ARDENT
CONSULTING ENGINEERS
AN EMPLOYEE OWNED COMPANY

PLACES FOR PEOPLE LIMITED

DOVE LANE, BRISTOL

DRAINAGE STRATEGY

REPORT REF. 2106011-R-001

June 2023

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Contents

Appendices

Document Control Sheet

REV	ISSUE PURPOSE	AUTHOR	CHECKED	APPROVED	DATE
-	DRAFT	AD	AC	AD	20-06-23

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1. Introduction

1.1. The proposed development at Dove Lane currently enjoys planning permission ref 22/1736/F.

1.2. As part of this permission Condition 3 relates to the application of SuDS for the scheme:

"No phase of development shall take place until a Sustainable Drainage Strategy and associated detailed design, management and maintenance plan of surface water drainage for the site using SuDS methods has been submitted to and approved in writing by the Local Planning Authority. The system shall follow the principles established within the Flood Risk Assessment and Drainage Statement (Rev. PL4, Fairhurst, dated February 2022)."

1.3. This Report has been produced to set out the proposed drainage strategy and how this conforms with to the approved principles set out in the Flood Risk Assessment and Drainage Statement.

2. Approved Scheme

2.1. The approved strategy for the drainage sets out the principles that should be followed as part of the more detailed design.

2.2. An existing drainage network has already been installed for a previous application which it is proposed to utilise for the new scheme, with betterments provided to improve the quality of the discharge.

2.3. The principle of the drainage is to restrict the flows to provide a 50% betterment to the existing area, meaning a peak discharge rate of 94.5l/s. The volume of discharge will be improved by means of reducing the existing hard standing.

2.4. The drainage is to incorporate SuDS features to provide water quality benefits.

2.5. An extract from the approved scheme is shown in Figure 2.1 below with a copy of the strategy reproduced at **Appendix A.**

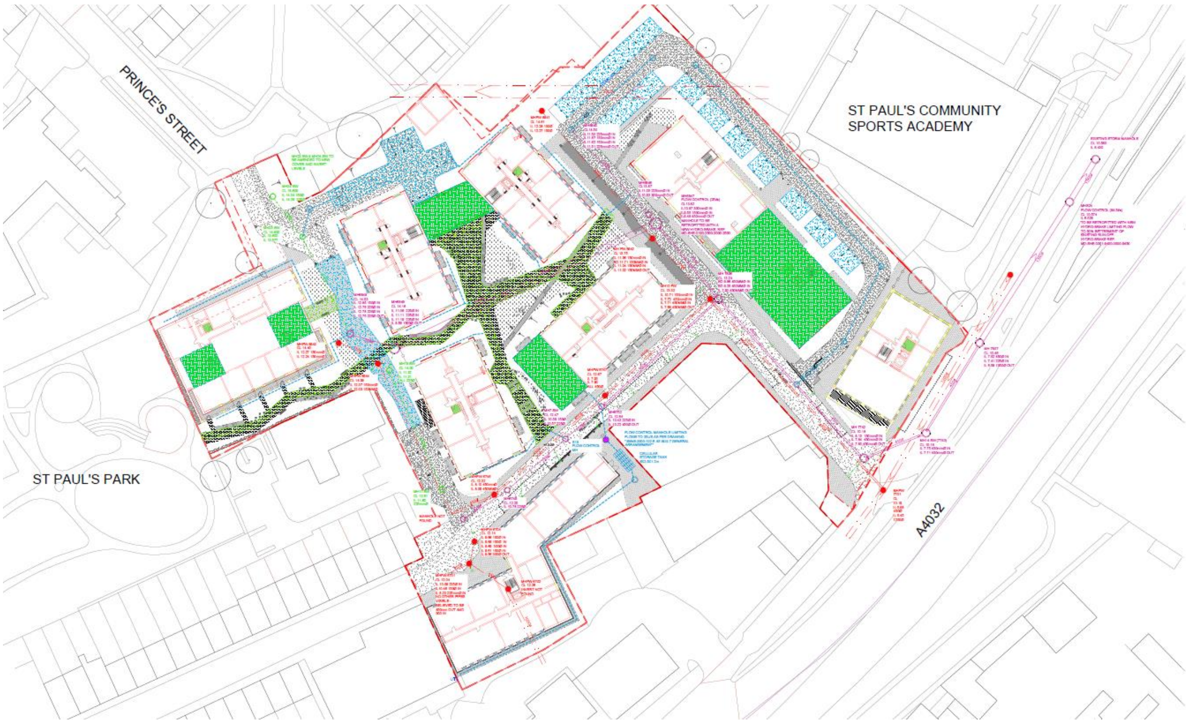

Figure 2-1: Outline Drainage Strategy

3. Drainage Strategy

3.1. DEFRA issued the non-statutory technical guidance for Sustainable Drainage Systems in March 2015. This document and the CIRIA Guidance C753 (The SuDS Manual) has been used to determine the appropriate SuDS Strategy, which considers the spatial and environmental constraints of the site.

