Looped Water Distribution Network

Introduction

Two looped water distribution networks for the two zones of the industrial park are computed in this report using Hardy Cross method.

Assumptions and conditions:

1. Water demand of each facility is taken from previously determined peak water demand for the design period of 30 years.
2. Flow entering a junction is equal to the flow leaving.
3. Algebraic sum of head loss in a closed loop is zero.
4. Value of Hazen-Williams constant k is assumed to be 1.
5. Value of x in Hazen-Williams equation is 1.85.

Methodology:

1. A layout of looped water distribution network is prepared for each zone.
2. Reasonable discharge rate is provided to each junction/intersection points throughout the network. The discharge rate is influenced by surrounding facilities' peak water demand.
   Note: For the industrial zone, production water demand is approximately distributed into relevant facilities
3. Through repeated trials, pipe flow is computed for each path using the Hazen-Williams equation for Hardy Cross method.
   a. For each loop, head loss (H) and H/Q was computed for each pipe.
   $$H = kQ^x$$
   Here,
   - H is head loss (ft).
   - k is a constant assumed to be 1.
   - Q is the assumed/corrected flow for the path.
   - x is 1.85.
   b. While taking into account the direction of flow with respect to adjacent loop, flow correction was computed and applied into initial pipe flow.
   $$Correction = -\frac{\sum H}{x\sum(H/Q)}$$
   c. This procedure is repeated until accuracy of 0.001 is obtained.
4. Pipe diameter (d) is computed assuming velocity (v) is 3 fps.
   $$Q = Av; A = \frac{\pi d^2}{4}$$

Sample Calculation

Zone 2, Trial 1:

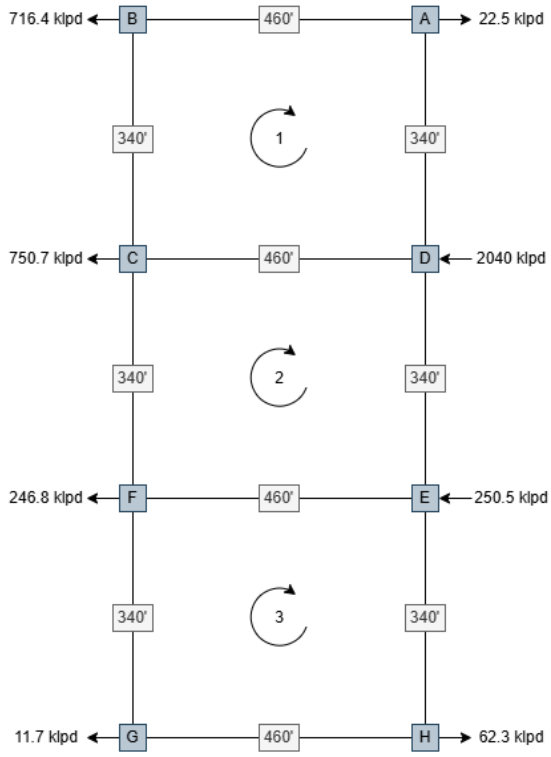


Figure 1 Schematic diagram of Zone 2 loop network

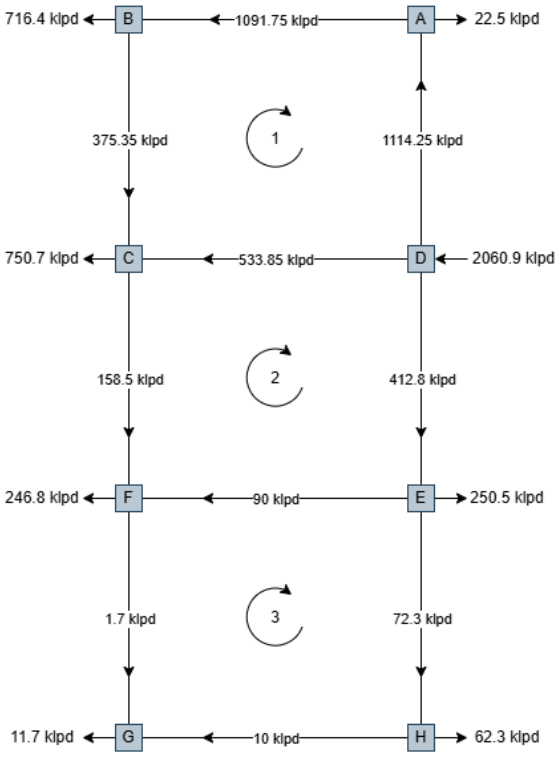


Figure 2 Initially assumed pipe flow of Zone 2

Loop 1:

