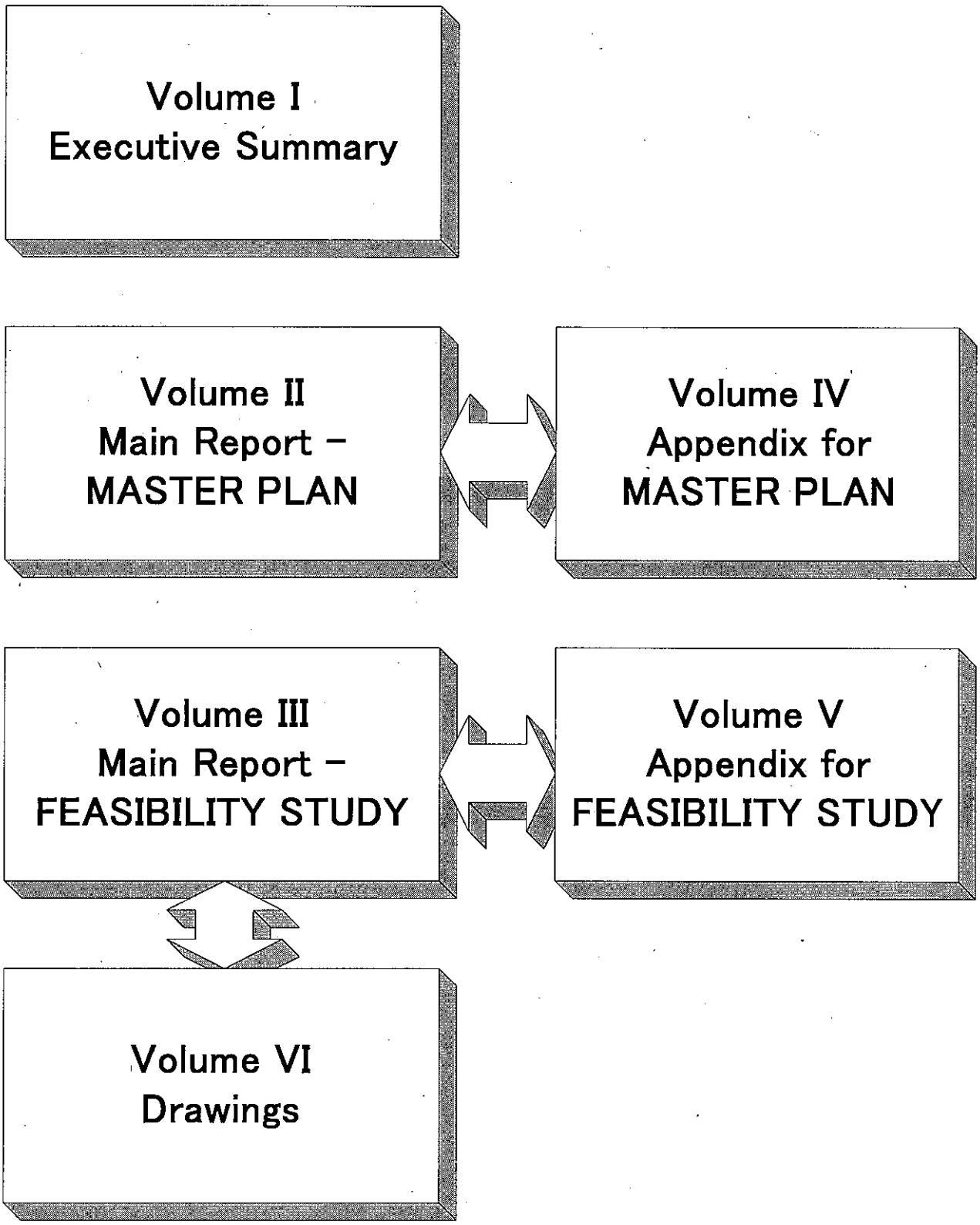
This report contains the Study Team's findings, conclusions and recommendations derived from the three phases of the Study. The main objective of the Phase I was to conducted a reconnaissance survey. That of Phase II was to formulate a long term master plan and to identify priority projects, whilst that of the Phase III was to examine the feasibility of the priority projects which had previously been identified in Master Plan during the course of the Phase II.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Health, Labour and Welfare of the Government of Japan for their valuable advice and suggestions. We would also like to express our deep appreciation to the relevant officers of Public Works Department of the Government of Goa and Ministry of Urban Development of the Government of the Republic of India for their close cooperation and assistance extended to us throughout our Study.

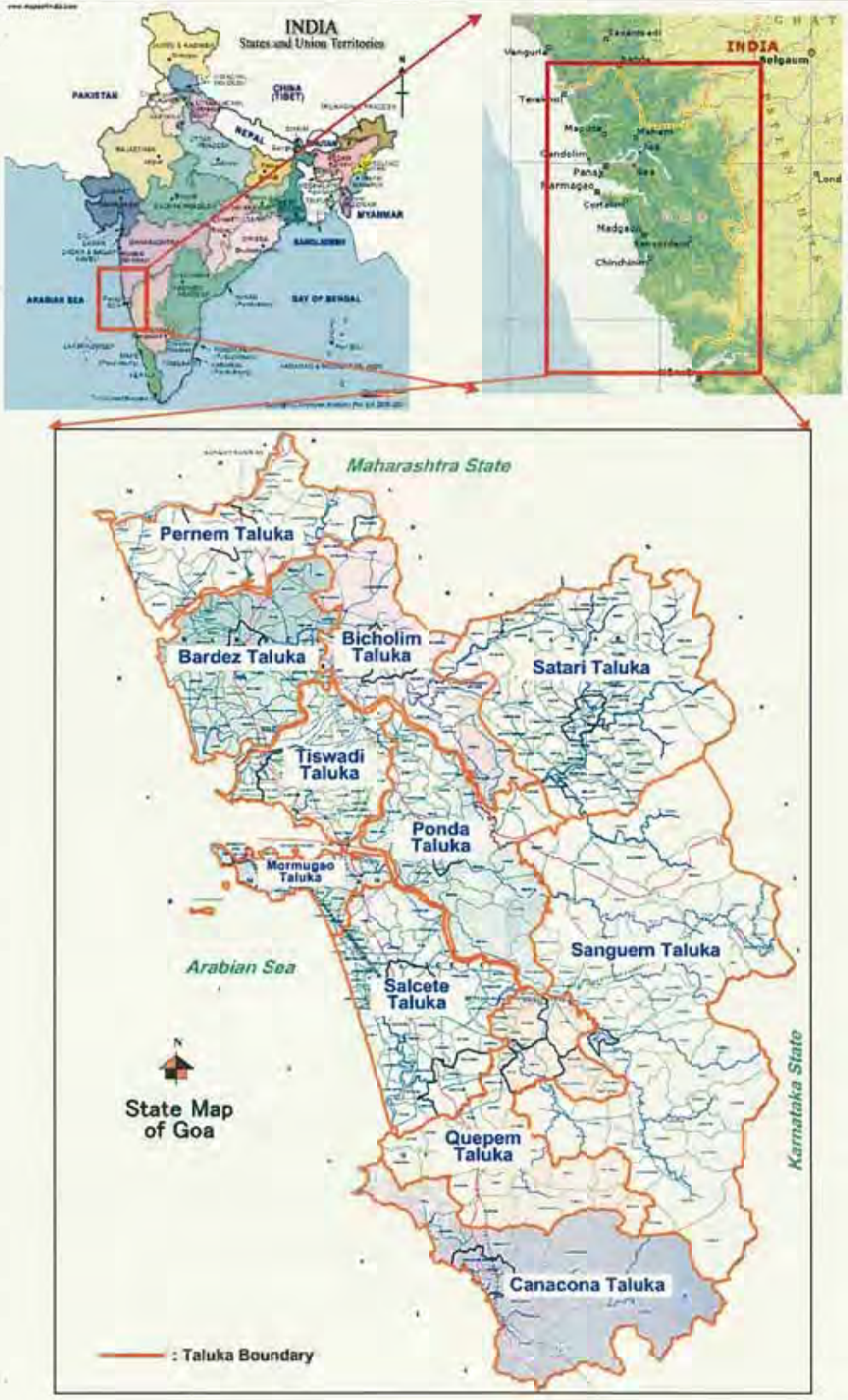
Very truly yours,

Takemasa Mamiya, Team Leader
Study on Augmentation of Water Supply
And Sanitation for Goa State in the
Republic of India

Structure of Report



Location Map



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

PUBLIC WORKS DEPARTMENT,
THE GOVERNMENT OF GOA
THE REPUBLIC OF INDIA

STUDY ON
AUGMENTATION OF WATER SUPPLY AND SANITATION
FOR
THE GOA STATE IN THE REPUBLIC OF INDIA

FINAL REPORT

VOLUME II: MAIN REPORT – MASTER PLAN

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ABBREVIATIONS

ACP	Asbestos Cement Pipe
ADB	Asian Development Bank
ATP	Affordability to Pay
BOD	Biochemical Oxigen Demand
CE	Chief Engineer
CI	Cast Iron
CMMS	Computerised Maintenance Management System
COD	Chemical Oxygen Demand
CPWD	Central Public Works Department
CRZ	Coastal Regulation Zone
CSM	Customer Service Management
D	Diameter
DI	Ductile Cast Iron
DSR	Debt-service Ratio
DST&E	Department of Science, Technology and Environment
EE	Executive Engineer
EIA	Environmental Impact Assessment
FS, F/S	Feasibility Study
GDP	Gross Domestic Product
GI	Galvanised Iron
GIS	Geographical Information System
GLR	Ground Level Reservoir
GOG	Government of Goa
GOI	Government of India
GOJ	Government of Japan
GRDP	Gross Regional Domestic Product
GSDP	Gross State Domestic Product
GVA	Gross Value Added
HDPE	High-density Polyethylene
IEE	Initial Environmental Examination
IS	Information Systems
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
KPI	Key Performance Indicator
lpcd	Per Capita Water Demand (liter per capita day)
M&E	Machinery and Electricity
MBR	Master Balancing Reservoir
MIS	Management Information System
MLD	Million Liter per Day
MNF	Minimum Night Flow
MOF	Ministry of Finance
MOUD	Ministry of Urban Development
MP, M/P	Master Plan

ABBREVIATIONS

MS	Mild Steel
NPV	Net Present Value
NRPP	NRW Reduction Pilot Project
NRW	Non Revenue Water
NTU	Nephelometric Turbidity Unit
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
OHR	Over Head Reservoir
PHE	Public Health Engineering
PSC	Prestressed Concrete
PSP	Public Stand Post
PVC	Polyvinyl Chloride
PWD	Public Works Department
RCC	Regional Control Centre
RL	Reduced Level (Height above specified datum level)
SC	Steering Committee
SCM	Supply Chain Management
SE	Superintending Engineer
SS	Suspended Solids
STP	Sewage Treatment Plant
TOR	Terms of Reference
UFW	Unaccounted-for Water
WSS	Water Supply Scheme
WTP	Water Treatment Plant
WTP	Willingness To Pay

SUMMARY

1 BACKGROUND OF THE STUDY

There is a clear need for additional water supply and sewage system capacity in Goa, especially for cities, industrial estates and tourism resorts in the southern districts. Therefore, during 2002, the Government of India (GOI) requested an assistance of the Government of Japan (GOJ) concerning the augmentation of water supply and sanitation for Goa. The GOJ has agreed to undertake the study. Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation programs for the GOJ, is responsible for the study.

In March 2005, the JICA Study Team was dispatched to India/Goa by JICA and the Study was conducted in three phases as shown below.

1st Phase: Reconnaissance Survey, from March to September 2005
2nd Phase: Preparation of Master Plan, from October 2005 to March 2006
3rd Phase: Feasibility Study, from April 2006 to November 2006

2 OBJECTIVES OF THE STUDY AND STUDY AREA

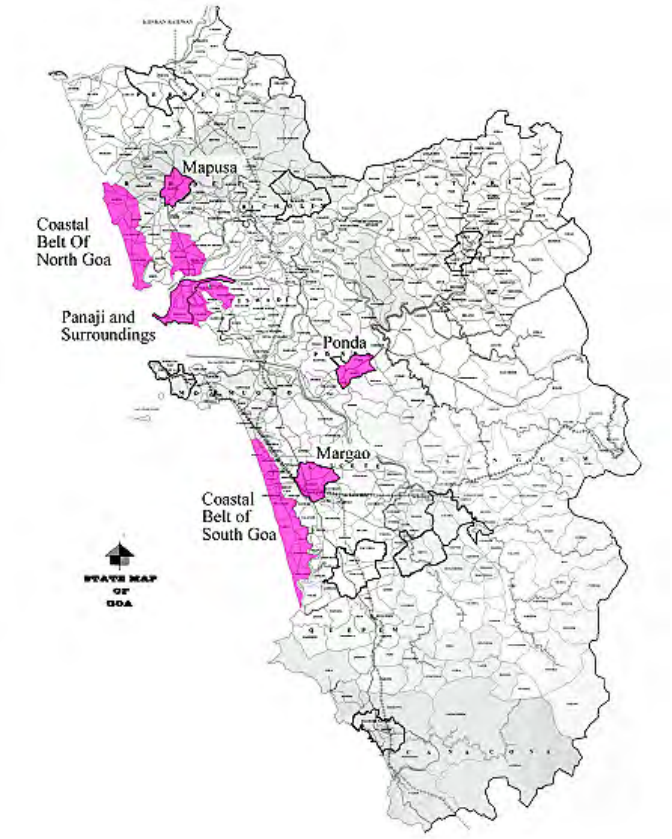
2.1 Objectives of the Study

The objectives of the Study are to:

1) formulate a master plan for augmentation of water supply and sanitation in Goa State. The target year of the master plan is 2025;
2) conduct a feasibility study for priority project(s) which will be selected from the master plan; and
3) pursue technology transfer to the counterpart personnel in the course of the study.

2.2 Study Area

The water supply study area covers all of Goa.



The sanitation study area covers the following areas as shown on Figure 22.1.

- Margao Municipality;
- Ponda Municipality;
- Mapusa Municipality;
- Coastal belt of south Goa;
- Coastal belt of north Goa; and
- Panaji Municipality and its surrounding area (Provorim, Taleigao, Dona Paula, Caranzalem, St. Cruz, Merces, Ribandar).

Figure 22.1 Study Area for Sanitation

3 EXISTING CONDITION OF THE WATER SUPPLY AND SANITATION / SEWERAGE SYSTEMS

3.1 Water Supply System

There are seven existing regional water supply schemes in Goa. These are listed in Table 31.1 and shown on Figure 31.1.

Table 31.1 List of Surface Water Supply Schemes in Goa

Water supply scheme		Water treatment plant		Trans. mains	Reservoirs	Distr. pipelines	Dom. house Connections	Name of Taluka mainly supplied by the scheme
		No. of Plants	Total Capacity	m	nos. & capacity	m	nos.	
1	Salaulim	1	160 MLD	276,586	68 53,000m³	1,424,990	74,930	Mormugao, Salcete, Quepem, Sanguem

Water supply scheme		Water treatment plant		Trans. mains	Reservoirs	Distr. pipelines	Dom. house Connections	Name of Taluka mainly supplied by the scheme
		No. of Plants	Total Capacity	m	nos. & capacity	m	nos.	
2	Opa	4	112 MLD	183,567	35 36,000 m³	704,003	45,118	Ponda, Tiswadi
3	Chandel	1	15 MLD	101,704	33 6,180 m³	328,628	6,346	Pernem
4	Assonora	2	42 MLD	213,940	49 46,225 m³	724,140	43,151	Bardez
5	Sanquelim	3	52 MLD	151,666	29 16,950 m³	159,900	11,643	Bicholim
6	Dabose	1	5 MLD	65,150	23 6,400 m³	183,000	5,886	Satari
7	Canacona	1	5 MLD	60,273	14 3,700 m³	48,085	3,411	Canacona
Total		12	391 MLD	1,052,886	251 168,455 m³	3,573,246	190,485	

Source: Sector Status Study – WSS Goa, 2004, (Data was confirmed to the PWD in 2005-2006)

Goa's 11 talukas are served by 7 regional water supply schemes. Areas that are not served by these 7 schemes are served by rural water supply schemes. The rural water supply schemes mainly source their water from groundwater or springs.

The PWD is currently facing a number of technical problems across Goa's water supply schemes, extending from the water source to service connections. The assessment completed as part of this study identified the following key problems:

(1) Raw Water Quality

Manganese and iron was present in the raw water for almost all the plants in Goa.

(2) Lack of Flow Measurement and Flow Control Systems

The flow rates of intake and transmission are not directly measured using flow meters. Lack of flow measurement means accurate chemical dosage is not possible. Also, the transmission flow rates along the transmission mains are not measured. This means flow control cannot be carried out properly.

