(6) Evaluation of Sewerage Facilities

1) Sewer Network

Results of hydraulic analysis (flow capacity) on sewer network of Panaji City to identify problems in existing condition, year 2001, are shown in this section.

a. Study Methodology

The steps of analysis are shown below.

Step 1: Figure out sewer service area, population
Step 2: Presume contributory population of target sewers of network
Step 3: Presume design flow of each sewer
Step 4: Figure out diameter, length, and slope of each sewer
Step 5: Figure out flow velocity and flow capacity of each sewer (Manning's formula)
Step 6: Compare the flow capacity with the design flow and judge

Assumptions as shown in Table 32.12 are set for the analysis on the sewer network for evaluation of sewer network capacity.

Table 32.12 Assumptions for Sewer Network Analysis

Item	Assumption
Population	Adopt population mentioned in the Report for year 2001
Connection rate	100%, that is whole wastewater generated is discharged into sewers
Contributory population of each sewer	Distribute zone population to each sewer catchments proportional to its sewer length
Sewer cross-section area reduction due to silting	Not considered
Flow capacity margin	Not considered

b. Sewerage Zone wise Population and Wastewater Quantity

Sewerage zone wise population and generated wastewater quantity in year 2001 have been considered as shown in Table 32.6.

c. Flow of Each Sewer

As contributory area, population and flow of each sewer for year 2001 are not mentioned in the Report "Project Outline on Environmental Upgrading of Panaji City, Phase-1", it was assumed that population in the catchment area of each sewer is proportional to its sewer length. Then sewerage zone wastewater quantity is divided into sewer catchment area in same manner as the population.

Sewers are designed for peak flow. According to the Manual on sewerage and sewage treatment or sewerage system of India, the peak factor should depend on the scale of contributory population in the sewer catchment area. In the case of Panaji City, with population 58,785 in year 2001, peak factor should be 2.25. See Volume IV Appendix M35.1 Flow Calculation Sheet for Main and Sub Main Sewers, Panaji City and M35.2 Flow Calculation Sheets for Branch Sewers, Panaji City for design flow of each sewer.

d. Sewer Flow Capacity

Flow capacity of main sewer, sub main sewers and branch sewers is estimated using following Manning's formula. Roughness coefficient of 0.015 (fair condition of concrete pipe) has been adopted because almost all sewers were installed within last 20 years and these sewers are not in so bad physical condition according to PWD engineers.

Manning's formula:

$$Q = AV$$

$$V = R^{2/3} \cdot I^{1/2} / n$$

Where:

- Q : Flow capacity (m^3/sec)
- A : Area of cross-section of sewer (m^2)
- V : Flow velocity (m/sec)
- n : Roughness coefficient (=0.015)
- R : Hydraulic radius (m)
- I : Gradient

e. Criteria for Evaluation on Flow Capacity

The adequacy of sewer flow capacity at present condition has been evaluated with criteria shown in Table 32.13 comparing peak flow with flow capacity of the sewer. In the case of gravity sewer, the sewer was judged "adequate" when flow capacity is greater than peak flow, leaving desirable capacity margin out of consideration, as this stage is not for design. In the case of pressure main, it was judged "inadequate" when flow velocity exceeds 3.0 m/sec as preliminary evaluation.

Table 32.13 Criteria for Evaluation on Flow Capacity Investigation

Type	Condition	Judgment
Gravity Sewer	Peak flow <= Flow capacity	Adequate
	Peak flow > Flow capacity	Inadequate
Pressure Main	Flow velocity <= 3.0 m/sec	Adequate
	Flow Velocity > 3.0 m/sec	Inadequate

f. Result of Evaluation of Sewer Flow Capacity in Present Condition

The result of evaluation is shown in Table 32.14. This Table includes the list of capacity gravity sewers and pressure main with inadequate flow capacity. Three reaches are detected as inadequate as shown in summary Table 32.14. See Figure 32.4 and Table in Volume IV Appendix M35.1 Flow Calculation Sheet for Main and Sub Main Sewers, Panaji City , M35.2 Flow Calculation Sheets for Branch Sewers, M35.5 Panaji City and Data of Flow Calculatoion Sheet of Sewers for details.

Table 32.14 Summary of Result of Evaluation on Sewer Flow Capacity

(List of Inadequate Capacity Sewers and Pressure Main in Present Condition)

Node 1		Node 2		**Estimated peak flow (lps)**	Diameter (mm)	Length (m)	Gradient	**Flow Capacity (lps)**	Remarks
From	To	From	To						
Zone III to Zone IV									
3	4 (PS3)	23	42	**66.5**	300	22	200	**59**	Gravity Sewer
		42	44	**70.2**		67			
		44	63	**79.8**		35			
		63	68	**83.0**		27			
		68	53	**87.2**		22			
		53	34F	**88.8**		28			
		34F	PS3	**102.6**		10			
Sub total						211			
4	5	PS3	21	102.6	200	320	**Velocity: 3.3 m/sec**		Pressure Main
Zone VII to Zone XII									
13	29 (STP)	223B	224A	**239.2**	600	130	500	**238**	Gravity Sewer
		224A	225	**241.3**		110			
		225	225A	**259.2**		44			
		225A	232	**269.9**		640			
		232	232C	**294.9**		76			
		232C	STP	**324.3**		70			
Sub total						1,070			

Note: (1) Node 1: Node numbers in column “Node 1”is coordinated to Figure 3.2.xx
(2) Node 2: Node numbers in column “Node 2” is coordinated to Sewerage Zone Map

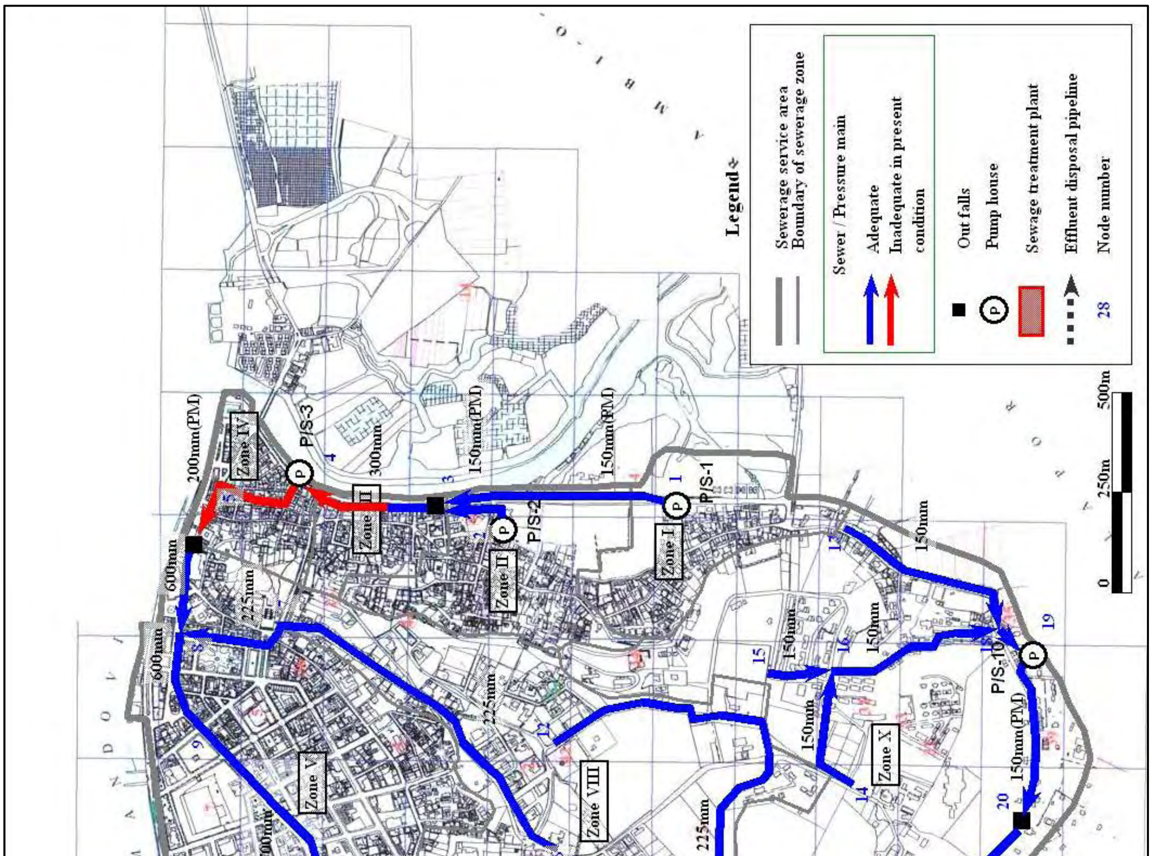

Figure 32.4 Result of Evaluation on Flow Capacity, Panaji City

g. Physical Condition of Sewers and Manholes

Many sewers and manholes in Zones I, II, III, IV, V and VII were installed in 1960's, about 40 years ago. After that, those in Zones VI, VIII, IX, X, XI and XII were installed during the period between 1970s and 1995. According to an interview of a PWD engineer who is in charge of sewerage system in Panaji City, PWD has not experienced severe damages of sewers caused by sulphuric acid or heavy traffic load. But almost all manholes are masonry works, and some are physically damaged because of long use. These damaged manholes and joints are supposed to be one reason for high infiltration rate in rainy season. But infiltration flow runs up about 50 % of actual wastewater in rainy season according to PWD.

2) Pumping Station

a. Evaluation of Pump Capacity

Table 32.15 compared the existing pumping station capacity with the sewage inflow in 2001 reported by "Project report on environmental upgradation of Panaji City".

Table 32.15 Pumping Station Capacity and Present Sewage Inflow

Pumping Station	Inflow (m^3/sec)	Pump Capacity (m^3/sec)	Evaluation
P/S-1	0.0237	0.1364	**OK**
P/S-2	0.0237	0.0414	**OK**
P/S-3	0.0870	0.1278	**OK**
P/S-5	0.2320	$0.5095 + \alpha^{*1}$	**OK**
P/S-9	0.0170	0.2105	**OK**
P/S-10	0.0111	0.0647	**OK**
P/S-11	0.0240	0.1000	**OK**
P/S-12	0.0020	0.0233	**OK**

*1; No information of discharging capacity in No.1 Pump

Photo 32.1 Outside View of P/S-3

Photo 32.2 Outside View of P/S-5

b. Existing Facility Evaluation

Mechanical and electrical equipment of the existing pumping stations are evaluated by observation, operation records and age. The results were presented in Volume IV Appendix M35.6 Information of Pumping Stations, Panaji City.

3) Sewage Treatment Plant

a. Evaluation of Treatment Capacity of the STP

There are two sewage treatment facilities in Panaji STP, one is trickling filter and the other is SBR. The new STP (= SBR) capacity will be evaluated by its design capacity because the old trickling filter is not in operation now.

The detailed process design calculation of SBR process is presented in Volume IV Appendix M35.7 Capacity Calculation of STP. The results of the design calculation are compared with capacity of the existing SBR in Table 32.16. The result shows that it has enough capacity.

The quality of raw sewage and treated effluent were also shown in Table 32.16. The effluent qualities treated by SBR are less than 10 mg/L both BOD and SS, they met the effluent standards. Regarding the raw sewage quality, BOD concentrations were low as 53 mg/L and 82 mg/L, however, they are almost in the range of fluctuation, past data ranged 66 to 208 mg/L shown in Table 32.10.

Table 32.16 Capacity and Water Quality of Existing STP (SBR Process)

Capacity			
Facilities	Design Requirement	Existing Facility	Evaluation
Wet Well	>5.0 min.	40.7 min.	OK
Pump	New equipment settled in 2005		OK
Grit Chamber	13.0 m^2	23.0 m^2	OK
SBR Tank	6,250 m^3	7,040 m^3	OK
Disinfection Tank	130 m^3	200 m^3	OK
Sludge Dewatering	11.7 m^3/hr	20.0 m^3/hr	OK
Sludge Drying Bed	284 m^2	2,025 m^2	OK

Water Quality, 2005						
	Parameters	Season	Sampling	Law sewage	Treated effluent	Standard
Panaji	pH	Dry	22/06/05	7.1	7.4	5.5 - 9.0
		Rainy	17/07/05	6.3	6.9	
	BOD(mg/L)	Dry	22/06/05	53	7.4	30
		Rainy	17/07/05	82	5.5	
	SS(mg/L)	Dry	22/06/05	42	4.5	100
		Rainy	17/07/05	67	5.0	
	Coliform(MPN/100ml)	Dry	22/06/05	46,000,000	1,100,000	
		Rainy	17/07/05	4,600,000	1,100,000	

Photo 32.3 Preliminary Treatment

Photo 32.4 SBR Reactor Tank

b. Existing Facility Evaluation

New SBR plant has no problem because it is just constructed in April 2005. The sewage treatment is operated properly by visual inspection at the site. Recently, sludge treatment/dewatering has started and treated sludge is disposed by tracks from Panaji STP.

Old trickling filter plant has been used over 40 year. The plant requires mechanical/electrical equipment replacement as well as rehabilitation and reinforcement of civil and architectural structures.

(7) Problems Identified

1) Sewer Network

The following problems are identified during the reconnaissance survey and the evaluation of existing sewers. Table 32.17 show the problems identified about sewers.

Table 32.17 Problems Identified

Problems Identified
1. Lack of information on sewer network detail 1.1 Drawings; - Sewerage service area, Sewer alignment - Longitudinal section of sewers 1.2 Flow calculation sheet - Catchment area, population, design flow - Diameter, length, slope, invert elevation - Flow velocity, flow capacity
2. Insufficient flow capacity for design flow - Main sewer upstream of Pumping Station No. 3 - Pressure Main from Pumping Station No. 3 - Main sewer upstream of Sewage Treatment Plant
3. Masonry work manholes cause much excess flow in rainy season
4. Silting due to low flow velocity, illegal disposal of garbage

2) Pumping Station

Although eight pumping stations have enough pumping capacity for the present sewage flow, there are many problems as shown below.

- All the existing pumping stations have no flow measuring equipment.
- Garbage covers wet wells in many pumping stations.
- Most of equipment has been operating more than 15 years, the possibility of sudden pump fault is increasing with its age.
- Existing pumping stations do not have provision for power supply failure.
- Lack of information (drawings, data of O&M, etc.) on pumping stations

3) Sewage Treatment Plant

Quantity of sewage inflow to the new treatment plant is less than its treatment capacity, the new treatment plant treat sewage satisfactorily.

- The existing plants do not have backup power supply.
- The treatment process of the old plant is quite different from the new one. The operation & maintenance of new plants will be complicated and it may cause operation/maintenance error.
- The cost of old plant rehabilitation will be quite large since it needs structural rehabilitation as well as equipment replacement.

3.2.3 Margao Sewerage System

(1) Introduction

Margao Municipality is regarded as commercial and cultural capital of Goa state, which is connected to the national highway and railway systems by the highway NH-4A and NH-17 and with Konkan Railway and South Central Railway. The population of Margao is 78,382 (census 2001). Margao is served by the Salaulim Water Supply Scheme.

For the sewerage system, the municipality has been divided into three zones, namely North, Central and South. The North and Central zones of the municipality have sewerage system. A sewage treatment plant of 7.5 MLD capacity has been commissioned in May 2000 to cater for North and Central zones. Because of financial constraint, the implementation of the sewerage scheme to the South zone has been delayed. In the South zone, the existing septic tank and soak pit system, and pit latrine are contaminating the surface and groundwater, which results in degradation of environment and public health.

(2) Sewer Network

In this section, current sewer network plan for Margao City will be reviewed for evaluation on flow carrying capacity of the sewer network mentioned. This plan was formulated in 1990's originally, but original documents are not available during this study. Therefore, a report named "Under Ground Drainage Scheme to Margao Town (published date not clear)" formulated for revising of project costs has been reviewed. However, abovementioned report was formulated for cost estimates mainly, and hence contains a few data on technical aspects except flow calculation sheets for sewers. In addition, a general sewer network plan including some tables on technical data and sewerage zone wise sewer network maps (4 maps, two for North Zone and two for Central Zone) are available for the review and reference.

1) Sewerage Service Area and Population

According to the Report "Under Ground Drainage Scheme to Margao Town", and attached general sewer network plan, sewerage service area is about 876 ha, a part of Margao Municipality area of 1,679 ha. As the general sewer network plan does not show actual service area boundary line for 876 ha, the boundary lines of actual service area were drawn tentatively considering existing branch sewer network, land use plan map for year 2007 and the comment of an engineer of PWD that the service area does not include uninhabited area such as steep hills, flood prone lowland and arable land. The prepared tentative sewerage service area by the Study Team is shown in Figure 32.5 shaded in yellow color. Based on the prepared map, the measured area covered under sewerage system is 841 ha (35 ha less than the figure given in above mentioned Report). The measured area value of 841 ha has been adopted for review on existing sewerage facility for year 2001.

Census population of 78,382 in year 2001 has been adopted for study in this section, as the Report does not mention regarding population in year 2001. It is assumed that sewerage service area population is same as total population of the Municipality. Sewerage service area and population are shown in Table 32.18.

Table 32.18 Sewerage Service Area and Population

Item	Area (ha)	Population in 2001	Remarks
Sewerage service area	**841**	78,382	
Out of sewerage service area	838	0	Uninhabited area
Total	1,679	**78,382**	

Source: Attached plan drawing for sewer system
Note: Population in year 2001 is Census figure

2) Wastewater Generation in the Sewerage Service Area

a. Per Capita Per Day Wastewater Generation

Wastewater generation of Margao City is calculated on the basis of projected population and per capita per day wastewater generation, not on water demands like Panaji City. It has been assumed that per capita per day wastewater generation in year 2001 is same as that of the target year considered in the report above mentioned as shown in Table 32.19.

Table 32.19 Per Capita Per Day Wastewater Generation

	Year 2001
Per Capita Per Day Wastewater Generation (lpcd)	180

Source: Attached plan drawing for sewer system
Note: It is assumed figure for year 2001same as year 2011 (=180 lpcd)

b. Wastewater Generation

Wastewater generation in the year 2001 is calculated using the value of the service population of 78,382 and per capita per day wastewater generation as shown in Table 32.20.

Table 32.20 Estimated Wastewater Generation

Item	Year 2001
Population	78,382
Per capita per day wastewater generation (lpcd)	180
Expected wastewater quantity (m^3/day)	14,109

3) Sewerage Zone and Zone wise Wastewater Quantity

The sewerage service area of Margao City is divided into 3 sewerage zones namely North Zone, Central Zone and South Zone as shown in Figure 32.5 and given in Table 32.21.

North Zone is located in north and west part of the City and it includes large areas with agricultural land and uninhabitable steep hills. Central Zone occupies central and east part of the city. In the center of this zone, east-west-long flood prone lowland lies and divides the sewerage zone into two sub sewerage zones. South Zone is located in south part of the City. Though South Zone contains congested commercial and institutional area of the City, sewers are not installed in the zone yet.

Table 32.21 Sewerage Zones and Zone Wise Area

Zone	Sewerage Service Area (ha)		Remarks
	The Report *1	Measured	
North Zone	360	**259**	Installed in 1990's-
Central Zone	308	**307**	Installed in 1990's-
South Zone	208	**275**	Not Sewered yet
Total	876	**841**	

Note: "Measured area" is measured on basis of Figure 32.4
*1; "Under Ground Drainage Scheme to Margao Town"

Zone wise wastewater quantity of year 2001 was calculated assuming that sewerage service area and population distribution in year 2001 is same as year 2011. Sewerage zone wise population, population density and wastewater quantity are presented in Table 32.22. Consequently, overall population density of whole sewerage service area has been estimated to be 93 persons/ha in year 2001.

Table 32.22 Sewerage Zone wise Population and Population Density

Zone	Area (ha)	Year 2001			Year 2011		
		Population	Population Density (Person/ha)	Wastewater Generation (MLD)	Population	Population Density (Person/ha)	Wastewater Generation (MLD)
North Zone	259	22,833	88	4.11	34,956	135	6.29
Central Zone	307	22,411	73	4.03	34,311	112	6.18
South Zone	275	33,138	121	5.97	50,733	184	9.13
Total	841	78,382	93	14.11	120,000	143	21.60

Note: (1) Areas of each sewerage zone is measured area on sewerage zone map
(2) South zone is not sewered in year 2001 yet

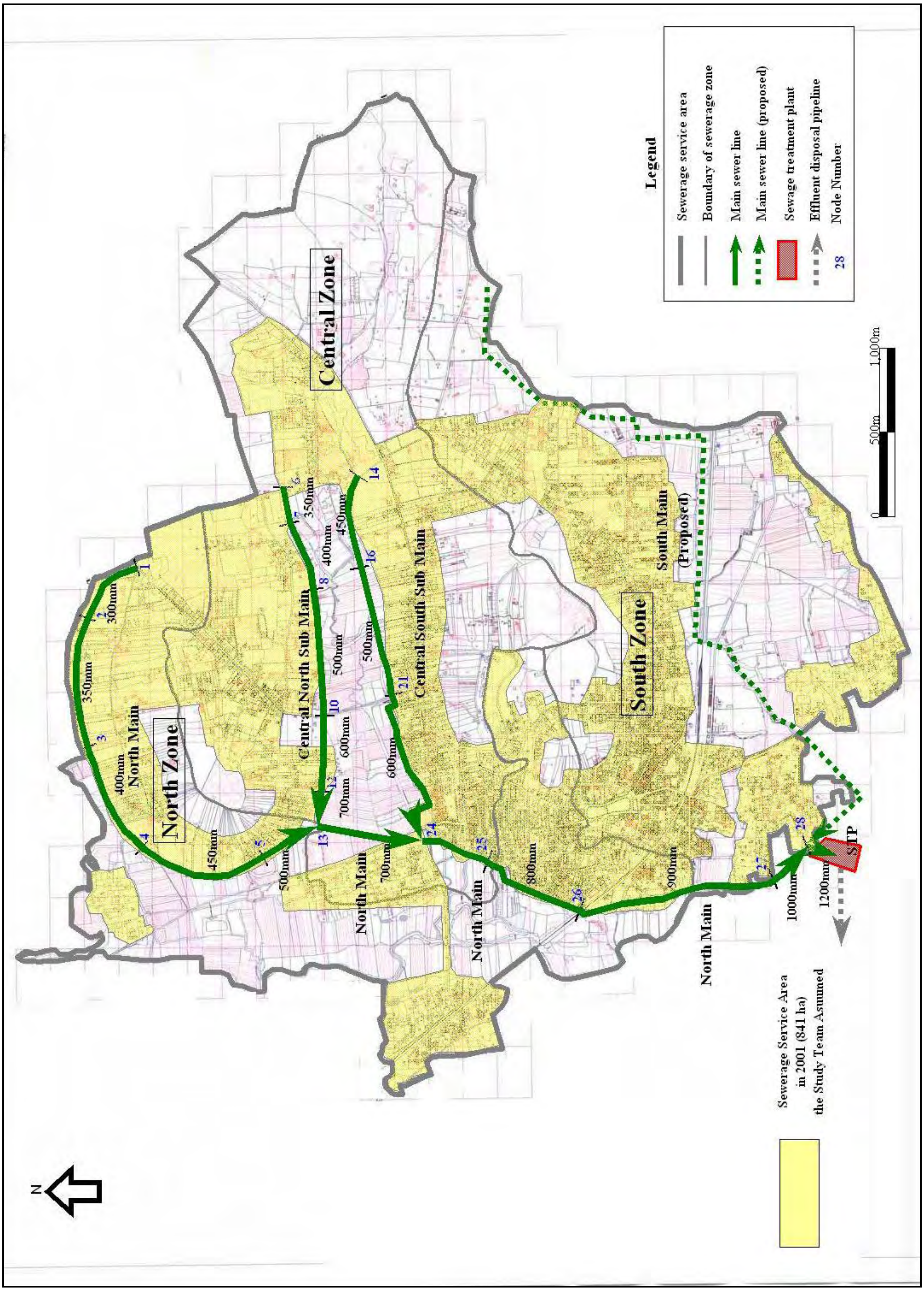

Figure 32.5 Existing Sewer Network, Margao City

4) Main Sewer and Sub Main Sewers

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 up to now. Some branch sewers in North and Central Zones are still under construction.

North Main starting at the northeast side of North Zone runs westward along a narrow canal/drainage channel to receive wastewater of households in low area easily, and then it turns southward to the sewage treatment plant in South Zone.

On the way to the sewage treatment plant, North Main receives wastewater from Central North Sub Main, then from Central South Sub Main. The catchments of these two sub mains are north part and south part of Central Zone, respectively.

The main sewer and sub main sewers are shown in Figure 32.5 and summary of main and sub main sewers are shown in Table 32.23. General descriptions of main and sub main sewers every node numbers used in Volume IV Appendix M35.11 General Description of Main and Sub Mains, Margao City corresponds to nodes shown on Figure 32.5. See flow calculation sheets in Volume IV Appendix M35.8 Flow Caculation Sheet for Main and Sub Main Sewer Margao City for detail of main sewer and sub main sewers.

Additionally, a main sewer namely South Main is proposed by PWD to receive sewage generated in South Zone, which will run westward in South Zone and will finally connect to North Main at a manhole located in the sewage treatment plant site. It is also observed that there is no pumping station for main sewer and sub main sewers in North and Central Zone. One pumping station is proposed by PWD in South Zone.

5) Branch Sewers

Diameter and Length of branch sewers are quoted from flow calculation sheet of the report "Under Ground Scheme to Margao Town". Some sewers were revised based on actual field condition according to engineers of PWD. The minimum diameter of branch sewer is 150 mm and maximum is 350 mm. See flow calculation sheets in Volume IV Appendix M35.9 Flow Calculation Sheet for Branch Sewers, Margao City for detail on branch sewers.

Summary of information for sewers is shown in Tables 32.23 and Volume IV Appendix M35.12 Sewerage Zone and Diameter wise Sewer length, Margao City.

Table 32.23 Summary of Existing Sewers

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
Note: South Zone is not sewered yet

(3) Pumping Station

There is no pumping station in North and Central Area because sewage is collected by gravity in these areas.

(4) Sewage Treatment Plant (STP)

The Margao sewage treatment plant is located in the south west of the municipality and it has stared operation from March 2000. It was designed by Indian consultant company and the finance source was PWD. The STP has been designed considering the future sewage generation in 30 years, which is estimated at 21.0 MLD. The capacity of the existing STP has built up in modules the first module being of 7.5 MLD capacity. The plant site is large enough for future expansion using the same treatment process. Facilities of the existing STP are presented in Volume IV Appendix M35.13 List of Existing STP Facilities, Margao City , flow diagram and layout are shown in Figure 32.6 and 32.7 respectively.

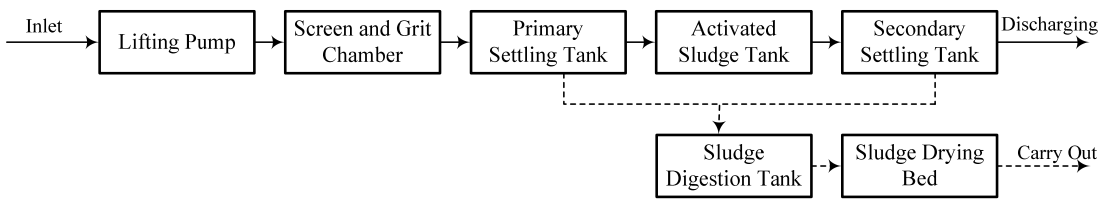

Figure 32.6 Flow Diagram of Margao STP

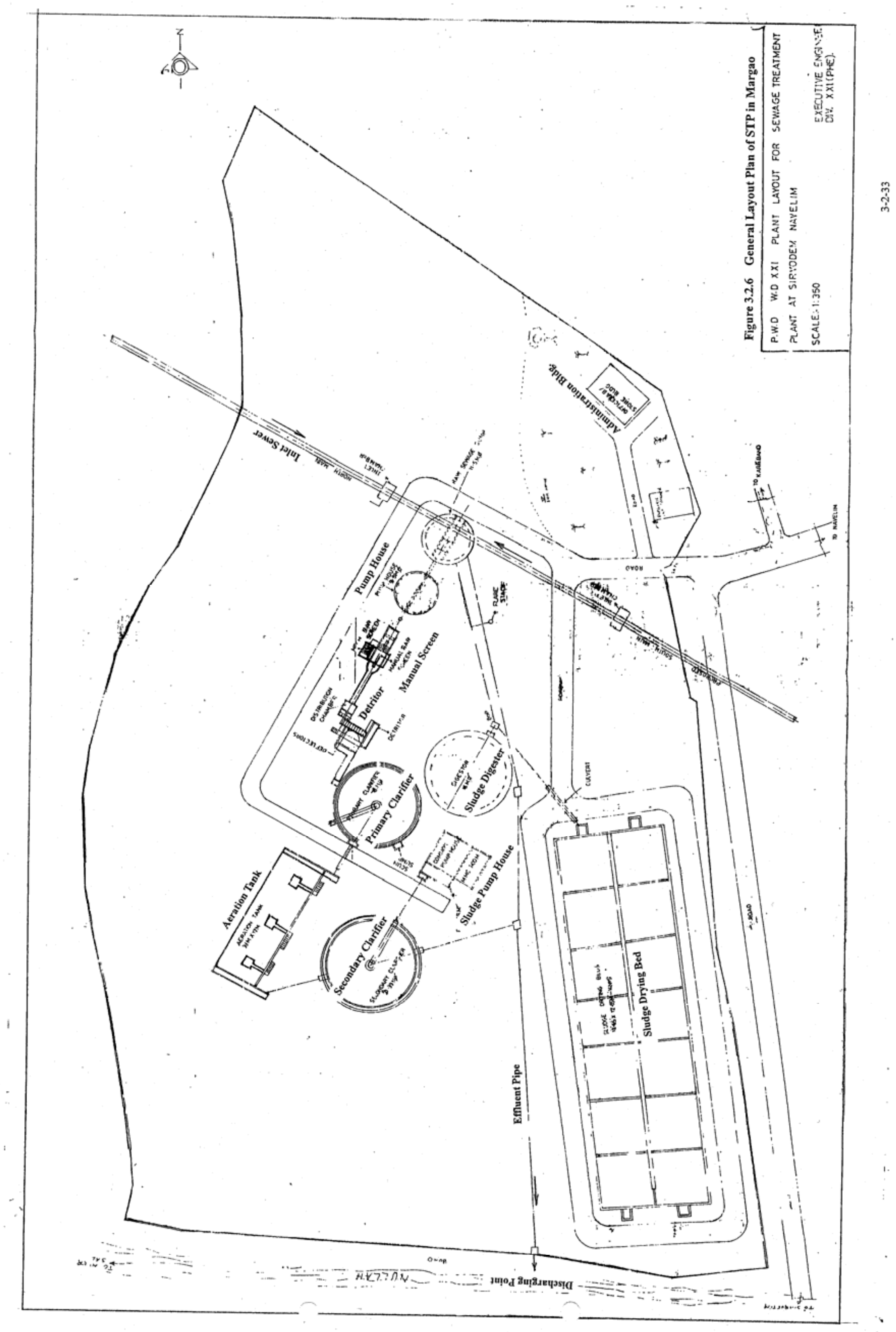

Figure 32.7 General Plan of Margao STP

Photo 32.5 Preliminary Treatment

Photo 32.6 Aeration Tank

(5) Evaluation of Sewerage Facilities

1) Sewer Network

a. Study Methodology

Results of hydraulic analysis on sewer network of Margao City to identify problems in existing condition, year 2001, are shown in this section. The evaluation of sewers is conducted with the same methodology as the study of Panaji (refer to Section 3.2.2, (6)).

b. Sewerage Zone wise Population and Wastewater Quantity

Sewerage zone wise population and generated wastewater quantity in year 2001 as shown in Table 32.20 are considered. As South Zone was not sewered till year 2001 although shown in table below, wastewater generated in South Zone is not discharged to the sewer network actually.

c. Flow of Each Sewer

Sewers are designed for peak flow. According to the Manual on sewerage and sewage treatment or sewerage system of India, the peak factor should depend on the scale of contributory population in the sewer catchment area. In the case of Margao, with population 78,382 in year 2001, peak factor should be 2.25. See Volume IV Appendix M35.8 Flow Calculation Sheet for Main and Sub Main Sewer Margao City and M35.9 Flow Calculation Sheet for Branch Sewers, Margao City for design flow of each sewer.

d. Sewer Flow Capacity

Flow capacity of main sewer, sub main sewers and branch sewers are estimated using the Manning's formula which is mentioned in Section 3.2.2, (6).

e. Criteria for Evaluation on Flow Capacity

Adequacy of sewer flow capacity in present conditions was evaluated with criteria shown in Table 32.24 comparing peak flow with flow capacity of the sewer. In the case of gravity sewer, the sewer has been judged "adequate" when flow capacity is greater than peak flow, leaving desirable capacity margin out of consideration, as this stage is not for design.

Table 32.24 Criteria for Evaluation on Flow Capacity Investigation, Margao City

Type	Condition	Judgment
Gravity Sewer	Peak flow <= Flow capacity	Adequate
	Peak flow > Flow capacity	Inadequate

f. Result of Evaluation of Sewer Flow Capacity in Present Conditions

In the case of Margao City, there is no sewer with insufficient flow capacity including main sewer, sub main sewers and branch sewers. The reason being that sewer network was designed for the service area population in year 2011 (120,000 persons) with enough flow capacity margin, and population in 2001 is 78,382, about 65% of the target population. See table in Volume IV Appendix M35.8 Flow Calculation Sheet for Main and Sub Main Sewer Margao City, M35.9 Flow Calculation Sheet for Branch Sewers, Margao City and M35.10 Data for Flow Calculation Sheet of Sewers in Year 2001, Margao City for details.

g. Physical Condition of Sewers and Manholes

According to a PWD engineer, PWD doesn't have serious troubles on sewers or manholes, as they are still new. Installation of Sewers and manholes in Margao City started from around year 1990, about 10 years ago in North and Central Zone.

2) Sewage Treatment Plant

a. Evaluation of Treatment Capacity of the STP

The existing Margao STP is evaluated comparing its design requirement to the present capacity. The detailed process design calculation is presented in Volume IV Appendix M35.14 Capacity Calculation of STP (Activated Sludge), Margao City. The results of comparison are set out in Table 32.25.

The result shows that it has enough capacity, only the activated sludge tank is slightly smaller than the requirement. The deficiency in task size is only 5 %, thus, it does not have any impacts on efficiency of the biological sewage treatment.

The water qualities of Margao STP were presented in Table 32.25 and the treated effluent qualities met the effluent standard.

Regarding the raw sewage quality, both BOD and SS concentrations are very low compared with Panaji ones（53 and 82 mg/L BOD 42 and 67 mg/L SS）, almost half in dry season and much less in rainy season. The reason of low concentration is considered that the few sewerage connection compared with the sewer construction.

Assuming the groundwater infiltration is coming according to the sewerage development, it is estimated 1,250 m^3/day, which is 17% of 7.5 MLD, STP capacity. Considering the condition of 2005, 1500 person were connected, the raw sewage quality is calculated as 47 mg/L BOD. The measured quality in dry season (30.5 mg/L BOD) is a little lower but it seems within a range of fluctuation. In addition, cross connections with drainage are suspicious considering the lower concentration in rainy season.

