# Analysis of 24×7 Water Distribution Network of Gabbur zone in Hubballi city, Karnataka state, India using EPANET software.

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**Abstract** -*The present study shows the remodeling of existing network and also designing the water distribution network using a programming tool, which performs the extended period simulation of hydraulic and water quality behavior within the pressurized network of pipes called EPANET. A network comprises of pipes, nodes, pumps, valve and storage tanks or reservoirs. EPANET estimates the flow of water in each pipe and the pressure at each node, EPANET is designed to be a research tool for improving the movement of drinking water within distribution network. This papers demonstrates the use of EPANET for the hydraulic study of the distribution network.*

***Key Words***: **EPANET, Analysis and water distribution network.**

## 1.INTRODUCTION

In India, water availability controls population distribution. To meet the increased water demand due to growing urban population, it is necessary to provide the required water quantity through the efficient design of pipe network. The most important task in distributing desired water quantity to individual consumers is the necessary pressure through a distribution network. It is essential that each point of the distribution network be supplied with a certain quantity of water flow with all the desired parameters. The water supply in most Indian cities is only available for a few hours of a day, pressure is irregular, and the water is of questionable quality. The function of a pipe network system is to supply water at required pressure and flow. Though, pressure is lost by the action of friction by the pipe wall, the loss in the pressure is also reliant on the water demand, length of the pipe, gradient and diameter. A number of well established empirical equations explain the pressure–flow relationship and these have been included into network modeling software packages.

Thus, while designing a network of pipe system, the primary aim is to achieve adequate pressure at supply point to receive required quantity of water to the consumer. Conventionally a water distribution network design is based on the proposed street plan and the topography. Using commercially available software, the modeler simulates flows and pressures in the network and flows in and out to/from the tank. In the present work, Gabbur Zone of Hubballi city has been selected to analyses and study network of piped water supply system which is done considering 24×7 water supply system to know pipe pressure, velocity, water age, etc.

## 2.STUDY AREA

Hubblli is situated at 15° 20’N latitude and 75° 13’E longitude and Dharwad is situated at 15°25’N latitude and 75°E longitude. The altitude of the twin cities, Hubballi- Dharwad, varies from 764 m to 593m with Dharwad being at a higher elevation. The twin city is located along National Highway No. 4 between Pune and Bengaluru cities and is at a distance of about 400 km from the State Capital, Bengaluru.

The total area of the city corporation area is 202.28sq.km covering 45 villages. The city is divided into 67 wards of which wards 1-22 come in Dharwad and 23-67 come under Hubblli and Gabbur zone have present population 19,567 area 1.13sq.km.

## 3. METHODOLOGY

The study area comes under the urban settlement. The projected population for the year 2045 is estimated to be 35085. The water demand of 135L/C/D has been used in the present work as per the standards of the Central Public Health Environment Engineering Organization (CPHEEO). The procedure followed for remodeling of existing water distribution network is as mentioned in the following paragraph.

*Step 1*: Import network file with the help of EPACAD software where network placed in a text file.
*Step 2:* Edit the properties of the objects that make up the system. It includes editing the properties and entering required data in various objects like links, node such as

diameter, length of pipe, elevation, base demand etc respectively.
*Step 3:* Description of how the system is operated.
*Step 4:* Run the EPANET software for the data to achieve desired pressure and flow rate.
*Step 5:* Analyze the water quality parameters.
Step6: Extract the results in tables and graph form.

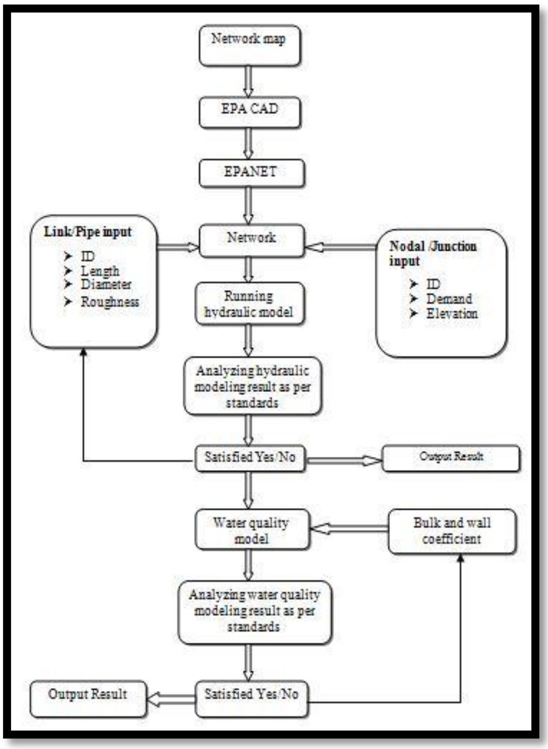


**Fig -1:** Methodology flow chart

## 3. ANALYSIS OF RESULTS

The water distribution network of Gabbur zone of Hubbali city has 162 links, 141 nodes and 01 overhead tank. The pipe line network is as shown below.

