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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.187	0.000	0.50			215.5	OK	
1.001	2	-0.077	0.000	0.98			455.7	OK	
1.002	3	-0.143	0.000	0.85			693.2	OK	
2.000	4	-0.195	0.000	0.46			214.1	OK	
2.001	5	-0.234	0.000	0.54			449.3	OK	
1.003	6	0.706	0.000	0.01			2.3	FLOOD RISK	
1.004	7	1.394	0.000	0.18			1.9	FLOOD RISK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 580266 189203 TQ 80266 89203
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
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 Soffits

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
1.000	47.952	1.998	24.0	0.246	5.00	0.0	0.600	o	500	Pipe/Conduit	
1.001	47.969	3.286	14.6	0.247	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.002	30.303	2.119	14.3	0.247	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.003	16.020	0.320	50.0	0.000	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.004	42.495	1.079	39.4	0.000	0.00	0.0	0.600	o	100	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)
1.000	50.00	5.18	70.500	0.246	0.0	0.0	0.0	4.45	873.4	33.3
1.001	50.00	5.32	68.502	0.493	0.0	0.0	0.0	5.71	1120.6	66.8
1.002	50.00	5.41	65.216	0.740	0.0	0.0	0.0	5.77	1132.2	100.2
1.003	50.00	5.49	63.100	0.740	0.0	0.0	0.0	3.08	604.3	100.2
1.004	50.00	6.07	62.780	0.740	0.0	0.0	0.0	1.23	9.7«	100.2

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.246	0.246	0.246
1.001	-	-	100	0.247	0.247	0.247
1.002	-	-	100	0.247	0.247	0.247
1.003	-	-	100	0.000	0.000	0.000
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.740	0.740	0.740

Surcharged Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.004		62.200	61.701	61.700	0	0

Datum (m) 61.700 Offset (mins) 0

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
288	0.375	864	0.375	1440	0.375	2016	0.375	2592	0.375
576	0.375	1152	0.375	1728	0.375	2304	0.375	2880	0.375

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 5, DS/PN: 1.004, Volume (m³): 5.5

Unit Reference	MD-SHE-0045-1000-1200-1000
Design Head (m)	1.200
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	45
Invert Level (m)	62.780
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	1.0	Kick-Flo®	0.398	0.6
Flush-Flo™	0.196	0.7	Mean Flow over Head Range	-	0.8

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	0.7	1.200	1.0	3.000	1.5	7.000	2.2
0.200	0.7	1.400	1.1	3.500	1.6	7.500	2.3
0.300	0.7	1.600	1.1	4.000	1.7	8.000	2.4
0.400	0.6	1.800	1.2	4.500	1.8	8.500	2.4
0.500	0.7	2.000	1.3	5.000	1.9	9.000	2.5
0.600	0.7	2.200	1.3	5.500	2.0	9.500	2.6
0.800	0.8	2.400	1.4	6.000	2.1		
1.000	0.9	2.600	1.4	6.500	2.2		

Storage Structures for Storm

Tank or Pond Manhole: 4, DS/PN: 1.003

Invert Level (m) 63.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	738.0	1.200	1344.0

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

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 580266 189203 TQ 80266 89203
Data Type	Point
Cv (Summer)	1.000
Cv (Winter)	1.000

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, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	25

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Summer	100	+25%					70.668
1.001	2	15 Summer	100	+25%					68.724
1.002	3	15 Summer	100	+25%					65.512
1.003	4	2880 Winter	100	+25%	100/120 Summer				63.990
1.004	5	2880 Winter	100	+25%	100/15 Summer				64.008

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.332	0.000	0.25			192.1	OK	
1.001	2	-0.278	0.000	0.41			406.9	OK	
1.002	3	-0.204	0.000	0.65			621.9	OK	
1.003	4	0.390	0.000	0.00			1.6	SURCHARGED	
1.004	5	1.128	0.000	0.11			1.0	FLOOD RISK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 580266 189203 TQ 80266 89203
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
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 Soffits

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
1.000	66.057	3.003	22.0	0.326	5.00	0.0	0.600	o	500	Pipe/Conduit	
1.001	58.257	3.003	19.4	0.327	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.002	36.373	2.393	15.2	0.327	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.003	11.269	0.113	100.0	0.000	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.004	81.286	3.889	20.9	0.000	0.00	0.0	0.600	o	100	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)
1.000	50.00	5.24	71.500	0.326	0.0	0.0	0.0	4.65	912.4	44.1
1.001	50.00	5.43	68.497	0.653	0.0	0.0	0.0	4.95	971.7	88.4
1.002	50.00	5.54	65.494	0.980	0.0	0.0	0.0	5.59	1098.1	132.7
1.003	50.00	5.63	63.100	0.980	0.0	0.0	0.0	2.17	426.6	132.7
1.004	50.00	6.43	62.900	0.980	0.0	0.0	0.0	1.70	13.3«	132.7

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.326	0.326	0.326
1.001	-	-	100	0.327	0.327	0.327
1.002	-	-	100	0.327	0.327	0.327
1.003	-	-	100	0.000	0.000	0.000
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.980	0.980	0.980

Surcharged Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.004		59.500	59.011	59.000	0	0

Datum (m) 59.000 Offset (mins) 0

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
288	0.375	864	0.375	1440	0.375	2016	0.375	2592	0.375
576	0.375	1152	0.375	1728	0.375	2304	0.375	2880	0.375

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 5, DS/PN: 1.004, Volume (m³): 4.9

Unit Reference	MD-SHE-0051-1400-1500-1400
Design Head (m)	1.500
Design Flow (l/s)	1.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	51
Invert Level (m)	62.900
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	1.4	Kick-Flo®	0.452	0.8
Flush-Flo™	0.224	1.0	Mean Flow over Head Range	-	1.1