3.2. Under the Planning Practice Guidance (PPG) an allowance of 40% for the effects of climate change will achieve the policy requirements for the proposed development.

3.3. Existing Surface Water Discharge

3.4. The site is currently positively drained to a drainage network that was installed for a previous application.

Proposed Sustainable Drainage Systems (SuDS)

3.5. Based on the guidance in the NPPF, surface water runoff should be disposed of according to the following hierarchy:

1. Into the ground (infiltration);
2. To a surface water body;
3. To a surface water sewer, highway drain, or another drainage system;
4. To a combined sewer;

3.6. The site is situated on made ground and therefore would not be suitable for infiltration due to the risk of mobilising contaminants present within this strata.

3.7. It is therefore proposed to provide a positive discharge from the site, with no surface water bodies present in the vicinity of the site. The point of discharge will be to the public surface water sewer network.

3.8. The constraints and opportunities for the use of SuDS techniques are appraised using the Management Train approach outlined in CIRIA C753 'The SuDS Manual' in **Table 3-1** below.

Table 3-1: C753 SuDS Management Train, Site Assessment

Type:	**Infiltration Devices** (Source Control)
Constraints:	Due to the made ground on the site soakaway use is limited.
Opportunities:	Limited due to made ground
Type:	**Lined Permeable Paving** (Source Control)
Constraints:	Maintenance and service margins need to be provided outside of the permeable paving.
Opportunities:	Limited due to the likely service margins within the site.
Type:	**Rainwater Harvesting** (Source Control)
Constraints:	The benefits of rainwater harvesting on a specific design storm event cannot be quantified, due to the seasonal availability of storage within the structure.
Opportunities:	Opportunities to provide harvesting features such as raised planters and water butts exist. However, it is difficult to quantify contribution, and confirm ongoing maintenance, and therefore not included within calculations as part of this surface water management strategy.
Type:	**Surface Water Basin** (Source Control)
Constraints	In order to provide practicable attenuation benefits and 1:3 side-slopes, surface water basins tend to require significant land take.
Opportunities	There are no opportunities to include a surface water basin that would provide a practicable attenuation benefit.
Type:	**Swales, etc.** (Permeable Conveyance)
Constraints:	In order to provide practicable attenuation benefits, 1:3 side-slope swales tend to require significant land take.
Opportunities:	Limited due to spatial constraints.
Type:	**Tree Pits/Rain gardens**
Constraints:	Adoption of these features is unlikely and linkage to an adopted system unlikely to be supported.
Opportunities:	Potential for use in shared garden areas.
Type:	**Living Roofs**
Constraints:	Sloped roofs are not suitable for living roofs or where plant is proposed on roofs
Opportunities:	Some of the roofs could potentially be living roofs subject to plant confirmation
Type:	**Attenuation Tanks** (end of pipe treatment)
Constraints:	None.
Opportunities:	Should additional attenuation be required this could be achieved by use of oversized sewers or storage attenuation.
Type:	**Proprietary SuDS – Downstream Defender (end of pipe system)**
Constraints:	None.
Opportunities:	Could be used if required to improve the quality of surface water discharge offsite.

3.9. After consideration of the CIRIA C753 SuDS Management Train approach, the most viable SuDS options for this site is a combination of permeable surfaces, living roofs, underground storage and where possible rain gardens/tree pits prior to discharging to the wider sewer network via a hydrobrake.

Proposed Drainage Strategy

3.10. The existing agreement sets the discharge from the site to 94.5l/s.

3.11. The proposed development has an impermeable area of 1.214Ha with no allowance for Urban Creep due to the type of construction.

