Impact Factor (SJIF): 3.632

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 3, Issue 7, July-2016

Water Supply Network Study of Sanand using Remote Sensing and GIS Techniques

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Abstract *— Water distribution systems constitute a vital part of civil infrastructure. An increasing demand for water due to population growth, industrial development and improvement of economic require management of water transfer and improve operation of distributed network systems. Design of water supply systems is one of this issues that can be mapping and analyses using GIS and RS techniques. The purpose of a water distribution system is to ensure the supply of water to users at spatter of urban expansion over the demographic change and land use modifications has also indicated that urban growth has mainly taken place linearly along the major roads in the study area.*

Keywords- Water supply Network, GIS, Remote sensing, EPANET,

I. INTRODUCTION

Water supply system (WSS) is a complex system that integrates several spatial features. Water supply systemic a structure of collection, storage, and distribution of the water for homes, commercial establishments, industry, and irrigation and for other purposes. In all cases, the water must fulfill both quality and quantity requirements. Design of the water supply system is related with the location and storage capacity of tank. Geographical Information System (GIS) is help to prepare and visualize the entire water supply network from source to household. The supplied water should be good in quality and sufficient in quantity.

II. TYPE WATER DISTRIBUTION SYSTEM

(1) RADIAL SYSTEM

The area is divided into the different zones in this system. Then the water is pumped to the distribution reservoir from the main source as shown in fig.

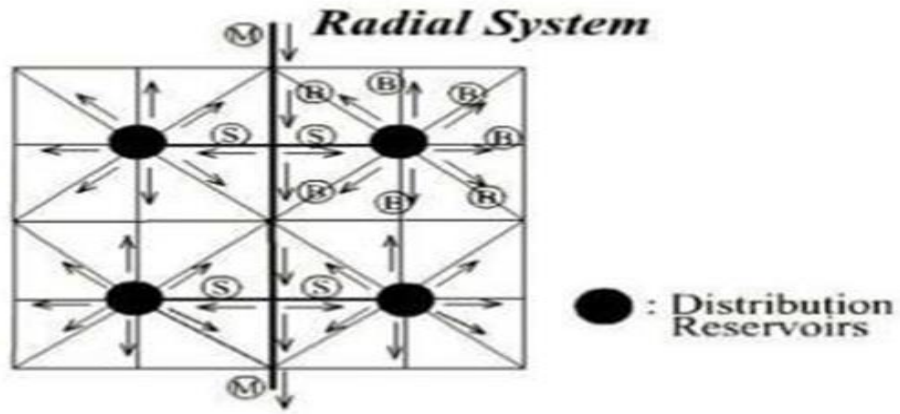


Fig. 1: Radial System

(2) Grid Iron System

This system is more suitable for the cities which have the rectangular layout. In this system, the main and branch pipes are laid in rectangles.