- Path DA:
  - $Q = \frac{1114.25 \times 1000}{28.317 \times 86400} = 0.4554\ ft^3/s$
  - $H = 1 \times 0.4554^{1.85} = 0.2334$ ft [anticlockwise]
  - $\frac{H}{Q} = \frac{0.2334}{0.4554} = 0.5125$
- Path BA:
  - $Q = \frac{1091.75 \times 1000}{28.317 \times 86400} = 0.4462\ ft^3/s$
  - $H = 1 \times 0.4462^{1.85} = 0.2247$ ft [anticlockwise]
  - $\frac{H}{Q} = \frac{0.2247}{0.4462} = 0.5037$
- Path CB:
  - $Q = \frac{375.35 \times 1000}{28.317 \times 86400} = 0.1534\ ft^3/s$
  - $H = 1 \times 0.1534^{1.85} = 0.0312$ ft [anticlockwise]
  - $\frac{H}{Q} = \frac{0.0312}{0.1534} = 0.2032$

- Path CD (common):
  - $Q = \frac{533.85 \times 1000}{28.317 \times 86400} = 0.2182\ ft^3/\text{s}$
  - $H = 1 \times 0.2182^{1.85} = 0.0598\ \text{ft}$ [clockwise]
  - $\frac{H}{Q} = \frac{0.0598}{0.2182} = 0.2742$
- Correction:
  - $\sum H = -0.2334 - 0.2247 - 0.0312 + 0.0598 = -0.4295\ \text{ft}$
  - $\sum \frac{H}{Q} = 0.5125 + 0.5037 + 0.2032 + 0.2742 = 1.4935$
  - $\Delta = -\frac{-0.4295}{1.85 \times 1.4935} = 0.1554\ \text{ft}^3/s = 380.30\ klpd$

Loop 2:

- Path ED:
  - $Q = \frac{412.80 \times 1000}{28.317 \times 86400} = 0.1687\ ft^3/\text{s}$
  - $H = 1 \times 0.1687^{1.85} = 0.0372\ \text{ft}$ [clockwise]
  - $\frac{H}{Q} = \frac{0.0372}{0.1687} = 0.2203$
- Path CD (common):
  - $Q = \frac{533.85 \times 1000}{28.317 \times 86400} = 0.2182\ ft^3/\text{s}$
  - $H = 1 \times 0.2182^{1.85} = 0.2742\ \text{ft}$ [anticlockwise]
  - $\frac{H}{Q} = \frac{0.2742}{0.2182} = 0.0598$
- Path FC:
  - $Q = \frac{158.50 \times 1000}{28.317 \times 86400} = 0.0648\ ft^3/\text{s}$
  - $H = 1 \times 0.0648^{1.85} = 0.0063\ \text{ft}$ [anticlockwise]
  - $\frac{H}{Q} = \frac{0.0312}{0.0648} = 0.0977$
- Path FE (common):
  - $Q = \frac{90.00 \times 1000}{28.317 \times 86400} = 0.0368\ ft^3/\text{s}$
  - $H = 1 \times 0.0368^{1.85} = 0.0022\ \text{ft}$ [clockwise]
  - $\frac{H}{Q} = \frac{0.0598}{0.0368} = 0.0604$
- Correction:
  - $\sum H = 0.0372 - 0.0598 - 0.0063 + 0.0022 = -0.0268\ \text{ft}$
  - $\sum \frac{H}{Q} = 0.2203 + 0.2742 + 0.0977 + 0.0604 = 0.6526$
  - $\Delta = -\frac{-0.0268}{1.85 \times 0.6526} = 0.0222\ \text{ft}^3/s = 54.22\ klpd$

Loop 3:

- Path HE:
  - $Q = \frac{72.30 \times 1000}{28.317 \times 86400} = 0.0296\ ft^3/s$
  - $H = 1 \times 0.0296^{1.85} = 0.0015$ ft [clockwise]
  - $\frac{H}{Q} = \frac{0.0015}{0.0296} = 0.0501$
- Path FE (common):
  - $Q = \frac{90.00 \times 1000}{28.317 \times 86400} = 0.0368\ ft^3/s$
  - $H = 1 \times 0.0368^{1.85} = 0.0022$ ft [anticlockwise]
  - $\frac{H}{Q} = \frac{0.0022}{0.0368} = 0.0604$
- Path GF:
  - $Q = \frac{1.70 \times 1000}{28.317 \times 86400} = 0.0007\ ft^3/s$
  - $H = 1 \times 0.0007^{1.85} = 1.46E-6$ ft [anticlockwise]
  - $\frac{H}{Q} = \frac{1.46E-6}{0.0007} = 0.0021$
- Path GH:
  - $Q = \frac{10.00 \times 1000}{28.317 \times 86400} = 0.0041\ ft^3/s$
  - $H = 1 \times 0.0041^{1.85} = 3.83E-5$ ft [clockwise]
  - $\frac{H}{Q} = \frac{3.83E-5}{0.0041} = 0.0093$
- Correction:
  - $\sum H = 0.0015 - 0.0022 - 1.46E-6 + 3.83E-5 = -0.0007$ ft
  - $\sum \frac{H}{Q} = 0.0501 + 0.0604 + 0.0021 + 0.0093 = 0.1219$
  - $\Delta = -\frac{-0.0007}{1.85 \times 0.1219} = 0.0031\ \text{ft}^3/s = 7.63\ klpd$

