Outline SuDS Strategy

in connection with proposed development at

No. 39 Fitzjohn's Avenue
Camden
London
NW3 5JY

for

Godfrey London

LBH4498suds Ver 1.1

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DOCUMENT CONTROL

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GENERAL

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1. Introduction

It is proposed to re-build a large Victorian property at No. 39 Fitzjohn's Avenue, which will include the construction of a basement beneath the full extent of the building that will also extend into the rear garden.

1.1 Brief

LBH WEMBLEY have been commissioned by Godfrey London to prepare an outline SuDS strategy to be submitted to London Borough of Camden, in support of a planning application (2018/2415/P) for the proposed development.

This report supersedes the SuDS assessment produced in the appendix 7 of the revised RWA BIA.

1.2 Guidance

The London Borough of Camden Planning Guidance for Sustainability (July 2015, updated March 2018) states:

"*All developments are expected to manage drainage and surface water on-site or as close to the site as possible, using Sustainable Drainage Systems (SUDS) and the hierarchy set out below.*

The Council will expect plans and application documents to describe how water will be managed within the development, including an explanation of the proposed SUDS, the reasons why certain SUDS have been ruled out and detailed information on materials and landscaping.

The Council will expect developments to achieve a greenfield surface water run-off rate once SUDS have been installed. As a minimum, surface water run-off rates should be reduced by 50% across the development."

A surface water drainage strategy for this site is therefore required to incorporate SuDS principles as laid out in the Non-Statutory Technical Standards[1] for Sustainable Drainage Systems and the London Plan[2].

SuDS 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.

The aim is to discharge surface run off 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.

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[1] DEFRA March 2015 Non-Statutory Technical Standards (NSTS) for sustainable drainage systems
[2] London Plan Chapter Five - London's Responses to Climate Change Policy 5.1.3 Sustainable Drainage

1.3 Report Structure

This report describes the site characteristics, following which consideration is given to the feasibility of SuDS techniques for this site. Finally, the recommended SuDS strategy to mitigate the risk of flooding across the site is presented in accordance with the 2015 CIRIA C753 SuDS Manual.

2. The Site

2.1 Site Location

The site is situated on the corner of Fitzjohn's Avenue and Nutley Terrace side of Kentish Town Road, approximately 400m to the northeast of Finchley Road underground station.

The site may be located approximately by postcode NW3 5JY or by National Grid Reference 526510, 185000.

2.2 Topographical Setting

The area lies on a gentle southern slopes of Hampstead Hill falling towards the headwaters of the River Tyburn which are located approximately a short distance from the site. The area is this naturally sloping ground that has been terraced.

2.3 Site Description

The site is occupied by a large three storey Victorian house

Owing to the relative drop in ground level between the north and south of the site, the lower ground floor opens out onto Nutley Terrace that borders the south of the site.

There are two 1950s extensions to the property; a three storey northern wing, which is connected to the Victorian building by a three storey link corridor and a three storey wing that adjoins to the west.

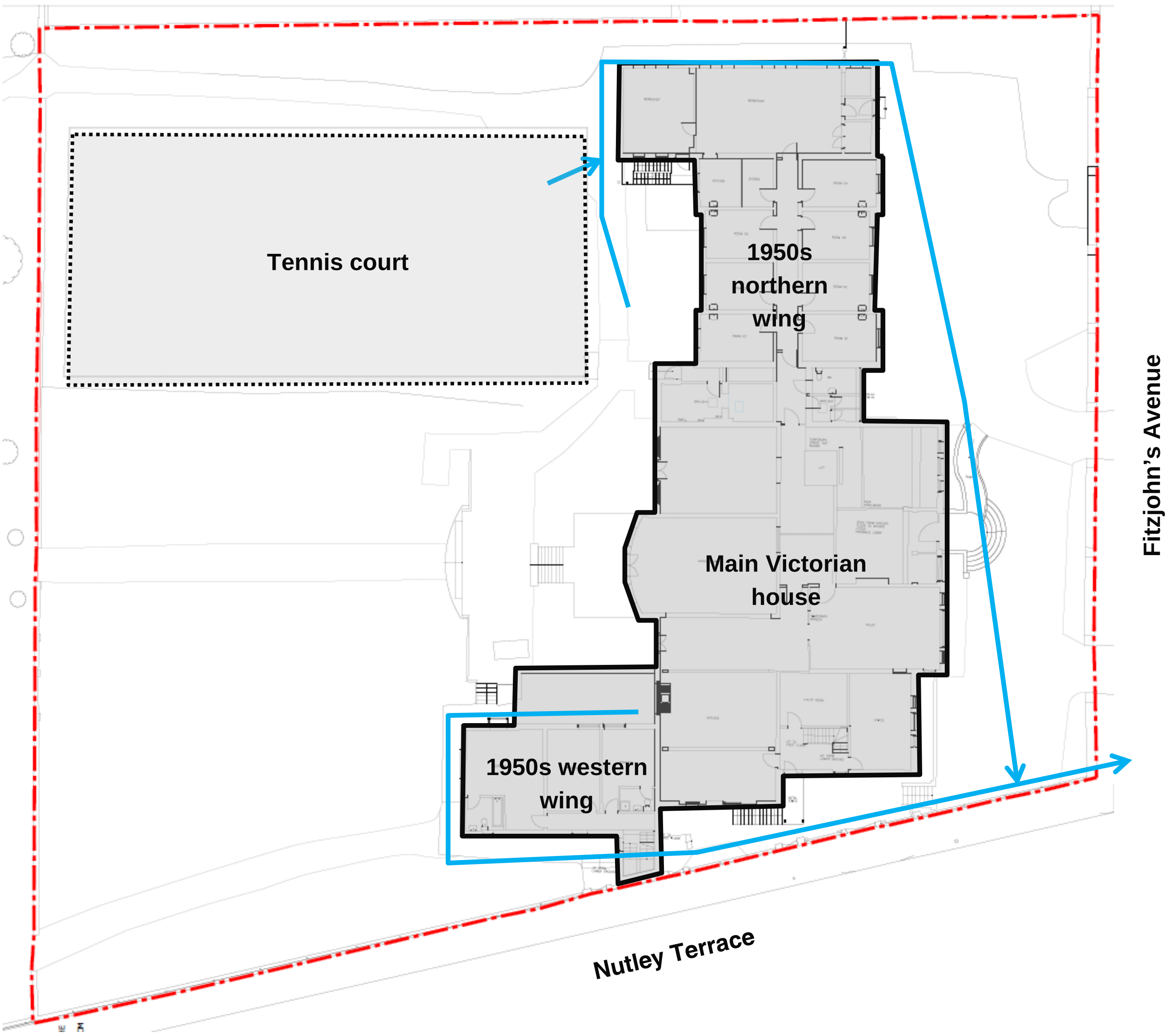
Main Victorian house (left) and northern wing extension (right)

Rear garden showing rear elevation of Victorian house

A large garden is situated to the rear of the Victorian house and gently slopes from approximately +78m OD in the north, to approximately +75m in the south.

A tennis court is situated in the northern half of the garden to the rear of the northern wing and is situated at around +77m OD.

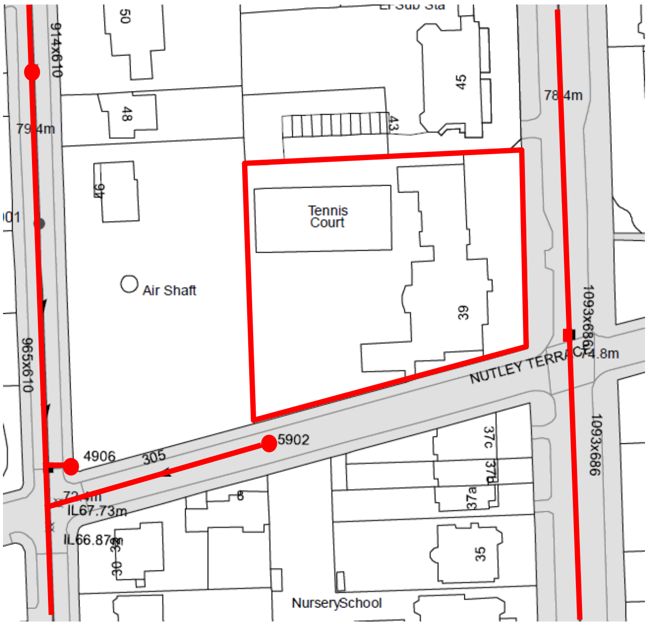
Rear garden (taken from northern wing extension)



Existing plan showing approximate line of drains

2.4 Site Characteristics

Thames Water public sewer records show that the site is served by a combined sewer with local dimensions of 1093mm x 686mm that falls southwards beneath Fitzjohn's Avenue



Rainfall incident on the roof hard standings and tennis court is collected and directed into the combined sewer that runs beneath Fitzjohn's Avenue.

2.5 Ground Conditions

A ground investigation has shown that, beneath shallow made ground, the site is directly underlain by the London Clay Formation.

No shallow groundwater table is present beneath this site.

3. Proposed Development

It is proposed to replace the existing Victorian property with a new four storey building with a basement. The front and side facades to the building will be retained and restored.

The new building will extend into the present rear garden with the new basement opening out onto a basement level patio that link to the remaining rear garden by means of some stepped planting.

As part of the proposed development, the existing western wing and the ink corridor to the northern wing will be removed. The northern wing will be retained as a separate building and extended rearwards.

Although the new building area is greater than the existing, the proposed development will result in a net increase in garden area as a result of removal of the existing tarmac tennis court.

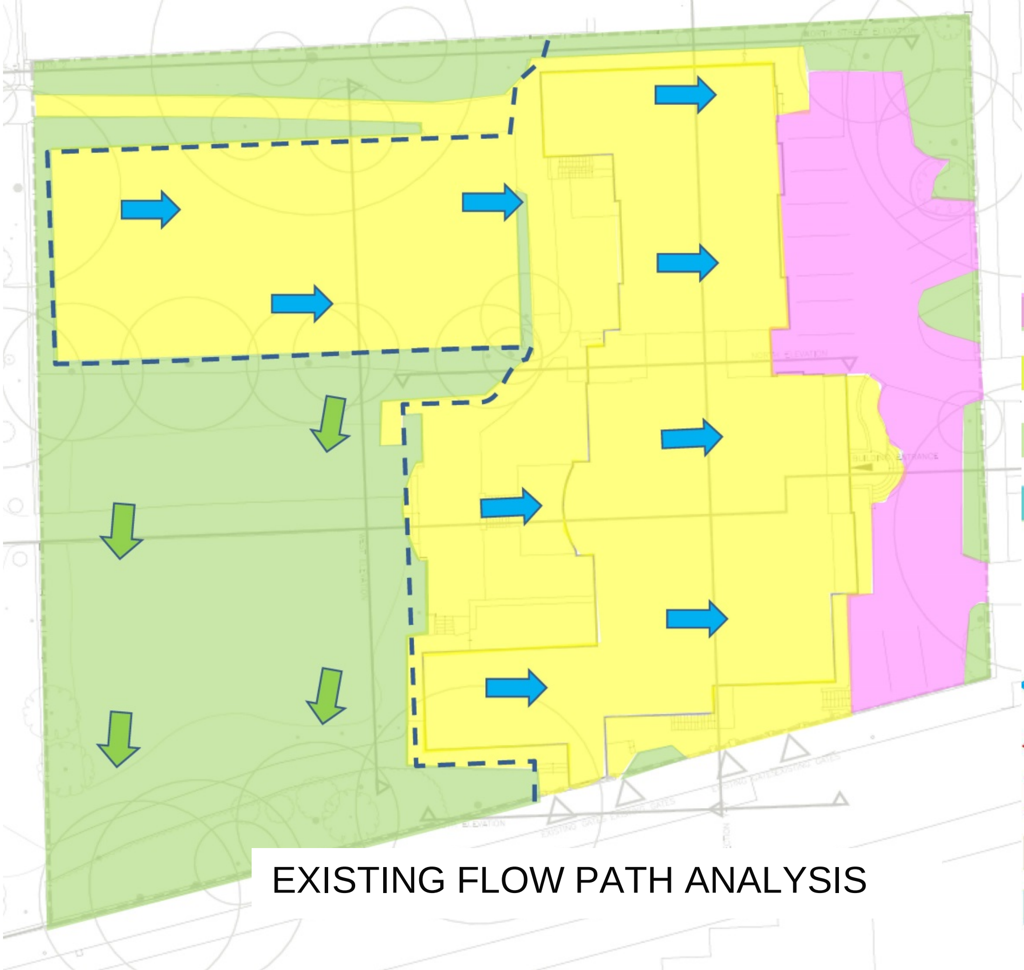
Schedule of estimated approximate areas for outline SuDS assessment

