INLAND HOMES LTD

HILLINGDON GARDENS

Surface Water Management Report

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Hillingdon Gardens

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1.0 Introduction

This Surface Water Management Report (SWMR) has been prepared by ICIS Design Limited for a new residential, commercial and retail development at Former Master Brewer Site, Freezeland Way, Hillingdon, London UB10 9PQ, which is in the London Borough of Hillingdon (LBH).

This report is to be read in conjunction with the ICIS Design Limited Flood Risk Assessment and drainage strategy drawings.

This report has been prepared to demonstrate that the surface water run-off rate and volume for the new residential development site is managed so it adheres to current regulations and local authority requirements.

This surface water management report has been prepared to the requirements of the:

- National Planning Policy Framework (NPPF) 2019 Paragraphs 149-150 and 155-165;
- National Planning Practice Guidance (NPPG);
- Principles of Sustainable drainage systems (SuDS) set out by DEFRA (2011);
- Ciria SuDS Manual C753 (2015);
- Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015);
- The London Plan (2016) Policy 5.12 and 5.13;
- The London Plan (Draft Version 2019);
- Greater London Authority: Sustainable Design and Construction Supplementary Planning Guidance – Mayor of London (2014);
- LBH Preliminary Flood Risk Assessment (May 2011);
- LBH Local Planning Policy LPP1 (2012) Policy EM6;
- LBH Local Planning Policy LPP2 (Main Modification 2019) Policy DMEI 9.

2.0 National and Local Planning Policies

This site-specific flood risk assessment has been prepared to the requirements set out in the national and local planning guidance.

National Planning Policy Framework and the National Planning Practice Guidance

NPPF 2019 set out the Government's national policy on development and flood risk, and seeks to provide clarity on what is required at regional and local levels, to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at highest risk.

NPPF Paragraphs 149 to 150 provide guidance for developments for the plans to take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk.

NPPF Paragraphs 155 to 165 provides guidance for planning and flood risk, where are plans should apply a sequential, risk-based approach to the location of development taking into account current and future impacts of climate change; to ensure that flood risk is not increased elsewhere due to the development; and to incorporate sustainable drainage systems.

NPPG, Paragraph 030, outlines that the objectives of this FRA are to establish whether a proposed development is likely to be affected by current or future flooding from any source; whether it will increase flood risk elsewhere; whether the measures proposed to deal with these effects and risks are appropriate; whether the evidence for the local planning authority to apply (if necessary) the Sequential Test; and whether the development will be safe and pass the Exception Test, if applicable.

Flood Water Management Act

The Flood and Water Management Act takes forward some of the proposals from three previous strategy documents published by the UK Government - Future Water (2008), Making Space for Water (2008) and the UK Government's response to the Sir Michael Pitt's Review of the summer 2007 floods. In doing so it gives the EA a strategic overview role for flood risk, and gives local authorities responsibility for preparing and putting in place strategies for managing flood risk from groundwater, surface water and ordinary watercourses in their areas.

London Plan (2016)

The London Plan Policy 5.12 and 5.13 state:

POLICY 5.12 FLOOD RISK MANAGEMENT

Strategic

A The Mayor will work with all relevant agencies including the Environment Agency to address current and future flood issues and minimise risks in a sustainable and cost effective way.

Planning decisions

B Development proposals must comply with the flood risk assessment and management requirements set out in the NPPF and the associated technical Guidance on flood risk[1] over the lifetime of the development and have regard to measures proposed in Thames Estuary 2100 (TE2100 – see paragraph 5.55) and Catchment Flood Management Plans.

C Developments which are required to pass the Exceptions Test set out in the NPPF and the Technical Guidance will need to address flood resilient design and emergency planning by demonstrating that:

- a the development will remain safe and operational under flood conditions
- b a strategy of either safe evacuation and/or safely remaining in the building is followed under flood conditions
- c key services including electricity, water etc will continue to be provided under flood conditions
- d buildings are designed for quick recovery following a flood.

D Development adjacent to flood defences will be required to protect the integrity of existing flood defences and wherever possible should aim to be set back from the banks of watercourses and those defences to allow their management, maintenance and upgrading to be undertaken in a sustainable and cost effective way.

LDF preparation

E In line with the NPPF and the Technical Guidance, boroughs should, when preparing LDFs, utilise Strategic Flood Risk Assessments to identify areas where particular flood risk issues exist and develop actions and policy approaches aimed at reducing these risks, particularly through redevelopment of sites at risk of flooding and identifying specific opportunities for flood risk management measures.

POLICY 5.13 SUSTAINABLE DRAINAGE

Planning decisions

A Development should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:

1. store rainwater for later use
2. use infiltration techniques, such as porous surfaces in non-clay areas
3. attenuate rainwater in ponds or open water features for gradual

release

4 attenuate rainwater by storing in tanks or sealed water features for gradual release

5 discharge rainwater direct to a watercourse

6 discharge rainwater to a surface water sewer/drain

7 discharge rainwater to the combined sewer.

Drainage should be designed and implemented in ways that deliver other policy objectives of this Plan, including water use efficiency and quality, biodiversity, amenity and recreation.

