34 Glenilla Road
London

Flood Risk Assessment and Drainage Report

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Acronyms	
AOD	Above Ordnance Datum
CIRIA	Construction Industry Research and Information Association
EA	Environment Agency
FRA	Flood Risk Assessment
NPPF	National Planning Policy Framework
PPG	Planning Practice Guidance
LBC	London Borough of Camden
SFRA	Strategic Flood Risk Assessment
SUDS	Sustainable Drainage Systems
TW	Thames Water
CDA	Critical Drainage Area
SWMP	Surface Water Management Plan
BGS	British Geological Survey
IH124	Institute of Hydrology Report 124

1 Introduction

Price & Myers have been commissioned to undertake a Flood Risk Assessment (FRA) for the proposed development at 34 Glenilla Road, London, NW3 4AN. The site is located within the London Borough of Camden (LBC).

This FRA has been carried out in accordance with the National Planning Policy Framework (NPPF) and the accompanying Planning Practice Guidance "Flood Risk and Coastal Change" (PPG). This FRA also incorporates advice and guidance from the Environment Agency, the London Borough of Camden Strategic Flood Risk Assessment (SFRA) March 2014 and Surface Water Management Plan (SWMP) June 2013, Camden Planning Guidance document on Basements (March 2018) and CIRIA documents.

The NPPF states that an appropriate FRA will be required for all development proposals of 1 ha or greater in Flood Zone 1 and for all new development within Flood Zones 2 or 3.

The EA's indicative floodplain map shows that the site is in Flood Zone 1 (with a site area of less than 1 ha), however this FRA has been prepared to support the Basement Impact Assessment for the proposed development.

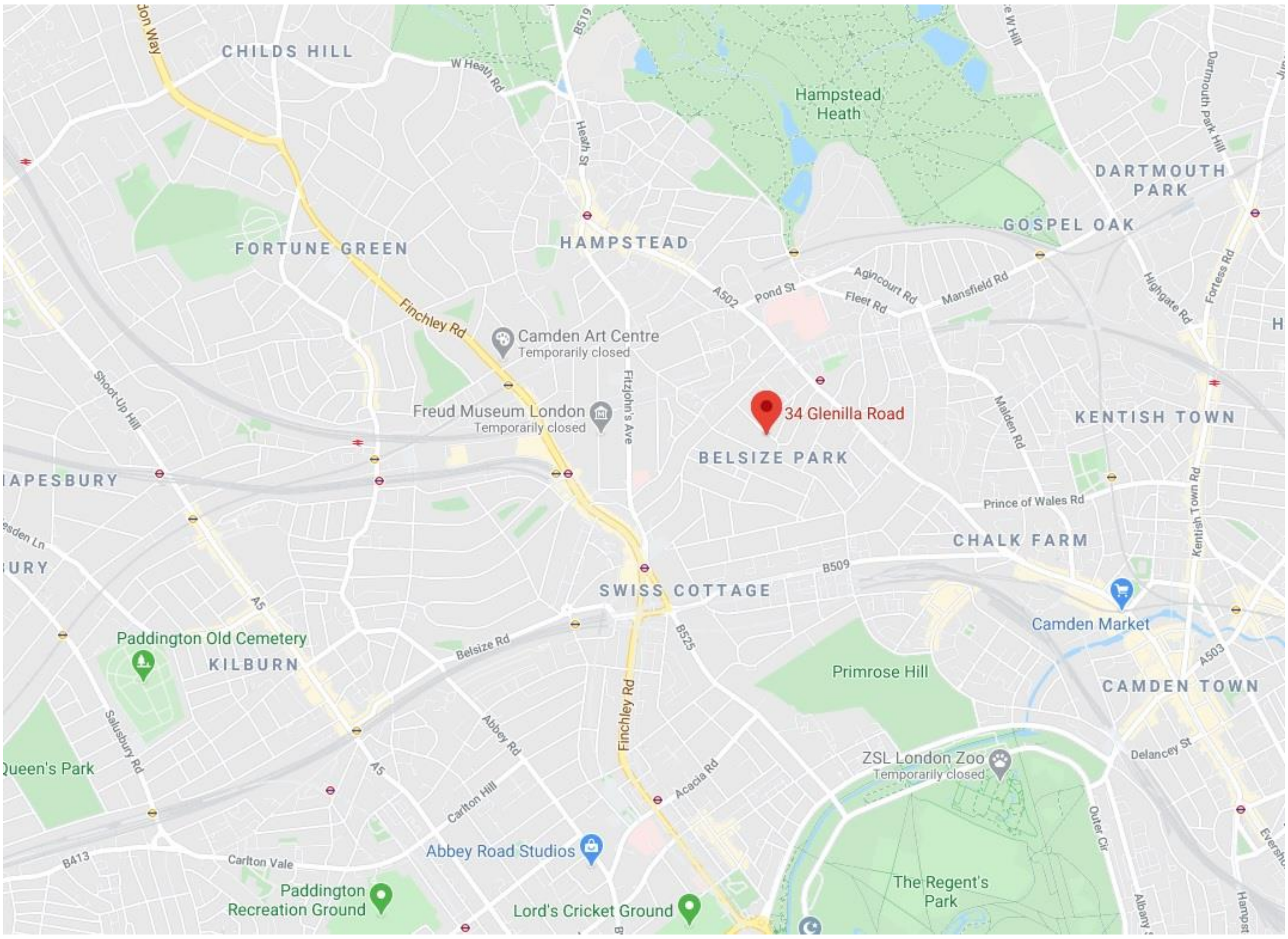


Figure 1.1: Site Location

2 Site Description and Location

The existing site comprises of a two-storey residential building with a basement level located on the west side of Glenilla Road. The site is within a residential area and bounded by properties to the east, west and south. Access to the site is available from Glenilla Road which runs alongside the site's northeast boundary. The site occupies an area of approximately 322m^2 and the topographical survey drawing shows that the average ground level on site is 61.80m AOD.

There are no watercourses in the vicinity of the site. The site's postcode is NW3 4AN and the OS grid reference is 527152mE, 184858mN.

Figure 2.1: Site Plan, showing site boundary

3 Development Proposal

The proposed development involves the extension of the existing basement and internal alteration of the existing building.

Figures 3.1 shows the proposed basement.

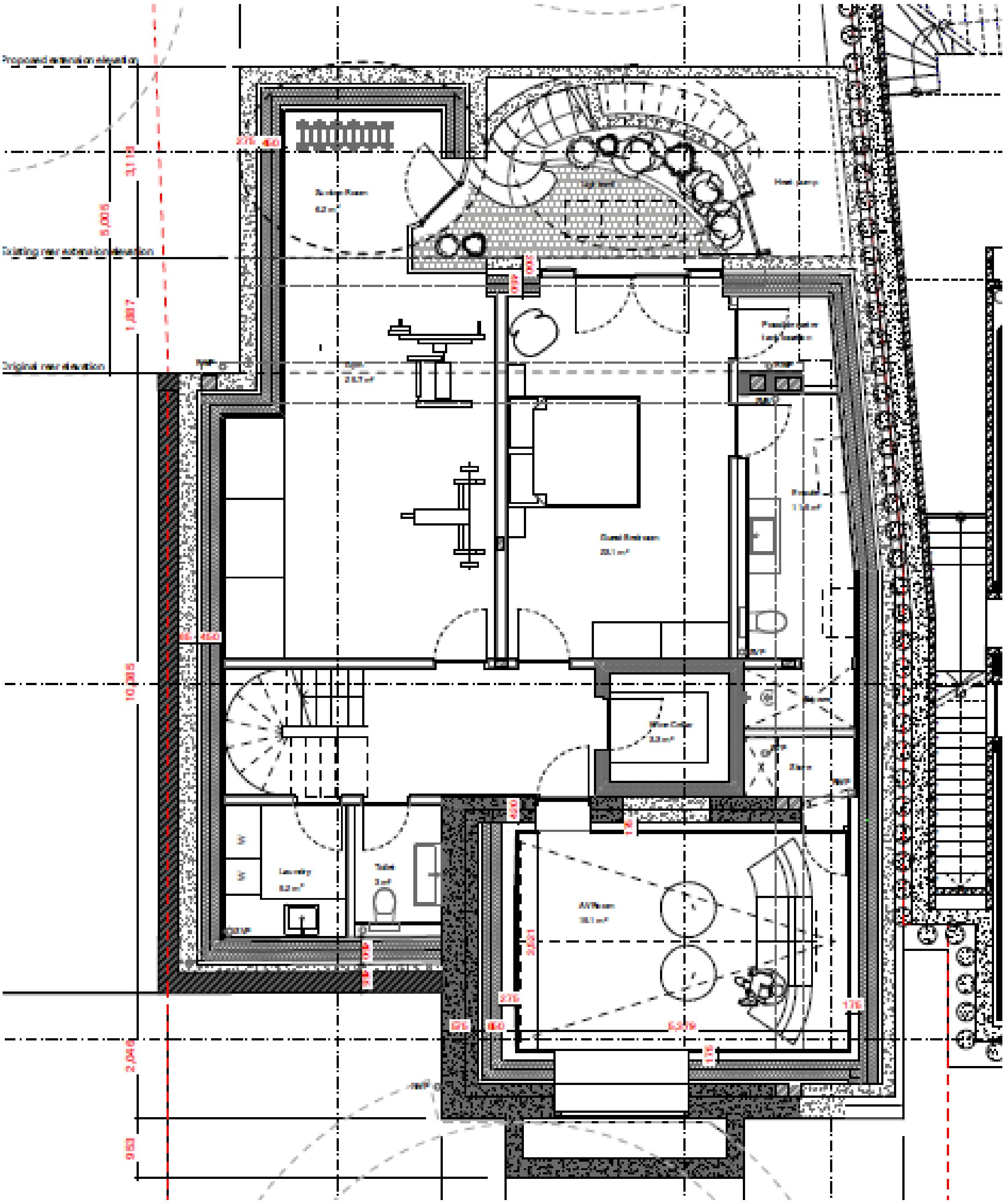


Figure 3.1: Proposed Basement Layout (Adam Khan Architects)