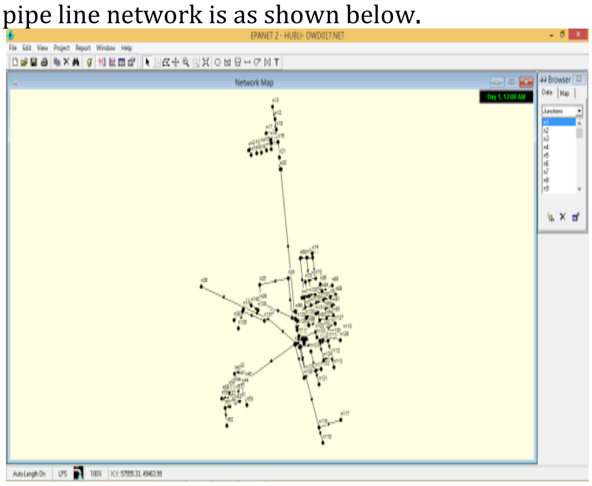

**Fig.-2:** The pipe line network for Gabbur zone

In the present study, EPANET software is used for assessing water distribution system such as effective planning, development and operation of water supply and distribution network for GABBUR zone. The results of the study show that pressure at all the junctions and the flow at all pipes is sufficient to provide water to every part of network system.

### 3.1 Hydraulic design of the water distribution network

The hydraulic design of the WDS consist of node, links etc. the sufficient flow should meet the nodal demand and pressure/head is to achieve minimum height of 7m.

**Table-1:** Hydraulic parameters at the nodes

| | Demand | Head | Pressure |
|---|---|---|---|
| Node ID | LPS | m | m |
| n1 | 0.03 | 637.89 | 42.5 |
| n2 | 0.14 | 637.89 | 41.99 |
| n3 | 0.18 | 637.89 | 41.81 |
| n4 | 0.17 | 637.89 | 41.54 |
| n5 | 0.17 | 637.89 | 41.42 |
| n6 | 0.12 | 637.89 | 41.24 |
| n7 | 0.05 | 637.89 | 42.31 |
| n8 | 0.05 | 637.89 | 41.83 |
| n9 | 0.05 | 637.89 | 42.03 |
| n10 | 0.05 | 637.89 | 41.62 |
| n11 | 0.05 | 637.89 | 41.62 |
| n12 | 0.21 | 637.89 | 39.87 |
| n13 | 0.11 | 637.89 | 39.89 |
| n14 | 0.12 | 637.89 | 41.13 |
| n15 | 0.03 | 637.89 | 41.39 |
| n16 | 0.43 | 637.89 | 39.99 |
| n17 | 0.13 | 637.89 | 40.68 |
| n18 | 0.33 | 637.89 | 40.11 |
| n19 | 1.57 | 637.9 | 39.32 |
| n20 | 0.11 | 637.9 | 39.28 |
| n21 | 0.1 | 637.9 | 39.73 |
| n22 | 1.37 | 637.92 | 30.92 |
| n23 | 0.79 | 637.91 | 32.19 |
| n24 | 0.7 | 637.9 | 35.92 |
| n25 | 0.51 | 637.9 | 42.75 |
| n26 | 0.63 | 637.9 | 41.87 |
| n27 | 0.05 | 637.92 | 30.56 |