Table 32.25 Capacity and Water Quality of Existing STP Facility

Capacity			
Facilities	Design Requirement	Existing Facility	**Evaluation**
Wet Well	>10.0 min.	152.0 min.	OK
Pump	15.1 HP + 30.1 HP	25.0 HP + 50.0 HP	OK
Grit Chamber	7.8 m^2	10.0 m^2	OK
Primary Settling Tank	242 m^2	254 m^2	OK
Activated Sludge Tank	1,250 m^3	1,188 m^3	OUT
Secondary Settling Tank	313 m^2	346 m^2	OK
Sludge Digestion Tank	1,875 m^3	2,709 m^3	OK
Sludge Drying Bed	2,083 m^2	2,222 m^2	OK

Water Quality, 2005						
	Parameters	Season	Sampling	Low sewage	Treated effluent	Standard
Margao	pH	Dry	09/06/05	6.4	7.2	5.5 - 9.0
		Rainy	13/07/05	6.1	7.2	
	BOD(mg/L)	Dry	09/06/05	30.5	13.0	30
		Rainy	13/07/05	6.0	3.0	
	SS(mg/L)	Dry	09/06/05	28.0	9.5	100
		Rainy	13/07/05	8.0	2.0	
	Coliform(MPN/100ml)	Dry	09/06/05	11,000,000	460,000	
		Rainy	13/07/05	4,600,000	46,000	

b. Existing Facility Evaluation

It has been only 5 years from the STP commissioning in May 2000. The following mentions are found by the site survey.

b-1 Operational Condition

- Sewage treatment was properly operated.
- Sludge treatment facility is not operated since no excess sludge is generated due to inflow of low pollution load.
- There are no disinfection facilities to control pathogen concentration.

b-2 Observation

- Structure walls of treatment facilities show some cracks.
- Metal structure such as handrails or steel panel was corroded badly. Some of them may cause danger to operators.

(6) Problems Identified

1) Sewer Network

The following problems are identified during the reconnaissance survey and the evaluation of existing sewers. Table 32.26 show the problems identified.

Table 32.26 Problems Identified

Problems Identified
1. Lack of information on sewer network detail
1.1 Drawings;
- Sewerage service area, Sewer alignment
- Longitudinal section of sewers
1.2 Flow calculation sheet
- Catchment area, population
- Invert elevation

2) Sewage Treatment Plant

- The largest problem is the inflow of weak crude sewage (low pollution load). STP cannot function effectively.
- No power generators are installed for power failure.
- No disinfection facility to improve the quality of effluent.

3.2.4 On-site Treatment System

(1) Septic Tank for Domestic Wastewater

The septic tank + soak pit is located in Aquem area in the main part of Margao City. This area will a part of the sewerage service area in the future, "South Zone", but is not sewered yet. The housing complex using this septic tank + soak pit includes several dozen of households and some shops on ground floor facing main road. As the septic tank is located on gentle slope of a hill, it may not be flooded even in rainy season. Detailed data with photos obtained during survey has been given in Volume IV Appendix M35.15 Data Sheets and Photos for Investigation on On-site Treatment Facilities.

The septic tank was constructed under the ground nearby the housing complex. According to PWD engineer who conducted survey, the septic tank is a typical one and made of laterite bricks and waterproofed by mortar plaster. Schematic of treatment process is shown below.

Schematic of Treatment Process

(Black and gray water from households and shops)

↓

Septic Tank

↓

Soak Pit

↓

(Infiltration) or (Overflow and discharging into side ditch of road)

During survey it is observed that soak pit effluent was discharged to side ditches. The effluent seemed clear and emitted no odors, but water in the ditch looked polluted and appeared gray in color. This side ditch meets a nala, wastewater/storm water drainage, and finally joins the Sal River.

According to the engineer, overflow from soak pit is usually observed not only in rainy season due to high elevation of water table, but also in dry season because of choking of old soak pit. Overflow from soak pit usually starts after six months to one year after its installation. Users of septic tank + soak pit are responsible for the maintenance, but it is common that soak pit is left as it is even if overflow begins. Operation and maintenance of septic tank is carried out occasionally when there is choking, not at regular intervals. Removed sludge is carried to Margao Sewage Treatment Pant and discharged into inlet chamber of its.

(2) Wastewater Treatment Facility for a Hotel

The hotel surveyed is Taj Exotica Hotel with 140 bedrooms at Varka beach, Salcete, near Margao City, located in "South Coastal Belt" of the study area, and this area is not sewered. See Volume IV Appendix M35.15 Data Sheets and Photos for Investigation on On-site Treatment Facilities for detail data and photos on this survey site.

Treatment facility is located beside hotel building and has the capacity of 220 m^3/day (0.22 MLD). Treatment process is activated sludge process, chemical coagulation, sand filtration, activated carbon adsorption, and water softening. Schematic of treatment process is shown below.

Treated effluent is used for gardening in hotel premises, but effluent discharging pipe to the sea is also installed for emergency purpose.

Schematic of Treatment Process

(Black and gray water from hotel) ↓ **Bar Screen** ↓ **Aeration Tank** ↓ **Secondary Clarifier** ↓ **Flocculator** ↓ **Clarified Water Tank** ↓ **Pressurized Sand Filter** ↓ **Activated Carbon Adsorber** ↓ **Softener** ↓ (Reuse for gardening in hotel campus or discharging into seawater)

(3) Wastewater Treatment Facility for a Factory

The factory surveyed is a chemical fertilizer of Zuari Industries Ltd. located in Zuari Industrial Complex on hillock near Dobolim Airport in Vasco-Da-Gama City, outside sewerage service area of the City. This factory, for its production purpose, uses public supplied water after additional treatments. Wastewater from production process is treated and recycled.

In addition to water treatment facilities used for production purposes, the factory has wastewater treatment plant for domestic wastewater generated by 800 employees of the factory. See Volume IV Appendix M35.15 Data Sheets and Photos for Investigation on On-site Treatment Facilities for detail data and photos on this survey.

Treatment facility for domestic wastewater is located inside the premises. Treatment process is activated sludge process, and sand filtration, and its capacity is 480 m^3/day (0.48 MLD) for 800 employees. Effluent of secondary sedimentation tank looks clear, but the sedimentation tank is covered with thick scum and weed indicating lack of maintenance. Schematic of treatment process is as shown below.

Treated effluent is used for gardening in factory premises, and is not discharged to public water body.

Schematic of Treatment Process

(Black and gray waters from factory employee)
↓
Aeration Tank
↓
Secondary Sedimentation Tank
↓
Pressurized Sand Filter
↓
(Reuse for gardening in factory premises)

(4) Wastewater Treatment Facility for a College

The college surveyed is Birla Institute of Technology, a new college for science and technology near Zuari Industrial Complex mentioned above. Students and teaching staff members is expected to 2,000 at present to 4,000 in the future. See Volume IV Appendix M35.15 Data Sheets and Photos for Investigation on On-site Treatment Facilities for detail data and photos collected during survey.

Treatment facility is located outside the college campus. Treatment process is FAB (Fluidized Aeration Beds) technology and sand filtration with the capacity of 600 m^3/day (0.60 MLD). A small centrifuge for sludge dewatering is equipped. The equipment was not operated temporarily due to summer holiday. Schematic of treatment process is shown below.

Treated effluent is used for gardening in college campus, and is not discharged to public water body. Excess sludge is dewatered at the plant and disposed to the dumping site.

Schematic of Treatment Process

(Black and gray water from college)
↓
Inlet Tank
↓
FAB Reactor Tank
↓
Secondary Sedimentation Tank
↓
Pressurized Sand Filter
↓
(Reuse for gardening in college campus)

3.2.5 Water Quality Analysis for Sanitation

(1) General

Water quality analysis of sewerage was undertaken to assess the treatment process efficiency at the existing Panaji and Margao Sewage Treatment Plants and to determine the need for new sewerage systems by investigating the receiving water quality in the river and sea.

Table 32.27 shows the number of samples and sample parameters. All the results of water quality analysis for sanitation is shown in Volume IV Appendix M33 Water Quality Analysis for Sanitation.

Table 32.27 Water Quality Analysis for the Sanitation

<table>
<tr><th colspan="3" rowspan="2">Sampling Locations</th><th colspan="4">Parameters for analysis</th></tr>
<tr><th>pH</th><th>BOD_5 *1</th><th>SS</th><th>Coliform</th></tr>
<tr><td rowspan="3">Panaji/Margao STPs</td><td colspan="2">Inlet</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td colspan="2">Treated Water</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td colspan="2">Discharged Water</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td rowspan="4">Rivers</td><td rowspan="2">Mandovi</td><td>River Mouth</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Upstream</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td rowspan="2">Zuari</td><td>River Mouth</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Upstream</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td rowspan="2">Sea</td><td colspan="2">North Goa（2 Points）</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td colspan="2">South Goa（2 Points）</td><td>2</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td colspan="3">Number of Samples to be taken in Each Season</td><td>14</td><td>14</td><td>14</td><td>14</td></tr>
<tr><td colspan="3">Total Number of Samples</td><td>28</td><td>28</td><td>28</td><td>28</td></tr>
</table>

*[1]: COD tests were used for the sea samples, instead of BOD_5.

The water quality for sewerage was evaluated on the ‘Ambient Standard for Ambient Air, Automobiles, Industries and Noise, Central Pollution Board in India, 2002 July’.

Figure 32.8 Location of Water Quality Sampling Point for Sanitation

(2) Results of Water Quality Analysis for Sanitation

1) Sewage Treatment Plant

For the existing Panaji and Margao sewage treatment plants, raw sewage and treated effluent quality were analyzed for pH, BOD,SS, and coliforms. The results of water quality examination were presented in Table 32.28.

Regarding the pH, BOD and SS, the treated effluent quality for both of the STPs met the effluent standards during both the dry and rainy seasons. Coliform is not regulated in standards, the analysis showed that the sewage treatment process reduced the number of coliforms at both STPs during both seasons. The raw sewage of both BOD and SS concentration in Margao are very low, it is analyzed in 3.2.3 (5) 2).

Table 32.28 Water Quality of Panaji and Margao STP

	Parameters	Season	Sampling	Low sewage	Treated effluent	Standard
Panaji	pH	Dry	22/06/05	7.1	7.4	5.5 - 9.0
		Rainy	17/07/05	6.3	6.9	
	BOD(mg/L)	Dry	22/06/05	53	7.4	30
		Rainy	17/07/05	82	5.5	
	SS(mg/L)	Dry	22/06/05	42	4.5	100
		Rainy	17/07/05	67	5.0	
	Coliform(MPN/100ml)	Dry	22/06/05	46,000,000	1,100,000	
		Rainy	17/07/05	4,600,000	1,100,000	
Margao	pH	Dry	09/06/05	6.4	7.2	5.5 - 9.0
		Rainy	13/07/05	6.1	7.2	
	BOD(mg/L)	Dry	09/06/05	30.5	13.0	30
		Rainy	13/07/05	6.0	3.0	
	SS(mg/L)	Dry	09/06/05	28.0	9.5	100
		Rainy	13/07/05	8.0	2.0	
	Coliform(MPN/100ml)	Dry	09/06/05	11,000,000	460,000	
		Rainy	13/07/05	4,600,000	46,000	

2) Rivers

The water quality examinations were conducted on samples from the Mandovi and Zuari Rivers and the samples for these rivers were taken from the river mouth as well as upstream. The survey results were presented in Table 32.29. The water quality was shown to be worse at the river mouth in both rivers, compared to their upstream water quality, during both the dry and rainy seasons.

The results of both Mandovi and Zuari Rivers showed that BOD levels exceed the water quality standards of 3mg/L, some pollutants may be derived from human activities. The results also showed that the water quality was worse in the rainy season compared with the dry season, pollutants settled in the dry season may be flushed by rainwater. To achieve the water quality standard, countermeasures including sewerage are recommended.

Table 32.29 Water Quality of the Mandovi and the Zuari Rivers

	Parameters	Season	Sampling	Place		Standard
	Location			Panaji River mouth	Khandola Upstream	
Mandovi	pH	Dry	11/06/05	7.8	7.7	6.5 - 8.5
		Rainy	28/07/05	7.0	6.6	
	BOD(mg/L)	Dry	11/06/05	4.8	3.4	3
		Rainy	28/07/05	5.8	4.6	
	SS(mg/L)	Dry	11/06/05	6.5	3.0	
		Rainy	28/07/05	30.0	14.0	
	Coliform(MPN/100ml)	Dry	11/06/05	460	430	
		Rainy	28/07/05	-	-	
	Location			Cortalim River mouth	Ponchavadi Upstream	
Zuari	pH	Dry	10/06/05	7.6	6.9	6.5 - 8.5
		Rainy	28/07/05	7.7	6.4	
	BOD(mg/L)	Dry	10/06/05	4.4	3.2	3
		Rainy	28/07/05	6.3	5.0	
	SS(mg/L)	Dry	10/06/05	20.5	7.0	
		Rainy	28/07/05	58.0	37.0	
	Coliform(MPN/100ml)	Dry	10/06/05	4,600	2,400	
		Rainy	28/07/05	110,000	24,000	

3) Sea

Four sea water samples were collected, one each from Baga and Calangute on the North Beach and Colva and Benaulim on the South Beach. The survey results were presented in Table 32.30.

The pH of both North and South Beach did not exceed the pH standard, on the other hand, the BOD levels exceed the water quality standards of 3mg/L same as rivers. Measures including sewerage is also recommended.

Table 32.30 Water Quality of North and South Coastal Belts

	Parameters	Season	Sampling	Place		Standard
Location				Baga	Calangute	
North Coastal Belt	pH	Dry	11/06/05	8.1	8.1	6.5 - 8.5
		Rainy	21/07/05	7.5	7.6	
	BOD(mg/L)	Dry	11/06/05	-	-	3
		Rainy	21/07/05	7.8	8.4	
	SS(mg/L)	Dry	11/06/05	8.5	10.0	
		Rainy	21/07/05	30	21.0	
	Coliform(MPN/100ml)	Dry	11/06/05	460	460	
		Rainy	21/07/05	2,400	4,300	
	Location			Colva	Benaulim	
South Coastal Belt	pH	Dry	10/06/05	7.9	7.9	6.5 - 8.5
		Rainy	20/07/05	7.9	8.1	
	BOD(mg/L)	Dry	10/06/05	-	-	3
		Rainy	20/07/05	8.0	7.3	
	SS(mg/L)	Dry	10/06/05	11.5	5.5	
		Rainy	20/07/05	16.0	11.0	
	Coliform(MPN/100ml)	Dry	10/06/05	75	95	
		Rainy	20/07/05	11,000	24,000	

4) Conclusion

The results of water quality analysis will be summarized as follows

- The treated effluent at the Panaji and Margao STPs did not exceed the effluent standards for pH, BOD, and SS in either the dry or rainy seasons.
- The sewage treatment process was shown to decrease the number of coliform during both the dry and rainy seasons.
- The pH levels did not exceed water quality standards in either the Mandovi or Zuari River, during either the dry and rainy seasons. The BOD standard was exceeded in both rivers during both seasons.
- The sea water quality for both North and South Goa did not exceed the pH standards during both the dry and rainy seasons. The BOD exceeded the water quality standard (of 3 mg/L) during the rainy season for both North and South Goa.
- The sea water quality at the North beach was worse than the sea water quality at the South beach.
- The sea and river water quality was found to be worse during the rainy season as compared to the dry season.

3.2.6 Summary of Existing Problems Identified

(1) Low Service Coverage of Sanitary Toilets

According to the Census 2001, 13% of Goa's urban population is served by sewerage systems and 51.8% of the rural population and 30.8% of the urban population had no sanitary toilet and use open defecation.

(2) Lack of Asset Drawings, Asset Data

The PWD does not have adequate drawings of sewerage service areas, sewer alignment and profile, pumping stations and sewage treatment plants (STP's) or records and data for the operation and maintenance of sewerage facilities. Also, flow calculation sheets for sewers and capacity calculations for pumping stations and STP's are not maintained. Some drawings and data are kept by individual offices.

(3) Weak Crude Sewage (Low pollution Load) in the Margao STP

According to the water quality analysis, inlet BOD and SS values are low compared to the design crude sewage quality. The main reasons are lack of house connections to sewers and substantial groundwater infiltration. To obtain stable treatment efficiency, raw sewage quality should be denser which can be achieved by increasing the number of house connections.

(4) Lack of Implementation Plan and Equipment for Sewer Cleaning

The PWD does not have implementation plans or effective equipment for sewer cleaning. Silting with sands, rocks and garbage etc. is causing blockage and raw sewage to overflow from sewers and manholes.

Photo 32.7 Balloons to close sewer

Photo 32.8 Rods to remove the block

(5) Electrical Power Outages

The pumping stations and sewage treatment plants in the Study Area do not have backup power supply.

(6) Lack of Flow Measurement Device in the Pumping Station

The flow volumes at pumping stations in Panaji are not directly measured using flow meters.

(7) Lack of Screenings and Scum Removal in the Pumping Station

Thick floating rubbish and scum is observed at many pumping stations in Panaji.

(8) Deterioration of Pump Equipment

Most of equipment has been operating more than 15 years, the possibility of sudden pump fault is increasing with their age.

Photo 32.9 Deteriorated Pump Equipment

Photo 32.10 Deteriorated Electrical Panel

(9) Lack of Disinfection Process

At present, treated effluent is discharged to the public water body without disinfection at Margao STP.

3.3 Operations & Maintenance (O&M)

3.3.1 Introduction

The Government of Goa are facing continuously increasing demands for services (due to increased tourism, population growth and economic development) and current water and sanitation systems have reached the 'point of saturation' which is beginning to constrain socio-economic development. Despite these challenges, the PHE Division has made significant strides in the water and sanitation arena.

However, much is still to be done and the role of the PHE Division is changing. This has been brought about by new priorities of Water Policy, Plan investments and recent Constitutional Amendments with a major shift in thinking and policy towards a decentralised, people centric and demand responsive approach.

This paradigm shift incorporates the principles of:

- Adoption of demand responsive approaches based on empowerment, full participation in decision making, control and management by communities
- Shifting the role of government from direct service delivery to that of planning, policy formulation, monitoring and evaluation and partial financial support
- Partial cost sharing and 100% O&M responsibility by users (beneficiary groups including local bodies)

The reforms also call for **substantial institutional development** with regard to services, enhancement of technical and managerial capacity, appropriate forms of public-private partnership, private sector participation, use of information systems etc. to achieve sustainability. Additionally, the 9th and 10th Plans advocate pricing mechanisms to discourage excessive water use, mandatory water efficient systems for flushing, reduction of leakage and UFW, reuse and recycling of sewage, rainwater harvesting etc.

> PHE are yet to embrace the challenges set by water sector reforms and continue to bear the financial burden of capital as well as ongoing O&M costs.

PHE is yet to seriously take up this challenge, however, systematic implementation of the 'Improvement Programmes' resulting from the 'JICA Study' will go some way in helping the PHE Division in meeting their future obligations. This has serious implications for the way PHE conduct their O&M activities and will require a major shift away from many of the current practices with development and adoption of new methods of working.

3.3.2 Review or Current O&M practices

The methodology adopted in conducting the O&M review incorporated the following steps:

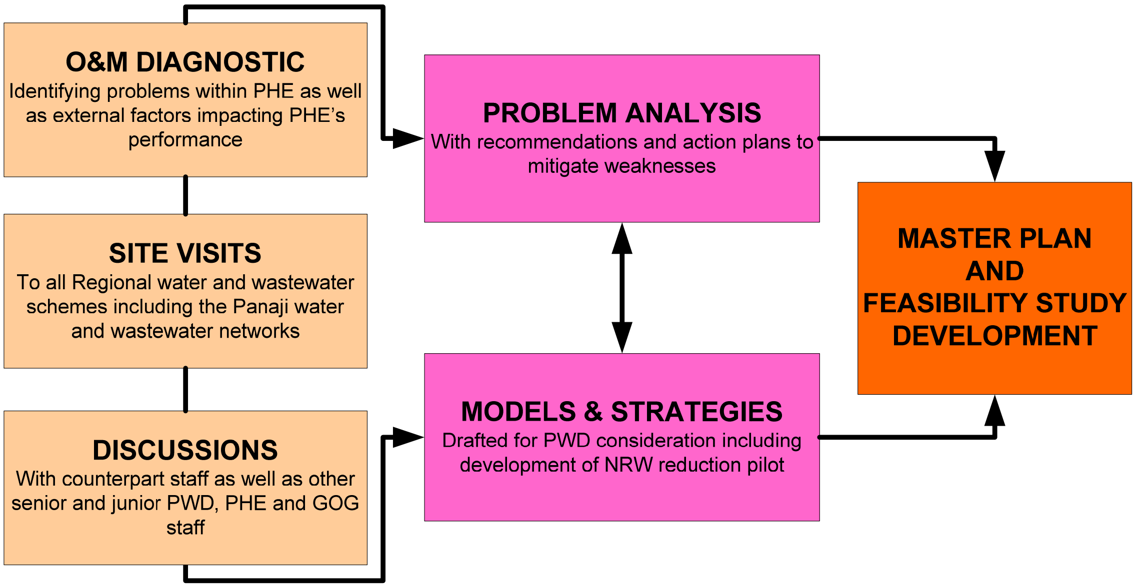

Figure 33.1 O&M Review Methodology

Based on the diagnostic, the key issues affecting The PHE Division that will require intervention are as follows. All of these issues (either directly or indirectly) impact Operations & Maintenance activities and performance:

Table 33.1 Key issues requiring intervention

BUSINESS ACTIVITY	KEY ISSUES
Institutional Arrangements	Lack of coordination with GOG Lack of sector agency coordination/cooperation Lack of community coordination/involvement Lack of structural arrangements for dealing with user/ beneficiary groups (non compliance with handing over rural schemes to Local Bodies)
Utility management	Lack of regulation enforcement Lack of strategy, policy, process development Lack of Process and Performance Management (example UFW reduction, energy and process chemicals efficiency, plant utilisation, labour efficiency, billing/revenue efficiency etc.)

BUSINESS ACTIVITY	KEY ISSUES
	Lack of project management skills and control Lack of systems development/computerisation Lack of awareness campaigns/outreach programmes (water usage, hygiene, conservation)
Resources	Insufficient funds/financing to meet current/future demands for services Lack of project and financial control measures Tariffs not based on full cost recovery Poor billing / revenue practices and performance Insufficient pricing mechanisms to regulate/conserve water Lack of sustainable practices/care for the environment/ regulatory enforcement
Political interference	Lack of financial and management autonomy Political influence on infrastructure projects and priorities and day-to-day management activities
Service provision	Contaminated/depleting (usable/accessible) water sources Fast growth of population (including tourism) – demand outstrips supply Poor compliance with mandated supply coverage (<100%) Low service levels/insufficient water supply and lack of sanitation services, insufficient infrastructure to meet demand Inability to measure and control leakage and UFW Lack of O&M strategy and planning Lack of planned preventative maintenance and supply chain management Deteriorating asset condition due to lack of infrastructure management/renewals

Based on the above, a number of O&M practices will need to be modified to improve operational performance of water and wastewater systems including the reduction of UFW. Additionally, a number of H&S practices will need to be modified to ensure safe systems of work and to ensure compliance with regulations in force. These are detailed in Chapter 7 of the Master Plan.

3.3.3 General Observations Relevant to O&M Activities

The Government of India (GOI) National Water Policy (1987) gave top priority to drinking water supply and set a target of 100% accessibility by 2003; this has not been achieved. It also laid down minimum per capita water supply norms of 40 lpcd (litres per person per day) for rural areas and 70 lpcd for urban areas. The new National Water Policy adopted in 2002 has recently superseded the 1987 policy and places even higher demands on PWD to improve services. Currently, water provision in most areas is intermittent with varying degrees of service provision. This will need to be rectified if the policy aim of providing a 24x7 supply is to be realised as will Network management practices in order to maximise supplies whilst at the same time reduce water losses.

Surface and groundwater sources are used for piped water supply schemes operated by PHE. These include rivers, artificial reservoirs or check dams, lakes and water extracted through bore/tube wells. The ‘sinking’ and use of wells has gone ‘unchecked’ with little effective regulation in force. The water collected from surface or groundwater sources is conveyed to treatment plants for removal of impurities. The treated water is disinfected and stored in clean water reservoirs to maintain its quality during transmission to customers. Overhead storage tanks along the piped transmission/distribution system are often used to maintain reasonable pressures at customer’s taps. The lack of monitoring and control devices will continue to hamper O&M practices now and in the future.

Recently, under the Eighth, Ninth and Tenth Plan as well as the 73rd and 74th Constitutional Amendments, the GOI has empowered state level Urban Local Bodies (ULB’s) to plan and administer water supply projects within their jurisdiction including rights to create tariff structures. Some states, notably Karnataka and Tamil Nadu, have taken the lead in this respect, however, it remains to be seen to what extent the GOG and PHE take up this challenge and change in roles and responsibilities.

Currently, PHE’s prime responsibility is the development and regulation of water supply and wastewater collection and disposal in the state of Goa. More recently, Local Bodies have also been mandated to implement water supply schemes throughout the State but have not taken on this responsibility. This has serious ramifications for O&M activities and expenditure and therefore the sector reforms will need to clearly define the extent of PWD’s future responsibilities in this regard.

3.3.4 Current O&M Organisation and Management Set-up

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 by the GOG. We believe 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 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's self-regulatory nature means that water quality problems can go unchecked.

Critical business activities such as Master Planning (strategic planning, source development, asset acquisition), Customer Services, Systems Development, Supply Chain Management, Operations & Maintenance Management, Health & Safety Management etc., remain underdeveloped due to lack of focus. This has led to the absence of policy development in these as well as other 'business critical' areas.

It appears that PHE does not actively encourage community, Local Body or NGO participation. It remains at the local manager's discretion the extent to which the local community participate or are consulted.

PHE is not 'driven' by a well developed 'Vision' or 'Mission' for the organisation. Whilst PWD have stated their intent in terms of their aims, objectives and responsibilities these are not widely shared with customers or employees and are not linked to individual, team or departmental targets. Consequently, O&M strategies, targets, key performance measures and control mechanisms are not well developed.

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 current organisational structure is a traditional functional hierarchy. The present arrangement means that each department or function invariably operates in isolation to other departments with little coordination or teamwork across processes or lines of responsibility. This type of set-up potentially exacerbates bureaucracy, inhibits information flow and communications, prevents the sharing of best practice and stifles teamwork, creativity and initiative. 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.

> The O&M approach of reacting to breakdowns does little to optimise asset performance or minimise service disruptions.

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.

Responsibility for reduction of NRW has not been assigned to a central 'process owner'. Subsequently, this does not currently form an integral part of O&M strategy. Coupled with 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 modelled 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. Refer to Chapter 5, Section 5.4 on NRW Reduction Planning.

> Due to PHE's 'passive' approach NRW remains at an unsustainable level.

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.

Current O&M practices requiring intervention

The organisational arrangements described above have influenced day to day operations and maintenance practices performed across the State. Based on the site visits an assessment of the current practices that would benefit from improved methods and strategy development are generalised as follows. Detailed site visit reports can be found in Volume IV Appendix M36 Site Visit Report.

Policy formulation, setting of departmental targets and objectives is not in evidence at SE level or below.

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.

> Of particular concern is the poor level of installation, operation and maintenance of chlorine facilities at most plants.

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.

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.

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

3.4 Sector Legislation, Policy, Regulations and Institutional Arrangements

3.4.1 Economic Planning

The core areas underpinning Goa's Tenth Five-Year Plan (2002-07) are: Education, Sustainable Village Economy, Good Governance, Tourism and Infrastructure Development with an overall emphasis on employment generation and environmental upgrading. The Plan lays out a broad multi-sectoral program to further Human Development in the State. Among the important objectives and targets set are the provision of 24-hour water supply service and state-of-the-art sewerage and sanitation network covering the entire State. The current Five-Year Plan has an "approved" outlay of 3,200 crores (about $800 M).

Annual Plans are also prepared to provide more detailed description of projects to be undertaken along with capital development budget outlay.

3.4.2 Governance Policies and Structures

The **Goa Municipalities Act, 1968** (as amended) was originally enacted on 2 April 1969. The Act consolidates all laws pertaining to governance of municipalities. Municipalities are classified according to population: Class A, for population greater the 50,000; Class B, for population between 10,000 and 50,000; and Class C, for population less than 10,000.

Each municipality has its own Council (with ward-elected Councillors), a Chairperson, Standing Committee, Chief Officer, Municipal Engineer and other officials. The Chief Officer implements all decisions and resolutions of the Council. An amendment in 1997 provides for the appointment of a state-level Director of Urban Development to take over the duties of the Collector (except those related to land revenue matters).

The Council is mandated to prepare plans for economic development and social justice and perform the functions and implement schemes entrusted to it in Schedule 10 of the Act, including: urban and town planning; regulation of land use and construction of buildings, urban forestry (protection of the environment); slum improvement and upgrading and other functions listed in the schedule. The Council regulates all construction activities in its jurisdiction activities through permits, including occupancy permits.

Municipal council also imposes a consolidated property tax on land and buildings, as well as other businesses taxes. The consolidated tax on property includes, among others, a general

water tax and a general sanitary tax. The Finance Commission, established under the Goa Panchayat Raj Act, 1994, reviews the financial position of all municipal councils.
Although Chapter 13 of the Act is entitled "Drainage", this section also makes reference to sewerage and sanitation matters.

"Unless the (state) government otherwise directs, it shall be the duty of every Council to undertake and to make reasonable provision …" of various public services, including water supply and sewerage[1]. Local bodies have been mandated to ensure that their respective constituencies have access to water supply and sanitation, but have not taken on this responsibility. Some states, notably Karnataka and Tamil Nadu, have taken the lead in this respect.

The **Goa Panchayat Raj Act (1994),** following the 73rd and 74th constitutional amendments, organized zilla panchayats and gram (village) panchayats and authorized them to undertake selected functions, including town planning. The Municipal Council prepares a development plan annually and submits it to the District Planning Committee. In the current Annual Plans, grant allocations (and loans) are available to low-income zilla and gram panchayats for local infrastructure, which may include wells, drains and toilets.

3.4.3 Environment Management

(1) Water Quality Standards and Effluent Standards

The Central Pollution Control Board (CPCB) has developed National Standards for Effluents and Emission under the statutory powers of the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981. These standards have been approved and notified by the Government of India, Ministry of Environment & Forests, under Section 25 of the Environmental (Protection) Act, 1986. Till now, effluent standards for 37 categories of industries and Emission Standards for 31 categories of industries have been evolved and notified besides standards for ambient air quality, ambient noise, automobile and fuels quality specifications for petrol and diesel. Guidelines have also developed separately for hospital waste management.

1) Water Quality Standards

Both fresh and coastal water are classified to several types of uses as shown in Tables 34.1 and 34.3. Depending of the types of uses and activities, water quality criteria have been specified to determine its suitability for a particular purpose as shown in Tables 34.2 and 34.4.

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[1] Article 51(2i. and j.), Goa Municipalities Act.

Table 34.1 Class of Fresh Water

Designated best uses	Class of Water Body
• Drinking water source without conventional treatment; but after disinfection	A
• Outdoor bathing (organized)	B
• Drinking water source with conventional treatment followed by disinfection	C
• Propagation of wild life and fisheries	D
• Irrigation. Industrial cooling. Controlled waste disposal	E

Source: Scheme for zoning and classification of Indian rivers, estuaries and coastal waters. Central Pollution Control Board.

Table 34.2 Water Quality Criteria of Fresh Water

Item	Unit	Class				
		A	B	C	D	E
pH		6.5-8.5	6.5-8.5	6.0-9.0	6.0-9.0	6.0-9.0
DO	mg/l	6.0 or more	5.0 or more	4.0 or more	4.0 or more	-
BOD	mg/l	2.0 or less	3.0 or less	3.0 or less	-	-
Total Coliform	MPN/100ml	50 or less	500 or less	5,000 or less	-	-

Source: Scheme for zoning and classification of Indian rivers, estuaries and coastal water (part one - sweet water); Central pollution control board, New Delhi

Table 34.3 Class of Sea Water

Designated best uses	Class of Water Body
• Salt pans. Shell fishing. Contact water sports	SW I
• Commercial fishing. Recreational (non-contact)	SW II
• Industrial cooling	SW III
• Harbour	SW IV
• Navigation. Controlled waste disposal.	SW V

Source: Scheme for zoning and classification of Indian rivers, estuaries and coastal waters. Central Pollution Control Board.

Table 34.4 Water Quality Criteria of Sea Water

Item	Unit	SW				
		I	II	III	IV	V
pH		6.5-8.5	6.5-8.5	6.5-8.5	6.5-9.0	6.5-9.0
DO	mg/l	5.0 mg/l or 60 % saturation value, which is higher	4.0 mg/l or 50 % saturation value, which is higher	3.0 mg/l or 40 % saturation value, which is higher	3.0 mg/l or 40 % saturation value, which is higher	3.0 mg/l or 40 % saturation value, which is higher
BOD	mg/l	-	3	-	3 (5)	
Fecal Coliform	MPN/100ml	-	100	500	500	500

Source: Environmental standards for ambient air, automobiles, fuels, industries and noise; Central pollution control board, July 2000

2) Drinking Water Quality Guidelines

The drinking water quality guidelines are set on ‘Manual on Water Supply and Treatment Third Edition, The Government of India, May 1999’ as minimum standards to ensure that the water supplied is free from pathogenic organisms, clear, potable and free from undesirable taste and odour. These guidelines consist of physical and chemical quality, and bacteriological quality. The recommended guidelines for physical and chemical quality are shown in Table 34.5, and for bacteriological quality are shown in Table 34.6.

Table 34.5 Recommended Guidelines for Physical and Chemical Parameters

No.	Characteristics	Acceptable[1)]	Cause for Rejection[2)]
1	Turbidity, NTU	1	10
2	Colour (Units on Platinum Cobalt scale)	5	25
3	Taste and Odour	Unobjectionable	Unobjectionable
4	pH	7.0 to 8.5	<6.5 or >9.2
5	Total dissolved solids, mg/L	500	2,000
6	Total hardness as $CaCO_3$, mg/L	200	600
7	Chlorides as Cl, mg/L	200	1,000
8	Sulphates as SO_4,mg/L	200	400
9	Fluorides as F, mg/L	1	1.5
10	Nitrates as NO_3, mg/L	45	45
11	Calcium as Ca, mg/L	75	200
12	Magnesium as Mg, mg/L	≦30	150
13	Iron as Fe, mg/L	0.1	1
14	Manganese as Mn, mg/L	0.05	0.5
15	Copper as Cu, mg/L	0.05	1.5
16	Aluminium as Al, mg/L	0.03	0.2
17	Alkalinity, mg/L	200	600
18	Residual Chlorine, mg/L	0.2	>1
19	Zinc as Zn, mg/L	5.0	15
20	Phenolic compounds as Phenol, mg/L	0.001	0.002
21	Anionic detergents as MBAS, mg/L	0.2	1
22	Mineral Oil, mg/L	0.01	0.03
	TOXIC MATERIALS		
23	Arsenic as As, mg/L	0.01	0.05
24	Cadmium as Cd, mg/L	0.01	0.01
25	Chromium as hexavalent Cr, mg/L	0.05	0.05
26	Cyanides as CN, mg/L	0.05	0.05
27	Lead as Pb, mg/L	0.05	0.05
28	Selenium as Se, mg/L	0.01	0.01
29	Mercury as total Hg, mg/L	0.001	0.001
30	Polynuclear aromatic hydrocarbons (PAH), μg/L	0.2	0.2
31	Pesticides (total), mg/L	Absent	Refer to WHO guidelines for drinking water quality Vol I-1993
	RADIO ACTIVITY		
32	Gross Alpha activity, Bg/L	0.1	0.1
33	Gross Beta activity, Bq/L	1	1

Notes

(1) The figures indicated under the column ‘Acceptable’ are the limits upto which water is generally acceptable to the consumers.

