Land West of Old Manor Farm, South of Lower Road, Bedhampton

Drainage Strategy Technical Note

Planning App: APP/21/01071
MJA Reference: SS/23/0157/6430
23rd March 2023

Introduction

1.1 MJA Consulting was appointed to prepare a drainage strategy for the disposal of surface water from the proposed development, incorporating the principles of Sustainable Drainage Systems (SuDS) and in accordance with Environment Agency guidance, The National Planning Policy Framework (NPPF) and through liaison with Hampshire County Council.

1.2 MJA Consulting previously prepared a drainage strategy for the development directly east of the site, under application APP/20/01031 (Land south of Lower Road, Havant) also known as Phase 1. The drainage strategy was approved by the Environment Agency (EA), Lead Local Flood Authority (LLFA) and Local Planning Authority (LPA). Due to the similarities between the two sites, namely in terms of topography and geology, it was proposed to mimic the drainage strategy for this site. However, after the LLFA raised concerns about the suitability of a strategy that utilised deep borehole soakaways to discharge the surface water, we now propose an alternative method for discharging runoff by following the drainage hierarchy.

1.3 Please refer to the Teams call with the LLFA where the principle of the alternative options was discussed and agreed – subject to the LLFA reviewing the detail.

Surface Water Strategy and SuDS Assessment

2.1 On Phase 2 (Land west of Old Manor Farm) it is proposed to use a combination of roadside swales, permeable paving, an attenuation basin, and a proprietary device to ensure sufficient water pollution mitigation to the receiving waterbody. A brief outline of how the proposed impermeable surfaces will drain as well as a description of the drainage features is listed below.

Roads

2.2 The roads will be a combination of impermeable macadam and impermeable block paving. The roads will drain either via flush kerbs and stone spillways into roadside swales or by gullies directly into the swales or pipe network.

Roadside Swales

2.3 The roadside swales would vary in depth from 0.3 m to 0.5 m and would be 2.5-3.0 m wide. The primary function of the swales is to provide shallow infiltration for the road run off and primary treatment for any hydrocarbons washed off from the carriageway. A vertical gravel trench will be provided in the base of the swale for conveyance of exceedance flows to perforated pipework laid in the base of the trench. The perforated pipework will either infiltrate the runoff to ground or convey the runoff to the next swale and so on until ultimately it reaches the attenuation basin. The pipework within the swales has been sized to ignore the effects of any infiltration.

Shared surface car parking areas

2.4 These areas drain via permeable block paving through to a permeable subbase. Hydrocarbon removal from run off takes place within the stone bedding layer of the block paving and the subbase itself. Run off that cannot infiltrate to ground is collected via permavoid collectors and directed towards the pipework located at the base of the sub-base/swales. This runoff ultimately makes its way to the attenuation basin.

Houses

2.5 The houses drain via gravity to either the permeable subbase of the shared surface car parking areas via permavoid distributors or directly into the pipework located within the base of the swales. This runoff ultimately makes its way to the attenuation basin.

Attenuation basin

2.6 The attenuation basin has been sized to ignore any potential infiltration that may have taken place upstream via the roadside swales or perforated pipework, as well as any infiltration within the unlined basin itself. All infiltration within the design calculation parameters has been set to zero. The basin is sized to attenuate the runoff from the development for all storm events up to, and including, the 1:100 year + 40% climate change event with an allowance for a minimum 300mm freeboard over and above this design level. The required volume to achieve this is 848m^3. Discharge from the basin is via a headwall and pipework located to the south-west side.

Hydrobrake control chamber

2.7 Flow into the treatment features and pump station will be regulated via a Hydrobrake situated within the flow control chamber. The flows will be limited to 3.3 l/s for all storm events up to, and including, the 1:100 year + 40%. This matches the greenfield runoff rate for the site which was calculated using the total proposed impermeable surface area. Please see appendices for calculations.

Up flow filter

2.8 Additional pollution removal will be provided by an 'Up Flow Filter' by Hydro International. This provides a 5-stage treatment train. This combines multiple sequential treatment processes to deliver sedimentation, screening and filtration all in one unit to remove a wide variety of pollutants including:

- Very Fine Particles:
  Greater than 80% removal of fine sand and silt particles to a mass-median particle size of 22 µm
- Heavy Metals:
  Greater than 70% removal of metals commonly found in surface water runoff.
- Gross Pollutants:
  Inclusion of the angled screen and protected bypass syphon effectively removes gross pollutants, including litter and leaf debris.
- Nutrients:
  Greater than 70% removal of phosphorus and other nutrients.
- Liquid and Sediment Bound Hydrocarbons:
  Sand filter removes various forms of hydrocarbons, including polycyclic aromatic hydrocarbons (PAHs).

2.9 These filter media target fine sediments and metals, as well as sediment bound pollutants, including polycyclic aromatic hydrocarbons (PAHs) – which have been identified by the EA as a significant pollutant of concern. PAH removal is strongly related to sediment removal, as typically 89% of PAHs are associated with sediments in runoff. Based on the Up-Flo™ filter removing 80% of sediments, it follows that the Up-Flo Filter will remove around 70% of PAHs.