4 Flood Risk Assessment

4.1 Flood Risk from Watercourses and Tidal Flooding

The EA's indicative floodplain map shows that the site is located in Flood Zone 1 and is therefore at low risk of flooding from watercourses (fluvial and tidal). This zone comprises of land assessed by the EA, as having a less than 1 in 1000 annual probability of flooding. Developments in this flood zone do not have any restrictions, provided the proposals do not increase the risk of flooding elsewhere.

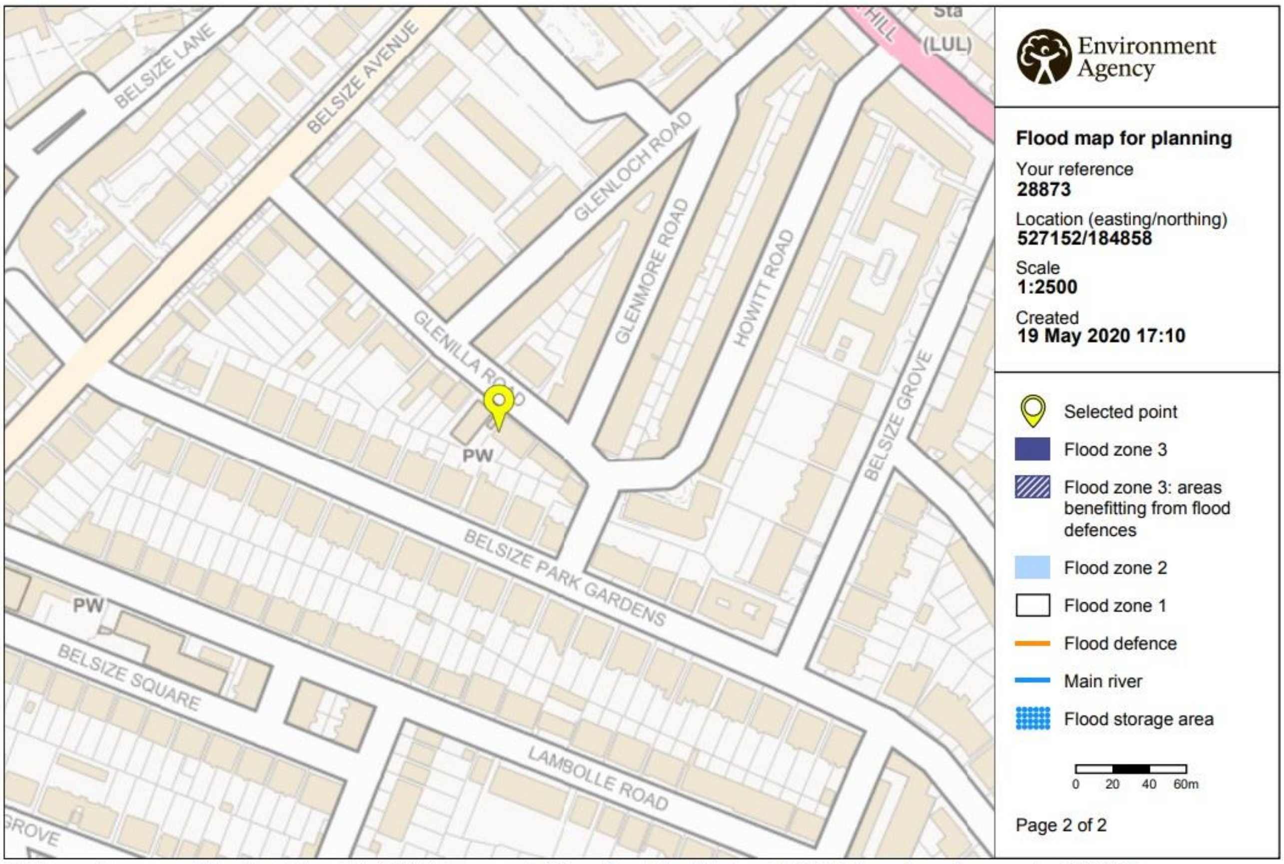


Figure 4.1: EA Flood Map for Planning

4.2 Flood Risk from Groundwater

Groundwater flooding occurs when water originating from sub-surface permeable strata emerges from the ground, typically after prolonged rainfall.

Camden's planning guidance document on basements states that basement development may affect groundwater flows, causing flooding in the local area. Furthermore, basements are vulnerable to groundwater flooding, as these structures can be located within the groundwater table. Therefore, the local geology and hydrogeology must be reviewed in order to assess the flood risk to the proposed basement extension and its impact on the surrounding areas.

The British Geological Survey (BGS) Maps show that there are no superficial deposits at this location and that the London Clay forms the local geology.

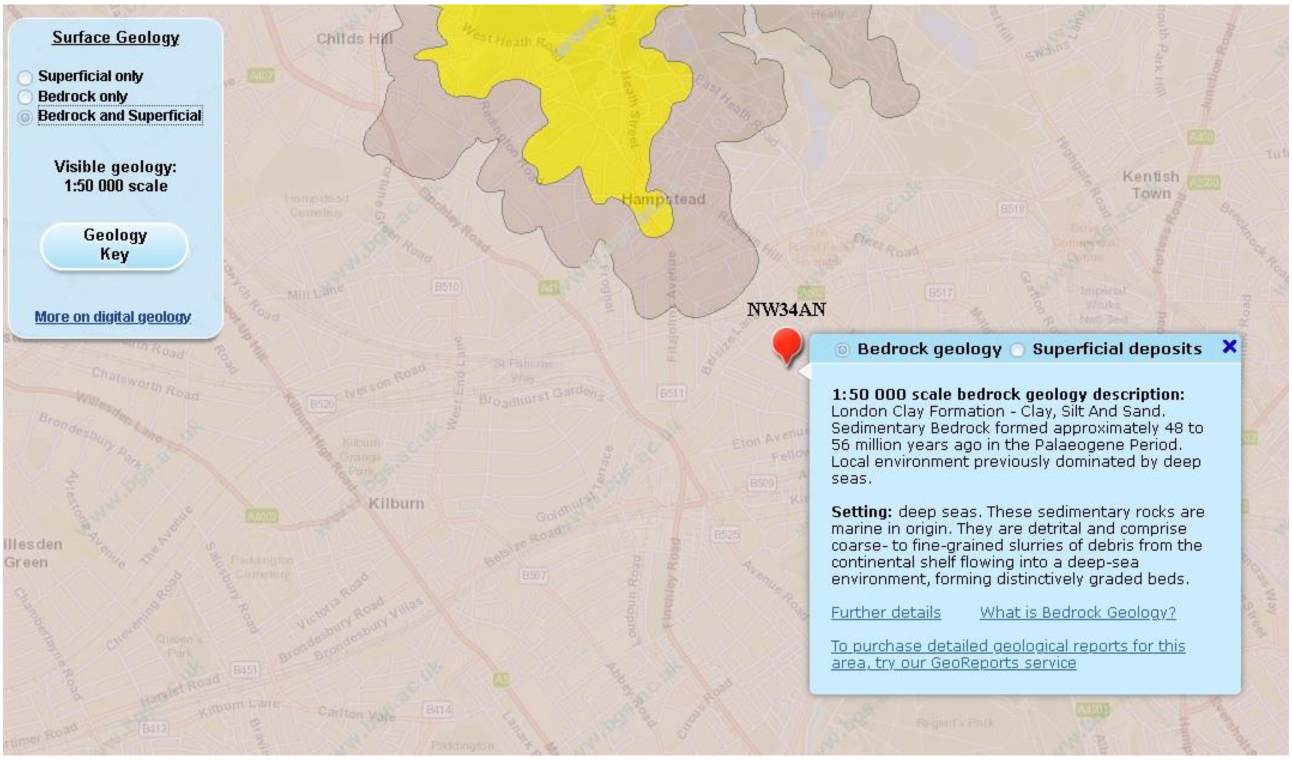


Figure 4.2: Local Geology (BGS Map)

The SFRA provides a map showing the areas susceptible to groundwater flooding and the recorded flood incidents within the Borough. Figure 4.3 below shows that the site is not within an area susceptible to groundwater flooding and that there are no recorded flood incidents from groundwater at this location.