LDF preparation

B Within LDFs boroughs should, in line with the Flood and Water Management Act 2010, utilise Surface Water Management Plans to identify areas where there are particular surface water management issues and develop actions and policy approaches aimed at reducing these risks.

Supplementary Planning Guidance

Sustainable Design and Construction Supplementary Planning Guidance (SPG) produced by the Greater London Authority offers recommendations for developers. Clauses 3.4.2, 3.4.12 and 3.4.14 set out the expectation of SuDS to be incorporated into the design of new developments to prevent increasing volumes of surface water runoff and reduce flood risk.

LBH – Preliminary Flood Risk Assessment

The London Borough of Hillingdon Preliminary Flood Risk Assessment (PFRA) process is aimed at providing a high-level overview of flood risk from all sources within a local area, including consideration of surface water, groundwater, ordinary watercourses and canals. The London Borough of Hillingdon was required to submit their PFRA to the Environment Agency for review by 22nd June 2011. The PFRA was produced as part of a coordinated programme of work across Greater London facilitated by the Drain London Forum and the GLA. The methodology for producing the PFRA is consistent with other London Boroughs and has been based on the Environment Agency's Final PFRA Guidance and Defra's Guidance on selecting Flood Risk Areas.

LBB Policy EM6: Flood Risk Management

The Council will require new development to be directed away from Flood Zones 2 and 3 in accordance with the principles of the National Planning Policy Framework (NPPF).

The subsequent Hillingdon Local Plan: Part 2 -Site Specific Allocations LDD will be subjected to the Sequential Test in accordance with the NPPF. Sites will only be allocated within Flood Zones 2 or 3 where there are overriding issues that outweigh flood risk. In these instances, policy criteria will be set requiring future applicants of these sites to demonstrate that flood risk can be suitably mitigated.

The Council will require all development across the borough to use sustainable urban drainage systems (SUDS) unless demonstrated that it is not viable. The Council will encourage SUDS to be linked to water efficiency methods. The Council may require developer contributions to guarantee the long term maintenance and performance of SUDS is to an appropriate standard.

2.0 Surface Water Management Principles

The surface water for the development site is to be managed so that it adheres to the current national regulations and local authority requirements.

Run-Off Destination

Surface water run-off is to discharge to one or more of the following in the order of priority shown:

- Discharge into the ground (infiltration);
- Discharge to a surface water body;
- Discharge to a surface water sewer, highway drain or other drain;
- Discharge to combined sewer.

The Management Train

A concept fundamental to implementing a successful SuDS scheme is the management train. This is a sequence of SuDS components that serve to reduce run-off rates and volumes and reduce pollution. The hierarchy of techniques that are to be used for the surface water management of the development are:

- Prevention - Prevention of run-off by good site design and reduction of impermeable areas;
- Source Control - Dealing with water where and when it falls (e.g. infiltration techniques);
- Site Control - Management of water in the local area (e.g. swales, detention basins);
- Regional Control - Management of run-off from sites (e.g. balancing ponds, wetlands).

Design Principles

The design principles for the surface water management of the development will be to:

- Ensure that people, property and critical infrastructure are protected from flooding;
- Ensure that the development does not increase flood risk off site;
- Ensure that SuDS can be economically maintained for the lifetime of the development.

Flood Risk

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

The drainage system will also be designed so that, unless an area is designed to hold and/or convey water, 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.

The design of the site will ensure that flows resulting from rainfall more than a 1 in 100-year rainfall event are managed in exceedance routes that avoid risk to people and property both on and off site.

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Peak Flow Control

The NPPG states the drainage is to be designed to control surface water run-off close to where it falls and mimic natural drainage as closely as possible, provide opportunities to reduce the causes and impacts of flooding, and remove pollutants from urban run-off at source.

A pre-development enquiry application was submitted to Thames Water in May 2017, with a response from Thames Water being received on the 30th May 2017 (see Appendix J).

The letter from Thames Water states that if the surface water cannot discharge to ground or to a waterbody, and therefore us to discharge to a sewer, the run-off rate is to be restricted to maximum rate of 5 l/s/ha.

Based on the above guidance, and pre-development response, the proposed surface water drainage system will restrict the surface water to the equivalent greenfield run-off rate of the surface water catchment area, or to the equivalent of 5l/s/ha of the equivalent surface water catchment area, whichever is the lower.

Volume Control

The run-off volume from the developed site for the 1 in 100-year 6-hour rainfall event will not exceed the pre-development run-off volume for the same event.

Should infiltration methods not be suitable, and it is not possible to achieve pre-development runoff volume, then it will be demonstrated that the increased volume will not increase flood risk on or off site.

Pollution

The SuDS design for the development site will ensure that the quality of any receiving water body is not adversely affected and preferably enhanced in accordance with Ciria SuDS Manual C753, Chapter 4.

Designing for Exceedance

The development site design will be such that when SuDS features fail or are exceeded, exceedance flows do not cause flooding of properties on or off site. This will be achieved by designing suitable ground exceedance or flood pathways, and run-off will be completely contained within the drainage system (including areas designed to hold or convey water) for all events up to a 1 in 30-year event.