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	0.9	1.200	1.3	3.000	1.9	7.000	2.8
0.200	1.0	1.400	1.4	3.500	2.1	7.500	2.9
0.300	1.0	1.600	1.4	4.000	2.2	8.000	3.0
0.400	0.9	1.800	1.5	4.500	2.3	8.500	3.1
0.500	0.9	2.000	1.6	5.000	2.4	9.000	3.2
0.600	0.9	2.200	1.7	5.500	2.5	9.500	3.3
0.800	1.1	2.400	1.7	6.000	2.6		
1.000	1.2	2.600	1.8	6.500	2.7		

Storage Structures for Storm

Tank or Pond Manhole: 4, DS/PN: 1.003

Invert Level (m) 63.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	642.0	1.500	1395.0

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

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 580266 189203 TQ 80266 89203
Data Type	Point
Cv (Summer)	1.000
Cv (Winter)	1.000

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, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	25

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Summer	100	+25%					71.689
1.001	2	15 Summer	100	+25%					68.781
1.002	3	15 Summer	100	+25%					65.856
1.003	4	2880 Winter	100	+25%	100/30 Summer				64.310
1.004	5	2880 Winter	100	+25%	100/15 Summer				64.334

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.311	0.000	0.30			254.5	OK	
1.001	2	-0.216	0.000	0.61			538.7	OK	
1.002	3	-0.138	0.000	0.87			823.5	OK	
1.003	4	0.710	0.000	0.01			1.9	FLOOD RISK	
1.004	5	1.334	0.000	0.10			1.4	FLOOD RISK	

1 in 100 year return period plus 40% climate change allowance

- Catchment 4a
- Catchment 4b
- Catchment 5a
- Catchment 5b

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 580266 189203 TQ 80266 89203
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
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 Soffits

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	59.733	1.600	37.3	0.285	5.00	0.0	0.600	o	500	Pipe/Conduit	
1.001	49.365	2.300	21.5	0.285	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.002	100.900	3.000	33.6	0.000	0.00	0.0	0.600	o	500	Pipe/Conduit	
2.000	63.690	0.378	168.5	0.285	5.00	0.0	0.600	o	500	Pipe/Conduit	
2.001	46.224	1.622	28.5	0.285	0.00	0.0	0.600	o	500	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)
1.000	50.00	5.28	70.200	0.285	0.0	0.0	0.0	3.56	699.7	38.6
1.001	50.00	5.45	68.600	0.570	0.0	0.0	0.0	4.70	923.7	77.2
1.002	50.00	5.90	66.300	0.570	0.0	0.0	0.0	3.76	737.4	77.2
2.000	50.00	5.64	65.300	0.285	0.0	0.0	0.0	1.67	328.0	38.6
2.001	50.00	5.82	64.922	0.570	0.0	0.0	0.0	4.08	801.3	77.2

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
1.003	68.651	2.296	29.9	0.000	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.004	111.123	3.011	36.9	0.000	0.00	0.0	0.600	o	500	Pipe/Conduit	
3.000	65.386	0.385	169.8	0.285	5.00	0.0	0.600	o	500	Pipe/Conduit	
3.001	128.140	3.815	33.6	0.285	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.005	34.614	0.836	41.4	0.000	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.006	27.535	0.665	41.4	0.000	0.00	0.0	0.600	o	500	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)
1.003	50.00	6.19	63.300	1.140	0.0	0.0	0.0	3.98	782.2	154.4
1.004	50.00	6.71	61.004	1.140	0.0	0.0	0.0	3.58	703.9	154.4
3.000	50.00	5.65	62.200	0.285	0.0	0.0	0.0	1.66	326.7	38.6
3.001	50.00	6.22	61.815	0.570	0.0	0.0	0.0	3.76	737.9	77.2
1.005	50.00	6.88	58.000	1.710	0.0	0.0	0.0	3.38	664.3	231.6
1.006	50.00	7.01	57.164	1.710	0.0	0.0	0.0	3.38	664.4	231.6

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.285	0.285	0.285
1.001	-	-	100	0.285	0.285	0.285
1.002	-	-	100	0.000	0.000	0.000
2.000	-	-	100	0.285	0.285	0.285
2.001	-	-	100	0.285	0.285	0.285
1.003	-	-	100	0.000	0.000	0.000
1.004	-	-	100	0.000	0.000	0.000
3.000	-	-	100	0.285	0.285	0.285
3.001	-	-	100	0.285	0.285	0.285
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				1.710	1.710	1.710

Surcharged Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.006		57.000	56.499	0.000	0	0

Datum (m) 56.500 Offset (mins) 0

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
288	0.375	864	0.375	1440	0.375	2016	0.375	2592	0.375
576	0.375	1152	0.375	1728	0.375	2304	0.375	2880	0.375

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 11, DS/PN: 1.006, Volume (m³): 10.1

Unit Reference	MD-SHE-0064-2400-1800-2400
Design Head (m)	1.800
Design Flow (l/s)	2.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	64
Invert Level (m)	57.164
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.800	2.4	Kick-Flo®	0.575	1.4
Flush-Flo™	0.281	1.8	Mean Flow over Head Range	-	1.8

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	1.5	1.200	2.0	3.000	3.0	7.000	4.5
0.200	1.7	1.400	2.1	3.500	3.3	7.500	4.7
0.300	1.8	1.600	2.3	4.000	3.5	8.000	4.8
0.400	1.7	1.800	2.4	4.500	3.7	8.500	4.9
0.500	1.6	2.000	2.5	5.000	3.8	9.000	5.1
0.600	1.5	2.200	2.6	5.500	4.0	9.500	5.2
0.800	1.7	2.400	2.7	6.000	4.2		
1.000	1.8	2.600	2.8	6.500	4.4		

Storage Structures for Storm

Tank or Pond Manhole: 10, DS/PN: 1.005

Invert Level (m) 58.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1866.0	1.200	2787.0

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

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 580266 189203 TQ 80266 89203
Data Type	Point
Cv (Summer)	1.000
Cv (Winter)	1.000

