246-248 KILBURN HIGH ROAD

NW6 2BS

LONDON BOROUGH OF CAMDEN

SUSTAINABLE DRAINAGE SYSTEMS ASSESSMENT

Studio 246 Media Ltd

PROJECT NUMBER: 17025

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WATER | ENVIRONMENT

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This Sustainable Drainage Systems (SuDS) Assessment was commissioned by andmoreplanning on behalf of Studio 246 Media Ltd in April 2017 to develop and assess a sustainable drainage strategy for the site at 246-248 Kilburn High Road in the London Borough of Camden.

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1. GLOSSARY

AOD	Above Ordnance Datum
BGL	Below Ground Level
BGS	British Geological Survey
DEFRA	Department for Environment Food and Rural Affairs
DTM	Digital Terrain Model
CDA	Critical Drainage Area
EA	Environment Agency
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
LBC	London Borough of Camden
LiDAR	Light Detection And Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
NPPF	National Planning Policy Framework
OS	Ordnance Survey
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Practise Guide
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan

1 INTRODUCTION

General Information

1.1 The proposed development is located at 246-248 Kilburn High Street in the London Borough of Camden (LBC).

1.2 The Development proposes more than ten dwellings and therefore in accordance with The Town and Country Planning Order 2015 the development is considered 'Major' and a Sustainable urban Drainage System (SuDS) Assessment has to be prepared to accompany the planning application.

Scope of Study

1.3 The main objectives of this study are to:

- Contact relevant statutory authorities and Thames Water to gather information on local drainage systems;
- Consideration of the pre- and post-development drainage schemes and calculation of pre- and post- development runoff rates based on standard methodologies;
- Provide design details for drainage system elements and appropriate connection locations;
- Confirmation of future management and maintenance requirements for proposed SuDS elements,
- Provide advice on the site layout and design that will ensure safe operation of the site in an extreme flood event, and
- Provide advice and guidance on the management of surface water runoff at the site to ensure the risk of surface water flooding on the site and on nearby sites does not increase following development.

2 SITE DESCRIPTION

Location

2.1 The Development is located at 246-248 Kilburn High Road in the LBC shown along with the site boundary in Figure 1.

Figure 1[1] – Location of the Development

Existing Development

2.2 The existing development on the site contains an existing dwelling. See Appendix A for the existing site layout.

2.3 A previous planning application in 2015 (2014/2662/P) at 248 Kilburn High Road was to construct 14 dwellings at the site which gain approval but was never built out. This application is a variation of the proposals.

2.4 The site (0.08ha) is completing hard standing at present and there are no SuDS features on the site.

Existing Site Levels

2.5 A topographic survey has been undertaken by CPB surveys in October 2011 for the site. It shows levels to be mostly flat on the site. The site has a threshold level of 42.35m AOD before falling to 42.14m AOD at the rear of the site.

2.6 The topographic survey can be found in the Appendix.

[1] © Crown copyright and database rights 2017 Ordnance Survey Retrieved 24/05/2017

Existing Surface Water Infrastructure

2.7 There are a number of sewers running close to the site. Thames Water asset data shows there is a combined sewer within Kilburn High Road. This sewer is a brick lined egg shaped sewer with dimension 1219x838mm.

2.8 In addition, the combined 1600mm dimeter Ranelagh sewer (West Hampstead Branch) is found to be north east of the site.

2.9 There are no surface water sewers located within close proximity of the site. The Thames Water Asset Plan can be found in Appendix A.

2.10 All the sewers serving the site flow into the sewers within Kilburn High Road. An onsite drainage survey shows that the existing site drainage connects into the Thames Water sewers within Kilburn High Road. The onsite drainage survey also shows that surface water is connected to the foul pipes on the site. A layout of the existing onsite drainage is shown within the Appendix A.

Proposed Development

2.11 The proposals are to demolish all existing buildings and construct a residential development comprising 27 residential units within two buildings with facilities e.g. bike storage.

2.12 Four of the proposed dwellings will be located adjacent to Kilburn High Road in the building to be known as the Street Block. While the other dwellings will be located to the east of the site in the block to be known as the Courtyard Block.

2.13 The proposed impermeable area is 0.02ha.

2.14 There are no basements proposed for the development.

2.15 The proposed plans are provided in Appendix A.

2.16 The proposals are considered 'Major Development' since there are more than 10 dwellings in the scheme, meaning a suitable SuDS is required with the application submission.

3 PLANNING POLICY

National Policy

National Planning Policy Framework

3.1 The National Planning Policy Framework[2] (NPPF) was published in March 2012 and sets out the Governments' planning policies for England and how these are expected to be applied.

3.2 In accordance with the NPPF, as a minimum requirement, run-off rates and volumes should not increase from any site following development, to prevent an increase in flood risk elsewhere as a result of the development.

The Town and Country Planning Order 2015

3.3 According to The Town and Country Planning (Development Management Procedure) (England) Order 2015, the Lead Local Flood Authority is now the statutory consultee regarding surface water drainage of a major development. The Lead Local Flood Authority for Kilburn High Road is the London Borough of Camden (LBC).

3.4 The proposed development falls under the classification of 'Major Development', as it involves the provision of more than 10 dwellings.

3.5 The development is therefore required to undertake a SuDS Assessment.

National Guidance

3.6 The Non-statutory Technical Standards for Sustainable Drainage Systems[3] was published in March 2015, to be used in conjunction with NPPF and Planning Practice Guidance[4] (PPG).

3.7 The document sets out the requirements for the provision of sustainable drainage within development, from design to construction and maintenance. The specific technical criteria considered within this SUDS strategy are as follows:

Peak Flow Control

~~***S2*** *For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.*~~ (Not applicable as existing site developed)

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

Volume Control

[2] Communities and Local Government, National Planning Policy Framework, 2012
[3] Department for Environment, Food and Rural Affairs, Sustainable Drainage Systems - Non-statutory Technical Standards for Sustainable Drainage Systems, 2015
[4] Communities and Local Government, Planning Practice Guidance, 2014

~~***S4*** *Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event.*~~ (Not applicable as existing site developed)

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

S6 *Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 or S5 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk.*

3.8 The wording of the requirements are such that the post development runoff rates and volumes, over the lifetime of the development, need to be considered against the present day conditions.

London Plan

3.9 As the site is within The Greater London Authority, the London Plan[5] 2011 (as revised in March 2015), is applied, which states within Policy 5.13 that:

"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:

- *store rainwater for later use*
- *use infiltration techniques, such as porous surfaces in non-clay areas*
- *attenuate rainwater in ponds or open water features for gradual release*
- *attenuate rainwater by storing in tanks or sealed water features for gradual release*
- *discharge rainwater direct to a watercourse*
- *discharge rainwater to a surface water sewer/drain"*

Local Planning Policy

3.10 The site is located within the LBC. This existing adopted policy related to SuDS is:

Camden Development Policies (2010)

DP23 Water

'The Council will require developments to reduce their water consumption, the pressure on the combined sewer network and the risk of flooding by:

- *a) incorporating water efficient features and equipment and capturing, retaining and re-using surface water and grey water on-site;*

[5] Greater London Authority, The London Plan – Spatial development strategy for Greater London, July 2011 Revised March 2015

- *b) limiting the amount and rate of run-off and waste water 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;*
- *c) 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 and shown on Map 2 as being at risk of surface water flooding are designed to cope with the potential flooding;'*

3.11 LBC emerging Local Plan due to be adopted in June 2017 states:

'…*developments to utilise Sustainable Drainage Systems (SuDS), to achieve greenfield run-off rates, unless demonstrated that this is not feasible. Surface water should be managed as close to its source as possible, in line with the drainage hierarchy in the London Plan. Where it is not possible to achieve greenfield run-off rates it should be as close to this as possible….'*

'Major developments will be required to constrain runoff volumes for a 1 in 100 year, 6 hour rainfall event, where feasible.'

'A drainage report should be submitted with all major applications, basement developments and other vulnerable development in areas identified at risk of flooding. This should include:

- *identification of flood risk;*
- *assessment of existing run-off rates;*
- *calculation of greenfield run-off rates;*
- *identification of measures, in line with the drainage hierarchy, to reduce runoff rates; and*
- *calculation of proposed run-off rates'*

4 SURFACE WATER MANAGEMENT

Existing Site Runoff

4.1 The site boundary encloses an area of 0.08 ha and consists of previously developed land. The existing site layout has been assumed to be completed hard paved and there are no SuDS features on the site.

4.2 The existing peak storm runoff for the 1% (1 in 100 year) annual probability rainfall event on the site was estimated to be 35.9 l/s. The calculation was based on the Wallingford Procedure[6] and the resulting runoff was calculated using the Modified Rational Method with a 5 minute critical storm (using M5-60 of 20mm and an 'R' value of 0.4) and a critical rainfall intensity of 169.1 mm/hr.

4.3 The rainfall runoff volume for the 1% (1 in 100 year) annual probability, 6 hour duration storm from the existing site is estimated to be 16.2 m^3.