	Existing	Cv	%	%	Proposed	Cv	%	%
Garden	1,215 m^2	0.40	34	34	1,330 m^2	0.40	37	37
Building	830 m^2	0.77	23	66	1,000 m^2	.77	28	63
Impermeable	1,555 m^2	0.77	43		865 m^2	.77	24	
Basement Terrace					405 m^2	.77	11	
Total:	3,600 m^2		100	33	3,600 m^2		100	100

It is envisaged that the new garden area will be provided with two sunken features that will act as swales, approximately 170 m^2 and 80 m^2 in area and that these will discharge via a flow control orifice to the combined sewer in Nutley Terrace.

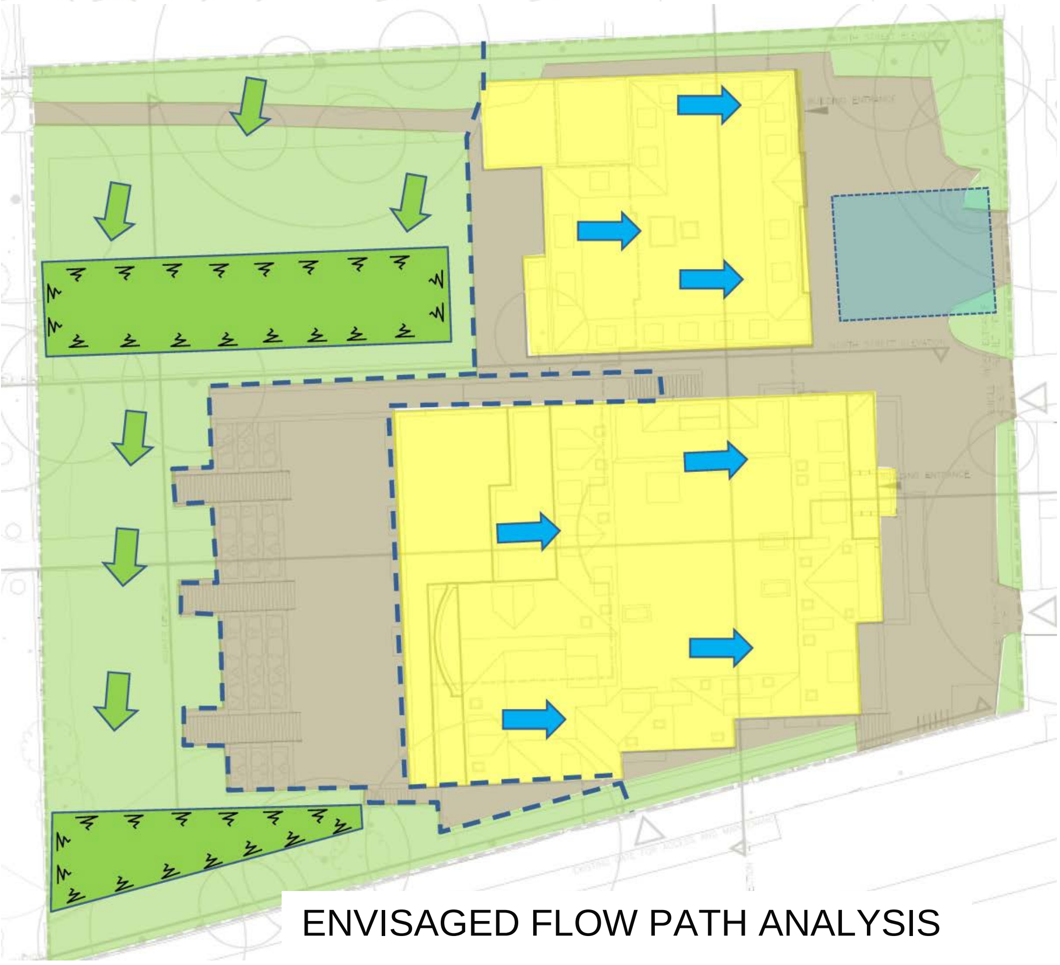
The new basement terrace will need to drain to a sump, from where water will be pumped up to an either a pond feature in the rear garden or to an attenuation tank situated beneath the front parking area. It has been assumed that terrace can be constructed with pervious paving over a porous substrate that will provide additional attenuation storage.

The remainder of the new development will drain to one or more attenuation tanks situated in the front parking area. The drainage from the parking area itself will be routed through petroleum interceptors, but will again use a system of pervious paving and a porous substrate to provide additional attenuation storage.



KEY:

- Impermeable Driveway
- Building & Impermeable
- Garden
- (not used)
- Flow Path (impermeable)
- Flow Path (permeable)
- Pipe (Indicative)
- Combined Sewer
- Sunken Garden /Swale
- Pervious Paving
- Attenuation Tank



4. Surface Water Management (SWM)

4.1 SWM objectives for the development

The drainage strategy follows the guidance set out in the 2015 CIRIA C753 SuDS Manual; the principle of SUDS design is that surface water runoff is managed for maximum benefit.

The types of benefits that may be achieved by utilising SUDS are categorised by the design objectives outlined in the following section.

4.1.1 Water Quantity Objective

The design objective is to control the quantity of runoff to support the management of flood risk and maintain and protect the natural water cycle.

In order to ensure that the surface water runoff from a developed site does not have a detrimental impact on people, property and the environment, it is important to control the rate and volume of the discharge from the site.

Sustainable Drainage Systems (SuDS) are to be incorporated into the design of a development. In aiming to achieve greenfield runoff rates, surface water runoff should be managed using the following techniques, as outlined in order of priority by the following drainage hierarchy:

SUDS Drainage Hierarchy	Suitable for the site? (Y/N)	Comment
Store rainwater for later use	Y	There is an opportunity to harvest rainwater.
Use infiltration techniques	N	The site is directly underlain by the London Clay, inhibiting infiltration on the site.
Attenuate rainwater in ponds or open water features for gradual release	Y	A dry swale could be considered to provide attenuation storage, although there is limited space within the rear garden. There is limited opportunity for green roofs on the rear extensions to the proposed building and existing northern wing.
Attenuate rainwater by storing in tanks or sealed water features for gradual release	Y	Attenuation storage could be provided by the provision of a high porosity drainage layer beneath the new basement courtyard area. Attenuation tanks could also be provided beneath the basement courtyard or front driveway.
Discharge rainwater direct to a watercourse	N	There is no available watercourse.
Discharge rainwater to a surface water sewer/drain	N	There is no surface water sewer serving the site.
Discharge rainwater to the combined sewer	Y	It is proposed that the new drainage system should ultimately include a discharge to the existing combined sewer serving the site.

The hierarchy above seeks to ensure that surface water runoff is controlled as near to its source as possible to mimic natural drainage systems and retain water on or near to the site.

Before disposal of surface water to the public sewer is considered, all other options set out in the above hierarchy need to be exhausted.

4.1.2 Water Quality

The water quality design objective is to manage the quality of runoff to prevent pollution, supporting the management of water quality in the receiving surface waters and groundwater and design system resilience to cope with future change.

Given that the surface water runoff from the roof and rear garden is not expected to pick up any contamination. Treatment, in the form of petrol interceptors, is envisaged only for the front vehicle parking area.

4.1.3 Amenity

The amenity design objective is to create and sustain better places for people by implementing the following criteria for the site:

- Maximise multi-functionality
- Enhance visual character
- Deliver safe surface water management systems
- Support development resilience/adaptability to future change
- Maximise legibility
- Support community environmental learning

There are opportunities to provide one or more water features such as a swale, pond, rain garden or green roof as part of the development.

4.1.4 Biodiversity

The biodiversity design objective is to create and sustain better places for nature by implementing the following criteria for the site:

- Support and protect natural local habitats and species
- Contribute to the delivery of local biodiversity objectives
- Contribute to habitat connectivity
- Create diverse, self-sustaining and resilient ecosystems

There are opportunities to provide one or more water features such as a swale, pond, rain garden or green roof as part of the development.

5. SUDS Discussion

In line with Policy 5.13 of the London Plan, developments should provide betterment to the risk of surface water runoff by aiming to attenuate surface water on site through the use of SuDS.

An analysis has been undertaken of the pre- and post- development surface water run-off rates and volumes over a range of storm intensities and durations.

The strategy will be to provide source control through infiltration and attenuation so that post development run-off rates are reduced as much as is practical in order to adhere to the guidance.

The following sections set out the presently envisaged proposals for drainage components.

5.1 Feasible Discharge Routes

It is envisaged that rainfall incident on the roofs to the new house and existing northern wing will be directed to attenuation provided by green roofs.

Surface water finding its way to the basement courtyard will be attenuated by pervious paving.

