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Augmentation to Amravati Water Supply Scheme

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ABSTRACT: Water Distribution Network is necessary infrastructure for supply of water. It connects consumers to sources of water using hydraulic components such as pipes, valves, pumps and tanks. The primary aim of water distribution network is to deliver water to meet the demands on pressure and quality. WaterGEMS is hydraulic modeling software which is used for analysis and design of water distribution network. The study presents hydraulic analysis of AUGMENTATION TO AMRAVATI WATER SUPPLY SCHEME. Google Earth used for ensuring layout of water distribution network and Satellite image of study area shown effectiveness for selection of alternate alignment of road. Steady state analysis has been carried out for calculation of hydraulic parameter such as head pressure and flow rate. The result obtained verified that the pressure at all junction and the flows with their velocities at all pipes are feasible enough to provide adequate water to the network of study area.

I. INTRODUCTION

The ancient name of Amravati is "Udumbravati", prakrut form of this is "Umbravati" and "Amravati" is known for many centuries with this name. The mispronunciation form of this is Amravati and now the Amravati is known with the same. It is said that Amravati is named for its ancient Ambadevi temple. The ancient proof of existence of Amravati can get from stone carved inscription on the base of marble statue of God Adinath (Jain God) Rhishabhnath. This shows that, these statues were set up here in 1097. Govind Maha Prabhu visited Amravati in 13 th century, at the same time Warhad was under the rule of Deogiri's Hindu King (Yadav). In 14th century, there was famine (drought) in Amravati & people abandoned Amravati and left for Gujrat and Malva. The local people were returned back after several years at Amravati, the result of this was scanty population. In 16 th century, Mager Aurangpura (today's, 'Sabanpura') was presented for Jumma Majseed by Badashah Aurangzeb. This reveals that Muslims and Hindus lived together here.

PRESENT STATUS & AMRAVATI W.S.S

1. Source: Upper Wardha Dam, Morshi approximately 60 km from WTP site.
2. Intake work: Intake well in R.C.C. is located in right bank divide wall of the dam. Intake well of 3.0x 8.0m size and 1250mm dia. MS outlet pipe are embedded in the masonry portion of the dam.
3. Raw water connecting main: Raw water connecting main of 1250mm dia MS pipe is laid from outlet of dam to raw water sump of length 600m.
4. Raw water sump and pump house: Raw water sump and pump house constructed in R.C.C.
5. Raw Water Pumping Machinery: Total 5 numbers of 750BHP were installed including 2 stand by.
6. Raw water rising main: 1422mm outer dia. MS pipe around 23.00km in length laid from sump to BPT.
7. Break Pressure Tank at Ner Pinglai Gad of capacity 8 lakhs litre.
8. Raw water gravity main of 1500mm dia PSC pipe of length around 31km laid from BPT at NerPinglai Gad to WTP at Taovan, Amravati.
9. Water treatment plant: 95 MLD old treatment plant and work of 61 MLD plant is ongoing under Amrut Abhiyan.
10. Transmission Mains: Transmission mains are laid from MBR at Tapovan WTP to 24 ESR/GSR ranging from 1600mm dia to 600 mm dia. DI/PSC pipeline approximate length 19.33km and are working flawlessly.
11. Distribution system: Distribution system includes various types of pipe viz. CI/DI/PVC/AC/HDPE material and of diameters ranging from 400mm to 80mm approximate length 350 km.

II. DETAILS OF ONGOING SCHEME IN AMRAVATI

Necessity of Scheme under Amrut Abhiyan:

Meanwhile from year 1994 Amravati city undergone huge development majorly horizontal development. Due to vast development, due to increasing population and in new areas it became important to augment the scheme for future requirement. The scheme was proposed with base year 2018 and intermediate year 2033 and Ultimate year 2048 with 135 lpcd. It was noticed from Population forecast for the year 2033 and 2048 that the Ultimate year demand for the year

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2016 calculated for old scheme (1994) which was 156 MLD was redundant because forecasted population for the year 2016 (as per old scheme was not achieved). Thus the new scheme under Amrut was proposed. Only with 156 MLD capacity for intermediate stage year 2033

As per the scheme of 1994 Jack Well, Raw Water Gravity Main, BPT, Pure water Rising main, Pure water Gravity Main were all designed for the 156 MLD. Hence these components were proposed to be used in the new scheme under Amrut. As existing WTP capacity is 95 MLD, it was proposed to be augmented to 156MLD from 95MLD and new conventional WTP of capacity 61 MLD was proposed. In this scheme additional Capacity ESRs were proposed to cater the demand of intermediate year 2033 which will be 156 MLD and additional leading mains and distribution system was designed for ultimate year 2048 as per the records available. The following works were included in Amrut Abhiyan so that people in new locality will get benefit of water supply scheme.