The design of the site ensures that flows resulting from rainfall more than a 1 in 100-year rainfall event are managed in exceedance routes that avoid risk to people and property both on and off site.

3.0 Existing and Proposed Site

Site Location

The proposed development is located at Former Master Brewer Site, Freezeland Way, Hillingdon, London UB10 9PQ, which is in the London Borough of Hillingdon (LBH).

The development site located within a commercial and residential area; is approximately 2km north-east of Uxbridge town centre; 300m south east of Hillingdon train station; and is bound by the A40 Western Avenue to the north; undeveloped land to the east; Freezeland Way to the south; and Long Lane the west.

The OS coordinates for the centre of the site are - E: 507770, N: 184901.

Existing Site Description

The site is 2.53 ha in area, and the existing site is currently vacant with vegetation growth across the entire site area.

The development site was previously occupied by a motel building with associated hard standing and soft landscaping areas.

Proposed Development

The proposed site plans are shown in Appendix A, with a full description of the development site being stated by the Architect. In brief, and in relation to this FRA, the proposal is:

"Construction of a residential-led, mixed-use development comprising buildings of between 2 and 11 storeys containing 514 units (Use Class C3); flexible commercial units (Use Class B1/A1/A3/D1); associated car (164 spaces) and cycle parking spaces; refuse and bicycle stores; hard and soft landscaping including a new central space, greenspaces, new pedestrian links; biodiversity enhancement; associated highways infrastructure; plant; and other associated ancillary development."

Site Topography

Details of the topography can be found in Appendix B.

The site has a general fall from west to east with the highest point of the development site being to the south west corner at approximately 36.04m AOD, and the lowest point of the development site being along the east boundary at an approximate level of 34.04m AOD.

There are notable low-lying areas within the centre of the site which are believed to be around the perimeter of the former motel building at approximate general level of 34.50m AOD.

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Watercourses / Rivers / Estuary / Canals

There are no watercourses, rivers, estuaries or canals within the direct vicinity of the development site.

The nearest watercourse to the site is the Yeading Brook which is approximately 650m to the east, and the nearest river is the River Pinn which is approximately 750m to the west.

Ground Conditions

A ground investigation report was produced by Delta-Simons in June 2015 that states that the:

Ground conditions either comprised of Made Ground consisting of tarmac/concrete over sandy gravel to depths between 0.3 m and 0.9 m below ground level (bgl), or Made Ground comprising grass overlying sandy gravelly clay (Topsoil) to depths of between 0.3 m bgl and 0.6 m bgl. These all overlay possible Weathered London Clay comprising predominantly firm to stiff, occasionally silty clay to depths between 1.7 m and 3.5 m bgl, overlying firm to stiff, multi-coloured clays of the Woolwich and Reading Beds (Upper Mottled Beds) to depth between 9.5 m and 16.2 m bgl, overlying Woolwich and Reading Beds (Laminated Beds) comprising firm brown laminated clay and slightly clayey sand layers proven to a maximum depth of 20.0 m bgl.

Resting groundwater levels recorded during the return monitoring visits were between 0.90 m and 2.36 m bgl, considered representative of confined groundwater struck within the Laminated Beds.

Existing Site Drainage

Topographical survey information (Appendix B) has identified foul and surface water drainage within the development site boundary.

The surface water network runs around the parameter of the previous motel building and consists of 150mm to 225mm pipes, with approximate depths of between 1.0m to 1.5m.

The discharge point of the surface water sewer is unknown, but it is believed to discharge to a pump station located to the south west of the site (adjacent to Freezeland Way).

Thames Water Assets and Survey

The Thames Water Asset records and CCTV drainage survey of the sewers (Appendix C) show that the nearest sewers to the site are surface and foul water sewers within Long Lane (west of site) and Freezeland Way (south of site).

The surface water sewers directly adjacent to the site are in Freezeland Way, and consist of a 1000mm diameter surface water sewer running in a west to east direction, at an approximate depth of 3.40m deep (approximate invert level of 32.64m AOD); a 300mm diameter surface water sewer also running in a west to east direction, at an approximate depth of 1.40m deep (approximate invert level of 34.05m AOD); and a 600mm – 750mm diameter foul water sewer again running in a west to east direction at an approximate depth of 4.50m (approximately invert level of 30.79m AOD).

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Site Areas

The overall development site / site boundary area is 25,285m² / 2.53 ha.

The existing / pre-development site is currently vacant, with existing buildings demolished and existing drainage networks assumed to be abandoned.

As detailed on drawing 10203-GA-600A (Appendix D), hard standing areas within the site remain, which consist of the previous access road; car park areas; and the concrete slabs from the previous buildings that equates to an approximate area 14,288m² / 0.14288 ha.

With regards to the proposed / post development site, the new landscape / green areas are deemed to be permeable, and will not be positively drained, and will discharge from the site at a greenfield rate. This equates to an approximately 10,590m² / 1.059 ha.