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| | | | |
|---|---|---|---|
| n28 | 0.17 | 637.93 | 29.62 |
| n29 | 0.27 | 637.94 | 30.26 |
| n30 | 0.11 | 637.93 | 30.87 |
| n31 | 0.32 | 637.93 | 31.15 |
| n32 | 0.06 | 637.91 | 30.84 |
| n33 | 0.4 | 637.9 | 30.97 |
| n34 | 0.7 | 637.79 | 39.57 |
| n35 | 0.86 | 637.73 | 40.28 |
| n36 | 0.54 | 637.72 | 47.47 |
| n37 | 0.58 | 637.72 | 40.23 |
| n38 | 0.13 | 637.72 | 40.38 |
| n39 | 1 | 637.9 | 31.34 |
| n40 | 0.82 | 637.83 | 45.75 |
| n41 | 0.22 | 637.83 | 44.63 |
| n42 | 0.07 | 637.83 | 45.63 |
| n43 | 0.07 | 637.83 | 45.63 |
| n44 | 0.3 | 637.79 | 45.55 |
| n45 | 0.2 | 637.77 | 44.52 |
| n46 | 0.16 | 637.76 | 44.66 |
| n47 | 0.11 | 637.76 | 44.76 |
| n48 | 0.12 | 637.75 | 44.29 |
| n49 | 0.22 | 637.75 | 44.78 |
| n50 | 0.16 | 637.79 | 42.36 |
| n51 | 0.14 | 637.76 | 42.58 |
| n52 | 0.13 | 637.76 | 42.58 |
| n53 | 0.15 | 637.75 | 44.19 |
| n54 | 0.07 | 637.76 | 44.92 |
| n55 | 0.09 | 637.75 | 45.03 |
| n56 | 0.03 | 637.75 | 45.17 |
| n57 | 0.02 | 637.75 | 44.53 |
| n58 | 0.04 | 637.75 | 45.49 |
| n59 | 0.04 | 637.75 | 45.49 |
| n60 | 0.09 | 637.75 | 44.09 |
| n61 | 0.29 | 637.75 | 45.63 |
| n62 | 0.15 | 637.75 | 45.51 |
| n63 | 0.2 | 637.92 | 31.32 |
| n64 | 0.22 | 637.91 | 30.81 |
| n65 | 0.5 | 637.87 | 29.94 |
| n66 | 0.21 | 637.87 | 29.63 |
| n67 | 0.18 | 637.87 | 27.49 |
| n68 | 0.03 | 637.87 | 29.94 |
| n69 | 0.41 | 637.86 | 34.39 |
| n70 | 0.35 | 637.86 | 34.39 |

| | | | |
|---|---|---|---|
| n71 | 0.3 | 637.86 | 34.39 |
| n72 | 0.26 | 637.86 | 30.34 |
| n73 | 0.41 | 637.86 | 30.34 |
| n74 | 0.04 | 637.86 | 36.62 |
| n75 | 0.12 | 637.87 | 31.61 |
| n76 | 0.36 | 637.87 | 28.12 |
| n77 | 0.1 | 637.87 | 29.95 |
| n78 | 0.22 | 637.87 | 26.21 |
| n79 | 0.3 | 637.87 | 26.85 |
| n80 | 0.33 | 637.86 | 25.66 |
| n81 | 0.32 | 637.87 | 25.32 |
| n82 | 0.24 | 637.86 | 26.87 |
| n83 | 0.34 | 637.86 | 24.64 |
| n84 | 0.37 | 637.86 | 25.18 |
| n85 | 0.14 | 637.86 | 24.86 |
| n86 | 0.07 | 637.86 | 26.26 |
| n87 | 0.24 | 637.86 | 23.86 |
| n88 | 0.07 | 637.86 | 24.41 |
| n89 | 0.34 | 637.86 | 23.33 |
| n90 | 0.19 | 637.86 | 23.36 |
| n91 | 0.02 | 637.86 | 23.37 |
| n92 | 0.22 | 637.87 | 25.55 |
| n93 | 0.17 | 637.87 | 25.55 |
| n94 | 0.33 | 637.87 | 23.92 |
| n95 | 0.08 | 637.87 | 23.7 |
| n96 | 0.35 | 637.87 | 26.67 |
| n97 | 0.46 | 637.87 | 27.08 |
| n98 | 0.26 | 637.88 | 30.19 |
| n99 | 0.2 | 637.88 | 30.77 |
| n100 | 0.16 | 637.87 | 27.77 |
| n101 | 0.34 | 637.87 | 25.4 |
| n102 | 0.32 | 637.87 | 26.19 |
| n103 | 0.33 | 637.91 | 27.07 |
| n104 | 0.3 | 637.93 | 30.87 |
| n105 | 0.48 | 637.93 | 31.05 |
| n106 | 0.49 | 637.88 | 28.94 |
| n107 | 0.22 | 637.87 | 28.07 |
| n108 | 0.21 | 637.87 | 27.52 |
| n109 | 0.26 | 637.87 | 27.28 |
| n110 | 0.14 | 637.87 | 27.07 |
| n111 | 0.24 | 637.88 | 28.88 |
| n112 | 0.34 | 637.88 | 30.03 |
| n113 | 0.1 | 637.88 | 31.06 |