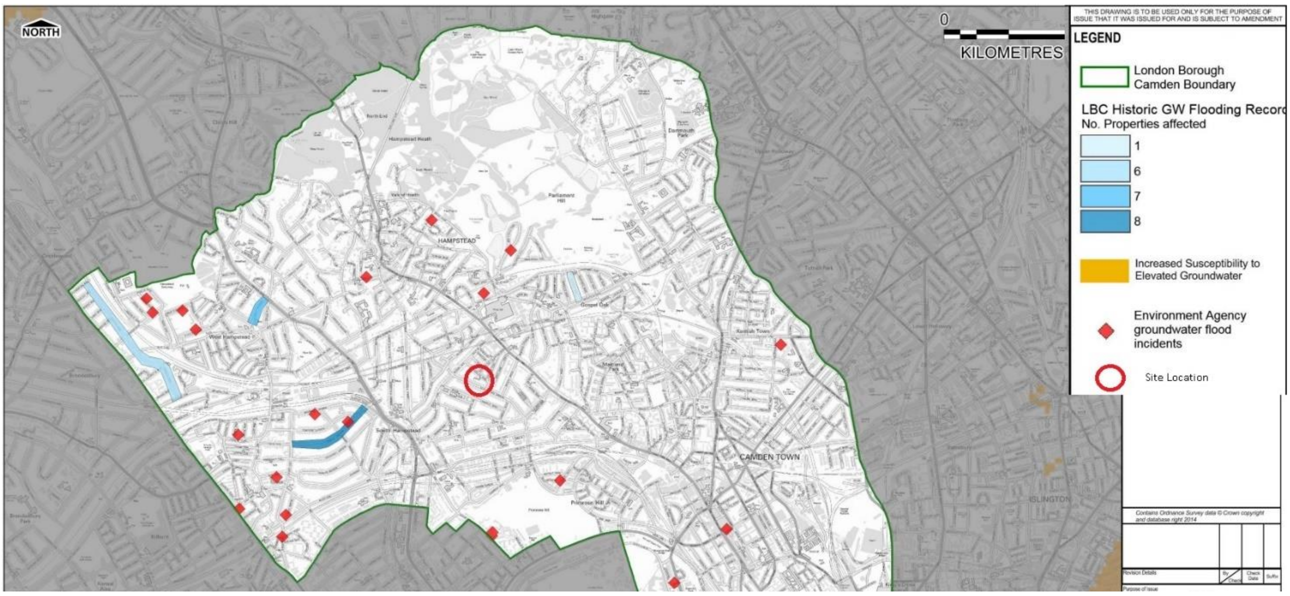


Figure 4.3: Areas Susceptible to Groundwater Flooding (SFRA)

A ground investigation report for 32 Glenilla Road states that *"groundwater was encountered during drilling adjacent to a claystone band at 56mOD(5.8mbgl). During the subsequent monitoring visit,* *groundwater was encountered at between 1.88mbgl and 4.15mbgl (57.74mOD to 59.81mOD), within the Made Ground and upper parts of the London Clay Formation. The boreholes were bailed dry during sampling of the groundwater. The recharge in all three boreholes monitored was noted to be slow. It is anticipated that the groundwater encountered within the London Clay Formation is perched water within the claystone band and is not representative of a groundwater table".* The same ground conditions are anticipated for the site which bounds number 32 Glenilla Road.

In conclusion the clay formation will be unable to transfer any large volumes of groundwater at this location. Only perched water is anticipated within the made ground (if any) and the clay formation. However, engineering techniques, such as basement waterproofing and cavity drainage systems, will be used in the design to reduce the flood risk further, Therefore, the flood risk from groundwater is low and the proposed development will not have an adverse impact on the local hydrogeology.

4.3 Flood Risk from Surface Water and Overland Flows

Surface water flooding occurs when intense rainfall is unable to soak into the ground or enter a drainage system due to blockages or the capacity of the system being exceeded. Overland flows can also be generated by burst water mains, failed dams and any failure in a system storing or transferring water.

The SFRA shows that the site is within Critical Drainage Area Group 3_005. However, the SFRA's map (Figure 4.4) shows that the site is not within a Local Flood Risk Zone (LFRZ). The SWMP states that a CDA a discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure. Furthermore, a LFRZ is defined as a discrete area of flooding that does not exceed the national criteria for a 'Flood Risk Area' but still affects houses, businesses or infrastructure. A LFRZ is defined as the actual spatial extent of predicted flooding in a single location.

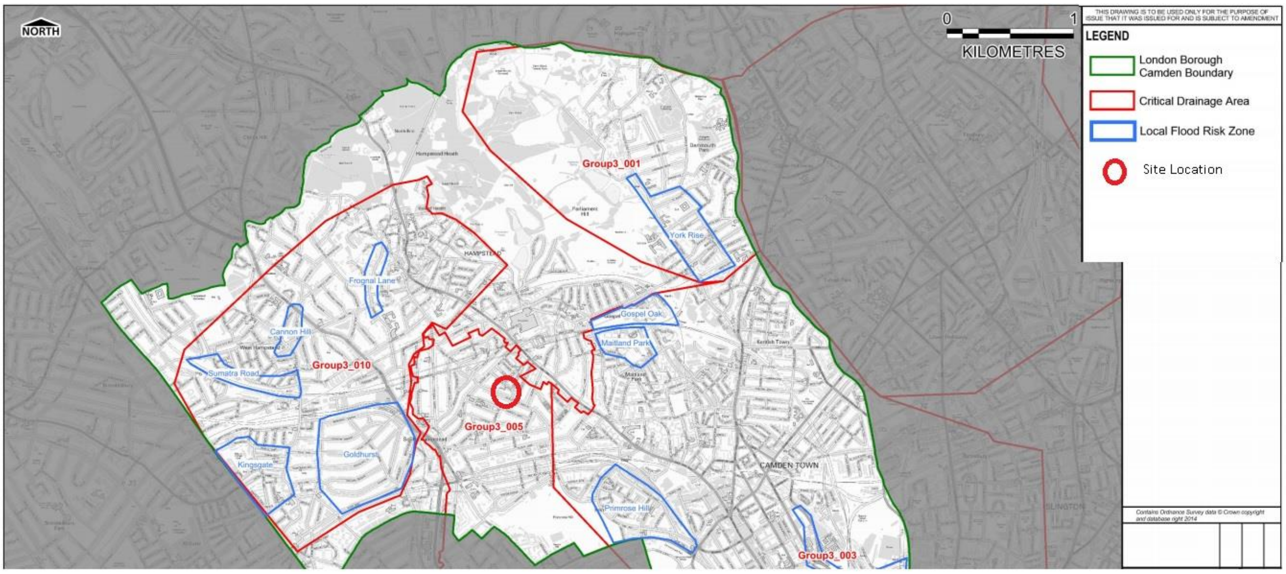


Figure 4.4 Critical Drainage Areas (SFRA)

Figure 4.4 shows that the site is within a large catchment area where flood risk from various sources may occur at various locations. However, the same figure shows that the site is not within a LFRZ.

The EA's flood risk from surface water maps show that parts of Glenilla Road are at risk of flooding from surface water. The topographical survey drawing shows that the road levels at this location form local valleys. While road gullies are provided at the low spots within the road, the EA's map has been designed for storm events exceeding the capacity of the road's drainage system. Therefore, local ponding will occur within Glenilla Road, if the drainage system fails or the capacity of the drainage system is exceeded.

Furthermore, the EA's maps show that the properties which bound the site to the south are at high risk of flooding from surface water. The topographical survey drawing shows that a retaining wall separates the site from these properties, aiming to accommodate the high-level difference in the ground levels. This suggests that a low-lying area exists south of the site which could result in surface water flooding. However, the elevated ground levels on site will prevent overland flows from flooding the building.