4.4 The calculation output is provided in Appendix B.

Existing Site Drainage

4.5 Thames Water asset plans indicate that there are only combined sewers within the area around the site.

4.6 Onsite drainage assessment confirms that the sewers connect to the Thames Water combined sewer within Kilburn High Road.

Greenfield Runoff Rate

4.7 The Greenfield runoff rates from the site were calculated using the UK SuDS online tool[7] and the Institute of Hydrology (IoH) 124 methodology (Appendix B).

4.8 The 1-year, 30-year and 100-year return period events result in a discharge rate of 0.3 l/s, 0.8 l/s and 1.11 l/s respectively.

Ground Conditions

4.9 According to the British Geological Survey (BGS) online geology maps, shows the bedrock geology at the site to be impermeable London Clay. The BGS mapping holds are no records of superficial deposits at the site.

4.10 The BGS borehole log data shows a couple of boreholes close to the site. Both boreholes show the bedrock of London Clay is close to the surface. These borehole logs can be found within the Appendix.

4.11 The Environment Agency hold no groundwater or geology information for the site.

4.12 An onsite ground investigation has been undertaken at the site. This was undertaken site Analytical Services Ltd in November 2015. Two boreholes were completed on the site to a depth of 15m below ground level. The boreholes confirm the site comprised of made ground underlain by London Clay. No groundwater was noted in the boreholes.

[6] HR Wallingford (200) The Wallingford Procedure for Europe – Best Practise Guide to urban drainage modelling (CD)
[7] http://www.uksuds.com/drainage-calculation-tools/surface-water-storage retrieved 28/04/2017

4.13 The information found for the site and surrounding areas indicates that the site geology is impermeable and therefore infiltration SuDS would not be compatible with the site.

Climate Change

4.14 The current best practice for climate change allowance is the National Planning Policy Framework (NPPF), which defers to the Environment Agency website to specify climate change allowances. The Environment Agency recommends an increase of river flows and an increase in rainfall intensity depending on which river basin district the site lies in and the type of development.

4.15 The range of allowances is based on percentiles. A percentile is a measure used in statistics to describe the proportion of possible scenarios that fall below an allowance level. The 50th percentile is the point at which half of the possible scenarios for peak flows fall below it and half fall above it. The:

- central allowance is based on the 50th percentile
- higher central is based on the 70th percentile
- upper end is based on the 90th percentile

4.16 The Environment Agency anticipated changes in extreme rainfall intensity in small and urban catchments are shown in Table 1 below.

Table 1-Peak rainfall intensity allowance in small and urban catchments

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	10%	20%	40%
Central	5%	10%	20%

4.17 The planned lifetime for the proposed development is assumed to be 100 years, in accordance with the PPG[8] for Flood Risk and Coastal Change.

4.18 The proposed development is classified as 'More Vulnerable' within Flood Zone 1 the 'Upper End' allowance is recommended[9]. A 3% increase in peak rainfall intensities has been adopted as the allowance for climate change as this is the average of the 'Upper End' and 'Central' allowances.

Proposed Site Runoff

4.19 The proposed development at the site comprised of a building footprint of 0.40 ha with a green roof with a substrate of 60-100mm. In addition, the site is incorporating 0.003ha of permeable landscaping post development.

[8] http://planningguidance.communities.gov.uk/blog/guidance/flood-risk-and-coastal-change/the-exception-test/what-is-considered-to-be-the-lifetime-of-development-in-terms-of-flood-risk-and-coastal-change/ Paragraph: 026 Reference ID: 7-026-20140306 Retrieved 18/05/2017.
[9] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances Retrieved 24/05/2017

4.20 It is proposed to limit the peak storm runoff for the 1% (1 in 100) annual probability rainfall event plus 30% allowance for future climate change to 3.3 l/s. This is equivalent to three times the Greenfield 1% (1 in 100) annual probability peak runoff rate; a significant reduction on the existing runoff rate of 35.9 l/s, and is in line with the requirements of London Plan.

4.21 From our calculation we have concluded that with the proposed green roof discharging at a conservative value of 50% (runoff coefficient of 0.5) in addition to the proposed permeable landscaping the site would need to attenuate 12.5m^3 of surface water to ensure surface water runoff was at 3.3l/s. This means the site will need to implement additional SuDS features.

4.22 The additional SuDS feature will be in the form of permeable paving across the hard standing areas (0.0145ha) of the development with a granular drainage blanket. With a porosity of 0.3 and 300mm depth of subbase, the drainage blanket would be able to attenuate 13m^3.

4.23 For lower return period events, runoff rate will be controlled to proportional rates subject to detailed design of flow control device.

4.24 Analysis has been undertaken in order to calculate the required attenuation storage for the proposed SuDS strategy. Calculation sheets are provided in Appendix B and details of the SuDS are described in the following sub-sections.

4.25 The rainfall runoff volume for the 1% (1 in 100) annual probability + 20% allowance for climate change, 6 hour duration storm from the proposed development is estimated to be 18.7 m^3.

4.26 The site does not lie in a Critical Drainage Area (CDA), known to suffer from surface water volume issues, nor is it served by a public sewer which experiences tide locking. As such it is considered that the restriction of the post-development runoff rates will be sufficient to mitigate any potentially negative impacts of this increase in runoff volume and therefore not adversely affect flood risk.

Sustainable Drainage Principles

4.27 The aim of SuDS is to emulate natural processes with the result that watercourses and storage areas receive the hydrological profiles under which they evolved, and that water quality in local ecosystems is protected or improved. The best practice guide states that a sustainable drainage system will[10]:

- reduce the impact of additional urbanisation on the frequency and size of floods;
- protect or enhance river and groundwater quality;
- be sympathetic to the needs of the local environment and community; and
- encourage natural groundwater recharge

4.28 The LBC Strategic Flood Risk Assessment[11] encourages that SuDS measures be specified to maximise the aforementioned multi-functional benefits by following the hierarchy in Figure 2.

4.29 The drainage design will instead aim to meet the objectives of the LBC by a number of SuDS elements to allow the attenuation of surface water runoff rates to three times the Greenfield runoff rate. This is in accordance with the requirements of the London Plan and a peak rate of 3.3l/s is the lowest reasonably practicable rate for ensuring self-cleansing velocities in the

[10] CIRIA C523 – Sustainable Urban Drainage Systems – Best Practice Manual
[11] Mouchel, 2008, North London Strategic Flood Risk Assessment

system. The application of the SuDS hierarchy to the proposed development is summarised in Table 2.

Most sustainable	SUDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
	Green roofs	✓	✓	✓
	Basins and ponds 1. Constructed wetlands 2. Balancing ponds 3. Detention basins 4. Retention ponds	✓	✓	✓
	Filter strips and swales	✓	✓	✓
	Infiltration devices 5. Soakaways 6. Infiltration trenches and basins	✓	✓	✓
	Permeable surfaces and filter drains 7. Gravelled areas 8. Solid paving blocks 9. Porous paviors	✓	✓	
Least sustainable	**Tanked systems** 10. Over-sized pipes/ tanks 11. Box storage systems	✓		

Figure 2[12] – The multi-functional benefits of SuDS

4.30 The ground conditions at the site are not appropriate for infiltration SuDS. Space on site is also very limited, so attenuation using open water features is not practicable.

4.31 The site is small, compact and in an established urban area. It is proposed to discharge surface water to the Thames Water sewer. For all these reasons, the site does not lead itself to basins, ponds or swales.

4.32 The site is proposing flats roofs on both buildings with photovoltaics. This makes the roof ideal for green roofs. To ensure that structural redesign is not required for the building at substrate of 60-150mm.

4.33 In addition, external hard standing areas will be constructed using permeable/porous surfaces underlain by a gravel drainage blanket. Although ground conditions are not suitable for infiltration in the form of a formal soakaway, there are no known contamination issues which preclude infiltration into the ground. Therefore, the base and sides of the drainage blanket will not be lined with an impermeable liner. Surface water percolating through the

[12] Source: Environment Agency 2006

permeable/porous surface and drainage blanket will be allowed to infiltrate into the ground. This infiltration is not included in the calculations of surface water runoff rates and any infiltration is considered a bonus.

Table 2 – Application of SuDS hierarchy to proposed development.

Most Sustainable	SuDS Technique	Suitability	Justification
	Living Roofs		
	1. Green Roofs	✓	Sufficient space and flat roofs proposed.
	2. Brown Bio-Diverse Roofs	✓	Sufficient space and flat roofs proposed.
	Basins and ponds		
	3. Constructed wetlands	✗	Insufficient space
	4. Balancing ponds	✗	Insufficient space
	5. Detention basins	✗	Insufficient space
	6. Retention ponds	✗	Insufficient space
	Filter strips and swales	✗	Inappropriate ground conditions, insufficient space and discharge to the Thames Water sewer.
	Infiltration devices		
	7. Soakaways	✗	Inappropriate ground conditions.
	8. Infiltration trenches & basins	✗	
	Permeable surfaces and filter drains	**Permeable surfaces**	**Permeable surfaces**
	9. Gravelled areas	✓	Sufficient space
Least Sustainable	10. Solid block paving	✓	Sufficient space
	11. Porous paviors	✓	Sufficient space
	Tanked Systems		
	12. Over-sized pipes/tanks	✓	Sufficient space
	13. Box storage systems	✓	Sufficient space

Proposed Surface Water Drainage System

4.34 The following design principles have been agreed for the strategic assessment:

- External site levels assumed flat throughout the courtyard and access road;
- Connection to Thames Water combined sewer in Kilburn High Road;
- HydroBrake control (or similar) to restrict flow for the 1-year, 30-year and 100-year return period storm in accordance with London Plan policy;
- All roof and hard standing drainage to discharge via silt traps to granular sub-base beneath access road and courtyard on the site, and
- No requirement for oil interceptors by virtue of permeably paved construction beneath courtyard and access road.