2.10 As far as liquid or free-floating hydrocarbons are concerned, the standard Up-Flo configuration incorporates a hooded bypass syphon with integrated floatables baffle. This helps to trap light liquids and other floatables within the chamber. To further protect the aquifer the normal internal by-pass facility wouldn't be installed to remove the possibility of any residual free-floating hydrocarbons not already removed by the treatment train from reaching the aquifer.

Surface Water Runoff Outfall Options

3.1 There are several options for the next stage in the drainage strategy, downstream of the basin. These are listed below in order of preference which is based on the drainage hierarchy and then the constraints on each. The drainage outfall hierarchy set out in the CIRIA SuDS Manual C753 and Building Regulations is as follows:

- Infiltration
- Discharge to surface waters
- Discharge to surface water sewers
- Discharge to highway drain
- Discharge to foul sewer

3.2 Following the drainage hierarchy, infiltration would be the first method of disposal for the runoff. However, infiltration tests proved insufficient to utilise soakaway features at shallow depths. Based on the information available, the LLFA considers that a watercourse outfall would be more reliable than utilising deep boreholes onsite. There is a watercourse that lies approximately 100m east of the Phase 1 development site. This ditch runs north to south and is a 'main river' EA classification. There are three options to achieve this watercourse outfall, all of which require the use of a surface water pump station to achieve discharge. All three options would require the rising main to be routed through Phase 1. This route can be constructed under circa 485m of soft ground to minimise disruption to the Phase 1 construction. See drainage strategy drawing in appendix A.

Drainage Strategy Outfall Option 1

3.3 The preferred route of a rising main to access the watercourse would be through the 3rd party parcel of land between Phase 1 and the watercourse. The landowner of this parcel has already entered into an Option with the Appellant for Phase 2 land. This is the shortest route to the watercourse and requires approximately 100m of rising main under soft ground. A headwall into the watercourse can be constructed as per the requirements of a flood risk exemption licence under the EA's environmental permitting rules.

Drainage Strategy Outfall Option 2

3.4 If the first option is not feasible then the rising main could connect to the DN225 Southern Water surface water sewer along Lower Road, north of both phases. See appendix B for sewer records. This would still require a rising main to be placed through phase 1. A length of the Southern Water sewer lies within the site boundary and developer's land ownership which could be a point of connection. This option would require a Section 106 agreement with Southern Water and a pre-development enquiry to confirm capacity.

Drainage Strategy Outfall Option 3

3.5 This option would require circa 200m of rising main to be laid along Lower Road before discharging to the watercourse south of the culvert beneath Lower Road. This culvert connects the north and south of Lower Road. This option would also require an adoptable pump station and necessary agreements with Highways. A headwall into the watercourse can be constructed as per the requirements of a flood risk exemption licence under the EA's environmental permitting rules.

Drainage Strategy Outfall Option 4

3.6 If all the previous options are not feasible, which is unlikely, then option 4 would be to reassess the potential for deep boreholes onsite. The depth of groundwater was found to be circa 2.71 m BGL. This is similar to the groundwater level found on the adjacent site (Land to the south of Lower Road). On that site, the Environment Agency was consulted and ultimately approved a design of deep borehole soakaways into the saturated chalk. This decision was based on the location not being within a Source Protection Zone and have a multistage treatment system and emergency penstock valve prior to the boreholes.

3.7 The depth of the boreholes would be based on the permeability testing undertaken within the chalk strata at a depth of 16.00m (Report: GE20814 WP02 220518). Falling head testing within the borehole gave an infiltration rate of 1.48×10^{-6} m/s. The discharge from the attenuation basin would have to be set at a maximum of 0.7 l/sec discharge for all storm events. Based on the permeability to achieve the 0.7 l/sec in the boreholes there would need to be a minimum of No.8 16m deep within the chalk strata. All boreholes will be 10 m apart. The required attenuation for the borehole strategy would be 1188m3. If required, this option would be subject to detailed discussions with the LLFA, based on the information available at the time.

Conclusion

4.1 A suitable drainage strategy onsite has been proposed, utilising a variety of SuDS features to mitigate flood risk and water pollution. The preferred outfall option would be to discharge to the watercourse via a rising main that runs through the land east of Phase 1. Discharge to the watercourse would be at greenfield rate of 3.3 l/s for all storm events up to, and including, the critical 1 in 100 year +40% event. The required attenuation volume to achieve this is $848m^3$. See drainage strategy drawing in appendix A.

4.2 The matter of outfall options can be addressed by means of imposing an appropriately worded condition(s), requiring full details to be submitted for approval as part of a reserved matters application. The applicant will work collaboratively with all parties involved, including the LLFA, to achieve a satisfactory method of surface water discharge following the drainage hierarchy as laid out within this report.

