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Water Distribution Network Analysis of Bedesa Town, Damot Woyde Woreda of Wolaita Zone, Southern Ethiopia

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Abstract
This study was conducted in Bedesa town, Wolaita zone, southern Ethiopia. The study was aimed to analyze the water distribution network of Bedesa town. In this study, the primary data sources were used. The primary data were collected by GPS from the field. In order to analyze the distribution network system, the available data and plan of the distribution network of water supply system was reviewed. Input data for the analysis of distribution system included size, type, length and age of pipe, and GPS reading of service reservoirs and junctions. For analysis of Bedesa town water supply distribution system, computer software called EPANET 2.0 was used. To compute friction head losses, Hazen-Williams equation was used with the assumption that viscosity is constant. The pressure map was prepared by Surfer 8.0 software. The findings of this study revealed that the existing pipes of the distribution system do not cover the peripheral build up of the town. Some areas which have high elevation and located close to reservoir site do not get enough water due to insufficient pressure head (<15m). Therefore, in order to achieve a 15m minimum and 70m maximum pressure, it is necessary to provide pressure controlling valve, establishing boosting station or replacing the old pipe with the new one that has a diameter of required size.
Keywords: Water supply, pressure map, distribution network: Bedesa.

1. INTRODUCTION

Water supply and sanitation are two of the most important sectors of development. Development of community water supply and sanitation results in improved social and economic conditions and improved health. The benefits of improved water supply and sanitation are many, including prevention of disease, improved basic health care, better nutrition, increased access to institutions such as health centers and schools, improved water quality, increased quantity of and access to water, reduction in time and effort required for water collection, promotion of economic activity, strengthening of community organization, improvements in housing, and ultimately improved quality of life (Andrea, 2002).

The provision of adequate supplies of potable water for use in urban areas in developing countries is crucial for the well-being of the people. The demand for such supplies in the developing countries has been increased over time as a result of rising standards of living that occur with economic progress and population increase resulting from natural growth, and rural urban migration and rising per capital income (Rewata and Sampath, 2000).

Inadequate access to clean drinking water directly or indirectly affects health. According to WHO, more than 80% of diseases in the world are attributed due to unsafe drinking water or to inadequate sanitation practices (WHO, 2003a). Global statistics estimate that currently the world is not on track to meet the MDG sanitation target, and 2.5 billion people still lack access to improved sanitation, including 1.2 billion who have no facilities at all particularly in Sub-Saharan Africa and Southern Asia (WHO/UNICEF, 2006).

Bedesa town is suffering from shortage and interruption of water supply. Accordingly, this study was conducted in Bedesa town, Wolaita zone, Southern Ethiopia in order to analyze the water distribution network of the town.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

Bedesa is geographically located approximately in latitudes of 6°51′30″ and 6°54′0″N, and longitudes of 37°54′30″ and 37°57′0″ E. The altitude of the Damot Woyde Woreda where the study area located ranges from 1001 to 2500 m.a.s.l.

2.2. Analysis of Distribution Network of the System

In order to analyze the distribution network system, the available data and plan of the distribution network of water supply system was reviewed. Input data for the analysis of distribution system included size, type, length and age of pipe, and GPS reading of service reservoirs and junctions.

For analysis of Bedesa town water supply distribution system, computer software called EPANET 2.0 was used. To compute friction head losses, Hazen-Williams equation was used with the assumption that viscosity is constant.

$$H_f = \frac{10.68LQ^{1.852}}{C^{1.852}D^{4.87}} \quad \text{..... (3.3)}$$

Where, Q=flow rate (m^3/s)
L=length of the pipe (m)
Hf=friction loss
C=roughness coefficient
D=diameter (mm)

2.3. Data Analysis

In this study, the field data for distribution system was evaluated by using the engineering software called EPANET-2. Besides, Surfer 8.0 software was used to prepare pressure map.

3. RESULTS AND DISCUSSION

3.1. Water Distribution Network

In Bedesa town, the source of piped water supply was found to be one spring stream. Water from the stream is transported by a gravity pipeline to the main distribution tank in the town before it is distributed to consumers. Fig 3.1 shows the distribution network map of the town water supply system. The purpose of a water distribution network is to provide system users the amount of water demanded and to supply it with sufficient pressure. The spatial extension of pipeline over any settlement area is a pre-condition for supplying the community with piped water.