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|---|---|---|---|
| n114 | 0.08 | 637.9 | 29.71 |
| n115 | 0.24 | 637.91 | 29.6 |
| n116 | 0.89 | 637.93 | 35.55 |
| n117 | 0.27 | 637.93 | 34.53 |
| n118 | 0.14 | 637.93 | 35.93 |
| n119 | 0.87 | 637.93 | 32.77 |
| n120 | 0.5 | 637.92 | 32.08 |
| n121 | 0.12 | 637.92 | 32.57 |
| n122 | 0.07 | 637.92 | 31.78 |
| n123 | 0.18 | 637.92 | 30.82 |
| n124 | 0.25 | 637.88 | 29.58 |
| n125 | 0.24 | 637.93 | 32.78 |
| n126 | 0.1 | 637.87 | 27.72 |
| n127 | 0.09 | 637.87 | 24.97 |
| n128 | 0.14 | 637.9 | 29.79 |
| n129 | 0.17 | 637.89 | 29.79 |
| n130 | 0.11 | 637.89 | 27.1 |
| n131 | 0.11 | 637.87 | 25.33 |
| n132 | 0.04 | 637.87 | 28.93 |
| n133 | 0.04 | 637.91 | 28.91 |
| n134 | 0.07 | 637.94 | 31.43 |
| n135 | 0.04 | 637.73 | 40.27 |
| n136 | 0.16 | 637.72 | 40.06 |
| n137 | 0.27 | 637.72 | 39.61 |
| n138 | 0.32 | 637.9 | 32.74 |
| n139 | 0.16 | 637.9 | 42.71 |
| n140 | 0.09 | 637.9 | 47.65 |
| n141 | 0.07 | 637.89 | 30.89 |

**Table-2:** Flow and velocity in pipes

| Pipe ID | Length m | Diameter mm | Flow LPS | Velocity m/s |
|---|---|---|---|---|
| p1 | 19.63 | 110 | 1.14 | 0.07 |
| p2 | 50.77 | 140 | 10.09 | 0.61 |
| p3 | 46.26 | 140 | 2.22 | 0.14 |
| p4 | 44.34 | 140 | 6.33 | 0.32 |
| p5 | 46.77 | 140 | 4.42 | 0.29 |
| p6 | 37.64 | 110 | 0.24 | 0.03 |
| p7 | 38.38 | 110 | 2.5 | 0.03 |
| p8 | 40.7 | 110 | 0.26 | 0.03 |
| p9 | 38.48 | 110 | 4.82 | 0.69 |
| p10 | 37.25 | 110 | 0.24 | 0.03 |
| p11 | 88.42 | 180 | 5.7 | 0.26 |
| p12 | 6.03 | 140 | 21.52 | 0.94 |
| p13 | 25.37 | 110 | 11.6 | 0.78 |
| p14 | 62.71 | 140 | 6.02 | 0.39 |
| p15 | 99.79 | 180 | 0.65 | 0.03 |
| p16 | 72.47 | 280 | 1.62 | 0.03 |
| p17 | 183.85 | 280 | 12.09 | 0.2 |
| p18 | 5.04 | 140 | 1.04 | 0.07 |
| p19 | 77.63 | 110 | 6.5 | 0.53 |
| p20 | 1014.82 | 280 | 20.96 | 0.34 |
| p21 | 29.29 | 200 | 14.4 | 0.46 |
| p22 | 268.7 | 140 | 5.26 | 0.34 |
| p23 | 120.9 | 140 | 0.76 | 0.05 |
| p24 | 9.72 | 200 | 42.21 | 1.34 |
| p25 | 59.43 | 280 | 59.43 | 0.97 |
| p26 | 25.38 | 280 | 71.92 | 1.17 |
| p27 | 32.71 | 280 | 27.51 | 0.45 |
| p28 | 28.25 | 180 | 4.85 | 0.36 |
| p30 | 7.26 | 110 | 18.45 | 1.78 |
| p31 | 303.4 | 140 | 36.43 | 1.94 |
| p32 | 235.7 | 140 | 12.93 | 0.84 |
| p33 | 415 | 140 | 2.7 | 0.18 |
| p34 | 99.12 | 110 | 3.37 | 0.43 |
| p35 | 512.2 | 180 | 18.5 | 0.73 |
| p36 | 66.88 | 110 | 1.8 | 0.19 |
| p37 | 51.38 | 110 | 0.33 | 0.03 |
| p38 | 53.45 | 110 | 0.35 | 0.04 |
| p39 | 53.82 | 110 | 12.59 | 1.32 |
| p40 | 46.76 | 110 | 10.29 | 1.08 |
| p41 | 39.04 | 110 | 5.43 | 0.57 |
| p42 | 33.45 | 110 | 4.3 | 0.45 |
| p43 | 29.7 | 110 | 1.81 | 0.19 |
| p44 | 38.23 | 110 | 1.33 | 0.14 |
| p45 | 126.7 | 110 | 0.82 | 0.09 |
| p46 | 68.3 | 110 | 3.86 | 0.41 |
| p47 | 40.11 | 110 | 3.16 | 0.33 |
| p48 | 56.77 | 110 | 2.53 | 0.27 |
| p49 | 50.91 | 110 | 6.33 | 0.48 |
| p50 | 21.18 | 110 | 1.95 | 0.2 |
| p51 | 24.65 | 110 | 7.16 | 0.69 |
| p52 | 27.05 | 110 | 1.32 | 0.14 |
| p53 | 33.28 | 110 | 0.22 | 0.02 |
| p54 | 35.09 | 110 | 9.02 | 0.78 |

