Table S1. Characteristics of the Optimal Network Obtained by ACOA-TGA-NLP for the First Test Example

Pipe No.	Node No.		Cover Depths (m)		Flow discharge (m^3/s)	Diameter (mm)	Length (m)	Slope	y/d	V(m/s)
	Up	Down	Up	Down						
1	1	7	1.000	1.880	0.00587	200	360	0.00300	0.410	0.485
2	7	13	1.000	1.950	0.00769	200	350	0.00300	0.477	0.520
3	7	8	1.880	3.126	0.01229	200	290	0.00361	0.600	0.624
4	8	14	3.126	3.879	0.0299	300	270	0.00316	0.554	0.744
5	5	8	1.000	1.680	0.00809	200	260	0.00300	0.491	0.527
6	9	8	1.000	1.260	0.00384	200	220	0.00300	0.327	0.432
7	9	15	1.000	1.320	0.00749	200	240	0.00300	0.470	0.517
8	9	10	1.000	1.775	0.01092	200	275	0.00300	0.590	0.566
9	4	3	1.000	1.620	0.00587	200	240	0.00300	0.410	0.485
10	3	2	1.620	2.420	0.00972	200	300	0.00300	0.548	0.551
11	1	2	1.000	2.570	0.00486	200	490	0.00300	0.370	0.460
12	2	57	2.570	3.626	0.01751	250	250	0.00382	0.508	0.700
13	5	57	1.000	2.000	0.01012	200	300	0.00300	0.562	0.556
14	10	57	1.775	2.882	0.01303	200	310	0.00406	0.600	0.662
15	57	6	3.626	4.081	0.04579	350	240	0.00231	0.618	0.733
16	6	11	4.081	4.759	0.05173	350	230	0.00208	0.700	0.719
17	11	17	4.759	5.415	0.07416	350	200	0.00428	0.700	1.031
18	12	11	1.000	1.570	0.00891	200	190	0.00300	0.520	0.540
19	10	11	1.000	2.907	0.01469	200	380	0.00515	0.600	0.746
20	10	16	1.000	1.500	0.00324	200	250	0.00300	0.299	0.411
21	16	21	1.500	1.950	0.00587	200	200	0.00300	0.410	0.485
22	13	18	1.950	3.273	0.01359	200	300	0.00441	0.600	0.690
23	30	25	1.000	1.840	0.00567	200	280	0.00300	0.402	0.480
24	25	18	1.840	3.122	0.01172	200	360	0.00328	0.600	0.596
25	18	19	3.273	4.490	0.02797	300	350	0.00291	0.546	0.709