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, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Summer	100	+40%					70.417
1.001	2	15 Summer	100	+40%					68.892
1.002	3	15 Summer	100	+40%					66.681
2.000	4	15 Summer	100	+40%	100/15 Summer				65.907
2.001	5	15 Summer	100	+40%	100/15 Summer				65.775
1.003	6	15 Summer	100	+40%	100/15 Summer				65.310
1.004	7	15 Summer	100	+40%	100/15 Summer				62.635
3.000	8	15 Summer	100	+40%					62.551
3.001	9	15 Summer	100	+40%					62.136
1.005	10	2880 Winter	100	+40%	100/60 Summer				58.985
1.006	11	2880 Winter	100	+40%	100/15 Summer				58.994

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.283	0.000	0.39			247.6	OK	
1.001	2	-0.208	0.000	0.63			524.7	OK	
1.002	3	-0.119	0.000	0.73			509.1	OK	
2.000	4	0.107	0.000	0.78			235.4	SURCHARGED	
2.001	5	0.353	0.000	0.63			451.1	SURCHARGED	
1.003	6	1.510	0.000	1.11			803.2	SURCHARGED	
1.004	7	1.131	0.000	1.17			782.7	SURCHARGED	
3.000	8	-0.149	0.000	0.81			243.9	OK	
3.001	9	-0.179	0.000	0.71			497.3	OK	
1.005	10	0.485	0.000	0.01			3.5	FLOOD RISK	
1.006	11	1.330	0.000	0.00			2.4	FLOOD RISK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 580266 189203 TQ 80266 89203
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
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 Soffits

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
1.000	53.906	2.898	18.6	0.276	5.00	0.0	0.600	o	375	Pipe/Conduit	
1.001	40.522	2.598	15.6	0.276	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.002	77.191	3.271	23.6	0.276	0.00	0.0	0.600	o	500	Pipe/Conduit	
2.000	71.553	4.310	16.6	0.276	5.00	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)
1.000	50.00	5.21	71.000	0.276	0.0	0.0	0.0	4.22	465.9	37.4
1.001	50.00	5.36	68.102	0.552	0.0	0.0	0.0	4.61	508.9	74.7
1.002	50.00	5.65	65.379	0.828	0.0	0.0	0.0	4.49	880.8	112.1
2.000	50.00	5.27	70.800	0.276	0.0	0.0	0.0	4.47	493.2	37.4

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	100.805	4.253	23.7	0.276	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.003	28.212	0.282	100.0	0.000	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.004	37.133	1.118	33.2	0.000	0.00	0.0	0.600	o	100	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	5.64	66.365	0.552	0.0	0.0	0.0	4.48	878.9	74.7
1.003	50.00	5.86	62.100	1.380	0.0	0.0	0.0	2.17	426.5	186.9
1.004	50.00	6.32	61.818	1.380	0.0	0.0	0.0	1.34	10.6«	186.9

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.276	0.276	0.276
1.001	-	-	100	0.276	0.276	0.276
1.002	-	-	100	0.276	0.276	0.276
2.000	-	-	100	0.276	0.276	0.276
2.001	-	-	100	0.276	0.276	0.276
1.003	-	-	100	0.000	0.000	0.000
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				1.380	1.380	1.380

Surcharged Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.004		61.200	60.700	0.000	0	0

Datum (m) 60.700 Offset (mins) 0

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
288	0.375	864	0.375	1440	0.375	2016	0.375	2592	0.375
576	0.375	1152	0.375	1728	0.375	2304	0.375	2880	0.375

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 7, DS/PN: 1.004, Volume (m³): 8.4

Unit Reference	MD-SHE-0059-1900-1500-1900
Design Head (m)	1.500
Design Flow (l/s)	1.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	59
Invert Level (m)	61.818
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	1.9	Kick-Flo®	0.529	1.2
Flush-Flo™	0.260	1.5	Mean Flow over Head Range	-	1.5

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	1.3	1.200	1.7	3.000	2.6	7.000	3.9
0.200	1.4	1.400	1.8	3.500	2.8	7.500	4.0
0.300	1.4	1.600	2.0	4.000	3.0	8.000	4.1
0.400	1.4	1.800	2.1	4.500	3.1	8.500	4.2
0.500	1.3	2.000	2.2	5.000	3.3	9.000	4.3
0.600	1.3	2.200	2.3	5.500	3.4	9.500	4.5
0.800	1.4	2.400	2.3	6.000	3.6		
1.000	1.6	2.600	2.4	6.500	3.7		

Storage Structures for Storm

Tank or Pond Manhole: 6, DS/PN: 1.003

Invert Level (m) 62.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	964.0	1.500	1853.0

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

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 580266 189203 TQ 80266 89203
Data Type	Point
Cv (Summer)	1.000
Cv (Winter)	1.000

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, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Summer	100	+40%					71.201
1.001	2	15 Summer	100	+40%	100/15 Summer				68.819
1.002	3	15 Summer	100	+40%					65.757
2.000	4	15 Summer	100	+40%					70.992
2.001	5	15 Summer	100	+40%					66.650
1.003	6	2880 Winter	100	+40%	100/30 Summer				63.431
1.004	7	2880 Winter	100	+40%	100/15 Summer				63.438

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.174	0.000	0.56			241.4	OK	
1.001	2	0.342	0.000	1.06			488.5	SURCHARGED	
1.002	3	-0.122	0.000	0.91			742.7	OK	
2.000	4	-0.183	0.000	0.51			239.8	OK	
2.001	5	-0.215	0.000	0.61			503.2	OK	
1.003	6	0.831	0.000	0.01			2.4	FLOOD RISK	
1.004	7	1.520	0.000	0.19			2.0	FLOOD RISK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 580266 189203 TQ 80266 89203
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
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 Soffits