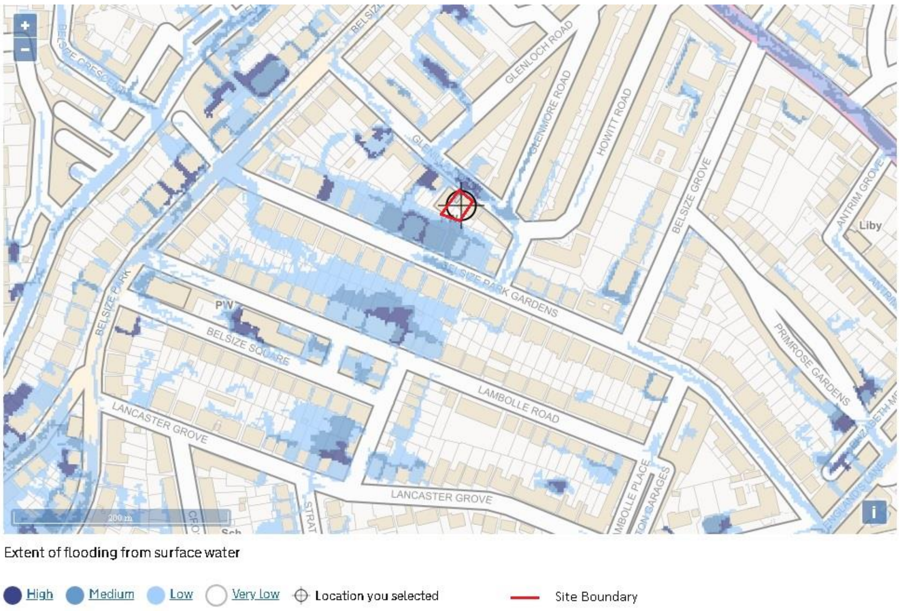


Figure 4.5 Environment Agency Flood Risk from Surface Water Map

In conclusion, the site is within a large geographical area where multiple and interlinked sources of flood risk cause flooding in one or more LFRZs. However, the site is not within a LFRZ and not at risk from surface water flooding, as the EA's map show. While local ponding could occur around the site during a high storm event, the site's topography will prevent overland flows from flooding the building. Therefore, the building and site users will be safe at all times and the flood risk from surface water is considered low.

4.4 Flood Risk from Infrastructure Failure.

The EA provides information on flood risk from reservoirs. The figure below shows that the site is at not at risk of flooding from reservoirs.

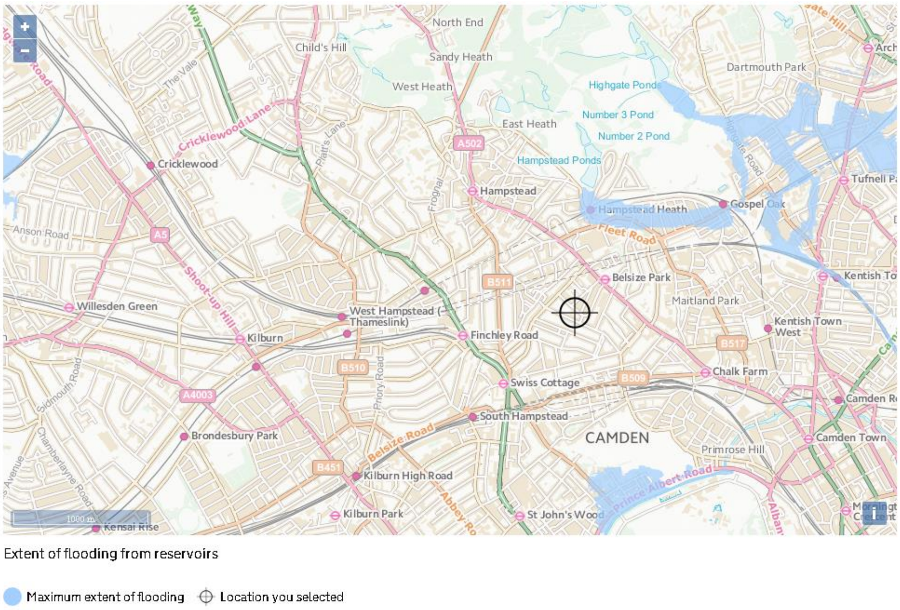


Figure 4.5 Environment Agency Flood Risk from Reservoir Failure Map

The SFRA also provides records of sewer flooding within the Borough. Figure 4.6 shows that the site is not within an area with recorded flood incidents from sewers, suggesting that the flood risk from sewers is low. However, pumps with non-return valves will be provided at basement level to prevent flooding from surcharged sewers.

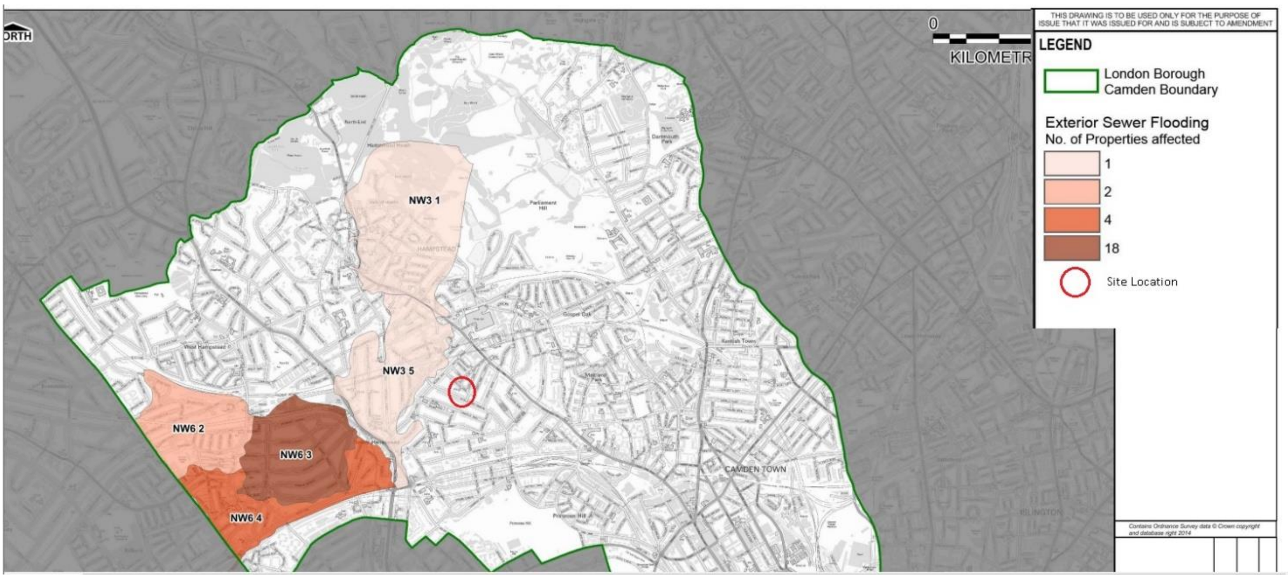


Figure 4.6 Flood Risk from Sewers Map (SFRA)

5 Surface Water Run-off Assessment

5.1 Existing Run-off

The site occupies an area of 322m^2 of which approximately 200m^2 or 0.020 ha is impermeable i.e. hardstanding.

The existing peak run-off rates for the design storm events (1 in 1, 1 in 30 and 1 in 100 year) were calculated using the modified rational method as shown below:

$Q_x = 2.78 \times i \times A$

Where 'x' is the return period in years, 'A' is the catchment area in ha and 'i' is the rainfall intensity in mm/hr as estimated from Micro Drainage software, using the modified rational method.

$Q_1 = 2.78 \times 35.55 \times 0.020 = 1.98$ l/s
$Q_{30} = 2.78 \times 82.42 \times 0.020 = 4.58$ l/s
$Q_{100} = 2.78 \times 107.27 \times 0.020 = 5.96$ l/s

5.2 Climate Change

The current EA guidance states that for the years 2070 to 2115 there is a 50% chance the peak rainfall intensity will increase by 20% or more and that there is a 10% chance it will increase by 40% or more. For this building, which is classed as More Vulnerable with a design life of 100 years an allowance of an additional 40% is considered appropriate.

5.3 Proposed Run-off

Due to the footprint of the proposed conservatory and lightwell the impermeable area is 222m^2 or 0.023 ha. The peak unrestricted run-off rate from the site may increase by 40% in the future due to climate change. The proposed peak unrestricted run-off rate for the 1 in 100 year plus 40% storm event was calculated based on the modified rational method:

$Q_{100} = 2.78 \times 150.18 \times 0.023 = 9.60$ l/sec

6 SUDS Assessment

In accordance with the London Plan, EA guidelines and CIRIA documents, surface water run-off should be managed as close to its source as possible. The London Plan states that all new developments should aim to reduce run-off to greenfield rates "utilising SuDS unless there are practical reasons for not doing so". Furthermore, LBC's guidance on SuDS states that the London Plan's hierarchy should be considered in the surface water drainage strategy for new developments.

Due to the density of the development on site and the presence of existing trees in the rear garden, the available options for SUDs are limited for this development. The existing building will generally remain unaffected from the proposed basement extension works. Therefore, opportunities for SUDS are very limited. The possibility of implementing SUDS at the site was assessed using a hierarchy of preferred surface water management methods in line with Policy 5.13 of The London Plan. The following paragraphs discuss the various methods in order of this hierarchy and evaluate the site's suitability for each method.