| | | | | |
|---|---|---|---|---|
| p55 | 32.78 | 110 | 0.21 | 0.02 |
| p56 | 27.1 | 110 | 4.89 | 0.37 |
| p57 | 29.17 | 110 | 5.14 | 0.48 |
| p58 | 43.38 | 110 | 1.18 | 0.12 |
| p59 | 63.23 | 110 | 10.04 | 1.43 |
| p60 | 117.3 | 110 | 2.76 | 0.38 |
| p61 | 56.21 | 200 | 16.14 | 0.51 |
| p62 | 98.81 | 200 | 15.13 | 0.48 |
| p63 | 72.11 | 125 | 14.02 | 1.14 |
| p64 | 29.72 | 125 | 7.24 | 0.59 |
| p65 | 37.14 | 125 | 5.56 | 0.45 |
| p66 | 19.3 | 110 | 0.13 | 0.01 |
| p67 | 262.22 | 125 | 4.16 | 0.34 |
| p68 | 56.87 | 125 | 2.09 | 0.17 |
| p70 | 57.48 | 125 | 1.24 | 0.1 |
| p71 | 141.04 | 125 | 0.45 | 0.04 |
| p72 | 60.94 | 125 | 1.76 | 0.14 |
| p73 | 99.31 | 125 | 4.67 | 0.38 |
| p74 | 30.37 | 125 | 0.2 | 0.02 |
| p75 | 151.65 | 125 | 0.88 | 0.07 |
| p76 | 95.9 | 125 | 0.62 | 0.05 |
| p77 | 73.62 | 125 | 0.48 | 0.04 |
| p78 | 62.78 | 125 | 1.51 | 0.12 |
| p79 | 53.1 | 125 | 2.75 | 0.22 |
| p80 | 64.49 | 125 | 2.12 | 0.17 |
| p81 | 63.75 | 125 | 1.35 | 0.11 |
| p82 | 69.4 | 125 | 1.88 | 0.15 |
| p83 | 103.9 | 125 | 6.68 | 0.79 |
| p84 | 50.78 | 125 | 0.33 | 0.03 |
| p85 | 66.13 | 125 | 0.83 | 0.07 |
| p86 | 51.14 | 125 | 0.33 | 0.03 |
| p87 | 69.52 | 125 | 1.73 | 0.14 |
| p88 | 64.41 | 125 | 0.68 | 0.06 |
| p89 | 14.17 | 125 | 6.09 | 0.33 |
| p90 | 4.182 | 125 | 7.48 | 0.61 |
| p91 | 66.7 | 125 | 2.91 | 0.24 |
| p92 | 65.07 | 125 | 6.42 | 0.87 |
| p93 | 104.78 | 125 | 3.3 | 0.27 |
| p94 | 59.12 | 125 | 3.55 | 0.29 |
| p95 | 60.56 | 140 | 7.68 | 0.5 |
| p96 | 94.41 | 140 | 6.67 | 0.43 |
| p97 | 59.17 | 125 | 0.73 | 0.06 |
| p98 | 50.6 | 125 | 5.12 | 0.42 |