(2) Figures in excess of those mentioned under ‘Acceptable’ render the water not acceptable, but still may be tolerated in the absence of an alternative and better source but upto the limits indicated under column “Cause for Rejection” above which the sources will have to be rejected.

Table 34.6 Recommended Guidelines for Bacteriological Quality

No.	Organisms	Guideline value
1	All water intended for drinking E.coli or thermotolerant coliform bacteria	 Must not be detectable in any 100 mL sample.
2	Treated water entering the distribution system E.coli or thermotolerant coliform bacteria Total coliform bacteria	 Must not be detectable in any 100 mL sample. Must not be detectable in any 100 mL sample.
3	Treated water in the distribution system E.coli or thermotolerant coliform bacteria Total coliform bacteria	 Must not be detectable in any 100 mL sample. Must not be detectable in any 100 mL sample. In case of large supplies, where sufficient samples are examined, must not be present in 95% of samples taken throughout any 12 month period.

3) Effluent Standards

Following standards as shown in Table 34.7 shall be applicable for industries, operations or processes other than those industries, operations or process for which standards have been specified in Schedule of the Environment Protection Rules, 1989.

Panaji STP is regulated as the same value as inland surface water standard in spite of its discharge water body is designated as SWII which is for sea water, thusother proposed STP will be regulated by the inland surface water standard.

Table 34.7 Effluent Standards

No.	Parameter	Inland surface water	Public sewers	Land for irrigation	Marine/coastal areas
	.	(a)	(b)	(c)	(d)
1	Color and odor	See 6 of Annexure-1I		See 6 of Annexure-1I	See 6 of Annexure-1I
2	Suspended solids mg/L, max.	100	600	200	(a) For process waste water 100 (b) For cooling water effluent 10 per cent above total suspended matter of influent.
3	Particle size of suspended solids	shall pass 850 micron IS Sieve	-	-	(a) Floatable solids, solids max. 3 mm (b) Settleable solids, max 856 microns
4	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
5	Temperature	shall not exceed 5oC above the receiving water temperature			shall not exceed 5oCabove the receiving water temperature
6	Oil and grease, mg/L max,	10	20	10	20
7	Total residual chlorine, mg/L max	1	-	-	1
8	Ammonical nitrogen (as N),mg/L, max.	50	50	-	50
9	Total kjeldahl nitrogen (as N);mg/L, max. mg/l, max.	100	-	-	100
10	Free ammonia (as NH3),	5	-	-	5

	mg/L,max.				
11	Biochemical oxygen demand (3 days at 27℃), mg/L, max.	30	350	100	100
12	Chemical oxygen demand, mg/l, max.	250	-	-	250
13	Arsenic(as As).	0.2	0.2	0.2	0.2
14	Mercury (As Hg), mg/L, max.	0.01	0.01	-	0.01
15	Lead (as Pb) mg/l, max	0.1	1	-	2
16	Cadmium (as Cd) mg/L, max	2	1	-	2
17	Hexavalent chromium (as Cr + 6),mg/L, max.	0.1	2	-	1
18	Total chromium (as Cr) mg/L, max.	2	2	-	2
19	Copper (as Cu)mg/L, max.	3	3	-	3
20	Zinc (as Zn) mg/L, max.	5	15	-	15
21	Selenium (as Se)	0.05	0.05	-	0.05
22	Nickel (as Ni) mg/L, max.	3	3	-	5
23	Cyanide (as CN) mg/L, max.	0.2	2	0.2	0.2
24	Fluoride (as F) mg/L, max.	2	15	-	15
25	Dissolved phosphates (as P),mg/L, max.	5	-	-	-
26	Sulphide (as S) mg/L, max.	2	-	-	5
27	Phenolic compounds (as C6H50H)mg/L, max.	1	5	-	5
28	Radioactive materials:				
	(a) Alpha emitters micro curie mg/L, max.	10^{-7}	10^{-7}	10^{-8}	10^{-7}
	(b)Beta emitters micro curie mg/L	10^{-6}	10^{-6}	10^{-7}	10^{-6}
29	Bio-assay test	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent
30	Manganese mg/L	2	2	-	2
31	Iron (as Fe) mg/L	3	3	-	3
32	Vanadium (as V) mg/L	0.2	0.2	-	0.2
33	Nitrate Nitrogen mg/L	10	-	-	20

(2) Environment Control in Goa

The **Goa Water (Prevention and Control of Pollution) Rules of 1988** follows Section 64 of Central Act 6 of 1974. The Goa State Pollution Control Board was established on 7 January 1988 following the Water (Prevention and Control of Pollution) Act, 1974. The Act provides for the regular monitoring of water quality by sampling and testing by the Board. The Board is also authorized to issue permits to discharge wastewater [there are similar regulations covering air pollution]. The Board also monitors and issues certification of accredited testing laboratories.

The Board, in determining effluent standards, considers the condition of the receiving natural water body. The class of water use in the Goa is shown in Figure 34.1.

The discharging water body of proposed STP in the Master Plan are categorized to Class SWII as shown in Table 34.8, because they are all tidal rivers. The water qualities of discharging water body were surveyed only Panaji and Margao, the water quality of discharge points were presented in Table 34.8.

Table 34.8 Class of Environmental Water Quality Standard of Discharging Water for Proposed STP

STP	Discharging water body	Present water quality	Water Quality Standard		Effluent Standard
			Class	Standard BOD mg/l	BOD mg/l
Panaji	Mandovi River	6.9, 4	SWII	3	30*2
St. Crus	Tributary of Mandovi R.	-			
Porvorim	Tributary of Mandovi R.	-			
Margao	Sal River	22.5, 2.2			
Ponda	Tributary of Zuari R.	-			
Mapusa	Tributary of Mandovi R.	-			
Coastal Belt of South Goa (Colva)	Sal River	-			
Coastal Belt of North Goa (Calangute & Candolim)	Baga River	-			

*1: Sampling date: Panaji: 22/6/2005 and 15/7/2005 Margao 9/6/2005 and 13/7/2005
*2: Inland surface water

Figure 34.1 Classification of Water Quality Standard

3.4.4 Urban Development, Land Management and Zoning

The **Goa, Daman and Diu Town and Country Planning Act, 1974** was enacted "to provide for planning the development and use of rural and urban land…" For this purpose, the Act mandates the Government to appoint an advisory Town and Country Planning Board. The Board also has appellate authority to settle issues with respect to implementation of the Act. The Chief Town Planner prepares the Regional Plan. When approved, the plan is published in the Official Gazette and it comes into force. However, the Planning and Development authorities (who have become the executing agencies), have been dwindling and are effective only in Panaji, Mapusa, Mormugao, Margao and Ponda.

The first regional Plan for Goa, following the Town and Country Planning Act, was approved in 1988. It was prepared for a target year 2001. A **Revised Regional Plan Goa – Perspective 2011** is now available, along with the settlement growth projected to the target year. The Plan quantifies the development demands to support the growth. It contains a chapter on the physical infrastructure, including urban and rural water supply, waste water and solid waste, needed to support the development. The regional plan, however, does not have indicative estimate of the development costs nor financing plan and institutional arrangements for implementing and sustaining the improvements.

3.4.5 Public Health

The **Goa Public Health Act (Act. No 25) of 1985**, as amended, was enacted to advance public health in the State. Subsequently, the **Goa Public Health Rules, 1986**, were were adopted. Specifically, the Act mandates the creation of the Public Health Board and the designation of Health Officers in the various areas. In Chapter 3 (Water Supply), the Act establishes the control of the state government over water supply systems operated by municipal councils or village panchayats to ensure continuous, reliable and potable supply. It defines the responsibility of local authorities to provide water supply to its area. Local authorities can declare any natural or man-made water body as a public water source and place it under its control. A "Collector" (auditor?) is appointed to check on the quality and quantity of the water source and direct alleviation measures. The Director of Public Health is also empowered to direct and issue instructions in case of contamination (or imminent risk) of water sources. In cases of contaminated water sources, the Health Officer can require the entity responsible for the source to undertake corrective measures; close water sources, either temporarily or permanently. Multi-family residential dwellings cannot be occupied without a certificate from the Health Officer attesting to the adequacy of and access to, among others, water supply and proper storage facilities. Chapter 4 (Drainage) of the Act mandates local authorities to provide and maintain the public drainage system. Section 24 empowers the Health Officer, if needed, to require premises to connect to the drainage system or construct cesspools or septic tanks. Untreated sewage is not allowed to drain onto open drains.

3.4.6 Water Resources Management (Including Groundwater Use and Protection)

The **Goa Ground Water Regulation Act** was approved on 25 January 2002 to "regulate and control the development of ground water resources and matters connected therewith." The Act was passed to curb the overexploitation of ground water resources, particularly in the coastal and mining areas. This Act mainly specified the violations and penalties for acts which are detrimental to the conservation of the resource. It requires the registration of existing wells and approval of permission for drilling of new wells. Approved registrations have to be renewed every 5 years. The Act also regulates the transportation (by pipeline or other means) of more than 30,000 liters of ground water annually. Such approvals need to be renewed annually. Such permissions or approvals may be amended or cancelled at any time for cause. The Act created and granted broad powers to the Goa Ground Water Cell and the Ground Water Officers to identify and declare, as needed, water-scarce areas. No new wells may be drilled in these areas. The GWO is authorized to close down existing well if it affects public drinking water sources. The **Goa Ground Water Regulation Rules** (15 February 2003) specified the forms to be used. Subsequent Orders from the Goa Department of Water Resources constituted the Goa Ground Water Cell on 5 March 2003 and appointed Ground Water Officers for North Goa and for South Goa on 31 March 2003.

In essence, the main responsibility for water resources rests with the Water Resources Department. Responsibility for various aspects of the 'water cycle' to ensure "sustainability" and 'integrated water resource management' is not well defined and therefore requires the interaction and close cooperation between the key players; namely, the Water Resources Department, the Ground Water Department, PHE and other stakeholders such as community groups/cooperatives, local bodies, non-government organizations (NGO's) etc.

The Sector Status Study indicated that the Act was not well founded on technical information and maps. Furthermore, it was not intended to be a basis for ground water resources management in the State as it does not address such concerns as pollution of ground waters, watershed management, effluent from domestic and industrial sources, water balance and other issues.

The **Goa Command Area Development Act, 1997** was enacted on August 8, 1997, mainly to promote increase in agricultural productivity through "command areas" optimum use of land

and water, prevention of land erosion and water logging, improvement in soil fertility, regulation of cropping patters and proper maintenance of irrigations systems.

3.4.7 National and State Water Policy

(1) National Water Policy

On April 2002, the Central Ministry of Water Resources, through the National Water Resources Council) issued the "National Water Policy – 2002" which superseded a 1987 policy. The Policy laid down guidelines for water resources planning based on very progressive concepts, including proper consideration for the economic value of water, promotion of multi-disciplinary approaches and strategies, development of multi-purpose projects and the promotion of river basin-based planning. It stresses the importance of water resources information systems at the central and state levels. The Policy espouses an integrated and multi-disciplinary approach to the "planning, formulation, clearance and implementation of projects." The Policy also gives drinking water supply the highest priority in water allocation decisions.

Serious consideration of the environmental impact and the social impact arising from dislocation and resettlement of people is mandate for all water-related projects. The Policy counsels that special efforts be taken to ensure that marginalized and disadvantaged groups gain access to the benefits of improved water resources. The participation of beneficiaries and stakeholders, particularly women and the local authorities (gram panchayats), is emphasized. The Policy urges formation and capacity building for water users associations to ensure sustainability and that due consideration be given to promote private sector participation in water resources activities.

The Policy urges local authorities to take the necessary measures to ensure sustainability of existing assets, particularly ground water resources and water quality. It advises local authorities to adopt measures for water zoning, conservation, flood control and land erosion control. In drought-prone and water-scarce areas, local authorities should promote and implement effective conservation programs and other efforts to reduce vulnerability. Water allocation conflicts are settled following the Inter-State Water Disputes Act of 1956. Finally, the Policy calls for more vigorous research and capacity building in the field of water resources.

(2) Goa State Water Policy – 2002

Following the previous 1987 National Water Policy, the State formulated its own State Water Policy 2000. The State policy recognizes the unique water resources situation in Goa where the state is a part of larger water basins; has small micro-basin areas; faces sharp imbalance in water availability between dry and monsoon seasons; and, the short river runs. “Although the rainfall in the state is higher than the national average, the steep topography, unique physiography…” require the need for independent water policy complementing the national policy. It calls for an integrated river basin development plan with demand and supply estimates and integrated watershed management plans. The policy points to the need for assessment of groundwater potentials. Other issues raised include: salinity intrusion, impact of mining activities, and pollution. The Policy establishes the Water Resources Control Board to prepare and administer long-term and short-term water management strategies for the state. Finally, the Policy reaffirms that allocation of water resources will follow the **Irrigation Act of 1973** and the **Goa Command Area Development Act 1997**.

(3) Central government support for water supply and sanitation

The GOI has provided funds to the Goa State Government to implement its water supply development plans. Some facilities currently in use, such as the Chandel regional water supply scheme, were supported through the **Accelerated Rural Water Supply Scheme (ARWSP)** and the **Accelerated Urban Water Supply Scheme (AUWSP)** of the central government. Although water is primarily a State concern, the Goa State Government nonetheless has to comply with overarching GOI policies, as applicable. The State continues to apply for these grants to support its capital improvement plans. The central government also provides assistance on training in and computerization of sector operations. Goa participates in the central government’s Total Sanitation Campaign.

3.4.8 Water Supply and Sewerage Services Provision

The basic regulation governing drinking water supplies in the State is embodied in **Portaria No 6802** of December 1956. Many provisions of this order have since been upgraded and revised. The current significance of the portaria is in its guidelines relationship between the service provider and the consumers. It also explains the basis for many of the structures and guidelines, still found in place today.

The previous National Water Policy (1987) gave top priority to drinking water supply and set a target of 100% accessibility by 2003. This has not been achieved. It also laid down minimum per capita water supply norms of 40 lpcd (liters per person per day) for rural areas and 70 lpcd for urban areas. The State follows the National Drinking Water Quality Standards.

The Goa State Pollution Control Board is responsible for ensuring that the discharge of wastewater to the natural water bodies is properly regulated. A new draft Sewerage Law is currently under consideration.

3.4.9 Institutional Arrangements

(1) The Goa State Government

1) Governance structure levels

At the head of the state hierarchy is the State Governor who represents and is appointed by the central government. The state assembly is unicameral with forty (40) elected "Members of the Legislative Assembly" or MLAs. The key function of this body is to enact state laws and monitor the performance of the government. State assembly elections are held every five years. The head of the party (or coalition of parties) with the majority of the MLA's is offered by the governor to be the Chief Minister. [The assembly elects the Chief Minister, deputy minister and other ministers.] The Chief Secretary and Secretaries are appointed from the Indian Administrative Service system.

Goa has two (2) administrative districts – North Goa and South Goa. Each district has a district magistrate (DM) and a superintendent of police (SP) who are responsible to the elected government. Districts are further divided into subdivisions or talukas. There are eleven (11) talukas in Goa.

Currently, Goa is represented in the national parliament through two (2) members in the lower house (each representing North Goa and South Goa) and one (1) in the upper house.
Generally, there is a clear division of tasks and activities between the central government and state government. The state takes the lead on matters related to police force, education, agriculture and industry.

2) Governance structure of Local Bodies

The lowest level of governance is the panchayat. There are 183 panchayats representing about 374 villages (each panchayat represents 1 or 2 villages). The panchayat has several wards each of which elects a panch (or member) every 5 years. The panch, in turn, elects a surpanch (leader) who becomes the head of the panchyat. About five or six panchyats constitutes an electoral district which can elect one MLA to the state assembly.

3) The Public Works Department of the State of Goa

The Public Works Department is the lead State agency for the construction, maintenance, repair of all works financed by the state government, principally state roads and highways, buildings and water, sewerage and sanitation facilities . The Public Health Engineering Wing of the PWD specifically deals with the provision of water, sanitation and sewerage services.

4） The Water Resources Department of the State of Goa.

WRD is responsible for the overall management, conservation and utilization of water in the State. It has prepared resource assessments and master plans for most of the State river micro-basins (about 78% of the land area). Since June 2004, WRD has been authorized to levy an assessment, currently at 0.5 Rs. per m^3, for raw water drawn.

5） The Sewerage Infrastructure Corporation, Ltd. -

This state-owned corporation was established, among others, to prepare proposals and implement improvement projects for sewerage in the State.

6) The private sector and NGO activities in the sector

The extent of participation in the provision of water supply, sanitation and sewerage in the State has not been high. At present, some of the PHE activities, notably the preparation of water bills and the repair and calibration of water meters, have been partially outsourced to private contractors.

3.4.10 Current Sector Reform Initiatives

The State has embarked on a major initiative to review and overhaul the operational concept and institutional arrangements for water and sanitation provision in the State, with the assistance of the World Bank. The discussions are ongoing and formal recommendations are under consideration by the Cabinet Committee. The JICA Study Team has participated in the discussions and consideration of these reforms. This JICA Study will focus on improving the internal operations of PHE; while the broader sector reform initiatives focuses on broader policy issues.

3.4.11 The Public Health Engineering Wing of the Public Works Department

(1) Objectives and responsibilities of Public Health Engineering Wing of PWD

The Public Health Engineering (PHE) wing is primarily responsible for the development and regulation of water supply and wastewater collection and disposal in the state of Goa. Specifically, PHE’s sector responsibilities include the following:

- Design, construction, execution, promotion, operation, maintenance and financing of schemes for the supply of water and for the collection and disposal of waste water
- Rendering all necessary services to the Government in relation to water supply, collection and disposal of waste water in the State of Goa
- Establishment of standards for water supply and waste water services in the State.
- Setting and revision of rates for water supply and sewerage maintenance with the approval of the Government of Goa

The high-level organization structure with an indication of the main functional responsibilities is shown on Table 34.9.

(2) Core functions of PHE

As a "group" of seven (7) regional water systems, the core functions of the PHE is much like other water companies: water treatment; water transmission; water distribution; billing and collection and customer service. Sewerage, on the other hand consists of: sewage collection, treatment and disposal. PHE, in addition to being a water and sewerage "operator", is also involved in capital investment planning and implementation – both large-scale and smaller-scale upgrading and rehabilitation of facilities.

(3) Allocation of responsibilities/functions and staffing levels at PHE

Table 34.9 Allocation of Key Functions and Responsibilities & Staffing Levels

Circle/ Division/ Sub-Division			Current Functions & Responsibilities (&/or Jurisdiction)	Staffing, July 2005			
				Regular	Work-charged	Contract	Total
Circle 5 (North Goa)	Division 3 (Panaji)	SD 1 Panaji	• Water supply distribution in Tiswadi (Panaji). • Billing and collection. • Maintenance of about 12 kms of trunk main (CI) from Opa Treatment Plant. • Laying of about 12 kms parallel trunk main (DI) from Opa.	39	84	165	288
		SD 2 Tonca	• Operation and maintenance of sewerage services for Panaji, including 36 kms of sewer lines (150-600 mm) and eight (8) sewage pumping stations. • Installation of sewer connections. • Operation and maintenance of Panaji (Tonca) Sewage Treatment Plant (5.7 MLD) and the smaller Patto Treatment Plant.	21	36	94	151
		SD 3 Panaji	• Operation and maintenance of village-level water systems in Chorao, Curca, Santan, Talaulim, Gaulimoula and Bambolim village.	12	14	17	43
		SD 4 Ponda	• Water supply distribution in Ponda. • Billing and collection. • Maintenance of about 12 kms of trunk main from Opa crossing their responsibility area. • Laying of about 12 kms parallel trunk main (DI) from Opa.	26	83	192	301
		SD 5 Opa	• Operation and maintenance of Opa Treatment Plant.	36	48	44	128
		SD 6	Inactive	0	0	10	10
			Office of the Executive Engineer	28	0	10	38
			SUB-TOTAL: Division 3 Office	162	265	532	959

Circle/ Division/ Sub-Division			Current Functions & Responsibilities (&/or Jurisdiction)	Staffing, July 2005			
				Regular	Work-charged	Contract	Total
	Division 17 (Porvorim)	SD 1 Mapusa	• Water supply services, including surveys and execution of extension projects, operation & maintenance and service connections for Bicholim. • Billing and collection. • Operation and maintenance of 40 MLD Podocem water treatment plant.	14	55	74	143
		SD 2 Bicholim	• Water supply services, including surveys & execution of extension project, operation and maintenance, including service connections in Pernem. • Billing and collection. • Operation & maintenance of 15 MLD Chandel WTP.	8	89	68	165
		SD 3 Porvorim	• Water supply services, including surveys and execution of extension project, operation & maintenance and service connections for part of Bardez. • Billing and collection.	9	94	139	242
		SD 4 Valpoi	• Operation and maintenance of 42 MLD Assonora water treatment plant. • Operation and maintenance of 12 MLD Sanquelim water treatment plant.	22	62	46	130
		SD 5 Assonora	• Water supply services, including surveys & execution of extension project, operation and maintenance and service connections for part of Bardez. • Billing and collection.	7	63	56	126
		SD 6 Pernem	• Water supply services, including surveys and execution of extension project, operation & maintenance and service connections for Sattari. • Billing and collection. • Operation and maintenance of the 5 MLD Dabose water treatment plant in Sattari which serves part of Sattari.	5	100	61	166
			Office of the Executive Engineer	26			26
			SUB-TOTAL: Division 17 Office	91	463	444	**998**

Circle/ Division/ Sub-Division			Current Functions & Responsibilities (&/or Jurisdiction)	Staffing, July 2005			
				Regular	Work-charged	Contract	Total
	Division 24 (Ponda)[2]	North Goa	• Monitor the existing PHE Revenue Collection System in North Goa district.	1	0	0	1
		South Goa	• Monitor the existing PHE Revenue Collection System in South Goa district.	1	0	0	1
		Office of the Executive Engineer		0	0	0	0
		SUB-TOTAL: Division 24 Office		2	0	0	2
	TOTAL: Circle 5 Office			**255**	**728**	**976**	**1959**
Circle 6 (Panaji)	Division 12 (Sanguem)	SD 1 Quepem	• Maintenance of about 10 kms transmission mains from Xelpem to Quepem (+2.5 to +12 kms), including service road. • Replacement of pipeline (PSC to MS). • Operation and maintenance of Bali Pumping Station.	1	28	17	46
		SD 2 Margao	• Maintenance of about 12.5 kms transmission main from Quepem to Margao (+12 to +25 kms), including service road. • Replacement of pipeline (PSC to MS). • Operation of minor water quality laboratory.	8	38	9	55
		SD 3 Sanguem	• Operation and maintenance of civil works of the 160 MLD Salaulim WTP in Salcete which serves Mormugao, Salcete, Sanguem, part of Tiswadi and Quepem.. • Maintenance of about 2.5 kms transmission main from WTP to Xelpem (+0 to +2.5 kms), including service road.	3	31	17	51
		SD 4	• Operation & maintenance of electrical/mechanical works of the Salaulim WTP, including pumping station, rising main and water quality laboratory (chemical & bacteriological).	20	28	67	115
		Office of the Executive Engineer		13	-	-	-
		SUB-TOTAL: Division 12 Office		45	125	110	**280**

[2] Not yet functioning. Order No 108 was issued on 20 July 2005. Division 24 was entrusted with this revenue monitoring functions and staffed with 1 AE, 1 JE, 1 UDC, 1 LDA and 1 peon for each of the 2 "squads". The staff is from other existing Divisions. EE of Division 3 is acting in charge. Each "squad" is expected to specifically monitor faulty meters, illegal taps from the main pipes, un-issued bills, taps before meters, un-metered connections, inaccessible meter locations, disconnection of accounts in arrears, pilferage/wastage in public taps, revenue collection effort, meter readers and other related activities.

Circle/ Division/ Sub-Division			Current Functions & Responsibilities (&/or Jurisdiction)	Staffing, July 2005			
				Regular	Work-charged	Contract	Total
	Division 21 (Margao)	SD 1 Margao	• Operation, maintenance and extension of sewerage services in "north zone" of Margao (gravity system). • Operation and maintenance of Margao sewage treatment plant in Salcete. • Support planning of the proposed augmentation in the "south zone".	4	6	16	26
		SD 2 Vasco	• Operation, maintenance and extension of the Vasco da Gama Sewerage Scheme serving the urban core of Mormugao. • Operation and maintenance of six (6) sewage pumping stations and the sewage treatment plant in Mormugao.	5	15	59	79
		SD 3 Margao	• Operation, maintenance and extension of sewerage services in "central zone" of Margao. • Support planning of the proposed augmentation in the "south zone".	5	7	-	12
			Office of the Executive Engineer	14	-	-	14
			SUB-TOTAL: Division 11 Office	28	28	75	**131**
			TOTAL: Circle 6 Office	**73**	**153**	**185**	**411**
Circle 8 (South Goa)	Division 9 (Margao) Water supply in Salcete and Marmurgao	SD 1 Vasco	• Water supply services for Mormurgao, Cortalim & Vasco. • Revenue billing and collection	10	60	99	169
		SD 2 Margao	• Water supply service in Margao, Fatorda and surrounding areas. • Revenue billing and collection	8	85	57	150
		SD 3 Margao	• All rural water supply schemes, including Cuncolim, Velim, Navelim & Curtolim. • Revenue billing and collection	11	66	61	138
		SD 4 Margao	• Water supply services for Loutolim & Benaulim • Revenue billing and collection	7	23	54	84
		SD 5 Verna	• Operation and maintenance of pumping station at Gogal and Verna.	4	-	21	25
			Office of the Executive Engineer	22	7	6	35
			SUB-TOTAL: Division 9 Office	62	241	298	**601**

Circle/ Division/ Sub-Division			Current Functions & Responsibilities (&/or Jurisdiction)	Staffing, July 2005			
				Regular	Work-charged	Contract	Total
	Division 20 (Margao)	SD 1 Sanguem	• Water supply services in Curchorem and Cacoda municipal areas and Sanvordem constituency (except Kalay Village); 122 small schemes, including 32 public stand posts. • Revenue billing and collection	4	38	38	80
		SD 2 Sanvordem	• Water supply services in Kalay Village of Sanvordem and entire Sanguem constituency; 23 small schemes, including 165 public stand-posts. • Revenue billing and collection	9	30	25	64
		SD 3 Quepem	• Water supply services for Quepem, except municipality of Curchorem and Cacoda; 35 small schemes, including 104 public stand posts. • Revenue billing and collection	9	57	28	94
		SD 4 Canacona	• Water supply services for Canacona; about 25 small schemes, including public stand posts. • Operation and maintenance of Canacona water treatment plant. • Revenue billing and collection. • Management of public toilet facilities.	9	52	43	104
			Office of the Executive Engineer	14	-	-	14
			SUB-TOTAL: Division 20 Office	45	177	134	**356**
			TOTAL: Circle 8 Office	**107**	**418**	**432**	**957**
Office/Staff of Superintending Engineer – Circle 5				34	-	-	34
Office/Staff of Superintending Engineer – Circle 6				28	-	-	28
Office/Staff of Superintending Engineer – Circle 8				1	-	-	1
Office/Staff of Chief Engineer				6	-	-	6
			GRAND TOTAL:	**504**	**1,299**	**1,593**	**3,396**

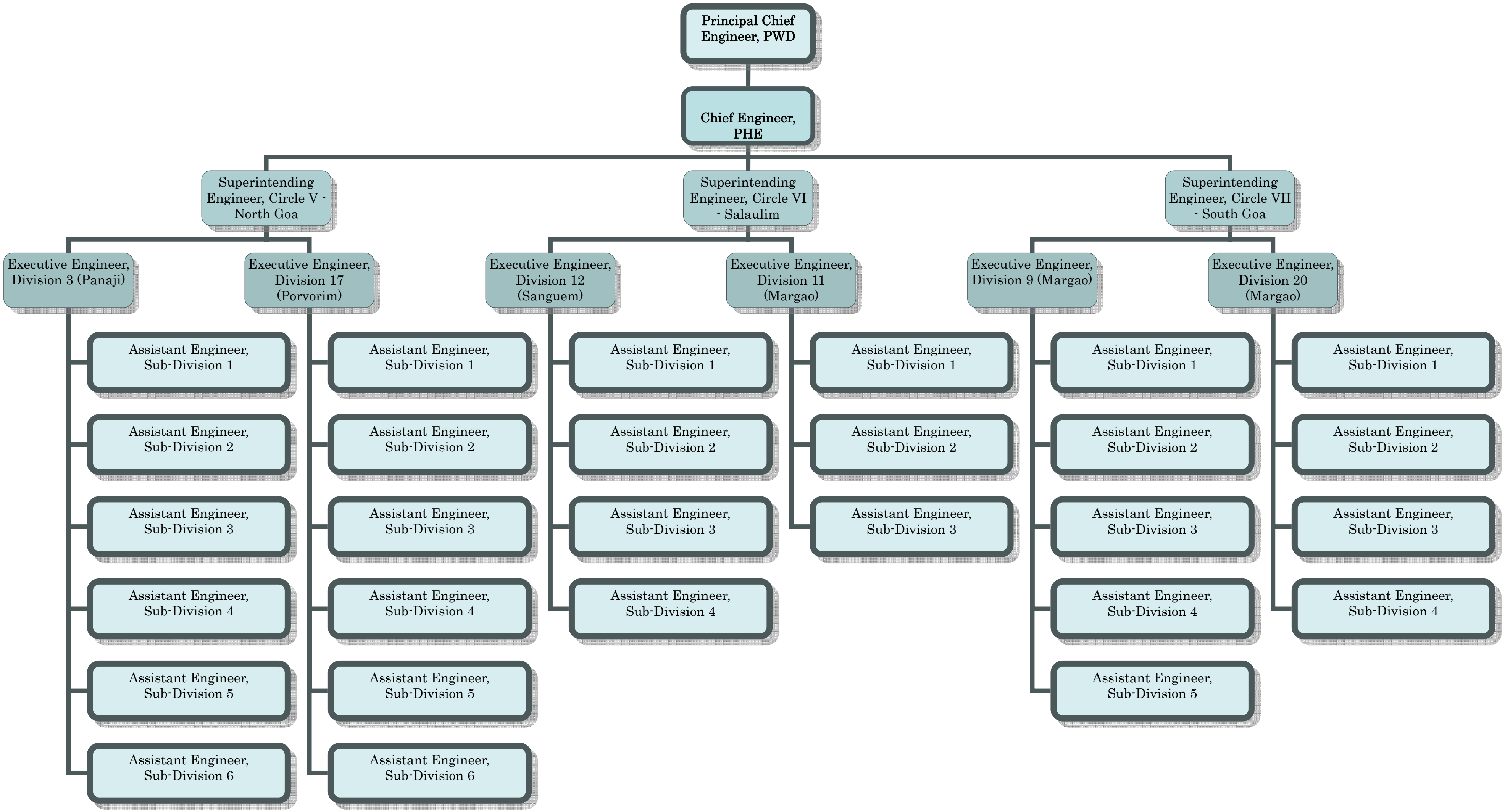


Figure 34.2 Current Organizational Chart of PHE

As of July 2005, PHE consists of 3,396 staff of which 504 are regular; 1,299 are work charged; and 1,593 are contractuals.

(4) Management Systems and Processes at PWD/PHE (planning and monitoring)

Much of the existing processes have been adapted from the operations and administration manuals of the Central Public Works Department (CPWD).

1) Management levels and responsibilities

A **Circle Office**, headed by a Superintending Engineer (SE), is an administrative office coordinating and supervising the activities of 4 – 6 Divisions engaged in either construction or operation and maintenance of facilities. It maintains close liaison with the office of the Chief Engineer in regard to works and all technical matters, and with the State Administrative Department on matters related to personnel and administration. The SE liaises with the Superintending Surveyor of Works for the layout, design, drawings and estimates of the works under its responsibility. The Superintending Engineer reports to the Chief Engineer.

The SE likewise exercises budgetary control over the divisions in the circle. The SE is required to regularly examine the books of the Division office and Sub-Division Offices to ensure that accounts are kept current and in good order. He also monitors strictly the expenditures to ensure that there are no excesses and that the funds are used efficiently and economically. The SE is authorized to sign contracts up to 70 lakhs (following a competitive bidding procedure); and up to 30 lakhs, for "single source contracts.

The **Division Office**, headed by an Executive Engineer (EE), is generally responsible for the efficient and effective implementation and/or operation of works under its responsibility. This may include procurement and utilization of resources, proper upkeep of the works accounts and implementation of the terms of the contracts or supervision of contractors and suppliers. A Division office usually supervises the activities of about 4 to 5 Sub-division offices.

The Superintending Engineers and Executive Engineers are responsible for the implementation of policies and programs laid down by the Principal Chief Engineer and the Chief Engineer (PHE). The Executive Engineers have to account for expenditures incurred on various projects to the satisfaction of the Audit. The EE is authorized to sign contracts up to 10 lakhs (following a competitive bidding procedure); and 1 lakh, for "single source" contracts.

The EE, as the head of the Division, is also responsible for compilation and maintaining the Works Accounts through the Junior Accounts Officer and Divisional Accountant. The Division is required to submit regular Monthly Account report to the SE and the CE. The EE is responsible for providing timely information in case estimated cost of the works will likely be exceeded. Annually, he is required to inspect the facilities under his responsibility and should take appropriate measures to ensure that they are in good working condition and that public land, buildings and other properties are not illegally encroached. Some Division Offices have been augmented with Junior Engineers and assistant Surveyor of Works and Divisional Accountant.

2) Typical structure of the Office of the Executive Engineer

The EE's Office normally has several branches to deal with works, administration, accounts and technical matters.

- The Correspondence Branch generally attends to all the administrative requirements of the Branch including records, office maintenance, etc.
- The Accounts Branch deals with financial matters, including cash management, audits and accounts of the Division. It also deals with matters related to the Provident fund of the staff. It assists the EE on financial matters related to contract administration.
- The Drawing Branch prepares the plans and drawings, maintains the registers of facilities, technical preparation and review of estimates and contract documents.
- The Assistant Surveyor of Works is generally responsible for technical review of the contract documents, including specifications, bill of quantities, change orders and deviations (or substitutions) from plans, designs and drawings. The ASW also prepares the preliminary and detailed estimates.

3） Work load norms for Divisions

The **Divisional Office** is established generally according to location or amount of workload it is put in charge of. The workload norm for a Division responsible for construction is currently in the order of 340 lakhs/annum (about $850,000) for civil works construction; and 219 lakhs/annum (about $550,000) for electrical works construction. No norms are available in the Manual for maintenance responsibilities.