6.1 Store Rainwater for Later Use

Rainwater harvesting promotes the storage and re-use of rainwater collected from roofs and hard surfaced areas. This type of system contributes to the reduction of runoff rates and volumes within a development.

The capacity of these systems to attenuate rainwater depends on the water use within the building. If there is no activity in the building and the harvester is full, no attenuation will be provided during a subsequent storm event. In the worst-case scenario, the rainwater harvester will provide no attenuation. A rainwater harvesting system can be installed below the basement slab or within the external paved areas. The rainwater harvesting system should serve all floors in order to take full advantage of the surface water attenuation and water consumption benefits it can provide. Pumps should be designed to transfer water upwards within the building and space within the existing loft should be used to accommodate a new distribution tank. The plumbing within the existing building should be modified to accommodate the new connections from the new rainwater tank. These arrangements are not practical in this instance. Furthermore, a pump will generate the need for energy consumption which is not be sustainable. Another pump will be required to transfer overflows from the rainwater harvesting system to the proposed attenuation drainage system which will be constructed in the front paved area, if the rainwater harvesting tank is installed below the basement slab. Deep excavations below the basement slab will also affect adjacent properties. Furthermore, pumps will increase the flood risk from pump failure.

In conclusion, the benefits these systems will provide for this development cannot outweigh their disadvantages and the lack of space on site make them impracticable for the proposed development. However, rainwater butts may be adopted within the garden subject to landscaping proposals.

6.2 Infiltration

Soakaways were considered for surface water discharge. However, British Standards require soakaways to be positioned at least 5m away from any building, 2.5m away from any site boundary and away from tress. Limited space on the site means this will not be possible.

The expected site geology suggests that the porosity properties of the ground are very poor for infiltration systems. Therefore, another method for surface water disposal should be considered.

6.3 Attenuation

DEFRA’s Non-statutory technical standards for SuDS prioritise reduction to Greenfield run-off rates from new developments. This is in line with the London Plan which states that all new developments should aim to reduce run-off to greenfield rates utilising SuDS unless there are practical reasons for not doing so.

The greenfield run-off rate for the site was calculated based on the IH124 method and using the uksuds website. The software requires a minimum catchment area of 0.1 ha which is larger than the site’s area of 0.0322 ha. Therefore, the results are modified accordingly to reflect the site area, showing that the site generates a maximum greenfield run-off rate of 0.44 l/sec in the 1 in 100-year storm event (see Appendix C). It is not practical to restrict the discharge to such a low flow rate.

The use of green roofs and/or blue roof has been assessed as part of the drainage strategy. However, the existing roof layout is to remain unchanged and therefore this kind of roof cannot be considered.

The opportunity to provide underground attenuation tanks was assessed, concluding that a 4m^3 cellular tank will be able to serve the proposed development in the 1 in 100 year plus 40% climate change storm event. The drainage system has been designed to attenuate surface water to 2.5 l/sec.

The joint DEFRA/EA R&D rainfall runoff management for developments Report-SC030219 states that *“a practicable minimum limit on the discharge rate from a flow attenuation device is often a compromise between attenuating to a satisfactorily low flow rate while keeping the risk of blockage to an acceptable level. This limit is set at 5 litres per second, using an appropriate vortex or other flow control device”.* Manufacturers have improved flow control devices since the DEFRA/EA report was published, permitting flows lower than 5 l/sec through their devices without increasing the flood risk from blockages. However, a self-cleansing velocity of 0.7 l/sec must be maintained in pipes and all pipes sizes should meet the Building Regulations Part H which require a minimum pipe size of 75mm for surface water drainage. This indicates that peak flow rates lower than 2.5 l/sec will either fail to meet BS EN 752-4 and/or the Building Regulations Part H requirements. This, in turn could increase the flood risk from blockages for the proposed development.

In addition, the proposed paved areas will be permeable, providing additional attenuation and water treatment benefits.

If the rainfall exceeds the design storm event, the drainage system will be unable to transfer surface water to the tank. The local topography suggests that water will flow to the south and north of the building preventing surface water flows from entering the building. Surface water will affect gardens and Glenilla Road in this instance.

6.4 Discharge to Combined Sewer

It is proposed that surface water from the site continues to discharge by gravity to the combined sewer in Glenilla Road. Surface water drainage will run at high level within the proposed basement, reusing the same drainage connection to the public sewer in Glenilla Road. Drainage design proposals are provided in Appendix B.

Furthermore, foul water from the proposed development will drain to the same sewers mimicking existing conditions. Building Regulations Part H, Table 5 shows that a single property generates a flow of 2.5 l/sec.

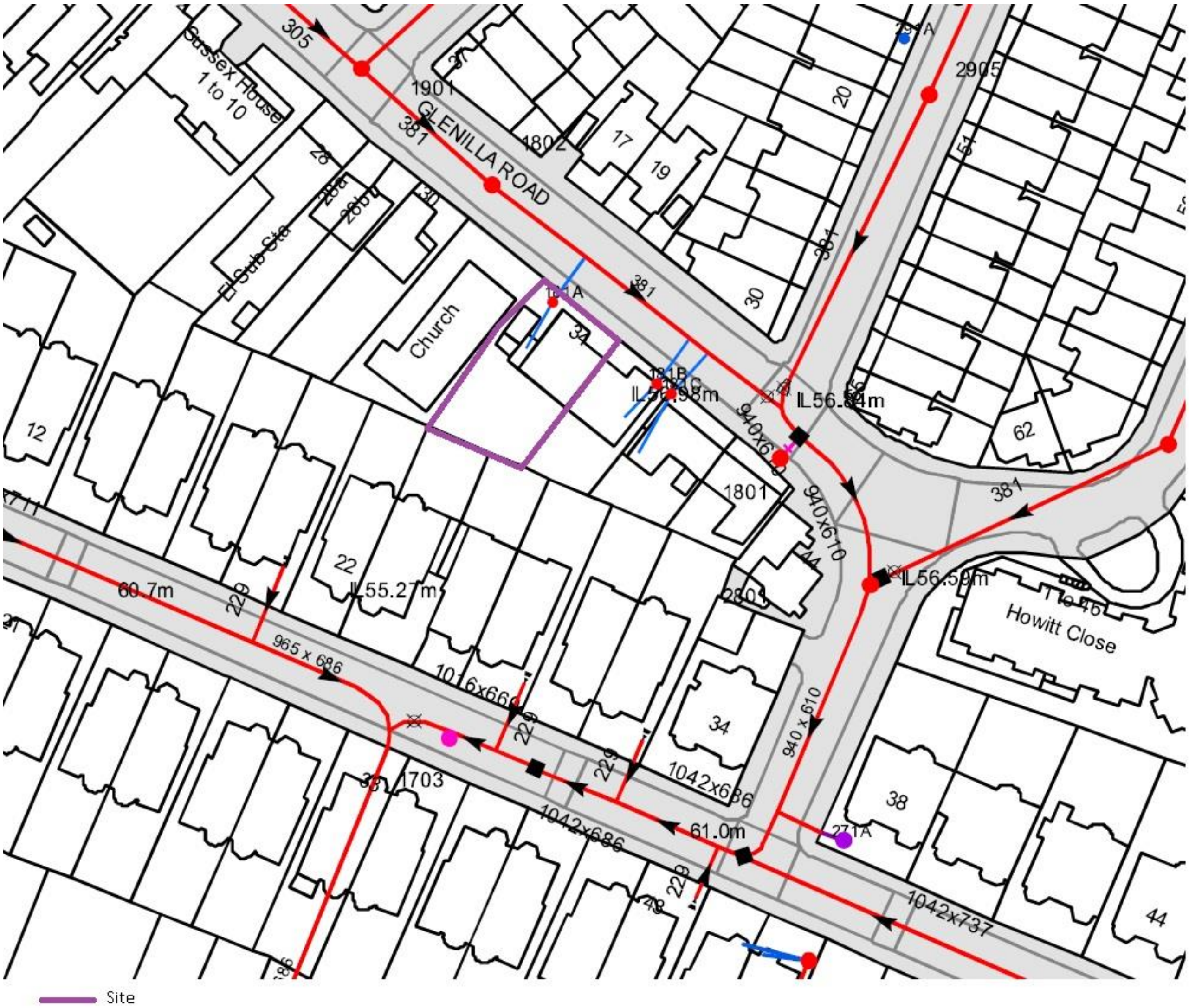


Figure 6.1 Thames Water Sewer Records

7 Surface Water Maintenance Strategy

The effective operation of a drainage system depends on a robust and clear maintenance strategy being implemented. The following measures should form part of the site's proposed management plan.

