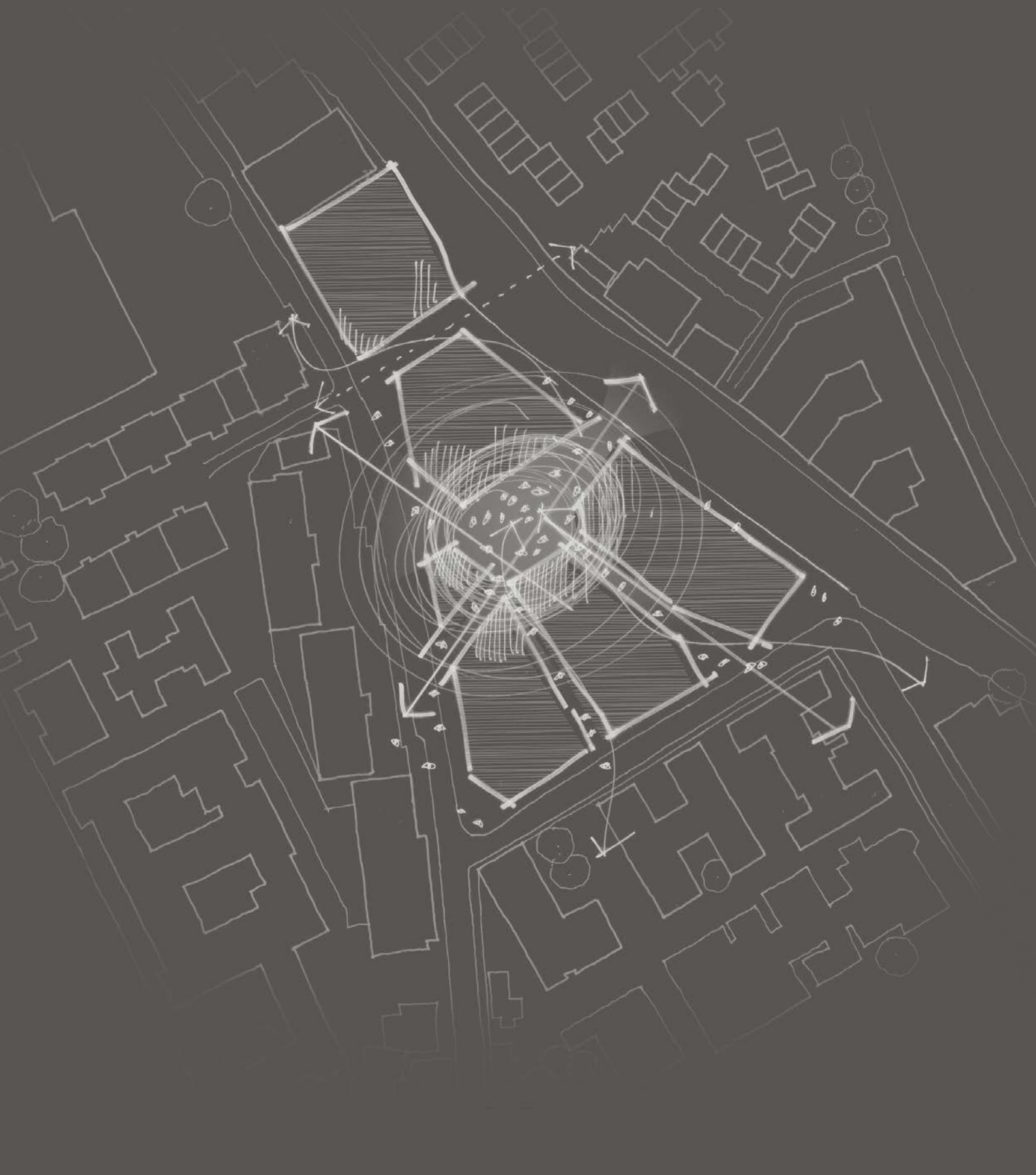
Transformation of the Ugly Brown Building

GD Partnership LTD

Flood Risk Assessment and SUDS Strategy

August 2017



TRANSFORMATION OF THE UGLY BROWN BUILDING, CAMDEN

FLOOD RISK ASSESSMENT AND SUDS STRATEGY

REF: WE/17015

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GLOSSARY OF TERMS

AOD	Above Ordnance Datum
CDA	Critical Drainage Area
FFL	Finished Floor Level
FRA	Flood Risk Assessment
LBC	London Borough of Camden
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
NPPF	National Planning Policy Framework
PPG	Planning Practise Guidance
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems
TWUL	Thames Water Utilities Limited

EXECUTIVE SUMMARY

The proposed development is located on the site named the 'The Ugly Brown Building' north of St Pancras International rail station in the London Borough of Camden (LBC). Proposals for the site are the erection of 6 new buildings, ranging in height from 2 storeys to 12 storeys above ground, and 2 basement levels comprising a mixed-use business, residential, hotel, retail and storage development with associated landscaping work. The site lies in Flood Zone 1 and is therefore considered to be at 'very low' risk of flooding from rivers or the sea. A full flood risk assessment (FRA) is required for developments in Flood Zone 1 which are more than 1 hectare or in an area with critical drainage problems, both of which apply to the site.

Potential flooding from rivers and the sea, surface water, sewers, groundwater and artificial sources have been assessed within the report. The development is considered to be at low risk from all sources of flooding, with the greatest risk from surface water/sewer flooding due to pressure on the Thames Water sewer network within the local area.

A surface water management plan has been designed to contain the 1% annual probability +40% climate change event, therefore reducing the risk of surface water flooding on the site and elsewhere.

The drainage strategy includes Sustainable Drainage System (SuDS) elements in order to reduce the rate of runoff by 50% from the pre-development rates in line with London Plan Policy 5.13. Part of the site will drain by gravity to the adjacent Regent's Canal and the remaining areas will drain to the combined sewer. This combination is deemed necessary to avoid including a pumped system as the water level of the canal is relatively high compared to site levels.

Attenuation storage is provided in the form of blue roofs and combination biodiverse/blue roofs on all buildings wherever possible and drained at controlled rates directly to the canal. Some roof areas are reserved for plant and will therefore drain to below ground storage on each plot. The remaining external areas will also drain to the underground storage before discharging at a controlled rate via a flow control device to the Thames Water combined sewer on St Pancras Way.

1. INTRODUCTION

General Information

1.1. The proposed development is located on the site named the 'Ugly Brown Building' north of St Pancras International rail station in the London Borough of Camden. The site boundary encloses an area of approximately 1.14 ha.

1.2. The application is for demolition of the existing building and erection of 6 new buildings, ranging in height from 2 storeys to 12 storeys above ground, and 2 basement levels comprising a mixed-use business, residential, hotel, retail and storage development with associated landscaping work.

1.3. The latest online Environment Agency Flood Zone maps indicate that the site lies in Flood Zone 1 and is therefore considered to be at 'very low' risk of flooding from rivers or the sea. A full flood risk assessment (FRA) is required for developments in Flood Zone 1 of more than 1 hectare in size or which are located in an area with critical drainage problems as notified by the Environment Agency. A flood risk assessment has therefore been prepared to accompany the planning application. As well as considering the risk of flooding to the site, the impact the development may have on flooding elsewhere has been assessed, with particular reference to surface water run-off.

1.4. This assessment has been compiled to meet the requirements of the National Planning Policy Framework (NPPF)[1].

Scope of Study

1.5. The main objectives of this study are to:

- assess the risk and implications of flooding on the site from all possible flood sources, including the future risk as a result of projected climate change over the lifetime of the development;
- assess the impact of the proposed development on flood risk elsewhere, with particular consideration of surface water management on the site;
- provide a flood risk assessment of the site, compliant with the guidelines set out in the NPPF and associated Planning Practice Guidance (PPG)[2], to accompany any application for planning permission;

[1] Department for Communities and Local Government (2012), *National Planning Policy Framework*.

- outline a drainage strategy for the new development by incorporating SUDS; and,
- provide advice on the site layout and design that will ensure safe operation of the site in an extreme flood or rainfall event, and avoid causing an unacceptable impact on the risk of flooding elsewhere.

[2] Department for Communities and Local Government (2014), *Planning Practice Guidance: Flood risk and coastal change*. www.gov.uk/guidance/flood-risk-and-coastal-change. Accessed 22/03/2017.

2. SITE DESCRIPTION

Location

2.1. The site address is 2-6 St Pancras Way, London, NW1 0TB and is located on land between St Pancras Way and Regent's Canal, approximately 500 m north of St Pancras International train station within the London Borough of Camden. Regent's Canal runs along the north eastern boundary of the site but this is not designated an Environment Agency 'Main River'. The site location is shown in Figure 1.

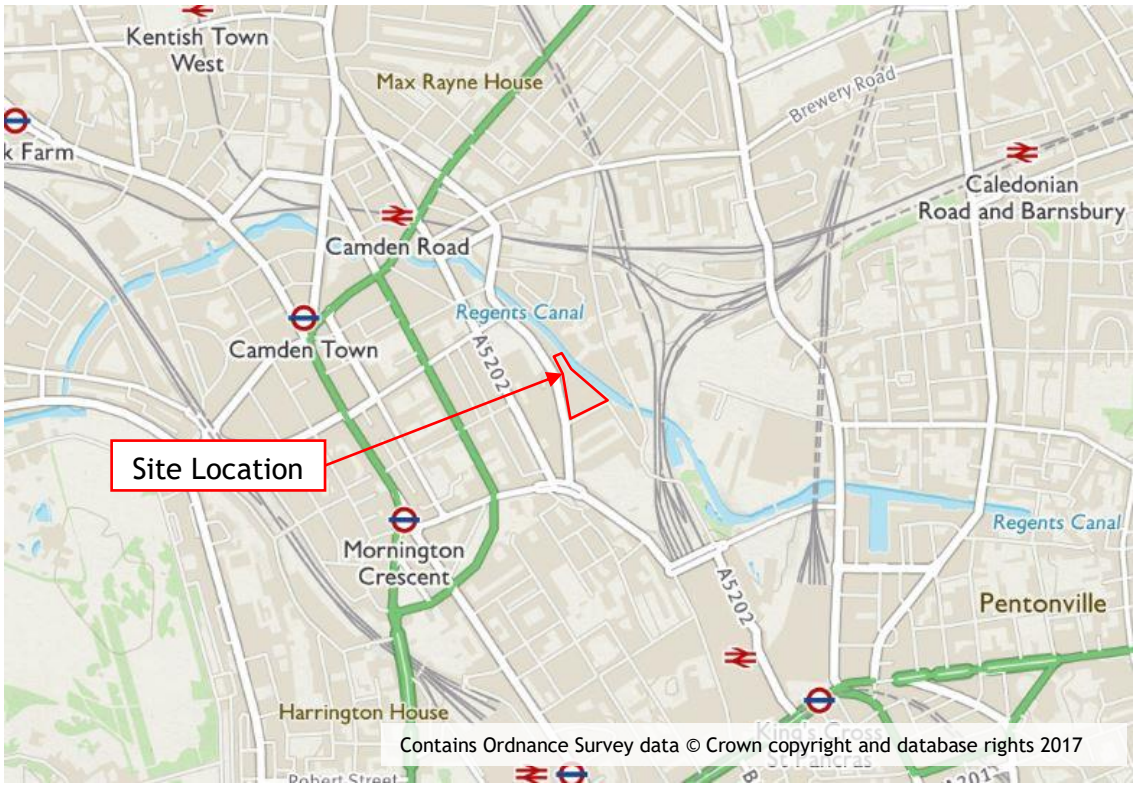

Figure 1 – Location of proposed development site

2.2. The site is bounded by Regent's Canal to the north east, by St Pancras Hospital to the south, by St Pancras Way to the west and by residential developments to the north.

Existing Development

2.3. The site covers a total area of approximately 1.14 ha and comprises a large four-storey building divided into three plots – A, B and C – each independently occupied. Plots A and B are currently office space, the latter occupied by Ted Baker Headquarters, and plot C is a data centre. The area along St Pancras Way is mostly hard-paved with a small grassy bed with shrubs and small trees to the south. The canal-side area is made up of a gravel fill.

Topographic Survey and Site History

2.4. A topographic survey of the site was carried out in February 2016 by Clugston Construction Limited, and is presented in Drawing 1 in Appendix A. The survey has been orientated to the Ordnance Survey National Grid and survey levels have also been GPS verified.

2.5. The ground levels range between 20.4 m AOD at the southernmost corner of the site and 23.6 m AOD along the edge of the canal at the north eastern boundary. The ground level increases north along St Pancras Way ranging from 20.4 m to 21.9 m AOD, and more steeply east along Granary Street from 20.4 m to 23.6 m AOD along the southern site boundary.

2.6. The retaining wall along the edge of the canal has a ground level along the top of 23.6 m AOD with the level in the canal measured at 23.13 m AOD (as at 22/01/2016). A drained walkway runs along the canal-facing side of the building at a level of 21.6 m AOD, with steps and a ramp leading up to the top of the retaining wall.

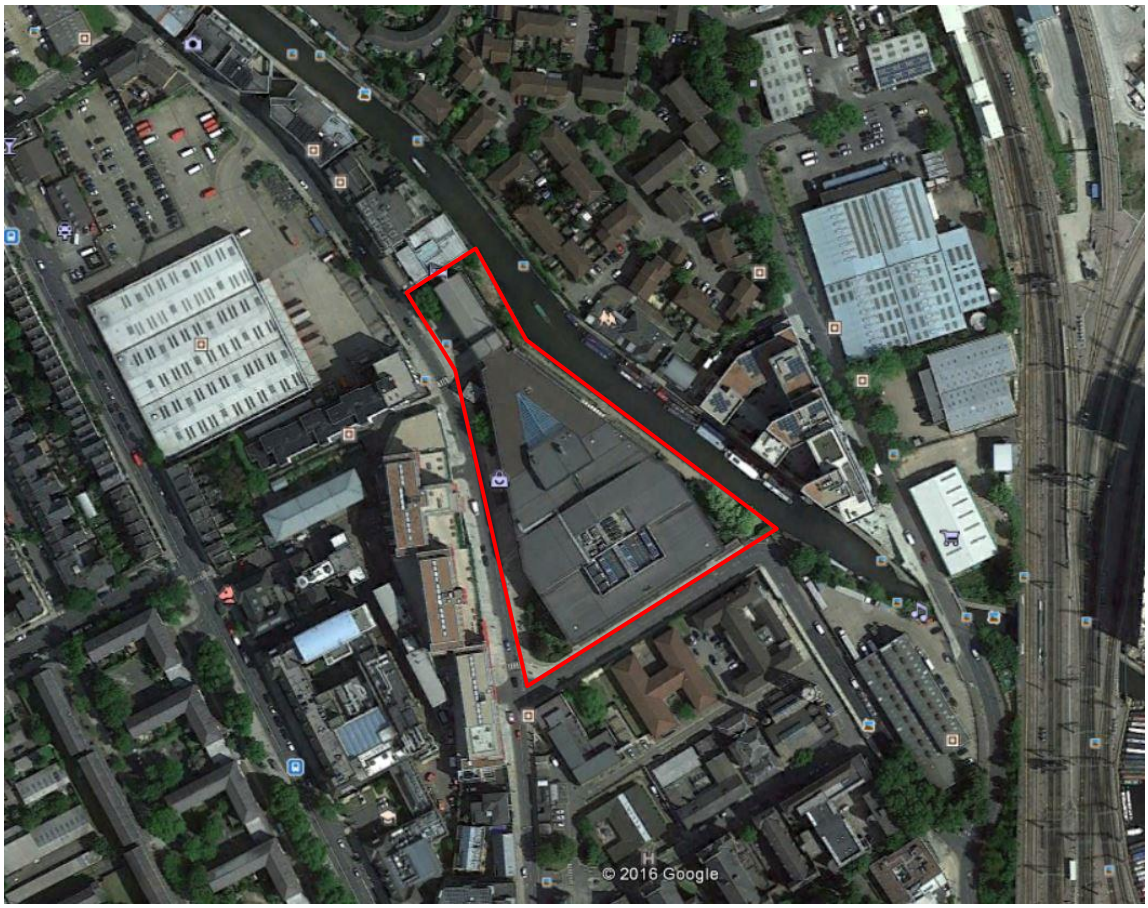

Figure 2 - Aerial photograph of site

Proposed Development

2.7. The proposed development comprises of demolition of the existing building and erection of 6 new buildings, ranging in height from 2 storeys to 12 storeys above ground, and 2 basement levels comprising a mixed-use business, residential, hotel, retail and storage development with associated landscaping work. The site is divided into three plots; A, B and C, and architect's drawings of the proposed development are included in Appendix A.

2.8. The proposals are for the demolition of the existing building and redevelopment to provide accommodation arranged around publicly accessible spaces. The proposed development comprises:

- an extended HQ for Ted Baker and boutique own brand hotel;
- business floorspace;
- residential dwellings;
- public open space along the canal edge and St Pancras Way, and within a central courtyard;
- retail units at ground floor creating a central public place;
- basements on each plot to provide centralised servicing and further commercial lettings.

2.9. The vulnerability classification of the development, as set out in Table 2 of the PPG, is 'more vulnerable' for the residential units and hotels and 'less vulnerable' for the commercial elements of the development.

2.10. Plot A and B have one basement level and Plot C has two basement levels proposed. The basement (Level -1) on Plot A has floor levels ranging between 17.5 m and 18.0 m AOD and comprises cycle storage, commercial units and plant. On Plot B, the split-level basement includes car parking for 30 cars with a Finished Floor Level (FFL) of 19.1 m AOD, and plant and multi-purpose space at 16.3 m AOD. Plot C upper basement includes retail space, gym facilities and cycle storage with a FFL from 16.1 m to 17.5m AOD. The lower basement (Level -2) is located solely within Plot C, and is to be used as storage with a FFL of 13.4 m AOD.

2.11. Vehicular access to the site is via an entrance from St Pancras Way to Plot B car park approximately halfway along the western boundary.

2.12. The ground floor level is 21.7 m AOD in Plot A, varies between 21.4 m and 23.6 m AOD in Plot B, and between 20.2 m and 23.6 m AOD on Plot C.

3. NATIONAL AND LOCAL PLANNING POLICY

National Planning Policy Framework

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

> *"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere."*

3.2. In addition to the NPPF, the Planning Practice Guidance was released to clarify planning aspects of flood risk management. The Planning Practice Guidance clarifies which development types are considered appropriate within each Flood Zone.

The London Plan

3.3. The London Plan[3] is the overarching spatial strategy for the Greater London Area, and provides the basic foundation for planning policy in London. Flood risk and drainage are considered in the London Plan under Chapter 5 "London's response to Climate Change", within the Climate change adaptation section, Policies 5.11 through to 5.15.

3.4. Policy 5.12 sets out detailed policy regarding flood risk management, and requires compliance with the NPPF and associated Planning Practice Guidance. The policy includes additional emergency provision for any development required to pass the Exception Test, and a requirement for protection of flood defences and watercourses. Policy 5.13 covers Sustainable Drainage, and requires implementation of the 7-stage drainage hierarchy, as well as a consideration of "water use efficiency, water quality, biodiversity, amenity and recreation".

Local Planning Policy

3.5. The site lies within the London Borough of Camden, which also acts as the Lead Local Flood Authority (LLFA). Below are a list of the policies relevant to flood risk within the recently adopted Camden Local Plan.

