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Turing House 5 Archway Manchester M15 5RL	Whole Site Rev B Manchester College Openshaw Campus	
Date 04/12/20 File J6776 HYDRAULIC CALCS WI...	Designed by S. McBride Checked by C Munro	
XP Solutions	Network 2014.1.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	30
M5-60 (mm)	18.000
Ratio R	0.358
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Inverts

Network Design Table for Storm

- Indicates pipe length does not match coordinates

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	8.159	0.054	151.1	0.062	5.00	0.0	0.600	o	150	
1.001	27.926	0.186	150.1	0.019	0.00	0.0	0.600	o	300	
2.000	25.986#	0.087	300.0	0.065	5.00	0.0	0.600	o	300	
2.001	44.004	0.196	225.0	0.057	0.00	0.0	0.600	o	300	
3.000	13.671	0.061	224.1	0.000	5.00	0.0	0.600	o	300	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E I.Area (ha)	E Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.17	54.330	0.062	0.0	0.0	0.0	0.82	14.4	8.4
1.001	50.00	5.53	53.688	0.081	0.0	0.0	0.0	1.28	90.5	11.0
2.000	50.00	5.48	53.785	0.065	0.0	0.0	0.0	0.90	63.8	8.8
2.001	50.00	6.18	53.699	0.122	0.0	0.0	0.0	1.04	73.8	16.5
3.000	50.00	5.22	53.593	0.000	0.0	0.0	0.0	1.05	73.9	0.0

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.002	25.981	0.115	225.9	0.072	0.00	0.0	0.600	o	300	
1.003	34.875	0.155	225.0	0.028	0.00	0.0	0.600	o	300	
1.004	35.777#	0.159	225.0	0.047	0.00	0.0	0.600	o	300	
4.000	21.562#	0.216	99.8	0.058	5.00	0.0	0.600	o	150	
4.001	20.341#	0.203	100.2	0.058	0.00	0.0	0.600	o	225	
5.000	28.785#	0.288	99.9	0.101	5.00	0.0	0.600	o	300	
5.001	10.683#	0.107	100.0	0.000	0.00	0.0	0.600	o	300	
6.000	20.282#	0.203	99.9	0.029	5.00	0.0	0.600	o	100	
5.002	37.055#	0.371	99.9	0.000	0.00	0.0	0.600	o	300	
4.002	7.724#	0.077	100.0	0.000	0.00	0.0	0.600	o	300	
4.003	5.376	0.053	101.4	0.037	0.00	0.0	0.600	o	300	
4.004	26.471#	1.324	20.0	0.026	0.00	0.0	0.600	o	300	
4.005	6.532#	0.327	20.0	0.000	0.00	0.0	0.600	o	225	
7.000	18.683	0.319	58.6	0.018	5.00	0.0	0.600	o	150	
7.001	21.926	0.375	58.5	0.000	0.00	0.0	0.600	o	150	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E I.Area (ha)	E Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.002	50.00	6.60	53.502	0.275	0.0	0.0	0.0	1.04	73.6	37.2
1.003	50.00	7.15	53.398	0.303	0.0	0.0	0.0	1.04	73.8	41.0
1.004	50.00	7.73	53.262	0.350	0.0	0.0	0.0	1.04	73.8	47.4
4.000	50.00	5.36	57.737	0.058	0.0	0.0	0.0	1.01	17.8	7.9
4.001	50.00	5.62	57.521	0.116	0.0	0.0	0.0	1.31	51.9	15.7
5.000	50.00	5.31	58.083	0.101	0.0	0.0	0.0	1.57	111.2	13.7
5.001	50.00	5.42	57.795	0.101	0.0	0.0	0.0	1.57	111.1	13.7
6.000	50.00	5.44	57.890	0.029	0.0	0.0	0.0	0.77	6.0	3.9
5.002	50.00	5.83	57.688	0.130	0.0	0.0	0.0	1.57	111.2	17.6
4.002	50.00	5.91	57.317	0.246	0.0	0.0	0.0	1.57	111.1	33.3
4.003	50.00	5.97	57.240	0.283	0.0	0.0	0.0	1.56	110.3	38.3
4.004	50.00	6.10	57.186	0.309	0.0	0.0	0.0	3.53	249.7	41.8
4.005	50.00	6.13	54.000	0.309	0.0	0.0	0.0	2.94	116.9	41.8
7.000	50.00	5.24	58.367	0.018	0.0	0.0	0.0	1.32	23.3	2.4
7.001	50.00	5.51	58.048	0.018	0.0	0.0	0.0	1.32	23.3	2.4

