Appendix M33

Water Quality Analysis for Water Supply System

Contents for Appendix M33

Appendix M33.1 General

Water quality analysis was undertaken to confirm the safety of the water supply. Salaulim Dam and 15 other wells were investigated as part of this study.

There are many iron and manganese mines throughout Goa. Spoil from these mining operations is sometimes discharged onto riverbanks. During the rainy season these deposits can be washed into the water sources when the water level in the rivers rises. Although iron and manganese do not present a significant problem for water purification, other chemicals such as arsenic associated with the mine spoil could cause health problems. The raw water quality was therefore analyzed on 34 chemicals including arsenic, iron and manganese etc. during both the dry and rainy seasons.

It was also important to confirm the safety of the supplied water (e.g. tap water). Residual chlorine was used as the indicator of tap water quality. The investigation was completed using simple water quality analysis kits.

Table M33.1.1 shows the number of samples. The sample locations are shown on Figures M33.1.1 and M33.1.2.

The planned intake site for Salaulim Dam was previously a mine, meaning the dam water was expected to be deep and possibly stratified. Therefore, the dam water quality investigation included two sets of water samples at each test location (one from the surface and another from the bottom of the dam).

Table M33.1.1 Water Quality Analysis for the Water Supply System

Sampling Point	Number of Samples	Parameter
Salaulim Dam	2 dry season samples. 1 from the surface and 1 from the bottom layer.	34 parameters required by Indian Dinking Water guidelines 2)
	2 rainy season samples. 1 from the surface and 1 from the bottom layer :	34 parameters required by Indian Dinking Water guidelines 2)
Water Supply Wells	1 dry season sample from each water supply well (i.e. 15 samples in total).	34 parameters required by Indian Dinking Water guidelines 2)
	1 rainy season sample from each water supply well (i.e. 15 samples in total).	34 parameters required by Indian Dinking Water guidelines 2)
Tap Water (seven schemes)	11 1)dry season samples :	Residual chlorine, standard plate count bacteria, coliform 3)
	11 1)rainy season :	Residual chlorine, standard plate count bacteria, coliform 3)

1) Tap Water Quality Sample Points
   Chandel Scheme: Permem
   Assonora Scheme: Mapusa
   Sanquelim Scheme: Bicholim
   Dabose Scheme: Valpoi
   Opa Scheme: Orgao, Panaji, Ponda（3 points）
   Salaulim Scheme: Vasco, Margao, Quepem（3 points）
   Canacona Scheme: Nagorcem
2) Source: The Government of India, Manual on Water Supply and Treatment Third Edition, 1999 May
3) When residual chlorine was detected the tests for standard plate count bacteria and coliform were not conducted.

Figure M33.1.1 Locations of Dam and Well Sampling Points

Figure M33.1.2 Locations of Tap water Sampling Points

M33.2 Evaluation of Water Quality for Water Supply

The water quality for water supply was evaluated on 'Acceptable' values of 12 parameters in 'Recommended Guidelines' presented on 'Manual on Water Supply and Treatment Third Edition, The Government of India, 1999 May'.

The Indian 'Recommended Guidelines' propose 34 parameters for drinking water quality and for each parameter, two values such as 'Acceptable' value and 'The cause of rejection' value are defined. According to 'Guidelines for Drinking-water Quality, Third Edition, WHO 2004' (hereinafter 'WHO Guidelines'), these Indian 34 parameters are categorized as 'health significance' aspects and 'acceptability' aspects. The 'health significance' aspects mean that parameters cause adverse health effects in humans. 'Acceptability' aspects mean that the appearance, taste and odor and these threshold concentrations of drinking water should be acceptance to consumer.

Among the Indian 'Recommended Guidelines', 12 parameters, such as E.coli, arsenic, chromium, fluoride, manganese, selenium, cadmium, cynide, mercury, nitrate, copper and lead, are categorized as health significance aspects. Since the purpose of water quality analysis is to confirm the safety of water, the water quality of water supply was evaluated on these 12 parameters categorized as 'health significance' aspects.

There are two values in 'Recommended Guidelines'. One is 'Acceptable' values and the other is 'the cause for rejection' values. 'Acceptable' values mean that the figures are the limits upto which water is generally acceptable to the consumers. 'The cause for rejection' values mean that water should be rejected if chemical concentrations are exceed the figures. 'Acceptable' figures are stricter than 'the cause for Rejection' figures. Acceptable values in 'Recommended Guidelines' therefore were used in the evaluation to confirm the safety of water.

Table M33.2.1 shows the Indian 'Recommended Guidelines', 'WHO Guidelines' and 'Analized Parameters'. A '○' mark shows an evaluation parameter.

Taking account of situation surrounding the sampling points, the most of parameters concerning chemicals from industry and agriculture were excluded from analysis.

Cadmium and lead on 'WHO Guidelines' have stricter values than Indian 'Recommended Guidelines'. The parameters also were referred to WHO guidelines.

Table M33.2.1 Indian 'Recommended Guidelines', 'WHO Guidelines' and 'Evaluation Parameters' (1/4)

	Parameter	Recommended Guidelines* (mg/L)		WHO Guidelines**** (mg/L)	Analyzed Parameter
		Acceptable**	Cause for Rejection***		
Health Significance Aspects	**1. Microbial aspects**				
	E.coli or Thermotolerant coliform bacteria	0 in 100ml sample		Must not be detectable in any 100ml sample	○
	2. Naturally occurring chemicals				
	Arsenic (As)	0.01	0.05	0.01	○
	Barium (Ba)	-	-	0.7	
	Boron (B)	-	-	0.5	
	Chromium (Cr^{6+})	0.05	0.05	0.05	○
	Fluoride (F)	1	1.5	1.5	○
	Manganese (Mn)	0.05	0.5	0.4	○
	Molybdenum (Mo)	-	-	0.07	
	Selenium (Se)	0.01	0.01	0.01	○
	Uranium (U)	-	-	0.009	
	3. Chemicals from industrial sources and human dwellings				
	Inorganics				
	Cadmium (Cd)	0.01	0.05	0.003	○
	Cyanide (CN)	0.05	0.05	0.07	○
	Mercury (Hg)	0.001	0.001	0.001	○
	Organics				
	Benzene	-	-	0.01	
	Carbon tetrachloride	-	-	0.004	
	Di(2-ethylhexyl)phthalate	-	-	0.008	
	Dichlorobenzene, 1,2-	-	-	1	
	Dichlorobenzene, 1,4-	-	-	0.3	
	Dichloroethane, 1,2-	-	-	0.03	
	Dichloroethene, 1,1-	-	-	0.03	
	Dichloroethene, 1,2-	-	-	0.05	
	Dichloromethane	-	-	0.02	
	Edetic acid (EDTA)	-	-	0.6	
	Ethylbenzene	-	-	0.3	
	Hexachlorobutadiene	-	-	0.0006	
	Nitrilotriacetic acid (NTA)	-	-	0.2	
	Pentachlorophenol	-	-	0.009	
	Styrene	-	-	0.02	
	Tetrachloroethene	-	-	0.04	
	Toluene	-	-	0.7	
	Trichloroethene	-	-	0.07	
	Xylenes	-	-	0.5	

* Source: The Government of India, Manual on Water Supply and Treatment Third Edition, 1999 May

**The figures indicated under the colum 'Acceptable' are the limits upto which water is generally acceptable to the consumers.

**The figures which are above 'Acceptable' but below 'Cause for Rejection' still may be tolerated in the absence of an alternative and better source.

**** Source: Guidelines for Drinking-water Quality Third Edition, WHO 2004

Table M33.2.1 Indian 'Recommended Guidelines', 'WHO Guidelines' and 'Evaluation Parameters' (2/4)

	Parameter	Recommended Guidelines* (mg/L)		WHO Guidelines**** (mg/L)	Analyzed Parameter
		Acceptable**	Cause for Rejection***		
Health Significance Aspects	**4. Chemicals from agricultural activities**				
	Non-pesticides				
	Nitrate (NO3)	45	45	50	○
	Nitrite (NO2) (long term)	-	-	3	
	Nitrite (NO2) (short term)	-	-	0.2	
	Pesticides used in agriculture				
	Alachlor	-	-	0.02	
	Aldicarb	-	-	0.01	
	Aldrin and dieldrin	-	-	0.00003	
	Atrazine	-	-	0.002	
	Carbofuran	-	-	0.007	
	Chlordane	-	-	0.0002	
	Chlorotoluron	-	-	0.03	
	Cyanazine	-	-	0.0006	
	2,4-D (2,4-dichlorophenoxyacetic acid)	-	-	0.03	
	2,4-DB	-	-	0.09	
	1,2-Dibromo-3-chloropropane	-	-	0.001	
	1,2-Dibromoethane	-	-	0.0004	
	1,2-Dichloropropane (1,2-DCP)	-	-	0.04	
	1,3-Dichloropropene	-	-	0.02	
	Dichlorprop	-	-	0.1	
	Dimethoate	-	-	0.006	
	Endrin	-	-	0.0006	
	Fenoprop	-	-	0.009	
	Isoproturon	-	-	0.009	
	Lindane	-	-	0.002	
	MCPA	-	-	0.002	
	Mecoprop	-	-	0.01	
	Methoxychlor	-	-	0.02	
	Metolachlor	-	-	0.01	
	Molinate	-	-	0.006	
	Pendimethalin	-	-	0.02	
	Simazine	-	-	0.002	
	2,4,5-T	-	-	0.009	
	Terbuthylazine	-	-	0.007	
	Trifluralin	-	-	0.02	

* Source: The Government of India, Manual on Water Supply and Treatment Third Edition, 1999 May

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**** Source: Guidelines for Drinking-water Quality Third Edition, WHO 2004

Table M33.2.1 Indian 'Recommended Guidelines', 'WHO Guidelines' and 'Evaluation Parameters' (3/4)

	Parameter	Recommended Guidelines* (mg/L)		WHO Guidelines**** (mg/L)	Analyzed Parameter
		Acceptable**	Cause for Rejection***		
Health Significance Aspects	**5. Chemicals used in water treatment or materials in contact with drinking-water**				
	Disinfectants				
	Chlorine (as OCL^-)	-	-	5	
	Monochloramine	-	-	3	
	Disinfection by-products				
	Bromate	-	-	0.01	
	Bromodichloromethane	-	-	0.06	
	Bromoform	-	-	0.1	
	Chloral hydrate (trichloroacetaldehyde)	-	-	0.01	
	Chlorate	-	-	0.7	
	Chlorite	-	-	0.7	
	Chloroform	-	-	0.2	
	Cyanogen chloride	-	-	0.07	
	Dibromoacetonitrile	-	-	0.07	
	Dibromochloromethane	-	-	0.1	
	Dichloroacetate	-	-	0.05	
	Dichloroacetonitrile	-	-	0.02	
	Formaldehyde	-	-	0.9	
	Monochloroacetate	-	-	0.02	
	Trichloroacetate	-	-	0.2	
	Trichlorophenol, 2,4,6-	-	-	0.2	
	Trihalomethanes	-	-	0.001	
	Contaminants from treatment chemicals				
	Acrylamide	-	-	0.0005	
	Epichlorohydrin	-	-	0.0004	
	Contaminants from pipes and fittings				
	Antimony (Sb)	-	-	0.02	
	Benzo[a]pyrene	-	-	0.0007	
	Copper (Cu)	0.05	1.5	2	○
	Lead (Pb)	0.05	0.05	0.01	○
	Nickel (Ni)	-	-	0.02	
	Vinyl chloride	-	-	0.0003	
	6. Cyanotoxins				
	Microcystin-LR	-	-	0.001	

* Source: The Government of India, Manual on Water Supply and Treatment Third Edition, 1999 May

**The figures indicated under the colum 'Acceptable' are the limits upto which water is generally acceptable to the consumers.

**The figures which are above 'Acceptable' but below 'Cause for Rejection' still may be tolerated in the absence of an alternative and better source.

**** Source: Guidelines for Drinking-water Quality Third Edition, WHO 2004

Table M33.2.1 Indian 'Recommended Guidelines', 'WHO Guidelines' and 'Evaluation Parameters' (4/4)

Parameter		Recommended Guidelines* (mg/L)		WHO Guidelines**** (mg/L)	Analyzed Parameter
		Acceptable**	Cause for Rejection***		
Acceptability Aspects	**7. Acceptability aspects**				
	Alkalinity	200	600		○
	Aluminium (Al)	0.03	0.2	0.1	
	Ammonia	-	-	1.5	
	Anionic detergent	0.2	1	-	○
	Calcium (Ca)	75	200	-	○
	Chloride (Cl)	200	1000	200-300	○
	Chlorine (as OCL^-)	-	-	0.6 - 1.0	
	Chlorophenols	-	-	0.0001-0.002	
	Color	5 Pt/Co Scale	25 Pt/Co Scale	15 TCU	○
	Copper (Cu)	0.05	1.5	5	○
	Dichlorobenzenes	-	-	0.002-0.03	
	Ethylbenzene	-	-	0.002-0.13	
	Gross Alpha activity (Bq/L)	0.1	0.1	-	
	Gross Beta activity (Bq/L)	1	1	-	
	Hardness	200	600	100-300	○
	Hydrogen sulfide (H2S)	200	400	0.05-0.1	
	Iron (Fe)	0.1	1	0.3	○
	Magnesium (Mg)	30	150	-	
	Manganese (Mn)	0.5	0.05	0.1	○
	Mineral Oil	0.01	0.03		○
	Monochloramine	-	-	0.3	
	Monochlorobenzene	-	-	0.01-0.02	
	Odor	Objectable	Objectable	acceptable	○
	Petroleum oils	-	-	-	
	pH	7.0 to 8.5	<6.5 or >9.2	6.5 - 8.5	○
	Phenol	0.001	0.002	-	
	Polynuclear aromatic hydrocarbon	0.0002	0.0002	-	
	Sodium (Na)	-	-	200	
	Styrene	-	-	0.004-2.6	
	Sulfate (SO4)	200	400	250	○
	Synthetic detergents	-	-	-	
	Taste	Objectable	Objectable	acceptable	○
	Toluene	-	-	0.04-0.17	
	Total dissolved solid (TDS)	500	2000	600-1000	○
	Trichlorobenzenes	-	-	0.005-0.05	
	Turbidity	1NTU	10NTU	5 NTU	○
	Xylenes	-	-	0.3	
	Zinc (Zn)	5	15	3-5	○

* Source: The Government of India, Manual on Water Supply and Treatment Third Edition, 1999 May

**The figures indicated under the colum 'Acceptable' are the limits upto which water is generally acceptable to the consumers.

**The figures which are above 'Acceptable' but below 'Cause for Rejection' still may be tolerated in the absence of an alternative and better source.

**** Source: Guidelines for Drinking-water Quality Third Edition, WHO 2004

M33.3 Results of Water Quality Analysis

(1) Salaulim Dam (refer to attachments)

Water quality of Salaulim dam was investigated. All parameters were satisfied with 'Recommended Guidelines' values during both seasons. Cadmium and Lead was also satisfied with 'WHO Guidelines'. Because E.coli was found in Salaulim dam, disinfection should be necessary for drinking water supply.

(2) Water Supply Wells and Springs (refer to attachments)

Fifteen samples were investigated. Two samples collected from Curca and Siroda were satisfied with 'Recommended Guidelines'. Other thirteen samples were satisfied with 'Recommended Guidelines' except for E.coli. Cadmium and lead were also investigated and these were also satisfied with 'WHO Guidelines'.

(3) Tap Water

Tap water was tested for residual chlorine at 11 locations, across 7 schemes. Two points in each place were selected as sampling sites.

It is reported that iron and manganese were found in raw water but treated water in WTPs was satisfied with 'Recommended Guidelines'. Then, only residual chlorine of tap water was investigated.

Residual chlorine was detected in all the tap water samples during both the dry and rainy seasons (see Table M33.3.1). The average chlorine concentration was approximately 0.3 mg/L in both the dry and rainy seasons. Tap water in Bicholim (which is in the Sanquelim scheme) had the highest average chlorine concentration during both the dry and rainy seasons. Tap water in Nagorecem (which is in the Canacona scheme) had the lowest average chlorine concentration.

Table M33.3.1 Residual Chlorine in Tap Water

Season		Dry			Rainy		
Water Scheme	Places	Point 1 (mg/L)	Point 2 (mg/L)	Average (mg/L)	Point 1 (mg/L)	Point 2 (mg/L)	Average (mg/L)
Chandel	**Pernem**	0.4	0.4	0.40	1.0	1.0	1.00
Assonora	**Mapusa**	0.4	0.4	0.40	0.4	0.4	0.40
Sanquelim	**Bicholim**	0.4	1.0	0.70	1.0	0.4	0.70
Dabose	**Valpoi**	0.2	0.2	0.20	0.1	0.2	0.15
Opa	**Orgao**	0.4	0.2	0.30	0.2	0.2	0.20
	Panaji	0.1	0.2	0.15	0.1	0.4	0.25
	Ponda	0.1	0.4	0.25	0.2	0.4	0.30
Salaulim	**Vasco**	0.1	0.2	0.15	0.1	0.2	0.15
	Margao	0.1	0.2	0.15	0.1	0.2	0.15
	Quepem	0.2	0.2	0.20	0.2	0.2	0.20
Canacona	**Nagorcem**	0.1	0.1	0.10	0.1	0.1	0.10
Total Average				0.27			0.33

Attachments

PHE-LABORATORY
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WATER ANALYSIS

Source of Sample - Salaulim Dam
Place of Collection - Surface (near the Dam)
Date of Collection - 9/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	32		-
2	pH.		7.4		7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	2.6	○	1
7	Specific Conductivity	(m mhos/cm)	117		-
8	Total Dissolved Solids	(mg/l)	75		500
9	Total Hardness	(mg/l)	20		200
10	Total Alkalinity as CaCO3	(mg/l)	20		200
11	Calcium as Ca	(mg/l)	4.8		75
12	Magnesium as Mg	(mg/l)	2		<30
13	Chlorides as Cl	(mg/l)	25		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.52	○	0.1
16	Phosphate as PO4 *	(mg/l)	0.9		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.05		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.01		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	0.5		-
28	Nitrate-N	(mg/l)	0.3		45
	Nitrite as NO2 *	(mg/l)	<0.01		-
29	Ammonia-N	(mg/l)	0.85		-
30	Dissolved Oxygen	(mg/l)	7		-
31	B.O.D. 5 days at 200C	(mg/l)	2.6		-
32	B.O.D. 3 days at 200C	(mg/l)	2.1		-
33	C.O.D (Cr)	(mg/l)	3.2		-
34	Sodium as Na *	(mg/l)	7.9		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.6		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	95	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	21	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

PHE-LABORATORY
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WATER ANALYSIS

Source of Sample - Salaulim Dam
Place of Collection - Bottom (Intake)
Date of Collection - 30/04/05 (JICA) **(Dry Season)**
Date of submission 13/06/05 (JICA)

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	30.0 (Lab)		-
2	pH.		6.9	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	1.6	○	1
7	Specific Conductivity	(m mhos/cm)	72.1		-
8	Total Dissolved Solids	(mg/l)	46		500
9	Total Hardness	(mg/l)	17		200
10	Total Alkalinity as CaCO3	(mg/l)	19		200
11	Calcium as Ca	(mg/l)	4.8		75
12	Magnesium as Mg	(mg/l)	1.25		<30
13	Chlorides as Cl	(mg/l)	6		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.12	○	0.1
16	Phosphate as PO4 *	(mg/l)	3.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.01		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	<0.01		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	Nil		-
28	Nitrate-N	(mg/l)	0.1		45
	Nitrite as NO2 *	(mg/l)	<0.01		-
29	Ammonia-N	(mg/l)	1.1		-
30	Dissolved Oxygen	(mg/l)	6.3		-
31	B.O.D. 5 days at 200C	(mg/l)	1.2		-
32	B.O.D. 3 days at 200C	(mg/l)	1		-
33	C.O.D (Cr)	(mg/l)	2.2		-
34	Sodium as Na *	(mg/l)	2.7		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.5		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	-		Not be Detectable
40	Fecal Coliform	MPN/100ml	-		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

PHE-LABORATORY
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WATER ANALYSIS

Source of Sample - Salaulim Dam
Place of Collection - Surface (near the Dam)
Date of Collection - 20/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	29.5		-
2	pH.		7.3		7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	1.43	○	1
7	Specific Conductivity	(m mhos/cm)	49.8		-
8	Total Dissolved Solids	(mg/l)	32		500
9	Total Hardness	(mg/l)	12.5		200
10	Total Alkalinity as CaCO3	(mg/l)	15		200
11	Calcium as Ca	(mg/l)	3.6		75
12	Magnesium as Mg	(mg/l)	0.88		<30
13	Chlorides as Cl	(mg/l)	6		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.08		0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	<0.0015		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	0.5		-
28	Nitrate-N	(mg/l)	0.2		45
	Nitrite as NO2 *	(mg/l)	0.09		-
29	Ammonia-N	(mg/l)	0.25		-
30	Dissolved Oxygen	(mg/l)	8.1		-
31	B.O.D. 5 days at 200C	(mg/l)	0.5		-
32	B.O.D. 3 days at 200C	(mg/l)	0.4		-
33	C.O.D (Cr)	(mg/l)	1.2		-
34	Sodium as Na *	(mg/l)	4.6		-
35	Oxygen absorbed from KMnO4	(mg/l)	Nil		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	240	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	93	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Salaulim Dam
Place of Collection - Bottom (Intake)
Date of Collection - 20/07/05
Date of submission 20/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	29		-
2	pH.		6.9	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	5.8	○	1
7	Specific Conductivity	(m mhos/cm)	47.3		-
8	Total Dissolved Solids	(mg/l)	30		500
9	Total Hardness	(mg/l)	12		200
10	Total Alkalinity as CaCO3	(mg/l)	14.5		200
11	Calcium as Ca	(mg/l)	3.4		75
12	Magnesium as Mg	(mg/l)	0.88		<30
13	Chlorides as Cl	(mg/l)	6		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.3	○	0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	<0.0015		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	1		-
28	Nitrate-N	(mg/l)	0.1		45
	Nitrite as NO2 *	(mg/l)	0.05		-
29	Ammonia-N	(mg/l)	0.33		-
30	Dissolved Oxygen	(mg/l)	6.85		-
31	B.O.D. 5 days at 200C	(mg/l)	0.6		-
32	B.O.D. 3 days at 200C	(mg/l)	0.4		-
33	C.O.D (Cr)	(mg/l)	1.4		-
34	Sodium as Na *	(mg/l)	8.4		-
35	Oxygen absorbed from KMnO4	(mg/l)	Nil		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	93	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	43	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

Results of Water quality analysis in Japan (Salaulim Dam)

Commision	Goa , India		
Classification	Raw water　Tap water　Others		
Sample name	reserved water		
Sampling Place	Salaulim Intake		
Sampling Date	2005/4/30	Weather	Clear weather
Air Temperature	37.0℃	Water Temperature	32.0℃
Sampling Person	Takehiko Oga		
Analysis Term	30/4/2005～17/5/2005		

	Description of analysis	Criteria	Results		Description of analysis	Criteria	Results
1	Standard plate count bacteria		130 /mL	31	Geosmin		0.01 mg/L未満
2	E.coli		not detected	32	2-Methylisoborneol		0.02 mg/L未満
3	Cadmium		＜ 0.001 mg/L	33	non-ionic surfactant		＜ 0.005 mg/L
4	Mercury		＜ 0.00005 mg/L	34	Phenols		＜ 0.0005 mg/L
5	Selenium		＜ 0.001 mg/L	35	Total organic carbons		1.0 mg/L
6	Lead		＜ 0.001 mg/L	36	pH		6.7
7	Arsenic		＜ 0.001 mg/L	37	Taste		Unobjectionable
8	Chromium(VI)		＜ 0.005 mg/L	38	Odor		Argal odour､Musty odour
9	Cyanide,Cyanogen chloride (as CN)		＜ 0.001 mg/L	39	Color		34.0
10	Nitrate nitrogen(NO_3-N) Nitrite nitrogen(NO_2-N)		＜ 0.02 mg/L	40	Turbidity		0.02
11	Fluoride		＜ 0.05 mg/L	41	Dissolbed Iron		＜ 0.03 mg/L
12	Boron		＜ 0.1 mg/L	42	Dissolved Manganese		＜ 0.005 mg/L
13	Carbon tetrachloride		＜ 0.0002 mg/L				
14	1,4-Dioxane		＜ 0.005 mg/L				
15	1,1-Dichloroethylene		＜ 0.001 mg/L				
16	cis-1,2-Dichloroethylene		＜ 0.001 mg/L				
17	Dichloromethane		＜ 0.001 mg/L				
18	Tetrachloroethylen		＜ 0.001 mg/L				
19	Trichloroethylene		＜ 0.001 mg/L				
20	Benzene		＜ 0.001 mg/L				
21	Zinc		＜ 0.01 mg/L				
22	Aluminium		＜ 0.02 mg/L				
23	Iron		0.04 mg/L				
24	Copper		＜ 0.01 mg/L				
25	Sodium		3.3 mg/L				
26	Manganese		0.064 mg/L				
27	Chloride (Cl^-)		4.6 mg/L				
28	Hardness		17.5 mg/L		Judgiment		
29	Total residue		34 mg/L				
30	Anionic surfactant		＜ 0.02 mg/L				

Results of Water quality analysis in Japan (Well in Shiroda)

Commision	Goa , India		
Classification	Raw water Tap water Others		
Sample name	Groundwater		
Sampling Place			
Sampling Date	2005/4/30	Weather	Clear weather
Air Temperature	35.0℃	Water Temperature	30.5℃
Sampling Person	Takehiko Oga		
Analysis Term	30/4/2005～17/5/2005		

	Description of analysis	Criteria	Results		Description of analysis	Criteria	Results
1	Standard plate count bacteria		4500 /mL	31	Geosmin		< 0.000001 mg/L
2	E.coli		not detected	32	2-Methylisoborneol		< 0.000001 mg/L
3	Cadmium		< 0.001 mg/L	33	Non-ionic surfactant		< 0.005 mg/L
4	Mercury		< 0.00005 mg/L	34	Phenols		< 0.0005 mg/L
5	Selenium		< 0.001 mg/L	35	Total organic carbons		< 0.2 mg/L
6	Lead		< 0.001 mg/L	36	pH		6.1
7	Arsenic		< 0.001 mg/L	37	Taste		Unobjectionable
8	Chromium(VI)		< 0.005 mg/L	38	Odor		Hydrogen sulfide odour
9	Cyanide,Cyanogen chloride (as CN)		< 0.001 mg/L	39	Color		2.8
10	Nitrate nitrogen(NO_3-N) Nitrite nitrogen(NO_2-N)		0.04 mg/L	40	Turbidity		0.5
11	Fluoride		0.05 mg/L				
12	Boron		< 0.1 mg/L				
13	Carbon tetrachloride		< 0.0002 mg/L				
14	1,4-Dioxane		< 0.005 mg/L				
15	1,1-Dichloroethylene		< 0.001 mg/L				
16	cis-1,2-Dichloroethylene		< 0.001 mg/L				
17	Dichloromethane		< 0.001 mg/L				
18	Tetrachloroethylen		< 0.001 mg/L				
19	Trichloroethylene		< 0.001 mg/L				
20	Benzene		< 0.001 mg/L				
21	Zinc		< 0.01 mg/L				
22	Aluminium		0.02 mg/L				
23	Iron		0.06 mg/L				
24	Copper		< 0.01 mg/L				
25	Sodium		10.4 mg/L				
26	Manganese		0.021 mg/L				
27	Chloride (Cl^-)		14.5 mg/L				
28	Hardness		18.0 mg/L		Judgiment		
29	Total residue		63 mg/L				
30	Anionic surfactant		< 0.02 mg/L				

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Vazangal – Shiroda Well
Place of Collection - Well (JICA)
Date of Collection - 30/04/05 (JICA) **(Dry Season)**
Date of submission 13/06/05 (JICA)

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	30.0 (Lab)		-
2	pH.		6.1	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	0.85		1
7	Specific Conductivity	(m mhos/cm)	125.4		-
8	Total Dissolved Solids	(mg/l)	80		500
9	Total Hardness	(mg/l)	17		200
10	Total Alkalinity as CaCO3	(mg/l)	24		200
11	Calcium as Ca	(mg/l)	4		75
12	Magnesium as Mg	(mg/l)	1.75		<30
13	Chlorides as Cl	(mg/l)	14		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.5	○	0.1
16	Phosphate as PO4 *	(mg/l)	1.6		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.01		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.06		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	Nil		-
28	Nitrate-N	(mg/l)	Nil		45
	Nitrite as NO2 *	(mg/l)	<0.01		-
29	Ammonia-N	(mg/l)	Nil		-
30	Dissolved Oxygen	(mg/l)	6.4		-
31	B.O.D. 5 days at 200C	(mg/l)	0.7		-
32	B.O.D. 3 days at 200C	(mg/l)	0.5		-
33	C.O.D (Cr)	(mg/l)	1.5		-
34	Sodium as Na *	(mg/l)	10.8		-
35	Oxygen absorbed from KMnO4	(mg/l)	Nil		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	-		Not be Detectable
40	Fecal Coliform	MPN/100ml	-		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Curca, Tiswadi
Place of Collection - Open Well (Chlorinated water)
Date of Collection - 14/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	30		-
2	pH.		6.3	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	<5.0		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	4.9	○	1
7	Specific Conductivity	(m mhos/cm)	668		-
8	Total Dissolved Solids	(mg/l)	428		500
9	Total Hardness	(mg/l)	140		200
10	Total Alkalinity as CaCO3	(mg/l)	40		200
11	Calcium as Ca	(mg/l)	25.2		75
12	Magnesium as Mg	(mg/l)	19.25		<30
13	Chlorides as Cl	(mg/l)	156		200
14	Sulphate as SO4	(mg/l)	87		200
15	Iron as Fe	(mg/l)	0.7	○	0.1
16	Phosphate as PO4 *	(mg/l)	1.6		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.01		-
20	Fluorides as F	(mg/l)	0.14		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.03		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	1		-
28	Nitrate-N	(mg/l)	Nil		45
	Nitrite as NO2 *	(mg/l)	<0.01		-
29	Ammonia-N	(mg/l)	Nil		-
30	Dissolved Oxygen	(mg/l)	6.1		-
31	B.O.D. 5 days at 200C	(mg/l)	Nil		-
32	B.O.D. 3 days at 200C	(mg/l)	Nil		-
33	C.O.D (Cr)	(mg/l)	Nil		-
34	Sodium as Na *	(mg/l)	57.2		-
35	Oxygen absorbed from KMnO4	(mg/l)	Nil		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	Nil		Not be Detectable
40	Fecal Coliform	MPN/100ml	Nil		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Mopa, Pernem
Place of Collection - Tube well
Date of Collection - 14/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	28.5		-
2	pH.		6.4	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	8.7	○	1
7	Specific Conductivity	(m mhos/cm)	150		-
8	Total Dissolved Solids	(mg/l)	97		500
9	Total Hardness	(mg/l)	81		200
10	Total Alkalinity as CaCO3	(mg/l)	77		200
11	Calcium as Ca	(mg/l)	16		75
12	Magnesium as Mg	(mg/l)	10.25		<30
13	Chlorides as Cl	(mg/l)	7		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.2	○	0.1
16	Phosphate as PO4 *	(mg/l)	1.7		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.01		-
20	Fluorides as F	(mg/l)	0.08		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.03		5
23	Copper as Cu *	(mg/l)	0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	2.5		-
28	Nitrate-N	(mg/l)	0.7		45
	Nitrite as NO2 *	(mg/l)	<0.01		-
29	Ammonia-N	(mg/l)	2.5		-
30	Dissolved Oxygen	(mg/l)	4.7		-
31	B.O.D. 5 days at 200C	(mg/l)	1.6		-
32	B.O.D. 3 days at 200C	(mg/l)	1.2		-
33	C.O.D (Cr)	(mg/l)	3.5		-
34	Sodium as Na *	(mg/l)	12.2		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.4		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	23	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	Nil		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Nirancal, Ponda
Place of Collection - Tube Well
Date of Collection - 15/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	30.5		-
2	pH.		6.8	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	5.8	○	1
7	Specific Conductivity	(m mhos/cm)	159.2		-
8	Total Dissolved Solids	(mg/l)	102		500
9	Total Hardness	(mg/l)	78		200
10	Total Alkalinity as CaCO3	(mg/l)	87		200
11	Calcium as Ca	(mg/l)	12.8		75
12	Magnesium as Mg	(mg/l)	11.5		<30
13	Chlorides as Cl	(mg/l)	7		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	1	○	0.1
16	Phosphate as PO4 *	(mg/l)	0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.05		-
20	Fluorides as F	(mg/l)	0.12		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.01		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	2		-
28	Nitrate-N	(mg/l)	Nil		45
	Nitrite as NO2 *	(mg/l)	0.02		-
29	Ammonia-N	(mg/l)	1.2		-
30	Dissolved Oxygen	(mg/l)	7.2		-
31	B.O.D. 5 days at 200C	(mg/l)	Nil		-
32	B.O.D. 3 days at 200C	(mg/l)	Nil		-
33	C.O.D (Cr)	(mg/l)	Nil		-
34	Sodium as Na *	(mg/l)	6.7		-
35	Oxygen absorbed from KMnO4	(mg/l)	Nil		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	Nil		Not be Detectable
40	Fecal Coliform	MPN/100ml	Nil		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Dharbandora, Sanguem
Place of Collection - Tube Well
Date of Collection - 15/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	29		-
2	pH.		7.1		7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	5 unit		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	12.3	○	1
7	Specific Conductivity	(m mhos/cm)	211		-
8	Total Dissolved Solids	(mg/l)	138.5		500
9	Total Hardness	(mg/l)	107		200
10	Total Alkalinity as CaCO3	(mg/l)	117		200
11	Calcium as Ca	(mg/l)	30		75
12	Magnesium as Mg	(mg/l)	8		<30
13	Chlorides as Cl	(mg/l)	7		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	2.25	○	0.1
16	Phosphate as PO4 *	(mg/l)	0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.05		-
20	Fluorides as F	(mg/l)	0.06		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.02		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	3.5		-
28	Nitrate-N	(mg/l)	0.9		45
	Nitrite as NO2 *	(mg/l)	0.01		-
29	Ammonia-N	(mg/l)	1.15		-
30	Dissolved Oxygen	(mg/l)	7.45		-
31	B.O.D. 5 days at 200C	(mg/l)	1.1		-
32	B.O.D. 3 days at 200C	(mg/l)	0.9		-
33	C.O.D (Cr)	(mg/l)	2.3		-
34	Sodium as Na *	(mg/l)	30.1		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.4		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	240	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	Nil		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Mollem, Sanguem
Place of Collection - Tube Well
Date of Collection - 15/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	30.5		-
2	pH.		5.6	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	1.8	○	1
7	Specific Conductivity	(m mhos/cm)	27.9		-
8	Total Dissolved Solids	(mg/l)	18		500
9	Total Hardness	(mg/l)	6		200
10	Total Alkalinity as CaCO3	(mg/l)	7		200
11	Calcium as Ca	(mg/l)	1.2		75
12	Magnesium as Mg	(mg/l)	0.75		<30
13	Chlorides as Cl	(mg/l)	6		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.14	○	0.1
16	Phosphate as PO4 *	(mg/l)	0.3		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.05		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.02		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	Nil		-
28	Nitrate-N	(mg/l)	0.8		45
	Nitrite as NO2 *	(mg/l)	<0.01		-
29	Ammonia-N	(mg/l)	1.1		-
30	Dissolved Oxygen	(mg/l)	7.15		-
31	B.O.D. 5 days at 200C	(mg/l)	0.6		-
32	B.O.D. 3 days at 200C	(mg/l)	0.5		-
33	C.O.D (Cr)	(mg/l)	1.4		-
34	Sodium as Na *	(mg/l)	<0.1		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.2		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	Nil		Not be Detectable
40	Fecal Coliform	MPN/100ml	Nil		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Govanem -Malpona, Sattari
Place of Collection - Open Well
Date of Collection - 17/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	28		-
2	pH.		6.3	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	4.6	○	1
7	Specific Conductivity	(m mhos/cm)	71.1		-
8	Total Dissolved Solids	(mg/l)	45.5		500
9	Total Hardness	(mg/l)	28		200
10	Total Alkalinity as CaCO3	(mg/l)	33		200
11	Calcium as Ca	(mg/l)	6		75
12	Magnesium as Mg	(mg/l)	3.25		<30
13	Chlorides as Cl	(mg/l)	7		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.7	○	0.1
16	Phosphate as PO4 *	(mg/l)	0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.05		-
20	Fluorides as F	(mg/l)	0.1		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.01		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	1.5		-
28	Nitrate-N	(mg/l)	0.2		45
	Nitrite as NO2 *	(mg/l)	<0.01		-
29	Ammonia-N	(mg/l)	0.8		-
30	Dissolved Oxygen	(mg/l)	4.7		-
31	B.O.D. 5 days at 200C	(mg/l)	2		-
32	B.O.D. 3 days at 200C	(mg/l)	1.5		-
33	C.O.D (Cr)	(mg/l)	3.7		-
34	Sodium as Na *	(mg/l)	2.2		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.3		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	1100	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	230	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY

P.W.D., TONCA-CARANZALEM

WATER ANALYSIS

Source of Sample - Caranzol, Sattari
Place of Collection - Tube Well
Date of Collection - 17/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	29.0 (Lab)		-
2	pH.		6.4	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	2.12	○	1
7	Specific Conductivity	(m mhos/cm)	298		-
8	Total Dissolved Solids	(mg/l)	190.5		500
9	Total Hardness	(mg/l)	106		200
10	Total Alkalinity as CaCO3	(mg/l)	90		200
11	Calcium as Ca	(mg/l)	28.4		75
12	Magnesium as Mg	(mg/l)	8.75		<30
13	Chlorides as Cl	(mg/l)	20		200
14	Sulphate as SO4	(mg/l)	25		200
15	Iron as Fe	(mg/l)	0.34	○	0.1
16	Phosphate as PO4 *	(mg/l)	0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.05		-
20	Fluorides as F	(mg/l)	0.11		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.02		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	0.5		-
28	Nitrate-N	(mg/l)	0.8		45
	Nitrite as NO2 *	(mg/l)	<0.01		-
29	Ammonia-N	(mg/l)	1.58		-
30	Dissolved Oxygen	(mg/l)	6		-
31	B.O.D. 5 days at 200C	(mg/l)	1.2		-
32	B.O.D. 3 days at 200C	(mg/l)	0.9		-
33	C.O.D (Cr)	(mg/l)	2.8		-
34	Sodium as Na *	(mg/l)	12.3		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.4		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	4600	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	30	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Gonteli, Sattari
Place of Collection - Open Well
Date of Collection - 17/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	29.0 (lab)		-
2	pH.		6.2	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	2.3	○	1
7	Specific Conductivity	(m mhos/cm)	77		-
8	Total Dissolved Solids	(mg/l)	49		500
9	Total Hardness	(mg/l)	28		200
10	Total Alkalinity as CaCO3	(mg/l)	28		200
11	Calcium as Ca	(mg/l)	6		75
12	Magnesium as Mg	(mg/l)	3.25		<30
13	Chlorides as Cl	(mg/l)	8		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.58	○	0.1
16	Phosphate as PO4 *	(mg/l)	0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.05		-
20	Fluorides as F	(mg/l)	0.11		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	<0.01		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	0.5		-
28	Nitrate-N	(mg/l)	0.7		45
	Nitrite as NO2 *	(mg/l)	0.01		-
29	Ammonia-N	(mg/l)	0.8		-
30	Dissolved Oxygen	(mg/l)	6.4		-
31	B.O.D. 5 days at 200C	(mg/l)	1		-
32	B.O.D. 3 days at 200C	(mg/l)	0.7		-
33	C.O.D (Cr)	(mg/l)	2.5		-
34	Sodium as Na *	(mg/l)	1.4		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.2		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	11000	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	150	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Netravalim,Sanguem
Place of Collection - Tube Well
Date of Collection - 20/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	29		-
2	pH.		7.5		7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	2.15	○	1
7	Specific Conductivity	(m mhos/cm)	303		-
8	Total Dissolved Solids	(mg/l)	194		500
9	Total Hardness	(mg/l)	183		200
10	Total Alkalinity as CaCO3	(mg/l)	180		200
11	Calcium as Ca	(mg/l)	36.6		75
12	Magnesium as Mg	(mg/l)	22.7		<30
13	Chlorides as Cl	(mg/l)	5		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.08		0.1
16	Phosphate as PO4 *	(mg/l)	0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.05		-
20	Fluorides as F	(mg/l)	0.14		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	<0.01		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	Nil		-
28	Nitrate-N	(mg/l)	0.5		45
	Nitrite as NO2 *	(mg/l)	0.01		-
29	Ammonia-N	(mg/l)	1		-
30	Dissolved Oxygen	(mg/l)	6.2		-
31	B.O.D. 5 days at 200C	(mg/l)	0.9		-
32	B.O.D. 3 days at 200C	(mg/l)	0.6		-
33	C.O.D (Cr)	(mg/l)	Nil		-
34	Sodium as Na *	(mg/l)	3.5		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.2		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	7	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	Nil		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Loliem, Canacona
Place of Collection - Open Well
Date of Collection - 20/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	28		-
2	pH.		5.3	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	9.1	○	1
7	Specific Conductivity	(m mhos/cm)	58.7		-
8	Total Dissolved Solids	(mg/l)	37.5		500
9	Total Hardness	(mg/l)	11		200
10	Total Alkalinity as CaCO3	(mg/l)	9		200
11	Calcium as Ca	(mg/l)	2.6		75
12	Magnesium as Mg	(mg/l)	1		<30
13	Chlorides as Cl	(mg/l)	10		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.05		0.1
16	Phosphate as PO4 *	(mg/l)	0.2		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.05		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.01		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	0.5		-
28	Nitrate-N	(mg/l)	0.9		45
	Nitrite as NO2 *	(mg/l)	0.02		-
29	Ammonia-N	(mg/l)	0.85		-
30	Dissolved Oxygen	(mg/l)	7		-
31	B.O.D. 5 days at 200C	(mg/l)	2.6		-
32	B.O.D. 3 days at 200C	(mg/l)	2.1		-
33	C.O.D (Cr)	(mg/l)	3.2		-
34	Sodium as Na *	(mg/l)	6.8		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.6		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	95	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	21	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Kazur , Quepem. -- Tube Well
Place of Collection - Public tap
Date of Collection - 9/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	28		-
2	pH.		6.6	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	12.2	○	1
7	Specific Conductivity	(m mhos/cm)	223		-
8	Total Dissolved Solids	(mg/l)	142		500
9	Total Hardness	(mg/l)	115		200
10	Total Alkalinity as CaCO3	(mg/l)	122		200
11	Calcium as Ca	(mg/l)	29.2		75
12	Magnesium as Mg	(mg/l)	10.5		<30
13	Chlorides as Cl	(mg/l)	7		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	3	○	0.1
16	Phosphate as PO4 *	(mg/l)	0.2		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.05		-
20	Fluorides as F	(mg/l)	0.13		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.73		5
23	Copper as Cu *	(mg/l)	0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	3.5		-
28	Nitrate-N	(mg/l)	0.7		45
	Nitrite as NO2 *	(mg/l)	0.04		-
29	Ammonia-N	(mg/l)	0.55		-
30	Dissolved Oxygen	(mg/l)	5.8		-
31	B.O.D. 5 days at 200C	(mg/l)	1.3		-
32	B.O.D. 3 days at 200C	(mg/l)	0.8		-
33	C.O.D (Cr)	(mg/l)	3.2		-
34	Sodium as Na *	(mg/l)	5.5		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.8		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	75	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	43	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Cordem ,Balli ,Quepem – Spring Water
Place of Collection - Spring
Date of Collection - 21/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	26.5		-
2	pH.		6.7	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	6.8	○	1
7	Specific Conductivity	(m mhos/cm)	75.2		-
8	Total Dissolved Solids	(mg/l)	48		500
9	Total Hardness	(mg/l)	27		200
10	Total Alkalinity as CaCO3	(mg/l)	26		200
11	Calcium as Ca	(mg/l)	4.8		75
12	Magnesium as Mg	(mg/l)	3.75		<30
13	Chlorides as Cl	(mg/l)	9		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.58	○	0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.05		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.07		5
23	Copper as Cu *	(mg/l)	0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	2		-
28	Nitrate-N	(mg/l)	0.1		45
	Nitrite as NO2 *	(mg/l)	0.01		-
29	Ammonia-N	(mg/l)	0.46		-
30	Dissolved Oxygen	(mg/l)	7.9		-
31	B.O.D. 5 days at 200C	(mg/l)	0.65		-
32	B.O.D. 3 days at 200C	(mg/l)	0.5		-
33	C.O.D (Cr)	(mg/l)	1.6		-
34	Sodium as Na *	(mg/l)	3.9		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.2		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	4600	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	150	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Morpilla ,Quepem ---- Spring Water
Place of Collection - Spring
Date of Collection - 21/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	26		-
2	pH.		6.5	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	6.8	○	1
7	Specific Conductivity	(m mhos/cm)	63.5		-
8	Total Dissolved Solids	(mg/l)	40.5		500
9	Total Hardness	(mg/l)	20		200
10	Total Alkalinity as CaCO3	(mg/l)	21		200
11	Calcium as Ca	(mg/l)	4		75
12	Magnesium as Mg	(mg/l)	2.5		<30
13	Chlorides as Cl	(mg/l)	9		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.4	○	0.1
16	Phosphate as PO4 *	(mg/l)	0.2		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.05		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.04		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	2.5		-
28	Nitrate-N	(mg/l)	0.1		45
	Nitrite as NO2 *	(mg/l)	0.01		-
29	Ammonia-N	(mg/l)	0.46		-
30	Dissolved Oxygen	(mg/l)	7.35		-
31	B.O.D. 5 days at 200C	(mg/l)	0.7		-
32	B.O.D. 3 days at 200C	(mg/l)	0.46		-
33	C.O.D (Cr)	(mg/l)	1.8		-
34	Sodium as Na *	(mg/l)	2.8		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.3		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	4600	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	230	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Ziltawadi, Gaondongrim , Canacona ---- Tubewell
Place of Collection - House Tap in Reservoir Complex.
Date of Collection - 23/06/05 **(Dry Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	celsius	25.5		-
2	pH.		7.9		7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	2.4	○	1
7	Specific Conductivity	(m mhos/cm)	226		-
8	Total Dissolved Solids	(mg/l)	144		500
9	Total Hardness	(mg/l)	117		200
10	Total Alkalinity as $CaCO_3$	(mg/l)	126		200
11	Calcium as Ca	(mg/l)	24		75
12	Magnesium as Mg	(mg/l)	14.25		<30
13	Chlorides as Cl	(mg/l)	7		200
14	Sulphate as SO_4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.4	○	0.1
16	Phosphate as PO_4 *	(mg/l)	0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr^{6+} *	(mg/l)	<0.05		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.01		0.01
22	Zinc as Zn *	(mg/l)	0.01		5
23	Copper as Cu *	(mg/l)	<0.01		0.05
24	Lead as Pb *	(mg/l)	<0.01		0.05
25	Mercury as Hg *	(mg/l)	<0.001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	Nil		-
28	Nitrate-N	(mg/l)	Nil		45
	Nitrite as NO_2 *	(mg/l)	<0.01		-
29	Ammonia-N	(mg/l)	0.16		-
30	Dissolved Oxygen	(mg/l)	7.8		-
31	B.O.D. 5 days at 200C	(mg/l)	0.48		-
32	B.O.D. 3 days at 200C	(mg/l)	0.25		-
33	C.O.D (Cr)	(mg/l)	1.4		-
34	Sodium as Na *	(mg/l)	8.5		-
35	Oxygen absorbed from $KMnO_4$	(mg/l)	0.3		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C_6H_5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	1100	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	240	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Curca, Tiswadi
Place of Collection - Open Well (Chlorinated water)
Date of Collection - 21/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	29		-
2	pH.		6	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	3.87	○	1
7	Specific Conductivity	(m mhos/cm)	163.6		-
8	Total Dissolved Solids	(mg/l)	104.5		500
9	Total Hardness	(mg/l)	55		200
10	Total Alkalinity as CaCO3	(mg/l)	42		200
11	Calcium as Ca	(mg/l)	15.2		75
12	Magnesium as Mg	(mg/l)	4.25		<30
13	Chlorides as Cl	(mg/l)	26		200
14	Sulphate as SO4	(mg/l)	5		200
15	Iron as Fe	(mg/l)	0.4	○	0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	<0.0015		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	1		-
28	Nitrate-N	(mg/l)	Nil		45
	Nitrite as NO2 *	(mg/l)	0.06		-
29	Ammonia-N	(mg/l)	Nil		-
30	Dissolved Oxygen	(mg/l)	6.2		-
31	B.O.D. 5 days at 200C	(mg/l)	Nil		-
32	B.O.D. 3 days at 200C	(mg/l)	Nil		-
33	C.O.D (Cr)	(mg/l)	Nil		-
34	Sodium as Na *	(mg/l)	17.7		-
35	Oxygen absorbed from KMnO4	(mg/l)	Nil		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	Nil		Not be Detectable
40	Fecal Coliform	MPN/100ml	Nil		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Mopa, Pernem
Place of Collection - Tube well
Date of Collection - 21/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	28		-
2	pH.		5.8	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	1.9	○	1
7	Specific Conductivity	(m mhos/cm)	125.5		-
8	Total Dissolved Solids	(mg/l)	80		500
9	Total Hardness	(mg/l)	37		200
10	Total Alkalinity as CaCO3	(mg/l)	42		200
11	Calcium as Ca	(mg/l)	10.8		75
12	Magnesium as Mg	(mg/l)	2.5		<30
13	Chlorides as Cl	(mg/l)	12		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.34	○	0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	0.02		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	0.3		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	1		-
28	Nitrate-N	(mg/l)	1.6		45
	Nitrite as NO2 *	(mg/l)	0.06		-
29	Ammonia-N	(mg/l)	0.7		-
30	Dissolved Oxygen	(mg/l)	4.8		-
31	B.O.D. 5 days at 200C	(mg/l)	0.5		-
32	B.O.D. 3 days at 200C	(mg/l)	0.4		-
33	C.O.D (Cr)	(mg/l)	1.2		-
34	Sodium as Na *	(mg/l)	8.75		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.1		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	1100	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	43	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Malpona, Govanem
Place of Collection - Open Well
Date of Collection - 22/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	28		-
2	pH.		5.6	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	3.8	○	1
7	Specific Conductivity	(m mhos/cm)	47.7		-
8	Total Dissolved Solids	(mg/l)	30.5		500
9	Total Hardness	(mg/l)	17		200
10	Total Alkalinity as CaCO3	(mg/l)	18		200
11	Calcium as Ca	(mg/l)	3.2		75
12	Magnesium as Mg	(mg/l)	2.25		<30
13	Chlorides as Cl	(mg/l)	6		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.14	○	0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	0.03		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	<0.0015		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	1.5		-
28	Nitrate-N	(mg/l)	0.1		45
	Nitrite as NO2 *	(mg/l)	0.05		-
29	Ammonia-N	(mg/l)	Nil		-
30	Dissolved Oxygen	(mg/l)	5.1		-
31	B.O.D. 5 days at 200C	(mg/l)	1.75		-
32	B.O.D. 3 days at 200C	(mg/l)	1.45		-
33	C.O.D (Cr)	(mg/l)	3.3		-
34	Sodium as Na *	(mg/l)	6.65		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.25		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	930	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	210	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Gontelli
Place of Collection - Open Well
Date of Collection - 22/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	28		-
2	pH.		6	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	0.8		1
7	Specific Conductivity	(m mhos/cm)	72.2		-
8	Total Dissolved Solids	(mg/l)	46		500
9	Total Hardness	(mg/l)	27		200
10	Total Alkalinity as CaCO3	(mg/l)	21		200
11	Calcium as Ca	(mg/l)	5.6		75
12	Magnesium as Mg	(mg/l)	3.25		<30
13	Chlorides as Cl	(mg/l)	8		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.2	○	0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	0.09		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	0.05		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	0.5		-
28	Nitrate-N	(mg/l)	1.55		45
	Nitrite as NO2 *	(mg/l)	0.58		-
29	Ammonia-N	(mg/l)	0.3		-
30	Dissolved Oxygen	(mg/l)	6.1		-
31	B.O.D. 5 days at 200C	(mg/l)	0.6		-
32	B.O.D. 3 days at 200C	(mg/l)	0.4		-
33	C.O.D (Cr)	(mg/l)	1.5		-
34	Sodium as Na *	(mg/l)	9.45		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.2		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	2400	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	210	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Caranzol, Sattari
Place of Collection - Tube well
Date of Collection - 29/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	29		-
2	pH.		6.4	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	1.5	○	1
7	Specific Conductivity	(m mhos/cm)	332		-
8	Total Dissolved Solids	(mg/l)	213		500
9	Total Hardness	(mg/l)	120		200
10	Total Alkalinity as CaCO3	(mg/l)	96		200
11	Calcium as Ca	(mg/l)	32		75
12	Magnesium as Mg	(mg/l)	10		<30
13	Chlorides as Cl	(mg/l)	33		200
14	Sulphate as SO4	(mg/l)	21		200
15	Iron as Fe	(mg/l)	0.06		0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	0.14		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	0.13		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	Nil		-
28	Nitrate-N	(mg/l)	3.5		45
	Nitrite as NO2 *	(mg/l)	1.44		-
29	Ammonia-N	(mg/l)	0.65		-
30	Dissolved Oxygen	(mg/l)	7.15		-
31	B.O.D. 5 days at 200C	(mg/l)	0.25		-
32	B.O.D. 3 days at 200C	(mg/l)	0.2		-
33	C.O.D (Cr)	(mg/l)	Nil		-
34	Sodium as Na *	(mg/l)	25.7		-
35	Oxygen absorbed from KMnO4	(mg/l)	Nil		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	930	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	70	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Nirankal, Ponda
Place of Collection - Tube Well
Date of Collection - 25/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	28		-
2	pH.		6.7	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	45	○	5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Musty odour	○	Unobjectionable
6	Turbidity	(NTU)	21.7	○	1
7	Specific Conductivity	(m mhos/cm)	153.8		-
8	Total Dissolved Solids	(mg/l)	98		500
9	Total Hardness	(mg/l)	72		200
10	Total Alkalinity as CaCO3	(mg/l)	80		200
11	Calcium as Ca	(mg/l)	11.6		75
12	Magnesium as Mg	(mg/l)	10.75		<30
13	Chlorides as Cl	(mg/l)	6		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	3.6	○	0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	0.1		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	0.33		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	12		-
28	Nitrate-N	(mg/l)	0.2		45
	Nitrite as NO2 *	(mg/l)	0.06		-
29	Ammonia-N	(mg/l)	0.45		-
30	Dissolved Oxygen	(mg/l)	5.85		-
31	B.O.D. 5 days at 200C	(mg/l)	Nil		-
32	B.O.D. 3 days at 200C	(mg/l)	Nil		-
33	C.O.D (Cr)	(mg/l)	Nil		-
34	Sodium as Na *	(mg/l)	11.6		-
35	Oxygen absorbed from KMnO4	(mg/l)	Nil		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	23	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	Nil		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Dharbandora
Place of Collection - Tube Well
Date of Collection - 25/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	28		-
2	pH.		7.4		7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	55	○	5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Musty odour	○	Unobjectionable
6	Turbidity	(NTU)	35	○	1
7	Specific Conductivity	(m mhos/cm)	218		-
8	Total Dissolved Solids	(mg/l)	139.5		500
9	Total Hardness	(mg/l)	107		200
10	Total Alkalinity as CaCO3	(mg/l)	112		200
11	Calcium as Ca	(mg/l)	28		75
12	Magnesium as Mg	(mg/l)	9.25		<30
13	Chlorides as Cl	(mg/l)	6		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	3.7	○	0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	0.03		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	0.3		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	<0.0015		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	12		-
28	Nitrate-N	(mg/l)	Nil		45
	Nitrite as NO2 *	(mg/l)	0.09		-
29	Ammonia-N	(mg/l)	Nil		-
30	Dissolved Oxygen	(mg/l)	5.6		-
31	B.O.D. 5 days at 200C	(mg/l)	Nil		-
32	B.O.D. 3 days at 200C	(mg/l)	Nil		-
33	C.O.D (Cr)	(mg/l)	Nil		-
34	Sodium as Na *	(mg/l)	9.75		-
35	Oxygen absorbed from KMnO4	(mg/l)	Nil		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	9	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	Nil		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Mollem
Place of Collection - Tube Well
Date of Collection - 25/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	29		-
2	pH.		6	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	1.5	○	1
7	Specific Conductivity	(m mhos/cm)	40.2		-
8	Total Dissolved Solids	(mg/l)	26		500
9	Total Hardness	(mg/l)	10		200
10	Total Alkalinity as CaCO3	(mg/l)	7		200
11	Calcium as Ca	(mg/l)	2.4		75
12	Magnesium as Mg	(mg/l)	1		<30
13	Chlorides as Cl	(mg/l)	6		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.95	○	0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	0.19		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	<0.0015		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	Nil		-
28	Nitrate-N	(mg/l)	0.6		45
	Nitrite as NO2 *	(mg/l)	0.07		-
29	Ammonia-N	(mg/l)	0.8		-
30	Dissolved Oxygen	(mg/l)	6.75		-
31	B.O.D. 5 days at 200C	(mg/l)	Nil		-
32	B.O.D. 3 days at 200C	(mg/l)	Nil		-
33	C.O.D (Cr)	(mg/l)	Nil		-
34	Sodium as Na *	(mg/l)	3.75		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.1		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	4	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	Nil		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Nitravalim
Place of Collection - Tube Well
Date of Collection - 26/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	29		-
2	pH.		7.3		7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	0.6		1
7	Specific Conductivity	(m mhos/cm)	314		-
8	Total Dissolved Solids	(mg/l)	201		500
9	Total Hardness	(mg/l)	185		200
10	Total Alkalinity as CaCO3	(mg/l)	180		200
11	Calcium as Ca	(mg/l)	42		75
12	Magnesium as Mg	(mg/l)	21.25		<30
13	Chlorides as Cl	(mg/l)	6		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.06		0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	0.04		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	0.08		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	Nil		-
28	Nitrate-N	(mg/l)	0.1		45
	Nitrite as NO2 *	(mg/l)	0.07		-
29	Ammonia-N	(mg/l)	Nil		-
30	Dissolved Oxygen	(mg/l)	6		-
31	B.O.D. 5 days at 200C	(mg/l)	0.65		-
32	B.O.D. 3 days at 200C	(mg/l)	0.45		-
33	C.O.D (Cr)	(mg/l)	Nil		-
34	Sodium as Na *	(mg/l)	3.3		-
35	Oxygen absorbed from KMnO4	(mg/l)	Nil		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	Nil		Not be Detectable
40	Fecal Coliform	MPN/100ml	Nil		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Kazur ,Quepem
Place of Collection - Tube Well
Date of Collection - 26/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	27		-
2	pH.		6.6	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	4.7	○	1
7	Specific Conductivity	(m mhos/cm)	217		-
8	Total Dissolved Solids	(mg/l)	139		500
9	Total Hardness	(mg/l)	110		200
10	Total Alkalinity as CaCO3	(mg/l)	115		200
11	Calcium as Ca	(mg/l)	27.2		75
12	Magnesium as Mg	(mg/l)	10.5		<30
13	Chlorides as Cl	(mg/l)	7		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.45	○	0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	0.19		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	0.45		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	1.5		-
28	Nitrate-N	(mg/l)	0.2		45
	Nitrite as NO2 *	(mg/l)	0.11		-
29	Ammonia-N	(mg/l)	0.35		-
30	Dissolved Oxygen	(mg/l)	5.35		-
31	B.O.D. 5 days at 200C	(mg/l)	0.7		-
32	B.O.D. 3 days at 200C	(mg/l)	0.5		-
33	C.O.D (Cr)	(mg/l)	1.5		-
34	Sodium as Na *	(mg/l)	14.5		-
35	Oxygen absorbed from KMnO4	(mg/l)	Nil		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	9	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	Nil		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Cordem ,Balli ,Quepem – Spring Water
Place of Collection - Spring
Date of Collection - 27/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	27		-
2	pH.		6.9	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	4.9	○	1
7	Specific Conductivity	(m mhos/cm)	50.8		-
8	Total Dissolved Solids	(mg/l)	32.5		500
9	Total Hardness	(mg/l)	24		200
10	Total Alkalinity as CaCO3	(mg/l)	16		200
11	Calcium as Ca	(mg/l)	6		75
12	Magnesium as Mg	(mg/l)	2.25		<30
13	Chlorides as Cl	(mg/l)	7		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.06		0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	<0.0015		5
23	Copper as Cu *	(mg/l)	<0.005		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	1.5		-
28	Nitrate-N	(mg/l)	0.3		45
	Nitrite as NO2 *	(mg/l)	0.05		-
29	Ammonia-N	(mg/l)	0.4		-
30	Dissolved Oxygen	(mg/l)	7.65		-
31	B.O.D. 5 days at 200C	(mg/l)	0.3		-
32	B.O.D. 3 days at 200C	(mg/l)	0.2		-
33	C.O.D (Cr)	(mg/l)	1		-
34	Sodium as Na *	(mg/l)	6.7		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.1		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	930	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	430	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Morpilla ,Quepem ---- Spring Water
Place of Collection - Spring
Date of Collection - 27/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	26		-
2	pH.		7		7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	2.9	○	1
7	Specific Conductivity	(m mhos/cm)	55.9		-
8	Total Dissolved Solids	(mg/l)	36		500
9	Total Hardness	(mg/l)	22		200
10	Total Alkalinity as CaCO3	(mg/l)	20		200
11	Calcium as Ca	(mg/l)	4.8		75
12	Magnesium as Mg	(mg/l)	2.5		<30
13	Chlorides as Cl	(mg/l)	8		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.14	○	0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	0.17		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	<0.0015		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	0.5		-
28	Nitrate-N	(mg/l)	0.5		45
	Nitrite as NO2 *	(mg/l)	0.05		-
29	Ammonia-N	(mg/l)	0.8		-
30	Dissolved Oxygen	(mg/l)	7.75		-
31	B.O.D. 5 days at 200C	(mg/l)	0.3		-
32	B.O.D. 3 days at 200C	(mg/l)	0.2		-
33	C.O.D (Cr)	(mg/l)	Nil		-
34	Sodium as Na *	(mg/l)	9.4		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.2		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	150	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	90	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Ziltawadi, Gaondongrim , Canacona ---- Tubewell
Place of Collection - House Tap in Reservoir Complex
Date of Collection - 27/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	26		-
2	pH.		8.2		7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	2.3	○	1
7	Specific Conductivity	(m mhos/cm)	240		-
8	Total Dissolved Solids	(mg/l)	154		500
9	Total Hardness	(mg/l)	145		200
10	Total Alkalinity as CaCO3	(mg/l)	145		200
11	Calcium as Ca	(mg/l)	27.2		75
12	Magnesium as Mg	(mg/l)	19.25		<30
13	Chlorides as Cl	(mg/l)	7		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.06		0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	0.05		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	<0.0015		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	Nil		-
28	Nitrate-N	(mg/l)	0.3		45
	Nitrite as NO2 *	(mg/l)	0.07		-
29	Ammonia-N	(mg/l)	0.08		-
30	Dissolved Oxygen	(mg/l)	7.75		-
31	B.O.D. 5 days at 200C	(mg/l)	0.3		-
32	B.O.D. 3 days at 200C	(mg/l)	0.2		-
33	C.O.D (Cr)	(mg/l)	1		-
34	Sodium as Na *	(mg/l)	11.6		-
35	Oxygen absorbed from KMnO4	(mg/l)	Nil		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	90	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	40	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Loliem, Canacona
Place of Collection - Open Well
Date of Collection - 27/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	29		-
2	pH.		6.2	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	Nil		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	1.5	○	1
7	Specific Conductivity	(m mhos/cm)	59.9		-
8	Total Dissolved Solids	(mg/l)	39		500
9	Total Hardness	(mg/l)	18		200
10	Total Alkalinity as CaCO3	(mg/l)	11		200
11	Calcium as Ca	(mg/l)	3.6		75
12	Magnesium as Mg	(mg/l)	2.25		<30
13	Chlorides as Cl	(mg/l)	9		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.02		0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	0.03		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	Nil		-
28	Nitrate-N	(mg/l)	1.4		45
	Nitrite as NO2 *	(mg/l)	0.1		-
29	Ammonia-N	(mg/l)	0.5		-
30	Dissolved Oxygen	(mg/l)	4.8		-
31	B.O.D. 5 days at 200C	(mg/l)	0.3		-
32	B.O.D. 3 days at 200C	(mg/l)	0.2		-
33	C.O.D (Cr)	(mg/l)	Nil		-
34	Sodium as Na *	(mg/l)	10.2		-
35	Oxygen absorbed from KMnO4	(mg/l)	Nil		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	390	○	Not be Detectable
40	Fecal Coliform	MPN/100ml	90	○	Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
Remark means that a chemical consentration is over the recommended guidelines
on "Manual on Water Supply and Treatment".

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Source of Sample - Vazangal – Shiroda Well
Place of Collection - Tube Well .
Date of Collection - 28/07/05 **(Rainy Season)**

Sr. No.	TEST PARAMETERS	Unit of Measurement	Results	Remark	Guidelines
1	Temperature	OC	30		-
2	pH.		5.7	○	7.0 to 8.5
3	Colour	(Unit on Pt.Co.scale)	5		5
4	Taste		Unobjectionable		Unobjectionable
5	Odour		Unobjectionable		Unobjectionable
6	Turbidity	(NTU)	8.1	○	1
7	Specific Conductivity	(m mhos/cm)	64.5		-
8	Total Dissolved Solids	(mg/l)	42		500
9	Total Hardness	(mg/l)	15		200
10	Total Alkalinity as CaCO3	(mg/l)	8		200
11	Calcium as Ca	(mg/l)	3.6		75
12	Magnesium as Mg	(mg/l)	1.5		<30
13	Chlorides as Cl	(mg/l)	10		200
14	Sulphate as SO4	(mg/l)	Nil		200
15	Iron as Fe	(mg/l)	0.4	○	0.1
16	Phosphate as PO4 *	(mg/l)	<0.1		-
17	Arsenic as As *	(mg/l)	<0.01		0.01
18	Managanese as Mn	(mg/l)	Nil		0.05
19	Hexavalent chromium as Cr6+ *	(mg/l)	<0.003		-
20	Fluorides as F	(mg/l)	Nil		1
21	Cadmium as Cd *	(mg/l)	<0.008		0.01
22	Zinc as Zn *	(mg/l)	<0.0015		5
23	Copper as Cu *	(mg/l)	<0.0015		0.05
24	Lead as Pb *	(mg/l)	<0.015		0.05
25	Mercury as Hg *	(mg/l)	<0.0001		0.001
26	Selenium as Se *	(mg/l)	<0.01		0.01
27	Total Suspended Solids	(mg/l)	2.5		-
28	Nitrate-N	(mg/l)	0.3		45
	Nitrite as NO2 *	(mg/l)	0.14		-
29	Ammonia-N	(mg/l)	0.45		-
30	Dissolved Oxygen	(mg/l)	7.75		-
31	B.O.D. 5 days at 200C	(mg/l)	0.35		-
32	B.O.D. 3 days at 200C	(mg/l)	0.25		-
33	C.O.D (Cr)	(mg/l)	Nil		-
34	Sodium as Na *	(mg/l)	20.3		-
35	Oxygen absorbed from KMnO4	(mg/l)	0.2		-
36	Cyanide as CN *	(mg/l)	<0.02		0.05
37	Phenolic compound as C6 H5OH *	(mg/l)	<0.001		0.001
38	Mineral Oil *	(mg/l)	<0.01		0.01
39	Coliforms	MPN/100ml	Nil		Not be Detectable
40	Fecal Coliform	MPN/100ml	Nil		Not be Detectable

* Parameters tested by an external Laboratory. Reports enclosed.
Method of testing: Standard Methods for the examination of water and wastewater APHA18th &20th Ed..
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Appendix M34

Results of Leakage Survey

Contents for Appendix M34

Appendix M34 Results of Leakage Survey

The extent of leakage in the PWD piped water service area was surveyed during the first phase of the study, from May to July 2005, by carrying out leakage surveys in the selected pilot areas.

M34.1 Methodology of the Survey

Leakage surveys were conducted using the following steps:

1. Selection of survey areas
2. Household survey
3. Mapping
4. Flow measurement, pressure measurement and house meter reading
5. Leakage Detection
6. Evaluation of Leakage Reduction

The survey areas were selected through discussions with relevant PWD division/sub-division offices. The survey areas contain approximately 200 house connections.

Once survey areas were selected, household surveys and mapping were conducted by the Study Team, because detailed distribution system drawings were not available at the PWD offices. During the household survey, family size (household size) was confirmed for each house. House and pipeline locations were surveyed, and maps of the survey areas were prepared before the field leakage survey was commenced.

After preparation of the maps, ultrasonic flow meter installation locations were chosen. Prior to the installation of the ultrasonic flow meter sensors, pits were excavated by the PWD in order to expose the distribution pipe. Following the installation of the ultrasonic flow meters, water flow was measured for 24 hours. Individual water meters on each house connection were read and recorded both before and after the 24 hour flow measurement, to compare water consumption with water flow into the survey area. These survey activities were conducted by the JICA Study Team together with their PWD counterparts.

M34.2 Selection of Survey Areas

Survey areas were selected through consultation with the PWD offices. As each survey area contains around 100 to 200 households, survey areas were generally selected from urban areas. Features of the five selected survey areas are as shown in Table M34.2.1.

Table M34.2.1 Features of Survey Areas

	Taluka	Name of Town	Name of Survey Area	Hours of Water Supply	Distribution Pipe Length (m)	Number of Household
1	Bicholim	Bicholim	Lamgao	24 hours	2,140	192
2	Bardez	Mapusa	Marod	6 hours (from 4 am to 10 am)	1,130	121
3	Ponda	Ponda	Khadpabandh	22 hours	1,780	173
4	Salcete	Margao	Fatorda	24 hours	1,310	116
5	Tiswadi	Panaji	Althino	3 hours (from 7 pm to 10 pm)	1.480	168

Pipe materials in all five survey areas are mixture of ACP, CI, GI, and PVC.

M34.3 Household survey

The house locations were plotted on a map. The following aspects were surveyed and recorded for each household:

- family size;
- whether or not there is a PWD connection; and
- whether or not they have their own well.

The number of house connections and the service ratio of the respective survey areas are shown in Table M34.3.1.

