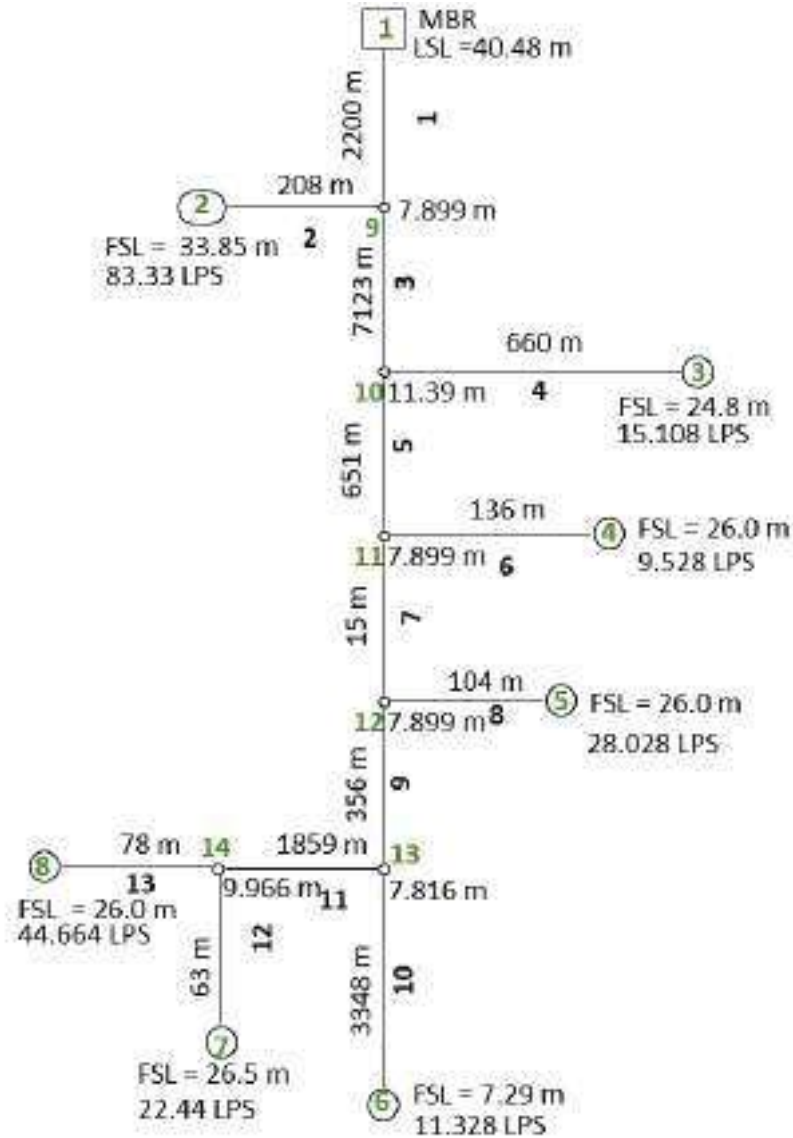


Annexure 6.3: Optimization of Gravity Transmission Main

One complete gravity water supply scheme of a city is considered for the sake of illustration.



The source of water is located at a higher level and after treatment water is stored in MBR from where it can be supplied by gravity to all the city reservoirs. The LSL of MBR is 40.48 m. MBR is supplying water to seven reservoirs labelled as 2 to 8. Other intermediate junctions are labelled from 9 to 14. The FSLs of reservoirs and ground elevation at junction nodes are given in Table 1. Nodal demands are also given in 1. These demands are increased by a factor of 1.058 to include the minor losses. Pipes are labelled 1 to 13 and their connectivity and lengths are given in Table 2. Available pipe sizes in mm and their unit costs in Rs/m length are given in Table 3.

The network is designed using JalTantra, considering the minimum residual head requirement of 3 m above the FSL of each reservoir.

Table 1: Node Data			Table 2: Pipe Data			
Node ID	Elevation, m	Demand, L/s	Pipe ID	Start Node	End Node	Length, m
2	33.85	83.33	1	1	9	2,200
3	24.8	15.108	2	9	2	208
4	26	9.528	3	9	10	7,123
5	26	28.028	4	10	3	660
6	27.29	11.328	5	10	11	651
7	26.5	22.44	6	11	4	136
8	26	44.664	7	11	12	15
9	7.899		8	12	5	104
10	11.39		9	12	13	356
11	7.899		10	13	6	3,348
12	7.899		11	13	14	1,859
13	7.816		12	14	7	63
14	9.966		13	14	8	78