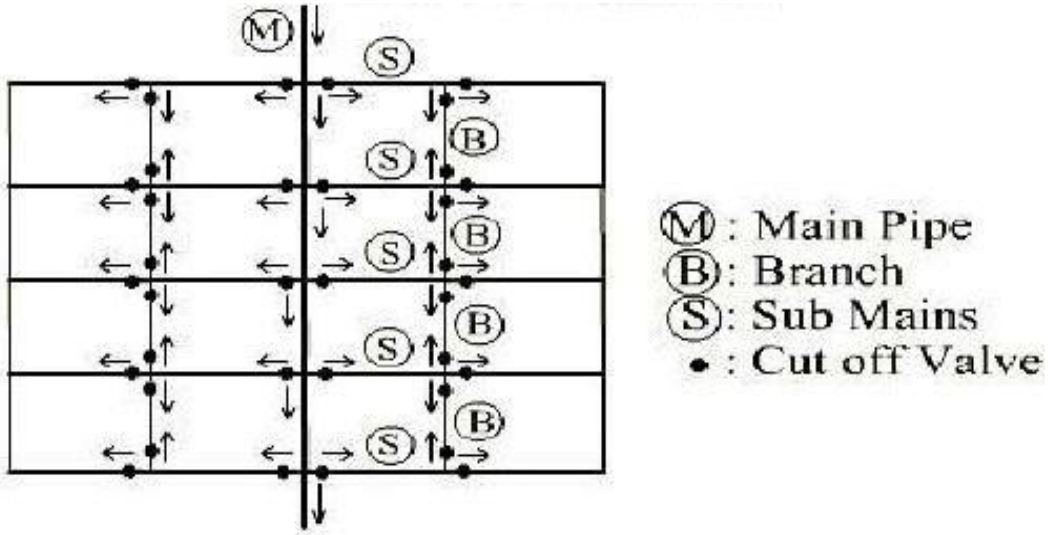


Fig.2: Grid Iron System

(3) Ring System

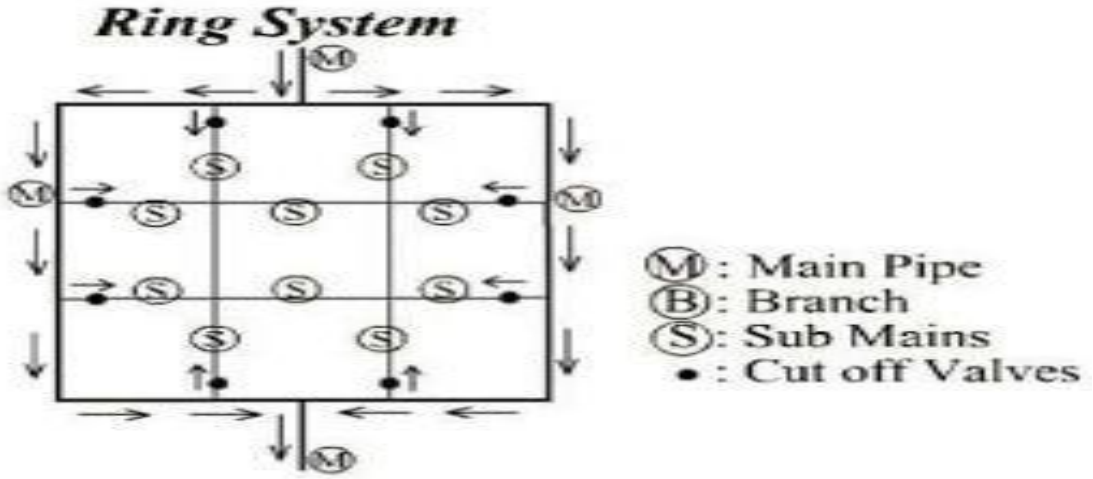


Fig.3: Ring System

In this system, the main supply pipes are laid on the peripheral roads and branch pipes are out from the main pipes.

(4) Dead End System

This system is more suitable for the old cities which having no definite pattern of roads. The planning of the water supply network is mainly depending on the population growth. . In this study, also discuss the basic concept of Remote Sensing and Geographic Information System. Remote Sensing is the process of get the information of any object without coming into physical contact

with the objects. After taking the images of the objects, important information is provided regarding the object. GIS play a major role by providing the linkage between the available technology and information domain.

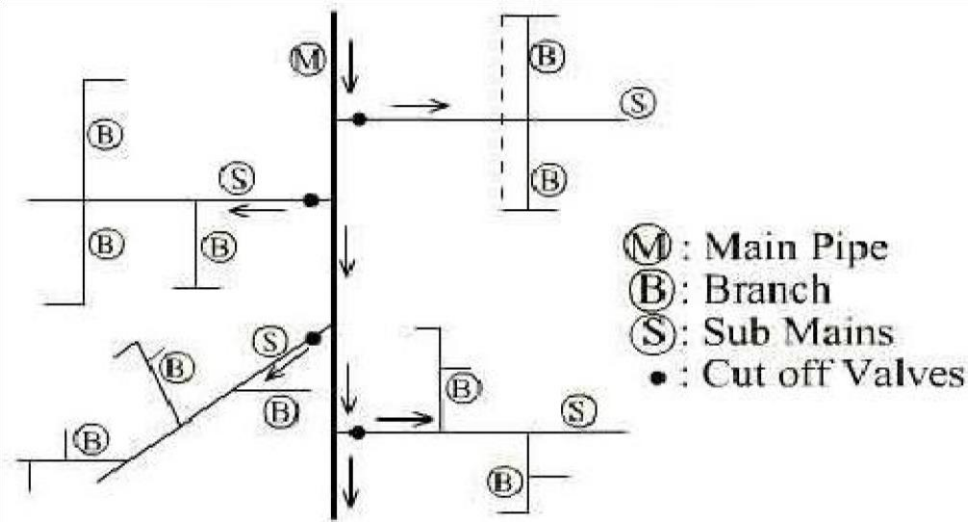


Fig.4: Dead End System

III. NEED OF THIS STUDY

The population is increased in urban area and also in rural. There is done the large development in this area. So that water demand is increased for residential, industrial and other purposes. As per IS code 1172:1993, the water requirement for rural area is 100 plod and for urban area is 135 plod. In this area, the water is supplied as per 70 lpcd. That's why existing water distribution system is to be analyzed.