The house owner possesses the primary responsibility for overseeing and implementing the maintenance and management plan and designating an organisation or person who will be responsible for the proper operation and maintenance of the storm water drainage structures.

The storm water management system protects and enhances the storm water runoff water quality through the removal of sediment and pollutants, catchpit manholes and silt trapped gullies will reduce the amount of pollutants entering the system. Preventive maintenance of the system will include a comprehensive source reduction program of regular sweeping and litter removal, prohibitions on the use of pesticides, and maintenance of bin areas.

Maintenance and cleaning of gullies, storm water manholes will assure adequate performance. Regular maintenance should include inspecting channel and gully inlet grates and remove any debris every 3 months, or as determined to be reasonable, based on experience with the installed systems to ensure that the gullies are working in their intended fashion and that they are free of debris. Quarterly inspections of gully sumps and bottom of drain manholes; if depth of sediment in sumps exceeds 50% capacity, sediment must be removed. Excessive sediment shall be removed and properly disposed by a licensed drainage cleaning company.

SuDS Element	Maintenance		
	Maintenance Schedule	**Required Action**	**Typical Frequency**
Attenuation Tank	**Monitoring / Inspections**	Inspect all inlets, outlets, vents, overflows and control structures to ensure they are working as they should	Annually or after severe storms
	Regular Maintenance	Inspect and identify any elements that are not operating correctly.	Monthly for three months, then Half yearly or as required.
		Remove sediments / debris from catch pits / gullies and control structures	Annually, after severe storms or as required
	Remedial Actions	Repair inlets, outlets, vents, overflows and control structures.	As required
Permeable Paving	**Monitoring / Inspections**	Initial inspection	Monthly for three months after installation
		Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Half yearly, 48 hours after large storms in first six months
		Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
		Monitor inspection chambers	Annually
	Regular Maintenance	Brushing and vacuuming -standard cosmetic sweep over whole surface	Once a year after autumn leaf fall

SuDS Element	Maintenance		
	Maintenance Schedule	**Required Action**	**Typical Frequency**
		Rubbish and litter removal	As required
	Remedial Actions	Remediate any landscaping which through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving.	As required
		Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	
		Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required

Table 7.1 SuDS Maintenance Strategy as taken from the CIRIA SUDS Manual

8 Conclusions

I. The development consists of a new basement, conservatory extension (10m^2) and internal modifications of an existing residential property.

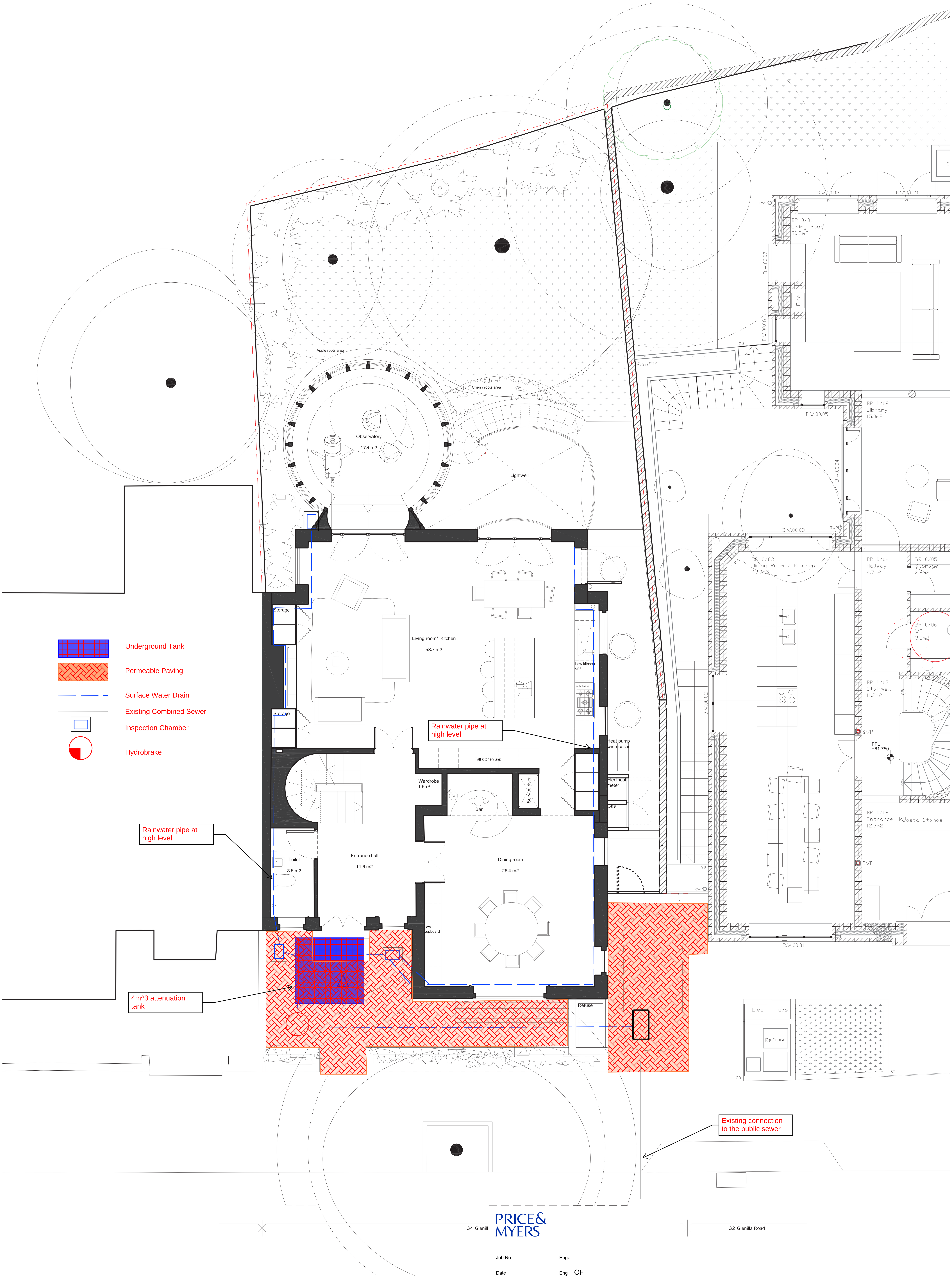
II. The site is at low risk of flooding from rivers, sea, groundwater and infrastructure failure.

III. The EA's maps show that surface water could cause local ponding in Glenilla Road and within the properties that bound the site to the south. However, the EA's map shows that the site will not be affected. Therefore, the proposed development has an acceptable flood risk within the terms and requirements of the NPPF.

IV. The existing site discharges both foul and surface water flows unrestricted to the combined water public sewer located in Glenilla Road. The existing drainage connection will be reused.

V. The possibility of implementing SUDS at the site was assessed using a hierarchy of preferred surface water management methods, in line with guidance set out in Policy 5.13 of The London Plan. The SUDS assessment concluded that a combination of a permeable paving system and an attenuation tank can be used to reduce the peak flow rates from the site to the public sewers. The proposed drainage system will reduce the peak flow rates to 2.5 l/sec in storm events with a return period up to 1 in 100 year plus climate change.

Appendix A
Indicative Surface Water Drainage Plan



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34 Glenilla Road
Client: Mrs Candy Wong
Location: 34 Glenilla Road, Belsize Park, London
Title: Proposed Ground Floor Plan

01	Information	AKA	22.04.20
Rev	Details	Drwn	Date

Original printed at A3

Appendix B
Calculations

Greenfield Run-off

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Dimitris Linardatos
Site name:	34 Glenilla Road
Site location:	London

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	51.54818° N
Longitude:	0.16754° W
Reference:	418974632
Date:	May 20 2020 12:08

Runoff estimation approach IH124

Site characteristics

Total site area (ha): .1

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm):	638	638
Hydrological region:	6	6
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	0.43	0.43
1 in 1 year (l/s):	0.37	0.37
1 in 30 years (l/s):	1	1
1 in 100 year (l/s):	1.38	1.38
1 in 200 years (l/s):	1.62	1.62