5.2 Feasible Drainage Components

SUDS Component	Description	Suitable for the site? (Y/N)	Comment
Rainwater harvesting	Collection of rainwater runoff from roofs or impermeable areas for reuse.	Y	There may not be sufficient space to achieve a gravity system.
Green roofs	Vegetated areas installed on the top of buildings provide visual and ecological benefits in addition to surface water runoff reduction and enhanced building performance.	N	There is insufficient scope for green roofs.
Blue roofs	Roof design intended to store water providing attenuation storage.	Y	There may be some scope to design the residential terraces as blue roofs.
Infiltration systems	Infiltration can contribute to reducing runoff rates and volumes while supporting base flow and groundwater recharge processes.	N	Infiltration is not possible into the London Clay Formation.
Proprietary treatment systems	Proprietary treatment systems are manufactured products which remove specified pollutants from surface water runoff.	N	Not required.
Filter strips/drains	Filter strips are gently sloping strips of grass that provide treatment of runoff from adjacent impermeable areas. Filter drains are gravel or	N	Not required.

	stone filled trenches which provide temporary subsurface storage for attenuation conveyance and filtration of surface water runoff.		
Swales	Swales are shallow, flat bottomed, vegetated open channels designed to convey, treat, and attenuate surface water runoff.	Y	Sunken garden features are proposed as a means of achieving open storage
Bioretention systems	Rain gardens or shallow landscaped depressions that may reduce surface water runoff rates and volumes and/or treat pollution using engineered soils and vegetation.	N	A small scale feature could be considered but is not required.
Trees	Trees aid surface water management through transpiration, inception, infiltration and phytoremediation.	N	No new tree planting is proposed.
Pervious Pavements	Pervious pavements facilitate the infiltration of surface water into a subsurface structure where filtration, adsorption, biodegradation or sedimentation may also provide treatment of the runoff.	Y	Pervious pavements are feasible in the basement courtyard area. It is envisaged that the underlying drainage layer would include collector pipes leading through silt traps to the combined sewer
Attenuation storage tanks	Attenuation storage tanks provide below-ground void space for the temporary storage of surface water before infiltration, controlled release or use.	Y	Attenuation storage tanks are also feasible below the basement courtyard area (and front driveway). These would be connected to the combined sewer.
Detention basins	Attenuation storage in the form of dry landscaped depressions.	Y	A basin feature could be considered as an alternative to a dry swale
Ponds and wetlands	Permanent water filled ponds or wetlands that provide attenuation storage or treatment of surface water runoff.	N	A small scale feature could be considered but is not required.

5.3 Water Quantity

It is anticipated the use of pervious paving will reduce runoff rates and volumes by providing a potential storage capacity in the form of a porous sub-base drainage layer or attenuation storage tanks.

5.4 Water Quality

There is no expectation that any treatment will be necessary to meet the appropriate water quality requirements for the method of discharge.

5.5 Amenity

Any above ground SuDS features can be designed in an aesthetically pleasing manner, providing valuable amenity in an urban area.

5.6 Biodiversity

Any above ground SuDS features can be designed to make a positive contribution to biodiversity – providing habitat and food for insects, invertebrates and birds.

Green roofs would act as a "stepping stone" or "island habitat" providing ecological value in an urban area.

5.7 Maintenance

Suds Component	Maintenance	
Attenuation storage Tanks	Regular	• Inspect and identify any areas that are not operating correctly. If required, take remedial action • Remove sediment from silt traps (Annually) • Repair inlets, outlet overflows and vents as necessary
	Monitoring	• Inspect 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)
Pervious Paving	Regular	• Brush and clear sand joints of any vegetation or moss. • Remove sediment from silt traps (Annually)
	Monitoring	• Initial inspection (monthly for three months after installation). • Inspect for evidence of poor operation and/or weed growth – if required, take remedial action. • Monitor inspection chambers (annually).
Open Storage	Regular	• Inspect all components for proper operation. • Inspect and check outfall flow controls. • Inspect drain inlets and outlets to ensure proper flow

6. Initial Design Considerations

Calculation sheets are appended. The initial design analysis may be summarised as follows.

6.1 Greenfield runoff rate

The Greenfield runoff rates from the site have been calculated using the UK SuDS online tool and the Institute of Hydrology (IoH) 124 methodology.

6.2 Existing runoff rate

The site boundary encloses an area of 0.36 ha and consists of a combination of permeable (34%) and impermeable (66%) surfacing. There are considered to be no present SuDS features.

The existing peak storm runoff for the 1% (1 in 100 year) annual probability rainfall event on the site was estimated to be 137 l/sec. The calculation was based on the Wallingford Procedure and the resulting runoff was calculated using the Modified Rational Method with an M5-60 of 20mm, an 'r' value of 0.42 and a critical rainfall intensity of 163.2 mm/hr.

The rainfall runoff volume for the 1% (1 in 100 year) annual probability, 6 hour duration storm from the existing site is estimated to be 191 m^3.

6.3 Proposed Discharge Rate

The proposed development will result in a 3% reduction in the amount of impermeable surfacing.

In line with the guidance it is proposed to limit the peak storm runoff for the 1% (1 in 100) annual probability rainfall event plus 40% allowance for future climate change to at least 50% of the current rate.

6.4 Attenuation storage

It is concluded that sufficient attenuation storage can be achieved through a combination of open (swale) features in the gardens combines with tanks and porous substrate to previous paving.

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7. Conclusion

It has been demonstrated that there are opportunities to introduce various SuDS type features as part of the proposed development and that a combination of storage features can be used to provide sufficient protection against the risk of future overloading of the sewer system, taking into account potential climate change.

APPENDIX

INITIAL SUDS ASSESSMENT CALCULATIONS

Surface Water Drainage Pro-forma for new developments

LBH 4498

1. Site Details

Site	39 Fitzjohn's Avenue
Address & post code or LPA reference	NW3 5JY
Grid reference	526510, 185000
Is the existing site developed or Greenfield?	Developed
Is the development in a LFRZ or in an area known to be at risk of surface or ground water flooding? If yes, please demonstrate how this is managed, in line with DP23?	No
Total Site Area served by drainage system (excluding open space) (Ha)*	0.36

* The Greenfield runoff off rate from the development which is to be used for assessing the requirements for limiting discharge flow rates and attenuation storage from a site should be calculated for the area that forms the drainage network for the site whatever size of site and type of drainage technique. Please refer to the Rainfall Runoff Management document or CIRIA manual for detail on this.

2. Impermeable Area

	Existing	Proposed	Difference (Proposed-Existing)	Notes for developers
Impermeable area (ha)	0.24	0.23	-0.01	If the proposed amount of impermeable surface is greater, then runoff rates and volumes will increase. Section 6 must be filled in. If proposed impermeability is equal or less than existing, then section 6 can be skipped and section 7 filled in.
Drainage Method (infiltration/sewer/watercourse)		Combined Sewer	N/A	If different from the existing, please fill in section 3. If existing drainage is by infiltration and the proposed is not, discharge volumes may increase. Fill in section 6.

3. Proposing to Discharge Surface Water via

	Yes	No	Evidence that this is possible	Notes for developers
Existing and proposed Drainage calculations	Yes		HR Wallingford	Please provide calculations of existing and proposed run-off rates and volumes in accordance with a recognised methodology or the results of a full infiltration test (see line below) if infiltration is proposed.
Infiltration		No	Infiltration will not be possible as the site is directly underlain by impermeable London Clay.	e.g. soakage tests. Section 6 (infiltration) must be filled in if infiltration is proposed.
To watercourse		No	There is no nearby watercourse.	e.g. Is there a watercourse nearby?
To surface water sewer		No	There is no nearby surface water sewer	Confirmation from sewer provider that sufficient capacity exists for this connection.
Combination of above		No	See above - Not possible.	e.g. part infiltration part discharge to sewer or watercourse. Provide evidence above.
Has the drainage proposal had regard to the SuDS hierarchy?	Yes		HR Wallingford	Evidence must be provided to demonstrate that the proposed Sustainable Drainage strategy has had regard to the SuDS hierarchy as outlined in Section 2.5 above.
Layout plan showing where the sustainable drainage infrastructure will be located on site.	Yes		See SUDS Layout Plan	Please provide plan reference numbers showing the details of the site layout showing where the sustainable drainage infrastructure will be located on the site. If the development is to be constructed in phases this should be shown on a separate plan and confirmation should be provided that the sustainable drainage proposal for each phase can be constructed and can operate independently and is not reliant on any later phase of development.

4. Peak Discharge Rates – This is the maximum flow rate at which storm water runoff leaves the site during a particular storm event.

	Existing Rates (l/s) (from Wallingford online tool and Procedure)	Proposed Rates (l/s) (taken as 50% Existing)	Difference (l/s) (Proposed - Existing)	% Difference (Difference / existing x 100)	Notes for developers
Greenfield QBAR	1.64	N/A	N/A	N/A	QBAR is approx. 1 in 2 storm event. Provide this if Section 6 (QBAR) is proposed.
1 in 1	47.50	23.75	0.00	-50%	Proposed discharge rates (with mitigation) should aim to be equivalent to greenfield rates for all corresponding storm events. As a minimum, peak discharge rates must be reduced by 50% from the existing sites for all corresponding rainfall events.
1 in 30	109.20	54.6	54.60	-50%	
1in 100	137.00	68.5	68.50	-50%	
1 in 100 plus climate change	N/A	68.5	N/A	N/A	The proposed 1 in 100 +CC peak discharge rate (with mitigation) should aim to be equivalent to greenfield rates. As a minimum, proposed 1 in 100 +CC peak discharge rate must be reduced by 50% from the existing 1 in 100 runoff rate sites.

5. Calculate additional volumes for storage – The total volume of water leaving the development site. New hard surfaces potentially restrict the amount of stormwater that can go to the ground, so this needs to be controlled so not to make flood risk worse to properties downstream.

	Greenfield runoff volume (m^3)	Existing Volume (m^3)	Proposed Volume (m^3)	Difference (m^3) (Proposed-Existing)	Notes for developers
1 in 1	30	66	64	-2	Proposed discharge volumes (with mitigation) should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable and as a minimum should be no greater than existing volumes for all corresponding storm events. Any increase in volume increases flood risk elsewhere. Where volumes are increased section 6 must be filled in.
1 in 30	85	146	143	-3	
1 in 100 6 hour	113	191	187	-4	
1 in 100 6 hour plus climate change	N/A	N/A	262 Unmitigated 190 Mitigated	72	The proposed 1 in 100 +CC discharge volume should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable. As a minimum, to mitigate for climate change the proposed 1 in 100 +CC volume discharge from site must be no greater than the existing 1 in 100 storm event. If not, flood risk increases under climate change.

6. Calculate attenuation storage – Attenuation storage is provided to enable the rate of runoff from the site into the receiving watercourse to be limited to an acceptable rate to protect against erosion and flooding downstream. The attenuation storage volume is a function of the degree of development relative to the greenfield discharge rate.

		Notes for developers
Storage Attenuation volume (Flow rate control) required to meet greenfield run off rates (m^3)	202	Volume of water to attenuate on site if discharging at a greenfield run off rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to reduce rates by 50% (m^3)	72	Volume of water to attenuate on site if discharging at a 50% reduction from existing rates. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to meet [OTHER RUN OFF RATE (as close to greenfield rate as possible] (m^3) . **3 x Greenfield**	148	Volume of water to attenuate on site if discharging at a rate different from the above – please state in 1st column what rate this volume corresponds to. On previously developed sites, runoff rates should not be more than three times the calculated greenfield rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to retain rates as existing (m^3)	51	Volume of water to attenuate on site if discharging at existing rates. Can't be used where discharge volumes are increasing
Percentage of attenuation volume stored above ground,	>50%	Percentage of attenuation volume which will be held above ground in swales/ponds/basins/green roofs etc. If 0, please demonstrate why.

7. How is Storm Water stored on site?

Storage is required for the additional volume from site but also for holding back water to slow down the rate from the site. This is known as attenuation storage and long term storage. The idea is that the additional volume does not get into the watercourses, or if it does it is at an exceptionally low rate. You can either infiltrate the stored water back to ground, or if this isn't possible hold it back with on site storage. Firstly, can infiltration work on site?

