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Cost Analysis: A Case Study of Sayajipura Village

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Abstract—*Water is an essential requirement of human being and water supply is becoming a challenging problem which is address by many researcher and attempts made towards tackling the crisis in providing safe water to the rural people in sufficient quantity, quality and at satisfactory pressure head with achieving economy constraint. The study presents project cost estimation as per the hydraulic analysis of Pipe line network of Sayajipura village near Vadodara city using EPANET v2.0. The village has 550 Ha area and 13,850 Population (2016). Source supplies water to village by 117 Nodes having 111 Pipes divided in two different zones. The village receives water supply from Timbi lake located at east of city. The water from this source is taken via network of pipes to the GSR (Ground Service Reservoirs) across the village. The water from these GSR is then pumped to the Adjacent ESRs (Elevated Service Reservoirs) during the supply hours and water is supplied to the village by gravity. The results obtained are verified that the pressures at all junctions, the velocities and flows in pipes are feasible enough to provide adequate water to the network of the study area. The cost of water supply projects have been investigated in present study.*

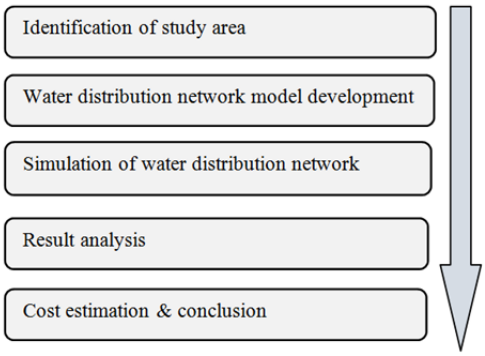
1. INTRODUCTION

This report presents the technical sustainability, an analysis and design of drinking water scheme at Sayajipura village near Vadodara city, which is a part of multi village water supply scheme. The hydraulic behavior within pressurized pipe networks is represented with the help of open sourced soft wares like EPACAD and EPANET. The cost for pipelines is estimated.

2. OBJECTIVES

- To study EPANET 2.0 and EPACAD v1.0 soft wares
- To develop and analyze Water Distribution Network (WDN) of village
- To analyze Hydraulic parameters of WDN
- To estimate the cost of WDN

3. METHODOLOGY



4. STUDY AREA

The rural regional pipeline scheme will be proposed for 11 villages near Vadodara city of Gujarat state. The nearest adequate water source for water supply scheme is Timbi lake. The location of this Lake is at Latitude 22˚18’48” and Longitude 73˚17’14”. The current population for all villages is estimated to be 28,211 souls residing in 3818.26 ha area. For present study, water supply network of SAYAJIPURA VILLAGE is analyzed.

