Supplementary Material

Systematic assessment on waterlogging control facilities in Hefei City of Anhui Province in east China

Hao Hu[1,2,#,*], Yan-Kun Liu[1,#,*], Jian-Kang Du[3], Rong-Qiong Liu[4], Bang-Lei WU[1], Qing-Wei Zeng[1]

[1] Anhui Provincial Key Laboratory of Environmental Pollution Control and Resource Reuse, School of Environment and Energy Engineering, Anhui Jianzhu University, Hefei 230601, P.R. China

[2] CAS Key Laboratory of Urban Pollutant Conversion, Department of Environmental Science and Engineering, University of Science and Technology of China, Hefei 230026, P.R. China

[3] Hefei Planning and Design Institute, Hefei 230041, P.R. China

[4] College of Ecology and Environment, Anhui Normal University, Wuhu 241002, P.R. China

*: Corresponding author

Dr. Hao Hu

Fax: +86 551-63828251

Email: huhao2019@ustc.edu.cn

**: Correspondence author

Mr. Yan-kun Liu

Fax: +86 551-63828252

Email: liuyankun@stu.ahjzu.edu.cn

[#] These authors contributed to the work equally and should be regarded as co-first

authors.

There are 14 pages totally in supplementary material including 6 tables and 3 figures.

Table S1 Information about the pipes before and after renovation in this area. The material for pipes before and after renovation is high density polyethylene (HD-PE).

Pipe	Initial node	Ending node	Function	Shape	Length (m)	Slope	Original Diameter (mm)	Renovated Diameter (mm)
GQ1	J1	J2	Storm	Circular	32.0	0.0031	250	315
GQ2	J3	J4	Storm	Circular	33.3	0.0015	250	315
GQ3	J2	J4	Storm	Circular	21.2	0.0023	315	315
GQ4	J4	J5	Storm	Circular	39.5	0.0954	250	315
GQ5	J5	J10	Storm	Circular	39.5	0.0063	300	400
GQ6	J10	J9	Storm	Circular	34.3	0.0143	300	400
GQ7	J6	J7	Storm	Circular	65.9	0.0093	250	315
GQ8	J8	J7	Storm	Circular	42.5	0.0202	250	315
GQ9	J7	J9	Storm	Circular	19.3	0.0098	315	315
GQ10	J11	J9	Storm	Circular	27.7	0.0181	250	315
GQ11	J17	J16	Storm	Circular	40.0	0.0030	250	315
GQ12	J9	J16	Storm	Circular	17.0	0.0106	400	500
GQ13	J16	J18	Storm	Circular	28.6	0.0109	400	500
GQ14	J19	J18	Storm	Circular	25.6	0.0265	250	315
GQ16	J18	J21	Storm	Circular	31.0	0.0061	400	500
GQ17	J13	J12	Storm	Circular	63.5	0.0032	250	315
GQ18	J12	J21	Storm	Circular	30.5	0.0482	250	315
GQ19	J14	J15	Storm	Circular	20.0	0.0125	250	315
GQ20	J15	J22	Storm	Circular	33.8	0.0047	250	315
GQ21	J22	J21	Storm	Circular	12.0	0.1133	315	315
GQ22	J23	J24	Storm	Circular	66.2	0.0251	250	315
GQ23	J21	J24	Storm	Circular	28.0	0.0032	500	600
GQ24	J24	J25	Storm	Circular	10.1	0.0029	500	600
GQ25	J25	J26	Storm	Circular	10.0	0.0030	500	600
GQ26	J26	J27	Storm	Circular	14.5	0.0069	500	600
GQ27	J30	J25	Storm	Circular	68.4	0.0152	250	315
GQ28	J28	J26	Storm	Circular	50.3	0.0243	250	315
GQ29	J29	J27	Storm	Circular	50.3	0.0263	250	315
GQ30	J31	J26	Storm	Circular	61.8	0.0238	315	315
GQ31	J32	J27	Storm	Circular	84.7	0.0191	250	315
GQ32	J27	J33	Storm	Circular	19.0	0.0053	500	600
GQ33	J34	J33	Storm	Circular	98.2	0.0241	250	315
GQ36	J36	J38	Storm	Circular	51.5	0.0041	250	315
GQ37	J37	J39	Storm	Circular	70.5	0.0217	250	315
GQ38	J38	J39	Storm	Circular	11.0	0.0036	315	315
GQ39	J39	J40	Storm	Circular	27.0	0.0529	350	400
GQ40	J41	J40	Storm	Circular	10.0	0.0260	250	315
GQ41	J40	J42	Storm	Circular	25.0	0.0040	350	400

