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ANALYSIS OF WATER DISTRIBUTION SYSTEM FOR EVALUATION OF WATER LOSS CASE STUDY- AHMEDNAGAR CITY

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ABSTRACT

The water supplies through municipal corporations in urban area of Maharashtra are faced more challenges of water loss and less efficiency of water supply. Water distribution network is in complex nature to understand and also in managing these losses. To evaluate these losses and improve efficiency of water distribution network, various methods and tools have been developed over the year according to suitability but their application to real world water distribution system has been found to be generally limited. The water balance table developed by IWA/AWWA is used to identify the point of entry and exit of water throughout the distribution system for analysis water loss. But the main problem to evaluate water loss is meters were not installed at consumer end without which evaluation is not possible. This paper review a method developed for measuring water loss in distribution pipe network using the population and water consumption data. Ahmednagar city water distribution system was selected for study. Random field survey was used to execute proposed methodology and consist of actual field measurement and physical inspection. Personal interview for daily consumption is used to evaluate water quantity. The collected data will be used to analysis water loss in the city.

Keywords: *Water losses, efficiency of water distribution network, field survey*

I. INTRODUCTION

Water deficiency has been prime concern at the moment as water is that the main supply of resource. As we tend to all recognize ninety seven in serious trouble on the world is salt water and solely three which there's water. Over past a hundred years, the consumption of fresh water has inflated by quite five hundred the troubles leading to water deficiency. it's calculable that by 2025 2 third of population can board water stressed areas.

The Ahmednagar water distribution system was taken for pilot study to execute water loss analysis. It was built decades ago and is currently in need of analysis. The Ahmednagar Municipal Corporation is not only expecting to supply safe drinking water at low cost but also address current demand of city. As raw water resource is far away from city 35 km, the available water management and distribution is more important. The AMC also suffer the effect of climate change, increasing regulatory repair and limited resource and funding.

The available infrastructure and resources was not fulfilling the current water demand of Ahmednagar city mainly due to high water loss or unaccounted water. Water losses in distribution pipe network occur in various elements but their quantity varies and broadly depends on the physical characteristics of pipe network, operation and maintenance of system, level of technology used by experts to evaluate and control losses.

Evaluating and quantifying water loss is very important need if considering present water coverage in Ahmednagar city. Quantity of water losses are subjected to variation and complex work to evaluate and quantify. In order to evaluate water loss at city level and in various zones actual daily consumption and onsite discharge measurement at consumer end is used. The evaluation of water loss and reducing water loss and leakage is an attractive solution for minimizing revenue loss.

II. LITERATURE REVIEW

According to World Bank study about 48 billion cubic meters of water is lost annually from water distribution system, costing water utilities approximately US 14 billion per year around the world (kingdom el at 2006). The quantity of water loss or non revenue water is a measure of the operational efficiency of a water distribution system (wallance 1987), and high level of NRW are indicative of poor governance (McIntosh 2003) and poor physical condition of the water distribution system (Male et ai. 1985).

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Magnitude of water loss is greatly varies from city to city or from one area to another. Water loss is a problem experienced in all water distribution systems. The first and foremost cause of water loss is leakage. Water put to inappropriate or excessive uses may also be considered as loss. Water that is unaccounted for because of measurement errors, including inaccurate meters, forgotten users, and unmeasured uses, are also some of the causes for water losses. Unaccounted for water is one of the commonly used methods for evaluating the water loss that is usually defined differently by different writers.

There is no universally applied or accepted definition of unaccounted for water as Unaccounted for water is the difference between the water supplied to a distribution system and water that leaves the system through its intended use (Richard G. et al. 2000)

The amount of water lost in a distribution system can be quantified by conducting a water balance. There are two main water balance methodologies used for quantifying the volume of water losses:

[A] The IWA/AWWA standardizes water balance methodology (Alegre et al. 2006; AWWA 2009).

[B] The UK water balance methodology (Farley and Trow 2003; Lambert 1994). These water balance methodologies evolved from earlier works in the United States by Male et al. 1985 and the water Research Foundation (Wallance 1987).