(3) Ineffective Coagulation, Sedimentation and Filtration

The sedimentation basins do not remove the majority of turbidity because coagulation and sedimentation might be ineffective. Therefore the turbidity of the water entering the filtration basin is large, which means the filters need to be backwashed more frequently. The field investigation indicated that the backwashing is not sufficient because the duration of the

backwashing process is not long enough or there is a structural problem of the filter basin.

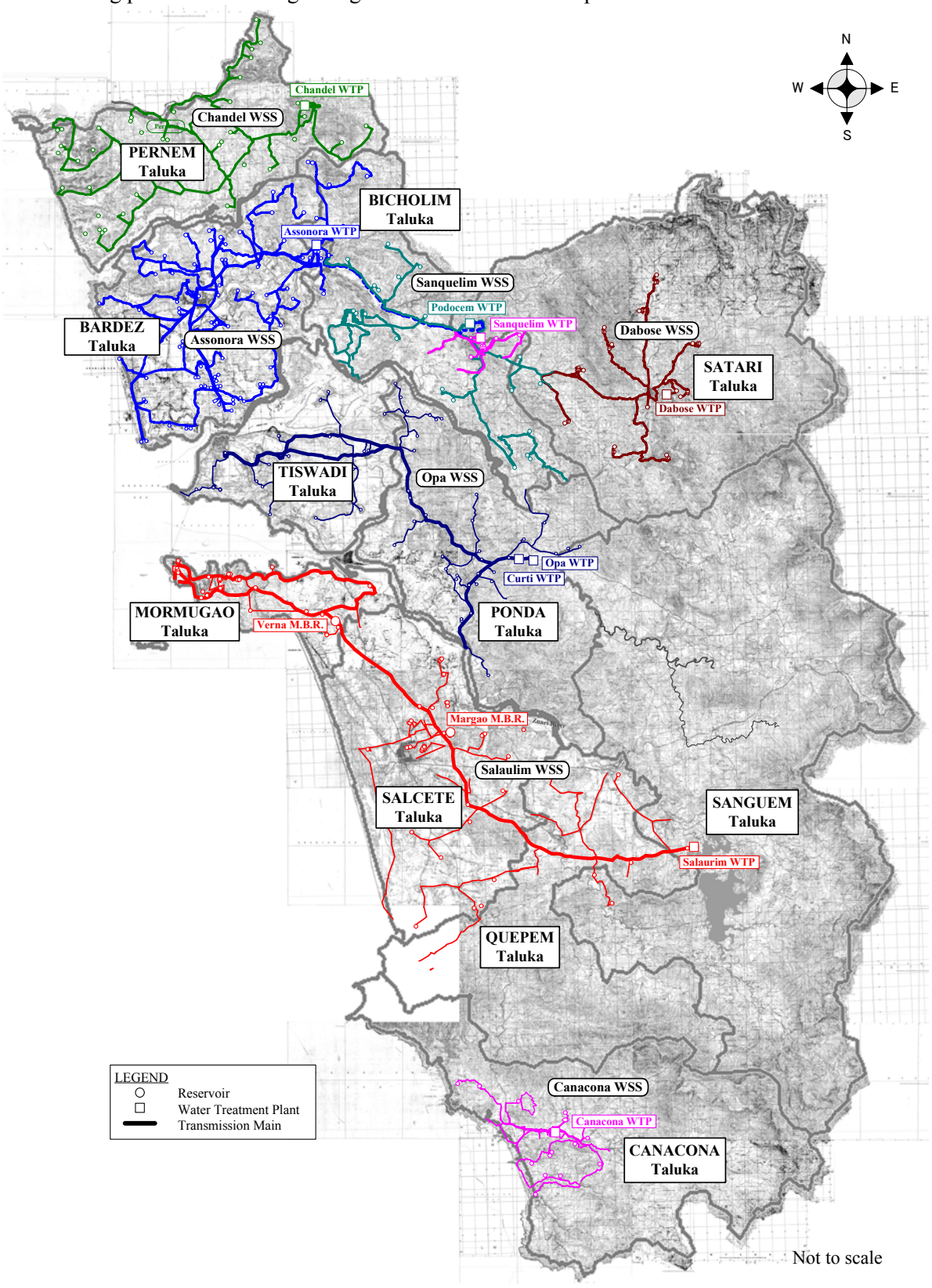


Figure 31.1 Regional Water Supply Schemes in Goa

(4) Safety Provision

Safety related to the chlorination systems at all the WTPs does not exist. For example, there are no facilities for adequately detecting or containing gas leaks, personal breathing apparatus is available in the laboratories at some WTPs but is not used or maintained, and combinations of small bore PVC and flexible plastic hoses are used to connect the cylinders to the chlorinators, instead of copper pipes.

(5) Electric Power Outages

Power failure means the water supply stops and the water supply facilities can be damaged.

(6) Visible leaks along the transmission mains

There are many visible leaks at the air and scour valves located along the transmission mains.

(7) Lack of operation and maintenance manuals and plans

There are no standard operation and maintenance manuals or plans for the treatment plants, transmission systems or distribution systems.

(8) Lack of asset drawings, asset data and process data

The PWD does not have updated drawings of the water supply facilities or maps that cover all the water supply areas. Also, records and data for the operation and maintenance of the schemes are not maintained. Some drawings and data are maintained by individuals, but this is not available for management of the system as a whole.

3.2 Sanitation System

3.2.1 General

According to the Census 2001, 51.8% of the rural population and 30.8% of the urban population had no latrine despite the continuous efforts of the State Government in the last 20 years to increase sanitation coverage as shown in Table 32.1.

Table 32.1 Coverage Ratio by Sanitary Toilet Type

Item	Urban Area (%)			Rural Area (%)		
	Pit latrine	Water Closet latrine	No latrine	Pit latrine	Water Closet latrine	No latrine
Goa State	18.7	38.9	30.8	18.9	20.8	51.8

The present water quality of Mandovi and Zuari rivers ranges 3 - 6 mg/L BOD and North and

South Coastal Area ranges 7 - 9 mg/L BOD. They exceed water quality standard of 3 mg/L BOD. However, pH of every survey results was within the standard. A coliform is not applied in the standard, 1.1×10^5 (MPN/100ml) was detected at the Zuari river in rainy season at large. Some pollutants may be derived from human activities. To improve water quality, countermeasures including sewerage are recommended.

An appropriate sewerage system is essential for improving public health and quality of life in urban areas and for attracting tourism development. Most of Goa does not have sewerage system. According to the Census in India, only 13 % of Goa's urban population is served by sewerage system, much lower than the all India average of 28%. In the principal municipalities in Goa, Panaji, Vasco and Margao have sewerage system.

3.2.2 Panaji Sewerage System

The sewage network and treatment plant for Panaji was installed in 1960's, this being the first sewerage project in the State of Goa. The old STP was designed to cater for a population of 30,000 with a capacity of 5.68 MLD. The old STP was constructed about 40 years ago and its facility which was adopted the trickling filter treatment process is not operated now because of its deteriorated condition. With the above conditions, PWD started the sewerage expansion project to increase treatment capacity and to improve the water quality in 2001.

(1) Sewer Network

The sewerage service area of Panaji City is divided into 12 sewerage zones and the total service area is 434.9 ha. Population of the service area is estimated to be 58,785 in year 2001. The general description of sewers and general sewerage plan are shown in Table 32.2 and Figure 32.1.

Table 32.2 Sewers of Panaji Sewerage System

Item	Main sewers	Sub main sewers	Branch sewers	Total
Diameter (mm)	150 – 700	150 - 350	150 - 300	-
Length (m)	4,110	7,700	27,270	39,080

(2) Pumping Station

There are eight pumping stations in Panaji City as shown in Figure 32.1. Submersible pumps are installed in only one pumping station, dry well pumps are installed for the other stations.

(3) Sewage Treatment Plant

Instead of old trickling filter facility, new treatment facility with capacity of 12,500 m^3/day started operating in April 2005. The treatment process used is SBR (Sequencing batch reactor)

method.

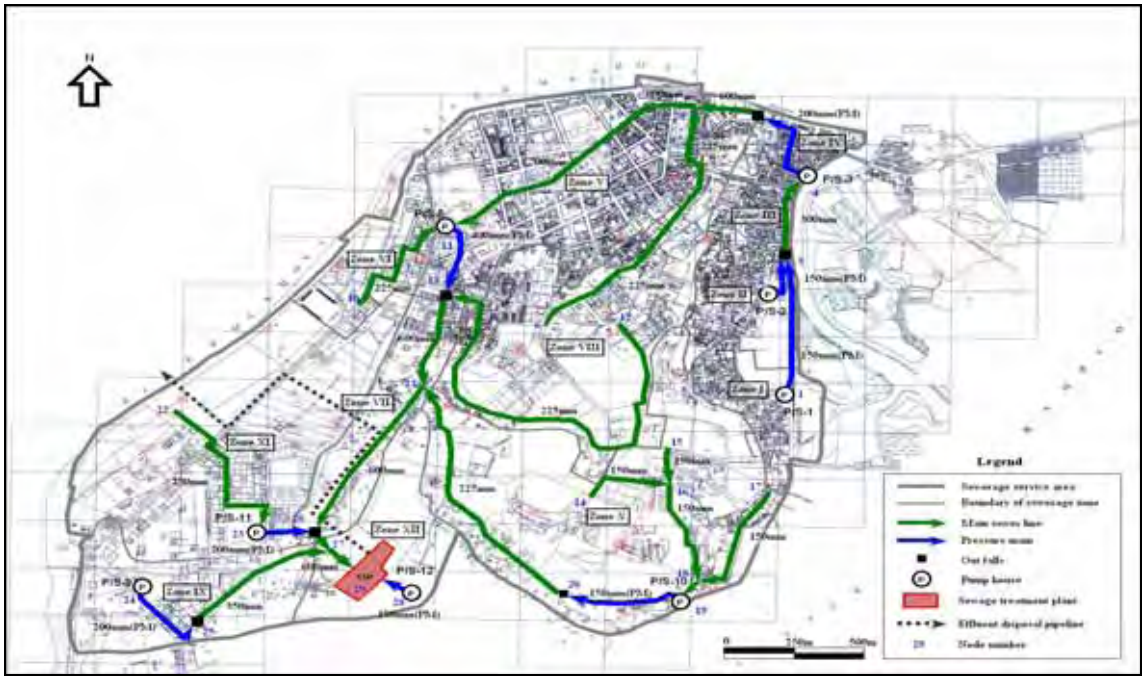


Figure 32.1 General Plan of Panaji Sewerage System

3.2.3 Margao Sewerage System

(1) Sewer Network

For the sewerage system, the municipality has been divided into three zones, namely North, Central and South as shown in Figure 32.2. The North and Central zones of the municipality have sewerage system. Main sewer namely North Main was installed in 1990's. Sub main sewers namely Central North Sub Main and Central South Sub Main and branch sewers in North Zone and Central Zone have been laid from 1990's to date. Some branch sewers in North and Central Zones are still under construction. The general description of sewers and general sewerage plan are shown in Table 32.3 and Figure 32.2.

Table 32.3 Sewers of Margao Sewerage System

Zone	Area (ha)	Diameter (mm)	Branch Sewer length (m)	Main and sub main length (m)	Total (m)	Sewer density (m/ha)
North Zone	259	150-1200	13,410	5,430	18,840	73
Central Zone	307		20,140	5,580	25,720	84
South Zone	-		-	-	-	
Total	566		33,550	11,010	44,560	79

Source: Under Ground Scheme to Margao Town

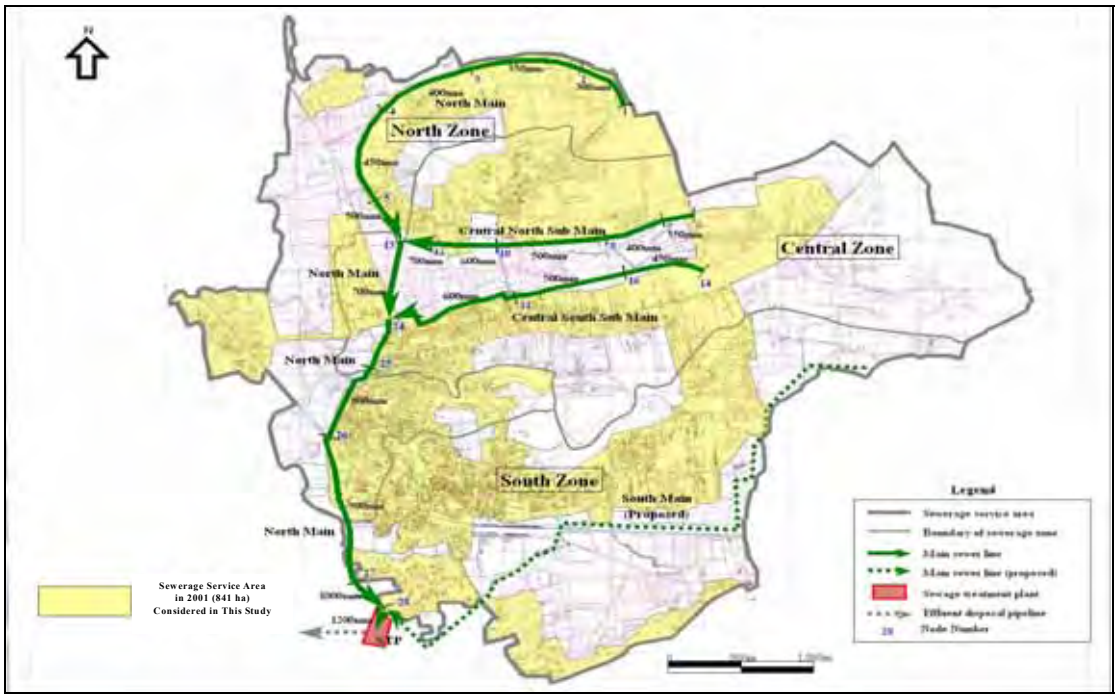


Figure 32.2 General Plan of Margao Sewerage System

(2) Sewage Treatment Plant

The Margao sewage treatment plant is located in the south west of the municipality and sewage treatment plant of 7.5 MLD capacity has been commissioned in May 2000 to cater for North and Central zones.

3.2.4 On-site Treatment System

In order to improve the hygienic conditions and to provide sanitation facilities, total 72,165 single seat low cost pour latrines have been constructed by the "Sulabh International Social Service Organization" since 1985. During the reconnaissance survey, on-site treatment facilities in hotel, factory and college school are inspected. These surveyed on-site treatment facilities are properly operated and treated effluents from treatment facility are used for gardening on the premises.

3.2.5 Summary of Existing Problems Identified

The following problems about the present sanitary conditions are identified during the reconnaissance survey.

- Low service coverage of sanitary toilets
- Lack of asset drawings, calculation sheets, data and records in the PWD
- Weak crude sewage (low pollution load) in the Margao STP
- Lack of implementation plan and equipment for sewer cleaning

- Frequent electrical power outages in the pumping stations and STPs
- Lack of flow measurement device in the pumping station
- Lack of screenings and scum removal in the pumping station
- Deterioration of pump equipment
- Lack of disinfection process in the Margao STP

3.3 Operation and Maintenance

Based on the review of current operation and maintenance practices it is evident that PHE faces a number of significant challenges in the delivery of its functions. These include severe funding problems, organisational issues and administrative/management constraints placed on them. The Study Team believes that PHE on the whole have shown considerable dedication and resourcefulness in working within this underlying framework of constraints, however, much could still be achieved to improve operational and commercial performance through increased focus on institutional strengthening and capacity building elements.

PHE's business and operational practices which have remained unchanged for many years espouse an organisation that provides essential services for the enhancement of public heath rather than a commercial entity seeking to make a return on investment. As such, the use of tariff or pricing mechanisms to regulate water usage is not actively or readily applied (PHE need to get GOG approval for price adjustments in any case) as the cost of services is highly politicised. For example, public taps (stand posts) are installed by PHE but all the water consumed is not charged. This contributes substantially to NRW (approximately 13% of water into supply) as well as O&M expenditure without financial return.

PHE currently use the Indian Standard ISI 91(revised 1991) adopted by the Bureau of India Standards and is based on acceptable world standards for drinking water quality. However, due to the lack of computerised management and laboratory information systems it is difficult to determine the extent to which PHE comply with the relevant standards in force throughout the various stages of the water production/supply/customer process.

Currently PHE is effectively 'self-regulating' for purposes of meeting water quality standards as a result of insufficient independent control measures. Whilst the GOG Public Health laboratory does take periodic water and wastewater samples and send the analyses to PHE, it is understood that the State Health Department do not impose or 'police' the required standards.

PHE does not have a strategy in place for the recruitment of trainees, graduates, or staff with new skills to satisfy future organisational needs. This will limit PHE's ability to embrace new technologies in future not only related to O&M activities.

The management approach and hence the policies, systems and procedures have been geared to the hierarchical structure. This has created many layers of management and supervision, whereby even minor decisions or sanction are often referred to the highest level in the organisation. As a result, O&M staff are often faced with having to find ways to 'workaround' operational and maintenance problems.

