

		Page 1
	Bridge Point, Uxbridge SW Network V2 22.12.21	
Date 22/12/2021 File Riverside Way - SW Netw...	Designed by paulg Checked by	
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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)	2	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.900	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.529	4-8	0.081

Total Area Contributing (ha) = 0.610

Total Pipe Volume (m³) = 6.455

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)	Section Type	Auto Design
1.000	21.000	0.105	200.0	0.106	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	3.000	0.012	250.0	0.317	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.002	4.000	0.016	250.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
2.000	22.000	0.402	54.7	0.135	4.00	0.0	0.600	o	225	Pipe/Conduit	
3.000	19.000	0.127	150.0	0.052	4.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	I.Area (ha)	Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	4.38	30.375	0.106	0.0	0.0	0.0	0.92	36.6	17.2
1.001	50.00	4.42	30.120	0.423	0.0	0.0	0.0	1.14	126.1	68.7
1.002	50.00	4.48	29.900	0.423	0.0	0.0	0.0	1.14	126.1	68.7
2.000	50.00	4.21	30.225	0.135	0.0	0.0	0.0	1.77	70.4	21.9
3.000	50.00	4.39	29.950	0.052	0.0	0.0	0.0	0.82	14.5	8.4

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Bridge Point, Uxbridge
SW Network
V2 22.12.21
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Date 22/12/2021
File Riverside Way - SW Netw...
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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)	Section	Type	Auto Design
2.001	3.000	0.012	250.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit		🟢
2.002	4.000	0.037	108.1	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit		🟢
4.000	4.000	0.013	307.7	0.000	4.00	0.0	0.600	o	300	Pipe/Conduit		🟡
2.003	17.000	0.063	269.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit		🔴
1.003	15.000	0.075	200.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit		🔴

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)
2.001	50.00	4.44	29.673	0.187	0.0	0.0	0.0	0.99	70.0	30.4
2.002	50.00	4.48	29.661	0.187	0.0	0.0	0.0	1.51	106.9	30.4
4.000	50.00	4.07	29.300	0.000	0.0	0.0	0.0	0.89	63.0	0.0
2.003	50.00	4.78	28.600	0.187	0.0	0.0	0.0	0.95	67.3	30.4
1.003	50.00	4.97	29.820	0.610	0.0	0.0	0.0	1.28	141.1	99.1

		Page 3
	Bridge Point, Uxbridge SW Network V2 22.12.21	
Date 22/12/2021 File Riverside Way - SW Netw...	Designed by paulg Checked by	
Innovyze	Network 2017.1.2	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	225	SO1	31.800	30.375	1.200	Open Manhole	1200
1.001	o	375	S02	31.850	30.120	1.355	Open Manhole	1350
1.002	o	375	Tank 1	31.500	29.900	1.225	Open Manhole	300
2.000	o	225	SG	31.350	30.225	0.900	Open Manhole	300
3.000	o	150	SG	30.850	29.950	0.750	Open Manhole	300
2.001	o	300	S03	31.250	29.673	1.277	Open Manhole	1200
2.002	o	300	PI	31.100	29.661	1.139	Open Manhole	300
4.000	o	300	Tank 2	30.950	29.300	1.350	Open Manhole	1200
2.003	o	300	S04 / PS	31.700	28.600	2.800	Open Manhole	1200
1.003	o	375	S04	31.500	29.820	1.305	Open Manhole	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	21.000	200.0	S02	31.850	30.270	1.355	Open Manhole	1350
1.001	3.000	250.0	Tank 1	31.500	30.108	1.017	Open Manhole	300
1.002	4.000	250.0	S04	31.500	29.884	1.241	Open Manhole	1500
2.000	22.000	54.7	S03	31.250	29.823	1.202	Open Manhole	1200
3.000	19.000	150.0	S03	31.250	29.823	1.277	Open Manhole	1200
2.001	3.000	250.0	PI	31.100	29.661	1.139	Open Manhole	300
2.002	4.000	108.1	S04 / PS	31.700	29.624	1.776	Open Manhole	1200
4.000	4.000	307.7	S04 / PS	31.700	29.287	2.113	Open Manhole	1200
2.003	17.000	269.8	S04	31.500	28.537	2.663	Open Manhole	1500
1.003	15.000	200.0	Sewer	30.600	29.745	0.480	Open Manhole	0

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)
1.003	Sewer	30.600	29.745	29.400	0	0