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 23 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.632	0.632	0.0	2.5	2.5	4.8	O K
30 min Summer	0.695	0.695	0.0	2.5	2.5	5.3	O K
60 min Summer	0.662	0.662	0.0	2.5	2.5	5.0	O K
120 min Summer	0.506	0.506	0.0	2.5	2.5	3.8	O K
180 min Summer	0.367	0.367	0.0	2.5	2.5	2.8	O K
240 min Summer	0.263	0.263	0.0	2.5	2.5	2.0	O K
360 min Summer	0.150	0.150	0.0	2.3	2.3	1.1	O K
480 min Summer	0.101	0.101	0.0	2.1	2.1	0.8	O K
600 min Summer	0.084	0.084	0.0	1.8	1.8	0.6	O K
720 min Summer	0.073	0.073	0.0	1.6	1.6	0.6	O K
960 min Summer	0.060	0.060	0.0	1.2	1.2	0.5	O K
1440 min Summer	0.048	0.048	0.0	0.9	0.9	0.4	O K
2160 min Summer	0.040	0.040	0.0	0.6	0.6	0.3	O K
2880 min Summer	0.035	0.035	0.0	0.5	0.5	0.3	O K
4320 min Summer	0.029	0.029	0.0	0.4	0.4	0.2	O K
5760 min Summer	0.025	0.025	0.0	0.3	0.3	0.2	O K
7200 min Summer	0.023	0.023	0.0	0.2	0.2	0.2	O K
8640 min Summer	0.021	0.021	0.0	0.2	0.2	0.2	O K
10080 min Summer	0.020	0.020	0.0	0.2	0.2	0.2	O K
15 min Winter	0.727	0.727	0.0	2.5	2.5	5.5	O K
30 min Winter	0.802	0.802	0.0	2.5	2.5	6.1	O K
60 min Winter	0.752	0.752	0.0	2.5	2.5	5.7	O K
120 min Winter	0.509	0.509	0.0	2.5	2.5	3.9	O K
180 min Winter	0.305	0.305	0.0	2.5	2.5	2.3	O K
240 min Winter	0.183	0.183	0.0	2.4	2.4	1.4	O K
360 min Winter	0.093	0.093	0.0	2.0	2.0	0.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	150.176	0.0	6.5	16
30 min Summer	97.039	0.0	8.4	26
60 min Summer	59.609	0.0	10.3	44
120 min Summer	35.353	0.0	12.2	76
180 min Summer	25.703	0.0	13.3	106
240 min Summer	20.385	0.0	14.1	134
360 min Summer	14.704	0.0	15.2	192
480 min Summer	11.652	0.0	16.1	248
600 min Summer	9.722	0.0	16.8	308
720 min Summer	8.381	0.0	17.3	368
960 min Summer	6.627	0.0	18.3	490
1440 min Summer	4.754	0.0	19.7	720
2160 min Summer	3.405	0.0	21.1	1084
2880 min Summer	2.685	0.0	22.2	1468
4320 min Summer	1.919	0.0	23.8	2176
5760 min Summer	1.511	0.0	25.0	2936
7200 min Summer	1.254	0.0	26.0	3672
8640 min Summer	1.077	0.0	26.8	4360
10080 min Summer	0.947	0.0	27.4	5088
15 min Winter	150.176	0.0	7.2	16
30 min Winter	97.039	0.0	9.4	28
60 min Winter	59.609	0.0	11.5	46
120 min Winter	35.353	0.0	13.7	82
180 min Winter	25.703	0.0	14.9	110
240 min Winter	20.385	0.0	15.7	136
360 min Winter	14.704	0.0	17.0	188

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
480 min Winter	0.074	0.074	0.0	1.6	1.6	0.6	O K
600 min Winter	0.063	0.063	0.0	1.3	1.3	0.5	O K
720 min Winter	0.057	0.057	0.0	1.1	1.1	0.4	O K
960 min Winter	0.049	0.049	0.0	0.9	0.9	0.4	O K
1440 min Winter	0.040	0.040	0.0	0.6	0.6	0.3	O K
2160 min Winter	0.033	0.033	0.0	0.5	0.5	0.3	O K
2880 min Winter	0.029	0.029	0.0	0.4	0.4	0.2	O K
4320 min Winter	0.024	0.024	0.0	0.3	0.3	0.2	O K
5760 min Winter	0.021	0.021	0.0	0.2	0.2	0.2	O K
7200 min Winter	0.019	0.019	0.0	0.2	0.2	0.1	O K
8640 min Winter	0.018	0.018	0.0	0.1	0.1	0.1	O K
10080 min Winter	0.017	0.017	0.0	0.1	0.1	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
480 min Winter	11.652	0.0	18.0	246
600 min Winter	9.722	0.0	18.8	308
720 min Winter	8.381	0.0	19.4	370
960 min Winter	6.627	0.0	20.5	490
1440 min Winter	4.754	0.0	22.0	734
2160 min Winter	3.405	0.0	23.7	1088
2880 min Winter	2.685	0.0	24.9	1460
4320 min Winter	1.919	0.0	26.7	2148
5760 min Winter	1.511	0.0	28.0	2944
7200 min Winter	1.254	0.0	29.1	3656
8640 min Winter	1.077	0.0	30.0	4248
10080 min Winter	0.947	0.0	30.7	5000

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	21.000	Shortest Storm (mins)	15
Ratio R	0.436	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.023

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.023

Model Details

Storage is Online Cover Level (m) 2.000

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m^2)	Inf. Area (m^2)	Depth (m)	Area (m^2)	Inf. Area (m^2)	Depth (m)	Area (m^2)	Inf. Area (m^2)
0.000	8.0	0.0	1.000	8.0	0.0	1.001	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0075-2500-1000-2500
Design Head (m)	1.000
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	75
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.5	Kick-Flo®	0.627	2.0
Flush-Flo™	0.307	2.5	Mean Flow over Head Range	-	2.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.1	0.800	2.3	2.000	3.4	4.000	4.7	7.000	6.2
0.200	2.4	1.000	2.5	2.200	3.6	4.500	5.0	7.500	6.4
0.300	2.5	1.200	2.7	2.400	3.7	5.000	5.3	8.000	6.6
0.400	2.5	1.400	2.9	2.600	3.9	5.500	5.5	8.500	6.8
0.500	2.4	1.600	3.1	3.000	4.1	6.000	5.7	9.000	7.0
0.600	2.1	1.800	3.3	3.500	4.5	6.500	6.0	9.500	7.1

Appendix C
LBC Pro-forma

Advice Note on contents of a Surface Water Drainage Statement

London Borough of Camden

1. Introduction

1.1 The Government has strengthened planning policy on the provision of sustainable drainage and new consultation arrangements for 'major' planning applications will come into force from 6 April 2015 as defined in the Written Ministerial Statement (18th Dec 2014).

1.2 The new requirements make Lead Local Flood Authorises statutory consultees with respect to flood risk and SuDS for all major applications. Previously the Environment Agency had that statutory responsibility for sites above 1ha in flood zone 1.

1.3 Therefore all 'major' planning applications submitted from 6 April 2015 are required demonstrate compliance with this policy and we'd encourage this is shown in a **Surface Water Drainage Statement**.

1.4 The purpose of this advice note is to set out what information should be included in such statements.

2. Requirements

2.1 It is essential that the type of Sustainable Drainage System (SuDS) for a site, along with **details of its extent and position**, is identified within the planning application to clearly demonstrate that the proposed SuDS can be accommodated within the development.

2.2 It will now not be acceptable to leave the design of SuDs to a later stage to be dealt with by planning conditions.

2.3 The NPPF paragraph 103 requires that developments do not increase flood risk elsewhere, and gives priority to the use of SuDS. Major developments must include SuDS for the management of run-off, unless demonstrated to be inappropriate. The proposed minimum standards of operation must be appropriate and as such, a **maintenance plan** should be included within the Surface Water Drainage Statement,clearly demonstrating that the SuDS have been designed to ensure that the maintenance and operation requirements are economically proportionate Planning Practice Guidance suggests that this should be considered by reference to the costs that would be incurred by consumers for the use of an effective drainage system connecting directly to a public sewer.

2.4 Camden Council will use planning conditions or obligations to ensure that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

2.5 Within Camden, SuDS systems must be designed in accordance with London Plan policy 5.13. This requires that developments should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve **greenfield run-off rates** and ensure that surface water run-off is managed as close to its source as possible in line with the following **drainage hierarchy**:

1 store rainwater for later use
2 use infiltration techniques, such as porous surfaces in non-clay areas
3 attenuate rainwater in ponds or open water features for gradual release
4 attenuate rainwater by storing in tanks or sealed water features for gradual release
5 discharge rainwater direct to a watercourse
6 discharge rainwater to a surface water sewer/drain
7 discharge rainwater to the combined sewer.

2.6 The hierarchy above seeks to ensure that surface water run-off is controlled as near to its source as possible to mimic natural drainage systems and retain water on or near to the site, in contrast to traditional drainage approaches, which tend to pipe water off-site as quickly as possible.

2.7 Before disposal of surface water to the public sewer is considered all other options set out in the drainage hierarchy should be exhausted. When no other practicable alternative exists to dispose of surface water other than the public sewer, the Water Company or its agents should confirm that there is adequate spare capacity in the existing system taking future development requirements into account.

2.8 Best practice guidance within the non-statutory technical standards for the design, maintenance and operation of sustainable drainage systems will also need to be followed. Runoff volumes from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the **greenfield runoff volume** for the same event.