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
4.006	17.540#	0.786	22.3	0.060	0.00	0.0	0.600	o	300	
4.007	14.600#	0.070	208.6	0.000	0.00	0.0	0.600	o	600	
1.005	69.122#	0.230	300.0	0.000	0.00	0.0	0.600	o	375	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
4.006	50.00	6.22	53.673	0.387	0.0	0.0	0.0	3.34	236.3	52.4
4.007	50.00	6.37	53.167	0.387	0.0	0.0	0.0	1.68	475.7	52.4
1.005	50.00	8.83	53.103	0.737	0.0	0.0	0.0	1.04	115.0	99.8

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.062	0.062	0.062
1.001	-	-	100	0.019	0.019	0.019
2.000	-	-	100	0.065	0.065	0.065
2.001	-	-	100	0.057	0.057	0.057
3.000	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.072	0.072	0.072
1.003	-	-	100	0.028	0.028	0.028
1.004	-	-	100	0.047	0.047	0.047
4.000	-	-	100	0.058	0.058	0.058
4.001	-	-	100	0.058	0.058	0.058
5.000	-	-	100	0.101	0.101	0.101
5.001	-	-	100	0.000	0.000	0.000
6.000	-	-	100	0.029	0.029	0.029
5.002	-	-	100	0.000	0.000	0.000
4.002	-	-	100	0.000	0.000	0.000
4.003	-	-	100	0.037	0.037	0.037
4.004	-	-	100	0.026	0.026	0.026
4.005	-	-	100	0.000	0.000	0.000
7.000	-	-	100	0.018	0.018	0.018
7.001	-	-	100	0.000	0.000	0.000
4.006	-	-	100	0.060	0.060	0.060
4.007	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.737	0.737	0.737

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D, L (mm)	W (mm)
1.005		54.900	52.873	53.090	600	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1
Number of Input Hydrographs	0	Number of Storage Structures	4
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

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Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.358		

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Online Controls for Storm

Hydro-Brake Optimum® Manhole: 13, DS/PN: 1.005, Volume (m³): 9.3

Unit Reference	MD-SCU-0222-4750-0950-4750
Design Head (m)	0.950
Design Flow (l/s)	47.5
Flush-Flo™	Calculated
Objective	Linear discharge profile
Diameter (mm)	222
Invert Level (m)	53.103
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.950	47.5
Flush-Flo™	0.258	29.5
Kick-Flo®	0.331	28.7
Mean Flow over Head Range	-	31.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.2	1.200	53.2	3.000	82.9	7.000	125.3
0.200	24.3	1.400	57.3	3.500	89.3	7.500	129.6
0.300	29.2	1.600	61.1	4.000	95.3	8.000	133.8
0.400	31.4	1.800	64.7	4.500	101.0	8.500	137.8
0.500	34.9	2.000	68.1	5.000	106.3	9.000	141.7
0.600	38.1	2.200	71.3	5.500	111.4	9.500	145.5
0.800	43.7	2.400	74.4	6.000	116.2		
1.000	48.7	2.600	77.3	6.500	120.9		

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Storage Structures for Storm

Swale Manhole: 8, DS/PN: 1.001

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

```

Infiltration Coefficient Base (m/hr) 0.00000
Infiltration Coefficient Side (m/hr) 0.00000
      Safety Factor          2.0
      Porosity              0.30
      Invert Level (m)      54.163
      Base Width (m)       4.9
      Length (m)          35.0
      Side Slope (1:X)     3.0
      Slope (1:X)         0.0
      Cap Volume Depth (m) 0.300
      Cap Infiltration Depth (m) 0.000
      Include Swale Volume  Yes

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Cellular Storage Manhole: 17, DS/PN: 3.000

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      Invert Level (m)      53.593
Infiltration Coefficient Base (m/hr) 0.00000
Infiltration Coefficient Side (m/hr) 0.00000
      Safety Factor          2.0
      Porosity              0.95

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Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	52.5	52.5	0.500	0.0	64.1
0.400	52.5	64.1			

Swale Manhole: 17, DS/PN: 7.001

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

```

Infiltration Coefficient Base (m/hr) 0.00000
Infiltration Coefficient Side (m/hr) 0.00000
      Safety Factor          2.0
      Porosity              0.30
      Invert Level (m)      57.910
      Base Width (m)       7.2
      Length (m)          7.2
      Side Slope (1:X)     3.0
      Slope (1:X)         0.0
      Cap Volume Depth (m) 0.300
      Cap Infiltration Depth (m) 0.000
      Include Swale Volume  Yes

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Whole Site Rev B
Manchester College
Openshaw Campus



