HILSON MORAN

Flood Risk Assessment

DATE OF ISSUE: **27 SEPTEMBER 2016**

REVISION NUMBER: 03

HM REFERENCE: **20186/S/FRA01/03**

PROJECT:
Greenwood Place Development
19 – 37 Highgate Road
Camden
NW5 1JY

CLIENT:
Fortnum Developments Ltd
Palladium House
1 – 4 Argyll Street
London, W1F 7LD

SHACKLETON HOUSE | HAYS GALLERIA
4 BATTLEBRIDGE LANE | LONDON | SE1 2HP
T: +44 (0)20 7940 8888 | F: 44 (0)20 7940 8801
www.hilsonmoran.com | info@hilsonmoran.com

HILSON MORAN

PROJECT NAME: **Greenwood Place Development**

REPORT NAME: **Flood Risk Assessment**

ISSUE STATUS: **FINAL**

HM REFERENCE: **20186/S/FRA01/03**

DATE OF ISSUE: **27 SEPTEMBER 2016**

REVISION NUMBER: **03**

AUTHOR: **T HALL**

CHECKER: **P BOND**

APPROVER: **S JOHNSON**

DOCUMENT HISTORY:

ISSUE	DATE	DETAILS
00	18/12/2015	DRAFT FINAL
01	15/4/2016	REVISED SUBMISSION
02	12/5/2016	FRONT COVER UPDATE
03	27/9/2016	REVISED SUBMISSION

Contents

Executive Summary

Hilson Moran Partnership Ltd (Hilson Moran) was appointed by Fortnum Developments Ltd to produce a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment (FRA) for the proposed redevelopment of 19 – 37 Highgate Road and the neighbouring A&A Self Storage unit, hereafter referred to as the Site.

The proposed application seeks to clear the existing site, including demolition of the current buildings on the site, for the construction of a new mixed-use development that comprises residential units, offices, retail units and the relocation of the self-storage provision to below ground.

The site lies in Environment Agency (EA) Flood Zone 1 (low flood risk), with the risk of flooding from groundwater, sewer and artificial sources also considered to be low. However, the risk of surface water flooding along Greenwood Place has been identified as presenting a medium risk to the development over its lifetime and requiring mitigation measure to be implemented in the design. Mitigation measures include the installation of manually operated flood barriers along the north and west boundaries of the Site. Responsibility for the installation of all barriers would remain with site management, which the Developer has confirmed will have a 24/7 presence on Site within the A&A Storage Unit.

Development constraints prevent the raising of ground floor levels. However, the final design of the development and this flood risk assessment has been completed in accordance with the principles set out in Section 5 of British Standard (BS) 8533:2011 'Assessing and managing flood risk in development – Code of practice'. **Therefore, it is recommended that 1 BREEAM Pol03 credit for Flood Resilience is awarded, provided the BREEAM Assessor is satisfied that all of the credit criteria are met. CfSH Sur 2 credits cannot be awarded as it is not possible to raise ground slab level 600mm above indicative flood levels.**

The FRA considers the revised UK Government climate change allowances, published on 19th February 2016. Taking a conservative 30% additional climate change contribution to runoff rates and volumes (midrange between the Central End Total and Upper End Total), the development will include at least 105 m^3 of rainwater water attenuation so as to limit run-off rate discharges leaving the site by 50% over the lifetime of the development (as compliant with the London Plan). The volume increase to 118 m^3 should the precautionary 40% climate change allowance be conditioned.

Attenuation is to be provided a basement storage tank and permeable paving. The Site will be managed by the developer who will take on all responsibility for the maintenance of installed SuDS.

Attenuated surface waters will be discharged to public sewer. Details of connection arrangements will be specified by the civil engineer but will include anti-flood valves to prevent any surcharge from the external outfall back into properties. **It is recommended that 2 BREEAM Pol03 credits for Surface Water Run-Off area awarded, provided the BREEAM Assessor is satisfied that all of the credit criteria are met. This is based on that appropriate attenuation through SuDS is provided to ensure that the peak rate of run-off for the 100 year critical return period for the development is no greater that pre-existing rates, AND the volume of run-off for the 100 year 6-hour storm duration is no greater over this period to the pre-existing volume. All calculations are inclusive of climate change.**

An infiltration based SuDS is not considered to be appropriate for the site due to a range of issues, most notably the provision of a 2-storey basement beneath the development across the whole site. **Consequently, the avoidance of discharge from the developed site for rainfall up to 5mm cannot be guaranteed for all events and the BREEAM Pol03 'Minimising watercourse pollution' and equivalent CfSH Sur 1 credit cannot be awarded.**

1. Introduction

1.1. Background

Hilson Moran Partnership Ltd (Hilson Moran) was appointed by Fortnum Developments Ltd to produce a NPPF compliant FRA for the proposed redevelopment of 19 – 37 Highgate Road and the neighbouring A&A Self Storage unit, hereafter referred to as the Site. The Site is centred on National Grid Reference TQ 28860 85405. A boundary plan of the Site is shown in Figure 1.1.

Figure 1.1 Site Boundary plan

The use of the Site is currently split, with 19-37 Highgate Road currently used as a National Health Service (NHS) Day Centre and the adjacent unit currently used for self-storage purposes. Proposals for the Site comprise a mixed development with residential units, offices and relocation of the self-storage provision to below ground.

1.2. Purpose

This FRA accords with the NPPF, the Flood and Water Management Act (2010) and Building Regulations, Part H (Drainage and Waste Disposal). Furthermore, the development is aiming to achieve a BREEAM Excellent rating under the 2014 New Construction Scheme and Code for Sustainable Homes (CfSH) Level 3. This report supports the BREEAM and CfSH assessments, where it is required to consider the risk of flooding and surface water management, and is produced in accordance with guidance contained within the NPPF relating to the necessary requirements of FRAs for the evaluation of risks associated with redevelopments.

1.3. Scope of the Assessment

This document comprises a FRA with respect to the proposed redevelopment of 19-37 Highgate Road and the A&A Self-Storage unit, London, NW5 1JY.

1.4. Structure

The following sections of the report appraise the pre-existing baseline conditions on the application site and describe the proposed development, flood issues relating to the development, flood risk posed by the development on the surrounding area, scope for mitigation and conclusions of the assessment.

Relevant appendices are included at the end of the report.

1.5. Limitation and Copyright

2. Certification

As the proposed development involves elements of new construction for office, industrial and residential uses, the development will be assessed under three different certification methods; (i) BREEAM 2014 NC Offices, (ii) BREEAM 2014 NC Industrial, and (iii) CsFH.

2.1. BREEAM 2014 – New Construction

BREEAM 2014 is an assessment system that allows the sustainability of a development to be established against a number of criteria, including energy and water efficiency, sustainable resource use, re-use of land, pollution prevention and impacts on biodiversity and ecology. Buildings are graded from 'Pass' to 'Outstanding' depending on their overall sustainable performance.

Although the industrial and office elements of the development are being assessed independently, they are both being assessed under the same scheme with the same criteria relating to flood risk and surface water run-off.

Pol03 Surface Water Run-off

The aim is to avoid, reduce and delay the discharge of rainfall to public sewers and watercourses, thereby minimising the risk and impact of localised flooding on and off-site, watercourse pollution and other environmental damage.

Pol03 is sub-divided into three sections: flood risk; surface water run-off; and, minimising watercourse pollution.

Flood Risk

2 credits are available where a site-specific flood risk assessment (FRA) confirms the development is situated in a flood zone that is defined as having a low annual probability of flooding (in accordance with current best practice national planning guidance), taking into consideration all current and future sources of flooding;

1 credit is available where a site-specific FRA confirms the development is located in a flood zone that is defined as having a medium or high annual probability of flooding and is not in a functional floodplain (in accordance with current best practice national planning guidance), taking into consideration all current and future sources of flooding, and the resilience and resistance of the development to flooding is increased by one of the following:

a) The ground level of the building and access to both the building and the site are designed so they are at least 600mm above the design flood level of the flood zone in which the assessed development is located; or,
b) The final design of the building and the wider site reflects the recommendations made by an appropriate consultant in accordance with the hierarchy approach outlined in Section 5 of British Standard (BS) 8533:2011[1].

Surface Water Run-off

The achievement of credits within this section is dependent upon achievement of the pre-requisite requirement for an appropriate consultant to be appointed and carry out, demonstrate and/or confirm the development's compliance with the following criteria:

1 credit is awarded where:

- Drainage measures are specified to ensure that the peak rate of run-off from the site to the watercourses (natural or municipal) is no greater for the developed site than it was for the pre-development site. This should comply at the 1-year and 100-year return period events;
- Relevant maintenance agreements for the ownership, long-term operation and maintenance of all specified SuDS are in place; and,
- Calculations include an allowance for climate change, this should be made in accordance with current best practice planning guidance.

1 credit is awarded where:

- Flooding of property will not occur in the event of local drainage system failure (caused either by extreme rainfall or a lack of maintenance); AND,

EITHER

- Drainage design measures are specified to ensure that the post-development run-off volume, over the development lifetime, is no greater than it would have been prior to the assessed site's development for the 100-year 6-hour event, including an allowance for climate change; and
- Any additional predicted volume of run-off for this event is prevented from leaving the site by using infiltration or other Sustainable Drainage System (SuDS) techniques.

OR (only where the above criteria cannot be achieved)

- Justification from the Appropriate Consultant indicating why the above criteria cannot be achieved, *i.e.* where infiltration or other SuDS techniques are not technically viable options;
- Drainage design measures are specified to ensure that the post-development peak rate of run-off is reduced to the limiting discharge. The limiting discharge is defined as the highest flow rate from the following options:
    i. The pre-development 1-year peak flow rate; or
    ii. The mean annual flow rate Qbar; or
    iii. 2 l/s/ha.
- Relevant maintenance agreements for the ownership, long-term operation and maintenance of all specified SuDS are in place;
- For either options above, calculations must include an allowance for climate change, which should be made in accordance with current best practice planning guidance.

Minimising Watercourse Pollution

1 credit is available where:

- There is no discharge from the developed site for rainfall up to 5mm (confirmed by the Appropriate Consultant);
- Where suitable pollution prevention measures are put in place (or already exist) for the different sources of pollution present on the assessed site, in accordance with Compliance note CN20;
- A comprehensive and up-to-date drainage plan of the site will be made available for the building/site occupiers; and
- Relevant maintenance agreements for the ownership, long-term operation and maintenance of all specified SuDS must be in place.

This credit can only be achieved for those developments where the use of infiltrating SuDS or rainwater harvesting with a catchment comprising the entire application site area is feasible to ensure no discharge from the developed site for rainfall up to 5mm. Although all other criteria will be met for this credit, due to constraints such as the known lack of ground level space, the inclusion of a site-wide basement and unsuitable strata, this credit is deemed unachievable as no discharge from the development site for rainfall up to 5mm cannot be guaranteed – this is demonstrated further within this report.

2.2. Code for Sustainable Homes

The CfSH was developed from the Building Research Establishment's (BRE's) EcoHomes standard to generate a standard method for assessing the sustainability credentials of new residential developments. Although the certification method has now been replaced, by the BRE's Home Quality Mark, some developments in the planning process will continue to have requirements to achieve CfSH certification.

Category 4 of CfSH deals with surface-water run-off and flood risk, with the assessment split into two sections: Sur 1 – Management of Surface Water Run-off from Developments; and, Sur 2 – Flood Risk.

Sur 1 Management of Surface Water Run-off from Developments

The aim of the credits is to design surface water drainage for housing developments which avoid, reduce and delay the discharge of rainfall run-off to watercourses and public sewers using SuDS techniques. This will protect receiving waters from pollution and minimise the risk of flooding and other environmental damage in watercourses.