The water balance is an effective tool for systematic accounting of water supply and consumption. The United Kingdom water balance differs from the IWA/AWWA methodology mainly in terminology used, for example, the term “apparent losses” is not used in the UK methodology, which focuses mainly on leakage computation. In addition, the UK methodology consider meter under registration as part of revenue water, thereby under declaring NRW (Mutikanga et al. 2011).

Although water loss occurs in all distribution system, in many water networks losses are even larger than 30 to 40 %, attributable to aging, deterioration of system components such as pipes and valves and incorrect management.(Nicola Fontana 2012).

Evaluations of water losses based on two major components of uncontrolled water in water distribution network are physical losses in mains and service connections and the volume of water consumed. (By Almandoz al 2005) The literature review was focusing on the water losses in a distribution system, cause of water losses, the consequence of water loss, methods of evaluating water loss, etc.

III. METHODOLOGY

As the Ahmednagar water distribution system were in working since 70’s the existing pipe network data were not available with the authority. For execution, it is necessary to generate primary data through field survey. Checklist was prepared to collect data in systematic format. The checklist consists of two kinds of information namely, Preliminary and Observations & Measurements. The treated water flow at consumer end was measured using simple 5 liter capacity of drum. The time required to fill the drum was measured and the rate of flow was calculated in liters/min. considering total time of water supply, volume of water received at consumer end was calculated. In this paper a key resource used to evaluate water loss is water balance method which was developed by Standard Component of Water Balance for Transmission or Distribution System (IWA 2001).

Table 1 Water balance table

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System Input Volume	Authorized Consumption	Billed Authorized Consumption	Billed Metered Consumption	Revenue Water
			Billed Unmetered Consumption	
		Unbilled Authorized Consumption	Unbilled Metered Consumption	Non Revenue Water
			Unbilled Unmetered Consumption	
	Water Losses	Apparent Losses	Unauthorized Consumption	
			Metering Inaccuracies	
		Real Losses	Leakage on Transmission and or Distribution Mains	
			Leakage and Overflow at Utility Storage Tank	
			Leakage on Service Connections up to Point of Customer Metering	

Survey

Random field survey was used to collect data. Six samples were collected in each zone to provide a practical means of enabling the data collection and processing components of research to be carried out. The six samples were collected in six zones in month of October 2014. The samples were labeled namely, A, B, C, D, E, F. The location of sample was decided where the entire family used treated tap water supplied from the Ahmednagar Municipal Corporation and there is no alternate source of water. The location was selected random with reference to the source of supply from reservoirs

IV. DATA COLLECTION

The collected data were tabulated in systematic format with all necessary calculation.

Table 2 Samples collected in October month

Sr. No.	Zone No.	Samples	Discharge (Liter/Min)	Duration of Supply (Min)	Quantity of water (Liters)	Frequency in (Days)	Water at consumer end (Liters)	No. of users	Water use (Lcpd)
1	Zone-I	A	27	35	948	2	474l	4	119
2		B	22	75	1631	2	8 16	7	117
3		C	35	47	1668	2	834	6	139
4		D	23	60	1352	2	676	5	135
5		E	40	55	2205	2	1102	8	138
6		F	46	47	2146	2	1073	8	134
7	Zone-II	A	37	35	1292	2	646	7	92
8		B	18	65	1187	3	396	4	99
9		C	22	37	796	2	398	4	100
10		D	25	35	890	2	445	5	89
11		E	21	44	933	2	467	5	93
12		F	22	31	671	2	336	4	84
13	Zone-III	A	21	55	1160	2	580	5	116
14		B	23	69	1579	2	790	8	99
15		C	21	87	1850	3	617	6	103
16		D	22	38	853	2	426	4	107
17		E	33	36	1193	2	597	5	119