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
1.000	47.952	1.998	24.0	0.246	5.00	0.0	0.600	o	500	Pipe/Conduit	
1.001	47.969	3.286	14.6	0.247	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.002	30.303	2.119	14.3	0.247	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.003	16.020	0.320	50.0	0.000	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.004	42.495	1.079	39.4	0.000	0.00	0.0	0.600	o	100	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)
1.000	50.00	5.18	70.500	0.246	0.0	0.0	0.0	4.45	873.4	33.3
1.001	50.00	5.32	68.502	0.493	0.0	0.0	0.0	5.71	1120.6	66.8
1.002	50.00	5.41	65.216	0.740	0.0	0.0	0.0	5.77	1132.2	100.2
1.003	50.00	5.49	63.100	0.740	0.0	0.0	0.0	3.08	604.3	100.2
1.004	50.00	6.07	62.780	0.740	0.0	0.0	0.0	1.23	9.7«	100.2

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.246	0.246	0.246
1.001	-	-	100	0.247	0.247	0.247
1.002	-	-	100	0.247	0.247	0.247
1.003	-	-	100	0.000	0.000	0.000
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.740	0.740	0.740

Surcharged Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.004		62.200	61.701	61.700	0	0

Datum (m) 61.700 Offset (mins) 0

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
288	0.375	864	0.375	1440	0.375	2016	0.375	2592	0.375
576	0.375	1152	0.375	1728	0.375	2304	0.375	2880	0.375

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 5, DS/PN: 1.004, Volume (m³): 5.5

Unit Reference	MD-SHE-0045-1000-1200-1000
Design Head (m)	1.200
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	45
Invert Level (m)	62.780
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	1.0	Kick-Flo®	0.398	0.6
Flush-Flo™	0.196	0.7	Mean Flow over Head Range	-	0.8

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	0.7	1.200	1.0	3.000	1.5	7.000	2.2
0.200	0.7	1.400	1.1	3.500	1.6	7.500	2.3
0.300	0.7	1.600	1.1	4.000	1.7	8.000	2.4
0.400	0.6	1.800	1.2	4.500	1.8	8.500	2.4
0.500	0.7	2.000	1.3	5.000	1.9	9.000	2.5
0.600	0.7	2.200	1.3	5.500	2.0	9.500	2.6
0.800	0.8	2.400	1.4	6.000	2.1		
1.000	0.9	2.600	1.4	6.500	2.2		

Storage Structures for Storm

Tank or Pond Manhole: 4, DS/PN: 1.003

Invert Level (m) 63.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	738.0	1.200	1344.0

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

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 580266 189203 TQ 80266 89203
Data Type	Point
Cv (Summer)	1.000
Cv (Winter)	1.000

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, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Summer	100	+40%					70.679
1.001	2	15 Summer	100	+40%					68.739
1.002	3	15 Summer	100	+40%					65.536
1.003	4	2880 Winter	100	+40%	100/60 Summer				64.086
1.004	5	2880 Winter	100	+40%	100/15 Summer				64.104

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.321	0.000	0.28			215.2	OK	
1.001	2	-0.263	0.000	0.46			455.7	OK	
1.002	3	-0.180	0.000	0.73			696.6	OK	
1.003	4	0.486	0.000	0.00			1.6	FLOOD RISK	
1.004	5	1.224	0.000	0.11			1.0	FLOOD RISK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 580266 189203 TQ 80266 89203
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
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 Soffits

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
1.000	66.057	3.003	22.0	0.326	5.00	0.0	0.600	o	500	Pipe/Conduit	
1.001	58.257	3.003	19.4	0.327	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.002	36.373	2.393	15.2	0.327	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.003	11.269	0.113	100.0	0.000	0.00	0.0	0.600	o	500	Pipe/Conduit	
1.004	81.286	3.889	20.9	0.000	0.00	0.0	0.600	o	100	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)
1.000	50.00	5.24	71.500	0.326	0.0	0.0	0.0	4.65	912.4	44.1
1.001	50.00	5.43	68.497	0.653	0.0	0.0	0.0	4.95	971.7	88.4
1.002	50.00	5.54	65.494	0.980	0.0	0.0	0.0	5.59	1098.1	132.7
1.003	50.00	5.63	63.100	0.980	0.0	0.0	0.0	2.17	426.6	132.7
1.004	50.00	6.43	62.900	0.980	0.0	0.0	0.0	1.70	13.3«	132.7

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.326	0.326	0.326
1.001	-	-	100	0.327	0.327	0.327
1.002	-	-	100	0.327	0.327	0.327
1.003	-	-	100	0.000	0.000	0.000
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.980	0.980	0.980

Surcharged Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.004		59.500	59.011	59.000	0	0

Datum (m) 59.000 Offset (mins) 0

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
288	0.375	864	0.375	1440	0.375	2016	0.375	2592	0.375
576	0.375	1152	0.375	1728	0.375	2304	0.375	2880	0.375

Online Controls for Storm

Hydro-Brake® Optimum Manhole: 5, DS/PN: 1.004, Volume (m³): 4.9

Unit Reference	MD-SHE-0051-1400-1500-1400
Design Head (m)	1.500
Design Flow (l/s)	1.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	51
Invert Level (m)	62.900
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	1.4	Kick-Flo®	0.452	0.8
Flush-Flo™	0.224	1.0	Mean Flow over Head Range	-	1.1

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	0.9	1.200	1.3	3.000	1.9	7.000	2.8
0.200	1.0	1.400	1.4	3.500	2.1	7.500	2.9
0.300	1.0	1.600	1.4	4.000	2.2	8.000	3.0
0.400	0.9	1.800	1.5	4.500	2.3	8.500	3.1
0.500	0.9	2.000	1.6	5.000	2.4	9.000	3.2
0.600	0.9	2.200	1.7	5.500	2.5	9.500	3.3
0.800	1.1	2.400	1.7	6.000	2.6		
1.000	1.2	2.600	1.8	6.500	2.7		

Storage Structures for Storm

Tank or Pond Manhole: 4, DS/PN: 1.003

Invert Level (m) 63.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	642.0	1.500	1395.0

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

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 580266 189203 TQ 80266 89203
Data Type	Point
Cv (Summer)	1.000
Cv (Winter)	1.000