A **Sub-divisional Office**, headed by an Assistant Engineer (AE) or Assistant Executive Engineer (AEE), is a field unit responsible for supervision or execution of works according to norms and standards as indicated in the designs, drawings and estimates. A Sub-Divisional Office may also be responsible for the proper operation and maintenance of buildings, structures, areas and equipment. The preparation of the Works Accounts and Stores Accounts is also the responsibility of the AE/AEE. He has to ensure the proper maintenance of the stores under his responsibility. He is required to inspect and certify to the safety of buildings, structures, areas and equipment under his responsibility at least once every six months.

4) Administration, including Human Resources Management and Development

The PHE refers to the CPWD Manual (Volume I) for all policies and procedures regarding organization, human resources and office procedures. Current version in use was issued in 1992. While this Manual was written principally for the CPWD, the contents are equally applicable and have been adapted by most state-level PWD's, including Goa.

Personnel matters are handled by the Director of Administration of the PWD. Job classification, qualification, pay scales for civil, electrical, architectural (and horticultural) engineers is fairly well defined.

The CPWD Manual includes a fairly rigorous procedure and criteria for personnel recruitment, including promotions, training, certification and testing and appointment formalities for all the major regular posts. The requirements and procedures are very rigorous and detailed

Regular staff are those who are included in the regular operating budget of PHE and are entitled to security of tenure and all the benefits of government staff. "Work charged" staff are those whose salaries are charged against the construction or maintenance budget allocations approved annually.

All PWD employees are governed by the same conditions as the State employees, including the Central Civil Service Services (Conduct) Rule 1964, which states that "No (C)PWD employee shall have a personal financial interest in the Government works being executed by (C)PWD."

There is a prescribed training program for training for senior level staff and certified by a training official. This, however, is very minimally done at present in the State. Access of PHE staff to training opportunities is very limited – even non-existent.

Performance evaluation is done annually through annual Confidential Reports with adequate provision for staff to respond to "adverse remarks" in the evaluation. Procedures, criteria and rules governing promotions, eligibility standards, appointment (for selection and non-selection posts) are detailed in the CPWD manual. In addition, the Manual also includes a system for salary and wage administration, staff leaves and a provident fund and other retirement benefits. Finally, the Manual prescribes a code of conduct and associated disciplinary measures. Office procedures for the Correspondence Branch/Accounts Branch of the divisions and subdivisions are in Chapter 7 of the Manual.

5) Construction Work

The PHE generally refers to the CPWD Works Manual (2003) for all policies and procedures governing the arrangements for the development and construction, including major maintenance activities, of sites and facilities. The CPWD Works Manual is a comprehensive compilation of circulars and directives governing the entire range of activities from pre-construction (preparation of construction estimates, qualification and pre-qualification of contractors, tendering, award, contracts), construction (inspection and quality control procedures, work accounts, materials procurement and control, payments to contractors, budgets, auditing) and conflict arbitration procedures. Reporting forms and examples are found in the appendix of the Manual.

3.4.12 Assessment

The Government of Goa is facing increasing demands for services (due to increased tourism, population growth and economic development) and current water and wastewater systems have reached the 'point of saturation' which is beginning to constrain socio-economic development. Despite these challenges, the PHE Division has made significant strides in the water and sanitation arena.

However, much is still to be done and the role of the PHE Division is changing. This has been brought about by new priorities of Water Policy, Plan investments and recent Constitutional Amendments with a major shift in thinking and policy towards a decentralised, people centric and demand responsive approach. This paradigm shift incorporates the principles of:

- Adoption of demand responsive approaches based on empowerment, full participation in decision making, control and management by communities
- Shifting the role of government from direct service delivery to that of planning, policy formulation, monitoring and evaluation and partial financial support
- Partial cost sharing and 100% O&M responsibility by users (beneficiary groups including local bodies)

The reforms also call for substantial institutional development with regard to services, enhancement of technical and managerial capacity, appropriate forms of public-private partnership, private sector participation, use of information systems etc. to achieve sustainability. Additionally, the 10^{th} Plan advocates pricing mechanisms to discourage excessive water use, mandatory water efficient systems for flushing, reduction of leakage and UFW, reuse and recycling of sewage, rainwater harvesting etc.

(1) Key sectoral or policy issues

The Chief Officer of each municipality and the panch in the panchayats have some powers which, if tapped by other agencies, can be helpful in providing the essential services. Minimal interaction with these officials by other state government agencies represents a missed opportunity for the water utilities.

Review, updating and consolidation of water and sewerage services provision (including the institutional arrangement) will be needed. Overlaps and gaps in responsibilities have been noted. There are also some provisions which have become outdated with the improvement in technology and regulations. The "over-specified" policies and provisions in the various acts will have to be broadened to allow for subsequent revisions without need for formal amendment. These will be further delineated in the succeeding missions in consultation with PHE officials. Changes in the legal provisions will likely be timed to go with the other legal amendments needed to implement the sector reform initiatives.

Overall, there is sufficient legislation and policy pronouncement already on place. The motivation, financing resources and institutional capacity to implement is sorely missing.

(2) Institutional Issues – Public Health Engineering Wing

PHE is yet to seriously take up this challenge above, however, systematic implementation of the 'Improvement Programmes' resulting from this JICA Study will go some way in helping the PHE Division in meeting their future obligations.

1) Organization vision and mission

The concept of operating as a water & sewerage company or enterprise does not exist. PHE stills principally sees itself as an engineering company, with a billing and collection function, which, at present, does not affect its resource budgets. PHE receives its budget whether the revenues are realized or not; neither does it receive additional incentives if revenue targets are surpassed.

2) Organizational culture

The current organizational culture may be generally described as efficiency-oriented and regulations-oriented. The organization's prime value is that of making sure that the regulations are followed as closely as possible and that all activities are done at the least cost. These are generally positive values. There is much less value placed on whether the services are, in fact, being delivered or not, whether there are better ways or achieving the same results or whether the market has confidence in their capabilities or not. Some transformation in organizational values and culture still needs to be promoted if PHE is to operate as an enterprise in the future.

3) Organization Structure

The prime basis for sizing the SD is equity in work load and financial responsibility. It does not consider as much the interdependence of inputs, possible efficiencies and economies of scale and lumping of similar activities. Thus, there are situations where: three different sub-divisions are maintaining different sections of the same transmission pipeline; WTP handled by 2 SD's – one for civil works, the other for electrical-mechanical works. This manner of structuring also leads to difficulty in determining actual unit operating costs and attributing results (or lack thereof) to a responsible party.

4) Management Systems

The CPWD manuals unfortunately do not cover various management and administrative process relevant specifically to water and sewerage utility operations. It was net specifically designed for that purpose. Thus, the utility planning and management control systems, specifically for financial management and control systems (and tariff adjustment process), operation and maintenance, and marketing and customer service, are not specifically addressed. Thus we have a situation where a fairly rigorous prescription relevant to primarily capital investment activities being made to apply to an institution which is equally (and more significantly) engaged in operation, maintenance and customer service activities. There being no manuals, each executive engineer devises his own system for data management and analysis and the organization does not have a unified system for consolidating these and coming up with a "big picture".

3.5 Financial System

3.5.1 PWD's Budgeting and Accounting System

The PWD is a state government department、 it receives a budget from the Government of Goa, and returns all of its revenue (gained from its activities) to the Government of Goa.

The fiscal year in Goa starts in April and ends in March. Table 35.1 shows the amount of the PWD's actual (expended) budget and how this was allocated between the major activities during the year 2003-2004.

Table 35.1 Actual Budget of PWD in 2003-2004

(Rs. In Lakhs)

Activities	Amount	Percentage of the total budget
Building	3,807.26	13%
Water Supply & Sanitation	14,654.73	50%
Roads & Bridges	11,023.99	37%
TOTAL	29,485.98	100%

Source: Performance Budget of Public Works Department for the year 2005-2006

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

When setting the annual budget, each divisional office submits the next year's budget estimate to the PWD head office. The PWD head office then reviews and approves the divisional estimates. After the PWD approval, the budget estimates are submitted to the Directorate of Finance and represents one component of the State budget estimate, which is submitted for approval to the Assembly of the State. The provisional budget is estimated before the start of the financial year and a revised estimate is determined by August. Each divisional office is allowed to spend one third of the total budget by August in the fiscal year. After the approval by the Assembly in August, the remaining portion of the revised budget is permitted to be spent. If necessary, the PWD reallocates the budget between each expense category during the financial year.

The PWD follows the accounting method specified in the manual called "Central Public Works Account Code". The manual describes the PWD's financial methods and accounting procedures in detail. Each divisional office follows this manual and prepares financial reports and the necessary documentation. The "Monthly Account" is the document which shows the revenue and expenditure for the divisional office of each month. The PWD head office reviews the financial information provided by each divisional office, including the general information of collected revenue and the budget expenditure.

The "Central Public Works Account Code" does not require the preparation of balance sheets nor income statements that include the depreciation costs. The "Monthly Account" only shows the monthly amount and breakdown of revenue and expenditure. The Division and Sub-Division offices do not have information about the value of their assets. In general, balance sheets show the composition of assets, liabilities, and equity at the end of the fiscal year. Income statements, or profit-loss statements, describe the amount of profit generated by the activities during a certain financial period. Although depreciation costs are not actual expenditure it is necessary to deduct depreciation as a cost component to keep the necessary funds for indispensable investments when the assets are superannuated. The "Central Public Works Account Code" accounting system 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. It is recommended that balance sheets and income statements are prepared regarding the activities of PHE.

3.5.2 Water Supply and Sewerage Tariff Structure

The changes to the water charges tariff Table over the previous decade are shown in Table 35.2.

Revision of the water supply and sewerage tariff requires Cabinet approval and is announced to the related agencies by the Governor through the NOTIFICATION. The present tariff table became effective on June 2006. The tariff system 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. For category 1 and 2, increasing block system is adopted. If the water meter is broken or faulty the water charge is calculated based on the average water volume consumed during the previous three months.

For the sanitation system, the initial connection charge covers the cost of installing the pipeline from the existing sewer pipeline (located on public land) to the private property. The customer must pay any additional costs associated with connecting the pipeline to the existing latrine located on the private property. This large expense is one of the major reasons why people tend not to connect to the public sewer system.

Table 35.2 Changes of Tariff Table since 1995

Month / Year, notified	**Category 1** Domestic	**Category 2** Small hotels / Restaurants / Defence / Fishing Boat Owners' Operator	**Category 3** Small scale / Medium / Large and all types of Industries including Hotel	**Category 4** Commercial / Industries / Bar / Cinema Theater / Construction / Establishments
April 1995	Rs.1/m^3 upto 30m^3 Rs.2/m^3 above 30m^3 Minimum Rs.15/month	Rs.1/m^3 upto 30m^3 Rs.7/m^3 above 30m^3 Minimum Rs.20/month	Rs.7/m^3 upto 100m^3 Rs.9/m^3 above 100m^3 MPT: Rs.9/m^3	
December 1997	Rs.2/m^3 upto 30m^3 Rs.4/m^3 above 30m^3 Minimum Rs.20/month	Small hotels: Rs.7/m^3, Minimum Rs.100/month Defence: Rs.7/m^3 upto 100m^3 Rs.9/m^3 above 100m^3	Rs.20/m^3	
September 1999	Rs.2/m^3 upto 30m^3 Rs.4/m^3 above 30m^3 Minimum Rs.20/month	Small hotels: Rs.10/m^3, Minimum Rs.150/month Defence: Rs.7/m^3 upto 100m^3 Rs.9/m^3 above 100m^3	Rs.26/m^3 Hotels (Registered): Rs.25/m^3 upto 500m^3 Rs.30/m^3 above 500m^3 upto 1000m^3 Rs.40/m^3 above 1000m^3 upto 5000m^3 Rs.50/m^3 above 5000m^3	
January 2001	Rs.2.5/m^3 upto 20m^3 Rs.5/m^3 above 20m^3 Minimum Rs.30/month	Small hotels: notified separately Defence / Fishing boat owners / Operators Association: Rs.10/m^3	Rs.30/m^3	
April 2002	Rs.2.5/m^3 upto 20m^3 Rs.5/m^3 above 20m^3 Minimum Rs.30/month	Small hotels / Restaurant / Defence / Fishing boat owners / Operators Association: Rs.10/m^3	Rs.30/m^3	
August 2003	Rs.2.5/m^3 upto 20m^3 Rs.5/m^3 above 20m^3 Minimum Rs.30/month	Small hotels / Restaurant / Defence / Fishing boat owners / Operators Association: Rs.10/m^3	Rs.20/m^3	Rs.30/m^3
November 2005	Rs.2.5/m^3 upto 15m^3 Rs.5.5/m^3 above 15m^3 Rs.12/m^3 above 50m^3 Rs.30/m^3 above 65m^3 Minimum Rs.30/month Students, Hostels, Hospitalais/Dispensaries and Educational Institutions & recognized charitable Trust Institutions fully aided by Govt. Rs.5.5/m^3 Minimum Rs.30/month	Students, Hostels /Hospitals /Dispensaries Business Profession which are not falling within the purview of Goa, Daman & Diu, shops and and Establishment Acts, Educational Institution and recognized charitable Trust institutions not aided by Govt. Rs.12/m^3 upto 300m^3 Rs.15/m^3 above 300m^3 Minimum Rs.30/month Small hotels / Restaurant: Rs.12/m^3 upto 100m^3 Rs.15/m^3 above 100m^3 Minimum Rs.150/month Defence / Fishing boat owners: Rs.12/m^3 Minimum Rs.150/month	Rs.22/m^3 Minimum Rs.150/month	Rs.30/m^3 Minimum Rs.150/month
June 2006 (Present tariff)	Rs.2.5/m^3 upto 20m^3 Rs.5/m^3 above 20m^3 Minimum Rs.30/month Students, Hostels, Hospitalais/Dispensaries and Educational Institutions & recognized charitable Trust Institutions fully aided by Govt. Same as November 2005	Students, Hostels /Hospitals /Dispensaries Business Profession which are not falling within the purview of Goa, Daman & Diu, shops and and Establishment Acts, Educational Institution and recognized charitable Trust institutions not aided by Govt. Same as November 2005 Small hotels / Restaurant: Same as November 2005 Defence / Fishing boat owners: Same as November 2005	Rs.22/m^3 Minimum Rs.150/month	Rs.30/m^3 Minimum Rs.150/month

Source: Notification, By order and in the name of the Governor of Goa

The Goa tariff system subsidizes domestic users by setting a higher unit price for non domestic users, especially for Category 4 users shown in Table 35.2 (e.g. commercial / industries including MPT/ bars / cinema theatres / construction / establishments). The appropriateness of the level of cross subsidy is checked by comparing the water charges for domestic users and for non domestic users. Table 35.3 shows this comparison for domestic and industrial users in major Asian countries.

Table 35.3 Comparison of water charges for domestic and industrial users

(Rs.)

	Goa	Bangladesh	Cambodia	China	Indonesia	Laos	Malaysia	Vietnam
Domestic ($1m^3$)	4.3	4.0	4.1	2.7	10.9	9.0	10.8	4.9
Industrial ($1m^3$)	30.0	11.1	11.6	4.3	18.3	57.0	25.5	22.4
Industrial/Domestic	6.9	2.8	2.8	1.6	1.7	6.3	2.4	4.6

Source: Data of Tariff table for foreign countries is referred from Second Water Utilities Data Book for the Asian and Pacific Region, ADB

Note: Calculated by the exchange rate for Indian Rupee and United States Dollar at Rs.45.24/US$

Tariff of each domestic and industrial is calculated for 30m3 consumption and divided by 30m3 for simplification

In Goa, industrial users pay 6.9 times more than domestic users to buy $1m^3$ water. The other six cities have smaller size of cross subsidy. If the unit rate for the industrial sector is too high, they will reduce the amount of water they purchase from the public water supply and find alternative methods for securing the necessary water. The cross subsidy is more of a burden to the commercial / industries / bar / cinema theatres / construction / establishments, in Goa than in other Asian countries. In fact, 15 bulk consumers of Division IX, including industries, hotel resorts, and shipyards are responsible for around 30% of the total PHE revenue. As mentioned above, the tariff structure was changed during August 2003, which reduced the unit price for some industries and hotels from Rs.30/m^3 to Rs.20/m^3. This is the main reason for the total decline in revenue, not only for Division IX but also for entire PHE. This was despite the increased revenue from the other divisions. The heavy dependence on a small number of customers makes the financial base, or revenue, of the water supply enterprise vulnerable.

Public awareness of tariffs was studied by the JICA Study Team. The results for average household income, total expense for water, and willingness to pay for water supply and sanitation are shown in the Table 35.4.

Table 35.4 Extracts of the Results of Public Awareness Surveys

No.	Survey Item	Result
1	Average income in water supply survey areas (Rs./month)	5,127
2	Average income in sanitation/sewerage survey areas (Rs./month)	5,406
3	Average water charge for domestic customers (Rs./month)	102.6
4	Willingness to pay (WTP) MORE water charges in addition to current expense in return for adequate pressure and improved water quality (Rs./month)	14
5	WTP MORE water charges in addition to current expense in return for a 24 hours water supply service (Rs./month)	11
6	WTP to connect the toilet/latrine to the sewer to improve the standard of living and improve the quality of environmental water (Rs./month)	66
7	WTP for the initial connection cost to connect to sewer (Rs.)	1,719
8	Hotel industries' WTP for improved piped water supply (incremental %)	+18%
9	Tourists WTP for preserving environmental water quality by connecting to sewer (Rs./night)	129

Source: Report on the Public Awareness Surveys

As shown in the above table, the average income of the sampled households in the water supply areas was Rs.5,127/month, and in the sanitation/sewerage survey areas it was Rs.5,406/month. The present average water charge for a domestic user is Rs.102.6/month. If the customer also connects to sewerage, the present total expense for water supply and sewerage would be Rs.128.25/month (since the sewerage charge is 25% of the water charge). The percentage of average household income spent on water charges and water/sewerage charges was calculated as follows:

- water charge as % of household income = 102.6 / 5,127 x 100 = 2.0 %
- water & sewerage charge as % of household income = 128.25 / 5,406 x 100 = 2.4 %

The IBRD "Project Appraisal Manual" estimates the limit for household affordability to pay for water supply and sewerage services as 4% of household income for the water supply services, and 1% for sewerage services. The Pan American Health Organization also recommends that the total water supply and sewerage charge should be less than 5% of the household income, consisting of 3.5% for water supply and 1.5% for sewerage. The results of the Public Awareness Survey carried out by the JICA Study Team show that the current water supply and sewerage charge in Goa is lower (almost half) than the affordability limits estimated by the international organizations.

Despite the relatively low charges, the willingness to pay (WTP) by domestic users is not high. Users are willing to pay Rs.127.6/month (based on the item 3., 4. and 5. in Table 35.4) for water supply services provided there is adequate pressure, improved water quality, and 24 hour continuous supply. Users are willing to pay Rs.66/month for sewerage services provided there is improved standard of living and improved environmental water quality. The charges, that the users are willing to pay, as a proportion of the average household income, is 2.5%

([Rs.127.6 / Rs,5,127] x 100) for the water supply service only, and 3.6% ([Rs.127.6 + Rs.66] / Rs.5,406 x 100) for both the water supply and sewerage services. These percentages based on the WTP are less than the affordability limits estimated by IBRD (4% for water supply, 5% for water and sanitation) and Pan American Health Organization (3.5% for water supply, 5% for water and sanitation).

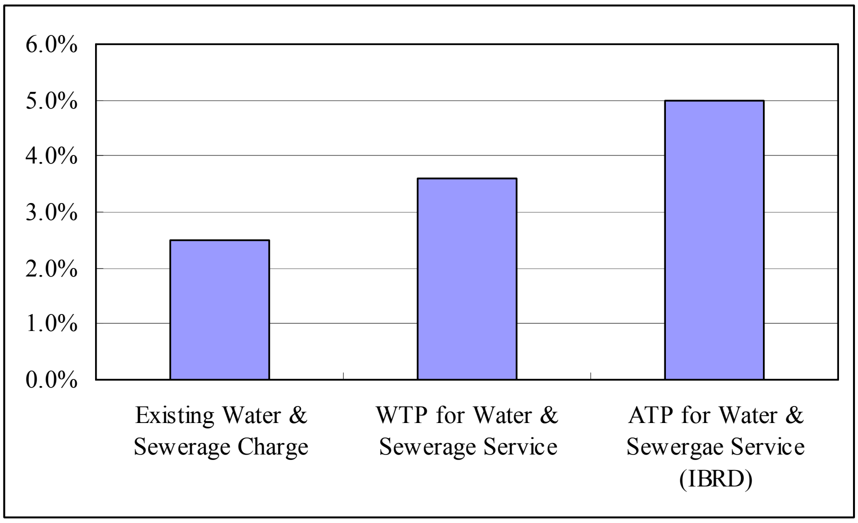


Figure 35.1 Percentage of Water & Sewerage Charge in Average Household Income

As shown in Figure 35.1, the present average expenditure for water supply and sewerage is not particularly high in relation to the average household income. However, WTP for the services is also not high. Based on the affordability limits there is some opportunity to increase tariffs, however customers are not willing to spend much more than they currently do for the services. Public relation activities are recommended to raise the customers' WTP.

3.5.3 Billing and Collection System

Meter reading, billing and collection services are conducted by some of the Sub-Division offices. Sewerage charges are collected at the same time as water charges (these charges are presented on the same bill) because sewerage charges are billed at 25% of water consumption charges. Meter reading, billing and collection are undertaken by four divisional offices: Division III, Division IX, Division XVII, and Division XX. Table 35.5 indicates the area covered by the Division offices and lists the Sub-Divisional offices which are responsible for the meter reading, billing and collection services.

Table 35.5 Divisional Offices responsible for Meter Reading, Billing & Collection and their coverage area (June 2005)

No.	Division	Sub Division	Coverage Area
1	Division III	Sub Division I Sub Division IV	Tiswadi taluka Ponda taluka
2	Division IX	Sub Division I Sub Division II Sub Division III Sub Division IV	Mormugao taluka Salcete taluka
3	Division XVII	Sub Division I Sub Division II Sub Division III Sub Division V Sub Division VI	Pernem taluka Bardez taluka Bicholim taluka Satari taluka
4	Division XX	Sub Division I Sub Division II Sub Division III Sub Division IV	Sanguem taluka Quepem taluka Canacona taluka

Source: Division Offices, PHE, PWD

Staff of each Sub-Division office reads the meter and delivers the previously metered bill to the customer at the same time. Some of the Division offices outsource the customer data management and bill printing to private companies but some conduct the task in-house. Division IX and Division XX outsource the task for all of their Sub-Division offices. In Division XVII, Sub-Divisions I, III, & V outsource the task and Sub-Division II & VI do it in-house. Division III carries out the customer data management and bill printing in-house. Customers pay their bills at banks or directly at the Sub-Division offices.

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. In some cases, meter reading is undertaken less frequently than every 60 days. 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. The variation in the metering cycle may also make it difficult for metering staff to identify meter malfunctions because 'unusual' consumption volumes are not known for each customer.

Management of the meter reading data, billing and collection varies between the Division offices depending on their level of interest in the customer data. The PWD head office only receives revenue and expenditure data from each divisional office on a monthly basis (refer to 3.5.1). The PWD head office does not collect meter reading data, or billing and collection information. There are no systems for reporting customer data to the PWD head office. The variations in data management also makes it difficult to understand the current situation in terms of number of connections, actual water consumption, unit consumption volume, total billed amount, total actual collected amount, and collection efficiency. It also makes it difficult to determine how best to improve customer services.

3.5.4 The PHE Financial Situation

As part of this study, a financial statement (a profit-loss statement for the last five years) for the water supply and sanitation sector of Goa was prepared. A balance sheet was not prepared due to the lack of available data including assets and equity. Based on the profit-loss statement, some financial indicators were calculated and are analyzed in the next section. The following conditions were assumed when preparing the profit-loss statement:

- The purpose of the financial analysis was to explain the present financial situation for water supply and sanitation management. The profit-loss table was developed for the PHE only, not for the whole of the PWD, since the PWD also covers other sectors than water supply and sanitation.
- The analysis treats PHE as an independent organization.
- The basic data for the profit-loss table was taken from the following financial documents: "Performance Budget of Public Works Department for the year 2005-2006", "2004-2005", "2003-2004", "2002-2003".
- Revenue expenditure and capital expenditure for water supply and sanitation (listed in the above financial documents as code numbers 2215 and 4215) were taken to be the PHE expenditure on water supply and sanitation services.
- Revenue data for water supply and sanitation services was provided by each divisional office. For the cases where the last five years of revenue data was not available, assumptions were made, as described in the note associated with Table 35.6.
- The "Annuity Contribution of Goa State Infrastructure Corporation contribution" listed in the Performance Budget, was treated as a repayment of the loan, or interest expenditure.
- Capital expenditure is the costs associated with purchasing, installing equipment, or constructing facilities which will be used for a long time. It is relevant for PHE to accumulate the renovation cost as depreciation so as to provide the sustainable water supply & sanitation service. Therefore, although capital expenditure was excluded from operation and maintenance costs, their depreciation costs were subtracted for each year. The depreciation cost was calculated adopting Straight Line Depreciation over a 30 year-life, with a salvage value set at 10% of the original price.
- The depreciation cost was calculated from the year 2000-2001, due to data limitations. It is important to note that the accumulated depreciation costs would exceed the calculated amount if the calculation method was applied to the relevant past

depreciation period.

- The administration costs in the profit-loss statement for each water supply and sanitation were calculated based on the relative number of staff.

Revenue for the last 5 years of PHE with the breakdown of each Division Offices is shown in Table 35.6. Profit Loss statement is shown in Table 35.7, reflecting the revenue data in Table 35.6, under the conditions and assumptions above. Table 35.8 and Table 35.9 show the revenue & expenditure of each water supply service and sanitation service divided from the Profit Loss statement of PHE.

Table 35.6 Revenue of Each Division Office in the last 5 years

(Unit: Rs. million)

	Water Supply				Total Water Supply	Sanitation		Total Sanitation	Grand Total W/S & Sanitation
	Division III	Division IX	Division XVII	Division XX		Division III	Division XXI		
2000-2001	98.6	277.9	43.0	17.5	437.0	2.8	8.3	11.1	448.1
% in Grand total	22%	62%	10%	4%	98%	1%	2%	2%	
2001-2002	114.0	338.8	54.2	19.6	526.6	4.4	12.4	16.8	543.4
% in Grand total	21%	62%	10%	4%	97%	1%	2%	3%	
2002-2003	114.1	360.5	59.3	20.7	554.6	3.0	9.3	12.3	566.9
% in Grand total	20%	64%	10%	4%	98%	1%	2%	2%	
2003-2004	115.0	339.5	64.4	23.6	542.5	3.0	9.9	12.9	555.4
% in Grand total	21%	61%	12%	4%	98%	1%	2%	2%	
2004-2005	127.9	322.5	69.0	23.4	542.8	2.0	7.9	9.9	552.7
% in Grand total	23%	58%	12%	4%	98%	0.4%	1%	2%	

Note: Division XII and Division XXIV do not conduct customer services including bill collection. Because of limitation of available data, sewerage charge in the Margao city is calculated based on the revenue at 110,255 per 45 days from April-May 2005, and applied to the last five years.

Source: Division Office, PWD

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. Tariff reduction during August 2003 resulted in a decline in the tariff revenue from the industries located in Division IX. Division III makes the second largest revenue contribution. Division III includes the cities of Panaji and Ponda, which are the source of approximately 20% of the total PHE revenue. Division XVII collects approximately 10% of the total revenue. Division XVII covers the four talukas in the north and includes vast rural areas. Division XX collects approximately 4% of the total revenue. Division XX covers the three talukas in the south and also includes vast rural areas. Division XXI collects approximately 2% of the total revenue. Division XXI is responsible for the sanitation service in Vasco and Margao. Revenue from Vasco represents almost 90% of the total Division XXI revenue.

Table 35.7 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					
Water supply	437.0	526.6	554.6	542.5	542.8
Sanitation	11.1	16.8	12.3	12.9	9.9
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
Water supply	610.7	675.1	820.2	632.6	685.8
Sanitation	125.4	120.9	113.5	97.1	93.9
2 Administration cost	67.5	74.1	73.7	75.6	96.2
Water supply	63.1	69.3	68.9	70.7	90.0
Sanitation	4.4	4.8	4.8	4.9	6.2
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. Other expenses	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
V. Interest expenses	**0.0**	**32.8**	**208.3**	**312.8**	**313.2**
VI. 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

Table 35.8 The PHE Revenue and Expenditure on Water Supply over the last 5 years

(Unit: Rs. million)

	2000-01	2001-02	2002-03	2003-04	2004-05
I. Revenue					
Total	437.0	526.6	554.6	542.5	542.8
II. Expenditure					
1 Operation & Maintenance cost	610.7	675.1	820.2	632.6	685.8
2 Administration cost	63.1	69.3	68.9	70.7	90.0
3 Other expenses	23.9	31.8	10.2	1.5	11.6
4 Depreciation	18.8	27.0	32.2	41.6	55.1
Total	716.5	803.2	931.5	746.4	842.5
III. Income from Operation	**-279.5**	**-276.6**	**-376.9**	**-203.9**	**-299.7**

Note: Other expenses for water supply is allocated based on the number of staff for each water supply and sanitation. Depreciation for water supply is allocated based on the Capital expenditure for each water supply and sanitation.

Table 35.9 The PHE Revenue and Expenditure on Sanitation over the last 5 years

(Unit: Rs. million)

	2000-01	2001-02	2002-03	2003-04	2004-05
I. Revenue					
Total	11.1	16.8	12.3	12.9	9.9
II. Expenditure					
1 Operation & Maintenance cost	125.4	120.9	113.5	97.1	93.9
2 Administration cost	4.4	4.8	4.8	4.9	6.2
3 Other expenses	1.7	2.2	0.7	0.1	0.8
4 Depreciation	1.4	2.1	2.5	3.5	4.0
Total	132.9	130.0	121.5	105.6	104.9
III. Income from Operation	**-121.8**	**-113.2**	**-109.2**	**-92.7**	**-95.0**

Note: Other expenses for water supply is allocated based on the number of staff for each water supply and sanitation. Depreciation for water supply is allocated based on the Capital expenditure for each water supply and sanitation.

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 the Table 35.7. It is important to note that operation and maintenance costs associated with water supply and sanitation accounts for more than 80% of the total operating expenditure. The amount of operating revenue is not even sufficient to cover the operation and maintenance costs. The net loss calculated after interest has been increasing, showing the effects of growing interest payment. As shown in Table 35.7, 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.

To sustain ably manage the water supply and sanitation services, the PHE must reduce their financial losses and increase the tariff revenue. These changes are required to cover the operating expenses, interest expenses, and the depreciation costs associated with future renovation/expansion of the water supply facilities/equipment. Table 35.9 shows that the financial situation of the sanitation services is worse than the financial situation of the water supply services. This is because the revenue for the sanitation services is too small in relation to the costs of delivering the services. For example, the revenue from sanitation represents only 10% of the operation and maintenance expenditure on sanitation. The next section provides a detailed financial analysis.

3.5.5 Evaluation and Problem Identification

Performance indicators were used to understand and evaluate the financial situation of the PHE. The performance indicators were based on the financial statement developed and presented in the previous section. Table 35.10 shows the performance indicators for the PHE. The calculation methods and assumptions are briefly described following the table.

Table 35.10 Performance Indicators of PHE

Item	Unit	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005
Profitability						
Operating ratio	%	179%	160%	178%	145%	158%
Ratio of ordinary income	%	53%	56%	45%	48%	44%
Unit production cost	Rs/m^3					12.38
Unit price	Rs/m^3					8.66
Current asset management capability						
Collection efficiency	%					95.6%
Debt management capability						
Debt service coverage ratio		-	-11.0	-2.2	-0.8	-1.1
Efficiency						
Non Revenue Water ratio	%					50.6%
Productivity						
Staff per 1,000 connections						16.1
Growth potential						
Revenue expansion ratio	%	-	21.3%	4.3%	-2.0%	-0.5%

Note:

Operating ratio – This indicator expresses the level of total operating expenditure necessary to generate one unit of operating revenue. The formula for this indicator is: Operating ratio = (Total annual operating expenses divided by Total annual operating revenue) x 100. Total annual operating expenses include operation and maintenance costs and administration costs.

Ratio of ordinary income – This indicator expresses the amount of total revenue generated in relation to one unit of total expenses. The formula for this indicator is: Ratio of ordinary income = (Total annual revenue divided by Total annual expenses) x 100. In this case, total expenses include depreciation costs and interest expenses.

Unit production cost – This indicator expresses the cost incurred to produce $1m^3$ of billed water. It is important to note that the incurred cost does not include depreciation costs or interest expenses. The cost would be higher if both of these costs were included in the calculation. It is also important to note that the indicator is calculated only for water supply (that is, costs relating to sanitation are excluded). The formula for this indicator is: Unit production cost = (Total annual operation and maintenance cost for water supply + annual administration cost for water supply) divided by the total annual billed consumption.

Unit price – This indicator expresses the average amount of revenue produced by supplying $1m^3$ of billed water. The formula for this indicator is: Unit price = (total annual revenue from water supply) divided by (total annual consumption that is billed).

Collection efficiency – This indicates the collectability of billing. Theoretically this is defined as: Collection efficiency = (Collected amount) divided by (Billed amount). Theoretically, the collected amount should be recovery from the original bills. In case of PHE, due to availability of data, both collected amount and billed amount during a same year are used in calculation. Collected amount includes the payment for arrears originated in the past period. Also, due to data availability, the collection efficiency for Division III was calculated on a monthly basis.

Debt service coverage ratio – This indicator is used to measure the extent that annual funds flow covers debt service requirements. The formula for this indicator is: Debt service coverage ratio = (net profit excluding depreciation, interest, and other non cash charges) divided by (total debt service). For the PHE, this indicator equals: (annual operating income + depreciation) divided by (annual loan repayment).

Non revenue water ratio – Non Revenue Water (NRW) is defined as the water which does not generate any revenue for the water supply enterprise. This indicator expresses the proportion of volume of water which does not generate any revenues in the total amount of water production volume. Revenue water includes billed metered consumption and billed unmetered consumption. NRW includes: unbilled authorized consumption (e.g. free water from public stand posts and water tankers etc), unbilled unauthorized consumption (e.g. illegal connections), metering inaccuracy, and leakage. The formula for this indicator is: NRW ratio = [(total annual production volume - annual consumption volume billed) divided by (total annual production volume)] x 100. The total production volume was estimated from the total capacity of the treatment plants (with consideration of the peak factor) because the actual production volume was not available.

Staff per 1,000 connections – This is a commonly used indicator to measure staff productivity. The formula for this indicator is: Staff per 1,000 connections = (total number of staff divided by number of connections) x 1000. For the PHE the total number of staff includes regular staff, work charged staff, and contract staff.

Growth expansion ratio – This indicator is used to evaluate and predict the trend of growth in a certain enterprise by showing the growth rate for the total annual revenue. The formula for this indicator is: Growth expansion ratio = (total annual revenue in the year divided by total annual revenue in the previous year – 1) x 100.

