Volume-4, Issue-5, October-2014, ISSN No.: 2250-0758
International Journal of Engineering and Management Research
Available at: www.ijemr.net
Page Number: 156-159

Water Loss Identification in Water Distribution System

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ABSTRACT

Water distribution systems word wide is facing challenges of water and revenue losses. The rapidly growing demand of drinking water has due to increasing global change pressure such as urbanization, climate change, population growth, fluctuation of nature. There is a high probability of further reducing in the available water resource in the future, also high rate of infrastructure deterioration which will result in great loss of treated energized drinking water.

Identification of water losses can help to identify and reduce actual water losses, eliminate the need for facility to expand resources on costly repairs also protect public health from disease causing pathogens through reduction in potential entry points. This paper review identification of water losses in water distribution system. The aim is to identify major causes of water losses in water distribution system and quantifies these losses in terms of ratings. The methodology for this work was the response from expert and persons involved in public water distribution system. This review could be valuable reference resource for researcher dealing with water loss management in water distribution system.

Keywords--- Water distribution system, Water loss identification.

I. INTRODUCTION

Safe drinking water is a necessity for life. Drinking water distribution system is facing more challenges and obstacles today. The infrastructure of many water distribution systems were built decades ago and are currently in need of attention. Water distribution systems are not only expect to produce safe drinking water at low cost but meet also address rapidly growing demand, limited water availability, climate change, increasing regulatory repair and limited resource and funding.

Potable water demand is increasing significantly, but the available resources are limited and diminishing. Water loss occurs in all water distribution system but the quantity of loss varies and broadly depends on the physical characteristics of pipe network, operation and maintenance of system, level of technology used by experts to control losses.

Reducing and controlling water losses is very important issue if considering rapidly growing demand and water resource subjected to fluctuations nature and it is beyond human control. In order to preserve valuable water resource many water distribution agencies developed new strategies to minimize losses to an economic and acceptable level.

The overall water demand consists of residential, commercial, industrial, public water use and unaccounted system loss and leakage. All components generate revenue to water utility except unaccounted water loss and leakage which are source of wasted production cost. The expense of detecting and reducing water loss and leakage is an attractive solution for minimizing operating cost.

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). 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 issues related to the water distribution system and losses of water in a distribution system, cause of water losses, the consequence of water loss, methods of evaluating water loss, etc

III. METHODOLOGY

Identification of water loss in water distribution system is critical. In this paper a key resource used to identify water loss is water balance method which was developed by Standard Component of Water Balance for Transmission or Distribution System (IWA 2001). In this methodology all water that enters and leaves the distribution system can be classified as belonging to one of the categories in the water balance table shown in table 1. The table is balance because it accounts for all of the water in the distribution system and the sum of any of the columns should also total the system input volume.

Table 1: Water Balance Table

<table>
<tr><td rowspan="8">System Input Volume</td><td rowspan="3">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled Metered Consumption</td><td rowspan="6">Non Revenue Water</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="5">Water Losses</td><td rowspan="2">Apparent Losses</td><td>Unauthorized 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 Overflow at Utility Storage Tank</td></tr>
<tr><td>Leakage on Service Connections up to Point of Customer Metering</td></tr>
</table>

It is important to distinguish between water loss and water leakage. Water loss is a total loss and equals the real losses and apparent losses from network. The real losses are physical losses and comprise leakage from pipe, joints and fittings, leakage through service reservoir floors and walls as well as from reservoir overflows.

The quantity of the water loss depends mainly on the network characteristic such as length of mains, number of service connection, length and material of supply pipe, the nature of soil and infrastructure condition & operating parameter like pressure and leakage detection and repair policies that are speed of detection location & repair. All losses in water distribution system not only consist of real and apparent losses but also over use or misuse of water.

Survey has been conducted through experts to identified and quantify priorities of losses for further investigation. Questionnaires have been prepared which consist of major losses short listed by reviewing literature and send to experts to identify the priority of major losses. This questionnaire has been send to 40 experts working in following area.

{1} Technical authority of Municipal Corporation
{2} Environmental Engineer
{3} Academic experts
{4} other associated peoples

Following losses has to be mainly occurs at different component parts of water distribution system

- Unauthorized consumption
- Metering inaccuracy
- Leakage on transmission or distribution mains
- Leakage and overflow at utility storage tank
- Leakage on service connections up to point of customer end
- Others

The above shortlisted losses are generated on the basis of **Standard Component of Water Balance for Transmission or Distribution System (IWA 2001).**

Survey

Rating of losses in degree of occurrence, So as to achieve the reliable results from the survey the five degree rating system has been adopted in which losses are rated varying from "Not exist "to "Major losses" in degree of occurrence ranging "1 to 5".