Corrected flow:

Path	Corrected Flow (klpd)
DA	$1114.25 - 380.30 = 733.95$
BA	$1091.75 - 380.30 = 711.45$
CB	$375.35 - 380.30 = -4.95$
CD	$533.85 + 326.08 = 859.93$
ED	$412.80 + 54.22 = 467.02$
FC	$158.50 - 54.22 = 104.28$
FE	$90.00 + 46.59 = 136.59$
HE	$72.30 + 7.63 = 79.93$
GF	$1.70 - 7.63 = -5.93$
GH	$10.00 + 7.63 = 17.63$

Pipe diameter, Path DA:

- After several trials, corrected flow: 568.84 klpd
- Pipe flow, $Q = \frac{568.84 \times 1000}{28.317 \times 86400} = 0.2325$ ft^3/s
- Assumed velocity, $v = 3$ ft/s
- Pipe area, $A = \frac{0.2325 \times 144}{3} = 11.16$ in^2
- Pipe diameter, $d_{req} = \sqrt{\frac{11.16 \times 4}{\pi}} = 3.77$ in
- Provided diameter, $d = 4$ in

Zone 2: Industrial

Pipe Flow Determination

Trial 1:

Loop 1:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
DA	-1114.25	-0.4554	-0.2334	0.5125	0.1554	380.30
BA	-1091.75	-0.4462	-0.2247	0.5037		
CB	-375.35	-0.1534	-0.0312	0.2032		
CD	533.85	0.2182	0.0598	0.2742		
Total			**-0.4295**	**1.4935**		

Loop 2:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
ED	412.80	0.1687	0.0372	0.2203	0.0222	54.22
CD	-533.85	-0.2182	-0.0598	0.2742		
FC	-158.50	-0.0648	-0.0063	0.0977		
FE	90.00	0.0368	0.0022	0.0604		
Total			**-0.0268**	**0.6526**		

Loop 3:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
HE	72.30	0.0296	0.0015	0.0501	0.0031	7.63
FE	-90.00	-0.0368	-0.0022	0.0604		
GF	-1.70	-0.0007	0.0000	0.0021		
GH	10.00	0.0041	0.0000	0.0093		
Total			**-0.0007**	**0.1219**		

Corrected flow:

Path	Flow (klpd)	Correction (klpd)	Corrected Flow (klpd)
DA	1114.25	-380.30	733.95
BA	1091.75	-380.30	711.45
CB	375.35	-380.30	-4.95
CD	533.85	326.08	859.93
ED	412.80	54.22	467.02
FC	158.50	-54.22	104.28
FE	90.00	46.59	136.59
HE	72.30	7.63	79.93
GF	1.70	-7.63	-5.93
GH	10.00	7.63	17.63

Trial 2:

Loop 1:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
DA	-733.95	-0.3000	-0.1078	0.3594	0.0312	76.42
BA	-711.45	-0.2908	-0.1018	0.3500		
CB	4.95	0.0020	0.0000	0.0051		
CD	859.93	0.3515	0.1445	0.4112		
Total			**-0.0650**	**1.1257**		

Loop 2:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
ED	467.02	0.1909	0.0467	0.2447	0.0640	156.53
CD	-859.93	-0.3515	-0.1445	0.4112		
FC	-104.28	-0.0426	-0.0029	0.0684		
FE	136.59	0.0558	0.0048	0.0861		
Total			**-0.0959**	**0.8104**		

Loop 3:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
HE	79.93	0.0327	0.0018	0.0546	0.0097	23.70
FE	-136.59	-0.0558	-0.0048	0.0861		
GF	5.93	0.0024	0.0000	0.0060		
GH	17.63	0.0072	0.0001	0.0151		
Total			**-0.0029**	**0.1617**		

Corrected flow:

Path	Flow (klpd)	Correction (klpd)	Corrected Flow (klpd)
DA	733.95	-76.42	657.52
BA	711.45	-76.42	635.02
CB	-4.95	-76.42	-81.38
CD	859.93	-80.11	779.83
ED	467.02	156.53	623.55
FC	104.28	-156.53	-52.25
FE	136.59	132.83	269.42
HE	79.93	23.70	103.63
GF	-5.93	-23.70	-29.63
GH	17.63	23.70	41.33

Trial 3:

Loop 1:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
DA	-657.52	-0.2688	-0.0880	0.3273	0.0240	58.83
BA	-635.02	-0.2596	-0.0825	0.3178		
CB	81.38	0.0333	0.0018	0.0554		
CD	779.83	0.3187	0.1206	0.3784		
Total			**-0.0480**	**1.0789**		

Loop 2:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
ED	623.55	0.2549	0.0797	0.3129	0.0142	34.71
CD	-779.83	-0.3187	-0.1206	0.3784		
FC	52.25	0.0214	0.0008	0.0380		
FE	269.42	0.1101	0.0169	0.1533		
Total			**-0.0232**	**0.8826**		