The following six aspects of management for the PHE are discussed below: Profitability, Current asset management capability, Debt management capability, Efficiency, Productivity, and Growth potential.

Profitability was assessed using four indicators: Operating ratio, Ratio of ordinary income, Unit production cost, and Unit price. These indicators are shown in Table 35.10. The Operating ratio and Ratio of ordinary income indicate the massive losses experienced during the past five years.

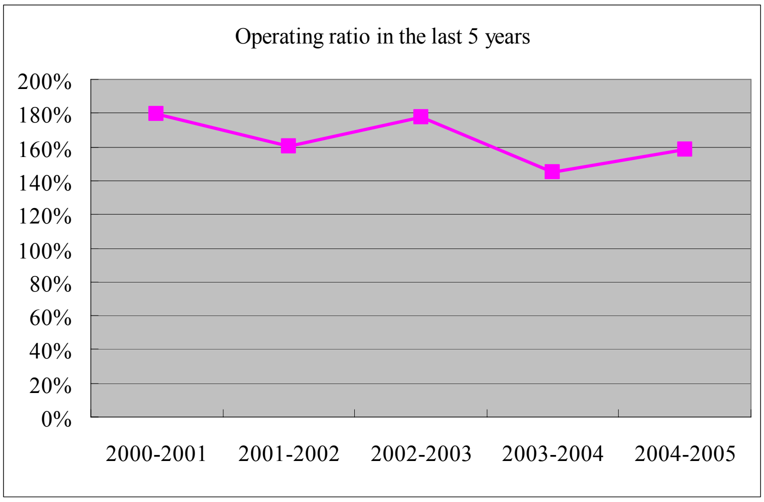


Figure 35.2 Operating ratio in the last five years

The operating ratio should be less than 100% when operating income (profit) is generated. During the past five years, the PHE has made massive losses through its operating activity. From 2000-01 to 2001-02 and from 2002-03 to 2003-04 the operating ratio was improving as a result of the increase in total revenue during 2000-01 to 2001-02 and decrease in operation and maintenance expenditure during 2002-03 to 2003-04. The operating ratio worsened from 2003-04 to 2004-05 due to the decline in total revenue.

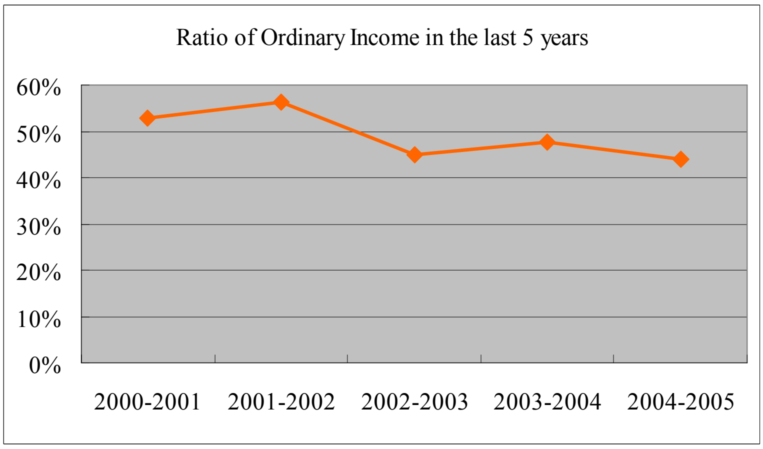


Figure 35.3 Ratio of ordinary Income in the last 5 years

The ratio of ordinary income should be more than 100% when a net profit is generated through operating and non operating activities. The numbers do not show an improvement over the last five years. The indicators show that the PHE is still not profitable. 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. It is suggested that the relationship between the Unit Production Cost and Unit Price can be reversed by reviewing the operation and maintenance costs and the tariff structure.

The current asset management capability of the PHE was assessed using the Collection efficiency. The indicator is close to 100%, which is desirable this means, the full billed amount is almost collected. However, the information of the total amounts billed and total amounts collected are not usually utilized by management class for the improvement of management. It is recommended that data regarding collection performance be accumulated to facilitate continuous monitoring of collection efficiency for further improvement.

Debt management capability was evaluated using the debt service coverage ratio. The negative numbers for this ratio show that summing the operating income and depreciation, results in a loss. Movements of the ratio towards zero indicate that the situation is worsening because this is caused by increases in loan repayments or decreases in funding. Currently the loan repayments are increasing under the massive operational deficits.

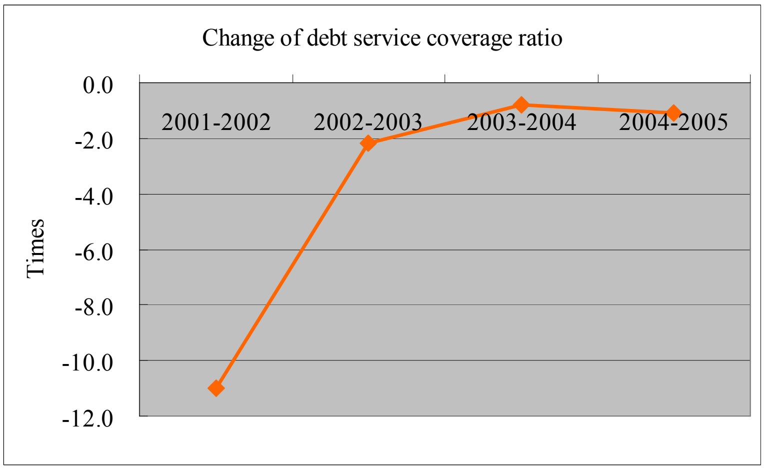


Figure 35.4 Debt service coverage ration in the last 5 years

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. Figure 35.5 shows the level of NRW for Goa and compares these to five other cities in Asian countries. 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 cities was 34%. In comparison to this, Goa's number is above the average.

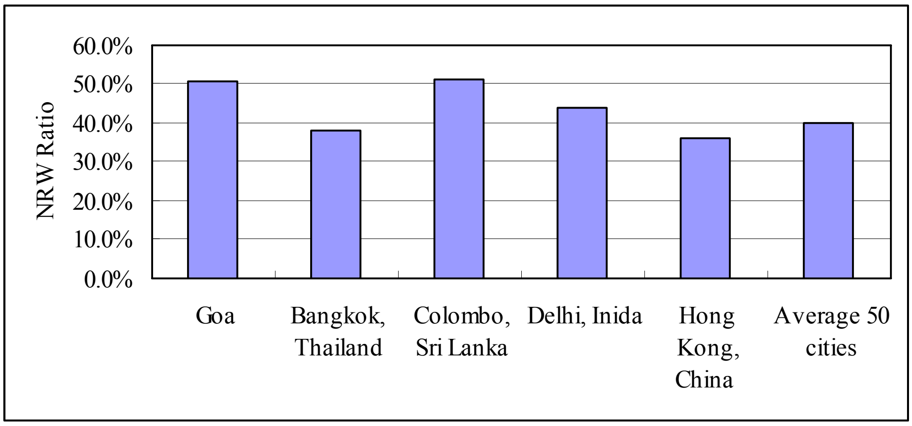


Figure 35.5 Comparison of NRW ratios in other cities in Asia

In Goa, 50.6% of water production does not result in revenue for the PHE. This results from leakage, free of charge public stand posts, meter inaccuracy, etc. A reduction in NRW would contribute to a reduced deficit and to an improved financial situation for the PHE. Understanding the components of NRW and the implementation of an effective strategy to reduce NRW are highly recommended.

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 for the 18 cities shown in Figure 35.6. This means the productivity of the PHE is lower than for the other countries.

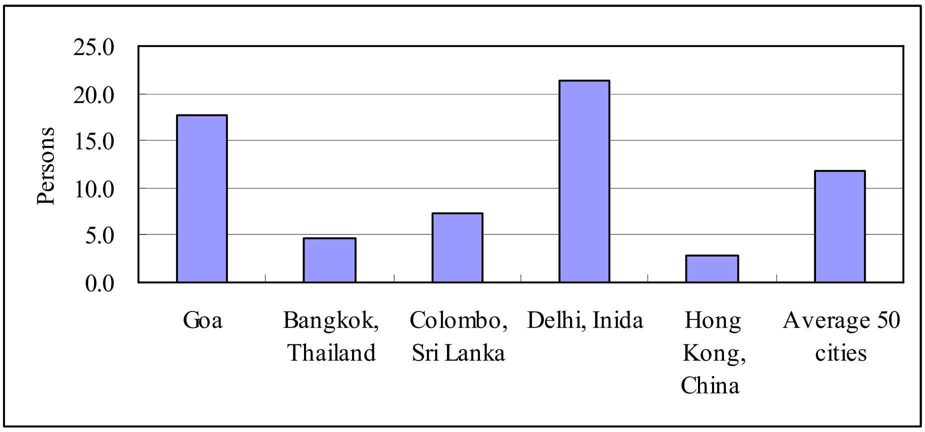


Figure 35.6 Comparison of Staff per 1,000 connections in other cities in Asia

Growth potential was assessed using the growth expansion ratio. The indicator shows the growth rate of total revenue. A positive number represents an increase in total revenue from the previous year. The total revenue from 2000-01 to 2001-02 increased for the PHE by 21.3%, and from 2001-02 to 2002-03 by 4.3%. However, the total revenue decreased by 2.0% from 2002-03 to 2003-04, and by 0.5% from 2003-04 to 2004-05. The tariffs were revised during August 2003 from Rs.30/m^3 to Rs.20/m^3. This resulted in a reduction of the unit charge for almost all types of industries except for large industries such as MPT (Mormugao Port Trust) and registered hotels. The tariff revision is considered to be one of the main reasons for the decrease in the total annual revenue after 2003-04.

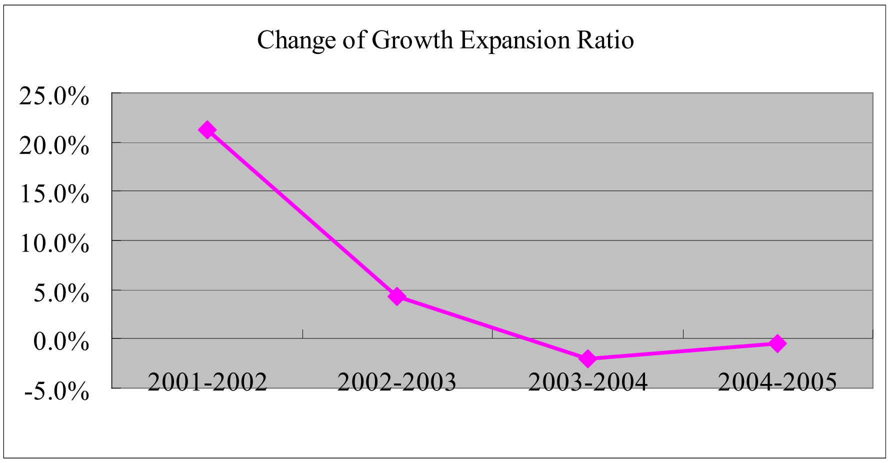


Figure 35.7 Change of growth expansion ratio in the last 5 years

3.6 Results of Public Awareness Surveys

This section describes results of public awareness surveys which were conducted during the 1st Phase of the Study. All detailed results are shown in Volume IV M38 Results of Public Awareness Surveys.

3.6.1 Methodology

(1) Purposes

The main purpose of the public awareness surveys was to understand the existing water supply and sanitation/sewerage situations; consumer complaints, demands and willingness to pay for these public services, and stakeholders' perception of the potential environmental and social impacts caused by the existing systems.

The public awareness surveys include two comprehensive questionnaire surveys and three stakeholder interviews, as listed below:

1. Questionnaire Survey for Residents regarding Water Supply (approx. 360 samples)
2. Questionnaire Survey for Residents regarding Sanitation/Sewerage (approx. 340 samples)
3. Stakeholder Interview for Residents living around the Existing STPs (20 samples)
4. Stakeholder Interview for Hotels regarding Water Supply and Sanitation/Sewerage (20 samples)
5. Stakeholder Interview for Tourists regarding Water Supply and Sanitation/Sewerage (30 samples)

The results of these surveys will be used to inform a range of aspects of the Study including facility planning, OM planning, economic analysis, tariff evaluation, Initial Environmental Evaluation (IEE), Environmental Impact Assessment (EIA), and recommendations for awareness enhancement.

(2) Preparation of Questionnaires and Sampling Design

Separate questionnaires were developed for:

- water supply;
- sanitation; and
- the stakeholder interviews for the residents around existing STPs, hotel resorts and tourists.

These questionnaires were prepared based on expertise sourced from JICA officials, the different JICA Study Team members, counterparts, local consultants and a local NGO. Prior to implementing the surveys, the questionnaires were checked by conducting pre-testing field surveys (at several households, a hotel, etc) for each type of questionnaire. Sampling design of each survey and survey area was finalized through site visits to different types of residential areas and consultation with the PWD engineers at regional offices.

(3) Implementation of the Surveys

A local consulting company (Shah Technical Consultants Private Ltd (STC)) was engaged to carry out the public awareness surveys. All the questionnaire surveys and stakeholder interviews were conducted via interviews.

(4) Accuracy of the Questionnaire Surveys

In general, the sample number for household survey is decided based on the required accuracy represented as the following two variables in addition to the size of universe (total household number).

1. Confidence level (%)
2. Sampling error (%)

The confidence level of sampling survey such as public awareness survey is usually set at 95% which is relatively high level, while its sampling error is set at 10% or less when deciding required sample number. In this study, the universe of the surveys were the estimated total household number in the water supply study area (Goa State) for the water supply questionnaire survey and the estimated total household number in all the sewerage study areas for sewerage questionnaire survey, respectively. The statistical equation for the calculation of sampling error having 95% of confidence level at given sampling number is show as follows.

$$e = 1.96 \sqrt{\frac{N-n}{N-1} \cdot \frac{P(1-P)}{n}}$$

e : Sampling Error
N : Universe
n : Sample Number
P : Population Rate (0.5: worst condition)
1.96 : Coefficient at 95% of confidence level

Table 36.1 summarizes the accuracy of the questionnaire surveys of the Study.

Table 36.1 Accuracy of Questionnaire Surveys

	Water Supply	Sewerage
Population in the Study Area	1,430,000	340,000
Average Number of Household Member	4.58	4.41
Universe (Total Households): N	312,227	77,098
Designed Sample Number	362	340
Collected Valid Sample Number: n	328	337
Population Rate: P	0.5	0.5
Sampling Error: e	5 %	5 %

The accuracy of the questionnaire survey has been confirmed as their calculated sampling errors are 5%. Total designed sample number of 700 is divided into 360 for the water supply questionnaire survey and 340 for the sewerage questionnaire survey by considering that water supply questionnaire survey covers rural areas where response rate is relatively low as well as urban area. Sample number to each area was allocated considering population size of the area and existence of water supply or sewerage facilities.

3.6.2 Questionnaire Surveys for Residents regarding Water Supply

(1) Main Questions asked in the Survey

The questionnaire survey for residents regarding water supply consisted of a large range of questions. The purpose of the survey was to understand the existing water supply situation and the perceptions of different types of residents. The information was gathered for each water supply scheme, each area type and also each water supply service type. The survey questions focused on the consumers' complaints about the current water supply services, the water supply situation during different seasons, hygiene practices, and the residents' willingness to pay for improved water supply services.

(2) Main Results of the Survey

The most important water supply aspect for households was found to be stability (continuous supply) (308 points). The second and third most important aspects were quantity and pressure (260 points) and water quality (244 points).

Table 36.2 shows that the average Willingness to Pay (WTP) for improved water supply (for adequate pressure, improve water quality, and for 24 hour water supply) is 25 Rs./month across the seven surface water supply schemes. The WTP differs scheme by scheme but does not significantly differ in terms of the type of survey area (e.g. populated and poorly served). However, the residents using rural water supply connections that are currently not charged clearly have less WTP for improvements to the water supply.

Table 36.2 Willingness to Pay Higher Water Charges per Month for Improved Water Supply (for adequate pressure, improve water quality, and for 24 hour water supply)

Types of Survey Areas		Water Supply Study Areas								
		1. Salaulim SCHEME Rs./month	2. Opa SCHEME Rs./month.	3. Chandel SCHEME Rs./month	4. Assonora SCHEME Rs./month	5. Sanquelim SCHEME Rs./month	6. Dabosei SCHEME Rs./month	7. Canacona SCHEME Rs./month	8. Distant form the SCHEME Rs./month	9.Average Rs./month
Survey Areas in Each Water Supply Scheme	1. to 4. Populated Area	11	19	16	21	19	20	42		25
		30	25							
		26								
		29								
	5. Beach and Sightseeing Areas	35	27	17	26					26
	6. Poorly served areas	51	42	17	42	12	13	13		27
Average of Each Scheme		33	28	17	29	16	117	28		25
7. and 8. Rural Water Supply Schemes within/outside the Scheme		-	12	-		15	-	16	-	16
									23	

3.6.3 Questionnaire Survey to Residents on Sanitation/Sewerage

(1) Main Questions asked in the Survey

The questionnaire surveys for residents regarding sanitation/sewerage included a large range of questions. The purpose of the surveys was to understand the existing sanitation/sewerage situation. The information was gathered for different types of residents, each study area, each type of sanitation system, and each income level. The questions focused on the respondents' complaints about the current sanitary situation and sewerage services, the reasons for not connecting to sewer, their perception of water pollution, and their WTP to use the sewerage system.

(2) Main Results of the Survey

Figure 36.1 shows that about 30% of the latrines without connection to sewer have experienced overflow problems. About 20% of those latrines overflow at least once a week, while 70% overflow a few times each month, and 10% overflow a few times each year.

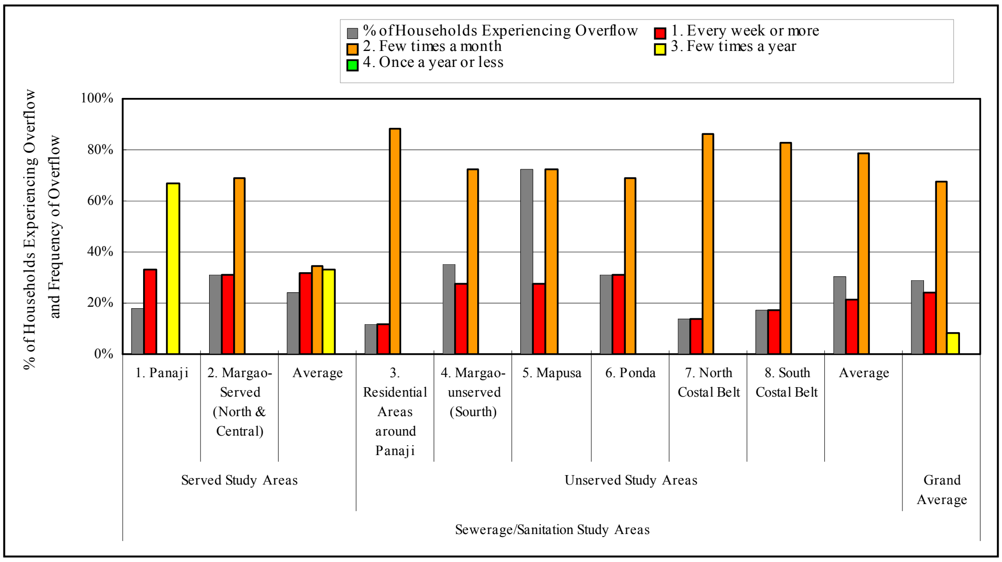


Figure 36.1 Percentage of Households that are not Connected to Sewer that Experience Toilet/Latrine Overflow and Frequency of the Overflows

Figure 36.2 shows that the respondents estimate that about 60% of the overflows are caused by high water tables, 20% of the overflows are a result of the hard laterite substrata, and 4 to 8% of the overflows are caused by inflow of storm water, poor maintenance, and clogging of chambers.

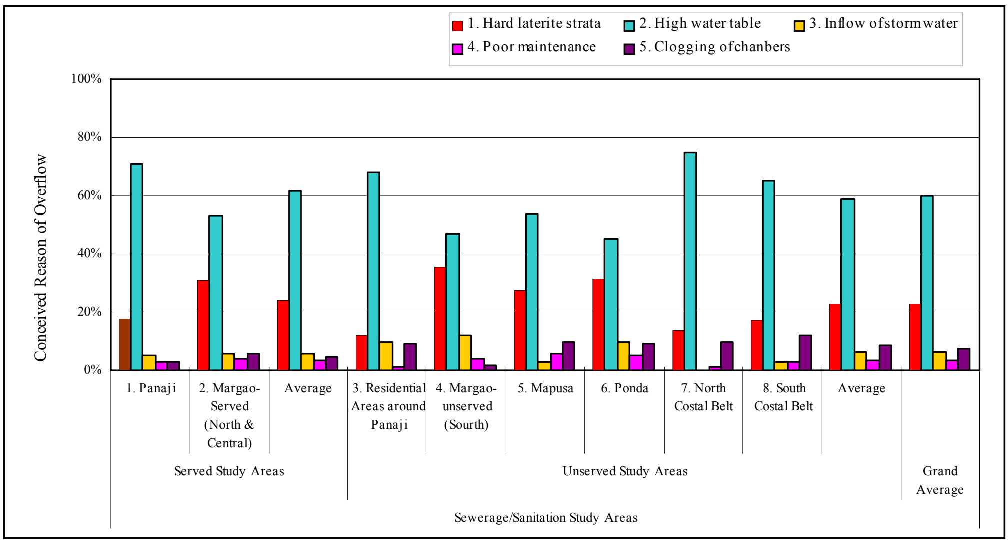


Figure 36.2 Perceived Reasons for Overflow of Toilets/Latrines that are not connected to Sewer

Figure 36.3 shows that when households that use latrines which are not connected to sewer upgrade their latrine, the most popular method is to connect to sewer (374 points). The second most popular method is to improve the on-site sanitation facilities (198 points). The next most popular upgrade method is to construct a latrine inside the house (109 points) followed by having regular sludge disposal services with exhauster (96 points). Figures 36.1 to 36.3 show there is a need to upgrade / expand the sewerage system in Goa.

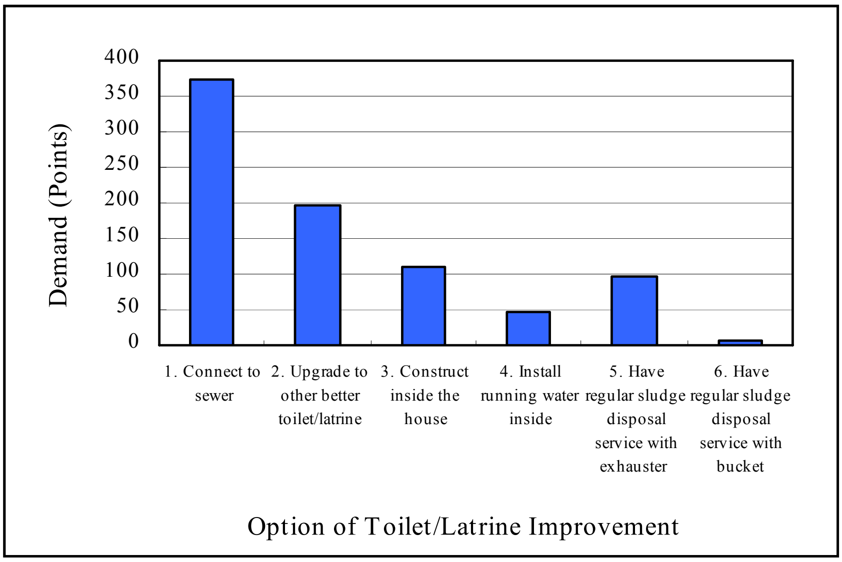


Figure 36.3 Public Preferences for Improvement Options for Existing On-site Sanitation

Table 36.3 shows that the average percentage of households willing to connect to sewer is quite high in the sewered areas of Panaji (100%) and Margao (93%), compared to the unsewered areas (75%). This difference seems to result from the different level of awareness about sewerage. Panaji has a long history of sewerage and residents awareness on sewerage is considered to be the highest in Goa. WTP for sewerage use was found to depend on income level and the level of difficulty people experience regarding their current sanitation facilities. However, the WTP by the low income groups of the Margao sewered area and the very low income groups of the unsewered areas are higher than those of higher income groups. In most cases, the residents in commercial areas have the highest WTP.

Table 36.3 Willingness to Pay to Connect Existing Toilet/Latrine to Sewer

Category	Sewerage/Sanitation Study Areas																
	1. Panaji - Served					2. Margao-Served (North & Central)					3. to 8. Unserved Areas (Average)						Average
	High Income	Low Income	Very Low Income	Commercial	Average	High Income	Middle Income	Low Income	Commercial	Average	High Income	Middle Income	Low Income	Very Low Income	Commercial	Average	
% of Households willing to Connect to Sewer	100%	100%	100%	100%	100%	100%	100%	90%	80%	93%	100%	97%	60%	33%	85%	75%	88%
1. WTP of Monthly Charges for Improving Quality of Life (Rs./month)	37	19	18	35	27	37	32	61	146	69	39	47	26	39	98	50	49
2. Additional WTP of Monthly Charge for Improving Water Environment (Rs./month)	20	10	10	18	15	21	14	19	28	21	21	19	10	8	27	17	17
1.+2. Total WTP of Monthly Charge for Using Sewerage (Rs./month)	57	29	28	53	42	57	47	80	174	89	61	65	36	47	125	67	66
3. WTP for Initial Connection Cost (Rs.)	2067	2500	3167	1633	2342	1647	1222	675	1179	1181	1885	2057	1078	1513	1719	1650	1719

3.6.4 Stakeholder Interviews for Residents around the Existing STPs

(1) Main Questions asked in the Interviews

Residents living near the STPs and the STP discharge points were interviewed to gain an understanding of the environmental and social considerations required for sewerage projects. These considerations include the types of sanitation facilities that are incorporated into the STPs, the method / degree of consultation in the past, and the social and environmental impacts of the STPs and the associated wastewater discharge. The results of these stakeholder interviews will be used to inform the IEE study in the second phase of this study.

(2) Main Results of the Interview

Even though the stakeholder interviews were conducted near the STPs, a large number of the sampled households (47%) have not connected to sewer. In fact, some households practice open defecation (10%). Approximately 25% of the respondents discharge their non-toilet wastewater to open drains. Of the households that are connected to sewer, 45% complained of clogged sewer lines, overflowing manholes, etc.

The majority of the residents were unaware that the STP was located nearby. Most residents had not participated in any public hearings or social meetings regarding the STP. Some of the residents (11%) who live near the STPs noticed that the value of their land has declined due to their proximity to the plants and the unpleasant odor emanating from the plants.

3.6.5 Water Supply and Sanitation/Sewerage Stakeholder Interviews with Hotels

(1) Main Questions asked in the Interview

Since tourism plays a very important role in Goa, the hotel industry makes an important contribution to the state revenue. The main intention of the questionnaire was to understand the hoteliers perception of the existing water supply and sanitation facilities. The hoteliers were also asked about their understanding / concerns regarding environmental pollution resulting from the existing water supply and sanitation situation and their willingness to pay for improved water supply and sanitation facilities.

(2) Main Results of the Interview

The occupancy rate for the hotel resorts in the peak tourist season is almost 100%, while the occupancy rate in the low season is around 65%.

Figure 36.4 shows that the hotel resorts in the Northern Coastal Belt are heavily dependent on open wells (%) and private water vendors (41%) to meet their water demand during the high season. The public piped water supply contributes only 17% of their demand. The hotel resorts in the center of the Southern Coastal Belt are also dependent on private water vendors (12%) while the southern end of the Southern Coastal Belt relies on their own wells (37%) during the high season.

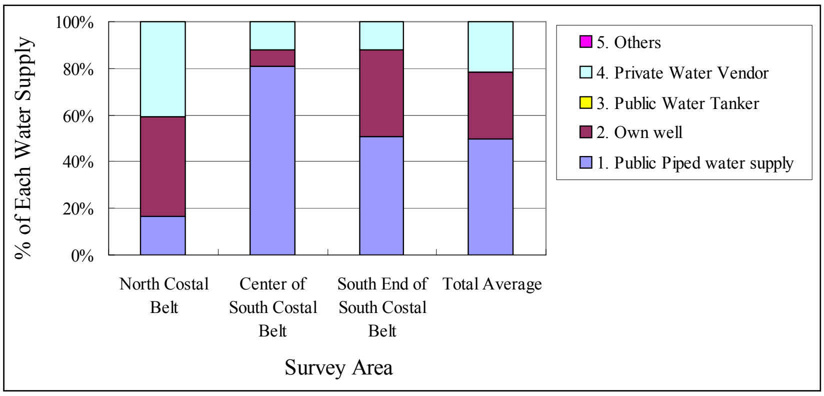


Figure 36.4 Proportion of Water Supplied from different sources during the High Season

It was found that 100% of the sampled hotels within the coastal belts understand the importance of the sewer network and are willing to connect to the sewer. On average, the hotels in the Northern Coastal Belt are willing to pay approximately Rs.7,500 for the initial sewerage connection and Rs.7,140 for the monthly sewerage charges. In the center of the Southern Coastal Belt, where many five star hotels are located, the average WTPs is 16,600 and 27,000 for connection costs and monthly charges, respectively.

3.6.6 Water Supply and Sanitation/Sewerage Stakeholder Interviews with Tourists

(1) Main Questions asked in the Interview

During the interview with both domestic and foreign tourists, the following three major topics were discussed:

- Water supply;
- Sanitation; and
- Environmental water.

A key aim was to determine whether tourists were satisfied with the quality and stability of the existing water supply service and to determine whether they would be willing to pay for improvements to meet international standards. The interviews were also aimed at determining the tourists' satisfaction levels regarding Goa's sanitary situation and also their willingness to pay for improvements to the sanitary situation in public toilets, restaurants and hotels. The tourists were also asked about their willingness to contribute to the cost of improving / expanding the sewerage systems with the aim of maintaining the water quality and water dependent ecosystems, which in turn could improve tourism in Goa.

(2) Main Results of the Interview

Attachment.7 presents the results of these stakeholder interviews in detail. The following section presents and discusses some of the main results.

Large portions of domestic (30%) and foreign (50%) tourists were not satisfied with the existing piped water supply system in terms of quality and stability and were annoyed on a daily basis by the intermittent supply of water. Many domestic (60%) and foreign (30%) tourists were also dissatisfied with the available sanitation facilities and were annoyed about the sanitary situation for public toilets, restaurants and hotels. Almost all of the sampled tourists believed that considerable improvement to the public water supply network and sanitation facilities would assist the future development of tourism in Goa. Table 36.4 shows the tourists' average WTPs for these improvements.

Table 36.4 Average Willingness to Pay for the Improvements to the Water Supply, Sanitary Situation and Water Environmental Water in Goa

Willingness to pay for each service improvement (Rs. per day per person)			
Service Improvement	Domestic Tourist	Foreign Tourist	Average
1. Water supply to international standards	36	197	117
2. Significant improvement of sanitary situation in public places etc.	27	181	104
3. Preserving environmental water quality by expanding / upgrading the sewerage system	18	240	129

CHAPTER 4

FUTURE POPULATION AND WATER DEMAND

CHAPTER 4 FUTURE POPULATION AND WATER DEMAND

4.1 Population

4.1.1 Past Trends in Population Growth

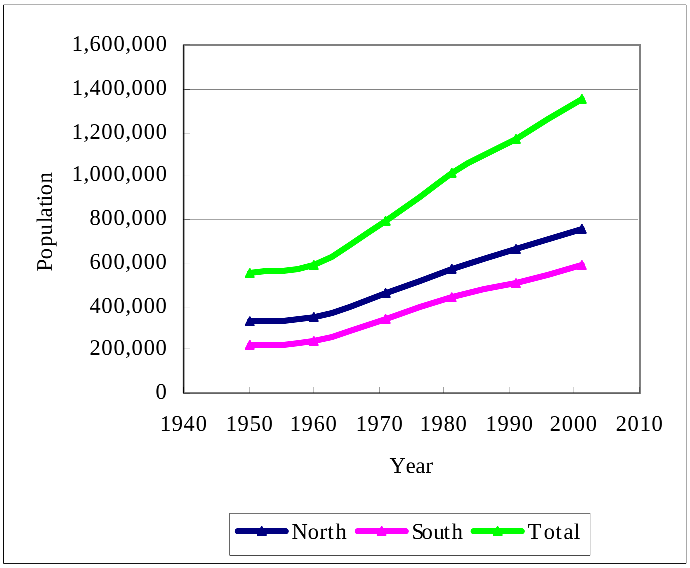
(1) State/District Population

The Government of India has undertaken population census from 1950 to 2001. These census were used to assess population trends, as shown in Table 41.1. The population census records from 1971 to 2001 are attached in Volume IV Appendix M41 Estimation of Future Population.

Table 41.1 Population Census Data for Goa State

Year	Population		
	North District	South District	Total of Goa State
1950	330,874	216,574	547,448
1960	349,667	240,330	589,997
1971	458,312	336,808	795,120
1981	568,021	439,728	1,007,749
1991	664,804	504,989	1,169,793
2001	758,573	589,095	1,347,668

Source: Directorate of Census Operations, Goa



Source: Directorate of Census Operations, Goa

Figure 41.1 Population Census Data for Goa State

As shown in the above table and figure, Goa's population has more than doubled since the 1950s and 1960s.

Table 41.2 and Figure 41.2 show the population growth rate for Goa.

Table 41.2　　　　Annual Population Growth Rate (%/year)

Year	Annual Population Growth Rate (%/year)		
	North District	South District	Total of Goa State
1950	-	-	-
1960	0.554%	1.046%	0.751%
1971	2.490%	3.116%	2.750%
1981	2.169%	2.702%	2.398%
1991	1.586%	1.393%	1.502%
2001	1.328%	1.552%	1.426%

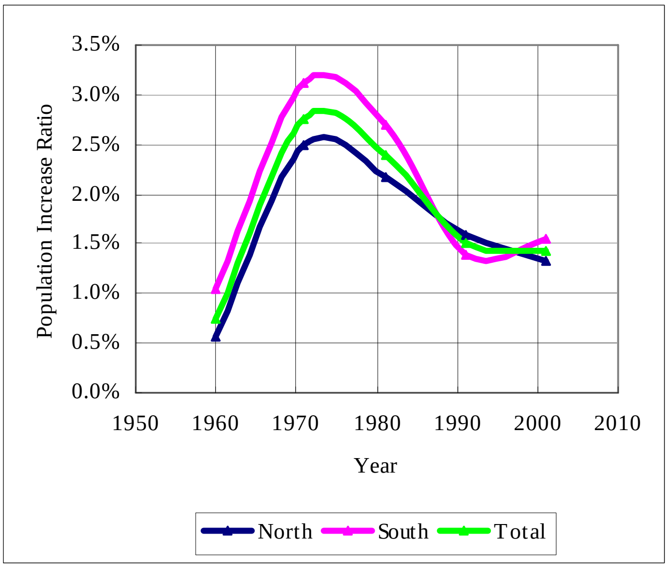
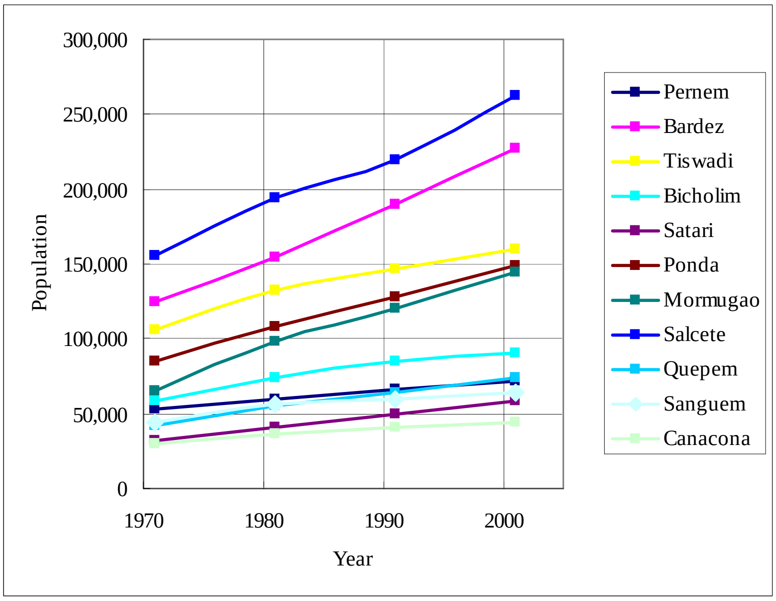


Figure 41.2　　　　Annual Population Growth Rate (%/year)

Between 1960 and 1970, the population growth rate was particularly high. It was 2.5 % in the northern district and 3.1% in the southern district.　From 1970 the growth rate slowed down, and over the past decade the growth rate has remained at approximately 1.5% per year.　The growth rate in the southern district is higher than in the northern district.