Table M34.3.1 Number of Connections and Service Ratio

	Taluka	Name of Town	Name of Survey Area	Number of Households	Number of PWD Connection	Service ratio
1	Bicholim	Bicholim	Lamgao	192	165	86%
2	Bardez	Mapusa	Marod	121	112	92%
3	Ponda	Ponda	Khadpabandh	173	164	94%
4	Salcete	Margao	Fatorda	116	101	87%
5	Tiswadi	Panaji	Althino	168	164	98%

The number of households which have both a PWD connection and their own well is shown in Table M34.3.2.

Table M34.3.2 Number of households with both a PWD connection and a well

	Taluka	Name of Town	Name of Survey Area	Total Number of Households	Number of Households with both PWD connection and well
1	Bicholim	Bicholim	Lamgao	192	72
2	Bardez	Mapusa	Marod	121	12
3	Ponda	Ponda	Khadpabandh	173	0
4	Salcete	Margao	Fatorda	116	12
5	Tiswadi	Panaji	Althino	168	0

M34.4 House Meter Reading

Water consumption in the survey areas was calculated from meter readings. For houses where the meter was malfunctioning or not readable, average water consumption (average per capita consumption in the area multiplied by household size) was applied.

Water meter condition was also investigated during the household survey. Meter condition is summarized in Table M34.4.1.

Table M34.4.1 Summary of Water Meter Condition

	Taluka (Town)	Name of Survey Area	Number of house connections	Number of unchecked houses	Meter Condition		
					Good	Not working	Not readable
1	Bicholim (Bicholim)	Lamgao	165	7	141(85%)	15(11%)	2(1%)
2	Bardez (Mapusa)	Marod	111	5	74(67%)	27(36%)	5(5%)
3	Ponda (Ponda)	Khadpabandh	154	26	65(42%)	23(15%)	49(32%)
4	Salcete (Margao)	Fatorda	101	8	70(75%)	21(23%)	2(2%)
5	Tiswadi (Panaji)	Althino	164	13	78(52%)	33(22%)	40(26%)

Several public stand pipes were also found in these survey areas. As these public taps are not equipped with water meters, the PWD/JICA Study Team installed new water meters at every public stand pipe.

The number of public stand pipes, and the respective water consumption, is shown in Table M34.4.2.

Table M34.4.2 Public stand pipes: number and water consumption

	Taluka	Name of Town	Name of Survey Area	Number of Public Stand Pipes	Total Consumption (m^3/day)	Average Consumption per Stand Pipe (m^3/day)
1	Bicholim	Bicholim	Lamgao	4	7.70	1.92
2	Bardez	Mapusa	Marod	2	1.74	0.87
3	Ponda	Ponda	Khadpabandh	None	-	-
4	Salcete	Margao	Fatorda	4	6.90	1.72
5	Tiswadi	Panaji	Althino	2	2.18	1.09
Total / Average				12	18.52	1.54

M34.5 Flow measurement and Leak Detection

Ultrasonic flow meters were installed on the points where distribution pipes cross the boundary of the respective survey areas. The quantity of water entering and leaving each survey area was measured. The balance of these two volumes represents water consumption and water leakage within the survey area.

Total water inflow (balance of “in” and “out”) and the water consumption of each survey area is shown in Table M34.5.1.

Table M34.5.1 Results of Flow Measurement and UFW Ratio

	Taluka	Name of Town	Name of Survey Area	Total Inflow (m^3/day)	Total Consumption (m^3/day)	UFW Ratio (%)
1	Bicholim	Bicholim	Lamgao	126.51	110.04	13.0%
2	Bardez	Mapusa	Marod	73.16	42.64	41.7%
3	Ponda	Ponda	Khadpabandh	479.40	124.41	74.0%
4	Salcete	Margao	Fatorda	178.04	106.05	40.4%
5	Tiswadi	Panaji	Althino	143.68	109.45	23.8%

The “UFW Ratio” shown in the above table is not exactly equivalent to “Water Losses” shown on Table M34.5.2: “Definition of Non-Revenue Water by IWA” (which is usually treated as “UFW”). This is because “Total Consumption” shown in the above table includes water consumption through public stand pipes. Water consumption from the public stand pipes is usually not measured and not billed. Therefore, this water consumption is categorized as “Unbilled Unmetered Consumption” under “Unbilled Authorized Consumption”.

However, to avoid complication, the balance between “Total Inflow” and “Total Consumption” is discussed as the UFW. The UFW ratio shown on the above table varies from 13% to 74 %.

Table M34.5.2 Definition of Non-Revenue Water

<table>
<tr><td rowspan="9">System Input Volume</td><td rowspan="4">Authorised Consumption</td><td rowspan="2">Billed Authorised Consumption</td><td>Billed Metered Consumption (including water exported)</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorised Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="7">Non-Revenue Water (NRW)</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="2">Apparent Losses</td><td>Unauthorised Consumption</td></tr>
<tr><td>Metering Inaccuracies</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and/or Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility’s Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering</td></tr>
</table>

Source: IWA “Best Practice” Water Balance and Terminology

During the flow measurement, leaks were detected using Leak Detectors and Stethoscopic Bars. Table M34.5.3 shows number of leak points found in each survey area.

Table M34.5.3 Number of Leak Points Found

	Name of Survey Area	Length of Distribution Pipe (m)	Number of Leaks Found	Leaks on Distribution Pipe	Leaks on Connection	Leaks per Pipe Length
1	Lamgao	2,140	17	3	14	7.7/km
2	Marod	1,130	4	1	3	3.5/km
3	Khadpabandh	1,780	(38)	(16)	(22)	(21.3/km)
4	Fatorda	1,310	12	6	6	9.9/km
5	Althino	1,480	(11)	(6)	(5)	(7.4/km)

Note: The number in brackets means confirmed leak points plus locations of unusual sound (leak noise), which were detected but not yet confirmed.

In the previous Table M34.5.1, survey area No. 3 shows the highest UFW ratio. The number of leak points is also the highest in survey area No. 3.

These leak points were repaired completely in survey areas 1, 2, and 4 by the PWD. In survey areas 3 and 5, some leak points were not repaired due to the very heavy rainfall during the wet season. After the repair of leak points, flow measurements were conducted using the ultrasonic flow meter. The results are shown in Table M34.5.4.

Table M34.5.4 Results of Flow Measurement and UFW Ratio after Leak Repair

	Taluka	Name of Town	Name of Survey Area	Total Inflow (m^3/day)	Total Consumption (m^3/day)	UFW Ratio (%)
1	Bicholim	Bicholim	Lamgao	98.97	109.09	-10%
2	Bardez	Mapusa	Marod	79.55	57.20	28%
3	Ponda	Ponda	Khadpabandh	459.40	112.96	75%
4	Salcete	Margao	Fatorda	153.58	94.03	39%
5	Tiswadi	Panaji	Althino	151.91	122.18	20%

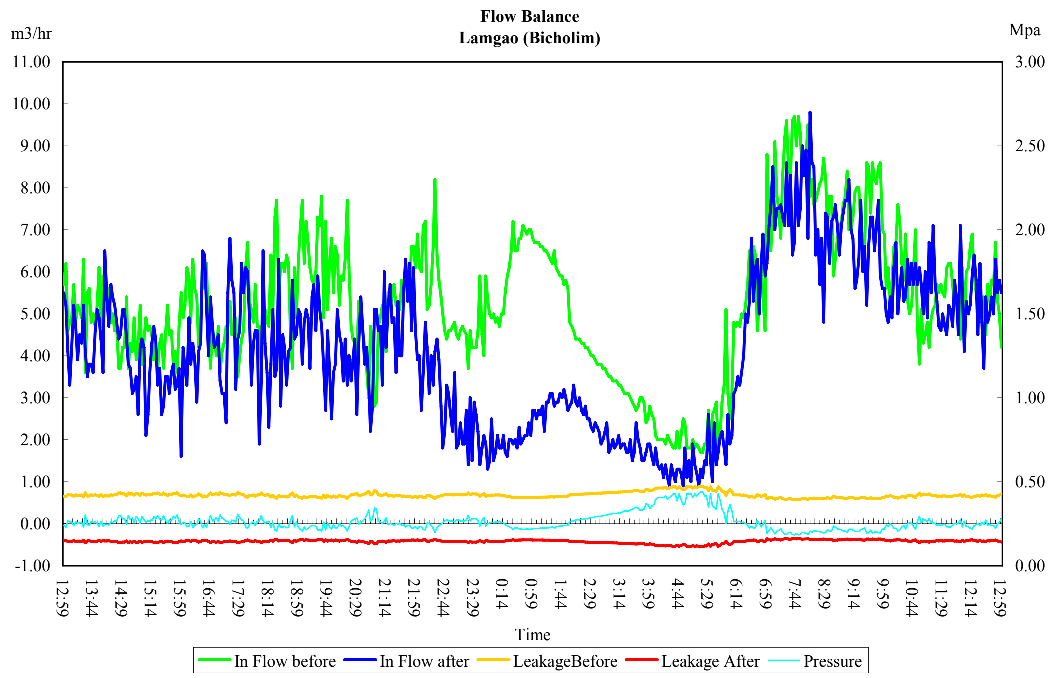
In survey area No. 1, the UFW ratio was negative. This may be because the estimated water consumption for house connections with malfunctioning water meters was lower than the applied average water consumption in the area. Table M34.5.5 shows a comparison of the UFW ratio before and after the leak repairs. In most of the survey areas the UFW ratios decreased after leaks were repaired.

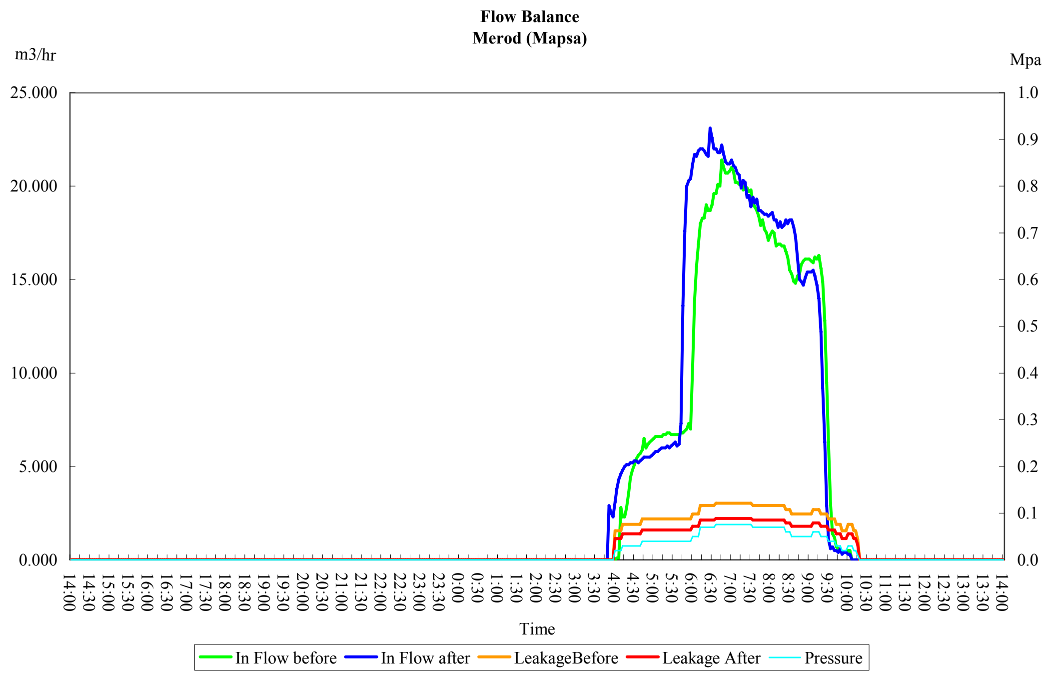
Table M34.5.5 Comparison of UFW Ratio Before and After Leak Repairs

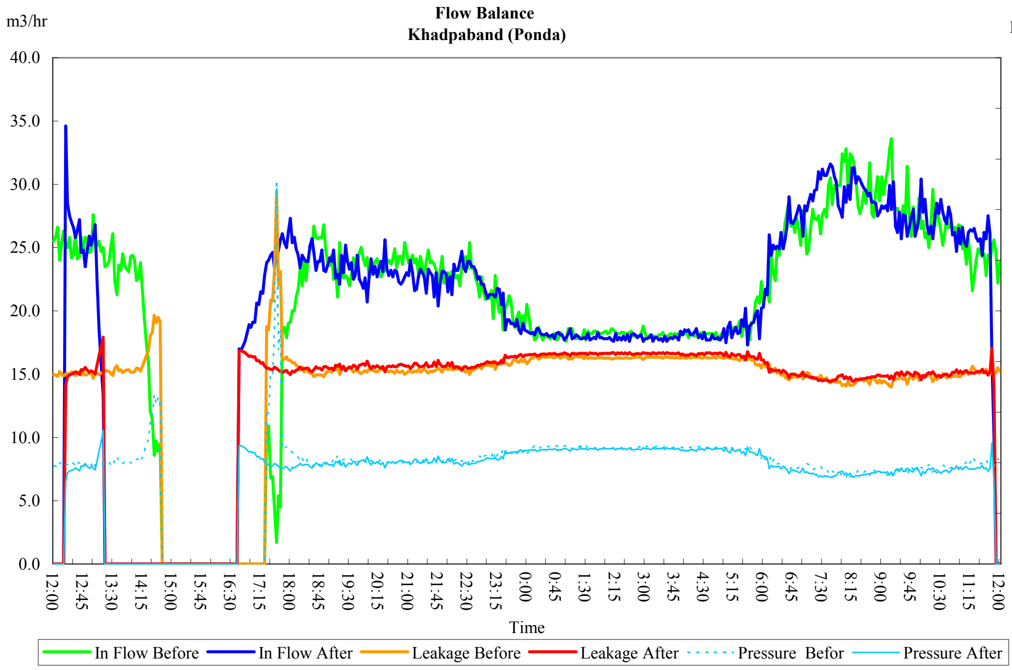
	Taluka	Name of Town	Name of Survey Area	UFW Ratio		Leak Repair Status
				Before Repair	After Repair	
1	Bicholim	Bicholim	Lamgao	13.0%	-10%	Complete
2	Bardez	Mapusa	Marod	41.7%	28%	Complete
3	Ponda	Ponda	Khadpabandh	74.0%	75%	Incomplete
4	Salcete	Margao	Fatorda	40.4%	39%	Complete
5	Tiswadi	Panaji	Althino	23.8%	20%	Incomplete

Figure M34.5.1 shows the results of flow measurement before and after leak repair, as well as leakage ,and pressure.

Figure M34.5.1 Results of Flow Measurement and Leakage






Flow Balance
Khadpaband (Ponda)
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Mpa
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35.0
30.0
25.0
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15.0
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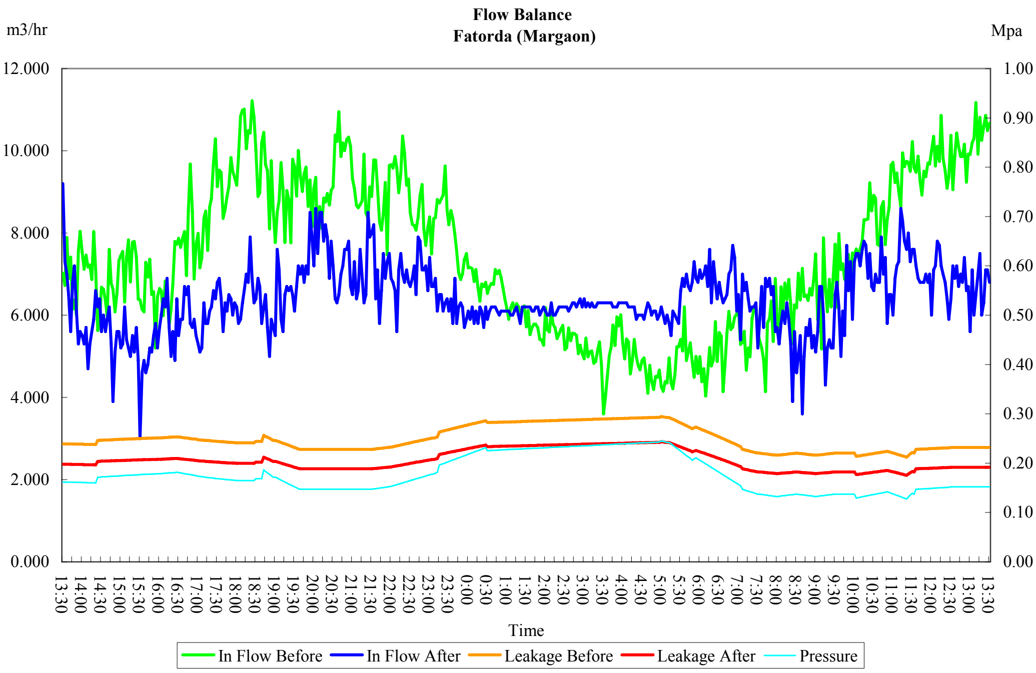
11:15
12:00
Time
In Flow Before
In Flow After
Leakage Before
Leakage After
Pressure Befor
Pressure After


Flow Balance
Fatorda (Margaon)
m3/hr
Mpa
12.000
10.000
8.000
6.000
4.000
2.000
0.000
1.00
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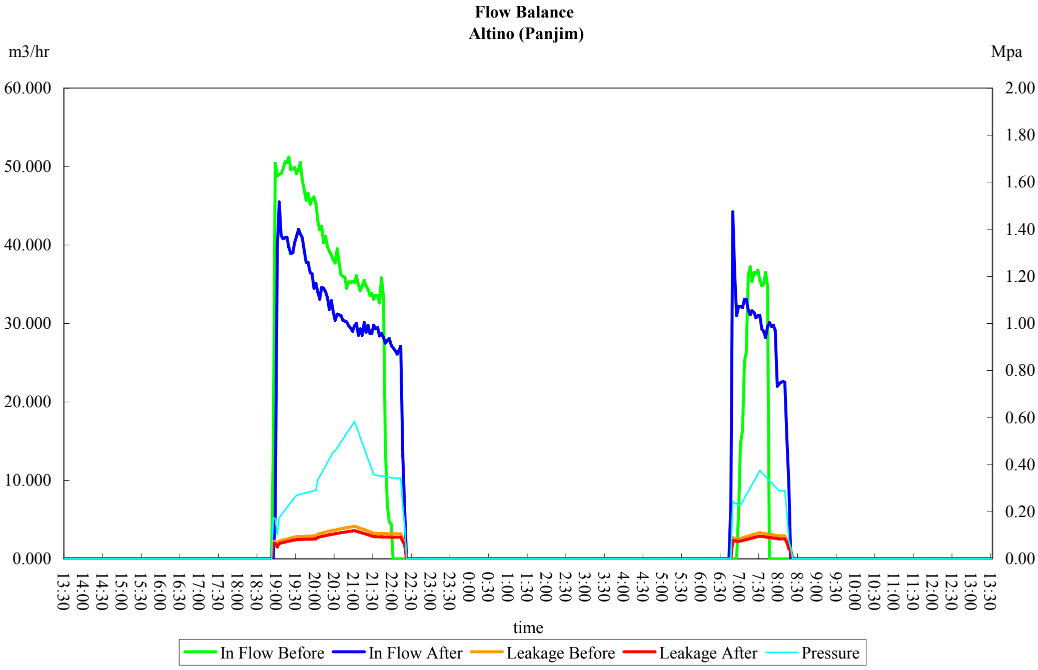
13:30
Time
In Flow Before
In Flow After
Leakage Before
Leakage After
Pressure



M34.6 Summary of Leakage Survey Results

- In the five leakage survey areas, several leaking points were found and the UFW ratio varied from 13 to 74 %. After these leak points were repaired, the UFW ratio decreased in several survey areas.
- Leakage points were found not only on house connections but also on distribution pipelines. Leaks on distribution pipelines were usually from pipe joints and deteriorated ACP pipeline.
- There were several visible (above ground) leakage points.
- Attention should be paid to water meter maintenance. The percentage of good working meters in the survey areas ranges from 42% to 85 %. Meter calibration is not conducted periodically, therefore water consumption data may contain a percentage of metering error.

Appendix M35

Existing Sanitation System

Contents for Appendix M35

Appendix M35.1 Flow Calculation Sheet for Main and Sub Main Sewers, Panaji City

Table M35.1.1 Flow Calculation Sheet for Main and Sub Main Sewers, Panaji City (Year 2001)

Node 1		Node 2		Population		Peak flow (lps)		Existing Sewer									Capacity Adequacy	Remarks
From	To	From	To	Increment	Cumulative	Increment	Cumulative	Size (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Velocity (m/sec)	Flow Capacity (lps)		
											u/s	d/s	u/s	d/s				
1 (PS1)	3	I-PS1	III-2	4,201	4,201	23.7	23.7	150	580	PM	4.67	5.73			1.343		Adequate	Pressure main
2 (PS2)	3	II-PS2	III-2	4,196	4,196	23.7	23.7	150	210	PM	3.79	5.73			1.341		Adequate	Pressure main
3	4 (PS3)	III-2	IV-PS3	9,774	18,171	55.2	102.6	300	353	200	5.73	4.41	0.68		0.840	59	NG	
4 (PS3)	5	IV-PS3	IV-21	0	18,171	0.0	102.6	200	320	PM	4.41	7.43		2.43	3.267		NG	Pressure main
5	8	IV-21	V-20	954	19,125	5.4	108.0	600	270	340	7.43	7.60	2.43		1.022	289	Adequate	
6	7	VIII-63	V-2	1,894	1,894	10.7	10.7	225	688	30	134.27	13.71	127.98	8.40	1.790	71	Adequate	
7	8	V-2	V-20	1,010	2,903	5.7	16.4	225	270	135	13.71		8.40		0.844	34	Adequate	
8	9	V-20	V-61	1,050	23,079	5.9	130.4	600	240	340					1.022	289	Adequate	
9	11 (PS5)	V-61	V-PS5	13,768	36,847	77.8	208.1	700	837	420					1.019	392	Adequate	
10	11 (PS5)	VI-35	V-PS5	1,383	1,383	7.8	7.8	225	546	135					0.844	34	Adequate	
11 (PS5)	13	V-PS5	VII-221	0	38,230	0.0	215.9	400	310	PM		8.79		4.58	1.718		Adequate	Pressure main
12	13	VIII-2	VII-221	2,855	2,855	16.1	16.1	225	1,742	30	194.20	8.79	190.00	4.58	1.790	71	Adequate	
13	21	VII-221	VII-225	1,628	42,714	9.2	241.3	600	370	500	8.79		4.58		0.843	238	NG	
14	16	X-12D	X-11	503	503	2.8	2.8	150	314	80		19.83		18.83	0.837	15	Adequate	
15	16	X-1	X-11	127	127	0.7	0.7	150	234	80		19.83		18.83	0.837	15	Adequate	
16	18	X-11	X-40	185	815	1.0	4.6	150	342	80	19.83		18.83		0.837	15	Adequate	
17	18	X-52	X-40	717	717	4.0	4.0	150	506	80	4.39		3.39		0.837	15	Adequate	
18	19 (PS10)	X-40	X-PS10	666	2,198	3.8	12.4	225	112	80					1.096	44	Adequate	
19 (PS10)	20	X-PS10	X-100	0	2,198	0.0	12.4	150	532	PM					0.702		Adequate	Pressure main
20	21	X-100	VII-225	609	2,807	3.4	15.9	225	920	135					0.844	34	Adequate	
21	26	VII-225	VII-232	2,250	47,771	12.7	269.8	600	684	500		4.15		6.46	0.843	238	NG	
23 (PS11)	26	XI-PS11	VII-232	4,242	4,242	24.0	24.0	200	180	PM		4.15		6.46	0.763		Adequate	Pressure main
26	27	VII-232	VII-232C	189	52,202	1.1	293.8	600	76	500	4.15		6.46					
24 (PS9)	25	IX-PS9	IX-47A	2,772	2,772	15.7	15.7	200	175	PM					0.498		Adequate	Pressure main
25	27	IX-47A	VII-232C	2,254	5,026	12.7	28.4	350	563	135					1.133	109	Adequate	
27	29 (STP)	VII-232C	STP	174	57,402	1.0	322.2	600	70	500		3.73		7.06	0.843	238	NG	
28 (PS12)	29 (STP)	XII-PS12	STP	1,383	1,383	7.8	7.8	150	360	PM		3.73		7.06	0.442		Adequate	Pressure main

Source (1): Diameter, length, gradient of pipes: Sewerage Scheme to Panaji, Govt. of Goa (zone-wise drawing)
Source (2): Zone-wise wastewater flow: Annexture J, Project Report on Envuronmental Upgradation of Panaji City Phase I
Pipe slopes are assumed based on upstream and downstream sewers

Node 1 cordinated with Figure 3.2.1
Node 2 cordinated with sewerage zone map
"PM": Pressure Main

Peak factor : 2.25
Manning's n: 0.015

Appendix M35.2 Flow Calculation Sheet for Branch Sewers, Panaji City

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (1/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
										Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Velocity (m/sec)	Flow Capacity (lps)		
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative				u/s	d/s	u/s	d/s				
Zone I																				Sewers in Zone I were installed in 1965-67
		20	22		154	154		0.9	0.9	150	62	80	12.40		7.75		0.835	15	Adequate	
		22B	22		57	57		0.3	0.3	150	23	80					0.835	15	Adequate	
		22	23B		120	331		0.7	1.9	150	48	80		8.78		3.10	0.835	15	Adequate	
		23F	23B		222	222		1.3	1.3	150	89	135	14.42	8.78	10.10	3.10	0.643	11	Adequate	
		23B	23C		82	635		0.5	3.6	200	33	135	8.78		2.85		0.779	24	Adequate	
		23C	25B		441	1,076		2.5	6.1	225	177	135					0.842	33	Adequate	
		25E	25B		115	115		0.6	0.6	150	46	80					0.835	15	Adequate	
		25B	16D		212	1,403		1.2	7.9	225	85	135					0.842	33	Adequate	
		10G	10A		150	150		0.8	0.8	150	60	80	8.11		3.69		0.835	15	Adequate	
		10F	10A		87	87		0.5	0.5	150	35	80					0.835	15	Adequate	
		10A	10C		112	349		0.6	2.0	150	45	80					0.835	15	Adequate	
		10C	17D		137	486		0.8	2.7	225	55	30		7.86		3.41	1.787	71	Adequate	
		18	17D		264	264		1.5	1.5	150	106	80	12.04	7.86		3.41	0.835	15	Adequate	
		17D	16A		107	857		0.6	4.8	150	43	80	7.86				0.835	15	Adequate	
		29B	5		152	152		0.9	0.9	150	61	15	33.63		26.47		1.928	34	Adequate	
		6A	5		75	75		0.4	0.4	150	30	60	15.67		11.00		0.964	17	Adequate	
		5	4		105	331		0.6	1.9	225	42	60					1.264	50	Adequate	
		4G	4B		167	167		0.9	0.9	150	67	80					0.835	15	Adequate	
		4C	4B		82	82		0.5	0.5	150	33	80	8.18		3.69		0.835	15	Adequate	
		4B	4		45	294		0.3	1.7	150	18	80		7.05		2.02	0.835	15	Adequate	
		3	4	5	202	207	0.0	1.1	1.2	150	81	80	9.30	7.05	5.61	2.02	0.835	15	Adequate	Receiving from Zone X (Sec. I)
		4	8		167	1,000		0.9	5.6	150	67	80	7.05		2.02		0.835	15	Adequate	
		8D	8		247	247		1.4	1.4	150	99	60	3.73	4.30	0.03	-2.43	0.964	17	Adequate	
		8	16A		521	1,767		2.9	10.0	150	209	80					0.835	15	Adequate	
		16A	16D		147	2,771		0.8	15.6	225	59	35					1.654	66	Adequate	
		16D	PS1		27	4,201		0.2	23.7	225	11	135		4.67		-5.37	0.842	33	Adequate	
1 (PS1)	3	PS-1	III-2			4,201			23.7	150	580	PM	4.67	5.73						Discharging into Zone III

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (2/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
Zone II																				Sewers in Zone II were installed in 1965-67
		44	15		171	171		1.0	1.0	150	85	80	77.31	21.90	73.00	18.00	0.835	15	Adequate	
		40	15		64	64		0.4	0.4	150	32	80		21.90		18.00	0.835	15	Adequate	
		15	13		48	283		0.3	1.6	150	24	80	21.90	16.71	18.00	14.52	0.835	15	Adequate	
		35	38D		301	301		1.7	1.7	150	150	60	101.76		77.70		0.964	17	Adequate	
		38D	38		191	492		1.1	2.8	225	95	30					1.787	71	Adequate	
		38N	38		76	76		0.4	0.4	150	38	80					0.835	15	Adequate	
		38	13		52	621		0.3	3.5	225	26	30		16.71		14.52	1.787	71	Adequate	
		13	12		90	994		0.5	5.6	225	45	60		9.69		7.00	1.264	50	Adequate	
		1	27A		223	223		1.3	1.3	150	111	80	16.57		13.20		0.835	15	Adequate	
		27E	27A		143	143		0.8	0.8	150	71	80					0.835	15	Adequate	
		27A	51		380	745		2.1	4.2	225	189	135					0.842	33	Adequate	
		52	51		74	74		0.4	0.4	150	37	80					0.835	15	Adequate	
		51	12		52	872		0.3	4.9	225	26	135		9.69		7.00	0.842	33	Adequate	
		18	19		32	32		0.2	0.2	150	16	80	10.20		6.00		0.835	15	Adequate	
		19A	19		28	28		0.2	0.2	150	14	80					0.835	15	Adequate	
		19	48		54	114		0.3	0.6	150	27	80					0.835	15	Adequate	
		48E	48		90	90		0.5	0.5	150	45	80					0.835	15	Adequate	
		48A	48		52	52		0.3	0.3	150	26	80					0.835	15	Adequate	
		48	12		60	317		0.3	1.8	150	30	80		9.69		7.00	0.835	15	Adequate	
		12	20B		159	2,342		0.9	13.2	225	79	135					0.842	33	Adequate	
		24D	24		167	167		0.9	0.9	150	83	80	10.04		5.74		0.835	15	Adequate	
		24	23A		163	329		0.9	1.9	225	81	135					0.842	33	Adequate	
		23I	23F		92	92		0.5	0.5	150	46	80					0.835	15	Adequate	
		23E	23F		68	68		0.4	0.4	150	34	80	10.67		4.01		0.835	15	Adequate	
		23F	23A		96	257		0.5	1.5	150	48	80					0.835	15	Adequate	
		23A	20B		40	627		0.2	3.5	225	20	135					0.842	33	Adequate	
		20B	20A		24	2,993		0.1	16.9	225	12	135					0.842	33	Adequate	
		22D	20A		374	374		2.1	2.1	150	186	135					0.643	11	Adequate	

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (3/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
		20A	PS2		34	3,401		0.2	19.2	225	17	135					0.842	33	Adequate	
		20V	20R		88	88		0.5	0.5	150	44	80					0.835	15	Adequate	
		20S	20R		16	16		0.1	0.1	150	8	80					0.835	15	Adequate	
		20R	20		64	169		0.4	1.0	150	32	80					0.835	15	Adequate	
		20-4	20		137	137		0.8	0.8	150	68	80					0.835	15	Adequate	
		20	20J		22	327		0.1	1.9	150	11	80					0.835	15	Adequate	
		20N	20J		251	251		1.4	1.4	150	125	80					0.835	15	Adequate	
		20J	PS2		217	795		1.2	4.5	150	108	80					0.835	15	Adequate	
2 (PS2)	3	PS-2	III-2			4,196			23.7	150	210	PM								Discharging into Zone III
Zone III																				Sewers in Zone III were installed in 1965-67
		3A	2		212	212		1.2	1.2	150	51	80	5.93	5.73	1.75	0.68	0.835	15	Adequate	
3	3a	2	19A	8,397	262	8,872	47.4	1.5	50.1	300	63	200	5.73		0.68		0.838	59	Adequate	Receiving from Zone I and II
		14	14C		300	300		1.7	1.7	150	72	80		3.03		2.24	0.835	15	Adequate	
		6	14C		200	200		1.1	1.1	150	48	60	8.89	3.03	8.86	2.24	0.964	17	Adequate	
		14C	11		50	550		0.3	3.1	150	12	80	3.03		2.24		0.835	15	Adequate	
		5A	5		50	50		0.3	0.3	150	12	80	5.83	5.94	5.71	1.71	0.835	15	Adequate	
		5B	5		62	62		0.4	0.4	150	15	60	7.48	5.94	3.00	1.71	0.964	17	Adequate	
		5	11		125	237		0.7	1.3	150	30	80	5.94		1.71		0.835	15	Adequate	
		11	19A		162	950		0.9	5.4	225	39	135					0.842	33	Adequate	
3a	3b	19A	19		137	9,960		0.8	56.3	300	33	200					0.838	59	Adequate	
		13	20		62	62		0.4	0.4	150	15	60	7.50		3.72		0.964	17	Adequate	
		20	19		171	233		1.0	1.3	150	41	100					0.747	13	Adequate	
3b	3c	19	23		192	10,385		1.1	58.7	300	46	200					0.838	59	Adequate	
		49B	26		192	192		1.1	1.1	150	46	60	12.46	13.03	8.56	5.80	0.964	17	Adequate	
		31	26		33	33		0.2	0.2	150	8	60	14.45	13.03	10.25	5.80	0.964	17	Adequate	
		26	16		196	421		1.1	2.4	150	47	60	13.03		5.80		0.964	17	Adequate	
		16C	16		112	112		0.6	0.6	150	27	80					0.835	15	Adequate	
		16	24		54	587		0.3	3.3	150	13	80		7.96		1.06	0.835	15	Adequate	
		45	22		87	87		0.5	0.5	150	21	80					0.835	15	Adequate	

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (4/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
		45B	22		104	104		0.6	0.6	150	25	60	11.88		8.00		0.964	17	Adequate	
		22	24		296	487		1.7	2.8	150	71	60					0.964	17	Adequate	
		24	23		154	1,229		0.9	6.9	225	37	135					0.842	33	Adequate	
		23B	23		62	62		0.4	0.4	150	15	80					0.835	15	Adequate	
3c	3d	23	42		92	11,768		0.5	66.5	300	22	200					0.838	59	NG	
		62	42		375	375		2.1	2.1	150	90	135	10.06	5.00	6.53	-2.54	0.643	11	Adequate	
3d	3e	42	44		279	12,422		1.6	70.2	300	67	200	5.00	5.15	-2.54	-3.37	0.838	59	NG	
		30F	32		262	262		1.5	1.5	150	63	80	48.56				0.835	15	Adequate	
		32	37A		500	762		2.8	4.3	150	120	60					0.964	17	Adequate	
		37B	37A		33	33		0.2	0.2	150	8	80					0.835	15	Adequate	
		37A	37		29	825		0.2	4.7	150	7	80					0.835	15	Adequate	
		6B	40		237	237		1.3	1.3	150	57	80		12.08		9.60	0.835	15	Adequate	
		40A	40		50	50		0.3	0.3	150	12	80		12.08		9.60	0.835	15	Adequate	
		40	38A		133	421		0.8	2.4	150	32	60	12.08		9.60		0.964	17	Adequate	
		38B	38A		50	50		0.3	0.3	150	12	80					0.835	15	Adequate	
		38A	37		87	558		0.5	3.2	150	21	60					0.964	17	Adequate	
		37	44		179	1,562		1.0	8.8	150	43	60		5.15		-3.37	0.964	17	Adequate	
3e	3f	44	63		146	14,130		0.8	79.8	300	35	200	5.15	4.96	-3.37	-3.83	0.838	59	NG	
		64D	63		458	458		2.6	2.6	150	110	80		4.96		-3.83	0.835	15	Adequate	
3f	3g	63	IV-68		112	14,701		0.6	83.0	300	27	200	4.96	5.14	-3.83	-4.16	0.838	59	NG	
		66	65		342	342		1.9	1.9	150	82	20	27.97		24.00		1.670	30	Adequate	
		65	60		158	500		0.9	2.8	150	38	60		5.14		-4.16	0.964	17	Adequate	
		60	IV-68		204	704		1.2	4.0	225	49	200					0.692	28	Adequate	Discharging into Zone IV
Zone IV																				Sewers in Zone IV were installed in 1965-67
3g	3h	68	53	15,405	31	15,437	87.0	0.2	87.2	300	22	200		5.96		2.09	0.838	59	NG	Receiving from Zone III
		83D	83A		52	52		0.3	0.3	150	37	15	11.55	10.56	8.08	6.55	1.928	34	Adequate	
		83B	83A		33	33		0.2	0.2	150	23	80		10.56		6.55	0.835	15	Adequate	
		83A	56		96	181		0.5	1.0	150	68	60	10.56		6.55		0.964	17	Adequate	
		56B	56		17	17		0.1	0.1	150	12	80					0.835	15	Adequate	

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (5/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
										Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Velocity (m/sec)	Flow Capacity (lps)		
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative				u/s	d/s	u/s	d/s				
		56	53		38	236		0.2	1.3	150	27	80		5.96		2.09	0.835	15	Adequate	
3h	3i	53	34F		40	15,712		0.2	88.7	300	28	200	5.96		2.09		0.838	59	NG	
		15B	1A		85	85		0.5	0.5	150	60	60	11.50		8.00		0.964	17	Adequate	
		8	1A		24	24		0.1	0.1	150	17	80	5.88		6.13		0.835	15	Adequate	
		1A	25		108	216		0.6	1.2	150	76	60		5.92		2.10	0.964	17	Adequate	
		23	25		34	34		0.2	0.2	150	24	80		5.92		2.10	0.835	15	Adequate	
		25	26		51	301		0.3	1.7	150	36	80	5.92	7.34	2.10	0.36	0.835	15	Adequate	
		36B	26		108	108		0.6	0.6	150	76	80	3.70	7.34	5.00	0.36	0.835	15	Adequate	
		26	28		31	440		0.2	2.5	225	22	135	7.34	8.60	0.36	-0.69	0.842	33	Adequate	
		28A	28		20	20		0.1	0.1	150	14	80	8.85	8.60	4.75	-0.69	0.835	15	Adequate	
		28	32		69	529		0.4	3.0	225	49	135	8.60		-0.69		0.842	33	Adequate	
		32A	32		17	17		0.1	0.1	150	12	80	8.35		2.25		0.835	15	Adequate	
		32	24A		64	610		0.4	3.4	225	45	135					0.842	33	Adequate	
		24E	24A		65	65		0.4	0.4	150	46	80	7.37		3.07		0.835	15	Adequate	
		24A	34E		59	734		0.3	4.1	225	42	135		4.41		5.63	0.842	33	Adequate	
		15A	17		51	51		0.3	0.3	150	36	60	8.85	1.10	4.75	5.53	0.964	17	Adequate	
		17A	17		27	27		0.2	0.2	150	19	60					0.964	17	Adequate	
		17	19		30	108		0.2	0.6	150	21	80					0.835	15	Adequate	
		20	19		23	23		0.1	0.1	150	16	60		1.10		5.53	0.964	17	Adequate	
		19	11		78	208		0.4	1.2	150	55	80	1.10		5.53		0.835	15	Adequate	
		78	74		122	122		0.7	0.7	150	86	30	35.60	22.32	32.64	18.50	1.364	24	Adequate	
		74M	74G		24	24		0.1	0.1	150	17	80		22.32		18.50	0.835	15	Adequate	
		74I	74G		14	14		0.1	0.1	150	10	80					0.835	15	Adequate	
		74G	74		52	91		0.3	0.5	150	37	80					0.835	15	Adequate	
		74	84		62	274		0.4	1.6	150	44	15	22.32	12.68	18.50		1.928	34	Adequate	
		84	70		72	347		0.4	2.0	150	51	40	12.68	11.38		6.48	1.181	21	Adequate	
		70I	70		99	99		0.6	0.6	150	70	15	34.22	11.38	27.00	6.48	1.928	34	Adequate	
		70	11		66	512		0.4	2.9	200	47	135	27.00	8.40	6.48	3.35	0.779	24	Adequate	
		11	34E		54	774		0.3	4.4	200	38	135	8.40	4.41	3.35	5.63	0.779	24	Adequate	
		34E	34A		35	1,544		0.2	8.7	200	25	135	4.41		5.63		0.779	24	Adequate	

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (6/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
		44D	44A		91	91		0.5	0.5	150	64	60	8.51		4.50		0.964	17	Adequate	
		44A	46		108	198		0.6	1.1	225	76	135		9.96		1.76	0.842	33	Adequate	
		35	47B		48	48		0.3	0.3	150	34	80	9.20		5.00		0.835	15	Adequate	
		47A	47B		35	35		0.2	0.2	150	25	60	10.30	9.22	6.25	2.98	0.964	17	Adequate	
		47B	46		48	132		0.3	0.7	150	34	80	9.22	9.96	2.98	1.76	0.835	15	Adequate	
		46	43		85	415		0.5	2.3	225	60	135	9.96		1.76		0.842	33	Adequate	
		36	40		45	45		0.3	0.3	150	32	60		7.75		2.29	0.964	17	Adequate	
		40A	40		28	28		0.2	0.2	150	20	80		7.75		2.29	0.835	15	Adequate	
		40	43		64	137		0.4	0.8	150	45	80	7.75		2.29		0.835	15	Adequate	
		43	48		55	607		0.3	3.4	225	39	135					0.842	33	Adequate	
		52B	51		89	89		0.5	0.5	150	63	40					1.181	21	Adequate	
		50	51		31	31		0.2	0.2	150	22	60	7.79		4.20		0.964	17	Adequate	
		51	48		42	163		0.2	0.9	150	30	80					0.835	15	Adequate	
		48	24B		52	822		0.3	4.6	225	37	135					0.842	33	Adequate	
		34D	24B		45	45		0.3	0.3	150	32	80	6.93		3.00		0.835	15	Adequate	
		24B	34A		25	893		0.1	5.0	225	18	135					0.842	33	Adequate	
		34A	34F		8	2,445		0.0	13.8	225	6	135					0.842	33	Adequate	
3i	4(PS3)	34F	PS-3		14	18,171		0.1	102.6	300	10	200					0.838	59	NG	
4(PS3)	5	PS-3	V-21			18,171			102.6	200	320	PM		7.43		2.43				Discharging into Zone V
	Zone V																			Sewers in Zone V were installed in 1965-67
5	5a	21	24	18,171	260	18,431	102.6	1.5	104.1	600	154	340	7.43	9.90	2.43	1.01	1.021	289	Adequate	Receiving from Zone IV
		28	31		132	132		0.7	0.7	150	78	80	38.07	14.40	33.50	5.50	0.835	15	Adequate	
		30	31		64	64		0.4	0.4	150	38	30	15.66	14.40	11.00	5.50	1.364	24	Adequate	
		31	24		47	243		0.3	1.4	150	28	80	14.40	9.90	5.50	1.01	0.835	15	Adequate	
5a	5b	24	36		142	18,816		0.8	106.3	600	84	340	9.90	7.60	1.01	0.73	1.021	289	Adequate	
		18	36		132	132		0.7	0.7	150	78	80	12.20	7.60	8.60	0.73	0.835	15	Adequate	
		36C	36B		30	30		0.2	0.2	150	18	80					0.835	15	Adequate	
		36D	36B		34	34		0.2	0.2	150	20	80					0.835	15	Adequate	
		36B	36		59	123		0.3	0.7	150	35	80		7.60		0.73	0.835	15	Adequate	

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (7/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
													Ground level (m)		Invert level (m)					
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	u/s	d/s	u/s	d/s	Velocity (m/sec)	Flow Capacity (lps)		
5b	8	36	20		54	19,125		0.3	108.0	600	32	340	7.60		0.73		1.021	289	Adequate	
		1	2		132	132		0.7	0.7	150	78	80	27.45	13.71	24.00	8.40	0.835	15	Adequate	
7	7a	2	7	1,894	287	2,312	10.7	1.6	13.1	225	170	135	13.71	9.74	8.40	3.06	0.842	33	Adequate	Receivin from Zone VIII, (Sec. I)
		8D	9		169	169		1.0	1.0	150	100	15	45.50	14.40	40.50	10.00	1.928	34	Adequate	
		9	7		253	422		1.4	2.4	150	150	135	14.40	9.74	10.00	3.06	0.643	11	Adequate	
7a	8	7	20		169	2,903		1.0	16.4	225	100	135	9.74		3.06		0.842	33	Adequate	
8	8a	20	20A		84	22,113		0.5	124.9	600	50	340					1.021	289	Adequate	
		20D	20A		110	110		0.6	0.6	150	65	80					0.835	15	Adequate	
		20E	20A		34	34		0.2	0.2	150	20	80					0.835	15	Adequate	
8a	8b	20A	37		51	22,307		0.3	126.0	600	30	340		8.84		1.93	1.021	289	Adequate	
		37A	37		42	42		0.2	0.2	150	25	80		8.84		1.93	0.835	15	Adequate	
8b	8c	37	51		98	22,447		0.6	126.8	600	58	340	8.84	10.12	1.93	2.44	1.021	289	Adequate	
		54	51		88	88		0.5	0.5	150	52	135		10.12		2.44	0.643	11	Adequate	
8c	8d	51	66		74	22,609		0.4	127.7	600	44	340	10.12	9.44	2.44	0.76	1.021	289	Adequate	
		58	54A		127	127		0.7	0.7	225	75	135	7.16		-0.17		0.842	33	Adequate	
		62	54A		59	59		0.3	0.3	150	35	80	6.68		2.25		0.835	15	Adequate	
		54A	60		71	257		0.4	1.5	150	42	80					0.835	15	Adequate	
		60A	60		51	51		0.3	0.3	150	30	80		10.35		1.39	0.835	15	Adequate	
		60	66		64	371		0.4	2.1	150	38	80		9.44		0.76	0.835	15	Adequate	
8d	9	66	61		98	23,079		0.6	130.4	600	58	340	9.44		0.76		1.021	289	Adequate	
		64C	61		160	160		0.9	0.9	225	95	135	6.66		2.86		0.842	33	Adequate	
		81B	66		388	388		2.2	2.2	225	230	135	10.56		7.06		0.842	33	Adequate	
		52	66		57	57		0.3	0.3	150	34	80					0.835	15	Adequate	
		66	67		47	493		0.3	2.8	225	28	135					0.842	33	Adequate	
		68A	67		64	64		0.4	0.4	150	38	80					0.835	15	Adequate	
		67	61		71	628		0.4	3.5	225	42	135					0.842	33	Adequate	
9	9a	61	70		152	24,019		0.9	135.7	700	90	420					1.018	392	Adequate	
		72	70		267	267		1.5	1.5	225	158	135	5.46		4.80		0.842	33	Adequate	
		78	77		172	172		1.0	1.0	150	102	80	13.64	10.78	8.00	4.16	0.835	15	Adequate	

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (8/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
		76C	77		135	135		0.8	0.8	150	80	80		10.78		4.16	0.835	15	Adequate	
		77	79		135	442		0.8	2.5	225	80	135	10.78	8.62	4.16	2.29	0.842	33	Adequate	
		81	79		41	41		0.2	0.2	150	24	80	9.02	8.62	4.32	2.29	0.835	15	Adequate	
		80F	80		71	71		0.4	0.4	150	42	80		8.50		4.95	0.835	15	Adequate	
		80	80A		74	145		0.4	0.8	150	44	80	8.50		4.95		0.835	15	Adequate	
		80D	80A		101	101		0.6	0.6	150	60	80					0.835	15	Adequate	
		80A	79		68	314		0.4	1.8	150	40	80		8.62		2.29	0.835	15	Adequate	
		79	82A		118	915		0.7	5.2	225	70	135	8.62		2.29		0.842	33	Adequate	
		82B	82A		20	20		0.1	0.1	150	12	80					0.835	15	Adequate	
		82A	82		37	973		0.2	5.5	225	22	135					0.842	33	Adequate	
		82C	82		37	37		0.2	0.2	150	22	80	8.79		4.25		0.835	15	Adequate	
		83	82		118	118		0.7	0.7	150	70	80	9.13		9.03		0.835	15	Adequate	
		82	85		138	1,266		0.8	7.2	225	82	135					0.842	33	Adequate	
		88	85		47	47		0.3	0.3	150	28	80	8.24		1.65		0.835	15	Adequate	
		86	85		91	91		0.5	0.5	150	54	60	8.84		4.50		0.964	17	Adequate	
		85	70		128	1,533		0.7	8.7	225	76	135					0.842	33	Adequate	
9a	9b	70	90		206	26,025		1.2	147.0	700	122	420					1.018	392	Adequate	
		91E	91		162	162		0.9	0.9	150	96	80		12.85		7.80	0.835	15	Adequate	
		91-10	91-70		91	91		0.5	0.5	150	54	80					0.835	15	Adequate	
		91-6	91-70		101	101		0.6	0.6	150	60	15					1.928	34	Adequate	
		91-70	91		64	257		0.4	1.5	150	38	80					0.835	15	Adequate	
		91	92		37	456		0.2	2.6	150	22	80		12.87		5.45	0.835	15	Adequate	
		116	115		81	81		0.5	0.5	150	48	80	14.00		10.00		0.835	15	Adequate	
		115	92		71	152		0.4	0.9	200	42	80		12.87		5.45	1.012	32	Adequate	
		92	94		155	763		0.9	4.3	225	92	135	12.87		5.45		0.842	33	Adequate	
		96	94		44	44		0.2	0.2	150	26	80					0.835	15	Adequate	
		95	94		41	41		0.2	0.2	150	24	80	9.71		5.18		0.835	15	Adequate	
		94	97		132	979		0.7	5.5	225	78	135		8.98		6.15	0.842	33	Adequate	

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (9/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
		99	97		84	84		0.5	0.5	150	50	80	8.50	8.98	4.50	6.15	0.835	15	Adequate	
		98	97		34	34		0.2	0.2	150	20	80	9.97	8.98	4.42	6.15	0.835	15	Adequate	
		97	100		138	1,236		0.8	7.0	225	82	135					0.842	33	Adequate	
		127	100		54	54		0.3	0.3	150	32	80					0.835	15	Adequate	
		101D	100		152	152		0.9	0.9	150	90	80	9.58		6.80		0.835	15	Adequate	
		100	90		54	1,496		0.3	8.5	225	32	135					0.842	33	Adequate	
9b	9c	90	102		125	27,646		0.7	156.2	700	74	420					1.018	392	Adequate	
		106B	107		172	172		1.0	1.0	150	102	60	6.63		2.50		0.964	17	Adequate	
		107	102		280	453		1.6	2.6	225	166	135					0.842	33	Adequate	
		113K1	113		351	351		2.0	2.0	150	208	80	65.29		61.59		0.835	15	Adequate	
		112	113		47	47		0.3	0.3	150	28	80					0.835	15	Adequate	
		113-7	113-2		220	220		1.2	1.2	150	130	80		19.02		16.03	0.835	15	Adequate	
		113-2B	113-2		108	108		0.6	0.6	150	64	80		19.02		16.03	0.835	15	Adequate	
		113-2	113		71	398		0.4	2.3	150	42	80	19.02		16.03		0.835	15	Adequate	
		113	114		81	878		0.5	5.0	225	48	135		16.11		9.64	0.842	33	Adequate	
		117H	117		388	388		2.2	2.2	150	230	80		16.11		9.64	0.835	15	Adequate	
		117	114		162	550		0.9	3.1	150	96	80					0.835	15	Adequate	
		114	115		186	1,614		1.0	9.1	225	110	135	16.11		9.64		0.842	33	Adequate	
		120	115		71	71		0.4	0.4	150	42	80	10.06		5.50		0.835	15	Adequate	
		121	115		155	155		0.9	0.9	150	92	80					0.835	15	Adequate	
		115	123A		74	1,915		0.4	10.8	225	44	135					0.842	33	Adequate	
		123B	123A		30	30		0.2	0.2	150	18	80					0.835	15	Adequate	
		123A	123		47	1,992		0.3	11.3	225	28	135					0.842	33	Adequate	
		124	123		68	68		0.4	0.4	150	40	80					0.835	15	Adequate	
		123	102		196	2,256		1.1	12.7	225	116	135					0.842	33	Adequate	
9c	9d	102	28		47	30,402		0.3	171.7	700	28	420		9.80		6.07	1.018	392	Adequate	
		135	135B		68	68		0.4	0.4	150	40	80					0.835	15	Adequate	
		135A	135B		47	47		0.3	0.3	150	28	80					0.835	15	Adequate	
		135B	28		84	199		0.5	1.1	150	50	80		9.80		6.07	0.835	15	Adequate	

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (10/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
9d	9e	28	139		115	30,716		0.6	173.5	700	68	420	9.80		6.07		1.018	392	Adequate	
		139B	139		20	20		0.1	0.1	150	12	80					0.835	15	Adequate	
		142	144		182	182		1.0	1.0	150	108	60	10.12		5.12		0.964	17	Adequate	
		145	144		74	74		0.4	0.4	150	44	60	8.58		3.58		0.964	17	Adequate	
		144	139		162	419		0.9	2.4	150	96	80					0.835	15	Adequate	
9e	9f	139	147A		68	31,223		0.4	176.4	700	40	420		10.11		6.95	1.018	392	Adequate	
		147B	147A		24	24		0.1	0.1	150	14	80		10.11		6.95	0.835	15	Adequate	
		147C	147A		51	51		0.3	0.3	150	30	80		10.11		6.95	0.835	15	Adequate	
9f	9g	147A	147		68	31,364		0.4	177.2	700	40	420					1.018	392	Adequate	
		164A	156		78	78		0.4	0.4	150	46	80	7.21		0.89		0.835	15	Adequate	
		167	156		44	44		0.2	0.2	150	26	80					0.835	15	Adequate	
		156	161		277	398		1.6	2.3	200	164	135					0.779	24	Adequate	
		131	161		226	226		1.3	1.3	150	134	80					0.835	15	Adequate	
		161	170		71	696		0.4	3.9	200	42	135					0.779	24	Adequate	
		170A	170		44	44		0.2	0.2	150	26	80					0.835	15	Adequate	
		170	170B		78	817		0.4	4.6	200	46	135					0.779	24	Adequate	
		170E	170B		101	101		0.6	0.6	150	60	80					0.835	15	Adequate	
		170B	147		61	979		0.3	5.5	200	36	135					0.779	24	Adequate	
		148	150		135	135		0.8	0.8	150	80	100	23.03		13.00		0.747	13	Adequate	
		151	150		118	118		0.7	0.7	225	70	190	10.91		3.09		0.710	28	Adequate	
		150	152		132	385		0.7	2.2	200	78	135					0.779	24	Adequate	
		153	152		57	57		0.3	0.3	150	34	100	8.80		2.85		0.747	13	Adequate	
		152	147		206	648		1.2	3.7	200	122	135					0.779	24	Adequate	
9g	9h	147	172		182	33,174		1.0	187.4	700	108	420					1.018	392	Adequate	
		177	179		213	213		1.2	1.2	150	126	80	8.97		3.00		0.835	15	Adequate	
		179	180		81	294		0.5	1.7	225	48	135	8.97		3.00		0.842	33	Adequate	
		166	168A		111	111		0.6	0.6	150	66	80	7.28		3.28		0.835	15	Adequate	
		168A	180		223	334		1.3	1.9	225	132	135		9.86		2.09	0.842	33	Adequate	

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (11/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
		182	180		233	233		1.3	1.3	225	138	135	9.94	9.86	6.50	2.09	0.842	33	Adequate	
		180	191		105	966		0.6	5.5	225	62	135	9.86	8.28	2.09	4.60	0.842	33	Adequate	
		190	191		68	68		0.4	0.4	150	40	80	9.85	8.28	8.50	4.60	0.835	15	Adequate	
		191	172		169	1,202		1.0	6.8	225	100	135	8.28		4.60		0.842	33	Adequate	
		173	174		47	47		0.3	0.3	150	28	80	8.78	9.50	3.53	0.98	0.835	15	Adequate	
		175	174		71	71		0.4	0.4	150	42	80	8.06	9.50	3.06	0.98	0.835	15	Adequate	
		174	172		196	314		1.1	1.8	225	116	135	9.50		0.98		0.842	33	Adequate	
9h	9i	172	194		88	34,779		0.5	196.5	700	52	420					1.018	392	Adequate	
		194A	194		17	17		0.1	0.1	150	10	80					0.835	15	Adequate	
		194B	194		30	30		0.2	0.2	150	18	80					0.835	15	Adequate	
9i	9j	194	201		287	35,113		1.6	198.3	700	170	420		9.97		9.97	1.018	392	Adequate	
		211C	214		476	476		2.7	2.7	150	282	80		12.49		5.73	0.835	15	Adequate	
		214	219		122	598		0.7	3.4	225	72	135	12.49	9.97	5.73	2.21	0.842	33	Adequate	
		217	219		199	199		1.1	1.1	150	118	80	10.34	9.97	6.29	2.21	0.835	15	Adequate	
		219	205A		34	831		0.2	4.7	225	20	135	9.97		2.21		0.842	33	Adequate	
		208C	205A		301	301		1.7	1.7	150	178	80					0.835	15	Adequate	
		205A	205		54	1,185		0.3	6.7	225	32	135					0.842	33	Adequate	
		205D	205		88	88		0.5	0.5	150	52	80					0.835	15	Adequate	
		205	200B		88	1,361		0.5	7.7	225	52	135		9.54		1.07	0.842	33	Adequate	
		200D	200B		95	95		0.5	0.5	150	56	80		9.54		1.07	0.835	15	Adequate	
		206	200B		111	111		0.6	0.6	150	66	80		9.54		1.07	0.835	15	Adequate	
		200B	201		91	1,658		0.5	9.4	225	54	135	9.54	9.97	1.07	9.97	0.842	33	Adequate	
9j	11(PS5)	201	PS-5		76	36,847		0.4	208.1	700	45	420					1.018	392	Adequate	Receiving from Zone VI
11(PS5)	13	PS-5	VII-221	1,383		38,230	7.8		216.0	400	310	PM								Discharging into Zone VII
Zone VI																				Sewers in Zone VI were installed in 1973
10	10a	35	39		177	177		1.0	1.0	225	136	190	9.57	9.56	6.57	4.00	0.710	28	Adequate	
10a	10b	39	31		77	253		0.4	1.4	225	59	190	9.56	9.45	4.00	2.49	0.710	28	Adequate	
10b	10c	31	6		222	475		1.3	2.7	225	171	135	9.45	10.57	2.49	-1.57	0.842	33	Adequate	
		12	8		103	103		0.6	0.6	150	79	100	9.60	9.08	4.93	2.09	0.747	13	Adequate	

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (12/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
										Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Velocity (m/sec)	Flow Capacity (lps)		
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative				u/s	d/s	u/s	d/s				
		9	8		26	26		0.1	0.1	150	20	80		9.08		2.09	0.835	15	Adequate	
		8	6		65	193		0.4	1.1	225	50	135	9.08	10.57	2.09	-1.57	0.842	33	Adequate	
10c	10d	6	4		75	744		0.4	4.2	225	58	135	10.57		-1.57		0.842	33	Adequate	
		4A	4		22	22		0.1	0.1	150	17	80					0.835	15	Adequate	
10d	10e	4	2A		58	825		0.3	4.7	225	45	135		8.18		-5.00	0.842	33	Adequate	
		2D	2C		26	26		0.1	0.1	150	20	80					0.835	15	Adequate	
		2F	2C		39	39		0.2	0.2	150	30	80					0.835	15	Adequate	
		2C	2A		9	74		0.1	0.4	150	7	80		8.18		-5.00	0.835	15	Adequate	
		42A	42B		38	38		0.2	0.2	150	29	60	11.12	13.37	5.00	1.57	0.964	17	Adequate	
		42B	43		151	188		0.9	1.1	150	116	80	13.37	11.02	1.57	-0.61	0.835	15	Adequate	
		44	43		25	25		0.1	0.1	150	19	80					0.835	15	Adequate	
		43	2A		171	384		1.0	2.2	225	132	135		8.18		-5.00	0.842	33	Adequate	
10e	11	2A	PS-5		100	1,383		0.6	7.8	225	77	135	8.18		-5.00		0.842	33	Adequate	Discharging into Zone V
Zone VII																				Sewers in Zone VII were installed in 1965-67
13	13a	221	222	41,085	199	41,285	232.1	1.1	233.2	600	80	500	18.69		8.90		0.842	238	Adequate	Receiving from Zone V & VIII (Sec. II)
		222D	222B		60	60		0.3	0.3	150	24	80					0.835	15	Adequate	
		222C	222B		60	60		0.3	0.3	150	24	80					0.835	15	Adequate	
		222B	222		129	249		0.7	1.4	150	52	80					0.835	15	Adequate	
		222F	222		100	100		0.6	0.6	150	40	80					0.835	15	Adequate	
13a	13b	222	223B		124	41,758		0.7	235.9	600	50	500		8.03		0.19	0.842	238	Adequate	
		223H	223B		259	259		1.5	1.5	150	104	80		8.03		0.19	0.835	15	Adequate	
13b	13c	223B	224A		324	42,340		1.8	239.2	600	130	500	8.03		0.19		0.842	238	NG	
		224D	224A		100	100		0.6	0.6	150	40	80					0.835	15	Adequate	
13c	21	224A	225		274	42,714		1.5	241.3	600	110	500					0.842	238	NG	
		225D	225		249	249		1.4	1.4	150	100	80					0.835	15	Adequate	
21	21a	225	225A	2,807	110	45,879	15.9	0.6	259.2	600	44	500					0.842	238	NG	Receiving from Zone X (Sec. II)
		225E	225A		299	299		1.7	1.7	150	120	80					0.835	15	Adequate	
21a	26	225A	232		1,593	47,771		9.0	269.9	600	640	500		4.15		6.46	0.842	238	NG	
26	27	232	232C	4,242	189	52,202	24.0	1.1	294.9	600	76	500	4.15		6.46		0.842	238	NG	Receiving from Zone XI
27	29(STP)	232C	STP	5,026	174	57,402	28.4	1.0	324.3	600	70	500	4.15	3.73	6.46	7.06	0.842	238	NG	Receiving from Zone IX

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (13/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
													Ground level (m)		Invert level (m)					
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	u/s	d/s	u/s	d/s	Velocity (m/sec)	Flow Capacity (lps)		
Zone VIII (Sector I, discharging to Zone V)																				Sewers in Zone VIII were installed in 1976-77
		2	69		53	53		0.3	0.3	150	56	80	176.14	171.38	171.40	164.38	0.835	15	Adequate	
		49	69		27	27		0.2	0.2	150	28	80	176.77	171.38	172.00	164.38	0.835	15	Adequate	
		69	5E		105	185		0.6	1.0	150	110	30	171.38	149.30	164.38	137.00	1.364	24	Adequate	
		5B	5E		38	38		0.2	0.2	150	40	80	160.29	149.30	138.85	137.00	0.835	15	Adequate	
		5E	63		46	269		0.3	1.5	150	48	80	149.30	134.27	137.00	127.98	0.835	15	Adequate	
		63E	63		149	149		0.8	0.8	150	156	30		134.27		127.98	1.364	24	Adequate	
6	6a	63	65		91	509		0.5	2.9	225	96	23	134.27	119.87	127.98	116.00	2.041	81	Adequate	
		82	86A		147	147		0.8	0.8	150	154	80	192.61	151.20	187.14	170.80	0.835	15	Adequate	
		86G	86A		38	38		0.2	0.2	150	40	80		181.02		170.80	0.835	15	Adequate	
		86A	86H		42	227		0.2	1.3	150	44	80	181.02	165.34	170.80	157.37	0.835	15	Adequate	
		86N	86H		162	162		0.9	0.9	150	170	80	197.98	165.34	185.85	157.37	0.835	15	Adequate	
		86E	86H		84	84		0.5	0.5	150	88	80	180.50	165.34	163.00	157.37	0.835	15	Adequate	
		86H	65		168	640		0.9	3.6	225	176	30	165.34	119.87	157.37	116.00	1.787	71	Adequate	
6a	6b	65	67A		162	1,311		0.9	7.4	225	170	30	119.87	97.06	116.00	91.87	1.787	71	Adequate	
		71	69		95	95		0.5	0.5	150	100	30	124.29	97.06	120.00	91.87	1.364	24	Adequate	
		69	67A		86	181		0.5	1.0	225	90	135	124.29	97.06	120.00	91.87	0.842	33	Adequate	
6b	7	67A	V-2		402	1,894		2.3	10.7	225	422	30	97.06	13.71	91.87	8.40	1.787	71	Adequate	Discharging into Zone V
Zone VIII (Sector II, discharging to Zone VII)																				
12	12a	2	4		74	74		0.4	0.4	150	78	80	194.20	190.11	190.00	185.98	0.835	15	Adequate	
12a	12b	4	7		112	187		0.6	1.1	225	118	60	190.11	184.76	185.98	175.38	1.264	50	Adequate	
12b	12c	7	8		40	227		0.2	1.3	225	42	135	185.76		175.38		0.842	33	Adequate	
12c	12d	8	6		272	499		1.5	2.8	225	286	60		157.98		151.78	1.264	50	Adequate	
		5A	6		61	61		0.3	0.3	150	64	60	161.20	157.98		151.78	0.964	17	Adequate	
12d	12e	6	26		122	682		0.7	3.9	150	128	80	157.98		151.78		0.835	15	Adequate	
		21A	26		137	137		0.8	0.8	150	144	80	148.06		143.83		0.835	15	Adequate	
12e	12f	26	38		208	1,027		1.2	5.8	225	218	30					1.787	71	Adequate	
		38Z	38R		84	84		0.5	0.5	150	88	80					0.835	15	Adequate	

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (14/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
		38U	38R		42	42		0.2	0.2	150	44	80					0.835	15	Adequate	
		38R	38H		42	168		0.2	0.9	150	44	80					0.835	15	Adequate	
		38J	38H		51	51		0.3	0.3	150	54	80					0.835	15	Adequate	
		38H	38E		46	265		0.3	1.5	150	48	80					0.835	15	Adequate	
		38P	38E		133	133		0.8	0.8	150	140	80					0.835	15	Adequate	
		38E	38		133	531		0.8	3.0	150	140	80					0.835	15	Adequate	
12f	12g	38	42B		269	1,827		1.5	10.3	225	282	80					1.094	44	Adequate	
		42P	42F		135	135		0.8	0.8	150	142	80					0.835	15	Adequate	
		42J	42G		67	67		0.4	0.4	150	70	80					0.835	15	Adequate	
		42R	42G		34	34		0.2	0.2	150	36	80					0.835	15	Adequate	
		42G	42F		29	130		0.2	0.7	150	30	80					0.835	15	Adequate	
		42F	42B		116	381		0.7	2.2	150	122	80					0.835	15	Adequate	
12g	12h	42B	91B		339	2,547		1.9	14.4	225	356	30					1.787	71	Adequate	
		91H	91B		86	86		0.5	0.5	150	90	80					0.835	15	Adequate	
12h	13	91B	VII-221		223	2,855		1.3	16.1	225	234	30		8.79		4.58	1.787	71	Adequate	Discharging into Zone VII
Zone IX																				Sewers in Zone IX were installed in 1980
		1B	4		245	245		1.4	1.4	150	132	80					0.835	15	Adequate	
		4	6		111	356		0.6	2.0	225	60	135					0.842	33	Adequate	
		6D	6		195	195		1.1	1.1	225	105	135					0.842	33	Adequate	
		6	23		893	1,444		5.0	8.2	300	482	135					1.020	72	Adequate	
		23H	23		337	337		1.9	1.9	150	182	80					0.835	15	Adequate	
		23	25		93	1,874		0.5	10.6	300	50	135					1.020	72	Adequate	
		35A	25		871	871		4.9	4.9	300	470	135					1.020	72	Adequate	
		25	PS-9		28	2,772		0.2	15.7	300	15	135					1.020	72	Adequate	
24(PS9)	25	PS-9	47A			2,772			15.7	200	175	PM								
25	25a	47A	55		602	3,375		3.4	19.1	350	325	135					1.131	109	Adequate	
		55-1	55		676	676		3.8	3.8	225	365	135					0.842	33	Adequate	
25a	25b	55	61		371	4,422		2.1	25.0	350	200	135					1.131	109	Adequate	
		61I	61		534	534		3.0	3.0	150	288	80					0.835	15	Adequate	
25b	27	61	VII-232C		70	5,026		0.4	28.4	350	38	135					1.131	109	Adequate	Discharging into Zone VII

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (15/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
		Zone X (Sector I, discharging to Zone I)																		Sewers in Zone X were installed in 1984
		1G	27		0	0		0.0	0.0	150	910	27					1.437	25	Adequate	
		27	I-3		5	5		0.0	0.0	150	10	80					0.835	15	Adequate	Discharging into Zone I
		Zone X (Sector II, discharging to Zone VII)																		
14	14a	12D	13		54	54		0.3	0.3	150	100	80		50.25		49.25	0.835	15	Adequate	
		13B	13		29	29		0.2	0.2	150	54	80		50.25		49.25	0.835	15	Adequate	
14a	14b	13	25		60	143		0.3	0.8	150	110	80	50.25	31.86	49.25	30.86	0.835	15	Adequate	
		26H	26		87	87		0.5	0.5	150	160	80					0.835	15	Adequate	
		26I	26		22	22		0.1	0.1	150	40	80					0.835	15	Adequate	
		26	25		21	129		0.1	0.7	150	38	80		31.86		30.86	0.835	15	Adequate	
		19C	24		70	70		0.4	0.4	150	130	80		38.57		37.57	0.835	15	Adequate	
		22B	24		73	73		0.4	0.4	150	134	80		38.57		37.57	0.835	15	Adequate	
		24	25		31	174		0.2	1.0	150	58	80	38.57	31.86	37.57	30.86	0.835	15	Adequate	
14b	16	25	11		56	503		0.3	2.8	150	104	80	31.86	19.83	30.86	18.83	0.835	15	Adequate	
15	16	1	11		127	127		0.7	0.7	150	234	80	47.33	19.83	46.25	18.83	0.835	15	Adequate	
16	18	11	40		185	815		1.0	4.6	150	342	80	19.83		18.83		0.835	15	Adequate	
		40G	40		50	50		0.3	0.3	150	92	80	5.64				0.835	15	Adequate	
		41-6E	41H		109	109		0.6	0.6	150	202	80					0.835	15	Adequate	
		41A	41D		31	31		0.2	0.2	150	58	80					0.835	15	Adequate	
		41D-2	41D		17	17		0.1	0.1	150	32	80					0.835	15	Adequate	
		41D	41E		8	57		0.0	0.3	150	15	80					0.835	15	Adequate	
		41E-4	41E		38	38		0.2	0.2	150	70	80					0.835	15	Adequate	
		41E	41H		33	127		0.2	0.7	150	60	80					0.835	15	Adequate	
		41H	44		87	323		0.5	1.8	150	160	80					0.835	15	Adequate	
		44B	44		23	23		0.1	0.1	150	42	80					0.835	15	Adequate	
		44	45		12	358		0.1	2.0	150	22	80					0.835	15	Adequate	
		45B	45		12	12		0.1	0.1	150	22	80					0.835	15	Adequate	
		45	48		27	397		0.2	2.2	150	50	80		3.31		2.31	0.835	15	Adequate	

Table M35.2.1 Flow Calculation Sheet for Branch Sewers, Panaji City (Year 2001) (16/16)

Node 1		Node 2		Population			Peak flow (lps)			Existing sewer									Capacity Adequacy	Remarks
From	To	From	To	From Other Zone	Increment	Cumulative	From Other Zone	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
		48B	48		18	18		0.1	0.1	150	34	80		3.31		2.31	0.835	15	Adequate	
		48	51		27	443		0.2	2.5	150	50	80	3.31	2.85	2.31	1.31	0.835	15	Adequate	
17	17a	52	51		107	107		0.6	0.6	150	198	80	4.39	2.85	3.39	1.31	0.835	15	Adequate	
17a	18	51	40		167	717		0.9	4.0	150	308	80	2.85		1.31		0.835	15	Adequate	
18	18a	40	91		39	1,620		0.2	9.2	150	72	80					0.835	15	Adequate	
		100	90		267	267		1.5	1.5	150	492	80	7.09	2.24			0.835	15	Adequate	
		72	90		260	260		1.5	1.5	150	480	80	6.10	2.24			0.835	15	Adequate	
		90	91		29	556		0.2	3.1	150	54	80	2.24				0.835	15	Adequate	
18a	19(PS10)	91	PS-10		22	2,198		0.1	12.4	150	40	80		2.14			0.835	15	Adequate	
19(PS10)	20	PS-10	100			2,198			12.4	150	532	PM	2.14							
		93	100		111	111		0.6	0.6	150	204	80	30.04	7.09	29.04		0.835	15	Adequate	
20	21	100	VII-225		498	2,807		2.8	15.9	225	920	135					0.842	33	Adequate	Discharging into Zone VII
Zone XI																				Sewers in Zone XI were installed in 1984
23	26	PS-11	VII-232			4,242			24.0	200	180	PM								Discharging into Zone VII
Zone XII																				Sewers in Zone XII were installed in 1995
		1	3		139	139		0.8	0.8	150	250	80					0.835	15	Adequate	
		2	3		11	11		0.1	0.1	150	20	80					0.835	15	Adequate	
		3	6		28	178		0.2	1.0	150	50	80					0.835	15	Adequate	
		4	6		161	161		0.9	0.9	150	290	80					0.835	15	Adequate	
		5	6		172	172		1.0	1.0	150	310	80					0.835	15	Adequate	
		6	10		24	536		0.1	3.0	150	44	80					0.835	15	Adequate	
		7	9		111	111		0.6	0.6	150	200	80					0.835	15	Adequate	
		8	9		67	67		0.4	0.4	150	120	80					0.835	15	Adequate	
		9	10		80	258		0.5	1.5	150	144	80					0.835	15	Adequate	
		10	STP		245	1,038		1.4	5.9	150	440	80					0.835	15	Adequate	
		11	PS-12		178	178		1.0	1.0	150	320	80					0.835	15	Adequate	
		12	PS-12		167	167		0.9	0.9	150	300	80					0.835	15	Adequate	
28(PS12)	29(STP)	PS-12	STP			345			1.9	150	360	PM								

Source (1): Diameter, length, gradient of pipes: Sewerage Scheme to Panaji, Govt. of Goa (zone-wise drawing)

Source (2): Zone-wise wastewater flow: Annexture J, Project Report on Envuronmental Upgradation of Panaji City Phase I

(yellow) Diameter and slope of sewers are assumed based on upstream and downstream sewers

Node 1 cordinated with Figure 3.2.1

Node 2 cordinated with sewerage zone map

"PM": Pressure Main

Peak factor : 2.25

Manning's n: 0.015

Appendix M53.3 Sewerage Zone and Diameter wise Sewer Length, Panaji City

Table M3.120 Sewerage Zone and Diameter wise Sewer Length, Panaji City

(meters)

	Branch Sewer						Main and Sub Main Sewer										Total
													Pressure Main				
	150mm	200mm	225mm	250mm	300mm	Sub Total	150mm	225mm	300mm	350mm	600mm	700mm	150mm	200mm	400mm	Sub Total	
Zone I	1,222	33	429	0	0	1,684	0	0	0	0	0	0	580	0	0	580	2,264
Zone II	1,499	0	590	0	0	2,089	0	0	0	0	0	0	210	0	0	210	2,299
Zone III	1,264	0	125	0	0	1,389	0	0	293	0	0	0	0	0	0	293	1,682
Zone IV	1,391	110	394	0	0	1,895	0	0	60	0	0	0	0	320	0	380	2,275
Zone V	5,142	530	2,650	0	0	8,322	0	270	0	0	510	837	0	0	310	1,927	10,249
Zone VI	337	0	182	0	0	519	0	546	0	0	0	0	0	0	0	546	1,065
Zone VII	504	0	0	0	0	504	0	0	0	0	1,200	0	0	0	0	1,200	1,704
Zone VIII	2,290	0	266	0	0	2,556	206	2,224	0	0	0	0	0	0	0	2,430	4,986
Zone IX	602	0	530	0	1,017	2,149	0	0	0	563	0	0	0	175	0	738	2,887
Zone X	3,673	0	0	0	0	3,673	1,508	920	0	0	0	0	532	0	0	2,960	6,633
Zone XI	0	0	0	0	0	0	0	0	0	0	0	0	0	180	0	180	180
Zone XII	2,488	0	0	0	0	2,488	0	0	0	0	0	0	360	0	0	360	2,848
Total	20,412	673	5,166	0	1,017	27,268	1,714	3,960	353	563	1,710	837	1,682	675	310	11,804	39,072

Note: Lengths were measured on sewerage zone map

M35.4 List of Existing STP Facilities, Panaji City

Table M35.4.1 List of Existing STP Facilities, Panaji City

Item	Dimension
1 General Condition	
Name of STP	Panaji Sewage Treatment Plant
Location	Tonca Caranzalem (by the side of the old STP) – Panaji
Commissioning year	April, 2005
Treatment capacity	12,500 m^3/day
2 Technical Details	
2.1 Intake Facility	
Inlet pipe diameter	600 mm (RC Pipe)
Size of chamber	15.00 m diameter
2.2 Raw Sewage Pump Facility	
Pump sum	15.00 m diameter × 4.50 m
Pump type	Non clog pumps horizontal model
Pump power and head	44.0 kw × 15.0 m × 2 units
	110.0 kw × 15.0 m × 2 units
2.3 Screening and Grit Chamber	
Screen type	Manual bar screen (3.00 m × 0.76 m × 0.65 m)
	Mechanical bar screen (3.00 m × 0.90 m × 0.65 m)
Size of grit chamber	5.40 m × 5.40 m × 1.05 m
2.4 SBR Tank (C-Tech) Basins	
Size	40.0 m × 22.0 m × 4.0 m × 2 basins
2.5 Chlorination System	
Type	Gas chlorine
Size	9.50 m × 2.60 m × 0.90 m × 9 passes
2.6 Sludge Dewatering	
Capacity	20.0 m^3/hr × 2 units (including 1 stand-by)

Source: Sector Status Study Water and Sanitation Goa, Draft Final Report (Appendix)

M35.5 Data for Flow Calculation Sheet of Sewers in Year 2001, Panaji City

Flow calculation sheets for Panaji City for evaluation on flow capacity in year 2001 have been prepared based on Project Report on Environmental Upgradation of Panaji City Phase I and Sewerage zone map. But these data are not sufficient for the required purposes as described in Table (1). Therefore, some presumptions and assumptions on missing data have been adopted to solve the purposes and are described in Table (2). See Appendix M35.1 and M35.2 for the flow calculation sheets prepared in this study.