Pipe	Initial node	Ending node	Function	Shape	Length (m)	Slope	Original Diameter (mm)	Renovated Diameter (mm)
GQ42	J45	J44	Storm	Circular	31.0	0.0029	250	315
GQ43	J43	J44	Storm	Circular	82.6	0.0041	250	315
GQ44	J44	J46	Storm	Circular	18.5	0.0086	250	315
GQ45	J47	J46	Storm	Circular	27.3	0.0165	250	315
GQ46	J48	J46	Storm	Circular	58.2	0.0077	250	315
GQ47	J46	J49	Storm	Circular	13.5	0.0104	350	400
GQ48	J50	J49	Storm	Circular	19.2	0.0307	250	315
GQ49	J49	J51	Storm	Circular	31.8	0.0031	400	500
GQ50	J51	J52	Storm	Circular	14.3	0.0028	400	500
GQ51	J52	J53	Storm	Circular	15.0	0.0093	400	500
GQ52	J54	J51	Storm	Circular	20.0	0.0145	250	315
GQ53	J42	J55	Storm	Circular	35.0	0.0040	350	400
GQ54	J55	J53	Storm	Circular	55.0	0.0112	350	400
GQ55	J56	J57	Storm	Circular	10.0	0.0290	315	315
GQ56	J53	J57	Storm	Circular	30.0	0.0040	500	600
GQ57	J57	PFK2	Storm	Circular	5.0	0.0210	500	600
GQ58	J33	J58	Storm	Circular	47.0	0.0029	600	700
GQ59	J58	PFK1	Storm	Circular	10.0	0.0440	600	700

Table S2 Area size and proportion of sponge facilities in the study area

Sponge facilities	Area of sponge facilities (m^2)	Proportion of sponge facilities in study area (%)
Infiltration road	1707.2	4.4
Planting ditch	1202.8	3.1
Permeable pavement	2871.2	7.4
Permeable parking lot	2250.4	5.8
Total	8031.6	20.7

Table S3 Infiltration rate and geological characteristics in the study area.

Foundation geological character	Thickness (m)	Bottom altitude (m)	Maximum infiltration rate (mm/h)	Minimum infiltration rate (mm/h)
Layer miscellaneous fill	0.30～4.30	7.32～29.18	64.8	3.24
Layer silty clay	0.60～3.10	4.22～26.83	2.52	0.36
Layer clay	Not drilled through	—	0.18	0.01

Note: The measured altitude is altitude system of Wusong of China.

Table S4 The curve integral areas of the rainwater depth over elapsed time of key nodes.

Key Nodes	J5	J18	J21	J24	J25	J33
20-a return period without sponge facilities	0.65	2.01	2.11	1.83	1.74	0.85
20-a return period with sponge facilities	0.28	1.41	1.75	1.36	1.38	0.72
50-a return period without sponge facilities	1.85	1.52	2.61	2.49	2.47	0.95
50-a return period with sponge facilities	0.76	2.41	2.52	2.12	2.01	0.84

The bottom areas of the rainwater wells at these key nodes were the same as each other and was set 1 unit. The accumulated rainwater volume (V) = $\int 1 \times \mathrm{h} dt = \int 1 \times \mathrm{h} dt$, in which h means rainwater depth in well, t means elapsed time, and which was coincidentally the curve integral areas of the rainwater depth over elapsed time.