4.35 With the following design principles and constraints, a strategic design has been completed which includes:

- Green roofs with an extensive substrate of 60-150mm (e.g. Bauder extensive substrate) across both proposed building accounting for 0.04 ha;
- Green roof overflow is to be connected to permeable paving and granular sub base to control surface water runoff from the roofs;
- Porous asphalt or permeable block paving (e.g. Formpave Aquaflow) within the proposed courtyard (150mm build up) eliminating the need for road gullies and reducing maintenance requirements;
- Lined granular sub-base (300mm depth and porosity of 0.3) beneath the courtyard (storage volume of 13 m^3);
- Lined granular sub-base linked design to collect and be discharged via hydrobrake to the Thames Water sewer in Kilburn Road; and
- Permeable landscaping totals 0.003 ha and courtyard permeable paving to be 145m^2 minimum.

4.36 The proposed strategic SuDS strategy can be seen within the drawings in Appendix A.

4.37 The proposed SuDS system has a number of elements including green roof, permeable paving and a granular subbase. These elements help to clean the surface water and increase the water quality that is discharged from the site.

4.38 Green roofs are compatible with photovoltaics on flat roofs. The presence of vegetation beneath the photovoltaic has been shown to increase their efficiency. This is because the use of vegetation reduces ambient temperature around the photovoltaic. Photovoltaics work best in cooler temperatures and start to be inefficient in higher temperatures.

4.39 The proposed finished ground levels will be designed to ensure that runoff is contained on the site during the 1 in 100 year plus climate change rainfall event. This is so that surface water can be discharged via the controlled methods mentioned in the SuDS strategy without flowing onto adjoining land.

4.40 The surface water system will be designed in detail in accordance with local planning policy and will be designed such that the 1 in 100 year plus climate change allowance is fully retained on the site and discharged at the controlled rate. Full drainage design will be undertaken at detail design stages.

4.41 The design principles set out above are subject to review at detailed design stage but serve to demonstrate a feasible drainage solution for the purpose of this assessment.

4.42 A checklist of LBC drainage strategy requirements is located within Appendix C.

SuDS Management and Maintenance

4.43 Management and maintenance of the drainage network will be the responsibility of the freeholder of the site. Management and maintenance agreements and plans will be arranged prior to completion of development.

4.44 Management and maintenance of the SuDS elements should be carried out in accordance with the supplier's guidance and specification at detailed design.

5 SUMMARY

5.1 The proposed development of 27 residential dwellings within two buildings with associated amenities and landscaping. The proposed development will be increasing building footprint on the site post development. The site will be implementing permeable areas as part of landscaping and amenity areas.

5.2 Although the site is increasing permeable areas at the site, surface water runoff rates post-development and the development must include an uplift for climate change over the lifetime of the development. Therefore the development must incorporate SuDS to ensure that the proposed development does not increase surface water runoff rates across the lifetime of the building.

5.3 As the site is located within the jurisdiction of the London Plan, the development must ensure that runoff rates post development are no larger than three times the Greenfield runoff rate of the site. It was found that the 1% AEP Greenfield runoff rates was 1.1l/s and therefore three times the Greenfield runoff would be 3.3l/s.

5.4 The most appropriate SuDS option identified for the development with the required discharge rate and storage is for the proposed development to include green roofs with a sub-base of 60-150mm and permeable paving with granular subbase.

5.5 Management and maintenance of the proposed SuDS strategy outlined in this report should be carried out in accordance with the supplier's guidance and specification.

5.6 Infiltration devices are not viable at the site due to the local geology consisting of impermeable London Clay. London Clay is impermeable and therefore cannot percolate and infiltrate surface water effectively.

5.7 The SuDS strategy is considered compliant with the DEFRA SuDS guidance, issued in March 2015, the NPPF, London Plan, LBC policy and emerging policy.

5.8 A checklist of LBC drainage strategy requirements is included in the Appendix.

APPENDIX A – DRAWINGS

Drawing 1 – Existing site plan

Inside Out Architecture Drawing No. P1512/P/101

Existing site plan.

Drawing 2 – Topographic Survey

CPS Surveys Drawing No. 2083/01 dated October 2011.

Plan of the existing levels on the site.

Drawing 3 – Existing Site Drainage

Inside Out Architecture Drawing No. P1512/P/200

Plan of the existing site drainage on site.

Drawing 4 – Proposed ground floor plan

Inside Out Architecture Drawing No. P1512/P/200

Proposed ground floor plan showing levels.

Drawing 5 – Proposed site plan

Inside Out Architecture Drawing No. P1512/P/102

Proposed site plan showing the green roofs.

Drawing 6 – Proposed landscape plan

Inside Out Architecture Drawing No. P1512/P/210

Proposed landscape plan showing surface treatments.

Drawing 7 – Site Investigation Borehole Records

Site Analytical Services Ltd borehole record for 248 Kilburn High Road.

Onsite ground investigation.

Drawing 8 – Thames Water Assets

Thames Water Asset Plans ALS/ALS_Standard/2017_3576711

Plans of Thames Water assets around the site.

Drawing 9 – SuDS Strategy

Water Environment Ltd, Drawing No. 17025 SK01

Proposed layout of SuDS elements

NOTES:

Do not scale off this drawing.
All Trade Contractors to be responsible for taking & checking their own site dimensions. Any errors or omissions to be reported to inside out architecture ltd immediately, prior to work being carried out.
All site dimensions shown are based upon the measured survey of the property carried out by independent surveyors. The accuracy of this information is not the responsibility of inside out architecture ltd
inside out architecture ltd also accept no responsibility for the accuracy of any Structural and Servicing information shown on this drawing. This information is shown for guidance purposes only, and where applicable - is based on information provided by the consulting Structural Engineers, consulting M&E Engineers, client representatives, and/or specialist subcontractors respectively. Reference should always be made to Engineers & Subcontractors current drawings & specifications.

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Project:
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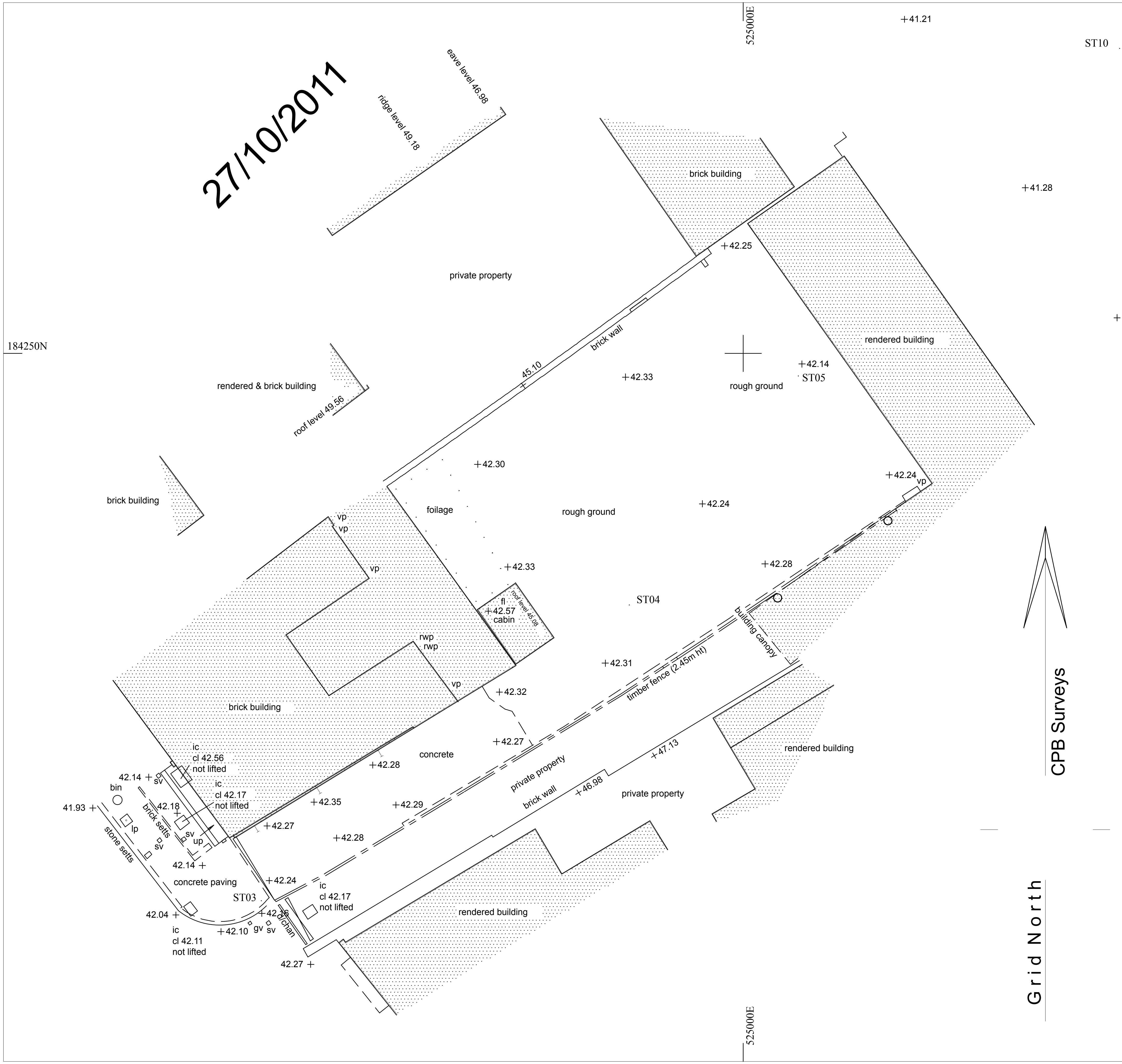
Client:
Studio 246 Media Ltd