			Notes for developers
Infiltration	**State the Site's Geology and known Source Protection Zones (SPZ)**	**London Clay (nil SPZ)**	Avoid infiltrating in made ground. Infiltration rates are highly variable and refer to Environment Agency website to identify and source protection zones (SPZ)
	Are infiltration rates suitable?	**No**	Infiltration rates should be no lower than 1x10 -6 m/s.
	State the distance between a proposed infiltration device base and the ground water (GW) level	**n/a**	Need 1m (min) between the base of the infiltration device & the water table to protect Groundwater quality & ensure GW doesn't enter infiltration devices. Avoid infiltration where this isn't possible.
	Were infiltration rates obtained by desk study or infiltration test?	**n/a**	Infiltration rates can be estimated from desk studies at most stages of the planning system if a back up attenuation scheme is provided..
	Is the site contaminated? If yes, consider advice from others on whether infiltration can happen.	**No**	Advice on contaminated Land in Camden can be found on our supporting documents webpage Water should not be infiltrated through land that is contaminated. The Environment Agency may provide bespoke advice in planning consultations for contaminated sites that should be considered.
In light of the above, is infiltration feasible?	**Yes/No? If the answer is No, please identify how the storm water will be stored prior to release**	**No**	If infiltration is not feasible how will the additional volume be stored?. The applicant should then consider the following options in the next section.

Storage requirements

The developer must confirm that either of the two methods for dealing with the amount of water that needs to be stored on site.

Option 1 Simple – Store both the additional volume and attenuation volume in order to make a final discharge from site at the greenfield run off rate. This is preferred if no infiltration can be made on site. This very simply satisfies the runoff rates and volume criteria.

Option 2 Complex – If some of the additional volume of water can be infiltrated back into the ground, the remainder can be discharged at a very low rate of 2 l/sec/hectare. A combined storage calculation using the partial permissible rate of 2 l/sec/hectare and the attenuation rate used to slow the runoff from site.

		Notes for developers
Please confirm what option has been chosen and how much storage is required on site.	Complex	The developer at this stage should have an idea of the site characteristics and be able to explain what the storage requirements are on site and how it will be achieved.

8. Please confirm

		Notes for developers
Which Drainage Systems measures have been used, including green roofs?	Up to 100 m^3 Storage comprising approximately 50 m^3 Open (Swales) 50 m^3 tanks / porous substrate	SUDS can be adapted for most situations even where infiltration isn't feasible e.g. impermeable liners beneath some SUDS devices allows treatment but not infiltration. See CIRIA SUDS Manual C697.
Drainage system can contain in the 1 in 30 storm event without flooding	YES	This a requirement for sewers for adoption & is good practice even where drainage system is not adopted.
Will the drainage system contain the 1 in 100 +CC storm event? If no please demonstrate how buildings and utility plants will be protected.	YES	National standards require that the drainage system is designed so that 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.
Any flooding between the 1 in 30 & 1 in 100 plus climate change storm events will be safely contained on site.	YES	**Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased.

How will exceedance events be catered on site without increasing flood risks (both on site and outside the development)?	As present	**Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased. Exceedance events are defined as those larger than the 1 in 100 +CC event.
How are rates being restricted (vortex control, orifice etc)	Orifice	Detail of how the flow control systems have been designed to avoid pipe blockages and ease of maintenance should be provided.
Please confirm the owners/adopters of the entire drainage systems throughout the development. Please list all the owners.	TBA	If these are multiple owners then a drawing illustrating exactly what features will be within each owner's remit must be submitted with this Proforma.
How is the entire drainage system to be maintained?	by management	If the features are to be maintained directly by the owners as stated in answer to the above question please answer yes to this question and submit the relevant maintenance schedule for each feature. If it is to be maintained by others than above please give details of each feature and the maintenance schedule. Clear details of the maintenance proposals of all elements of the proposed drainage system must be provided. Details must demonstrate that maintenance and operation requirements are economically proportionate. Poorly maintained drainage can lead to increased flooding problems in the future.

9. Evidence Please identify where the details quoted in the sections above were taken from. i.e. Plans, reports etc. Please also provide relevant drawings that need to accompany your proforma, in particular exceedance routes and ownership and location of SuDS (maintenance access strips etc

Pro-forma Section	Document reference where details quoted above are taken from	Page Number
Section 2	Suds Report	var
Section 3	Suds Report	var
Section 4	Calculation Sheets	var
Section 5	Calculation Sheets	var
Section 6	Calculation Sheets	var
Section 7	Suds Report	var
Section 8	Suds Report	var

The above form should be completed using evidence from the Flood Risk Assessment and site plans. It should serve as a summary sheet of thedrainage proposals and should clearly show that the proposed rate and volume as a result of development will not be increasing. If there is an increase in rate or volume, the rate or volume section should be completed to set out how the additional rate/volume is being dealt with.drainage proposals and should clearly show that the proposed rate and volume as a result of development will not be increasing. If there is an increase in rate or volume, the rate or volume section should be completed to set out how the additional rate/volume is being dealt with.

This form is completed using factual information from the Flood Risk Assessment and Site Plans and can be used as a summary of the surface water drainage strategy on this site.

VERSION	DATE	COMMENT	AUTHORISED
1	19th Dec 2018	Initial Issue	**Seamus Lefroy-Brooks** BSc(hons) MSc CEng MICE CGeol FGS CEnv MIEnvSc FRGS SiLC RoGEP UK Registered Ground Engineering Adviser NQMS SQP DoWCoP QP DEFRA National Expert Panel Member

GREENFIELD RUN-OFF

Catchment Area: 3600sqm 0.360ha

PO Code : NW3 5JY

Hydrological Region: 6 *From Wallingford on-line tool*

SAAR: 650mm *From Wallingford on-line tool*

SOIL type: 4 *From Wallingford on-line tool*

SPR: 0.47 *Derived as follows:*

SOIL	*Sand*	*Clayey Sand*	*Sandy Clay*	*Clay*	*Rock*
	1	*2*	*3*	*4*	*5*
SPR	*0.1*	*0.3*	*0.37*	*0.47*	*0.53*

From Wallingford on-line tool using IH 124 Method

Qbar: 1.64 *Calculated from SPR and SAAR*

Growth curve Factor

0.85
2.30
3.19
3.74

Qbar:	**1.64 l/sec**
Greenfield Peak Run-off Rate:	
1 in 1	**1.39 l/sec**
1 in 30	**3.77 l/sec**
1 in 100	**5.23 l/sec**
1 in 200	**6.13 l/sec**

National Non-Statutory Guidance:
For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

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.

Where reasonably practicable, for greenfield development, 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 should never exceed the greenfield runoff volume for the same event.

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.

RAINFALL PEAK INTENSITY (i)

M5-60 : 20 *From Wallingford Fig A1*
r: 0.42 *From Wallingford Fig A2*

D Duration		Z1	M5-D
5min	5min	0.38	7.6mm
10min	10min	0.55	11.0mm
15min	15min	0.65	13.0mm
30min	30min	0.75	15.0mm
1hr	60min	1.00	20.0mm
2hr	120min	1.20	24.0mm
4hr	240min	1.40	28.0mm
6hr	360min	1.60	32.0mm
10hr	600min	1.70	34.0mm
24hr	1440min	2.20	44.0mm
48hr	2880min	2.50	50.0mm

			Z2								
D Duration		M5-D	M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	7.6mm	0.62	0.79	0.89	0.97	1.02	1.19	1.36	1.43	1.79
10min	10min	11.0mm	0.61	0.79	0.90	0.97	1.03	1.22	1.41	1.49	1.91
15min	15min	13.0mm	0.61	0.79	0.90	0.97	1.03	1.22	1.41	1.49	1.91
30min	30min	15.0mm	0.62	0.81	0.90	0.97	1.03	1.24	1.44	1.53	1.99
1hr	60min	20.0mm	0.64	0.81	0.90	0.97	1.03	1.24	1.45	1.54	2.03
2hr	120min	24.0mm	0.64	0.81	0.90	0.97	1.03	1.24	1.45	1.54	2.03
4hr	240min	28.0mm	0.66	0.82	0.91	0.97	1.03	1.24	1.44	1.53	2.01
6hr	360min	32.0mm	0.68	0.83	0.91	0.97	1.03	1.22	1.42	1.51	1.97
10hr	600min	34.0mm	0.68	0.83	0.91	0.97	1.03	1.22	1.42	1.51	1.97
24hr	1440min	44.0mm	0.70	0.84	0.92	0.97	1.02	1.19	1.38	1.47	1.89
48hr	2880min	50.0mm	0.72	0.85	0.93	0.98	1.02	1.17	1.34	1.42	1.81

			MT-D								
D Duration		M5-D	M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	7.6mm	4.7mm	6.0mm	6.8mm	7.4mm	7.8mm	9.0mm	10.3mm	10.8mm	13.6mm
10min	10min	11.0mm	6.7mm	8.7mm	9.9mm	10.7mm	11.3mm	13.4mm	15.5mm	16.4mm	21.0mm
15min	15min	13.0mm	7.9mm	10.3mm	11.7mm	12.6mm	13.4mm	15.9mm	18.3mm	19.4mm	24.8mm
30min	30min	15.0mm	9.3mm	12.2mm	13.5mm	14.6mm	15.5mm	18.6mm	21.6mm	22.9mm	29.9mm
1hr	60min	20.0mm	12.8mm	16.2mm	18.0mm	19.4mm	20.6mm	24.8mm	29.0mm	30.9mm	40.6mm
2hr	120min	24.0mm	15.4mm	19.4mm	21.6mm	23.3mm	24.7mm	29.8mm	34.8mm	37.0mm	48.7mm
4hr	240min	28.0mm	18.5mm	23.0mm	25.5mm	27.2mm	28.8mm	34.7mm	40.3mm	42.9mm	56.3mm
6hr	360min	32.0mm	21.8mm	26.6mm	29.1mm	31.0mm	33.0mm	39.0mm	45.4mm	48.4mm	63.0mm
10hr	600min	34.0mm	23.1mm	28.2mm	30.9mm	33.0mm	35.0mm	41.5mm	48.3mm	51.5mm	67.0mm
24hr	1440min	44.0mm	30.8mm	37.0mm	40.5mm	42.7mm	44.9mm	52.4mm	60.7mm	64.5mm	83.2mm
48hr	2880min	50.0mm	36.0mm	42.5mm	46.5mm	49.0mm	51.0mm	58.5mm	67.0mm	71.0mm	90.5mm