[3] Mayor of London, Further Alterations to the London Plan 2015, March 2016

Camden Local Plan (2017)

3.6. Camden has recently adopted the new Local Plan, and below are the relevant policies regarding flooding and SuDS.

Policy CC2 Adapting to climate change

3.7. The Council will require development to be resilient to climate change. All development should adopt appropriate climate change adaptation measures such as:

- a. the protection of existing green spaces and promoting new appropriate green infrastructure;
- b. not increasing, and wherever possible reducing, surface water runoff through increasing permeable surfaces and use of Sustainable Drainage Systems;
- c. incorporating bio-diverse roofs, combination green and blue roofs and green walls where appropriate; and
- d. measures to reduce the impact of urban and dwelling overheating, including application of the cooling hierarchy.

Policy CC3 Water and flooding

3.8. The Council will seek to ensure that development does not increase flood risk and reduces the risk of flooding where possible. We will require development to:

- a. incorporate water efficiency measures;
- b. avoid harm to the water environment and improve water quality;
- c. consider the impact of development in areas at risk of flooding (including drainage);
- d. incorporate flood resilient measures in areas prone to flooding;
- e. utilise Sustainable Drainage Systems (SuDS) in line with the drainage hierarchy, unless inappropriate, to achieve a greenfield run-off rate where feasible; and
- f. not locate vulnerable development (such as basement dwellings) in flood-prone areas.

Camden Strategic Flood Risk Assessment

3.9. URS prepared a Strategic Flood Risk Assessment[4] (SFRA) for the London Borough of Camden in July 2014. The SFRA is used to inform this site-specific flood risk assessment.

Sequential Test

3.10. The site lies entirely within Flood Zone 1 and the vulnerability classification for the development is *Less Vulnerable* for the retail and business use, and *More Vulnerable* for the residential units and hotel.

3.11. The sequential test is not normally required for development within Flood Zone 1 unless "the Strategic Flood Risk Assessment for the area, or other more recent information, indicates there may be flooding issues now or in the future" (PPG). The dominant risk of flooding in the borough is from surface water as a result of sewer overloading, however the risk is shown to be low for the application site, and therefore the sequential test is not required for this development.

3.12. Additionally, Table 3 of the PPG for Flood Risk and Coastal Change deems all development to be appropriate within Flood Zone 1.

[4] London Borough of Camden (July 2014) Strategic Flood Risk Assessment

4. POTENTIAL FLOODING ON SITE

Flooding from Rivers and the Sea

4.1. As stated in the Camden SFRA, all Main Rivers historically located within the Borough are now culverted and incorporated into the Thames Water Utilities Limited (TWUL) sewer network and therefore there is no fluvial flood risk to the site. The site is also shown to be in Flood Zone 1 according to the Environment Agency flood map for planning, which is defined as land having a less than 0.1% annual probability of river or sea flooding. Therefore the risk of flooding from rivers or the sea is very low.

4.2. The site is located approximately 20 m above sea level and consequently there is considered to be no risk of flooding from the sea.

Flooding from Surface Water

4.3. Flooding can occur during periods of intense rainfall from runoff flowing overland before entering a watercourse or sewer. In an urban environment, the risk of flooding from surface water and from overloaded sewers is closely related, and both are included in the relevant surface water flooding datasets. Flooding events are typically of short duration (unless there is a drainage system blockage), but can be severe.

4.4. The Environment Agency has published a surface water flood map available online, as shown in Figure 3. The information on this map is suitable for identifying approximate areas which would flood and the likely depth of this flooding. It is unlikely to be reliable for identifying individual properties at risk.

4.5. Appendix B Figure 6 of the SFRA shows the majority of Camden has been identified as being within a Critical Drainage Area (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."

4.6. The site is predominantly shown to have a *very low* risk of surface water flooding as shown as 'clear' on the flood map, equivalent to less than 0.1% annual probability of flooding. The northern part of the site is shown to be at *low* risk (between 0.1% and 1% annual probability). The thin strips of *medium* risk areas along the canal are due to the existing walkway along that side of the building, currently set 2 m below the top of bank. This walkway will no longer exist in the proposed development.

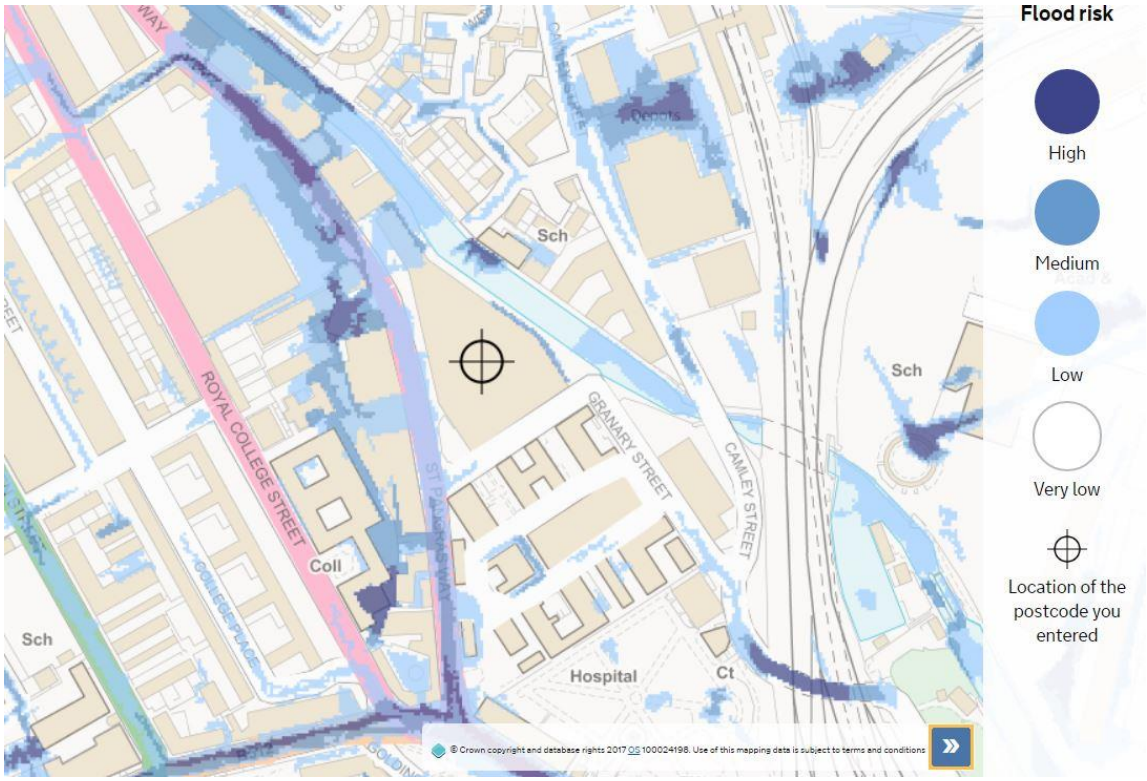

Figure 3 - Environment Agency online surface water flood map

4.7. The surface water drainage strategy for the development (refer to Section 5 of this report) will ensure that overland flow is appropriately managed on the site, by use of green/blue roofs and underground attenuation storage. The surface water management system will ensure no flooding for the 1% annual probability plus climate change event will occur on the site.

4.8. If an extreme rainfall event occurred causing surface water flooding in the wider area, it is expected that flood water would be contained within St Pancras Way since ground levels within the road are lower than on site. The risk of surface water flooding to the site is therefore considered to be low, on the condition that an adequate maintenance programme is adopted for the onsite surface water system.

Flooding from Sewers

4.9. Thames Water asset location plans have been acquired for the site and surrounding area, included in Appendix B. These show a 2134 mm diameter trunk combined sewer passing beneath the site with an invert level of 13.6 m AOD, approximately 2 m below the proposed basement on plot A (17.5 m AOD). In addition, there is a 1093 x 762 mm combined sewer along St Pancras Way flowing in a north-south direction, with a contributing 152 mm diameter sewer along Granary Street.

4.10. A Thames Water sewer flooding history enquiry at 6a St Pancras Way indicates that there have been no incidents of flooding in the requested area as a result of surcharging public sewers. It is therefore unlikely that the sewers in the vicinity will surcharge onto the site unless linked to a surface water flood event. In the unlikely event of sewer flooding from the sewer in St Pancras Way, flood water is likely to be contained within the road flowing south past the site.

4.11. Figure 5a in Appendix B of the SFRA displays information from the DG5 internal sewer flooding register and the site is shown to be in a postcode district that has no recorded incidents of flooding.

4.12. A drainage CCTV survey of the existing site was carried out by Drainage Technical Services Ltd on 2nd April 2017. This confirmed that all surface water drainage, including from the canal-side, discharges to the combined sewer network on St Pancras Way.

4.13. The proposed scheme will include entirely new sewer infrastructure, only retaining the existing connection to the public sewer network. The surface water network onsite will be designed and sized based on expected discharges for the 1% annual probability event including an allowance for climate change for the lifetime of the development. On the basis of this information, the risk of flooding from sewers is considered to be low.

Flooding from Groundwater

4.14. The bedrock geology underlying the site shown on the British Geological Survey online map consists of London Clay Formation (clay, silt and sand). No superficial deposits are shown in the area. The geology is confirmed by two boreholes (TQ28SE314 and TQ28SE1564) adjacent to the site. London Clay forms an impermeable layer lowering the risk of groundwater emergence at the surface, and at the site's location, the absence of a superficial aquifer results in a low risk of perched groundwater.

4.15. Figure 4e in Appendix B of the SFRA displays areas at increased susceptibility to elevated groundwater along with historic records of groundwater flooding held by LBC and the Environment Agency. The site is not shown to be at increased susceptibility to elevated groundwater and there are no records of groundwater flooding incidents within a 500 m radius of the site.

4.16. The SFRA refers to the Camden Geological, Hydrogeological and Hydrological Study, stating that, within Camden, groundwater can be encountered within river terrace deposits, isolated perched water bodies within sandy layers of the London Clay and a more significant water table within the Bagshot Beds. Based on available below-ground information, there is

no indication of any substantial sandy layers underlying the site or presence of shallow groundwater. Therefore the risk of groundwater flooding to the site is considered to be low.

4.17. Despite the expected low risk, groundwater levels can fluctuate throughout the year and therefore, it is recommended that consideration should be given to flood resistant design for the basement units as a preventative measure against future ingress of groundwater or damp.

Flooding from Artificial Sources

4.18. Flooding can occur as a result of the failure of infrastructure that impounds water, such as reservoirs, lakes and canals. The site is not shown to be within the maximum extent of possible flooding from reservoirs on the Environment Agency Reservoir Inundation Map (as shown in Figure 4).

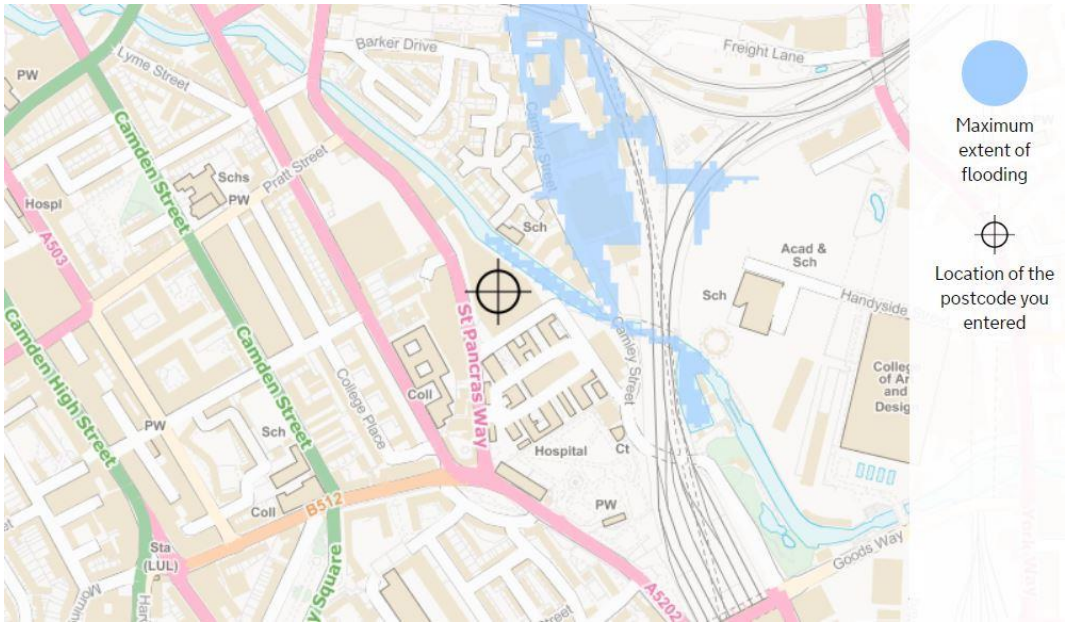

Figure 4 - Environment Agency Reservoir Inundation Map

4.19. The Reservoirs Act 1975[5] (as amended by the Flood and Water Management Act 2010[6]) requires asset owners to maintain their reservoirs such that the annual probability of a breach of the reservoir is less than 1 in 50,000. It is therefore considered that the risk of flooding from reservoirs is extremely low.

[5] Reservoirs Act 1975 (c.23). London, Her Majesty's Stationery Office.

[6] *Flood and Water Management Act 2010* (c.29). London, Her Majesty's Stationery Office.

4.20. The Regent's Canal is managed by the Canals & Rivers Trust. The Canals & Rivers Trust ensures that the canal does not overtop its banks by controlling the water levels in the canal via the lock systems on the Regent's Canal. High water levels within canals can be managed by moving the water through the locks down to unaffected lock reaches.

4.21. No further artificial sources of flooding have been identified within the vicinity of the site.

Flood Warning and Emergency Access/Egress

4.22. The flood risk to the site is considered to be low from all sources, however there is a residual risk from surface water flooding in the event of an extreme rainfall event (e.g. > 0.1% annual probability) which exceeds the designed capacity of the onsite surface water drainage system. The proposals include commercial uses in the basement levels and the following information has been identified on the LBC website[7]:

Businesses and residents in basements are advised to:

- Take note of weather forecasts for heavy rainfall identified as red alert,
- Sign up for emergency text alerts on Camden's alert system – this will endeavour to relay high risk warnings when Camden are made aware of them, but this will not be a 24/7 service,
- Have an emergency plan for taking you and your family or colleagues out of harm's way to a higher floor so that you are not at risk.

4.23. This information should be supplied to any future owners and occupants of the basement units, and they should be encouraged to sign up for the emergency text alerts described in the previous paragraph.

Climate Change

4.24. The predicted increase in frequency and severity of rainfall events as a result of climate change will increase the likelihood of flooding from rivers, land, sewers and artificial bodies as storage becomes overwhelmed. In line with the latest guidance[8], a climate change factor of +40% has been applied to the 1% annual probability rainfall event in the design of the surface water management system.

[7] www.camden.gov.uk/ccm/content/policing-and-public-safety/emergencies/flooding/ Accessed 21/04/2017

[8] www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances Accessed 24/04/2017

5. SURFACE WATER MANAGEMENT

5.1. 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.

5.2. The proposed development falls under the classification of 'major development', therefore, under The Town and Country Planning (Development Management Procedure) (England) Order 2015, the site must adopt a sustainable drainage approach, through the use of SuDS.

5.3. Additional guidance to the requirements of London Plan Policy 5.13 are presented in the Sustainable Design and Construction Supplementary Planning Guidance (SPG)[9], which states that a 50% attenuation of pre-development runoff rate is "the minimum expectation from development proposals".

Existing Site Runoff

5.4. The site is considered to be entirely impermeable, predominantly consisting of a large flat roof with hard paving around the site boundary. There is a small raised bed of shrubs to the south west of the site, however, due the nature of its design, it is expected to have negligible effects on the site runoff.

5.5. Source Control (Microdrainage 2017) was used to calculate design rainfall intensities and resulting runoff rates with input rainfall ratio, R of 0.41 and expected rainfall M5-60 of 20.6 mm/h from FSR based on the site location. Calculation sheets are provided in Appendix C.

5.6. The existing peak runoff rates for the 1-year, 30-year and 100-year return period rainfall events are as follows:

Return Period (year)	**1**	**30**	**100**
Discharge rate (l/s)	101	247	322

[9] Mayor of London, Sustainable Design and Construction SPG, April 2014

Greenfield Runoff

5.7. The greenfield runoff rates for the site were calculated using IoH124 methodology and the online tools provided by HR Wallingford on the UK SuDS website[10], and are as follows (calculation sheet provided in Appendix C):

Return Period (year)	Qbar	1	30	100
Discharge rate (l/s)	4.77	4.05	10.96	15.21

Existing Site Drainage

5.8. A site visit undertaken by Water Environment Ltd on 16th March 2017 confirmed the existing roof drains by gravity through gutters along the front and rear of the building and several downpipes before joining the underground drainage network.

5.9. A CCTV survey of the existing site drainage was undertaken by Drainage Technical Services Ltd on 2nd April 2017. Based on the survey, all surface water drainage from the site, including on the canal-side, is assumed to flow into the public combined sewer under St Pancras Way via a connection between plot A and B.

5.10. The TWUL asset location plans show three existing lateral connections to the combined sewer under St Pancras Way. There are no existing surface water outfalls to Regent's Canal from the site, and from visual inspection during a site visit, no other developments in the area appear to have outfalls to the canal.

Proposed Surface Water Drainage System

5.11. Surface water will be managed on site through the provision of Sustainable Drainage Systems (SuDS) where possible in line with national policy. No attenuation of surface water exists on the site, and currently all runoff discharges directly to the public sewer network.

5.12. The site is entirely hardstanding and the underlying London Clay geology is unlikely to be appropriate for direct infiltration of surface water. Surface water can therefore only discharge from the site via Regent's Canal or the Thames Water combined sewer network. Both Thames Water and the Canal & River Trust have been consulted in order to agree discharge rates into each respective network.

[10] www.uksuds.com/drainage-calculation-tools/greenfield-runoff-rate-estimation Accessed 24/04/2017

5.13. Regent's Canal runs to the northeast of the site with an approximate water level of 23.13 m AOD, which is at a higher level than the majority of external areas on the proposed site. Underground attenuation storage is therefore unable to discharge directly to the canal by gravity. Surface water runoff from all external areas would therefore require pumping in order to discharge to the canal. Pumped systems are considered the least sustainable of systems with the highest maintenance liability and the highest chance of failure, and should therefore be avoided in so far as possible.

5.14. The following guiding principles were used in developing the proposed drainage strategy:

- attenuating surface water using SuDS wherever possible;
- reducing the peak surface water runoff by a minimum 50% of the existing rate including an allowance for future climate change;
- ensuring the peak runoff requirement is met by plots A, B and C independently to accommodate phased construction and independent future ownership;
- maximising the proportion of surface water runoff discharging to the canal, alleviating the pressure on the local public sewer network;
- avoiding a pumped system.

5.15. The proposed development consists of approximately 69% roof area and 31% hard landscaping. Only the roof areas are high enough to drain to the canal by gravity and due to spatial restrictions at ground level, attenuation storage is proposed in the form of paved-over blue roofs and *combination biodiverse/blue roofs*. The term *combination biodiverse/blue roof* is used here to describe a biodiverse roof with additional attenuation storage beneath it.

5.16. Paved-over blue roofs and combination biodiverse/blue roofs have been included on all buildings across the site wherever possible (refer to SuDS drawing in Appendix A). Some roof areas are reserved for plant and have to be drained to the public combined sewer. Since it is not possible to provide attenuation storage beneath the plant at roof level, it will therefore drain to below-ground attenuation storage before discharging to the public sewer at a reduced rate. Similarly, some roof terraces cannot accommodate the blue roof build-up depth whilst maintaining a level threshold with the internal finished floor level and therefore will also drain to below ground attenuation storage.