The remaining areas of the site are deemed to be impermeable and will be positively drained off the site. The green roof areas (podium and roof levels) will also be positively drained off the site, but at a reduced rate.

The positively drained areas of the site equate to approximately 19,830m² / 1.983 ha, with 2,380m² / 0.238 ha being a green roof.

In summary, the areas of the post development site relevant to the surface water management report are as follows:

Overall Development Area	=	25,285m² / 2.53 ha
Landscape / Green Areas Not Positively Drained	=	10,590m² / 1.059 ha
Green Roof Areas	=	2,380m² / 0.238 ha
Positively Drained Area (excluding green roof and rain garden areas)	=	17,450m² / 1.745 ha
Total Positively Drained Area (including green roof and rain garden areas)	=	**19,830m² / 1.983 ha**

Refer to drawing 10203-GA-600 in Appendix D for permeable / impermeable areas and green roof areas. In terms of the restricted run-off rate calculations, to mimic the existing greenfield rate, the positively drained areas to be considered only. This will ensure that the restricted surface water run-off from the whole (including the landscape / grassed areas) development site will discharge at the greenfield run-off rate.

4.0 Surface Water Run-Off Analysis

The post development surface water run-off is to be reduced to as low as possible, to reduce the risk of flooding, with the preferred and minimum being the greenfield run-off rate.

The landscaped / grass areas of the post development site will not be positively drained, and will discharge off the site at a greenfield rate. Therefore, the calculations for the restricted surface water run-off rates to adhere to the above, will be for the post development positively drained area only.

To establish the required reduction / restriction for the post development surface water run-off rates, the pre-development greenfield run-off rate is to be calculated. The post development surface water run-off rates are then to be calculated to establish the impact of the development in terms of flood risk. The pre and post development figures are to be used to analyse the required SuDS methods to control the surface water, and to calculate the attenuation volumes required to prevent flooding for the 1 in 30-year storm, and controlled flooding for the 1 in 100-year storm including climate change.

5.0 Development Greenfield Run-Off Rate and Volume

To minimise the surface water run-off from the new development areas of the site, it is preferred that the post development surface water run-off be restricted to the equivalent greenfield run-off rate for the post development positively drained area.

To calculate the greenfield run-off rates the data from the Flood Estimation Handbook (FEH) has been used, as the Flood Studies Report (FSR) data is no longer the preferred rainfall calculation method.

The FEH method of calculation determines a Median Annual Flood (QMED) rate for the development, which is to be used as the known greenfield run-off rate. The input variables and calculation to determine QMED is as follows:

$$Q_{med.cds} = 8.3062\,AREA^{0.8510} \times 0.1536^{(1000/SAAR)} \times FARL^{3.4451} \times 0.0460^{BFIHOST^2}$$

where:

$Q_{med.cds}$	=	median annual maximum flood estimated from catchment descriptors
AREA	=	the area of the catchment in km²
SAAR	=	Standard Average Annual Rainfall for the period 1961–1990 in mm
FARL	=	a measurement of the attenuation influence of water bodies (eg lakes) in the catchment; it is unlikely that *FARL* will be relevant for development site runoff estimation, so this factor becomes 1.0 and therefore drops out
BFIHOST	=	a measure of the level of baseflow (ie ongoing runoff) from the catchment; the measure is provided within the FEH software or, if a suitable site soil assessment is available, then IH126 **Table 2.12** (Boorman *et al*, 1995) can be used to allocate a HOST category to the site soils, and IH126 **Table 3.4** can then be used to obtain a corresponding value for *BFIHOST*.

The FEH data that are specific to the development site are as follows:

Site Location	=	GB 507250 184950 TQ 07250 84950
Area	=	1.983 ha
SARR (mm)	=	637
SPRHOST	=	50.580
URBTEXT	=	0.47
BFIHOST	=	0.175
FARL	=	1.000

Based on these variables, and the calculation results provided by the MicroDrainage computer software (Appendix E), the QMED (Greenfield run-off) rate for the positively drained area of the site is as follows:

$QMED_{urban}$ = **11.70 l/s** = (5.90 l/s/ha)

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Greenfield Run-Off Volume

The greenfield run-off volume for the 1 in 100-year 6-hour storm event has been calculated in the XP Solution software using the data from the Flood Estimation Handbook (FEH), with the results shown in Appendix E.

The FEH data and variables used to calculate the greenfield run-off volume for the post development positively drained areas of the site are as follows:

Site Location	=	GB 507250 184950 TQ 07250 84950
C (1km)	=	-0.025
D1 (1km)	=	0.304
D2(1km)	=	0.321
D3 (1km)	=	0.230
E (1km)	=	0.305
F (1km)	=	2.546
Areal Reduction Factor	=	1.000
Area	=	1.938 ha
SAAR	=	637
CWI	=	93.660
SPR Host	=	50.58
URBTEXT	=	0.470

The results from the MicroDrainage calculations show that the greenfield run-off volume from the positively drained areas of the site equates to**:**

Q_{100} = **766.15m³** (360-minute storm duration)

6.0 Post Development Surface Water Run-Off Rates – No SuDS

The post development surface water run-off rates and volumes are to be calculated to assess the impact of the development in terms of surface water management. The post development surface water run-off rates are based on the positively drained area of 1.9703 ha.