3.12. As set out above there are several means of SuDS proposed for the site, however at this stage we are proposing all the attenuation is provided solely within the attenuation tank and oversized pipes as a conservative approach. Drawing No. 2106011-002 in **Appendix B** shows the Indicative Surface Water drainage strategy and associated attenuation.

3.13. Water quality benefits will be provided through the provision of permeable surfaces and living roofs.

3.14. A Microdrainage Network model has been developed for the strategy to demonstrate that the proposed storage is sufficient and that no flooding occurs on site up to the 1 in 100 year, including 40% climate change event. These calculations are included in **Appendix C**.

Water Quality

3.15. A breakdown of the treatment level provided and required in accordance with the CIRIA C753 Simple Index Treatment Method is shown in Tables 3-2/3/4 below:

Table 3-2: Pollution hazard indices for different land use classifications (land use in bold applicable for the development).

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/industrial roofs)	Low	0.3	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (e.g. cul de sacs, home zones and general access roads) and non-residential car parking with infrequent change (e.g. schools, offices) i.e. < 300 traffic movements/day	**Low**	**0.5**	**0.4**	**0.4**
Commercial yard and delivery areas, non-residential car parking with frequent change (e.g. hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	0.7	0.6	0.7
Sites with heavy pollution (e.g. haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways	High	0.8	0.8	0.9

Table 3-3: Indicative SuDS mitigation indices for discharges to surface waters (bold text is applicable to this development).

	Mitigation indices		
Type of SuDS component	TSS	Metals	Hydrocarbons
Filter strip (Rain Garden)	0.4	0.4	0.5
Filter drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Bio retention system	0.8	0.8	0.8
Permeable pavement	**0.7**	**0.6**	**0.7**
Detention basin	0.5	0.5	0.6
Pond	0.7	0.7	0.5
Wetland	0.8	0.8	0.8
Proprietary treatment systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Table 3-4: SuDS mitigation indices provided

For surface water discharge from Residential Parking Areas and Low Traffic Roads <300 traffic movements/day			
	Required mitigation indices		
Source	TSS	Metals	Hydrocarbons
Low Traffic Roads	**0.5**	**0.4**	**0.4**
Type of SuDS component provided			
Permeable Surfaces	0.7	0.6	0.7
Total	**0.7**	**0.6**	**0.7**
Check	**+0.20**	**+0.20**	**+0.30**

Urban Creep and Long Term Storage

3.16. Given the style of development (i.e. flats) and in accordance with Non Technical Standards Best Practice Guidance, urban creep has not been allowed for as increases in impermeable area, without planning, are unlikely.

3.17. The proposals would decrease the amount of impermeable area at the site and therefore Long Term Storage would not be required.

Maintenance and Management of System

3.18. The maintenance of all SuDS components will be in accordance with best practice and the CIRIA Manual C753, with a private management company appointed to maintain the surface water drainage network.

3.19. Details of the typical processes required for the site have been provided in **Appendix D.**

Foul Drainage

3.20. Foul drainage from the site will discharge directly to the public sewer within Dove Lane.

3.21. Wessex Water have confirmed that the discharge from the site will be allowable in an e-mail on 7th July 2022.

4. Conclusion

4.1. This report has been produced to set out the drainage strategy for the proposed development at Dove Lane, Bristol and how it conforms with the approved drainage strategy.

4.2. The drainage strategy set out in this report is suitable to protect the site and surrounding areas from surface water flooding for all events up to and including the 1 in 100-year storm event including climate change.

4.3. The principles of the strategy are in keeping with the approved strategy and Local and National Guidance reducing discharge rates and volumes from current brownfield rates providing a 50% betterment whilst also providing water quality benefits through the use of appropriate SuDS systems.

4.4. The foul drainage would discharge to the existing foul sewer in Dove Lane.

Appendix A
Outline Planning Drainage Strategy

Do not scale from this drawing.