26	14	19	3.879	4.497	0.0376	350	230	0.00269	0.521	0.742
27	30	31	1.000	1.590	0.00364	200	230	0.00300	0.317	0.425
28	31	32	1.590	2.632	0.01698	300	250	0.00417	0.371	0.712
29	26	31	1.000	1.396	0.01132	200	260	0.00306	0.600	0.575
30	26	19	1.000	1.950	0.01132	250	310	0.00306	0.422	0.576
31	19	20	4.497	5.106	0.07233	450	300	0.00170	0.595	0.733
32	15	20	1.320	2.114	0.01359	200	180	0.00441	0.600	0.690
33	27	32	1.000	1.170	0.00992	200	190	0.00300	0.555	0.554
34	27	20	1.000	1.880	0.00708	200	260	0.00300	0.455	0.509
35	20	21	5.106	5.631	0.09396	450	320	0.00180	0.700	0.790
36	24	23	1.000	1.920	0.00445	200	290	0.00300	0.353	0.450
37	22	23	6.129	6.486	0.17181	600	325	0.00125	0.710	0.801
38	17	22	5.415	6.129	0.07669	350	200	0.00457	0.700	1.066
39	22	29	1.000	1.430	0.00688	200	210	0.00300	0.448	0.506
40	21	22	5.631	6.029	0.10809	500	370	0.00121	0.732	0.702
41	21	28	1.000	1.580	0.00263	200	260	0.00300	0.269	0.388
42	28	33	1.580	1.970	0.00728	200	230	0.00300	0.462	0.513
43	32	33	2.632	3.286	0.02647	300	225	0.0031	0.516	0.720
44	33	34	3.286	4.260	0.03699	350	350	0.0026	0.519	0.734
45	37	34	1.400	1.890	0.00668	200	180	0.0030	0.440	0.502
46	29	34	1.430	2.138	0.01821	250	230	0.0039	0.515	0.715
47	34	35	4.260	5.151	0.06149	350	320	0.0029	0.700	0.855
48	23	35	6.486	6.666	0.18873	600	440	0.0013	0.750	0.830
49	35	43	6.666	7.017	0.25289	700	290	0.0010	0.750	0.817
50	36	35	1.950	3.154	0.02264	250	310	0.0037	0.600	0.736
51	24	36	1.000	1.920	0.01052	200	440	0.0030	0.576	0.562
52	44	36	1.000	1.950	0.00506	200	350	0.0030	0.378	0.466

53	44	50	1.000	2.030	0.00405	200	310	0.0030	0.335	0.438
