

Lynas Engineers		Page 1
Wilton Centre	Top Park, Bury	
Redcar	Surface Water	
TS10 4RF	Drainage Design Rev-P04	
Date 06/11/2024	Designed by MR	
File 23061-LE-ZZ-05-CA-D-0001-SURFAC...	Checked by WF	
XP Solutions	Network 2018.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales			
Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	40
Ratio R	0.250	Minimum Backdrop Height (m)	20.000
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	20.000
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

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
SW1.000	2.152	0.004	500.0	0.000	5.00	0.0	0.600	o	160	Pipe/Conduit	
SW1.001	10.000	0.020	500.0	0.064	0.00	0.0	0.600	o	160	Pipe/Conduit	
SW1.002	10.000	0.020	500.0	0.063	0.00	0.0	0.600	o	160	Pipe/Conduit	
SW1.003	10.000	0.020	500.0	0.062	0.00	0.0	0.600	o	160	Pipe/Conduit	
SW1.004	10.000	0.020	500.0	0.061	0.00	0.0	0.600	o	160	Pipe/Conduit	
SW1.005	10.000	0.020	500.0	0.063	0.00	0.0	0.600	o	160	Pipe/Conduit	
SW1.006	10.000	0.020	500.0	0.063	0.00	0.0	0.600	o	160	Pipe/Conduit	
SW1.007	10.000	0.020	500.0	0.063	0.00	0.0	0.600	o	160	Pipe/Conduit	
SW1.008	10.000	0.020	500.0	0.069	0.00	0.0	0.600	o	160	Pipe/Conduit	
SW1.009	10.000	0.020	500.0	0.061	0.00	0.0	0.600	o	160	Pipe/Conduit	
SW1.010	7.368	0.015	500.0	0.063	0.00	0.0	0.600	o	160	Pipe/Conduit	
SW1.011	85.242	2.316	36.8	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
SW1.012	21.851	0.910	24.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
SW1.013	60.906	10.151	6.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
SW1.014	10.906	0.424	25.7	0.000	0.00	0.0	0.600	o	150	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)
SW1.000	50.00	5.08	162.696	0.000	0.0	0.0	0.0	0.46	9.3	0.0
SW1.001	50.00	5.44	162.692	0.064	0.0	0.0	3.5	0.46	9.3«	12.1
SW1.002	50.00	5.80	162.672	0.127	0.0	0.0	6.9	0.46	9.3«	24.0
SW1.003	50.00	6.16	162.652	0.189	0.0	0.0	10.2	0.46	9.3«	35.8
SW1.004	50.00	6.52	162.632	0.250	0.0	0.0	13.6	0.46	9.3«	47.5
SW1.005	50.00	6.88	162.612	0.314	0.0	0.0	17.0	0.46	9.3«	59.5
SW1.006	50.00	7.24	162.592	0.377	0.0	0.0	20.4	0.46	9.3«	71.5
SW1.007	50.00	7.60	162.572	0.440	0.0	0.0	23.9	0.46	9.3«	83.5
SW1.008	50.00	7.96	162.552	0.510	0.0	0.0	27.6	0.46	9.3«	96.6
SW1.009	50.00	8.32	162.532	0.571	0.0	0.0	30.9	0.46	9.3«	108.2
SW1.010	50.00	8.59	162.512	0.634	0.0	0.0	34.3	0.46	9.3«	120.2
SW1.011	50.00	9.44	162.201	0.634	0.0	0.0	34.3	1.66	29.4«	120.2
SW1.012	50.00	9.62	159.885	0.634	0.0	0.0	34.3	2.06	36.5«	120.2
SW1.013	50.00	9.86	158.975	0.634	0.0	0.0	34.3	4.14	73.2«	120.2
SW1.014	50.00	9.95	148.824	0.634	0.0	0.0	34.3	1.99	35.2«	120.2

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
SW1.01	163.201	0.505	Junction		SW1.000	162.696	160				
SW1.02	163.201	0.509	Junction		SW1.001	162.692	160	SW1.000	162.692	160	
SW1.03	163.201	0.529	Junction		SW1.002	162.672	160	SW1.001	162.672	160	
SW1.04	163.201	0.549	Junction		SW1.003	162.652	160	SW1.002	162.652	160	
SW1.05	163.201	0.569	Junction		SW1.004	162.632	160	SW1.003	162.632	160	
SW1.06	163.201	0.589	Junction		SW1.005	162.612	160	SW1.004	162.612	160	
SW1.07	163.201	0.609	Junction		SW1.006	162.592	160	SW1.005	162.592	160	
SW1.08	163.201	0.629	Junction		SW1.007	162.572	160	SW1.006	162.572	160	
SW1.09	163.201	0.649	Junction		SW1.008	162.552	160	SW1.007	162.552	160	
SW1.10	163.201	0.669	Junction		SW1.009	162.532	160	SW1.008	162.532	160	
SW1.11	163.201	0.689	Junction		SW1.010	162.512	160	SW1.009	162.512	160	
SW1.12	163.201	1.000	Open Manhole	1200	SW1.011	162.201	150	SW1.010	162.497	160	306
SW1.13	160.645	0.760	Open Manhole	1200	SW1.012	159.885	150	SW1.011	159.885	150	
SW1.14	159.966	0.991	Open Manhole	1200	SW1.013	158.975	150	SW1.012	158.975	150	
SW1.15	150.000	1.176	Open Manhole	1200	SW1.014	148.824	150	SW1.013	148.824	150	
SWS1.12	150.000	1.600	Open Manhole	0		OUTFALL		SW1.014	148.400	150	