Drawing:
Planning Submission - DRAFT
Existing Plan

Drawing Number: P1512_F_101
Rev:

Date: May 16
Scale: 1:100@A1



Notes

This plot has been prepared with a scaling accuracy for a plot at a scale of 1/200

All levels are in metres and related to GPS.

The co-ordinate grid is based on GPS values.

All tree heights and spreads are approximate.

We have tried to identify tree types, however if tree species are critical specialist advice should be gained.

Drainage pipe sizes have been measured from the surface, chamber access has not been gained for safety reasons, therefore sizes should be regarded as approximate.

Station	Easting	Northing	Level
ST01	524960.115	184210.215	42.222
ST03	524973.589	184220.012	42.197
ST04	524993.757	184236.212	42.315
ST05	525003.019	184248.759	42.155
ST10	525020.625	184266.711	40.710

bl	bed level
cl	cover level
il	invert level
tl	threshold level
utl	unable to lift
wl	water level
wfc	water filled chamber

CBH/SKH A/CAD

JOB
246a/248 Kilburn High Road
London
NW6 2BS

CLIENT
Inside Out Architecture Ltd

TITLE
Land Survey

DWG No
2083/01

SCALE
1/200 @ A3

DATE
October 2011

CPB Surveys
TOPOGRAPHICAL
AND
MEASURED BUILDING SURVEYORS
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E-MAIL: info@cpbsurveys.com

Status:
Planning Submission

Project:
248 Kilburn High Rd, London NW6

Client:
Studio 246 Media Ltd

Drawing:
Proposed Site Plan

Drawing Number: P1512_P_102
Rev: -

Date: May 2017
Scale: 1:100@A1

+44 (0)20 7367 6831

Inside Out Architecture
6-8 Cole Street
London
SE1 4YH

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InsideOut

Status:
Planning Submission

Project:
248 Kilburn High Rd, London NW6

Client:
Studio 246 Media Ltd

Drawing:
Proposed Ground Floor Plan

Drawing Number: P1512_P_200

Rev: -

Date: May 2017

Scale: 1:100@A1

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Site Analytical Services Ltd.

Site	Borehole Number
248 KILBURN HIGH ROAD, LONDON, NW6 2BS	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
ROTARY PERCUSSIVE	128mm cased to 0.00m		Mr CHRIS BEECH	1524419
	Location	**Dates**	**Architect**	**Sheet**
	TQ249842	30/10/2015	INSIDE OUT ARCHITECTURE	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.40)	MADE GROUND: Concrete		
0.25	D1					0.40			
0.50	D2					(0.30)	MADE GROUND: Soft clay with scattered peices of brick, ash and concrete		
						0.70			
0.75	D3						MADE GROUND: Soft mottled grey black silty sandy clay.		
1.00-1.45 1.00	SPT(C) N=3 D4		DRY	1,0/1,0,1,1					
						(1.55)			
1.75	D5								
2.00-2.45	U1			40 blows					
						2.25	Sift mottled brown, light grey, blue silty sandy fissured CLAY, with occassional gypsum crystals		
2.75	D6								
3.00-3.45 3.00	SPT N=17 D7		DRY	3,3/4,4,4,5					
3.75	D8								
4.00-4.45	U2			65 blows					
4.75	D9								
5.00-5.45 5.00	SPT N=23 D10		DRY	4,5/6,5,6,6					
						(7.45)			
6.00	D11								
6.50-6.95	U3			100 blows					
7.50	D12								
8.00-8.45 8.00	SPT N=30 D13		DRY	5,7/8,7,7,8					
9.00	D14								
9.50-9.95	U4			120 blows					
						9.70 (0.30)	Very stiff dark grey, blue silty sandy fissured CLAY, with occassional gypsum crystals and claystone		

Remarks
D= Disturbed sample
SPT (C)= Standard Penetration Test (Cone)
U= Undisturbed 100mm diameter sample
SPT= Standard Penetration Test
Excavating from 0.00 to 1.00mm for 1 hour

Scale (approx)	Logged By
1:50	MH

Figure No. 1524419.1

Site Analytical Services Ltd.

Site	Borehole Number
248 KILBURN HIGH ROAD, LONDON, NW6 2BS	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
ROTARY PERCUSSIVE	128mm cased to 0.00m		Mr CHRIS BEECH	1524419
	Location	**Dates**	**Architect**	**Sheet**
	TQ249842	30/10/2015	INSIDE OUT ARCHITECTURE	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						10.00	Very stiff dark grey, blue silty sandy fissured CLAY, with occassional gypsum crystals and claystone		
10.50	D15								
11.00-11.45	SPT N=47		DRY	9,10/15,10,10,12					
11.00	D16								
12.00	D17								
12.50-12.95	U5			130 blows		(5.00)			
13.75	D18								
14.55-15.00	SPT N=58		DRY	10,13/14,13,15,16					
14.55	D19								
						15.00	Complete at 15.00m		

Remarks
D= Disturbed sample
SPT (C)= Standard Penetration Test (Cone)
U= Undisturbed 100mm diameter sample
SPT= Standard Penetration Test
Excavating from 0.00 to 1.00mm for 1 hour

Scale (approx)	Logged By
1:50	MH

Figure No. 1524419.1

Site Analytical Services Ltd.

Site	Borehole Number
248 KILBURN HIGH ROAD, LONDON, NW6 2BS	BH2

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
ROTARY PERCUSSIVE	128mm cased to 0.00m		Mr CHRIS BEECH	1524419
	Location	**Dates**	**Architect**	**Sheet**
	TQ249842	29/10/2015	INSIDE OUT ARCHITECTURE	1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
							MADE GROUND: Grey granite chippings over brick rubble with a silty sand cement fill		
0.25	D1								
						(0.90)			
0.50	D2								
0.75	D3								
						0.90	MADE GROUND: Soft grey black silty sandy clay.		
1.00	D4					(0.40)			
						1.30	Firm mottled brown light grey, blue silty sandy fissured CLAY, with occasional gypsum crystals and claystones		
1.75	D5								
2.00-2.45	U1			30 blows					
2.75	D6								
3.00-3.45	SPT N=17		DRY	3,4/4,4,4,5					
3.00	D7								
3.75	D8								
4.00-4.45	U2			65 blows					
4.75	D9								
5.00-5.45	SPT N=19		DRY	5,6/6,6,1,6					
5.00	D10								
						(8.70)			
6.00	D11								
6.50-6.95	U3			90 blows					
7.50	D12								
8.00-8.45	SPT N=30		DRY	5,6/7,7,8,8					
8.00	D13								
9.00	D14								
9.50-9.95	U4			110 blows					

Remarks
D=Disturbed sample
SPT (C)= Standard Penetration Test (Cone)
U= Undisturbed 100mm diameter sample
SPT= Standard Penetration Test
Excavating from 0.00m to 1.00m for 1 hour

Scale (approx)	Logged By
1:50	MH

Figure No. 1524419.2

Site Analytical Services Ltd.