1. Replacing, damaged existing Air valve Isolating 200 mm dia sluice valve by C.I. PN 1.6 rating Glandless new sluice valve on 1422 mm dia M.S. rising main from H/W Simbhora to BPT @ Nerpinglai, 1500 mm dia PSC G/M from Nerpingali to WTP Tapovan:- In this work 112 Air valves and sluice valves are to be replaced with tamperproof Air valves to avoid leakages and NRW.
2. Designing Providing & constructing & Commissioning conventional Water Treatment Plant of Cap. 61 Mld at Tapovan:- In this work 61MLD capacity WTP is proposed to achieve 156MLD capacity for which the Headworks is designed.
3. Lowering, Laying and Jointing Transmission Main for Connecting New proposed ESR:- In this work nearly 16km DI pipeline of various diameter to serve the newly built ESR is included.
4. Designing and constructing RCC Ground service reservoirs of various capacity & RCC Elevated service reservoir of various capacity & staging heights in Amrvati city: In this work 9 ESR and 2 GSR of capacity 1 to 2 ML design and construction work is proposed.
5. Providing, Lowering, Laying and Jointing D.I/ H.D.P.E. Pipes 90 mm dia to 400 mm dia. for replaces pipe line in Distribution System IN ALL ZONES: In this work, nearly 260km old existing pipeline of PVC/AC/GI pipeline replacement work is proposed. The pipelines are replaced with HDPE pipes and the service connections of existing consumers are also shifted to new pipeline.
6. Providing, Lowering, Laying and Jointing D.I/ H.D.P.E. Pipes 90 mm dia to 400 mm dia. for proposed & extended area in Distribution System IN ALL ZONES: In this work, nearly 251km pipeline of HDPE material is proposed for new areas.
7. Repairs to old existing RCC ESR at various places in Amravati city: In this work repairs to existing RCC ESR are proposed such as Chain link fencing, coloring, water level indicator, lightening arrester etc. are proposed.
8. Raw Water Pumping Machinery: In this work, old existing 750HP pumps at Simbhora Pumping Station were replaced by new 900HP pumps 5 Nos to enhance the pumping capacity to 156MLD.

Above Amrut work was accorded Technical sanction as per letter No.531, dated.29.3.2016 for Net cost Rs. 11914.75 lakh and Administrative Approval vide GR Amrut-2016/Ch. No. 145(1)/UD-33 Dated.23/6/2016 for net cost Rs.114.35 Crore. All above works are completed successfully & scheme is running smoothly.

III. POPULATION FORECAST AND WATER DEMAND

a) Population Forecast

Population forecasting is based upon the traditional methods considering the base year (2025), Intermediate stage (2040) population is forecasted as per 3 methods and as per general guidelines by taking average of Three i.e. Arithmetic progression, Geometric Progression & Incremental Increase method population is finalized for PFR purpose and population adopted as below. Details of Population projection for MENS & ANIMALS are worked out separately

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Design Criteria / Data

Sr.No.	Particulars		Data	
1	Population			
		Census	Population	
		1981	261387	souls
		1991	433746	souls
		2001	549510	souls
		2011	647057	souls
		2021	869590	souls
2	Decade Rate of Growth (2011-2021)		34.39	%
3	Design Period of Scheme		Statement attached separately	
4	Preparation, Tendering & Execution Period of scheme		3	Years
5	Projected Stage (Year)			
	Immediate Stage (Year)		2025	
	Intermediate Stage (Year)		2040	
	Ultimate Stage (Year)		2055	
6	Floating population	2025	50000	
7	Rate of water supply for floating population		45	lpcd
8	Institutional Demand		15	% of total demand
6	Domestic Rate of Supply		135	lpcd
7	Fire fighting Demand		100(P^0.5)	or min 5 % of total demand
8	System Losses		15	%
9	System Hours		23	Hrs