A mandatory requirement for the credits under this section is for the SuDS Management train to be used as a guide to achieve the following:

1) *Peak Rate of Run-off*

- If there is no increase in the man-made impermeable area as a result of the new development, then the peak rate of run-off criterion does not apply;
- Where there is an increase in impermeable area, ensure that the peak rate of run-off over the development lifetime, allowing for climate change, will be no greater for the developed site that is was for the pre-development site. This should comply at the 1-year and 100-year return period events;

- Where the pre-development rate of run-off for the site would result in a requirement for the post-development flow rate (referred to as the limiting discharge) to be less than 5l/s at a discharge point, a flow rate of up to 5l/s may be used where required to reduce the risk of blockage.

2) Volume of Run-off

- If there is no increase in the man-made impermeable area as a result of the new development, then the volume of run-off criteria does not apply;
- If the developed site would otherwise discharge, over the development lifetime allowing for climate change, a greater volume of rainwater run-off than the pre-development site for the 100-year 6-hour event, then criterion A applies. If A cannot be satisfied, then B applies:

  a) Ensure that the post-development volume of run-off, allowing for climate change over the development lifetime, is no greater than it would have been before the development.

     The additional predicted volume of run-off for the 100-year 6-hour event must be prevented from leaving the site by using infiltration or other SuDS techniques;

OR

  b) If A cannot be satisfied (full justification must be provided) then reduce the post-development peak rate of run-off to the limiting discharge.

     The limiting discharge is the pre-development flow rate equivalent to the 1-year peak flow rate, mean annual flood flow rate (Qbar) or 2 l/s/ha, whichever is the highest flow rate.

     For the 1-year peak flow rate the 1-year return period event criterion in Section 1 above applies. For all other events up to the 100-year return period event, the peak rate of run-off for the developed site must not exceed the limiting discharge.

     Where the limiting discharge flow rate would require a flow rate of less than 5l/s at a discharge point, a flow rate of up to 5 l/s may be used where required to reduce the risk of blockage.

3) Designing for local drainage system failure

- Demonstrate that the flooding of property would not occur in the event of local drainage system failure (caused either by extreme rainfall or a lack of maintenance).

1 credit can be awarded by ensuring there is no discharge from the developed site for rainfall depths up to 5mm.

1 credit can be awarded by ensuring that the run-off from all hard surfaces shall receive an appropriate level of treatment in accordance with the SuDS Manual to minimise the risk of pollution.

Sur 2 Flood Risk

The aim of the credits is to promote housing development in low flood risk areas, or to take measures to reduce the impact of flooding on houses build in areas with a medium or high risk of flooding.

2 credits are available for developments located in Flood Zone 1 – low annual probability of flooding) and where the site-specific FRA indicates that there is a low risk of flooding from all sources;

1 credit is available for developments located in Flood Zones 2 and 3a – medium and high annual probability of flooding) where the finished ground floor level of all habitable parts of dwellings and access routes to the ground level and the site, are placed at least 600mm above the design flood level of the flood zone. The FRA must demonstrate to the satisfaction of the local planning authority and statutory body that the development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed.

3. Policy Framework and Legislative Regulation

3.1. Planning Policy

3.1.1. National

The NPPF[2] sets out policies which apply to the preparation of local plans, and to development management decisions. This framework sets out the Government's economic, environmental and social planning policies for England. Taken together, these policies articulate the Government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations. The NPPF states that flood risk and surface water disposal are material considerations for Local Planning Authorities (LPAs) when determining individual land-use planning proposals. The NPPF supersedes the previous Planning Policy Statement 25 on the consideration of flood risk in the planning process.

The NPPF reinforces the importance that the Government attaches to the management and reduction of flood risk in the land-use planning process, whilst also adopting a precautionary approach and fully accounting for the effects of climate change. The NPPF states how flood risk should be considered at all stages of planning and development, in an attempt to reduce future loss of life and damage to property.

The NPPF also states that surface water disposal is a material consideration for LPAs when determining individual land-use planning proposals and that SuDS should be incorporated into a development wherever practical.

In particular, Paragraph 103 of the NPPF states that:

'When determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- *within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location; and,*
- *development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning, and it gives priority to the use of sustainable drainage systems*'.

The NPPF is supported by planning practice guidance[3], which provides further information on key issues in the implementation of policies identified in the NPPF, and Technical Guidance to the NPPF[4], which sets out the requirements for a site specific FRA. The overall aim of the NPPF technical guidance is to steer development into areas of low flood risk (Flood Zone 1). The NPPF requires LPAs to demonstrate application of the Sequential Test, which aims to steer development into areas of low flood risk where all development types are considered to be appropriate. Sites in Flood Zone 3 should only be considered where opportunities in Flood Zones 1 or 2 are not reasonably available with the flood risk vulnerability of land uses taken into account and the application of the Exception Test if required.

3.1.2. Metropolitan

The London Plan[5] is the strategic planning document for London, produced by the Greater London Authority (GLA), setting out an integrated economic, environmental, transport and social framework for the development of London over 20 – 25 years. The London Plan requires all Borough development plans to be in general conformity with it.

The main policy in the London Plan dealing with flood risk is Policy 5.12 on Flood Risk Management, which states that:

- *'The Mayor will work with all relevant agencies...to address current and future flood issues and minimise risks in a sustainable and cost effective way*';
- '*Development proposals must comply with the flood risk assessment and management requirements set out in the NPPF...*';
- '*Development adjacent to the flood defences will be required to protect the integrity of existing flood defences...*';
- '*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...*'.

In addition to this Policy 5.13 on Sustainable Drainage provides relevant guidance, and states that:

'*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 n 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'.

The London Plan Sustainable Design and Construction Supplementary Planning Guidance (SPG)[6], which provides further guidance on the implementation of the London Plan policies, identifies that '*London Plan Policy 5.13 states that developers should aim for a Greenfield run-off rate from their developments [*formerly known as the Mayor's 'Preferred Standard' - this is interpreted as achieving the greenfield run-off rate from the pre-existing site during events ranging from 1 in 1 year to 1 in 100 year peak flows]. *Greenfield run-off rates are defined as the run-off rates from a site, in its natural state, prior to any development. Typically this is between 2 and 8 litres per second per hectare...*

If greenfield run-off rates are not proposed, developers will be expected to clearly demonstrate how all opportunities to minimise final site run-off, as close to greenfield rate as practical, have been taken... Most development s referred to the Mayor have been able to achieve at least 50% attenuation of the undeveloped site's surface water run-off at peak times. This is the minimum expectation from development proposals [formerly known as the Mayor's 'Essential Standard' – this is interpreted as achieving 50% surface water attenuation, both in run-off rate and volume from the pre-existing site (*i.e.* either brownfield or greenfield, depending on the use of the land immediately prior to the construction of the proposed development), during events ranging from 1 in 1 year to 1 in 100 year peak flows]...

All developments on greenfield sites must maintain greenfield run-off rates. On previously developed sites, run-off rates should not be more than three times the calculated greenfield rate. The only exceptions to this, where greater discharges may be acceptable, are where a pumped discharge would be required to meet the standards or where surface water drainage is to tidal waters and therefore would be able to discharge at unrestricted rates...

Development should utilise SUDS unless there are practical reasons for not doing so'.

3.1.3. Local

Local planning policy for the London Borough of Camden is currently provided through the Local Development Framework, which is made up of a number of planning documents including the Core Strategy[7], Development Policies[8] and Planning Guidance[9]. The Core Strategy sets out the key elements of the Council's vision for the development of the borough, the Development Policies set out detailed planning criteria that the Council use to determine applications for planning permission in the borough and the Planning Guidance comprises as series of documents that provide advice and information on how the Council applies its planning policies.

Core Strategy Policy CS13 on 'Tackling climate change through promoting higher environmental standards' provides strategic guidance in relation to flood risk, with the following aspects of the policy of relevance to this assessment:

'*The Council will require all development to take measures to minimise the effects of, and adapt to, climate change and encourage all development to meet the highest feasible environmental standards that are financially viable during construction and occupation by...ensuring buildings and spaces are designed to cope with, and minimise the effects of, climate change*'.

The Council '*will make Camden a water efficient borough and minimise the potential for surface water flooding by:*

- *Requiring development to avoid harm to the water environment, water quality or drainage systems and prevents or mitigates local surface water and downstream flooding, especially in areas up-hill from, and in areas known to be at risk from surface water flooding such as South and West Hampstead, Gospel Oak and King's Cross.*

Development Policy DP23 on Water provides the principle guidance on planning criteria relating to flood risk, and identifies that '*the Council will required developments to reduce their water consumption, the pressure on the combined sewer network and the risk of flooding by:*

c) Incorporating water efficient features and equipment and capturing, retaining and re-using surface water and grey water on-site;

d) Limiting the amount and rate of run-off and wastewater entering the combined storm water and sewer network through the methods outlined in part a) and other sustainable urban drainage methods to reduce the risk of flooding;

e) Reducing the pressure placed on the combined storm water and sewer network from foul water and surface water run-off and ensuring developments in the areas identified by the North London Strategic Flood Risk Assessment as being at risk of surface water flooding are designed to cope with the potential flooding;

f) *Ensuring that developments are assessed for upstream and downstream groundwater flood risks in areas where historic underground streams are known to have been present; and,*

g) *Encouraging the provision of attractive and efficient water features.*

In addition to this, Development Policy 22 on 'Promoting sustainable design and construction' identifies that '*the Council will require development to incorporate sustainable design and construction measures. Schemes must: a) demonstrate how sustainable development principles, including sustainable urban drainage systems, have been incorporated into the design and proposed implementation; and, b) incorporate green or brown roofs and green walls wherever suitable*'. The Policy also identifies that '*the Council will require development to be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures, such as: ...limiting run-off, reducing water consumption, not locating vulnerable uses n basements in flood-prone areas...*'.

Development Policy DP27 on 'Basements and lightwells' identifies that '*in determining proposals for basement and other underground development, the Council will require an assessment of the scheme's impact on drainage, flooding, groundwater conditions and structural stability, where appropriate. The Council will only permit basement and other underground development that does not cause harm to the built and natural environment and local amenity, and does not result in flooding or ground instability. The Council will require developers to demonstrate by methodologies appropriate to the site that schemes: avoid adversely affecting drainage and run-off or causing other damage to the water environment.*

The Council will not permit basement schemes which include habitable rooms and other sensitive uses in areas prone to flooding'.

The Sustainability Camden Planning Guidance document identifies exactly what the Council expects from a development proposal:

- '*Developments must not increase the risk of flooding, and are required to put in place mitigation measures where there is known to be a risk of flooding;*
- *Within the areas identified on Core Strategy Map 5 the Council will expect water infrastructure to be designed to cope with a 1 in 100 year storm event in order to limit the flooding of, and damage to, property;*
- *All sites in Camden over one hectare or 10,000 sq m require a Flood Risk Assessment in line with the National Planning Policy Framework. The assessment should be site specific and concentrate on the management of surface water run-off, and/or groundwater where applicable, and should address the amount of impermeable surfaces resulting from the development and the potential for increased flood risk both on site and elsewhere within the catchment. These must be prepared by a suitably qualified professional and should be submitted with a planning application;*
- *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;*
- *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*'.

The Council are, however, consulting on a new draft Local Plan[10], which will replace the existing planning policy documents. Although the Local Plan has not yet been formally adopted, the planning policies contained within the draft version provide a useful understanding of the Council's current thinking regarding flood risk in the borough.

The main guidance with regards to flood risk will be provided through Policy CC3 'Water and flooding', which requires developments to consider the impact of the development on Local Flood Risk Zones, achievement of greenfield run-off rate or, where infeasible, equal to that pre-development, and location of vulnerable uses. The main principle of not increasing flood risk remains, with an aim of reducing flood risk through the development.