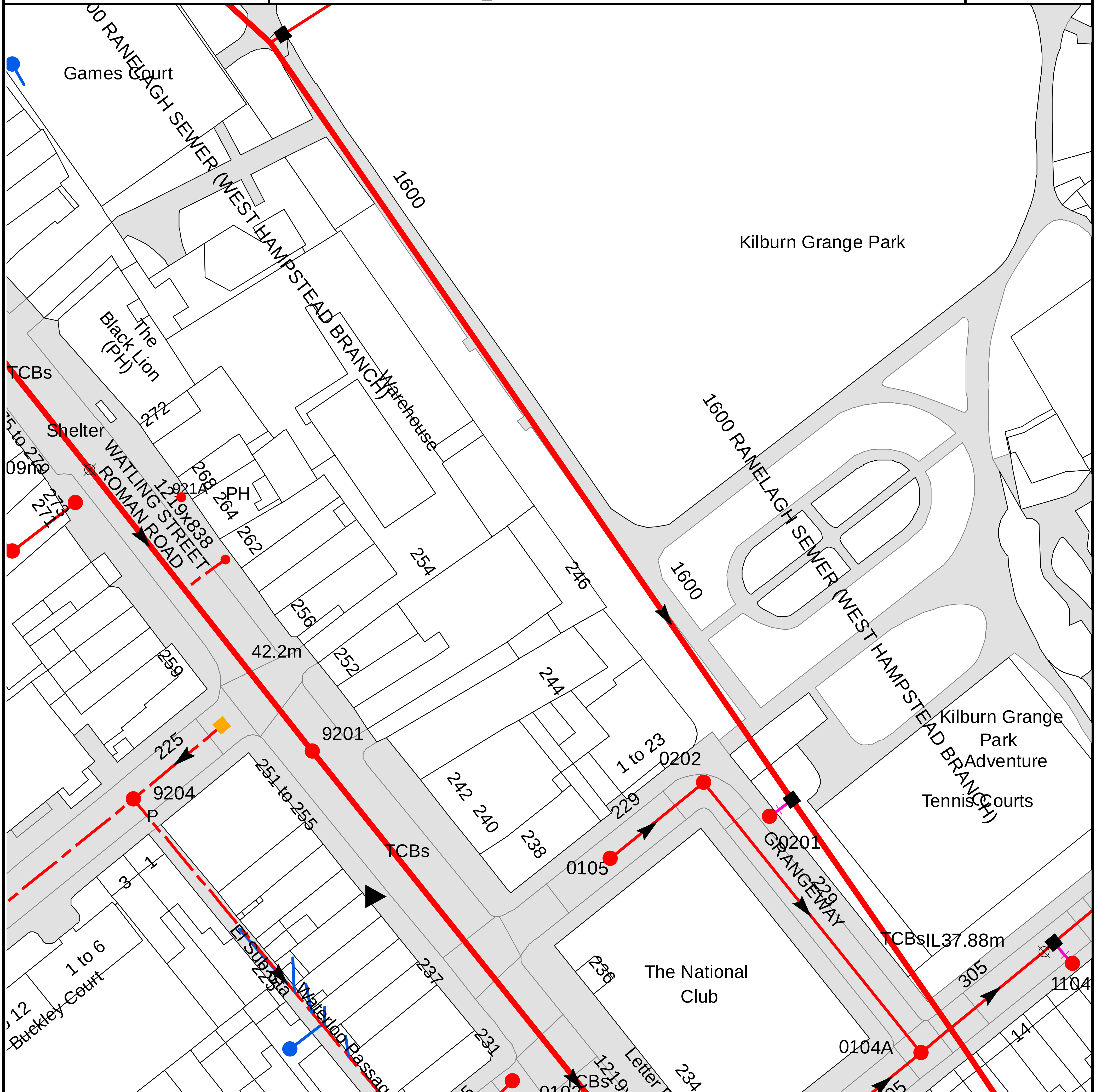
Site	Borehole Number
248 KILBURN HIGH ROAD, LONDON, NW6 2BS	BH2

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
ROTARY PERCUSSIVE	128mm cased to 0.00m		Mr CHRIS BEECH	1524419
	Location	**Dates**	**Architect**	**Sheet**
	TQ249842	29/10/2015	INSIDE OUT ARCHITECTURE	2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						10.00 (0.20) 10.20	Firm mottled brown light grey, blue silty sandy fissured CLAY, with occasional gypsum crystals and claystones		
							Very stiff dark grey, blue silty sandy fissured CLAY, with occasional gypsum and claystones		
10.50	D15								
11.00-11.45 11.00	SPT N=43 D16		DRY	8,9/10,10,11,12					
12.00	D17								
12.50-12.95	U5			130 blows		(4.80)			
13.50	D18								
14.55-15.00 14.55	SPT N=57 D19		DRY	9,10/13,13,15,16					
						15.00	Complete at 15.00m		

Remarks	Scale (approx)	Logged By
	1:50	MH
	Figure No. 1524419.2	

Asset Location Search Sewer Map - ALS/ALS Standard/2017_3576711



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 525008,184253

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

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

Manhole Reference	Manhole Cover Level	Manhole Invert Level
93BC	n/a	n/a
92AI	n/a	n/a
92AJ	n/a	n/a
9204	43.02	39.44
921A	n/a	n/a
921B	n/a	n/a
9201	42.25	35.53
0105	42.13	39.27
0202	41.71	39.18
0201	n/a	n/a
1104	n/a	n/a
0102	42.62	40.72
0104A	41.82	38.66
91DB	n/a	n/a

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

SuDS Strategy

To reduce runoff rate to three times Greenfield Rate 3.3l/s.

To attenuate runoff to the required rate the development will need to provide 12.5m^3 of surface water storage on the site.

It is proposed to have green roofs with a substrate of 60-150mm with permeable paving with a granular sub-base of 300mm with porosity 0.3.

Full details are outlined within the Water Environment SuDS Assessment (WEL-17025).

WATER | ENVIRONMENT

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Notes

Do Not Scale
Drawing is indicative only
Drawing is based on Inside Out Architects P1512_F_200 and P1512_P_102

Rev	Date	Amendments	Drawn	Approved

Client	Studio 246 Media Ltd
Job Title	17025 246-248 Kilburn High Road
Drawing Title	SuDS Strategy

Drawing No	17025-SK01
Rev	
Scale	DNS
Date	31/05/17
Drawn by	CB
Checked by	GL
Approved by	GL

APPENDIX B – CALCULATIONS

Calculations of rainfall runoff and volume

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ANNEX A: CALCULATIONS — COVER SHEET

Job No.	17025	
Job Name	Kilburn High Street	
Engineer	Claire Burroughs	CB
Checked By	Guy Laister	GL
Date	30-05-2017	

Site Characteristics

Site Area (ha) 0.0804

	Overall		Discharging from site		
Existing Pervious Surfaces (ha)	0	0%	0	β	0%
Existing Impervious Surfaces (ha)	0.0804	100%	0.0804	α	100%
Total:	0.0804	Total:	0.0804		

	Overall		Discharging from site		
Proposed Pervious Surfaces (ha)	0.0032	4%	0.0032	β	100%
Proposed Impervious Surfaces (ha)	0.0369	46%	0.0369	α	100%
Proposed Green Roof	0.0403	50%	0.02015	γ	50%
Total:	0.0804	Total:	0.06025		

Green Roof Type: Sedum-moss-herbaceous plants >6-10 cm Course Depth
Construction Depth: 60-100mm Gradient: of up to 15°,

Peak Rate of Runoff

Existing Site	BROWNFIELD	
Detailed Modelling Used?	No	e.g. Microdrainage, HydroCAD, Multiple Catchments
Runoff Calculation Method (Existing)	Wallingford/Modified Rational	Calculation Sheets Attached
Runoff Calculation Method (Proposed)	Wallingford/Modified Rational	Calculation Sheets Attached
Allowance for Future Climate Change	To 2115 30%	
Surface Water Management Strategy	Attenuated on Site	

	1yr	30yr	100yr		
Existing Discharge Rate	**12.0**	**28.4**	**35.9**	l/s	
IoH Greenfield Discharge Rate (full site)	**0.3**	**0.8**	**1.1**	l/s	
Detailed modelling output/FEH:				l/s	
Limiting Discharge Rate	12.0	28.4	35.9	l/s	3.3 l/s
Post-Development Discharge Rate	7.3	17.2	21.8	l/s	
Detailed modelling output:				l/s	
including allowance for climate change	**9.5**	**22.4**	**28.4**	l/s	
Proposed Discharge Rate	12.0	28.4	35.9	l/s	
Bespoke Limiting Discharge Rate	0.9	2.4	3.3		
Design discharge rate:	**0.9**	**2.4**	**3.3**	l/s	Bespoke Rate
Minimum Storage Required	**4.1**	**9.8**	**12.5**	m^3	

Volume of Runoff

Additional Volume (above Greenfield) of Runoff Generated

Existing Site	16.2	m^3
Proposed Site (unmitigated)	20.3	m^3
Rainwater retained on-site for re-use (where limited)	0.0	m^3
Long Term Storage Required	4.0	m^3
Proposed Site (including soakaways/infiltration SUDS)	9.8	m^3

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IH124 : Greenfield Peak Runoff

17025	Kilburn High Street	
Calculations By: CB	Checked By: GL	Date: 30-05-17

Catchment Area	AREA	ha	0.0804
Standard average annual rainfall 1941 - 1970	SAAR	mm	638
Soil Index (from FSR or Wallingford Procedure WRAP maps)*	SOIL		0.47

*SOIL is the SPR for the soil type, and for larger sites is a weighted sum of the individual soil classes for the site, where:

$$SOIL = \frac{0.1A_{SOIL1} + 0.3A_{SOIL2} + 0.37A_{SOIL3} + 0.47A_{SOIL4} + 0.53A_{SOIL5}}{AREA}$$

For smaller sites, use the SPR for the local soil type, as follows:

SOIL TYPE	1	2	3	4	5
AREA	0	0	0	0.0804	0
SPR	0.1	0.3	0.37	0.47	0.53

SOIL:
0.47

$QBAR = 0.00108 . (0.01AREA)^{0.89} . SAAR^{1.17} . SOIL^{2.17}$

* The site area is less than 50ha. Since the IoH124 methodology is not calibrated for sites less than 50ha in area, the calculation should be undertaken based on a 50ha site area and proportionately adjusted based on the ratio of the site size to 50ha.