5. WATER DISTRIBUTION NETWORK (WDN) MODEL DEVELOPMENT

Fig. 1. AutoCAD drawing file of sayajipura .dwg file of water supply network

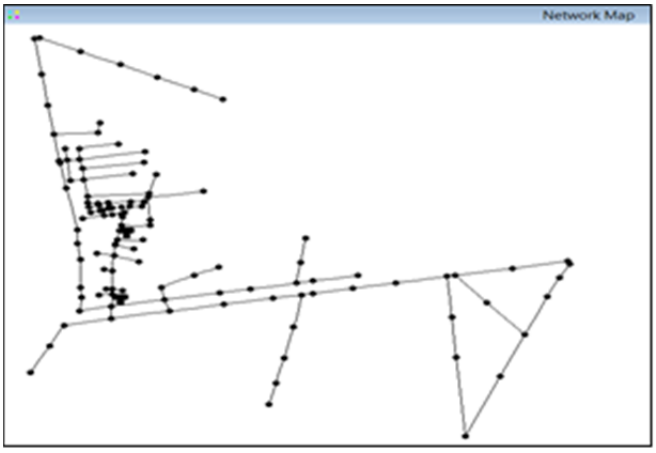


Fig. 2. .Net file converted from wdn using EPACAD

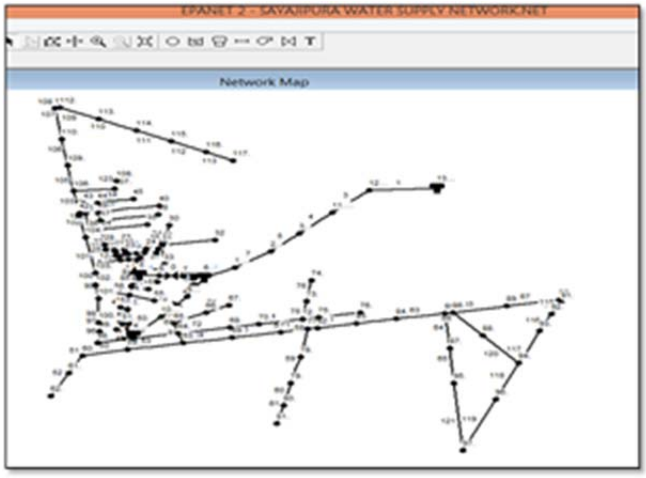


Fig. 3.Water distribution network in EPANET

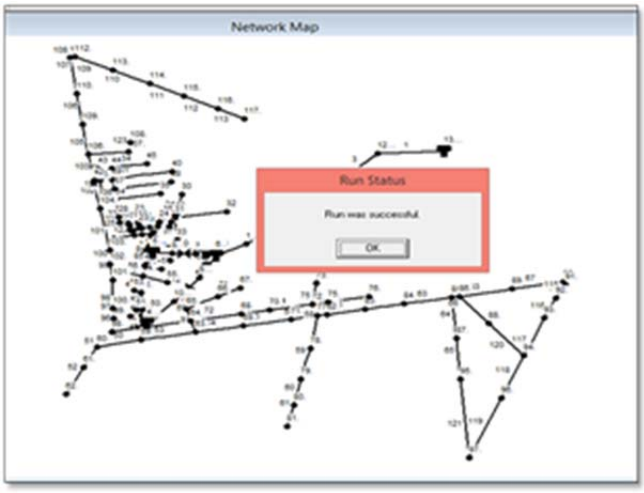


Fig. 4. Model run successful

The water supply network of village is converted into EPANET network (Fig. 2) from AUTOCAD drawing file (Fig. 1) using software EPACAD. The network is completed by connecting GSR of the village with the Master Sump (MS), which provides water to GSR of all other villages. GSRs of all villages are also connected (Fig. 3). After inputting following parameters for all nodes and pipes, the model of WDN is getting RUN SUCCESSFUL (Fig. 4). For all graphical representations, limited value of those parameters are indicated as per CPHEEO manual, 1999. The expected material selected for the pipe distribution analysis is ductile iron (DI) for rising mains and polyethylene (PE) with the roughness coefficient for Hazen-Williams 130 and 140 respectively. WDN contains 117 nodes connected by 111 links.

The developed model of WDN of the village is superimposed on google earth image by using software ARCGIS (Fig. 5).

Fig. 5.Georeferencing of Water Distribution Network of Sayajipura Village Using ARCGIS

6. RESULT ANALYSIS

Table 1: Analysis of output parameters

Parameter	Maximum value	Minimum value
Pressure	14.00 m at node 95	8.84 m at node 4
Velocity	1.05 m/s at pipe 53	0.24 m/s at pipe 111
Unit head loss	3.29 m/km at pipe 46	0.23 m/km at pipe 105

- For area, where two storied buildings are common, the minimum pressure of 7 m is needed for supplying water to ground level storage tanks, as per the CPHEEO manual (1999).
- The velocity should below 1 m/s for rural water supply and minimum velocity of 0.6m/s should be present to avoid silting in the lines as per CPHEEO manual, 1999.

- According to AWWA (American Water Works Association) the maximum value of head loss should not be more than 10m/km.

7. COST ANALYSIS

Table 2: Total length of pipe for zone1

Zone 1		
Diameter (mm)	**Pipe Material**	**Length (m)**
77	PE	2287
94	PE	71
107	PE	73
120	PE	400
137	PE	275
154	PE	158
171	PE	165
192	PE	56
214	PE	107
239	PE	156
300	DI	120
		3868

Required total length of pipes with suitable diameters are mentioned for both zone 1 (Table 2) & zone 2 (Table 3) which are used to calculate quantity and total amount for distribution work for both zone 1 (Table 4) & zone 2 (Table 5).

Table 3: Total length of pipe for zone2

Zone 2		
Diameter (mm)	**Pipe Material**	**Length (m)**
77	PE	1405
94	PE	1066
107	PE	84
120	PE	436
137	PE	1288
154	PE	1470
171	PE	503
192	PE	703
214	PE	750
239	PE	724
250	DI	1421
300	DI	769
350	DI	867
400	DI	74
500	DI	37
		11597

Table 4: cost for distribution work for zone 1

Quantity of excavation of pipe lines (m3)	**up to 1.5 m depth**	**4043.87**	**4053.25**
	from 1.5 to 3 m depth	**9.38**	
Total deductions (m3)	For pipes	67.85	463.03
	For valve chambers	71.61	
	For pipe bending	323.58	
Net quantity (m3)	Quantity of excavation of pipe lines	4053.25	3590.21
	Total deductions	463.03	
Total amount (Rs.)			49,37,701.00

Table 5: cost for distribution work for zone 2

Quantity of excavation of pipe lines (m3)	**up to 1.5 m depth**	**13474.87**	**13525.83**
	from1.5 to 3 m depth	**7.74**	
Total deductions (m3)	For pipes	486.15	1696.01
	For valve chambers	193.33	
	For pipe bending	1016.53	
Net quantity (m3)	Quantity of excavation of pipe lines	13525.83	11829.82
	Total deductions	1696.01	
Total amount (Rs.)			27882590.0