The basement and lightwell policy (DP27) will remain largely the same, however the new policy (A5) will place a requirement for the completion of a Basement Impact Assessment and, where necessary, a Basement Construction Plan. The requirements of Policy DP22 will be required through the new Policy CC2 'Adapting to Climate Change'.

3.2. Legislative Regulation

3.2.1. Building Regulations Part H: Drainage and Disposal (2010)

Building Regulations Approved Document Part H3[11] states that, where feasible, the first choice for surface water removal should be to discharge such waters to an adequate soakaway or infiltration system. If this is not reasonably practicable then discharge should be to a watercourse, the least favoured option being to an existing sewer.

3.2.2. Environmental Protection Act (1990)

The Environmental Protection Act (1990)[12] states that '*Contaminated land is any land which appears to be in such a condition, by reason of substances in, on or under the land, that:*

- *Significant harm is being caused or there is a significant possibility of such harm being caused, or*
- *Pollution of controlled waters is being or is likely to be caused*'.

3.2.3. Flood and Water Management Act (2010)

The Flood and Water Management Act 2010 (FWMA)[13] makes specific provision for the management of risks associated with flooding and coastal erosion.

The Act states that construction work which has drainage implications may not be commenced un less a drainage system for the work has been approved by an approving body (unitary authority/ county council).

In determining an application for approval the approving body must:

- '*grant it, if satisfied that the drainage system, if constructed as proposed, will comply with national standards for sustainable drainage*; or,
- *refuse it, if not satisfied*'.

The Act therefore removes the automatic right to connect to the public sewer if the proposed drainage strategy does not fully consider the feasibility of sustainable drainage techniques and instead gives powers to local authorities as SuDS Approving Bodies (SABs) to approve new drainage systems and their connection to public sewers.

It is intended that SABs should assess whether surface water drainage proposals meet a new National Standard for SuDS and Specified Criteria. The SAB also has a further duty to adopt and maintain approved drainage systems serving more than one property and not forming part of the public (adopted) highway.

4. Baseline Conditions

4.1. Existing Site

The Application Site cover an area of 2,720 m^2 (0.27 ha) and is currently developed, supporting a NHS day care centre and A&A Self-Storage unit. The Site is bounded to the north and west by Greenwood Place, to the east by Highgate Road and to the south by the Christ Apostolic Church.

The NHS day care centre fronts onto Highgate Road, providing specialist services for the care of those with mental ill-health. The centre has a small patio garden along the southern and western boundaries of the property and a car park to the north which also has a small patch of amenity grassland.

The A&A Self-Storage building fronts onto Greenwood Place and occupies the development site on the western half. The building houses a number of self-storage units, with office provision at the top floor. A small car parking area is present on the northern side of the building.

4.2. Topography

The topography at the borough scale is described in the London Borough of Camden SFRA, which identifies that the land within the borough typically slopes in a south-easterly direction with Hampstead Heath and north Hampstead representing the high points in the borough with a peak around 121 to 135m Above Ordnance Datum (AOD). The central London locations around St. Pancras and Holborn in the south of the borough represent the low points with the heights in these locations getting down to between -2 and 12m AOD.

The development site and immediate surrounding area shows a general slope site towards the north-west, with the lowest point of the Site being 36.43 m AOD. Highgate Road, which runs along the eastern boundary of the Site is at an elevated height compared to Greenwood Place, with the road being approximately 37.40m AOD. Greenwood Place then slopes down from this point to the low point at the bend in the road, with the road sloping upwards as it runs south. The buildings located along Highgate Road are slightly higher in level to those along Greenwood Place, with the NHS Day Care Centre entrance on Highgate Road being at 37.53m AOD whilst the car park entrance is located at 36.85m AOD and the A&A Self-Storage Unit located at 36.61m AOD. The adjacent Christ Apostolic Church is located at a higher level, 38.23m AOD, although the adjacent buildings along Greenwood Place are at a similar level of around 36.5m AOD.

4.3. Geology and Soils

The British Geological Survey's Geology of Britain viewer[14] provides an understanding of the geological formations throughout Great Britain. Review of the information at the 1:50,000 scale mapping identifies that the application site is located on a bedrock of clay, silt and sand from the London Clay Formation, a sedimentary bedrock formed approximately 34 to 56 million years ago in the Palaeogene Period. The bedrock in the vicinity of the development site is not overlain by superficial geological deposits, with no superficial deposits in close proximity to the site.

The National Soil Resources Institute (NSRI) Soilscape[15] database identifies the soil types across England and Wales. The database identifies that the land on which the development site stands is overlain with slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils. This soil type naturally has impeded drainage properties.

Reference is also made to the British Geological Survey's online borehole archive records. Although no records currently exist for the development site, a single borehole record is located approximately 55 m to the east at the Kentish Town Fire Station (National Grid Reference TQ 28943 85430). The borehole was drilled to a depth of 9.14m, with the top 0.91m comprising made ground, followed by 0.76m of brown clay and scattered gravel, 5m of firm brown mottled clay and the final 2.5m comprised of firm brown fissured clay.

4.4. Hydrology

4.4.1. Information Sources

In determining hydrological conditions across the proposed site reference has been made to a number of sources. In particular, information has been brought together from:

- The EA's Flood Map internet resource;
- The London Borough of Camden Flood Risk Management Strategy (FRMS)[16];
- The London Borough of Camden Strategic Flood Risk Assessment (SFRA)[17];
- The London Borough of Camden Surface Water Management Plan (SWMP)[18].

4.4.2. Surface Waters

The London Borough of Camden no longer contains any main rivers, with historic culverting of the Rivers Fleet, Tyburn and Brent which had their sources in the area of Hampstead Heath. The River Fleet now comprises one of the largest of London's subterranean rivers. The two sources of the River Fleet feed two chains of ponds on Hampstead Heath (Hampstead Ponds and Highgate Ponds), following which they are entirely enclosed within the sewer system until their discharge into the River Thames under Blackfriars Bridge. Historically, the river would have flowed in close proximity to the development site, with the two branches passing through Gospel Oak and Kentish Town before converging to the north of Camden Town. Similarly, the Rivers Tyburn and Kilburn have been incorporated within the sewer network.

The absence of main rivers was confirmed by a review of the Detailed River Network provided by the EA in support of the SFRA.

As a result, significant surface waters in the borough are restricted a number of ponds present within Hampstead Heath, which are located along the original path of the River Fleet, three ponds located within Waterlow Park in the north-west of the Borough and Regent's Canal, which bisects the borough from east to west some 1.2km to the south of the development site.

4.4.3. Flood Mapping

The EA Flood Zone Mapping identifies that the Application Site is located wholly within Flood Zone 1 (Low risk, *i.e.* less than 1 in 1,000 annual probability of river or sea flooding - <0.1%), with the Camden Flood Risk Management Strategy identifies that there is no flood risk from rivers or the sea in the borough.

4.4.4. Groundwater

The London Borough of Camden SFRA identifies that areas underlain by bedrock within the Borough are expected to have depths to the water table of either >5m throughout the year or <3m for part of the year. Using information from a variety of sources, the London Borough of Camden SWMP identified areas in which it was considered there was an increased potential for groundwater levels to rise within 2m of the ground surface following periods of higher than average recharge. The areas identified as having increased potential for elevated groundwater are all within the southern part of the Borough, around the Euston and King's Cross areas, and associated with permeable superficial deposits.

The London Borough of Camden FRMS identifies that the risk of groundwater flooding in Camden is uncertain and that further information research is required. However, the document identifies that the EA has published a map of areas within the borough that are more susceptible to groundwater flooding. The areas identified are associated with the southern area of the Borough, around the King's Cross and Euston area, and the northern parts of the Borough, around Hampstead and Highgate. The development site is significantly distanced from both areas of risk.

The EA's groundwater protection map identifies that the entire application site falls outside of the Total Catchment area of all Source Protection Zones (SPZs) in the region, with the closest SPZ (Outer Zone – Zone II) lying approximately 1.7 km to the south-west of the site to the north of Regent's Park.

Given that the site is located beyond the outer bounds of any SPZ/potable water abstraction points, groundwater resources or underlying aquifers, the potential risk of contaminant mobilisation and migration to these resources is considered to be of low significance and no special measures or restrictions are anticipated when designing the drainage systems for the scheme.

4.4.5. Surface Water Flooding

Surface water flooding occurs when intense, often short duration, precipitation events are unable to enter a drainage system due to blockages, breakages in water pipes or where the drainage capacity has been exceeded. This type of flooding is usually short-lived, associated with heavy precipitation events and can be highly localised. The effects of climate change are predicted to increase the frequency of heavy downpours, therefore increasing the number of events that exceed the capacity of the sewer system.

Surface run-off will tend to flow towards low spots where it collects. Flood and drainage modelling conducted for the London Borough of Camden have identified that the majority of the borough, including the area of the Site, is located within a Critical Drainage Area (CDA). CDAs are discrete geographic areas, usually a hydrological catchment, where multiple and interlinked sources of flood risk cause flooding.

Within the CDAs, are smaller areas identified as Local Flood Risk Zones (LFRZs). LFRZs are defined in the SFRA as "*discrete areas of flooding that do not exceed the national criteria for a 'Flood Risk Area' but still affect houses, businesses or infrastructure".* The development site does not lie within a LFRZ, the closest of which is Maitland Park approximately 325 m to the west of the Site.

The most recent and up-to-date surface water modelling available for the Borough is provided by the EA's updated Flood Map for Surface Water, which demonstrates that for modelled scenarios (1 in 30 year, 1 in 100 year and 1 in 1,000 year events) susceptibility of surface water flooding broadly follows the natural topography of the Borough as well as infrastructure routes (*i.e.* roads and rail). Figure 4.1 provide an extract of Surface Water Flood Map modelled by URS and which is contained within Camden's SFRA. Greenwood Place, running along the north and west of the site, is shown to be susceptible to potential flooding surface water flooding.

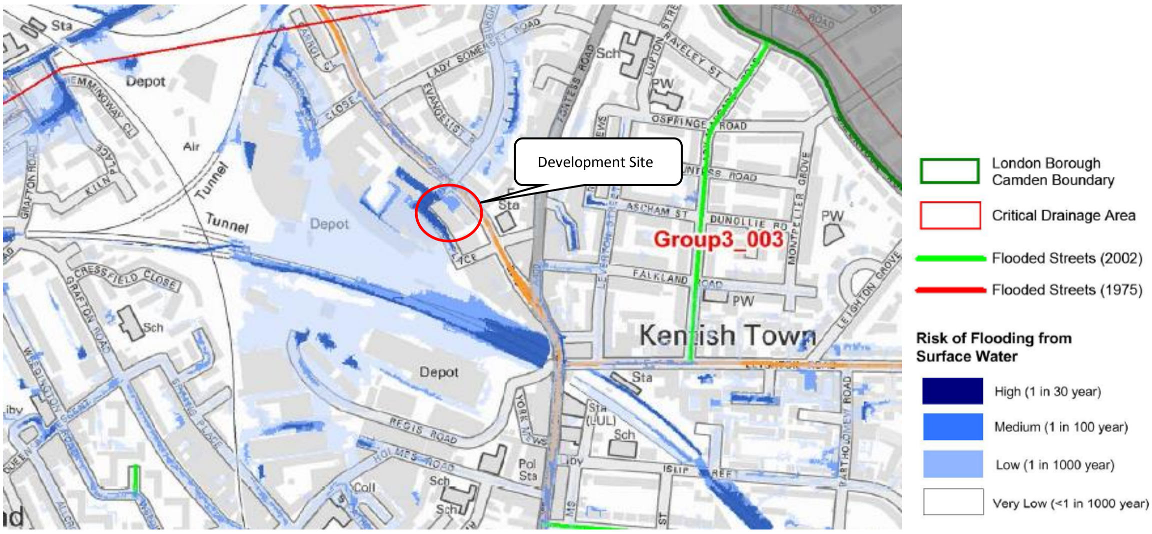


Figure 4.1 ***Surface Water Flood Risk.*** *Source: London Borough of Camden SFRA)*

Indicative flood depths of from surface water flooding are provided by the EA's Surface Water Depth map (Figure 4.2). For the medium probability (1 in 100 year or 1% AEP), as is appropriate for the proposed residential development (refer to Section 6), surface water flood depths along Greenwood Place are within the 300mm and 900mm range.