The current set-up does not encourage communication and as a result the sharing of ideas and learning is limited. This is having a detrimental impact on O&M performance as little is known or shared regarding best practice within or between Regions.

Due to the need for Systems and Process improvements, the O&M stance is 'reactive' in nature with little time to assume a more 'pro-active' approach.

PHE's low level of computerisation has led to labour intensive manual practices involving a large number of employees performing clerical, administrative or menial tasks compared to those performing skilled or technical/managerial tasks. Any O&M information currently kept is manually maintained and therefore provides little value for decision making.

Due to the lack of appropriate measuring devices at treatment plants or along the transmission/distribution network, it is not possible to accurately measure NRW, UFW or leakage generally. The distribution networks design and set-up as well as management practices have not been geared to reducing or managing leakage or UFW. For example, the various networks are not adequately modeled or set-up by discrete supply zones with adequate ability to measure network performance. The networks are lacking equipment such as flow and pressure measuring devices as well as basic equipment such as 'zonal' meters, isolation or pressure control valves to aid leakage detection, measurement and control. Additionally, leakage detection equipment and active leakage detection techniques are not practiced centrally or regionally. As a consequence it is not currently possible for PHE to accurately measure water losses throughout the supply process from source to customer taps or accurately measure other customer and commercial components that make up the other elements of NRW.

PHE places overall responsibility for all of the various functional activities such as projects,

O&M, commercial, financial and administration under the departmental head, headed by Chief Engineer (PHE) assisted by geographical head (Superintending Engineer (SE)) who manages the 'Circle' office supported by a 'Divisional' and 'Sub-Divisional' office set-up. This can lead to dilution of effort or lack of focus in key areas associated within each functional activity. For example, a commercial drive or focus to improve customer services, billing and cash collection could conflict with or dilute efforts to maximise water production, distribution or project implementation bearing in mind that 'geographical heads' have to balance budgets, priorities and resource in functional areas that require different and specialist core skills.

Asset management plans are not in existence and asset information is not recorded.

On the whole, PHE operate and maintain their assets, including leakage repairs, although in some areas, management contracts have been awarded for O&M of new schemes. Generally, anything other than 'running maintenance' is contracted out to third parties including breakdown, plant repairs, overhauls, leakage repairs, new connections, sewer cleaning etc.

H&S policy/manuals and contingency/emergency plans are not in existence and H&S and security practices appear to be ad hoc and at the 'discretion' of individual managers within regions. H&S appears to be of low priority at all levels of operation of plants, street works activities etc. The lack of appreciation for the hazards associated with the O&M of these facilities poses a serious threat to the safety of staff and in some cases local residents.

Statistical process control techniques are not practiced; however various logs are kept at each plant showing power use, run hours, chemical parameters, chemical use, breakdowns etc.

Little management information is recorded or reported. There is no formal (written) reporting upwards of plant performance such as treatment volumes/costs/labour/plant breakdowns/power failures/treatment bypassing/quality parameters etc. Performance is not reported against targets and on the whole process and business reviews do not take place.

Most water treatment plants (WTP's) appear to be deficient good maintenance and H&S practices although security and housekeeping standards are good.

Sanitation schemes appear to be deficient good maintenance, housekeeping, H&S and security standards.

Most offices appear to be deficient good housekeeping standards. Under investment is apparent. Little or no computerisation of activities is evident even where computers have been provided.

3.4 Sector Legislation, Policy Regulations and Institutional Arrangements

3.4.1 Sector Legislation and Policy

A legislation and policy review was done to establish extent of the mandate of PHE as the lead sector institution and the presence of basic policies which guide the provision of water and sewerage services in the State. In the context of this MP/FS Study, the purpose of the legislative study was to understand the legal framework under which PHE is mandated to deliver the water and sewerage service and to implement the proposed capital improvements.

The Study reviewed the relevant sections of the following key documents: 73rd & 74th Constitutional amendments; the Goa Municipalities Act, 1968; Goa Panchayat Raj Act, 1994; Goa Public Health Act, 1985 & Rules (1086); Goa State Water Policy – 2002; Goa Groundwater Regulation Act (2002) & Rules; Water supply bylaws (Portaria 6802); Goa Water (Prevention of Pollution) Rules, 1988; and the Goa Town and Country Planning Act and the Goa Command Area Development Act, 1997. In addition various state-level planning documents were reviewed: Draft Regional Plan Goa – Perspective 2011; the Goa 10th Five-Year Plan (2002/07) and a draft Annual Plan (2004/05).

Findings

- Overall, sufficient legislation and policy statements are in place. The motivation, financing resources and institutional capacity to carry out can be strengthened.
- The local Chief Officer and the panch can play a more significant role in supporting PHE activities. At this point, this represents a missed opportunity for PHE since the level of interaction and coordination with local bodies can still be improved.
- It would be useful to consolidate various policy statements. The Water Sector Reform initiative is also suggesting consideration of new sector legislation.
- Current laws mandate connection to sewerage only for public health or nuisance reasons. There is no state policy requiring mandatory connection to the sewerage system within a fixed time to achieve viability of investments.

3.4.2 Institutional Arrangements

The Study reviewed the Central Public Works Department manuals to understand the key internal management and institutional arrangements in PHE.

Findings

- Little or no accountability for results by lower levels of management
- Highly centralized decision making
- Too many management tiers
- Little attention to organization "health" (renewal) and capacity; often in "coping" mode
- Little focus on strategic issues. Managers continue to be burdened by details
- Organization structure does not reflect all "core processes"
- Higher priority on achieving balanced work load distribution

3.4.3 Institutional Capacity Assessments: Strengths and Weaknesses

The assessment (and subsequent planning) of institutional plan followed a frame briefly explained below. To establish a comprehensive and integrated approach for strengthening of PHE, it is useful to view the strengths and weaknesses in the wider context of an organization consisting of parts or systems, as follows:

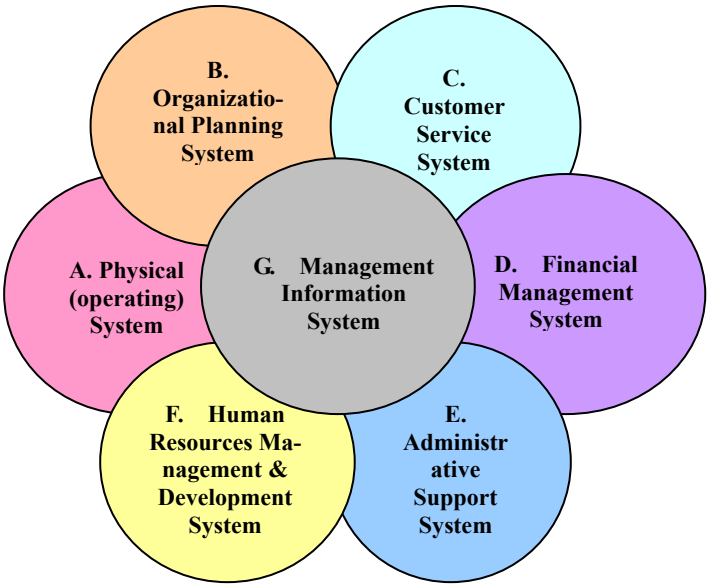


Figure 34.1 Institutional Strengthening Framework

In the succeeding sections, system components are briefly described and the major strengths and weaknesses of each is presented using a SWOT matrix.

(a) Physical System

The **physical (or operating) system** of PHE includes all the resources and activities needed for the preparation of technical plans and designs, implementation of construction, the operation of water supply facilities and the maintenance of installations and equipment. The operational system functions through its subsystems for design and construction management, water operation, and installations and equipment.

Strengths	**Weaknesses**
• PHE technical staff is experienced in construction and rehabilitation work and capital improvements, i.e., locally-financed and relatively small.	• O&M deficiencies • Not all O&M procedures and standards written, documented and readily available for both water supply and sewerage. • Limited operation and maintenance skills and equipment. • Deteriorating asset condition; • Low service levels; intermittent supplies; • Lack of sewer optimisation; • Water supply system monitoring • Difficulty in quickly assessing impact of pressure-flow variations in the water system along transmission lines and network.
Opportunities	**Threats**
• Pilot exercise has demonstrated benefits of an NRW program; staff trained; equipment available.	• NRW is high due to various reasons. • Poor work practices and safety practices and conditions. • No experience in management and supervision of large capital investments, particularly those supported or funded externally.

In addition to the immediate specific actions needed to improve the current operating conditions, the assessments pointed to the need for operation and maintenance management systems and tools to reduce the incidence of "crisis" situations in the future.

(b) Organization Planning System

This **organizational planning system** begins with analysis of the problems and solutions by comparing PHE's current services with targets set according to social, economic, environmental and regulatory policies under which it must function.

Using this frame of reference, the planning system must aim to effectively achieve the objectives of PHE in the long-, medium- and short-term. The planning system must make sure all parts of PHE work efficiently to meet targets so that PHE delivers the services (safe drinking water and sewerage) required by the State. This system generates physical expansion and institutional development programs. Supported by the management information system, the

planning system establishes feasibility of the objectives, plans and programs and controls their implementation.

Strengths	Weaknesses
• PHE has undertaken a comprehensive water sector reform initiative; clear proposals are on the table to improve current sector management, including planning • Budget-conscious planning.	• Goa State's annual development plans are not translated into a PHE corporate or business plan. • Minimal participation of managers and supervisors, and possibly other stakeholders, in planning. • No "big picture". • Planned operation & maintenance.
Opportunities	**Threats**
• Many similar reform experiences done in the other States from which to learn from.	• Inadequate participation of lower-level managers and staff in planning process. • Minimal direct input or participation from customers and local bodies.

(c) Customer Service System

The **customer service system** is a strategic element for attaining the objectives of PHE. It is a tool for the promotion and sale of services and for recovery of the cost of delivering those services to the users. This enables PHE to be financially self-sufficient. PHE performs its function according to policies, standards and plans established in the light of consumer demands and official regulations. The system includes subsystems related to consumption measurement (for water supply), billing and collection, consumer registration and marketing.

Strengths	Weaknesses
• Good experience with outsourcing of bill preparation function. • PHE has piloted a system of direct payment through banks with selected customers. • High collection efficiency.	• Low customer service orientation among PHE staff. • Lack of customer confidence in PHE. • No formal customer service standards • Variation / differences in meter reading-billing cycle periods among SD's (difficulties in consumption analysis and to customer complaints. • Differences among division and sub-division offices in customer data availability. • No marketing / public information plan.
Opportunities	**Threats**
• Few people are connected to the sewer system; low connection rates.	• Lack of customer participation and interest in PHE affairs.

(d) Financial Management System

The **financial management system** includes all policies and standards established by PHE to carry out its financial tasks, together with the procedures used for recording and evaluating financial operations and reporting on their results. These activities are found in the financial

management and accounting subsystems.

Strengths	Weaknesses
• Concern for cost reduction and cost efficiency is relatively higher among staff and officers. • Current data and reports more suited to an asset creation (or project) organization.	• Difficult to assess financial performance of PHE as a public utility due to absence of readily-available data. • Non-uniform billing and collection system leads to difficulty in customer consumption analysis. • Inadequate billing & collection data reporting system for management use. • Less concern about revenue generation among Division and Sub-Divisions. • CPWD Account Codes are not for water supply and sanitation only, therefore, important cost details on WSS operations - electricity, chemicals, raw water cost, etc. - are not routinely kept and reported.
Opportunities	**Threats**
• Balance sheets, income statements are "not required" in the present system.	• Depreciation is not calculated for capital expenditures. • PHE is not able to assess the impact of tariff structure adjustments on the overall revenue. • Apparently minimal cost consideration / cost analysis in tariff revision decisions.

(e) Administrative Support System

The **administration support system** includes three (3) sub-systems – for supplies administration, for asset management and for social communication.

Strengths	Weaknesses
• High priority on office records keeping and maintenance system.	• No formal system to guide decision-making on asset acquisition and maintenance matters, i.e., not based on data about serviceability, demand, risk analysis, value analysis and other 'life cycle' parameters • No analysis of maintenance expenditures. • Inventory and spare parts system needs to be better planned and controlled.
Opportunities	**Threats**
• PWD is installing an asset management system, initially with the roads sector.	• Low priority given to administrative support systems – asset management, security, general upkeep of office facilities, etc.

(f) Human Resources Management & Development System

The **human resources management & development system** comprises all policies, standards and procedures which ensure that PHE has the personnel it needs at the right time and that the personnel are appropriately trained.

Strengths	Weaknesses
• Very formal and rigid personnel systems. • High technical competencies.	• Low staff productivity (16.1 staff/1,000 connections). • Insufficient job descriptions and qualification standards for all job titles • No method for determining staffing requirements and skill specifications • Inadequate performance evaluation and incentive system. • Unsafe working conditions, particularly in the chlorination facilities, along the major roads and streets and in confined-space facilities. • Financial analysis skills limited. • Narrow "competencies" among technician-level staff. • Personnel systems administered directly from PWD HQ
Opportunities	**Threats**
• Lack of long-term human resources development plan.	• Limited opportunities for staff development and training. • Over-specified procedures tend to remove or reduce responsibilities for results. • Worker safety & health issues.

(g) Management Information System

The management information system defines the flow of information within the organization to support the planning and decision-making processes of PHE.

Strengths	Weaknesses
• Each EE has his own system for data management.	• Link between operational performance and financial performance not evident; costing (& pricing) for services not streamlined. • Data and record keeping not standardized; "individualized" information systems. • Minimal sharing ("consolidation") of information among working units.
Opportunities	**Threats**
• Plans are underway for establishing an MIS system for PWD, initially focusing on its roads operations.	• Limited familiarity with information systems and information technology

3.5 Financial System

The PWD, a State Government department, receives a budget from the Government of Goa, and returns all of its revenue (gained from its activities) to the Government of Goa. Approximately,

50% of the total PWD budget was expended on water supply and sanitation through the PHE.

The PWD follows the accounting method specified in the manual called "Central Public Works Account Code". The manual does not require the preparation of balance sheets nor income statements that include the depreciation costs. The accounting system following the manual is applied not only to the water supply and sanitation services, but also to all of the Government's activities. Therefore, the information requirements are general, meaning the Division offices are not requested to provide information that is important for the water supply and sanitation sector, such as the cost of electricity, chemicals, and raw water.

The tariff system in Goa classifies users into major four categories or small seven categories and applies a volumetric charge based on the readings from water meters that are installed at each individual house connection. The tariff system subsidizes domestic users by setting a higher unit price for non domestic users. In Goa, industrial users pay 6.9 times more than domestic users to buy 1 m^3 water. The cross subsidy is more of a burden to the non-domestic users in Goa than in other Asian countries.

The results of the Public Awareness Survey by the JICA Study Team show that the percentage of current water supply and sewerage charge in average household income in Goa is 2.4%. It is lower (almost half) than the affordability limits at 5% estimated by the international organizations. However, WTP for the services is 3.6%, which is also not high. Based on the affordability limits there are some opportunities to increase tariffs, however customers are not willing to spend much more than they currently do for the services.

Meter reading, billing and collection are undertaken by four divisional offices: Division III, Division IX, Division XVII, and Division XX. Meter reading is carried out once every 30 to 60 days, depending on the capabilities of each sub-division. Even in the same sub-division, the cycle of the meter reading varies throughout the year. This variation in the cycle of meter reading makes it difficult for management to accurately understand customer service information such as: collection efficiency, water consumption per connection, water charges per connection, and unit price of water.

As part of this study, profit-loss statements for the last five years for the water supply and sanitation sector of Goa were prepared. Division IX, which covers the cities of Margao and Vasco, is the largest source of revenue for the PHE. Division IX is responsible for approximately 60% of the total revenue. More than half of the revenue from Division IX is

collected from just 15 industries which include a shipyard and hotel resorts.

Table 35.1 Profit Loss Statement for the PHE over the last 5 years

(Unit: Rs. million)

	2000-01	2001-02	2002-03	2003-04	2004-05
I. Revenue					
Total	448.1	543.4	566.9	555.4	552.7
II. Expenditure					
1 Operation & Maintenance cost	736.1	796.0	933.7	729.7	779.7
2 Administration cost	67.5	74.1	73.7	75.6	96.2
3 Other expenses	25.5	34.0	10.9	1.6	12.4
4 Depreciation	20.2	29.1	34.7	45.1	59.0
Total	849.3	933.2	1,053.0	852.0	947.3
III. Income from Operation	**-401.2**	**-389.8**	**-486.1**	**-296.6**	**-394.6**
IV. Interest expenses	**0.0**	**32.8**	**208.3**	**312.8**	**313.2**
V. Net profit	**-401.2**	**-422.6**	**-694.4**	**-609.4**	**-707.8**

Source: Prepared by the JICA Study Team based on data provided by PHE

If it is assumed that the PHE is funded only by revenue generated from water supply and sanitation services, the PHE has experienced a large deficit over the last five years. As shown in Table 35.1, the PHE made a net loss of approximately Rs.700 million during 2004-2005. Presently, this loss is compensated for by funding from the State Government.