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POPULATION FORECAST

Year	Population	Increment X	Incremental Increase-Y	Rate of growth per decade
1981	261387			
1991	433746	172359		0.659
2001	549510	115764	-56595	0.267
2011	647057	97547	-18217	0.178
2021	869590	222533	124986	0.344
Total	2761290	608203	50174	**1.448**
Average	552258	152051.00	16724.67	**0.362**
			Geometric mean, r_g =	**0.322**

First population year **1981** **40**

Last population year **2021**

ESTIMATION OF FUTURE POPULATION FOR THE YEAR

Sr. No.	Year	No.of years	No. of Decade
1	2025	4	0.4
2	2040	19	1.9
3	2055	34	3.4

1) Geomentrical Progression Method

Population for 2025 Population in 2011* $(1+r_g)$^no. of decade

= 869590 * 1.12

= **972302**

Population for 2040 Population in 2011* $(1+r_g)$^no. of decade

= 869590 * 1.70

= **1477835**

Population for 2055 Population in 2011* $(1+r_g)$^no. of decade

= 869590 * 2.58

= **2246212**

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2) Incremental Increase Method

Pn = P1 + nX + n (n+1) Y/ 2

P1 Population of 2011

n No of decade from 2011 to Pn--

Population for 2025 **Pn + nX + n(n+1)Y/2**

935093

Population for 2040 **Pn + nX + n(n+1)Y/2**

1204563

Population for 2055 **Pn + nX + n(n+1)Y/2**

1511664

3) Arithmatic Increase Method

Pn = P1 + nX + n (n+1) Y/ 2

P1 Population of 2011

n No of decade from 2011 to Pn--

Population for 2025 **Pn + nX**

930410

Population for 2040 **Pn + nX**

1158487

Population for 2055 **Pn + nX**

1386563

Year	*Geometric Progression*	*Incremental Increase*	*Arithmatic Increase*	*Decadal Growth Method*	*Average of G.P., I.I. and A.I. Method*	*Average of I.I. and A.I. Method*
Population for 2025	*972302*	*935093*	*930410*	989216	*945935*	*932752*
Population for 2040	*1477835*	*1204563*	*1158487*	1499526	*1280295*	*1181525*
Population for 2055	*2246212*	*1511664*	*1386563*	2273092	*1714813*	*1449114*

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b) Water Demand

Statement Showing Yearly Requirement Calculations

Sr. No.		Particulars	Year			Unit
			2025	2040	2055	
1		2	3	4	5	7
1		Total Design Population	**932487**	**1181492**	**1451249**	Souls
2		**Daily Domestic Demand**				
	a	Design Population	932487	1181492	1451249	Souls
	b	Domestic Rate of Water Supply	135	135	135	lpcd
	c	Daily Domestic demand	**125885745**	**159501420**	**195918615**	Lit.
3		**Other Demand**				
	1	Floating Population	50000	63335	77679	Souls
	a	Rate of Water Supply	45	45	45	lpcd
	b	Daily Demand	**2250000**	**2850075**	**3495555**	Lit.
4		Daily Institutional / Industrial and commercial Demand as per statement 15%	18882862	23925213	29387792	Lit.
5		Fire Demand	0	0	0	Lit.
6		**Daily Total Demand (4+5+6)**	**147018607**	**186276708**	**228801962**	**Lit.**
7		Daily Demand at E.S.R. considering 10 % losses in Distribution System	163354008	206974120	254224403	Lit.
8		Daily Demand at exist of W.T.P.. considering 1 % losses in Pure Water Gravity Main	165004048	209064768	256792326	Lit.
9		Daily Demand at Entrance of W.T.P. considering 3 % Backwash losses in W.T.P.	170107266	215530689	264734357	Lit.
10		Total Daily Demand at Head Works Considering 1 % Losses of Raw water Gmain/Rmain	171825521	217707767	267408441	Lit.
11		Yearly Requirement of Water at Head Works	62716315165	79463334955	97604080965	Lit.
			62716.32	79463.33	97604.08	ML
			62.716	**79.463**	**97.604**	**MM^3**

PROPOSED CIVIL WORKS

1. **Providing & L/L/J of Gravity Main – 1950mm dia**

   In this Subwork, existing 1500mm PSC gravity main in proposed to be replaced by 1950mm diameter Mild Steel Gravity Main which will cater demand of year 2055. For population forecast, average of Arithmetic Increase & Incremental Increase Method is assumed; population of last 5 decades upto 2021 is taken into account as per instructions of CPDM. Population of year 2021 is certified from Amravati Municipal Corporation.
2. **Providing & L/L/J of Rising Main – 1400mm dia**

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In this Subwork, new parallel rising main of Mild Steel and of 1400mm diameter will be laid parallel to existing 1400mm MS rising main. In the year 2055, demand will be met by two rising mains working simultaneously.