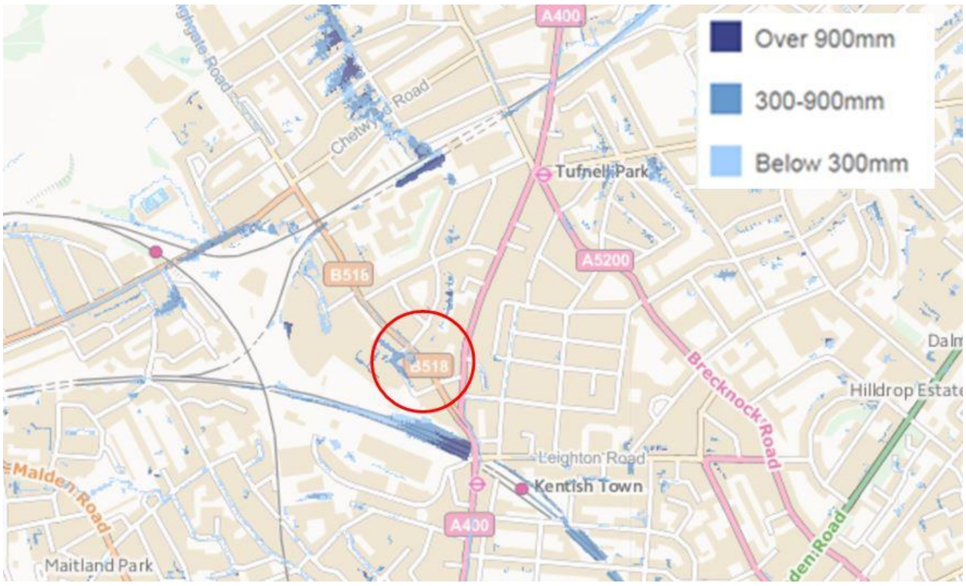


Figure 4.2 ***Surface Water Flood Depth Mapping.*** *Source: Environment Agency*

It is recognised by Camden in its SFRA that the surface water flood modelling has limitations and therefore application on its use. Section 3.2.8 of the SFRA notes the limitation as:

- Use of a single drainage rate for all urban areas;
- It does not show the susceptibility of individual properties to surface water flooding;
- The mapping has significant limitations for use in flat catchments;

- No explicit modelling of the interaction between the surface water network, the sewer systems and watercourses;
- In a number of areas, modelling has not been validated due to a lack of surface water flood records;
- As with all models, the updated Flood Modelling for Surface Water (uFMfSW) is affected by a lack of, or inaccuracies, in available data.

Section 5.4 of Camden's 2013 Flood Risk Management Strategy states that the modelling *"is not detailed enough to determine which individual properties would be affected, but can be used to identify areas where* we [Camden] *should focus our resources."*

The uFMfSW method is explained in detail within the EA's 'What is the updated Flood Map for Surface Water?' report, dated November 2013. Surface water flow paths in urban areas are recognised to be influenced by the buildings, roads and infrastructure. For the modelling performance, the ground slab of buildings are raised by 300mm and road levels lowered by the 125mm to *"ensure the principal flood pathways are better represented".* Urban drainage removal rates of 12mm/hr are adopted in the model (as indicated by bullet point 1 above) although it is recognised that calculated sewer capacity range between 5 mm/hr and 54 mm/hr.

Camden's FRMS comments that drainage capacity modelling doesn't take account of local variation and notes that capacity of in Camden is greater than in much of the country due to the incorporation of the river Fleet into the drainage system.

Introduced through the FWMA 2010, Lead Local Flood Authority (LLFA) were established for the purpose, amongst others responsibilities, of assessing local flood risk and setting out objectives for managing local flooding. The London Borough of Camden acts as the LLFA which is recognised within their 2013 report 'Managing Flood Risk in Camden'. The report makes reference to two flood events having occurred across the borough in 1975 and 2002. The SFRA does not record any flooding to have occurred on Greenwood Place or along Highgate Road in the vicinity of the Site during either of these two events (SFRA Figure 3 ii). Furthermore, the 2002 event is noted to have affected the postcode area of the Site (NW5) and have "had a 1% chance of happening in any year or 1 in 100 year return period".

The risk of surface water flooding to the proposed development without mitigation is deemed to be medium. The mitigation strategy in discussed in Section 6.

4.4.6. Sewer Flooding

During heavy rainfall, flooding from the sewer system may occur if: the rainfall event exceeds the capacity of the sewer system/drainage system; the system becomes blocked (by debris or sediment); or the system surcharges due to high water levels in receiving watercourses.

The London Borough of Camden SFRA identifies that the majority of the borough is served by a combined surface water and foul water sewer system, with the Thames Water Utilities Limited sewer systems now typically designed and constructed to accommodate rainfall events with a 3.3% AEP or less. However, the North London SFRA identified that the sewer network within Camden was particularly old, with some sections potentially designed to only convey storms up to the 10% AEP event.

As previously identified, the combined sewer systems incorporate a number of underground river systems, including the River Fleet. The Fleet Storm Relief Sewer was built in the 1870s to increase the ability of the sewer network to cope during extreme rainfall events, which passes through Kentish Town railway station before running parallel to the Fleet Trunk Sewer to their respective outfalls into the River Thames.

The combined sewer network is designed to outfall into the River Thames during intense rainfall events when the sewer network reaches capacity. However, the SFRA identifies that there is evidence that during the 1975 and 2002 extreme rainfall events surcharging of the local sewer network occurred as its capacity was exceeded. The reason for this was potential as a result of the inability of the combined sewer network to discharge to the River Thames at a high enough rate to convey surface water present during particularly extreme rainfall events.

4.4.7. Artificial Waterbodies

The London Borough of Camden SFRA identifies three main sources of potential flood risk associated with the Borough: raised reservoirs within Hampstead Heath, Maiden Lane Reservoir in Islington and Regents Canal.

Hampstead Heath contains about 30 ponds, three of which are classified as 'large raised reservoirs' under the Reservoirs Act 1975. The reservoirs are owned and managed by the City of London Corporation and English Heritage, with both being fed by the River Fleet and discharging into the sewer network. Maiden Lane Reservoir is a covered service water reservoir owned by Thames Water located in Islington.

The SFRA identifies that, in the event of a breach, flood water from any of the three Hampstead Heath and Highgate Pond reservoirs, would result in extensive flooding with waters flowing southwards at velocities up to 2m/s with flood depths potentially ranging between 0.3m and 2m. Flooding from the Maiden Lane Reservoir, a covered service water reservoir owned by Thames Water Utilities Limited, would result in a similar impact on the borough.

However, flooding from these sources would need to result either from the reservoirs being overtopped (gradual) or failing (catastrophic). The former is unlikely because the water levels of large reservoirs are carefully management and water can be transferred in and out through pipes and main river systems. The latter is unlikely because the Reservoirs Act requires that, regardless of the level at which a large reservoir might overtop, there must be no risk of catastrophic breach from an event with an annual probability of occurrence of less than 1 in 10,000 (0.01%). All large reservoirs must be inspected and supervised by reservoir panel engineers.

The water level in Regent's Canal is carefully controlled by a series of lock gates, with the risk of flooding as a result of overtopping or breaching of the canal considered by the SFRA to be low.

4.5. Records of Historical Flooding

4.5.1. Riverine

The SFRA confirms that the EA's Historic Flood Map shows no flooding has occurred within the London Borough of Camden as a result of flooding from fluvial or tidal sources.

4.5.2. Groundwater

There are a total of 23 EA groundwater flood incidents identified in the SFRA, which are spread out across the borough, with four discrete areas identified where properties have been affected by historical groundwater flooding, which are mainly located in the South and West Hampstead areas.

The SFRA does not identify any known historical records of groundwater flooding within the development site or in close proximity to it.

4.5.3. Surface Water

The SFRA identifies that the development site has not been subject to historic surface water flooding, however Highgate Road was subject to flooding as a result of the 1975 extreme rainfall event, when 170.8mm of rainfall was recorded by the Hampstead Scientific Society in a 2 to 3 hour period, and the 2002 extreme rainfall event.

4.5.4. Sewer

The SFRA identifies the areas in which historical sewer flooding has occurred, which due to data protection requirements has been provided at the 4 digit post code level. In the last 10 years, no properties within the post code area in which the development sits has been subject to internal or external sewer flooding.

Records of sewer flooding identified that the principle area of historical sewer flooding are located in the South Hampstead (NW6 2; NW6 3; NW6 4; NW3 4; NW3 5), Hampstead (NW3 1), Primrose Hill (NW3 3; NW8 6) and Camden Town (NW1 9) areas.

4.5.5. Artificial Waterbodies

There are no records of historical flooding from Regent’s Canal within the London Borough of Camden. Following the 1975 rainfall event the dams on the Hampstead Heath Ponds experienced some damage and the Stock Pond, within the Highgate Chain, was overtopped in 2010 during a rainfall event. However, further works to these ponds as a result has been investigated as part of the Hampstead Heath Ponds Project to ensure they are safe and provide an adequate level of flood protection.

5. Proposed Development

The Proposed Development comprises demolition of the existing buildings on the site and construction of a new mixed-use development that comprises residential units, offices, retail units and the relocation of the self-storage provision to below ground.

The development will take the form of two buildings, separated through the middle of the site by a landscaped pedestrian area that links Highgate Road and the parallel component of Greenwood Place (to the proposed Greenwood Centre). The building on the southern part of the site will be 6 storeys above ground and the building on the northern part of the site will be 8 storeys above ground, with a two storey basement extending across the entire site.

The ground level Highgate Road frontage will comprise the A&A Self-Storage retail on the northern building, with self-storage units located in the two basement levels, and the cafe on the smaller southern building. Office accommodation is proposed for inclusion within the larger building in the northern part of the site across the second and third floors, with access to a shared amenity terrace. Residential units are proposed across all floors of the southern buildings and the ground and fourth floors and above on the northern building.

6. Flood Risk Effects of the Proposed Development

6.1. Assessment of On-Site Flood Risk

The EA Flood Map and London Borough of Camden SFRA indicate that the proposed development is wholly located in the EA's Flood Zone 1. Referring to NPPF Technical Guidance, the location of the proposed development would be categorised as '*Low Flood Probability*' – *i.e.* the annual probability of flooding from riverine sources is less than 0.1%. Consequently, there is no requirement to provide compensatory fluvial flood storage and the residual risk of fluvial/coastal flooding is **not considered to be significant**.

Review of the EA and London Borough of Camden SFRA information also demonstrates that the site does not lie within an area susceptible to groundwater flooding. However, although the site is not located in one of the more susceptible areas in the borough, the FRMS does highlight uncertainty in the risk of groundwater flooding in the borough and that further information is required to fully understand it. Nonetheless, the susceptible locations in the borough are largely located on superficial geological deposits with the development site not located on such a feature. Therefore, the risk of groundwater flooding to the proposed development is **not considered to be significant**.