| | | | | |
|---|---|---|---|---|
| p99 | 65.84 | 125 | 2.37 | 0.19 |
| p100 | 54.82 | 125 | 1.59 | 0.13 |
| p101 | 66.95 | 125 | 1.74 | 0.14 |
| p102 | 61.47 | 125 | 1.11 | 0.09 |
| p103 | 62.24 | 125 | 1.75 | 0.14 |
| p104 | 69.96 | 125 | 2.22 | 0.18 |
| p105 | 62.18 | 125 | 2.98 | 0.24 |
| p106 | 57.66 | 125 | 2.13 | 0.17 |
| p107 | 67.7 | 125 | 5.68 | 0.46 |
| p108 | 55.84 | 125 | 16.05 | 1.31 |
| p109 | 160.1 | 180 | 17.9 | 0.7 |
| p110 | 8.606 | 110 | 10.73 | 1.13 |
| p111 | 179.2 | 110 | 7.11 | 0.92 |
| p112 | 56.4 | 125 | 5.74 | 0.3 |
| p113 | 58.3 | 125 | 5.27 | 0.43 |
| p114 | 68.1 | 110 | 3.48 | 0.37 |
| p115 | 70.18 | 110 | 7.18 | 0.87 |
| p116 | 17.7 | 110 | 2.53 | 0.27 |
| p117 | 105.54 | 110 | 3.69 | 0.37 |
| p118 | 77.7 | 110 | 2.47 | 0.26 |
| p119 | 109.3 | 110 | 1.25 | 0.13 |
| p120 | 74.36 | 110 | 0.48 | 0.05 |
| p121 | 96.93 | 110 | 4.81 | 0.51 |
| p122 | 51.89 | 125 | 4.77 | 0.39 |
| p123 | 52.08 | 125 | 2.18 | 0.18 |
| p124 | 44.9 | 140 | 13.8 | 0.9 |
| p125 | 14.2 | 110 | 16.64 | 1.75 |
| p126 | 63.67 | 180 | 26.47 | 1.04 |
| p127 | 70.96 | 280 | 58.58 | 0.95 |
| p128 | 209.6 | 140 | 1.36 | 0.09 |
| p129 | 109.8 | 140 | 0.71 | 0.05 |
| p130 | 366.1 | 280 | 6.53 | 0.11 |
| p131 | 201.6 | 280 | 15.2 | 0.25 |
| p132 | 13.11 | 140 | 25.08 | 2.63 |
| p133 | 98.03 | 110 | 4.34 | 0.46 |
| p134 | 95.22 | 110 | 0.62 | 0.07 |
| p135 | 51.08 | 110 | 0.33 | 0.03 |
| p136 | 138.1 | 110 | 0.9 | 0.09 |
| p137 | 75.62 | 110 | 5.92 | 0.17 |
| p138 | 120.5 | 110 | 2.19 | 0.23 |
| p139 | 183.9 | 110 | 1.2 | 0.13 |
| p140 | 79.98 | 110 | 0.52 | 0.05 |
| p141 | 72.94 | 125 | 1.4 | 0.11 |

| | | | | |
|---|---|---|---|---|
| p142 | 66.05 | 125 | 0.43 | 0.04 |
| p143 | 4.48 | 110 | 2.43 | 0.26 |
| p144 | 44.07 | 110 | 1.38 | 0.15 |
| p145 | 83.9 | 110 | 0.55 | 0.06 |
| p146 | 85.72 | 125 | 0.56 | 0.05 |
| p147 | 30.28 | 110 | 0.2 | 0.02 |
| p148 | 34.13 | 110 | 0.22 | 0.02 |
| p149 | 53.2 | 110 | 0.35 | 0.04 |
| p150 | 10.31 | 180 | 45.89 | 1.8 |
| p151 | 108.16 | 110 | 8.61 | 0.91 |
| p152 | 11.89 | 110 | 5.92 | 0.17 |
| p153 | 17.11 | 110 | 5.73 | 0.3 |
| p154 | 123 | 110 | 0.8 | 0.08 |
| p155 | 210.2 | 110 | 1.37 | 0.14 |
| p156 | 243.5 | 110 | 6.58 | 0.62 |
| p157 | 308.2 | 140 | 5.2 | 0.34 |
| p158 | 56.43 | 110 | 1.28 | 0.13 |
| p159 | 70.49 | 110 | 0.46 | 0.05 |
| p160 | 268.6 | 140 | 1.77 | 0.12 |
| p161 | 82.84 | 280 | 3.93 | 0.06 |
| p162 | 56.62 | 110 | 0.37 | 0.04 |

### 3.2 WATER QUALITY MODELING

The water quality analysis has been done using the EPANET software to know the dosage on addition of chlorine for disinfection satisfying the norms stipulated by world health organization.