(1) Data on Sewers Details, Controversial Points

Item	Description / Controversial Point	Source
(1) Service Area	Total service area: Described (about 400 ha) Sewerage zone wise service area: Not described Catchment area of each sewer: Not described	(1)
(2) Service area Population	Total population in service area: Described 58,785 persons in year 2001 96,112 persons in year 2031 (target year of current plan) Sewerage Zone wise population: Not described Contributory population of each sewer: Not described	(1)
(3) Wastewater Quantity	Calculated based of water demand categorized as below Domestic, major hotels, other hotels and non-domestic Converted to wastewater quantity using return factor (0.80). Added 20% infiltration Total wastewater quantity: Described and categorized Sewerage Zone wise quantity: Described but not categorized Location of hotels: Not described Flow of each sewer: Not described	(1)
(4) Sewer Alignment	Described on the map clearly except Zone XI	(2)
(5) Diameter and Slope of Sewers	Described on the map for some sewers	(2)
(6) Length of Sewers	Not described	None
(7) Ground Elevation	Described on the map for some nodes, but not clear	(2)
(8) Invert Elevation of Sewer	Described on the map for some sewer but not clear Some logical errors like down stream is higher than up stream	(2)
(9) Flow Velocity	Not described	None
(10) Flow Capacity	Not described	None

Source: (1) Project Report on Environmental Upgradation of Panaji City Phase I
(2) Sewerage Zone Maps for Zone I to Zone XII

(2) Countermeasure for Flow Calculation Sheet and Evaluation on Flow Capacity

Item	Description / Countermeasure
(1) Service Area	Zone wise service area: Measured on the sewerage zone map Sewer wise catchment area: Not measured Not used for calculating sewer wise wastewater quantity
(2) Service area Population	Sewer wise population: Not used for calculating sewer wise wastewater quantity
(3) Wastewater Quantity, Design flow	Sewer wise wastewater quantity: Distribute sewerage zone wise total wastewater including hotel, non-domestic and infiltrated water to each sewers based on its length assuming that wastewater generation is proportional to sewer length, as sewer wise catchment area and population is not available. Adopt peak factor of 2.25 depending on present population.
(4) Sewer Alignment	Adopt sewer alignment described on sewerage zone map.
(5) Diameter and Slope of Sewers	Adopt diameter and slope described on sewerage zone map when available. Presume diameter and slope based on adjacent sewers for other sewers, if appropriate. Assume diameter and slope 150 mm and 1/80 for other distal branch sewers.
(6) Length of Sewers	Measure alignment described on sewerage zone map
(7) Ground Elevation	Adopt ground elevation described on sewerage zone map when available.
(8) Invert Elevation of Sewer	Adopt invert elevation of sewer described on sewerage zone map when available.
(9) Flow Velocity	Calculate using Manning's formula with 0.015 as roughness coefficient
(10) Flow Capacity	Based on flow velocity and cross section area of sewer
(11) Evaluation of Flow Capacity	For present condition: When full flow capacity exceeds design flow, flow capacity is evaluated as adequate. Leave margin capacity out of consideration.

M35.6 Information of Pumping Stations, Panaji City

Detailed Information of Pumping Stations, Panaji City

The following Table A-1 to A-8 are shown based on the equipment list made by PWD, the result of interview with PWD Division Ⅲand the detail survey conducted by the Study Team.

1. Pumping Station - 1
1.1 List of Existing Equipment
(Table A-1)

Location		**Neuginagar**		
Number of Pump Units		3 units		
Dimension of No.1 Pump		100 mm diameter × 60.0 l/sec × 10.0 HP × 6.0 m(head)		
Dimension of No.2 Pump		100 mm diameter × 65.0 l/sec × 15.0 kw × 17.0 m(head)		
Dimension of No.3 Pump		100 mm diameter × 41.0 m3/hour × 3.0 HP × 4.8 m(head)		
Total Discharging Flow		Q= 0.1364 m3/sec		
Year of Manufacture		No.1	No.2	No.3
		1994	1994	1994
Company Name	Pump	KSB	Kirloskar	Kirloskar
	Motor	Kirloskar	Kirloskar	Kirloskar

Diameter of the Pumping Main Pipe : 150 mm

1.2 Comments about the Operational Conditions by the PWD Staff

- Pumps and motors are old and needs replacement
- Working satisfactorily

1.3 Comments about the Operational Conditions by the Study Team

- No.1 pump and motor should be replaced because of deteriorated and corrosive condition
- Piping in the dry well should also be replaced
- Electrical panel looks good condition

2. Pumping Station - 2
2.1 List of Existing Equipment
(Table A-2)

Location		**Bhandari Hospital, Mala**	
Number of Pump Units		2 units	
Dimension of No.1 Pump		100 mm diameter × 30.0 l/sec × 14.0 kw × 30.0m(head)	
Dimension of No.2 Pump		80 mm diameter × 41.0 m3/hour × 1.5 kw × 4.8 m(head)	
Total Discharging Flow		Q= 0.0414 m3/sec	
Year of Manufacture		No.1	No.2
		5 years	>15 years
Company Name	Pump	Kirloskar	Kirloskar
	Motor	Kirloskar	Kirloskar

Diameter of the Pumping Main Pipe : 150 mm

2.2 Comments about the Operational Conditions by the PWD Staff

- Working satisfactorily

2.3 Comments about the Operational Conditions by the Study Team

- No.3 pump and motor has already removed
- No.2 pump and motor should be replaced because of deteriorated
- Electrical panel looks good condition

3. Pumping Station - 3

3.1 List of Existing Equipment

(Table A-3)

Location		**Hotel Avanti**		
Number of Pump Units		3 units		
Dimension of No.1 Pump		150 mm diameter × 60.0 l/sec × 10.0 HP × 6.0 m(head)		
Dimension of No.2 Pump		100 mm diameter × 1,300 l/min × 5.5 kw × 25.0 m(head)		
Dimension of No.3 Pump		100 mm diameter × 2,770 l/min × 5.5 kw × 20.0 m(head)		
Total Discharging Flow		Q= 0.1278 m3/sec		
Year of Manufacture		No.1	No.2	No.3
		2years (pump), 5 (motor)	>15 years	>15 years
Company Name	Pump	Kirloskar	Jyoti	Jyoti
	Motor	Kirloskar	Kirloskar	Kirloskar

Diameter of the Pumping Main Pipe : 200 mm

3.2 Comments about the Operational Conditions by the PWD Staff

・ Two old pumps needs replacement

3.3 Comments about the Operational Conditions by the Study Team

・ No.2 and No.3 pumps and motors should be replaced because of deteriorated
・ Piping in the dry well should also be replaced
・ Electrical panel looks good condition

4. Pumping Station - 5

4.1 List of Existing Equipment

(Table A-4)

Location		**Don Bosco**				
Number of Pump Units		5 units				
Dimension of No.1 Pump		150 mm diameter × - m3/hour × 30.0 HP × - m(head)				
Dimension of No.2 Pump		150 mm diameter × 127.0 l/sec × 21.5 kw × 10.0 m(head)				
Dimension of No.3 Pump		200 mm diameter × 7,650 l/min × 20.0 HP × 10.0 m(head)				
Dimension of No.4 Pump		200 mm diameter × 7,650 l/min × 20.0 HP × 10.0 m(head)				
Dimension of No.5 Pump		200 mm diameter × 7,650 l/min × 20.0 HP × 10.0 m(head)				
Total Discharging Flow		Q= 0.5095 m3/sec + No.1 Pump				
Year of Manufacture		No.1	No.2	No.3	No.4	No.5
		1992	10 years	30 years	-	-
Company Name	Pump	Jyoti	Kirloskar	Jyoti	-	-
	Motor	Kirloskar	Kirloskar	-	-	-

Diameter of the Pumping Main Pipe : 400 mm

4.2 Comments about the Operational Conditions by the PWD Staff

・ Working satisfactorily

4.3 Comments about the Operational Conditions by the Study Team

・ No.4 and No.5 pumps and motors should be replaced because of deteriorated
・ Piping and valves in the dry well should also be replaced
・ No.1 to No.3 pumps and motors are good conditions
・ Electrical panel looks good condition
・ Gate and screen will be settled by PWD in this year

5. Pumping Station - 9

5.1 List of Existing Equipment

(Table A-5)

Location		**Dempo Collage (HRK house)**		
Number of Pump Units		3 units		
Dimension of No.1 Pump		100 mm diameter × 65.0 l/sec × 15.0 kw × 17.0 m(head)		
Dimension of No.2 Pump		100 mm diameter × 65.0 l/sec × 15.0 kw × 17.0 m(head)		
Dimension of No.3 Pump		100 mm diameter × 80.5 l/sec × 6.8 kw × 21.5 m(head)		
Total Discharging Flow		Q= 0.2105 m3/sec		
Year of Manufacture		No.1	No.2	No.3
		>15 years	>15 years	2years (pump), >15 (motor)
Company Name	Pump	Kirloskar	Kirloskar	Kirloskar
	Motor	Kirloskar	Kirloskar	Kirloskar

Diameter of the Pumping Main Pipe : 150 mm

5.2 Comments about the Operational Conditions by the PWD Staff

- Working satisfactorily

5.3 Comments about the Operational Conditions by the Study Team

- All pumps, motors, piping and panel are good working

6. Pumping Station - 10

6.1 List of Existing Equipment

(Table A-6)

Location		**Bhatulem**	
Number of Pump Units		2 units	
Dimension of No.1 Pump		100 mm diameter × 34.72 l/sec × 10.0 HP × 10.0 m(head)	
Dimension of No.2 Pump		100 mm diameter × 30.00 l/sec × 15.0HP × 30.0 m(head)	
Total Discharging Flow		Q= 0.0647 m3/sec	
Year of Manufacture		No.1	No.2
		>15 years	>10 years
Company Name	Pump	Kirloskar	Kirloskar
	Motor	Cromption	Kirloskar

Diameter of the Pumping Main Pipe : 150 mm

6.2 Comments about the Operational Conditions by the PWD Staff

- Need replacement.

6.3 Comments about the Operational Conditions by the Study Team

- All pumps, motors, piping and panel are good working

7. Pumping Station - 11

7.1 List of Existing Equipment

(Table A-7)

Location		**Miramar, Campal (Lakeview colony)**		
Number of Pump Units		3 units		
Dimension of No.1 Pump		100 mm diameter × 90.0 m3/hour × 8.7 kw × 20.0 m(head)		
Dimension of No.2 Pump		100 mm diameter × 90.0 m3/hour × 8.7 kw × 20.0 m(head)		
Dimension of No.3 Pump		80 mm diameter × 50.0 l/sec × 4.74 kw × 20.0 m(head)		
Total Discharging Flow		Q= 0.1000 m3/sec		
Year of Manufacture		No.1	No.2	No.3
		-	-	-
Company Name	Pump	Kirloskar	Kirloskar	Kirloskar
	Motor	Kirloskar	Kirloskar	Kirloskar

Diameter of the Pumping Main Pipe : 200 mm

7.2 Comments about the Operational Conditions by the PWD Staff

- Working satisfactorily.

7.3 Comments about the Operational Conditions by the Study Team

- No.3 pump and motor should be replaced because of deteriorated
- Electrical panel looks good condition

8. Pumping Station - 12

8.1 List of Existing Equipment

(Table A-8)

Location		**Kamrabhat**	
Number of Pump Units		2 units (Submersible Pump)	
Dimension of No.1 Pump		100 mm diameter × 42.0 m3/hour × 3.7 kw × 10.0 m(head)	
Dimension of No.2 Pump		100 mm diameter × 42.0 m3/hour × 3.7 kw × 10.0 m(head)	
Total Discharging Flow		Q= 0.0233 m3/sec	
Year of Manufacture		No.1	No.2
		1988	1988
Company Name	Pump	KSB	KSB
	Motor	KSB	KSB

Diameter of the Pumping Main Pipe : 150 mm

8.2 Comments about the Operational Conditions by the PWD Staff

- Only one pump is working, other pump is out of order.

8.3 Comments about the Operational Conditions by the Study Team

- All pumps, motors, piping and panel are good working

Summary of the Operation and Maintenance Conditions for P/S in Panaji

The following information are described based on the list of the data of PWD Division Ⅲ in Panaji

Pumping Station	Electrical Charge (Rs / month)	Staff Numbers		Salaries for Staff (Rs / month)
		Operator	Helper	
P/S-1	2,686	4	-	-
P/S-2	2,541	3	3	21,310
P/S-3	4,491	4	3	33,900
P/S-5	10,683	2	3	166,000
P/S-9	3,758	-	-	8,800
P/S-10	4,565	1	5	16,500
P/S-11	25,000	5	-	11,000
P/S-12	2,222	-	-	8,800
Total	55,946	19	14	266,310

M35.7 Capacity Calculation of STP (Sequencing Batch Reactor), Panaji City

CAPACITY CALCULATION OF SEWAGE TREATMENT FACILITIES

＜Sequencing Batch Reactor (SBR) Method in Panaji Municipality＞

1 BASIC CONDITIONS

1-1 Basic Items

(1) Name : **Panaji Tonca** Sewage Treatment Plant

(2) Land Area : Approximately 30,000 m^2

(3) Elevation : 3.00 m

(4) Inlet Pipe Level : -1.00 m

(5) Pipe Diameter : Concrete Pipe 600 mm

(6) Land Use : Exclusively for Sewage Treatment Plant

(7) Collection System : Combined System ・ Separate System

(8) Treatment Method :

Sewage Treatment ; Pre-treatment + SBR Tank + Disinfection Tank

Sludge Treatment ; Sludge Dewatering (Drying Bed as a stand-by facility)

(9) Effluent Point : Mandovi river

(10) Effluent Point Water Level : High Level = +2.50m, Low Level = 0.00m

(11) Target Year : 2005 Year

1-2 Design Population and Area

Design Population : 96,112 Persons Present : 60,000 Persons

Design Area : 765.0 ha

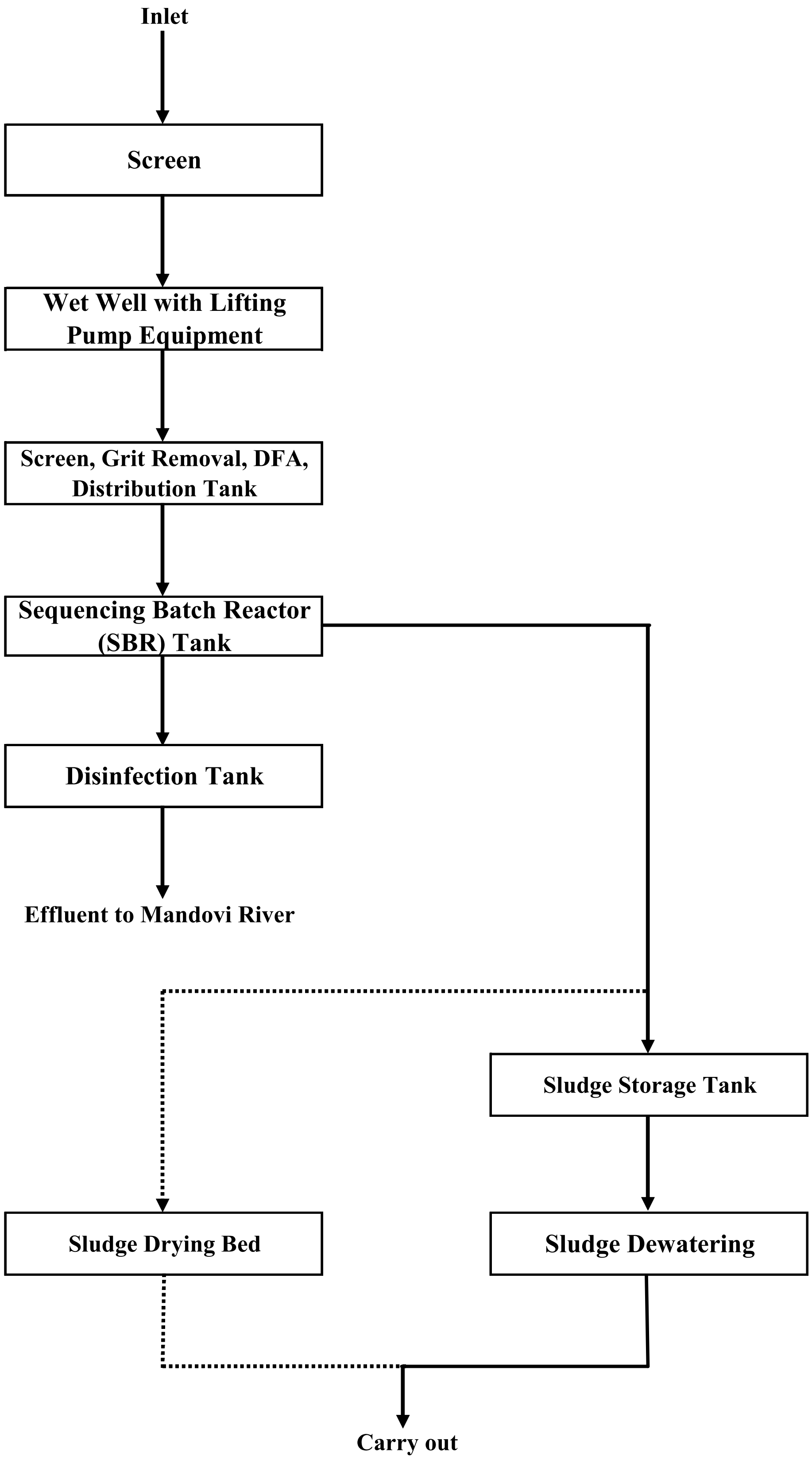
1-3 Design Sewage Flow

Item	m^3/day	m^3/hr	m^3/min	m^3/sec	Remarks
Daily Average (DA)	12,500	520.8	8.68	0.145	
Daily Maximum (DM)	17,857	744.0	12.40	0.207	DA : DM = 0.7 : 1.0
Hourly Maximum (HM)	28,125	1,171.9	19.53	0.326	DA : HM = 1.0 : 2.25

1-4 Design Sewage Quality

Item	Influent (mg/L)	Removal Rate (%)	Effluent (mg/L)	Remarks
BOD	200	85	30	Effluent Quality Regulation = 30 mg/l
SS	200	75	50	Effluent Quality Regulation = 100 mg/l

1-5 Flow Chart (SBR Method)



1-6 Design Criteria for SBR Method

Items	Unit	Figure *1	Figure *2	Adoption
1-6-1 Grit Chamber				
(1) Water Surface Load	m3/m2/day	1,800	2,160	2,160
(2) Average Velocity	m/sec	0.3	0.15 - 0.30	0.3
1-6-2 Wet Well with Pump Facilities				
(1) Pump Inlet Flow Velocity	m/sec	1.5 - 3.0	-	1.5 - 3.0
(2) Retention Time in Wet Well	min	-	> 5.0	5.0
1-6-3 SBR Tank (C-Tech Basin)				
(1) BOD-SS Load	kgBOD/kgSS・day	0.2 - 0.4	-	0.2 - 0.4
(2) MLSS Concentration	mg/L	1,500 - 2,000	-	1,750
(3) Cycle	cycle/day	3 - 4	-	8
(4) Hydraulic Retention Time	hour	12 - 24	-	12.0
(5) Water Depth	m	4 - 6	-	4.0
(6) Pull-out Ratio	-	1/4 - 1/2	-	1/4
1-6-4 Disinfection Tank				
(1) Retention Time	min.	15.0	-	15.0
(2) Dosage Ratio	mg/L	2 - 8	-	3.0
1-6-5 Sludge Storage Tank				
(1) Retention Time	hr	-	-	8.0
1-6-6 Sludge Dewatering				
(1) Operation Time	hr/day	-	-	8.0
(2) Raw Sludge Moisture Ratio	%	99.0	-	99.0
(3) Sludge Recovery Ratio	%	90 - 95	-	90.0
(4) Dewatered Sludge Moisture Ratio	%	78.0 - 80.0	60.0	78.0
1-6-7 Sludge Drying Bed				
(1) Retention Time	day	10 - 15	< 2 weeks	10.0
(2) Depth of Sludge Bed	m	0.20 - 0.30	max 0.30	0.30
(3) Required Area	m2/capita	-	0.10 - 0.25	0.10 - 0.25

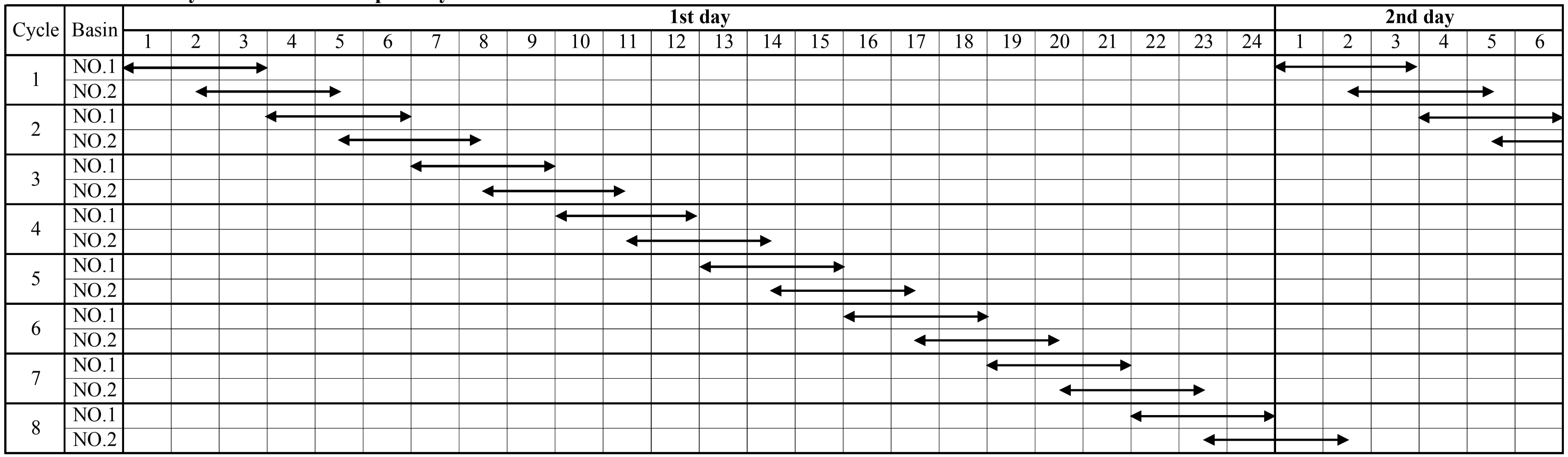
*1: Design Criteria in Japanese standard and "Wastewater Engineering" by Metcalf & Eddy
*2: Design Criteria in India named "Manual on Sewerage and Sewage Treatment"

1-7 Summary of the New STP in Panaji (Tonca STP)

Item	Dimension
1 General Condition	
Name of STP	Panaji Sewage Treatment Plant
Location	Tonca Caranzalem (by the side of existing STP) - Panaji
Commissioning Year	April , 2005
Capacity	12,500m^3/day
2 Technical Details	
2.1 Intake Facility	
Inlet Pipe Diameter	600mm (RC Pipe)
Size of Chamber	15.00m diameter
2.2 Raw Sewage Pump Facility	
Pump Sum	15.00m diameter × 4.50m
Pump Type	Non clog pumps horizontal model
Pump Power and Head	44kw × 15m × 2units
	110kw × 15m × 2units
2.3 Screening and Grit Chamber	
Screen Type	Manual bar screen (3.00m × 0.76m × 0.65m)
	Mechanical bar screen (3.00m × 0.90m × 0.65m)
Size of Grit Chamber	4.80m × 4.80m × 0.80m
2.4 SBR Tank (C-Tech Basins)	
Size	40.00m × 22.00m × 4.00m × 2basins
2.5 Chlorination System	
Type	Gas Chlorine
2.6 Sludge Dewatering	
Capacity	20.0 m3/hr×2 units (including 1 stand-by)

Source: Sector Status Study Water & Sanitation Goa, Draft Final Report (Appendix), August 2004, P.117

1-8 SBR Tank Cycle Time Schedule per Day



Note: Breakdown schedule of one cycle of SBR method is shown below.

↔ : Influent (45 min)

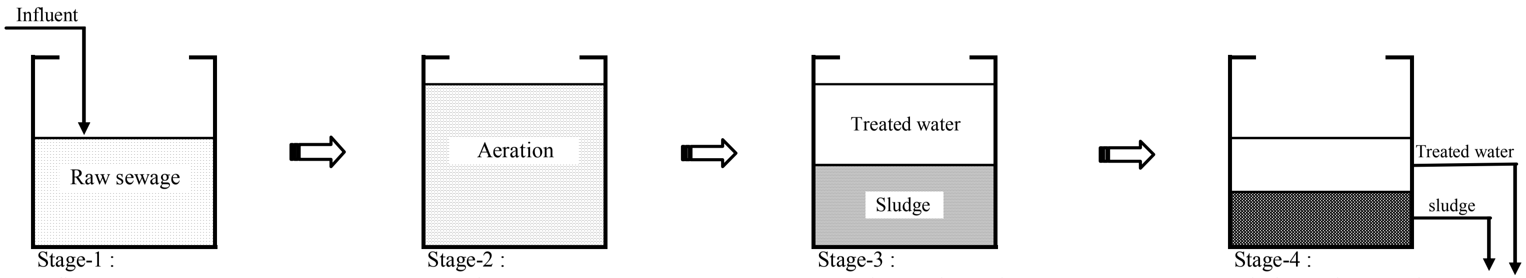
↔ : Aeration (45 min)

↔ : Settling (45 min)

↔ : Effluent (45 min)

⟷ : **Total 3.0 hr/cycle**

<u>Treatment Process in SBR</u>



Stage-1 : Influent	Stage-2 : Aeration	Stage-3 : Stop the aeration and settling	Stage-4 : Discharge the treated water and draw the accumulated sludge
(45.0 min/cycle)	**(45.0 min/cycle)**	**(45.0 min/cycle)**	**(45.0 min/cycle)**

2 STUDY OF THE TREATMENT CAPACITY

2-1 Wet Well with Pump Facilities

(1) Wet Well

Q2	Design sewage flow (Hourly Maximum)	:	28,125	m3/day	=	19.53	m3/min
RT	Retention Time	:	> 5.0	min			
RV	Required Volume	:	Q2×RT	=	97.7	m3	
	Size of Existing Well	:	15.0	m dia.	×	4.5	m dep.
V1	Volume of Existing Well	:	V1=	794.8	m3		
	Calculated Retention Time	:	V1/Q2	=	40.7	min	

Comparison of the retention time between the criteria and calculated figure

Design criteria	Calculated figure
> 5.0 min	**40.7 min**

∴ **OK**

(2) Pump Facilities

Q2	Design sewage flow (Hourly Maximum)	:	28,125	m3/day	=	19.53	m3/min
PN	Units number	:	2	units	(small capacity)		
			2	units	(large capacity)		
PC	Discharging capacity	:	1 : 1 : 2 : 2	(assumption)			
			Small pump	3.26	m3/min./unit		
			Large pump	6.51	m3/min./unit		
H	Pump head	:	15.0	m			

D1 Calculated pump diameter (Small pump) : $D1 = 146\times(PC/1.5\sim3.0)^{0.5}$

$= 152 \sim 215$

= **200 mm**

D2 Calculated pump diameter (Large pump) : $D2 = 146\times(PC/1.5\sim3.0)^{0.5}$

$= 215 \sim 304$

= **250 mm**

P1 Calculated motor power (Small pump) : $P1 = 0.163\times PC\times H\times(1+0.15)/0.60$

= **15.3 kw**

P2 Calculated motor power (Large pump) : $P1 = 0.163\times PC\times H\times(1+0.15)/0.60$

= **30.5 kw**

Comparison of the pump specifications between the existing and calculated facilities

Pump specification		Existing facilities	Required figures by calculation
Diameter	small	-	200 mm
	large	-	250 mm
Discharging capacity	small	-	3.26 m3/min./unit
	large	-	6.51 m3/min./unit
Pump head	small	15.0 m	15.0 m
	large	15.0 m	15.0 m
Motor power	small	44.0 kw	15.3 kw
	large	110.0 kw	30.5 kw
Units number	small	2 units	2 units
	large	2 units	2 units

2-2 Grit Chamber

Q2 Design sewage flow (Hourly Maximum) : 28,125 m3/day = 19.53 m3/min
SL Water surface load : 2,160 m3/m2/day
RA Required surface area : RA= Q2/SL = 13.0 m2
A Area of existing grit chamber : 4.80 m × 4.80 m
= 23.0 m2

Comparison of the surface area between the existing and required figures

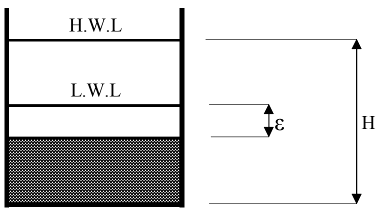
Existing facilities	Required area by calculation
23.0 m2	**13.0 m2**

∴ **OK**

AW Actual water surface load : AW= Q2/A = 1,221 m3/m2/day

2-3 SBR Tank (C-Tech Basin)

Q1 Design sewage flow (Daily Average) : 12,500 m3/day = 520.8 m3/hr
BODin Inlet BOD : 200 mg/l
MS MLSS concentration : 1,750 mg/l
BS BOD-SS load : 0.3 kgBOD/kgSS・day
CY Cycle : 8 cycle/day
m Sludge draw ratio : 4
AT Aeration time : AT= 24×BODin/(BS×m×MS)
= 2.3 hrs/cycle



H Basin depth : 4.0 m
ε Clearance depth : 0.5 m
V0 Settling velocity : 3.0 m/hr
ST Settling time :
ST= (H×(1/m)+ε) / V0
= 0.5 hrs/cycle

e Aeration time ratio : e= CY×AT/24 = 0.76
RV Required volume : RV= Q1×BODin/(e×MS×BS)
= 6,250 m3
S Dimension of existing tank :
40.00 m × 22.00 m × 4.00 m × 2 basins
EV Volume of existing aeration tank : EV= 7,040 m3

Comparison of the SBR tank volume between the existing and calculated figures

Existing facilities	Required volume by calculation
7,040 m3	**6,250 m3**

∴ **OK**

2-4 Disinfection Tank

Q1 Design sewage flow (Daily Average) : 12,500 m3/day = 8.68 m3/min
RT Retention time : 15.0 min
RV Required volume : RV= Q1×RT = 130.2 m3
S Dimension of existing tank :
9.50 m × 2.60 m × 0.90 m × 9 pass
EV Volume of existing aeration tank : EV= 200 m3

Comparison of disinfection tank volume between the existing and calculated figures

Existing facilities	Required volume by calculation
200 m3	**130 m3**

∴ **OK**

2-5 Sludge Storage Tank

Q1	Design sewage flow (Daily Average)	: 12,500 m3/day
SSin	Inlet SS	: 200 mg/l
SSout	Outlet SS	: 50 mg/l
GS-1	Generated sludge	: GS-1= Q1 × (SS in - SS out) × 10^{-6}
		= 1.88 t/day
W	Sludge moisture ratio	: W= 99.0 %
GS-2	Generated sludge in volume	: GS-2= GS-1×100/(100-W)
		= 187.5 m3/day
RT	Retention time	: 8.0 hrs (assumption)
RV	Required volume	: RV= GS-2×RT = 62.5 m3/day
S	Dimension of existing tank	: 8.50 m × 8.50 m × 2.00 m
EV	Volume of existing aeration tank	: EV= 145 m3

Comparison of sludge storage tank volume between the existing and calculated figures

Existing facilities	Required volume by calculation
145 m3	**63 m3**

∴ **OK**

2-6 Sludge Dewatering

-	Type	: Centrifugal type
GS-2	Generated sludge in volume	: GS-2= 187.5 m3/day
N	Unit number	: N= 2 units
T	Operating time	: T= 8 hr/day
P1	Dewatering capacity	: P1= GS-2/(N×T) = 11.7 m3/hr
S	Dimension of existing facility	: 20.0 m3/hr (1 working + 1 Stand-by)

Comparison of sludge dewatering facility between the existing and calculated figures

Existing facilities	Required volume by calculation
20.0 m3	**11.7 m3**

∴ **OK**

2-7 Sludge Drying Bed

Q1	Design sewage flow (Daily Average)	: 12,500 m3/day
SSin	Inlet SS	: 200 mg/l
SSout	Outlet SS	: 50 mg/l
GS-1	Generated sludge	: GS-1= Q1 × (SS in - SS out) × 10^{-6}
		= 1.88 t/day
W	Average sludge moisture ratio	:
	W=(99.0 + 78.0)/2 = 88.5 %	
GS-2	Generated sludge in volume	: GS-2= GS-1×100/(100-W)
		= 16.3 m3/day
RT	Retention time	: RT= 10.0 days
RV	Required volum	: RV= GS-2×RT = 163.0 m3
H	Depth of sludge bed	: H= 0.30 m

RA	Required area	:	RA= RV/H	=	543.5	m2				
S	Dimension of existing facility	:								
		15.00	m ×	7.50	m ×	0.30	m ×	18	basin	
EA	Area of existing drying bed	:	EA=	2,025	m2					

Comparison of sludge drying bed areas between the existing and calculated figure

Existing facilities	Required area by calculation
2,025 m2	**543 m2**

∴ **OK**

M35.8 Capacity Calculation of STP(Activated Sludge), Margao City

CAPACITY CALCULATION OF SEWAGE TREATMENT FACILITIES
＜Activated Sludge Method in Margao Municipality＞

1 BASIC CONDITIONS

1-1 Basic Items

(1) Name : **Margao** Sewage Treatment Plant

(2) Land Area : Approximately 31,500 m^2

(3) Elevation : 20.50 m

(4) Inlet Pipe Level : 14.00 m

(5) Pipe Diameter : Concrete Pipe 1,200 mm

(6) Land Use : Exclusively for Sewage Treatment Plant

(7) Collection System : Combined System ・ Separate System

(8) Treatment Method :

Sewage Treatment ; Pre-treatment + Primary settling + Activated sludge + Secondary settling

Sludge Treatment ; Sludge Digestion + Sludge drying Bed

(9) Effluent Point : Sal river

(10) Effluent Point Water Level : High Level = + m, Low Level = + m

(11) Target Year : 2011 Year

1-2 Design Population and Area

Design Population : 120,000 Persons

Design Area : 876.0 ha

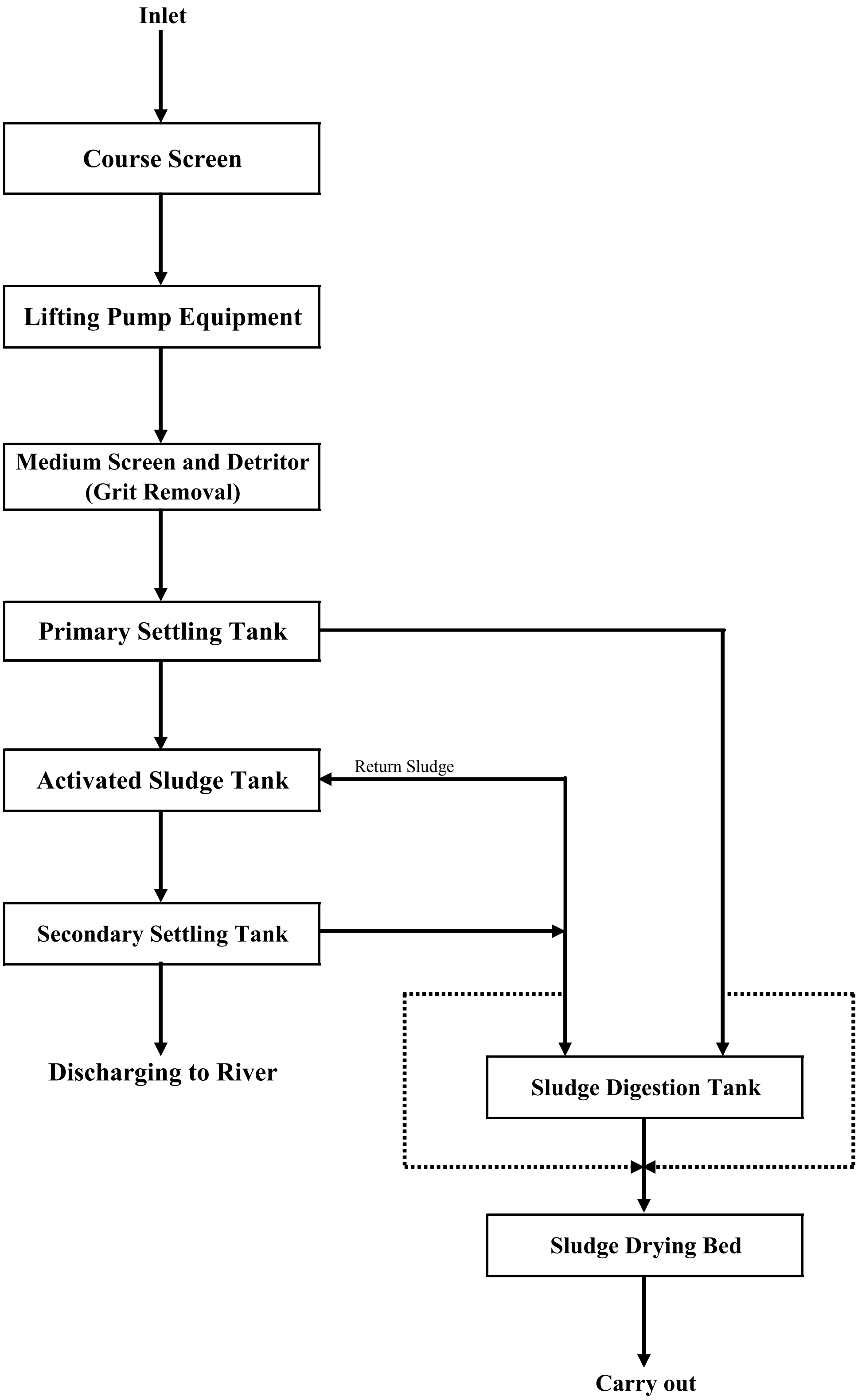
1-3 Design Sewage Flow

Item	m^3/day	m^3/hr	m^3/min	m^3/sec	Remarks
Daily Average (DA)	7,500	312.5	5.21	0.087	
Daily Maximum (DM)	10,714	446.4	7.44	0.124	DA : DM = 0.7 : 1.0
Hourly Maximum (HM)	16,875	703.1	11.72	0.195	DA : HM = 1.0 : 2.25

1-4 Design Sewage Quality

Item	Influent	Removal Rate	Effluent	Remarks
	(mg/L)	(%)	(mg/L)	
BOD	300	90	30	Effluent Quality Regulation = 30 mg/l
SS	300	83	50	Effluent Quality Regulation = 100 mg/l

1-5 Flow Chart (Activated Sludge Method)



1-6 Design Criteria for Activated Sludge Method

Items	Unit	Figure *1	Figure *2	Adoption
1-6-1 Grit Chamber				
(1) Water surface load	m3/m2/day	1,800	2,160	2,160
(2) Average velocity	m/sec	0.3	0.15 - 0.30	0.3
1-6-2 Wet Well with Pump Facilities				
(1) Pump inlet flow velocity	m/sec	1.5 - 3.0	-	2.25
(2) Retention time in Wet Well	min	-	> 5.0	5.0
1-6-3 Primary Settling Tank				
(1) Water surface load	m3/m2/day	35.0 - 70.0	35.0 - 50.0	31.0
(2) Water depth	m	2.5 - 4.0	2.5 - 3.5	2.5
1-6-4 Activated Sludge Tank				
(1) Type of activated sludge	-	-	-	Complete mixed
(2) MLSS concentration	mg/L	1,500 - 2,000	1,500 - 3,000	4,000
(3) BOD-SS Load	kgBOD/kgSS･day	0.2 - 0.4	0.3 - 0.4	0.45
(4) Retention time	hr	6.0 - 8.0	4.0 - 6.0	4.0
(5) Water depth	m	4.0 - 6.0	3.0 - 4.5	3.0
1-6-5 Secondary Settling Tank				
(1) Water surface load	m3/m2/day	20.0 - 30.0	15.0 - 35.0	24.0
(2) Water depth	m	2.5 - 4.0	3.5 - 4.5	2.5
1-6-6 Sludge Conditions				
(1) Raw sludge moisture ratio	%	99.0	-	99.0
(2) Digested sludge moisture	%	96.0 - 97.5	-	97.0
1-6-7 Sludge Digestion Tank				
(1) Type of digestion	-	-	-	High rate
(2) Retention time	day	20	10 - 20	10
1-6-7 Sludge Drying Bed				
(1) Retention Time	day	10 - 15	< 2 weeks	10.0
(2) Depth of Sludge Bed	m	0.20 - 0.30	max 0.30	0.30
(3) Required Area	m2/capita	-	0.10 - 0.25	0.10 - 0.25

*1: Design Criteria in Japanese standard and "Wastewater Engineering" by Metcalf & Eddy
*2: Design Criteria in India named "Manual on Sewerage and Sewage Treatment"

1-7 Summary of the Existing STP in Margao

Item	Dimension
1 **General Condition**	
Name of STP	Margao Sewage Treatment Plant
Location	Sirvodem, Navelim - Margao
Commissioning Year	2000, May, 03
Capacity	15,000m^3/day (designed), 7,500m^3/day (existing)
2 **Technical Details**	
2.1 Intake Facility	
Inlet Pipe Diameter	1,200mm (RC Pipe)
Size of Chamber	4.00m × 3.50m × 4.00m
2.2 Raw Sewage Pump Facility	
Pump Sum	12.30m diameter, 15.0m height
Pump Type	Non clog pumps horizontal model Centrifugal
Pump Dimension	200m^3/hour (3.33m^3/min) × 12m × 25HP ×2units
(7 years old)	400m^3/hour (6.67m^3/min) × 12m × 50HP ×2units
2.3 Screening and Grit Chamber	
Screen Type	Mechanical type
Size of Screen	20mm screen opening
Size of Grit Chamber	8.00m × 0.35m × 1.25m
2.4 Primary Clarifier	
Size	18.00m diameter × 3.00m depth
2.5 Activated Sludge Tank	
Method of Aeration	Surface Aerators
Size	33.00m × 12.00m × 3.00m
2.6 Secondary Clarifier	
Size	21.00m diameter × 3.00m depth
2.7 Sludge Digester	
Size	18.00m diameter × 10.65m depth
2.8 Sludge Drying Beds	
Size	12.80m × 12.40m × 14basins
2.9 Treated Water Disposal	Discharging to sea through masonry drain

Source: Sector Status Study Water & Sanitation Goa, Draft Final Report (Appendix), August 2004, P.111

2 STUDY OF THE TREATMENT CAPACITY

2-1 Wet Well with Pump Facilities

(1) Wet Well

Q2	Design sewage flow (Hourly Maximum)	:	16,875 m3/day	=	11.72	m3/min
RT	Retention Time	:	5.0	min		
RV	Required Volume	:	Q2 × RT	=	58.6	m3
	Size of Existing Well	:	12.3 m dia.	×	15.0	m dep.
V1	Volume of Existing Well	:	V1=	1,781		m3
	Calculated Retention Time	:	V1/Q2	=	152.0	min

Comparison of the retention time between the criteria and calculated figure

Design criteria	Calculated figure
> 5.0 min	**152.0 min**

∴ OK

(2) Pump Facilities

Q2 Design sewage flow (Hourly Maximum) : 16,875 m3/day = 11.72 m3/min

PN Units number : 2 units (small capacity)
2 units (large capacity, including 1 stand-by unit)

PC Discharging capacity : 1 : 1 : 2 (assumption)
Small pump 2.95 m3/min./unit
Large pump 5.90 m3/min./unit

H Pump head : 12.0 m

D1 Calculated pump diameter (Small pump) : $D1 = 146 \times (PC/1.5 \sim 3.0)^{0.5}$
= 145 ~ 205
= **150 mm**

D1 Calculated pump diameter (Large pump) : $D1 = 146 \times (PC/1.5 \sim 3.0)^{0.5}$
= 205 ~ 290
= **250 mm**

P1 Calculated motor power (Small pump) : $P1 = 0.222 \times PC \times H \times (1+0.15)/0.60$
= **15.1 HP**

P2 Calculated motor power (Large pump) : $P1 = 0.222 \times PC \times H \times (1+0.15)/0.60$
= **30.1 HP**

Comparison of the pump specifications between the existing and calculated facilities

Pump specification		Existing facilities	Required figures by calculation
Diameter	small	-	150 mm
	large	-	250 mm
Discharging capacity	small	3.33 m3/min./unit	2.95 m3/min./unit
	large	6.67 m3/min./unit	5.90 m3/min./unit
Pump head	small	12.0 m	12.0 m
	large	12.0 m	12.0 m
Motor power	small	25.0 HP	15.1 HP
	large	50.0 HP	30.1 HP
Units number	small	2 units	2 units
	large	2 units	2 (1) units

2-2 Grit Chamber

Q2	Design sewage flow (Hourly Maximum)	:	16,875 m3/day	=	11.72	m3/min
SL	Water surface load	:	2,160 m3/m2/day			
RA	Required surface area	:	RA= Q2/SL	=	7.8	m2
A	Area of existing grit chamber	:	8.00 m × 1.25 m			
			= 10.0 m2			

Comparison of the surface area between the existing and required figures

Existing facilities	Required area by calculation
10.0 m2	**7.8 m2**

∴ OK

AW Actual water surface load : AW= Q2/A = 1,688 m3/m2/day

2-3 Primary Settling Tank

Q1	Design sewage flow (Daily Average)	:	7,500 m3/day	=	312.5	m3/hr
WSL	Water surface load	:	WSL= 31 m3/m2/day			
RA	Required surface area	:	RA= Q1/WSL	=	241.9	m2
A	Surface area of existing primary settling tank	:	18.0 m dia.			
				=	254.3	m2

Comparison of the surface area between the existing and required figures

Existing facilities	Required area by calculation
254 m2	**242 m2**

∴ OK

2-4 Activated Sludge Tank

Q1	Design sewage flow (Daily Average)	:	7,500 m3/day	=	312.5	m3/hr
MS	MLSS concentration	:	4,000 mg/l			
RT1	Retention time	:	RT1= 4.0 hr			
RV1	Required volume	:	RV1= Q1×RT1	=	1,250	m3
V	Volume of existing tank	:	33.0 m × 12.0 m × 3 m			
			= 1188 m3			
RT2	Retention time calculated based on the existing tank	:	RT2= V/Q1			
				=	3.8	hr
BS	BOD-SS load	:	0.45 kgBOD/kgSS･day			
BOD2	BOD quality at inlet to aeration tank	:	300.0 × 0.5			(assumption)
			= 150.0 mg/l			
RV2	Required volume	:	RV2= Q1×BOD2/(BS×MS)			
			= 625 m3			

Comparison of required volume between the existing and calculated facilities

Volume of existing tank	Calculated volume based on retention time	Calculated volume based on BOD-SS load
1188 m3	**1,250 m3**	**625 m3**

2-5 Secondary Settling Tank

Q1	Design sewage flow (Daily Average)	:	7,500 m3/day	=	312.5	m3/hr
WSL	Water surface load	:	WSL= 24 m3/m2/day			
RA	Required surface area	:	RA= Q1/WSL	=	312.5	m2

A Surface area of existing primary settling tank : 21.0 m dia.
= 346.2 m2

Comparison of the surface area between the existing and required figures

Existing facilities	Required area by calculation
346 m2	**313 m2**

∴ **OK**

2-6 Sludge Digestion Tank

- \- Type of sludge digestion : High rate digestion
- Q1 Design sewage flow (Daily Average) : 7,500 m3/day
- SSin Inlet SS : 300 mg/l
- SSout Outlet SS : 50 mg/l
- GS-1 Generated sludge : GS-1= Q1 × (SS in - SS out) × 10^{-6}
  = 1.88 t/day
- W Sludge moisture ratio : W= 99.0 %
- GS-2 Generated sludge in volume : GS-2= GS-1×100/(100-W)
  = 187.5 m3/day
- RT Retention time : 10 days
- RV Required volume : RV= GS-2×RT = 1,875 m3
- V Volume of existing tank : 18.0 m dia. × 10.65 m depth
  V= 2,709 m3

Comparison of the tank volume between the existing and required figures

Existing facilities	Required volume by calculation
2,709 m3	**1,875 m3**

∴ **OK**

2-7 Sludge Drying Bed

- Q1 Design sewage flow (Daily Average) : 7,500 m3/day
- SSin Inlet SS : 300 mg/l
- SSout Outlet SS : 50 mg/l
- GS-1 Generated sludge : GS-1= Q1 × (SS in - SS out) × 10^{-6}
  = 1.88 t/day
- W Digested sludge moisture ratio : W= 97.0 %
- GS-2 Generated sludge in volume : GS-2= GS-1×100/(100-W)
  = 62.5 m3/day
- RT Retention time : RT= 10.0 days
- RV Required volum : RV= GS-2×RT = 625.0 m3
- H Depth of sludge bed : H= 0.30 m
- RA Required area : RA= RV/H = 2,083 m2
- A Area of existing drying bed : 12.80 × 12.40 × 14 basins
  A= 2,222 m2

Comparison of drying bed area between the existing and required figures

Existing facilities	Required area by calculation
2,222 m2	**2,083 m2**

∴ **OK**

Appendix M35.9 Flow Calculation Sheet for Main and Sub Main Sewers, Margao City

Table M35.9.1 Flow Caculation Sheet for Main and Sub Main Sewer Margao City (Year 2001)

Node 1		Node 2		Population		Peak flow (lps)		Existing Sewer									Capacity Adequacy	Remarks
From	To	From	To	Increment	Cumulative	Increment	Cumulative	Size (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Velocity (m/sec)	Flow Capacity (lps)		
											u/s	d/s	u/s	d/s				
1	**2**	0M	15M	2,869	2,869	13.4	13.4	300	430	180					0.884	62	Adequate	**North Main**
2	**3**	15M	40M	1,166	4,035	5.5	18.9	350	750	300					0.759	73	Adequate	**North Main**
3	**4**	40M	59M	1,501	5,537	7.0	26.0	400	630	375					0.742	93	Adequate	**North Main**
4	**5**	59M	87M	2,179	7,716	10.2	36.2	450	920	430					0.749	119	Adequate	**North Main**
5	**13**	87M	103M	1,947	9,662	9.1	45.3	500	510	500					0.745	146	Adequate	**North Main**
6	7	1M	7M	2,680	2,680	12.6	12.6	350	214	200					0.929	89	Adequate	Central North Sub Main
7	8	7M	21M	1,493	4,173	7.0	19.6	400	450	275					0.866	109	Adequate	Central North Sub Main
8	9	21M	33M	1,131	5,304	5.3	24.9	500	360	300					0.962	189	Adequate	Central North Sub Main
9	10	33M	47M	2,179	7,483	10.2	35.1	500	409	575					0.695	136	Adequate	Central North Sub Main
10	11	47M	53M	3,487	10,971	16.3	51.4	600	180	425					0.913	258	Adequate	Central North Sub Main
11	12	53M	64M	954	11,924	4.5	55.9	600	360	525					0.821	232	Adequate	Central North Sub Main
12	13	64M	103M	946	12,870	4.4	60.3	700	160	575					0.870	335	Adequate	Central North Sub Main
13	**24**	103M	77M	0	22,533	0.0	105.6	700	720	750					0.762	293	Adequate	**North Main**
14	15	0M	13M	6,187	6,187	29.0	29.0	450	369	200	33.530	31.240	29.825		1.099	175	Adequate	Central South Sub Main
15	16	13M	17M	1,734	7,921	8.1	37.1	450	190	140	31.235				1.313	209	Adequate	Central South Sub Main
16	17	17M	24M	906	8,827	4.2	41.4	500	180	300		29.780		26.310	0.962	189	Adequate	Central South Sub Main
17	18	24M	27M	1,103	9,930	5.2	46.5	500	73	300	29.780		26.310		0.962	189	Adequate	Central South Sub Main
18	19	27M	37M	946	10,876	4.4	51.0	500	311	300					0.962	189	Adequate	Central South Sub Main
19	20	37M	42M	670	11,546	3.1	54.1	500	123	300					0.962	189	Adequate	Central South Sub Main
20	21	42M	48M	749	12,295	3.5	57.6	500	220	300					0.962	189	Adequate	Central South Sub Main
21	22	48M	56M	276	12,571	1.3	58.9	600	232	280					1.125	318	Adequate	Central South Sub Main
22	23	56M	64M	394	12,965	1.8	60.8	600	235	300					1.087	307	Adequate	Central South Sub Main
23	24	64M	77M	512	13,477	2.4	63.2	600	361	350					1.006	284	Adequate	Central South Sub Main
24	**25**	77M	92M	2,250	38,260	10.5	179.3	800	430	750					0.833	418	Adequate	**North Main**
25	**26**	92M	111M	4,291	42,551	20.1	199.5	800	570	750					0.833	418	Adequate	**North Main**
26	**27**	111M	303M	6,380	48,931	29.9	229.4	900	1,260	950					0.800	509	Adequate	**North Main**
27	**28**	303M	313M	0	48,931	0.0	229.4	1000	300	1,200					0.764	600	Adequate	**North Main**
28	**29 (STP)**	313M	STP	29,451	78,382	138.1	367.4	1200	60	1,200					0.862	975	Adequate	**North Main**

Note: Node 1 coordinates with Figure 3.2.2
Node 2 coordinates with Sewerage zone map

Peak factor : 2.25
Manning's n: 0.015

M35.10 Flow Calculation Sheets for Branch Sewers, Margao City

Table M35.10.1 Flow Calculation Sheet for Branch Sewers, Margao City (Year 2001) (1/10)

Node 1		Node 2		Population			Peak flow (lps)			Existing Sewer									Capacity Adequacy	Remarks
From	To	From	To	From Sub Main	Increment	Cumulative	From Sub Main	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
	North Zone Sector I																			
		1	**0M**		213	213		1.0	1.0	150	595	104					0.732	13	Adequate	
		40	46		197	197		0.9	0.9	150	180	46					1.101	19	Adequate	
		46	46A		32	229		0.1	1.1	200	30	46					1.334	42	Adequate	
		34	46A		59	59		0.3	0.3	150	220	20					1.670	30	Adequate	
		46A	48		55	343		0.3	1.6	200	60	46					1.334	42	Adequate	
		61	48		51	51		0.2	0.2	150	90	100					0.747	13	Adequate	
		48	50		55	449		0.3	2.1	200	60	46					1.334	42	Adequate	
		21A	50		146	146		0.7	0.7	150	420	20					1.670	30	Adequate	
		50	51		28	623		0.1	2.9	200	30	57					1.198	38	Adequate	
		51	56		489	1,111		2.3	5.2	200	160	57					1.198	38	Adequate	
		74	56		102	102		0.5	0.5	150	180	40					1.181	21	Adequate	
		56	**0M**		169	1,383		0.8	6.5	200	55	57					1.198	38	Adequate	
1	**2**	**0M**	**15M**		1,273	2,869		6.0	13.4	300	430	180					0.884	62	Adequate	**North Main**
		62A	81		39	39		0.2	0.2	150	115	40					1.181	21	Adequate	
		90	85		126	126		0.6	0.6	150	150	55					1.007	18	Adequate	
		85	81		126	252		0.6	1.2	150	117	55					1.007	18	Adequate	
		81	75		24	315		0.1	1.5	150	20	65					0.926	16	Adequate	
		75	**15M**		138	453		0.6	2.1	200	258	50					1.280	40	Adequate	
2	**2A**	**15M**	**31M**		374	3,696		1.8	17.3	350	480	300					0.759	73	Adequate	**North Main**
		92	**31M**		126	126		0.6	0.6	150	420	30					1.364	24	Adequate	
2A	**3**	**31M**	**40M**		213	4,035		1.0	18.9	350	270	300					0.759	73	Adequate	**North Main**
		103A	105		43	43		0.2	0.2	150	71	60					0.964	17	Adequate	
		105	**40M**		134	177		0.6	0.8	200	412	60					1.168	37	Adequate	
3	**3A**	**40M**	**46M**		193	4,406		0.9	20.7	400	190	375					0.742	93	Adequate	**North Main**
		127	125		63	63		0.3	0.3	150	60	30					1.364	24	Adequate	
		125	120		126	189		0.6	0.9	150	158	60					0.964	17	Adequate	
		115	120		118	118		0.6	0.6	150	150	50					1.056	19	Adequate	
		120	**46M**		221	528		1.0	2.5	200	210	50					1.280	40	Adequate	
3A	**3B**	**46M**	**53M**		244	5,178		1.1	24.3	400	240	375					0.742	93	Adequate	**North Main**

Table M35.10.1 Flow Calculation Sheet for Branch Sewers, Margao City (Year 2001) (2/10)

Node 1		Node 2		Population			Peak flow (lps)			Existing Sewer									Capacity Adequacy	Remarks
													Ground level (m)		Invert level (m)					
From	To	From	To	From Sub Main	Increment	Cumulative	From Sub Main	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	u/s	d/s	u/s	d/s	Velocity (m/sec)	Flow Capacity (lps)		
		131	128		63	63		0.3	0.3	150	100	30					1.364	24	Adequate	
		128	**53M**		91	154		0.4	0.7	200	277	30					1.652	52	Adequate	
3B	**4**	**53M**	**59M**		205	5,537		1.0	26.0	400	200	375					0.742	93	Adequate	**North Main**
		134	138		39	39		0.2	0.2	150	120	20					1.670	30	Adequate	
		138	**59M**		51	91		0.2	0.4	150	106	60					0.964	17	Adequate	
4	**4A**	**59M**	**73M**		697	6,325		3.3	29.6	450	450	430					0.749	119	Adequate	**North Main**
		132	157		166	166		0.8	0.8	150	105	30					1.364	24	Adequate	
		157	159		106	272		0.5	1.3	150	54	40					1.181	21	Adequate	
		159	**73M**		83	355		0.4	1.7	200	295	40					1.431	45	Adequate	
4A	**4B**	**73M**	**79M**		323	7,003		1.5	32.8	450	210	430					0.749	119	Adequate	**North Main**
		168	173		122	122		0.6	0.6	150	160	30					1.364	24	Adequate	
		173	**79M**		189	311		0.9	1.5	200	226	30					1.652	52	Adequate	
4B	**5**	**79M**	**87M**		402	7,716		1.9	36.2	450	260	430					0.749	119	Adequate	**North Main**
		180	183		102	102		0.5	0.5	150	90	30					1.364	24	Adequate	
		183	187		114	217		0.5	1.0	150	110	60					0.964	17	Adequate	
		187	**87M**		99	315		0.5	1.5	200	130	30					1.652	52	Adequate	
5	**5A**	**87M**	**91M**		363	8,394		1.7	39.3	500	150	500					0.745	146	Adequate	**North Main**
		202	192		146	146		0.7	0.7	150	205	20					1.670	30	Adequate	
		192	**91M**		150	296		0.7	1.4	200	120	30					1.652	52	Adequate	
5A	**5B**	**91M**	**99M**		674	9,363		3.2	43.9	500	280	500					0.745	146	Adequate	**North Main**
		209	206		39	39		0.2	0.2	150	90	30					1.364	24	Adequate	
		206	**99M**		67	106		0.3	0.5	200	145	60					1.168	37	Adequate	
5B	**13**	**99M**	**103M**		193	9,662		0.9	45.3	500	80	500					0.745	146	Adequate	**North Main**
Central Zone North Sector																				
		11	23		1,828	1,828		8.6	8.6	250	390	50					1.485	73	Adequate	
		23	**1M**		461	2,290		2.2	10.7	300	90	60					1.531	108	Adequate	
		1	5		67	67		0.3	0.3	150	120	50					1.056	19	Adequate	
		5	**1M**		110	177		0.5	0.8	200	180	50					1.280	40	Adequate	
6	**7**	**1M**	**7M**		213	2,680		1.0	12.6	350	214	200					0.929	89	Adequate	**Central North Sub Main**
7	**7A**	**7M**	**10M**		59	2,739		0.3	12.8	400	130	275					0.866	109	Adequate	**Central North Sub Main**
		26	28		126	126		0.6	0.6	150	90	30					1.364	24	Adequate	
		70	66		150	150		0.7	0.7	150	120	40					1.181	21	Adequate	
		66	28		16	166		0.1	0.8	200	90	30					1.652	52	Adequate	

Table M35.10.1 Flow Calculation Sheet for Branch Sewers, Margao City (Year 2001) (3/10)

Node 1		Node 2		Population			Peak flow (lps)			Existing Sewer									Capacity Adequacy	Remarks
From	To	From	To	From Sub Main	Increment	Cumulative	From Sub Main	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
		28	50		106	398		0.5	1.9	200	240	60					1.168	37	Adequate	
		37	42		150	150		0.7	0.7	150	120	90					0.787	14	Adequate	
		42	50		236	386		1.1	1.8	200	171	120					0.826	26	Adequate	
		52	50		166	166		0.8	0.8	150	69	40					1.181	21	Adequate	
		50	**10M**		335	1,285		1.6	6.0	250	135	150					0.857	42	Adequate	
7A	**8**	**10M**	**21M**		150	4,173		0.7	19.6	400	320	275					0.866	109	Adequate	**Central North Sub Main**
		74	76		43	43		0.2	0.2	150	120	30					1.364	24	Adequate	
		76	56		71	114		0.3	0.5	200	180	30					1.652	52	Adequate	
		53	56		130	130		0.6	0.6	150	120	50					1.056	19	Adequate	
		56	82		130	374		0.6	1.8	200	142	60					1.168	37	Adequate	
		93	89		126	126		0.6	0.6	150	120	40					1.181	21	Adequate	
		89	82		154	280		0.7	1.3	200	30	40					1.431	45	Adequate	
		82	**21M**		118	772		0.6	3.6	250	158	70					1.255	62	Adequate	
8	**9**	**21M**	**33M**		359	5,304		1.7	24.9	500	360	300					0.962	189	Adequate	**Central North Sub Main**
		59	71		51	51		0.2	0.2	150	130	30					1.364	24	Adequate	
		71	108		158	209		0.7	1.0	200	160	30					1.652	52	Adequate	
		110A	108		47	47		0.2	0.2	150	100	50					1.056	19	Adequate	
		108	104		189	445		0.9	2.1	200	25	50					1.280	40	Adequate	
		98	102		35	35		0.2	0.2	150	120	50					1.056	19	Adequate	
		102	104		43	79		0.2	0.4	200	60	30					1.652	52	Adequate	
		104	119		16	540		0.1	2.5	200	55	50					1.280	40	Adequate	
		114	119		59	59		0.3	0.3	150	120	30					1.364	24	Adequate	
		120	123		51	51		0.2	0.2	150	90	30					1.364	24	Adequate	
		123	119		63	114		0.3	0.5	200	90	50					1.280	40	Adequate	
		119	130		213	926		1.0	4.3	200	240	80					1.012	32	Adequate	
		130	**33M**		394	1,320		1.8	6.2	250	370	75					1.212	60	Adequate	
9	**10**	**33M**	**47M**		859	7,483		4.0	35.1	500	409	575					0.695	136	Adequate	**Central North Sub Main**
		154A	156		35	35		0.2	0.2	150	90	30					1.364	24	Adequate	
		178A	156		47	47		0.2	0.2	150	90	40					1.181	21	Adequate	
		162	165		47	47		0.2	0.2	150	110	20					1.670	30	Adequate	
		165	156		51	99		0.2	0.5	200	30	20					2.023	64	Adequate	

