



Riverside Central, Reading

Drainage Strategy

On behalf of

LIPMAN
PROPERTIES

Project Ref: 46110 | Rev: - | Date: June 2020

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For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved

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1 Introduction

- 1.1.1 Stantec UK has been commissioned by Lipman Properties Ltd to produce a Surface Water Drainage Strategy for Dukesbridge House, Reading. The report will support the planning application for the extension and new build proposals on the site.
- 1.1.2 This report has been prepared to accompany the Flood Risk Assessment for the site, document reference: 46110/4001.
- 1.1.3 This report has been prepared in accordance with the relevant national, regional and local planning policy guidance as follows:
- National policy regarding flood risk as contained within National Planning Policy Framework (NPPF), dated March 2012, and the accompanying National Planning Practice Guidance (PPG), dated November 2016;
 - The Ministerial Statement HCW161, dated 18th December 2014;
 - Non-statutory Technical Standards for Sustainable Drainage Systems, March 2015, Defra;
 - Reading Borough Local Plan, adopted November 2019, Reading Borough Council;
 - Flood Risk Assessments: Climate Change Allowances, 19th February 2016, Environment Agency;
 - Reading Borough Council (RBC) Strategic Flood Risk Assessment (SFRA), June 2017; and
 - RBC Revised Sustainable Design and Construction Supplementary Planning Document, 11th July 2011.

2 Site Information

2.1 Site Location

2.1.1 The site is situated within the centre of Reading and is bordered by residential accommodation to the north, Highbridge Wharf to the east, the River Kennet to the south and Duke Street to the west. The exact location of the site is shown below (Figure 2.1).

2.1.2 The site is approximately 0.2 ha in area.

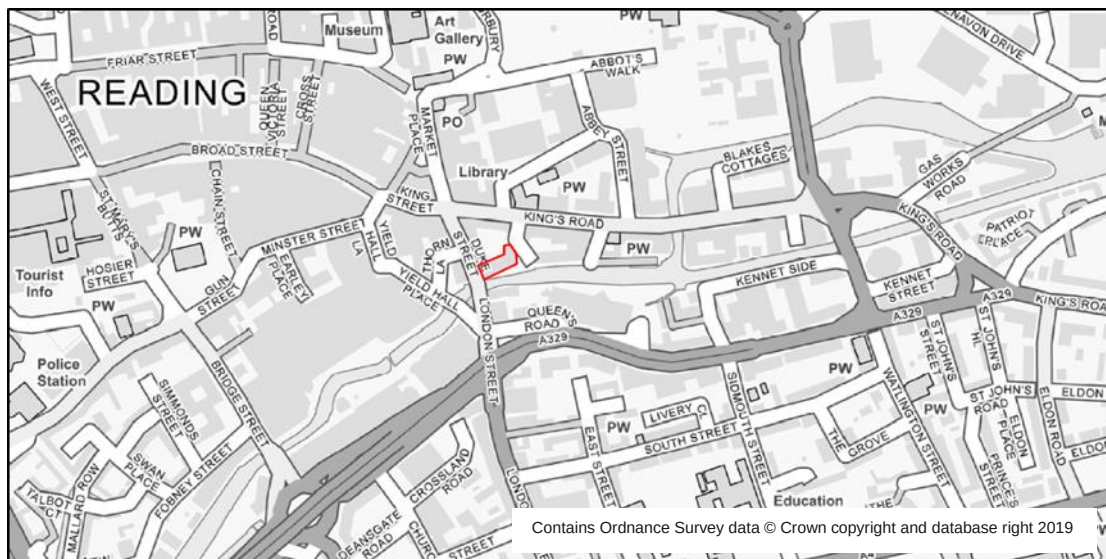


Figure 2.1: Site Location Plan

2.1.3 The existing buildings on the site are currently used as offices with a small retail unit on Duke Street. There is car parking provided in the enclosed forecourt at the rear of the site and in an under-croft area.

2.1.4 The site has a predominant fall from north to south towards the River Kennet, levels within the forecourt vary between 37.5m AOD and 38.3m AOD. A copy of the topographical survey is contained within Appendix A.

2.2 Proposals

2.2.1 The site has approval for a change of use from Class B1 offices to class C3 dwelling houses following the submission of General Permitted Development (PD) application. The approved scheme comprises 77 dwellings across the existing lower ground, ground, first, second, third and loft floors.

2.2.2 In addition to the PD scheme, the following is proposed at the site:

Roof and side extensions to existing building to provide a residential-led scheme with associated landscaping, public realm improvements, alterations to the existing vehicular access and car parking and provision of cycle parking and waste storage.

2.2.3 A copy of the Proposed Site Plan (Emre Arolat Architecture, dated 21st February 2020) is contained within Appendix B.

3 Existing Drainage

- 3.1.1 There is currently separate foul and surface water drainage infrastructure serving the existing buildings on the site. This drainage connects to Thames Water Utilities Limited (TWUL) sewers and comprise the following:
- A surface water sewer running north to south in Highbridge Wharf discharges directly to the River Kennet; and
 - A 150mm diameter foul water sewer leaving the rear of the site running south to north in Highbridge Wharf.
- 3.1.2 A copy of the TWUL asset records (document reference: ALS/ALS Standard/2019_4121926, dated December 2019) is contained within Appendix C.
- 3.1.3 The existing site is currently entirely impermeable and there are no known attenuation features. It has been assumed that surface water runoff from the site discharges freely to the River Kennet.
- 3.1.4 An estimate of the existing brownfield discharge rate has been undertaken using the HR Wallingford Modified Rational Method. An estimate of the greenfield discharge rate has also been undertaken using the method outlined in the Rainfall Runoff Management for Developments report (SC030219, dated October 2013, Defra/EA). The discharge rates are summarised in Table 3.1, below:

Existing Discharge Rates		
Return Period	Greenfield Runoff (l/s)	Brownfield Runoff (l/s)
1 in 1 Year	0.3	29.9
1 in 30 Year	0.9	72.0
1 in 100 year	1.2	89.1

Table 3.1: Existing Discharge Rates

- 3.1.5 The supporting discharge rate calculation sheets are provided within Appendix C.

4 Proposed Foul Water Strategy

- 4.1.1 It is proposed that connections are made to the existing foul water drainage on the site to serve the new buildings. Where vertical extension of the existing building is proposed, the existing below ground foul water connections will be utilised.
- 4.1.2 Details of the proposed foul water discharge destinations are provided on the Proposed Drainage Strategy Drawing (46110/2001/001), contained within Appendix D.
- 4.1.3 To ensure there is capacity in the existing sewer network, a Pre-Development Enquiry has been submitted for the new build proposals on the site. Stantec is still awaiting a response from Thames Water at this stage.

5 Proposed Surface Water Strategy

5.1 Proposed Strategy

- 5.1.1 The proposed drainage strategy will look to reuse the existing surface water drainage infrastructure on the site and limit the rate of surface water discharge using a flow restricted blue / green roof system. A green roof will be utilised where the roof area is not to be used by the residents and a blue roof system used in accessible terrace areas. A copy of the Proposed Drainage Strategy Drawing (46110/2001/001) is contained within Appendix D.

5.2 Discharge Destination

- 5.2.1 In accordance with the discharge destination hierarchies of the Building Regulations H3 and the NPPG an assessment of the suitability of the site to utilise infiltration drainage techniques has been undertaken.