5.17. All external areas at ground level will also drain to below-ground attenuation storage.

5.18. Due to the high relative water level of the canal and the spatial restrictions adjacent to it, below-ground attenuation storage discharging to the canal is not possible unless a pumped system is installed. In order to avoid this, all below-ground attenuation storage will discharge to the combined sewer, while all biodiverse/blue roofs will discharge to the canal.

5.19. In order to satisfy the 50% reduction in pre-development runoff rates during phased construction, each plot will have separate attenuation storage for runoff discharging to the combined sewer. Plot A will have underground cellular crate storage beneath the basement cycle store; Plot B will have underground cellular crate storage beneath the basement car parking; and Plot C will have a 150 mm depth cellular crate storage beneath the external paved areas, above the basement level. All design proposals are subject to review at the detailed design stage, however the principles of the drainage strategy will remain unchanged.

5.20. The proposed discharge rates for the 100-year rainfall event including an allowance for future climate change are shown for each plot in Table 1. The proposed discharge rates represent a reduction of 50% from the existing 100-year rainfall event (no climate change) and are subject to agreement with Thames Water and the Canal & River Trust.

Table 1: Proposed discharge rates for the 100-year event + 40% climate change

	Plot A	Plot B	Plot C	Total
Area (as % of site)	15%	22%	63%	100%
Discharge to canal (l/s)	4.4	13.1	17.3	35
Discharge to sewer (l/s)	19.8	22.6	83.8	126
Total discharge (l/s)	24.2	35.7	101.1	161

5.21. The proposed discharge rate for the 100-year event +40% allowance for climate change for the whole site is 161 l/s, which complies with the 50% of existing runoff rate requirement of the London Plan. The system will be designed such that runoff from the 100-year event +40% for future climate change is fully retained on the site within attenuation storage and discharged at a controlled rate. Runoff rates will be controlled by flow control devices for every outfall from the site and are to be designed to reduce runoff rates for the 1, 30 and 100 year return periods by a minimum 50% of existing rates.

5.22. ABG have provided specifications for the proposed blue roofs and combination biodiverse/blue roofs including storage volumes and discharge rates. MicroDrainage (Source Control) has been used to calculate the volumes of below-ground attenuation storage required. A summary of the attenuation storage volumes is presented in Table 2. Calculation sheets are included in Appendix C.

Table 2: Proposed attenuation storage volumes

	Plot A	Plot B	Plot C	Total
Blue roof volume (m^3)	13.9	41.7	55.0	111
Below ground storage volume (m^3)	34.2	34.2	150	218
Total attenuation volume (m^3)	48.1	75.9	205	329

5.23. For extreme events greater than the 100-year event +40%, the below ground storage may reach full capacity, in which case surface water would backup and overflow onto the site before flowing overland into the drainage system in St Pancras Way.

5.24. The site will remain 100% hard standing post-development, however, the proposed array of biodiverse roofs will result in a significant reduction of hard roof area and will reduce the volume of surface water discharging from the site.

Sustainable Drainage Systems (SuDS)

5.25. The London Plan sets out a SuDS multi-functional benefits hierarchy, outlining solutions from the most sustainable drainage methods to the least sustainable methods as shown in Figure 5. The objective of the SuDS hierarchy is to ensure that surface water run-off is managed as close to its source as possible.

5.26. The aim of Sustainable Urban Drainage Systems (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[11]:

- reduce the impact of additional urbanisation on the frequency and size of floods;
- protect or enhance river and groundwater quality;

[11] CIRIA C523 – Sustainable Urban Drainage Systems – Best Practice Manual

- be sympathetic to the needs of the local environment and community; and
- encourage natural groundwater recharge.

5.27. A large proportion of the site area is occupied by roof space and, and following the SuDS hierarchy shown in Figure 5, biodiverse roofs are included wherever possible on all the major buildings.

Most Sustainable	*SUDS technique*	*Flood Reduction*	*Pollution Reduction*	*Landscape & Wildlife Benefit*
	Living roofs	✓	✓	✓
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter strips and swales	✓	✓	✓
	Infiltration devices - soakaways - infiltration trenches and basins	✓	✓	✓
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviors	✓	✓	
Least Sustainable	**Tanked systems** - over-sized pipes/tanks - storms cells	✓		

Figure 5 – SuDS Hierarch

5.28. Green roofs are considered amongst the most sustainable of all the SuDS techniques, providing similar benefits as greenfield land such as:

- reduced rainwater runoff;
- enhanced roof insulation properties;
- attractive visual appearance;
- reduction in urban heat island effect;
- enhanced roof lifespan by protecting underlying waterproofing system; and,
- provision of green space in urban areas and encouragement of biodiversity.

5.29. It should be noted that green roofs are suitable for use in combination with photovoltaics. The presence of a green roof beneath photovoltaic cells has been shown to cool the ambient air temperature around the photovoltaic cells making them more efficient.

5.30. Due to the constrained nature of the site, there is very limited space for the provision of basins or ponds and it is not feasible to include these SuDS elements into the design.

Additionally, the geology beneath the site is not suited to the use of infiltration devices as a means of discharging surface water directly to the ground. Figure 4c in Appendix B of the SFRA shows the site is "not within a zone of high or probable compatibility for infiltration SuDS; however bespoke solutions may be applicable".

5.31. The first basement level extends beneath most of the site. The strip of land along the side of the canal is not capable of supporting any SuDS elements and is reserved for the ongoing maintenance and support of the canal. The remaining external areas change in elevation by approximately 2m from the canal to the road, which makes the use of permeable surfaces with a granular sub-base unsuitable.

5.32. The remaining choice for storage attenuation is within an underground storage structure, which is proposed to attenuate any surface water not captured by the blue roofs, discharging to the TWUL sewer network.

SuDS Management and Maintenance

5.33. Management and maintenance of the drainage network, including the biodiverse roof areas and underground storage tank, will be the responsibility of the freeholder of the site. Management and maintenance agreements and plans will be arranged prior to completion of development.

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

6. SUMMARY OF FLOOD RISK ASSESSMENT

1. Development site and location	
a. Where is the development site located?	2 – 6 St Pancras Way, London, NW1 0TB
b. What is the current use of the site?	Office space, Ted Baker HQ, data centre
c. Which Flood Zone (for river or sea flooding) is the site within?	Flood Zone 1
2. Development proposals	
a. What are the development proposal(s) for this site? Will this involve a change of use of the site and, if so, what will that change be?	Following demolition of the Ugly Brown Building, proposals to erect multiple mixed use buildings comprising of business floorspace, hotel, retail units, and residential accommodation.
b. In terms of vulnerability to flooding, what is the vulnerability classification of the proposed development?	More vulnerable due to residential component
c. What is the expected or estimated lifetime of the proposed development likely to be?	100 years
3. Sequential test	
a. What other locations with a lower risk of flooding have you considered for the proposed development?	N/A
b. If you have not considered any other locations, what are the reasons for this?	N/A
c. Explain why you consider the development cannot reasonably be located within an area with the lowest probability of flooding (Flood Zone 1); and, if your chosen site is within Flood Zone 3, explain why you consider the development cannot reasonably be located in Flood Zone 2.	N/A
d. As well as flood risk from rivers or the sea, have you taken account of the risk from any other sources of flooding in selecting the location for the development?	N/A
4. Climate Change	
How is flood risk at the site likely to be affected by climate change?	Extreme rainfall events will become more frequent and more intense. An increase in rainfall of 40% has been used in the assessment in line with national guidance.

5. Site specific flood risk	
a. What is/ are the main source(s) of flood risk to the site?	Surface water flooding
b. What is the probability of the site flooding, taking account of the maps of flood risk available from the Environment Agency, the local planning authority's Strategic Flood Risk Assessment and any further flood risk information?	Less than 0.1% annual probability of flooding from rivers or the sea. EA online map indicates the site is at very low risk from surface water, however St Pancras Way adjacent to the site is at low to medium risk. The site is also within a critical drainage area. The risk of flooding from all other sources is considered to be very low
c. Are you aware of any other sources of flooding that may affect the site?	No
d. What is the expected depth and level for the design flood?	No flooding expected for the 1% annual probability event including climate change due to the proposed surface water management plan
e. Are properties expected to flood internally in the design flood and to what depth?	No
f. How will the development be made safe from flooding and the impacts of climate change, for its lifetime?	The surface water management system will be maintained for its lifetime to ensure the development is safe from flooding.
g. How will you ensure that the development and any measures to protect the site from flooding will not cause any increase in flood risk off-site and elsewhere? Have you taken into account the impacts of climate change, over the expected lifetime of the development?	Surface water will be attenuated significantly reducing the pre-development peak runoff rate using flow control devices.
h. Are there any opportunities offered by the development to reduce the causes and impacts of flooding?	The site currently has no surface water attenuation measures and is 100% hardstanding. The proposals will include significant surface water attenuation.
6. Surface water management	
a. What are the existing surface water drainage arrangements for the site?	The existing site drains entirely to the TWUL combined sewer network
b. If known, what (approximately) are the existing rates and volumes of surface water run-off generated by the site?	The peak storm runoff for the 100 year event is estimated at 322 l/s
c. What are the proposals for managing and discharging surface water from the site, including any measures for restricting discharge rates?	Runoff from roofs will be attenuated and stored on using combination biodiverse/blue roof systems and flow control devices into the canal. Runoff from remaining areas will be attenuated in below ground attenuation storage with a flow control devices limiting discharge into the public sewer network.

d. How will you prevent run-off from the completed development causing an impact elsewhere?	The surface water management system has been designed to the 100-year rainfall event including an allowance for climate change and provides a significant reduction on pre-development runoff rates.
e. Where applicable, what are the plans for the ongoing operation and/or maintenance of the surface water drainage systems?	An appropriate maintenance plan will be provided prior to construction
7. Occupants and users of the development	
a. Will the development proposals increase the overall number of occupants and/or people using the building or land, compared with the current use? If this is the case, by approximately how many will the number(s) increase?	The number of occupants will increase post development due to the new residential units and increased density. However, the flood risk to the site is considered to be very low, and therefore no increase to occupants is anticipated.
b. Will the proposals change the nature or times of occupation or use, such that it may affect the degree of flood risk to these people?	The flood risk is considered very low and therefore the proposals do not have an effect on flood risk
c. Where appropriate, are you able to demonstrate how the occupants and users that may be more vulnerable to the impact of flooding (e.g., residents who will sleep in the building; people with health or mobility issues; etc.,) will be located primarily in the parts of the building and site that are at lowest risk of flooding? If not, are there any overriding reasons why this approach is not being followed?	N/A
8. Exception test	
a. Would the proposed development provide wider sustainability benefits to the community? If so, could these benefits be considered to outweigh the flood risk to and from the proposed development?	N/A
b. How can it be demonstrated that the proposed development will remain safe over its lifetime without increasing flood risk elsewhere?	N/A
c. Will it be possible for the development to reduce flood risk overall (e.g. through the provision of improved drainage)?	N/A

9. Residual risk	
a. What flood related risks will remain after the flood risk management and mitigation measures have been implemented?	There remains a residual risk to parts of the site from surface water/sewer flooding in extreme rainfall events of greater than 0.1% annual probability.
b. How, and by whom, will these risks be managed over the lifetime of the development?	Maintenance of the SuDS elements will be managed by an appropriate management group for the lifetime of the development.
10. Flood risk assessment credentials	
a. Who has undertaken the flood risk assessment?	Water Environment Ltd on behalf of GD Partnership
b. When was the flood risk assessment completed?	July 2017

7. CONCLUSIONS

7.1. The risk of flooding to the site has been considered from all sources and is assessed to be low. The greatest risk is from surface water flooding as a result of exceedance of the onsite drainage system, however the surface water management plan is designed to contain the 1% annual probability +40% climate change event within SuDS elements.

7.2. A reduction in runoff rates from the existing site of 50% will be achieved by attenuating the 1% annual probability +40% event using paved-over blue roofs, combination biodiverse/blue roof systems and below ground storage. The site has very limited space and options for the use of SuDS, however the reduction in runoff rates achieved on the proposed development is in line with the London Plan Policy 5.13 and significantly decreases the risk of flooding elsewhere. Discharge to the canal will also help alleviate pressure on the TWUL sewer network within the local area.

7.3. A suitable management and maintenance plan will be necessary in order to guarantee the effectiveness of the SuDS elements and ensure that a low risk of flooding to the site, and surrounding third-party land, is maintained.

7.4. Future owners and occupants of the basement units should be encouraged to sign up for the emergency text alerts provided by the London Borough of Camden.

APPENDIX A – DRAWINGS

Drawing 1- Topographic Survey

Clugston Survey Services Drawing Nos. 3948/10/001 and 3948/10/002

Topographic survey of the site showing existing levels, buildings and infrastructure.

Drawing 2 – Proposed Basement Plan B2

Bennetts Associates Architects Drawing No. 1603_P_098 Rev C

Proposed level 2 basement layout plan

Drawing 3 – Proposed Basement Plan B1

Bennetts Associates Architects Drawing No. 1603_P_099 Rev F

Proposed level 1 basement layout plan

Drawing 4 – Proposed Level 00

Bennetts Associates Architects Drawing No. 1603_P_100 Rev H

Proposed ground floor level and landscaping

Drawing 5 – Proposed Roof Plan

Bennetts Associates Architects Drawing No. 1603_P_RP Rev C

Proposed roof layout plan

Drawing 6 – Proposed Drainage Strategy

GDP Drawing No. 16-017-SK01 Rev 3

Layout of the proposed SuDS elements

Notes

1. Surveyed February 2016.
2. Survey related to Ordnance Survey "OS Net" at control point STN06, using realtime correction received via Leica Geosystems "Smart Net" service. Survey plotted to flat plane metric grid with no local scale factor applied, i.e. LSF 1.00.
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Control

STN	East	North	Level	Type
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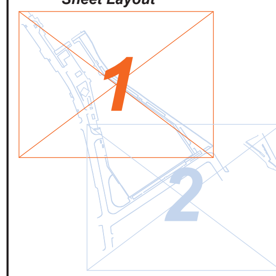
STN02	529550.297	183826.937	21.878	Nail
STN03	529571.347	183797.636	21.730	Nail
STN04	529574.842	183759.821	21.102	Nail
STN05	529582.286	183723.530	20.640	Nail
STN06	529612.269	183667.799	20.619	Nail
STN07	529702.498	183712.938	23.540	Nail
STN08	529652.381	183691.851	22.853	Nail
STN09	529757.421	183732.580	27.414	Nail
WM1	529597.310	183806.435	21.610	Nail
WM2	529590.889	183816.080	21.574	Nail
WM3	529573.557	183841.252	21.607	Nail
WM4	529589.828	183822.432	23.734	Nail
WM5	529603.593	183809.256	23.660	Nail
WM6	529587.896	183833.990	23.696	Nail
WM7	529610.325	183796.943	21.634	Nail
WM8	529636.603	183778.624	21.591	Nail
WM9	529655.407	183765.008	21.669	Nail
WM10	529672.503	183752.163	21.617	Nail
WM11	529691.499	183724.045	21.682	Nail
WM12	529680.876	183749.510	23.760	Nail
WM13	529700.399	183729.944	23.642	Peg
WM14	529701.421	183724.477	23.544	Nail

Sheet Layout



General

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Legend

- Top / Bottom of Bank
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- Wall
- Solid Surface Feature / Road Edge
- Hard / Soft Surface Change
- Kerb / Dropped Kerb
- Combined Kerb & Drainage System
- Drainage Channel
- Fence Line -

BW	Barbed Wire	HR	Hand Rail	PR	Post & Rail
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ChNut	Chestnut	Mtl PR	Metal Post & Rail	SF	Security Fence
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- Hedge Line — Bush
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Woodland Area (Deciduous); Woodland Area (Coniferous)

Feature Abbreviations

ACU	Air Conditioning Unit	FH	Fire Hydrant	NP	Name Plate	SVP	Soil Vent Pipe
BB	Belisha Beacon	FP	Fence Post	PB	Post Box	TAP	Stand Pipe
BO	Bollard	FL	Flood Light	PM	Parking Meter	TCB	Telephone Box
BO(L)	Bollard (Lit)	G	Gully (with Level)	RBB	Rodent Bait Box	TEL	Telecom's Cover
BP	Boundary Post	GP	Gate Post	RE	Rodding Eye	TL	Traffic Light
BS	Bus Stop	GAS	Gas Cover	RS	Road Sign	TP	Telephone Pole
CATV	Cable TV Cover	KO	Kerb Offlet	RS(L)	Road Sign (Lit)	VP	Vent Pipe
CCTV	Close Circuit TV	LB	Lighting Beacon	RWP	Rain Water Pipe	WM	Water Meter
COL	Column	LBIN	Litter Bin	SNR	Sensor	WO	Wash Out
CP	Concrete Post	LP	Lamp Post	SP	Sign Post	WV	Water Valve
DWB	Dog Waste Bin	ME	Meter	SP(L)	Sign Post (Lit)	UC	Unknown Cover
EL	Electric Cover	MH	Manhole	SPDC	Speed Camera	UTL	Unable to Lift
EP	Electricity Pole	MP	Marker Post	STAY	Cable Stay	Ø	Diameter
ER	Earth Rod	MEP	Metal Post	SV	Stop Valve		

Description Abbreviations

Asmd Rt	Assumed Route	Flw Bd	Flower Bed	O/H	Overhead
BkDrp	Back Drop	FW	Foul Water	OSBM	Ordnance Survey Bench Mark
Bk	Brick	GTrp	Grease Trap		
BusStKb	Bus Stop Kerb	Ht	Height	RetWall	Retaining Wall
Bldg	Building	Hg	Hedge	Rd Edg	Road Edge
CDrnKbS	Combined Drainage & Kerb System	Intcpr	Interceptor	Spd Rtr	Speed Retarder
		Lvl	Level	St	Stone
Conc	Concrete	m	Metres	STN	Station
CPit	Catch Pit	mm	Millimetres	SW	Surface Water
DrpKB	Drop Kerb	MSL	Mean Sea Level	Tac	Tactile Paving
Drn Chnl	Drainage Channel	No.	Number	Tmc	Tarmac

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No.	Description	Date	Signed

Revisions

Drawing Status FINAL

Surveyed WM	Date 09.02.16	Scale 1:200
Drawn WM	Sheet 1 of 2	Approved AF

Client **Reef Estates**

Title Topographical Survey

Project **Property at St Pancras Way Camden, NW1 0QG Greater London**

Drawing No. 3948/10/001 Rev. -

Clugston

Clugston Survey Services
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Normanby Road
Scunthorpe
North Lincolnshire
DN15 8QT