Designed by S. McBride

Checked by C Munro

Network 2014.1.1

Invert Level (m)	53.164
Infiltration Coefficient Base (m/hr)	0.00000
Infiltration Coefficient Side (m/hr)	0.00000
Safety Factor	2.0
Porosity	0.95

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	160.0	160.0	0.900	0.0	201.6
0.800	160.0	201.6			

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
7.001	600 Winter	1	0%					
4.006	15 Winter	1	0%	100/15 Winter				
4.007	60 Winter	1	0%	100/15 Summer				
1.005	60 Winter	1	0%	30/15 Summer				

PN	US/MH Name	Water		Flooded		Pipe		Status
		Level (m)	Surch'd Depth (m)	Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	
1.000	1	54.414	-0.066	0.000	0.59	0.0	7.3	OK
1.001	8	53.756	-0.232	0.000	0.11	0.0	9.3	OK
2.000	2	53.859	-0.226	0.000	0.13	0.0	7.7	OK
2.001	9	53.789	-0.210	0.000	0.19	0.0	13.0	OK
3.000	17	53.595	-0.298	0.000	0.00	0.0	0.1	OK
1.002	10	53.639	-0.163	0.000	0.42	0.0	27.9	OK
1.003	11	53.539	-0.159	0.000	0.44	0.0	30.0	OK
1.004	12	53.411	-0.151	0.000	0.49	0.0	33.2	OK
4.000	8	57.805	-0.082	0.000	0.41	0.0	6.8	OK
4.001	15	57.601	-0.145	0.000	0.27	0.0	12.8	OK
5.000	15	58.152	-0.231	0.000	0.12	0.0	11.9	OK
5.001	16	57.872	-0.223	0.000	0.15	0.0	12.0	OK
6.000	11	57.946	-0.044	0.000	0.59	0.0	3.4	OK
5.002	17	57.766	-0.222	0.000	0.15	0.0	15.4	OK
4.002	9	57.449	-0.168	0.000	0.40	0.0	27.9	OK
4.003	3	57.394	-0.146	0.000	0.51	0.0	31.5	OK
4.004	4	57.264	-0.222	0.000	0.15	0.0	34.0	OK
4.005	5	54.102	-0.123	0.000	0.42	0.0	34.1	OK
7.000	16	58.399	-0.118	0.000	0.10	0.0	2.1	OK
7.001	17	58.054	-0.144	0.000	0.01	0.0	0.2	FLOOD RISK
4.006	6	53.763	-0.210	0.000	0.20	0.0	39.7	OK
4.007	Dummy	53.320	-0.447	0.000	0.05	0.0	15.8	OK
1.005	13	53.317	-0.161	0.000	0.24	0.0	26.1	OK

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coefficient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	4
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.357
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	OFF
Inertia Status	OFF

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	Storm	Return Period	Climate Change	First X Surge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	30	0%	30/15	Summer			
1.001	15 Winter	30	0%	100/15	Summer			
2.000	15 Winter	30	0%	100/15	Summer			
2.001	15 Winter	30	0%	100/15	Summer			
3.000	30 Winter	30	0%	100/15	Summer			
1.002	15 Winter	30	0%	100/15	Summer			
1.003	15 Winter	30	0%	30/15	Winter			
1.004	60 Winter	30	0%	30/15	Summer			
4.000	15 Winter	30	0%	30/15	Winter			
4.001	15 Winter	30	0%	100/15	Summer			
5.000	15 Winter	30	0%					
5.001	15 Winter	30	0%					
6.000	15 Winter	30	0%	30/15	Summer			
5.002	15 Winter	30	0%	100/15	Summer			
4.002	15 Winter	30	0%	30/15	Summer			
4.003	15 Winter	30	0%	30/15	Summer			
4.004	15 Winter	30	0%					
4.005	15 Winter	30	0%	100/15	Summer			
7.000	15 Winter	30	0%					

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
7.001	60 Winter	30	0%					
4.006	15 Winter	30	0%	100/15 Winter				
4.007	60 Winter	30	0%	100/15 Summer				
1.005	60 Winter	30	0%	30/15 Summer				