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, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Summer	100	+40%					71.702
1.001	2	15 Summer	100	+40%					68.803
1.002	3	15 Summer	100	+40%					65.888
1.003	4	2880 Winter	100	+40%	100/30 Summer				64.430
1.004	5	2880 Winter	100	+40%	100/15 Summer				64.455

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.298	0.000	0.34			285.0	OK	
1.001	2	-0.194	0.000	0.68			603.3	OK	
1.002	3	-0.106	0.000	0.97			922.4	OK	
1.003	4	0.830	0.000	0.01			2.0	FLOOD RISK	
1.004	5	1.455	0.000	0.11			1.4	FLOOD RISK	

Background Information – Surface Water Drainage

Job Name: Land East of Rayleigh Road

Job No: 332210105/47268

Note No: Introduction Note – Note 332210105/003/Rev A

Date: 13/04/2022

Prepared by: Y Riley

Subject: **Background Information to ECC – Surface Water Drainage**

Item	Subject
1.	**Introduction** This desk-based summary provides the information necessary to provide further background information to Essex County Council (ECC) as Lead Local Flood Risk Authority (LLFA) to inform future consultation for the site. This follows a previous pre-application advice meeting in late July 2021. The minutes for the aforementioned meeting are included in **Appendix A**. A Flood Risk Assessment (FRA) and Drainage Statement (DS) are currently in development however, this note and supporting information will be used to help inform these emerging documents, along with recent comments received from the LLFA to date.
2.	**Surface Water Drainage Strategy Update - Modelling and Sensitivity Checks** **Network Design** Following pre-application advice from the LLFA to assess and advise on the proposed surface water drainage strategy, it was confirmed that the surface water sewer network design must demonstrate that there is no surcharging for the 1 in 1 Annual Exceedance Probability (AEP), and no flooding up to and including the 1 in 30 AEP event. Details of overland flood flow routes are to be provided for the 1 in 100 AEP plus 40% climate change event if surface water run off cannot be contained within the system demonstrating no internal flooding to properties or third parties. As shown in the preliminary proposed catchments and attenuation drawing included in **Appendix B**, the strategic attenuation basins have been sized to attenuate up to and including the 1 in 100 AEP plus 20% climate change, with a 300 mm freeboard. The strategic basins have also been sized to accommodate the 1 in 100 AEP plus 40% climate change, with no flooding to the wider site. The supporting storage volume and discharge calculations are provided in **Appendix C**. **Surcharged Outfalls** The LLFA previously confirmed that proposed surface water outfalls should be above the water level associated of the 1 in 100 AEP plus climate change of the receiving watercourse, or

DOCUMENT ISSUE RECORD

Technical Note No	Rev	Date	Prepared	Checked	Reviewed (Discipline Lead)	Approved (Project Director)
332210105/TN003	-	13.04.22	Y. Riley	H. Ali	Å. Söderberg	

Item	Subject

alternatively, the effect of surcharging the outfall should be modelled and appropriate measures put in place if required.

It was discussed with the LLFA that due to unavailability of survey data for the receiving ordinary watercourse, outfall surcharge sensitivity testing is not required for the outline planning application stage but will be discussed post planning. Previous correspondence and meeting minutes with the LLFA are included in **Appendix A**.

A sensitive check of the attenuation basins discharging into the watercourse (catchment basins 4A, 4B, 5A and 5B) with a surcharged outfall has been undertaken for the 1 in 100 AEP plus 20% climate change, in addition to the 1 in 100 AEP plus 40% climate change.

The MicroDrainage Network function was used to model a surcharged outfall from each catchment basin. It was assumed that the watercourse in each outfall location was three-quarters full for 48 hours. In addition, due to a lack of survey data it is assumed that the depth of the watercourse is 0.5m.

The surcharged outfall modelling results summarised in **Table 2-1** show that catchment basins 4A, 4B, 5A and 5B are still able to operate without flooding during the 1 in 100 AEP plus 20% climate change critical storm and the 1 in 100 AEP plus 40% climate change critical storm. The supporting MicroDrainage Network results are included in **Appendix D**.

Table 2-1: Surcharged Outfall to Watercourse Sensitivity Check

Catchment	Discharge Location	1 in 100 AP plus 20% climate change (Critical Storm)		1 in 100 AP plus 40% climate change (Critical Storm)	
		Flooded Volume (m^3)	Discharge rate (l/s)	Flooded Volume (m^3)	Discharge rate (l/s)
4A	Watercourse	0.00	2.4	0.00	2.5
4B	Watercourse	0.00	1.6	0.00	1.6
5A	Watercourse	0.00	1.1	0.00	1.1
5B	Watercourse	0.00	1.2	0.00	1.3

Storage Requirements – Half Drain Time

The LLFA confirmed that details on half-drain time for storage structures should be submitted for review, outlining that should half-drain time be in excess of 24 hours for the 1 in 30 AEP plus climate change, then it must be demonstrated that storage features are capable of storing the 1 in 30 AEP followed by a subsequent 1 in 10 AEP.

As the half drain down time for the 1 in 30 AEP plus 20% climate change exceeds the 24-hour requirement, **Table 2-2** below demonstrates there is sufficient storage available for the 1 in 30 AEP plus 20% climate change followed by a subsequent 1 in 10 AEP.

Table 2-2: Storage Volumes for the 1 in 10 AEP, and 1 in 30 AEP plus 20% climate change

Catchment	Storage Provided (m^3)	Storage Volume (m^3)		
		1 in 10 AEP	1 in 30 AEP plus 20% climate change	1 in 10 AEP + 1 in 30 AP plus 20% climate change
1	2539	915	1552	2467
2	1038	370	609	979
3	749	264	437	701

Background Information – Surface Water Drainage

Item	Subject

4A	2328	840	1427	2267
4B	1508	551	935	1486
5A	1004	377	621	998
5B	1234	461	768	1229

It is noted that the LLFA advise a 300mm freeboard is to be maintained for storage features for the 1 in 30 AEP plus climate change followed by a 1 in 10 AEP. It is acknowledged that there is sufficient space to allow for a 300mm freeboard in the masterplan and exact sizing is to be considered at the detailed design stage.