IV. SCOPE OF STUDY

- The assessment of existing water supply system will help in understanding the water distribution requirement of this area for the better utilization and management of water.
- GIS based assessment of the Water Supply System will give the precise result.
- By using the EPANET software, the results can be obtained accurately with saving time.
- The modification of WSS will be easily done, if require.

1.4 OBJECTIVES OF STUDY

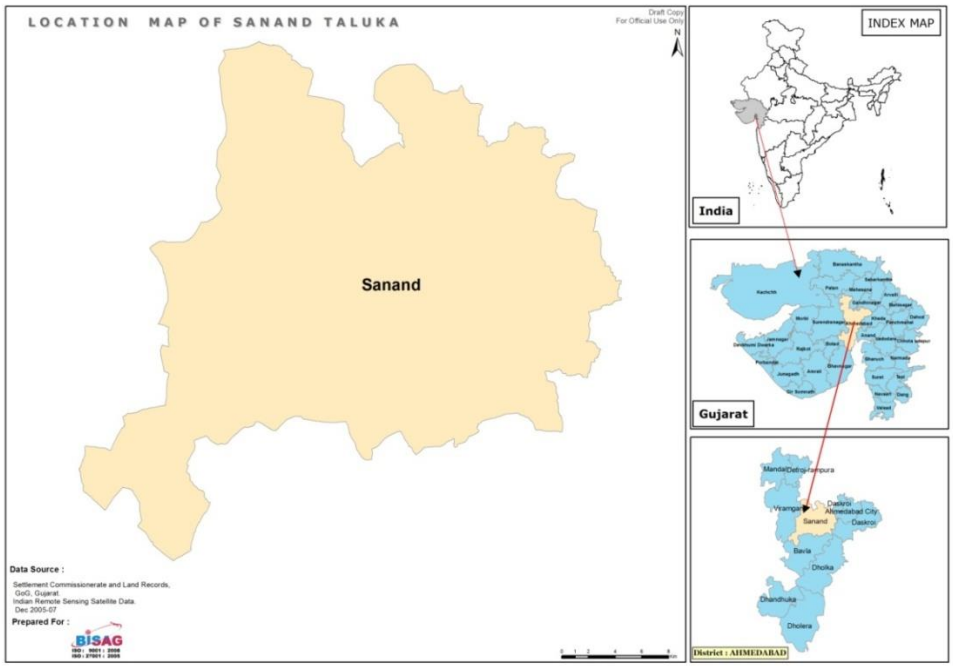
- Evaluation of existing water supply system of Sanand taluka using geoinformatics techniques and EPANET software.
- Suggestions for the modifications of water supply system considering the present and future requirement of the study area.

4.1 Study Area

In the Present study, the study area is taken Sanand, Gujarat. Sanand is located In Ahmedabad district. Sanand is Larger Talukas in Sujalam Suflam Water Supply A-2 Scheme.

4.2 Location

Sanand 72.3833' East (Longitude) to 22.9833' North (Latitude) on the world map. Geographical area of the talukas is 2,163, 48 sq.km. sanand has an average elevation of 38 meters (124 feet). The city is north-central-East Gujarat. The 6230 km^2 area around sanand is a city and a municipality in Ahmedabad district.



METHODOLOGY

Review of the literature and selection of study area.

□□Collection of the data from government organisations such as GWSSB and

BISAG like population data, water demand data, road network data, land use/land covers data, existing water distribution map etc.

□□Preparation of various thematic layers such as land use map, road network map, soil map, slope map by using Remote Sensing and GIS.