			Intensity i								
D Duration			M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	56.5mm/hr	72.0mm/hr	81.2mm/hr	88.5mm/hr	93.0mm/hr	108.5mm/hr	124.0mm/hr	130.1mm/hr	163.2mm/hr
10min	10min	0.17hr	40.3mm/hr	52.1mm/hr	59.4mm/hr	64.0mm/hr	68.0mm/hr	80.5mm/hr	93.1mm/hr	98.3mm/hr	126.1mm/hr
15min	15min	0.25hr	31.7mm/hr	41.1mm/hr	46.8mm/hr	50.4mm/hr	53.6mm/hr	63.4mm/hr	73.3mm/hr	77.5mm/hr	99.3mm/hr
30min	30min	0.50hr	18.6mm/hr	24.3mm/hr	27.0mm/hr	29.1mm/hr	30.9mm/hr	37.2mm/hr	43.2mm/hr	45.8mm/hr	59.7mm/hr
1hr	60min	1.00hr	12.8mm/hr	16.2mm/hr	18.0mm/hr	19.4mm/hr	20.6mm/hr	24.8mm/hr	29.0mm/hr	30.9mm/hr	40.6mm/hr
2hr	120min	2.00hr	7.7mm/hr	9.7mm/hr	10.8mm/hr	11.6mm/hr	12.4mm/hr	14.9mm/hr	17.4mm/hr	18.5mm/hr	24.4mm/hr
4hr	240min	4.00hr	4.6mm/hr	5.7mm/hr	6.4mm/hr	6.8mm/hr	7.2mm/hr	8.7mm/hr	10.1mm/hr	10.7mm/hr	14.1mm/hr
6hr	360min	6.00hr	3.6mm/hr	4.4mm/hr	4.9mm/hr	5.2mm/hr	5.5mm/hr	6.5mm/hr	7.6mm/hr	8.1mm/hr	10.5mm/hr
10hr	600min	10.00hr	2.3mm/hr	2.8mm/hr	3.1mm/hr	3.3mm/hr	3.5mm/hr	4.1mm/hr	4.8mm/hr	5.1mm/hr	6.7mm/hr
24hr	1440min	24.00hr	1.3mm/hr	1.5mm/hr	1.7mm/hr	1.8mm/hr	1.9mm/hr	2.2mm/hr	2.5mm/hr	2.7mm/hr	3.5mm/hr
48hr	2880min	48.00hr	0.6mm/hr	0.8mm/hr	0.8mm/hr	0.9mm/hr	0.9mm/hr	1.1mm/hr	1.3mm/hr	1.3mm/hr	1.7mm/hr
48hr	2880min	48.00hr	0.8mm/hr	0.9mm/hr	1.0mm/hr	1.0mm/hr	1.1mm/hr	1.2mm/hr	1.4mm/hr	1.5mm/hr	1.9mm/hr

SuDs CALCULATIONS
Project: 39 Fitzjohn's Avenue
RAINFALL PEAK INTENSITY

Project Reference: LBH 4498
Date: 16/12/2018 Rev: A
Client: Godfrey London Ltd.
LBH WEMBLEY ENGINEERING

GREENFIELD PEAK RUN-OFF

Hydrological Region: 6 *From Wallingford on-line tool* **Qbar: 1.64 l/sec**

			Run-Off Q								
D Duration			**M1-D**	**M2-D**	**M3-D**	**M4-D**	**M5-D**	**M10-D**	**M20-D**	**M30-D**	**M100-D**
5min	5min	0.08hr	1.39 l/sec	1.44 l/sec	1.66 l/sec	1.88 l/sec	2.10 l/sec	2.66 l/sec	3.23 l/sec	3.94 l/sec	5.23 l/sec
10min	10min	0.17hr	1.39 l/sec	1.44 l/sec	1.66 l/sec	1.88 l/sec	2.10 l/sec	2.66 l/sec	3.23 l/sec	3.94 l/sec	5.23 l/sec
15min	15min	0.25hr	1.39 l/sec	1.44 l/sec	1.66 l/sec	1.88 l/sec	2.10 l/sec	2.66 l/sec	3.23 l/sec	3.94 l/sec	5.23 l/sec
30min	30min	0.50hr	1.39 l/sec	1.44 l/sec	1.66 l/sec	1.88 l/sec	2.10 l/sec	2.66 l/sec	3.23 l/sec	3.94 l/sec	5.23 l/sec
1hr	60min	1.00hr	1.39 l/sec	1.44 l/sec	1.66 l/sec	1.88 l/sec	2.10 l/sec	2.66 l/sec	3.23 l/sec	3.94 l/sec	5.23 l/sec
2hr	120min	2.00hr	1.39 l/sec	1.44 l/sec	1.66 l/sec	1.88 l/sec	2.10 l/sec	2.66 l/sec	3.23 l/sec	3.94 l/sec	5.23 l/sec
4hr	240min	4.00hr	1.39 l/sec	1.44 l/sec	1.66 l/sec	1.88 l/sec	2.10 l/sec	2.66 l/sec	3.23 l/sec	3.94 l/sec	5.23 l/sec
6hr	360min	6.00hr	1.39 l/sec	1.44 l/sec	1.66 l/sec	1.88 l/sec	2.10 l/sec	2.66 l/sec	3.23 l/sec	3.94 l/sec	5.23 l/sec
10hr	600min	10.00hr	1.39 l/sec	1.44 l/sec	1.66 l/sec	1.88 l/sec	2.10 l/sec	2.66 l/sec	3.23 l/sec	3.94 l/sec	5.23 l/sec
24hr	1440min	24.00hr	1.39 l/sec	1.44 l/sec	1.66 l/sec	1.88 l/sec	2.10 l/sec	2.66 l/sec	3.23 l/sec	3.94 l/sec	5.23 l/sec
48hr	2880min	48.00hr	1.39 l/sec	1.44 l/sec	1.66 l/sec	1.88 l/sec	2.10 l/sec	2.66 l/sec	3.23 l/sec	3.94 l/sec	5.23 l/sec

			Run-Off Volume								
D Duration			**M1-D**	**M2-D**	**M3-D**	**M4-D**	**M5-D**	**M10-D**	**M20-D**	**M30-D**	**M100-D**
5min	5min	0.08hr	0.4 m3	0.4 m3	0.5 m3	0.6 m3	0.6 m3	0.8 m3	1.0 m3	1.2 m3	1.6 m3
10min	10min	0.17hr	0.8 m3	0.9 m3	1.0 m3	1.1 m3	1.3 m3	1.6 m3	1.9 m3	2.4 m3	3.1 m3
15min	15min	0.25hr	1.3 m3	1.3 m3	1.5 m3	1.7 m3	1.9 m3	2.4 m3	2.9 m3	3.5 m3	4.7 m3
30min	30min	0.50hr	2.5 m3	2.6 m3	3.0 m3	3.4 m3	3.8 m3	4.8 m3	5.8 m3	7.1 m3	9.4 m3
1hr	60min	1.00hr	5.0 m3	5.2 m3	6.0 m3	6.8 m3	7.6 m3	9.6 m3	11.6 m3	14.2 m3	18.8 m3
2hr	120min	2.00hr	10.0 m3	10.4 m3	12.0 m3	13.5 m3	15.1 m3	19.1 m3	23.2 m3	28.3 m3	37.7 m3
4hr	240min	4.00hr	20.1 m3	20.8 m3	23.9 m3	27.1 m3	30.2 m3	38.3 m3	46.4 m3	56.7 m3	75.3 m3
6hr	360min	6.00hr	30.1 m3	31.2 m3	35.9 m3	40.6 m3	45.3 m3	57.4 m3	69.7 m3	85.0 m3	113.0 m3
10hr	600min	10.00hr	50.2 m3	52.0 m3	59.8 m3	67.7 m3	75.6 m3	95.6 m3	116.1 m3	141.7 m3	188.3 m3
24hr	1440min	24.00hr	120.4 m3	124.7 m3	143.6 m3	162.5 m3	181.4 m3	229.5 m3	278.7 m3	340.1 m3	452.0 m3
48hr	2880min	48.00hr	240.9 m3	249.4 m3	287.2 m3	325.0 m3	362.7 m3	459.1 m3	557.3 m3	680.1 m3	904.0 m3

SuDs CALCULATIONS

Project: 39 Fitzjohn's Avenue

GREENFIELD PEAK RUN-OFF

Sheet 3 of 7

Project Reference: LBH 4498

Date: 16/12/2018 Rev: A

Client: Godfrey London Ltd.

LBH WEMBLEY ENGINEERING

EXISTING PEAK RUN-OFF

C_V: 0.65 *Volumetric Run-Off Coefficient*

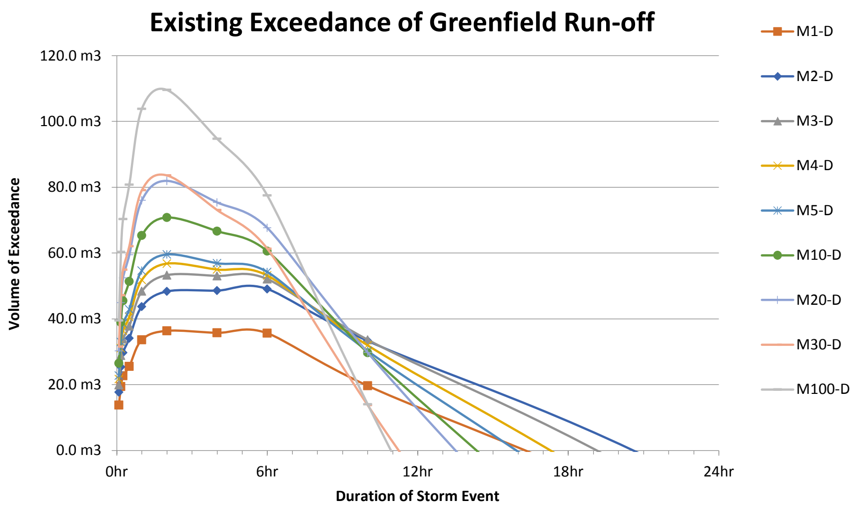
C_R: 1.3 *Routing Coefficient*

D Duration			Run-Off Q								
			M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	47.5 l/sec	60.5 l/sec	68.1 l/sec	74.3 l/sec	78.1 l/sec	91.1 l/sec	104.1 l/sec	109.2 l/sec	137.0 l/sec
10min	10min	0.17hr	33.8 l/sec	43.8 l/sec	49.9 l/sec	53.7 l/sec	57.1 l/sec	67.6 l/sec	78.1 l/sec	82.6 l/sec	105.8 l/sec
15min	15min	0.25hr	26.6 l/sec	34.5 l/sec	39.3 l/sec	42.3 l/sec	45.0 l/sec	53.3 l/sec	61.5 l/sec	65.0 l/sec	83.4 l/sec
30min	30min	0.50hr	15.6 l/sec	20.4 l/sec	22.7 l/sec	24.4 l/sec	25.9 l/sec	31.2 l/sec	36.3 l/sec	38.4 l/sec	50.1 l/sec
1hr	60min	1.00hr	10.7 l/sec	13.6 l/sec	15.1 l/sec	16.3 l/sec	17.3 l/sec	20.8 l/sec	24.3 l/sec	25.9 l/sec	34.1 l/sec
2hr	120min	2.00hr	6.4 l/sec	8.2 l/sec	9.1 l/sec	9.8 l/sec	10.4 l/sec	12.5 l/sec	14.6 l/sec	15.5 l/sec	20.4 l/sec
4hr	240min	4.00hr	3.9 l/sec	4.8 l/sec	5.3 l/sec	5.7 l/sec	6.1 l/sec	7.3 l/sec	8.5 l/sec	9.0 l/sec	11.8 l/sec
6hr	360min	6.00hr	3.0 l/sec	3.7 l/sec	4.1 l/sec	4.3 l/sec	4.6 l/sec	5.5 l/sec	6.4 l/sec	6.8 l/sec	8.8 l/sec
10hr	600min	10.00hr	1.9 l/sec	2.4 l/sec	2.6 l/sec	2.8 l/sec	2.9 l/sec	3.5 l/sec	4.1 l/sec	4.3 l/sec	5.6 l/sec
24hr	1440min	24.00hr	1.1 l/sec	1.3 l/sec	1.4 l/sec	1.5 l/sec	1.6 l/sec	1.8 l/sec	2.1 l/sec	2.3 l/sec	2.9 l/sec
48hr	2880min	48.00hr	0.6 l/sec	0.7 l/sec	0.8 l/sec	0.9 l/sec	0.9 l/sec	1.0 l/sec	1.2 l/sec	1.2 l/sec	1.6 l/sec