3. **Construction of RCC GSR of capacity 4.5ML at Maltekdi & RCC ESR as a Surge Tank at Simbhora Headworks**

In this Subwork, RCC GSR is proposed as a replacement of existing GSR which was constructed nearly 40 years before and is now deteriorating at a faster rate. The new GSR is of same capacity as old one which will cater most of the City water supply demand.

RCC ESR of 3,30,000 Litres capacity and staging height 17m is proposed at Simbhora Headworks which will act as a Surge Tank to prevent water hammer effect produced in the rising main.

IV. PROPOSED MECHANICAL WORKS

Following works are proposed in this proposal for Amravati Water Supply Scheme.

1. **R/W pumping machinery at Simbhora H/W - 900 HP VT Pumps - 3 Nos**

Previous Amravati Water Supply Scheme was designed for 95 MLD demand and for this 750 HP - 5Nos (3 Working + 2 Standby) were operating at Simbhora H/W. At present City demand is 156 MLD so total 8 Nos of VT Pumps are in operation at Simbhora H/W out of which working 5 Nos 900 HP VT Pumps (Q - 1365000 LPH , Head - 121 mtr) are successfully installed and commissioned under Amrut Abhiyan in December – 2018 and old existing 750 HP - 3 Nos VT Pumps (Q - 1368000 LPH, Head – 107 mtr) are used as standby arrangement for 900 HP VT Pumps as per instructions of Hon. Member Secretary vide letter No. MJP/Amrut/613 dated 01.09.2017. But as these 750 HP - 3 Nos Pumps are near about 26 years old, some operational faults occur frequently also efficiency of pumps decreased due to which O & M and electric bill expenditure on Scheme increases. So for giving efficient and uninterrupted water supply to city it's necessary to replace these old 750 HP - 3 Nos VT Pumps by new 900 HP - 3 Nos VT Pumps.

Similarly, all substation, Control and Relay panel, EOT, MS common header equipments were installed in the year of 1994 hence practically their life span is over. These equipments are not suitable as far as operation and safety is concerned. Hence, all these equipments are considered for replacement. Existing system consists of one conventional air vessel which frequently needs maintenance. Hence we are retrofitting it with Bladder vessel which is maintenance free water hammer control device (73 Cum suitable for 156 MLD). There is a separate parallel rising main is proposed with existing one. Hence we have proposed a separate bladder vessel (73 Cum suitable for 156 MLD) for proposed rising m

2. **Replacement of Blowers, Recirculation Pumps, Substation LT Panels, etc. at 95 MLD WTP, Tapovan**

Blowers – 2 Nos, Recirculation Pumps (Q - 250000 LPH & Head - 18mtr) - 4 Nos, Transformers, CLF Gear boxes, Gas Chlorination System, Filter media, LT Panels and other allied elect/mech equipments at 95 MLD WTP are near about 26 years old so these give less performance and somewhat operation & maintenance problems occur because of which O & M expenditure of scheme increases. So replacement of all these is necessary.

Also, Tapovan Water Treatment Plant is in "A" Category as far as security is concerned. Hence highmast towers and surveillance system proposed for security purpose.

3. **Pure water pumping machinery at Maltekadi Pumping station**

100 HP Centrifugal Pumps - 3 Nos at Maltekadi are near about 26 years old so here replacement of these 3 pumps, motors and other allied equipments is proposed.

4. **Standby Transformer for Maltekadi Pumping Station**

Since in rainy season or at any instant some faults occur in transformer, water supply to city from this pumping station get disturbed, to avoid this standby transformer arrangement is essential. So here standby transformer with substation is proposed.