See the Planning Practice Guidance

This states:

"Generally the aim should be discharge surface runoff as high up the following hierarchy of drainage options as reasonably practicable:

- 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."*

- 5.2.2 It is assumed that the groundwater level is relatively high on the site due to the close proximity to the River Kennet, also the small site area means that a suitable offset could not be provided between an infiltration feature and the existing buildings on the site. Therefore, it is proposed that runoff from the site continues to discharge to the River Kennet via the Thames Water sewer in Highbridge Wharf.

5.3 Peak Flow Control – Defra Technical Standard S3

S3. For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

- 5.3.1 As previously discussed, the application site is currently developed and the existing peak discharge rates for the site are contained in Table 3.1.
- 5.3.2 The EA's Flood Risk Assessments: Climate Change Allowances guidance which supports the NPPF provides contingency allowances for potential increases in sea level rise, peak river flow and rainfall intensity (allowances are set out in Table 4.1).
- 5.3.3 In accordance with this guidance, the potential for increased flood probability as the result of possible climate change has been taken into account in the consideration of mitigation

measures over the lifetime of the development through a +40% allowance for increases in peak rainfall intensity.

Table 4.1: Flood Risk Assessments: Climate Change Allowance Table 2 - Peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper End	10%	20%	40%
Central	5%	10%	20%

- 5.3.4 In accordance with best practice the proposed drainage strategy seeks to reduce the peak discharge rate from the site to *'as close as reasonably practicable to the greenfield runoff rate'*.
- 5.3.5 Due to the spatial constraints on the site, it is not feasible to reduce the discharge rate to that of the greenfield site. Therefore, it is proposed that the surface water discharge from the site is reduced through the use of a green roof system.
- 5.3.6 Table 4.2 below outlines the proposed peak discharge rates and the betterment provided.

Table 4.2: Proposed Discharge Rates and Reduction on Existing

Return Period	Proposed Peak Discharge (l/s)	% Reduction in Discharge to TWUL Sewer
1 in 1 Year	12.2	59%
1 in 30 year	30.5	58%
1 in 100 year	40.3	55%
1 in 100 year + 40% allowance for climate change	53.7	-

- 5.3.7 In order to demonstrate that the proposed peak discharge rates are deliverable within the site, an outline surface water drainage network has been modelled. A copy of the MicroDrainage calculations for the proposed network is contained within Appendix E.

5.4 Volume Control - Defra Technical Standard S6

S5. Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.

- 5.4.1 The impermeable area of the site will remain unchanged following completion of the works. Therefore, the volume of runoff in the 100 year 6 hour storm cannot be constrained to that of greenfield. The management of runoff volume through infiltration or re-use is not considered reasonably practicable for this site. To prevent an adverse effect on flood risk the rate of runoff will be reduced for all storm events.

5.5 Flood Risk within the Development – Defra Technical Standards S7 to S9

S7. The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.

S8. The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement) or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

- 5.5.1 The proposed surface water drainage network has been designed not to flood in a 1 in 100 annual probability event or a 1 in 100 annual probability event with a +40% allowance for climate change.

- 5.5.2 A copy of the Proposed Drainage Strategy Drawing (46110/2001/001) is contained within Appendix D.

S9. The design of the site must ensure that so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.

- 5.5.3 In the event of a storm in excess of 100 year + 40% climate change, surface water will flow overland to regions of lower topography. In this case, water will flow towards the River Kennet at the south of the site.

5.6 SuDS Selection

- 5.6.1 The Ministerial Statement HCWS161, dated 18th December 2014 states that:

*'.....the Government's expectation is that sustainable drainage systems will be provided in new developments **wherever this is appropriate.**'*

- 5.6.2 The PPG paragraph 051 describes SuDS as follows:

*'Sustainable drainage systems are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible. **They provide opportunities to:***

- *reduce the causes and impacts of flooding;*
- *remove pollutants from urban run-off at source;*
- *combine water management with green space with benefits for amenity, recreation and wildlife.'*

- 5.6.3 The current planning policy and guidance advises that SuDS in the form of open or near surface systems employing natural processes should be used where possible, not that they must be used. They can also provide opportunities to combine water management with amenity and wildlife, but only where appropriate.

- 5.6.4 In accordance with the principles outlined in the PPG, it is proposed that a blue / green roof is installed at the site. This will provide opportunities to promote increased biodiversity and reduce flood risk. It is not considered feasible to provide open surface systems at ground level

due to the spatial constraints on the site and presence of the existing drainage network. Pollutant / contaminant removal on the site will be provided through the use of trapped gullies and catchpits within the existing carpark.

5.7 Structural Integrity – Defra Technical Standards S10 & S11

S10. Components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirement for reasonable levels of maintenance.

S11. The materials, including products, components, fittings or naturally occurring materials, which are specified by the designer must be of a suitable nature and quality for their intended use.

- 5.7.1 The components that make up any drainage network have different life expectancies which can be greatly affected by the effectiveness of their maintenance regime and upstream sediment capture / management.
- 5.7.2 This drainage network comprises a piped network, inspection chambers / catchpits, and a blue / green roof. As with any drainage system, this network requires regular inspection and maintenance to ensure that the individual components continue to operate as designed, both in terms of hydraulic capacity and potential pollutant removal.
- 5.7.3 All the drainage channel sumps, catchpits, and storage features will therefore be inspected and cleaned regularly by a private maintenance company.
- 5.7.4 The detailed design of each of the individual components will be undertaken at the subsequent design stage.
- 5.7.5 Further details regarding the maintenance of the proposed system are contained in Section 6.

6 Maintenance Strategy

6.1.1 This section sets out the inspection and maintenance requirements for long term management of the development's surface water drainage system. This work is to be undertaken by a private maintenance company.

6.2 Health, Safety and Welfare

6.2.1 All those responsible for maintenance should take appropriate health, safety and welfare precautions for all activities including lone working, if relevant, and risk assessments should always be undertaken. The site's infrastructure Health and Safety File should be consulted before carrying out any works either inside or outside of the development's boundary and information regarding the location of existing utilities passed on to operatives.

6.2.2 The requirements of the Health and Safety at Work Act 1974 and The Construction (Design and Management) Regulations 2015 should be adhered to and any residual risks identified in the Health and Safety File should be managed and information passed on to maintenance operatives through task specific risk assessments.

6.3 Operation and Maintenance

6.3.1 There are three types of maintenance activities associated with surface water drainage systems. The SuDS Manual, CIRIA C753, defines these as:

- Regular Maintenance – *'basic tasks undertaken on a frequent and predictable schedule' including vegetation management, litter and debris removal, and inspections.'*
- Occasional Maintenance – *'tasks that are likely to be required periodically, but on a much less frequent and predictable basis than the routine tasks (sediment removal is an example).'*
- Remedial Maintenance – *'intermittent tasks that may be required to rectify faults associated with the system, although the likelihood of faults can be minimised by good design. Where remedial work is found to be necessary, it is likely to be due to site-specific characteristics or unforeseen events, and as such timings are difficult to predict.'*

6.3.2 Specific maintenance needs should be monitored and maintenance schedules adjusted to suit the location and condition of the drainage feature in question.

Operation and Maintenance Activity	SuDS Component	
	Piped Network / Inspection Chambers	Green Roof
Regular Maintenance		
Inspection	■	■
Litter and debris removal	■	
Grass cutting		
Weed and invasive plant control		■

Operation and Maintenance Activity	SuDS Component	
	Piped Network / Inspection Chambers	Green Roof
Shrub management (including pruning)		
Occasional Maintenance		
Sediment management ¹	■	
Vegetation replacement		■
Vacuum sweeping and brushing		
Remedial Maintenance		
Structure rehabilitation / repair	□	□
Infiltration surface reconditioning		
■ Will be required □ May be required ¹ Sediment should be collected and managed in pre-treatment systems, upstream of the main device.		