These areas are also to be used, with the data given by the Flood Estimation Handbook (FEH), where the post development surface water run-off rates have also been simulated in the XP Solution MicroDrainage software (Appendix F).

The variables used (FEH data) to calculate the surface water run-off rates for the post development site with no restrictions / SuDS methods are as follows:

Positively Drained Area	=	1.983 ha
Site Location	=	GB 507250 184950 TQ 07250 84950
C (1km)	=	-0.025
D1 (1km)	=	0.304
D2(1km)	=	0.321
D3 (1km)	=	0.230
E (1km)	=	0.305
F (1km)	=	2.546
Time of Entry	=	5 minutes
Rainfall Intensity Increase (RII)	=	40%*

* This figure is based on the information provided by the 'Environment Agency – Table 2 Peak Rainfall Intensity in Small and Urban Catchments', where the upper end figure rainfall intensity increase for the life span of the development is stated to be 40%.

Based on the above variables and computer software results, the post development surface water run-off rates including the RII will be as follows:

Q_1	=	519 l/s (15-minute storm duration*)
Q_{30}	=	1688 l/s (15-minute storm duration*)
Q_{100}	=	2554 l/s (15-minute storm duration*)

**The critical storm duration to calculate the run-off rates in the mock network for each of the return period, is 15 minutes.*

Based on the above variables for the impermeable area surface water run-off, it has been calculated that the post development surface water discharge volume for a 1 in 100-year 6-hour storm event (including RII) will be **2122.52m³.**

7.0 Surface Water Run-Off Destination

The destination of the surface water run-off from the post development site has been assessed against the prioritisation set by the guidance from The London Plan Policy 5.13 and Approved Document H (2010). The feasibility of the surface water run-off to the priority receptors are as follows:

Run-Off Destination	Feasible	Description
Discharge to Ground	No	A ground investigation report was produced by Delta-Simons in June 2015, which states that the ground consists of made ground over London Clay. Clay is known to have a very low / zero infiltration rate, and therefore discharging the surface water to ground is not possible.
Discharge to Surface Water Body	No	There are no known surface water bodies within the vicinity of the development site.
Discharge to Surface Water Sewer	**Yes**	As the surface water cannot discharge to ground, and there are no know waterbodies near the development site. The only feasible method is to discharge the surface water to the nearest surface water sewer. The nearest surface water sewer with adequate depths to discharge the surface water by gravity s believed to be the 1000mm diameter sewer within Freezeland Way. The surface water will connect / discharge to this sewer at a restricted rate.
Discharge to Highway Drain or Other	No	Not required as discharge to surface water sewer.
Discharge to Combined Water Sewer	No	Not required as discharge to surface water sewer.

8.0 SuDS Hierarchy

As the results from the above calculations show, the post development (no SuDS) surface water run-off rates exceed the greenfield rates, but have a reduction from the positively drained rates for all storm events due to the introduction of green roofs and rain gardens.

However, to reduce the surface water run-off to the preferred rate of greenfield, further SuDS methods are to be introduced to the post development design.

ICIS Design Limited have considered all SuDS methods as per the Sustainable Drainage System (SuDS) hierarchy, and the Non-Statutory Technical Standards for Sustainable Drainage Systems – March 2015.

The various SuDS methods, their description and feasible use on this development are described below: -

SuDS Methods	Feasible	Description and Feasibility
Living Roofs	**Yes**	It is proposed to have green roofs for new buildings within the site, and at the podium level above the car park, as shown on drawings 10203-GA-600. The green roofs will reduce the surface water run-off from these areas, and will also act as a pollutant control. Therefore, it is deemed that the green roofs in these areas will be a feasible SuDS method.
Basins; Ponds; and Swales	**Yes**	It is proposed to have swales and ponds to the north of the development (adjacent to new buildings), and along the southern boundary of the development. The swales and ponds will attenuate the surface water when being restricted; will act as a pollutant control; and will add biodiversity to the development.
Raingardens / Filter Strips	**Yes**	There is potential to have raingardens and filter strips within the landscape areas adjacent to the building. The surface water will not infiltrate to ground, but will reduce the surface water run-off from these areas, and will also act as a pollutant control.
Rainwater Harvesting Tanks	No	Rainwater harvesting is not appropriate as attenuation in the drainage network, as the capacity of the rainwater harvesting tank will not be available if the residents do not use the volume of water. However, rainwater butts can be used for environmental reasons, to reduce the amount of treated water used for irrigation. Therefore, they will not be part of the drainage calculations, but are ecologically beneficial.