		Page 4
	Bridge Point, Uxbridge SW Network V2 22.12.21	
Date 22/12/2021 File Riverside Way - SW Netw...	Designed by paulg Checked by	
Innovyze	Network 2017.1.2	
<u>Simulation Criteria for Storm</u> Volumetric Runoff Coeff 0.900 Additional Flow - % of Total Flow 0.000 Areal Reduction Factor 1.000 MADD Factor * 10m³/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 2 Number of Online Controls 2 Number of Time/Area Diagrams 0 Number of Offline Controls 0 Number of Real Time Controls 0 <u>Synthetic Rainfall Details</u> Rainfall Model FSR Profile Type Summer Return Period (years) 2 Cv (Summer) 0.900 Region England and Wales Cv (Winter) 0.840 M5-60 (mm) 20.000 Storm Duration (mins) 30 Ratio R 0.400		
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		Page 5
Bridge Point, Uxbridge SW Network V2 22.12.21		
Date 22/12/2021 File Riverside Way - SW Netw...	Designed by paulg Checked by	
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Online Controls for Storm

Pump Manhole: S04 / PS, DS/PN: 2.003, Volume (m³): 3.9

Invert Level (m) 28.600

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.200	2.0000	1.800	2.0000	3.400	2.0000	5.000	2.0000
0.400	2.0000	2.000	2.0000	3.600	2.0000	5.200	2.0000
0.600	2.0000	2.200	2.0000	3.800	2.0000	5.400	2.0000
0.800	2.0000	2.400	2.0000	4.000	2.0000	5.600	2.0000
1.000	2.0000	2.600	2.0000	4.200	2.0000	5.800	2.0000
1.200	2.0000	2.800	2.0000	4.400	2.0000	6.000	2.0000
1.400	2.0000	3.000	2.0000	4.600	2.0000		
1.600	2.0000	3.200	2.0000	4.800	2.0000		

Complex Manhole: S04, DS/PN: 1.003, Volume (m³): 4.4

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0088-3700-1200-3700
Design Head (m)	1.200
Design Flow (l/s)	3.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	88
Invert Level (m)	29.820
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	3.7
Flush-Flo™	0.361	3.7
Kick-Flo®	0.743	3.0
Mean Flow over Head Range	-	3.2

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	2.7	0.600	3.5	1.600	4.2	2.600	5.3
0.200	3.5	0.800	3.1	1.800	4.5	3.000	5.7
0.300	3.7	1.000	3.4	2.000	4.7	3.500	6.1
0.400	3.7	1.200	3.7	2.200	4.9	4.000	6.5
0.500	3.6	1.400	4.0	2.400	5.1	4.500	6.9

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		Page 6																																
	Bridge Point, Uxbridge SW Network V2 22.12.21																																	
Date 22/12/2021 File Riverside Way - SW Netw...	Designed by paulg Checked by																																	
Innovyze	Network 2017.1.2																																	
<u>Hydro-Brake® Optimum</u> <table border="1"> <thead> <tr> <th>Depth (m)</th> <th>Flow (l/s)</th> <th>Depth (m)</th> <th>Flow (l/s)</th> <th>Depth (m)</th> <th>Flow (l/s)</th> <th>Depth (m)</th> <th>Flow (l/s)</th> </tr> </thead> <tbody> <tr> <td>5.000</td> <td>7.2</td> <td>6.500</td> <td>8.2</td> <td>8.000</td> <td>9.0</td> <td>9.500</td> <td>9.8</td> </tr> <tr> <td>5.500</td> <td>7.5</td> <td>7.000</td> <td>8.4</td> <td>8.500</td> <td>9.3</td> <td></td> <td></td> </tr> <tr> <td>6.000</td> <td>7.9</td> <td>7.500</td> <td>8.7</td> <td>9.000</td> <td>9.5</td> <td></td> <td></td> </tr> </tbody> </table> <u>Orifice</u> Diameter (m) 0.022 Discharge Coefficient 0.600 Invert Level (m) 30.920			Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	5.000	7.2	6.500	8.2	8.000	9.0	9.500	9.8	5.500	7.5	7.000	8.4	8.500	9.3			6.000	7.9	7.500	8.7	9.000	9.5		
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)																											
5.000	7.2	6.500	8.2	8.000	9.0	9.500	9.8																											
5.500	7.5	7.000	8.4	8.500	9.3																													
6.000	7.9	7.500	8.7	9.000	9.5																													
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		Page 7
	Bridge Point, Uxbridge SW Network V2 22.12.21	
Date 22/12/2021 File Riverside Way - SW Netw...	Designed by paulg Checked by	
Innovyze	Network 2017.1.2	