Table 5.1: Extract from The SuDS Manual Table 32.1: Typical key SuDS components operation and maintenance activities

6.4 Piped Network / Inspection Chambers

- 6.4.1 Piped network components requires regular inspection and maintenance to ensure that the individual components continue to operate as designed, both in terms of hydraulic capacity and potential pollutant removal. All the gullies, inspection chambers and catchpits will therefore be inspected and cleaned regularly.

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any features that are not operating correctly. If required take remedial action.	Monthly for three months, then six monthly
	Debris removal from catchment surface / gratings (where may cause risks to performance).	Monthly (and after large storms)
	Remove sediment from trapped sumps, manholes and catchpits.	Annually or as required
Remedial Maintenance	Repair / rehabilitation of gratings, inlets and outlets.	As required
Monitoring	Inspect / check all gratings, trapped sumps, manholes and catchpits to ensure that they are in good condition and operating as designed.	Annually and after large storm events
Structure Rehabilitation / Repair	Regular Maintenance and Monitoring to identify if repair and / or replacement of features or pipework is required.	As required

Table 5.2: Piped Network / Inspection Chambers operation and maintenance

6.5 Green Roof

- 6.5.1 A green roof system incorporates an area of living vegetation over a growing medium, reservoir layer and waterproofing. Green roofs provide a visual benefit, ecological value, enhanced building performance and reduction in surface water discharge rates. Reduced discharge rates are achieved through the use of a reservoir layer and flow control device at the outlets.

Maintenance Schedule	Required Action	Typical Frequency
Regular Inspections	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability.	Annually and after severe storms
	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
Regular Maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth.	Six monthly and annually or as required
	During establishment (ie year one), replace dead plants as required.	Monthly (but usually responsibility of the manufacturer)
	Post establishment, replace dead plants as required (where >5% of 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 Actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled.	As required
	IF drain inlet has settled, cracked or moved, investigate and repair as appropriate.	As required

Table 5.3: Extract from The SuDS Manual Table 12.5: Operation and maintenance requirements for green roofs

6.6 Blue Roof

- 6.6.1 A blue roof system comprises shallow depth attenuation crates laid across a waterproofed podium slab. Runoff can enter the blue roof through conventional surface drainage features or permeable paving. Runoff is stored within the attenuation crates and released at a reduced rate. The maintenance procedure for a blue roof is outlined below.

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required take remedial action	Monthly for three months, then annually
	Remove debris from catchment surface (where may	Monthly

	cause risks to performance)	
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary	Annually
Remedial Maintenance	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, and after large rainfall events
Structure Rehabilitation / Repair	Regular Maintenance and Monitoring to identify if repair and / or replacement of storage units is required.	As required

Table 5.4: Extract from The SuDS Manual Table 21.3: Operation and maintenance requirements for attenuation storage tanks

7 Summary

- 7.1.1 This Drainage Strategy has been developed in accordance with the relevant national, regional and local planning policy guidance.
- 7.1.2 Due to spatial constraints on the site the use of infiltration drainage features is not considered appropriate. Therefore, it is proposed that surface water continues to discharge to the River Kennet via the TWUL sewer in Highbridge Wharf.
- 7.1.3 The proposed drainage strategy will limit surface water discharge through the use of a blue / green roof system with a connection to the existing surface water drainage network. This will ensure that there is a 50% reduction in peak discharge rates in comparison with the existing regime.
- 7.1.4 A private maintenance contractor will be responsible for the long -term maintenance of the proposed system and will undertake inspection and maintenance in accordance with the principles outlined in this Strategy.
- 7.1.5 The information provided in this report ensures that the principles advocated by relevant national, regional and local planning policy guidance have been satisfactorily addressed.

Appendix A Topographical Survey

Dukesbridge house reading-topo survey

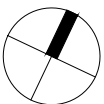


Appendix B EAA Proposed Site Plan

FOR PLANNING

© EAA - EMRE AROLAT ARCHITECTURE

DO NOT SCALE FROM THIS DRAWING. VERIFY ALL DIMENSIONS ON SITE. DRAWING SHOULD BE READ IN CONJUNCTION WITH INFORMATION FROM ALL OTHER DESIGN CONSULTANTS AND CONTRACTORS. ALL DRAWINGS IN DIGITAL FORMAT ARE FOR REFERENCE ONLY. PAPER COPIES ARE AVAILABLE ON REQUEST.



21 DUKE ST, READING
RG1 4SA

0 5m 10m 25m

NO	DATE	BY	REVISION
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DRAWING TITLE			
PROPOSED SITE PLAN			

PROJECT NAME	
RIVERSIDE CENTRAL	

EAA EMRE AROLAT ARCHITECTURE NEW YORK-LONDON-ISTANBUL	40 BOWLING GREEN LANE, LONDON UK EC1R 0NE T.020 7415 7235-36-37 london@emrearolat.com - www.emrearolat.com
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CLIENT	
LIPMAN PROPERTIES	

PROJECT NO	DRAWN	ISSUE DATE
236	KU	21.02.2020
	CHECKED	SCALE
	UY	1/250@A1

BLOCK	STAGE	DRAWING NO	REVISION
AB	P	21-02	-

FOR PLANNING

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MARKET SALE		
UNIT NUMBER	TOTAL	AMENITY
501 (1B2P)	61,29sqm	2,99sqm
502 (1B2P)	61,67sqm	5,68sqm
503 (1B2P)	53,64sqm	2,27sqm
504 (1B2P)	51,97sqm	4,42sqm
505 (STUDIO)	47,25sqm	2,73sqm
506 (STUDIO)	49,15sqm	9,28sqm
507 (2B3P)	64,22sqm	7,77sqm
508 (STUDIO)	47,71sqm	2,93sqm
509 (2B3P)	58,70sqm	5,43sqm

DRAWING NOTES

Hatched areas do not form part of this planning application and are shown here for illustrative purposes only.

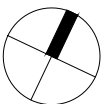
Court yard landscape design is indicative please refer to landscape package for design & access.

*Area target above are those outlined in the nationally described space standards for overall area.

**Surrounding builings are shown indicatively and must be verified on site

***Arbitrary levels have been taken from Herts Engineering dated 20.03.2019

Affordable rent STUDIO
Affordable rent 1B2P
Affordable rent 2B3P
Affordable rent 2B4P
Affordable rent 3B4P
Intermediate STUDIO
Intermediate 1B2P
Intermediate 2B3P
Intermediate 2B4P
Intermediate 3B4P
Market Sale STUDIO
Market Sale 1B2P
Market Sale 2B3P
Market Sale 2B4P
Market Sale 3B4P



21 DUKE ST, READING
RG1 4SA

0 2.5m 5m 10m

NO	DATE	BY	REVISION
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DRAWING TITLE

PROPOSED ROOF PLAN

PROJECT NAME

RIVERSIDE CENTRAL

EAA

EMRE AROLAT ARCHITECTURE
NEW YORK-LONDON-ISTANBUL

50 BOWLING GREEN LANE, LONDON UK
EC1R 0NE T.020 7415 7235-36-37
london@emrearolat.com - www.emrearolat.com

CLIENT

LIPMAN PROPERTIES

PROJECT NO	DRAWN	ISSUE DATE
	KU	11.12.2019
236	CHECKED	SCALE
	UY	1/100@A1

BLOCK	STAGE	DRAWING NO	REVISION
A	P	22-10	-

Appendix C TWUL Asset Records & Discharge Rates

Asset Location Search Sewer Map - ALS/ALS Standard/2019_4121926

The map displays a detailed street network and sewer infrastructure. Key streets include King's Road, Duke Street, High Street, and Queen's Road. The River Kennet flows through the area, with the High Bridge crossing it. Various sewer assets are marked, including manholes (red dots), valves (blue dots), and pipes (red and blue lines). Key locations include Highbridge House, Highbridge Wharf, and the Cycle Hire Station. The map also shows the River Kennet and the High Bridge.