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.000	0.000	0.000
1.001	User	-	100	0.064	0.064	0.064
1.002	User	-	100	0.063	0.063	0.063
1.003	User	-	100	0.062	0.062	0.062
1.004	User	-	100	0.061	0.061	0.061
1.005	User	-	100	0.063	0.063	0.063
1.006	User	-	100	0.063	0.063	0.063
1.007	User	-	100	0.063	0.063	0.063
1.008	User	-	100	0.069	0.069	0.069
1.009	User	-	100	0.061	0.061	0.061
1.010	User	-	100	0.063	0.063	0.063
1.011	-	-	100	0.000	0.000	0.000
1.012	-	-	100	0.000	0.000	0.000
1.013	-	-	100	0.000	0.000	0.000
1.014	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.634	0.634	0.634

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)
SW1.014	SWS1.12	150.000	148.400	0.000	0	0

Online Controls for Storm

Hydro-Brake® Optimum Manhole: SW1.12, DS/PN: SW1.011, Volume (m³): 1.3

Unit Reference	MD-SHE-0132-8000-1000-8000
Design Head (m)	1.000
Design Flow (l/s)	8.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	132
Invert Level (m)	162.201
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	8.0	Kick-Flo®	0.664	6.6
Flush-Flo™	0.302	8.0	Mean Flow over Head Range	-	6.9

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)	Depth (m)	Flow (l/s)
0.100	4.7	0.800	7.2	2.000	11.1	4.000	15.4	7.000	20.1
0.200	7.8	1.000	8.0	2.200	11.6	4.500	16.3	7.500	20.8
0.300	8.0	1.200	8.7	2.400	12.1	5.000	17.1	8.000	21.5
0.400	7.9	1.400	9.4	2.600	12.6	5.500	17.9	8.500	22.1
0.500	7.7	1.600	10.0	3.000	13.4	6.000	18.7	9.000	22.7
0.600	7.2	1.800	10.5	3.500	14.5	6.500	19.4	9.500	23.3

Volume Summary (Static)

Length Calculations based on Centre-Centre

Storage			
Pipe Number	USMH Name	Structure Volume (m³)	Total Volume (m³)
SW1.000	SW1.01	0.000	0.000
SW1.001	SW1.02	53.250	53.250
SW1.002	SW1.03	47.250	47.250
SW1.003	SW1.04	46.500	46.500
SW1.004	SW1.05	45.750	45.750
SW1.005	SW1.06	47.250	47.250
SW1.006	SW1.07	47.250	47.250
SW1.007	SW1.08	47.250	47.250
SW1.008	SW1.09	51.750	51.750
SW1.009	SW1.10	45.750	45.750
SW1.010	SW1.11	47.250	47.250
SW1.011	SW1.12	0.000	0.000
SW1.012	SW1.13	0.000	0.000
SW1.013	SW1.14	0.000	0.000
SW1.014	SW1.15	0.000	0.000
Total		479.250	479.250

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

Simulation Criteria			
Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coefficient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		
Number of Input Hydrographs	0	Number of Offline Controls	0
Number of Online Controls	1	Number of Storage Structures	10
		Number of Time/Area Diagrams	0
		Number of Real Time Controls	0
Synthetic Rainfall Details			
Rainfall Model	FSR M5-60 (mm)	19.000	Cv (Summer) 0.750
Region	England and Wales	Ratio R	0.250
		Cv (Winter)	0.850
Margin for Flood Risk Warning (mm)			0.0
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, 240, 360, 480, 960, 1440		
Return Period(s) (years)		2, 30, 100	
Climate Change (%)		0, 0, 40	