Table M35.10.1 Flow Calculation Sheet for Branch Sewers, Margao City (Year 2001) (4/10)

Node 1		Node 2		Population			Peak flow (lps)			Existing Sewer									Capacity Adequacy	Remarks
										Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Velocity (m/sec)	Flow Capacity (lps)		
From	To	From	To	From Sub Main	Increment	Cumulative	From Sub Main	Increment	Cumulative				u/s	d/s	u/s	d/s				
		156	161		114	296		0.5	1.4	200	150	40					1.431	45	Adequate	
		166	170		87	87		0.4	0.4	150	120	30					1.364	24	Adequate	
		170	161		95	181		0.4	0.8	200	60	30					1.652	52	Adequate	
		161	222		35	512		0.2	2.4	200	115	50					1.280	40	Adequate	
		215	219		67	67		0.3	0.3	150	120	50					1.056	19	Adequate	
		219	222		244	311		1.1	1.5	200	155	30					1.652	52	Adequate	
		222	227		20	843		0.1	4.0	200	120	50					1.280	40	Adequate	
		179	183		43	43		0.2	0.2	150	120	30					1.364	24	Adequate	
		183	227		102	146		0.5	0.7	200	300	30					1.652	52	Adequate	
		227	230		232	1,222		1.1	5.7	250	80	50					1.485	73	Adequate	
		199	203		55	55		0.3	0.3	150	120	40					1.181	21	Adequate	
		203	230		193	248		0.9	1.2	200	300	50					1.280	40	Adequate	
		230	236		587	2,057		2.8	9.6	250	222	50					1.485	73	Adequate	
		253	257		71	71		0.3	0.3	150	120	60					0.964	17	Adequate	
		257	236		83	154		0.4	0.7	200	60	60					1.168	37	Adequate	
		236	**47M**		768	2,979		3.6	14.0	350	235	90					1.385	133	Adequate	
10	**11**	**47M**	**53M**		508	10,971		2.4	51.4	600	180	425					0.913	258	Adequate	**Central North Sub Main**
		237	239		110	110		0.5	0.5	150	120	20					1.670	30	Adequate	
		239	250		189	299		0.9	1.4	200	150	20					2.023	64	Adequate	
		250	265		150	449		0.7	2.1	200	84	40					1.431	45	Adequate	
		265	270		83	532		0.4	2.5	200	150	60					1.168	37	Adequate	
		270	**53M**		63	595		0.3	2.8	250	70	60					1.355	67	Adequate	
11	**12**	**53M**	**64M**		359	11,924		1.7	55.9	600	360	525					0.821	232	Adequate	**Central North Sub Main**
		247	243		130	130		0.6	0.6	150	132	60					0.964	17	Adequate	
		243	281		288	418		1.3	2.0	200	210	30					1.652	52	Adequate	
		282	281		47	47		0.2	0.2	150	100	90					0.787	14	Adequate	
		281	**64M**		134	599		0.6	2.8	200	45	60					1.168	37	Adequate	
12	**13**	**64M**	**103M**		347	12,870		1.6	60.3	700	160	575					0.870	335	Adequate	**Central North Sub Main**
13	**24**	**103M**	**77M**	9,662	0	22,533	45.3	0.0	105.6	700	720	750					0.762	293	Adequate	**North Main**
Central Zone South Sector																				
		1	3		79	79		0.4	0.4	150	58	30	53.895		52.985		1.364	24	Adequate	
		3	25		493	571		2.3	2.7	250	662	45					1.565	77	Adequate	
		25	40A		1,580	2,152		7.4	10.1	300	498	145		36.515		32.570	0.985	70	Adequate	

Table M35.10.1 Flow Calculation Sheet for Branch Sewers, Margao City (Year 2001) (5/10)

Node 1		Node 2		Population			Peak flow (lps)			Existing Sewer									Capacity Adequacy	Remarks
From	To	From	To	From Sub Main	Increment	Cumulative	From Sub Main	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
		41	40A		130	130		0.6	0.6	200	330	40	41.065	36.515	40.065	32.570	1.431	45	Adequate	
		40A	**0M**		1,289	3,570		6.0	16.7	350	180	100	36.515	33.505	31.815	30.015	1.314	126	Adequate	
		67	62		173	173		0.8	0.8	150	138	40	45.580	42.145	44.480	40.225	1.181	21	Adequate	
		62E	62B		110	110		0.5	0.5	150	90	40	45.085		44.085		1.181	21	Adequate	
		62B	62		71	181		0.3	0.8	200	66	100		42.145		40.225	0.905	28	Adequate	
		62	70		292	646		1.4	3.0	200	85	40	42.145	39.705	40.030	38.675	1.431	45	Adequate	
		70	77		213	859		1.0	4.0	250	205	65	39.705	36.405	38.675	35.225	1.302	64	Adequate	
		78	81		39	39		0.2	0.2	150	90	50	38.215		37.215		1.056	19	Adequate	
		81	77		87	126		0.4	0.6	200	120	90		36.405		35.225	0.954	30	Adequate	
		77	96		236	1,222		1.1	5.7	250	180	65	36.405	34.495	35.225	32.815	1.302	64	Adequate	
		90	96		95	95		0.4	0.4	150	170	90	35.205	34.495	34.205	32.815	0.787	14	Adequate	
		96	**0M**		595	1,911		2.8	9.0	300	248	100	34.495	33.505	32.225	30.015	1.186	84	Adequate	
14	**15**	**0M**	**13M**		705	6,187		3.3	29.0	450	369	200	33.530	31.240	29.825		1.099	175	Adequate	**Central South Sub Main**
		129	133		83	83		0.4	0.4	150	147	50	46.155		45.155		1.056	19	Adequate	
		133	120		315	398		1.5	1.9	200	276	30		35.690		33.755	1.652	52	Adequate	
		110	113		217	217		1.0	1.0	150	90	50	36.390		35.390		1.056	19	Adequate	
		113	120		528	745		2.5	3.5	200	208	100		35.690		33.755	0.905	28	Adequate	
		120	**13M**		24	1,166		0.1	5.5	250	300	90	35.690	31.235	31.510		1.107	54	Adequate	
15	**16**	**13M**	**17M**		567	7,921		2.7	37.1	450	190	140	31.235				1.313	209	Adequate	**Central South Sub Main**
		123	127		59	59		0.3	0.3	150	120	30					1.364	24	Adequate	
		127	144		240	299		1.1	1.4	200	295	20					2.023	64	Adequate	
		144	155		232	532		1.1	2.5	200	130	60		35.910		31.585	1.168	37	Adequate	
		156B	158		79	79		0.4	0.4	200	120	20	46.630		45.630		2.023	64	Adequate	
		158	155		118	197		0.6	0.9	200	145	30		35.910		31.585	1.652	52	Adequate	
		155	**17M**		99	828		0.5	3.9	250	236	80	35.910		31.585		1.174	58	Adequate	
16	**17**	**17M**	**24M**		79	8,827		0.4	41.4	500	180	300		29.780		26.310	0.962	189	Adequate	**Central South Sub Main**
		173	177		35	35		0.2	0.2	150	120	20	51.210		49.210		1.670	30	Adequate	
		177	172		63	99		0.3	0.5	150	120	20		34.955		32.610	1.670	30	Adequate	
		170	172		162	162		0.8	0.8	150	72	30		34.955		32.610	1.364	24	Adequate	
		172	**24M**		288	548		1.3	2.6	200	355	60	34.955	29.780	32.220	26.310	1.168	37	Adequate	
17	**18**	**24M**	**27M**		556	9,930		2.6	46.5	500	73	300	29.780		26.310		0.962	189	Adequate	**Central South Sub Main**
		197	201		87	87		0.4	0.4	150	120	30	40.605		39.605		1.364	24	Adequate	
		201	**27M**		453	540		2.1	2.5	200	321	40					1.431	45	Adequate	

Table M35.10.1 Flow Calculation Sheet for Branch Sewers, Margao City (Year 2001) (6/10)

Node 1		Node 2		Population			Peak flow (lps)			Existing Sewer									Capacity Adequacy	Remarks
										Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Velocity (m/sec)	Flow Capacity (lps)		
From	To	From	To	From Sub Main	Increment	Cumulative	From Sub Main	Increment	Cumulative				u/s	d/s	u/s	d/s				
18	**19**	**27M**	**37M**		406	10,876		1.9	51.0	500	311	300					0.962	189	Adequate	**Central South Sub Main**
		193	226		47	47		0.2	0.2	150	140	40	36.870	33.445	35.820	32.370	1.181	21	Adequate	
		211	226		102	102		0.5	0.5	150	130	90	33.720	33.445	32.720	32.370	0.787	14	Adequate	
		226	229A		146	296		0.7	1.4	200	67	60	33.445	34.220	31.280	32.660	1.168	37	Adequate	
		237	240		20	20		0.1	0.1	150	90	10	49.190		47.690		2.362	42	Adequate	
		240	236		28	47		0.1	0.2	200	55	15		35.175		34.220	2.336	73	Adequate	
		236	230		0	47		0.0	0.2	200	40	50	35.175		34.220		1.280	40	Adequate	
		231	234		39	39		0.2	0.2	150	90	20	44.070		42.470		1.670	30	Adequate	
		234	230		43	83		0.2	0.4	200	57	20					2.023	64	Adequate	
		230	229A		4	134		0.0	0.6	200	38	50		34.220		32.660	1.280	40	Adequate	
		229A	**37M**		185	615		0.9	2.9	250	275	50	34.220		30.166		1.485	73	Adequate	
19	**20**	**37M**	**42M**		55	11,546		0.3	54.1	500	123	300					0.962	189	Adequate	**Central South Sub Main**
		272	266		32	32		0.1	0.1	150	90	40	37.480	35.795	36.480	34.230	1.181	21	Adequate	
		267	266		118	118		0.6	0.6	150	120	60	36.600	39.795	35.600	34.230	0.964	17	Adequate	
		266	246		102	252		0.5	1.2	200	210	40	39.795		33.600		1.431	45	Adequate	
		250	246		71	71		0.3	0.3	150	120	50	32.535		31.535		1.056	19	Adequate	
		246	**42M**		173	497		0.8	2.3	250	120	60					1.355	67	Adequate	
20	**21**	**42M**	**48M**		252	12,295		1.2	57.6	500	220	300					0.962	189	Adequate	**Central South Sub Main**
		251	254		55	55		0.3	0.3	150	90	50	32.685		31.685		1.056	19	Adequate	
		254	**48M**		55	110		0.3	0.5	200	110	20					2.023	64	Adequate	
21	**22**	**48M**	**56M**		166	12,571		0.8	58.9	600	232	280					1.125	318	Adequate	**Central South Sub Main**
		283	263		51	51		0.2	0.2	150	120	40	33.665	30.725	32.665	29.665	1.181	21	Adequate	
		258	261		39	39		0.2	0.2	150	90	50	32.400		31.400		1.056	19	Adequate	
		261	263		236	276		1.1	1.3	200	80	60		30.725		29.665	1.168	37	Adequate	
		263	**56M**		28	355		0.1	1.7	200	145	30	30.725		25.270		1.652	52	Adequate	
22	**23**	**56M**	**64M**		39	12,965		0.2	60.8	600	235	300					1.087	307	Adequate	**Central South Sub Main**
		300A	297		63	63		0.3	0.3	150	53	30	26.775	25.325	25.775	23.775	1.364	24	Adequate	
		291	294		55	55		0.3	0.3	150	90	50	27.365		26.365		1.056	19	Adequate	
		294	297		87	142		0.4	0.7	200	90	50		25.325		23.775	1.280	40	Adequate	
		297	**64M**		91	296		0.4	1.4	200	90	50	25.325		22.315		1.280	40	Adequate	
23	**24**	**64M**	**77M**		217	13,477		1.0	63.2	600	361	350					1.006	284	Adequate	**Central South Sub Main**
24	**24a**	**77M**	**79M**		0	36,009		0.0	168.8	800	57	750					0.833	418	Adequate	**North Main**

Table M35.10.1 Flow Calculation Sheet for Branch Sewers, Margao City (Year 2001) (7/10)

Node 1		Node 2		Population			Peak flow (lps)			Existing Sewer									Capacity Adequacy	Remarks
From	To	From	To	From Sub Main	Increment	Cumulative	From Sub Main	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
		375	**79M**		43	43		0.2	0.2	150	90	30	22.820		21.820		1.364	24	Adequate	**North Main**
24a	**24b**	**79M**	**81M**		0	36,053		0.0	169.0	800	153	750					0.833	418	Adequate	**North Main**
		341B	345B		75	75		0.4	0.4	150	120	40	33.775		33.475		1.181	21	Adequate	
		345B	362		126	201		0.6	0.9	200	210	40					1.431	45	Adequate	
		361	362		20	20		0.1	0.1	150	30	40	26.980		25.980		1.181	21	Adequate	
		362	363		39	260		0.2	1.2	200	60	60					1.168	37	Adequate	
		350	353		28	28		0.1	0.1	150	90	30					1.364	24	Adequate	
		353	363		35	63		0.2	0.3	200	65	20					2.023	64	Adequate	
		363	365		39	363		0.2	1.7	200	55	60					1.168	37	Adequate	
		346	346A		71	71		0.3	0.3	150	120	40					1.181	21	Adequate	
		341A	346A		28	28		0.1	0.1	150	120	50					1.056	19	Adequate	
		346A	365		55	154		0.3	0.7	200	160	40					1.431	45	Adequate	
		317	321		63	63		0.3	0.3	150	120	25	40.035		39.035		1.494	26	Adequate	
		321	329		201	264		0.9	1.2	200	240	40		30.240		27.285	1.431	45	Adequate	
		314	329		32	32		0.1	0.1	150	90	20	33.700	30.240	32.700	27.285	1.670	30	Adequate	
		273	277		67	67		0.3	0.3	150	120	50	37.885		36.885		1.056	19	Adequate	
		277	329		205	272		1.0	1.3	200	360	50		30.240		27.285	1.280	40	Adequate	
		329	332		323	891		1.5	4.2	250	85	40	30.240	26.490	26.735	24.610	1.660	81	Adequate	
		302	305		28	28		0.1	0.1	150	90	30	32.200		31.200		1.364	24	Adequate	
		305	332		47	75		0.2	0.4	200	110	30		26.490		24.610	1.652	52	Adequate	
		332	369		110	1,076		0.5	5.0	250	280	90	26.490	23.760	24.240	21.115	1.107	54	Adequate	
		369	367		288	1,363		1.3	6.4				23.760		19.950					Data Missing
		341	367		51	51		0.2	0.2	150	150	50					1.056	19	Adequate	
		367	365		0	1,415		0.0	6.6											Data Missing
		365	380		0	1,931		0.0	9.1											Data Missing
		386	380		59	59		0.3	0.3	150	110	30	25.095		23.545		1.364	24	Adequate	
		380	**81M**		122	2,112		0.6	9.9	200	90	30					1.652	52	Adequate	
24b	**24c**	**81M**	**89M**		0	38,165		0.0	178.9	800	134	750					0.833	418	Adequate	**North Main**
		383	388		24	24		0.1	0.1	150	90	50	23.640	24.555	22.640	20.840	1.056	19	Adequate	
		388	89M		71	95		0.3	0.4	200	170	40	24.555		20.840		1.431	45	Adequate	
24c	**25**	**89M**	**92M**		0	38,260		0.0	179.3	800	86	750					0.833	418	Adequate	**North Main**

Table M35.10.1 Flow Calculation Sheet for Branch Sewers, Margao City (Year 2001) (8/10)

Node 1		Node 2		Population			Peak flow (lps)			Existing Sewer									Capacity Adequacy	Remarks
										Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m)		Invert level (m)		Velocity (m/sec)	Flow Capacity (lps)		
From	To	From	To	From Sub Main	Increment	Cumulative	From Sub Main	Increment	Cumulative				u/s	d/s	u/s	d/s				
North Zone Sector II																				
		327	331		12	12		0.1	0.1	150	92	30					1.364	24	Adequate	
		331	334		16	28		0.1	0.1	200	95	40					1.431	45	Adequate	
		285	288		71	71		0.3	0.3	150	83	30					1.364	24	Adequate	
		288	326		67	138		0.3	0.6	200	153	30					1.652	52	Adequate	
		292	326		16	16		0.1	0.1	150	122	20					1.670	30	Adequate	
		326	335		59	213		0.3	1.0	200	30	40					1.431	45	Adequate	
		335	334		83	296		0.4	1.4	250	210	40					1.660	81	Adequate	
		334	**92M**		0	323		0.0	1.5	250	30	40					1.660	81	Adequate	
25	**25a**	**92M**	**100M**	38,260	355	38,937	179.3	1.7	182.5	800	235	750					0.833	418	Adequate	**North Main**
		211	240		646	646		3.0	3.0	150	880	24					1.525	27	Adequate	
		240	244		386	1,032		1.8	4.8	200	150	114					0.847	27	Adequate	
		255	244		83	83		0.4	0.4	150	230	38					1.220	22	Adequate	
		244	246		126	1,241		0.6	5.8	200	63	125					0.809	25	Adequate	
		250	253		43	43		0.2	0.2	150	95	20					1.670	30	Adequate	
		253	246		142	185		0.7	0.9	150	190	30					1.364	24	Adequate	
		246	275		106	1,533		0.5	7.2	200	255	50					1.280	40	Adequate	
		272	273		16	16		0.1	0.1	150	35	50					1.056	19	Adequate	
		273	275		32	47		0.1	0.2	200	74	50					1.280	40	Adequate	
		275	276		193	1,773		0.9	8.3	300	53	50					1.677	119	Adequate	
		283	281		67	67		0.3	0.3	150	64	20					1.670	30	Adequate	
		281	279		63	130		0.3	0.6	200	60	60					1.168	37	Adequate	
		279	276		106	236		0.5	1.1	250	80	60					1.355	67	Adequate	
		276	300		437	2,447		2.1	11.5	300	120	60					1.531	108	Adequate	
		304	300		8	8		0.0	0.0	150	120	30					1.364	24	Adequate	
		300	307		8	2,463		0.0	11.5	350	100	60					1.696	163	Adequate	
		311	314		51	51		0.2	0.2	150	90	45					1.113	20	Adequate	
		383	385		20	20		0.1	0.1	150	80	40					1.181	21	Adequate	
		385	314		39	59		0.2	0.3	200	140	40					1.431	45	Adequate	
		308	314		59	59		0.3	0.3	150	90	30					1.364	24	Adequate	
		314	316		28	197		0.1	0.9	200	50	45					1.349	42	Adequate	

Table M35.10.1 Flow Calculation Sheet for Branch Sewers, Margao City (Year 2001) (9/10)

Node 1		Node 2		Population			Peak flow (lps)			Existing Sewer									Capacity Adequacy	Remarks
From	To	From	To	From Sub Main	Increment	Cumulative	From Sub Main	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
		316	307		177	374		0.8	1.8	200	135	50					1.280	40	Adequate	
		307	346		8	2,845		0.0	13.3	350	185	60					1.696	163	Adequate	
		354	346		59	59		0.3	0.3	150	162	30					1.364	24	Adequate	
		346	349		4	2,908		0.0	13.6	350	75	60					1.696	163	Adequate	
		359	362		43	43		0.2	0.2	150	90	30					1.364	24	Adequate	
		362	349		39	83		0.2	0.4	200	61	30					1.652	52	Adequate	
		349	350		4	2,995		0.0	14.0	350	45	60					1.696	163	Adequate	
		364A	366		32	32		0.1	0.1	200	95	40					1.431	45	Adequate	
		366	350		28	59		0.1	0.3	200	40	40					1.431	45	Adequate	
		350	353		4	3,058		0.0	14.3	350	75	60					1.696	163	Adequate	
		379	353		47	47		0.2	0.2	150	125	40					1.181	21	Adequate	
		353	**100M**		4	3,109		0.0	14.6	350	40	60					1.696	163	Adequate	
25a	**26**	**100M**	**111M**		504	42,551		2.4	199.5	800	335	750					0.833	418	Adequate	**North Main**
		390	393		51	51		0.2	0.2	150	90	20					1.670	30	Adequate	
		393	373		79	130		0.4	0.6	200	12	20					2.023	64	Adequate	
		368	371		47	47		0.2	0.2	150	90	30					1.364	24	Adequate	
		371	373		16	63		0.1	0.3	200	62	40					1.431	45	Adequate	
		373	374		16	209		0.1	1.0	200	50	40					1.431	45	Adequate	
		374	375		71	280		0.3	1.3	250	45	50					1.485	73	Adequate	
		397D	397		32	32		0.1	0.1	150	100	20					1.670	30	Adequate	
		397	375		43	75		0.2	0.4	200	125	40					1.431	45	Adequate	
		375	378		87	441		0.4	2.1	250	57	50					1.485	73	Adequate	
		378	432		225	666		1.1	3.1	250	180	75					1.212	60	Adequate	
		432	157		177	843		0.8	4.0	250	100	75					1.212	60	Adequate	
		411	414		43	43		0.2	0.2	150	90	20					1.670	30	Adequate	
		414	415A		43	87		0.2	0.4	200	40	20					2.023	64	Adequate	
		403	406		28	28		0.1	0.1	200	150	30					1.652	52	Adequate	
		406	415A		59	87		0.3	0.4	150	90	20					1.670	30	Adequate	
		415A	149		79	252		0.4	1.2	250	120	40					1.660	81	Adequate	
		422	425		32	32		0.1	0.1	150	90	20					1.670	30	Adequate	
		425	146		47	79		0.2	0.4	200	130	40					1.431	45	Adequate	
		146	149		3,216	3,294		---	0.4	300	83	200					0.838	59	Adequate	Receiving sewage from South Zone
		149	157		418	3,964		2.0	3.5	300	240	200					0.838	59	Adequate	
		157	**111M**		0	4,808		0.0	7.5											Data Missing

Table M35.10.1 Flow Calculation Sheet for Branch Sewers, Margao City (Year 2001) (10/10)

Node 1		Node 2		Population			Peak flow (lps)			Existing Sewer									Capacity Adequacy	Remarks
From	To	From	To	From Sub Main	Increment	Cumulative	From Sub Main	Increment	Cumulative	Diameter (mm)	Length (m)	Gradient (1/x)	Ground level (m) u/s	Ground level (m) d/s	Invert level (m) u/s	Invert level (m) d/s	Velocity (m/sec)	Flow Capacity (lps)		
26	**27**	**111M**	**303M**		1,572	48,931		7.4	214.3	900	1,260	950					0.800	509	Adequate	**North Main**
27	**28**	**303M**	**313M**		0	48,931		0.0	214.3	1000	300	1,200					0.764	600	Adequate	**North Main**
28	**29 (STP)**	**313M**	**STP**		29,451	78,382		---	214.3	1200	60	1,200					0.862	975	Adequate	**North Main (Proposed South Main connected here)**

Note: **Sewer 146-149 will receive wastewater of South Zone in future**
North Main 313M-STP will receive wastewater of South Zone through proposed South Main in future

Note: **Node 1 coordinates with Figure 3.2.2**
Node 2 coordinates with Sewerage zone map

Peak factor : 2.25
Manning's n: 0.015

Appendix M35.11 Data for Flow Calculation Sheet of Sewers in Year 2001, Margao City

Flow calculation sheets for Margao City for evaluation on flow capacity in year 2001 have been prepared based on Project Report on Environmental Upgradation of Margao City Phase I and Sewerage zone map. But these data are not sufficient for the required purposes as described in Table (1). Therefore, some presumptions and assumptions on missing data have been adopted to solve the purposes and are described in Table (2). See Appendix M35.9 and M35.10 for the flow calculation sheets prepared in this study.

(1) Data on Sewers Details, Controversial Points

Item	Description / Controversial Point	Source
(1) Service Area	Total service area: Described (about 876 ha) Sewerage Zone wise service area: Described North Zone: 360 ha Central Zone: 308 ha South Zone: 208 ha Total: 876 ha Catchment area of Each Sewer: Not described	(2)
(2) Service area Population	Total population in service area: Described 120,000 persons in year 2011 (target year of current plan) Sewerage Zone wise population: Described North Zone: 34,956 Central Zone: 34,311 South Zone: 50,733 Total: 120,000 Contributory population of each sewer: Not described	(2)
(3) Wastewater Quantity	Calculated not based on water demand Calculated based on population and per capita per day wastewater generation (180 lpcd). Total wastewater quantity: Described (21.6 MLD in 2011) Sewerage Zone wise quantity: Described Location of hotels: Not described	(2)
	Flow of each sewer: Described Total wastewater Quantity: 28.6 MLD This doesn't match the value estimated based on population and per capita wastewater generation 21.6 MLD. The reason of the difference is not clear. But this calculation sheet is useful to estimate flow of each sewer.	(1)
(4) Sewer Alignment	Described on the map clearly	(3)
(5) Diameter and Slope of Sewers	Described in flow calculation sheet clearly	(1)
(6) Length of Sewers	Described in flow calculation sheet clearly	(1)
(7) Ground Elevation	Described on the map for some nodes in South sector of Central Zone	(3)
(8) Invert Elevation of Sewer	Described on the map for some nodes in South sector of Central Zone	(3)

Item	Description / Controversial Point	Source
(9) Flow Velocity	Calculated using Manning's formula with 0.015 as roughness coefficient	(1)
(10) Flow Capacity	Based on flow velocity and cross section area of sewer at a design depth depending on diameter of the sewer as given below Diameter — Design depth 150mm-400mm — 0.50 450mm-900mm — 0.67 1000mm-1200mm — 0.75	(1)

Source: (1) Report titled "Under Ground Drainage Scheme to Margao Town"
(2) General Sewer Network Plan
(3) Sewerage Zone Maps

(2) Countermeasure for Flow Calculation Sheet and Evaluation on Flow Capacity

Item	Description / Countermeasure
(1) Service Area	Zone wise service area: Adopt figures in the Report Sewer wise catchment area: Not measured Not used for calculating sewer wise wastewater quantity
(2) Service area Population	Sewer wise population: Calculated based on design flow of each sewer described in the flow calculation sheet for year 2011. Assuming that population distribution pattern in year 2001 is same as year 2011.
(3) Wastewater Quantity, Design flow	Sewer wise wastewater quantity: Calculated based on sewer wise population and per capita wastewater generation. Adopt peak factor of 2.25 depending on present population.
(4) Sewer Alignment	Adopt sewer alignment described in sewerage zone map.
(5) Diameter and Slope of Sewers	Adopt figures described in the flow calculation sheet.
(6) Length of Sewers	Adopt figures described in the flow calculation sheet.
(7) Ground Elevation	Adopt ground elevation described in sewerage zone map when available.
(8) Invert Elevation of Sewer	Adopt invert elevation of sewer described on sewerage zone map when available.
(9) Flow Velocity	Calculate using Manning's formula with 0.015 as roughness coefficient
(10) Flow Capacity	Based on flow velocity and cross section area of sewer
(11) Evaluation of Flow Capacity	For present condition: When full flow capacity exceeds design flow, flow capacity is evaluated as adequate. Leave margin capacity out of consideration.

M35.12 General Description of Main and Sub Main Sewers, Margao City

Table M35.12.1 General Description of Main and Sub Mains, Margao City

(A) North Main

Node From	Node To	Diameter (mm)	Length (m)	Type	Sub main connected to main
1	2	300	430	Gravity Sewer	
2	3	350	750		
3	4	400	630		
4	5	450	920		
5	13	500	510		
13	24	700	720		Central north Sub Main
24	25	800	430		Central south Sub Main
25	26	800	570		
26	27	900	1,260		
27	28	1,000	300		
28	STP	1,200	60		(Proposed South Main)
Sub total			6,580		

(B) Central North Sub Main

Node From	Node To	Diameter (mm)	Length (m)	Type	Sub main connected to main
6	7	350	214	Gravity Sewer	North part of Central Zone
7	8	400	450		
8	9	500	360		
9	10	500	409		
10	11	600	180		
11	12	600	360		
12	13	700	160		
Sub total			2,133		

(C) Central South Sub Main

Node From	Node To	Diameter (mm)	Length (m)	Type	Sub main connected to main
14	15	450	369	Gravity Sewer	South part of Central Zone
15	16	450	190		
16	17	500	180		
17	18	500	73		
18	19	500	311		
19	20	500	123		
20	21	500	220		
21	22	600	232		
22	23	600	235		
23	24	600	361		
Sub total			2,294		
Total			11,007		

Source: Under Ground Scheme to Margao Town

M35.13 Sewerage Zone and Diameter wise Sewer Length,Margao City

Table M35.13.1 Sewerage Zone and Diameter wise Sewer length, Margao City

(meters)

	Branch Sewers						Main and Sub Main Sewers												Total
	150mm	200mm	250mm	300mm	350mm	Sub Total	300mm	350mm	400mm	450mm	500mm	600mm	700mm	800mm	900mm	1000mm	1200mm	Sub Total	
North Zone (Sector I)	4,086	2,468	0	0	0	6,554	430	750	630	920	510	0	0	0	0	0	0	3,240	9,794
Central (North)	2,681	3,592	1,425	90	235	8,023	0	214	450	0	769	540	880	0	0	0	0	2,853	10,876
Central (South)	3,898	4,953	2,343	746	180	12,120	0	0	0	559	907	828	0	430	0	0	0	2,724	14,844
North Zone (Sector II)	3,098	1,920	822	496	520	6,856	0	0	0	0	0	0	0	570	1,260	300	60	2,190	9,046
Total	13,763	12,933	4,590	1,332	935	33,553	430	964	1,080	1,479	2,186	1,368	880	1,000	1,260	300	60	11,007	44,560

Note: Lengths were measured on sewerage zone map
Note: (1) North Zone (Sector I):Catchment area of North Main (From starting point to junction with Central North Sub Main)
(2) Central Zone (North): Catchment area of Central North Sub Main
(3) Central Zone (South): Catchment area of Central North Sub Main
(4) North Zone (Sector II): Catchment area of North Main (Junction point with Central South Sub Main to sewage treatment plant)

Appendix M35.14 List of Existing STP Facilities, Margao City

Table M35.14.1 List of Existing Sewage Treatment Plant in Margao

Item			Dimension
1	General Condition		
	Name of STP		Margao Sewage Treatment Plant
	Location		Sirvodem, Navelim - Margao
	Commissioning year		May. 03. 2000
	Treatment capacity		7,500 m^3/day
2	Technical Details		
	2.1	Intake Facility	
		Inlet pipe diameter	1,200 mm (RC Pipe)
		Size of chamber	4.00 m × 3.50 m × 4.00 m
	2.2	Raw Sewage Pump Facility	
		Pump sum	12.30 m diameter × 15.0 m
		Pump type	Non clog pumps horizontal model centrifugal
		Pump power and head	200 m^3/hr × 12.0 m × 25 HP × 2 units
			400 m^3/hr × 12.0 m × 50 HP × 2 units
	2.3	Screening and Grit Chamber	
		Screen type	Mechanical screen type
		Size of screen	20 mm screen opening
		Size of grit chamber	8.00 m × 0.35 m × 1.25 m
	2.4	Primary Clarifier	
		Size	18.00 m diameter × 3.00 m depth
	2.5	Activated Sludge Tank	
		Method of Aeration	Surface aerator
		Size	33.00 m × 12.00 m × 3.00 m depth
	2.6	Secondary Clarifier	
		Size	21.00 m diameter × 3.00 m depth
	2.7	Sludge Digester	
		Size	18.00 m diameter × 10.65 m depth
	2.8	Sludge drying bed	
		Size	12.80 m × 12.40 m × 14 basins

Source: Sector Status Study Water and Sanitation Goa, Draft Final Report (Appendix)

M35.15 Capacity Calculation of STP(Activated Sludge), Margao City

CAPACITY CALCULATION OF SEWAGE TREATMENT FACILITIES
＜Activated Sludge Method in Margao Municipality＞

1 BASIC CONDITIONS

1-1 Basic Items

(1) Name : **Margao** Sewage Treatment Plant

(2) Land Area : Approximately 31,500 m^2

(3) Elevation : 20.50 m

(4) Inlet Pipe Level : 14.00 m

(5) Pipe Diameter : Concrete Pipe 1,200 mm

(6) Land Use : Exclusively for Sewage Treatment Plant

(7) Collection System : Combined System ・ Separate System

(8) Treatment Method :

Sewage Treatment ; Pre-treatment + Primary settling + Activated sludge + Secondary settling

Sludge Treatment ; Sludge Digestion + Sludge drying Bed

(9) Effluent Point : Sal river

(10) Effluent Point Water Level : High Level = + m, Low Level = + m

(11) Target Year : 2011 Year

1-2 Design Population and Area

Design Population : 120,000 Persons

Design Area : 876.0 ha

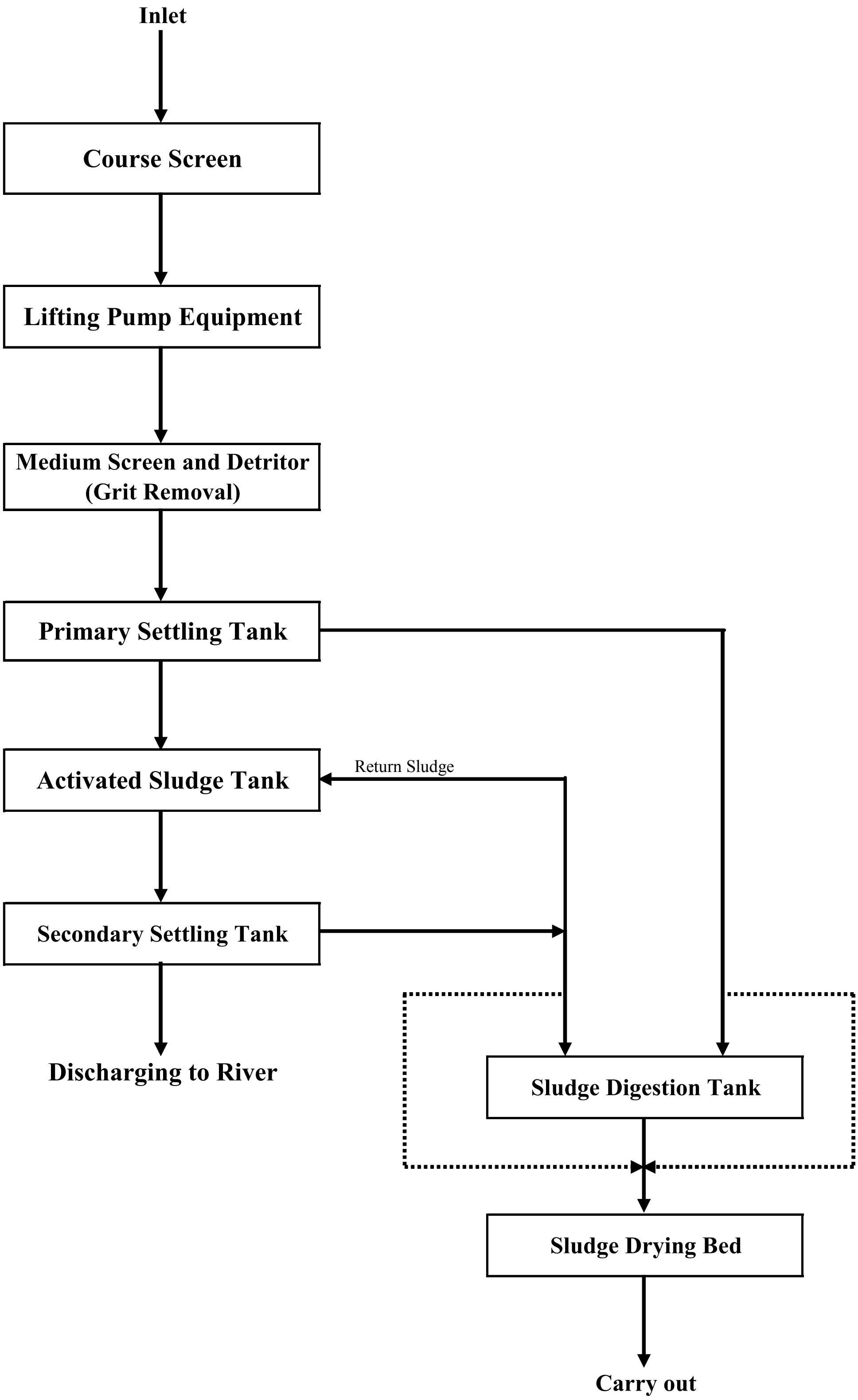
1-3 Design Sewage Flow

Item	m^3/day	m^3/hr	m^3/min	m^3/sec	Remarks
Daily Average (DA)	7,500	312.5	5.21	0.087	
Daily Maximum (DM)	10,714	446.4	7.44	0.124	DA : DM = 0.7 : 1.0
Hourly Maximum (HM)	16,875	703.1	11.72	0.195	DA : HM = 1.0 : 2.25

1-4 Design Sewage Quality

Item	Influent (mg/L)	Removal Rate (%)	Effluent (mg/L)	Remarks
BOD	300	90	30	Effluent Quality Regulation = 30 mg/l
SS	300	83	50	Effluent Quality Regulation = 100 mg/l

1-5 Flow Chart (Activated Sludge Method)



1-6 Design Criteria for Activated Sludge Method

Items	Unit	Figure *1	Figure *2	Adoption
1-6-1 Grit Chamber				
(1) Water surface load	m3/m2/day	1,800	2,160	2,160
(2) Average velocity	m/sec	0.3	0.15 - 0.30	0.3
1-6-2 Wet Well with Pump Facilities				
(1) Pump inlet flow velocity	m/sec	1.5 - 3.0	-	2.25
(2) Retention time in Wet Well	min	-	> 5.0	5.0
1-6-3 Primary Settling Tank				
(1) Water surface load	m3/m2/day	35.0 - 70.0	35.0 - 50.0	31.0
(2) Water depth	m	2.5 - 4.0	2.5 - 3.5	2.5
1-6-4 Activated Sludge Tank				
(1) Type of activated sludge	-	-	-	Complete mixed
(2) MLSS concentration	mg/L	1,500 - 2,000	1,500 - 3,000	4,000
(3) BOD-SS Load	kgBOD/kgSS・day	0.2 - 0.4	0.3 - 0.4	0.45
(4) Retention time	hr	6.0 - 8.0	4.0 - 6.0	4.0
(5) Water depth	m	4.0 - 6.0	3.0 - 4.5	3.0
1-6-5 Secondary Settling Tank				
(1) Water surface load	m3/m2/day	20.0 - 30.0	15.0 - 35.0	24.0
(2) Water depth	m	2.5 - 4.0	3.5 - 4.5	2.5
1-6-6 Sludge Conditions				
(1) Raw sludge moisture ratio	%	99.0	-	99.0
(2) Digested sludge moisture	%	96.0 - 97.5	-	97.0
1-6-7 Sludge Digestion Tank				
(1) Type of digestion	-	-	-	High rate
(2) Retention time	day	20	10 - 20	10
1-6-7 Sludge Drying Bed				
(1) Retention Time	day	10 - 15	< 2 weeks	10.0
(2) Depth of Sludge Bed	m	0.20 - 0.30	max 0.30	0.30
(3) Required Area	m2/capita	-	0.10 - 0.25	0.10 - 0.25

*1: Design Criteria in Japanese standard and "Wastewater Engineering" by Metcalf & Eddy
*2: Design Criteria in India named "Manual on Sewerage and Sewage Treatment"

1-7 Summary of the Existing STP in Margao

Item	Dimension
1 General Condition	
Name of STP	Margao Sewage Treatment Plant
Location	Sirvodem, Navelim - Margao
Commissioning Year	2000, May, 03
Capacity	15,000m^3/day (designed), 7,500m^3/day (existing)
2 Technical Details	
2.1 Intake Facility	
Inlet Pipe Diameter	1,200mm (RC Pipe)
Size of Chamber	4.00m × 3.50m × 4.00m
2.2 Raw Sewage Pump Facility	
Pump Sum	12.30m diameter, 15.0m height
Pump Type	Non clog pumps horizontal model Centrifugal
Pump Dimension	200m^3/hour (3.33m^3/min) × 12m × 25HP ×2units
(7 years old)	400m^3/hour (6.67m^3/min) × 12m × 50HP ×2units
2.3 Screening and Grit Chamber	
Screen Type	Mechanical type
Size of Screen	20mm screen opening
Size of Grit Chamber	8.00m × 0.35m × 1.25m
2.4 Primary Clarifier	
Size	18.00m diameter × 3.00m depth
2.5 Activated Sludge Tank	
Method of Aeration	Surface Aerators
Size	33.00m × 12.00m × 3.00m
2.6 Secondary Clarifier	
Size	21.00m diameter × 3.00m depth
2.7 Sludge Digester	
Size	18.00m diameter × 10.65m depth
2.8 Sludge Drying Beds	
Size	12.80m × 12.40m × 14basins
2.9 Treated Water Disposal	Discharging to sea through masonry drain

Source: Sector Status Study Water & Sanitation Goa, Draft Final Report (Appendix), August 2004, P.111

2 STUDY OF THE TREATMENT CAPACITY

2-1 Wet Well with Pump Facilities

(1) Wet Well

Q2	Design sewage flow (Hourly Maximum)	:	16,875	m3/day	=	11.72	m3/min
RT	Retention Time	:	5.0	min			
RV	Required Volume	:	Q2×RT	=	58.6	m3	
	Size of Existing Well	:	12.3	m dia.	×	15.0	m dep.
V1	Volume of Existing Well	:	V1=	1,781	m3		
	Calculated Retention Time	:	V1/Q2	=	152.0	min	

Comparison of the retention time between the criteria and calculated figure

Design criteria	Calculated figure
> 5.0 min	**152.0 min**

∴ OK

(2) Pump Facilities

Q2 Design sewage flow (Hourly Maximum) : 16,875 m3/day = 11.72 m3/min

PN Units number : 2 units (small capacity)

2 units (large capacity, including 1 stand-by unit)

PC Discharging capacity : 1 : 1 : 2 (assumption)

Small pump 2.95 m3/min./unit

Large pump 5.90 m3/min./unit

H Pump head : 12.0 m

D1 Calculated pump diameter (Small pump) : $D1 = 146\times(PC/1.5\sim3.0)^{0.5}$

$= 145 \sim 205$

= **150 mm**

D1 Calculated pump diameter (Large pump) : $D1 = 146\times(PC/1.5\sim3.0)^{0.5}$

$= 205 \sim 290$

= **250 mm**

P1 Calculated motor power (Small pump) : $P1 = 0.222\times PC\times H\times(1+0.15)/0.60$

= **15.1 HP**

P2 Calculated motor power (Large pump) : $P1 = 0.222\times PC\times H\times(1+0.15)/0.60$

= **30.1 HP**

Comparison of the pump specifications between the existing and calculated facilities

Pump specification		Existing facilities	Required figures by calculation
Diameter	small	-	150 mm
	large	-	250 mm
Discharging capacity	small	3.33 m3/min./unit	2.95 m3/min./unit
	large	6.67 m3/min./unit	5.90 m3/min./unit
Pump head	small	12.0 m	12.0 m
	large	12.0 m	12.0 m
Motor power	small	25.0 HP	15.1 HP
	large	50.0 HP	30.1 HP
Units number	small	2 units	2 units
	large	2 units	2 (1) units

2-2 Grit Chamber

Q2 Design sewage flow (Hourly Maximum) : 16,875 m3/day = 11.72 m3/min
SL Water surface load : 2,160 m3/m2/day
RA Required surface area : RA= Q2/SL = 7.8 m2
A Area of existing grit chamber : 8.00 m × 1.25 m
= 10.0 m2

Comparison of the surface area between the existing and required figures

Existing facilities	Required area by calculation
10.0 m2	**7.8 m2**

∴ **OK**

AW Actual water surface load : AW= Q2/A = 1,688 m3/m2/day

2-3 Primary Settling Tank

Q1 Design sewage flow (Daily Average) : 7,500 m3/day = 312.5 m3/hr
WSL Water surface load : WSL= 31 m3/m2/day
RA Required surface area : RA= Q1/WSL = 241.9 m2
A Surface area of existing primary settling tank : 18.0 m dia.
= 254.3 m2

Comparison of the surface area between the existing and required figures

Existing facilities	Required area by calculation
254 m2	**242 m2**

∴ **OK**

2-4 Activated Sludge Tank

Q1 Design sewage flow (Daily Average) : 7,500 m3/day = 312.5 m3/hr
MS MLSS concentration : 4,000 mg/l
RT1 Retention time : RT1= 4.0 hr
RV1 Required volume : RV1= Q1×RT1 = 1,250 m3
V Volume of existing tank : 33.0 m × 12.0 m × 3 m
= 1188 m3
RT2 Retention time calculated based on the existing tank : RT2= V/Q1
= 3.8 hr
BS BOD-SS load : 0.45 kgBOD/kgSS・day
BOD2 BOD quality at inlet to aeration tank : 300.0 × 0.5 (assumption)
= 150.0 mg/l
RV2 Required volume : RV2= Q1×BOD2/(BS×MS)
= 625 m3

Comparison of required volume between the existing and calculated facilities

Volume of existing tank	Calculated volume based on retention time	Calculated volume based on BOD-SS load
1188 m3	**1,250 m3**	**625 m3**

2-5 Secondary Settling Tank

Q1 Design sewage flow (Daily Average) : 7,500 m3/day = 312.5 m3/hr
WSL Water surface load : WSL= 24 m3/m2/day
RA Required surface area : RA= Q1/WSL = 312.5 m2

A Surface area of existing primary settling tank : 21.0 m dia.
= 346.2 m2

Comparison of the surface area between the existing and required figures

Existing facilities	Required area by calculation
346 m2	**313 m2**

∴ **OK**

2-6 Sludge Digestion Tank

- \- Type of sludge digestion : High rate digestion
- Q1 Design sewage flow (Daily Average) : 7,500 m3/day
- SSin Inlet SS : 300 mg/l
- SSout Outlet SS : 50 mg/l
- GS-1 Generated sludge : GS-1= Q1 × (SS in - SS out) × 10^{-6}
  = 1.88 t/day
- W Sludge moisture ratio : W= 99.0 %
- GS-2 Generated sludge in volume : GS-2= GS-1×100/(100-W)
  = 187.5 m3/day
- RT Retention time : 10 days
- RV Required volume : RV= GS-2×RT = 1,875 m3
- V Volume of existing tank : 18.0 m dia. × 10.65 m depth
  V= 2,709 m3

Comparison of the tank volume between the existing and required figures

Existing facilities	Required volume by calculation
2,709 m3	**1,875 m3**

∴ **OK**

2-7 Sludge Drying Bed

- Q1 Design sewage flow (Daily Average) : 7,500 m3/day
- SSin Inlet SS : 300 mg/l
- SSout Outlet SS : 50 mg/l
- GS-1 Generated sludge : GS-1= Q1 × (SS in - SS out) × 10^{-6}
  = 1.88 t/day
- W Digested sludge moisture ratio : W= 97.0 %
- GS-2 Generated sludge in volume : GS-2= GS-1×100/(100-W)
  = 62.5 m3/day
- RT Retention time : RT= 10.0 days
- RV Required volum : RV= GS-2×RT = 625.0 m3
- H Depth of sludge bed : H= 0.30 m
- RA Required area : RA= RV/H = 2,083 m2
- A Area of existing drying bed : 12.80 × 12.40 × 14 basins
  A= 2,222 m2

Comparison of drying bed area between the existing and required figures

Existing facilities	Required area by calculation
2,222 m2	**2,083 m2**

∴ **OK**

Appendix M35.16 Data Sheets and Photos for Investigation on On-site Treatment Facilities

(1) Septic Tank and Soak Pit for Domestic, Margao City

(2) Wastewater Treatment Facility for Taj Exotica Hotel

(3) Wastewater Treatment Facility for Factory of Zuari Industry Ltd.

(4) Wastewater Treatment Facility for Birla Institute of Technology (College)

Data Sheets for Investigation on On-site Treatment Facilities (1/4)

Date of Investigation: August 18, 2005

1. Type of Facility:	Treatment Facility for Domestic
2. Location of Facility:	Aquem area, near Vishand theatre, Margao City (In South Sewerage Zone of the City: Not sewered yet)
3. Type of Water Supply:	Public water supply
4. Quantity of Water Consumption:	-

5. Type of wastewater:	Domestic and commercial wastewater
6. Type of Wastewater Treatment Method:	Septic tank and soak pit
7. Size of Facility:	For over 50 persons
8. Actual Wastewater Flow:	No data
9. Discharging Point of Treated Effluent:	Discharging to a side ditch of road for storm water
10.Wastewater Quality:	No data
11. Treatment and Disposal Method of Sludge:	Remove from the tank and carry to Margao STP by contractors, as occasion arises

12. Others:

- Overflow effluent from soak pit is discharging into side ditch of road for storm water
- The effluent seems to be diluted with storm water and looks clean
- No smell detected at the discharging point
- Septic tank is built of laterite bricks and waterproofed with mortar

Apartment Complex with shops, using target septic tank and soak pit

Top of Septic tank and soak pit, covered by concrete slab and pavement

Discharging point of overflow effluent from soak pit into a side ditch of road

Overflow Effluent

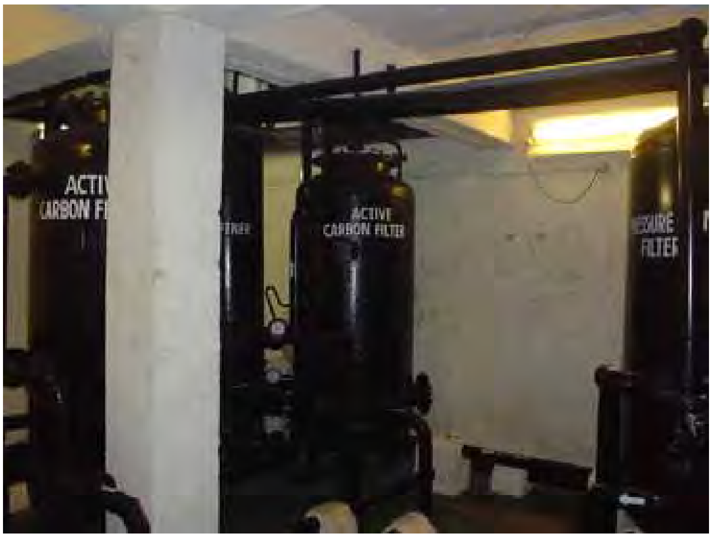
Data Sheets for Investigation on On-site Treatment Facilities (2/4)

Date of Investigation: June 8, 2005

1. Name of Hotel:	Taj Exotica Hotel
2. Location of Hotel:	Benaulim, Varka Beach
3. Number of Rooms.	140 rooms
4. Type of Water Supply:	Public water supply
5. Quantity of Water Consumption:	- m^3/day
6. Type of Wastewater:	Wastewater, kitchen wastewater
7. Type of Wastewater Treatment Method:	Activated sludge method + chemical clarification + Sand filtration + Activation carbon absorption
8. Design Wastewater Flow:	220 m^3/day
9. Actual Wastewater Flow:	85-180 m^3/day
10. Discharging Point of Treated Effluent:	Not discharging to public water body usually Effluent is used in hotel premise for gardening Discharging pipe to sea for emergency available
11.Wastewater Quality:	No data
12. Treatment and Disposal Method of Sludge:	-

Treatment facility.
Aeration Tank

Treatment facility.
Secondary clarifier and tertiary clarifier



Treatment facility.
Activated carbon adsorber

Data Sheets for Investigation on On-site Treatment Facilities (3/4)

Date of Investigation: July 28, 2005

1. Name of Factory:	Zuari Industry Ltd.
2. Location of Factory:	Zuari Industry complex, Vasco-Da-Gama City (Out of sewerage service area)
3. Type of Product:	Chemical fertilizer
4. Number of Employees:	800 persons approximately
5. Type of Water Supply:	Public water supply
6. Quantity of Water Consumption:	10,500 m^3/day (for production process)

(a) Wastewater Treatment Plant for Process Water

7. Type of wastewater:	Process wastewater
8. Type of Wastewater Treatment Method:	Primary, secondary and tertiary treatment
9. Design Wastewater Flow:	No data
10. Actual Wastewater Flow:	No data
11. Discharging Point of Treated Effluent:	Not discharging to public water body Effluent is reused in production process
12.Wastewater Quality:	No data
13. Treatment and Disposal Method of Sludge:	

(b) Domestic Wastewater of Employees

14. Type of wastewater:	Domestic wastewater of employees
15. Type of Wastewater Treatment Method:	Activated sludge method + Sand filter
16. Design Wastewater Flow:	480 m^3/day (20 m^3/hr)
17. Actual Wastewater Flow:	No data
18. Discharging Point of Treated Effluent:	Not discharging to public water body Effluent is used in factory campus
19.Wastewater Quality:	No data
20. Treatment and Disposal Method of Sludge:	Sludge dried and used as filler material in NPK (Nitrogen Phosphorus Kalium) and diammonium phosphate plant

21. Others:

- The plant was working. Aerator is on.

- One aeration tank and one secondary sedimentation tank (concrete)
- Two sand filter tanks (steel)
- Surface of secondary sedimentation tank is covered with thick scums and some plants
- An engineer of the treatment plant said that the scums are removed once a month

Treatment facility for domestic wastewater of employees. Aeration tank and secondary sedimentation tank

Secondary sedimentation tank covered with thick scums and some plants

Sand filtration tank for treated water of secondary treatment facility

Data Sheets for Investigation on On-site Treatment Facilities (4/4)

Date of Investigation: July 28, 2005

1. Name of Factory:	Birla Institute of Technology (College)
2. Location of Factory:	Vasco-Da-Gama City (Out of sewerage service area)
3. Type of Product:	-
4. Number of Employees:	4,000 persons approximately (teachers, students, staffs) in future, 2,000 persons at present
5. Type of Water Supply:	Public water supply
6. Quantity of Water Consumption:	600 m^3/day

7. Type of wastewater:	Domestic wastewater of teachers, students and staffs
8. Type of Wastewater Treatment Method:	FAB (Fluidized Aerated Bioreactor) system + Sand filter
9. Design Wastewater Flow:	600 m^3/day
10. Actual Wastewater Flow:	No data
11. Discharging Point of Treated Effluent:	Not discharging to public water body Effluent is used in college campus for gardening
12.Wastewater Quality:	No data
13. Treatment and Disposal Method of Sludge:	Sludge dewatered by centrifugal dewatering and disposed outside

14. Others:

- The plant was not working. College is in summer vacation.
- One inlet well, one FAB reactor and one effluent storage tank (concrete)
- Two sand filter tanks (steel)

Treatment facilities
Aeration tank and secondary clarifier

Treatment facilities
Sand filtration tank

Sludge treatment facilities
Centrifugal dewatering

Appendix M36

Water Quality Analysis for Sanitation

Contents for Appendix M36

Appendix M36.1 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 M36.1.1 shows the number of samples and sample parameters. The sampling locations are shown on Figure M36.2.1.

Table M36.1.1 Water Quality Analysis for the Sewerage System

Sampling Locations			Parameters for analysis			
			pH	BOD_5 *1	SS	Coliform
Panaji/Margao STPs	Inlet		2	2	2	2
	Treated Water		2	2	2	2
	Discharged Water		2	2	2	2
Rivers	Mandovi	River Mouth	1	1	1	1
		Upstream	1	1	1	1
	Zuari	River Mouth	1	1	1	1
		Upstream	1	1	1	1
Sea	North Goa（2 Points）		2	2	2	2
	South Goa（2 Points）		2	2	2	2
Number of Samples to be taken in Each Season			14	14	14	14
Total Number of Samples			28	28	28	28

*[1]: COD tests were used for the sea samples, instead of BOD5

M36.2 Evaluation of Water Quality for Sewerage

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

Figure M36.2.1 Locations of Sewerage Treatment Plants, River Sampling Points and Sea Sampling Points

M36.3 Results of Water Quality Analysis for Sanitation

(1) Sewage Treatment Plant (refer to Attachments)

The water quality results for the Panaji and Margao sewage treatment plants are shown in Tables M36.3.1 and M36.3.2. Raw water, treated water and discharge water quality was analyzed for pH, BOD,SS, and coliform.

The raw water and treated water qualities were worse during the dry season. The treated water quality for both of the STPs met the pH, BOD and SS 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 coliform at both STPs during both seasons.

Table M36.3.1 Water Quality of Panaji STP

Test Parameters	Season	Raw Water	Treated Water	Discharged Water	Standards*
pH	Dry	7.1	7.4	7.6	5.5 to 9.0
	Rainy	6.3	6.9	7.2	
BOD(mg/L)	Dry	53	7.4	6.9	30
	Rainy	82	5.5	4.0	
SS(mg/L)	Dry	42	4.5	8.0	100
	Rainy	67	5.0	9.5	
Coliform(MPN/100mL)	Dry	46,000,000	1,100,000	95,000	-
	Rainy	4,600,000	1,100,000	4,300	

* Source: Central Pollution Control Board (July 2002), Environmental Standards for Ambient Air, Automobiles, Industries and Noise, p55

Table M36.3.2 Water Quality at Margao STP

Test Parameters	Season	Raw Water	Treated Water	Discharged Water	Standards*
pH	Dry	6.4	7.2	7.1	5.5 to 9.0
	Rainy	6.1	7.2	6.9	
BOD(mg/L)	Dry	30.5	13	22.5	30
	Rainy	6.0	3.0	2.2	
SS(mg/L)	Dry	28	9.5	22.0	100
	Rainy	8.0	2.0	1.5	
Coliform(MPN/100mL)	Dry	11,000,000	460,000	240,000	-
	Rainy	4,600,000	46,000	110,000	

* Source: Central Pollution Control Board (July 2002), Environmental Standards for Ambient Air, Automobiles, Industries and Noise, p55

(2) **Rivers** (refer to Attachments)

The water quality test results for the Mandovi and Zuari Rivers are shown in Tables M36.3.3- 4 The samples for these rivers were taken from the river mouth as well as upstream.

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 for the Mandovi River showed that the effluent standards were not exceeded for pH, however the BOD standard (of 3mg/L) was exceeded. The results also showed that the water quality was worse in the rainy season as compared to the dry season.

Table M36.3.3 Water Quality in Mandovi River

Test Parameters	Season	Panaji (River Mouth)	Khandola (Upstream)	Standards* (category SWII)
pH	Dry	7.8	7.7	6.5 to 8.5
	Rainy	7.0	6.6	
BOD(mg/L)	Dry	4.8	3.4	3
	Rainy	5.8	4.6	
SS(mg/L)	Dry	6.5	3.0	-
	Rainy	30.0	14.0	
Coliform(MPN/100mL)	Dry	460	430	-
	Rainy	-	-	

* Source: Central Pollution Control Board (July 2002), Environmental Standards for Ambient Air, Automobiles, Industries and Noise, p55

The water quality results for the Zuari River showed that the pH standard was met at all points, however the BOD levels exceed the standard (of 3mg/L) during both the dry and rainy seasons. These water quality trends were the same as observed in the Mandovi River. The BOD, SS and coliform levels were higher in the rainy season as compared to the dry season.

Table M36.3.4 Water Quality in Zuari River

Test Parameters	Season	Cortalim (River Mouth)	Ponchavadi (Upstream)	Standards* (category SWII)
pH	Dry	7.6	6.9	6.5 to 8.5
	Rainy	7.7	6.4	
BOD(mg/L)	Dry	4.4	3.2	3
	Rainy	6.2	5.0	
SS(mg/L)	Dry	20.5	7.0	-
	Rainy	58	37.0	
Coliform(MPN/100mL)	Dry	4,600	2,400	-
	Rainy	110,000	24,000	

* Source: Central Pollution Control Board (July 2002), Environmental Standards for Ambient Air, Automobiles, Industries and Noise, p55

(3) Sea (refer to Attachment)

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 sea water quality results are shown in Tables M36.3.5 to 6.

The samples from the North Beach did not exceed the pH standard in either the dry or rainy season. However, the BOD did exceed the standard during the rainy season. A BOD sample was not collected during the dry season. The results indicate that the sea water quality is worse during the rainy season.

Table M36.3.5 Sea Water Quality in North Goa

Test Parameters	Season	Baga	Calangute	Average	Standards* (category SWII)
pH	Dry	8.1	8.1	8.1	6.5 to 8.5
	Rainy	7.5	7.6	7.6	
BOD(mg/L)	Dry	–	–	–	3
	Rainy	7.8	8.4	8.1	
SS(mg/L)	Dry	8.5	10.0	9.3	-
	Rainy	30	21.0	25.5	
Coliform(MPN/100mL)	Dry	460	460	460	-
	Rainy	2,400	4,300	3,350	

* Source: Central Pollution Control Board (July 2002), Environmental Standards for Ambient Air, Automobiles, Industries and Noise, p55

The water quality trends for the South Beach were the same as for the North Beach. That is, the sea water quality was worse during the rainy season in terms of BOD, SS, and coliform levels. The pH levels did not exceed the standard, however the BOD levels did exceed the standard during the rainy season.

Table M36.3.6 Sea Water Quality in South Goa

Test Parameters	Season	Colva	Benaulim	Average	Standards* (category SWII)
pH	Dry	7.9	7.9	7.9	6.5 to 8.5
	Rainy	7.9	8.1	8.0	
BOD(mg/L)	Dry	–	–	–	3
	Rainy	8.0	7.3	7.7	
SS(mg/L)	Dry	11.5	5.5	8.5	-
	Rainy	16.0	11.0	13.5	
Coliform(MPN/100mL)	Dry	75	95	85	-
	Rainy	11,000	24,000	17,500	

* Source: Central Pollution Control Board (July 2002), Environmental Standards for Ambient Air, Automobiles, Industries and Noise, p55

The results show that in general the sea water quality at the North Beach was worse than at South Beach, except for coliform during the rainy season.

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.

Attachments

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
Sewage Analysis

Panaji Sewage Treatment Plant
Place of collection Panaji S T P
Date of collection 22/06/05 **(Dry Season)**

Sr. No.	Test Parameters	Unit of Measurment	Inlet of Panaji STP	Outlet of Panaji STP	Discharge Pt. of Panaji STP	Effluent WQ Standard Inland Surface Water
1	pH.	----	7.1	7.4	7.6	5.5 to 9.0
2	BOD 5 days at 20 celsius	(mg/1)	53	7.4	6.9	30
3	BOD 3 days at 20 celsius	(mg/1)	44	6.8	6.2	-
4	S.S	(mg/1)	42	4.5	8	100
6	Coliform	MPN/100ml	46,000,000	1,100,000	95,000	-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
Sewage Analysis

Margao Sewage Treatment Plant
Place of collection - Margao S T P.
Date of collection 09/06/05 **(Dry Season)**

Sr. No.	Test Parameters	Unit of Measurment	Inlet of Margao STP	Outlet of Margao STP	Discharge Pt. of Margao STP	Effluent WQ Standard Inland Surface Water
1	pH.		6.4	7.2	7.1	5.5 to 9.0
2	BOD 5 days at 20 celsius	(mg/1)	30.5	13	22.5	30
3	BOD 3 days at 20 celsius	(mg/1)	25	11.5	18	-
4	S.S	(mg/1)	28	9.5	22	100
5	Coliform	MPN/100ml	11,000,000	460,000	240,000	-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
Sewage Analysis

Panaji Sewage Treatment Plant

Place of collection : Panaji S T P

Date of collection : 15/07/05 **(Rainy Season)**

Sr.No.	Test Parameters	Unit of Measurment	Inlet of Panaji STP	Outlet of Panaji STP	Discharge Pt. of Panaji STP	Effluent WQ Standard Inland Surface Water
1	pH.	----	6.3	6.9	7.2	5.5 to 9.0
2	BOD 5 days at 20 celsius	(mg/1)	82	5.5	4	30
3	BOD 3 days at 20 celsius	(mg/1)	68	5	3.3	-
4	S.S	(mg/1)	67	5	9.5	100
6	Coliform	MPN/100ml	4,600,000	1,100,000	4,300	-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
Sewage Analysis

Margao Sewage Treatment Plant

Place of collection : Margao S T P.

Date of collection : 13/07/05 **(Rainy Season)**

Sr.No.	Test Parameters	Unit of Measurment	Inlet of Margao STP	Outlet of Margao STP	Discharge Pt. of Margao STP	Effluent WQ Standard Inland Surface Water
1	pH.		6.1	7.2	6.9	5.5 to 9.0
2	BOD 5 days at 20 celsius	(mg/1)	6	3	2.2	30
3	BOD 3 days at 20 celsius	(mg/1)	5	2.5	1.8	-
4	S.S	(mg/1)	8	2	1.5	100
5	Coliform	MPN/100ml	460,000	46,000	110,000	-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Public Water Bodies – River
Source of samples : Zuari River
Place of collection : Zuari River Mouth at Cortalim
Date of collection : 10/06/05 **(Dry Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW II
1	pH.	---	7.6		6.5 to 8.5
2	BOD 5 days at 20 celsius	(mg/1)	4.4	○	3
3	BOD 3 days at 20 celsius	(mg/1)	3.5		-
4	S.S	(mg/1)	20.5		-
5	Coliform	MPN/100ml	4600		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Public Water Bodies – River Zuari .
Source of samples : Zuari River
Place of collection : Zuari River Upstream at Musher, Panchawadi .
Date of collection : 10/06/05 **(Dry Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW II
1	pH.	---	6.9		6.5 to 8.5
2	BOD 5 days at 20 celsius	(mg/1)	3.2	○	3
3	BOD 3 days at 20 celsius	(mg/1)	2.3		-
4	S.S	(mg/1)	7		-
5	Coliform	MPN/100ml	2400		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Public Water Bodies – River
Source of samples : Mandovi River
Place of collection : Mandovi River Mouth at Panaji .
Date of collection : 11/06/05 **(Dry Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW Ⅱ
1	pH.	---	7.8		6.5 to 8.5
2	BOD 5 days at 20 celsius	(mg/1)	4.8	○	3
3	BOD 3 days at 20 celsius	(mg/1)	3.2		-
4	S.S	(mg/1)	6.5		-
5	Coliform	MPN/100ml	460		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Public Water Bodies-Mandovi River
Source of samples : Mandovi River-- Upstream
Place of collection : Mandovi River upstream at Khandola.
Date of collection : 110/06/05 **(Dry Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW Ⅱ
1	pH.	---	7.7		6.5 to 8.5
2	BOD 5 days at 20 celsius	(mg/1)	3.4	○	3
3	BOD 3 days at 20 celsius	(mg/1)	2.7		-
4	S.S	(mg/1)	3		-
5	Coliform	MPN/100ml	430		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
Water Analysis

Public Water Bodies – River
Source of samples : Zuari River
Place of collection : Zuari River Mouth at Cortalim
Date of collection : 28/07/05 **(Rainy Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW Ⅱ
1	pH.	---	7.7		6.5 to 8.5
2	BOD 5 days at 20 celsius	(mg/1)	6.2	○	3
3	BOD 3 days at 20 celsius	(mg/1)	5.3		-
4	S.S	(mg/1)	58.0		-
5	Coliform	MPN/100ml	110,000		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
Water Analysis

Public Water Bodies – River Zuari .
Source of samples : Zuari River
Place of collection : Zuari River Upstream at Musher, Panchawadi .
Date of collection : 28/07/05 **(Rainy Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW Ⅱ
1	pH.	---	6.4		6.5 to 8.5
2	BOD 5 days at 20 celsius	(mg/1)	5.0	○	3
3	BOD 3 days at 20 celsius	(mg/1)	4.0		-
4	S.S	(mg/1)	37.0		-
5	Coliform	MPN/100ml	24,000		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
Water Analysis

Public Water Bodies – River
Source of samples : Mandovi River
Place of collection : Mandovi River Mouth at Panaji .
Date of collection : 28/07/05 **(Rainy Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW Ⅱ
1	pH.	---	7.0		6.5 to 8.5
2	BOD 5 days at 20 celsius	(mg/1)	5.8	○	3
3	BOD 3 days at 20 celsius	(mg/1)	4.2		-
4	S.S	(mg/1)	30		-
5	Coliform	MPN/100ml	4,600		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
Water Analysis

Public Water Bodies-Mandovi River
Source of samples : Mandovi River-- Upstream
Place of collection : Mandovi River upstream at Khandola.
Date of collection : 28/07/05 **(Rainy Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW Ⅱ
1	pH.	---	6.6		6.5 to 8.5
2	BOD 5 days at 20 celsius	(mg/1)	4.6	○	3
3	BOD 3 days at 20 celsius	(mg/1)	3.8		-
4	S.S	(mg/1)	14.0		-
5	Coliform	MPN/100ml	7,500		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Public Water Bodies – Beaches
Source of samples : Colva Beach
Place of collection : Colva
Date of collection: 10/06/05 **(Dry Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW II
1	pH.		7.9		6.5 to 8.5
2	S. S.	(mg/1)	11.5		-
3	Coliform	MPN/ 100ml	75		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Public Water Bodies – Beaches
Source of samples : Benaulim Beach
Place of collection ; Benaulim
Date of collection : 10/06/05 **(Dry Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW II
1	pH.	---	7.9		6.5 to 8.5
2	S. S.	(mg/1)	5.5		-
3	Coliform	MPN/ 100ml	95		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Public Water Bodies – Beaches
Source of samples : Baga Beach
Place of collection: Baga
Date of collection 11/06/05 **(Dry Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW II
1	pH.	---	8.1		6.5 to 8.5
2	S. S.	(mg/1)	8.5		-
3	Coliform	MPN/ 100ml	460		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
WATER ANALYSIS

Public Water Bodies – Beaches
Source of samples : Calangute Beach
Place of collection : Calangute
Date of collection : 11/06/05 **(Dry Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW II
1	pH.	---	8.1		6.5 to 8.5
2	S. S.	(mg/1)	10		-
3	Coliform	MPN/ 100ml	460		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
Water Analysis

Public Water Bodies – Beaches
Source of samples : Colva Beach
Place of collection : Colva
Date of collection: 20/07/05 **(Rainy Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW II
1	pH.		7.9		6.5 to 8.5
2	BOD 5 days at 20 celsius	(mg/1)	8.0	○	3
3	S. S.	(mg/1)	16.0		-
4	Coliform	MPN/ 100ml	11,000		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
Water Analysis

Public Water Bodies – Beaches
Source of samples : Benaulim Beach
Place of collection ; Benaulim
Date of collection: 20/07/05 **(Rainy Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW II
1	pH.	---	8.1		6.5 to 8.5
2	BOD 5 days at 20 celsius	(mg/1)	7.3	○	3
3	S. S.	(mg/1)	11.0		-
4	Coliform	MPN/ 100ml	24,000		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
Water Analysis

Public Water Bodies – Beaches
Source of samples : Baga Beach
Place of collection: Baga
Date of collection 21/07/05 **(Rainy Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW Ⅱ
1	pH.	---	7.5		6.5 to 8.5
2	BOD 5 days at 20 celsius	(mg/1)	7.8	○	3
3	S. S.	(mg/1)	30.0		-
4	Coliform	MPN/ 100ml	2,400		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

PHE-LABORATORY
P.W.D., TONCA-CARANZALEM
Water Analysis

Public Water Bodies – Beaches
Source of samples : Calangute Beach
Place of collection : Calangute
Date of collection 21/07/05 **(Rainy Season)**

Sr.No.	Test Parameters	Unit of Measurment	Results	Remark	Water Quality Standard SW Ⅱ
1	pH.	---	7.6		6.5 to 8.5
2	BOD 5 days at 20 celsius	(mg/1)	8.4	○	3
3	S. S.	(mg/1)	21.0		-
4	Coliform	MPN/ 100ml	4,300		-

Method of Testing: Standard Methods for the Examination of Water Wastewater 18th Ed..