Table S5 The four flow parameters of two outlets (PFK1 and PFK2) variation after renovation with and without sponge facilities

Return period	Outfall Nodes	Programme	Water flow frequency Percentage (%)	Average flow rate（m^3/s）	Peak flow（m^3/s）	Total emissions（m^3）
2a	PFK1	No sponge measures after renovation	57.79	0.210	0.487	903
		Renovation with sponge facilities	52.14	0.187	0.436	649
		Reduction	5.65	0.023	0.051	254
		Percentage reduction %	9.78	10.95	10.47	28.13
	PFK2	No sponge measures after renovation	57.67	0.098	0.228	423
		Renovation with sponge facilities	50.91	0.086	0.159	292
		Reduction	6.76	0.012	0.069	131
		Percentage reduction %	11.72	12.24	30.26	30.97
5a	PFK1	No sponge measures after renovation	63.36	0.300	0.727	1276
		Renovation with sponge facilities	58.57	0.297	0.629	1006
		Reduction	4.79	0.030	0.098	270
		Percentage reduction %	7.56	10.00	13.48	21.63
	PFK2	No sponge measures after renovation	63.26	0.140	0.341	597
		Renovation with sponge facilities	57.57	0.138	0.298	457
		Reduction	5.69	0.02	0.043	140
		Percentage reduction %	8.99	14.3	12.61	23.45
10a	PFK1	No sponge measures after renovation	66.03	0.356	0.857	1551
		Renovation with sponge facilities	61.83	0.310	0.760	1270
		Reduction	4.20	0.046	0.097	281
		Percentage reduction %	6.36	12.92	11.32	18.12
	PFK2	No sponge measures after renovation	65.96	0.166	0.413	726

		Renovation with sponge facilities	60.94	0.148	0.358	579
		Reduction	5.02	0.018	0.055	147
		Percentage reduction %	7.61	10.84	13.32	20.25
20a	PFK1	No sponge measures after renovation	68.14	0.410	1.041	1839
		Renovation with sponge facilities	64.39	0.366	0.897	1536
		Reduction	3.75	0.044	0.144	303
		Percentage reduction %	5.50	10.73	13.83	16.48
	PFK2	No sponge measures after renovation	68.07	0.192	0.548	861
		Renovation with sponge facilities	63.58	0.155	0.434	705
		Reduction	4.49	0.037	0.114	156
		Percentage reduction %	6.60	19.28	20.80	18.12
50a	PFK1	No sponge measures after renovation	70.37	0.463	1.156	2175
		Renovation with sponge facilities	67.04	0.418	1.074	1846
		Reduction	3.33	0.045	0.082	329
		Percentage reduction %	4.73	9.72	7.09	15.13
	PFK2	No sponge measures after renovation	70.31	0.221	0.686	1035
		Renovation with sponge facilities	66.33	0.194	0.543	864
		Reduction	3.98	0.027	0.143	171
		Percentage reduction %	5.66	12.22	20.85	16.52

Table S6 The measured and predicted flow rates of two discharge outlets (PFK1 and PFK2).

	Flow rates from model (m^3/s)		**Measured flow rates (m^3/s)**	**Relative error (%)**
PFK1	2 year period	0.210	0.230	9.5
	5 year period	0.300	0.230	23.3
PFK2	2 year period	0.098	0.101	3.0
	5 year period	0.140	0.101	27.9