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Fax: 01724 748171
survey@clugston.co.uk
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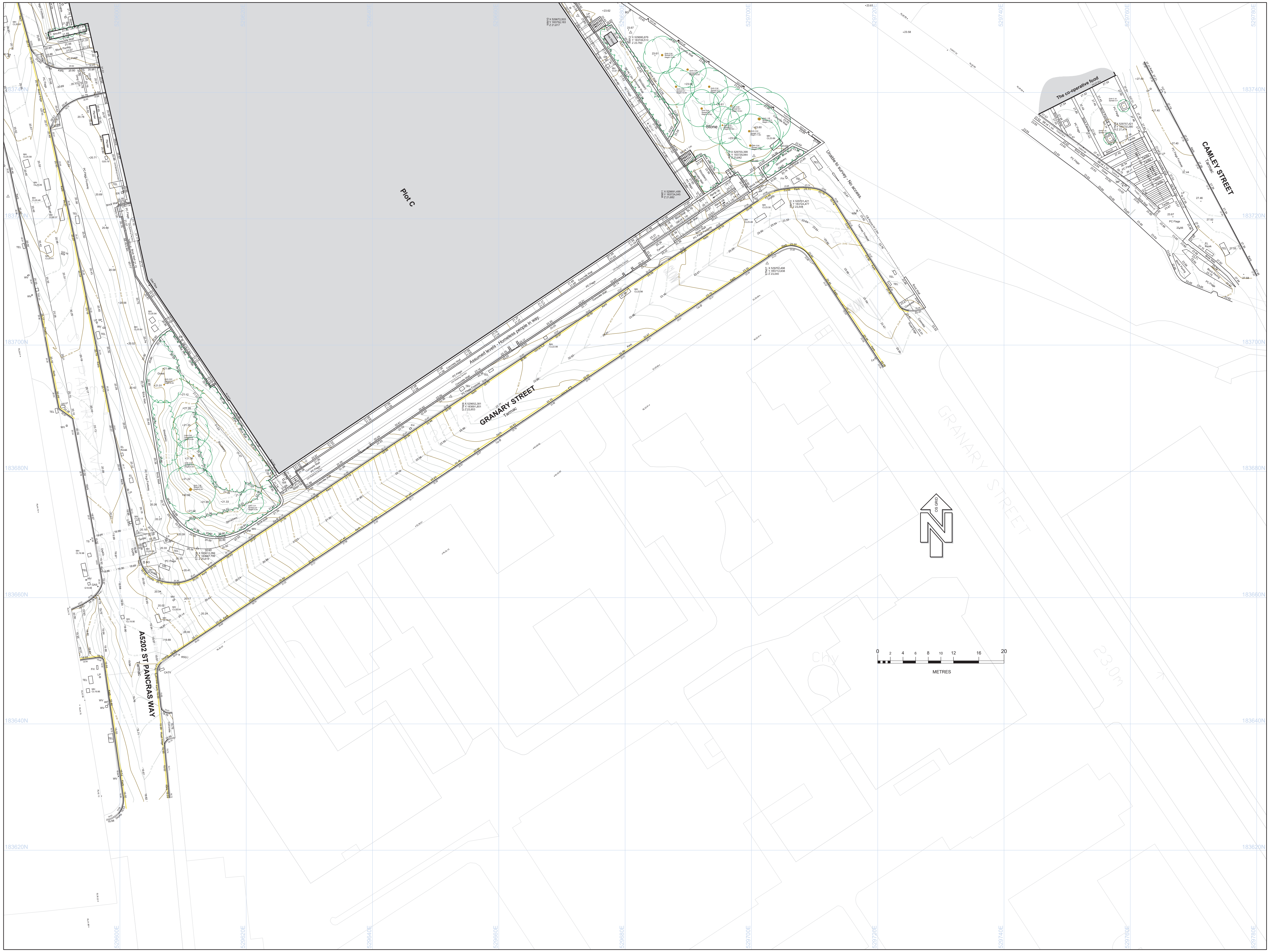

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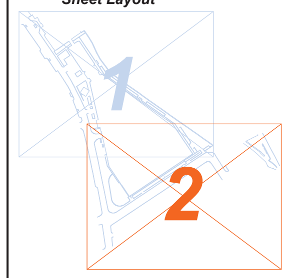

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Revisions

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Camden, NW1 0QG
Greater London

Drawing No. 3948/10/002 Rev. -

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Regional Office in Leeds

PLOT A

PLOT A PLOT B

PLOT B PLOT C

PLOT C

Storage B8
+13.400

Revisions	By	Chk
\ 170322 Stage 2 GA Issue - Design freeze	RM	SE
A 170428 Issued for Information	JS	DK
B 170526 Issued for Planning	AD	DK
C 170714 Issued for Planning	AD	DK

Notes

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Project Project No. 1603

The Ugly Brown Building

Reef Estates

Drawing Title

Proposed Basement B2 Plan

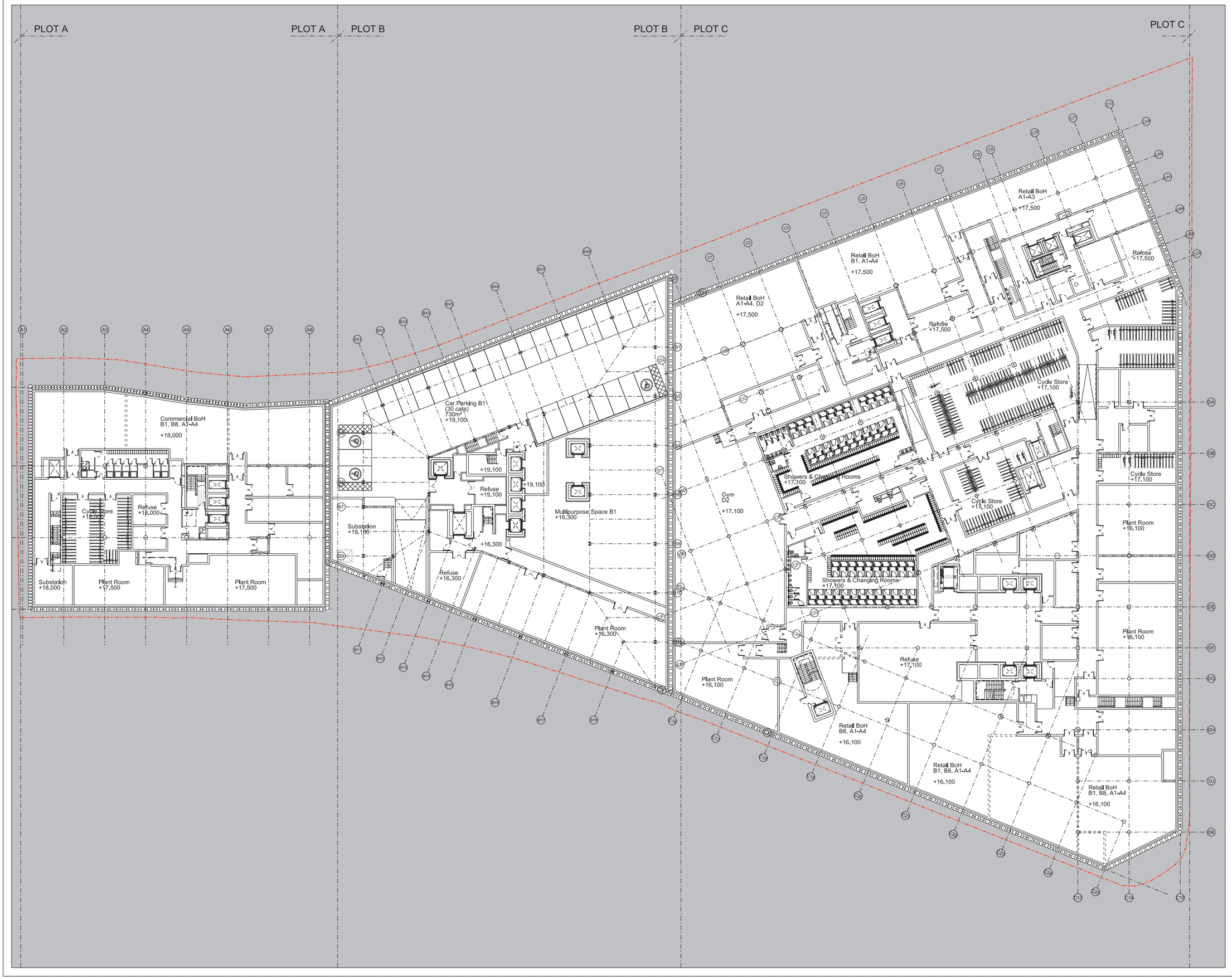
Drawing Number 1603_P_098

Revision C

Scale @ A3 1 : 500

Scale @A1 1 : 250

Revision Date 170714 YY MM DD



Revisions		By	Chk
\	170130 Stage 2 GA Issue	JS	DK
A	170221 Stage 2 GA Issue Plot A & C Grids Revised; Plot A & C basement layouts and core locations amended; general amendments	RM	DK
B	170322 Stage 2 GA Issue - Design freeze	RM	DK
C	170428 Issued for Information	JS	DK
D	170526 Issued for Planning	AD	DK
E	170714 Issued for Planning	JS	DK
F	170721 Use classes added Issued for Planning	AD	DK

Notes

Bennetts Associates Architects

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Project

The Ugly Brown Building

Reef Estates

Project No. 1603

Drawing Title

Proposed
Basement Level B1

Drawing Number
1603_P_099

Revision
F

Scale @ A3
1 : 500

Scale @A1
1 : 250

Revision Date
170721
YY MM DD

PLOT A

PLOT A

PLOT B

PLOT B

PLOT C

PLOT C

REGENTS CANAL

GRANARY STREET

ST PANCRAS WAY

COLLEGE GROVE

Business Floorspace / Retail
B1, A1-A3
+23,600

Business Floorspace / Retail
B1, A1-A4
+21,700

Entrance Lobby
B1
+21,700

Bike Store
+22,300

+19,350

+21,600

+21,600

+21,370

+21,380

+21,350

+21,300

Hotel Bar
C1
+23,600

Hotel Entrance
C1
+22,600

Hotel Restaurant
C1
+21,600

Ted Baker Lobby
B7
+21,380

Delivery Bay

Retail
A1-A4
+23,600

Business Floorspace / Retail
B1, A1-A4
+23,600

Retail
A1-A3
+23,600

Retail
A1-A3
+23,200

+23,000

+23,000

Office
B1
+23,000

Retail
A1-A3
+22,910

Retail
A1-A3
+22,910

Loading Bay
+22,000

Entrance Lobby
B1
+22,000

Retail
A1-A4
+21,890

Business Floorspace / Retail
B1, A1-A4
+20,400

Business Floorspace / Retail
B1, A1-A4
+20,275

Business Floorspace / Retail
B1, B8, A1-A4
+20,275

Revisions		By	Chk
\	170130 Stage 2 GA Issue	JS	DK
A	170221 Stage 2 GA Issue Plot A & C Grids Revised; Plot A & C1 core locations amended; general	RM	DK
B	170322 Stage 2 GA Issue - Design Freeze	RM	DK
C	170428 Issued for Information	JS	DK
D	170526 Issued for Planning	AD	DK
E	170601 Issued for Planning	JS	DK
F	170714 Issued for Planning	JS	DK
G	170721 Use classes added Issued for Planning	AD	DK
H	170810 Final comments from DP9 & Reef Issued for Planning	AD	DK

Notes

Application Boundary

Bennetts Associates Architects

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Project Project No. 1603

The Ugly Brown Building

Reef Estates

Drawing Title

Proposed
Level 00 Ground Floor

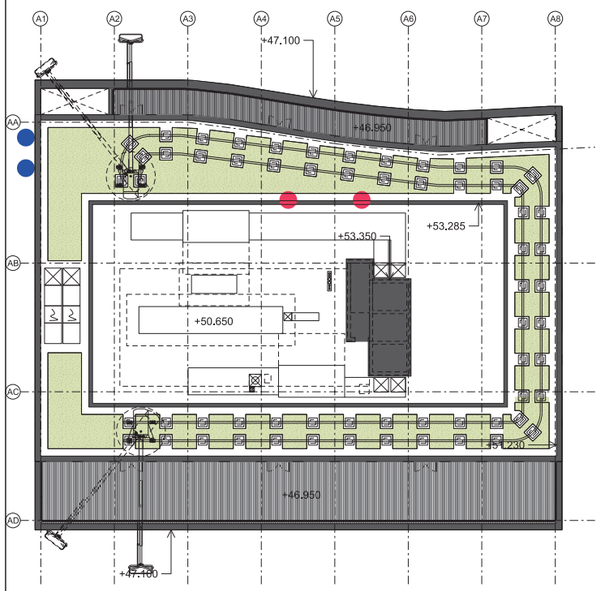
Drawing Number 1603_P_100

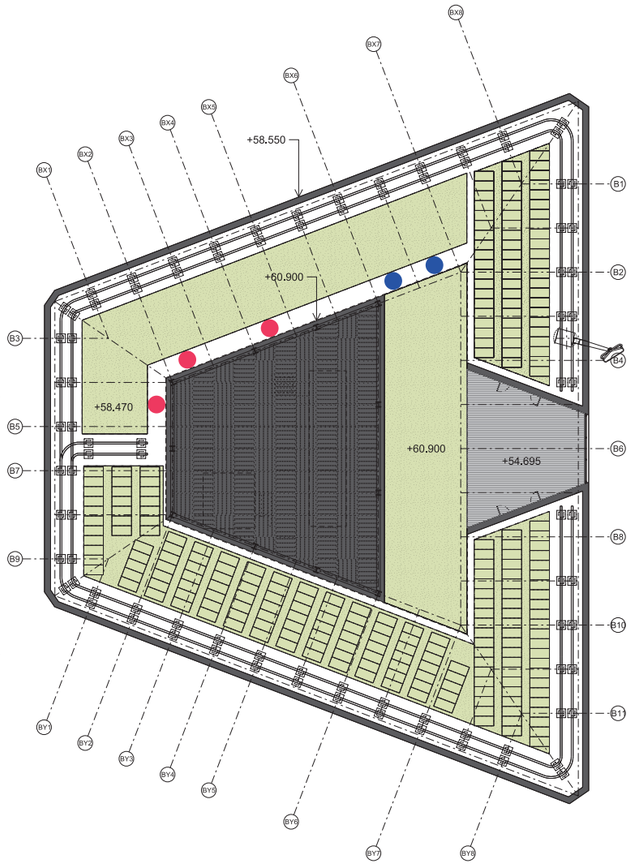
Revision H

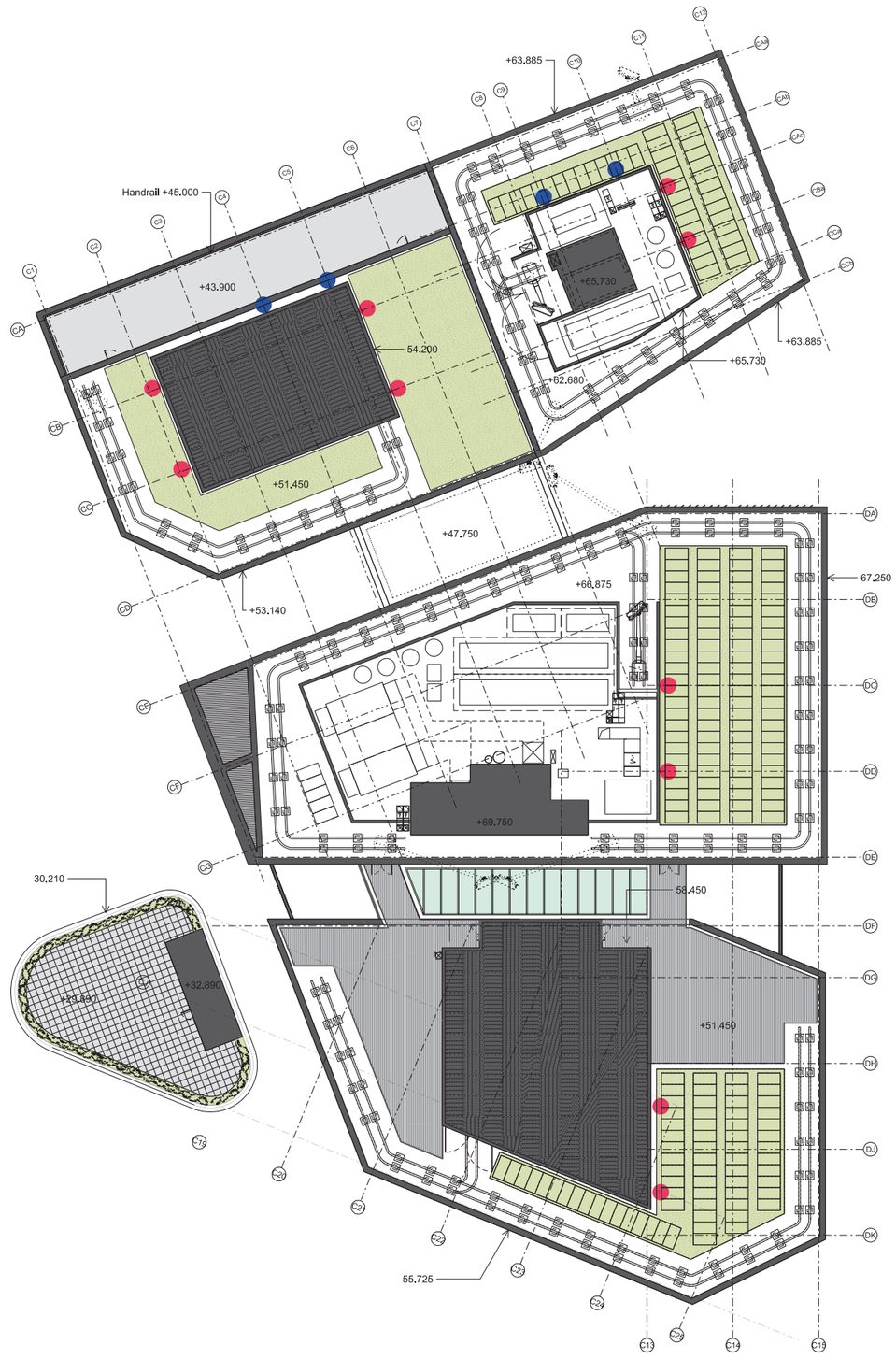
Scale @ A3 1:500

Scale @A1 1:250

Revision Date 170810
YY MM DD







Revisions	By	Chk
\ 170321 Design Freeze Issue	JS	DK
A 170428 Issued for Information	JS	DK
B 170601 Issued for Planning	AD	DK
C 170714 Issued for Planning	JS	DK

Notes

Biodiverse Roof
(with PVs where indicated)

Accessible Terrace

Proposed location for bird boxes

Proposed location for bat boxes

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For Bennetts Associates' electronic information issue disclaimer -
www.bennettsassociates.com/informationdisclaimer/

Project Project No. 1603

The Ugly Brown Building

Reef Estates

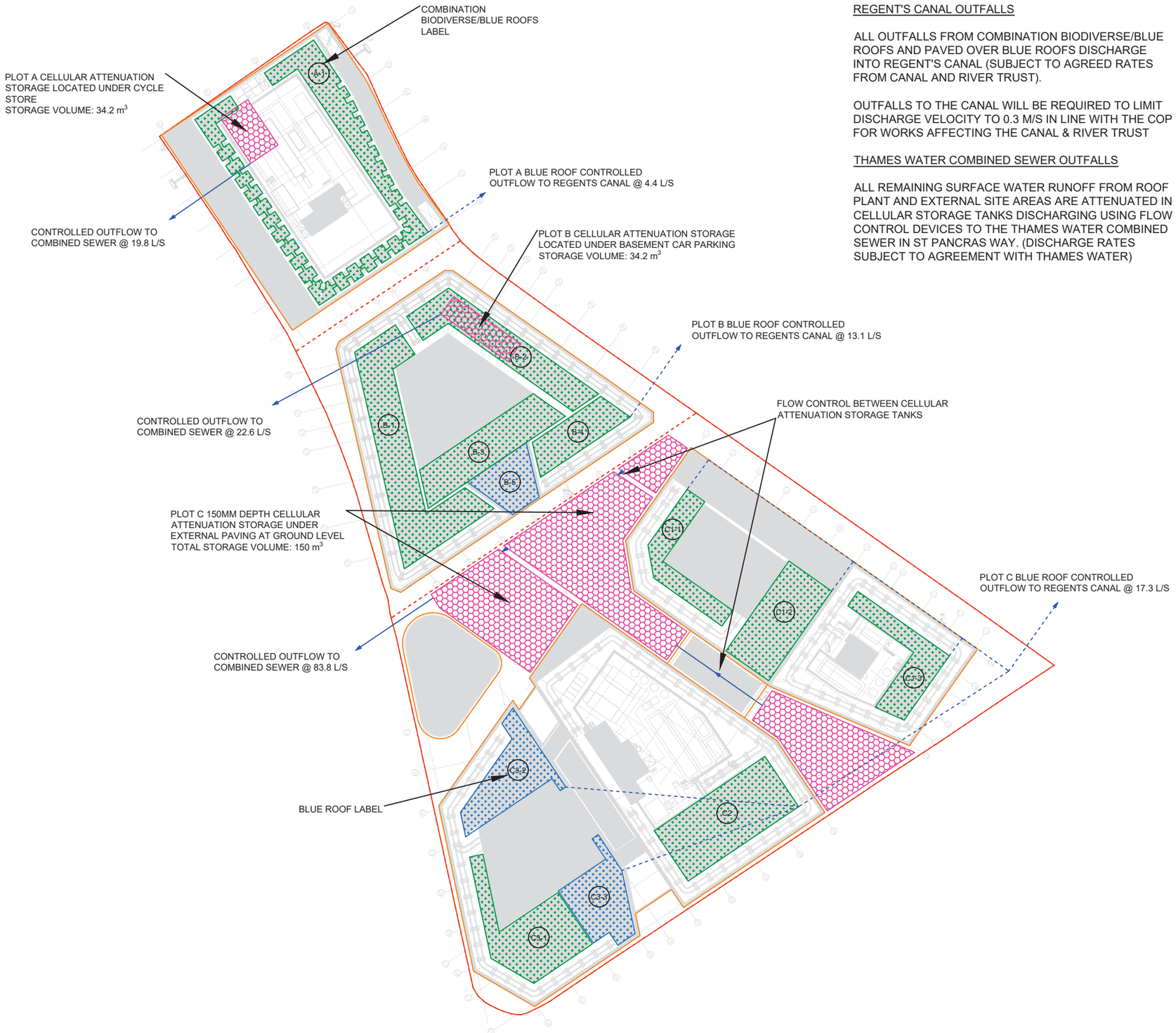
Drawing Title

Proposed
Roof Plan

Drawing Number	Revision
1603_P_RP	C

Scale @ A3	Scale @A1	Revision Date
1 : 500	1 : 250	170714

YY MM DD



REGENT'S CANAL OUTFALLS

ALL OUTFALLS FROM COMBINATION BIODIVERSE/BLUE ROOFS AND PAVED OVER BLUE ROOFS DISCHARGE INTO REGENT'S CANAL (SUBJECT TO AGREED RATES FROM CANAL AND RIVER TRUST).