The EA and London Borough of Camden SFRA and SWMP information demonstrate that part of the development site is susceptible to surface water flooding. Within the development site, moderate risk surface water flooding is associated with the NHS day care centre car park, present on the northern part of the site alongside Highgate Road, and will occur during the 1 in 100 and 1 in 1000 year events. Greenwood Place itself is identified as susceptible to high risk surface water flooding, occurring during the 1 in 30, 1 in 100 and 1 in 1000 year events, with the area of flood risk appearing in the London Borough of Camden SFRA to extend to the edge of the A&A Self-Storage building. Following development, the high risk surface water flooding area encroaches over the development site, notably associated with the loading bay and ventilation grilles that lead to the basement areas as well as part of the self storage car park. The moderate flood risk area extends across the A&A Self-Storage shop front, reception and car park areas. Consequently, without mitigation, the risk of flooding of the proposed development from surface water flooding is therefore considered to be of **moderate adverse significance**.

Although information provided through the London Borough of Camden SFRA and North London SFRA highlight a potential susceptibility of the borough to sewer flooding, there are no records of flooding incidents as a result of sewer flooding within the post code area containing the development. Consequently, the risk of flooding of the site from the sewers is **not considered to be significant**.

Although the London Borough of Camden SFRA and EA Flood Mapping identifies the potential for flooding of the Application Site from the Hampstead Heath and Highgate Reservoirs and the Maiden Lane Reservoir. However, the SFRA identifies that such an event is extremely unlikely to occur due to tight regulations and controls surrounding the operation and maintenance of waterbodies classified under the Reservoirs Act 1975. Flooding from other artificial sources, notably Regent's Canal, was identified as negligible in the SFRA. Therefore, flooding of the development from artificial sources is **not considered to be significant**.

6.1.1. Mitigation Consideration

The London Borough of Camden SFRA identifies that, although there is no set guidance for the setting of finished floor levels of developments in relation to flood risk other than fluvial sources, the London Borough of Camden should consider requiring a freeboard for proposed developments in areas of surface water flood risk. The EA's requirement for a minimum freeboard of 300mm above the 1% AEP plus climate change peak flood level is considered to be an appropriate recommendation for More Vulnerable developments, such as housing.

Further to this, the SFRA recommends that in order to mitigate any potential flood damage a range of flood resilient construction techniques are implemented, as recommended in the Department for Communities and Local Government guidance document 'Improving the Flood Performance of New Buildings, Flood Resilient Construction'[19]. The aim of this document is to provide guidance to developers on how to improve the resilience of new properties in low or residual flood risk areas, through the use of suitable materials and construction details. Figure 6.1 provides and extract from the document that identifies potential design strategies associated with flooding depths.

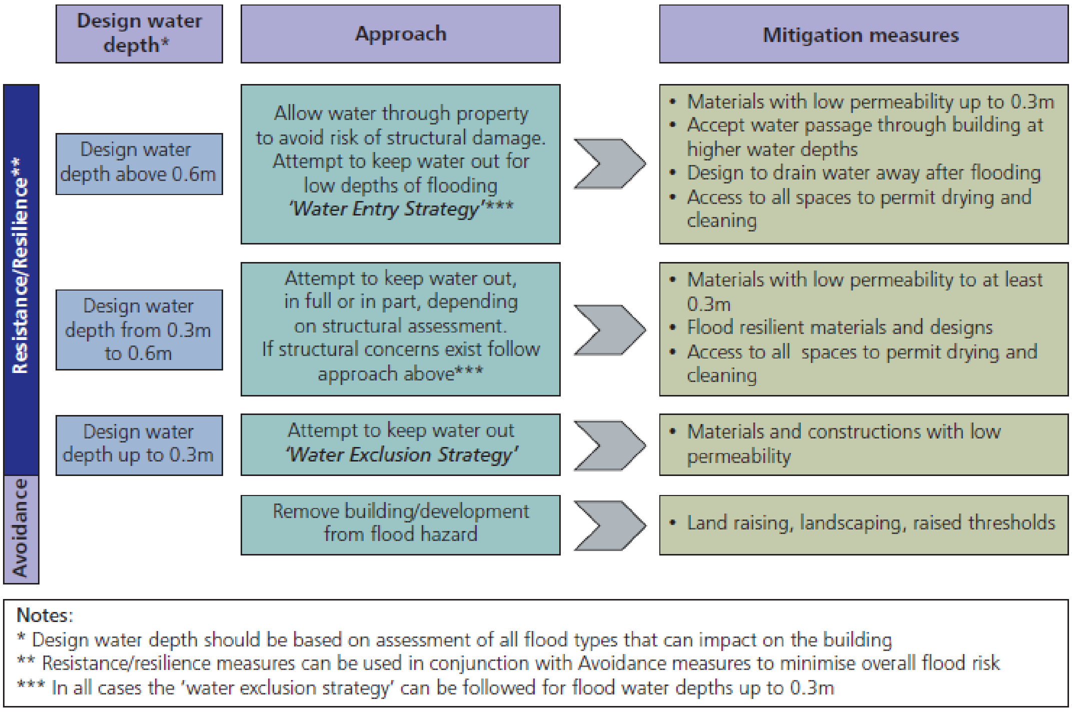


Figure 6.1 ***Flood Resilient Design Strategies*** *(from Department for Communities and Local Government Guidance Document[20])*

However, application of these recommendations is difficult due to the limitations of the surface water flood risk data. The modelling on which this is based is of a relatively coarse scale that allows for the identification of areas at risk and approximate flood depths, rather than specifying particular properties that are at risk or specific depths of flooding that could occur.

Therefore, the Site has been considered to be at moderate risk of surface water flooding and mitigation measures have been adopted to mitigate against this. As the indicated flood depths are based on a coarse scale modelling assessment and considering an absence of historical surface water flooding records for the site, including during the 1975 and 2002 extreme rainfall events, flood protection up to a depth of 600mm is considered to be a pragmatic approach for the development site.

The raising of finished flood levels within the development site has not been considered to be feasible due to constraints associated with the site layout, which aims to provide the most pragmatic solution to the provision of residential units and assisted living units, and topographical levels surrounding the site. As the development agreement includes the provision of ground floor assisted living accommodation units it is not possible to re-locate less sensitive uses into this area of the development.

Consequently, flood resistance mitigation measures have been identified that follow the recommendations of Figure 6.1in regards to design water depths of 0.3m to 0.6m, adopting a flood exclusion strategy. The DCLG guidance document[21] identifies flood resistance measures as measures that *'prevent floodwater from entering the building and damaging its fabric'*. It has been confirmed by the project's structural engineer, Meinhardt, that neither floodwater nor the accompanying water pressures would have a detrimental effect on the building structure, and therefore an exclusion strategy up to 0.6m is appropriate.

Flood barriers provide the most suitable flood resistance mitigation measure for the development site, and therefore it is recommended that hydrostatic barriers are provided along the building entrances along the northern and western boundaries of the development site. In addition to the barriers, it is recommended that the window sill levels along the western boundary of Buildings 1 and 2 are raised to 600mm to ensure floodwaters cannot enter the building through these.

Manually erected barriers, such as that supplied by Flood Control International, typically comprise 'slot in place' barriers which are manually inserted into pre-installed wall channels. Where longer barriers are proposed intermediate posts are utilised, which are bolted into pre-installed intermediate bases. A system of the size required for the development site is estimated to require approximately 45 minutes to 1 hour for 2 able persons to implement.

Responsibility for the erection of all barriers in a storm event would fall to Site Management within the A&A Storage Unit. Fortnum Development has confirmed that the Site will be manned permanently by at least two people. Management would ensure that all staff are familiar with the location and installation of barriers. Installation protocols would be implemented instruction the installation of barrier to more sensitive area first, i.e. residential units. No responsibility would rest with residents of the ground floor living units.

Site Management will have responsibility, set out by daily management protocols, to check the weather forecast in readiness to install barrier in the event of heavy rainfall. Where available, Site Management would register to receive EA/Met Office warnings of potential flash flooding.

Figure 6.2 identifies the recommended locations for the implementation of flood barriers, which includes entrances to ground floor properties, the service route to Building 1 onto Greenwood

Place, the sub-station, A&A Self-Storage Access on Greenwood Road and the southern private access to Building 2. In addition to this, a flood barrier will be provided on the western end of the central pedestrian route between Buildings 1 and 2 ensuring an appropriate step-free escape route onto Highgate Road is available for all residents (see Figure 6.3).

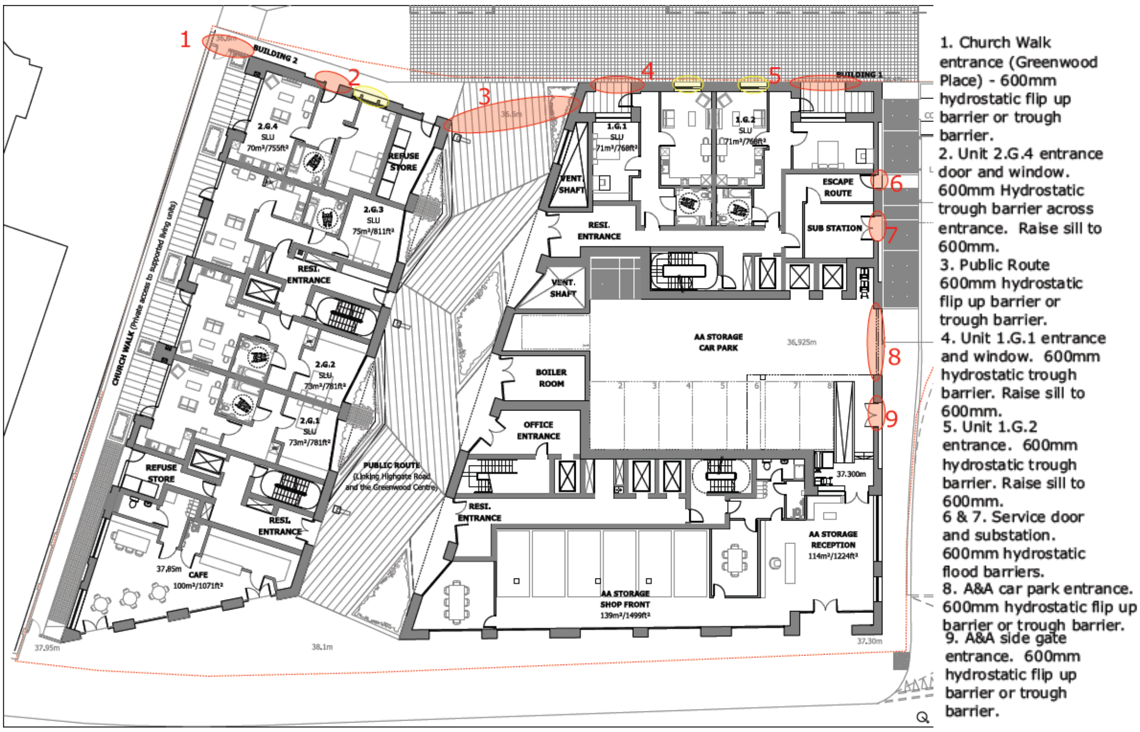


Figure 6.2 Recommended Locations for Flood Resistant Mitigation Measures

Figure 6.3 Emergency Escape Routes in Flooding Events

6.2. Assessment of Effects on Surrounding Area

6.2.1. Surface Water Management and SuDS Philosophy

The NPPF states that the Government's policy is to reduce flood risk. Therefore, redevelopment of the Site should be seen as an opportunity for environmental enhancement and a net reduction in flood risk. As such, the development should aim to reduce run-off below the existing condition. If this is deemed impractical due to various constraints, the proposed development should at least maintain run-off rates and volumes at existing conditions.

SuDS can be a combination of both physical structures and techniques used to control surface water run-off as close to its origin as possible, before surface water discharges to a watercourse or to ground. There are a wide variety of sustainable drainage options available that can be applied in different ways to help manage both surface and ground waters in a sustainable manner. Specific solutions need to be developed for each site, the choice of which will depend on factors such as the nature of the site, the type of pollutants potentially present, the hydrology of the area and the presence of Groundwater SPZs.