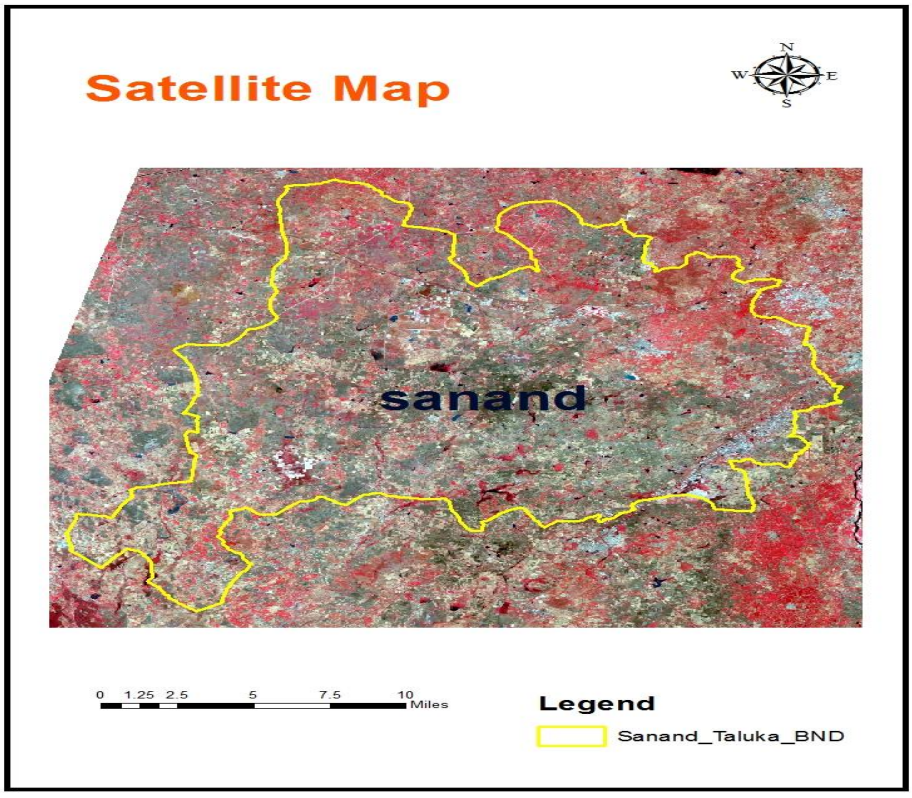
□□Overlaying of various thematic layers for analysis.

□□By input the data like elevation, length of pipe, base demand at each node, diameter of pipe, the results such as velocity, head loss in pipe, pressure at each node are obtained from EPANET

□□Analysis of spatial data (thematic layers) and non-spatial data (results of EPANET.

□□Suggestion of modification of existing water supply system.