Table 35.2 Profitability, Efficiency and Productivity of the PHE

Item	Unit	2004-2005
Profitability		
Unit Production Cost	Rs/m^3	12.38
Unit Price	Rs/m^3	8.66
Efficiency		
Non Revenue Water Ratio	%	50.6%
Productivity		
Staff per 1,000 Connections		16.1

Source: Data from Division Offices and Bill Printing Company

Performance indicators as shown in Table 35.2 were used to understand and evaluate the financial situation of the PHE. One of the structural problems for non profitable condition of PHE is clearly observed in the relationship between Unit Production cost and Unit Price. Unit Production Cost (Rs.12.38/m^3) exceeds the Unit Price (Rs.8.66/m^3). Under the present tariff and operation and maintenance systems, the PHE continues to make a loss through its operating activity. The Efficiency of the PHE was analyzed using the Non Revenue Water ratio. The ratio of 50.6% shows one of the major factors which cause massive deficits. According to the Asian Development Bank's "Water in Asian Cities, Utilities' Performance and Civil Society

Views" (2004), the average ratio for NRW for 18 Asian major cities was 34%. Productivity of the PHE was assessed using the Staff per 1,000 connections indicator. Staff per 1,000 connections in Goa is 16.1. This is higher than the average (11.8) for the 18 cities. The productivity of the PHE is lower than for the other countries.

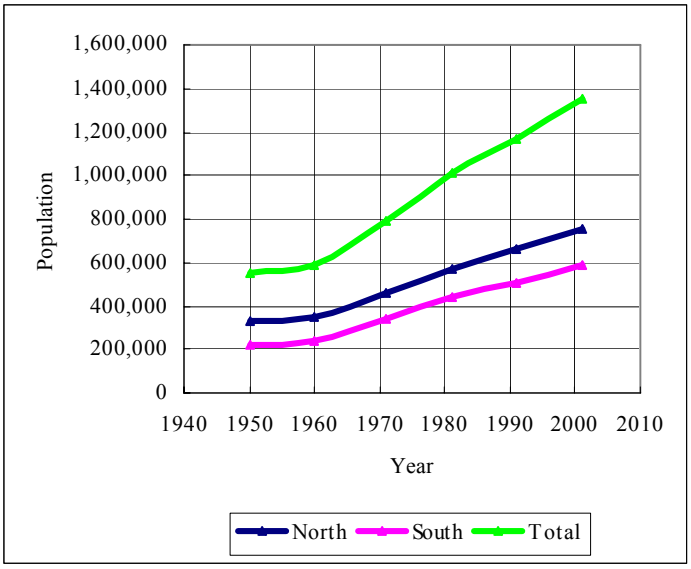
4 MASTER PLAN

4.1 Future Population and Water Demand

4.1.1 Future Population

(1) Past Trend of Population Growth

The Government of India has undertaken population census from 1950 to 2001. These census were used to assess population trends which is shown in Figure 41.1. As shown in the above figure, Goa's population has more than doubled since the 1950s and 1960s.



Source: Directorate of Census Operations, Goa

Figure 41.1 Population Census Data for Goa State

(2) Future Population

The future population was estimated for each unit using the five statistical equations. Historical census data (1971, 1981, 1991, and 2001) was used to predict the population size for all years up until 2025 which is the master plan target year. Figure 41.2 shows the results of future population projections.

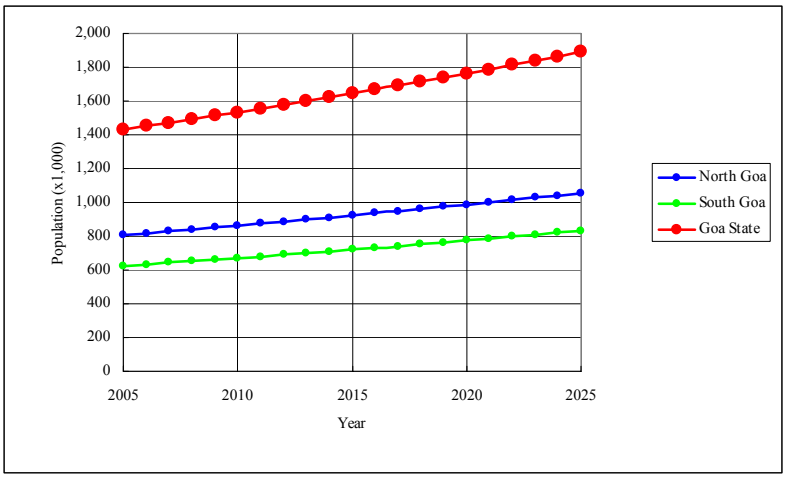


Figure 41.2 Future Population Projection (for each District)

4.1.2 Water Demand

(1) Basis of the Future Water Demand Forecast

Future water demand was estimated based on the population predictions and the number of tourists. The following conditions were assumed for the calculations:

1) Service Ratio

Area	Service Ratio in 2025
Urban	Gradually increased from current service ratio to 100 % in 2025
Rural (for Tiswadi, Mormugao, and Salcete talukas)	Gradually increased from current service ratio to 100% in 2025
Rural (for Pernem, Bardez, Bicholim, Satari, Ponda, Quepem, Sanguem, and Canacona talukas)	Gradually increased from current service ratio to 90 % in 2025

2) Domestic Per Capita Consumption

Domestic per capita consumption (liter per capita per day: lpcd) is an important design factor for estimating future domestic water demand. This study considered the following three per capita consumption rates:

- Case 1:Urban=135 lpcd, Rural=70 lpcd
- Case 2: Urban=150 lpcd, Rural=100 lpcd
- Case 3: Urban=200 lpcd, Rural=200 lpcd

- Case 1: This per capita consumption rate is the standard recommended in the CPHEEO manual. However, as discussed in the previous section, current per capita consumption for urban and rural areas already exceeds these levels.
- Case 2: The current average per capita consumption for urban areas is currently 144 lpcd and for rural areas is 88 lpcd. Case 2 increased these consumption rates in accordance

with predicted improvements in living standards.

- Case 3: This case assumes a more rapid increase of per capita consumption in urban areas and in rural area.

Through the discussion with PWD Goa, the Case 2 was adopted for future facility planning since the Case 2 was judged as realistic from current per capita water consumption level.

3) UFW Ratio

Based on other reports and the data that is available, the UFW ratio was assumed to be 35%. It was assumed that these efforts will reduce the UFW ratio to 15 % during the next 30 years (i.e. by 2035). Therefore, the UFW ratio in 2025 was estimated to be 21.7 %.

(2) Total Water Consumption

Figure 41.3 presents the future domestic and non-domestic water consumptions. These consumptions are net consumptions which do not include UFW.

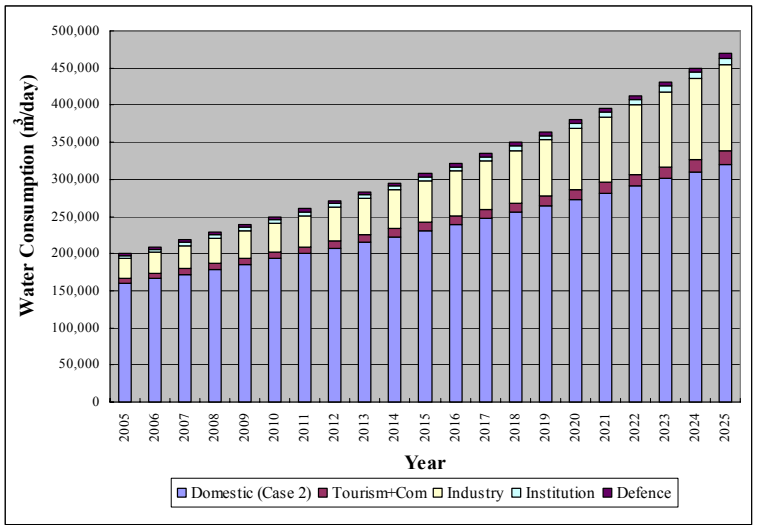


Figure 41.3 Domestic and Non-Domestic Water Consumption (without UFW)

The total future water consumption that was calculated from net water consumption shown on Figure 41.3 taking into account the future UFW ratio and peak factor.

"Consumption" shown on the Figure 41.4 is calculation results of future water consumption. Quantity of water consumption in year 2005 is calculated from existing actual water consumption and adding a balance of the maximum and average water consumption.

"Potential Demand" shown on the Figure 41.4 is the potential water demand. The potential water demand is calculated applying ultimate service ratio and ultimate per capita water consumption. Hence, in year 2025, water consumption and potential water demand become same quantity.

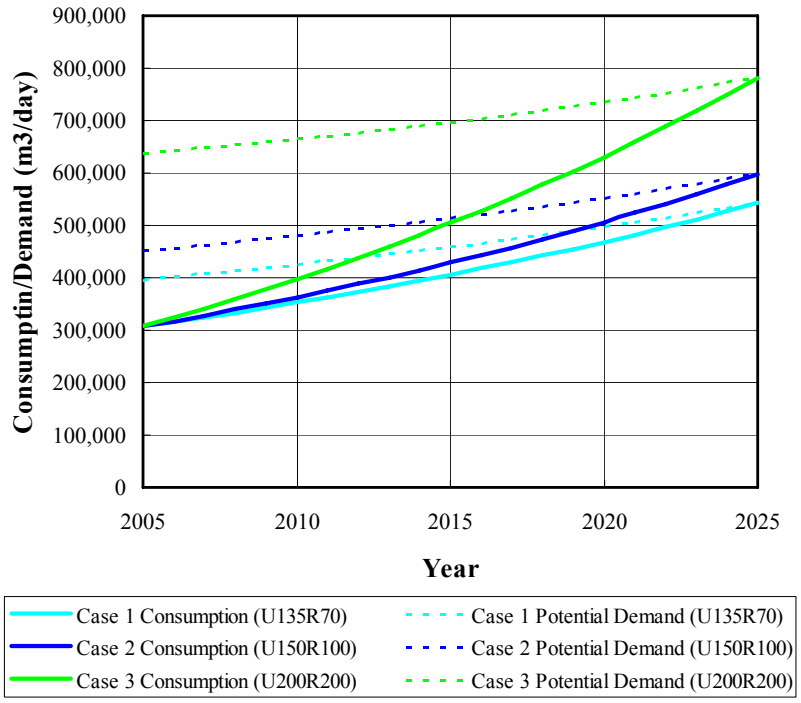


Figure 41.4 Future Water Consumption and Potential Water Demand

4.2 Water Supply System

The Water Supply Master Plan covers seven regional water supply schemes (WSSs). The master plan was developed to solve existing problems, which the PWD and people of Goa currently experience. It was also developed to increase the water supply capacity and to provide an adequate transmission system. The existing supply capacity is not sufficient to meet potential water demand.

The master plan will enable the PWD to meet future water demands and realize continuous and equal water supply services for customers by 2025. To help achieve continuous water supply, the master plan includes improvement plans for water supply facilities, operation and maintenance, institutional and capacity building, unaccounted-for water (UFW) and non revenue water (NRW) reduction, tariff strategies to restrain excessive consumption and wastage, and public relations with regards to wise water use.

To meet the increases in future water demand and to secure the existing water supply system, the master plan provides a facility improvement plan for each scheme as shown in Figure 42.1 and listed in Table 42.1.

Table 42.1 Summary of Components for the Water Supply Master Plan until 2025

Component	Water Supply Scheme (WSS)						
	Salaulim	Opa	Chandel	Assonora	Sanquelim	Dabose	Canacona
Proposed System (additionally required facilities)							
Water Treatment Plant (m^3/day)	200,000	-	15,000	50,000	-	10,000	10,000
Transmission Main	108 km	14 km	36 km	41 km	7 km	48 km	35 km
Reservoir	7	-	14	16	-	4	7
Pumping Station	7	-	1	1	2	1	3
Distribution Pipeline	965 km	436 km	67 km	377 km	99 km	88 km	75 km
House Connection	68,000	30,600	4,680	26,500	7,000	6,200	5,300
Rehabilitation/Improvement of the Existing System							
Water Treatment Plant (m^3/day)	160,000	114,000	15,000	30,000	52,000	5,000	5,000
Transmission Main	83 km	50 km	-	6 km	4 km	11 km	2 km
Reservoir	18	19	7	14	5	5	3
Pumping Station	16	4	-	2	3	10	3
Distribution Pipeline	540 km	268 km	125 km	275 km	61 km	70 km	18 km
House Connection	229,000	129,000	25,900	116,500	18,000	16,500	12,800

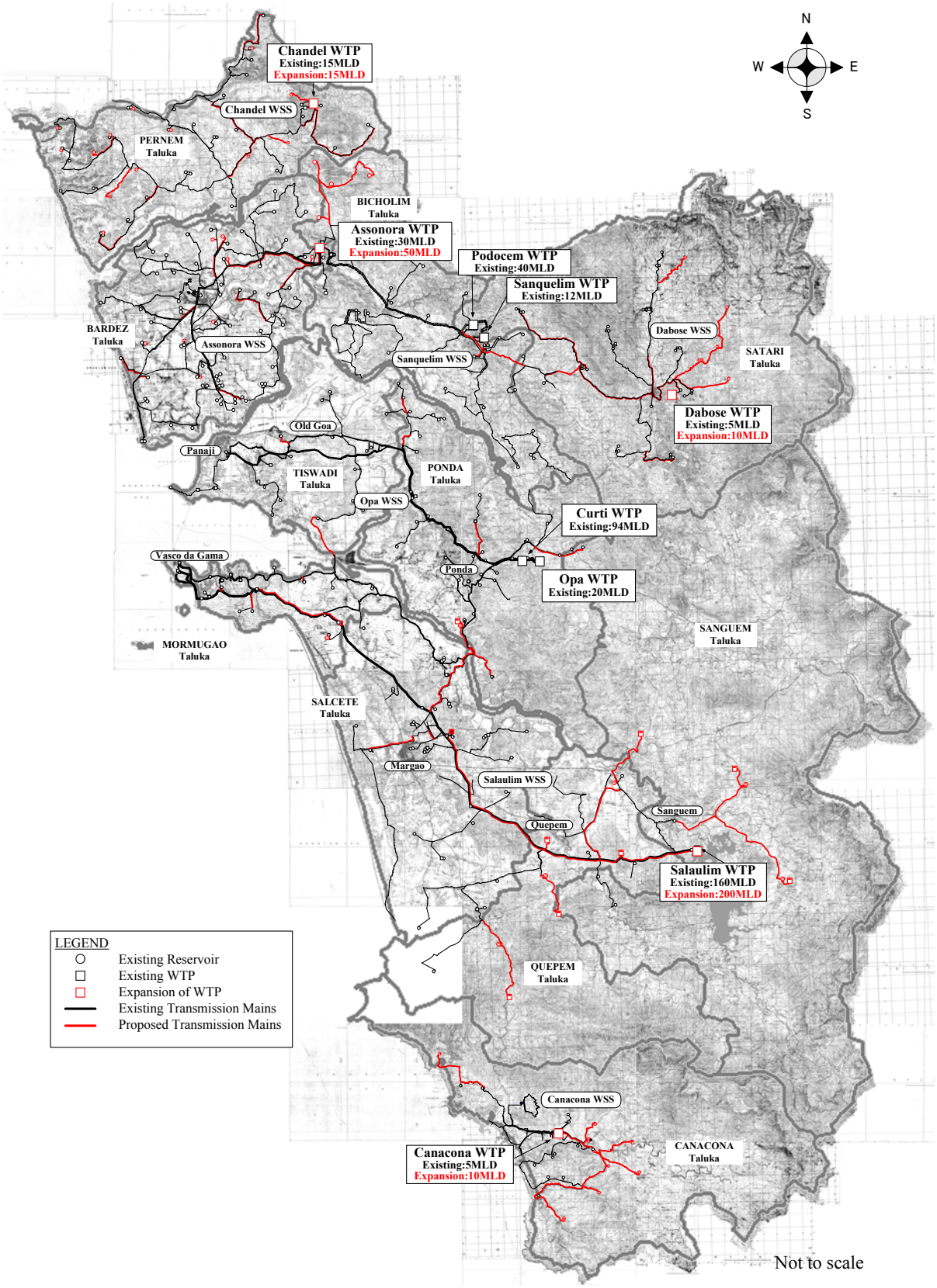


Figure 42.1 Proposed Water Supply System in 2025

4.3 Sanitation System

The most appropriate sanitation system (either on-site, decentralized, or sewerage systems) was selected for each area based on the demographic, geological and economic situations. The groundwater table level and the long-term infiltration rate of the soil were also taken into account when assessing the infiltration ability. Also, a comparative study of the construction costs for on-site systems and sewerage systems was conducted to ensure the most appropriate system.