OUTFALLS TO THE CANAL WILL BE REQUIRED TO LIMIT DISCHARGE VELOCITY TO 0.3 M/S IN LINE WITH THE COP FOR WORKS AFFECTING THE CANAL & RIVER TRUST

THAMES WATER COMBINED SEWER OUTFALLS

ALL REMAINING SURFACE WATER RUNOFF FROM ROOF PLANT AND EXTERNAL SITE AREAS ARE ATTENUATED IN CELLULAR STORAGE TANKS DISCHARGING USING FLOW CONTROL DEVICES TO THE THAMES WATER COMBINED SEWER IN ST PANCRAS WAY. (DISCHARGE RATES SUBJECT TO AGREEMENT WITH THAMES WATER)

N

General Notes:

Do Not Scale
This drawing is for planning purposes only

Drawing based on Bennetts Associates Architects
'Proposed Roof Plan'
1603_P_RP Rev C

- Combination Biodiverse/Blue Roof
- Blue Roof
- Cellular Attenuation Storage
- Above-Ground Surface Water Network
- Below-Ground Surface Water Network
- Roof Outline

PRELIMINARY

Rev.	Date:	By:	Chkd:	Revision Notes:
3	31/08/17	GE	TC	ISSUED FOR INFORMATION
2	14/07/17	GE	TC	**ISSUED FOR INFORMATION**

G D Partnership Ltd
Consulting Engineers
GDP
The Cart Lodge, Lullingstone Lane, Eynsford, Kent. DA40HZ
Tel: 01322 868622 Fax: 01322 861050
Email : contact@gdteam.co.uk

Client:
REEF ESTATES LTD

Project:
THE UGLY BROWN BUILDING

Drawing:
SUSTAINABLE DRAINAGE STRATEGY

Scale: NTS at A3
Drawn: GE | Checked: TC | Date: Jul'17

Job No: 16-017-SK01
Drawing No:
Rev: 3

APPENDIX B – THAMES WATER ASSET SEARCH

Asset Location Search Sewer Map - ALS/ALS Standard/2016_3266264

The width of the displayed area is 500 m and the centre of the map is located at OS coordinates 529614,183754

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
36DI	n/a	n/a
3501	22.84	8.17
36EB	n/a	n/a
4602	n/a	n/a
471A	n/a	n/a
4701	23.71	13.66
4721	23.86	n/a
4614	n/a	n/a
5718	20.05	17.31
5704	19.71	16.96
5701	21.24	14.4
55AE	n/a	n/a
5702	n/a	n/a
55AJ	n/a	n/a
6601	19.88	14.88
6501	n/a	n/a
6701	n/a	n/a
7604	23.2	22.52
7803	26.85	23.93
7606	n/a	n/a
7701	27.5	24.8
7702	27.5	25
7605	n/a	n/a
7601	23.22	22.53
7602	n/a	n/a
7703	27.5	25.4
8507	n/a	n/a
8508	n/a	n/a
8506	19.98	19.05
8505	20.03	19.46
8901	27.36	13.72
8504	20.07	19.31
8503	20.23	19.28
5501	18.95	15.59
55AI	n/a	n/a
55AF	n/a	n/a
8510	n/a	n/a
8509	n/a	n/a
59DH	n/a	n/a
59DI	n/a	n/a
59FH	n/a	n/a
59FI	n/a	n/a
59AF	n/a	n/a
59FD	n/a	n/a
59FG	n/a	n/a
5801	n/a	n/a
59AE	n/a	n/a
59DG	n/a	n/a
59AJ	n/a	n/a
59AD	n/a	n/a
59BA	n/a	n/a
59BC	n/a	n/a
59BB	n/a	n/a
59AC	n/a	n/a
59AB	n/a	n/a
59EG	n/a	n/a
59FC	n/a	n/a
59EF	n/a	n/a
59EH	n/a	n/a
6901	27.2	23.25
6902	27.75	22.6
6903	26.5	23.55
6904	26.5	22
7801	26.5	21.44
7802	26.5	23.9
49DF	n/a	n/a
50EC	n/a	n/a
3814	23.94	n/a
4902A	n/a	n/a
49DI	n/a	n/a
4901B	21.24	19.17
49CC	n/a	n/a
49DG	n/a	n/a
49CD	n/a	n/a
49AJ	n/a	n/a
4802	21.26	17.29
49CB	n/a	n/a
59EC	n/a	n/a
59AH	n/a	n/a
5803	21.36	16.99
59DJ	n/a	n/a
59EB	n/a	n/a
59AG	n/a	n/a
59FJ	n/a	n/a
3001	25.29	12.67

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

Control Valve

Drop Pipe

Ancillary

Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Outfall

Undefined End

Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

Public/Private Pumping Station

Change of characteristic indicator (C.O.C.I.)

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plans are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole level indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Sewer Flooding
History Enquiry

GD Partnership Ltd

Search address supplied	Ted Baker Ltd 6a St. Pancras Way London NW1 0TB
Your reference	6a StPancrass Way
Our reference	SFH/SFH Standard/2016_3265554
Received date	**24 February 2016**
Search date	**24 February 2016**

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0118 925 1504
E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Sewer Flooding

History Enquiry

Search address supplied: Ted Baker Ltd,6a,St. Pancras Way,London,NW1 0TB

This search is recommended to check for any sewer flooding in a specific address or area

TWUL, trading as Property Searches, are responsible in respect of the following:-

(i) any negligent or incorrect entry in the records searched;

(ii) any negligent or incorrect interpretation of the records searched;

(iii) and any negligent or incorrect recording of that interpretation in the search report

(iv) compensation payments

Thames Water Utilities Ltd

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PO Box 3189
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E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Sewer Flooding
History Enquiry

History of Sewer Flooding

Is the requested address or area at risk of flooding due to overloaded public sewers?

The flooding records held by Thames Water indicate that there have been no incidents of flooding in the requested area as a result of surcharging public sewers.

For your guidance:

- A sewer is "overloaded" when the flow from a storm is unable to pass through it due to a permanent problem (e.g. flat gradient, small diameter). Flooding as a result of temporary problems such as blockages, siltation, collapses and equipment or operational failures are excluded.
- "Internal flooding" from public sewers is defined as flooding, which enters a building or passes below a suspended floor. For reporting purposes, buildings are restricted to those normally occupied and used for residential, public, commercial, business or industrial purposes.
- "At Risk" properties are those that the water company is required to include in the Regulatory Register that is presented annually to the Director General of Water Services. These are defined as properties that have suffered, or are likely to suffer, internal flooding from public foul, combined or surface water sewers due to overloading of the sewerage system more frequently than the relevant reference period (either once or twice in ten years) as determined by the Company's reporting procedure.
- Flooding as a result of storm events proven to be exceptional and beyond the reference period of one in ten years are not included on the At Risk Register.
- Properties may be at risk of flooding but not included on the Register where flooding incidents have not been reported to the Company.
- Public Sewers are defined as those for which the Company holds statutory responsibility under the Water Industry Act 1991.
- It should be noted that flooding can occur from private sewers and drains which are not the responsibility of the Company. This report excludes flooding from private sewers and drains and the Company makes no comment upon this matter.
- For further information please contact Thames Water on Tel: 0800 316 9800 or website www.thameswater.co.uk

Thames Water Utilities Ltd

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PO Box 3189
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Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

APPENDIX C – CALCULATION SHEETS

- UK SuDS Greenfield Calculator – greenfield runoff
- MicroDrainage – Existing runoff
- MicroDrainage – Proposed discharge to TW sewer and attenuation storage
- ABG – Proposed combination biodiverse/blue roof discharge rates to Regent's Canal and attenuation storage

HR Wallingford
Working with water

Greenfield runoff estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Water Environment
Site name:	Ugly Brown Building
Site location:	NW1 0TB

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site coordinates

Latitude:	51.53783° N
Longitude:	0.13244° W

Reference:	5906391
Date:	2017-03-16T10:22:42

Methodology	IH124

Site characteristics

Total site area (ha)	1.138

Methodology

Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type

	Default	Edited
SOIL type	4	4
HOST class	---	---
SPR/SPRHOST	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm)	620	620
Hydrological region	6	6
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 30 year	2.3	2.3
Growth curve factor: 100 year	3.19	3.19

Notes:

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

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

Where flow rates are less than 5.0 l/s consents are usually set at 5.0l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set in which case blockage work must be addressed by using appropriate drainage elements

(3) Is SPR/SPRHOST ≤ 0.3?

Greenfield runoff rates

	Default	Edited
Qbar (l/s)	4.77	4.77
1 in 1 year (l/s)	4.05	4.05
1 in 30 years (l/s)	10.96	10.96
1 in 100 years (l/s)	15.21	15.21

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	20.258	0.258	88.9	4.0	O K
30 min Summer	20.262	0.262	91.9	4.1	O K
60 min Summer	20.252	0.252	84.4	3.8	O K
120 min Summer	20.217	0.217	63.7	2.8	O K
180 min Summer	20.193	0.193	51.2	2.2	O K
240 min Summer	20.178	0.178	43.3	1.8	O K
360 min Summer	20.156	0.156	33.3	1.3	O K
480 min Summer	20.141	0.141	27.6	1.1	O K
600 min Summer	20.131	0.131	23.8	0.9	O K
720 min Summer	20.123	0.123	20.9	0.8	O K
960 min Summer	20.107	0.107	16.8	0.6	O K
1440 min Summer	20.089	0.089	12.5	0.4	O K
2160 min Summer	20.075	0.075	9.3	0.3	O K
2880 min Summer	20.067	0.067	7.6	0.2	O K
4320 min Summer	20.059	0.059	5.6	0.2	O K
5760 min Summer	20.055	0.055	4.8	0.2	O K
7200 min Summer	20.052	0.052	4.0	0.1	O K
8640 min Summer	20.050	0.050	3.5	0.1	O K
10080 min Summer	20.047	0.047	3.1	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	32.223	0.0	68.9	14
30 min Summer	20.981	0.0	89.7	22
60 min Summer	13.233	0.0	113.2	36
120 min Summer	8.176	0.0	139.8	66
180 min Summer	6.139	0.0	157.5	96
240 min Summer	5.003	0.0	171.1	126
360 min Summer	3.720	0.0	190.8	188
480 min Summer	3.010	0.0	205.9	246
600 min Summer	2.553	0.0	218.3	306
720 min Summer	2.233	0.0	229.1	366
960 min Summer	1.806	0.0	247.1	488
1440 min Summer	1.340	0.0	275.0	726
2160 min Summer	0.995	0.0	306.3	1080
2880 min Summer	0.805	0.0	330.2	1460
4320 min Summer	0.597	0.0	367.3	2184
5760 min Summer	0.483	0.0	396.3	2928
7200 min Summer	0.410	0.0	420.5	3640
8640 min Summer	0.359	0.0	441.5	4400
10080 min Summer	0.320	0.0	460.1	5120

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	20.274	0.274	100.5	4.5	O K
30 min Winter	20.273	0.273	99.7	4.5	O K
60 min Winter	20.244	0.244	78.4	3.6	O K
120 min Winter	20.196	0.196	52.8	2.2	O K
180 min Winter	20.173	0.173	40.6	1.7	O K
240 min Winter	20.156	0.156	33.3	1.3	O K
360 min Winter	20.134	0.134	24.9	1.0	O K
480 min Winter	20.122	0.122	20.3	0.8	O K
600 min Winter	20.109	0.109	17.3	0.6	O K
720 min Winter	20.100	0.100	15.1	0.5	O K
960 min Winter	20.087	0.087	12.2	0.4	O K
1440 min Winter	20.074	0.074	9.1	0.3	O K
2160 min Winter	20.064	0.064	6.9	0.2	O K
2880 min Winter	20.058	0.058	5.5	0.2	O K
4320 min Winter	20.052	0.052	4.1	0.1	O K
5760 min Winter	20.049	0.049	3.3	0.1	O K
7200 min Winter	20.045	0.045	2.8	0.1	O K
8640 min Winter	20.041	0.041	2.5	0.1	O K
10080 min Winter	20.038	0.038	2.2	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	32.223	0.0	77.1	14
30 min Winter	20.981	0.0	100.5	22
60 min Winter	13.233	0.0	126.7	36
120 min Winter	8.176	0.0	156.6	68
180 min Winter	6.139	0.0	176.3	96
240 min Winter	5.003	0.0	191.6	126
360 min Winter	3.720	0.0	213.7	184
480 min Winter	3.010	0.0	230.6	246
600 min Winter	2.553	0.0	244.5	306
720 min Winter	2.233	0.0	256.5	366
960 min Winter	1.806	0.0	276.7	484
1440 min Winter	1.340	0.0	308.0	712
2160 min Winter	0.995	0.0	343.1	1092
2880 min Winter	0.805	0.0	369.9	1432
4320 min Winter	0.597	0.0	411.4	2168
5760 min Winter	0.483	0.0	443.9	2832
7200 min Winter	0.410	0.0	471.0	3576
8640 min Winter	0.359	0.0	494.4	4400
10080 min Winter	0.320	0.0	515.3	5040

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Shortest Storm (mins)	15
Ratio R	0.410	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.140

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.380	4	8	0.380	8	12	0.380

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	20.406	0.406	218.9	8.5	O K
30 min Summer	20.412	0.412	225.9	8.6	O K
60 min Summer	20.393	0.393	202.3	8.1	O K
120 min Summer	20.339	0.339	149.0	6.5	O K
180 min Summer	20.296	0.296	116.9	5.2	O K
240 min Summer	20.269	0.269	97.1	4.4	O K
360 min Summer	20.235	0.235	73.3	3.3	O K
480 min Summer	20.209	0.209	59.5	2.6	O K
600 min Summer	20.192	0.192	50.7	2.1	O K
720 min Summer	20.180	0.180	44.3	1.8	O K
960 min Summer	20.161	0.161	35.3	1.4	O K
1440 min Summer	20.136	0.136	25.7	1.0	O K
2160 min Summer	20.115	0.115	18.7	0.7	O K
2880 min Summer	20.099	0.099	14.8	0.5	O K
4320 min Summer	20.081	0.081	10.8	0.3	O K
5760 min Summer	20.072	0.072	8.7	0.3	O K
7200 min Summer	20.066	0.066	7.3	0.2	O K
8640 min Summer	20.062	0.062	6.3	0.2	O K
10080 min Summer	20.059	0.059	5.6	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	79.107	0.0	169.1	13
30 min Summer	51.269	0.0	219.2	21
60 min Summer	31.749	0.0	271.5	36
120 min Summer	19.074	0.0	326.2	66
180 min Summer	14.006	0.0	359.3	96
240 min Summer	11.200	0.0	383.1	126
360 min Summer	8.170	0.0	419.1	188
480 min Summer	6.525	0.0	446.3	248
600 min Summer	5.477	0.0	468.3	306
720 min Summer	4.746	0.0	487.0	368
960 min Summer	3.783	0.0	517.6	486
1440 min Summer	2.746	0.0	563.4	720
2160 min Summer	1.990	0.0	612.7	1088
2880 min Summer	1.583	0.0	649.8	1444
4320 min Summer	1.146	0.0	705.3	2176
5760 min Summer	0.910	0.0	747.1	2856
7200 min Summer	0.761	0.0	781.0	3568
8640 min Summer	0.658	0.0	809.6	4400
10080 min Summer	0.581	0.0	834.5	5136

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	20.429	0.429	247.6	9.0	O K
30 min Winter	20.426	0.426	244.4	9.0	O K
60 min Winter	20.383	0.383	189.5	7.9	O K
120 min Winter	20.304	0.304	123.2	5.4	O K
180 min Winter	20.263	0.263	92.2	4.2	O K
240 min Winter	20.237	0.237	74.4	3.4	O K
360 min Winter	20.200	0.200	54.7	2.3	O K
480 min Winter	20.180	0.180	44.1	1.8	O K
600 min Winter	20.165	0.165	37.0	1.5	O K
720 min Winter	20.152	0.152	32.0	1.3	O K
960 min Winter	20.135	0.135	25.5	1.0	O K
1440 min Winter	20.115	0.115	18.5	0.7	O K
2160 min Winter	20.093	0.093	13.5	0.4	O K
2880 min Winter	20.081	0.081	10.7	0.3	O K
4320 min Winter	20.068	0.068	7.8	0.2	O K
5760 min Winter	20.061	0.061	6.2	0.2	O K
7200 min Winter	20.057	0.057	5.3	0.2	O K
8640 min Winter	20.054	0.054	4.6	0.2	O K
10080 min Winter	20.052	0.052	4.1	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	79.107	0.0	189.4	14
30 min Winter	51.269	0.0	245.5	21
60 min Winter	31.749	0.0	304.0	36
120 min Winter	19.074	0.0	365.3	66
180 min Winter	14.006	0.0	402.4	96
240 min Winter	11.200	0.0	429.0	126
360 min Winter	8.170	0.0	469.4	186
480 min Winter	6.525	0.0	499.8	244
600 min Winter	5.477	0.0	524.5	306
720 min Winter	4.746	0.0	545.4	362
960 min Winter	3.783	0.0	579.7	484
1440 min Winter	2.746	0.0	631.0	726
2160 min Winter	1.990	0.0	686.2	1104
2880 min Winter	1.583	0.0	727.7	1464
4320 min Winter	1.146	0.0	789.9	2148
5760 min Winter	0.910	0.0	836.8	2848
7200 min Winter	0.761	0.0	874.7	3640
8640 min Winter	0.658	0.0	906.7	4208
10080 min Winter	0.581	0.0	934.6	5208