5.1.1 Satellite image:

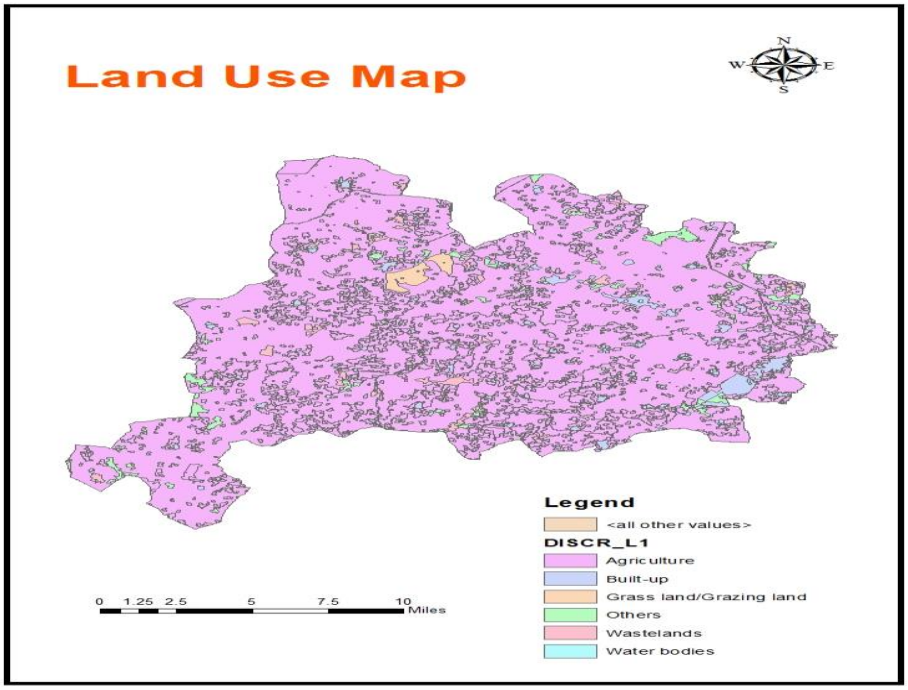


5.2.1 Land Use/Land Cover Map

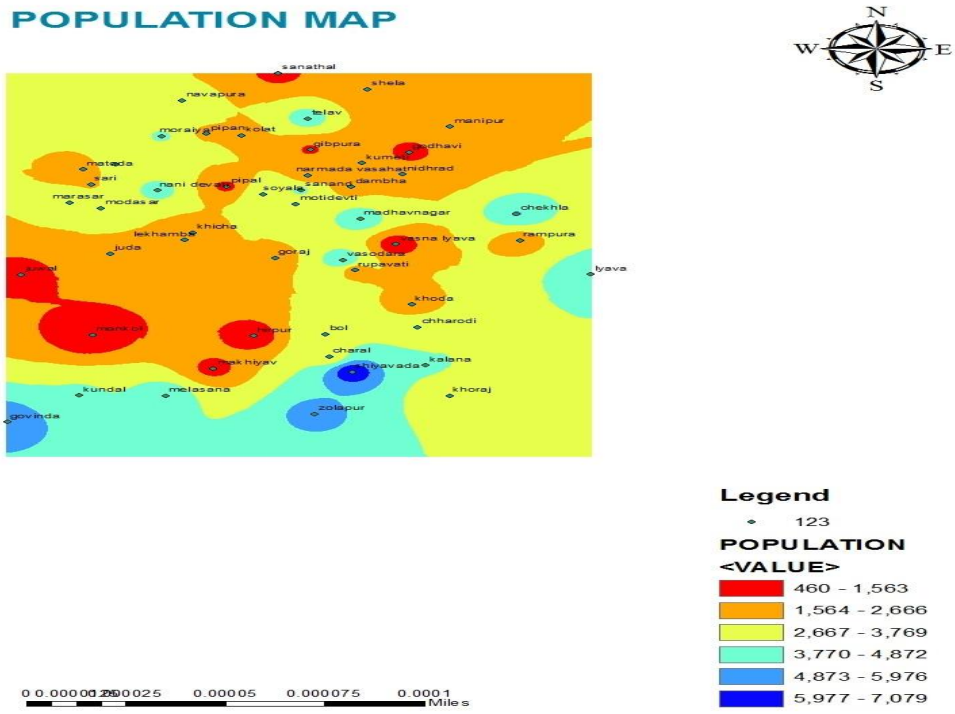
Land cover map shows that how much of area is covered by forests, water body,road, agriculture etc.