As a result of these comparative assessments and technical studies, a decentralized system is proposed for small cities from which less than 1,000 m³ / day of sewage flow is generated. The decision tree is explained in Figure 43.1. The population density is the criteria for selection of sanitation system and it was set as 41 person/ha. This figure was obtained from comparison of construction costs for onsite, sewerage, and decentralized systems.

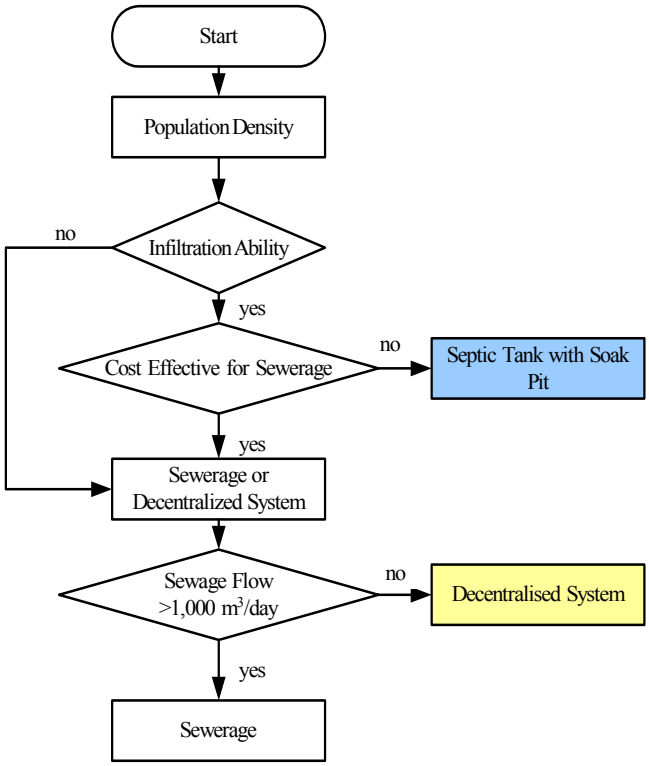


Figure 43.1 Sanitation System Selection

Introducing these sewerage projects, sewage originated from 370,000 residents and 70,000 tourists can be treated in 2025, discharging BOD load will be reduced up to 20 % of present one despite of population increase in the proposed sewerage areas. Regarding the whole study area, 35 % of discharging BOD load will be reduced against present one comprised with sewerage, de-centralized system and septic tank development.

The existing sewage collection systems in Panaji and Margao use a separate collection system. The separate sewage collection system is also proposed for the rest of the sewerage areas taking into account the above mentioned reason and the water pollution control in the rainy season. On the other hand, the combined sewage collection system suffers from several disadvantages such as sluggish flow during non stormy days, leading to deposition of sewage solids causing

foul odours and increased cost of sewers, sewage treatment plant and pumping station costs.

The separate sewage collection system is also proposed for the rest of the sewerage areas taking into account the above mentioned reason and the water pollution control in the rainy season.

The quantity of sewage was calculated based on the residential and tourist population size and the per capita water demand. The sewage return ratio and groundwater infiltration ratio were taken from the CPHEEO manual.

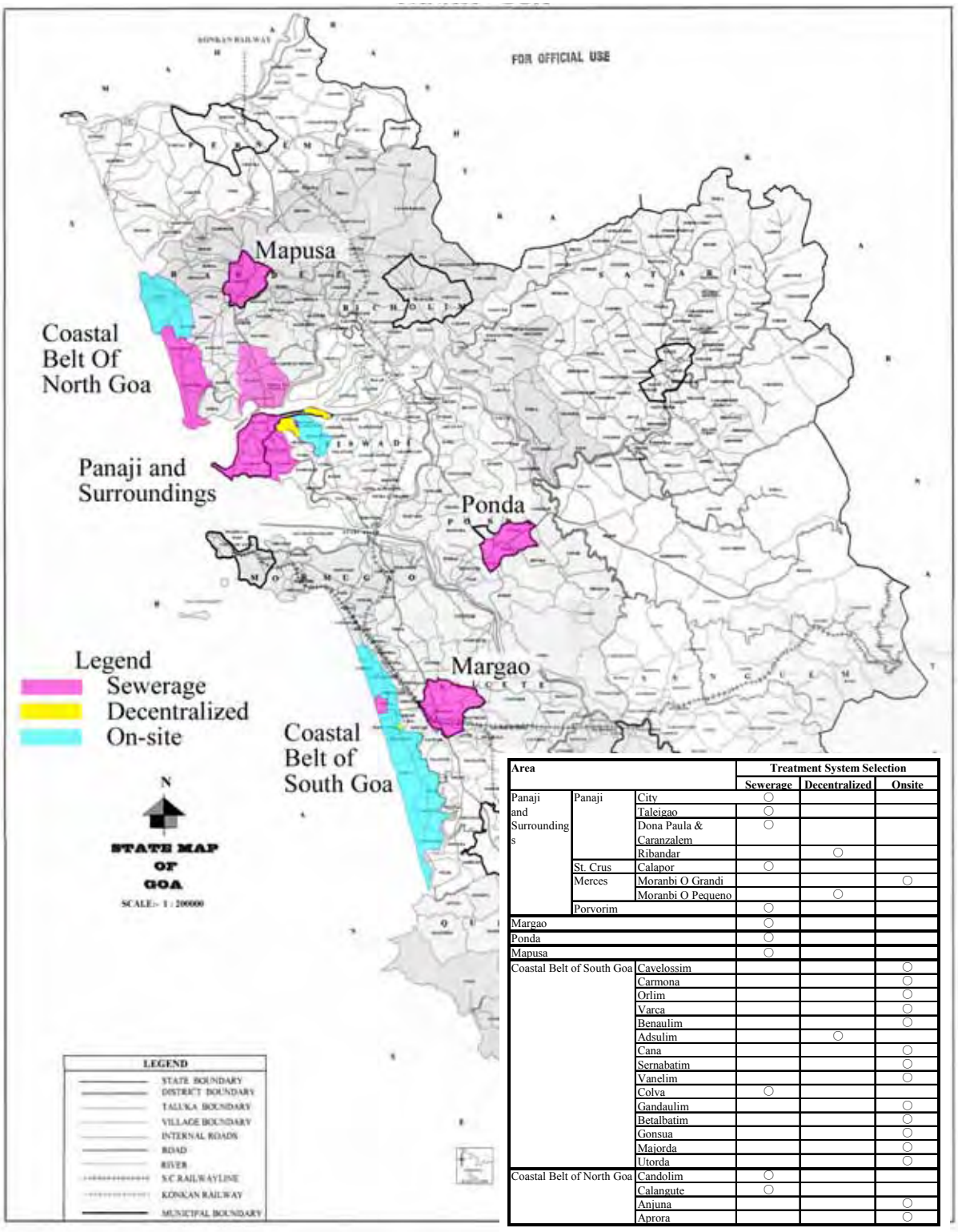
The sewage quality was estimated from the pollution load divided by the sewage flow rate. The per capita pollution load of BOD was assumed to be 45 g/capita/day (as defined in the CPHEEO manual). The quality of the treated effluent must comply with the Indian standards for sewage discharge.

In general, gravity collection systems and biological treatment processes are proposed. The sewerage facilities (including sewer network, pumping stations and treatment plants) will be designed in accordance with the CPHEEO manual. The treatment plant sites were selected based on the topography, ease in land acquisition, and environmental and social considerations.

Figure 43.2 shows the selected sanitation system and Table 43.1 shows a summary of the proposed sewerage system.

Table 43.1 Summary of Sewerage System

Location	Unit	Panaji including Taleigao, Dona Paula & Caranzalem	St. Cruz	Porvorim	Margao	Ponda	Mapusa	Colva (South Coastal Belt)	North Coastal Belt
Target Year		2025							
Collection System		Separate System							
Covered Population	Persons	56,557	16,918	47,848	118,193	19,401	68,255	5,279	39,358
Tourist	Persons	33,576	-	1,653	5,429	2,097	1,703	5,231	20,261
Per Capita Sewage Flow	L/capita/day	150							
Return Ratio	%	100%	80%						
Groundwater Infiltration	%	20%							
Sewage Flow	m^3/day	21,390	2,538	7,608	20,859	3,455	10,781	2,152	11,172
Sewage Quality (BOD)	mg/L	210	300	300	300	280	300	220	240
(SS)	mg/L	180	250	250	250	240	250	190	200
Treated Effluent (BOD)	mg/L	30							
(SS)	mg/L	100							
Capacity (Proposed)	m^3/day	8,900	2,600	7,700	13,400	3,500	10,800	2,200	11,200
(Existing)	m^3/day	12,500	-	-	7,500	-	-	-	-
Treatment Method		Biological Process							



Area			Treatment System Selection		
			Sewerage	Decentralized	Onsite
Panaji and Surroundings	Panaji	City	○		
		Taleigao	○		
		Dona Paula & Caranzalem	○		
		Ribandar		○	
	St. Crus	Calapor	○		
	Merces	Moranbi O Grandi			○
		Moranbi O Pequeno		○	
	Porvorim		○		
Margao			○		
Ponda			○		
Mapusa			○		
Coastal Belt of South Goa		Cavelossim			○
		Carmona			○
		Orlim			○
		Varca			○
		Benaulim			○
		Adsulim		○	
		Cana			○
		Sernabatim			○
		Vanelim			○
		Colva	○		
		Gandaulim			○
		Betalbatim			○
		Gonsua			○
		Majorda			○
		Utorda			○
Coastal Belt of North Goa		Candolim	○		
		Calangute	○		
		Anjuna			○
		Aprora			○

Figure 43.2 Selected Sanitation Systems for the Study Area

4.4 Operation and Maintenance

4.4.1 Operation and Maintenance of Water and Sanitation Schemes

Effective operation and maintenance of water and wastewater assets requires the development and implementation of strategies that ensure that asset performance is optimised bearing in mind the whole life cycle cost of the assets. It is also crucial to ensure that assets are maintained and operated in accordance with best operating practice employing safe systems of work. This will enhance plant operability, service delivery and the health, safety and welfare of staff, contractors, customers and the general public.

Operations are the "doing" part of the organisation. It is responsible for the 'source to tap' process, which includes water resources, dams, reservoirs, production, transmission, supply, non-revenue water and operations and maintenance. It is also responsible for the 'drain to river' process, which includes wastewater collection, sewerage network operation and wastewater treatment and disposal. Appropriate systems will need to be introduced to aid the management, operation, control and maintenance of water and sanitation operations. Such systems might include; 'job management system' (JMS), 'geographical information system' (GIS), 'computerised maintenance management system' (CMMS), Supervisory Control and Data Acquisition (SCADA).

Appropriate procedures will need to be introduced to cover the following activities:

- Asset Management (asset planning, asset acquisition/new schemes/project management, asset optimisation)
- Network Management (operations, control and maintenance: valve operations, pressure/flow management, flushing, leak detection/fixing leaks, rehabilitation of service connections and networks, new connections, meter exchanges/maintenance/calibration)
- Pumping Station Management (operation, control and maintenance of water and wastewater assets)
- Well Stations Management (operation, control and maintenance)
- Tanks/Service Reservoirs (operation, control and maintenance)
- Maintenance Management (breakdown maintenance, planned preventative maintenance, asset optimisation)
- Treatment Plant Management (operation, control and maintenance of water treatment facilities)

- Process Management (process control/optimisation, water quality compliance, continuous process improvements)
- Wastewater Collection & Disposal (operation, control and maintenance of sewerage networks and wastewater treatment facilities)

PHE will need to provide greater emphasis on maintenance of assets by introducing a 'planned preventative maintenance' system as opposed to the current 'corrective maintenance' approach. Effective maintenance practices will add value by providing improvements to the efficiency, cost effectiveness and reliability of assets and enhance operational performance. PHE will need to develop their maintenance practices to:

- Provide an efficient maintenance service with optimum use of available resources and allocation based on operational priorities
- Minimize asset life costs through the application of cost effective planned preventative maintenance procedures and working practices
- Improve maintenance financial management and budget control. This will include the provision of better financial information to improve decision making
- Improve the knowledge and skills of maintenance staff by identifying and rectifying skill gaps, introducing individual development plans and providing cost effective training focused on meeting the needs of the business
- Optimize stock holding of materials and spare parts through the development of a spares policy and by identifying inventory requirements
- Develop a disciplined and professional approach towards health and safety and maintenance work practices. This includes the use of safe systems of work and lock-out/tag-out procedures

4.4.2 NRW Reduction Planning

An 'active' approach to NRW reduction will need to be institutionalised for best results. PHE operate a "Passive" approach to leakage reduction whereby leak detection and repairs are managed on a reactive basis such that only visible leaks are dealt with. Due to low pressures it is likely that many leaks will not appear above ground and therefore go unnoticed. Many of the leaks will be as a result of poor materials, installations or repairs. Leaks can cause water quality issues due to back-siphonage as well as causing commercial losses. The current emphasis is to tackle physical or 'real' losses with little or no emphasis on tackling commercial

or ‘apparent’ losses.

PHE aims to progressively implement enhanced services. Where this includes the provision of 24 hour supply systems, PHE will need to ensure that water supply networks are managed effectively to maintain NRW at an economic level. It is well proven that a focus on reducing NRW will produce a positive financial return based upon operational savings and capital deferment.

The aim of a NRW Reduction Strategy will be to:

- Maximise the use of available water resources
- Improve the efficiency of water supply systems
- Improve services to customers
- Defer capital investment
- Reduce operating costs through water savings
- Increase revenue through water savings

A successful NRW Reduction Strategy will require:

- **Leadership** – from the top of the organisation, there must be a “Champion” to ensure that the whole organisation concentrates upon the basics of increasing income and reducing the physical leakage.
- **Commitment** – throughout the organisation there must be a determination to follow through the processes that reduce NRW.
- **Resources** – significant resources are required to make the step change necessary to reduce NRW. Once NRW is under control and efficient and effective processes are in place then the resource can be reduced to a lower level. It must be recognised that NRW control is an ongoing operation.

In order to implement a successful NRW reduction strategy, PHE will need to:

- Get the basics right now to control and reduce the current levels of NRW such as capturing accurate data required to monitor and control physical and commercial losses
- Implement ‘Active Leakage’ control techniques to reduce the current levels of UFW
- Develop staff and systems for progressive and sustained improvements in NRW
- Minimise future leakage by raising standards of installation and repair
- Minimise future commercial losses by raising standards of metering, billing and revenue collection
- Undertake ‘enabling works’ to monitor and control UFW in future. PHE will need to

consider contracting out the enabling works and the 'primary UFW reduction' to an agreed target level. Following this period, PHE would need to take responsibility for ongoing UFW control

4.5 Institutional Development

4.5.1 Framework for Institutional Development Master Plan

Priorities to be accomplished/facilitated by the structure & key changes envisaged

2007-2012 Priority themes include:

- Sharpening of organizational directions;
- Strengthening of management systems; and
- Promotion of delegation of duties, accountability and responsibility for results.

2012-2018 Priority themes include:

- Sharpening of coordination and interaction among work units.
- Re-emphasis on evaluation and control systems

2019-2025 Priority themes include:

- Strengthening collaboration and consolidation.

In each of the three (3) institutional development stages, the priorities are expected to shift. A thorough review of the institutional situation at the end of each stage will be needed to confirm or adjust the priority themes for the succeeding stages. The emerging strategy for the initial stage consists of:

- Strengthening business orientation and customer orientation (transformation of organizational "culture")
- Transforming PHE (Circles/Divisions) from an engineering company into an accountable service provider.
- Focus on assisting PHE plan and implement the **internal** organizational changes needed to support the sector reform objectives through effective management of assets, processes, systems and people.
- Collaborate and contribute to the reforms in sector policy and legislation.

During the first stage, a 3-pronged agenda will be formulated consisting of a policy agenda, a restructuring agenda and a capacity building agenda will be needed.

4.5.2 Policy Agenda

The priority objectives of policy decisions for PHE institutional development are envisaged to promote:

- increased financial autonomy for PHE to make the link between performance and resources transparent;
- clear performance accountability at all levels of PHE management; and
- performance incentives to effective work teams and staff.

4.5.3 Restructuring Agenda

The core functions of PHE consist of the following:

- Services provision as per service delivery agreement
    - Coverage & supply as per guidelines / norms
- Operations & maintenance of assets
    - Water production & treatment
    - Water transmission & distribution
    - Sewage collection
    - Sewage treatment & disposal
- Customer services (billing, collection, service requests, complaints, etc)
- Asset creation (investment plan implementation, procurement of capital works)
- Business planning and development

With this restructuring agenda, PHE is envisaged to be better able to:

- Lay the foundation for increased delegation of responsibilities and authority to lower levels;
- Prepare itself for implementation and operation of major, externally-supported capital investments;
- Set service and performance targets and standards by work groups; and
- Establish a flexible & responsive organization

These can be achieved through:

- A more process-focused, business-oriented and customer-friendly structure;
- Clear accountability for results on specific managers / teams;
- Mechanisms for internal review and improvement (“renewal”);
- More adaptable and flexible for future organization reforms;
- Balanced responsibilities with resources and authority; and

- A policy & system for regular review and updating of departmental and office responsibilities, functions and structure.