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Based on the Ordnance Survey Map with the Sanction of the controller of H.M. Stationery Office, License no. 100019345 Crown Copyright Reserved.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
8251	38.26	36.28
8256	n/a	n/a
8257	n/a	n/a
8255	n/a	n/a
8201	38.24	34.65
8358	38.25	37.26
8356	n/a	n/a
8360	n/a	n/a
8352	38.3	36.71
731E	n/a	n/a
73NF	n/a	n/a
8302	38.28	36.15
831D	n/a	n/a
731D	n/a	n/a
73ME	n/a	n/a
8303	38.25	35.95
7355	n/a	n/a
7302	39.32	n/a
7301	38.72	34.73
7351	39.88	39.05
7350	39.41	38.08
741A	n/a	n/a
7252	38.41	n/a
7202	38.45	34.9
8253	n/a	n/a
8252	38.25	35.98
7264	38.9	36.26
7253	37.92	36.99
7260	39	36.4
7259	39.6	36.36
721A	n/a	n/a
6213	37.5	36.43
7203	38.52	n/a
6211	38.2	36.13
8203	37.29	35.95
6212	38.2	36.34
6352	38.09	36.23
6367	38.2	36.89
7303	38.37	35.09
731C	n/a	n/a
7306	38.77	35.77
7304	38.52	35.09
731B	n/a	n/a
731A	n/a	n/a
7305	38.56	34.77
8355	38.03	36.39
8353	38.3	36.55
8357	38.01	37.05
The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.		



ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

	Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.		Trunk Foul
	Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.		Trunk Surface Water
	Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.		Trunk Combined
	Storm Relief		Bio-solids (Sludge)
	Vent Pipe		Proposed Thames Water Foul Sewer
	Proposed Thames Surface Water Sewer		Proposed Thames Water Foul Sewer
	Gallery		Foul Rising Main
	Surface Water Rising Main		Combined Rising Main
	Sludge Rising Main		Proposed Thames Water Rising Main
	Vacuum		

Notes:

- 1) All levels associated with the plans are to Ordnance Datum Newlyn.
- 2) All measurements on the plans are metric.
- 3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
- 4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
- 5) 'na' or '0' on a manhole level indicates that data is unavailable.

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

	Air Valve
	Dam Chase
	Fitting
	Meter
	Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

	Control Valve
	Drop Pipe
	Ancillary
	Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

	Outfall
	Undefined End
	Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

	Public/Private Pumping Station
	Change of characteristic indicator (C.O.C.I.)
	Invert Level
	Summit

Areas

Lines denoting areas of underground surveys, etc.

	Agreement
	Operational Site
	Chamber
	Tunnel
	Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

	Foul Sewer		Surface Water Sewer
	Combined Sewer		Gully
	Culverted Watercourse		Proposed
			Abandoned Sewer

- 6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

	Dukesbridge House, Reading Surface Water Drainage Strategy Existing Brownfield Runoff	JOB NO:	46110/2001		SHEET:	1 of 1
		DATE:	25.06.20	BY:	JP	CHECKED:

Calculation based on 'Modified Rational Method', HR Wallingford.

Assumes that water travels across the site at 1m/s from the furthest point to the connection with the existing network

Data

M5-60min 17 mm Q=2.78CiA
r 0.40

Calculation - 1 in 1 Year

Catchment Area	Impermeable Area ha	Duration (D) min	Z1	M5-Dmin mm	Z2	M1-Dmin mm	i mm/hr	Impermeable Runoff l/s
1	0.225	5	0.38	6.46	0.62	3.98	47.8	29.9
Total								29.9 l/s

Note: Duration relates to time of concentration for the catchment including allowance for time of entry

D	Z1	M5	Z2 for 1 in 1yr
5	0.38	5	0.620
10	0.51	7.03	0.616
15	0.57	10	0.610

Calculation - 1 in 30 Year

Catchment Area	Impermeable Area ha	Duration (D) min	Z1	M5-Dmin mm	Z2	M100-Dmin mm	i mm/hr	Impermeable Runoff l/s
1	0.225	5	0.38	6.46	1.48	9.59	115.0	72.0
Total								72.0 l/s

Note: Duration relates to time of concentration for the catchment including allowance for time of entry

D	Z1	M5	Z2 for 1 in 30yr*
5	0.38	5	1.460
10	0.51	7.03	1.484
15	0.57	10	1.520

* - extrapolated from Z2 values from other storm events and durations

Calculation - 1 in 100 Year

Catchment Area	Impermeable Area ha	Duration (D) min	Z1	M5-Dmin mm	Z2	M100-Dmin mm	i mm/hr	Impermeable Runoff l/s
1	0.225	5	0.38	6.46	1.84	11.87	142.5	89.1
Total								89.1 l/s

Note: Duration relates to time of concentration for the catchment including allowance for time of entry