EXISTING DRAINAGE - TO BE MAINTAINED

- SURFACE WATER SEWER TO BE MAINTAINED
- SURFACE WATER MANHOLE. TO BE MAINTAINED
- FOUL WATER SEWER.TO BE MAINTAINED
- FOUL WATER MANHOLE TO BE MAINTAINED
- HIGHWAY GULLY
- HIGHWAY DRAINAGE, TO BE MAINTAINED

NOTES:

1. SHOWN DRAINAGE NOT EXHAUSTIVE ROUTES BASED UPON DRAWING: 30728-TOPO BY MKSURVEYS DECEMBER 2021
2. PROPOSED ROUTES SHOWN AS INDICATIVE FOR INFORMATION, SUBJECT TO DETAILED DESIGN, CONFIRMED DRAINAGE POINTS AND LEVELS
3. MANHOLE SIZES TO BE CONFIRMED

PROPOSED DRAINAGE

- TANKED PERMEABLE PAVING - CAR PARKING AND ACCESS ROADS
- TANKED PERMEABLE PAVING - FOOTPATHS
- SURFACE WATER MANHOLE.
- SURFACE WATER DRAIN. INDICATIVE ROUTE
- FLOW CONTROL MANHOLE
- CELLULAR STORAGE TANK
- PETROL INTERCEPTOR
- PROPOSED GREEN ROOFS

Rev.	Date	Description	Drawn	Checked	Approved
PL4	13.09.22	HYDRO-BRAKES AMENDED	OP	X	X
PL3	27.07.22	HYDRO-BRAKES AMENDED	OP	AJ	X
PL2	15.07.22	DRAINAGE UPDATED TO PLANNING COMMENTS	OP	AJ	X
PL1	22.02.22	ORIGINAL ISSUE FOR PLANNING	ML	MH	X

Client: PLACES FOR PEOPLE

Project Title: DOVE LAVE

Drawing Title: DRAINAGE LAYOUT

FAIRHURS

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Scale at A1:	Status:	
1:250	FOR PLANNING	
Drawn: ML	Checked: MH	Approved: X
Date: 22.02.22	Date: 22.02.22	Date: X

Drawing No.: 145339-SK02

Appendix B
Detailed Drainage Strategy

KEY (SURFACE WATER):

- MAIN SW SEWER & MANHOLE (WITH REFERENCE) REFER TO MH SCHEDULE FOR FURTHER DETAILS
- PLOT SW DRAIN (150mmØ UNLESS NOTED OTHERWISE)
- CL:49.85 IL:47.55 — SW TYPE 4 NON-ENTRY ACCESS CHAMBER (450Ø) MAX DEPTH TO INVERT 3m OR 'TEGRA' NON-ENTRY ACCESS CHAMBER (600Ø) FOR DEPTHS >3m BUT <5m MAX LOADING - LIGHT VEHICULAR FLEXIBLE CONSTRUCTION (CONCRETE COLLAR REQUIRED FOR VEHICULAR LOADING)
- PPO — 100mmØ PERMEABLE PAVING OUTFALL PIPE (PPO) DEPTH TO INVERT LEVEL;
- RG — ROAD GULLY

KEY (FOUL WATER):

- EXISTING FW SEWER & MANHOLE
- PLOT FW DRAIN (100mmØ UNLESS NOTED OTHERWISE)
- CL:49.85 IL:47.55 — FW TYPE 4 NON-ENTRY ACCESS CHAMBER (450Ø) MAX DEPTH TO INVERT 3m OR 'TEGRA' NON-ENTRY ACCESS CHAMBER (600Ø) FOR DEPTHS >3m BUT <5m MAX LOADING - LIGHT VEHICULAR FLEXIBLE CONSTRUCTION (CONCRETE COLLAR REQUIRED FOR VEHICULAR LOADING)
- DOMESTIC FOUL WASTE OUTLET POSITION
- ROUTE OF DIVERTED FOUL SEWER

GENERAL:

- EXISTING DRAINAGE TO BE ABANDONED/REMOVED
- PROPOSED PERMEABLE SURFACING
- PROPOSED LIVING ROOF

FOR INFORMATION ONLY

Rev	Description	Drn	Chk	App	Date

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ISO 9001 BUREAU VERITAS Certification 1828

Client:
PLACES FOR PEOPLE GROUP LIMITED

Project Title:
DOVE LANE, BRISTOL

Drawing Title:
OUTLINE DRAINAGE STRATEGY

A0 Scale	Date	Designed by
1:250	June 2023	AD
Drawn by	**Checked by**	**Approved by**
AD	AC	AD

Drawing Number: 2106011-002 | Rev: -

File Location: y:\ardent projects\2106011 - dove lane, bristol (condition discharge)\technical\acad\drawings\2106011-002 site drainage.dwg

Appendix C
MicroDrainage Calculations

Time Area Diagram for 2106011-SWS-NT1.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.495	4-8	0.711	8-12	0.008