Appendix M37

Site Visit Reports

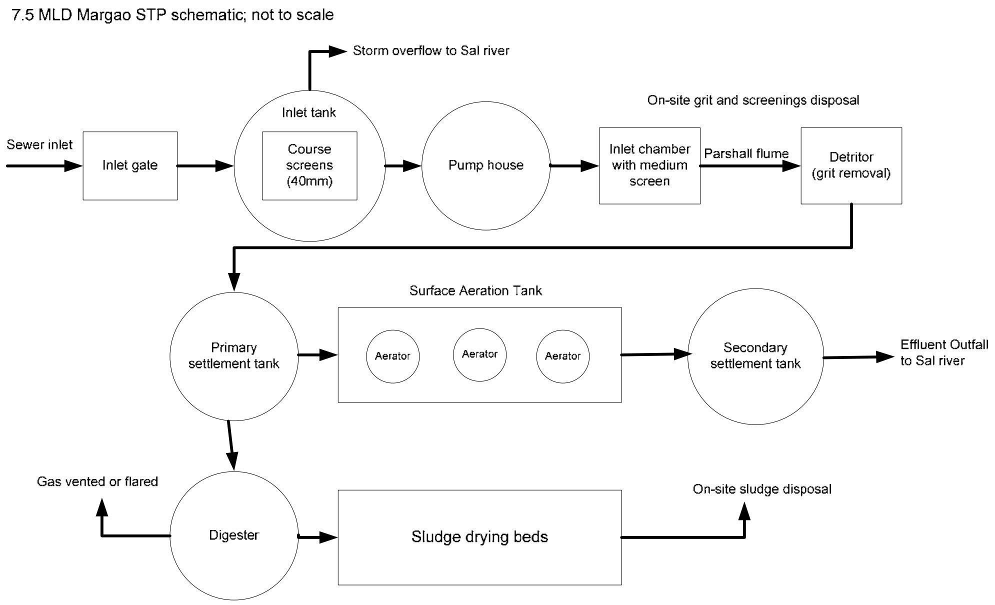
Contents for Appendix M37

Appendix M37.1 Site Visit Report 10/05/05:
7.5 MLD Margao Sewage Treatment Plant (W.D.XXI)

The current plant represents Phase I of a 15 MLD scheme.

Tour of site conducted with Dayanand Kolkar (Fitter Grade I) and M.U. Jamadar (Technical Assistant)

Plant was built and commissioned by Hindustan Dorr-Oliver Limited approximately 5 years ago (2000), schematic as follows:



The sewerage network feeding the plant conveys the sewage by gravity. The sub-divisions let annual maintenance contracts for sewer cleaning and maintenance.

The plant is ‘consented’ to operate within agreed quality standards and volume parameters by the Goa State Pollution Control Board. A copy of the consent is held at the plant.

The Directorate of Health Services – Environmental and Pollution Control Wing samples and analyses raw and treated sewage at the plant on a monthly basis. Copies of the reports are held at the plant. Compliance standards are not shown on the reports, however, if compared to the consent standards, the effluent meets the standard for all parameters. Interestingly, the raw sewage results are below the consent standards for all parameters also. This is assumed to be caused by high infiltration levels as a result of a high water table in the catchment area (this requires investigation from the wastewater team). This being the case, there is currently no need for any treatment beyond primary settlement to comply with environmental standards, thus saving energy costs.

The plant and compound looked reasonably clean and tidy, although initial impression and general appearance is of a plant older than 5 years. The plant appeared to be in good working order. The site is manned on an 8 hour basis by 7 staff including operators, fitters and cleaners.

The compound is gated and enclosed by a concrete wall and secured by 24 hour on-site security personnel. Hand railing looked adequate. Guarding of moving machinery was not inspected closely. This will be reviewed as part of a more detailed review of O&M practices at a later date.

The Plant is manually operated. No operating procedures or process control charts/parameters displayed or evident. There were limited drawings on site but no O&M manuals in evidence. We understand these are kept at the sub-divisional office.

The pump house contains 2 number 25HP pumps (1 duty/1 standby) and 2 number 50HP pumps (1 duty/1 standby). There does not appear to be any other redundancy of plant/equipment on site.

'Running maintenance' is the responsibility of on-site staff who are equipped with basic hand tools. Simple maintenance such as gland packing, greasing etc. takes place for which materials are available; however, stocks of other spares are not maintained at the plant. Planned/preventative maintenance measures are not practiced; maintenance is on a breakdown basis. Maintenance procedures/records are not computerised.

We understand that there have not been any incidents or major breakdowns since commissioning; we understand in such circumstances repairs/plant replacement would be on a contract basis, either by open tender or competitive quotations.

The digesters are cleaned bi-monthly with the resulting material diverted to the sludge beds. The screenings, detritus and sludge are contained on site.

Logs are kept for pump running hours, electricity consumption, O&M problems and activities as well as petty cash operational expenditure for consumables etc. We understand that the electric meters are read monthly by sub-divisional staff who hold the operating budget for the plant O&M running costs.

Logs are kept for tankers offloading septic waste at the plant. Separate logs are kept for Municipal tankers and private tankers. Municipal tankers are not charged. Private tankers are charged Rs.500 payable at the divisional offices. The receipt is presented to the plant operators prior to allowing discharge to the plant.

Data from the logs is not reported ‘upwards’ (we understand that senior staff inspect the logs periodically). There does not appear to be an established system in place for reporting of management information. Computerised MIS or other systems are not in existence at the plant.

Appendix M37.2 Site Visit Report 16/05/05:
12.5 MLD Phase I Panaji Sewage Treatment Plant (Div. III)

The new sequencing batch reactor (SBR) plant came into operation during February 2005 at which time the old 8MLD (trickling filters/digester) plant was decommissioned with the exception of the raw sewage well/pumping plant which is still in use until the new pumping plant is commissioned.

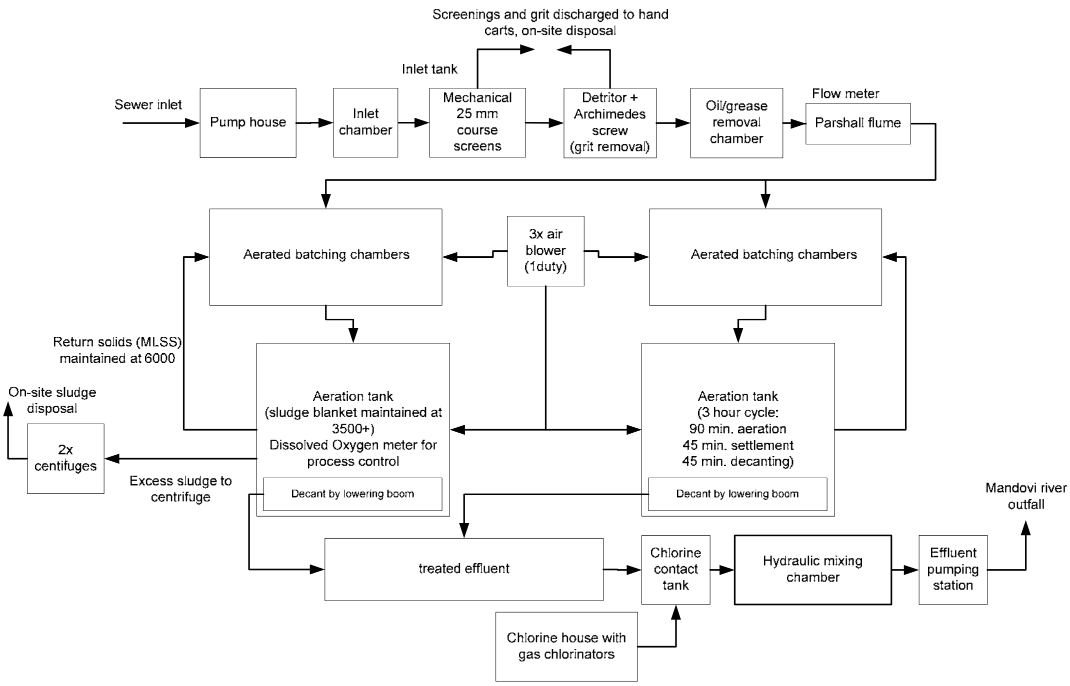
Tour of the site was conducted with Mr. Shetye (J.E) and Mr. Bhat (Managing Partner of H.N. Bhat & Co.)

Plant was built and commissioned by a joint venture company (H.N. Bhat, Pune & SFCU, Austria) between 23/10/03 and 16/02/05. Bhat provided the construction, manufacturing and process know-how, whilst SFCU provided the process automation (PLC/SCADA systems) expertise. It is understood that a remote communication link is maintained between the PLC/SCADA system and SFCU to monitor performance.

There are no printing facilities to log alarms, system parameters, faults or plant performance. We understand that this did not form part of the Contract. We recommend this be addressed as soon as possible.

The plant schematic is as follows:

12.5 MLD Phase I Panaji STP schematic, not to scale



The sewerage network feeding the plant conveys the sewage via 8 sewage pumping stations (SPS's). The sub-division responsible for the sewerage network (including SPS's) does the sewer cleaning and maintenance in-house.

We understand that the plant is yet to be 'consented' to operate within agreed quality and volume parameters by the Goa State Pollution Control Board.

The compound is not adequately gated, fenced or secured although we understand that the site is manned by 24 hour on-site security personnel. The site is being encroached by informal dwellings and is still ostensibly a 'construction site' with a number of hazards with little regard for safety being shown by contractors or PHE (children are freely living and playing on site). Whilst the contractors are responsible for O&M activities, this does not relieve PHE of their H&S responsibilities as 'controller of premises'.

Bhat/SFCU have been contracted to operate and maintain the plant for 5 years. It is evident that there was little formal involvement of PHE staff during the construction/commissioning phases. This continues to be the case for O&M practices. Due to the nature of technology employed (this is the only plant in Goa with process automation) we would recommend that PHE staff work along side the contractors to ensure transfer of knowledge sooner rather than later.

The Plant is automated with manual override and manned 24 hours per day (3 shift system). There are no operating procedures or process control charts/parameters displayed or evident. Whilst there are some equipment catalogues on site there are no written 'standard operating procedures' (SOP's), 'O&M manuals', 'H&S procedures', 'Safe Systems of Work' (example, plant isolation/lock-off procedures for maintenance of moving machinery, working in confined spaces, working in potentially explosive atmospheres etc.) or 'Emergency/Contingency plans'.[1] These will be required to ensure adequate transfer of knowledge and technology to ensure staff proficiency and optimum plant performance, as opposed to the existing informal custom and practice of 'on the job demonstration and instruction'.

Due to regular power failures, standby generation has been proposed but not yet provided.

The existing pump house contains 5 pumps, the 'running maintenance' of which is the responsibility of on-site staff equipped with basic hand tools. Simple maintenance such as gland packing, greasing etc. takes place for which materials are available; however, stocks of other spares are not maintained at the plant. Planned/preventative maintenance measures are not practiced; maintenance is reactive on a breakdown basis. Maintenance procedures/records are not computerised. Logs are kept for pump running hours, voltage and load.

The pump couplings/shafts are not guarded.

Operators/maintenance staff are not issued with personal protective equipment (PPE) such as gloves, goggles masks, helmets, safety shoes etc.

There is no portable gas detection equipment available (in cases of sewage flooding into pump house basement during breakdowns/maintenance).

There is no forced air ventilation equipment available (in cases of sewage flooding into pump house basement during breakdowns/maintenance).

The overhead crane and lifting tackle is not tested/certified periodically.[2]

The new pumping station contains 5 pumps with sufficient standby (3x 586 m3/hr + 2x 288 m3/hr). Pump couplings/shafts are not guarded.

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[1] Check compliance with relevant regulation in force
[2] Check compliance with relevant regulation in force

Handrails are 0.9m high (need to check that this complies with relevant regulation).

A single dry powder fire extinguisher is provided, however, we understand that no fire fighting training has been provided.[3]

The overhead crane is not stamped with a 'safe working load'.

There is no forced air ventilation equipment available (in cases of sewage flooding into pump house basement during breakdowns/maintenance), but am told that this is to be provided prior to operation of the plant.

Remote pump switches, lighting and other electrical equipment are not 'explosion proof'.[4]

Safety awareness is low and plant operators/maintenance staff (contractors and PHE), are not issued with PPE.

The Chlorine facility is not yet commissioned. It is intended that the final effluent is chlorinated prior to discharge; however, we are informed that it is not the intention of the contractor to provide forced air breathing apparatus for cylinder change-over or for emergencies.

We understand that the plant will be maintained on a planned/preventative basis; however, 'planned maintenance schedules', a system of 'job tickets' or a system for recording asset information is not in existence. We are informed that a system of manual logs will be introduced as opposed to a computerised maintenance management system (CMMS). A limited number of spares are maintained on site, however, a formal stores/stock control system is not in existence or intended for the plant.

There does not appear to be an established formal system in place for reporting of management information including the need for the contractor to provide compliance and performance data to PHE.

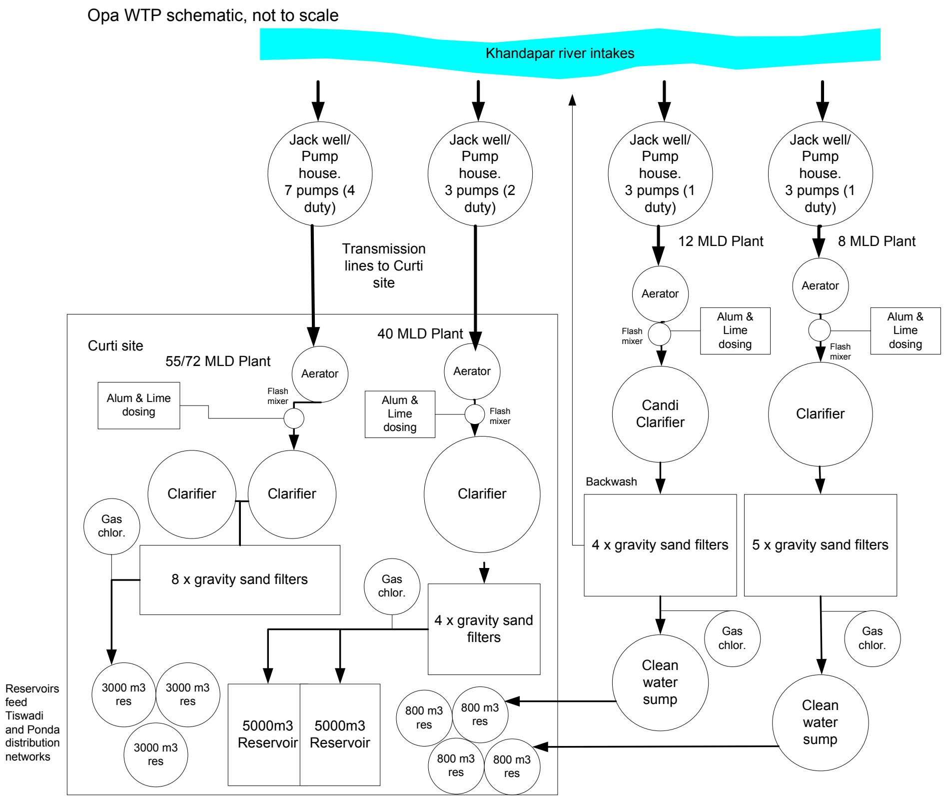
[3] Check compliance with relevant regulation in force
[4] Check compliance with relevant regulation in force

Appendix M37.3 Site Visit Report 16/05/05: Opa Water Treatment Plants (Div. III)

The Opa facility has been augmented over the years and currently consists of 4 river intakes (one for each self contained WTP). The original site contains Plant I, 8MLD commissioned in 1957 and Plant II, 12 MLD commissioned in 1967. Plant III, 55MLD commissioned in 1972 (later increased to 72 MLD by adding an extra filter bed) and Plant IV, 40 MLD commissioned in 2004 are both sited at Curti, approximately 2.0 km away.

Tour of the site was conducted with Mr. Subhash Parab (A.E) and other technical staff.

The plant schematic is as follows:



Both compounds are adequately gated, fenced and secured by 24 hour on-site security personnel and all plants are operated and maintained on a 3 shift system covering 24 hours.

Raw water supplied to the plants as well as clean water fed to reservoirs is estimated based on pump design capacities and running hours. Flow measurement devices are not available on the plants with the exception of the newest plant.

The original compound has a process control lab covering 8 MLD and 12 MLD plants. The plants are manually controlled and considering the respective ages of the plants, most equipment looked in good working order with the exception of the Alum and Lime mixers which looked in poor order/defunct. Both plants had good housekeeping standards.

Gas chlorination is employed using 1 tonne cylinders. Housekeeping, installation standards and operation and maintenance practices for chlorine use are poor. There are no facilities for adequately detecting or containing gas leaks. Personal breathing apparatus is available in the lab but not used or maintained.

Logs are kept by the laboratory staff for chemical usage and treatment parameters.

Logs are kept for pump running hours, load, filter backwashing etc. as well as clear water reservoir levels, however, there are no maintenance logs detailing repairs to assets or maintenance/breakdown problems.

Hi speed pump couplings/shafts are not guarded.

The 40 MLD plant has its own process control lab. Logs are kept by the laboratory staff for chemical usage and treatment parameters.

The plant was commissioned, operated and maintained for 18 months prior to hand-over to PHE by 'M/S Enviro Control Associates Private Ltd – Surat'. A basic O&M manual has been provided with basic operating, maintenance and H&S instructions. On the job training was provided by the contractors during the O&M period.

The plant appeared to be in good working order and housekeeping standards are good. The plant is manually operated but electrical valve actuators are in use. We understand that a proposal for a SCADA system has been prepared.

Logs are kept for pump running hours, load, filter backwashing etc. as well as clear water reservoir levels, however, there are no maintenance logs detailing repairs to assets or maintenance/breakdown problems.

Gas chlorination is employed using 3 x 1 tonne cylinders. Housekeeping, installation standards and operation and maintenance practices for chlorine use are poor. There are no facilities for adequately detecting or containing gas leaks. Personal breathing apparatus is available in the lab but not used or maintained.

The 72 MLD plant has its own process control lab. Logs are kept by the laboratory staff for chemical usage and treatment parameters.

Logs are kept for pump running hours, load, filter backwashing etc. as well as clear water reservoir levels, however, there are no maintenance logs detailing repairs to assets or maintenance/breakdown problems.

An Electro-chlorination system is used for disinfection. This appeared to be in good working order and housekeeping standards were good with the exception of the chlorination room. Gas chlorination using 1 tonne cylinders is still available for back-up purposes but appeared to be in relatively poor order with no facilities for detection or containment of leaks.

General observations

Running maintenance and reactive breakdown maintenance is done by PHE staff for all 4 plants. We understand that regular maintenance such as oiling and greasing is carried out as well as periodic maintenance but this is not recorder or formalised. Planned/preventative maintenance systems are not in place or intended. Repairs for major breakdowns are tendered by the divisional office. Records are maintained manually and there are no plans for employing a computerised maintenance management system.

Guarding of machinery is poor, especially on high speed rotating equipment (pump couplings/shafts).

Safety awareness is low and plant operators/maintenance staff are not issued with personal protective equipment (PPE).

Safety awareness and practices for use of chlorine gas is poor. For example, there are no written procedures for handling and connection of cylinders to chlorinators or for the maintenance of equipment, including replacement intervals for copper piping etc. Gas detectors are not installed and immersion tanks are not maintained fit for purpose. Personal breathing apparatus is available but not used or maintained.

There are no operating procedures or process control charts/parameters displayed or evident. Whilst there are some equipment catalogues on site there are no written 'standard operating procedures' (SOP's), 'O&M manuals' (with the exception of the newest plant), 'H&S procedures', 'Safe Systems of Work' (example, plant isolation/lock-off procedures for maintenance of moving machinery, working in confined spaces, etc.) or 'Emergency/Contingency plans'.

There does not appear to be an established formal system in place for reporting of management information such as compliance and performance data, maintenance issues, maintenance of assets data, H&S issues etc.

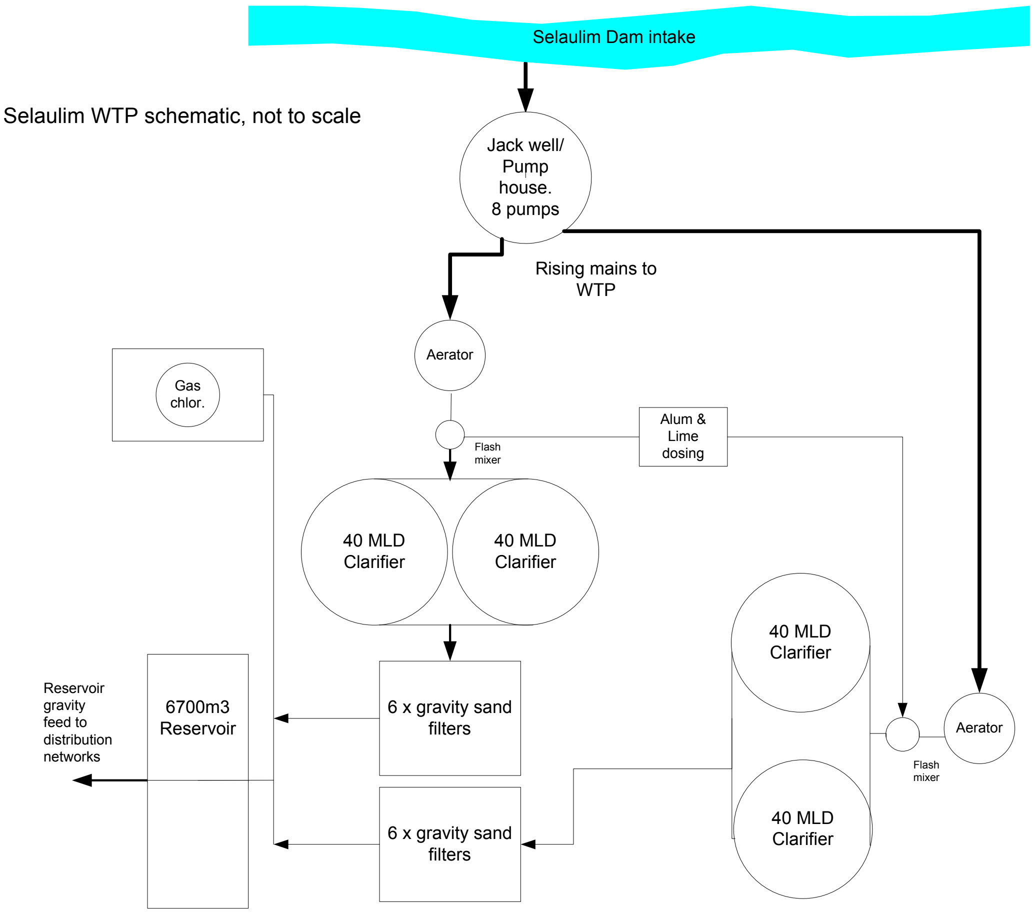
Appendix M37.4 Site Visit Report 17/05/05: Selaulim Water Treatment Plant (Div. XII)

The Salaulim facility was commissioned in 1989 and has a design capacity of 160 MLD although we are told that the plant is currently producing approximately 170 MLD. The raw water pump house supplies water to the plant via 2 No.1000mm rising mains approximately 1 km from the intake.

It is expected that the plant will be augmented with a further 40 MLD some time next year (currently being tendered). Plans are also well developed for a new proposed plant of 220 MLD for which the green field site has already been secured. Water for the existing and proposed plants is via the Selaulim Dam.

Tour of the site was conducted with Mr. Paranjape (E.E), Mr. Kunde (A.E) and other technical staff.

The plant schematic is as follows:



Both the raw water pumping compound and the treatment plant compound were adequately gated, fenced and secured by 24 hour on-site security personnel and the plant is operated and maintained on a 3 shift system covering 24 hours.

Raw water supplied to the plant as well as clean water fed to the transmission system via the clean water reservoir is estimated based on pump design capacities and running hours. Flow measurement devices (electromagnetic) are no longer working.

The raw water pump house has 8 pumps each of 1181 m3 capacity. Housekeeping standards are good; however, the drive couplings/shafts are not adequately guarded. We understand that the 10 tonne O/H crane has not been tested since installation in 1989 and whilst chains have been replaced periodically, records are not maintained for chains or lifting tackle.

Logs are maintained for pump running hours, loads etc; however, maintenance records are not kept. A well established system of monthly oiling and greasing is practiced; otherwise a system of reactive corrective maintenance is employed. Pumps are either oiled, greased or impellers replaced when showing signs of reduced discharge. There are no O&M manuals available and training for new staff is provided on the job by existing experienced staff. We are told that due regard is given for safety of staff whilst conducting maintenance, for example removing fuses when working on pumps, however there are no written or formal safe systems of work for plant isolation.

The treatment plant is manually controlled and considering its age most equipment looked in good working order including the Alum and Lime mixers. Generally, good housekeeping standards were evident; however, pump couplings/shafts are not adequately guarded.

Logs are kept for pump running hours, load, filter backwashing etc. as well as clear water reservoir levels, however, there are no maintenance logs detailing repairs to assets or maintenance/breakdown problems.

Logs are kept by the laboratory staff for chemical usage and treatment parameters.

Gas chlorination is employed using 1 tonne cylinders, usually 5 cylinders in the chlorine house at any one time. There are 4 vacuum type chlorinators (Aqua Pura Corp – Pune, who provide spares). Maintenance of chlorinators is performed in-house, but chlorinators are not periodically calibrated and records of maintenance are not kept. Housekeeping, installation standards and operation and maintenance practices for chlorine use are poor. Ammonia solution is used as a means of detecting leaks at pipe and connection joints; however, there are no facilities for adequately detecting or containing gas leaks with the exception of an immersion tank which is not easily accessible in an emergency. Personal breathing apparatus is available in the lab but not used or maintained. A combination of small bore PVC and flexible plastic hose is employed for connecting cylinders to chlorinators and from chlorinators to the contact tank. This is not safe practice.

The clean water reservoir has two compartments and is cleaned annually. The procedure is to remove covers to aid natural ventilation and to allow approximately 120 unskilled contract labour to enter to conduct manual desludging including the hosing/flushing down of internal surfaces. There are no safety precautions, safety equipment or safe system or work.

General observations

Running maintenance and reactive breakdown maintenance is done by PHE staff. Whilst regular maintenance such as oiling and greasing is carried out as well as periodic maintenance, this is not recorder or formalised. Planned/preventative maintenance systems are not in place or intended. Repairs for major breakdowns are tendered by the divisional office. Records are maintained manually and there are no plans for employing a computerised maintenance management system.

Guarding of machinery is poor, especially on high speed rotating equipment (pump couplings/shafts).

Safety awareness is low and plant operators/maintenance staff are not issued with personal protective equipment (PPE).

Safety awareness and practices for use of chlorine gas is poor. For example, there are no written procedures for handling and connection of cylinders to chlorinators or for the maintenance of equipment, including replacement intervals for copper piping etc. Gas detectors are not installed and personal breathing apparatus is available but not used or maintained.

There are no operating procedures or process control charts/parameters displayed or evident. Whilst there are some equipment catalogues on site there are no written ‘standard operating procedures’ (SOP’s), ‘O&M manuals’ (with the exception of the newest plant), ‘H&S procedures’, ‘Safe Systems of Work’ (example, plant isolation/lock-off procedures for maintenance of moving machinery, working in confined spaces, etc.) or ‘Emergency/Contingency plans’.

There does not appear to be an established formal system in place for reporting of management information such as compliance and performance data, maintenance issues, maintenance of assets data, H&S issues etc.

Appendix M37.5 Site Visit Report 18/05/05: PHE Sub-Division I (Div. XVII), Podocem WTP, Sanquelim WTP and Dabose WTP

The AE Sub-Division I (XVII) takes responsibility for customer services (new connections, meter reading, billing, revenue collection, complaints handling), transmission mains, distribution network, reservoirs and treatment facilities in his geographic region of control (Podecem WTP and Dabose WTP due to retirement). The Sanquelim WTP visited is under the jurisdiction of the sub-division managing the Assonora WTP.

Manual records are kept of water (value) billed versus collected as well as outstanding arrears. These are reported monthly to the Divisional office. Some recovery action is taken by PHE for defaulters, including disconnection. Cases older than 3 months with arrears exceeding Rs.1000 are forwarded to the Revenue Recovery Court (Government body with legal powers to recover charges on behalf of PWD).

We are told that water is available in the system for approximately 12 hours per day and the AE takes responsibility for periodic measurement of residual chlorine at the tail ends of the network. Some drawings are available of transmission lines and reservoirs but generally distribution mains with valve arrangements and customer connections are not available. Locations of pipes and valves are known to staff who are experienced on the system but there is no formal system for recording of asset data.

O&M of the distribution network including burst pipe repairs is carried out by PHE staff. Whilst backfilling of trenches is carried out by PHE, ‘PWD roads division’ are responsible for resurfacing/repairs to road surfaces and bill PHE for work conducted.
Some stock items are maintained such as pipe fittings, repair couplings, meters etc; with stocks normally replenished from the Divisional stores. Whilst material usage is recorded, there is no system for relating material usage against individual assets and burst pipe records are not maintained.

There are no control centres through out the PHE division as currently all networks are independent to each supply scheme.

A complaints log is maintained during office hours. The AE is on call to customers on a 24 hour (residence and mobile numbers listed in the local telephone directory). Also, we understand that PWD do operate a 24 hour help line for emergencies and pass on water/wastewater related calls to the appropriate AE in charge.

PHE do not have a customer service strategy or citizens charter stating levels of service provision. Common design/installation standards are not applied for new connections; however, CPWD Manuals and Byelaws are available for reference. Revenue meters are sealed and certified by the manufacturer; however, the meter does not have a non return valve and is not sealed to fittings such as stop valves. PHE do not have a system of periodic maintenance, cleaning, calibration or replacement of meters.

Staff conducting street works do not have a safe system of work and only limited "work in progress" signage is available. Only rudimentary tools are available for O&M activities. Active leakage control practices are not conducted.

Tour of the sites was conducted with Mr. Shel (A.E), Mr. Joshi (T.A) and other technical staff from each plant.

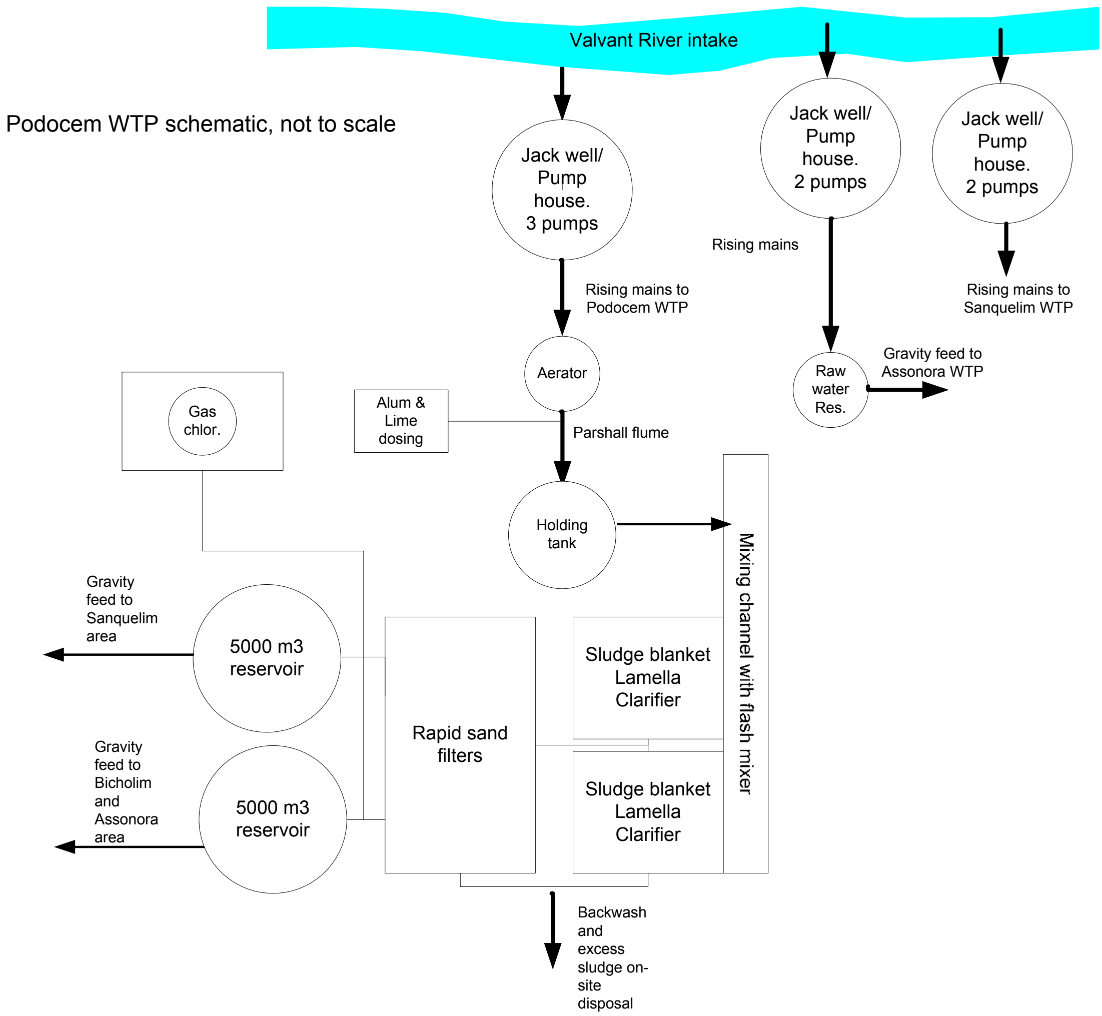
Podocem WTP

The Podocem facility has recently been commissioned (2003) and has a design capacity of 40 MLD. The newly constructed raw water pump house supplies water from the Valvant River to the plant approximately 0.6 km from the intake. There are 3 pumps (2 duty) which are not adequately guarded. A log of running hours, loads etc. is maintained. O&M of the pump house and treatment plant has been contracted to a local company (run by a retired PHE engineer) on a 3 month basis which may be followed by a longer contract (2-5 years).

The Pump house compound also contains a pump house commissioned in 1992 with 2 pumps (1 duty) which are not adequately guarded supplying 25 MLD to Assonora WTP via a short rising main to a reservoir from which it is fed by gravity to the plant approximately 20 km away. A log of running hours, loads etc. is maintained.

A third pump house containing 2 pumps (1 duty) commissioned in 1972 supplies water to the 12 MLD Sanquelim WTP via a 0.6 km rising main. This pump house is untidy and the pumps are not adequately guarded. A log of running hours, loads etc. is maintained.

The plant schematic is as follows:



Both the raw water pumping compound and the treatment plant compound were adequately gated, fenced and secured by 24 hour on-site security personnel and the plant is operated and maintained on a 3 shift system covering 24 hours.

Raw water supplied to the plant as well as clean water fed to the transmission system via the clean water reservoirs is estimated based on pump design capacities and running hours. Flow measurement devices are not available.

Logs are maintained for pump running hours, loads etc; however, maintenance records are not kept. A well established system of monthly oiling and greasing is practiced; otherwise a system of reactive corrective maintenance is employed. There are no O&M manuals available and training for new staff is provided on the job by existing experienced staff. There are no written or formal safe systems of work for plant isolation.

The treatment plant is manually controlled but valves are operated remotely by pneumatic actuators. The plant is new and looked in good working order including the Alum and Lime mixers. Generally, good housekeeping standards were evident; however, pump couplings/shafts are not adequately guarded.

Logs are kept for pump running hours, load, filter backwashing etc. as well as clear water reservoir levels, however, there are no maintenance logs detailing repairs to assets or maintenance/breakdown problems.

Logs are kept by the laboratory staff for chemical usage and treatment parameters.

Gas chlorination is employed using 1 tonne cylinders, usually 2 cylinders in the chlorine house at any one time. There are 2 vacuum type chlorinators (Metito Mach4). Maintenance of chlorinators is performed in-house, but chlorinators are not periodically calibrated and records of maintenance are not kept. Operation and maintenance practices for chlorine use are poor. Ammonia solution is used as a means of detecting leaks at pipe and connection joints; however, there are no facilities for adequately detecting or containing gas leaks. No immersion tank has been provided. Personal breathing apparatus is available in the lab but not used or maintained. Copper connection pipes are being repaired locally and looked in poor condition. These should be discarded, not repaired. The galvanised iron feed pipe to the contact tank was badly corroded and should be replaced.

The clean water reservoirs are cleaned annually. The procedure is to remove covers to aid natural ventilation and to allow manned entry for sludge removal and flushing. There are no safety precautions, safety equipment or safe system or work.

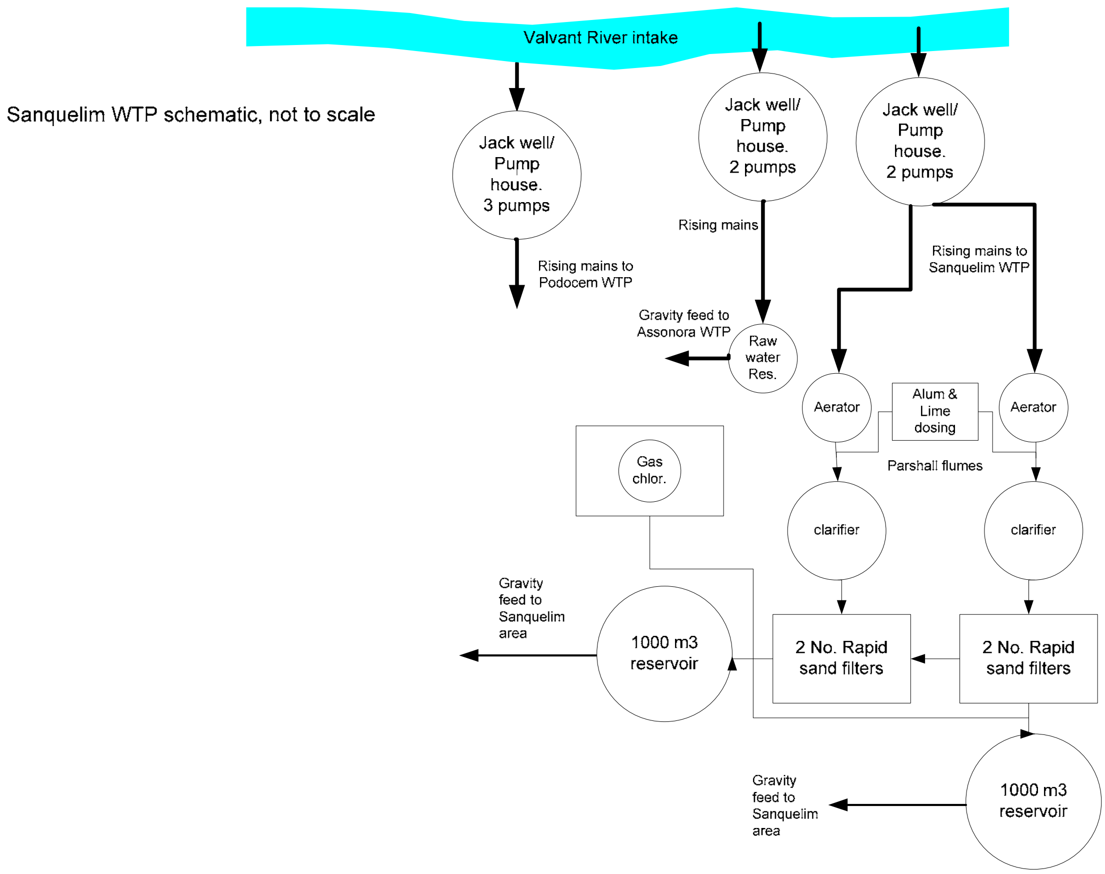
Sanquelim WTP

The scheme consists of a 7 MLD plant and a 5 MLD plant, commissioned around 1972.

The plants are manually operated and despite their age appear to be in good working condition. Housekeeping standards look reasonable apart from the chemical mixing areas. The chlorine house was equipped with a 1 tonne cylinder and 1 vacuum type chlorinator with no standby.

Logs are maintained for pump run hours, load, chemical use and treatment parameters.

The plant schematic is as follows:



Dabose WTP

The scheme consists of a 5 MLD plant, commissioned around 1992. We are told that the plant is currently running at 7 MLD to help met demand.

The raw water pump house contains 2 pumps (1 duty) and draws water from the Madei River. The pumps were well guarded.

The plant is manually operated and despite its age appears to be in good working condition. There are no flow measuring devices.

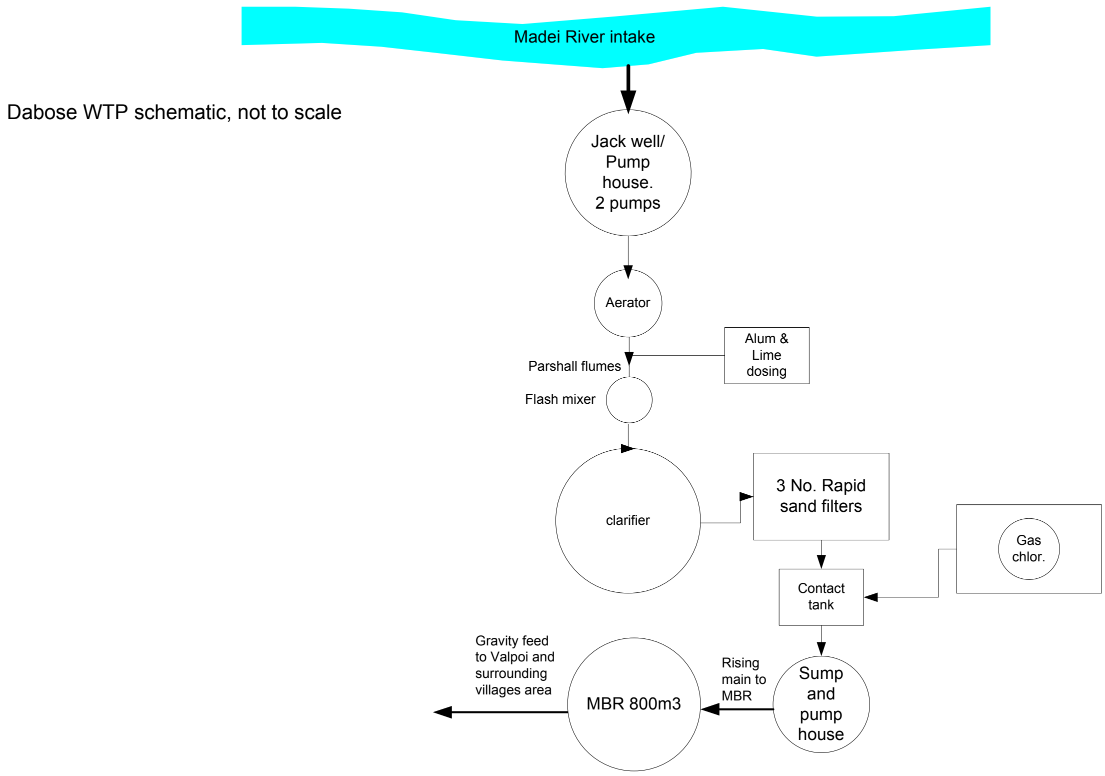
Security arrangements at the complex are good.

Housekeeping standards are very good apart from the chemical mixing areas. The chlorine house is equipped with 2 No. 1 tonne cylinders and 1 vacuum type chlorinator with no standby. An immersion tank is present. The chlorine installation looked tidy and well maintained.

A standby generator is available at the site in case of power failures.

Logs are maintained for pump run hours, load, chemical use and treatment parameters.

The plant schematic is as follows:



General observations

Running maintenance and reactive breakdown maintenance is done by contract staff. Whilst regular maintenance such as oiling and greasing is carried out as well as periodic maintenance, this is not recorder or formalised. Planned/preventative maintenance systems are not in place or intended. Records are maintained manually and there are no plans for employing a computerised maintenance management system.

Guarding of machinery is poor, especially on high speed rotating equipment (pump couplings/shafts).

Safety awareness is low and contract staff are not issued with personal protective equipment (PPE).

Safety awareness and practices for use of chlorine gas is poor. For example, there are no written procedures for handling and connection of cylinders to chlorinators or for the maintenance of equipment, including replacement intervals for copper piping etc. Gas detectors are not installed and personal breathing apparatus is available but not used or maintained.

There are no operating procedures or process control charts/parameters displayed or evident. Whilst there are some equipment catalogues on site there are no written 'standard operating procedures' (SOP's), 'O&M manuals' (with the exception of the newest Podocem plant), 'H&S procedures', 'Safe Systems of Work' (example, plant isolation/lock-off procedures for maintenance of moving machinery, working in confined spaces, etc.) or 'Emergency/Contingency plans'.

There does not appear to be an established formal system in place for reporting of management information such as compliance and performance data, maintenance issues, maintenance of assets data, H&S issues etc.

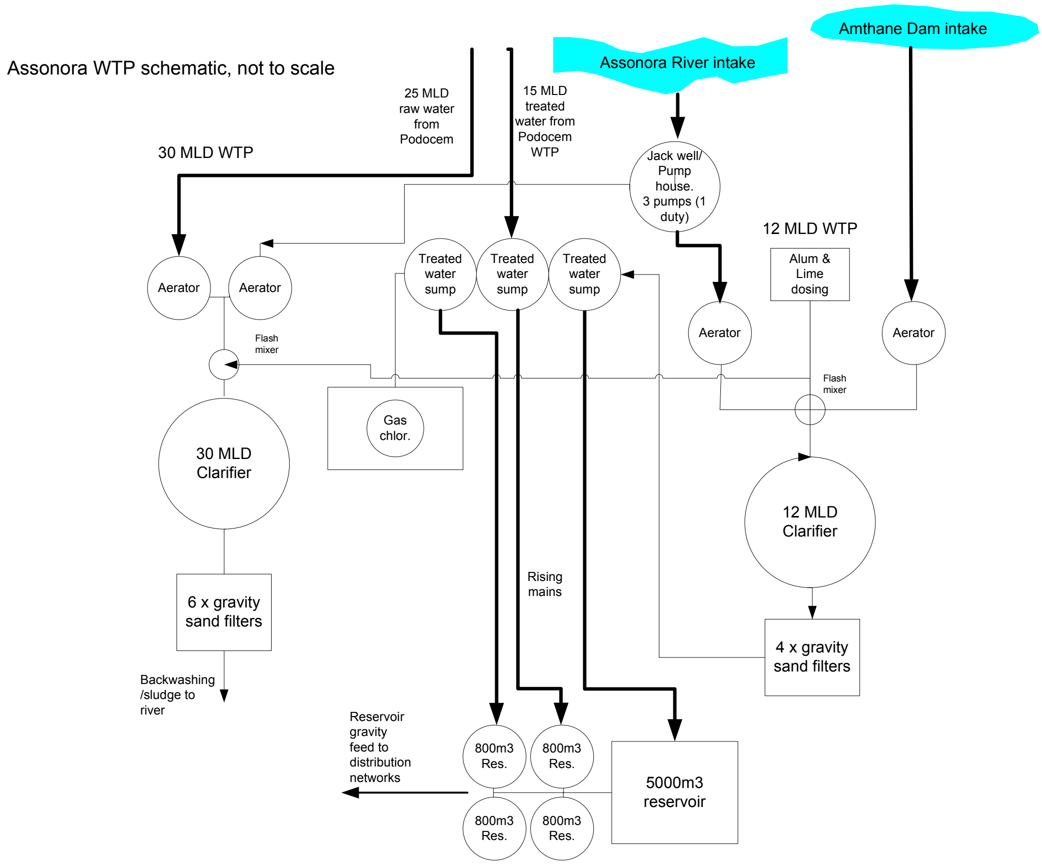
Appendix M37.6 Site Visit Report 19/05/05:
Assonora Water Treatment Plant (Sub-Division IV, Div. XVII)

The Assonora facility consists of a 12 MLD plant commissioned in 1968 and a 30 MLD planned commissioned in 1992. The 12 MLD plant sources water from the Amthane Dam by gravity feed approximately 10 km from the plant as well as a supplementary supply from the Assonora River via a jack well. The river source supply line is interconnected with the 30 MLD plant to supplement the main incoming raw water supply from Podocem (20 km's away) which provides 25 MLD to the plant. The site also contains a clear water sump for the approximately 15 MLD treated water received from Podocem WTP for onward distribution to the Assonora supply area.

We understand that a proposal for an additional 40 MLD plant has been prepared and submitted to PWD for approval.

Tour of the site was conducted with Mr. Vijay Joglekar (A.E), Mr. Halarenker (J.E), Mr. Naik (chemist) and other technical staff.

The plant schematic is as follows:



The raw water pump house and the treatment plant are within the same compound which was adequately gated, fenced and secured by 24 hour on-site security personnel. The plant is manually operated and maintained on a 3 shift system covering 24 hours.

Raw water supplied to the plant from the Dam, river and Podocem and clean water fed to the plant from Podocem WTP as well as onward transmission via the clean water reservoirs is estimated based on pump design capacities and running hours. Flow measurement devices are not installed.

The raw water pump house has 3 pumps (1 duty) each of 15 MLD capacity. Housekeeping standards are good; however, the drive couplings/shafts are not adequately guarded.

Logs are maintained for pump running hours, loads etc; however, maintenance records are not kept. Apart from regular oiling and greasing, a system of reactive corrective maintenance is employed. There are no O&M manuals available and training for new staff is provided on the job by existing experienced staff. There are no written or formal safe systems of work for plant isolation.

The treatment plants are manually controlled and considering their respective ages most equipment looked in good working order with the exception of the Alum and Lime mixers which are defunct. Subsequently, lime and alum are added by hand at the flash mixer point. Generally, good housekeeping standards were evident and the treated water pumps were well guarding. This should be used as an example of good practice to other sites.

Logs are kept for pump running hours, load, filter backwashing etc. as well as clear water reservoir levels, however, there are no maintenance logs detailing repairs to assets or maintenance/breakdown problems.

Logs are kept by the laboratory staff for chemical usage and treatment parameters.

Gas chlorination is employed using 1 tonne cylinders, usually 8 cylinders in the chlorine house at any one time (5 empty). There are 4 vacuum type chlorinators (2 standby). Maintenance of chlorinators is performed in-house, but chlorinators are not periodically calibrated and records of maintenance are not kept.

Housekeeping, installation standards and operation and maintenance practices for chlorine use are poor. Ammonia solution is used as a means of detecting leaks at pipe and connection joints; however, there are no facilities for adequately detecting or containing gas leaks with the exception of an immersion tank which is not easily accessible in an emergency and was empty at the time of visit.

The flexible copper pipes were trailing on the platform and presented a trip hazard and the pipes are susceptible to damage; this is not safe practice. The feeder pipe to the contact tanks is PVC and unprotected; this is not safe practice. Personal breathing apparatus is available in the lab but not used or maintained. **This facility is probably in the poorest condition of all the facilities visited and presents a serious health hazard.**

The clean water reservoirs are cleaned every 6 months by PHE staff. The procedure is to remove covers to aid natural ventilation and to allow entry to conduct manual desludging including the hosing/flushing down of internal surfaces. There are no safety precautions, safety equipment or safe system or work.

General observations

Running maintenance and reactive breakdown maintenance is done by PHE staff. Whilst regular maintenance such as oiling and greasing is carried out as well as periodic maintenance, this is not recorder or formalised. Planned/preventative maintenance systems are not in place or intended. Records are maintained manually and there are no plans for employing a computerised maintenance management system.

Guarding of machinery is poor, especially on high speed rotating equipment (pump couplings/shafts) with the exception of the treated water pumps.

Safety awareness is low and plant operators/maintenance staff are not issued with personal protective equipment (PPE).

Safety awareness and practices for use of chlorine gas is poor. For example, there are no written procedures for handling and connection of cylinders to chlorinators or for the maintenance of equipment; including replacement intervals for copper piping etc. (stocks of piping and chlorinator spares are available in the lab). Gas detectors are not installed and personal breathing apparatus is available but not used or maintained.

There are no operating procedures or process control charts/parameters displayed or evident. Whilst there are some equipment catalogues on site there are no written ‘standard operating procedures’ (SOP’s), ‘O&M manuals’, ‘H&S procedures’, ‘Safe Systems of Work’ (example, plant isolation/lock-off procedures for maintenance of moving machinery, working in confined spaces, etc.) or ‘Emergency/Contingency plans’.

There does not appear to be an established formal system in place for reporting of management information such as compliance and performance data, maintenance issues, maintenance of assets data, H&S issues etc.

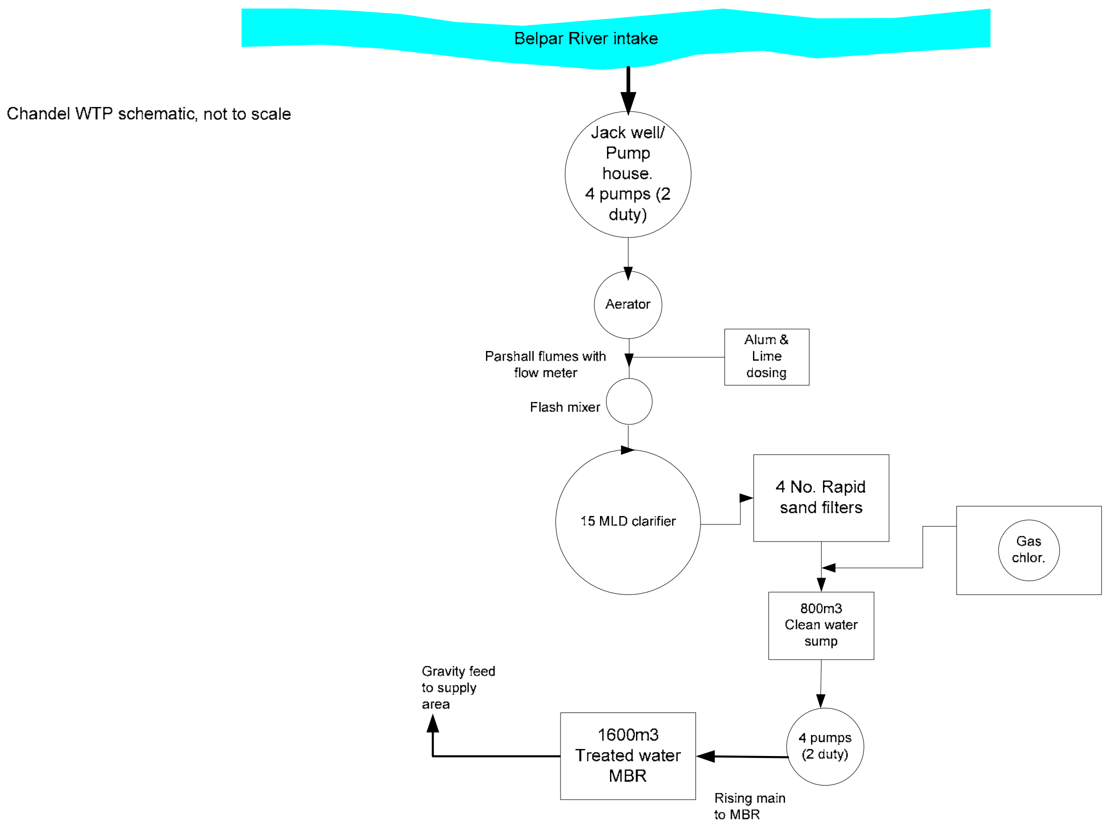
Appendix M37.7 Site Visit Report 19/05/05:
Chandel Water Treatment Plant (Sub-Division II, Div. XVII)

The Chandel facility consists of a 15 MLD plant commissioned in 2002. Raw water is sourced from the Belpar River which is pumped approximately 150m to the plant. The site contains a clear water sump from which water is pumped to the MBR approximately 800m away for onward gravity feed to the distribution system.

We understand that prior to commissioning of the plant, a number of rural water supply schemes were in operation and the networks for these schemes are now interconnected with the Chandel plant. We understand that the rural schemes serve to augment the regional scheme at peak demand times.

Tour of the site was conducted with Mr. Rao (A.E) and other technical staff.

The plant schematic is as follows:



The raw water pump house and treatment plant are sited in separate compounds which were adequately gated, fenced and secured by 24 hour on-site security personnel. The plant is manually operated and maintained on a 3 shift system covering 24 hours. We are told that due to the need to enhance the distribution network the plant currently only operates at 8.5 MLD.

Raw water supplied to the plant was measured at the Parshall flume which had a working flow measuring device. Flow to the MBR and onward transmission via the clean water reservoirs is estimated based on pump design capacities and running hours. Flow measurement devices are not installed.

The raw water pump house has 4 pumps (2 duty) each of 200lps capacity. Housekeeping standards are good and the drive couplings/shafts are well guarded.

Apart from regular oiling and greasing, a system of reactive corrective maintenance is employed. There is no O&M manual available (although some equipment catalogues are available) and training for new staff is provided on the job by existing experienced staff. There are no written or formal safe systems of work for plant isolation.

The treatment plant is manually controlled and most equipment looked in good working order with the exception of the Alum and Lime mixers. The Lime mixers are not functioning, subsequently; lime is added by hand at the flash mixer point. Generally, good housekeeping standards were evident and the treated water pumps were well guarding.

Currently there are no logs maintained at the plant.

The plant does not have an on-site laboratory, although equipment for measuring residual chlorine and ph levels was available. We are told these parameters are measured hourly by the plant operators for process control, however logs are not kept. We understand that staff from the Panaji lab visit the site and take samples for analysis once a week.

Gas chlorination is employed using 1 tonne cylinders, usually 1 cylinder in the chlorine house at any one time. There is 1 vacuum type chlorinator (no standby), although we are told that another chlorinator is to be provided. Maintenance of chlorinators is performed in-house, but chlorinators are not periodically calibrated and records of maintenance are not kept. There are no spares on-site for the chlorine facility. Housekeeping, installation standards and operation and maintenance practices for chlorine use are poor. Ammonia solution is used as a means of detecting leaks at pipe and connection joints; however, there are no facilities for adequately detecting or containing gas leaks with the exception of an immersion tank which is not easily accessible in an emergency. The feeder pipe to the contact tanks was poor quality flexible plastic hose and was unprotected; this is not safe practice and should be rectified immediately. Personal breathing apparatus is not provided and the lack of safety awareness for the safe use of chlorine was evident.

General observations

Running maintenance and reactive breakdown maintenance is done by PHE staff.

Whilst regular maintenance such as oiling and greasing is carried out this is not recorder or formalised. Planned/preventative maintenance systems are not in place or intended. Records There are no plans for employing a computerised maintenance management system.

Guarding of machinery is good, including high speed rotating equipment (raw and treated water pump couplings/shafts).

Safety awareness is low and plant operators/maintenance staff are not issued with personal protective equipment (PPE).

Safety awareness and practices for use of chlorine gas is poor. There are no written procedures for handling and connection of cylinders to chlorinators or for the maintenance of equipment; including replacement intervals for copper piping etc. Stocks of piping and chlorinator spares are not available on site. Gas detectors are not installed and personal breathing apparatus is not provided. **This is not safe practice.**

There are no operating procedures or process control charts/parameters displayed or evident. Whilst there are some equipment catalogues on site there are no written ‘standard operating procedures’ (SOP’s), ‘O&M manuals’, ‘H&S procedures’, ‘Safe Systems of Work’ (example, plant isolation/lock-off procedures for maintenance of moving machinery, working in confined spaces, etc.) or ‘Emergency/Contingency plans’.

There does not appear to be an established formal system in place for reporting of management information such as compliance and performance data, maintenance issues, maintenance of assets data, H&S issues etc.

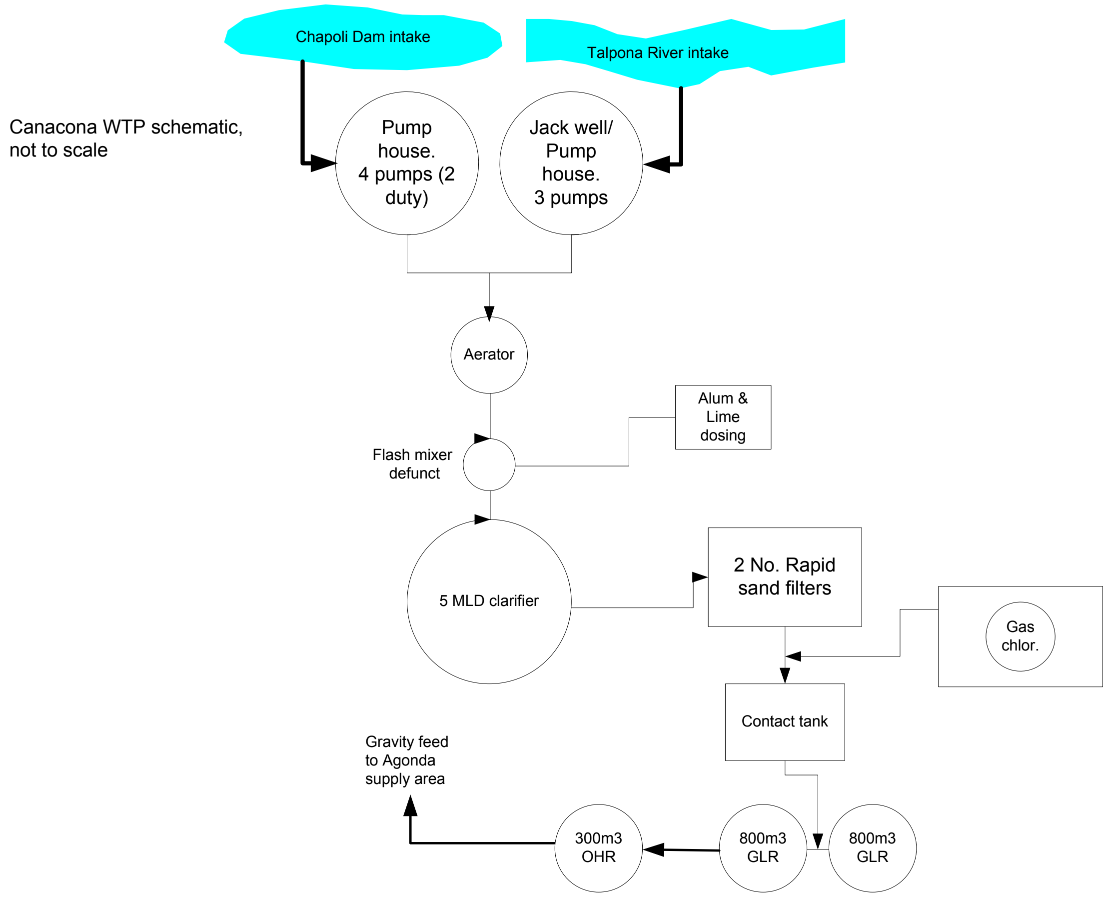
Appendix M37.8 Site Visit Report 20/05/05:
Canacona Water Treatment Plant (Sub-Division IV, Div. XX)

The Canacona facility consists of a 5 MLD plant commissioned in 1983. Raw water is sourced from the Tapona River as well as the Chapoli Dam which came into operation in 1997. The river intake has a jack well with 3 pumps (this was locked at the time of visit and therefore we could not assess the condition). The Dam intake pump house was equipped with 3 number 100HP pumps and a small submersible pump (not adequately guarded). The rising main to the plant is approximately 8.5km long.

We understand that there are 40 rural water supply schemes still in operation and the networks for these schemes are completely independent from each other as well as form the regional scheme. The rural supply scheme at Matve was visited which supplies water to Parekatta.

Tour of the site was conducted with Mr. Bhangle (J.E) and other technical staff.

The plant schematic is as follows:



The raw water pump house and treatment plant are sited in separate compounds which were adequately gated, fenced and secured by 24 hour on-site security personnel. The plant is manually operated and maintained on a 3 shift system covering 24 hours.

Raw water supplied to the plant was not measured. Water leaving the plant was not measured.

The Dam intake raw water pump house has 3 pumps (1 duty) each of 100HP capacity and a small submersible pump to augment supplies rather than run a second large pump. Housekeeping standards are good; however, the drive couplings/shafts are not guarded.

Apart from regular oiling and greasing, a system of reactive corrective maintenance is employed. There is no O&M manual available and training for new staff is provided on the job by existing experienced staff. There are no written or formal safe systems of work for plant isolation.

The treatment plant is manually operated and controlled and most equipment looked in good working order with the exception of the flash mixer and the clarifier which were not working at the time of visit. Generally, good housekeeping standards were evident. A log is maintained for run hours, loads, etc; however, there were no maintenance logs.

The plant has a small on-site laboratory and a log is kept of the usual treatment parameters as well as chemical usage.

Gas chlorination is employed with bleaching powder being added manually as a back-up. The chlorine house is of open construction using 1 tonne cylinders, usually 2 cylinders in the chlorine house at any one time. There is 1 vacuum type chlorinator (no standby). Maintenance of chlorinators is performed in-house, but chlorinators are not periodically calibrated and records of maintenance are not kept. There are no spares on-site for the chlorine facility. Housekeeping, installation standards and operation and maintenance practices for chlorine use are poor. There are no facilities for adequately detecting or containing gas leaks with the exception of an immersion tank which empty at the time of visit. Flexible rubber hose is used instead of copper tubing for connecting cylinders to the chlorinator. This is not safe practice. The feeder pipe to the contact tanks was poor quality flexible plastic hose and was unprotected; **this is not safe practice and should be rectified immediately**. Gas masks are provided (canister type); however, general lack of awareness for the safe use of chlorine was evident.

General observations

Running maintenance and reactive breakdown maintenance is done by PHE staff.

Whilst regular maintenance such as oiling and greasing is carried out this is not recorder or formalised. Planned/preventative maintenance systems are not in place or intended. There are no plans for employing a computerised maintenance management system.

Guarding of machinery is poor (raw and treated water pump couplings/shafts).

Safety awareness is low and plant operators/maintenance staff are not issued with personal protective equipment (PPE).

Safety awareness and practices for use of chlorine gas is poor. There are no written procedures for handling and connection of cylinders to chlorinators or for the maintenance of equipment; including replacement intervals for copper piping etc. Stocks of piping and chlorinator spares are not available on site. Gas detectors are not installed although canister type breathing apparatus is provided.

There are no operating procedures or process control charts/parameters displayed or evident. Whilst there are some equipment catalogues on site there are no written 'standard operating procedures' (SOP's), 'O&M manuals', 'H&S procedures', 'Safe Systems of Work' (example, plant isolation/lock-off procedures for maintenance of moving machinery, working in confined spaces, etc.) or 'Emergency/Contingency plans'.

There does not appear to be an established formal system in place for reporting of management information such as compliance and performance data, maintenance issues, maintenance of assets data, H&S issues etc.

Rural water supply scheme; Matve to Parekatta

The scheme consisted of a manned pump house (24 hour manning) with a small (5 HP) submersible pump suspended in a bore well approximately 160m deep. This was commissioned in 1991. Bore wells are constructed by the Central Ground Water Board on behalf of the PHE. The pump feeds a 25m3 OHR which provides a gravity feed to the village. A chlorine solution (5%) is added to the OHR from 25 litre plastic containers to maintain residual levels; however, it is not clear if the residual chlorine level is regularly tested. There is no standby pump and therefore villagers can go without water for days when the pump breaks down.

We understand that the scheme supplies a population of approximately 1000 people with 2 or 3 hours supply per day. Supply valves are controlled by PHE staff. There are approximately 25 private connections and 25 public stand posts. There is no charge for water consumed from stand posts in rural or urban areas and consumption is not measured.

Appendix M37.9 Site Visit Report 23/05/05:
Sub-Division II (Div. III) Sewerage Network -Panaji

The EE Division III takes responsibility for water and wastewater systems within his geographic area of control (Ponda and Tiswadi Talukas). This includes, water production, transmission and distribution systems O&M (including pumping stations, reservoirs, tanker deliveries etc.), customer services including meter reading, billing, revenue collection, new supplies and complaints handling, sewerage network/pumping stations and sewage treatment plant O&M. Regional responsibility is also held for capital schemes (proposals, outline designs, estimation, tendering, contract supervision etc.).

The AE Sub-Division II (Div. III) takes responsibility for the Panaji STP and the Panaji sewerage network. (The STP has been subject to a separate review).
Sub-Division II has 114 staff (to be confirmed as organisation charts are not available) consisting of 'regular', 'work charged' and 'contract' categories.

Discussions were held with Mr. Radhakrishnan (AE) and a tour of the sewerage network was conducted with Mr. Charles De Souza (J.E) and other technical staff.

The Panaji system consists of approximately 40 km of sewers with 8 sewage pumping stations (SPS) dating back to 1967, conveying sewage to the Panaji STP. The network is not combined with storm water draining; this is the responsibility of the Municipal Council which also takes responsibility for solid waste disposal. There are drawings available of the network showing location of manholes, inspection chambers etc. There does not appear to be a formal system in place to ensure that asset information is kept up to date. We understand that approximately 85% of Panaji is covered by the network, with a relatively high connection rate of 81% of premises. Pumping mains are either DI or CI and sewers are either stoneware or concrete pipes.