2.9 Camden Development Policy 23 (Water) requires developments to reduce pressure on combined sewer network and the risk of flooding by limiting the rate of run-off through sustainable urban drainage systems. This policy also requires that developments in areas known to be at risk of surface water flooding are designed to cope with being flooded. Camden's SFRA surface water flood maps, updated SFRA figures 6 (LFRZs), and 4e (increased susceptibility to elevated groundwater) , as well as the Environment Agency updated flood maps for surface water (ufmfsw), should be referred to when determining whether developments are in an area at risk of flooding.

2.10 Camden Planning Guidance 3 (CPG3) requires developments to achieve a greenfield run off rate once SuDS have been installed. Where it can be demonstrated that this is not feasible, a minimum 50% reduction in run off rate across the development is required. Further guidance on how to reduce the risk of flooding can be found in CPG3 paragraphs 11.4-11.8.

2.11 Where an application is part of a larger site which already has planning permission it is essential that the new proposal does not compromise the drainage scheme already approved.

3. Further information and guidance

3.1 Applicants are strongly advised to discuss their proposals with the Lead Local Flood Authority at the pre-application stage to ensure that an acceptable SuDS scheme is submitted.

3.2 For general clarification of these requirements please Camden's Local Planning Authority or Lead Local Flood Authority

Surface Water Drainage Pro-forma for new developments

This pro-forma accompanies our advice note on surface water drainage. Developers should complete this form and submit it to the Local Planning Authority, referencing from where in their submission documents this information is taken. The pro-forma is supported by the Defra/EA guidance on Rainfall Runoff Management and uses the storage calculator on www.UKsuds.com. This pro-forma is based on current industry best practice and focuses on ensuring surface water drainage proposals meet national and local policy requirements. The pro-forma should be considered alongside other supporting SuDS Guidance.

1. Site Details

Site	34 Glenilla Road
Address & post code or LPA reference	34 Glenilla Road, London, NW3 4AN
Grid reference	TQ271848
Is the existing site developed or Greenfield?	Developed
Is the development in a LFRZ or in an area known to be at risk of surface or ground water flooding? If yes, please demonstrate how this is managed, in line with DP23?	The site is not within a LFRZ and it is at low risk of flooding from all sources.
Total Site Area served by drainage system (excluding open space) (Ha)*	0.023

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

2. Impermeable Area

	Existing	Proposed	Difference (Proposed-Existing)	Notes for developers
Impermeable area (ha)	0.020	0.023	0.03 or 23sqm	If the proposed amount of impermeable surface is greater, then runoff rates and volumes will increase. Section 6 must be filled in. If proposed impermeability is equal or less than existing, then section 6 can be skipped and section 7 filled in.
Drainage Method (infiltration/sewer/watercourse)	Sewer	Sewer	N/A	If different from the existing, please fill in section 3. If existing drainage is by infiltration and the proposed is not, discharge volumes may increase. Fill in section 6.

3. Proposing to Discharge Surface Water via

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

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

	Existing Rates (l/s)	Proposed Rates (l/s)	Difference (l/s) (Proposed-Existing)	% Difference (difference /existing x 100)	Notes for developers
Greenfield QBAR	0.14	N/A	N/A	N/A	QBAR is approx. 1 in 2 storm event. Provide this if Section 6 (QBAR) is proposed.
1 in 1	1.98	2.5	1.98	0	Proposed discharge rates (with mitigation) should aim to be equivalent to greenfield rates for all corresponding storm events. As a minimum, peak discharge rates must be reduced by 50% from the existing sites for all corresponding rainfall events.
1 in 30	4.58	2.5	2.08	45.4	
1in 100	5.96	2.5	3.46	58.1	
1 in 100 plus climate change	N/A	2.5			The proposed 1 in 100 +CC peak discharge rate (with mitigation) should aim to be equivalent to greenfield rates. As a minimum, proposed 1 in 100 +CC peak discharge rate must be reduced by 50% from the existing 1 in 100 runoff rate sites.

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

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

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

		Notes for developers
Storage Attenuation volume (Flow rate control) required to meet greenfield run off rates (m^3)	4	Volume of water to attenuate on site if discharging at a greenfield run off rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to reduce rates by 50% (m^3)	FRA	Volume of water to attenuate on site if discharging at a 50% reduction from existing rates. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to meet [OTHER RUN OFF RATE (as close to greenfield rate as possible] (m^3)	N/A	Volume of water to attenuate on site if discharging at a rate different from the above – please state in 1st column what rate this volume corresponds to. On previously developed sites, runoff rates should not be more than three times the calculated greenfield rate. Can't be used where discharge volumes are increasing
Storage Attenuation volume (Flow rate control) required to retain rates as existing (m^3)	Not required	Volume of water to attenuate on site if discharging at existing rates. Can't be used where discharge volumes are increasing
Percentage of attenuation volume stored above ground,	Not included in calcs	Percentage of attenuation volume which will be held above ground in swales/ponds/basins/green roofs etc. If 0, please demonstrate why.

7. How is Storm Water stored on site?

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

			Notes for developers
Infiltration	**State the Site's Geology and known Source Protection Zones (SPZ)**	Clay, no SPZ	Avoid infiltrating in made ground. Infiltration rates are highly variable and refer to Environment Agency website to identify and source protection zones (SPZ)
	Are infiltration rates suitable?	No	Infiltration rates should be no lower than $1x10^{-6}$ m/s.
	State the distance between a proposed infiltration device base and the ground water (GW) level	N/A	Need 1m (min) between the base of the infiltration device & the water table to protect Groundwater quality & ensure GW doesn't enter infiltration devices. Avoid infiltration where this isn't possible.

	Were infiltration rates obtained by desk study or infiltration test?	N/A	Infiltration rates can be estimated from desk studies at most stages of the planning system if a back up attenuation scheme is provided..
	Is the site contaminated? If yes, consider advice from others on whether infiltration can happen.	N/A	Advice on contaminated Land in Camden can be found on our supporting documents webpage Water should not be infiltrated through land that is contaminated. The Environment Agency may provide bespoke advice in planning consultations for contaminated sites that should be considered.
In light of the above, is infiltration feasible?	**Yes/No? If the answer is No, please identify how the storm water will be stored prior to release**	No	If infiltration is not feasible how will the additional volume be stored?. The applicant should then consider the following options in the next section.

Storage requirements

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

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

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

		Notes for developers
Please confirm what option has been chosen and how much storage is required on site.	Option 1, 4m3	The developer at this stage should have an idea of the site characteristics and be able to explain what the storage requirements are on site and how it will be achieved.

8. Please confirm

		Notes for developers
Which Drainage Systems measures have been used, including green roofs?	Permeable paving, Attenuation Tank	SUDS can be adapted for most situations even where infiltration isn't feasible e.g. impermeable liners beneath some SUDS devices allows treatment but not infiltration. See CIRIA SUDS Manual C697.
Drainage system can contain in the 1 in 30 storm event without flooding	Yes	This a requirement for sewers for adoption & is good practice even where drainage system is not adopted.
Will the drainage system contain the 1 in 100 +CC storm event? If no please demonstrate how buildings and utility plants will be protected.	Yes	National standards require that the drainage system is designed so that flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.
Any flooding between the 1 in 30 & 1 in 100 plus climate change storm events will be safely contained on site.	No flooding for these events	**Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased.
How will exceedance events be catered on site without increasing flood risks (both on site and outside the development)?	Site's topography will direct overland flows to the adopted road and back gardens.	**Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased. Exceedance events are defined as those larger than the 1 in 100 +CC event.
How are rates being restricted (vortex control, orifice etc)	Hydrobrake	Detail of how the flow control systems have been designed to avoid pipe blockages and ease of maintenance should be provided.
Please confirm the owners/adopters of the entire drainage systems throughout the development. Please list all the owners.	House owner	If these are multiple owners then a drawing illustrating exactly what features will be within each owner's remit must be submitted with this Proforma.
How is the entire drainage system to be maintained?	Refer to the FRA	If the features are to be maintained directly by the owners as stated in answer to the above question please answer yes to this question and submit the relevant maintenance schedule for each feature. If it is to be maintained by others than above please give details of each feature and the maintenance schedule. Clear details of the maintenance proposals of all elements of the proposed drainage system must be provided. Details must demonstrate that maintenance and operation requirements are economically proportionate. Poorly maintained drainage can lead to increased flooding problems in the future.

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

Pro-forma Section	Document reference where details quoted above are taken from	Page Number
Section 2	FRA	12
Section 3	FRA	13, 14, 15
Section 4	FRA	12
Section 5		
Section 6	FRA	Appendix B
Section 7	FRA	8
Section 8	FRA	Multiple

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

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

Form Completed By Oliver Frapwell……………………………………………………………………………………….........................
Qualification of person responsible for signing off this pro-forma MEng...

Company Price & Myers LLP………………………………………………………………………,..
On behalf of (Client's details) Mr & Mrs Wong..
Date: 28/05/2020………………………………..........................