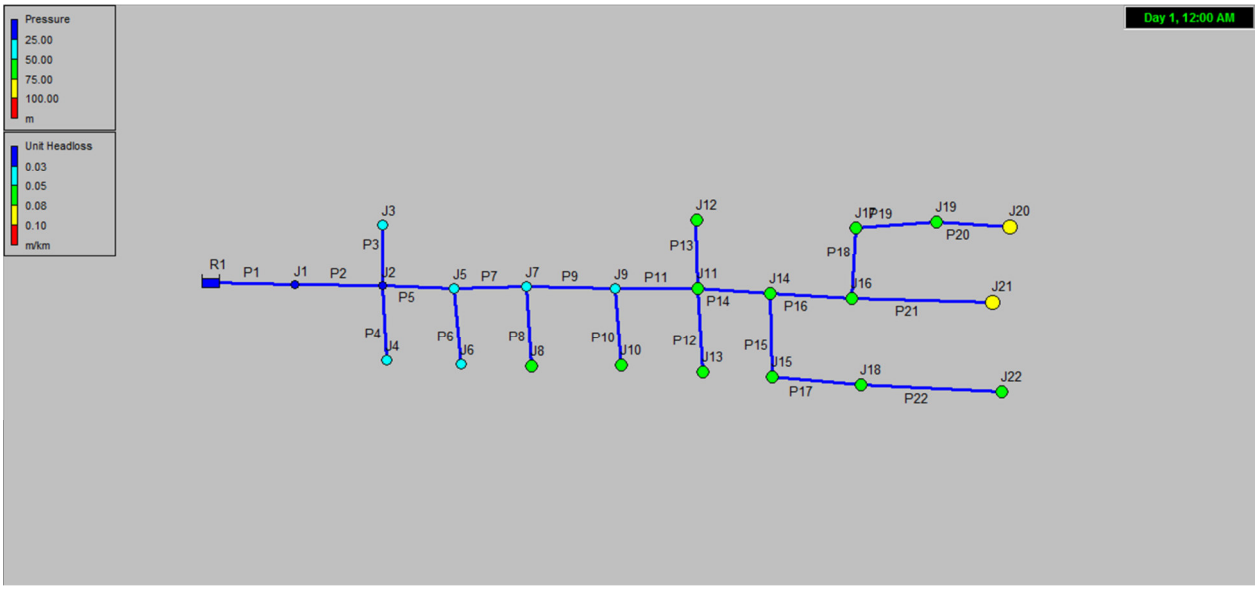

Figure 3.1. Water Distribution Network Map of Bedesa Town

Pressure influences supply capacity of the distribution system. The reason behind the provision of a minimum pressure requirement during water distribution system design is customer satisfaction. A low pressure head would not be acceptable and could result in numerous customer complaints. In addition, it could lead to operation and maintenance problems, with cost implications if equipment is damaged such as pipe collapse due to negative pressure. The pressure in a water distribution system is at a minimum when the flows and subsequent head losses in the pipes are at peak demand. On the other hand, the pressure is a maximum when the flow is at a minimum normally at night time while most consumers are asleep and institutions are shut down.

The Ethiopian guideline criteria for the minimum and maximum operating pressure value in the distribution network are 15 m and 70m respectively (MoWR, 2006). The guide line further states that water velocity shall be maintained at less than 2 m/sec and a minimum of 0.6m/sec, but for looped systems there will be pipelines with section of zero velocity. The low pressure nodes are normally those nodes which are located relatively at high elevations and far from the supply points. During hydraulic modeling of water pressure, 22 nodes were identified having records of low pressure.