#### 3.2.1 CHLORINE IN THE DISTRIBUTION NETWORK AT DIFFERENT TIME

The chlorine dosage required as per the WHO standard is 0.2mg/lit to 0.6mg/lit. The figure 3, 4, 5 shows the chlorine dispersion in the network at the time 3 am, 7 am and 11pm respectively. The blue color in the contour map indicates 0mg/lit to 0.20mg/lit, light blue indicates chlorine ranging from 0.20mg/lit to 0.30mg/lit, green color indicates chlorine ranging from 0.30mg/lit to0.40mg/lit, pink color indicates 0.40mg/lit to 0.50mg/lit and red color indicates >0.50mg/lit chlorine. The analysis indicates the chlorine in the piped water supply satisfies the norms of WHO.

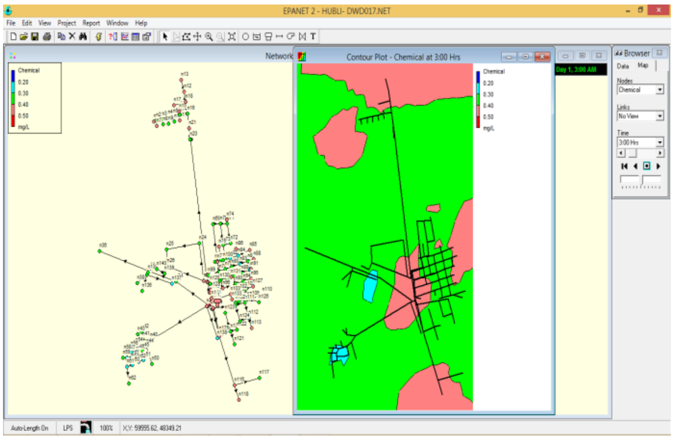

**Fig-3:** Map showing chlorine concentration at 3am

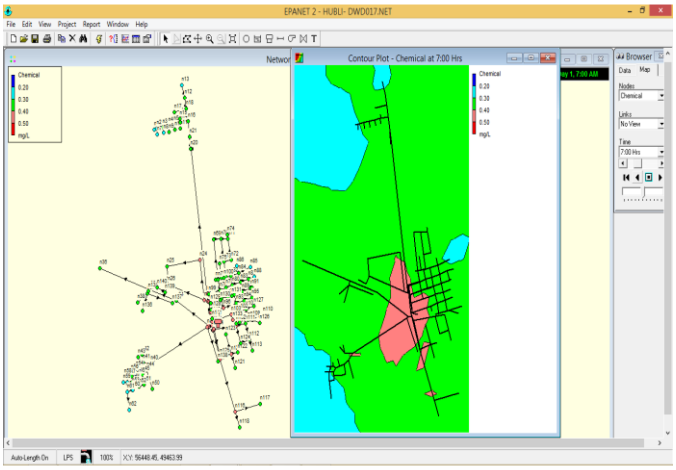

**Fig-4:** Map showing chlorine concentration at 7am

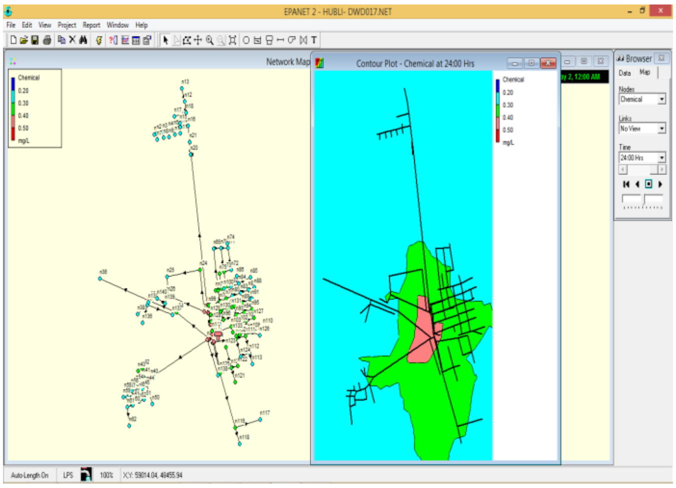

**Fig-5:** Map showing chlorine concentration at 11pm

### 3.2.2 AGE OF WATER IN THE WATER DISTRIBUTION NETWORK

The EPANET software can also be used to generate water age map corresponding to different time period. In the present it is demonstrate to show the water age corresponding to three time intervals such as 1 to 8 hours, 8 to 16 hours and 16 to 24 hours. The results showing graphical representation of the age of water in the network corresponding to the above time intervals are shown in the figure 6, 7, 8. The water age is indicated with colors on contour map, blue colour indicates water age as less than 1hours, light blue color indicates water age ranging from 1hours to 8hours, green color indicates water age ranging from 8hours to 16hours, pink color indicates water age ranging from 16hours to 24hours and red color indicates >24hours.