D	Z1	M5	Z2 for 1 in 100yr
5	0.38	5	1.790
10	0.51	7.03	1.838
15	0.57	10	1.910

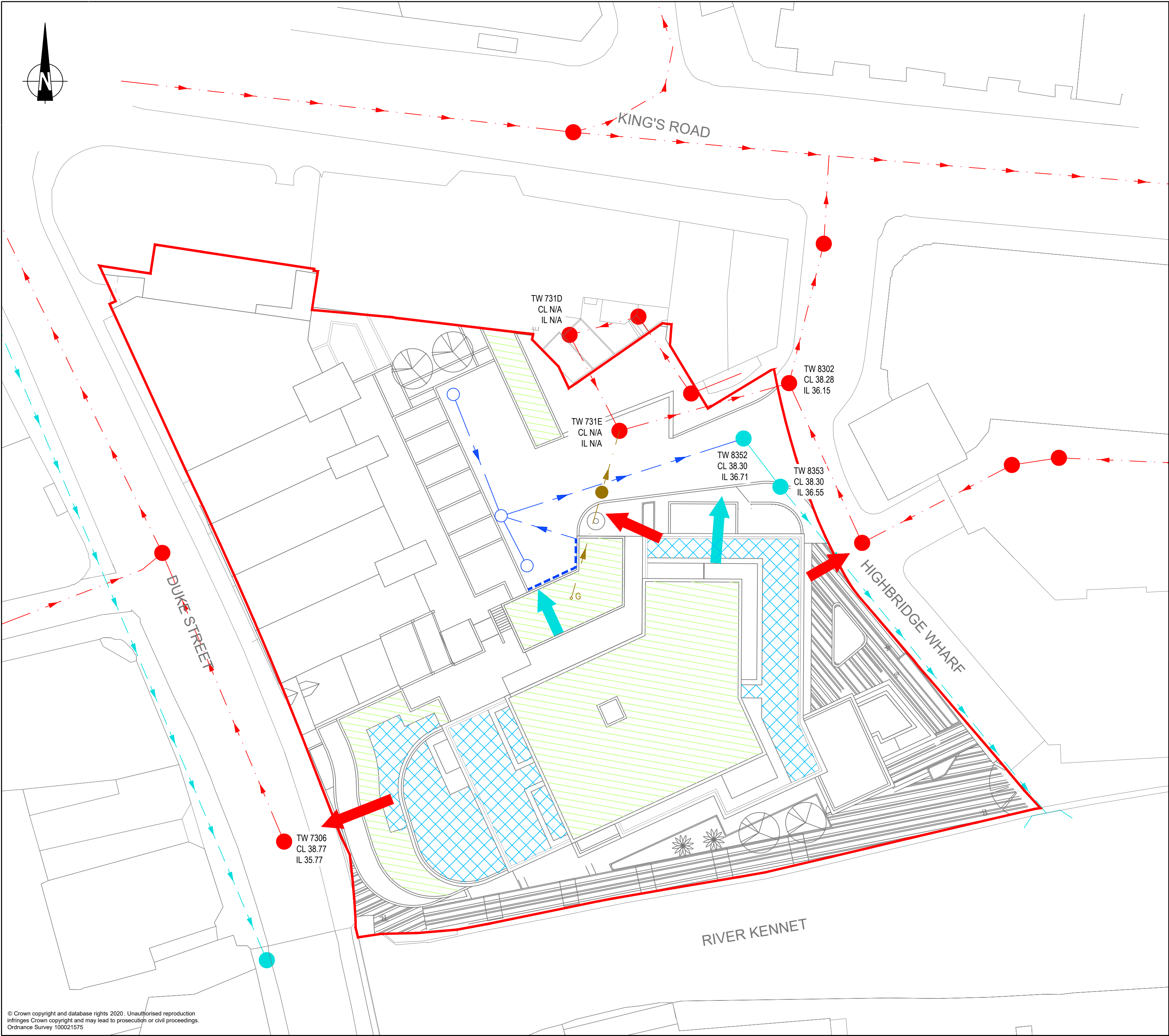
	Dukesbridge House, Reading		JOB No:		SHEET:	
			46110/2001		1 of 1	
	Surface Water Drainage Strategy		DATE:	BY:	CHECKED:	
	Calculation of Greenfield Discharge Rate		25.06.20	JP		

Calculation based on 'Rainfall runoff management for developments' - Report SC030219, October 2013, Defra / Environmental Agency

	Site	
R	6	Hydrological region (see Figure A1.1)
S	2	SOIL type from: http://www.uksuds.com/drainage-tools-members/surface-water-storage-tool.html
Catchment	<200	ha
$A_{(site)}$	1.00	ha
SAAR or AAR	642	mm
SPR	0.3	For SOIL type 1 (0.1), type 2 (0.3), type 3 (0.37), type 4 (0.47), type 5 (0.53)
$A_{(50)}$	50	ha
$Q_{BAR(50)}$	82.35	l/s
Q_{BAR}	1.65	l/s
$Q_{BAR(site)}/A_{(site)}$	1.65	l/s/ha
$Q_{throttle}$	5.00	l/s
$Q_{throttle}/A_{(site)}$	5.00	l/s/ha
$Q_{throttle}/3.5A_{(site)}$	1.43	l/s/ha
Q_{BAR}/A	1.65	l/s/ha
GC_1	0.85	Value taken from Line 10.1
GC_{30}	2.30	Value from: http://www.uksuds.com/drainage-tools-members/surface-water-storage-tool.html
GC_{100}	3.19	Value from: http://www.uksuds.com/drainage-tools-members/surface-water-storage-tool.html
Q_{1yr}	1.40	l/s/ha
Q_{30yr}	3.79	l/s/ha
Q_{100yr}	5.25	l/s/ha
Total Q_{1yr}	0.31	l/s
Total Q_{30yr}	0.85	l/s
Total Q_{100yr}	1.18	l/s

for 0.225 ha

Appendix D Proposed Drainage Strategy Drawing



NOTES:

- DO NOT SCALE THIS DRAWING. IF IN DOUBT PLEASE REQUEST FURTHER INFORMATION.
- ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT CONTRACT DRAWINGS, CONSTRUCTION DETAILS AND SPECIFICATIONS.
- PROPOSED GREEN ROOF HAS AN APPROXIMATE AREA OF 520m² WITH ASSUMED DISCHARGE RATE OF 0.5l/s PER RWP.
- PROPOSED LAYOUT FROM EAA PROPOSED ROOF PLAN DRAWING NO. 22-10-P.
- FURTHER DRAINAGE INVESTIGATIONS WILL BE CARRIED OUT AT THE NEXT DESIGN STAGE TO CONFIRM THE ROUTE OF EXISTING DRAINAGE.

KEY:

- SITE BOUNDARY
- THAMES WATER SURFACE WATER SEWER
- ASSUMED ROUTE OF EXISTING SURFACE WATER DRAINAGE
- PROPOSED LINEAR DRAINAGE CHANNEL
- PROPOSED GREEN ROOF DISCHARGE POINTS
- THAMES WATER FOUL WATER SEWER
- PROPOSED FOUL WATER DRAINAGE
- PROPOSED FOUL WATER GULLY
- PROPOSED FOUL WATER DISCHARGE POINTS
- PROPOSED GREEN ROOF
- PROPOSED BLUE ROOF TERRACE

A	UPDATED ROOF PLAN	25.06.20	JC	JP
Mark	Revision	Date	Drawn	Chkd

SCALING NOTE: Do not scale this drawing - any errors or omissions shall be reported to Stantec without delay.
UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

Drawing Issue Status
FOR INFORMATION

DUKESBRIDGE HOUSE, READING
EXTENSION & NEW BUILD
PROPOSED DRAINAGE STRATEGY

Client
LIPMAN
PROPERTIES



Date of 1st Issue 17.01.2020	Designed JP	Drawn JC
A2 Scale 1:250	Checked JP	Approved PJG

Drawing Number 46110/2001/001	Revision A
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READING
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Appendix E MicroDrainage Calculations

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Caversham Bridge House Waterman Place Reading RG1 8DN	Dukesbridge House Reading Pr Surface Water Drainage	
Date 26/06/2020	Designed by JP	
File 46110_2000_PR DRAINAGE.MDX	Checked by	
XP Solutions		Network 2020.1

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)	2	PIMP (%)	100
M5-60 (mm)	17.000	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	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	15.135	0.091	166.3	0.030	5.00	0.0	0.600	o	225	Pipe/Conduit	
2.000	7.768	0.025	310.7	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	
2.001	0.507	24.638	0.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
2.002	3.865	0.039	99.1	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
2.003	11.062	0.066	167.6	0.030	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	16.987	0.102	166.5	0.030	0.00	0.0	0.600	o	225	Pipe/Conduit	
3.000	7.603	0.025	304.1	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	
3.001	0.543	24.804	0.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
3.002	4.068	0.041	100.0	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)
1.000	50.00	5.25	37.023	0.030	0.0	0.0	0.0	1.01	40.2	4.1
2.000	50.00	5.23	61.800	0.000	0.0	0.0	0.0	0.56	10.0	0.0
2.001	50.00	5.23	61.750	0.000	0.0	0.0	0.0	70.93	1253.4	0.0
2.002	50.00	5.29	37.112	0.000	0.0	0.0	0.0	1.01	17.8	0.0
2.003	50.00	5.48	36.998	0.030	0.0	0.0	0.0	1.01	40.0	4.1
1.001	50.00	5.76	36.932	0.090	0.0	0.0	0.0	1.01	40.2	12.2
3.000	50.00	5.22	61.800	0.000	0.0	0.0	0.0	0.57	10.1	0.0
3.001	50.00	5.22	61.750	0.000	0.0	0.0	0.0	68.77	1215.2	0.0
3.002	50.00	5.29	36.946	0.000	0.0	0.0	0.0	1.00	17.8	0.0