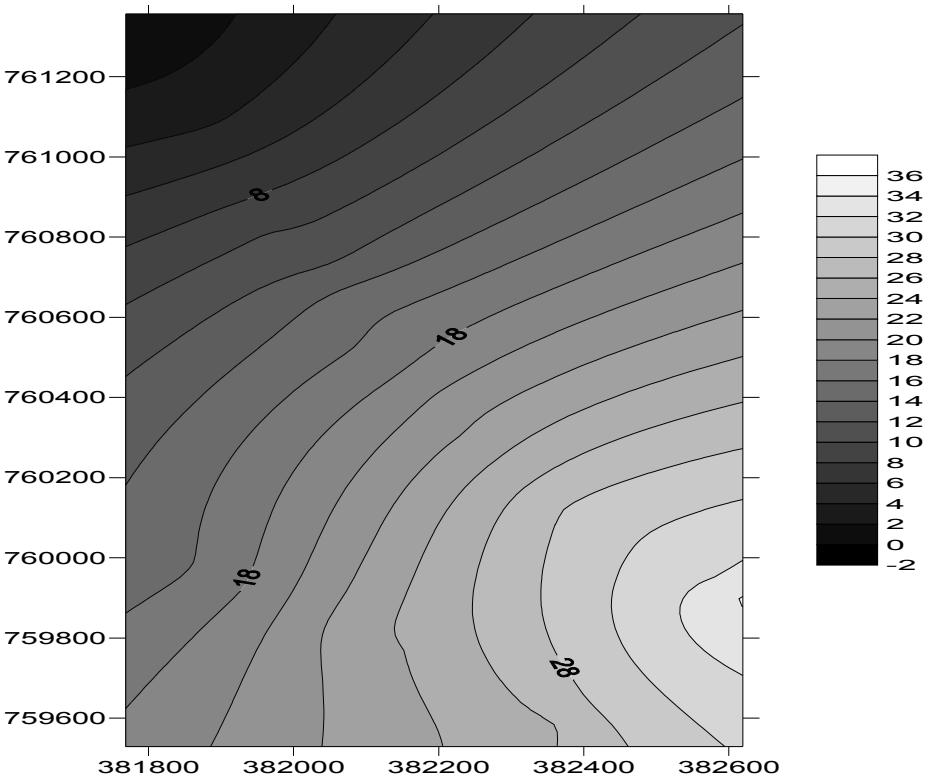

Figure 3.2. Pressure map for Bedesa town water supply system

Those households located on higher elevations and close to reservoir site have low water pressure. Low water pressure creates a low level of reliability of water users on a water supply system. To win the confidence of users, the water supplying agency should attempt to ensure optimal pressure in pipelines. In regard of this, Zephania (1988) has stated that if pressure system is not adequate to produce adequate pressure in all areas, pressure zoning should be adopted. In the case of Bedesa town, as the service reservoir is located at higher elevation than the major part of the town, water shortage combined with small storage reservoir is more pronounced than inadequacy of pressure in the pipelines. The main cause of water supply interruption was water shortage from the source and lack of maintenance.

Some places which are located nearer to the reservoir (Rs-1) site, and have an elevation close to the reservoir site have low pressure as compared to the standards. Furthermore, a high pressure which is beyond the standard value (>70m) was occurred at some areas of the town (Nodes 20 and 21).

Therefore, in the area of distribution system having record of low pressure, it is important to provide small sized pipes to achieve a 15 m minimum pressure; however, in areas distribution having records of high pressure, it is crucial to replace the existing small sized pipes with the new pipes of large size. In conclusion, in order to achieve a 15m minimum and 70m maximum pressure, it is necessary to provide pressure controlling valve, establishing boosting station or replacing the old pipe with the new one that has a diameter required size.

4. CONCLUSION AND RECOMMENDATION

4.1. Conclusion

The provision of adequate supplies of potable water for use in urban areas in developing countries is crucial for the well-being of the people. This study was conducted to analyze the water distribution network of Bedesa town, southern Ethiopia. The finding of this study revealed that the existing pipes of the distribution system do not cover the peripheral build up of the town. Some areas which have high elevation and located close to reservoir site do not get enough water due to insufficient pressure head (<15m).

4.2. Recommendation

In order to achieve a 15m minimum and 70m maximum pressure, it is necessary to provide pressure controlling valve, establishing boosting station or replacing the old pipe with the new one that has a diameter of small size.

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