(2)　　Population Classified by Taluka

Population for each taluka is available from census data starting in 1971, as shown in Figure 41.3.



Source: Directorate of Census Operations, Goa

Figure 41.3 Historical Population Data for each Taluka

According to the results of the 2001 census, the talukas that have the largest populations are Salcete, Bardez, Tiswadi, Ponda, and Mormugao. Together, these talukas represent 70 % of Goa's total population. Figure 4.14 shows the distribution of population between each taluka.

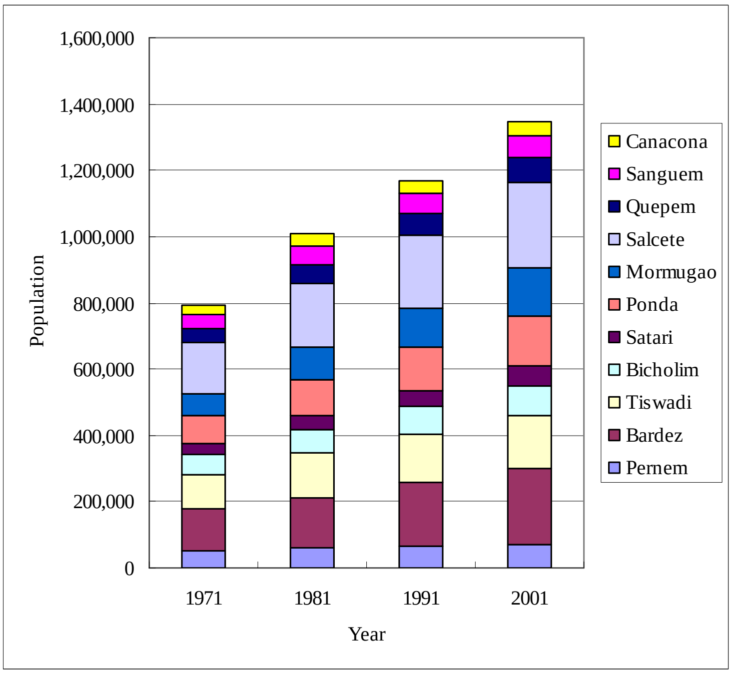


Figure 41.4 Distribution of Population between each Taluka

The population growth rate for each taluka was calculated and the growth rates are shown in

Table 41.3 and Figure 41.5.

Table 41.3 Annual Population Growth Rate for each Taluka (%/year)

Name of Taluka	1971-1981	1981-1991	1991-2001
Pernem	1.156%	1.172%	0.769%
Bardez	2.176%	2.095%	1.859%
Tiswadi	2.232%	1.048%	0.895%
Bicholim	2.410%	1.327%	0.711%
Satari	2.305%	1.948%	1.698%
Ponda	2.463%	1.742%	1.543%
Mormugao	4.167%	2.032%	1.864%
Salcete	2.212%	1.274%	1.769%
Quepem	2.955%	1.500%	1.385%
Sanguem	2.287%	0.601%	0.769%
Canacona	1.998%	1.257%	0.778%

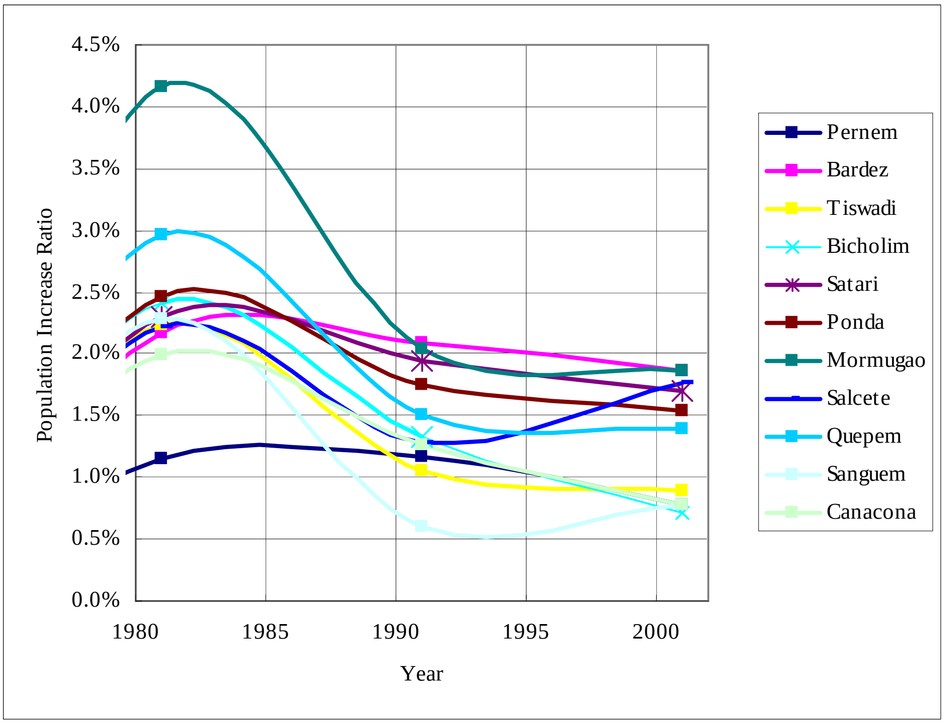


Figure 41.5 Annual Population Growth Rate for each Taluka (%/year)

Of the five talukas with the largest populations (mentioned above), Bardez, Salcete, Ponda, and Mormugao also have the highest population growth rates. However, the population growth rate for the Tiswadi taluka (which includes the capital city Panaji) has been decreasing and over the past decade. The population in the Tiswadi taluka has increased by only 0.9 % over the past decade.

The population growth rate for each taluka is shown in Figure 41.6.

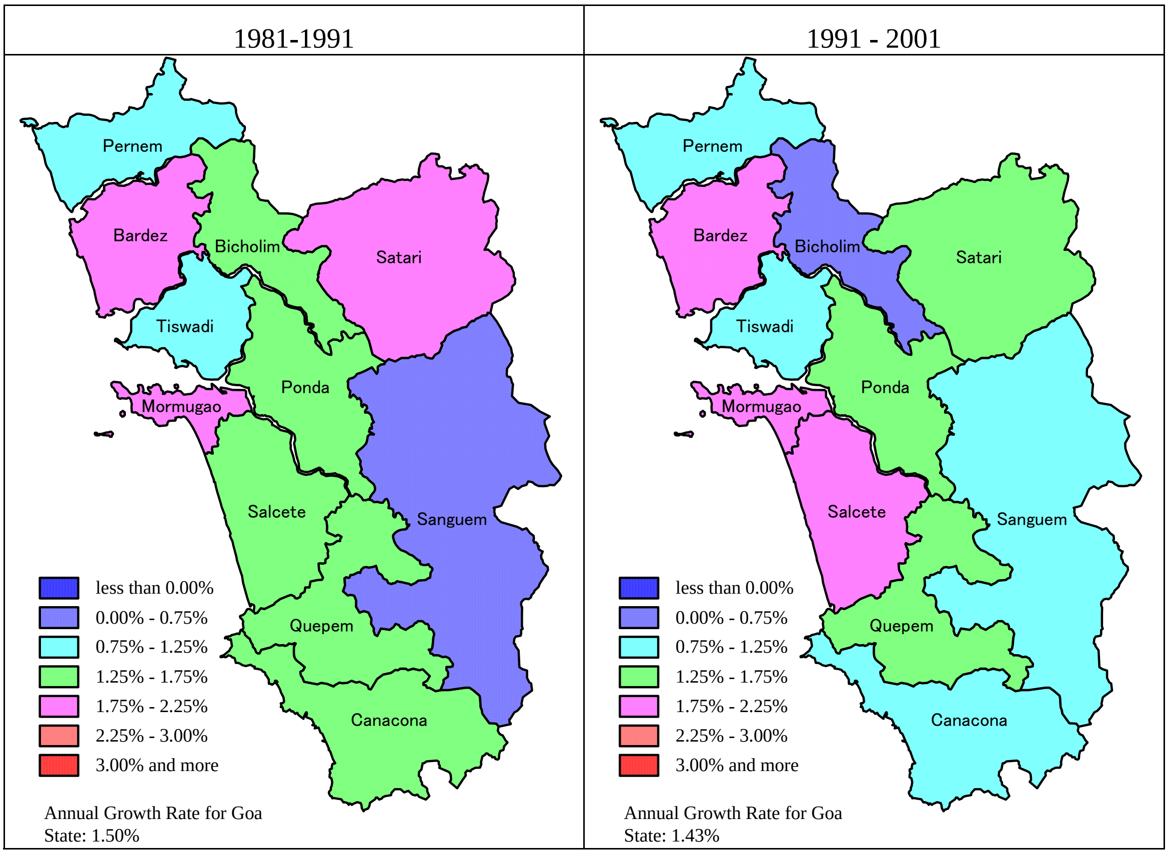


Figure 41.6 Spatial Representation of the Average Annual Population Growth Rate (%/year)

4.1.2 Future Population Projections

(1) Method for Predicting Future Population

Each taluka is divided into spatial units called villages, towns, or municipalities. The number of each unit type for each taluka is shown in Table 41.4.

Table 41.4 Number of Units for Each Taluka

Name of Taluka	Village	Census Town (CT)	Municipality (MCI)	Total
Goa State	347	36	14	397
North Goa District	209	26	7	242
Pernem Taluka	26	1	1	28
Bardez Taluka	33	10	1	44
Tiswadi Taluka	26	10	1	37
Bicholim Taluka	22	2	2	26
Satari Taluka	74	0	1	75
Ponda Taluka	28	3	1	32
South Goa District	138	10	7	155
Mormugao Taluka	11	2	1	14
Salcete Taluka	39	7	2	48
Quepem Taluka	36	0	2	38
Sanguem Taluka	45	1	1	47
Canacona Taluka	7	0	1	8

The future population was estimated for each unit using the five equations listed below. 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.

Equations used to predict future population size:

1. Arithmetic Line
2. Geometric Curve
3. Exponential Curve
4. Power Curve
5. Logistic Curve

The results of the equation that has the highest conformity coefficient, when compared to the measured data, was selected as the estimated the future population for that unit.

The total estimated future population for each taluka was determined by summing the estimated population for each of its units.

(2) Results of Future Population Projections

Table 41.5 and Figures 41.7 and 41.8 show the results of future population projections for each taluka to 2025. The population projections for each unit (village, town and municipality) within the taluka are shown in Volume IV Appendix M41 Estimation of Future Population.

Table 41.5 Future Population Projection (x 1,000)

Year	Pernem	Bardez	Tiswadi	Bicholim	Satari	Ponda	North Goa	Mormugao	Salcete	Quepem	Sanguem	Canacona	South Goa	Goa State
2005	75	246	166	96	64	159	**806**	157	276	78	68	46	**624**	**1,430**
2006	76	250	168	97	65	161	**817**	159	280	79	69	46	**633**	**1,450**
2007	77	255	170	97	67	163	**828**	162	285	80	69	47	**642**	**1,471**
2008	78	259	171	98	68	165	**840**	165	289	81	70	47	**652**	**1,491**
2009	78	264	173	99	69	168	**851**	168	293	81	71	48	**661**	**1,512**
2010	79	269	175	100	70	170	**863**	171	298	82	71	48	**671**	**1,533**
2011	80	273	176	101	72	172	**874**	174	303	83	72	48	**681**	**1,555**
2012	80	278	178	102	73	174	**886**	177	307	84	73	49	**690**	**1,577**
2013	81	283	180	103	74	177	**898**	181	312	85	73	49	**700**	**1,599**
2014	82	288	182	104	76	179	**910**	184	317	86	74	50	**711**	**1,621**
2015	82	293	184	105	77	181	**923**	187	322	87	75	50	**721**	**1,644**
2016	83	299	186	105	79	184	**935**	190	327	88	76	50	**731**	**1,667**
2017	84	304	188	106	80	186	**948**	194	332	89	76	51	**742**	**1,690**
2018	85	309	190	107	81	188	**961**	197	338	90	77	51	**753**	**1,714**
2019	85	315	192	108	83	190	**974**	201	343	91	78	51	**764**	**1,738**
2020	86	320	194	109	84	193	**987**	205	348	92	79	52	**775**	**1,762**
2021	87	326	197	110	86	195	**1,000**	209	354	93	79	52	**787**	**1,787**
2022	87	332	199	111	87	198	**1,014**	213	360	93	80	53	**798**	**1,812**
2023	88	338	201	112	89	200	**1,028**	217	365	94	81	53	**810**	**1,838**
2024	89	344	204	113	90	202	**1,042**	221	371	95	82	53	**822**	**1,864**
2025	90	350	206	114	92	205	**1,056**	225	377	96	82	54	**834**	**1,890**

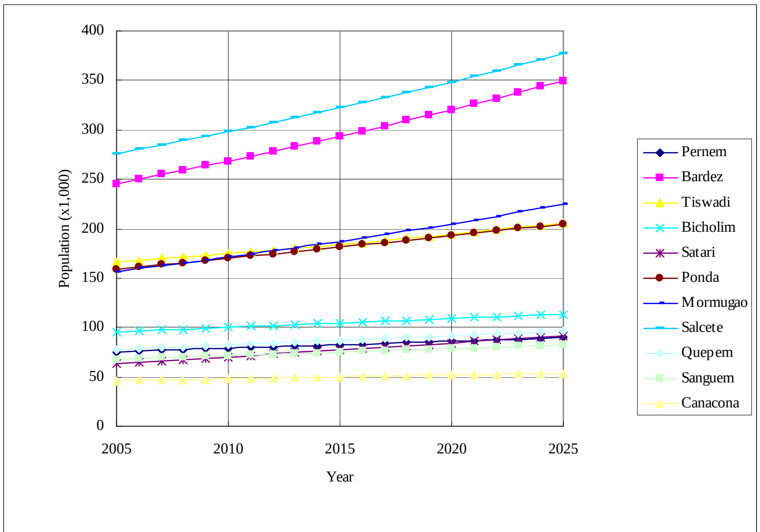


Figure 41.7 Future Population Projection (for each Taluka)

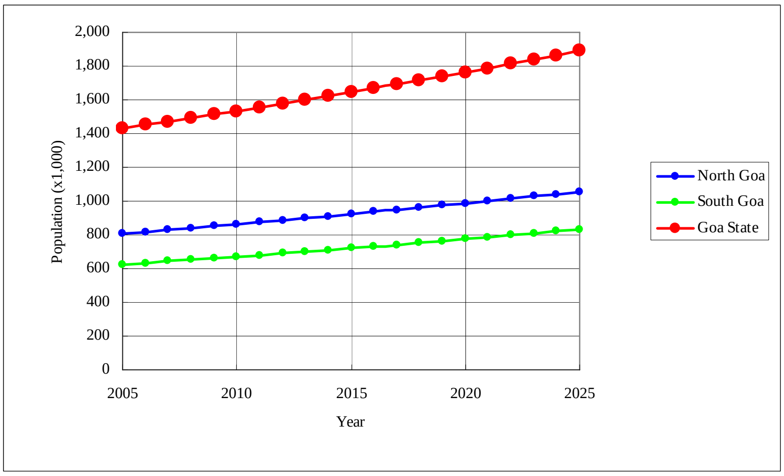


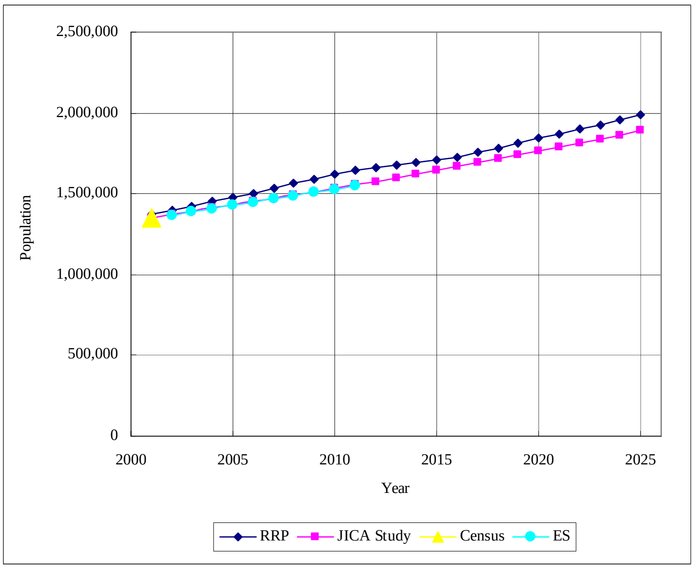
Figure 41.8 Future Population Projection (for each District)

(3) Comparison with Other Population Projections

Two other studies have been completed that estimate the future population size in Goa:

- The "Revised Regional Plan Goa Perspective – 2011, Final Draft Report" (Town and Country Planning Department, Government of Goa, September 2003): This report estimates the population in Goa for the years 2006, 2011, 2016, and 2026.
- The "Economic Survey, 2003 – 2004" (Directorate of Planning, Statistics, and Evaluation, Government of Goa): This report estimates the population in Goa each year until 2011.

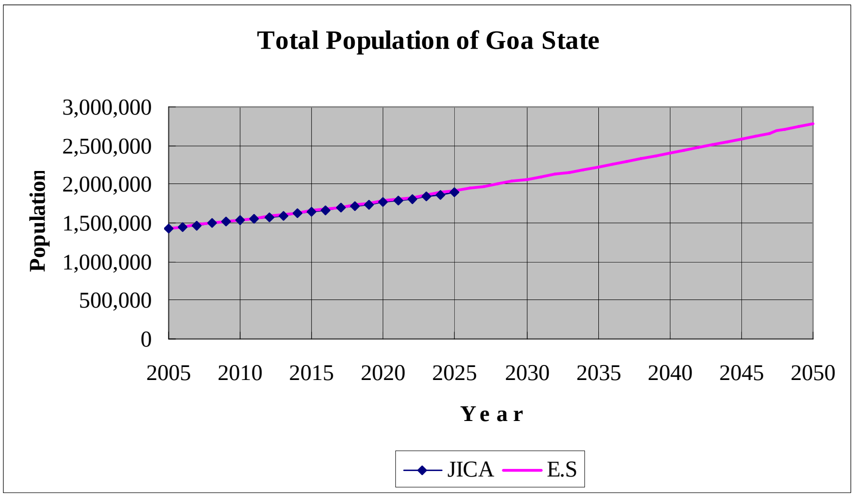
Figure 41.9 compares the above two studies with the results of calculations made by this current study.



RRP: Revised Regional Plan Goa Perspective – 2011, Final Draft Report, In RRP, data in years 2006, 2011, 2016, and 2026 are available. Data in other years were calculated proportionally based on available data.
ES: Economic Survey, 2003 – 2004

Figure 41.9 Comparisons of Future Population Projections

The above figure shows that the three population projections are very similar. In particular, the population estimates made by the Directorate of Planning, Statistics, and Evaluation and this current study are almost the same. In 2005, the latest version of the "Economic Survey 2004-05" was issued by Directorate of Planning, Statistics and Evaluation, Government of Goa and population forecast until year 2050 was available in the Economic Survey. Figure 41.10 shows the comparison of the forecast of the Economic Survey and by this Study.



Note: E.S: Population forecast shown in "Economic Survey 2004-05" by Directorate of Planning, Statistics and Evaluation, Government of Goa, JICA: Population forecast by this Study

Figure 41.10 Total Population of Goa State

As shown on the figure above, future population forecast by this Study is almost same as forecast made by the Directorate of Planning, Statistics and Evaluation, Government of Goa.

(4) Urbanization Trend

The historical urbanization trend was assessed using census data. Urbanization is the proportion of the population living in urban areas. Table 41.6 and Figure 41.11 show that urbanization has been increasing.

Table 41.6 Percentage of Population living in Urban Areas

	1971	1981	1991	2001
Pernem	6%	7%	7%	13%
Bardez	16%	29%	45%	59%
Tiswadi	56%	59%	65%	66%
Bicholim	15%	15%	24%	41%
Satari	9%	10%	14%	14%
Ponda	9%	14%	11%	33%
North Goa	**22%**	**27%**	**34%**	**45%**
Mormugao	67%	71%	80%	83%
Salcete	31%	40%	51%	58%
Quepem	7%	21%	46%	46%
Sanguem	11%	11%	10%	17%
Canacona	5%	5%	26%	27%
South Goa	**30%**	**38%**	**50%**	**56%**
Goa	**26%**	**32%**	**41%**	**50%**

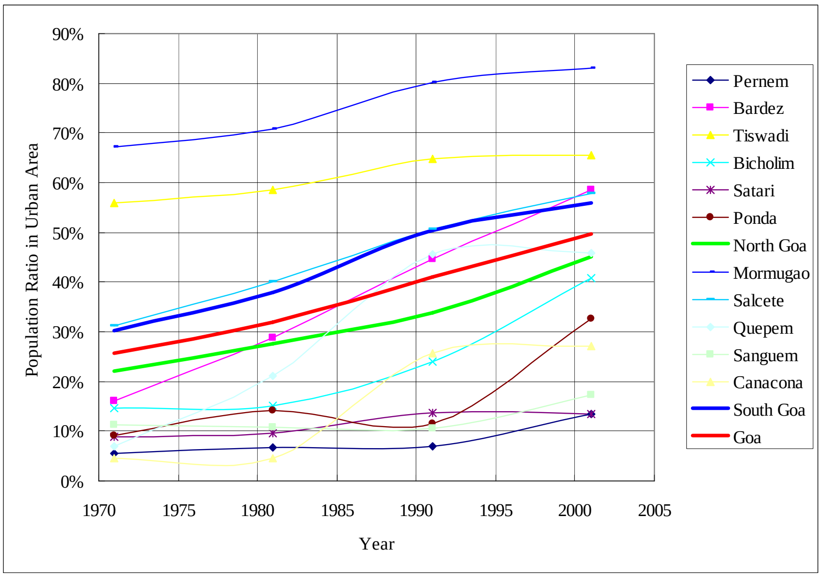


Figure 41.11 Percentage of Population Living in Urban Areas

In most talukas, the percentage of the population living in urban areas has been continuously increasing. In 2001, on average, 50% of Goa's population lived in urban areas. In 1971, only 26% of Goa's population lived in urban areas. That is, over the last three decades, the percentage of the population living in urban areas has approximately doubled.

Future urbanization trends (until 2025) were estimated based on historical data. The results are shown in Figure 41.12. These calculations predict that the percentage of the population living in urban areas will be approximately 70 % by the year 2025.

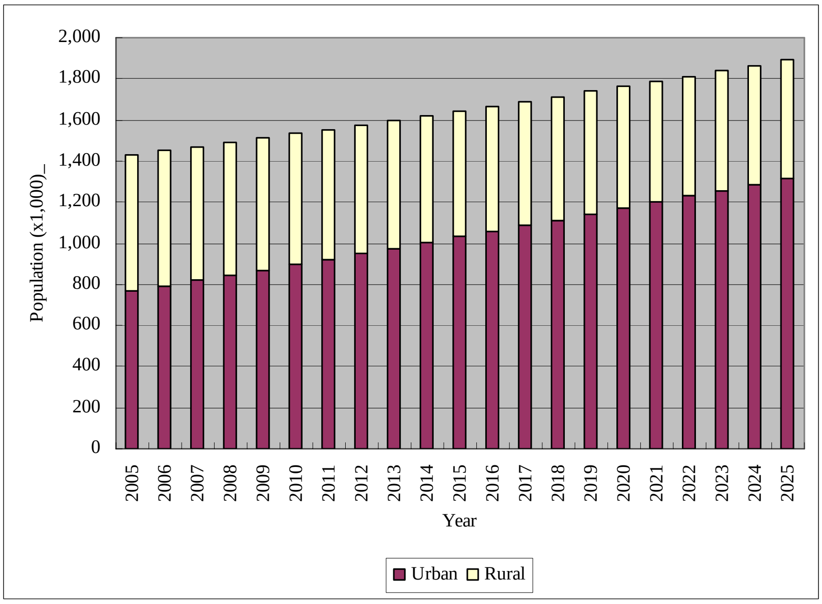


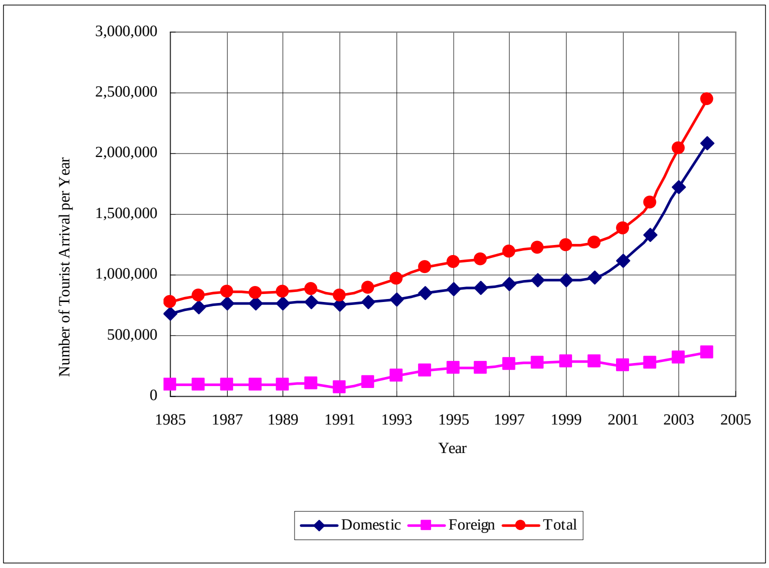
Figure 41.12 Future Urbanization Trends

4.1.3 Tourism Trends

The tourism industry is one of the most important economic and social activities in Goa. It was important to estimate the number of tourists in Goa as this affects water demand calculations.

(1) Historical Tourist Numbers

The Department of Tourism, Government of Goa, records the number of domestic and foreign tourists visiting Goa. Figure 41.13 shows the number of tourists arriving in Goa from 1985 to 2004.



Source: Tourist Statistics 2004, Department of Tourism, Government of Goa

Figure 41.13 Numbers of Tourists in Goa

Domestic tourism has rapidly increased since 2000, doubling between 2000 to 2004. The Department of Tourism, Government of Goa, has indicated they have been increasing their tourism campaign budget. The budget increased from 30 million Rs. in 2000 to 290 million Rs. in 2005.

(2) Future Tourism Projections

The number of tourists visiting Goa was projected based on the historical records shown above, using the same equations that were used for projecting population size. Figure 41.14 shows the projection for domestic tourism and Figure 41.15 shows foreign tourism.

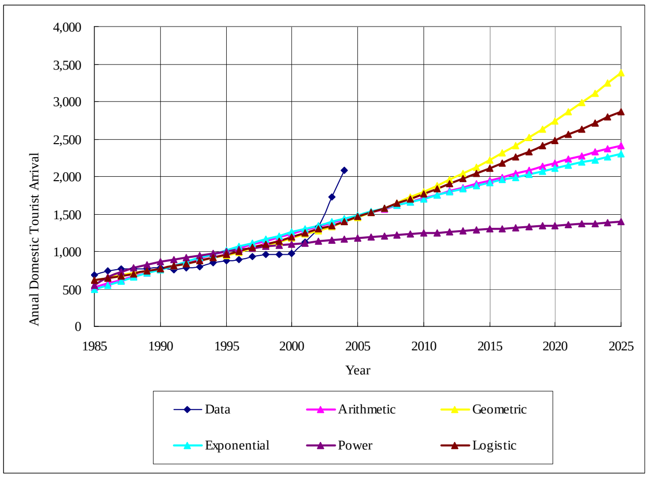


Figure 41.14 Projection of Future Domestic Tourism (×1,000)

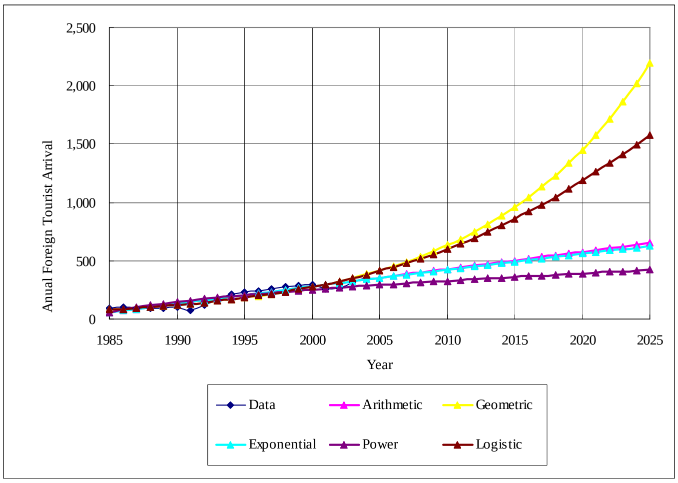


Figure 41.15 Projection of Future Foreign Tourism (×1,000)

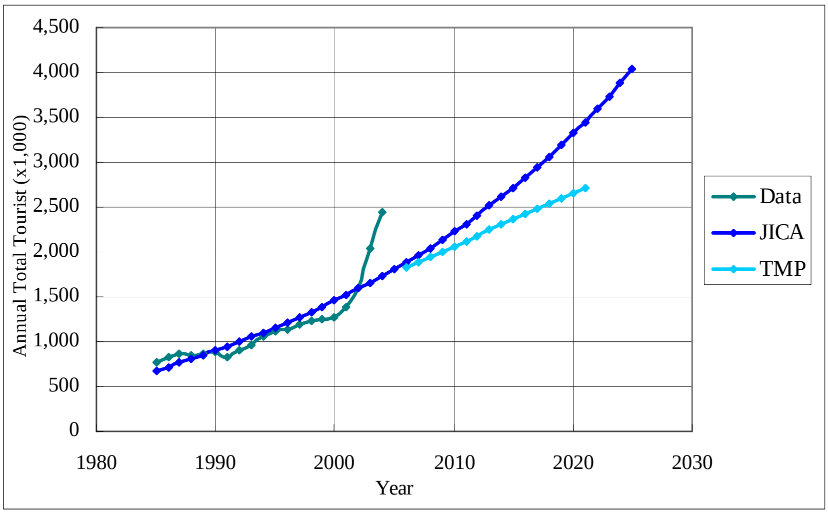
The Geometric Curve showed the highest conformity coefficient for domestic tourism. This curve reflected the steep increase after the year 2000. The Arithmetic Line showed the highest conformity coefficient for foreign tourism. The Line showed a steady increase in tourist numbers. Table 41.7 summarizes the results of the projections.

Table 41.7 Future Annual Number of Tourist Visitors (x1,000)

Year	Domestic	Foreign	Total
2005	1,453	353	1,806
2006	1,516	368	1,884
2007	1,581	383	1,964
2008	1,650	398	2,048
2009	1,721	413	2,134
2010	1,795	428	2,223
2011	1,873	442	2,315
2012	1,954	457	2,411
2013	2,038	472	2,511
2014	2,127	487	2,614
2015	2,219	502	2,720
2016	2,315	517	2,831
2017	2,415	532	2,946
2018	2,519	547	3,065
2019	2,628	561	3,189
2020	2,742	576	3,318
2021	2,860	591	3,451
2022	2,984	606	3,590
2023	3,113	621	3,734
2024	3,247	636	3,883
2025	3,388	651	4,038

(3) Comparison with Other Tourism Projections

The report "Tourism Master Plan: Goa -2011" Final Report (Department of Tourism, Government of Goa, Feb. 2001), presents an estimate of future tourist numbers (TMP). The target year of the master plan was 2011, however projections were made from 2006 until 2021. Figure 41.16 compares the master plan projection with the figures calculated by this current study.



TMP: Tourism Master Plan: Goa -2011

Figure 41.16 Comparisons of Tourist Projections

The projection for TMP was conducted in 2000. Therefore, the TMP projection did not consider the rapid increase in tourism after 2000. This means the TMP projection for future tourism is less than the projection made by this current study.

(4) Variation in Tourism Throughout the Year

Tourism in Goa varies significantly throughout the year, largely due to the reluctance of tourists to visit during the wet season (which is from June to September). Figure 41.17 shows this seasonal variation in tourist numbers for domestic and foreign tourism. More detailed data is attached in Volume IV Appendix M41 Estimation of Future Population.