5. **Converting 33 kV OH Express Feeder to UG Cable at Head Works Simbhora and Provision for Shifting Existing Overhead Feeders along the alignment of Rising and Gravity Main**

Simbhora pumping station is powered with 33 kV express feeder from Morshi Substation which is around 10 km away. Existing feeder is an overhead line mainly on PSC poles and laid cross country. During rainy season uncontrolled growth of trees and vines, interference of wild animals like monkeys, wind and lightning causes frequent tripping of feeder. A Single trip even of the 5 minutes duration tends to cause 1 hour of pumping loss. Hence, 10 km (Double Run) 33 kV Underground express feeder is proposed.

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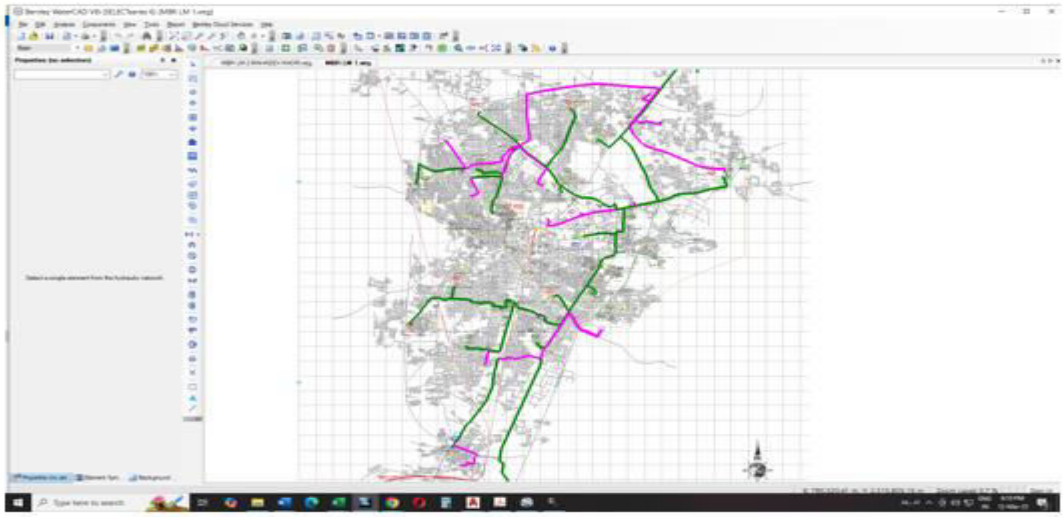
V. METHODOLOGY

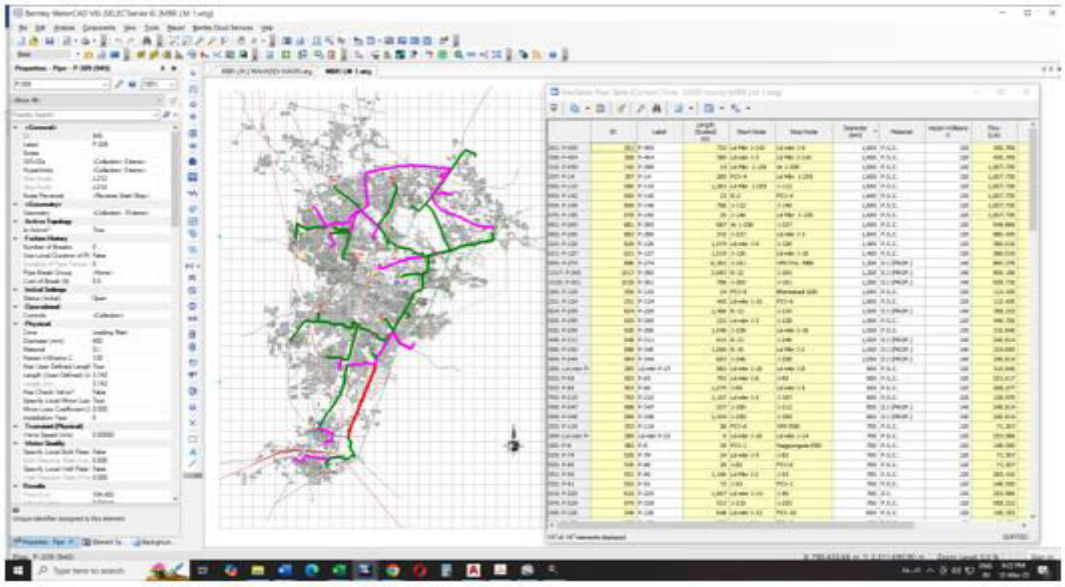
Methodology Flow Chart consist of following steps

1) Take Road map of the study area from Google earth map.
2) Draw water distribution network in WaterGEMS software.
3) Put the value of design constraints,
4) Specify population based peak factor as per CPHEEO manual.
5) Validate and compute the network.