Appendices

Appendix A – Drainage Strategy
Appendix B – Southern Water Sewer Records
Appendix C – Greenfield Runoff Calculations
Appendix D – Surface Water Network Calculations

Appendix A – Drainage Strategy

KEY:

Proposed Sewers:

Foul sewer

Storm sewer

Foul rising main

Storm rising main

Proposed Private Drainage:

Foul drain

Storm drain

Rodding eye

Yard gully

All private inspection chambers shall be polypropylene non-access chambers in accordance with The Building Regulations, Part H.

Chamber sizes:
Depth to invert <0.6m DN300
Depth to invert >0.6m DN475

Invert levels shown thus: F10.00 S10.00

Indicative finished floor levels: FFL 10.00

Exceedance Flow Path

Network catchment areas are also shown in various colours.

REV. No.	DATE	DESCRIPTION	INITIALS
P2	23.03.23	Updated to show prefered watercourse outfall strategy.	SS

Client: BARGATE HOMES

Project: Land west of Old Manor Farm

Title: Proposed drainage strategy rising main

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Scale	Date	Drawing No.	Rev
1:500@A1	Mar'21	6430:002	P2
Checked SS	Drawn KTG		

Appendix B – Southern Water Sewer Records

SEWER RECORDS PAGE 1 OF 2

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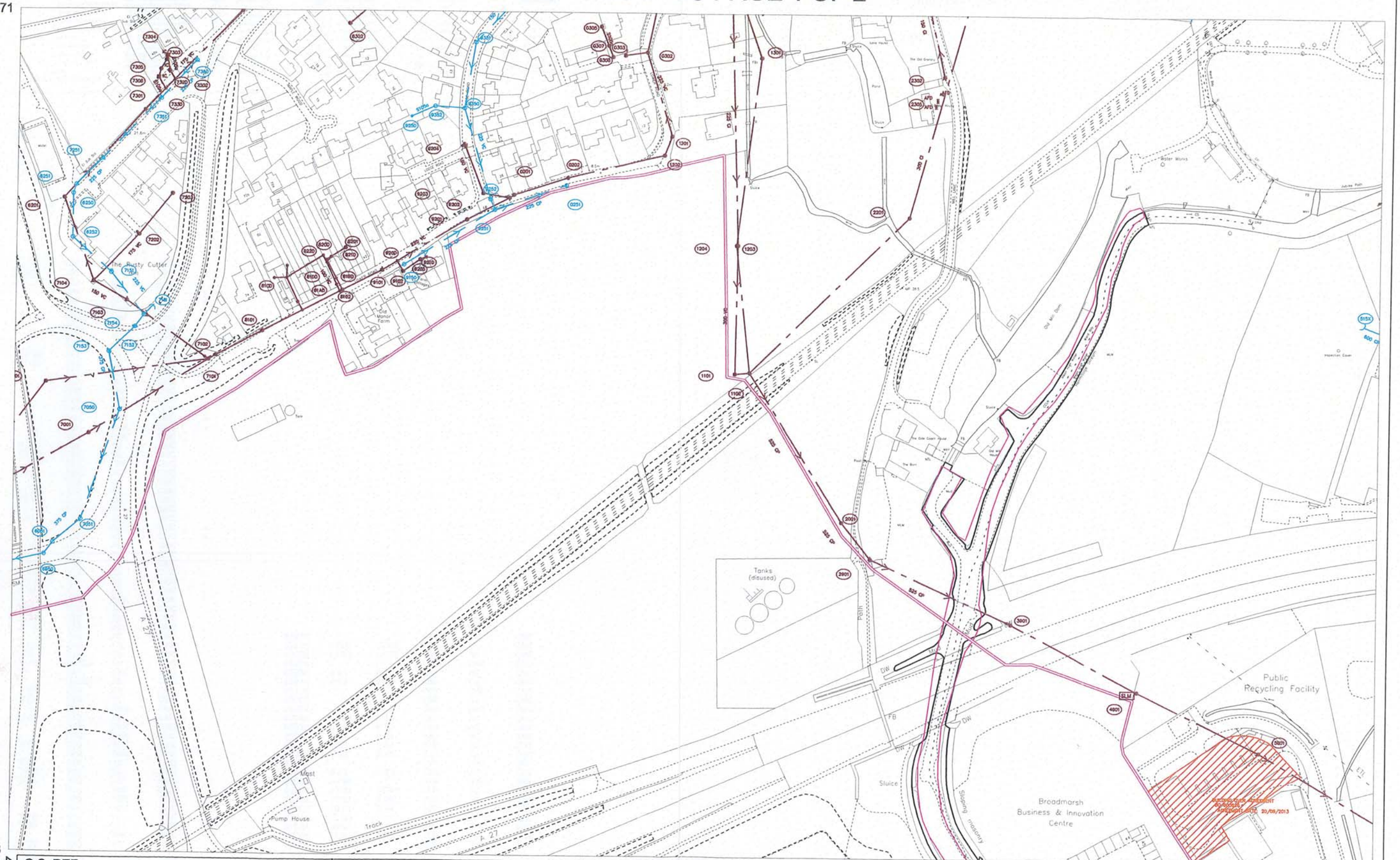

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O.S. REF. SU7006SW	Drawn by: mondaln	The positions of pipes shown on this plan are believed to be correct, but Southern Water Services Ltd accept no responsibility in the event of inaccuracy. The actual positions should be determnined on site.
	Scale: 1:2500	WARNING: BAC pipes are constructed of Bonded Asbestos Cement WARNING: Unknown (UNK) materials may include Bonded Asbestos Cement
Title: Land at Manor Farm Lower Road	Date: 23/06/2015	Based upon Ordnance Survey Digital Data with the permission of the controller of H.M.S.O. Crown Copyright Reserved Licence No. WU 298530.