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18		F	23	68	1533	2	767	7	110
19	Zone-IV	A	24	40	967	2	484	6	81
20		B	28	46	1273	2	636	7	91
21		C	21	48	1015	2	508	6	85
22		D	32	30	968	2	484	5	97
23		E	20	61	1211	3	404	4	101
24		F	29	39	1142	2	571	8	71
25	Zone-V	A	22	35	761	2	381	5	76
26		B	23	30	683	2	342	5	68
27		C	20	60	1202	3	401	6	67
28		D	19	35	654	2	327	5	65
29		E	16	39	613	2	306	4	77
30		F	14	57	808	2	404	5	81
31	Zone-VI	A	14	68	970	2	485	6	81
32		B	34	47	1595	2	798	8	100
33		C	19	55	1042	2	521	6	87
34		D	18	68	1206	3	402	4	101
35		E	20	69	1397	2	699	7	100
36		F	13	57	728	3	243	3	81

V. RESULT & DISCUSSION

The collected data samples were analyse using the parameters like rate of discharge, duration of supply per capita consumption and demand & supply difference.

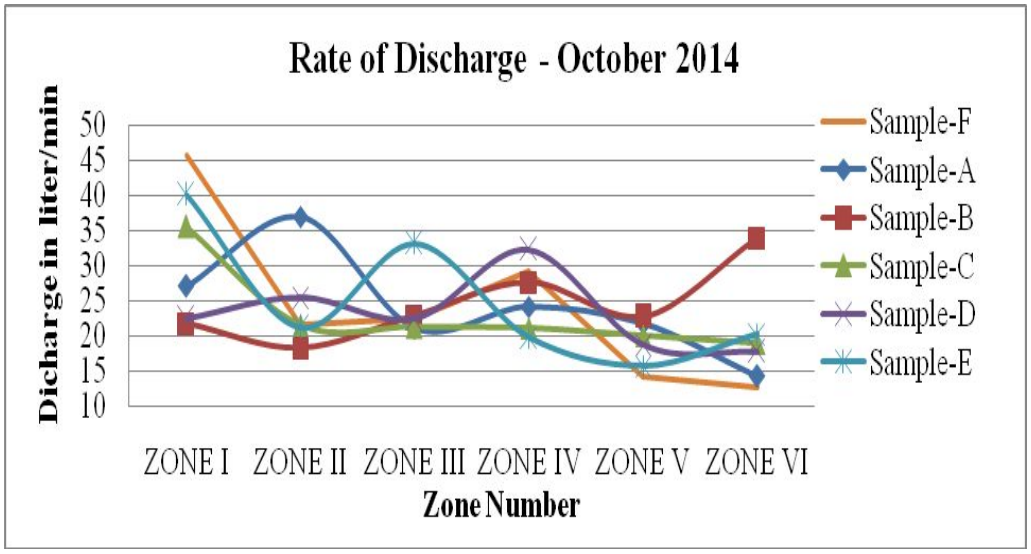

Figure 1 Showing graphical representation of rate of discharge

In the month of October at sample station F in Zone-I found highest rate more than 45 liters/ min. The lowest rate of discharge at consumer end was observed at sample station F in Zone VI, sample station E in Zone VI and sample station D in Zone VI. The highest variation of rate of discharge was observed in Zone I. The rate of discharge was found considerable constant in the range of 20 to 25 liters/ minute in Zone III. From the above discussion we can conclude that the rate of discharge in the city varies from place to place. Low rate shows high pressure head loss in the distribution pipe network.