The implementation of SuDS as an alternative to conventional drainage systems can provide significant direct and indirect long-term environmental benefits. Depending on the choice of the system these can include:

- Reduction in overall flood risk on-site and downstream from the proposed redevelopment by reducing surface water run-off to watercourses, either permanently or after peak flow periods in the system;

- Providing opportunity for infiltration of surface water into soil, where feasible, to replenish groundwater, and help maintain baseflows in rivers;
- Promoting a healthier waterway flow regime to receiving watercourses and reducing the impact of bank erosion and habitat damage caused by the increase in flow rate of additional surface water run-off;
- Reducing the amount of pollutants reaching waterways and infiltrating the ground;
- Habitat creation and enhancement of the amenity of an area. This applies predominantly to open drainage options, especially where wet ponds or wetlands are implemented;
- Potential reduction in development costs, by reducing costs for the provision of surface water drainage on-site;
- Refund of the annual surface water drainage fee that is usually charged for the provision of surface water drainage services on the property. If a SuDS device manages all of a site's surface water and there is an agreement ensuring no surface water connection will be made to foul sewers, the service provider (*e.g.* Thames Water) will annually refund this portion of the service rate;
- If adopted as a philosophy rather than simply an engineering solution and integrated at the outset of a design layout, SuDS can offer significant infrastructure savings and add amenity value to a project.

6.2.2. Site Characteristics

The Application Site covers an area of 2,720 m^2 and is predominantly covered by existing buildings and hardstanding. Approximately 110 m^2 of the site is comprised of semi-natural habitats, consisting of amenity grassland in the north-east corner and planting areas in the garden of the NHS day care centre. As a result, the surface impermeability is 95.96%.

The re-development of the site would increase the area of impermeability to 100% as a result of the loss of these semi-natural areas, and although landscaping is proposed for the development with the presence of a basement across the site these will have to be within artificial raised planters.

6.2.3. General Design Considerations

For new developments there is a general expectation that a drainage system should be adequate, subject to compliance with Building Regulations. Adequate performance will usually be achieved if the drainage system:

- Conveys the flow via a suitable network of treatment systems to a suitable outfall (a soakaway, a watercourse, a surface water or combined sewer);
- Minimises the risk of blockage or leakage with good access for clearing blockages and any necessary maintenance;
- Has sufficient capacity to carry or retain the expected flow at any point in the system and so does not increase the vulnerability of the development to flooding;
- Provides drainage from roofs or paved areas to an adequately and suitably designed drainage system; and
- Where necessary is adequately ventilated such that foul air does not enter buildings.

It should be noted that:

- The priority for discharge of rainwater is firstly to an adequate soakaway or infiltration system, if that is not reasonably practicable then to a watercourse, the last option (as is the case for the proposed development) is to a sewer; and
- Discharges into the ground (where permitted) should be distributed sufficiently so that foundations of buildings or structures are not damaged.

In considering the most appropriate SuDS for the Proposed Development, reference has been made to the CIRIA 'Sustainable Drainage System Manual'[22] and the Office of the Deputy Prime Minister's (ODPM's) 'Interim Code of Practice for Sustainable Drainage Systems'[23].

Location

Building Regulation H3 states: '*The requirements of H3 will be met if rainwater soaking into the ground is distributed sufficiently so that it does not damage foundations of the proposed building or adjacent structures*'. Typically, therefore, soakaways or other infiltrating structures should be located a minimum of 5 m from any building (including buildings located over the boundary). Sub-surface conditions should be assessed by a geotechnical expert to ensure that the operation of the soakaway will not saturate the foundations of any structure. Thus, direction of groundwater flows, depth of existing groundwater and the presence of shallow impermeable strata should all be considered when selecting a suitable location.

Given the extent of the buildings comprising the application site and the underlying basement, it would not be deemed appropriate to recommend infiltrating SuDS for this scheme unless a dedicated assessment of its suitability had been made by a suitably qualified and experienced geotechnical expert.

Groundwater

In assessing the risk of contamination to 'exposed' groundwater resources, it has been established in Section 4.4.4 that the application site lies outside of all SPZs, with the nearest Total Catchment SPZ being 1.7 km to the south-west by Regent's Park.

Soil Contamination

Building Regulation H3 stipulates that '...[Infiltration devices should not be built] *where the presence of any contamination in the run-off could result in the pollution of a groundwater source or resource*'. This is re-affirmed in the SuDS manual, which states that '*in areas containing contaminated soils or contaminated groundwater, soakaways are not acceptable*'.

Furthermore, The Environmental Protection Act (1990) states that '*Contaminated land is any land which appears to be in such a condition, by reason of substances in, on or under the land, that:*

a) *Significant harm is being caused or there is a significant possibility of such harm being caused; or,*

b) *Pollution of controlled waters is being or is likely to be caused*'.

The use of the Site and surrounding buildings have comprised a mix of industrial storage and works buildings. Shallow Soils and groundwater are reported to have been affected by low levels of contamination. Natural firm impermeable London Clay is encountered around 1.0m depth below surface level.

The proposed development comprises a site-wide dig for the construction a new two-storey basement. With the exception of a very small peripheral area on the northwest corner of the Site, the construction of an infiltrating SuDS systems is not possible. The identification of shallow contamination counters the installation of infiltrating SuDS elsewhere.

6.2.4. Preliminary Run-off Calculations

The following section provides an empirical demonstration of the reduction in surface water run-off volumes and rates.

Methodology

Firstly, the greenfield peak run-off rates for a range of return periods have been estimated using the Interim Code of Practice for SuDS (ICP SuDS) methodology, included within the Micro Drainage WinDes drainage design suite. For sites <50 ha, ICP SuDS advocates a pro rata methodology based on IH Report 124[24] with growth curves from the Flood Studies Report[25] and CIRIA Book 14[26]. The method requires input of the standard average annual rainfall (SAAR) for the site in question, which was extracted from the Flood Estimation Handbook (FEH) CD-ROM (*i.e.* 665 mm)[27]. The HR Wallingford UK Sustainable Drainage website[28] and Wallingford Procedure Technical Report[29] were used to determine values for the soil index (SOIL) and 'urban catchment wetness index' (UCWI) for the Application Site, which are 0.47 and 128 respectively.

The FEH CD-ROM is able to generate design rainfall depths for a range of specified return periods and storm durations. FEH design rainfall data have therefore been used in conjunction with the Wallingford Procedure (Modified Rational Method) to determine the Brownfield (existing) and proposed development run-off rates and volumes. Run-off rates and volumes for the proposed development have subsequently been re-assessed after the incorporation of SuDS devices.

With reference to the size and layout of the site, the Kinematic Wave Equation was used to determine a time to concentration (t_c) of approximately 9.19 minutes. However, the use of FEH design storm data is not recommended for storm durations of less than 30-minutes. Therefore, a 30-minute time to concentration of surface water run-off from the site was used to model a range of return periods in order to simulate the range of worst case scenario run-off rates and volumes from the site.

Furthermore, in accordance with the SuDS Manual, the 100-year 6-hour event was modelled for each scenario respectively, permitting the difference in run-off volume pre- and post-development for this event to be calculated. The use of the 100-year 6-hour event is a simple rule of thumb, which is particularly aimed at protecting smaller watercourses and the modelling of this event is typically requested by the Environment Agency for new developments.

Greenfield Run-off Rates

Greenfield run-off rates were calculated using the methodology described in Section 6.3.1. The results of this procedure are presented in Table 6.1, which identifies an estimated greenfield run-off rate for the 100-year storm of 6.99 l/s or 25.72 l/s/ha.

Table 6.1 ICP SuDS Greenfield Run-off Rates

Return Period (Years)	Peak Greenfield Run-off Rate (l/s)	Peak Greenfield Run-off Rate (l/s/ha)
$QBAR_{rural}$	2.19	8.07
1	1.1	4.04
2	1.93	7.08
5	2.81	10.32
10	3.55	13.04
30	4.96	18.24
100	6.99	25.72

Existing (Pre-Developed Brownfield) Run-off Rates and Volumes

Existing run-off rates and volumes have been calculated using the above described methodology with a percentage impermeable surface area of 95.96% equating to a winter percentage run-off (PR) value of 80.58 %, using the Wallingford Procedure.

The results of this procedure are presented in Table 6.2, which identifies an estimated brownfield run-off rate and volume for the 100-year 30-minute storm of 73.02 l/s or 268.45 l/s/ha and 101.20 m^3. The brownfield 100-year 6-hour storm (78.75 mm rain) was also modelled and returned a run-off rate and volume of 10.40 l/s or 38.22 l/s/ha and a volume of 172.61 m^3.

Table 6.2 Existing (Pre-developed) Brownfield Peak Run-off Rates and Volumes

Return Period (Years)	30-Minute FEH Storm Depth (mm)	Run-off Volume (m^3)	Peak Flow Q	
			(l/s)	(l/s/ha)
1*	4.41	9.67	6.99	25.69
2	10.36	22.71	16.41	60.34
5	15.50	33.97	24.56	90.28
10	20.13	44.12	31.89	117.25
30	30.02	65.80	47.56	174.85
100	46.09	101.02	73.02	268.45

Proposed Development Run-off Rates and Volumes

Run-off rates and volumes have been calculated in the absence of any mitigation. The percentage impermeable surface area will increase to 100%, and as a result the run-off rates and volumes post-development will increase. The run-off rates and volumes have been modelled using the 100% impermeable surface area, which, using the Wallingford Procedure, equates to a percentage run-off (PR) value of 83.93 %.

The results are presented in Table 6.3 and demonstrate an estimated run-off rate for the 100-year 30-minute storm of 76.06 l/s or 279.62 l/s/ha and a volume of 105.22 m^3. The Brownfield 100-year 6-hour storm (78.75 mm rain) was also modelled and returned a run-off rate and volume of 10.83 l/s or 39.81 l/s/ha and a volume of 179.79 m^3.

* 1 in 1 year depths derived from 1 in 1.0004 year, due to inability of FEH method to provide depths for 1 year and less return periods.

Table 6.3 Proposed Development Peak Run-off Rates and Volumes (without Mitigation)

Return Period (Years)	30-Minute FEH Storm Depth (mm)	Run-off Volume (m^3)	Peak Flow Q	
			(l/s)	(l/s/ha)
1†	4.41	10.07	7.28	26.75
2	10.36	23.65	17.10	62.85
5	15.50	35.39	25.58	94.03
10	20.13	45.96	33.22	122.12
30	30.02	68.54	49.54	182.12
100	46.09	105.22	76.06	279.62

Consequently, when comparing the pre- and post-development run-off rates and volumes in the absence of mitigation, the re-development of the site will result in an increase in the run-off rate of 0.43 l/s or 1.6 l/s/ha and volume of 7.18 m^3 during the 100-year 6-hour storm.

Revised UK Government climate change allowances were published on 19th February 2016. Both central and upper end predictions for peak rainfall intensity are provided in Table 2 of the guidance ("*peak rainfall intensity allowance in small and urban catchments*") and the guidance goes on to advise that "f*or flood risk assessments and strategic flood risk assessments, assess both the central and upper end allowances to understand the range of impact*." Assuming a 100 year lifetime for the residential development, the guidance suggests that the central total potential change anticipated for 2060 to 2115 is +20 % and the upper end total potential change anticipated for the same period is 40 %.

The former NPPF guidance applied a 30% allowance for increased rainfall intensity over the anticipated lifetime of the proposed residential-led redevelopment. This allowance falls between the Central End and Upper End totals and is considered precautionary. Applying this to the proposed developed, the modelled runoff rates and volumes was calculated that showed the post-development 100-year critical storm duration (59.9 mm rain) results in a run-off rate of 98.87 l/s or 363.50 l/s/ha and a volume of 136.79 m^3.

