

# Calculation of Revenue and Non-Revenue Water in Water Supply System – A Case Study of Chiplun City

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## ABSTRACT

Water Audit is a way to find the Revenue and Non-Revenue Water. A water audit determines the amount of water lost from a water supply system and the cost of this loss to the utility. It will quantify Unaccounted for Water (UFW), Revenue Water (RW) and Non-Revenue Water (NRW). Water audits balance the amount produced with the amount billed and account for the remaining water (loss). Comprehensive audits can give the utility a detailed profile of the water supply system and water users, allowing easier management of resources and improved reliability. It is an important step towards water conservation and, if linked with a leak detection plan, can save the utility a significant amount of money and time.

## Keywords

Revenue Water (RW), Non-Revenue Water (NRW), Unaccounted for Water (UFW)

## 1. INTRODUCTION

Chiplun municipal council is the head quarter of taluka Chiplun in Ratnagiri district of Maharashtra state situated on a west coast of Indian. This region is hilly and town lies in a valley between the Western Ghats on one side and Arabian Sea on the other, linking western coast to the interiors of Maharashtra. The area of Chiplun town is 14.60 Sq. Kms.

The industrial developments are very fast across the town. There are 3 MIDC developed at a distance of 12

to 15 Kms from town. The most of industries around the town are Pharmaceutical and Chemical. Koyana Hydro Electric Power Generation Project is 20 Kms from Chiplun town. Due to neighbouring to this project, there is been always adequate flow of water in Vashishthi river.

## 2. POPULATION FORECASTING OF CHIPLUN

The earlier studies carried for water supply improvements are reviewed and basic information is utilized for analysing existing water supply system for Chiplun municipal council area. Chiplun municipal council has 5 zones and 20 administrative wards. According to the Census report, decade wise population of Chiplun town is depicted in Table 1.

Table 1. Decade wise Population of Chiplun

Decade	Population	Increase in Decade	Growth in % Per Decade
1951	15,847	-	-
1961	17,335	1,488	9%
1971	21,000	3,665	21%
1981	27,240	6,240	29%
1991	34,299	7,059	25%
2001	46,022	11,723	34%
2011	55,034	9012	20%

Projection of population & demand for the preparation of development plan has been worked out by the different conventional methods as given in Development Plan report of Chiplun town. It is meant

for framing the development-plan proposals which shown in Table 2.

**Table 2. Population Forecasting of Chiplun**

Year	Population Forecast Methods		Population (Weighted Avg.)	Water Demand in MLD
	Incremental Increase	Geometrical Increase		
2013	53,867	58,561	57,174	9.08
2028	69,027	84,116	79,625	12.64
2043	88,260	1,20,904	1,11,111	17.65

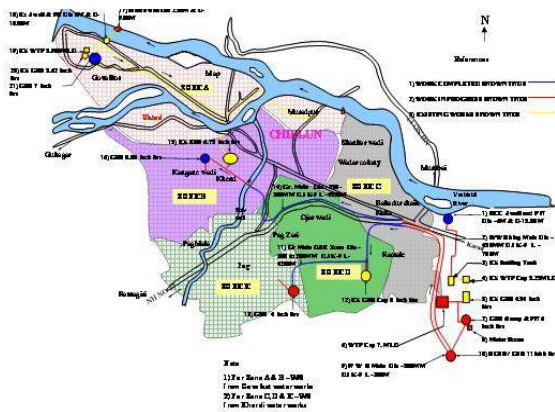
### 3. WATER SUPPLY SYSTEM OF CHIPLUN CITY

Chiplun Municipal Council is having two separate sources for water supply. Water is lifted from two sources, those are given in Table 3.

**Table 3. Sources of Water Supply**

Intake Work	Location	Capacity
Intake Work- 1	Govalkot	5.25MLD
Intake Work - 2	Kherdi	5.25MLD

Present supply zones from both the sources are shown in Figure 1.