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Southern Water

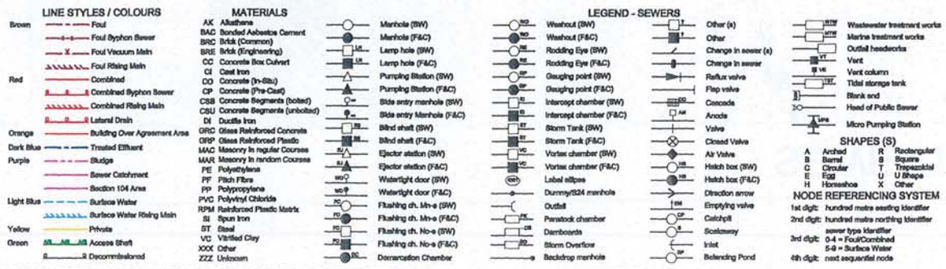
SEWER RECORDS PAGE 2 OF 2

Node	Cover	Invert	Size	Material	Shape	
0201X	9.3	6.73	225	VC	CIRC	
0202X	8.89		UNK	UNK	CIRC	
0251X	8.8	8.29	150	CI	CIRC	
0302X	8.37	6.16	225	VC	CIRC	
0303X			UNK	UNK	UNK	
0305X			UNK	UNK	CIRC	
0307X			UNK	UNK	CIRC	
1101X	6.99	3.87	300	VC	CIRC	
1102X	6.86	3.08	525	CP	CIRC	
1201X	8.25	6.28	225	VC	CIRC	
1202X	8.14		UNK	UNK	CIRC	
1203X	7.28	4.05	300	VC	CIRC	
1204X	6.84		UNK	UNK	CIRC	
1301X	6.66		UNK	UNK	CIRC	
2001X	4.7	2.63	525	CP	CIRC	
2201X	4.28		UNK	UNK	CIRC	
2302X	7.06	6.54	150	CI	CIRC	
2901X	3.65	2.48	525	CP	CIRC	
3901X	3.25		OTHER	CP	CIRC	
4901X	2.84		UNK	UNK	CIRC	
5801X	3.01	0.11	OTHER	CP	CIRC	
6051X	10.09	7.8	375	CP	CIRC	
6101X	18.76	7.93	300	CP	CIRC	
6201X	20.65		175	VC	CIRC	
6250X	20.69	19.83	225	VC	CIRC	
6251X	20.78	19.86	225	CP	CIRC	
6252X	19.34	18.1	225	VC	CIRC	
7950X	10.05		UNK	UNK	UNK	
7001X	14.16	7.84	225	VC	CIRC	
7050X	12.62	9.73	375	CP	CIRC	
7051X	10.52	8.88	375	CP	CIRC	
7101X	12.76	7.55	225	VC	CIRC	
7102X	12.99	7.51	225	VC	CIRC	
7103X	14.66	11.26	150	VC	CIRC	
7104X	16.7	14.14	150	VC	CIRC	*
7104Y	16.7		UNK	UNK	CIRC	*
7151X	16.53	15.05	225	VC	CIRC	
7152X	13.08	11.13	225	VC	CIRC	
7153X	13.23	10.63	375	CP	CIRC	
7154X	13.12	11.58	225	VC	CIRC	
7151X	11.16		225	VC	CIRC	
7202X	16.59	14.87	175	VC	CIRC	
7203X			UNK	UNK	CIRC	
7251X	21.57	20.75	225	CP	CIRC	
7301X	22.4	21.21	175	VC	CIRC	
7302X			UNK	UNK	CIRC	
7303X			UNK	UNK	CIRC	*
7303Y			UNK	UNK	CIRC	*
7304X			UNK	UNK	CIRC	
7305X			UNK	UNK	CIRC	
7306X			UNK	UNK	CIRC	
732DX			175	VC	CIRC	
733DX			175	VC	CIRC	
7350X	23.11	21.89	225	CP	CIRC	
7351X	22.19	21.35	225	CP	CIRC	
8101X	10.86		225	VC	CIRC	
8102X			225	VC	CIRC	
810DX			UNK	UNK	CIRC	
811DX			UNK	UNK	CIRC	
812DX			UNK	UNK	CIRC	
813DY			225	VC	CIRC	*
813DX			UNK	UNK	CIRC	*
814DX			225	VC	CIRC	
81ADX	10.32	8.85	100	VC	CIRC	
81BDX	10.35		100	VC	CIRC	