Total Area Contributing (ha) = 1.214

Total Pipe Volume (m³) = 266.102

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for 2106011-SWS-NT1.SWS

« - 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	13.046	0.540	24.2	0.033	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	27.979	0.970	28.8	0.033	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	12.431	1.885	6.6	0.033	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.000	34.200	0.290	117.9	0.033	5.00	0.0	0.600	o	225	Pipe/Conduit	
2.001	5.984	0.445	13.4	0.063	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	75.829	0.110	689.4	0.190	0.00	0.0	0.600	o	1500	Pipe/Conduit	
3.000	28.728	0.850	33.8	0.038	5.00	0.0	0.600	o	225	Pipe/Conduit	
3.001	36.517	0.745	49.0	0.151	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.004	25.656	1.560	16.4	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
4.000	20.294	0.210	96.6	0.029	5.00	0.0	0.600	o	225	Pipe/Conduit	
4.001	12.649	0.125	101.2	0.029	0.00	0.0	0.600	o	225	Pipe/Conduit	
5.000	28.349	0.350	81.0	0.027	5.00	0.0	0.600	o	225	Pipe/Conduit	
5.001	20.138	0.150	134.3	0.027	0.00	0.0	0.600	o	225	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	5.08	14.260	0.033	0.0	0.0	0.0	2.67	106.3	4.5
1.001	50.00	5.27	13.720	0.066	0.0	0.0	0.0	2.45	97.2	8.9
1.002	50.00	5.31	12.750	0.099	0.0	0.0	0.0	5.13	203.9	13.4
2.000	50.00	5.47	11.600	0.033	0.0	0.0	0.0	1.20	47.8	4.5
2.001	50.00	5.50	11.310	0.096	0.0	0.0	0.0	3.59	142.6	13.0
1.003	50.00	6.28	9.590	0.385	0.0	0.0	0.0	1.63	2873.4	52.1
3.000	50.00	5.21	12.350	0.038	0.0	0.0	0.0	2.26	89.8	5.1
3.001	50.00	5.54	11.500	0.189	0.0	0.0	0.0	1.87	74.5	25.6
1.004	50.00	6.36	9.480	0.574	0.0	0.0	0.0	5.03	800.4	77.7
4.000	50.00	5.25	10.780	0.029	0.0	0.0	0.0	1.33	52.9	3.9
4.001	50.00	5.42	10.570	0.058	0.0	0.0	0.0	1.30	51.7	7.9
5.000	50.00	5.32	11.050	0.027	0.0	0.0	0.0	1.45	57.8	3.7
5.001	50.00	5.62	10.700	0.054	0.0	0.0	0.0	1.13	44.8	7.3

STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for 2106011-SWS-NT1.SWS

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
5.002	27.530	0.180	152.9	0.027	0.00	0.0	0.600	o	225	Pipe/Conduit	
5.003	4.668	0.031	150.6	0.027	0.00	0.0	0.600	o	225	Pipe/Conduit	
5.004	7.381	0.049	150.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
5.005	10.518	0.070	150.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
4.002	41.587	2.300	18.1	0.029	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.005	30.725	0.050	614.5	0.073	0.00	0.0	0.600	o	450	Pipe/Conduit	
6.000	46.260	0.950	48.7	0.023	5.00	0.0	0.600	o	225	Pipe/Conduit	
6.001	23.726	1.625	14.6	0.023	0.00	0.0	0.600	o	225	Pipe/Conduit	
6.002	7.481	0.575	13.0	0.023	0.00	0.0	0.600	o	225	Pipe/Conduit	
6.003	15.294	0.925	16.5	0.083	0.00	0.0	0.600	o	225	Pipe/Conduit	
6.004	16.877	0.200	84.4	0.075	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.006	25.555	0.040	638.9	0.029	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.007	17.508	0.120	145.9	0.029	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.008	27.713	0.220	126.0	0.029	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.009	52.427	0.160	327.7	0.029	0.00	0.0	0.600	o	1350	Pipe/Conduit	
1.010	10.000	0.031	322.6	0.029	0.00	0.0	0.600	o	1350	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)
5.002	50.00	6.06	10.550	0.081	0.0	0.0	0.0	1.05	41.9	11.0
5.003	50.00	6.13	10.370	0.108	0.0	0.0	0.0	1.06	42.3	14.6
5.004	50.00	6.25	10.339	0.108	0.0	0.0	0.0	1.06	42.3	14.6
5.005	50.00	6.41	10.290	0.108	0.0	0.0	0.0	1.06	42.3	14.6
4.002	50.00	6.56	10.220	0.195	0.0	0.0	0.0	4.80	763.2	26.4
1.005	50.00	7.19	7.920	0.842	0.0	0.0	0.0	0.81	129.3	114.0
6.000	50.00	5.41	13.150	0.023	0.0	0.0	0.0	1.88	74.7	3.1
6.001	50.00	5.53	12.200	0.046	0.0	0.0	0.0	3.44	136.9	6.2
6.002	50.00	5.56	10.575	0.069	0.0	0.0	0.0	3.65	145.0	9.3
6.003	50.00	5.64	10.000	0.152	0.0	0.0	0.0	3.23	128.6	20.6
6.004	50.00	5.84	9.075	0.227	0.0	0.0	0.0	1.42	56.6	30.7
1.006	50.00	7.72	7.870	1.098	0.0	0.0	0.0	0.80	126.7«	148.7
1.007	50.00	7.89	7.830	1.127	0.0	0.0	0.0	1.68	267.4	152.6
1.008	50.00	8.15	7.710	1.156	0.0	0.0	0.0	1.81	287.9	156.5
1.009	50.00	8.54	6.590	1.185	0.0	0.0	0.0	2.22	3172.2	160.5
1.010	50.00	8.62	6.430	1.214	0.0	0.0	0.0	2.23	3197.2	164.4