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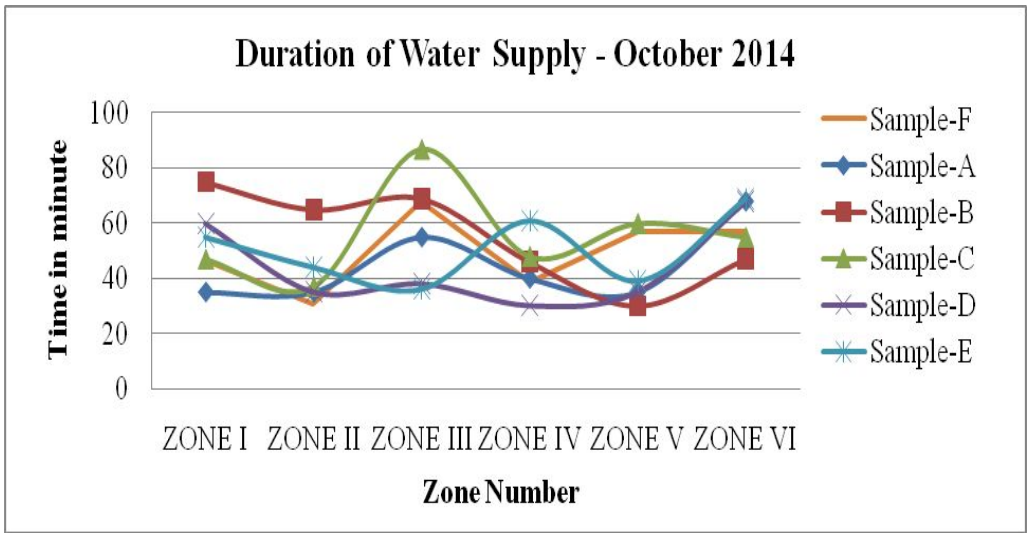

Figure 2 Showing graphical representation of duration of water supply

The highest duration of supply water supply in the city was obsereved 85 minutes in Zone III at sample station C. The lowest duration of water supply in the city were obsereved in Zone II at sample station F and in Zone V at sample staion B 25 minutes. The moderate rate of duration of supply were obsereved in Zone V. from the above disscisiion we can conclude that, the duration of water supply in the entire city found very low as compared with the developing cities in India. This may not sufficient to fulfill current demand of the city.

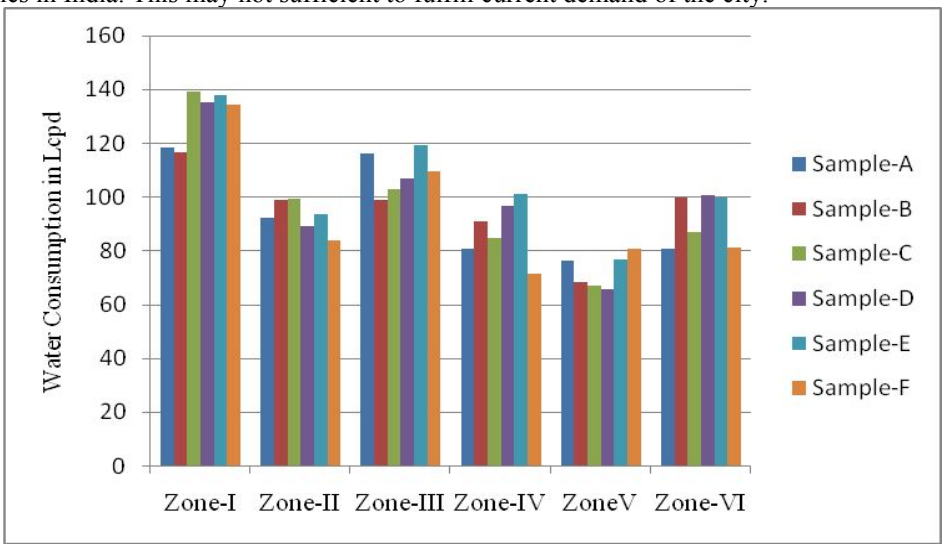

Figure 3 Showing graphical representation of actual maximum daily consumption of water in each zone

From the analisis of random field survey great variation was observed among the consumption data of the samples located in newly developed area in Zone I and old city area in all of the rest Zones. The highest rate of consumption was found in Zone I (139 lcpd) while the lower consumption was found in Zone V (65lcpd).