**Fig 1: Map Showing Various Zones of Water Supply from Kherdi&Govalkot Source**

### 4. WATER AUDIT

Water Audit to be carried out for existing following system Components

- Raw Water Intake – 10.5 MLD
- Raw Water Rising Main – 300mm dia. mains
- Water Treatment Plant – 15.375 M (WTP at Kherdi is under rehabilitation)
- Gravity Feeder Mains – CI/AC pipelines
- Storages / S&P house – Total Capacity – 4.151 ML
- Pure Water Rising Main – CI mains
- Distribution Network – CI/AC pipelines – 36 KMs

The diameter wise consumer connections in Chiplun municipal council are given in Table 4.

**Table 4. Diameter wise Consumer Connection**

Ward wise Connection Details in CMC Area					
Ward No.	1/2"		3/4"		Total
	Domestic	Com.	Domestic	Com.	
1	198	3	51	1	253
2	99	0	19	0	118
3	257	7	139	22	425
4	295	1	105	0	401
5	781	7	430	29	1247
6	604	3	119	8	734
7	472	31	179	21	703
8	892	6	250	16	1164
Upnagar	708	20	499	48	1275
<b>Total</b>	<b>4306</b>	<b>78</b>	<b>1791</b>	<b>145</b>	<b>6320</b>
Outside CMC	29	0	5	1	35
	4335	78	1796	146	6355

Consumers in Chiplun municipal council area are charged on flat rates per annum irrespective of water consumed by them. Present tariff structure in and outside Chiplun Municipal Limits is given in Table 5 and 6 respectively. Ultrasonic Flow Meters (UFM) were installed at each source and inlet of each water district (present supply zone) to ascertain the total inflow to the system as well as total inflow to each water district.

**Table 5. Present Tariff Structure in Municipal Limits**

Connection Type	Size	12 Months	9 Months	6 Months	3 Months
Residential	1/2"	900	675	450	225
Residential	3/4"	1650	1237	825	412.5
Commercial	1/2"	3000	2250	1500	750
Commercial	3/4"	5000	3750	2500	1250

**Table 6. Present Tariff Structure outside Municipal Limits**

Connection Type	Size	12 Mont hs	9 Mont hs	6 Mont hs	3 Mont hs
Residential	½"	4000	3000	2000	1000
Commercial	¾"	5000	3750	2500	1250

**5. WATER LOSS**

Total losses in various sections for Govalkot and Kheri Sources are as given respectively in Table 7 and 8.

**Table 7. Total losses in various sections for Govalkot Source**

Sr.No.	System Component	Inflow in MLD	Outflow in MLD	Loss in MLD	% loss in each component	% loss wrt to Inflow at source
1	Raw Water Rising Main	7.77	7.67	0.10	1.29%	1.29%
2	Water Treatment Plant	7.67	6.93	0.74	9.65%	9.52%
3	Gravity Feeder Mains	6.93	6.68	0.25	3.61%	3.22%
4	Storage Reservoirs	3.57	3.00	0.57	15.92%	7.31%
5	Pure Water Rising Mains	0.62	0.61	0.02	2.72%	0.22%
6	Distribution Network	6.09	4.63	1.46	23.97%	18.79%
	<b>TOTAL</b>	<b>7.77</b>	<b>4.63</b>	<b>3.14</b>		<b>40.39%</b>

**Table 8. Total losses in various sections for Kheri Source**

Sr.No.	System Component	Inflow in MLD	Outflow in MLD	Loss in MLD	% loss in each component	% loss wrt to Inflow at source
1	Raw Water Rising Main	5.36	5.32	0.04	0.75%	0.75%
2	Water Treatment Plant	5.32	4.95	0.37	6.95%	6.90%
3	Gravity Feeder Mains	4.95	4.37	0.58	11.72%	10.82%
4	Storage Reservoirs	2.94	2.56	0.38	12.93%	7.09%
5	Pure Water Rising Mains	2.57	2.49	0.08	3.11%	1.49%
6	Distribution Network	4.37	3.10	1.27	29.06%	23.69%
	<b>TOTAL</b>	<b>5.36</b>	<b>3.10</b>	<b>2.26</b>		<b>42.16%</b>

Summary of losses from both the Govalkot and Kheri sources are shown in Table 9.