4.5.4 Capacity Building Agenda/Directions

Following the assessment framework, specific development objectives and interventions will be introduced into each of the systems. This is fully described in the feasibility study. In addition, a technical assistance project to support Capacity Building in PHE has been formulated as part of the Priority Project.

4.6 Preliminary Cost Estimates

4.6.1 Introduction

Preliminarily costs have been estimated based on the analysis presented in the previous chapter. All costs mentioned in this chapter are based on the value of Indian Rupees in 2007. Taxes and duties vary depending on the type of equipment or material and were included in the corresponding unit costs. The estimated investment cost was based on a staged implementation of the project, which corresponds to the priorities and timeframes discussed in the Report. The operation and maintenance improvement costs are described in Chapter 7. Institutional and organizational improvement costs were estimated to be 4% of the direct construction costs.

4.6.2 Water Supply

A summary of the water supply component costs is presented in Table 46.1.

Table 46.1 Cost Estimate for Water Supply Components

Item	Amount	
	(In Million Rs.)	(In Million US$)
1.Construction Cost	12,679.560	280.27
1) Expansion Project	7,295.400	161.26
(1) Water Treatment Plant	2,708.870	59.88
(2) Transmission Main	2,133.970	47.17
(3) Reservoir	369.000	8.16
(4) Pumping Station	43.400	0.96
(5) Distribution Pipe	1,685.550	37.26
(6) House Connection	354.610	7.84
2) Rehabilitation Works	5,058.020	111.80
(1) Water Treatment Plant	1,170.950	25.88
(2) Transmission Main	1,165.770	25.77

(3) Reservoir	142.060	3.14
(4) Pumping Station	132.280	2.92
(5) Distribution Pipe	1,086.270	24.01
(6) House Connection	1,360.690	30.08
3) Water Quality Control	25.500	0.56
4) O&M Improvement	300.640	6.65
(1) Water Supply System O&M	276.840	6.12
(2) NRW Reduction Improvements	23.800	0.53
2. Engineering Cost	1,267.940	28.03
3. Administration Cost	697.380	15.42
4. Land Acquisition	26.280	0.58
5. Physical Contingency	1,397.370	30.89
6. Price Contingency	10,012.880	221.33
Total excluding Price Contingency	16,068.530	355.18
Total	26,081.410	576.51

Note: US$1.00 = Rs.45.24
Costs for (2) NRW Reduction Improvements includes only costs for leakage detection equipment. Other costs required are included in "Rehabilitation Works" and Table 46.3.

4.6.3 Sanitation

A summary of the sanitation component costs is presented in Table 46.2.

Table 46.2 Cost Estimate for Sanitation Components

Item	Amount	
	(In Million Rs.)	(In Million US$)
1.Construction Cost	2,647.730	58.53
1) Expansion Project	2,462.280	54.43
(1) Trunk Sewer	633.300	14.00
(2) Branch Sewer *	885.510	19.57
(3) Pump	70.370	1.56
(4) Sewage Treatment Plant	873.100	19.30
2) Rehabilitation Works	143.450	3.17
3) O&M Improvement	42.000	0.93
2. Engineering Cost	317.730	7.02
3. Administration Cost	148.270	3.28
4. Land Acquisition	24.800	0.55
5. Physical Contingency	299.040	6.61
6. Price Contingency	2,900.970	64.12
Total excluding Price Contingency	3,437.570	75.99
Total	6,338.540	140.11

Note: * Branch sewer cost includes house connection 144.11 Mill Rs
US$1.00=Rs.45.24

In addition to costs shown above, the costs required for decentralized and onsite system will be 254 million Rs. (equivalent to 5.6 million US$)

4.6.4 Capacity Building, Institutional/Organizational Improvement

A summary of the capacity building, institutional/organizational improvement costs is presented in Table 46.3.

Table 46.3 Cost Estimate for Capacity Building, Institutional/Organizational Improvement

Item	Amount (In Million Rs.)	Amount (In Million US$)
1. Institutional /Organizational Improvement Cost	578.16	12.78
2. Engineering Cost	59.84	1.32
3. Administration Cost	31.93	0.71
4. Physical Contingency	63.81	1.41
5. Price Contingency	480.24	10.62
Total excluding Price Contingency	733.74	16.22
Total	1213.98	26.83

Note: US$1.00 = Rs.45.24

4.7 Economic and Financial Analysis

Economic evaluation, as well as financial evaluation, was conducted utilizing the discounted cash flow method. Economic Internal Rate of Return (EIRR), NPV, and B/C ratio were selected as indicators for economic evaluation. Among the above three, EIRR was set as the most important indicator. Regarding the financial evaluation, the financial internal rate of return (FIRR), NPV, and B/C ratio were selected as indicators for financial evaluation. Among the above three, FIRR was set as the most important indicator. These indicators for economic and financial evaluation are computerized based on many preconditions and assumptions mentioned in the Volume II: Master Plan. In case the preconditions and assumptions are changed, evaluation results would be also changed. It should be noted that there are these kinds of limitations in economic and financial evaluation.

(1) Water Supply Master Plan

Following benefits in Table 47.1 were deemed and enumerated as the tangible economic benefit for the water supply master plan. Economic costs were converted from financial cost.

Table 47.1 Economic Benefit of Water Supply Master Plan

1	Cost reduction effects	1-1	Saving of alternative water procurement cost
		1-2	Saving of incurred costs by public water supply stoppages
		1-3	Saving cost for purchasing bottled water
2	Improvement of public hygiene	2-1	Saving of medical expenditures by decrease of waterborne diseases
		2-2	Reduction of absence from work caused by waterborne diseases

The EIRR of the proposed projects was 13.2%, which exceeds the opportunity cost of capital at 12%. This indicates that the projects are economically viable. For the reference, NPV, and B/C ratio was Rs.730 million and 1.09, respectively.

When conducting the financial evaluation, FIRR was not available for the present tariff. NPV, and B/C ratio was minus Rs.7,056 million and 0.610, respectively. Full cost recovery is not realized under the present tariff. Assuming that the tariff increases in Table 47.2 were applied each year, the FIRR were calculated as follows. Since the present cross subsidy from non-domestic to domestic is higher than those of other countries, four cases are set by constraining the annual tariff raise for non-domestic lower.

Table 47.2 FIRR Estimation for Each Case of Tariff Increase

Case	Tariff increase per annum				FIRR
Case 1	Domestic	0%	Non-domestic	0%	N.A.
Case 2	Domestic	3.00%	Non-domestic	1.50%	1.14%
Case 3	Domestic	4.00%	Non-domestic	2.50%	2.56%
Case 4	Domestic	4.50%	Non-domestic	3.00%	3.26%

Note: *1; Rate of tariff increase excludes the inflation adjustment.

Water tariff in the year 2025 by applying annual 4.00% increase is estimated at 2.25% of the average household income, assuming continuous economic growth of Goa State. The percentage is under the household's willingness to pay (2.48%) and is below the household's affordability to pay (3.5%). The project is deemed to financially feasible when the loan interest rate is less than 2.56%, and if the annual tariff increase of 4% and 2.5% is implemented for domestic and non-domestic sectors respectively. In this case, full cost recovery will be realized for the construction and maintenance of expanded facilities under water supply M/P until the end of the evaluation period.

(2) Sanitation Master Plan

Following benefits in Table 47.3 were selected and enumerated as tangible economic benefits of

the M/P for sanitation. Economic costs were converted from financial cost.

Table 47.3 Economic Benefit of Sanitation Master Plan

1	Cost reduction effects	1-1	Saving cost for alternative sanitation facilities
2	Environment preservation effects	2-1	Preservation of water environment expressed by willingness to pay of tourists

The economic evaluation indicated that EIRR was 15.6%. NPV, and B/C ratio was Rs.338 million and 1.24, respectively. The project is economically viable because the EIRR exceeds the opportunity cost of capital at 12%.

The FIRR was not available for the proposed sanitation projects. The benefit cost ratio (B/C) was found to be only 0.17, which indicates the present value of benefits is only 17% of the present value of costs. NPV was minus Rs.3,147 million. Input of subsidy from State Government is indispensable for PHE to implement proposed projects in the M/P for sanitation and to maintain the service. Necessary amount of subsidy and tariff increase for sanitation were estimated in the Financial Plan.

(3) PHE Financial Plan for the Water Supply and Sanitation Master Plan

1) Necessary tariff increases and subsidy for sanitation services

The financial plan consists of income statements and necessary subsidy amounts for water supply and sanitation through the project evaluation period. If only the operation and maintenance costs (including administration costs and other costs) need to be covered the sewerage charge increase in Table 47.4 would be required.

Table 47.4 Necessary Tariff Raise for Sanitation to Recover the O&M Cost

Category	Increase rate	Note
Domestic	7.5% per annum	Without inflation adjustment
Non-domestic	6.0% per annum	Without inflation adjustment

Water tariff in the year 2025 by applying annual 7.50% increase is estimated at 1.03% of the average household income, assuming continuous economic growth of Goa State. The percentage is under the household's willingness to pay (1.29%) and is below the household's affordability to pay (1.5%). The tariff increases above will significantly impact on customers. However, if the tariff raises are not implemented, the expansion of the sanitation service would result in a continuous deficit for the PHE sanitation service. It is therefore recommended that

the PHE carefully considers the expansion of the sanitation service. The PHE will need to provide better service and will need to implement public relation activities to obtain support and understanding from customers.

Following chart shows the estimated necessary amount of subsidy for sewerage enterprise with the tariff raise at 7.5% per annum for domestic and at 6.0% per annum for non-domestic, in order to keep providing the sewerage service continuously. Without this annual subsidy for sewerage enterprise, it is impossible to keep providing the project benefits perpetually.

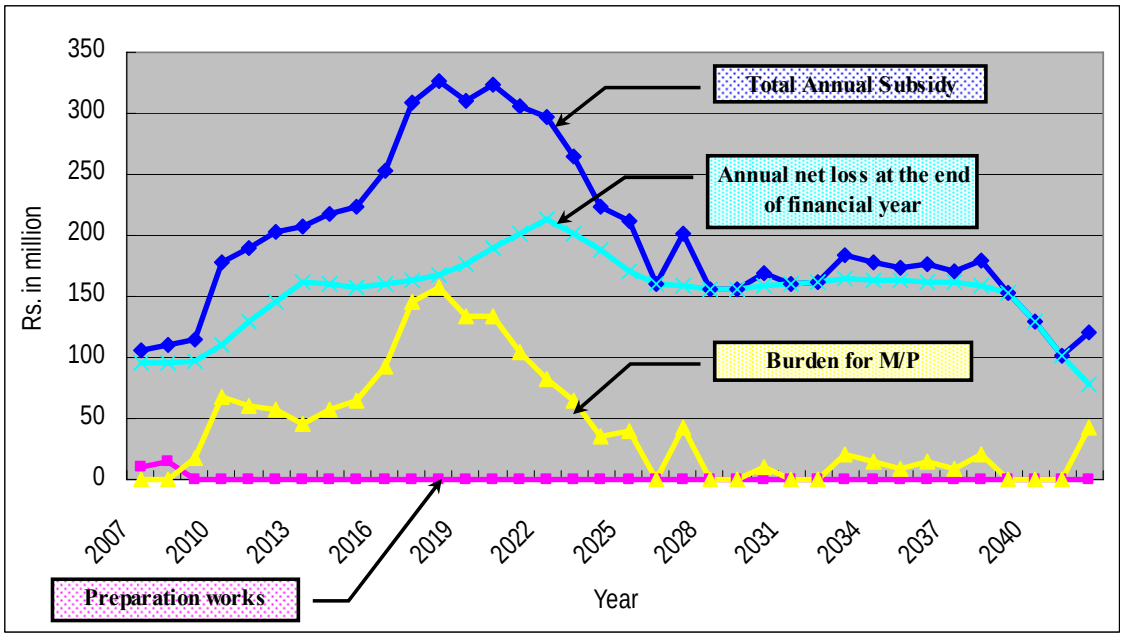


Figure 47.1 Annual Necessary Subsidy for Sanitation Service

Water and sewerage tariff in the year 2025 by applying annual 4.00% increase for water supply and annual 7.50% increase for sewerage is estimated at 3.28% of the average household income, assuming continuous economic growth of Goa State. The percentage is under the household's willingness to pay (3.77%) and is below the household's affordability to pay (5.00%).

2) Necessary subsidy for water supply services

If the tariff increases at a rate of 4% per annum at constant price, the necessary subsidy will decrease from 2013 to 2025, and will be zero after 2026. For the period between 2007 and 2017, the necessary subsidy from the State Government will reach as much as Rs.2,200 million. This large subsidy between 2007 and 2017 is the result of an annual net loss during the early stage of project and the burden for project implementation.

3) Net profit/loss and the accumulated profit/loss trends

The annual net loss during the early stage of the evaluation period will become a profit by 2023/24 and the net profit will continue after that right through to the end of the evaluation period. Due to the net losses during the early stage, the accumulated loss will increase up until the year 2022/23 and will reduce after 2023/24. An important point to note is that 'Revenue' begins to exceed 'Expenditure'. This increase in annual revenue is mainly a result of the 4% (for domestic) and 2.5% (for non-domestic) annual water tariff increases. Without this tariff raise, accumulated loss for PHE cannot reduce. The sanitation tariff increase also contributes to the reduction in the PHE's annual loss.

4.8 Initial Environmental Examination

(1) Public Consultation

Stakeholder participation has been incorporated into the project from an early stage. The public consultation has focused on the consideration of a wide range of environmental and social impacts. The stakeholder meeting (SHM) was carried out in each stage inline with the three phases of the Study. The 1st SHM was held to explain the public consultation approach that was being adopted. During the development of the Master Plan, the Study Team assisted the PWD incorporate these stakeholders' opinions into the TOR for the Initial Environmental Examination (IEE). The 2nd SHM was held by the PWD in cooperation with the Study Team. The important purpose of the meeting was to discuss site specific issues regarding the environmental and social considerations identified through the IEE with the local stakeholders.

(2) Implementation of IEE

The Study Team assisted the PWD to conduct the IEE for the Master Plan and prepared the draft environmental scoping and draft TOR for the EIA. When the PWD executed the IEE that was undertaken in conjunction with the formulation of the Master Plan, there were no reasons for changing the classification from Category "B" which were identified during preliminary Study stage.

In 1994 the MoEF listed 32 categories of industry which require mandatory EIA studies. These categories are specified in Schedule I of the Environmental Laws Acts. For water supply and sewerage projects are not listed on the Schedule I. This means an EIA report does not require submitting to the Central Government. However, the proponent needs to prepare the "rapid EIA" to gain official approval from the Goa State Pollution Control Board and DST&E and to satisfy requirement of international donor agencies.

(3) Results of IEE and Recommended Mitigation Measures

The IEE study was undertaken to identify any potential negative or positive impacts on the social and natural environment, resulting from the projects proposed under the master plan. A full evaluation of potential significant impacts and the recommendation of mitigation measures are provided in the IEE Report (see Volume IV Appendix M). Environmental scoping for the EIA was conducted in the context of the IEE.

In conclusion, it is strongly recommended that a rapid-EIA document be prepared by the proponent (PWD) to submit to the DST&E without delay. The baseline survey for the rapid-EIA should be initiated at the same time as the Feasibility Study, at the latest.

4.9 Priority Projects and Emergency Measures

4.9.1 Water Supply System

(1) Priority Projects

Expansion and rehabilitation of Salaulim Water Supply Scheme were selected as the priority projects because the scheme has the most serious problem of water shortage from the urgency point of view. The project scale was set based on a careful examination of water demand, supply capacity, raw water availability and the PWD's financial capabilities. The priority projects have been selected from the components of Stage 1 of the Salaulim Scheme. The priority projects are described below:

- Expansion of the Salaulim Treatment Plant by 100,000 m^3/day, resulting in a total capacity of 260,000 m^3/day.
- Rehabilitation and Improvement of the Existing Salaulim Treatment Plant, which has a production capacity of 160,000 m^3/day.
- Construction of a 20,000 m^3 Master Balancing Reservoir (MBR) at Sirvoi rock hill.
- Installation of 73.65 km of Transmission Mains, ϕ 150 to ϕ 1400
- Rehabilitation of 13.8 km of the Existing Transmission Mains, ϕ 1200
- Construction of six Reservoirs
- Construction of five Pumping Stations
- Replacement of 4 units of Pumping Equipment at Verna Pumping Station
- Improvement of Operation and Maintenance such as installation of flow meters, control valves and float valves and improvement of safety standards of WTPs for 7 WSSs
- Establishment of Central Laboratory

In addition to the facility expansion and rehabilitation, reduction of NRW is also major objective of the priority projects. To reduce NRW in Goa State, NRW Reduction Roll-out Plan is recommended. The NRW reduction plan includes rehabilitation of distribution facilities, improvement of quantity measurement system at treatment plants and transmission system, and replacement of defective water meters on house connections. Furthermore, in addition to the facility improvements, organizational improvements such as establishment of NRW Reduction Unit, capacity building for implementation of the NRW reduction plan are proposed in the feasibility study as part of the priority projects.