Greenfield Rates

It can be confirmed that the discharge rate from the site to any outfall can be limited to the 1 in 1-year greenfield runoff rate of 1.4 l/s/ha, as summarised in **Table 2-3** below with supporting calculations included in **Appendix C**.

The LLFA recommended that the combined discharge from the catchments is not in excess of the 1 in 1-year greenfield rate calculated for the entire developable area for the redline plan.

The site developable area is measured to be approximately 13.2 ha resulting in a discharge rate for the developable area to be 18.5 l/s (1 in 1 year greenfield runoff rate = 1.4 l/s/ha. 13.2ha x 1.4 l/s/ha = 18.5 l/s).

Table 2-3 below indicates the proposed combined discharge rate is 13.2 l/s demonstrating the combined discharge rate is not in excess of the 1 in 1-year greenfield rate calculated for the entire developable area for the redline plan (18.5 l/s).

Table 2-3: Proposed Discharge Rates (1:1-Year) and Discharge Locations, as agreed with Anglian Water where applicable

Catchment	Discharge Location	Proposed Discharge Rate (l/s)
1	Public Sewer	2.7
2	Public Sewer	2.0
3	Public Sewer	2.0
4A	Watercourse	2.5
4B	Watercourse	1.6
5A	Watercourse	1.1
5B	Watercourse	1.3
	TOTAL	***13.2***

3. Summary

In summary, a sensitivity check of the attenuation basins discharging into the watercourse with a surcharged outfall has demonstrated that basins are able to operate without flooding during the 1 in 100 AEP plus climate change events.

In addition, as half drain down time for the 1 in 30 AEP plus 20% climate change exceeds the 24 hour requirement, it can be demonstrated that there is sufficient storage available in each basin for the 1 in 30 AEP plus 20% climate change allowance storm followed by a subsequent 1 in 10 AEP storm.

Background Information – Surface Water Drainage

Item	Subject
	It can also be confirmed that the discharge rate from the site to any outfall can be limited to the 1 in 1-year greenfield runoff rate of 1.4 l/s/ha.

Appendix N ECC SuDS Proforma

Essex County Council

SuDS Water quantity and Quality – LLFA Technical Assessment Proforma

Introduction

This proforma identifies the information required by Essex LLFA to enable technical assessment the Designers approach to water quantity and water quality as part of SuDS design approach in compliance with Essex SuDS Design Guide.

Completion of the proforma will also allow for technical assessment against Non-statutory technical standards (NSTS) for Sustainable Drainage. The proforma will accompany the site specific Flood Risk Assessment and Drainage Strategy submitted as part of the planning application.

Please complete this form in full for full applications and the coloured sections for outline appllications. This will help us identify what information has been included and will assist with a smoother and quicker application.

Instructions for use

Use the units defined for input of figures.
Numbers in brackets refer to accompanying notes.
Where ……m^3 .....m^3/m^2 *are noted – both values should be filled in.*

Site details

1.1	Planning application reference (if known)			
1.2	Site name	Land East of Rayleigh Road Essex		
1.3	Total application site area (1)		ha	
1.4	Predevelopment use (4)	Greenfield		
1.5	Post development use	Residential		
	If other, please sepcify			
1.6	Urban creep applicable	Yes	if yes, factor applied:	10%
1.7	Proposed design life / planning application life	100 years		
1.8	Method(s) of discharge: (5)			

☐ *Reuse* ☐ *Infiltration* ☑ *Hybrid* ☑ *Waterbody* ☑ *Storm sewer* ☐ *Combined sewer*

1.9	Is discharge direct to estuary / sea	No
1.10	Have agreements in principle (where applicable) for discharge been provided	Yes

Essex County Council

SuDS Water quantity and Quality – LLFA Technical Assessment

Calculation inputs

2.1	Area within site which is drained by SuDS (2)		m^2
2.2	Impermeable area drained pre development (3)	0	m^2
2.3	Impermeable area drained post development (3)	82986	m^2
2.4	Additional impermeable area (2.3 minus 2.2)	82986	m^2
2.5	Method for assessing greenfield runoff rate	See Appendix L - FEH Statistical Method	
2.6	Method for assessing brownfield runoff rate	N/A	
2.7	Coefficient of runoff (Cv) (6)	1	
2.8	Source of rainfall data (FEH Preferred)	FEH	
2.9	Climate change factor applied 40	%	

Attenuation (positive outlet)

2.10 Drainage outlet at risk of drowning (tidal locking, elevated water levels in watercourse/sewer)
Note: Vortex controls require conditions of free discharge to operate as per manufacturers specification.

2.11 Invert level at final outlet varies see report mAOD

2.12 Design level used for surcharge water level at point of discharge (16) varies mAOD

Infiltration (Discharge to Ground)

2.13 Have infiltration tests been undertaken Yes

2.14 If yes, which method has been used BRE 365

2.15 Infiltration rate (where applicable) 1.79 x 10-6 m/s

2.16 Depth to highest known ground water table 0.61 mAOD

2.17 If there are multiple infiltration features please specify where they can be found in the FRA N/A

2.18 Depth of infiltration feature N/A mAOD

2.19 Factor of safety used for sizing infiltration storage N/A

Essex County Council

SuDS Water quantity and Quality – LLFA Technical Assessment Proforma

Calculation outputs

Sections 3 and 4 refer to site where storage is provided by full attenuation or partial infiltration. Where all flows are infiltrated to ground go straight to Section 6.