**Table 9. Summary of Losses from Both the Sources**

Sr.No.	System Component	Inflow in MLD	Outflow in MLD	Loss in MLD	% loss in each component	% loss wrt to Inflow at source
1	Raw Water Rising Main	13.13	12.99	0.14	1.07%	1.07%
2	Water Treatment Plant	12.99	11.88	1.11	8.55%	8.45%
3	Gravity Feeder Mains	11.88	11.05	0.83	6.99%	6.32%
4	Storage Reservoirs	6.51	5.56	0.95	14.57%	7.22%
5	Pure Water Rising Mains	3.19	3.10	0.10	3.04%	0.74%

6	Distribution Network	10.47	7.73	2.74	26.13%	20.83%
	<b>TOTAL</b>	<b>13.13</b>	<b>7.73</b>	<b>5.4</b>		<b>41.13%</b>

**6. NINE TASK WATER AUDIT**

Nine Task Water Audit Work Sheet for Calculating System Input, Revenue Water, Non-Revenue Water & Water Losses are as shown in Table 10.

**Table 10. Nine Task Water Audit**

A	B	C	D	E	
System Input Volume  MLD <b>13.13</b> <b>MLD</b>	Authorized Consumption (Billed Authorized Consumption + Unbilled Authorized Consumption) MLD <b>7.73</b> <b>MLD</b> <b>(59%)</b>	Billed Authorized Consumption MLD <b>7.58 MLD</b> <b>(58%)</b>	Billed Metered Consumption (Including water exported) <b>Nil</b>	Revenue Water (Total billed quantity) MLD <b>7.58 MLD</b> <b>(58%)</b>	
			Billed Un-metered Consumption <b>7.58 MLD</b> <b>(58%)</b>		
	Water Losses (System Input Volume - Authorized Consumption)  <b>5.40</b> <b>MLD</b> <b>(41%)</b>	Unbilled Authorized Consumption MLD <b>0.154 MLD</b> <b>(1%)</b>		Unbilled Metered Consumption <b>Nil</b>	Non-Revenue Water (System Input Volume - Total Billed Quantity) <b>5.55 MLD</b> <b>(42%)</b>
				Unbilled Un-metered Consumption <b>0.154 MLD</b> <b>(1%)</b>	
		Apparent Losses MLD <b>0.486 MLD</b> <b>(4%)</b>	Un-authorized Consumption <b>183.773 Cum/Day</b> <b>(6%)</b>		
			Metering Inaccuracies <b>Nil</b>		
Real Losses (Water losses - Apparent losses) MLD <b>4.914 MLD</b> <b>(37%)</b>	Leaks MLD (Transmission /WTP /Feeder/Distribution) <b>3.964 MLD</b> <b>(30%)</b>				
	Burst in MLD <b>Nil</b>				
	Leakages & overflows at Storages <b>0.95 MLD</b> <b>(7%)</b>				

**Total System Input Water - 13.13 MLD (100%)**

**Total Revenue Water - 7.58 MLD (58%)**

**Total Non-Revenue Water - 5.55 MLD (42%)**

**7. SERVICE LEVEL BENCHMARK**

Service level benchmarking for water supply system of Chiplun Municipal Council is given in Table 11.

**Table 11. Service level Benchmarking of Water Supply System**

Sr. No.	Indicator	Unit	Baseline Indicator	Reliability of Measurement	Targeted Indicator	Remark
1	Coverage of water supply connections	%	90%	B	100%	Coverage to be increased to 100%
2	Per Capita Supply of water	lpcd	Gross - 238 Net - 138	A	135	LPCD is OK
3	Extent of metering of water connections	%	0%	A	100%	Need policy for fixing consumer meters

4	Extent of Non-Revenue Water	%	42%	A	20%	Need volumetric tariff structure to reduce NRW
5	Continuity of water supply	Hours/day	1 hour to 8 hours	B	24 Hrs	Need Rehabilitation of network
6	Quality of water supplied	%	93%	A	100%	Need to collect more samples
7	Efficiency in Redressal of Customer Complaints	%	75%	C	80%	Need to form Separate Cell
8	Cost Recovery of Water supply Services	%	75%	B	100%	Need computerized billing system
9	Efficiency in Collection of Charges	%	80%	B	90%	Need Service improvements

## 8. OBSERVATIONS AND RECOMMENDATIONS

Observations and recommendations on existing water supply system of Chiplun Municipal Council are given in Table 12.