Infiltration Devices	No	A ground investigation report was produced in by Delta-Simons in June 2015, which states that the ground consists of made ground over London Clay. Clay is known to have a very low (if any) infiltration rate, and therefore the use of infiltration devices for the development site is not a feasible SuDS method.
Permeable Surfaces	**Yes**	Permeable block paving could be incorporated into road, footpath and car parking spaces throughout the site. The surface water would not be able to infiltrate to ground, but can be used in conjunction with the drained sub-base, where it will act as a pollutant control and will reduce the surface water run-off rates.
Tank Systems	**Yes**	To ensure the surface water is restricted to the desired rate, a flow control system is to be incorporated into the proposed drainage network. The surface water can be attenuated in the SuDS features detailed above, but there will also be a requirement for oversized pipes, oversized manholes and / or a cellular storage structure, to ensure no flooding occurs during the 30-year storm event, and that controlled / contained flooding only occurs during the 100-year + 40% RII storm event.

9.0 Surface Water Management Analysis

SuDS Summary

As detailed in the above sections, the post development surface water run-off rate exceeds the required pre-development greenfield run-off rates and minimum of 5 l/s/ha as stated by Thames Water.

Therefore, suitable SuDS methods are to be used in the post development design to reduce the post development surface water run-off and discharge volume to the required rates.

The preferred SuDS methods are to use infiltration devices; living roofs; basin / ponds / swales; filter strips / raingardens; rainwater harvesting; and permeable paving. If none of the above are practical, then tanked systems (with flow control) are to be used.

A ground investigation report was produced by Delta-Simons in June 2015, which states that the ground consists of made ground over London Clay. Clay is known to have a very low (if any) infiltration rate, and therefore the use of infiltration devices for the development site is not a feasible SuDS method.

The SuDS methods deemed to be feasible for the development site are the living roofs; swales and ponds; permeable paving; and potential rainwater gardens and filter drains.

As the infiltration is not feasible, and there are no waterbodies near the site, the only suitable destination for the surface water will be to the surface water sewer in Freezeland Way.

To ensure that the controlled surface water discharge does not increase the flood risk to the site or areas near the site, suitable below ground attenuation is to be provided.

Surface Water Run-Off Rate

To adhere to the London Plan, Paragraph 5.13, the surface water is to be restricted to the greenfield rate of positively drained areas of the development

The QMED (greenfield) run-off rate from the positively drained area of the development (1.983 ha) has been calculated to be **11.70 l/s.**

This is greater than the rate approximated greenfield rate stated by Thames Water of 5 l/s/ha (1.983 x 5 l/s = 9.92 l/s), but as it is the equivalent to the actual greenfield run-off rate, which is deemed to be acceptable.

Surface Water Run-Off Volume

The surface water run-off volumes for the post development site have been calculated for the 1 in 100-year, 6-hour duration (Inc. 40% RII) within the XP Solution MicroDrainage software (Appendix J).

The computer software calculation shows, that the surface water discharge volume for this storm event will be **443.98m^3**. The greenfield run-off volume for the equivalent storm event is **766.15m^3**, and therefore there will be a surface water volume decrease of **322.17m^3**.

The 'Non-Statutory Technical Standards for Sustainable Drainage Systems – March 2015' states that '*the post development surface water run-off rate should not exceed the pre-development greenfield rate, but where this is not reasonably practical the surface water run-off volume must be discharged at a rate that does not adversely affect flood risk.'*

The post development surface water run-off volume for the 1 in 100-year, 6-hour storm event (Inc. 40% climate change) will not exceed the pre-development rate, and therefore adheres to current regulations.

10.0 Surface Water Attenuation Volume Estimate

As stated above, if the post development run-off rates were restricted to 11.70 l/s there will be a requirement for surface water attenuation.

The attenuation volume can be achieved within the surface water network; swales / ponds; and a below ground cellular structure. The estimated storage volume will give an indication of what the pipe and manhole sizes, and the below ground cellular storage needs to be to prevent flooding, to adhere to:

Ciria SuDS Manual 2015, Paragraph 10.2.4 which states that: *'Exceedance flows (i.e. flows in excess of those for which the system is designed) should be managed safely in above-ground space such that risks to people and property are acceptable'.*

And PPS25 Practice Guidance Paragraph 5.51 which previously stated that: *'For events with a return-period in excess of 30 years, surface flooding of open spaces such as landscaped areas or car parks is acceptable for short periods, but the layout and landscaping of the site should aim to route water away from any vulnerable property, and avoid creating hazards to access and egress routes. No flooding of property should occur as a result of a one in 100-year storm event (including an appropriate allowance for climate change)'*.

The estimated attenuation volume has been calculated via in the Source Control of the XP Solutions software, using the variables and data set out previously in this report (refer Appendix G).

The MicroDrainage output file indicates the maximum volume of attenuation required (highlighted in red), which is the equivalent required attenuation volume.

The summary of the estimated attenuation volumes for the post development surface water catchment area of 1.983 ha, restricted to 11.70 l/s, and for each of the storm events are as follows:

Q_1	=	243m^3
Q_{30}	=	703m^3
Q_{100}	=	1043m^3
$Q_{100 + 40\% \text{ Climate Change}}$	=	1541m^3

Note: The MicroDrainage computer software calculations also show that the surface water half drain time is below 24-hours / 1440-minutes when discharge at 11.70 l/s, with the above attenuation.