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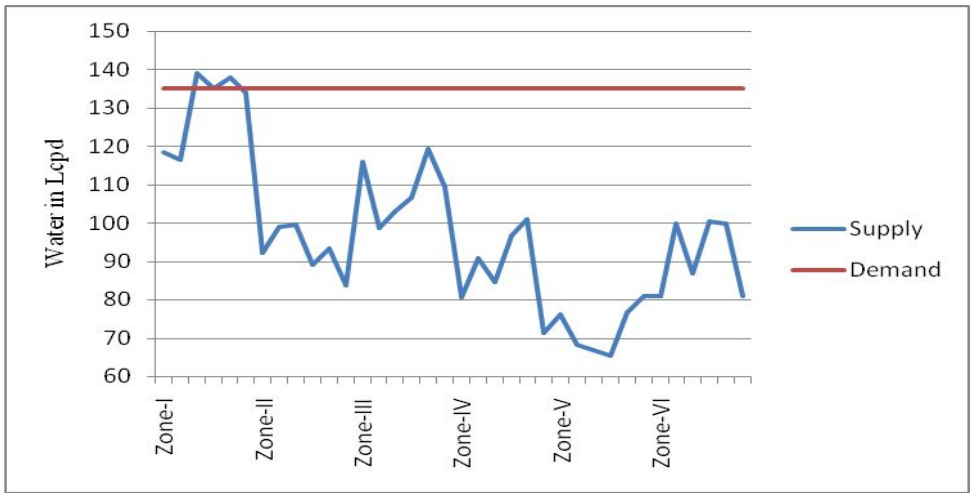

Figure 4 Showing graphical representation of demand and supply difference

The supply rate were found equal or more than demand in Zone I at sample station C, D, E. the highest difference were observed in Zone V where supply rate were in the range of 65 lcpd to 80 lcpd. There were considerable difference in demand and supply was observed among all six Zones. From the above analysis we can conclude that the available treated water was not reached to consumer in full volume due to high water loss in distribution pipe network.

Water Loss

The water loss in each zone was calculated using the actual average daily consumption of water and population data. The volumes of water supplied through reservoirs were compared with the actual consumption. Water loss is expressed in terms of percentage of net volume of water production and calculated using the following equation

$$\text{Total Water loss} = \frac{(\text{Total water production} - \text{total water consumption}) \times 100}{\text{Total water production}}$$

Table 3 Water losses in each zone

Zone	Population	Daily water consumption in lcpd	Outflow in MLD	Inflow in MLD	Water Loss in MLD	Water Loss in percentage
1	27491	130	3.57	4.5	0.93	20.58
2	28583	93	2.66	4.5	1.84	40.93
3	25322	109	2.76	4.5	1.74	38.66
4	29394	88	2.59	4.5	1.91	42.52
5	9494	72	0.68	1.0	0.32	31.64
6	8594	91	0.78	1.0	0.22	21.79
Total			13.04	20.0	6.96	Average= **34.78%**

The average water loss found in six Zones was 34.78 % from the above calculation. The highest water loss was observed in Zone IV (42.52%) where lowest water loss was observed in Zone I (20.58%). The red colors used to show highest water loss, yellow showing moderate water loss and green color shows low water loss compared to other Zones.

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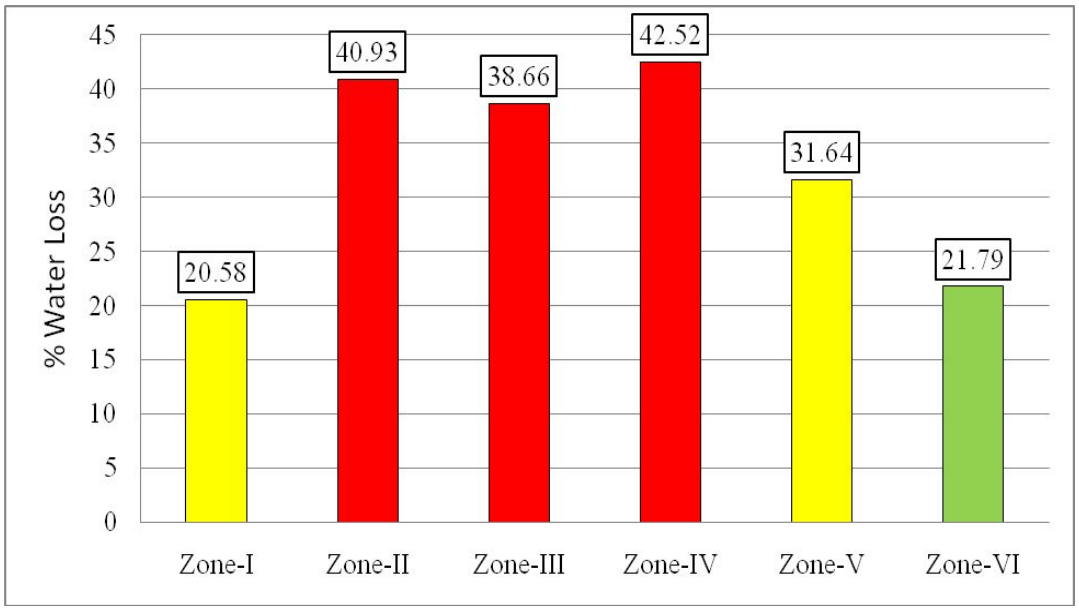