**Table 12. Observations and Recommendations on Existing Water Supply System**

Sr.No.	Particulars	Observations	Recommendations
1	RWRM	Old pipeline observed to be leaking at few locations  Air Valve on RWRM are heavily leaking	Replace leaky rising main (RWRM) with DI K-9 or MS pipe  Immediately replace the Air Valve
2	WTP	Various units of WTP such as sedimentation tank, flocculator, filter, sump / GSR are observed to be ok but the piping to all these units observed to be leaking	Rehabilitate piping arrangements of various units of WTP to reduce leakages. Make arrangement for Filter Back Wash Recycle
3	PWGM (Feeder Mains)	Visible leakages were observed during study are informed to CMC	Remove visible leakages and replace AC pipelines
4	Storage Reservoirs	Storages at Khend and kangawadi are leaking heavily	Rehabilitate storages to prevent leakages. Dismantle old masonry storages and construct new RCC storages
5	PWRM	Existing RWRM observed to be leaking at few locations	Replace old leaky pipe with DI K-9 pipe
6	Bulk Meters	There are no bulk meters installed in the entire water supply system. Except at source which is not in order	Fix bulk meters at source, inlet & outlets of WTP, inlet point of each supply zone to measure the flows on daily basis
7	Distribution Network	Old and existing CI/AC pipelines are observed to be leaking at various locations in the city. Visible leakages were removed during study period.  Sluice Valves are old and observed to be leaking	Replace old and leaky pipeline in the network  Replace leaking Sluice Valve
8	Consumer Connections (House Service Connection)	Most of consumer connections are of GI pipes and observed to be leaking due to corrosion Complaints of low pressure due to corroded pipes	Replace all consumer connections (HSC) with MDPE pipes to avoid corrosion and hence leakage
9	Asset Management	There is no updated data on consumer survey and no updation of water supply infrastructure	CMC has carried out GIS mapping of City. CMC should carryout consumer survey and updation of water supply infrastructure and link it to GIS platform for permanent records
10	Billing &	Present recovery v/s billing is very	Introduce computerized billing and recovery

	Recovery	poor	system
11	Continuous Water Supply	Present water is being supplied intermittently i.e few hours in a day (1 hr to 4 hours)	Hydraulic modelling of entire network shall be carried out & design shall be done to supply 24X7 water supply to all consumer of CMC at equitable pressure
12	Water Quality monitoring	7% sample observed to be failed	Sampling shall be increased and efforts shall be made to have 100% satisfied quality parameters
13	Electro-Mechanical Works	Detailed Energy Audit is carried out all pumping stations & WTP	Recommendations are submitted in Separate report

Chiplun Municipal Council should approach to Hon State Government to carryout reform works such as Consumer Survey, GIS mapping, Fixing of Bulk Meters, Leak Detection and Repairs, House Service Connections, Computerized billing and recovery system, Hydraulic Modelling Software's, Computers etc. These works are being funded by Hon. State Government under SujalNirmalAbhiyan.

### 9. ANALYSIS OF AUDIT RESULT

- Identify recoverable losses
  - Estimate the value of recoverable losses
  - Estimate the cost of recovering losses and corrective measures
  - Prepare the cost benefit Analysis
  - Prepare Action Plan for implementation
  - Monitor the result
  - Update the audit
  - Update the master plan
- And it's a continues process.

### 10. BENEFIT OF WATER AUDIT

- Reduced water losses
- Financial Improvement
- Increased knowledge of distribution system
- More efficient use of existing supply
- Safe guarding public health to safety
- Improved public relation
- Reduced legal liability
- Provides the yard stick for performance of O & M team.

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