Node	Cover	Invert	Size	Material	Shape	
81CDX	11.035		UNK	UNK	CIRC	
81DDX	10.67	9.37	100	VC	CIRC	*
81DDY	10.67		UNK	UNK	CIRC	*
8201X	10.92	10.43	100	VC	CIRC	
820DX	10.62	9.36	100	VC	CIRC	
821DX	10.81	9.68	100	VC	CIRC	
822DX	10.91	10.91	UNK	VC	CIRC	
8302X	18.89		UNK	UNK	CIRC	
9101X	9.19	7.13	225	VC	CIRC	
9102X			UNK	UNK	CIRC	
9150X	9.06	8.45	225	CP	CIRC	
9201X	9.22	6.95	225	VC	CIRC	
9202X	9.81	8.07	150	VC	CIRC	
9203X	9.22	6.79	225	VC	CIRC	
9204X	11.56	8.76	150	VC	CIRC	
9205X			UNK	UNK	CIRC	
920DX			225	VC	CIRC	
921DX			UNK	UNK	CIRC	
9251X	9.37	8.86	225	CP	CIRC	
9252X	9.57	8.86	225	VC	CIRC	
925DX			UNK	UNK	CIRC	
9350X	12.67	11.36	225	VC	CIRC	
9351X	14.01	12.08	150	VC	CIRC	
9352X			UNK	UNK	CIRC	

Node	Cover	Invert	Size	Material	Shape

Node	Cover	Invert	Size	Material	Shape



Drawn by: mondaln	Southern Water
Title: Land at Manor Farm Lower Road	
Date: 23/06/2015	

Appendix C – Greenfield Runoff Calculations

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.400
Area (ha)	0.920	Urban	0.000
SAAR (mm)	729	Region Number	Region 7

Results	**l/s**
QBAR Rural	3.3
QBAR Urban	3.3
Q100 years	10.5
Q1 year	2.8
Q30 years	7.4
Q100 years	10.5

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Greenfield Runoff Volume

FSR Data

Return Period (years)	100
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	19.500
Ratio R	0.349
Areal Reduction Factor	1.00
Area (ha)	0.920
SAAR (mm)	789
CWI	116.484
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	49.10
Greenfield Runoff Volume (m^3)	291.412

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Appendix D – Surface Water Network Calculations

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)	5	PIMP (%)	100
M5-60 (mm)	19.600	Add Flow / Climate Change (%)	0
Ratio R	0.335	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	550	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.	0.750	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	0.576	4-8	0.202

Total Area Contributing (ha) = 0.778

Total Pipe Volume (m³) = 165.714

Network Design Table for Storm

« - Indicates pipe capacity < flow

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
S1.000	14.241	0.047	303.0	0.040	5.00	0.0	0.600	[]	1	Pipe/Conduit	
S1.001	56.632	1.596	35.5	0.038	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	27.882	0.093	299.8	0.025	5.00	0.0	0.600	[]	1	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)
S1.000	80.37	5.14	7.200	0.040	0.0	0.0	0.0	1.71	1178.9	8.7
S1.001	77.80	5.57	7.153	0.078	0.0	0.0	0.0	2.20	87.6	16.4
S2.000	79.56	5.27	5.650	0.025	0.0	0.0	0.0	1.72	1185.2	5.4

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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)	Section Type	Auto Design
S1.002	59.522	0.993	59.9	0.050	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.003	20.634	0.138	149.5	0.096	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.004	11.358	0.057	199.3	0.048	0.00	0.0	0.600	[]	1	Pipe/Conduit	
S1.005	12.050	0.603	20.0	0.039	0.00	0.0	0.600	o	300	Pipe/Conduit	
S3.000	28.782	0.272	105.8	0.040	5.00	0.0	0.600	[]	1	Pipe/Conduit	
S4.000	18.172	0.061	297.9	0.024	5.00	0.0	0.600	[]	1	Pipe/Conduit	
S4.001	12.358	0.211	58.6	0.054	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.001	16.264	0.155	104.9	0.057	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.002	33.226	0.403	82.4	0.048	0.00	0.0	0.600	[]	1	Pipe/Conduit	
S3.003	14.761	0.098	150.6	0.088	0.00	0.0	0.600	o	300	Pipe/Conduit	
S3.004	68.458	1.170	58.5	0.060	0.00	0.0	0.600	[]	1	Pipe/Conduit	
S3.005	17.545	0.426	41.2	0.071	0.00	0.0	0.600	[]	1	Pipe/Conduit	
S1.006	12.142	0.024	505.9	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.007	9.329	0.154	60.6	0.000	0.00	0.0	0.600	o	450	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)
S1.002	75.10	6.05	5.557	0.153	0.0	0.0	0.0	2.03	143.8	31.1
S1.003	73.71	6.32	4.564	0.249	0.0	0.0	0.0	1.28	90.7	49.7
S1.004	73.25	6.41	4.426	0.297	0.0	0.0	0.0	2.11	1455.8	58.9
S1.005	72.97	6.47	4.369	0.336	0.0	0.0	0.0	3.53	249.7	66.4
S3.000	80.21	5.17	6.000	0.040	0.0	0.0	0.0	2.90	2001.0	8.7
S4.000	80.14	5.18	6.000	0.024	0.0	0.0	0.0	1.73	1189.0	5.2
S4.001	79.40	5.30	5.939	0.078	0.0	0.0	0.0	1.71	68.1	16.8
S3.001	78.14	5.51	5.728	0.175	0.0	0.0	0.0	1.28	50.7	37.0
S3.002	77.17	5.68	5.573	0.223	0.0	0.0	0.0	3.29	2268.2	46.6
S3.003	76.10	5.87	5.170	0.311	0.0	0.0	0.0	1.28	90.4	64.1
S3.004	74.54	6.16	5.072	0.371	0.0	0.0	0.0	3.91	2694.1	74.9
S3.005	74.21	6.22	3.902	0.442	0.0	0.0	0.0	4.66	3212.9	88.8
S1.006	71.87	6.69	3.476	0.778	0.0	0.0	0.0	0.90	142.7«	151.4
S1.007	71.59	6.75	3.452	0.778	0.0	0.0	0.0	2.62	416.0	151.4