(2) Emergency Measures to be Taken by PWD/PHE

As the emergency measures, the PWD is recommended to conduct the following activities as soon as possible.

- Preparation of Asset Drawings
- Collection of Operation and Maintenance Data
- Preparation of Operation and Maintenance Manuals and Plans
- Cleaning up the Facilities
- Repair of Visible Leaks
- Implementation of On-going Projects without any Delay
- Ganjem and Maisal Schemes

4.9.2 Sanitation

(1) Priority Projects

The following factors were considered when the priority projects were being selected: number of beneficiaries, cost effectiveness, positive impacts, and urgency. The results are shown in Table 49.1. Three (3) projects, namely North Coastal Belt, Margao, and Mapusa were selected as the priority projects. A summary of the priority projects is provided in Table 49.2. In addition to the construction of sewerage facilities, sewer cleaning equipment is also proposed to be procured as part of the priority projects to secure an appropriate maintenance of sewers.

Table 49.1 Selection of Sewerage Priority Projects

		Panaji	St. Cruz	Porvorim	Margao	Ponda	Mapusa	Colva (South Coastal Belt)	North Coastal Belt
Point	Beneficiary	4.1	1.2	3.9	4.8	1.9	5.4	1.7	7.9
	Cost Effects	7.5	4.3	4.6	9.5	6.9	7.5	0.0	7.3
	Positive Impacts	3.3	1.0	2.9	5.0	1.3	4.0	0.8	4.2
	Urgency	1.2	1.5	2.2	1.2	0.4	2.7	0.5	3.5
	Total	16.1	8.0	13.6	20.5	10.5	19.6	3.0	22.9
Rank		4	7	5	2	6	3	8	1
Priority Project					★		★		★

Table 49.2 Summary of Priority Projects

Location	Unit	North Coastal Belt	Margao	Mapusa	Remarks
Expansion Area	ha	354	392	193	
Population in the Expansion Area	Person	19,771	36,781	34,260	
Trunk Sewer Construction	km	5.4	6.4	5.0	
Branch Sewer Construction	km	25.2	36.1	20.7	
Pumping Station Construction	Nos.	1	1	0	
Treatment Plant Capacity	MLD	5.6	(7.5)+6.7	5.4	(Existing)

(2) Emergency Measures to be Taken by PWD/PHE

- Implement measures upgrading sewerage connection rate including public relationship improvement, legislation setup, technical and financial assistance for the people in the coverage area.
- Undertake periodic sewer cleaning to prevent blockages and/or reduction in the sewer capacity resulting from accumulation of sand, soil and other materials.
- Survey sewer conditions, prepare cleaning schedules, procure cleaning equipment, and secure appropriate personnel and budgets.
- Prepare and maintain written records and data for assets and activities. This is very important for water supply and sewerage management.
- Replace the decayed pump facilities to secure enough capacity including stand-by pumps for peak flow and alternative operation.
- Improve sanitation in areas that will not have access to the sewerage service. This should be done by providing technical and financial assistance to the residents in terms of construction and maintenance of on-site and decentralized treatment facilities.
- Improve public relations with regards to sanitation.
- Establish a long-term renewal plan for old and deteriorated facilities. This plan should consider the installation date and the design life of each equipment/facility.
- Monitor the surface and groundwater quality to assess/improve the water environment. An effective monitoring system should include relevant organizations/agencies (e.g. the pollution control board, the health department, and the water resource department).

4.9.3 Institutional Development and Capacity Building

Following the assessment framework, specific development objectives and interventions will be introduced into each of the systems. This is fully described in the feasibility study. A technical assistance project to support Capacity Building in PHE has been formulated as part of the Priority Projects.

In the FS, technical proposal has been developed which details a broad range of institutional development activities. Some of these activities can be implemented by PHE on its own without much external support. These activities will help to lay the ground work for future improvements in organizational and management systems.

4.9.4 Improvement of Accounting System

Introduction of the independent accounting system shall be initiated by PHE and PWD with the assistance of management consultant planned in the priority projects for capacity building. Management consultant shall help the implementation of the improvement of accounting system of PWD/PHE. Counterpart of the independent accounting system development shall be selected from the major accounting staff of PHE. Management consultants will support the preparation works of the accounting system and necessary documents by the counterpart.

4.9.5 Necessity of Review of the Master Plan

This Master Plan was prepared based on information available about plans that the Goa Government has for future development, the types of developments, reasons for those developments, existing social and environmental conditions, and the general characteristics of Goa.

Great care was taken when preparing the Master Plan to address and consider the aspects listed above, based on the information available at the time. The Master Plan will need to be amended from time to time to reflect new information, changes in social, economic and environmental conditions, and changes in government policy, as they become evident. It is therefore suggested that an initial review of the Master Plan be undertaken during 2008 when the feasibility study is undertaken for the Stage II projects.

The purpose of the Master Plan is to set an overall vision for the water supply and sanitation situation in Goa and to guide water supply and sanitation improvement works that will help achieve that vision. The Master Plan is a strategic document and therefore does not define all the components of the water supply and sanitation system in detail. This means that some individual water supply / sanitation projects may be required even though they are not identified in the Master Plan. Also, emergency water supply developments may be required from time to time to mitigate severe water shortages that could not be foreseen or planned for in the Master Plan. The PWD should use their own judgment to make decisions to proceed with these small scale and emergency projects. These projects should not be discounted only because they are not included in the Master Plan.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

Goa is India's smallest state (with an area of 3,702 km^2) and as of the year 2001 had a population of approximately 1.3 million. Goa is located south of Mumbai and plays an important role as a hub connecting the northern and southern parts of India. Goa State is rich in natural mineral resources, such as Iron and Manganese, which are mined and exported to Japan. Socio-economic indicators such as the literacy rate and gross domestic product (GDP) are higher for Goa than the national averages. Land use in Goa includes a mixture of industrial, rural, urban and tourism uses. The topography includes elevated hilly areas and lower flat areas, which are used as paddy fields.

Goa has a monsoonal climate, with an average annual precipitation in excess of 2,000 mm. There are seven existing surface water supply schemes in Goa (e.g. the Salaulim Scheme which sources water from Salaulim Dam) and approximately 15 existing groundwater supply schemes. Water supply service is limited to several hours each day even in the capital city Pananji.

Water demand is continuously increasing (due to population growth and economic development) and is approaching the capacity of the existing water supply system. This is beginning to constrain socio-economic development in Goa.

Only the cities of Panaji, Vasco, and part of Margao are serviced by conventional sewerage systems. The average coverage ratio is only 5 %, which is lower than the national average. Even where sewer pipelines are installed, the connection ratios remain low (e.g. 7 % in Margao and 19% in Vasco in year 2004). People who are not connected to the sewerage system mainly use on-site sanitation (e.g. pit latrines), however 30% of the rural population does not have adequate sanitation facilities and therefore depends on open defecation.

During the peak tourism season (i.e. the dry season) the populations in coastal areas double and therefore the volume of sewage generated increases. The existing sewage systems do not have sufficient capacity to accommodate the higher loads and therefore inadequately treated sewage is discharged into the sea. The Government of Goa is eager to develop a range of industries and believes that tourism could be a key growth industry, due to Goa's beautiful coastal resources. However, an increase in tourism could increase the amount of inadequately treated sewage being discharged to the sea. During the rainy season many septic tanks overflow due to rises in the groundwater table. The inadequate capacity of the sewage systems within Goa is

a concern because the overflows and discharges pollute the coastal areas.

There is a clear need for additional water supply and sewage system capacity in Goa, especially for cities, industrial estates and tourism resorts in the southern districts. Therefore, during 2002, the Government of India (GOI) requested an assistance of the Government of Japan (GOJ) concerning the augmentation of water supply and sanitation for Goa. The GOJ has agreed to undertake the study. Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation programs for the GOJ, is responsible for the study.

During September 2004, JICA dispatched a Preparatory Study Team to India to undertake a preliminary investigation to define the purpose and scope of the study. The purpose and scope of the study was agreed between GOI and the JICA.

In March 2005, the JICA Study Team was dispatched to India/Goa to hold inception meeting with Indian side such as Ministry of Urban Development (MOUD), Government of Goa, and Public Work Department (PWD) Goa. The JICA Study Team explained the study purpose, study area, scope of work, work schedule, work assignments, personnel schedule, reporting requirements and role of the GOI which were described in Inception Report.

Indian side and the JICA Study Team agreed contents of the Inception report and signed Minutes of Meeting on the Inception Report. During the Inception meeting, the Indian side requested to extend the target year from 2020 to 2025 and the JICA agreed the extension. This agreement is also described in the Minutes of Meeting.

1.2 Milestones of the Study Work

The Study was conducted in three phases as shown below.

1st Phase: Reconnaissance Survey, from March to September 2005
2nd Phase: Preparation of Master Plan, from October 2005 to March 2006
3rd Phase: Feasibility Study, from April 2006 to November 2006

As an output of each phase, the Study Team prepared and submitted several reports. Report submissions and milestones of the Study are as follows.

September 22, 2004	Signing agreement on Scope of Work for Study
September 22, 2004	Signing Minutes of Meeting on Preparation of Scope of Work
March 2, 2005	Submission of Inception Report
March 4, 2005	Meeting on the Inception Report with MOUD in Delhi
March 7, 2005	Meeting on the Inception Report with PWD Goa
March 11, 2005	Signing Minutes of Meeting on the Inception Report at MOUD in Delhi
April 17, 2005	Commencement of 1st Phase Study Work in India
August 22, 2005	1st Steering Committee Meeting
August 23, 2005	1st Workshop and 1st Stakeholder Meeting
October 16, 2005	Commencement of 2nd Phase Study Work in India
October 17, 2005	Submission of Progress Report to MOUD in Delhi
October 19, 2005	Submission of Progress Report to PWD Goa
November 9, 2005	Meeting on Progress Report
December 1, 2005	Signing Minutes of Meeting on the Progress Report at PWD Goa
December 23, 2005	2nd Stakeholder Meeting
January 5, 2006	2nd Steering Committee Meeting
January 6, 2006	2nd Workshop
April 4, 2006	Commencement of 3rd Phase Study Work in India
April 5, 2006	Submission of Interim Report to MOUD in Delhi
April 10, 2006	Submission of Interim Report to PWD Goa
April 27, 2006	3rd Steering Committee Meeting on the Interim Report
Jun 29 , 2006	Signing Minutes of Meeting on the Interim Report
July 18, 2006	3rd Stakeholder Meeting
July 25, 2006	3rd Workshop
July 27, 2006	4th Steering Committee Meeting
September 26, 2006	Submission of Draft Final Report to MOUD in Delhi
September 28, 2006	Submission of Draft Final Report to PWD Goa
September 29, 2006	5th Steering Committee Meeting
October 4, 2006	Signing Minute of Meeting on the Draft Final Report

Respective minutes of meeting of meetings shown above are included in Volume IV M11 Minutes of Meetings.

CHAPTER 2

OBJECTIVES OF THE STUDY AND STUDY AREA

CHAPTER 2 OBJECTIVES OF THE STUDY AND STUDY AREA

2.1 Objectives of the Study

The objectives of the Study are to:

1) formulate a master plan for augmentation of water supply and sanitation in Goa State. The target year of the master plan is 2025;
2) conduct a feasibility study for priority project(s) which will be selected from the master plan; and
3) pursue technology transfer to the counterpart personnel in the course of the study.

2.2 Study Area

The water supply study area covers all of Goa.

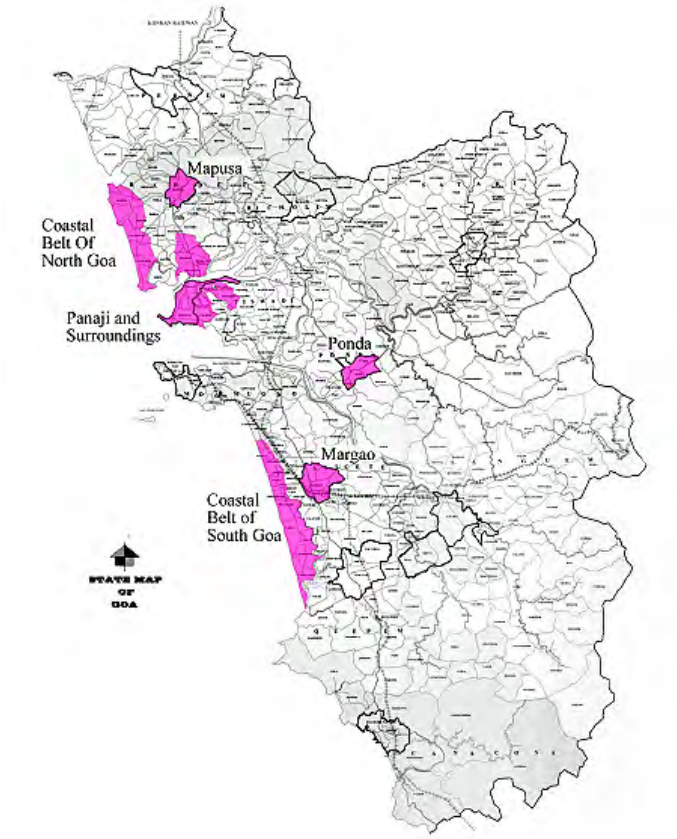


Figure 22.1 Study Area for Sanitation

The sanitation study area covers the following areas as shown on Figure 22.1.

- Margao Municipality;
- Ponda Municipality;
- Mapusa Municipality;
- Coastal belt of south Goa;
- Coastal belt of north Goa; and
- Panaji Municipality and its surrounding area (Provorim, Taleigao, Dona Paula, Caranzalem, St. Cruz, Merces, Ribandar).

2.3 Description of the Study Area

2.3.1 Natural Conditions

(1) Location and Topography

The state of Goa is located on the western seaboard of India, about 600km south of Mumbai. The state is relatively small having an area of 3,702 km^2. Goa has 11 talukas which are divided into the two districts of North Goa and South Goa. The state capital is Panaji and the commercial capital is Margao.

Goa has similar physical features to those of the neighboring states of Karnataka and Maharashtra. Goa has the following three distinct geographical divisions:

1) The Sahyadri Region: This region is located to the east, is mountainous, covers an area of approximately 600 km^2, and has an average elevation of 600m . The Sahyadri Region is covered by forest and is the catchments area of the rivers.

2) The Middle Level Plateaus: At the centre of this region there are plateaus, with elevations of between approximately 30m to 100m. Iron-ore mining and cashew and spice plantations are common in this region. Although the soil depths are generally thin in this area, some low-lying areas are cultivated.

3) The Costal Region: This region consists of the low lying river basins and includes the costal areas and the floodplains/alluvial flats. The Coastal Region has productive agricultural cultivation and therefore has rural agricultural settlements. There are also fishing villages and urban settlements.

Soil corrosiveness was examined under the study and results of the soil investigation are shown in Volume IV Appendix 21 Soil Corrosiveness Survey. Tow samples were taken from the middle level plateaus, laterite samples, and these samples were not corrosive according to the results of analysis. However soil along the coastal lines might be corrosive because of sea water intrusion.

(2) Weather and Precipitation

Goa has balmy tropical weather, with temperatures generally ranging between 25 to 32 centigrade (during April-May and October-November the temperature exceeds 30 degree by noon). Goa has torrential monsoon rains between June and September. The average annual

rainfall is approximately 3,000 mm, while the average rainfall during the monsoon season (June-September) is approximately 2,700mm (which is 90% of the annual rainfall). Figure 23.1 shows the average rainfall for each month from 1999 to 2001 at Ghatja Pandu and Neturlim.