									Water	Surcharged	Flooded
	US/MH		Return	Climate	First (X)	First (Y)	First (Z)	Overflow	Level	Depth	Volume
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Act.	(m)	(m)	(m³)
SW1.000	SW1.01	480 Winter	2	+0%					162.741	-0.115	0.000
SW1.001	SW1.02	480 Winter	2	+0%	100/240 Winter				162.741	-0.111	0.000
SW1.002	SW1.03	960 Winter	2	+0%	100/240 Winter				162.734	-0.098	0.000
SW1.003	SW1.04	960 Winter	2	+0%	100/120 Winter				162.724	-0.088	0.000
SW1.004	SW1.05	960 Winter	2	+0%	100/120 Winter				162.712	-0.080	0.000
SW1.005	SW1.06	960 Winter	2	+0%	100/120 Summer				162.698	-0.074	0.000
SW1.006	SW1.07	960 Winter	2	+0%	100/120 Summer				162.683	-0.069	0.000
SW1.007	SW1.08	1440 Winter	2	+0%	100/120 Summer				162.666	-0.066	0.000
SW1.008	SW1.09	1440 Winter	2	+0%	100/120 Summer				162.647	-0.065	0.000
SW1.009	SW1.10	1440 Winter	2	+0%	100/120 Summer				162.624	-0.068	0.000
SW1.010	SW1.11	1440 Winter	2	+0%	100/120 Summer				162.592	-0.080	0.000
SW1.011	SW1.12	1440 Winter	2	+0%	30/360 Winter				162.304	-0.047	0.000
SW1.012	SW1.13	1440 Winter	2	+0%					159.923	-0.112	0.000
SW1.013	SW1.14	1440 Winter	2	+0%					159.001	-0.124	0.000
SW1.014	SW1.15	1440 Winter	2	+0%					148.863	-0.111	0.000

		Pipe			
PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Level Exceeded Status
SW1.000	SW1.01	0.00		0.0	OK*
SW1.001	SW1.02	0.10		0.8	OK*
SW1.002	SW1.03	0.18		1.3	OK*
SW1.003	SW1.04	0.26		1.9	OK*
SW1.004	SW1.05	0.33		2.4	OK*
SW1.005	SW1.06	0.39		2.8	OK*
SW1.006	SW1.07	0.45		3.3	OK*
SW1.007	SW1.08	0.50		3.6	OK*
SW1.008	SW1.09	0.56		4.1	OK*
SW1.009	SW1.10	0.62		4.5	OK*
SW1.010	SW1.11	0.50		5.0	OK*
SW1.011	SW1.12	0.17		5.0	OK

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

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe	Level	
				Flow (l/s)	Status	Exceeded
SW1.012	SW1.13	0.14		5.0	OK	
SW1.013	SW1.14	0.07		5.0	OK	
SW1.014	SW1.15	0.16		5.0	OK	

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

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000

Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000

Hot Start Level (mm) 0 Inlet Coefficient 0.800

Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000

Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0

Number of Online Controls 1 Number of Storage Structures 10 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.000 Cv (Summer) 0.750

Region England and Wales Ratio R 0.250 Cv (Winter) 0.850

Margin for Flood Risk Warning (mm) 0.0

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, 240, 360, 480, 960, 1440

Return Period(s) (years) 2, 30, 100

Climate Change (%) 0, 0, 40

									Water	Surcharged	Flooded
	US/MH		Return	Climate	First (X)	First (Y)	First (Z)	Overflow	Level	Depth	Volume
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Act.	(m)	(m)	(m³)
SW1.000	SW1.01	480 Winter	30	+0%					162.774	-0.082	0.000
SW1.001	SW1.02	480 Winter	30	+0%	100/240 Winter				162.774	-0.078	0.000
SW1.002	SW1.03	480 Winter	30	+0%	100/240 Winter				162.771	-0.061	0.000
SW1.003	SW1.04	480 Winter	30	+0%	100/120 Winter				162.764	-0.048	0.000
SW1.004	SW1.05	480 Winter	30	+0%	100/120 Winter				162.755	-0.037	0.000
SW1.005	SW1.06	960 Winter	30	+0%	100/120 Summer				162.745	-0.027	0.000
SW1.006	SW1.07	960 Winter	30	+0%	100/120 Summer				162.733	-0.019	0.000
SW1.007	SW1.08	960 Winter	30	+0%	100/120 Summer				162.717	-0.015	0.000
SW1.008	SW1.09	960 Winter	30	+0%	100/120 Summer				162.696	-0.016	0.000
SW1.009	SW1.10	960 Winter	30	+0%	100/120 Summer				162.669	-0.023	0.000
SW1.010	SW1.11	960 Winter	30	+0%	100/120 Summer				162.634	-0.038	0.000
SW1.011	SW1.12	960 Winter	30	+0%	30/360 Winter				162.619	0.268	0.000
SW1.012	SW1.13	1440 Winter	30	+0%					159.934	-0.101	0.000
SW1.013	SW1.14	1440 Winter	30	+0%					159.008	-0.117	0.000
SW1.014	SW1.15	1440 Winter	30	+0%					148.875	-0.099	0.000