11.0 Surface Water Drainage Network

As detailed on the outline drainage layout drawings (GA-601 and GA-602) in Appendix H, the surface water network consists of 225mm to 750mm pipes, with 1500mm to 2100mm manholes.

The surface water network shows the main drainage routes only, where the pipes and manholes are to be located within the car parking areas; access road areas; and partly in the amenity spaces of the site.

The surface water drainage network flows towards the south west of the development, where the surface water will pass through, and restricted by, a flow control (Hydro-Brake), prior to discharge by gravity to the 1000mm diameter surface water sewer within Freezeland Way.

The restricted surface water will surcharge the oversized pipes and manholes, and the overflow pipes that are connected to the cellular unit tank structure within the car park area (building west of site), and the various sale / ponds through the north and south of the site.

As detailed in the MicroDrainage output files (and drainage drawings) in Appendix I, to prevent flooding for all storms up to and including the 1 in 100-year event + 40% RII, the cellular storage structure is to be 873.60m³, with additional storage being provided within the swells / ponds, and oversized pipes and manholes within the network. The attenuation tank and pipe / manhole diameters have been sized to prevent flooding up to the 1 in 100-year + 40% RII event, to ensure that no flooding occurs to any of the buildings, and that safe ingress and egress (as detailed below) can be achieved through out the site.

Also, as detailed below, in the event of a storm greater than 1 in 100-year + 40% RII, flooding will occur at the lowest cover levels in the network. This will be in the car park area, and therefore this is where the potential flooding will occur, and will be contained without increasing the flood risk of flooding to properties on or near the development site.

Safe Ingress and Egress

As detailed within the MicroDrainage calculations (Appendix I), in the text above, and the drainage layout drawing GA-601 (Appendix H), there will be no surface water flood during the 1 in 100-year storm event including 40% climate change event anywhere in the network. Potential flooding will be in the car park area only, for storm exceedance events (greater than 100-year + RII), but safe access and egress can still be gained from the pedestrian and vehicular routes around the development site.

Surface Water Drain Time and Volume

The attenuation tank volume proposed for the development site (to prevent flooding) is 873.60m³. The surface water is to discharge at 11.70 l/s, and therefore based at this discharge rate, and if the tank were to be full, it would take 10.4 hours for half the volume of water to be discharged. This has been calculated by (436.8m³ x 1000) / (60 seconds x 60 minutes) / 11.70 l/s.

Therefore, as half the tank volume will discharge in 10.40 hours, the half drain time is achieved.

12.0 Maintenance Requirements

The extent of the drainage network and SuDS features for the development site are shown on the below ground drainage layout drawings in Appendix H.

Details of the maintenance required, and the parties to carry out the maintenance of all drainage aspects, to ensure that the SuDS methods are working affectively, and subsequently reducing the risk of flooding on the site are as follows:

Drainage networks

The management and maintenance of the surface water drainage networks will be by the estate management of the overall site, where the retail and residential unit owners / tenants, will be instructed to pay into an annual estate management fund when purchasing / renting the property.

SuDS Features

The management and maintenance of the SuDS features will also be by the estate management of the overall site, where the retail and residential unit owners / tenants, will be instructed to pay into an annual estate management fund when purchasing / renting the property, to ensure that the whole drainage system and paving will remain in a suitable condition for them to continue to act as a SuDS feature.

Surface Water Drainage Network

The required maintenance for the drainage network will be as follows:

Operation	Frequency
Inspect and identify any areas that are not operating correctly, if required, take remedial actions	Monthly for 3 months, then six monthlies
Debris removal from manholes (where may cause risk performance)	Monthly
Where rainfall into network from above, check surface or filter for blockage or silt, algae or other matter by jetting	As required, but at least twice a year
Remove sediment from pipework by jetting.	Annually or as required
Repair/check all inlets, outlets and overflow pipes	As required
Inspect/check all inlets, outlets, and overflow pipes to ensure that they are in good condition and operating as designed	Annually and after large storms

Swales / Ponds

Operation	Frequency
Inspections to identify any areas not operating correctly; eroded areas, hydrocarbon pollution, blocked outlets and silt accumulation. Record any areas that are ponding and where water is lying more than 48 hours.	Monthly

Collect and remove from the site all extraneous rubbish that is detrimental to the operation of the SUDS feature and appearance of the site, including paper, packaging materials, bottles, cans and similar debris.	Monthly
Maintain grass within the specified range (50mm above specified design water depth). Ensure that the soil and grass does not become compacted. Do not cut during periods of drought or when ground conditions or grass are wet	As required, but at least twice a year
Scarifying and spiking	As required
Reinstate design levels, repair eroded areas or damaged areas by returfing and reseeding.	As required
Seed or sod bare eroded areas.	As required

Flow Control and Attenuation Tank

Operation	Frequency
Inspect and identify any areas that are not operating correctly, if required, take remedial actions	Monthly for 3 months, then six monthlies
Debris removal from flow control chamber and attenuation tank (where may cause risk performance)	Monthly
Where rainfall into flow control chamber and attenuation tank from above, check surface or filter for blockage or silt, algae or other matter by jetting	As required, but at least twice a year
Remove sediment from upstream surface water network by jetting.	Annually or as required
Repair/check all inlets, outlets and overflow pipes	As required
Inspect/check all inlets, outlets, and overflow pipes to ensure that they are in good condition and operating as designed	Annually and after large storms

