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Assessment of the Cost Implication of Water Leakages from Pipes in some selected Locations of University of Maiduguri, Maiduguri, Nigeria

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Abstract
A study was conducted to estimate the quantity of water that is lost through leakages due to faulty/malfunctioning fittings and appliances in some selected locations within the campus, with a view to determining its cost implication. Measuring containers and stopwatch were used to determine the volume as well as flow rates at each point of leakage. The supply was monitored over a period of seven (7) days at scheduled intervals of 3 hours. Based on this, a probable supply of twelve (12) hours daily was established. The volume of leakages was measured at 9-11 AM, 2-4 PM, and 7-9 PM at each point of the study area. Average volume of leakage in each location was established. The total volume of leakage was estimated to be 12, 942.72 liters daily, which represents about 0.647% of the 75% of water supplied from water treatment plant to the campus. The cost of leakage was estimated to be ₦11, 648.45 per month. Bearing in mind that these figures were obtained only from five selected areas, the volume of leakage and its cost implication would be better appreciated if all locations of leakage were considered. The problem of these leakages can be minimized by selection of high quality fitting and appliances, and through proper maintenance of the water supply installations.

Keywords: Water loss, Flow Rate, Leakages, Volume, Cost.

1.0 Introduction

Water is an essential natural resource for human existence. Despite the abundance of this resource on earth, only a limited percentage is useable in terms of meeting human needs i.e. household use (cooking, drinking, sanitation, etc), agriculture and industrial processes. The supply of adequate and good quality water, particularly on a large-scale is a capital-intensive venture. Huge costs were spent to construct reservoirs, complex treatment plants, and extensive distribution networks. Maintenance and running costs of water supply system also require huge financial expenditure. In most water supply systems, a large percentage is lost in transit from treatment plant to consumers (WHO, 2001). Leakage may constitute a high proportion of water losses especially if they are not discovered or controlled in good time. Beside loss of useful quantity of water and waste of money, leakage leads to additional economic loss in the form of damage to pipe network causing contamination, erosion of pipe bedding, damage to the foundation of roads and buildings. Gathering, converting and distribution of safe drinking water is a serious challenge in Nigeria and some other developing nations, these constraints occurred as water is lost due to leakages in conveyance pipeline, wastages, theft, improper billing and metering systems (May,1994).

It is important to distinguish between total water loss (sometimes referred to as 'Unaccounted-for Water' (UFW) and leakage. Total water loss describes the difference between the amount of water produced and the amount which is billed or consumed.

Leakage is one of the components of the total water lost in a network, and comprises the physical losses from pipes, joints and fittings, and also from overflowing service reservoirs. These losses can be severe, and may be undetected for months or even years. The larger losses are usually from burst pipes, or from the sudden rupture of a joint, whereas smaller losses are from leaking or weeping joints, fittings, service pipes, and connections. This in turn depends on whether the soil type allows water to be visible at the surface. Unaccounted for water (UFW) 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. In general, unaccounted-for water (UFW) is the difference between the water supplied to a distribution system and the water that leaves the system through its intended use (Muazu, 2005).

Two broad types of losses were identified by the International Water Association, i.e. Apparent and Real Losses (AWWA, 2007). Apparent losses include unauthorized consumption, customer metering errors and data handling errors. Real losses include leakages on transmission and distribution mains, leakages and overflow at utility's storage tanks, and other form of leakages within the distribution network. The major causes of real water losses include: poor network design, construction and quality control; aging pipe network; and leakage at connections, joints, valves and fittings and from broken mains (WHO, 2001). The amount of water losses will depend largely on the pressure in the system and on the 'awareness' time, i.e. how quickly the loss is noticed and dealt with (Stenberg, 1982). The volume of waste also depends on the leakage detection and repair policy of the water supply Authority.

This study seeks to estimate the quantity of water that is lost through leakages due to faulty/malfunctioning distribution networks and some appliances in some selected locations of the campus.

2.0 Materials and Methods

2.1 Study Area

University of Maiduguri (UNIMAID) was established by the Federal Government of Nigeria in 1975. It was situated on the outskirts of Maiduguri along Bama road. Maiduguri city in Borno state is located on the Sahel savannah region of North-east Nigeria at latitude 11^{o}05' North and longitude 13^{o}05' East and at about 350m above sea level. Maiduguri has mean annual rainfall and temperature of about 630mm and 32^{o}C respectively (Inuwa, 2016).

The materials used for this study are a Stop watch, 1 liter measuring cylinder, 10-liter bucket, 1.5-liter Cup, Excavating equipment (shovel, digger etc.), Hand gloves, Boot.

2.2 Methods

Water supply in the campus experiences frequent interruptions. This made it necessary to first establish the duration of supply in order to make a reasonable estimate of the leakages. However, the water supply was observed to be not continuous. The study was conducted

through a field reconnaissance survey on the campus. The various points and locations of leakage were identified through a preliminary inspection of the water distribution network. Some sanitary conveniences were selected for the study due to the large number of leakage points observed.