PN	US/MH Name	Water		Flooded		Pipe		Status
		Level (m)	Surch'd Depth (m)	Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	
1.000	1	54.534	0.054	0.000	1.43	0.0	18.0	SURCHARGED
1.001	8	53.817	-0.171	0.000	0.28	0.0	23.1	OK
2.000	2	53.909	-0.176	0.000	0.33	0.0	18.7	OK
2.001	9	53.854	-0.145	0.000	0.50	0.0	34.8	OK
3.000	17	53.664	-0.229	0.000	0.06	0.0	3.5	OK
1.002	10	53.794	-0.008	0.000	0.89	0.0	58.8	OK
1.003	11	53.725	0.027	0.000	0.89	0.0	60.5	SURCHARGED
1.004	12	53.668	0.106	0.000	0.68	0.0	46.3	SURCHARGED
4.000	8	57.912	0.025	0.000	0.96	0.0	16.2	SURCHARGED*
4.001	15	57.719	-0.027	0.000	0.70	0.0	32.7	OK
5.000	15	58.195	-0.188	0.000	0.29	0.0	29.2	OK
5.001	16	57.920	-0.175	0.000	0.36	0.0	29.5	OK
6.000	11	58.193	0.203	0.000	1.34	0.0	7.8	SURCHARGED
5.002	17	57.812	-0.176	0.000	0.36	0.0	36.8	OK
4.002	9	57.633	0.016	0.000	0.96	0.0	66.7	SURCHARGED
4.003	3	57.563	0.023	0.000	1.21	0.0	74.2	SURCHARGED
4.004	4	57.311	-0.175	0.000	0.36	0.0	79.7	OK
4.005	5	54.181	-0.044	0.000	0.99	0.0	79.8	OK
7.000	16	58.417	-0.100	0.000	0.24	0.0	5.3	OK
7.001	17	58.075	-0.123	0.000	0.07	0.0	1.6	FLOOD RISK
4.006	6	53.818	-0.155	0.000	0.46	0.0	93.4	OK
4.007	Dummy	53.648	-0.119	0.000	0.07	0.0	24.7	OK
1.005	13	53.645	0.167	0.000	0.33	0.0	36.2	SURCHARGED

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Turing House 5 Archway Manchester M15 5RL	Whole Site Rev B Manchester College Openshaw Campus	
Date 04/12/20	Designed by S. McBride	
File J6776 HYDRAULIC CALCS WI...	Checked by C Munro	
XP Solutions		Network 2014.1.1

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
for Storm

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
7.001	30 Winter	100	+40%					
4.006	60 Winter	100	+40%	100/15 Winter				
4.007	60 Winter	100	+40%	100/15 Summer				
1.005	60 Winter	100	+40%	30/15 Summer				

PN	US/MH Name	Water		Flooded		Pipe		Status
		Level (m)	Surch'd Depth (m)	Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	
1.000	1	54.774	0.294	0.000	2.54	0.0	31.9	FLOOD RISK
1.001	8	54.399	0.411	0.000	0.37	0.0	30.3	FLOOD RISK
2.000	2	54.461	0.376	0.000	0.32	0.0	18.2	FLOOD RISK
2.001	9	54.450	0.451	0.000	0.48	0.0	32.8	SURCHARGED
3.000	17	54.429	0.536	0.000	0.23	0.0	14.0	SURCHARGED
1.002	10	54.430	0.628	0.000	0.75	0.0	49.3	SURCHARGED
1.003	11	54.543	0.845	0.000	0.74	0.0	50.0	SURCHARGED
1.004	12	54.625	1.063	0.000	0.91	0.0	62.1	SURCHARGED
4.000	8	58.800	0.913	0.000	1.65	0.0	27.7	FLOOD RISK*
4.001	15	58.200	0.454	0.000	1.16	0.0	54.5	SURCHARGED
5.000	15	58.240	-0.143	0.000	0.53	0.0	52.9	OK
5.001	16	58.078	-0.017	0.000	0.60	0.0	48.9	OK
6.000	11	58.801	0.811	0.000	2.04	0.0	11.9	FLOOD RISK
5.002	17	58.044	0.056	0.000	0.58	0.0	59.2	SURCHARGED
4.002	9	57.926	0.309	0.000	1.60	0.0	111.4	SURCHARGED
4.003	3	57.732	0.192	0.000	2.04	0.0	125.1	SURCHARGED
4.004	4	57.357	-0.129	0.000	0.60	0.0	135.5	OK
4.005	5	54.907	0.682	0.000	1.68	0.0	135.1	SURCHARGED
7.000	16	58.437	-0.080	0.000	0.44	0.0	9.5	OK
7.001	17	58.100	-0.098	0.000	0.26	0.0	5.8	FLOOD RISK
4.006	6	54.717	0.744	0.000	0.52	0.0	105.9	SURCHARGED
4.007	Dummy	54.643	0.876	0.000	0.20	0.0	67.9	SURCHARGED
1.005	13	54.633	1.155	0.000	0.53	0.0	57.4	FLOOD RISK