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.600	Shortest Storm (mins)	15
Ratio R	0.410	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.140

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.380	4	8	0.380	8	12	0.380

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	20.458	0.458	284.7	9.6	O K
30 min Summer	20.466	0.466	295.6	9.7	O K
60 min Summer	20.444	0.444	267.5	9.3	O K
120 min Summer	20.388	0.388	195.9	8.0	O K
180 min Summer	20.344	0.344	153.1	6.7	O K
240 min Summer	20.308	0.308	126.2	5.6	O K
360 min Summer	20.267	0.267	95.2	4.3	O K
480 min Summer	20.241	0.241	76.8	3.5	O K
600 min Summer	20.220	0.220	65.3	2.9	O K
720 min Summer	20.203	0.203	56.6	2.4	O K
960 min Summer	20.182	0.182	45.1	1.9	O K
1440 min Summer	20.154	0.154	32.6	1.3	O K
2160 min Summer	20.130	0.130	23.4	0.9	O K
2880 min Summer	20.115	0.115	18.5	0.7	O K
4320 min Summer	20.092	0.092	13.3	0.4	O K
5760 min Summer	20.080	0.080	10.6	0.3	O K
7200 min Summer	20.073	0.073	9.0	0.3	O K
8640 min Summer	20.068	0.068	7.7	0.2	O K
10080 min Summer	20.063	0.063	6.7	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	102.810	0.0	219.8	13
30 min Summer	67.170	0.0	287.2	22
60 min Summer	41.754	0.0	357.0	36
120 min Summer	25.051	0.0	428.4	66
180 min Summer	18.324	0.0	470.0	96
240 min Summer	14.589	0.0	498.9	126
360 min Summer	10.583	0.0	542.9	186
480 min Summer	8.418	0.0	575.8	246
600 min Summer	7.044	0.0	602.3	306
720 min Summer	6.087	0.0	624.6	366
960 min Summer	4.831	0.0	660.9	484
1440 min Summer	3.483	0.0	714.7	726
2160 min Summer	2.507	0.0	771.6	1088
2880 min Summer	1.983	0.0	813.8	1464
4320 min Summer	1.423	0.0	876.3	2184
5760 min Summer	1.124	0.0	922.6	2920
7200 min Summer	0.935	0.0	959.7	3552
8640 min Summer	0.805	0.0	990.8	4392
10080 min Summer	0.708	0.0	1017.6	4960

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	20.492	0.492	321.2	10.1	O K
30 min Winter	20.492	0.492	321.7	10.1	O K
60 min Winter	20.430	0.430	249.6	9.1	O K
120 min Winter	20.356	0.356	161.7	7.1	O K
180 min Winter	20.301	0.301	121.0	5.4	O K
240 min Winter	20.269	0.269	97.1	4.4	O K
360 min Winter	20.230	0.230	70.7	3.2	O K
480 min Winter	20.203	0.203	56.6	2.4	O K
600 min Winter	20.186	0.186	47.2	2.0	O K
720 min Winter	20.174	0.174	41.1	1.7	O K
960 min Winter	20.154	0.154	32.6	1.3	O K
1440 min Winter	20.130	0.130	23.6	0.9	O K
2160 min Winter	20.108	0.108	16.9	0.6	O K
2880 min Winter	20.093	0.093	13.5	0.4	O K
4320 min Winter	20.076	0.076	9.7	0.3	O K
5760 min Winter	20.068	0.068	7.8	0.2	O K
7200 min Winter	20.063	0.063	6.5	0.2	O K
8640 min Winter	20.059	0.059	5.6	0.2	O K
10080 min Winter	20.056	0.056	4.9	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	102.810	0.0	246.1	14
30 min Winter	67.170	0.0	321.6	21
60 min Winter	41.754	0.0	399.9	36
120 min Winter	25.051	0.0	479.8	66
180 min Winter	18.324	0.0	526.4	96
240 min Winter	14.589	0.0	558.8	126
360 min Winter	10.583	0.0	608.0	188
480 min Winter	8.418	0.0	644.9	248
600 min Winter	7.044	0.0	674.6	308
720 min Winter	6.087	0.0	699.5	364
960 min Winter	4.831	0.0	740.2	488
1440 min Winter	3.483	0.0	800.4	728
2160 min Winter	2.507	0.0	864.1	1108
2880 min Winter	1.983	0.0	911.5	1468
4320 min Winter	1.423	0.0	981.4	2128
5760 min Winter	1.124	0.0	1033.3	2896
7200 min Winter	0.935	0.0	1074.9	3600
8640 min Winter	0.805	0.0	1109.7	4264
10080 min Winter	0.708	0.0	1139.7	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)	20.600	Shortest Storm (mins)	15
Ratio R	0.410	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.140

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.380	4	8	0.380	8	12	0.380

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

Half Drain Time : 14 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	16.429	0.429	0.0	20.0	20.0	22.4	O K
30 min Summer	16.514	0.514	0.0	20.0	20.0	26.8	O K
60 min Summer	16.495	0.495	0.0	20.0	20.0	25.9	O K
120 min Summer	16.368	0.368	0.0	20.0	20.0	19.2	O K
180 min Summer	16.265	0.265	0.0	19.9	19.9	13.9	O K
240 min Summer	16.206	0.206	0.0	19.4	19.4	10.7	O K
360 min Summer	16.165	0.165	0.0	15.5	15.5	8.6	O K
480 min Summer	16.144	0.144	0.0	12.7	12.7	7.5	O K
600 min Summer	16.130	0.130	0.0	10.8	10.8	6.8	O K
720 min Summer	16.120	0.120	0.0	9.5	9.5	6.2	O K
960 min Summer	16.105	0.105	0.0	7.6	7.6	5.5	O K
1440 min Summer	16.088	0.088	0.0	5.5	5.5	4.6	O K
2160 min Summer	16.074	0.074	0.0	4.0	4.0	3.8	O K
2880 min Summer	16.065	0.065	0.0	3.2	3.2	3.4	O K
4320 min Summer	16.055	0.055	0.0	2.3	2.3	2.8	O K
5760 min Summer	16.048	0.048	0.0	1.8	1.8	2.5	O K
7200 min Summer	16.044	0.044	0.0	1.5	1.5	2.3	O K
8640 min Summer	16.041	0.041	0.0	1.3	1.3	2.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.934	0.0	37.7	20
30 min Summer	94.038	0.0	49.3	29
60 min Summer	58.456	0.0	61.4	46
120 min Summer	35.072	0.0	73.6	76
180 min Summer	25.654	0.0	80.8	104
240 min Summer	20.424	0.0	85.8	132
360 min Summer	14.816	0.0	93.3	192
480 min Summer	11.786	0.0	99.0	252
600 min Summer	9.862	0.0	103.5	312
720 min Summer	8.522	0.0	107.4	372
960 min Summer	6.764	0.0	113.6	492
1440 min Summer	4.876	0.0	122.8	736
2160 min Summer	3.509	0.0	132.6	1100
2880 min Summer	2.776	0.0	139.9	1468
4320 min Summer	1.993	0.0	150.6	2196
5760 min Summer	1.574	0.0	158.6	2936
7200 min Summer	1.310	0.0	165.0	3600
8640 min Summer	1.127	0.0	170.3	4344

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
10080 min Summer	16.038	0.038	0.0	1.1	1.1	2.0	O K
15 min Winter	16.501	0.501	0.0	20.0	20.0	26.2	O K
30 min Winter	16.588	0.588	0.0	20.0	20.0	30.7	O K
60 min Winter	16.541	0.541	0.0	20.0	20.0	28.2	O K
120 min Winter	16.331	0.331	0.0	20.0	20.0	17.3	O K
180 min Winter	16.205	0.205	0.0	19.4	19.4	10.7	O K
240 min Winter	16.171	0.171	0.0	16.2	16.2	8.9	O K
360 min Winter	16.139	0.139	0.0	12.0	12.0	7.2	O K
480 min Winter	16.121	0.121	0.0	9.6	9.6	6.3	O K
600 min Winter	16.109	0.109	0.0	8.1	8.1	5.7	O K
720 min Winter	16.100	0.100	0.0	7.0	7.0	5.2	O K
960 min Winter	16.088	0.088	0.0	5.6	5.6	4.6	O K
1440 min Winter	16.074	0.074	0.0	4.0	4.0	3.8	O K
2160 min Winter	16.062	0.062	0.0	2.9	2.9	3.2	O K
2880 min Winter	16.055	0.055	0.0	2.3	2.3	2.8	O K
4320 min Winter	16.046	0.046	0.0	1.6	1.6	2.4	O K
5760 min Winter	16.041	0.041	0.0	1.3	1.3	2.1	O K
7200 min Winter	16.037	0.037	0.0	1.1	1.1	1.9	O K
8640 min Winter	16.034	0.034	0.0	0.9	0.9	1.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.992	0.0	174.9	5144
15 min Winter	143.934	0.0	42.3	21
30 min Winter	94.038	0.0	55.3	30
60 min Winter	58.456	0.0	68.7	48
120 min Winter	35.072	0.0	82.5	80
180 min Winter	25.654	0.0	90.5	104
240 min Winter	20.424	0.0	96.0	132
360 min Winter	14.816	0.0	104.5	192
480 min Winter	11.786	0.0	110.9	252
600 min Winter	9.862	0.0	116.0	314
720 min Winter	8.522	0.0	120.2	372
960 min Winter	6.764	0.0	127.2	490
1440 min Winter	4.876	0.0	137.6	732
2160 min Winter	3.509	0.0	148.5	1108
2880 min Winter	2.776	0.0	156.7	1444
4320 min Winter	1.993	0.0	168.7	2204
5760 min Winter	1.574	0.0	177.6	2920
7200 min Winter	1.310	0.0	184.8	3656
8640 min Winter	1.127	0.0	190.8	4304

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
10080 min Winter	16.032	0.032	0.0	0.8	0.8	1.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	0.992	0.0	195.9	4984

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)	20.600	Shortest Storm (mins)	15
Ratio R	0.410	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.140

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.047	4	8	0.047	8	12	0.047

Model Details

Storage is Online Cover Level (m) 17.500

Cellular Storage Structure

Invert Level (m) 16.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	55.0	0.0	0.601	1.0	0.0
0.600	55.0	0.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0203-2000-0600-2000
Design Head (m)	0.600
Design Flow (l/s)	20.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	203
Invert Level (m)	16.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	20.0
Flush-Flo™	0.298	20.0
Kick-Flo®	0.490	18.2
Mean Flow over Head Range	-	15.6

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)
0.100	7.0	1.000	25.5	2.400	38.9	5.500	58.1
0.200	19.3	1.200	27.8	2.600	40.4	6.000	60.6
0.300	20.0	1.400	30.0	3.000	43.3	6.500	62.6
0.400	19.5	1.600	32.0	3.500	46.6	7.000	65.0
0.500	18.3	1.800	33.8	4.000	49.8	7.500	67.3
0.600	20.0	2.000	35.6	4.500	52.7	8.000	69.5
0.800	22.9	2.200	37.3	5.000	55.4	8.500	71.7

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
9.000	73.8	9.500	75.8				

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

Half Drain Time : 12 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	17.949	0.449	0.0	23.0	23.0	25.6	O K
30 min Summer	18.036	0.536	0.0	23.0	23.0	30.6	O K
60 min Summer	18.016	0.516	0.0	22.9	22.9	29.4	O K
120 min Summer	17.884	0.384	0.0	23.0	23.0	21.9	O K
180 min Summer	17.777	0.277	0.0	22.9	22.9	15.8	O K
240 min Summer	17.715	0.215	0.0	22.3	22.3	12.2	O K
360 min Summer	17.673	0.173	0.0	17.7	17.7	9.9	O K
480 min Summer	17.651	0.151	0.0	14.6	14.6	8.6	O K
600 min Summer	17.636	0.136	0.0	12.4	12.4	7.8	O K
720 min Summer	17.626	0.126	0.0	10.8	10.8	7.2	O K
960 min Summer	17.610	0.110	0.0	8.7	8.7	6.3	O K
1440 min Summer	17.592	0.092	0.0	6.3	6.3	5.3	O K
2160 min Summer	17.577	0.077	0.0	4.6	4.6	4.4	O K
2880 min Summer	17.568	0.068	0.0	3.6	3.6	3.9	O K
4320 min Summer	17.557	0.057	0.0	2.6	2.6	3.3	O K
5760 min Summer	17.551	0.051	0.0	2.1	2.1	2.9	O K
7200 min Summer	17.546	0.046	0.0	1.7	1.7	2.6	O K
8640 min Summer	17.543	0.043	0.0	1.5	1.5	2.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.934	0.0	43.1	20
30 min Summer	94.038	0.0	56.4	29
60 min Summer	58.456	0.0	70.1	46
120 min Summer	35.072	0.0	84.1	76
180 min Summer	25.654	0.0	92.3	104
240 min Summer	20.424	0.0	98.0	132
360 min Summer	14.816	0.0	106.6	192
480 min Summer	11.786	0.0	113.1	252
600 min Summer	9.862	0.0	118.3	312
720 min Summer	8.522	0.0	122.7	372
960 min Summer	6.764	0.0	129.8	492
1440 min Summer	4.876	0.0	140.4	736
2160 min Summer	3.509	0.0	151.6	1100
2880 min Summer	2.776	0.0	159.9	1444
4320 min Summer	1.993	0.0	172.1	2156
5760 min Summer	1.574	0.0	181.3	2920
7200 min Summer	1.310	0.0	188.5	3664
8640 min Summer	1.127	0.0	194.7	4328

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
10080 min Summer	17.540	0.040	0.0	1.3	1.3	2.3	O K
15 min Winter	18.023	0.523	0.0	23.0	23.0	29.8	O K
30 min Winter	18.414	0.914	0.0	28.1	28.1	34.5	O K
60 min Winter	18.061	0.561	0.0	23.0	23.0	32.0	O K
120 min Winter	17.844	0.344	0.0	23.0	23.0	19.6	O K
180 min Winter	17.714	0.214	0.0	22.3	22.3	12.2	O K
240 min Winter	17.679	0.179	0.0	18.5	18.5	10.2	O K
360 min Winter	17.646	0.146	0.0	13.7	13.7	8.3	O K
480 min Winter	17.627	0.127	0.0	11.0	11.0	7.2	O K
600 min Winter	17.615	0.115	0.0	9.3	9.3	6.5	O K
720 min Winter	17.605	0.105	0.0	8.0	8.0	6.0	O K
960 min Winter	17.593	0.093	0.0	6.4	6.4	5.3	O K
1440 min Winter	17.578	0.078	0.0	4.6	4.6	4.4	O K
2160 min Winter	17.565	0.065	0.0	3.3	3.3	3.7	O K
2880 min Winter	17.558	0.058	0.0	2.7	2.7	3.3	O K
4320 min Winter	17.548	0.048	0.0	1.9	1.9	2.7	O K
5760 min Winter	17.543	0.043	0.0	1.5	1.5	2.4	O K
7200 min Winter	17.539	0.039	0.0	1.2	1.2	2.2	O K
8640 min Winter	17.536	0.036	0.0	1.1	1.1	2.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.992	0.0	199.9	4984
15 min Winter	143.934	0.0	48.3	21
30 min Winter	94.038	0.0	63.1	29
60 min Winter	58.456	0.0	78.5	48
120 min Winter	35.072	0.0	94.2	78
180 min Winter	25.654	0.0	103.4	104
240 min Winter	20.424	0.0	109.8	132
360 min Winter	14.816	0.0	119.4	192
480 min Winter	11.786	0.0	126.7	252
600 min Winter	9.862	0.0	132.5	312
720 min Winter	8.522	0.0	137.4	374
960 min Winter	6.764	0.0	145.4	490
1440 min Winter	4.876	0.0	157.2	738
2160 min Winter	3.509	0.0	169.8	1088
2880 min Winter	2.776	0.0	179.1	1460
4320 min Winter	1.993	0.0	192.8	2140
5760 min Winter	1.574	0.0	203.0	2840
7200 min Winter	1.310	0.0	211.2	3672
8640 min Winter	1.127	0.0	218.0	4376

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
10080 min Winter	17.534	0.034	0.0	0.9	0.9	1.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	0.992	0.0	223.9	5016

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)	20.600	Shortest Storm (mins)	15
Ratio R	0.410	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.160

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.053	4	8	0.053	8	12	0.053

Model Details

Storage is Online Cover Level (m) 19.100

Cellular Storage Structure

Invert Level (m) 17.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	60.0	0.0	0.601	1.0	0.0
0.600	60.0	0.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0216-2300-0600-2300
Design Head (m)	0.600
Design Flow (l/s)	23.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	216
Invert Level (m)	17.500
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	23.0
Flush-Flo™	0.311	23.0
Kick-Flo®	0.497	21.0
Mean Flow over Head Range	-	17.7

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)
0.100	7.3	1.000	29.4	2.400	44.7	5.500	66.9
0.200	21.1	1.200	32.0	2.600	46.5	6.000	69.8
0.300	22.9	1.400	34.5	3.000	49.8	6.500	72.1
0.400	22.5	1.600	36.8	3.500	53.7	7.000	74.8
0.500	21.1	1.800	38.9	4.000	57.3	7.500	77.5
0.600	23.0	2.000	41.0	4.500	60.7	8.000	80.1
0.800	26.4	2.200	42.9	5.000	63.9	8.500	82.6

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
9.000	85.0	9.500	87.3				

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	17.750	0.650	84.0	97.5	O K
30 min Summer	17.876	0.776	84.0	116.4	O K
60 min Summer	17.856	0.756	84.0	113.4	O K
120 min Summer	17.685	0.585	84.0	87.8	O K
180 min Summer	17.539	0.439	83.4	65.9	O K
240 min Summer	17.451	0.351	81.0	52.6	O K
360 min Summer	17.386	0.286	64.7	43.0	O K
480 min Summer	17.351	0.251	53.3	37.7	O K
600 min Summer	17.327	0.227	45.5	34.1	O K
720 min Summer	17.309	0.209	39.7	31.4	O K
960 min Summer	17.285	0.185	32.1	27.7	O K
1440 min Summer	17.255	0.155	23.4	23.2	O K
2160 min Summer	17.230	0.130	17.0	19.4	O K
2880 min Summer	17.214	0.114	13.4	17.2	O K
4320 min Summer	17.196	0.096	9.7	14.4	O K
5760 min Summer	17.185	0.085	7.6	12.7	O K
7200 min Summer	17.177	0.077	6.4	11.6	O K
8640 min Summer	17.171	0.071	5.5	10.7	O K
10080 min Summer	17.167	0.067	4.8	10.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.934	0.0	159.8	20
30 min Summer	94.038	0.0	208.9	29
60 min Summer	58.456	0.0	259.9	46
120 min Summer	35.072	0.0	311.9	76
180 min Summer	25.654	0.0	342.2	106
240 min Summer	20.424	0.0	363.2	132
360 min Summer	14.816	0.0	395.2	192
480 min Summer	11.786	0.0	419.2	252
600 min Summer	9.862	0.0	438.5	312
720 min Summer	8.522	0.0	454.7	372
960 min Summer	6.764	0.0	481.1	492
1440 min Summer	4.876	0.0	520.2	736
2160 min Summer	3.509	0.0	561.8	1100
2880 min Summer	2.776	0.0	592.6	1468
4320 min Summer	1.993	0.0	637.9	2184
5760 min Summer	1.574	0.0	671.8	2936
7200 min Summer	1.310	0.0	698.8	3664
8640 min Summer	1.127	0.0	721.4	4288
10080 min Summer	0.992	0.0	740.9	5048