Free Flowing Outfall Details for 2106011-SWS-NT1.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.010	11	10.450	6.399	0.000	0	0

Simulation Criteria for 2106011-SWS-NT1.SWS

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	1
Number of Online Controls	3	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.350		

Online Controls for 2106011-SWS-NT1.SWS

Hydro-Brake® Optimum Manhole: 5, DS/PN: 1.004, Volume (m³): 150.8

Unit Reference	MD-SHE-0190-2500-3000-2500
Design Head (m)	3.000
Design Flow (l/s)	25.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	190
Invert Level (m)	9.480
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	3.000	25.0	Kick-Flo®	1.699	19.1
Flush-Flo™	0.822	24.4	Mean Flow over Head Range	-	21.5

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	6.6	1.200	23.6	3.000	25.0	7.000	37.6
0.200	17.4	1.400	22.5	3.500	26.9	7.500	38.8
0.300	20.7	1.600	20.5	4.000	28.7	8.000	40.1
0.400	22.3	1.800	19.6	4.500	30.4	8.500	41.3
0.500	23.3	2.000	20.6	5.000	31.9	9.000	42.4
0.600	23.9	2.200	21.5	5.500	33.4	9.500	43.5
0.800	24.4	2.400	22.5	6.000	34.9		
1.000	24.2	2.600	23.3	6.500	36.2		

Hydro-Brake® Optimum Manhole: 24, DS/PN: 5.005, Volume (m³): 2.6

Unit Reference	MD-SHE-0212-2500-1500-2500
Design Head (m)	1.500
Design Flow (l/s)	25.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	212
Invert Level (m)	10.290
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Hydro-Brake® Optimum Manhole: 24, DS/PN: 5.005, Volume (m³): 2.6

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	25.0	Kick-Flo®	1.000	20.6
Flush-Flo™	0.455	25.0	Mean Flow over Head Range	-	21.5

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	7.2	1.200	22.5	3.000	34.8	7.000	52.5
0.200	20.6	1.400	24.2	3.500	37.5	7.500	54.3
0.300	24.2	1.600	25.8	4.000	40.0	8.000	56.0
0.400	24.9	1.800	27.3	4.500	42.4	8.500	57.7
0.500	24.9	2.000	28.7	5.000	44.6	9.000	59.3
0.600	24.7	2.200	30.0	5.500	46.7	9.500	60.9
0.800	23.7	2.400	31.3	6.000	48.7		
1.000	20.7	2.600	32.5	6.500	50.6		

Hydro-Brake® Optimum Manhole: 10, DS/PN: 1.010, Volume (m³): 87.8

Unit Reference	MD-SHE-0351-9450-3500-9450
Design Head (m)	3.500
Design Flow (l/s)	94.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	351
Invert Level (m)	6.430
Minimum Outlet Pipe Diameter (mm)	Site Specific Design (Contact Hydro International)
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	3.500	94.5	Kick-Flo®	2.141	74.5
Flush-Flo™	0.991	94.3	Mean Flow over Head Range	-	81.9