Loop 3:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
HE	103.63	0.0424	0.0029	0.0681	0.0258	63.20
FE	-269.42	-0.1101	-0.0169	0.1533		
GF	29.63	0.0121	0.0003	0.0235		
GH	41.33	0.0169	0.0005	0.0312		
Total			**-0.0132**	**0.2760**		

Corrected flow:

Path	Flow (klpd)	Correction (klpd)	Corrected Flow (klpd)
DA	657.52	-58.83	598.69
BA	635.02	-58.83	576.19
CB	-81.38	-58.83	-140.21
CD	779.83	24.11	803.94
ED	623.55	34.71	658.27
FC	-52.25	-34.71	-86.97
FE	269.42	-28.48	240.94
HE	103.63	63.20	166.83
GF	-29.63	-63.20	-92.83
GH	41.33	63.20	104.53

Trial 4:

Loop 1:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
DA	-598.69	-0.2447	-0.0740	0.3022	0.0052	12.62
BA	-576.19	-0.2355	-0.0689	0.2926		
CB	140.21	0.0573	0.0050	0.0880		
CD	803.94	0.3286	0.1276	0.3883		
Total			**-0.0102**	**1.0711**		

Loop 2:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
ED	658.27	0.2691	0.0881	0.3276	0.0140	34.19
CD	-803.94	-0.3286	-0.1276	0.3883		
FC	86.97	0.0355	0.0021	0.0586		
FE	240.94	0.0985	0.0137	0.1394		
Total			**-0.0236**	**0.9140**		

Loop 3:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
HE	166.83	0.0682	0.0070	0.1020	0.0022	5.31
FE	-240.94	-0.0985	-0.0137	0.1394		
GF	92.83	0.0379	0.0024	0.0620		
GH	104.53	0.0427	0.0029	0.0686		
Total			**-0.0015**	**0.3720**		

Corrected flow:

Path	Flow (klpd)	Correction (klpd)	Corrected Flow (klpd)
DA	598.69	-12.62	586.07
BA	576.19	-12.62	563.57
CB	-140.21	-12.62	-152.83
CD	803.94	-21.57	782.37
ED	658.27	34.19	692.46
FC	-86.97	-34.19	-121.16
FE	240.94	28.88	269.82
HE	166.83	5.31	172.14
GF	-92.83	-5.31	-98.14
GH	104.53	5.31	109.84

Trial 5:

Loop 1:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
DA	-586.07	-0.2395	-0.0711	0.2968	0.0051	12.48
BA	-563.57	-0.2304	-0.0661	0.2871		
CB	152.83	0.0625	0.0059	0.0947		
CD	782.37	0.3198	0.1213	0.3794		
Total			**-0.0100**	**1.0580**		

Loop 2:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
ED	692.46	0.2830	0.0968	0.3420	0.0021	5.20
CD	-782.37	-0.3198	-0.1213	0.3794		
FC	121.16	0.0495	0.0038	0.0777		
FE	269.82	0.1103	0.0169	0.1535		
Total			**-0.0037**	**0.9527**		

Loop 3:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
HE	172.14	0.0704	0.0074	0.1048	0.0051	12.53
FE	-269.82	-0.1103	-0.0169	0.1535		
GF	98.14	0.0401	0.0026	0.0650		
GH	109.84	0.0449	0.0032	0.0715		
Total			**-0.0037**	**0.3948**		

Corrected flow:

Path	Flow (klpd)	Correction (klpd)	Corrected Flow (klpd)
DA	586.07	-12.48	573.59
BA	563.57	-12.48	551.09
CB	-152.83	-12.48	-165.31
CD	782.37	7.28	789.65
ED	692.46	5.20	697.66
FC	-121.16	-5.20	-126.36
FE	269.82	-7.33	262.49
HE	172.14	12.53	184.67
GF	-98.14	-12.53	-110.67
GH	109.84	12.53	122.37

Trial 6:

Loop 1:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
DA	-573.59	-0.2344	-0.0683	0.2914	0.0008	1.88
BA	-551.09	-0.2252	-0.0634	0.2817		
CB	165.31	0.0676	0.0068	0.1012		
CD	789.65	0.3228	0.1234	0.3824		
Total			**-0.0015**	**1.0568**		

Loop 2:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
ED	697.66	0.2852	0.0982	0.3442	0.0028	6.94
CD	-789.65	-0.3228	-0.1234	0.3824		
FC	126.36	0.0516	0.0042	0.0806		
FE	262.49	0.1073	0.0161	0.1500		
Total			**-0.0050**	**0.9571**		

Loop 3:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
HE	184.67	0.0755	0.0084	0.1112	0.0007	1.66
FE	-262.49	-0.1073	-0.0161	0.1500		
GF	110.67	0.0452	0.0033	0.0720		
GH	122.37	0.0500	0.0039	0.0784		
Total			**-0.0005**	**0.4115**		