The sub-division operates with the minimal of material and equipment resources which includes 1 jeep, 10 bicycles and a number of hand tools such as picks, hammers, shovels and sewer rods with various attachments for attending to blockages. These are hand operated. Powered cleaning equipment such as mechanically operated rods, dredgers, swab pulleys, gully suckers, pressure washers, etc; are not available, although, we understand that on occasions, contractors are employed with high pressure jetting machines/gully suckers etc. when the need arises. As within other divisions, staff are accustomed to using personal mobile phones and personal vehicles to enable them to carry put their official duties more effectively.

Staff are not equipped with PPE, spark proof tools, explosion proof torches, road signage, manhole lifting keys, gas detection equipment, forced ventilation equipment, tripods/safety harnesses etc. **Currently, SPS and sewer O&M are conducted with little regard for safety and without 'safe systems of work'.**

We understand that problem areas prone to blockage due to build up of fat/grease and solid waste are inspected and cleared regularly, however, there is not a system in place (scheduling) for regular inspections, cleaning, or maintenance of the network including manhole covers/inspection chambers. O & M records are not maintained. Debris removed from the sewers is usually taken to the Panaji STP for on-site disposal.

We are told that there are instances of illegal connections to the network as well as regular problems caused by the fish market who have tampered with the manholes to allow debris to be swept into the sewers (this was witnessed during our visit) and hotels that do not properly maintain or clean grease traps. Whilst PHE staff visit problem hotels and restaurants occasionally requesting that they 'clean up their act', **there are no formal systems in place to ensure 'trade effluent compliance'.**

Three of the eight sewage pumping stations were visited that were considered representative, as follows:

SPS (5) Don Bosco

This is the largest SPS and is manually operated on a 3 shift 24 hour basis. Most of the equipment is more than 30 years old.

The site is not gated or adequately fenced or secured. The wet well is open and not guarded. We are told that the wet well is emptied and cleaned by hand; manually desludged, annually.

The pump house is untidy and there are a number of trip hazards. 5 pump (1duty), shafts are not guarded.

Lighting is poor and tools for O&M work are inadequate.

Staff are not issued with spark proof tools.

There are no safe systems of work for operation or maintenance activities.
Staff are not issued with PPE with the exception of rubber gloves for unblocking pumps, although we are told that staff do not use these as they are cumbersome.

There is no standby generation equipment.

There is no extraction or forced air ventilation.

There is no method of safely detecting a build up of methane gas.

The electrical switchgear and lighting is not spark or explosion proof.

Reactive breakdown maintenance methods are practiced. Maintenance records are not maintained, however, a log is kept for pump run hours.

This site represents a serious hazard to staff and to the general public.

SPS (10) Bhatulem
This SPS is manually operated on a 3 shift 24 hour basis. Most of the equipment is more than 15 years old.

The site is gated but not locked, or adequately fenced or secured. The wet well is not adequately guarded. We are told that the wet well is emptied and cleaned by hand; manually desludged, annually.

The pump house is untidy and there are a number of trip hazards. 2 pump (1duty), shafts are not guarded.

Lighting is poor and tools for O&M work are inadequate.

Staff are not issued with spark proof tools.

There are no safe systems of work for operation or maintenance activities.

Staff are not issued with PPE with the exception of rubber gloves for unblocking pumps, although we are told that staff do not use these as they are cumbersome.

There is no standby generation equipment.

There is no extraction or forced air ventilation.

There is no method of safely detecting a build up of methane gas.

The electrical switchgear and lighting is not spark or explosion proof.

Reactive breakdown maintenance methods are practiced. Maintenance records are not maintained, however, a log is kept for pump run hours.

SPS (3) Avanti

This SPS is manually operated on a 3 shift 24 hour basis. Most of the equipment is more than 15 years old.

The site is on the public highway pavement and not gated or adequately fenced or secured. The wet well is not adequately guarded. We are told that the wet well is emptied and cleaned by hand; manually desludged, annually.

The pump house is untidy and there are a number of trip hazards. 3 pump (1duty), shafts are not guarded.

Lighting is poor and tools for O&M work are inadequate.

Staff are not issued with spark proof tools.

There are no safe systems of work for operation or maintenance activities.

Staff are not issued with PPE with the exception of rubber gloves for unblocking pumps, although we are told that staff do not use these as they are cumbersome.

There is no standby generation equipment.

There is no extraction or forced air ventilation.

There is no method of safely detecting a build up of methane gas.

The electrical switchgear and lighting is not spark or explosion proof.

Reactive breakdown maintenance methods are practiced. Maintenance records are not maintained, however, a log is kept for pump run hours.

General observations

Running maintenance and reactive breakdown maintenance is done by PHE staff.

Sewer cleaning and maintenance is done by PHE staff. Sewer cleaning equipment is inadequate.

O&M records are not maintained. Planned/preventative maintenance systems are not in place or intended. Records are maintained manually and there are no plans for employing a computerised maintenance management system.

Guarding of machinery is poor, especially on high speed rotating equipment (pump couplings/shafts).

Safety awareness is low and plant operators/maintenance staff are not issued with personal protective equipment (PPE).

Unsafe practices are employed for working in highways and in potentially explosive atmospheres in sewers and sewage pumping stations. For example, staff are not issued with specialist tools, gas detection equipment, ventilation or extraction equipment, safety masks, PPE or adequate signage or methods for controlling traffic movement.

Lighting and electrical equipment does not appear to be either spark or explosion proof.

There are no written inspection schedules, 'standard operating procedures' (SOP's), 'O&M manuals', 'H&S procedures', 'Safe Systems of Work' (example, plant isolation/lock-off procedures for unblocking/maintenance of moving machinery, working in confined spaces, working in potentially explosive atmospheres etc.) or 'Emergency/Contingency plans'.

There does not appear to be an established formal system in place for reporting of management information such as operations and maintenance issues, updating of assets data, H&S issues etc.

Appendix M37.10 Site Visit Report 24/05/05:
PHE Sub-Division I (Div. III), Panaji water network

Discussions were held with MR. Gopalan (AE) and staff.

The AE Sub-Division I (III) takes responsibility for customer services (new connections, meter reading, billing, revenue collection, complaints handling), transmission mains, distribution network and reservoirs in his geographic region of control. The Regional water supply scheme (OPA) supplying the Panaji area is managed by the Opa AE who also takes responsibility for transmission mains up to sub-division I boundary. Sub-Division IV takes responsibility for the mains crossing their geographic region of control. The 'allocation' of water from the plant to the various divisional boundaries is based on custom and practice as there is no means of measuring the flow.

We understand that there is no system for regular meetings within divisions or between division or opportunities for discussing operational issues or sharing of best practice.

An organisation chart for the Division is not in existence.

Maintenance records are not maintained.

There are no O&M or H&S manuals for the network or reservoirs and there are no formal safe systems of work.

Staff are not issued with communications equipment or PPE. There are a limited number of works vehicles available (2 jeeps, 2 trucks and 2 water tankers), staff are accustomed to using their own personal vehicles for work related activities.

Manual records are kept of water (value) billed versus collected as well as outstanding arrears. These are reported monthly to the Divisional office. Some recovery action is taken by PHE for defaulters, including disconnection. Cases older than 3 months with arrears exceeding Rs.1000 are forwarded to the Revenue Recovery Court (Government body with legal powers to recover charges on behalf of PWD).

We are told that water is available in the system for approximately 2 to 4 hours per day and the AE takes responsibility for periodic measurement of residual chlorine at the tail ends of the network. Some drawings are available for the distribution network and reservoirs but valve arrangements and customer connections are not available. Locations of pipes and valves are known to staff who are experienced on the system but there is no formal system for recording of asset data.

O&M of the distribution network including burst pipe repairs is carried out by PHE staff. Whilst backfilling of trenches is carried out by PHE, 'PWD roads division' are responsible for resurfacing/repairs to road surfaces and bill PHE for work conducted.

Some stock items are maintained such as pipe fittings, repair couplings, meters etc; with stocks normally replenished from the Divisional stores. Whilst material usage is recorded, there is no system for relating material usage against individual assets and burst pipe records are not maintained.

There are no control centres through out the PHE division as currently all networks are independent to each supply scheme.

A complaints log is maintained during office hours. The AE is on call to customers on a 24 hour (residence and mobile numbers listed in the local telephone directory).

PHE do not have a customer service strategy or citizens charter stating levels of service provision. Common design/installation standards are not applied for new connections; however, CPWD Manuals and Byelaws are available for reference. Revenue meters are sealed and certified by the manufacturer; however, the meter does not have a non return valve and is not sealed to fittings such as stop valves. PHE do not have a system of periodic maintenance, cleaning, calibration or replacement of meters.

Staff conducting street works do not have a safe system of work and only limited "work in progress" signage is available. Basic tools are available for O&M activities such as small generators for electric pipe cutters and emergency lighting and small pumps.

Active leakage control practices are not conducted. Leaks are repaired when they become evident, either reported by the general public or discovered by PHE staff. Pipe locating and cable locating equipment is not available and we are told that a high incident of leaks is caused by other utility companies digging trenches.

PHE do not have meter repair workshops or facilities to calibrate meters. Occasionally, defunct meters refurbishment is contracted out. Meters are procured from registered manufacturers/suppliers who are certified by the GOG (Director General for Supply and Disposal).

A petty cash system is operated for purchase of materials in emergencies. This is maintained at Rs.5000, however, the AE's spending limit is Rs.500 per voucher, above which, authorisation is required from the EE. For larger expenditure, quotations are sought for approval by the CE.

The Public Service Commission decide on promotions within the PWD from AE upwards and is mainly based on seniority. 'Confidential reports' (staff appraisals) are conducted by AE's and above annually and forwarded to the CE.

The Principle CE (PWD) has a HRD department who coordinate/administer HR and training activities throughout PWD including the PHE Division. However, the training is not targeted to meet personal or corporate development needs.

Burst pipe repairs

We attended a burst pipe repair to a small (2.5 inch) galvanised iron distribution mains at the side of a busy road. The trench was dug by hand and the pipe exposed. The trench was dewatered by use of a plastic bottle. Methods were not employed to control traffic or to protect staff working in the road. As supply was not on in that area, there was no need to isolate distribution valves. The pipe was exposed and a temporary repair was made using rubber strapping. It was intended to discard the old pipe and re-connect those customers to a larger newer main running in parallel.

Although burst pipe records are not kept, we understand that the majority of leeks are discovered on supply pipes due to corrosion, saddles and PVC pipes and joints. This will be assessed as part of the leakage survey.

Safety awareness is low and contract staff are not issued with personal protective equipment (PPE).

Althino reservoir complex

The complex is controlled by the distribution department and contains 5 number 800m3 GLR's, 1 number 5000m3 GLR, 1 number 450m3 OHR and 1 number 650m3 OHR, supplying the Althino and Panaji areas. The complex is manned on a 24 hour basis and secured. The site is gated and well fenced, but the site is untidy and there were a number of hazards including uncovered valve pits and unprotected pump couplings/shafts. The 650m3 OHR is used for filling tankers (mostly private tankers contracted to PWD) as well as other private tankers. A sales voucher system is used which are issued at the sub-division office and shown to security/operating staff at the reservoir complex prior to loading.

Re-chlorination is carried out to ensure adequate residual chlorine levels prior to discharging from reservoirs to the network. An electro-chlorination facility (with bleaching powder back-up) with an on-site laboratory is available for this purpose.

A diesel generator is maintained at the site due to frequent power failures.

Guarding of machinery is poor, especially on high speed rotating equipment (pump couplings/shafts).

There does not appear to be an established formal system in place for reporting of management information such as compliance and performance data, maintenance issues, maintenance of assets data, H&S issues etc.

Appendix M38

Water Supply and Sewerage Tariff Structure

Contents for Appendix M38

Appendix M38.1 Water Supply and Sewerage Tariff Structure

Table M38.1.1 Tariff System of PWD Goa

1. Water charges

	Category	Minimum charge	Rate	Range
1-a	Domestic Consumers	Rs. 30/month	Rs. 2.50 /m^3 Rs. 5.00 /m^3	0 - 20 m^3 20 - 50 m^3
1-b	Students, Hostels, Hospitals/Dispensaries and Educational Institutions and recognized charitable Trust Institutions fully aided by Govt.	Rs. 30/month	Rs. 5.50 /m^3	All range
2-a	Students, Hostels, Hospitals/Dispensaries Business Profession *1, Educational Institution and recognized charitable Trust Institutions not aided by Govt.	Rs. 30/month	Rs. 12.00 /m^3 Rs. 15.00 /m^3	0 - 300 m^3 300 m^3 -
2-b	Small hotels *2, Small restaurants*3	Rs. 150/month	Rs. 12.00 /m^3 Rs. 15.00 /m^3	0 - 100 m^3 100 m^3 -
2-c	Defence, Fishing boat owners, Operators association at various Jetties in Goa, All the water bills issued to S.G.P.D.A. market complex at Margao	Rs. 150/month	Rs. 12.00 /m^3	All range
3	Small scale / Medium / Large and all types of Industries / Hotels (registered) (other than small hotels restaurant, Tourist Hostels)	Rs. 150/month	Rs. 22 /m^3	All range
4	Commercial incldg. MPT/Bar/Cinema Theatres/ Construction/ Establishments *4	Rs. 150/month	Rs. 30 /m^3	All range

Note:
*1; Not falling within the purview of Goa, Daman & Diu Shops and Establishment Act, 1974
*2; No restaurants, number of rooms less than 15 with A/C room less than three.
*3; Non air conditioned, area up to 150 m^2
*4;Registered under the Gaoa, Daman & Diu Shops and Establishment Act, 1974

2. Sewerage charges

25% of water consumption charges

* In case of consumers who consume water from source other than the Govt. water supply, the billing will be done on actual quantity consumed from all the sources as assessed by the department

3. Installation charge

Water Supply Sector			
I	**Category**	**Size of connection**	**Amount per connection**
1	Domestic & Small Hotels, Small Restaurants	15mm / 20 mm	Rs. 500.00
		20 mm/25 mm	Rs. 1,000.00
2	Other than Domestic/small hotels/small restaurants	15 mm / 20 mm	Rs. 2,000.00
		20 mm / 25 mm	Rs. 5,000.00
		25 mm - 150 mm	Rs. 10,000.00
Sewerage Sector connection to Sewerage System			
I	**Category**	**Size of connection**	**Amount per connection**
1	Domestic	Up to 150 mm	Rs. 200.00
		Above 150 mm	Rs. 350.00
2	Non-Domestic	Upto 150 mm	Rs. 500.00
		Above 150 mm	Rs. 700.00

4. Delayed payment charges and reconnection charges

1) 2% per month shall be become due and payable, if bill is not paid on or before due date of payment specified in the water bill.
2) The water supply/sewerage connection is liable for disconnection in case payment of water bills remains overdue for 2 months.
3) The reconnection charges of the meter after disconnection shall be Rs. 200/-.

5. Meter rent charge

No.	Size of meter	Rates per month
1	15 mm (1/2 inch)	Rs. 15.00
2	20 mm (3/4 inch)	Rs. 20.00
3	25 mm (1 inch)	Rs. 25.00
4	40 mm (1 1/4 inch)	Rs. 100.00
5	50 mm (2 inches)	Rs. 150.00
6	80 mm (3 inches)	Rs. 200.00
7	100 mm (4 inches)	Rs. 250.00
8	150 mm (6 inches)	Rs. 400.00

Appendix M39

Results of Public Awareness Surveys

Contents for Appendix M39

M39.1 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 Master Plan including facility planning, OM planning, economic analysis, tariff evaluation, Initial Environmental Evaluation (IEE), Environmental Impact Assessment (EIA), and recommendations for awareness enhancement.

(2) Coordination with Other Public Awareness Surveys

In 2004, the PWD conducted a Customer Preference Survey (CPS) regarding water supply as part of the Sector Status Study 2004. The CPS covered cities, towns and villages in Goa and showed the differences in water supply between rural and urban areas in each taluka. The results of the CPS were used to design the questionnaires for the public awareness surveys that were undertaken as part of this current study. This meant the current study did not unnecessarily duplicate questions from the previous survey. The current study also investigated sanitation/sewerage, which was not covered by the 2004 PWD survey.

The PWD had also engaged a local consulting company to conduct household awareness surveys (called the Goa Sanitation Baseline Survey) as part of the Total Sanitation Campaign. These surveys investigated sanitation and water supply for rural areas only. It was agreed at the Inception Meeting for this current study that the PWD would provide the JICA Study Team with the results of Goa Sanitation Baseline Survey to help inform this Progress Report. However, the PWD's survey in rural areas has been delayed and is not expected to be completed for another few months. The JICA Study Team therefore decided to survey both the urban and rural areas in Goa as part of the public awareness surveys.

Some household data regarding water supply, sanitation and drainage that was collected during the 2001 census and the CPS was used to supplement the public awareness surveys.

(3) 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.

(4) 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. Attachment.1 (Implementation of the Public Awareness Surveys) presents information regarding the implementation structure for the surveys and interviews, the survey schedules, the training and orientation methods for the field survey, and the supervision and reporting procedures.

Dozens of photographs were taken during the field surveys. These photographs document the current water supply and sanitation/sewerage situation pictorially. The photographs are presented in Attachment.2 (Photographs taken during the Public Awareness Surveys).

M39.2 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) Sampling Design and Survey Areas

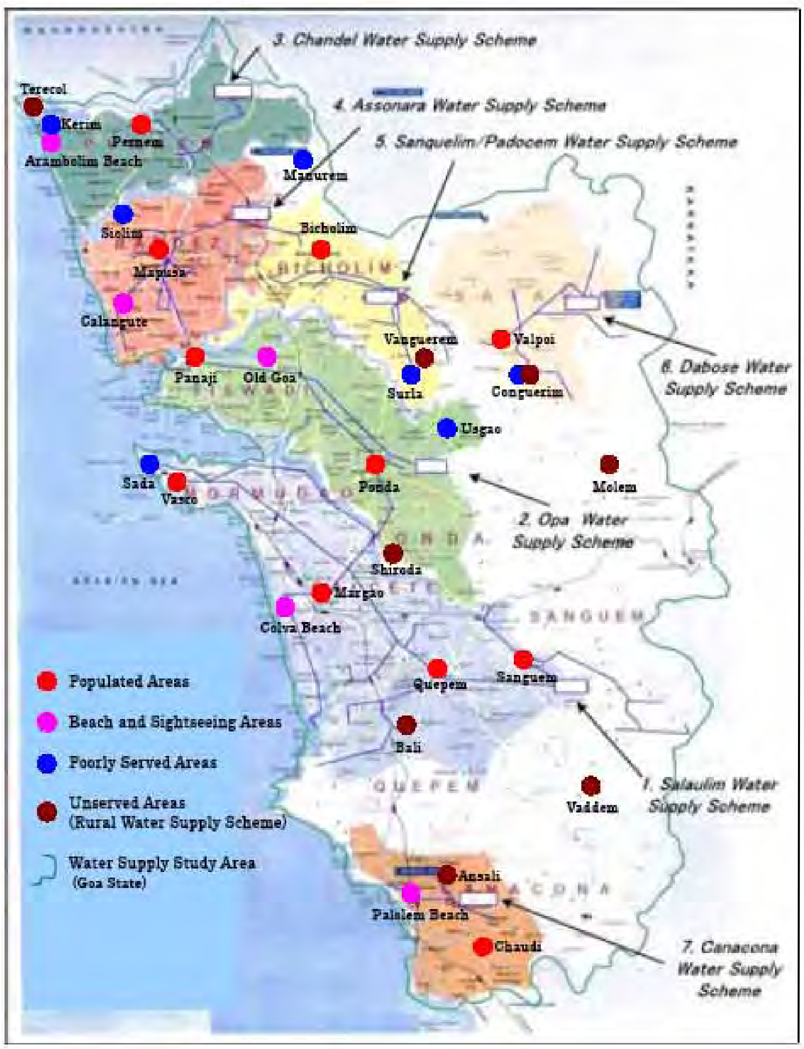


Figure M39.2.1 Water Supply Survey Areas

Figure M39.2.1 shows the survey areas. The sampling was primarily undertaken for the seven large-scale surface water supply schemes. However, some rural water supply schemes were also included. For each surface water supply scheme the survey area included the populated area, the beach/sightseeing area, the area poorly served by the surface water supply scheme, and the area not served by the surface water supply scheme. The survey area for each surface water supply scheme did not include rural water supply schemes. Approximately 360 surveys were conducted in these survey areas.

(3) Main Results of the Survey

Attachment.3 presents the results of the questionnaire survey for residents regarding water supply. Some of the main survey results are presented and discussed below.

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). The least important aspect of water supply was found to be low water charges (52 points). However, Figure M39.2.2 shows that approximately 25% of the households that have house connections (individual house and building connections) believe their current water charges are too expensive, while about 70% believe the charges are fair.

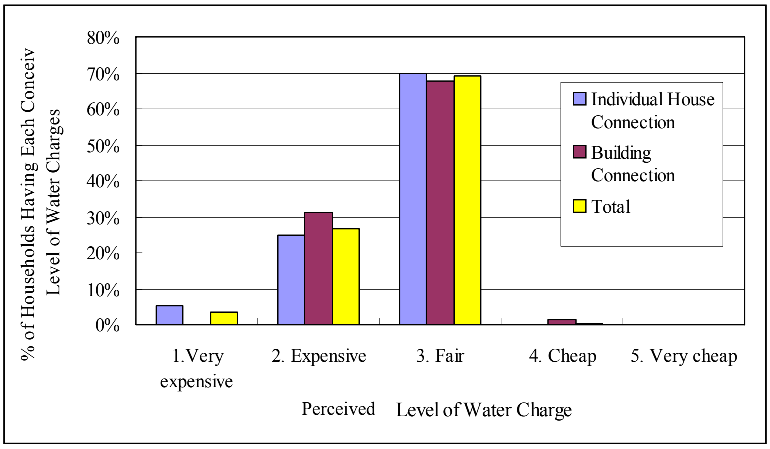


Figure M39.2.2 Perceived Level of Water Charge

Figure M39.2.3 shows that the high monthly water charges and the high connection fees are the main reasons for not connecting to the water supply system. Also, residents can access alternative water supplies (such as public stand posts and open wells) meaning they do not have to connect to the piped water supply.

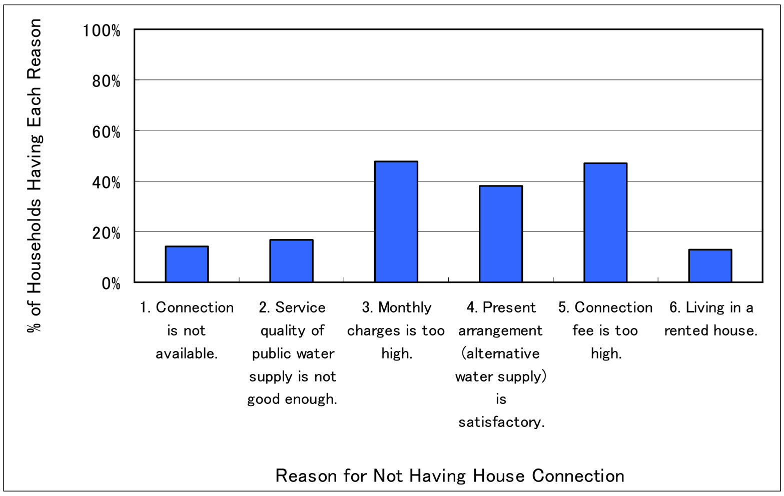


Figure M39.2.3 Reasons for Not Having House Connection

Table M39.2.1 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. (Rs.14 +Rs.11) 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 M39.2.1 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 S.W.S.S Rs.	2. Opa S.W.S.S Rs.	3. Chandel S.W.S.S Rs.	4. Assonora S.W.S.S Rs.	5. Sanquelim S.W.S.S Rs.	6. Dabosei S.W.S.S Rs.	7. Canacona S.W.S.S Rs.	8. Distant form the S.W.S.S Rs.	9.Average Rs.
Survey Areas in Each Surface Water Supply Scheme (S.W.S.S)	1. to 4. Populated Area	11+0*=11	11+8=19	7+9=16	10+11=21	10+9=19	12+8=20	26+16=42		14+11=25
		16+14=30	17+8=25							
		14+12=26								
		15+14=29								
	5. Beach and Sightseeing Areas	20+15=35	19+8=27	7+10=17	14+12=26					15+11=26
	6. Poorly served areas	29+22=51	26+16=42	10+7=17	17+25=42	6+6=12	8+5=13	5+8=13		14+13=27
Average of Each S.W.S.S		18+15=33	18+10=28	8+9=17	13+16=29	8+8=16	10+7=17	16+12=28		14+11=25
7. and 8. Rural Water Supply Schemes within/outside the S.W.S.S		- **	7+5=12	- **		10+5=15	- **	8+8=16	- **	9+7=16
									13+10=23	

Notes: *This survey area already has 24 hour water supply, so additional WTP for 24 hour water supply was not investigated here.
** There were not enough surveys collected in these rural water supply schemes to determine WTP.

M39.3 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) Sampling Design and Survey Areas

Initially, the sewerage study areas were broadly classified into sewered and unsewered areas. Then, the high, middle, low and very low income areas were identified for each of these classifications in each study area. Also, the houses and residential buildings in commercial areas were selected as survey areas. Figure M39.3.1 shows the survey areas in the sewered areas (i.e. Pananji and the north and central zones of Margao). Figure M39.3.2 shows the survey areas for the unsewered areas (i.e. the areas surrounding the residential areas of Panaji, the southern zone of Margao, the Northern and Southern Coastal Belts, Mapusa and Ponda). Approximately 340 surveys were undertaken on sanitation/sewerage.

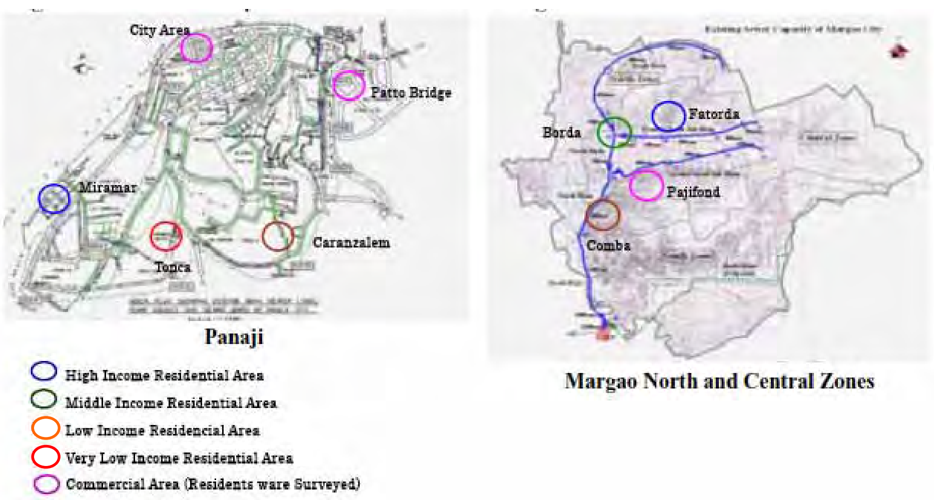


Figure M39.3.1 Survey Areas for the Sewered Study Areas

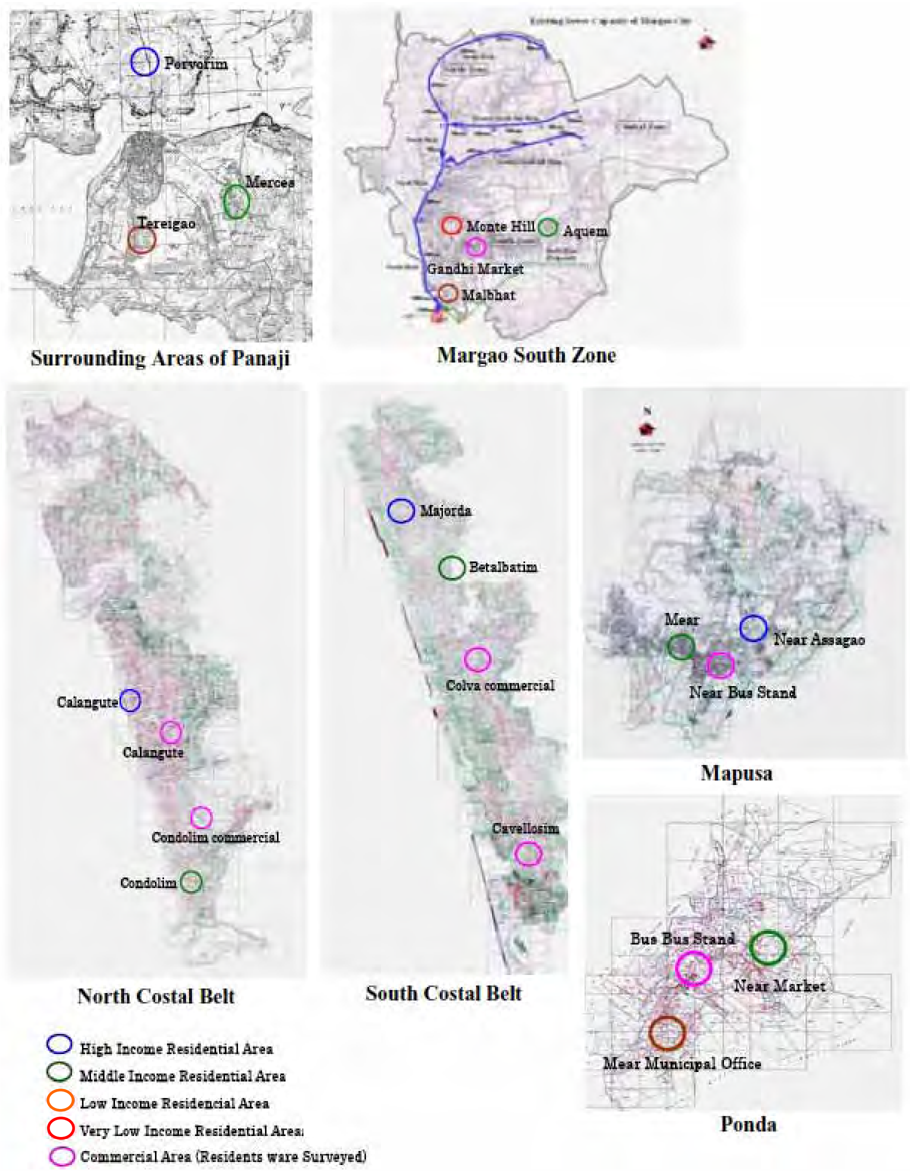


Figure M39.3.2 Survey Areas for the Unsewered Study Area

(3) Main Results of the Survey

Attachment.4 presents the results of the questionnaire survey for residents regarding sanitation and sewerage. The following section presents and discusses some of the main results.

Figure M39.3.3 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.

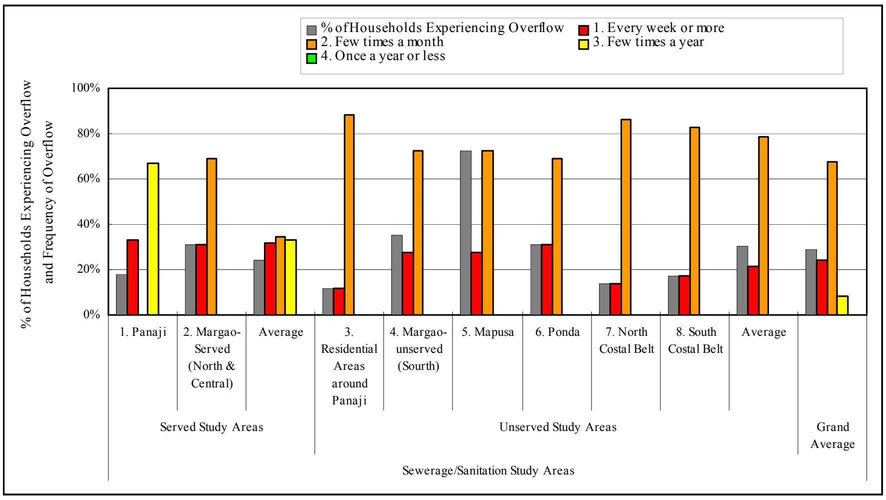


Figure M39.3.3 Percentage of Households that are not Connected to Sewer that Experience Toilet/Latrine Overflow and Frequency of the Overflows

Figure M39.3.4 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.

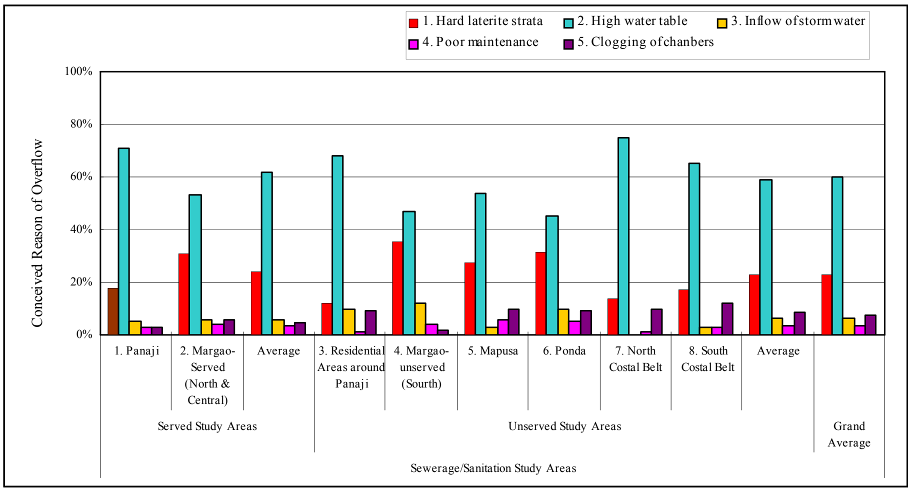


Figure M39.3.4 Perceived Reasons for Overflow of Toilets/Latrines that are not connected to Sewer

Figure M39.3.5 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 M39.3.3 to

M39.3.5 show there is a need to upgrade / expand the sewerage system in Goa.

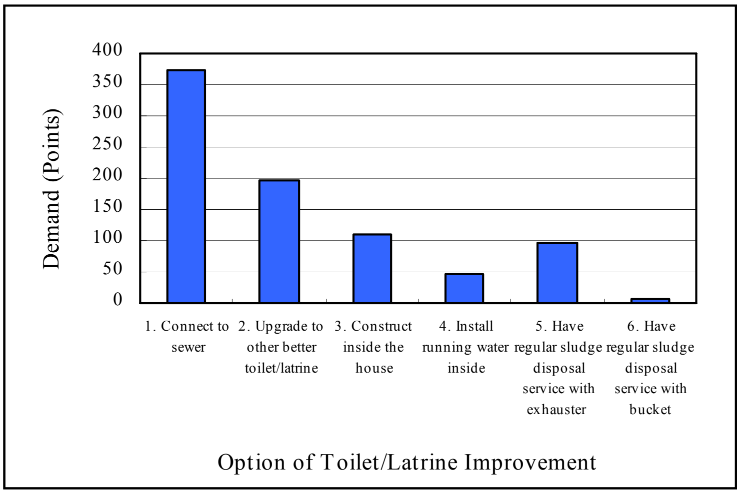


Figure M39.3.5 Public Preferences for Improvement Options for Existing On-site Sanitation

Table M39.3.1 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 M39.3.1 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.)	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.)	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.)	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

M39.4 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) Sampling Design and Survey Areas

The interviews were conducted with people living near the STPs at Panaji near Tonca (seven samples) and Margao near Shirvodem (five samples) and living near the relatively small Panaji commercial STP located behind the Kadamba Bus Stand (five samples). The discharge points of Margao STP and Panaji commercial STP are located next to the STPs. However, the treated wastewater from Panaji STP is discharged into Aguada Bay through a discharge pipeline that passes behind the sporting field and swimming pool near Miramar Beach. Therefore, a few additional interviews were conducted in the area in front of the sporting field (three samples). In total, 20 interviews were undertaken.

The income levels of the residents living near the Panaji STP vary considerably. For example, a low income group lives adjacent to the drain near the STP and a middle income group lives in the buildings adjacent to the STP. The number of interviews in this area was higher than for other areas to adequately capture this range of income levels. The residents living around the Margao WWTP are mainly low income earners. The Panaji commercial STP is located close to offices, shops etc. and therefore only a few residents live nearby.

(3) Main Results of the Interview

Attachment.5 presents the full results of the stakeholder interviews. The following section presents and discusses some of the main results.

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.

M39.5 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) Sampling Design and Survey Areas

There are many hotels and resorts of various standards which cater to the needs of the tourists. The hotels and resorts are mainly located in coastal areas. The stakeholder interviews were conducted in the most populated tourist destinations as listed here: the Candolim and Calangute areas of the Northern Coastal Belt (10 samples), Benaulim and Colva at the center of the Southern Coastal Belt (5 samples) and Mobor, which is another city popular with tourists at the southern end of Southern Coastal Belt (5 samples). In total, 20 interviews were conducted.

(3) Main Results of the Interview

Attachment.6 presents the detailed results of these stakeholder interviews. The following section presents and discusses some of the main results.

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 M39.5.1 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.

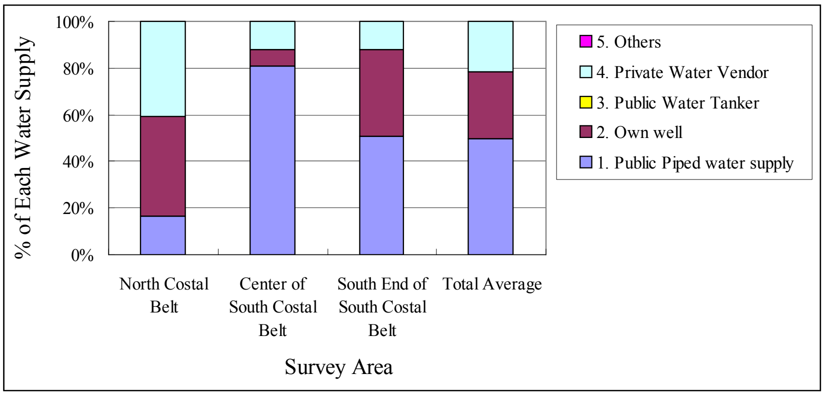


Figure M39.5.1 Proportion of Water Supplied from different sources during the High Season

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.

M39.6 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) Sampling Design and Survey Areas

Tourism is one of Goa's main sources of income. It was therefore important to include tourists in these stakeholder interviews. The stakeholder interviews for tourists were conducted in Candolim (12 for foreign tourists and 5 for domestic tourists) in the Northern Coastal Belt, and Benaulim (5 for foreign tourists and 3 for domestic tourists) and Mobor (3 for foreign tourists and 2 for domestic tourists) in the Southern Coastal Belt.

(3) 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 M39.6.1 shows the tourists' average WTPs for these improvements.

Table M39.6.1 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

List of Attachment

Attachment 1 Implementation of the Public Awareness Surveys

(1) Implementation Structure

The following figure shows the implementation structure of the surveys organized by the entrusted local consultants, Shah Technical Consultants Private Ltd. (STC).

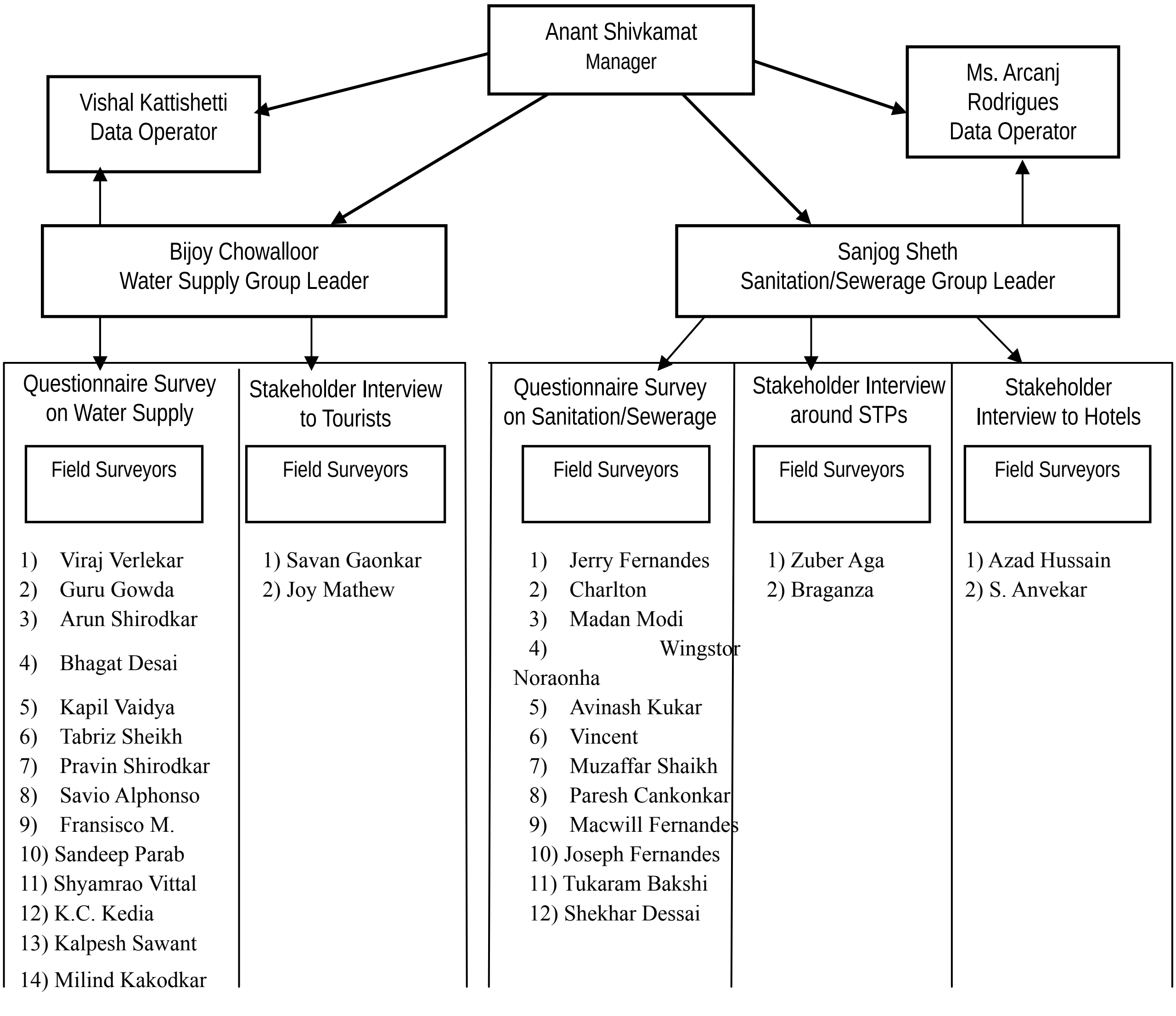


Figure AT.1.1 Organizational Chart of the Survey Team

(2) Implementation Schedule

The entrusted work of the public awareness surveys was implemented in five weeks from July 22th, 2005 to August 25th, 2005 as follows;

Week 1: Preparation of the detailed survey schedules, finalization of questionnaires and survey design including pre-test surveys, and preparation of the survey implementation.

Weeks 2 – 4: Implementation of the questionnaire surveys and stakeholder interviews, and data input and data processing (including 2 days for training).
Week 5: Analysis of the results and preparation of the report.

(3) Training and Orientation of Survey Teams

All the survey team members were given a two days orientation and training regarding the background, importance and purpose of the assessment of water supply and sanitation. Detail briefing of each questionnaire and methodology of conducting the interview, appropriate attitude and patience to be adopted while conducting the interview were also explained so that accurate information is elicited.

Each surveyor was given an ID card.

(4) Conducting the field surveys

As there were two different questionnaires each for water supply and sanitation, two groups each were formed for the same. A team of two members for each of the three types of the stake holder interview were formed.

Water survey team

The survey was conducted in seven water supply schemes and two sites outside the water supply schemes. A group of fourteen members were basically further divided into seven teams. The mode of operation would be to go to the Panchayat/Municipality office as per the survey area, appraise the Panchayat/Municipality officers about the purpose of the questionnaire and take a list of the areas/wards therein.

The survey members spent four days for collecting the information from Salaulim water supply scheme, three days for Opa water supply scheme, two days for Assonora water supply scheme and Sanquelim water supply scheme respectively and one day each for Dabose water supply scheme, Chandel water supply water scheme and Canacona water supply scheme. The survey team used to cover twenty eight to thirty household per day.

Sanitation survey team

Sanitation survey was done in six areas. Group of twelve members were basically divided into six teams. The mode of operation would be to go to the Panchayat/Municipality office as per the survey area, appraise the Panchayat/Municipality officers about the purpose of the questionnaire and take a list of the areas/wards therein.

They spent three days each in Panaji served area and Margao served area respectively. Two day for Margao unserved area, residential areas around Panaji and 1 day each in Mapusa, Ponda, North Costal Belt, and South Costal Belt. The survey team used to cover twenty eight to thirty household per day.

<u>Stake holder interview</u>

Stake holder interview in the areas surrounding sewerage treatment plant was carried out in Panaji and Margao. Team of two members carried out the survey.

Stake holder interview of hotels was carried out in North Coastal Belt, Center of South Coastal Belt and South End of South Coastal Belt. Team of two members carried out the survey.

Stake holder interview of tourist was carried out in various tourist places in North Coastal Belt, and South Coastal Belt. A team of two members carried out the survey.

(5) Supervision of the surveys

One group leader instructed the surveyors for the questionnaire survey on water supply and the stake holder interview to tourist. Another group leader instructed the surveyors for the questionnaire survey on sanitation/sewerage and the stake holder interview to the residents living around existing sewerage treatment plants and the stake holder interview to hotels. Group leaders were in charge of logistics and co-ordination of the day's activities. Initially, each team member would check each of his/her own formats for errors and omissions and then, these would be further checked by the group leader. Only completed forms were accepted for data-entry and further processing. At the end of each day's visit, the group leaders would submit the completed and checked forms along with a list of the number of formats each team member had completed.

The collected data were entered and also checked first by the data operators and these would be further checked by the manager. Manager would then check random formats for any further errors and if any mistakes were noticed, next morning these formats would be given back to the concerned survey team member for correction.

Supervision of the field survey was done independently by the manager through surprise visits to a particular location which was under survey on particular day, contacting the field teams and then accompanying them on a few household visits. Feedback was given to the teams the next day regarding observations made during the visit.

(6) Reporting on the Public Awareness Surveys

The report of the public awareness surveys was drafted by the entrusted local consultants with support from the JICA Study Team. The report was prepared in accordance with the detailed instruction sheets on the reporting which had been prepared by the JICA Study Team.

Attachment 2 Photographs Taken During the Public Awareness Surveys

Regional water supply scheme source, open well

Storage tank outside the house.
Habitants totally dependent on tanker water.

Big open well -shared by 2 to 3 households

Spring water source

Hand pump

Public stand post leaking water

Metered stand post / metered water connection outside house shared by 2 to 3 houses in Monte Hill , Margao

People fetching water from Public Stand Post

Private water Tanker

Local people called Kunbi Tribe in front of

Example of polluted open well

a rural water supply scheme (open well)

House wastewater discharged into open ground

Open well and toilet very closely placed

Temporary habitant for coustruction wokers

Sulabh privated toilet

Open drain polluted by mining

Questionnaire survey in progress

Questionnaire survey completed


Garbagecollection outside common toilet (sulabh toilet) in Monte Hill (slum), Margao


Example of Indian water close let type toilet with flushing system in sulabh toilet


Home wastewater pipeline and sepetic tank in Monte Hill, Margao


Drainage in Monte Hill, Margao


Solidwaste dumped outside collection bin in Monte Hill, Morgao


Very low income area in Mapusa


Closed draing close to houses in low income aras, Sada, Vasco


Zuari Nagar low incom residencial area, Mormugao

Temperory structures of cunstruction workers

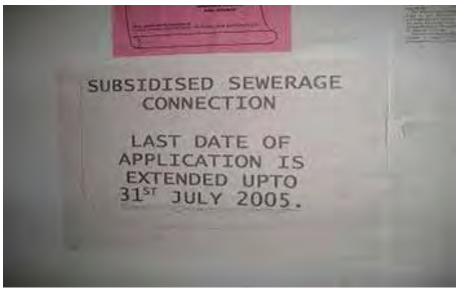
Pilot survey to a low income household in Comba, Margao

Another pilot survey to a low income household not connected to sewer in sewerage served area in Margao

Sewerage manhole chambers overflowing in wet season in Margao

Pilot survey in high income neighborhood

PWD owned sluge suction machine



Notice of sewerage connection in PWD

Around Margao Sewerage Treatment Plant

Water stored in utensils only for cooking and drinking in a rural household

Woman cleaning at Public Stand Post

Nallah meeting the Sea at Colva Beach, South Costal Area

Near Calangute Beach, North Costal Zone

Tourist hotel-GTDC where a pilot survey was conducted

Underground closed water tank having metered water connection in a hotel

Sepetic tank corved with grass in a hotel

Discharge point of Panaji Commercial STP

Plastic garbage in nallah near Vasco

PWD owned water tanker

Attachment 3 Results of the Questionnaire Survey for Residents Regarding Water Supply

(1) Existing Situation

1) Water Supply Service Types

- ✓ Table AT.3.1 shows that the dependency on the other water sources by the household having individual/building house connection during the difficult season and the purpose for which it is being used. It is found that the individual building household connection mainly depends on the public water tankers supplied by the PWD during the shortage of water in their regular source. This water is mainly used for washing and bathing.
- ✓ Table AT.3.2 shows that the respondents having public stand post as their main source are dependent on mainly public water tankers and open wells for their daily water requirement in the difficult season. The water from open wells is used for drinking, cooking and other activities while the water from public tanker is mainly used for washing and bathing.
- ✓ Table AT.3.3 shows that the respondents having open well as their main water source are scarcely depend on public stand post and rivers, lakes, ponds, springs, etc. for the water requirement during difficult season.
- ✓ Table AT.3.A4 shows that the respondents using rivers, lakes, ponds, springs etc. as the primary water source are generally not depending on other water sources like public or private water vendors and public stand posts.
- ✓ Table AT.3.5 shows that the respondent having usable wells is only 15% for the households using individual house connection as their primary water source and 1% in case of building connection.
- ✓ Average size of the wells of the sampled households is 3.7m in diameter, 7.5m in depth. Average water levels of the wells in wet season (June to September) and dry season (October to May) are 5.0m and 2.7m from ground level, respectively. Average initial construction cost of well facilities (including the costs of boring, pump, etc.) and average annual maintenance cost of well facilities are about Rs. 4200 and Rs. 400 per year, respectively. The wells and pumping facilities are assumed to have 11 years more of life time on average.
- ✓ In this survey, 64% and 36% of the sample are allocated to households having house connection and household without house connection, respectively. It was found that 2.3% of the sampled households having house connection use free alternative water sources such as public stand posts, open well as their primary water source. This

percentage seems to be lower than actual situation because in this survey the fewer sample number was allocated to rural areas where there are more stand post left. The 49% of the household without house connection (using public stand post, well, etc.) answered that they do not have house connections because public stand post is available at free of charge, while 7% and 11% of the household without house connection answered that the house connection is too expensive and quality of house connection service is not good enough.

- ✓ Table AT.3.6 shows that about 20% of the sampled households having individual house connection, on average buy bottled water for drinking. Their average monthly cost of bottled water is Rs. 90 per month.
- ✓ Table AT.3.7 shows that 7% of the sampled household buy water from private water vendors. 81% and 11% of the households buying water form private water vendor say that it is because public water service is not sufficient and as there are problems with public water services. Their average monthly cost of water from private venders is about Rs. 260 per month. The price of water per tanker is around Rs. 500.

Table AT.3.1 Different water sources for different purposes for households using house connection as their main water source

Water Sources	1. Drinking	2. Cooking	3. Washing	4. Bathing	5. Flushing toilet/latrine	6. Irrigating garden	7. Others
1. Individual House Connection	48	48	47	47	33	1	2
2. Building/Apartment House Connection	26	26	26	25	25	2	2
3. Public Stand Post	1	1	2	3	3		
4. Open Well	1	1	4	1	3	3	
5. Deep Well	2	2	2	3	1		
6. Public Water Tanker	9	12	22	23	18		2
7. Private Water Vendor	2	1	4	4	3		1
8. River, Lake, Pond, Spring, Rain							

(Water Uses)

Table AT.3.2 Different water sources for different purposes for households using public stand posts as their main water source

Water Sources	1. Drinking	2. Cooking	3. Washing	4. Bathing	5. Flushing toilet/latrine	6. Irrigating garden	7. Others
1. Individual House Connection							
2. Building/Apartment House Connection							
3. Public Stand Post	26	26	26	26	15	2	7
4. Open Well	3	3	3	3	2	1	
5. Deep Well							
6. Public Water Tanker	6	7	10	13	7		6
7. Private Water Vendor			1	1	1		4
8. River, Lake, Pond, Spring, Rain		1	1	1			

(Water Uses)

TableAT.3.3 Different water sources for different purposes for households using open wells as their main water source

Water Sources	1. Drinking	2. Cooking	3. Washing	4. Bathing	5. Flushing	6. Irrigating garden	7. Others
1. Individual House Connection							
2. Building/Apartment House Connection							
3. Public Stand Post	1	2	2	2	2		
4. Open Well	6	6	6	6	4	1	1
5. Deep Well							
6. Public Water Tanker							
7. Private Water Vendor							
8. River, Lake, Pond, Spring, Rain	1	1	1	1		1	

(Water Uses)

Table AT.3.4 Different water sources for different purposes for households using river, lake pond, spring, rain, etc. as their main water source

Water Uses

Water Sources	1. Drinking	2. Cooking	3. Washing	4. Bathing	5. Flushing toilet/latrine	6. Irrigating garden	7. Others
1. Individual House Connection							
2. Building/Apartment House Connection							
3. Public Stand Post							
4. Open Well							
5. Deep Well							
6. Public Water Tanker							
7. Private Water Vendor							
8. River, Lake, Pond, Spring, Rain	11	11	11	11	6	1	0

Table AT.3.5 Percentage of the household having usable wells

Perception	Type of Primary Water Source						
	1. Individual House Connection%	2. Building Connection%	3. Public Stand Post%	4. Private Well (Mostly Open wells)%	5. Public/Private Water Tanker%	6. Others (river, spring, etc.)%	Grand Average%
1. Having Usable Wells	15%	1%	24%	100%	0%	0%	23%
2. Not having Usable Wells	85%	99%	76%	0%	0%	100%	60%

Table AT.3.6 Percentage of buying bottled Water

Perception	Type of Primary Water Source						
	1. Individual House Connection	2. Building Connection	3. Public Stand Post	4. Private Well (Mostly Open wells)	5. Public/Private Water Tanker	6. Others (river, spring, etc.)	Grand Average
1. Yes, buy bottled water	20%	24%	15%	0%	0%	0%	10%
2. No, don't buy bottled water	80%	76%	85%	100%	0%	100%	74%

Table AT.3.7 Percentage of buying water from private water vendors

Perception	Type of Primary Water Source						
	1. Individual House Connection	2. Building Connection	3. Public Stand Post	4. Private Well (Mostly Open wells)	5. Public/Private Water Tanker	6. Others (river, spring, etc.)	Grand Average
1. Yes, buy water from private vendor	9%	10%	21%	0%	0%	0%	7%
2. No, don't buy water from vendor	91%	90%	79%	100%	0%	100%	77%

2) Water Consumption

- ✓ It is found in the survey that 99% of the sampled households secure enough water for drinking, cooking, washing hands, however about 5% and 15% of the household do not have enough water for taking bath and washing clothes in usual time respectively. 64% of the household would like to use more water, but 77% of them answered that low availability of water is the main constraint for them to use more water while cost of water and time/labor to fetch water are minor constraints.
- ✓ In the survey 98% of households using piped public water supply services (individual house connection, building connection and public stand post) answered that they are saving water. 100% of the users saving water answered that they save water because it is a common and limited resource. 65% of the users saving water also answered that they do so because water charge is expensive. In the survey, it is also found that 94% of the piped public water supply users think that the use of house connection should be charged depending on the volume of water use to encourage saving water rather than be charged with a fixed price per person.
- ✓ Table AT.3.8 shows that the metered water consumption is 111 lpcd in populated areas and 205 lpcd in beach and sight seeing areas of Salaulim water supply scheme. The metered consumption is on 55 lpcd in a populated area of Opa water supply scheme. This may be due to the poor supply by the system as there is less water at the source.
- ✓ Table AT.3.9 shows that the total water consumption i.e. house connection and water from private/public water vendors. It is observed that of the requirement of 152 lpcd by the respondents in populated area of the water supply scheme the actual metered consumption is 97 lpcd. The balance 55 lpcd is catered by the other sources viz., public water tankers and private water vendors.
- ✓ Table AT.3.10 shows the total water consumption of household using public stand post.

Table AT.3.8. Metered water consumption of house connection (Individual and Building connection) in lpcd.

Types of Survey Areas		Water Supply Study Areas								
		1. Salaulim S.W.S.S	2. Opa S.W.S.S	3. Chandel S.W.S.S	4. Assonora S.W.S.S	5. Sanquelim S.W.S.S	6. Dabosei S.W.S.S	7. Canacona S.W.S.S	8. Distant form the S.W.S.S	Average
Survey Areas in Each Surface Water Supply Scheme (S.W.S.S)	1. to 4. Populated Area	111 (Sanguem)	59 (Ponda)	62 (Pernem)	129 (Mapusa)	113 (Bicholim)	84 (Valpoi)	107 (Chaudi)		
		111 (Quepem)	55 (Panaji)							
		114 (Margao)								
		118 (Vasco)								97
	5. Beach and Sightseeing Areas	205 (Colva Beach)	96 (Old Goa)	59 (Arambol)	91 (Calangute)					113
	6. Poorly Served Areas	100 (Sada)	159 (Usgoa)	81 (Kerim)	79 (Siolim)	71 (Surla)	76 (Conquerim)	60 (Palolem)		89
Average of Each S.W.S.S		127	92	67	100	92	80	84		97
Average Domestic LPCD Supply of House Connection and Stand Post presented in Sector Status Study 2004*		176	225	80	158	96	120	98		136
7. and 8. Rural Water Supply Schemes within/outside the S.W.S.S		54 (Bali)	68 (Shiroda)	- (Terekhol)		56 (Mankurem)	- (Conquerim (Partly))	57 (Ansali)	- (Molem)	
									84 (Valdem)	64

Reference: * Sector Status Study 2004, PWD, Appendix p.79

Note: S.W.S.S. means the seven large-scale surface water supply schemes which are not rural water supply schemes.

Table AT.3.9 Total water consumption (including different type water supply and sources) of the households having house connection in lpcd

Types of Survey Areas		Water Supply Study Areas: 1. Salaulim S.W.S.S	2. Opa S.W.S.S	3. Chandel S.W.S.S	4. Assonora S.W.S.S	5. Sanquelim S.W.S.S	6. Dabosei S.W.S.S	7. Canacona S.W.S.S	8. Distant form the S.W.S.S	Average
Survey Areas in Each Surface Water Supply Scheme (S.W.S.S)	1. to 4. Populated Area	163	100	175	181	154	131	150		154
		165	138							
		173								
		175								
	5. Beach and Sightseeing Areas	193	106	131	180					155
	6. Poorly Served Areas	122	153	163	142	90	105	100		125
Average of Each S.W.S.S		164	124	125	168	122	118	125		145
Average Domestic LPCD Supply of House Connection and Stand Post presented in Sector Status Study 2004*		176	225	80	158	96	120	98		136
7. and 8. Rural Water Supply Schemes within/outside the S.W.S.S		100	90	-		100	-	100	-	103
									125	

Reference: * Sector Status Study 2004, PWD, Appendix p.79
Note: S.W.S.S. means the seven large-scale surface water supply schemes which are not rural water supply schemes.

Table AT.3.10 Total water consumption (including different type water supply and sources) of household using public stand post in lpcd

Types of Survey Areas		Water Supply Study Areas: 1. Salaulim S.W.S.S	2. Opa S.W.S.S	3. Chandel S.W.S.S	4. Assonora S.W.S.S	5. Sanquelim S.W.S.S	6. Dabosei S.W.S.S	7. Canacona S.W.S.S	8. Distant form the S.W.S.S	Average
Survey Areas in Each Surface Water Supply Scheme (S.W.S.S)	1. to 4. Populated Area	-	100	108	125	100	133	75		
		50	100							
		75								
		100								97
	5. Beach and Sightseeing Areas	100	75	93	100					92
	6. Poorly Served Areas	67	125	130	125	125	100	50		103
Average of Each S.W.S.S		78	100	110	117	113	117	63		98
Average Domestic LPCD Supply of House Connection and Stand Post presented in Sector Status Study 2004*		176	225	80	158	96	120	98		136
7. and 8. Rural Water Supply Schemes within/outside the S.W.S.S		50	67	117		125	100	67	75	
									100	88

Reference: * Sector Status Study 2004, PWD, Appendix p.79
Note: S.W.S.S. means the seven large-scale surface water supply schemes which are not rural water supply schemes.

3) Current Situation of Individual/building Connection

- ✓ Table AT.3.11 shows that 20% of the individual house connection has got a tap for supply of piped water on outside their household.
- ✓ Table AT.3.13 shows that 31% of the respondents having house connection does not have ground water tank and pumping facilities to pump up the water. However there may be other types of water storage by these households such as PVC tanks, overhead tanks, drums, etc.
- ✓ Table AT.3.14 shows that 97% and 73% of building and individual house connection respectively has water tanks installed on the upper floor for storage of water during the supply hours.
  - ✓ It is found that the most important reason given by the respondents for having house connection is convenience including the reduction of hard work to fetch water.
  - ✓ In the survey it is found that 88% of the households having house connection recognize that house connection contribute to reduce the frequency of diarrhoea in their households.
  - ✓ Table AT.3.15 shows that on an average the respondents having metered house connection pay Rs. 102.60 for 15.8 m^3 of water per month.

- ✓ Tables AT.3.17, 18 and 19 infer that 100% of the house connection has water meters of which 6% of the meters are having some defects. 60% of the household having said that the current water charges for the piped water supply is fair.
- ✓ Table AT.3.20 shows that 3% of the respondents having house connection said that they think that water charges are fixed per month while 14% didn't know.
- ✓ A total of 12% of the respondents in the entire survey sample said that they metered bill as they say that the metering system is not proper.

Table AT.3.11 Taps in the house connection

Type	1. Both inside and outside	2. Only outside	3. Only inside
1. Individual house connection	47%	20%	33%
2. Building connection	3%	1%	95%

Table AT.3.12 Number of water taps in household

Type	Average Tap Number
1. Individual house connection	4.2
2. Building connection	3.9
3. Average	4.1

Table AT.3.13 Ground water tank and pumping facilities

Type	Having a ground water tank and pumping facilities to pump up water	
	Yes	No
1. Individual house connection	66%	40%
2. Building house connection	81%	19%
3. Average	69%	31%

Table AT.3.14 Water tank on upper floor

Type	Having a water tank installed on the roof or upper flower	
	Yes	No
1. Individual house connection	73%	33%
2. Building house connection	97%	3%
3. Average	79%	21%

Table AT.3.15 Water consumption and water charge

Type	Water consumption m^3 per month per household	Metered lpcd	Water charges Rs. per month
1. Individual House Connection	16.6	105.5	99.1
2. Building Connection	14.6	98.0	110.4
3. Average	15.8	102.3	102.6

Table AT.3.16 Reasons for not paying water charges.

	If you do not pay for water, what is the reason?						
Type	1. No money	2. Meter is broken	3. No Legal action even not to pay	4. No disconnection even not to pay	5. Believing that Government should pay	6. No reason	7. Government doesn't know you are connected
1.Individual House Connection	49.5%	4.0%	3.0%	0.0%	4.0%	38.4%	0.0%
2. Building Connection	49.2%	6.6%	0.0%	0.0%	0.0%	44.3%	0.0%
3. Average	50.0%	4.9%	1.9%	0.0%	2.5%	40.1%	0.0%

Table AT.3.17 Perception of water charge

Type	Do you think the water charge of house connection is expensive?				
	1.Very expensive	2. Expensive	3. Fair	4. Cheap	5. Very cheap
1. Individual House Connection	5.4%	24.8%	69.8%	0.0%	0.0%
2. Building Connection	0.0%	31.1%	67.6%	1.4%	0.0%
3. Average	3.4%	26.8%	69.3%	0.5%	0.0%

Table AT.3.18 Water meter installed

Type	Water meter installed to house connection	
	Yes	No
1. Individual House Connection	100.0%	0.0%
2. Building Connection	98.6%	1.4%
3. Average	99.5%	0.5%

Table AT.3.19 Condition of water meter

Type	Condition of the water meter			
	1. Broken	2. Not accurate	3. Working	4. I don't know
1. Individual House Connection	3.1%	3.1%	92.1%	1.6%
2. Building Connection	2.8%	2.8%	83.3%	11.1%
3. Average	3.0%	3.0%	89.1%	5.0%

Table AT.3.20 Perception of respondents on water charges based on volume or fixed

Type	Water charges the household pay		
	1. Based on the measured volume,	2. Fixed	3. I don't know
1. Individual House Connection	86.1%	4.1%	9.8%
2. Building Connection	76.4%	1.4%	22.2%
3. Average	82.7%	3.1%	14.3%

Table AT.3.21 Preference of paying water charges as fixed charge or metered bill by household connection

Types	Preference for fixed charge or metered bill	
	1.Fixed charge	2. Metered bill
1. Individual House Connection	10.1%	89.9%
2. Building Connection	13.5%	86.5%
3. Average	11.2%	88.8%

4) Fetching Water

- ✓ The sampled households fetching water from public stand posts, well, etc. carry 470 litres of water a day taking 1.9 hours on average. The average age of the person fetching water is 29 years old and 75% of them are females. 72% of the households without house connection use public stand posts. About a half of the other 28 % do not use public stand post as there are none existing close to their household, while 30% of them do not use public stand post as they are having other options.
- ✓ On an average the public stand post were at a distance of 20 m from the respondents households. One public stand post is shared among 4.5 household. The average water consumption of public stand post per household is 410 litres per day. The average time required to fetch water from the public stand post each time was 7.5 minutes. All of the

sample households using public stand post answered that they carry water by walk. 25% of the sampled households without house connection expressed their needs to have a public stand post more close to their household.

(2) Complaints and Needs

1) Complain in Each Scheme

- ✓ It is found that the most important aspect in water supply recognized among sampled households is stability (continuous supply) (308 points). The second and third important aspects are quantity & pressure (260 points) water quality (244 points) respectively. On the other hand, low water charge was recognized as the least important aspect (52 points).
- ✓ Table AT.3.22 shows that almost 30% of the respondents in the surface water supply scheme are having complains on the current public piped water supply service with a high degree of complain of 52% and 41% in Opa water supply scheme and Assonora water supply scheme respectively. Most of the complains are obtained from the tail end users of the various schemes.
- ✓ The respondents main complain on the current public piped water supply service is about the quantity and pressure followed by current operation hours and quality of water supplied.
- ✓ Table AT.3.23 shows that the sampled household were also interested in knowing about the water supply management. The first aspect were of water quality control, the second aspect being how the water charges is decided and the third being that they should be informed about when and where the water supply is cut off.

Table AT.3.22 Perception on complains on the current public piped water supply scheme

Perception	Surface water supply schemes									
	1. Salaulim	2 Opa	3. Chandel	4. Assonora	5. Sanquelim	6. Dabose	7. Canacona	Average within the	8. Rural Water Supply Schemes	Grand Average
1. Yes, have complain on supply	21%	52%	9%	41%	27%	28%	27%	30%	28%	29%
2.No, do not have complain on supply	79%	48%	91%	59%	73%	72%	73%	70%	72%	71%

Table AT.3.23 To know more about water supply management

Areas of Interest among Customers of Public Water Supply	Level of Interest (Points)
1. How water charge is decided (rate setting)	328
2. How the water charge collected is utilized	252
3. Water quality control	387
4. Financial status of water providing organization/company (Financial Management)	93
5. What is water source, how the water treated, transmitted, and distributed.	137
6. How the water business is run (business management)	90
7. Extension, rehabilitation plan	134
8. When and where the water supply is cut-off	270
9. Others:	5

2) Hours of Water Supply and Pressure of Piped Public Water Supply Services

- ✓ The survey found that the respondents find the month of March to June as the most difficult season to gain desirable water sources as shown in Figure AT.3.3 per day.
- ✓ Table AT.3.24 and 25 shows that the respondents get an average of 11 hours of water supply in Chandel water supply during the regular season and respondents depending on Assonora water supply scheme receives only 5 hours per day of water supply. During difficult season the same schemes gives 7 hours and 3 hours of water supply per day.
- ✓ Figure AT.3.2 shows usual daily pattern of water supply on average among the whole sampled households, however the timing and period of water supply differ area by area in the reality.
- ✓ Table AT.3.26 shows that 60% of the respondents in Chandel water supply scheme is unhappy about the water supply during both the difficult as well as regular season. This may be due to the less quantity of water available at source. Similarly there is a high discontent among the respondents in Dabose water supply scheme. 23% of the respondents are not satisfied with the piped water supply in the regular season from Selaulim water supply scheme. The main reason might be that water is not reaching the tail end users of these schemes.
- ✓ Table AT.3.27 and Figure AT.4.3 show that 50% and 40% of the respondents in Dabose and Assonora water supply scheme respectively feels that the water pressure is a little low when water is supplied, 55% and 41% respondents of Chandel and Sanquelim water supply scheme respectively conceived that the water pressure is very low.
- ✓ Table AT.3.28 shows that 56% of the respondents having house connection are willing to pay more for improved water supply service if the raise is reasonable and 13% are ready to pay even if it is raised.