Therefore, the post-development 100-year critical storm event modelled above, inclusive of a 30% allowance for increased rainfall intensity due to climate change, indicates that the application site, with the impacts of climate change over the lifetime of the development, would lead to an increase of approximately 35.8 m^3 in the volume of rainfall run-off during the 100-year critical storm event, when compared against the existing situation.

The runoff volume of the post-development 100-year 6-hour storm event, inclusive of climate change, was also modelled and returned a run-off volume of 233.72 m^3. Therefore with the impacts of climate change over the lifetime of the development, would lead to an increase of approximately 61.1 m^3 in the volume of rainfall run-off during the 100-year 6-hour storm event, when compared against the existing situation.

Upper End Total:

† 1 in 1 year depths derived from 1 in 1.0004 year, due to inability of FEH method to provide depths for 1 year and less return periods.

Assuming a conservative stance and applying a 40% *Upper End Total* allowance for increased rainfall returned post-development runoff rates and volumes for 100-year critical storm duration (59.9 mm rain) results in a run-off rate of 106.48 l/s or 391.46 l/s/ha and a volume of 147.31 m^3.

Therefore, the post-development 100-year critical storm event modelled above, inclusive of a 40% allowance for increased rainfall intensity due to climate change, indicates that the application site, with the impacts of climate change over the lifetime of the development, would lead to an increase of approximately 46.3 m^3 in the volume of rainfall run-off during the 100-year critical storm event, when compared against the existing situation.

The runoff volume of the post-development 100-year 6-hour storm event, inclusive of climate change, was also modelled and returned a run-off volume of 251.72 m^3. Therefore with the impacts of climate change over the lifetime of the development, would lead to an increase of approximately 79.1 m^3 in the volume of rainfall run-off during the 100-year 6-hour storm event, when compared against the existing situation.

Mitigation Consideration

The 2015 London Plan and its accompanying Supplementary Planning Guidance 'Sustainable Design and Guidance' set out the Mayor's expectation for surface water attenuation on all developments. The requirement is that peak surface water run-off rates are reduced by 50% from pre-existing rates.

The pre-existing rate of run-off from the site is 73.02 l/s during the 1 in 100 year critical storm. The requirement is therefore to reduce this to 36.51 l/s through the use of on-site surface water attenuation. The volume of storage required to achieve this rate reduction over the life time of the development, *i.e.* inclusive of climate change, is calculated to be 105 m^3 (factoring 30% climate change addition) or 118 m^3 (factoring the conservative Upper End Total 40% CC addition).

Provision of this volume of attenuation goes significantly beyond the minimum requirement of offsetting the additional runoff from climate change (35.8 m^3 and 46.3 m^3 respectively for the 30% and 40% climate change scenarios) and is to be provided through the installation of a basement attenuation tank and permeable paving.

The tank would be located in the northwest corner of basement level -1, as shown in the architect's drawing, reference C645_P_B1_001. A copy of this drawing is provided in Appendix 2. The area set aside for the attenuation tank measures 17.22m by 5.1m with a floor to ceiling height of 2.5 m. Assuming a minimum clearance of 0.5m around the sides of the tank and 1m headroom clearance, a glass reinforced plastic tank (as is typically specified) and constructed of 1m^2 or 0.5m^2 panels, with approximate dimension 16.5m by 4.5m by 1.5m could be installed, demonstrating a maximum tank storage of approximately 111.4 m^3.

Attenuation storage, would also be provided by permeable paving within the pedestrian link separating Blocks 1 and 2. It is proposed to place a modular sub-surface storage system, such as Permavoid Althon SUDS SEL Source Control System. A single layer of modular storage extends to 0.15m and has a 95% void volume. Provision of this system across this paved area would therefore provide up to 40.7 m^3 of attenuation storage (as identified in Figure 6.4).

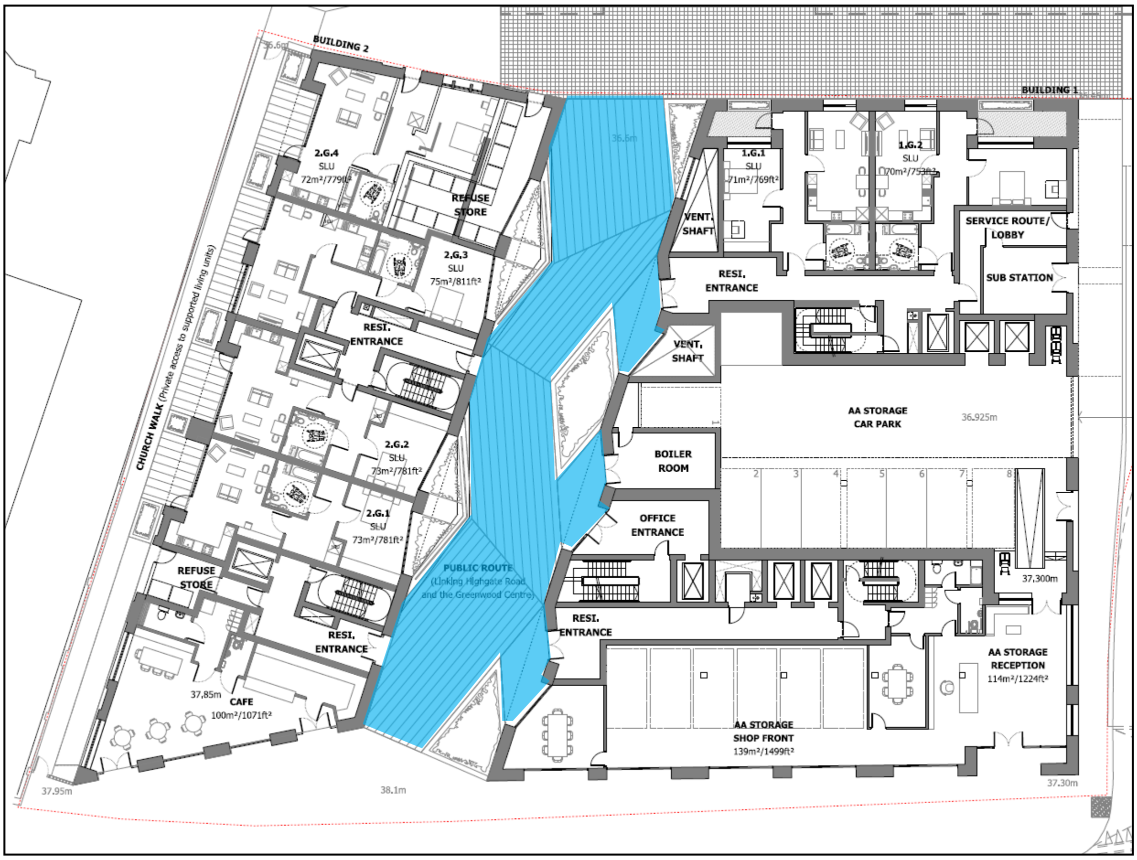


Figure 6.4 Area of Proposed Development Suitable for Permeable Paving

In total the proposed maximum attenuation storage that the development could accommodate is 152.1 m^3.

This significantly exceeds the additional runoff volumes during both the critical storm event and 6-hour storm events (35.8 m^3 and 61.1 m^3 respectively for the 30% climate change scenario, and 46.3 m^3 and 79.11 m^3 respectively for the 40% scenario) inclusive of climate change and over the lifetime of the development.

Furthermore, this volume also exceeds the storage volume necessary to reduce by 50% the overall pre-existing runoff rates from the Site during the critical storm event inclusive of additional contribution from climate change over the lifetime of the development (105 m^3 or 118 m^3 respectively for either the 30% or 40% scenarios).

It is considered that the 30% figure for additional runoff contribution from climate change is pragmatic and should be applied. The exact attenuation storage arrangement and volumes will form part of the detailed civils works post-planning.

6.2.5. Maintenance of SuDS

The provisions of the FWMA 2010 have been subject to significant delay and have not yet been fully implemented (refer to Section 3.2.3).

During this interim period, it is recommended that SuDS are constructed to the National Standards with the future allowance that they could be adopted by the local SAB once the Schedule 3 responsibilities come into force.

Anticipated maintenance will comprise annual inspections of channels/gullies/outfall(s) for litter/blockages and an annual sweep of permeable pavement external surfaces where installed.

It is anticipated that the new permeable pavements/sub-surface storage will remain privately owned and maintained by site management (their efficient operation and maintenance possibly being secured through condition). Permavoid offer an annual maintenance arrangement of its installed systems which may be opted for by site management.

6.2.6. Pollution Minimisation during Construction

Minimisation of pollution events during the construction phase will be ensured by the adequate maintenance of vehicles, the responsible handling and storage of potentially polluting materials and liquids and suitable training of staff.

In order to reduce the impact of accidental spillages (*e.g.* from plant fuel) during construction, appropriate planning will identify such risks and the precautionary measures to be taken such as:

- Spillage response kits;
- Seals to drains;
- Bunding of high risk areas; and,
- Training of staff in emergency procedures.

Furthermore, the Control of Pollution (Oil Storage) (England) Regulations 2001 together with the Environment Agency's Pollution Prevention Guidelines will be complied with. The Regulations cover the storage of oil of any kind, including petrol, mineral oil, heating oil, lubricating oil, vegetable oil, heavy oils such as bitumen, and oils used as solvents, such as paraffin and kerosene. The Regulations stipulate the strength, integrity and delivery systems of oil containers and prescribe secondary containment systems such as drip trays or bunds, which will ensure that the likelihood of oil spillages are minimised.

It should be noted that as infiltration based SuDS would not be suitable for this site (due to a range of reasons but primarily the result of the inclusion of a site wide basement) the avoidance of discharge from the developed site for rainfall up to 5mm cannot be guaranteed for all events, and the additional BREEAM Pol03 credit and the first Sur1 credit relating to minimising water course pollution cannot be awarded.

7. Summary and Conclusions

The proposed application seeks to clear the existing site, including demolition of the current buildings on the site, for the construction of a new mixed-use development that comprises residential units, offices, retail units and the relocation of the self-storage provision to below ground.

The site lies in EA Flood Zone 1 (low flood risk), with the risk of flooding from groundwater, sewer and artificial sources also considered to be low. However, the risk of surface water flooding along Greenwood Place has been identified as presenting a medium risk to the development over its lifetime and requiring mitigation measure to be implemented in the design. Mitigation measures include the installation of manually operated flood barriers along the north and west boundaries of the Site. Responsibility for the installation of all barriers would remain with site management, which the Developer has confirmed will have a 24/7 presence on Site within the A&A Storage Unit.

Development constraints prevent the raising of ground floor level. However, the final design of the development and this flood risk assessment has been completed in accordance with the principles set out in Section 5 of BS 8533:2011 'Assessing and managing flood risk in development – Code of practice'. **Therefore, it is recommended that 1 BREEAM Pol03 credit for Flood Resilience is awarded, provided the BREEAM Assessor is satisfied that all of the credit criteria are met. CfSH Sur 2 credits cannot be awarded as it is not possible to raise ground slab level 600mm above indicative flood levels.**

The FRA considers the revised UK Government climate change allowances, published on 19th February 2016. Taking a conservative 30% additional climate change contribution to runoff rates and volumes (midrange between the Central End Total and Upper End Total), the development will include at least 105 m^3 of rainwater water attenuation so as to limit run-off rate discharges leaving the site by 50% over the lifetime of the development (as compliant with the London Plan). The volume increase to 118 m^3 should the precautionary 40% climate change allowance be conditioned.

Attenuation is to be provided through a basement storage tank and permeable paving. The Site will be managed by the developer who will take on all responsibility for the maintenance of installed SuDS.