3.0 Greenfield runoff rates (incl. Urban Creep)

3.1	1 in 1 year rainfall	1.4	l/s/ha,	l/s for the site
3.2	1 in 30 year rainfall	3.9	l/s/ha,	l/s for the site
3.3	1 in 100 year rainfall + CCA	5.2	l/s/ha,	l/s for the site

4.0 Brownfield runoff rates (incl. Urban Creep)

4.1	1 in 1 year rainfall	N/A	l/s/ha,	l/s for the site
4.2	1 in 30 year rainfall	N/A	l/s/ha,	l/s for the site
4.3	1 in 100 year rainfall + CCA	N/A	l/s/ha,	l/s for the site

5.0 Proposed maximum rate of runoff from site (incl. Urban Creep) (7)

5.1	1 in 1 year rainfall	1.4	l/s/ha,	1.4	l/s for the site
5.2	1 in 30 year rainfall	3.9	l/s/ha,	3.9	l/s for the site
5.3	1 in 100 year rainfall + CCA	5.2	l/s/ha,	5.2	l/s for the site

6.0 Attenuation storage to manage flow rates from site (incl. Climate Change Allowance (CCA) and Urban Creep)

6.1	Storage - 1 in 100 year + CCA (9)	1062 to 1076	m^3	m^3/m^2
6.2	50% storage drain down time 1 in 30 years			hours

7.0 Controlling volume of runoff from the site(10)

7.1	Pre development runoff volume(12) (development area)	m^3 for the site
7.2	Post development runoff volume (unmitigated) (12)	m^3 for the site
7.3	Volume to be controlled (5.2 - 5.1)	m^3 for the site

Essex County Council

7.4 Volume control provided by:

- Interception losses(13) m^3
- Rain harvesting (14) m^3
- Infiltration m^3
- Attenuation m^3
- Separate volume designated as long term storage(15) m^3

7.5 Total volume control (sum of inputs for 5.4) m^3 (17)

8.0 Site storage volumes (full infiltration only)

8.1	Storage - 1in 30 year + CCA (8)	m^3	m^3/m^2 (of developed impermeable area)
8.2	Storage - 1 in 100 year + CCA (11)	m^3	m^3/m^2

SuDS Water quantity and Quality – LLFA Technical Assessment Proforma

Design Inputs

Proposed site use: Residential, with early learning and small commercial

Pollution hazard category (see C753 Table 26.2): See 7.10 of Report

High risk area defined as area storing fuels chemicals, refuelling area, washdown area, loading bay.

Design Outputs

List order of SuDS techniques proposed for treatment: Swales, Porous Paving, Bio-Retentiaon Areas (on plot)

Strategic Attenuation Basins with wetland grass mix.

Note that gully pots, pipes and tanks are not accepted by Essex LLFA as a form of treatment (for justification see C753 Section 4.1, Table 26.15 and Box B.2)

Are very high pollution risk areas drained separate from SuDS to foul system: No

Other

Please include any other information that is relevant to your application

Essex County Council

SuDS Water quantity and Quality – LLFA Technical Assessment Proforma

Notes

1. All area with the proposed application site boundary to be included.
2. The site area which is positively drained includes all green areas which drain to the SuDS system and area of surface SuDS features. It excludes large open green spaces which do not drain to the SuDS system.
3. Impermeable area should be measured pre and post development. Impermeable surfaces include, roofs, pavements, driveways and paths where runoff is conveyed to the drainage system.
4. Predevelopment use may impact on the allowable discharge rate. The LLFA will seek for reduction in flow rates to GF (Essex SuDS Design Guide).
5. Runoff may be discharge via one or more methods.
6. Sewers for Adoption 6th Edition recommends a Cv of 100% when designing drainage for impermeable area (assumes no loss of runoff from impermeable surfaces) and 0% for permeable areas. Where lower Cv's are used the applicant should justify the selection of Cv.
7. It is Essex County Council's preference that discharge rates for all events up to the 1 in 100 year event plus climate change are limited to the 1 in 1 greenfield rate. This is also considered to mitigate the increased runoff volumes that occur with the introduction of impermeable surfaces. If discharge rates are limited to a range of matched greenfield flows then it is necessary to provide additional mitigation of increased runoff volumes by the provision of Long-term Storage.
8. Storage for the 1 in 30 year must be fully contained within the SuDS components. Note that standing water within SuDS components such as ponds, basins and swales is not classified as flooding. Storage should be calculated for the critical duration rainfall event.
9. Runoff generated from rainfall events up to the 1 in 100 year will not be allowed to leave the site in an uncontrolled way. Temporary flooding of designated areas to shallow depths and velocities may be acceptable.
10. The following information should only be provided if increased runoff volumes are not mitigated by limiting all discharge rates back to the greenfield 1 in 1 year rate.
11. Climate change is specified as 40% increase to rainfall intensity, unless otherwise agreed with the LLFA / EA.
12. To be determined using the 100 year return period 6 hour duration winter rainfall event.
13. Where Source Control is provided Interception losses will occur. An allowance of 5mm rainfall depth can be subtracted from the net inflow to the storage calculation where interception losses are demonstrated. The Applicant should demonstrate use of subcatchments and source control techniques. Further information is available in the SuDS Design Guide.
14. Please refer to Rain harvesting BS for guidance on available storage.
15. Flows within long term storage areas should be infiltrated to the ground or discharged at low flow rate of maximum 2 l/s/ha.
16. Careful consideration should be used for calculations where flow control / storage is likely to be influenced by surcharged sewer or peak levels within a watercourse. Outlets can be tidally locked where discharge is direct to estuary or sea. Calculations should demonstrate that risk of downed outlet has been taken into consideration. Vortex controls require conditions of free discharge to operate as per specification.
17. In controlling the volume of runoff the total volume from mitigation measures should be greater than or equal to the additional volume generated.