Permeable Paving, Filter Drain, Swales / Ponds

Operation	Frequency
Inspect and identify any areas that are not operating correctly, if required, take remedial actions	Monthly for 3 months, then six monthlies
Debris removal from catchment surface on surface of paving (where may cause risk performance)	Monthly
Where rainfall infiltration into paving and filter drains, check surface for blockage or silt, algae or other matter by jetting	As required, but at least twice a year

Linked and Further Maintenance

The maintenance of the drainage network and SuDS features are to be linked with the wider site maintenance for the new residential landscaped / garden areas.

Maintenance Activities

A log of all maintenance activities is to be kept and made available to the local planning authority (LPA) and / or the Lead Local Flood Authority (LLFA) on request.

13.0 Pre and Post Development SW Flow Routes

As detailed on drawings 10203-GA-600 and 10203-GA-600A (Appendix D), there is no surface water run-off from outside the site boundary that will flow into the post development site. This is due to the high points of the site being along the southern and western boundary (adjacent to existing carriageway), with the back of footpath levels being higher than the road channel levels.

If an extreme storm greater than the 1 in 100-year were to occur, or the maintenance of the SuDS features is not carried out, flooding may occur from the network.

As shown on drainage layout drawings 10203-GA-601 and 10203-GA-602 (Appendix I), the surface water will flow away from the proposed buildings towards the low points within the landscape areas and access road areas, where it will be contained.

The depth of the surface water within these areas will be less than 150mm, and therefore safe access and egress will be achievable even in the extreme storm event conditions.

Therefore, surface water will not flood the proposed buildings, and will not increase the flooding to areas within the vicinity of the site.

14.0 Pollution Prevention

The car parking areas will be covered by the building roofs, and therefore the pollutants from this area will be low as no surface water run-off from the car parking in this area will occur.

The other areas of the site also consist of footpaths and roof areas will have low pollutants in the surface water run-off, and will discharge partly through the green roof system and filter drain / rainwater garden system, which will act as a pollutant control.

The surface water run-off from the car parking bays and access road will discharge via permeable paving system where pollutants will be minimised before discharging to the main drainage network.

Prior to connection / discharge to the surface water sewer, the restricted surface water run-off will pass through a pollutant control chamber.

15.0 Development Management and Construction Phase

No surface water run-off will discharge from the proposed buildings until the below ground drainage and SuDS methods have been built.

16.0 Third Party Agreement

A pre-development enquiry application was submitted to Thames Water in May 2017, with a response from Thames Water being received on the 30th May 2017 (see Appendix K).

Thames Water sated that the surface water discharge is to be restricted to a maximum of 5 l/s/ha. Thames Water are to be consulted on the calculated greenfield run-off rate of 11.70 l/s, which exceeds the 5 l/s/ha.

17.0 Conclusion

The proposed / post development surface water drainage has aimed to meet the requirement of The London Plan Paragraph 5.13 that states that the preferred surface water run-off is to greenfield levels where practical, and to the guidance in Sustainable Design and Construction Supplementary Planning Guidance produced by the Greater London Authority that states that the surface water run-off is to be a 50% betterment of the pre-development run-off rates.

All SuDS methods have been assessed to establish whether these are feasible for the development to reduce the surface water run-off to the preferred greenfield rate.

Due to the nature of the site, as well as the ground conditions, the use of wetlands, ponds, detention basins or infiltration devices are not feasible SuDS options for the development site.

Therefore, the only alternative would be to use living roofs; permeable paving; swales / ponds; and filter drains / rainwater gardens.

As surface water cannot infiltrate to the ground, the only alternative would be to discharge the surface water to the existing surface water sewer within Freezeland Way, with the surface water being restricted to a rate of 11.70 l/s, which is the equivalent to the greenfield rate.

To prevent / reduce the risk of flooding for an area within or near the site, suitable attenuation is to be provided for all storms up to and including the 1 in 100-year (Inc 40% RII) in the form of a below ground cellular structure, swales / ponds and oversized pipes and manholes.

The drainage network and storage structures have been designed so that no flooding occurs on the site during the 1 in 100-year storm event including 40% RII.

The surface water management of the post development site adheres to all current regulations.

Appendix A – Proposed Development Plans

Appendix B – Topographical Survey

Appendix C – Thames Water Asset Records and Drainage Survey

Appendix D – Development Areas and SW Flow Routes

Appendix E – Greenfield Run-Off Rates and Volume

Appendix F – Post Development SW Run-Off Rates and Volume – No SuDS

Appendix G – Surface Water Attenuation Volume Estimate

Appendix H – Outline Drainage Layouts

Appendix I – Surface Water Drainage Network Calculations

Appendix J – SW Drain Time and Volume Calculation

Appendix J – Thames Water Correspondence