$QBAR_{50ha}$	l/s	216.57
QBAR/ha	l/s/ha	4.33
$QBAR_{site}$	l/s	**0.35**

Hydrological Area	fig 4.2	6

Return Period (years)	Growth Factor (table 4.3)	Discharge rate l/s
1	0.85	**0.30**
2	0.88	0.31
10	1.62	0.56
30	2.3	**0.80**
50	2.62	0.91
100	3.19	**1.11**

Figures and table references from CIRIA C753 The SUDS Manual © CIRIA 2015

Date Printed: 31-05-17

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IH124 : Greenfield Peak Runoff	17025	Kilburn High Street	
	Calculations By: CB	Checked By: GL	Date: 30-05-17

Catchment Area	AREA	ha	0.0804
Drained Area	AREA	ha	0.0804
Standard average annual rainfall 1941 - 1970	SAAR	mm	638
Soil Index (from FSR or Wallingford Procedure WRAP maps)*	SOIL		0.47

*SOIL is the SPR for the soil type, and for larger sites is a weighted sum of the individual soil classes for the site, where:

$$SOIL = \frac{0.1ASOIL1 + 0.3ASOIL2 + 0.37ASOIL3 + 0.47ASOIL5 + 0.53ASOIL5}{AREA}$$

For smaller sites, use the SPR for the local soil type, as follows:

SOIL TYPE	1	2	3	4	5
AREA	0	0	0	0.0804	0
SPR	0.1	0.3	0.37	0.47	0.53

SOIL:
0.47

$$\mathbf{QBAR = 0.00108 \cdot (0.01AREA)^{0.89} \cdot SAAR^{1.17} \cdot SOIL^{2.17}}$$

* The site area is less than 50ha. Since the IoH124 methodology is not calibrated for sites less than 50ha in area, the calculation should be undertaken based on a 50ha site area and proportionately adjusted based on the ratio of the site size to 50ha.

$QBAR_{50ha}$	l/s	216.57
QBAR/ha	l/s/ha	4.33
$QBAR_{site}$	l/s	**0.35**

Hydrological Area	fig 4.2	6

Return Period (years)	Growth Factor (table 4.3)	Discharge rate l/s
1	0.85	**0.30**
2	0.88	0.31
10	1.62	0.56
30	2.3	**0.80**
50	2.62	0.91
100	3.19	**1.11**

Figures and table references from CIRIA C753 The SUDS Manual © CIRIA 2015

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Wallingford Procedure : Existing Peak Runoff

17025	Kilburn High Street	
Calculations By: CB	Checked By: GL	Date: 30-05-17

Site Characteristics

Site Area	AREA	ha	0.0804
Drained Catchment Area	AREA	ha	0.0804
Approximate Longest Drainage Path	L	m	10
Difference in Ground Levels	ΔH	m	0.1
Slope	Slope (S)		1: 100
Permeable Surfaces (Rational Method runoff coefficient = 0.4)		ha	0%
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)		ha	100%
Area Weighted Rational Method Runoff Coefficient			0.950

Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)

60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40

Time of Concentration

Recommended Tc Method: SCS: Sheet Flow

Tc Method Choice: SCS: Sheet Flow

Sheet Flow

Surface Description			Concrete (Broken or Rough)
Slope			Shallow
Roughness Coefficient	(Manning's n)		0.035
Flow Length, L		m	10
M2-24hr		mm	37.70
Land Slope		m/m	0.01000
Tc		hr	0.04

Time of Concentration	T_c	min	2.4
Critical Storm Duration (minimum 5min)	T_{crit}	min	5.0

Critical Storm Rainfall and Runoff

$Z1_{TC}$ 0.38 *Wallingford Procedure Figure 3.6

$M5\text{-}T_{crit}$ 7.7

C 0.950

Discharge Rate
Q = 2.78CiA

Return Period (years)	Z2*	Depth (mm)	Intensity (mm/hr)	Discharge Rate l/s
1	0.62	4.7	56.7	**12.03**
2	0.79	6.1	72.7	15.43
10	1.20	9.2	110.6	23.48
30	1.45	11.1	133.6	**28.36**
50	1.60	12.2	146.8	31.18
100	1.84	14.1	169.1	**35.91**

*Wallingford Procedure Table 3.2

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Wallingford Procedure : Developed Peak Runoff

17025	Kilburn High Street	
Calculations By: CB	Checked By: GL	Date: 30-05-17

Site Characteristics

Site Area	AREA	ha	0.0804
Drained Catchment Area	AREA	ha	0.06025
Approximate Longest Drainage Path	L	m	10
Difference in Ground Levels	ΔH	m	0.1
Slope	Slope (S)		1: 100

Permeable Surfaces (Rational Method runoff coefficient = 0.4)	ha	5%
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)	ha	61%
Green Roof of gradient of up to 15°, and depth of 60-100mm , c=	0.5 *	33%
Area Weighted Rational Method Runoff Coefficient		0.77

*in line with Table 10.1 of CIRIA C644

Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)

60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40

Time of Concentration

Recommended Tc Method: SCS: Sheet Flow
Tc Method Choice: SCS: Sheet Flow

Sheet Flow			
Surface Description			Paving or Brick
Slope			Shallow
Roughness Coefficient	(Manning's n)		0.018
Flow Length, L		m	10
M2-24hr		mm	37.70
Land Slope		m/m	0.01000
Tc		hr	0.02

Time of Concentration	T_c	min	1.4
Critical Storm Duration (minimum 5min)	T_{crit}	min	5.0

Critical Storm Rainfall and Runoff

$Z1_{TC}$ 0.38 *Wallingford Procedure Figure 3.6
$M5\text{-}T_{crit}$ 7.7
C 0.770

Discharge Rate
Q = 2.78CiA

Return Period (years)	Z2*	Depth (mm)	Intensity (mm/hr)	Discharge Rate l/s	Future Rate l/s
1	0.62	4.7	56.7	**7.31**	**9.51**
2	0.79	6.1	72.7	**9.38**	12.19
10	1.20	9.2	110.6	**14.27**	18.55
30	1.45	11.1	133.6	**17.23**	**22.41**
50	1.60	12.2	146.8	**18.94**	24.63
100	1.84	14.1	169.1	**21.82**	**28.36**

*Wallingford Procedure Table 3.2

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MRM 100 year Event Storage Calculator

17025	Kilburn High Street	
Calculations By: CB	Checked By: GL	Date: 30-05-17

Site Parameters

Drained Catchment Area	AREA	ha	0.06025
Approximate Longest Drainage Path	L	m	10
Difference in Ground Levels	ΔH	m	0.1
Slope	Slope (S)		1: 100

Permeable Surfaces (Rational Method runoff coefficient = 0.4)	ha	5%
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)	ha	61%
Green Roof of gradient of up to 15°, and depth of 60-100mm , c=	0.5 *	33%
Area Weighted Rational Method Runoff Coefficient		0.77

*in line with the FLL Guidelines on Planning, Execution and Upkeep of Green Roof Sites, 2002

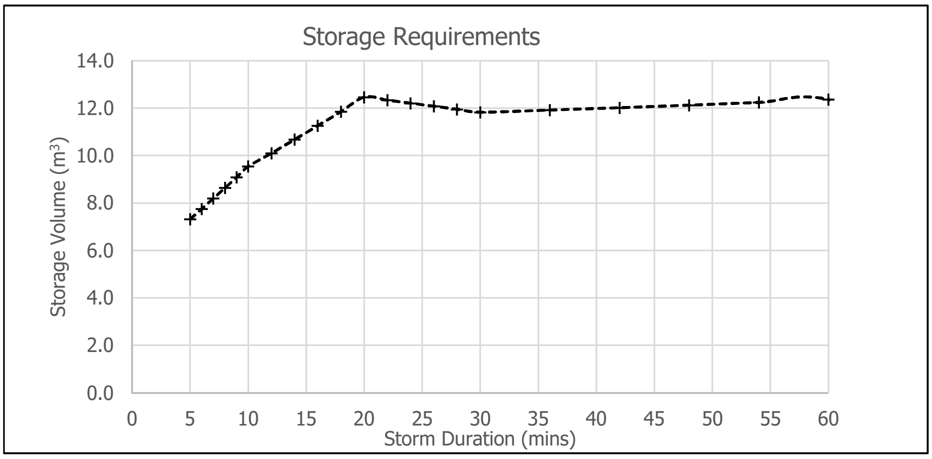
Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)