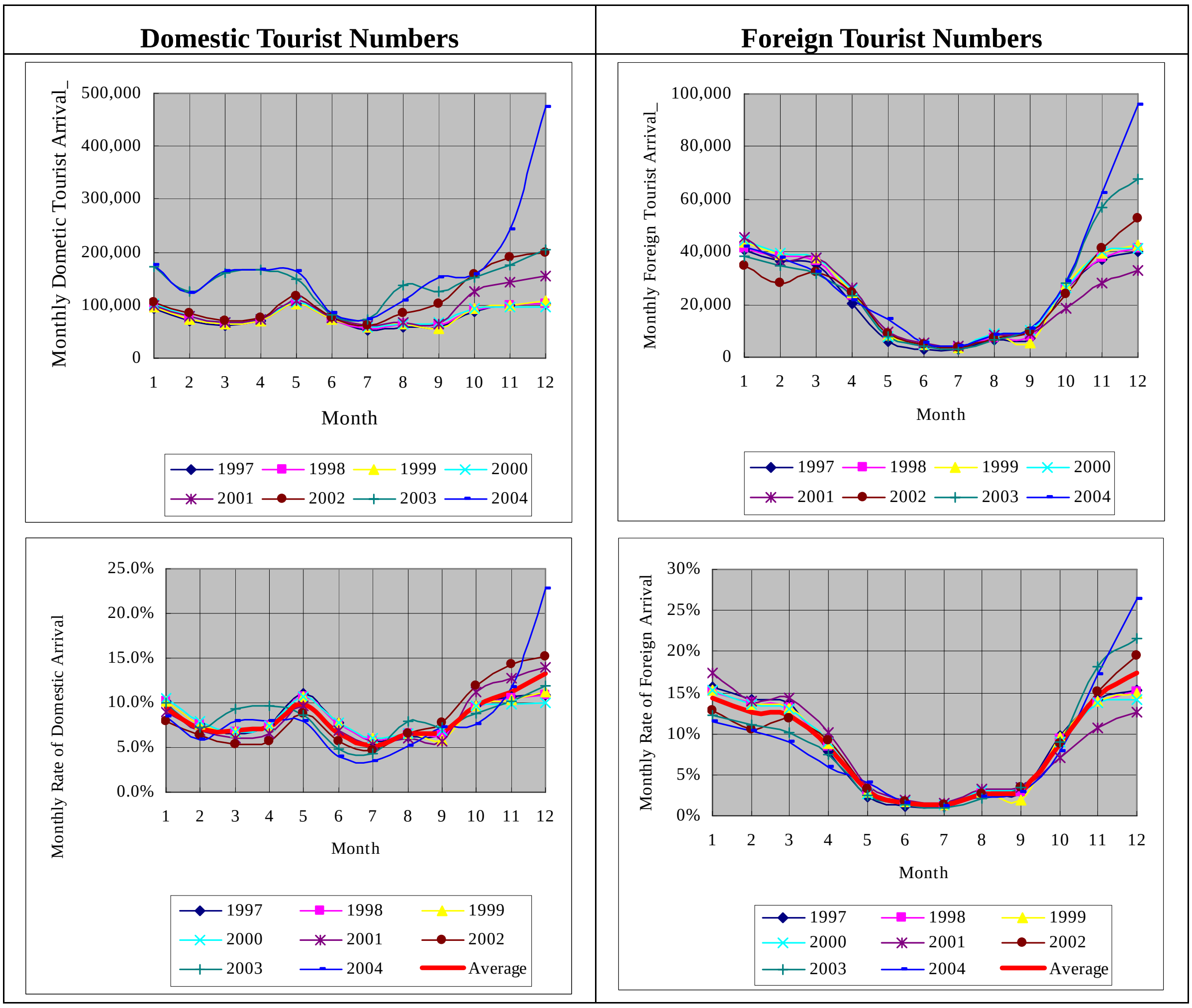


Figure 41.17 Seasonal Variations in Tourist Numbers

The above figures show that the busiest period is from December to January for both domestic and foreign tourism. Approximately 15% of domestic and 20% of foreign tourists visit during December. This variation is an important aspect to consider when planning water supply and sewerage systems because these utilities need to have capacity to support this peak season.

(5) Assessment of Tourism for each Taluka

When assessing future water demand, it is important to understand which areas of Goa are visited by tourists. Tourist stay not only in coastal talukas, but also at other talukas that contain key tourism attractions. Figure 41.18 shows the number of domestic and foreign tourists in each taluka.

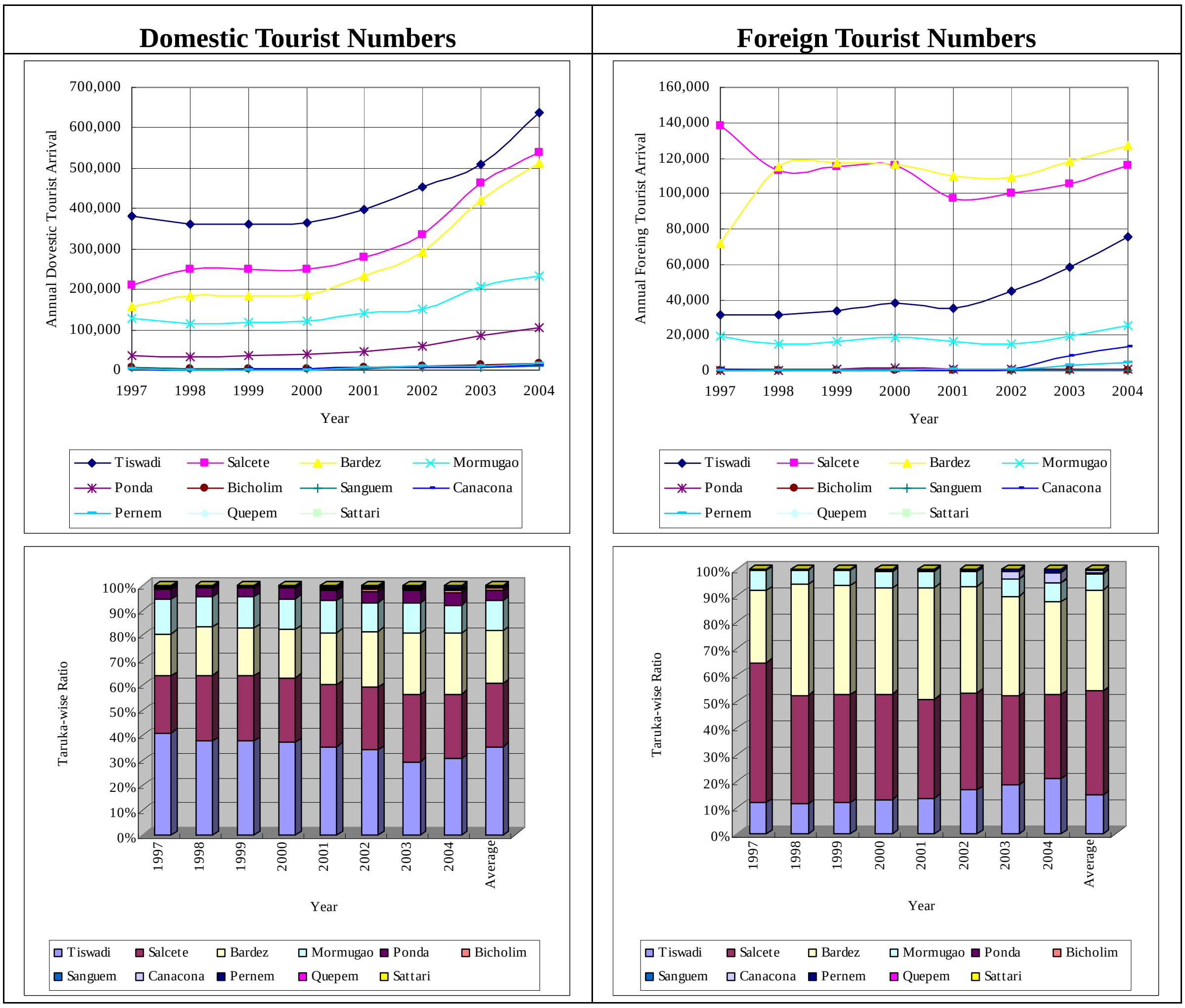


Figure 41.18 Spatial Distribution of Tourism in Goa (classified by Taluka)

The majority of foreign tourists stay in the Bardez and Salcete talukas. These two talukas have beach resorts. Domestic tourist also visit Bardez and Salcete, but another popular taluka is Tiswadi.

4.1.4 Transient Population

As mentioned, Goa has a relatively strong economy compared to the surrounding states. Workers' wages in Goa are relatively high compared to the surrounding states. Therefore, construction firms tend to source their contractor workers from the surrounding states, as they can pay them less. This contractor population is mobile and transient.

Tourism workers also tend to be transient. As mentioned, one of Goa's main industries is tourism, and the number of tourists tends to vary throughout the year. Therefore, hotels, restaurants, and other tourist spots employ seasonal workers to meet the demands during the high tourist season.

This section assesses the affects these transient populations have on water demand forecasts.

(1) Construction Workers

The number of construction workers was estimated from the rate of increase in number of households in Goa. It was assumed that 10 workers are required from outside of Goa State to construct a new house or apartment for a household, and it was assumed that each worker would stay in Goa for one year.

The annual increase in number of households was calculated based on the population growth rate and the average household size, for each Taluka. The average household size was based on 2001 census data. The number of construction workers was calculated based on the number of households. It was found that the number of construction workers represents approximately 3 % of the total population of Goa.

(2) Seasonal Tourism Workers

Figure 41.16 shows the seasonal variations in domestic and foreign tourist numbers. For domestic tourism the low season is February to April and June to September. It is assumed that the tourism workers who are required for these low seasons, permanently reside in Goa. The transient workers were assumed to be required only for the high season.

Table 41.8 shows the domestic tourist arrival rate (monthly arrival/total arrival) for each month in the low season as well as the average low season arrival rate.

Table 41.8 Monthly Arrival Rate in the Low Season (Domestic Tourists)

Month	Feb	Mar	Apr	Jun	Jul	Aug	Sep	Average
Arrival Rate (%)	7.14%	6.93%	7.47%	6.53%	5.18%	6.47%	6.69%	6.63%

The maximum domestic tourism arrival rate occurs during December (the rate is 13.33%). The number of domestic tourists is equal to the difference between the average of 6.63% and the maximum of 13.33 %, which is 6.7%. It was assumed that these tourists will be served by seasonal workers sourced from outside of Goa.

The seasonal workforce required during the foreign tourist high season was calculated using the same method as for domestic tourism. The low season for foreign tourists is form May to

September. Table 41.9 shows the arrival rate for foreign tourists in the low season (monthly arrival/total arrival) as well as the average arrival rate for the low season.

Table 41.9 Monthly Arrival Rate in the Low Season (Foreign Tourists)

Month	May	Jun	Jul	Aug	Sep	Average
Arrival Rate (%)	3.01%	1.57%	1.25%	2.70%	3.02%	2.31%

The maximum foreign tourism arrival rate occurs during December (the rate is 17.43%). The number of foreign tourists is equal to the difference between the average of 2.31% and the maximum of 15.12 %. These tourists will be served by the seasonal workers sourced from outside of Goa.

4.2 Water Demand

4.2.1 Basis of the Future Water Demand Forecast

Future water demand was estimated based on the population predictions and the number of tourists, which were discussed in the previous section. 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

The current average service ratio in urban areas is 90%. It was assumed that the urban service ratio will reach 100 % within 20 years (i.e. by 2025). For the talukas of Tiswade, Mormugao, and Salcete, the service ratio in their rural areas was assumed to be 100% by 2025 because these talukas are located in the centre of the state, where their rural areas are adjacent to urban areas in the neighboring talukas. For the other talukas the rural service ratio in 2025 was assumed to reach 90%.

The proportion of people in rural and urban areas compared to the total population that are serviced and the service ratio are shown in Volume IV Appendix M42 Future Water Consumption.

(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) Tourism Water Demand

The water demand for tourism was estimated based on tourist per capita water demand per day, the number of tourists and the average length of stay of tourists. The per capita water demand was assumed to be the same as presented in the CPHEEO manual.

For High Class Hotel:	500 lpcd
For Medium Class Hotel:	340 lpcd
For Low Class Hotel:	180 lpcd

The total number of tourists was discussed in the previous section. The average length of stay for foreign and domestic tourists was based on recorded data.

Average length of stay:

For foreign tourists:	9 days
For domestic tourists:	5 days

(4) Industrial Water Demand

Industrial water demand was forecast until 2025 using an annual increase ratio of 1.094. This ratio was based on the Gross State Domestic Product of Secondary Industry (Economic Survey 2003-2004) increase ratio.

(5) Institutional Water Demand

Future institutional water demand was forecast assuming that the ratio of institutional water demand to domestic water demand will not change.

(6) UFW Ratio

The UFW ratio is difficult to accurately quantify because almost all metering devises at supply side do not function and data regarding the amount of water supplied are not available. Based on other reports and the data that is available, the UFW ratio was assumed to be 35%.

The PWD recognizes the importance of reducing UFW and has therefore recently established a section within the Department that is responsible for reducing UFW and NRW. 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 %.

(7) Seasonal Peak Factor

Water demand fluctuates monthly. Water supply facilities (such as treatment plant) are usually planned based on the maximum water demand. The domestic per capita water demand discussed in the previous section is the average water demand. The total domestic water demand used when planning water supply facilities should be multiplied by the peak factor (which is the ratio of the maximum water demand divided by the average water demand).

The peak factor was based on the historical monthly water demand fluctuation. However, as mentioned in the previous chapter, monthly demand fluctuation is difficult to accurately quantify because the meter reading and billing cycles are not consistent across the PWD. Therefore, the fluctuations in monthly water demand resulting from the different meter reading/billing cycles were mathematically smoothed. This smoothed data gave a peak factor of 1.21, which was used in the calculations.

4.2.2 Future Domestic Water Consumption

Future water consumption projections were estimated as presented in Table 42.1, assuming the conditions explained in the previous section. The future domestic water consumption predictions for each Taluka are shown in Volume IV Appendix M42 Future Water Consumption.

Table 42.1 Future Domestic Water Consumption (m^3/day)
(Daily Maximum Basis, without UFW)

Pernem Taluka	2005	2010	2015	2020	2025
Case 1 (Urban 135 lpcd, Rural 70 lpcd)	3,361	4,756	6,314	7,837	9,220
Case 2 (Urban 150 lpcd, Rural 100 lpcd)	3,361	5,138	7,238	9,493	11,824
Case 3 (Urban 200 lpcd, Rural 200 lpcd)	3,361	6,412	10,317	15,012	20,501
Bardez Taluka					
Case 1 (Urban 135 lpcd, Rural 70 lpcd)	34,214	39,199	44,700	50,773	56,869
Case 2 (Urban 150 lpcd, Rural 100 lpcd)	34,214	40,495	47,567	55,517	63,929
Case 3 (Urban 200 lpcd, Rural 200 lpcd)	34,214	44,812	57,124	71,330	87,462
Tiswadi Taluka					
Case 1 (Urban 135 lpcd, Rural 70 lpcd)	23,165	25,684	28,225	30,633	33,350
Case 2 (Urban 150 lpcd, Rural 100 lpcd)	23,165	26,478	30,011	33,675	37,917
Case 3 (Urban 200 lpcd, Rural 200 lpcd)	23,165	29,128	35,963	43,816	53,142
Bicholim Taluka					
Case 1 (Urban 135 lpcd, Rural 70 lpcd)	11,816	13,057	14,366	15,746	16,999
Case 2 (Urban 150 lpcd, Rural 100 lpcd)	11,816	13,574	15,459	17,466	19,421
Case 3 (Urban 200 lpcd, Rural 200 lpcd)	11,816	15,296	19,100	23,199	27,497
Satari Taluka					
Case 1 (Urban 135 lpcd, Rural 70 lpcd)	4,704	5,669	6,753	7,945	9,227
Case 2 (Urban 150 lpcd, Rural 100 lpcd)	4,704	6,065	7,712	9,672	11,965
Case 3 (Urban 200 lpcd, Rural 200 lpcd)	4,704	7,384	10,909	15,429	21,091
Ponda Taluka					
Case 1 (Urban 135 lpcd, Rural 70 lpcd)	12,805	16,870	21,070	25,344	29,816
Case 2 (Urban 150 lpcd, Rural 100 lpcd)	12,805	17,581	22,771	28,328	34,398
Case 3 (Urban 200 lpcd, Rural 200 lpcd)	12,805	19,952	28,438	38,277	49,669
Mormugao Taluka					
Case 1 (Urban 135 lpcd, Rural 70 lpcd)	13,613	18,114	23,449	29,867	37,600
Case 2 (Urban 150 lpcd, Rural 100 lpcd)	13,613	18,621	24,793	32,491	42,093
Case 3 (Urban 200 lpcd, Rural 200 lpcd)	13,613	20,310	29,273	41,238	57,069
Salcete Taluka					
Case 1 (Urban 135 lpcd, Rural 70 lpcd)	41,944	45,592	49,372	53,269	57,244
Case 2 (Urban 150 lpcd, Rural 100 lpcd)	41,944	47,126	52,795	58,976	65,662
Case 3 (Urban 200 lpcd, Rural 200 lpcd)	41,944	52,236	64,203	77,998	93,724

Quepem Taluka	2005	2010	2015	2020	2025
Case 1 (Urban 135 lpcd, Rural 70 lpcd)	8,363	9,344	10,371	11,374	12,400
Case 2 (Urban 150 lpcd, Rural 100 lpcd)	8,363	9,778	11,338	12,990	14,791
Case 3 (Urban 200 lpcd, Rural 200 lpcd)	8,363	11,224	14,561	18,377	22,758
Sanguem Taluka					
Case 1 (Urban 135 lpcd, Rural 70 lpcd)	2,014	3,349	4,853	6,524	8,340
Case 2 (Urban 150 lpcd, Rural 100 lpcd)	2,014	3,564	5,512	7,902	10,752
Case 3 (Urban 200 lpcd, Rural 200 lpcd)	2,014	4,279	7,711	12,495	18,793
Canacona Taluka					
Case 1 (Urban 135 lpcd, Rural 70 lpcd)	2,601	3,379	4,217	5,063	5,951
Case 2 (Urban 150 lpcd, Rural 100 lpcd)	2,601	3,569	4,707	5,981	7,442
Case 3 (Urban 200 lpcd, Rural 200 lpcd)	2,601	4,202	6,340	9,040	12,411
Total	**2005**	**2010**	**2015**	**2020**	**2025**
Case 1 (Urban 135 lpcd, Rural 70 lpcd)	158,598	185,013	213,691	244,376	277,016
Case 2 (Urban 150 lpcd, Rural 100 lpcd)	158,598	191,987	229,902	272,492	320,193
Case 3 (Urban 200 lpcd, Rural 200 lpcd)	158,598	215,235	283,939	366,213	464,117

4.2.3 Future Non-Domestic Water Consumption Forecast

Table 42.2 shows the predicted future non-domestic water consumption, which was based on the conditions outlined in section 4.2.1. The future non-domestic water consumption for each Taluka is shown in Volume IV Appendix M42 Future Water Consumption.

Table 42.2 Future Non-Domestic Water Consumption (m^3/day, without UFW)

Taluka	2005	2010	2015	2020	2025
Pernem	138	218	328	478	690
Bardez	1,873	2,539	3,458	4,755	6,621
Tiswadi	4,404	5,971	8,190	11,407	16,189
Bicholim	868	1,117	1,461	1,949	2,657
Satari	80	122	189	294	459
Ponda	1,732	2,721	4,272	6,731	10,666
Mormugao	23,173	32,562	45,206	62,165	84,825
Salcete	7,894	10,092	13,185	17,657	24,270
Quepem	445	586	789	1,087	1,540
Sanguem	56	82	117	162	221
Canacona	135	186	252	337	449
Total	40,799	56,196	77,446	107,021	148,586

4.2.4 Total Water Consumption

Figure 42.1 presents the future domestic and non-domestic water consumptions, which were discussed in the previous sections. These consumptions are net consumptions which do not include UFW,

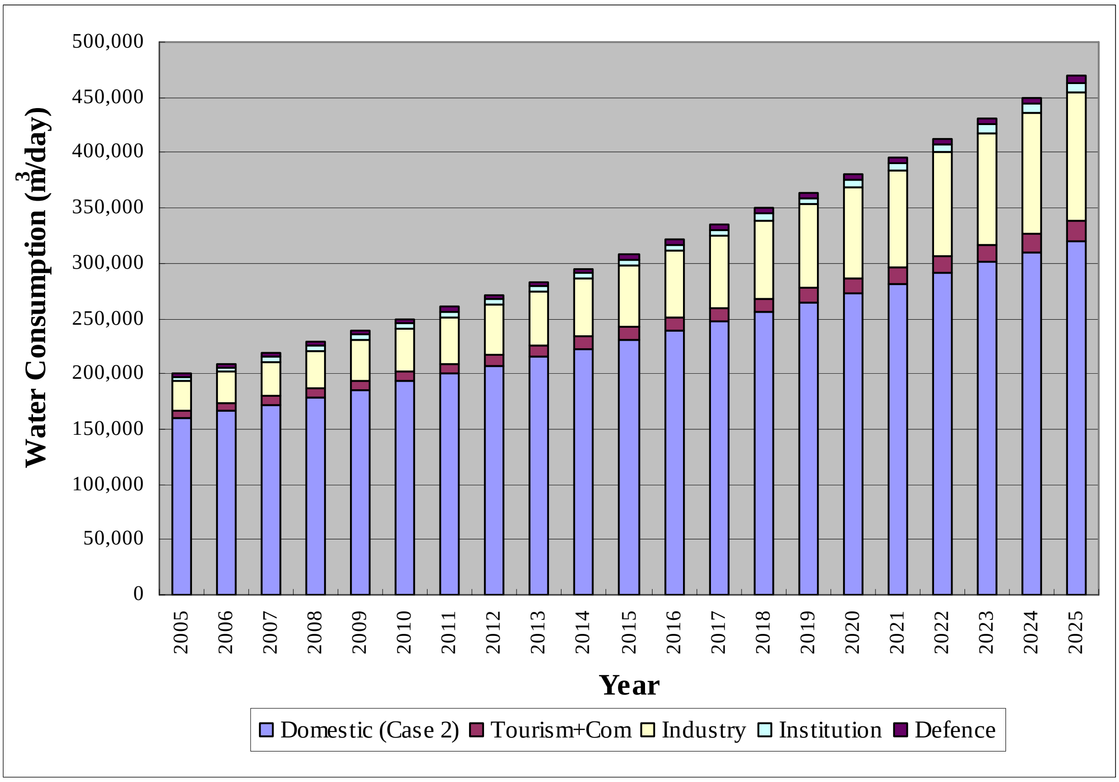


Figure 42.1 Domestic and Non-Domestic Water Consumption (without UFW)

The total future water consumption that was calculated from net water consumption shown on Figure 42.1 taking into account the future UFW ratio and peak factor mentioned above. The total future consumption for each Taluka is shown on Figure 42.2 together with potential water demand.

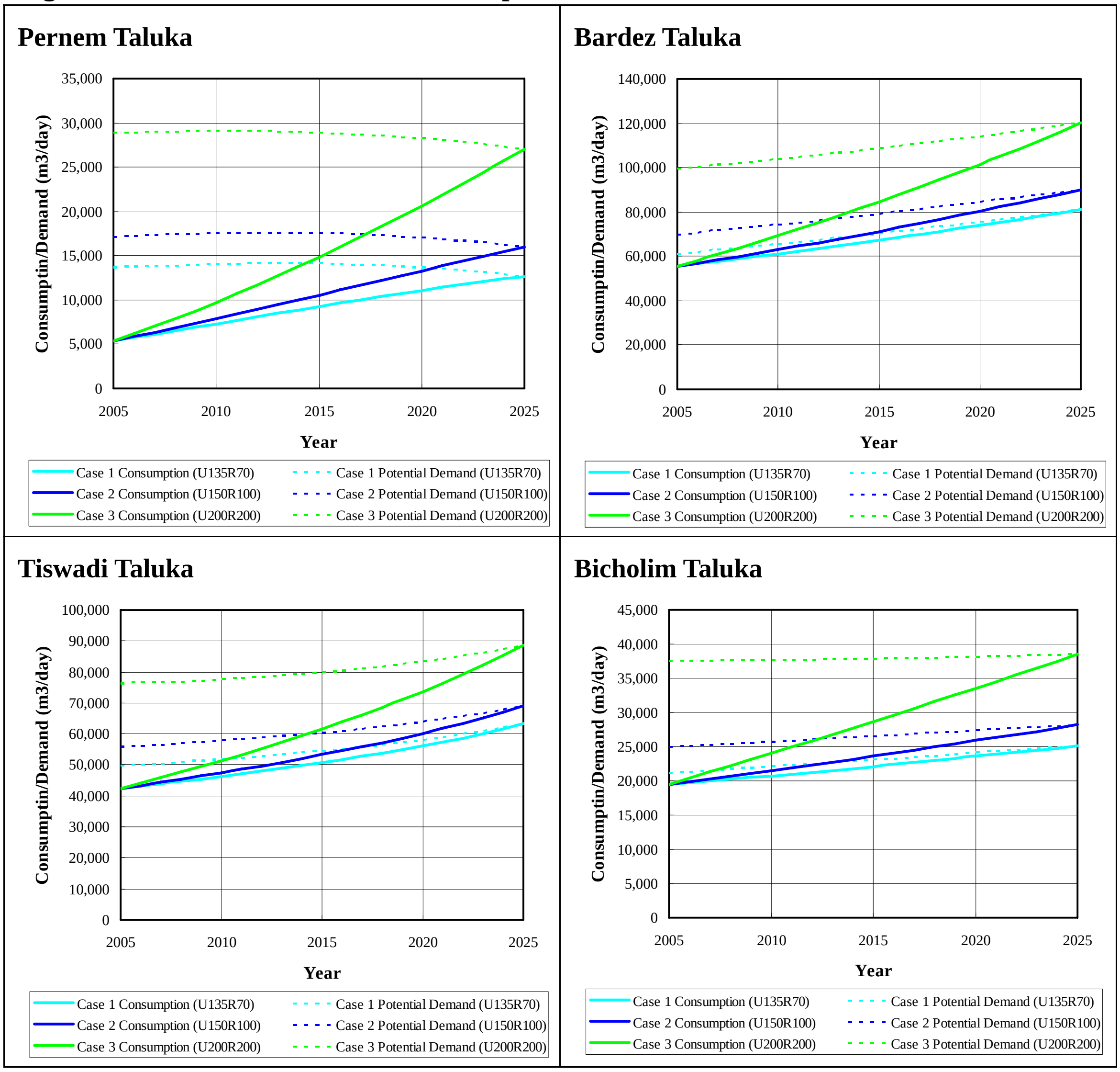
"Consumption" shown on the Figure 42.2 is calculation results of future water consumption described above based on conditions explained in 4.2.1 above. Quantity of water consumption in year 2005 is calculated from existing actual water consumption and adding a balance of the maximum and average water consumption.

"Potential Demand" shown on the Figure 42.2 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.

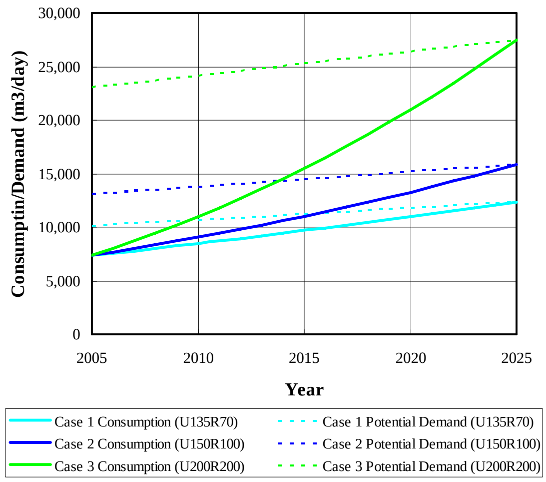
In some Taluka, “Potential Demand” is tend to decrease; this is because water saving by UFW ratio reduction is dominant over the increase of water demand by population increase.

Detailed results for the total water demand calculations are shown in Volume IV Appendix M42 Future Water Consumption together with the results of potential water demand.

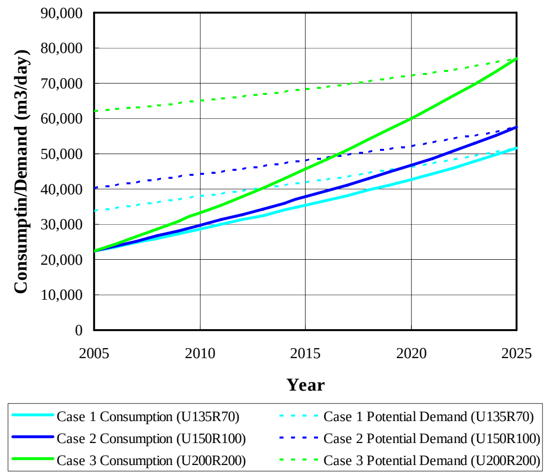
Figure 42.2 Future Water Consumption and Potential Water Demand



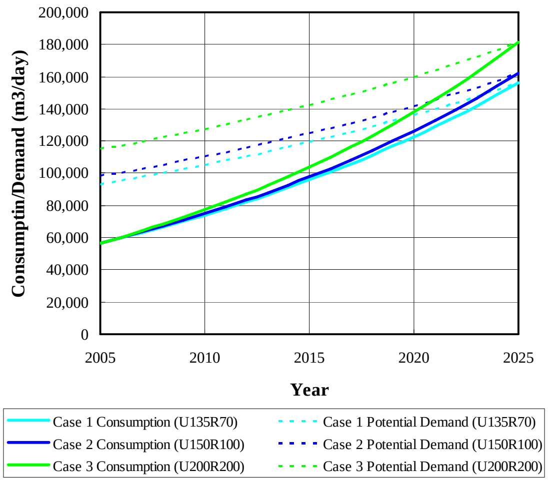
Satari Taluka



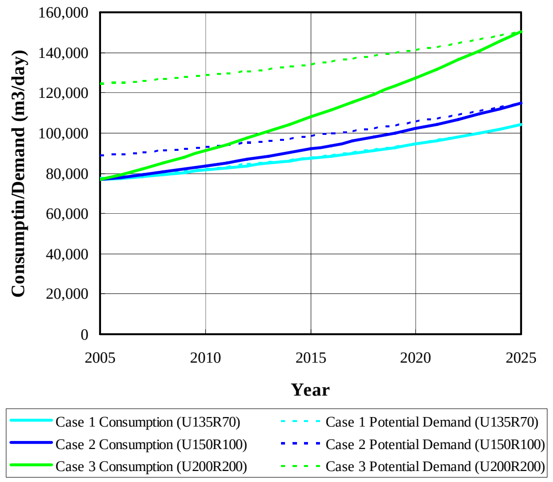
Ponda Taluka



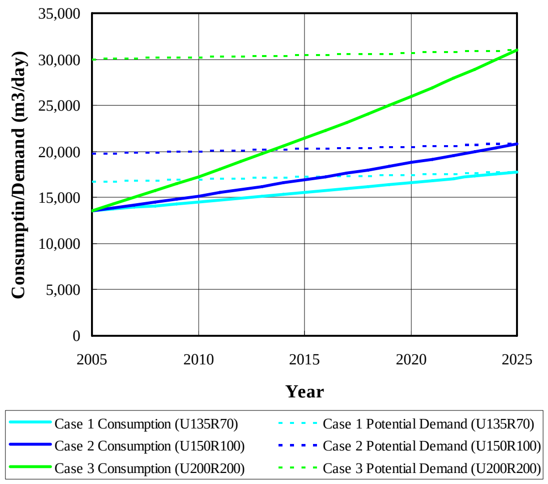
Mormugao Taluka



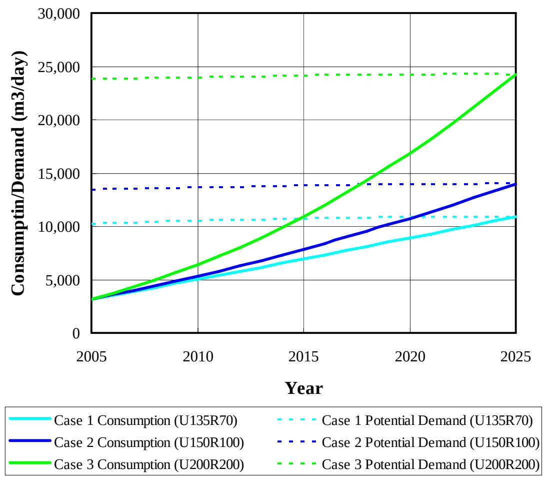
Salcete Taluka

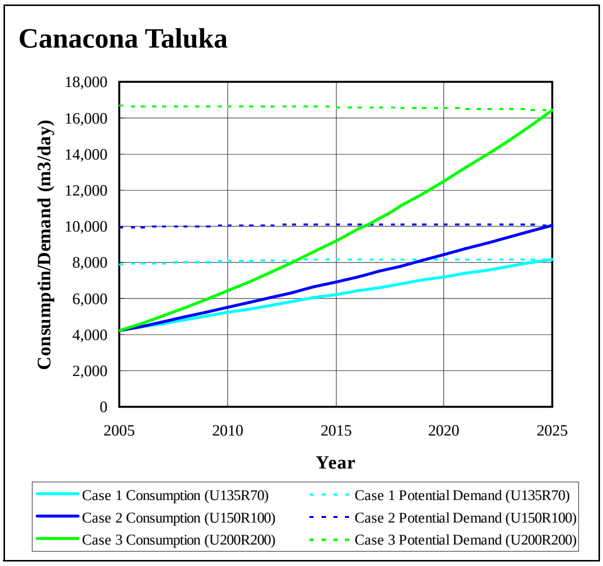


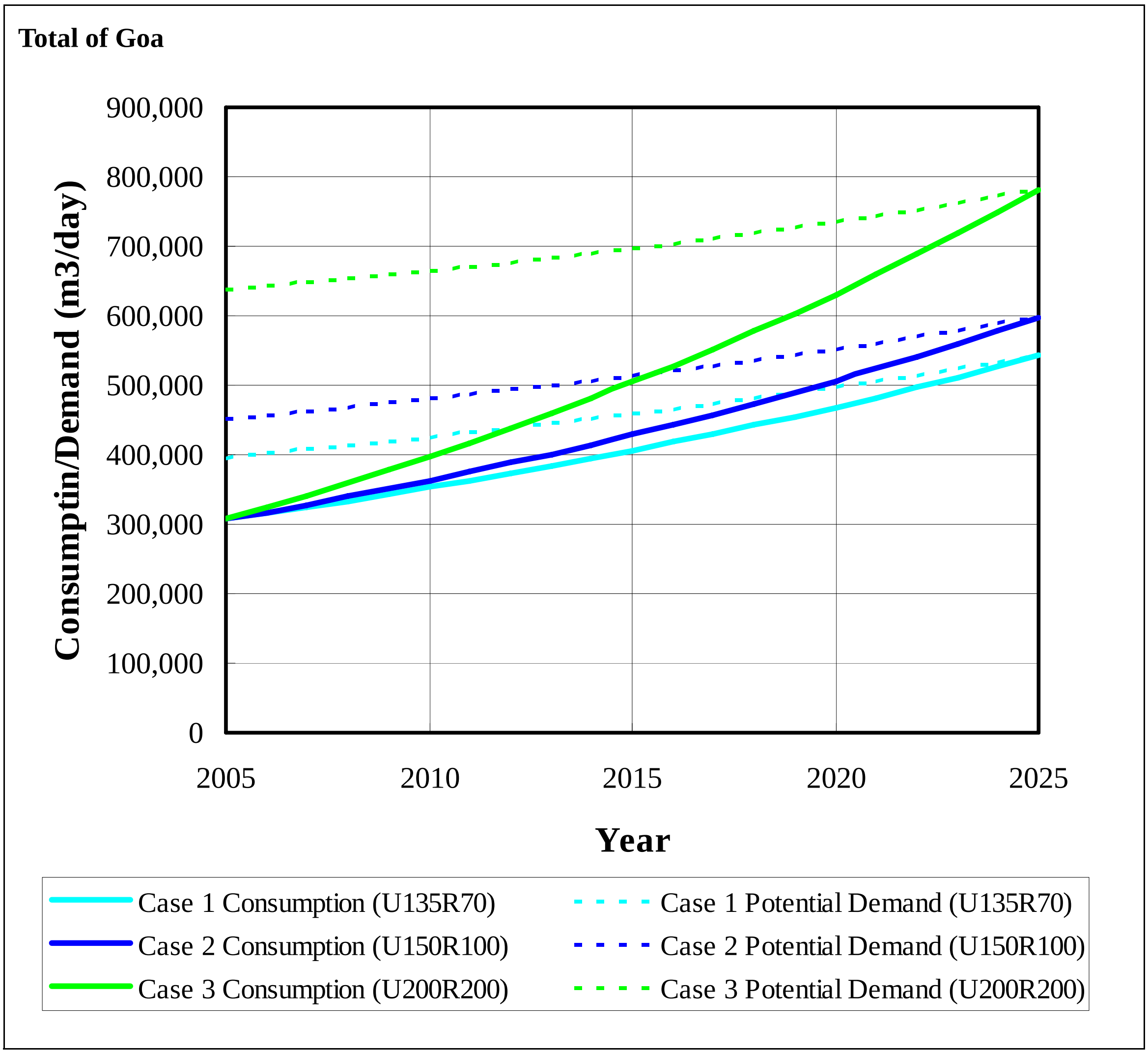
Quepem Taluka



Sanguem Taluka




Canacona Taluka
Consumptin/Demand (m3/day)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
2005
2010
2015
2020
2025
Year
Case 1 Consumption (U135R70)
Case 1 Potential Demand (U135R70)
Case 2 Consumption (U150R100)
Case 2 Potential Demand (U150R100)
Case 3 Consumption (U200R200)
Case 3 Potential Demand (U200R200)


Total of Goa
Consumptin/Demand (m3/day)
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
2005
2010
2015
2020
2025
Year
Case 1 Consumption (U135R70)
Case 1 Potential Demand (U135R70)
Case 2 Consumption (U150R100)
Case 2 Potential Demand (U150R100)
Case 3 Consumption (U200R200)
Case 3 Potential Demand (U200R200)

CHAPTER 5

WATER SUPPLY MASTER PLAN

CHAPTER 5 WATER SUPPLY MASTER PLAN

5.1 Basic Concepts and Conditions for Planning the Water Supply System

5.1.1 Basic Concept

The aim of the water supply master plan is to provide continuous water supply for the customers in the service area by 2025. Continuous water supply means the water must be delivered to customers 24 hours a day, 7 days a week. The people of Goa have indicated that they want continuous water supply.