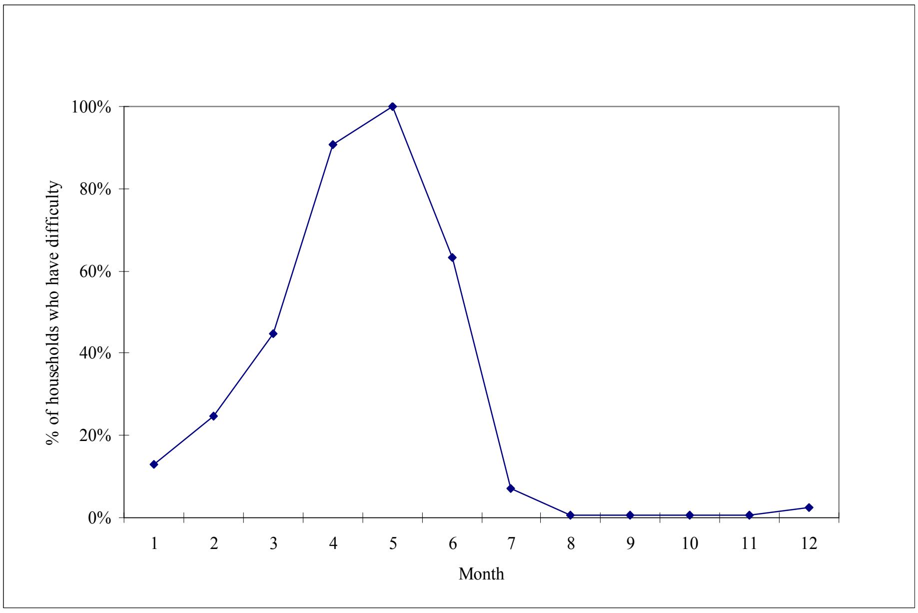


Figure AT.3.1 Degree of difficulty to have enough water in each month

Table AT.3.24 Regular hours of water supply in Usual

Types of Survey Areas		Water Supply Study Areas: 1. Salaulim S.W.S.S	2. Opa S.W.S.S	3. Chandel S.W.S.S	4. Assonora S.W.S.S	5. Sanquelim S.W.S.S	6. Dabosei S.W.S.S	7. Canacona S.W.S.S	8. Distant form the S.W.S.S	Average
Survey Areas in Each Surface Water Supply Scheme (S.W.S.S)	1. to 4. Populated Area	24	19	20	8	21	17	24		
		24	2							
		19								
		14								18
	5. Beach and Sightseeing Areas	22	2	5	4					8
	6. Poorly Served Areas	6	19	3	3	7	5	18		9
Average of Each S.W.S.S		14	11	11	5	14	11	21		12
Average presented in Sector Status Study 2004*		18	10	13	6	7	8	4		9
7. and 8. Rural Water Supply Schemes within/outside the S.W.S.S		24	20	1		4	2	12	7	
									12	10

Reference: * Sector Status Study 2004, PWD, Appendix p.85

Table AT.3.25 Hours of Piped Public Water Supply in Difficult Seasons

<table>
<tr><th colspan="2" rowspan="2">Types of Survey Areas</th><th colspan="9">Water Supply Study Areas</th></tr>
<tr><th>1. Salaulim S.W.S.S</th><th>2. Opa S.W.S.S</th><th>3. Chandel S.W.S.S</th><th>4. Assonora S.W.S.S</th><th>5. Sanquelim S.W.S.S</th><th>6. Dabosei S.W.S.S</th><th>7. Canacona S.W.S.S</th><th>8. Distant form the S.W.S.S</th><th>Average</th></tr>
<tr><td rowspan="6">Survey Areas in Each Surface Water Supply Scheme (S.W.S.S)</td><td rowspan="4">1. to 4. Populated Area</td><td>19</td><td>15</td><td>16</td><td>7</td><td>15</td><td>13</td><td>19</td><td rowspan="4"></td><td rowspan="4">14</td></tr>
<tr><td>20</td><td>2</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>15</td><td rowspan="2"></td></tr>
<tr><td>12</td></tr>
<tr><td>5. Beach and Sightseeing Areas</td><td>20</td><td>2</td><td>3</td><td>2</td><td></td><td></td><td></td><td></td><td>7</td></tr>
<tr><td>6. Poorly Served Areas</td><td>4</td><td>18</td><td>2</td><td>1</td><td>4</td><td>3</td><td>13</td><td></td><td>7</td></tr>
<tr><td colspan="2">Average of Each S.W.S.S</td><td>15</td><td>9</td><td>7</td><td>3</td><td>10</td><td>8</td><td>16</td><td></td><td>10</td></tr>
<tr><td colspan="2" rowspan="2">7. and 8. Rural Water Supply Schemes within/outside the S.W.S.S</td><td>24</td><td>17</td><td>0</td><td rowspan="2"></td><td>2</td><td>1</td><td>10</td><td>5</td><td rowspan="2">8</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>3</td></tr>
</table>

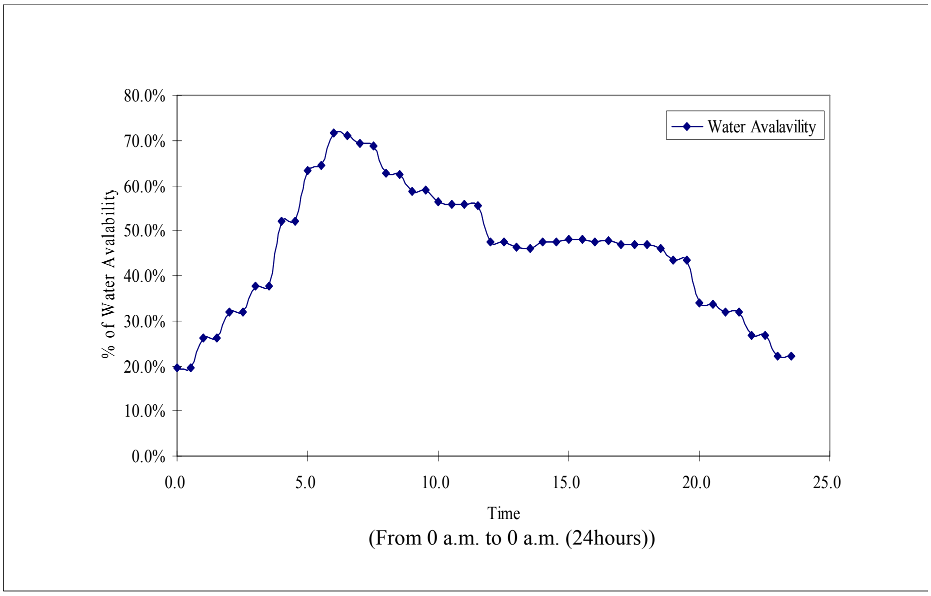


Figure AT.3.2 Water availability of public water supply service at each time of the day

Table AT.3.26 Perception on household unhappy about the water supply hours

Types of Survey Areas	Surface water supply schemes								
	1. Salaulim	2. Opa	3. Chandel	4. Assonora	5. Sanquelim	6. Dabose	7. Canacona	8. Rural water supply schemes	Average
1. Not, Enough water Supply in Difficult Seasons	28%	53%	61%	81%	34%	73%	3%	17%	62%
2. Not, Enough water supply in regular seasons	23%	44%	63%	75%	20%	62%	0%	8%	38%

Table AT.3.27 Perception on adequateness of water pressure

Types of survey areas		Surface water supply schemes 1. Salaulim	2. Opa	3. Chandel	4. Assonora	5. Sanquelim	6. Dabose	7. Canacona	8. Rural water supply schemes	Average
Adequateness of water pressure	1. Too High	0%	0%	0%	0%	3%	0%	0%	0%	1%
	2. Enough	70%	71%	31%	23%	23%	33%	100%	83%	54%
	3. A Little Low	14%	21%	14%	40%	33%	50%	0%	0%	21%
	4. Very Low	16%	8%	55%	37%	41%	17%	0%	17%	24%

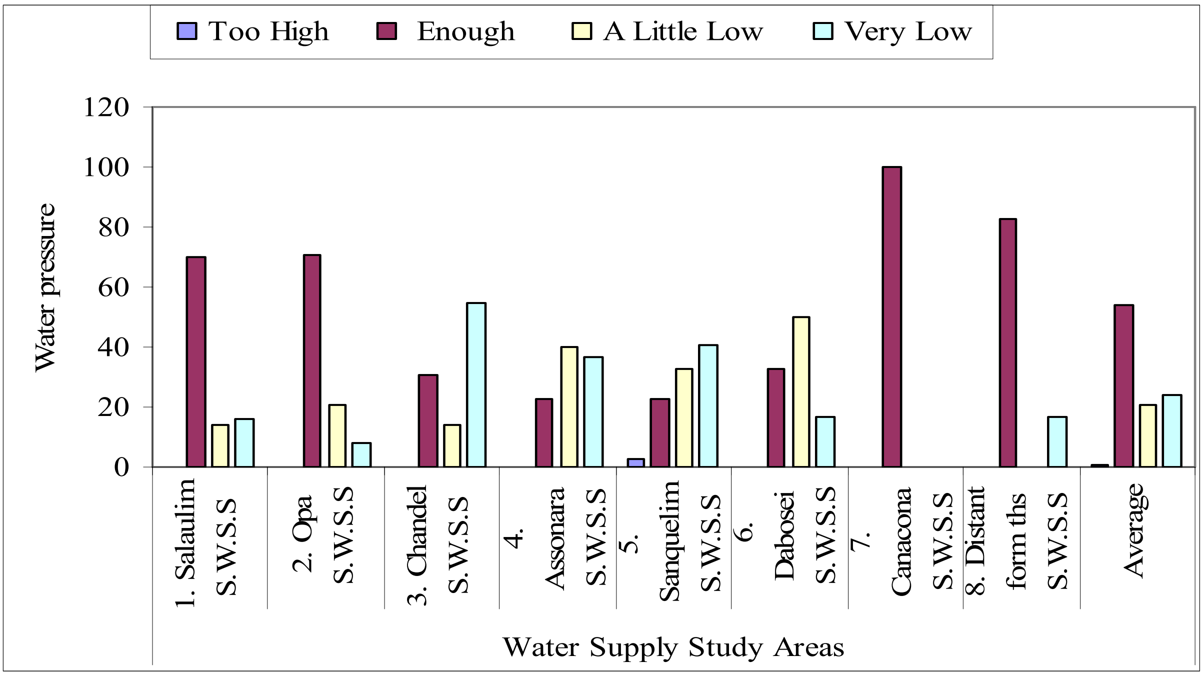


Figure AT.3.3 Perception on adequateness of water pressure

Table AT.3.28 Perception on improved public water supply service, even if current water charge is increased

	Perception on improved public water supply service, even if current water charge is increased					
	1. I am satisfied by the current service and charge.	2. Yes, if it is reasonable raise	3. Yes, even if it is steep raise	4. No, even if it is reasonable raise	5. No, if it is steep raise	6. I don' know
1. Individual House Connection	18.6%	58.9%	9.3%	4.7%	3.1%	5.4%
2. Building Connection	28.4%	51.4%	20.3%	0.0%	0.0%	0.0%
3. Total	22.0%	55.6%	13.2%	2.9%	2.0%	4.4%

3) Perception on Water Quality of Different Water Supply Services

- ✓ Table AT.3.29 shows that an average of 27% of the households depending on surface water supply schemes feels that the quality of water is not good.
- ✓ Table AT.3.30 shows that the biggest concern regarding the quality of water is turbidity followed by taste, smell, chemicals, colour, etc.

- ✓ Table AT.3.31 shows that 37% of the respondents in the sample area feels that the water causes various kinds of illness in their household.

Table AT.3.29 Perception of water quality

Perception of water quality	Type of water source						
	1. Individual House Connection	2. Building Connection	3. Public Stand Post	4. to 5. Private Well (Mostly Open wells)	6. to 7. Public/Private Water Tanker	8. Others (river, spring, etc.)	Grand Average
1. Water is of good quality	85%	75%	58%	27%	0%	13%	43%
2.Water is not of good quality	15%	25%	42%	73%	0%	88%	41%

Table AT.3.30 Perception on biggest concern of each water supply services and water sources.

Perception on biggest concern of each water supply	Type of water source						
	1. Individual House Connection	2. Building Connection	3. Public Stand Post	4. to 5. Private Well (Mostly Open wells)	6. to 7. Public/Private Water Tanker	8. Others (river, spring, etc.)	Grand Average
1. Turbidity	7	5	4	3	0	2	4
2. Taste	6	3	2	2	0	1	2
3. Smell	4	0	0	0	0	0	1
4. Chemicals	3	0	0	0	0	0	1
5. Colour	0	0	0	0	0	3	1

Table AT.3.31 Perception of water causing illness in household

Perception	Type of water source						
	1. Individual House Connection	2. Building Connection	3. Public Stand Post	4. to 5. Private Well (Mostly Open wells)	6. to 7. Public/Private Water Tanker	8. Others (river, spring, etc.)	Grand Average
1. Feels that water causes illness	21%	16%	47%	65%	0%	72%	37%
2.Water do not cause illness	79%	84%	53%	35%	0%	18%	45%

(3) Willingness to Pay for Water Supply Services

1) Basic Information for the Evaluation of Willingness to Pay

- ✓ Table AT.3.32 shows that the average of total persons in each household in the surface water supply scheme is 4.98 and in the rural water supply scheme is 6.27.
- ✓ Table AT.3.33 shows that 33% and 6% of the respondent in water supply survey area and 29% and 4% of the respondents in sanitation survey area felt that the electricity charges per month is expensive to very expensive. However an average of 64% of the total respondents including water supply survey area and sanitation survey area felt that the electricity charges are fair.

Table AT.3.32 Average no of persons in sampled households.

Perception	Type of Water Supply Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	Average within the S.W.S.S	7. and 8. Rural Water Supply Schemes within/outside the S.W.S.S	Grand Average
1. Adult men	1.57	1.86	2.19	1.87	2.64	2.255
2. Adult women	1.51	1.79	2.14	1.81	2.19	2
3. Children (< 16 years olds)	1.07	1.40	1.43	1.30	1.44	1.37
4. In total	4.15	5.38	5.76	4.98	6.27	5.625

Table AT.3.33 Perception on housing ownership in sampled household in each survey area

Housing ownership in sample household	Type of Water Supply Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	Average within the S.W.S.S	7. and 8. Rural Water Supply Schemes within/outside the S.W.S.S	Grand Average
1. House hold	48%	43%	46%	46%	45%	46%
2. Wife	20%	25%	23%	23%	11%	17%
3. Husband	6%	10%	3%	6%	13%	10%
4. Parent	2%	2%	3%	2%	0%	2%
5. Child	10%	10%	10%	10%	22%	13%
6. Grand parent	2%	2%	8%	4%	0%	3%
7. Grand child	0%	0%	3%	1%	0%	1%
8. Relative	0%	0%	0%	0%	0%	0%
9. Tenants	12%	8%	7%	9%	9%	9%
10. Room mate	0%	0%	0%	0%	0%	0%
11. Employee	0%	0%	0%	0%	0%	0%
12. Others	0%	0%	0%	0%	0%	0%

Table AT.3.34 Average income and electricity bill of sampled household

Category	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Average income (Rs.)	6041	6280	5102	3083	5127	9162	5193	2868	2150	7657	5406
2. Average electric bill (Rs.)	135	116	83	55	97	199	126	78	66	468	187

Table AT.3.35 Perception of the electricity bill of sampled household

Category	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Very expensive	7%	7%	0%	10%	6%	3%	3%	0%	0%	4%	2%
2. Expensive	28%	21%	40%	44%	33%	18%	31%	20%	41%	34%	29%
3. Fair	63%	67%	58%	47%	59%	77%	67%	79%	59%	58%	68%
4. Cheap	1%	5%	1%	0%	2%	2%	0%	1%	0%	4%	1%
5. Very cheap	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

2) Perception on Responsibility to Pay Water Charges

- ✓ Table AT.3.36 and Figure AT.3.4 show that 31% of the respondents in surface water supply scheme are of the opinion that most of the cost for running public water supply services shall be covered by the user fee with 15% of respondents feeling that half of the cost should only be covered by the user fee.
- ✓ Table AT.3.37 shows that individual house connection and buildings/apartment connection pays a total expense of Rs. 103/- and Rs. 105/- respectively for both public water supply and private water vendors.
- ✓ 43% of the sampled households having house connection answered that water charge collected from the users should recover only the cost of operation and maintenance of water supply system. 26% answered both the construction cost and operation and maintenance cost should be recovered by the users charges, while 30% answered that they do not have any idea.

Table AT.3.36 Perception on who should pay for running water supply services.

Perception	Type of Water Supply Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	Average within the S.W.S.S	7. and 8. Rural Water Supply Schemes within/outside the S.W.S.S	Grand Average
1. Yes, most to be covered by the user fees	32%	28%	33%	31%	3%	24%
2. No half to be covered by the user fees	14%	14%	18%	15%	22%	17%
3. No, most to be covered by tax/government	8%	14%	18%	13%	8%	12%
4. No, I don't have any idea	46%	44%	33%	41%	67%	47%

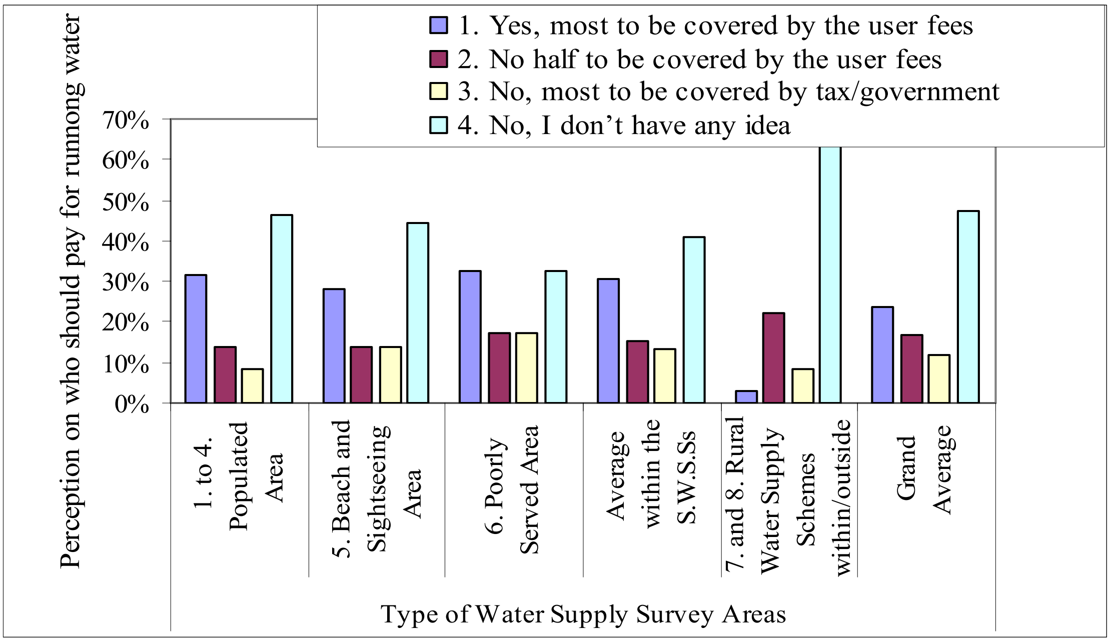


Figure AT.3.4 **Perception on who should pay for running water supply services.**

Table AT.3.37 **Total expense for water (public water supply and private water vendor) of each type of households which used different type of water supply as primary water source)**

	Type of Primary Water Source					
	1. Individual house connection	2. Building connection	3. Public stand post	4. Private Well (Mostly Open wells)	5. Public/ Private Water Tanker	6. Others (river, spring, etc.)
1. Total expense for water per month (Rs.)	103	105	49	35	0	0

3) Willingness to Pay of Current House Connection for Improved Water Supply Services

- ✓ Table AT.3.38 and 39 shows that on average in each surface water supply scheme the respondents are willing to pay Rs. 14/- more above the existing water charges per month for adequate pressure and improved water quality and an average of Rs. 12/- per month for 24 hours water supply service.
- ✓ 82% of the sampled households having house connection answered that the quality of water supplied should be of an international standard (24 hour supply, directly drinkable, transparent) to improve the tourism in Goa. Those 82% of households have willingness to

pay of Rs. 16/- on average as a contribution to improve the public water supply services to international standards for the tourism in Goa.

Table AT.3.38 Willingness to pay more water charge per month for adequate pressure and improve water quality

Types of Survey Areas		Water Supply Study Areas								
		1. Salaulim S.W.S.S Rs.	2. Opa S.W.S.S Rs.	3. Chandel S.W.S.S Rs.	4. Assonora S.W.S.S Rs.	5. Sanquelim S.W.S.S Rs.	6. Dabosei S.W.S.S Rs.	7. Canacona S.W.S.S Rs.	8. Distant form the S.W.S.S Rs.	Average Rs.
Survey Areas in Each Surface Water Supply Scheme (S.W.S.S)	1. to 4. Populated Area	11	11	7	10	10	12	26		
		16	17							
		14								
		15								14
	5. Beach and sightseeing Areas	20	19	7	14					15
	6. Poorly served areas	29	26	10	17	6	8	5		14
Average of Each S.W.S.S		18	18	8	13	8	10	16		14
7. and 8. Rural Water Supply Schemes within/outside the S.W.S.S		-	7	-		10	-	8	-	
									13	9

Table AT.3.39 Willingness to pay more water charge per month for 24 hours water supply service

Types of Survey Areas		1. Salaulim S.W.S.S Rs.	2. Opa S.W.S.S Rs.	3. Chandel S.W.S.S Rs.	4. Assonora S.W.S.S Rs.	5. Sanquelim S.W.S.S Rs.	6. Dabosei S.W.S.S Rs.	7. Canacona S.W.S.S Rs.	8. Distant form the S.W.S.S Rs.	Average Rs.
		Water Supply Study Areas								
Survey Areas in Each Surface Water Supply Scheme (S.W.S.S)	1. to 4. Populated Area	-	8	9	11	9	8	16		11
		14	8							
		12								
		14								
	5. Beach and sightseeing Areas	15	8	10	12					11
	6. Poorly served areas	22	16	7	25	6	5	8		13
Average of Each S.W.S.S		15	10	9	16	8	7	12		11
7. and 8. Rural Water Supply Schemes within/outside the S.W.S.S		-	5	-		5	-	8	-	7
									10	

4) Willingness to Pay for New House Connection

- ✓ Table AT.3.40 shows that the main reason of the 28% of respondents for not having a house connection of public piped water supply is that the monthly charges along with the connection fee is too high and 38% respondents in this group feels that the present arrangement (alternative water supply) is satisfactory.
- ✓ It was found in the survey that 72% of the respondents without house connection would like to have an individual house connection, provided PWDs piped water supply services newly covers their areas or increase the amount of piped water supply to their area so that they can get enough water supply at adequate pressure with good water quality. Among them, the willingness to pay per month to have new individual house connection is Rs. 41/- on average. On the other hand, the average willing to spend for the initial connection cost (including material and labour costs) for new house connection is Rs. 273/-.

Table AT.3.40 Reasons for not having house connection

Reasons for not having house connection	%
1. Connection is not available	14%
2. Service quality of public water supply is not good enough	17%
3. Monthly charges is too high	48%
4. Present arrangement (alternative water supply) is satisfactory	38%
5. Connection fee is too high	47%
6. Living in a rented house	13%

5) Willing to pay for New Sewerage Connection

- ✓ 29% of the households sampled in the survey on water supply practice open defecation, when asked about their sanitation option. While 68% and 13% are using toilets/latrines without connection to sewer and toilets/latrines connected to sewer, respectively. 20% of the household using toilets/latrine use common toilets.
- ✓ The respondents are willing to pay Rs. 600/- for the new sewerage connection and Rs. 24/- as the monthly sewerage charges in the surveyed areas of water supply.

Attachment 4 Results of the Questionnaire Survey for Residents Regarding Sanitation and Sewerage

(1) Existing Situation

1) Sanitation/Sewerage types

- ✓ Table AT.4.1 shows the different toilets/latrines not connected to sewer used by different income level. An average of 51% of the respondents in the sanitation survey has their toilet/latrine connected to septic tanks.

Table AT.4.1 Percentage of Each Type of On-Site Sanitation in Each Area

	Sewerage/Sanitation Study Areas																
	1. Panaji - Served					2. Margao-Served (North & Central)					3. to 8. Unserved Areas (Average)						Average
Survey Areas in Each Study Area	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	
1. Simple Pit Latrine	9%	1%	16%	5%	8%	17%	20%	27%	4%	17%	17%	0%	0%	0%	0%	3%	9%
2. Pour-Flush Latrine without Septic Tank	18%	3%	10%	18%	12%	0%	12%	19%	14%	11%	0%	2%	0%	0%	5%	1%	8%
3. Double Pit Pour-Flush Latrine	0%	31%	20%	27%	20%	29%	17%	15%	24%	21%	0%	17%	40%	0%	26%	16%	19%
4. Septic Tank connected to drain	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	2%	40%	0%	4%	13%	5%
5. Septic Tank connected to Soak Pit	73%	65%	54%	50%	61%	54%	51%	39%	58%	51%	67%	79%	20%	50%	51%	53%	55%
6. Others	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	15%	13%	5%

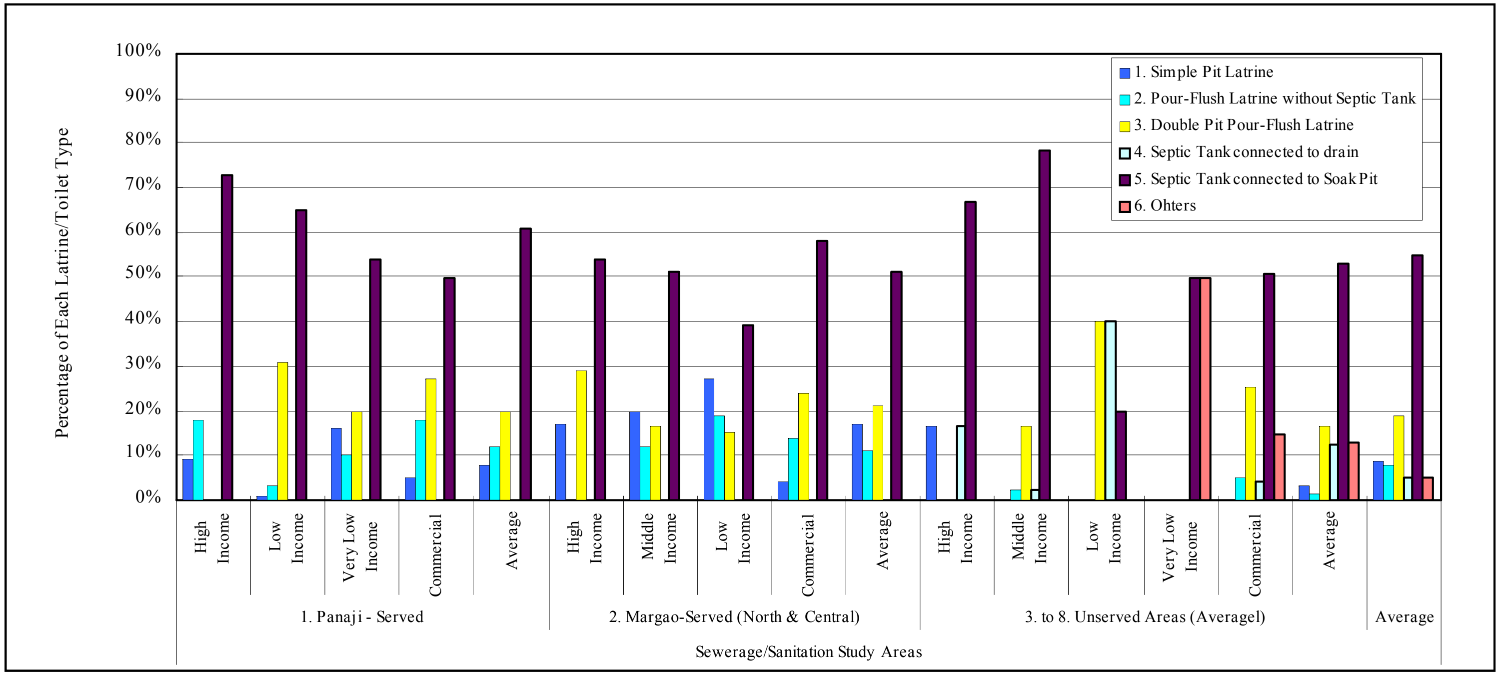


Figure AT.4.1 Percentage of Each Type of On-Site Sanitation in Each Area

2) Problem of Toilets/Latrines not connected to Sewer

- ✓ Table AT.4.2 shows an average of 32% of the total respondents are having problem of their toilet/latrine which are not connected to sewer. 47% of the respondents in Panaji served area but not connected to sewer has various problems with their toilet/latrine, in which the major problem of 75% is due to non availability of water.
- ✓ Table AT.4.3 and its figure show the occurrence of overflow from the toilet/latrine not connected to sewer in Margao is 35% and the unserved area of Mapusa is 73%. The reason for such higher occurrence of overflow may be due to the poor sanitary conditions and maintenance prevailing in these areas.
- ✓ Table AT.4.4 shows that the reasons of overflow from toilet/latrine in served and unserved areas is due to the high water table 62% and 59% respectively. The second main reasons in both served and unserved areas is due to the hard late rite strata 24% and 23% respectively. The hard late rite does not allow the toilet water to soak in it causing clogging.
- ✓ Table AT.4.5 shows that even though the target respondents are having open wells, they are of the opinion that the water is not being polluted as their toilet/latrines are far away from the well.

Table AT.4.2 Perception of toilet / latrine not connected to sewer

Category	Sewerage/Sanitation Study Areas			
	1. Panaji-Served	2. Margao-Served (North & Central)	3. to 8. Unserved Areas (Average)	Average
1. Yes, toilet latrine have problem	47%	18%	33%	32%
a. Dirty	0%	0%	17%	6%
b. Bad smell	0%	0%	21%	7%
c. Dangerous	0%	0%	0%	0%
d. No water available	75%	0%	18%	31%
e. Problem with privacy	25%	0%	0%	8%
f. Overflow	0%	75%	20%	32%
g. Others	0%	13%	23%	12%

Table AT.4.3 **Occurrence and frequency of over flow from the toilets not connected to Sewer**

Category		Sewerage/Sanitation Study Areas										
		Served Study Areas			Unserved Study Areas							Grand Average
		1. Panaji	2. Margao-Served (North & Central)	Average	3. Residential Areas around Panaji	4. Margao-unserved (South)	5. Mapusa	6. Ponda	7. North Costal Belt	8. South Costal Belt	Average	
Occurrence of Overflow	1. Yes, Overflow	18%	31%	24%	12%	35%	73%	31%	14%	17%	30%	29%
	2. No	82%	69%	76%	88%	73%	27%	69%	86%	83%	71%	72%
Frequency of Overflow	1. Every week or more	33%	31%	32%	12%	27%	27%	31%	14%	17%	21%	24%
	2. Few times a month	0%	69%	35%	88%	73%	73%	69%	86%	83%	79%	68%
	3. Few times a year	67%	0%	33%	0%	0%	0%	0%	0%	0%	0%	8%
	4. Once a year or less	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

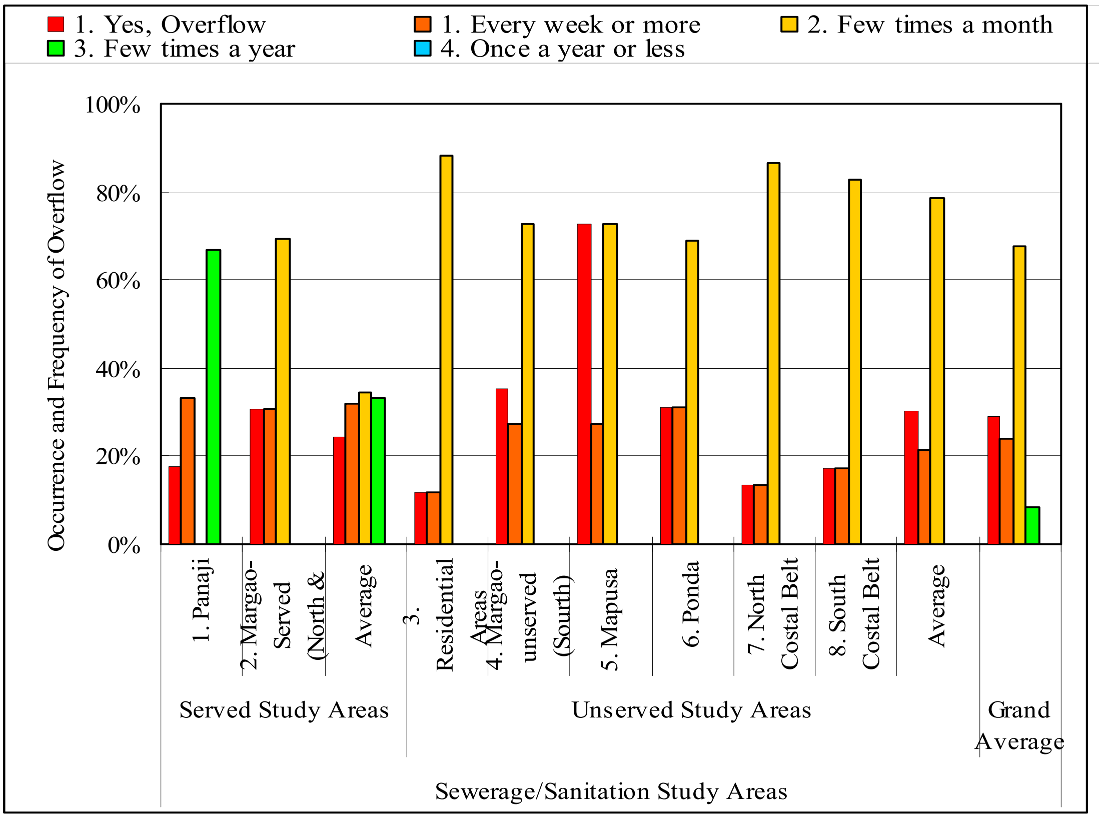


Figure AT.4.2 **Occurrence and frequency of over flow from the toilets not connected to Sewer**

Table AT.4.4 Reasons of Overflow

Category	Sewerage/Sanitation Study Areas										
	Served Study Areas			Unserved Study Areas							Grand Average
	1. Panaji	2. Margao-Served (North & Central)	Average	3. Residential Areas around Panaji	4. Margao-unserved (South)	5. Mapusa	6. Ponda	7. North Costal Belt	8. South Costal Belt	Average	
Hard late rite strata	18%	31%	24%	12%	35%	27%	31%	14%	17%	23%	23%
High water table	71%	53%	62%	68%	47%	54%	45%	75%	65%	59%	60%
In flow of storm water	5%	6%	6%	10%	12%	3%	10%	0%	3%	6%	6%
Poor maintenance	3%	4%	4%	1%	4%	6%	5%	1%	3%	3%	3%
Clogging of chambers	3%	6%	5%	9%	2%	10%	9%	10%	12%	9%	8%

Table AT.4.5 Pollution of household open well

Open well	Water Supply Survey Areas					Sewerage/Sanitation Study Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	Open Defecation	Simple Pit Latrine	Pour Flash Latrine	Septic Tank	Sewerage	Average
1. Own open well	13%	33%	24%	25%	24%	4%	5%	0%	13%	4%	5%
2. Toilets within 10 meters	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

3) House Wastewater and Water use in Toilets

- ✓ Table AT.4.6 shows that the home waste water is disposed to the kitchen garden by 32% of the respondents in water supply survey area, whereas in Sewerage/Sanitation survey household 33% dispose home waste water to the open drain. It is also observed that in the sanitation survey area covered by sewerage 50% of the respondents dispose the waste water into the sewer line.
- ✓ Table AT.4.7 and its figure show that 36% and 41% of the respondents in the North costal belt and south costal belt respectively use open drainage facility for disposing their home

waste water. These table and figures are made from the data collected in Census 2001 and Sector Status Study 2004, PWD

- ✓ It is also conceived by the survey that even though 90% of the respondents connected to sewer has availability of water supply in the toilet, 60% of the household having use of semi auto flushing device would prefer more mater in their toilet/latrine as per Table AT.4.9.
- ✓ It is found that water is available in 90% of the respondents who have connected to sewerage of which 85% are having semi auto flushing device.
- ✓ It is also observed from Table AT.4.12 that 70% and 41% of the respondents from Panaji served and Margao served areas respectively required more water to flush their toilets.

Table AT.4.6 Home waste water disposal types

Importance	Water Supply Survey Areas					Sewerage/Sanitation Study Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	Open Defecation	Simple Pit Latrine	Pour Flash Latrine	Septic Tank	Sewerage	Average
1. To the sewer	25%	0%	3%	0%	7%	0%	0%	0%	0%	50%	10%
2. To the open drain	16%	19%	29%	19%	21%	62%	46%	22%	28%	5%	33%
3. To the closed drain	10%	14%	18%	7%	12%	27%	27%	17%	9%	5%	17%
4. To the street	1%	0%	3%	3%	2%	9%	0%	8%	0%	0%	3%
5. To the soak pit/septic tank	28%	37%	22%	10%	24%	2%	8%	25%	53%	40%	26%
6. Kitchen garden	20%	21%	26%	60%	32%	0%	19%	28%	10%	0%	11%
7. It is re-used	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table AT.4.7 Percentage of Household using Each Drainage Type in 2001 and Sewerage connection in 2004

Study Area	Census 2001				Sector Status Study 2004
	Number of Households	Closed Drainage (including sewerage)	Open Drainage	No Drainage	Sewerage Connection
1. Panaji Municipality	15513	64%	18%	18%	81%
2. Margao Municipality	16521	56%	27%	17%	3%
3. Mapusa Municipality	8382	41%	24%	35%	0%
4. Ponda Municipality	3853	67%	19%	14%	0%
5. Major Towns of North Costal Belt (Calangute, Candolim)	4793	30%	36%	33%	0%
6. Major Towns of South Costal Belt (Benaulim, Varca)	3199	30%	41%	29%	0%

Source: Census 2001, Sector Status Study PWD 2004 Chapter 4. p 30 (Number of Sewerage Connection)

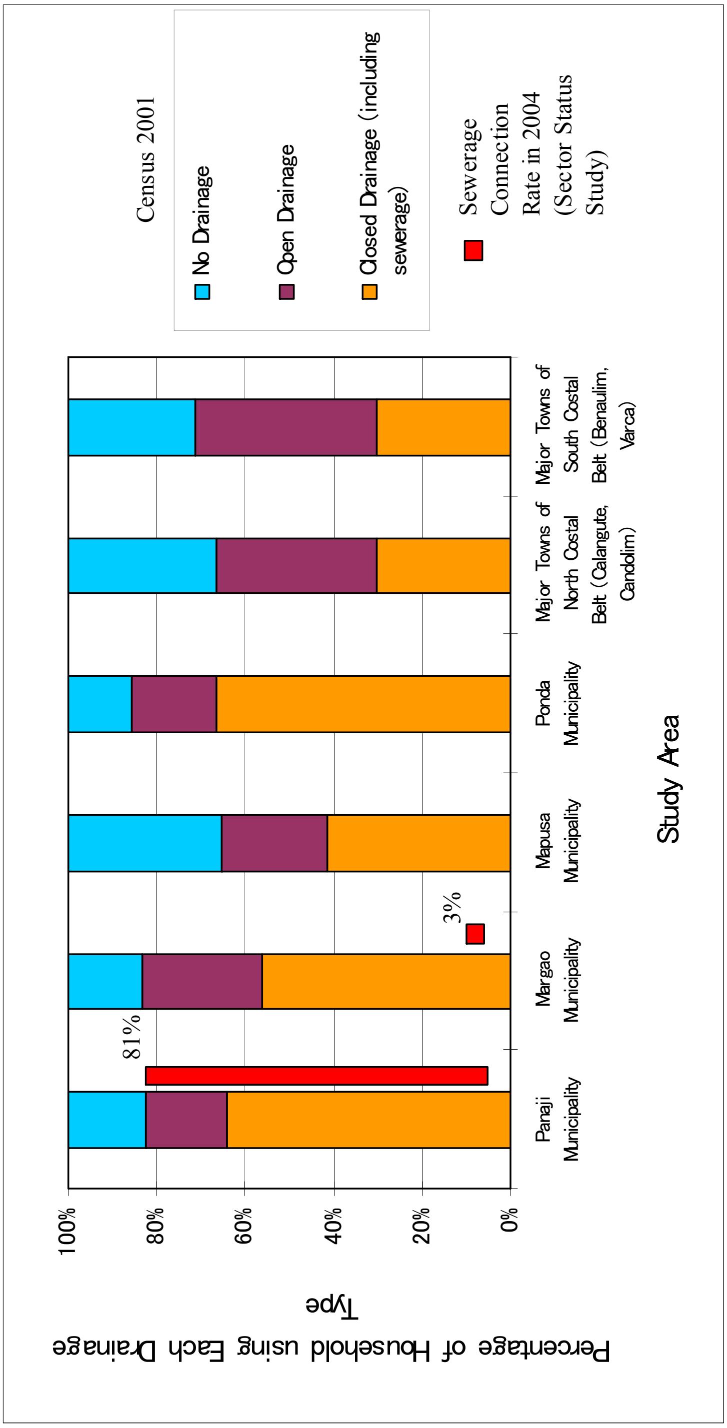


Figure AT.4.3 **Percentage of Households using Each Drainage Type in 2001 (Census) and Sewerage Connection Rate in 2004 (Sector Status Study)**

Table AT.4.8 Percentage of Households using Each Drainage Type

Type of Drainage		SURFACE WATER SUPPY SCHEME								Total Outside of the Surface WSS
		Chandel WSS	Assonora WSS	Sanquelim/Padocem WSS	Dabose WSS	Salaulim WSS	Opa WSS	Canacona WSS	Total within Surface WSS	
Total Number of Households		14286	48409	18228	6363	105716	57394	6392	256788	22428
Sector Status Study in 2004	Sewerage Connection	0	0	0	0	4170	12570	0	16740	-
Census in 2001	1. Closed Drainage (the number of sewerage connection is deducted)	325	13958	1877	121	27805	5559	283	49928	-
	2. Open Drainage	1362	13700	3437	960	34144	15291	682	69576	-
	3. No Drainage	12598	20751	12469	5282	39598	23974	5427	120100	-
Sector Status Study in 2004	1. % of Sewerage connection	0%	0%	0%	0%	4%	22%	0%	7%	-
Census in 2001	1. % Closed Drainage (does not include sewerage)	2%	29%	10%	2%	26%	10%	4%	19%	-
	2. % of Open Drainage	10%	28%	19%	15%	32%	27%	11%	27%	-
	3. % of No Drainage	88%	43%	68%	83%	37%	42%	85%	47%	-

Source: Census 2001, Sector Status Study PWD 2004 Chapter 4 p. 30 and Appendix 9.1 p.78

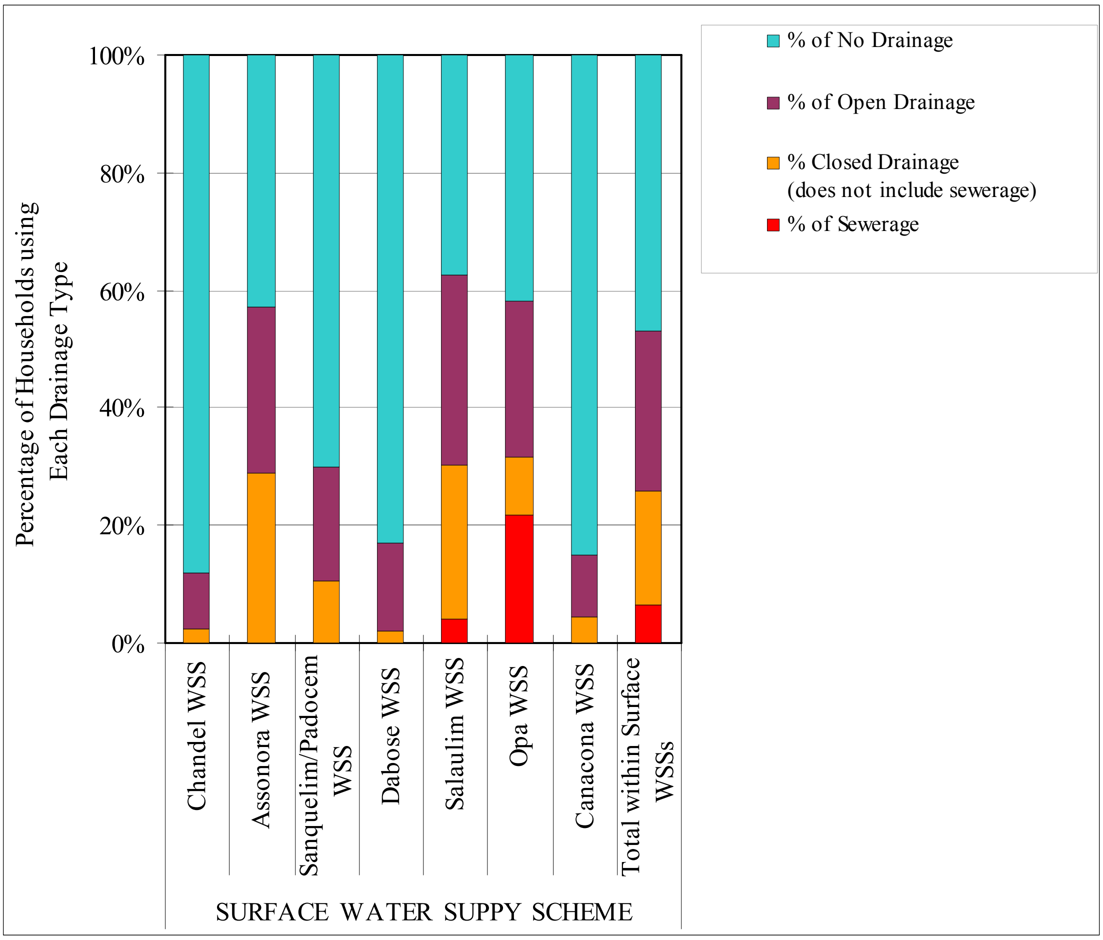


Figure AT.4.4 Percentage of Households using Each Drainage Type

Table AT.4.9 Type of flushing device

Category	Sewerage/Sanitation Study Areas		
	Panaji - Served	Margao-Served (North & Central)	Average
1. Semi-Auto Flushing	45%	74%	60%
2. Pour Flush	55%	26%	40%

Table AT.4.10 Flushing types for sanitation

Category	Simple pit latrine	Pour flush toilet	Septic tank	Sewerage
1. Semi-auto flushing with a device (large amount of water),	16%	31%	79%	85%
2. Pour flushing (small amount of water)	84%	69%	21%	15%

Table AT.4.11 Availability of water in toilet connected to sewer

	Water Supply Survey Areas					Sewerage/Sanitation Study Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	Open Defecation	Simple Pit Latrine	Pour Flash Latrine	Septic Tank	Sewerage	Average
1. Availability of water supply in toilet	89%	83%	73%	85%	83%	0%	60%	75%	80%	90%	61%

Table AT.4.12 Need more water to flush the toilets

Category	Sewerage/Sanitation Study Areas		
	Panaji - Served	Margao-Served (North & Central)	Average
1. Require more water	70%	41%	55%
2. Do not need more water	30%	59%	45%

(2) Awareness and Needs

1) Pollution by Human Waste and Home Wastewater.

- ✓ Table AT.4.13 shows that 100% of the respondents using open defecation are aware that their human waste is polluting the living and natural environment of Goa and 65% of the respondent having simple pit and pour flush type toilets feels that their home waste water disposed is polluting the natural environment.
- ✓ Table AT.4.14 and its figure show that almost 52% and 9% of the respondents of both water supply and sanitation survey areas feels that the pollution of water environment in Goa is serious and very serious in nature respectively.

- ✓ Table AT.4.15 and its figure show that 34% and 45% of the respondents of water supply and sanitation survey area respectively feels that residential areas is the most polluted environment in Goa.
- ✓ Table AT.4.16 and its figure show that 44% and 53% of the target respondents of water supply and sanitation respectively feels that the local drains and nallas should be cleaned so that the pollution level of the residential area may drop.
- ✓ Table AT.4.17 and its figure show that 90% of all the respondent of different income level of water supply and sanitation survey area feels the need for drastic improvement in the sanitary situation in the state. A high 91% of respondents in the unserved area of water supply survey area felt that the water environment is becoming polluted and a total of 90% of the respondents in both water supply and sanitation survey area think that there is a need to prevent further deterioration of the living environment.
- ✓ Table AT.4.18 throws light that 86%, 76% and 47% of the respondents practicing open defecation in the served areas of Panaji, Margao and the unserved areas respectively are not satisfied by the existing situation and would prefer better alternative for human waste disposal.
- ✓ Table AT.4.19 shows that 55% and 77% of the respondents in Panaji and Margao sewerage areas connected to sewer says that they would prefer better human waste disposal.

Table AT.4.13 Perception on pollution by human waste and home waste water

Types	Water Supply Survey Areas					Sewerage/Sanitation Study Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	Open Defecation	Simple Pit Latrine	Pour Flash Latrine	Septic Tank	Sewerage	Average
1. Yes, polluting living & natural environment by human waste	-	-	-	-	-	100%	85%	49%	35%	25%	59%
2. Yes, polluting natural environment by home waste	34%	23%	51%	31%	35%	20%	62%	65%	41%	22%	42%

Table AT.4.14 Conceived pollution of water environment in Goa

Category	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Very serious	8%	16%	8%	3%	9%	13%	11%	3%	5%	9%	8%
2. Serious	53%	42%	58%	54%	52%	62%	50%	54%	27%	51%	49%
3. Not Serious	39%	42%	35%	43%	39%	23%	39%	41%	68%	40%	42%
4. Not polluted at all	0%	0%	0%	0%	0%	2%	0%	3%	0%	0%	1%

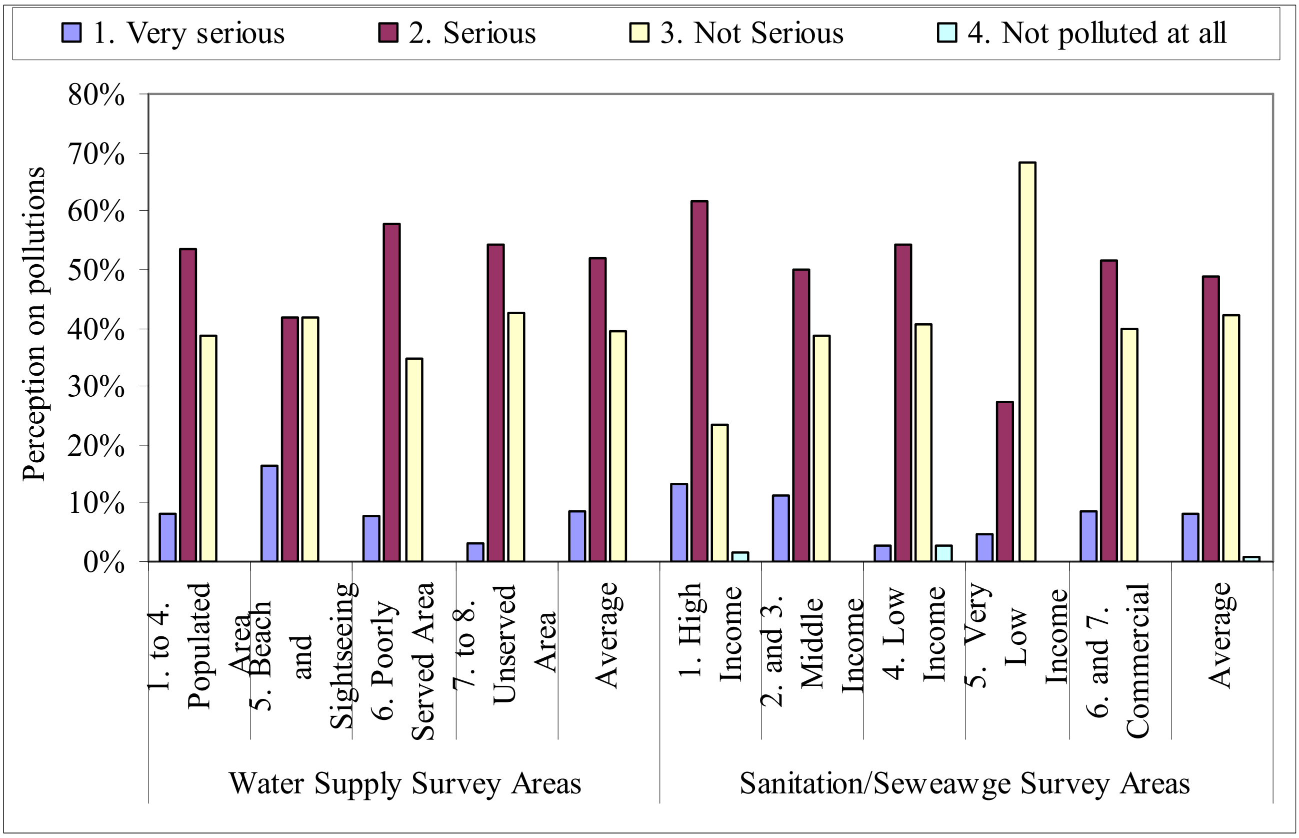


Figure AT.4.5 Conceived pollution of water environment in Goa

Table AT.4.15 Conceived most polluted environment in Goa

Category	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserv ed Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Rivers	6%	19%	18%	22%	16%	17%	13%	4%	9%	16%	12%
2. Lakes and ponds	46%	44%	37%	47%	44%	47%	47%	27%	32%	27%	36%
3. Beaches	4%	12%	4%	6%	6%	3%	9%	5%	9%	12%	8%
4. Residential area	43%	26%	41%	25%	34%	33%	31%	64%	50%	46%	45%
5. Others	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

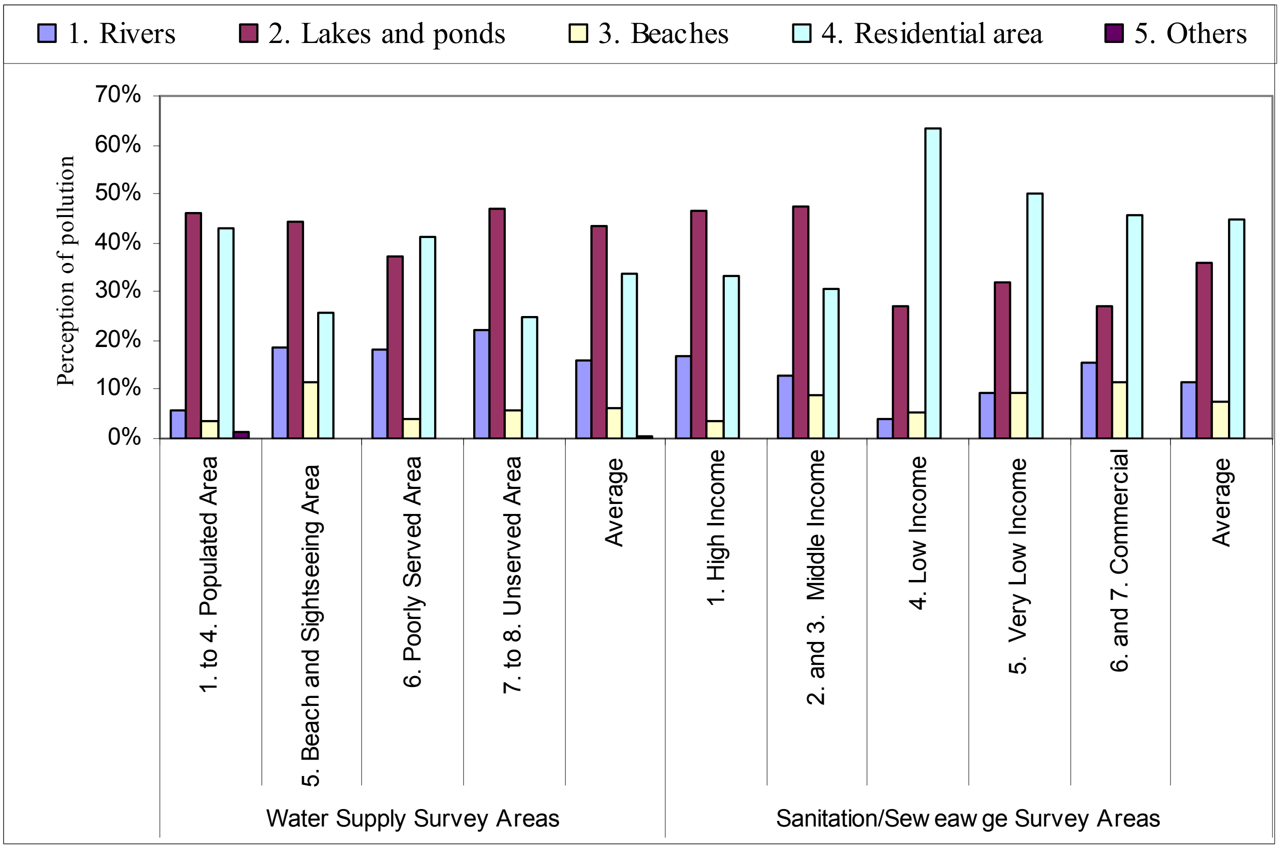


Figure AT.4.6 Conceived most polluted environment in Goa

Table AT.4.16 Most important environment to clean

Category	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Local drains and nallas	56%	56%	40%	25%	44%	55%	46%	51%	50%	62%	53%
2. Nearby rivers for local people	42%	37%	56%	74%	52%	40%	36%	36%	45%	21%	36%
3. Beaches for tourists	1%	7%	4%	1%	3%	5%	16%	11%	5%	17%	11%

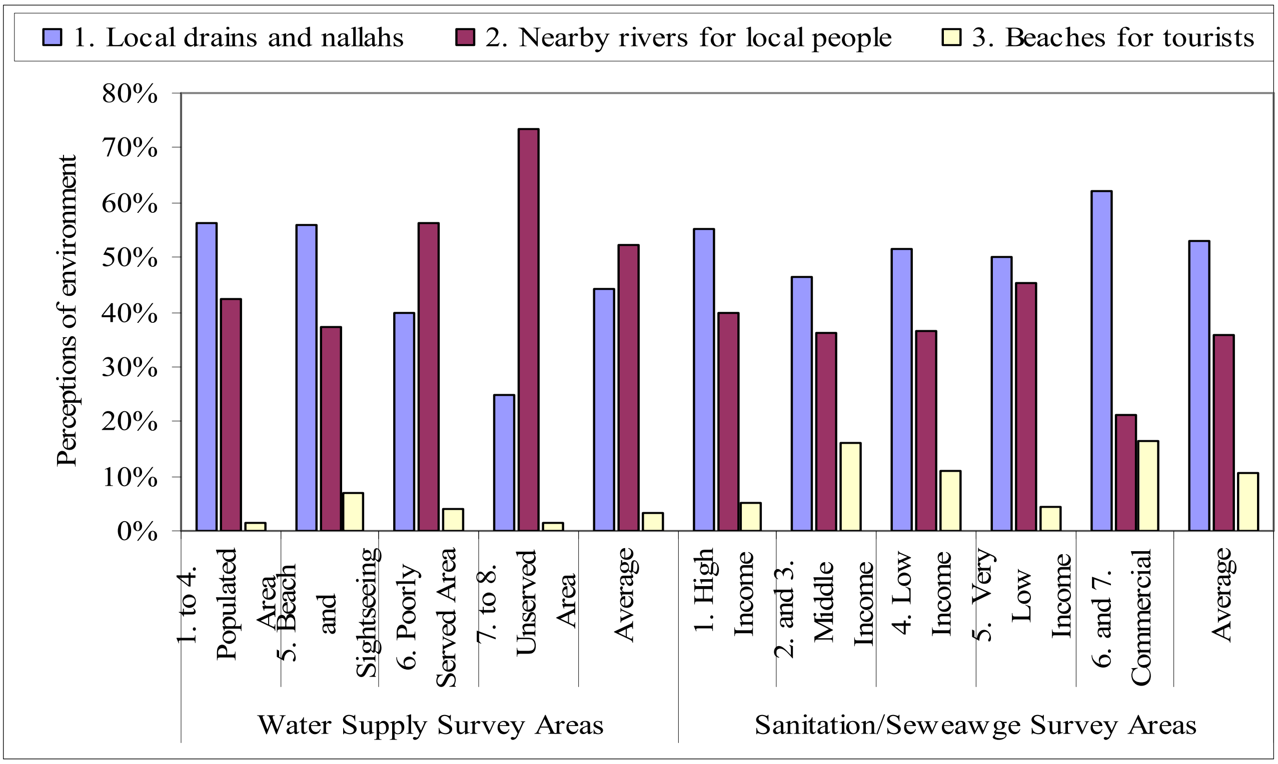


Figure AT.4.7 Most important environment to clean

Table AT.4.17 Perception on improvement of the environment

Category	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Yes, need to improve sanitary situation						98%	88%	88%	100%	82%	91%
2. Yes, water environment becoming polluted	85%	77%	86%	91%	85%	78%	69%	74%	95%	81%	79%
3. Yes, prevent further deterioration	95%	86%	96%	99%	94%	80%	88%	86%	100%	88%	88%

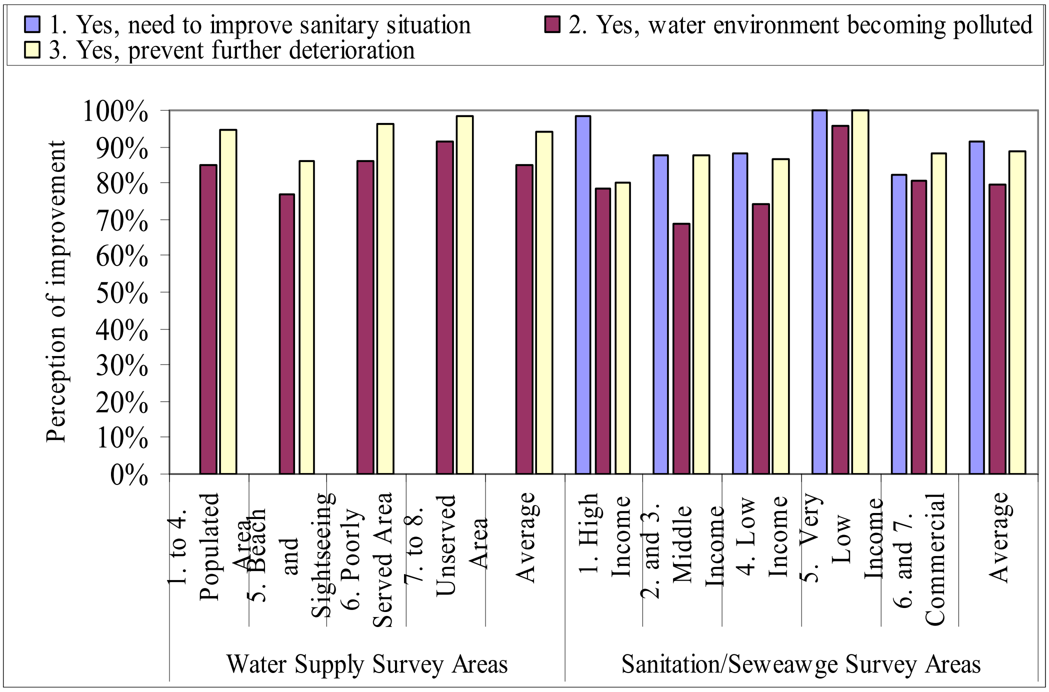


Figure AT.4.8 Perception on improvement of the environment

Table AT.4.18 Satisfaction level for household human waste disposal

Survey Areas in Each Study Area	Sewerage/Sanitation Study Areas														
	1. Panaji - Served					2. Margao-Served (North & Central)					3. to 8. Unserved Areas (Average)				
	Open Defecation	Simple Pit Latrine	Pour Flash Latrine	Septic Tanks	Sewerage	Open Defecation	Simple Pit Latrine	Pour Flash Latrine	Septic Tanks	Sewerage	Open Defecation	Simple Pit Latrine	Pour Flash Latrine	Septic Tanks	Sewerage
1. Yes, satisfied	14%	0%	0%	29%	67%	0%	0%	0%	16%	54%	22%	0%	7%	29%	0%
2. Moderately satisfied	0%	0%	0%	47%	30%	24%	100%	0%	74%	44%	33%	40%	93%	42%	0%
3. Not satisfied at all	86%	0%	0%	24%	3%	76%	0%	0%	11%	3%	47%	0%	0%	21%	0%

Table AT.4.19 Preference for better human waste disposal

	Sewerage/Sanitation Study Areas														
	1. Panaji - Served					2. Margao-Served (North & Central)					3. to 8. Unserved Areas (Average)				
Survey Areas in Each Study Area	Open Defecation	Simple Pit Latrine	Pour Flash Latrine	Septic Tanks	Sewerage	Open Defecation	Simple Pit Latrine	Pour Flash Latrine	Septic Tanks	Sewerage	Open Defecation	Simple Pit Latrine	Pour Flash Latrine	Septic Tanks	Sewerage
1. Would prefer better human waste disposal	71%	0%	0%	100%	55%	57%	100%	0%	87%	77%	69%	40%	90%	90%	0%
2. Do not prefer better human waste disposal	29%	0%	0%	0%	45%	43%	0%	0%	13%	23%	28%	0%	10%	10%	0%

2) Open Defecation

- ✓ Table AT.4.20 shows that 50% of the people practicing open defecation is aware that it will cause various diseases and 54% of the people practicing the same would like to use common toilets.
- ✓ Table AT.4.21 shows that out of 20% of people practicing open defecation in unserved area are having community toilets, but cannot use them as it is too far.
- ✓ Table AT.4.22 shows the reasons that people practicing open defecation have not constructed toilet/latrine so far. 60% of the people living in Panaji served area could not construct as they are staying in rented places with the land lord refusing permission to construct a toilet in his land. 36% of the total respondent which are generally migrant labourers have not constructed toilet as they are staying on temporary basis.
- ✓ Table AT.4.23 shows that 45% of the respondent practicing open defecation are not willing to borrow money on low interest loan available from the government as they being of low and very low income feels that the government can set up common toilets like sulabh, etc. so that the people are not burdened with the expenses of constructing the same.

Table AT.4.20 Situation of people practicing open defecation

People practicing open defecation		Sewerage/Sanitation Study Areas			
		1. Panaji - Served	2. Margao-Served (North & Central)	3. to 8. Unserved Areas (Average)	Average
Open defecation	1. Yes, know that it cause diseases	67%	33%	49%	50%
	2. No, do not know that it cause disease	33%	67%	51%	50%
	3. Have available latrine	15%	13%	20%	16%
	4. Would like to have a private latrine	30%	27%	17%	25%
	5. Would like to have a common latrine	50%	58%	53%	54%
	6. No, doesn't need latrine	20%	15%	30%	22%

Table AT.4.21 Latrine not being used

Category	Sewerage/Sanitation Study Areas			
	1. Panaji - Served	2. Margao-Served (North & Central)	3. to 8. Unserved Areas (Average)	Average
1. Latrine for storage	0%	0%	0%	0%
2. Latrine is dirty	0%	0%	4%	1%
3. Pit filled	0%	0%	11%	4%
4. Built on subsidy	0%	0%	0%	0%
5. Land lord has forbidden	100%	60%	5%	55%
6. Against culture	0%	0%	0%	0%
7. Community toilet is too far	0%	40%	75%	38%
8. Others	0%	0%	0%	0%

Table AT.4.22 Latrine not constructed

Category	Sewerage/Sanitation Study Areas			
	1. Panaji - Served	2. Margao-Served (North & Central)	3. to 8. Unserved Areas (Average)	Average
1. Latrine not needed	0%	0%	0%	0%
2. Latrine too expensive	0%	20%	38%	19%
3. Rented place, no permission	60%	20%	0%	27%
4. No space for constructing latrine	20%	7%	4%	10%
5. Not enough water	0%	7%	0%	2%
6. Loan not available	0%	0%	0%	0%
7. Temporary residence	20%	47%	42%	36%
8. Others	0%	0%	0%	0%

Table AT.4.23 Borrow money on low interest loan availability from Government

Category	Sewerage/Sanitation Study Areas			
	1. Panaji - Served	2. Margao-Served (North & Central)	3. to 8. Unserved Areas (Average)	Average
1. Yes, willing to borrow money	71%	43%	51%	54%
2. Not willing to borrow money	29%	57%	49%	45%

3) Toilet/latrines without Connection to Sewer

- ✓ Table AT.4.24 and its figure show that 50% of the respondent living in Margao served area is of the opinion that the effluent from the toilet/latrine pollutes the surrounding environment and 76% of the people residing in unserved areas feel that their toilet/latrine is polluting the ground water whereas the respondents thinking that the overflow causing health hazards in neighbourhood is 35% in Panaji served area.
- ✓ Table AT.4.25 indicates that 51% of respondent thinks that the negative impact due to overflow from toilet on living and natural environment is of serious nature.
- ✓ From Table AT.4.26 it is generally observed that the toilet/latrine is constructed simultaneously along with the house/buildings. Hence the main source of construction is once own finance.
- ✓ From Table AT.4.27 it is observed that the respondents aspects of toilet/latrine with respect to technology type, quality of construction and maintenance and cleanliness ranges from fair to good.
- ✓ The improvement listed by the respondents to be made to their toilet/latrine in connection to sewer is first followed by up gradation to a better toilet/latrine. Constructing the toilet/latrine within the house is the third priority.
- ✓ Table AT.4.29 shows that 76% of the respondents in the served areas but not connected to sewer are willing to connect to sewer if a general/common law is enforced which makes it compulsory to connection to sewer compulsory.