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Caversham Bridge House Waterman Place Reading RG1 8DN	Dukesbridge House Reading Pr Surface Water Drainage	
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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.002	7.466	0.045	167.0	0.030	0.00	0.0	0.600	o	225	Pipe/Conduit	
4.000	9.728	0.025	389.1	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	
4.001	0.526	24.621	0.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
4.002	2.287	0.023	99.4	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
4.003	14.190	0.142	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
4.004	10.352	0.104	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.003	7.042	0.030	238.0	0.000	0.00	0.0	0.600	o	300	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)
1.002	50.00	5.88	36.830	0.120	0.0	0.0	0.0	1.01	40.1	16.2
4.000	50.00	5.32	61.800	0.000	0.0	0.0	0.0	0.50	8.9	0.0
4.001	50.00	5.32	61.750	0.000	0.0	0.0	0.0	69.61	1230.2	0.0
4.002	50.00	5.36	37.129	0.000	0.0	0.0	0.0	1.01	17.8	0.0
4.003	50.00	5.60	37.106	0.000	0.0	0.0	0.0	1.00	17.8	0.0
4.004	50.00	5.77	36.964	0.000	0.0	0.0	0.0	1.00	17.8	0.0
1.003	50.00	6.00	36.710	0.120	0.0	0.0	0.0	1.01	71.7	16.2

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Caversham Bridge House	Dukesbridge House	
Waterman Place	Reading	
Reading RG1 8DN	Pr Surface Water Drainage	
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XP Solutions	Network 2020.1	

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	Pipe Out PN	Invert Level (m)	Diameter (mm)	Pipes In PN	Invert Level (m)	Diameter (mm)	Backdrop (mm)
1	38.000	0.977	Open Manhole	1200	1.000	37.023	225				
2	62.200	0.400	Open Manhole	1200	2.000	61.800	150				
3	62.200	0.450	Junction		2.001	61.750	150	2.000	61.775	150	25
4	37.600	0.488	Junction		2.002	37.112	150	2.001	37.112	150	
5	37.600	0.602	Open Manhole	1200	2.003	36.998	225	2.002	37.073	150	
6	37.670	0.738	Open Manhole	1200	1.001	36.932	225	1.000	36.932	225	
								2.003	36.932	225	
7	62.200	0.400	Open Manhole	1200	3.000	61.800	150				
8	62.200	0.450	Junction		3.001	61.750	150	3.000	61.775	150	25
9	38.300	1.354	Junction		3.002	36.946	150	3.001	36.946	150	
10	38.300	1.470	Open Manhole	1200	1.002	36.830	225	1.001	36.830	225	
								3.002	36.905	150	
11	62.200	0.400	Open Manhole	1200	4.000	61.800	150				
12	62.200	0.450	Junction		4.001	61.750	150	4.000	61.775	150	25
13	37.600	0.471	Junction		4.002	37.129	150	4.001	37.129	150	
14	37.600	0.494	Open Manhole	1200	4.003	37.106	150	4.002	37.106	150	
15	38.280	1.316	Open Manhole	1200	4.004	36.964	150	4.003	36.964	150	
16	38.320	1.610	Open Manhole	1200	1.003	36.710	300	1.002	36.785	225	
								4.004	36.861	150	1
	38.300	1.620	Open Manhole	0		OUTFALL		1.003	36.680	300	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
1	471772.065	173362.224	471772.065	173362.224	Required	
2	471788.639	173327.705	471788.639	173327.705	Required	
3	471785.377	173334.755			No Entry	
4	471785.207	173335.233			No Entry	
5	471783.994	173338.902	471783.994	173338.902	Required	

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Caversham Bridge House Waterman Place Reading RG1 8DN	Dukesbridge House Reading Pr Surface Water Drainage	
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XP Solutions	Network 2020.1	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
6	471778.833	173348.686	471778.833	173348.686	Required	
7	471799.109	173342.173	471799.109	173342.173	Required	
8	471798.478	173349.750			No Entry	
9	471798.127	173350.163			No Entry	
10	471795.252	173353.042	471795.252	173353.042	Required	
11	471804.423	173325.021	471804.423	173325.021	Required	
12	471812.357	173330.651			No Entry	
13	471812.170	173331.142			No Entry	
14	471811.537	173333.340	471811.537	173333.340	Required	
15	471809.259	173347.346	471809.259	173347.346	Required	
16	471802.423	173355.120	471802.423	173355.120	Required	
	471809.393	173354.115			No Entry	

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Caversham Bridge House Waterman Place Reading RG1 8DN	Dukesbridge House Reading Pr Surface Water Drainage	
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PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	225	1	38.000	37.023	0.752	Open Manhole	1200
2.000	o	150	2	62.200	61.800	0.250	Open Manhole	1200
2.001	o	150	3	62.200	61.750	0.300	Junction	
2.002	o	150	4	37.600	37.112	0.338	Junction	
2.003	o	225	5	37.600	36.998	0.377	Open Manhole	1200
1.001	o	225	6	37.670	36.932	0.513	Open Manhole	1200
3.000	o	150	7	62.200	61.800	0.250	Open Manhole	1200
3.001	o	150	8	62.200	61.750	0.300	Junction	
3.002	o	150	9	38.300	36.946	1.204	Junction	
1.002	o	225	10	38.300	36.830	1.245	Open Manhole	1200
4.000	o	150	11	62.200	61.800	0.250	Open Manhole	1200
4.001	o	150	12	62.200	61.750	0.300	Junction	
4.002	o	150	13	37.600	37.129	0.321	Junction	
4.003	o	150	14	37.600	37.106	0.344	Open Manhole	1200
4.004	o	150	15	38.280	36.964	1.166	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	15.135	166.3	6	37.670	36.932	0.513	Open Manhole	1200
2.000	7.768	310.7	3	62.200	61.775	0.275	Junction	
2.001	0.507	0.0	4	37.600	37.112	0.338	Junction	
2.002	3.865	99.1	5	37.600	37.073	0.377	Open Manhole	1200
2.003	11.062	167.6	6	37.670	36.932	0.513	Open Manhole	1200
1.001	16.987	166.5	10	38.300	36.830	1.245	Open Manhole	1200
3.000	7.603	304.1	8	62.200	61.775	0.275	Junction	
3.001	0.543	0.0	9	38.300	36.946	1.204	Junction	
3.002	4.068	100.0	10	38.300	36.905	1.245	Open Manhole	1200
1.002	7.466	167.0	16	38.320	36.785	1.310	Open Manhole	1200
4.000	9.728	389.1	12	62.200	61.775	0.275	Junction	
4.001	0.526	0.0	13	37.600	37.129	0.321	Junction	
4.002	2.287	99.4	14	37.600	37.106	0.344	Open Manhole	1200
4.003	14.190	100.0	15	38.280	36.964	1.166	Open Manhole	1200
4.004	10.352	100.0	16	38.320	36.861	1.309	Open Manhole	1200

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Caversham Bridge House Waterman Place Reading RG1 8DN	Dukesbridge House Reading Pr Surface Water Drainage	
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XP Solutions	Network 2020.1	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.003	o	300	16	38.320	36.710	1.310	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.003	7.042	238.0		38.300	36.680	1.320	Open Manhole	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1
Number of Input Hydrographs	0	Number of Storage Structures	3
Number of Online Controls	3	Number of Time/Area Diagrams	3
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.000	Storm Duration (mins)	30
Ratio R	0.400		