In the given network the ductile iron pipes are used and the different colors of pipe show different diameters.
After completing the design of network, then the network is divided into four different zones. After dividing the networks successfully in four different zones then the pipe diameters are provided for each pipe. Then the complete network is designed and finally the network is computed. After computation of network the next step is to validate the results and if there are errors in network then those errors are adjusted and further the network is validated. Finally, the results for pipe network are obtained as follows.



PIPE NETWORK WTP TO MBR & ESR



PIPE NETWORK WITH REPORT

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VI. RESEARCH METHODOLOGY

- To collect & compile survey data, details of zones & plots in the Amravati city area, available with the PHED, Municipal Corporation, and other authority.
- To take help of officers and other concerned persons of the Public Health Engineering Department, who have experience of city problems related to water supply system.
- To collect the data of total station survey as per requirement and prepare a digital map of water supply network.
- To prepare hydraulic design and estimates of proposed project on the basis of latest SOR (Schedule of Rates) of SSRMJP, MPPHED, MPPWD, MPWRD, including detailed rate analysis of items.
- Fixing location of over head tank, location of existing water supply network etc.
- Assessment of the existing capacity of water treatment plants. Upgrading will be carried out the same and proposed new water treatment plant if required.
- Assessment of water quantity likely to collect from existing water supply system including consumption of water in city area and for utilization of available capacity for the proposed area.

VII. CONCLUSION

In this paper WaterGEMS software is used for obtaining optimal design of water supply network of Amravati City. The software also gives different alternative optimal design solution considering pipe diameters and pipe material. The WaterGEMS software provide required standard and economic environment for design, analysis and troubleshooting of new and existing supply network with accuracy and minimum time duration. The software is also used for solving problems in existing network and also in expansion of existing water supply network.

REFERENCES

1. Arpita Bansal ,M. Plan (Urban and Regional Planning), B. Arch-“ Mega Events as Catalyst for Urban Transformation
2. Dhumal J.R, Danale M.S. and Jadhav G.H.(Mrach-2018)- " Design of Continuous Water Supply System by Using Watergems", ISBN :978-93-87793-03-3
3. Dr. R.M. Damgir, Supriya Patil –Maharashtra, India (June-2017)-“Hydraulic Modelling of Water Distribution System with Refrence to Technical Sustainability by using WaterGems” ISSN :2347-6710, vol.6 Issue 6,June-2017
4. Dr. Sanjay and V. Dahasahasra - Member Secretary Maharashtra Jeevan Pradhikaran Mumbai, India . (Aug 2007) “A model for transforming an intermittent into a 24x7 water supply system”Case-Study .
5. Elsheikh M. A., Salem H.I., Rashwan I.M. and El-Samadoni M.M. (2013), “Hydraulic modelling of water supply distribution for improving its quantity and quality”, Sustain. Environ. Res., 23(6), 403-411.
6. Machell J., S. R. Mounce, and J. B. Boxall (2010), “Online modelling of water distribution systems: a UK case study”, Drinking Water Engineering and Science, 3, 21–27.
7. “Manual on water supply and treatment” third edition, may-1999, CPHEEO, Ministry of Urban Development, New Dehli.
8. Prashant Virjibhai Vaghela, Sejal S. Bhagat (2013). —"Analysis of existing water distribution network by using Water GEMS a case study of Rajkot city", International Journal of Advance Research in Engineering, Science Management. 9. Sajedkhan S. Pathan., Dr. U. J. Kahalekar (2015).—Design of Optimal Water Supply Network and Its Water Quality Analysis by using Water GEMS, Internation Journal Of Science and Research (IJSR) ISSN (Online): 2319-7064.
9. Sumithra R.P., Nethaji Mariappan V. E., Joshua Amarnath (2013), “Feasibility analysis and design of water distribution system for tirunelvelli corporation using Loop and Watergems software”, International Journal of Applied Bioengineering”, Vol.7, No.1.
10. http://www.mpphed.gov.in/. Madhya Pradesh Public Health Engineering

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