60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40
Time of Concentration	T_c	min	1.4

Maximum Storm Runoff Storage Volume (modified rational method)

	5	
T_d	20.0	min
$Z1_{TD}$	0.70	*Wallingford Procedure Figure 3.6
$M5\text{-}T_d$	14.0	mm
C	0.77	
$Z2_{100}$	1.97	*Wallingford Procedure Table 3.2
$M100\text{-}T_d$	27.6	mm
Intensity	82.9	mm/hr
Q_d	10.7	l/s
$Q_{d,climate\ change}$	13.9	l/s
$Q_{limiting\ discharge}$	3.3	l/s

Maximum storage required	m^3	12.5



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MRM 30 year Event Storage Calculator

17025	Kilburn High Street	
Calculations By: CB	Checked By: GL	Date: 30-05-17

Site Parameters

Drained Catchment Area	AREA	ha	0.06025
Approximate Longest Drainage Path	L	m	10
Difference in Ground Levels	ΔH	m	0.1
Slope	Slope (S)		1: 100

Permeable Surfaces (Rational Method runoff coefficient = 0.4)	ha	5%
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)	ha	61%
Green Roof of gradient of up to 15°, and depth of 60-100mm , c=	0.5 *	33%
Area Weighted Rational Method Runoff Coefficient		0.77

*in line with the FLL Guidelines on Planning, Execution and Upkeep of Green Roof Sites, 2002

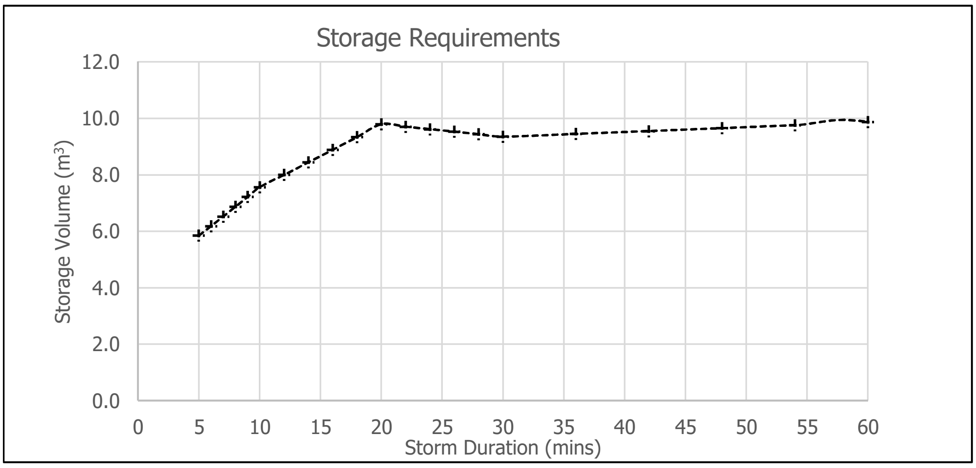
Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)

60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40
Time of Concentration	T_c	min	1.4

Maximum Storm Runoff Storage Volume (modified rational method)

T_d	20.0	min
$Z1_{TD}$	0.70	*Wallingford Procedure Figure 3.6
$M5\text{-}T_d$	14.0	mm
C	0.77	
$Z2_{30}$	1.52	*Wallingford Procedure Table 3.2
$M30\text{-}T_d$	21.3	mm
Intensity	63.8	mm/hr
Q_d	8.2	l/s
$Q_{d,climate\ change}$	10.7	l/s
$Q_{limiting\ discharge}$	2.4	l/s

Maximum storage required m^3 9.8



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Email: contact@waterenvironment.co.uk· web: www.waterenvironment.co.uk

MRM 1 year Event Storage Calculator

17025	Kilburn High Street	
Calculations By: CB	Checked By: GL	Date: 30-05-17

Site Parameters

Drained Catchment Area	AREA	ha	0.06025
Approximate Longest Drainage Path	L	m	10
Difference in Ground Levels	ΔH	m	0.1
Slope	Slope (S)		1: 100
Permeable Surfaces (Rational Method runoff coefficient = 0.4)		ha	5%
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)		ha	61%
Green Roof of gradient of up to 15°, and depth of 60-100mm , c=		0.5 *	33%
Area Weighted Rational Method Runoff Coefficient			0.77

*in line with the FLL Guidelines on Planning, Execution and Upkeep of Green Roof Sites, 2002

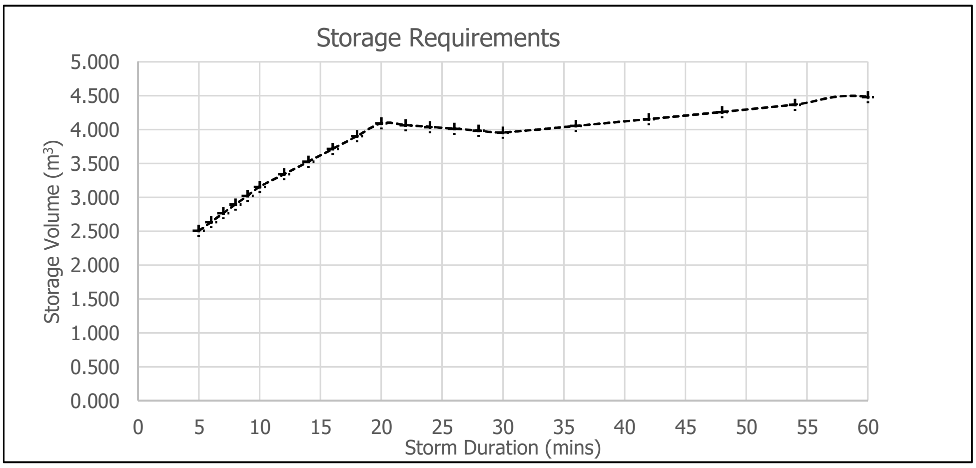
Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)

60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40
Time of Concentration	T_c	min	1.4

Maximum Storm Runoff Storage Volume (modified rational method)

T_d	20.0	min
$Z1_{TD}$	0.70	*Wallingford Procedure Figure 3.6
$M5\text{-}T_d$	14.0	mm
C	0.77	
$Z2_1$	0.62	*Wallingford Procedure Table 3.2
$M1\text{-}T_d$	8.7	mm
Intensity	26.0	mm/hr
Q_d	3.3	l/s
$Q_{d,climate\ change}$	4.4	l/s
$Q_{limiting\ discharge}$	0.9	l/s

Maximum storage required	m^3	4.1



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SUDS Manual Volume Calculation (Existing)

17025	Kilburn High Street	
Calculations By: CB	Checked By: GL	Date: 30-05-17

Site Characteristics

Site Area	AREA	ha	0.0804
Permeable Surfaces (Existing Case)			0%
Proportion discharging to sewer network or local watercourses	β		0%
*zero if all runoff collected from unpaved surfaces is retained on site or discharged to ground			
Impermeable Surfaces (Existing Case)	PIMP		100%
Proportion discharging to sewer network or local watercourses	α		100%
*zero if all runoff from paved surfaces remains on site or is collected and discharged to ground			
Soil Index (from FSR or Wallingford Procedure WRAP maps)*	SOIL		0.47

*SOIL is the SPR for the soil type, and for larger sites is a weighted sum of the individual soil classes for the site, where:

$$SOIL = \frac{0.1A_{SOIL1} + 0.3A_{SOIL2} + 0.37A_{SOIL3} + 0.47A_{SOIL4} + 0.53A_{SOIL5}}{AREA}$$

For smaller sites, use the SPR for the local soil type, as follows:

SOIL TYPE	1	2	3	4	5
AREA	0	0	0	0.0804	0
SPR	0.1	0.3	0.37	0.47	0.53

SOIL:
0.47

Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)

60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40

Volume Calculation for the 100 year return period 6hr storm

$Z1_{6hr}$	1.55	*Wallingford Procedure Figure 3.6
M5-6hr	31.1	
$Z2_{100yr}$	1.97	*Wallingford Procedure Table 3.2
M100-6hr	61.2	

Additional volume (m^3) of existing site runoff over Greenfield runoff:

$$Vol = \text{"M100-6hr"}.AREA.10[PIMP/100\ (0.8\alpha)+(1-PIMP/100)SOIL\ .\ \beta-SOIL]$$

* EQ24.10 CIRIA C753 The SUDS Manual © CIRIA 2015

Additional Volume of Runoff (above Greenfield state): m^3 **16.2**

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SUDS Manual Volume Calculation (Proposed)