Attenuated surface waters will be discharged to public sewer. Details of connection arrangements will be specified by the civil engineer but will include anti-flood valves to prevent any surcharge from the external outfall back into properties. **It is recommended that 2 BREEAM Pol03 credits for Surface Water Run-Off area awarded, provided the BREEAM Assessor is satisfied that all of the credit criteria are met. This is based on that appropriate attenuation through SuDS is provided to ensure that the peak rate of run-off for the 100 year critical return period for the development is no greater that pre-existing rates, AND the volume of run-off for the 100 year 6-hour storm duration is no greater over this period to the pre-existing volume. All calculations are inclusive of climate change.**

An infiltration based SuDS is not considered to be appropriate for the site due to a range of issues, most notably the provision of a 2-storey basement beneath the development across the whole site. **Consequently, the avoidance of discharge from the developed site for rainfall up to 5mm cannot be guaranteed for all events and the BREEAM Pol03 'Minimising watercourse pollution' and equivalent CfSH Sur 1 credit cannot be awarded.**

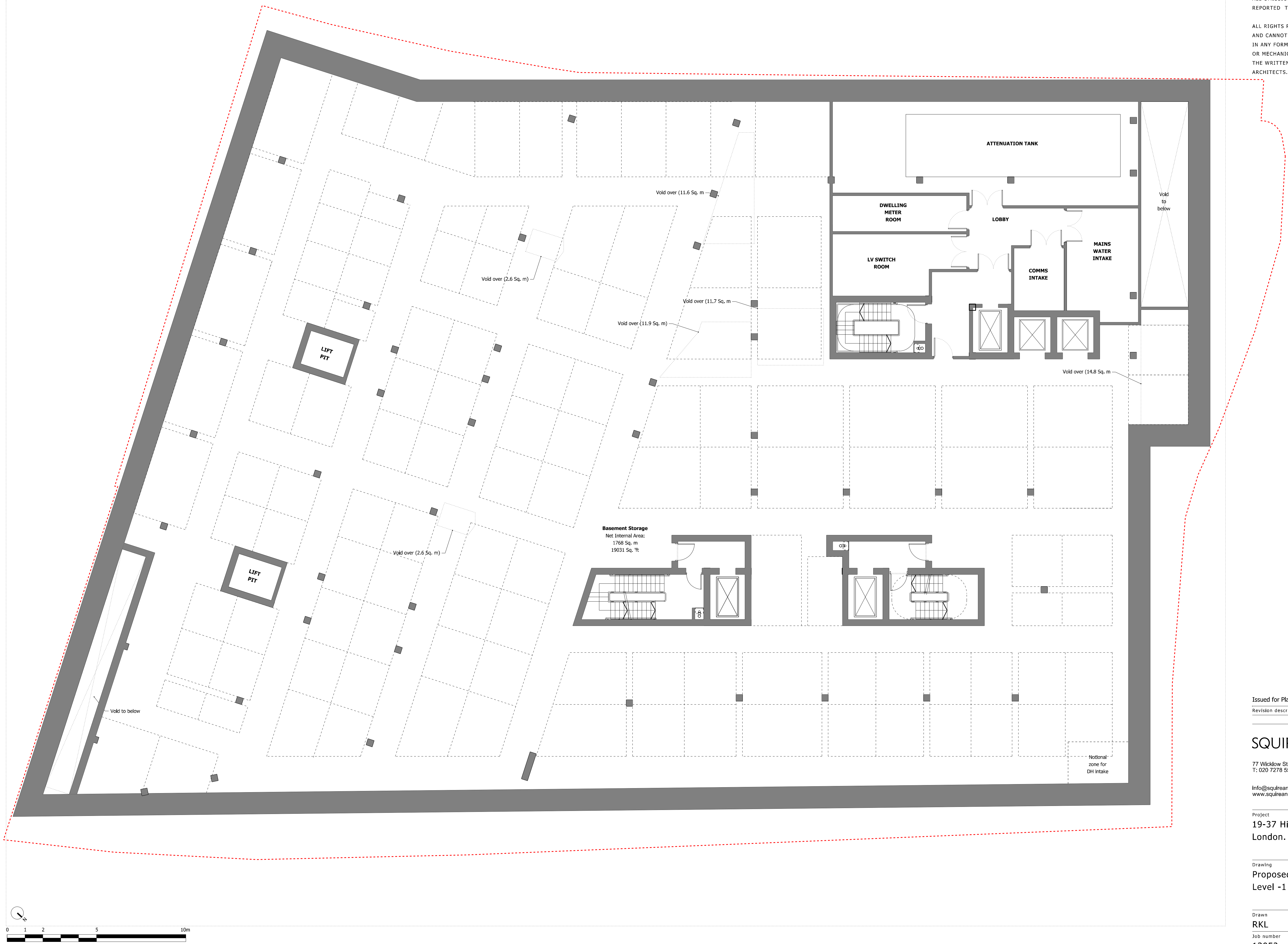
Appendix 1 Explanation of the Levels of Significance Used in FRAs

Significance	Impact of Proposed Development on both local and catchment hydrology	Risk of flooding of Proposed Development following completion
Not Significant	Proposed Development does not affect the quantity/quality of surface run-off and does not alter surface / groundwater flow locally or elsewhere within the catchment.	Proposed Development is not located in a 1:100 year fluvial or 1:200 year tidal floodplain. Flooding as a result of the accumulation of surface run-off on site, or elsewhere in the catchment is highly unlikely.
Low Significance	Proposed Development has a minor effect on the quantity/quality of surface run-off or surface/ groundwater flow either locally or elsewhere within the catchment. Such changes may be sustainable without mitigation measures.	Proposed Development is located in a 1:100 year fluvial and/or 1:200 year tidal floodplain, although no mitigation measures are required due to regional flood defences. Existing local drainage measures are sufficient to ensure that the accumulation of surface run-off does not result in flooding on site or increase the risk of flooding elsewhere within the catchment.
Moderate Significance	Proposed Development has a notable effect on the quantity/quality of surface run-off and has a discernible impact upon surface/groundwater flow either locally or elsewhere within the catchment. Mitigation measures may be required in order for the development to be sustainable throughout the duration of its intended lifetime.	Proposed Development is located in a 1:100 year fluvial and/or a 1:200 year tidal floodplain and mitigation measures are required to reduce flood risk to an acceptable level. Surface run-off attenuation methods may be required to ensure that the accumulation of surface run-off does not result in flooding on site or increase the risk of flooding elsewhere within the catchment.
Moderate – High Significance	Proposed Development has a large effect on the quantity/quality of surface run-off and has a considerable impact upon surface/groundwater flow either locally or elsewhere within the catchment. A primary commitment to successful mitigation measures will be required in order for the development to be sustainable throughout the duration of its intended lifetime.	Proposed Development is located in a 1:100 year fluvial and/or 1:200 year tidal floodplain and significant mitigation measures are required to reduce flood risk to an acceptable level. A range of surface run-off attenuation methods will be required to ensure that the accumulation of surface run-off does not result in flooding on site or increase the risk of flooding elsewhere within the catchment.
High Significance	Proposed Development has a major effect on the quantity/quality of surface run-off and has a severe impact upon surface/groundwater flow locally or elsewhere within the catchment. The incorporation of even a wide range of practicable mitigation measures may not ensure that the development remains sustainable throughout the duration of its intended lifetime.	The Proposed Development is considered to be particularly susceptible to either tidal or fluvial flooding or a combination of both. Resultant changes in the rates of surface run-off as a result of the development will increase flood risk both on site and elsewhere in the catchment. The incorporation of even a wide range of practicable mitigation measures may not ensure that the development remains sustainable in terms of flood risk for the duration of its intended lifetime.

Appendix 2 Basement Level -01 Drawing

NOTES:

DO NOT SCALE FROM THIS DRAWING.
ALL DIMENSIONS TO BE CHECKED ON SITE.
ALL OMISSIONS AND DISCREPANCIES TO BE REPORTED TO THE ARCHITECT IMMEDIATELY.



Revision description	Date	Check	Rev
Issued for Planning Application	24/06/16	BJ	-

SQUIRE & PARTNERS

77 Wicklow Street London WC1X 9JY
T: 020 7278 5555 F: 020 7239 0495

info@squireandpartners.com
www.squireandpartners.com

Project
19-37 Highgate Road, London. NW5

Drawing
Proposed Basement Plan
Level -1

Drawn	Date	Scale
RKL	14/12/15	1: 100@A1 1: 200@A3

Job number	Drawing number	Revision
13052	C645_P_B1_001	-

References

1 British Standard 8533:2011 Assessing and managing flood risk in development – Code of Practice, 2011.
2 Department for Communities and Local Government (2012) National Planning Policy Framework
3 Department for Communities and Local Government (2014) Planning Practice Guidance – Flood Risk and Coastal Change. Accessed through http://planningguidance.planningportal.gov.uk.
4 Department for Communities and Local Government (2012) Technical Guidance to the National Planning Policy Framework.
5 Greater London Authority (2015) The London Plan. Spatial Development Strategy for Greater London.
6 Greater London Authority (2014) Sustainable Design and Construction Supplementary Planning Guidance. Accessed through https://london.gov.uk.
7 London Borough of Camden (2010) Camden Local Development Framework – Core Strategy 2010 – 2025. Adopted Version 2010.
8 London Borough of Camden (2010) Camden Local Development Framework – Development Policies. Adopted Version 2010.
9 London Borough of Camden (2015) Camden Planning Guidance CPG3. – Sustainability.
10 London Borough of Camden (2015) Draft Camden Local Plan 2015.
11 HM Government (2015) Building Regulations Part H (Drainage and Waste Disposal). Accessed through http://www.planningportal.gov.uk.
12 Environmental Protection Act (1990), HMSO.
13 Flood and Water Management Act (2010), HMSO.
14 British Geological Survey (2015) Geology of Britain Viewer. Accessed through http://mapapps.bgs.ac.uk
15 National Soil Resources Institute (2015) Soilscapes Map. Accessed through http://www.landis.org.uk
16 London Borough of Camden (2013) Managing Flood Risk in Camden. The London Borough of Camden Flood Risk Management Strategy.
17 URS (2014) London Borough of Camden Strategic Flood Risk Assessment.
18 London Borough of Camden (2011) Surface Water Management Plan.
19 Department for Communities and Local Government (2007) Improving the Flood Performance of New Buildings, Flood Resilient Construction.
20 Department for Communities and Local Government (2007) Improving the Flood Performance of New Buildings, Flood Resilient Construction.
21 Department for Communities and Local Government (2007) Improving the Flood Performance of New Buildings, Flood Resilient Construction.
22 Woods Ballard, B., Wilson, S., Udale-Clarke, H., Illman, S., Scott, T., Ashley, R. and Kellagher, R. (2015) The SuDS Manual, Ciria Report C753. 2nd Edition. Ciria, London.
23 Office of the Deputy Prime Minister (2004) Interim Code of Practice for Sustainable Drainage Systems. National SuDS Working Group, July 2004.
24 Marshall, D. C. W. And Bayliss, A. C. (1994) Flood Estimation for Small Catchments. Institute of Hydrology.
25 Natural Environment Research Council (1975) Flood Studies Report, 5 Volumes. NERC, London.
26 Hall, M. J., Hocking, D. L. and Ellis, J. B. (1993) Design of Flood Storage Reservoirs. CIRIA Book 14.
27 Institute of Hydrology (1999) Flood Estimation Handbook CD-ROM, Version 2.0.
28 HR Wallingford - UK Sustainable Drainage Guidance & Tools Website (http://geoservergisweb2.hrwallingford.co.uk/uksd/surfacewaterstorage_js.htm#SoilType) accessed 26/10/15.
29 Department of the Environment, National Water Council (1981) Wallingford Procedure for Design and Analysis of Urban Storm Drainage, 3 Volume Ste. Ref: WP5 CD, Standing Technical Committee Reports No 31.