Appendix O Provisional Foul Water Drainage Strategy and Foul Phasing Plan

Stantec

Stantec UK Limited
CAMBRIDGE
50/60 Station Road, Cambridge, CB1 2JH
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Notes

LEGEND

- ROOT PROTECTION AREAS
- TREE PRESERVATION ORDER
- EXISTING FOUL WATER PUBLIC SEWER
- EXISTING SURFACE WATER PUBLIC SEWER
- AREA A FOUL WATER CATCHMENT
- AREA B FOUL WATER CATCHMENT
- AREA C FOUL WATER CATCHMENT
- AREA D FOUL WATER CATCHMENT
- AREA E FOUL WATER CATCHMENT
- PROPOSED FOUL WATER DRAIN (FOR ILLUSTRATION PURPOSES ONLY)
- PROPOSED FOUL WATER RISING MAIN (FOR ILLUSTRATION PURPOSES ONLY)

P01 AMENDED ACCORDING TO NEW SITE BOUNDARY	KB	SK		2022.11.28
Issued/Revision	By	Appd		YYYY.MM.DD
	HA	HA	SK	2022.02.01
	Dwn.	Dsgn.	Chkd.	YYYY.MM.DD

Issue Status

PRELIMINARY

This document is suitable only for the purpose noted above.
Use of this document for any other purpose is not permitted.

Client/Project Logo

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Client/Project

HADLEIGH SITE CASTLE POINT

Title

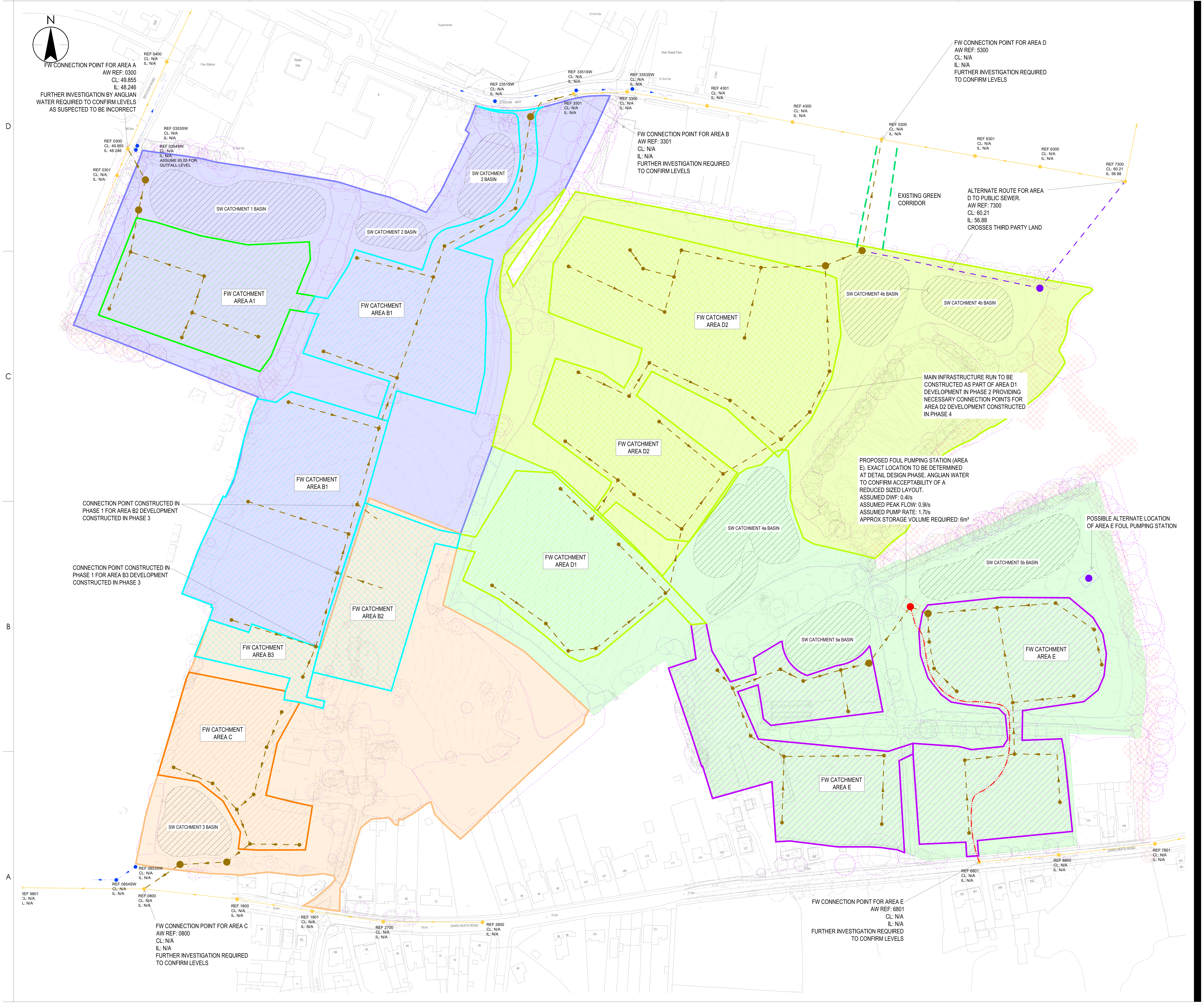
PROPOSED FOUL WATER DRAINAGE STRATEGY

Project No. 47268

Scale 1:1250

Revision P01

Drawing No. 47268/2001/013



Stantec

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Notes

LEGEND

- ROOT PROTECTION AREAS
- TREE PRESERVATION ORDER
- EXISTING FOUL WATER PUBLIC SEWER
- EXISTING SURFACE WATER PUBLIC SEWER
- DEVELOPMENT PHASE 1
- DEVELOPMENT PHASE 2
- DEVELOPMENT PHASE 3
- DEVELOPMENT PHASE 4
- PROPOSED FOUL WATER DRAIN (FOR ILLUSTRATION PURPOSES ONLY)
- PROPOSED FOUL WATER RISING MAIN (FOR ILLUSTRATION PURPOSES ONLY)

Rev	Description	By	Appd	Date
P01	AMENDED ACCORDING TO NEW SITE BOUNDARY	KB	SK	2022.11.28

Issued/Revision

Dwn.	Dsgn.	Chkd.	YYYY.MM.DD
HA	HA	SK	2022.02.01

Issue Status

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Client/Project

HADLEIGH SITE CASTLE POINT

Title

PROPOSED FOUL WATER DRAINAGE PHASING STRATEGY

Project No.	Scale
47268	1:1250

Revision	Drawing No.
P01	47268/2001/014