17025	Kilburn High Street	
Calculations By: CB	Checked By: GL	Date: 30-05-17

Site Characteristics

Site Area	AREA	ha	0.0804
Permeable Surfaces (Proposed Case)			4%
Proportion discharging to sewer network or local watercourses	β		100%
*zero if all runoff collected from unpaved surfaces is retained on site or discharged to ground			
Impermeable Surfaces (Proposed Case)	PIMP		96%
Proportion discharging to sewer network or local watercourses	α		100%
*zero if all runoff from paved surfaces remains on site or is collected and discharged to ground			
Soil Index (from FSR or Wallingford Procedure WRAP maps)*	SOIL		0.47

*SOIL is the SPR for the soil type, and for larger sites is a weighted sum of the individual soil classes for the site, where:

$$SOIL = \frac{0.1A_{SOIL1} + 0.3A_{SOIL2} + 0.37A_{SOIL3} + 0.47A_{SOIL4} + 0.53A_{SOIL5}}{AREA}$$

For smaller sites, use the SPR for the local soil type, as follows:

SOIL TYPE	1	2	3	4	5
AREA	0	0	0	0.0804	0
SPR	0.1	0.3	0.37	0.47	0.53

SOIL: 0.47

Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)

60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40

Volume Calculation for the 100 year return period 6hr storm

$Z1_{6hr}$	1.55	*Wallingford Procedure Figure 3.6
M5-6hr	31.1	
$Z2_{100yr}$	1.97	*Wallingford Procedure Table 3.2
M100-6hr	61.2	
With Climate Change	79.6	30%

Additional volume (m^3) of development runoff over Greenfield runoff:

$$Vol = \text{M100}-\text{6hr}.AREA.10\left[\frac{PIMP}{100}(0.8\alpha)+\left(1-\frac{PIMP}{100}\right)SOIL.\beta - SOIL\right]$$

* EQ24.10 CIRIA C753 The SUDS Manual © CIRIA 2015

Additional Rainfall Volume (above Greenfield state) for the developed site: m^3 **20.3**

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SUDS Manual Volume Calculation (Developed)

17025	Kilburn High Street	
Calculations By: CB	Checked By: GL	Date: 30-05-17

Site Characteristics

Catchment Area	AREA	ha	0.0804
Permeable Surfaces (Proposed Case)	PGF		4%
Areas discharging to soakaway or prevented from leaving site via mitigation		ha	0.0032
	β		92%
Impermeable Surfaces (Proposed Case)	PIMP		46%
Areas discharging to soakaway or prevented from leaving site via mitigation		ha	0.0145
	α		97%
Green Roof Area (Proposed Case)	PGR	Depth of Green Roof	50%
Annual coefficient of discharge*	ψ_a	>6-10 cm	0.5

**Inline with Table 3 of the FLL Planning, Execution and Upkeep of Green-roof sites, 2002*

Soil Index (from FSR or Wallingford Procedure WRAP maps)*	SOIL	0.47

*SOIL is the SPR for the soil type, and for larger sites is a weighted sum of the individual soil classes for the site, where:

$$SOIL = \frac{0.1A_{SOIL1} + 0.3A_{SOIL2} + 0.37A_{SOIL3} + 0.47A_{SOIL4} + 0.53A_{SOIL5}}{AREA}$$

For smaller sites, use the SPR for the local soil type, as follows:

SOIL TYPE	1	2	3	4	5
AREA	0	0	0	0.0804	0
SPR	0.1	0.3	0.37	0.47	0.53

SOIL: 0.47

Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)

60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40

Volume Calculation for the 100 year return period 6hr storm

$Z1_{6hr}$	1.55	*Wallingford Procedure Figure 3.6
M5-6hr	31.1	
$Z2_{100yr}$	1.97	*Wallingford Procedure Table 3.2
M100-6hr	61.2	
With Climate Change	79.6	30%

Additional volume (m^3) of development runoff over Greenfield runoff:

$$Vol = \text{"M100-6hr"}.AREA.10[PIMP/100\ (0.8\alpha) + (\text{PGF}/100) SOIL.\beta + (\text{PGR}/100).\Psi a - SOIL]$$

* Modified from EQ24.10 CIRIA C753 The SUDS Manual © CIRIA 2015

Additional Volume of Runoff (above Greenfield state) leaving the site:	m^3	9.8
Rainwater harvesting or other re-use scheme committed volumes:	m^3	0
Additional Volume of Runoff (above Greenfield state) leaving the site:	m^3	**9.8**

APPENDIX C – LBC SUDS PRO FORMA

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	246-248 Kilburn High Road
Address & post code or LPA reference	NW6 2BS
Grid reference	TQ24973 94208
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?	Yes, located in Kingsgate LFRZ and Group 3_010 CDA
Total Site Area served by drainage system (excluding open space) (Ha)*	0.08 Ha

***** 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)	0.08	0.02	0.06	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	Infiltration & 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	Y		In SuDS Assessment	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	Y		In SuDS Assessment	e.g. soakage tests. Section 6 (infiltration) must be filled in if infiltration is proposed.
To watercourse		N		e.g. Is there a watercourse nearby?
To surface water sewer	Y		In SuDS Assessment	Confirmation from sewer provider that sufficient capacity exists for this connection.
Combination of above	Y		In SuDS Assessment	e.g. part infiltration part discharge to sewer or watercourse. Provide evidence above.
Has the drainage proposal had regard to the SuDS hierarchy?	Y		In SuDS Assessment	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.	Y		In SuDS Assessment	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	0.35	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	12.0	0.9	11.1	92.5	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	28.4	2.4	26.0	91.5	
1in 100	35.9	3.3	32.6	90.8	
1 in 100 plus climate change	N/A	3.3	N/A	N/A	The proposed 1 in 100 +CC peak discharge rate (with mitigation) should aim to be equivalent to greenfield rates. As a minimum, proposed 1 in 100 +CC peak discharge rate must be reduced by 50% from the existing 1 in 100 runoff rate sites.

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

	Greenfield runoff volume (m^3)	Existing Volume (m^3)	Proposed Volume (m^3)	Difference (m^3) (Proposed-Existing)	Notes for developers
1 in 1					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	N/A	16.2	N/A	N/A	
1 in 100 6 hour plus climate change	N/A	N/A	20.3 unmitigated 9.8 with SuDS	N/A	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)	20.4m^3	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)	2.6m^3	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) Three times Greenfield Runoff (London Plan)	12.5m^3	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)	N/A	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,	18% in Green Roofs	Percentage of attenuation volume which will be held above ground in swales/ponds/basins/green roofs etc. If 0, please demonstrate why.

7. How is Storm Water stored on site?

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

			Notes for developers
Infiltration	**State the Site's Geology and known Source Protection Zones (SPZ)**	London Clay bedrock with no superficial deposits notes No SPZ Category	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, permable paving and unlined drainage blanket will allow some infiltration. However, this has not be calculated to ensure the SuDS scheme could accomdate the worse case situation.	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		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.

No SI, BGS borehole records show no groundwater in the area

	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.	Unknown but SuDS scheme does not rely on infiltration.	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**	Not as the single solution, as part of a SuDS scheme, yes.	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	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?	Green Roof, Permeable Paving, and Granualar Sub-base	SUDS can be adapted for most situations even where infiltration isn't feasible e.g. impermeable liners beneath some SUDS devices allows treatment but not infiltration. See CIRIA SUDS Manual C697.
Drainage system can contain in the 1 in 30 storm event without flooding	Yes	This a requirement for sewers for adoption & is good practice even where drainage system is not adopted.
Will the drainage system contain the 1 in 100 +CC storm event? If no please demonstrate how buildings and utility plants will be protected.	Yes	National standards require that the drainage system is designed so that flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.
Any flooding between the 1 in 30 & 1 in 100 plus climate change storm events will be safely contained on site.	Yes	**Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased.
How will exceedance events be catered on site without increasing flood risks (both on site and outside the development)?	Yes, site levels rise 150mm across the site.	**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)	Yes, via HydroBrake or similar	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.	Freeholder(s) of the site	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?	To be organised by the freeholder(s) of the site. Freeholder(s) will also follow manufactors specifications.	If the features are to be maintained directly by the owners as stated in answer to the above question please answer yes to this question and submit the relevant maintenance schedule for each feature. If it is to be maintained by others than above please give details of each feature and the maintenance schedule. Clear details of the maintenance proposals of all elements of the proposed drainage system must be provided. Details must demonstrate that maintenance and operation requirements are economically proportionate. Poorly maintained drainage can lead to increased flooding problems in the future.

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

Pro-forma Section	Document reference where details quoted above are taken from	Page Number
Section 2	SuDS Assessment	3 &4
Section 3	SuDS Assessment	8-10
Section 4	SuDS Assessment	8-10
Section 5	SuDS Assessment	10
Section 6	SuDS Assessment	10
Section 7	SuDS Assessment	11 & 13
Section 8	SuDS Assessment	ALL

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…Claire Burroughs……………………………………………………………………........................

Qualification of person responsible for signing off this pro-forma MSc DIC, MEng (Hons), MCIWEM ....

Company…Water Environment Ltd………………………………………………,..

On behalf of (Client's details) Andmoreplanning..

Date:…1st June 2017……………………….........................