54	49	50	1.000	1.780	0.00789	200	260	0.0030	0.484	0.524
55	50	55	2.030	3.423	0.01522	250	300	0.0043	0.452	0.706
56	53	54	5.360	6.100	0.07191	400	350	0.0020	0.700	0.765
57	49	54	7.442	7.868	0.27188	700	230	0.0012	0.750	0.878
58	54	55	7.868	8.309	0.32832	700	280	0.0018	0.750	1.060
59	55	56	8.309	8.697	0.33758	1050	500	0.0008	0.487	0.807
60	51	52	2.380	3.089	0.01285	200	180	0.0039	0.600	0.653
61	45	51	1.690	2.380	0.00972	200	230	0.0030	0.548	0.551
62	38	45	1.000	1.690	0.00466	200	230	0.0030	0.361	0.455
63	38	39	1.000	1.710	0.00142	200	270	0.0030	0.197	0.324
64	31	39	1.000	1.850	0.00324	200	250	0.0030	0.299	0.411
65	40	41	1.710	2.895	0.01322	200	260	0.0042	0.600	0.672
66	32	40	1.000	1.420	0.00182	200	140	0.0030	0.223	0.348
67	39	40	1.000	1.710	0.00506	200	270	0.0030	0.378	0.466
68	39	46	1.850	3.085	0.01359	200	280	0.0044	0.600	0.690
69	46	47	3.085	4.067	0.02372	300	280	0.0032	0.483	0.702
70	52	53	4.761	5.360	0.06694	400	350	0.0017	0.700	0.712
71	47	52	4.154	4.761	0.05379	350	270	0.0022	0.700	0.748
72	48	47	1.900	2.896	0.01751	250	230	0.0039	0.505	0.705
73	41	47	2.895	4.154	0.01821	250	300	0.0039	0.518	0.710
74	42	41	1.000	1.960	0.00324	200	320	0.0030	0.299	0.411
75	42	37	1.000	1.400	0.00304	200	150	0.0030	0.289	0.404
76	42	48	1.000	1.900	0.01072	200	300	0.0030	0.583	0.564
77	42	43	1.000	1.770	0.00628	200	290	0.0030	0.425	0.493
78	43	49	7.017	7.442	0.2669	700	280	0.0012	0.750	0.862
79	44	43	1.000	1.930	0.00809	200	310	0.0030	0.491	0.527

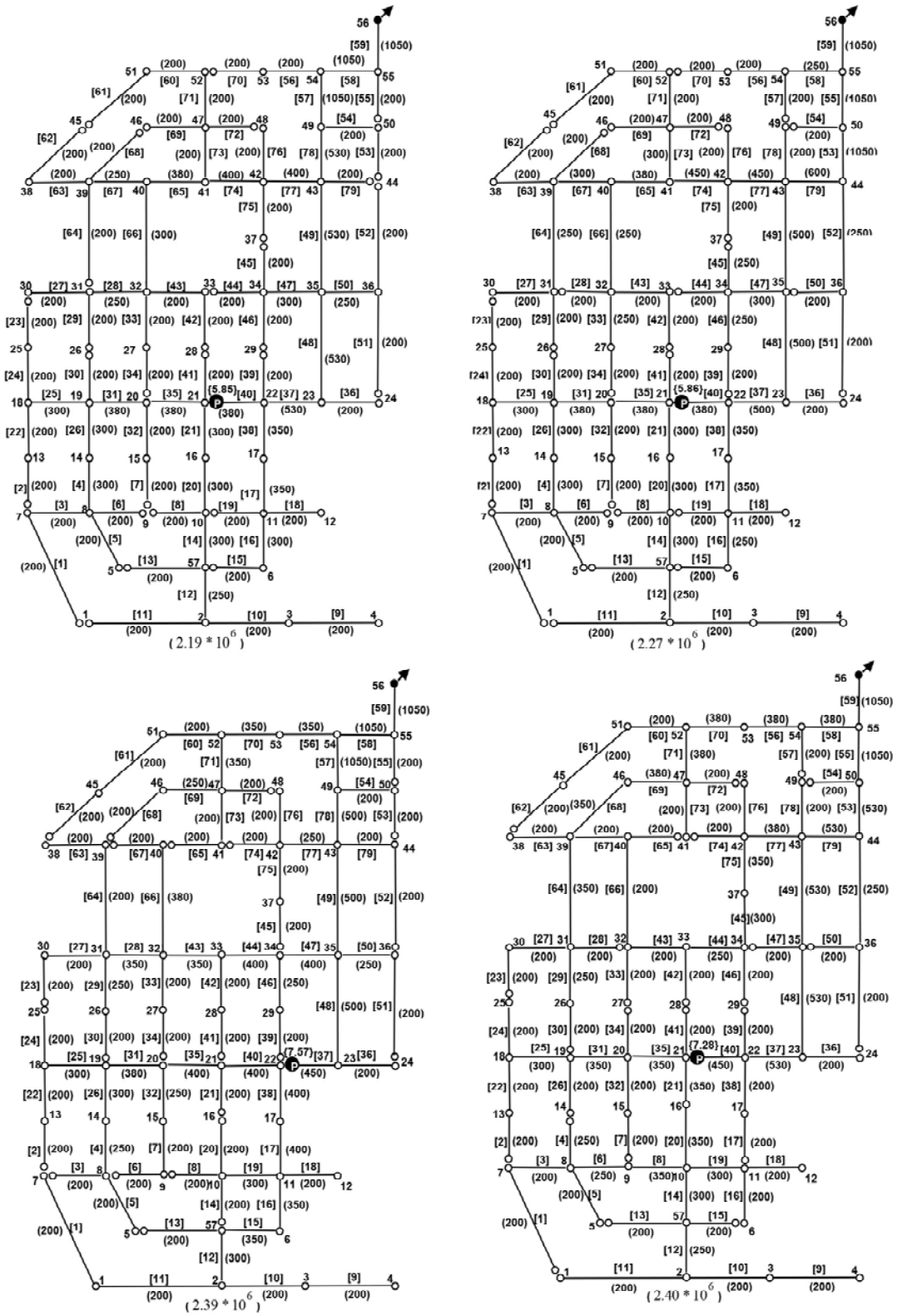

Figure S1. Near optimal solutions obtained by the proposed ACOA-TGA-NLP method in ten runs for the first test example.