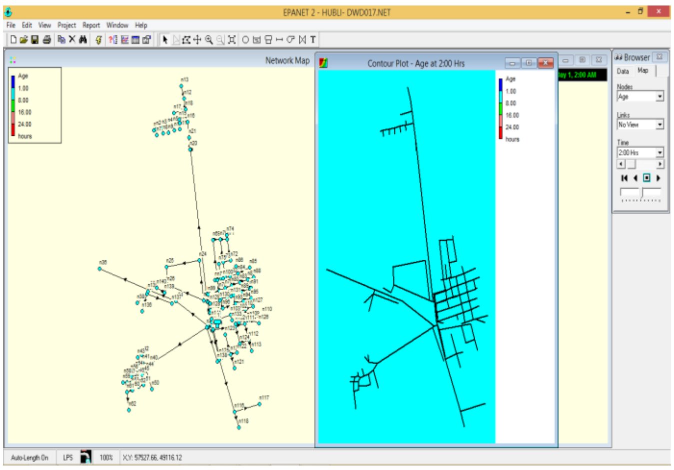

**Fig-6:** Water age for the entire network in 1 to 8 hours

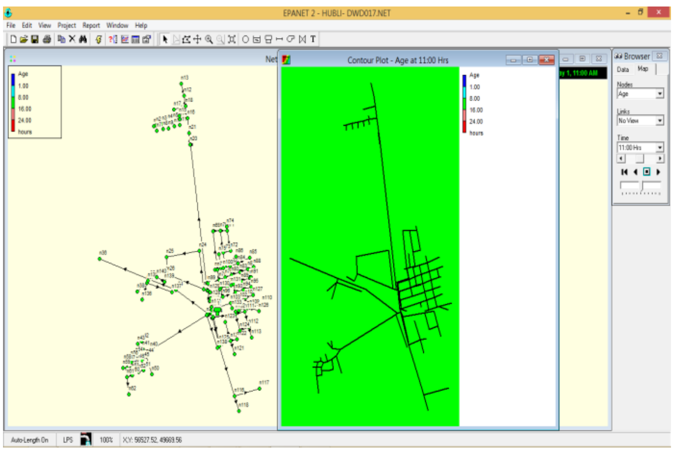

**Fig-7:** Water age for the entire network in 8 to 16 hours

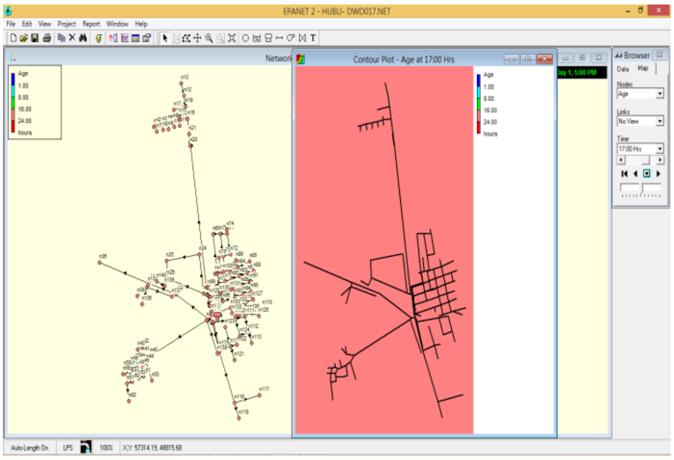

**Fig-8:** Water age for the entire network in 16 to 24 hours

## 5. CONCLUSIONS

An attempt made in remodeling of existing water distribution network adopting 24×7 water supply shows good results satisfying the desired limits of hydraulic and water quality parameters as per WHO and CPHEEO. The results of analysis are as listed below:

- The present network model is remodeled for the future 30 years.
- The analysis is done for 24×7 water supply satisfying the norms of WHO and CPHEEO.
- The desired residual pressure and flow at all the nodes and links are met as per the standard of central public health environment engineering organization (CPHEEO) manual.
- The residual chorine in the water distribution system satisfies the guidelines of world health organization (WHO).
- The water distribution network remodeled using EPANET gives the satisfactory results for the proposed diameter of the pipe, pressure, head loss and velocity.

The analysis will help us to know the deficiencies, if any, in the water distribution network working, operation and its management.

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