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)
0.100	10.2	0.600	90.3	1.600	90.1	2.600	81.8
0.200	35.4	0.800	93.5	1.800	86.5	3.000	87.7
0.300	65.2	1.000	94.3	2.000	80.7	3.500	94.5
0.400	82.5	1.200	93.7	2.200	75.4	4.000	100.8
0.500	87.1	1.400	92.3	2.400	78.7	4.500	106.8

Hydro-Brake® Optimum Manhole: 10, DS/PN: 1.010, Volume (m³): 87.8

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
5.000	112.4	6.500	127.7	8.000	141.3	9.500	153.7
5.500	117.7	7.000	132.4	8.500	145.6		
6.000	122.8	7.500	137.0	9.000	149.7		

Storage Structures for 2106011-SWS-NT1.SWS

Cellular Storage Manhole: 23, DS/PN: 5.004

Invert Level (m) 10.339 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	6.0	4.0	1.300	0.0	14.0
1.200	6.0	13.6			

Summary of Critical Results by Maximum Level (Rank 1) for 2106011-SWS-NT1.SWS

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 1
Number of Online Controls 3 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.350
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 20.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
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 Winter	100	+40%					14.330
1.001	2	15 Winter	100	+40%					13.826
1.002	3	60 Winter	100	+40%	100/60 Winter				13.737
2.000	12	30 Winter	100	+40%	100/30 Winter				12.610
2.001	13	60 Winter	100	+40%	100/30 Summer				13.734
1.003	4	60 Winter	100	+40%	100/30 Summer				13.729
3.000	14	60 Winter	100	+40%	100/15 Summer				13.762
3.001	15	60 Winter	100	+40%	100/15 Summer				13.757
1.004	5	60 Winter	100	+40%	100/15 Summer				13.729
4.000	16	15 Winter	100	+40%					10.873
4.001	17	15 Winter	100	+40%					10.723
5.000	19	15 Winter	100	+40%	100/15 Winter				11.353
5.001	20	15 Winter	100	+40%	100/15 Summer				11.332
5.002	21	15 Winter	100	+40%	100/15 Summer				11.301
5.003	22	15 Winter	100	+40%	100/15 Summer				11.248
5.004	23	15 Winter	100	+40%	100/15 Summer				11.229
5.005	24	15 Winter	100	+40%	100/15 Summer				11.205
4.002	18	15 Winter	100	+40%					10.321
1.005	6	60 Winter	100	+40%	100/15 Summer				9.900
6.000	25	15 Winter	100	+40%					13.217

Summary of Critical Results by Maximum Level (Rank 1) for 2106011-SWS-NT1.SWS

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	-0.155	0.000	0.21			19.6	OK	
1.001	2	-0.119	0.000	0.45			40.3	OK	
1.002	3	0.762	0.000	0.18			32.0	SURCHARGED	
2.000	12	0.785	0.000	0.35			15.6	FLOOD RISK*	3
2.001	13	2.199	0.000	0.33			31.0	FLOOD RISK	
1.003	4	2.639	0.000	0.05			115.0	SURCHARGED	
3.000	14	1.187	0.000	0.15			12.2	SURCHARGED	
3.001	15	2.032	0.000	0.87			61.2	SURCHARGED	
1.004	5	3.799	0.000	0.04			29.5	FLOOD RISK	
4.000	16	-0.132	0.000	0.36			17.0	OK	
4.001	17	-0.072	0.000	0.79			35.1	OK	
5.000	19	0.078	0.000	0.29			15.6	SURCHARGED	
5.001	20	0.407	0.000	0.54			22.1	FLOOD RISK	
5.002	21	0.526	0.000	0.82			32.0	SURCHARGED	
5.003	22	0.653	0.000	1.49			44.7	SURCHARGED	
5.004	23	0.665	0.000	0.88		9	27.6	SURCHARGED	
5.005	24	0.690	0.000	0.70			24.9	SURCHARGED	
4.002	18	-0.349	0.000	0.11			77.5	OK	
1.005	6	1.530	0.000	0.88			98.4	SURCHARGED	
6.000	25	-0.158	0.000	0.19			13.4	OK	