Pipe						
PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
SW1.000	SW1.01	0.00		0.0	OK*	
SW1.001	SW1.02	0.17		1.3	OK*	
SW1.002	SW1.03	0.34		2.5	OK*	
SW1.003	SW1.04	0.48		3.5	OK*	
SW1.004	SW1.05	0.59		4.3	OK*	
SW1.005	SW1.06	0.64		4.6	OK*	
SW1.006	SW1.07	0.72		5.3	OK*	
SW1.007	SW1.08	0.81		5.9	OK*	
SW1.008	SW1.09	0.91		6.6	OK*	
SW1.009	SW1.10	1.00		7.3	OK*	
SW1.010	SW1.11	0.84		8.3	OK*	
SW1.011	SW1.12	0.28		8.0	SURCHARGED	

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

	US/MH	Flow /	Overflow	Pipe		Level
PN	Name	Cap.	(l/s)	Flow	Status	Exceeded
SW1.012	SW1.13	0.23		8.0	OK	
SW1.013	SW1.14	0.11		8.0	OK	
SW1.014	SW1.15	0.25		8.0	OK	

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 Coefficient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		
Number of Input Hydrographs	0	Number of Offline Controls	0
Number of Online Controls	1	Number of Time/Area Diagrams	0
		Number of Storage Structures	10
		Number of Real Time Controls	0
Synthetic Rainfall Details			
Rainfall Model	FSR M5-60 (mm)	19.000	Cv (Summer) 0.750
Region	England and Wales	Ratio R	0.250
		Cv (Winter)	0.850
Margin for Flood Risk Warning (mm)			0.0
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, 240, 360, 480, 960, 1440		
Return Period(s) (years)		2, 30, 100	
Climate Change (%)		0, 0, 40	

									Water	Surcharged	Flooded	
	US/MH			Return	Climate	First (X)	First (Y)	First (Z)	Overflow	Level	Depth	Volume
PN	Name	Storm	Period	Change		Surcharge	Flood	Overflow	Act.	(m)	(m)	(m³)
SW1.000	SW1.01	360 Winter	100	+40%						162.856	0.000	0.000
SW1.001	SW1.02	960 Winter	100	+40%	100/240	Winter				162.900	0.048	0.000
SW1.002	SW1.03	960 Winter	100	+40%	100/240	Winter				162.899	0.067	0.000
SW1.003	SW1.04	960 Winter	100	+40%	100/120	Winter				162.896	0.084	0.000
SW1.004	SW1.05	960 Winter	100	+40%	100/120	Winter				162.882	0.090	0.000
SW1.005	SW1.06	960 Winter	100	+40%	100/120	Summer				162.862	0.090	0.000
SW1.006	SW1.07	480 Winter	100	+40%	100/120	Summer				162.842	0.090	0.000
SW1.007	SW1.08	480 Winter	100	+40%	100/120	Summer				162.822	0.090	0.000
SW1.008	SW1.09	480 Winter	100	+40%	100/120	Summer				162.802	0.090	0.000
SW1.009	SW1.10	480 Winter	100	+40%	100/120	Summer				162.782	0.090	0.000
SW1.010	SW1.11	480 Winter	100	+40%	100/120	Summer				162.762	0.090	0.000
SW1.011	SW1.12	960 Winter	100	+40%	30/360	Winter				162.836	0.485	0.000
SW1.012	SW1.13	1440 Winter	100	+40%						159.934	-0.101	0.000
SW1.013	SW1.14	1440 Winter	100	+40%						159.008	-0.117	0.000
SW1.014	SW1.15	1440 Winter	100	+40%						148.875	-0.099	0.000

		Pipe			
PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Level Exceeded
SW1.000	SW1.01	0.00		0.0	SURCHARGED*
SW1.001	SW1.02	0.17		1.2	SURCHARGED*
SW1.002	SW1.03	0.34		2.5	SURCHARGED*
SW1.003	SW1.04	0.50		3.6	SURCHARGED*
SW1.004	SW1.05	0.61		4.5	SURCHARGED*
SW1.005	SW1.06	0.77		5.6	SURCHARGED*
SW1.006	SW1.07	0.97		7.1	SURCHARGED*
SW1.007	SW1.08	1.10		8.0	SURCHARGED*
SW1.008	SW1.09	1.26		9.2	SURCHARGED*
SW1.009	SW1.10	1.42		10.3	SURCHARGED*
SW1.010	SW1.11	0.93		9.2	SURCHARGED*
SW1.011	SW1.12	0.28		8.0	SURCHARGED

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

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe	Status	Level
				Flow (l/s)		Exceeded
SW1.012	SW1.13	0.23		8.0	OK	
SW1.013	SW1.14	0.11		8.0	OK	
SW1.014	SW1.15	0.25		8.0	OK	