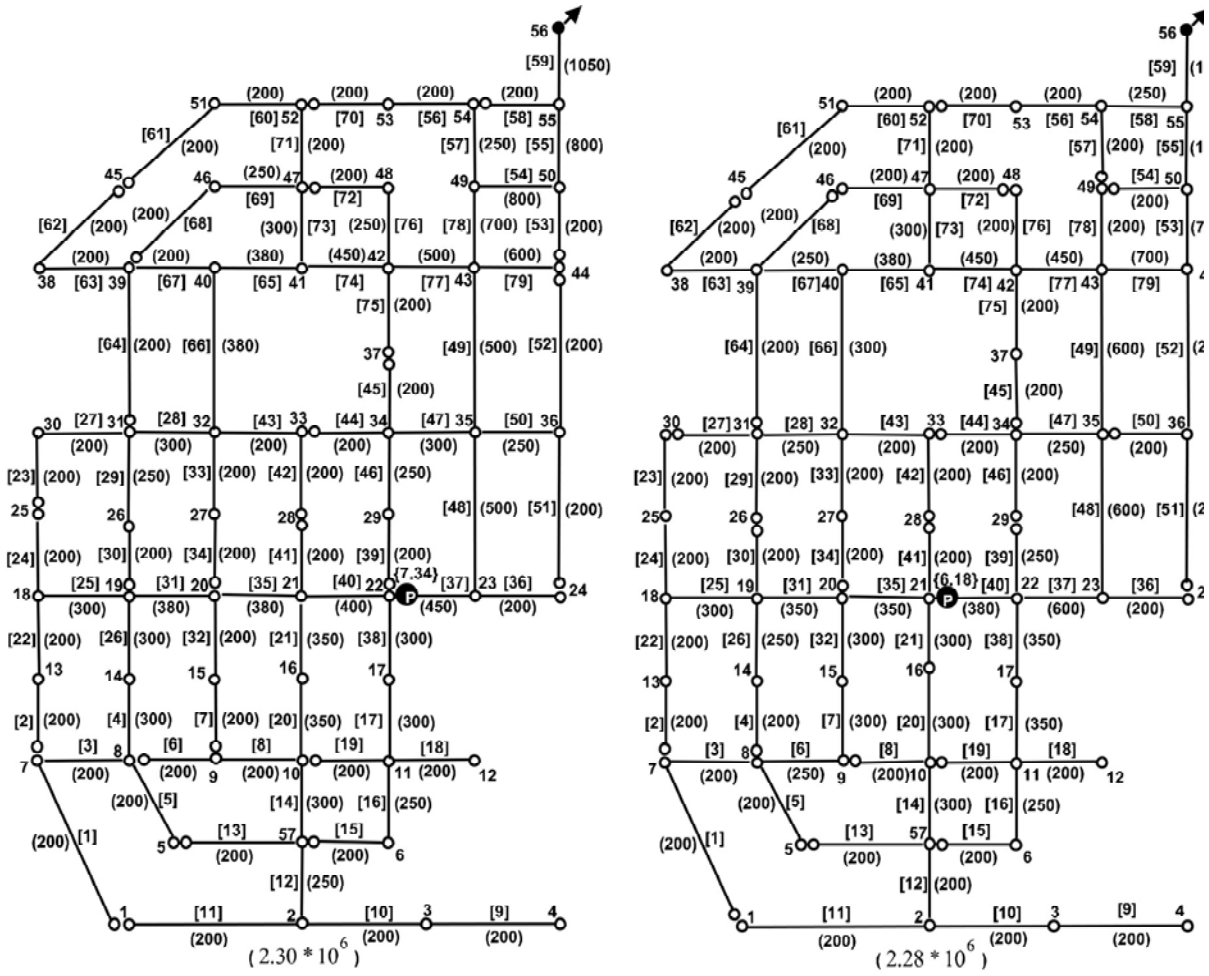

Figure S1 (continued). Near optimal solutions obtained by the proposed ACOA-TGA-NLP method in ten runs for the first test example.