Storage Structures for Storm

Cellular Storage Manhole: Tank 1, DS/PN: 1.002

Invert Level (m) 29.900 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

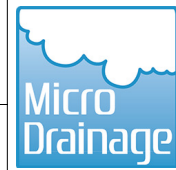
Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	320.0	320.0	5.200	0.0	377.3
0.400	320.0	348.6	5.600	0.0	377.3
0.800	320.0	377.2	6.000	0.0	377.3
0.801	0.0	377.3	6.400	0.0	377.3
1.600	0.0	377.3	6.800	0.0	377.3
2.000	0.0	377.3	7.200	0.0	377.3
2.400	0.0	377.3	7.600	0.0	377.3
2.800	0.0	377.3	8.000	0.0	377.3
3.200	0.0	377.3	8.400	0.0	377.3
3.600	0.0	377.3	8.800	0.0	377.3
4.000	0.0	377.3	9.200	0.0	377.3
4.400	0.0	377.3	9.600	0.0	377.3
4.800	0.0	377.3	10.000	0.0	377.3

Cellular Storage Manhole: Tank 2, DS/PN: 4.000

Invert Level (m) 29.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	60.0	60.0	5.200	0.0	84.8
0.400	60.0	72.4	5.600	0.0	84.8
0.800	60.0	84.8	6.000	0.0	84.8
0.801	0.0	84.8	6.400	0.0	84.8
1.600	0.0	84.8	6.800	0.0	84.8
2.000	0.0	84.8	7.200	0.0	84.8
2.400	0.0	84.8	7.600	0.0	84.8
2.800	0.0	84.8	8.000	0.0	84.8
3.200	0.0	84.8	8.400	0.0	84.8
3.600	0.0	84.8	8.800	0.0	84.8
4.000	0.0	84.8	9.200	0.0	84.8
4.400	0.0	84.8	9.600	0.0	84.8
4.800	0.0	84.8	10.000	0.0	84.8

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Bridge Point, Uxbridge
SW Network
V2 22.12.21
```



Date 22/12/2021
File Riverside Way - SW Netw...

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Network 2017.1.2

1 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 Coeffiecient	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	2
Number of Online Controls	2	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	0.400
Region	England and Wales	Cv (Summer)	0.925
M5-60 (mm)	20.000	Cv (Winter)	0.925

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

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

PN	US/MH		Return Period	Climate Change	First (X)		First (Y)		First (Z)	Overflow Act.
	Name	Storm			Surcharge	Flood	Overflow			
1.000	S01	15 Summer	1	+0%	30/15	Summer	100/15	Summer		
1.001	S02	15 Summer	1	+0%	30/15	Summer				
1.002	Tank 1	360 Winter	1	+0%	30/120	Summer	100/180	Summer		
2.000	SG	15 Summer	1	+0%	30/15	Summer	100/15	Summer		
3.000	SG	15 Summer	1	+0%	30/15	Summer	100/15	Summer		
2.001	S03	15 Summer	1	+0%	30/15	Summer				
2.002	PI	15 Summer	1	+0%	30/15	Summer	100/30	Winter		
4.000	Tank 2	60 Winter	1	+0%	30/15	Summer	100/30	Summer		
2.003	S04 / PS	15 Summer	1	+0%	1/15	Summer				
1.003	S04	360 Winter	1	+0%	30/30	Summer	100/180	Summer		

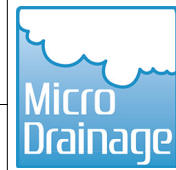
PN	US/MH Name	Water	Surcharged	Flooded			Pipe	Status	Level Exceeded
		Level (m)	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)		
1.000	SO1	30.499	-0.101	0.000	0.58		19.3	OK	1
1.001	SO2	30.367	-0.128	0.000	0.75		62.1	OK	

		Page 9
	Bridge Point, Uxbridge SW Network V2 22.12.21	
Date 22/12/2021 File Riverside Way - SW Netw...	Designed by paulg Checked by	
Innovyze	Network 2017.1.2	

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m ³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.002	Tank 1	30.097	-0.178	0.000	0.05		3.6	OK	16
2.000	SG	30.322	-0.128	0.000	0.39		24.8	OK	2
3.000	SG	30.043	-0.057	0.000	0.70		9.5	OK	24
2.001	S03	29.855	-0.119	0.000	0.67		34.3	OK	
2.002	PI	29.823	-0.138	0.000	0.56		34.3	OK	
4.000	Tank 2	29.543	-0.057	0.000	0.04		2.0	OK	14
2.003	S04 / PS	29.632	0.732	0.000	0.03		2.0	SURCHARGED	
1.003	S04	30.101	-0.094	0.000	0.03		3.7	OK	16

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Bridge Point, Uxbridge
SW Network
V2 22.12.21
```



Date 22/12/2021
File Riverside Way - SW Netw...