Figure 5 Showing graphical representation percentage water loss in six zones

The average water production and distribution to the system in a month of October 2014 was recorded 65 MLD and the average total water loss as derived using the above expression for six Zones was 34.78% which accounts to 22.6 MLD. The average water consumption rate at city level was found 42.4 MLD showing in figure 6.

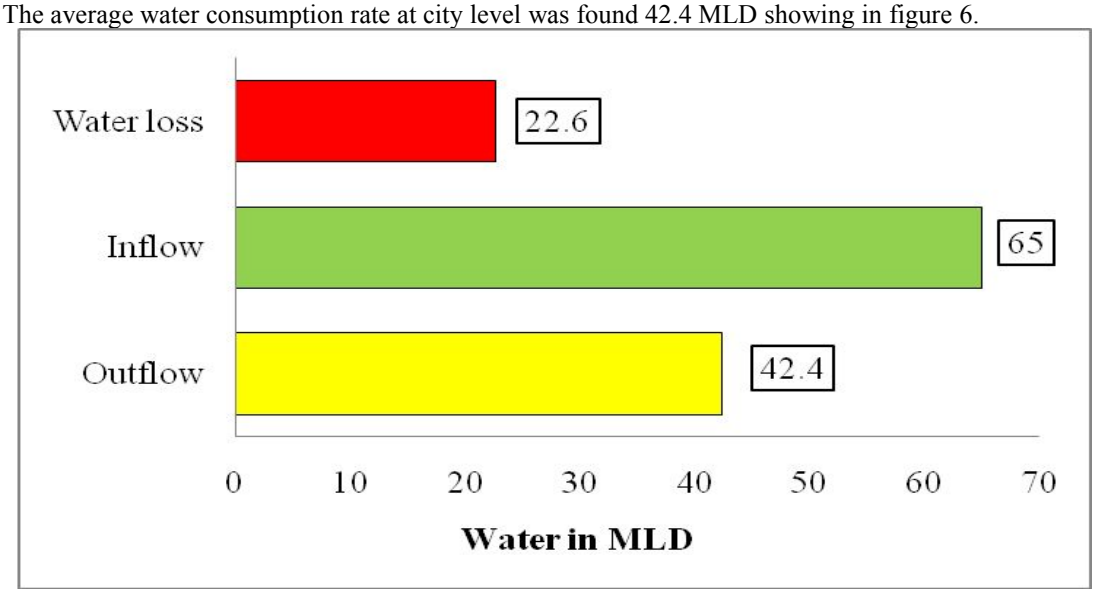

Figure 6 Showing graphical representation total water loss in MLD at city level

VI. CONCLUSION

Measuring and evaluating water loss needs a detail knowledge attributable to its complicated nature. The average water loss was founded 34.78% at city level which is more than standard set by AWWA and need to take action to reduce it by making strategies as per local condition. Water loss are often calculated with the accessible knowledge and field survey knowledge victimization higher than methodology however from the standard of accessible knowledge this conclusion may solely be taken as suggestive findings to be a base for any study.

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