Summary of Critical Results by Maximum Level (Rank 1) for 2106011-SWS-NT1.SWS

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
6.001	26	15 Winter	100	+40%					12.272
6.002	27	15 Winter	100	+40%	100/15 Summer				10.902
6.003	28	15 Winter	100	+40%	100/15 Summer				10.833
6.004	29	15 Winter	100	+40%	100/15 Summer				10.341
1.006	7	60 Winter	100	+40%	100/15 Summer				9.872
1.007	8	60 Winter	100	+40%	100/15 Summer				9.837
1.008	9	60 Winter	100	+40%	100/15 Summer				9.806
1.009	9a	60 Winter	100	+40%	100/15 Summer				9.768
1.010	10	60 Winter	100	+40%	100/15 Summer				9.764

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
6.001	26	-0.153	0.000	0.22			27.8	OK	
6.002	27	0.102	0.000	0.37			39.6	SURCHARGED	
6.003	28	0.608	0.000	0.74			83.7	SURCHARGED	
6.004	29	1.041	0.000	2.48			125.1	SURCHARGED	
1.006	7	1.552	0.000	1.89			180.5	SURCHARGED	
1.007	8	1.557	0.000	0.97			189.4	SURCHARGED	
1.008	9	1.646	0.000	0.81			198.2	SURCHARGED	
1.009	9a	1.828	0.000	0.08			194.9	SURCHARGED	
1.010	10	1.984	0.000	0.07			94.3	SURCHARGED	

Appendix D

SuDS Management Plan

SUDS Element	**Rainwater Harvesting Systems**	
Maintenance Period	**Maintenance Task**	**Frequency**
Regular Maintenance	Inspection of the tank for debris and sediment build-up, inlets/outlets/withdrawal devices, overflow areas, pumps, filters	Annually (and following poor performance)
	Cleaning of tank, inlets, outlets, gutters, withdrawal devices and roof drain filters of silts and other debris	Annually (and following poor performance)
Occasional Maintenance	Cleaning and/or replacement of any filters	Three monthly (or as required).
Remedial Actions	Repair of overflow erosion damage or damage to tank	As required
	Pump repairs	As required

SUDS Element	**Green Roofs**	
Maintenance Period	**Maintenance Task**	**Frequency**
Regular Maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	6 monthly and annually, or as required
	During establishment (i.e. year one) replace dead plants	Monthly
	Post establishment, replace dead plants as required (where >5% coverage)	Annually (in autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow grasses, prune shrubs and manage other planting (if appropriate) as required – clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial Work	If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required.
	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources or erosion damage should be identified and controlled	As required.
Monitoring	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of	Annually and after severe storms.

	waterproofing and structural stability.	
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources.	Annually and after severe storms.
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system.	Annually and after severe storms.
	Inspect underside of roof for evidence of leakage.	Annually and after severe storms.

SuDS Element	**Trees**	
Maintenance Period	**Maintenance Task**	**Frequency**
Regular Maintenance	Remove litter and debris	Monthly (or as required)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets and outlets	Inspect monthly
Occasional Maintenance	Check tree health and manage tree appropriately	Annually
	Remove silt build-up from inlets and surface and replace mulch as necessary	Annually, or as required
	Water	As required (in periods of drought)
Monitoring	Inspect silt accumulation rates and establish appropriate removal frequencies	Half yearly

Maintenance Period	**Permeable Paving**	
	Maintenance Task	*Frequency*
Regular Maintenance	Brushing and vacuuming	Once a year or as required
Occasional Maintenance	Stabilise and mow contributing adjacent area	As required
	Removal of weed or management using glyphospate applied directly into weeds by an applicator rather than spraying	As required
Remedial Work	Remediate any landscaping which has been raised to within 50mm of the level of the paving	As required.
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to structural performance or a hazard to users.	As required.
	Rehabilitation of surface or upper structure by remedial sweeping	Every 10 to 15 years, or as required
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	3 monthly, 48hrs after large storms in first 6 months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Maintenance Period	**Attenuation Tank**	
	Maintenance Task	*Frequency*
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risk to performance)	Monthly
	Remove sediment from pre-treatment structures and/or internal forebays.	Annually, or as required.
Remedial Work	Repair/rehabilitate inlets, outlets, overflows and vents	As required.
Monitoring	Inspect/check all inlets, outlets, vents, and overflows to ensure that they are in good condition and operating as designed	Annually.
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required.