Figure S1. The layout of sponge facilities in this study area

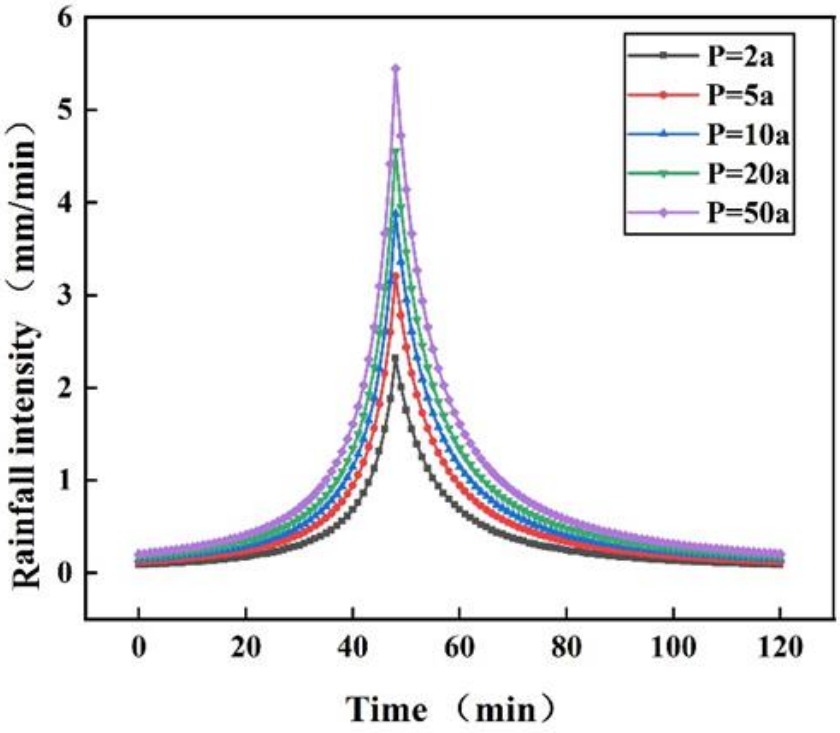


Figure S2. Rain intensity under different return periods by the Chicago Rain Typer

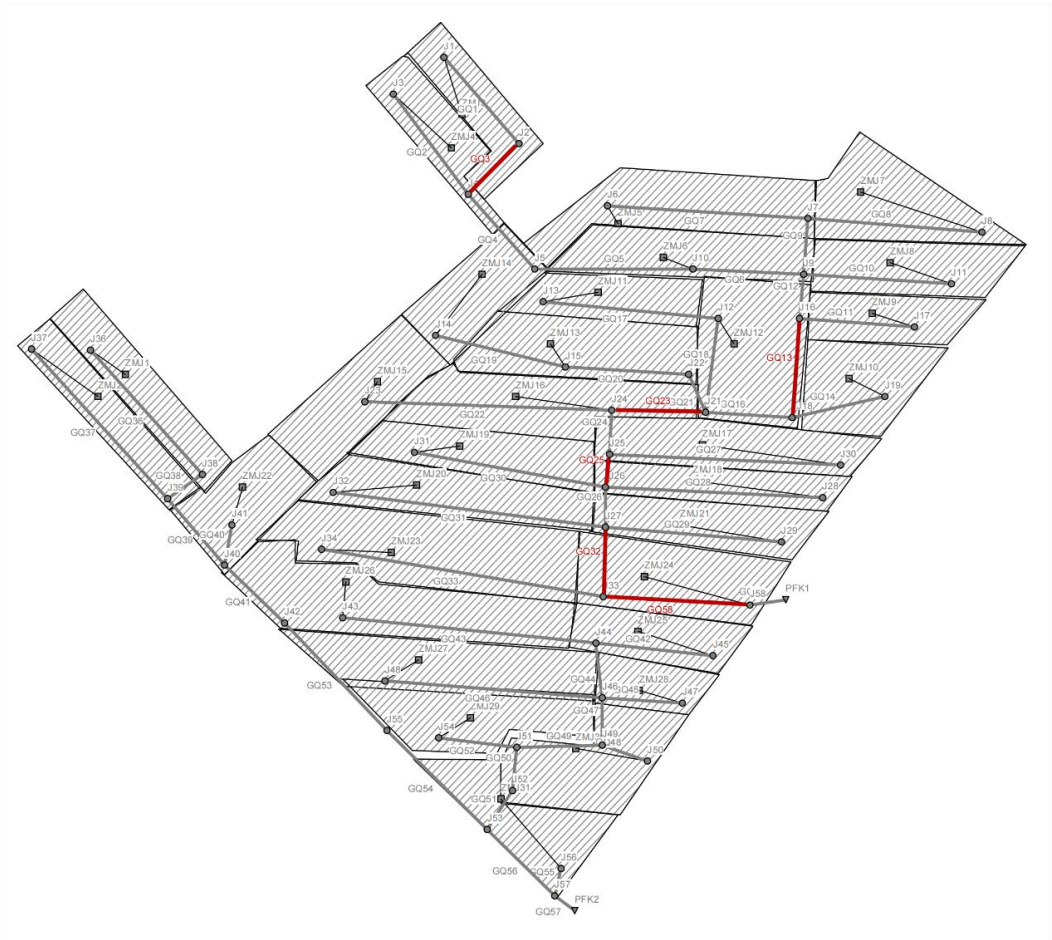
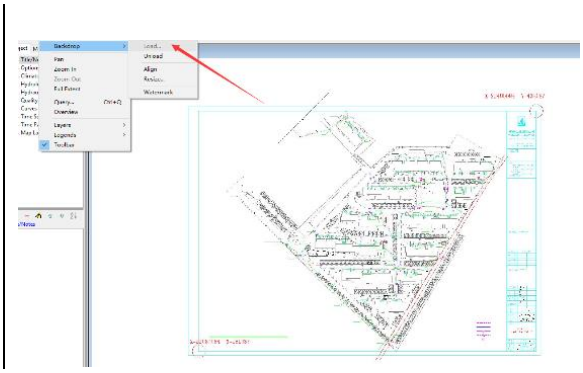