A number of leakage points were identified in some selected locations and only five points were taken for this study as presented in Table 1. Scheduled visit of these locations was conducted at intervals of three hours; 9-11 AM, 2-4 PM and 7-9 PM (i.e. three times in a day for each point), and lasted for 25 days. Based on this, probable supply duration of 12 hours daily was established. The measuring containers were used to quantify the volume of water that is lost through leakages. A stopwatch was used to record the time over which a given volume of water is lost. Flow rates (liters per second) were estimated for each leakage point. Five set of readings were taken for each point, and an average of the five readings was considered as flow rate at that point. This is because of variation in water pressure between night and day time. The estimated daily volume of leakages was obtained by multiplying the average flow rate by the estimated daily hours of supplies (12 hours).

Table 1: Locations selected for the study

S/N	Location Code	Location
1	0101	Department of Civil and Water Resource Engineering (CWE) Female Toilet
2	0102	Department of Civil and Water Resource Engineering (CWE) Male Toilet
3	0103	service tap at Ibrahim Imam Hall Block D3
4	0104	service tap at Ibrahim Imam Hall Block D4
5	0105	service tap at Ibrahim Imam Hall Block D5

3.0 Results and Discussion

Total Estimated Volume of Leakages

Table 2 shows a total flow rate of 0.2996lit/sec and the total estimated volume of water lost through leakages was 12,942.72 liters for the period of study.

Table 2: Total Flow Rates and Volume of Leakages in various Locations

Location Code	Flow Rate for all Points of Leakage (ltrs/sec)	Estimated Daily Volume of Water Lost (ltrs)
0101	0.0005	21.6
0102	0.0002	8.64
0103	0.1235	5335.2
0104	0.0042	181.44
0105	0.1712	7395.84
Total	0.2996	12,942.72

Estimated Cost of Leakages

The costs of daily/monthly leakages in the locations and the total cost of these leakages based on ₦0.030/ltr supply cost were shown in Table 3.

Table 3: Estimated Costs of Leakages

Location	Daily Volume of Leakages (ltrs)	Daily Cost of Leakages (₦)	Monthly Cost of Leakages (₦)
0101	21.60	0.6480	19.440
0102	8.64	0.2592	7.776
0103	5335.20	160.0560	4,801.68
0104	181.44	5.4432	163.296
0105	7395.84	221.8752	6,656.26
Total	12,942.72	378.28	11,648.45

The total daily estimated cost of water loss amount to ₦ 378.28 and the total monthly estimated cost was ₦11, 648.45. The survey revealed that about 95% of the water leakages occur due to faulty taps and pipe leaked. Market survey indicated that the costs of these fittings are between ₦500.00 to ₦900.00. Based on the above, it is established that all the malfunctioning fittings can be replaced at the cost of about ₦ 3,494.54, which is less than 35% of the estimated monthly cost of water leakages.

4.0 Conclusion

About 75% of water distribution in the campus is supplied from water treatment plant which flows through distribution network within the Campus. The method of water loss detection was employed and the resulting losses obtained were measured and analyzed. A daily volume of 12,942.72 liters per day was obtained from the five study locations identified with a corresponding monthly cost of ₦11, 648.45. Overflow on flowers, domestic losses and unidentified leaks were not analyzed for this study. Inadequate water supply still remains a problem on the campus. While efforts are being made to improve the supply situation, inadequate attention is paid toward minimizing the losses, particularly leakages due to faulty fittings, faulty taps through which water flows continuously once there is supply and contributes a very significant amount of the losses.

However, the following recommendations were made;

i. Leakage detection and repair policy for the water supply system should be adequately maintained by the Works Department of the University and a sound reaction time should be given whenever leakage is identified or reported.
ii. Attention should be paid to selection of high quality fittings that would have a longer life span and reduce their failure rate. This would possibly minimize the occurrence of leakages.
iii. More so, further studies should consider both the 75% of water supply from water treatment plant and the remaining 25% that is pumping from borehole within the campus.

References

AWWA, American Water Works Association, (2007). *Apparent and Real Losses.* The Manual of Water Supply Practices: Retrieved from http://www.awwa.org/waterwiser/waterloss/Docs.

Inuwa, Y. D. (2016). *Assessment of the Cost Implication of Water Leakages from Pipes in some selected Locations of University of Maiduguri* (Unpublished B. Eng Project), Department of Civil and Water Resources Engineering, University of Maiduguri, Maiduguri, Nigeria.

May, J. (1994). Pressure Dependent Leakage. *Seminal Article in World Water and Environmental Engineering Management*, *October*. Retrived from http://www.wef.org

Muazu, U. (2005) *An Assessment of the Cost Implication of Water Wastage in Selected Locations of Ahmadu Bello University Zaria* (Unpublished B.Sc. Project), Department of Building, Ahmadu Bello University, Zaria, Nigeria.

Stenberg, R. (1982). Leakage Detection in Water Supply Systems. Swedish Water Works Association, Stockholm, Sweden.

W.H.O. (2001). *Leakage Management and Control-A best Practice Training Manual*. World Health Organization, Geneva, Switzerland: Farley, M.