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PIPE NETWORKING FOR WATER DISTRIBUTION USING EPANET

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ABSTRACT

It is taken for granted that water will be available in desired quantity when we open taps, without our bothering to know how it is brought to us. This is the natural human tendency and it is observed in all walks of life. It is necessary for water supply engineers to have good knowledge of water supply engineering in general and water distribution in particular. This will help in proper planning, analysis of water distribution system. EPANET software provides us an easy and user friendly method of designing a pipe networking system for water distribution. The study on the water supply system depends upon the assumptions considering with future water consumption, availability of water, and assuming steady state analysis. The study for identification of the root cause for losses attributable to water leakage is to be carried out and a suitable management strategy to overcome the key issues has to be formulated.

Keywords: EPANET, Network, Leak Detection.

1. INTRODUCTION

The primary purpose of a water distribution system is to deliver water to the individual consumer in the required quantity and at sufficient pressure. Water distribution systems typically carry potable water to residences, institutions, and commercial and industrial establishments. The proper function of a water distribution system is critical to providing sufficient drinking water to consumers as well as providing sufficient water for fire protection. This chapter focuses on the overview of the critical hydraulic elements of planning and design of a municipal water distribution system.

Municipal water systems typically consist of one or more sources of supply, appropriate treatment facilities, and a distribution system. Sources of supply include surface water, such as rivers or lakes, groundwater, and in some instances, brackish or sea water. Water distribution systems usually consist of a network of interconnected pipes to transport water to the consumer, storage reservoirs to provide for fluctuations in demand, and pumping facilities. The system comprises a series of hydraulic elements which is considered to be the most significant factors for planning and designing a water distribution system such as Water Head, Water pressure, Average day demand, Maximum day demand, Peak hour demand and Velocity of the flow.

2. EPANET

EPANET is a computer program that performs extended period simulation of hydraulic and water quality behavior within pressurized pipe networks. A network consists of pipes, nodes (pipe junctions), pumps, valves and storage tanks or reservoirs. EPANET tracks the flow of water in each pipe, the pressure at each node, the height of water in each tank, and the concentration of a chemical species throughout the network during a simulation period comprised of multiple time steps.

In addition to chemical species, water age and source tracing can also be simulated. EPANET is designed to be a research tool for improving our understanding of the movement and fate of drinking water constituents within distribution systems. It can be used for many different kinds of applications in distribution systems analysis.

Sampling program design, hydraulic model calibration, chlorine residual analysis, and consumer exposure assessment are some examples. EPANET can help assess alternative management strategies for improving water quality throughout a system.

These includes

- Altering source utilization within multiple source systems,
- Altering pumping and tank filling/emptying schedules,
- Use of satellite treatment, such as re-chlorination at storage tanks,
- Targeted pipe cleaning and replacement.

Running under Windows, EPANET provides an integrated environment for editing network input data, running hydraulic and water quality simulations, and viewing the results in a variety of formats. These include color-coded network maps, data tables, time series graphs, and contour plots.

3. METHODOLOGY

i. Drawing the layout of the college using EPANET.
ii. Collection of data
iii. Location of tank over civil department block.
iv. Connection of all the nodes to the distribution tank.
v. Calculation of overall demand in LPS (Liters per second) of the college.
vi. Calculation of water demand in LPS at each ward.
vii. Entering the demands at each node.
viii. Finally, the pressure, head loss, velocity are calculated using EPANET software.

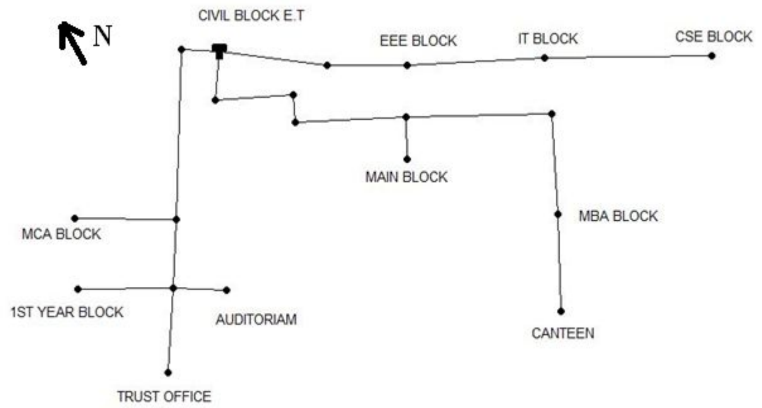

Figure 1. Study Area.

4. CALCULATION OF THE DEMAND

Total number of persons=4500

Demand per head for one day = 135 lpcd

Average quantity of water = 4500×135
= 1.35 MLD

Peak quantity of water = 1.5×1.35
= 2.025 MLD

5. RESULT ANALYSIS

After a network has been suitably described, water demand at each junction was calculated. Hydraulic analysis for head and pressure head were carried out to understand the performance and behavior network and head loss results are shown in figure 2.