Table 3: Commercial Pipe Data			Table 4: General Data	
Diameter	Roughness	Cost (Rs/m)	Network Name	MBR
80	140	750	Organisation Name	CPHEEO
100	140	952	Minimum Node Pressure	3
150	140	1,383	Default Pipe Roughness 'C'	140
200	140	1,870	Minimum Head loss per KM	0
250	140	2,485	Maximum Head loss per KM	500
300	140	3,106	Maximum Water Speed	2.5
350	140	3,919	Number of Supply Hours	24
400	140	4,558	Source Node ID	1
450	140	5,560	Source Elevation	40.48
500	140	6,405	Source Head	40.48
600	140	8,175		
700	140	10,370		

Table 5: NODE OUTPUT					
Node ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (m)	Min. Pressure (m)
2	69.44	33.85	36.85	3	3
3	12.59	24.8	27.8	3	3
4	7.94	26	29	3	3
5	23.36	26	29	3	3
6	9.44	27.29	30.29	3	3
7	18.7	26.5	29.5	3	3
8	37.22	26	29	3	3
9	0	7.9	39.23	31.33	3
10	0	11.39	32.71	21.32	3
11	0	7.9	32.23	24.33	3
12	0	7.9	32.22	24.32	3
13	0	7.82	32	24.18	3
14	0	9.97	29.54	19.57	3

Table 6: PIPE OUTPUT

Pipe ID	Start Node	End Node	Length (m)	Flow (LPS)	Speed (m/s)	Diameter (mm)	Roughness 'C'	Head loss (m)	Head loss (m/KM)	Cost (Rs)
			m	L/s	m/s	mm		m	m/Km	Rs.
1	1	9	13	178.69	0.91	500	140	0.018	1.364	85,570
	1	9	2,187	178.69	0.632	600	140	1.227	0.561	1,78,75,783
2	9	2	69	69.44	2.21	200	140	1.419	20.539	1,29,172
	9	2	139	69.44	1.415	250	140	0.963	6.928	3,45,227
3	9	10	7,123	109.25	0.687	450	140	6.526	0.916	3,96,03,880
4	10	3	118	12.59	1.603	100	140	2.992	25.421	1,12,053
	10	3	542	12.59	0.712	150	140	1.914	3.529	7,49,997
5	10	11	651	96.66	0.608	450	140	0.475	0.73	36,19,560
6	11	4	83	7.94	1.58	80	140	2.653	32.089	62,012
	11	4	53	7.94	1.011	100	140	0.577	10.825	50,759
7	11	12	15	88.72	0.558	450	140	0.009	0.623	83,400
8	12	5	30	23.36	2.974	100	140	2.401	79.865	28,625
	12	5	74	23.36	1.322	150	140	0.82	11.086	1,02,248
9	12	13	356	65.36	0.52	400	140	0.224	0.628	16,22,648
10	13	6	3,348	9.44	0.3	200	140	1.707	0.51	62,60,760
11	13	14	777	55.92	0.791	300	140	1.484	1.909	24,14,860
	13	14	1,082	55.92	0.581	350	140	0.975	0.901	42,38,468

Table 6: PIPE OUTPUT

Pipe ID	Start Node	End Node	Length (m)	Flow (LPS)	Speed (m/s)	Diameter (mm)	Roughness 'C'	Head loss (m)	Head loss (m/KM)	Cost (Rs)
			m	L/s	m/s	mm		m	m/Km	Rs.
12	14	7	63	18.7	0.381	250	140	0.038	0.61	1,56,555
13	14	8	2	37.22	2.106	150	140	0.045	26.27	2,352
	14	8	76	37.22	1.185	200	140	0.494	6.471	1,42,680

Table 7: COST RESULTS			
Diameter	Length	Cost	Cumulative Cost
80	83	62,012	62,012
100	201	1,91,437	2,53,448
150	618	8,54,596	11,08,044
200	3,493	65,32,612	76,40,656
250	202	5,01,782	81,42,438
300	777	24,14,860	1,05,57,298
350	1,082	42,38,468	1,47,95,766
400	356	16,22,648	1,64,18,414
450	7,789	4,33,06,840	5,97,25,254
500	13	85,570	5,98,10,824
600	2,187	1,78,75,783	7,76,86,607
Total	16,801	7,76,86,607	

Remarks

1. Some of the links as shown in pipe data (Table 6) are of two sizes. For example, pipe 1 of 2,200 m in length is split into two sizes of 600 mm and 500 mm having a length of 2,187 m and 13 m, respectively.
2. Small lengths of split sizes like 13 m in link 1 of 500 mm can be changed to a higher size to avoid a reducer. This will, however, result in the excess head at one or more reservoirs which will then be required to be dissipated by providing head-dissipating devices.
3. Incidentally, dropping 500 mm size, will not require any procurement of that size as can be seen from Table 6.3.7.