D Duration			Run-Off Volume								
			M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	14.2 m3	18.1 m3	20.4 m3	22.3 m3	23.4 m3	27.3 m3	31.2 m3	32.8 m3	41.1 m3
10min	10min	0.17hr	20.3 m3	26.3 m3	29.9 m3	32.2 m3	34.2 m3	40.6 m3	46.9 m3	49.5 m3	63.5 m3
15min	15min	0.25hr	24.0 m3	31.0 m3	35.4 m3	38.1 m3	40.5 m3	47.9 m3	55.4 m3	58.5 m3	75.0 m3
30min	30min	0.50hr	28.1 m3	36.7 m3	40.8 m3	44.0 m3	46.7 m3	56.2 m3	65.3 m3	69.2 m3	90.2 m3
1hr	60min	1.00hr	38.7 m3	49.0 m3	54.4 m3	58.6 m3	62.3 m3	74.9 m3	87.6 m3	93.3 m3	122.7 m3
2hr	120min	2.00hr	46.4 m3	58.7 m3	65.3 m3	70.4 m3	74.7 m3	89.9 m3	105.2 m3	111.9 m3	147.2 m3
4hr	240min	4.00hr	55.8 m3	69.4 m3	77.0 m3	82.1 m3	87.2 m3	104.9 m3	121.9 m3	129.7 m3	170.1 m3
6hr	360min	6.00hr	65.8 m3	80.3 m3	88.0 m3	93.8 m3	99.6 m3	118.0 m3	137.3 m3	146.3 m3	190.5 m3
10hr	600min	10.00hr	69.9 m3	85.3 m3	93.5 m3	99.7 m3	105.8 m3	125.4 m3	145.9 m3	155.5 m3	202.4 m3
24hr	1440min	24.00hr	93.1 m3	111.7 m3	122.3 m3	129.0 m3	135.6 m3	158.2 m3	183.5 m3	195.0 m3	251.3 m3
48hr	2880min	48.00hr	108.8 m3	128.4 m3	140.5 m3	148.1 m3	154.1 m3	176.8 m3	202.5 m3	214.6 m3	273.5 m3

D Duration			Exceedance of Greenfield Run-Off Volume								
			M1-D	M2-D	M3-D	M4-D	M5-D	M10-D	M20-D	M30-D	M100-D
5min	5min	0.08hr	13.8 m3	17.7 m3	19.9 m3	21.7 m3	22.8 m3	26.5 m3	30.3 m3	31.6 m3	39.5 m3
10min	10min	0.17hr	19.4 m3	25.4 m3	28.9 m3	31.1 m3	33.0 m3	39.0 m3	44.9 m3	47.2 m3	60.4 m3
15min	15min	0.25hr	22.7 m3	29.7 m3	33.9 m3	36.4 m3	38.6 m3	45.5 m3	52.5 m3	55.0 m3	70.3 m3
30min	30min	0.50hr	25.6 m3	34.1 m3	37.8 m3	40.6 m3	42.9 m3	51.4 m3	59.5 m3	62.1 m3	80.8 m3
1hr	60min	1.00hr	33.7 m3	43.8 m3	48.4 m3	51.9 m3	54.7 m3	65.4 m3	76.0 m3	79.1 m3	103.9 m3
2hr	120min	2.00hr	36.4 m3	48.4 m3	53.3 m3	56.8 m3	59.6 m3	70.8 m3	81.9 m3	83.6 m3	109.6 m3
4hr	240min	4.00hr	35.8 m3	48.6 m3	53.1 m3	55.0 m3	56.9 m3	66.7 m3	75.4 m3	73.1 m3	94.7 m3
6hr	360min	6.00hr	35.7 m3	49.1 m3	52.1 m3	53.2 m3	54.3 m3	60.6 m3	67.7 m3	61.3 m3	77.5 m3
10hr	600min	10.00hr	19.7 m3	33.3 m3	33.7 m3	32.0 m3	30.3 m3	29.7 m3	29.8 m3	13.8 m3	14.1 m3
24hr	1440min	24.00hr	-27.4 m3	-13.0 m3	-21.3 m3	-33.5 m3	-45.7 m3	-71.3 m3	-95.2 m3	-145.0 m3	-200.7 m3
48hr	2880min	48.00hr	-132.1 m3	-120.9 m3	-146.6 m3	-176.9 m3	-208.6 m3	-282.3 m3	-354.9 m3	-465.6 m3	-630.5 m3

			C_V:
Catchment Area:	3600sqm	100%	
Permeable:	1214sqm	34%	0.40
Impermeable:	2386sqm	66%	0.77
			0.65



SuDs CALCULATIONS

Project: 39 Fitzjohn's Avenue

EXISTING PEAK RUN-OFF

Sheet 4 of 7

Project Reference: LBH 4498

Date: 16/12/2018 Rev: A

Client: Godfrey London Ltd.

LBH WEMBLEY ENGINEERING

POST- DEVELOPMENT PEAK RUN-OFF + CC

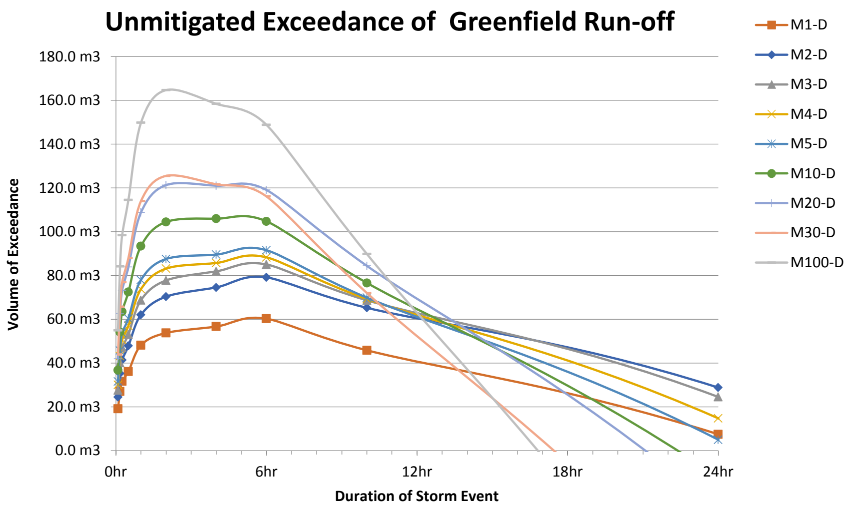
C_V:	0.63	*Volumetric Run-Off Coefficient*	Climate Change Allowance: 40%
C_R:	1.3	*Routing Coefficient*	

D Duration			Run-Off Q								
			M1-D	**M2-D**	**M3-D**	**M4-D**	**M5-D**	**M10-D**	**M20-D**	**M30-D**	**M100-D**
5min	5min	0.08hr	65.2 l/sec	83.1 l/sec	93.6 l/sec	102.0 l/sec	107.3 l/sec	125.2 l/sec	143.1 l/sec	150.1 l/sec	188.3 l/sec
10min	10min	0.17hr	46.4 l/sec	60.1 l/sec	68.5 l/sec	73.8 l/sec	78.4 l/sec	92.9 l/sec	107.3 l/sec	113.4 l/sec	145.4 l/sec
15min	15min	0.25hr	36.6 l/sec	47.4 l/sec	54.0 l/sec	58.2 l/sec	61.8 l/sec	73.2 l/sec	84.6 l/sec	89.4 l/sec	114.6 l/sec
30min	30min	0.50hr	21.5 l/sec	28.0 l/sec	31.1 l/sec	33.6 l/sec	35.6 l/sec	42.9 l/sec	49.8 l/sec	52.8 l/sec	68.9 l/sec
1hr	60min	1.00hr	14.8 l/sec	18.7 l/sec	20.8 l/sec	22.4 l/sec	23.8 l/sec	28.6 l/sec	33.5 l/sec	35.6 l/sec	46.8 l/sec
2hr	120min	2.00hr	8.9 l/sec	11.2 l/sec	12.5 l/sec	13.4 l/sec	14.3 l/sec	17.2 l/sec	20.1 l/sec	21.4 l/sec	28.1 l/sec
4hr	240min	4.00hr	5.3 l/sec	6.6 l/sec	7.3 l/sec	7.8 l/sec	8.3 l/sec	10.0 l/sec	11.6 l/sec	12.4 l/sec	16.2 l/sec
6hr	360min	6.00hr	4.2 l/sec	5.1 l/sec	5.6 l/sec	6.0 l/sec	6.3 l/sec	7.5 l/sec	8.7 l/sec	9.3 l/sec	12.1 l/sec
10hr	600min	10.00hr	2.7 l/sec	3.3 l/sec	3.6 l/sec	3.8 l/sec	4.0 l/sec	4.8 l/sec	5.6 l/sec	5.9 l/sec	7.7 l/sec
24hr	1440min	24.00hr	1.5 l/sec	1.8 l/sec	1.9 l/sec	2.1 l/sec	2.2 l/sec	2.5 l/sec	2.9 l/sec	3.1 l/sec	4.0 l/sec
48hr	2880min	48.00hr	0.9 l/sec	1.0 l/sec	1.1 l/sec	1.2 l/sec	1.2 l/sec	1.4 l/sec	1.6 l/sec	1.7 l/sec	2.2 l/sec

D Duration			Run-Off Volume								
			M1-D	**M2-D**	**M3-D**	**M4-D**	**M5-D**	**M10-D**	**M20-D**	**M30-D**	**M100-D**
5min	5min	0.08hr	19.6 m3	24.9 m3	28.1 m3	30.6 m3	32.2 m3	37.6 m3	42.9 m3	45.0 m3	56.5 m3
10min	10min	0.17hr	27.9 m3	36.1 m3	41.1 m3	44.3 m3	47.1 m3	55.7 m3	64.4 m3	68.1 m3	87.2 m3
15min	15min	0.25hr	32.9 m3	42.6 m3	48.6 m3	52.4 m3	55.6 m3	65.9 m3	76.1 m3	80.4 m3	103.1 m3
30min	30min	0.50hr	38.6 m3	50.5 m3	56.1 m3	60.4 m3	64.2 m3	77.2 m3	89.7 m3	95.1 m3	124.0 m3
1hr	60min	1.00hr	53.2 m3	67.3 m3	74.7 m3	80.6 m3	85.5 m3	103.0 m3	120.4 m3	128.2 m3	168.6 m3
2hr	120min	2.00hr	63.8 m3	80.7 m3	89.7 m3	96.7 m3	102.7 m3	123.6 m3	144.5 m3	153.8 m3	202.3 m3
4hr	240min	4.00hr	76.7 m3	95.3 m3	105.8 m3	112.8 m3	119.8 m3	144.2 m3	167.4 m3	178.3 m3	233.7 m3
6hr	360min	6.00hr	90.4 m3	110.3 m3	120.9 m3	128.9 m3	136.9 m3	162.1 m3	188.7 m3	201.1 m3	261.8 m3
10hr	600min	10.00hr	96.0 m3	117.2 m3	128.5 m3	137.0 m3	145.4 m3	172.3 m3	200.5 m3	213.7 m3	278.2 m3
24hr	1440min	24.00hr	127.9 m3	153.5 m3	168.1 m3	177.2 m3	186.4 m3	217.4 m3	252.2 m3	268.0 m3	345.3 m3
48hr	2880min	48.00hr	149.5 m3	176.5 m3	193.1 m3	203.5 m3	211.8 m3	242.9 m3	278.2 m3	294.8 m3	375.8 m3