5.1 NETWORK TABLE – NODES (JUNCTIONS)

Node ID	Demand (LPS)	Head (m)	Pressure (m)
Junction 14	1.02	138.19	36.94
Junction 16	1.02	138.33	37.03
Junction 17	0.34	138.44	36.44
Junction 20	1.02	139.49	38.19
Junction 21	1.36	139.59	38.09
Junction 23	1.36	138.52	36.52
Junction 24	1.02	138.97	36.97
Junction 26	1.02	138.94	37.44
Junction 27	0.68	138.71	38.51
Junction 38	0.68	139.68	38.48
Junction 39	0.34	139.67	38.52
Junction 42	0.68	139.67	38.52
Junction 10	1.02	139.44	38.19
Junction 18	1.02	139.43	38.23
Junction 28	0.34	139.67	38.47
Junction 29	0.34	138.33	37.03
Junction 30	0.68	138.15	36.95
Junction 31	0.68	138.14	36.94
Junction 32	0.34	139.71	38.56
Tank 1	-14.36	140.00	10.00

5.2 NETWORK TABLE - LINKS (PIPES)

LINK ID	FLOW LPS	VELOCITY m/s	UNIT HEADLOSS(m/km)	FRICTION FACTOR
Pipe 13	-2.38	0.30	2.17	0.046
Pipe 14	-3.74	0.48	5.01	0.043
Pipe15	-4.08	0.52	5.89	0.043
Pipe18	-3.06	0.39	3.46	0.045

Pipe19	-5.44	0.69	10.03	0.041
Pipe22	3.06	0.39	3.46	0.045
Pipe28	2.04	0.26	1.63	0.047
Pipe29	0.34	0.04	0.06	0.062
Pipe32	0.68	0.09	0.21	0.056
Pipe16	2.04	0.26	1.63	0.047
Pipe17	1.02	0.13	0.45	0.053
Pipe24	0.34	0.04	0.06	0.062
Pipe25	0.35	0.04	0.06	0.062
Pipe26	-4.08	0.52	5.89	0.043
Pipe27	4.42	0.56	6.83	0.042
Pipe31	6.46	0.82	13.79	0.040
Pipe33	1.36	0.17	0.77	0.050
Pipe34	0.68	0.21	0.21	.056
Pipe35	0.34	0.06	0.06	0.062

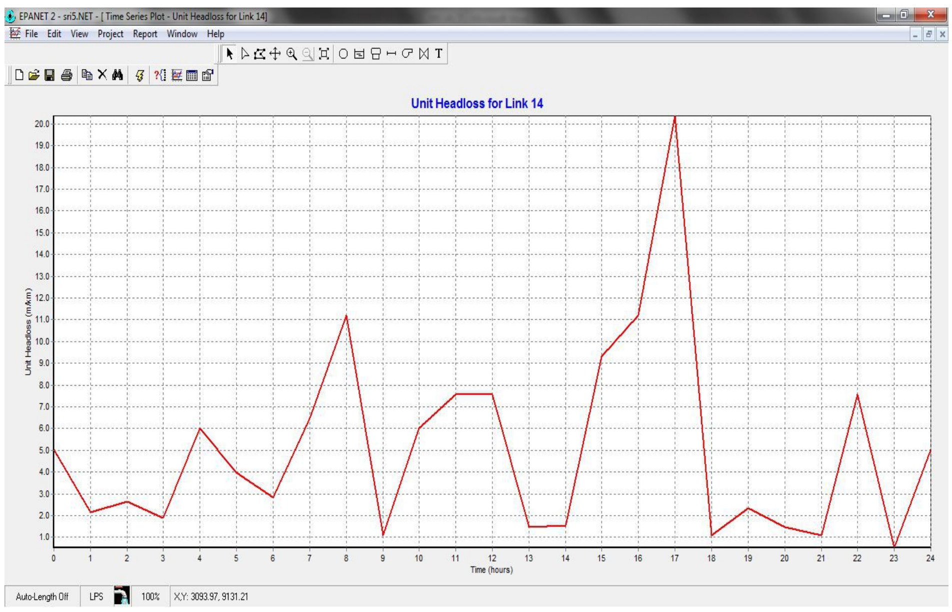

Figure 2. Graph of unit head loss for link14

6. MANUAL CALCULATION

For manual calculation, HAZEN-WILLIAMS FORMULA has been used to verify the head loss stimulated from EPANET.

For pipe 13, at 0^{th} hr

$V=085CH\times R^{0.63}\times S^{0.54}$

$Q=A\times V$

$V=Q/A$

Q=0.00238cumec

D=0.01 m

$V=0.00238\times 4/3.14\times 0.1^2$

V=0.3 m/s

$0.3=0.85\times 100\times 0.0978\times S^{0.54}$

$S=0.036^{1.85}$

HL/L=0.00213

$HL=0.00213\times 1000$

HL=2.13m/km

For pipe14, at 0^{th} hr

$V=085C_H\times R^{0.63}\times S^{0.54}$

$Q=A\times V$

$V=Q/A$

Q= 0.0037 cumec

D= 0.01 m

V=0.0037×4/3.14×0.1^2

V=0.47 m/s

$0.47=0.85\times 100\times 0.0978\times S^{0.54}$

$S=0.056^{1.85}$

HL/L=0.00483

$HL=0.00483\times 1000$

HL=4.83 m/km

Table 1. Comparison of result

S.No	Pipe Number	Manual calculation of Head loss (m/km)	Software calculation of head loss (m/km)
1.	13	2.13	2.17
2.	14	4.83	5.03

7. CONCLUSION

The main focused of this study is to analyze the water distribution network and identify deficiencies in it is analysis, implementation and its usage. At the end of the analysis it was found that the resulting pressures at all the junctions and the flows with their velocities at all pipes are adequate enough to provide water to the study area of strength 4500 peoples. The pressure and head-loss of the pipe lines are calculated manually and software based analysis were made and compared. The results are nearly equal in both the calculation. It was observed that the pipes connected to the tanks as distribution pipes to the other pipes have smaller diameters.

8. REFERENCES

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