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	17.852	0.752	84.0	112.8	O K
30 min Winter	17.995	0.895	84.0	134.3	O K
60 min Winter	17.933	0.833	84.0	124.9	O K
120 min Winter	17.636	0.536	84.0	80.4	O K
180 min Winter	17.453	0.353	81.0	52.9	O K
240 min Winter	17.397	0.297	68.1	44.6	O K
360 min Winter	17.343	0.243	50.7	36.5	O K
480 min Winter	17.312	0.212	40.6	31.8	O K
600 min Winter	17.292	0.192	34.2	28.7	O K
720 min Winter	17.277	0.177	29.7	26.5	O K
960 min Winter	17.255	0.155	23.6	23.3	O K
1440 min Winter	17.230	0.130	17.1	19.5	O K
2160 min Winter	17.209	0.109	12.3	16.3	O K
2880 min Winter	17.196	0.096	9.7	14.4	O K
4320 min Winter	17.181	0.081	7.0	12.2	O K
5760 min Winter	17.172	0.072	5.5	10.7	O K
7200 min Winter	17.165	0.065	4.6	9.8	O K
8640 min Winter	17.160	0.060	3.9	9.0	O K
10080 min Winter	17.157	0.057	3.5	8.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	143.934	0.0	179.0	21
30 min Winter	94.038	0.0	234.0	31
60 min Winter	58.456	0.0	291.1	48
120 min Winter	35.072	0.0	349.3	80
180 min Winter	25.654	0.0	383.3	104
240 min Winter	20.424	0.0	406.8	134
360 min Winter	14.816	0.0	442.7	192
480 min Winter	11.786	0.0	469.5	254
600 min Winter	9.862	0.0	491.1	314
720 min Winter	8.522	0.0	509.3	374
960 min Winter	6.764	0.0	538.9	494
1440 min Winter	4.876	0.0	582.7	736
2160 min Winter	3.509	0.0	629.2	1100
2880 min Winter	2.776	0.0	663.7	1468
4320 min Winter	1.993	0.0	714.5	2188
5760 min Winter	1.574	0.0	752.4	2872
7200 min Winter	1.310	0.0	782.7	3624
8640 min Winter	1.127	0.0	808.0	4352
10080 min Winter	0.992	0.0	829.8	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)	20.600	Shortest Storm (mins)	15
Ratio R	0.410	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.593

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.198	4	8	0.198	8	12	0.198

Model Details

Storage is Online Cover Level (m) 18.300

Tank or Pond Structure

Invert Level (m) 17.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	150.0	1.000	150.0	1.001	1.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0367-8400-1000-8400
Design Head (m)	1.000
Design Flow (l/s)	84.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	367
Invert Level (m)	17.100
Minimum Outlet Pipe Diameter (mm)	450
Suggested Manhole Diameter (mm)	2100

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	84.0
Flush-Flo™	0.523	84.0
Kick-Flo®	0.831	76.8
Mean Flow over Head Range	-	64.9

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)
0.100	10.4	1.200	91.7	3.000	143.3	7.000	216.9
0.200	36.8	1.400	98.8	3.500	154.5	7.500	224.4
0.300	69.0	1.600	105.5	4.000	164.9	8.000	231.6
0.400	82.5	1.800	111.7	4.500	174.7	8.500	238.6
0.500	83.9	2.000	117.6	5.000	183.9	9.000	245.4
0.600	83.5	2.200	123.2	5.500	192.7	9.500	252.0
0.800	78.3	2.400	128.5	6.000	201.1		
1.000	84.0	2.600	133.6	6.500	209.2		

BLUE ROOF STORAGE AND OUTFLOW ESTIMATE

abg creative geosynthetic engineering

Project Name:	Ugly Brown Building, Camden
Prepared for:	Water Environment Limited
Date:	29/06/2017
ABG Project ID:	11723
Prepared by:	MG
Notes/description:	Drainage Area - A1 Option 3. Finish: Green Roof

Blue Roof Estimate

Input Parameters - Rainfall Information			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Rainfall ratio, R:	0.41		*From statistics based on location (FSR)*
M5-60 expected rainfall:	20.6	mm/h	*From statistics based on location (FSR)*
Location selected for FSR data:	London (NW)		

Input Parameters - Roof Information			
Catchment area:	309	m^2	*As supplied by Client*
Storage area:	309	m^2	*As supplied by Client*
Maximum allowable runoff:	4.4	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Rainfall (l/s/m^2)	Storage Required (l/m^2)	Time to Empty	Restricted Outflow (l/s)
5 mins	0.0602	20	0 hours and 30 minutes	2.4
10 mins	0.0492	31	0 hours and 40 minutes	3.3
15 mins	0.0397	35	0 hours and 50 minutes	3.7
30 mins	**0.0260**	**40**	**0 hours and 50 minutes**	**4.0**
1 hour	0.0163	38	0 hours and 50 minutes	3.9
2 hours	0.0097	28	0 hours and 40 minutes	3.1
4 hours	0.0057	16	0 hours and 20 minutes	2.0
6 hours	0.0041	12	0 hours and 10 minutes	1.5
10 hours	0.0028	10	0 hours and 10 minutes	1.0
24 hours	0.0014	9	0 hours and 0 minutes	0.5
48 hours	0.0008	8	0 hours and 0 minutes	0.3

Total storage required: 12.4 m^3

Output - Recommended Blue Roof System	
System Name:	ABG blueroof BRG B72
Description:	72mm deep system including 40mm reservoir layer to store water for green roof vegetation
Total storage capacity:	13.9 m^3
Number of Blue Roof outlets:	2

Notes:

1. This document contains an estimate which has been prepared by ABG Ltd and is illustrative only and not a detailed design.
2. Further details on the theories used in this estimate are available upon request from ABG. The values given are indicative and correspond to nominal results obtained in our laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes without notice at any time.
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BLUE ROOF STORAGE AND OUTFLOW ESTIMATE

abg creative geosynthetic engineering

Project Name:	Ugly Brown Building, Camden
Prepared for:	Water Environment Limited
Date:	29/06/2017
ABG Project ID:	11723
Prepared by:	MG
Notes/description:	Drainage Area - B-5. Finishes: Paved

Blue Roof Estimate

Input Parameters - Rainfall Information			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Rainfall ratio, R:	0.41		*From statistics based on location (FSR)*
M5-60 expected rainfall:	20.6	mm/h	*From statistics based on location (FSR)*
Location selected for FSR data:	London (NW)		

Input Parameters - Roof Information			
Catchment area:	90	m^2	*As supplied by Client*
Storage area:	90	m^2	*As supplied by Client*
Maximum allowable runoff:	1.3	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Rainfall (l/s/m^2)	Storage Required (l/m^2)	Time to Empty	Restricted Outflow (l/s)
5 mins	0.0602	20	0 hours and 40 minutes	0.6
10 mins	0.0492	31	1 hour and 0 minutes	0.8
15 mins	0.0397	36	1 hour and 10 minutes	0.9
30 mins	**0.0260**	**42**	**1 hour and 20 minutes**	**1.0**
1 hour	0.0163	41	1 hour and 20 minutes	1.0
2 hours	0.0097	32	1 hour and 10 minutes	0.8
4 hours	0.0057	18	0 hours and 40 minutes	0.6
6 hours	0.0041	12	0 hours and 20 minutes	0.4
10 hours	0.0028	8	0 hours and 10 minutes	0.3
24 hours	0.0014	5	0 hours and 0 minutes	0.1
48 hours	0.0008	5	0 hours and 0 minutes	0.1

Total storage required: 3.8 m^3

Output - Recommended Blue Roof System	
System Name:	ABG blueroof BRB A56
Description:	56mm deep system
Total storage capacity:	4.2 m^3
Number of Blue Roof outlets:	2

Notes:

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BLUE ROOF STORAGE AND OUTFLOW ESTIMATE

abg creative geosynthetic engineering

Project Name:	Ugly Brown Building, Camden
Prepared for:	Water Environment Limited
Date:	07/06/2017
ABG Project ID:	11723
Prepared by:	MG
Notes/description:	Drainage Area - B1 Option 3. Finishes: Brown

Blue Roof Estimate

Input Parameters - Rainfall Information			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Rainfall ratio, R:	0.41		*From statistics based on location (FSR)*
M5-60 expected rainfall:	20.6	mm/h	*From statistics based on location (FSR)*
Location selected for FSR data:	London (NW)		

Input Parameters - Roof Information			
Catchment area:	341	m^2	*As supplied by Client*
Storage area:	341	m^2	*As supplied by Client*
Maximum allowable runoff:	4.8	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Rainfall (l/s/m^2)	Storage Required (l/m^2)	Time to Empty	Restricted Outflow (l/s)
5 mins	0.0602	20	0 hours and 30 minutes	2.4
10 mins	0.0492	31	0 hours and 50 minutes	3.4
15 mins	0.0397	36	0 hours and 50 minutes	3.7
30 mins	**0.0260**	**41**	**1 hour and 0 minutes**	**4.1**
1 hour	0.0163	41	1 hour and 0 minutes	4.0
2 hours	0.0097	31	0 hours and 50 minutes	3.3
4 hours	0.0057	18	0 hours and 20 minutes	2.2
6 hours	0.0041	13	0 hours and 10 minutes	1.6
10 hours	0.0028	10	0 hours and 10 minutes	1.1
24 hours	0.0014	9	0 hours and 0 minutes	0.5
48 hours	0.0008	8	0 hours and 0 minutes	0.3

Total storage required: 14.1 m^3

Output - Recommended Blue Roof System		
System Name:	ABG blueroof BRB B72	
Description:	72mmdeep system	
Total storage capacity:	15.3	m^3
Number of Blue Roof outlets:	2	

Notes:

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BLUE ROOF STORAGE AND OUTFLOW ESTIMATE

abg creative geosynthetic engineering

Project Name:	Ugly Brown Building, Camden
Prepared for:	Water Environment Limited
Date:	07/06/2017
ABG Project ID:	11723
Prepared by:	MG
Notes/description:	Drainage Area - B2 Option 3. Finishes: Green

Blue Roof Estimate

Input Parameters - Rainfall Information			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Rainfall ratio, R:	0.41		*From statistics based on location (FSR)*
M5-60 expected rainfall:	20.6	mm/h	*From statistics based on location (FSR)*
Location selected for FSR data:	London (NW)		

Input Parameters - Roof Information			
Catchment area:	204	m^2	*As supplied by Client*
Storage area:	204	m^2	*As supplied by Client*
Maximum allowable runoff:	2.9	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Rainfall (l/s/m^2)	Storage Required (l/m^2)	Time to Empty	Restricted Outflow (l/s)
5 mins	0.0602	20	0 hours and 30 minutes	1.4
10 mins	0.0492	31	0 hours and 50 minutes	1.9
15 mins	0.0397	36	1 hour and 0 minutes	2.1
30 mins	**0.0260**	**41**	**1 hour and 10 minutes**	**2.3**
1 hour	0.0163	41	1 hour and 10 minutes	2.3
2 hours	0.0097	31	0 hours and 50 minutes	2.0
4 hours	0.0057	18	0 hours and 30 minutes	1.3
6 hours	0.0041	12	0 hours and 20 minutes	1.0
10 hours	0.0028	9	0 hours and 10 minutes	0.6
24 hours	0.0014	7	0 hours and 0 minutes	0.3
48 hours	0.0008	7	0 hours and 0 minutes	0.2

Total storage required: 8.5 m^3

Output - Recommended Blue Roof System	
System Name:	ABG blueroof BRB B72
Description:	72mmdeep system
Total storage capacity:	9.1 m^3
Number of Blue Roof outlets:	2

Notes:

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BLUE ROOF STORAGE AND OUTFLOW ESTIMATE

abg creative geosynthetic engineering

Project Name:	Ugly Brown Building, Camden
Prepared for:	Water Environment Limited
Date:	07/06/2017
ABG Project ID:	11723
Prepared by:	MG
Notes/description:	Drainage Area - B3 Option 3. Finishes: Green

Blue Roof Estimate

Input Parameters - Rainfall Information			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Rainfall ratio, R:	0.41		*From statistics based on location (FSR)*
M5-60 expected rainfall:	20.6	mm/h	*From statistics based on location (FSR)*
Location selected for FSR data:	London (NW)		

Input Parameters - Roof Information			
Catchment area:	186	m^2	*As supplied by Client*
Storage area:	186	m^2	*As supplied by Client*
Maximum allowable runoff:	2.6	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Rainfall (l/s/m^2)	Storage Required (l/m^2)	Time to Empty	Restricted Outflow (l/s)
5 mins	0.0602	20	0 hours and 30 minutes	1.4
10 mins	0.0492	31	0 hours and 50 minutes	1.9
15 mins	0.0397	35	1 hour and 0 minutes	2.1
30 mins	**0.0260**	**40**	**1 hour and 0 minutes**	**2.3**
1 hour	0.0163	39	1 hour and 0 minutes	2.2
2 hours	0.0097	29	0 hours and 50 minutes	1.8
4 hours	0.0057	16	0 hours and 20 minutes	1.2
6 hours	0.0041	11	0 hours and 20 minutes	0.9
10 hours	0.0028	9	0 hours and 10 minutes	0.6
24 hours	0.0014	7	0 hours and 0 minutes	0.3
48 hours	0.0008	7	0 hours and 0 minutes	0.2

Total storage required: 7.6 m^3

Output - Recommended Blue Roof System		
System Name:	ABG blueroof BRB B72	
Description:	72mmdeep system	
Total storage capacity:	8.3	m^3
Number of Blue Roof outlets:	2	

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BLUE ROOF STORAGE AND OUTFLOW ESTIMATE

Project Name:	Ugly Brown Building, Camden
Prepared for:	Water Environment Limited
Date:	07/06/2017
ABG Project ID:	11723
Prepared by:	MG
Notes/description:	Drainage Area - B4 Option 3. Finishes: Brown

Blue Roof Estimate

Input Parameters - Rainfall Information			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Rainfall ratio, R:	0.41		*From statistics based on location (FSR)*
M5-60 expected rainfall:	20.6	mm/h	*From statistics based on location (FSR)*
Location selected for FSR data:	London (NW)		

Input Parameters - Roof Information			
Catchment area:	107	m^2	*As supplied by Client*
Storage area:	107	m^2	*As supplied by Client*
Maximum allowable runoff:	1.5	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Rainfall (l/s/m^2)	Storage Required (l/m^2)	Time to Empty	Restricted Outflow (l/s)
5 mins	0.0602	20	0 hours and 40 minutes	0.8
10 mins	0.0492	31	0 hours and 50 minutes	1.1
15 mins	0.0397	35	1 hour and 0 minutes	1.2
30 mins	**0.0260**	**41**	**1 hour and 10 minutes**	**1.3**
1 hour	0.0163	40	1 hour and 10 minutes	1.3
2 hours	0.0097	29	0 hours and 50 minutes	1.0
4 hours	0.0057	16	0 hours and 30 minutes	0.7
6 hours	0.0041	11	0 hours and 20 minutes	0.5
10 hours	0.0028	8	0 hours and 10 minutes	0.3
24 hours	0.0014	6	0 hours and 0 minutes	0.2
48 hours	0.0008	6	0 hours and 0 minutes	0.1

Total storage required: 4.4 m^3

Output - Recommended Blue Roof System		
System Name:	ABG blueroof BRB B72	
Description:	72mmdeep system	
Total storage capacity:	4.8	m^3
Number of Blue Roof outlets:	2	

Notes:

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BLUE ROOF STORAGE AND OUTFLOW ESTIMATE

Project Name:	Ugly Brown Building, Camden
Prepared for:	Water Environment Limited
Date:	29/06/2017
ABG Project ID:	11723
Prepared by:	MG
Notes/description:	Drainage Area - C3-2. Finishes: Paved

Blue Roof Estimate

Input Parameters - Rainfall Information			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Rainfall ratio, R:	0.41		*From statistics based on location (FSR)*
M5-60 expected rainfall:	20.6	mm/h	*From statistics based on location (FSR)*
Location selected for FSR data:	London (NW)		

Input Parameters - Roof Information			
Catchment area:	163	m^2	*As supplied by Client*
Storage area:	163	m^2	*As supplied by Client*
Maximum allowable runoff:	2.3	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Rainfall (l/s/m^2)	Storage Required (l/m^2)	Time to Empty	Restricted Outflow (l/s)
5 mins	0.0602	20	0 hours and 40 minutes	1.1
10 mins	0.0492	31	1 hour and 0 minutes	1.4
15 mins	0.0397	36	1 hour and 10 minutes	1.6
30 mins	0.0260	42	1 hour and 20 minutes	1.7
1 hour	**0.0163**	**42**	**1 hour and 20 minutes**	**1.7**
2 hours	0.0097	33	1 hour and 0 minutes	1.5
4 hours	0.0057	19	0 hours and 40 minutes	1.0
6 hours	0.0041	13	0 hours and 20 minutes	0.8
10 hours	0.0028	9	0 hours and 10 minutes	0.5
24 hours	0.0014	7	0 hours and 0 minutes	0.3
48 hours	0.0008	6	0 hours and 0 minutes	0.1

Total storage required: 7 m^3

Output - Recommended Blue Roof System		
System Name:	ABG blueroof BRB A56	
Description:	56mm deep system	
Total storage capacity:	7.6	m^3
Number of Blue Roof outlets:	2	

Notes:

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BLUE ROOF STORAGE AND OUTFLOW ESTIMATE

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Project Name:	Ugly Brown Building, Camden
Prepared for:	Water Environment Limited
Date:	29/06/2017
ABG Project ID:	11723
Prepared by:	MG
Notes/description:	Drainage Area - C3-3. Finishes: Paved

Blue Roof Estimate

Input Parameters - Rainfall Information			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Rainfall ratio, R:	0.41		*From statistics based on location (FSR)*
M5-60 expected rainfall:	20.6	mm/h	*From statistics based on location (FSR)*
Location selected for FSR data:	London (NW)		

Input Parameters - Roof Information			
Catchment area:	140	m^2	*As supplied by Client*
Storage area:	140	m^2	*As supplied by Client*
Maximum allowable runoff:	2.0	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Rainfall (l/s/m^2)	Storage Required (l/m^2)	Time to Empty	Restricted Outflow (l/s)
5 mins	0.0602	20	0 hours and 30 minutes	1.1
10 mins	0.0492	31	0 hours and 50 minutes	1.4
15 mins	0.0397	35	1 hour and 0 minutes	1.6
30 mins	**0.0260**	**40**	**1 hour and 10 minutes**	**1.7**
1 hour	0.0163	39	1 hour and 0 minutes	1.7
2 hours	0.0097	29	0 hours and 50 minutes	1.4
4 hours	0.0057	16	0 hours and 30 minutes	0.9
6 hours	0.0041	11	0 hours and 20 minutes	0.7
10 hours	0.0028	8	0 hours and 10 minutes	0.4
24 hours	0.0014	6	0 hours and 0 minutes	0.2
48 hours	0.0008	6	0 hours and 0 minutes	0.1