D Duration			Exceedance of Greenfield Run-Off Volume								
			M1-D	**M2-D**	**M3-D**	**M4-D**	**M5-D**	**M10-D**	**M20-D**	**M30-D**	**M100-D**
5min	5min	0.08hr	19.1 m3	24.5 m3	27.6 m3	30.0 m3	31.6 m3	36.8 m3	42.0 m3	43.8 m3	54.9 m3
10min	10min	0.17hr	27.0 m3	35.2 m3	40.1 m3	43.2 m3	45.8 m3	54.1 m3	62.5 m3	65.7 m3	84.1 m3
15min	15min	0.25hr	31.7 m3	41.3 m3	47.1 m3	50.7 m3	53.7 m3	63.5 m3	73.2 m3	76.9 m3	98.4 m3
30min	30min	0.50hr	36.1 m3	47.9 m3	53.1 m3	57.0 m3	60.4 m3	72.5 m3	83.9 m3	88.0 m3	114.5 m3
1hr	60min	1.00hr	48.1 m3	62.1 m3	68.8 m3	73.8 m3	78.0 m3	93.4 m3	108.8 m3	114.0 m3	149.8 m3
2hr	120min	2.00hr	53.7 m3	70.3 m3	77.7 m3	83.1 m3	87.5 m3	104.5 m3	121.3 m3	125.5 m3	164.7 m3
4hr	240min	4.00hr	56.7 m3	74.6 m3	81.9 m3	85.7 m3	89.5 m3	105.9 m3	121.0 m3	121.6 m3	158.4 m3
6hr	360min	6.00hr	60.3 m3	79.1 m3	85.0 m3	88.3 m3	91.5 m3	104.7 m3	119.0 m3	116.1 m3	148.8 m3
10hr	600min	10.00hr	45.8 m3	65.2 m3	68.7 m3	69.3 m3	69.9 m3	76.6 m3	84.4 m3	72.0 m3	89.8 m3
24hr	1440min	24.00hr	7.5 m3	28.8 m3	24.5 m3	14.8 m3	5.0 m3	-12.1 m3	-26.5 m3	-72.1 m3	-106.7 m3
48hr	2880min	48.00hr	-91.4 m3	-72.9 m3	-94.1 m3	-121.5 m3	-151.0 m3	-216.2 m3	-279.1 m3	-385.3 m3	-528.2 m3

			C_V:
Catchment Area:	3600sqm	100%	
Permeable Garden	1330sqm	37%	0.40
Impermeable:	2270sqm	63%	0.77
			0.63



SuDs CALCULATIONS

Project: 39 Fitzjohn's Avenue

POST-DEV. PEAK RUN-OFF

Sheet 5 of 7

Project Reference: LBH 4498

Date: 16/12/2018 Rev: A

Client: Godfrey London Ltd.

LBH WEMBLEY ENGINEERING

POST- DEVELOPMENT & SOURCE MITIGATION PEAK RUN-OFF + CC

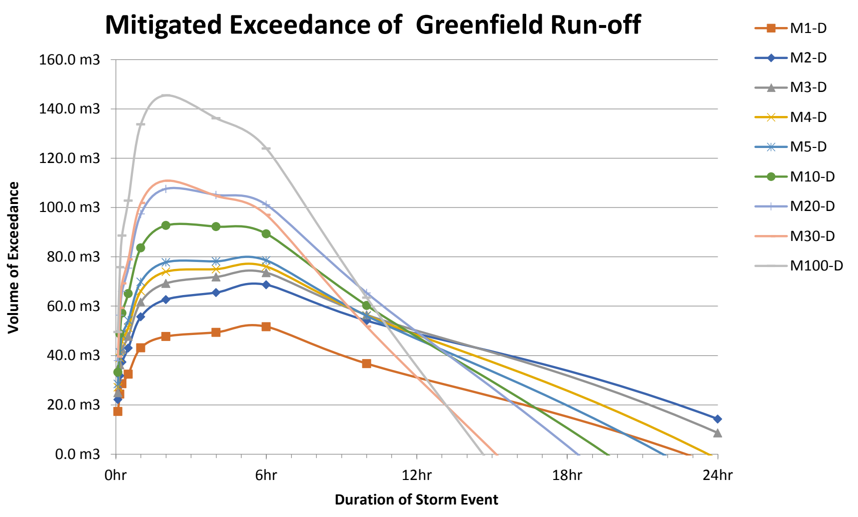
C_V:	0.57	*Volumetric Run-Off Coefficient*	Climate Change Allowance:	40%
C_R:	1.3	*Routing Coefficient*		

			Run-Off Q								
D Duration			**M1-D**	**M2-D**	**M3-D**	**M4-D**	**M5-D**	**M10-D**	**M20-D**	**M30-D**	**M100-D**
5min	5min	0.08hr	59.0 l/sec	75.2 l/sec	84.8 l/sec	92.4 l/sec	97.1 l/sec	113.3 l/sec	129.5 l/sec	135.9 l/sec	170.5 l/sec
10min	10min	0.17hr	42.0 l/sec	54.4 l/sec	62.0 l/sec	66.9 l/sec	71.0 l/sec	84.1 l/sec	97.2 l/sec	102.7 l/sec	131.6 l/sec
15min	15min	0.25hr	33.1 l/sec	42.9 l/sec	48.9 l/sec	52.7 l/sec	55.9 l/sec	66.3 l/sec	76.6 l/sec	80.9 l/sec	103.7 l/sec
30min	30min	0.50hr	19.4 l/sec	25.4 l/sec	28.2 l/sec	30.4 l/sec	32.3 l/sec	38.8 l/sec	45.1 l/sec	47.8 l/sec	62.3 l/sec
1hr	60min	1.00hr	13.4 l/sec	16.9 l/sec	18.8 l/sec	20.3 l/sec	21.5 l/sec	25.9 l/sec	30.3 l/sec	32.2 l/sec	42.4 l/sec
2hr	120min	2.00hr	8.0 l/sec	10.2 l/sec	11.3 l/sec	12.2 l/sec	12.9 l/sec	15.5 l/sec	18.2 l/sec	19.3 l/sec	25.4 l/sec
4hr	240min	4.00hr	4.8 l/sec	6.0 l/sec	6.7 l/sec	7.1 l/sec	7.5 l/sec	9.1 l/sec	10.5 l/sec	11.2 l/sec	14.7 l/sec
6hr	360min	6.00hr	3.8 l/sec	4.6 l/sec	5.1 l/sec	5.4 l/sec	5.7 l/sec	6.8 l/sec	7.9 l/sec	8.4 l/sec	11.0 l/sec
10hr	600min	10.00hr	2.4 l/sec	2.9 l/sec	3.2 l/sec	3.4 l/sec	3.7 l/sec	4.3 l/sec	5.0 l/sec	5.4 l/sec	7.0 l/sec
24hr	1440min	24.00hr	1.3 l/sec	1.6 l/sec	1.8 l/sec	1.9 l/sec	2.0 l/sec	2.3 l/sec	2.6 l/sec	2.8 l/sec	3.6 l/sec
48hr	2880min	48.00hr	0.8 l/sec	0.9 l/sec	1.0 l/sec	1.1 l/sec	1.1 l/sec	1.3 l/sec	1.5 l/sec	1.5 l/sec	2.0 l/sec

			Run-Off Volume								
D Duration			**M1-D**	**M2-D**	**M3-D**	**M4-D**	**M5-D**	**M10-D**	**M20-D**	**M30-D**	**M100-D**
5min	5min	0.08hr	17.7 m3	22.6 m3	25.4 m3	27.7 m3	29.1 m3	34.0 m3	38.9 m3	40.8 m3	51.1 m3
10min	10min	0.17hr	25.2 m3	32.7 m3	37.2 m3	40.1 m3	42.6 m3	50.5 m3	58.3 m3	61.6 m3	79.0 m3
15min	15min	0.25hr	29.8 m3	38.6 m3	44.0 m3	47.4 m3	50.3 m3	59.6 m3	68.9 m3	72.8 m3	93.3 m3
30min	30min	0.50hr	35.0 m3	45.7 m3	50.8 m3	54.7 m3	58.1 m3	69.9 m3	81.2 m3	86.1 m3	112.2 m3
1hr	60min	1.00hr	48.1 m3	60.9 m3	67.7 m3	72.9 m3	77.4 m3	93.2 m3	109.0 m3	116.0 m3	152.6 m3
2hr	120min	2.00hr	57.7 m3	73.1 m3	81.2 m3	87.5 m3	92.9 m3	111.9 m3	130.8 m3	139.3 m3	183.2 m3
4hr	240min	4.00hr	69.5 m3	86.3 m3	95.8 m3	102.1 m3	108.4 m3	130.5 m3	151.6 m3	161.4 m3	211.6 m3
6hr	360min	6.00hr	81.8 m3	99.9 m3	109.5 m3	116.7 m3	123.9 m3	146.8 m3	170.8 m3	182.1 m3	237.0 m3
10hr	600min	10.00hr	86.9 m3	106.1 m3	116.3 m3	124.0 m3	131.7 m3	155.9 m3	181.5 m3	193.4 m3	251.8 m3
24hr	1440min	24.00hr	115.8 m3	139.0 m3	152.2 m3	160.5 m3	168.7 m3	196.8 m3	228.3 m3	242.6 m3	312.6 m3
48hr	2880min	48.00hr	135.3 m3	159.8 m3	174.8 m3	184.2 m3	191.7 m3	219.9 m3	251.9 m3	266.9 m3	340.2 m3