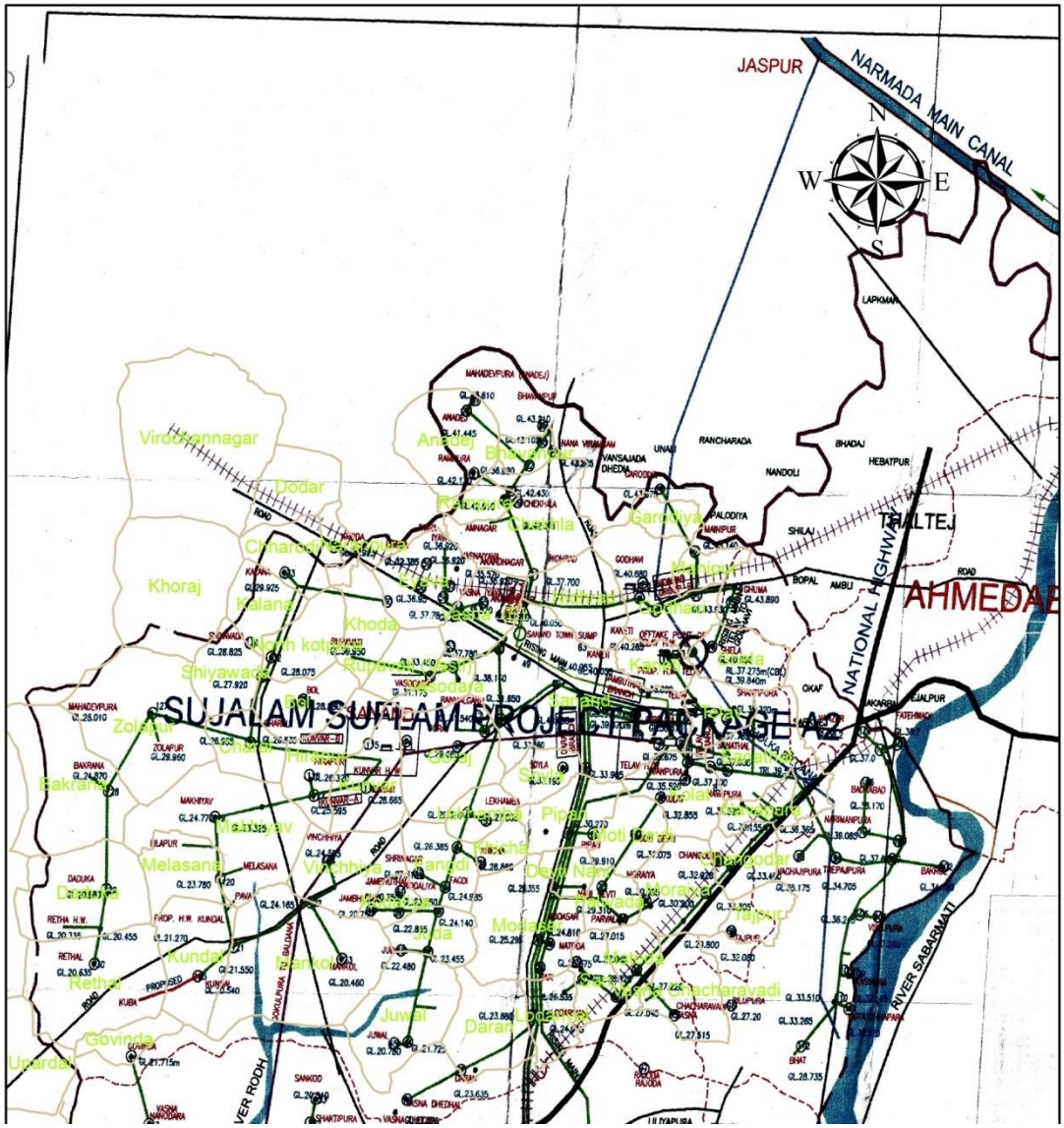
Land use shows that how people use the land for different purposes. Land use map is related with the socio-economic activity such as water network, parking, garden and school etc.