Total storage required: 5.7 m^3

Output - Recommended Blue Roof System		
System Name:	ABG blueroof BRB A56	
Description:	56mm deep system	
Total storage capacity:	6.5	m^3
Number of Blue Roof outlets:	2	

Notes:

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BLUE ROOF STORAGE AND OUTFLOW ESTIMATE

Project Name:	Ugly Brown Building, Camden
Prepared for:	Water Environment Limited
Date:	07/06/2017
ABG Project ID:	11723
Prepared by:	MG
Notes/description:	Drainage Area - C1-1 Option 3. Finishes: Green

Blue Roof Estimate

Input Parameters - Rainfall Information			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Rainfall ratio, R:	0.41		*From statistics based on location (FSR)*
M5-60 expected rainfall:	20.6	mm/h	*From statistics based on location (FSR)*
Location selected for FSR data:	London (NW)		

Input Parameters - Roof Information			
Catchment area:	111	m^2	*As supplied by Client*
Storage area:	111	m^2	*As supplied by Client*
Maximum allowable runoff:	1.6	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Rainfall (l/s/m^2)	Storage Required (l/m^2)	Time to Empty	Restricted Outflow (l/s)
5 mins	0.0602	20	0 hours and 30 minutes	0.9
10 mins	0.0492	30	0 hours and 50 minutes	1.2
15 mins	0.0397	35	0 hours and 50 minutes	1.4
30 mins	**0.0260**	**39**	**1 hour and 0 minutes**	**1.5**
1 hour	0.0163	37	1 hour and 0 minutes	1.4
2 hours	0.0097	26	0 hours and 40 minutes	1.1
4 hours	0.0057	14	0 hours and 20 minutes	0.7
6 hours	0.0041	10	0 hours and 10 minutes	0.5
10 hours	0.0028	8	0 hours and 10 minutes	0.4
24 hours	0.0014	6	0 hours and 0 minutes	0.2
48 hours	0.0008	6	0 hours and 0 minutes	0.1

Total storage required: 4.4 m^3

Output - Recommended Blue Roof System		
System Name:	ABG blueroof BRB B72	
Description:	72mm deep system	
Total storage capacity:	4.9	m^3
Number of Blue Roof outlets:	2	

Notes:

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BLUE ROOF STORAGE AND OUTFLOW ESTIMATE

Project Name:	Ugly Brown Building, Camden
Prepared for:	Water Environment Limited
Date:	07/06/2017
ABG Project ID:	11723
Prepared by:	MG
Notes/description:	Drainage Area - C1-2 Option 3. Finishes: Green

Blue Roof Estimate

Input Parameters - Rainfall Information			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Rainfall ratio, R:	0.41		*From statistics based on location (FSR)*
M5-60 expected rainfall:	20.6	mm/h	*From statistics based on location (FSR)*
Location selected for FSR data:	London (NW)		

Input Parameters - Roof Information			
Catchment area:	192	m^2	*As supplied by Client*
Storage area:	192	m^2	*As supplied by Client*
Maximum allowable runoff:	2.7	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Rainfall (l/s/m^2)	Storage Required (l/m^2)	Time to Empty	Restricted Outflow (l/s)
5 mins	0.0602	20	0 hours and 30 minutes	1.7
10 mins	0.0492	30	0 hours and 40 minutes	2.2
15 mins	0.0397	35	0 hours and 50 minutes	2.4
30 mins	**0.0260**	**39**	**0 hours and 50 minutes**	**2.6**
1 hour	0.0163	36	0 hours and 50 minutes	2.5
2 hours	0.0097	25	0 hours and 40 minutes	2.0
4 hours	0.0057	14	0 hours and 20 minutes	1.2
6 hours	0.0041	11	0 hours and 10 minutes	0.9
10 hours	0.0028	9	0 hours and 10 minutes	0.6
24 hours	0.0014	7	0 hours and 0 minutes	0.3
48 hours	0.0008	7	0 hours and 0 minutes	0.2

Total storage required: 7.5 m^3

Output - Recommended Blue Roof System	
System Name:	ABG blueroof BRB B72
Description:	72mm deep system
Total storage capacity:	8.6 m^3
Number of Blue Roof outlets:	2

Notes:

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BLUE ROOF STORAGE AND OUTFLOW ESTIMATE

abg creative geosynthetic engineering

Project Name:	Ugly Brown Building, Camden
Prepared for:	Water Environment Limited
Date:	07/06/2017
ABG Project ID:	11723
Prepared by:	MG
Notes/description:	Drainage Area - C1-3 Option 3. Finishes: Brown

Blue Roof Estimate

Input Parameters - Rainfall Information			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Rainfall ratio, R:	0.41		*From statistics based on location (FSR)*
M5-60 expected rainfall:	20.6	mm/h	*From statistics based on location (FSR)*
Location selected for FSR data:	London (NW)		

Input Parameters - Roof Information			
Catchment area:	133	m^2	*As supplied by Client*
Storage area:	133	m^2	*As supplied by Client*
Maximum allowable runoff:	1.9	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Rainfall (l/s/m^2)	Storage Required (l/m^2)	Time to Empty	Restricted Outflow (l/s)
5 mins	0.0602	19	0 hours and 30 minutes	1.2
10 mins	0.0492	30	0 hours and 40 minutes	1.6
15 mins	0.0397	34	0 hours and 50 minutes	1.7
30 mins	**0.0260**	**38**	**0 hours and 50 minutes**	**1.8**
1 hour	0.0163	35	0 hours and 50 minutes	1.8
2 hours	0.0097	24	0 hours and 40 minutes	1.4
4 hours	0.0057	13	0 hours and 20 minutes	0.9
6 hours	0.0041	10	0 hours and 10 minutes	0.6
10 hours	0.0028	7	0 hours and 10 minutes	0.4
24 hours	0.0014	6	0 hours and 0 minutes	0.2
48 hours	0.0008	6	0 hours and 0 minutes	0.1

Total storage required: 5.1 m^3

Output - Recommended Blue Roof System		
System Name:	ABG blueroof BRG B72	
Description:	72mm deep system	
Total storage capacity:	5.9	m^3
Number of Blue Roof outlets:	2	

Notes:

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BLUE ROOF STORAGE AND OUTFLOW ESTIMATE

abg creative geosynthetic engineering

Project Name:	Ugly Brown Building, Camden
Prepared for:	Water Environment Limited
Date:	07/06/2017
ABG Project ID:	11723
Prepared by:	MG
Notes/description:	Drainage Area - C2 Option 3. Finishes: Brown

Blue Roof Estimate

Input Parameters - Rainfall Information			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Rainfall ratio, R:	0.41		*From statistics based on location (FSR)*
M5-60 expected rainfall:	20.6	mm/h	*From statistics based on location (FSR)*
Location selected for FSR data:	London (NW)		

Input Parameters - Roof Information			
Catchment area:	271	m^2	*As supplied by Client*
Storage area:	271	m^2	*As supplied by Client*
Maximum allowable runoff:	3.8	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Rainfall (l/s/m^2)	Storage Required (l/m^2)	Time to Empty	Restricted Outflow (l/s)
5 mins	0.0602	20	0 hours and 40 minutes	1.7
10 mins	0.0492	31	1 hour and 0 minutes	2.3
15 mins	0.0397	36	1 hour and 10 minutes	2.5
30 mins	0.0260	43	1 hour and 20 minutes	2.8
1 hour	**0.0163**	**44**	**1 hour and 20 minutes**	**2.8**
2 hours	0.0097	35	1 hour and 0 minutes	2.5
4 hours	0.0057	21	0 hours and 40 minutes	1.7
6 hours	0.0041	14	0 hours and 20 minutes	1.3
10 hours	0.0028	10	0 hours and 10 minutes	0.9
24 hours	0.0014	8	0 hours and 0 minutes	0.4
48 hours	0.0008	7	0 hours and 0 minutes	0.2

Total storage required: 11.8 m^3

Output - Recommended Blue Roof System		
System Name:	ABG blueroof BRG B72	
Description:	72mm deep system	
Total storage capacity:	12.1	m^3
Number of Blue Roof outlets:	2	

Notes:

1. This document contains an estimate which has been prepared by ABG Ltd and is illustrative only and not a detailed design.
2. Further details on the theories used in this estimate are available upon request from ABG. The values given are indicative and correspond to nominal results obtained in our laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes without notice at any time.
3. This estimate is specific to the characteristics of ABG products and may not be applicable to other products.
4. The copyright in this document belongs to ABG Ltd.
5. The estimate given in this report is based on the stated parameters as per the brief. If these parameters are not correct or have changed, ABG should be contacted to provide a revised estimate.
6. No guarantee or liability can be drawn from the information in this report.
7. Final determination of the suitability of any information is the sole responsibility of the user. ABG will be pleased to discuss the use of this or any other product but responsibility for selection of a material and its application in any specific project remains with the user.

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BLUE ROOF STORAGE AND OUTFLOW ESTIMATE

Project Name:	Ugly Brown Building, Camden
Prepared for:	Water Environment Limited
Date:	08/06/2017
ABG Project ID:	11723
Prepared by:	MG
Notes/description:	Drainage Area - C3 Option 3. Finishes: Brown

Blue Roof Estimate

Input Parameters - Rainfall Information			
Return period:	100	years	*As supplied by Client*
Allowance for Climate Change:	40	%	*As supplied by Client*
Rainfall ratio, R:	0.41		*From statistics based on location (FSR)*
M5-60 expected rainfall:	20.6	mm/h	*From statistics based on location (FSR)*
Location selected for FSR data:	London (NW)		

Input Parameters - Roof Information			
Catchment area:	211	m^2	*As supplied by Client*
Storage area:	211	m^2	*As supplied by Client*
Maximum allowable runoff:	3.0	l/s	*As supplied by Client*

Output - Rainfall Calculation

Duration	Rainfall (l/s/m^2)	Storage Required (l/m^2)	Time to Empty	Restricted Outflow (l/s)
5 mins	0.0602	20	0 hours and 30 minutes	1.7
10 mins	0.0492	31	0 hours and 50 minutes	2.3
15 mins	0.0397	35	0 hours and 50 minutes	2.5
30 mins	**0.0260**	**40**	**1 hour and 0 minutes**	**2.7**
1 hour	0.0163	38	1 hour and 0 minutes	2.6
2 hours	0.0097	28	0 hours and 40 minutes	2.1
4 hours	0.0057	16	0 hours and 20 minutes	1.4
6 hours	0.0041	11	0 hours and 10 minutes	1.0
10 hours	0.0028	9	0 hours and 10 minutes	0.7
24 hours	0.0014	7	0 hours and 0 minutes	0.3
48 hours	0.0008	7	0 hours and 0 minutes	0.2

Total storage required: 8.5 m^3

Output - Recommended Blue Roof System	
System Name:	ABG blueroof BRG B72
Description:	72mm deep system
Total storage capacity:	9.4 m^3
Number of Blue Roof outlets:	2

Notes:

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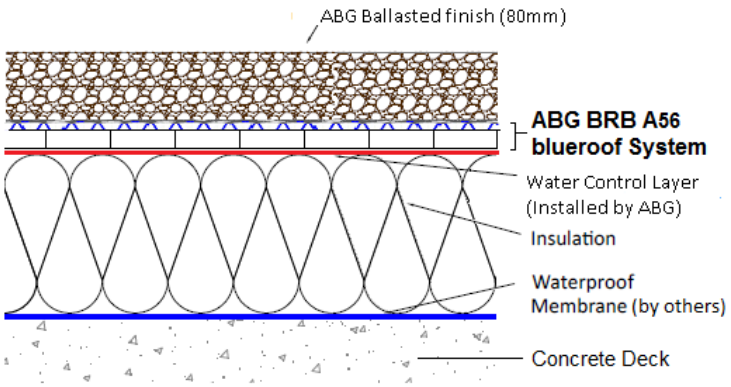
blueroof System BRB A56

creative geosynthetic engineering

Data Sheet



ABG **blueroof** systems provide temporary attenuation, filtration and controlled release of stormwater, containing key elements of a good SuDS design. The storage element of the system must be used in conjunction with ABG's **blueroof** restrictor chambers. These chambers are bespoke to each project in order to achieve the planning team's maximum outflow levels, and to suit the required build-up and final use of the podium/roof area.
ABG's blue roofs are generally used for zero falls, inverted/warm roof applications, under a mix of hard and soft landscaped finishes. Other blue roof systems and surface finishes are available. Please refer to ABG's Technical team for project/system specific advice & blue roof calculations.

System Properties				
Thickness at 2kPa	(mm)	56	±10%	EN ISO 9863-1
Maximum saturated weight	(kg/m²)	54	approx	EN ISO 9864
Stormwater attenuation volume	(l/m^2)	47		
Drainable void space	%	84		
Perpendicular Water Inflow (in non-design storm event conditions)				
Water flow at 50mm head	(l/m^2.s)	75 (Lower drainage path)	±30%	EN ISO 11058
Resistance to weathering		Greater than 60% retained tensile strength		EN 12224
Resistance to chemicals		Excellent		EN 14030
Design life		120 years (manufacturer's declaration)		
Upper Filter/Separator Geotextile Properties				
Pore size O_{90}	(µm)	120	±30%	EN ISO 12956
Breakthrough head	(mm)	0	nominal	BS 6906 Part 3
CBR puncture resistance	(N)	1600	-20%	EN ISO 12236
Dynamic perforation cone drop	(mm)	32	+20%	EN ISO 13433
Type and material	Non-woven needle-punched and heat-treated long staple fibre polypropylene Protector: Non-woven felt of polypropylene. Min wt. of 260g/m^2			
Product Dimensions				
Standard system BRB A56	56mm deep. Width & length as blue roof area.			

Notes

1. The values given are indicative and correspond to nominal results obtained in our laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes without notice at any time..
2. Any additional installations such as services, PV panels, or paved areas, must be discussed with ABG prior to their installation.
3. Final determination of the suitability of any information is the sole responsibility of the user. ABG will be pleased to discuss the use of this or any other product but responsibility for selection of a material and its application in any specific project remains with the user.
4. Can be used in conjunction with rainwater harvesting systems. Any petrochemical pollution waste discharged from the system to be treated by others.

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blueroof System BRG B72

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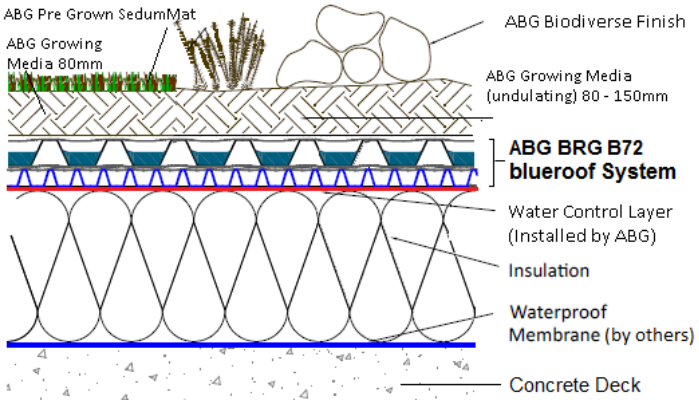
Data Sheet



ABG **blueroof** systems provide temporary attenuation, filtration and controlled release of stormwater, containing key elements of a good SuDS design. The storage element of the system must be used in conjunction with ABG's **blueroof** restrictor chambers. These chambers are bespoke to each project in order to achieve the planning team's maximum outflow levels, and to suit the required build-up and final use of the podium/roof area.
ABG's blue roofs are generally used for zero falls, inverted/warm roof applications, under a mix of hard and soft landscaped finishes. Other blue roof systems and surface finishes are available. Please refer to ABG's Technical team for project/system specific advice & blue roof calculations.

System Properties				
Thickness at 2kPa	(mm)	72	±10%	EN ISO 9863-1
Maximum saturated weight	(kg/m²)	50	approx.	EN ISO 9864
Stormwater attenuation volume	(l/m^2)	45		
Drainable void space	%	62		
Perpendicular Water Inflow (in non-design storm event conditions)				
Water flow at 50mm head	(l/m^2.s)	72 (Lower drainage path)	±30%	EN ISO 11058
Resistance to weathering	Greater than 60% retained tensile strength			EN 12224
Resistance to chemicals	Excellent			EN 14030
Design life	120 years (manufacturer's declaration)			
Upper Filter/Separator Geotextile Properties				
Pore size O_{90}	(µm)	70	±30%	EN ISO 12956
Breakthrough head	(mm)	0	nominal	BS 6906 Part 3
CBR puncture resistance	(N)	3 400	-20%	EN ISO 12236
Dynamic perforation cone drop	(mm)	17	+20%	EN ISO 13433
Type and material	Non-woven needle-punched and heat-treated long staple fibre polypropylene Protector: Non-woven felt of polypropylene. Min wt. of 250g/m^2			
Product Dimensions				
Standard system BRG B72	72mm deep (inclusive of 40mm reservoir board). Width & length as blue roof area.			

Notes
1. The values given are indicative and correspond to nominal results obtained in our laboratories and testing institutes. In line with our policy of continuous improvement the right is reserved to make changes without notice at any time..
2. Any additional installations such as services, PV panels, or paved areas, must be discussed with ABG prior to their installation.
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APPENDIX D – CAMDEN SUDS 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	Ugly Brown Building
Address & post code or LPA reference	2-6 St Pancras Way, London, NW1 0TB
Grid reference	529620, 183762
Is the existing site developed or Greenfield?	Previously 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?	Located in a CDA. Proposed green/blue roof systems, underground cellular storage with flow control, with outfalls into Regent's Canal where possible, and remaining into TW combined sewer.
Total Site Area served by drainage system (excluding open space) (Ha)*	1.14 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)	1.14	1.14	0	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	canal and 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 Appendix C	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		e.g. soakage tests. Section 6 (infiltration) must be filled in if infiltration is proposed.
To watercourse	x		Regent's Canal	e.g. Is there a watercourse nearby?
To surface water sewer	x		Combined sewer, Thames Water have been consulted	Confirmation from sewer provider that sufficient capacity exists for this connection.
Combination of above		x		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 Section 5	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 Appendix A SK01 Suds Drawing	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	4.78	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	101			see FRA section 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	247			see FRA section 5	
1in 100	322			see FRA section 5	
1 in 100 plus climate change	N/A	161	161	50%	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		213	213	0	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		469	469	0	
1in 100 6 hour		608	608	0	
1 in 100 6 hour plus climate change		851	851*	see FRA section 5 Provision of biodiverse roofs will reduce volume discharge	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)	622	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)	329	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)	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,	33.7%	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)**		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?		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.

	Were infiltration rates obtained by desk study or infiltration test?		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.		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**		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.		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?	Blue roof with green roof and underground storage	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, to the 1 in 100 + 40% event	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)?	Surface water in excess of the 1 in 100 + 40% event will bypass the roof flow controls and flow to the public sewer	**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 (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.	Owned by freeholder	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?	A suitable maintenance plan will be required at the detailed design stage	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	
Section 3	FRA	
Section 4	FRA	
Section 5	FRA	
Section 6	FRA	
Section 7	Not required	
Section 8	FRA	

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 Gabriel Eve
Qualification of person responsible for signing off this pro-forma Environmental Engineer (MEng Civil & Environmental)

Company Water Environment Limited
On behalf of (Client's details) Reef Estates
Date: 14/07/2017