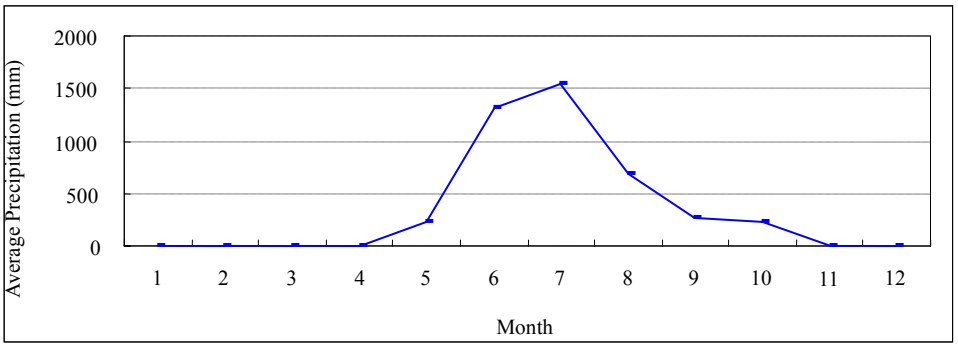


Figure 23.1 Average Rain Fall in Each Month

(3) Water Resources

Goa has many rivers, creeks, backwaters and marshes. There are nine main rivers, Tiracol, Mandovi, Zuari, Colvale, Sal, Talpona, Saleri, Canacona and Galjibag, with a total of 42 tributaries. The longest river is Zuari (63km) followed by Mandove (62km). These main rivers provide water for irrigation, transportation (of ore and people), fish nurseries and potable water sources. The rivers are feed by rainfall runoff and are tidal. During high tide, the salty seawater surges upstream into the rivers making wells along the riverbanks brackish and unpotable.

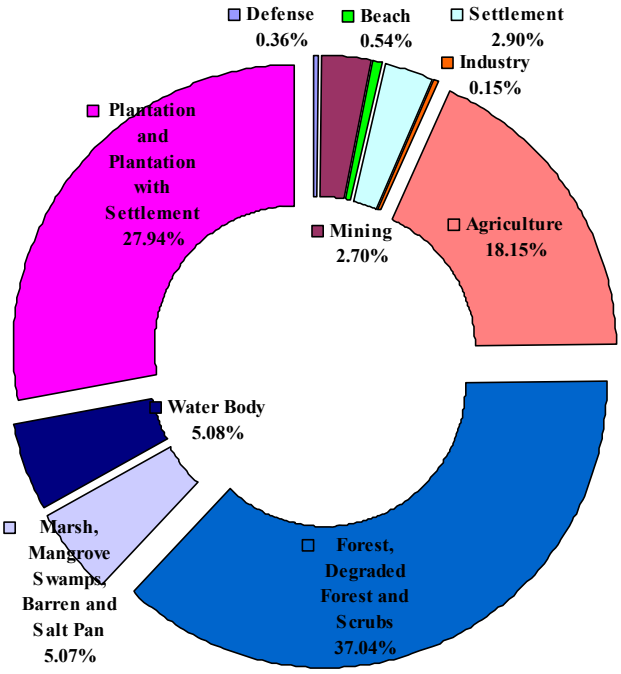
It is estimated that Goa has access to 8,570 million m^3 of surface water each year. Based on estimates of the amount of land suitable for irrigation development, approximately 1,125 m^3/year could be required to irrigate 82,280 ha of land. Another 200 million m^3/year or water has been considered for domestic, industrial, power and tourism uses.

The total rechargeable ground water resources of Goa are estimated at approximately 340 million m^3/year. Of this, approximately 100 million m^3/year is proposed for domestic and industrial uses, leaving a balance of 240 million m^3/year for irrigation. Currently, only 8.3% of the ground water resources are being used (this includes irrigation and domestic/industrial uses).

(4) Land Use

Figure 23.2 shows the current land use types, based on satellite images from the year 1999. The main land use characteristics are as follows:

1) Most of the settlement and road development is concentrated in the costal talukas.
2) Agricultural areas are located mainly along the rivers or near the coast.
3) The areas used exclusively for plantations are located in the midlands, while the plantations that are interspersed with settlements are usually located in coastal areas.



Source: Town and Country Planning Department 1999

Figure 23.2 Existing Land Use Distribution

(5) Ecology

More than 37% of Goa is covered by forests (see figure 23.2). Approximately 60% of the forest area is declared "protected areas" (PA) as wildlife sanctuaries and national parks. These PAs support and nurture a variety of ecosystems and life forms – both flora and fauna. In particular, the Western Ghat areas are one of the most biodiversity areas of the world.

(6) Environmental Problems

Goa faces a multitude of environmental problems. Mining and related activities cause very significant environmental impacts. The other environmental issues include deforestation, erosion, soil acidity, irrigation within forest land, and ingress of brackish water onto low lying land.

The rivers (mainly Mandovi and Zuari rivers) have high turbidity, suspended solid loads and

electrical conductivity, largely as a result of effluent discharge from wet mine pits, beneficiation plants, and draining of mine dumps into the rivers. Also, untreated domestic effluent is discharged in large quantities into the Zuari and Mandovi rivers. This pollution increases the biological oxygen demand (BOD) and suspended solid load of the rivers. The activities also restrict the use of river water for further use and adversely affect the downstream hydraulic regime.

Fertilizer usage is very low in Goa (approximately 42kg per ha compared to the national average of 90kg per ha). The consumption of phosphorous and potash has been decreasing since 1990-91 and, nitrogen consumption has not increased as much as expected.

2.3.2 Socio-Economic Conditions

(1) Cultural Background

Historically, Goa was a Portuguese colony, while most of India was under British rule. The Portuguese left Goa in 1961, and Goa remained under the central government's control until 1987, when Goa was recognized as a state of India.

The major tribes in Goa are Dhodia, Dubla, Naikda, Siddi, and Varli. The official language of the Goa is Konkani. English and Hindi are widely understood.

The majority of the people in Goa are Hindu. The other main religions are Christianity and Muslim. The Uniform Civil Code of Goa advocates equality to all religions and castes.

(2) Population and Urbanization

The population census of 2001 estimated the population of Goa to be 1,343,998. Four censuses have been completed for Goa (1971, 1981, 1991 and 2001). The census data shows that that the population growth rate of Goa decreased from 16.08% during 1981-1991 to 15.21% during 1991-2001.

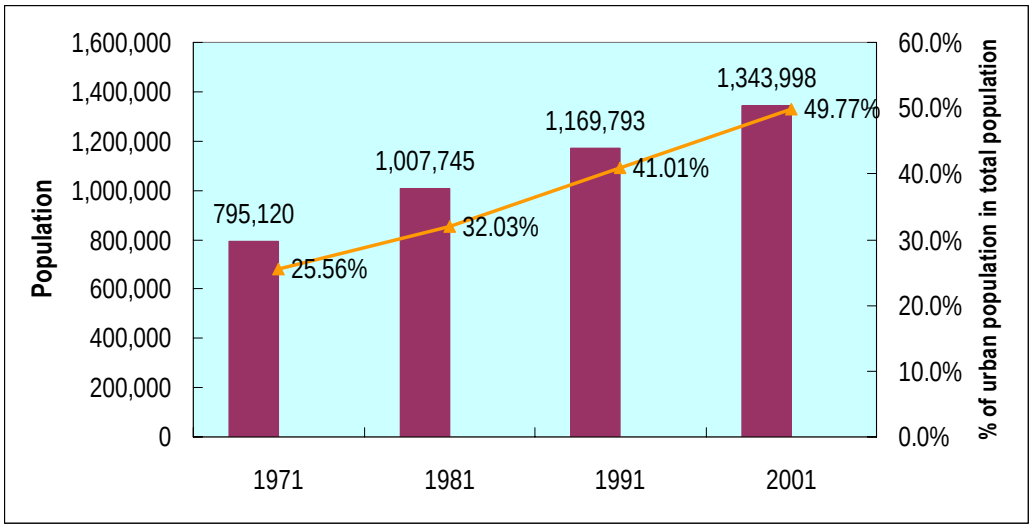


Figure 23.3 Population of Goa

In Goa, half of the total population lives in urban area. The increase in urban population has been occurring for some time, as shown in Figure 23.3. For example, in 1981 32% of the population lived in urban areas, in 1991 this had grown to 41% and by 2001 49% of the population was living in urban areas. The urbanization in Goa is closely related to the development of the tertiary industry (service sector) in urban area.

(3) Economic Conditions

Goa is one of India's most developed states. Goa has the highest per capita net state domestic product in India (Rs. 49, 673 in 2001-2002). During the period 1993-94 to 1999-2001, the Gross State Domestic Product (GSDP) of Goa increased by 8.7% each year, at constant prices. Table 23.1 shows recent GSDP details.

Table 23.1 Gross State Domestic Product at Factor Cost by Industry of Origin from 1998-99 to 2002-03 at Current Prices

(Rs. In Lakhs)

No.	Category	1998-99	1999-2000	2000-2001	2001-2002	2002-2003 projection
1	Agriculture, Frestry, & Fishing	54,119	61,734	61,669	61,287	66,944
2	Mining & Quarrying	31,679	26,308	28,636	28,047	35,343
	Sub Total - Primary Industry	*85,798*	*88,042*	*90,305*	*89,334*	*102,287*
3	Manufacturing	151,664	192,198	204,498	229,257	245,557
4	Electricity, Gas and Water Supply	11,491	8,727	2,668	8,809	21,721
5	Construction	31,553	27,163	44,000	50,015	49,889
	Sub Total - Secondary Industry	*194,708*	*228,088*	*251,166*	*288,081*	*317,167*
6	Trade, Hotels and Restaurants	85,849	91,735	116,005	92,928	93,302
7	Transport, Storage & Communication	90,737	98,825	113,973	114,901	121,717
8	Financing, Insurance, Real Estate & Business Services	88,320	103,803	105,707	110,623	120,718
9	Community, Social & Personal Services	62,094	65,672	74,952	84,432	89,315
	Sub Total - Tertiary Industry	*327,000*	*360,035*	*410,637*	*402,884*	*425,052*
10	**Total Gross State Domestic Product (GSDP)**	**607,506**	**676,165**	**752,108**	**780,299**	**844,506**

Source: Economic survey 2003-2004, and Economic Survey 2004-2005

The proportion of the GSDP represented by the primary sector is continuously declining (e.g. from 21% in 1993-94 to 11% at 2001-2002). The percentage of workers in the primary sector also declined from 27.5% in 1991 to 16.6% in 2001.

The secondary (industrial) sector has grown at annual rate of 11.9%, at constant prices, during 1993-94 to 2000-01. There are now over 6,000 small scale industrial plants and 154 medium and large industries. During 2001-2002 the secondary sector represented 36.9% of the GSDP. The manufacture of chemicals and chemical products contribute the largest proportion of the secondary sector income (54%). The manufacture of food products and beverages is the second largest at 14%. Goa produces more than 60% of the India's total iron ore exports. Goa's iron ore exports represent almost Rs.1,000 crore per year.

The tertiary sector produces most of Goa's GSDP. The tertiary sector has grown at 9.5%, at

constant prices, during the period of 1993-94 to 2000-01. Tourism plays an important economic role for Goa, as shown in Table 23.1 (e.g. trade, hotels and restaurants represent 11.9% of the total GSDP in 2001-02).

(4) Tourism

Many tourists visit Goa every year. Over 10% of all foreign travelers in India visit Goa. Tourism in Goa earns nearly 15% (more than Rs.1,500 crore per annum) of India's total foreign exchange. Table 23.2 shows the actual tourist numbers in Goa.

Table 23.2 Tourist Arrival in Goa 2000 - 2004

Year	Number of Tourist			Annual Growth Rate
	Domestic	Foreign	Total	
2000	976,804	291,709	1,268,513	1.9%
2001	1,120,242	260,071	1,380,313	8.8%
2002	1,325,296	271,645	1,596,941	15.7%
2003	1,725,140	314,357	2,039,497	27.7%
2004	2,085,729	363,230	2,448,959	20.1%

Source: Department of Tourism, Governemnt of Goa

The population in Goa (1,343,998 people) is almost equal to the number of tourists visiting Goa in 2001. The annual number of tourists visiting Goa is increasing. For example, in 2000 there was a 1.9% increase, in 2002 there was a 15.7% increase and in 2004 there was a 20.1% increase. This trend is expected to continue. It is important to preserve Goa's tourism resources to help sustain economic growth (especially for the tertiary industry) in Goa, and to sustain the country's foreign exchange earnings.

(5) Poverty

Goa has less poverty than most other Indian states. The Statistical Hand Book of Goa (2001) quotes the average annual income per capita in Goa as Rs. 45,105, which is about 2.7 times higher than the average national income (which is Rs. 16,487). According to the survey carried out by the Planning Commission in 2000, the proportion of the state's population below the poverty line is only 4.4% (consisting of 7.7% in urban areas and 1.35% in rural areas). Most of those living in poverty in urban areas within Goa have come from other states, they live in informal settlements and do not have stable incomes.

(6) Education

The literacy rate in Goa (in 2001 they were: total 82.3%, male 88.9%, female 75.7% in 2001) is significantly higher than the national average (total 52.41% in 2001). Goa is the second most literate state in India (Kerala is the most literate). The teacher – pupil ratio in Goa is 1:22, which is higher than the national ratio of 1:40. The proportion of children advancing to high school is 23.2% in Goa, which is higher than the national average of 17.4%.

(7) Public Health

Table 23.3 (Directorate of Health Service (DHS)) shows that public health conditions in Goa are better than many other states in India.

Table 23.3 Comparison of health indicators between Goa and all India

Indicator		Goa	All India
Birth rate (1998)		1.77	3.2
Infant mortality rate (2002)		17/1,000	63/1,000
Average life expectancy (2001)	Male	61.1	54.1
	Female	66.6	54.7
Population per hospital (2001)		9,217	61,810
Population per bed in hospital (2001)		259	1,412

Source: Statistical Hand Book of Goa 2001, and Economic Survey 2004-2005

(8) Budget and Financial Situation of the Government of Goa

Goa's revenue and expenditure is shown in Table 23.4. The Government of Goa collects revenue from three major sources: the state's tax revenue, non-tax revenue, and transfers from the central Government. Approximately 70% of the tax revenue originates from sales tax. The main sources of non-tax revenue are from the supply of power and water. However, water supply revenue only represents 5% of the total revenue. Of special interest is the fact that the PWD budget represented 16% of the total state expenditure during 2002-2003, and the PHE budget represented 8.8% of the total state expenditure in the same year.

Presently, the Government of Goa is experiencing a fiscal deficit, and the deficit is growing, as shown in the Table 23.4. In the fiscal year 2001-2002, the proportion of fiscal deficit to GSDP was 5%. In 1993-1994, the ratio of fiscal deficit to GSDP was 2.5%.

Table 23.4 Revenue and Expenditure of the Government of Goa

(Rs. In crore)

Year	Tax Revenue	Non-tax revenue	Central Transfers	**Total Revenue**	Revenue Expenditure	Capital Expenditure	**Total Expenditure**	Other Income (loss)	**Fiscal Deficit**	**Public Debt Stock**
1999-2000	458	119	136	**714**	923	178	**1100**	42	**-344**	**1198**
2000-2001	515	103	172	**790**	1016	303	**1319**	116	**-413**	**1490**
2001-2002	570	194	167	**931**	1159	271	**1431**	76	**-424**	**1826**
2002-2003	603	330	191	**1124**	1291	290	**1581**	82	**-375**	**2141**
2003-2004	811	356	188	**1355**	1395	397	**1792**	7	**-430**	**2570**
2004-2005(RE)	836	440	302	**1578**	1654	570	**2224**	18	**-628**	**n.a.**

Note: n.a.; not available. RE: Revised Estimates

Source: Economic Survey 2004-2005

As of 31 March 2004, Goa had Rs.2570 crore of public debt as shown in Table 23.4. Approximately 60% of the debt was originated from central loans and 31% was from market loans. Interest payments as a percentage of the total State Government revenue was 26.5% during the year 2000-2001, which means one quarter of the total revenue was expended on interest payments. During 2000-2001, 55.7% of State Government borrowings were used for current expenditure and 44% was used for investment. More than half of the borrowed money was expended for short-term purposes.

The State Government is currently implementing the 2000 – 2005 Medium Term Fiscal Reforms Programme (MTFRP). The MTFRP is being implemented in accordance with the Eleventh Finance Commission report of the Government of India, which sets targets for all the Indian states. As a component of the fiscal reform strategy, the Government of Goa has implemented a Voluntary Retirement Scheme for government employees. This is the first time that this scheme has been introduced in India. With regards to the water supply sector, the MTFRP raised the target for the annual compound growth rate to 17% as a means of increasing the non-tax revenue. The continuous growth of the water supply sector is important for Goa's financial situation.

(9) Power Supply

Frequent power supply cuts are a major problem for the operation of water supply and sewerage systems in Goa. Goa's only power generation plant is in Napthqa, (operated by M/s Reliance Salgaonkar Power Company Ltd) and produces 48 million watts. Therefore, Goa almost entirely depends on power allocated from the centrally controlled power stations in the western and southern regions of India, delivered through neighboring state grids. Currently, 284 million watts are delivered from the western region and 100 million watts form the southern

region. A major problem for power delivery to Goa is that there are no dedicated transmission lines from the central power stations directly to Goa. There are some potential sites for hydro power generation (estimated at approximately 36 MW at 60% load factor, which is equivalent to 60 million watts of hydro power potential), however the realization of this potential is restricted by the presence of reserve forest areas in the Western Ghats Region.