Land use map is used to identify the existing condition and future development of that particular area. Land Use/Land Cover Map is very useful in planning of the water supply network.



Population data:

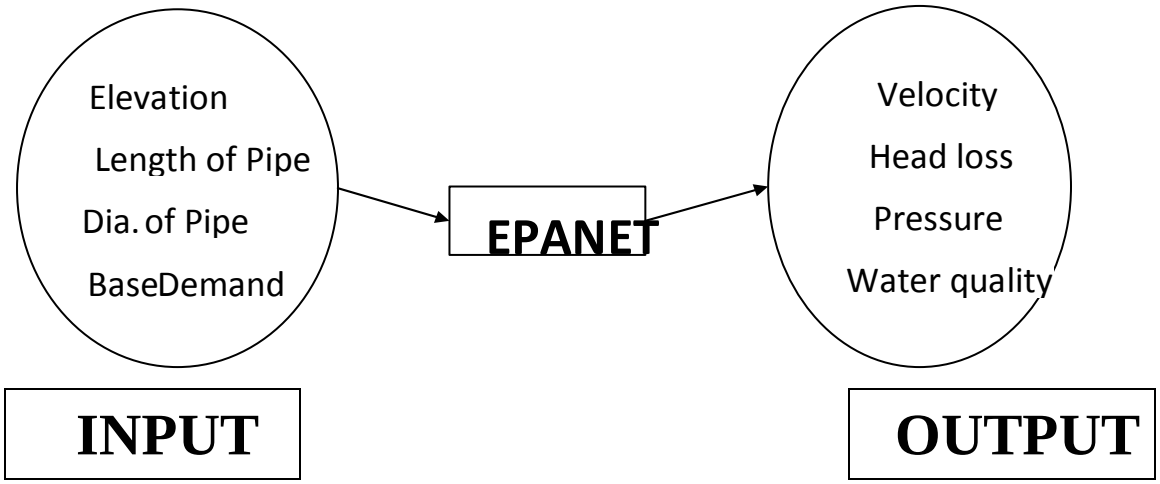


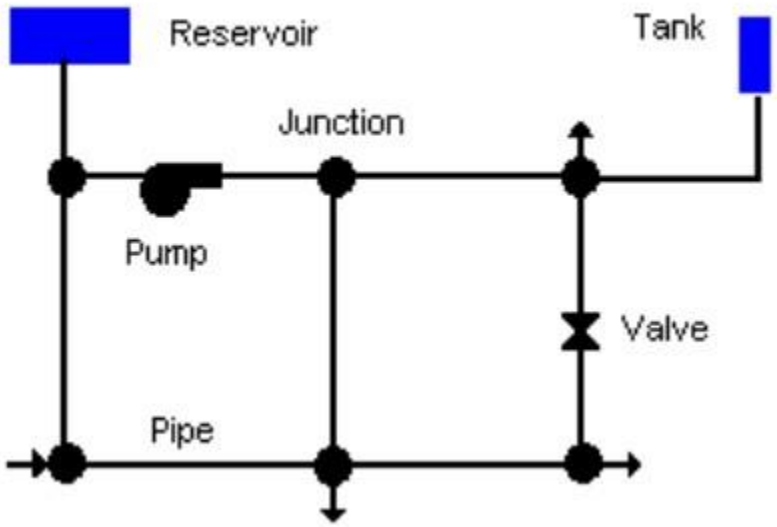


5.4 EPANET software:

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.





Pipe report:

Pipes are links that convey water from one point in the network to another. EPANETassumes that all pipes are full at all times. Flow direction is from the end at higher hydraulic head (internal energy perweight of water) to that at lower head.

The principal hydraulic input parameters for pipes are:

- start and end nodes
- diameter
- length
- roughness coefficient (for determining head loss)
- status (open, closed, or contains a check valve)

The hydraulic head lost by water flowing in a pipe due to friction with the pipe Wall scan be computed using one of three different formulas:

- Hazen-Williams formula
- Darcy-Weisbach formula
- Chezy-Manning formula

The Hazen-Williams formula is the most commonly used head loss formula .It cannot be used for liquids other than water and was originally developed for turbulent flow only. The Darcy-Weisbach formula is the most theoretically correct. It applies over all flow regimes and to all liquids. The Cheesy-Manning formula is morecommonly used for open channel flow.

Table Pipe Head loss Formula

Formula	*Resistance Coefficient (A)*	*Flow Exponent (B)*
Hazen-Williams	$4.727\ C^{-1.852}\ d^{-4.871}\ L$	1.852
Darcy-Weisbach	$0.0252\ f(\varepsilon,d,q)d^{-5}L$	2
Chezy-Manning	$4.66\ n^2\ d^{-5.33}\ L$	2

Notes: C = Hazen-Williams roughness coefficient
ε = Darcy-Weisbach roughness coefficient (ft)
f = friction factor (dependent on ε, d, and q)
n = Manning roughness coefficient
d = pipe diameter (ft)
L = pipe length (ft)
q = flow rate (cfs)

Table Roughness Coefficients

Material	*Hazen-Williams C (unitless)*	*Darcy-Weisbach ε (feet x 10^{-3})*	*Manning's n (unitless)*
Cast Iron	130 – 140	0.85	0.012 - 0.015
Concrete or Concrete Lined	120 – 140	1.0 - 10	0.012 - 0.017
Galvanized Iron	120	0.5	0.015 - 0.017
Plastic	140 – 150	0.005	0.011 - 0.015
Steel	140 – 150	0.15	0.015 - 0.017
Vitrified Clay	110		0.013 - 0.015

SUMMARY

The assessment of Water Supply System is carried out for three zones using Goo informatics technology and EPANET software. The population and water demand are estimated. The various thematic maps such as land use, road network, slope and soil maps are generated in Arc map. The geo-referencing and overlaying of these thematic maps are carried out. The inputs such as elevation of nodes and length of pipes are recorded from the Google earth image. These data used in this software for the analysis of pressure and head loss. The results such as pressure and head loss for Telav zone, Kunvar zone and Nidhrad zone are obtained using EPANET software. The outcome results for these three zones are analysed. The unit head loss for the Telav zone is compared for the water supply of 70 lpcd and 100 lpcd. Comparison of head loss:

CONCLUSION

In this thesis, the main focus is to check the adequacy of the existing Water Supply System. At the end of analysis it was found that the pressures at all junctions are adequate enough to provide water in the case of 70 lpcd water supply. But when we increased the water supply up to 100 lpcd that time the pressures at all junctions are reduced and head loss in all pipes are increased. Thus we can conclude that before supply the 100 lpcd water, there should be increased the diameter of pipes. Thesuggestions for the modification of diameter of pipes for these three zones are shown table 5.13, 5.14, 5.15. This study would help to the engineers as this process is fast.

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