Table 2: Rating Terms

Rating	Losses Occurrence
1	Not exist
2	Negligible
3	Minor
4	Moderate
5	Major

IV. DATA COLLECTION

For the data collection we have shortlisted 11 causes through losses takes place and questionnaire is prepared for the same to which respondent had to reply. Questionnaire has been sent to 40 respondents from industry and academic, who are associated with water distribution system.

V. ANALYSIS OF DATA

Data collection from respondents was examined and tabulated in the proper format as showing in following table. For each type of losses score was calculate considering rating given by respondent and number of respondent. According to that scoring rank is given to each loss.

Table 3: Calculation of Losses

Sr. No.	Losses occurrence	Not exist	Negligible	Minor	Moderate	Major	Score
	Score	1	2	3	4	5	Total
1	Unauthorized Connections	0	0	0	5	35	195
2	Meter	23	13	4	0	0	61
3	Water main	0	0	8	14	18	170
4	Storage reservoir leakage	36	4	0	0	0	44
5	Storage reservoir Overflow	37	3	0	0	0	43
6	Water service line	0	0	7	14	19	172
7	Valve	6	29	5	0	0	73
8	Pipe Fittings	10	26	4	0	0	64
9	Fire hydrant	22	13	5	0	0	63
10	Age of pipe	26	14	0	0	0	54
11	Pressure/head variation	21	15	4	0	0	63

Graphical Representation

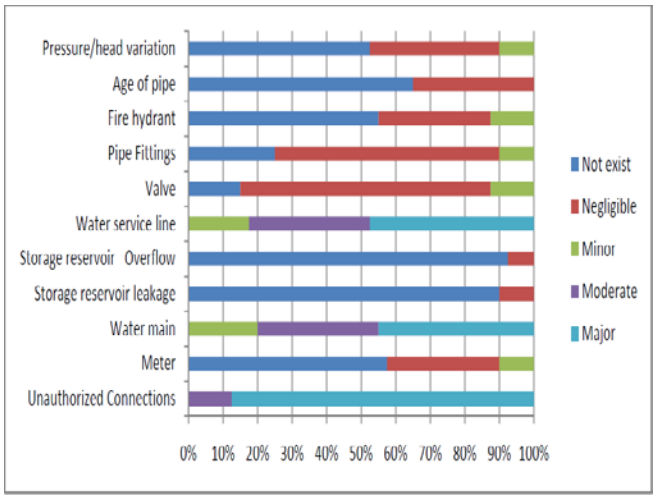

Figure 1: A graph shows quantitative analysis of water loss in water distribution system.

Table 4: Impact Score of Water Losses

Sr. No	Water Losses	Impact Score
1	Unauthorized Connections	195
2	Water service line	172
3	Water main	170
4	Valve	73
5	Pipe Fittings	64
6	Fire hydrant	63
7	Pressure/head variation	63
8	Meter	61
9	Age of pipe	54
10	Storage reservoir leakage	44
11	Storage reservoir Overflow	43

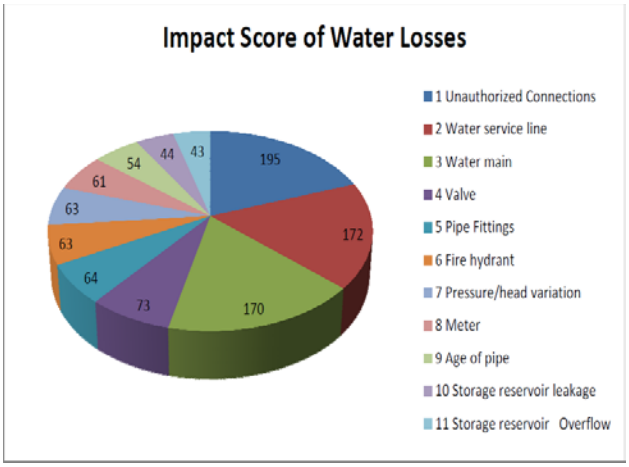

Figure 2: Showing impact value of each type of water loss occurrence in water distribution system.

Table 5: Water Loss Priorities

Rank	Water Losses
1	Unauthorized Connections
2	Water service line
3	Water main
4	Valve
5	Pipe fittings
6	Fire hydrant
7	Pressure/head variation
8	Meter
9	Age of pipe
10	Storage reservoir leakage
11	Storage reservoir overflow

VI. CONCLUSION

From the above study all the possible losses occurring in water distribution systems are shortlisted. It has been observed that water losses use to occur at different component parts of system. According to rank we can decide the priorities to execute water loss control program. It is recommended to further evaluate these losses.

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