			Exceedance of Greenfield Run-Off Volume								
D Duration			**M1-D**	**M2-D**	**M3-D**	**M4-D**	**M5-D**	**M10-D**	**M20-D**	**M30-D**	**M100-D**
5min	5min	0.08hr	17.3 m3	22.1 m3	24.9 m3	27.2 m3	28.5 m3	33.2 m3	37.9 m3	39.6 m3	49.6 m3
10min	10min	0.17hr	24.4 m3	31.8 m3	36.2 m3	39.0 m3	41.3 m3	48.9 m3	56.4 m3	59.3 m3	75.8 m3
15min	15min	0.25hr	28.6 m3	37.3 m3	42.5 m3	45.7 m3	48.5 m3	57.2 m3	66.0 m3	69.3 m3	88.6 m3
30min	30min	0.50hr	32.5 m3	43.1 m3	47.8 m3	51.3 m3	54.3 m3	65.1 m3	75.4 m3	79.0 m3	102.8 m3
1hr	60min	1.00hr	43.1 m3	55.7 m3	61.7 m3	66.2 m3	69.9 m3	83.7 m3	97.4 m3	101.9 m3	133.8 m3
2hr	120min	2.00hr	47.7 m3	62.7 m3	69.2 m3	74.0 m3	77.8 m3	92.8 m3	107.6 m3	110.9 m3	145.5 m3
4hr	240min	4.00hr	49.4 m3	65.5 m3	71.9 m3	75.0 m3	78.2 m3	92.3 m3	105.1 m3	104.7 m3	136.2 m3
6hr	360min	6.00hr	51.7 m3	68.7 m3	73.6 m3	76.1 m3	78.6 m3	89.4 m3	101.2 m3	97.0 m3	124.0 m3
10hr	600min	10.00hr	36.7 m3	54.1 m3	56.5 m3	56.3 m3	56.1 m3	60.3 m3	65.4 m3	51.7 m3	63.5 m3
24hr	1440min	24.00hr	-4.6 m3	14.3 m3	8.6 m3	-2.0 m3	-12.6 m3	-32.7 m3	-50.4 m3	-97.5 m3	-139.4 m3
48hr	2880min	48.00hr	-105.5 m3	-89.6 m3	-112.4 m3	-140.7 m3	-171.0 m3	-239.2 m3	-305.5 m3	-413.2 m3	-563.8 m3

DEVELOPMENT MITIGATION PROPOSALS			**C_V:**
Catchment Area:	3600sqm	100%	
Permeable Garden	1330sqm	37%	0.40
Pervious Paving	1270sqm	35%	0.60
Impermeable:	1000sqm	28%	0.77
			0.57



SuDs CALCULATIONS			
Project:	39 Fitzjohn's Avenue		
POST-DEV.-MIT. PEAK RUN-OFF			
Sheet 6 of 7			
Project Reference:	LBH 4498		
Date:	16/12/2018	Rev:	A
Client:	Godfrey London Ltd.		

LBH WEMBLEY ENGINEERING

POST- DEVELOPMENT & SOURCE MITIGATION PEAK RUN-OFF + CC ATTENUATION STORAGE REQUIREMENTS

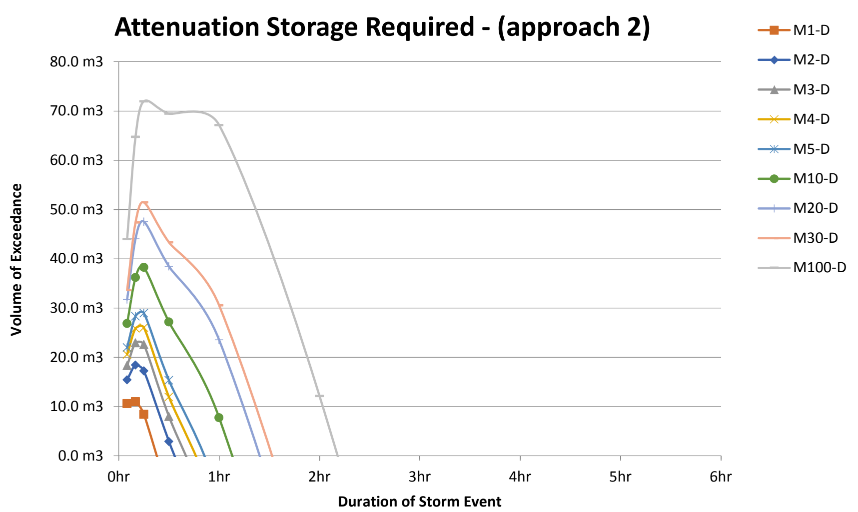
Proposed Discharge Rate: **23.75 l/sec** (approach 2 - 50% Existing)
1.64 l/sec *QBar*

D Duration			INFLOW								
			M1-D	**M2-D**	**M3-D**	**M4-D**	**M5-D**	**M10-D**	**M20-D**	**M30-D**	**M100-D**
5min	5min	0.08hr	17.7 m3	22.6 m3	25.4 m3	27.7 m3	29.1 m3	34.0 m3	38.9 m3	40.8 m3	51.1 m3
10min	10min	0.17hr	25.2 m3	32.7 m3	37.2 m3	40.1 m3	42.6 m3	50.5 m3	58.3 m3	61.6 m3	79.0 m3
15min	15min	0.25hr	29.8 m3	38.6 m3	44.0 m3	47.4 m3	50.3 m3	59.6 m3	68.9 m3	72.8 m3	93.3 m3
30min	30min	0.50hr	35.0 m3	45.7 m3	50.8 m3	54.7 m3	58.1 m3	69.9 m3	81.2 m3	86.1 m3	112.2 m3
1hr	60min	1.00hr	48.1 m3	60.9 m3	67.7 m3	72.9 m3	77.4 m3	93.2 m3	109.0 m3	116.0 m3	152.6 m3
2hr	120min	2.00hr	57.7 m3	73.1 m3	81.2 m3	87.5 m3	92.9 m3	111.9 m3	130.8 m3	139.3 m3	183.2 m3
4hr	240min	4.00hr	69.5 m3	86.3 m3	95.8 m3	102.1 m3	108.4 m3	130.5 m3	151.6 m3	161.4 m3	211.6 m3
6hr	360min	6.00hr	81.8 m3	99.9 m3	109.5 m3	116.7 m3	123.9 m3	146.8 m3	170.8 m3	182.1 m3	237.0 m3
10hr	600min	10.00hr	86.9 m3	106.1 m3	116.3 m3	124.0 m3	131.7 m3	155.9 m3	181.5 m3	193.4 m3	251.8 m3
24hr	1440min	24.00hr	115.8 m3	139.0 m3	152.2 m3	160.5 m3	168.7 m3	196.8 m3	228.3 m3	242.6 m3	312.6 m3
48hr	2880min	48.00hr	135.3 m3	159.8 m3	174.8 m3	184.2 m3	191.7 m3	219.9 m3	251.9 m3	266.9 m3	340.2 m3

D Duration			OUTFLOW								
			M1-D	**M2-D**	**M3-D**	**M4-D**	**M5-D**	**M10-D**	**M20-D**	**M30-D**	**M100-D**
5min	5min	0.08hr	7.1 m3	7.1 m3	7.1 m3	7.1 m3	7.1 m3	7.1 m3	7.1 m3	7.1 m3	7.1 m3
10min	10min	0.17hr	14.3 m3	14.3 m3	14.3 m3	14.3 m3	14.3 m3	14.3 m3	14.3 m3	14.3 m3	14.3 m3
15min	15min	0.25hr	21.4 m3	21.4 m3	21.4 m3	21.4 m3	21.4 m3	21.4 m3	21.4 m3	21.4 m3	21.4 m3
30min	30min	0.50hr	42.8 m3	42.8 m3	42.8 m3	42.8 m3	42.8 m3	42.8 m3	42.8 m3	42.8 m3	42.8 m3
1hr	60min	1.00hr	85.5 m3	85.5 m3	85.5 m3	85.5 m3	85.5 m3	85.5 m3	85.5 m3	85.5 m3	85.5 m3
2hr	120min	2.00hr	171.0 m3	171.0 m3	171.0 m3	171.0 m3	171.0 m3	171.0 m3	171.0 m3	171.0 m3	171.0 m3
4hr	240min	4.00hr	342.0 m3	342.0 m3	342.0 m3	342.0 m3	342.0 m3	342.0 m3	342.0 m3	342.0 m3	342.0 m3
6hr	360min	6.00hr	513.0 m3	513.0 m3	513.0 m3	513.0 m3	513.0 m3	513.0 m3	513.0 m3	513.0 m3	513.0 m3
10hr	600min	10.00hr	855.0 m3	855.0 m3	855.0 m3	855.0 m3	855.0 m3	855.0 m3	855.0 m3	855.0 m3	855.0 m3
24hr	1440min	24.00hr	2052.0 m3	2052.0 m3	2052.0 m3	2052.0 m3	2052.0 m3	2052.0 m3	2052.0 m3	2052.0 m3	2052.0 m3
48hr	2880min	48.00hr	4104.0 m3	4104.0 m3	4104.0 m3	4104.0 m3	4104.0 m3	4104.0 m3	4104.0 m3	4104.0 m3	4104.0 m3

D Duration			ATTENUATION STORAGE REQUIRED TO MEET PROPOSED DISCHARGE RATE								
			M1-D	**M2-D**	**M3-D**	**M4-D**	**M5-D**	**M10-D**	**M20-D**	**M30-D**	**M100-D**
5min	5min	0.08hr	10.6 m3	15.4 m3	18.3 m3	20.6 m3	22.0 m3	26.9 m3	31.7 m3	33.6 m3	44.0 m3
10min	10min	0.17hr	11.0 m3	18.4 m3	23.0 m3	25.9 m3	28.3 m3	36.2 m3	44.1 m3	47.4 m3	64.7 m3
15min	15min	0.25hr	8.4 m3	17.2 m3	22.6 m3	26.0 m3	29.0 m3	38.3 m3	47.5 m3	51.4 m3	72.0 m3
30min	30min	0.50hr	-7.8 m3	2.9 m3	8.0 m3	12.0 m3	15.3 m3	27.2 m3	38.5 m3	43.3 m3	69.5 m3
1hr	60min	1.00hr	-37.4 m3	-24.6 m3	-17.8 m3	-12.6 m3	-8.1 m3	7.7 m3	23.5 m3	30.5 m3	67.1 m3
2hr	120min	2.00hr	-113.3 m3	-97.9 m3	-89.8 m3	-83.5 m3	-78.1 m3	-59.1 m3	-40.2 m3	-31.7 m3	12.2 m3
4hr	240min	4.00hr	-272.5 m3	-255.7 m3	-246.2 m3	-239.9 m3	-233.6 m3	-211.5 m3	-190.4 m3	-180.6 m3	-130.4 m3
6hr	360min	6.00hr	-431.2 m3	-413.1 m3	-403.5 m3	-396.3 m3	-389.1 m3	-366.2 m3	-342.2 m3	-330.9 m3	-276.0 m3
10hr	600min	10.00hr	-768.1 m3	-748.9 m3	-738.7 m3	-731.0 m3	-723.3 m3	-699.1 m3	-673.5 m3	-661.6 m3	-603.2 m3
24hr	1440min	24.00hr	-1936.2 m3	-1913.0 m3	-1899.8 m3	-1891.5 m3	-1883.3 m3	-1855.2 m3	-1823.7 m3	-1809.4 m3	-1739.4 m3
48hr	2880min	48.00hr	-3968.7 m3	-3944.2 m3	-3929.2 m3	-3919.8 m3	-3912.3 m3	-3884.1 m3	-3852.1 m3	-3837.1 m3	-3763.8 m3

Approach 2 ATTENUATION STORAGE REQUIRED: 72.0 m3



SuDs CALCULATIONS	
Project:	39 Fitzjohn's Avenue
STORAGE REQUIREMENTS	
Sheet 7 of 7	
Project Reference:	LBH 4498
Date: 16/12/2018	Rev: A
Client:	Godfrey London Ltd.

LBH WEMBLEY ENGINEERING