Corrected flow:

Path	Flow (klpd)	Correction (klpd)	Corrected Flow (klpd)
DA	573.59	-1.88	571.71
BA	551.09	-1.88	549.21
CB	-165.31	-1.88	-167.19
CD	789.65	-5.06	784.59
ED	697.66	6.94	704.61
FC	-126.36	-6.94	-133.31
FE	262.49	5.28	267.77
HE	184.67	1.66	186.34
GF	-110.67	-1.66	-112.34
GH	122.37	1.66	124.04

Trial 7:

Loop 1:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
DA	-571.71	-0.2337	-0.0679	0.2906	0.0010	2.51
BA	-549.21	-0.2245	-0.0630	0.2809		
CB	167.19	0.0683	0.0070	0.1022		
CD	784.59	0.3207	0.1220	0.3803		
Total			**-0.0020**	**1.0540**		

Loop 2:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
ED	704.61	0.2880	0.1000	0.3471	0.0004	0.98
CD	-784.59	-0.3207	-0.1220	0.3803		
FC	133.31	0.0545	0.0046	0.0843		
FE	267.77	0.1094	0.0167	0.1525		
Total			**-0.0007**	**0.9643**		

Loop 3:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
HE	186.34	0.0762	0.0085	0.1121	0.0010	2.51
FE	-267.77	-0.1094	-0.0167	0.1525		
GF	112.34	0.0459	0.0033	0.0729		
GH	124.04	0.0507	0.0040	0.0793		
Total			**-0.0008**	**0.4168**		

Corrected flow:

Path	Flow (klpd)	Correction (klpd)	Corrected Flow (klpd)
DA	571.71	-2.51	569.19
BA	549.21	-2.51	546.69
CB	-167.19	-2.51	-169.71
CD	784.59	1.53	786.12
ED	704.61	0.98	705.59
FC	-133.31	-0.98	-134.29
FE	267.77	-1.53	266.24
HE	186.34	2.51	188.84
GF	-112.34	-2.51	-114.84
GH	124.04	2.51	126.54

Trial 8:

Loop 1:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
DA	-569.19	-0.2326	-0.0674	0.2895	0.0001	0.35
BA	-546.69	-0.2235	-0.0625	0.2798		
CB	169.71	0.0694	0.0072	0.1035		
CD	786.12	0.3213	0.1224	0.3810		
Total			**-0.0003**	**1.0538**		

Loop 2:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
ED	705.59	0.2884	0.1002	0.3475	0.0006	1.39
CD	-786.12	-0.3213	-0.1224	0.3810		
FC	134.29	0.0549	0.0047	0.0848		
FE	266.24	0.1088	0.0165	0.1518		
Total			**-0.0010**	**0.9651**		

Loop 3:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
HE	188.84	0.0772	0.0087	0.1133	0.0001	0.35
FE	-266.24	-0.1088	-0.0165	0.1518		
GF	114.84	0.0469	0.0035	0.0743		
GH	126.54	0.0517	0.0042	0.0807		
Total			**-0.0001**	**0.4201**		

Corrected flow:

Path	Flow (klpd)	Correction (klpd)	Corrected Flow (klpd)
DA	569.19	-0.35	568.84
BA	546.69	-0.35	546.34
CB	-169.71	-0.35	-170.06
CD	786.12	-1.03	785.09
ED	705.59	1.39	706.97
FC	-134.29	-1.39	-135.67
FE	266.24	1.04	267.28
HE	188.84	0.35	189.19
GF	-114.84	-0.35	-115.19
GH	126.54	0.35	126.89

Pipe Diameter Determination

Path	Velocity (fps)	Flow (klpd)	Flow (ft^3/s)	Pipe Area (in^2)	Required Diameter (in)	Provided Diameter (in)
DA	3	568.84	0.2325	11.16	3.77	4
BA	3	546.34	0.2233	10.72	3.69	4
CB	3	170.06	0.0695	3.34	2.06	2.5
CD	3	785.09	0.3209	15.40	4.43	4.5
ED	3	706.97	0.2890	13.87	4.20	4.5
FC	3	135.67	0.0555	2.66	1.84	2
FE	3	267.28	0.1092	5.24	2.58	3
HE	3	189.19	0.0773	3.71	2.17	2.5
GF	3	115.19	0.0471	2.26	1.70	2
GH	3	126.89	0.0519	2.49	1.78	2