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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)
S1.000	[]	1	S1	8.000	7.200	0.200	Open Manhole	3000
S1.001	o	225	S2	8.000	7.153	0.622	Open Manhole	3000
S2.000	[]	1	S3	6.250	5.650	0.000	Open Manhole	3000
S1.002	o	300	S4	6.250	5.557	0.393	Open Manhole	3000
S1.003	o	300	S5	5.250	4.564	0.386	Open Manhole	1200
S1.004	[]	1	S6	5.100	4.426	0.074	Open Manhole	3000
S1.005	o	300	S7	5.100	4.369	0.431	Open Manhole	3000
S3.000	[]	1	S8	6.750	6.000	0.150	Open Manhole	3000
S4.000	[]	1	S9	6.750	6.000	0.150	Open Manhole	3000
S4.001	o	225	S10	6.550	5.939	0.386	Open Manhole	3000
S3.001	o	225	S11	6.550	5.728	0.597	Open Manhole	3000
S3.002	[]	1	S12	6.250	5.573	0.077	Open Manhole	3000
S3.003	o	300	S13	6.000	5.170	0.530	Open Manhole	3000
S3.004	[]	1	S14	5.750	5.072	0.078	Open Manhole	3000
S3.005	[]	1	S15	5.600	3.902	1.098	Open Manhole	3000

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)
S1.000	14.241	303.0	S2	8.000	7.153	0.247	Open Manhole	3000
S1.001	56.632	35.5	S4	6.250	5.557	0.468	Open Manhole	3000
S2.000	27.882	299.8	S4	6.250	5.557	0.093	Open Manhole	3000
S1.002	59.522	59.9	S5	5.250	4.564	0.386	Open Manhole	1200
S1.003	20.634	149.5	S6	5.100	4.426	0.374	Open Manhole	3000
S1.004	11.358	199.3	S7	5.100	4.369	0.131	Open Manhole	3000
S1.005	12.050	20.0	S16	5.000	3.766	0.934	Open Manhole	3000
S3.000	28.782	105.8	S11	6.550	5.728	0.222	Open Manhole	3000
S4.000	18.172	297.9	S10	6.550	5.939	0.011	Open Manhole	3000
S4.001	12.358	58.6	S11	6.550	5.728	0.597	Open Manhole	3000
S3.001	16.264	104.9	S12	6.250	5.573	0.452	Open Manhole	3000
S3.002	33.226	82.4	S13	6.000	5.170	0.230	Open Manhole	3000
S3.003	14.761	150.6	S14	5.750	5.072	0.378	Open Manhole	3000
S3.004	68.458	58.5	S15	5.600	3.902	1.098	Open Manhole	3000
S3.005	17.545	41.2	S16	5.000	3.476	0.924	Open Manhole	3000

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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)
S1.006	o	450	S16	5.000	3.476	1.074	Open Manhole	3000
S1.007	o	450	S17	5.000	3.452	1.098	Open Manhole	1350

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)
S1.006	12.142	505.9	S17	5.000	3.452	1.098	Open Manhole	1350
S1.007	9.329	60.6	SOutfall	4.800	3.298	1.052	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)
S1.007	SOutfall	4.800	3.298	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	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	8
Number of Online Controls	1	Number of Time/Area Diagrams	2
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	5	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.600	Storm Duration (mins)	30
Ratio R	0.335		

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Online Controls for Storm

Depth/Flow Relationship Manhole: S17, DS/PN: S1.007, Volume (m³): 3.8

Invert Level (m) 3.452

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.3000	0.800	3.3000	1.500	3.3000	2.200	3.3000
0.200	3.3000	0.900	3.3000	1.600	3.3000	2.300	3.3000
0.300	3.3000	1.000	3.3000	1.700	3.3000	2.400	3.3000
0.400	3.3000	1.100	3.3000	1.800	3.3000	2.500	3.3000
0.500	3.3000	1.200	3.3000	1.900	3.3000		
0.600	3.3000	1.300	3.3000	2.000	3.3000		
0.700	3.3000	1.400	3.3000	2.100	3.3000		