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Network 2017.1.2

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 Coeffiecient	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	2
Number of Online Controls	2	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	0.400
Region	England and Wales	Cv (Summer)	0.925
M5-60 (mm)	20.000	Cv (Winter)	0.925

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

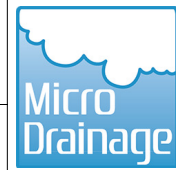
Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

US/MH			Return	Climate	First (X)		First (Y)		First (Z)	Overflow
PN	Name	Storm	Period	Change	Surcharge		Flood		Overflow	Act.
1.000	SO1	15	Summer	30	+0%	30/15	Summer	100/15	Summer	
1.001	SO2	15	Summer	30	+0%	30/15	Summer			
1.002	Tank 1	600	Winter	30	+0%	30/120	Summer	100/180	Summer	
2.000	SG	15	Summer	30	+0%	30/15	Summer	100/15	Summer	
3.000	SG	15	Summer	30	+0%	30/15	Summer	100/15	Summer	
2.001	SO3	180	Winter	30	+0%	30/15	Summer			
2.002	PI	120	Winter	30	+0%	30/15	Summer	100/30	Winter	
4.000	Tank 2	180	Winter	30	+0%	30/15	Summer	100/30	Summer	
2.003	SO4 / PS	120	Winter	30	+0%	1/15	Summer			
1.003	SO4	600	Winter	30	+0%	30/30	Summer	100/180	Summer	

PN	US/MH Name	Water	Surcharged	Flooded			Pipe	Status	Level Exceeded
		Level (m)	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)		
1.000	SO1	30.911	0.311	0.000	1.40		46.5	SURCHARGED	1
1.001	SO2	30.699	0.204	0.000	2.23		186.0	SURCHARGED	

		Bridge Point, Uxbridge SW Network V2 22.12.21		Page 11					
Date 22/12/2021 File Riverside Way - SW Netw...		Designed by paulg Checked by							
Innovyze		Network 2017.1.2							
30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) <u>for Storm</u>									
PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.002	Tank 1	30.428	0.153	0.000	0.05		4.1	SURCHARGED	16
2.000	SG	30.470	0.020	0.000	0.92		59.2	SURCHARGED	2
3.000	SG	30.466	0.366	0.000	1.59		21.6	SURCHARGED	24
2.001	S03	30.162	0.189	0.000	0.33		16.6	SURCHARGED	
2.002	PI	30.194	0.233	0.000	0.37		22.5	SURCHARGED	
4.000	Tank 2	30.161	0.561	0.000	0.12		6.1	SURCHARGED	14
2.003	S04 / PS	30.219	1.319	0.000	0.03		2.0	SURCHARGED	
1.003	S04	30.442	0.247	0.000	0.03		3.7	SURCHARGED	16
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Bridge Point, Uxbridge
SW Network
V2 22.12.21
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Date 22/12/2021
File Riverside Way - SW Netw...

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Innovyze

Network 2017.1.2

100 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 Coeffiecient	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	2
Number of Online Controls	2	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	0.400
Region	England and Wales	Cv (Summer)	0.925
M5-60 (mm)	20.000	Cv (Winter)	0.925

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

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

US/MH				Return	Climate	First (X)		First (Y)		First (Z)	Overflow
PN	Name	Storm	Period	Change		Surcharge		Flood		Overflow	Act.
1.000	SO1	15	Summer	100	+40%	30/15	Summer	100/15	Summer		
1.001	S02	600	Winter	100	+40%	30/15	Summer				
1.002	Tank 1	600	Winter	100	+40%	30/120	Summer	100/180	Summer		
2.000	SG	15	Summer	100	+40%	30/15	Summer	100/15	Summer		
3.000	SG	240	Winter	100	+40%	30/15	Summer	100/15	Summer		
2.001	S03	60	Summer	100	+40%	30/15	Summer				
2.002	PI	60	Summer	100	+40%	30/15	Summer	100/30	Winter		
4.000	Tank 2	120	Summer	100	+40%	30/15	Summer	100/30	Summer		
2.003	S04 / PS	60	Summer	100	+40%	1/15	Summer				
1.003	S04	600	Winter	100	+40%	30/30	Summer	100/180	Summer		

PN	US/MH Name	Water	Surcharged	Flooded			Pipe	Status	Level Exceeded
		Level (m)	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)		
1.000	SO1	31.800	1.200	0.154	2.45		81.4	FLOOD	1
1.001	SO2	31.527	1.032	0.000	0.32		26.8	SURCHARGED	