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Online Controls for Storm

Orifice Manhole: 3, DS/PN: 2.001, Volume (m³): 0.1

Diameter (m) 0.043 Discharge Coefficient 0.600 Invert Level (m) 61.750

Orifice Manhole: 8, DS/PN: 3.001, Volume (m³): 0.1

Diameter (m) 0.043 Discharge Coefficient 0.600 Invert Level (m) 61.750

Orifice Manhole: 12, DS/PN: 4.001, Volume (m³): 0.2

Diameter (m) 0.043 Discharge Coefficient 0.600 Invert Level (m) 61.750

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Storage Structures for Storm

Cellular Storage Manhole: 3, DS/PN: 2.001

Invert Level (m) 61.750 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	353.0	165.0	0.086	0.0	170.3
0.085	353.0	170.3			

Cellular Storage Manhole: 8, DS/PN: 3.001

Invert Level (m) 61.750 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	353.0	165.0	0.086	0.0	170.3
0.085	353.0	170.3			

Cellular Storage Manhole: 12, DS/PN: 4.001

Invert Level (m) 61.750 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	354.0	165.0	0.086	0.0	170.3
0.085	354.0	170.3			

Time Area Diagram for Green Roof at Pipe Number 2.000 (Storm)

Area (m³) 353 Evaporation (mm/day) 3
Depression Storage (mm) 5 Decay Coefficient 0.050

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To: (ha)		From: To: (ha)		From: To: (ha)		From: To: (ha)	
0 4 0.006415		32 36 0.001295		64 68 0.000261		96 100 0.000053	
4 8 0.005252		36 40 0.001060		68 72 0.000214		100 104 0.000043	
8 12 0.004300		40 44 0.000868		72 76 0.000175		104 108 0.000035	
12 16 0.003520		44 48 0.000711		76 80 0.000144		108 112 0.000029	
16 20 0.002882		48 52 0.000582		80 84 0.000117		112 116 0.000024	
20 24 0.002360		52 56 0.000476		84 88 0.000096		116 120 0.000019	
24 28 0.001932		56 60 0.000390		88 92 0.000079			
28 32 0.001582		60 64 0.000319		92 96 0.000064			

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Time Area Diagram for Green Roof at Pipe Number 3.000 (Storm)

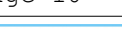
Area (m³) 353 Evaporation (mm/day) 3
Depression Storage (mm) 5 Decay Coefficient 0.050

Time (mins) From:	Time (mins) To:	Area (ha)	Time (mins) From:	Time (mins) To:	Area (ha)	Time (mins) From:	Time (mins) To:	Area (ha)	Time (mins) From:	Time (mins) To:	Area (ha)
0	4	0.006415	32	36	0.001295	64	68	0.000261	96	100	0.000053
4	8	0.005252	36	40	0.001060	68	72	0.000214	100	104	0.000043
8	12	0.004300	40	44	0.000868	72	76	0.000175	104	108	0.000035
12	16	0.003520	44	48	0.000711	76	80	0.000144	108	112	0.000029
16	20	0.002882	48	52	0.000582	80	84	0.000117	112	116	0.000024
20	24	0.002360	52	56	0.000476	84	88	0.000096	116	120	0.000019
24	28	0.001932	56	60	0.000390	88	92	0.000079			
28	32	0.001582	60	64	0.000319	92	96	0.000064			

Time Area Diagram for Green Roof at Pipe Number 4.000 (Storm)

Area (m³) 354 Evaporation (mm/day) 3
Depression Storage (mm) 5 Decay Coefficient 0.050

Time (mins) From:	Time (mins) To:	Area (ha)	Time (mins) From:	Time (mins) To:	Area (ha)	Time (mins) From:	Time (mins) To:	Area (ha)	Time (mins) From:	Time (mins) To:	Area (ha)
0	4	0.006433	32	36	0.001299	64	68	0.000262	96	100	0.000053
4	8	0.005267	36	40	0.001063	68	72	0.000215	100	104	0.000043
8	12	0.004312	40	44	0.000871	72	76	0.000176	104	108	0.000035
12	16	0.003530	44	48	0.000713	76	80	0.000144	108	112	0.000029
16	20	0.002890	48	52	0.000584	80	84	0.000118	112	116	0.000024
20	24	0.002367	52	56	0.000478	84	88	0.000096	116	120	0.000019
24	28	0.001938	56	60	0.000391	88	92	0.000079			
28	32	0.001586	60	64	0.000320	92	96	0.000065			