To achieve continuous water supply (as shown on Figure 51.1), it is necessary to improve not only the water supply system facilities but also to improve operation and maintenance practices, build capacity, reduce unaccounted-for water (UFW), improve the knowledge and understanding of wise water use, and to set adequate water tariff. The sustainability of a continuous water supply system should be carefully checked with regards to both technical and financial aspects.

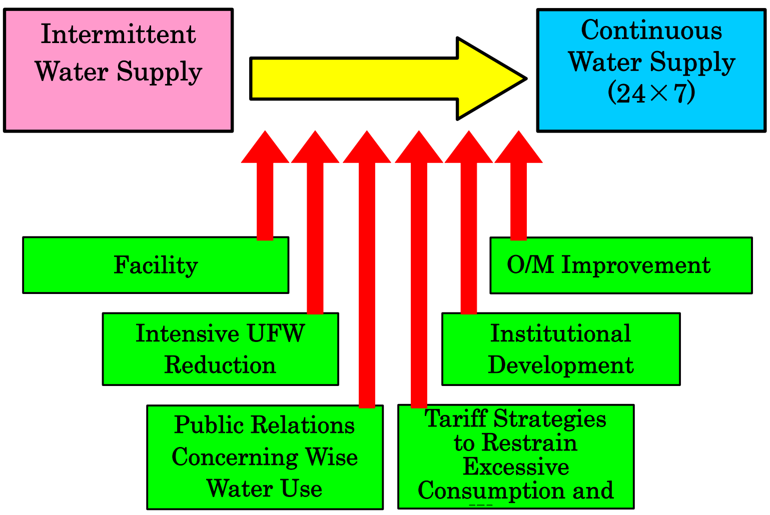


Figure 51.1 Concept of Water Supply Master Plan

Facility improvement includes facility expansion to meet future water demands, and rehabilitation and improvement of the existing facilities to use existing facilities as effective as possible. Operation and maintenance improvements must aim for adequate, timely, preventive, and proactive operation and maintenance practices. In addition, water supply services improvements will never be achieved without institutional and capacity building.

Intermittent water supply means that water flows for only several hours each day. Continuous water supply requires constant water flow. Therefore continuous water supply may increase UFW i.e. leakage, meaning intensive UFW reduction is required. Also, continuous water supply will mean water wastage could increase from leaks such as unattended opened taps, overflowing household water tanks, broken toilets and other in-house leakages. Therefore, public education about wise water use is essential for water conservation as well as tariff strategies to restrain excessive consumption and wastage.

This section presents the facility improvements for the water supply system. The operation and maintenance improvements, institutional and capacity developments, UFW reduction, public education and the sanitation system are explained in later sections.

5.1.2 Conditions for Planning

(1) Water Treatment Process

There are four aspects that need to be considered when planning water treatment processes, as explained below.

a. Design Criteria

The water treatment plant is designed using the 'The Government of India, Manual on Water Supply and Treatment, CPHEEO, May 1999'. Any design criteria not stipulated in this Indian manual were based on the 'Japan Water Works Association, Design Criteria for Waterworks Facilities, 2000'. A general comparison of water treatment process design criteria used in India and Japan is shown in Table 51.1.

Table 51.1 General comparisons of water treatment process design criteria in India and Japan

Type	Design Parameter	India*		Japan**	
Coagulation	G value	300	s^{-1}	—	
Mechanical Device	Detention time	30 - 60	seconds	60 - 300	seconds
(Rapid Mixing)	Ratio of impeller diameter to tank diameter	0.2 - 0.4		—	
Flocculation	G value	10 - 100	s^{-1}	10 - 75	s^{-1}
Horizontal Flow Flocculato	Detention time	15 - 20	minutes	20 - 40	minutes
(Slow Mixing)	Water Velocity	0.1 - 0.3	m/s	0.15 - 0.3	m/s
	Water depth	1.0 or more	m	—	
	Clear distance between baffles	0.45 or more	m	—	
	Clear distance between end of baffle and wall	0.6 or more	m	—	
Sedimentation	Surface Loading	30 - 40	$m^3/m^2/d$	21.6 - 43.2	$m^3/m^2/d$
Horizontal Flow Tanks &	Detention Time	2 - 2.5	hours	—	
Circular tank	Length of tank (rectangular)	30 - 100	m	—	
	Ratio of length to width	3:1 - 5:1		3:1 - 5:1	
	Length of square tank	up to 20	m	—	
	Diameter of tank	up to 60	m	—	
	Depth of tank	2.5 - 5	m	3 - 4 (Water	m
	Inlet velocity	0.2 - 0.3	m/s	less than 0.4	m/s
	Weir Loading	up to 300	$m^3/d/m$	500	$m^3/d/m$
Rapid Sand Filters	Filtration rate	4.8 - 6	m/hr	5 - 6.25	m/hr
	Number of filter beds (minimum)	4 or 2 (small plants)		2	
	Maximum Filter areas	up to 100	m^2	up to 150	m^2
Chlorination	Residual Chlorine (Effluent)	0.2 - 0.3	mg/L	—	
	Contact Time (Effluent)	30	minutes	—	
	Residual Chlorine (prechlorinatio	0.3 - 0.4	mg/L	—	

* The Government of India, Manual on Water Supply and Treatment, May 1999
**Japan Water Works Association, Design Criteria for Waterworks Facilities, 2000

b. Design of Water Treatment Facilities

Water treatment facilities are designed based on the maximum daily water demand, and operation / maintenance process water (plant loss) etc. In this study the plant loss is estimated to be 10% or less of the maximum daily water demand.

c. Raw Water Quality and Existing Water Treatment Process Conditions

The raw water quality and the existing water treatment process conditions were considered when selecting water treatment processes. This is because iron and manganese were found in the raw water during the reconnaissance survey.

d. Rehabilitations and Improvements for Water Treatment facilities

The design life for the water treatment facilities is shown in Table 51.2. The design life for civil works is 50 years and the design life for mechanical and electrical equipment is 15 years.

Once the design life is exceeded, the facilities will be abandoned and new facilities will be constructed, if necessary.

Table 51.2 Design Life for the Water Treatment Facilities

Items	Life Time (years)
Intake	
Pump house (civil works)	50
Mechanical and electrical equipments	15
Water treatment Plant	
Tank and basin (civil works)	50
Mechanical and electrical equipments	15

The proposed improvements to the existing facilities planned and these were based on plant safety, process control, and the need for continuous water supply. Plant safety is the most important aspect of the proposed improvements. Most water treatment plants do not have safety measurement equipment for chlorine gas. Therefore safety and health improvements have been set as the highest priority. Process control improvements such installing flow meters are set as the second priority. Providing continuous water supply (e.g. installing a generator, replacing water process equipment) is the third priority.

(2) Transmission System

a. Proposed System

The transmission system design is mainly based on the "Manual on Water Supply and Treatment, Third Edition – Revised and Updated, CPHEEO, MOUD, May 1999". The key components are outlined below.

- Formula for Hydraulic Calculation: Hazen-Williams Formula

There are a number of formulae available to calculate the velocity of flow (e.g. Hazen-Williams formula, Manning's formula, Darcy-Weisbach's formula and Colebrook-White formula). The Hazen-Williams formula is the best for situations involving pressure conduits. The formula is:

$$V = 0.84935\ C\ R^{0.63}\ I^{0.54}$$

For circular conduits, the formula is restated as

$$hf = 10.666\ C^{-1.85}\ D^{-4.87}\ Q^{1.85}\ L$$

Where,
V = Velocity (m/s)
C = Hazen-Williams coefficient
R = Hydraulic Radius (m)
I = Hydraulic Gradient, hf/L

hf = Friction Head Loss (m)

D = Diameter of Pipe (m)

Q = Discharge (m^3/s)

L = Pipe Length (m)

- Hazen-Williams Coefficient (C Value): 110 for all materials

The manual recommends that the Hazen-Williams coefficient (C value) for new pipes made from cast iron, ductile iron or mild steel with cement mortar lining should be between 130 and 145. However, it is generally recommended that in the absence of specific data, a C value of 110 should be adopted. Therefore, a C value of 110 was adopted when designing the transmission system, including the existing pipelines.

- Hourly Peak Factor: 2.0

When designing the distribution system hourly demand fluctuations must be considered. For example, during the night people use less water, but in the morning and evening people use much more water. Figure 51.2 shows the distribution flow to Lamgao at Bicholim City. This flow data was obtained during the first Phase Reconnaissance Survey.

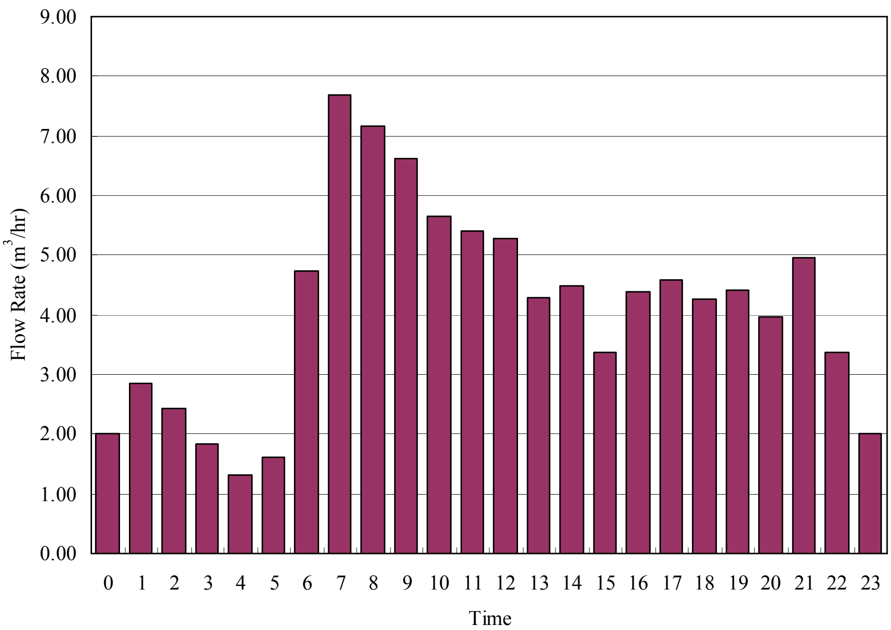


Figure 51.2 Distribution Flow to Lamgao at Bicholim City, Bicholim Taluka

In this case, the hourly peak flow is about 1.9 times the average distribution flow rate.

Therefore, when designing the distribution system a hourly peak factor of 2 was adopted as well as the fluctuation pattern shown in Figure 51.2.

- Software for Hydraulic Analysis: WaterCAD v7.0, Haestad Methods Inc

The hydraulic analysis was conducted using a computer software program called WaterCAD v7.0 for 500 pipes, which runs under the AutoCAD environment, Haestad Methods Inc. A computer display from WaterCAD is shown in Figure 51.3.

Figure 51.3 Computer Display from WaterCAD v7.0

It should be noted that since there is no recorded data or drawings of the existing transmission systems or details of the reservoirs, the modelling for the hydraulic analysis was prepared based on interviews with the PWD's engineers, for the followings system components:

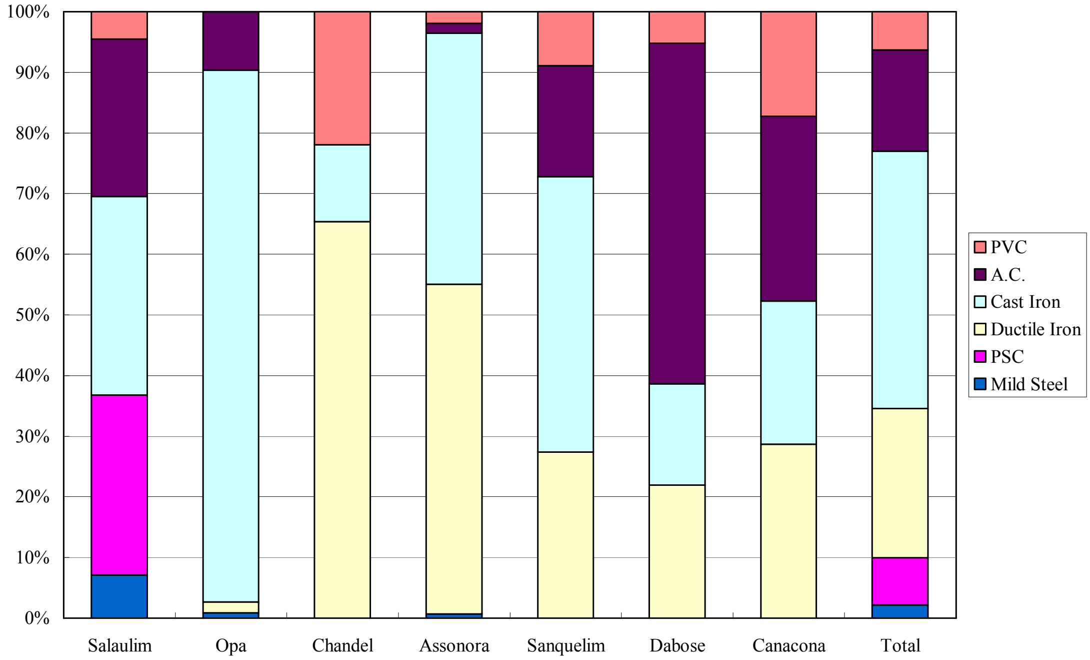
- routes, materials and diameters of transmission mains; and
- locations, capacities and water level of reservoirs.

b. Rehabilitation and Replacement of the Existing System

The rehabilitation and replacement of the transmission mains will include the replacement of the following:

- all asbestos cement pipes which were installed before 1990; and
- 30 % of the all pipes that were installed before 1975.

For reference, the proportions of different materials used in the existing transmission system are shown in Figure 51.4.



Source: Sector Status Study – WSS Goa, 2004

Figure 51.4 Percentage of Pipe Materials for each Scheme

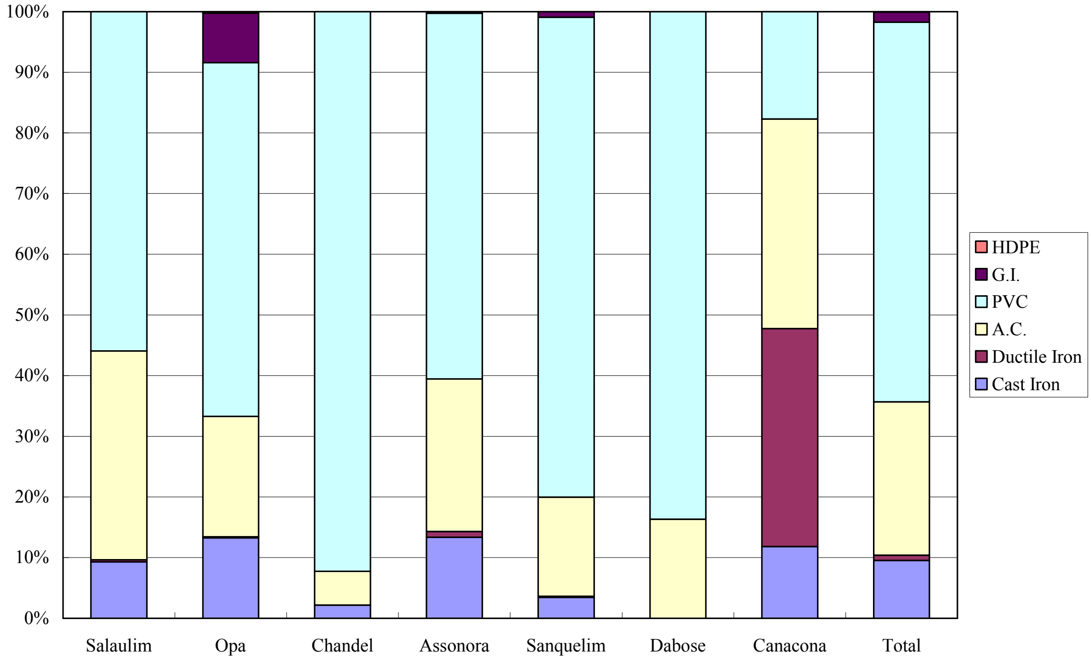
(3) Distribution Pipeline and House Connection

a. Proposed Distribution Pipeline and House Connection

The required length of the new distribution pipelines that will be installed when the supply area expands was estimated from the existing distribution pipeline lengths and the existing number of house connections, giving a unit length of 14.26 m. This means 14.26m of distribution pipeline is needed to provide one additional house connection. The number of domestic house connections was based on the increase in the population serviced.

b. Rehabilitation of the Existing Distribution Pipelines and House Connections

It was assumed that distribution pipelines need to be rehabilitated / replaced after 50 years. It is planned that 2 % of the existing distribution pipelines will be replaced every year, which means 38 % of all distribution pipelines will be replaced between 2007 and 2025. Figure 51.5 shows the proportion of distribution pipe materials for each scheme, for reference.



Source: Sector Status Study – WSS Goa, 2004

Figure 51.5 Proportion of Distribution Pipe Materials for each Scheme

It was assumed that house connections need to be rehabilitated / replaced after 10 years. It is planned that all the existing water meters will be replaced within 10 years.

5.2 Service Area and Water Demand

5.2.1 Condition of the Present Water Supply System

Figure 52.1 shows the water demand and supply capacity in 2005. In this figure, "Existing Supply Capacity" refers to the design capacity of the respective water treatment plants.

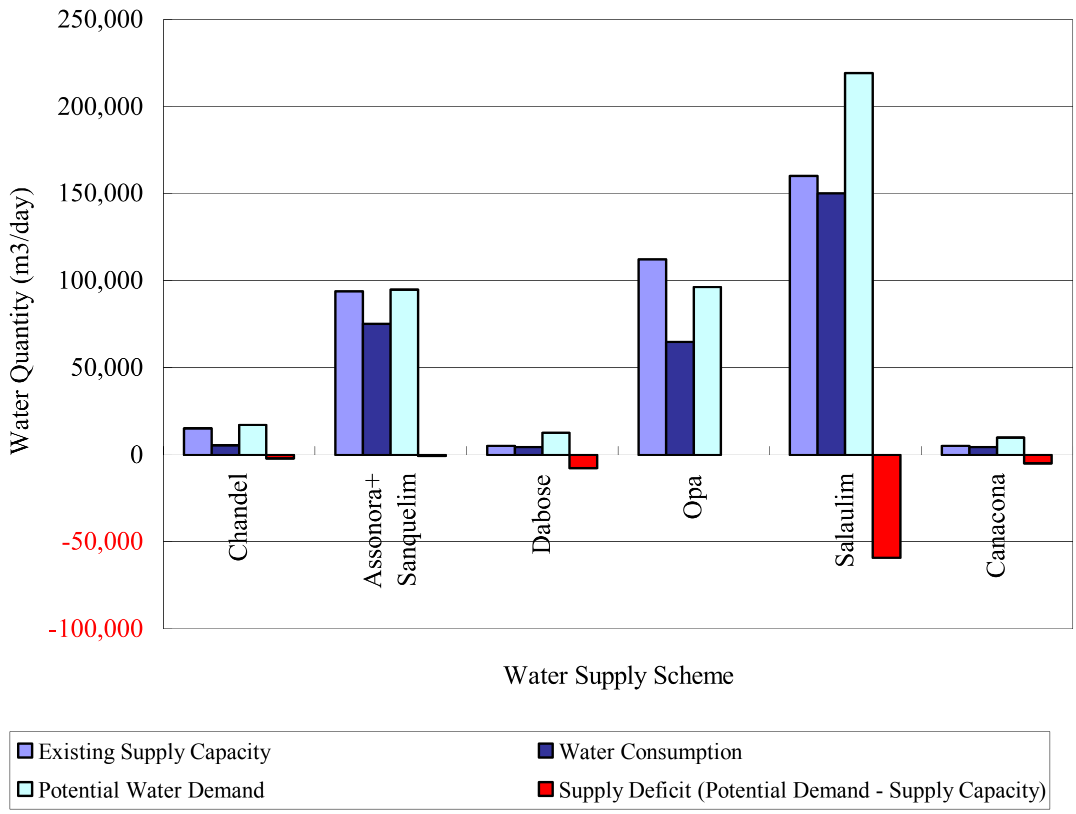


Figure 52.1 Water Demand and Supply Capacity of Each WSS during 2005

"Water Consumption" refers to the actual quantity of water distributed from the respective treatment plants including estimated leakage, 35%. As shown on this figure, the quantity of water consumed is less than the water supply capacity for all the WSSs. This is because the water treatment plants cannot be operated at design capacity all the time since plant operation is disturbed by frequent power failures, unexpected high raw water turbidity, and inadequate operation and maintenance practices, and/or the actual unaccounted for water ratio including leakage may be higher than 35 % which was estimated by the previous study.

The "Potential Water Demand" is calculated based on the ultimate per capita water consumption and service ratio in 2025. The "Supply Deficit" is calculated by comparing the "Potential Water Demand" with the "Existing Supply Capacity".

As shown on the Figure 52.1, the existing supply capacity cannot meet the potential water demand for all the WSSs. The supply deficits in Salaulim WSS is the most significant. As explained later, the Dabose and Canacona WSSs plan to augment their treatment plant capacity (tenders are underway).

5.2.2 Service Area by WSSs

In principle, each taluka is serviced by one WSS, however due to topographical features, some WSSs supply water to an area exceeding the taluka administrative boundary. The areas proposed to be serviced by each WSS are also dependent on where there are expected to be future water supply services, the supply capacity of each WSS, and the water resource availability as shown in Table 52.1.

Table 52.1 Raw Water Availability for WSSs

WSS	Water Source	Availability
Salaulim	Salaulim Reservoir	380.0 MLD
Opa	Khandepar River Diversion from Salaurim Reservoir Diversion from Ganjem Bandhara Storage	35.0 MLD 50.0 MLD 30.0 MLD 25.0 MLD
	Total	140.0 MLD
Chamdel	Tillari Canal	110.0 MLD
Assonora	Tillari Canal	250.0 MLD
Sanquelim	Valvant River	57.2 MLD
Dabose	Manderi River	18.7 MLD
Canancona	Chapoli Reservoir	15.0 MLD

Source: Department of Water Resources, Goa Government, as of June 2006

(1) Salaulim WSS

The existing Salaulim WSS supplies water treated at the Salaulim WTP to four talukas (Sanguem Taluka, Quepem Taluka, Salcete Taluka and Mormugao Taluka). The treatment plant has a capacity of 160 MLD. Approximately 1,350 m^3/day (i.e. the average flow from March to October 2005) is also supplied to the Tiswadi Taluka across the Zuwari River. However, the northern part of the Sanguem Taluka is supplied from the Opa WSS. The Study recommends that from 2018 the Salaulim WSS should cover a part of the Ponda Taluka and a part of the Tiswadi Taluka. These talukas are currently supplied by the Opa WSS as shown in Figure 52.2. The raw water source availability for the Opa WSS is not sufficient to meet future water demands and depends on a diversion from the Salaulim Dam. However, it would be best if the northern part of the Sanguem Taluka were covered by the Opa WSS, as is currently the case. The proposed service area in 2025 is shown in Figure 52.2.

(2) Opa WSS

The existing Opa WSS supplies 112MLD of water (which is treated at Opa Water Treatment Plant) to two talukas (Ponda Taluka and Tiswadi Taluka). However, the northern and southern ends of the Tiswadi Taluka are supplied from the Sanquelim WSS and Salaulim WSS respectively. As explained in the previous section, the northern part of the Sanguem Taluka is supplied from the Opa WSS. The Study recommends that in the future the Opa WSS should cover almost the same area as it currently does for the Tiswadi Taluka, however the southern part of the Ponada Taluka should be supplied from the Salaulim WSS. This is due to the limited raw water source availability for the Opa WSS. The proposed future boundary of the Opa WSS is shown in Figure 52.2.

(3) Chamdel WSS

The existing Chandel WSS supplies water from the Chandel WTP to all of the Pernem Taluka. The Study recommends that in the future the Chandel WSS should cover this same area. The proposed future boundary for the Chandel WSS is shown in Figure 52.2.

(4) Assonora WSS

The existing Assonora WSS mainly covers the Bardez Taluka and supplies water from the Assonora Water Treatment Plant. The Assonora WTP has a supply capacity of 57 MLD (A production capacity of the WTP is 42 MLD). Some water is also supplied to the northern part of Bicholim Taluka. The study recommends that in the future the Assonora WSS should cover this same area. The proposed service area in 2025 is shown in Figure 52.2.

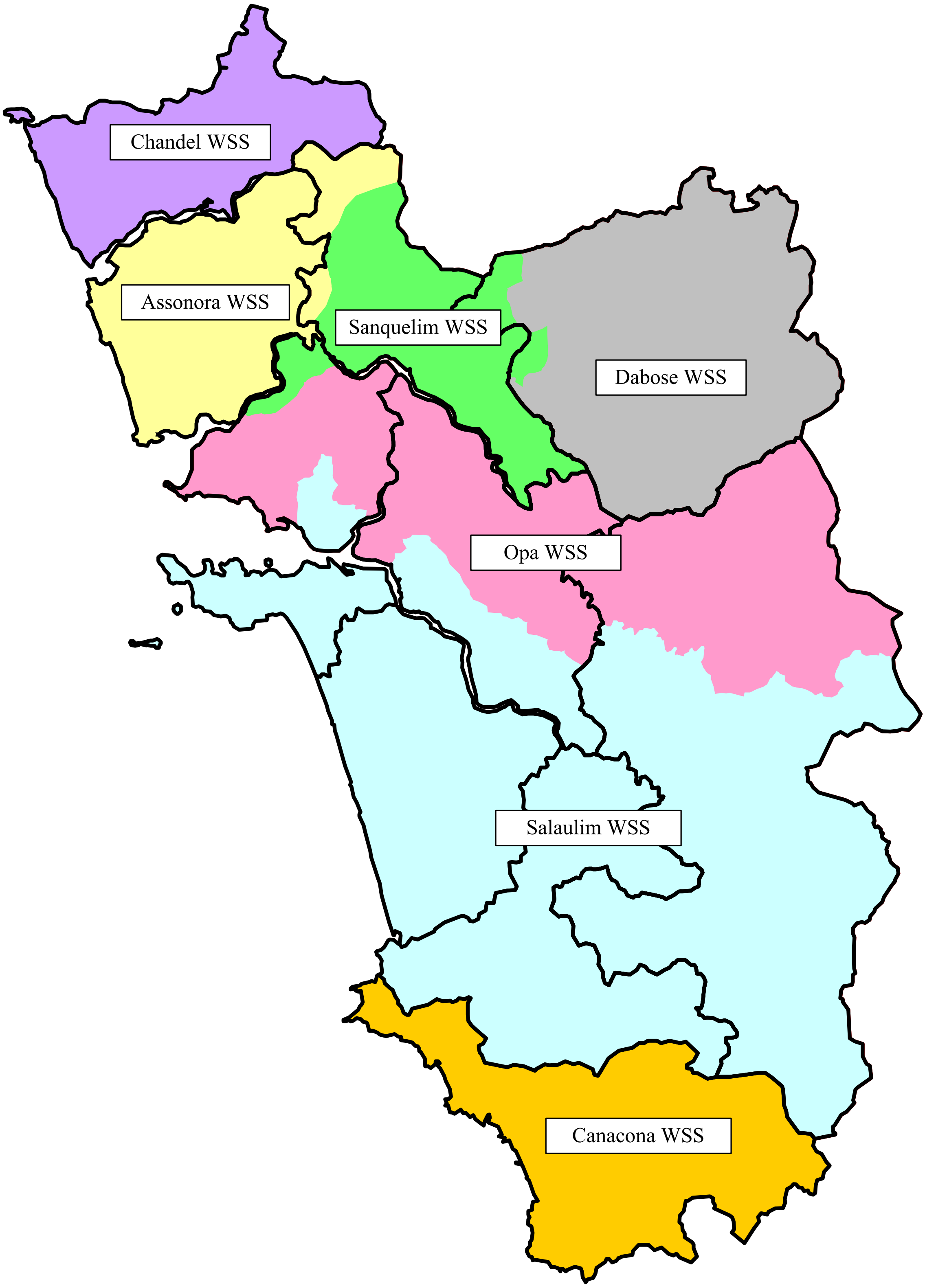


Figure 52.2 Proposed Service Area Boundary of Each Regional WSS in 2025

(5) Sanquelim WSS

The Sanquelim WSS supplies treated water from the Sanquelim and Podosem Water Treatment Plants to the Bicholim Taluka. However, the northern part of the Bicholim Taluka is supplied from the Assonora WSS as mentioned above. The Sanquelim WSS supplies the north-west portion of the Satari Taluka and the northern end of the Tiswadi Taluka. The Study recommends that in the future the Sanquelim WSS should supply almost the same area as it currently does. The future boundary for the Sanquelim WSS is shown in Figure 52.2.

(6) Dabose WSS

The existing Dabose WSS supplies the Satari Taluka, however the north-west region of the Taluka is supplied by the Sanquelim WSS. The study recommends that in the future the Dabose WSS should supply almost the same area as it currently does. The future boundary for the Dabose WSS is shown in Figure 52.2.

(7) Canacona WSS

The existing Canacona WSS mainly supplies the urban area of the Canacona Taluka. The study recommends that in the future the Canacona WSS should cover the same area as it currently does. The future boundary for the Canacona WSS is shown in Figure 52.2.

5.2.3 Water Demand

As discussed in Chapter 4 “Future Population and Water Demand”, the 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

The current average per capita consumption for urban areas is 143 lpcd and for rural area is 84 lpcd. Comparing these figures to the CPHEEO manual, the study adopted ‘Case 2: Urban = 150 lpcd, Rural = 100 lpcd’ when planning the water supply system.

The water demand for each WSS is described in Volume IV Appendix M51 Service Area and Water Demand. The water demand was calculated based on the service area of each WSS (as outlined above) and the water demand for each taluka as presented in Chapter 4 and detailed in Volume IV Appendix M51 Service Area and Water Demand.

The total daily maximum water demand for Goa State is the sum of the seven WSSs. Table 52.2 and Figure 52.3 summarise the total demand.

Table 52.2 Daily Maximum Water Demand for Goa State

Year	2005	2006	2007	2008	2009	2010	2011
Demand (m^3/day)	306,765	317,356	328,270	339,545	351,184	363,196	375,472
Year	2012	2013	2014	2015	2016	2017	2018
Demand (m^3/day)	388,143	401,256	414,821	428,858	443,192	458,046	473,446
Year	2019	2020	2021	2022	2023	2024	2025
Demand (m^3/day)	489,424	506,017	523,063	540,789	559,230	578,434	598,442

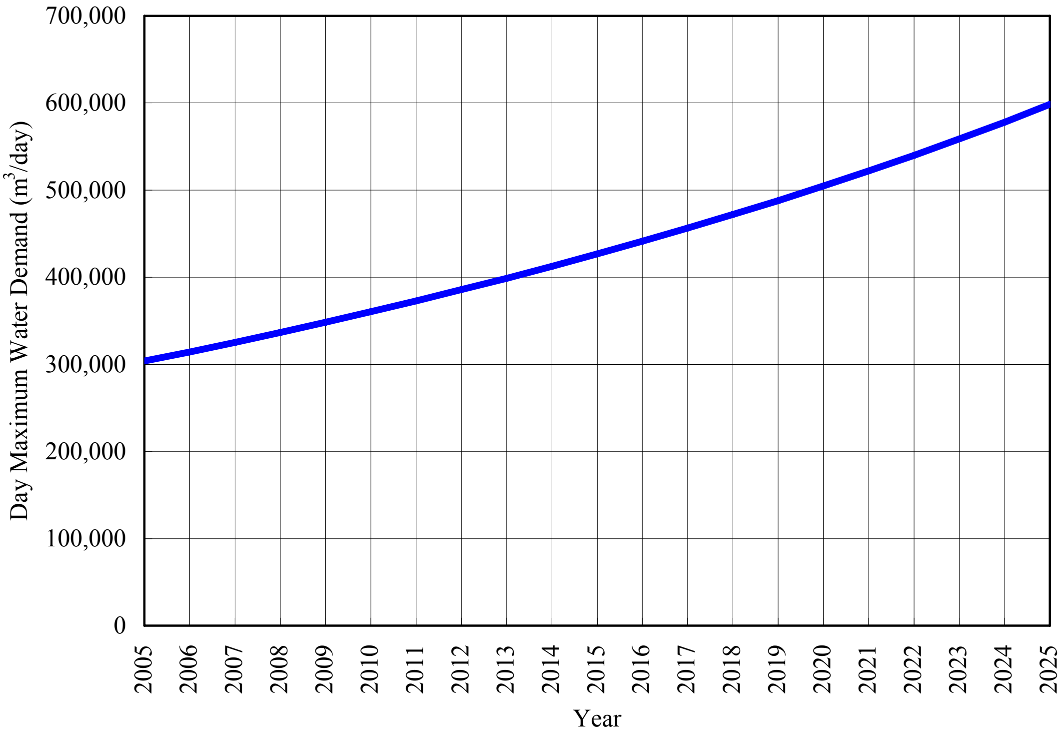


Figure 52.3 Daily Maximum Water Demand for Goa State