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Storage Structures for Storm

Swale Manhole: S1, DS/PN: S1.000

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	Length (m)	12.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	300.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	7.200	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.6	Include Swale Volume	Yes

Swale Manhole: S3, DS/PN: S2.000

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	Length (m)	20.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	300.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	5.650	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.6	Include Swale Volume	Yes

Swale Manhole: S6, DS/PN: S1.004

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	Length (m)	16.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	200.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	4.426	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.6	Include Swale Volume	Yes

Swale Manhole: S8, DS/PN: S3.000

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	Length (m)	29.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	110.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	6.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.6	Include Swale Volume	Yes

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Swale Manhole: S9, DS/PN: S4.000

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	Length (m)	19.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	300.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	6.000	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.6	Include Swale Volume	Yes

Swale Manhole: S12, DS/PN: S3.002

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	Length (m)	35.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	100.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	5.573	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.6	Include Swale Volume	Yes

Swale Manhole: S14, DS/PN: S3.004

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	Length (m)	90.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	60.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	5.072	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.6	Include Swale Volume	Yes

Tank or Pond Manhole: S16, DS/PN: S1.006

Invert Level (m) 3.476

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	330.0	0.400	447.0	0.800	576.0	1.200	714.0
0.100	357.0	0.500	479.0	0.900	610.0	1.300	750.0
0.200	386.0	0.600	511.0	1.000	645.0	1.400	787.0
0.300	417.0	0.700	543.0	1.100	680.0	1.500	824.0

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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	8
Number of Online Controls	1	Number of Time/Area Diagrams	2
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.330
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.700	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	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	S1	15 Winter	1	+0%				
S1.001	S2	15 Winter	1	+0%				
S2.000	S3	15 Winter	1	+0%				
S1.002	S4	15 Winter	1	+0%				
S1.003	S5	15 Winter	1	+0%	100/15 Summer			
S1.004	S6	15 Winter	1	+0%				
S1.005	S7	15 Winter	1	+0%				
S3.000	S8	15 Winter	1	+0%				
S4.000	S9	15 Winter	1	+0%				
S4.001	S10	15 Winter	1	+0%				
S3.001	S11	15 Winter	1	+0%	100/15 Summer			
S3.002	S12	15 Winter	1	+0%				
S3.003	S13	15 Winter	1	+0%	100/15 Summer			
S3.004	S14	15 Winter	1	+0%				
S3.005	S15	15 Winter	1	+0%	100/360 Winter			
S1.006	S16	480 Winter	1	+0%	30/120 Summer			

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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 (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	7.215	-0.585	0.000	0.01		4	5.0	OK	
S1.001	S2	7.202	-0.176	0.000	0.10			8.8	OK	
S2.000	S3	5.658	-0.592	0.000	0.00		3	3.1	OK	
S1.002	S4	5.627	-0.230	0.000	0.12			16.6	OK	
S1.003	S5	4.669	-0.195	0.000	0.27			21.2	OK	
S1.004	S6	4.468	-0.558	0.000	0.03		7	25.3	OK	
S1.005	S7	4.445	-0.224	0.000	0.15			28.6	OK	
S3.000	S8	6.004	-0.596	0.000	0.00		4	5.2	OK	
S4.000	S9	6.009	-0.591	0.000	0.00		4	3.0	OK	
S4.001	S10	5.996	-0.168	0.000	0.15			8.5	OK	
S3.001	S11	5.830	-0.123	0.000	0.42			19.0	OK	
S3.002	S12	5.591	-0.582	0.000	0.02		5	23.8	OK	
S3.003	S13	5.296	-0.174	0.000	0.37			27.9	OK	
S3.004	S14	5.092	-0.580	0.000	0.01		6	33.2	OK	
S3.005	S15	3.924	-0.578	0.000	0.02			39.3	OK	
S1.006	S16	3.752	-0.174	0.000	0.07			6.0	OK	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.007	S17	480 Winter	1	+0%	30/60 Winter	100/120 Winter		

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.007	S17	3.753	-0.149	0.000	0.01			3.3	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 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	8
Number of Online Controls	1	Number of Time/Area Diagrams	2
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.330
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.700	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	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	S1	15 Winter	30	+0%				
S1.001	S2	15 Winter	30	+0%				
S2.000	S3	15 Winter	30	+0%				
S1.002	S4	15 Winter	30	+0%				
S1.003	S5	15 Winter	30	+0%	100/15 Summer			
S1.004	S6	15 Winter	30	+0%				
S1.005	S7	15 Winter	30	+0%				
S3.000	S8	15 Winter	30	+0%				
S4.000	S9	15 Winter	30	+0%				
S4.001	S10	15 Winter	30	+0%				
S3.001	S11	15 Winter	30	+0%	100/15 Summer			
S3.002	S12	15 Winter	30	+0%				
S3.003	S13	15 Winter	30	+0%	100/15 Summer			
S3.004	S14	15 Winter	30	+0%				
S3.005	S15	600 Winter	30	+0%	100/360 Winter			
S1.006	S16	600 Winter	30	+0%	30/120 Summer			