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

Simulation Criteria

Number of Input Hydrographs	0	Number of Storage Structures	3
Number of Online Controls	3	Number of Time/Area Diagrams	3
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

```
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)	1, 30, 100
Climate Change (%)	0, 0, 0

									Water
	US/MH		Return	Climate	First (X)	First (Y)	First (Z)	Overflow	Level
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Act.	(m)
1.000	1	15 Winter	1	+0%					37.071
2.000	2	120 Winter	1	+0%					61.833
2.001	3	1440 Winter	1	+0%					61.761
2.002	4	1440 Winter	1	+0%					37.114
2.003	5	15 Winter	1	+0%					37.044
1.001	6	15 Winter	1	+0%	100/15 Winter				37.010
3.000	7	120 Winter	1	+0%					61.833
3.001	8	1440 Winter	1	+0%					61.761
3.002	9	1440 Winter	1	+0%					36.948
1.002	10	15 Winter	1	+0%	100/15 Summer				36.930
4.000	11	120 Winter	1	+0%					61.836
4.001	12	1440 Winter	1	+0%					61.761
4.002	13	1440 Winter	1	+0%					37.132
4.003	14	1440 Winter	1	+0%					37.108
4.004	15	1440 Winter	1	+0%					36.966
1.003	16	15 Winter	1	+0%					36.809

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1)
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PN	US/MH Name	Surcharged Flooded		Flow / Overflow		Half Drain	Pipe	Status	Level Exceeded
		Depth (m)	Volume (m ³)	Cap.	(l/s)	Time (mins)	Flow (l/s)		
1.000	1	-0.177	0.000	0.10			3.5	OK	
2.000	2	-0.117	0.000	0.11			1.0	OK	
2.001	3	-0.139	0.000	0.00		1776	0.0	OK*	
2.002	4	-0.148	0.000	0.00			0.0	OK*	
2.003	5	-0.179	0.000	0.09			3.0	OK	
1.001	6	-0.147	0.000	0.26			9.4	OK	
3.000	7	-0.117	0.000	0.11			1.0	OK	
3.001	8	-0.139	0.000	0.00		1776	0.0	OK*	
3.002	9	-0.148	0.000	0.00			0.0	OK*	
1.002	10	-0.125	0.000	0.41			12.2	OK	
4.000	11	-0.114	0.000	0.14			1.0	OK	
4.001	12	-0.139	0.000	0.00		1776	0.0	OK*	
4.002	13	-0.147	0.000	0.00			0.0	OK*	
4.003	14	-0.148	0.000	0.00			0.0	OK	
4.004	15	-0.148	0.000	0.00			0.0	OK	
1.003	16	-0.201	0.000	0.24			12.2	OK	

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

Simulation Criteria

Areal Reduction Factor 1.000

Additional Flow - % of Total Flow 0.000

Hot Start (mins) 0

MADD Factor * 10m³/ha Storage 2.000

Hot Start Level (mm) 0

Inlet 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 Storage Structures 3

Number of Online Controls 3

Number of Time/Area Diagrams 3

Number of Offline Controls 0

Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR

Ratio R 0.400

Region England and Wales Cv (Summer) 0.750

M5-60 (mm) 17.000 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) 1, 30, 100

Climate Change (%) 0, 0, 0

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	30	+0%					37.118
2.000	2	30 Winter	30	+0%					61.861
2.001	3	960 Winter	30	+0%					61.776
2.002	4	960 Winter	30	+0%					37.124
2.003	5	15 Winter	30	+0%					37.112
1.001	6	15 Winter	30	+0%	100/15 Winter				37.101
3.000	7	30 Winter	30	+0%					61.860
3.001	8	960 Winter	30	+0%					61.776
3.002	9	15 Winter	30	+0%					37.055
1.002	10	15 Winter	30	+0%	100/15 Summer				37.055
4.000	11	60 Winter	30	+0%					61.867
4.001	12	960 Winter	30	+0%					61.776
4.002	13	960 Winter	30	+0%					37.143
4.003	14	960 Winter	30	+0%					37.115
4.004	15	960 Winter	30	+0%					36.974
1.003	16	15 Winter	30	+0%					36.878

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

PN	US/MH Name	Surcharged Flooded		Flow / Overflow		Half Drain	Pipe	Status	Level Exceeded
		Depth (m)	Volume (m³)	Cap.	(l/s)	Time (mins)	Flow (l/s)		
1.000	1	-0.130	0.000	0.23			8.3	OK	
2.000	2	-0.089	0.000	0.34			2.9	OK	
2.001	3	-0.124	0.000	0.00		880	0.2	OK*	
2.002	4	-0.138	0.000	0.02			0.2	OK*	
2.003	5	-0.111	0.000	0.26			8.7	OK	
1.001	6	-0.056	0.000	0.66			23.7	OK	
3.000	7	-0.090	0.000	0.34			2.9	OK	
3.001	8	-0.124	0.000	0.00		880	0.2	OK*	
3.002	9	-0.041	0.000	0.05			0.7	OK*	
1.002	10	0.000	0.000	1.01			30.3	OK	
4.000	11	-0.083	0.000	0.41			2.9	OK	
4.001	12	-0.124	0.000	0.00		880	0.2	OK*	
4.002	13	-0.136	0.000	0.02			0.2	OK*	
4.003	14	-0.141	0.000	0.01			0.2	OK	
4.004	15	-0.141	0.000	0.01			0.2	OK	
1.003	16	-0.132	0.000	0.59			30.5	OK	

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	3
Number of Online Controls	3	Number of Time/Area Diagrams	3
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.400
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	17.000	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)	1, 30, 100
Climate Change (%)	0, 0, 0

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	100	+0%					37.178
2.000	2	30 Winter	100	+0%					61.873
2.001	3	480 Winter	100	+0%					61.784
2.002	4	15 Winter	100	+0%					37.164
2.003	5	15 Winter	100	+0%					37.174
1.001	6	15 Winter	100	+0%	100/15 Winter				37.159
3.000	7	30 Winter	100	+0%					61.872
3.001	8	480 Winter	100	+0%					61.784
3.002	9	15 Winter	100	+0%					37.083
1.002	10	15 Winter	100	+0%	100/15 Summer				37.084
4.000	11	30 Winter	100	+0%					61.880
4.001	12	480 Winter	100	+0%					61.784
4.002	13	480 Winter	100	+0%					37.146
4.003	14	480 Winter	100	+0%					37.119
4.004	15	480 Winter	100	+0%					36.978
1.003	16	15 Winter	100	+0%					36.911

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

PN	US/MH Name	Surcharged Flooded		Flow / Overflow		Half Drain	Pipe	Status	Level Exceeded
		Depth (m)	Volume (m³)	Cap.	(l/s)	Time (mins)	Flow (l/s)		
1.000	1	-0.070	0.000	0.30			10.6	OK	
2.000	2	-0.077	0.000	0.47			4.0	OK	
2.001	3	-0.116	0.000	0.00			0.3	OK*	
2.002	4	-0.098	0.000	0.03			0.4	OK*	
2.003	5	-0.049	0.000	0.30			10.2	OK	
1.001	6	0.002	0.000	0.85			30.6	SURCHARGED	
3.000	7	-0.078	0.000	0.46			4.0	OK	
3.001	8	-0.116	0.000	0.00			0.3	OK*	
3.002	9	-0.013	0.000	0.06			0.8	OK*	
1.002	10	0.029	0.000	1.36			40.7	SURCHARGED	
4.000	11	-0.070	0.000	0.56			4.0	OK	
4.001	12	-0.116	0.000	0.00			0.3	OK*	
4.002	13	-0.133	0.000	0.03			0.3	OK*	
4.003	14	-0.137	0.000	0.02			0.3	OK	
4.004	15	-0.136	0.000	0.02			0.3	OK	
1.003	16	-0.099	0.000	0.77			40.3	OK	

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m ³ /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 Storage Structures	3
Number of Online Controls	3	Number of Time/Area Diagrams	3
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.400
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	17.000	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)

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	15 Winter	100	+40%	100/15 Summer				37.333
2.000	2	30 Winter	100	+40%					61.890
2.001	3	480 Winter	100	+40%					61.797
2.002	4	15 Summer	100	+40%					37.262
2.003	5	15 Winter	100	+40%	100/15 Summer				37.326
1.001	6	15 Winter	100	+40%	100/15 Summer				37.306
3.000	7	30 Winter	100	+40%					61.889
3.001	8	480 Winter	100	+40%					61.797
3.002	9	15 Summer	100	+40%					37.096
1.002	10	15 Winter	100	+40%	100/15 Summer				37.167
4.000	11	30 Winter	100	+40%					61.901
4.001	12	480 Winter	100	+40%					61.797
4.002	13	480 Winter	100	+40%					37.150
4.003	14	480 Winter	100	+40%					37.123
4.004	15	15 Winter	100	+40%					36.985
1.003	16	15 Winter	100	+40%					37.010

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

PN	US/MH Name	Surcharged	Flooded	Flow / Cap.	Overflow (l/s)	Half Drain	Pipe	Status	Level Exceeded
		Depth (m)	Volume (m³)			Time (mins)	Flow (l/s)		
1.000	1	0.085	0.000	0.41			14.4	SURCHARGED	
2.000	2	-0.060	0.000	0.67			5.7	OK	
2.001	3	-0.103	0.000	0.00		520	0.5	OK*	
2.002	4	0.000	0.000	0.11			1.3	SURCHARGED*	
2.003	5	0.103	0.000	0.40			13.6	FLOOD RISK	
1.001	6	0.149	0.000	1.16			41.7	SURCHARGED	
3.000	7	-0.061	0.000	0.65			5.7	OK	
3.001	8	-0.103	0.000	0.00		520	0.5	OK*	
3.002	9	0.000	0.000	0.07			0.9	SURCHARGED*	
1.002	10	0.112	0.000	1.86			55.5	SURCHARGED	
4.000	11	-0.049	0.000	0.79			5.7	FLOOD RISK	
4.001	12	-0.103	0.000	0.00		520	0.5	OK*	
4.002	13	-0.129	0.000	0.05			0.5	OK*	
4.003	14	-0.133	0.000	0.03			0.5	OK	
4.004	15	-0.129	0.000	0.02			0.3	OK	
1.003	16	0.000	0.000	1.03			53.7	OK	