Table AT.4.24 Perception on effluent from toilet/latrine not connected to sewer

Category	Sewerage/Sanitation Study Areas			
	1. Panaji - Served	2. Margao-Served (North & Central)	3. to 8. Unserved Areas (Average)	Average
1. Yes pollutes surrounding environment	35%	50%	23%	36%
2. Yes, pollutes ground water	47%	78%	76%	67%
3. Yes, health hazards in neighbourhood due to overflow	35%	79%	80%	65%

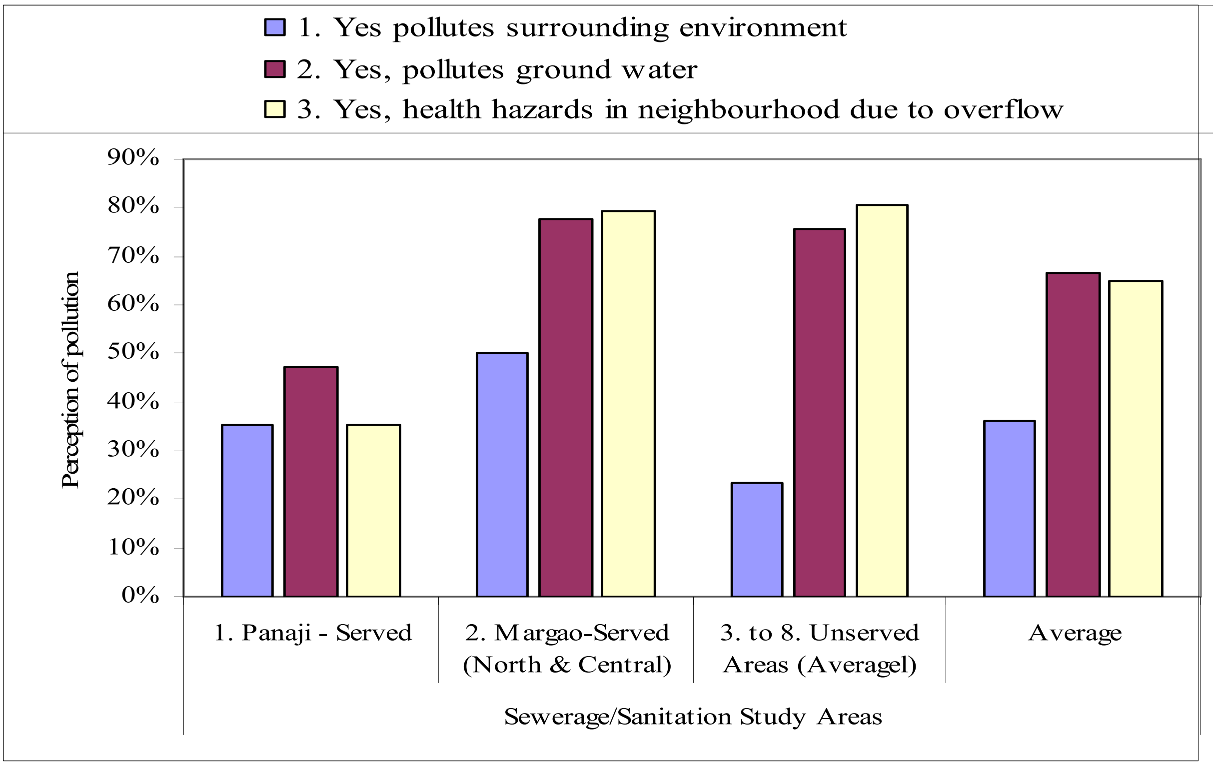


Figure AT.4.9 Perception on effluent from toilet/latrine not connected to sewer

Table AT.4.25 Perception on the living & natural environment due to overflow from toilets

Category	Sewerage/Sanitation Study Areas			
	1. Panaji - Served	2. Margao-Served (North & Central)	3. to 8. Unserved Areas (Average)	Average
1. Very serious on living &natural environment	12%	6%	28%	15%
2. Serious	59%	50%	45%	51%
3. Not very serious	29%	44%	27%	34%
4. Not serious at all	0%	0%	0%	0%

Table AT.4.26 Finance for construction of toilet / latrine

Category	Sewerage/Sanitation Study Areas			
	1. Panaji - Served	2. Margao-Served (North & Central)	3. to 8. Unserved Areas (Average)	Average
1. Own source construction toilet	69%	94%	86%	83%
2. Government subsidy	19%	6%	13%	12%
3. Borrow money	13%	0%	1%	5%

Table AT.4.27 Unsatisfaction levels of toilet/latrine not connected to sewer

Technology type	2.5
Quality of construction	2.7
Maintenance & Cleanliness	2.6

Table AT.4.28 Improvement liked to be made of households toilet/latrine

1. Connect to sewer	374
2. Upgrade it to other better toilet/latrine	198
3. Construct it inside the house	109
4. Install running water inside it	46
5. Have regular sludge disposal service with exhauster	96
6. Have regular sludge disposal service with bucket	7

Table AT.4.29 Connection to sewer if sewerage law is enforced

Category	Sewerage/Sanitation Study Areas			
	1. Panaji - Served	2. Margao-Served (North & Central)	3. to 8. Unserved Areas (Average)	Average
1. Yes, if sewerage law is enforced	75%	67%	86%	76%
2. No, even when sewerage law is enforced	25%	33%	14%	24%

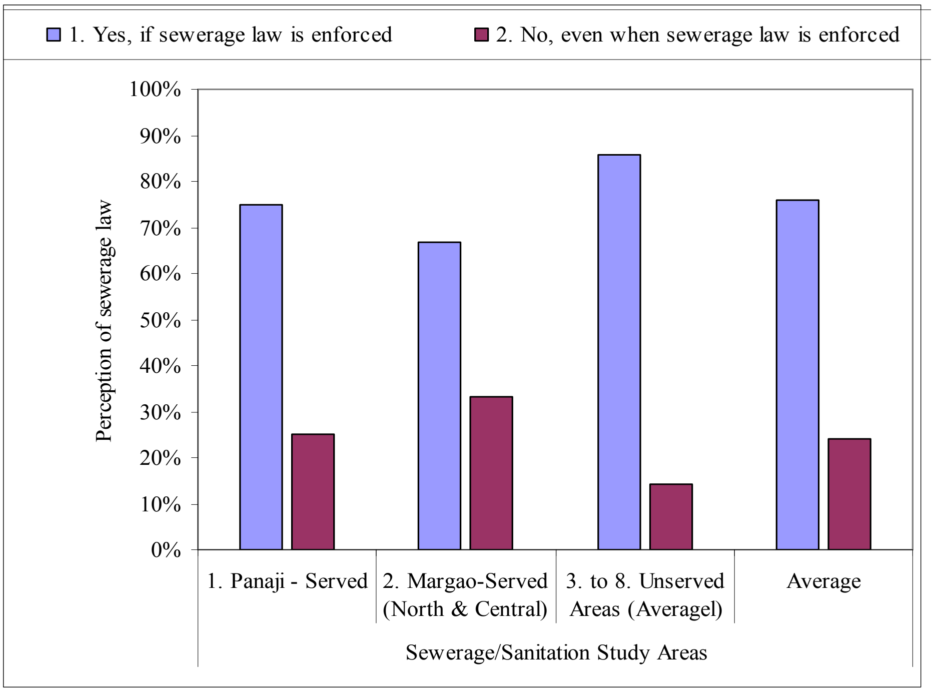


Figure AT.4.10 Connection to sewer if sewerage law is enforced

4) Toilets/Latrine connected to Sewer

- ✓ Table AT.4.30 shows that in the served areas of Panaji and Margao the reasons obtained from respondents for connection to sewer for improving household sanitation is 47% and for the improving surrounding water environment is 19%.
- ✓ Table AT.4.31 and 3.32 shows that 45% and 38% of the respondents in Panaji served and Margao served respectively has conceived that there are complains in the existing sewerage system with 18% in Margao served still feeling that frequency of diarrhoea has not reduced even after connection to sewer.
- ✓ The respondents already connected to sewer has listed the 3 major complains of the existing sewerage system. The largest complaint is that initial sewerage connection charge is expensive, second largest is the monthly charge is too expensive and the third largest complaint is clogging.

Table AT.4.30 Reason for connecting to Sewer

Category	Sewerage/Sanitation Study Areas		
	Panaji - Served	Margao-Served (North & Central)	Average
1. Before moving in	6%	26%	16%
2. Improve Household Sanitation	45%	49%	47%
3. Improve surrounding Water Environment	30%	8%	19%
4. For Convenience	15%	18%	17%
5. Forced to connect	0%	0%	0%
6. Others	3%	0%	1%
7. I don't know	0%	0%	0%

Table AT.4.31 Frequency of Diarrhoea after connecting to Sewer

Category	Sewerage/Sanitation Study Areas		
	Panaji - Served	Margao-Served (North & Central)	Average
1. Yes Diarrhoea decreased	94%	82%	59%
2. No	6%	18%	12%

Table AT.4.32 Complains of Existing Sewerage system users

Category	Sewerage/Sanitation Study Areas		
	Panaji - Served	Margao-Served (North & Central)	Average
1. Yes, having complains on the existing system	45%	38%	42%
2. No, complains on the existing system	55%	62%	59%

(3) Difference in Willing to Pay by Income Level

1) Basic Information for the Evaluation of Willingness to Pay

- ✓ Table AT.4.33 shows that the average high income group is having an income of Rs. 9000/- per month and for low income group the average monthly income is around Rs. 2500/-. It is also interesting to note that the commercial income groups income per month is found to be in between the high income and the middle income group. The average income varies between Rs. 2000/- to Rs. 9000/- per month.
- ✓ Table AT.4.34 shows that there is an average of 5.59 persons in each household in the sewerage/sanitation survey area.
- ✓ Table AT.4.36 and 3.37 shows that the electricity bill per month in the high income group is Rs. 199/- and for the very low income group is Rs. 66/- per month. 41% and 34% of the respondents in the very low income group and commercial income group feels that the existing electricity charges are expensive.
- ✓ Table AT.4.38 shows that 50% of the respondents in the higher income group of the entire survey area has conceived that the user fee should be covering the cost for running the sewerage service. 31% of the low income group in the Panaji served area feel that the cost for running the sewerage service should be covered by tax/government. A high 60% of the low and very low income group of Panaji served and Margao unserved has no idea about the basic principle that most of cost for running sewerage service other the capital costs shall be covered by the user fee.
- ✓ Table AT.4.39 shows that 54% of the respondents in the served area of Panaji and Margao feels that the initial connection cost should be borne by the government using our tax and 42% and 56% of respondents in Panaji and Margao respectively has conceived that cost of running the sewerage works to be charged to the household connected as monthly sewerage charges.

Table AT.4.33 Average household Income in each survey area.

	Sewerage/Sanitation Study Areas										
	Served Study Areas			Unserved Study Areas							Grand Average
Survey Areas of Different Income Group in Each Study Area	1. Panaji	2. Margao-Served (North & Central)	Average	3. Residential Areas around Panaji	4. Margao-unserved (South)	5. Mapusa	6. Ponda	7. North Costal Belt	8. South Costal Belt	Average	
1. High Income	10545	8805	9675	8929		10143		7714	8757	8886	9149
2. Middle Income		4528	4528	4367	5022	7367	6306	5660	4233	5492	5355
3. Low Income	3708	2930	3319	2410	2525		2500			2478	2815
4. Very Low Income	2491		2491		1809					1809	2150
5 & 6. Commercial	8209	8342			6981	7713	6338	6950	4513		
	8368		8306					6838	10500	7119	7475

Table AT.4.34 Average number of persons in sampled households

People	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Adult Men	1.87	1.73	1.82	2.14	2.76	2.06
2. Adult Woman	1.67	1.85	1.85	1.91	1.46	1.75
3. Children (<16 years old)	1.40	1.65	1.89	2.09	1.08	1.62
4. Total	4.93	6.00	5.57	6.14	5.29	5.59

Table AT.4.35 Housing ownership in sampled household

People	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Household himself	53%	54%	59%	50%	62%	56%
2. Wife	27%	22%	9%	14%	7%	16%
3. Husband	10%	8%	15%	18%	11%	12%
4. Parents	0%	0%	5%	9%	1%	3%
5. Child	10%	9%	3%	0%	6%	6%
6. Grand Parents	0%	1%	5%	9%	2%	4%
7. Grand Child	0%	6%	1%	0%	1%	2%
8. Relative	0%	0%	1%	0%	0%	0%
9. Tenant	0%	0%	0%	0%	0%	0%
10. Room mate	0%	0%	0%	0%	0%	0%
11. Employee	0%	0%	0%	0%	4%	1%
12. Others	0%	0%	0%	0%	5%	1%

Table AT.4.36 Average income and electricity bill of sampled household

Category	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Average income (Rs.)	6041	6280	5102	3083	5127	9162	5193	2868	2150	7657	5406
2. Average electric bill (Rs.)	135	116	83	55	97	199	126	78	66	468	187

Table AT.4.37 Perception of the electricity bill of sampled household

Category	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Very expensive	7%	7%	0%	10%	6%	3%	3%	0%	0%	4%	2%
2. Expensive	28%	21%	40%	44%	33%	18%	31%	20%	41%	34%	29%
3. Fair	63%	67%	58%	47%	59%	77%	67%	79%	59%	58%	68%
4. Cheap	1%	5%	1%	0%	2%	2%	0%	1%	0%	4%	1%
5. Very cheap	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table AT.4.38 Perception of payment for running Sewerage system by the user

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	
1. Yes, by user Fee	73%	0%	36%	50%	40%	57%	50%	31%	38%	44%	35%	28%	0%	0%	10%	15%	31%
2. No, with user fee	18%	0%	0%	18%	9%	0%	13%	10%	4%	7%	17%	9%	5%	0%	11%	9%	8%
3. No, by Government Tax	0%	31%	0%	5%	9%	19%	17%	0%	4%	10%	14%	13%	25%	18%	13%	17%	12%
4. No Idea	9%	69%	64%	27%	42%	24%	21%	59%	54%	39%	34%	50%	70%	82%	66%	60%	48%

Table AT.4.39 Perception of payment for initial connection and cost of running sewerage works for households connected to sewer

Category		Sewerage/Sanitation Study Areas		
		Panaji - Served	Margao-Served (North & Central)	Average
Initial Connection cost	1. Household to be connected	33%	59%	46%
	2. Government using tax	67%	41%	54%
Cost of Running sewerage works	1. Household connected as monthly sewerage charge	42%	56%	49%
	2. Government using tax as subsidy	58%	44%	51%

2) Willingness to Pay

- ✓ Table AT.4.40 shows that 43% and 40% of the middle income in unserved area and Margao served area practicing open defecation are willing to construct a toilet/latrine to avoid the negative impacts on their household and on the water environment in Goa. It is also interesting to note that 100% of people in Panaji served are willing to construct the toilet/latrine.
- ✓ Table AT.4.41 shows that on an average Rs. 261/- is spent by the respondents of the survey study area for annual maintenance cost of the facility including sludge disposal. The construction cost of toilet/latrine not connected to sewer is Rs. 24,227/- for high income groups in the study area.
- ✓ Table AT.4.42 shows that 100% of the high income and middle income in Margao served area are ready to connect to sewer as compared to only 26% in the high income group of unserved area. This may be because the high income group respondents may have already spent for constructing toilets, septic tanks, etc. The monthly sewerage charges for the purpose of improving the quality of life is given as RS. 37/- and Rs. 20/- by the high income and low income group respectively. Overall the respondents are ready to pay Rs. 49/- as total monthly charges for usage of sewerage connection. The willingness to pay the initial connection cost varies from Rs. 3000/- for high income group to Rs. 500/- for very low income group in the study area.
- ✓ Table AT.4.43 shows that the respondents in low income pay Rs 34/- and Rs. 39/- for the existing sewerage charge per month in Panaji and Margao served area. 57% of the commercial area are only willing to keep the existing sewerage network which infers that the balance 43% has some problem with the system and require improvement on the same.

The respondents in the commercial group were found willing to pay Rs. 78/- as total monthly charges for the existing sewerage connection so as to improve the quality of life in the household and for the water environment in Goa.

3) sons of Low Willingness of Connecting to Sewer and Keeping the Connection

- ✓ Table AT.4.44 shows that only a low of 7% of the respondents are not willing to connection to sewer. The main reasons given by these respondents as per Table AT.4.45 is first that they don’t want to spend any money for sewerage. The reasons that current toilet/latrine is enough and don’t think that sewerage is essential for life are the second and third reasons respectively.

Table AT.4.40 Willingness to pay (of people practicing open defecation) to construct new toilet/latrine connected to sewer to avoid negative impacts of open defecation

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	
1. Yes, like to construct toilet	-	100%	100%	100%	100%	-	40%	60%	40%	47%	-	50%	90%	100%	60%	75%	74%
2. Monthly Rs. for quality of life	-	20	15	3	12	-	8	9	10	7	-	9	29	22	55	29	18
3. Monthly more for environment	-	10	6	3	7	-	8	8	5	5	-	8	13	10	8	10	8
4. Monthly cost to connect to sewer	-	5	7	3	5	-	5	7	2	3	-	5	8	7	7	7	5
5. Total Monthly charges	-	35	28	8	24	-	20	23	17	15	-	21	50	39	70	45	31

Table AT.4.41 Willingness to pay for annual maintenance cost of construction cost for toilet / latrine user without connecting 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	
1. Annual maintenance Cost Rs.	517	400	0	1125	510	456	261	270	223	302	358	339	134	88	1011	386	398
2. Construction cost Rs.	6833	4500	5500	7417	6063	22214	4689	16667	18500	15517	6542	6385	2050	7042	6583	5720	8840

Table AT.4.42 Willing to pay to connect toilet/latrine to sewer for improving household livelihood & water environment in Goa

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	
1. Yes, connect to sewer	100%	100%	100%	100%	100%	100%	100%	90%	80%	93%	100%	97%	60%	33%	85%	75%	88%
2. Monthly charges for quality of life (Rs.)	37	19	18	35	27	37	32	61	146	69	39	47	26	39	98	50	49
3. Monthly more for improving water environment (Rs.)	20	10	10	18	15	21	14	19	28	21	21	19	10	8	27	17	17
4. Total monthly for use of sewerage (Rs.)	57	29	28	53	42	57	47	80	174	89	61	65	36	47	125	67	66
5. Initial connection cost (Rs.)	2067	2500	3167	1633	2342	1647	1222	675	1179	1181	1885	2057	1078	1513	1719	1650	1719

Table AT.4.43 Willingness to pay to keep the existing sewerage connection

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	
1. Current monthly sewerage charge (Rs.)	56	24	16	61	39	52	40	39	171	76	-	-	-	-	-	-	58
2. Yes, to keep sewerage the existing connection	86%	100%	100%	57%	86%	90%	70%	100%	78%	84%	-	-	-	-	-	-	85%
3. Monthly more for sewerage connection or improving quality of life (Rs.)	30	13	9	24	19	23	19	14	50	27	-	-	-	-	-	-	23
4. Monthly more for improving water environment (Rs.)	18	11	8	17	13	15	15	10	28	17	-	-	-	-	-	-	15
5. Total monthly for use of sewerage (Rs.)	48	24	17	41	32	38	34	24	78	44	-	-	-	-	-	-	38

Table AT.4.44 Toilet/latrine not liking to connect to sewer

	Sewerage/Sanitation Study Areas																
	1. Panaji - Served					2. Margao-Served (North & Central)					3. to 8. Unserved Areas (Average)						Average
Survey Areas in Each Study Area	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	
1. Do not like to connect to sewer	0%	0%	0%	0%	0%	0%	0%	11%	20%	8%	0%	27%	0%	0%	8%	11%	7%

Table AT.4.45 Reasons for not liking to have a sewer connection

1. Monthly charge of sewer connection is too expensive	9
2. Cost of connecting to sewer is too expensive	8
3. Don't want to spend any money for sewerage	30
4. Current toilet/latrine is enough	20
5. Not enough water to use flush toilet	8
6. Don't think sewerage is essential for our life	11
7 Don't think sewerage can improve our livelihood or environment	2
8. Neighbors also don't connect to sewerage	0
9. The government doesn't enforce the connection and the use of sewerage	0
10. Others (please specify)	0

(4) vironmental Education and Sanitation Promotion

- ✓ Table AT.4.46 shows that 58% of the toilet/latrines of simple pit type, 18% each of the toilet/latrines of pour flush and septic tank type are having bad sanitary situation.
- ✓ Table AT.4.47 shows that 40% and 45% of the respondents of pour flush and septic tank toilet/latrines clean the toilet every day as against 46% of the respondents of the simple pit toilet/latrine who cleans the toilet every two weeks. It is also found that 58% of the toilets of simple pit type were having bad sanitary situation.
- ✓ Table AT.4.48 indicates that 45% and 33% of the respondents having simple pit toilets and pour flush toilet respectively has to remove the sludge from their toilet/latrines annually.
- ✓ Table AT.4.49 shows that in the sanitation survey area among the very low income group 36% and 79% of adults and children respectively wash their hands without soap after defecation. Also in the water supply schemes of poorly served area it is observed that 35% of children do not wash hand with soap after defecation an d51% of the adults do not wash their hands with soap before eating.
- ✓ Table AT.4.50 shows that 43% of the respondents in low and very low income group does not use any domestic water treatment before using water with 60% of the balance 57% of the same respondent group use boiling method of water treatment before drinking.
- ✓ Table AT.4.51 occurrence of diarrhoea is 6.8 times in a year for poorly served area and 4.0 times in a year in beach and sight seeing areas of water supply areas and 6.4 in low income areas of sanitation survey area. It is also found that the respondent suffer from malaria 5 times in a year in the very low income group of sanitation survey area.

- ✓ Table AT.4.52shows that diarrhoea is prevalent in respondents going in for open defecation which is 9.7 times in a year and 6.8 times in the poorly served areas of water supply.
- ✓ Table AT.4.53 shows that 60% of the adults in all the income level, high, middle, low and commercial does not have exposure to hygiene education and a high 91% of very low income level similarly does not have any exposure to any type of education or sanitary promotion. Almost 44% of the respondents in the low income group does not know whether the schools have any kind of hygiene education for their children with 37% of the respondent in high income level says that there is no promotion of sanitation education in the school. The table also shows that an average 68% of all the target respondents think that the promotion or education on water related hygiene and sanitation is necessary for the household to be more healthier.

Table AT.4.46 Cleanness of Toilet /latrine not connected to sewer

Category	Types of Toilets/latrines			
	Simple Pit Latrine	Pour Flash Latrine	Septic Tanks	Average
1. Impossible Sanitary Situation	0%	2%	0%	0%
2. Bad Sanitary Situation	58%	17%	18%	23%
3. Acceptable Sanitary Situation	27%	61%	64%	38%
4. Good Sanitary Situation	15%	20%	18%	9%

Table AT.4.47 Frequency of Cleaning the Toilet / Latrine not connected to sewer

Category	Types of Toilets/latrines			
	Simple Pit Latrine	Pour Flash Latrine	Septic Tanks	Average
1. Everyday	8%	27%	0%	9%
2. Every Few Days	19%	40%	45%	26%
3. Once a Week	19%	32%	18%	17%
4. Every Two Weeks	46%	2%	18%	17%
5. More Than Two Weeks	8%	0%	18%	6%

Table AT.4.48 Sludge Withdrawal of Toilet / Latrine not connected to sewer

Category	Types of Toilets/latrines			
	Simple Pit Latrine	Pour Flash Latrine	Septic Tanks	Average
1. Six Months	0%	0%	0%	0%
2. Annually	45%	33%	0%	19%
3. Five Years	0%	16%	0%	4%
4. More Than Five Years	10%	22%	0%	8%
5. Never Did	45%	29%	100%	43%

Table AT.4.49 Hygiene practices washing hand with soap

Category			Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
			1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
After defecation	Adult	1. No washing	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%
		2. Washing without soap	2%	14%	14%	22%	13%	5%	20%	23%	36%	24%	22%
		3. Washing with soap	98%	86%	86%	78%	87%	95%	80%	76%	64%	76%	78%
	Children	1. No washing	0%	0%	0%	0%	0%	0%	0%	10%	0%	0%	2%
		2. Washing without soap	7%	22%	35%	37%	25%	8%	34%	47%	79%	38%	41%
		3. Washing with soap	93%	78%	65%	63%	75%	92%	66%	43%	21%	63%	57%
Before eating	Adult	1. No washing	0%	2%	0%	3%	1%	0%	1%	3%	14%	4%	4%
		2.Washing without soap	30%	21%	51%	34%	34%	48%	34%	71%	55%	57%	53%
		3. Washing with soap	70%	77%	49%	63%	65%	52%	65%	26%	32%	39%	43%
	Children	1. No washing	0%	3%	0%	4%	2%	0%	1%	15%	17%	6%	8%
		2. Washing without soap	44%	36%	72%	43%	49%	59%	75%	73%	78%	70%	71%
		3. Washing with soap	56%	61%	28%	53%	50%	41%	23%	12%	6%	24%	21%

Table AT.4.50 Domestic water treatment before using water

Domestic water treatment	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. No domestic water treatment before use	11%	19%	22%	12%	16%	10%	38%	43%	43%	29%	33%
2. Both Boiling and Simple filtering	38%	41%	35%	69%	46%	46%	39%	7%	8%	19%	24%
3. Boiling	46%	47%	55%	29%	44%	21%	33%	60%	77%	53%	49%
4.Simple Filtering	16%	12%	10%	2%	10%	33%	29%	28%	0%	22%	22%
5.Domestic Chlorination	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
6. Other means	0%	0%	0%	0%	0%	0%	0%	5%	15%	5%	5%

Table AT.4.51 Occurrence of water borne disease (income level wise)

Types of Disease	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Diarrhoea	3.0	4.0	6.8	3.2	4.2	2.5	6.0	6.4	5.9	6.5	5.5
2. Typhoid	1.1	0.7	2.2	0.7	1.2	1.3	1.9	4.2	3.6	1.9	2.1
3. Hepatitis	0.1	0.2	0.5	0	0.2	0.2	2.1	1.1	0	0.8	0.7
4. Malaria	1.5	1.2	2.3	0.9	1.5	1.2	3.5	3.2	5.0	3.5	1.5

Table AT.4.52 Occurrence of water borne diseases (sanitation type wise)

Types	Water Supply Survey Areas					Sewerage/Sanitation Study Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	Open Defecation	Simple Pit Latrine	Pour Flash Latrine	Septic Tank	Sewerage	Average
1. Diarrhoea	3.0	4.0	6.8	3.2	4.2	9.7	1.5	4.4	4.0	2.8	4.5
2. Typhoid	1.1	0.7	2.2	0.7	1.2	5.0	2.0	0.6	1.5	1.4	2.1
3. Hepatitis	0.1	0.2	0.5	0	0.2	3.0	0	0	0.2	0.3	0.8
4. Malaria	1.5	1.2	2.3	0.9	1.5	4.8	2.5	3.3	3.6	2.2	3.3

Table AT.4.53 Hygiene education and sanitation promotion

Category		Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
		1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
Exposure to Hygiene Education	1. Yes	63%	53%	59%	82%	64%	40%	38%	31%	9%	41%	32%
	2. No	37%	47%	41%	18%	36%	60%	63%	69%	91%	59%	68%
Hygiene education for children in school	1. Yes	60%	48%	55%	76%	60%	58%	31%	22%	27%	49%	37%
	2. No	23%	38%	27%	11%	24%	37%	36%	33%	50%	27%	37%
	3. I don't know	17%	15%	18%	13%	16%	5%	33%	44%	23%	24%	26%
Promotion or Education of hygiene & sanitation	1. Yes	90%	88%	76%	81%	84%	85%	64%	50%	64%	78%	68%
	2. No	10%	12%	24%	19%	16%	15%	36%	50%	36%	22%	32%

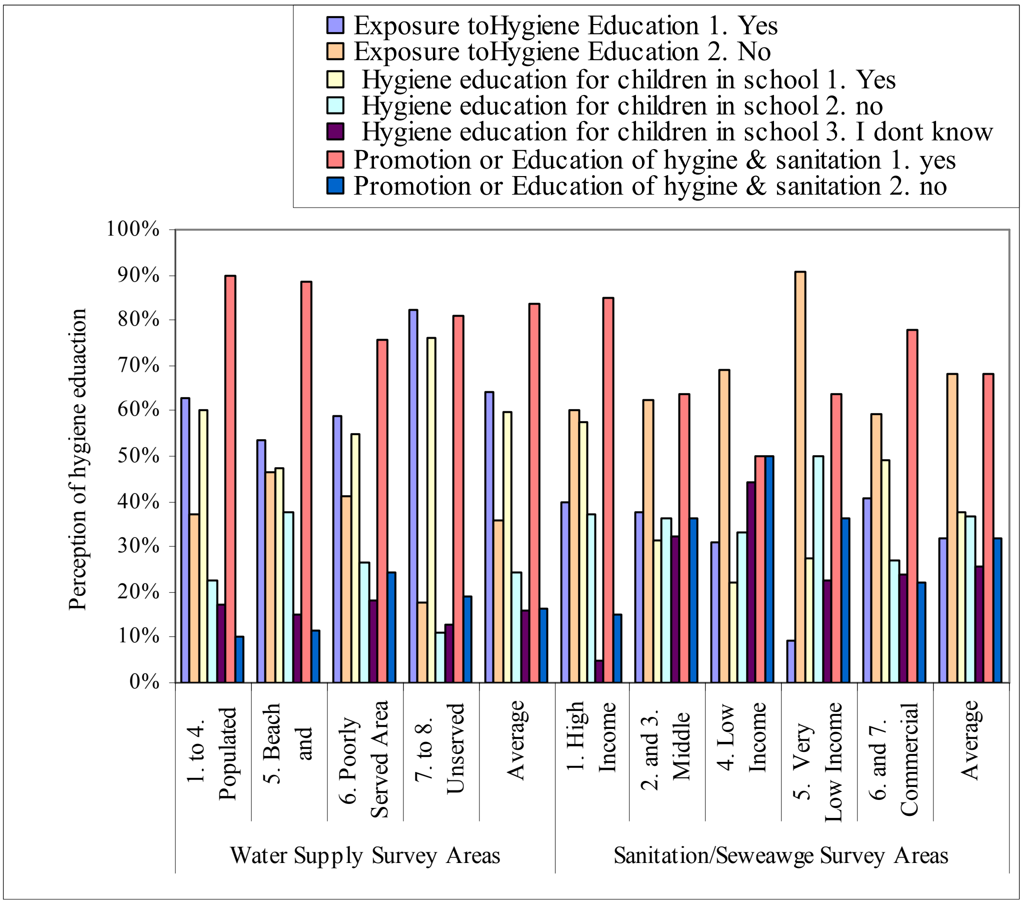


Figure AT.4.11 Hygiene education and sanitation promotion

(5) Omparison between Water Supply and Sewerage/Sanitation

- ✓ Table AT.4.54 shows that overall respondents in sewerage survey area prefers that government should invest 54% for the improvement of water supply and 46% for sanitation facilities.
- ✓ Table AT.4.55 shows that the respondents require the government to invest more in water supply as the first priority in both the survey areas of water supply and sanitation. The second priority given by the respondents in the water supply survey area is improvement in the facilities of schools. The improvement of electricity is the fifth and sixth development factor in case of water supply and sanitation survey area respectively.
- ✓ Table AT.4.56 shows that only 15% of the target respondents feel that convenient flush toilet/latrine connected to sewer is more important that 24 hours water supply. This low margin is because of the lack of hygiene education and sanitation promotion.

- ✓ Table AT.4.57 shows that 31% of middle income only feels that improving sanitation and water environment by sewerage is more important for their household as against only 5% in the very low income group favoring improvement of sanitary conditions.
- ✓ Table AT.4.58 shows that the respondents feels that more improvement of water supply and sanitation facility is needed for the residential areas of the local people.
- ✓ Table AT.4.59 shows that 55% of the respondents in the low income group feels that improvement in water supply system can lower the water borne disease. 45% of the high and middle income group thinks that improvement of sanitation facilities is more effective to reduce the water borne disease.
- ✓ Table AT.4.60 shows that the respondents prefers only 25% as the appropriate proportion of sewerage charges to water charges.

Table AT.4.54 Conceived proportion of investment by government for improvement of water supply & sanitation

Types	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Water supply proportion	52%	53%	55%	50%	52%	55%	51%	52%	58%	55%	54%
2. Sanitation	48%	47%	45%	50%	48%	45%	49%	48%	43%	45%	46%

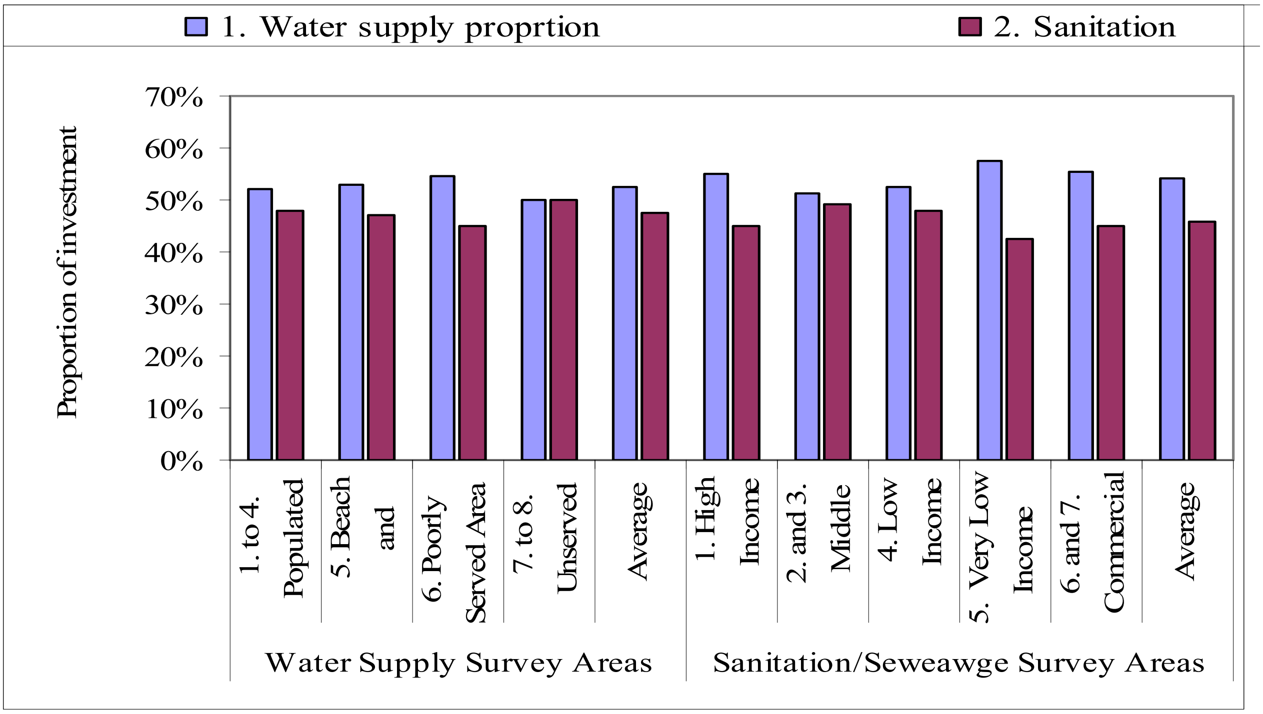


Figure AT.4.12 **Conceived proportion of investment by government for improvement of water supply & sanitation**

Table AT.4.55 Development works in which the government should invest more

Table, showing in which Government should develop more	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Water Supply (House connection)	597 (1)	899 (1)	762 (1)	692 (3)	737 (1)	849 (1)	799 (1)	794 (2)	921 (2)	747 (1)	822 (1)
2. Sanitation/Sewerage (Human waste disposal)	442 (3)	847 (3)	665 (3)	613 (5)	642 (4)	823 (2)	744 (2)	706 (3)	903 (4)	578 (3)	786 (2)
3. Home waste disposal (sewer/Drain)	289 (5)	803 (5)	565 (6)	586 (7)	561 (6)	676 (5)	613 (4)	567 (6)	868 (6)	443 (5)	633 (5)
4.Storm water drainage (Drain)	224 (7)	784 (7)	520 (8)	0 (10)	527 (8)	623 (8)	532 (7)	511 (7)	845 (10)	392 (6)	581 (7)
5. Solid Waste Management (collection disposal)	153 (10)	759 (9)	426 (10)	533 (9)	468 (10)	594 (9)	460 (9)	479 (8)	850 (8)	294 (9)	535 (9)
6. School	511 (2)	866 (2)	741 (2)	803 (1)	726 (2)	813 (3)	694 (3)	811 (1)	940 (1)	609(2)	773 (3)
7. Hospital	337 (4)	843 (4)	650 (4)	740 (2)	642 (3)	681 (4)	602 (5)	654 (4)	914 (3)	485 (4)	667 (4)
8. Electricity	280 (6)	786 (6)	583 (5)	670 (4)	580 (5)	664 (6)	553 (6)	607 (5)	880 (5)	373 (7)	615 (6)
9. Road	193 (8)	778 (8)	541 (7)	595 (6)	527 (7)	651 (7)	461 (8)	503 (8)	855 (7)	330 (8)	560 (8)
10. Police Office	155 (9)	729 (10)	469 (9)	546 (8)	475 (9)	564 (10)	444 (10)	469 (9)	847 (9)	254 (10)	516 (10)

Table AT.4.56 Conceived importance for household

Importance	Water Supply Survey Areas					Sewerage/Sanitation Study Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	Open Defecation	Simple Pit Latrine	Pour Flash Latrine	Septic Tank	Sewerage	Average
1. 24 hour water supply	72%	84%	86%	60%	75%	100%	85%	86%	82%	76%	15%
2. Convenient flush toilet connected to sewer	28%	16%	14%	40%	25%	0%	15%	14%	18%	24%	15%

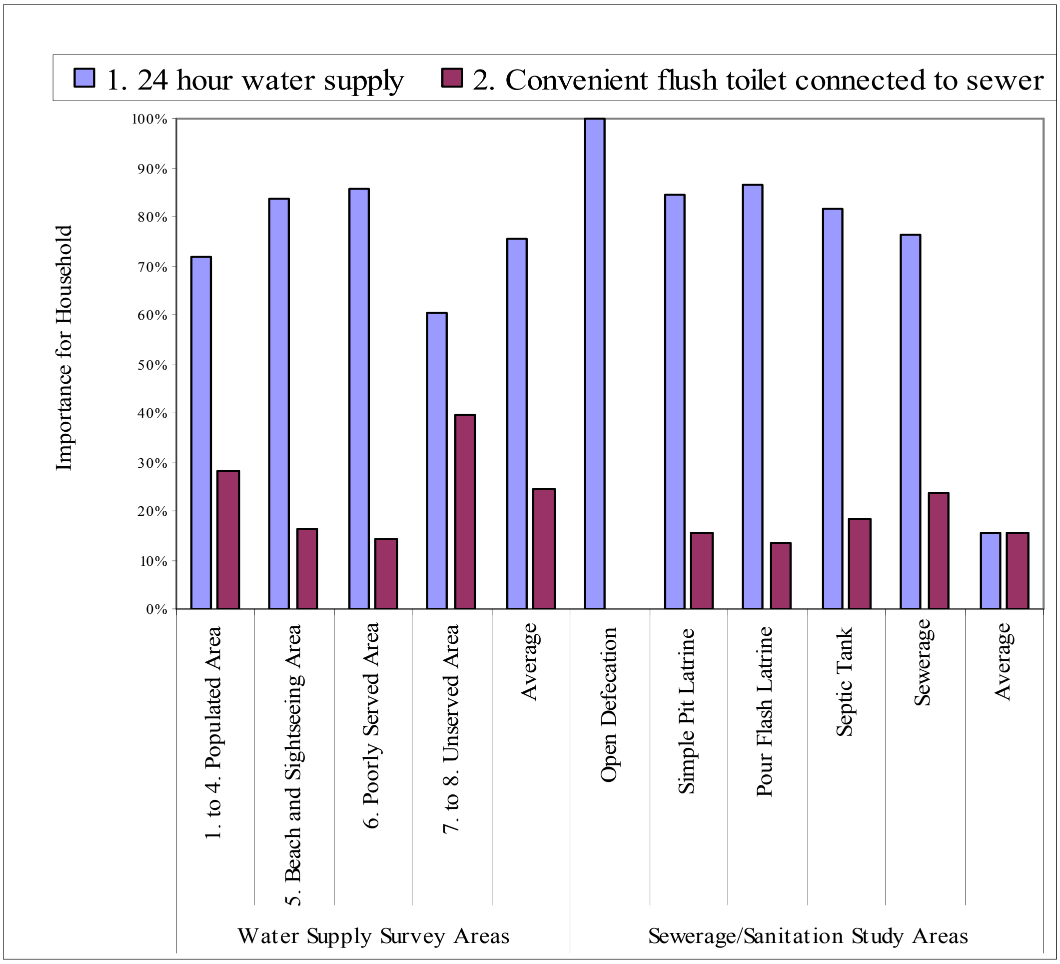


Figure AT.4.13 Conceived importance for household

Table AT.4.57 Conceived importance for household

Types	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. 24 hour water supply	61%	81%	78%	43%	66%	80%	69%	78%	95%	79%	80%
2. Improving sanitation and water environment by sewerage	39%	19%	22%	57%	34%	20%	31%	22%	5%	21%	20%

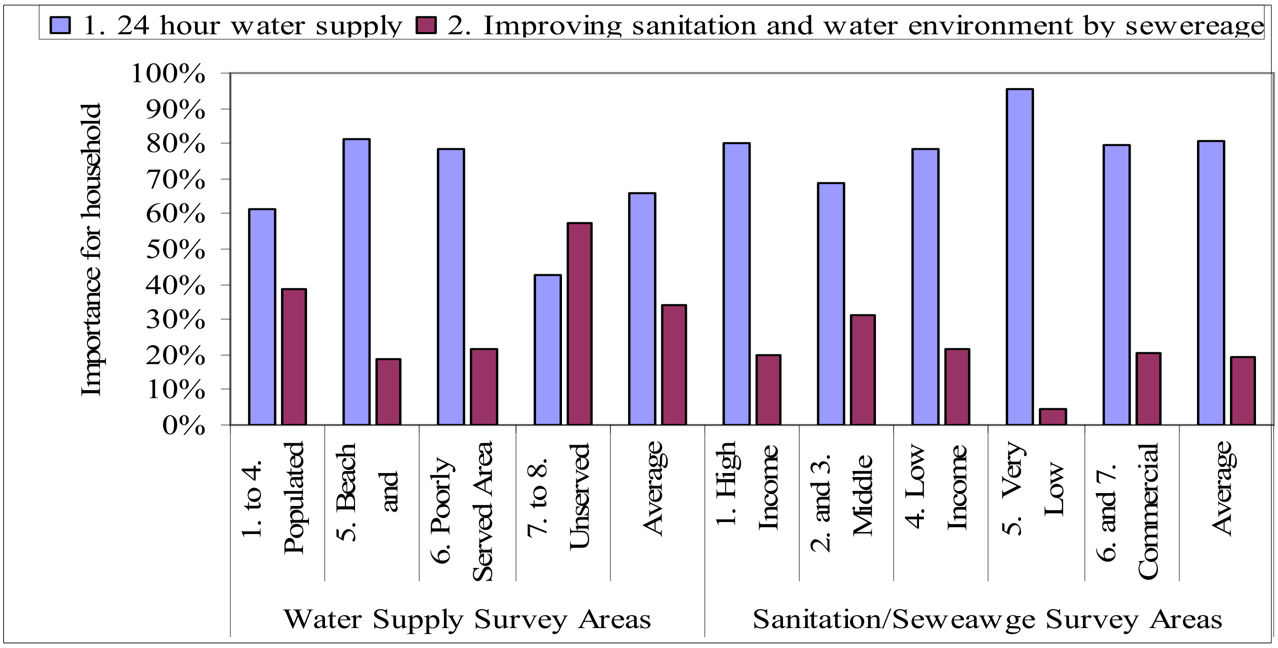


Figure AT.4.14 Conceived importance for household

Table AT.4.58 Areas needing more improvement in water supply and sanitation conditions

Types	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Tourism areas	2%	12%	4%	0%	4%	12%	4%	0%	5%	12%	6%
2. Residential areas for local people	96%	81%	92%	96%	91%	67%	74%	86%	86%	80%	79%
3. Residential areas for immigrants and seasonal workers	2%	7%	4%	4%	4%	22%	23%	14%	9%	8%	15%

Table AT.4.59 Conceived countermeasure to reduce water borne diseases

Category		Water Supply Survey Areas: 1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	Sanitation/Sewerage Survey Areas: 1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
Countermeasure to reduce water borne disease	1. Improvement Water supply system	34%	44%	60%	40%	45%	40%	40%	55%	68%	52%	51%
	2. Sanitation facilities	36%	40%	23%	12%	28%	45%	46%	39%	27%	41%	40%
	3. Hygiene education/sanitation promotion	30%	16%	17%	49%	28%	15%	14%	5%	5%	7%	9%

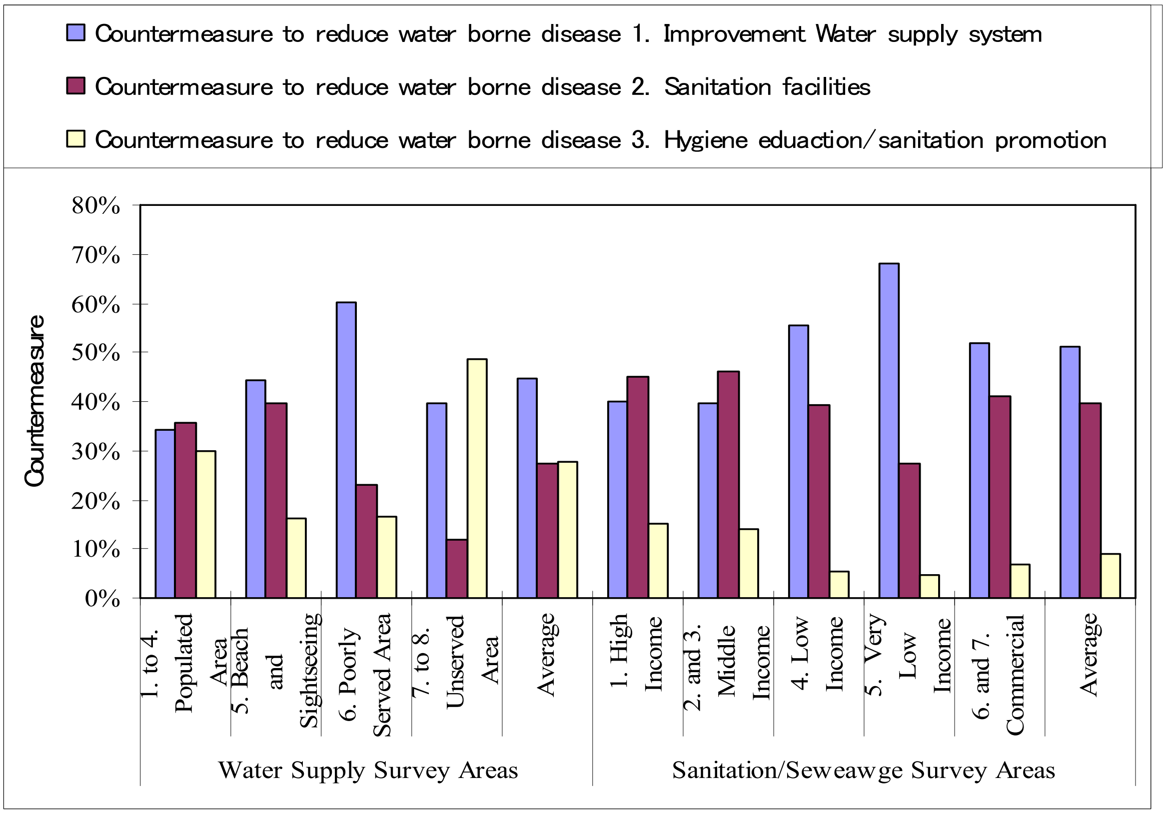


Figure AT.4.15 Conceived countermeasure to reduce water borne diseases

Table AT.4.60 Conceived proportion of sewerage charges to water charges

	Water Supply Survey Areas					Sanitation/Sewerage Survey Areas					
	1. to 4. Populated Area	5. Beach and Sightseeing Area	6. Poorly Served Area	7. to 8. Unserved Area	Average	1. High Income	2. and 3. Middle Income	4. Low Income	5. Very Low Income	6. and 7. Commercial	Average
1. Proportion of sewerage charges to water charges	34%	30%	27%	33%	31%	36%	28%	21%	15%	26%	25%

Attachment 5 Results of the Stakeholder Interview for Residents around the Existing STPs

(1) Existing Conditions and Perception of the Residents living around the STPs

- ✓ Table AT.5.1 shows that there are still some people 10% practicing open defecation and that about the half of them 47% have not connected to sewer although they are living around the STPs. It was also found that 10% of the households, which are using the toilets/latrine without connection to sewer, are using common toilets (sulabh international).
- ✓ Table AT.5.2 also shows that 10% of the households are not satisfied with current situation of their human waste disposal.
- ✓ Table AT.5.3 shows 25% of the respondents discharge their house wastewater to the open drains although they live around the STPs.
- ✓ It was also found in the survey that 45% out of 11 sewerage users have complains on the existing sewerage system around the STPs.
- ✓ Table AT.5.4 shows that clogging of sewer is more serious matter than expensiveness of monthly sewerage charges for the people living near STP.
- ✓ The survey also disclosed that 95% of the residents living around the STPs and discharge points proud that their area contributes to environmental protection with the STP.
- ✓ It is interesting to observe that 70% to 75% of the household near STP are aware about the fact that their household waste water is also being treated in the plant before discharge & are also inquisitive to know more about the functioning of the STP.

Table AT.5.1 Types of sanitation used for disposing human waste (feces and urine)around the STPs

Sanitation Type	%
1. Open defecation	10%
2. Toilet/latrine without connection to sewer	45%
3. Toilet/latrine connected to sewer	45%

Table AT.5.2 Perception of satisfaction with current situation of household's human waste disposal

Satisfaction Level	%
1. Fully Satisfied	30%
2. Moderately Satisfied	60%
3. Not Satisfied	10%

Table AT.5.3 Types of the house wastewater (drain water from kitchen, etc.) disposal around the STPs

Drainage Type	%
1. To sewer	40%
2. To the open drain	25%
3. To the closed drain	0%
4. To the street	0%
5. To the soak pit/septic tank	35%
6. Kitchen garden	0%
7. Re-used	0%

Table AT.5.4 Types of complains on the existing sewerage system by users

Type of Complains	Points
1. Monthly charge is too expensive	7
2. Cost to connect to sewer was too expensive	1
3. Not enough water to use flush toilet	2
4. Clogging	10
5. Others	2

Note: Points shows the level of complain

(2) Public Notification

Table AT.5.5 shows that the majority of people 60% became aware about the construction of STP just before the construction started and the participation of the people for the public hearing about STP was negligible.

Table AT.5.5 Timing of Public Notification about the construction of STP

Timing of Public Notification	%
1. Long time before construction	20%
2. Short time before construction	10%
3. Just before the start of construction	60%
4. After the construction	10%
5. Moved to this area after the construction started	0%

(3) Social Influences of the STPs

- ✓ Initially during the construction of Phase-I of the STPs there were minor disputes and agitations regarding the land acquisitions. Few people were also concerned regarding the discharge of the wastewater from the STPs. However, construction of phase II was easier as there were no land acquisitions and moreover no social problems relating to the discharge wastewater from the STP.
- ✓ Table AT.5.6 shows that 11% of the people staying around the STPs feels that their social/commercial value has changed.
- ✓ Table AT.5.7 shows that 60% of the people do not know, understand or accept the reason why the STP was constructed in their neighborhood.
- ✓ Table AT.5.8 shows that 20% of the people feel there is misdistribution of benefit and negative impacts concerning the STPs.

Table AT.5.6 Feeling the social/commercial value of the surrounding land has been decreased by the STPs

Answer	%
1. Yes, land value has been decreased.	11%
2. No, land value has not been decreased.	89%

Table AT.5.7 Understanding/Accepting the reason why the STP was constructed

Answer	%
1. Yes, the reason was understandable / acceptable.	35%
2. No, the reason was not understandable / acceptable.	65%

Table AT.5.8 Feeling the misdistribution of benefit and damage concerning the STP

Answer	%
1. Yes, we feel the misdistribution	26%
2. No, we don't feel the misdistribution	74%

(4) Environmental Influences of the STPs

- ✓ Table AT.5.9 shows that on an average only 10% of the people have felt that there was an environmental impact due to the STP.
- ✓ Table AT.5.10 shows that people staying in an around the STP has to frequently face the odour coming from the plant.
- ✓ Table AT.5.11 shows that 80% of the people feel that the discharge from the WWTP still pollutes the receiving water source.

Table AT.5.9 Perception on the environmental impacts by the STP

Questions on Each Type of Environmental Impacts	% of Respondents who answered "Yes"
1. Having noticed any environmental impacts caused by the WWTP?	10%
2. Feeling that the landscape become less beautiful due to the WWTP?	25%
3. Having noise and vibration problems during the construction of the WWTP?	15%
4. Having noise and vibration problems during the operation of the WWTP?	5%

Table AT.5.10 Perception on the seriousness of the odour from the STPs

Level of Seriousness of the Odour	%
1. Very serious	25%
2. Serious	37%
3. Not very serious	38%

Table AT.5.11 Perception on the negative impacts of wastewater discharged from the STP

Perception on the Negative Impacts of Discharged Wastewater	%
1. Very serious	10%
2. Serious	80%
3. Not very serious	10%

Attachment 6 Results of the Stakeholder Interview for Hotels regarding Water Supply and Sanitation/Sewerage

(1) Current Situation

1) Hotel Information

- ✓ Goa being the most sought after tourist destination in India, the occupancy rate of hotels during the high season is 100% and 60% to 70% during the low season. However, the number of hotel employee usually does not significantly change between high and low season. High season is from October to June and Low season is from July to September.
- ✓ Table AT.6.1 shows that most of the star hotel resorts, which are clustered around the costal belts, consists of about 173 beds on an average. Moreover, employing on an average of almost 148 people during the high season. The average electricity bill of sampled hotels is Rs.91,667/- per month.

Table AT.6.1 Hotel Information.

Hotel Information	North Coastal	Center of South Coastal	South End of South Coastal	Total Average
1. No of beds (Beds)	129	143	246	173
2. Employees in high season (Nos.)	83	141	220	148
3. Electricity bill (Rs.)	71000	83000	121000	91667

2) Water Supply

- ✓ Table AT.6.2 shows that average water usage during the high season is 4507 m^3 per month for hotels in the north coastal belt and in the 5 star hotel resorts of the center of south costal belt it is 10550 m^3 per month. Additional private water tankers contribute 3060 m^3 per month of water to the hotel resorts of north costal belt during the high seasons.
- ✓ Table AT.6.3 shows that during the high tourist season the average electricity consumption per bed of the hotel resort is Rs. 540/- per month and the average water consumption is 46 m^3 per bed per month. The electricity consumption shown in the Table AT.6.3 also covers the total hotel requirement of lighting of the hotel area, fencing, including landscape garden etc. and the water consumption caters to the requirement of the guests, landscape and gardens, swimming pools, etc.
- ✓ Table AT.6.4 shows that the hotel resorts in the north costal belt heavily depend on open

well 43% and private water vendors 41% to fulfill the demand of water during the tourist high season. The public piped water supply contributes to only a poor 17% of their demand. The hotel resort in south costal belt are also dependent on private water vendors 12% and another tourist city viz. Mobor are relying on their own well sources.

- ✓ Figure AT.6.1 shows that the hotels along the north coastal belt is having a severe water crisis of piped water supply, getting an average water supply for 2 hours a day. The water availability along the south coastal belt is better than north coastal but a lot more is required to be done for improvement of the piped water supply system.
- ✓ Figure AT.6.2 shows that 100% of the hotel industry is using water from private water vendors for the daily requirement of water. The hotel resorts in north costal belt is dependent on private water vendors for both high and low tourist season with maximum tanker water usage for the summer months from March to June.

Table AT.6.2 Water Usage

Water Used	North Coastal	Center of South Coastal	South End of South Costal	Total Average
1. Water used in high season (m3)	4507	10550	14690	9916
2. Additional water required during high season (m3)	3060	600	840	1500

Table AT.6.3 Electricity and water consumption per occupied bed in high season

Answers	Hotels
1. Electricity consumption (Rs./bed/month)	540
2. Water consumption in high season (m3/bed/month)	46
3. Water consumption in low season (m3/bed/month)	26

Table AT.6.4 Proportion of water supply during tourists high season.

Water Sources	North Coastal	Center of South Coastal	South End of South Costal	Total Average
1. Public Piped water supply	17%	81%	51%	50%
2. Own well	43%	7%	37%	29%
3. Public Water Tanker	0%	0%	0%	0%
4. Private Water Vendor	41%	12%	12%	22%
5. Others	0%	0%	0%	0%

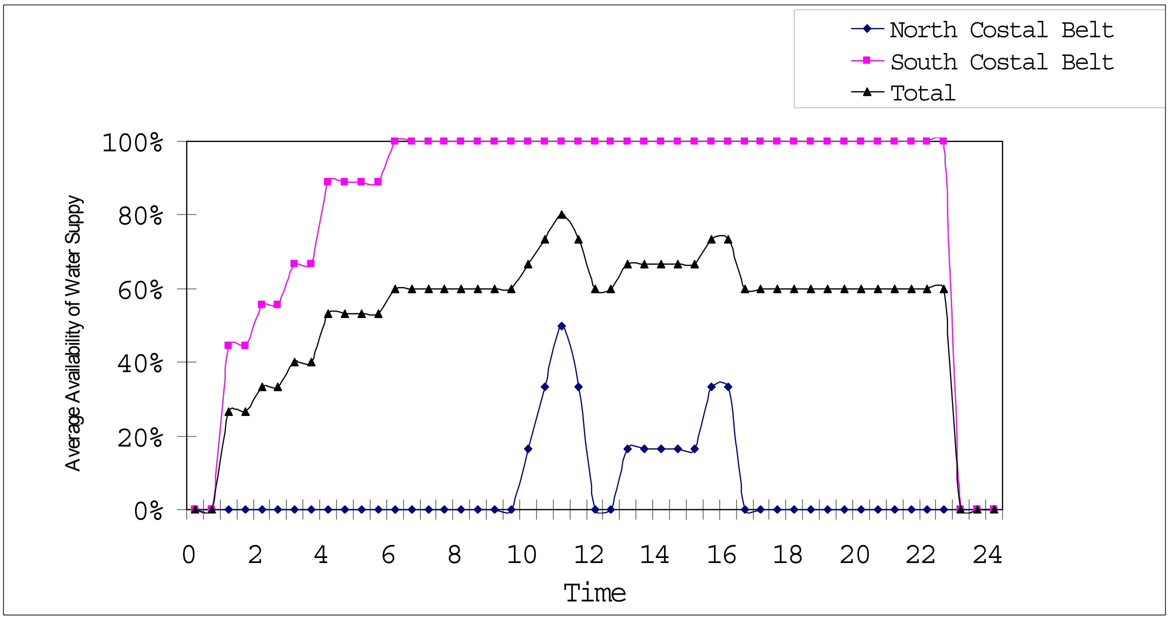


Figure AT.6.1 Average availability of Water Supply

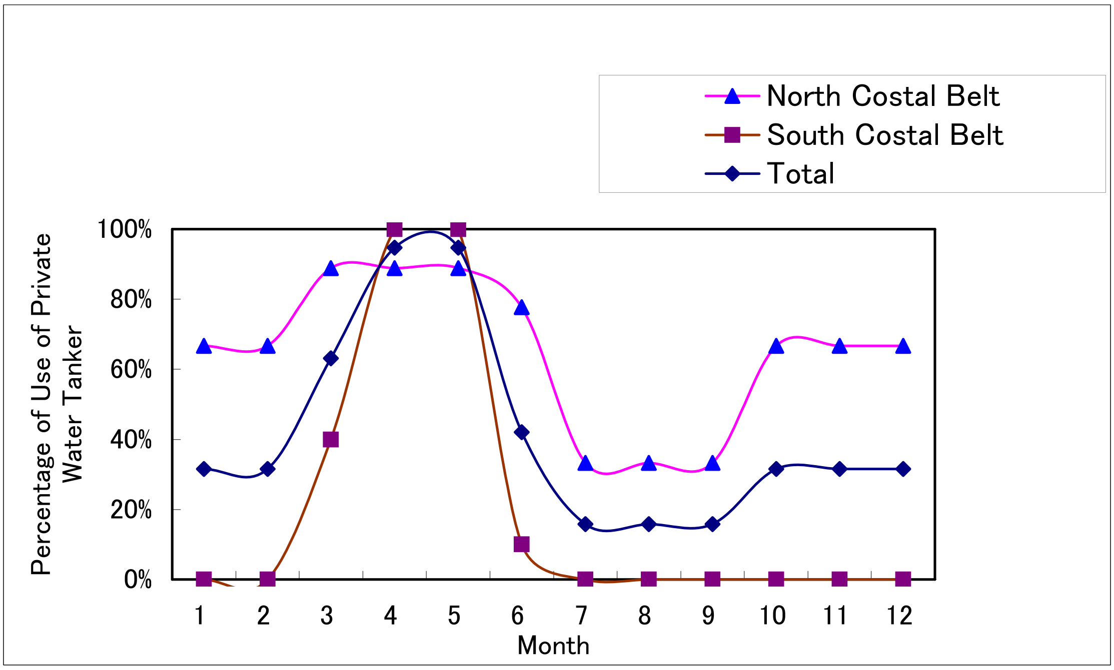


Figure AT.6.2 Percentage of Private Water Tanker Use in Each Month

(2) Awareness and Needs

1) Treatment Facilities for Water and Sewerage

- ✓ Table AT.6.5 shows that 15% of the total hotels does not have any kind of water purification facility.
- ✓ Table AT.6.6 shows that 60% of the costal hotel resorts are having waste water treatment facility.
- ✓ It was also observed that most of the higher grade of hotel resorts spends about Rs. 40,000/- annually on operation and maintenance of the waster water and sludge treatment facilities.

Table AT.6.5 Availability of water purification facility in the hotel

Water Treatment	Hotels
1. Water purification facility available	85%
2. Water purification facility not available	15%

Table AT.6.6 Facility of Waste Water Treatment.

Water Treatment	Hotels
1. STP facility available	60%
2. Not available	40%

2) Water Supply

- ✓ Table AT.6.7 shows that the incentive of offering reduced water charges to encourage the hoteliers for using pipe water supply is of no avail. 90% of the hoteliers would prefer better service quality of the water supplied to them by the PWD.
- ✓ Table AT.6.8 shows that the north costal belt contributes to Rs. 20,940/- per month in high season for the piped water supply services as against Rs. 1,72,000/- in the south costal belt. It also shows that the hotel resorts along the north costal belt are willing to pay Rs. 10,450/- per month for the improvement of water supplied by the PWD to meet the international standards.
- ✓ Table AT.6.9 shows that the average water charge is Rs. 576/- per bed per month during the tourist high season for the piped water supply given by PWD, which infers that 60% of the total volume of water required by the hotels are catered by outside sources other than PWD.

✓ Table AT.6.10 showing the perception on existing water supply infers that none of the hotel resorts in the north costal belt and Mobor are satisfied at the existing water supply hours. The frequency of disruption is 25% for the hotel resorts of south costal belt.

Table AT.6.7 Encouragement to use more piped water supply

Level of Encouragement	%Respondent
1. Less water charge	0%
2. Better service quality	90%
3. Public pipe water not required	10%

Table AT.6.8 Water Charges.

Charges	North Coastal	Center of South Coastal	South End of South Costal	Total Average
1. Average water charges of PWD pipe water per month (Rs.)	20940	172000	197000	129980
2. Willingness to pay for improved water supply (Rs.)	10450	6000	10000	8817

Table AT.6.9 Water Charges per occupied bed in high season

	Hotels (Rs./bed/month)
1. Water charges in high season	576
2. Water charges in low season	338

Table AT.6.10 Perception on Existing Water Supply.

Perception	North Coastal	Center of South Coastal	South End of South Costal	Total Average
1. Satisfaction of existing supply hours	0%	80%	0%	27%
2. Frequency of disruption	23%	25%	20%	23%

3) Sanitation/Sewerage

✓ Table AT.6.11 shows that none of the hotels catering to the majority of tourists in the costal belt of Goa are connected to sewerage system. Most of the hotels have their own

STP or are using the septic tank connected to soak pit for discharging their hotel waster water.

Table AT.6.11 Disposal of Waste Water

Perception	North Coastal	Center of South Coastal	South End of South Costal	Total Average
1. Open drain	0%	0%	0%	0%
2. Sewer	0%	0%	0%	0%
3. Street	0%	0%	0%	0%
4. Field	0%	0%	0%	0%
5. River Stream pond	10%	0%	0%	3%
6. Re-used recycled	60%	40%	80%	60%
7. Septic tank	30%	60%	20%	37%

(3) Willingness to Pay

1) For Improvement of Water Supply

- ✓ Table AT.6.12 strongly indicates that 90% of the hotel resorts in north Goa and 80% of another tourist city Mobor is of the opinion that the improvement of piped water supply is very important.
- ✓ Table AT.6.13 shows that none of the hotel resorts in the costal region of Goa wants reduction in the water tariff. Most of the resorts in the north costal belt have given an opinion that they are ready to pay 22% extra on the water charge for a better and improved water supply system.

Table AT.6.12 Perception on Improvement of Water Supply

Perception	North Coastal	Center of South Coastal	South End of South Costal	Total Average
1. Very important	90%	20%	80%	64%
2. Important	0%	80%	20%	50%
3. Not very important	0%	0%	0%	0%
4. Not important at all	10%	0%	0%	0%

Table AT.6.13 Willingness to pay for improved Piped Water Supply

Willing to Pay	North Coastal	Center of South Coastal	South End of South Costal	Total Average
1. Extra increased percentage of water charge	22%	9%	22%	18%
Reduced percentage of water	0%	0%	0%	0%

2) For Improving Sewerage/Sanitation

- ✓ Table AT.6.14 shows that 100% of the hotel industry around the costal belt feel the importance of the sewer network and are willing to connect to the sewer for disposing the hotel waste water and human waste.
- ✓ Table AT.6.15 shows that the hotels in the north coastal belt are ready to pay approximately Rs.7,500/- for the new sewer connection and a monthly sewerage charge of Rs. 27,000/- was found reasonable by the hotels in the south costal belt.

Table AT.6.14 Perception of Sewerage and Sanitation

Perception	North Coastal	Center of South Coastal	South End of South Costal	Total Average
1. Pollution of rivers and streams	0%	0%	0%	0%
2. Importance of sewer	100%	100%	100%	100%
3. Willingness to connect to sewer	100%	100%	100%	100%

Table AT.6.15 Willingness to spend for new sewer connection

Willingness to pay	North Coastal	Center of South Coastal	South End of South Costal	Total Average
1. Sewer connection cost (Rs.)	7500	16600	10200	11434
2. Sewer monthly charge (Rs.)	7140	27000	18000	17380

Attachment 7 Results of the Stakeholder Interview for Tourists regarding Water Supply and Sanitation/Sewerage

(1) Current Situation

Since Goa is a popular safe tourist destination it is found that the tourism industry is galloping at a very fast rate, the domestic tourists arriving in the state are from almost all the different states of India and foreign tourists are mainly from Europe, USA, South Africa and down under from New Zealand and many other countries. However, the domestic tourists are generally staying for around 3 to 4 days approximately and the foreign tourist for more than a week.

1) Water Supply

- ✓ Table AT.7.1 infers that the tourists both domestic 30% and foreign 50% coming to Goa are not satisfied with the piped water supply provided to them.
- ✓ Table AT.7.2 shows that 30% of both the tourists category are annoyed over the intermittent piped water supply.
- ✓ Table AT.7.3 shows that the level of disappointment shows that is to the tune of 20% almost every day for the domestic tourist who come for a short duration and also 15% a week for the foreign tourist.
- ✓ Foreign tourist was having problem with the quality of water supplied in terms of high turbidity, hardness, standard of water and in some case foul smell. Also one of the major complain was that the pipe water was not up to the standard with respect to their country.

Table AT.7.1 Satisfaction among domestic tourist, foreign tourist and average for water supply

Type of Tourists	Satisfied	Not Satisfied
1. Domestic Tourists	70%	30%
2. Foreign Tourists	50%	50%
3. Average	60%	40%

Table AT.7.2 Annoyed tourist (domestic, foreign, total) in terms of water supply

Category	Domestic Tourist	Foreign Tourist	Average
1. Yes, annoyed over intermittent water supply	30%	30%	30%
2. No, not annoyed over intermittent water supply	70%	70%	70%

Table AT.7.3 Frequency of disappointment regarding water supply

Level of Disappointment	%Respondent		
	Domestic Tourist	Foreign Tourist	Average
1. Every day	20%	0%	10%
2. Almost every day	20%	5%	13%
3. Few times a week	0%	5%	3%
4. Once a week	0%	15%	8%
5. Less than once a week	0%	5%	3%

2) Sewerage and Sanitation

- ✓ Table AT.7.4 shows that a high level of almost 60% of the domestic tourist are not satisfied with the sewerage and sanitation facility available in the state. Also the foreign tourist unhappy about the situation is 30%.
- ✓ Table AT.7.5 shows that 30% to 15% of both the domestic tourists and the foreign tourist are annoyed over the sanitary situation in Goa on daily basis.
- ✓ In case of sanitation the major problems faced by tourists were overflowing of toilet and septic tanks, chambers & manhole being open, flooding of the roads due to bad storm water drainage system, garbage strewn all over at major tourist places as the bins are full.

Table AT.7.4 Satisfaction among domestic tourist foreign tourist and average (separately presented) for Sewerage and Sanitation

Type of Tourists	Satisfied	Not Satisfied
1. Domestic Tourists	40%	60%
2. Foreign Tourists	70%	30%
3. Average	55%	45%

Table AT.7.5 Frequency of disappointment regarding sewerage and sanitation

Level of Disappointment	%Respondent		
	Domestic Tourist	Foreign Tourist	Average
1. Every day	10%	0%	5%
2. Almost every day	20%	15%	18%
3. Few times a week	10%	5%	8%
4. Once a week	0%	5%	3%
5. Less than once a week	0%	5%	3%

(2) Awareness and Needs

- ✓ Table AT.7.6 shows that 90% of the total tourists are of the opinion that there should be considerable improvement of public water supply network.
- ✓ Table AT.7.7 shows that on an average of 98% of the total tourists would prefer improve sewerage and sanitation facilities for the further development of tourist industry in Goa.

Table AT.7.6 Perceptional importance of water supply improvement for tourists

Perception on improvement of water supply	%Respondent		
	Domestic Tourist	Foreign Tourist	Average
1. Very important	40%	55%	48%
2. Important	40%	40%	40%
3. Not very important	20%	5%	12%
4. Not important at all	0%	0%	0%

Table AT.7.7 Perceptional importance of sanitation/sewerage improvement for tourists

Perception on improvement of sanitation	%Respondent		
	Domestic Tourist	Foreign Tourist	Average
1. Very important	50%	75%	63%
2. Important	50%	20%	35%
3. Not very important	0%	0%	0%
4. Not important at all	0%	0%	0%

(3) Willingness to Pay

- ✓ Table AT.7.8 shows that the tourists both domestic and foreign are willing to pay more per night per person for the water supply level in Goa to the international standards.
- ✓ Table AT.7.8 shows that the foreign tourist are ready to pay Rs. 181/- per day per person to facilitate improvement of sanitary situation of restaurants and hotels in Goa.
- ✓ For preserving the water and ecosystem in rivers and costal areas the tourists are willing to pay Rs. 129/- extra per day as a contribution for running and improving the sewerage facilities.

Table AT.7.8 Average willingness to pay for the improvement of water supply standard, sewerage and sanitation situation.

Willingness to pay for each service improvement (Rs.)			
Services	Domestic Tourist	Foreign Tourist	Average
1. Water supply to international standards	36	197	117
2. Significant improved sanitary situation	27	181	104
3. For preserving water by sewerage	18	240	129