Table 6: cost for work for rising main (RM) zone1

Quantity of excavation of pipe lines (m3)	**up to 1.5 m depth**	**611.23**	**612.16**
	from1.5 to 3 m depth	**0.94**	
Total deductions (m3)	For pipes	21.32	34.72
	For valve chambers	13.40	
Net quantity (m3)	Quantity of excavation of pipe lines	612.16	577.45
	Total deductions	34.72	
Total amount (Rs.)			1550374.00

Table 7: cost for work for rising main (RM) zone2

Quantity of excavation of pipe lines (m3)	**up to 1.5 m depth**	**86.39**	**89.01**
	from1.5 to 3 m depth	**2.62**	
Total deductions (m3)	For pipes	5.61	24.96
	For valve chambers	19.35	
Net quantity (m3)	Quantity of excavation of pipe lines	89.01	64.05
	Total deductions	24.96	
Total amount (Rs.)			317448.00

Table 8: cost for work for sump

Item		**Cost (Rs.)**	**Total amount (Rs.)**
Chlorination plant		**1347086.50**	5281086.50
Sump of capacity 15.40 lac liter	15 lacs liter capacity	3860000	
	15 lacs up to 50 lacs (0.40 lacs liter)	74000	

Net quantity and total amount for the Rising main work (RM) from sump to ESR are also estimated for both zone 1 (Table 6) & zone 2 (Table 7). The total cost of providing Master Sump (MS) is calculated (Table 8). The cost of providing, supplying, fixing, erecting & commissioning of Panel Mounted Chlorination Plant with complete equipment is also considered.

Table 9: cost for work for ESR

Item		**Cost (Rs.)**	**Total amount (Rs.)**
Electromagnetic Flowmeter		**873226.91**	9273955.91
ESR of capacity 10 lac liter & 18 m height	For 12 m staging	7912089	
	for additional staging height of 6 m	488640	

Table 10: cost for work for pump from sump to ESR

Sr.NO	**Location**	**Rs.**
1	Zone 1	1490200.00
2	Zone 2	2608100.00
	Total	4098300.00

The total amount required for the construction of Elevated storage reservoir (ESR), having capacity 10.00 lac liter and height 18 m, is estimated for zone 2 (Table 9). The required capacity of ESR in zone 1 can be satisfied with the existing ESR. So, there will be no need to construct new ESR in zone 1.The cost for Supply of Full Electromagnetic Flowmeter with factory calibrated, Battery operated, flanged connection, Flow sensor, indicator, transmitter and totalizer with all accessories viz. power and control cables up to stator panel, cabinets, hard wares, etc. comp.with necessary by pass arrangement is also considered.

The total cost for pump work is estimated for both zones (Table 10). It is proposed to install 2 Nos. (1 working + 1 Standby) new pumps of submersible centrifugal type having 15 KW, 19 HP of 29.94 LPS discharged against of 25 m head in zone 1. It is required to install new pumps of submersible centrifugal type of 29 KW, 38HP 3 Nos. (2 working + 1 Standby) of 47.74 LPS discharged against of 32 m head.

Total project cost for the WDN in sayajipura village is estimated **575.75 lac Rs.** (Table 11), which includes the cost for Road Reinstatement, R.C.C.Precast Compound Wall with Gate and 2 nos.of R.C.C.Column, R.C.C. approach road too.

Table 11: Total project cost of sayajipura village

SAYAJIPURA_ PROJECT COST			
Sr. No.	Name of Work	Cost (Rs.)	Cost (Rs in Lac)
	SAYAJIPURA_PROJECT COST		
1	Distribution Network		
1.1	Zone:-1	4937701.00	49.38
1.2	Zone:-2	27882590.00	278.83
	TOTAL	32820291.00	328.20
2	Rising Main		
2.1	From Sump to ESR(Zone-1)	1550374.00	15.50
2.2	From Sump to ESR(Zone-2)	317448.00	3.17
	TOTAL	1867822.00	18.68
3	Underground Sump with Pump House		
3.1	Zone:-2	5281087.00	52.81
	TOTAL	5281087.00	52.81
4	Elevated Service Reservoir		
4.1	Zone-2	9273956.00	92.74
	TOTAL	9273956.00	92.74
5	Pumping Machinery		
5.1	Pumping Machinery For Sump to ESR (Zone-1)	1490200.00	14.90
5.2	Pumping Machinery For Sump to ESR (Zone-2)	2608100.00	26.08
	TOTAL	4098300.00	40.98

8. CONCLUSION

- The pressures at all the nodes are ranging from 8.84 m to 14 m, which is above the minimum pressure of 7 m.
- The velocities in most of the links/pipes are in the range below 1 m/s. Further, velocities more than 1 m/s are observed in few links which is due to sudden change in diameter of pipes.
- The head losses in all links are in range of 0 to 10 m/km.
- At the end of the analysis it has been found that the resulting pressures at all the junctions and velocities in all the links are adequate enough for water supply to the GSRs.
- Results from the study can be useful for the expansion of network to provide wide water supply coverage to satisfy future demand of Sayajipura village.
- Cost analysis is showing that project is economical as a part of multi village water supply scheme.

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