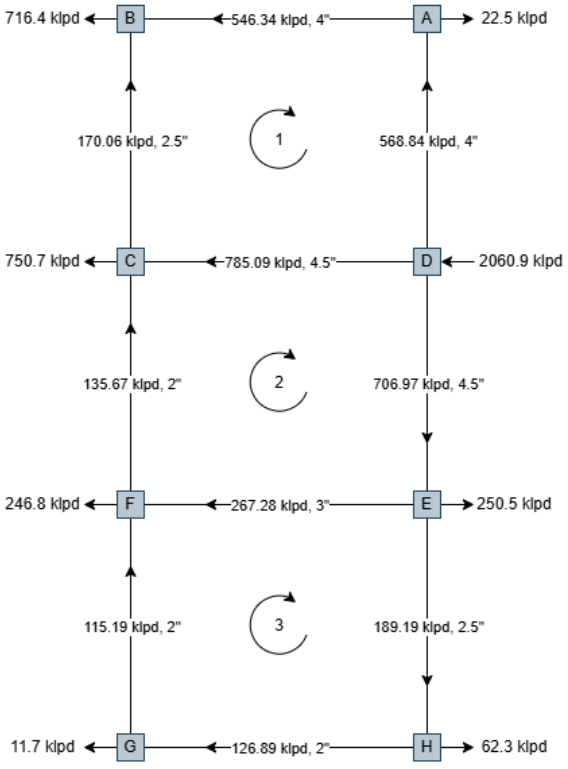


Figure 3 Pipe parameters of Zone 2

Zone 1: Residential, Commercial, Administrative

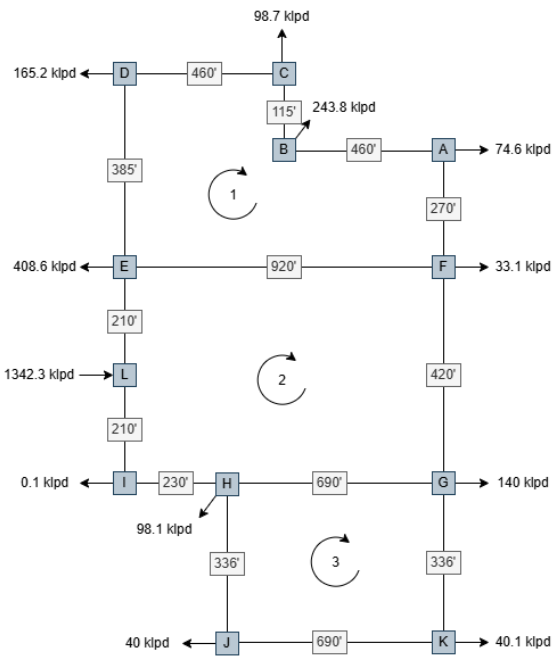


Figure 4 Schematic diagram of Zone 1 loop network

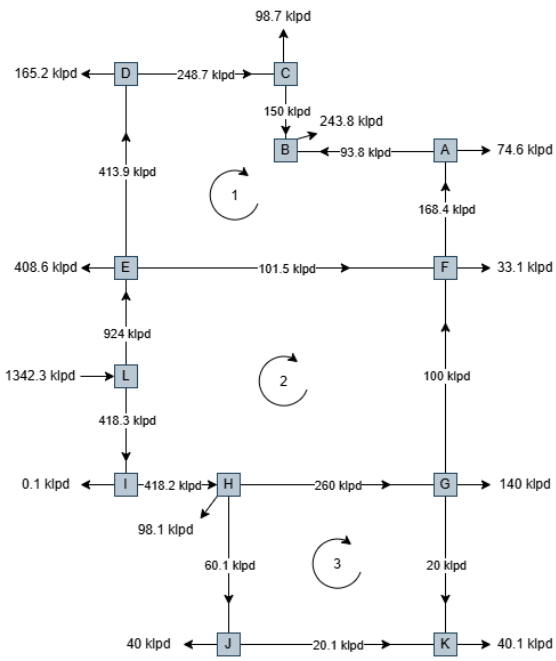


Figure 5 Initially assumed pipe flow of Zone 1

Pipe Flow Determination

Trial 1:

Loop 1:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
BA	-93.80	-0.0383	-0.0024	0.0625	-0.0356	-87.05
BC	150.00	0.0613	0.0057	0.0932		
DC	248.70	0.1017	0.0146	0.1432		
ED	413.90	0.1692	0.0374	0.2208		
EF	-101.50	-0.0415	-0.0028	0.0669		
FA	-168.40	-0.0688	-0.0071	0.1028		
Total			**0.0454**	**0.6895**		

Loop 2:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
EF	101.50	0.0415	0.0028	0.0669	-0.0340	-83.09
LE	924.00	0.3777	0.1651	0.4371		
IL	-418.30	-0.1710	-0.0381	0.2228		
IH	-418.20	-0.1709	-0.0381	0.2228		
HG	-260.00	-0.1063	-0.0158	0.1487		
GF	-100.00	-0.0409	-0.0027	0.0660		
Total			**0.0732**	**1.1643**		

Loop 3:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
HG	260.00	0.1063	0.0158	0.1487	-0.0354	-86.61
JH	-60.10	-0.0246	-0.0011	0.0428		
JK	-20.10	-0.0082	-0.0001	0.0169		
KG	20.00	0.0082	0.0001	0.0168		
Total			**0.0148**	**0.2253**		