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30 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)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S1	7.244	-0.556	0.000	0.02		5	12.4	OK
S1.001	S2	7.235	-0.143	0.000	0.28			23.8	OK
S2.000	S3	5.684	-0.566	0.000	0.01		4	7.2	OK
S1.002	S4	5.675	-0.182	0.000	0.32			43.8	OK
S1.003	S5	4.748	-0.116	0.000	0.69			54.7	OK
S1.004	S6	4.518	-0.508	0.000	0.08		7	65.4	OK
S1.005	S7	4.498	-0.171	0.000	0.38			74.4	OK
S3.000	S8	6.012	-0.588	0.000	0.01		3	12.5	OK
S4.000	S9	6.043	-0.557	0.000	0.01		4	7.9	OK
S4.001	S10	6.039	-0.125	0.000	0.40			23.6	OK
S3.001	S11	5.940	-0.013	0.000	1.00			45.0	OK
S3.002	S12	5.618	-0.555	0.000	0.04		6	59.6	OK
S3.003	S13	5.391	-0.079	0.000	0.90			67.9	OK
S3.004	S14	5.123	-0.549	0.000	0.04		7	81.9	OK
S3.005	S15	4.114	-0.388	0.000	0.01			15.4	OK
S1.006	S16	4.114	0.188	0.000	0.30			24.1	SURCHARGED

PN	US/MH Name	Level Exceeded
S1.000	S1	
S1.001	S2	
S2.000	S3	
S1.002	S4	
S1.003	S5	
S1.004	S6	
S1.005	S7	
S3.000	S8	
S4.000	S9	
S4.001	S10	
S3.001	S11	
S3.002	S12	
S3.003	S13	
S3.004	S14	
S3.005	S15	
S1.006	S16	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.007	S17	2160 Summer	30	+0%	30/60 Winter	100/120 Winter		

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.007	S17	4.388	0.486	0.000	0.01			3.3	SURCHARGED

PN	US/MH Name	Level Exceeded
S1.007	S17	

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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	8
Number of Online Controls	1	Number of Time/Area Diagrams	2
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.330
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.700	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	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	S1	15 Winter	100	+40%				
S1.001	S2	15 Winter	100	+40%				
S2.000	S3	15 Winter	100	+40%				
S1.002	S4	15 Winter	100	+40%				
S1.003	S5	15 Winter	100	+40%	100/15 Summer			
S1.004	S6	960 Winter	100	+40%				
S1.005	S7	960 Winter	100	+40%				
S3.000	S8	15 Winter	100	+40%				
S4.000	S9	15 Winter	100	+40%				
S4.001	S10	15 Winter	100	+40%				
S3.001	S11	15 Winter	100	+40%	100/15 Summer			
S3.002	S12	15 Winter	100	+40%				
S3.003	S13	30 Winter	100	+40%	100/15 Summer			
S3.004	S14	15 Winter	100	+40%				
S3.005	S15	960 Winter	100	+40%	100/360 Winter			
S1.006	S16	960 Winter	100	+40%	30/120 Summer			

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100 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 (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S1	7.276	-0.524	0.000	0.03		5	22.4	OK
S1.001	S2	7.268	-0.110	0.000	0.51			43.1	OK
S2.000	S3	5.725	-0.525	0.000	0.01		4	13.1	OK
S1.002	S4	5.721	-0.136	0.000	0.57			77.9	OK
S1.003	S5	4.918	0.054	0.000	1.22			96.7	SURCHARGED
S1.004	S6	4.588	-0.438	0.000	0.02		239	13.0	OK
S1.005	S7	4.588	-0.081	0.000	0.08			14.7	OK
S3.000	S8	6.079	-0.521	0.000	0.01		4	18.9	OK
S4.000	S9	6.119	-0.481	0.000	0.02		5	11.9	OK
S4.001	S10	6.119	-0.045	0.000	0.55			32.1	OK
S3.001	S11	6.077	0.124	0.000	1.36			61.3	SURCHARGED
S3.002	S12	5.636	-0.537	0.000	0.05		9	85.0	OK
S3.003	S13	5.521	0.051	0.000	1.29			97.8	SURCHARGED
S3.004	S14	5.139	-0.533	0.000	0.05		11	117.1	OK
S3.005	S15	4.587	0.085	0.000	0.01			18.1	SURCHARGED
S1.006	S16	4.588	0.662	0.000	0.13			10.0	SURCHARGED

PN	US/MH Name	Level Exceeded
S1.000	S1	
S1.001	S2	
S2.000	S3	
S1.002	S4	
S1.003	S5	
S1.004	S6	
S1.005	S7	
S3.000	S8	
S4.000	S9	
S4.001	S10	
S3.001	S11	
S3.002	S12	
S3.003	S13	
S3.004	S14	
S3.005	S15	
S1.006	S16	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.007	S17	960 Winter	100	+40%	30/60 Winter	100/120 Winter		

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.007	S17	4.809	0.907	0.000	0.01			3.3	FLOOD RISK

PN	US/MH Name	Level Exceeded
S1.007	S17	

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