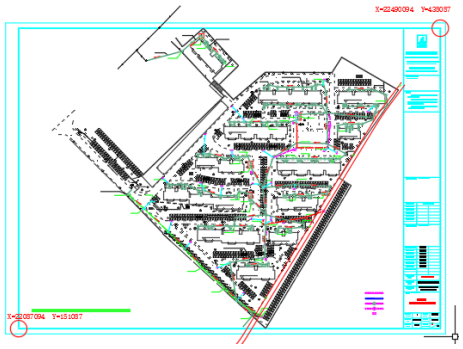
Figure S3. Generalized map of rainfall pipes in this study area. ZMJ means sub-catchments; J means rainwater inspection wells; GQ means rain water pipe; PFK means outlet; and number represents sequence number. Pipes GQ3, GQ13, GQ23, GQ25, GQ32, and GQ58 selected for maximum flow rate and water depth analysis were marked in red on the map.

The generalized method was described as follows:

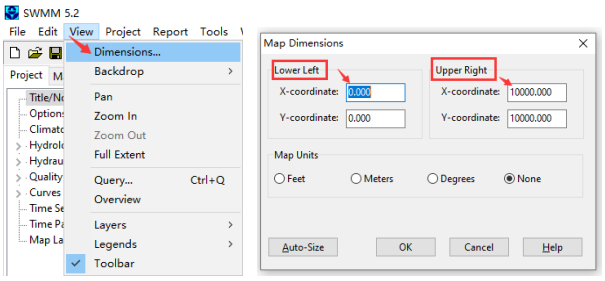
Convert the design drawing of rainwater pipe network to JPG format, then import it into SWMM. Register the image based on the coordinates of the lower left and upper right corners. Once registered, proceed with generalization to create a generalized map. The main steps are illustrated below.



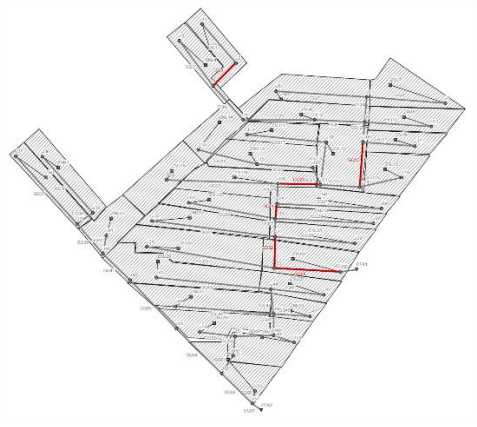
(1) Conversion to JPG format,



(2) Import into SWMM



(3) Registration



(4) Generalization