Corrected flow:

Path	Flow (klpd)	Correction (klpd)	Corrected Flow (klpd)
DC	248.70	-87.05	161.65
BC	150.00	-87.05	62.95
BA	93.80	87.05	180.85
FA	168.40	87.05	255.45
ED	413.90	-87.05	326.85
EF	101.50	3.96	105.46
IH	418.20	83.09	501.29
HG	260.00	-3.53	256.47
IL	418.30	83.09	501.39
LE	924.00	-83.09	840.91
GF	100.00	83.09	183.09
JK	20.10	86.61	106.71
JH	60.10	86.61	146.71
KG	20.00	-86.61	-66.61

Trial 2:

Loop 1:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
BA	-180.85	-0.0739	-0.0081	0.1093	-0.0046	-11.19
BC	62.95	0.0257	0.0011	0.0446		
DC	161.65	0.0661	0.0066	0.0993		
ED	326.85	0.1336	0.0241	0.1807		
EF	-105.46	-0.0431	-0.0030	0.0691		
FA	-255.45	-0.1044	-0.0153	0.1465		
Total			**0.0055**	**0.6494**		

Loop 2:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
EF	105.46	0.0431	0.0030	0.0691	-0.0049	-12.11
LE	840.91	0.3437	0.1387	0.4034		
IL	-501.39	-0.2049	-0.0533	0.2599		
IH	-501.29	-0.2049	-0.0533	0.2599		
HG	-256.47	-0.1048	-0.0154	0.1470		
GF	-183.09	-0.0748	-0.0083	0.1104		
Total			**0.0114**	**1.2498**		

Loop 3:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
HG	256.47	0.1048	0.0154	0.1470	-0.0085	-20.91
JH	-146.71	-0.0600	-0.0055	0.0915		
JK	-106.71	-0.0436	-0.0030	0.0698		
KG	-66.61	-0.0272	-0.0013	0.0467		
Total			**0.0056**	**0.3550**		

Corrected flow:

Path	Flow (klpd)	Correction (klpd)	Corrected Flow (klpd)
DC	161.65	-11.19	150.46
BC	62.95	-11.19	51.76
BA	180.85	11.19	192.04
FA	255.45	11.19	266.64
ED	326.85	-11.19	315.66
EF	105.46	-0.92	104.54
IH	501.29	12.11	513.40
HG	256.47	-8.80	247.67
IL	501.39	12.11	513.50
LE	840.91	-12.11	828.80
GF	183.09	12.11	195.20
JK	106.71	20.91	127.62
JH	146.71	20.91	167.62
KG	-66.61	-20.91	-87.52

Trial 3:

Loop 1:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
BA	-192.04	-0.0785	-0.0090	0.1150	-0.0006	-1.36
BC	51.76	0.0212	0.0008	0.0377		
DC	150.46	0.0615	0.0057	0.0934		
ED	315.66	0.1290	0.0226	0.1754		
EF	-104.54	-0.0427	-0.0029	0.0686		
FA	-266.64	-0.1090	-0.0166	0.1520		
Total			**0.0007**	**0.6421**		

Loop 2:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
EF	104.54	0.0427	0.0029	0.0686	-0.0012	-2.99
LE	828.80	0.3388	0.1350	0.3985		
IL	-513.50	-0.2099	-0.0557	0.2653		
IH	-513.40	-0.2098	-0.0557	0.2652		
HG	-247.67	-0.1012	-0.0144	0.1427		
GF	-195.20	-0.0798	-0.0093	0.1166		
Total			**0.0028**	**1.2569**		

Loop 3:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
HG	247.67	0.1012	0.0144	0.1427	-0.0015	-3.72
JH	-167.62	-0.0685	-0.0070	0.1024		
JK	-127.62	-0.0522	-0.0042	0.0812		
KG	-87.52	-0.0358	-0.0021	0.0590		
Total			**0.0011**	**0.3854**		

Corrected flow:

Path	Flow (klpd)	Correction (klpd)	Corrected Flow (klpd)
DC	150.46	-1.36	149.10
BC	51.76	-1.36	50.40
BA	192.04	1.36	193.40
FA	266.64	1.36	268.00
ED	315.66	-1.36	314.30
EF	104.54	-1.63	102.91
IH	513.40	2.99	516.38
HG	247.67	-0.74	246.94
IL	513.50	2.99	516.48
LE	828.80	-2.99	825.82
GF	195.20	2.99	198.18
JK	127.62	3.72	131.35
JH	167.62	3.72	171.35
KG	-87.52	-3.72	-91.25

Trial 4:

Loop 1:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
BA	-193.40	-0.0790	-0.0091	0.1157	-0.0001	-0.32
BC	50.40	0.0206	0.0008	0.0369		
DC	149.10	0.0609	0.0057	0.0927		
ED	314.30	0.1285	0.0225	0.1748		
EF	-102.91	-0.0421	-0.0028	0.0677		
FA	-268.00	-0.1095	-0.0167	0.1526		
Total			**0.0002**	**0.6403**		

Loop 2:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
EF	102.91	0.0421	0.0028	0.0677	-0.0002	-0.49
LE	825.82	0.3375	0.1341	0.3973		
IL	-516.48	-0.2111	-0.0563	0.2666		
IH	-516.38	-0.2111	-0.0563	0.2665		
HG	-246.94	-0.1009	-0.0144	0.1424		
GF	-198.18	-0.0810	-0.0096	0.1181		
Total			**0.0005**	**1.2585**		

Loop 3:

Path	Q (klpd)	Q (ft^3/s)	H (ft)	H/Q	Correction (ft^3/s)	Correction (klpd)
HG	246.94	0.1009	0.0144	0.1424	-0.0004	-1.06
JH	-171.35	-0.0700	-0.0073	0.1044		
JK	-131.35	-0.0537	-0.0045	0.0832		
KG	-91.25	-0.0373	-0.0023	0.0611		
Total			**0.0003**	**0.3911**		

Corrected flow:

Path	Flow (klpd)	Correction (klpd)	Corrected Flow (klpd)
DC	149.10	-0.32	148.78
BC	50.40	-0.32	50.08
BA	193.40	0.32	193.72
FA	268.00	0.32	268.32
ED	314.30	-0.32	313.98
EF	102.91	-0.17	102.74
IH	516.38	0.49	516.88
HG	246.94	-0.57	246.37
IL	516.48	0.49	516.98
LE	825.82	-0.49	825.32
GF	198.18	0.49	198.68
JK	131.35	1.06	132.41
JH	171.35	1.06	172.41
KG	-91.25	-1.06	-92.31

Pipe Diameter Determination

Path	Velocity (fps)	Flow (klpd)	Flow (ft^3/s)	Pipe Area (in^2)	Required Diameter (in)	Provided Diameter (in)
DC	3	148.78	0.0608	2.92	1.93	2
BC	3	50.08	0.0205	0.98	1.12	1.5
BA	3	193.72	0.0792	3.80	2.20	2.5
FA	3	268.32	0.1097	5.26	2.59	3
ED	3	313.98	0.1283	6.16	2.80	3
EF	3	102.74	0.0420	2.02	1.60	2
IH	3	516.88	0.2113	10.14	3.59	4
HG	3	246.37	0.1007	4.83	2.48	2.5
IL	3	516.98	0.2113	10.14	3.59	4
LE	3	825.32	0.3373	16.19	4.54	5
GF	3	198.68	0.0812	3.90	2.23	2.5
JK	3	132.41	0.0541	2.60	1.82	2
JH	3	172.41	0.0705	3.38	2.08	2.5
KG	3	92.31	0.0377	1.81	1.52	2

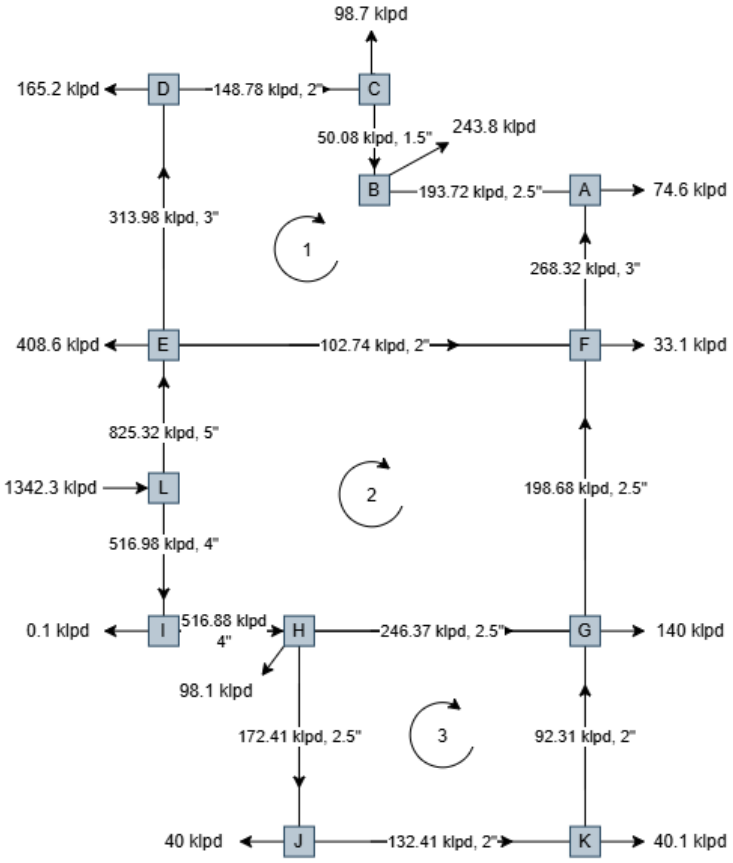


Figure 6 Pipe parameters of Zone 1